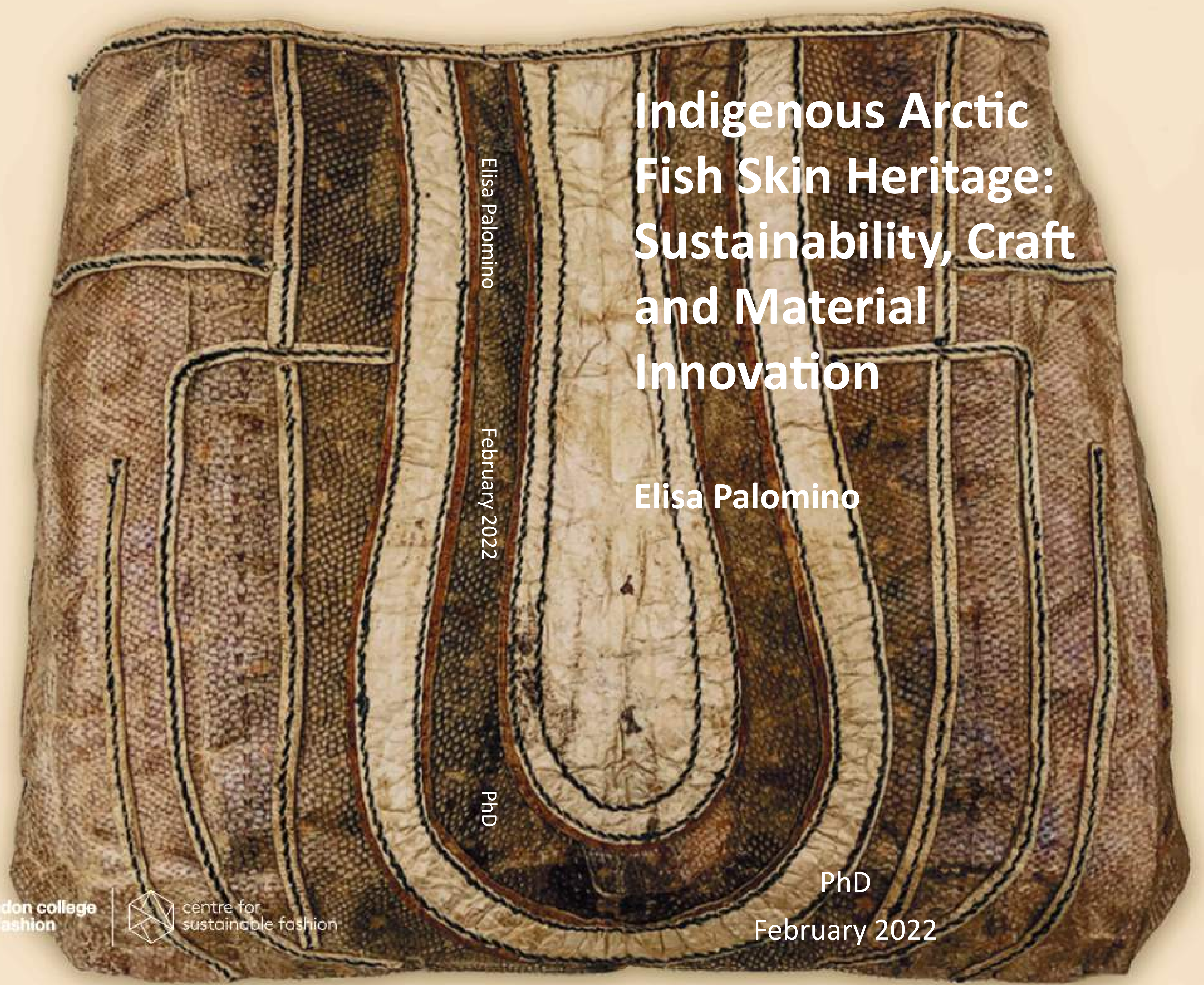

Indigenous Arctic Fish Skin Heritage: Sustainability, Craft and Material Innovation

Elisa Palomino

PhD

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Elisa Palomino February 2022 PhD

ual: london college of fashion

centre for sustainable fashion

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Elisa Palomino

Thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy (PhD) at the University of the Arts London

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University of the Arts London
London College of Fashion

London College of Fashion Supervisory Team
Director of Studies: Dilys Williams
Supervisor: Simon Thorogood

Arctic Studies Center Advisors: William Fitzhugh and Stephen Loring

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Cover: Fish skin pouch. Aleut Unangax. Collected in 1921. National Museum Natural History, Smithsonian Institution. Washington DC.USA.

Figure 0.1. Fish skin child's parka. Anchorage Museum. Alaska, 2019

Abstract

The use of fish skin[1] for the construction of garments and accessories is an ancient tradition shared by coastal Arctic societies as a subsistence lifestyle[2] depending on aquatic resources for food and clothing. Arctic Indigenous[3] Peoples[4] need formidable resourcefulness to thrive in inhospitable ecosystems; fish skins provide them physical and spiritual protection[5]. During the last century, they resisted not only colonisation and repression by humans but also dramatic ecological changes in seafood security. Fish skin craft became a way to communicate traditional knowledge where practical benefits combined cultural resilience[6]. As market goods have replaced traditional fish skin clothing, the need for the skills required to create these items have diminished. The decrease of local natural resources also threatens the craft.

The focus of this research is primarily to propose a vision of sustainability as an anthropological study of the resourcefulness and resilience of the Arctic Indigenous Peoples, their lifestyles, and fish skin practices. Secondarily it identifies the historical, cultural, environmental, and socio-economic importance of fish skin as an innovative sustainable material, explored through the study of materials, processes and artefact analysis. Thirdly, the application of fish skin materials and craft practices has been tested through participatory workshops to explore how this material and the skill transmissions can contribute to sustainability practices in fashion.

The contribution to knowledge is firstly the mapping of fish skin craft participatory practices with Artic Indigenous communities as this is the first time that such a survey has been undertaken. The material study of fish skin and its contribution to fashion sustainability forms a secondary contribution.

[1] Within this thesis, the terms fish skin and fish leather are used to indicate different processes of the same material. Fish skin. Skin indicates the superficial dermis of an animal. In the thesis fish skin is referred as the historical raw material tanned following traditional methods: mechanical, oiling, smoking, bark, brain, urine, fish eggs and corn flour tanning. Fish Leather is used to indicate that the fish skin has passed one or more stages of industrial vegetable or chrome tanning production and is ready to be used to produce leather goods.

[2] Subsistence activities of hunting, herding, fishing and gathering continue to be of major significance to the Indigenous Peoples of the Arctic in providing food, social relationships and cultural identity.

[3] Indigenous Peoples are descent from the populations which inhabited a geographical region at the time of colonisation and who retain some or all of their own social, economic, cultural and political institutions. In this thesis, I use the terms 'Indigenous' and 'Native' interchangeably. In some countries, one of these terms may be favoured over the other.

[4] The specific Arctic Indigenous groups with historical evidence of fish leather production are the Inuit, Yup'ik and Athabascan of Alaska and Canada; the various Siberian peoples, such as the Nivkh and Nanai; the Ainu from the Hokkaido Island in Japan and Sakhalin Island, Russia; the Hezhe from northeast China and the Saami of northern Scandinavia.

[5] Arctic Indigenous Peoples believed that humans, animals and nature shared spiritual qualities. Arctic seamstresses decorated hunters' fish skin clothing with motifs imbued with spirits, which gave protection from danger.

[6] Arctic Indigenous Peoples have become a symbol of cultural resilience, actively adapting to colonisation, place dislocation due to land dispossession and resettlement, challenging the persistence of Indigenous knowledge systems.

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Research for this PhD was also conducted at the Library of Congress as an AHRC Kluge Fellow and was facilitated by the staff of the Kluge Center: Travis Hensley, Kevin Butterfield, Michael Stratmoen, Daniele Turello, Andrew Breiner and David Konteh. At the Asian Reading Room: Cameron Penwell, Eiichi Ito and Ian Chapman; Geography and Maps room: Cynthia Smith; European Reading room: Matthew Young and Angela Cannon; Print and Photographs: Jonathan Eaker; Anthropology: Laura Gottesman; Decorative Arts: Kathy Woodrell ; Rare book collection: Marianna Stell and Amanda Zimmerman; Special thanks to Cheryl Adams for all her wise advice during my fellowship.

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Contents

List of Outputs related to the PhD

Website
Website with workshops, events and conferences represented through image, film and text to evidence the practice-based research. http://www.fishskinlab.com

Appended Papers
The publications support the thesis discussion and where they expand on an aspect discussed in the thesis - the reader is directed to the relevant publication.

1. **Palomino**, E. (2020) 'SDG 14 Life Below Water: Introducing Fish Skin as a Sustainable Raw Material for Fashion', in Franco, I., Chatterji, T., Derbyshire, E., Tracey, J. (ed.) *Actioning the Global Goals for Local Impact. Science for Sustainable Societies*. Singapore: Springer. pp.229–246. dpi: https://doi.org/10.1007/978-981-32-9927-6

2. **Palomino**, E. (2022) 'Fish skin Coat from the Amour River'. *TEXT for the Study of the History, Art and Design of Textiles*. Volume 48: 2021. Pat Frost (ed). London: The Textiles Society.

3. **Palomino,** E. Rahme, L. Karadottir, K. (2019) Indigenous Arctic Fish skin clothing traditions: Cultural and ecological impacts on Fashion HE. CUMULUS Conference Rovaniemi. ISBN 978-952-337-158-3.

4. **Palomino,** E. Boon, J. (2020) Preservation of Hezhe Fish Leather tradition through Fashion Education. Textiles, Identity and Innovation. Taylor & Francis. ISBN 9780367252441.

5. **Palomino**, E. and Pardue, J. (2021) Alutiiq Fish Skin Traditions: Connecting Communities in the COVID-19 Era. *MDPI Heritage*, 4, pp. 4249–4263. doi: https://doi.org/10.3390/heritage4040234

6. **Palomino**, E. and Defeo, G. (2019) 'Material Design Research - Fish skin, a new environmental -friendly material for fashion', in Rodgers, P.A. (ed.) *Design Research for Change*. London: Design Museum. pp. 293–309.

7. **Palomino**, E., Karadottir, K. M. and Phirri, E. (2020) 'Indigenous Fish Skin Craft Revived Through Contemporary Fashion'. *IFFTI conference*. Cleveland: Kent State University. doi: https://oaks.kent.edu/node/10451

8. **Palomino**, E., Freilich, O. and Raine, I. (2021a) 'A virtual Ainu fish skin workshop during Covid 19'. *Global Fashion conference*. Academy of Fine Arts of Warsaw.

9. **Palomino**, E., Karmon, A., Topaz, O., Solo, A. and Cordoba, A. (2021b) 'Making fish skin pattern-based garments: developing digital tools for the fashion industry based on Ainu Indigenous tradition'. *Responsible Fashion Series - Breaking the Mould*. University of Antwerp.

10. **Palomino**, E. and Káradóttir, K. M. (2021) 'The Case of Fish Skin: A Historical Material Assimilated as an Innovative Sustainable Material for Fashion', in Foltyn; J.K. and Petican, L. (ed.). *Fashion: Culture, Commerce, Craft, and Identity.* Leiden: Brill. doi: 10.1163/9789004446595

11. Trachter, G. F., **Palomino**, E. and Defeo, G**.** (2021) **'**Patagonian fish skin tanning processes'. *XXXVI IULTCS Congress Greening the Leather Value Chain*

Manuscripts in Preparation

1. **Palomino**, E., Pardue, J., Rahme, L., Donkan, A., Rowe, S., Murray, C. (2024) The tanning, dressing and conservation of aquatic skins. In: Conservation of Leather and Related Materials. London: Routledge.
2. **Palomino**, E., Pardue, J., Donkan, A., Zhang, Z. (2023). At the Edge of Land and Ocean, the Ainu and Salmon. In:The Decolonisation of Japanese Studies. London: Japan Forum.
3. **Palomino**, E. (2023) Volume 1 Raw materials: 'Fish skin, an Indigenous Arctic raw material'. Volume 8 Politics & Power: 'Fish skin craft a cultural resilience tool for Arctic indigenous Peoples'. Volume 9 Sacred and Ceremonial: 'Fish skin clothing, sacred and ceremonial meaning and use' Volume 10 Textiles' futures: ' Fish Leather, a new raw material for fashion'. In: Janis Jefferies, J. and Norris, L. (ed.) Bloomsbury Encyclopaedia of world Textiles. Bloomsbury.
4. **Palomino**, E., Karadottir, K., Rahme, L., Kokita, M. and Defeo, G. (2022) Fish skin traditional natural dyeing. Journal of the Society of Dyers and Colourists. London.
5. Defeo, G. and **Palomino**, E. (2022) Animal based leather versus alternatives to leather: bio-based and fossil-based composition. Materials & Design. Elsevier.

Conference Presentations

1. March 2022 | Bunka Gakuen Costume Museum. Tokyo, Japan.
'Arctic Indigenous Fish Skin Networking Conference'. Funded by Japan Foundation Intellectual Exchange Conferences.
2. November 2022| Science Agora. Tokyo, Japan.
'Fish skin Horizon 2020' Open forum connecting society to science.
3. November 2021| I Fish waste for profit. Reykjavik, Iceland.
'Fish skin: Water based ink jet printing on fish leather'.
4. November 2021 | XXXVI IULTCS Congress Greening the Leather Value Chain.
Addis Ababa, Ethiopia. 'Patagonian fish skin tanning processes'
5. October 2021 | Responsible Fashion Series - Breaking the Mould. University of Antwerp. 'Making fish skin pattern-based garments: developing digital tools for the fashion industry based on Ainu Indigenous tradition'.
6. October 2021 | Global Fashion conference. Academy of Fine Arts of Warsaw.
'A virtual Ainu fish skin workshop during Covid 19'.

7. July 2021 | Science Agora. 'FishSkin Horizon 2020': Advantages and mutual benefits of bilateral EU-Japan collaboration in research and innovation'. Kyoto Seika University.
8. March 2020 | International Foundation of Fashion Technologies Institutes. IFFTI conference. Kent, Ohio.: 'Indigenous Fish Skin Craft Revived Through Contemporary Fashion'
9. Dec 2019 | Design Research for Change. Design Museum. London, UK. Material Design Innovation: Fish Leather, a new environmentally friendly material.
10. November 2019 | Craft Conference 2019. Viljandi, Estonia. 'Fish skin: Sustainability, Craft and Material Innovation and its application to Fashion Higher Education'.
11. September 2019 | Centre for Innovation in Traditional Industries. Kyoto Seika University. Manga Museum, Kyoto, Japan. 'FishSkin: Developing fish skin as a sustainable raw material for the Fashion Industry'.
12. July 2019 | Carrie M. MClain M. Museum. Nome. Alaska. 'Arctic Indigenous materials inspiration in contemporary Fashion.'
13. May 2019 | CUMULUS 2019 University of Lapland, Rovaniemi Finland. 'Indigenous Arctic Fish skin clothing traditions: Cultural and ecological impacts on Fashion Higher Education'.
14. April 2019 | IONA: Early Medieval Studies on the Islands of the North Atlantic Simon Fraser University, Vancouver, Canada. 'Preservation of early medieval Fish Leather tradition through Higher Education'.
15. March 2019 | British Council. Crafting Futures: China. London, UK. 'Hezhe Fish skin tradition'.
16. January 2019 | LineaPelle Innovation Talks. London. 'Fish Skin, Sustainability, and Innovation in the Luxury Industry'.
17. November 2018 | ELIA- European League of the Institutes of the Arts Biennial Conference, Rotterdam, The Netherlands. 'An exploration of Fish Leather Craftsmanship amongst Nordic Universities in Iceland'.
18. July 2018 | Bunka Gakuen University, Tokyo, Japan. 'Fish Skin Innovation in the luxury Industry'. Organised by the JSPS. Kakenhi grant.

Films

1. Preservation of Hezhe Fish Skin Tradition through Fashion Higher Education. Film featuring Wenfeng You, Hezhe fish skin artist. Winner of 'Best Green Fashion Film.' Fashion Film Festival Milano 2021; 'Best documentary' Croatia Fashion Film Festival 2021. . Available at: https://fashionfilmfestivalmilano.com/project/preservation-of-hezhen-fish-skin-tradition-through-fashion-higher-education-2021/
2. Preservation of Ainu Fish Skin tradition through Fashion Higher Education
3. Preservation of Nordic fish skin tradition through Fashion Higher Education

Exhibitions

1. Nov 2021 | FUTURES exhibition. Smithsonian Institution Arts & Industries building. Washington, DC, USA. Indigo died fish leather clutch exhibited next to Inuit fish skin bag from National Museum of Natural History.
2. April 2021 | OCEANISTA. Maritime museum of Denmark. Copenhagen, Denmark. Fish leather clutch digitally printed with water inks.

Press, Publications

1. January 2022 | Fish Skin as Fashion – from Indigenous Knowledge to the Runway. Smithsonian Ocean Magazine. Available at: https://ocean.si.edu/human-connections/fish-skin-fashion-indigenous-knowledge-runway
2. January 2022 |2022 Fish skin, pelle di pesce contro gli sprechi Istituto Italiano Tecnologia. Available at: https://opentalk.iit.it/fishskin-pelle-di-pesce-sostenibile-contro-gli-sprechi/
3. November 2021 |These Smithsonian objects bridge the past and the future. Smithsonian Magazine. Available at: https://www.si.edu/stories/these-smithsonian-objects-bridge- past-and-future
4. September 2021 | *Elisa Palomino.* Leather Naturally, Meet the Makers. Available at: https://www.leathernaturally.org/Our-Story/The-Makers/Elisa-Palomino
5. June 2021 | *Does fish skin have a future in fashion?* Smithsonian Magazine. Available at: https://www.smithsonianmag.com/innovation/does-fish-skin-have-future-fashion-180977931/
6. February 2021 | *Best Green Fashion Film champions sustainable fish skin craft.* UAL. Available at: https://www.arts.ac.uk/about-ual/press-office/stories/best-green-fashion-film-award-for-short-film-championing-sustainable-fishskin-craft
7. January 2021 | *The film on fish skin tanning, typical of the Hezhe group*. La Conceria. Available at: https://www.laconceria.it/en/news/the-film-on-fish-skin-tanning-typical-of-the-hezhen-group-video/?utm_source=mailpoet&utm_medium=email&utm_campaign=bi-weekly-news-or-december-2-2019-issue-83_710
8. March 2020 |*Bringing fish skin to market as the sustainable new leather. UAL.* Available at: https://www.arts.ac.uk/about-ual/press-office/stories/bringing-fish-skin-to-market-as-the-sustainable-new-leather
9. April 2020 | *The Art of Turning Fish into Leather.* Hakai Magazine. Available at: https://hakaimagazine.com/features/the-art-of-turning-fish-into-leather/
10. May 2020 |*Fashion Workshop in Anchorage.* Smithsonian Institution Arctic Studies Center Newsletter.N 27. pp: 57-58. Available at: https://repository.si.edu/bitstream/handle/10088/105306/ASC_NL_2020.pdf?sequence=1&isAllowed=y
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13. Nov 2019 | *Is fish skin the new frontier for eco-friendly fashion?* Fashion United. Available at: https://fashionunited.com/news/fashion/is-fish-skin-the-new-frontier-for-eco-friendly-fashion/2019110530709

EU Funded Projects

1. 2019-2022 EU Horizon 2020-MSCA-RISE. Fish skin: Developing Fish Skin as a Sustainable Raw Material for the Fashion Industry. Principal UAL Investigator. UAL (UK), Atlantic leather, Iceland University of the Arts (Iceland), Shenkar, Kornit, Oceanographic Research (Israel), Ars Tinctoria SRL, Kyoto Seika University (Japan). 600.000€.
2. 2018 Worth Partnership Project. Funded by European Commission, EASME, under (COSME 2014-2020) Access to financial funding and mentoring to create a fish skin leather clutch collection with Atlantic Leather. 10.000€.

Research Fellowships and Grants

1. 2022 AHRC Kluge Fellowship at the Library of Congress. Arctic Fish Skin Heritage. £8000
2. 2021 Textile Society Professional Development Award £300
3. 2021 John Crump Studentship. British Association for Japanese Studies £600
4. 2021 CSM Fashion Programme Fund for Knowledge Exchange / Research Projects. £500
5. 2021 Japan Foundation. Indigenous Fish skin conference in Hokkaido. £12,900.
6. 2019 Fulbright Scholar Award Smithsonian Institution Arctic Studies Center $15.000
7. 2019 AHRC LDoc Student Development Fund. £2000
8. 2019 Daiwa Foundation Grant. Japanese dyes on fish skin. £3000
9. 2019 Nordic Culture Fund. Handmade. Fish skin Horizon 2020 network event. 50000 DKR
10. 2019 Icelandic Textile Centre Residency. £1000
11. 2018-2022 AHRC LDoc London Doctoral Design Centre scholarship. £41,940
12. 2018 Nordic Culture Fund. OPSTART. Nordic Fish skin workshop. 25000 DKR
13. 2018 Society of Dyers and Colourists. Nordic Fish skin workshop. £500
14. 2018 Foundation Research of Ainu Culture. Ainu Fish skin workshop. £1000.
15. 2018 The Japan Foundation Endowment Committee. Ainu Fish skin workshop. £2500.
16. 2017 The Great Britain Sasakawa Foundation. Ainu Fish skin workshop. £3000

Fieldwork experience in Museums

1. 2021 Museo Antropologia ed Etnologia. Firenze, Italy.
2. 2021 Reykjavik City Museum. Reykjavik, Iceland.
3. 2021 National Museum of Iceland. Reykjavik, Iceland.
4. 2021 Stibbert Museum. Florence, Italy.
5. 2019 Smithsonian National Museum of Natural History, Washington D.C., USA
6. 2019 Smithsonian National Museum of American Indian, Washington D.C., USA.
7. 2019 Smithsonian Museum Resource Center, Suitland, MD, USA
8. 2019 Smithsonian Institution Archives, Washington D.C., USA
9. 2019 Anchorage Museum, Anchorage, USA
10. 2019 Wells Fargo Museum, Anchorage, USA
11. 2019 Alaska State Museum, Juneau, USA
12. 2019 Sheldon Jackson Museum, Sitkha, USA
13. 2019 Carrie M. MacLaine memorial museum, Nome, USA
14. 2019 Pratt Museum, Homer, USA
15. 2019 Alutiiq Museum, Kodiak, USA
16. 2019 University of Alaska Museum of the North, Fairbanks, USA
17. 2019 Victoria & Albert Museum, London, UK.
18. 2018 Hokkaido University Museum, Sapporo, Hokkaido, Japan
19. 2018 Ainu culture research centre of Hokkaido Museum, Sapporo, Hokkaido, Japan
20. 2018 Ainu Museum, Sapporo, Hokkaido, Japan
21. 2018 Kushiro city museum, Kushiro, Hokkaido, Japan
22. 2018 Abashiri Hokkaido museum of Northern peoples, Abashiri , Hokkaido, Japan
23. 2018 Nibutani Ainu Culture Museum, Nibutani, Hokkaido, Japan
24. 2018 National Museum of Ethnology Minpaku, Osaka, Japan
25. 2018 Jiejinkou Hezhe Village ethnic museum, Jiejinkou, China
26. 2018 Hezhe Ethnic Minority Culture Museum, Jiejinkou, China
27. 2018 Musée du quai Branly-Jacques Chirac, Paris, France
28. 2018 Textiles Museum, Blondous, Iceland

Current Institutional Affiliations

1. Smithsonian National Museum of Natural History, Research Associate, Department of Anthropology.

SECTION ONE: INTRODUCTION

Figure 1.1. Fish skin mittens. University of Alaska Museum of the North, Fairbanks, Alaska, 2019.

1. Chapter One: Context of the Research

Figure 1.2. John Galliano’s prêt-à-porter Autumn/ Winter 2002 collection. Natural salmon skin parka.
Photographer: Patrice Stable, 2002.

Chapter One: Context of the research

Chapter One lays out an introduction to the research. It states the main questions, aims and objectives.

1.1 Personal Background

The research draws on the design practices that I instigated during my eight years as head of the design studio at John Galliano, developing fish leather garments for Galliano and Christian Dior collections in 2002 (Fig. 1.2, 1.3). We were amongst the first brands to use fish leather and by doing so, we situated the barely unknown sustainable material within the context of the luxury Industry. Directing the John Galliano studio, I oversaw creating two collections a year for his namesake brand. They acted as a laboratory of ideas, allowing his imagination to run wild, free from both commercial pressures associated with a house as iconic as global as Dior, a pure expression of his personal design style. Galliano's extraordinary genius, mixing historical and ethnic references and contemporary trends, gave rise to imaginative and exquisite design collections full of handcrafted objects. We, the design team, travelled the world physically and through libraries and museums bringing back elements collated in a research book that I would create and that was the starting point for the collection. We were genuinely interested in other cultures and the research was done with respect, honour, and creativity.

I would have never dreamt 20 years ago that I would embark through my PhD studies on a fashion anthropological journey to understand processes of social, cultural, and historical transformation through the study of fish skin practices. My interest in fashion anthropology was the natural evolution of my early passion for museum artefacts and the knowledge of other cultures than mine. The Arctic fish skin studies in this PhD are linked to specific cultural, historical, economic, political, and religious developments in the Arctic, rather than a mere cultural appropriation from the West through recent processes of globalization. Combining my recent knowledge in Arctic anthropology and my previous experience in fashion, has allowed me to recognise Indigenous sustainable ways of life in contrast to contemporary overconsumption fashion patterns, to identify Arctic and contemporary material cultures, as well as to understand how to communicate more effectively with these communities and higher education students.

As the researcher, I offer experience drawn from over twenty-five years designing for luxury fashion brands internationally[1]. This is complimented by my current practice as educator in the role of Fashion Print Pathway Leader at Central Saint Martins[2], University of the Arts, London and fashion lecturer at international universities, supporting students in engaging with sustainability. The strengths from both disciplines have been invaluable for this research. Conducting this study

[1] http://www.elisapalominoconsulting.com
[2] https://responsiblefashioncsm.wordpress.com

as an educator, the research is practice-led and process oriented; the workshops and participatory practices initiate and inform the research. Issues of cultural appropriation were carefully considered while developing the methodology for the workshops and discussed with the Indigenous communities since fish skin processing is their own traditional knowledge past by many generations.

It is important to note that I approach the development of the Indigenous tanning technology in Chapter 6 from the perspective of an experienced textile designer, but a somewhat inexperienced tanner. I tanned my first fish skin in 2018, and as such, the tanning knowledge I have is very specifically developed for the context of this PhD. I always sought the advice and support of experienced Native and non-Native tanners, and I have experienced many Indigenous traditional Arctic fish skin tanning techniques that could provide the fashion world with more environmentally friendly processes in the future.

While fish leather material innovation is still a part of this research, through the PhD process, my study and practice have changed fundamentally to a holistic understanding of issues emerging from an Indigenous view of Arctic Fish Skin Heritage. The goal of sustainability and material innovation was maintained throughout all my workshops' experimentation. And yet, a more holistic consideration evolved. This was influenced by findings of Arctic Fish Skin Heritage in the context of the Arctic Animistic society who championed nature itself against its subjugation and exploitation by humans. This lens enabled me to see the fashion industry differently and was critical to the development of all the design methods used and all the theoretical models reached.

Figure 1.3. John Galliano's prêt-à-porter Autumn/ Winter 2002 collection. Yellow salmon skin skirt.
Photographer: Patrice Stable, 2002.

1.2 Research Aims and objectives

Research Questions

- What can be learnt from the use of fish skin by Artic Indigenous Peoples, their resilience and resourcefulness, and its connection with contemporary sustainable fashion practices?
- How can the development and testing of traditional Arctic fish skin material and craft contribute to fashion and sustainability?

Aims and Objectives

Aim 1. To undertake a study of the historical, cultural, environmental, and socio-economic importance of fish skin to Arctic communities.
Objective 1.1. Assess the literature on the historical use of fish skin to explore the material and its cultural sustainability.
Objective 1.2. Conduct fieldwork, create focus groups and interviews investigating the importance of fish skin.
Objective 1.3. Analyse artefacts considering the cultural, environmental, and socio-economic context of fish skin.

Aim 2. To Undertake an anthropological study of the use of fish skin with Artic Indigenous Peoples to explore their resilience and resourcefulness and its connection with contemporary fashion sustainable practices.
Objective 2.1. Co-Create four fish skin workshops with Native and non-Native tanners in different Arctic communities to carry out a cross referenced study of the difference in the fish skin material between different Arctic Indigenous Peoples.
Objective 2.2. Document and learn with the Arctic Indigenous Peoples' fish skin traditions and processes, so the tradition does not get lost.
Objective 2.3. Explore how fish skin craft as material and practice can contribute to sustainability in fashion.

1.3 Contribution to New Knowledge

- This thesis brings contribution to the knowledge of a renewed raw material for the leather industry. Information regarding traditional tanning methods enriches the insufficient knowledge in this area and provides a new contribution to fashion sustainability.
- The mapping and visualisation of fish skin craft participatory practices co-created with Artic Indigenous communities forms a secondary contribution, as this is the first time that such a survey has been undertaken.

1.4 Main Beneficiaries of the research

The knowledge gathered from the research have been disseminated to inform discipline and practice through fish skin workshops, international conferences, presentations at international leather fairs, meetings with luxury leather goods brands and publications in peer reviewed journals. The outcomes of the research could impact a diverse range of beneficiaries from researchers, creative practitioners, fashion designers, fashion students, leather manufacturers, the leather luxury goods sector, and above all Arctic Indigenous Peoples.

- People and Planet. Fish leather, a by-product from the food industry, when sourced sustainably from fish farms, could reduce marine pollution (Chapter 4). Countries with a big consumption of fish in their diet could benefit from the development of a model of fish leather-waste production (Chapter 4).
- Arctic Indigenous Peoples could benefit from the preservation and dissemination of their fish skin cultural heritage (Chapter 4 and 7).
- Higher Education Students and academics could benefit from education in fish skin craft and its contribution to sustainability (Chapter 7).
- Practitioners could use museum archives not only as a source of visual inspiration but for learning about material consumption (Chapter 5).
- Luxury brands in the fashion industry could benefit from a renewed raw material for the leather industry and its greener technologies (Chapter 4).
- Museum curators could benefit from the traditional knowledge of fish skin processes (Chapter 6).

1.5 Thesis Overview

The thesis is divided into eight chapters.

- Chapter 1 consists of an Introduction to the research, the main research questions, aims and objectives.
- Chapter 2 outlines the context, methods and the experimental approach used for the research. It explores issues of Indigenous knowledge and cultural appropriation.
- Chapter 3 outlines the historical background and aspects motivating the research and frames the PhD study in the context of spirituality and resourcefulness of Arctic Indigenous Peoples.
- Chapter 4 frames the PhD in the context of sourcing raw materials in contemporary fashion and explores the opportunity for fish leather to activate change as a renewed fashion material, comparing it with other types of leather.
- Chapter 5 introduces fish skin artefacts' analysis in museum's collections.
- Chapter 6 outlines traditional technical, methodological fish skin tanning findings to provide a guideline for creating at a more industrial level, more environmentally friendly processes for future fashion, and a reduction of the supply of chemicals and the

diminishment of the environmental impact.

- Chapter 7 unpacks through experimentation the practices of fish skin tanning through four workshops with Arctic Peoples.
- Chapter 8 summarises the research findings and signposts possible future avenues of exploration.
- Chapter 9 provides a glossary of terms related to fashion sustainability, fish skin and Arctic Indigenous Peoples.
- Chapter 10 holds the Bibliography of this PhD.
- Appendix I describes the EU Horizon 2020-MSCA-RISE project FISHSkin: Developing Fish skin as a Sustainable Raw Material for the Fashion Industry, that I wrote parallel to this PhD in 2018. The appendix is a visual portfolio of fish leather I have developed that supports this practice-based PhD.
- Appendix II expands on the international exhibitions where my fish skin research has been displayed promoting the collaboration between museums and artists and the showcase of historical artefacts.
- Appendix III expands on the international film festivals where my fish skin research has been displayed.
- Appendix IV contains the workshops' information pack and survey.
- Appendix IV provides a List of publications that supports the thesis discussion and where they expand on an aspect discussed in the thesis the reader is directed to the relevant publication.

Figure 1.4:. Atlantic Leather tannery. Stretched salmon skins. Photographer: Nathalie Malric, 2018.

2. Chapter Two: Research Methodology

2. Chapter Two: Research Methodology

2.1 Introduction

A qualitative methodology has been employed for its relevance in studying evolving processes. An arts-based inquiry (Denzin and Lincoln, 2008) was chosen to define the roles of the participants and myself as researcher. This methodology aims to create new knowledge conceived by those who actively participate in its making. Methodologically, the approach was practice-led. Emphasis was placed on 'hands on interaction' with the fish skin and processes. Collaboration with the fish skin artists and students was also key, along with dissemination throughout.

2.2 Methodology

Through a literature review, I explored existing theories and approaches to community design and fashion design for sustainability, and I identified gaps in knowledge relating to skills, and design methods that fashion students can use in their own practice.

Case studies

A multiple-case-study was used (Denzin and Lincoln,2008). Typical features are the selection of a phenomenon, collection of information through a range of methods including, but not limited to, observations, interviews, and documentary analysis (Yin, 2009). I developed a set of fish skin tanning workshops connecting fashion students with Native and non-Native Arctic fish skin artists. The workshops were created following practice-based design, with activities around fish skin to apply sustainable design knowledge via 'learning-by-doing'.

The methodology included the preparation of the participants through an online platform, and dialogue through social media networks, culminating in a fish skin craft workshop. The workshops' contents have been put together on a website for other students, tutors, designers, and others to view http://www.fishskinlab.com

Centre for Sustainable Fashion

The workshops are inspired by fashion sustainability projects developed at the Centre for Sustainable Fashion (CSF) a research centre based at London College of Fashion (LCF) where I have pursued my doctoral studies .The four case studies follow academic scholarship by Sterling (2001), Williams and Fletcher (2010; 2013), Williams (2016; 2018) and Williams and Toth Fejel (2017) , on how to embody sustainability content in fashion Higher Education practices. This study aims to embody the principles of sustainable design where students can share new methodologies and create an exchange while retaining their individuality (Williams and Fletcher, 2010). Fashion sustainability researchers Fletcher and Williams believe that sustainability education in fashion should combine experiential and practical understandings of sustainability and connect people with nature. This study draws on their approach to a fashion education that is oriented towards creative participation in social, environmental, and economic projects (Fletcher and Williams 2013). The workshops have explored Williams' methodologies of participation to promote a shift to a society where humans and nature thrive together on an equal footing (Williams, 2016). The workshops conform with the role and influence of design within crafts communities (Vezzoli and Manzini, 2008; Manzini, 2010; Williams and Fletcher 2013). This work follows Fletcher's ideas linked to designing and precepts of designing and communities sustained by product design and development which foster a sense of community connection (Fletcher, 2013).

2.3 Research Methods

Ethnographic research

The ethnographic research aims at answering questions of groups of people (Myers, 2008), or about specific aspects of their lives (Hammersley and Atkinson, 1995). Typical features are the selection of a group, organisation or community of interest or concern, immersion of the researcher in that setting, and use of participant observation. Semi-structure ethnographic in-situ observations of fish skin traditions and techniques were used at the historical locations where fish skin tradition had developed, to research the craft and records available in the setting while collaborating with the Arctic Indigenous Peoples (Touliatos and Compton, 1988). The purpose of ethnographic research was to gain understanding of Arctic Peoples and their culture (Myers, 2008). The focus was learning with them rather than studying them. Using Participatory Action Research (PAR), which lies between traditional participant observation and Native autoethnography, a collaboration was created between myself, as the researcher, and the fish skin artists who assumed the role of co-researchers, being recognised as equal partners and proactive participants, signaling their pivotal role in the co-production of knowledge. I sought the participation of Native and non-Native fish skin artists at all levels of the research, from workshop design, planning, implementation, analysis, and interpretation of the results to the dissemination of the outcomes through co-authored articles and presentations at international conferences.

Participation and participatory learning

Participant observation in family, community and regional activities were made all through all the research. Participatory methods representative of the craft and design worlds were used during the workshops. A typical feature was the close collaboration between me and the individuals at the centre of the investigation. Participatory Case Studies were undertaken to address the research objective 2.1. To Create four fish skin workshops in different Arctic communities through which to carry out a cross referenced study of the differences of the fish skin material between different Arctic Indigenous Peoples. I disseminated the knowledge of fish skin craft previously gathered through literature review literature with students and craftspeople. I tried to experience the same phenomenon as the subjects (Touliatos and Compton, 1988). To bring change in my teaching practices required me to undertake the same transformative process that I encouraged in my students (Williams and Toth Fejel, 2017). Engaging with the students and the Arctic

communities brought new knowledge systems and perspectives (Fletcher and Williams, 2013). There was a reciprocity of process; teachers learnt from the students and students learnt from the teachers.

Fieldwork

The fieldwork taught me about Arctic fish skin craft, history and culture in a practical and surprising way not covered by the literature review. The only logical solution was to write from my viewpoint, as a field researcher. I am the one who read the literature background material. I flew to remote villages, talked to craftspeople, visited museums, participated in festivals, and ate lots of salmon. I was there and at the same time I was able to consider what I have seen with a perspective informed by history, environment, and other cultures, including my own.

Like many practitioners wishing to improve their understanding of the methods used in the past, I have attempted all of the fish skin tanning techniques myself, together with my students under the guidance of Native and non-Native artists. To evaluate the traditional tanning processes, samples of fish skin were undertaken using traditional skin processing technology. Methods used in this study include mechanical, smoke, brain, urine, oil, fish roe, cornmeal, and bark tanning. Involving students in experiential learning introduced them to new skills and was essential for their academic and professional development.

Photography and film

Since the subject of study is highly visual, photography of artefacts and workshops has provided an invaluable record (Flynn and Foster, 2009). Photographing the Arctic Indigenous Peoples and students in the workshop setting was instrumental to compliment the verbal descriptions of their activities. Moreover, the photographic and film research has recorded for posterity crafts that soon may be lost due to Western influences.

Object or artefact analysis

An analysis of the fish skin objects in museums was made, identifying, and interpreting to address the research objective 1.3. This was to survey museum collections including a limited sample of everyday garments, shoes, bags, and ceremonial costume. This helped to decipher formal design elements of the fish skin garments and to reveal certain prehistoric references embodied in the outward appearance and actual construction of the clothing and accessories. The museum collections studied were chosen for the size, geographic distribution and fish skin holdings related to the specific Indigenous communities covered by this research. Artefacts were analysed considering the cultural, environmental, and socio-economic context of fish skin. Historical collections in museums revealed clothing traditions that uniquely mark Arctic Indigenous identity and demonstrate their ingenious use of local resources. Since fish skin garments and artefacts were the subject of this qualitative study, a material culture analysis using Prown's (1982) methodology was adopted as an analytical research tool. This looking at objects as repositories of information entailed a close observation of historical fish skin artefacts and the exploration of their connection with contemporary fashion-sustainable practices. During the analysis, I carefully recorded any traces of the individual makers, the techniques they employed, the garment construction, the economy of fish skin, its quiddity and 'spirituality'. The analysis of historical fish skin artefacts in international collections has been analysed in collaboration with indigenous experts and culminates in this PhD in an in-depth study of the material cultural histories and design elements of five key historical artefacts from Siberia, Iceland, Alaska, Northeast China and Hokkaido, Japan, belonging to the five specific groups with historical evidence of fish skin production (Chapter 5).

Dissemination

Feedback has been sought throughout via activities such as documentaries, conferences, peer reviewed papers and communication through my website. http://www.fishskinlab.com

2.4 Methods of data collection

Information was gathered on three levels: firstly, through library and museum research, secondly via informal interviews with fish skin craftspeople, museum curators and fashion HE students, Participatory Action Research (PAR), and by participant observation in community activities. All data obtained from various sources and methods was analysed collectively to increase the accuracy of findings (Patton, 2014). Qualitative and quantitative approaches were developed for analysis and evaluation of practice research outcomes. The protocol for data organisation was a fieldwork journal, photographs, and video recording to preserve and review the observations at a later date. Nominal Group Technique (NGT) and semi-structured interviews were chosen as methods to explore the fish skin craft (Shank, 2002).

Literature review

An examination of the literature on the historical use of fish skin, and other interrelated disciplines, intangible cultural heritage, material and cultural sustainability - ground this study within existing scholarship. To compare and contrast with standard ethnographic literature, I have looked for information in oral histories of Arctic Indigenous people in the late nineteenth and early twentieth centuries. The aim of this phase was to conduct a critical review of the literature on the historical use of fish skin, intangible cultural heritage, material, and cultural sustainability to address research objective 1.1. I reviewed the main areas of research separately and drew conclusions through the development of a framework to guide this investigation on Indigenous Arctic Fish Skin Heritage. The framework resulted from the literature review was developed and challenged both a theoretical level through further literature reviews and through the four case studies conducted using a participatory design research approach. The framework essentially encompassed anything that would allow information gathering on traditional fish skin cultural theory and practice.

Semi-structured interviews

As a follow up of this study, short semi structured interviews (Shank, 2002) were conducted in film and on paper with selected participants to address the research objective 2.2. to hear directly from participants. The research draws particularly on the Elders' testimonies (through fieldwork) transmitting their encountered environmental, ancestral, and spiritual knowledge. Storytelling by fish skin craftspeople during workshops brought teachers and students together, merging subjective experiences and communal interpretations.

Qualitative data was collected to evaluate the outcome of this research. Questions around fish skin sustainability, history and heritage were asked to each interviewee, in order to draw a more complete picture. Interviewees' interpretations of fish skin were scrutinised. Findings around fish skin craft and sustainability identified from the literature review were shared with the participants, with the aim of increasing the scope of this study. Their general satisfaction and levels of interest in the workshop activities were ascertained through oral discussion and written feedback forms. The interviews were 20 minutes approximately and were conducted during the workshops. The interviews were written, or audio recorded and transcribed verbatim.

2.5 Sampling strategy

In line with the qualitative type of this research, a purposeful sampling strategy was adopted (Creswell, 2009) to learn from people whose knowledge was relevant to the research. The aim was to give voice to experts from different backgrounds who might have different perspectives on fish skin. Participants were selected among Arctic HE fashion students, chosen for their experience in alternative materials within sustainable fashion. Historically fish skin seamstress were largely female. In contrast, the students chosen to participate in the workshops represented different genders, ages, socioeconomic backgrounds, education, and international experiences. Although they came from diverse backgrounds, they were united in their passion for exploring sustainable fashion practices. Fish skin artists were chosen for their specific expertise in fish skin technology and they were both Native and non-Native. Museum curators were chosen for their knowledge in anthropology and fish skin artefacts within the museum.

- 45 interviews were made with Higher Education students, to understand better their expectations, perceptions, and experiences with fish skin before and after the workshops.
- 8 interviews were made with craftspeople to understand better about traditional fish skin processing technology in theory and practice.
- 10 interviews were made with museum curators to gain understand better about the techniques employed to construct the fish skin artefacts, fish skin materiality and 'spirituality'.

2.6 Ethical principles

The research project was introduced to participants via presentation, including visual materials.

The high commitment levels were outline from the start in terms of attendance, engagement in discussion and the need of some form of documentation of the process. An information sheet, an informed consent form, a photography and video recording consent form and the written interview questions were provided to all those participating in the project. These documents were translated as required.

Upon agreement, the participants received via email an information pack, including a list of semi-structured interview questions. The interviews were conducted face to face. Each interview lasted 20 min. During the interviews I used prompts to elicit further information.

2.7 Data analysis

Due to the qualitative type of this research, large amounts of data were collected, in myriad forms.

- Photographs, video recording, field notes, samples, and sketches.
- Drawing conclusions from data helped to identify emerging themes between the workshops.
- The themes were also used to structure the narrative of the visual portfolio, designed from each of the workshops.
- The data gathered manually was analysed electronically the content from handwritten notes and audio recordings was transcribed into digital format using Microsoft Office Word. The individual steps for the analysis of the interview data were fourfold.
- The recorded interview data was transcribed from audio to text format.
- All data transcribed was read through to get the general sense of the overall meaning. This in- depth survey identified emerging themes.
- These emerging themes organized the material.

Transcripts of the interviews were analysed to identify the multiple perspectives on fish skin within the workshops and their potential impact as identified by the participants[1]. Overall, no contrasting opinions emerged, but participants presented myriad case studies to support the findings. The data analysis from participants from the different case studies allowed a consolidated literature review and enriched the initial theoretical framework. This framework was subsequently be enriched through further literature review.

Having structured the data, I interpreted it in the context of fish skin history and fashion sustainability. I compared these findings with information taken from the literature review (Creswell 2009). The presentation of Indigenous traditional fish skin knowledge and processes as in opposition to contemporary fashion practices in this PhD it is not intended to be in competition with each other and is far from engaging in a primitivist discourse. However, by presenting Arctic fish skin in contrast to contemporary fashion, it engages in a dialogue across time and

1 Chapter 7. Fish skin tanning workshops survey.

space, sharing a huge sense of respect for this traditional knowledge. Sustainability and the connection with Arctic materials and processes are proposed in this thesis as possible solutions for waste reduction in the fashion industry and how this could be achieved by learning from Arctic communities. This thesis recognises these sustainable traditional practices as new possibilities and alternative directions that the fashion industry and Western societies must increasingly consider.

2.8 Indigenous Peoples

This section offers a contribution to the discussion of concepts such as ‘Indigenous Peoples’ and ‘Indigenous knowledge’, understood as an endured identity within the framework of ongoing colonial politics. Research on Indigenous Peoples have been studied through the studies of: Sanders, 1999; United Nations, 2007 and Loftsdóttir, 2018. While Indigenous Knowledge has been addressed through the contributions of Ruddle, 1993; Laenui, 2000; Bruchac, 2014; Venero Aguirre and Tualima, 2017; Dahl and Tejsner, 2020; Fortin, 2020; Heleniak and Napper, 2020; and Langdon, 2020.

According to the United Nations (United Nations, no date) “Indigenous Peoples are inheritors and practitioners of unique cultures and ways of relating to people and the environment. They have retained social, cultural, economic and political characteristics that are distinct from those of the dominant societies in which they live. Despite their cultural differences, Indigenous Peoples from around the world share common problems related to recognition of their identity, their way of life and their right to traditional lands, territories, natural resources and the protection of their rights as distinct peoples”. The Arctic is home to many Indigenous Peoples and, due to the drastic climate and environmental change that is currently taking place, it is already affecting the Indigenous Peoples’ traditional ways of life in many ways.

The specific Arctic and Subarctic Indigenous Peoples with historical evidence of fish skin production are the Inuit, Yup’ik, Alutiiq and Athabascan of Alaska and Canada, the various Siberian peoples, such as the Ulchi, Nivkh and Nanai, the Ainu from Hokkaido Island in Japan and Sakhalin Island in Russia, the Hezhe from northeast China and the Saami of northern Scandinavia.

Icelanders also share a long history of using fish skin to manufacture shoes, but Iceland is the only Arctic state without an Indigenous population as its inhabitants are descendants of Celts and Scandinavians. Whilst the title of this thesis focuses on the Indigenous Arctic fish skin heritage, the study of Icelandic fish skin tradition is of great relevance. Although Iceland is not inhabited by Indigenous Peoples, there are many commonalities between the Icelandic fish skin tradition and that of the cultures of the other Indigenous Arctic Peoples. Icelanders right from the settlement of Iceland in the 9th century obtained their subsistence from the coastline by fishing salmon, wolffish and cod and they still have their ancestors’ spirit of finding the useful in everything. Iceland, like the rest of the Arctic fish skin nations, shares the same past as a colony exploited by Norway and later Denmark, which prevented its full independence until 1944. Moreover, according to Loftsdóttir (2018) Icelanders, from the Danish perspective, have long been considered as their other colonised and racialised populations within the Danish realm.

While the challenges regarding the well-being, self-determination and sustainability of Indigenous Peoples in the Arctic have been similar throughout the ages, the circumstances vary considerably from region to region. Even though the cultural expressions of fish skin artefacts might vary in the different Arctic nations, their traditional knowledge, innovation, ingenuity and agency has helped them thrive despite changing environments and political, social, economic and cultural conditions.

2.9 Indigenous Knowledge

Indigeneity is well-recognised among scholars and Indigenous Peoples working on issues related to Indigenous knowledge and practices of decolonisation. On this section, I offer a critical reflection on the he identification of 'Indigenous knowledge', as a key community of practice.

Indigenous knowledge (IK) relates to the total holistic understanding of the world by an Indigenous group including spirituality, modes of artistic expression and the ways in which knowledge is acquired across generations (Simons et al, 2016). It is the understandings, skills, crafts and philosophies developed by Indigenous Peoples and their interaction with their natural surroundings rooted in their traditional heritage (Bruchac, 2014). This body of knowledge and skills has developed outside the formal education system, allowing societies to thrive. Indigenous Knowledge encompasses traditional or local knowledge embedded in a unique culture, place and society, it is territorial and cultural context-specific, collective, holistic and evolutive (Mistry, 2009). Indigenous Knowledge encompasses the identity of a people, the land they have inhabited, the methods they used to obtain and process resources, and their relationships with other communities, other species and the universe. This collective body of knowledge has been handed down from generations and are constantly adapted to remain relevant to contemporary Indigenous life. This term is also used to designate those knowledge systems that differ from the dominant Western knowledge systems (Simons *et al.*, 2016). These conceptions constitute a system called Indigenous knowledge (IK) or Traditional knowledge (TK) (Bruchac, 2014). Dahl and Tejsner (2020) observe the current transition in use of concepts from Traditional knowledge to Indigenous knowledge. Moreover, The Inuit term Qaujimajatuqangit (IQ) refers to Inuit "Traditional knowledge".

Physical evidence of Indigenous Knowledge includes artefacts and animal remains uncovered by archeologists during excavations. This locally embedded knowledge contains information that can provide interpretation of scientific data. Indigenous Knowledge holders and their knowledge are integrated into contemporary science, policy and societal issues such as sustainable development, encouraging interdisciplinary collaborations with scientists and policy makers and applying

innovative methodologies to deepen understanding of climate change effects, adaptation and mitigation (UNESC0, no date).

According to the 2007 United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) Indigenous Peoples are members of sovereign nations and have treaty rights that must be honoured. Article 11, number 1, has direct implications for Indigenous design: "Indigenous Peoples have the right to practice and revitalise their cultural traditions and customs. This includes the right to maintain, protect and develop the past, present, and future manifestations of their cultures, such as archaeological and historical sites, artefacts, designs, ceremonies, technologies and visual and performing arts and literature" (United Nations, 2007). According to Brown (2018) Indigenous and non-Indigenous peoples living in single-nation societies are called upon to recognise the importance of Indigenous sovereignty and rights.

Article 8(j) of the United Nations' Convention on Biological Diversity (no date) dedicated to promoting sustainable development states that "Each contracting party shall, as far as possible and as appropriate: Subject to national legislation, respect, preserve and maintain knowledge, innovations and practices of Indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge innovations and practices".

Similarly, the World Intellectual Property Organisation and UNESCO (WIPO and UNESCO, 1982), in their Model Provisions for National Laws on the Protection of Expressions of Folklore against Illicit Exploitation, have created legal protection for human creations, including works of art, designs and symbols, to enable intellectual property right holders to prevent others from using their creations without their authorisation. "Intangible cultural heritage" (ICH), developed by UNESCO and WIPO (1982), aims to protect living cultural expressions: practices, knowledge and skills that communities, groups and individuals recognise as their heritage as intellectual property (Venero Aguirre and Tualima, 2017).

However, there are many controversies surrounding the mapping of Indigenous Knowledge and its transfer to other communities and other settings. It is being questioned to what extent Indigenous Knowledge might be shared outside the situation in which it was generated. While many lessons can be learned from Indigenous Knowledge systems, their protection in international law is scarce and vulnerable to usurpation (Mistry, 2009). Contemporary Indigenous agency aims to supplant entrenched patriarchal relations from the governmental bodies that historically controlled and dictated all aspects of life during the colonial period (Fortin, 2020).

Traditional Tanning

Within the framework of this PhD, I further contribute to the debate on the concept of traditional tanning, which involves not only the physical art of tanning, but also the act of "reviving" a dead animal skin and turning it into a "living being" with soul, power and sacredness. It is this traditional knowledge of transformation that is held by Indigenous tanners. Tanning is a "sacred act" for many Indigenous communities which is transferred to someone wanting to tan. The tanning protocol is a time-consuming process that requires personal commitment. The men and women who tan skins were and still are highly respected in their communities. They perform an essential role in ensuring the survival of their immediate family and the community, as it is they who will provide the raw materials needed to manufacture the garments that will be worn during the long winters. In this PhD, the term "Traditional Tanning" is emphasised to distinguish a tanning process that differs from the methods employed by tanners using electric machines and chemical processes. All of these traditional processes combined create a superior product associated with Native hand-tanned skins. According to Baillargeon (2011), tanners play a key role in keeping the culture of the community alive. Since fish skin tanning is a dying art, most Alaska Native tanners are willing to teach anyone who shows an interest in this art. They consider tanning to be a very important technique that needs to be passed on, and the knowledge and skill required to achieve a perfect tanned skin is equally important.

2.10 Cultural Appropriation

Transmission, according to Ruddle (1993) is understood as the process of transferring cultural elements, such as skills and knowledge, from one individual to another. Is the responsibility of the Elders in most Arctic Indigenous groups to pass on the Traditional Knowledge, reaffirming their status as knowledge holders. All cultures have protocols as to how knowledge is shared, they vary from region to region and its preservation, protection and transmission are subject to significant cultural constraints by different Arctic groups. Cultural restrictions are associated with customary laws, which govern different Indigenous groups' practices. But there are also restrictions in federal legislation that impose limitations on the use of certain Arctic materials. For instance, in Alaska, all marine mammals, including seals and sea lions, are protected by the federal Marine Mammal Act, and may only be hunted or harvested by Alaska Natives and only for subsistence purposes (food or crafts) and provided it is not done in a wasteful manner (NOAA,1972). This law poses serious challenges for the future of the gut skin handcraft since the definition of Alaska Native in the Alaska Native Land Claims Settlement Act (ANCSA) stipulates that a person must be a fourth Alaska Native by genealogy to be eligible. Due to recent marriage patterns, many Alaska Natives do not meet the one-quarter Alaska Native ancestry requirement and are therefore ineligible to hunt or process marine mammals (Langdon, 2020). However, fish skin does not undergo any protection laws that would prevent its use by non-Indigenous groups.

According to Smith (1999) it is recommended that Indigenous research be developed and conducted by Indigenous researchers and community members to be authentic, and that non-

Indigenous researchers and community members be involved in enhancing their understanding of Indigenous Knowledge and theories to ensure their safety. An Indigenous research agenda should include healing of previous harms , change of action, and decolonisation.

Indigenous Peoples have their own systems of knowledge transmission, along with their own forms of sustainable livelihoods based on the resources of their natural surroundings. Knowledge and skills are passed on from generation to generation and are constantly expanding. Fish skin tanning dyeing and sewing technologies were passed down from mother to daughter using different strategies such as observation, oral knowledge sharing, and participation in order to preserve and protect this knowledge so that it can be accessed by the next generation. At the time it was done to prepare young girls for adulthood and for the big task of producing the attires and containers for an entire family.

Appropriation or misappropriation of cultural heritage can refer to tangible or intangible heritage. One form of tangible appropriation of cultural heritage is the removal of an object from the community or artist that originated it, exemplified by the accumulation of Indigenous artefacts in museums during the colonial era. The appropriation of intangible heritage is carried out when someone from a different culture uses a design for a purpose other than that for which it was originally intended. When the appropriated motif is spiritually significant to an Indigenous community, it may be also offensive to Indigenous customary law (La Salle, 2014).

Cultural Appropriation in Fashion

Academics, educators, and museum curators face a shift in public opinion on borrowing material culture, especially from Indigenous communities. Novelty has always been celebrated in the history of Western fashion. Couturiers and designers strove to impress their customers with garments that had never been seen before (Kawamura, 2022). Fashion historian and curator Pamela Golbin claims that material culture has flowed freely in all directions for almost a millennium, gaining intensity from the 15th century, when the colonies established trading companies in the East Indies. In addition, Cally Blackman, fashion history and theory lecturer at Central Saint Martins argues that every aspect of our culture, from food to fashion, is a product of cross-cultural exchange. Indian artisans adapted their production making fabrics for the European market and south Indian plaids, known as Madras, were exported to Africa and adopted by the Maasai population. With the collapse of colonial empires in the second half of the 20th century and the emergence of post-colonial theories the Western European fashion industry is an example of the power imbalance towards Indigenous cultures (Socha, 2020). Kawamura (2022) points that, following colonial power dynamics, the dominant society felt entitled to borrow from the dominated. Valerie Steele, director of the FIT Museum in New York, argues that fashion is often accused of cultural appropriation, as clothing is part of a person's identity (Socha, 2020). We must therefore make design choices judiciously and responsibly.

The concept of cultural appropriation differs from intercultural exchanges, curiosity about other cultures and cultural diversity (Berthon, 2016). In the late 19th and early 20th century all things foreign were perceived as exotic and treasured; both fashion designers and fine artists incorporated ‘exotic cultures’ into their collections. Paul Poiret (2019) created opera coats inspired by kimonos, and Madeleine Vionnet studied the kimono flat sleeve construction to design her gowns. At the time, however, no one accused them of cultural appropriation (Kawamura, 2022). Multiculturalism has always had a strong influence on the fashion world, in the Nineties, designers creating ethnic collections such Kenzo, John Galliano and Jean Paul Gaultier were truly interested in learning about the cultures of other countries when they were inspired by them. But even if fashion has served to discover other cultures, what was once considered correct no longer fits with our contemporary values (Socha, 2020).

The internet has allowed the complicated narrative of this issue to be brought to light. Kirsten Scott, director of the fashion design program at London’s Istituto Marangoni, claims that inspiration from increased travel and Internet has led to the appropriation of culturally valuable elements from their communities of origin. Educators and curators, through both educational programs and museum exhibitions, should represent the material culture of other communities in a respectful way and discuss the work of designers who appropriate it culturally (Socha, 2020).

Consequently, if the active participation of Indigenous communities is largely restricted to the sharing of Indigenous Knowledge which is then translated by non-Indigenous designers, with little or nonreciprocal benefit for the community, but with obvious gains for the designer, this is more the last remnant of colonisation, rather than the beginning of decolonisation (Fortin, 2020). One of the most significant issues is when fashion corporations use Indigenous cultural material, making huge profits that are not returned to the community. If someone in a position of power uses the material culture of an Indigenous community with no acknowledgement without benefiting that culture or community in any way, this is cultural appropriation, claims Kirkland, associate professor of cultural and historical studies at London College of Fashion (Socha, 2020).

There should be dialogue through a collaborative endeavor, education, and acknowledgment on the sharing of the Indigenous Knowledge. It should be done with respect and honour and the end results should benefit the community. Designers, curators, and educators should be aware and show respect in the academic world with issues of cultural appropriation.

Case studies of cultural appropriation of Arctic Indigenous designs

According to Laenui (2000), Indigenous Knowledge risks being transformed into the culture of the dominant colonial society, and therefore Indigenous sacred symbols may end up decorating mainstream fashion apparel without being aware of the spiritual dimensions of these symbols, forming the basis for economic exploitation. In the past, certain motifs were used to

distinguish their wearers as members of a particular community, social status, religion, or area of competence.

An example of fashion industry’s confrontations with cultural appropriation of Arctic Indigenous designs is the case of the British brand Kokon To Zai. In 2015 KTZ showcased on the runway a fur parka almost identical to that of the early 20th century Inuit shaman Qingailisaq, made of caribou skin and decorated with sacred symbols. According to Bernadette Driscoll Englestad, research associate at the Smithsonian Arctic Studies Centre and also discoverer of the parka in 1978 at the American Museum of Natural History, it is the most unique garment known to have been created in the Canadian Arctic. The design was taken by KTZ without the consent of the Nunavut shaman’s descendants, disrespecting the true spiritual meaning of the sacred component. In addition, the community might potentially incur spiritual and physical harm due to misuse and exposure to dangerous spirits or energies (La Salle, 2014). KTZ apologised to the family and removed the garment from its online shops. The negative reviews suffered in different social networks greatly harmed the brand on an economic and social level (Zerehi, 2015). In such a scenario, with limited social resources, Indigenous communities are often exploited, as their intangible cultural heritage is usually not legally protected (Kawamura, 2022).

On the other hand, Canada Goose, a Canadian outerwear company, launched a social entrepreneurship project (the Atigi Project) in 2019, collaborating with Inuit seamstresses for a collection of parkas, all of whose proceeds go to the national organisation that defends Inuit rights in Canada. This collaboration helps to showcase the talent of Inuit designers by sharing their culture and craftsmanship with the world, while protecting and respecting Inuit intellectual property and designs (Nunatsiaq News, 2019).

Designers such as Marcella Echevarria, who advises the United Nations and UNESCO through her brand Noir Handmade, collaborates with artisans worldwide by connecting local knowledge, and argues that “cultural collaboration” should be at the heart of fashion, including the sourcing of its raw materials (Socha, 2020). Techniques and artisans must be recognised when Western fashion brands use them, and respectful collaboration between the fashion industry and smaller marginalised communities is paramount.

Fish skin workshops as practical case studies of knowledge transfer

Cultural exchange can also bring benefits, such as broadening diversity by creating new and innovative art forms or mixing cultural ideas in a meaningful way (La Salle, 2014). Furthermore, I believe that it represents a significant loss of creativity for fashion students and designers to limit themselves to their own cultures and avoid cross-cultural references. New educational approaches have to change to reflect such referencing through consultation and acknowledgement. In re-envisioning a fashion design curriculum for the evolving 21st century, I can only agree with

Rissanen's (2023) views that fashion education must foster creativity and imagination, while addressing the many pressing threats such as overproduction, climate change, biodiversity loss and cultural appropriation. Education programs like the ones proposed on this PhD provide important tools for young designer's development, but they should not compromise the transmission of Indigenous Knowledge. Through fashion education, students spend much time learning passively in computer settings, rather than engaged in hands-on learning with natural materials. There are important opportunities for educators and researchers to experiment traditional skills and practices where creating a culturally appropriate and environmentally sensitive art across the Arctic.

The practice-led workshops on this PhD document fish skin heritage and skills, analysing these cultural material practices and the potential for cross-cultural knowledge exchange. The workshops are a collective effort to respect Indigenous fish skin traditions while celebrating new work by students. The workshops were held with community-based knowledge holders from the five Arctic regions of fish skin heritage. The workshops were done in consultation with a community of fish skin artists with full acknowledgement of them, their history, and skills. The group was composed of three Indigenous artists: June Pardue (Alaska Native Alutiiq), Wengfen Yu (Chinese Hezhe ethnic minority) Anatoly Donkan (Siberian Nanai) and two non-Indigenous: Lotta Rahme (Swedish working the Saami community) and Shigehiro Takano (Japanese working within the Ainu community). Held in person and online during the Covid 19 pandemic, the workshops are inspired by the sustainability education movement in fashion, in which the University of the Arts where I teach and research for over ten years is at the forefront. The work of bridging cultural studies and the dynamic world of creative practice, connecting Indigenous artists and students across cultural and political boundaries, is a challenging task that this PhD hopes to contribute positively to the field. Through collaborative work with the five fish skin artists, I have been dealing with issues of appropriation, preservation, and innovation.

Indigenous Knowledge bearers co created and participated as expert instructors and coresearchers. Recompense to traditional knowledge holders took the form of tangible resources, through fair retribution, a reciprocal exchange of knowledge, recognition for their collaboration and contribution via co-authored papers and international conference presentations, sharing the products of the research. Consent, research processes, research design and agreement over the results of the workshops were carefully questioned to the fish skin artists while implementing the project. Researchers often must earn the trust of a community before Traditional Knowledge is shared; therefore, many meetings were held prior the creation of the final workshops. Critical strategies and discussions were applied to address the potential cultural appropriation of Indigenous Arctic fish skin processes and design, combining my efforts with those of other educators and fashion students to transmit Indigenous Knowledge of fish skin, avoiding misuse of sacred symbols and preventing threats to authenticity.

Fish skin oral histories were collected and transformed via documentaries to promote a vision of sustainable future. To avoid the assumption that the researcher or students were trying to solve the Indigenous communities' problems, the project listened the voices of the Indigenous artists through recognition, respect, reciprocity and prior, informed consent. Building relationships through communication within the Indigenous communities is paramount to ensure that they have control over how their heritage is used and their interests are respected and protected (La Salle, 2014). The extensive museum-based research and fieldwork developed across three continents, seven countries and twenty-eight international ethnographic museums documenting fish skin collections was also done in collaboration with local Indigenous artists. Dissemination activities showing the co-creation process helped to amplify the impacts of the project.

Methodologies of Land Acknowledgment

During the workshops, the Indigenous artists and students acknowledged their United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) recognising the rights and historical territories at the different lands of the circumpolar region where the workshops were held, being conscious of the importance of Indigenous stewardship and the significance of ancestral territories. Issues of environmental sustainability, climate crisis and action were discussed between the Indigenous artists and students.

Building relationships with Indigenous partners must be a continuous development process where the wishes and needs of all parties are considered and respected. The main goal to create Indigenous partnerships through these projects is an enduring sentiment of collaboration and reconciliation with northern cultures, past and present building an institutional academic foundation for respecting and valuing cross-cultural collaboration with a new generation of students within the design world.

In 2019 during my Fulbright scholarship in Alaska at the Smithsonian Arctic Studies Center, I met Melissa Shaginoff, an artist, social activist, and curator of Contemporary Indigenous Art and Culture at the Anchorage Museum. Melissa is part of the Udzisyu (caribou) and Cui Ui Ticutta (fish-eater) clans from Nay'dini'aa Na Kayax (Chickaloon Village, Alaska). Her work revolves around methodologies of Land Acknowledgment (Shaginoff, 2021) recognizing the history and work of Indigenous Peoples, offering respect, understanding, and looking to Elders for guidance on Indigenous ways of being to ensure a collective future. After meeting Shaginoff, I started using her methodologies of Land Acknowledgment, publicly recognizing the Arctic Indigenous Peoples whose traditional fish skin craft was studied. In my guidance of the students, I covered: Recognizing the Arctic Indigenous Peoples, consulting with Indigenous-led organizations, educating oneself and students on the Indigenous histories, their resilience and the current work Indigenous Peoples are doing for their tribal communities.

Upon visiting the Sheldon Jackson Museum in Sitka, Alaska, in 2019, I met the gifted Yup'ik artist Peter Williams. While admiring his sealskin garments and discussing the difficulties of working with them as CITES-listed species (Convention on International Trade in Endangered Species of Wild Fauna and Flora), I shyly suggested that he concentrate on his fish skin work in anticipation of the great renaissance this ancient technique is having not only in Alaska but also in the rest of the Arctic. In the subsequent article on fish skin tanning that he published in 2021, interviewing numerous Alaska Native fish skin artists, Williams (2021) argues that the creative control and knowledge related to fish skin artefacts preserved in museums is not in the hands of Alaska Natives, nor is most of the literature written about them. It also exhorts Swedish tanner Lotta Rahme for having built her career on the knowledge of many indigenous cultures, without acknowledging the people who taught her and leaving indigenous women nameless and faceless. I must agree with Williams' admonishment to Lotta for not acknowledging on her fish skin tanning book (Rahme and Hartman, 2012) the names of the tanners from whom she learned. But it is also essential to recognise the importance of Lotta's lifelong dedication to passing on her knowledge, especially to members of the Saami culture, who had largely forgotten the techniques of tanning fish skin. Similarly, Shigehiro Takano, the instructor who ran the fish skin tanning workshop in Hokkaido, although not Ainu but Japanese, has devoted himself since his arrival in Nibutani in the 1970s to successively learning and teaching more than 200 Ainu crafts that had been to a great extent forgotten by the Ainu community. While I fully support Williams (2021) that in revitalising ancestral practices altered by colonialism, such as fish skin craft, Native artists must be in the driver's seat, I also respect the work of artists such as Lotta and Takano who have established for more than three decades strong relationships of respect and reciprocity with indigenous communities. But to avoid misappropriation of cultural heritage, these relationships must be constantly negotiated and respected.

'Conservation of Leather' volume as practical case study of knowledge transfer

In 2022 I was contacted to work on the chapter on aquatic skins in the forthcoming revision of the publication 'Conservation of Leather and related materials' (Kite and Thomson, 2006). This is a remarkable textbook that has been a great source of knowledge for many conservators but had become outdated over time. Here I saw the opportunity to create a team to engage with conservators in collaboration with Native and non-Native fish skin experts to present real-life scenarios in which to test conservation theories and methodologies. Challenges in the treatment of fish skin artefacts include insufficient understanding of the material by many conservators. Moreover, museums and Indigenous communities share an interest in fabrication methods and material technology and are increasingly seeking to engage in collaborative working relationships. However, resources to help guide this work have been lacking and museums need to engage with traditional creators and owners of Indigenous artefacts held in museum collections in the restoration of the knowledge that makes up the artefact and the guidance in the care and conservation of these materials. In the process of revising the Leather Conservation volume (Palomino *et al.*, 2024), I have brought together Sophie Rowe (Rowe, 2020), a British Museum conservator who has recently undertaken conservation work on a Yup'ik fish skin bag on display in the Arctic exhibition (Lincoln, 2020a), with fish skin artists June Pardue, Alaska Native, and Lotta Rahme, Swedish, in co-writing the Yup'ik fish skin bag case study for the publication. Rowe had already attended a course with Rahme on how to tan fish skins and had researched the material and processing through videos on the Smithsonian Arctic Studies Centre's YouTube channel, where June Pardue had previously contributed sharing her knowledge. I have also engaged Minneapolis Institute of Art curator Courtney Murray, who recently worked on the conservation of the Nivkh fish skin coat for the exhibition 'Dress by Nature, Textiles of Japan' (Bortolot, 2022), to collaborate with Native Nanai fish skin artist Anatoly Donkan in co-writing this case study. Establishing a working group composed with conservators and fish Native and non-Native fish skin artists and holding periodically meetings will broaden the understanding of traditional fish skin knowledge, identify challenges for Indigenous communities and explore ways to protect knowledge and material culture. It will also contribute to increase the literature on fish skin written by Native scholars that Williams has longed for (Williams, 2021).

Native June Pardue, Wengfen Yu and Anatoly Donkan have become representatives, and social advocates of their own Indigenous culture (Alutiiq, Hezhe and Nanai respectively). As Pardue notes, "sharing is part of Alaska Native culture, we wish to share knowledge and food with each other. It is not culture that we teach, but experiences". Many Alaska Native women, having learned to tan salmon skin, have begun using it in their crafts, which they sell and display all over Instagram. It has gone from a museum artefact to a household and economic boon (Williams, 2021). Since our joint online workshop in April 2020 until today (Palomino and Pardue, 2021), June has delivered on her own more than 200 fish skin workshops online and in person worldwide to Native and non-Native students and she has earned the position of associate lecturer of Alaska Native Art history teaching fish skin tanning at University of Alaska Anchorage UAA. In 2022 June Pardue collaborated with the Alaska office of the Smithsonian Arctic Studies Center and the Alaska Native Heritage Center on a project to perpetuate Alaska Native knowledges of natural dyes from Dena'ina Lands. She participated in the creation of instructional resources, a set of 15 videos and a booklet featuring the dyeing of fish skin and other Alaska Native subsistence materials. The videos on Smithsonian Learning Lab are a living proof on how to build collaborations addressing culturally sensitive issues around traditional knowledge (TK) of fish skin practices. As Dawn Biddison claims on the ASC website, 'the knowledge that Alaska Natives have shared is their cultural heritage, and they have cultural property rights to this knowledge. What is learned must be used with respect for their rights, including the right not to use it for personal gain, such as selling artwork derived from this knowledge' (Smithsonian Arctic Studies Center in Alaska, 2023).

The Internet, an opportunity for creators to connect

In response to mass production, consumers are turning to authentic objects made from natural raw materials, using artisanal processes from local cultures expressing their traditional know-how. The Internet provides openings for creators to connect with traditions from other cultures and digital platforms are having a transformational effect on the practices of makers, amplifying their collective ability to share knowledge and develop expertise. After participating in the fieldwork I organised in Hokkaido in 2022 with June Pardue and Anatoly Donkan (Palomino *et al.*, 2023) , June set up a Facebook group to share her knowledge of fish skin tanning with a global audience and in less than 2 months she gained over 2000 followers. The internet is helping fish skin enthusiasts to connect around this process. Without geographical restriction, these enthusiasts can spread all over the world; thus, a tradition originally linked to Arctic and Sub-Arctic areas has developed new cultural connections through individuals and groups experimenting with this heritage. These Arctic fish skin practices are not completely national or regional in origin but interwoven and interconnected with each other. So, while the Internet offers opportunities for connection with traditions from other cultures, it is vital that issues of mutual respect and exchange are considered.

Fashion sketchbook workshop as practical case study of knowledge transfer

In 2019 to thank all the fish skin advisors that I met during my travels in Alaska I organised together with the Arctic Studies Center at the Anchorage Museum a Fashion sketchbook workshop to mentor Inuit designers and artists in a wide range of professional work in the arts with an interest in clothing design. During the fashion sketchbook workshop students were taken through the process of collecting personal research from diverse and inspiring sources. They documented their responses through drawing, photography and collage in order to create a unique sketchbook to help them on their personal creative practice. Students had the opportunity to use imagery from the Smithsonian's collections as part of the research content for their sketchbook, encouraging them further research about their own Alaskan Native culture. Through a reciprocal exchange of knowledge, I paid respect to the Indigenous communities and their environments, acknowledging their contribution to my own research.

Foning Bao final year fashion collection as practical case study of knowledge transfer

The opportunities for the commercialisation of cultural heritage can also be valuable when carried out by, with the consent and controlled by the community of origin (La Salle, 2014). Foning Bao, a Chinese fashion student at CSM, attended the Hezhe fish skin workshop delivered in the framework of this PhD. Through the lectures of Wengfen Yu she learnt about the history and culture of the Hezhe Indigenous community and practical traditional fish skin tanning techniques. During her final year at university, she travel back to Heilongjiang, carried on conversations with Wengfen Yu and the Hezhe Indigenous community and acquired fish skins to create her final year collection. The Hezhe fish skin process and culture was negotiated and transformed by mixing fish skins with crochet and pearls, while the fashion silhouettes were radically different from traditional Hezhe (Figures 7.76, to 7.79). Bao used fish skin and fully fashioned knit learning from the Hezhe sustainable use of fish skins, transforming her collection into zero knitting, zero cutting and zero waste garments.

She promoted the Hezhe collaboration on her social media platforms, paying respect to the Hezhe Indigenous Peoples and their environments, through co-operation, collaboration, respect, mutual benefit and acknowledging the sources of all the ideas in her collection. Foning Bao used fashion as a tool to represent the voice of the Hezhe as a social advocate.

2.11 Codes of Conduct for Fish skin tanning workshops

Through the series of fish skin workshops across the Arctic I learned an enormous amount about the considerations to be taken into account by a western researcher and designer working with Indigenous communities. My background as a practitioner and teacher has been invaluable in this as well as the newly acquired experience using participatory methods of working collaboratively across different ways of knowing. Below, I propose a series of recommendations for building collaborations addressing culturally sensitive issues around traditional knowledge (TK) of fish skin practices. The methods and approaches are to inspire work between communities with the aim of assisting other researchers, academics, students and Indigenous artists involved in similar scenarios by providing models for the inclusion of Indigenous values in the design, negotiation and implementation of workshops when Traditional Knowledge transfer is involved.

Workshop methodology

- Design a methodology to avoid invasive relationships between academics, students and Indigenous communities.
- Identify the sovereignty of the different Arctic Indigenous groups guiding all aspects of the workshop.
- Respect the Indigenous community you are working with and aim to heal of past harms.
- Mend the misconduct from previous researchers that has contributed to the current feeling of distrust.
- Understand that mistakes might be made, and that the team should be supported and learn from these mistakes when they happen.
- Research thoroughly the history of each Arctic Indigenous group prior to each workshop.
- Establish a working group composed of the fish skin artists involved in the project.
- Hold meetings with Indigenous and non-Indigenous fish skin experts to broaden understanding of traditional fish skin knowledge, identify challenges for Indigenous communities and explore ways to protect knowledge and material culture.
- Design, teaching and implementation of workshops should be done by Indigenous fish skin artists with the support of the researcher.
- Co-design and distribute a survey to promote awareness of cultural appropriation issues among community members and obtain feedback for protecting it.
- Acknowledge during each workshop the original land the workshop is taking place upon, respecting the traditional owners.

- Earn the trust of the community before traditional knowledge is shared.
- Use traditional ways of knowing, teaching and learning when passing on cultural knowledge to third parties.

Compensation

- Create a written agreement clearly defining the responsibilities and rights of each party.
- Informants and tutors should be fairly compensated, which could include economic compensation, acknowledgement as author, co-author or contributor, royalties, copyright, patent, trademark, or other forms of compensation.
- If there are economic gains involved, the end results should benefit the informant/ tutors.
- Provide in return additional sources of knowledge and expertise.

Protection of intellectual property rights

- Request Indigenous Peoples' right to give or withhold their 'free, prior and informed consent' (FPIC) in any project involving intellectual resources that affect their cultures.
- Consult with Native artists on the issues of protecting their traditional knowledge connected with fish skin tanning and processing that is being shared with others.
- Avoid the potential risk of third parties taking advantage of the use of traditional knowledge in products that can be traded on international markets.
- Negotiate the use of fish skin processing and designs with the tradition holders and significantly alter them in the creation of a new work transforming them to the cultural settings in which they are introduced.
- Researcher and students should pay respect to the Indigenous communities and their environments acknowledging the sources of all the ideas.

Customary Laws

- Develop an understanding of the local customary laws that govern access to the techniques associated with fish skin.
- Identify individual versus collective rights in the context of Native laws and legislation.
- Consider and respect the wishes of the communities in order to avoid misappropriation of cultural heritage, constantly negotiating these relations.
- Develop a form of protection that respects the nature of Indigenous cultural and intellectual property.
- The style and decorations of the fish skin clothing, shoes and containers vary greatly according to the region, location and Indigenous group. Decorations can denote social status, gender or spiritual meanings. Identify motifs that are spiritually significant to an Indigenous community, and whose usage may be offensive avoiding their use.

Communication of results

- Provide periodic updates, to share progress and to ensure that people feel informed.
- Provide recognition of all Indigenous artists and their work.

2.12 Codes of Conduct for Museum consultations

Discussion and engagement are the key to anthropological fieldwork. Collaboration between researchers and their Native informants is not new in anthropology but it involves multiple challenges and benefits. Museums are developing methods to incorporate the concerns of descendant communities with an interest in the artefacts. Transforming museum practices by increasingly encouraging research with Native Peoples through partnership working benefits both the museum and the community. This PhD is a collaborative research, and the analysis of historical artefacts in collaboration with Indigenous experts and museum curators has been conducted in a respectful, reciprocal and transparent manner, negotiating the direction of the research while sharing agency in the research practices. Beyond mere data collection, the links with the individual fish skin artists and museum curators featured in this PhD have developed over time into genuine cross-cultural friendships. I have put together below some logistics, providing practical information to establish the best possible outcomes for museum consultations with Indigenous communities and steps for collaboration developing fundable research proposals for such consultations.

Participatory Action Research

- Adopt Participatory Action Research (PAR) towards an Indigenisation of Ethnography.
- Develop a broad interest on the culture you are studying, not just a narrow focus on your research interest.
- Create a collaboration between the researcher and those being researched becoming co-researchers.
- Seek participation of Native Peoples at all levels of research: design, planning, conduction, analysis, interpretation, knowledge transfer and dissemination.
- Build trust and respect with the Native team through decision making, discussion and consensus.
- Combine Western research methods with the Native practice of attentive listening and observation.
- Follow local etiquette and norms.
- When developing a fundable research proposal for museum consultations, set up a steering committee including Native Elders to collaborate on the writing of the grant proposal.
- Move forward with the steering committee from ideas to grant writing to implementation.
- Circulate a draft of the grant proposal to be edited collaboratively before submission.
- Provide Native collaborators full disclosure of funding sources and institutional affiliations.

Interview methodology

- Develop, discuss, and revise research questions, interviews and methods with Native communities and Elders.
- Modify questions based on what has been learnt from previous interviews or projects.
- Offer the choice between face-to-face interviews and anonymous open-ended questionaries to ensure privacy.
- Provide the choice to have the interview conducted in English or their Native language.
- Keep the names of the interviewees confidential.
- Record the interviews, transcribe them and translate them. Destroy the recordings.
- Review transcripts of cultural information with Natives to ensure accuracy.
- Follow traditional protocols in the interpretation of traditional knowledge.
- When documenting oral history, always attempt to reproduce the original meaning.

Museum consultation

- Transform extended fieldwork into repeated short trips avoiding time constraints.
- Secure budget for technical assistance and for consultations with fish skin artists.
- Facilitate access to museum collections for the descendants of the peoples from whom these objects originate.
- Avoid culturally sensitive collections in museums (medicine bundles, funerary items or human remains).
- Plan all fieldtrips well in advance, request permission from museum curators and fish skin artists by email at least 3 months in advance and follow up by phone on the day.
- Set aside 2 to 3 days for the consultation to facilitate the exchange of information.
- Maintain a small consultation team to facilitate the exchange of information and to avoid corporate presence becoming overwhelming.
- Ask consultants which artefacts they are most interested in.
- Provide information about the collections to be viewed before the visit.
- Pay each consultant standard honorarium and cover all travel expenses.
- Allow native consultants to handle the objects as these artefacts are very intimate components of their lives.
- Record artefacts details through observation, measurements, photographs and researching accession files.
- Listen to discussions regarding tangible as well as intangible aspects of collections.
- Seek to participate in local subsistence fishing activities to better understand the relevance to Native communities and learn from their methods of resource management.
- Attempt to sample the subsistence foods available in each location.
- Value the importance of sharing meals as a way of showing respect and hospitality.
- Allow time for reflection between field visits, to gather information.
- After the fieldtrip, compare the ethnographic data with the literature review.

Communication of results

- Allow sufficient time for native contributors' review, approval and access to the final results of all material.
- Provide a mechanism for community feedback on results.
- Communicate research results in a practical manner back to the communities.
- Provide results that are useful to share with their community, such 'visual repatriation' and 'digital repatriation' of traditional artefacts at distant museums.
- Include recognition of all research contributors in the final report, paper or conference.

2.13 Emerging themes from the Research Methodology

Academic research on cultural appropriation is a relatively recent topic of study. This research intends providing an overview for future discussions. The difference between "appropriate" forms of cultural exchange and harmful cultural appropriation is complex, but there has to be mutual understanding, equality and respect for true exchange to take place. Cultural exchange, sharing of Traditional Knowledge and commercialisation of products are not intrinsically negative, but it is necessary to respect Indigenous values and traditions to find out who benefits from them without being at the expense of Indigenous communities. The goal is to identify how this Indigenous Knowledge could be consciously and respectfully passed on to non-Indigenous third parties avoiding loss of livelihoods and loss of artistic control on the part of Indigenous communities.

There is a long history of use of Indigenous cultural heritage by non-Indigenous people for commercial purposes. I have outlined various issues raised by the potential appropriation of Indigenous fish skin cultural heritage, highlighted the risks and explained how to avoid potential misappropriation. I paid particular attention to the misuse of sacred Arctic motifs in the fashion industry exposing the case study of a specific design linked to a particular Arctic Indigenous culture as an example of fashion's confrontations with cultural appropriation. I have exposed the role of artisans in revitalising traditional crafts and how digital tools are supporting the regeneration for makers geographically isolated, encouraging participation and helping fish skin craft to become more resilient. The case studies presented here are only a fraction of the studies that can be shared. This chapter brings together fresh perspectives on methodology and theoretical concepts around collaborative work of Indigenous and Non-indigenous artists and non-Indigenous researcher and students. The questions posed are not easy to answer, but the most important aspect is to pay due attention to Indigenous voices. The work I have developed through this PhD is deeply related to traditional knowledge and cultural appropriation. It is based on my experience over the past six years of establishing and building relationships of trust, honesty, respect, collaboration, commitment and engagement. It focuses on indigenous communities, has a personalised approach and has been thoroughly grounded.

Figure 3.1. Ainu fishing salmon on rivers using gaff-like spears.
Photograph: Library of Congress Prints and Photographs Division Washington, D.C.

SECTION TWO: HISTORICAL

Figure 3.2. Fish skin pouch. Aleut (Unangax). 1921. National Museum Natural History, Smithsonian Institution. Washington DC.USA, 2019.

3. Chapter Three: Fish skin Historical Context

3. Chapter Three: Historical Context

3.1 Introduction

A literature review on the historical use of fish skin and the disciplines of material culture and fashion sustainability ground this study within existing scholarship. The contextual review has two themes:

- Fish skin, a historical context.
- Fish leather, an alternative raw material for fashion.

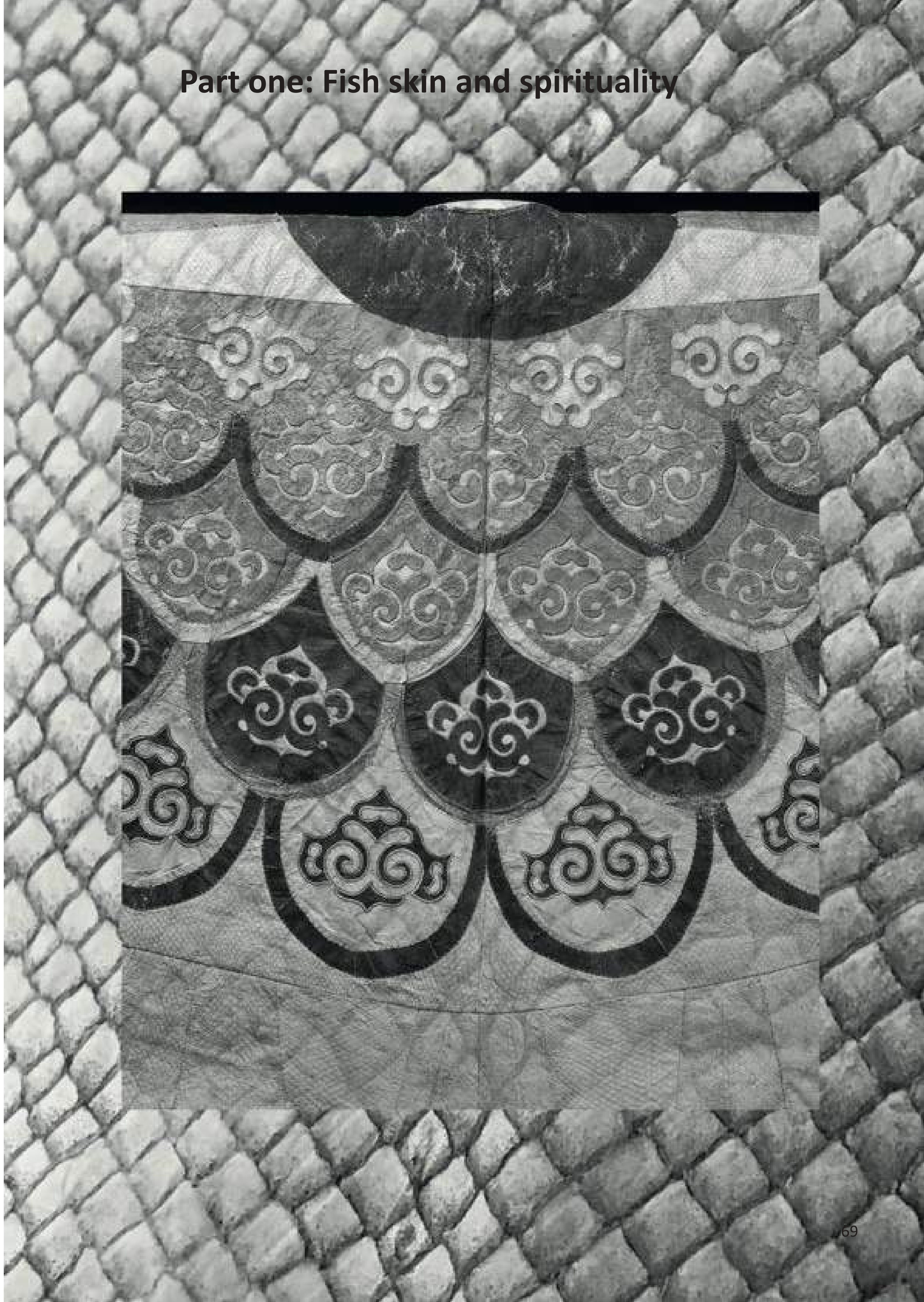
3.2 Fish skin, a historical context

A study of material culture has been developed through investigation of the historical origins of fish skin traditional craft, firstly tracing them back to the Arctic Indigenous Peoples who developed them and then examining their aesthetic, cultural, environmental, social, spiritual, and technological significance. Issues of gender, identity, ethnicity, and cultural contact have been examined. The roles of men and women in Arctic subsistence societies and creative approaches developed as sustainable responses to climate change have also been addressed.

The use of fish skin by Arctic Indigenous Peoples has been investigated through the studies of several ethnographers: Nelson, E.W. 1899; Osgood, 1940; Nelson, R.K. 1969; Fienup-Riordan (1983; 1990; 1994; 2005; 2007); Berg, 1984; Hickman, 1987; Vávra, 2020. The ethnographic fieldwork, museum research and creation of fish skin workshops developed through this PhD, show how fish skin craft connects Arctic Indigenous identities to ancestral values and lifestyles. The dialogue on global indigeneity and multiculturalism, material culture, and the construction of ethnicity in current Arctic societies increases understanding of both the effects of colonialism and of the current indigenous revival movements in the Arctic and Sub Arctic (Lewallen, 2016; 2018). Arctic clothing has been studied extensively with a focus on the design elements and their cultural significance: Hatt and Taylor ,1969; Driscoll, 1983; Chaussonnet, 1988; 1995; Oakes and Riewe, 1998; Driscoll-Engelstad, 2005; 2020; Oakes, 1991; 2000; Issenmann, 1997 ; Cooper, 2020; Lincoln, 2020a. Fewer researchers have focused on the tanning processes of Arctic fish skin: Reed, 2005; Rahme and Hartman, 2012; Jackinsky- Sethi, 2014; 2020; Williams, 2021. While some researchers have addressed functional aspects of Arctic skin clothing: Klokkernes and Sharma, 2005; Klokkernes, 2007; spirituality and connections to nature Cevoli, 2015; Glebova, 2015; a research into the historical, cultural, environmental, and socio-economic importance of fish skin has not yet been made.

Figure 3.3. Gilyak fish skin coat from the lower Amur River near Vladivostok in Eastern Siberia. ©Victoria and Albert Museum, London.

Part one: Fish skin and spirituality



Part one: Fish skin and spirituality

3.3 Arctic and Sub Arctic Indigenous Peoples

The Arctic region

The Arctic[1] is the most northerly place on earth and covers 4% of its surface. Centred on the North Pole, its southern border is the Arctic Circle. Its centre, the North Pole, rests over the Arctic Ocean, which until recently has been covered by year-round sea ice (Lincoln and Loovers, 2020, p. 44). The Arctic has been occupied for millennia and the cultures are remarkably old. When much of Europe was covered in glaciers, the plains of north-eastern Siberia were glacier free, and it was possible to settle. Recent archaeological findings show that Palaeolithic hunters occupied north- eastern Siberia 30,000 years ago. The earliest Arctic inhabitants used resources available to them with remarkable innovation, creating beautiful artefacts. Climate change is transforming the Arctic. Warmer temperatures on land and in the ocean are promoting the retreat of sea ice and glaciers and thawing the permafrost[2] (Cooper, 2020, p.19). The expansion of novel aquatic species endangers existing native species, and it is changing the ocean chemistry. Seasons have been altered as well, contributing to rapid and significant change of the region and its cultural customs. At the same time, globalization and increasing international interest in the region adds new pressures to access the area and change land use, altering the geopolitical positioning of the Arctic.

Arctic and Sub-Arctic Indigenous Peoples

The Arctic and Sub-Arctic areas covered by this research are the northern most parts of the Eurasian and North American continents, including the regions of Canada, Alaska, Siberia, China, Japan, Iceland, and Scandinavia (figure 3.4). The Arctic is home to about four million people, both indigenous and those arrived from southern regions. Around 400,000 are Indigenous Peoples with ancestral ties to the Arctic. These Arctic Peoples belong to over forty different ethnic groups. They share many cultural traits and have been trading and communicating with one another across the Circumpolar North for thousands of years. The Arctic Indigenous Peoples have distinct but sometimes related languages and cultures (Stuckenberger, 2007). These Arctic cultures are connected within a circumpolar world that transcends the political boundaries of recently created countries. The Arctic region is united by Indigenous communities who have exchanged ideas, materials, and livelihoods for thousands of years. The specific groups with historical evidence of fish skin production are the Inuit, Yup'ik, Alutiiq and Athabascan of Alaska and Canada, the various

1 The word 'Arctic' as well as the term 'the Circumpolar North' are used to delineate a northern region where Arctic Peoples or Indigenous Circumpolar Peoples have developed common adaptations to particular environments and share cultural views of those environments. The term Circumpolar North' reminds us that Arctic Peoples have been well connected for millennia, as water and ice aid transportation. Similarly, environments, animals and weather patterns are integrated around the pole.

2 Permafrost is ground that remains frozen for two or more consecutive years. It is composed of rock, soil, sediments, and varying amounts of ice that bind the elements together. Some permafrost has been frozen for tens or hundreds of thousands of years.

The Arctic and Sub Arctic Region

Figure 3.4. Map of the Arctic and Sub Arctic region with historical fish skin areas highlighted.
CIA. Library of Congress. Washington DC, USA.

Siberian peoples, such as the Ulchi, Nivkh and Nanai, the Ainu from Hokkaido Island in Japan and Sakhalin Island in Russia, the Hezhe from northeast China, the Saami of northern Scandinavia and Icelanders.

Traditionally these Indigenous Peoples have maintained a subsistence lifestyle, and their lives and spirituality were shaped by the unique Arctic seasonal cycle and its daily weather conditions (Stuckenberger, 2007). Arctic Indigenous Peoples have developed highly specialized techniques to harvest and process materials. They have been known for their link with their natural surroundings, in one of the most demanding climates in the world.

Without the protection of adequate clothing, human migration and settlement would not have been possible. To obtain the warmth needed from their clothing, Arctic Indigenous Peoples have used the skins of the animals they hunted and fished, transforming them into a distinctive form of costume with stylistic variation across the Arctic (Driscol, 1983).

There are many common cross-cultural similarities within these Arctic communities in fishing traditions, in attitudes toward the dead and in relationships between nature and humans and in fishing festivals in coastal regions, fish skin artefacts and rituals (Chaussonet, 1995). The fish skin tradition illustrates the diversity and similarity of the cultures and peoples of the Arctic. This can be seen in the design of fish skin clothing and accessories and in the distinctive decorative patterns applied to garments and artefacts which each culture produces, clearly distinct from those of its neighbours. Equally there are many similarities related to the innovation, skills, and resilience of these Arctic communities and their ability to survive and even thrive for thousands of years — despite climate change, famine, flood, fire, colonisation, disease, capitalism, social and economic exclusion, and cultural genocide. The resilient strategies, such as cultural adaptation, material innovation and social cooperation, used by Arctic Peoples to mitigate the effects of both environmental and social change are all common to these Arctic societies. They have provided Indigenous responses to social, economic, and political shifts, which include the quest for the Northwest Passage, the European exploration of the Arctic, the global fur trade, colonialisation and global Indigenous rights movements. Arctic Indigenous Peoples have consistently innovated using Arctic materials and technological innovations and have culturally adapted to the changes brought about by colonisation, through close and fruitful interaction with nearby and distant communities (Cooper, 2020, p.20).

Resilience and ingenuity

Arctic Indigenous Peoples share a history of colonisation. The first outsiders to come to Arctic Indigenous lands were whalers, followed by fur traders and missionaries. Orthodox missionaries made repeated attempts to replace the 'pagan' religions of the Siberian Natives with Christianity. After the establishment of the Russian colony in Alaska in the 18th century, the Orthodox mission

expanded its scope across the Bering Strait. The Ainu animist faith, recognising a spiritual power within all things, was also banned during the period of Japanese assimilation. During the colonial period, when the different states persecuted shamans, Arctic Peoples continued to feed their spirits in secret. Following their first exploration of the Arctic regions, the colonisers settled permanently in the Arctic. They divided the Arctic into colonial states, introducing policies to control the Arctic Peoples' economies (Lincoln, 2020b, p.222). To maintain their cultural values and traditions Arctic Peoples used traded materials in innovative ways and adopted new technologies. In many cases, they resisted colonial power through art and crafts.

3.4 Arctic Indigenous Peoples and nature

The close connection between Arctic Natives and their surroundings has been explored in relation to fish skin, following the ethnological studies on Native cultures of Alaska and Siberia by Ager, 1982; Fitzhugh and Kaplan, 1982; Chaussonet (1988; 1995); Driscoll, 1983; Fitzhugh and Crowell, 1988; Fitzhugh, 2008; Crowell, 2010; Lincoln *et al.*, 2020. According to Ager (1982), with the abundance of fish in the Arctic rivers and the Native peoples' close affinity to the land and its resources, it followed naturally for fish skin to become widely used as a 'fabric' in the construction of garments, accessories, and containers. Shirokogoroff (1935) agrees that the needs of a hunter-gatherer mode of life are activated using the materials found at hand in the most economical way. Indigenous Peoples continue to hold critical knowledge on sustainable living—in balance with our planet and with one another. Behind this sacred knowledge lies a belief system that honours and respects all life forms and their interconnection. From birth, Indigenous Peoples hold a responsibility to their land and to future generations and a deep respect for all life forms.

The original belief of Arctic Natives is defined as animist, meaning that any element of nature is animated by a soul. They believe that all natural phenomena - animals, humans, or weather - all have souls and are capable of purposeful action. There is no concept of hierarchy, animals, humans, and environment are equal. Since time immemorial, the Indigenous Arctic Peoples have been highly reliant on animals. Part of this interdependence is that they maintain an exchange relationship. They recognise animals as fully conscious, non-human beings, with whom they share a common awareness. The creatures that were hunted or fished were sentient beings that could choose whether or not to surrender to the hunter or the fisherman. They would surrender themselves only to those who treat them respectfully. As a result, humans had to behave properly in regard to the animals. When respectfully treated, the souls of the animals taken would be reborn, providing season after season subsistence to their communities (Lincoln and Loovers, 2020, p.89). Fishermen also used to give away the first catch as a sign of generosity to the bounty provided by the sea. Arctic Peoples practice respect of animals by sharing food and treating the remains of the fish frugally to ensure the continuation of life.

Figure 3.5. Map of Alaska, 1875 Dall, W.H. US Coast Survey. Library of Congress Geography and Map Division Washington, D.C.
Figure 3.6. Children, under salmon hanging from rack, in Alaska. Nowell, Frank H. Library of Congress. Prints and Photographs Division. Washington, D.C.
Figure 3.7. Map of Siberia. ref: www.japanmaps.davidrumsey.com
Figure 3.8. Nanai family, Amur River, Siberia, 1897-1902 ref: www.American Museum of Natural History.
Figure 3.9 Map of Iceland. Insulae Islandial .Homann, Johann Baptist, 1663-1724 ref: www.davidrumsey.com
Figure 3.10. Fish Drying at Þingeyri. Photographer. Auguste Houzé de l'Aulnoit. ref www. National Museum of Iceland.

Figure 3.11. Map of Northeast China, 1883. ref: www.davidrumsey.com
Figure 3.12. HHezhe family. ref: www. commons.wikimedia.org
Figure 3.13. Map of Scandinavia ref: www.japanmaps.davidrumsey.com
Figure 3.14. Saami family. Norway, ca. 1890. Library of Congress Prints and Photographs Division Washington, D.C.
Figure 3.15. Map of Hokkaido, 1897. ref: www.japanmaps.davidrumsey.com
Figure 3.16. Ainu men and women outside an Ainu home, Yezo, Japan. Library of Congress Prints and Photographs Division Washington, D.C.

According to Fienup-Riordan (1994), for all Inuit Peoples the relationship between human and animal is crucial for the construction of shared values. Arctic Peoples understand that fish choose to approach those fishermen and their wives who have kind thoughts and behave respectfully. Fish 'give themselves' to the rightful fisherman. Arctic Peoples do not regard hunting and fishing as the practice of slaughtering animals, but rather as the granting and reception of gifts (Lincoln and Loovers, 2020, p.89). The power dynamic is subverted. The hunted are the donors, the hunters are the recipients. Understanding the nature of this relationship promotes respect gratitude and parsimony. Women's skillful and aesthetic production of clothing from animal skins, expresses the respect and gratitude of the individual and the community towards the animal's gift (Driscoll, 2020). By contrast, in many parts of the world, the success of an individual to kill an animal is solely dependent on the skill of the hunter or fisherman. Indeed, in modern industrialised societies, humans are expected to have control over the environment and feel entitled to exploit it. With our clothing consumption habits, we have caused biodiversity loss and depletion of finite resources (Table 3.1, theme 1).

According to Nadasdy (2007), hunting and fishing in Arctic societies have historically formed a long-term relationship between the animals and the humans who hunted them (Table 3.1). This is echoed by Martin (2001) who states that in order to be successful in hunting and fishing, Indigenous Peoples had to maintain a respectful relationship with the animals by offering them prayers, wearing appropriate clothing, participating in ceremonies and wearing amulets to attract or placate the animal spirits. Wearing skin clothing created not only a connection with the animal but also a tribute to it. The salmon gave itself to the fisherman. He, receiving the gift, then gave the fish to his spouse. She, in turn, shared the flesh with her relatives and made gifts of fish skin clothing to her husband. Through careful harvesting, processing, and sewing, seamstresses could pass an animal's 'soul' into a garment made from its skin (Steffian, 2018). Women's responsibilities were to reconstitute the animal through the creation of animal skin clothing. Spiritually, a woman's skillful production of skin clothing would reconstitute the animal and thereby renew the cyclical nature of life (Driscoll-Engelstad, 2020). Sewing fish skins into clothing, seamstresses symbolically regenerated animals and mediated between the fisherman and the fish. Wearing a fish skin parka (Figure 0.1) tailored to project the image of the fish, the fisherman disguised himself so that by virtue of his costume he became one with the animal physically and spiritually. Seamstress would give clothing animal characteristics to endow the wearer with protection and specific powers. Wearing the skin of a fish may have been a protection during dangerous activities like hunting. By imitating the appearance of the animal, man acknowledged his relationship with nature and his dependence on it (Driscoll, 1983). By looking more like a fish, the fisherman could easily get closer to the subject if his quest.

In some cases, seamstresses incorporated naturalistic as well as metaphoric references to act of fishing. For example, a pair of Ainu salmon boots (Figure 3.40) might retain the fin of the salmon at the bottom of the boot. The fish fin acts as a symbolic reference to the animal as well as a strategic feature to help the wearer gain traction on the snow. The seamstress would symbolically transfer the salmon's speed to the child through the fin, so he could move as quickly and smoothly as a fish in his salmon boots. Equally, garments are also made from animals of specific sizes and ages; children's clothing therefore is often sewn from younger animal skins (Figure 0.1). These skins are also lightweight soft and light, to avoid overburdening the children. Also, they are proportionally sized for construction(Lincoln, 2020a, p. 118).

The raw materials used to create these garments are only borrowed from an environment to which they will return. This circularity is symbolic; animal parts and even human substances (urine used in tanning) are crafted into beautiful objects emphasising resourceful creation and the reciprocity between humans and animals. The circularity is also physical, these garments are fully biodegradable, and they will eventually return to the environment from which they came. The Arctic framework for material culture is the very antithesis of current trends towards disposability so prevalent in contemporary consumeristic fashion. The contemporary industrialised societies' view on materials of animal origin like exotic skins is unfortunately very different to that of Indigenous Peoples' (Figure 3.17) and their infinite respect for the animal. Women in current society has had the impulse to wear exotic animal skins (Figure 3.18), to emulate the animals' attributes and exoticism (Brajato, 2017). The power of exotic skins has always attracted women, as a symbol of wealth status and power. Wearing exotic skins asserts the wearers superiority over the animal (Ehrman, 2018). Their perceived glamour and erotic connotations evoke human ideas about reptiles, whose attributes - power, stealth, and steely grace and even animality - humans admire and fear (Watt, 2003). The fashion industry has a long history of using exotic skins, with some degree of controversy. Designers have tried to transfer attributes from the animal world, the wild, dark, aggressive, seductive jungle onto the garments created from Victorian times to the present day (Brajato, 2017). Environmental concern of the extinction rates of certain exotic species has called into question our relationship to nature through fashion. There does appear to be a marked sea change in this regard. In addition, many fashion brands, such as Chanel and Mulberry, have recently banned the use of exotic skins in their collections (Bailey- Cooper, 2019) (Table 3.1).

According to Williams (2018) the contemporary dominant world view places humans as not only distinct from nature and animals but masters over them. Fletcher (2019a) believes that if we can design according to principles observable in nature we will naturally focus on efficient use of materials. She argues that the troubled or exploitative relationship between humans and nature and fashion and nature could be redeemed by a more holistic approach as practiced by the Arctic Indigenous Peoples.

Figure 3.17. Wenfeng Yu's mother. Hezhe Fish skin craftsperson wearing a fish skin suit made by her. Heilongjiang, China.

Figure 3.18. Anna Wintour wearing a snakeskin jacket for the Vanity Fair Party. New York 2014. ref: www. dreamstime. com.

3.5 Fish skin spiritual roles

Clothing made from fish skins as a spiritual protection has been studied thoroughly in Cevoli's (2015) Esthétiques de l'Amour: Sibérie extreme-orientale exhibition at Musée du quai Branly. Hickman (1987); Oakes (1991; 2000); Driscoll-Engelstad (2005; 2020) and Steffian (2018) have equally surveyed the ancestral art of skin clothing connected with the spiritual concerns of Arctic Peoples.

In addition to providing essential nutrition, the relationship between animals and humans shapes Arctic identity and sustains spirituality (Martin, 2001). Arctic Indigenous Peoples have developed highly ritualistic relationships with the spirit forces they associate with the animals. The animals were believed capable of assuming human form, as the humans took animal form in the wearing of their skins. Many men also believed themselves to have an animal self, revealed to them through visions (Lipton, 1977). For the Inuit, hunting and fishing was more than a means of subsistence, they believed that humans, animals and nature shared spiritual qualities. Everyone was his or her own spiritual master; and people received secret knowledge through amulets from spirits, elders or shamans. Through rituals, broken links between humans, spirits, and animals could be re-established, and afflictions were healed (Fitzhugh, 2007).

In the past Nivkh and Nanai seamstresses decorated hunters' fish skin clothing with embroidered applique motifs imbued with spirits (Figure 8), which gave assistance and protection from danger (Oakes, 2000). The patterns were placed specially on the back, acting as a protective shield against the evil spirits, thought to arrive from behind without being seen indeed is understandable to protect your vulnerable back (Table 3.1). The motifs, and ornaments, like the art of arranging them, were used as intermediaries between animals and humans in order to facilitate their capture and to appease their spirits (Lipton, 1976). Through ceremonies, charms, and the help of a shaman, the hunter sought to avoid evil and to placate the spirits of the animals he was preparing to hunt. Shamans played important ceremonial roles, including predicting the weather. They wore fish skin garments to ensure a prosperous future. Hickman (1987) describes Alaska Native fish skin parkas as a component in shamanistic ceremonies preparing for the first fishing of the season. They were pieces of artwork that expressed the identity of their owner and talismans that demonstrated and forged a close spiritual connection between people and animals. By incorporating symbolic references to the skin, the seamstress articulates the holistic, universal relationship that intimately connects people and animals (Driscoll, 2020).

The sewing skin garments was a sacred act restricted by many taboos, paying respect to the exchange between humans and animals, between natural and supernatural (Driscol, 1983). In his accounts Across Arctic America Rasmussen narrates that seamstresses were not allowed to sew while her husband was hunting, for fear of offending the animal he was pursuing, and were strictly forbidden to sew during the darkest nights of winter (Rasmussen, 1927).

Figure 3.19. Nivkh coat. Fish skin appliqued. Siberia. Amour river. Penn Museum Philadelphia, USA. 2022

Magical virtualization can be done with any garment. Nivkh and Nanai Siberian Natives ritualized fish skin garments and this act was socially implemented (Glebova, 2015). When working with the salmon, they would connect with the elemental spirits associated with water, and with the salmon and the spirits in return would bring protection to the wearer. Nowadays, the origin of most materials we wear is synthetic, therefore, less spiritually charged as the fish skin although is on the gist of the wearer to imbue any item of clothing with the spirituality desired.

Early 20th century anthropologist Cornelius Osgood (1940) reported that in Alaska's lower Yukon River, salmon skin cradles were used for a baby born after the death of another child because it was believed that the salmon skin would keep away evil spirits and protect the potentially vulnerable child.

Lately, clothing styles no longer respond to such ancestral traditions and concerns but instead to the proclivities of the fashion industry. Guided by Arctic philosophy, contemporary clothing could become more 'spiritually charged' as a means to lowering consumption practices in the manufacture of clothing. Fletcher advocates for mindfulness, suggesting that when fashion pieces are used with attention and knowledge, it might decrease consumption and increase appreciation of what we already own (Fletcher, 2016). Clothes that become more imbued with such 'attention' and knowledge would be probably more expensive and therefore produced in smaller quantities, so in turn consumers may not be able to afford to buy as many clothes but the clothes they will buy would at least be better made and maintained.

Death and Fish skin

For some Arctic Peoples, observances of gratitude take place during the winter season after food had been procured and processed. During this winter ceremonial season people gathered into communities of 300 to 400. Yup'ik men and boys over the age of five worked, ate, and slept in a quasgiq (communal men's house) while the women lived separately dwellings with the young children (Fienup-Riordan, 1994). People came together to celebrate in ceremonies involving dancing and drumming, in which animals were honoured and thanked for giving up their lives. They danced to songs accompanied by wooden drums covered with fish skin, celebrating successful hunts, related myths, passing on knowledge and honouring animals and spirits.

Shamans made their own drums during their initiation period. To journey to the spirit world, a shaman entered a trance by hitting a fish skin drum with a stick. Some Nivkh[3] shamans had special drums made of fish skin (Glebova, 2015). These are very light structures but surprisingly robust made with skins sometimes smoke tanned, sometimes raw, and

3 The Nivkh are an Arctic Indigenous ethnic group inhabiting the northern half of Sakhalin Island and the lower Amour River and coast on the adjacent Russian mainland.

Figure 3.20. Fish Skin container used for offering rituals during Elriq, the Great Feast of the Dead. 1879. St. Michael, Alaska, USA. Collector Edward W. Nelson. National Museum of Natural History. Smithsonian Institution. Washington, DC, USA, 2019.

translucent. In Siberia, the drum is conceived as an animated entity of the same nature as the shaman. It may represent the shaman's spirit- wife or the auxiliary animal whose skin has been stretched over the frame. The shaman perceived a drum as a living being. Playing the drum helped the shaman to communicate with the spirits and to travel from earth to heaven and the underworld. Passages to death could be unlocked by communication between the living and the dead. Yup'ik men singing and drumming in the quasgiq, 'drew with noise' members of the spirit world (Fienup-Riordan, 1994). Drums made of fish skin would allow the shaman to cross the 'river of the world'. The shaman using the fish skin drum was helped by water spirits. Ityzan, a Nivkh shaman was reputed to be assisted by a female sea mammal spirit. In Siberian societies, shamans were called upon in cases of serious illness, sudden misfortune in hunting or fishing and to fight against evil spirits. They also engaged in divination (Dalles and Cevoli, 2015).

Fish skin bags (Figure 3.20) used for storing clothing, dried fish, and other essentials, were among the gifts traditionally offered by the Yup'ik to the spirits of the dead during Elriq, the Inuit Great Feast of the Dead. During this time, the deceased were believed came back as guests with their living relatives. Yup'ik sent gifts of food and water to the dead and their namesakes soon after their death. The exchanges of gifts through rituals forged the relationships between the human, animal and spirit worlds created the pathways between them. Over the last half century many of these feasts have been replaced by catholic festivals (Fienup-Riordan,1994).

Nivkh Indigenous Peoples dressed the dead in a new set of fish skin clothes, which may have helped their journey to the spirit world and enhanced their visibility there. Clothing, both signaled and supported the transformation of the dead. Indeed, traditional fish skin clothing was designed as a symbolic barrier between the world of the living and the dead. Dalles and Cevoli (2015) recognise that the Nivkh fish skin seamstress is therefore endowed with a powerful skill. She uses her knowledge to forge balance between the visible and the invisible realities for the well-being of those around her. Her embroidery (Figure 3.19) could even help a dead person find, alone, without shaman, the path to the world of the dead. For the Yup'ik, after the death of a family member, many interdictions were put in place to avoid blocking the way to the world of the dead. It was paramount to avoid sewing during the first 4 days after a death, which would correspond to the four steps that mark the distance between the land of the living and the dead (Fienup-Riordan, 1994). Moreover, for the mistress of the afterlife was imagined by the Udege[4] people as a solitary old woman in a fish skin dressing gown.

4 The Udege are an Indigenous population living in the Primorsky and Khabarovsk regions in Russia. They live along the tributaries of the Ussuri, Amour, Kungari and Anyuy rivers.

3.7 Two-spirit shamans

For the Inuit, in the past, sexes and genders did not have rigid boundaries. Unlike the binary conception that predominates among westerners, this non-social binarism between genders sees an Indigenous recognition of two-spirit people, a tripartite system in which some individuals, men or women, straddle the social frontier between the sexes and genders. According to Saladin D'Anglure (2005) the Yup'ik from St Lawrence Island in the Bering Strait believed there was a third sex between women and men. When a male dressed like a woman, Elders thought that he was respecting his nature and these third sex people were protected by the Creator. Many families transmitted the identity of a beloved dead relative to the 'newborn', regardless of their sex. When the sex was different, the children were cross-dressed until puberty, then they took on the gender corresponding to their sex, but some of these young people became shamans and continued to assume the third social sex. These male and female 'two-spirit'[5] become medicine people, healers, and ceremonial leaders. Men who performed women's tasks became artists and shamans, and women became warriors, hunters and chiefs (Roscoe, 1998). Before the European colonisation of North America, the oral traditions of Alaska Natives includes gay, lesbian, bisexual, and transgender literature in the form of two-spirit people playing important mythical roles, from creators of earth to heroes in battle (Elledge, 2002). In Inuit mythology the role of the two-spirit was to mediate; being at the edge between sex and gender roles he/she was able to go beyond the boundaries of humans and animals' worlds and between the dead and the living. The two-spirit term, denoting those born with a male and a female spirit, was introduced in 1990 to self-identify alternative sex and gendered Native Americans and refers to gay, lesbians, transgender or not heterosexuals as a historical reminder that before colonisation Native tribes had multiple genders (Longman, 2002).

The androcentrism deeply embedded in 'western' society made that 18th century explorers, and Jesuits judged and persecuted under Christian morals the crossdressing and women's tasks and behaviours featured by the two-spirit people (Longman, 2002). Colonisation introduced a patriarchal organization, and a rigid gender binary with two opposing genders. European colonisers had difficulties in classifying Native people who appeared to be mixing genders, encompassing "man" and "woman," their sexuality was not constrained to relationships between "opposite" genders defined by anatomical sex (Jacobs *et al.*, 1997). Today, we see increased visibility of Native two-spirit, nonbinary, transgender, and gender- neutral identities, reviving the two-spirit role and its traditions. National gatherings of two-spirit people have been held since the early 1990s, and regional gatherings take place in many parts of the US amongst Natives.

Two-spirit people are the shamans of today, unconstrained by the common views of gender. They choose clothing to code their identity in a world where each of us can adopt masculine or feminine appearances and roles as we feel appropriate. The two-spirit vision challenges the basis

5 "Two-spirit" was coined at a gathering of Native American and First Nations people in 1990 and embraced for its connotations of balancing or combining male and female qualities.

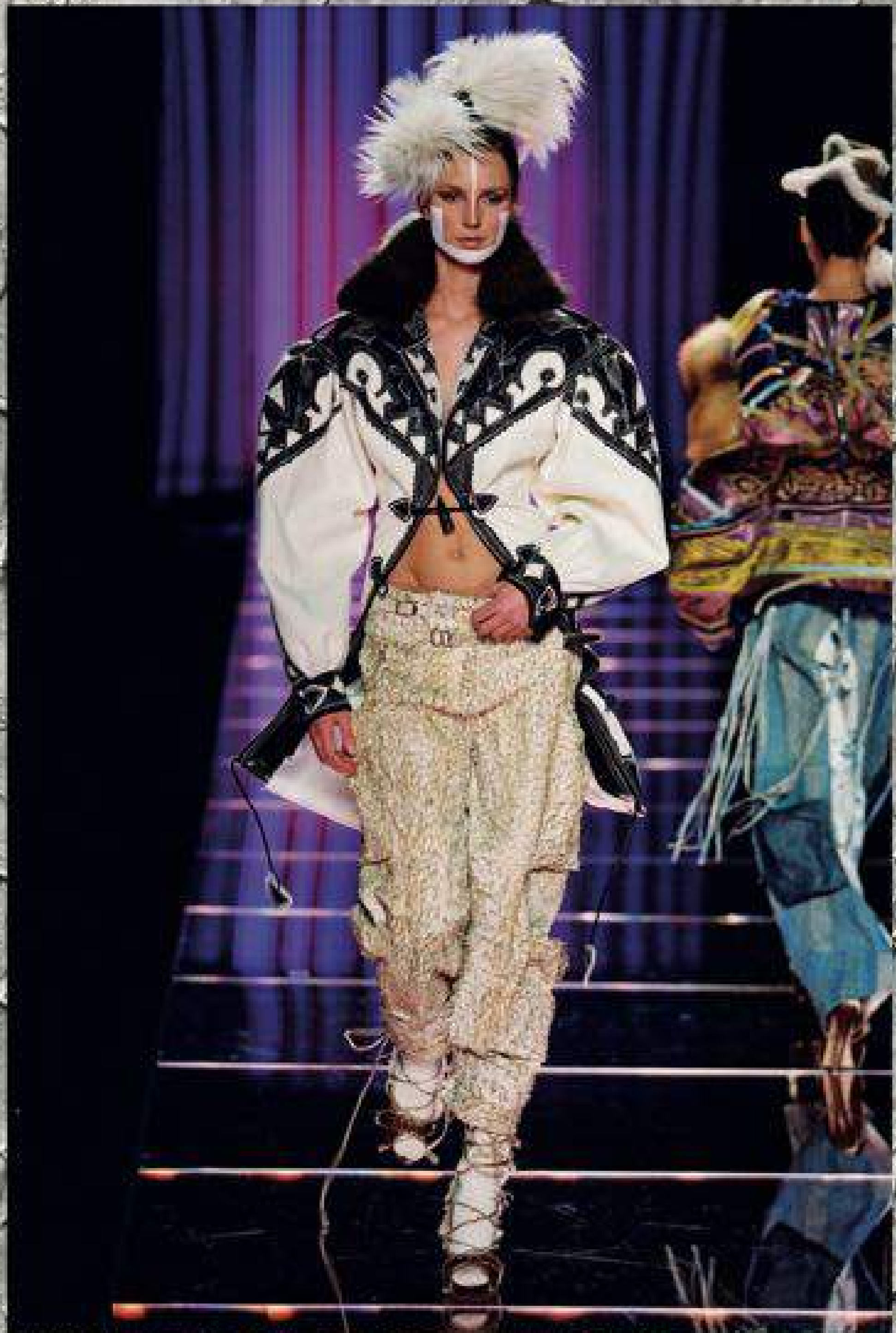


Figure 3.21. John Galliano’s prêt-à-porter Autumn/ Winter 2002 collection. Atlantic Leather's perch skin trousers. Photographer: Patrice Stable, 2002.

of the dualistic way most ‘western’ societies understand and define sexes and genders (Roscoe, 1998). The Inuit have a great deal to teach us and to assist us in discovering in our own culture important freedoms for both males and females.

European fashion specifically parallels this ‘genderless’ today and historically. John Galliano has played games with gender since his 1984 BA graduation collection, where his clothes were worn by models of both sexes, reflecting the ‘New Romantics’ hedonistic London club scene (Fury, 2018). Before Galliano started designing traditionally defined menswear (between 2004 and 2011) there were always men who dressed up in women’s clothes at each of his womenswear shows. His Autumn/Winter 2002 collection (Figure 3.21) was inspired by a family of Inuit travelling back in time to a 1950s Christian Dior’s catwalk. The notion of nomadic tribes, gathering garments like mementos, pervades this collection. Galliano combined 1950s silhouettes with eclectic materials such fish skin, bleached denim, knits and brocades. He dressed the modern two-spirit shaman with fish skin parkas and trousers (Figure 1.2), preparing them for the ceremonial role and shamanistic ceremony that his seasonal fashion shows had become over the years.

3.8 The subsistence partnership between men and women

In contrast to this nonbinary two -spirit shamans, Arctic Indigenous husband and wife had extremely defined gender roles. The raw materials and tools for processing the fish skins were provided by the hunter and husband. The expertise and labour of constructing the fish skin garments was provided by the seamstress (Figure 3.22) and wife (Martin, 2001). The combined efforts of husband and wife provided a subsistence partnership key to the construction of skin garments. Arctic clothing, produced through the combined efforts of hunter and seamstress, represent the importance of that partnership in sustaining Arctic Indigenous societies. Their survival rested on the interdependent collaboration of husband and wife.

In the past, consideration of the needs of his wife was part of a fisherman’s job. Seamstresses knew the exact skin required to construct a garment, so men would catch fish based on the preferences of their wives. When men went fishing for salmon they would think of their wives, and which garment they wanted to make. If they caught a small salmon, their wives would use it to make mittens. If they caught a big male salmon, it would be used for boots or trousers.

Beautiful Arctic clothing indicated a successful marriage, as it was the husband’s hunting ability that supplied the sinew to sew them. Sinew is made of the dried tendons of caribou but can also be harvested from other large mammals (musk-ok, polar bear, elk, and moose) and marine mammals (seal, narwhal and whale) (Hall *et al.*,1994). Seamstress would peel off one strand at a time and store them in a bundle (Barton, 2014). The wife’s sewing and creative skills in return was expressed in the functional garments she made (Lincoln and Loovers, 2020, p.52). The quality and quantity of fish eaten by a household, the beauty of skins sewn, the evenness of the stitches in

Figure 3.22. Katrina Cutting a King salmon 1964. Yukon River Alaska collection of Atwood Resource Center. Anchorage Museum.Alaska, USA. Photographer: Steve McCutcheon.
Figure 3.23. Ulu knife, a fish skin scraping tool, 2021.

garments were more than sustenance and clothing: they represented an affectionate and successful family. In the context of contemporary fashion, Fletcher argues that durability provided by material qualities and construction emerges from human intention that things will last when people want and need them to (Fletcher, 2016).

Alaska Native seamstresses use scrapers or Ulus[6] (Figure 3.23) to remove the flesh from the fish skins. Ulus were originally made from a variety of local materials, such as horn and walrus tusks. Handles were usually carved by fathers or husbands to fit the hands of their daughters or wives, who in return used the scraper (figure 3.23) to fashion bespoke clothing for them (Lincoln, 2020a, p.126). The elaborate designs of the Ulus demonstrate the value the carver attributed to well-made clothing and the expertise of the seamstress, who used them. Tools and garments were made to be beautiful, since they provided messages about the skill of the seamstress and the success of the hunter or fisherman.

According to Reed (2005), the main difference between making garments of animal hides and those of fish skin lays is the easy availability of the raw materials to the Alaska Native women. To make fur garments, the men hunted and provided the hides while the women did all the construction and sewing. In contrast, while making fish skin garments, women, children, and the elderly were also capable of setting nets or practicing ice-hole fishing (Figure 3.24) to harvest fish. The use of fish skin garments gave women the freedom and independence to source the raw materials by themselves (Table 3.1).

This cooperation of man and woman and sexual division of labour with females as gatherers and seamstresses and males as hunters and fishermen is a major empirical regularity of hunter- gatherer ethnography, suggesting an ancestral behavioural pattern. Current archaeological discoveries at the Andean highland site of Wilamaya challenge the man-hunter hypothesis. The excavations reveal a 9000-year-old human burial with hunting and animal processing tools.
Osteological analyses indicate that this early hunter was a young adult female who subsisted on plants and animals. The findings are consistent with nongendered labour practices in which early hunter-gatherer females were big-game hunters. Despite such theoretical considerations, some scholars have been reluctant to ascribe hunting functionality to tools associated with female burials (Haas *et al*., 2020).

With colonisation and the arrival of European cultures, the North became a male led society a place to be exploited. Nowadays, Arctic Indigenous female artists dismantle this myth, testifying to the vital role that Indigenous women have held, and continue to hold, in Northern communities. Likewise, women's labour, often unseen or underpaid, supports economies in Alaska as a whole (Anchorage Museum, 2020).

6 An Ulu is a very important tool for Alaska Native Peoples, used for cooking, cutting meat, skinning seals and cutting and marking patterns for sewing. While regional styles and materials vary, all ulus share an elegant crescent shape designed to reduce wrist fatigue during long hours of processing food and skins.

Figure 3.24. An Inuit woman and her daughter fish through a hole on an icy expanse in Alaska.
Photographer: Evans.
Figure 3.25. Kenyan women tanning fish leather at Victorian Foods tannery.
Photographer: Luis Tato. ref: www.victorian-foods.com

Coral Chernoff - an Alutiiq artist I met in 2019 in Kodiak Island, Alaska - is a good example of a contemporary hunter-gatherer Arctic Indigenous female. Her studio overlooks Kodiak harbour where she has created a 'cabinet des curiosités' filled with the skulls and pelts of animals she has hunted and tanned over the years. Coral works in many mediums. She is particularly drawn to the beauty of natural materials and much of her artwork highlights the qualities of the skins and fibres she uses. She hunts, fishes, gathers and process all the animals and grasses that she utilizes on her work: from birds to deer, caribou, ermine, porcupine, sea lion, seal, salmon and tree bark. In addition to all this, Coral is a skilful seamstress and has sewn many exquisite gutskin parkas for international museums. She is also a board member of the Kodiak Fish and Game Advisory Committee safeguarding the traditional subsistence uses of migratory birds in Alaska.

Contemporary Ethical Fashion initiatives harness the power of fashion as a vehicle to empower female artisans in third world countries. Fish leather could become a way to improve women's livelihoods in fishing communities without compromising their food security. Kenya's Victorian Foods working with FAO's Fisheries and Aquaculture Department, uses the skins of Nile perch fished from Lake Turkana, the world's largest desert lake. After three years in operation the company now produces 400kg of leather per week. They have created a new revenue stream for the community and local fishermen, who now get 30% more for each fish they sell. The company employs 10 women (Figure 3.25) at the tannery and is working to train an additional group to manufacture fish leather goods (Timmins, 2019) (Table 3.1).

3.9 Fish skin as a mark of identity

Wearing fish skin or having the ability to work with fish skins can be a mark of identity, reinforcing a person's relationship to their own culture (Jackinsky-Sethi, 2014). As a cultural expression, Arctic clothing design provides the social mirror that binds communities together through a shared ideology. Across the Arctic, animal skin clothing displays the ecology of the region and the social identity of the group (Driscoll-Engelstad, 2020). Decorative motifs identify local communities and even families. Specific design features differentiate men's and women's garments. Across the North American Central Arctic, clothing is specific to each gender and age group. Certain design elements mark the passage from childhood to adolescence and so to adulthood (Driscoll, 1983). Seamstresses encoded references to gender, social roles and spirituality to everyday and shamanistic garments. Arctic clothing is more than a link to the Arctic culture, it negotiates kinship, gender and spirituality. It expresses individual identity and group affiliation and represents one of the major categories of material culture available because of its visibility and proximity to the body (Martin, 2001).

Fletcher (2016) argues that specific garment choices can promote a connection between people and place forging community. Fashion plays a key cultural role in society. At a personal level, fashion enables people to express their individuality through clothing and at a collective level brings connection and belonging (Jacobs, 2020). While it is an important cultural and personal language, we over consume to make visible our identity, our in grouping and economic worth through changing dress (Fletcher, 2016). Change is the central and unfortunate principle of fashion.

3.10 Fish skin, an emotional connection

Arctic women spent countless hours turning natural materials like fish skin into beautifully decorated clothing. According to Cevoli (2015), the Nivkh woman cutting the fish and scraping its skin (Figure 3.22), enters into a close relationship with the material in a long physical process of both secular and spiritual knowledge (Table 3.1). Up to two centuries ago, women knew the history and origin of every one of the limited amount of things they ate and owned, as well as the history of the people and tools involved in their production (De Botton, 2010). Producing beautiful, functional fish skin garments involved ecological knowledge and strong relationships between people, animals, and weather. Given the effort to make this clothing and the relationships involved, Arctic Peoples made sure that these precious items lasted. Yup'ik seamstresses knew that if stored in a cold place, folded carefully, and put away dry, a good fish skin parka could last for many years. Large fish skin bags were made specifically to store clothing and were often given to a newly married Yup'ik woman (Lincoln, 2020a).

Fletcher (2016) argues that nowadays we are not able to distinguish one material from another nor to see their value and quality. The majority of people do not know how garments are made and do not appreciate the fine detail. Lately, younger, and older consumer groups are becoming increasingly more educated and informed about the overall nature of their clothing, their patterns of consumption, their origin and where they may end up at the end-of-life cycle. This research into fish skin as an alternative to less environmentally friendly fashion practices links with this philosophical change in 'consumerhood,' and is reflective of broader evolving consumption practices. This close relationship with the material in fish skin contrast sharply with contemporary consumerism in the fashion industry, where, according to Chapman (2005), by cultivating
an emotional and experiential connection between person and object, we can disrupt our dependency on consumption of new goods. Emotional durability could be enhanced by involving the user in the making of their garment. Fletcher agrees that participation of the user in the construction of their clothing can create an engagement with the garment. Williams argues that contemporary sustainable practices are defined by the recognition and valuing of the time taking to produce the garment - both by nature producing the raw materials and by the craftsperson who process them (Williams, 2018). Fletcher (2016) believes that the wearer can infuse a garment with human warmth and memory, providing satisfaction and aesthetic pleasure and increase motivation to use and keep it well.

3.11 Fish skin storytelling

Myths, legends, and storytelling have been part of the Arctic culture for millennia. Storytelling has been passed down across generations through oral culture. In the long harsh winters, people gathered at home around the fire. These indoor times were used resourcefully. Hunters and fishermen would make and mend tools to prepare for good weather, seamstresses would sew and mend garments. Elders would tell hunting stories to share their expertise across the generations. Listening to elders' stories reinforced the importance of storytelling in the survival of oral culture. Arctic Peoples use storytelling to pass on skills, knowledge, morals lessons and expertise.

A fish skin seamstress would use her personal anecdotes of living in the Arctic, incorporating traditional spirit creatures and tales of the supernatural into her narrative. Nature plays a main role in the storytelling. The majority of stories are set in winter. Animals are the protagonist and the main theme. The animals embody the Arctic Indigenous Peoples' beliefs and taboos of a particular tribe or clan. Guidance for the everyday life is an important aspect within many Native Arctic stories. Contemporary Arctic Peoples apply the lessons in Arctic storytelling for modern life.

Part Two: Fish skin, resourcefulness of Arctic Indigenous Peoples

Figure 3.26. Woman ice fishing with a baby on her back and a pile of fish next to her. Mrs. Keok, Wales 1916.
University of Alaska, Anchorage, USA.

Part two: Fish skin, resourcefulness of Arctic Indigenous Peoples

3.12 Fish as a means of subsistence

People living outside the Circumpolar North often imagine the Arctic as barren. There are lean seasons during the dark winter months, but they alternate with periods of extraordinary abundance. Continuous daylight during the summer brings a multitude of berries, grasses, mushrooms, and sea algae, which attracts salmon (Lincoln and Loovers, 2020, p.50). Arctic Peoples harness this abundance to survive the winter. Because the Circumpolar North does not support agriculture, historically, Arctic and Sub Arctic diets and livelihoods have relied on a combination of herding, hunting, and fishing (Figure 3.27), following seasonal patterns of animal migration. Seasonal weather determines when hunting and fishing activities take place and fishermen might make journeys from their villages to fishing grounds by crossing land or sea ice.

Men typically are the hunters and fishermen, but women play equally essential roles, preserving and preparing food. Although today Arctic Peoples participate in commercial fishing, tourism, and industry, most maintain some connection to their traditional subsistence economy. Fish has been part of the subsistence system of human cultures as a source of animal protein and fat since the Palaeolithic period. The role of fishing has been determined by the availability of fish and some Arctic coastal cultures have evolved greater dependency on fish than on other food sources (Vávra, 2020). Flesh and fat are not the only resources fish can provide. Bones, bladder, skin, and scales have all been used since ancient history.

Accessing traditional foods like salmon is a concern for Arctic Indigenous Peoples. Even today, there are elders in the Arctic who have experienced and remember starvation (Table 3.1). Today, locally hunted, and fished food is preferred, but in the event of low animal populations other food sources are sold in stores and there are government programs for those in economic need.
To this day food security concerns persist. Food is nourishment, but for hunters and fishermen, delivering and serving food is also a demonstration and manifestation of their cultural identity.

3.13 Traditional salmon fishing

Salmon, specifically, has traditionally been of great importance to the local economies and cultures of all the Indigenous groups covered in this PhD. Native North Atlantic peoples in the U.S. and Canada, Northeast China, Hokkaido, Japan and Russia. Each national government has similarly mistreated the local Indigenous populations by restricting their people’s access to traditional fishing in order to force them to adopt non-traditional ways of life, such as farming, through cultural assimilation (Roche and McHutchison, 1998). The Ainu (Figure 3.27), Hezhe and Nanai Indigenous Peoples were forced into mass agricultural labour during the late 19th Century.

Figure 3.27. Ainu couple salmon fishing in a local Hokkaido River as an Aboriginal right and traditional livelihood activity. Kumaneko Hall.

All these Native groups were soon living as a second-class minority among the Japanese, Chinese or Russian labour forces; and their traditional hunter-gatherer lifestyle disappeared. Indigenous communities across the world are still dealing with the effects of the historical trauma of centuries of colonisation. In this last century, they have demonstrated resilience to exploitation and to the dramatic ecological changes in seafood security (Watterson, 2019). The protection of the fishing rights of the Native Arctic Peoples is a prerequisite to saving the fish skin craft but there are still some unresolved problems for the Ainu in Japan and the Scandinavian Saami.

Life in the Arctic is structured seasonally, based on the careful management, and use of available resources. Food is sourced around subsistence cycles and ceremonial rituals are organised not by calendars but by seasons. The resources of plants and animals are highly seasonal and Arctic people rely on their harvest each year. Current weather changes linked with global warming make it difficult to predict the availability and location of resources (Cooper, 2020, p.21).

3.14 Fish skin: a precious resource

Historically, resources were both scarce and precious so no part of an animal went unused; it might mean the difference between life and death to a community. In addition to drawing nutrients from animals, Arctic Peoples have always used the non-edible parts of animals in creative and skilful ways (Table 3.1). This resourcefulness reflects also an important moral position shared among Arctic Peoples that, the whole animal taken is used and no parts are wasted.

Historically there were no stores in the Arctic from which to purchase materials, so each family had provided for its own needs. Seamstresses rely on what is available to them for clothing and food. Salmon is a reliable source of nutrition and raw materials for the Indigenous Arctic Peoples identified in this PhD study. For them, few animals have been honoured as much and for as long as salmon. After the flesh was eaten, seamstresses took care of the inedible remains of fish with imagination and innovation. Alaska Native women used salmon skins to sew clothes, boots, bags, blankets and tents, Nivkh and Nanai women used bones as decorative elements in clothing and carved into useful items like needles. Hezhe women used fish bladders to create glue to join skins together. No part of the fish went unused. The practice of using the whole fish promotes artistic creativity to generate beautiful and useful objects (Golovnev, 2020).

In the rites for the dead, the Yup'ik gave special attention to human actions that might open passages between the worlds of the living and the deceased. The thoughtless human action of wasteful eating was deemed to block these passages and create unwelcome obstacles between these worlds. Appropriate boundaries, such as covering the corpse with leftover food, would allow the dead to pass between the worlds. The food scraps acted as boundary maintenance devices and protective coverings that allowed people to reach the underworld (Fienup-Riordan, 1994).

In modern industrialised societies, we have grown distant from the sources of our food, taking what we like and discarding the rest. Processed foods have increasingly come to replace the old ingredients in the Arctic too, from convenience and enforced by colonial convention. This attitude is slowly changing, although seasonality and localism have become available only for those individuals who can afford it (Mishan, 2020).

A fundamental precept of sustainability is minimal waste. Fletcher defines an economic activity by ecological limits, switching attention to qualitative development without quantitative growth. Her 'Craft of Use' theory encourages less consumerist forms of fashion activity (Fletcher 2016).

3.15 Shortage of raw materials

The shortage of raw materials like fish skin in conjunction with improved access to alternative materials like cotton and silk, have challenged the preservation of the fish skin craft (Malloy, 2008). Women, who were responsible for the production of garments, now have other priorities and have substituted fish skin (Figure 3.38) with less time-consuming materials with the 'same qualities' like PVC (Figure 3.39), readily available in the stores. And so traditional knowledge is rapidly losing its place in a new way of life. Shirokogoroff (1935) argues that if a natural resource is reduced the skills and technology connected to it may be lost. This is seen in contemporary fashion practices, where new cheaper materials are incorporated, and older processes disappear. Fletcher urges us to reconnect with our materials and making, to produce garments that are based on values, on skill and on carefully sourced fibres (Fletcher and Tham, 2019). Fashion has to be mindful of resources, and there is marked change in this regard, as both brands and consumers become aware of current overconsumption patterns.

3.16 Fish skin seamstresses' skills

For centuries, skin processing in Arctic cultures has been an important female role of creativity, labour and love. Clothing was specifically tailored to the wearer and skilled seamstresses were cherished for their expertise. By harnessing weather conditions through the appropriate use of materials, women have manufactured garments that could keep their husbands dry while hunting and allow their children to play in the open air, giving them freedom of movement (Lincoln, 2020a, p.141).

Ethnographic literature of fish skin production mentions women as strong tradition bearers, with great knowledge of fish skin tanning technology, and artists in this field. Knowledge is passed down through generations, mainly through the female side of the family. To marry an exceptional seamstress was always the wish of every Arctic Indigenous male. Without well-crafted clothing, a hunter had no hope of surviving storms and harsh temperatures. If the husband was a good hunter or fisherman, he would bring back home many skins to be made into clothes. If the skins were of poor quality, the skills of a good seamstress would be thoroughly tested. Equally, if a woman was a poor seamstress, the good quality of these skins would not make any difference. In this manner, superior sewing skills gave a woman prestige (Driscol, 1983). A good seamstress was always perceived as a woman with a special talent, particularly recognised and put forward in these societies (Cevoli, 2015). These women, the skin sewers, were vital to survival and treated with great reverence. In the past, when conflict arose from outside invaders, these women were hidden in secret caves so they would not be harmed (Nelson, 1899). A women would wear a strip of salmon skin as an amulet, a reminder that her even stiches should follow the rhythm of the scales of a salmon. By attempting perfection through her stitches, they imitated nature's perfection (Driscol, 1983). To make such intricate garments, fish skin seamstresses needed numerous skills, such as tanning, dyeing, cutting, and sewing patches of fish skin. Wachowich (2018, p.33) in her tribute to the legacy of Leah Aksaajuq Otak (Igloolik oral historian, curator of Inuit heritage and key player in the British Museum's Annuraaq Inuit costume exhibition) quotes Leah's words: "A great seamstress, must master all trades, being at once artist, designer, biochemist, zoologist, climatologist as well as always a grandmother, aunt, sister, mother, and daughter".

Similarly, a movement is now emerging where biologists and designers are attempting to replicate systems that exist in nature and apply them to their design practices. Designers are beginning to collaborate with scientists to define and create the clothes of the future using biomaterials (Table 3.1). Suzanne Lee in the early 2000s coined the term "biocouture" when she began growing fabrics using yeast, bacteria, tea, and sugar (Roberts-Islam, 2019). These will be the clothes of the future.

The historical technologies of Arctic clothing and Arctic seamstresses' skills have been praised with justification, as the most suitable apparel ever developed for a cold climate, and the best-known item is the parka. During colonisation, explorers were vulnerable to inclement weather, and a well-stitched fish skin parka from the Alaskan Natives could save their lives. Lightweight and warm, it doesn't wear out quickly or tear easily. Without the knowledge of the local climate and the material technology that the Inuit shared with the Arctic explorers, they would not have been able to survive. Afterwards, Arctic inventions and technology, such as parkas, were adopted worldwide. We have to thank Alaska Natives for the existence of this outerwear garment (Lincoln, 2020a, p, 222). Many big-name outdoor clothing companies, including Patagonia and North Face have borrowed from ingenious designs from Inuit seamstresses – a gift they have shared with the world. Much of today's high-street fast fashion is made with cheap materials poorly constructed, creating garments which fall apart and need constant replacement. Preservation of scarce natural resources could be achieved by making use of skills, and community knowledge (Fletcher, 2016) a prototype that can be found in the Arctic expertise.

As with Arctic societies, nowadays we value the expertise of the trained craftsperson. If a garment is well made of delicate handwork, it will be honoured by the wearer (Fletcher, 2016). In Haute Couture fashion houses, the treasured *petites mains* (tiny hands), are artisans creating exquisite

Figure 3.28. FSalmon skin ball by Yup'ik artist Maggie Separy of St. Michael, Alaska. Alaska State Museum, Juneau, Alaska, USA 2019.
Figure 3.29. Fish skin doll by June Pardue. Alutiiq artist. Alutiiq Museum. Kodiak Island, Alaska, USA, 2019.

handwork that transforms a designer's dress into a sumptuous luxury item. This community of artisans make the magic of the Haute Couture season after season. In this world, not only the creativity and innovation of the fashion designer are key to the development of a collection, but also the capability of the team of *petites mains*. Like the Arctic fish skin seamstresses, Paris Couture houses are part of a tight community of traditional artisans who are responsible for the production of the seasonal collections. Unfortunately, these incredibly skilled artists are slowly losing their rank and status amongst Parisian fashion houses as well as their artisanal methods. Their craftsmanship and respect for tradition is dying because of the use of cheaper materials and newer processes (Palomino and Káradóttir, 2021).

In the past, Arctic children would learn adult skills by playing with small replicas of their parents' tools and by making their own toys. Boys would make fish skin balls stuffed with reindeer hair (Figure 3.28). To stay fit during the long winter nights, Inuit groups would hang a ball from the ceiling and kick it from a chair. These contests are still happening today every two years, hosted by different Arctic communities as the international World Eskimo Indian Olympics (Lincoln, 2020a, p.137).

Girls would learn their mothers' sewing skills by making their own dolls. Dolls were not just for playing, they were models of adult life in miniature, and they would teach children by giving them a chance to enact adult behaviour and the roles of men and women in society (Lenz and Kidwell, 2004). Doll making would take the material leftovers from large projects such as the construction of adult garments from fish skin (Figure 3.29). Since resources were both scarce and precious, Arctic seamstresses taught their daughters to value the material by making sure that no part of the tanned skin went unused.

3.17 Fish skin pattern cutting

The connexion between Arctic fish skin clothing and minimal waste pattern cutting has also been explored by Cevoli (2015). Arctic clothing reflects the efficiency and technical skill of Indigenous seamstresses in the use of animal resources (Driscoll-Engelstad, 2020). Arctic women economically combined the materials while making fish skin garments. Each garment was made from the results of several weeks of fishing, processing, and sorting of skins obtained by an entire family or tribe.

The fish shape and its qualities gave form to Arctic fish skin clothing. The garment was constructed according to the fish skin shape (Figure 3.32 and 3.33); every skin fitted with the next like a jigsaw where nothing was wasted (Jackinsky-Sethi, 2014). The pattern was made according to the length and shape of each skin and not by cutting pieces of a flat continuous sheet as in woven textile construction. These ancestral artisans were unwittingly enacting contemporary concepts of zero waste, an alternative pattern cutting technique where the pattern pieces are designed to fit together so that no fabric is wasted during the cutting phase. Fish skins have a unique rectangle

Figure 3.30. Fish skin pouch. Aleut (Unanagax). 1921 NMNH, Smithsonian Institution, Washington DC.,USA, 2019.
Figure 3.31. Fish skin pouch. NMNH, Smithsonian Institution. Washington DC., USA, 2019.

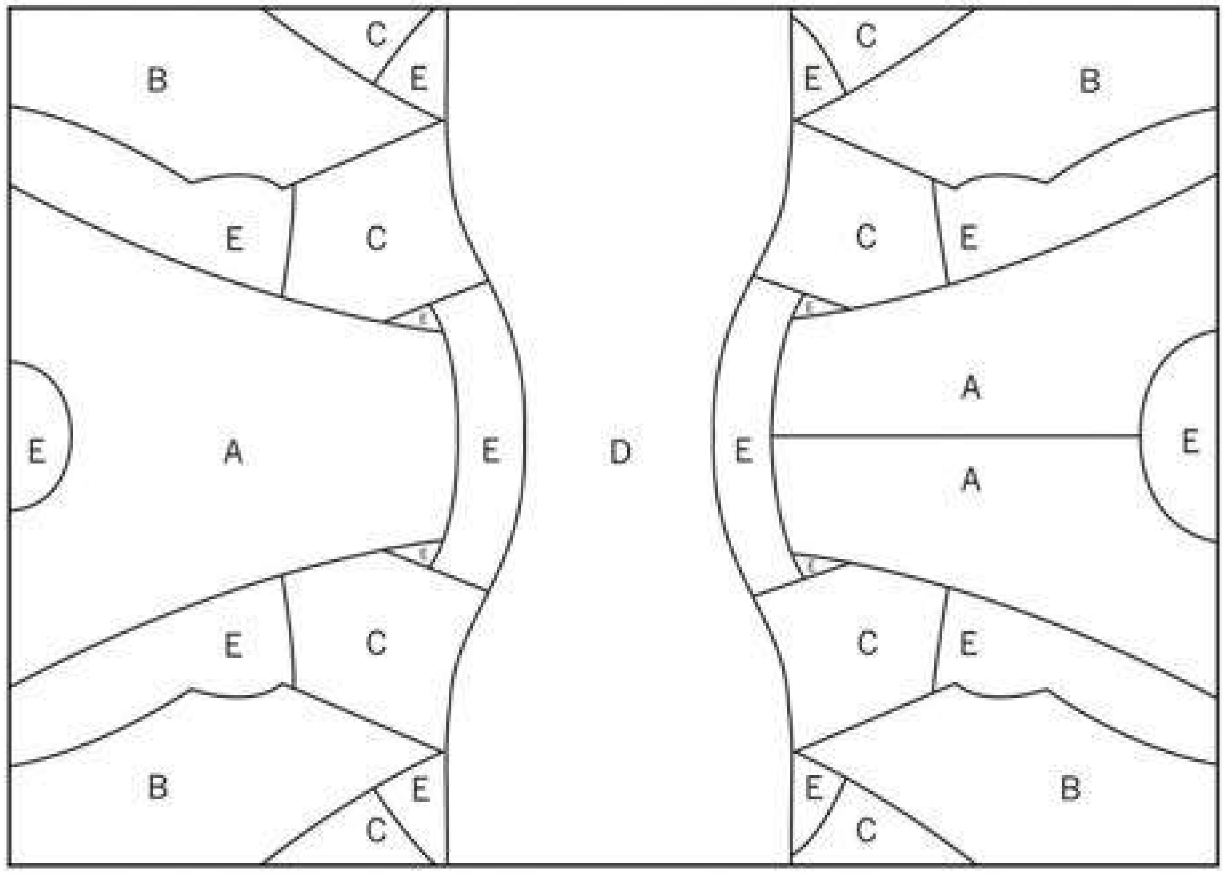


Fig. 3.32 Gilyak fish skin coat from the lower Amur River near Vladivostok in Eastern Siberia.
©Victoria and Albert Museum, London.
Figure 3.33. Zero waste pattern cutting.

shape, with two long sides and two short ones (one longer than the other). Since each fish has two sides to its body, fish skins come in pairs of left and right, which can create a symmetrical repeat between the two sides of the body. This theory is further developed in my publication 'Making fish skin pattern-based garments: developing digital tools for the fashion industry based on Ainu Indigenous tradition'. The paper shows the potential of using parametric tools for material conservation and zero waste integration of fish skins in garments (Palomino, 2021b).

Arctic light is extreme. The sun never sets in summer and barely rises in winter. The seasonal contrast between light and dark is fundamental to Arctic life and Arctic Art (Driscoll-Engelstad, 2020). This play of light and dark is a motif used by Arctic seamstresses, contrasting the white skin of the fish belly against the dark skin of the dorsal area. Specific design references within the body of the garments are created by contrasting the light and dark areas of the fish skin. The natural appearance of fish serves as an inspiration in the creative design of fish skin clothing and accessories. The design of these two salmon skin bags from western Alaska (Figures 3.30 and 3.31) have carefully worked with the shape of the fish's fins to create a pattern. The holes left by the fins have been filled with the oesophagus of a seal. The seamstress has utilized leftover pieces of the animal carefully, wasting none of this precious material. The work of the seamstress demonstrates attention to the longevity of the materials, knowing that some materials would support more wear than others. According to Fletcher (2016) durability is an outcome and not an aim of product choice. A reasonable lifespan is needed to satisfy the user and durability is linked to performance rather than products.

3.18 Repurposing materials

Repurposing brings a new life to something already used, and contributes to decrease textile waste, offering an opportunity in contemporary fashion to reduce the use of non-renewable resources and the negative impacts of the fashion industry. This sustainable aspect also has fish skin precedence. When out in the wilderness, a man's fish skin parka (Figure 3.34) could keep the hunter warm and protected in his pursuit of the animal, but also it could also become a tent or a sleeping bag at night adapting it to best maintain its function as a protective cover against wind (Jackinsky-Sethi 2014). In the winter, Yup'ik[1] men never left home without qasperrluk— very loose-fitting fish skin parkas, with very large hoods —which could double as shelter in an emergency (Table 3.1). When preparing to camp in the wilderness, to sleep on the ground, the men would stick the ice pick into the ground and put the parka over it. They put the hood over the end of the ice pick, so that the air could come out, and tucked the sleeves inside. Then they would spread grass to make a mattress on the ground and tuck the parka with weights around the bottom edges. The parkas were very ample and sometimes up to three people could sleep inside them (Fienup-Riordan, 2007). The Pogosky Nivkhi and Oroki-Evenki Collection at the Chicago

1 The Yup'ik are a group of Native Peoples of western, southwestern, and southcentral Alaska and the Russian Far East. Yup'ik women made clothes and footwear from animal skins of marine and land mammals including fish, sewn together using needles made from animal bones and threads made from sinew from caribou tendons.

Figure 3.34. Fish skin hood. Alutiiq 1921. NMNH, Smithsonian Institution. Washington DC, USA, 2019.
Figure 3.35. CP Company's Sleeping bag designed by Moreno Ferrari from the "Transformables" line .ref: www.cpcompany.com

Field Museum of Natural History contains a conical fish skin tent cover from late 19th century used by the Oroki in both winter and summer (VanStone, 1985). According to Osgood (1940) the Athabaskan on the lower Yukon used fish skin blankets to protect themselves from the rain during activities such as canoe-building.

Similarly, contemporary sportwear brands such CP Company innovate with functional garments. In 2000 they released the "Transformables" line (Figure 3.35) consisting of dual-purpose pieces that could be 'transformed' instantaneously. One of their bi-functional garments is an entirely weather resistant coat designed also as a protective tent and air-mattress. The Sleeping Bag Jacket can be transformed from a hooded jacket and shoulder bag into a full-length sleeping bag with the use of a single zip. The designs fit to the wearer's requirements in different conditions.

Another previous historical use of fish skin outside fashion apparel was on the construction of windowpanes. In 1432, Venetian nobleman Pietro Querini (Querini *et al*., 2007) shipwrecked off the coast of Røst island, *Nordland* County, *on* the *Lofoten* archipelago, Norway. Him and the remain of his crew remained there for a month until they were rescued by fishermen. On their return to Venice, Pietro Querini, Nicolò de Michiele and Cristofalo Fioravante passed on to posterity the story of the lifestyle of the inhabitants of the Lofoten Islands. Querini wrote in his journal: "The houses have only one window located in the middle of the roof, and since it gets very cold here in winter, they have covered them with large fish skins. The skins have been prepared in a way that allows light to shine through them" (Jonassen, 2021). Berg, in his essay on the use of fish skin in northern Europe, mentions that Swedes and Russians used burbot skins to patch cracks in windowpanes by virtue of their transparency (Berg, 1984, p. 99). The Lofoten Islanders in Norway and the Hezhe Indigenous Peoples in northeast China took advantage of the windproof and translucent qualities of fish skin. Thinner-skinned fish such as burbot were especially suitable in the Yukon-Kuskokwim Delta (Alaska) for the construction of window coverings (Stefánsson, 1914).

Nowadays technology in the fashion industry emphasizes the importance of innovation and design. Long before these concepts became mainstream, Indigenous communities valued and practiced these beliefs. Nomadic minimalism meant that everything beautiful must also be practical. Arctic practical inventions—such as making garments from fish skin or applying fish oil to waterproof their canoes and fish skin shoes—demonstrate an advanced knowledge of science, technology, and innovation. Arctic explorers were impressed with the innovative technologies they came across, often adopting them, including parkas. This Indigenous wisdom can be traced back across more than 15,000 years of experience. This knowledge is in the Arctic's peoples' DNA, passed down for generations, and it is alive in every Indigenous person I have met.

Fletcher (2016) advocates for garments to be reworked to meet changing needs. She argues that the knowledge and skills to adjust a garment to fit the wearer makes the individual more

Figure 3.36. Salmon skin Ainu robe (detail). Botanic Garden & Museum(HUNHM), Field Science Center for Northern Biosphere, Hokkaido University, Sapporo, Japan.
Figure 3.37. Salmon skin Ainu robe (detail). Botanic Garden & Museum(HUNHM), Field Science Center for Northern Biosphere, Hokkaido University, Sapporo, Japan.

self-assured and the society more confident. Adaption encompasses both multifunctionality and proper tailoring and modification to the individual's body and needs. By promoting garment adaptation, we explore resourcefulness and replace consumption with action. The multiple functions of a single garment helps the longevity of a piece that might not seem immediately apparent. The recent attempts to reduce the profligate resource consumption of the fashion sector, has seen new opportunities to donate and reuse garments at the end of a first life have arisen (Fletcher, 2016). This repurposing is a third variation of multifunctionality and adaptation.

3.19 Fish skin clothing could avoid starvation

In the past, starvation was an ever-present threat in the Arctic. If men were out hunting and their return was delayed, with absolutely nothing left to eat, women and children could survive by chewing their fish skin garments (Figure 3.36). Even men out in the woods could toast a fish skin sleeve from their parka to satiate their hunger (Wilder, 1976) (Table 3.1).

This extra quality of being able to eat your own garment in extreme situations finds its reverse in contemporary society with the current need to substitute dominant fibres with more sustainable materials. These fibres derive from biomass sources including algae, mushrooms, kombucha, sugar cane, pineapple leaves, grape seed or citrus peel and biodegradable synthetics like corn starch and soya bean fibre. Arctic Indigenous Peoples used their clothes as food, we are using our food as clothes.

3.20 Salmon transient journey

Salmons live most of their lives in the ocean, yet they return home to reproduce and then die in fresh water. Salmon migrates upstream to spawn in June, July, and August. For most of the salmons, the up-river fight is a one-way trip. Some of the salmons are eaten by predators like brown bears on their way up to the spawning grounds. After spawning they experience a sudden aging, and they die where they were born. The decaying bodies of the salmon fertilize the stream and create an environment which favours the growth of the young fish. Their carcasses return essential nutrients to the water, forest, and ecosystems. Once more the salmon brings life after death to their offspring, the water, and forests (Heinrich, 2012).

3.21 Fish skin: A High-performance material

When making a garment, Arctic seamstresses would choose the best materials and they would construct a strong garment so it could resist damage from the weather: rain, humidity, wind and from the wearer: sweat, friction and erosion. Arctic seamstresses have built up a vast amount of climate knowledge. Passed down through generations, this knowledge on how raw materials respond to weather elements informs every step-in skin processing and garment sewing. Women would piece together fish skins with thread made with caribou sinew or fish skin. The best material for sewing garments, footwear and mittens was considered by the Udege people

in Siberia to be the skin of a chum salmon (Melnikova, 2005). When the thread made of sinew or fish skin gets wet, it expands and fills the hole made by the needle, making the seams watertight (Rajagopolan and Buijs, 2003). Women across the Arctic working with natural materials have devised construction technologies that retain body heat while wicking away moisture (Lincoln, 2020a, p.123). Fish skin provides excellent insulation, protecting the skin of the wearer from the draughty, frosty air, preserving heat very well (Table 3.1). In the past, fish skin was worn over bare skin. When rubbing against the skin, it could remove sweat and dirt. Fish skin parkas were tailored with a loose fit that allowed for air circulation around the body, creating pockets of warm air that conserved body heat.

In addition, loose-fitting clothing could be layered over other garments if needed, to adjust to changing weather conditions and the activity of the wearer. Fish skin parkas (Figure 3.38) were worn over caribou fur parkas for added warmth. This ingenious method of insulation relied on an in-depth knowledge of fur and fish skin properties – caribou fur retains body heat as the hair is hollow (Lincoln,2020a, p.123).. Loose-fitting clothing could be worn by the small and the large so it could be shared easily between people. Fletcher argues that sharing clothes saves resources since fewer pieces are bought. Sharing is also reinforced by a bond and joint identity, and it reinforces in its turn (Fletcher, 2016).

The early fish skin garments efficiently solved the problems of utility (Martin, 2001). These fish skin parkas (Figure 3.38) were identical to the layering systems of contemporary mountaineering gear and a predecessor of contemporary athletic garments. To increase ventilation and to retain their heat- keeping ability even when wet, current material developments in athletic apparel include naturally breathable materials.

Fish skin is light, flexible, strong, and easy to work—the GORE-TEX (Fig 3.39) of its day (Jude, 2016). In the early 1970s, most commercially available windproof sportwear gear was made from heavy wax or oil-treated cloth and PVC-bonded cloth. PVC did not allow perspiration to escape, creating a clammy feeling for the wearer. GORE-TEX mimics the properties of fish skin allowing heat and sweat to dissipate without getting in the way of the body's natural ability to regulate its temperature.

Fish skin footwear (Figure 3.40) was designed to insulate from Arctic weather (Jackinsky-Sethi, 2014). Fish skin has high levels of breathability (further explored and tested in the material analysis of chapter 6), much higher than conventional leathers, other textiles, and synthetics. Ainu, Hezhe, Alaska and Siberian Natives knew about this quality and crafted their boots with fish skin. Arguably the fundamental role of a shoe is to keep the foot warm and dry and allow comfort and efficient of movement. Fish skin is antibacterial and even more breathable than the cowhide used in shoes and, of course, much more breathable than plastic shoes. In 2006, Nike created a trainer capsule collection made of perch leather (Figure 3.41) taking full advantage of these qualities.

Figure 3.38. Pike skin parka for child from the Kuskokwim. Yup'ik. National Museum of the American Indian, Washington DC, USA, 2019.
Figure 3.39. Goretex parka by Yoshi Yamamoto. ref: www.highxtar.com

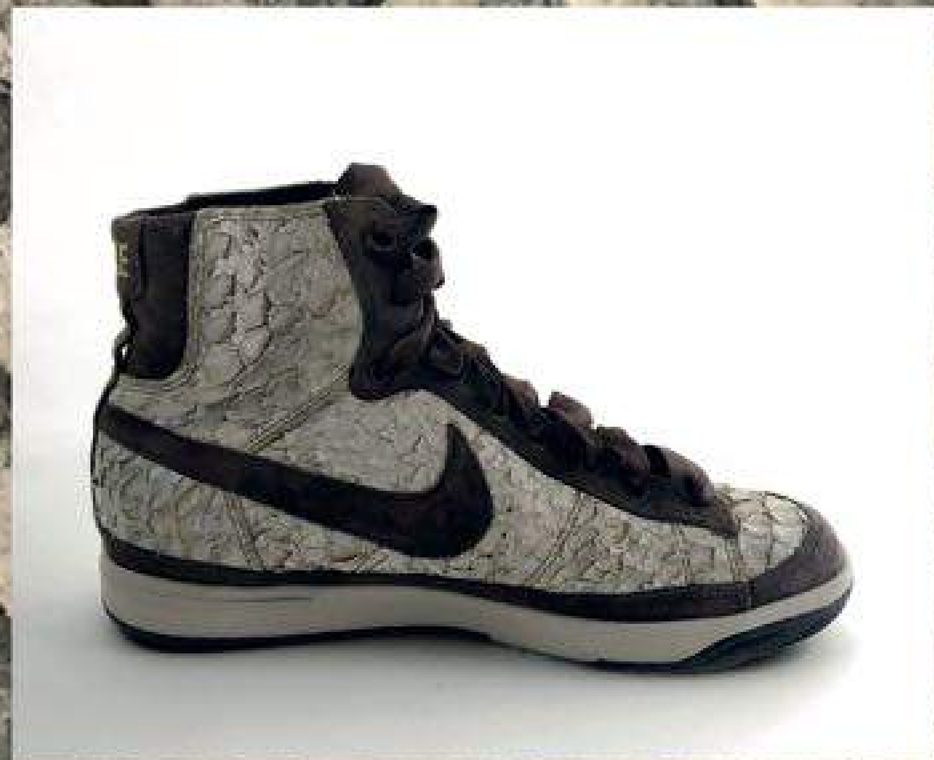


Figure 3.40. Salmon skin boots Ainu, Hokkaido, Japan. NMNH, Smithsonian Institution. Washington DC., USA, 2019.
Figure 3.41. Nike sneakers made of perch leather from Atlantic Leather, 2021.

The high breathability of fish skin, however, accompanies its lack of water resistance. According to Hickman (1987) it is the slime of fish removed with tanning that renders it waterproof. Once tanned for human use fish skin must be keep out the wet. Of all the Arctic's fish skin crafters the Icelandic alone make shoes only and not garments. They believed that fish skin if worn while fishing would 'disappear with its wearer and become part of the ocean once again' (Kristjánsson, 1986).

Ainu Indigenous Peoples generally designed specific footwear for specific frozen surfaces. Essential for moving through snowdrifts and grainy snow, snowshoes, like fish skin boots, distribute the wearer's weight to stop them from sinking into the snow. In the case of fish skin boots made by Alaska Natives, the scales would provide traction for the soles when walking across snow, ice, or slippery surfaces (Jackinsky-Sethi, 2014). While the Ainu would keep the dorsal fin intact while making salmon skin boots; the fin would promote good grip while moving through the snow (Figure 3.40).

Another traditional material used by Ainu and Alaska Native Peoples in combination with fish skin was the beach grass that grows along the shorelines of the Circumpolar North. The grass was harvested after the first frost in late autumn when the stems and tassels had wilted and dried (Kayano ,1999). In addition to providing insulation the stuffing also absorbed sweat. The grass was often woven into socks to provide insulation and to keep moisture away from the feet. Grass socks worn inside fish skin boots absorbed moisture and sweat and dried quickly when removed from boots. A precursor to today's moisture wicking sportwear socks.

Historically, during the fish skin tanning process, the seamstress could choose to remove the fish scales from the skins, but they were often retained for both functional and aesthetic purposes. In the case of mittens (Figure 3.42), they were usually left, since they provide good grip qualities (Vávra, 2020). Modern good grip working gloves (Figure 3.43) have printed plastic motifs on the palm, providing similar grip qualities as the fish scales.

3.22 Healing properties of fish skin

Traditional Arctic foods, like salmon, berries, and willow contain medicinal and healing properties such omega 3 and 6 which are very important to Arctic Peoples' wellbeing. They provide a good source of vitamin D lacking in the winter months, and they help joint lubrication.

Berg's study of the use of fish skins in northern Europe before the industrial revolution highlights eel-skins as prevention against rheumatism and gout in England, Ireland and some German-speaking countries (Berg, 1984). Garters of eel skin around the thigh were also worn in Suffolk to prevent rheumatism and cramp. Eel skins wrapped around the finger to ward off cramp were also a Scottish medical tradition. The eel had first to be killed, skinned and then dried out to keep its

Figure 3.42. Fish skin mittens. Kuskwogmiut Yup'ik. circa 1905. Kuskokwin river, Alaska, Calista Native Corporation. National Museum of the American Indian, Smithsonian Institution, Washington DC, USA, 2019.
Figure 3.43. Good grip working gloves. ref: www. legionsafety.com

coiled shape (Science Museum, 2021). Similarly, in the 13th century Mongolian Khagan, Kublai Khan ordered fish-skin slippers from Korea to heal his gout (Bartlett, 2009). In recent studies, researchers from the University of Auckland are now using zebrafish embryos to develop new anti-inflammatory treatments for gout (Hall, 2018). Exploited traditionally in Northern Europe and Korea we are now turning to it ourselves.

Kerecis, a company working in regenerative tissue, is using fish skin to heal wounds and tissue damage on patients. Fish skin provides a platform rich in Omega-3 polyunsaturated fatty acids into which healthy new human skin can grow (Wyke, 2021). This was used to help bears burnt in the Alaskan bush fires of 2019 and has been further tested humans since (Table 3.1). Fish skin and its traditional knowledge again is a tool to counteract man's negative impact on the environment.

Covid-19 has brought to light a new niche market: that of bio-intelligent materials offering breathability, anti-odour, temperature control and anti-bacterial properties. Fish skin has a very high collagen content that can act as a skin moisturiser boasting antimicrobial properties. Alaska Natives took advantage of these properties, wearing fish skin parkas next to their skin. Recently, Taiwanese company Umorfil has created a functional fibre using collagen peptides found in the scales of milkfish which has anti-bacterial properties (Dyson, 2016).

3.23 Arctic changing climate

Indigenous Peoples make up only 5 percent of the world's population, yet Indigenous lands and territories hold 80 percent of the world's biodiversity. Arctic Indigenous Peoples have lived with naturally defined seasonal weather for 30,000 years. Through adaptation and innovation, they have thrived despite dramatic, environmental and social change. Weather affects the food they eat, the clothing they wear, and the histories they share. Until recently, Arctic Peoples were able to harness the weather to support them through the seasons. Global climate change is rendering generations of weather knowledge obsolete. The Arctic is warming twice as fast as anywhere else in the planet. Global climate change is a huge challenge for Indigenous Arctic communities.

Ice hole fishing (Figure 3.44) is a way of harvesting food for the Arctic communities. Today, sea ice conditions and animal migrations are shifting due to climate change, disrupting subsistence fishing, schedules and quantities. Subsistence fishing, a key element for Arctic Indigenous Peoples to this day, would also be disrupted (Stuckenberger, 2007). If the Arctic Sea ice melts away, the dynamic relationship between animals, humans and ice will be lost. The Inupiat[2] of northern Alaska preserve dry salmon in underground ice cellars dug deep into the permafrost. As these natural fridges are disappearing due to global climate change, governments need to find environmental

2 The Inupiat, Iñupiat, Iñupiaq or Inupiaq, are a group of Alaska Natives, whose traditional territory roughly span norteast from Norton Sound on the Bering Sea to the northernmost part of the Canada–United States border and often claim to be the first people of the Kauwerak. They have a lifestyle that is heavily dependent on the subsistence harvest of marine mammals, land mammals, fish, and migratory birds.

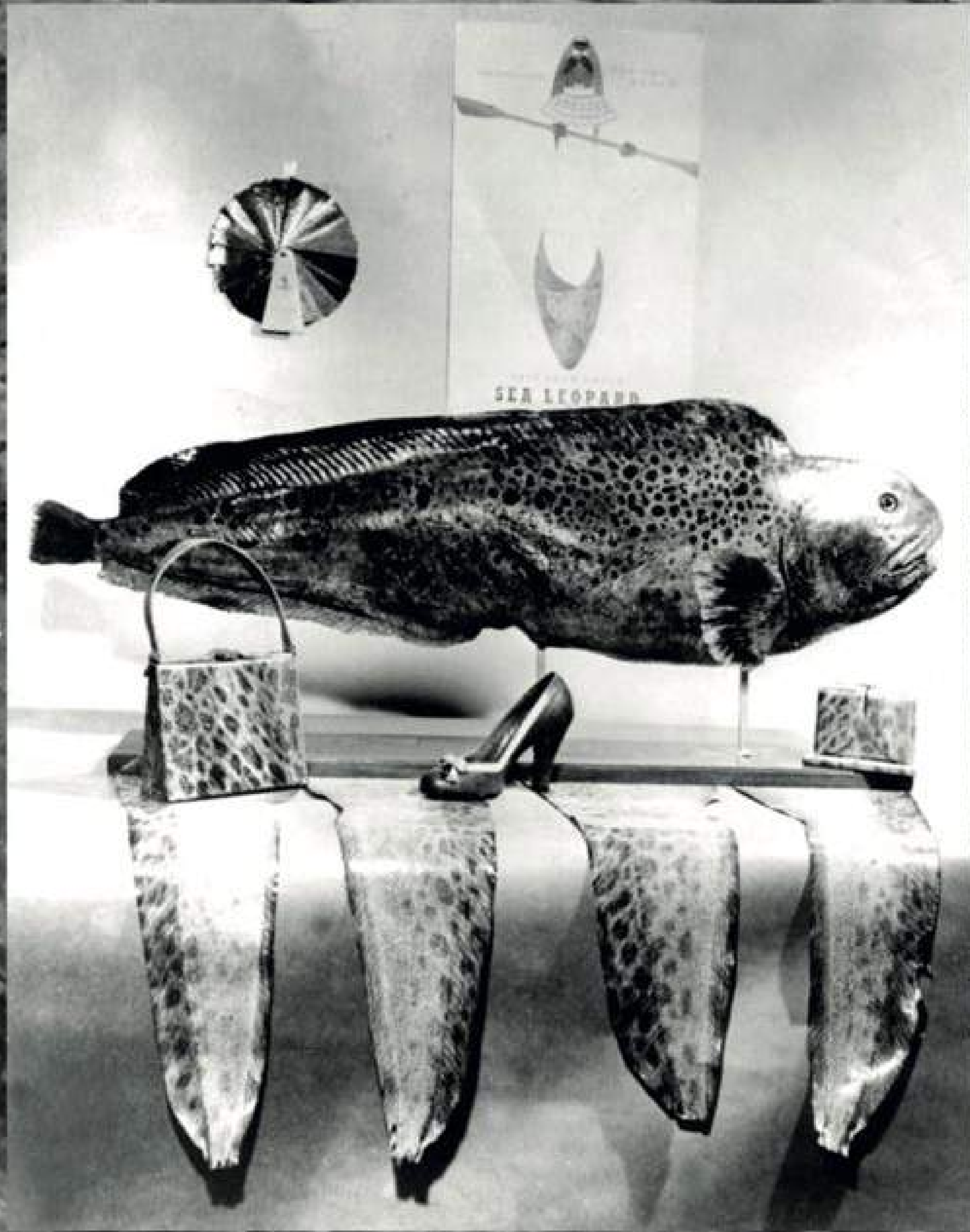
Figure 3.44. Winter fishing on Lake Baikal. ref www.alamy.com

solutions and reduce the impacts of climate change on the Circumpolar Arctic.
Salmon define the rivers, communities and culture of Alaska Native, Nivkh, Nanai, Hezhe and Ainu Peoples, they are magical creatures that uniquely connect ocean and land through their incredible lifecycle. Human activity - hydroelectric dams, industry, pollution, global climate change - has created challenges that even the resilient salmon struggle to survive. Wild salmon runs throughout the rivers of the Northern Hemisphere have drastically declined or completely disappeared in the past 50 years. Across the Arctic, different runs of salmon are listed as endangered or threatened, pressuring the communities that depend on them. Climate change and warming water temperatures on recently engineered dams built as part of water reservoirs, threaten salmon which depend on cold water and snowmelt. From commercial fisheries and tribal communities which have depended on salmon as food for generations, there are now not enough fish available (France, 2020). Arctic Peoples studied on this PhD had applied sustainable practices in salmon fishing for thousands of years but discarding these principles has led to the excessive depletion and near extinction of this species (Table 3.1). According to Fienup-Riordan (2020), for contemporary Alaska Natives, the challenge is not scarcity of subsistence resources, but access to them. In the past, a man, woman, old person or child could set a fish trap near their home. Today, they have to use motorboats and must earn money for fuel by working for the local salaried economy. Traditional fishing is linked to the ability to earn cash, which makes fishing unaffordable during Alaska's current economic hardship.

Modern industrialised societies considered most 'successful' have been the greatest cause of our current climate instability. Arctic Peoples, who have lived sustainably with the environment for millennia, are now experiencing the most dramatic impacts of global climate change caused by unsustainable practices elsewhere in the world (Cooper, 2020, p.21).

Figure 3.45. Salvatore Ferragamo 1954. Wolf fish skins, handbags and shoes. Copyright: Sipo Trading Company, Copenhagen. Courtesy Museo Ferragamo, Florence

Part Three: Fish Leather in the 20th Century



Part three: Fish leather in the 20th Century

3.24 Salvatore Ferragamo

Salvatore Ferragamo was the first designer of the 20th century to start using fish skin. In the late 1920s, Ferragamo explored the use of new materials in his shoes due to the growing popularity of exotic skins combined with calfskin or suede. Since the quality of these skins was far below Ferragamo's standards, numerous advances in leather tanning were made. The Italian tannery Salp in Rivarolo Canavese, Piedmont specialised in the tanning of fish skins, particularly of dentex but also salmon, cod, perch, wolfish, and snapper. In the mid-1930s, Salp made an agreement with Genepesca to supply them with the skin of fish, which once tanned, they marketed under the brand name 'Sirena'. Ferragamo bought the multicoloured dentex skins from Salp which, due to their small size, required great skill in cutting the uppers and manufacturing (La Calzatura, 1939). (Figure 3.46 and 3.47). Once again during World War II, Italy's international trade relations were interrupted by sanctions imposed against fascism. To overcome the lack of resources for the production of shoes, Ferragamo worked with humbler materials, replacing exotic leathers with fish skin (Ricci, 1997). In a more recent period during the 1990s, the Icelandic tannery Atlantic Leather would follow a similar method of sourcing their fish skins locally.

3.25 Sourcing local materials during WWII

During the 1940s, much of the world's production of basic commodities was directed into the war. Governments allowed some everyday needs to be made available but rationed them in an effort to prevent a total lack of necessities. The rationing procedure reduced the amount of leather available to manufacture shoes for civilians. The military had a high need for leather, not just for shoes and combat boots, but also for their popular leather flight jackets. As a result, citizens were forced to do with less leather.

The restrictions turned fashion designers, manufacturers, and women into experts in the art and craft of recycling and substitution. Inventive manufacturers introduced shoes made from unrationed materials, namely natural resources. This was the era of platform shoes with wooden soles. Cork, wood and old car tyres were used for making soles, while unconventional materials like offcuts of fabric and leather, furnishing fabrics, felt, fish skins (Figure 3.48 and 3.49), hemp, mesh, raffia, rope and straw were used to produce the upper of platform shoes (Morgan, 2018).

In Denmark, many industrial raw materials imported from overseas before the war became unavailable after the German occupation. The occupation forces in Norway and Denmark confiscated their animal hides and in order to optimise industrial production, the Germans set out to exploit their raw material reserves (Futselaar, 2008). The Danes and Norwegians drew on their fishing resources and substituted cowhide for fish skin to make belts, harnesses and accessories. Bright dyes and a textured surface enhanced the quality of the material (Wormald, 2018).

Figure 3.46. Dentex skin shoes. 1939. La Calzatura Magazine. ref: www.thehistorialist.com
Figure 3.47. Salvatore Ferragamo, Laced shoe, 1930. Dentex skin. Florence, Museo Ferragamo. Courtesy Museo Ferragamo, Firenze. Photograph: Christopher Broadbent.

During the war eel skin was used in industrial machinery for drive belts and lacing. Among the qualities of eel skin are its thinness, flexibility and extreme strength, providing a good sheath. Unlike other leathers eel skin splits lengthwise, prevented disastrous failures from occurring in industrial settings (Waxman, 2020).

Fashion was resistant to the crisis of the Second World War and in the face of limitations new trends and styles emerged. These fish leather accessories testify how when sources run low resourcefulness run high. The materials used to make shoes reveal how people coped with shortages of specific materials. If we applied that same inventiveness, we could bring a renewed spirit to the unsustainable world of fashion (Battista, 2009). Currently we will need to assess how consumers will adapt after coming out of the Covid-19 pandemic crisis, since history shows there can often be a collective shift in behaviour after periods of crisis.

3.26 Emerging themes in the historical use of fish leather

Through the historical context literature review, my research has endeavour to understand the of Arctic Fish Skin Heritage from an Indigenous viewpoint. And yet a more holistic consideration has evolved, influenced by findings related to the Arctic Animistic society concerned with man's role in nature as a component not as a master. Fish skin technological innovations are a living proof of the sustainability of different Arctic cultures, based on their life choices as on their resilience to a harsh environment. Fish skin craft narrates the connection between people and nature and the everyday objects and choices these people made in relation to their environment. They tell the story of how they choose to fish, to process the fish skins as raw materials, to harvest these resources for the best benefit of the community and the environment. This material cultural evidence demonstrates the ability of Arctic Indigenous Peoples to survive the Arctic, enjoying complex cultural dialogue with nature. The investigation of the fish skin traditional crafts has been done firstly tracing back to the Arctic Indigenous Peoples who developed them and then examining their myriad significance (aesthetic, cultural, environmental, social, spiritual and technological). Issues of gender, identity, ethnicity, and cultural contact have been examined through a focus on material culture, fish skin and dress identity. The roles of men and women in Arctic subsistence societies and creative approaches developed as sustainable responses to climate change have also been approached.

The table below shows emerging themes of resilience and resourcefulness using traditional Arctic fish skin craft taken from the literature review above. The strong relationship with the environment, subsistence lifestyle, the spiritual role of fish skin and the economy of materials could all benefit contemporary sustainable fashion practices. Although embedded within the holistic awareness of possible sustainable practices, this research does not intend to address all of these global challenges. Yet, the adoption of traditions, practices and properties of fish skin material could undoubtedly contribute to sustainable solutions within fashion.

Figure 3.48. and 3.49. Salmon skin shoes made by Eduard Rheinberger A.G. of Pirmasens in West Germany in 1940. Alfred Gillett Trust, Somerset, UK.

Emerging Themes	Traditional Indigenous Arctic Fish skin	Contemporary Sustainable Fashion Practices
1. Human connections with Nature	For Arctic Natives wearing fish skin honoured and created a connection with the animal.	Designing according to principles observable in nature we could naturally focus on efficient use of materials.
2. Threats to Biodiversity	Arctic people had used sustainable salmon fishing for years. Recently discarding this principle had led to the near extinction of this species.	Due to an environmental concern over extinction rates of certain exotic species, fashion designers have banned the use of exotic skins in their collections.
3. Spiritual role of fish skin	Clothing in the Arctic was spiritually protective. Women decorated hunters fish skin clothing with motifs for protection from danger and hunger.	Contemporary clothing could become more 'spiritually charged' lowering consumption practices, valuing what we already own.
4. The Empowerment of Women	By harvesting the fish and making the garments, women gain the freedom to provide for themselves.	Contemporary Ethical Fashion initiatives harness the power of fashion as a vehicle to empower marginalized women artisans in third world countries.
5. Biologists and designers	A good seamstress in the Arctic was at once artist, designer, biochemist, zoologist and climatologist.	There is currently a movement of biologists and designers who replicate nature to design clothes.
6. Food By- products	After salmon flesh was eaten, Arctic seamstresses used the non-edible parts of the fish in innovative ways, creating clothes and accessories.	Fish leather is a by-product of the seafood industry. Transforming industrial waste into new materials takes the pressures off over produced materials.
7. Lower consumption practices	In the past, resources were scarce and precious in the Arctic, so no part of an animal went unused.	One of the precepts of sustainability is wasting as little as possible, encouraging fewer consumerist forms of fashion.
8. Emotional connection	Women who worked with fish skin entered a spiritual relationship with the material.	By cultivating an emotional connection between person and object, we can stop our dependency on new goods.
9. Marker of Identity	Across the Arctic, fish skin clothing displays the region's ecology and the group's social identity.	Fashion enables people to express through clothing and at a collective level brings connection and belonging.
10. Economy of materials	Women making fish skin garments combined the economy of materials, creating pattern pieces where nothing was wasted.	Contemporary concepts of zero waste work to fit together pattern pieces so that no fabric is wasted during the cutting phase.
11. Repurpose/reuse of materials	Hunters used fish skin parkas during the day and reused them as tents at night to cover against wind.	Repurposing brings a new life to something that is used, contributing less to textile waste.
12. Biomaterials	When there was nothing to eat, Arctic Indigenous Peoples could survive by eating their fish skin garments.	Contemporary biomaterials made from algae, mushrooms, kombucha, grape seeds or citrus peels make use of edible materials from nature.
13. Insulating properties	The insulating properties of fish skins were used against Arctic wind.	Current athletic materials include naturally breathable fibres to increase ventilation and retain their heat.
14. Breathability properties	Fish skin has high levels of breathability. Arctic Indigenous Peoples knew about this quality and crafted their boots with fish skin.	Shoes have an important role to keep the feet dry and comfortable during walking. In 2006 Nike created a sneaker capsule collection made of perch leather.
15. Healing properties	Fish skin has a high collagen content boasting antistatic and antimicrobial properties.	Taiwanese company Umorfil has recently created a fibre using collagen peptides found in the scales of milkfish.
16. Overfishing and water pollution	Arctic people applied sustainable practices in salmon fishing for thousands of years. Discarding this principle in modern times has led to the excessive depletion of these species.	The future availability of seafood is threatened by overfishing, seafood farming practices and ocean pollution. Current growth in aquaculture could put stress on the fish industry to meet increased demand.
17. Shortage of raw materials	Arctic women recently substituted fish skin with less time-consuming materials.	In contemporary fashion new cheaper materials are incorporated, and older processes disappear.

Table 3.1: Historical emerging themes: Traditional Indigenous Arctic Fish skin versus contemporary sustainable fashion practices.

3.27 Codes of Conduct for sustainable fish leather

We can incorporate many lessons from Arctic societies into contemporary fashion practices using materials, such as fish leather, to address current fashion disruptive practices. In this chapter I have explored theories of sustainable fashion by comparing them with historical Arctic fish skin practices to situate the study in historical and current debates. By reducing the use of non-renewable resources and using materials such as fish leather, fashion can become a powerful instrument to reduce waste. We must learn from Indigenous communities and their material knowledge that have lasted for millennia, in contrast to the contemporary fossil fuel-dependent system and consumption-based production models. To design more ecologically, culturally and socially sustainable products, several elements of the lessons learned from the use of fish skin by Indigenous Arctic Peoples must be taken into account. Below follows a list of practices that could contribute to more sustainable solutions in the fashion industry.

Connection with nature

- Acknowledge your relationship with nature and your dependence on it.
- Avoid the exploitative relationship between humans and nature.
- Express respect and gratitude towards the exchange between humans and animals.
- Adopt the circularity of vegetable tanned fish leather that returns to its natural environment at the end of life.

Spiritual connection

- Create a connection with the animal's 'soul', honouring it.
- While wearing fish leather, become one with the animal physically and spiritually.
- Guided by Arctic philosophy, wear more "spiritually charged" clothing, reducing consumerism.
- Cultivate an emotional connection between the person and the product, reducing consumption of new goods.

Materials' Sourcing

- Source fish skins from legal sources while keeping fish stocks at sustainable levels.
- Prevent the depletion of fish resources making an efficient and measured use of them.
- Use fish waste from local sustainable fishing industries.
- Inform yourself about the fish leather provenance.
- Reconnect with carefully sourced ecological high quality raw material and processing.
- Promote collaboration with scientists to create the clothes of the future using biomaterials.

Material properties

- Respond to weather conditions through the appropriate use of fish leather.

- Benefit from the antibacterial properties of fish leather to make sweat-resistant items.
- Harness the insulating properties of fish leather making wind wicking garments.
- Manufacture shoes with fish leather to keep the foot warm and dry.
- Make long-lasting items by using the tensile and tear strength qualities of fish leather.
- Use loose-fitting fish leather clothing overlapping with other garments, adjusting to weather changes.
- Enjoy the nuances of vegetable tanned fish leather acquired over time.
- Benefit from the added skin safety factor for people with sensitive skin.
- Enjoy the exotic look of fish leather as opposed to snake skins from endangered species, threaten biodiversity.

Garment construction

- Produce fish leather garments based on values and craftsmanship.
- Increase durability by involving the wearer in the making of their garment.
- Reduce waste by constructing garments according to the fish skin shape.
- Return to well-tailored clothes, honouring them.
- Adjust a garment to fit the wearer according to the individual's body and needs.
- Harness the longevity of fish leather by tapping into the multiple functions of a garments.
- Repurpose your fish leather items bringing a new life to something already used.
- Value the material by making sure that no part of the leather goes unused.
- Use the natural appearance of fish as an inspiration in the creative design of items.
- Mend and repair damaged fish leather items.

Consumption

- Value the time involved by nature in growing the raw material and by the craftsman who processes them.
- Use fish leather items longer encouraging fewer consumerist forms of fashion.
- Return to smaller-scale manufacturing with lower impact than the current mass production model.
- Embrace Arctic nomadic minimalism, where beautiful fish leather attire should also be practical.
- Share fish leather items to save resources, so fewer items are purchased, strengthening bonds.
- Consider fish leather as a niche product, keeping its market volume relatively small.

Societal changes

- Promote the creation of jobs and income for local coastal populations.
- Empower women's livelihoods in fishing communities through fish leather production.
- Provide safe working conditions and living wages for all people in the supply chain.

Fig 4.1. Digitally printed fish skin clutch by Elisa Palomino, 2021.

4. Chapter Four: Fish leather, Contemporary context

Chapter Four: Fish leather, Contemporary context

This critical review of contemporary theories and practices comparing fish leather with other sustainable materials has been developed through investigation of the fashion industry, aspects of the climate crisis, the loss of biodiversity, and the depletion of finite resources. Contemporary issues around animal rights and the possibility of replacing exotic leathers from endangered species with fish leather have also been reviewed. Fish leather as a food waste by-product and its high market value has been mapped, focusing on the EU fish leather value chain. Fish leather's environmental, aesthetic, technical and social characteristics have also been researched and compared with vegan, exotic (crocodile/snake) and faux leathers as alternatives.

4.1 Fashion and Nature: Diversifying the choice of materials

All things we wear—garments, accessories, footwear- are made from materials found in the world around us (Ehrman, 2018). Fashion materials are 'made from nature' and derived from plants, animals, insects, oils, minerals, and metals. Processing and innovating with nature have given fashion all of its materials: cotton, linen, bast fibres, silk, leather, fur, fish leather, wool, feathers and bioplastics. Even materials not derived from living species (such as oil-based synthetics) are 'extracted from nature'. Including the chemicals used to produce polyester originated in nature. As fashion takes from nature, causing the extinction of species, land degradation, deforestation, and pollution it needs to give back (Fashion Values, 2021).

The global fashion industry has a significant impact on the natural environment, from the extraction of raw materials to the production, distribution, wear, and disposal of clothes (Badiali *et al*., 2019). Fashion's current industrial practices make use of huge amounts of water, chemicals, and fossil fuels, degrading the land and the diversity of nature's species. The fashion industry needs to shift from the 'age of extraction to the age of regeneration' (Goldsworthy, 2021). Nature provides us with the water, soil, and other life forms to produce the garments we wear. The relationship between fashion and nature depends on how these elements are valued and used (Fashion Values, 2021).

Until recently, the fashion industry has been dominated by fast fashion with the over-production of low-quality cheap garments made of unsustainable materials (Fletcher and Grose, 2012). To move towards an industry that can help tackle the current climate crisis, a more sustainable and responsible supply chain is needed (Pinnock, 2019). Therefore, the fashion industry as a whole must strive to change and rethink its raw materials and processes. There is a trend for the adoption of new types of materials and processing technologies allowing low-energy, low-water processing (C&A Foundation, 2019). In order to reduce stress on ecosystems, the fashion industry can diversify the materials they use selecting less common choices from renewable sources, agricultural and marine waste and recycled materials - produced with regenerative practices. The diversification of materials shifts from seeking them to meet specific design requirements to a design approach based on consideration of the characteristics of available natural materials. This provides a switch from ‘human-centric’ to ‘nature-centric ‘design (Fashion Values, 2021). The debate on the finiteness of resources, overuse of ecosystems and pollution of the environment by non-degradable or harmful substances is of particular concern to the fashion industry. Designers of new materials are trying to replace fossil-based polymers with biobased and fully biodegradable materials, free of harmful substances. Ideally, the new materials are made from household waste, or organic waste (Meyer *et al*., 2021).

As the demands on the Earth’s resources by the fashion industry continue to grow, innovative materials, such as fish leather can address the impact on the natural world. Fish leather is a bio-based and biodegradable material with a tradition nearly as long as mankind. Alternative materials, like fish leather, are increasingly seeing a resurgence as they require less energy, time, and resources to produce than conventional materials (Global Fashion Agenda, 2019). Due to the scarcity in raw materials, alternative resources become more important for a sustainable fashion industry. Therefore, the evaluation of fish leather seems paramount (Adıgüzel-Zengin *et al*., 2015).

4.2 Contemporary biobased materials

The research in this thesis has investigated contemporary issues around the exploitation of resources, animal rights and the question of whether, with a continuing shift towards vegan lifestyles, we should move towards animal-free fashion. An increasing number of people want to eat consciously meat-free or to do without any products of animal origin entirely. The market for biobased alternatives to leather is increasing aiming to replace animal-based materials with vegan alternatives (Meyer *et al*., 2021). A growing number of fashion customers are replacing animal derived materials altogether, citing the need for options that are guilt and cruelty-free. We need to remember that the day we all stop eating meat and fish, leather will disappear. All these facts have been identified but they are beyond the scope of this thesis.

“Bio-based” means the use of biogenic raw materials to manufacture a variety of products instead of fossil gas, coal, or petroleum as part of the bioeconomy (Meyer *et al*., 2021). Amongst the new biobased materials recently developed in the fashion industry is the bio-fabricated leather created by material science companies. Traditional leather is made from collagen-based animal hides that have been chemically altered through tanning processes to remove almost everything but collagen. In contrast, bio-fabricated leather is made from collagen grown from yeast in a lab. Bio-fabricated material innovations include the Lab-grown leather Zoa from Modern Meadow and Vitrolabs (Jacobs, 2018).

Other materials grown from live microorganisms, such as bacteria, yeast, algae, and fungi root structures include mycelium-based leather Mylo and Muskin, or seaweed materials such as AlgiKnit and Algaefabrics (Common Objective, 2020b).

Additional innovative fashion suppliers are creating sustainable materials out of agricultural and food waste (Schipper,2019). Food crop agriculture creates big volumes of waste from the parts of the plants that are not utilised (leaves, barks, fruit skins). Often these waste residues are burned or left to rot, damaging the environment with the greenhouse gasses generated in decomposition, which exacerbating climate change. Plant biomass from waste residues contains biopolymers such as cellulose, lignin and pectin, which can be developed into fibres for textiles. Converting agricultural waste into fibres reverts the fashion industry’s extractive pattern, helps reducing the environmental impact and land and water overuse from agriculture (Common Objective, 2020a).

Recently, we have seen a surge in the development of vegan or fruit leathers such as Piñatex (made from pineapple leaves) Desserto (made from cactus leaves) Vegea (made from waste from the wine industry) Orange Fibre (made from orange peel waste) and Appleskin (made from apple pectin) (Bailey-Cooper, 2021). The majority of these new materials are still in the development stage (though many are working towards scalability within the next few years) and there is limited data available and no full life cycle assessments to draw on. These alternative strategies aiming to replace leather pursue the development of nature-based, animal-free materials. Most of these leather substitutes rely on fossil-based coatings to become water-repellent and durable. The processing of fossil-based raw materials often requires the application of solvents, crosslinking agents, or plasticizers to achieve suitable material properties. In a recent study published by MDPI Coatings journal (Meyer *et al*., 2021) restricted substances were identified in the samples of leather alternatives such Appleskin, Piñatex, Desserto and Vegea where synthetic and biobased raw materials have been combined. All the aforementioned materials need further development to become fully natural alternatives to leather and they should invest in developing biobased coatings to replace their current PU based coatings. There needs to be a holistic approach between the leather and vegan material departments, and they should not be antagonistic.

All these new fabric developments are inspired by the food industry and veganism. While the food industry can quickly cultivate new products thanks to manufacturing systems, the fashion industry is slower to change. For fashion companies to start using vegan leather a shift in manufacturing infrastructure needs to happen. A total shift in attitude from is required from the executives to the manufacturer infrastructure to the customer. Change, as noted earlier, is a basic tenet of fashion and the fashion industry should be more open to this essential aspect of change working with material engineers, determining the required properties and social and cultural values of the new materials (Bailey-Cooper 2021).

On the other hand, there is fish leather, a food waste by-product of the seafood industry. The technology for its processing has been developed over millennia and it is ready to be used and implemented in the fashion industry. The social and cultural values of fish leather linked to

Fig. 4.2 Nanai coat. Fish skin. Hand Painted. Siberia. Amour River. Penn Museum Philadelphia, 2022.

Arctic Indigenous cultures also need to be acknowledged and respected.

4.3 Exotic leathers

Although outside the scope of this thesis, I have nevertheless examined how fish leather, due to its similar appearance and properties, could become an alternative to exotic leathers from endangered species such as snake.

Exotic leather is produced from reptiles reared solely for their skins to be processed into leather. The breeding and hunting of exotic species, such crocodile, snake, and python, are subject to quotas and governed by the CITES Convention (Convention on International Trade in Endangered Species of Wild Fauna and Flora). Exotic leather producers argue that the demand for this leather drives conservation of species, habitats, and cultures, while creating jobs and income for local populations. According to exotic leather producers, the current halt in exotic leather production will turn them from valuable products to undesirable pests. Exotic leather producers argue that cessation of production could bring damage to the environmental social and economic welfare of its workers and cause the animals endangered again (Cotance, 2020a).

Issues around the contemporary use of exotic leather in the fashion luxury industry have been investigated. Brands like Chanel and Prada have choosen not to use exotic skins in their collections (Berezhna, 2018) and PETA battles against the use of reptile skins in LVMH brands (PETA, 2017). Since 2018, Mulberry, Jill Sander, Tom Ford, Paul Smith, Diane von Furstenberg, and Victoria Beckham have also decided to remove entirely the use of exotic skins in their collections. Most recently, Rick Owens and Courrèges for their S/S2020 collections swapped exotic skins for those of the pirarucu fish, a staple of the Amazonian diet (Friedman, 2018). Chiara Morelli, the Group Operations Sustainability Manager at Kering told me during Linea Pelle's 2020 leather fair, that Kering has requested Caravel, the world's biggest exotic tannery to start tanning fish leather for the Kering group. This could be the beginning of a switch from reptiles to fish or to diminish the use of exotic skins.

4.4 Faux leather

Synthetic alternatives to leather usually consist of a textile support covered by two or more layers of synthetic polymers. Nowadays, polyester textiles coated with PVC films or polyurethane films are often used, making them a completely fossil-based material. Many terms are used to describe these materials on the market such as artificial leather, synthetic leather, leatherette, imitation leather, bonded leather, pleather, textile leather or polyurethane (PU)- leather (Meyer *et al*., 2021). In this thesis I have used the term 'faux leather' to describe synthetic materials that imitate the optical appearance of leather.

Faux leather was developed in the 1970s as a substitute for leather providing the visual and tactile aspect at a cheaper price. Two very common ingredients of faux leather are polyvinyl chloride, or PVC, and polyurethane, or PU. Both of these are plastic-based materials. The process of making faux leather or PVC requires petroleum and large amounts of energy, thus making it reliant on fossil fuels. During the production process carcinogenic by-products, dioxins, are released, which are toxic to humans and animals. When PVC ends up in landfill it does not decompose and can release dangerous chemicals into the water and soil. Dioxin present in surface soil may take from 9 to 15 years to degrade to half its concentration. In the past, synthetic materials triumphed due to lower prices, they are often easier to be processed and can be manufactured as a continuous material according to industrial needs in roll-to-roll production lines (Meyer *et al*., 2021).

Some of these faux leathers are: Lorica (a material made from several different microfibres); Kydex (an acrylic-PVC used by Kleerdex); Birko-Flor (a synthetic material made from PVC and fleece) and Vegatan (a microfibre material that is specifically designed and used as an animal-friendly leather alternative) although they are 'animal friendly' they are not environmentally friendly (Scott, 2020).

4.5 An opportunity for fish leather to activate change

This study has examined literature by Sigfusson and Arnason, 2012; Sigfusson *et al.*, 2013; Sigfusson, 2016; 2018; 2020; Timmins, 2019 on how the use of fish skin by Indigenous Arctic Peoples, has since the late 1990s, been assimilated as an innovative sustainable material for fashion, due to its low environmental impact. Fish skins are sourced from the food industry using waste (Sigfusson and Arnason, 2012). Fish are not killed for their skins, as they represent only a small part of the value of the animal. The use of fish skin to produce leather avoids the waste of a potentially renewable resource.

Currently fish leather is only produced as a by-product of the fish farming industry (Timmins, 2019). Fish leather by-products are residues of an economic activity determined to produce other goods (fish fillets). By-products are not produced on purpose. This is why co-products like fish meat carry the burden of the correspondent environmental footprint, while fish skins ought to have a zero allocation, like waste. By recycling waste, fish leather minimises landfill and keeps resources in use for longer. In recent years, the constant accretion in fish farming and the generation of wastes has caused environmental problems. The processing of fish skins could be a solution for diversifying raw materials for the fashion industry and a solution to the problem of waste of fish farming (Adıgüzel-Zengin *et al*., 2015).

The manufacture of fish leather embraces three aspects of sustainability: the economic benefit of creating value from waste, the social benefit of bringing new employment opportunities in coastal areas, and the environmental benefit of producing leather without damaging biodiversity and not using endangered animals.
This study follows academic scholarship by Fletcher on the use of alternative materials and their

potential, not only to serve our material needs but also to reduce consumption of materials and thereby the threat to biodiversity. This use of alternative materials could lead to more regional sourcing of materials and more local jobs (Fletcher, 2014). Fish leather tanneries source their raw material from local fisheries and bring new employment opportunities in coastal areas. For Manzini (2010), the key to social innovation is collaborative networks based on a new relationship with local resources and local communities. Some fish 'waste' products like fish leather could have a very high value in the market. A more efficient use of marine resources will benefit the marine environment and the fishing industry's bottom line (Bechtel et al., 2002). In a world that needs to produce at least 50% more food to feed 9 billion people by 2050 (FAO, 2013), marine aquaculture is a promising solution with many advantages over conventional agriculture.

4.6 Seafood waste

A study of literature on the increase of global production of fish over the last decade has revealed that currently in Europe, more than 50% of the total fish catch becomes waste material. (FAO, 2018). To date, the European Environment Protection Agency allows seafood processors to dispose of fish skins in marine waters. The decomposing organic waste can suck up available oxygen from marine species and introduce disease into the local ecosystem (EPA, 2012). Fish and shellfish (seafood), fulfil a crucial role in global food, being valuable sources of essential nutrients. Seafood is considered to be the only readily available source of omega-3 highly unsaturated fatty acids and key micronutrients, such as iron, zinc and selenium (Kok *et al.*, 2020). Governments globally encourage citizens to double their average intake of seafood consumption to promote healthier diets.

In 2020, a seaganism diet flourished, where people were including sustainably sourced seafood in their diets to benefit from omega-3 fatty acids. There is a renewed focus on home-harvested regional food in the US and Britain. This is born partly as a result of Covid-19 lockdown restrictions and growing awareness of food provenance and a desire to support local fisheries. In its annual Food and Drink Report 2021, the UK supermarket Waitrose noted that sales in British seafood have tripled in the last six months (Wyke, 2021).

Experts in the field of fisheries have estimated that about a quarter of waste coming from fisheries is discarded, causing not only a significant environmental impact but also a loss of the potential value of such products. Around 50 percent of each fish by weight generally remains after processing for 'the fillet market'. This includes fins, heads, skin and viscera becoming by-products from processing. They are low value, perishable and difficult to store, resulting in high levels of wastage. This half of the fish is often discarded, or sold very cheaply, despite the valuable proteins and nutrients contained for a wide range of applications. A better use of the fish means greater economic value and opportunity for fishermen, processors, and consumers (Kok *et al.*, 2020). Every year discards from the world's fisheries exceed 20 million tons, equivalent to 25% of the

total production of the marine fishery catch. The use of by-products from aquaculture aligns with broader policies, such as the European Union's policies on the "Circular Economy", "Blue Bioeconomy" (European Commission, 2020a), and "Blue Growth". These elements are in the FAO's guidance on protein sources for animal feed and several of the UN's Sustainable Development Goals (SDGs) (SDG, 2020). The seafood industry needs to find adequate modalities for by-product management, considering using them for high value applications, such as the textile industry (Caruso, 2015).

FAO's Blue Fashion initiative supports new ocean-based value chains by raising awareness and partnering with designers to promote material innovation. The use of marine resources in the fashion industry can increase the sustainability of both the fashion and fisheries sectors. The capture fisheries and fish farming sectors generate enormous amounts of fish skin, which are most often discarded as waste. These fish skins can be turned into fish leather, adding value to locally caught or farmed fish, leading to higher incomes and creating alternative employment opportunities for local communities (Meier, 2021).

Seafood waste reduction has the potential to support increased seafood consumption without further stressing aquatic resources. If current trends in overfishing and ocean pollution continue, scientists estimate that we will run out of seafood by 2050. Reducing global seafood loss will not only cut down on waste and reduce the number of discards dumped back into the ocean, but it will also help combat overfishing and hopefully maintain a protein-rich supply of seafood to nourish a growing global population (Chandra, 2021). Valorising and upcycling seafood industry waste will result in a reduction in the current amount of discarded fish parts by the aquaculture/ fish processing industries. Optimising seafood by-products could become a solution providing biodiversity of raw materials in the fashion industry while developing a new sustainable economy.

The growing global population and ecological threats, such as climate change are placing increasing demands on global seafood supplies (Love *et al*.,2015). 66% of marine environment is "severely altered" by human actions (Fashion Values, 2021). Strategies aimed at increasing utilization of fish skin must be carefully considered. The creation of markets for fish leather as an alternative leather runs the risk of incentivizing the growth of farmed fish production and creating fishing pressure on species currently viewed as potential sources fish leather potential.

Regional production

The fashion industry needs to shift from centralized manufacturing to the resilience of decentralized, local production, where local impacts can be measured against the earth resources. Fashion manufacturing should limit itself to the capacity of specific zones with

Atlantic salmon MT By-products (2018)	UK	Ireland	Norway	Denmark	Poland	Spain	Germany	Italy	France
Skin (incl. scales)	1924	1230	3263	1101	5178	1102	1332	1040	1966

Table 4.1. FAO 'aquaculture production/import/export of seafood commodities data' for 2017 and 2018

Figure 4.3. Icelandic Ocean Cluster chart on fish by products, Reykjavík, 2019.

ecological issues, producing locally where appropriate. New levels of environmental restoration, the promotion of biodiversity, and the return of fair local jobs could become possible when shortening the supply chain (Banwell, 2020). By making a shift in production methods following the demand of local manufacturing, fashion companies could have a global impact. Fish leather tanneries work with local filleters and fish farmers, they use available local materials, they have a better control of production cycles, and they have reduced transportation costs while bringing new employment opportunities in local coastal communities that will contribute to the socio-economic objectives of the EU Green Deal.

The European salmon processing industry

Atlantic salmon is one of the top 3 species consumed in the EU. Most of the raw material is imported fresh. In Europe the processing is mainly done in Poland, France, UK, Baltic states and the Netherlands. According to FAO (2020) production of Atlantic salmon reached in 2018 1.56 MT with a market value of USD 9.9 billion. Salmon processing provides approximately 56% of fillets and remaining 44% consist of by-products that might be generally divided into heads (10%), frames (10%), trimmings (8%), skin (incl. scales, 5%) and viscera (11%). Leading salmon processing plants store different types of wastes to offer them later to companies interested in further processing (upcycling). The main aim is to reduce costs related to utilization of by-products. However, separated skins are problematic because there is no ready human consumption option, and they are difficult to process into animal feeds. They are tough and elastic because of their collagen content, meaning that they often get caught in machinery (GAIN, 2021). Fish leather offers an excellent opportunity to add value to salmon skins that may otherwise be wasted.

Salmon skin 'availability' is directly linked to the demand for processed smoked and filleted salmon, which could change over time depending on markets. There is an impact associated with the aquaculture production use of energy and feed, but this is relatively low compared with some livestock species. However, lots of by-products (sometimes up to 50% of the fish) from aquaculture production are discarded and using them more efficiently could increase the output (food, feed, and value) of the aquaculture industry without using more resources. Therefore, the strategic use of fish by-products, which is already available resource, is seen as a promising sustainability strategy for the fashion sector (GAIN, 2021).

The FAO updated the 'aquaculture production/import/export of seafood commodities data' for

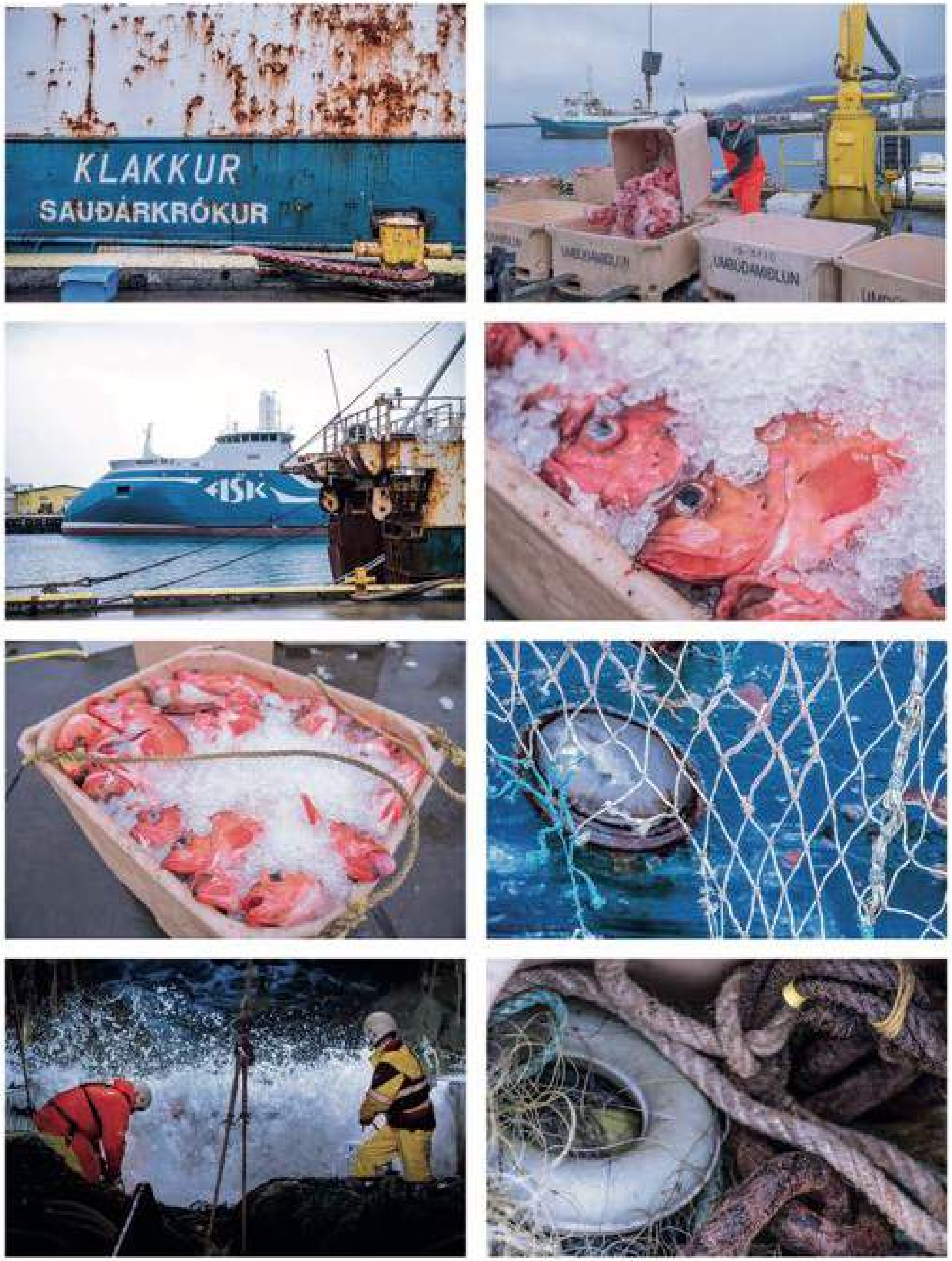


Figure 4.4 to 4.11: Sauðárkrókur harbour, Iceland. Nordic Fish Leather's Hometown. Photographer: Nathalie Malric, 2018.

2017 and 2018. The table below shows the salmon skin residue in aquaculture production. It is important to note that skin is removed prior to smoking and therefore becomes available during this process. The countries in the table below are active in salmon smoking and are therefore relevant in determining 'available' salmon skin volumes. Recent research results show that salmon aquaculture is net neutral, producing as much fish biomass as is consumed (Kok *et al.*, 2020).

By developing fish leather, we could increase the value of the fish catch and it would become a profit for the global economy (Bechtel *et al.*, 2002) . Before fashion started using fish skin to produce leather, the fisheries would throw the skins away. Now, they are not only a source of income to the local people, but no longer contribute to biological waste.

The Icelandic model of seafood waste use

A study by the Iceland Ocean Cluster (Figure 4.3) estimates turnover in the fish industry in Iceland to reach USD 40 millions in 2020-21. An increase from around USD 3 million in 2010. Companies in Iceland, the pioneers of the fishing industry, have been developing a wide range of uses for fish waste. The fillet accounts for only 43% of a fish and the remainder is used for enzymes, pharmaceuticals, dietary supplements, cosmetics, and leather goods (Sigfusson, 2020). The discarded fish parts contain the collagen and keratin protein that makes up human skin. Recently the Icelandic company Kerecis is using fish skin as a regenerative-tissue for burns using its Omega-3 polyunsaturated fatty acids properties (Wyke, 2021). Other Icelandic start-ups and companies using fish waste are Feel Iceland, Iceprotein, Marine Collagen and Lýsi (Sigfusson, 2020). In remote places like Alaska, where it is too expensive to ship offcuts to other manufacturers after seafood is processed for human consumption, salmon skin and crab shell leftovers are typically discarded back into the ocean, creating additional environmental harm. Tidal Vision became Alaska's first chitosan producer by using crab shell leftovers. A derivative of chitin, chitosan is a polymer with antimicrobial properties. It is produced from crustacean shells and has a variety of uses, from winemaking to medical applications (Chandra, 2021).

The Icelandic use of seafood waste model has proved reliable and sustainable over 20 years. Iceland has transformed itself from being one of the poorest countries in the world a century ago to becoming a niche leader in fish processing and one of the richest nations in the world. Iceland is a nation which has shown pride in its seafood industry and uses new innovation to safeguard the environment, create wealth, derive more value from each fish and manage fisheries in a sustainable way (Sigfusson, 2020).

The Icelandic model can be duplicated in seafood industries around the world (Sigfusson, 2018). This would create new opportunities in coastal areas with a big demand for fish in their diet.
Thus, indigenous fishing communities which used to subsist and dress themselves with fish skin items could be able to reach agreements with nearby fishing plants for the supply of fish waste to develop new products that will enhance their economy.

Figure 4.12. F/W 2017 Osklen Amazonian pirarucu fish leather from Brazilian tannery Nova Kaeru. ref: www.osklen.com

4.7 Fish leather tanneries

It is known that in regions rich in fish resources, such as Iceland, Alaska, Australia, Canada, and Korea, there are numerous manufacturers who process fish skin and other types of waste into enzymes, pharmaceuticals, dietary supplements and cosmetics. Fish leather production is said to be viable in combination with fish processing activity and is effective for a niche export market (Gaidau *et al*., 2013). Currently there are over twenty fish leather tanneries around the world. They are Iceland's Nordic Fish Leather (Vautard, 2019); Norwegian Norskin (Jonassen, 2021); Kenya's Victorian Foods (Tato, 2018); Nigerian Owino (La Conceria, 2018); Alaskan Tidal Vision (Gullufssen, 2018); Canadian Seven Leagues (Seven Leagues, 2021); French Cuir de Thon Pantuna® (Sebille, 2019a), Ictyos Cuir Marine de France (Sebille, 2018), Femer (Menard, 2019a) Lohi (Menard, 2019b) and Cuir de Carpe de Dombes® (Roesslinger, 2020); Italian Newport (Cordis, 2018); German Nanai leather (Material District, 2009); Swiss Piscis Leather (Piscis Leather, 2020) ; Siberian hub Novosibirsk Technopark (La Conceria, 2018); Chinese Kotaï (Sebille, 2019b); Australian Mermaid leather (Gee, 2020); Japanese Tototo (Howard, 2021) and Brazilian Nova Kaeru (Sebille, 2019c) producing leather from the Amazonian pirarucu fish (Figure 4.12).

Pirarucu leather has become the new luxurious exotic skin, used by Brazilian brand, Osklen. Since the implementation of a sustainable management plan twenty years ago, the Pirarucu stock has increased 427 %, which has helped to stabilise a traditional food source and the local economy of the region. In addition, Pirarucu farming has lower CO^2 emissions than cattle farming and avoids deforestation of the Amazon (Wightman-Stone, 2019).

Nordic Fish Leather tannery

Former Atlantic Leather tannery (now Nordic Fish Leather) is the biggest global fish leather tannery in the world. They have processed fish leather since 1994, based on the ancient Icelandic tradition of making shoes from the skins of catfish (Rahme and Hartman, 2012) (more research can be found in chapter 5) increasing the utilization and value of fish waste by creating fish leather (Sigfusson and Arnason, 2012). Nordic Fish Leather has been supplying fish leather to fashion brands such as Nike, Jimmy Choo, Galliano, Dior, Prada, and Ferragamo. The tannery has brought this historic eco-luxury material back into fashion, simultaneously reviving ancestral tanning techniques and providing jobs for the local community.

Nordic Fish Leather has developed an innovative business based on the valorisation of the north Atlantic Ocean skins of salmon, cod and wolffish. By surrounding themselves with a network of local partners, filleters and fish farmers (Figure 4.5 to 4.12) and by prioritising players with ASC[1],

1 The ASC for "Aquaculture Stewardship Council" is an international label created in 2010 for fish from sustainable aquaculture. This certification guarantees that the fish has been produced in an environmentally friendly way and under good working conditions.

Fig. 4.13. Fish leather clutch by Elisa Palomino, 2021.
Fig. 4.14. 14 Snakeskin bag. ref:www.amazon.com
Fig. 4.15. 4.15 Pineapple used to make pineapple leather bags.
Fig 4.16. Faux leather bag. ref:www.haraz.com

MSC[2] and GLOBAL G.A.P[3] labels, they control, without intermediaries, their supply chain for salmon, cod and wolffish skins and are part of a virtuous ecosystem. Since 2019, Hlynur Ársælsson is the COO and responsible for research and development at Nordic Fish Leather. His background is in the seafood industry where he gained deep knowledge of fish processing before he became responsible for managing Iceland Seafood GmbH, a large international sales and marketing fishery company in Germany.

In September 2021 I spent a month in Iceland and worked closely with Hlynur at the Nordic Fish Leather facility as part of the EU-funded Horizon 2020-MSCA-RISE project FISHSkin: Developing Fish Skin as a Sustainable Raw Material for the Fashion Industry (Appendix I) for which I am the principal investigator at UAL. I reviewed with Hlynur the tests carried out at the Ars Tinctoria Laboratory in chapter 6 of this thesis. The tests compare traditional fish skin tanning processes with the current industrial tanning methodologies recently developed by Hlynur at NFL. We discussed the process of transforming raw material into crust and the determination of chromium and metal content in industrially tanned fish leather. I am currently working with NFL and Ars Tinctoria to improve this process. I also shared with him a number of sustainable dyeing methods I have used on fish leather, digitally printed fish leather samples with high adhesion and light fastness properties, as well as different embellishment techniques. Hlynur was very enthusiastic about the advances in fish leather surface treatments and the impact they could have on his final product.

4.8 Rationale for fish leather as a fashion material

Fish leather has been identified as an appropriate focus for this study due to its environmental, aesthetic, technical and social characteristics. Knowledge of the origin of the fish, the conditions under which it was reared, and all the stages of processing from the skin to the finished products, are a prerequisite to certify the fish leather eco-responsibility. A demand for transparency shared by the end consumer, buyers and tanners is one of the main subjects of investment and innovation in the leather industry. A large number of tanners have taken the decision to build their reputation around sustainability showing transparency in the production and the origin of the materials.

4.9 Comparing fish leather with other types of leather

The market for biobased and synthetic alternatives to leather is growing with the aim of replacing animal-based materials with vegan alternatives. In parallel, raw materials of biological origin should replace synthetic raw materials of fossil origin (Meyer *et al.*, 2021). The study below compares fish leather with other types of leather in order to juxtapose and so assess their

2 The MSC for "Marine Stewardship Council" is an international label created in 2000 to certify that seafood products have been caught sustainably, respecting fish stocks and marine ecosystems in accordance with the principles of sustainability and respect for the environment.

3 The GLOBALG.A.P. Aquaculture Standard sets criteria for the entire production and supply chain, from broodstock, seedlings and feed suppliers to farming, harvesting and processing. From farm to retailer.

Fig 4.17. Fish leather: By product of the fish industry ref: www.fineartamerica.com
Fig 4.18: Exotic leather: Animals are farmed solely for their skin. ref: www.independent.co.uk
Fig 4.19. Vegan leather: byproduct of the agricultural waste. ref: www.agrifarming.com
Fig 4.20. Synthetic leather: Polyvinyl Chloride. ref: www.stock.adobe.com

traceability, origin, threats to biodiversity, energy use, biodegradability, animal ethics, amongst other examples of environmental and human impact.

The different types of leather compared below are:

- **Fish leather:** The skins of salmon, tuna, cod, carp, catfish, sturgeon, tilapia and pirarucu are suitable for fish leather production. This study has focused on the production of Nordic Fish Leather using north Atlantic fish waste: salmon, cod and wolfish.
- **Exotic leather:** Alligator, crocodile, lizard, snakeskin, tod, and ostrich are the most common exotic skins used in the fashion luxury industry. Python sourced by Caravel, a leading tannery of exotic skins owned by Gucci Logistics S.p.A. (member of the French group Kering) was chosen for this study due to its similar appearance to fish leather.
- **Vegan leather:** Vegan alternatives to leather examples are: Piñatex, Orange Fiber, Vegea and Frumat. Piñatex was specifically chosen for this study because it is the most advanced vegan leather on the market and the one with the most market research to date.
- **Faux leather:** Synthetic alternatives to leather consist of a textile support covered by two or more layers of synthetic polymers. Examples of petroleum-based alternatives to animal leather with a polyurethane or PVC coating are: Vegatan, Lorica, Birko-Flor, and Kydex. Birko-Flor, a synthetic material made from PVC and fleece used exclusively by Birkenstock has been chosen for this study since they are a historic brand committed to environmentally friendly operations.

The different types of leather have been assessed according to the following **Sustainability Criteria:**

4.9.1 Transparency and traceability

With consumers wanting more sustainable products from more responsible companies, traceability is a key factor in this conversation. Transparency relates directly to relevant information being made available to all elements in the value chain in a standardized way, which allows common understanding, accessibility, clarity, and comparison (European Commission, 2020b). Transparency is vital in understanding the socioeconomic impacts (positive or negative) of sourcing raw materials (Table 4.2). In 2021, the state of New York has unveiled the Fashion Sustainability and Social Accountability Act, a bill that, if passed, would hold major fashion brands accountable for their role in climate change. The Act would require companies to map a minimum of 50 percent of their supply chain, starting with the farms where the raw materials originate through factories and shipping (Friedman, 2022). They would then be required to disclose their social and environmental impact on fair wages, energy, greenhouse gas emissions, water and chemical management, and make plans to reduce those numbers following the Paris Climate Accords (UNFCCC, 2022).

Fish leather

According to the Leather Working Group, leather tanneries should adhere to a holistic

Figure 4.21. Fish leather: Use of farmed raised salmon from Icelandic regulated farms. ref: www.nicelandseafood.com
Figure 4.22. Exotic leather: Snakes cut open alive in Indonesia. ref: www.peta.org
Figure 4.23. Pineapple used to make pineapple leather bags.
Figure 4.24. Synthetic leather: No use of animal products. ref: www.walterychina.com

assessment of a tannery performance, that covers all elements of responsible leather manufacturing, including environmental management, traceability, chemical management, social responsibility, and governance (Leather Working Group, 2021). Although the leather industry insists on
the principle that the lifecycle of leather starts when the hides and skins are obtained in the slaughterhouse or fish farms, their animal origin is not to be ignored or disregarded. Traceability guarantees to the customer, that the leather they receive comes from ethically sustainable sources (Cotance, 2020b). Nordic Fish Leather uses fish waste from Nordic government regulated sustainable farms which provides a source of food while maintaining fish stocks (Sigfusson, 2016). Their fish leather made from salmon, cod and wolffish waste derive from fisheries and farming industries that have got a third party sustainably accreditation. For the Cod and wolffish they use MSC certification (MSC, 2022) and for salmon they use both Global Gap (GLOBAL G.A.P. , 2022) and ASC certification (ASC, 2022). These are the leading sustainability standards for fish meeting best practice guidelines set out by United Nation's Food and Agricultural Organisation FAO (Nordic Fish Leather, 2021).

Exotic Leather

There is a requirement to source 100% of exotic leather material legally according to CITES multilateral treaty to protect endangered plants and animals. Despite multiple layers of control by countries and companies, illegally killed wildlife exotic skins are part of the supply chain of some of the biggest fashion brands in the world (Nuwer, 2020). Exotic leather producers argue that the demand for this leather helps to safeguard the species it employs. Their arguments include that the same scheme that protects animal species within the framework of their economic exploitation also protects their habitat and cultures (La Conceria, 2021). In 2013, the Python Conservation Partnership was established as a collaboration between Kering, the International Trade Centre (ITC) and the Boa and Python Specialist Group of the International Union for Conservation of Nature. The Partnership's program focuses on recommendations around improving sustainability, transparency of the supply chain, animal welfare and local livelihoods for the python skin trade in production countries (Lyons and Natush, 2014).

Vegan Leather

Ananas Anam (Piñatex producer) is a Certified B Corporation, a for-profit company that uses the power of business to build a more inclusive and sustainable economy. These corporations meet the highest verified standards of social and environmental performance, transparency, and accountability. This is one of the only certifications that is not for a product or service, but for the whole business behind the product or service (Ananas Anam, 2021).

Faux Leather

Birkenstock stands by their impeccable reputation and invests a lot of effort to ensure that

Figure 4.25.Fish leather: Salmon hatcheries. Protection of wild fish species. ref: www.worldwildlife.org
Figure 4.26.Exotic leather Trade of exotic skins threats biodiversity. ref: www.peta.org
Figure 4.27.Vegan leather: Pineapple agricultural abuse threats biodiversity loss in the Philippines. ref: www.agrifarming.com
Figure 4.28. Synthetic leather: Phthalates: the most environmental damaging plastic. ref: www.walterychina.com
Figure 4.24. Synthetic leather: No use of animal products. ref: www.walterychina.com

their product is manufactured in a conscientious manner. They are very open to sharing their raw materials and production processes, and firmly claim to operate in an environmentally friendly manner (Morton, 2014). The protection of nature and the environment is of paramount importance to Birkenstock, promoting socially responsible production (Birkenstock, 2022). In 2021 Birkenstock sold a majority stake to the company behind LVMH. The decision of the founders to continue staying in the company as minority shareholders will hopefully ensure continuity of commitment towards Birkenstock's sustainability values (BSMAC, 2021).

4.9.2 Animal welfare

Animal welfare concerns the legislation to protect animal on farms, in transport, at markets and at slaughter (Table 4.2). The concept of animal welfare first emerged in the 1960s defining how an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well-nourished, safe, able to express innate behaviour and if it is not suffering from unpleasant states such as pain, fear and distress (OIE , 2016). Given the leather industry's inherent link with the meat and fish industry, brands and consumers continue to raise animal welfare concerns in the leather supply chain. Issues on animal husbandry, welfare, transport, and legislation should guide brands on the additional steps they need to take to ensure good animal welfare procedures in their products, allowing companies to carry out their own animal welfare due diligence as part of their sourcing process (Leather Working Group, 2021). The leather reflects the treatment of the animals. Skins from healthy, clean and well-bred animals have little or no defects and will become the high quality leather that luxury consumers want to acquire (Cotance, 2020b).

Fish leather

Fish leather tanneries need to trace the history of the fish skins from the hatcheries onwards. The transport and slaughter of animals (including fish) in Europe is governed by regulations on animal protection and welfare. The MSC (Marine Stewardship Council) certifies that seafood products have been caught sustainably, respecting fish stocks and marine ecosystems. Big efforts are being made to combat stress, disease, and the enhancement of fish welfare, but there are still many challenges in improving aquaculture while securing global seafood demand (Kok *et al.*, 2020) and therefore for improving fish leather standards as a by-product of the seafood industry.

Exotic Leather

For the two French empires in luxury goods, LVMH and Kering, addressing animal welfare is an urgent priority. Their farming and trapping conditions of exotic animals is questionable. LVMH aims to source exclusively from farms respecting animal welfare via either certified or audited processes with strong capacity building programs. LVMH aimed to increase the proportion of certified crocodilian suppliers to 100% by 2020 and continue capacity-building initiatives or training activities for suppliers dealing with pythons, snakes or lizards (LVMH, 2019). Kering seeks to maintain the highest standards in the way the exotic animals are managed, handled, harvested, transported and slaughtered (Kering, 2020). These stated aims are laudable but not necessarily enacted. An investigation carried out by People for the Ethical Treatment of Animals (PETA, 2019), found that snakes are commonly wild caught, then skinned alive, while suppliers claimed captive breeding in Laos, Malaysia, and Vietnam. They also recorded pythons being hit on the head with hammers and skinned alive in Indonesia. According to a 2013 report by the Swiss Federal Veterinary Office on the reptile skin trade, many slaughter methods - including decapitation, freezing, heating, suffocation, drowning and cutting jugular veins - were cruel and unethical (Nuwer, 2020). The high-end leather industry has expressed an interest in captive breeding production systems to ensure that international demand for python skins can be met in a way that is globally acceptable in terms of sustainability and animal welfare standards. However, conservationists and wildlife managers have queried the biological and economic feasibility of breeding pythons for skins, casting doubts about the applicability of this system. Kering aims improving reptiles farming and to employ appropriate slaughter methods that ensure brain destruction (Lyons and Natush, 2014).

Vegan Leather

Conversely Piñatex is 100% animal free, PETA approved and registered by the Vegan Society.

Faux Leather

Birko-Flor is part of Birkenstock's vegan collection, and it is produced entirely free from animal products.

4.9.3 Biodiversity threat

This is a loss of animal species as a result of climate change and over-exploitation of natural resources (Table 4.2). Biodiversity is defined by the United Nations as "variability among living organisms from all sources including, among other things, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems" (UN, 1992). Biodiversity is the variety of life that we have in the planet and includes animals, plants, the habitats and ecosystems they live in, and how they interact with each other (Fashion Values, 2021).

Fish leather

Nordic Fish leather does not use endangered species, which will threaten biodiversity. Since his arrival at NFL, Hlynur has focused on processing only north Atlantic Ocean fish skins: salmon, cod and wolffish. The Icelandic cod stock has been the main source of income in Iceland for centuries (Sigfusson, 2018). Hlynur sources cod skins from the Akurery auction house in northern Iceland, where he bids for the largest cod together with his fish processing partners, who keep the flesh and provide him with skins large enough to make leather. The wolffish is sourced from the Dalvík fish auction market and is caught by mid-water or bottom trawlers allocated to specific fishing

areas to limit the impact on the ecosystem. Vessels are not allowed to trawl in fish spawning areas and the use of "T90 bottom trawls" (with 30% less net) with pelagic doors (which do not drag on the bottom), has led to considerable fuel savings without negative consequences for ecosystems. Total allowable catch (TAC) quotas are also allocated to each vessel to prevent overfishing, and this is monitored by the authorities and through a public database. In addition, it is illegal in Iceland to throw by-catch back into the sea: everything that is landed must be used. This by-catch law is unique in Iceland and one of the many reasons why the country is recognised for its excellence in fisheries management worldwide (MFRI, 2021). Salmon is sourced in a very small part domestically since most salmons in Iceland are sold with skins internationally. The rest of the salmon skins are sourced from Norwegian and Faroe Islands fishing fleets (Timmins, 2019).
The creation of markets for fish leather as an alternative leather, runs the risk of incentivizing the growth of farmed fish production and creating fishing pressure for species currently viewed as fish leather potential.

Exotic Leather

According to Kering, farming pythons for their skins within closed-cycle breeding facilities may assist the conservation of certain species only if it reduces unsustainable wild harvests, and does not encourage illegal laundering of wild-caught pythons through farms. However, commercial production may create commercial incentives favouring extinction rather than the recovery of wild populations. Thus, python farming may undermine conservation because it provides little or no incentive for protection of wild pythons and their habitats (Lyons and Natush, 2014). A common violation amongst exotic skin suppliers is the illegal capture of the in the wild is mislabelled as captive bred. While some fashion brands have made efforts to improve their wildlife-related practices, more must be done. Given their resources, reach, and expertise, luxury fashion brands have a unique position to influence their suppliers for better practices. Brands under the Kering luxury group ensure sustainable offtake and support conservation of wild species and no use of species listed endangered in CITES (Kering, 2020). The Convention on International Trade in Endangered Species of Wild Fauna and Flora which regulates wildlife trade, strictly bans the trade in 13 of at least 60 species. But most of the exotic species, including African rock pythons, sunbeam snakes, and several species of cobra, have not been granted protections under CITES. There are different levels of protection for species depending on how threatened they are. Where trade is allowed, countries are supposed to grant export permits only if scientific evidence shows that trade will not undermine the animals' survival in the wild. More than half the U.S. seizures of exotic skin accessories at customs are regularly imports from Italy, France, and Switzerland, though most of the animal products originated in Southeast Asia (Nuwer, 2020).

Vegan Leather

Although 100% animal free, Piñatex has an impact on biodiversity. Made from the waste leaves of the pineapple plant, this textile takes a by-product from the existing pineapple harvest, so the raw material requires no additional environmental resources to produce (Ananas Anam, 2021). After harvesting the pineapple, the suitable plant leaves left behind are collected in bundles and the long fibres are extracted using semi-automatic machines (Ortiz and Torres, 2020). For Piñatex, strategies aimed at increasing utilization of pineapple leaves, run the risk of biodiversity loss in the Philippines. Intensively grown crops like pineapple produced for export to international partners have large adverse impacts on the environment and biodiversity.

Faux Leather

Birko-Flor is a synthetic material. The upper layer is made of PVC, which has been lined on the inside with a layer of fleece. Birko-Flor contains phthalates, synthetic chemicals used as plasticizers in a wide range of PVC plastic products. There is a human health and environmental concern of these alternative plastics. Phthalates pose risks for aquatic and terrestrial ecosystems, particularly in the vicinity of the processing industries. Some phthalates are bio accumulative and have been detected in aquatic organisms. They have been shown to be toxic and cause long- term adverse effects in aquatic environments (Lowell Center, 2011).

4.9.4 Transportation

Sourcing and processing raw materials close to home shortens transport routes, lowers carbon footprint, and increases transparency across the supply chain. Considering the capacity of specific ecological zones, producing locally where appropriate, brings new levels of environmental restoration and the promotion of biodiversity promotion (Table 4.2). Companies need to reduce greenhouse gas emissions due to detrimental transport practices. Ideally, brands should source materials within a 200-mile radius from the point of production in order to reduce transport emissions (Common Objective, 2020a).

Fish leather

Based on previous by-product studies (GAIN, 2021), we can allocate the available amount of salmon skin on a country-wide level. We can use a weighted average distance, based on relative volumes of salmon skin calculating the distance from the processing country to the tannery in order to calculate the transport emissions. In the case of Nordic Fish Leather tannery, they work with a network of local partners, filleters and fish farmers, controlling, without intermediaries, their supply chain for salmon, cod and wolfish skins. For instance, wolffish skins are sourced locally from nearby fisheries in Dalvik, a town about an hour's drive up the fjord and cod skins are sourced from the Akurery auction house a few hours away from the tannery. Most of their salmon skins are sourced from Norwegian and Faroe Islands fishing fleets. By 2032, NFL aims to source all salmon skins locally from Icelandic land-based fish farming company Samherji Fiskeldi, with a target of producing 20,000 tones of salmon (Nordic Fish Leather, 2021). By using 100% of the fish, fish leather tanneries can lower further carbon footprint in the transportation.

Exotic Leather

Caravel claims a high production capacity, with exotic skins selected and purchased all over the world, a system of logistics management amongst the most efficient in the fashion industry enabling them to create large quantities of pythons and alligators (Caravel, 2022). The transport from the python slaughterhouse to the tannery must be taken in consideration. The length of the journey of the raw hide from the python slaughterhouse in Vietnam to the Italian tannery Caravel is roughly 10.000 km. Fashion is one of the largest sectors by volume of both ocean and air freight shipping. Fashion groups like Kering have a huge opportunity to create the market demand needed for the deployment of Zero Emission Vessels (ZEVs) no later than 2030 to enable a deep decarbonization of shipping (Cook and Rommwatt, 2020).

Vegan Leather

At Piñatex, once Piñafelt, the non-woven mesh which forms the base of all Piñatex collections, is created, the rolls of Piñafelt are then shipped by boat from the Philippines to Spain or Italy for specialised finishing, adding extra transport routes, and increasing the material carbon footprint. Piñatex claims to reduce their direct CO_2 emissions by choosing carbon neutral shipments (Ananas Anam, 2021).

Faux Leather

Birkenstock raw materials once they have been individually processed all over the world, must be transported to the manufacturing location in Germany. These materials are from a wide variety of places and must be transported over long distances. Birkenstock, which is very open about its production and manufacturing, does not have much information on the methods of transportation. Like most products, its biggest pitfall lies in the large consumption of fossil fuels that it takes to transport the different materials and ship the final product (Morton, 2014).

4.9.5 Energy use

Leather production and processing have significant environmental impacts, including overexploitation of freshwater resources, use of hazardous chemicals, nonbiodegradable liquid waste, and chemical pollution of waterways and surrounding land (Granskog *et al.*; 2020). There is an intense use of energy throughout the leather production process. Thermal energy is typically used to heat water and for leather drying operations. Electricity is used mainly to power drums and other machinery. However, tanneries, including those working with exotic skins are currently investing in renewable energy resources (Cotance, 2020b). Humankind's consumption of carbon-based resources has created a series of interconnected environmental challenges, including climate change and pollution of air, earth, and water. In view of these challenges, the fashion industry must reduce its dependence on non-renewable resources such as coal, oil, and natural gas and deliver necessary solutions that enable sustainable living (Table 4.2).

Figure 4.29. Fish leather: Use of Icelandic geothermal volcanos renewable energy. ref: www.volcanodiscovery.com
Figure 4.30. Exotic leather: Snakeskin production in Indonesia. ref: www.roadsandkingdoms.com
Figure 4.31. Vegan leather: Woven fabric roll manufacturers. ref: www.istock.com
Figure 4.32. Synthetic leather: Use of fossil resources. ref: www.counterfire.org

Fish leather

Nordic Fish Leather tannery uses only Icelandic renewable energy sources for its production of fish leather. The two main sources are hydroelectric and geothermal power. 100% of the electricity supply is from a Hydro Electric power plant. In terms of geothermal power, the warm water is derived from wasted seawater streams from a geothermal power plant close to the town, where the factory is located. The total power usage is therefore CO2 neutral (Nordic Fish Leather, 2021).

Exotic Leather

Caravel claims that along with all the companies in the Kering group, pursues a policy based on ecology oriented towards the logic of energy saving and environmental compatibility.
Caravel has recently invested in technologies that reduce the environmental impact of their tanning processes in terms of energy efficiency to reduce the emission of CO2 obtaining an environmental certification according to the UNI EN ISO 14001 requirements (Caravel, 2022). Additional improvements to be expected include significant advances in the design of the drums to further reduce energy consumption and reducing water consumption by reusing a large part of the tannery water. Greater use of geothermal and solar energy can also be expected given the location of Caravel in Italy, a country with high exposure to sunlight and geothermal energy (Redwood, 2013).

Vegan Leather

According to Ananas Anam, renewable resources are used in the making of Piñatex, composed of agricultural waste and renewable feedstock (Ananas Anam, 2021). Piñatex promotes its polymer finish to be polylactide, which can be produced fully biobased. However, recent analysis showed a remarkable content of synthetic polymer (similar to polyurethane acrylate) in the finish (Meyer *et al.*, 2021). These coatings are oil based and require large amounts of energy to be produced, they are significant contributors to impacts related to climate change and the depletion of fossil resources (Eionet, 2021).

Faux Leather

In the Birkenstock Group Code of Conduct, they claim that any procedures in force for waste management, handling chemicals and other hazardous substances and their disposal and those pertaining to emissions and wastewater treatment shall be observed (Birkenstock, 2022). Faux leather like Birko-Flor is made from chemicals sourced from fossil fuels. PVC manufacture is also highly energy- and water-intensive using fossil resources, and non-renewable energy. The fashion industry is a significant contributor to fossil fuel emissions, further locking humanity into a reliance on dirty energy. With an EU target of carbon neutrality by 2050, there is no room for increased plastics production that promotes climate change through methane emissions (Robb, 2020). Unless we move away from the fossil fashion production model, we risk the planet in our quest for cheap fashion.

4.9.6 Processing technologies

The chemicals contained in leather products can impact workers' and consumers' health (Meier, 2021). Consumers increasingly request an understanding of the full environmental impact of leather and leather manufacturers must demonstrate compliance with a Restricted Substance Lists (RSL) and a Manufacturing Restricted Substance List (MRSL). Leather manufacturers must meet chemical management requirements, restricted substances criteria, and extra measures to prevent the formation of Chromium VI (CrVI) in their tanning processes. As the presence of Chromium VI remains a concern for both brands and consumers, CrVI testing is required, as well as the limits to which a tannery should conform. As such, brands can be reassured that material they purchase has a reduced risk of CrVI formation (Leather Working Group, 2021). Chemicals play a major role in leather manufacture. They are used to remove unwanted components from raw hides and skins to make them durable and to confer the desired mechanical and aesthetic properties to the finished leather (Table 4.2). Between 2016 and 2018, European tanneries consumed an average of 2.15 kg of chemicals per square metre of finished leather. In recent years, the fashion sector has demanded metal-free leathers. These are produced with substances that can substitute chromium, but they require larger quantities of auxiliaries during the re tanning phase, to obtain performances comparable to chromium-tanned leather (Cotance, 2020b).

Fish leather

Fish leather processing technologies are reported to be less polluting than those of other types of leather (Gaidau *et al.*, 2013). The processing provides a reduction of harsh chemicals like sodium sulphide or cyanides used in the traditional liming process for dissolving fats and hairs from mammal hides (Gee, 2020).

In 2020, I conducted a series of preliminary tests in the Ars Tinctoria laboratory on the crust of chrome-tanned NFL salmon leather (more research can be found in chapter 6). From the tests we were able to discover some critical problems: there were many scale residues and residues of epidermis and pigmentation in the finished fish leather. The CrVI content was higher than 12 mg/kg (this is the point at which chromium III is transformed into chromium VI). As for the pH, it is a risk if the pH is above 8 (even temporarily). Metals and metal ions (Fe^{2+} Co^{3+} Zn^{2+}) were also present. These are more critical at pH > 8. Also, the presence of unsaturated oils with a subsequent generation of free radicals (R - C = C - R - COOH) was found. The natural presence of Omega III and Omega VI in fish skin could also become a high-risk factor in the tanning process. Ever since sharing the results with Hlynur during my visit to the tannery in September 2021, he has been improving the tanning technology. The scale residue problem has largely been eliminated, but the pigmentation residues is still a challenge although they have made a good progress. They have also been replacing the old dyes stuffs that contained a lot of minerals, even cobalt. With very few exceptions all their dye stuffs are now metal free. They are using fish oil-based fats in the dyeing process as this gives the best softness. This was done after I shared with Hlynur the results from Chapter 5 where historically Icelandic fishermen would smear cod liver oil on their sheepskin coats to make them waterproof. We are also working together with Katrin Karadottir from Iceland University of the Arts on a small plant-based dye colour card of Indigenous Icelandic plants for specific customers. Hlynur is also improving the vegetable tanning process of fish leather by using the mimosa bark extract from Silvateam, a world leader in the production of vegetable extracts (Silvateam, 2022). In terms of the current state of knowledge chromium when properly used remains the best tannages for fish leather. Vegetable tanning uses more tannins than chrome-tanned leathers. The effluent produced also requires more treatment before it can be discharged. However, it has the benefit of using natural, sustainable and renewable raw materials (Nara, 2021). The depletion of forests must also be taken into account when addressing a shift from chrome to vegetable tanning (Redwood, 2013).

Exotic Leather

In Caravel, almost all manufacturing processes are performed in-house under the supervision of highly skilled tanners trained at Santa Croce sull'Arno Leather District in Italy. All chemical operations occur with the use of water and chemical reagents in the drum. Subsequently python skins proceed to the mortar, that is the relaxation of the dermal tissue in order to increase the absorption capacity of tanning products also by chemical processes. They use partial saponification for the peeling of the skin. The lime is then removed with the purge. In this phase, water is added, and the pH is lowered up to values close to those of the isoelectric point of collagen. The pickle completes the purge phase using sulfuric and hydrochloric acids. The dermis deflates and gets a pH (2.8 to 3 degrees). These characteristics are obtainable through the use of chromium which has an astringent effect on tanned leather and is solvable through the basification (increasing the PH of about 4 degrees) so as to bring it back to the original thickness. Out from the drums, skins undergo the process of wet shaving in order to obtain a uniform thickness over the entire surface (about 1.1 / 1.5 cm). They pass through a series of rollers with sharp blades which remove part of the skin. Then they switch to synthetic tanning in order to be whitened and allow coloring during the dyeing process (Caravel, 2022). The Italian tanning system uses a big amount of chemicals in all the operations, above all in the post-tanning and finishing stages (Notarnicola *et al.*, 2011). Kering luxury group claims to protect people's health (employees and customers) by maintaining a protection policy on chemical management with the help of the Kering RSL (Restricted Substances List) and their membership of ZDHC (Zero Discharge of Hazardous Chemicals) (Kering, 2020).

Vegan Leather

The processing technology of Piñatex takes the fluff-like pineapple leaf fibre (PALF) and mixes it with a corn based polylactic acid (PLA) submits it to mechanical process to create Piñafelt, a non- woven mesh which forms the base of all Piñatex collections. According to Piñatex, the resin used to coat their vegan leather is a water-based PU resin which is REACH compliant, meaning there are no detectable volatile compounds. They claim to have optimised the maximum amount of bio- based PU used while still ensuring longevity of their materials (Ananas Anam, 2021). A recent article published in MDPI Coatings investigated the chemical constitution and additives of several leather alternatives (Appleskin, Piñatex, Desserto, Vegea) for potentially hazardous substances by thermal desorption analysis on a number of samples where synthetic and biobased raw materials had been combined. The processing of fossil-based raw materials often requires the application of solvents, crosslinking agents, or plasticizers to achieve suitable material properties. Restricted substances such DIBP were identified in the samples of Piñatex. The PUR-coated textile contained considerable amounts of dimethylformamide (DMFa), toluene, and traces of N, N dimethylacetamide (Meyer *et al.*, 2021). Vegan leathers like Piñatex have the same issues as faux leather produced with fossil fuels which indeed make up 30% of their content. The problem is not only environmental, toxins and non-biodegradability but also functional, these materials tear much more easily than the leather they emulate. All plastics derived from oils or plants do not withstand tearing unless they contain 30% of petroleum derivates. In vegan materials, the vegetable fibres need a 30% of polyurethane added to them to bind them together, otherwise they will not resist tear or last over time. In contrast, the grain of leather has a natural binding, collagen, as it is a natural material which is much more resistant. Laboratories like Codyeco in Santa Croce sull'Arno, Italy are currently working on solutions to polyurethane, researching polymer materials based on natural plant derivatives (Ars Tinctoria, 2021).

Faux Leather

Faux leather like Birko-Flor is made of PVC, lined on the inside with a layer of fleece. Polyvinyl Chloride (PVC) is made from fossil fuel derivatives, the most environmentally damaging of all plastics which has already impacted many humans through the use of harmful chemicals in their production. During both its manufacture and disposal, the PVC within faux leather releases dioxins, which are potentially dangerous in enclosed spaces. During the manufacturing process plasticisers such as phthalates are used to make the material more flexible. Phthalates are a class of synthetic chemicals used as plasticizers in a wide range of polyvinyl chloride (PVC) plastic products (Hafez, and Hassan, 2015). In 2021 Birkenstock sold a majority stake to the company behind LVMH. Big luxury fashion groups like LVMH are focused on reducing its use of plastic and moving to biobased materials. The LVMH standard for plastic is grounded in the commitment to minimize use and release of toxic substances during manufacturing and to entirely avoid the most hazardous types of plastic (i.e., ban of PVC) (LVMH, 2019). The use of faux fur such as Birko-Flor in an LVMH brand should be highly questioned.

4.9.7 Waste generation

Fashion production generates waste from the production of raw materials, to processing and manufacture, to end of life. This waste includes chemicals and the shedding of microfibres which are both added to landfill (Table 4.2). These three waste streams pollute waterways, air and land, poison aquatic life and contribute to habitat loss (Fashion Values, 2021). As with any other production activity, leather processing generates waste. Waste management is the second largest financial cost for European tanneries who currently covert solid residues, such as fleshing, splits, shavings, and trimmings, into collagen and gelatine or fertilisers for agricultural applications. Chromium, the most used tanning chemical, can be recovered from exhausted tanning baths and reused on-site (Cotance 2020b). Tannery solid waste management includes the following phases: transport of the solid waste to the respective disposal/recovery plants, disposal and recovery treatment, final disposal of the treated solid waste (Notarnicola *et al.*, 2011).

Fish leather

During the discussion with Hlynur on fish skin production processes, it became clear that the traditional tanning sector is almost non-existent in Iceland, which places NFL fish leather tannery in a position of isolation. An examination of the constraints facing the tannery showed that the main problems included ensuring that the dirty or wet stages in the tanning process, which produce most of the effluents, were properly regulated, as the effluent producing stages are currently not adequately carried out, since there are no proper effluent regulations in Iceland. Recommendations to encourage technological innovation in the disposal of their waste include the provision of good infrastructure facilities, such as an EU-regulated effluent drainage and disposal system (Nordic Fish Leather, 2021).

Exotic Leather

Proper consideration is given to the management of all wastes and the use of inputs including water, energy and all chemicals within the manufacturing process in Italian tanneries like Caravel. The Italian tanning system uses many chemicals, part of which is released to water. The concentration of polluting substances in the Italian wastewater and the total emissions to water of suspended solids such sulphides, sulphates, chrome (III) and chlorides can be elevated.

The Italian system is characterised by a higher rate of matter recovery by tanning solid waste. This implies two kinds of environmental (and economic) advantages: the first one is related to the lower quantity of waste disposed of in landfill, which means, less emissions of NH_3 and CH_4 due to the anaerobic fermentation of the organic components of waste; the second one is related to the recovery of matter that implies a lower need of virgin raw materials in other productive systems as fertilisers etc. The cooperative management of the solid waste in the district of Santa Croce sull' Arno permits to reach environmental advantages (Notarnicola *et al.*, 2011).

Vegan Leather

According to Piñatex, between 2018 and 2020, they have reduced their fossil resources by 30% and water usage by 74% by using 825 tons of leaves wasted from the pineapple harvest instead of burning them. The burning of these would release the equivalent of 264 tons of

CO_2 into the atmosphere. This is equivalent to charging more than 33 million smartphones (Ananas Anam, 2021). Piñatex claims that biofuel is created during the decorticating stage of the pineapple leaves. This biofuel is put back into the soil as a rich fertilizer that will provide energy to the pineapple harvest (Agoston *et al*.,2019).

Faux Leather

Dioxin is created from the manufacture of PVC. Dioxin is one of the deadliest of man-made poisons and it's a cumulative toxin, meaning it stays in the body for a long time. A major problem in the recycling of PVC is its high chlorine content of raw PVC (56 percent of the polymer's weight) and the high levels of hazardous additives added to the polymer to achieve the desired material quality (Bloch, 2010).

4.9.8 Longevity

Fish leather

Fish skins are totally different from those of land animals (cow, sheep, etc.) due to the high pressure and density that the water applies to the fish's body. Their fibre structure runs crosswise, rather than parallel as in cowhide (Leather dictionary, 2019). Fish leather has a comparable strength value with calf leather and has higher mechanical properties: tensile, tear and stitch tear strength values are significantly higher than other leathers due to the intersecting fibre pattern (Adıgüzel-Zengin *et al.*, 2015). Fish leather is flexible, durable, scratch and stain resistant and does not lose its lustre over time (Gaidau *et al.*, 2013).
Fish leather has outstanding longevity compared to synthetic materials, thereby reducing consumer waste (Sigfusson, 2017). This longevity and durability provides fish leather an important ability to develop aesthetically with age.

Exotic Leather

Python 'skins are thin, soft and flexible but they are the highest maintenance of the exotic leathers, colours can sometimes fade over time with regular use and they are very susceptible to cracking.

Vegan Leather

Piñatex claims to be highly durable and long lasting (Agoston *et al.*,2019). Alternative materials like Piñatex have specific advantages, but according to the tests carried out at FILK Freiberg Institute (a global leader in the development, functionalization and testing of flexible multilayer polymer materials) Piñatex does not combine high mechanical strength and flex resistance with high water vapour permeability as in the case of leather (Meyer *et al.*, 2021).

Faux Leather

Birko-Flor is a durable, tear-resistant PVC material used for the production of Birkenstock sandals

(Good on You, 2022). The materials of the shoe are made to be durable and long lasting. With proper upkeep, a pair of Birkenstock shoes can last years. Birkenstock claims that thanks to their durability, their products are sustainable by nature. In the long run, the durability of this shoe make it a very sustainable and worthwhile investment. It is a relatively costly pair of shoes for the average consumer. Since this shoe is meant to last so long, it would take the place of several pairs of shoes that would have been used within its lifetime (Morton, 2014).

4.9.9 Biodegradability

Naturally, hides and skins are biodegradable before they are tanned. The tanning process modifies the chemical composition of the leather grain to make it more difficult to be broken down by bacterial and fungal enzymes (Nera, 2021). The biodegradability of the material is also modified as a result. The rate of degradation and environmental impact depends on the tanning chemistry used. Biodegradation is the process by which a raw material such as leather can degrade in the environment through the breakdown of organic materials into simpler compounds, such as carbon dioxide, water and ammonia, by the intervention of micro-organisms and physico/chemical attack. (Meyer *et al.*, 2021). Compostability is a special case of biodegradability where a material can biodegrade into nutrient-rich compost that can be used for soil improvement. However, many types of leather are coated with polymers and plastics, decreasing their biodegradability, and some of these coatings do not break down in the landfill for centuries (Nera, 2021). The EU assessment of landfill simulation to biodegrade leather in an aerobic aqueous medium condition takes up to 28 days. Only if the biodegradation is greater than 70% a material is considered inherently biodegradable (Redwood, 2013).

Tanning technologies historically focused on the durability (and therefore longevity) of the skins; however, today's fashion brands demand an additional sustainable property: skins that biodegrade and can re-integrate natural cycles. Chrome tanning was developed in the 19th century to facilitate mass production of leathers. Strength of chrome makes it not easily biodegradable. Vegetable tanning is produced with tanning agents of certain barks, fruits or leaves which transform the skin into a durable material, those tanning agents are biodegradable.

Fish leather

Biodegradability is another area requiring considerable work with fish leather as we know that chromium tanned leather does not easily biodegrade but the tanning agents of vegetable tanned leathers could be biodegradable. Tanners must therefore be very careful, and have done proper testing, before calling any leather biodegradable.

Exotic Leather

Chromium, bark and a combination of tannages can be used in the production of exotic skins (Chala *et al.*, 2020). When chromium tanned, exotic skins do not easily biodegrade.

Figure 4.33. Fish leather: Fish leather creates jobs for coastal dwellers. ref: www.victorian-foods.com
Figure 4.34. Exotic leather: Exotic industry unregulated jobs. ref: www.roadsandkingdoms.com
Figure 4.35. Vegan leather: developing farming communities. ref: www.agrifarming.com
Figure 4.36. Synthetic leather: Microfibres shed threatens human health. ref: www.theplasticchallenge.org

Vegan Leather

Piñatex claims that its substrate material (made from 80% pineapple leaf fibre and 20% PLA) is biodegradable under controlled industrial conditions (Ananas Anam, 2021). PLA (polylactic acid) is a vegetable-based plastic material made from corn starch which comes from a renewable source, but it is not biodegradable (Ars Tinctoria, 2021). The unfinished Piñatex substrate is biodegradable however, the material is coated with petroleum-based resin during the finishing process rendering Piñatex non-biodegradable. Although Piñatex is not 100% biodegradable, the company is working with specialists researching a better and greener solution to its recycling issues (Agoston *et al.*,2019). When reaching the end of their useful lives, some textiles are collected for recycling but most of the textile waste is burned in a municipal waste incinerator, largely without energy recapture, or landfilled – plastic-based fibres, however, do not biodegrade and remain present in landfill sites for at least multiple decades (Common Objective, 2020a).

Faux Leather

Birkenstock encourages consumers to recycle the shoes when they are done, by donating them to people who are in need. The only new raw material that enters in at this step is the fossil fuels that transport the shoes to those who they are being donated to. Since the shoes have such a long life, and are made of mostly sustainable materials, they often outlive people's interest in them. Therefor donating them proves to be another great way to extend their life. Overall, Birkenstock is recycle-friendly (Morton, 2014). Other environmental issues involving faux leather relate to the disposal of the materials used in the manufacture of the leather. Since they are plastic-based, they take a very long time to decompose. Though there are methods to break down the materials, they end up releasing highly toxic particles (Scott, 2021). If the material is burned during disposal, it can release particles and toxins that are highly dangerous to humans.

4.9.10 Social responsibility

Social responsibility is an essential element to ensure a truly responsible fashion industry. One of the pillars on which the social responsibility of the European tanning industry is based is the respect and valorisation of human resources (Table 4.2). This is essential for an industry that combines technological innovation and craftsmanship (Cotance, 2020b).

Fish leather

Iceland, home to the NFL, the world's largest fish leather tannery, is a country internationally recognised for being at the forefront of social responsibility, equality and sustainable development. 'Nearshoring' the fish leather production in countries like Iceland has also provided new job opportunities for the coastal communities by converting existing fish waste into a more valuable resource (Sigfusson, 2017).

Exotic Leather

The production of exotic skins in developing countries is carried out using poor labour practices, weak health and safety regulations, using toxic chemicals, encouraging low wages and inflicting child labour. According to exotic skin producers, the model for sustainable use of dangerous reptiles provides an incentive for people to live in close contact with these animals, creating an economic spin-off that supports entire communities. They also state that the crocodile industry in Indonesia is an important and sometimes the only source of income for many rural communities (La Conceria, 2021). Both empires in luxury goods, LVMH and Kering claim that are currently working with tanneries to improve their subcontracting working conditions and remuneration practices, to encourage them to go beyond local laws (LVMH,2019) (Kering, 2020). The Kering "Assessment of Python Breeding Farms Supplying the International High-end Leather Industry" report shows that python farming can provide a source of income for many people, and that satellite farming plays a larger role in income generation for small-scale farmers than self-contained farms. However, closed-cycle captive breeding of pythons in general generates benefits for a small number of people and communities (Lyons and Natush, 2014). European tanneries such as Caravel, consider health and safety in the workplace a priority. For European tanners, compliance with high workplace safety standards is a global priority (Cotance, 2020b).

Vegan Leather

Piñatex uses pineapple leaf fibre, an agricultural waste product. The leaves are the by-product of existing agriculture, and their use creates an additional income stream for farming communities, providing positive, social and economic impact. Piñatex is grounded on a business model that develops regenerative economic outcomes. Those outcomes being as essential as security, respect, inclusion, employment, improved health and wellbeing and an end to hunger. £200K Additional income was earned by Philippine pineapple growers through this new second stream of revenue and 100+ jobs were created in rural farming cooperatives in the Philippines, a country where pineapple plantations make up nearly 10% of all agriculture (Agoston, 2019).

Faux Leather

With around 3,000 employees, Birkenstock is a tradition-rich, sixth-generation family-owned business and the German footwear industry's largest employer. More than 1,100 new jobs have been created since the beginning of 2013, almost all of them in Germany. Birkenstock produces most of its products at its own production facilities in Rhineland-Palatinate, North Rhine-Westphalia, Hesse and Saxony with an extensive amount of handwork (Birkenstock, 2022). They claim their raw materials come from sustainable natural resources. Where possible, they source these materials in Europe. It is not clear if Birko-Flor is sourced in Europe or elsewhere.

4.9.11 Gender Balance

Women account for approximately 80 per cent of the garment sector workforce (Meier, 2021).

The number of females in the European tanning industry workforce has increased slightly compared to 2012. With the physical nature of tannery work, it is unlikely that gender balance will be achieved soon. The slight increase in female personnel is linked to the transformation and technological innovation of manufacturing processes, which has reduced the very physical nature of some activities. The introduction of the management of commercial relations, communication and sustainability, have led to an increase in the number of office-based professionals in the tanning sector, and greater opportunities for women (Cotance, 2020b).

Fish leather

Iceland where NFL tannery is located, is the global leader in gender equality according to the World Economic Forum's Global Gender Gap Report (Jafnréttisstofa , 2012).

Exotic Leather

Women are mainly employed in the bottom tier of the production system in exotic leather tanneries in Asia, leaving them more vulnerable to occupational injuries and exposure to hazardous chemicals. Those tanneries need promoting gender equality through social dialogue and strengthening knowledge and good practices amongst stakeholders in the sector. They should also address violence and harassment in work (Meier, 2021).

Vegan Leather

At Piñatex gender balance was attained at factory and management levels (Ananas Anam, 2021).

Faux Leather

Birkenstock code of conduct states that discrimination when hiring and employing is prohibited. In particular, any active or passive discrimination, exclusion or preference based on race, cast, skin colour, sex, age, religion, political opinions, membership of an employee organisation, physical or mental disability, ethnic, national or social origin, nationality, sexual orientation or other personal characteristics is prohibited (Birkenstock, 2022).

4.10 Emerging themes from the contemporary context of fish leather

Fish leather does not come from a fossil fuel base. Nevertheless, the future limitations on raw material supply and the importance of integrity in the supply chain means that tanners will have to make sure their tanning processes remain eco-friendly. Despite the improvements made by tanners around the world, the fish leather industry is challenged by a fashion industry that is promoting fossil fuel-based leather alternatives as being better than the natural environment. Fish leather is a bio-based material with a tradition nearly as long as mankind. Fish (and

	FISH LEATHER Nordic Fish Leather	EXOTIC LEATHER Python from Caravel, Kering luxury group	VEGAN LEATHER Piñatex	FAUX LEATHER Birko-Flor by Birkenstock
1.TRANSPARENCY AND TRACEABILITY Raw Material origin	Fish leather is a by product of the seafood industry meeting FAO best practice guidelines.	Pythons are farmed solely for their skins. They are sourced fo-llowing CITES guidelines to protect endangered animals.	Plant based by-product of the food industry with Polyurethane (PU) coating.	Birko-Flor is made of Polyvinyl Chloride (PVC) and fleece.
2.ANIMAL WELFARE How they are reared raised and slaughtered.	Nordic Fish Leather uses fish from North Atlantic Ocean regulated farms or caught by mid-water or bottom trawlers.	Addressing animal wel-fare is an urgent priority for the Kering group. Snakes are commonly wild caught, then skin-ned alive.	Piñatex is 100% animal free, PETA approved and registered by the Vegan Society.	Birko-Flor is 100% animal free.
3.BIODIVERSITY THREAT Loss of animal and plant species in the planet.	NFL uses of non-endan-gered species of fish. Risks creating pressure for fish leather potential species such salmon. Overfishing could deple-te oceans.	Trade of exotic skins of endangered species threatens biodiversity.	Intensively grown crops like pineapple have adverse impacts on biodiversity.	Phthalates used in PVC plastic products pose risks for aquatic and terrestrial ecosystems.
4. TRANSPORT Transportation practices	NFL works with local fish farmers. 'Near-shoring' fish leather production lowers transportation carbon footprint.	The length of the jour-ney from the Vietname-se python slaughterhou-se to the Italian tannery increases its carbon footprint.	The rolls of Piñafelt are shipped by boat from the Philippines to Spain for specialised finishing increasing its carbon footprint.	Birkenstock raw mate-rials are processed all over the world, then transported to Germany increasing their carbon footprint.
5.ENERGY USE Use of renewal energies and CO² emission	NFL uses only Icelandic hydroelectric and geothermal power. The total power usage is CO2neutral.	There is an intense use of energy in the exotic leather production process.	The Polyurethane (PU) finish manufacture is highly energy- and water-intensive using fossil resources, and non-renewable energy.	PVC manufacture is highly energy- and water-intensive using fossil resources, and non-renewable energy.
6.USE OF CHEMICALS Chemicals used on the production process	Fish leather processing technologies are less polluting than those of other types of leather. NFL must control the formation of Chromium VI (CrVI) in their tanning processes.	Exotic leather produc-tion uses hazardous chemicals, above all in the post-tanning and finishing operations.	Piñatex is coated with Polyurethane (PU) which contains con-siderable amounts of dimethylformamide and traces of dimethylacetamide.	Birko-Flor is made of Polyvinyl Chloride (PVC). Phthalates are synthetic chemicals used as plas-ticizers in PVC.
7. WASTE GENERATION Solid waste manage-ment and recovery	NFL must improve their infrastructure facilities and their waste policies must follow EU-regu-lated effluent drainage and disposal system.	Exotic leather produc-tion uses many che-micals part of which is released to water. The cooperative manage-ment of the solid waste in Santa Croce sull' Arno brings environmental advantages to the area.	Biofuel is created during the decorticating stage of the pineapple leaves, and it is put back into the soil as a rich fertilizer.	Dioxin, one of the most deadliest of man-made poisons, is created from the manufacture of PVC.
8.BIODEGRADABILITY Capacity to decompose over time.	Chromium tanned fish leather does not easily biodegrade but vegeta-ble tanned fish leather is easier to biodegrade.	Exotic leather is chro-mium tanned therefor does not easily biode-grade.	The unfinished Piñatex substrate is biodegra-dable however the material is coated with petroleum-based resin rendering Piñatex non-biodegradable.	Faux leather is made from petroleum-based materials that do not decompose.
9.HUMAN IMPACT Labour practice & Heal-th and Safety.	Fish leather creates new job opportunities for coastal dwellers.	Exotic leathers carry poor labour practices in developing countries.	Piñatex creates new jobs from agriculture waste for developing farming communities in Philippines.	Birkenstock sixth-ge-neration family-owned business is the German footwear industry's largest employer.

Table 4.2. Fish Leather versus other type of leathers.

therefore fish leather) have been around for thousands of years, while global warming takes off with the discovery of oil. If we were serious about preventing global warming, the most reliable action would be to avoid using any fossil fuel-based materials.

The market for biobased and synthetic alternatives to leather is increasing aiming to replace animal-based materials with vegan alternatives. In parallel, bio-based raw materials should be used instead of fossil-based synthetic raw materials. The study and comparison of fish leather with alternative leathers have brought to light many positive issues about the material. With regards to fish skins since they are fully utilised to make fish leather they are a by-product of the seafood industry. No salmon is killed for its skin. Another positive result is the origin of the fish skins. In the case of Nordic Fish Leather tannery, they use fish waste from North Atlantic Ocean regulated farms or caught by mid-water or bottom trawlers, controlling, without intermediaries, their supply chain. The fish leather production in countries like Iceland also provides new job opportunities for the coastal communities. Regarding the conditions under which the fish is reared, big efforts are being made to combat disease, and to enhance fish welfare, but there are still many challenges in improving aquaculture. The creation of markets for fish leather, runs the risk of creating fishing pressure for species currently viewed as fish leather potential. The capacity of the fish leather market must remain linked to the availability of waste skins produced by active fisheries. Regarding the stages of processing from the skin to the finished products, NFL tannery uses only Icelandic renewable energy sources but even though the technologies are reported to be less polluting than those of other types of leather, NFL must ensure that their tanning processes remain eco-friendly. Moreover, longevity and durability are some other positive features of fish leather due to its tensile, tear and stitch tear strength, significantly higher than other leathers due to the intersecting fibre pattern. Well made into well designed articles fish leather lasts far longer than vegan alternatives and grows in beauty with age. Neither vegan leather nor faux leather alternatives show a similar high performance as fish leather due to the multi-layer structure of the latter. To date, this structure could neither be achieved with synthetic nor with bio-based materials (Meyer *et al.*, 2021). Synthetic materials competing with fish leather can win over their lower prices, they are often easier to be processed and can be manufactured as a continuous material in roll-to-roll production lines. In addition, the unique pattern of fish leather, have exotic appearance like snakeskin. They can be evaluated as a more environmental-friendly raw material compared to the production of exotic leather which are not by-products and come from endangered species, threatening biodiversity. The fish leather final product is a luxury product with a much lower price than that of exotic skins (Gaidau *et al.*, 2013).

Fish leather however, is a niche product, and its market size should remain relatively small. It is unlikely that fish leather will penetrate the mass market due to capacity constraints and the highly manual nature of the process. Some of the fish leather limitations include:

- Longer processing times (3 to 4 weeks instead of days), as fish is largely handmade.

- Inconsistent feedstock quality, where skins can vary in thickness, shape, and behaviour.
- Restricted capacity, being tightly linked to geographical resource availability and the strength of partnerships within the aquaculture supply chain.
- Limited Global supply is restricted to a handful of key players producing fish leather.
- Resistance to mass market adoption due to the exotic or unfamiliar look.

The table below shows emerging themes of the above study comparing fish leather with other types of leather such as traceability, origin, threats to biodiversity, energy use, biodegradability, animal ethics, amongst other examples of environmental and human impact.

4.11 Codes of Conduct for fish leather production

Fish leather is a readily available raw material and when ethically and properly produced could reduce unnecessary reliance on fossil-fuel-based materials, reducing the need for its extraction and retaining more carbon in the earth. The nature of fish leather has a potential for a positive contribution to reducing the climate impacts of over consumed products. Fish leather tanneries must adhere to a holistic assessment covering responsible leather manufacturing, including environmental management, traceability, chemical management, social responsibility and governance. Below are some recommendations addressing better implementation of control mechanisms, animal welfare concerns and environmental impacts of fish leather production. These practices respond to the demand for more sustainable materials, from farm to finished leather, and aim for environmental and social responsibility.

Transparency and traceability

- Ensure complete traceability of fish leather with sustainable sourcing of raw materials.
- Monitor the fish leather life cycle from the source of the skins in the hatcheries.
- Use fish waste from government-regulated fish farms with MSC, Global Gap and ASC accreditations.
- If the raw material source is wild fish, use the Marine Stewardship Council to certify that they have been harvested sustainably, respecting fish stocks and marine ecosystems.
- Create economic benefit from waste providing a source of food while keeping fish stocks.
- Increase regional sourcing of materials and local employment in coastal areas.
- Work with local filleters and fish farmers, using available materials, improving control of production cycles.

Animal welfare

- Request the origin of the fish and the conditions under which it was reared.
- Combat disease, enhance fish welfare best practices of animal husbandry improving aquaculture.

- Undertake breeding, raising, transportation, handling and slaughter of fish in compliance with animal welfare.
- Use healthy, clean and well-bred fish, which are defect-free and will become high-quality leather.

Biodiversity threat

- Use of non-endangered species of fish mitigating the impact on biodiversity.
- Never source fish species on the CITES lists of endangered species.
- Avoid loss of fish species as a result of overexploitation of natural resources.
- Avoid creating fishing pressure on species viewed as potential sources of fish leather.
- Maintain market capacity for fish leather linked to the availability of waste skins produced by active fisheries.

Environmental impact

- Upcycle fish skins for a reduction in the current waste in the aquaculture industry.
- Minimise landfill and keep resources in use for longer by upcycling fish waste.
- Process fish skins to diversify raw materials for the fashion industry.
- Prevent overfishing that could deplete the oceans.

Energy use

- Avoid overexploitation of freshwater resources.
- Use renewable energy sources such thermal energy to heat water and for leather drying operations.

Chemical compliance

- Demonstrate compliance with Restricted Substance Lists (RSL) Manufacturing Restricted Substance List (MRSL)
- Audit chromium and metal content of fish leather.
- Support extra measures to prevent the formation of Chromium VI (CrVI).
- Seek to switch from chrome tanning to vegetable tanning.
- Consider the depletion of forests when shifting from chrome to vegetable tanning.
- Support LCA methodologies measuring the environmental impact of fish leather including end of life.
- Replace dyes with high mineral content with metal-free ones.
- Use fish oil-based fats in the dyeing process for maximum softness.

Waste generation

- Control waste generation from the production of raw material in the hatcheries, to processing and manufacture, to end of life.

- Ensure the right treatment of the wet phases of the tanning process generating the bulk of the effluents.
- Encourage EU-regulated effluent drainage and disposal system facilities.
- Avoid pollution of waterways, poisoning aquatic life and contributing to habitat loss.
- Attempt to convert solid waste, such as flesh and trimmings, into agricultural fertilisers.

Biodegradability

- Favour metal-free vegetable tanned leather that, at the end of its life, will biodegrade.
- Promote biodegradation into nutrient-rich fertilisers to be used for soil improvement.

Transportation

- Source and process material locally, shortening transport and reducing the carbon footprint.
- Work with a local filleters and fish farmers, controlling the process without intermediaries.
- Reduce transport greenhouse gas emissions sourcing materials within a 200-mile radius.
- Avoid large consumption of fossil fuels shipping the final product.
- Encourage low emissions solutions for medium and long-range transportation services.

Social responsibility

- Create positive impact within local communities.
- Foster the social benefit of creating new employment opportunities in coastal areas.
- Increase gender equality and greater opportunities for women in the tanning sector.
- Avoid inadequate labour practices and poor health and safety regulations around toxic chemicals.

Figure 5. 1. Traditional scraping tools and moose jaw. Photographer Kristin Askelsdottir (2018).

SECTION THREE: PRIMARY RESEARCH

Figure 5.2 Ainu robe made of salmon skin from Sakhalin Island. Kushiro City Museum. Kushiro, Hokkaido, Japan, 2018.

Chapter Five: Fish skin in Museum collections: Artefact analysis

5. Chapter Five: Fish skin in Museum collections, Artefact analysis

5.1 Fish skin as an artefact for heritage transmission

International museums with anthropological collections provide knowledge and information about relationships between humans and nature. Fish skin material culture manifests the connection between people and nature creating the everyday objects that capture the choices people have made in relation to the environment. The artefacts I have viewed since 2017 in archives of Arctic collections, demonstrate the great technological development and the capacity for cultural transformation that the various populations in the several Arctic regions have undergone as a result of the passage of time. They are testament to the endurance not only of their material options, but also of the sustainability of the various Arctic societies as a whole (Cooper, 2020, p.20). Arctic Indigenous Peoples believe fish skin historical objects to be highly animated. They can channel the spirit and characteristics of the fish they are made from to the individual. More than objects, they are conduits. Fish skin everyday objects share the narrative of how Arctic Indigenous Peoples have chosen to fish and process their skins as raw materials and how they have harvested the fish resources for their own benefit. The fish skin material evidence demonstrates their ability to inhabit the Arctic connected with nature.

For centuries anthropological museums have broadened the cultural horizons of the general public, to better understand human and cultural diversity. In the past 50 years museums have become spaces of conflict (Klobe and Thomas, 2014). Issues around indigenous rights, evolving ideas about colonisation, and the struggles over cultural ownership, question the legitimacy and public mission of museums (Brown, 2009). Over the past 200 years at least, museums internationally have built ethnographic collections. Ritual objects, clothing made with animal skins, tools for fishing, baskets and other household items, were collected to document the material culture of what they assumed to be were disappearing cultures. These collections embodied Native Peoples' history, science and heritage - traditional knowledge. These holdings contain information about how humans utilise both biological raw materials and material culture. Today Native Peoples can learn much about their Indigenous cultures from artefacts found in collections around the world. Museums carry traditional knowledge of material culture from flora, fauna and other elements of biocultural heritage found on community lands. Many collection artefacts are closely tied to colonialist expansions and were collected using violent means. This difficult history has led museums to acknowledge past practices and the nature of collecting itself, engaging in a deeper collaboration with Indigenous Peoples on the display and interpretation of artefacts (Klobe and Thomas, 2014).

The artefact analysis of the items in this chapter was made drawing upon ethnographic research methods and photography in a selection of international anthropology museums. In the course of 5 years, I visited 28 different museums in 7 countries, 3 continents, across the Arctic region and examined 75 fish skin items dating from circa 1830 to 1990. The artefacts were when possible, studied together with Native and non-Native fish skin artists and Elders in order to tap into the collective memory of tools, materials and techniques. Much of the most interesting information on materials, processing, and use of objects has come from conversations with fish skin artists such as June Pardue, Coral Chernoff, Wenfeng Yu, Anatoly Donkan, Sigherhiro Takano and Lotta Rahme. Also invaluable were discussions with Alaska Native community members and artists recorded on the Smithsonian Arctic Studies Center in Alaska 'Sewing Salmon' series (Biddison, 2019) containing detailed explanations and demonstrations from Alaska fish skin makers. An investigation of the historical production of Indigenous artefacts provided records of social and cultural dynamics within each Arctic society. In a new phase of work, I explored the different ways in which the fish skin artefacts could be read (aesthetic, cultural, environmental, social, spiritual, and technological significance) in order to increase my knowledge. The last phase of artefact analysis took place after the second literature review and at the end of fish skin workshops (Chapter 7) where I aimed not only to document endangered knowledge of traditional fish skin tanning processes (Chapter 6) but to enact them myself. This information complimented my study of the fish skin artefacts available to view in museums. This practical experience informed my theoretical knowledge and helped me to better understand the spiritual and emotional aspect involved in the craft. I wanted not to study the Arctic Indigenous Peoples and their artefacts, but to learn from them and with them.

The four artefacts chosen for evaluation in this chapter belong to four of the five specific groups with historical evidence of fish skin production. They are:

- A pair of Icelandic wolfish skin shoes.
- An Athabascan salmon skin bag from Bristol Bay, Alaska.
- A Hezhe salmon skin jacket and trousers from Northeast China.
- An Ainu salmon skin boot or 'Cep Keri' from Hokkaido, Japan.
- A fifth artefact (A Nivkh salmon skin coat from the lower Amour River in Eastern Siberia) has been published on TEXT for the Study of the History, Art and Design of Textiles, a journal of The Textiles Society, London (Appendix V, Paper1) thus completely covering the five groups.

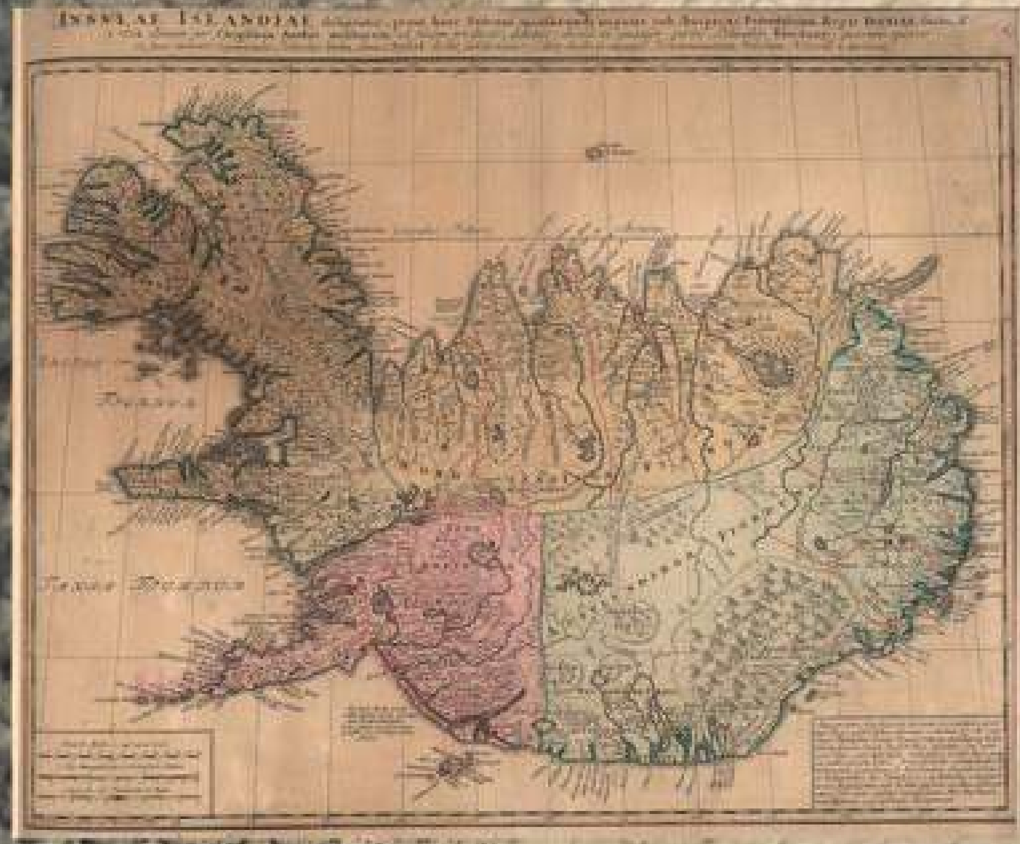


Figure 5.3. Map of Iceland. Insulae Islandial. Homann, Johann Baptist, 1663-1724 ref: www.davidrumsey.com
Figure 5.4. Fish Drying at Þingeyri. Photographer. Auguste Houzé de l'Aulnoit. ref www. National Museum of Iceland.

5.2 Icelandic Peoples and fish skin

Geographically Iceland is on the margins of Europe, yet it has never been completely isolated from it (Table 5.1). Iceland was known to the ancient Greeks; it was a sacred place for Celtic hermits and a refuge for Vikings from Scandinavia and the British Isles. For centuries the country was an exploited colony of Norway, then Denmark, and the British, French, Spanish and Germans fished around Iceland's coasts (Johnson, 1984).

Icelandic history, right from the settlement of Iceland in the 9th century, has been interwoven with marine resources and fish have been the main source of food and income (Sigfusson, 2018). Most of the Icelanders obtained their subsistence from the sea and coastline by fishing salmon, cod and wolfish used for their meat and skin and by hunting seabirds used for their meat, eggs, and in the case of ducks, eiderdown (Johnson, 1984). Icelanders are known for reusing everything and they still have their ancestors' spirit of finding the useful in everything. Through history they had great respect for the skins of wolfish and so their waste has therefore always been frowned on (Table 5.1). If not eaten by humans would be used as animal fodder. Fresh wolfish skins were washed and scraped and used moist to wrap up butter. Wolfish skins were also used for binding books and for making shoes (Kristjánsson, 1986).

Little information is readily available on the history of leather processing in Iceland. Contemporary historic accounts suggest that oil -tanned and mechanically processed leathers (Thomson, 2006) were traditionally used to make shoes and clothing, while vegetable tanned leathers, using birch bark, were used for saddlery and book bindings (Mould, 2018). According to Sigríður Sigurðardóttir, historian and curator of the Skagafjörður Heritage Museum, since the 12th century Icelanders have practiced the processing of wolfish skins. It was an important practical activity, part of the country's culture: girls were told that the quality of the first pair of wolfish skin shoes they tanned and sewed would foretell the quality of their marriages (Cataneo, 2018).

The people from the neighbour Faroe Islands commonly cured their cow hides with the aid of tormentil roots, producing a very fine leather of a yellowish colour. The traditional use of tormentil seems to have been restricted to the Faroe Islands. The inhabitants of the neighbouring Faroe Islands used to cure their cow skins with tormentil roots, producing a very fine, yellowish leather. This practice seems to have been restricted to the Faroe Islands, since it does not exist on the Scandinavian peninsula or in Scotland. Formerly, the hides were suspended in the smoke from the kitchen fire, which only exuded through a small hole in the roof (Landt, 1810). The hides were made into thin shoes, which were worn around the house and in the villages by both sexes. Similar shoes made of raw wolfish skin, were made by the Icelanders (Annandale, 1903). Accounts of travels around Iceland in the mid to late 18th century describe Icelanders wearing traditional shoes made of wolfish skin (Hald, 1972) suggesting that they were worn on a daily basis. Daniel Bruun, a young officer in the Danish army, an archaeologist, writer and cartographer well known

Figure 5.6 Svanfríður Jóhannesdóttir in Bárðardalur. Photograph Daniel Bruun. National Museum Denmark.

for his expeditions to Greenland and the Faeroe Islands, and his ethnographic studies of Iceland in the 1890s and first two decades of the 20th century took hundreds of photographs of Icelanders in their daily lives (Hansen, 2017). The portrait of Svanfríður Jóhannesdóttir (Figure 5.6) is one of a series of photographs of Icelandic countrywomen at work in the fields. In this historic image, Svanfríður, a milkmaid from Bárðardalur, wears a pair of wolfish skin shoes as she walks the path from the stable to her home. Bruun's study of Icelandic popular culture is invaluable, he made sketches of farms and recorded working methods, customs and popular beliefs and practices (Indriðason, 2019).

There is also literature evidence of wolfish skin shoes on a passage in one of the Icelandic Sagas in which it is described how two men, who had taken off their shoes while haymaking, were surprised by their enemies and slain, because their fish skin shoes had dried in the sun, and they could not get them on again (Table 5.1) (Annandale, 1903).

Roðskór is the Icelandic name for wolfish skin shoes. They were traditional soft, flexible, flat-soled footwear (Mould, 2018). Wolfish (*Anarhichas lupus*) is found all around Iceland, but not in great numbers in the warmer waters of the south and south-west coast, and it is caught mainly in early summer. Fifty years ago, wolfish was in most Icelandic households the most popular fish eaten fresh, dried or cured. Salted wolfish was eaten almost every day during the winter. Farmers on the land often obtained it by trading with fishermen and gave lamb and butter in return (Kristjánsdóttir, 1971). The fish skin shoes most commonly found in the west fjords of Iceland were made from the skin of the sea leopard (Figures 5.7 and 5.8) or spotted wolfish (*Anarhichas minor*) a close relative of the wolfish (Kristjánsson, 1986). These skins were most sought, as they were sometimes big enough to make two pairs of shoes, one for a grown up and one for a child. The bigger shoes were made from the wider part of the skin and were considered both more beautiful and less likely to break. Two types of shoes were made, one that had a seam at the toe and the heel and another that only had a seam at the toe that was pulled together and sewed with a string to a strip of fish skin (Figure 5.9) or sometimes lambskin (Rahme and Hartman, 2012). In the west Fjords, shoes were also made of lump skin, which were not so common in other areas, and were quite large in size. These were used only for sailors' shoes. Their skin is barbed, which prevented them from slipping on the boats (Rahme and Hartman, 2012).

Among qualities of the fish skin shoes were considered that they were light, warm and did not become stiff. They were not summer footwear because the feet would bake inside them in warm weather, and it would be a painful ordeal to walk on the stones (Kristjánsson, 1986). However, they were excellent footwear in frost and soft snow, as they lay very close to the foot and very little snow made its way into them (Ólafsson and Kristjánsdóttir, 1971). Icelandic people designed wolfish skin footwear for moving through snowdrifts, preventing them from sinking into the snow. The downsides were that they did not last very long and were not suitable for wet snow. Women

Figure 5.7. and 5.8. Spotted wolfish skin shoes. Back. National Museum of Iceland, 2021.
Figure 5.9. Wolffish skin shoes with woollen insoles. Skagafjörður Heritage Museum at Glaumbær. Iceland, 2021

used these shoes mostly indoors but men mostly outdoors during winter when the ground was covered with snow. New wolfish skin shoes were very slippery on the ice and when the snow melted it was discovered if there were hook holes in the skin. However, fishermen were careful not to stab the hook into the fish's body when catching wolfish (Kristjánsdóttir, 1971). If the scales of the fish were not removed, they would provide traction for the soles when walking across snow, ice, or slippery surfaces (Jackinsky-Sethi, 2014). Historically, during the fish skin processing, the seamstress could choose to remove the fish scales from the skins or retained them for both functional and aesthetic purposes. In the case of lump fish skin shoes, scales were left, since they provide good grip qualities (Vávra, 2020). Fish skin footwear was designed to insulate from Arctic weather (Jackinsky-Sethi, 2014). Arguably the fundamental role of a shoe is to keep the foot warm and dry and allow comfort and efficient of movement. Fish skin has high levels of breathability, much higher than conventional leathers, vegan leathers, and synthetics (Chapter 6). In 2006, Nike launched a capsule collection of shoes made from perch leather sourced from the Icelandic tannery Atlantic Leather taking full advantage of these qualities.

Fish skin was not considered suitable for fishing clothing by the Icelanders as the skin was better dry. The high breathability of fish skin accompanies its lack of water resistance. According to Hickman (1987) it is the slime of fish removed with tanning that renders it waterproof. Once tanned for human use fish skin must be keep out the wet. Of all the Arctic's fish skin artists the Icelandic alone make shoes only and not garments. They believed that fish skin if worn while fishing would 'disappear with its wearer and become part of the ocean once again' (Kristjánsson, 1986).

Wolfish skins shoes were made by women in the domestic sphere (Figure 5.10) where they had considerable responsibilities, running large households. There was a division of labour based upon gender at this time. Women did not only the domestic work, but also took part in the production of subsistence and exchange goods (Johnson, 1984). During the winter the women's main task was to clean, card, spin, knit and weave wool, to make clothing and making shoes for the household and produce cloth and knitted goods which were traded .The women never had idle hands because as well as the daily work they often needed to wash and dry the men's clothing when they came in soaking from the sea (Troil, 1780). In Iceland it was a custom for women to help men undress at the end of the day. As well as playing their part in the processing of the fish, women made their fisherman husband's clothing and shoes and ensured that they had dry clothes for the next day's fishing. There is also evidence that women in some parts of the country went fishing in the open rowing boats (Jonsson, 1975). The work was organised on a household basis and carried out by the family members and family servants. The type of work and remuneration were set down in law. The Farming Law of 1722 stated that a woman in the winter months was expected to weave 12 lengths of cloth in six days. She was also obliged to provide clean, dry footwear for two working men if this was needed (Johnson, 1984) (Table 5.1). In the past fishermen were

Figure 5.10. Snæbjörg Ólafsdóttir, last Icelandic fish skin craft inheritor at Reykjavik City Museum sewing wolfish skin shoes. Photographer: Sverrir Morgunblaðið, 2005.

taught from young age to sew leather so that they could maintain their own leather garments and shoes (Kristjánsson, 1986). Seamen's waterproofs jackets and trousers ('oil-skins') were carefully prepared from lambskin and smeared with cod liver oil to make them waterproof (Tómasdóttir, 2018). To keep the skin-clothes and shoes soft and supple and to prevent them from becoming damp it was necessary to grease them regularly with fresh and not very fat liver, skate liver being consider best for this purpose (Kristjánsson, 1986). After sharing this historical literature with Hlynur, COO of Nordic Fish leather tannery, he started using fish oil-based fats in the dyeing process and on a new waterproof fish leather formula.

Around 1910, fish skin shoes started to disappear, but some Icelanders still made shoes from skate skin and sometimes also gloves worn over woolen gloves for extra protection. Tanning of fish skin has not been common in the post-war period until its renaissance in 1994 by the hands of Atlantic Leather tannery located in Sauðárkrókur, on the north coast of Iceland. They have processed fish leather based on the ancient Icelandic tradition of making shoes from the skins of wolfish reviving ancestral tanning techniques. The tannery has brought this historic eco-luxury material back into fashion providing Blue jobs for coastal dwellers in remote rural areas, maintaining the viability of the fisheries sector and attracting young people to work in them (Palomino, 2020).

5.2.1 A pair of Icelandic wolfish skin shoes or Roðskór

This pair of Icelandic wolfish skin shoes (Figures 5.14 to 5.17) comes from Blönduós Textile Museum. The woman who made these shoes was Una Ó. Thoroddsen (1914-2013). She was born in Vatnsdalur, an Icelandic village in the west fjords situated 4 km northeast of Patreksfjörður and later on she moved to Ísafjördur also in the west fjords. She donated the shoes to the museum. She could recall that when she was a little girl and both her and her siblings were sent between farms, people would talk about how many shoes they needed for the journey. In the western fjords, each mountain chain that a traveller can access is called a heath, and the breadth of the heaths between the fjords used to be measured by how many shoes would be worn out on the way and how many "wolfish shoes" people needed to cross, one, two or even three heaths. This was for the route that was taken back and forth. Þorskafjarðarheiði was called a three-shoe heath and Látraheiði was a six-shoe heath (Glaumbær, 2021). When the shoes were worn out, people pulled out the shoelaces and put them in the new pair of shoes. The old shoes were then folded and put under a rock or a stone. Sometimes the wolfish shoes were used as cover over the lambskin shoes (Rahme and Hartman, 2012).

The fish skin used to make these shoes comes from non-spotted wolfish (*Anarhichas lupus*). During the summer the wolfish were catch and the skins were collected, tied together in bundles and stored for the winter (Kristjánsdóttir, 1971). These skins were not cured so as to be flexible (Annandale, 1903) and they were processed in the traditional Icelandic manner. When the fish was dried, the skin was removed before eating so that it remained intact. Fish both new or salted were

Figure 5.11. Pattern and replica of fish skin shoes made with cow leather. Woollen insoles with eight-pointed roses.
National Museum of Iceland, 2021.
Figure 5.12. Bone tongs made of sheep bone used to pull the needle when sewing fish skin shoes. National Museum of Iceland, 2021.
Figure 5.13. Wolffish skin shoes. National Museum of Iceland, 2021.

skinned and the skins layered out to dry in the sun (Kristjánsdóttir, 1971). Therefore, they were not tanned but washed and smoothed on a wooden board to which the skins adhere with its own fat (Table 5.1). When the skin dried, it came off the board. This was done for a while until dried and ready to be used as shoes (Rahme and Hartman, 2012). They were often dried on the north side of the fish drying hut (Figure 5.4) and hung upside down. Then they were stored in bundles like the dried fish (Kristjánsdóttir, 1971). When the shoes were ready to be crafted, the skins were wetted. The dried skins were put in cold water, but only for a short while because it was not good for them to get too wet, then they were placed under a weight to regain their shape. From there they could be removed after a few minutes. Then they were stretched out (Kristjánsdóttir, 1971).

In the construction of these shoes, fish skin is used in a size according to the foot for which it is to be adapted and the person who is going to wear the shoe puts her/his foot on it. Then from the front of each skin a suitable length for a shoe was cut. It was advisable for each person to measure their hand from the hollow of the thumb, around the hand over the back of the hand and down to the wrist bone. This measurement method is a little hard to understand but it seems exactly like the Ainu system of measurements where a seamstress would use the human body as a ruler (Lewallen, 2016). The skin is then folded up over the toes in front, and round the back of the heel behind, in order to get the exact size leaving a V-shaped opening over the instep (Landt, 1810). The two edges are sewn together on the foot, stitching along following the contours of the foot until the finishing seam is parallel to the toes. The long hairs of sheep coarse wool in reddish brown or grey were spun and usually greased with tallow. Then it was threaded through the eye of a shoe needle (Kristjánsdóttir, 1971).

The maker would use homemade pincers (Björnsson, 1994) to pull the needle through the fish skin. The pincers were made from whalebone, sheep leg bones (Figure 5.12) or calf leg bones. There was a stopper in the end of the bone and the needles were kept in the medullary cavity (Kristjánsson, 1986). An overcasting stitch was used to sew the skins (Rahme and Hartman, 2012). The form of the shoe was maintained by sewing a strip of wool or raw skin around the edge which would tighten the shape back to the heel (Figure 5.13). A couple of holes were made in the leather on each side of this opening, and knitted woollen or skin strings were fastened through them, crossed over the instep, twisted several times round the ankle, and secured behind by having the loose ends tucked in and being bound along the edge of the opening above with a narrow band of skin and the shoe tightened over the foot and then tied around the bottom of the leg (Kristjánsdóttir, 1971). People were very particular not to fasten the strings too high on the ankle (Annandale, 1903).

This pair of shoes features hand-woven striped wool insoles (Figure 5.14) which were devised to provide warmth and comfort to the shoe wearer (Ólafsson and Kristjánsdóttir, 1971). The knitting technique in Icelandic is called garða-prjón, which translates into garter stitch, a very

Figure 5.14. Wolfish skin shoes with woolen insoles. Blönduós Textile Museum. Iceland, 2021.

straightforward knitting pattern. The straight central part is woven in one piece, while the toe and heel are added later. The edges are crocheted. The main colours used are grey, yellow, light brown and dark reddish-brown (this reddish-brown colour is called mórauður or mórautt, to describe the sheep with this colour). This Icelandic tradition dates back to the 17th century, when vivid geometric designs incorporated into fish skin shoes insoles were intended to be worn (but never seen) for Sunday church outings and other special occasions. The motifs incorporated into the fancier insoles are four- and eight-pointed roses (Figure 5.11), squares, diamonds and flowerpots, which were woven in intarsia style, on a garter stitch background - a combination that is probably unique in Iceland - in cheerful reds, yellows, blues and greens, often with striped trimmings or banded woven borders. A pair of woollen insoles was considered an extravagant gift. At the time when the insoles were in use, they were the only colourful item in the otherwise dreary brown, black, dark blue or grey wardrobes of hard-working farming and fishing families. Everyone liked to have a pair of these insoles; they brought colour and joy to extremely difficult lives (Magnússon, 2009).

Figure 5.18. Map of Alaska, 1875 Dall, W.H. US Coast Survey.   Library of Congress Geography and Map Division Washington, D.C.
Figure 5.19. Children, under salmon hanging from rack, in Alaska. Nowell, Frank H. Library of Congress.
Prints and Photographs Division. Washington, D.C.

5.3 Alaska Native Peoples and fish skin

What we now call Alaska was defined in 1741 by Danish explorer Vitus Bering, travelling on behalf of Imperial Russia (Table 5.1). The area defined by Bering, was made of complex trading routes of maritime peoples along the coast, and inland continental peoples (Cloud, 2022). When Bering landed on Kodiak Island in the northern Alutiiq territory, Native culture was flourishing and at its peak, after evolving for 7000 years (Palomino and Pardue, 2021). By 1760, Russian fur hunters began regularly trading with Alaska Native Peoples (Crowell, 1988). To a government whose most important source of imperial revenue came from furs, Alaska was "a brave new world." Russians fur traders exploited Native labour for their mammal hunting expertise, which the Russians lacked and they banned indigenous hunting and processing of furs destined for the commercial market. They exhausted all the Alaska Native fur skin resources, and local seamstresses were forced to rely on skins with little value to the export fur trade, particularly fish skins and bird skins to make their clothes (Steffian and Laktonen Counceller, 2015). By the time the Russians sold Alaska to the United States in 1867, Natives' lives were again in peril. The Karluk River on the west side of Kodiak Island, one of the richest salmon streams in the world, had long been spotted as an exploitable fishery resource by Russians and Americans. The first cannery in Karluk was established in 1882. Salmon, the staple of the Alaska Native diet became a commercial trade to feed the American economy. The explosion of the salmon industry quickly led to overfishing and a dramatic decline in salmon that had fed Natives for many generations (Mason, 1995).

5.3.1 Subsistence fishing then and today

Alaska Native Peoples share similar patterns of adaptation to the environment in their hunting and fishing techniques, in their clothing and shelter, and in their perception of life. They are also distinguished by their primary source of food supply. There are inland Native Peoples who include both caribou-hunting, tundra dwellers and river-fishing peoples. And there are the coastal dwellers who were primarily sea mammal hunters and depended upon Arctic fish as a large part of their diet. Many of the similarities between widely separated Alaska Native groups have their basis in this orientation to and dependence on the marine environment and its animal resources (Martin, 2001). Salmon was a principal source of food for many Indigenous Peoples of Alaska: Alutiiq, Athabascan, Iñupiaq, Tlingit, and Yup'ik Inuit. Among the North Alaska cultures of the prehistoric period, salmon is reported to have been the principal fish consumed (Anderson, 1984) (Table 5.1).

Cultures from Southeast Alaska consumed salmon as early as 1000 BC and the cultures of the Northwest coast began to feed on salmon as early as 8000 BC. Salmon was a reliable source of food for the Southwest Alaska Yup'ik. Central Inuit caught salmon mainly during summer with spears of three points, hooks, baits (fish shapes carved in ivory), and sometimes nets. In contrast, Copper Inuit both men and women fished by breaking holes in the ice and using hooks during winter. It is also reported that they used "gill" or "seine" nets, fishing salmon during the month of July (Kuhnlein and Humphries, 2017). Fish were abundant in the Yukon-Kuskokwim Delta throughout the year, and it was considered a paradise in fish and game (Huntington, 1993). Fishing was the most stable food source for Alaska Natives (Nelson, 1973).

According to local Elders fishermen should not stay in the same area for too long. Doing so would kill all the fish. One should not risk and get stuck at the time of freezing in the wrong place, where there would be no fish available. Rather, fleeing through the last crust of spring snow, using snowshoes and moving quickly to reach the Yukon River in time to build fish traps before the salmon run begins (Huntington, 1993). According to Schmitter, the Upper Yukon Native customs included going to the riverbank in spring, where they could build canoes and nets in preparation for salmon fishing. Dog salmon was preferred to king salmon because it is less oily. They would use "hand nets" for salmon which they let down to the bottom of the river in deep places. Gradually they were replaced by fish wheels. Whitefish and grayling were also taken with nets (Schmitter, 1985). In the past there were no fish nets on the Yukon River, they used fish traps in the sloughs, using long willow branches (Mischler, 1995). Fish traps were replaced by fish nets after contact (Nelson, 1973). Salmon were packed in bunches of 50-60 fish to feed the dogs, which could eat between 250 to 300 fish per winter. There was an average of nine dogs per family, so people needed 40-50 salmon bales for the winter (Curt and Yarber, 1981b). The importance of fishing dramatically declined because people no longer needed to feed dog teams (Nelson, 1973). Practically all fishing on the upper Tanana River was done in July. At this time the white fish run from the lakes into the main river and are at their fattest. The streams draining the lakes are relatively small and slow moving, which greatly facilitates the use of fish weirs, and for a few weeks the natives congregate about the well-known fishing spots to take and dry their fish supply (McKennan, 1959). For the Gwich'in, a group of Athabaskan-speaking of northern Alaska and northwest Canada, salmon was very important and their general subsistence pattern of fishing in river was from July to October. King, dog and silver salmon was catch with fish traps at the end of V-shaped weirs, in small tributaries rivers. Large wickerwork traps were used for salmon. Other fish vital for their subsistence were whitefish, suckers, louche, grayling, jackfish and trout (Osgood, 1936). Ice fishing was done in winter and spring, especially for pike. They used a short pole, and a strip of pike skin on the hook as lure (Nelson, 1973).

Everyone but the small children played a direct part in the economy of the small riverine and mountain fishing communities. The youngsters at play imitated the endeavours of their elder counterparts, and they soon acquired skills for playing their roles in the family. The little girls remained with their mothers and older sisters and soon learned the art of making nets and cleaning, drying and tanning fish skins (Clark,1974).

Currently many of the world's wild salmon stocks are depleted due to overfishing, habitat damage, or pollution. Alaska is the only state in the nation with a constitutional mandate that all fish must

be managed sustainable and commercial fishing is strictly regulated to preserve the populations. Salmon are a key species to Alaska's ecosystems. Wild salmon returns to the exact river they were born in – after traveling thousands of miles and spending 2 to 5 years at sea. This lifecycle allows Alaska's wild salmon to be harvested at the tail-end of their life – allowing them to contribute to their role in the food chain along with orcas, seals, and other fish to help maintain a balanced, sustainable, and diverse ecosystem (Salmon Sisters, 2021).

Fishing is the most significant subsistence activity in Alaska. Millions of pounds of fish are harvested each summer as a source of food that can last throughout the year. Beyond the importance of fish as sustenance and a means of economic livelihood, fishing also serves important cultural functions within Alaska Native communities. Fishing camps brings people together in the activity of catching and storing fish. Fish skin was once a common material in Alutiiq, Athabascan, Iñupiaq, Tlingit, and Yup'ik communities in Alaska. In these past few years, Alaska Native artists have taken up the use of fish skin. Artists are researching the technology to process and sew the material by consulting museum collections, examining the construction of historic fish skin artefacts. In other cases, artists have taught themselves by experimenting with the material. Recently, fish skin workshops where artists learn from each other and share their techniques have proliferated across the state (Jackinsky- Sethi, 2014).

5.3.2 Fish skin, a leather resource

The records of ethnographers and collectors from the late 19th and early 20th centuries reflect that Alaska Native Peoples throughout the state used the skins of various species of fish as an important source of leather wealth. During the late 1880s, Smithsonian Institution collector Edward Nelson recorded that in the Lower Yukon, locals used salmon skins to manufacture their garments (Nelson, 1899). Similar observations were made during the same time period by the collector Reverend Sheldon Jackson who noted that the Natives of Kodiak Island made shirts out of the skins of codfish and salmon. Anthropologist Cornelius Osgood working in the interior part of the state in the early 20th century recorded that the Deg Hit'an Athabascan people created fine fish skin garments and that every adult own several fish skin bags (Osgood, 1940). In the 1950s, American ethnologist Frederica de Laguna documented that the Tlingit in the Yakutat area continued to manufacture halibut skin bags which were used as bags to store clothing, skins and food, as well as smaller versions that were used to store seal oil or sewing materials (Jackinsky-Sethi, 2014).

Throughout this timeline, explorers, collectors and anthropologists from the Smithsonian Institution travelled to this vast and fascinating land to learn about the Indigenous groups that resided there and to acquire artefacts as scientific specimens that would document what they thought were cultures on the verge of disappearing. As a result, many fish skin baskets, gloves, boots, clothing and other items were left permanently in Washington DC. For the communities

Figures 5.20 and 5.21 Fish Skin bag or kellarvik for storing and carrying clothes pieced with narrow sealskin strips, decorated with brown cutwork. Alaska, USA. NMNH, Smithsonian Institution. Washington DC. USA, 2019.

of origin, the removal of their material culture, led to the increasing scarcity of certain types of artefacts, as well as the activities associated with them (Crowell, 2010). In 1994, the National Museum of Natural History's Arctic Studies Center (ASC) established an Alaska branch at the Anchorage Museum at the Rasmuson Center. Reflecting the new paradigm of museums forming partnerships with those whose cultures they hold in their storage rooms, the NMNH ASC staff brought teams of Alaska Native consultants to Washington DC to explore artefacts that had been removed from their communities' years earlier. Alaska Native Elders visited from the late 1990s through 2009 the Museum Support Center (MSC) the principal off-site conservation and collections *storage* facility for the National Museum of Natural History contributing to the knowledge of these materials. The information listed in this chapter comes from this series of interviews with Native specialists, as well as the back-to-back field surveys I conducted with Native fish skin artists across the territory in Alaska.

With the abundance of fish in the Alaskan rivers, and with the Native peoples' close affinity to the land and its resources, it followed naturally for fish skin to become widely used as a 'fabric' in the construction of garments, mittens, boots and containers (Fitzhugh and Kaplan, 1982). By treating the thin fish skins, seamstresses created garments that could be worn over fur or bird skin clothing (Driscoll-Engelstad, 2020). Most of the goods traded and exchanged among Alaska Native were raw materials, including fish skins and items made from fish skins (Huntington, 1993). From the mouth of the Yukon River to the Kuskokwim, where salmon is abundant throughout the year, fish skin was used as a traditional protective material historically used by many cultural groups across Alaska to make items like drums, parkas, pants, boots, mittens, hats, quivers, bedding, blankets, tent coverings, windowpanes, bags and drinking containers (Jackinsky- Sethi, 2014) (Table 5.1). Adults wore fish skin clothing, gloves and boots as a protection against wind (Hickman, 1987). Osgood describes some articles made of fish skin that do not exist in Alaskan collections today such a fish skin cradle made for a baby after a family has lost one child by death. The salmon skin keeps away the evil spirits that caused the death of the previous child. Osgood also mentions a baby one-piece suit with trousers, footwear and a front opening. As the child grows, the suit is enlarged by inserting a strip of fish skin. Moss is placed in the seal of the garment as a diaper (Osgood, 1940).

The fish skin items would be used in the spring after the snow was gone (Brink, 1980). Skins became a form of accumulated wealth, which could be traded or given away as gifts during ceremonies (Osgood, 1940). The king, chum and silver salmon made the largest supply of food and contributed greatly to the spiritual and material Alaska Native culture. The skin of the chum salmon was preferred for garment construction, as it was highly durable, strong and lightweight (Osgood, 1940). Also popular were the whitefish and blackfish. The Arctic char, a species closely related to the salmon or lake trout, and nearly identical to the Dolly varden char, was abundant throughout the Alaska rivers (Reed, 2005). Thinner-skinned fish such as burbot was also used

Figure 5.22. Fish skin bag decorated with reddish brown skin strips and white cutwork. Alaska, USA. NMNH, Smithsonian Institution. Washington DC. USA, 2019.
Figure 5.23. Fish skin container with decorative skin strips and hair stitching. Thin row of fur trim. Sealskin strip surrounding top. Alaska, USA. NMNH, Smithsonian Institution. Washington DC. USA, 2019.
Figure 5.24. Fish Skin container for clothing. Askinuk (Hooper Bay), Near Cape Romanzof. Yukon & Kuskokwim Delta. Alaska, USA. Collector Edward W. Nelson. 1879. NMNH, Smithsonian Institution. Washington DC. USA, 2019.
Figure 5.25. Fish Skin Sack or Wallet. Yup'ik, Kaialigamiut (Qaluyaarmiut). Yukon & Kuskokwim Delta, Askinuk (Hooper Bay), Near Cape Romanzof, Alaska, USA. Collector Edward W. Nelson 1879. NMNH, Smithsonian Institution. Washington DC. USA, 2019.

for clothing and was especially suitable as an alternative to gut in the construction of window coverings (Stefánsson, 1914). Eels, too, were a major source of material for the construction of garments and bags because of their massive migrations up the Yukon River each year (Nelson, 1899; VanStone, 1989). The processed skins from lamprey eel, jackfish, whitefish, blackfish, halibut, burbot, grayling, and Arctic char as well as all five species of salmon (Chinook, coho, chum, sockeye, and pink) were used by Alaska Native Peoples (Jackinsky- Sethi, 2014). According to Hatt and Taylor (1969) fish skin has been used in the past both in Kodiak Island (von Langsdorff 1812, quoted in Hatt and Taylor, 1969, p. 9), as well as along the Yukon and Kuskokwim rivers (Wrangel 1839, quoted in Hatt and Taylor , 1969, p. 9). Nelson describes that the population along the Yukon River made use of salmon skins to manufacture their garments (Nelson, 1899, quoted in Hatt and Taylor , 1969, p. 9).

During the American period, Alaska Native Peoples were introduced to industrially manufactured clothing and gradually the need for Native-made clothing disappeared (Chaussonnet, 1995). Although Alaska Natives continued to use fish as an important food supply, by the mid-20th century the use of fish skin clothing dramatically declined. With a few exceptions, fish skin boots and parkas were replaced by rubber boots and commercially manufactured rain gear (Palomino and Pardue, 2021).

5.3.3 Fish skin bags, kellarvik or qemaggvik

Fish skin artefacts are directly connected with the important Alaskan Native subsistence activities of fishing. Throughout the circumpolar region, from coastal Alaska, northern Canada, and northern Europe to northern Siberia, people carried their goods on fish skin baskets. Baskets and containers had many sizes and shapes, and they were used for storing fish and fish heads, there were also berry and root baskets (Clark, 1974). Fish skin bags were made in a variety of shapes from shallow baskets to long tubular bags. These latter were typically made with a circular piece. The bags themselves would have been used for different ends. Fish skin bags were used for storing and keeping things dry (Fienup-Riordan, 2005). Large round or oblong bags (Figure 5.20) served for storing and carrying clothes, furs and skins inside the home, keeping clothes dry and were given to newly married Yup'ik women (Rowe, 2020). The materials to be stored in the bags were stuffed inside, the ends of the bags were being generally tied up with fish skin or tanned caribou skin drawstrings along the top of the bag to close them (Osgood, 1940). When the son of a couple got married, a bag like this would be brought out filled with garments for the bride (Alaska Native collections, 2021). These storage bags or containers are known as *kellarvik* or or *qemaggvik*.

During the Danish expedition to Arctic North America, Knud Rasmussem[1] took these notes in Alaska in 1924 from his journey to the heart of the Arctic: "There she told him to remove all his

1 Greenlandic–Danish explorer and anthropologist. He was the first European to cross the Northwest Passage via dog sled.

Figure 5.26. Salmon skin pouch for storing fire-making equipment. Cape Darby, Norton Sound. Alaska, USA. 1880. Collector: Edward W. Nelson. NMNH, Smithsonian Institution. Washington DC. USA, 2019.
Figure 5.27. Fish skin woman's workbag (kakiwik or housewife). Cape Darby, Norton Sound. Alaska, USA. 1880 Collector: Edward W. Nelson. NMNH, Smithsonian Institution. Washington DC. USA, 2019.

clothing, and then went outside to her umiaq[2] whereafter she returned with a salmon-skin bag full of new clothing; these she gave him, new clothing from top to toe, and suggested that he should go home with her; he was willing. So, they travelled home to her parents, sometimes flying through the air like birds, sometimes swimming in the sea like fishes. In this fashion the girl got a man and married the son of an umialik[3] since then these amulets have been used on all umiaqs" (Rasmussen, 1927) (Table 5.1).

Small bags (Figures 5.22 to 5.25) were likely to have been used outside to pick berries or to store foods such as fish eggs and salmon oil and or for holding fire implements (Rowe, 2020). An old salmon skin boot could also become a container for fish eggs when it was no longer useful as a boot (Hickman, 1987). Some small bags were made into a *kakivik*, or *kakiwik,* also known as a "housewife"(Figure 5.27.) a bag with a rounded U-shaped top and a pouch at the bottom where a woman kept her needles, thimbles, awls, and other sewing implements (Jackinsky- Sethi, 2014). In the Koyukuk River small fish skin bags (Figure 5.26.) were made for carrying and storing fire- making equipment, paint, pigments, spruce gum for mending canoes, and sewing equipment. Some were carefully decorated with weasel or marten hair. When they were decorated in this manner they became highly desired items of great prestige value (Clark, 1974). Such bags were so valuable that it was one item burned with a person's body. In old days, people were cremated in their best clothes, wearing all of his ornaments, knife sheath and fire tinder bag. Such small fish skin bags were also shown around the neck in early drawings of Alaska Natives (McKennan, 1959). Mourning women also used small fish skin pouches to hold the locks of hair of their loved ones (Osgood, 1940). Fish skin bags, used for storing dried fish, and other essentials, were amongst the gifts traditionally offered to the spirits of the dead through their namesakes during Elriq, the Great Feast of the Dead (Fienup-Riordan, 1994).

According to Osgood (1940) a fish skin bag would take from a few hours to several days to make, depending on their size and complexity and could last about four years, depending upon how much it was exposed to the sun. When the fish skin is heated too much in the sun, it bulges and hardens, whereas if left alone the fish skin becomes tougher over time. When a fish skin bag is brought into the house at night to dry, it should be done after the fire has gone out. A hot fire will dry the fish skins and spoil them.

The function of a bag is not only to contain, to store but also to allow you to travel more easily with your necessities. They seem very practical but how spiritual invested are contemporary bags? If we consider the enormous emotional charge of handbags to contemporary women perhaps, should reconsider. Because they allow you to move freely holding to what you need, they give you protection and they give you adventure.

2 Open skin boat, used by both Yup'ik and Inuit, originally found in all coastal areas from Siberia to Greenland.

3 Umialik was the employer of a whaling crew, recruiting his men for their professional ability and acting as benefactor to them and their families.

5.3.4 Salmon fish skin bag from the Yukon Delta, Alaska

During my Fulbright scholarship at the Smithsonian NMNH, I was able to access the Indigenous Arctic fish skin ethnological collections documenting fish skin artefacts, practices, peoples, and cultures of the Alutiiq, Yup'ik and Athabascan Peoples from Alaska. I had the opportunity to work with Dr. Stephen Loring, museum anthropologist and Arctic archaeologist at the Smithsonian ASC since 1991, who has been incredibly supportive throughout this PhD.

This fish skin bag (Figures 5.28 and 5.29) was collected in 1879 by naturalist and collector, Edward William Nelson, who travelled extensively through Alaska. Nelson (1983) arrived in the Bering Strait region of western Alaska as a weather observer for the U.S. Army Signal Corps in 1877. In addition to his meteorological duties, he also gathered items for the Smithsonian Institution's National Museum of Natural History. While Nelson worked in the region, he collected and documented the material culture of Native Alaskans from 1878 until leaving his position in 1881 (Fienup-Riordan, 2007). This bag was collected well after Russian and western European colonists established trade routes and trading posts to exploit local fur resources (Ewing and Darwent, 2018). In 1899 Nelson wrote: "In the Lower Yukon the poor people made use of salmon skins to make their frocks". Fitzhugh and Kaplan suggest, however, that these fish skin garments were robust and windproof (Fitzhugh and Kaplan, 1982, p. 131) and Ager confirms that the Peoples of the Bering Sea used fish skins for garments, mittens, boots and containers (Ager, 1982, p. 43). When this salmon skin bag was collected in western Alaska in the 1880s, such beautiful objects were common and Arctic households would have owned several fish skin bags.

There is not much historic literature on fish skin tanning and most Alaska Native tanners have applied other hide tanning techniques to their fish skin tanning processes (Table 5.1). Amongst the techniques shared from other hides are soaking them in a tub with rotted caribou brains, hanging them outside, and smoking them (McKennan, 1959). Then more scraping was done, and the result was a smooth, soft, flexible white skin (Hadleigh West, 1963). Following a moose skin tanning recipe, one should choose a warm sunny day to tan the skins to keep the skins moist. The tanning liquid was made from moose brains, mixed with fish oil and marrow, which was placed in an airtight container and left to sour (Curt, and Yarber, 1981a). Rabbit skins, for example, were given a coating of fish eggs mixed with urine, rubbed and then hung to dry (Osgood, 1940). Steinbright mentions that the Athabaskan method of tanning muskrat skins was to use a tanning oil made from boiled fish vertebrae mixed with sudsy soap. (Steinbright, J. 1984, p. 80). Skins could also be smoked on a dome-shaped frame (Hadleigh West, 1963). To obtain the 'proper' colour and fragrance rotten spruce, willow and cedar could be used during the smoking process (Baillargeon, 2011).

Leather tanning was considered a woman's job (McKennan, 1959). During the winter season women begin tanning the skins from the previous season as the cold aids in making the skins soft.

Making new parkas, footgear, gloves and getting their family's winter clothing in good repair was also done during the winter (Clark, 1974). The skins were usually scraped and rubbed indoors, while stretching and drying took place outdoors (Osgood, 1940). Osgood's records of the tanning and use of fish skin by the Ingalik Athabascan Indians is the earliest available documentation of this process. The salmon was first dried and, once being eaten, the skin was kept. The fish was prepared for drying by placing a stick in the skin to avoid curling (Osgood, 1940, p.162-164). After detaching the flesh from the skin, the remaining flesh is scraped away from the skin using a half-moon knife or ulu, a spoon, a bone implement or a seashell. Care must be taken not to tearing through the skin, otherwise is rendered useless (Jackinsky- Sethi, 2014). Once the skin was well scrubbed, it was placed for rinsing in the qurrulluk (urine bucket) outside the house. These wooden vats contained the urine of unweaned babies, where the ammonia in the urine was used to remove excess oils and break down the remaining fat. The skins are then rolled up and left in a warm room until the flesh and scales can be easily scraped off (Steffian and Laktonen, 2015). The next step was to manually manipulate the skins for hours, massaging and stretching them until they became supple and soft (Jackinsky- Sethi, 2014). The skins were then washed by hand, hung in the cold to dry. The freeze-dried fish skin was difficult to crack or break (Fienup-Riordan, 2005). That is why the skins were dried in the open air to allow them to air well (Brink, 1980). After been tanned with human urine they were treated with fish or seal oil to soften them further (Fienup-Riordan, 2007). The skins were first soaked in the salted salmon water. When the skins were softened, they were rolled up and kept overnight. The next day, they were removed, oiled and left overnight. Then they were rubbed by hand to soften them again. The bags were also made waterproof by being smeared with seal oil after they were assembled (Alaska Native collections, 2002). Today Alaska Native artists have modified the technique. Instead of soaking the skins in urine, they use lye or another soap or detergent (Palomino and Pardue, 2021).

The curvilinear shape of the fish made the construction of bags more difficult, but it helped to generate exciting individual designs. Salmon skin, for instance, was very different from the skins of eel, burbot or Arctic char in size, shape, durability and transparency. Unlike the simple shapes of the intestine and bird skin, each fish skin shape produced its own creative challenges (Reed, 2005). The skins are turned inwards so that the scales are on the inside of the bag and the softer smoother skin underneath is exposed (Fienup-Riordan, 2005). Fish skin bags were often constructed in a highly decorative way by mixing narrow bands around the top of the bag or on the sides with other types of fish skin such as louche, horse mackerel and grayling (Osgood, 1940). For this purpose, vertical strips of undyed fish skin were contrasted with red skins dyed with alder bark or red ochre, and strips of dyed marine mammal oesophagus could also be added as piping. To increase the strength of the seams, as well as to embellish them, they were finished with ribbons, coastal grass, thread and caribou skin (Figures 5.23 and 5.25) (Jackinsky- Sethi, 2014) (Table 5.1).

This bag is ornamented with white and red bands of bleached seal oesophagus. Red ochre (hematite) was dug from the ground, and it was used for decorating leather (McKennan, 1959). Soft and hard red pigment was burned in intense fire to reduce them to powder (Osgood, 1936). Red ochre was also soaked in fish blood and placed in the fire to redden (Snow, 1981). It would be used wet placed at the end of a small stick and applied to seams of bags, boots, parkas, and to the face (Hadleigh West, 1963). Berry juice could also be painted along the seams of the clothing and containers (McKennan, 1959). Red ochre was considered a valuable commodity and it was used in trade (Osgood, 1940). The locations where it was found were considered sacred, and offerings were left when it was taken. Supernatural power was also attributed to red ochre (Slobodin, 1981). Another kind of red paint was made from jasper, blood, and water. Other types of dye were made from stones, clay, rotten birch, spruce wood, blackberry and blueberry juice.

The seal's oesophagus was soaked in alder bark water or red ochre. The skins were placed on aged urine, the outer bark of the alder trees was stripped off, the bark was placed on the fish skin and left overnight or for two nights. When the colour came out of the bark, they would rub it on the skin, along with those pieces of bark. Then they were tied, covered and left to soak. Hot water could be used instead of urine to leach colour from alder bark. The dried oesophagus was dyed red using the same method. Skins could also be dyed by rubbing them with red ochre moistened with water. Once the intestine was treated like that It was used to decorate objects like this fish skin bag adorning them alternating white strips of bleached seal oesophagus and red strips of oesophagus. The dyed seal intestines were measured and cut the same length and were placed on the seam to prevent them from breaking (Fienup-Riordan, 2005).

Historically, seamstresses used sinew or thin strips of salmon skins to connect the skins together using a couching stitch, a running stitch, or an overstitch (Jackinsky- Sethi, 2014). They used sinew (tendon) from back of reindeer or caribou to sew the scraped, tanned and treated salmon skins together (Keys, 2020). Sinew is a material created from processed tendon and must be split by hand to the desired width. A strip of sinew is first softened by soaking in water, or with saliva, and then it is split to the desired thickness. The sinew can be left flat and used as thread (Ewing and Darwent, 2018). Sinew could be used dry to sew with awls made from loon mandible, or caribou splint bone (Hadleigh West, 1963), or it could be used wet with marten penis bone needle (Snow, 1981).

The choice of thread material how the thread is prepared (twisted or not twisted), the size of needle used (as evidenced by the size of holes in the material where the needle passes through), and the chosen stitch type all affect how the bag is constructed. Overcast stitch and running stitch were used to construct this bag. Overcast stitch creates a seam where the material seats edge- to-edge smoothly. Running stitch creates a smooth interior surface. Other stitches that can be used for sewing this type of bag include the waterproof stitch, so that when the salmon and deerskin thread expands when wet, it would create a watertight seal (Biddison, 2019).

Figures 5.28 and 5.29 Fish Skin Sack. Nulukhtulogumut, Yukon & Kuskokwim Delta, Alaska, USA. Collector: Edward W. Nelson. 1879. NMNH, Smithsonian Institution. Washington DC. USA, 2019.

The play of light and dark of skins mimicking the seasonal contrast between light and dark in the Arctic, is a key aesthetic device used by seamstresses contrasting the white of the fish belly against the animal's dark dorsal fin area as well as dark strips of sealskin to highlight the design elements of baskets. This contrast between light and dark serves as a principal narrative featured in Inuit art showcasing the skill, patience, and diligence of the artisan (Driscoll-Engelstad, 2020). To produce a bag like this one, carefully selected alternate strips of dark and light fish skin were stitched side by side. The usual placement of tail end next to head end, with tail, head and fins removed, holes patched, skins flattened out and edges stitched, led to great variation and created a patchwork feast. Natural fish skin shapes were not trimmed into equal sizes or exact shapes to fit more neatly (Hickman, 1987). This bag has a cylindrical shape with a flat bottom. The bulk of the piece is salmon skin, with four vertical panels of dark red and white sealskin reaching from the bottom to where they meet an identical band of brown and white sealskin running horizontally. The red sealskin is cut in thin bands which are sewn on the greater widths of white sealskin. The white and red decoration strips of sealskin (very thin and soft in texture) may be from the throat of the seal. This is likely to be bleached seal throat, or perhaps oesophagus, often used to decorate fish skin bags. In wintertime, the oesophagi of seals would be cut from the stomach, inflated, and left to freeze-dry outside in the cold, which turn them very white. These freeze-dried oesophagi are called nerutet in Yup'ik (Rowe, 2020). The bottom is also made from a very large piece of fish skin. A rawhide drawstring encircles the top. While the bag is drying, the seamstress would fill it with sand or dry grass to keep its shape. When dry, these bags would keep out dampness (Hickman, 1987).

Figure 5.30. Map of Northeast China. Letts' Popular Atlas .1883. David Rumsey Collection. ref: www.davidrumsey.com
Figure 5.31. Hezhe family. ref: www. commons.wikimedia.org

5.4 Hezhe Ethnic Minority

China is a multi-ethnic country. To date, the central government has identified and recognised 56 ethnic groups in its vast territory. The Han ethnic group is the most numerous, while that of the other 55 are relatively small. China's diverse ethnic groups gave rise to its unique cultures, as well as its historical development, creating Chinese civilisation (Zhu, 2014).

The Hezhe are a Chinese ethnic minority in the multi-ethnic Heilongjiang Province, located on the northern border of China facing Russia. The area features mountains and rivers and an abundance of natural resources. The countryside has been renowned for fishing and hunting since antiquity. The three main border rivers: the Amour, Ussuri and Sungari and the numerous lakes scattered around have supplied the Hezhe Peoples for hundreds of years with a bounty of fish to feed themselves and for the construction of garments and accessories (Guo *et al.*, 2017) (Table 5.1). These rivers were givers of biological life, economic livelihood and a great spiritual power imbued in these natural surrounds by their shamanic worldview (Pulford, 2019). A group of very closely related peoples inhabited the lower Amour valley and the northern half of the Maritime Region. This group of fishermen is comprised of the following officially recognized Ethnic Minority groups: Nanai, Ulcha, Ulta (also officially called Orok; the Ulta resettled community in Abashiri of Hokkaido is no longer referred as Orokko but Uiruta), Orochi, and Udehe (also known as Udege) and Hezhe on the Chinese side of the Amour valley. At present the Amour Ethnic Minorities are officially divided into separate ethnic groups and classified in Russia as the Nanai, Ulcha, Orochi, Udehe and Ulta, and in China as Hezhe. Their cultural unity with the Pacific Northeast Asian peoples, especially the Ainu, indicates their ethnogenetic role in the cultural development of the region (Zgusta, 2015). These Indigenous groups interacted with each other in exchange networks that stretched across northeast Asia to present-day Sakhalin Island, Hokkaido and eventually Alaska (Pulford, 2019). They all share a common background including material culture and decorative art, social and political organization, religious beliefs, and oral traditions.

Before the Russians and Chinese settled in this area, the Amour valley Ethnic Minorities would subsist mostly on fishing in these rivers. The ancestors of today's Nanai and Hezhe were labeled 'Fish skin tartars' given their use of that material to make clothing and they lived secluded from either Chinese or Russian imperial influence. Sporadic contacts included visits by French Jesuit cartographers (Du Halde, 1735) dispatched by the Manchu Qing court to map the region (Pulford, 2019). French Jesuits travelling on the Ussury and the Amour in 1709 described Hezhe and Nanai Peoples for the first time as local 'tatars' (*yupi*) wearing modified Manchu and Chinese outfits made of fish skin whose fineness the missionaries admired. They also recorded aspects of their animistic beliefs and traditions (Du Halde, 1735). For over a century now, the Nanai have been growing estranged from their riverine neighbors to the south in China, the Hezhe.

The Hezhe ethnic minority has been continually oppressed by many populations (Table5.1). They first came under Chinese domination during the Tang Dynasty (618-907), when the Heilong Military

Region was created to govern the area. In the early Qing Dynasty (1644-1911), they were recruited by the Manchu leaders into the military system. During Imperial China, they were recruited once more into the army and engaged as river patrols (Hays, 2015). During the Japanese occupation of Manchuria – the historic name of this area of China – between 1931 and 1945, they were relocated and forced to work in the mines and on the railways. A policy of genocide was enforced, whereby they were herded into concentration camps. Their diet was inadequate, as they could not hunt or fish freely, and an opium addiction was instigated. The death rate under these conditions was extreme, by 1949 just before China's national liberation, 80 to 90 % of them had died and they numbered about 300, almost too little to qualify as a separate ethnic group (Hays, 2015). When the People's Republic of China was founded, aid came for the Hezhe to rebuild their communities (Sun, 2020). Imperialist ideas instigated by the USSR towards the Nanai and by the PRC in China towards the Hezhe forcibly encouraged both groups to settle in permanent villages and into fishing cooperatives with the help of the central government. Their intimate knowledge of land and water were replaced by fishing brigades and industrialized exploitation of the local environment that ravaged fish stocks on both sides of the border (Pulford, 2019).

The Hezhe have been victims of various "civilising missions" being incorporated within the borders of these regimes of power and ethnic separation. This has involved the material culture of household objects, transport technologies, fish skin clothing, food and other items that the Nanai and Hezhe interact with on a daily basis. So the new layout of the region bears the imprint of the pre-colonial fishermen and their lives materially and spiritually wrapped in the skin of the fish (Pulford, 2020).

Fishing enables the Hezhe to sustain themselves. They fish seasonally, according to the patterns and behaviours of the different fish and their usual catching grounds. Fishing is broadly divided into three seasons: spring, autumn and winter. The best fishing season is the autumn salmon season. In the spring, they catch all kinds of small fish; in summer, they repair fishing nets and arrange fishing gear. Autumn is their harvest season. They fish for salmon, sturgeon and wolffish. The Hezhe live in a very cold region above 45 degrees north latitude, where there is a freezing period of more than 7 months. In winter, the Amour River freezes up to 1-2 metres; this is a favourable time for them to ice fishing both with nets and dry hook. The large trawl net they use is more than 100 metres long, and the way to get under the ice requires a number of skills from the trained fishermen (Chen, 2012).

5.4.1 Hezhe fish skin mythology

The Hezhe enjoy a peaceful coexistence with nature, rather than a conquest, control and exploitation of the environment (Sun, 2020). They have traditionally been animists, believing that all objects and natural phenomena have their own spirits and that their shamans can control the impact of these spirits on human beings. Shamans played an important role in Hezhe society

and religion, regarded as empowered to communicate with the non-human realms providing solutions to issues that gods or demons had caused to humans. There were various types of shamans with different duties. The Hezhe believe that each person has three souls, one that dies with the body and two others that survive it. Of these two, one is reincarnated as a person or an animal whose species depends on its proper or improper behaviour in a previous life. The other will be taken, through relevant ceremonies, to the world of the dead, a world similar to that of the living, inhabited by the spirits of the ancestors (Hays, 2015). Not only the human soul can join the body of a human being, but also any animal by becoming a deer, a horse or a fish (Table 5.1). The human spirit is not constrained by a body, the soul can merge with anybody, and humans and animals can engage with each other. There are many advantages to this configuration during hunting, fishing and daily activities. Firstly, the fisherman or hunter can disconcert the pray to protect themselves and defeat it unexpectedly by changing their form. Secondly, the individual can realise his aspirations in a completely new shape. In this way, human beings have multiple ways of fulfilling their yearnings (Sun, 2020). However, shamanism, on which the Hezhe had built their spiritual life, almost completely vanished due to the influence of Chinese culture (Hays, 2015).

The Hezhe have been named the "fish skin tribes" because of their intimate relationship with fish, traditions of eating raw fish and wearing fish skin garments. Indeed, they are themselves the descendants of fish according to their genesis mythology. Most Hezhe tribes recall the legends that narrate how their first human female ancestor was mated with a fish to generate their race (Hays,2015). They also eat fish, which embodies the nostalgia for their ancestors in their Indigenous subconscious. They believe that they can draw energy from their predecessors and thus to never forget themselves. By eating the fish, they can give it a new life. Among some ethnic groups, creatures related to ancestors will become taboos for later generations, thus the Manchu will not eat dogs because, according to their mythology, they saved their relatives. There is no similar taboo among the Hezhe (Sun, 2020). For them fish carry both material and cosmological significance in local customs. By serving materially as insulation and food, these beings also played a spiritual role in shamanistic and animistic worldviews at large (Pulford, 2020). They worship nature and believe that all things in the world are governed by the gods. Moreover, a sage with a shamanic nature can turn into a sacred form to get help from the divine power of nature (Sun, 2020). Before fishing in the river, they first make a sacrifice to the river and to the Fish God. After the tribute is made, they bow down to ask for a good catch (Zhang *et al.*, 2020). During the fishing season, usually in spring and autumn, they spend the night on the river singing their Yimakan. They believe that in this way they can encourage the river deities to provide them with a plentiful catch the next morning (Hays, 2015). Narrated in their language, Yimakan storytelling consists of many independent episodes depicting tribal alliances and battles, including the defeat of monsters and invaders by Hezhe heroes. This oral heritage highlights the ethnic identity and territorial integrity, but also preserves traditional knowledge of shamanic rituals, fishing and hunting. Lacking a writing language, the Yimakan play a key role in the preservation of their mother tongue,

Figure 5.32. Yulin Sun. Hezhe fish skin craftsperson creating fish skin cutouts or paintings, 2018.

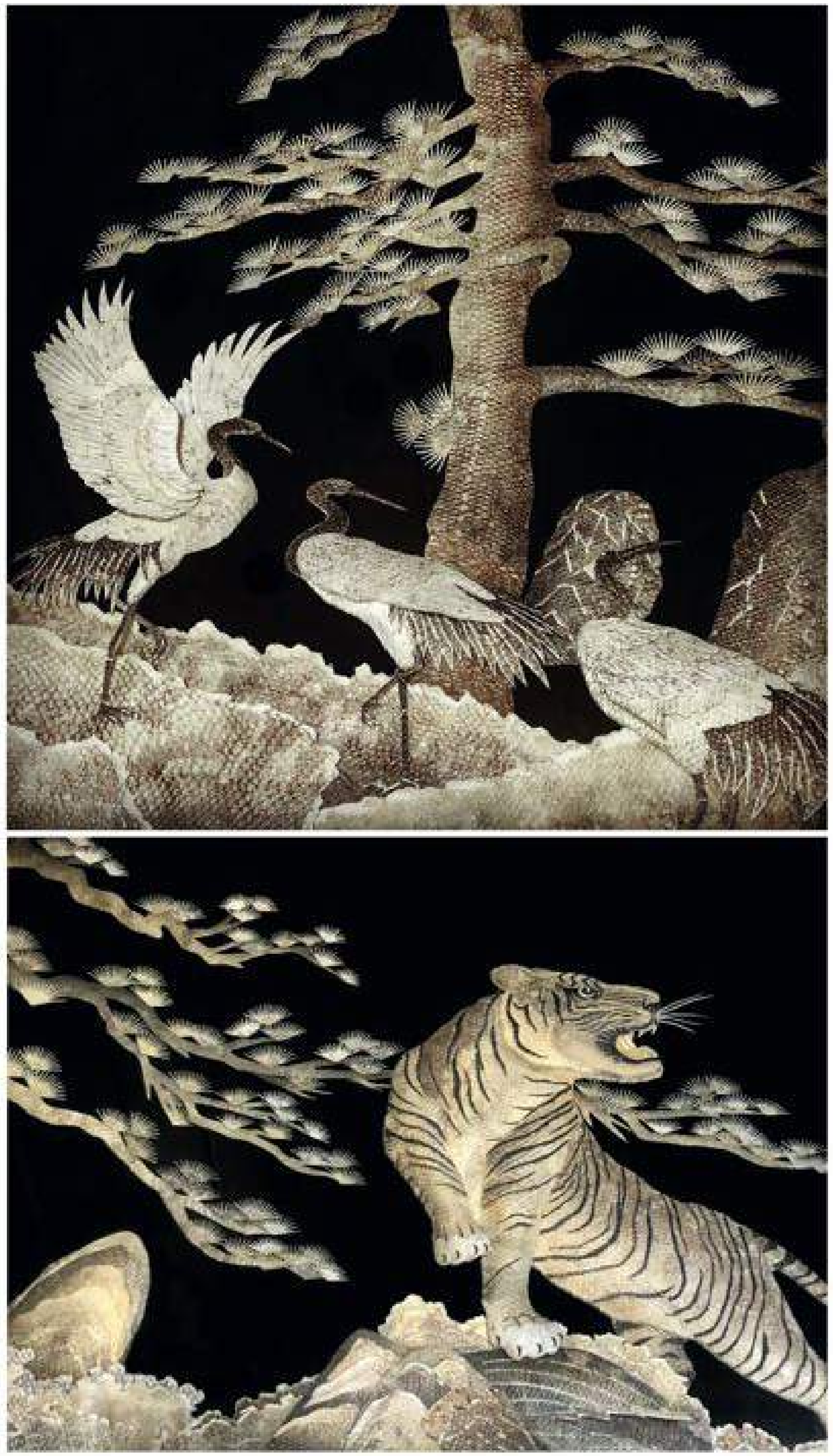


Figure 5.33. and 5.34. Hezhe Fish skin painting made by Yulin Sun, 2018.

religion, beliefs, folklore and customs (UNESCO, 2011). In 2011, Yimakan was listed by UNESCO as an intangible cultural heritage in need of urgent safeguarding.

In their legends, women are not only men's companions, but also their helpers in war. In daily life and work, men go hunting and fishing, and women take care of daily household affairs working with men in their joint family lives (Sun, 2020). Fish skin is also used in their funerals. Fish skin wedding dresses are worn for three days during the marriage ceremony, and then properly stored and preserved. When one dies is buried in their best fish skin attire to travel to the other world. In the same fashion the cuffs of a hunting suit are wrapped and placed next to the hunter's body so that he can continue hunting in the next world (Heilongjiang, 2019).

5.4.2 Hezhe Ethnic Minority and fish skin

The Hezhe have several activities related to their folklore that continue today, birch bark and fish skin processing are two of them (Guo *et al.*, 2017). Originally fish skin was used to make the decorations hanging outside their homes for Chinese New Year. While in the rest of China these were made of paper, the Hezhe made them out of fish skin. The original paintings had deities' symbols on them and later some local motifs reflecting the theme of the advent of winter fishing (Zhang *et al.*, 2020). The belief symbolism of shamanism can be shown through the expression of the fish skin cut-out (Yu, 2018). The totem cult of the fish in Northeast Asia is closely linked to fish harvesting. For their ancestors, the fish was a totem, a tool for creating life. The fish skin cut-outs were the first ritual representation that the shaman used in a ceremony, becoming an important carrier of shamanism through the artistic creation of the object and the cult of the gods. The salmon, bear and tiger were worshiped as the totems and protectors of their clan. After hunting, fishing and eating bear, tiger and salmon, they performed rituals or acts of apology towards these animals creating fish skin paintings (Figure 5.34). They believed that if an object was holy, it could ward off evil. The custom of hanging animal fish skin paintings next to the baby's cradle meant that such paintings could protect the baby from evil spirits (Zhang *et al.*, 2020). Currently fish skin paintings with Han flower and animal motifs are the most popular amongst tourist customers visiting the Hezhe Folk Park (Figures 5.33. and 5.34.). The process of matching the fish skin colours in a painting is quite complicated. Shading and depth in the fish skin paintings is provided by the alternate placement of fish bellies and upper backs.

Historically they would also create fish bone paintings (Figure 5.35) to counteract evil forces following the belief that certain animals like the salmon could keep a family peaceful, happy, and free from evil (Zhang *et al.*, 2020). Artists such Yulin Sun (Figure 5.32) have developed the ancient fish skin and fish bone painting craft with traditional cutting and pasting technology, extending the ancient culture to tourism art. During the Hezhe fish skin workshop we co created in 2018, described in detail in paper 4 in Appendix V (Palomino and Boon, 2020) Yulin Sun taught our students both ancient crafts.

Figure 5.35. Fish Bone sculpture. Tongjiang Hezhe Ethnic Museum. Tongjiang, China, 2018.

There are several reasons that could explain the almost complete vanishing of fish skin traditions from everyday Hezhe life. Their ancestors were forced to migrate from the northern region of Heilongjiang and the eastern region of Lake Baikal to the Sanjiang basin at the conjunction of three rivers. To better adapt to the environment, they changed their productivity patterns and lifestyle. Their main activity changed from hunting and fishing to farming, losing their connection with nature. Although the Sanjiang Plain is rich in natural resources, they had to face very long winters, vast snow coverage and wild bears (Zhu, 2014). Despite the rebound in population, overfishing and water pollution have caused fish stocks to drop in the rivers and many Hezhe turned to farming and tourism to make a living. The shortage of raw materials and omnipresence of modernity has challenged the preservation of the fish skin craft (Jiao, 2012). Greater access to fabrics such as cotton and silk to make their garments, and the fact that many young people left to study and work, meant that there were fewer people left to fish and learn traditional crafts. Moreover, the making of fish skin garments is so complicated and specialised that it is difficult for any unskilled craftsperson to carry out. This makes the inheritance of the craft somewhat difficult. In addition, the disruption of local natural resources and the environment play a significant role. In the past, most of the processed fish skins were from salmon, inhabiting the Heilongjiang River. But this fish is gradually decreasing in quantity due to pollution and overfishing in recent years. As a result of all these factors, the famous fish skin handicraft of Hezhe village almost completely disappeared (Zhu, 2014).

Fish skin tradition seemed at the verge to extinction. However, it saw some hope with the boom of tourism in the Heilongjiang region (Jiao, 2012). With the end to civil war and the Japanese invasion, the government started a program to help raise the living standards of its ethnic minorities, many of whom live in border areas. They needed them to help secure their borders. While most of China had a one-child family planning policy, minorities like the Hezhe were encouraged to have more than one child. The government opened minority universities to encourage the 55 different minority cultures to improve their economic condition (Malloy, 2008). With the improvement of transportation, Jinkou Hezhe Folk Park and other tourism projects were created. Tongjiang's government-funded and curated tourist village and Hezhe Museum include early Amour fishing implements as tools that allowed for 'accelerated economic development'. From shamanic drums to costumes and handicrafts, these objects are seen to embody Indigenous culture (Pulford, 2020). The number of tourists has increased as well as the interest in the traditional fish skin craft (Heilongjiang, 2019). At the Hezhe village, the Amour riverbank known as the 'Fishing Platform', a spot where men would catch fish with hooked lines through the water, is now one of Jiejinkou's foremost attractions in summer when domestic tourists come to experience the local 'minority culture' (Pulford, 2020). In order to preserve and inherit the fish skin skill, the Hezhe have changed their products from aesthetic to practical, developing fish skin national costumes, and fish skin paper-cut art, so that the fish skin production technology has found a new soil for survival and development in contemporary society (Heilongjiang, 2019). Since the 1990s,

Figure 5.36. Wenfeng Yu. Hezhe Fish skin artist wearing a fish skin suit made by her by the Amour River. Heilongjiang, China, 2018

some researchers have worked to rescue the important inheritors and the skills they mastered. From 2004 to 2005, Heilongjiang Provincial Culture Department strengthened the protection of fish skin craft and established the "Hezhe fish skin production technology" research group.

5.4.3 Hezhe fish skin jacket and trousers

Hezhe women were very accomplished in making beautiful fish skin garments and the ethnic group has a history of more than 1,000 years in handcrafting various fish skin items (Zhu, 2014). They fished, ate them and wore their skins, admiring the fish in its aesthetic sense. Therefore, in their belief, the behaviour of eating and dress themselves with fish can be seen as the deconstruction of the identity of fish and their own identity (Sun, 2020). They consider fish skin clothes as their unique ethnic costume, currently worn only on festive occasions. Wenfeng You (Figure 5.36) is a fish skin artist belonging to China's Hezhe Ethnic Minority group. She was born in Tongjiang, Heilongjiang province, a quiet city near the north-eastern border with Russia where she currently lives. Like the rest of her family, she used to fish for a living. She has learnt the process of making fish skin from her mother and grandmother. She has more that 60 years-experience sewing fish skin clothes. Since her mother passed away, she has shouldered the responsibility of keeping this dying craft alive. She is one of the few people in her community who can still make clothing from the skin of fish. She has imparted the fish skin tanning and sewing knowledge to local Han Chinese women in Tongjiang (Zhang *et al.*, 2020). Due to the needs of museum collections, the older generation in Jiejinkou, Tongjiang City have recreated fish skin costumes for museums at home and abroad, which has made this technique survive in some areas. Wenfeng You has created garments from the skins of Amour pike and chum salmon for museums in China, Japan (Figure 5.37), Switzerland, and Canada. In 2006, the Hezhe method of making clothes with fish skin was listed a national intangible cultural heritage, and Wenfeng Yu was appointed its heir. During the workshop we co-created in Hezhe fish skin tanning, described in detail in paper 4 in Appendix V (Palomino and Boon, 2020) Wenfeng Yu taught our students how to tan fish skin and to produce fish skin embellishments.

This salmon skin suit made by Wenfeng Yu (Figure 5.36) consists of jacket and trousers. This was the first fish skin contemporary artefact I was able to view, outside of a museum. Not only was I able to meet the craftsperson who made it but to witness her wearing it and the tanning and sewing process behind it. Wenfeng You used to spear fish when she was a child. Today, she prefers to make clothes with fish caught by net, so their skins are not damaged, but most of the time the salmons she uses are sourced from the marketplace.

The raw material for fish skin goods comes from northern cold-water fish, whose skin has a certain thickness and toughness and can therefore be made into clothing. There are more than 10 species of fish used by the Hezhe to make fish skin garments: salmon, fathead fish, carp, grass carp, herring, pike, dogfish, sturgeon, yellow croaker, huaitou fish and Siberian giant trout. In the

past, they have used yellow croaker, pike, carp, and salmon to produce summer clothes, boots and gloves; trousers and bags were made from huaitou fish (Hays, 2015). These days, the most common fish skin used to make fish skin garments is salmon from the Heilongjiang River. The Kaluga fish was the Hezhe tribute to the emperor. They used the swim bladder of the Kaluga as glue to stick various patterns on the fish skin garments. It was widely believed that the Kaluga could eat humans, this does not mean that the fish ate people, it is more likely that the fish were really big and the boats too small, so the fish could drag fishermen into the water and kill them (Zhang *et al.*, 2020).

The fish skin processing consists of skinning, drying, tanning, cutting, sewing, and embellishing the skin, a whole set of complex procedures which have been mastered by Hezhe women for centuries (Guo *et al.*, 2017). With over a dozen separate steps, tanning fish skin is an important art form. First, the full skin of the fish is removed. Bamboo, which does not damage the skin, is used to separate the skin from the animal. The skin is then air dried, where it hardens, and scraped with a knife. Then, the scales (Figure 5.37) are eliminated or left for embellishment purpose and the skin is hammered down with a wooden mallet to make it as soft as cotton cloth. Male and female fish have different skin properties, so this influences choice. Male skins are heavier and tougher, better to make trousers and boots and female skins are softer and lighter suitable for jackets. Because they are thinner female skins are also easier to manipulate and to tan (Table 5.1).

Fish skin garments are fitted to the body and are influenced by 19th and 20th century Chinese styles (Malloy, 2008) resembling that of the Han. The only difference lies in the material they use, fish skin. Woman's jackets were opened on the side, like they are today. Men's jackets were open in front. Both men and women wore trousers. This short jacket (Figure 5.36) has a standing collar, a diagonal placket stretching from collar to the right side of waist, made of salmon skin decorated with cloud motifs on the placket, collar and cuffs. The jacket was created by joining together multiple pieces of salmon skin. The fish skins were not dyed but used on their natural colourway. The natural appearance of the fish skin serves as an inspiration in the creative design of the jacket. The white skin of the fish belly is contrasted against the dark skin of the dorsal area. Specific design references within the body of the garments are created by contrasting the light and dark areas of the fish skin. Due to the small size of fish, the symmetry of the joints and natural colours need to be accounted for as the garment is assembled- each piece of clothing is pieced together from a patchwork of skins. Stitching together the fish skin pieces is the final step after ensuring continuity of patterns and the smoothing and flattening of the skin. Wengfen Yu also needs to consider the shape and size of the garment. Lengths of skins are compared and cut by hand without using a ruler or pattern; all done free hand. The slit, cuff and bottom is hemmed with fish skin of a lighter colour (pike or sheatfish) made of decoupe motifs.

Embroidery is a highly developed art among the Hezhe (probably perfected over the centuries of

Figure 5.37.Hezhe carp skin robe made by Wenfeng Yu. Nibutani Ainu Culture Museum. Nibutani, Hokkaido, Japan, 2018.

long winter nights). Geometrical and floral patterns decorate clothing, shoes and tobacco pouches. The decorations of traditional designs and symbols of good luck are attached first with glue from the bladder of the yellow croaker and then sewn. Animals and nature symbols, representing the mountains, the waves, the clouds (Figure 5.38) and their lucky animals such lizards, hedgehogs or wild pigs and good luck or religious symbols are used to decorate garments. The motifs are pieced together in accordance with the colour and scale patterns of the fish. Ornaments such as seashells and bronze bells are also used as embellishments. Buttons and loops (Figure 5.38) are made of fish skin, but they could also be made of fish bone (Malloy, 2008).

In the past, seamstress used bones of bears, tigers or fish to make needles; the thread was made from either animal sinews or thin strips of the skin of fat fish such silver carp (Ehrlich, 2015). Thread could also be made of the skin of Siberian buso sturgeon and glue extracted from their bladders. Fish skin thread was done by smearing fatty fish liver to the skins to make them soft, and then folding and flattening them into fine threads (Global, 2012). In fact, until recently every single component of the fish skin clothes of the Hezhe came from their catch in the river and woods. Now cotton thread is used instead of fish skin thread as Siberian buso sturgeon is on the edge of extinction and under state protection. Wenfeng You keeps a piece of bladder glue, but only as a memento as it is the only one remaining (Zhang *et al.*, 2020). Instead of tiger bone, embroidery needles are used nowadays.

The fish skin trousers were made from a big male salmon weighing about 50 kilograms as male fish skin is two or three times as thick as the female skin, and they are more resistant to scratches. In the past, trousers were tailored differently for men and women (Zhang *et al.*, 2020). The trousers are wide, trimmed and embroidered with patterns. They are also durable and, at the same time, resistant to cold and windy weather. Men's trousers were lined at the upper end and trimmed with black cloth at the bottom. When hunting in winter, these trousers were remarkably warm and withstood the most strenuous wear and tear. In the spring and autumn fishing seasons, they protected the fisherman's knees as he knelt down in the water (Hays, 2015). Wengfen You's trousers followed the tailoring traditional for women. They were simple with a front seam running down the front of each leg and the dark side of the skin mirror reflecting from the seam. A woman's jacket and trousers require 50 fish, a man's 56 fish. Today, modern life and the availability of other materials and designs have radically changed Hezhe clothing. The fish skin garments that Hezhe women used to make exist as a folk handicraft collected and ordered by museums, researchers of national culture and tourists (Hays, 2015). Thus, is why it was so wonderful to see it partially out of this context.

During the Hezhe fish skin workshop we co created in 2018, described in detail in paper 4 in Appendix V (Palomino and Boon, 2020) we shot a short film (Appendix III) made as part of this

Figure 5.38. Hezhe fish skin robe with cloud embellishment motifs. Tongjiang Hezhe Ethnic Museum. Tongjiang, China, 2018.

PhD research. 'Preservation of Hezhe fish skin tradition through fashion higher education'[4] won the Best Green Fashion Film award at the Fashion Film Festival Milano 2021. The film narrates the practices of the Hezhe people. The application of this craft to fashion was tested through a participatory workshop with fashion students from Central Saint Martins, UAL. The film features the work of Foning Bao, a 2019 graduate of BA Fashion Knit, focusing on what she learned with the Hezhe artisans while sourcing the fish skin raw material from them.

4 https://fashionfilmfestivalmilano.com/project/preservation-of-Hezhe-fish-skin-tradition-through-fashion-higher-education-2021

Figure 5. 39. Map Railway lines in Hokkaido. 1897. David Ramsey. ref: www.japanmaps.davidrumsey.com
Figure 5.40. Ainu men and women outside an Ainu home, Hokkaido, Japan. Library of Congress Prints and Photographs Division Washington, D.C. USA.

5.5 Ainu Indigenous Peoples

In 2018 and 2019, thanks to the combined grants from the Great Britain Sasakawa Foundation, Daiwa Foundation, The Japan Foundation Endowment Committee and the Foundation Research and Promotion of Ainu Culture, I accomplished a substantial amount of fieldwork research in Hokkaido museums to view ethnographic collections from the Ainu Indigenous Peoples. The museums' materials gave me a clear idea of the original culture of the Sakhalin and Hokkaido Ainu: their main economic activities (fishing, hunting, gathering and agriculture) domestic activities and handcrafts (wood processing, elm bark weaving, and fish skin processing), their everyday items, spiritual culture and traditional religious beliefs.

The word Ainu means "human being" in the Ainu language. Long before they were incorporated within any nation state, their land, which they called Ainu moshir ("the Land of Men") originally encompassed the North Pacific islands (Hokkaidô, Sakhalin and Kuril Islands) Southern Kamchatka and the Amour River estuary region (Godefroy, 2018) (Table 5.1). According to archaeological findings, the Ainu have lived there for three thousand years (Takasami, 1998). They are one of the most enigmatic ethnic groups in the Far East. There is a great interest in knowing where their homeland is, how their anthropological, linguistic and ethnocultural type was formed, and how they live in the 20th century. They are thought to have been descended from some of the earliest humans to leave Africa and settle in Asia, and to have links to three cultures: the ancient Jomon culture that dominated the islands of modern Japan from 1,400 to 300 B.C.; the later Satsumon culture on the north of the main island of Honshu and the northern island of Hokkaido; and the Okhotsk culture from Russia's far east (Denyer, 2020).

The Ainu have always been renowned for their physical appearance, especially their hirsute bodies and beautiful beards (Figure 5.40.) which contrast sharply with the hairless Japanese neighbours. They mainly lived along Hokkaido's warmer southern coast and traded with the Japanese. From the first millennium AD, under the pressure of the newcomers from the south, the Ainu have been pushed increasingly northwards, and it some of them settled on Sakhalin, on the Kuril Islands and on the southern tip of Kamchatka (Cevoli, 2015). Trade between China and Japan played an essential role in their lives. By the 17th century a trade route had formed from northern China, across the lower Amour River, home to the Hezhe, Nanai, Ulchi and Nivkh, to the Ainu of Sakhalin and onwards to Hokkaido. Silk fabric, fish skin, metal objects, adornments and lacquer bowls had become subjects of exchange (SRM, 2021).

The nomadic Ainu economy was based on hunting animals and fishing for salmon in their local rivers (Figure 3.27.). Throughout the centuries, the fish were the main bounty of the Ainu land. In addition to river and lake fish, every year the spawning rivers were full of transient fish: salmon, humpback salmon, chum, taimen and hucho (Table 5.1). Circa 200 rivers on Hokkaido had salmon populations (Morita *et al.*, 2006). Natural resources (primarily fish) determined the lifestyle and economic activity of the Ainu. Even the pattern of settlement was determined by their fishing habits. They settled mainly on the seashore, in gulfs and at the mouths of rivers abundant in fish, in lagoons or in the centre of islands that were naturally close to spawning rivers (Takasami, 1998). They lived in very small settlements called kotan. Each of these kotan had a chief, but the Ainu people as a whole had no single leader (Godefroy, 2018). They placed primary importance on fish as a food resource since it provided food for both humans and deities like bears and it was deeply related to Ainu religion. Salmon was preserved by drying, salting or smoking them for later use during their long winters months. Preserved salmon was an important trade item with the Japanese. They traditionally caught salmon using various fishing methods. They used "tes" (weir) and "marek" (detachable spear-hook), fishing net, and "ra-oma-p" (fishing trap). They used a special fishing gear, called "chi-etaye-kanki" (hook with a curved handle) for night fishing. They also trained dogs to catch salmon (Iwasaki- Goodman and Nomoto, 2001). The Ainu had a fishing management system based on recognition of exclusive fishing rights to kin-based corporate groups. Five basic principles determined these rights. Firstly, a certain group was given a fishing right over a given area if they seasonally or continuously fished there. No other people were allowed to fish in that spot. Secondly, the group was organized mainly on kinship. To gain fishing rights, the group had to have occupied the area for a certain length of time or permanently lived there. Fourthly, when the resource in the area become low, competition on fishing rights intensified, and a conflict was likely to develop. People could also gain a share of the fishing rights by giving the rights owner a gift (Iwasaki-Goodman and Nomoto, 2001).

As the salmon fishing at the mouth of the rivers expanded, the negative effect on the Ainu salmon fishing grounds became more serious, since the increased salmon catch began to negatively affect the reproduction of salmon. Soon, various restrictions on salmon fishing were implemented to enhance the salmon resources. Eventually the traditional subsistence fishing rights were abolished by the assimilation policy pursued by the Japanese government during the Meiji period (Godefroy, 2011). It was at this time, in 1878, that salmon hatchery operations began and by 1888, they were well developed for the three native salmon species (Morita *et al.*, 2006) and the salmon resources did not recover until recent years. In the early Meiji era, salmon fishing in the rivers was banned for the purpose of enhancement of salmon stocks. Consequently, the Ainu lost their access to their traditional fishing grounds. Subsistence salmon fishing by the Ainu was not allowed, and any salmon fishing in the rivers was considered illegal. Anyone who engaged in such fishing was arrested. The government implemented a fishery management system in which the fishing rights for salmon were allocated to individual fishermen. Ainu who lost their traditional subsistence means of life began to work for Japanese fishermen as laborers (Iwasaki-Goodman and Nomoto, 2001).

During the second half of the 20th century, there were considerable changes in the riverine habitat in Hokkaido. Rivers have been increasingly fragmented by damming, degraded by channelling and

invaded by exotic predatory fish. The programmes directed to increase the number of hatchery-reared fish in Hokkaido increased the population of the target species while negative impacting on wild fish and environmental changes. There are risks associated with hatchery programmes, such as competition between cultured and wild salmon, genetic impacts on wild salmon and disease outbreaks. If genetically modified captive stock is released into rivers where wild fish occur, both wild and hatchery fish may decline (Morita *et al.*, 2006).

During the Japanese colonisation of Hokkaido in the 17th century, the people of mainland Japan began to migrate to Hokkaido as Japanese colonised the northernmost island. Under the Japanese government, a state policy of assimilation of the Ainu was put in place. Ainu people moved from traditional nomadic to rural village life. Gradually, the Ainu lost the ability to hunt and fish; their traditional rituals and clothing were banned. The Japanese discouraged the use of native Ainu language along with nearly all aspects of indigenous culture (Table 5.1). Discriminatory practices such as the Hokkaido Ancient Aborigines Protection Act of 1899 relocated the Ainu from their traditional lands to the mountainous and barren area in the centre of the island. They were compelled to adopt Japanese names, to speak the Japanese language and were progressively stripped of their culture and traditions, including the bear ceremony. Due to their extensive stigmatisation, many Ainu hid their ancestry for an extended period of time (Cobb, 2020). Not until 2008 were the Ainu formally recognised by the Japanese government for the first time as "Indigenous Peoples with a distinct language, religion and culture " (Godefroy, 2011). In 2019 the Ainu were recognised as Indigenous Peoples for the first time in legislation with the objective of realizing a society that will respect the pride of the Ainu as an ethnic group. This legislation accompanied the international focus in Japan as host of the Olympic games in 2021. The new law sets aside money to promote Ainu culture and makes it easier for Ainu Peoples to catch salmon in rivers and to harvest in state-owned forests (using the elm bark fibre to weave fabric from which they create Ainu robes) (Denyer, 2020). But salmon fishing is still illegal in rivers under the law on the protection of fishery resources and Hokkaido's regulations on inland fishing. The Ainu can only fish salmon for traditional fishing and must request permission from the governor (Japan Times, 2020). A hundred years or so since the banning of traditional salmon fishing, the Ainu have revitalized their "salmon rituals" in several communities in Hokkaido, as the recent cultural revival movement spreads (Iwasaki-Goodman and Nomoto, 2001).

Despite assimilation, ethnic negation, discrimination and the damage of cultural practices during a century and a half, a distinct Ainu ethnicity has persisted. Ainu culture has been successfully reshaped itself over many decades (Godefroy, 2011).

Figure 5.41 Fish skin boot. Ainu. Upopoy National Ainu Museum and Park, Shiraoi, Hokkaido, Japan, 2018.

5.5.1 Ainu fish skin mythology

Among the Ainu, all-natural phenomena (including flora, fauna, and inanimate objects) are believed to have a spiritual essence, and particular animals: brown bears, killer whales, horned owls and salmons (Krutak, 2012). The Ainu of Sakhalin Island and northern Hokkaido are spiritually connected with the multiform spiritual entities that surround them, whom they call kamuy (spirits). As many hunter-gatherer and north-eastern Siberian Indigenous Peoples, their religion revered god-spirits that would visit the Earth assuming the forms of flora, fauna and forces of nature (Godefroy, 2018). The spirits they honoured were everywhere: in the natural elements (fire, water, wind), in the vital essence of animals (bears, foxes, birds, salmons), in the plants and domestic objects of everyday life. The Ainu have traditionally believed that the earthly things that sustained them (the animals and plants they ate) were gods in disguise, spirits temporarily visiting the world of humans. Ainu kamuy deities are not so different from Japanese kamis (spirits).

The Ainu believe that everything in the physical world - mountains, trees, lakes and animals - is inhabited by spirits and should be treated with respect. They consider animal deities to have the same powers as those associated with humans and regard them as whimsical creatures who can bring good or bad fortune according to their moods. The most important deities are associated with mountains, fire, houses, the sun, the moon, water, forests, bears, foxes, owls, seals and salmons. According to a famous Ainu legend, the trout carries the world upon its back. "Before God made the world, there was nothing but swamp, in which, there dwelt a very large trout. This trout was a mighty fish, for his body reached from one end of the swamp to the other. When the Creator produced the Earth, He made this creature to become its foundation. There lies the living trout beneath the world, taking in and sending out the waters of the sea through his mouth. When he sucks the water in, the ebb of the tide takes place, but when he sends it out the tide flows" (Ainu Legends, 2000) (Table 5.1). The Ainu thought that a good relationship with the gods ensured a successful catch, and they conducted various rituals such as hitting the head of the salmon with a sacred stick "i-sapa-kik-ni" when they catch them to send the spirit of the salmon back to the land of gods. Ainu placed two sacred sticks at the bank of the river to offer to the two gods who ruled the river. They were considered to be a male and a female god (Iwasaki-Goodman and Nomoto, 2001).

The Ainu believe that most beings in the universe possess a soul that can leave a person's body and experience things in places the person has never been (Hays, 2009). Ainu shamans are believed to have the power to travel to the world of the dead and bring back spirits to the world of the living. Both men and women could be shamans. The Ainu's spiritual religion includes many rituals and procedures that are rather similar to the natives of Siberia and also to North America. Shamans were among the most important people in the Siberian and Sakhalin Ainu populations. But by the last couple of centuries in Hokkaido, shamanism had disappeared and had changed into healing ceremonies that were done by women, without a lot of the ritual known in

Figure 5.42., 5.43. and 5.44. Fish skin boot. Ainu. Upopoy National Ainu Museum and Park, Shiraoi, Hokkaido, Japan, 2018.

Siberian shamanism (Fitzhugh and Dubrueil, 1999).
The communication between the Ainu and these multiform entities is expressed through a sensitive approach to working with natural materials and the creation of objects and clothing with an aesthetic filled with spirituality. Traditionally, the Ainu made their clothes with the materials resulting from their "exchanges" with various animal and plant species. As with all the fishing populations of the Amour River basin and the shores of the Sea of Okhotsk, fish skin was their preferred traditional material (Cevoli, 2015). Depending on location and local climate, the Ainu employed a number of locally available natural resources in providing their everyday clothing (Williams, 2017). They had the highest respect for all of nature's creatures and wasted very little. This delicate balance was more and more at a peril with their growing dependency towards Japanese commercial goods, and the intrusion of the Ainu territory by merchants and hunters during the second half of the Edo period (Godefroy, 2018). Daily activities for women included cooking, gardening, fishing, gathering edible or medicinal plants and the making of intricately designed clothing. Men hunted, fished, and carved (Fitzhugh and Dubrueil, 1999).

5.5.2 Ainu Indigenous Peoples and fish skin

The various regions of the Japanese islands produce garments and textiles in a variety of materials and designs. The inventiveness of its inhabitants has for many centuries created fabrics from local materials such as fish skin, paper, elm bark, nettle, banana leaf fibre, hemp, wisteria, deerskin, cotton, silk, and wool. From the 18th to the mid-20th century the Ainu created robes and other items from bast fibre plants such as nettle, hemp and elm bark, as well as salmon skin. These basic materials were transformed into precious objects in the homes of these hunters and gatherers through a kind of textile alchemy (Murray, *et al.*, 2018).

Much of their clothing was made with animal materials like fish skin, deer skin, and bird skin, and these types of clothing survived in Sakhalin and the Kurile Islands into the twentieth century. Since most items were only used on ceremonial grounds such as ritual bear sacrifices, a number of great examples have been preserved in remarkable condition. Ainu of the 18th, 19th, early 20th century wore kimono-like robes made with elm-bark fibre and robes, mittens and boots made from salmon skin (Hays, 2009). Ainu items made of salmon skin were highly prized for making strong, light, durable garments and shoes (Table 5.1). Sakhalin Ainu decorated fish skin garments with delicate appliqué, as did their Nanai and Nivkh neighbours in the lower Amour River region (Fitzhugh and Dubrueil, 1999). Elm bark and materials processed from fibres of elm trees or thistle plants were woven by Ainu women into beautiful textiles and their embroidery on these materials make some of the most spectacular designs of native clothing worldwide. Ainu embroidery may have had a correlated functional significance. On early Ainu salmon skin and elm bark attush (Ainu robe) garments, women embroidered simple double-thread braids. The design motifs were placed on the borders of all the openings of the traditional tunics (collar, arms, legs, front fastening and hem) and all the edges to prevent evil spirits from entering the body openings and

Figure 5.45. and 5.46. Pair of fish skin boots. Ainu. Abashiri Hokkaido museum of Northern peoples. Abashiri, Hokkaido, Japan, 2018.

they had symbolic references. For example, the upper borders represented the Upper World and the motifs placed there offered protection in that direction; the hem represented the underworld or underwater world; and the central parts represented the world inhabited by humans. The original designs, which resemble braided rope, were no more than a solid colour, usually red or dark blue similar to the colour of tattoo pigment (Krutak, 2012). Among the Indigenous Peoples of the lower Amour River basin (with whom the Ainu traded), similar designs were embroidered and applied on traditional fish skin garments granting the wearer protection against evil spirits. Ainu women ornamented these clothes with motifs to protect their loved ones against potential harm. The motifs conveyed security and embedded layers of protection to the wearer. The heart and feelings of the seamstress toward their intended recipients is inserted into the cloth of the garment through the embroidery. When the wearer puts the garment on his or her body, the feelings of the artisan are said to be transmuted, and the wearer is protected by this healing and protective properties through the motifs embroidered on the coat. The maker and the recipient are linked through the emotional feeling that is concentrated in the garment with each stitch of the needle. Despite the fact that the colonialism has had a devastating impact on Ainu traditions, Hokkaido textile artists continue to imbue the cloth with spiritual force by introducing a blessing during the process (Lewallen, 2018).

Nowadays in Japan, Ainu women promote cultural vitalization by moving between “being Ainu” through their natal status and actively “becoming Ainu” through their craftwork. They craft these spaces to reconnect with their past. Women weave Ainu Indigenous identities through craftwork making connections to ancestral values and lifestyles. They engage in very active process of learning Ainu language, oral history and traditional crafts learning fish skin processing, traditional embroidery or weaving a kimono from elm bark.

Like Hezhe women, Ainu women had a traditional Ainu system of measurements. A seamstress did not have a need for rulers but would use as measurements the length from her pinkie finger to the thumb, from the wrist to the elbow and from the wrist to the shoulder. All of these have specific names in the Ainu language. The human body became a ruler, and those body measurements were used instead (Lewallen, 2016).

5.5.3 Salmon skin boot or Cep Keri

Throughout Sakhalin, Hokkaido and the Kurils, summers were usually mild, and clothing was kept to a minimum. Images and accounts of the Ainu in the 18th and 19th centuries suggest that for most activities, everyone went barefoot. It is likely that the Ainu began to wear summer footwear only after the arrival of the Japanese and the techniques they introduced for making sandals (Williams, 2017). However, there were occasions on which footwear was essential. First, when hunting in winter, especially on snow and ice, where going barefoot would have risked frostbite. Winter footwear was made from deer or salmon skin (Kayano ,1999). Fish skin boots were worn

for hunting deer, bear and seals and for fishing on the ice. In these conditions it was essential to insulate the feet from the cold and boots were oversized to allow them to be worn with a sock made of bast fibre like elm, willow or reed bent grass (Williams, 2017). The grass was woven into socks to keep moisture away from the feet. Grass socks worn inside fish skin boots absorbed moisture and dried quickly when removed from boots.

Salmon skin boots were soaked in water prior to wearing to mould to the feet. They were then tied up with a cord around the ankle. In the Kurils, Ainu wore both sealskin and fish skin boots (Savage Landor, 1893). However well-made or fitted fish skin boots had limitations. They were not waterproof and were not designed for use on rocky surfaces. Typically, they were used in conjunction with snowshoes. The salmon skin boots would only be used in winter on snow. They could catch fire easily and were sometimes eaten by dogs (Kayano ,1999). Cep-keri are Ainu ankle-length boots made from salmon skin. Cep means fish, and keri means shoe. The salmon skin used in making boots was taken from fish that had just begun their upstream migration in late summer or early autumn. Their skin was at its thickest at this time of year. Before laying eggs, a salmon’s skin is harder, stronger and more durable than after its eggs have been laid. Generally, each boot required two skins: one for the sole and heel and one for the upper part that protected the instep and ankle (Kayano, 1999) (Table 5.1).

The original structure of these Ainu boots (Figure 5.47.) has a round foot and a puffed toe. The boot is made by combining the soft skin of the humpback salmon in the boot uppers and the large scales and hard skin of the Sakhalin taimen also known as the Japanese hucho, a large East Asian species in the salmon family used on the boot’s sole. Lightweight, resistant, these non-slip boots are true works of art. The refinement of the craftsman’s gesture can be admired in the cut and the mix of the natural colours of the chosen skins like the honey-brown skin of the big-scaled hucho used on the sole. These boots demonstrate the range of textures and colours produced when skins are subjected to different weather conditions and scraping techniques while tanning the skins. The innermost layers of skins can also be scraped away to reveal a paler coloured skin, as seen in the boot uppers. The wider end of one skin was gusseted and folded up to form the toe section and the sides. The narrower (tail) end became the heel. With the outer surface of the skin facing outwards the sides, heel and toe sections were sewn together. A second skin with all its fins removed was cut into a rectangular shape for the boot uppers. Then the piece was sewn to the toe and sides to form the upper surface of the boot. This upper piece extended well up the shin and protected the wearer’s skin. The upper edge is reinforced with a narrow band of black dyed strip of cotton cloth.

Final construction and shaping required that the skin be remoistened. This technique of working with wet skins on the foot directly recalls the technique of making wolf fish skin shoes in Iceland. The skins were sewn together either with deer sinew or thin cordage made from the bast of nettle

Figure 5.47. Salmon fish skin boots Ainu, Japan, Hokkaido. NMNH, Smithsonian Institution. Washington, DC, USA, 2019.

or linden. In order to ensure the best and most comfortable fit the boots were also soaked just prior to wearing them. The Ainu would keep the dorsal fin intact while making salmon skin boots. The jagged dorsal fin of the fish was used in the bottom part of the boot to gain traction on the snow during the winter months and prevent slipping. However useful this might have been on snow, ice or mud, it is also obvious that to remove the fin would have weakened the construction (Kayano ,1999). The fin of the salmon at the bottom of the boot acts as a symbolic reference to the animal. The seamstress would symbolically transfer the salmon's speediness through the fin, so the wearer could move as quickly and smoothly as a fish in the salmon boots.

5.6 Emerging themes from the Fish Skin Artefact Analysis in Museum collections.

The Arctic Indigenous Peoples studied in this chapter inhabit territories of the Arctic and Subarctic. Out of a total of 4 million inhabitants of the Arctic, approximately 500,000 belong to Indigenous Peoples. Iceland is the only Arctic State that does not have an Indigenous population. Iceland inhabitants descend from Celts and Scandinavians (Arctic Iceland, 2022) and the subjection of the country under Norway and then later under Denmark, prevented full independence until 1944. Throughout much of its history, Iceland was one of the poorest countries in Europe, and its inhabitants were often viewed elsewhere in Europe as the 'savages' living in other parts of the world (Loftsdóttir, 2018). Likewise, despite assimilation, ethnic negation, discrimination and the almost complete disappearance of cultural practices during a century and a half, a distinct ethnicity has persisted in all the Arctic and Subarctic Indigenous groups with historical evidence of fish skin production: the Inuit, Yup'ik, Alutiiq and Athabascan of Alaska and Canada, the various Siberian peoples, such as the Ulchi, Nivkh and Nanai, the Ainu from Hokkaido Island in Japan and Sakhalin Island in Russia, the Hezhe from northeast China, the Saami of northern Scandinavia.

Historical records are invaluable for the interpretation of fish skin artefacts. However, the traditional knowledge from Arctic and Subarctic Peoples about these artefacts is even more relevant. Artefacts documenting the identity of Indigenous Arctic Peoples were collected by explorers and scientists over two centuries, from 1740 to 1920. These artefacts remained in museum storage in territories distant from the indigenous peoples, who have been alienated from much of their heritage, suffering cultural and spiritual losses. Historical collections reveal fish skin traditions that uniquely marked Arctic Indigenous Peoples' identity and demonstrated ingenious use of local resources. Through my study I have explored the differences and similarities illustrated in Arctic fish skin clothing, accessories and containers. Their design, tanning processes, construction, and use. The museum artefacts studied on this chapter show how the Arctic and Subarctic Peoples make, wear, and interpret the meaning of fish skin artefacts. I have also investigated the role of fish skin in maintaining the subsistence- based social structure during the past 150 years, and, finally, I have assessed how these Peoples have employed the processes of ethnicity and tradition to maintain their cultural identity. This has involved both field and archival research. I have acquired data on fish skin artefacts from earlier periods from historical literature, published sources, and from artefacts preserved in museum collections. In addition to standard ethnographic literature, I have found information in oral histories and memoirs of Arctic Indigenous Peoples, and of traders, teachers, who worked in Alaska, Hokkaido, Northeast China in the late nineteenth and early twentieth centuries. Icelandic ethnographic literature has been more difficult to source, but oral histories from last Icelandic fish skin craft inheritors have also enriched this study.

The various cultures examined in this chapter are within a considerable distance of each other and have had both similar access to natural resources and comparable needs in terms of clothing. The geographical distance would have led one to expect little contact between these groups, at least historically. However, the study of the literature of all these civilisations shows that most Indigenous groups interacted with each other in exchange networks that stretched across the natural border of the Amour River between Northeast China and Siberia to present-day Sakhalin, Hokkaido and eventually Alaska.

All were originally hunter-fisher-gatherers, and they placed primary importance on fish as a food resource since it provided food to support their families. Their relationship with salmon played an important role in maintaining their identities, creating important ties with the environment. Salmon not only nurtured the body but also the soul. Despite the importance of salmon to all these Arctic Indigenous Peoples, the traditional subsistence fishing rights were abolished by the assimilation policies pursued by the Japanese to the Ainu, the Russians and Americans to the Alaska Native People, the Chinese to the Hezhe and the Russians to the Nivkh, Nanai and Ulch. Arctic Indigenous groups lost their access to their traditional fishing grounds, subsistence salmon fishing was not allowed and salmon fishing in the rivers was considered illegal until recent times. All these Indigenous groups were compelled to adopt Japanese, Chinese, Russian or American names. They were discouraged the use of their native languages and were forced to speak Japanese, Chinese, Russian or English and were progressively stripped of nearly all aspects of their indigenous culture. Their traditional rituals and clothing were also banned.

Currently many of the wild salmon stocks in these areas are depleted due to overfishing, habitat damage, or pollution. Local rivers have been increasingly fragmented by damming and invaded by exotic predatory fish. Industrialized exploitation of salmon through hatchery-reared fish in these areas have negative impacted on wild salmon and the local environment of these Arctic communities.

A hundred years or more since the banning of traditional salmon fishing, rituals and clothing connected to salmon, Arctic Indigenous Peoples engage in very active process of learning their Native languages, oral history and traditional crafts such fish skin processing promoting cultural

vitalization as a cultural revival movement spread. Artists are researching the technology to process and sew fish skin by consulting museum collections, examining the construction of historic fish skin artefacts. Despite the fact that colonialism has had a devastating impact on Arctic fish skin craft, Arctic artists continue to imbue fish skin with spiritual force by introducing a blessing during the process. Although their occupational activities today vary greatly, they still rely to some degree on salmon for food, but no longer for clothing and footwear.

The fish skin materials, from which clothing, footwear and containers are manufactured, are similar across the Arctic and Subarctic. One can see within this vast array of diversity many common themes and similarities in fishing technology used throughout the coastal regions; in tanning processes; in artefact types and rituals linked to fish used by Arctic Peoples; in cross-cultural similarities in fishing “harvest” festivals; in attitudes toward the dead and fish skin; and in beliefs about spirits and humans’ place in the world around them. Stylistic variations distinguish regional groups, while design motifs further identify local communities and even families. Specific design features differentiate men’s and women’s garments.

I have tried to describe traditional construction techniques and document the intricate designs executed in salmon with the aid of embroidery, applique, paint, and dye adorning the artefacts, from everyday parkas, robes and boots to Nivkh shamans’ robes (Appendix V, Paper 1). Symbolically embellished boots and clothing provided people with a strong connection to the spirits of ancestors, animals and the land itself, which were fundamental to their survival. In recording the complex belief systems that inform nearly every aspect of a garment’s construction and decoration, I have hoped to trace the history of the region, exploring relationships among different groups in both historical and contemporary times.

Protective clothing is essential for human existence in the Arctic, and fish skin clothing has played a pivotal role over millennia. This traditional clothing system developed and used by these groups is the most effective cold weather clothing developed to date. In the main time, the clothing of these Indigenous Peoples has evolved, so that today they are able to live comfortably within the region, in spite of the bitter weather.

During this research I tried to record procedures used to tan and construct, fish skin garments accessories and containers. It is critical to document these techniques before the Elders who have the knowledge pass away. Participant-observation technique supplemented with data from museum artefacts, historic photographs, archival sources, and literature was used to collect detailed information on production procedures used to make men’s, women’s, and children’s parkas, robes, shoes, gloves and containers. A study of historical and contemporary sewing tools, construction techniques, and materials used to sew fish skin garments has been made which will enable future generations to learn about their own historic material culture based on information presented by their ancestors. This research reveals the creative skill of Arctic and Subarctic seamstresses in shaping cultural ideas and preserving ancestral traditions through their designs. We can only hope that the beauty of these materials and artefacts will continue to inspire new generations of Arctic peoples to express their views of themselves and the world around them with the artistry seen in the creations of their ancestors.

Table 5.1. Emerging themes from the Fish skin Artefact Analysis in Museum collections.

	ICELANDIC PEOPLES	ALASKA NATIVE PEOPLES	IHEZHE ETHNIC MINORITY	AINU INDIGENOUS PEOPLES
1. ARCTIC INDIGENOUS PEOPLES	Iceland is the only Arctic State that does not have Indigenous population. They descend from Celts and Scandinavians.	Salmon was a l source of food and clothing for Alaska Native Peoples: Alutiiq, Athabascan, Iñupiaq, Tlingit, and Yup'ik.	The Hezhe are a Chinese Ethnic Minority in the multi-ethnic Heilongjiang Province.	Ainu descend from the earliest humans to leave Africa to settle in Asia. In 2008 they were recognised by the Japanese as Indigenous Peoples.
2. GEOGRAPHIC LOCATION	Iceland is on the margins of Europe, yet never completely isolated from Europe. It was known to the ancient Greeks and was a refuge for Vikings and the British Isles.	Located at the northwest of North America, Alaska was defined in 1741 by Danish explorer Vitus Bering, an area made of maritime peoples and inland continental peoples.	The Hezhe are based in Heilongjiang Province, located on the northern border of China facing Russia between the rivers Amour, Ussuri and Sungari.	The Ainu lived in an area originally encompassed the North Pacific islands (Hokkaidô, Sakhalin and Kuril Islands) Southern Kamchatka and the Amour River region.
3. CULTURAL ASSIMILATION	After settlement, subjugation under Norway and Denmark prevented independence til 1944.	When Alaska was purchased, the USA government attempt to assimilate Alaska Natives giving up their way of life.	The Hezhe Ethnic Minority has been oppressed by Chinese domination, and by Japanese with a policy of genocide.	Japanese colonisation of Hokkaido began in the 17th century. A state policy of assimilation of the Ainu was put in place.
4. SUBSISTENCE FISHING	Icelandic history, since the 9th century, has been interwoven with fish as the main source of food and income.	Alaska Native groups have their dependence on the marine environment and its animal resources.	Fishing is an activity that enables the Hezhe to sustain themselves. They fish for salmon, sturgeon and wolfish.	Ainu nomadic economy was based on fishing salmon in their local rivers. They lived along rivers and on the seashore.
5. DEPLETING MARINE RESOURCES	Iceland's marine resources prior to the 1990s were being depleted at an unsustainable rate. Then they introduced a system of individual transferable quotas.	When the Russians sold Alaska to the USA in 1867 salmon fed the American economy. The explosion of the salmon industry quickly led to overfishing and a dramatic decline in salmon.	Their intimate knowledge of and water was replaced by industrialized exploitation of the Amour River that ravaged fish stocks. Salmon is decreasing due to pollution and overfishing.	During the second half of the 20th century rivers have been fragmented by damming and hatchery-reared fish in Hokkaido, increasing the negative impact on wild fish and environmental changes.
6. TANNING PROCESS	Icelandic peoples softened their wolfish skins mechanically, with hands and tools.	Alaska Native Peoples use urine, fish roe, bark or brains to tan the fish skins.	Hezhe use cornmeal to soak up the fish oil and a wooden scissor instrument to mash and soften the fish skins.	The Ainu in Hokkaido, stretch the fish skins first and then smoke them for five days inside their home.
7. FISH SKIN ARTEFACTS	Accounts of travels around Iceland in the 18th century describe Icelanders wearing traditional shoes made of wolfish skin.	Fish skin was used to make drums, parkas, pants, boots, mittens, hats, quivers, bedding, blankets, tent coverings, windows, and containers.	Hezhe used yellow croaker, pike, carp, and salmon to produce summer clothes, boots and gloves; trousers and bags were made from huaitou fish.	Ainu of the 18th, 19th, early 20th century wore robes, mittens and boots made from salmon skin.
8. ARTEFACTS' CONSTRUCTION	The fish skin used to make Icelandic fish skin shoes comes from spotted wolfish.	Fish skin bags were decorated with pieces of other fish, yarn and caribou fur.	Hezhe lucky animals and good luck or religious symbols were used to decorate garments.	Salmon skin used in making boots was taken from upstream migrating fish in late summer since it was at its thickest.
9. FISH SKIN MYTHOLOGY	In one of the Icelandic Sagas two men were slain by their enemies, because their fish skin shoes had dried in the sun, and they could not get them on again.	Fish skin bags were amongst the gifts traditionally offered to the spirits of the dead during Elriq, the Great Feast of the Dead.	When a Hezhe died was buried in their best fish skin attire to travel to the other world. The cuffs of a hunting costume were placed on the hunter's body so he could hunt in the other world.	The design motifs placed on the borders of the openings of the traditional robes prevented evil spirits from entering the body openings and they had symbolic references.
10. FISH SKIN SEAMSTRESS	Farming Law of 1722 stated that a woman in the winter months was expected to provide fish skin footwear for two working men.	In the past, when conflict arose from outside invaders, Alaska Native seamstress were hidden in secret caves so they would not be harmed.	Hezhe women were not only men's companions, but also their helpers in war. In daily life women took care of household affairs such fish skin garment production.	The heart of the Ainu seamstress is inserted into the cloth of the garment through the embroidery and the wearer is protected by this passion.
11. TRADITIONS TODAY	In 1994 Atlantic Leather tannery start processing fish leather based on the Icelandic tradition of wolfish skin shoes.	Recently, Alaska Native artists have taken up the use of fish skin,researching the processes consulting museum collections.	In 2006, the Hezhe method of making clothes with fish skin was listed a national intangible cultural heritage.	Despite the colonialism their ancestors have been subject to, Ainu women promote cultural vitalization through their craftwork.

Figure 6.1 Traditionally tanned fish skins by Lotta Rahme, 2021.

Chapter Six: Fish skin traditional tanning processes

6. Chapter Six: Fish skin traditional tanning processes

6.1 Introduction

The aim of this chapter is to interpret traditional Arctic fish skin tanning technology and its historical heritage, to provide a guideline for creating, on a more industrial level, more environmentally friendly processes in the future, reducing the supply of chemicals, the overall environmental impact and generating cleaner water and less CO_2. This is an opportunity to revive old technologies for processing non-conventional raw materials like fish skin on a qualitatively new level (Sokolovsky and Sokolovskaya, 2010).

There had been very few sources before the 20th century outlining historical and contemporary methods of tanning fish skin. Subsequently, in the second half of the 20th century some studies have been made by ethnographers and fish skin tanners such as Hatt and Taylor (1969), Wilder (1976), Berg (1984), Issenman (1997), Oakes (1991, 2000), Oakes and Riewe (1998), Reed (2005), Fienup-Riordan (2007,2020), Baillargeon (2011), Rahme and Hartman (2012, 2014) and Hurcombe (2014) which are mentioned here.

Research in the leather industry has allowed the development of new methods of industrial technologies for making leathers from the skins of commercially farmed fish. The contemporary methods used now to process fish leather use mineral tanning agents, chrome being the most popular today. Chrome tanning uses a solution of chemicals, acids and salts (including chromium sulphate) which if not properly managed, will have a negative environmental impact. The process is ‘less natural’ than when using organic tannin substances.

The chapter includes an assessment of the difference between traditional Arctic fish skin tanning processes, industrial chrome tanning and vegetable tanning. For this comparison, fish skin samples were prepared for testing using each methodology. In response to my request, the Swedish tanner expert Lotta Rahme prepared all the samples following the Arctic fish skin tanning knowledge that she had acquired in her 30 years of experience working with Indigenous communities. She included new methods, such as cornmeal tanning, that I had learned from my experience working with the Hezhe community in northeast China.

These samples were compared to commercial contemporary chrome and vegetable tanned fish leather from the Icelandic tannery Atlantic Leather. Traditional methods used in this study include mechanical softening and tanning with smoke, urine, brain, oil, cornmeal, bark and gallnuts.

The chapter contains individual subchapters on different fish skin tanning techniques. The steps, photographs and illustrations provide a practical guidance to fish skin tanning. The different tanning methods are meant to present traditional knowledge about the tanning and the physical mechanics of tanning. It is important to note that I approach the development of the Indigenous tanning technology in this chapter from the perspective, advice, and support of experienced Native and non-Native tanners, and all the many Indigenous traditional Arctic fish skin tanning techniques that I have experienced that could provide the fashion world with more environmentally friendly processes in the future.

The tanning processes were done following an experimental analysis involving replication of materials to test hypotheses linked to original production methods (Mathieu, 2002). The experimental analysis allows the testing of the functional properties of an historical material and the level of expertise needed to complete a task (Ferguson, 2010). This process brings a holistic understanding of the technology used and how an object may have affected the life of the maker and the life of the user. By conducting this set of fish skin tanning experiments, I have not only evaluated the properties of traditional tanning in comparison to modern tanning but seen that this process can also help to better understand how humans culturally and technologically adapted to the Arctic. The time-consuming nature of tanning technologies both traditional and industrial not only provides an understanding of the labour-intensive lives of women in the Arctic environments but also approaches slow fashion and demonstrates the respect for the animal that provided their skins.

6.2 Fish Skin versus Fish leather

Within this thesis, the terms fish skin and fish leather are used to indicate different processes of the same material.

Fish skin. Skin indicates the superficial dermis of an animal. In the thesis fish skin is referred as the historical raw material processed mechanically or tanned following traditional methods: smoke, oil, brain, urine, fish, bark or cornmeal.

Fish Leather is used to indicate that the fish skin has passed one or more stages of industrial vegetable or chrome tanning production and is ready to be used to produce leather goods.

Ethnographic and recent leather processing traditions reveal that there are many ways of tanning a skin that would not be recognised as true leather production according to modern definitions. Tanning is a term to define a raw skin that has been processed and preserved. Many authors reserve the term leather for irreversible full tanning processes such as vegetable tanning or bark tanning, while other techniques such as alum tawing, oil tanning and smoking are considered “pseudo-tannage” (van Driel-Murray, 2000). In this PhD and following Hurcombe’s tanning theories (2014), tanning describes a skin that has been treated and worked regardless of the process, but it is however understood that many methods would be considered as “pseudo-tannings” by other authors.

6.3 Tanning

According to Theodore White (1956) tanning is the practical conjunction of science, art, botany and chemistry. These raw materials were transformed into gold by textile alchemy in Arctic hunter-gatherer and fishermen’s settlements (Murray, *et al.*, 2018).

A dead animal skin in its raw state is not suitable for use as a clothing material. Therefore, the tanning of skins is a very old industry, almost as old as the use of skins for clothing and it was most highly developed among Indigenous Arctic Peoples (Hatt and Taylor, 1969). Skins rot quickly when wet or damp, but they can be kept for a long time if they are perfectly dry, but then they become hard and serve no useful purpose. According to Lollar (1958) tan is the conversion of skin into leather by impregnation with an infusion of bark or some other form of tannin to convert the readily putrescible animal skin into a durable and a flexible material: leather. During the industrial process known as tanning, by saturating the raw skins with tannin, or the astringent substance of vegetables (Martin,1813) they are converted to non-putrescible material which resists bacterial attack, chemical degradation and mechanical deformation (Maina *et al.,* 2019). A tannin is a molecule that bonds easily with proteins and will draw liquids out of the skin.

To begin the process, the skins are soaked in a tanning solution. The tannin molecules will enter the skin replacing the space left by the water molecules occupying the inter-fibrillar spaces (Trachter, 2023). The water is drawn out, but as the tannins take the place of the removed water, the leather does not grow inflexible as fully dehydrated leather otherwise would. The leather gains stability, durability, and strength (Priyanka *et al.,* 2015). The stability is attributed to the strong interlocking of the collagen fibres. The function of tanning is to stabilise the structure of the collagen matrix of the skin, increase its thermal stability and protect it from microbial degradation. Current commercial tanning agents, include mineral (mainly Chrome (III)), vegetable (polyphenolic tannin), and organic (aldehyde) reagents.

In this chapter, a comprehensive study of traditional tanning technology has been done in order to provide a base for the design of more sustainable and environmentally friendly tanning processes. The chapter aims to research the effects of current and past practices, forecast the requirements of new tanning reagents and processes, and predict the results of the proposed new practices.

6.4 The Chemical composition of fish skin

Fish skin consists of two layers: the cellular epidermis and the mostly fibrous dermis. The epidermis contains cells that secrete mucus and help the fish glide easily through the water by reducing friction (Hurcombe, 2014). The dermis provides the structure of the skin. The effective processing of a skin into leather removes the epidermis and only the dermis remains.

The dermis is built up of several layers consisting of loose and tight connective tissues. The latter consists of 98% collagen found primarily in the lower layer of the dermis, and it is this layer that is processed during tanning (Rahme and Hartman, 2012). Collagen fibres are held tightly together, but they also need to be kept apart so that the structure of the skin can flow freely. Tanning assists in this process. The tanning process involves adding substances containing tannin to strengthen the cross binding between the collagen fibres which helps hold them apart and retain their three-dimensional network structure.

When tanning fish skin, it is important to take into account a number of features:

- The characteristic odour of fish skin which is generated by the decomposition of lipids (Sen, 2005). The dissolution of these odour-generating compounds is a key step in fish skin processing.
- Other features include fish skin sensitivity to acids and bacteria, being greater than in mammal hides.
- Fish skins are sensitive to high temperatures and 20° C should never be surpassed during the tanning process.
- The structure of the dermis, which lacks volume and orientation of collagen fibres in a linear direction is adapted to their aquatic environment (Gaidau *et al.* 2013).
- Fish skin is found to be more stretchable along its length than width and it is thinner than mammal hides.
- The connective tissue of fish skin is like a woven material, making it much stronger than a mammal skin of the same thickness (Rahme and Hartman, 2012).
- Species, sex, age and season of capture will affect the quality of the skins (Hurcombe, 2014).
- The crosslinking of the collagen increases as the animal ages and the skin proportionally thickens due to the increasing amount of collagen fibres. The skin of an older fish will be not only bigger but also thicker than a younger counterpart.
- These collagen fibres will react with the tanning agents and give the leather the characteristic resistance to degradation by bacterial and thermal attacks.

6.5 The fish skin tanning process

Several methods can be adopted for turning the skin of a fish into something useful and durable, they have a common theme and follow a sequential path. The process may be divided into three main stages:

Preparation for tanning involving skinning the fish, removal of the epidermal system and the flesh; and the opening up of the fibres structure to receive the tanning agent.

Tanning in which, through the aid of the tanning agents the skin is rendered imputrescible.

Finishing which includes softening the skins, incorporation of lubricating and oils and dyeing.

6.5.1 Types of Conservation

Before the skin of a fish can be used it has to be processed. Once caught, the fish is likely to get skinned very quickly. If the skins are not processed immediately there are a few conservation methods that can be used. This can be drying, salting or freezing. The stabilisation process is key to preserving the qualities of the skin afterwards. All these techniques work better if the skin is cleaned first. If there is the possibility of freezing , this is preferred to brining and dry salting, because if the skins are preserved with these practices, it will then be necessary to rehydrate them, adding agents that overcome the surface tension of the collagen fibres and possibly bactericides. If the rehydration time is prolonged more products will be used, and more time will be consumed (Trachter, 2023). Both wet and dry salting are appropriate. It is likely that the processes used to stabilise the skins with salt comes from coastal areas or are relatively late techniques, as salt was a very expensive commodity when it was discovered. The use of salt water for sea-caught fish could be an effective option connecting with fashion circularity principles.

1. Brining

Brining consists of soaking the skins in a container of salt-saturated water for later use, or until the salt has been absorbed and the skins reach a balance. This is followed by draining and storing in a cool climate-controlled environment. It is important that the salt employed for curing should be free from halobacterium, otherwise skin quality during soaking may be compromised.

2. Dry Salting

After filleting and fleshing, the skin is washed in water and allowed to drain for 10 minutes. After draining the skin is placed flesh-side upward and coated in fine grained salt. The quantity of salt used is equal to approximately 50% of the total weight of the skin and distributed evenly. Afterwards the skin is further drained on a wooden board for a minimum of two hours. Lastly, a smaller quantity of salt is applied, and the skins are stowed in pairs with the flesh sides facing inward (Calvillo *et al.,* 2015).

3. Freezing

The freezing process is used in cold climates, where the skins are exposed to extremely dry cold to extract moisture from the skin by freeze-drying. Freezing must be done quickly, as the water in the skin freezes (Rahme and Hartman,2012), which mechanically separates the fibres and helps to soften the skins. In the Arctic the fish skin can be tacked on a wall left to dry in the cold dry air. In a normal setting the washed skins are drained and are stowed in pairs with the flesh sides facing inward. Then they are stored frozen at a temperature below -18°.

4. Storage

Dry salted preserved skins should be stored refrigerated until used since warm and fluctuating temperatures facilitate degradation. Special attention should be paid in order to avoid putrefaction. Poorly fleshed skins cause improper chemical saturation in the subsequent processes (Calvillo *et al.,* 2015).

6.5.2 Pre-tanning Process

Soaking

The first step involves defrosting the skins and soaking skins in a salt solution for several hours to eliminate blood and dirt. Skins can also be soaked in a liming solution, where the high PH preserves them from bacterial attack and a structural loosening occurs which will be reflected in the finished leather. The length of time in liming depends on the species, as it can degrade the skins (Trachter, 2023). The temperature should not exceed 20° Celsius.

Skinning

After removing the fish head, tail, and entrails, the meat is separated from the skin (Figure 6.2.B). Skinning the fish is a critical step. The fish skin is placed upside down on a cutting board. Starting at the tail, the blade of a sharp flexible knife is inserted between the meat and the skin, and the skin carefully cut away. The tail section is held while slowly sawing back-and-forth at a 45-degree angle.

Scraping

The skins are thoroughly rinsed in fresh water. It is essential that the water should be at a temperature of at most 12° to 18 ° C. The first step of the fleshing is to extend and lie flat the skins on a clean table with the flesh-side facing upwards. This is then followed by removing the excess flesh with a knife or scraper (Figure 6.2.D), taking care to prevent puncture holes and marks on the skin (Calvillo *et al.,* 2015). This fleshing is relatively easy due to the layered structure of the fish skin and should, to avoid any unnecessary damage, be done without excessive force, but sufficiently thoroughly so that finally no flesh remains on the skin. Fish skin is made up of several thin tissue membranes and the finest leather is obtained if the outermost tissue is scraped off before tanning (Rahme and Hartman, 2012).

Removing odour from skins

It is essential to start removing all traces of fat from the skin since they produce an unpleasant odour. To do so, there is a set of techniques that Arctic women have passed on from generation to generation. Women of the Amour River basin in Russia and China use pieces of rotten wood rolled into the skins that are kneaded for days. Rotten wood is an excellent natural absorbent. Prior to drying the skins on a wooden board, they are washed with water to which wood ash has been added. This is a perfect natural degreaser. Other methods they use to remove odours include cutting mugworth in the morning and placing them between the skins (Glebova, 2015).

Scaling

When removing the scales care must be taken to avoid damage or even rupture of the skin. Best is to start at the tail end, moving towards the head (Figure 6.2.F). Depending on the size of the fish scales, you may not need to remove them, or you may decide to leave them as a special decorative feature.

Softening the skins

Softening is an essential part of the tanning process. Soft skins are achieved through stretching (Figure 6.2.J), scraping, pulling and working the skin over a rough surface. The manipulation process is done with both wet and dry skins. Physical manipulation in the form of stretching and

pulling the skin breaks down the bonds between the fibres and fibrils, creating spaces around the fibre bundles. Tanners use different methods to stretch a skin, such as pulling the skin over a knee or pulling the skin attached to a tree. Kneading involves folding or rolling up the skin and working it like bread dough. Abrading involves pulling the dry skin over a metal or wooden object or rubbing it with a rough object like sandpaper. The softening process requires several hours of work over the course of a day or two. The softest leather is obtained by working the skin lengthwise and crosswise.

Stretching the skins

Stretching the skin is a way of preventing it from shrinking during the drying. The skin is dried on a smooth wooden board (Figure 6.2.I) with the inside facing in. When dry, it will simply peel off from the board. The skin has to be stretched along both its length and width by hand in order to get the proper form. According to Fienup-Riordan (2007) if an Alaska Native seamstress was going to use a fish skin to make a garment, she would cut the fish open making sure that the slits were straight. While stretching the skins, she carefully ensured that the edges were not crooked so that each skin was easy to sew to the next one.

Tanning Materials

Historically, a whole series of traditional techniques were used to tan skins that today we would refer to as:

- Mechanical processed skins.
- Smoked tanned skins.
- Oil tanned skins.
- Alum-tawed skins.
- Fully vegetable tanned leathers.

The early Indigenous Arctic Peoples developed traditional tanning methods with considerable local differences. They could opt to soften the skins without any tanning solution, or they could alternatively choose to use three groups of tanning materials: fats, vegetable and mineral. To prepare the tanning bath, the early tanners used materials of animal origin such as urine, brains, liver, kidneys, bone marrow, fish oil, fish roe, butter, eggs, or materials of vegetable origin such as cornmeal, tree bark, leaves, gallnuts or a combination of the above (Reed, 1980).

There are several tanning methods and materials, and the choice depends mainly on:

- The properties required in the finished product.
- The cost of the tanning materials.
- The materials available.
- The fish species (Maina, 2019).

The bio-tanning of skin refers to tanning the skin by employing vegetable matter, animal matter and microorganisms (enzymes) to produce leather. Bio- tanning is considered the “green tanning process” because of it is environmentally friendly, capable of biodegradation and can easily be applied for various sorts of leather (Duraisamy *et al.*, 2016).

6.6 Traditional tanning

6.6.1 Mechanical Processing

The oldest way to process animal skins is to soften them mechanically, through a repetitive process, with hands and tools were no added fats or substances are applied to the skin. The mechanical operation opens the collagenic structure, allowing a deeper contact of the natural fats present within the fish skin internal fibres, oxidising them with a consequent curing effect. The transformation of raw skins into soft, malleable material demands the skilful handling of various tools. Alaska Native women use both blunt and sharp instruments to clean away fibre and flesh; they apply crescent-shaped and razor-sharp copper blades called Ulu to remove the first layer of flesh (Rethman, 1999). Once the skins are clean, they are worked for hours by manual manipulation (Figure 6.2.J) through massaging, stretching or hammering the skins until the fibres break down and they become pliable and soft (Rahme and Hartman, 2012). The oldest tools are the hands and teeth of the tanners themselves to rub, scratch, chew, wring and stretch the skin until the desired softness and flexibility. By chewing the skins, they not only exerted a mechanical softening action, but the saliva also promoted the tanning of the skins.

According to Glevoba (2015) Nivkh and Nanai Siberian women from the Amour River basin used unique knives made of wood or bone to remove the skin of the fish. Then they removed the remaining scales with the curved end of a metal knife (Figure 6.2.F) . A wooden instrument with a U-shape in the centre is used (Figure 6.2.G). The skins are wrapped tightly around a wormwood stick, then soaked in water and placed in the cavity of the wooden instrument. Using a wooden hammer with two rounded sides, the skins are pounded, removing the scales and softening them (Figure 6.2.H). The tanner beats the skin and repeats the action many times. This rhythmic work softens the fibres of the skin and makes them thinner, lighter and more compact (Donkan, 2022; Palomino *et al.*, 2023). For uniform drying, the skins are attached to the wall of a dwelling (Figure 6.2.I) taking care not to expose them to direct light. The drying process, slow and regular, requires a few days. In order to obtain very flat skins, they are placed in the open air under small piles of stones, where the drying process is completed. Then the skins are rubbed between the balls of the hand (Figure 6.2.J) until they are totally soft and supple, this can be quite time consuming. A natural pumice stone can be used to rub the outer surface. The fish skin becomes buffed, very flexible and can be used to sew a robe, gloves or a pair of boots (Glevoba, 2015). The above method is shared among all the Peoples of the Amour River basin in Siberia and Northeast China.

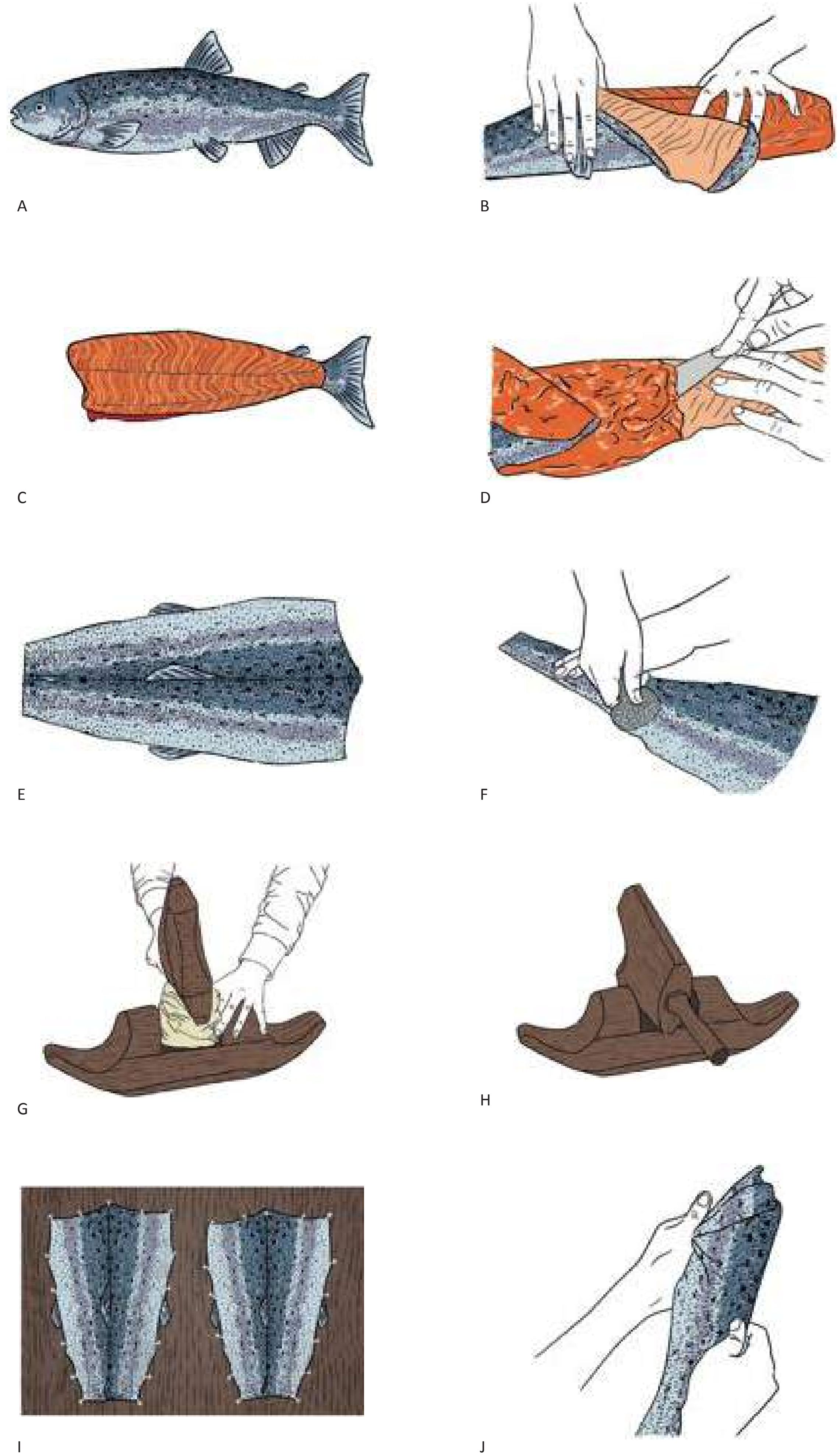


Figure 6.2: Mechanical processing. Illustrations Laura Fernández (2023)

6.6.2 Organic tanning

A. Smoke tanning

Smoking is an aldehyde tannage, known since the late Neolithic (van Driel-Murray, 2000). Burning wood releases aldehydes and phenols, an active ingredient known to have tanning power, whose quantity differs depending on the wood type being burned. Aldehydes contain carbonyl groups that react with amino groups in collagen to form a very stable bond (Rahme and Hartman, 2014). When fish skins are smoked, water is slowly removed without altering the suppleness. The loss of water also reduces bacterial growth that would otherwise cause the skins to decay. Smoke impregnates the skin making it more watertight, preventing the skin from getting soaked and from shrinking (Fienup-Riordan, 2007). Evergreen trees provide further water-repellent qualities to the smoked skin (Baillargeon, 2011). Smoke aids in the preservation of the skin, while also providing colour and fragrance. Depending on the types of wood the smoke will produce different tonalities. A golden hue is obtained from aspen; alder will bring a darker shade; and pine still darker. Smoke tanning is often used to complement oil or vegetable tanning. In Alaska, salmon were never sliced along with the skin, as the skin was always used. The salmon was cleaned, hung, and smoked. After eating the flesh, the skin was carefully removed taking care not to break it (Fienup-Riordan, 2007).

Smoke curing has a long tradition in both China and Japan. The Ainu in Hokkaido use the smoking to produce their salmon skin boots. Once the residual flesh has been scraped (Figure 6.3.D) and the skin has been washed under cool running water, the skins are stretched first in order to be smoked. Four to six holes each side of the fish skin are made using an awl, depending on the size of the skin. Wooden skewers larger than the width of the skin are sharpened at either end and inserted horizontally into the top part of the skin creating enough tension to maximize the surface area exposed to the smoke (Figure 6.3.F). A hole is then dug in the earth ground inside the Ainu home or chise (Figure 6.3.G.) in which a small fire is built. The skins are hung lengthwise, flesh side out and skin side in, and placed over the low open flame, capturing as much smoke as possible but without overheating. This is best achieved using rotting wood to produce the maximum smoke with minimum heat. After five days, the skins are taken down, rolled up and left in a tent overnight for the smoke in the surface to be fully absorbed. In the morning the skins are hung outside to release excess smoke and to stop the process. After smoking, the skins might feel a bit stiff, and they should be massaged vigorously (Figure 6.3.H). The final skin would withstand a thorough wetting and return to its original soft and pliable condition when dried.

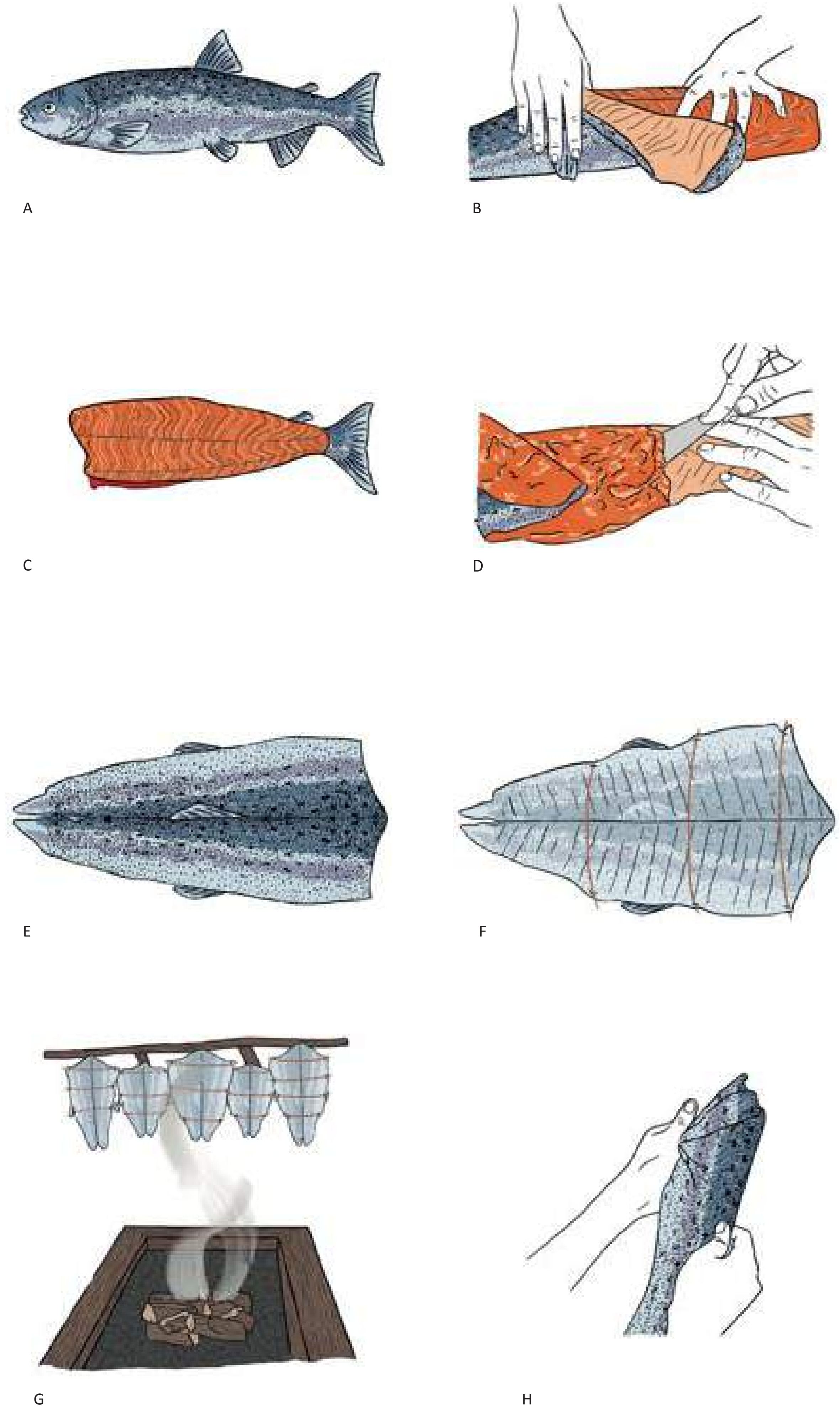


Figure 6.3: Smoke Tanning. Illustrations Laura Fernández (2023)

Skin nº 1A. The outermost tissue was removed. After scraping the skins, they were dried on a board and when they were almost dry the skins were processed by hand and with wooden tool.

Figure 6.4. Mechanical fish skin processing. Photographer Nathalie Malric, 2018.

Figure 6.5., 6.6. and 6.7. Ainu Smoke fish skin tanning. Nibutani Ainu Museum. Hokkaido, Japan, 2018.

B. Urine tanning

Osgood's (1940) accounts in Alaska document the use of urine to tan fish skins. Rahme and Hartman (2012) claim that skins last longer when urine from a baby boy before weaning is used (Figure 6.8.G). The urine has no synthetic chemicals, only the mother's digested milk (6.8.G). For tougher skins the urine from an older boy around the time that his voice changes must be used (Hickman, 1987). Every Yup'ik household would have stored a bucket of urine to preserve this cleansing agent with which they washed their hands, face and hair; then rinsed it off with water. Fish skin gloves and boots were rehydrated by dipping them in the aged urine and once dry, oil was rubbed into the seams to prevent water from seeping in (Fienup-Riordan *el al.*, 2020). The urine of Alaska Native Peoples might have had elevated acidic levels, due to their high intakes of meat (the degradation of the meat proteins results in a highly acidic urine). Uric acidification also occurs when food is scarce, and the human body begins to consume its own reserves to meet metabolic needs (Trachter, 2023). During harsh winters, they might have experienced such food scarcity. Urine is used in the process called pickling, to acidify the collagen fibre of the still raw skins, to fix the tanning elements. It also helps to fix the oils of the skin being processed to produce flexibility and resistance. The urine tanning method relies on oils binding to the collagen, but instead of adding oil from external sources, the skin's natural oils are used. Concentrating the urine by evaporation (ageing it) a strong ammonia solution is released that can be used to degrease the skins so that they do not contain fats that can oxidise. The concentrated urine is also very salty, helping to dehydrate the skins preventing microorganisms from breaking down the tissue. Urine contains formic acid, urinase and uric acid which cause cross linkages between the proteins in connective tissue to dissociate, thus making skins softer and more pliable. Ammonia leads to the breakdown of fats in the skin creating glycerol and free fatty acids that will penetrate the skin and react with the fibres tanning the skin (Rahme and Hartman, 2012).

The process begins with the fish skin soaked in the urine (Figure 6.8.H), then rolled into a bundle with the scales furled outside. The soaked skin is carefully stored in a dark, cool place overnight. The following morning the skins are washed in salt water and softened as they dried by flexing them with both hands and pulling on them to stretch them (6.8.I). The skins are then hung outside (6.8.J). When done in a cold climate, it cures and makes the skins softer and whiter, and the smell disappears (Fienup-Riordan, 2007).The tanning process usually lasts approximately five to six days. The longer the skins are soaked in urine, the softer they become. Arctic women prefer to tan fish skins in the summer outdoors where the wind blows away offensive odours (Rethman, 1999).

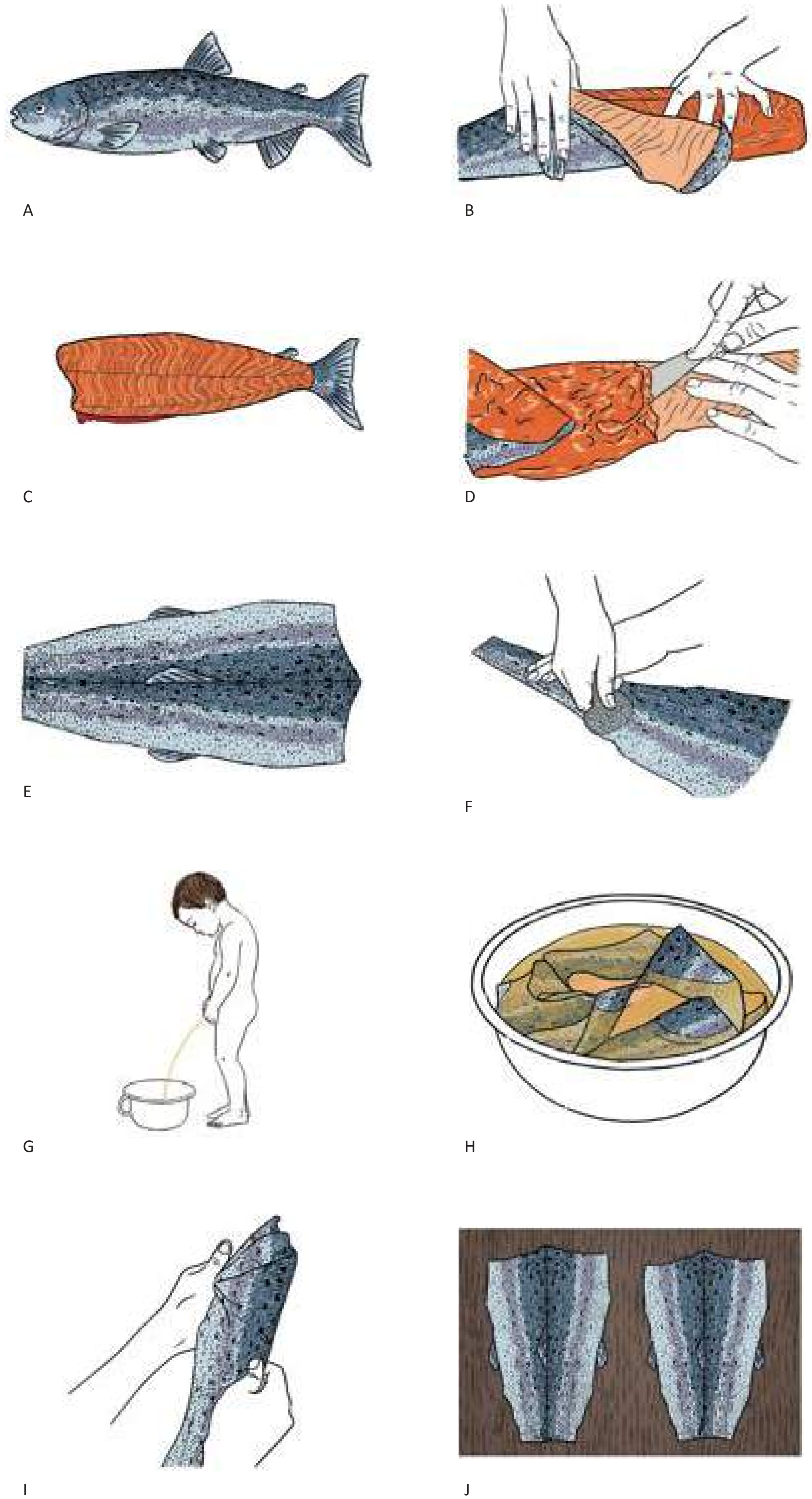


Figure 6.8. Urine Tanning. Illustrations Laura Fernández (2023)

6.6.3 Fat tanning

The use of fats and oils is undoubtedly one of the oldest traditional tanning methods used by different Indigenous groups around the world (Mathur, 1927). Tanning with oils involves the penetration of fatty substances into the fibrous structure of the skin which are oxidized and combined with the fibres of the skins. Unsaturated fats can be manipulated and mechanically processed so that they enter into a permanent relationship with the dermal fibres and, in particular, oxidise, thus coating the fibres and creating an oil-tanned skin. The unsaturated fats best used in this process are those contained in substances derived from mammals, fish and birds (brains, fish oil, fish roe, seabird eggs) and a variety of plant oils such as rapeseed, corn, coconut and olive oil.

A. Brain tanning

According to Indigenous North American cultures, the souls of men and animals reside in the head (the brain). By employing the animal's brain in the tanning process, the animal's soul is introduced into the skin, bringing it back to life (Baillargeon, 2011). The animal's own brain should be enough to tan its hide. It is a labour-intensive process using emulsified oils, from the brains of deer, cattle and buffaloes. The final product brings and exceptional softness and washability. The lubricants locked in the brains are types of water-soluble fats called phospholipids, which are active ingredients that easily penetrate the skin. The largest part of the brain, the inner part, is 'the white matter' and contains more lubricants than the outer layer or 'grey matter' containing more blood and less lubricants. A skin tanned with only the 'white matter' will produce a wonderful smelling skin. If tanned with only the 'grey matter' will have a dirty appearance (Baillargeon, 2011). Brains have fatty substances with a softer consistency, facilitating their mixing with water and their absorption by the skin (Hatt and Taylor, 1969). Brains (6.9.G) are used by macerating the material (this could be done by cooking the brain for a few minutes in water) or they can be broken down mechanically (Hurcombe, 2014). The brain mixture can be spread directly on the skin. Alternatively, the skin can be soaked in a brain and water solution for at least 15 to 20 minutes (Figure 6.9. H) where the brain's oils will lubricate the fibres to make the skin soft, pliable, and elastic. Consecutively the skin should be hanged in the sun (Figure 6.9.I) since UV light facilitates the tanning process. With strong aeration, double bonds turn into peroxide and later aldehyde, reacting with the fibres, tanning them. Then the skin should be squeezed and stretched for approximately 45 minutes to one hour to make the oily brain solution go deeper into the skin, softening it (Figure 6.9.J). The gall content of half-rotten, broken liver has a dissolving effect on the fatty substances and is also used as tanning material among North American cultures (Hatt and Taylor, 1969, p.15). Certain tanners smoke their skins after they have had the brain solution applied. This is done with a light smoking for a total of three days.

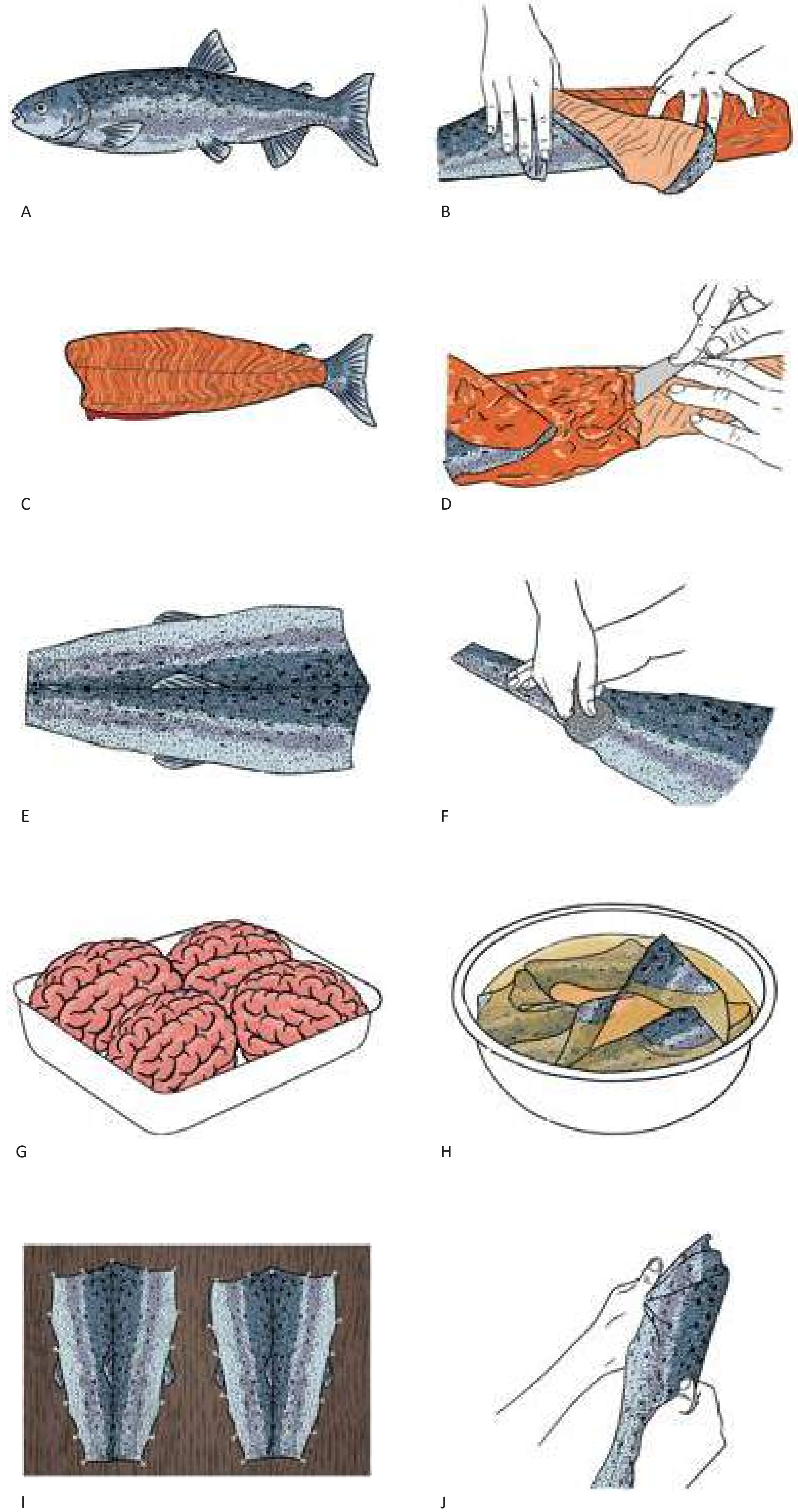


Figure 6.9. Brain Tanning. Illustrations Laura Fernández (2023)

B. Oil tanning

Oil tanning is considered to be one of the oldest processes, probably employed in combination with smoke tanning. Neolithic excavations have revealed elk and deerskins tanned with oil and then smoked. Oil tanning may have been discovered by the Inuit because the corresponding oils from whales, fish and seals were readily available to them. In Europe, the oil tanning technique has been known since at least the 10th to 12th century AD and was practiced by Basques after whaling and trading in fish oil with the Inuit (Trommer, 2008). Erman mentions that fish skins smeared with fat become airtight and tough, not as warm as furs, but more waterproof in case of snow or rain (Erman 1833, quoted in Hatt and Taylor, 1969, p. 8,9).

Oil has great potential as a tanning agent for fish skin. A multiplicity of oils may be implemented, such as seal oil, cod liver oil, olive oil and rape seed oil amongst others (Maina *et al.*, 2019). The oils, when used for tanning purposes, create hydroxy compounds within the fibrous structure on the animal fibre (Mathur, 1927). Animal oils, especially fish oils provide greater softness. Seal oil comes from the blubbers detached from the seals. These hydroxy acids impart a brownish tint to the oil providing a superior tanning over other oils. Cod liver oils and shark liver oils also change their appearance in the presence of moisture (Mathur, 1927). Tanning using fish oil faces odour and colour issues, caused by oxidized fish oil residue attaching on the skin. Vegetable oils promote a dry, medium-firm texture (Calvillo *et al.*, 2015) and they are odourless, but early tanners used what they had to hand (Suparno *et al.,* 2009).

Rhame's technique for oil tanning fish skins consists in using rape seed oil and egg yolk (Rahme and Hartman, 2012) (Figure 6.16.F). Rape seed oil acts as a good tanning agent similar to fish oil whereas other vegetable oils contains lesser amount of unsaturated fatty acids. Materials like egg yolk have phospholipids that are excellent for tanning and aid in drawing other fats into the skin (Hurcombe and Williams, 2002). The skin is placed on the egg-oil mixture, kneaded by hand and left to rest for 15 minutes. The skin is then hung in the sun (Figure 6.16.H) or in a warm room. Here, the oxidation of the oils takes place. The oil tanning process is based on oxidisable oils from fats, which are repeatedly manipulated into the skin (Figure 6.16.J) until they replace the natural moisture in the original skin. Their reaction is responsible for crosslinking the collagen and thus for tanning the skins. When oils are worked into the skin it becomes softer, since the fibres are encased in a protective coating and do not break as easily. The oil lubricates the fibres and increases their strength and tear resistance. In between these periods of manipulation, the skin is suspended in the sun or in a warm room. When the process is finished, the excess oils are washed out with an alkaline solution. The skin is then hung to dry after thorough washing.

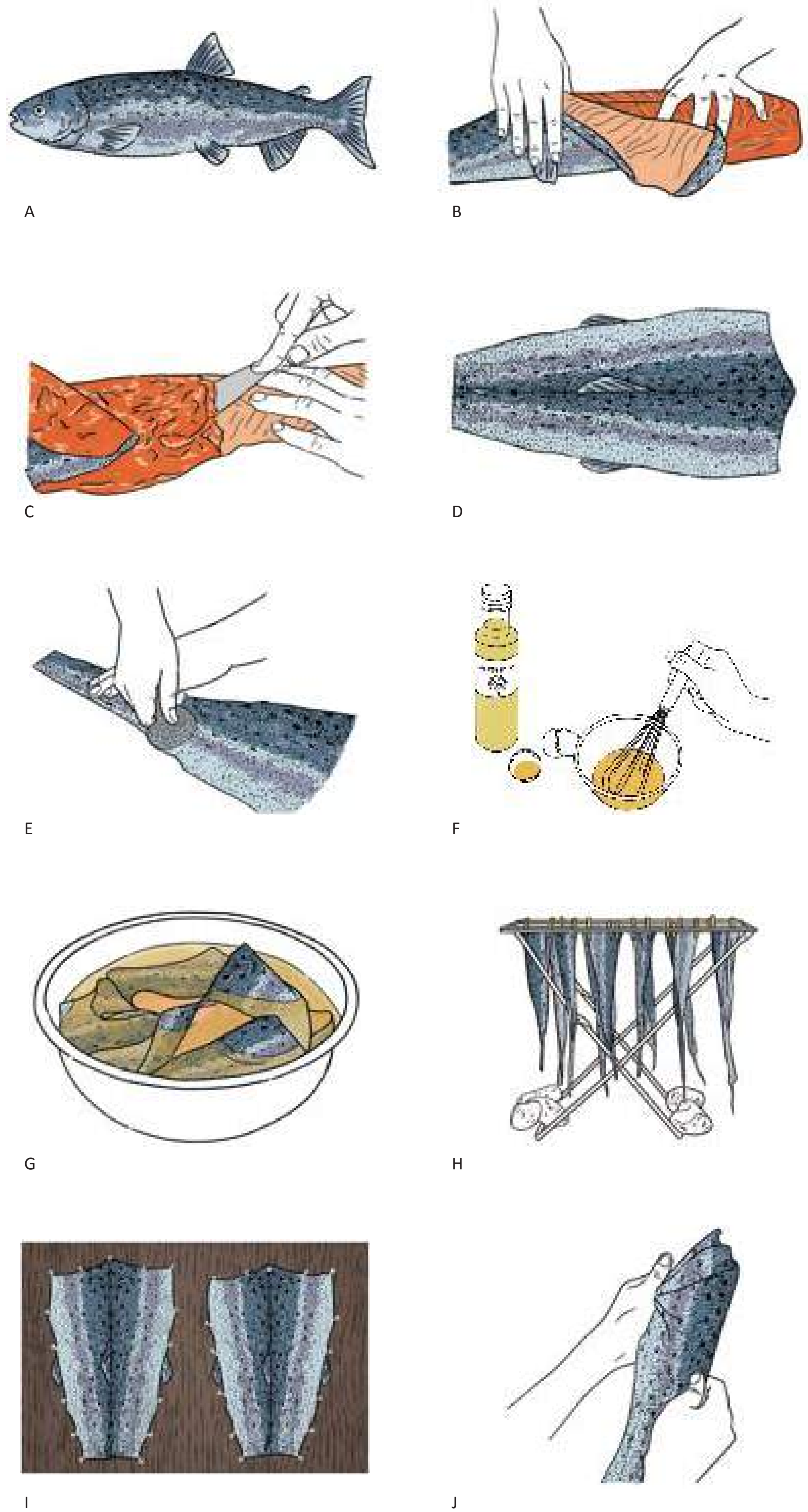


Figure 6.10 Oil tanning. Illustrations Laura Fernández (2023)

Skin nº 4A was scraped and scaled, tanned for 20 hours in a mixture of 50% urine and 50% water. The urine had been left in a container with a lid on for a day or so, to bring out the ammonia, which draws the fat out of the skin. Then the same amount of water as urine is poured in. The skin sat in the fluid for 20 hours with occasional agitation. The skin was washed out twice in ash lye with Ph. 8,2. After washing the skins were flattened out on a vertical wooden board, t inside facing in, tails downwards. When, they fall from the board they are sufficiently dry and can be mechanically softened by hand.

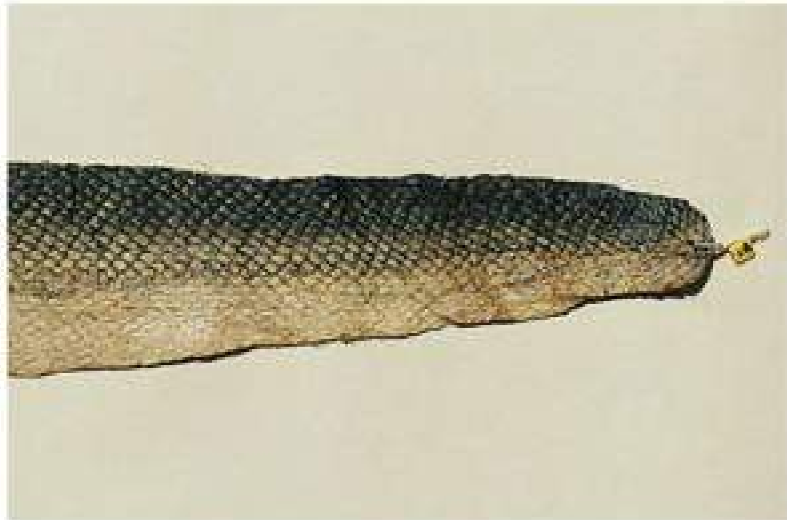
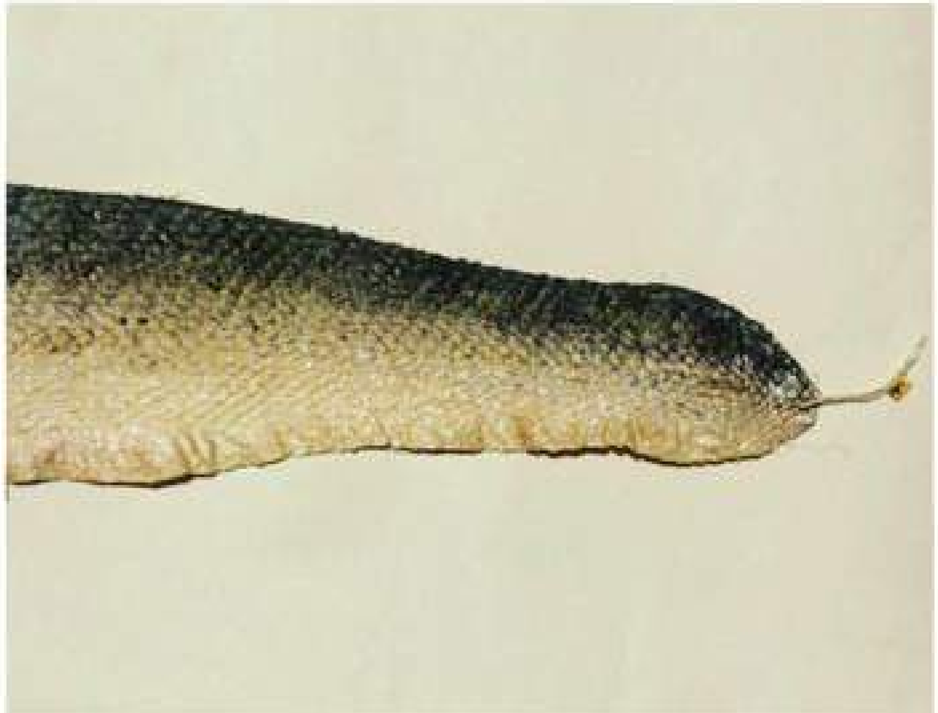


Figure 6.11., 6.12. and 6.13. Urine tanning process. Photographer Nathalie Malric, 2018

Skins nº 6A and 7A were treated in the same way as 5A but instead of brain nº 6A was tanned with a mixture of 1 dl rapeseed oil, 1 egg yolk, 1 tsp of soap. Skin nº 7 was tanned with 1 dl olive oil, 1 egg yolk, 1 tsp of soap.



Figures 6.14., 6.15 and 6.16. Oil tanning process. Photographer Nathalie Malric, 2018.

C. Fish roe tanning

Alaska Natives used fish roe or seabird eggs to tan their fish skins (Figure 6.12). The unsaturated fats contained in fish eggs can be manipulated and processed to impregnate the dermal fibres which when oxidised tan the skins by generation of aldehyde bonds. These skins will retain much of their former softness.

Hatt and Taylor (1969) describe the Native Peoples of Kamchatka to tan their skins with a mixture of rotten wood and fish roe. He points to the various uses of fish roe for tanning skins, described by Pallas (1776) and Georgi (1775), and mention that the nomadic Finno-Ugric Peoples of western Siberia used seabird eggs and fish roe as tanning agents. Fish roe or dried fish stomachs were chewed and then spat out onto the previously cleaned and scraped skin (Pallas, 1776, quoted in Hatt and Taylor, 1969, p. 15). Erman's (1833) points that fish roe is particularly rich in fat during the winter months and therefore did not need to be boiled or melted down (Erman, 1833, quoted in Hatt and Taylor, 1969, p. 15). According to Khvostov and Davydov, in the Aleutian Islands, bird skins were tanned with half-rotten fish roe (Khvostov and Davydov, quoted in Hatt and Taylor, 1969, p. 15), whereas Nelson notes that in the Bering Strait, the Inuit used cooked and still-warm fish roe to tan caribou skins (Nelson, 1899, quoted in Hatt and Taylor, 1969, p. 15) .

Perhaps the process of tanning fish skins with fish roe may have been similar to the seal skin tanning technology described by Zagoskin (1967) during his ethnographic research in the Yukon and Kuskokwim River valleys of Alaska. Wet seal skins were smeared with fermented fish roe (Figure 6.17.G), and then left, rolled up for three days in a warm place. The fish eggs were then washed and soaked in fermented urine. After being washed in urine (Figure 6.17.H), skins were rinsed in water and knead in hands until dry (Figure 6.17.I). The skins were stretched (Figure 6.17.J) hung in the air taking on a translucent reddish colour.

According to Fienup-Riordan (2007) Yup'ik elders would smear fish eggs on fish skin to make it stronger. Fish eggs are quite gluey, so water was added to them and when they softened, they were smeared and left to stand overnight. When the skins had soaked and softened on this mixture were easier to sew. Fish roe tanning like brain tanning has the advantages of good softness and pleasing fashion circularity, the roe of a fish should be enough to tan its skin.

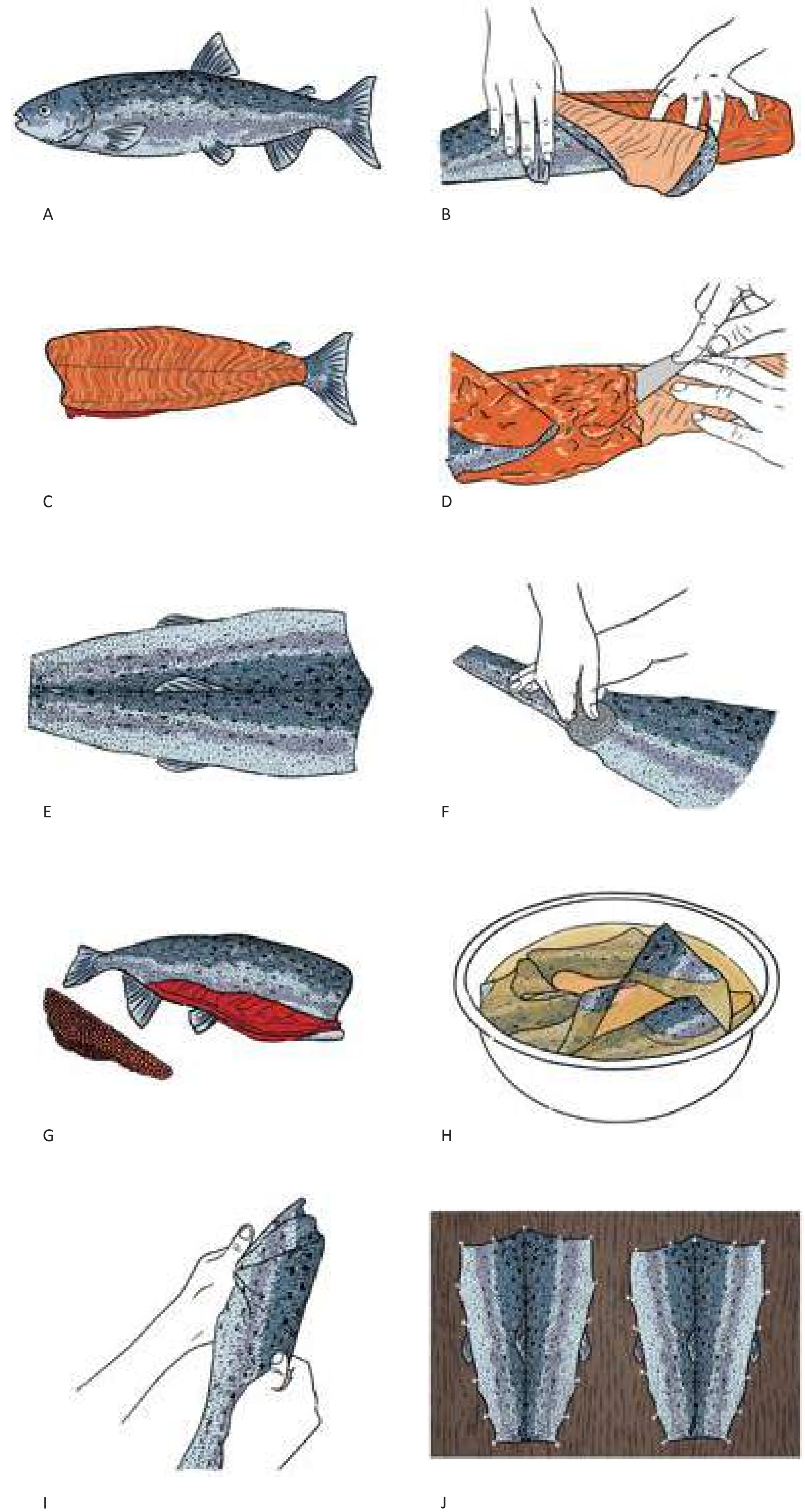


Figure 6.17 Fish Roe tanning. Illustrations Laura Fernández (2023)

D. Cornmeal tanning

Materials such as grains (cornmeal) have phospholipids that can in themselves be excellent for tanning but also aid in drawing other fats into the skin (Hurcombe, 2014). The cornmeal tanning technique is used in the two banks of the Amour River: in China by the Hezhe Ethnic Minority and in Siberia by the Nanai and Nivkh Indigenous groups. According to Glebova (2010), the skin is not immediately removed from the fish as soon as it is caught. After being gutted, the skin is removed; the fins are cut off, leaving fin holes as small as possible. Any remaining bits are scraped off with a birch knife to prevent the skin rotting. The raw skin is nailed to the wall of a barn to dry, stretching it as much as possible making sure that the lines of the skins are straight. After two days of drying, the skins are removed from the wall, placed on top of each other, pressed down with weights, and finally dried in the wind. Then a mixture of fine and coarse cornmeal is used to remove the fish oil and make the skins softer (Figures 6.18. G). The fine cornmeal sucks up fat from the skins and the coarse cornmeal helps to soften the skins mechanically. The skins are placed flesh side to flesh side and scale side to scale side and sprinkled with the cornmeal mixture between every layer (Figure 6.18.H.). Up to eight skins are roll together and wrapped in a piece of cloth. The rolls of skins are mashed and softened in a wedge-shaped piece of wood which pushes the skin into a groove in a wooden log. This large wooden scissor-like instrument is called a 'muhe' in Chinese or a 'gejikou' in the Hezhe language (Figure 6.18.I.). The work consists of beating the bundle of folded skins with the hoe while turning them over often. Afterwards the skins are unrolled, and they are rubbed further in cornmeal to accelerate the drying process (Figure 6.18.J). In the past, to remove the characteristic fishy smell, Nanai and Nivkh tanners rinsed the skins in ash water and wrapped them with rotten bark that they pounded on the hammer, which acted as an odour neutraliser (Glebova, 2010).

The fish skin and any remaining scales are scraped away with stones, clamshells or a dull metal scraper. Lastly, skins are twisted, kneaded, and rubbed against each other for two consecutive days to soften them. This stage fulfils four functions: the skin is whitened; the skin is softened; the skin is further stretched and blocked; and any excess flesh that may still be on the skin is removed. The Nanai and Nivkh Natives used fish roe and animal brains to reoil their fish skin. These substances are crushed in a grinder and finally squeezed by hand on the fish skin (Glebova, 2010). In some cases, to produce an even finer texture and whiter appearance, the skin is rubbed with sandstone.

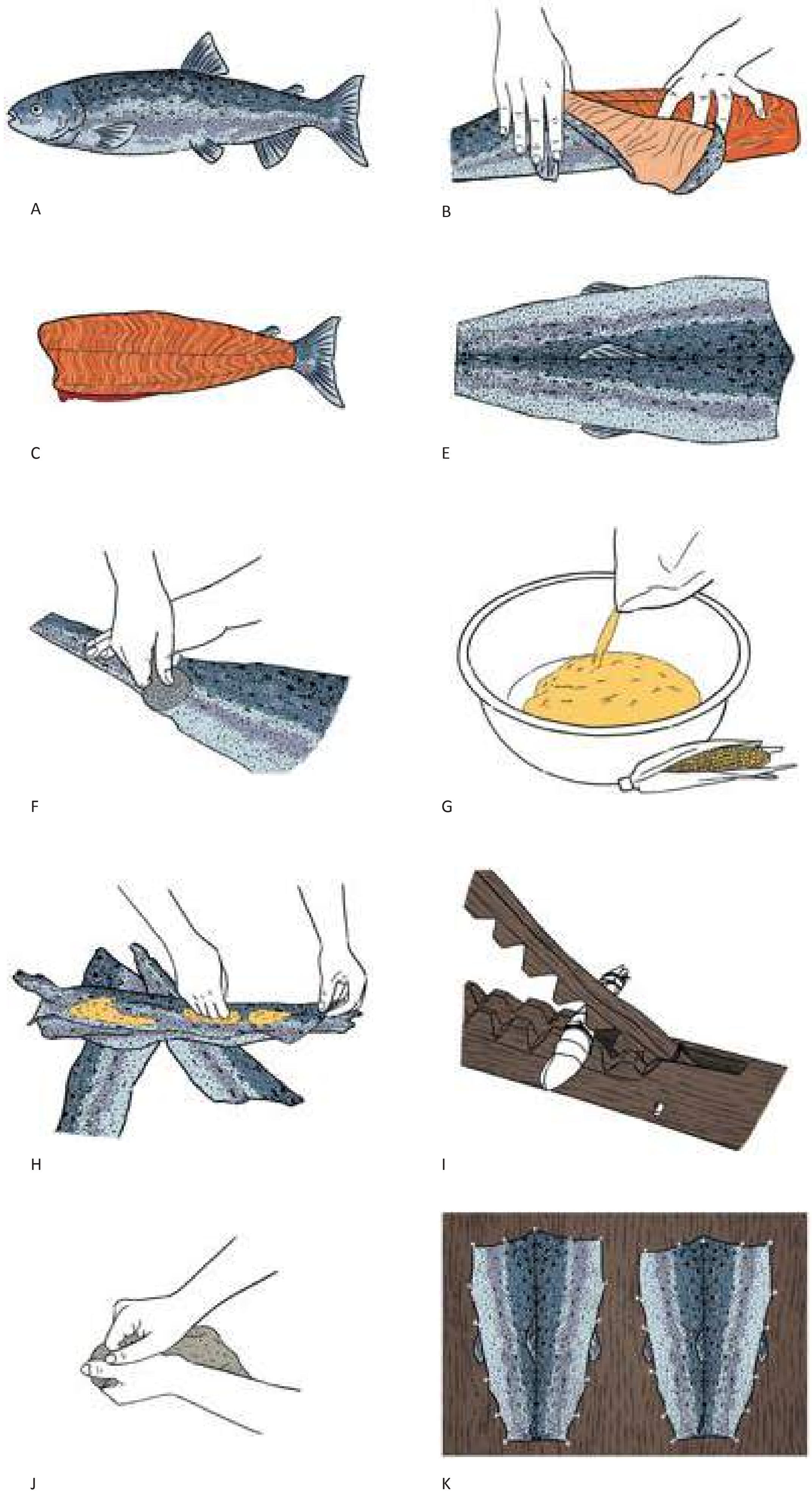
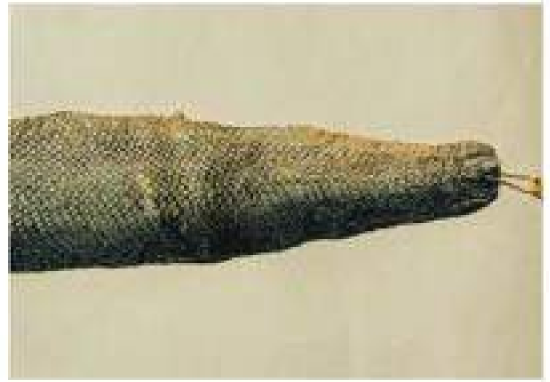


Figure 6.18 Cornmeal tanning. Illustrations Laura Fernández (2023)

Figure 6.19. Fish roe tanning process, 2018.

Skins nº 2A and 3A were scraped, scaled and left to dry for a day. They were also divided in two, and on one piece the outermost tissue was removed. A mixture of 50% fine cornmeal and 50% coarse cornmeal was made.



Figures 6.20., 6.21., 6.22 and 6.23. Cornmeal tanning process, 2018.

E. Vegetable tanning

Tanning can be achieved with a variety of plant materials such as berries, bark, tree twigs, leaves, and roots. This is often referred to as vegetable or bark tanning. Vegetable tanning involves treating the skins with such leaves and barks containing tannins. Tannins are polyphenolic[1] compounds naturally found in plant materials. Their presence in nature has prompted their historical use in leather tanning. The high content of tannins in plants - up to 20% of dry weight- explain their use since it represents a valuable material from an economic and natural source (Fraga-Corral *et al.* , 2020). Vegetable tanned leather produces a permanent change in the material, so that when it is wetted and re-dried it becomes slightly stiff but retains its suppleness. It can be further waterproofed by adding fats and oils, and the amount of softening will determine the suppleness of the material depending on the original thickness of the skin. Most tree barks are good sources of tanning materials and mimosa, tara, oak, spruce, oak and quebracho are all used. The different vegetable tanning material will produce different characteristics in the skins and will be selected accordingly, or by availability. Because there are many plants suitable for vegetable tanning this section will be divided into subsections detailing a selection.

E.1 Vegetable tanning material

Barks

Barks from different tree species are important raw materials in the production of vegetable tanned leathers. The trees from which the bark will be extracted should not be too mature, as the tanning content can lower with age. Barks are removed from trees aged between 12 and 15 (Miguelez, 1805), between spring and early summer when trees begin to leaf, and sap rises when tannin presence is highest which is also the easiest time for the bark to peel off the tree (Hurcombe, 2014).

Wood

At the beginning of the 19th century, chestnut and oak began to be used for tanning being also rich in ellagitannins. In the late 19th century, Europe began to import quebracho, an exotic wood from south America (Falcão, and Araújo, 2018).

Leaves

Sumac leaves were one of the most important tanning materials used since ancient times in Europe. In Spain Sumac leaves were used to tan cordovan leather made from goat skins. Leaves from gambier, myrtle, mastic and rédoul were also used for leather production.

Fruits

A few fruits were also used as tanning materials, the most important being Valonia, the acorns of Turkish oak, picked in August and dried out for the cups.

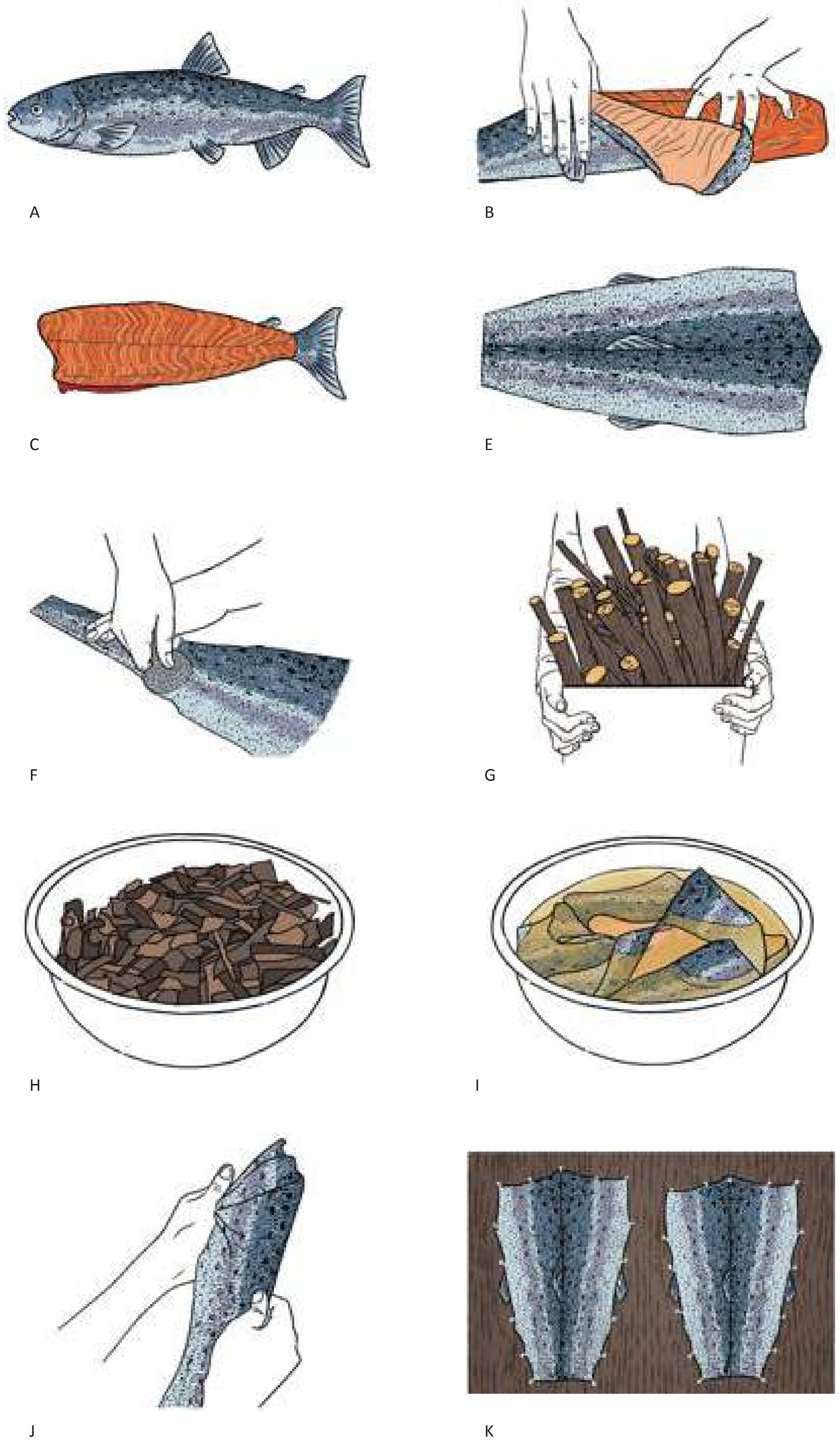
Galls

Galls have a high content of tannins and are pathological excrescences formed in the branches and leaves of plants as a response to the bites of certain parasites (Falcão and Araújo, 2018).

Roots

The polyphenols contained in the rhubarb root can be used for the production of tannins.

1 Polyphenols comprise a vast family of secondary metabolites which are stored in vacuoles of vegetal cells such as esters or glycosides. Tannins are considered polyphenols with high molecular weights.



Figures 6.24 Vegetable tanning. Illustrations Laura Fernández (2023)

The selection of specific plants depends on local availability. In Central Europe, several species of oak are mostly used, whereas in northern Europe, birch, willow, spruce and larch are more readily available. In southern Europe and the Mediterranean, sumac, valonia, various acacias and oak galls are favoured (Thomson, 2006). Skin shades vary according to the plants used to tan. Skin tanned with gallnuts is much paler than skin tanned with oak bark, which contains a brown colouring matter (Davy, 1840). Willow gives a nutty brown shade; reddish tones can be created by adding alder bark to the tanning solution and spruce and oak provides a darker colour.

Table 6.1 lists the most important sources of tannins from autochthonous plants used in European tanneries before the 18th century and until the development of mineral tanning.

Bark	Wood	Fruit	Leaves	Roots	Galls
Birch	Quebracho	Pomegranate	Sumac	Rhubarb	Oak
Willow	Oak	Valonia (Acorn	Tea	Madder	
Acacia	Chestnut	oak Cups)			
Walnut		Tara			
Elm					
Spruce					
Larch					
Pine					
Alder					

Table 6.1 Vegetable tannins.

During the vegetable tanning process, raw skin is transformed into leather. This involves crosslinking collagen fibres and binding tannins to those collagen fibres (Moog, 2005) (Russ- Popa, 2011). The tanning method varies from country to country. The bark is chopped and ground in a mill into a coarse powder producing the bark infusion obtained by the first maceration, containing mainly tannin and extractive matter. The skins are immersed in the tanning liquor with crushed plant parts containing those tannins (Figure 6.24.H). In the course of the maceration of the skins in these liquors, the tannin gradually combines with the collagen, which, in an organised form, mainly constitutes the skin, and forms with it a compound insoluble in water, dense and impermeable to that fluid. The skins remain in the tanning liquor until they are fully tanned. That way vegetable- tanned leathers become dense and resistant (Thomson, 2006). The gallic acid contained in vegetable tannins facilitates the action of their tanning by converting the skin into leather. The skin collagen is in a state hardened by slight oxidation; gallic acid to some extent deoxidises it, and thus reduces it to that state in which it combines more readily with collagen (Martin, 1813)

Skin nº 10A was tanned with willow bark collected in the spring when it contains most tannic acid. The bark was boiled in water for one hour, and then the solution was left to cool. The skin was scraped, the outermost tissue was removed and descaled and put in the solution for 11 days each day making the solution a little stronger by adding more bark. The pH value went from 6 to 5,5. Then the skins were placed on a wooden board to dry. Then they were mixed in a mixture of rapeseed oil, egg yolk and soap. When it was almost dry it was softened with hands and tools.

Figure 6.25., 6.26., 6.27. and 6.28. Bark tanning process. Photographer: Nathalie Malric, 2018.

F. Fat liquoring

The vegetable tanning process aims to preserve the fibre structure from bacterial attack. Preliminary tanning removes most of the natural oils from the skin. Whatever the pre-treatment and tanning, the leather at the time of tanning completion does not retain sufficient oils to prevent it from drying out (Thorstensen, 1993). The last tanning phase must include a softening process so that the result is a supple material. The tannins tend to dry out the skin and oils are usually applied at the end of the whole process. The softening process causes the fibres to work against each other and cause further drying. Oils can assist in this process and unsaturated and dispersed oils are best for penetrating the skin (Hurcombe, 2014).

Fat liquoring is the last step of the skin tanning process, and before the discovery of chrome tanning, the lubricants were incorporated into the wet skin by smearing it with natural oils and fats, which coated the fibres, introducing a slight degree of water repellence. The early fat liquors were prepared by emulsifying the oil in water through the use of active album agents, such as soap, and the use of protective colloids such as egg, casein, or natural gums (Battles, 1962). The use of oil in water emulsions, now called fat liquors, originated during the twentieth century. Fat liquors usually consist of a mixture of oils and emulsifying agents to give the skin the desired lubricity. Proper lubrication, or fat liquoring, helps to prevent splitting, stretching, stitch tearing, giving greater tensile strength. The application of the oil in the emulsified form differentiates between fat liquoring and other means of incorporating oil or fat. Under the conditions of the fat liquor the emulsion is deposited in the skin with the absorption of the oil on the fibres of the skin. The water is then removed in subsequent drying operations and the oil remains deposited in the skin, lubricating the fibres. The characteristic of elasticity given to the leather is provided by the added oils during the fat liquoring process.

Rahme and Hartman (2012) suggest making a mixture of water, olive or rapeseed oil, egg yolks and natural soap. Skins should be deepened in the mixture for 10 minutes, squeezed and hang to dry. While slightly damp the softening process begins.

Listed below are the main fat liquoring formulations used in the leather industry (Thorstensen, 1993).

- Castor oil, a triglyceride containing high amounts of ricinoleic acid.
- Cod liver oil, with a high degree of unsaturation providing fullness to the leather.
- Neatsfoot oil, obtained from cattle hooves and the most common fat liquoring oil used.
- Moellon, produced by the oxidation of raw cod oil providing more hydrophilic properties.
- Sperm whale oil, a soft lubricating oil containing an ester rich in fatty alcohol.
- Shark liver oil, herring oil and seal oil have been reported in the literature as fat liquoring formulations used by Indigenous Arctic Peoples (Fienup-Riordan, 2007).
- Corn oil, cottonseed oil, olive oil, palm oil, coconut oil, soyabean oil and rice bran oil are some of the vegetable oils used in fat liquoring (Battles, 1962).

It was the custom of many northern peoples to keep their skin clothes oiled at all times. The Saami were known for often rubbing their skin clothes with grease to keep them soft and waterproof, and Erman recalls that the fish skin clothes of the nomadic Finno-Ugric of western Siberia smelled of fish oil (Erman 1833, quoted in Hatt and Taylor, 1969, p. 15).

According to Hrdlicka (1945) Aleutian used lukewarm shark liver oil to treat the skins of sea lion used in kayak construction. Murdoch (1893) mentions that Alaska Natives from Point Barrow treated skins (‘oil dressed skins’) with train oil obtained from the blubber of whales for waterproof soles in boots and to make the skins softer. Greasing with train oil is the last phase of skin treatment, following the scraping and drying. In Alaska, salmon skin boots were used for winter travel. Chum salmon was used for the uppers and king salmon for the soles. Women wore waterproof boots made of king salmon skin smeared with seal oil to prevent them from getting soaked. The seal oil conferred the skins transparency (Fienup-Riordan, 2007).

G. Taking care of skins

Fish skin boots and garments if properly cared for, they will last a long time, but they demand careful maintenance. If exposed to heat when wet, they char easily. When someone walked into the house with wet fish skin boots, the heat burned them, so they had to loosen the laces of the boots and tie them up again on the way out. Children were also told not to walk on dog faeces because the fish skin boots would rot. Fish skin is composed mainly of collagen, therefore, when stepping in dog faeces, the collagen contained in fish skin soles would be exposed to enzymes breaking down the fibrous network (Fienup-Riordan, 2007). Dog faeces, as well as those of other animals, such as birds, have pancreatic enzymes that attack the proteins, hence these organic materials can also be used in small proportions to soften the skins (Trachter, 2023).

6.6.4 Mineral tanning

A. Alum Tawing

The employment of alum and salt in tanning originated in countries where alum is found as a natural product. The art was introduced into Spain from Morocco (Procter, 1903). Alum ‘tawing’ occurred by exposure to water containing alum, or by the replacement of common salt with alum in hot countries where it existed as a result of the weathering of aluminous shales (Waterer, 1946). After the 20th century, it was largely replaced by chrome tanning. Alum is also used as a mordant in dyeing and in the past it was used as an energetic astringent in pharmaceuticals. Interestingly, ancient alchemical recipes were a mixture of magic and technology.

Tanning baths were prepared by adding mineral substances such as common salt, rock alum or iron sulphates in a solution of vinegar or human urine (Reed, 1980). Alum is hydrated potassium aluminium sulphate; the complex molecules only adhere in a small proportion to the skin and have a lesser tanning effect (Rahme and Hartman, 2012). Using these aluminium salts, a stabilizing action occurs and even if the final leather is not watertight, it is exceptionally smooth with a soft velvety texture and a stretchy finish. Rock alum modifies the colour of the skin providing whiter shades which do not easily fade. Alum-tawed leather does not tolerate heat well, even less than untanned leathers. This technique is called alum-tawing and by this process a very stable material is obtained if kept dry, but if it gets wet it can revert to the state of untanned skin. For this reason, to distinguish it from properly tanned skin (which can withstand the action of water) it is called alum-tawed rather than alum-tanned (Reed, 1980).

The alum tawing method for fish skin is swift and the skins are easily softened. The skin is cleaned and scraped, then dipped in a mixture of alum and salt for 12 hours. Alum-tawed skins can be made more resilient by adding eggs, oil, flour or vegetable substances to the mixture (Rahme and Hartman, 2012). The skin is removed from the bath, and the alum and salt mixture is strengthened, leaving the skin for further 12 hours to complete the absorption of the salt and alum (Procter, 1903). Afterwards the skin is soaked in water until thoroughly wet in all parts. This not only softens the skin, but prepares it for dyeing, while removing the superfluous alum and salt, and the flour and egg in the mixture. To replace these, re-oiling is necessary, and egg-yolk, or egg-yolk and flour and a proportion of salt, and alum could be added. The skin is then properly softened. Procter (1903) mentions that the 'tawed' leathers produced by the agency of alum, and other salts of alumina are frequently used in combination tanning with vegetable materials and this is frequently accomplished by the use of materials in the dye-liquor containing tannins. The essential difference between tanning and tawing is that in the former case the skin is combined with tanning and other vegetable matter and in the latter with something which it absorbs from the alum and salt, and which is never removed by subsequent washing and branning (Welsh, 1964).

B. Chrome tanning

During the industrial era of the 19th century, the tanning drum replaced the open pit used in the past for vegetable tanning increasing the efficiency. In 1840, the medical community adopted sutures stabilised by immersion in a Chromium (III) solution. A few years later, it was discovered that soaking these chrome-tanned sutures in glycerol made them more flexible, and therefore softer. These two advances in medical technology were soon adapted by tanners becoming chrome tanning (Leather International, 2013).

The complexity, expense and time involved in tanning with vegetable tannins led by 1858, to the development of alternative mineral tanning agents. The basic principle remains the same removing water molecules from the collagen and replacing them with the tannin agents, in this case chromium, but the process is much quicker when using chemicals. Chromium is the most popular mineral agent tanning today. 90% of global leather is tanned with chrome. Chrome tanning uses a solution of chemicals, acids and salts (including chromium sulphate) to tan fish skins. The skin is 'pickled' by first an immersion in the acid salt mixture then in the chromium sulphate. Then all skins, regardless of the original colour come out looking light blue (known as 'wet blue') and have

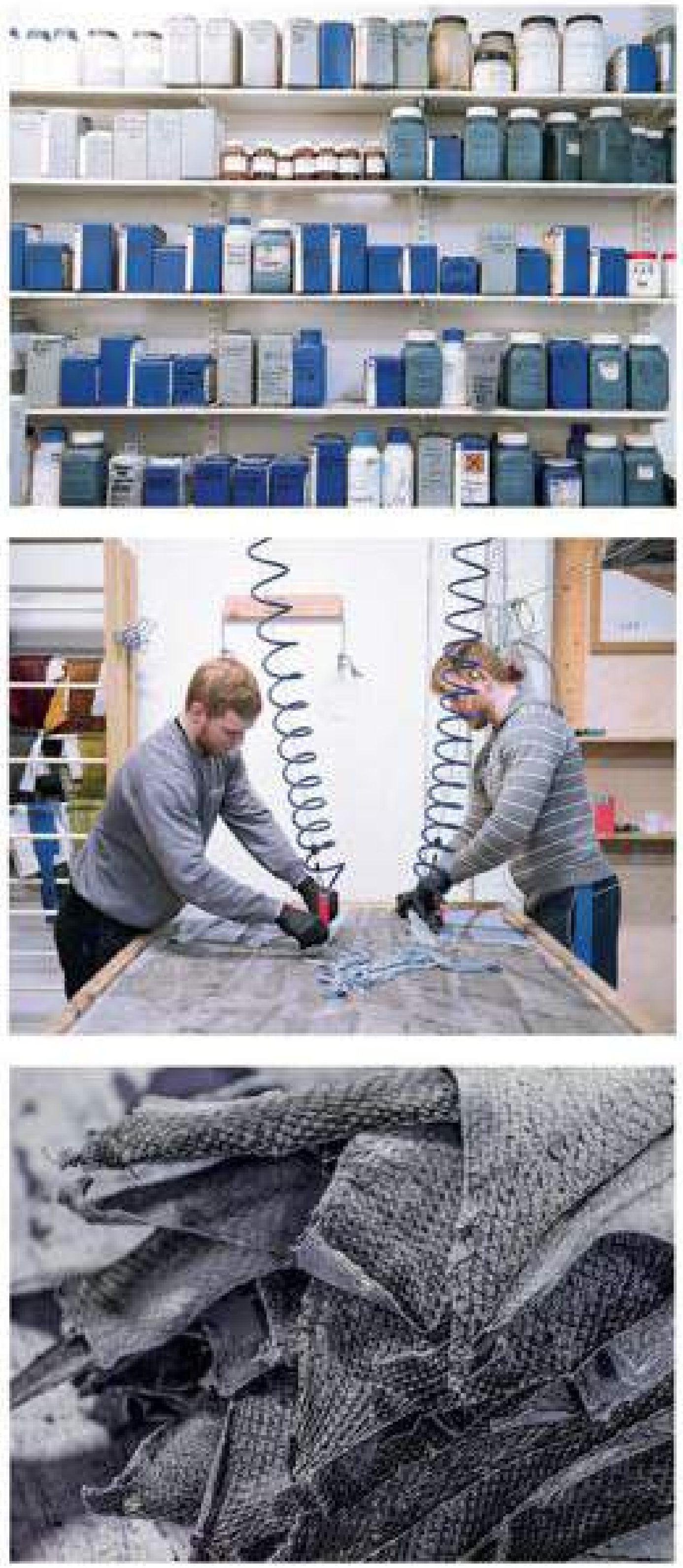


Figure 6.29, 6.30. and 6.31. Industrial chrome tanning process. Atlantic Leather tannery. Photographer: Nathalie Malric, 2018.

a finishing colour applied. The whole process can be automated and finished in one day, as the chrome ions displacing the water and binding with the collagen are much smaller than vegetable tanning molecules. This makes chrome tanned fish leather thinner and softer than vegetable tanned fish leather. The process, however, is much less 'natural' -involving first placing the skins in acidic salts to better make the chrome fit in between the collagen molecules – and then returning the skins to a normal pH level. This requires the use of acids and other chemicals as well as the chromium sulphates themselves. If not properly managed, these have a negative environmental impact. Currently the entire leather industry is under a lot of pressure to become cleaner as more regulations are introduced to reduce the use of chemicals and generate cleaner waste waters. Conversely it is important to note if the artisanal methods were employed on an industrial scale there will be also an environmental impact: deforestation of willow for the tannin agents on its bark, raspberry as a monoculture for its tannin agent. It is a question of scale.
Table 6.4 lists the most important differences between vegetable and chromium tanned fish leather.

Vegetable tanned fish leather	**Chromium tanned fish Leather**
Only natural ingredients are used	Requires use of acids and chromium sulphates
It is biodegradable	Biodegradation is much slower
It has durability and strength and can last several lifetimes	It is thinner, softer, and suppler
Colours are rich deep earthy tones but limited	It is available in any colour
Being an organic material, it will change over time, growing darker and softer and developing a patina	The colour will remain uniform
Does not react well with water. Can stain easily	More resistant to stain, heat and water
Time and skills involved makes it expensive	Quick and easy to produce, cheaper materia
The process can take up to one week	The whole process can be finished in one day
It has a distinctive earthy fragrance	Often smells of chemicals
It is an age-old tradition performed by artisans	It is often mass produced with little skills

Table 6.4. Vegetable versus Chromium tanned fish leather

6.7 Tests

Empirical tests were carried out in order to understand the physical properties of the different traditional tanning methods their mechanical, tensile strength, their resistance to breakage under tension and how well the skin will perform in vigorous use (Rengasamy and Wesley, 2011). The strength of the skin was of vital importance, as it guaranteed that the garment would not tear during strenuous use, despite the constant wear and tear caused by the movement of the legs and arms. If the skin is weak, it will tear. A split seam in a skin garment in the Arctic would be fatal to a hunter or fisherman (Ewing and Darwent, 2018). Fish skin garments had to not only keep a person warm but perform well during strenuous and repetitive activities that had a high impact on materials.

By testing ancient Arctic fish skin tanning techniques, we gain a better understanding of the physical properties and its limitations. Different tanning techniques allow fish leather to resist very challenging conditions and can make it into a truly all-purpose material, equally fit for a hostile environment, as adopted for its practical as well as aesthetic capacities.

Physical and mechanical limits have to be achieved by a material to be suitable for use in the fashion and accessories industry. These limits must be evaluated in regard to the stresses associated with the production, processing, and use of the materials. In general, examinations to qualify materials and to quantify their properties need to be performed according to standardized testing procedures. The fish leather samples were tested according to the appropriate internationally harmonized and accepted specifications for shoe, glove, and apparel goods. The physical characterization comprised standardized measurements of tensile strength, tear strength, flex resistance, water vapor absorption, and water vapor permeability. The surfaces of the materials were portrayed by light microscopy at different magnifications.

The most important mechanical properties for leather used for shoes, gloves, and apparel goods are tensile strength, tear strength and resistance to mechanical stress. The species of fish and its thickness are the first parameters used to adjust the choice of material to purpose. Oil tanning lubricates the fibres and thus increases tear resistance. Resistance to rubbing, soiling, and sweat is another important factor. Friction is a major cause of wear, so it is essential to protect the surface of the fish leather. Extraneous particles dust, sweat and dirt are better able to adhere to a rough surface than a smooth one. If the leather is worn through friction the dirt will adhere in these areas, becoming incrusting overtime in the grain of the leather. This happens particularly in outdoor environments. To combat soiling, we can add texture agents such as oils to the finish, which make the leather smoother and more resistance to friction. Sweat also plays a part in the deterioration of leather. The sebum eventually penetrates the finish causing discoloration and migration of colour. The more the leather is coated, the better it is protected against sweat.

Resistance to light and direct sunlight is important. Natural daylight intensity and UV content will bleach colours and intensify the shade of vegetable tannins with consequent colour alteration. This is particularly noticeable when exposed to bright sunlight, where its colour will tend to be bleached or altered. Vegetable-tanned leather is particularly light hypersensitive. Rain-resistance it is also an important factor. It stops water from penetrating the leather preventing water damage which will cause brittleness and breakage. To waterproof fish leather action is required during the oiling stages, replacing the intrinsic oils with industrial waterproof oiling products.

I specifically examined with weighted stress tests how traditional fish skin tanning methods compare to commercial chrome tanning and vegetable tanning. The tensile strength was tested in a dynamometer comparing traditional tanning processes with modern commercial chrome tanned fish leather, sampling the skins both parallel to backbone and perpendicularly. The skins were tested for breakpoint strength by attaching them to a bar that was hooked to a digital scale and a weight applied. The strength of the skin samples was tested similarly. Samples of fish skin were tested individually on the same digital scale. The breakpoints were compared to those of modern commercial chrome and vegetable tanned fish leather cut to the same length. The physical and rheological properties of the different traditional tanning methods were measured for colour stability and suitability. The skins were subjected to light and rub fastness tests and colour measurements.

Tests were performed with farmed salmon from Norway. These skins were tanned with gallnut for five days and then dyed with:

- Nr 5. Pomegranate.
- Nr 6. Madder.
- Nr 7. Brazil wood.
- Nr 8. Onion skin.
- Nr 9. Black beans.
- Nr 10. Cochineal

Tests on wild- caught salmon, Bothnian Bay, Sweden.
No. 1A. Was softened with wooden tool and hands.
No.1AB. Was softened with wooden tool and hands. The outermost tissue was not removed from the flesh side.
No. 2A. Was scraped and left to dry for a day. A mixture of 50% fine cornmeal and 50% coarse cornmeal was used during the softening process. The outermost tissue was not removed from the flesh side.
No. 3A. Was scraped and left to dry for a day. A mixture of 50% fine cornmeal and 50% coarse cornmeal was used during the softening process.
No. 4A. Was scraped and scaled, tanned for 20 hours in a mixture of 50% urine and 50% water. The urine was left with a lid on for a day or so, to bring the ammonia out, which draws the fat out of the skin. Then the same amount of water as urine is poured in. The skin sat in the fluid while stirring them once in a while for 20 hours. The skin was washed out two times in ash lye, ph. 8,2. When washed, the scales on the surface of the skins were easily rubbed off. After it were washed, the skin was flattened out on a wooden board, the inside facing in, stroking down towards the tail. When dry, it will fell off from the wooden board. Before the skin was completely dry, it was mechanically softened by hand.
No.5A. Followed the Native Americans technique for brain tanning moose hides. The fish skin was scraped; the outermost tissue was removed, scaled and washed in cold water with ash lye. Brain from reindeer was boiled in water for a few minutes, and when the mixture had cooled down to 20°C the fish skin was laid in this mixture for 20 min. After that the skin was hung outdoors in the sun until it was "half dried" and then it was rubbed by hand until it was dry and soft. It was left to mature until the next day and washed in water with ash lye, pH 8,2. The skin was dried again and softened with wooden tools and hands.
No.6A. Was treated in the same way as 5A but instead of brain it was tanned with a mixture of 1 dl rapeseed oil, 1 egg yolk and 1tsp of soap.
No.7A. Was treated in the same way as 5A but instead of brain it was tanned with 1 dl olive oil, 1 egg yolk and 1tsp of soap.
No. 8A. Was tanned with a solution of gallnut-powder together with salt and water. The skin was scraped and scaled and put in the solution for five days. The mixture was made a little stronger each day starting at pH 7 going down to pH 4,5. When the skin was drip-dried it was worked in a mixture of rapeseed oil, egg yolk, soap before it was laid it out to dry on a board; and when it was almost dry it was softened with hands and tools.

No.10A. Was tanned with willow-bark. The willow bark was collected in the spring when the bark contains the most tannic acid. The bark was boiled in water for one hour, and then the solution was left to cool. The skin was scraped and scaled and put in the solution for 11 days. The mixture was made a little stronger each day starting at pH 6 and the final solution had pH 5,5. When the skin was drip-dried, it was worked in a mixture of rapeseed oil, egg yolk and soap before it was laid out to dry on a board. When it was almost dry it was softened with hands and tools.
No.11A. Was tanned with rhubarb root dug up in the autumn. The root was washed, broken into smaller pieces, and allowed to dry. When it was ready to be used, the pieces were boiled in water for an hour after which the solution was allowed to cool to 20°C. The skin was scraped and scaled and put in the solution for 7 days. The mixture had pH 7 to start with and then it was made a little stronger each day. The final mixture had pH 4,5. When the skin was drip-dried it was worked in a mixture of rapeseed oil, egg yolk, soap before it was laid it out to dry on a board; and when it was almost dry it was softened with hands and tools.
No.12A. Was brain tanned. Alaska.

Table 6.2. Traditional tanning tests on wild- caught salmon, Bothnian Bay, Sweden.

Tests on farmed salmon from Norway.
After tanning, re-oiling and softening, the skin surface was painted with whipped egg whites. Once the egg whites were dry the skins were polished.
No.1. Was tanned with willow bark for 11days and then re-oiled.
No. 2. Was tanned with willow bark for 11days and then re-oiled. The surface was not polished with egg white.
No. 4. Tanned with willow bark for 11days, soaked in an iron-and bark solution for 12 hours, then re-oiled.
No. 5-10. Were tanned with a solution of gallnut-powder together with salt and water. The skins were scraped, scaled and put in the solution for five days. The mixture was made a little stronger each day starting at pH 7 going down to pH 4,5.
No. 5. Was dyed with pomegranate, alum, salt and then re-oiled.
No. 6. Was dyed with madder and then re-oiled.
No. 7. Was dyed with brazil wood, alum, salt and then re-oiled.

No. 8.	Was dyed with onion skin and then re-oiled.
No. 9.	Was dyed with black beans, alum, salt and then reoiled.
No.10.	Was dyed with cochineal and then reoiled.
No.11.	Vegetable tanned at Atlantic Leather, Iceland.
No.12.	Chrome tanned at Atlantic Leather, Iceland.

Table 6.3 Vegetable tanning and Natural dyeing tests on farmed salmon from Norway.

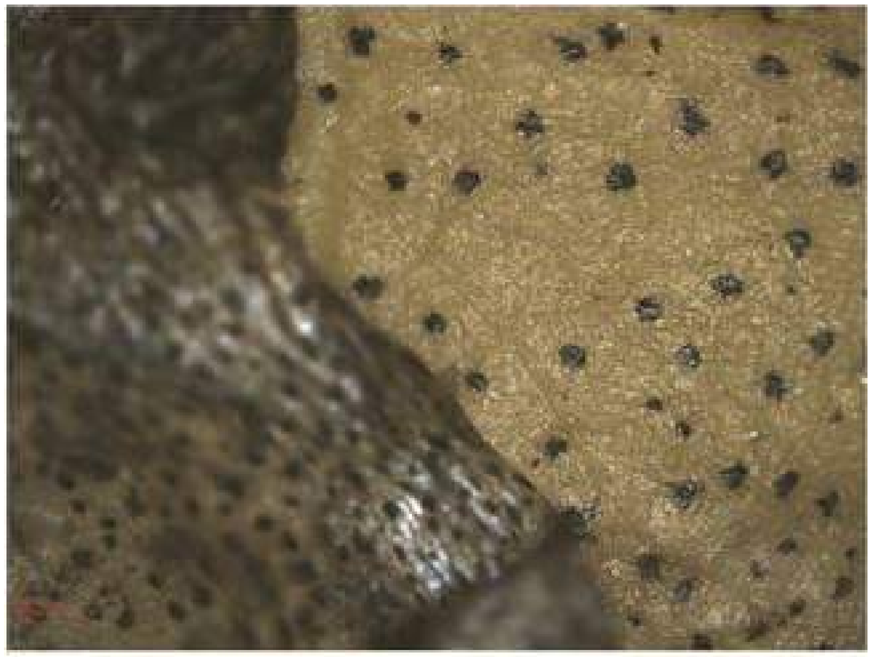


Figure 6.32. and 6.33. Surface morphology. Optical images taken with a profilometer for fast 3D measurements of surface morphology. Giovanni Perotto, 2020.

6.7.1 Surface morphology

Optical images were taken with a profilometer (Optical profilometer Zeta-20 by ZETA, for fast 3D measurements of surface morphology on the mm size scale; max z range 25 mm, z resolution 10 nm). Due the irregularity of the surface of the upside of the fish skin, a 5X magnification lens was used, providing a good compromise obtaining images of a wider surface and avoiding diffractional defects of the microscope. The tests show that the type of tanning influences the colour of the skin. In particular, while the willow bark tanning gives a brownish colour, the cornmeal tanning, the olive oil tanning and the boiled brain tanning give a yellowish colour. Industrial chrome tanning without a specific dye makes the skin grey under the microscope.

In all the traditional tanning techniques, black spots are visible on both inside the scales and on the scale edges (Figure 6.32.). These spots sometimes are covered by the dye and are less visible, as in the case of the black bean dye and cochineal dye. The average diameter of the spots is about 70 µm. Since the spots are in every sample, they are not a consequence of the type of tanning; they are an intrinsic property of the salmon. In particular, they are formed by specialized chromatophores (melanophores or melanocytes) which produce the dark pigment eumelanin (Bagnara, 1998). However, these spots are not visible in the samples that have been industrially chromium tanned.

In conclusion, these traditional tanning techniques alter neither the natural look of the fish skin nor its biochemistry compared to the industrial chromium tanning, which is less sustainable and has a higher environmental impact.

6.7.2 Fastness properties

ISO 105-B02:2013 Textiles - Tests for colour fastness **- Part B02: Colour fastness to artificial light**. We used a Xenon arc fading lamp test. This test emulates the weathering of a colour sample by exposure to solar light. In this case the colour fading of the samples is rated against a blue scale on fabrics representing the values 1 to 8, where 8 is the highest standard. The samples were exposed for 24 hours to artificial light (Figures 6.34. and 6.35.). Each sample was divided into three portions, as the colours to be tested were multiple. The table shows the results obtained with the light fastness tests at 24 hours. Sample n ° 8, tanned with a solution of gallnut powder, gave the best results (Table 6.5).

ISO 15700: 1998 Leather - Tests for colour fastness - Colour fastness to water spotting. This International Standard specifies a method for assessing the effect, on leather of all kinds, caused by spotting with water (Figure 6.36.). The method is suitable for assessing the change in physical appearance and the colour change of the leather. The water drop test resulted in moderate swelling with 4/5 grey scale colour degradation for all tested samples (1,5,7,8,9,10).

Sample	Rating sample portion A blue wool scale	Rating sample portion B blue wool scale	Rating sample portion C blue wool scale
1	5	3	3
4	7	6	2/3
5	4	2/3	2/3
7	4	3/4	3
8	6	6	6
9	2/3	2	1/2
10	7	6/7	5

Table. 6.5. Tests for colour fastness - Part B02: Colour fastness to artificial light.

ISO 11640: 2018 Leather - Tests for colour fastness - Colour fastness to cycles of to-and-fro rubbing. This International Standard specifies a method for determining the behaviour of the surface of a leather on rubbing with a wool felt. It is applicable to leathers of all kinds. The colour fastness to cycles of to-and-fro rubbing (Figures 6.37. and 6.38.) gave very low results, specifically 2 grey scale. The best sample was sample 8, tanned with a solution of gallnut-powder dyed with onion skin, with colour staining on white felt 3 grey scale (Table 6.6).

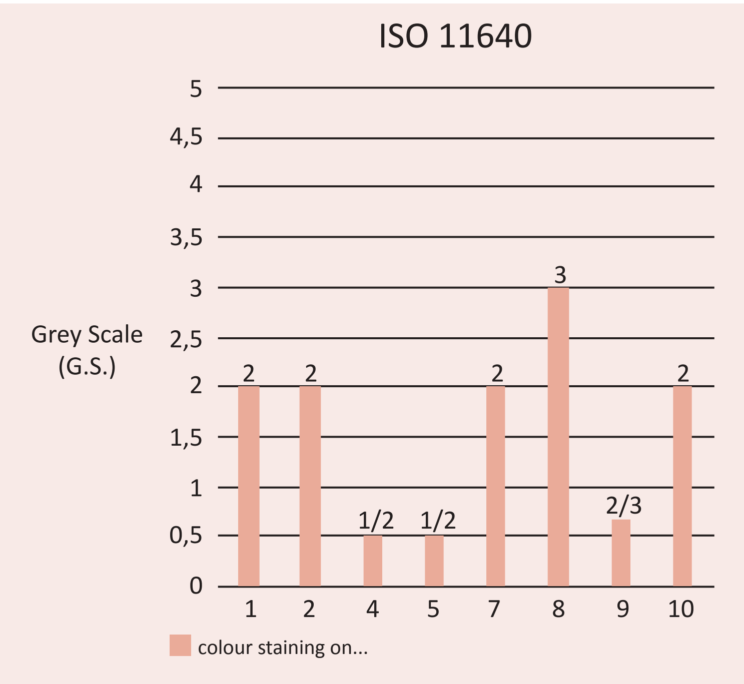


Table. 6.6. Tests for colour fastness to cycles of to-and-fro rubbing.

6.7. 3. Physical and mechanical properties

ISO 14268:2012 Leather - Physical and mechanical tests - Determination of water vapour permeability. This International Standard describes a method for determining the water vapour permeability of leather and provides alternative methods of sample preparation (Table 6.7).

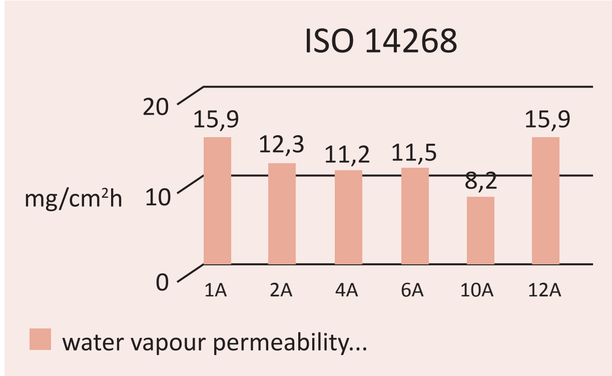


Table 6.7. Water vapour permeability values of various tested samples.
samples 1A and 12A have a high-water vapour permeability.

ISO 2417:2016 Leather - Physical and mechanical tests - Determination of the static absorption of water. This International Standard specifies a method for determining the water absorption of leather under static conditions (without friction). The method is applicable to all types of leather, particularly heavy leather. This test did not give positive results; the samples tested already after 15 minutes gave already a result a water absorption of 95/100%. This across-the-board failure confirms that fish leather is not waterproof unless coated with oils.

ISO 3376:2011 Leather - Physical and mechanical tests - Determination of tensile strength and percentage extension. This International Standard specifies a method for determining the tensile strength, elongation at a specified load and elongation at break of leather. It is applicable to all types of leather (Table 6.8 and 6.9).

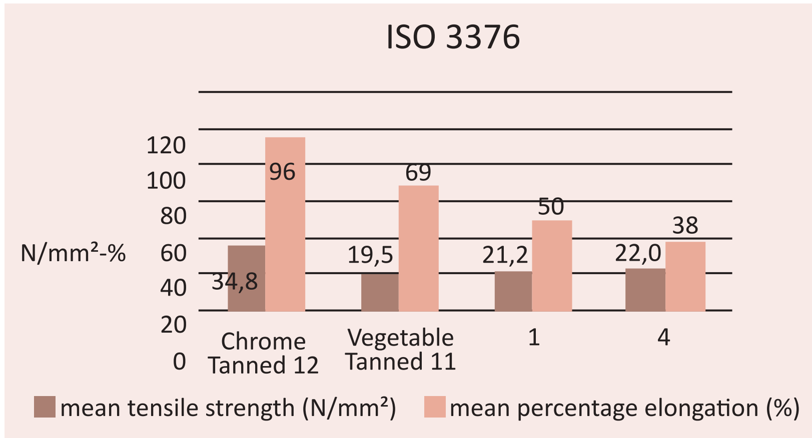


Table 6.8. Mean tensile strength and mean percentage elongation values of various tested samples; comparison between industrial chrome and vegetable tanned fish leather from Atlantic Leather and sample 1 and 4.

Figure 6.34. and 6.35. Determination of colour fastness to artificial light, 2020.
Figure 6.36. Determination of colour fastness to water spotting, 2020.

Figures 6.37. and 6.38. Determination of colour fastness to cycles of to and fro rubbing, 2020.

ISO 3377-1:2011 Leather - Physical and mechanical tests - Determination of tear load - Part 1: Single edge tear. This International Standard specifies a method for determining the tear strength of leather using a single-edge tear. The method is sometimes described as a trouser tear. It is applicable to all types of leather (Table 6.10).

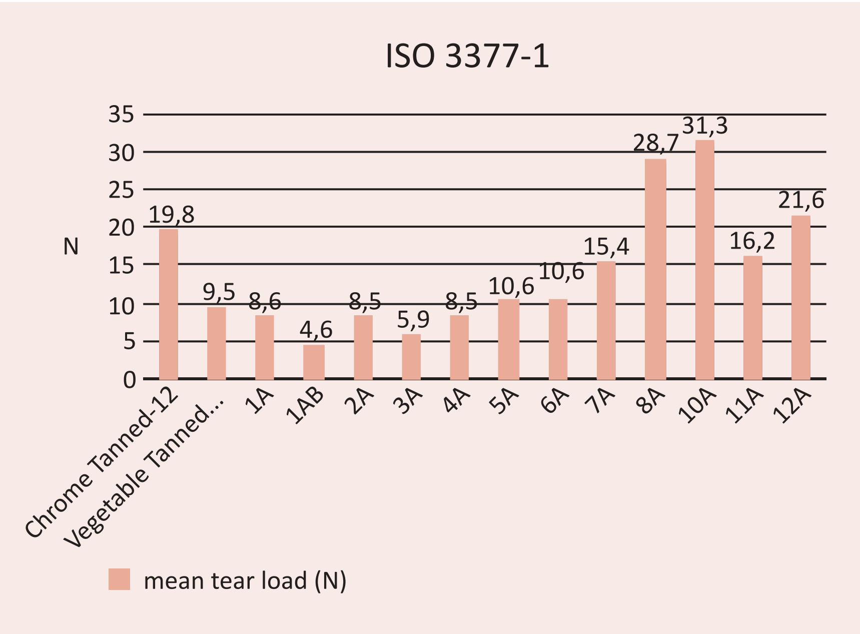


Table 6.10. Mean tear load values of various tested samples; between industrial chrome and vegetable tanned fish leather from Atlantic Leather and samples from 1A to 12A. Samples 8A and 10A have a medium to high tear load compared to the other samples tested.

ISO 5403-1:2011 Leather - Determination of water resistance of flexible leather - Part 1: Repeated linear compression (penetrometer). This International Standard specifies a method for determining the dynamic water resistance of leather(Figures 6.44., 6.45. and 6.46.) by means of repeated linear compression. It is applicable to all flexible leathers but is particularly suitable for leathers intended for footwear applications. It uses a Penetrometer-type machine (Figures 6.41., 6.42. and 6.43.) and includes an option for electronic detection (Tables 6.11 and 6.12).***ISO 5403-***

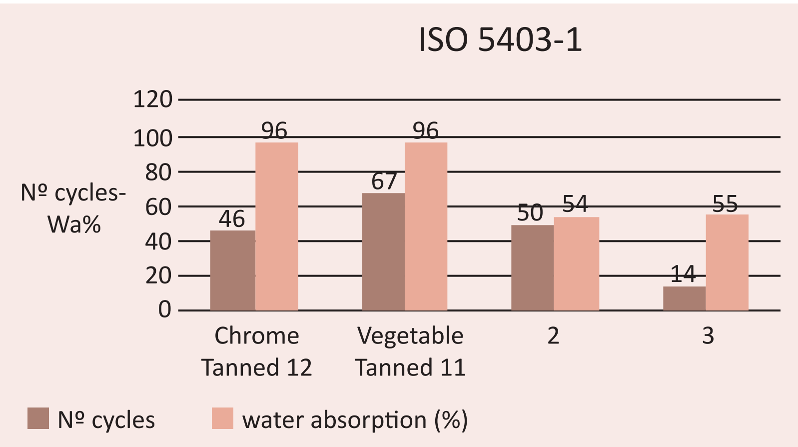


Table 6.11. N°cycles and water absorption values of various tested samples; comparison between industrial chrome and vegetable tanned fish leather from Atlantic Leather and sample 2 and 3.

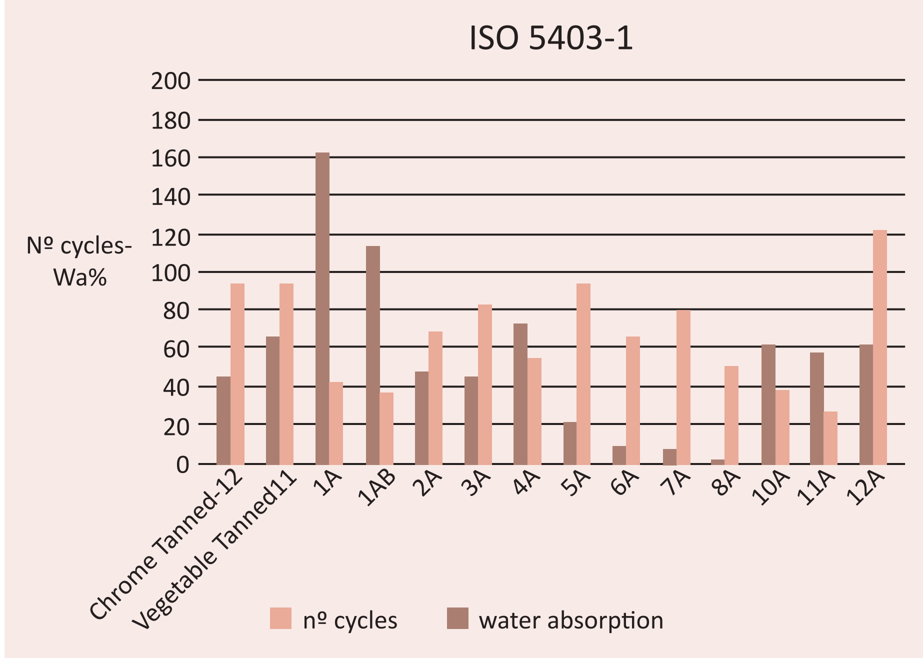


Table 6.12. N°cycles and water absorption values of various tested samples between industrial chrome and vegetable tanned fish leather from Atlantic Leather and samples from 1A to 12A.

2:2011 Leather - Determination of water resistance of flexible leather -Part 2: Repeated angular compression (Maeser). This International Standard specifies a method for determining the dynamic water resistance of leather by means of repeated angular compression. It is applicable to all flexible leathers but is particularly suitable for leathers intended for footwear applications. It uses a Maeser-type machine and includes an option for electronic detection (Figures 6.41, 6.42. and 6.43.) (Table 6.13).

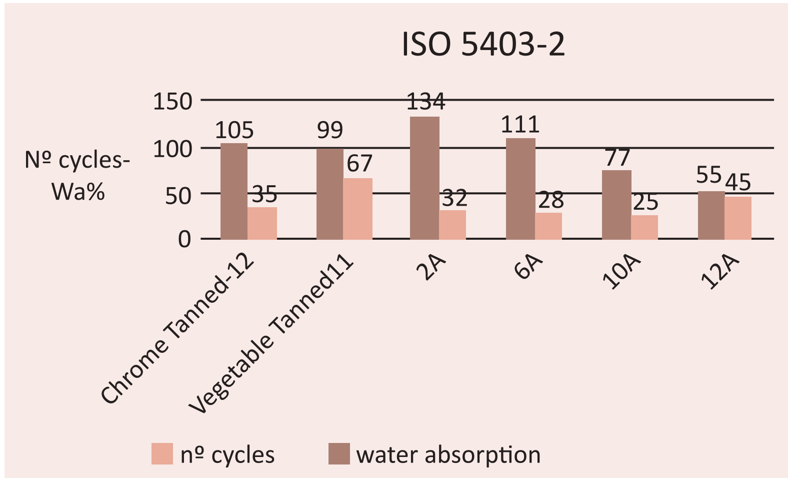
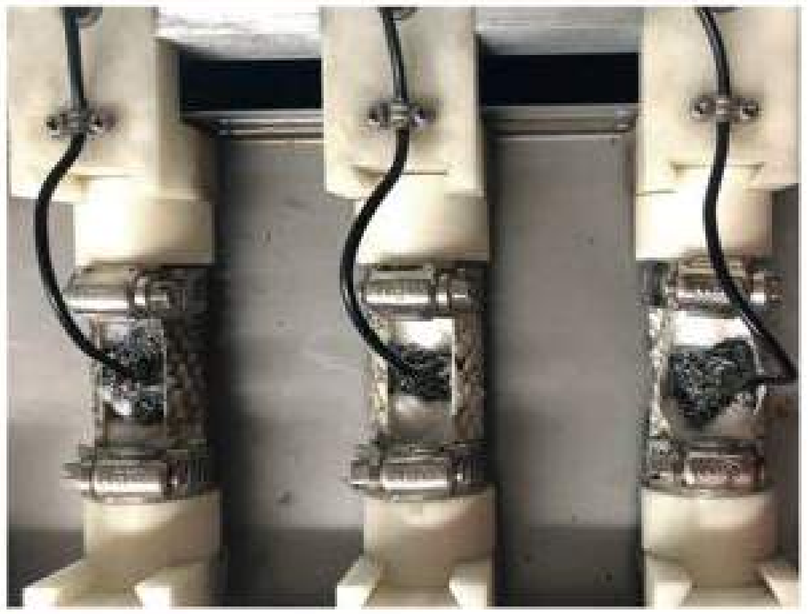


Table 6.13. N°cycles and water absorption values of various tested samples; comparison between industrial chrome and vegetable tanned fish leather from Atlantic Leather and samples from 2A, 6A, 10A and 12A.

Figure 6.39 and 6.40. Determination of tensile strength, 2020.



Figures 6.41., 6.42. and 6.43. Determination of water resistance of flexible leather - Part 1: Repeated linear compression (penetrometer) (2020)

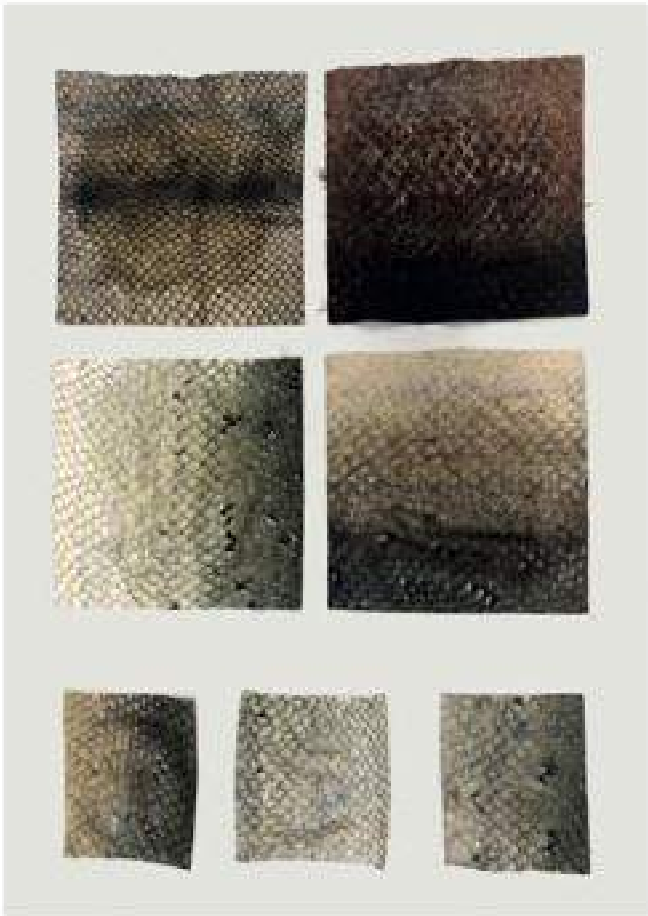
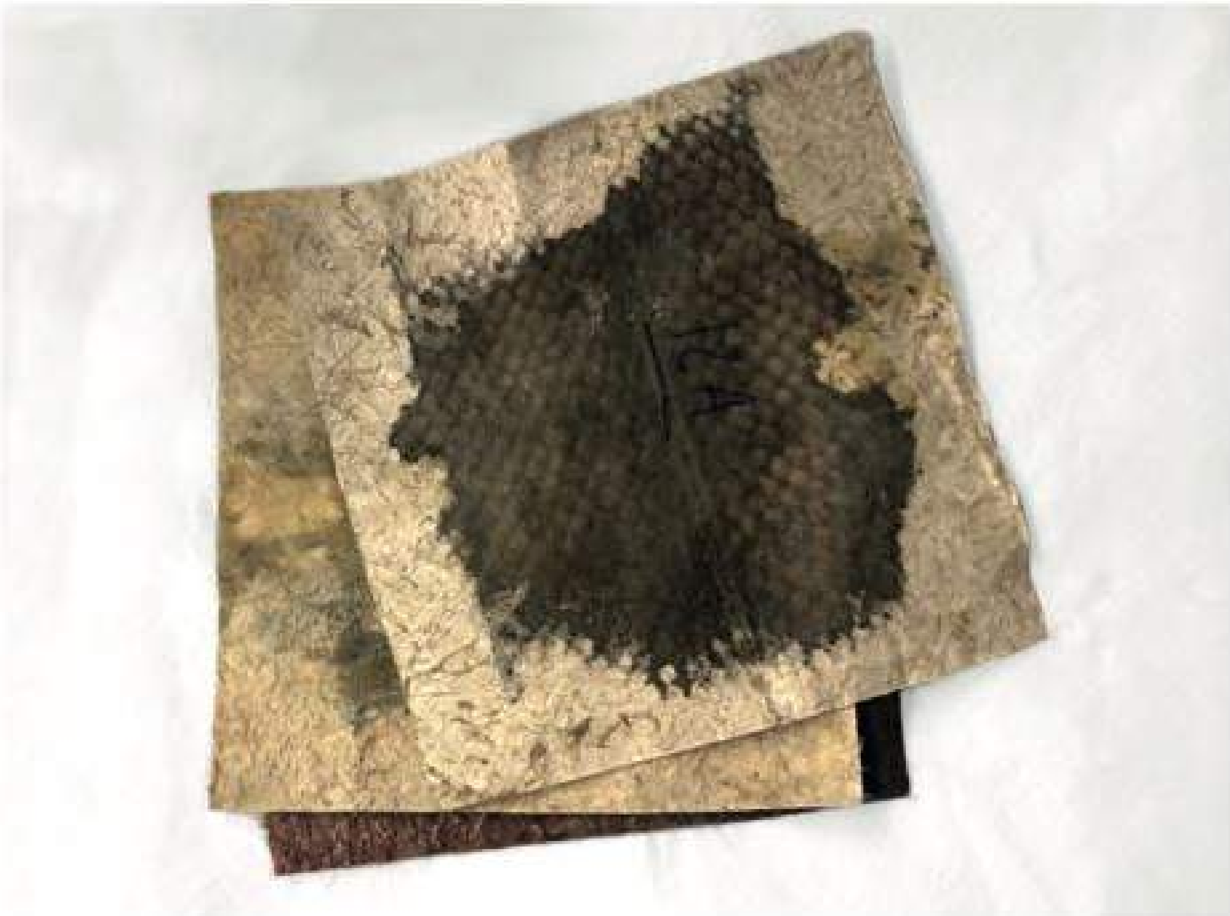




Figure 6.44, 6.45. and 6.46. Determination of water resistance of flexible leather -Part 2: Repeated angular compression (Maeser Test), 2020.

6.8 Test Conclusions

The colour fastness tests showed sufficient light fastness, which was surprisingly for the organically tanned leathers, but not for the chromium tanned leather taking into account the fact that all traditionally tanned samples tested were not chemically treated. The best result was that of sample No. 8, tanned with gallnut-powder (6 on the blue scale) on all portions of the sample and tested for 24 hours.

The water drop test after 30 minutes demonstrated the poor performance of the leather, as we obtained moderate swelling and hardening on the tested surfaces, with 4/5 grey scale colour degradation for all tested samples (1,5,7,8,9,10). The colour fastness to cycles of to-and-fro rubbing gave results of similarly low performance, specifically 2 grey scale; again, the best sample was sample No. 8, with colour staining on white felt 3 grey scale.

Pleasant wearing comfort of shoes, gloves, or apparel is related to the water vapor permeability (WVP) of the material, which allows transporting the humidity of the body through the clothing material to its surface. The comfort is also enhanced by the ability of the materials to absorb water vapor (Meyer *et al.*, 2021). The water vapour permeability test gave results of very satisfactory performance: in all samples tested the permeability is greater than 8 mg/cm²h, in particular the values are the highest for the 1A sample processed mechanically by hand and the 12A tanned with brain (15.9 mg/cm²h). Typically, the required values on leathers and textiles are:

Type of materials	**Water vapour permeability (mg/cm²h)**
Leather full grain side	5.0
Nubuck leather	7.5
Leather crust	10.0
Textiles and synthetic	12.0
Fish leather (12A)	15.9

Table 6.14. Comparison of vapour permeability of fish leather with other materials.

Therefore, based on the values obtained, a high breathability of the fish leather is observed, much higher than conventional leathers, other textiles, and synthetics (Table 6.14). If we compare the permeability of fish leather (15.9 mg/cm²h.) with that of new leather alternative materials such as vegan leather Piñatex (0.4 mg/cm²h.) The tests indicate that the water vapour permeability of the fish leather was larger than that of the vegan leather. Fish skin covers a broad set of aimed functions. It has to protect the body for a long time against mechanical impact, it is flexible to allow mobility, and often it has to regulate the temperature and water balance. Alternative materials have specific advantages, but they don't combine high mechanical strength with high water vapor permeability as in the case of fish leather.

We can conclude that fish leather makes an ideal material candidate for sports footwear, considering its overall fastness properties, particularly regarding its high specific tear strength and water vapour permeability, the last playing a very important role in keeping the feet dry from sweat and comfortable during walking. The effect of water vapor permeability of fish leather would affect the water vapor transfer in a shoe. We could improve the thermal comfort of a shoe by creating the right microclimate, harnessing the water vapour permeability of the fish leather. The absolute humidity in the microclimate of a shoe made of fish leather will be lower than one of faux leather. In 2006 Nike created a capsule collection made of perch leather from Atlantic Leather. This collection sold out and it is currently unavailable. I am currently working with Cristina Mirri, previously shoe designer at John Galliano, to create my own capsule collection of fish leather trainers (Figure 6.47) (Appendix 1).

But the high breathability of these fish leather samples goes hand in hand with the negative performance in the water resistance tests (ISO 5403-1 and ISO 5403-2): after a few minutes there was water penetration and high-water absorption. This could be mitigated by the addition of oils or treatment with chemical waterproofing agents.

Fish leather as the grown skin tissue shows a very high mechanical stability (tensile strength, tear strength). Tensile strength and elongation tests showed that chrome tanned leather has the best elongation percentage (96%) and average tensile strength (N/mm²), better or equal to the rest of the samples tested. The only sample with a higher average tensile strength is 5A (brain tanned), which, however, has a lower percentage elongation (61%). The graph in table 6.9 shows that the percentage elongation decreases from chrome-tanned leather to industrially tanned vegetable-tanned leather and finally to samples 1A and 4A (mechanically processed and urine tanned). As far as the average tensile strength is concerned, on the other hand, a similar value is observed for the industrially chrome-tanned sample and samples 1 and 4, which are lower than the chrome-tanned sample. (The values obtained in terms of average tensile strength and percentage elongation (31%), in most cases, are in line with the values obtained for bovine hides).

The tensile strength of fish skins was tested both parallel to the backbone and perpendicularly. The analysis of the results shows that the smallest marginal stresses occur along the backbone of fish skins and the smallest marginal deformations occur perpendicularly (This distribution of strength properties differs from the distribution of strength properties in bovine hides). The orientation of collagen fibres in a linear direction is adapted to the aquatic environment of the fish, therefore fish leather is found to be more stretchable along its length than width. For the single tear-resistance test 3 samples have a higher average load: 8A, 10A, 12A.

Figure 6.47., 6.48. and 6.49. Katazome dyed fish leather sneaker designed and created by Cristina Mirri at Calzaturificio Tarcio of Bologna. Photographer, Laura Fernandez, 2021

6.9 Emerging themes from the Fish skin Traditional Tanning processes

Through this chapter I have illustrated the diversity of different traditional tanning methods. They represent only a part of the multiple possibilities developed over the long history of early tanning technologies. Traditional vegetable tanning process in conjunction with the historic smoke, brain, urine, fish roe and oil tanning, have more importance today than ever. Currently the leather industry is searching for the substitution of mineral tanning by the inclusion natural molecules obtained from renewable resources modified using harmless additives. To achieve promising results, cost-efficient and eco-friendly extraction methods have been designed. Once these green alternatives have been verified, they have been successfully applied to leather tanning formulas (Fraga-Corral *et al.*, 2020). We need to bring the old technologies up to date but the answers are all there.

Skin processing technology is based on traditional knowledge of materials: the knowledge to physically manipulate materials to acquire the properties that are needed for a specific purpose, and the ability to adapt materials and methods according to current conditions (Shirokogoroff, 1935). The purpose of processing skins is to obtain specific qualities for specific ends, like water repellence, flexibility or colouring (Klokkernes, 2007). The fish skin tanning techniques explored in this chapter depend on the geographical location, climate, natural resources available, local tradition and cultural identity.

It is important not only to test traditional tanning techniques, but also to achieve a better understanding of craftspeople decision-making when it comes to material processing. As this study has demonstrated, leather production starts with the tanning of the skin. Without skilfully tanned skins, no garment would have the ability to protect humans in the harsh environment of the Arctic (Ewing and Darwent, 2018). To better understand exactly how the traditional tanning was done, experimental replication was necessary. The main difference between traditional tanning and modern mineral tanning is convenience and cost. Commercially chromed tanned leather is cheaper than vegetable tanned leather. The vegetable tanning of fish leather is time-consuming and needs a different set of skills. However, it has unique properties. These traditional tanning innovations were pivotal in the design and production of comfortable and functional fish skin clothing in the Arctic and are a testament to the ingenuity of Arctic Indigenous Peoples.

Traditional methods provide future answers for current crisis. I hope in this research to forge links between the old and the new, the west and the north, the science, and the tradition. Much of this Arctic Indigenous science and technology has been blamed of lacking strong scientific evidence for its efficacy and has not been considered as a science because of its overreliance upon traditional knowledge and mystical beliefs. In choosing the science focus of this research we can continue to advocate for respect for the Indigenous Arctic knowledge systems. The perceived gap between Arctic Indigenous knowledge and Western science is enormous, there are differences, but understanding the links can deepen our understanding of both Arctic and Western thoughts. According to Fienup-Riordan (2007) Western science is primarily concerned with developing and testing hypotheses to understand what is happening within and between these variables. Nevertheless, the two are both complementary in the sense that Yup'ik[2] science is the result of a major process of trial and error that has produced sophisticated results, while Western science can explain how these results have been achieved. Although there is no word for science in the Yupik language, it is the very essence of their lives. We need to bridge the gap between Western scientific and academic approaches and Indigenous traditional knowledge. The tested methods, tools and the tanning technology that Arctic peoples used to process fish skins can provide a lot of wisdom about their environment. Their processing and technology could help to understand how their knowledge is part of Arctic everyday life to survive in such a hostile environment.

Through this chapter I have identified the biochemical logic of the traditional fish skin tanning process using natural principles with a very low environmental impact. Currently, both academy and industry are searching for the substitution of unsafe chemical tanning processes for which the organic tanned process have great relevance. They could be introduced to contemporary industrial tanning, cutting the supply of chemicals, and minimising the environmental impact of fish leather production.

More than ever before, the task of design is to articulate the right directions in material development to move towards more sustainable choices. Understanding materials, production processes, viability, and desirability are key to the fashion industry. New materials, processes, and techniques are often the result of the successful union of fashion and technology to help drive the industry real change in terms of sustainability. The findings of this chapter have been gathered through a partnership between myself, the Swedish fish skin tanner Lotta Rahme, the information gathered from Indigenous fish skin tanners across the Arctic, the Icelandic tannery Nordic Fish Leather and the Italian analytical laboratory Ars Tinctoria. The connection has brought together the knowledge and skills of a fashion designer and researcher, traditional tanners, a scientist and leather technician in order to advance material innovation by using traditional tanning process technology on fish leather. The findings identify new materials, processes, and techniques are often the result of the successful union of fashion and technology to help drive the industry towards a more sustainable future. By bringing the field of fashion design from Arts and Humanities in contact with Science and Technology, this study has the potential to bring benefits to a wide range of subject areas. It will encourage the joint development of scholarship and collaboration across these disciplines, and it will support the cross-referencing of methods to advance scientific and artistic knowledge of fish leather as a more sustainable alternative.

2 The Yup'ik are a group of native peoples of western, southwestern, and southcentral Alaska and the Russian Far East. They are related to the Inuit and Inupiat Peoples

Figure 7.1 Hezhe fish skin painting by Yulin Sun. Tongjiang, China, 2018.

Chapter Seven: Research in practice, Fish skin workshops

7. Chapter Seven: Research in Practice: Fish skin workshops

7.1 Introduction

This chapter focuses on the practice of implementing the research aims set out in chapter 1. These aims were:

Objective 2.1. Create four fish skin workshops in different Arctic communities to carry out a cross referenced study of the difference in the fish skin material between different Arctic Indigenous Peoples.

Objective 2.3. Explore how fish skin craft as material and practice can contribute to sustainability in fashion.

7.2 Fish skin and Education for Sustainable Development

The workshops created for this PhD take inspiration from sustainability education in fashion, emerging from ecological and participatory research at CSF, London College of Fashion. It follows CSF's six pedagogic principles for sustainability education through practice and with reference to UN Economic and Social Council (2011). These are futures thinking, critical and creative thinking, participation and participatory learning, systemic thinking, interdisciplinarity, and place-based learning. Education for Sustainable Development (ESD) offers a critique of current models of fashion education and business, to be set against our ability to live well, without jeopardizing our futures and our fellows.

This study follows academic scholarship by Williams and Fletcher (2010; 2013) and Williams (2016; 2018) on how to embody sustainability content in fashion HE practices. It aims to integrate the principles of sustainable design where designers can share new methodologies, creating exchange while retaining their individuality (Williams and Fletcher, 2010). Their principles on sustainability education in fashion have equally been explored through the experiential and practical understanding of sustainability, drawing connections between people and nature. Methodologies of participation and knowledge exchange - to shift to a society that thrives within nature and with human equality - have been put in practice (Williams, 2015).

Many studies have been devoted to analysing collaborative and participatory processes in higher education, such as Fuad-Luke's (2014) theories on cultural and social product design, which by involving stakeholders in the design process can contribute to improving practices in fashion higher education. This study has also been inspired by the existing intellectual framework of design thinking and practice already developed by Manzini (1994; 2010). Manzini's concepts related to HE and social innovation, the promotion of sustainable livelihoods and the role of designers and design researchers in empowering social innovation for sustainability have been explored. Otto von Busch's (2008) theories on creating opportunities for people to work collaboratively so that everyone has something to offer to the design process have also been considered. The role and influence of design within crafts communities have also been discussed (Williams and Fletcher 2010; 2013; Manzini, 2010; Jégou and Manzini, 2008). Fletcher (2913) agrees that few ideas are more ecologically powerful than those linked to designing and developing products to sustain communities while providing people with meaningful work and a sense of connection with the place and the people with whom they live. According to Thackara (2015), the best product is the one that makes citizens look at their community with fresh eyes. In my case I am bringing fresh eyes to the ancient craft of fish skin tanning.

Preserving traditional knowledge of fish skin is essential to the Arctic world. This study seeks to draw attention to the vital importance of traditional fish skin craft to the Arctic Indigenous Peoples, as the basis of their culture and key component of their identities, and to encourage their artists to re-introduce the skills used by their ancestors as a tool for community development. The academic scholarship mentioned above has been introduced through design facilitation, creating a series of international workshops on fish skin craft. The workshops were designed to bring together students from diverse Arctic fashion universities in order to give them direct experience of fish skin traditional craft; to broaden their understanding about the sustainability of the material and to connect them with traditional crafts communities and artists. This people-centred learning process, inspired by a sustainability focus and applied to fashion design, has followed CSF scholarship on sustainability education through practice.

7.3 Fish skin tanning workshops

The workshops were designed to bring together students to explore sustainable fish skin craft with traditional crafts communities. Within this context, the fish skin workshops' participatory case studies are explored as approaches towards sustainability in historical, anthropological, social, cultural, economic, and environmental terms. For the purpose of this research, four fish skin craft communities were chosen as case studies to survey sustainability found in the resourcefulness and resilience of the Arctic Peoples.

The selected students were invited via email to take part in the workshop; a participant information pack (Appendix IV) was sent, explaining the aims, and expected outcomes as well as the schedule of the workshop. The workshops have explored the potential for fish leather to become a competitive sustainable material for fashion, and the possibility that fish leather may reduce demand for exotic materials which have a higher environmental impact. Consequently, students, when they start working in the fashion industry, will be able to inspire brands that use leather goods to use fish leather as an alternative sustainable material in their collections.
To enhance student engagement and to test a new learning experience, I co-designed with the Native and non-Native fish skin artists 4 workshops to encourage students to produce fish skin work using the traditional skills. The aim was to preserve fish skin cultural heritage in areas with

a history of fish skin leather production, such as Iceland, Sweden, Finland, Denmark, Hokkaido, Northeast China and Alaska while strengthening Arctic networking activity.

The following workshops were created:

- Nordic fish skin workshop (with Icelandic, Swedish, Finish, Danish and British students) taught by Non-native Swedish tanner Lotta Rahme (Figure 7.2.). The outcomes of this workshop have been published in paper 3 (Appendix V).
- Hezhe Fish skin workshop (with Chinese students) taught by Hezhe Ethnic Minority artists Wenfeng You (Figure 7.3.) and Yulin Sun (Figure 5.32.). The outcomes of this workshop have been published in paper 4 (Appendix V).
- Ainu fish skin workshop (with Japanese students) taught by Non-native Japanese artist Shigeharu Takano (Figure 7.5.).
- Alutiiq fish skin workshop in the Covid 19 era (with Alaska Native students) taught by Alutiiq Native artist June Pardue (Figure 7.4.). The outcomes of this workshop have been published in paper 5 (Appendix V).

Figure 7.2. Lotta Rahme tanning fish skins in her studio in Sigtuna, Sweden. Photographer Håkan Olse'n., 2018.

Figure 7.3. Hezhe fish skin artist Wenfeng Yu, during the Hezhe fish skin workshop by the Amour river, Heilongjiang, China, 2018.

Figure 7.4 Alutiiq fish skin artist June Pardue harvesting alder bark during the Alutiiq fish skin workshop, Sutton, Alaska,2020.

Figure 7.5. Shigerhiro Takano peeling a salmon during the Ainu fish skin workshop, Nibutani, Hokkaido, Japan, 2018.

7.4 Ainu Fish Skin workshop

Project creation

The Ainu fish skin tanning workshop was conceived and created over a period of six months. The workshop was created by me in the role of Fashion Print pathway leader at Central Saint Martins, London, with the collaboration of the Nibutani Ainu Culture Museum and funded by the Foundation for Research and Promotion of Ainu Culture, FRPAC, The Japan Foundation Endowment Committee and The Great Britain Sasakawa Foundation. This workshop took place in July 2018 at the Nibutani Ainu Culture Museum. It focused on how little Ainu Fish Leather craft heritage has been preserved and promoted and has sought to contribute to the academic debate of Hokkaido traditional crafts' recognition by the Japanese government. In 2006 the skill of processing fish skin was one of the first listed as intangible cultural heritage of China but in Japan, the remaining Ainu fish skin craft is still in danger of extinction. Since the Japanese Traditional Craft Act in 1974, only two Ainu crafts were recognized by the Japanese government in 2013 and fish skin craft was not one of them. The workshop sought to draw attention to the vital importance of salmon to the Ainu, not only as a food resource, but as the basis of their culture and a component of their identities. In particular, local craftspeople in Nibutani were encouraged to reintroduce this craft used by their ancestors, for its preservation and for the promotion of community development. The workshop was taught by a local craftsman to a group of higher education students to ensure the continuity and sustainability of fish skin traditional skills. The project was developed as a design practice exploring the traditional fish skin material, promoting new uses, examining the process and implications of design practice within local communities. The objective of the project was to equip the students with skills, such as 'purposeful learning', to preserve the Ainu fish skin tradition.

Participants

The project worked with 10 undergraduate students in fashion design from Kyoto Seika University, Osaka Bunka, and Tokyo Bunka Gakuen, two Japanese craftspeople, three fashion design tutors and a film director. Other members of the team were Mitsuhiro Kokita, head of the fashion department at Kyoto Seika University, Akira Sugiyama, head of the Osaka Bunka fashion department and Joseph Boon, a recent CSM graduate who participated in the creation phase. Joseph contributed with his knowledge of fish skin tanning, acquired during the last year of his degree. He learned about traditional fish skin to create his own material for his final year fashion show by experimenting with different types of fish skin waste that he obtained free of charge from the Billingsgate fish market in London. He demonstrated true arctic inventiveness by finding the coastal fishing community in an urban environment and using every scrap of the fish, at no economic cost.

Shigehiro Takano and Keiko Takano

Mr. Takano is not Ainu, but he holds the knowledge of the Hokkaido Ainu As a young man he

Figure 7.6. Ainu ceremony. Kayano Shigeru Nibutani Ainu Museum. Nibutani, Hokkaido, Japan, 2018.
Figure 7.7. Salmon boots. Hokkaido Museum, Sapporo, Hokkaido, Japan, 2018.
Figure 7.8. Fish skin mittens. Hokkaido Museum of Northern Peoples, Abashiri, Hokkaido, Japan, 2018.

hitchhiked from Tokyo to Hokkaido, where he learned about Ainu culture and became obsessed with it. He convinced his wife Keiko to come and live in Nibutani. Since then, they have spent their lives learning about the Ainu culture and are also trying to keep it alive. They have mastered more than 200 of the over 400 traditional Ainu crafts documented and preserved by Shigeru Kayano, the most influential figure in the preservation of Ainu culture. During the workshop, Mr. Takano gave several lectures on traditional Ainu handicrafts and taught us how to make a salmon skin boot. He participated in museum visits to introduce the students to the Ainu fish skin artefacts in the Nibutani museums. Keiko Takano taught the students how to make the laces and thread for sewing the boots from the fibres of the female red berry vine "Tsurume-modoki", collected in the village of Nibutani.

Kenji Sekine and Maki Sekine

Kenji Sekine was born and raised in Takarazuka (near Osaka). He stopped in Nibutani, Hokkaido (where 80% of the inhabitants are of Ainu descent) thirty years ago while on a cross-country bicycle trip, and never left. He married Maki, an Ainu woman who teaches Ainu decorative needlework at the Nibutani Museum of Ainu Culture, and whose mother, Yukiko Kaizawa is one of the last elm bark weavers on the island of Hokkaido. Kenji became so involved in the community that he now devotes his life to reviving Ainu, a critically endangered language of which there are hardly any native speakers left. Having become a self-taught, fluent Ainu speaker, he now teaches the language to children in the village. He also runs educational radio programmes in Ainu. The revival of their language remains one of the crucial issues for the Ainu people. Kenji Sekine works at the Nibutani Ainu Culture Museum, where the workshop was held. Kenji collaborates with local craftspeople to give practical seminars on traditional Ainu crafts, such as wood carving and sewing, which are held in traditional Ainu or Chise (Figure 7.15.) houses on the museum premises. In 2018 Kenji collaborated with me on creating the first fish skin tanning workshop with Shigehiro Takano and Keiko Takano. Maki Sekine gave a lecture of Ainu decorative sewing, and we were able to witness Yukiko's Ainu's ancestral elm bark weaving from the processing of the bark, the natural dyeing and the weaving on the handmade loom.

Workshop location

The remote location of Nibutani in Hokkaido was chosen as an inspiring environment to test new learning experience methods and to help preserve the fish skin craft within the Ainu Ethnic minorities by communicating it to the Japanese Fashion students.

The Nibutani Ainu Culture Museum is situated within a series of tourist villages created in the 1960s as part of the ethnic tourism encouraged by the Japanese for economic development. Japanese headlines at the time incorrectly branded the Ainu as a dying race, which fuelled an already growing touristic interest. The Nibutani museum was created to invigorate Ainu culture and identity, and facilitate its preservation and transmission, while providing new employment

Participants	Expertise	Provenance
Researcher	Lecturer in Fashion, Textiles and Sustainability with experience as fashion designer in the luxury industry, enabling a process of embedding sustainability within educational programmes.	UAL
Tutor	Lecturer in Fashion, with experience as fashion designer in the fashion industry.	Kyoto Seika, Osaka Bunka
Student	Higher Education students with previous background on sustainable fashion and textiles, alternative materials, and environmental activism.	Japanese Fashion Universities
Craftsperson	Carrier of Indigenous fish skin heritage Expert on fish skin tanning technology.	Hokkaido, Japan
Museum curator	Museum curator's expert in fish skin artefacts, with experience in working with crafts communities.	Hokkaido, Japan

Table 7.1. The diverse roles and skills of the participants in the Ainu fish skin workshop study.

and a sense of community. The museum holds a collection of more than 1,000 everyday Ainu items and, in terms of diversity, one of the largest collections in Japan. Some have been reconstructed, but almost all were actually used in the region; many are believed to be from the Meiji and Taisho periods over 100 years ago. According to Kenji, "there is almost no other place where you can see utensils of this type that were actually used in the region".

Workshop programme

The programme consisted of preparation, implementation, evaluation and follow-up phases. Students learnt traditional Ainu fish skin craft to integrate in their own fashion practice. The workshop lasted five days and included:

- A sustainability background introduction based on this thesis literature review which aimed to address the research objective 1.1. To assess the literature on the historical use of fish skin drawing on anthropological texts to explore the material and its cultural sustainability.
- A lecture on historical fish skin artefacts in international museums. Aimed at addressing the research objective 1.3 To analyse artefacts considering the cultural, environmental and socio-economic context of fish skin.
- An archival research at Nibutani Ainu Culture Museum and Kayano Shigeru Nibutani Ainu Museum to study traditional fish skin artefacts which aimed addressing the research objective 2.3 The analyse artefacts considering the cultural, environmental and socio-economic context of fish skin.
- Workshop on fish skin tanning methods and how to produce a traditional salmon Ainu boot or - 'cep-keri' -to test ideas through teaching and learning, observing students' design approaches with fish skin as an alternative material for fashion. This aims to address the research objective 2.2. Document and learn from the Arctic Indigenous peoples' fish skin traditions and processes, so the tradition does not get lost.
- Sketchbook development. Using a range of techniques such as photography of fish skin

artefacts, research into different fish skin Arctic communities, illustration and design development. Sketchbooks provided a visual repository collating all the information.

- A documentary was filmed during the workshop, featuring interviews with students, curators and craftspeople to observe students' development of fish skin finishes as a form of design research. This aimed at addressing the research objective 2.3. Explore how fish skin craft as material and practice can contribute to sustainability in fashion. This documentary includes informal interviews, audio recording and photography of the students, craftsmen and curators involved in the workshop. The documentary can be viewed here: http://www.fishskinlab.com/28/projects/ainu-fishskin-craft-workshop
- The workshop used skins from salmon we bought in the Sapporo fish market. The salmons are by-products of the food Industry and have not been farmed for the sole purpose of the fashion use. They are not an endangered species.

Sustainability Background Introduction

The group was briefed at an introductory session, providing inspiration and a basic outline of the ethics and sustainability of fish skin. Another objective was to place this project in the frame of alternative fashion sustainable materials. In order to adhere to this strategy, a comparative study of different leathers and fish skin was made. Suggestions for further reading and research were given to students, but the focus here was fish skin, a raw material that has been used by Ainu Indigenous Peoples to produce their clothing and accessories for centuries.

Visit to Museums

During our trip, we visited many museums: the Hokkaido Museum, the Historical Village of Hokkaido, the Nibutani Ainu Culture Museum and the Kayano Shigeru Nibutani Ainu Museum. The Hokkaido Museum and the historical village at Sapporo gave us a little history about the Ainu but focused mainly on how Hokkaido changed during the Meiji period (1868-1912). The Nibutani Ainu Culture Museum was incredibly informative about their rich culture and its close relationship with nature and it shamanistic belief system. The Shigeru Kayano Museum was crucial for the understanding of Ainu modern culture. In 1994, Shigeru Kayano became the first Ainu politician in the Japanese government. During his 4 years of service, he supported and encouraged domestic and international media coverage of the Ainu cause. He established the Shigeru Kayano Museum and gathered everyday Ainu objects as a repository to a wealth of domestic and industrial artefacts. Shigeru Kayano's grandson, Kimihiro Kayano, runs a guest house in Biratori where the Ainu's identity and language are kept alive. We had the possibility to stay at Kimihiro's guest house and we interviewed him for our workshop documentary. We also learnt from Kimihiro that Shigeru Kayano had once held a symposium for a selection of minority ethnic groups from around the world. This provided me the inspiration to create a conference and workshop on fish skin craft that was held in Nibutani

in March 2022 with Arctic Indigenous Peoples from around the world. We also viewd fish skin garments, both Ainu and from the Hezhe. It was very encouraging to see that these cultures had been in contact with each other. In fact, one of the Hezhe fish skin robes in the museum was made by Wengfen Yu, the Hezhe fish skin artist who taught the fish skin workshop in Northeast China. The tangible creation of a multicultural network is not only extremely encouraging but testifies the validity of this project.

Fish skin tanning

- We started working with the frozen salmon, now headless, without pectoral fins and guts (Figure 7.9). We cut the tough part of the skin of the fish adjacent to where the gill cover had been, and then cut right through the centre of the fish (figure 7.10), along its belly (ventral side) to the tail, leaving the anal fin on the right or left side. Part of the cutting was done earlier, when the fish was gutted.
- We cut up and around the fish just before the caudal fin to enable its removal when peeling. From where the head had been, we pushed our fingers delicately (Figure 7.12.) but also with some force, between the skin and the muscles of the salmon. The aim is to remove the skin without taking off the flesh but to do so entirely was difficult.
- After pulling off both left and right sides of the skin, we severed the dorsal (top) fin from inside the skin where it attached to the body of the fish. This left us with a kite shape salmon skin, all the fins intact except the caudal (tail fin).
- Next, we removed any residual flesh from the skin, especially near the fins and along the edges. In order to do this, we used a simple hand scrapper, making sure not to tear the skin with the corners of the scrapper as we pushed the blade away from us.
- The skin was then washed under cool running water.
- The skins had to be stretched prior to smoking.
- Four to six holes were made on each side using an awl, depending on the size of the skin.
- Wooden skewers larger than the width of the skin were sharpened at either end, and inserted horizontally into the holes creating enough tension to maximize the surface area exposed to the smoke (Figures 7.13. and 7.14.).
- The skins were then smoked for 3 days. This was not ideal; the optimum time is at least 10 days (Figure 7.15.).
- The meat of the salmon was given to Mr. Takano's and Kenji's family. From the salmon meat Kenji's mother-in-law created a number of delicious Ainu dishes for us to eat throughout our stay in Nibutani and was able to provide from this also food for the community. Everything was used, nothing went to waste.

Shoelaces

- Shoelaces, and thread to sew the shoes were then made from the fibres of the female,

Figures 7.9., 7.10., 7.11. and 7.12. Peeling off the salmon skins, 2018.

red berried 'Tsurume-modoki' vine tree (Figures 7.17. and 7.18.), collected from the Nibutani village.

- The bark was removed, and the fibres were peeled from the wood beneath (Figure 7.16.). The female vines, less knotty and rough, are preferred to provide maximum length strips of fibre to be woven together.
- To make the yarn or 'kaeka', the fibres are heated in water, and they turn green.
- Mr. Takano told us in the winter, when the shoes are traditionally made, the fibres are placed in the snow to cool, and the green colour disappears.
- Keiko Takano took over the next day as 'kaeka' is traditionally a woman's job. She explained that in the past, Ainu grandmothers were always making thread, whilst chatting with friends or out and about. For our visit, it took two weeks of 8-hour days to prepare enough fibre to make the thread to sew twelve shoes.
- Traditionally, during 'kaeka' the thread was held between the teeth so both hands were free to twist the fibres. We taped the thread to a table to provide similar tension.
- The dried brown fibres were rubbed together by hand in order to get rid of the dust.
- Then they were straightened out and detangled.
- The longest fibres were selected and divided until they were 1 or 2mm wide.
- The first fibre was folded in half to give two strips, then from the folded end, it was twisted to create a thread.
- The twisting technique may seem simple enough, under and over, under and over, but the tension must be accented in the fibre moving under from the left to the right, in order to keep the thread straight.
- When either the right or left side ran out a new piece was intertwined (not knotted) to extend it.
- Two 2m lengths were made by each student (Figure 7.19.).
- The shoelaces were made of three threads plaited together or a plaited hessian rope.
- Deer tendons were soaked and hammered to divide their sinews. This produced an extra strong thread used at key points on the shoe - to hold the two sides of the fish skin in place at the front of the shoe, and to create the turn up of the toe.

Making the salmon boot

- After the fish skins were smoked in the traditional Ainu house we rinsed them in cool water again to make them soft and malleable, ready for folding and stitching.
- Two skins were used to create the shoe: one for the sole and the other for the tongue/top.
- A last (wooden foot shaped mould) (Figure 7.20.) was placed in the centre of the fish skin used for the sole, with the dorsal fin external and in the middle of the bottom of the shoe (Figure 7.21.). The dorsal fin was used to provide traction for the shoe in the snow.
- The broadest end of the fish forms the toe, and the tail end forms the heel of the shoe.
- The right side of the fish skin folds to cover the toe, then the left side follows, overlapping to

Figure 7.13., 7.14. and 7.15. Smoking the salmon skins with Shigeharu Takano at the Chise (Ainu traditional home), 2018.

Figure 7.16, 7.17., 7.18. and 7.19. Shoelaces made from the fibres of the female 'Tsurume-modoki' vine tree, 2018.

create a cover for the toe of the mould. The skin that extends beyond the mould then folds back to form the front of the shoe (Figures 7.22. and 7.23.).

- These three folds were then tacked in place twice using the deer tendon sinews thread.
- The second fish skin was then cut into a rectangle shape with the edges folded in for extra strength.
- Sharp bone needles were used traditionally to sew the shoe together. We used an awl with a threading hole.
- One end of the second skin was placed over the toe of the shoe and the other extended up to and above the front of the ankle. This strip was then pinned temporarily at the front corners and sewn into place, attaching the first to the second skin.
- As the skin layers up, especially towards the sides, use of an awl is necessary to make the holes which enabled the thread to pass through the thick layers of skin. Attaching the two fish skins together requires roughly only 18 stitches 6 stitches in the front, and 6 either side of the shoe (depending on its size) (Figure 7.25.).
- For the heel, the tail end of the fish skin at the back and the side of the mould is folded upwards, and the excess skin folded inwards down the sides of the mould and held in place with a cross stitch.
- The long shoelace (Figure 7.27.) was tied around the middle of the shoe, from where it went around the ankle, above both the pelvic fins on the sides and adipose fin on the heel. Finally, the lace comes forward again, and a bow is tied at the front of the ankle.

Sketchbook development

The workshop included a training on sketchbook development. Students documented the journey and workshop through observation in sketchbooks with drawings, research images and design process. On the last day, we held a critique where the students presented their fish skin shoes, research, and design development to Ainu craftspeople and museum curators.

Conclusions

The workshop and fieldwork in Hokkaido formed an excellent multifaceted experience. We were able to meet fascinating artists. We were privileged to meet Japanese scholars who were incredibly dedicated to preserving this unique culture, not their own as well as a number of other Ainu scholars who are preserving additional Ainu crafts. As an international group of students and teachers we gained much practical and historical knowledge from the workshop.

Feedback from participants, artists and museum curators suggests that the dissemination of the fish skin knowledge and skills was of great relevance and pleasure to them, as was the immersive experience at the Nibutani village. This activity managed to inspire deeper relationships between the students involved, between the students and the Nibutani community with their environment. Students were eager to learn about their own national traditions and to see how they could contribute to solving

Figures 7.20, 7.21, 7.22, 7.23, 7.24 and 7.25 Sewing the salmon boot, 2018.

Figure 7.26. Ainu Fish skin workshop participants, 2018.
Figure 7.27. Finished Ainu salmon boot, 2018.

the problems that these communities are facing. These solutions include economic development, gaining control over their land and fishing rights and language and cultural revival. Artisans were thrilled of the cultural exchange as well as the preservation of their ancient fish skin traditions.

The research process culminated in an event involving the fashion students, tutors, craftspeople and the local community at the Nibutani Ainu museum to share the workshop findings and results: the sketchbooks and final Ainu traditional salmon skin boots. Members of the Nibutani Ainu community and Hokkaido Ainu community participated in the critic. The outcomes of this project could impact a diverse range of beneficiaries from Arctic Indigenous communities, educators, students, researchers, creative practitioners and fashion designers. Ainu Indigenous Peoples could benefit from the preservation and dissemination of their fish skin cultural heritage.

Figures 7.28. and 7.29. Ainu fish skin sketchbook workshop, 2018.

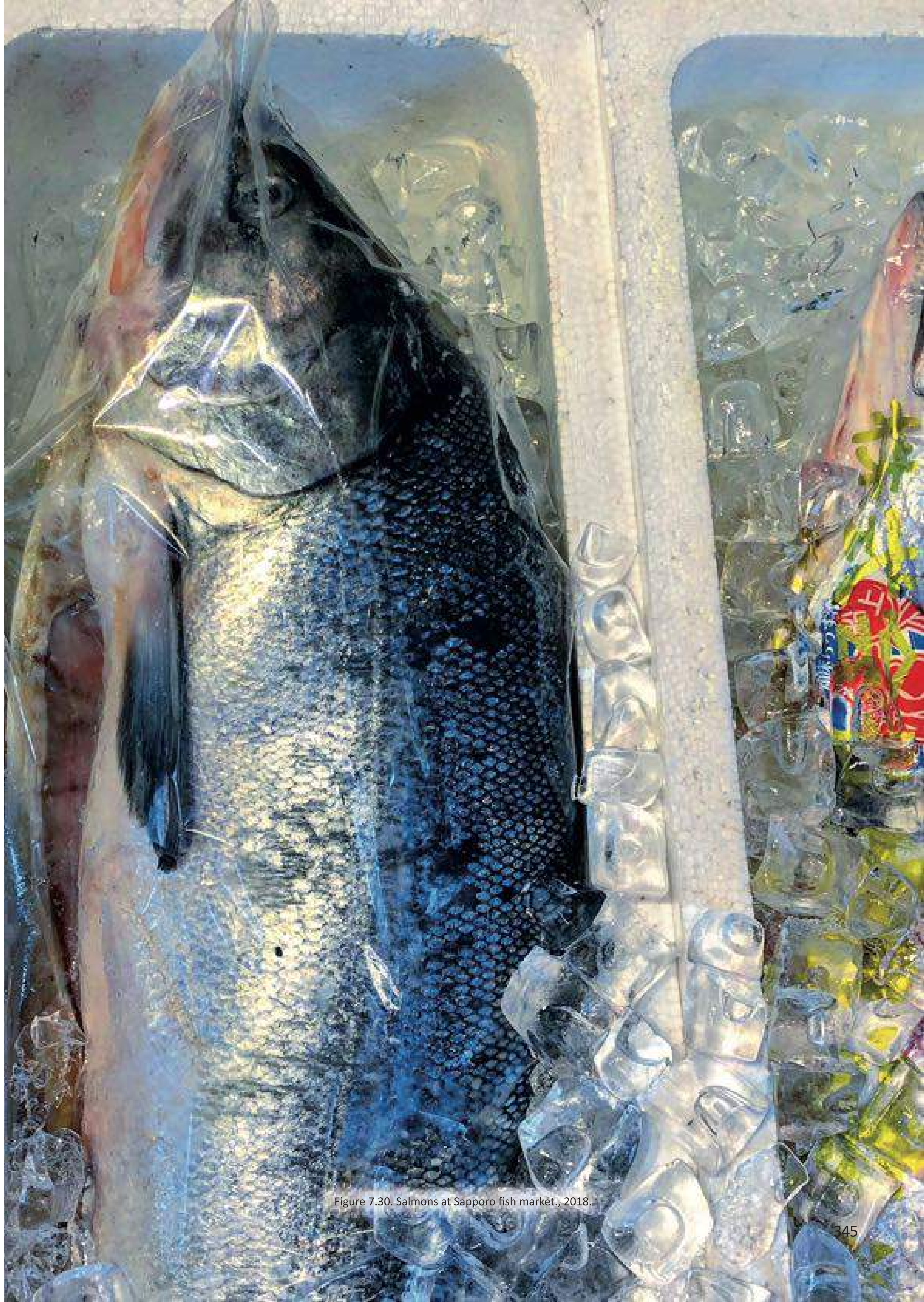


Figure 7.30. Salmons at Sapporo fish market., 2018.

7.5 Fish skin tanning workshop survey

After the four fish skin workshops have been executed, a general survey regarding the outcomes was developed and distributed via email to all students who had participated. The survey was also sent to the members of the Facebook fish skin community, an enthusiastic group of amateur fish skin tanners, museum curators, university professors, researchers, Alaskan Elders and professional book binders. The survey was conducted from 15 December 2020 to 20 January 2021, and involved a mix of multiple-choice and open-ended questions. In addition to the survey, follow up conversations helped to clarify input or complement survey results. All the participants responded eagerly to the survey. The full survey is located in Appendix IV.

7.6 Fish skin tanning workshop survey results

Summary

In this report I have analysed the most relevant responses from the fish skin survey I conducted to find out the impact of the workshop on the participants. In order to analyse the data in the most practical and effective way, I have taken into account the most pertinent questions to make the results as relevant and realistic as possible and to get a complete picture of what the participants enjoyed or disliked.

Methods

The main software I used to analyse the data was Tableau public, which provides a wide range of functions to create graphs based on qualitative and continuous variables. In addition, I also used R, which is a programming language that provides a wider range of functions than Tableau when dealing with numerical information. Finally, to be as comprehensive as possible, I created word clouds that conveyed the main ideas of the questions that had the bulkiest text and that could not normally be analysed with any of the previous programmes. To do this, I used Tag crowd[1] which allows you to paste data from your data frame and develops a word cloud that removes any words not relevant to your research. To keep the graphs clean and clear, I chose the ones that could be easily interpreted at a quick glance, such as bar charts, maps, pie charts and word clouds. I also made sure to insert different colours in those graphs where the visualisation was less clear and made sure that the size was in line with the data provided.

The dataset I used was the answers provided by the Google forms survey, which I converted to "csv" so that I could manipulate it with the different programs.

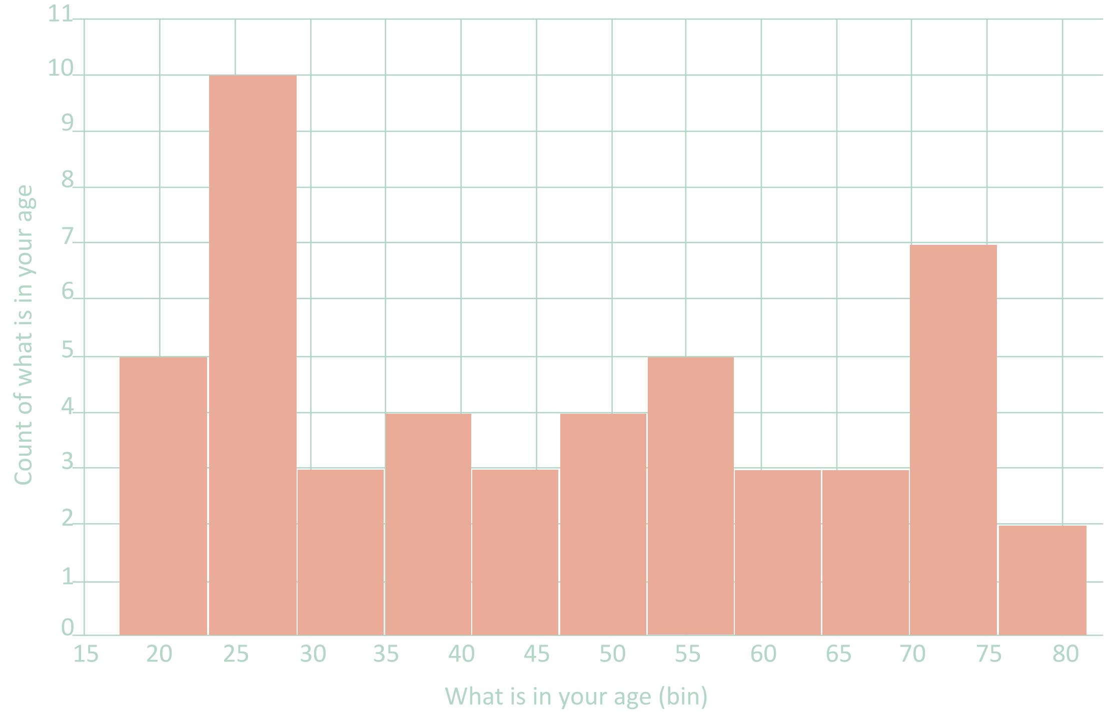
Data analysis and graphics

51 individuals participated in this survey, which provided a wide opportunity to find out plausible and realistic answers about their feelings towards the fish skin workshop.

1 ttps://tagcrowd.com

What is your age?

The average age of respondents was 46. According to this graph, the most common age was between 23 and 30 (10 individuals) and between 70 and 75 (7 individuals). As we can see from this bar chart, there is a wide range of ages in the survey, which makes it a very plausible and realistic survey experience.



What is your country of residency?

This map graph clearly depicts the country of residence of the participants. To make this

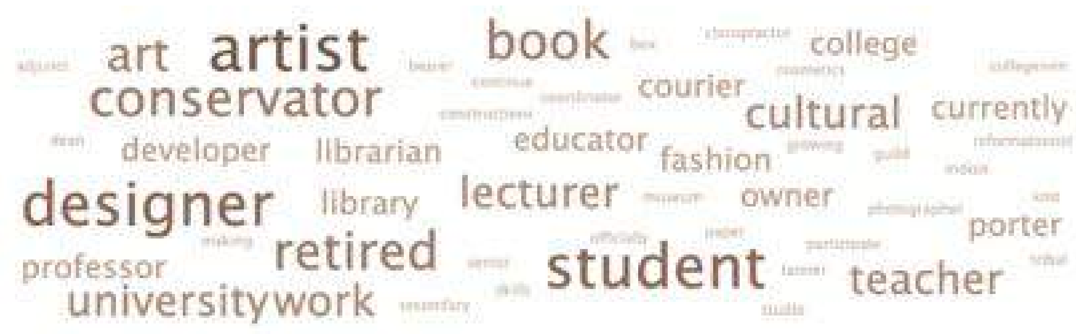
graph easy to read, there is a spectrum of colours ranging from lighter blue (meaning fewer individualsin these countries) to darker blue (meaning there is a higher concentration of people from these countries). Respondents came from all over the world, but there is a higher concentration of respondents residing in the United States (Alaska) and Japan.

What is your education background?

For this question, I developed a word cloud that summed up the key words the participants had submitted. The visualization in this graph is quite simple. The larger the font of the word, the more participants put this answer. Consequently, the most popular education background was BA fashion, design, and art.

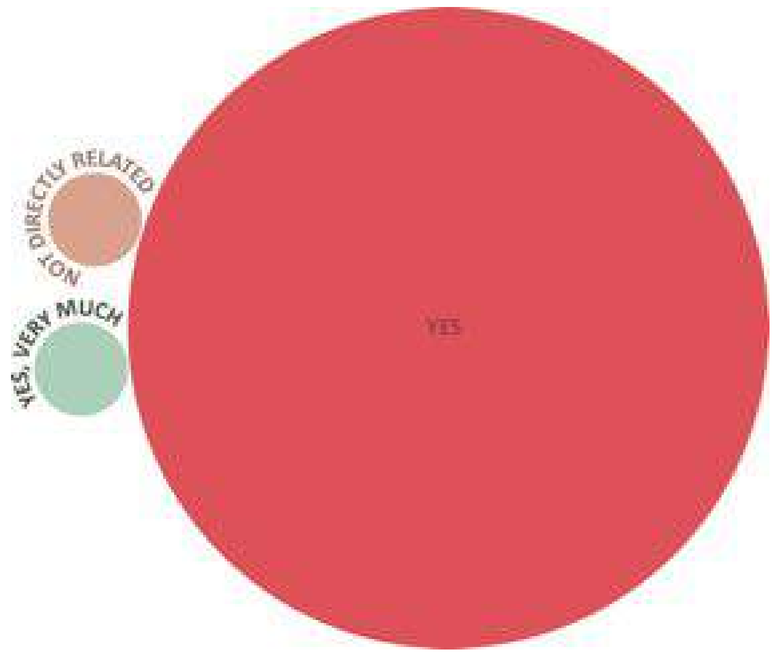
What is your occupation?

The most popular answer was artist, designer or student. The answer differed according to the age group. The best graphic to use was a global cloud in which the main occupations provided by the participants could be easily represented.



Did you enjoy the workshop?

In this graph, we can clearly observe that the most common answer is "yes" with 47 of the 51 respondents choosing this answer. This means that 94% of the participants enjoyed the workshop.

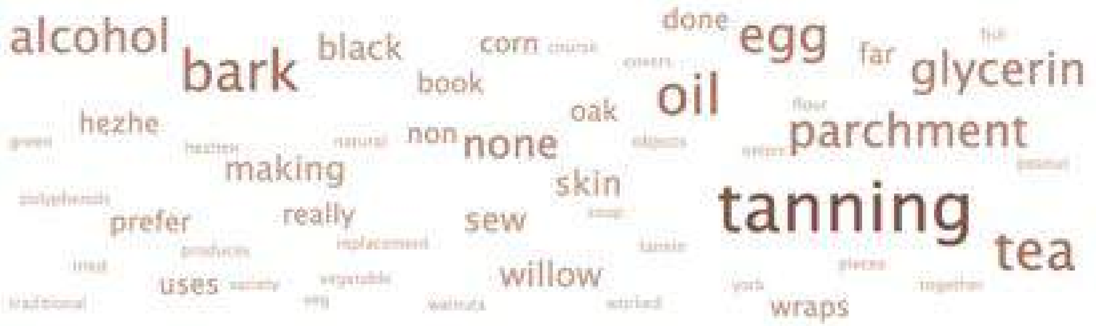


Which fish species have you tanned since you took the workshop?

The most popular response was salmon, followed by trout. However, one of the most important aspects of this analysis lies in the geographical location of the participants and the fish species available to them.

Which tanning techniques have you used since you took the workshop?

The most common answer to this question was bark, glycerine, oil and alcohol.



What is your favourite fish meal?

As in the previous graph, the responses were very different. However, the most common food was salmon along with grilled fish and sushi, sashimi or any other fish that can be eaten raw. However, two respondents claimed to be vegan, so they did not eat fish. This kind of variety in the responses gives us a much broader spectrum of the respondents' cultures and nationalities.

What was the thing you enjoy at the least?

The most common answer was the skin, followed by nothing and the fish. Other relevant answers were the smell and softening the skins.

What was the most valuable thing for you about this workshop?

The things that individuals enjoyed most, according to these responses, were learning, the process, working with the fish and skin, and the tutors.

7.7 Emerging themes from the Fish Skin Workshops

The four workshops provided the students with field experience and the necessary skills for tanning their own fish skins. The experience left a significant impression on the students. The reality of climate change and its effects on the Arctic and Subarctic areas where the workshops were delivered became particularly apparent through our conversations with local community members. The design experience in such remote environments inspired students and allowed them to explore a wide range of interests while learning how to develop new materials. The workshops enabled students to explore different fields related to Arctic fish skin crafts in a dynamic environment. As the workshops concluded, students reflected on their experiences and what it meant to them. Several reported that the experience sparked their interest in pursuing research about sustainable materials, the environment and climate change. Some of the workshop participants did not define themselves as sustainable designers, but they all acknowledged that after the workshops their work was much more sustainably focused, and they expressed their will to develop much more sustainable materials and practices in the future. The workshop used concepts of sustainable fashion in a process of learning to better produce one own sustainable materials. After the workshops, several students remained engaged through advocating for non- waste practices. Three of the participants chose to use fish skin for their graduate collections.

Using fish skin material and processes to give voice to their ideas, allowed the students to create a range of fish skin samples. None of the participants had worked with fish skin before and they felt the material was rich and versatile. The key findings from the questionnaire verified that students would be likely to use fish skin in their work as an alternative sustainable material. Some recurring themes identified included taking pleasure in using their hands, discovering the raw materials origin, a delight in embracing new experiences, a willingness to collaborate and a broadening of their skills to address social issues. Analysed data suggests that the participants were happy to learn new handcraft techniques and to incorporate them into their own practice. Through their work, students attempted to raise awareness of local environmental issues and minority inequality and ethnic rights.

The skin processing technology studied during the four different workshops showed that they differ between each Arctic Indigenous group. The Saami ethnic minority in Scandinavia tan fish skins using a bark solution made from boiled sallow bark or using rape seed oil, egg yolk and soap for oil tanning. The Ainu in Hokkaido, Japan stretch the skins first and then smoke them for five days inside their home. Hezhe Indigenous Peoples use cornmeal to soak up the fish oil and a large wooden scissor-like instrument to mash and soften the skins. Inuit in Alaska use urine, fish roe, bark, or brains to tan their skins.

After each workshop, I shared the results and further outcomes via email and social media with all the students and craftspeople, as an additional means to keep them engaged in the ongoing study. During my fieldwork around the Arctic, I have given talks in museums, schools and universities sharing all the knowledge I have gathered. In the aftermath of the Hezhe's fish skin workshop and the subsequent Milan Fashion Film Festival winning documentary, Wenfeng You and Yulin Sun have received international recognition for their work. After the Nordic fish skin workshop, I continued a close collaboration with the Swedish tanner Lotta Rahme, writing together three articles and presented papers at four conferences. As a result of this collaboration, Lotta now holds an honorary position at Gothenburg University and has received the title of Swedish Master tanner from The Swedish Craft Council. In 2019 Swedish traditional tanning techniques were

registered as intangible cultural heritage in Sweden thanks to her endeavours. June Pardue has taught over 200 fish skin workshops since the first one we taught online and now holds a position as Associate Professor of Alaska Native Art History at the University of Alaska Anchorage UAA.

The collaboration and cooperation of different Artic universities and professionals provided a key element in the project. This is a fine example of an innovative way of linking the preservation of traditional knowledge and culture to the development of culturally relevant programmes for students, with community involvement, and conservation of resources. The workshops provided a case study for working across Arctic universities to develop their cultural identities and foster narratives of social sustainability. The cross-disciplinary project has created a new structure to demonstrate how much Arctic communities have in common with each other in their traditional use of fish skin. They share a profound awareness of the natural world linked to livelihoods, great creativity and aesthetic design sense, as well as problem-solving skills, effective support networks and the resourcefulness required to thrive in complex ecosystems.

With the improvement of living conditions and the impact of external cultures, the lifestyle of the Arctic Indigenous Peoples has changed. They wear readily available clothes from the stores rather than their traditional handmade fish skin garments, except as special occasion attire. Indeed, the process of this traditional art is so complicated that it is difficult to accomplish without specialized training and it is highly time consuming and labour intensive. This will hinder the inheritance of the craft. As market goods have replaced traditional clothing, the needs for the skills required to create these remarkable items have diminished, making it difficult or impossible to observe ethnographically the construction of traditional fish skin garments. The students participating in the workshops have been amongst the few still to be able to witness this almost extinct craft.

Challenges

The case studies highlighted that the creation of new materials also involved students in facing many difficulties. Working in challenging circumstances such as the harshness of the weather, isolation, and limited availability of materials formed a unique source of creativity and inspiration during the workshops. Since these took place in resource-scarce contexts, technical barriers also emerged such fish skin being the only available material, compelling students to think creatively and seek new design possibilities. Students created innovative design solutions from fish skin. Eco-consciousness played a fundamental role in the students' designs using remnant materials.

Working with vulnerable participants such Indigenous Peoples who during the last century have resisted both colonisation and repression, necessitated tact, empathy and the ability to build trusting relationships. Through this project I have been fortunate to foster a distinctive relationship with these Arctic communities, sharing the knowledge that I previously gathered in workshops across the circumpolar region. Finding ways to give back to the Arctic communities to which the fish skin knowledge belongs is of high importance to me. Fashion has been blamed for constantly taking inspiration from Indigenous communities, from materials to designs. Fish skin knowledge sharing has the potential to be detrimental. Through this process there were concerns around cultural appropriation. I mitigated these by openly discussing the use of fish skin by the students in a respectful manner. I have created a 'codes of conduct for Fish skin tanning workshops ' included in chapter 2 where I propose a series of recommendations for building collaborations addressing culturally sensitive issues around traditional knowledge (TK) of fish skin practices. The workshops and the research behind them are an attempt to preserve and protect the fish skin crafts from Arctic Indigenous communities. The workshops have been envisioned as the beginning of a continuing and expanding discourse on the future of fish skin craft. Collaboration with Indigenous partners has enormously enriched my understanding of this material. The experiences gained continue to guide and inform the methods and attitudes I used and will continue to use working generally and with Native communities.

Table 7.2 displays some recurring themes identified during the workshops gathered from participants' feedback. The themes are informed by the conceptual framework drawn from the literature review and enriched by the initial methodological framework developed as an outcome of the Nordic, Ainu, Hezhe and Alutiiq fish skin workshops' case studies. The framework represents an approach to mapping the fish skin craft participatory practices with Artic Indigenous communities within a context, making sense of its contribution to fashion sustainability. The table displays the objectives to be achieved, as well as the challenges encountered and the opportunities to be taken into consideration for future work.

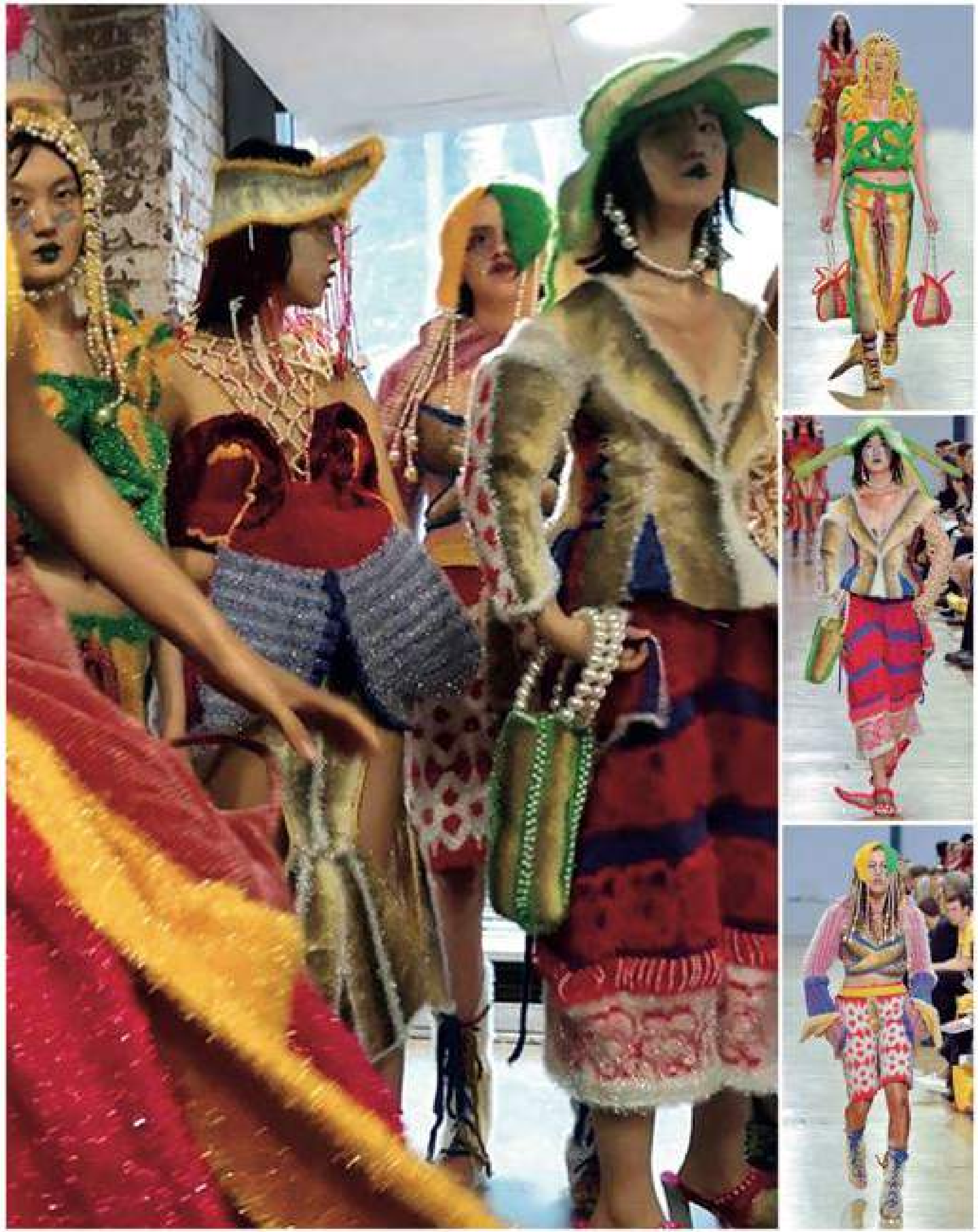
Themes	Students' feedback	Literature review
Objective 1.1. Assess the literature on the historical use of fish skin drawing on anthropological texts in order to explore the material and cultural sustainability.		
1.Raw materials origin	Students valued paying more attention to where our materials came from.	The use of alternative materials could lead to more regionally sourced materials (Fletcher, 2014).
2.Made by hand	Students felt pleasure associated with 'making' with their own hands a new material.	Slow design (Fletcher, 2016)
3.Time investment and new skills	Students valued the amount of work and skills placed on the production of self-tanned fish skins.	When people appreciate the skill level and investment of time in the making, it is valued more highly. (Walker, 2007)
4.Environmental benefits	Students valued producing fish skins without damaging biodiversity not using endangered animals.	Fish skins are sourced from the food industry, using waste (Sigfusson, and Arnason, 2017)
5.Environmental issues	Students developed an awareness of local environmental issues linked with overfishing and water pollution.	Sustainability education in fashion should connect people with nature (Fletcher, Williams 2013).
Objective 1.2. Conduct fieldwork, create focus groups and interviews investigating the importance of fish skin.		
6.New system of making	The fish skin material and tanning process fostered a shifting from consuming to creating.	Slow design (Fletcher, 2016)
7.Integration of sustainable design principles	Students learnt new methodologies and skills, creating an exchange with craftsmen. Participants chose to use fish skin for their graduate collections.	How to embody sustainability content in fashion HE practices. Williams (2013, 2015, 2016, 2018), Williams and Fletcher (2010, 2013)
8.Fish skin as a repurposed natural material	Students through their work appreciated the low environmental impact of fish skin, sourced from the food industry, using waste.	Using a greater number of small volume fibre types encourages fashion to diversify from other dominant fibres (Fletcher, 2019).
Objective 2.1. Create four fish skin workshops in different Arctic communities to carry out a cross reference study of the differences of the fish skin material between different Arctic indigenous people.		
9.Connection with communities	Students developed relationships with fish skin suppliers and craftspeople for the supply of raw material for their graduate collections.	Collaborative networks based on a new relationship with local resources and local communities Manzini (2010).
10.Community engagement	Opportunity for students to witness and engage with remote communities.	The role of design within crafts communities (Williams and Fletcher 2010; Manzini, 2010; Jegou, and Manzini, 2008).
11.Strengthening Arctic networking activity	Students valued the preservation their fish skin cultural heritage in areas with a history of fish skin production such as Iceland, Sweden, Finland, Denmark, Heilongjiang province, China.	There is evidence of historical fish skin production in Scandinavia, Alaska, Hokkaido, Japan, north east China, and Siberia (Jiao 2012)
12.Social Issues	Students developed awareness of Arctic Indigenous Peoples' equality and rights. Students broadened their skill set to address social issues.	Indigenous communities across the world, are still dealing with the effects of historic trauma from centuries of colonisation (Watterson, 2019).
Objective 2.2. Document and learn from Arctic Indigenous peoples 'fish skin traditions and processes, so the tradition does not get lost.		
13.Engagement with ancient stories and practices	Students engaged with ancient technology while simultaneously reframing what this sustainable material can offer them in their current fashion practice.	Historical methods of tanning fish skins made by fish skin craft practitioners: Wilder (1976), Issenman (1997), Oakes and Riewe (1998), Reed (2000), Rhame (2006)
14.Preservation of the Craft	Students participating in the workshops have been amongst the few to still be able to witness this almost extinct craft.	Better access to alternative materials has challenged the preservation of the fish skin craft (Campbell, 2010)

Table 7.2 Workshops emerging themes.

7.8 Workshop Outcomes. Case Studies: Students' final collections after the workshops

Maintaining momentum and sustaining the workshops results over time has been the main challenge faced by me and the participants, whose use of fish skin in their practice requires alternative funding or sponsorship. There has been some difficulty in assessing the impacts of some the participants' projects after leaving the workshops. To summarise the sustainable fashion education in practice through these workshops, I have attempted to describe the work of some of the students who have used fish skin.

These examples and are presented here not to the exclusion of the theoretical work, but to enrich it. These projects managed to encompass relevant sustainable and social issues as well as to elevate the humble fish skin, thereby reshaping its possibilities. The promising cases that have been mentioned here below, emerge from a continuous interaction between me and the students. The students, using their design strengths, their knowledge acquired on fish skin with the application of traditional tanning techniques and new technologies and their resulting material innovation, conceived and implemented these collections. The results were unforeseen.
Student Ran Graber's work is presented in the Appendix V of this thesis (paper 8). The paper "A virtual Ainu fish skin workshop during Covid-19 times" was part of the Global Fashion Conference 2021 (Palomino *et al.* 2021a). From April to June 2020, during the Covid-19 isolation, Ran Graber, a third-year student of Shenkar University, Tel Aviv, elected to study and remake a 19th century fish skin Ainu robe, under my guidance and that of Orit Freilich. This small project brought together workwear and artwear, utilitarianism and spirituality, ancient tradition/history, contemporary society, and future thinking. It bought together Tel Aviv, London, and Hokkaido during the Covid-19 isolation.



7.8.1 FONING BAO, BA FASHION CSM LONDON UK

Bao participated in the Hezhe fish skin workshop during the summer of her internship year. The experience was invaluable for her not only to discover an ethnic minority in her own country that she had been unaware of, but also to make the connections with the craftspeople who first introduced her to fish skin and later on provided her with the raw material, techniques and inspiration for her 2019 CSM BA Fashion Knitwear final collection. She decided to bring the fish skin ideas to her final collection and continue to develop the possibilities of it. Instead of tanning the fish skin by herself, she focused on studying the zero-waste concept of fish skin and how to use it in different ways. With her knowledge on fish skin craftsmanship and knitting, she built her final looks mixed with yarns and fish skin, no fabrics. The knit pieces are all hand knitted, and the fish skin pieces are all hand-linked by crochet.
As a sustainable knitwear designer, she restricted herself to the use fish skin and fully fashioned knit skills for her final collection. Knitting pattern pieces to shapes instead of knitting a sheet of fabric from which the pattern pieces are cut is a zero-waste practice just like zero waste pattern cutting (see chapter 2). This is not only more skilful and complicated but also has zero waste allocation. Zero fabric, zero cut and zero waste were the key points of her work. She used the fish skins in combination with crochet both in garments and accessories. The very humble material became all of a sudden playful and full of colour. She used the fish skins to make all her accessories as well (Figures 7.8.1 to 7.8.13). Her final show was featured at the end of the film 'Preservation of Hezhe Fish skin Tradition through Fashion Higher Education' which won the Green Fashion Film award at the Fashion Film Festival Milano. She was also selected as: L'Oreal Professional Prize, Green Trail Maison/0 Prize and The Mills Sustainability Prize. In 2020, she collaborated with the fresh juice company Innocent and a yarn company using their leftover yarns mixing them with fish skin and launched a series of hats for the bottles using knitting and fish skin.

https://www.baofoning.com/

https://www.instagram.com/baofoning/

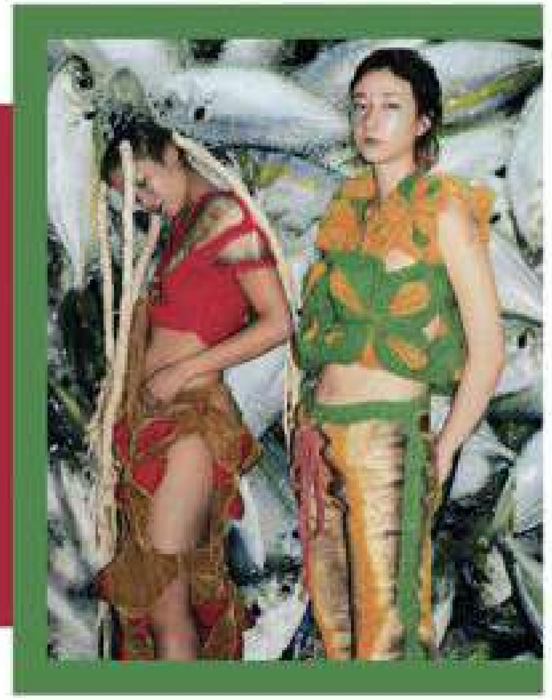
https://www.fashioncrossover-london.com/foning-bao-central-saint-martins-2019-i2028

Figures 7.8.1, 7.8.2., 7.8.3. and 7.8.4 Foning Bao. Central Saint Martins BA Fashion Knit final collection. Photographer UAL, 2019







Figures 7.8.5, to 7.8.13 Foning Bao. Central Saint Martins BA Fashion Knit final collection. Photographer Foning Bao, 2019

7.8.2 ANNA SOLVEIG PALSDOTTIR, BA FASHION POLIMODA FLORENCE ITALY

Solveig is an Icelandic student who graduated in June 2018 from Polimoda fashion school, Florence, Italy. Solveig's appreciation of fish began early. Her grandfather had a passion for recreational fishing and fishing fly-making. A fishing fly is a hook that has been dressed with pieces of feathers, fur, thread, and other materials to resemble a literal fly or some other small insect or fish. They are used to attract the fish's attention and lure it to the hook. Solveig's grandfather was a salmon fly dresser. He would create salmon flies, from the whipping of hook and gut together to the finishing of the head using wing-feathers, fur, silk and tinsel, prepared for forming the artificial insect. It is a work of great labour, and he greatly enjoyed the art of making artificial flies. He used natural materials, many types of fur (rabbit, fox, seal, and mink), hair (elk, caribou, and deer), and feathers (chicken, peacock, and marabou). Solveig's grandmother, who was the village teacher, was desperate to see her husband spending all her savings on buying feathers from the fashionable houses in Paris to create his fishing flies. All that magic and materials served as an incentive for Solveig to devote herself to fashion and the use of natural materials in her collections.

Solveig's father was a fisherman as a young adult. Atlantic cod (Gadus morhua) – from which virtually all salt cod is made, it roams the icy waters of the North Atlantic. Fishermen on both sides of the Atlantic have been eating cod since the earliest times. During the summer months he would fish Atlantic cod for the Basques. Solveig spent all her summers in her family house in Arnarstapi with a river at the end of the garden. The wildness of the area stirred Solveig's life-long passion for nature, the sea, fishing and fish skin.

After the Nordic Fish skin workshop with Lotta Rahme and, following her example of going back to basics, Solveig spent the summer curing skins in Arnarstapi. Her final year menswear collection (Figure 7.74.), inspired In Icelandic fisherman traditions, explored new ways of using fish skin in fashion. She mixed her self-tanned skins with traditional Icelandic cable knits (Figure 7.75.) and hand-embroidered pieces. For Solveig, this collection took her into new ways of working with novel materials and provided an opportunity to explore the connection to her own Icelandic culture and family fishing history (Figures 7.8.14., 7.8.15. and 7.8.16.).

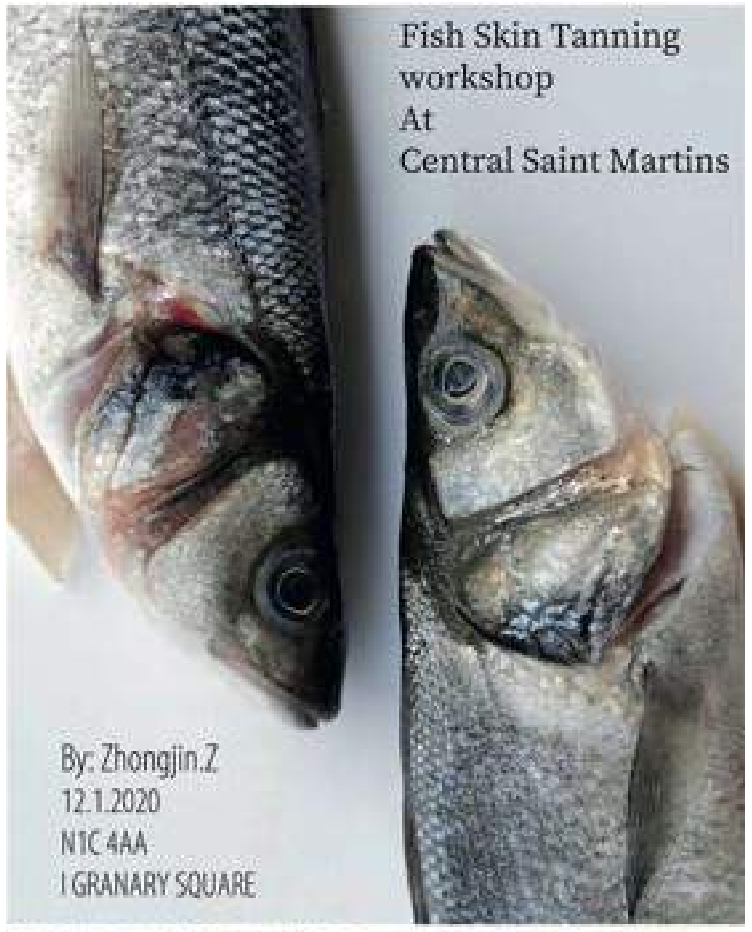
Figures 7.8.14., 7.8.15. and 7.8.16 Solveig Palsdottir. Polimoda final BA final collection. Photographer: Vogue Italia, 2018.

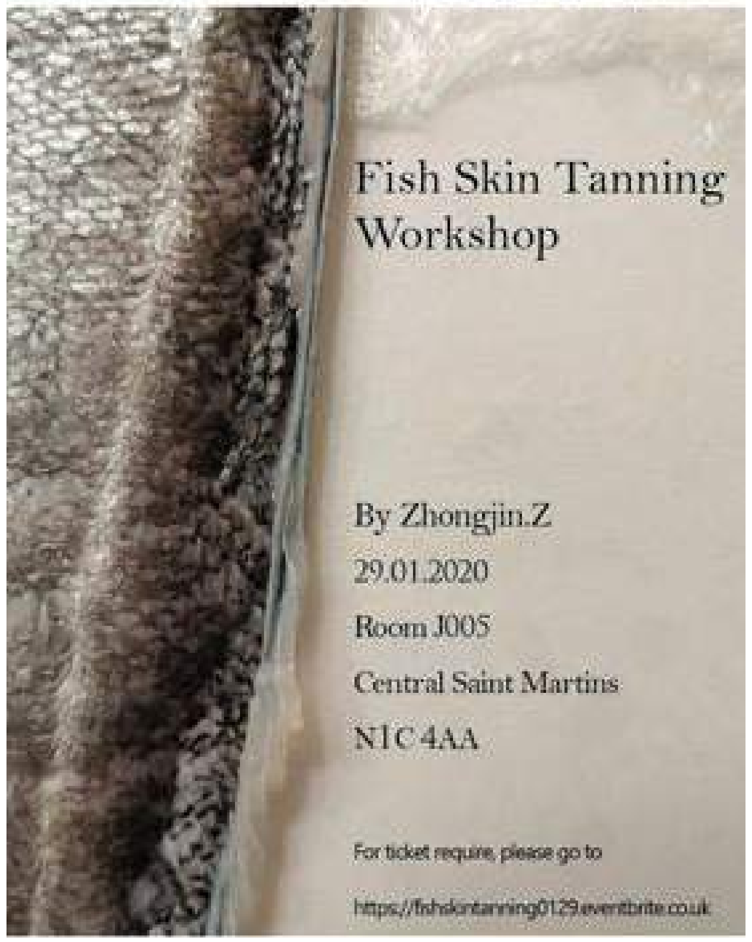
7.8.3 ZHONGJIN ZHANG, BA PERFORMANCE: DESIGN AND PRACTICE CSM LONDON UK

Zhongjin Zhang studied BA Performance Design and Practice at Central Saint Martins. He took part in the Hezhe fish skin workshop. He learnt fish skin tanning with Wenfeng You and fish skin painting with Yulin Sun. Returning from the workshop, gathering all the fish skin tanning techniques that he had learnt and experimented with, he has created his own brand, 'Tan your waste'. He has delivered several fish skin tanning workshops at CSM as part of UAL Climate Emergency events and as a response to the food waste generated daily by us all. His workshops are pop up events which are very popular and have brought a lot of curiosity amongst students across CSM and UAL (Figures 7.8.17. and 7.8.18.) https://www.eventbrite.co.uk/e/fish-skin-tanning-workshop-tickets-90589498629#

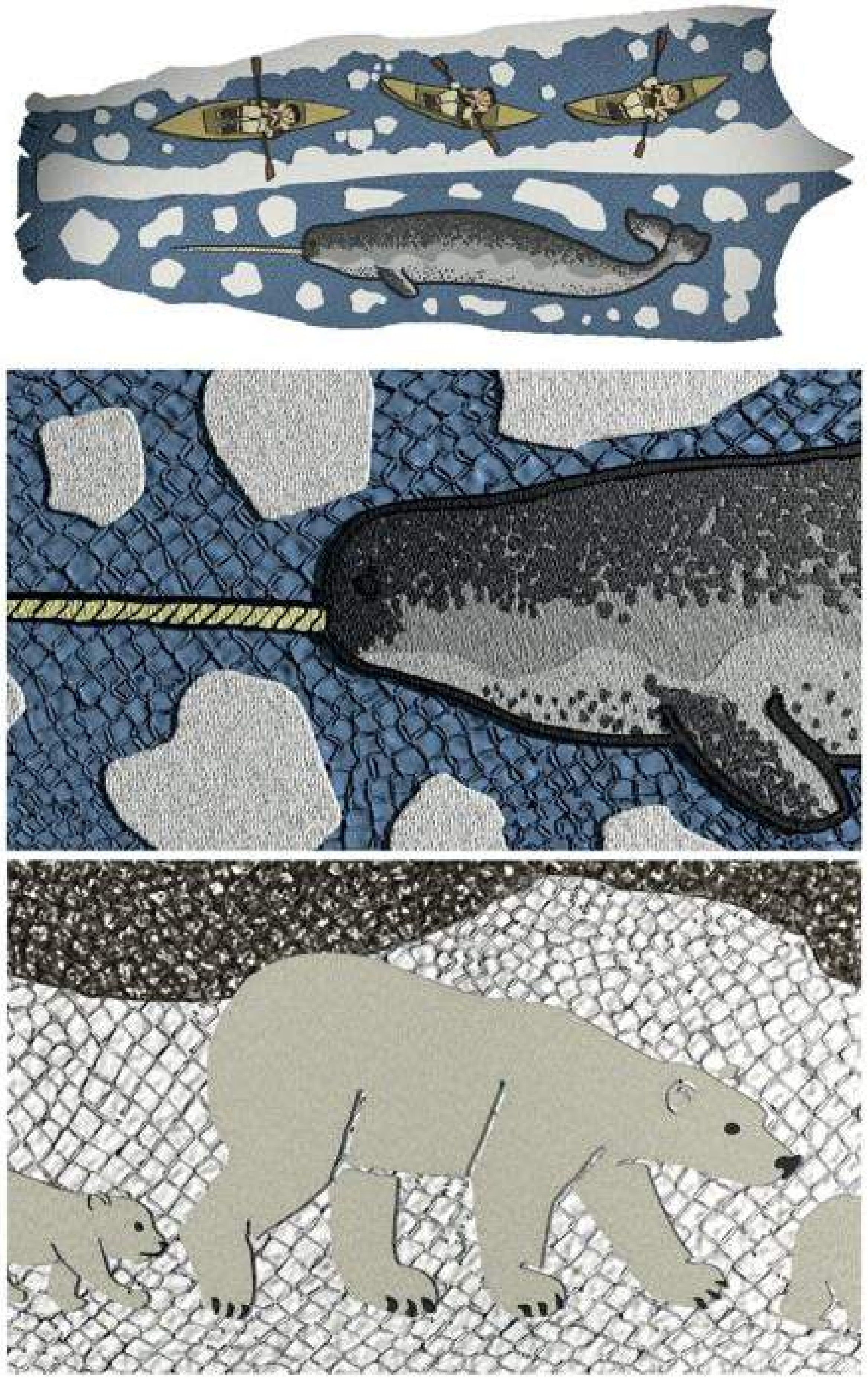
In 2019 and 2020 he held six workshops in the UK (UAL) and China (Beijing Institute of Fashion and Technology) to more than 30 students each time. He delivered a fish skin tanning workshop called 'Redesign the traditional fashion elements' at the Beijing Institute of Fashion and Technology. It was a 7-day workshop with 20 students. Students started by researching the Hezhe culture, the history of fish skin and their own inspiration, and developed a piece of their own work. All the fish used during the workshops was food waste from local fishmongers and the leftover flesh was donated to a stray cat protection organization. When doing fish skin tanning in London all the skins used by Zhongjin were recycled from local fishmongers. None of them were endangered species.
https://www.instagram.com/utikustudio/ https://www.xiaohongshu.com/user/profile/54e67011e7798919a1cb923d?xhsshare=CopyLink&appuid=54e67011e7798919a1cb923d&apptime=1607580341

Together with myself and Joseph Boon, he directed the film Preservation of 'Hezhe Fish skin Tradition through Fashion Higher Education' which won the Green Fashion Film award at the Fashion Film Festival Milano.





Figures 7.8.17. and 7.8.18. Zhongjin Zhang 'Tan your waste' fish skin tanning workshop. Climate Emergency, UAL. CSM BA Performance Design and Practice. Photographer: Zhongjin Zhang, 2020.



Figures 7.8.19., 7.8.20. and 7.8.21 Jonathan Katz. Use of 3D simulation to create fish skin embellished pieces. MA Illustration Royal college of Art. Photographer: Jonathan Katz, 2021.

Figures 7.8.22. 7.8.23. and 7.8.24. Jonathan Katz. Use of 3D simulation to re-create an Alutiiq fish skin parka from the Anchorage Museum. MA Illustration Royal college of Art. Photographer: Jonathan Katz, 2021.

7.8.4 JONATHAN KATZ, MA ILLUSTRATION ROYAL COLLEGE OF ART

Jonathan Katz is an MA alumni from the Royal College of Arts that I mentored during his final year collection. His final project creates a series of Arctic narratives, on how global warming and climate change affect those who inhabit the region. The circumstances of multiple lockdowns, restrictions and other limitations have deeply influenced Jonathan's work. It became clearer that although he is a very enthusiastic physical analogue maker, there were different (and perhaps better) ways to execute his visions and express his critical thoughts visually, while at the same time expand his image vocabulary.
In his works, fish skin and traditional making techniques have been adapted to virtual spaces (Figures 7.8.19., 7.8.20. and 7.8.21.). His use of 3D simulation bridges his practice as a visual creator, and as a researcher who is an outsider to the Arctic and the traditional craftsmanship of fish skin made there. It offers a view from his own position towards another way of living. It also emphasises the promise of this raw material for a more sustainable and less wasteful future.

The images of the fish skin parka (Figures 7.8.22. 7.8.23. and 7.8.24) are part of a case study of collaborative design preserving Arctic fish skin cultural heritage between Jonathan Katz, myself and Alaska Alutiiq elder, June Pardue. Jonathan used 3D software to create a digital replica of a 19th century Inuit fish skin parka from the Anchorage Museum. He worked under my guidance as Research Associate at the Smithsonian National Museum of Natural History, where I am conducting a comparative study of fish skin artefacts and the Indigenous communities that create them. To respond to the distance challenges posed by the pandemic, I brought together in a virtual cultural heritage setting the artefacts that curators from the NMNH and Anchorage Museum had shared with me prior the pandemic. Consultations with Indigenous fish skin artists in Alaska provided additional insights on the utilitarianism and spirituality of the fish skin artefacts. The project bought together communities from Washington, Anchorage and London from across the ocean finding new means to participate in heritage activities. This case study explores the opportunities for digital engagement with collections, interconnections between heritage institutions and communities, and evaluation of the impact of collections-inspired university teaching that has been pushed to digital delivery. By capturing this case study and good practice relating to developing digitised collections with Indigenous Heritage holders, we hope to offer support to museums, universities and Indigenous communities.

https://2021.rca.ac.uk/students/jonathan-katz

SECTION FOUR: CONCLUSIONS, REFLECTIONS AND FURTHER WORK

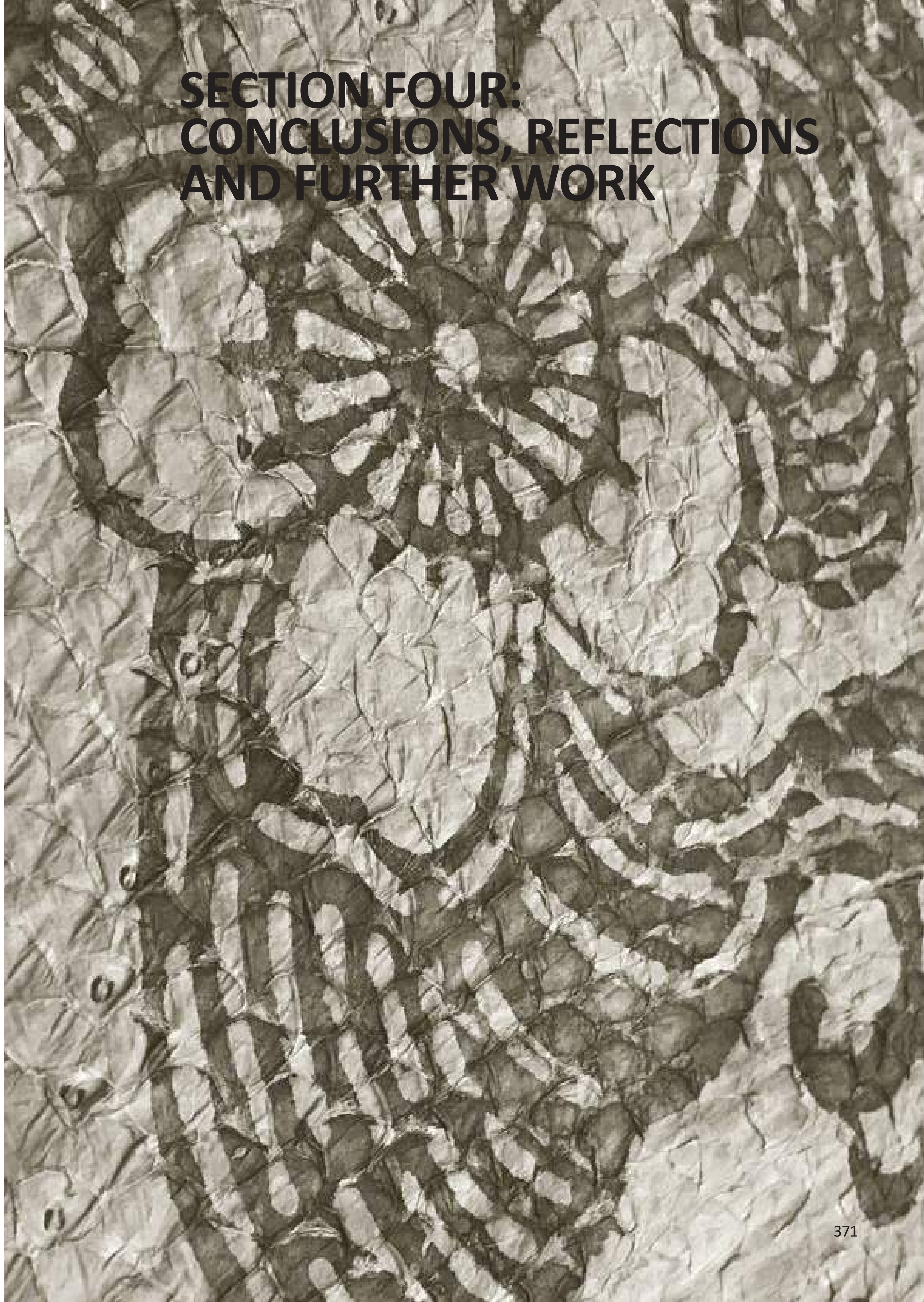


Figure 8.1. Fish leather dyed following the Kakishibu traditional Japanese dyeing method. Elisa Palomino, 2019.

Chapter Eight: Conclusions

Figure 8.2. Fish leather dyed following the tie and dye traditional Japanese dyeing method. Elisa Palomino, 2019.

8. Chapter Eight: Conclusions

8.1 Introduction

Throughout the research process and within this thesis, different strands of theory and practice have been intertwined. As a design and education practitioner, my research has focused on fish skin tanning methods, historical fish skin artefacts and the design education process; but I have also studied aspects of history, anthropology and fashion sustainability, to contextualise the research and situate it in historical and current debates. This chapter discusses as a whole, the findings and central concepts explored in the thesis. It begins with a summary of the thesis showing how the aim and objectives of this research project were met. A discussion of the limitation of my research follows. The chapter ends with a discussion of the Areas of Future Research.

8.2 Conclusions

In Chapter One, I explain how, while designing for John Galliano, I first sourced fish leather in 2002, as an alternative sustainable material. In this PhD I have continued this discussion. I have addressed many issues within contemporary sustainable fashion practices, with approaches inspired by Arctic fish skin heritage, such as transforming seafood waste into leather, taking the pressure off over-produced materials, lowering consumption practices, safeguarding, repurposing and responsible disposal of materials. Themes of resilience and resourcefulness from different Arctic cultures have been explored with the aim of protecting the rights of Indigenous Peoples as tradition holders, alongside the rights of animals and the natural environment. For this to happen, however, I had to make connections between literatures that have so far been separate such as fashion, anthropology and Indigenous knowledge.

In Chapter Two, I explore a practice-led methodology, where existing theories of community design and fashion design for sustainability were tested. Gaps in both theoretical and practical knowledge were identified, so fashion students were equipped with the skills to be used in the fish skin workshops I co-created with the Indigenous fish skin artists. A 'hands on interaction' with the fish skin processes and collaboration with the craftspeople was emphasized. This section offers a contribution to the discussion of 'Indigenous Peoples' and 'Indigenous knowledge', understood as an endured identity within the framework of ongoing colonial politics and as a key community of practice. Issues of misappropriation of tangible or intangible cultural heritage are also discuss through case studies of cultural appropriation of Arctic Indigenous designs. Codes of Conduct for fish skin tanning workshops and for museum consultations are also included.

In Chapter Three I discuss the Indigenous Arctic fish skin practices' historical connection with nature, from sustainable salmon fishing to Indigenous lower consumption in the Arctic where resources were scarce and precious. I suggest that through that reconnection, mankind can encourage a less consumerist form of fashion. I examine the historic aspects of fish skin in the Arctic, establishing that the craft has been and continues to be a common practice for Indigenous Peoples there. I study the connection between physical tanning of fish skins and spiritual practices, bringing together the material and intangible, producing spiritually charged items. I demonstrate how the current fashion system has dismissed effective earth management approaches practiced by Indigenous Peoples for millennia. These alternative practices respect the relationship between all things on earth, in stark contrast to the contemporary vision destroying in the name of commerce. The chapter includes a list of practices or Codes of Conduct using fish leather that could contribute to more sustainable solutions in the fashion industry.

In Chapter Four I present fish leather as an alternative raw material for fashion. I discuss fully the impact of fish leather on natural resources and the environment, compared with those of exotic, faux and vegan leathers, considering the conditions under which animals are reared, pollutant chemicals used for tanning and dyeing, water, energy use, hazardous waste and effluents produced. A codes of conduct for fish leather production is also to be found in this chapter responding to the demand for more sustainable materials, from farm to finished leather, and aiming for environmental and social responsibility.

At the start of my PhD, I lacked a critical view on the use of fossil fuel based raw materials in the fashion industry. My position changed in the light of emerging information about these materials derived from fossil fuels. In the context of fashion, the use of faux leathers or vegan materials appeals to a vegan customer as a cruelty free alternative to leather. My experience researching these materials in the laboratory was to encounter toxic fossil fuel-based compounds in the finishing layers of these materials such Piñatex and of course on faux leathers. Cruelty free, maybe but, unlike leather, they will never biodegrade, and so are cruel to the planet.

The fashion industry and academia need to develop new design methods to stop making products that waste resources and start using waste resources to make products. The industry needs to consider the utilization of fish waste. This research also stresses the need to continue to develop strategies that integrate with regenerative aquaculture practices. We must safeguard local practices working with nearby fisheries to continue to source fish skins responsibly without over-development. This is a delicate balance to strike. Every production that impacts on the environment needs to be considered. This research explored existing fish leather production systems and does not advocate for the increase of fish leather production for its own sake. Instead, any development should be within the bounds of planetary systems.

In Chapter Five I research historic fish skin artefacts, identifying aesthetic traits of traditional Indigenous Arctic heritage. I describe the history, processes and meaning surrounding the making of these artefacts in the Icelandic, Nivkh, Ainu, Alaska Native and Hezhe cultures; tracing the fish

skin traditions so central to Arctic culture for millennia. I explore the significance of decoration in Arctic fish skin artefacts as a means of communicating gender, age, status, ritual and the spiritual. I present specific fish skin artefacts emerging directly from fishing for subsistence, transformed through tanning, dyeing and sewing into garments, shoes and containers.

Colonisation has negatively impacted traditional Indigenous Arctic heritage. Denying Indigenous fishing rights also damaged their relationships with the environment as a whole, and consequently their own sense of identity. For many Indigenous communities colonialism has been a history of myriad dispossessions, of their land, their water, their traditional knowledge, and their practices both material and spiritual. Across the world, heritage has been, and still is, placed under increasing stress. The fish skin objects created by Arctic Indigenous Peoples and the social memory around them, provide broader understandings of their past, their heritage. During the fieldwork both in museum and amongst Arctic communities, my research found these cultural objects embedded not only in their own Arctic environments with their own histories, but also within the context of a global environmental that is in crisis, a crisis that disproportionally endangers Indigenous communities, who had no part in causing it. My research led to an exploration of how fish skin heritage can strengthen a sense of community by fortifying the relationship of the community to its locality. Additionally, fish skin heritage needs to be developed to add an important resource for fostering cultural resilience and supporting social cohesion.

In Chapter Six, I examine two models for fish skin tanning. ‘Fish skin’ is the historical raw material, tanned following traditional methods; ‘Fish leather’ is when the fish skin has passed one or more stages of industrial vegetable or chrome tanning production and is ready to be used to produce leather goods. Both have enormous potential for a reduction in seafood waste, but traditional tanning is the more sustainable of the two. This research found several methods for traditional fish skin processing: initial mechanical softening and followed by tanning with smoke, bark, brain, urine, fish roe and oil. This transforms an Arctic subsistence food resource into an additional textile resource.

This PhD reframes traditional Indigenous Arctic fish skin knowledge systems and technologies, as highly innovative processes with much to offer to the global future. There is a profound message to be learned from traditional fish skin practices, namely how we might better collaborate with nature. This ranges from sustainable fishing and tanning processes to respectful animal husbandry as we cultivate and hunt for food, and a symbiotic relationship with the environment that we inhabit. These processes have been sustainably performed for millennia by the Arctic Indigenous Peoples.

In Chapter Seven I describe the development of the fish skin workshops, to explore the material and the Indigenous societies linked to it, leading to our novel understanding of the material, and how to utilise it in fashion. The fish skin workshops, and subsequent interviews outlining the contemporary need for sustainable materials, find one source in fish skin waste which, through design-led solutions, can become a resource. This conversion from waste to resource was achieved through first-hand fish skin tanning practice – its feedback was traced in the form of data collection and interviews with students who incorporated fish skin successfully in their collections after the workshops. In mapping the workshops' results, it became clear that the use fish skin to replace existing materials within contemporary fashion is welcomed not only by many students but also Native artists. All of the field tests and interviews show an emerging renaissance of fish skin traditions in Native communities, particularly in Alaska.

Cultural appropriation and Fish skin

During the fieldwork, this research continued to encounter issues of cultural appropriation. The experience led to research of new systems, shifting my original research program towards Indigenous views and methods. I used Melissa Shaginoff's (2021) methodologies of Land Acknowledgment, publicly recognizing the Arctic Indigenous Peoples whose traditional fish skin craft was studied, consulting with Indigenous-led organizations and educating myself and my students on the Indigenous histories. Through my research and teaching connected to fish skin I continue to navigate issues around cultural appropriation, ownership, and identity. These are major concerns in contemporary fashion design too, as designers use the cultural property of others with relative impunity. It is important for my students to be conscious of these issues, so I emphasise them in my teaching through lectures, workshops and fieldwork to help my students manage these issues in their design choices.

Fashion has been criticized for constantly taking inspiration from Indigenous communities, from materials to designs. Through my responsibilities as researcher and educator and through the research process itself, I have learned how best to consult about traditional knowledge, in order to create solutions to the ongoing challenges of incorporating Indigenous interests into our integration of traditional fish skin heritage. Fashion can be(come) a space of empathy, a vehicle for connection. We need to acknowledge how connected we are to one another and hold the vision of a shared humanity. We need to learn from each other, to share knowledge and resources. This is not cultural appropriation; it is humble learning.

The climate crisis, from which we all suffer, was not caused by the Indigenous communities but by the non-marginalized societies. Moreover, it is precisely these Indigenous communities that are the first to suffer the impacts of the climate crisis they did not cause. These communities have a knowledge and respect for the environment that we have lost, and this loss risks the loss of the environment itself for them as well as for us. We need to learn from them, and we need to start now (Palomino, 2021b).

Key lessons learned through fieldwork

To a great extent, I have had to be flexible and reactive to challenges and opportunities as and when they arose, embracing whatever happened. Sometimes this was random. Atlantic Leather tannery went bankrupt halfway through my PhD and under new ownership became Nordic Fish Leather. Although this meant for a period, I was unable to make contact, the new owners adopted a more sustainable attitude to fish leather tanning techniques. Covid radically affected the organisation and experience of workshops and museum visits. My background as fashion industry professional and teacher already taught me this essential adaptability. Issues of cultural appropriation are pervasive and supremely important. Through the series of field trips I learned an enormous amount about the considerations to be taken into account by a non- Indigenous designer and educator working with Indigenous artists. Subsequently I have created a set of Codes of Conduct with information to establish the best possible outcomes for workshops and museum consultations with Indigenous communities with the aim of assisting other researchers, academics, students and Indigenous artists involved in similar scenarios.

Thus, numerous issues arose that were unforeseen, and my plans had to be adjusted and adapted to circumstances beyond my control. There are some things that I would have done differently to create a more fully collaborative project and I am currently working on many future aspects, to ensure its longer-term sustainability. Below I summarise the key issues.

8.3 Meeting the Research Aims and Objectives

This section summarise how the research aims and objectives were achieved throughout the thesis.

Aim 1. To undertake a study of the historical, cultural, environmental, and socio-economic importance of fish skin to Arctic communities.

Aim 2. To Undertake an anthropological study of the use of fish skin by Artic Indigenous Peoples to explore their resilience and resourcefulness and its connection with contemporary fashion sustainable practices.

Objective 1.1. *Assess the literature on the historical use of fish skin to explore the material and its cultural sustainability.*

An extensive literature review was carried out following the ethnological studies of the Native cultures of Alaskans, Siberians, Hezhe, Ainu and Icelanders, examining their myriad fish skin significance (aesthetic, cultural, environmental, social, spiritual and technological). This identified a gap in knowledge on how the themes of resilience and resourcefulness, strong relationship with the environment, subsistence lifestyle, spiritual role of fish skin and the economy of materials could all benefit contemporary sustainable fashion practices. As a result and influenced by findings, this research proposes the adoption of traditions, practices and properties of fish skin material to contribute to sustainable solutions within fashion. This conceptual framework was drawn to inform the subsequent phases of this investigation.

Objective 1.2. *Conduct fieldwork, create focus groups and interviews investigating the importance of fish skin.*
A scoping study was conducted as a focus group followed by semi-structured interviews with students and tutors who had participated in the fish skin workshops, amateur fish skin tanners, museum curators, university professors, researchers and Arctic Indigenous Elders. This led to identify the opportunities offered by fish leather, such as human connections with nature, the empowerment of women in Arctic societies, Arctic lower consumption practices, repurpose/reuse of materials, healing properties and emotional and spiritual connection with the material. As an outcome and informed by the results, during my fieldwork around the Arctic, I have given talks in museums, schools and universities sharing all the knowledge I have gathered through the literature review on the historical use of fish skin, the analysis of fish skin artefacts and the historical and contemporary methods of tanning fish skins.

Objective 1.3. *Analyse artefacts considering the cultural, environmental, and socio-economic context of fish skin.*
The analysis of fish skin artefacts was carried out using ethnographic research methods in a selection of international anthropological museums. Over the course of 5 years, I visited 28 different museums in 7 countries, 3 continents, throughout the Arctic region and examined 75 fish skin artefacts dating from around 1830 to 1990. This identified a gap in knowledge on procedures used to tan and construct fish skin artefacts. As a result and influenced by findings, the documenting of these techniques could enable future generations to learn about their own historic material culture based on information presented by their ancestors. Fashion and materials developed within a slower model by the Arctic Indigenous Peoples have the ability to hold deeper values that could be applied in fashion practice today.

Objective 2.1. *Create four fish skin workshops in different Arctic communities to carry out a cross referenced study of the difference in the fish skin material between different Arctic Indigenous Peoples.*
Four participatory case studies were carried out: one in Iceland with Icelandic, Swedish, Finnish, Danish and British students taught by Swedish tanner Lotta Rahme; one in northeast China with Chinese students taught by a community of Hezhe ethnic minority artists, Wenfeng You and Sulin Yu; one in Hokkaido, Japan with Japanese students taught by Japanese artist Shigeharu Takano; one online with Alaska Native students taught by Alutiiq Native artist June Pardue. The students participating in the workshops have been amongst the few still to be able to witness this almost extinct craft. This identified a gap in knowledge about the policies of assimilation, ethnic denial,

discrimination and the almost complete disappearance of cultural practices over a century and a half suffered by Arctic Indigenous Peoples with historical evidence of fish skin production. As an outcome of the case studies, a framework was developed and reviewed as an approach to mapping the fish skin craft participatory practices with Artic Indigenous communities. The framework draws from anthropological studies with cultural sensibility to better scope meaningful interventions within a context, interweave compelling narratives and activate legacies within local communities. As a result and influenced by findings the students have explored the potential for fish leather to become a competitive sustainable material for fashion, reframing what this material can offer them in their current fashion practice.

Objective 2.2. *Document and learn with the Arctic Indigenous Peoples' fish skin traditions and processes, so the tradition does not get lost.*
Extensive study and practice of historical and contemporary fish skin tanning methods was carried out with fish skin practitioners to interpret traditional tanning techniques and their cultural heritage. This identified a gap in the knowledge of the biochemical logic of the traditional fish skin tanning process using natural principles with a very low environmental impact. The findings identify new materials, processes, and techniques that could substitute unsafe chemical tanning processes with organic ones. They could be introduced to contemporary industrial tanning methods, cutting the supply of chemicals, and minimising the environmental impact of fish leather production.

Objective 2.3. *Explore how fish skin craft as material and practice can contribute to sustainability in fashion.*
A critical review comparing fish leather with other sustainable materials has been developed through investigation of the fashion industry, aspects of the climate crisis, the loss of biodiversity, and the depletion of finite resources. Contemporary issues around animal rights and the possibility of replacing exotic leathers from endangered species with fish leather have been reviewed. Fish leather as a food waste by-product and its high market value has also been mapped. This identified a gap in knowledge on how fish leather is challenged by a fashion industry that is promoting fossil fuel-based leather alternatives as being better than the natural environment. This led to identify the challenges and opportunities offered by fish leather's environmental, aesthetic, technical and social characteristics compared with vegan, exotic (crocodile/snake) and faux leathers as alternatives.

8.4 Limitations of Research

This research traverses a broad, holistic field. It moves from the assessment of the literature on the historical use of fish skin in the context of the material and its cultural sustainability; through to the documenting of the Arctic Indigenous Peoples' fish skin traditions and processes; on to the lessons learned through this process, and their practical applications – helping to improve








Figure 8.3. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with fish skin painting by Hezhe artist Yulin Sun.
Figure 8.4. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with Fish skin painting by Olga Kambolova, Russian artist from Sakhalin Island.
Figure 8.5. Handmade clutch with digitally printed fish leather with Eco-friendly water-based ink-jet inks. Exhibition OCEANISTA. Fashion and the Sea. Maritime Museum of Denmark. Copenhagen, Denmark.
Figure 8.6. Handmade clutch with digitally printed fish leather with Eco-friendly water-based ink-jet inks.
Figure 8.7. and 8.8. Handmade fish leather clutch with Indigo Katazome panels by leather craftsman Jay Zaccheus. Smithsonian's "FUTURES" exhibition, an interdisciplinary show at the Arts and Industries Building in Washington.
Figure 8.9. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with origami pattern by Ester Cellucci.
Figure 8.10. Fish leather clutch with Japanese Inlay (Zougan) technique by Florentine based Zougan artist Takafumi Mochizuki.

contemporary tanning technology; and thus on to the creation and delivery of fish skin workshops in different Arctic communities, which in disseminating the information, enriched it. This topic, like the preceding sentence, can turn into a massive sprawl. So for brevity I focus on the fish skin material and processes as the lens through which to explore past and existing fish skin craft.

The theoretical models have only been tested in the context of this research - four fish skin workshops, subsequent interviews, and laboratory tests of the traditional tanning processes. Further exploration of these models in other contexts, with other practices would be invaluable to determine the broader application and impact of this thesis. At the time of writing, the findings of this thesis are being reviewed for use in other case studies.

The findings related to Indigenous Arctic fish skin as a Heritage are only explored here through the context of garments, shoes and containers, both museum-archival and workshop-created. I have not been able to explore other subsistence materials like the skins of other fishes than salmon (e.g. eel) or other Indigenous Arctic subsistence materials than fish (e.g. land animals), or other subsistence materials than animal (e.g. vegetable matter). Although some extrapolation could be conjectured, further exploration would be valuable.

Methods outside traditional tanning and dyeing were not explored. However, contemporary printing and embellishment techniques on fish leather might yield some interesting insights for the fashion industry. These have been fully explored in the FISHSKIN Horizon 2020 project in Appendix I and paper 6 in Appendix V (Palomino and Defeo, 2019).

The following research limitations have been identified and relate to both the surveys and the case study interviews:

- The elements of the research are limited by the extensive physical geography in the Arctic where this Indigenous Fish Skin heritage was studied. Gaps in data are inevitable due to limited accessibility in certain areas. The necessary timeframe of the investigation also resulted in incomplete data gathering, especially in areas like Siberia where, due to Covid travel restrictions I was able neither to travel, nor to collect materials nor to run a workshop. The research is therefore limited by a lack of inclusion of data from certain geographical areas.
- The use of English language is recognised as a limitation in connecting and conversing with artists with languages other than mine. In Alaska they speak English, but I experienced difficulties in Japan and China.
- Although I am located in Europe, I have created Arctic Fish Skin networks amongst the different artists, Elders and museum curators globally. I recognise that this has the potential to offer a Eurocentric perspective rather than an Arctic view. The fish skin craftspeople that have collaborated in the workshops, however, are all Indigenous, apart

from two, from Arctic and Subarctic locations, with long-standing ancestral connection with the subject, and they are all recognised locally and internationally for their work with fish skin. The research is also limited by the small number of case studies in each Arctic area.

- Given the constraints of the time frame, it was not possible to represent all the world's museums with fish skin artefacts in their collections. Thus, there is no data from Siberian museums, very little from Chinese museums. I have only been able to study exhaustively one artefact per Indigenous group, the rest being only images; but I look forward to further exploration in future publications.
- The Nordic Fish Leather tannery (formerly Atlantic Leather) was interviewed on several occasions regarding their levels of sustainability. Given a longer time frame, further data would have been gathered also from other fish leather tanneries internationally to offer a more representative sample of fish leather companies.
- The research should not be considered an exhaustive representation of either Indigenous Arctic fish skin heritage or contemporary fish leather process. It is a collection of case studies and practices, artefacts from museum collections and history of fish skin heritage to outline a preliminary perspective on the topic.
- This research connects the knowledge and experience gathered during my PhD studies. This knowledge draws on findings from a wide range of craftspeople, Elders, museum curators, students, industry practitioners and academics globally, who have shared with me their practices and knowledge. It is informed by research undertaken across the Arctic, synthesized through reflection always with maximum respect for the Arctic Indigenous communities.

8.5 Areas for further research

While the research attempts depth in certain areas, the field explored remains wide open for further exploration. Subsequent work will include further development of the platform of Indigenous, academic and industry partnerships that I have had the opportunity to establish.

Indigenous connections

- Indigenous co-authorship, the best option for fish skin knowledge sharing, has been encouraged through collaboration with Indigenous artists to transpose oral fish skin knowledge to written form. This has been explored in co-authorship with Alutiiq Native June Pardue (Palomino, 2021a) in paper 5 located in the Appendix V and at the time of writing, other papers with Indigenous co-authorship (Nanai Native Anatoly Donkan and June Pardue) are being jointly prepared for publication (Palomino *et al.*, 2023)
- I received a Japan Foundation grant for Intellectual Exchange Conferences to create a FISHSKIN conference in Nibutani, Hokkaido, Japan in 2022. The initiative has brought Indigenous Arctic artists, museum professionals, academics and fashion designers together to explore the historical traditions and contemporary practices revolving around

the circumpolar use of fish skin. The conference fostered international collaboration around fish skin traditional tanning techniques and develop new technologies. The project has included a conference, fish skin tanning workshops, panel discussions and visits to national museums. The project will result in documentation on fish skin material knowledge systems from five Indigenous communities: Ainu from Japan; Nanai from Russia; Alutiiq from Alaska; Hezhe from China; Saami from Sweden. The conference has tremendous potential for the revitalization of a clothing tradition among circumpolar peoples as well as from the perspective of sustainable fashion practices and also for museum anthropology.
- As part of the fish skin heritage, I aim to file the Arctic Indigenous fish skin processing in the UNESCO List of Intangible Cultural Heritage in Need of Urgent Safeguarding. The five fish skin culture bearers I have been working with for the past five years would join me in the drafting and ethnographic documentation of the practices. The papers and joint conferences co-written and delivered across the world will reinforce the candidature.
- A capsule collection of fish skin accessories has been designed in collaboration with Indigenous and non-Indigenous artists (Figures 8.3. to 8.1.). This can potentially foster opportunities for Indigenous artists to create and expand business opportunities and feel a greater sense of belonging in an industry like fashion, from which many have long felt excluded. This has been further featured in Appendix I.
- I have worked on the curation of two exhibitions where my fish skin research has been featured: One of my handmade fish leather clutches with Indigo Katazome panels (Figures 8.7. and 8.8.) was exhibited next to an Inuit fish skin bag from the National Museum of Natural History at the Smithsonian Institution "FUTURES" exhibition, an interdisciplinary show at the Arts and Industries Building in Washington. Another handmade clutch with digitally printed fish leather with Eco-friendly water-based ink-jet inks was exhibited at OCEANISTA, Fashion and the Sea at the Maritime Museum of Denmark in Copenhagen. There is potential for further collaboration with museums to showcase historical Indigenous Arctic subsistence materials and their impact on contemporary sustainably sourced textiles. This has been further elaborated in Appendix II.

Industry

- In collaboration with Nordic Fish Leather tannery and Ars Tinctoria laboratory we are experimenting further to replace modern chrome tanned fish leather with Arctic traditional tanning methods and their very low environmental impact.
- Primarily Arctic Indigenous plants and dyeing methods for fish skin have been explored. There is potential for these methods to be applied in industrial fish leather substituting contemporary unsustainable chemical dyeing processes. This is currently being explored, by developing a colour palette with Indigenous plants from Japan, Iceland, and Sweden (Appendix I). There is potential to use indigo dye in fish leather production using

Katazome, a traditional Japanese textile process (Figures 8.7. and 8.8.). This has been further explored in a specific paper 9 (Palomino *et al.*, 2021b) in Appendix V and in Appendix I.

- New digital printing technology, water-based ink-jet inks providing high bonding and light fastness, has been successfully tested on fish leather (Figures 8.5. and 8.6.). This has been further explored in paper 6 in Appendix V (Palomino and Defeo, 2019) and in Appendix I.
- Parallel to this PhD research, I have produced fish leather samples (Appendix I) following some of the traditional techniques studied in this thesis. These samples have been subjected to materials-based research, creating full-scale prototypes that test visual and mechanical characteristics against existing leathers on the market, not in laboratory samples but in physical products like shoes and bags (Figures 8.3. to 8.10.). These prototypes identify areas of suitability for fish leather in the fashion industry.
- The traditional Arctic use of fish oils for processing fish skins to obtain qualities like water repellence are currently under exploration with Nordic Fish Leather tannery and Ars Tinctoria laboratory, to create waterproof fish leather.
- Development of digital tools for the use of fish leather in garment construction has been explored, creating a fish skin module as a building block for contemporary pattern making, introducing parametric design tools to test zero waste principles. This is further explored in paper 9 (Palomino *et al.*, 2021b) in Appendix V.
- Interaction with broader approaches like 3D printing has been carried out, researching upcycling seafood waste by-products, developing a 3D printing filament with fish skin waste and chitosan to improve PLA[1] based filaments. This would also include experimentation with new 3D printing machinery and the further exploration of the potential of new designs for this process. At the time of writing, I have led the formulation of the proposal for a Horizon Twin Green and Digital Transition 2021 project on this subject.
- In collaboration with the Ars Tinctoria laboratory, we are comparing animal-based leather with synthetic alternatives to leather which, in line with current fashions, are trying to replace animal-based materials with vegan alternatives. Our aim is to compare their structure and technical performance and their percentage of bio-based and fossil-based composition. Plant-based leather is becoming an increasingly popular alternative to animal-based leather, but it often relies on fossil-based coatings to be water repellent and durable. We plan to work on a bio-based coating that aims to make plant-based leather more sustainable by replacing PU coatings. The research is currently being carried out by myself and Ars Tinctoria laboratory for brands such as Chanel and Nike in response to their search for the most sustainable raw materials on the market.

1 Polylactic acid, also known as PLA, is a thermoplastic monomer derived from organic sources such as corn starch or sugar cane.. PLA is the most widely used plastic filament material in 3D printing.

Education

- The fish skin workshops have delivered innovative fashion sustainable education. Not only informing cross disciplinary curricula in Fashion Higher Education, but also crystallising a vision for a more sustainable fashion ecosystem. There is a potential to keep developing the use of Indigenous Arctic fish skin design methods explored in this thesis in an international education context. This has been further explored in paper 8 (Palomino *et al.*, 2021a) in Appendix V.
- Recently my international career in the world of education has been rewarded by being chosen to join, as a personality of recognised prestige, the Spanish Higher Council for Artistic Education (CSEA), chaired by the Minister of Education and Vocational Training to design the reform of Arts Education in the Spanish education system. Such reform can bring much benefit to the new generations of Art students, and it will be a challenge to support and promote new educational models in which creativity, art, inclusion and sustainability are basic pillars to transmit.

During my PhD studies, the more I learned, the more I was astounded by the ever-increasing scope of this rich and largely untapped resource. It has been an enduring pleasure and privilege for me.

Figure 9.1. Wolf fish skin shoes and Bone tongs. National Museum of Iceland. Reykjavik, Iceland, 2021.

SECTION FIVE: REFERENCES

Chapter Nine: Glossary of Terms

Figure 9.2. Dried and slated fish: Reykjavik Maritime Museum, Iceland, 2021.

9. Chapter 9. Glossary of terms

AINU

The Ainu or Ezo (the Japanese term historically used to refer to the people and the lands to the northeast of the Japanese island of Honshu), are an Indigenous Peoples of Japan, Hokkaido, and Russia (Sakahalin, the Kuril Islands, Kahabarovsk and the Kamchatka Peninsula). The Ainu economy was based on hunting, fishing, and gathering. Ainu Peoples made clothes by sewing together fish skins such as those of salmon and trout.

ANTHROPOLOGY

Anthropology is the scientific study of humans, human behaviour, and societies in the past and present. Social anthropology studies patterns of behaviour and cultural anthropology studies cultural meaning, including norms and values. Among the several branches of anthropology are archaeology, which focuses on the remains and artefacts of people who lived in the past, and ethnography, which deals with living people. Generally, ethnography is based on face-to-face interaction between the researcher and the people being studied. Ethnographers study human culture: how people live and how they view their world.

APPROPRIATION

The use of pre-existing work (such as existing designs, patterns) in the creation or composition of a design or creative work. If the appropriated works are significantly altered in the creation of a new work, the use is often deemed to be a fair use. However, appropriation can raise significant copyright and ethical concerns, particularly if the existing works are used without the original creator's knowledge or permission, or if the appropriated works are used with little alteration or without sensitivity.

ALGIKNIT

A biomaterial developed from seaweed waste. A durable yet rapidly degradable yarn.

ALUTIIQ

The term "Alutiiq" is relatively new. It has been used by Native speakers and scholars since the early 1980s to refer to both the language and culture of the group of Alaska Native Peoples indigenous to the Kodiak Island Archipelago, the southern coast of the Alaska Peninsula, Prince William Sound, and the lower tip of the Kenai Peninsula.

ANIMAL WELFARE

The concept of animal welfare first emerged in the 1960s with the definition of the Five Freedoms (Freedom from hunger and thirst, discomfort, pain, injury and disease, to express normal behaviour, and from fear and distress). These were adopted by the OIE (World Organization for Animal Health) which defines animal welfare as "how an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well-nourished, safe, able to express innate behaviour and if it is not suffering from unpleasant states such as pain, fear and distress».

APPLE LEATHER

An alternative material to leather produced by re-working leftovers from harvested apples –apple seeds, cores and peel that are dehydrated, cooled and ground to create a cellulose material that can be used in accessories.

ARCHAEOBOTANY

The specialized study of plant remains from archaeological sites. Archaeobotany provides important information about uses of plants by human groups like leather tanning and dyeing.

ARCTIC

The Arctic is a cold climate area surrounding the North Pole. It is characterised by a long winter, and a short growing season. The Arctic encompasses the Arctic Ocean and an abundance of islands and well as the strips of Asia, Europe, and North America edging the ocean. In some areas, the local economy includes traditional activities such as fishing, hunting, herding and gathering, which provide local consumption and support vital cultural traditions of Arctic peoples (IPCC 2014). The Arctic is the homeland of 40 different groups of Indigenous Peoples.

ARTEFACT

Any object that has been manufactured or modified by humans.

ATHABASCAN

The Alaskan Athabascans are the original inhabitants of the interior of Alaska. It is an inland creek and river fishing (also coastal fishing by only Dena'ina of Cook Inlet) and hunter-gatherer culture. They often covered great distances in their quest for food. The changing seasons, the weather, and the behaviour of fish and game ordered the Athabaskans' lives. The Athabaskans used all parts of a fish. They used fish skin to make tents, waterproof parkas and boots.

BIOBASED

"Bio-based" means the use of biogenic raw materials to manufacture a variety of products instead of fossil gas, coal, or petroleum as part of the bioeconomy.

BIODEGRADABLE

The process by which organic materials or substances are decomposed by micro- organisms into simpler components such as carbon dioxide, water, and ammonia. Biodegradable means that a product can break down naturally without any negative effects on the environment, such as releasing harmful chemicals.

BIODEGRADABLE LEATHER

Leather and leather goods are made to last and wear well but have the potential to degrade biologically in 10-50 years. It depends, among other, on the chemicals being used. Any leather can be composted but the speed of degradation and environmental impact depends on the tanning chemistry used.

BIODIVERSITY

Biodiversity is the variety and variability of life on Earth. Biodiversity is typically a measure of variation at the genetic, species, and ecosystem level.

BLUE ECONOMY

Blue economy encompasses sustainable development of aquatic-based industries, including fisheries (capture and culture), fish processing, transport, tourism, and energy. Similar to the concept of green economy, the blue economy looks into maximizing the socioeconomic benefits of aquatic industries, improved livelihoods, and jobs while minimizing environmental degradation and preserving the health of ocean ecosystem.

BIOFABRICATION

Instead of creating textiles by extracting raw materials derived from oil, animals and plants, biofabrication is a process of growing fabrics using living micro-organisms. Humans have been harnessing the power of micro-organisms for thousands of years: bread, cheese, yoghurt, alcohol, kimchi and kombucha. Today's new biofabrication factories are laboratories of living cells: bacteria, fungi, algae and yeast.

BLUE FASHION

Blue Fashion supported by the Commonwealth as part of its work on the blue economy – in partnership with FAO and the Nordic Atlantic Co-operation is working on the development of fish leather. This will enable women and youths to learn new skills and allow the African areas to diversify its work force towards the blue agenda creating wealth and opportunity.

BY-PRODUCTS

While co-products are products that are jointly or subsequently produced sharing the same market destination and determining the economic activity (e.g. meat and dairy), by-products are residues of an economic activity determined to produce other goods (hides, skins, hooves). By-products are not produced on purpose, while co-products are.

CARBON NEUTRAL

Carbon is used as a shorthand for all the various greenhouse gases — carbon dioxide, methane, and nitrous oxide — that absorb and emit radiant energy that increase the temperature of the earth's surface and therefore contribute to climate change. A company striving for carbon neutrality aims to eliminate all carbon emissions from their supply chain.

CHRISTIAN DIOR

Christian Dior was a French fashion designer, best known as the founder of one of the world's most renown fashion houses, which is now owned by LVMH. John Galliano served as Dior's creative director from 1996 to 2011.

CHROME TANNED LEATHER

The complexity, expense and time involved with tanning with vegetable tannins led, in 1858, to the development of using alternative mineral tanning agents. The whole process can be automated and finished in a day, and the chrome ions displacing the water and binding with the collagen are much smaller than vegetable tanning molecules. This generally makes chrome tanned leather thinner and softer than vegetable tanned leather. The process, however, is less natural than when using vegetable tannins. It involves first placing the hides in acidic salts to better make the chrome fit in between the collagen molecules – and then returning the hides to a normal pH level. This requires the use of acids and other chemicals as well as the chromium sulphates themselves. If not properly managed, these will have a negative environmental impact.

CHROME FREE LEATHER

Leather tanned using alternative methods to chrome - usually aldehydes.

CIRCULAR ECONOMY

A framework for systemic solutions addressing global challenges such as climate change, biodiversity loss, waste and pollution. It is based on three principles: eliminating waste and pollution, circulating products and materials at maximum value and regenerating nature.

CIRCULAR FASHION

Circular fashion refers to the entire lifecycle of a product and centres on a circle of create, use, recycle, rather than create, use, dispose. It looks at products beyond their original function and timespan and focuses on how their materials can be consistently utilized and repurposed. Circular fashion takes into consideration everything including the design, sourcing, transportation, storage, marketing, sale and disposal of the product.

CITES

CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments aiming is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

CLIMATE CHANGE

Climate change occurs when changes in Earth's climate system result in new weather patterns that remain in place for an extended period of time. This length of time can be as short as a few decades to as long as millions of years.

COMMONWEALTH BLUE CHARTER

The Commonwealth Blue Charter is an agreement by all 53 Commonwealth countries to co- operate actively to solve ocean-related problems and meet commitments for sustainable ocean development. The Blue Charter ensures that the Commonwealth takes a fair, equitable, inclusive and sustainable approach to ocean economic development and protection. For Commonwealth countries, where fishing and seafaring often underpin traditional ways of life, the blue economy is already part of the social fabric. Small enterprises in Kenya like Victoria Foods are already embracing the blue economy approach. In fashion some local producers are using fish skin – normally seen as waste – to make fish leather with local clothing and handbag designers.

COMMONWEALTH FASHION COUNCIL

Commonwealth Fashion Council (CFC) is a not-for-profit accredited organisation dedicated to developing and promoting the Commonwealth Fashion Industries. The CFC works with over 20 fashion weeks and council in order to develop programmes which focus on sustainable development, education, trade, youth and gender empowerment.

COMPOSTING

Microbial decomposition of organic matter in the presence of oxygen. In a circular economy, composting can be used to convert food by-products and other biodegradable materials into compost, which can be used as a soil enhancer.

CO PRODUCT

Co-products are desirable secondary goods that are generated during the manufacturing process and can be sold or reused profitably. They might also be products that are usually manufactured together or sequentially because of product or process similarities.

COTANCE

The Confederation of National Associations of Tanners and Dressers of the European Community (COTANCE) is the representative body of the European Leather Industry. It is a non-profit organization established in order to promote the interests of the European tanning industry at international level. Apart from representing European tanners and dressers, it also has the mission of promoting European leather both in the European and international markets.

CULTURE

The set of learned values, behaviours and beliefs that are characteristic of a particular society.

CULTURAL APPROPRIATION

When members of a dominant culture adopt elements of an Indigenous, disadvantaged or minority culture. This is seen as 'stealing' from a culture. It is also called 'Cultural Misappropriation'.

CULTURAL ASSIMILATION

Cultural assimilation is the process whereby individuals or groups of differing ethnic heritage are absorbed into the dominant culture of a society. The process of assimilating involves taking on the traits of the dominant culture to such a degree that the assimilating group becomes socially indistinguishable from other members of the society. As such, assimilation is the most extreme form of acculturation. Although assimilation may be compelled through force or undertaken voluntarily, it is rare for a minority group to replace its previous cultural practices completely; religion, food preferences and aesthetics are among the characteristics that tend to be most resistant to change.

CULTURAL RESILIENCE

The ability of a culture to face colonisation, place dislocation due to land dispossession, resettlement, and landscape fragmentation, challenging the persistence of Indigenous knowledge systems. Arctic Indigenous Peoples have become a symbol of adaptation and cultural resilience, actively observing and adapting to change in a diversity of ways.

CRUELTY FREE

Cruelty-free means that companies did not test ingredients or products on animals during the production phase. Cruelty-free, therefore, also means that no animals were killed or harmed anywhere in the world during production.

DEGRADATION

The process by which any material or substances is broken into simpler components through chemical or physical non-enzymatic methods.

DEG HIT'AN

Deg Hit'an, or Deg Xinag, formerly Ingalik (pejorative), refers to Athabaskan-speaking North American Indian tribe. They were interior hunting people, probably centred in the eastern Alaskan, in the basins of the upper Kuskokwim and lower Yukon Rivers, and north-western Canadian cordilleran region. They were primarily subsistence fishermen, supplementing this by hunting caribou, moose, bear, and other fur-bearing animals. The predictable salmon runs permitted a more sedentary life and larger populations than among Athapaskan groups who relied on big game. Traditional crafts included fish skin clothing and accessories.

DURABILITY

The ability of a material to remain functional when used as originally intended. Durability usually applies to the physical attributes of a product such the ability to resist damage and wear and can be emotional such the ability of certain garments to remain desirable over time.

ECO-FRIENDLY FASHION

Eco-friendly is a term that takes many factors into account. "Eco" is short for ecology, the study of interaction between organisms and the environment. It relates to the minimising of anything that would negatively affect that balance. The lifespan of the product must be considered - what material a product is made from, whether it is dyed with organic dye or chemicals, and how much water is used to grow the fabric, how was the raw material transported to the mill, how does it biodegrade.

ENVIRONMENTAL IMPACT

The environmental impact encompasses the possible adverse effects caused by the release of a substance in the environment.

ENVIRONMENTAL SUSTAINABILITY

This is the responsibility for implementing a rational utilisation of materials, manufacturing processes, energy usage, recyclability, and re-usability by maintaining a critical understanding of the science and technologies necessary to create designs that minimise environmental impact.

ETHICAL FASHION

Ethical fashion is an umbrella term that includes fashion design, production and retail. Ethical fashion indicates an active approach to creating goods that positively impact the environment and the lives of those making them, reducing poverty through non-exploitative employment (fair pay, fair hours, good conditions).

ETHNOGRAPHY

Ethnography is the anthropological study and description of a specific culture based on direct fieldwork. It is designed to explore cultural phenomena where the researcher observes society from the point of view of the subject of the study.

FAIR TRADE FASHION

Fairtrade focuses on products that comply with internationally agreed Fairtrade social, environmental and economic standards. Profits made from products that qualify for the Fairtrade Mark go towards supporting farmers and workers and improving lives and communities.

FAST FASHION

Fast fashion is the term used to describe clothing that is produced quickly and cheaply. Brands and retailers that engage in fast fashion often create products based on seasonal trends directly inspired by the runway. This fashion is made fast to be discarded fast. Fast fashion brands are associated with overproduction, low retail prices, mass waste, poor working conditions, and negative environmental impact.

FAO

The Food and Agriculture Organization (FAO) is specialized agency of the United Nations that leads international efforts to defeat hunger. Its goal is to achieve food security for all and make sure that people have regular access to enough high-quality food to lead active, healthy lives. With over 194 member states, FAO works in over 130 countries worldwide.

FAUNA

Latin term referring to animals.

FINITE MATERIALS

Materials that are non-renewable such fossil forms of carbon such as oil.

FISH LEATHER

Fish leather is used to indicate that the fish skin has passed one or more stages of industrial vegetable or chrome tanning production and is ready to be used to produce leather goods. FISH

SKIN

Skin indicates the superficial dermis of an animal. In this thesis fish skin is referred as the historical raw material of animal origin that has been processed mechanically or tanned following traditional methods and ingredients such as oiling, smoking, bark, brain, urine, fish roe and corn flour.

FLORA

Latin term referring to plants.

GENOCIDE

The Genocide Convention was the first human rights treaty adopted by the General Assembly of the United Nations on 9 December 1948. According to the Genocide Convention, genocide is a crime that can take place both in time of war as well as in time of peace. Its adoption marked a crucial step towards the development of international human rights.

GEOTHERMAL ENERGY

Geothermal energy is thermal energy generated and stored in the Earth. Due to the geological location of Iceland (over a rift in continental plates), the high concentration of volcanoes in the area is often an advantage in the generation of Geothermal energy the heating and making of electricity.

GREENWASHING

Greenwashing is when a brand gives a false impression of its sustainable endeavours. With the increasing demand for sustainability in the fashion industry, some brands are trying to convince consumers about their production values to raise their profiles and encourage sales.

HATCHERY

A Hatchery is a facility where large numbers of fish eggs are hatched under artificial conditions. Fish farms use hatcheries to cultivate fish to sell for food, eliminating the need to find the fish in the wild and even providing some species outside their natural season.

HEZHE

Hezhe Ethnic Minority people settled in the drainage areas of Songhua River, Heilongjiang River, and Wusuli River in Northeast China. The Hezhe's ancestry can be traced to the Xizhens, Suzhens or Jizhens, a race of the nomadic Tartar horsemen living in northern China in the ancient times. Hezhe people made their clothing of fish skin or animal skin.

HIDE

Hides are skins from bigger animals- mainly cattle or buffalo, they are a by-product of the food production.

ICELAND OCEAN CLUSTER

The Iceland Ocean Cluster's mission is to create value from fish waste by connecting together entrepreneurs, businesses and knowledge in the marine industries. To serve this mission they operate a business cluster of 68 companies in the Icelandic Fisheries sector and a business incubator which has fostered the development of 20 fishery-residue companies in Iceland.

INDIGENOUS AND TRIBAL PEOPLES CONVENTION 1989

Indigenous Peoples are descent from the populations which inhabited a country, or a geographical region to which the country belongs, at the time of conquest or colonisation and who, irrespective of their legal status, retain some or all of their own social, economic, cultural and political institutions.. Attention has been called to the distinctive contributions of Indigenous Peoples to the cultural diversity and social and ecological harmony of humankind and to international co-operation and understanding. Indigenous Peoples should enjoy the full measure of human rights and fundamental freedoms without hindrance or discrimination. The social, cultural, religious, and spiritual values and practices of these Peoples shall be recognised and protected, and due account shall be taken of the nature of the problems which face them both as groups and as individuals.

INDIGENOUS ARCTIC PEOPLES

Indigenous Arctic Peoples are closely linked to nature and subsistence resources and they developed over centuries formidable creative skills, abilities and assets including a highly evolved design aesthetic, deep knowledge of the natural world, ability to problem solve and adapt, the development of powerful support networks, and a keen awareness of resources to thrive in demanding ecosystems. The specific Arctic indigenous groups with historical evidence of fish skin production are the Inuit, Yup'ik and Athabascan of Alaska and Canada; the various Siberian peoples, such as the Nivkh and Nanai; the Ainu from the Hokkaido Island in Japan and Sakhalin Island, Russia; the Hezhe from northeast China and the Saami of northern Scandinavia

INDIGENOUS ENVIRONMENTAL KNOWLEDGE

As a field of study in anthropology, Indigenous and other traditional knowledge of local resources refers to a cumulative body of knowledge and practice handed down through generations through traditional songs, stories and beliefs. It is concerned with the relationship of living beings (including human) with their traditional groups and with their environment.

INFORMANT

An individual from whom an anthropologist obtains information about the way of life of that individual's culture.

INGALIK

Ingalik is a Northern Athabaskan language spoken by the Deg Hit of the lower Yukon River, the Innoko River and the Middle Kuskokwim River valleys of Alaska.

INTANGIBLE CULTURAL HERITAGE

"Intangible cultural heritage" means the practices, representations, expressions, knowledge, skills as well as the instruments, objects, artefacts, and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognize as part of their cultural heritage.

INUIT

The Inuit are a group of culturally similar Indigenous Peoples inhabiting Inuit Nunangat, the Arctic regions of Greenland, Canada and Alaska. Inuit are the descendants of the Thule People, who emerged from western Alaska around 1000 CE. They had split from the related Aleut group about 4000 years ago and from north-eastern Siberian migrants. The semi-nomadic eco-centred Inuit were fishers and hunters. Their traditional clothing system is the most effective cold weather wardrobe developed to date. Inuit women made clothes and footwear from animal skins of marine and land mammals including fish skin.

INUPIAT

The Inupiat, Iñupiat, Iñupiaq or Inupiaq, are a group of Alaska Natives, whose traditional territory roughly spans northeast from Norton Sound on the Bering Sea to the northernmost part of the Canada–United States border and often claim to be the first people of the Kauwerak. They have a lifestyle that is heavily dependent on the subsistence harvest of marine mammals, land mammals, fish, and migratory birds.

JOHN GALLIANO

John Galliano is a Gibraltar-born British fashion designer who was the head designer of French fashion companies Givenchy, Christian Dior, and his own label John Galliano. John Galliano created a collection of fish leather garments for his 2002 Autumn/Winter collection. At present, Galliano is the creative director of Paris-based fashion house Maison Margiela.

KOMBUCHA LEATHER

Kombucha, a fermented Asian superfood drink, made from tea bacterial cultures has been transformed into a cellulose material that with time can be made into a form of "leather".

KUSPUK

From Yup'ik qaspeq; Iñupiaq: atikłuk. Kuspuk is a hooded overshirt of lightweight cloth with a large front pocket commonly worn among Alaska Natives. Kuspuks are tunic-length, falling anywhere from below the hips to below the knees. They are traditionally worn by aboriginal Alaskans over the parka especially by Alaskan women and children.

LEATHER
Hide or skin with its original fibrous structure more or less intact, tanned to be imputrescible, where the hair or wool may or may not have been removed.
LCA
Life Cycle assessment.
LIVING WAGE
Living wage is a fair salary paid to workers from all aspects of the production process, so they are not trapped in poverty. Living wage should consider how many family members a person is supporting, their nutritional needs, education, housing, and other living costs, and calculate wages based on that. A living wage varies from country to country and is also taken into consideration.
LIFESPAN
The period of time from when a product is released for use after manufacture to the time when it becomes obsolete with no possibility of recovery at the product level.
MANTAIN
Maintaining a product in its current state of quality, functional and/or aesthetic, to prevent its deterioration. It is a practice that preserves the maximum value of a product by extending its period of use.
MARICULTURE
Mariculture is a specialized branch of aquaculture involving the cultivation of marine organisms for food and other products in the open ocean, an enclosed section of the ocean, or in tanks, ponds or raceways which are filled with seawater.
MATERIAL CULTURE
Generic term used to refer to the wide variety of objects produced by human societies through the transmission between generations of knowledge and skills.
MODERN MEADOW
Bio-leather company developing a new material grown in labs from living cells that produce collagen – an animal-free process that results in a sort of 'leather'.
MUSKIN
Muskin is a 100 percent biodegradable 'vegan leather', extracted from mushroom caps and 'tanned' using chemical-free methods.
NATURAL RESOURCES
Natural resources are resources that exist without actions of humankind. This includes wind, water, natural vegetation, solar energy, and animals.
NIVKH
The Nivkh are an Indigenous ethnic group inhabiting the northern half of Sakhalin Island and the lower Amour River and coast on the adjacent Russian mainland. Nivkh were traditionally fishermen, hunters and gatherers. They were semi-nomadic, living near the coasts in the summer and wintering inland along streams and rivers to catch salmon. Nivkhs traditionally wore robes fastened on the left side of the body made of fish skins.

OCEAN ACIDIFICATION
Ocean acidification is the ongoing decrease in the pH of the Earth's oceans, caused by the uptake of carbon dioxide from the atmosphere. Seawater is basically pH-neutral, and ocean acidification involves a shift towards pH-neutral conditions rather than a transition to acidic conditions.
OCEAN WASTE
Ocean waste or marine debris is concerned with persistent solid material (such as plastic) that is manufactured or processed and disposed of into the marine environment. Not only does this injure and kill marine life and causes potential navigation and safety risks, but it also poses a threat to human health.
OIE
The World Organisation for Animal Health, formerly the Office International des Epizooties (OIE) is an intergovernmental organisation coordinating, supporting, and promoting animal disease control and it is responsible for improving animal health worldwide.
ORANGE FIBRE
Orange fibre patented and manufactured the first sustainable fabric from citrus juice by- products. With a silky texture, it is designed to meet the demand of innovation and sustainability of fashion brands.
ORGANIC
Organic in fashion refers to the materials used and how they are grown, namely without the use of pesticides, synthetic fertilizers, genetically modified organisms (GMOs), sewage sludge, ionizing radiation, or other chemicals.
PARKA
The word 'parka' – describing a warm winter coat with a hood – derives from the Nenets language (the Indigenous Peoples of Northwest Siberia). Nenets travel thousands of kilometres on sleds with their reindeer in very cold temperatures. For them, parkas are absolutely essential.
PERMAFROST
Permafrost is ground that remains frozen for two or more consecutive years. It is composed of rock, soil, sediments, and varying amounts of ice that bind the elements together. Some permafrost has been frozen for tens or hundreds of thousands of years.
PIÑATEX
Piñatex is a non-woven textile made from pineapple leaves, vegan alternative to leather harvested in the Philippines created by Dr Carmen Hijosa.
POLYPHENOLS
Polyphenols comprise a vast family of secondary metabolites which are stored in vacuoles of vegetal cells such as esters or glycosides. Tannins are considered polyphenols with high molecular weights.
PRE AND POST CONSUMER WASTE
Pre-consumer waste refers to manufacturing waste. Post-consumer waste refers what it is collected after the owner has disposed of it.

RAW MATERIAL

Term used to describe the substance from which an artefact is made : bone, ivory, antler, wood, or skin.

RECYCLED AND UPCYCLED FASHION

Recycling refers to the industrial process in which a product is broken down into its base materials, which are then used for the production of something new. Upcycling is about creatively re-imagining the purpose of an object, transforming and reinventing its function.

RENEWABLE ENERGIE

Energy derived from resources that are not depleted on geological timescales such wind, solar, hydropower, hydrothermal, ocean (wave and tidal) and geothermal.

RENEWABLE MATERIALS

Materials that are continually replenished at a rate equal to or greater than the rate of depletion such cotton, hemp, wool and leather. To fit in a circular economy such materials (where relevant) must be produced using regenerative production practices.

REPAIR

Operation by which a broken product is returned back to a usable state to fulfil its intended use.

RESILIENCE

Resilience is the individual's ability to adapt in the face of adverse conditions - the capacity to recover quickly from difficulties.

RESOURCEFULNESS

Resourcefulness is the ability to find quick and clever ways to overcome difficulties.

REUSE

The repeated use of a product for its intended purpose without significant modification.

SAAMI

The Saami people are a Finno-Ugric Peoples inhabiting Sápmi, which today encompasses large northern parts of Norway and Sweden, northern parts of Finland and the Murmansk Oblast of Russia. Traditionally, the Saami have pursued a variety of livelihoods, including coastal fishing, fur trapping, and sheep herding. In southern Sápmi eel and burbot skins have been used for the production of bags and bracelets.

SALVATORE FERRAGAMO

Salvatore Ferragamo was an Italian shoe designer and the founder of his eponymous luxury goods brand. Ferragamo worked with many Hollywood stars in the 1920s, before returning to Italy to launch his company of bespoke footwear. His creative approach to shoes spawned many innovations such as the creation of fish leather shoes.

SHARING

The use of a product by multiple users. The practice retains the highest value of a product by extending its use period.

SINEW

Animal sinew (e.g. caribou) that can be braided into rope or thread. Arctic Peoples used all parts

of an animal. They ate the meat and fat from the caribou's legs. When dried, caribou tendons provided sinew that seamstresses used as thread for sewing.

SKIN

Skin refers to the raw material provided by smaller animals, mainly sheep, goats, pigs and fish used in the leather industry. They are a by-product of the food industry.

SLOW FASHION

Slow fashion is the opposite of fast fashion. It rejects consumeristic impulses and embraces a slower, more mindful model of consumerism. It refers to only buying things you actually need and items of quality that will last. It is about being conscious of what you buy and how that purchase will impact others and the environment.

SOCIAL RESPONSIBILITY

Social responsibility requires a company to adhere to a business framework that values people and the planet as well as profit. It is about benefiting local communities and their environment.

SPIRITUAL PROTECTION

Arctic Indigenous Peoples believed that humans, animals and nature shared spiritual qualities. Arctic seamstresses decorated hunters' fish skin clothing with embroidered applique motifs imbued with spirits, which gave assistance and protection from danger and forged a close spiritual connection between people and animals.

SUBSISTENCE ECONOMY

The methods by which a group of people obtain the food, shelter and clothing necessary to support life. Subsistence activities of hunting, herding, fishing and gathering continue to be of major significance to the Indigenous Peoples of the Arctic in providing food, social relationships and cultural identity. Customary harvesting practices are not only culturally but also economically important locally, although their role varies by region, ethnic group, urban or rural setting, and generation.

SUSTAINABILITY

Sustainability in this PhD context is understood as the manufacturing, marketing and use of garment, footwear and accessories, their parts, and components, taking into account the environmental, health, human rights and socio-economic impacts, and their continuous improvement through all stages of the product's life cycle.

TANNING

Tanning is the process of treating skins and hides of animals to produce leather. Industrial methods of tanning skins into leather involves a process which permanently alters the protein structure of skin, making it more durable and less susceptible to decomposition, and also possibly colouring it. Traditionally, tanning used tannin, an acid chemical compound from which the tanning process draws its name. The use of a chromium (III) solution was adopted by tanners in the Industrial Revolution. Traditional methods of processing hides or skins that would not be recognised as true leather production according to modern definitions are mechanical softening and tanning with smoke, urine, brain, oil, fish roe, cornmeal and bark.

TANNINS

Tannins are polyphenolic compounds naturally found in plant materials. Their presence in nature has prompted their historical use in leather tanning. The high content of tannins in plants—they can represent up to 20% of dry weight- explain their use since it represents a valuable material from an economic and natural source.

TRACEBILITY

Traceability is the ability to "identify and trace the history, application, location and distribution of products, parts and materials, to ensure the reliability of sustainability claims, in the areas of human rights, labour (including health and safety), the environment and anti-corruption"; and "the process by which enterprises track materials and products and the conditions in which they were produced through the supply chain".

TRANSPARENCY

Transparency relates directly to relevant information being made available to all elements of the value chain in a standardized way, which allows common understanding, accessibility, clarity and comparison. In order to be transparent, a brand shares the names and information about every factory involved in the manufacturing process. In turn, this gives a product traceability, meaning consumers can trace a product and its components back through each step of the supply chain, right down to its raw material.

TWO SPIRIT

"Two spirit" was coined at a gathering of Native American and First Nations people in 1990 and embraced for its connotations of balancing or combining male and female qualities. Today, "two spirit" (sometimes rendered as "two-spirited") is used in reference to both male-bodied and female-bodied Native people who mix, cross, or combine the standard roles of men and women. Two spirit means being born with a male and a female spirit, a historical reminder that before colonisation all of the native American tribes had multiple genders. In many instances, male and female. Two spirited were medicine people, healers, shamans, and ceremonial leaders.

ULU

A multi-purpose woman's knife with a crescent-shaped blade of sharpened stone or metal and a handle of bone, ivory or wood. This tool was used in the manufacture and the processing of other materials (e.g. skin). An ulu is a very important tool for Alaska Native Peoples, used for cooking, cutting meat, skinning seals and fish and cutting and marking patterns for sewing. While regional styles and materials vary, all ulus share an elegant crescent shape designed to reduce wrist fatigue during long hours of processing food and skins.

UNANGAX

The Native Peoples of the greater Aleutian Islands region refer to themselves by two names, Unangax̂ and Aleut, the former in their own language, Unangam tunuu, and the latter a name applied only after foreigners first came to the region in the mid-1700s.

UNESCO

This is the United Nations Educational, Scientific and Cultural Organization.

VEGETABLE TANNED LEATHER

Vegetable tanned leather is a leather in its own right produced with tanning agents of certain barks, fruits or leaves which transforms the hide or skin of an animal into a durable material. New formulations have appeared recently from grape seeds, olive tree leaves and rhubarb. This process makes it possible to obtain leathers that are firm, highly resistant to abrasion, technical and hypoallergenic. They also have antibacterial advantages and are breathable, with good absorption and evacuation of moisture. They possess a characteristic scent, warm shades that deepen over time and an ability to age well.

VEGAN FASHION

Vegan fashion means that no animal testing nor animal-derived materials such as leather, fur, or exotic skins are included in products and collections.

VEGAN LEATHER

A term used to refer to synthetic material made to look like leather. Once the biomaterials enter the manufacturing facility, the chemicals applied to turn them into a leather alternative are deliberately obfuscated to make them appear more sustainable than they are. Each vegan leather contains a variety of ingredients ranging from biopolymers to restricted substances that are definitely harmful to the planet.

VEGEA

Vegea is an Italian company making leather from wine grapes. Using by-products and waste from the winemaking process, Vegea has developed a 'leather-like' material and is the winner of H&M's Global Change award.

YUP'IK

The Yup'ik are a group of Native Peoples of western, southwestern, and southcentral Alaska and the Russian Far East. They are related to the Inuit and Inupiat peoples. Yup'ik women made clothes and footwear from animal skins of marine and land mammals including fish.

ZDHC

This is Zero Discharge of Hazardous Chemicals.

ZERO WASTE

Zero waste is an alternative pattern making technique where the pattern pieces are fit together so that no fabric is wasted during the cutting phase.

Figure 10.1. Wolf fish skin shoes. National Museum of Iceland. Reykjavik, Iceland, 2021.

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Harvard style

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Appendix I
EU Horizon 2020-MSCA-RISE FISHSkin: Developing Fish Skin as a Sustainable Raw Material for the Fashion Industry.

In 2017 I wrote the proposal ‘ FISHSkin: Developing Fish Skin as a Sustainable Raw Material for the Fashion Industry’ for the EU Horizon 2020-MSCA-RISE-2018 call. The proposal was inspired by my PhD research but with the distinct focus on improving existing fish leather tanning technologies and developing new finishing techniques.

For this Horizon 2020 RISE (Research Innovation Staff Exchange) funding call, our proposal with GRANT NUMBER 823943 received the highest score of 98.6% in 2018. The project was first out of 600 proposals with an acceptance rate of about 15%. This is a collaborative project with 7 European participants of academic and non-academic character, with a proposition to use fish skin waste from the food industry, as raw material for the fashion industry. While fish skin was used for centuries by Arctic Peoples in Alaska, Siberia, Scandinavia, Iceland, Hokkaido, Japan and China, it was pushed aside by other alternatives which at the time offered better characteristics.
Today, however, circular economy principles combined with state-of-the-art technology and changing consumer tastes – allow us to challenge existing fashion assumptions and explore the viability of fish leather for a variety of applications. There is a pressing urgency to find solutions for waste reduction in Mariculture and encourage a zero-waste in the food and fashion industries and beyond. Through secondments and network training events we are currently generating knowledge cohesion from different disciplines: Fashion design, Material science and Marine biology where academic and industrial experts strive to develop new techniques and methodologies for a market take up of fish leather. The objective is to create aesthetically relevant and technically crafted fish leather products as a driver for innovation and sustainable processes. The project looks at the strategies implemented by practice in the field of material design innovation fed by new technologies, addressing changes in interactions between humans and with our environments. The current zeitgeist, which is highly influenced by the ongoing impacts of the Covid 19 pandemic and by pressing environmental needs, has strengthened the premise for this project, and intensified the urgency to develop raw materials that are not sourced directly from fossil fuels. Our project touches upon relevant, culturally, and scientifically complex issues relating, among others, the use of animal/bio-based materials, the relationship between innovation and historical crafts/heritage, the centrality of technologically enhanced materials, digital representation and commerce, waste management and circularity, inter-sectoral industrial coordination, amongst others. Publications and participation in conferences and lectures, especially driven by me in collaboration with other partners, has sprung particular interest and received considerable attention and recognition.

Leather remains a vital material for most luxury fashion houses. Thanks to the use of new technologies, the luxury industry offers a vast array of appearances and finishes among conventional leather, while both the use and creative development of fish leather has been largely neglected. The aim of this research is to pilot and develop non-polluting technologies for fish leather finishes to advance the development of future manufactured fish leather products. The project explores existing traditional knowledge of fish skin processes and applies the analysis of this learning using state-of-the-art practices and developing new technologies while addressing specific challenges of the use of fish leather for the fashion industry. The results can bring a fresh look at how fish leather development with new technologies can underpin and reshape luxury fashion accessories.

On this project I have contributed with knowledge regarding printing and surface manipulation geared for the fashion industry. Designing with new techniques, materials, layering and finishing I bring design-led investigation of new ways of using fish leather, developing new sustainable dyeing methods, new digital print technology and new embellishment techniques, exploring the relationship between digital technologies for fish leather with traditional print and dyeing processes to produce prototypes/samples for accessories and developing new skills in completely new disciplines to 'grow' future high-performance sustainable fashion fish leather products and services.

The project started with an investigation of ancient and traditional leather embellishments culminating with a training in traditional printing and finishing techniques in Kyoto, Japan. Once traditional data was established, I have continued to develop novel printing techniques for fish leather and assisting technologies for surface manipulation given different 3D structures of the leather. A variety of new sustainable dyeing methods, new digital printing technology with high bonding and light fastness and as well as embellishment techniques have been explored and categorized via-a-vis a variety of the relevant fish leather.

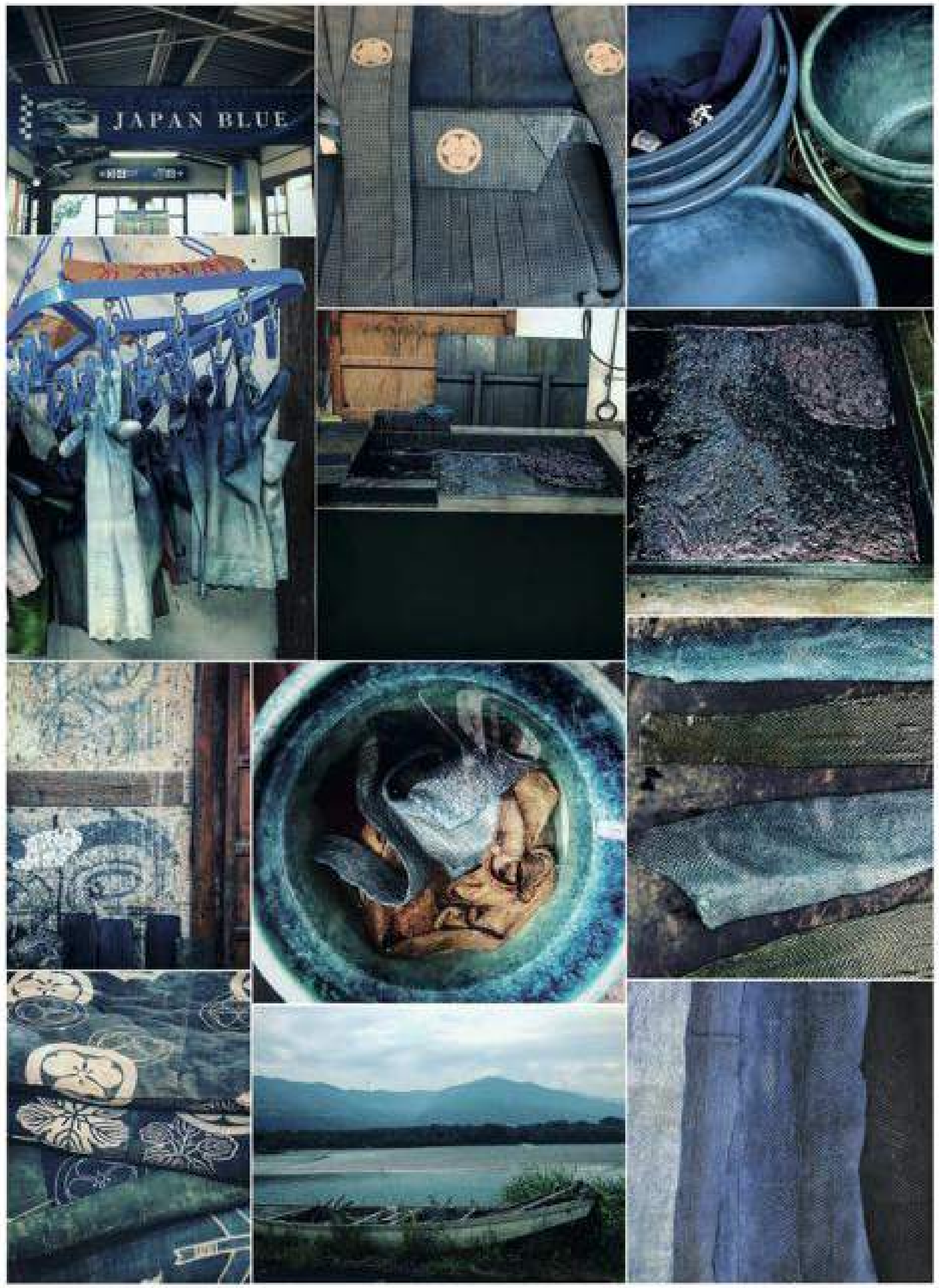


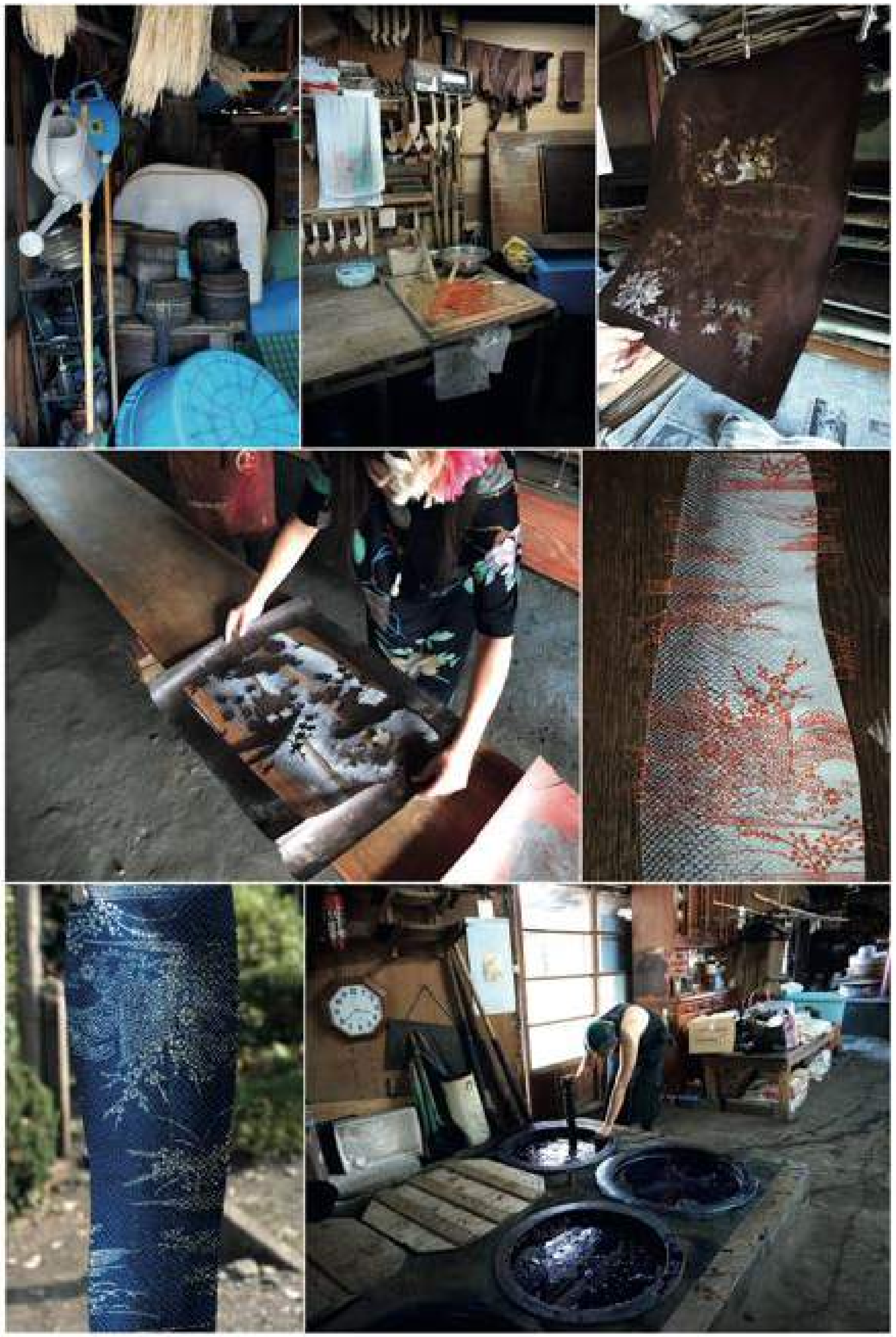
Figure 11.5. to 11.16. Fish leather indigo dyeing process at the Indigo Museum, Tokushima, Japan, 2019.

Testing traditional dyeing processes

For the development of traditional dyeing processes, I worked with Kyoto Seika University, the Japanese partner of the EU Horizon 2020 FISHSkin project. Mitsuhiro Kokita, CSM alumni and longtime collaborator of mine put me in touch with traditional Japanese indigo dye masters, and I was able to experiment with traditional indigo katazome and Shibori dyeing techniques to apply them to fish leather. During my field trip to Japan's Kanagawa prefecture in December 2019, I worked closely with indigo master Takayuki Ishii, an artisan who runs an indigo dyeing business using traditional techniques and materials. Takayuki is one of six artisans left in Japan cultivating indigo plants and producing sukumo to preserve the traditional method of indigo dyeing. He has passed on his knowledge to many artists and young students and strives to preserve the traditional technique. At his studio I tried both Indigo and persimmon dyeing. Takayuki taught me how to create my own mulberry paper stencil (Figure 11.26.) and I used both my newly created stencil and vintage stencils to print the glutinous rice resist paste and deep the fish leather in his indigo vats (Figures 11.26. to 11.35.). He taught me the whole process of sukumo indigo (Figures 11.36. to 11.41.), as he himself grows the indigo plants nearby. He also taught me the shibori dyeing technique (Figure 8.2.), which I successfully applied to fish leather. On the last day we tried traditional persimmon dyeing with the juice of green persimmons (Figures 11.62. to 11.68). The results were equally successful. We also tried pine smoke dyeing, but the fish leather was too stiff, so this technique is not recommended as a dyeing alternative.

Japanese rural people have been using indigo blue dye "Aizome" for colouring their textiles for centuries. The indigo plant grew wild and was plentiful throughout most areas of the Japanese Islands and its dye was favoured for its ability to hold the deep blue colour in the fabric after many years of use (Austin, 2020). Katazome, is a traditional Japanese textile process using a katagami or stencil pattern for dying textiles used for printing Kimonos. The technique uses a resist paste made from rice flour that is passed through the katagami stencil (Figures 11.26. to 11.35.) onto the material before dipping into the indigo vats (Figures 11.36. to 11.41.). The paste resists dyes and once removed after dyeing, the patterns and imagery from the stencil are revealed. Katagami paper is made from several layers of handmade mulberry paper lacquered together with fermented persimmon juice acting as a tannin to waterproof and strengthen the paper.

Figure 11.17. Fish leather indigo dyed at the Indigo Museum, Tokushima, Japan. Photographer, Laura Fernandez, 2021.



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Figures 11.36. to 11.41. Indigo Katazome process using a katagami or stencil pattern for dying textiles used for printing Kimonos at Takayuki Ishii Indigo dyeing workshop. Photographer Takayuki Ishii, 2019.

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Figure 11.47. Fish leather clutch dyed with Indigo Katazome process using a katagami or stencil pattern for dying textiles used for printing Kimonos.Photographer, Laura Fernandez, 2021.

Research and development of 3D prototyping of fish leather

Each sample of fish leather I have produced using the newly developed techniques has been subjected to materials-based research, creating full-scale prototypes that test specific visual and mechanical characteristics against existing leathers on the market and to test specific uses and particular products. These prototypes will identify areas where fish leather would be suitable for the fashion industry. Depending on the results, further characterisations of fish leather will be considered, to cover the suitability for known applications as well as new ones, which will be generated by these innovative experimentations.

Fish leather footwear

Fish leather can be used in several wear resistant fashion items such as apparel and accessories. It can also be used in footwear such as shoes, sandals and boots. It is more commonly used in smaller fashion items like bags, belts and wallets. Further research reveals that fish leather is also being used for fashion related products such as smart phones and tablet covers. However despite common belief that the size of fish leather lends it for more common use in smaller fashion objects, it can be used for much larger items. This is achieved with pieces of the leather put together to make large sizes enough to produce bigger prototypes.

Another of my contributions to the EU Horizon 2020 FISHSkin project is the development of an indigo katazome dyed fish leather sneaker (Figure 11.48.). The sneaker was done in collaboration with Cristina Mirri, a former colleague of mine from our time working at John Galliano's studio. The sneaker was made by Calzaturificio Tarcio https://tarcio.it/ .The company is a small shoe factory, with an artisan workshop based in Bologna, in which three brothers work following in the footsteps of their father, a shoemaker. The company is not very industrialized and most of the work is done by hand. The factory is dedicated to made-to-measure production and is designed to meet the different needs and desires of each customer. They work on small quantities and on all kinds of materials with the attention and know-how typical of Italian craftsmanship.

An average running sneaker generates 13.6 kg of CO_2 emissions, as calculated by Allbirds — a 2013 MIT study (Chu, 2013). Two-thirds of a running shoe's carbon impact can come from manufacturing processes, with a smaller percentage arising from acquiring raw materials. A typical pair of running shoes comprises 65 parts requiring more than 360 processing steps to assemble, from sewing and cutting to injection moulding, foaming and heating. For these small, light components such processes are energy-intensive — and therefore, carbon-intensive — compared with the energy that goes into making shoe materials, such as polyester and polyurethane.

Our goal was to identify ways to improve designs and reduce the shoe's carbon footprint. Our sneakers could cut CO_2 emissions by more than a half, because of their eco design, use of low impact fish leather material and production process. The model that has been created has the

Figure 11.48. Katazome dyed fish leather sneaker designed and created by Cristina Mirri at Calzaturificio Tarcio of Bologna. Photographer, Laura Fernandez, 2021.

proportions and comfort of a sneaker and the technical characteristics of each component from raw materials to manufacture are the result of extensive research in the field of sustainability.

The reinforcements used inside the upper are in leather and not thermoplastic. The adhesives for both the upper and the sole are water-based, completely hypoallergenic and non-polluting. The sole has been produced in Italy by Wearlight, a world leader in the moulding of plastic soles at the forefront of research into recycled or natural materials, with no chemical agents that are hazardous to the health of human and the environment. The sole is made of EVA with 60% recycled material from the waste of internal processing. Manufacturing facilities tend to throw out unused material. Recycling these scraps can reduce carbon footprint.

The upper is made entirely of fish leather from Nordic Fish Leather. https://nordicfishleather.com/ The fish leather has been dyed by me in collaboration with Japanese Indigo Master Takayuki Ishii with indigo Katazome (Figure 11.49.), a traditional Japanese textile process using a katagami or stencil pattern for dying textiles used for printing kimonos.

The lining is made of calfskin with soft vegetable tanning non-toxic and anti-allergenic (also without toxic dyes) for the health of human and the environment. The laces are made in Italy by Centro Accessori and 100% cotton. https://centroaccessori.eu/collezione-sostenibile/

The internal fussbett is removable for cleaning and breathability, it is lined in the same natural hypoallergenic leather as the upper and the plastic part in memory foam was moulded in Italy by Miami, studying a compound with a high percentage of recycled material.
https://www.miamisrl.co/products/injected

Figure 11.49. Fish leather dyed with Indigo Katazome process using a katagami or stencil pattern for dying textiles used for printing Kimonos. 2021.

Ainu Fish skin robe replica

During my Fulbright scholarship at the Smithsonian National Museum of Natural History (NMNH), Arctic Studies Center, I was able to dive on the NMNH collection and access Arctic and Sub Arctic artefacts that have deeply influenced my artistic practice. Among the artefacts at the NMNH, there was a traditional Ainu robe made with a Japanese kimono cotton fabric created with the Katazome indigo dyed technique. This particular robe inspired me to develop a series of Katazome indigo dyed fish leather samples during my following fieldtrip in Japan's Kanagawa Prefecture, with Indigo Master Takayuki Ishii. These Katazome dyed fish skins are part of a study hypothesizing what would have happened if during the Meji era, the Japanese instead of making the Ainu shift from hunting, fishing, and gathering to agriculture had brought their own traditions like Katazome indigo dyeing and had blend them with the Ainu tradition of creating garments and accessories with fish skin.

The fish skin robe replica (Figures 11.50. to 11.57.) was sewn by Vanna Bellini, former head of Valentino's Haute Couture atelier in Rome, a pattern maker and garment technologist with over 50 years' experience working for the ready-to-wear and Haute-Couture collections at Armani, Ferre, Versace and many others. The garment was constructed according to the fish skin shape; every skin fitted with the next and nothing was wasted. The natural appearance of the fish skins served as an inspiration in the sewing process of this fish skin robe. We used the contrast of the white skin of the fish belly against the dark skin of the dorsal area. Specific design references within the body of the garment, like belt and kimono sleeve, were created by contrasting the light and dark areas of the fish skin.

Figures 11.50. to 11.55. Replica of an Ainu fish skin robe made with indigo katazome dyed fish skins inspired by Japanese kimono patterns, 2021.

Figures 11.56. and 11.57. Replica of an Ainu fish skin robe made with indigo katazome dyed fish skins inspired by Japanese kimono patterns, 2021.

Figure 11.58. Ainu fish skin avatar robe with Japanese indigo katazome pattern created with Blender and CLO3D by Ana Cordoba Crespo.

Figure 11.59., 11.60. and 11.61. Ainu avatar wearing a fish skin robe with Japanese indigo katazome pattern created with Blender and CLO3D by Ana Cordoba Crespo.

Figure 11.62. and 11.63. Ainu avatar wearing a fish skin robe with Japanese indigo katazome pattern created with Blender and CLO3D by Ana Cordoba Crespo.

Figures 11.64. to 11.67 fish leather dyed following the Kakishibu traditional Japanese dyeing method using the discoloration caused by oxidation of the fermented juice of unripen persimmon fruit containing strong tannin, 2019.

Figure 11.68. fish leather dyed following the Kakishibu traditional Japanese dyeing method using the discoloration caused by oxidation of the fermented juice of unripen persimmon fruit containing strong tannin, Photographer, Laura Fernandez, 2021.

Appendix I
WORTH Partnership Project

My project FISHSKINLAB: a fish skin clutch collection, won the first call of the WORTH Partnership Project, funded by the European Commission under COSME, the EU Programme for the competitiveness of Small and Medium-sized Enterprises. WORTH is the sole European project where designers, SMEs, manufacturers, and tech providers work together to develop innovative, design-oriented business ideas. The project focuses on lifestyle industries, including fashion and textiles, footwear, leather, furniture, home decoration, interior design, jewellery and accessories. The project provides companies with an incubation programme to develop new businesses, including 10.000 € in financial support; coaching on business strategy and technology development; legal advice on intellectual property rights and protection; participation in exhibitions; networking and professional links. The first edition (2017-2021) involved partners from EU-27, UK and COSME countries.

The winning FISHSKINLAB project aims to introduce concepts such as the sustainability and craft innovation of fish leather in the luxury industry with the final aim of substituting exotic skins from luxury leather- based products while preserving ancient and innovative techniques. The technological challenge was to pilot and develop new technologies, based on fish leather finishes together with a high component of design promoting future manufactured fish leather products for the luxury industry. The collaboration and cooperation among the Icelandic tannery Atlantic Leather and myself as fashion designer, is a fine example of an innovative way of linking the preservation of traditional knowledge and culture and the development of culturally relevant fashion items taking in consideration the sustainable limits of the planet's natural resources. The Fishskinlab clutch collection combines the technological progress of Atlantic Leather, an Icelandic tannery leading in manufacturing leather from fish skin with my designs. Fishskinlab presents a clutch collection using salmon leather in a diverse range of colours, textures and finishes. The idea itself is rooted in tradition where centuries ago Icelanders wore shoes made of wolfish skin.

http://www.fishskinlab.com/41/projects/worth-partnership

Japanese Inlay (Zougan) technique

Zougan is a traditional Japanese inlay craft to make pictures or patterns using natural wood of different colours. Various techniques of inlay crafts have prevailed widely around the world since ancient times. Metal inlay crafts originate from Damascus in Syria, and it is said that the technique travelled along the Silk Road and reached Japan around the Asuka period (592-710). Until end of the Edo period, Zougan was mostly used for decorating valuable items, such as swords for samurai lords and imperial members. Eventually, the Zougan technique began to be used for other items.

The inlaid woodwork of Japanese prefectures of Hakone and Odawara is made from natural wood of various colours, however some products have parts which cannot be depicted by natural wood colours, so the timber must be dyed soaking completely the interior of the wood. Moreover, the white colour of the wood is the result of bleaching it with the rain which allows the colour to emerge (Kyo Zogan, 2015).

I have been privileged to work with Japanese Master Takafumi Mochizuki to mix this technique with fish leather through his skilful labour in the form of these inlaid woodwork/ fish leather masterpieces (Figures 11.69. to 11.79). Born in Tokyo in 1979, Takafumi Mochizuki moved to Florence in 2007 to refine his wood restoration and inlay techniques. Trained in the workshop of master craftsman Renato Olivastri, Takafumi inaugurated his brand Zouganista in 2014, choosing the Oltrarno as his operational and creative base. Over the years, Takafumi has worked for commercial brands, designers and private individuals, as well as collaborating with other international artists and craftsmen. His work ranges from interior design to the production of fashion accessories. With more than 15 years of mastering the Zougan technique, he has achieved incredible skills that have been honoured by regional art exhibitions. Cutting by hand all the various woods used for his intricately woven masterpieces, Mr. Takafumi has preserved an artform unrivalled throughout the world.

Figures 11.69.to 11.72. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with the Japanese Inlay (Zougan) technique to make pictures or patterns by using natural woods with various colours. Florentine based Zougan artist Takafumi Mochizuki skillfully mixed the shiny mimosa tanned fish leather with the natural woods. Photographer Jay Zaccheus, 2021.

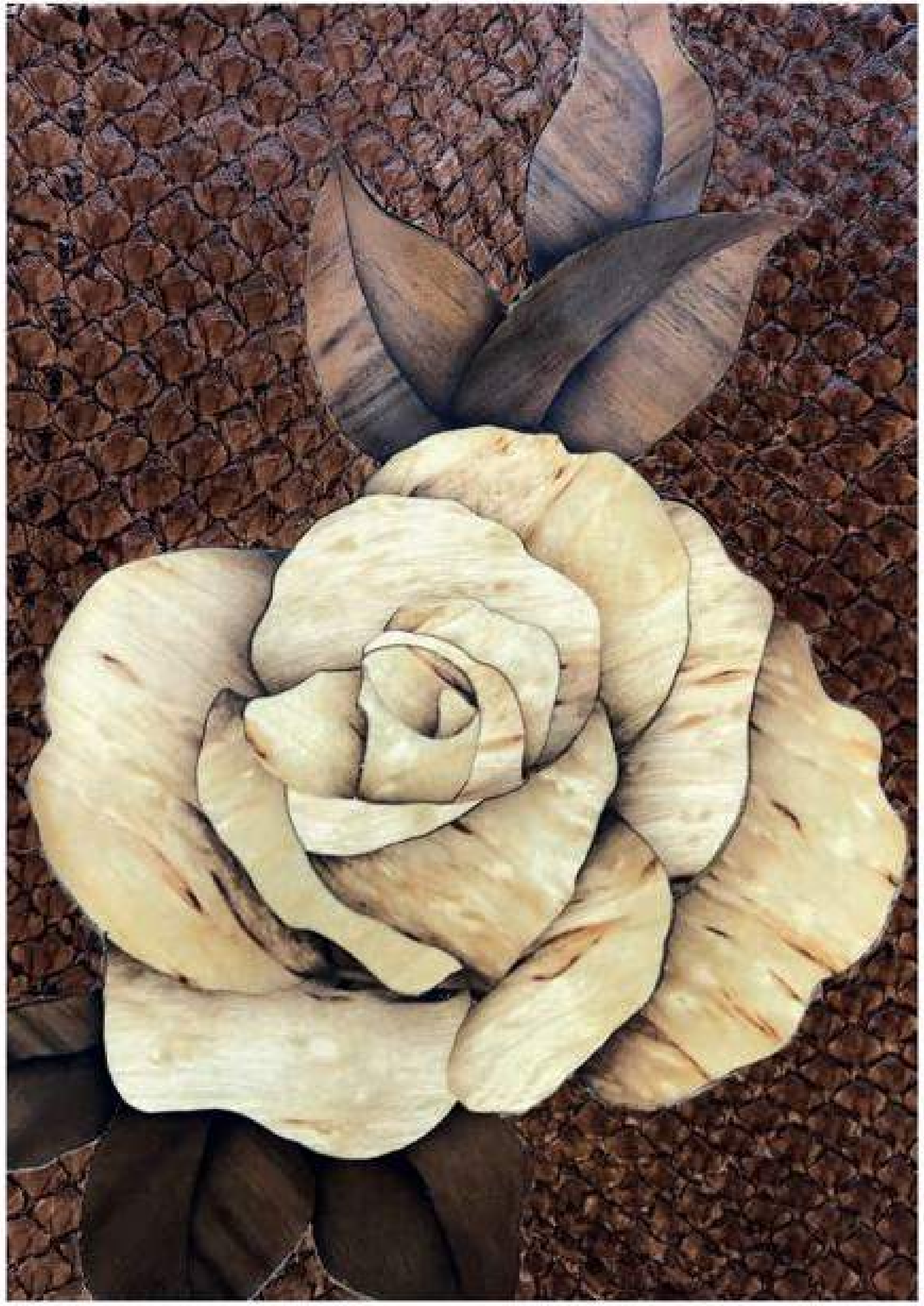


Figure 11.73. Handmade fish leather clutch made with the Japanese Inlay (Zougan) technique to make pictures or patterns by using natural woods with various colours. Florentine based Zougan artist Takafumi Mochizuki skillfully mixed the shiny mimosa tanned fish leather with the natural woods, Photographer, Laura Fernandez, 2021.

Figure 11.74. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with the Japanese Inlay (Zougan) technique to make pictures or patterns by using natural woods with various colours. Florentine based Zougan artist Takafumi Mochizuki skillfully mixed the shiny mimosa tanned fish leather with the natural woods, Photographer, Laura Fernandez, 2021.

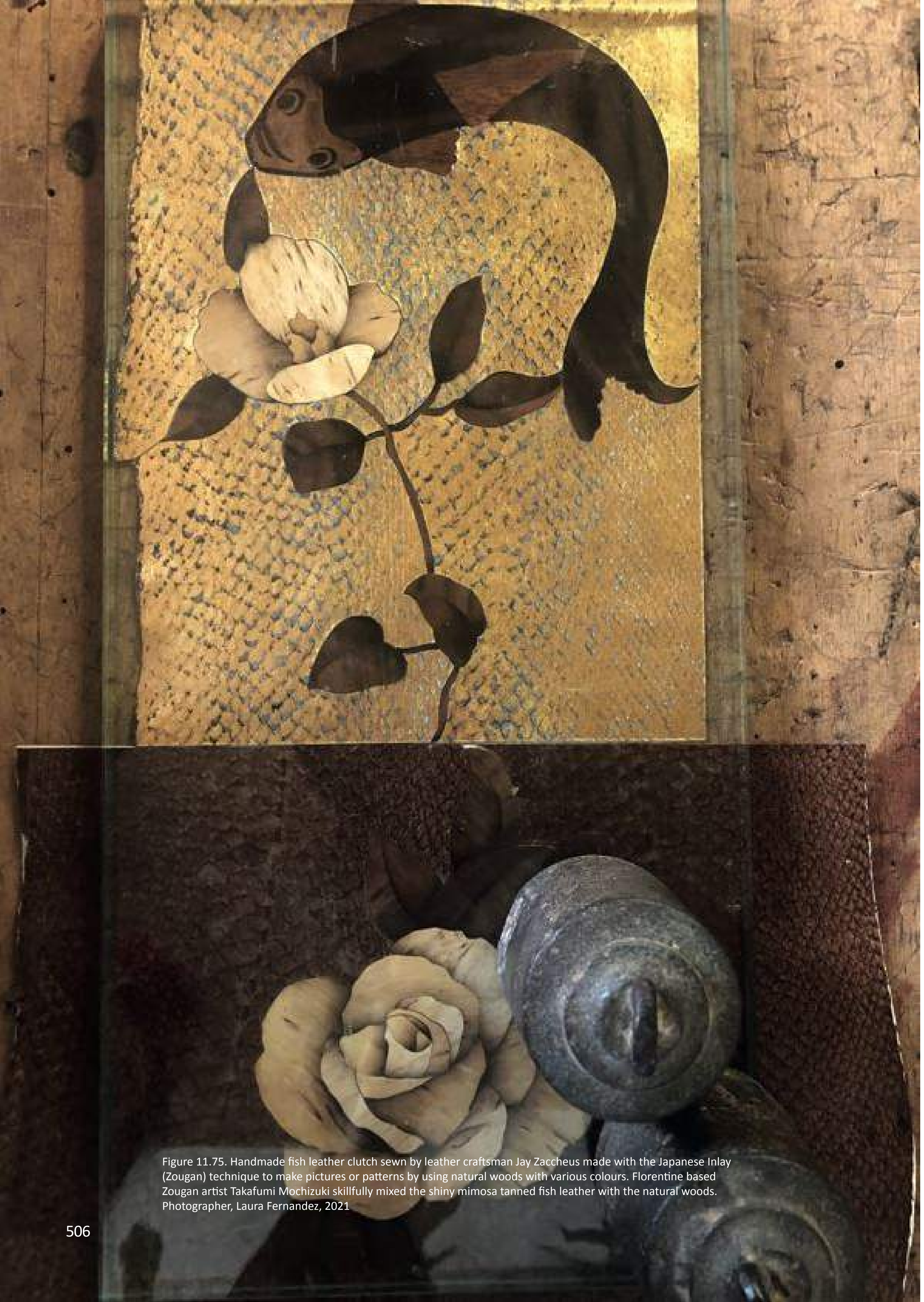


Figure 11.75. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with the Japanese Inlay (Zougan) technique to make pictures or patterns by using natural woods with various colours. Florentine based Zougan artist Takafumi Mochizuki skillfully mixed the shiny mimosa tanned fish leather with the natural woods. Photographer, Laura Fernandez, 2021

Figure 11.76 to 11.79. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with the Japanese Inlay (Zougan) technique to make pictures or patterns by using natural woods with various colours. Florentine based Zougan artist Takafumi Mochizuki skilfully mixed the gold foiled fish leather with the natural woods. Photographer Jay Zaccheus, 2021.

Figure 11.80. Fish leather clutch with Japanese Inlay (Zougan) technique. Florentine based Zougan artist Takafumi Mochizuki skillfully mixed the gold foiled fish leather with the natural woods. Photographer, Laura Fernandez, 2021.

Figure 11.81. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with the Japanese Inlay (Zougan) technique to make pictures or patterns by using natural woods with various colours. Florentine based Zougan artist Takafumi Mochizuki skillfully mixed the gold foiled fish leather with the natural woods, Photographer, Laura Fernandez, 2021.

Japanese Origami Technique

Many studies assert that origami was invented by the Japanese about a thousand years ago, but its roots may well be in China. It is also highly probable that the process of folding was applied to other materials before paper was invented, so the origins of recreational folding may lie with cloth or leather. Paper was invented in China, and a Chinese court official, Cai Lun, has been traditionally credited as the inventor. Japanese papermakers improved the quality of paper still further until it was suitable for folding (Robinson, 2022). The earliest records of origami in Japan date to the Heian Period (794-1185). It was during this period that Japan's nobility had its golden age, and it was a time of great artistic and cultural advances. Paper was still a rare enough comodity and a pastime for the elite. The traditional Japanese technique of origami typically involves folding paper into a variety of intricate shapes—often representative of animals or plants.

For this Origami Clutch (Figures 11.82. to 11.84), I collaborated with Florence based artist Ester Cellucci—who creates dynamic origami pieces with leather. Ester has worked with Shingo Sato, master of "Transformational Reconstruction Technique", learning his origami techniques. Shingo Sato's method is a combination of origami, flat patternmaking and three-dimensional draping. He shapes his work with traditional two-dimensional pattern techniques to achieve three dimensional effects, often cut in waves, stripes and other geometric patterns of fabric and colour (David and Sato, 2018).

In this case Ester used folding, forming, layering, twisted draping, smocking and precision pattern cutting to create the Origami Clutch.

Figure 11.82. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with origami pattern by Florence based artist Ester Cellucci. She uses leather to create intricate origami patterns. Photographer Jay Zaccheus, 2021.

Figure 11.83. Fish leather origami pattern by Florence based artist Ester Cellucci. She uses leather to create intricate origami patterns, Photographer, Laura Fernandez, 2021.

Figure 11.84. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with origami pattern by Florence based artist Ester Cellucci. She uses leather to create intricate origami patterns, Photographer, Laura Fernandez, 2021.

Development of sustainable digital printing technologies for fish leather

One of my key contributions to the EU Horizon 2020 FISHSkin project is the development of new techniques of digital printing with high bonding and light fastness for fish leather. The new printing techniques will allow the inks to be applied with great precision and will reduce the ecological footprint as it will cause less ink waste and consume less energy, water and chemicals. This contribution has led to the development of a collection of digitally printed fish leather samples and clutches (Figures 11.85. to 11.97.). The skins were sourced at Nordic Fish Leather, I have developed the prints and followed the technical process while the digital printing was produced at DevStudio and tested at Italian chemical laboratory Ars Tinctoria.

Textile digital printing emerged in the 1990s as a prototyping tool and a vehicle for printing small batches of fabric for niche-market products (Provost, 1994). Inkjet printing involves the propelling of tiny droplets of dye or pigment onto a fabric electrostatically. The selected dyes or pigments are dosed on demand and avoid print paste residues at the end of each run and if pigmented inks are used (rather than those based on dyes) no solvent which associated volatile organic compound emissions is required to dissolve the colourant (Fletcher, 2013). Recent decades have seen the growing popularity of water-based ink-jet inks for textile printing.

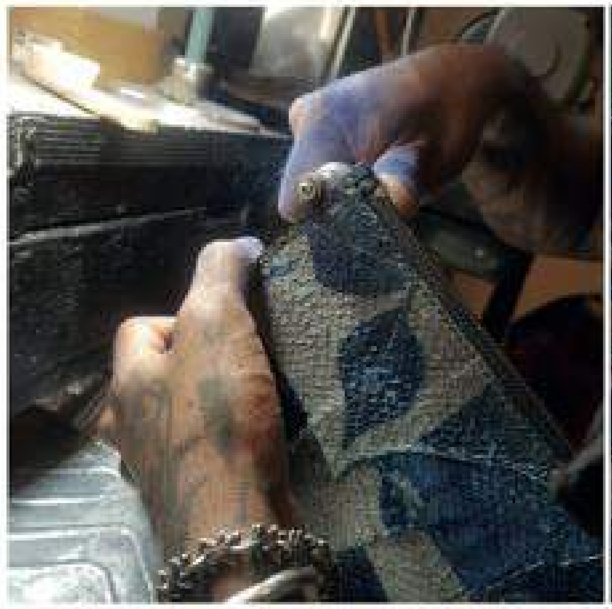
The fish leather samples were printed at DevStudio (www.devstudio.it) a software producer with twenty years' experience in the development of PostScript RIP (software for digital printing) solutions for the retail market, OEM software in digital printing and colour management. DevStudio chose to use water-based ink-jet inks (for their environmental sustainability) for digital textile printing on fish leather for this project. DevStudio company has developed in-house vital components such as the colour engine, multi-channel linearization module that controls each ink separately, and the profiler (compatible with the ICC 4,0 standard). Over the years DevStudio has established OEM partnerships with several major companies applying its digital printing technology in many vertical markets and developing specific skills both on the various types of printing machines as well as on different surfaces such fabric, leather, glass and wood. DevStudio solutions are designed to save from 30 to 90% on ink for printing on coloured backgrounds thanks to an exclusive patent BG.A.P.TM, acronym of BackGround Adaptive Profile that allows the designer to use the background colour, modulated by white ink, as if it were a dye, to build the image. A specific software RIP for special media is essential for an accurate control of the amount of ink deposited on the skin and, therefore, to obtain a qualitative and durable print on that support.

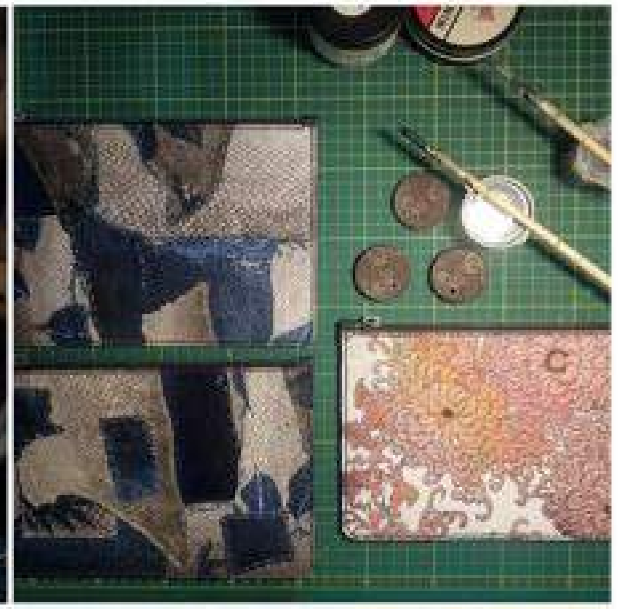
The print tests were performed on small pieces of salmon leather of different sizes. To determine and optimize the placement of the design, DevStudio used their own visual assisted print (VAP) solution which uses a camera working with the print RIP. With this solution it is possible to print exactly on every shape, saving material and ink.

Fish leather printing can be difficult since ink generally does not bond well to a non-uniform, organic, complex substrate. The non-uniformity and surface roughness of the fish scales was one of the main obstacles during the process. The significant variation on a single fish skin as well as between skins of a batch was also a challenge. Techniques for printing on fish leather may suppress at least one usual property of fish leather, e.g., appearance, feel and/or absorption. Printing onto the surface of fish leather could be disadvantageous if the ink is weakly bonded and it could be easily removed during normal wear and tear, or if the print cracks when flexed (Pantelis, 2013). During the test phase, the printing of fish leather included the application of an ink base coat directly onto the surface of the fish leather. The experiments show that a selected combination of pressure and temperature is required. Success was achieved when the transfer of ink into the fish leather occurred across the leather sample with good penetration. In unsuccessful tests, the transfer of ink into the leather had a non-uniform penetration.

The physical and rheological properties of the inks were measured for the evaluation of ink stability and suitability for ink-jet printing. The tests were found to be suitable. The prints were subjected to light and rub fastness tests and colour measurements. Colour consistency and fastness results, especially after fixation, are comparable with those on conventional leather, which paves the way for the production of environmentally friendly water-based ink-jet inks for the digital printing of fish leather.

Figure 11.85. Fish leather digitally printed with Eco-friendly water-based ink-jet inks, 2021.





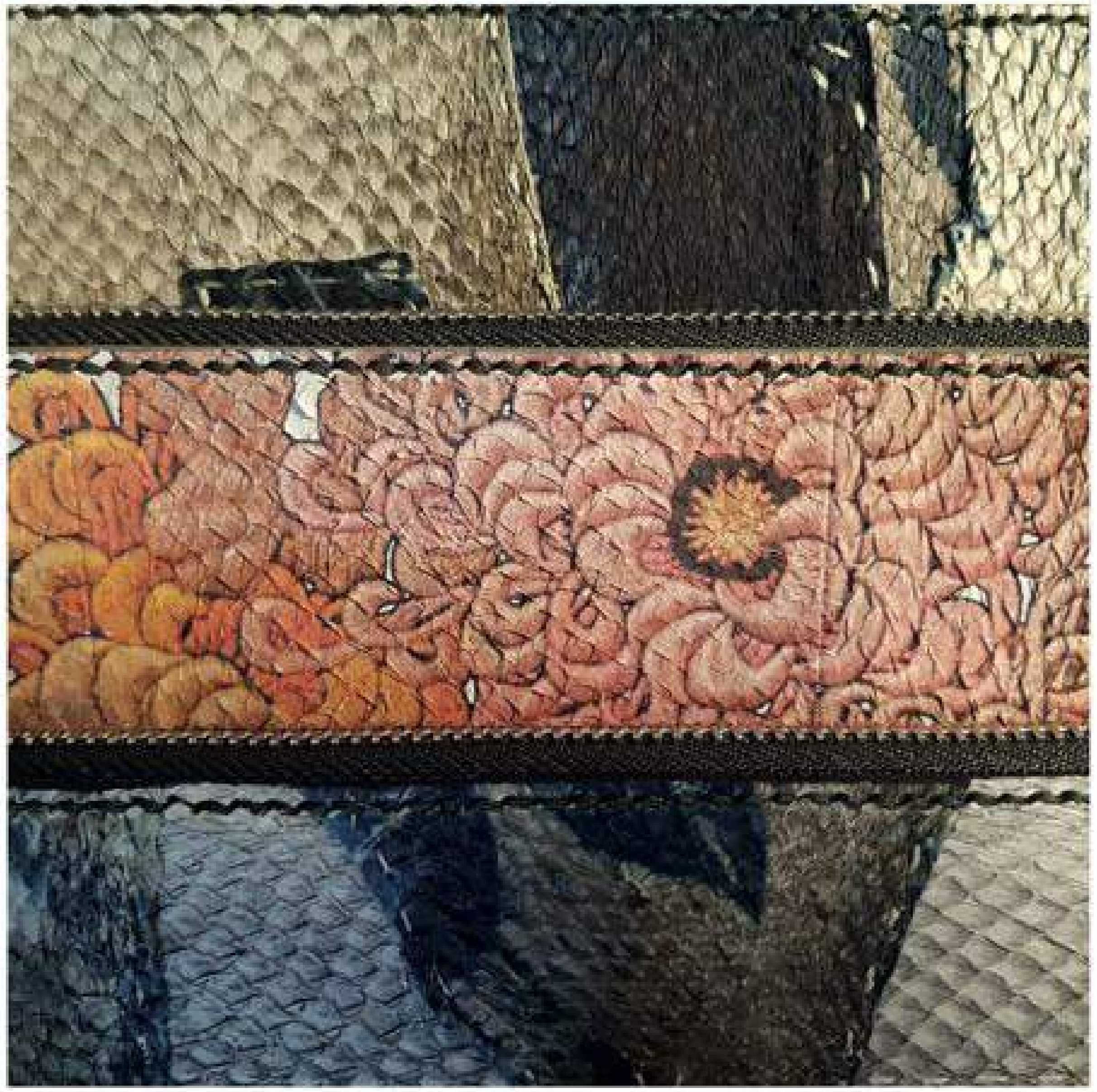


Figure 11.86. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with Boro technique indigo dyed fish leather. Photographer Jay Zaccheus, 2021.
Figure 11.87 and 11.88. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with fish leather digitally printed with Eco-friendly water-based ink-jet inks. Photographer Jay Zaccheus, 2021.

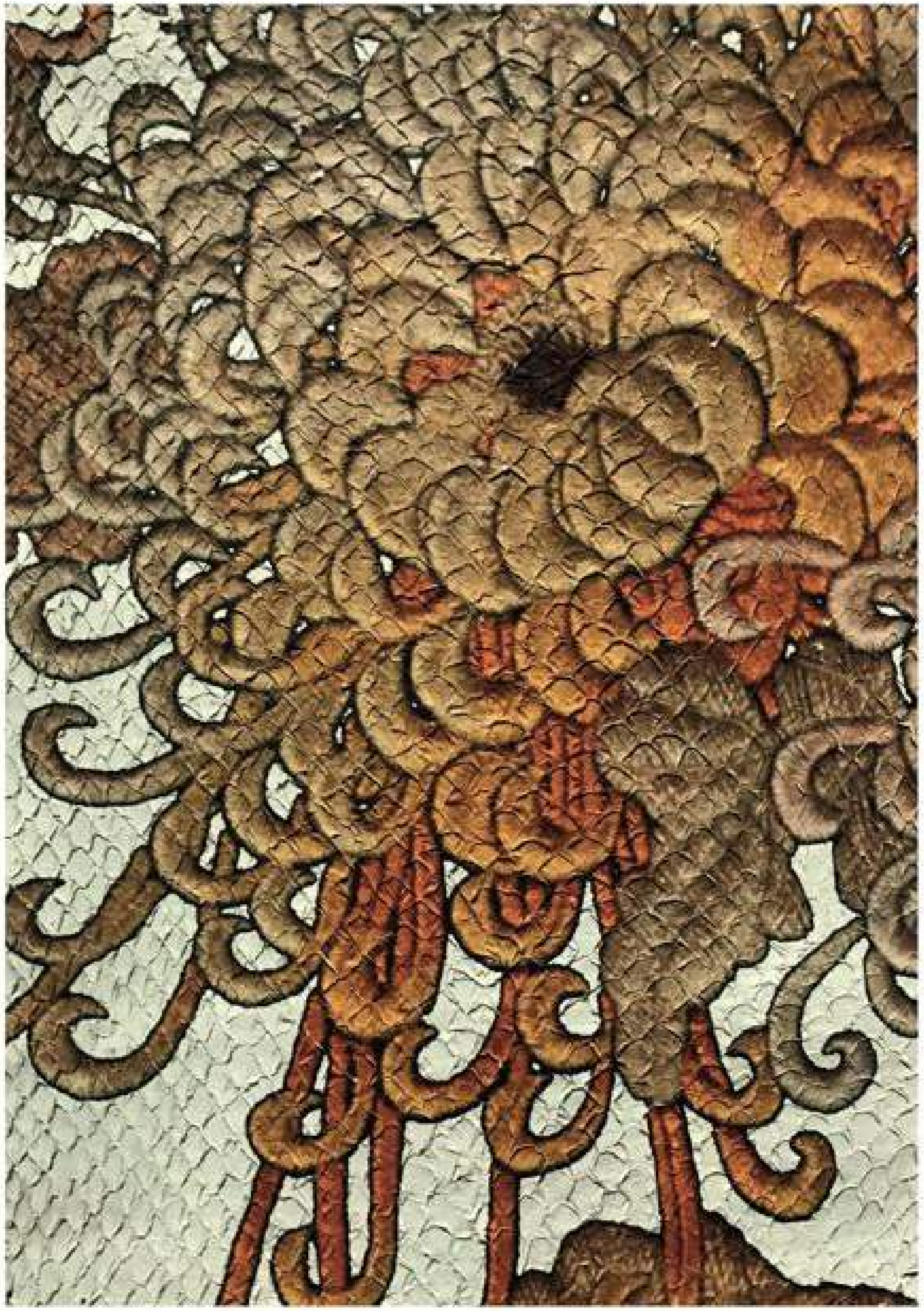


Figure 11.89. Fish leather digitally printed with Eco-friendly water-based ink-jet inks, Photographer, Laura Fernandez, 2021.

Figure 11.90. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with fish leather digitally printed with Eco-friendly water-based ink-jet inks., Photographer, Laura Fernandez, 2021.

Figure 11.91. UV light digital printing on fish leather, Photographer, Laura Fernandez, 2021.

Figure 11.92. UV light digital printing on fish leather, Photographer, Laura Fernandez, 2021.

Figure 11.93. UV light digital printing on fish leather, Photographer, Laura Fernandez, 2021.

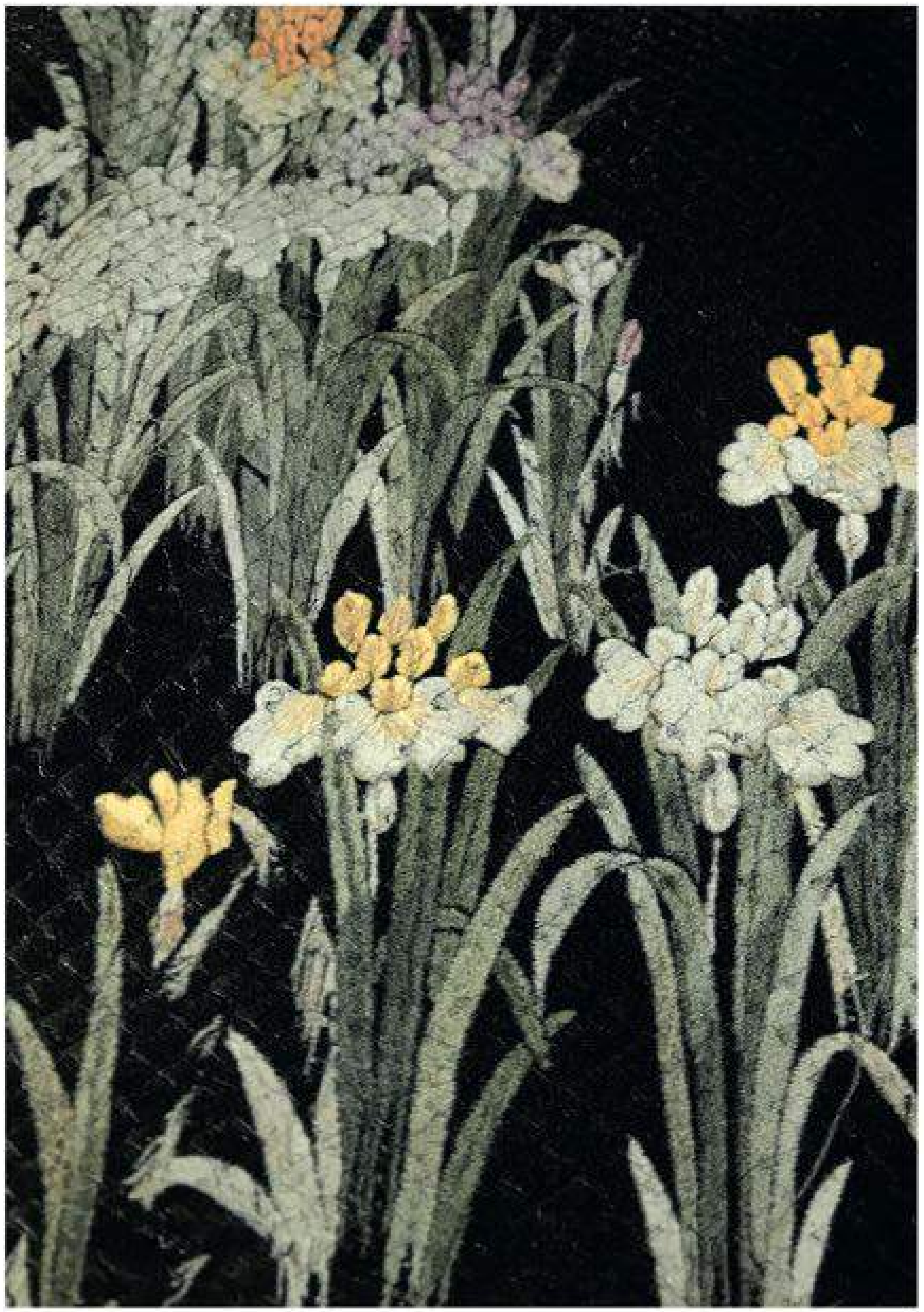


Figure 11.94. UV light digital printing on fish leather, Photographer, Laura Fernandez, 2021.

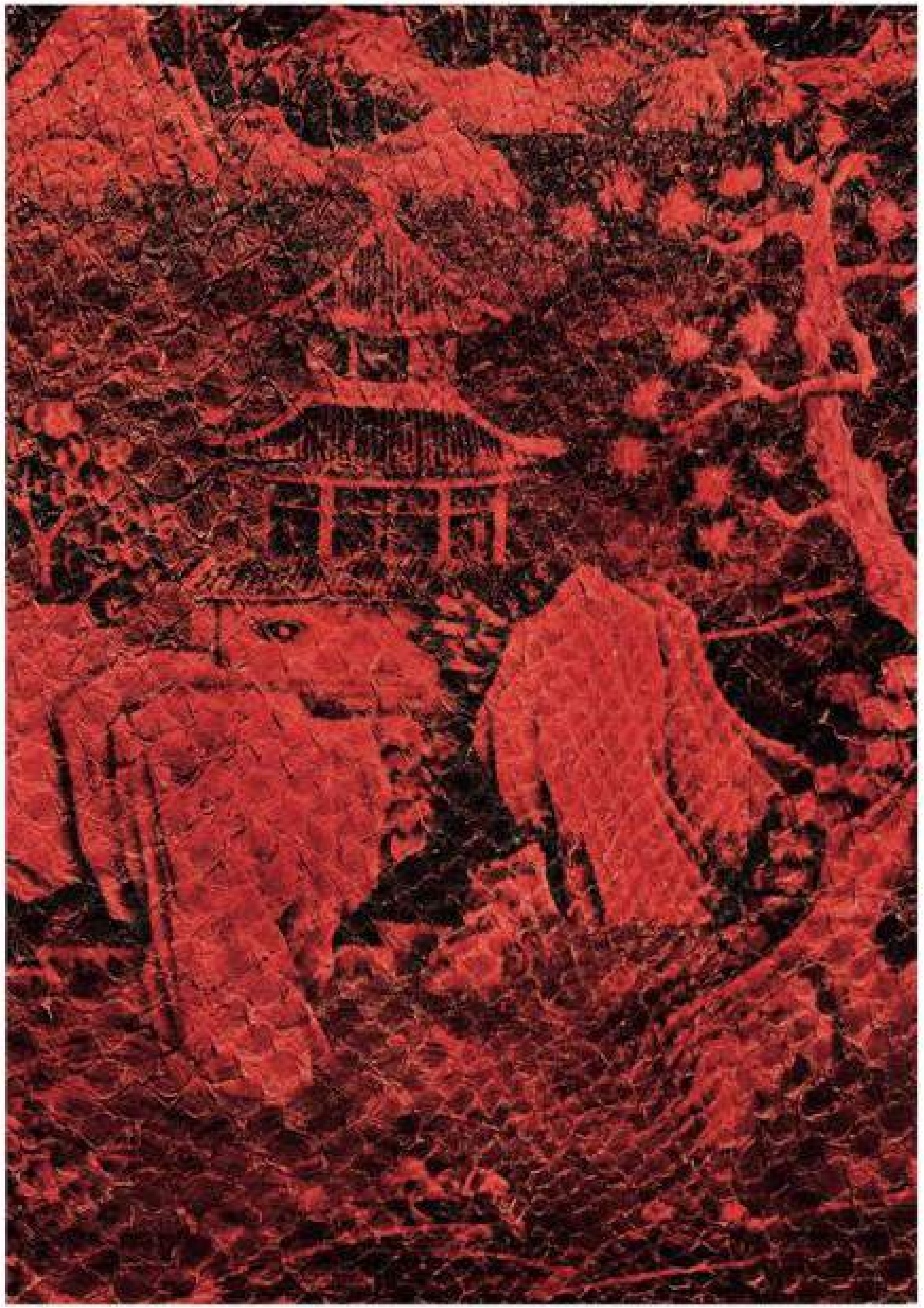


Figure 11.95. Fish leather digitally printed with Eco-friendly water-based ink-jet inks, Photographer, Laura Fernandez, 2021.

Figure 11.96. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with fish leather digitally printed with Eco-friendly water-based ink-jet inks, Photographer, Laura Fernandez, 2021.

Figure 11.97. UV light digital printing on fish leather, Photographer, Laura Fernandez, 2021.

Development of laser etching technologies for fish leather.

The fashion leather industry has been using several techniques for upgrading the quality of leathers over the years. The invention of O2 lasers for cutting biological material has paved way for its use for surface improvement through engraving. Infrared lasers like CO2 are advantageous due to large beam size, high laser efficiency, easy operation, use of non-toxic gases, and low cost. Engraving is done by the local heating caused by the absorption of laser radiation, leading to modification of the microstructure, and the physical properties (Venkateswarlu, 2015). The process of etching leather results in a debossed effect and, depending on the surface of the leather, produces a noticeable contrast. Light-colored leathers produce significant colour contrast, whereas engraving darker leathers results in a more subtle contrast. During laser engraving process on leather, any design can be burnt based on power of the laser that can be controlled by computer. The quality of the final imprint depends on the selection of suitable leather and laser parameters like power and speed of operation. The engraving results are mostly dependent on the type of fish leather used as well as the laser speed, power, and frequency settings.

Fish leather was etched with laser to incorporate surface designs. Laser etching occurred only on the surface of the fish leather without affecting its structure. Laser engraving processing causes slight oxidation of the leather surface and changes the leather surface properties, topography, and color due to thermal influence. With the increase of the number of laser pulses the leather surface becomes darker as some top layers are burned. Laser etched fish leather revealed that the collagen component underwent structural modification which most probably resulted in darkening (a precursor to charring) of the fish leather colour. In addition, since the fish leather does not have a uniform surface thickness and texture due to the fish scales, the laser etching was less consistent.

Plain colour (Figure 11.98.) fish leather was engraved as well as gold laminated fish leather. A very thin top layer is laminated onto a core fish leather of a contrasting color. By engraving the metallic material, the top layer is being removed and the core layer underneath appears. The results emulate traditional Japanese lacquerware (Figure 11.99. and 11.100.).

The obtained results revealed that pulsed CO2 laser engraving can be used as an effective tool for fish leather surface treatment. Laser technology allows the creation of a unique appearance of materials without the application of chemical methods and is environmentally friendly in comparison to other conventional methods used for the creation of the same effect embellishments.

Figure 11.98. Engraved or etched fish leather resulting in a debossed effect producing a noticeable and clean contrast, Photographer, Laura Fernandez, 2021.

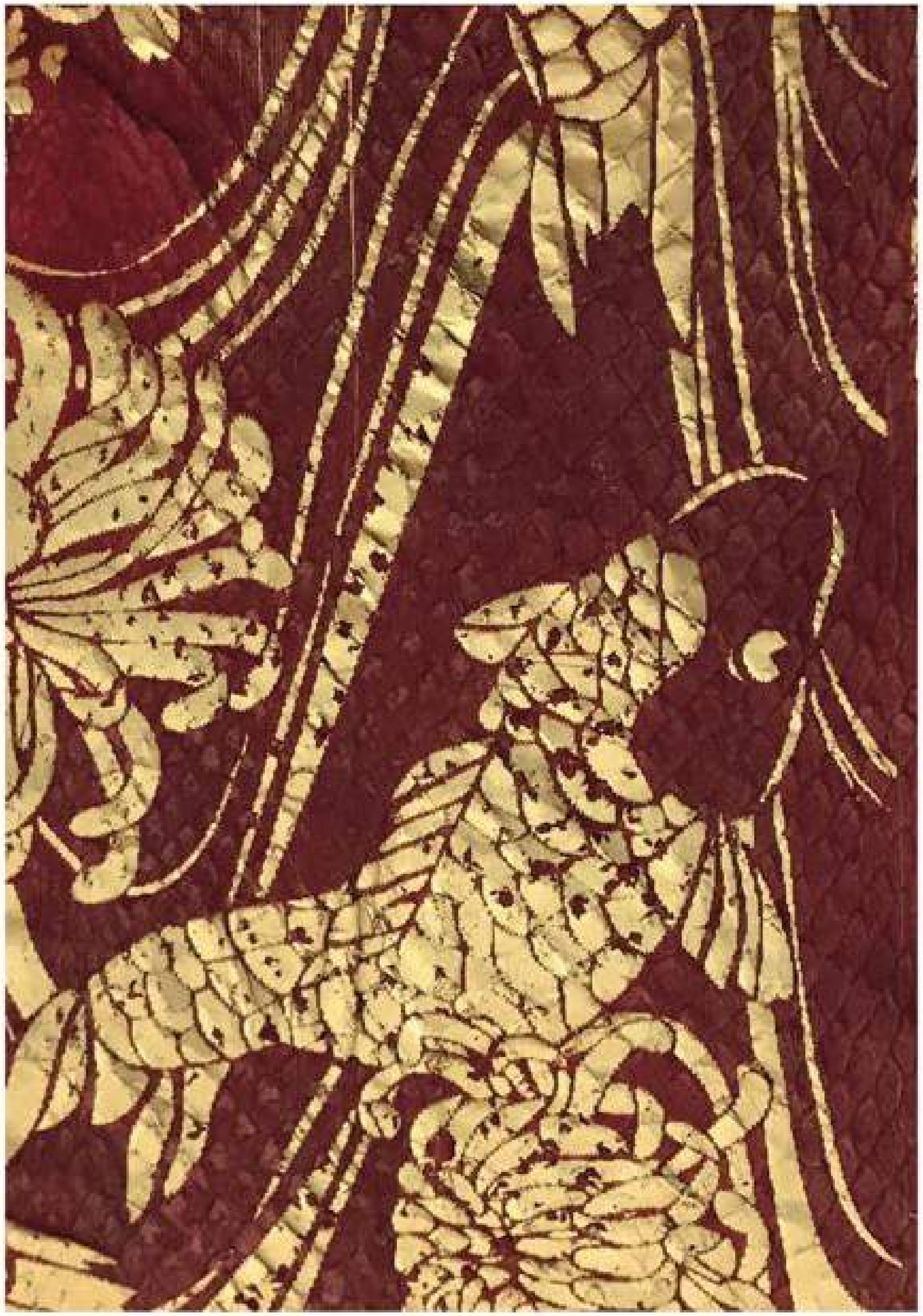


Figure 11.99. Engraved or etched fish leather. This previously laminated fish leather produced a colour contrast between the original red background discovered after laser engraving the laminated surface. The results emulate traditional Japanese lacquerware, Photographer, Laura Fernandez, 2021.

Figure 11.100. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with engraved fish leather. This previously laminated fish leather produced a colour contrast between the original red background discovered after laser engraving the laminated surface. The results emulate traditional Japanese lacquerware, Photographer, Laura Fernandez, 2021.

Figure 11.101. Hand cut fish leather, Photographer, Laura Fernandez, 2021.

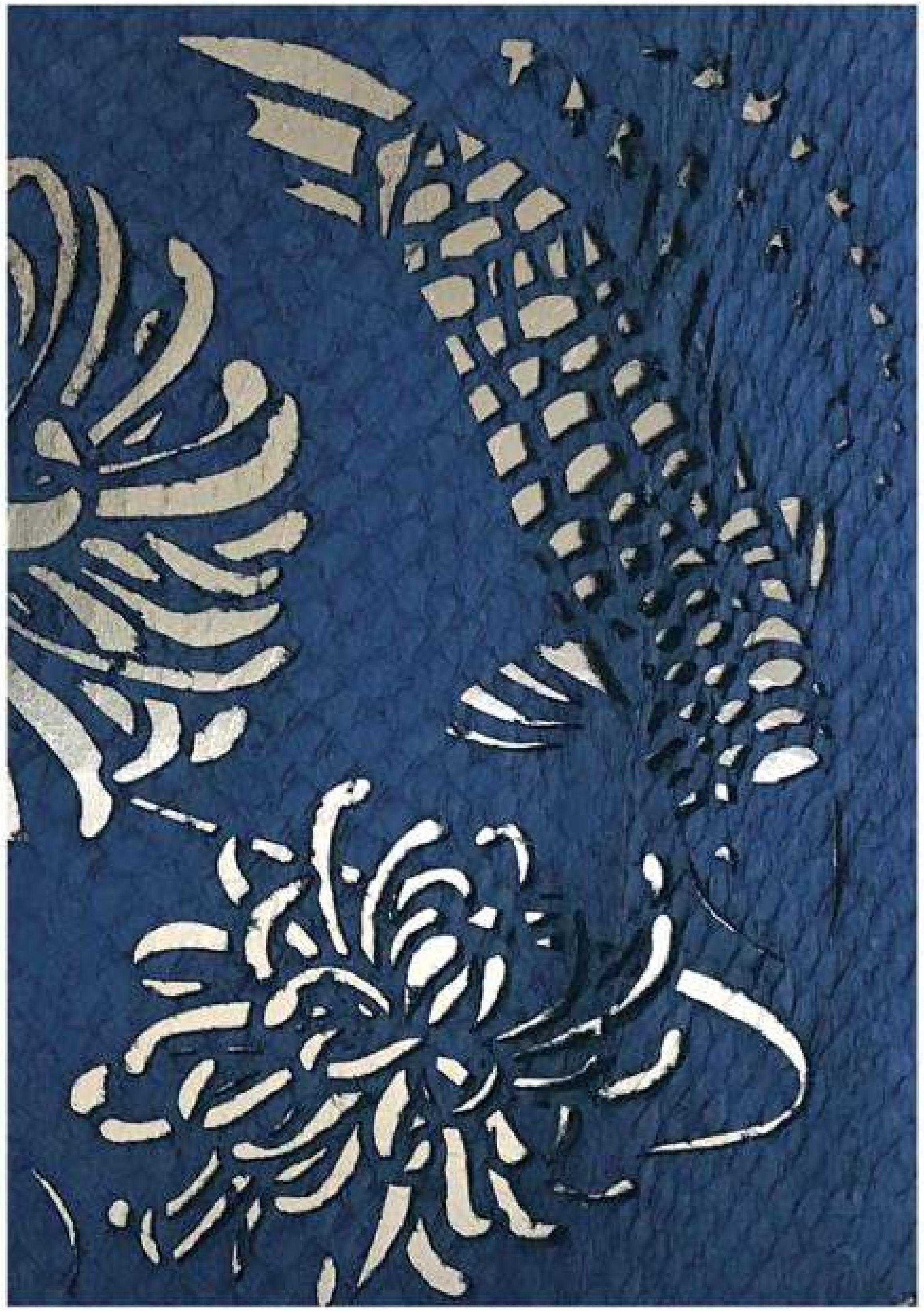


Figure 11.102. Laser cut fish leather, Photographer, Laura Fernandez, 2021.

Figure 11.103. Laser cut fish leather clutch, Photographer, Laura Fernandez, 2021.

Japanese Gold leaf

A gold leaf is made by beating gold into an extremely thin sheet with a thickness of 0.1 to 0.125 millionths of a meter. The traditional production of Japanese gold leaf, called kinpaku, has a long history in the city of Kanazawa. In 1593, Lord Toshiie Maeda ordered the Kaga domain, the site of the present-day Kanazawa, to produce gold and silver leaf— a long and arduous process that requires the repeated pounding of metals into thin sheets. Gold leaf art was used to adorn temples and shrines, and was used on pottery, lacquerware and scrolls. Today, Kanazawa gold leaf is used in local handicrafts, and the production has become a cultural staple in the city (Hoy, 2021). In 2014, Japan certified entsuke gold leaf as a Selected Conservation Technique, and in December 2020, UNESCO added entsuke gold leaf to its list of Intangible Cultural Heritage.

While visiting Kanazawa I discovered the gold leaf technique, then I contacted Kyoto Leather workshop, specialists on processing Kyo-Yuzen printing for kimonos and gold leaf techniques on leather. The aim of this study was to propose a coating formulation that would help obtain a metallic finish with gold leaf. A further aim was to study the possibility of replacing the foil products used by Nordic Fish Leather obtaining leathers commercially acceptable. Leathers which, in turn, meet all the quality requirements for the production of leather goods. Metallic looks on fish leather are made by applying a metallic foil and heat fusing it into the grain of the fish leather. The metallic foil is generally used on low-quality leathers. The problems to be faced when applying a metallic foil are finish cracking and foil peeling off on ageing.

At Kyoto Leather we worked with a gold leaf master. He handled the gold leaf with bamboo chopsticks to prevent the buildup of static electricity. Expert skill is required to join the edges of each gold leaf sheet, all while maintaining a steady working speed. After the gold leaf was applied, we used a vintage kimono silk screen to print a black landscape on top of the gold leaf background (Figure 11.104.). The level of gloss achieved by the gold leaf is of much higher quality than the metallic foil produced by Nordic Fish Leather, but the technique is very expensive to be commercialized.

Figure 11.104. Gold leaf and silkscreen printed fish leather at Kyoto Leather workshop. Photographer, Laura Fernandez, 2021.

Embroidery

I tried different embroidery techniques such tambour beading or Lunéville embroidery where a tambour hook is used for beading. Unlike traditional embroidery, tambour is worked on the wrong side of the fabric. The only thing the stitcher sees is the back of the design. The actual stitching and bead application is worked with the left hand under the fabric and frame. The hook catches the thread on the backside of the material, pulling it to the front side to attach beads and sequins. This is a much quicker method than previously used and the precise nature of the application means that subtle patterns could be created allowing embroiderers to introduce countless innovations. On a design of Korean pearl divers by Jonathan Katz, fine pearls were embroidered on the fish leather (Figures 11.105 to 11.108.).

I combined the Japanese technique Oshi-e with goldwork thread to create the fish leather bamboo sample (Figure 11.109 and 11.110.). Oshi-e is made up of many pieces of kimono fabric, padded with cotton in between, and is glued together to create a three-dimensionally raised ornament. Oshie is commonly featured as main decoration on wall hangings as an artwork of seasonal symbols.

Figure 11.105 to 11.108 Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with hand beaded design by Jonathan Katz. Photographer Jay Zaccheus, 2021.

Figure 11.109. Hand beaded fish leather sample. Design by Jonathan Katz. Photographer Jay Zaccheus. Photographer, Laura Fernández, 2021.

Figure 11.110. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with hand beaded design by Jonathan Katz. Photographer, Laura Fernández, 2021.

Figure 11.111. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with hand embroidery.
Photographer, Laura Fernández, 2021.

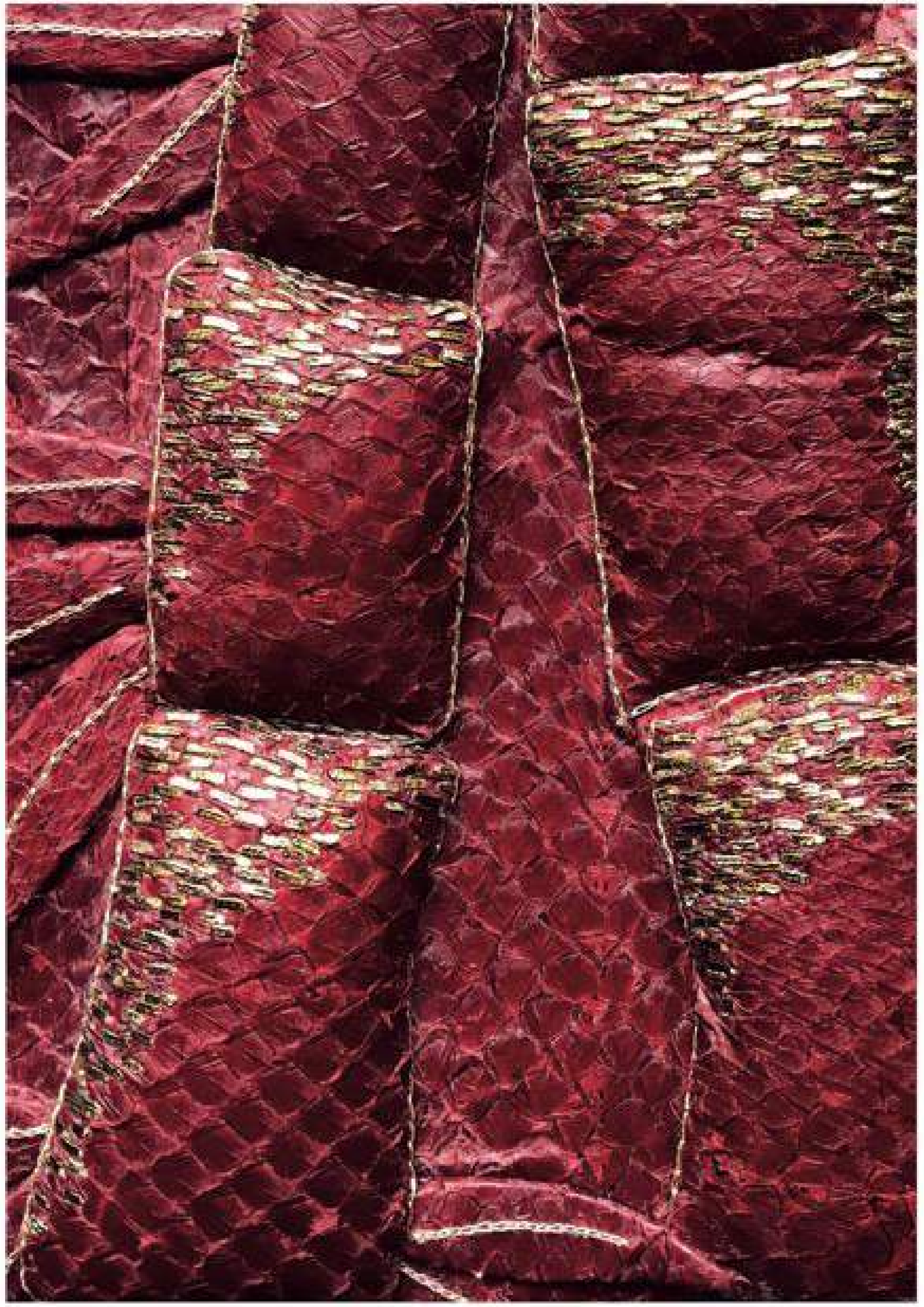


Figure 11.112. Hand embroidery fish leather sample. Photographer, Laura Fernández, 2021.

Figure 11.113. Hand embroidery fish leather sample. Photographer, Laura Fernández, 2021.

Figure 11.114. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with hand embroidery. Photographer, Laura Fernández, 2021.

Development of a small fish skin clutch capsule collection with Hezhe Indigenous artist Sulin Yu

While fashion is still working to address its historic lack of inclusivity, the social awakening of the Covid pandemic is an opportunity for fashion to embrace Indigenous artists (Cernansky, 2021). Fashion's interest in working with Indigenous artisans in a positive and respectful way has been growing steadily supporting artisans globally. Organisations are working to connect Indigenous communities to global markets to create employment opportunities and revitalise traditional craft techniques. Fashion's shifting landscape can foster business opportunities for Indigenous artists in the fashion industry that have long been excluded from. Collaborations with Indigenous communities done properly, can offer paths to boost the artists' income, to diversify the art and cultures represented in fashion, and to uplift both groups in the process.

Through this collaboration I worked with Yulin Sun, an Indigenous Hezhe fish skin artist that taught my students during the Hezhe fish skin workshop in 2018. With the aid of a third partner, Zhongjing Zhang, a CSM student who also participated in the workshop and whose brand, "Utiku Studio", offers fish skin activities, we discussed how the artwork would be used on the final product. The ability for Yulin Sun to fully participate in the entire design process from beginning to end was paramount. It ensured the collaboration benefited both parties, and did not result in appropriation or feelings of disrespect. Listening to the communities you are working with and building relationships with them is the most important thing in the process. Designers who had been inspired by Indigenous designs in the past, rather than taking them and selling them off as their own, should take the time to cultivate the relationships with those who are creating them, learning who they are and creating business opportunities for them.

The bags were made from fish by-products from the Amour River in the Heilongjiang province. The project could enable local Indigenous Hezhe artisans to create new artefacts and bring economic, social and environmental benefits to the Amour coastal areas. Yulin used hand-tanned fish skins to make the flower and fish motifs (Figures 11.121. to 11.125.). The shading and depth in the fish skin paintings were achieved by alternating the placement of the bellies and backs of the fish. Jay Zaccheus, the leather artisan making the bag, chose the widest and longest fish skins (Figures 11.126 to 11.129.); he sewed the edges and attached the embellishments with simple stitches. He added decorative stitching to help fold the gussets down the centre like a paper bag (Figures 11.130. to 11.131.); then closed the base, burnished, smoothed the edges with a wooden slicker and painted them. The handles were made wrapping fish skin around a cord used for bag piping.

Figures 11.115 to 11.118. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with fish skin painting by Hezhe artist Yulin Sun using hand-tanned fish skins. Photographer Jay Zaccheus, 2021.

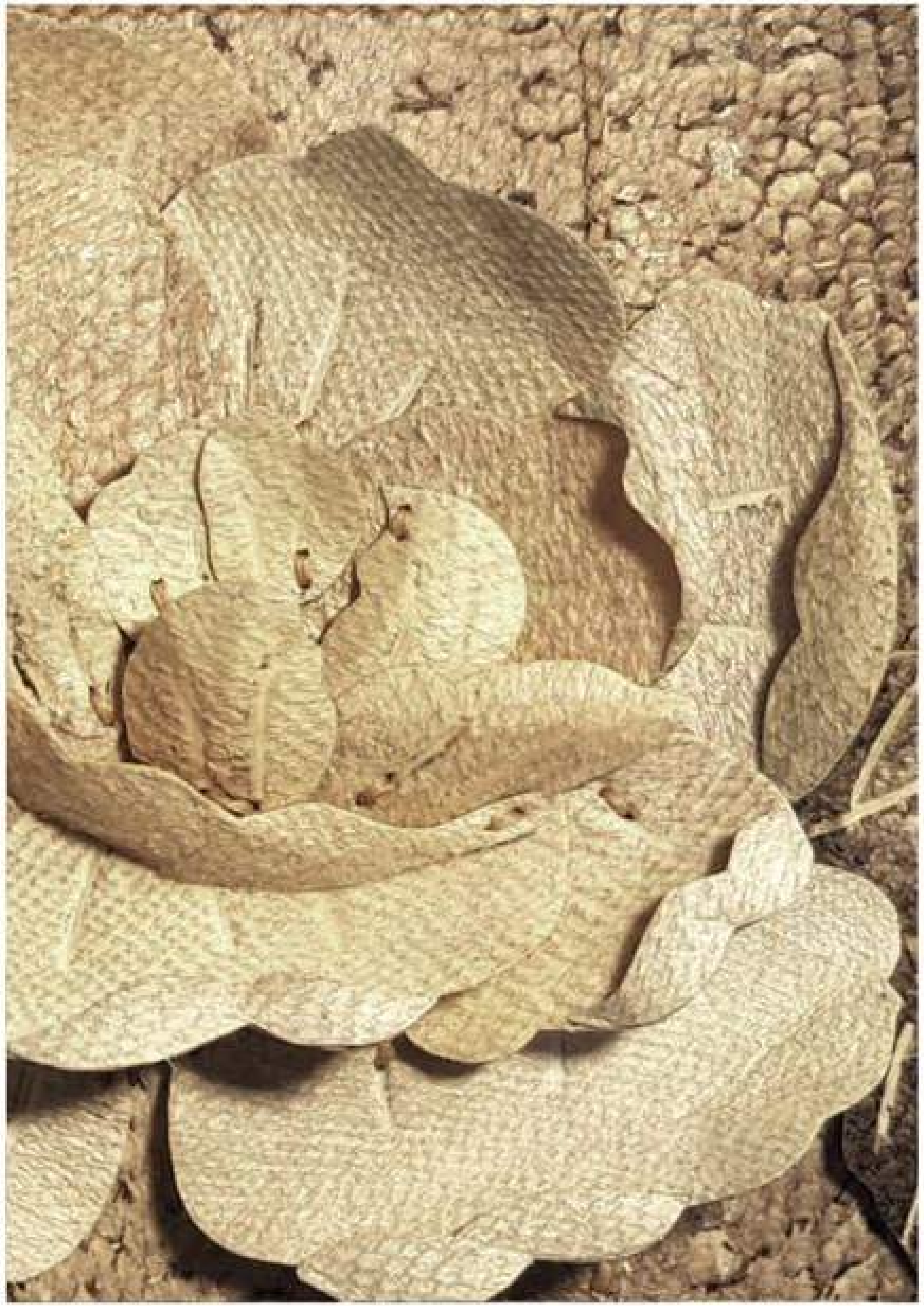


Figure 11.119. Fish skin painting by Hezhe artist Yulin Sun using hand-tanned fish skins. Photographer, Laura Fernandez, 2021.

Figure 11.120. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with fish skin painting by Hezhe artist Yulin Sun using hand-tanned fish skins. Photographer Jay Zaccheus, 2021.

Figure 11.121. Fish skin painting with fish motifs by Hezhe artist Yulin Sun using hand-tanned fish skins.
Photographer Jay Zaccheus, 2021.

Figures 11.122. to 11.125. Fish skin paintings with flower and fish motifs by Hezhe artist Yulin Sun using hand-tanned fish skins.
Photographer Jay Zaccheus, 2021.

Figures 11.126. to 11.129. Handmade fish leather shopping bag sewn by leather craftsman Jay Zaccheus made with fish skin painting by Hezhe artist Yulin Sun using hand-tanned fish skins. Photographer Jay Zaccheus, 2021.

Figure 11.130. and 11.131. Handmade fish leather shopping bag sewn by leather craftsman Jay Zaccheus made with fish skin painting by Hezhe artist Yulin Sun using hand-tanned fish skins. Photographer Jay Zaccheus, 2021.

Development of a small fish skin clutch capsule collection with Olga Kambolova, Russian artist from Sakhalin Island

Olga Kambolova is a fish leather artist based in Novosibirsk, Russia. She has worked with fish skin for over eight years. She uses salmon, tuna, plaice, cod, char and almost any kind of fish skins to make her own leather. She uses traditional Sakhalin techniques for tanning her skins, that requires lengthy manual labour, with beautiful results. She was born in Nogliki, a settlement located near the eastern coast of the Sakhalin Island (Russia). She had the opportunity to work with many Indigenous groups of the Sakhalin Island. Fishing has always been the key activity for Sakhalin people, being the staple food in the traditional cuisine. Her first experience of working with fish leather was with Veronika Osipova, an Indigenous Ulchi woman based in Sakhalin. Olga is fascinated by ancient myths and traditions. Each of her work depicts distinct yet linked themes addressing the local life and culture, nature, folklore and traditional ornaments. Each piece is produced by hand through a laborious process of tanning and piecing fish skins together.

The Sakhalin fish skin painting technique in this clutch (Figures 11.132. to 11.141.) was created by Olga Kambolova. To create this intricate collage, each piece was laboriously shaped from the hand-tanned skins of a variety of species of fish.

Figures 11.132. to 11.137. Fish skin painting by Olga Kambolova. Russian artist from Sakhalin Island. Each piece was produced by hand through a laborious process of hand tanning each different species of fish. Photographer Olga Kambolova, 2020.

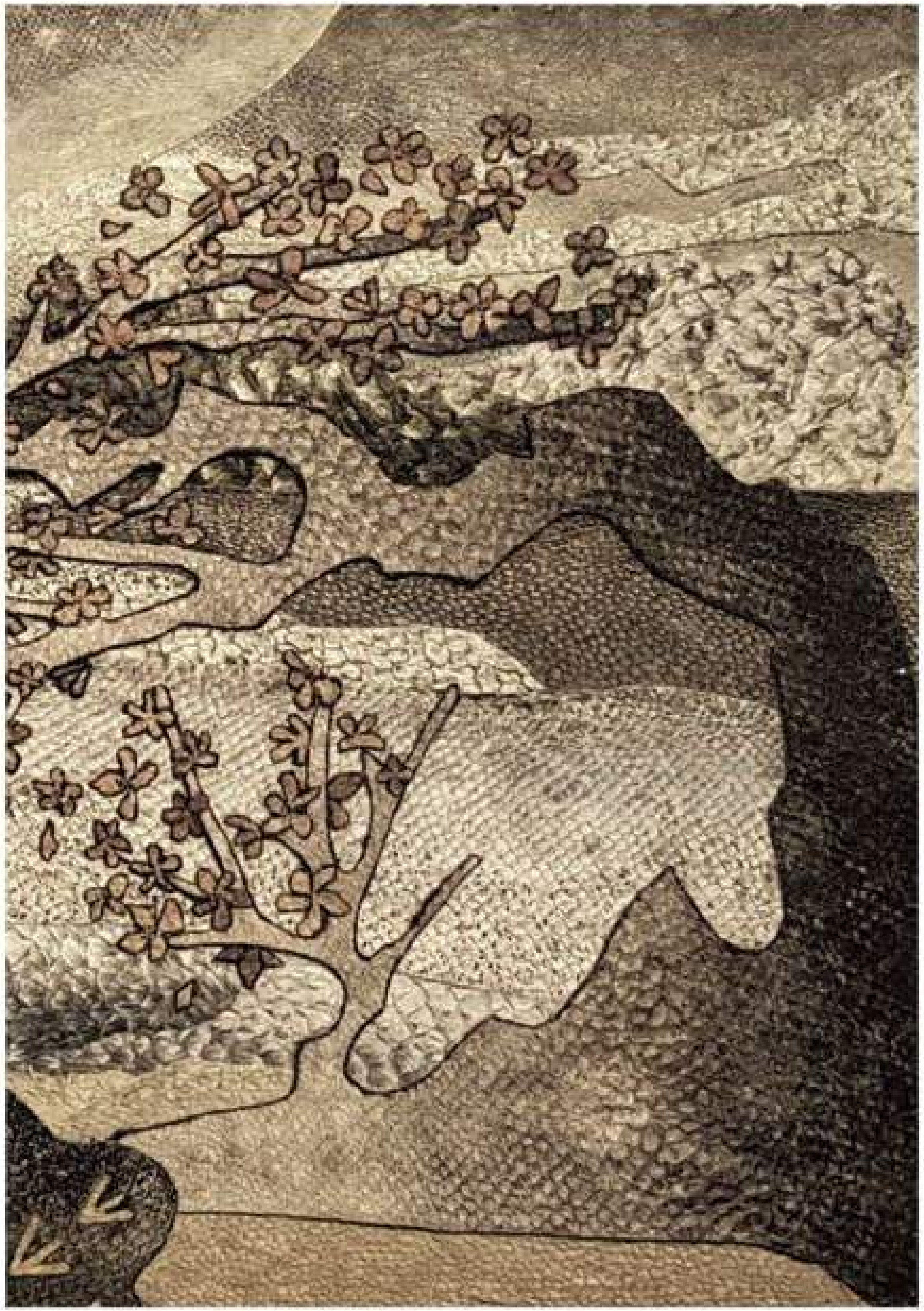


Figure 11.138. Fish skin painting by Olga Kambolova. Russian artist from Sakhalin Island. Each piece was produced by hand through a laborious process of hand tanning each different species of fish. Photographer, Laura Fernandez, 2021.

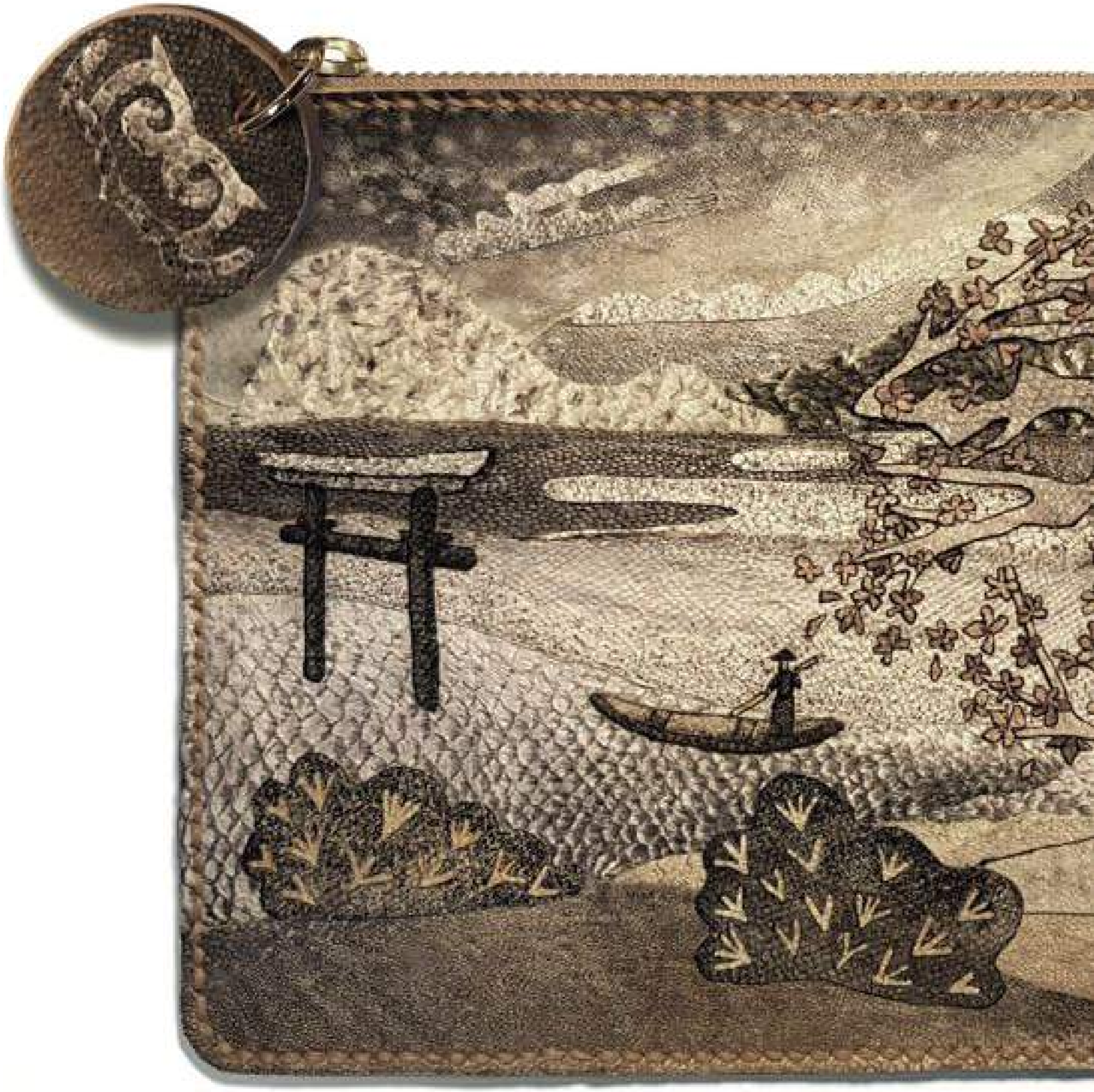


Figure 11.139. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with Fish skin painting by Olga Kambolova, Russian artist from Sakhalin Island. Photographer, Laura Fernandez, 2021.

Figure 11.140. Handmade fish leather clutch sewn by leather craftsman Jay Zaccheus made with Fish skin painting by Olga Kambolova, Russian artist from Sakhalin Island. Photographer, Laura Fernandez, 2021.

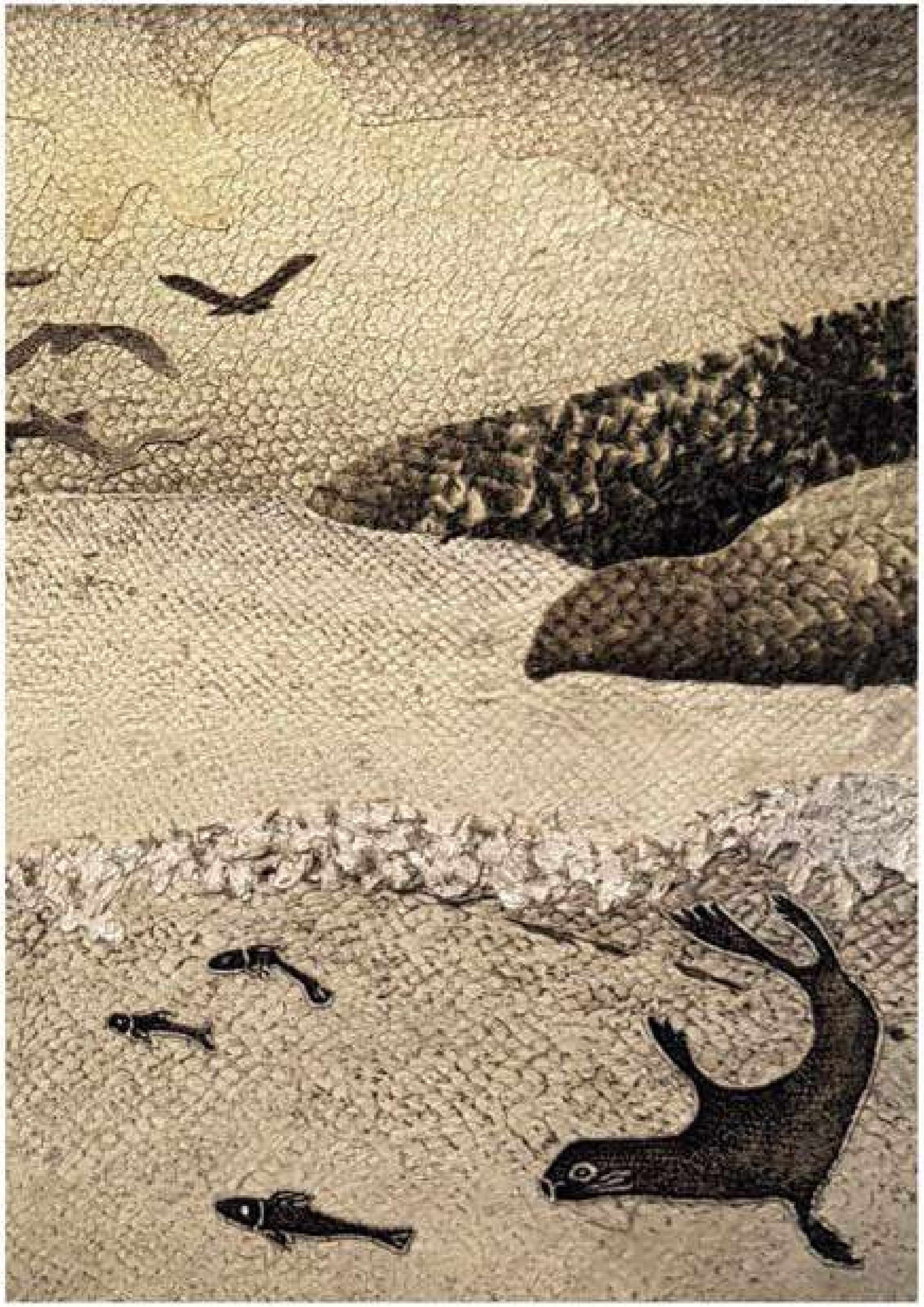


Figure 11.141. Fish skin painting by Olga Kambolova, Russian artist from Sakhalin Island. Each piece was produced by hand through a laborious process of hand tanning each different species of fish. Photographer, Laura Fernandez, 2021.

Figure 11.142. Smithsonian's "FUTURES" exhibition, an interdisciplinary show at the Arts and Industries Building in Washington, D.C featuring one of my Indigo katazome dyed fish skin clutches next to a Yup'ik fish skin bag from the Smithsonian National Museum of Natural History. Photographer, Laura Fernandez, 2021.

Appendix II: International Exhibitions.

Appendix II : International Exhibitions

Throughout my research I have experimented with fish leather to sample and produce bags and shoes that explored my ideas about the material, the surface, texture and beauty. They represent an assimilation of knowledge that I have gained through the research and making process, and they are the physical evidence of some of the concepts that I propose in my PhD.

These pieces were exhibited in 2020, 2021 and 2022 in two major museums, the Smithsonian Institution Arts & Industries building and the Maritime Museum of Denmark where I was able to participate on the curation of the exhibitions with my own unique fish skin research. In both cases historical fish skin artefacts were paired with contemporary fish skin items connecting anthropology, ethnography, craftsmanship and sustainability documenting and learning from the Arctic Indigenous Peoples' traditional fish skin craft practices.

The aim of presenting both historical and contemporary fish skin artefacts is the preservation and dissemination of cultural heritage connected with fish skin. The collaboration of museum curators and fashion designers is a fine example of an innovative way of linking the preservation of traditional knowledge and culture and the development of relevant fashion items taking in consideration the sustainable limits of the planet's natural resources. The exhibits will hopefully enhance both collaboration between museums and designers and promote the showcase of historical pieces in different contexts.

FUTURES exhibition. Smithsonian Institution Arts & Industries building.

One of my fish skin clutches was exhibited at the interdisciplinary exhibition, FUTURES, at the Arts and Industries Building in Washington, D.C. from November 2021 and running through the summer 2022. “FUTURES” highlights nearly 150 objects dedicated to different visions of the future of humanity. In the building’s West Hall, one of my fish skin clutches was on display next to a Yup’ik fish skin pouch (Figure 11.142.) handcrafted in Western Alaska and acquired by the National Museum of Natural History in 1921, as a way of connecting traditional objects and contemporary work from the same crafting process. This section of “FUTURES” focuses on the value of slowness, and innovation that isn’t technological and digital. Fish skin fashion is a testament to how the future of sustainability may find its salvation in time-honoured traditions. When we talk about Indigenous traditions, Indigenous practices, Indigenous cultures; they’re still living and breathing.

During my anthropology fellowship, and now as a research associate, at the National Museum of Natural History’s Arctic Studies Center in Washington D.C. I have studied both physically and virtually from home, due to the Covid-19 pandemic—fish skin baskets, boots and mittens in the Smithsonian’s collection, from communities like the Inuit people of Alaska, Yup’ik people of Kuskokwim River in Southwest Alaska and the Alutiiq on Kodiak Island. These artefacts and my conversations with Indigenous elders in Alaska inspired me to create fish skin bags and sneakers. I am currently trying to put together a fish skin coalition with artists from Alaska, Japan, Iceland, Siberia and northeast China to collaborate and explore fish skin fashion and technology.

Figure 11.143. Smithsonian’s “FUTURES” exhibition, an interdisciplinary show at the Arts and Industries Building in Washington, D.C featuring one of my Indigo katazome dyed fish skin clutches next to a Yup'ik fish skin bag from the Smithsonian National Museum of Natural History. Photographer Stephen Loring, 2021.

OCEANISTA. Fashion and the Sea. Maritime Museum of Denmark.
During 2020-2021 the Maritime Museum of Denmark exhibited one of my digitally printed fish skin clutches. The Inspiration for the fish skin clutch draws on Indigenous Arctic heritage of fish skin artefacts. In this case, a Nanai fish skin hood from the National Museum of Denmark, which cares for one of the world's most important collections of cultural material from the Arctic peoples. The fish skin hood is the outcome of the collaboration between Elisa Palomino, BA Fashion Print lecturer at Central Saint Martins and Dr Anne Lisbeth Schmidt from the National Museum of Denmark during the Horizon 2020 FISHSkin Network event in Iceland to deepen the knowledge on Arctic Indigenous fish skin materials. The contemporary fish skin clutch is inspired by the historical Nanai Siberian hood fish skin artefact from the National Museum of Denmark to present and compare tradition and modernity. The ingenuity and resourcefulness of Arctic Indigenous Peoples is the key to much of what sustainable fashion is about nowadays.

The Nanai Indigenous peoples of Russia Far East have traditionally lived along the Amour River basin. They sourced their materials from animals that were necessary for their survival like salmon, and they used their skins for the construction of garments and accessories. For Nanai people, an important element for the production of fish skin clothing was the use of natural dyes to paint the ornaments on clothing. For the preparation of colours, blue and red minerals were collected on the shores of the Lower Amour River since ancient times. They were ground with dry red caviar and diluted with water to obtain a homogeneous mixture. In the Amour region, one can also find raw materials for dyeing of vegetable origin. To obtain blue, the petals of common commelina will give a juice that will dye the fish skins in ultramarine blue. Red comes from boiled pine bark or the juice of cranberries or blueberries. Yellow is obtained from rotten wood crumbled and diluted in water, and brown by decoction of alder. Black is obtained by mixing dry salmon caviar. Nature provides a rich palette of colours that natives used to decorate their clothes.

The fish leather clutch was produced under the Worth partnership, funded by European Commission, EASME, under COSME 2014-2020. For the Wisteria clutch (Figures 11.144. to 11.147.), water-based ink jet printing technology was used for the production of environmentally friendly prints and to mimic Arctic natural dyeing techniques.



Figures 11.144. to 11.147. One of my digitally printed fish skin clutches at the exhibition OCEANISTA. Fashion and the Sea. Maritime Museum of Denmark. Copenhagen, Denmark, 2021.

Figure 11.148. Image from short film Preservation of Hezhe fish skin tradition through fashion higher education, Best Green Fashion Film award at the Fashion Film Festival Milano 2021.

Appendix III: Fashion Film Festivals.

Appendix III: Fashion Film Festivals

The short film Preservation of Hezhe fish skin tradition through fashion higher education won the Best Green Fashion Film award at the Fashion Film Festival Milano 2021. The film was made as part of my PhD and adds to my comprehensive and ongoing body of research into the use of fish leather as a sustainable raw material for fashion. The film follows the practices of the Hezhe people - one of China's smallest ethnic minorities living in north-eastern China by the Amour River basin, with a traditional economy based on hunting and fishing. Featuring interviews with Hezhe craftspeople, scenes of their fish skin processing and shot with my students, the film identifies the importance of fish skin as an innovative sustainable material. It represents a story and study in sustainability from the resourcefulness and resilience of the Hezhe Indigenous Peoples, their lifestyles and fish skin practices.

Applying this craft to fashion was tested through a participatory workshop with fashion students from Central Saint Martins, UAL taught by Hezhe craftspeople, to investigate how this material and the transmission of fish skin skills can contribute to sustainability practices in fashion. In the film we can see work by 2019 BA Fashion Knit graduate Foning Bao inspired by what she learned from the Hezhe community and working with them to source her fish skin raw material. To create her final year collection she restricted herself to the use of fish skin and 'fully fashion' knit skills. As a sustainable designer, zero fabric, zero cut and zero waste were the key points of her work. She used the fish skins in combination with crochet on her garments and accessories, bringing this humble material into vibrant and contemporary design.
The film won an award, 2 nominations and was part of two official selections: Award:
Fashion Film Festival Milano, Best green fashion film 2021.

Nominations:
Croatia Fashion Film Festival, Best documentary 2021. UK Fashion Film Festival, The best documentary 2021.

Official Selections:
Canadian Fashion Film Festival 2021
Bokeh South Africa International Lifestyle & Fashion Film Festival 2021.

Figure 11.149. Image from the short film Preservation of Hezhe fish skin tradition through fashion higher education, Best Green Fashion Film award at the Fashion Film Festival Milano 2021.

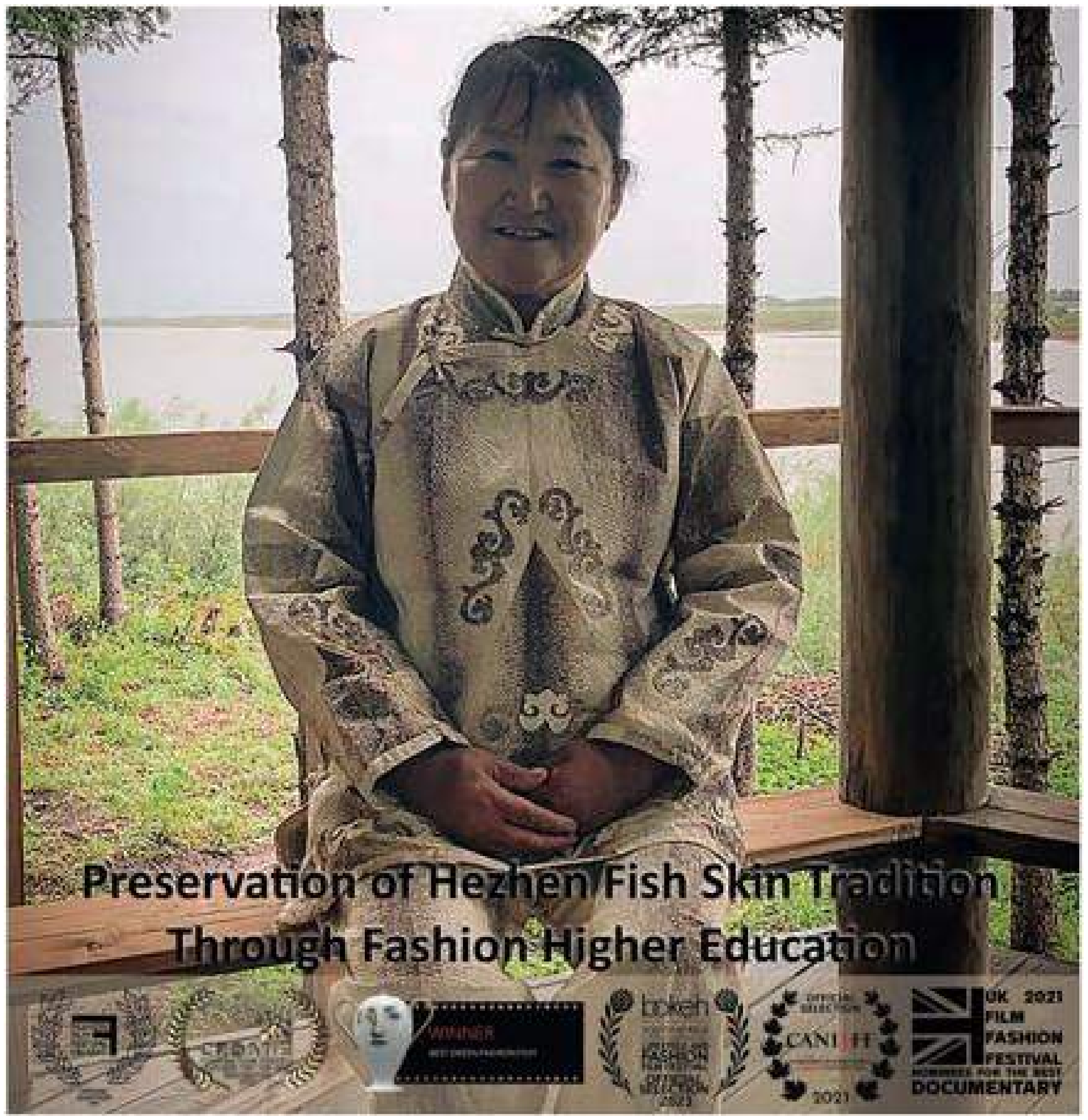


Figure 11.150. Poster for short film Preservation of Hezhe fish skin tradition through fashion higher education, Best Green Fashion Film award at the Fashion Film Festival Milano 2021.

Appendix IV: Workshops information pack

Figure 11.151. Fish bones for Hezhe fish bone painting, 2018.

Appendix IV: Workshop information pack and Fish skin Workshop survey

This section sets out the workshops' information sheet, consent form and interview questionnaire used during the qualitative study, establishing the research approach to data collection and analysis. The questionnaires are directed to the three case studies through semi-structured interviews. There are also four interviews with one student participant in each workshop.

A. WORKSHOP INFORMATION SHEET

Project Title: Fish Skin: Sustainability and Craft innovation in Higher Education.
Fish leather craftsmanship workshop.

Invitation

You are invited to participate in a workshop that aims to encourage Fashion Design students to produce fish leather artefacts using traditional fish skin tanning skills.
The study is being conducted as part of a research project by Elisa Palomino– a PhD student working on a project about The Sustainability and Craft innovation of Fish Leather in Higher Education.
Before you decide whether you are willing to take part in this study or not, you need to understand why the study is being done and what it will involve. *Please take time to read this Information Sheet carefully before signing the consent form document.*
If you have any queries, please do not hesitate to ask.

What is the purpose of this study?

Inspiration and information regarding ethics and sustainability of fish skin leather. Research historical fish leather garments and artefacts at National museums. Development of a sketchbook with fish skin research and design development with Elisa Palomino. Learn traditional fish skin tanning techniques with local craftsman.

Are there any risks involved?

The workshop will be conducted in accordance with the University's health & safety guidelines http://www.arts.ac.uk/students/health--safety-for-students/policies-and-procedures/procedures-and-standards/
Any potential risks regarding participation will have been minimised in advance. You may be exposed to materials containing animal parts. If the material is considered sensitive or potentially upsetting, participants will be notified prior to the workshop.
You should inform us if you suffer from any fish allergies.

Participants' rights

You have the right to withdraw at any time during the study and you can require that your own data, including recordings, be destroyed.
You have the right to refuse to answer some questions.
You have the right to refuse to be photographed or filmed.

Why have I been invited?

You have been invited because you are an undergraduate or postgraduate student in Art & Design. Genuine interest in participation is essential to the study.

Participation in the study

If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. You will also receive a copy of the signed consent form to keep. This consent will not expire. Either you or the workshop team may terminate your participation in the study under any unanticipated circumstances, but the results obtained by that point will be still used for research purposes.

IPR Rights

The IPR intellectual property rights in works develop during this workshop that are the sole creation of the student(s) and craftsmen, belong to those student(s)and craftsmen.

Expenses and payments
-No monetary compensation will be offered to the student participants.
-Tuition fees, materials and tools will be covered for all the students
- Expenses to be incurred by Students include:
-Insurance: Students will have to organise their own travel insurance
-Flight tickets
-Accommodation
-Students will have to take care of their own subsistence.
-Students will have to take care of their entrance tickets to museums.

What does the study involve?
If you agree to take part in the study, you will be participating for a total duration of 1 week. Over this period, you will be asked to participate in 1 workshop, and your pictures and interview from this workshop will be uploaded on an online platform. The results of the workshop may be exhibited through pictures and you may be required to have your picture taken with your work. Photographs and video recording as well as a short interview will be performed during the workshop. Please find the questions for the interview in the form attached.

Data Storage
Your data will be stored electronically on a secure university file store. The paper documents with the same sort of content will be scanned and uploaded. Access to this file store will be protected by a password unique to me. The data will be kept securely to assure its use only for the purposes for which it was obtained, by those authorised to use it; it will not be kept longer than necessary; and it will not be passed on to third parties.

Research Ethics at Research Management and Administration
If you would like to talk to an independent contact to raise any issues or concerns about the research, please contact Research Ethics at Research Management and Administration, University of the Arts London (email: researchethics@arts.ac.uk; Tel: 020 7514 2113)

Elisa Palomino
PhD Candidate
London College of Fashion
University of the Arts London
Email: e.palomino@csm.arts.ac.uk

University of the Arts London
Research Management & Admin
5th Floor Granary Building
1 Granary Square, LondonN14 4AA
Tel: +44 (0)2017.514.9389
Email: researchdegrees@arts.ac.uk

B. WORKSHOP INTERVIEW

Project Title: Fish Skin: Sustainability and Craft innovation in Higher Education. Fish leather craftsmanship workshop.

Questions:

-When did you hear about fish skin in the first place?

-Why did you choose to participate on this workshop?

-What was the most valuable thing for you about this workshop?

-Which aspect about fish skin craftsmanship you find the most relevant to your own creative practice?

-The use of Python is very big in the luxury industry, but many of the manufacturers source snakes illegally in Indonesia, is this a concern to you?

-Most pythons are inflated while alive to stretch their skin, then their heads are chopped off. Is this method a concern to you?

-The use of exotic leather is predicted to be banned in the near future, in a similar manner to the banning of fur. Could fish skin replace the exotic skins in the luxury market?

-The fish skin scales and patterns are similar to python but without the gilt factor, is this appealing to you?

-Which aspect about fish skin sustainability you find the most important to you?

-How would you be incorporating the knowledge that you have gathered through this course into your own creative practice?

-Do you plan to share the knowledge that you have gathered through this course with your own university and fellow students?

-Is this a material that you might be using when you start working in the fashion industry?

-How would you like to be informed about the advance of knowledge in fish skin that this group will generate?

-What is your best memory of the workshop?

Elisa Palomino
PhD Candidate
London College of Fashion
University of the Arts London
Email: e.palomino@csm.arts.ac.uk

University of the Arts London
Research Management & Admin
5th Floor Granary Building
1 Granary Square, LondonN14 4AA
Tel: +44 (0)2017.514.9389
Email: researchdegrees@arts.ac.uk

C. CONSENT FOR PHOTOGRAPHY AND VIDEO RECORDING

Project title: Fish Skin: Sustainability and Craft innovation in Higher Education.
Fish Leather Craftsmanship workshop.

I hereby consent to photographs and video recording of myself taken during the Fish Leather Craftsmanship workshop.
I understand that some images or recordings may be used for research, publication, education, displays and exhibitions in the research thesis: Fish Leather: Sustainability and Craft innovation in the Luxury Industry.
The data will be anonymised so that individuals, organisations or businesses cannot be identified from the data. Including names, addresses, postcode information, telephone number, information on workplace, organisation, education institution or occupation.
Faces will be removed from photographs and video recording.

I have been given the opportunity to ask questions and I am satisfied with the answers I have been given regarding the project. I have a copy of this Consent Form for Photography.

Declaration by participant:

Name of the participant:

Signed:

Date:

Name of Researcher:
I believe that the participant has given informed consent.

Name of the researcher: Elisa Palomino

Signed:

Date:

Elisa Palomino
PhD Candidate
London College of Fashion
University of the Arts London
Email: e.palomino@csm.arts.ac.uk

University of the Arts London
Research Management & Admin
5th Floor Granary Building
1 Granary Square, LondonN14 4AA
Tel: +44 (0)2017.514.9389
Email: researchdegreesarts.ac.uk

D. WORKSHOP INFORMED CONSENT FORM

Project Title: Fish Skin: Sustainability and Craft innovation in Higher Education.

You are invited to participate in this research project. Before you decide to take part, it is important to understand why the research is being conducted and what it will involve. Please take time to read the attached Information Sheet before signing this document. If you have any queries, please do not hesitate to ask.

Please tick the boxes if you agree with these statements and sign the form:

-I have read and understand the information sheet for subjects taking part in the study designed to explore Fish skin leather craftsmanship Yes No

-I have had enough time to talk with the study team about the nature and purpose of the study and what I will be expected to do.
Yes No

-I have been given the opportunity to ask questions and I am satisfied with the answers I have been given regarding the project. I have a copy of this Consent Form and Information Sheet. Yes No

-I know who to contact if I have any questions about the study. Yes No

-I understand that taking part in this study is voluntary (my choice) and I may withdraw from the study at any time, without giving any reasons, and this will not affect my legal rights. Yes No

-I understand that I can refuse to answer some questions and to be photographed or filmed. Yes No

-The data collected from my participation may be recorded and used as data for this research project. I understand that my participation in this project is not strictly confidential and pictures and video recording will be used in the reports Yes No

-I give consent for my image to be revealed through video recording or photograph Yes No

-I give consent for the contents of my interview to be used for further publications such a PhD thesis, conference, journal articles and a book. Yes No

Declaration by participant:
I hereby consent to take part in this project
Name:
Date:
Signature:

Declaration by researcher:
I believe that the participant understands the project and has given informed consent to participate.
Name: Elisa Palomino
Date:
Signature:

Elisa Palomino
PhD Candidate
London College of Fashion
University of the Arts London
Email: e.palomino@csm.arts.ac.uk

University of the Arts London
Research Management & Admin
5th Floor Granary Building
1 Granary Square, LondonN14 4AA
Tel: +44 (0)2017.514.9389
Email: researchdegreesarts.ac.uk

E. Fish Skin Workshop Survey

These questions will be used for research purposes, answer them as truthfully as possible.

When did you hear about fish skin in the first place?

Your answer: ______________________________

When did you hear about fish skin in the first place?

◯ Yes
◯ No
◯ Other: ______________________________

Why did you choose to participate on a fish skin tanning workshop? *

Your answer: ______________________________

Was the workshop useful to you?

	1	2	3	4	5	
1 being not useful at all	◯	◯	◯	◯	◯	5 being very useful

Was the workshop interesting to you?

	1	2	3	4	5	
1 being not useful at all	◯	◯	◯	◯	◯	5 being very useful

Did you enjoy it?

◯ Yes
◯ No
◯ Other: ______________________________

What was the most valuable thing for you about this workshop?

Your answer: ____

What was the thing you enjoy the least?

Your answer: ____

How could this workshop be improved?

Your answer: ____

Which aspect about fish skin you find the most relevant to your own work?

Your answer: ____

How would you be incorporating the knowledge that you have gathered through this workshop into your own creative practice?

Your answer: ____

Do you plan to share the knowledge that you have gathered through this workshop with other people you know?

- ◯ Yes
- ◯ No
- ◯ Other: ____

What is your best memory of the workshop?

Your answer: ____

What are your impressions of working with fish?

Your answer: ____

What is your favourite fish meal?

Your answer: ____

What have you done related to fish skin since you took the workshop?

Your answer: ____

Which fish species have you tanned since you took the workshop?

Your answer: ____

Which tanning techniques have you used since you took the workshop?

Your answer: ____

Can you tell us a bit about yourself?

Your answer: ____

Where is your country of residency? *

Your answer: ____

What is your education Background? *

Your answer: ____

What is your occupation? *

Your answer: ____

What is your gender *

- ◯ Male
- ◯ Female
- ◯ Other
- ◯ Prefer not to say

What is your age *

Your answer: ____

These questions are quite dry, but I would love to know your answers. And if you have anything not covered here please tell me! I really do appreciate it. Thank you for joining in!

Your answer: ____

Figure 11.152. Ainu fish skin avatar robe with Japanese indigo katazome pattern created with Blender and CLO3D by Ana Cordoba Crespo.

Appendix V: Publications

Paper 1: SDG 14 Life Below Water

Palomino, E. (2020) 'SDG 14 Life Below Water: Introducing Fish Skin as a Sustainable Raw Material for Fashion', in Franco, I., Chatterji, T., Derbyshire, E., Tracey, J. (ed.) Actioning the Global Goals for Local Impact. Science for Sustainable Societies. Singapore: Springer. pp.229–246. dpi: https://doi.org/10.1007/978-981-32-9927-6

Actioning the Global Goals for Local Impact
Towards Sustainability Science, Policy, Education and Practice

ISSN 2197-7348 ISSN 2197-7356 (electronic) Science for Sustainable Societies
ISBN 978-981-32-9926-9 ISBN 978-981-32-9927-6 (eBook)
https://doi.org/10.1007/978-981-32-9927-6

Chapter 15
SDG 14 Life Below Water

Introducing Fish Skin as a Sustainable Raw Material for Fashion

Actioning the Global Goals for Local Impact pp 229-246

Part of the Science for Sustainable Societies book series (SFSS)

Elisa Palomino

Abstract In recent years there has been a growing interest in fish skin – a by-product of the food industry – as an alternative sustainable raw material for fashion. Global production of fish has steadily increased over the last decade and more than 50% of the total remaining material from fish capture results in 32 million tonnes of waste. A substantial amount of this waste is the skin of the fish; only a small percentage of this skin is processed into leather. While, to date, the European Environment Agency allows seafood processors to dispose of fish skins in marine waters, this is expected to change as the decomposing organic waste can suck up available oxygen from marine species and introduce disease into the local ecosystem. Fish skin leather processing could prevent and significantly reduce marine pollution and sustainably protect marine ecosystems in order to achieve healthy and productive oceans. This paper describes the conditions necessary for the development of fish skin craftsmanship within a Fashion Higher Education sustainable curriculum. In order to enhance the innovation and sustainable design of fish leather products, the author has developed an impactful capacity-building approach connecting fashion students with the Icelandic fish leather industry, which is renowned for sustainable sourcing from Nordic fish farms, promoting the sustainable use of ocean-based resources.

Keywords Fish skin; Food Industry By-Product; Sustainable Management of the Oceans; Arctic Economic Growth of Fisheries; Fashion Education for sustainability

E. Palomino
Central Saint Martins, University of the Arts, London, UK
e-mail: e.palomino@csm.arts.ac.uk

I. B. Franco *et al.* (eds.), Actioning the Global Goals for Local Impact, Science for Sustainable Societies, https://doi.org/10.1007/978-981-32-9927-6_15

15.1 Introduction

This chapter outlines the importance of fish skin, a by-product of the food industry, as an innovative sustainable material for fashion. Fish skins are sourced from the food industry, using waste and applying the principle of circular economy. None of the fish used to make this alternative leather are farmed for their hides. They require no extra land, water, fertilisers or pesticides to produce them and they have low environmental impact, unlike conventional leather (Jacobs, 2018). The processing of fish skin leather avoids throwing the fish skins into the ocean and can significantly reduce marine pollution and sustainably protect marine ecosystems in order to achieve healthy and productive oceans.

The Atlantic Leather tannery, located on the north coast of Iceland, has processed fish leather since 1994, based on the ancient Icelandic tradition of making shoes from the skins of catfish. It supports local economies by sourcing from sustainably-managed Nordic fish farming. The manufacturing of fish skin leather works with three aspects of sustainability: the economic benefit of creating value from waste; the social benefit of reconciling sustainability with fashionably exotic fish skin; and the environmental benefit of producing skins without damaging biodiversity or endangering animals.

The results presented in this study are based on the United Nations Sustainable Development Goal 14, Life Below Water, and they highlight the opportunity to develop fish skin leather as a key part of achieving sustainable development of the ocean. SDG 14 deals with the conservation and sustainable management of the oceans, seas and marine resources and it is strongly connected with other SDGs, in particular SDG 2 (ending hunger and achieving food security, improved nutrition and sustainable agriculture) and SDG 12 (sustainable production and consumption).

Fisheries and aquaculture make a crucial contribution to global food security, nutrition and livelihoods, but overfishing, unsustainable seafood farming practices, ocean pollution and acidification will threaten the future of seafood availability worldwide.

The oceans are recognised as indispensable for addressing many of the global challenges facing the planet, from food security and climate change to the provision of energy and natural resources. The use of the sea and its resources for sustainable economic development (Blue economy), contributing to prosperity today and into the future (WWF 2015), is expanding rapidly, but the oceans are under stress. They are already over-exploited, polluted and confronted with climate change. As carbon emissions have risen over time, the ocean has absorbed much of the carbon dioxide, leading to acidification. Sea temperatures and sea levels are rising, resulting in loss of biodiversity and habitat and changes in fish stock composition. Future ocean development is threatened by overfishing and depleted fish stocks in many parts of the world (OECD 2016).

Atlantic Leather, an Icelandic fish skin tannery, uses the full potential of the ocean by taking a responsible, sustainable approach during fish skin processing, and taking into consideration the wealth of the ocean and its great potential for boosting economic growth, employment and innovation.

This chapter explores the qualities of fish skin leather, a by-product of the food industry and part of the ocean economy: its capacity for creating future employment and innovation and its role in addressing the global challenges facing oceans. Special attention is given to the new technologies used in fish skin production, their potential for innovation and their contribution to addressing challenges such as energy, environment and climate change.

The World Ocean Council (WOC) has been working to advance global ocean business collaboration to develop industry-driven solutions to sustainable development. The Atlantic Leather fish skin tannery is playing an influential role in promoting sustainable practices, producing fish skin leather that implements sustainable concepts, reducing environmental impacts and creating social value. Creating sustainable value chains within ocean and maritime industries is a key priority for the Icelandic fishing sector. Since maritime technology has been developed in Iceland and private companies have set more value on businesses supporting ocean sustainability than before, the concept of the Blue economy has received increasing attention and interest (Hansen, 2018).

Atlantic Leather works with fisheries with blue technology, which considers the intersection of the economic benefits of the ocean, environmental health and societal value in policies and best practices (Hansen, 2018) and exploits the harvested raw material of fish skin to the maximum level within its value chain. By maximising the usage of fish skin, Atlantic Leather has added value within the fishing industry; the company's efforts to utilise 100% of the raw material contribute to maintaining fish stocks at biologically sustainable levels. Using the entire fish adds to the value chain, benefitting fashion buyers as well as the fisheries themselves. Since the benefits of 100% utilisation can be applied when the supplier or fishermen are registered and connected within the value chain, this idea of 100% utilisation helps reduce undocumented fisheries and over-fishing.

The activities of Atlantic Leather which are most closely related to the relevant SDG 14 targets are:

1- Reducing ocean acidification: Atlantic Leather reduces CO2 emissions by ceasing to throw fish skins into the ocean.
2- Regulating harvesting, and ending overfishing and illegal unreported fishing practices: 100% utilisation of fish raw materials is applied when the supplier or fishermen are registered and this helps to decrease undocumented fisheries and overfishing.
3- Increasing economic benefits from the sustainable use of marine resources: Atlantic Leather develops fish skin leather while preserving environmental biodiversity by sourcing from Nordic sustainably managed fish farming.
4- Providing access for small-scale artisanal fisheries to marine resources/markets: Atlantic Leather promotes value-added profits within the value chain by creating new job opportunities for coastal dwellers using a by-product of the fishing industry to produce fish skin leather for the luxury fashion industry.
5- Increasing scientific knowledge, developing research capacity and transferring marine technology: Atlantic Leather uses new technologies for the development of sustainably produced fish skin leather.

This chapter has presented a brief introduction of the development of fish skin use and reflected on the sustainable concepts of fish skin production in Iceland. The study proposes that the sustainable development of fish skin as a by-product could become an innovative sustainable raw material for the fashion industry. After this introduction, Chapter 2 reviews the historical context of fish skin leather. Chapter 3 introduces the fish

skin Concepts of Sustainability, the main contribution of knowledge to this field, and then reviews how fish skin leather and the Atlantic Leather tannery align with the SDG14 Life Below Water. Through the findings presented, this chapter aims to provide insights relevant to policymakers, fish industry stakeholders and academia, and to encourage continuous improvement towards more sustainable fashion practices. Chapter 4 introduces methods and methodology for the case study and action research.

Chapter 5 presents a case study of **Best Practices in Fashion Higher Education** with Arctic students. The study examines a fish skin workshop developed at the Icelandic tannery Atlantic Leather involving fashion students from five Nordic universities, providing new data on cross-collaboration between industry and academia. Such insights will inform industry and academia how fish skin leather, a by-product of the food industry, can better contribute to responsible marine resource use. Chapter 6 focuses on implementing measures and recommendations for both academia and industry, followed by the conclusions of the study.

15.2 Literature Review

15.2.1 *Historical Context:* Fish skin through history

Making leather from fish skin is an age-old craft practised by many societies along rivers and coasts around the world and there is evidence of historical fish skin leather production in Scandinavia, Alaska, Hokkaido, Japan, north east China and Siberia. Before synthetic fibres were invented, people clothed themselves with natural materials available in the surroundings where they lived, including fish skin (Jiao, 2012).

Arctic people display a remarkable intelligence in utilising natural resources, reforming natural conditions, adapting to the environment and creating a better life; in the past, this included making clothes from fish skin leather. However, the shortage of raw materials and the omnipresence of modernity have challenged the preservation of the fish skin craft. Better access to the modern world meant that Arctic people were able to access textiles like cotton and silk to create their clothing, leaving fewer people to develop the traditional fish skin craft. There are currently only a few people left who know how to create these fish skin garments (Campbell, 2010). Overfishing and water pollution have caused fish stocks to drop and many Arctic aboriginals have turned to farming and tourism to make a living, abandoning their fish skin skills (Lin, 2007).

15.2.2 Iceland's traditional knowledge of fish skin

For much of their history, Icelanders wore shoes made of fish skins processed using traditional tanning methods. Each shoe was cut from a single piece of fish skin, with a vertical seam at the heel and a seam at the toe. They were soft, supple, flat-soled traditional footwear (Mould, 2018). Contemporary accounts of travels around Iceland in the mid to later 18th century describe and illustrate men wearing traditional fish skin shoes (Hald, 1972), suggesting that the working man wore them on a daily basis. Icelanders made their shoes from wolf fish leather and they measured distances by how many pairs of fish skin shoes would be worn out by walking over the path.

15.2.3 *Fish waste: Use of fish by-products by aboriginal peoples*

The use of fish by-products was well-known to aboriginal peoples in Arctic communities (Hardy, 1992). The specific material properties of fish skin have been known since ancient times. Some human cultures developed unique techniques to process fish leather from fish skin and used this leather for clothing and shoes (Ehrlich, 2015). Icelandic history, right from the settlement of Iceland in the 9th century, has been interwoven with marine resources and fish have been their main source of food and income (Sigfusson and Arnason, 2017). Icelanders are known for reusing everything and they still have their ancestors' spirit of finding the useful in everything. Improved usage of so-called waste and other by-products could help meet increasing demand for seafood without further stress to the ecosystem. Some "waste" products can have a very high value if they are used. A more efficient use of resources will benefit society, the environment and the industry's bottom line (Bechtel, 2003).

The use of fish skin by the Arctic's aboriginal peoples has recently been assimilated as an innovative sustainable material for fashion due to its low environmental impact. Fish skins are sourced from the food industry, using waste, applying the principle of the circular economy (Jacobs, 2018).

2.4 Protecting natural and cultural resources

For indigenous Arctic people, the relationship with fish, and specifically with salmon, plays an important role in maintaining their identities as distinct cultures. Salmon provides them with more than nutrients. It also plays a role in ceremonial traditions, creating important ties between people and their environment.

The Arctic is undergoing dramatic climate change which threatens indigenous people, impacting their food security and traditional knowledge systems which rely on fishing activities for their physical, cultural and spiritual wellbeing. Coastal Indigenous Peoples in the Arctic share links to marine environments, mainly through fishing. The relationship with the sea plays an important role in maintaining their identities as distinct cultures, but climate change is threatening indigenous people's ties to oceans and marine resources around the world (Yoshitaka, 2017). Fisheries management is a human security issue as well as an environmental issue, and we need to bring social equity into global governance of the oceans, to respect coastal Indigenous Peoples and their relationship with fish.

Preserving traditional knowledge with regard to fish skin is essential to the Arctic world. This chapter seeks to draw attention to the vital importance of traditional fish leather craft to the Arctic people as the basis of their culture and a component of their identities and to encourage their artisans to re-introduce the skills used by their ancestors as a tool for community development.

15.3 Sustainability Context Icelandic fish skin leather: Concepts of sustainability. Aligning fish skin leather with the United Nations Sustainable Development Goal 14. Life Below Water.

15.3.1 SDG 14.3 Reduce ocean acidification

Sustainable Development Goal 14:3 is "Minimise and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels".

Atlantic Leather's production of fish skin leather using fish waste aligns with this goal.

Global production of fish has steadily increased over the last decade and more than 50% of the total fish catch becomes waste material resulting in 32 million tonnes of waste (Arvanito, Kassaveti, 2008). To date, the European Environment Protection agency allows seafood processors to dispose of fish skins in marine waters, but this is expected to change as the decomposing organic waste can suck up available oxygen from marine species and introduces disease into the local ecosystem (EPA, 2012). Unlike the EU's fisheries policy, the Icelandic system decrees that non-saleable fish cannot be tossed back into the ocean, but must be brought ashore and counted towards the quota, therefore maintaining fish populations (Deliso, 2015).

Fishermen create waste by using fishing methods that are not discriminating enough or by targeting only part of the fish (e.g., roe, fins) and discarding the rest. Fishermen and sea processors are incentivised to discard low-value species or trimmings to help maximise the value of their catch. Moreover, fish waste is typically unsorted and geographically dispersed, which makes it costly to collect and process. The high-value uses of seafood by-products like fish leather make fish skin collection and upcycling more feasible and attractive for the fishing industry (Henning, and Jain, 2017). Iceland has also made voluntary commitments to reduce marine litter in its waters and to address acidification by producing an updated climate mitigation strategy by the end of 2017, in line with the Paris Agreement, with obligations of a 40% reduction of greenhouse gas emissions by 2030 (Gunnarsdóttir, 2017).

The technology for sustainable processing of fish leather can be of great environmental benefit as well as profit for the global economy. Fish skin leather processing could prevent fish waste ending up in marine waters and significantly reduce marine pollution and sustainably protect marine ecosystems in order to achieve healthy and productive oceans. Before Atlantic Leather started using fish skin to produce leather, fish skins used to be thrown away. Now, they are a source of income for the local people, besides avoiding being turned into biological waste.

15.3.2 *SDG14.4 Regulate harvesting and end overfishing*

Sustainable Development Goal 14:3 is "Conserve and sustainably use the oceans, seas and marine resources for sustainable development".

By 2020, the aim is to effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest feasible time, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics.

15.3.2.1 *Marine biodiversity*

Concentrating on improving the sustainable value chain, Atlantic Leather works closely with the fisheries who supply them with fish skin to improve the sustainability of fish resources and to unite the efforts of the world's leading seafood industries to reduce the global extent of illegal, unregulated fisheries. These activities and efforts have linked Icelandic private enterprises in a common movement to save Icelandic marine biodiversity by restricting illegal fishing and undocumented fisheries. The fish catch in Iceland is made in a conscious and non-predatory way that respects environment laws and procreation periods.

Atlantic Leather uses fish from Nordic government regulated farms with sustainable management, which provides employment for local communities and a sustainable source of food while maintaining fish stocks. Fish is a key part of both food and the local economy in Iceland.

The fishing is carried out in a sustainable way, under the control of government agencies dedicated to the preservation of species and biodiversity. It helps the local communities and respects the Nordic environmental balance. With stock sustainability and the ecological effects of fishing and management systems as core concerns, Iceland has become even more competitive in the global marketplace (Sigfusson, and Arnason, 2017).

15.3.2.2 Sustainable management of Arctic fisheries

As much as 40% of the ocean is heavily affected by depleted fisheries and other human activities (UN 2018). The growth in aquaculture could put stress on the fish industry to meet increased demand, by ignoring fishing quotas imposed by responsible governments. The sustainability role of the fisheries industry is an important issue which has to be taken into consideration as a concern about the future availability of raw material for fish (Bechtel, 2003).

Fisheries are the single most important industry in Iceland and the living marine resources are their most important natural resources, but they are limited, and it is important to utilise these resources in a sustainable way. In 1984, fixed quotas for each vessel were introduced in order to control exploitation of the fish stocks (Valdimarsson, 1990). The main objective of the quota legislation was to prevent overfishing and to encourage responsible handling of all catches and exploitation of under-utilised marine life. There is no doubt that the quota system has had a major effect on changing attitudes towards full utilisation of catches. The fishermen and the processing industries are becoming more aware of the possibilities of making marketable products from raw materials that are currently discarded, such as fish leather. Through research and development, publicly

funded institutions assist the industry to increase the utilisation of seafoods (Bechtel, 2003). Iceland, as an Arctic coastal state, takes part in the ongoing negotiations on a new agreement to prevent unregulated high seas fisheries in the Central Arctic Ocean and has been engaged, within the Arctic Council, in consultations on increased Arctic Marine cooperation (Gunnarsdóttir, 2017).

15.3.2.3 Fish Skin as A By-Product of the Food Industry. Resource Efficiency by Generating Value from Waste.

Fashion is an extremely wasteful and polluting industry, creating a negative impact on the environment and on people. The fashion industry is currently going through a significant change in its approach towards sustainability (BCG, 2017). Therefore, the fashion industry as a whole must strive to change and rethink its raw materials and processes. There is a trend for the adoption of new materials, which have a lower environmental impact than their conventional alternatives (Textile Exchange 2016). Fish skin is an innovative and sustainable alternative material with a lower environmental and social impact than conventional leather. Fish skin as a new raw material for the fashion industry could provide a (partial) solution for aquaculture waste, which the European Union has committed to reduce through actions in the Circular Economy Package.

Almost half of the fish caught for human consumption is discarded before it even reaches our shelves. This represents a significant amount of potential profit that is effectively being thrown away. The average production of one tonne of fish fillets results in roughly 40 kilograms of discarded skins. Improved usage of fish by-product waste could help meet increasing demand for seafood without further stress on the ecosystem. More efficient use of resources will benefit society, the environment and the industry's bottom line. Reducing discards and up-cycling by-products will likely increase profitability (IOC, 2013).

When Atlantic Leather converts the fish skins into leather, it creates new value and far-reaching economic opportunities. Atlantic Leather has been perfecting the fish skin tanning techniques to turn it into high value products for non-food sectors (fashion) by up-cycling fish skin into exquisite fish leather. Recycling fish skin into leather is eco-friendly, cost effective and sustainable. With an estimated 43% of fish and shellfish resources ending up as wastage, Atlantic Leather is converting once discarded parts of the fish into desirable products and income: fashion and accessories; the tannery is proud that it can reduce waste while sourcing salmon skins from certified sustainable Nordic fisheries. Atlantic Leather is part of a group of pioneering industry experts from Iceland involved in the commercial fishing, aquaculture and processing sector and the creation of value from fish processing by-products. Companies in Iceland, the pioneers of this industry, have developed a wide range of uses for fish waste: enzymes, pharmaceuticals, dietary supplements, cosmetics and leather goods (Sigfusson, and Arnason, 2017).

15.3.2.4 Chrome-free tanned fish skin

The processing of leather is most commonly linked with environmental pollution. Many of the chemicals used during tanning are toxic, with substances like mineral salts and chromium routinely used. Environmental protection standards tend to be insufficient in primary leather producing regions, with waste water and solid waste from the tanning process dumped directly into rivers, devasting nearby flora and fauna. Tanning does not just have an environmental cost; a number of the chemicals used to tan leather are carcinogenic, endangering the health of those who labour in tanneries (Shean, 2018).

Atlantic Leather Commits to SDG 14: Actions for Businesses: Record and disclose information on the chemical usage within products to facilitate closing the loop. Atlantic Leather produces chrome-free fish leather using mimosa bark in a traditional process of vegetable tanning, avoiding chromium salts, which are extremely toxic and polluting. Vegetable tanned fish leather is sustainable, durable and surprisingly strong, even stronger than other kinds of leather. This is due to the alignment of the fibres in the skin: in mammals, these run parallel to each other, but in fish they are in a cross-hatched pattern, making fish leather much stronger for the same thickness.

15.3.2.5 Harnessing renewable energy

Iceland has a unique situation in an era when climate change is making it necessary for countries around the world to implement sustainable energy solutions. Today, almost 100% of the electricity consumed in Iceland comes from renewable energy. The glaciers and rivers of the interior of the country are harnessed to generate 80% of the country's electricity needs through hydropower, while the geothermal fields provide the remaining 20%. Iceland has also focused on sharing its knowledge and technical expertise in geothermal development (Logadóttir, 2015). The entire process of producing fish skin at Atlantic Leather relies on the power of nature and is non-impactful on the environment – even in terms of electricity consumption, as geothermal water is used to produce fish skin leather and their electricity comes from a nearby hydroelectric power station.

The use of geothermal energy for fish by-products is likely to increase in the future. The interest in Iceland is focused on the use of geothermal energy in low-heat regions. It can be expected that the price of oil will increase more than the local energy in the future, and therefore it is worth paying attention to the use of locally available energy sources for the fishing industry (Bechtel, 2003).

15.3.3 *SDG14.9 Support Artisanal Fishermen*

Sustainable Development Goal 14:9 is: Provide access for small-scale artisanal fishermen to marine resources and markets

In recent history, fisheries and fish processing jobs have been in decline in Iceland. Like many other countries, Iceland has been mindful not to overfish. With stock sustainability and the ecological effects of fishing and management systems as core concerns, Iceland has become even more competitive in the global marketplace by using fish by-products. Iceland has discovered one way of creating value and jobs, especially in remote and rural areas where such opportunities are not taken for granted (Sigfusson, 2017).

This approach has been beneficial to all levels of the supply chain, including fishermen in remote areas who have seen the prices of fish triple in recent years due to increased interest

in value-added issues. The sustainability of the Icelandic system means that fishermen now rank among Iceland's highest-paid workers. The Icelandic model has proved reliable and this model could be duplicated in seafood industries around the world, creating new opportunities in coastal areas (Sigfusson, 2017).

15.3.3.1 Creation of new job opportunities for coastal dwellers.

Since the 9th century, Icelanders have derived vitality and stamina from fish. Atlantic Leather has propelled a Nordic tradition to increase the utilisation and value from fish waste to create fish leather and in so doing create new job opportunities, especially for coastal dwellers.

The Atlantic Leather tannery sits in a thriving community on the North East coast of the island – inhabited by fewer than 3,000 people, with fishing grounds located just off-shore. Such proximity to the source means that transportation to the point of manufacture is significantly reduced; it also presents the innovation that the tannery only uses waste fish skins from food consumption.

Atlantic Leather creates blue tech and blue jobs in a remote coastal area promoting a sustainable ocean industry. A key challenge for these coastal areas is to maintain the viability of the fisheries sector and to attract young people to work in it. Atlantic Leather aims to preserve the rich cultural traditions that have been developed within the Icelandic fishing industry when processing their fish leather.

Fish leather is also benefiting other sectors, such as tourism. In 2014, Atlantic Leather – Iceland's last remaining tannery – opened a museum for tourists. The museum recreates the traditional and contemporary tanning process of fish leather and displays historical photos and implements (Deliso, 2015).

15.4 Methodology

15.4.1 Study Methodology

The aim of this case study is to explore the link between sustainable materials (fish skin, a by-product of the fish industry, as a new raw material for fashion) and transferring the intangible heritage skills of fish skin craft from Arctic ethnic minorities to higher education fashion students from Nordic universities.

The literature review highlighted that in Iceland, as in many other countries around the world, better utilisation of marine resources is being widely called for. There is well-documented support for the Icelandic commitment to a sustainable seafood sector and a reduction of sea food waste.

To reflect upon the interaction of fish skin using traditional craft techniques, bibliographic and documentary research was initially done:

- Enquiry [Theory]. Following the workshop (see Chapter 5), data was collected through primary and secondary sources to reveal areas of potential development.
- Contextual and visual analysis.
- Making [Practice]. Higher education students produced fish skin samples in collaboration with an Arctic ethnic minority craftsperson. Photographic documentation

was used for the illustration and classification of results.

- Sharing [Dissemination]. Feedback has been sought through activities such as conferences, published articles, teaching and communication via the author's website http://www.fishskinlab.com

4.2 Methods

Action research was used during this study. The data was collected through:

- Archival research in museums to study traditional knowledge in fish skin processing.
- Mapping traditional fish skin crafts to validate their technical feasibility.
- Field Trip. The field trip covered the area around Sauðárkrókur on the North East coast of Iceland.
- Workshop on fish skin leather craft to test ideas through teaching and learning, observing students' design approaches using fish skin as an alternative material.
- Photographs and video recording.
- A documentary filmed during the workshop, featuring interviews with students, curators and craftsman to observe students' development of fish skin finishes as a form of design research.
- Sketchbook development.
- Literature review.

15.5 Discussion and Results: Best Practices in Fashion Higher Education Increasing the Co-production of Knowledge Sharing Indigenous/Traditional Knowledge with Arctic Higher Education Fashion Students.

The Fish Leather Craftsmanship workshop was organised by the author, Elisa Palomino, BA, Fashion Print pathway leader at Central Saint Martins, London and Katrin Karadottir, Programme Director in Fashion Design at Iceland Academy of the Arts, in collaboration with Atlantic Leather tannery, with the participation of students from Iceland University of the Arts, the Royal Danish Academy of Arts, Boras University, Aalto University and Central Saint Martins.

In order to provide an inspiring environment in Arctic higher education, to enhance student engagement and test a new learning experience, the author designed a workshop encouraging Artic design students to produce fish leather designs using traditional skills built over generations by Arctic Indigenous Peoples. The aim was to promote the vast set of knowledge and skills on fish skin that the North possesses, developing sustainable design within the Arctic's traditional ways of life in areas with a history of fish skin leather production, such as Iceland, Sweden, Finland and Denmark, preserving and using fish skin cultural heritage and strengthening networking activity.

The workshop took place in Sauðárkrókur, Iceland, and combined learning about traditional knowledge on fish skin tanning with studying the technological progress of

the Icelandic tannery Atlantic Leather, which has been turning local fish skin into highly sustainable leather since 1994. A total of ten students from universities in the circumpolar area (Iceland, Denmark, Sweden, Finland) and the UK benefited from the workshop. A Swedish craftsperson from the Sami ethnic minority delivered the workshop. Lotta Rhame shared traditional Sami fish skin tanning methods and passed down the endangered fish skin craft to the next generation of Nordic students as part of a sustainable fashion higher education programme to learn best practices for social change and sustainability. The programme included preparation, implementation, evaluation and a follow-up phase.

The workshop was designed to build community knowledge around material culture and to bring participant voices together to promote understanding of fish skin craft culture, with the aim of improve knowledge of fish skin craft to address the pressing sustainability issues in the current fashion industry and to understand the duty to change fashion systems through education, inculcating fashion students with the values of sustainability. The workshop aimed to develop new fashion practices, taking students out of the classroom and into nature and contributing to the learning experience about fashion sustainability. Another important aim was to improve the awareness and protection of traditional Arctic fish skin culture. Students learnt traditional fish skin handcraft heritage in order to integrate it into their fashion practice. According to Fletcher, participatory design and co-design structures are key to changing fashion systems and to fostering lasting relationships between the makers and the final product (Fletcher, 2008). The workshop's main objectives were to:

- Map existing traditional knowledge of fish skin craft from the Sami ethnic minority in the Arctic.
- Build an interdisciplinary collaborative network which intersects craftspeople from Arctic ethnic minorities and higher education students to study fish skin ancient traditions.
- Preserve and disseminate Arctic cultural heritage connected with fish skin, promoting sustainable development of their unique craft culture.
- Help higher education students develop fish skin leather samples as an environmentally responsible alternative material for fashion.
- Enhance the visibility and attractiveness of fish skin leather as a new sustainable material for Nordic fashion students.
- Bring together sustainable methods from fashion design and traditional crafts to foster international knowledge exchange that will develop the capacity for practice in these fields.
- Identify tools about best practice on fish skin leather craft and test the ideas at higher education fashion institutions in the Arctic and internationally, supporting students to engage in sustainability facilitated through the use of fish skin as an alternative material.
- Promote collaboration between industry and education in order to ensure that fashion programmes are meeting industry needs; industry involvement to train fashion graduates on sustainability issues; attracting Arctic fashion students to the maritime industry.

The workshop was five days long and included:

- An introduction to the sustainability background
- Lectures on historical fish skin artefacts at international museums
- A visit to the Atlantic Leather fish skin tannery
- A visit to the local textile museum
- Traditional fish skin tanning
- Sketchbook development

The workshop brought together traditional knowledge holders and community representatives from across the Arctic in order to explore the roots of Nordic fashion and design traditions linked with fish skin, to create space for communities to share wisdom, skills and techniques around fish skin processing and to co-produce new work using both traditional knowledge and British sustainable design methodologies. The workshop promoted sustainable material engagement through a full immersive experience in a teaching-in-the field approach, creating a collaborative network for further projects, and setting up an international design environment for sharing knowledge.

The workshop methodologies reflected the geographical contrasts of the area. The harshness of the weather, the isolation and the limited availability of materials formed a unique source of creativity and inspiration for the students during the workshop. Fish skin was the only available material, spurring students to think creatively and seek new design possibilities. Eco-consciousness played a fundamental role in the students' designs using remnant materials. Fish leather offers outstanding longevity, one of the most important elements in sustainability, and has the benefit of being a highly biodegradable natural by-product.

The object of the workshop was the preservation and dissemination of the cultural heritage connected with fish skin. In order to achieve this, the collaboration and cooperation among different Artic areas, universities and professionals provided a key element in the project. This was a fine example of an innovative way of linking the preservation of traditional knowledge and culture and the development of culturally relevant programmes for students, community involvement and the conservation of resources. The project provided a case study for working across Arctic universities to develop their cultural identities and foster narratives of social sustainability. The cross-disciplinary project has created a new structure to demonstrate how much Arctic communities have in common.

The workshop seeks to inspire fashion lecturers involved in the development of sustainability and craftsmanship within their curriculums to implement this transformative teaching and learning experience in their own practice. Hopefully, the workshop will inspire new ideas across the student and staff communities that were involved, which in turn may contribute to public debate on sustainability issues in the fashion industry (Fletcher and Williams, 2010). The Nordic fish skin network has blended the highly qualified skills of a Swedish craftsperson, Lotta Rhame, with British cutting-edge sustainable design education. Development of sustainability within the curriculum has been identified as a high priority for students (Reid, 2011) and this project's outputs will inform existing courses naming sustainability, as well as a broad spectrum of design courses.

Through this workshop, the author, as a member of the London College of Fashion, Centre for Sustainable Fashion, has brought its commitment to using fashion to drive change, build a sustainable future and improve the way we live, using human and ecological resilience as a lens for design in fashion's artistic and business practice (CSF 2015). The author has made a contribution to the field of Design for Sustainability (DfS) in fashion, furthering the sense of our interconnections as people and to our natural world. This workshop has specifically supported the following four of the seventeen United Nations Sustainable Development Goals:

- SDG 4 – Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
- SDG 12 – Ensure sustainable consumption and production patterns.
- SDG 13 – Take urgent action to combat climate change and its impacts.
- SDG 14 – Conservation and sustainable management of the oceans, seas and marine resources.

The workshop has developed a collaboration framework between industry and education and has managed to:

- Raise awareness on ocean-related issues and the maritime economy with higher education students.
- Create new cooperation between education and maritime industry.
- Improve the employability of students thanks to the acquisition of new sustainability and craft skills.
- Share resources between different educational institutes and industry at the trans-national level.

The case study recommends transferable skills for educational models and demonstrates how relevant the indigenous fish skin knowledge in partnership with sustainable design strategies - can be to connect people to their culture, communities and the environment. The case study reflects on the dialogue between indigenous craftsmen and Nordic fashion students on common Arctic issues, in particular issues of sustainable development, sustainable material innovation and Arctic environmental protection, in order to restore some of the damage that has already happened to the Arctic's indigenous culture related to fishing rights and fish skin clothing traditions, helping to build resilience amongst the Arctic communities. This project recommends engagement with local communities and traditional fish skin knowledge holders, laying the groundwork for an assessment that is co-produced by both traditional knowledge and British fashion education.

15.6 Impact Sustainability - Final Remarks

The supply of fish in the oceans is not endless and therefore we need to manage fisheries in a more sustainable way. By developing fish skin leather, we could achieve sustainable ocean development, optimising fisheries management and increasing the value of the catches. (Bechtel, 2003). The future availability of seafood, however, is threatened by overfishing, unsustainable seafood, farming practices, ocean pollution and acidification. Strategies aimed at increasing the utilisation of fish skin that would otherwise be discarded must be carefully considered. Creating markets for fish skin runs the risk of incentivising bigger catches and creating fishing pressure for species currently viewed as fish skin potential.

The Icelandic fish skin model has proved reliable and this model can be duplicated in seafood industries around the world, creating new opportunities in coastal areas (Sigfusson, 2017).

The project could be scaled up by developing a model of fish leather-waste production that can be used by factories in other countries with a big consumption of fish in their diet and countries with a history of using fish skin leather. By doing so, indigenous fishing communities which used to subsist upon, and dress themselves with, fish skin leather items – like the Ainu in Hokkaido, the Nanai in Siberia and Alaska's Inuit – will be able to reach agreements with nearby fishing plants for the supply of fish skins to recover their ancient craft skills of tanning fish skins and develop productions that will boost their economy.

Fish skin leather can be used in wallets, bags, and shoes. The process is low-tech and requires little capital, which makes it ideal for small businesses or for setup in developing countries (Henning and Jain, 2017). The overall findings align with the Icelandic industry's commitment towards greater sustainability. The study suggests that there is a great financial opportunity to use fish skin as a new raw material for fashion. Countries with both high demand and cultural reliance on fish are potential candidates for the marketing and sale of fish skin leather. It is highly recommended that similar case studies are developed in other fish-producing consumer areas.

The case study has also given new insights into the potential for even greater sustainability actions through the implementation of workshops within higher education fashion. Students have studied how fish by-products are used in the value chain and how it demonstrates positive waste reduction.

Through examining the strategic management of fish skin, this study has outlined the ability for the aquaculture industry to produce more value from the same amount of resources. In conclusion, there are economic and environmental benefits that should be considered in order to develop fish skin further as a new raw material for fashion.

With collaboration between industry and academia, the rise of fish skin as a new by-

product raw material for fashion will contribute to the sustainable development and future growth of the aquaculture and fashion industries.

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PROFESSIONAL DEVELOPMENT AWARD

FISH SKIN COAT FROM THE AMOUR RIVER

ELISA PALOMINO

Along the lower reaches of the Amour River, in Eastern Siberia, where the water empties into the Pacific Ocean, the indigenous Nivkh, Ulch and Nanai peoples dressed themselves with fish skin coats made with the skin of the chum salmon. Until the beginning of the twentieth century, these Indigenous Peoples lived entirely from fishing and hunting. Salmon was an essential part of their world view, providing them with food and clothing for centuries. Living at a crossroads in East Asia, these groups have always interacted with each other and with the Chinese, Manchu, Koreans, Japanese and Russians. Imagination, resourcefulness, and materials have flowed in and out of their homeland for thousands of years. These Amour groups have distinctive identities. Yet centuries of sharing materials have led to similar material cultures, belief systems and rituals.

This paper looks at a Nivkh coat from the lower Amour River in Eastern Siberia acquired by the V&A Museum in 1905 and compares it to a John Galliano fish skin parka from the Autumn/Winter 2002 collection. The paper draws on the design practice that I instigated developing fish leather garments whilst working as head of the design studio at John Galliano. The paper reflects on the use of fish skin by Indigenous Arctic peoples, which has, since the late 1990s, been assimilated as an innovative sustainable material for fashion, due to its low environmental impact. Moreover, it reflects on the anthropological fashion journey on which I have embarked to understand processes of social, cultural and historical transformation through the study of fish skin practices in the Arctic.

International museums with anthropological collections provide knowledge in the relationships between humans and nature. Fish skin material culture features the connection between people, nature and the everyday objects that embody the choices people have made in relation to the environment. Fish skin artefacts reveal the technological innovation and cultural adaptation that different communities have chosen in different Arctic regions throughout time. They are physical proof of the sustainability of various Arctic cultures and of their resilience based on the material choices they have made. Arctic Indigenous Peoples think of fish skin historical objects to be highly animated. They can channel the spirit and characteristics of the fish they are made from to the individual. This makes them more like conduits than just objects in themselves. Everyday objects made of fish skin share the narrative of how Arctic Indigenous Peoples have chosen to fish and process their skins as raw materials and how they have harvested the fish resources for their own benefit. The material evidence of fish skin demonstrates the ability of Arctic indigenous people to inhabit the Arctic by developing complex cultural traditions connected with nature[1]

The production and functional properties of fish skin are key to the creation of Arctic fish skin clothing, both in the strength of the skin itself and how it was sewn into garments.

Another key element is the use of natural tanning substances and dyes in the process. Usually, fish skin clothing was sewn in the winter. Cool temperatures rendered the skins more supple and the task of sewing easier[2]. The people of the Amour used needles made of fish bones and thread made from reindeer sinew or fish skin thread. Sinew collected from along the spine and the legs of the reindeer was enough to sew an entire garment. Fish skin was also used as thread for sewing. After drying and softening the fish skin, it was cut into a long narrow strip that was used as thread. During the sewing of the skins, particular

[1] Lincoln, A., Cooper, J., Peter, L, L. (2020) *The Citi exhibition. Arctic, Culture and Climate.* The British Museum. Thames and Hudson.

[2] Rajagopalan, S., Buijs C. (2001) *Layers of meaning: Clothing on the Amour.* Leiden National Museum of Ethnology.

Fish skin coat circa 1900 from the lower Amur River in Eastern Siberia, Nivkh population. The back features scale patterns mimicking the fish's own scales with black-blue-red abstract swirling patterns, Victoria & Albert Museum. London.

attention was paid to symmetry in the arrangement of the scales of the different skins to ensure continuity of the surface to make the seams imperceptible[3].

The Nivkhs preferred to use whitened carp or salmon skins for the production of women's festive coats. They were bleached and processed to obtain a very smooth and honeycombed surface. They were whitened with white clay collected on the banks of the river Amour. The clay was collected in summer, at low tide, when it appeared on the shores of bays in the form of small lumps. The fish skin was smeared with a thin layer of clay, dried in the sun, smeared again, dried and then rubbed again. Another method of whitening fish skin was to hang the untreated skin out in the frost and leave it out until it turned white.[4]

The Nivkh coat (ca 1900) analysed in this paper is in the V&A Asian Department and was acquired by the museum in 1905. This coat is described as a Gilyak coat (an older term used for the Nivkh Indigenous people) from the lower Amour River near Vladivostok in Eastern Siberia, and there is a note adding that 'The tribe who make this work is said to be dying out' (V&A, 2021). Sixty salmon were used to make this coat, each estimated to have weighed between 15 and 20 pounds, which were sewn together with sinew using the natural shape of the fish as a decorative element.[5] The Nivkh used the skins of female chum salmon, which was softer, to make a gown. The exact number depended on the size of the gown being made. The underside of the fish skin had a terry surface (the fibres covering the fish skin were called ungsu) and hence did not cause discomfort to the person when in contact with the body.[6] On the flesh side, the garment has long collagen fibres which ensure a high resistance and a lining with a "fur" effect which is particularly soft to the touch.[7]

The Nivkh fish skin coat has an almost austere look to it, with the exception of the decorative pattern on the left and right side of the garment. From the hem upwards on each side of the garment there is a black applied and painted border. This panel ends with an ornament of a scrolling design at the waist. A black painted border edges the neck, front overlap panel, hem, and sleeves. One could assume this was to protect the areas most prone to wear and tear, but we could also assume that the black paint may have a spiritually protective property to it. The neck edge is turned in and stitched. The hem, sleeve ends, and edge of the outer front panel are finished with a cut edge.[8] The outer front panel overlaps from left to right. The coat's style is reminiscent of Chinese and Manchurian clothing. It has a Manchu-inspired T-cut, characteristic of the region, with a wide left flap that is attached to the right flank. Its opening is to the right, like the neighbouring Chinese (Rajagopalan, 2001). Additionally, the pattern and sewing of the salmon skins is incredibly precise and methodical. You can tell that this coat was a labour of love and precision. The coat is unlined and has no fastenings. The absence of lining at the hem and edges reveals the silky, flowing fall of the skin as well as the structure of the skirt, which has a flat surface, well weighted by a large, heavy, black hem.

The back of the coat has a stunning, swirling, scale-shaped appliqué. The upper part of the back is decorated by painting (blue, red, and black) the inner side of the fish skin (fish-scale shaped pieces).[9] The decoration is not only intricately detailed, with incredibly precise sewing, but also colourful and symbolic. Red, blue, and black dye had been used to paint the fish skin and the thread used to sew the fish skin appliqué onto the coat. A blue dyed, double creasing effect had been applied to the armhole

[3] Cevoli, D, Glebova, E. (2015) Esthétiques de l'amour : Sibérie extrême-orientale. Paris: Musee du Quai Branly. Flammarion.

[4] Melnikova, T. (2005) The gift of "fish-skin barbarians"

[5] V&A (2021) Gilyak coat from the lower Amour River in Eastern Siberia. V&A Collections.

[6] Melnikova, T, ibid

[7] Cevoli, ibid

[8] V&A (2021), ibid

[9] V&A, ibid

and additional shoulder seamed panels. This blue area was made of thicker fish skin and was done to reinforce an area prone to wear. Furthermore, being another pattern piece, it probably was more easily replaceable than the fish skin making up the main body of the coat.

The Nivkh adorned their clothes with elaborate motifs. They used fish skin appliqué patterns which they glued on to the surface of the garment using fish-glue. Colours and designs were used alternately on the layers for a multi-coloured, multi-layered effect. Girls who were skilled in the art of appliqué were considered very good candidates for marriage.[10] Clothing was adorned with complex spiral patterns intermingled with plant and animal motifs, or figures of mythical beasts (Rajagopalan, 2001).

Decorations on clothing were meant to keep evil away and pacify the spirits of the animal world.[11] People of the Amour attributed special powers to nature and animals, and they used them in stylised and conventional ways in clothing. The stylised depiction of birds, fish, snakes and water is used in fish skin robes.[12]. According to the legends of the Nanai (whose material culture and symbolic system bear close resemblance to that of the Nivkh), the designs on the back of the jacket are supposed to protect a woman from what is not visible to her. A woman working at the fire with her back to the door needed extra protection. The placement of the appliqué motifs also provides a message around restricted communication taboos between women and men. Since a woman never faced her guests directly in traditional society, she compensated by displaying an ornately decorated back. Women sat at the fire, with their backs to visitors, but those beautifully decorated backs said much more than their faces.[13]

This coat features a scale pattern mimicking the fish's own scales with black-blue-red abstract swirling patterns. Water, both as river and sea, is a recurring motif in the belief system of the Amour people. Local legends suggest fluidity between land and water, so that when characters cross the water, it is usually to begin a new phase of life. The water and the crossing thereof is a metaphor for transformation. The designs on this coat in all their symmetry, twist and curve gracefully - perhaps the flow of these spirals suggests the central place that water occupies in the lives of the Amour people.[14]

Colours most frequently used in Amur decorative arts were red, blue and black. Black was considered appropriate for festive clothing.[15] For Amur River people, an important element for the production of fish skin clothing was the use of natural dyes to paint the ornaments on clothing. Nature provided them with a rich palette of colours used to decorate their clothes. For the preparation of colours, blue and red minerals had been collected on the shores of the Lower Amur River since ancient times. They were ground with dry red caviar and diluted with water to obtain a homogeneous mixture. In the Amur region, one can also find raw materials for dyeing of vegetable origin.[16]

The pigment analysis of the coat done at the V&A in 1998 revealed that the orange-red pigment is a natural earth pigment or ochre; the black is probably a carbon black; the green blue is probably Dyers Knotgrass. From the dye analysis, the orange red is likely to be safflower (Carthamus tinctorius L); the grey-green is likely to be knotgrass (Polygonum tinctorum L); the dark blue is likely to be knotgrass (P.

[10] Rajagopalan, S., Buijs C. (2001) *Layers of meaning: Clothing on the Amour*. Leiden National Museum of Ethnology.

[11] Oakes, J. Riewe R. (1998) *Spirit of Siberia: Traditional Native Life, Clothing, and Footwear.* Washington, D.C.: Smithsonian Institution Press.

[12] Rajagopalan, S., Buijs C. (2001), ibid

[13] Jude, I. (2016) The Secret Language of Salmon Skin Coats. Hakai Magazine.

[14] Van Deusen, K. (1997) "Protection and Empowerment: Clothing Symbolism in the Amour River Region of the Russian Far East"

[15] Rajagopalan, S., Buijs C. (2001) Layers of meaning: Clothing on the Amur. Leiden National Museum of Ethnology.

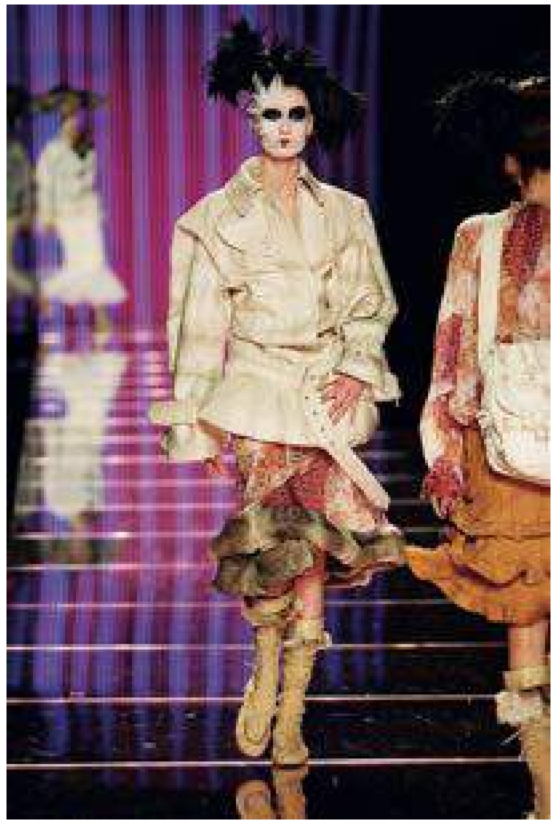
[16] Cevoli, D, Glebova, E, ibid

tinctorum); the strong green is likely to be knotgrass (P. tinctorum) plus a natural yellow mordant dye.[17]

The use of fish skin by Indigenous Arctic Peoples, has, since the late 1990s been assimilated as an innovative sustainable material for fashion, due to its low environmental impact,[18] since fish skins are sourced from the food industry's waste.[19] The use of fish leather avoids the waste of a potentially renewable resource. As the demands on the Earth's resources by the fashion industry continue to grow, innovative materials, such as fish leather can address the impact on the natural world. Fish leather is increasingly seeing a resurgence as it requires less energy and resources to produce than conventional materials.[20] Due to the scarcity of raw materials, turning to other resources becomes more important for a sustainable fashion industry.

The Nivkh coat has been compared to a fish skin parka from John Galliano's Autumn/Winter 2002 collection. This research draws on my previous industry experience as a fashion designer working in the luxury industry for John Galliano. For this collection, we designed fish leather garments and accessories. We used salmon, perch, and cod skins sourced at Atlantic Leather, the world's biggest fish skin tannery, based in Iceland. We were amongst the first brands to use fish leather and by doing so, we situated the barely unknown sustainable material within the context of the luxury industry.

The collection was inspired by a family of Inuit travelling back in time to a 1950s Christian Dior catwalk. The notion of nomadic tribes, gathering garments like mementos, pervades this collection. Galliano combined 1950s silhouettes with eclectic materials such as fish skin, bleached denim, knits and brocades. On this occasion, Galliano dressed his modern shaman with fish skin parkas preparing them for the ceremonial role and shamanistic ceremony that his seasonal fashion shows had become over the years.



[17] V&A, ibid

[18] Jacobs, B. (2018) HowNow Magazine: *The future of leather is plant-based*

[19] Sigfusson, and Arnason, 2017

[20] (Global Fashion Agenda, 2017)

John Galliano's prêt-à-porter Autumn/Winter 2002 collection.
Atlantic Salmon skin jacket©2002, Patrice Stable

Directing the John Galliano studio, I oversaw the creation of two collections a year for his namesake brand. They acted as a laboratory of ideas, allowing him to let his imagination run wild, free from both the commercial pressures associated with a house as iconic and as global as Dior and as a pure expression of his personal design style. Galliano's extraordinary genius for imaginative and exquisite design created collections full of handcrafted objects mixed with historical and ethnic references. We travelled the world physically and virtually through libraries and museums, bringing back elements transformed in the form of research books that would be the starting point for the collection. We were genuinely interested in other cultures when we were inspired by them. We were in search of beauty. It was done with respect, honour, and creativity.

I would have never thought 20 years ago that I would embark on a fashion anthropology journey to understand processes of social, cultural, historical, and religious developments in the Arctic through the study of Arctic indigenous fish skin practices. Combining this recent knowledge with my previous experience in fashion has allowed me to recognise Indigenous ways of sustainable life alongside contemporary fashion patterns of over consumption and to identify Arctic and contemporary material cultures.

Being published in *Text* will give me the chance to present my findings on the subject of Arctic Indigenous fish skin studies to the Society. It will provide a unique opportunity to spread knowledge of fish skin as a renewable raw material for the leather industry, making a significant contribution to fashion sustainability.

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Paper 3: Indigenous Arctic Fish skin clothing traditions: Cultural and ecological impacts on Fashion HE.

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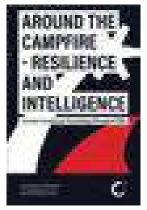

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Indigenous Arctic Fish skin clothing traditions: Cultural and ecological impacts on Fashion Higher Education.

Elisa Palomino
Central Saint Martins, University of the Arts, London, UK
e.palomino@csm.arts.ac.uk

Katrín María Káradóttir
Iceland University of the Arts, Reykjavík, Iceland
katak@lhi.is

Lotta Rhame
Lottas tannery, Sigtuna, Sweden
lottastannery@yahoo.se

Joseph Boon
The Slade School of Fine Art, University College London, UK
josephboon@live.com

Abstract

The use of fish skin is an ancient tradition in societies along rivers and coasts around the world and there is evidence of fish skin leather production in Scandinavia, Alaska, Hokkaido, Japan, northeast China and Siberia.For Arctic indigenous people, their relationship with fish plays an important role in maintaining their identities creating important ties with the environment. The Arctic is undergoing dramatic climate changes threatening indigenous people, impacting their food security and traditional knowledge systems as they rely on fishing activities for their physical, cultural and spiritual well-being.

This research looks at how the use of fish skin by aboriginal Arctic people has recently been assimilated as an innovative sustainable material for fashion due to their low environmental impact. Fish skins are sourced from the food industry, using waste, applying the principle of circular economy. This paper describes the Fish skin workshop delivered at the world's biggest fish skin tannery: Atlantic Leather in Iceland, where an experienced Swedish craftsperson passed down the endangered Arctic fish skin craft to the next generation of Nordic students from universities in the circumpolar area (Iceland, Denmark, Sweden, Finland)

and UK as part of a sustainable fashion higher education program. The methods of sustainable material engagement and the full immersive experience through a teaching-in-the field approach are recommended as transferable skills for educational models. The workshop demonstrates how relevant the Indigenous fish skin knowledge -in partnership with sustainable design strategies- can connect people to their culture, communities and the environment.

Author keywords

Indigenous peoples of the Arctic; Fish skin craft; Traditional Knowledge; Food Industry By-Product; Fashion education for sustainability.

Introduction

The research is investigated through author 1 and 2 current practices as educators, supporting fashion design students to engage in sustainability facilitating the use of fish skin as an alternative raw material for fashion.
This research is an interdisciplinary study of northern indigenous Arctic fish skin heritage, building connections between anthropology, ethnography and environmental protection to address current global issues of fashion sustainability at a time when the changing Arctic environment and its wider impacts are receiving widespread attention.
The aim of the project is the preservation and dissemination of cultural heritage connected with fish skin taking into consideration the sustainable limits of the planet's natural resources.

Main research questions

How can we protect sustainable development of cultural heritage connected with fish skin?

How can we assist fashion students and educators in developing sustainable fish skin material by sharing traditional crafts from Arctic indigenous people?

Contribution to knowledge

The project addresses gaps in knowledge in the fields of:Intangible cultural heritage preservation connected with fish skin.Sustainable design education, inspiring students to develop environmentally responsible new processes for fish skin to advance material innovation. New participatory design practices with craftspeople. Because fish skin craft is not an aspect of Arctic culture that is commonly studied, this research attempts to fill a gap in the literature of the Arctic indigenous communities and will call for further research on the topic of Arctic crafts, Arctic ethnic identities and their representation in society today.

Aims

Blend the highly qualified skills of the fish skin craftsperson with cutting-edge sustainable design education.Map existing traditional knowledge of fish skin processing.Take students out of the classroom and into nature contributing to the learning experience about sustainability to change students' mind sets. Identify tools about best practice on fish skin craft and test the ideas at Fashion Higher Education institutions.

Objectives

Position fish skin craft to exemplify best practice in the field of fashion design higher education. Promote living with environmental change, using fish skin leather as a by-product of the food industry to reduce waste and to change consumer behaviours. Community Resilience:Develop case studies working across indigenous communities with historical use of fish skin to foster narratives of social sustainability. Implement a material-based design methodology for creating new crafting procedures for fish skin leather.

Background

UAL

UAL is Europe's largest specialist arts and design University, with more than 3,000 academic, research and technical staff and about 19,000 students from more than 100 countries. UAL is actively engaged in research and innovation as well as artistic, cultural and education projects and its overall quality profile placed it in the top 25 of UK Universities. UAL has been a pioneer in the development of practice-based and practice-led research in creative fields. Elisa Palomino id the BA Fashion Print pathway leader at Central Saint Martins and researcher at the Textile Future Research Centre (TFRC). She has experience of running successful network projects (e.g. EU Horizon 2020-MSCA-RISE FISHSkin 823943. FISHSkin a Sustainable Raw Material; EU COSME WORTH project: Fish leather in the Luxury Industry, Recipient of Fulbright Scholar Award: 'Arctic Fishskin clothing traditions' at the Smithsonian Institute)

IUA

Iceland University of the Arts is a self-governing institution providing higher education in fine arts, theatre, dance, music, design, architecture, and art education.
IUA combines Iceland's long tradition for sustainability with the aesthetics of Nordic design. The University is a member of the Arctic Sustainable Arts and Design network consisting of art and design art education universities in the circumpolar area. (Canada, Iceland, Norway, Sweden and Russia).Katrín María Káradóttir has extensive experience using unconventional textiles, she is a slow

fashion pioneer in Iceland and is interested in building new systems focusing on sustainability, low environmental impact, thinking about the origins and end-point of textiles. She is a partner of the consortium EU Horizon 2020-MSCA-RISE FISHSkin 823943. FISHSkin a Sustainable Raw Material.

Lotta Rhame

Lotta Rhame is a Swedish craftsperson who has been working with traditional tanning and processing since 1982. She has lectured and led many workshops throughout the Arctic region. Much of her knowledge comes from visiting cultures where skins are still cured using traditional methods: the Inuit's in Greenland and Canada, the Native Americans and the Sami in Scandinavia as well as by studying archaeological sources and experimenting with them to adapt recipes. Most of these ethnic minorities have lost the traditional skills of tanning fish skin, but they have passed down to her the oral history inherited by their ancestors. She has retaught a number of Sami communities the lost craft and they are now able to transfer the acquired knowledge so the tradition stays alive. She regularly holds traditional fish skin tanning courses and lectures worldwide.

Joseph Boon

Studying fashion at Central St. Martins, Joseph Boon made his final collection out of fish skin that he hand-tanned from Billingsgate fish market. Working with fish skin for over three years, he has been to and met some of the world's most recognised fish skin leather producers in Iceland, Japan and China.

Historical context

According to Rahme (2012), making leather from fish skin is an age-old craft historically used by many societies along rivers and coasts around the world. Jiao (2012)**,** describes that before synthetic fibres were invented, people clothed themselves with natural materials available in their surroundings such as fish skin. The shortage of raw materials and omnipresence of modernity have challenged the preservation of the fish skin craft. Better access to the modern world meant that Arctic people were able to access textiles like cotton and silk to create their clothing, leaving fewer people to develop the traditional fish skin craft and there are currently only a few people left who know how to create these fish skin garments.

Environmental context

Protecting natural and cultural resources

Yoshitaka (2017) argues that the relationship with the sea plays an important role in maintaining the identities of Arctic coastal Indigenous Peoples as distinct cultures but climate change is threatening their ties to oceans and marine resources around the world. Preserving fish skin traditional knowledge is essential to the Arctic world. This paper seeks to draw attention to the vital importance of traditional fish skin craft to the Arctic people as a basis for their culture and a component of their identities and to encourage their artisans to re-introduce the skills used by their ancestors, making a tool for community development.

Fish waste: Use of fish by-products by the fashion industry.

The use of fish skin by aboriginal peoples in Arctic communities has been recently assimilated as an innovative sustainable material for fashion due to the low environmental impact. Fish skins are a by-product of the food industry, using waste, applying the principle of circular economy. Fish skin leather processing prevents the throwing of skins into the ocean and could significantly reduce marine pollution and sustainably protect marine ecosystems. There is a trend in the fashion industry toward the adoption of new materials which have a lower environmental impact than their conventional alternatives (Textile Exchange 2016).Fish skin is an innovative and sustainable alternative material with a lower environmental and social impact than conventional leather.

The use of fish skin by Icelandic people

For much of their history, Icelanders wore shoes made of wolf fish skins processed using traditional tanning methods and they measured distances by how many pairs of fish skin shoes would be worn-out walking over the path (Rahme, L. 2012). Anthropologist Mould (2018) mentions that each shoe was cut from a single piece of fish skin, with a vertical seam at the heel and a seam at the toe. The fish skin was not tanned but washed and smoothed on a wooden board to which it adhered with its own fat. When the skin dried, it was folded and sewn together with a strap of raw skin around the edge and tightened to form the shape of the shoe (Rahme, L. 2012). According to Sigfusson (2017), Icelandic history, right from the settlement of Iceland in the 9th century, has been interwoven with marine resources. Fish has been their main source of food and income and they still have their ancestor's spirit of finding usefulness in everything.

Fashion Education for Sustainability

Figure 1. Traditional Icelandic shoes made out of Cow leather (left) and wolf fish skin (right) lined with knitted wool. Photographer: Nathalie Malric.

This research fits in to our broader commitment to sustainable fashion through raising awareness of new raw materials for fashion informed by aboriginal ancestral practices. The research provides us with the opportunity to change how fashion is taught in higher education. Furthermore, it will promote the integration of sustainable design thinking into the fashion curriculum. We believe, as educators we have the responsibility to integrate sustainable design thinking into our whole practice, from the sourcing of raw materials to understanding the impact of those materials on people and the planet, right back to the beginning of the supply chain. Drawing upon indigenous knowledge on raw material processes is crucial to helping fashion students to stay at the cutting edge of sustainable innovation. The research proposes an innovative approach to teaching fashion sustainability, through the creation and delivery of a fish skin educational programme where students have engaged in a knowledge-based project creating new kinds of collaboration amongst themselves and the craftsperson.

Description of activity

Project creation

The Fish Leather Craftsmanship workshop was organised by Elisa Palomino and Katrín María Káradóttir and taught by Lotta Rhame in collaboration with Atlantic Leather tannery. The authors designed a workshop encouraging Artic design students to produce fish leather designs using traditional skills built over generations by Arctic Indigenous Peoples. The aim was developing sustainable design within the Arctic traditional ways of life in areas with a history of fish skin leather production such as Iceland, Sweden, Finland and Denmark. Preserving and using fish skin cultural heritage and strengthening networking activity.

Recruitment

Author 1 and 2 were interested to develop an immersive experiential learning process as a practical educational model of sustainability in action. Author 1 and 2 engaged with partners from Iceland University of the Arts, Royal Danish Academy of Arts, Boras University, Aalto University and Central Saint Martins to recruit students from their universities willing to participate in the workshop to explore further alternative sustainable fashion materials such as fish skin. A total of 10 students from universities in the circumpolar area (Iceland, Denmark, Sweden, Finland) and UK benefited from the workshop, author 3, a Swedish craftsperson delivered the workshop, shared Sami traditional fish skin tanning methods and passed down the endangered craft to the next generation of Nordic students.

Figure 2. Visit to Atlantic Leather fish skin tannery. Photographer: Nathalie Malric.

Workshop location

The workshop took place in Sauðárkrókur, Iceland, combining the traditional knowledge on fish skin tanning with the technological progress of Icelandic tannery Atlantic Leather, which has been turning local fish skin into highly sustainable leather since 1994.

Workshop programme

The programme included a preparation, implementation, evaluation and a follow-up phase. Students learnt traditional fish skin handcraft heritage to integrate into their fashion practice. The workshop was 5 days long and included:

- Sustainability background Introduction
- Lectures on historical fish skin artefacts in international museums
- Visit to Atlantic Leather fish skin tannery
- Visit to the local textile museum
- Traditional fish skin tanning and dyeing methods
- Sketchbook development

Figure 3. Sketchbook development. Photographer: Nathalie Malric

Fish skin tanning

Lotta Rhame worked with students and tutors to create and experiment around tanning fish skin. We scraped two skins each with traditional and Contemporary scraping tools in order to remove any residual flesh that would 26 potentially rot. In order to soften the skins, we used a variety of tools that Lotta had been brought from Sweden, ranging from handmade wooden implements to the jaw of a moose. Whilst scraping the skins we explored the different layers and thickness we could achieve, in some cases removing even the top, two-tone layer. We used two different methods to tan the skins; one method included using 30 a bark solution made from boiled sallow bark (the bark was collected in Dalarna, Sweden during the spring when the bark contains more tanning acid), and the other tanning method consisted on oil tanning using rape seed oil, egg yolk and soap.

In order to dye the fish skins, we boiled onion skins to make a yellow dye and cochineal to make a red dye. When the oil-tanned skins were dry and soft we put them in the solutions for 3-4 hours. We then rinsed them in water, dried them and softened them again. For the bark-tanned skins we mixed a strong bark solution with the onion skins and cochineal and when it was under 20 Celsius, we put the skins in. We left the skins in the liquid to dye overnight and 31 re-oiled and softened them the next morning. In addition, Lotta Rhame, showed us how to make traditionally thread with the sinews and tissue of the fish and we learnt traditional sewing techniques.
32 On the last day of the trip we held a critique with the students, and they all presented their skins, research and development from the trip.

Figure 4. Softening the fish skin with the jaw of a moose.
Photographer:Nathalie Malric.

Conclusion

The paper demonstrates how relevant the Indigenous fish skin knowledge -in partnership with sustainable design strategies- can be to connect people to their culture, communities and the environment. Feedback from participants and craftsperson suggests that the passing on the fish skin knowledge and skills was of great relevance to them as well as the immersive experience at the fish skin tannery Atlantic Leather. This fashion activity managed to inspire deeper relational connections amongst the students involved, the community and their environment. Working outside of the classroom can provoke a learning method that usually does not occur in the university campus. Students became the main players in realising resilience through the community-in-place.

The workshop seeks to inspire Academia involved in the development of sustainability and craftsmanship within their curriculums to implement this transformative teaching and learning experience in their own practice. The workshop methodologies reflected the geographical contrasts of the area. The harshness of the weather, the isolation and the limited availability of materials formed a unique source of creativity and inspiration for the students during the workshop. Fish skin was the only available material, urging students to think creatively and seek new design possibilities from fish skin. Eco-consciousness played a fundamental role in the students' designs using remnant materials. The traditional tanning processes we learnt, the use of environmental substances such as oils and bark, combined with modern state-of-the-art knowledge can provide a more environment friendly tanning industry.

The project provided a case study for working across Arctic Universities to develop their cultural identities and foster narratives of social sustainability. The cross disciplinary project has created a new structure to demonstrate how much the various Arctic communities have in common.
This project recommends engagement with local communities and traditional fish skin knowledge holders— laying the ground work for an assessment that is co-produced by both traditional knowledge and fashion higher education.

AROUND THE CAMPFIRE – Resilience and Intelligence

Figure 5. Fish skin tanning process. Photographer: Nathalie Malric.

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Paper 4: Preservation of the Hezhe people's fish skin tradition through fashion education

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Preservation of the Hezhe people's fish skin tradition through fashion education

E. Palomino
UAL, Central saint Martins; University of the Arts, London

J. Boon
UAL, Central saint Martins; University of the Arts, London & Slade School of Fine Art, London.

ABSTRACT: People have worn clothes made from fish skin since early times, with earliest traces being found in Northeast China belonging to the Hezhe ethnic minority group. There is evidence of fish skin leather production in Scandinavia, the USA (Alaska), Japan (Hokkaido), Northeast China, and Russia (Siberia). Although the craft has almost disappeared, in 2006 the skill of processing fish skin was one of the first listed as Intangible Cultural Heritage of China. This paper describes the FishSkinLab workshop delivered in Tongjiang, China, where experienced Hezhe craftspeople have pass down the endangered fish skin craft to the next generation of Chinese students as part of a sustainable fashion higher education programme to learn best practices for social change and sustainability. The students mapped their creative journey, explored the rich cultural background of the Hezhe communities, and created a collection of fish skin textile samples with the help and guidance of Hezhe fish skin masters.

1. INTRODUCTION

FishSkinLab is a textile-based programme. The project was delivered in partnership with IAIA and it was designed to build and promote community knowledge around fish skin material culture. This paper describes the findings of the second phase of the project from October 2017 until August 2018. The FishSkinLab programme delivered a workshop at Jiejinkou Hezhen Village ethnic museum, Heilongjiang province, in Northeast China, and brought together a community of craftspeople from the Hezhe ethnic minority and fashion higher education students. FishSkinLab aims to develop new fashion practices, taking students out of the classroom and into nature, contributing to the learning experience about fashion sustainability. The project aims to improve the awareness and protection of traditional Chinese culture from the point of view of cultural integration. Students learn traditional handcraft heritage to integrate it in their fashion practice.

Participatory design and co-design structures are key to changing fashion systems and to foster lasting relationships between makers and final product (Fletcher 2008).

The main project objectives are:

- Mapping the existing traditional knowledge of fish skin craft from Hezhe ethnic minority.
- Building an interdisciplinary collaborative network which intersects Hezhe craftspeople and higher education (HE) students.
- Preserving and disseminating the Hezhe cultural heritage connected with fish skin.
- Strengthening Hezhe participation in international endeavours via the inclusion of master craftspeople in network collaborative events.
- Helping HE students engage in sustainability by developing fish skin samples as an environmentally responsible alternative material for fashion.
- Bringing together sustainable methods from fashion design and traditional crafts to foster international knowledge exchange.
- Identifying tools about best practice on fish skin craft and testing the ideas at fashion higher education institutions in the UK and internationally.

The FishSkinLab team set up a workshop with different activities such fish skin tanning, fish skin painting, fish bone painting and ethnographic fieldwork of historical fish leather artefacts at national museums. A total of 20 students from different Chinese provinces benefited from the workshop, 2 Hezhe ethnic minority craftspeople delivered the workshop, 20 members of the Hezhe ethnic minority engaged in a public exhibition of the results and over 500 Chinese students participated on the online crit.

The paper describes the FishSkinLab methods of sustainable material engagement and the full immersive experience through a teaching-in-the field approach. The paper analyses its findings in order to recommend transferable skills for educational models. The paper concludes to recommend the importance of Hezhe ethnic community visibility within China to facilitate intangible cultural heritage knowledge exchange.

2. BACKGROUND

An overview of the FishSkinLab network project partners as well as the historical context of fish skin craft and notion of intangible cultural heritage.

2.1 UAL

UAL is Europe's largest specialist arts and Design University, bringing together six arts, design, fashion and communication Colleges with more than 3,000 academic, research and technical staff and about 19,000 students from more than 100 countries. UAL is actively engaged in research and innovation as well as artistic, cultural and education projects. UAL has particularly strong links with industry and creative practice and has been a pioneer in the development of practice-based and practice-led research in creative fields.

The author of this paper is the Fashion Print Pathway leader at Central Saint Martins, UAL and a researcher based at the TFRC – Textile Future Research Centre UAL. The author draws on her previous industry experience back in 2004, designing for John Galliano and Christian Dior fish leather garments and accessories made out of salmon, perch and cod skins sourced at Atlantic leather, the world's biggest fish skin tannery based in Iceland, situating the use of fish leather within the context of the luxury Industry. The author has experience running network projects linked with fish skin (e.g. EU Horizon 2020-MSCA-RISE Marie Sklodowska Curie: Fish Skin a Sustainable Raw Material), and has been funded by EU COSME WORTH partnership project to develop a Fish skin leather accessories collection with the aim to increase the use and sustainability of fish leather in the luxury fashion industry.

The results in this paper do not attempt to describe the contemporary use of fish skin as an innovative sustainable material for fashion and accessories but they aim to describe the transmission of the fish skin craft to fashion higher education students instead.

The research is investigated through the researcher's current practice as educator at Central Satin Martins, supporting fashion design students to engage in sustainability.

2.2 *International Art Institutes Association (IAIA)*

The International Art Institutes Association (IAIA), in Beijing, China, is a company specialized in providing Chinese Fashion students educational consulting and application mentoring. IAIA is the only official partner of UAL Beijing representative Office. IAIA works to cultivate future Chinese designers with both global vision and better understanding of Chinese culture, they cooperate with world-class artists to provide more advanced design concepts while keeping a strong interest in their rich Chinese cultural traditions.

Under the guidance of the author, Ms. Yuhan Chen, the director of IAIA Fashion Studio recruited the Chinese students and secured the craftspeople, location and logistics of the trip.

2.3 Historical context: the Hezhe ethnic minority

The Hezhe are one of China's smallest ethnic minorities (Hays 2008). The 2010 census counted 5,300 individuals belonging to this group. They live in Heilongjiang province in north eastern China, in the Amur-Heilong and Ussuri-Wusuli river basins along the border with Siberia, and their traditional economy is based on hunting and fishing. The use of fish skin clothing is a tradition shared by the Amur River people, an area from the interior of Asia to the Pacific Ocean in south eastern Siberia, north of the Japanese island of Hokkaido and Sakhalin Island (Fitzhugh, 1988).

Before synthetic fibres were invented, people clothed themselves with the natural materials available in the surroundings where they lived. In the case of the Hezhe, it was fish skin (Jiao, 2012). There are several reasons that could account for the disappearance of the fish-skin clothing from the everyday lives of the Hezhe. During the Japanese occupation of Manchuria – the historic name of this area of China – between 1931 and 1945, the Hezhe were resettled or put in forced labour and their numbers diminished to about 300 people. With the foundation of the People's Republic of China, in 1949, came relief to help the Hezhe rebuild their communities. Despite the rebound in population, overfishing and water pollution have caused fish stocks to drop in the rivers and many Hezhe turned to farming and tourism to make a living. The shortage of raw materials and omnipresence of modernity have challenged the preservation of the craft (Lin, 2007). Better access to the modern world meant the Hezhe were able to access textiles like cotton and silk to create their clothing and many young Hezhe moved away for their education and work, leaving fewer people to fish and learn the traditional crafts. There are currently only a few people left who know how to create these fish skin garments (Campbell, 2010).

In 2006, the Hezhen method of making clothes with fish skin was listed a national intangible cultural heritage, and You Wenfeng – our main craftsperson during this workshop – was appointed its heir. Fish skin clothing seemed at the verge to extinction. However, it saw some hope with the boom of tourism in the region (Jiao, 2012). With the improvement of transportation, Jinkou Hezhen Folk Park and other tourism projects have continued to develop. The number of tourists has increased as well as the interest in the traditional Hezhe fish skin craft.

This paper seeks to draw attention to the vital importance of traditional Fish skin craft to the Hezhe as a basis for their culture and a component of their identities and to encourage their artisans on re-introducing such skills used by their ancestors making a tool for community development.

The author proposes the continuation of the skills through a craft-academic collaboration where she has co-created a workshop with the local community and experienced craftspeople have pass down the endangered art to the next generation of fashion students as part of a sustainable higher education program.

Because fish skin craft is not an aspect of Hezh culture that is commonly studied, this paper attempts to fill a gap in the literature of the Hezhe minority group. This paper will call for further research on the topic of Hezhe crafts, Hezhe ethic identities and their representation in Chinese society today.

2.4 Intangible Cultural Heritage context

In the convention for the safeguarding of the Intangible Cultural Heritage, UNESCO defines Intangible
Cultural Heritage as:

1. The 'intangible cultural heritage' means the practices, representations, expressions, knowledge, skills as well as the instruments, objects, artefacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognize as part of their cultural heritage. This intangible cultural heritage, transmitted from generation to generation, is constantly recreated by communities and groups in response to their environment, their interaction with nature and their history, and provides them with a sense of identity and continuity, thus promoting respect for cultural diversity and human creativity.
2. The 'intangible cultural heritage,' as defined in the paragraph above, is manifested in the following domains:
    a. Oral traditions as a vehicle of the intangible cultural heritage;
    b. Knowledge and practices concerning nature and the universe;
    c. Traditional craftsmanship.
3. 'Safeguarding' means measures aimed at ensuring the viability of the intangible cultural heritage, including the identification, documentation, research, preservation, protection, promotion, enhancement, transmission, particularly through formal and non-formal education, as well as the revitalization of the various aspects of such heritage.

The physical cultural carriers are the materials. But the non-physical cultural carriers are people, their tools, the handicrafts and the cultural place (Zhang, 2010). The interaction between higher education students and craftspeople acts as cultural carriers and allows cultural preservation and conservation

2.5 Environmental context

The fashion industry is currently going through a significant change in its approach towards sustainability (BCG, 2017) and must strive to change and rethink its raw materials and processes. FishSkinLab develops research that concentrates on promoting a new category of raw materials for fashion: fish leather.

A few underlying assumptions situate fish leather as a more sustainable alternative:

- Fish skins are sourced from the food industry, using what is now considered waste, applying the principle of circular economy.
- Using food industry waste will result in a reduction in the current level of pollution by the food and fishing industry.

Global production of fish has steadily increased over the last decade and more than 50% of the total fish capture remaining material results in 32 million tonnes of waste (Arvanito & Kassaveti, 2008). While, to date, the European Environment Protection agency allows seafood processors to dispose fish skins in marine waters, this is expected to change as the decomposing organic waste can suck up available oxygen from marine species and introduces disease to the local ecosystem (EPA, 2012). Consequently, the promotion and preservation of fish leather craft could be of great environmental benefit as well as profit for the Chinese economy.

The project could be scaled up in other countries such Japan and Russia, with history of use of fish skin leather. By doing so, indigenous fishing communities which used to subsist and dress themselves with fish skin leather items like the Ainu in Hokkaido, the Nanai in Siberia and Alaska's Inuit will be able to reach agreements with nearby fishing plants for the supply of fish skins to get back specialised in the development of their ancient crafts and develop new fish skin craft productions that will implement their economy.

3 INNOVATION

Products made of fish skin in the Heilongjiang province have not change over the years. There is room for innovation within their fish skin craft.

In the case of fish skin painting the arrival of machine tanned fish skins makes the craftsman's job easier and quicker compared to the fish skin tanning where the whole manual tanning process is involved.

In order not to lose completely the fish skin craft, strategies must be implemented for its preservation and promotion. We should use design methodologies to rescue fish skin endangered cultural heritage and make this most distinctive traditional culture displayed again.

In an interventionist methodology, we propose the use of new fish skin designs developed by fashion HE students involved in this workshop for the creation of new craft items such fish skin paintings or fish bone paintings to be used by the Hezhe ethnic minority crafts community.

These new designs will probably give a new perspective of the traditional fish skin craft and lead to new consumptions.

4 METHODOLOGY

To reflect upon the interaction of textile design using traditional craft techniques, a bibliographic and documentary research was initially done:

- Enquiry [Theory]. Following the fieldwork, data was collected through primary and secondary sources to reveal areas of potential development.
- Contextual and visual analysis.
- Making [Practice]. HE students produced fish skin samples with the ethnic minority craftspeople.
- Photographic documentation was used for illustration and classification of results.
- Sharing [Dissemination]. Feedback has been sought through activities such as conferences, articles, teaching and communication via the author's website http://www.fishskinlab.com.

5 METHODS

Action research was used during this study. The data was collected through:

- Archival research in museums to study traditional knowledge in fish skin processing.
- Mapping traditional fish skin crafts to validate their technical feasibility.
- The Field Trip covered the area around Jiejinkou Hezhen Village ethnic museum, Heilongjiang province, north east China by the Amur River bank which empties into the Pacific Ocean in south eastern Siberia.
- Workshop on fish skin leather craft to test ideas through teaching and learning, observing students design approaches using fish skin as an alternative material for fashion.
- A documentary filmed during the workshop, featuring interviews with students, curators and craftsmen to observe students' development of fish skin finishes as a form of design research.
- Sketchbook development.
- Literature review.

6 ACTIVITY DESCRIPTION

6.1 *Project creation*

The workshop aim is an experiential learning process, based on sustainability values, where the students could create fish skin textile samples as a practical educational model of sustainability in action. The workshop seeks to develop a teaching and learning experience most suited to Fashion Design higher education.

The passing on of the fish skin knowledge and skills is of great relevance as well as the immersive experience at the remote ethnic minorities' villages. These fashion activities are meant to inspire deeper relational connections amongst the students involved, and between the students, the community and their environment.

The experimental and exploratory nature of this workshop has advanced the enquiry of Fashion Design for Sustainability for the students and tutors involved.

The project was created over a period of 10 months. A … graduate, Joseph Boon, was involved in this phase. He contributed with his expert knowledge on fish skin tanning that he achieved during the final year of his BA. He learnt about the Hezhe people and decided to create his own fish skin material. He experimented with many different types of fish from Billingsgate Fish Market including; Brill, Dover Sole, Sea Bass, Flounder and Salmon to produce a womenswear collection inspired by 40's zoot suits made out the fish skins he had tanned himself.

During the workshop he shared his knowledge with the craftspeople and assisted students with the tanning process.

6.2 Recruitment

The main objective for the IAIA was providing educational consulting and application mentoring from the author to the students involved.

The author was interested to develop an immersive experiential learning process at the ethnic minorities' villages as a practical educational model of sustainability in action.

Over a period of 10 months the author engaged with UAL partners in China IAIA to contact local craftspeople in Tongjiang village for the delivery of the workshop. The two most skilful craftspeople in the area were recruited for this purpose.

Wen Feng You (figure 2) is a Hezhe craftsperson born in Tongjiang, she has spent all her life in the village, receiving only a primary school education. Like the rest of her family, she fished for a living. She has learnt the fish skin craft from her mother and grandmother. Since her mother passed away, Wen Feng You has shouldered the responsibility of keeping this dying craft alive.

When, in 2006, the Hezhen method of making clothes with fish skin was listed a national intangible cultural heritage, You Wen Feng You was appointed its heir. She is now in her sixties and she has produced more than 20 suits for museums in Japan and China. Ms. You taught us traditional methods of tanning fish skin developed by the Hezhe ethnic minority.

Sun Yulin is a craftsperson in Jiejinkou Hezhen County Tongjiang, Heilongjiang Province. His main skills are fish skin painting and fish bone painting. He has learnt the craft from his later uncle, and he has passed down the craft to this wife and children. The rise in recent years of the tourism industry makes his fish skin paintings business grow steadily. He is also invited to display the craftsmanship of fish skin paintings in different areas in mainland China.

In order to recruit the students involved in the workshop IAA, the UAL partner in Beijing looked for Chinese fashion and textiles students on their first year at UAL institutions willing to improve their portfolio skills and explore further alternative sustainable fashion materials such fish skin working with local ethnic minorities.

The project responds to a gap in local arts and craft teaching provision. While the Chinese government encourages the fish skin painting craft and every year organises a small course for Chinese University students, the fish skin tanning craft is currently completely over looked by the government.

6.3 Workshop location

The project was developed at Jiejinkou Hezhen Village museum, located in the northeast of Tongjiang City with mountains and rivers around it, next to the Russian Border and connected to the Jiejinkou National Forest Park. The village was founded in 1936 and its population consists of Han, Manchu, Korean, and Hezhen nationals. Currently there are 70 households and 3,000 people in the Village.

6.4 Workshop programme

The workshop was 10 days long and included:

- Sustainability background Introduction;
- Visit to museums;
- Fish skin tanning;
- Fish skin painting;
- Fish bone painting;
- Sketch development.

6.5 *Sustainability background introduction*

The group was briefed at an introductory session providing inspiration, basic information regarding ethics and sustainability of fish skin leather. Another objective was to place this project in the frame of alternative sustainable materials.

In order to adhere to this strategy, a comparative study of different leathers and fish leather was made. Suggestions for further reading and research were given to students.

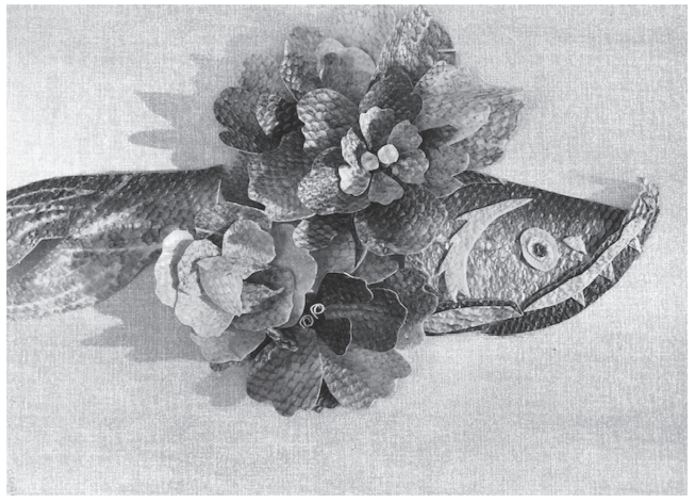

Figure 1. Fish skin painting workshop with Mr Sun Yu Lin. Student's work.

Figure 2. Fish skin tanning workshop with Mrs You Wen Fen.

6.6 *Visit to museums*
The workshop included ethnographic fieldwork of historical fish skin artefacts at national museums and crafts communities. There were lectures on fish skin artefacts at international collections.

The Jiejinkou Hezhen Village ethnic museum displays the traditional lifestyle of Hezhe people. Items in exhibit were collected from Sanjiang plain area of Heilongjiang province. They cover a time span from the Qing Dynasty (1616-1911) to modern times.

The interaction between students and museum fish skin collections helped their creative practice by observing and translating traditional methods.

6.7 *Fish skin tanning*
We worked with salmons we bought at the fish market. When processing the fish, we separated the flesh and the skins, and cut off the fins, as can be seen in figure 3. Then, we scraped off any remaining bits with a birch knife. We plastered the skins onto a wooden board to dry for a day. Afterwards, we made sure the lines of the skins were straight. We put several skins into layers separated with corn flour to soak up the fish oil. We rolled them into a cylinder and mash and soften them in a large wooden scissor-like instrument. Lastly, we softened the skins by rubbing pieces of skin against each other.

The tanning methods differs enormously from the ones developed by the Sami ethnic minority in Scandinavia where fish skins are tanned using a bark solution made from boiled sallow bark or using rape seed oil, egg yolk and soap for oil tanning. It also differs from the tanning methods used by the Ainu ethnic minority in Hokkaido, Japan where skins are stretched first and then smoked for 5 days inside the Ainu home or chise.

6.8 *Fish skin painting*
Originally fish skin was used to make the paper decorations outside of the Hezhe homes for Chinese New Year. While in the rest of China were made of paper, the Hezhe made them out of fish skin. The original paintings had deities' symbols on them and later some local motifs reflecting the theme of winter fishing started to appear. Currently Han flower and animal motifs are the most popular ones. We used machine tanned fish skins unlike our previous workshop where we tanned our own skins. The process of matching the skin colours proved to be quite complicated. Students managed to innovate with new designs and mixing media on their artwork as can be seen in figure 1.

6.9 Fish bone painting
Historically fish bone paintings are created to counteract evil force and are based on the folk totem, evil counteracting animal. The animal is a spirit animal in ancient Chinese legends and can ward off evils. Fish bones are considered to be an auspicious object for the Buddhists. Fish bone painting, combining the two, can exorcise evil spirits and keep a family peaceful, happy, and lucky. We used fish bones with different shapes and sizes in a canvas, drawing according to the shape of fish bones to form a fish bone painting.

Figure 3. Fish Skin tanning workshop. Skinned salmons.

6.10 Sketchbook development
The workshop included a training on Sketchbook development. Students documented the journey and workshop through observation in sketchbooks with drawings, research images and design process.

6.11 Project exhibition
The research process culminated in an event involving the fashion students, tutors, craftspeople, and the community at the Jiejinkou Hezhen village ethnic museum to share the workshop results and findings: final tanned fish skins, fish skin paintings, fish bone paintings and sketchbooks related to the research.

The IAIA organised a skype conference call with over 500 students who witnessed the Hezhe dances and singing session and the student's crit.

6.12 Observations and participation
Observational and participatory methods were utilised to obtain data. The author immersed herself as a researcher physically into the fieldwork so she could observe and experience first-hand.

Using fish skin material and processes to give voice to their ideas, allowed the students to create a range of textile samples. None of the participants have worked with fish skin before and they felt the material was rich and versatile. The key findings from the questionnaire verified that students would be prone to use fish skin in their work as an alternative material to exotic skins.

Analysed data suggests that the participants were happy to learn new hand craft techniques to incorporate them into their own practice. Through their textile samples students attempt to raise awareness of local environmental issues and Hezhe minority inequality and rights. Two of the participants chose to use fish skin for their graduate collections and they are currently developing samples out of fish skins.

6.13 Ethical principles
The research project was introduced via presentation, including visual materials. It was clearly explained what the commitment to the project was in terms of workshop attendance, engagement in a discussion and the need of some form of documentation of the process. An Information Sheet, an Informed Consent Form, a photography and video recording consent form and a form with the interview questions was provided to those participating in the project. These documents were translated in accordance to the individual requirements.

The research project involved participation of craftspeople from the Hezhe ethnic minority and one of their representatives from the Intangible Cultural Heritage Protection Centre was involved in the implementation of the project to help build trust between the craftspeople and the researcher to ensure the use of culturally and socially appropriate research techniques from the start of the project for the physical and mental comfort of the participants.

The workshop involved using animal skins (fish skins) from salmon. They are by-products of the food industry and have not been farmed for the sole purpose of the fashion industry use. They are not endangered species. The workshop did not involve the use of elements that may cause harm to the environment, animals or plants.

7 FINDINGS

Feedback from participants, craftspeople, and museum curators suggest that the passing on the fish skin knowledge and skills was of great relevance to them as well as the immersive experience at the Jiejinkou Hezhen Village. This fashion activity managed to inspire deeper relational connections amongst the students involved, and between the students and the Hezhe community and their environment.

Working outside of the classroom can provoke a learning method that usually does not occur in the university campus.

The workshop created opportunities for students to meet remote communities and their ancient fish skin leather craft by:

- Observation of the community, their crafts and environment.
- Reflexion, research and creative design process.
- Prototyping of traditional fish skin samples Students became the main players in realising resilience through the community-in-place.

Craftsmen were inspired to teach a different group of people and they assimilated students' ideas and techniques for their own future work.

The Anglo-Chinese network has blended the high skills of Chinese craftspeople with British cutting-edge sustainable design education.

The workshop seeks to inspire Academia involved in the development of sustainability and craftsmanship within their curriculums to implement this transformative teaching and learning experience in their own practice which in turn may contribute to public debate on sustainability issues in the fashion industry (Fletcher & Williams, 2010). Development of sustainability within the curriculum has been identified as a high priority (Reid 2011). The hope is that the observations gathered through the workshop will aid to understand how to embody craftsmanship and sustainability content in fashion HE practices.

8 CONCLUSIONS AND FUTURE WORK

Fish skin craft is regarded as Intangible Cultural Heritage in China. It is important to find ways to preserve and promote it within its own Hezhe community and with younger generations. The researcher concludes that it is possible to introduce new designs into fish skin craft. Innovations can give bigger visibility to this craft which will disappeared unless there are new interventions happening. The target of fish skin tourism product marketing should bring mutual benefit to local craftspeople developing national economy and protecting ethnic culture (Chen, 2009).

Once the project is over – as a longer-term aim/ potential legacy of the project – findings could be delivered in the shape of craft workshops for higher education students to align universities with the United Nations in actively supporting principles in the areas of sustainability. The project could be implemented through a programme of workshops for Fashion higher education students in those areas where fish skin leather was originated (Scandinavia, Alaska, Hokkaido island, Japan and Siberia). Craftspeople from ethnic minorities will pass down the endangered fish skin craft techniques and will benefit from preservation of their craft. Students will benefit from education in craft and sustainability. Thanks to the FishSkinLab project, the author has advanced knowledge on fish skin craft and has been able to deliver two more workshops developing methods of tanning fish skin in areas where traditionally fish skin was developed:

- Nordic fish skin workshop, Blondous, Iceland. Workshop in collaboration with the fish leather tannery Atlantic Leather at the Icelandic Textile Centre with the participation of students from top

Nordic Universities: Iceland University of the Arts, Royal Danish Academy of Arts, Boras University, Sweden; Aalto University, Finland and Central Saint Martins College of Art, UK. Funded by the Nordic Culture Fund and the Society of Dyers and Colourists.
- Nibutani Ainu culture museum, Hokkaido, Japan. Workshop on Ainu Fish leather craftsmanship with students from Japanese universities: Bunka Gakuen, Osaka Bunka, Kyoto Seika University. Funded by FRPAC. Foundation for Research and Promotion of Ainu Culture, the Japan Foundation Endowment Committee and The Great Britain Sasakawa Foundation.

The long perspective for the network will be a knowledge exchange to build a cultural network on Fish skin craft innovation.

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Paper 5: Alutiiq Fish Skin Traditions

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Alutiiq Fish Skin Traditions: Connecting Communities in the COVID-19 Era

Elisa Palomino [1,*] and June Pardue [2]

[1] Central Saint Martins, Fashion Department, University of the Arts, London N1C 4AA, UK
[2] Alaska Pacific University, Anchorage, Alaska 99508, USA; june.pardue@icloud.com
* Correspondence: e.palomino@csm.arts.ac.uk

Abstract: The Alutiiq, Indigenous inhabitants of the coastal regions of Southwest Alaska, created garments made from fish skins, especially salmon, expertly sewn by women from Kodiak Island. Traditionally, Alutiiq education focused on acquiring survival skills: how to navigate the seas in all weathers, hunting, fishing and tanning animal skins. Today, many Alutiiq people continue to provide for their families through subsistence fishing, honouring the ocean and navigating difficult times by listening to their collective wisdom. This paper describes the series of fish skin tanning workshops taught by June Pardue, an Alutiiq and Inupiaq artist from Kodiak Island that connected participants in Alaska Native communities during the COVID-19 isolation months. Through an online platform, June passed on expert knowledge of the endangered Arctic fish skin craft, assisting participants in coping with the pandemic crisis by tapping into their knowledge of the natural world, cultural resourcefulness, storytelling abilities and creative skills. Brought into the digital age, the fish skin workshops strengthened connections among Alutiiq and Alaskan craftspeople while establishing new connections with an expanded network of fashion designers, museum curators, conservators and tanners. Finally, the paper highlights how fish skin Indigenous practices address the United Nations Sustainable Development Goals (SDGs) regarding poverty, health and well-being, gender equality, clean water and sanitation, decent work and economic growth, social inequality, responsible consumption and production, climate change and maritime issues.

Keywords: Alutiiq Indigenous peoples; fish skin craft; traditional knowledge; education for sustainability; United Nations Sustainable Development Goals.

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1. Alutiiq Indigenous Peoples and Fish Skin

1.1. Alutiiq Indigenous Peoples

As noted by Rachel Mason [1], *Alutiiq* is a relatively new term that has been used since the early 1980s to refer to both the language and culture of the group of Alaska Native people indigenous to the Kodiak Island Archipelago (Figure 1) on the southern coast of the Alaska Peninsula and the lower tip of the Kenai Peninsula. Some archaeologists believe that the ancestors of the present-day Alutiiq have inhabited the land for over 7000 years [2].

With a subsistence economy largely dependent on the marine environment and its animal resources, the island and coastal regions of southwest Alaska provided access to a range of fish species, especially salmon, used in the past for clothing production. Archaeological data indicates that Kodiak's first settlers harvested salmon throughout the prehistoric era, with increasing intensity over time. About 900 years ago, Alutiiq people established large villages along major salmon streams where quantities of fish could be harvested [3].

When the first Europeans arrived in Alaska, Alutiiq culture was flourishing. In 1741, Danish explorer Vitus Bering (travelling on behalf of Russia) landed on Kodiak Island in the northern Alutiiq territory, and by 1760, Russian fur hunters were regularly trading with Alutiiq people [4]. Russians exploited native labour for their mammal hunting expertise exporting and eventually exhausted Alutiiq fur skin resources. Local seamstresses were forced to rely on skins with little value to the export fur trade, particularly fish skins and bird skins to make clothes for their families [3].

Figure 1. Alaska Peninsula and Aleutian Islands. *Crossroads of Continents*. Huffman. AK Audubon. 2017.

The arrival of Russian missionaries in Kodiak in 1794 and "institutionalised education" also had negative consequences for the Indigenous population. Missionaries attempted to supress traditional spiritual practice by banning shamanistic rituals, although some elders kept information about these rites. Traditionally, Alutiiq shamans, as healers and spiritual practitioners, made contact with the supernatural world [1]. The Russian education system attempted to eclipse the practice of the traditional Alutiiq culture which focused primarily survival skills: how to navigate the seas in all weathers, hunting fishing, or even how to repair your fish skin parka while out in the Arctic wilderness.

When Russia sold Alaska to the United States in 1867, Alutiiq lives were in peril. The Karluk River on the west side of Kodiak Island, one of the richest salmon streams in the world, had long been used as an exploitable fishery resource by Russians and Americans. The first cannery in Karluk was established in 1882 (Figure 2). Salmon, the staple of the Alutiiq diet, became a highly desired commodity, feeding the American economy. The industrial expansion of the salmon fishery quickly led to overfishing and a dramatic decline in salmon resources that had supported Native families for generations [1].

Figure 2. The Alaska Improvement Company. Salmon cannery at the mouth of the Karluk River. Kodiak Island. Alaska, USA. NARA. Kodiak Historical Society. 1889.

During the American period, Alaskan traditional clothing styles were viewed as backward by the newly arrived Americans who introduced manufactured Western clothing styles. Gradually the need, desire and respect for Native-made clothing disappeared [5]. Although fish remained an important food supply, by the mid-20th century, the use of fish skin clothing dramatically declined, with fish skin boots and parkas being replaced by rubber boots and commercially manufactured rain gear.

In the 1990s, the Kodiak Area Native Association (KANA) began to take greater control of salmon resource management and several Alutiiq communities implemented salmon hatchery programs, developing a firm economic base, balancing subsistence and commercial fishing. Although the technologies used to harvest and process fish have changed with time, Alutiiq people still rely heavily on fish and the tradition of handling the fish respectfully from initial capture to consumption has been passed from one generation to the next.

1.2. Alutiiq Fish Skin Traditions

During the eighteenth century, an Alutiiq wardrobe included garments made from animal skins, especially sea otter, seal, bird, caribou, ground squirrel and various species of fish. These garments were expertly sewn by women from Kodiak Island. Specifically, the skins of salmon, cod, herring and halibut were used to make clothing, straps, bags and shoes. Women spent countless hours working during the dark winter months, by the light of oil lamps, to turn these natural materials into durable and beautifully decorated clothing.

Alutiiq used the skin of salmons to construct resilient, windproof parkas (Figure 3), ideal for Kodiak's maritime environment. A parka could be used as a bed, as a blanket and even as a house while travelling; that way, Alutiiqs were not afraid of damp, frost or wind [6]. Parkas were circulated through trade and travel and were regarded as coveted gifts. Festival hosts presented parkas to visitors at the end of winter gatherings. Before warfare, leaders distributed parkas to the members of their raiding party and parkas were considered valuable loot when taken from raided villages.

Figure 3. Alutiiq doll wearing a fish skin parka, gloves and boots. Alaska State Museum. Juneau, Alaska, USA. Artist: June Pardue. 2012.

For Alutiiq peoples, garments hold spiritual significance. As significant art pieces, they express the creativity and identity of the seamstress; as talismans, they provide a spiritual connection between people and animals, serving as both personal amulets and portraits of the Alutiiq universe. Through traditional tanning, processing and sewing, Alutiiq women believe it is possible to transfer the "spirit of an animal" into a garment made from its skin [7]. Hickman [8] describes fish skin parkas as a key component in shamanistic ceremonies preparing for the first fishing of the season. They were pieces of artwork that expressed the identity of their owner and forged a close spiritual connection between people and animals.

Historically, Alutiiq people dressed the dead in their best set of fish skin clothes, assisting them on their journey to the other side and enhancing their visibility in the spirit world. In this way, clothing both signalled and supported the transformation of the dead [7].

Recent cultural revitalization movements have strengthened craft traditions for Alutiiq people. Similar movements have occurred elsewhere among Alaska Native people. The Kodiak Area Native Association and the North Pacific Rim Health Corporation have developed a cultural heritage program supporting programs contributing to cultural identity [1]. Fish skin was once used as a common material in the Aleutian Islands; today, the number of Alutiiq artists continuing this tradition keeps growing. Many Alaska Native artists are making choices to preserve and pass on their Indigenous traditions and skills, such as fish skin tanning and sewing, so that these traditions remain a vital part of Alaska Native culture and identity [9].

2. Alutiiq Fish Skin Workshop during COVID-19 Isolation: Case Study

2.1. Project Creation

The research is investigated through Elisa Palomino and June Pardue's current practices as educators. Elisa Palomino supports fashion design students engaged in the sustainable use of fish skin as an alternative raw material for fashion and June Pardue is an educator in Indigenous cultural skills teaching in major Alaskan universities and over 25 rural locations across Alaska.

Before the arrival of COVID-19, Elisa had collaborated with three different Arctic and Sub-Arctic indigenous communities (Ainu from Hokkaido, Japan; Hezhen from Heilongjiang province, China; Athabascan from Alaska, U.S.) and she had created four fish skin tanning workshops across the Arctic [10]. Through their fish skin tanning practices, they had shared with her the knowledge of living in harmony with nature and with each other to navigate the hardest of times. In 2019, Elisa received a Fulbright scholarship to research Indigenous Arctic fish skin clothing at the Arctic Studies Center (ASC) at the Smithsonian National Museum of Natural History in Washington, D.C. and the ASC, Anchorage Museum in Alaska where Aron Crowell and Dawn Biddison introduced Elisa to the 2018 "Sewing Salmon project". In a series of video recorded workshops, Alaska Native artists met to learn and teach methods and cultural knowledge about fish skin processing and sewing through studying historic fish skin objects and through sharing and comparing techniques they developed [11]. June was part of the "Sewing Salmon project" and simultaneously ran many fish skin tanning workshops in Alaska also featured at the Anchorage Museum Arctic Studies Center web platform [12].

During the COVID-19 lockdown, Elisa kept asking herself: "Are we prepared to learn from this crisis?" "Who can we look to for inspiration?" "Where can we find a real model of resilience?" As Westerners, we have much to learn from Indigenous Peoples. Despite centuries of cultural assimilation, they continue to maintain a close connection with nature, resisting the standardization that comes with globalization. The Arctic Indigenous Peoples' vital relationship with the environment and essential dependence on the animals that support a subsistence lifestyle—including economy of materials and the spiritual role of fish skin—resonated with a variety of issues emerging during the COVID-19 pandemic lockdown.

"Resilience is the capacity of individuals, societies, cultures, economies, and ecosystems to reorganise and recover from change and disruption in a way that enables them to retain their identity and develop further" [13].

A means of responding to the critical issues posed by the COVID-19 lockdown emerged in the proposal to co-host an online fish skin tanning workshop with June Pardue, a highly respected Alutiiq and Inupiaq artist from Kodiak Island, Alaska (Figure 4). Meeting in 2019 at the Smithsonian's Arctic Studies Center in Anchorage, Alaska, Elisa and June stayed in touch by social media. As educators, the lockdown presented similar problems in engaging students, both in Alaska (for June) and in London (for Elisa).

One the biggest challenges the COVID-19 emergency has created has been how to teach studio-based, hands-on courses online. Although universities around the globe have suspended classes and transitioned to remote teaching, distance learning is not easy for students who learn by making, requiring access to studios and workshops. As a response to digitalised education, Elisa wanted students to learn a new craft and start working with their hands again. Craft-based skills need to prevail in the context of massive digitalization during this specific period in history. Craft has the power to stimulate, inspire and soothe us—an important reason to keep making with our hands through this difficult period. Although online craft courses are not a new phenomenon, this fish skin platform offered possibilities for students from a range of backgrounds and nationalities to come closer despite the physical distance. Technologies such as Zoom online classes have helped to resolve contemporary issues, including the lack of connection during lockdown. Furthermore, lessons learned in lockdown will be imbedded into their practice for good.

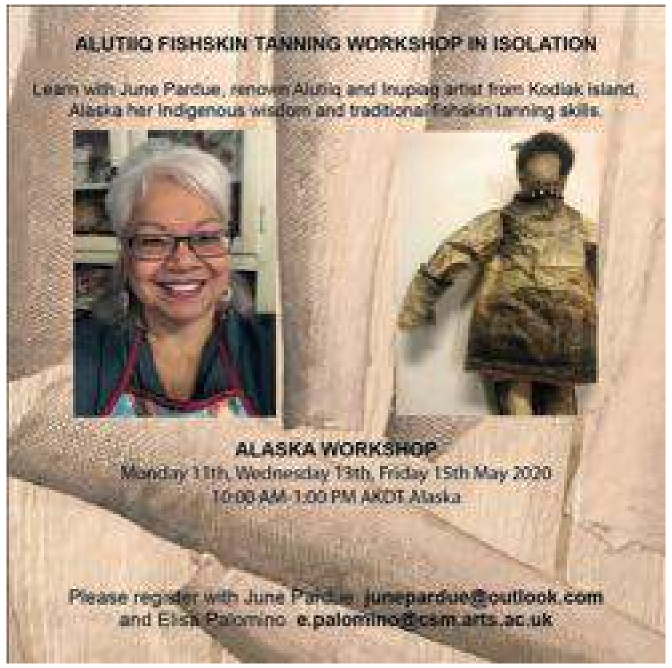

Figure 4. Alutiiq fish skin tanning workshop in isolation flyer. May 2020.

Students had been in isolation on their own or with families for up to 12 weeks. It was paramount to bring them closer despite the physical distance. The goal was trying to support students through this difficult time keeping them inspired and connected. Engagement was also really important at a time where students were suffering from the lack of structure associated with the traditional classroom experience. Students missed the peer support they received by being in the studio with each other, since so much additional learning goes on during that time.

The first fish skin workshop involved fashion students, an amateur leather tanner with knowledge on tanning technology and a museum curator expert in fish skin artefacts with experience in working with craft communities. After the initial workshop, June has taught more than twenty fish skin workshops amongst different Alaska village tribes and communities. As a result to all her commitment with fish skin tanning, June has recently been awarded a fellowship from the Rasmusen Foundation of Anchorage, Alaska. The contemporary struggles of Arctic Indigenous communities are often reflected in the loss of Indigenous practices. Indigenous technology, knowledge and cultural resources, such as those related to fish skin tanning, remain relatively inaccessible to students in Alaskan schools. Through the workshops, knowledge of fish skin tanning has provided students with specific skills and brought them closer to nature.

Focusing on what fish skin heritage means to different Arctic Indigenous groups and how they may value fish skin heritage differently, the workshops aimed to engage with cultural diversity and audiences with different abilities and areas of expertise, including museum curators, amateur tanners and young Indigenous students. Traditional knowledge of fish skin craft offers important opportunities for greater access to cultural heritage. In particular, fish skin heritage provides new opportunities in (re)connecting Arctic communities with common cultural heritage, which was removed through processes of colonization and assimilation. The fish skin workshops brought into the digital age could make new and sustainable connections between the virtual world and craftspeople.

2.2. Participants

Over a two-week period, Elisa and June publicised the initial fish skin workshop by reaching out to students, museum staff and amateur tanners, and through social media around the Arctic, by inviting Native students from remote communities around Alaska.

After the initial workshop (Table 1), June was invited to teach remotely in several

Alaska Native institutions where she usually teaches in person. Non-profit institutions provide financial support to encourage heritage programs, creating opportunities to make Alaska Native technology more accessible in the state. This support for artists and tradition bearers to pursue their work provides awareness of Alaska Native culture, reversing the negative impacts of colonisation by reinforcing Indigenous traditions and encouraging pride in a culture that has been previously controlled by dominant globalising cultures [9].

Participants	Expertise	Provenance
Researcher	Lecturer in fashion, textiles and sustainability with experience as a fashion designer in the luxury industry, enabling a process of embedding sustainability within educational programmes.	UAL, U.K.
Craftsperson	Carrier of Indigenous fish skin heritage, expert in fish skin tanning technology.	AK, USA
Students	Students with knowledge on tanning technology and environmental activism.	Worldwide
	Leather tanners with knowledge on tanning technology.	Worldwide
	Members of the Alaskan Indigenous community.	AK, USA
	Museum curators, experts in fish skin artefacts with experience in working with craft communities.	UK,AK, USA

Figure 5. Juneau Alaska State Museum curator Ellen Carrlee's Facebook page after her fish skin workshop with June Pardue.

Table 1. Description of the diverse roles and skills of the participants in the Alutiiq fish skin workshop in isolation.

The online workshops for remote communities around Alaska were taken both by artists and young students. Families and parents participated with their younger generations during the live classes, reinforcing the strong connections amongst Arctic communities. One of the Alaska Native Corporations' Educational Programs paid for an Elder to take June's class so that she could learn the ancient skill to begin her fish skin tanning industry. Ellen Carlee, curator at Juneau's Alaska State Museum who participated in one of the workshops, shared photographs on her Facebook page (the most common social media for Alaska Native artists) of fish skin artefacts stored at Alaska State Museum so the rest of June's students could benefit from them (Figure 5). Following the workshop, Ellen processed fish skin with several friends in Juneau and gave a lecture to some conservation students at from New York University on Alaskan proteins used in material culture, encouraging them to try experimenting with fish leftovers from dinner.

3. Workshop Content

3.1. A lecture on Historical Fish Skin Artefacts in International Museums

During the workshop, Elisa introduced a series of fish skin artefacts from archives and museum collections around the Arctic that she has studied during her previous fieldwork (Figure 6). These objects, created by artisans throughout the nineteenth and early twentieth centuries, reveal Arctic peoples' intimate relationship with their environment through fishing and skilfully processing the fish skins. Fish skin objects from the Arctic and Subarctic regions reflect everyday items of clothing, bags, boots, mittens and skin scrapers for preparing hides. Today, these artefacts are highly valued and sought after by the native descendants of those who created them for their artistic value, craft and representation of cultural development and humanity adapting to a wide range of environmental conditions [14].

Figure 6. Images from the lecture on historical fish skin artefacts in international museums.

3.2. Storytelling

June and her husband Charlie share a childhood spent travelling between ancestral fishing camps. During the workshop and while engaged in the mechanical processes of tanning the fish skins, June often passed on elders' stories, sharing environmental, ancestral and spiritual knowledge. These narratives brought teacher and students together, inspiring warmth and intimacy, further emphasizing the need to keep the fish skin tradition alive within younger generations.

"Oral history does more than provide information about the past, it brings the past into correspondence with the present, providing scope for imagining new" [15].

June uses personal anecdotes about living in the Arctic, often weaving traditional stories passed down from her elders with her own life stories, including tales of long harsh winters where people gathered at home around the fire. Listening to elders' stories reinforces the importance of storytelling in terms of cultural survival of oral culture.

3.3. Subsistence Partnership

June Pardue and her husband Charlie harvest salmon during autumn. Using fish skin to make traditional Indigenous artefacts is an extension of the subsistence activities that she takes part in with her family. June stressed the importance of the combined efforts

of husband and wife in their subsistence partnership with the raw materials and tools for processing the skins provided by Charlie, as hunter/fisherman and husband, and the expertise and labour of tanning the skins provided by June as the seamstress/wife. This partnership has long sustained the social structure of Arctic Indigenous societies. Arctic fish skin clothing is, therefore, produced through the combined efforts of fisherman and seamstress.

Tanning skins, which consists of scraping, soaking skins in rotten brains or urine and hanging them outside, is considered women's work. In the past, Alutiiq women tanned skins with urine collected in large wooden tubs stationed outside their houses, relying on the ammonia in the urine for one or two days to remove excess oils and break down any remaining fat. Then, they rolled and left them in a warm place to sit until the flesh and scales could be easily scraped away [3]. Today, tanners have modified the technique, using lye or another soap or detergent. Once the skins are clean, they are worked for hours by manual manipulation, massaging and stretching the skins until the fibres break down, becoming soft and pliable.

4. Fish Skin Tanning and Dyeing

4.1. Materials

June and Elisa agreed to use materials not too difficult to access during lockdown. Students were asked to go to parks and woods to gather bark from willow, alder or oak trees for tanning and obtain fresh beets from stores. Students used fish skins locally available to them. For example, Charlotte Ridley, a conservator from the Horniman Museum in London, used sea bass fillets from Waitrose supermarket (Figure 9) while Joe, an amateur tanner from Minnesota, used trout skins he had caught himself.

Figure 7. June's willow, alder bark and beet root tanned skins with handmade scraping tools and Ulu knife (bottom)

Figure 8. Skins tanned with alder bark left to dry.

Figure 9. Two sea bass fillets from Waitrose tanned by Charlotte Ridley, a conservator from the Horniman museum in London.

We cut off the skins from the fish as close to the skin as possible without cutting through it. We scraped the flesh off the skin with a metal spoon or butter knife (Figure 11). June used the traditional Ulu (Figure 7), a knife with a semi-circular blade used by Native women across the Arctic for over three thousand years. After rinsing the fish skins in cold water, we soaked them in soapy water, leaving them to sit for a whole day.

Figure 10. Linda Hobson (left) and Seth Hobson preparing willow bark. Photo by Renae Zackar.

4.2. Tanning Solution

During the initial workshop, June instructed the participants in using a bark solution to tan the skins. We peeled the outer part of the tree branches with a potato peeler (Figure 10). As June noted, the middle part is not used since it is full of sugar and it will ferment the tanning solution. Peeling four organic beets, we added them to the tanning solution to soften the fish skin. This provided a beautiful red tone. We placed the bark and beet peels into a pot and poured water to fill the pot, bringing the tanning solution to a boil. After adding a spoonful of non-iodine salt to the tanning solution, the mixture of bark and beets was simmered for 5 hours and then left to cool overnight.

Figure 11. From left: Seth Hobson, Sea Hobson and Renae Zackar scraping fish skins. Photo by Ida Nelson.

The tanning solution was generously applied to the skins in the evening, and they were left to soak overnight, stirring them to make sure they were completely immersed. Skins were removed from the bark solution in the morning, then we rubbed coconut butter on the skins and pulled them with our hands in all directions. Fish skins were stretched as they dried and we rubbed them again to soften them. Afterwards, they were set aside to dry for an hour, making sure that they will not harden. Skins were then rubbed and pulled until dry and soft.

5. Fish Skin Indigenous Practices Aligned with the United Nations Sustainable Development Goals

The 2030 Agenda for Sustainable Development released by the United Nations consists of 17 goals and 169 targets, of which 73 have significant links to the UN Declaration on Rights of Indigenous Peoples [16]. In this section of the paper, we explore how traditional knowledge-based practices related to Indigenous fish skin production and use are interconnected with the Sustainable Development Goals (SDGs).

Indigenous communities throughout the world have developed valuable traditional knowledge about nature and sustainable practices, which can contribute to achieving the SDGs related to environmental sustainability. The goals on climate change adaption, sustainable management of oceans and use of water resources reflect priorities that Indigenous Peoples have always embraced to protect the ecosystems and biodiversity of their mountains, rivers and forests. Indigenous Peoples have constantly contributed towards the SDG targets on increasing awareness on lifestyles in harmony with nature [16].

5.1. SDG 1: No Poverty

SDG 1 is linked to end poverty everywhere, in all its forms. Alaska Native Heritage educational programming aims to connect Indigenous artisans with marginalised communities. Thanks to their funding, artist June Pardue was able to teach several fish skin workshops across Alaska during the COVID-19 pandemic. By learning from Alaska Native Elders, younger artisans are able to improve their lives through work that values their craft and heritage, becoming agents of change in their respective communities.

5.2. SDG 3: Good Health and Well-Being

The health impacts of industrial chemicals used in the leather production process has detrimental effects on the health of workers, as well as communities affected by environmental pollution, is explicitly linked to SDG 3. Contemporary industrial methods used to process fish leather employ mineral tanning agents, chrome being the most popular (a solution of chemicals, acids and salts including chromium sulphate). If not properly managed, these can impact workers' and consumers' health and will have a negative environmental impact. The traditional methods used in tanning fish skin provide an environmentally friendly process without relying on harmful industrial chemicals. This is an opportunity to revive old technologies for processing non-conventional raw materials such as fish skin.

5.3. SDG 4: Quality Education

SDG4 aims to ensure that all learners acquire the knowledge and skills needed to promote sustainable lifestyles and cultural contributions to sustainable development. The SDG target makes specific reference to ensuring equal access to education for Indigenous children. Through Alaska Native Heritage programmes, June supports the development of young Native talents, integrating Indigenous knowledge into formal education. By educating future generations of young Native Alaskans in sustainable traditional practices, Native communities are able to grow and develop, building on this ancient knowledge.

5.4. SDG5: Gender Equality

The contribution of Indigenous female artists across the Arctic testifies to the vital role Indigenous women have held, and continue to hold, in Northern communities. Women's labour, often unseen and underpaid, is a vital means of support for families, communities and economies throughout Alaska [17].

5.5. SDG 6: Clean Water and Sanitation

SDG6 relates to water pollution, the release of hazardous chemicals and materials, treatment of wastewater and water-use efficiency. There is a potential pollution during the dyeing and finishing process of materials such as fish leather. Sustainable innovations such as vegetable tanned fish leather developed by June Pardue are reducing this, and these sustainable alternatives should be favoured [18].

5.6. SDG 8: Decent Work and Economic Growth

SDG 8 seeks to promote sustained, inclusive and sustainable economic growth. Through the fish skin workshops, June has been increasing and disseminating traditional

knowledge. Thanks to this training, micro-entrepreneurs are encouraged to grow small enterprises such as local fish leather tanneries, creating new jobs and, ultimately, building social capital. Through the Alaska Native Heritage programmes, June mentors the development of Native artisans, thereby supporting and developing their business capacities.

5.7. SDG 10: Reduced Inequalities

A key entry point for Indigenous Peoples in the 2030 Agenda is the strong commitment to "leave no one behind" and "reach the furthest behind first". The fish skin workshops have promoted an inclusive philosophy sharing traditional knowledge and expanding international and professional contacts in a manner that has the potential to contribute in a significant way to reducing social and economic inequalities.

5.8. SDG 12: Responsible Consumption and Production

SDG 12 commits to ensuring sustainable consumption and production patterns addressing the use of natural resources, chemical waste, fossil fuels and the integration of sustainable practices into the production cycles. The use of alternative materials such as fish leather has the potential not only to serve our material needs but also to reduce the over-consumption of certain materials threatening biodiversity. The use of alternative materials could lead to more regional sourcing of materials and more local jobs in coastal areas [19]. The key to social innovation is collaborative networks based on a new relationship with local resources and local communities [20].

5.9. SDG 13: Climate Action

SDG 13 commits member nations to combat and curb human-induced climate change, with modern industrialised societies recognised as the greatest source of climate instability. Living sustainably with the environment for millennia, Arctic Indigenous Peoples are now experiencing the most dramatic impacts of global climate change caused by unsustainable practices elsewhere in the world [21]. Ignoring sustainable practices in salmon fishing used by Arctic Indigenous Peoples for thousands of years has led to the excessive depletion and near extinction of this species. Indigenous traditional knowledge about nature and sustainable practices can make a significant contribution to achieving the SDG 13 related to environmental sustainability.

5.10. SDG 14: Life Below Water

This fish skin traditional workshop has shared new ocean-based value chains by raising awareness and partnering with Native locals to share material innovation. The capture fisheries and fish farming sectors generate enormous amounts of fish skin, typically discarded as waste. Turning fish skins into fish leather adds value to locally caught or farmed fish, creating additional employment opportunities for local coastal communities [22]. The innovative use of aquatic resources serves as a critical means of increasing sustainability in both the fashion and fisheries sectors.

6. Conclusion

Ancient shamans drew inspiration from nature, harmonising the fire, water, earth and air elements to navigate perilous times. In times of disorientation, distress and challenge, such as the COVID-19 pandemic, it is crucial to reinstitute balance by reconnecting with nature. The fish skin tanning workshops provided a creative practice to help participants through these challenging times, strengthening their intimate connection with nature while also benefiting the greater community. The increase in communication and involvement of individuals from different backgrounds and areas of expertise across the planet during the COVID-19 lockdown enabled a closer connection with each other and with nature. Along with climate change, the pandemic crisis has brought a shift in perception of nature and the role of humanity as a responsible keeper. Arctic Indigenous Peoples have a lot to teach in this respect. In recent years, governments have tapped into traditional Indigenous knowledge preparing for and responding to nature disasters and health crises. As Clement [23] points out, the idea of traditional Indigenous knowledge and resilience comes from paying attention and being a part of one's environment, thereby gaining experience and learning from it collectively.

The Alutiiq Indigenous fish skin tanning workshops provided a platform for novel interventions across the disciplines of fashion, craft production and museum curation, challenging and merging the digital environment with that of crafts in this period of the pandemic. Reintroducing the knowledge of ancestral tanning practices has involved the participation of multigenerational community members. Activities around the tanning workshop, including storytelling and people gathering together, have created opportunities for young people to learn from elders, who are considered to be the backbone of Native communities. The engagement with fish skin material and objects connects the object to the place where the materials were collected and the people who inhabit that region, strengthening a distinct cultural identity [9].

Throughout centuries of colonisation, Alaska Native people experienced profound sense cultural loss. Denied opportunities to learn about their cultural practices, many were made to feel ashamed of their Native heritage. Today, the resurgence in cultural pride, ethnic identity and control of resources is reshaping the future for Alaska Native people and their communities [5]. The Native-led fish skin workshop contributes to this effort, increasing access to skill development opportunities for Native youth and supporting cultural revitalization in Native education.

Fashion educator Elisa Palomino

Elisa Palomino, fashion print senior tutor at Central Saint Martins, University of the Arts, London, has 25 years of experience working in the fashion luxury industry. Drawing on her previous industry experience, designing fish leather garments and accessories made out of fish leather for John Galliano, Elisa situates the use of fish leather within the context of the luxury industry. Her experience running network projects linked with fish skin includes the EU Horizon 2020-MSCA-RISE Marie Sklodowska Curie: Fish Skin a Sustainable Raw Material the EU COSME WORTH partnership project to develop a collection of fish skin leather accessories. As a UK—US Fulbright Scholar, she completed research on Arctic fish skin clothing traditions at the Smithsonian Arctic Studies Center in Anchorage as well as at the National Museum of Natural History in Washington, D.C.

Artist and educator June Pardue

June (Simeonoff) Pardue, an Alutiiq and Inupiaq artist originally from Old Harbor village on Kodiak Island, is a recognised weaver, fish and sea mammal skin sewer, storyteller and beader. In addition, June is a well-known artist with works of art in the permanent collections of the Alutiiq Museum, Kodiak History Museum, Autry National Center in Los Angeles, Sheldon Jackson Museum in Sitka and the Alaska Native Heritage Center. She has taught weaving, fur sewing and beading at the United Nations in New York, the Autry Museum of the American West in Los Angeles, California, and Hermitage Museum in St. Petersburg, Russia. June is an adjunct professor for Alaska Pacific University, Kenai Peninsula College and for the University of Alaska Anchorage. She has recently been awarded a fellowship from the Rasmusen Foundation of Anchorage, Alaska. June teaches the Alutiiq language as well as salmon skin tanning, weaving, beading and fur sewing in rural locations throughout Alaska. Although fish skin materials were once used as a common textile material from the far north to the south-central regions of Alaska's coast, June Pardue is one of the few Alaskan artists continuing this tradition.

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Paper 6: Material Design Research - Fish skin

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Material Design Innovation: Fish leather, a new environmental-friendly material

Elisa Palomino
Gustavo Adrian Defeo

Abstract
This paper explores the material design innovation process during a cross-disciplinary project working with fish leather. The *Fishskinlab* project aims to generate a deeper understanding of fish leather as an alternative to conventional leather to encourage more sustainable fashion practices. The objective is to create aesthetically relevant fish leather products that illuminate sustainability thinking as a driver for innovation. The project looks at the strategies implemented by practice in the field of material design innovation fed by new technologies, addressing changes in interactions between humans and with our environments.
The research draws on findings gathered through a partnership between the researcher, the Icelandic tannery Atlantic Leather and the Italian analytical laboratory Ars Tinctoria connecting fashion designers, scientists and leather technicians from the UK, Italy, and Iceland to advance material innovation by using new technology (water-based ink digital printing methods) on fish leather. This led to the development of a collection of digitally printed fish leather bags.
The skins were sourced at Atlantic leather, the researcher developed the prints and followed the technical process while the digital printing was produced and tested at the Italian analytical laboratory Ars Tinctoria.
This paper presents the journey of the mapping process, illustrating the key stages of the research, which led to the discovery of new material properties and finishes applying digital printing processes to a food industry by-product material such fish leather.
The methods and practices of the project included dynamic interaction between the researchers facilitated through the cooperative framework of the project. The feedback of the work presented during Brussels Industry days and Milano Design week offered the researcher an information flow that influenced the development of the final prototypes and the ultimate presentation of process and outcomes.
The findings identify that new materials, processes, and techniques are often the result of the successful union of fashion and technology to help drive the industry towards a more sustainable future.

Keywords: Material Innovation, Sustainable Fashion, Fish Leather, Food Industry By-Product, Waste, Digital Printing, Leather Industry.

Introduction
The project explores existing traditional knowledge of fish skin processes and applies the analysis of this learning using state-of-the-art practices and developing new technologies while addressing specific challenges of the use of fish leather for the fashion industry. The research maps best practice and knowledge transfer of water-based ink digital printing technologies for fish leather.
The research has brought together sustainable methods from fashion design, material science, and analytical chemistry to foster international knowledge exchange that will develop the capacity for research and practice in these fields.
This design research is about innovation, design, and sustainability paving the way for the future of fashion by using unique leftover materials such as fish skins while illustrating shifts in material values and resources.

The paper is divided into seven parts. The first part covers an introduction to the project and main objectives. The second part examines the historical context of fish leather. The thrid part covers the environmental context. The fourth part describes the methodology used. The fifth part develops the design research through practice: the Fishskinlab research case study. The sixth part explores the digital printing methods used and chemical tests done. The final part describes the findings and conclusions.

Figure 1. Atlantic leather fish skin tannery. Picture by Nathalie Malric (2018)

Historical Context

The use of fish skin for clothing is an ancient tradition in Arctic societies along rivers and coasts and there is evidence of fish skin leather production in Scandinavia, Alaska, Japan, northeast China and Siberia.

Before synthetic fibres were invented, people clothed themselves with natural materials available in the surroundings where they lived, including fish skin (Jiao, 2012).

People in the Arctic coastal regions sourced their materials from animals that were necessary for their survival, such as salmon and they used their skins for clothing and accessories (Hatt, 1969).

The shortage of raw materials and omnipresence of modernity have challenged the preservation of the fish skin craft (Lin, 2007). Better access to the modern world meant that Arctic people were able to access textiles like cotton and silk to create their clothing, leaving fewer people to develop the traditional fish skin craft. Overfishing and water pollution have caused fish stocks to drop and many Arctic aboriginals have turned to farming to make a living, abandoning their fish skin skills (Lin, 2007). The use of fish skin by aboriginal Arctic people has recently been assimilated as an innovative sustainable material for fashion due to their low environmental impact.

The Atlantic Leather tannery, located on the north coast of Iceland, has been one of the main agents in the renaissance of the fish skin craft. Processing fish leather since 1994, based on the ancient Icelandic tradition of making shoes from the skins of wolfish (Figure 2). The tannery has brought this historic eco-luxury material back into fashion, simultaneously reviving ancestral tanning techniques and providing jobs for the local community (Figure 1). Their fish leather is a by-product of the fishing industry, exploiting fish not bred specifically for their skin, that would otherwise be discarded. All the fish skin used by Atlantic Leather is sourced from sustainably-managed farms in the Nordic countries (Figure 3). Special attention is given to the new technologies used on their fish skin production and to address challenges such as energy, environment and climate change. The entire process of producing fish skin at Atlantic Leather relies on the power of nature using geothermal water and is non-impactful on the environment. The manufacturing of fish skin leather works with three aspects of sustainability: the economic benefit of creating value from waste; the social benefit of reconciling sustainability with fashionably exotic fish skin; and the environmental benefit of producing skins without damaging endangering animals. Atlantic leather is the winner of the "Tannery of the Year Europe Territory 2016" award, taking in consideration how the tanning process was executed, how the staff was treated, the factory's surroundings and how the small community around the factory is benefiting from it.

Figure 2. Icelandic traditional shoes made of wolffish skin (right). Picture by Nathalie Malric (2018)

Environmental Context

The fashion industry is currently going through a significant change in its approach towards sustainability and luxury brands need to think about the natural resources they rely on and come up with innovation on alternative sustainable materials and processes. Fashion needs to invest in technologies able to reduce environmental impact to enhance the materials and create products that respect the environment (Pavione, E. *et al.*2016)

FishSkinLab research concentrates on promoting a new category of raw material for fashion: fish leather. Fish skins are sourced from the food industry, using what is now considered waste, applying the principle of circular economy, combining research and innovation to enhance the well-being of the earth and its people through the entire life cycle of the product.

Global production of fish has steadily increased over the last decade and more than 50% of the total fish capture remaining material results in 32 million tonnes of waste. (Arvanito, Kassaveti, 2008). While to date, the European Environment Protection agency allows seafood processors to dispose of fish skins in marine waters, this is expected to change as the decomposing organic waste can suck up available oxygen from marine species and introduces disease to the local ecosystem. (EPA, 2012).

The processing of fish leather avoids throwing the fish skins into the ocean and can significantly reduce marine pollution and sustainably protect marine ecosystems in order to achieve healthy and productive oceans. Consequently, the promotion of fish leather could be of great environmental benefit as well as profit for the coastal economy.

Figure 3. Salmon fish skins through the tanning process. Picture by Nathalie Malric (2018)

The use of alternative materials such fish leather has the potential not only to serve to our material needs but also reduce resource consumption of other over exploited materials such conventional leather and it could lead to more locally sensitive production, more regional sourced materials and more local jobs (Fletcher, 2014).

By growing, sourcing and processing raw materials close to home shortens transport routes, lowers carbon footprint and increases transparency across the supply chain. By using local industry waste such as fish skin, nearshoring material production can provide exciting opportunities for the community whilst minimising environmental impact, both locally and globally (Banathy, 1996).

Fish leather being recoverd as waste, requires limited resources from the sourcing of the raw material leaving a lower carbon footprint than the one associated with raising cattle. Fish leather requires no extra land, water, fertilisers or pesticides to be produced and it has a lower environmental impact than conventional leather (Jacobs, 2018).

In luxury fashion, innovation, new materials and traceability are critical. Many luxury brands are actively researching into new materials to make sure the next product is better than the previous one. Luxury fashion brands in the future will be forced to view sustainability as a business imperative; sustainability, in fact, represents innovation and generates competitiveness in the global

luxury marketplace (Pavione, E. *et al.*2016). Any luxury brand which understand these issues and uses fish leather will be regarded at the forefront of the developing innovative market.
According to Williams, new conversations about the materials that we choose, the products that we make, and the ways in which we work as designers can be responsive and make a positive contribution to the world around us as the premise of all good design. (Williams, 2013)
This research draws on the field of Design for Sustainability with scholars such as Stuart Walker drawing attention to design as a process of re-consideration of the present as part of the creation of shared futures (Walker,2016). Walker has suggested that when people begin to appreciate the level of skill and the massive investment of time involved in making a piece, it is valued more highly. High fashion conundrum valuing handmade products versus low end disposable fashion are also part of the fish leather discussion. The highly qualified skills necessary to produce fish leather makes it a unique luxury material for fashion

Figure 4. Fishskinlab project: Wisteria digital printed fish skin clutch by Elisa Palomino. Photo by Giacomo Iezzi (2019)

Methodology

A preliminary round of research was conducted to understand the status of the field in terms of research coverage and gaps, and towards a better definition of the research objectives and their scope. The analysis covered studies on historical and contemporary use of fish skin, sustainability aspects and alternative digital printing methods.
The research looked into demonstrating the contemporary relevance of fish leather as a new sustainable material identifying fish skin's positive ecological impact and its potential for application in fashion. The methods included prefiguring avenues and sketching strategies for developing new printing techniques for fish leather within the fashion luxury industry.
The methodology of this research identifies risk-taking and co-experimentation of materials as essential strategies as the key stages of the research process: Mapping new terrain of sustainable materials, fish leather material investigation, public feedback and critical evaluation. This paper presents a journey of the process, illustrating the key stages of the research.

Observational and participatory methods were utilised to obtain data. This involved talking to the general public during the presentation of the project at Brussels Industry days and Milano Design week. Feedback from the general public during the design fairs supported the progression of the project applying design thinking to the journey.
The key findings from the general feedback verified that the public would be likely to buy fish leather items as an alternative material for fashion.The information influenced the development of the final fish leather prototypes and the ultimate presentation of process and outcomes.

Design Research through Practice: Fishskinlab research case study

Leather remains a vital material for most luxury fashion houses, even more so when it is an exotic skin. Thanks to the use of new technologies, the luxury industry offers a vast array of appearances and finishes among conventional leather, while both the use and creative development of fish leather has been largely neglected. The aim of this design research is to pilot and develop non-polluting technologies for fish leather finishes to advance the development of future manufactured fish leather products. The results can bring a fresh look at how fish leather development with new technologies can underpin and reshape luxury fashion accessories.
This research draws on the researcher Elisa Palomino's experience working in the fashion luxury industry back in 2002, designing for John Galliano fish leather garments and accessories sourced at Atlantic leather. The researcher has experience running network projects linked with fish skin (e.g. EU Horizon 2020-MSCA-RISE Marie Sklodowska Curie: Fish Skin a Sustainable Raw Material; and she is the recipient of the UK-US Fulbright Scholar Award: 'Arctic Fishskin clothing traditions' at the Smithsonian Institute)
In 2018, the author collaborated with Atlantic Leather in the development of 'Fishskinlab', a Worth Partnership Project, funded by the European Commission, EASME, under (COSME 2014-2020) with access to financial funding, market exposure and mentoring to produce a collection of bags made of fish leather developing new embellishments and eco-friendly digital printing which has informed this practice-based research.

Phase 1

With her knowledge on textile and leather printing the main aim for the researcher was to see how fish leather would be transformed under digital printing, compared with the relatively well-known process of textile and leather digital printing. The first round of tests, as seen in Figure 7, resulted in findings that the water-based inks did not adhere easily to the fish leather when the designs had full coverage.

Phase 2

The first review of the digital printed tests identified the need to expand the selection of designs to include designs with less coverage (Figure 8) that could withstand the even coverage and produce new results. As the author became more specific in her design choices and experiment with a number of design combinations the final results were very successful.

Phase 3

Prototypes of small bags were created with the print samples to exemplify the materiality of fish leather for luxury fashion accessories.

Phase 4

The author decided that, in order to gain feedback on the project, it would be advantageous to build in a participatory knowledge exchange. In 2019 the Fishskinlab project took part in Milano Design week and EU Industry Days in Brussels (Figure 6) under the theme of industry and sustainability. Both exhibitions provided an excellent opportunity to engage with a diverse audience representing a variety of industrial sectors from all over Europe. A key element of the participation on the Brussels Industry days was to facilitate a venue that could inspire consumers and EU policy makers to engage with materials through closed-loop thinking, to share their ideas with the designer and to obtain additional professional feedback. The aim of the participation was to push the boundaries of material design practice to identify how it can be used as a tool for citizen engagement, for both: the designer, and the public who wished to engage with the product to identify opportunities to improve both its environmental and social impacts.
The feedback outlined the successful elements of the project, the value of sustainability and use of waste materials and highlighted the qualities that a waste approach can bring to accessories design.
The element that emerged was the close link created between the sustainable approach and innovation. The public was surprised of how something that is considered waste in many countries is given a much higher value through the action of design. Seduced by its beauty, the public was aware of the material being the skin of a fish and inspired about the value of everyday materials. The high visual standards of the final product fits with luxury fashion and becomes a benchmark for redefining the beauty of sustainability. (Figure 5) The project is a fine example of an innovative way of linking the preservation of traditional knowledge and culture and the development of relevant fashion items taking in consideration the sustainable limits of the planet's natural resources.

Figure 6. Fishskinlab project: Pagoda digital printed fish skin clutch by Elisa Palomino. Banner for the Brussels EU Industry days. Photo by Giacomo Iezzi (2019)

Fish leather digital printing

The researcher is an expert in the field of textile design, familiar with digital and analogue printing methods but there are no previous attempts known to the researcher to print fish leather. There are different methods that could be used: silk screen printing and digital print.
Textile digital printing emerged in the 1990s as a prototyping tool and a vehicle for printing small batches of fabric for niche-market products (Provost, 1994). Inkjet printing involves the propelling of tiny droplets of dye or pigment onto a fabric electrostatically. The selected dyes or pigments are dosed on demand and avoid print paste residues at the end of each run and if pigmented inks are

used (rather than those based on dyes) no solvent which associated volatile organic compound emissions is required to dissolve the colourant. (Fletcher, 2013) Recent decades have seen the growing popularity of preparing water-based ink-jet inks for textile printing.
Water-based ink-jet inks for digital textile printing were used on fish leather for this project. Fish leather printing can be difficult since ink generally does not bond well to a non-uniform, organic, complex substrate. The non-uniformity and surface roughness of the fish scales was one of the main obstacles during the process. (See Figure 7). The significant variation on a single fish skin as well as between skins of a batch was also a challenge. Techniques for printing on fish leather may suppress at least one usual property of fish leather, e.g. appearance, feel and/or absorption. Printing onto the surface of fish leather could be disadvantageous if the ink is weakly bonded and it could be easily removed during normal wear and tear, or if the print cracks when flexed. (Pantelis, 2013)
During the test phase, the printing of fish leather included the application of an ink base coat directly onto the surface of the fish leather. The experiments show that a selected combination of pressure and temperature is required. Success was achieved when the transfer of ink into the fish leather occurred across the leather sample with good penetration (See Figure 8). In unsuccessful tests, the transfer of ink into the leather had a non-uniform penetration (See Figure 7).
The digital printing was produced and tested at the Italian analytical laboratory Ars Tinctoria.

They are specialised in colour, light and organic analytical research. Based in Santa Croce sull'Arno, heart of the Italian Leather production cluster, the laboratory is equipped with the latest generation instruments and is active in several fields, including synthesis, analytical research and the study of molecular structures of dyes, the search for hazardous substances, and measurement and standardization of colour and light. Gustavo Adrián Defeo, its CEO is an industrial chemist, active in the leather field since 1985 with multinational chemistry groups with expertise in dyes kinetics, psychophysics, colour perception, light and colour measurement, industrial waste recycling, ecology and analytical methods for the leather sector.

The physical and rheological properties of the inks were measured for the evaluation of ink stability and suitability for ink-jet printing. The tests were found to be suitable. The prints were subjected to light and rub fastness tests and colour measurements. Colour consistency and fastness results, especially after fixation, are comparable with those on conventional leather, which paves the way for the production of environmentally friendly water-based ink-jet inks for the digital printing of fish leather.

Figure 7. Non uniform penetration of ink on the Pagoda digital print sample. Picture by Elisa Palomino (2019)

Figure 8 . Good penetration of ink on the Wisteria digital print sample. Picture by Elisa Palomino (2019)

Fastness properties of Wisteria digital printing
Fastness properties were analysed following updated ISO standards.

Figure 9 – Migration into polymeric materials

ISO 15701:2015 (IULTCS/IUF 442) Leather - Colour fastness to migration into polymeric material (for this test migration was tested on standard PVC layers: This test helps to understand if there will be potential colour migration into plastic materials, and eventual stain of polymeric finishings applied, by contact with neighbouring materials.
Results obtained which can be observed on Figure 9 were excellent (rate 4,5 /5 on grey scale, where the value 5 represents the highest standard). Such a result allows combining the print obtained with any other neighbouring material without risk of stains.

ISO 11641:2012 (IULTCS/IUF 426) Leather - Colour fastness to perspiration (on multifibre): This test was developed to understand eventual colour fading or migration into different textile fibres with

artificial acidic perspiration (Figure 10). A multifibre fabric composed, from the top, of Acetate, Cotton, Polyester, Acrylic and Wool was used in this test.
Apart of a Light stain on Acetate (rated 4/5), all fibre types showed excellent performance. Also in this case staining was rated against grey scale where perfect values are represented by rate 5.
The final test was ISO 105-B02:2013 Textiles - Tests for colour fastness - Part B02: Colour fastness to artificial light: Xenon arc fading lamp test: This test emulates weathering of a colour sample by exposition to natural solar light. In this case samples' colour fading is rated against a blue scale on fabrics representing the values 1 to 8, where rate 8 is the highest standard. The light fastness obtained (Figure 11) is > 6, which is an excellent result considering the naturality of the finishing.

Figure 10 - Colour fastness to perspiration

Figure 11 - Xenon arc fading lamp test

Chemical Tests:
Wisteria printing on Salmon leather was analysed to verify the eventual presence of Substances of Very High Concern (SVHC) after European REACh protocols.
Results shown the absence of any substance of concern, such as Aromatic amines derived from Azo dyestuffs, Hexavalent Chrome (Cr VI), Reach Annex XIV and Annex XVII listed Phthalates, Alkyl phenol and Alkyl phenol ethoxylates, Free formaldehyde and Chlorophenols.

Conclusions

This paper portrays the journey of a collaborative research project between the authors Elisa Palomino, designer, educator and researcher at BA Fashion Print at Central Saint Martins and Gustavo Adrian Defeo, industrial chemist CEO at Ars Tinctoria. The project started as an open-ended research investigation combining design with science and technology exploring fish leather material testing in the hope to develop new finishes and techniques.
Material research has rapidly expanded into a more interdisciplinary practice and designers need to broaden the disciplines in which the methods and concepts of sustainable materials are taken as a vehicle for new collaborative ways of making. This paper suggests methods and processes to invite more sustainable material research and investigates how knowledge about materials can be integrated and communicated within the framework of research.
Current research is now looking into the development of low environmental impact processes to offer new sustainable production methods for the fashion industry. More than ever before the task of design is to articulate the right directions in material development to move towards more sustainable choices.
Understanding materials, production processes, viability, and desirability are key to the fashion industry. New materials and techniques are often the result of the successful union of fashion and technology to help drive the industry real change in terms of sustainability.
The Fishskinlab project was designed to experiment with new techniques, generate a deeper understanding of the fish leather processes and open up further opportunities for research with other disciplines.
This project wants to bring more attention to urgent international matters such as sustainability in the leather industry by using nature-given resources and upcycling leftovers from the food industry.
The paper reflects ethical values linked to research on sustainability and renewable sources, destined to become the driving force for the future of high-quality fashion.
The paper outlines an investigation between design and chemistry and the space in between them. The potential use of water-based ink jet printing for the production of environmentally friendly fish leather prints was investigated. The results were excellent, and this paves the way to challenge more manufactories to sustainable and innovative visions in existing production processes. We were able to measure challenges and possibilities of a design framework based on sustainability values.
The project has enhanced the creativity and innovation in the UK and Italy's leather sector, building stronger connections between the researchers and creating opportunities for future exchange. The fashion creative industries are critical to industrial and commercial success in the UK and Italy. This Anglo-Italo-Icelandic network has blended the skills of Italian leather technology and their passion to create high-quality products with Icelandic sustainable technology and British cutting-edge sustainable design.
The project will have an economic impact by putting fish skin leather on a new level of excellence capable of conquering new markets globally.
By bringing the field of fashion design from Arts and Humanities in contact with Science and Technology, this project has the potential to bring benefits to a wide range of subject areas. It will encourage the joint development of scholarship and collaboration across these disciplines, and it will support the cross-referencing of methods to advance scientific and artistic knowledge of fish leather as a more sustainable alternative to conventional leather.
The outcomes of this project will enable an informed discourse on sustainable thinking for creative practitioners, fashion designers, fashion students, leather manufacturers of luxury goods and retailers across a broad contemporary landscape.
The research developed in this project will benefit scientists coming from a polymer and chemical backgrounds from the research know-how in transforming fish skin, a biological residue, into fish leather – a workable raw material. Chemical scientist at the tanneries will benefit from the transferring of the bio-digital printing results and technology. Practice-based academics from fashion higher education and fashion designers will benefit from the new possibilities for visual and physical attributes for fish leather for the purpose of creating a rich library of effects relevant for the fashion industry.
From a research perspective, this project has enabled the work of the researcher as Fashion Print pathway leader at UAL, to inform future design for sustainability practices in industry and education.

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Paper 7: Indigenous Fish Skin Craft Revived Through Contemporary Fashion

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Indigenous Fish skin craft revived through contemporary Fashion.

Elisa Palomino, Central Saint Martins, University of the Arts, UK
Edwin Phiri, London College of Fashion, University of the Arts,UK
Katrín María Káradóttir, Iceland University of the Arts, Iceland

Abstract

The use of fish skin for the construction of garments and accessories is an ancient tradition shared by Arctic societies in coastal areas. They have maintained a strong relationship with the environment, developing a subsistence lifestyle depending on the marine environment's animal resources for food and clothing. Arctic fish skin craft has become a way to communicate ecological change and traditional knowledge - effectively enhancing cultural resilience for the Arctic people. During the broad transformation occurring over the last century, Arctic Indigenous peoples have demonstrated resilience to systematic colonisation and repression of their language, culture and native fishing rights as well as dramatic ecological changes in seafood security. This paper looks at the role of fish skin in the Arctic as a way to bridge knowledge and social justice between generations and cultures and to nurture resilience during times of change and transformation.

Meanwhile, the use of fish skin by Arctic Indigenous people has recently been assimilated as a fashion sustainable alternative material to exotic leather due to its lower environmental impact. The Atlantic Leather tannery, located on the north coast of Iceland, has been one of the main agents in the renaissance of the fish skin craft. Processing fish leather since 1994, based on the ancient Icelandic tradition of making shoes from the skins of wolfish reviving ancestral tanning techniques. The tannery has brought this historic eco-luxury material back into fashion providing Blue jobs for coastal dwellers in remote rural areas, maintaining the viability of the fisheries sector and attracting young people to work in them. This paper looks at Atlantic Leather's role to preserve the rich cultural traditions that have been developed within the Icelandic fishing industry while processing fish leather promoting social justice through inclusive jobs.

Keywords: Fishskin, Arctic traditional Knowledge, Sustainable material, Inclusive jobs.

Historical Context

Specific groups with historical evidence of fish leather production are the Inuit, Yup'ik and Athabascan of Alaska and Canada; the Nivkh and Nanai Siberian peoples; the Ainu from the Hokkaido island in Japan and Sakhalin Island, Russia; the Hezhe from northeast China, Icelanders and the Saami of northern Scandinavia.

Arctic Indigenous Peoples depended for centuries on hunting wildlife, fishing for salmon, and gathering berries and roots, for their livelihood (Ichikawa, 2003). Their history is closely linked to the issue of aboriginal hunting and fishing rights. Salmon has been of great importance to the local economies and to the aboriginal cultures of Native North Atlantic in the U.S. and Canada, Northeast China, Japan and Russia, but national governments similarly mistreated the local populations by, among other things, limiting or restricting their access to traditional fishing trying to force them to adopt non-traditional ways of life to them such farming through cultural assimilation (Roche, 1998). Today, much of the Arctic traditional subsistence way of life has been lost due to longstanding assimilation policies and the subsequent impact has been extremely damaging for Arctic Indigenous peoples (Ichikawa, 2003).

Corresponding Author: Elisa Palomino,
e.palomino@csm.arts.ac.uk

The Ainu from the Hokkaido island in Japan, the Hezhe from northeast China and the Nanai from Russian Siberia were forced into mass agricultural and industrial labour during the late 19th Century (Jiao, 2012). All these indigenous groups were soon working and living as a second-class minority group among Japanese, Chinese or Russian labour force. These collectives irrevocably altered the lifestyle of the Arctic indigenous people. Their traditional hunter gatherer lifestyle disappeared.

Despite the importance of the salmon to the Ainu way of life, the Japanese government prohibited the Ainu from taking salmon since the 1870s, when the Meiji regime force them through assimilation policies. Consequently, Ainu people who relied on salmon to support their families were prohibited from fishing it. Today, the Ainu people are engaged in a movement to re-establish their rights as indigenous people and to restore important elements of their traditional culture like their fishing rights (Ichikawa, 2003).

Arctic Indigenous Peoples, like many indigenous communities across the world, are still dealing with the effects of deep historic trauma from centuries of colonisation, exploitation and misrepresentation. During this broad transformation occurring over the last century, they have demonstrated resilience and adaptability to systematic colonisation and repression of their language and culture as well as dramatic ecological changes in seafood security (Watterson, 2019).

Arctic fish skin craft has become a way to communicate ecological change and traditional knowledge - effectively enhancing cultural resilience for them. The protection of the cultures and rights of native Arctic people is a prerequisite to saving the fish skin craft. But there are still some unresolved problems, especially in the field of native fishing rights for Ainu people in Hokkaido, Japan, and Scandinavian Saami. Governments need to give a true recognition of Arctic indigenous fishing rights.

Ancient Icelandic Tradition of Making Shoes from Wolffish Skins

Icelandic history, right from the settlement of Iceland in the 9th century, has been interwoven with marine resources and fish have been their main source of food and income (Sigfusson and Arnason, 2017). Icelanders are known for reusing everything and they still have their ancestors' spirit of finding the useful in everything. Icelanders through history had great respect for the skins of fish and to waste them was therefore been frowned upon. If not eaten it was dried or tanned, used to make shoes and occasionally to bind books.

Icelanders wore shoes made of fish skins processed using traditional tanning methods. They were soft, supple, flat-soled traditional footwear (Mould, 2018). Mostly wolfish skin was used as it was considered both beautiful and durable. The shoes made of fish skin were most common in the West fjords of Iceland and was the skin of the leopard fish, a close relative of the wolfish, most sought after as the skin was sometimes big enough to get 2 pairs of shoes, one for a grownup and one for a child. The bigger shoes were made from the wider part of the skin and were considered both more beautiful and less likely to break. Two kinds of shoes were made, one that had a seam at the toe and the heal and another that only had a seam at the toe but pulled together and sewed with a string to a strip of fish skin or sometimes lambskin.

Among qualities of the fish skin shoes were considered that they were light, warm, did not become hard, and were good in frost and soft snow as they lay very close to the foot and very little snow made its way into them. The downsides were that they did not last very long and were not suitable for wet snow. Women used these shoes mostly indoors but men mostly outdoors during winter when the ground was covered with snow.

Contemporary accounts of travels around Iceland in the mid to later 18th century describe and illustrate men wearing traditional fish skin shoes (Hald, 1972), suggesting that the working man wore them on a daily basis. Icelanders measured distances by how many pairs of fish skin shoes would be worn out by walking over the path.

Around 1910 fish skin shoes started to disappear but some Icelanders still made shoes from skate skin and sometimes gloves worn over wool gloves for protection. Fish skin was not considered suitable for clothes used for fishing as the skin was better dry and was it widely considered that the fish skin would disappear and become a part of the ocean once again (Kristjánsson, 1980)

Contemporary Context

Atlantic Leather's Role in Preserving Icelandic Fishing Industry Cultural Traditions

The Atlantic Leather tannery, located on the north coast of Iceland, has been one of the main agents in the renaissance of the fish skin craft. Processing fish leather since 1994, based on the ancient Icelandic tradition of making shoes from the skins of wolfish (Rahme, 2006).

The use of fish skins as leather was almost lost in Iceland within a generation with the arrival of new materials. The founder of Atlantic leather, Gunnsteinn Björnsson had been working already for a few years tanning sheepskins. He remembered the Icelandic tradition of fish skin shoes and was curious to try and develop fish skin as a fully tanned leather and did so with great success. The product is today a part of Icelandic cultural tradition and fits with a national identity of a nation that still considers fishing extremely important. It is also a great example towards the increasing wish to waste less and to lessen the national carbon footprint per capita.

The tannery has brought this historic eco-luxury material back into fashion, simultaneously reviving ancestral tanning techniques and providing jobs for the local community. Their fish leather is a by-product of the fishing industry, exploiting fish not bred specifically for their skin, that would otherwise be discarded (Gestsson, 2012, Jacobs, 2018) By recycling waste, fish skin minimises landfill and keeps resources in use for longer.

Atlantic Leather skins are sourced locally from nearby Nordic regulated farms which provides a sustainable source of food while maintaining fish stocks (Sigfusson, 2017).

Sourcing and processing raw materials close to home shortens transport routes, lowers carbon footprint and increases transparency across the supply chain (Texcycle, 2019) 'Nearshoring' the fish skin production has provided new job opportunities for the coastal dwelling communities whilst minimising environmental impact, both locally and globally.

Special attention is given to the new technologies used on their fish skin production and to address challenges such as energy, environment and climate change. The entire process of producing fish skin at Atlantic Leather requires less energy to produce than conventional leather. It relies on the power of nature using geothermal energy from Icelandic volcanos to power the production processes (Logadóttir, 2015) and is non-impactful on the environment.

Fish leather does not use endangered species that could threaten biodiversity (Rahme, 2006) but is produced instead from four different non-endangered species of fish; Salmon, perch, wolf fish and cod in a diverse range of colours, textures, and finishes all tested by the European Chemical Agency.

Fish leather is a highly biodegradable natural by-product and it has outstanding longevity, one of the most important elements in sustainability (Sigfusson, 2017). Fish leather is stronger than other leather types, if the same thickness are compared. The fibre structure of fish skin runs crosswise, rather than parallel as in cowhide. The tensile strength of fish leather reaches up to 90 Newtons (Leather dictionary, 2019).

The manufacturing of fish skin leather works with three aspects of sustainability: the economic benefit of creating value from waste; the social benefit of reconciling sustainability with fashionably exotic fish skin; and the environmental benefit of producing skins without damaging endangering animals.

Creating New Job Opportunities

Atlantic Leather creates blue tech and blue jobs in a remote coastal area that contributes to the promotion of a sustainable ocean industry. A key challenge for these coastal areas is to maintain the viability of the fisheries sector and to attract young people to work in it. Atlantic Leather aims to preserve the rich cultural traditions that have been developed within the Icelandic fishing industry when processing their fish leather. In recent history, fisheries and fish processing jobs have been in decline in Iceland.

The tannery remains among the few that is holding its own in that respect. Atlantic Leather is stationed in Sauðárkrókur, a small but vibrant community of roughly 3000 inhabitants, located in the heart of Skagafjörður, Iceland. Its location in the North East of the island, with fishing grounds located just off-shore puts it within reach of the fish-rich resource that provides it with its mainstay commercial activity. Additionally, such proximity to the source of the raw materials means that transportation to the point of manufacture is significantly reduced.

In terms of promoting employment opportunities the tannery is also key when it comes to providing blue collar jobs for coastal dwellers in the remote rural areas of fishing communities whose subsistence existence benefits from the tannery's activities. Aside from tapping in to what these rural communities have to offer, the company contributes to the country's economy as it has become one of the important ways in which businesses create improved livelihood, adds value within the supply chain system including the benefits that job is creation, especially in remote and rural areas where such opportunities are not taken for granted (Sigfusson, 2017).

Atlantic Leather's products were voted best luxury leather at the Asia Pacific Leather Fair (APLF) exhibition in Hong Kong in 2013 and the company was winner of tannery of the Year – Europe Territory 2016 presented by the World Leather Magazine enhancing the company's reputation abroad. The award took in consideration how the tanning process was executed, how the staff was treated, the factory's surroundings and how the small community around the factory is benefiting from it.

Another unique strength of the company is that as its international reputation has continued to grow, as it makes a name for itself and continue to be considered one of the key players in the fish leather industry not least because of the demand for its products by important international fashion brands it has led to a growth in its network of distributors and agents. Atlantic Leather products have been sold in European countries like Italy, France, Germany, England, Finland, Scandinavian countries and India (atlantic.is, 2019). They have been supplying fish skin leather to fashion and accessories brands such as Nike, Jimmy Choo, Galliano, Dior, Prada, and Ferragamo.

The company's vision and mission are to run a firm which is well organized in order to have a safe workplace to keep the its staff happy, and thus produce quality leather and good service around it. At the heart of its strategy is the desire to be a worthy part of the community of Skagafjörður as well as to keep themselves as a leader company in the fish leather industry. Having such a business philosophy results into not only having loyal and dedicated staff but is in line with the company's values of promoting social through inclusive jobs.

The network of raw material suppliers from the rural coastal communities are treated with the same respect and consideration as its various local and international agents driven by the firm's commitment to offer unique and innovative products for the apparel industry, keep researching and developing new methodologies in energy management, continue developing and promoting a trustworthy reputation and image and keeping a financially reliable, profitable and growing business. As part of its Corporate Social Responsibility (CSR), Atlantic Leather has been involved in philanthropic projects in the community including aiding Syrian refugees in the community.

Another feature of Atlantic Leather's business portfolio is vertical integration in the form of running a gift shop. Located in the front floor of the tannery, the fish leather outlet is on one of the official tourist routes of Iceland. The store which doubles as a touristic museum opened its doors in 2014 and recreates the traditional and contemporary tanning process of fish leather and displays historical photos and implements (Deliso, 2015). In this way fish leather is creating employment as well as value for the benefit of other sectors such as tourism.

However, like many other countries, Iceland has to be mindful not to overfish. With stock sustainability and the ecological effects of fishing and management systems as core concerns, Iceland has realised that becoming even more competitive in the global marketplace by using fish by-products calls for a rethink in the way it has to manage its resources much more sustainably. To this effect a number of initiatives and innovations are being embarked upon to enhance sustainable fishing and overall use of the abundant fishing and fisheries resource.

An environment in which private enterprise, government led and government supported projects are undertaking research continues to develop. In one example the government of Iceland provides information, advise and support to ensure that the country makes responsible use of its living marine resources by pursuing responsible and sustainable harvesting strategies that are science based and in accordance with international commitments (government.is). One other example is the emergence of institutes like the Innovation Centre Iceland that wishes to promote the advancement of new ideas in the Icelandic economy by supporting entrepreneurs and businesses that undertake projects that include the fishing industry sector resulting in the creation of direct jobs for the business owners and staff and in-direct employment opportunities in the supporting businesses and supply chain.

Conclusions

This paper has explored the use of fish skin for the construction of garments and accessories as an ancient tradition shared by coastal arctic societies. During the last century, Arctic Indigenous peoples resisted both colonisation and repression by humans and dramatic ecological changes in seafood security. Fish skin craft became a way to communicate traditional knowledge where practical benefits combined cultural resilience.

This paper has equally examined how the use of fish skin by Arctic Indigenous people has since the 1990's been assimilated as an innovative sustainable material for fashion due to its low environmental impact. Fish skins are sourced from the food industry, using waste. Alternative materials like fish skin are increasingly seeing a resurgence as they require less energy and resources to cultivate than conventional materials (Global Fashion Agenda, 2017)

Improved usage of so-called waste and other by-products could help meet increasing demand for seafood without further stress to the ecosystem. Some "waste" products can have a very high value if they are used. A more efficient use of resources will benefit society, the environment and the industry's bottom line (Bechtel, 2003).

Developing processes to transform post-consumer and industrial waste into new materials takes the pressures off overconsumed materials. Recycling waste minimises landfill and keeps resources in use for longer. By growing, sourcing and processing raw materials close to home shortens transport routes, lowers carbon footprint and increases transparency across the supply chain. Using local fish industry waste and nearshoring production can provide new opportunities for the community whilst minimising environmental impact, both locally and globally.

Before fashion started using fish skin to produce leather, fish skins used to be thrown away. Now, they are not only a source of income to the local people, but no longer contributing to biological waste.

The Icelandic fish leather model has proved reliable and sustainable over 20 years and this model could be duplicated in seafood industries around the world (Sigfusson, T. 2017). This would create new opportunities in coastal areas with a big demand of fish in their diet and countries with a history of use of fish skin leather. Thus, indigenous fishing communities which used to subsist and dress themselves with fish skin leather items like the indigenous Ainu in Hokkaido, the Nanai in Siberia and Alaska's Inuit will be able to reach agreements with nearby fishing plants for the supply of fish skins to get back in their ancient crafts of fish skin tanning and to develop of new productions that will positively implement their economy.

Glossary of Terms

Ainu: An indigenous people of Japan (Hokkaidō and formerly North-Eastern Honshū) and Russia (Sakhalin, the Kuril Islands, Khabarovsk Krai and the Kamchatka Peninsula) The Ainu economy was based on hunting, fishing and gathering. Ainu people made clothes by sewing together fish skins such as those of salmon and trout.
Blue Economy: The sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystem.
Hezhe: People settled in the drainage areas of Songhua River, Heilongjiang River, and Wusuli River in Northeast China. The Hezhe's ancestry can be traced to the Xizhens, or called Suzhens or Jizhens, a race of the nomadic Tartar horsemen living in northern China in the ancient times. Hezhe people made their clothing of fish skin or animal skin.
Indigenous Arctic Peoples: Indigenous Arctic peoples are closely linked to nature and subsistence resources. Their material knowledge is rooted in centuries of keen observation and direct experience with the environment. Their ability to adapt and accumulated knowledge built upon direct interaction with the environment over long periods of time have enabled Arctic Native peoples to thrive in these northern lands. Traditionally, they moved seasonally to hunting and fishing grounds to support their subsistence ways of life. (Dorantes, 2012) Indigenous Arctic peoples developed over centuries formidable skills, including a highly evolved design aesthetic, creation and mastery of specialized tools, deep knowledge of the natural world, a nimble ability to problem solve and adapt, the development of powerful support networks, and a keen awareness of resources required to thrive in demanding ecosystems. (CIRI, 2015)
Inuit: Indigenous peoples inhabiting the Arctic regions of Greenland, Canada and Alaska. Inuit are the descendants of the Thule people, who emerged from western Alaska around 1000 CE. The semi-nomadic Inuit were fishers and hunters harvesting lakes, seas, ice platforms and tundra. Inuit women made clothes and footwear from animal skins of marine and land mammals for clothing including fish, sewn together using needles made from animal bones and threads made from other animal products, such as sinew.
Saami: A Finno-Ugric people inhabiting Sápmi, which today encompasses large northern parts of Norway and Sweden, northern parts of Finland, and the Murmansk Oblast of Russia. Traditionally, the Saami have pursued a variety of livelihoods, including coastal fishing, fur trapping, and sheep herding. In southern Lapland eel and burbot skins have been used for the production of purses and bracelets.
Yup'ik: A group of indigenous or aboriginal peoples of western, southwestern, and southcentral Alaska and the Russian Far East. They are related to the Inuit and Iñupiat peoples. Yup'ik women made clothes and footwear from animal skins of marine and land mammals for clothing including fish.

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Paper 8: A virtual Ainu fish skin workshop during Covid 19

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A virtual Ainu fish skin workshop during Covid-19 times

Elisa Palomino
Central Saint Martins, University of the Arts, London, UK
e.palomino@csm.arts.ac.uk
Orit Freilich
Shenkar College of Engineering Design& Art, Tel Aviv, Israel
oritf@shenkar.ac.il
Isaac Raine
Central Saint Martins, University of the Arts, London, UK
isaacraine@hotmail.co.uk

Elisa Palomino

Elisa Palomino has thirty years of experience designing for luxury fashion brands internationally as well as creating her own brand. Currently Fashion Print senior lecturer at Central Saint Martins, and fashion lecturer at eight international universities, she globally supports student engagement with sustainability. She is a Research Associate in the Department of Anthropology at the Smithsonian National Museum of Natural History, where she is conducting a comparative study of fish skin artefacts and the Indigenous communities that create them. In 2017 Elisa Palomino embarked on a PhD at London College of Fashion, Center for Sustainable Fashion. For the last four years, under her Fulbright scholarship, she has travelled within the Arctic, researching fish skin craft. Learning from the Arctic Indigenous communities, she has supplemented this education with the knowledge of museum curators worldwide and a study of their artefacts and added to this the expertise of artisanal and industrial tanners. Elisa is also the UAL principal investigator of the EU Horizon 2020 funded project FishSkin, 'Developing fish leather as a sustainable alternative within the fashion industry'. http://www.fishskinlab.com

Orit Freilich

Orit Freilich is a senior fashion lecturer at Shenkar College of Engineering Design & Art and a member of the EU Horizon 2020 funded project FishSkin, 'Developing fish leather as a sustainable alternative within the fashion industry'. She is both an artist and fashion designer and holds a master's degree in philosophy and the theory of ideas in the digital age from Tel Aviv University, a master's degree in art - specializing in fashion design, from the University of Middlesex and a bachelor's degree in fashion design from Margareta-Skolen, Copenhagen, Denmark. Orit directs the "Re-starting Fashion" course at Shenkar which brings together the Fashion Design Department at Shenkar University and the Dizengoff Center Mall in Tel Aviv with one essential goal - to assimilate the values of sustainability in fashion for an urban retail environment. Other collaborations include working with Israeli mass-production "Renuar" and many other Israeli brands. In 2015 the course collaborated with Israeli defence forces recycling their old uniforms and student Lia Kassif won the Redress Design Award 2017, the world's largest sustainable design competition for emerging designers. Orit is the creator of the F4*3D fashion course at Shenkar.

Isaac Raine

Having graduated with first class honours for his degree in English Literature at Christ Church, Oxford, Isaac studied Fashion Design at Central St Martins, London before working at Diane Von Furstenberg, Chloe, Hermes, Lanvin and Sies Marjan. He specialises in draping, with minimum waste, using the fabric resourcefully. He has taught his interns, and online classes at Dia Beacon, New York, and Central St Martins, where he has also been an external examiner, as he was at Parsons, New York. He has written, freelance, for The London Review of Books, The Telegraph, The Daily Mail, The Sunday Telegraph, The Spectator, Arete and Harpers Bazar. Since graduating, he has never stopped editing for friends.

Structured Abstract

From April to June 2020, during the Covid-19 isolation, Ran Graber, a third-year student of Shenkar University, Tel Aviv, elected to study and remake a 19th century fish skin attush (Ainu robe), under the guidance of Elisa Palomino, Orit Freilich, Ran Kassas and Debbie Elhayeni, as part of the F4*3D course. This small project of individuals – one student, one course, one study, one sample – nevertheless brought together workwear and artwear, utilitarianism and spirituality, ancient tradition/history, contemporary society, and future thinking. It bought together Tel Aviv, London, and Hokkaido – as well as all of you here now, from across the globe.

By disseminating the ancient Indigenous Ainu fish skin craft – as exemplified in this robe – to a non-Indigenous student, we were able not only to provide an example of an environmentally sustainable alternative material for fashion, but also, in so doing, to suggest a way of preventing marine pollution by exploiting skins discarded by the food industry that would otherwise be thrown in the sea. We were able to sustain an endangered historic tradition, to bring it to a new arena, and to plant the seeds of its further dissemination as the fashion students graduate and become industry professionals across the world.

The paper is centred on the research questions:
'How can we assist fashion students in developing sustainable materials by sharing traditional fish skin craft from Ainu Indigenous Peoples?'
'How can a faculty provide creative new ways of teaching that benefit both staff and students during difficult times?'

Keywords: Ainu Indigenous Peoples; Fish Skin Craft; Traditional Knowledge; Fashion Education for Sustainability; Food Industry By-Product.

Fig. 1 Ran Graber's sketchbook

Fish Leather as an alternative material for fashion

Fashion is a global industry. The problems of the world are the problems of fashion, in cause and effect. These environmental, social, and economic challenges, very real to the fashion world, are only microcosms of their global equivalents. The growing environmental crisis calls urgently for action. The Covid-19 pandemic presented an immediate crisis, necessitating rapid and radical change. While bringing new problems in its wake, it demonstrated our ability to adapt, at speed. Now we need to match this reactivity to the global environmental crisis. Because the issues and implications are literally global, there is no single solution - rather a series of endeavours contributing to overall amelioration. We hope that this workshop may be one such endeavour.

The fashion industry creates massive, acknowledged pollution. The leather industry contributes to greenhouse gases through deforestation for grazing cattle and the methane they release. Bovine leather is slow and expensive to grow (even without ensuring good quality of life before slaughter). Vegan leather alternatives are bonded with up to 40% of fossil fuel-based polymers that will never biodegrade. Fish leather provides an alternative with positive environmental, social, and economic implications that are practical, practiced, and practicable.

Fish - for food - is an established, flourishing sector. Fish has significant nutritional benefits over meat, is more rapidly harvestable and does not add to carbon emissions. Fish leather, a by-product from fileting, would otherwise be thrown back into the ocean, creating 20 million tons of discards yearly, worldwide. This is not just a double good preventing pollution and creating a product from a free source, it is multiply positive - lessening the need for environmentally damaging leather, while creating a circular economy; providing local employment; increasing a sense of community; keeping alive an endangered ancient craft; and, finally, providing the demanding fashion industry with novelty and beauty.

This case study creates a concatenation of players and of impact - the robe, the course, the teachers, the Ainu, the world. The robe is studied as part of the course, supervised by the teachers, drawing on Ainu subsistence resourcefulness in the face of adversity – which outlook speaks to a world shaken now by the adversities of Covid, and in the immediate future by those of the climate crisis. This is how the elements link: for clarity, we will discuss them one by one.

Ainu Indigenous Peoples and fish skin

The use of fish skin to create articles of clothing is an ancient tradition shared by Arctic and Sub Arctic societies along rivers and coasts. This grouping encompasses Iceland to the Sami region in Scandinavia – Sweden, Norway, and Finland – through the Russian Far East, Northeast China, the traditional Ainu islands of Hokkaido in Japan and Sakhalin in Russia, to the North American Arctic in the east (Palomino, 2021). Before synthetic fibres were invented, people clothed themselves with whatever they could – namely the natural materials available in their surroundings - like fish skin (Palomino, 2020). Subsistence living in a harsh climate requires frugality, intelligence, and resourcefulness. Nothing is wasted – because waste could be a matter of life and death**.** We must learn from this now, and change, lest our profligacy be the death of us.

The Ainu are an Indigenous Peoples of Japan (Hokkaidō and formerly North-Eastern Honshū) and Russia (Sakhalin, the Kuril Islands, Khabarovsk Krai, and the Kamchatka Peninsula). The Ainu economy was based on hunting, fishing (figure 3), and gathering. Ainu people made clothes by sewing together fish skins such as those of salmon and trout. For Ainu Indigenous Peoples (figure 2), their relationship with fish plays an important role in maintaining their identities, creating important ties with the environment. The Ainu indigenous people drew a sense of their identity in relation to fish; for them, fish, man, and the environment were all one, all equal.

Fig 2. Ainu man. Hata, Awagimaru. Ezotō Kikan. Japan 1799. Library of Congress. Washington DC

Fig 3. Ainu men fishing. Hata, Awagimaru. Ezotō Kikan.

Throughout the centuries, fish were the main bounty of the Ainu land. The perennial river and lake fish were joined each year by spawning transient newcomers: humpback salmon, chum, taimen and hucho. Natural resources (primarily fish) determined the lifestyle and economic activity of the Ainu. Even the pattern of settlement was determined by their fishing habits - mainly in areas of abundant fish stock - on the seashore, in gulfs and at the mouths of rivers, in lagoons or in the centre of islands close to spawning rivers (Takasami, 1998).The Ainu placed primary importance on fish as a food resource, fresh in summer and spring, and preserved for later use in winter - when they subsisted on it.

Fish are deeply related to the Ainu religion. Fish not only nurtured the body but also the soul. The Ainu revere multiform spiritual entities - kamui - God-spirits, who will visit the earth assuming the forms or flora, fauna, and forces of nature. The communication between the Ainu and these multiform entities is expressed through a sensitive approach to working with natural materials, and the creation of objects and clothing under an aesthetic imbued with spirituality. Traditionally, the Ainu made their clothes with the materials resulting from their “exchanges” with various animal and plant species. As with all the fishing populations of the Amur River basin and the shores of the Sea of Okhotsk, fish skin was their preferred traditional material, which they worked with care and reverence (Cevoli, 2015).

Despite the importance of salmon to the Ainu, the Japanese government banned their salmon fishing in the 1870s, as Part of the Meiji regime’s enforced assimilation policies, during their colonisation of Hokkaido. Consequently, Ainu people who relied on salmon to support their families were prohibited from fishing it. This had a negative impact on the Indigenous population. Today, the Ainu people are engaged in a movement attempting to reassert their rights as Indigenous Peoples and to restore important elements of their traditional culture like their fishing rights (Ichikawa, 2003).

Historical fish skin artefacts in international museums

During the workshop Elisa shared with Ran a series of Ainu fish skin artefacts from archives and museum collections that she had visited during her previous fieldwork around the Hokkaido Island of Japan. The 19th and early 20th century objects shared with Ran are everyday items of clothing (Figure 4), bags, boots, and mittens. Today, these artefacts are sought after for their artistic value, craft, and representation of cultural development, and of humanity adapting to a wide range of environmental conditions (Fitzhugh, 2007). The museums’ fish skin artefacts provided the student with an overall idea of the original culture of the Sakhalin and Hokkaido Ainu: their main economic activities (fishing, hunting, gathering and agriculture); domestic activities and handcrafts (wood processing, weaving, fur, and fish skin processing); their everyday items, spiritual culture, and traditional religious beliefs, which we shall further discuss later.

Fig. 4. Ainu fish skin attush. 19th century. Kushiro City Museum. Kushiro, Hokkaido, Japan.

Fig. 5. Painting it in a negative form with white chalk on black paper. Part of Orit’s “toolbar”.

The coat at the centre of this case study, and the focus of Ran's project, is an Ainu man's fish skin attush from Sapporo University Museum in Hokkaido, Japan (Figure 4). Fish skins used in the manufacture of garments like this one were softened by being beaten with a wood mallet after they were dry. This coat, which has wide kimono-like sleeves, reaches to the knees. It is constructed of rectangular rows of nearly whole salmon skins. Since each skin, when opened flat, narrows toward the tail, there is a triangular gap between some pairs of skins. These gaps are filled with separate pieces of skin. The design of this coat has carefully worked with the shape left by the removed fish's fins, filling the holes left by the fins with lighter fish skins to create a pattern. Despite the many pieces of fish skin used, a careful effort at matching has assured a uniform colour for the garment. There are, however, many places on this robe where small, irregularly shaped pieces of fish skin have been used to fill oddly shaped areas. Where the individual skins meet one another, an overcast stitch is used. On the front opening, a double strip of black dyed quilted cotton cloth has been sewn. There is also a band of black cotton at the cuffs and across the bottom. There are finer or more worked examples of other Ainu fish skin robes, but this this is a very utilitarian piece of workwear, as befits the F4*3D fashion course.

Workshop Content

The structured framework for the study of this coat was provided by the F4*3D Fashion course at Shenkar University. The course is inspired by the quotation from 19th century architect Louis Sullivan: "Form Follows Function", in this case "Fashion Form Follows Function" (Sullivan, 1988). This course, unique in the university's syllabus, eschews fashion to focus exclusively on workwear. Since workwear is designed for functionality and performance rather than aesthetics, it can be construed almost as anti-fashion. Perhaps it is more 'antidote', rather than just 'anti'. Utilitarian, functional and robust, workwear is designed and constructed to withstand and endure. There is no planned obsolescence here. Innocent of fashionable elements, it is outside fashion, and so can outlast it. Having no need for excessive volume, frills or ornamentation, workwear is made more economically, more ecologically than fashion wear. Its form, stemming from its function, is equally more essential, less frivolous – not to beautify or denote status, but to aid the worker in his operation, or protect him from its dangers. In this age of climate crisis, of apparel ambivalence, of fast fashion, of an outmoded, unsustainable six season year, the essentially fundamental, functional simplicity of workwear speaks powerfully.

The Fashion F4*3D course has been taught in Shenkar's fashion design department for seven years, by fashion designer Orit Freilich, industrial designer Ran Kasses, and technician specializing in pattern cutting and sewing, Debbie Elhayeni. The course provides a broad vision, combining industrial and

conceptual design methodologies, bringing an industrial perspective to a fashion study of technical apparel.

Workshop programme

The workshop was 3 months long and included different activities:

- Sustainability background Introduction
- Cultural appropriation
- Historical fish skin artefacts in international museums
- Shamanistic aspects of fish skin
- Sketchbook development.
- Power Point Presentation including sketches, fabric samples, paper-patterns, toile, and 30 digital multi-deconstructed collages and photographs.
- Pattern cutting of a historical fish skin robe replica
- Fish skin Digital Printing

In the workshop, the students choose an item they have researched that represents a working garment dating back to the 19th century. From this original they make an exact replica. The replica is made based on the original patterns as gleaned from a study of the object itself in the Rose Archive at Shenkar or taken from images in books and the internet. The process of making the replica is relatively short: 3-4 weeks. The students develop a design process considering a combination of both conceptual and practical methods.


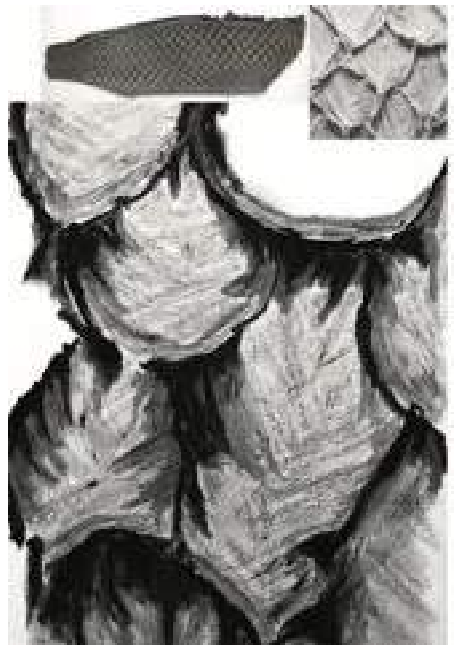

Fig. 6 and 7. Hand drawings of Ainu fish skin robe and fish skin scale details by Ran Graber.

Producing an exact replica of a specific item of a utility clothing worn by a craftsman/professional, the students examine how its design-derives from its function. The research is done through visual mapping. They first collect images of the craftsman/worker wearing his or her designated garment and examine-the purposes for which the clothing has been evolved. Does it protect or facilitate? What are the materials from which it is made and what the variety of elements that allow it to fulfil its intended functions?

Usually, the students isolate a clear photograph of the chosen garment (figure 4) and transcribe its negative form with white chalk on black paper (Figure 5). The critical deciphering process begins as dimensions are plotted from hand drawn studies of photographs of the original garment (figures 6 and 7), from which a paper pattern is developed, then worked, draped and adjusted on the mannequin. This is used to create a toile, (figure 11) and then finally, the replica itself. In the final review, they present their replica and the study, detailing the specific form and function of the garment, its component materials and its continued use, modification, or abandonment in the present day. They also analyze the difference between their replica and the original.

Fig. 8 and 9."Toolbar" developed by Orit working with collages. Collages by Ran Graber.

This case study follows Ran Graber's remaking of the Ainu fish skin coat. Taking place during stringent covid lockdown, geographical distance was critical but irrelevant. Neither he, nor his tutors could travel to college, but they could unite through zoom, virtually, at a moment's notice, whether in Tel Aviv or London. Adversity promoted resourcefulness and limitations became advantages. Without

external distractions, Ran's work with his tutors was intensely focused. He received a unique "toolbar" that Orit had developed for practicing his design skills by working with collage (Figure 8 and 9) and establishing all kind of textures "that mimic" the original replica (Figure 7) besides bringing some fabrics in order to expand as much as possible the student's range of craftsmanship and his creativity in order to offer an outfit inspired by the Ainu replica he made with his own hands.

During the creation of the workshop content, the tutors' concerns were as much pastoral as academic. It was vital not only to impart knowledge to Ran - all the information of the Ainu coat came from the photographs Elisa had taken when she visited several museums in the Hokkaido Island of Japan - but to keep him inspired and connected during a period when students were suffering from the lack of classroom interaction that afflicts remote learning. This online platform provided excitement, connection, a new fish skin craft expertise and the opportunity to engage with remote Ainu knowledge, as well as with museum artefacts, bringing an awareness of ancient traditions to modern industrial concerns.

Both Central St Martins and Shenkar maintain an approach to fashion education based on the development of manual skills of drawing and illustration, paper patternmaking, sewing, fabric manipulation, draping fabric on mannequins, silk-screen printing, and hand-dyeing. The student, confined at home with limited materials and technologies, was prompted to reconsider, recuperate, and upcycle, and so to reflect on overconsumption, waste and the scarcity that follows. The practical prompted the philosophical. Using materials available from home created a reciprocity between craftsmanship and innovation, producing by hand new materials (Mallon, 2020).

Just as the tutors' concerns were as much pastoral as academic, so too this F4*3D course is designed not only to reproduce, but to prompt analysis and understanding of intangible concepts – sustainability and cultural appropriation.

The workshop was part of the EU Horizon 2020 funded project FishSkin, 'Developing fish leather as a sustainable alternative within the fashion industry'. The project proposed the sustainable development of fish skin as an innovative raw material for the fashion industry to encourage more sustainable fashion practices.

The main project objectives were:

−Helping Higher Education students engage in sustainability by developing fish skin inspired shapes and material samples as an environmentally responsible alternative material for fashion.

−Bringing together sustainable methods from fashion design and traditional crafts to foster the international exchange of knowledge.

−Identifying tools about best practice in fish skin craft and testing the ideas at fashion higher education institutions internationally.

-Preserving and disseminating the Ainu cultural heritage connected with fish skin.

This project described the methods of sustainable material engagement and the full immersive experience through an online teaching approach. The paper analysed its findings in order to recommend transferable skills for educational models, for this project to be further disseminated.

Sustainability: a background Introduction

The student was briefed with in an introductory session providing inspiration, basic information regarding ethics and sustainability of fish skin. An important objective was to place this project in the frame of alternative sustainable materials. In order to adhere to this strategy, a comparative study of different leathers and fish leather was made. Comparing fish leather with other sustainable materials highlighted aspects of the climate crisis, the loss of biodiversity, and the depletion of finite resources. Contemporary issues around animal rights and the possibility of replacing exotic leathers from endangered species with fish leather were also raised and discussed. Fish leather as a food waste by-product and its high market value was equally mentioned. Fish leather's environmental, aesthetic, technical and social characteristics were shared and compared with vegan, exotic (crocodile/snake) and faux leathers as alternatives. Suggestions for further reading and research were given to the student.

Fish skin and Education for Sustainable Development

This workshop took inspiration from sustainability education in fashion, emerging from ecological and participatory research at the Centre for Sustainable Fashion, London College of Fashion. It followed CSF's six pedagogic principles for sustainability education through practice (Fletcher, 2013). These are futures thinking, critical and creative thinking, participation and participatory learning, systemic thinking, interdisciplinarity, and place-based learning. The workshop followed academic scholarship by Fashion sustainable researchers Dilys Williams and Kate Fletcher (2010, 2013) on how to embody sustainability content in fashion Higher Education practices drawing connections between people and nature. The study drew on their approach to a fashion education that is oriented towards creative participation in social, and environmental aspects.

Cultural appropriation

Issues of cultural appropriation were carefully considered and discussed during the workshop. The intention was to preserve and disseminate the Ainu cultural heritage connected with fish skin, but in so doing, it was essential to try to avoid any form of cultural appropriation. This refers to the taking of someone else's culture— their intellectual property, artefacts, art form, style —without their permission. It is a fraught issue. The term culture has the potential to embrace an infinity of aspects - dance, dress, music, language, folklore, cuisine, traditional medicine, religious symbols – that are increasingly intangible**.** What is culture? And who decides who is entitled to give permission for its appropriation? If a member of a relatively privileged group writes a story about a member of a marginalized group, this may be an act of cultural appropriation and therefore could do harm. A wide variety of acts and practices are condemned as cultural appropriation (Scafidi, 2005).

Fashion has been criticized for constantly taking inspiration from Indigenous communities, from materials to designs. Fish skin knowledge sharing does have the potential to be seen as detrimental to Indigenous communities since it is their own traditional knowledge passed down by many generations,-which they feel possessive about.

There are always concerns around cultural appropriation; this process was no exception. The researcher Elisa Palomino mitigated these by openly discussing the use of fish skin with the student in a respectful manner. She had used Shaginoff's methodologies of Land Acknowledgment (Shaginoff, 2021) publicly recognizing the Ainu Indigenous peoples whose traditional fish skin craft was studied. In her guidance of the student, she covered: -recognizing the Ainu Indigenous Peoples, consulting with Indigenous-led organizations, educating oneself on the Indigenous histories, their resilience and the current work Indigenous Peoples are doing for their tribal communities.

The workshops and the research behind them attempted to pass on the fish skin craft from Arctic Indigenous communities, preserving and protecting them. The workshops have been envisioned as the beginning of a continuing and expanding discourse on the future of fish skin craft. Collaboration of the researcher with Indigenous partners has enormously enriched the understanding of this material. The experiences gained continue to guide and inform the methods and attitudes she uses and will continue to use working generally and with Native communities.

Fashion can be(come) a space of empathy, a vehicle for connection. Great artists maintain the quality of their awareness of others, the responsiveness to other people, what it is like to live in other people's realities. We need to acknowledge how connected we are to one another and to hold the vision of a shared humanity (Morton, 2020). Indeed, fear of cultural appropriation could lead to division, isolationism, xenophobia and even racism. We need to learn from each other, to share knowledge and resources. The climate crisis, from which we will all suffer, was not caused by the actions of the Indigenous communities but by the non-marginalized societies. Moreover, it is precisely these Indigenous communities that are the first to suffer the impacts of the climate crisis that they did not cause. These communities have a knowledge and respect for the environment that we have lost, thereby risking the loss of the environment itself. We need to learn from them, and we need to start now.

This fish skin craft is only one of many examples of an Indigenous model providing an environmentally sustainable alternative to current practice. The move towards sustainability in fashion practice, via dissemination of such knowledge, without cultural appropriation, is a primary concern of this case study of Ran's project.

We learned from Ran as he learned from us, from himself and from the Ainu. This project was never a simple xeroxing of the original workwear – but the current global situation bought unforeseen consequences.

Pattern cutting of a historical fish skin robe replica

Debby, the pattern cutting tutor, had to teach Ran how to develop the pattern of the Ainu robe online. Ran did not have paper to create his patterns or a dummy to try it on, nor, in the covid lockdown, was he able to obtain them. He had to think frugally, to maximize the resources available to him. He sat down with the photographs of the Ainu robe to make the pattern by himself at home. Without pattern cutting paper, he used leftovers from photocopies or newspaper taped together to create a huge bit of paper, from which to cut the patterns. He took pictures of the pattern on the floor and shared them with Debby online. The Ainu pattern is a relatively easy one, so it was not a particularly complicated task. With calico leftovers from previous projects, he created the Ainu toile (figure 11). Without a mannequin, he fitted the toile on his own body. He handpainted fish skin texture on each calico pattern piece mimicking the scales of the salmon (figure 10). He turned adversity into advantage, and overcame want with an abundance of creative, freethinking frugality - like the Ainu peoples, whose coat he was studying.

Fig. 10 Hand painting of the fish skin texture on each calico pattern piece. Fig. 11. Ainu fish skin toile and pattern pieces by Ran Graber

He also bought to the project and garment an unexpected spirituality, customary for the Ainu, unprecedented in Tel Aviv.

Shamanistic aspects of fish skin: the kamui

The Ainu of Sakhalin Island and northern Hokkaido are spiritually connected with the multiform spiritual entities that surround them, whom they call kamui (spirits). As many hunter-gatherers and north-eastern Siberians, their religion revered god-spirits, who would visit the Earth in the forms of flora, fauna, and forces of nature (Geoffroy, 2018). Shamans were among the most important people in the Ainu populations, as intercessors with the god spirits. The Ainu Indigenous Peoples embroidered and applied design motifs on traditional fish skin garments to grant the wearer protection against evil spirits. On early Ainu salmon-skin attush (Ainu robe) garments (Figure 3), women embroidered design motifs placed on the borders of all the openings of the traditional tunics (collar, arms, legs, front fastening, and hem) and all the edges to prevent evil spirits from entering the body openings. The motifs had structured symbolic references - the upper borders represented the Upper World and the motifs placed there offered protection in that direction, the hem represented the underworld or underwater world; and the central parts represented the world inhabited by humans (Krutak, 2012). These clothes offered as much spiritual as practical protection - and the Ainu saw no distinction between the two.

The original idea of the fish skin workshop had been to make a replica of a historical item of workwear that enabled the wearer to function and/or protected him whilst so doing. In choosing to reproduce a 19th century Ainu hunter coat of fish skin (Figure 4), Ran was prompted to reflect on the practical usage of the coat, how to transform it into protective gear. During the Covid lockdown, the student's mother was working as a nurse in a local hospital treating Covid patients, in the frontline and at high risk. She was afraid of getting infected with the disease and transmitting it at home. And Ran was scared for her. He shared with us tutors, his anxiety about his mother's health.

Elisa told him about Ainu shamans and the spiritual roles of fish skin robes. Ran decided to include spiritual aspects into the coat he was making to create a powerful fish skin robe like the ones worn by shamans in the past, with protective properties - in this case against Covid. The student used one of his mother's health care personal protective equipment gowns (Figures 12 and 13) as a base onto which he applied the traditional Ainu fish skin shapes. This bought him to question what makes people feel safe, and how his mother felt wearing this gift from him. Ran was able to bring spiritual aspects of the Ainu and past shamanic traditions into contemporary context. His isolation in lockdown acted like a shamanic initiation into fish skin craft.

Fig. 12 and 13. Health care personal protective equipment gown with Ainu fish skin shapes drawn into it by Ran Graber.

During the Covid lockdown, students did not have the required materials and teachers were not there to help them physically. When you have limited resources, you need to find alternatives and become very resourceful. Likewise, Ainu Indigenous Peoples lived in Sub Arctic regions thriving in subsistence economies where resources were precious, and they used fish skins in a resourceful and efficient manner. This was also an ethical position made out of respect to the animal (Palomino, 2020). Once the lockdown restrictions were finished, the student returned to the classroom at Shenkar. His project had been very focused when he was at home but when he came out of lockdown, he lost a lot of focus and interest in the project. This is symptomatic of humankind. When you have more resources, you stop being so careful with them. We knew this already, but the case study taught us to recognise it once more.

Fish skin Digital Printing

Once the Covid lockdown eased, Ran was advised by Orit Freilich to make a decision whether to use real fish skins for the final garment that he was developing. Orit made the link between the student and the Icelandic tannery Nordic Fish Leather for the purchase of the fish skins. Afterwards Orit made a liaison between the student and the company Kornit digital printers (an Israeli company who are part of the EU Horizon 2020 project, Fishskin) to print his designs on fish skins from Nordic Fish Leather (Figures 14 and 15). Printing the fish leather goes against the utilitarian principles of the F4*3D course but it brings it into a new arena and makes it part of the modern world.

Kornit is a textile digital printing company which offers end-to-end solutions for industrial

business. Kornit lines of high speed DTG (direct to garment) and DTF (direct to fabric) printers are based on proprietary digital technology which involves inkjet wet-on-wet method. During printing process, aqueous ink drops undergo fixation on the fly which avoids absorption of the ink through the garment. Fish leather had very good absorption. Then the printed item is exposed to a curing and drying process which is carried out at 110 degrees for 12 minutes. Of note, mentioned temperature is problematic for fish skin as, due to its collagen content, high temperatures damage the skin and promote shrinkage. With this goal in mind, Kornit team optimised the curing process and reduced curing temperature to 90 degrees which allows post process without further shrinkage.

In addition, recently Kornit launched QFIX technology which maximizes new possibilities and allows printing on non-absorbed skins. The fish skins (figure 14) were printed for free as part of the EU Horizon 2020 funded project FishSkin, ‘Developing fish leather as a sustainable alternative within the fashion industry’.

Fig. 14. Digitally printed Fish skin using Kornit’s FOF technology   Fig. 15 Salmon print by Ran Graber.

Conclusions

The increase of communication and availability of different individuals across the planet during the Covid lockdown has provided the participants with a closer relationship to each other and with nature. The crisis has brought about a shift in the perception of nature and the role of humankind within it, as keeper, rather than despoiler. Ainu Indigenous Peoples have much to teach us in this respect, and now is surely a time for them to be heard, and for us to listen. Traditional Indigenous knowledge and resilience stems from paying attention and being a part of your environment, experiencing and learning from it collectively (Clement 2020).

To navigate perilous times, ancient shamans drew inspiration from nature, harmonising the fire, water, earth, and air elements. The Ainu fish skin workshop has offered the student and tutors a way to help us through these challenging times of disorientation, distress, and challenge, strengthening our connection with nature, and with matters reaching even beyond the realm of science.

The Ainu fish skin workshop challenged and merged the digital and crafts environment during the pandemic. Younger generations from any background must be equipped both with traditional skills to thrive culturally and with digitalization skills needed for success in the modern world (Chaussonnet 1995). The digital needs to accompany the analogue, the two working together, rather than in competition.

The workshop has proposed taking the best both worlds have to offer. In this digital age, it can make new and sustainable connections between the virtual world and traditional craft. It can bring a spiritual understanding to the practical. It has allowed the student and tutors from different backgrounds and nationalities to come closer despite physical distance and pandemic lockdown, forging life-enhancing connections in a time of isolation. This online fish skin workshop created a new form of communication and learning when classrooms, museums and libraries were closed.

It sought to inspire Academia involved in the development of sustainability and craftsmanship within their curricula. We hope that this transformative teaching and learning experience may be absorbed and repeated in other practices, which in turn may contribute to public debate on sustainability issues in the fashion industry (Fletcher & Williams, 2010).

Development of sustainability within the curriculum has been identified as a high priority (Reid 2011). The hope is that the observations gathered through the workshop will help us understand how to embody craftsmanship and sustainability content in fashion Higher Education practices.

Through the workshop, the student built on the knowledge, skills, and traditions of Fish skin technology, engaged in learning activities based on traditional ways of knowing and learning, demonstrated awareness and appreciation of natural resources, and-began to understand how humans and nature interact.

Future Work

Now that this project is over, we can consider its longer-term aim and potential legacy. The findings could be delivered in the shape of design workshops for Higher Education students, aligning universities with the United Nations, in actively supporting principles of sustainability. The project could be implemented through a programme of workshops for Fashion Higher Education students in those areas where fish skin leather originated (Scandinavia, Alaska, Hokkaido Island, Japan, and Siberia). Craftspeople from ethnic minorities could pass down the endangered fish skin craft techniques and would benefit from preservation of their craft. Students will benefit from education in craft and sustainability – the world, and us with it, will benefit from any and every increase in sustainability.

Thanks to this project, the author Elisa Palomino has advanced knowledge on fish skin craft and has been able to deliver four more workshops developing methods of tanning fish skin in areas where traditionally fish skin was developed:

- Nordic fish skin workshop, Blondous, Iceland. This was a Workshop in collaboration with the fish leather tannery Atlantic Leather at the Icelandic Textile Centre with the participation of students from top Nordic Universities: Iceland University of the Arts, Royal Danish Academy of Arts, Boras University, Sweden; Aalto University, Finland and Central Saint Martins College of Art, UK and fish skin craftsperson Lotta Rahme. Funded by the Nordic Culture Fund and the Society of Dyers and Colourists.
- Nibutani Ainu culture museum, Hokkaido, Japan. Workshop on Ainu Fish leather craftsmanship with students from Japanese universities: Bunka Gakuen, Osaka Bunka, Kyoto Seika University, and fish skin craftsperson Shigerhiro Takano. Funded by FRPAC. Foundation for Research and Promotion of Ainu Culture, the Japan Foundation Endowment Committee and The Great Britain Sasakawa Foundation.
- Hezhe fish skin workshop, Workshop on Hezhe Fish leather craftsmanship with Chinese students from UAL and with Indigenous crafts people Wen Feng You and Sun Yin. Funded by IAIA, the Jiejinkou Hezhe Village ethnic museum, the Hezhe ethnic minority craftspeople.
- Alutiiq Fishskin tanning workshop. Online workshop on Alutiiq Fish leather craftsmanship with Indigenous craftsperson June Pardue as a response to Covid 19.

Elisa Palomino In her role as BA Fashion Print lecturer at Central Saint Martins has shared the sum of this knowledge with her students and learned again from them in the process.

They, in their turn, have been keen to disseminate this knowledge further amongst their friends and classmates and - as they become professionals - within the fashion industry. It has been a truly global project. She has created a series of fish skin craft workshops, in situ, bringing fashion students from Nordic, Chinese, Japanese, and American backgrounds to the specific Indigenous communities with historical evidence of fish skin production to learn from them and from each other. When the Covid pandemic rendered travel impossible, she made these workshops virtual. One such, is this case study.

Acknowledgements

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Paper 9: Making fish skin pattern-based garments

Palomino, E., Karmon, A., Topaz, O., Solo, A. and Cordoba, A. (2021b) 'Making fish skin pattern-based garments: developing digital tools for the fashion industry based on Ainu Indigenous tradition'. Responsible Fashion Series - Breaking the Mould. University of Antwerp.

Responsible Fashion Series - Breaking the Mould

University of Antwerp October 2021

Making fish skin pattern-based garments: developing digital tools for the fashion industry based on Ainu fish skin robes and Japanese Kimono Patterns

Elisa Palomino
Fashion Designer with 25 years-experience designing for fashion luxury (John Galliano, Christian Dior) and her own brand. Fashion Print lecturer at Central Saint Martins. Fulbright scholar and Anthropology Associate Researcher at the Smithsonian Institution, studying Arctic Indigenous fishskin. UAL principal investigator EU Horizon 2020: FISHSkin.
Central Saint Martins, University of the Arts, London, UK
e.palomino@csm.arts.ac.uk
+44 7404 430210
ORCID: **0000-0002-4496-3701**

Anna Solo
Technology coordinator and senior lecturer in the Fashion Design Department at Shenkar. She has 32 years of professional experience in fashion industry. BA in Fashion Design from Shenkar College and an MA in Apparel Technology from Saint Petersburg university of Technology and Design.
Department of fashion Design, Shenkar – Engineering. Design. Art. Ramat Gan, Israel
anasolo@shenkar.ac.il
+972 52 877 8005

Ayelet Karmon
Is an architect and senior lecturer in the Faculty of Design at Shenkar. She is one of the founders of CIRTex, the David & Barbara Blumenthal Israel Center for Innovation and Research in Textiles, where she serves as coordinator of the FISHSkin RISE H2020 project. She is a doctoral student in the Department of Civil and Environmental Engineering, Ben-Gurion University.
CIRTex, The Israel Center for Innovation and Research in Textiles
Shenkar – Engineering. Design. Art. Ramat Gan, Israel
karmon@shenkar.ac.il
+972 54 460 5719

Ori Topaz
Is a designer specializing in leather craftwork. Received her M.Des with honours in Interdisciplinary Design from Shenkar College. Currently works as a researcher at CIRTex, the Israeli Center for Innovation and Research in Textiles, and as Interdisciplinary Design lecturer at Shenkar Collage. Personal research focuses on innovation between craft and technology and circular economy in textiles and leather. oritopaz.com
CIRTex, The Israel Center for Innovation and Research in Textiles
Shenkar – Engineering. Design. Art. Ramat Gan, Israel
ori@shenkar.ac.il
+972 52 2735213

Ana Cordoba Crespo
Is a 22-year-old fashion student at Central Saint Martins. Her main focus is 'innovation' within the fashion industry through the use of technology. Her ultimate goal is to make fashion more inclusive, where coding reinforces the thread.
Central Saint Martins, University of the Arts, London, UK
a.cordobacrespo0320191@arts.ac.uk
+34 608 958 005

Abstract

Before the invention of synthetic fibres, people dressed in natural materials available in their environment such as skins and hides from local wildlife. The use of fish skin to create articles of clothing is an ancient tradition shared by Arctic societies along rivers and coasts, amongst them the Ainu Indigenous Peoples of Hokkaido Island (Japan). In this research we propose to use fish skin, a waste product of the food industry, as raw material for the fashion industry under the principles of zero waste. Throughout this project we recreated an Ainu fish skin robe, using digital tools and the material itself, as a means for gaining knowledge and experimenting with the use of fish skin for garment construction. The idea behind the project draws on the Ainu Indigenous Peoples' subsistence resourcefulness and their heritage, with regards to traditional fish skin craft practices. The project thus connects between anthropology, ethnography, and craftsmanship with current interest in fashion sustainability, advanced digital technologies, and contemporary production processes in fashion.
The Ainu garment is part of a study that hypothesises what would have happened if, during the Meji era, the Japanese, instead of making the Ainu shift from fishing to farming, had brought their own traditions, such as Katazome indigo dyeing, and blended them with the Ainu tradition of creating clothing from fish skin. The projects presented in this paper include a combination of different digital technologies and applications which were used to create a contemporary replica of an Ainu fish skin robe using a Japanese katazome indigo pattern. Firstly, we used the shape of an Ainu robe to create a fish skin module as a building block, and tested its relevancy for contemporary pattern making, and later introduced parametric design tools to test zero waste principals. We then used digital animation software to create an Ainu avatar and to recreate the fish skin garment situated in a virtual digital context. Finally following the digitally created garment, we have physically dyed in indigo the fish skins with Katazome stencils and lastly sewed a replica of the fish skin robe.

The project aims to preserve traditional Ainu fish skin knowledge and introduce new advanced digital technology to enable the design and production of zero-waste fish skins for fashion.

Keywords: Ainu Indigenous Peoples; Fish Skin Craft; Traditional Knowledge; Katazome Indigo Dyeing; Digital Pattern Cutting; Module Based Design; Zero Waste.

Ainu Indigenous Peoples of Hokkaido Island, Japan

The word Ainu means "human being" in the Ainu language. Long before the Ainu were incorporated within any nation state, their land, which they called Ainu Moshir ("the Land of Men") originally encompassed the North Pacific islands (Hokkaidô, Sakhalin and Kuril Islands) Southern Kamchatka and the Amur River estuary region (Godefroy, 2011). According to archaeological findings, the Ainu (Figure 2) have lived for three thousand years (Takasami, 1998) mainly along Hokkaido's warmer southern coast and they traded with the Japanese. From the first millennium AD, under the pressure of the newcomers from the south, the Ainu have been pushed increasingly northwards, and it is presumably for this reason that some of them settled on Sakhalin, on the Kuril Islands and on the southern tip of Kamchatka (Cevoli, 2015).

The nomadic Ainu economy is based on hunting animals and fishing for salmon in their local rivers (Cevoli, 2015). Despite the importance of salmon to the Ainu, during the colonisation of Hokkaido, the Japanese government banned their salmon fishing in the 1870s, as part of the Meiji regime's enforced assimilation policies (Ichikawa, 2003). Ainu were forced to shift from hunting and fishing to agriculture and they were discouraged from using their native Ainu language along with nearly all aspects of indigenous culture. Forced into agriculture, they could no longer fish for salmon in their rivers.

The Ainu Fish Skin Robe

The Attush is a traditional Ainu costume, made from the soft inner fibres of elm bark, and was worn by both genders. In the nineteenth century, the Ainu gradually replaced elm bark fibre by more convenient cotton, often using old Japanese kimonos like the one on the picture (Figure 1). Cotton, a wondrous and luxury item was traded from the Japanese and used by the Ainu to create appliqué robes to which they added dark strips around the neck, front opening, sleeves, and hem (Figure 1). This kind of attire only began to appear during the Meiji era (1868-1912) because it was only at around that time that cotton fabrics became available at a reasonable cost to many Ainu people (Hays, 2009).

Figure 1 Ainu robe with Indigo Katazome dyed cotton from an old Japanese kimono. Smithsonian National Museum of Natural History. Washington DC

Figure 2 Old Ainu Man from the series Fashions of Ainu in Hokkaido. Leonard A. Lauder Collection of Japanese Postcards

Cultural and resource borrowing has long been a response to changing climates and ecosystems amongst Indigenous Peoples (Lewallen, 2016). Ainu Indigenous Peoples have always maintained flexible relations with their neighbours and Ainu women used new materials sometimes borrowed from neighbour countries such as sealskins and cotton fabrics while following Ainu aesthetics and cultural codes to produce their robes.

Besides using the fibers of elm bark, Ainu people also made clothing from furs, bird skins, and salmon skin (Figure 3). Fifty or more salmons could be used to make a single fish skin coat (Batchelor, 1892). In the homes of these hunters and gatherers, these raw materials were transformed by a sort of textile alchemy into gold (Watson, 2019). Ainu artefacts made of salmon skin were highly prized for making strong, light, durable robes and shoes. Sakhalin Ainu decorated fish skin garments with delicate appliqué, as did their neighbours in the lower Amur River region (Fitzhugh, 1999).

Figure 3 Ainu fish skin robe 19th century Kushiro city Museum. Hokkaido, Japan

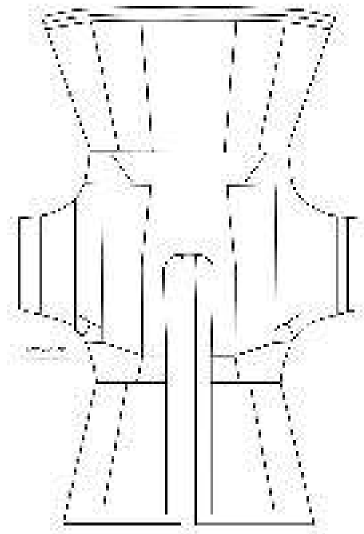

Figure 4 Ainu fish skin robe pattern

The work presented in this paper includes the reproduction of an Ainu fish skin robe in a digital context. The aim was studying closely the construction logic of the robe, its aesthetical value and appearance, and its relevancy for contemporary fashion. The digital environment allows us to animate the historical robe in a new context, maintain historical accuracy, while enabling material, geometrical and print manipulation.

The robe reproduced in this project, is an Ainu man's fish skin robe from Sapporo University Museum in Hokkaido, Japan (Figure 3). This coat has wide kimono-like sleeves and reaches to the knees. It is constructed of rectangular rows of nearly whole salmon skins. Despite the many pieces of fish skin used, a careful effort at matching has assured a uniform colour for the garment.

Resourcefulness of Ainu Indigenous Peoples

Ainu Indigenous Peoples lived in Sub Arctic regions thriving in subsistence economies where materials were precious, and they used fish skins in a resourceful and efficient manner. This was also an ethical position made out of respect to the animal (Palomino, 2020). Subsistence living in a harsh climate requires that nothing is wasted – because waste could be a matter of life and death. Throughout the centuries, fish were the main bounty of the Ainu land. The Ainu placed primary importance on fish as a food resource. Depending on location and local climate, the Ainu employed a number of locally available natural resources in providing their everyday clothing (Williams, 2017). This delicate balance was at a peril with the growing dependency of the Ainu people towards Japanese commercial goods, and the growing intrusion of the Ainu territory by merchants and hunters during the second half of the Edo period (Godefroy, 2011).

Fish skin clothing is a feast of high fashion, combining economy and harmony of materials and textures. Ainu seamstresses prepare and assemble skins of different species, with ancestral know-how. Ainu fish skin robes (Figure 3 Ainu fish skin robe 19th century Kushiro city Museum.

Figure 4 Ainu fish skin robe pattern) were constructed according to the fish skin shape and each skin fitted to the next like a puzzle without leaving any leftovers (Palomino, 2021). The pattern was made according to the skins length and shape and not by cutting a pattern out of a flat continuous sheet like in current fashion industry. Each garment was made from the remains of several weeks of fishing; processing and sorting of skins of an entire family or tribe. These ancestral artisans were unwittingly enacting contemporary concepts of zero waste that are nowadays getting the fashion's world attention and respect. When it comes to working with waste materials, the importance of implementing zero waste is extremely important.

According to Dorothy Burnham (Burnham, 1973) going back to prehistoric time, various factors affected pattern cutting—the body, climate, geographic terrain, social status—they were all important, but the material from which a garment is made is the factor that has the most influence on the particular shaping of it. Garments made of animal skins are based on the shape of the animal. The first garments worn by humans were skins draped over the body. Ainu fish skin robes were made in a more complex fashion, where multiple fish skins were joined together and shaped to the body. Tanning a fish skin was so labour intensive to create, that every bit that could be used was used. That, and the width of the skin that a salmon provided, put limits on the design that were ingeniously worked around.

Integrating Fish Skins in Contemporary Fashion Using Computational Tools

Today, the consumption of fish for food is growing massively worldwide. Anticipating large quantities of fish skin waste, which could become new raw material for fashion, requires developing and customising existing production tools for fashion, so that they can complement the necessary work process. This task entails two quests: to understand the best way to connect fish skin pieces into continuous sheets, and garments and to understand the production tools of the fashion industry such as patternmaking, cutting, sewing, and printing which would need to accommodate the inclusion of fish skins as a new material for fashion. Integrating the use of fish skin in fashion has the opportunity to create a big impact, as tons of fish waste will be recycled instead of being thrown away. Additionally, a newly found implementation for fish skins, which is currently considered a waste product, has the potential to create a new market and incur economic benefits. The development of processes to transform post-consumer and industrial waste into new materials reduces pressure on excess materials consumed. Recycling waste minimises landfill and keeps resources in use for longer (Palomino, 2020).

Zero waste is defined as a waste prevention and reuse system, it aims to tackle the waste created by humanity. McQuillan (2021) argues that in the fashion industry we currently waste about 35 percent between the raw materials to the finished garment, from the material processing, cutting the garment and constructing it, until it is a finished piece. That does not include water, energy, and chemicals, just the raw material. If we include post-consumer waste that is produced after the garment has been sold, then that amount goes from 35 percent to about 66 percent within one year. In addition, two-thirds of all the raw materials we used to make garments are back in landfill within one year (McQuillan, 2020).

The Fish Skin Module in Contemporary Patterns

Fish skins have a unique trapezoid shape, with two long sides and two short sides (one longer than the other). As each fish has two sides to its body, fish skins usually come in pairs of left and right, which can create a symmetrical repetition between the two sides of the body (Figure 15). The team of designers from Shenkar used the methodology of the Ainu Indigenous Peoples, who used the fish skin module as a recuring building block for constructing their designs. This was a key point in developing the use of the fish skins for contemporary fashion design purposes, using the trapezoidal module to form a continuous semi-circular or rectangular surface, depending on the logic of assembly.

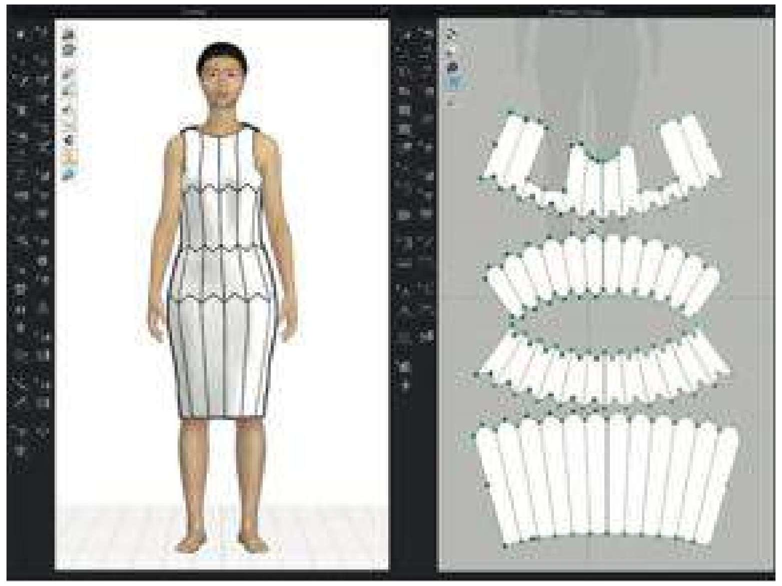

Figure 5 Digital interface of fish skins which ensures zero- waste designs by Ana Solo.

Advanced digital tools, which are used by the contemporary fashion world, enable designers to create endless variations. Companies such as Browzwear, Clo3D (Figure 5) and Optitex (*Browzwear*, 2021; *Clo3D*, 2021; *Optitex*, 2021) created a complete digital workflow, including pattern making, fabric management, pattern (print) design, cutting table and fully rendered 3D simulating tools for the designed garment. This pattern cutting system is fully computerized, digitized and with 3D supported visualization capabilities.

In our research we have focused on two things: looking for aesthetic and compatible ways to connect between the trapezoid shape of the fish skin for contemporary pattern making techniques, and to use the digital tools that are at our disposal for further developing the feasibility of the fish skin as a modern building block in garment design. It was important for us to be inspired by the Ainu traditional pattern making and establishing a connection with current pattern cutting technology as the basis for successful implementation of fish skin into contemporary fashion.

All contemporary pattern-cutting, could be considered as a process of flattening a three-dimensional (3D) volume to enable a system of production. The translation of a desired 3D garment, enveloping a volumetric body, into a 2D pattern that can be cut from a flat material requires the planning of seams, gathers, and darts in order to construct the 3D form. In the digital environment the 3D volume can be automatically 'undone' and flattened to form the various pattern pieces. The simultaneous flattening and its corresponding forming actions are the core of most pattern cutting methodologies (McQuillan, 2020).

In our work process, a number of classic garments were chosen as case studies to show the potential implementation of the fish skin module as part of modern pattern making, with particular focus on: (1) the classic fitted dress, (2) the panel flared skirt, and (3) the godet skirt. Historically, skirts were made of a rectangle fabric which was defined by the width of the hips, with the excess material gathered and tucked at the waistline (Phyllis G. Tortora, 2014). Eventually the gathering was formed by creating darts that narrowed the skirt at the waist. Examining a classic pencil skirt reveals that it has two darts and a curved side seam that is responsible for the reduction in circumference between the waist and hip lines. In the Ainu fish skin robe pattern (Figure 6 Ainu fish skin robe pattern. Kushiro city Museum. Hokkaido, Japan), the narrow parts of the skins face the waistline, and form empty triangular voids in-between. These voids are accurately filled with sewn-in fish skins triangles, which complete the surface into a continuous large flat sheet of connected fish skins.

Figure 6 Ainu fish skin robe pattern. Kushiro city Museum. Hokkaido, Japan

For our new design we used the software Clo3D, to form the skirt with similarly patterned voids, which were left empty and were not filled with additional material. When the triangular voids

were sewn as darts, a three-dimensional volume was created (Figure 7 2D (left) and 3D (right) modeling of triangular voids sewn as darts).

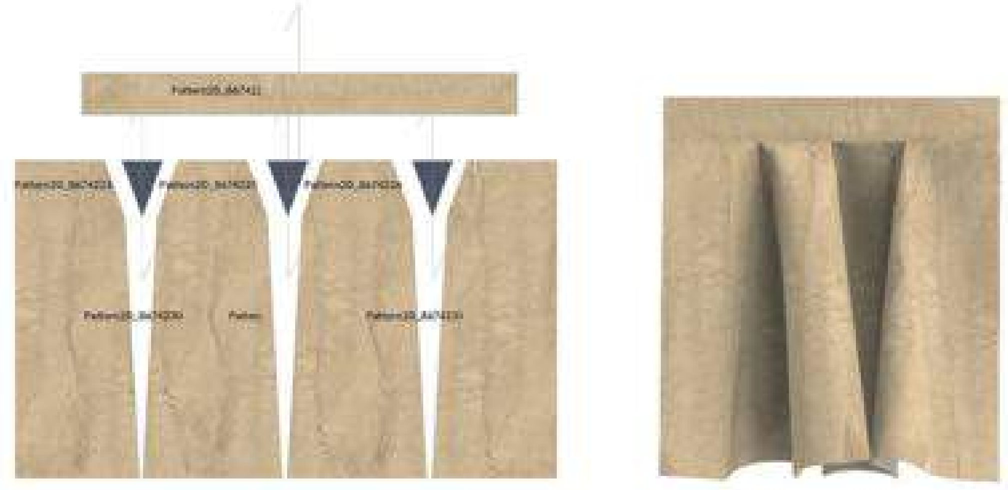

Figure 7 2D (left) and 3D (right) modeling of triangular voids sewn as darts

Skirts that have a flare at the bottom differ from one another by the amount and form of flare created when the skirt is draped around the body. The fish skins in the Ainu garment construction are positioned to create a deliberate flare. The narrow parts of the skins are consistently positioned so that they face the waistline, whereas the wider parts face the bottom. In-between, some skins are deliberately integrated to create additional flare. In addition, flared parts at the upper torso give room for the shoulder and the kimono sleeve. These construction principals are relevant for contemporary garment construction and were used by us to form new designs. The fish skin panel skirt demonstrates the compatibility of fish skins trapezoids to create the flared form of the skirt (Figure 8 Use of software Clo3D, to form a skirt with similarly patterned voids to the Ainu robe.).

Figure 8 Use of software Clo3D, to form a skirt with similarly patterned voids to the Ainu robe.

In a classic fitted dress (Figure 9 A classic fitted dress where the trapezoid panels create multiple vertical lines, enabling to construct the dress according to the lines of the hips, waist and bust) the trapezoid panels create multiple vertical lines, which enable to add and subtract excess material, and construct the form of the dress according to the differentiating lines of the hips, waist and bust.

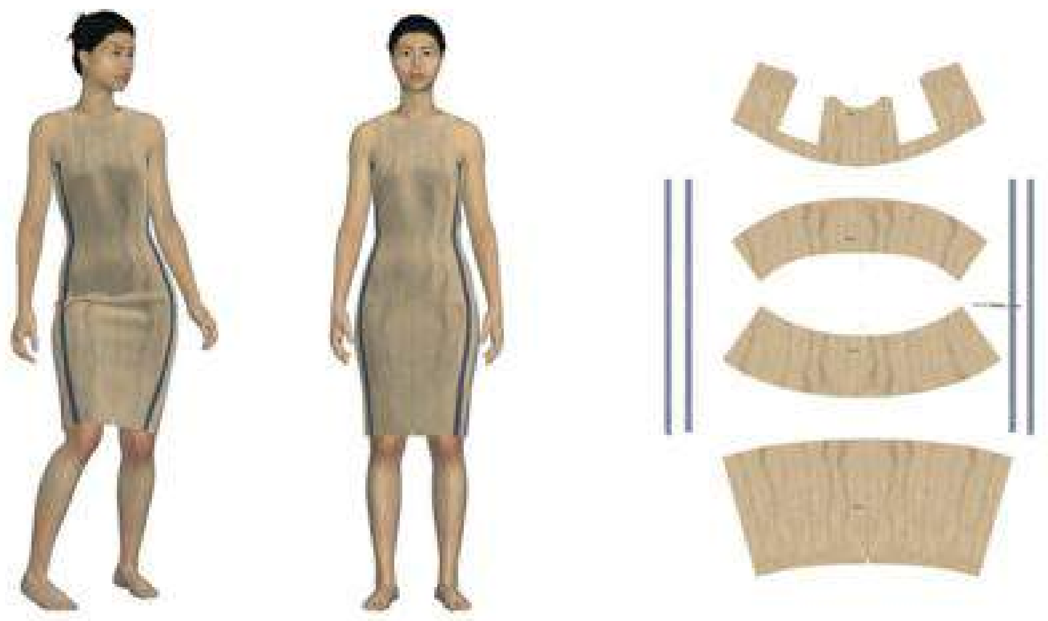

Figure 9 A classic fitted dress where the trapezoid panels create multiple vertical lines, enabling to construct the dress according to the lines of the hips, waist and bust

The direction of fish skins layout has further implications for the drape of the overall surface formed, which stems from the directionality of the skins. When using regular textiles, the length, cross and diagonal grain of fabric have great influence on the behaviour of the textile when the garment is assembled. With leather and skins, the elasticity and thickness of each skin piece is considered when choosing the function and location of the pieces within the garment or product. Fish skins are much thinner than hides but maintain a difference in flexibility between the belly and the backbone sides. Based on these considerations we explore various ways of connecting skins – back-to-back, belly-to-belly or belly-to-back. In addition, we explore adding a middle cutting line to the width of the skin which allows for better tiling of the skins, like in the godet skirt in Figure 10 a godet panel skirt – exploring new possibilities which allows for better tiling of the skins.

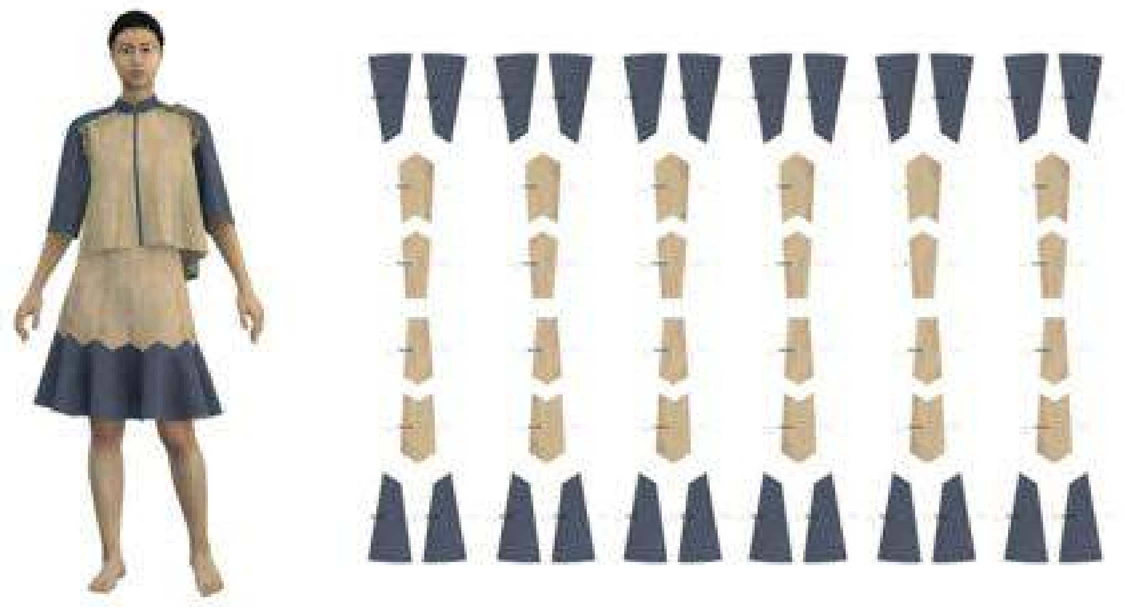

Figure 10 a godet panel skirt – exploring new possibilities which allows for better tiling of the skins

Using Parametric Tools Towards Resourceful Integration of Fish Skins in Fashion

Traditional pattern cutting is dependent on nesting, which refers to the practice of arranging as many irregular shaped pieces of patterns as possible onto a roll of continuous fabric, while occupying the least length, before cutting and assembling the pieces together to form garments (Heistermann & Lengauer, 1995). Nesting is of particular interest to our work, since it is directly related to material use, with accurate nesting leading to reduced amounts of waste and improved material utilisation (Fragapane et al., 2017). Nesting is dependent on the fabric nap, the directionality of the main design. Usually, pattern pieces can be rearranged at 180 degrees, in relation to the fabric boarders, without compromise in appearance. In addition, consistency in directionality has implication on the fabric drape and stretch, which are often uneven across all fabric directions (Baldacci et al., 2014).

According to the literature, an advantage humans have over nesting algorithms stems from experienced nesters intentionally using slight angles in order to achieve better alignment, i.e. fit more pattern pieces onto a fabric area on the expense of adhering to strict directionality. This slight variation is very hard to detect in the final garment and is reported as difficult to compute. In recent years many researchers propose new algorithms to optimize nesting heuristically (Alves et al., 2012; Crispin et al., 2005), yet it is still considered a technological challenge. Traditional leather nesting differs from fabric in that the leather is less susceptible to directionality as it does not have transverse and longitudinal grain stretch differences. Additionally, traditional leather boundaries are irregularly shaped, and leather needs to be scanned for natural blemishes and defects which are identified, evaluated and when substantial are avoided in the fitting process (treated as waste). Advanced leather nesting involves technology such as image scanning, analysis, and processing directly at the cutting table for better optimization of leather use (Jones, 2014).

In fish skins we identify a reversal of the problem – rather than cutting irregular patterns *out* of larger continuous sheets, we have small irregular shapes that need to be joined together to form larger pattern pieces. In line with the values of zero-to-minimum waste we look for: (1) identifying a recurring pattern within the small fish skin area that will be geometrically defined and repeatable, despite natural fish variations. (2) Look for productive and efficient ways to connect the pieces in a way that would result in workable continuous areas suitable for contemporary garment making, both in their aesthetics appearance and physical attributes such as drape and tensile properties. We propose to use parametric design tools (*Grasshopper*, 2021; *Rhino 3D*, 2021) for creating the initial studies for the two problems stated above. The work we present is based on scans of real fish leather pieces, originating from one type of fish examined so far: Salmon skins.

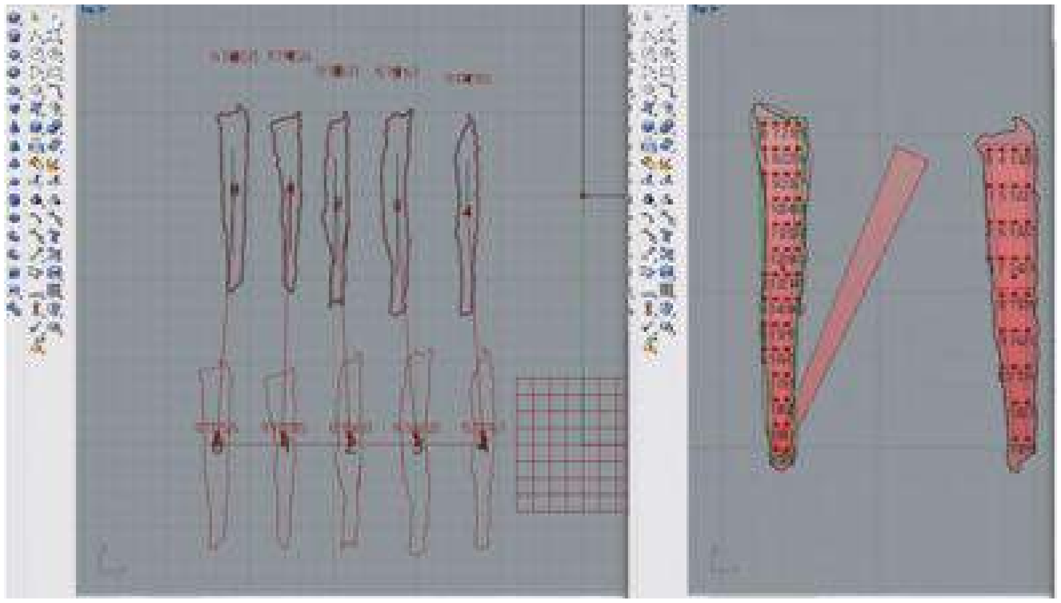

Figure 11 (Left) A code for automatic sorting by geometrical attributes (Right) Simplified trapezoid extracted from a fish skin outline, Rhino 3D Grasshopper

<u>*Fish Skin Trapezoids*</u>

We look at the traditional patterns of the Ainu fish skin robes to identify the trapezoid as a recurring geometry which lends itself particularly useful for garment pattern making. Variations in the trapezoids include different lengths of each face, and varying angles between faces. Although no two trapezoids (as no two skins) are identical, their recurring logic is identifiable. For each scanned irregular skin, we created a sampling grid for which an algorithm identifies viable edges that are within the skin surface. An outline is created, out of which corner points are defined, and a new simplified *trapezoid* outline is formed. Most often, with the skins studied so far, 4 corner points are identified, but depending on the skin geometry instances with more than 4 corner points are possible. The grid scale is parametrically controlled allowing to calibrate the sampling scale (see Figure 11 (Left) A code for automatic sorting by geometrical attributes (Right) Simplified trapezoid extracted from a fish skin outline, Rhino 3D Grasshopper right image).

<u>*Joining Fish Skins*</u>

Prior to joining the newly formed trapezoids we look at various ways to sort the skins. Different

sorting parameters for the skins are central to achieving zero waste. Whereas the Ainu approach to joining different fish skins was based on the symmetry of individual fish, and on carefully considered combinations of different pieces, in contemporary context this will not be possible. We are interested to tap into modern fish aquaculture and industrial food industry production where waste is a critical challenge, and where fish is already sorted by size and weight during cultivation. We propose to leverage computational tools in order to have the flexibility to manage a large-scale inventory of tanned skins. Sorting can easily be executed through calculating for example: total area, longitudinal length, angle variation of a particular face length, etc (see Figure 11 (Left) A code for automatic sorting by geometrical attributes (Right) Simplified trapezoid extracted from a fish skin outline, Rhino 3D Grasshopper left image). We predict that different sorting approaches may be relevant to different applications and allow for parametric control over each sorting method. At the level of the single module, in which one fish skin is joint with another, two approaches were examined parametrically: (1) joining two skins back-to-back creating a fanned surface, and (2) joining belly to back in a flipped manner so that the resulting surface is more rectangle in nature. The work on parametric modelling presented so far in the research shows the potential to use computational technology to leverage the use of fish skins and open up an opportunity for more substantial intake of skins in fashion, so that their use can have a real environmental impact.

Animation Tools for Situating Fish Skin Designs in a Traditional Context

The implementation of computational design tools to facilitate the design of 3D clothing can be done using modern technological tools such as Clo3D in combination with the free software Blender (*Blender*, 2021). The convenient interface of Clo3D facilitates an automated process of constructing a drawing of flat polygonal patterns, which are then assembled into three-dimensional garments. Many companies are now using digital technologies such as Clo3D to plan and form the pattern for their garments without the need for samples or physical models of the items. With the aid of Clo3D software, the communication between the designer, pattern maker and production company has become much more straightforward (McQuillan, 2020).

The example shown here includes the integration of a 3D garment first assembled in Clo3d, then imported into the free software Blender, which was used to animate an Ainu avatar and situate it in a relevant context, which was put into motion as a short video. The goal of situating the avatar dressed in the garment, is aimed at highlighting the cultural and historical context to which the design is referring to. The Central Saint Martin's Fashion Print student Ana Cordoba Crespo was in charge to create the Ainu avatar. She used Blender to develop a personalized figure following the individualities of Ainu men. The Ainu (Figure 2) have always been renowned for their physical appearance (especially their hirsute bodies, beautiful beards and abundant wavy hair), which contrast sharply with the hairless Japanese neighbours (Cevoli, 2015). Ana created an elder Ainu avatar using Bender's multi-resolution digital sculpting. The full 3D pipeline was used from modelling, rigging, animation, simulation, rendering and compositing. Blender can be used to simulate hair and rigid bodies. She created the hair through particles that she supplementary added to the avatar and that she afterwards combed, cut, and made grow in a particular fashion.

Figure 12 Left and center: Fish skin robe created in CLO 3D from a two dimensioned segmented pattern previously illustrated using Adobe. Right: A pair of Katazome indigo dyed fish skins, by Elisa Palomino

She developed the fish skin robe (Figure 12 Left and center: Fish skin robe created in CLO 3D from a two dimensioned segmented pattern previously illustrated using Adobe. Right: A pair of Katazome indigo dyed fish skins, by Elisa Palominofrom a two dimensioned segmented pattern of the piece, which she had previously illustrated using Adobe (*Adobe*, 2021). Blender allows procedural and node-based textures, as well as texture painting like the fish scale pattern. Generating a garment on a screen follows the same process of draping it with the physical fabric, but it elevates the piece to a different dimension, as the possibilities are endless. The boundaries and obstacles of the physical world become meaningless, as one can pin, sew, overlock or screen-print with a mouse click.

Figure 13 Ainu avatar robe created with Blender and CLO3D by Ana Cordoba Crespo

Figure 14 Ainu avatar created with Blender and CLO3D by Ana Cordoba Crespo

The Ainu avatar (Figure 13 Ainu avatar robe created with Blender and CLO3D by Ana Cordoba Crespois situated in a similar context to the traditional painting depicted by Ezotō Kikan, in his work form 1799 (Figure 15 Ainu fishing. Hata, Awagimaru, and Japanese Rare Book Collection. Ezotō Kikan. Japan 1799. Using Blender and Clo 3D the animation of the environment surrounding the avatar was enabled including the physical attributes of the surrounding ocean water, the wind impact on the avatar hair, and the sky above. Once all the elements were modelled, the scene was animated using motion tracking, video editing and 2D animation. https://youtu.be/_egusQhiPVg

Figure 15 Ainu fishing. Hata, Awagimaru, and Japanese Rare Book Collection. Ezotō Kikan. Japan 1799 Library of Congress. Washington DC

Figure 16 Ainu avatar created with Blender and CLO3D by Ana Cordoba Crespo

Katazome **Indigo Fish Skin Robe – the Design of a New Print inspired by Japanese Kimono patterns**

During the Fulbright scholarship of researcher Elisa Palomino at the Smithsonian National Museum of Natural History (NMNH)**,** Arctic Studies Center, she was able to dive on the NMNH collection and access Arctic and Sub Arctic artefacts that have deeply influenced her artistic practice. Among the artefacts at the NMNH, there was a traditional Ainu robe made with a Japanese kimono cotton

Figure 17 Elisa Palomino with Indigo Master Takayuki Ishii at Fujino mountains, Japan.

Figure 18 Takayuki Ishii Indigo vats

fabric created with the *Katazome* indigo dyed technique. This particular robe inspired Elisa to develop a series of *Katazome* indigo dyed fish skin samples (Figure 20) during her following fieldtrip in Japan's Kanagawa Prefecture, with Indigo Master Takayuki Ishii (Figure 17 Elisa Palomino with Indigo Master Figure 18 Takayuki Ishii Indigo vats. These *Katazome* dyed fish skins are part of a study hypothesizing what would have happened if during the Meji era, the Japanese instead of making the Ainu shift from hunting, fishing, and gathering to agriculture had brought their own traditions like *Katazome* indigo dyeing and had blend them with the Ainu tradition of creating clothes and accessories with fish skin.

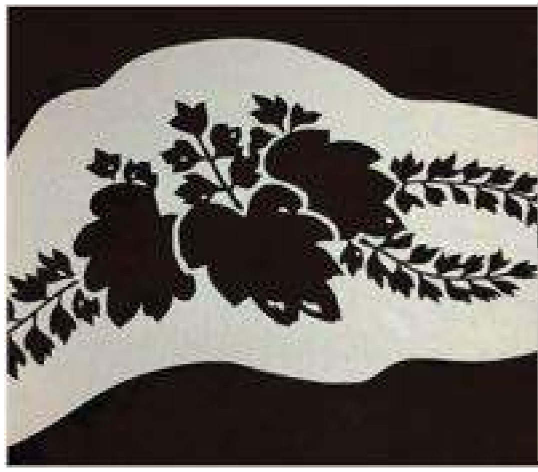

Figure 19 Traditional Katagami stencil

Figure 20 Indigo katazome dyed fish skin by Elisa Palomino

Japanese rural people have been using indigo blue dye "Aizome" for colouring their textiles for centuries. The indigo plant grew wild and was plentiful throughout most areas of the Japanese Islands and its dye was favoured for its ability to hold the deep blue colour in the fabric after many years of use (Austin, 2020). Takayuki Ishii (Figure 17 Elisa Palomino with Indigo Master Figure 18 Takayuki Ishii Indigo vatsis an artisan running an indigo dyeing company using traditional techniques and materials. Takayuki is one of the six left artisans in Japan growing the indigo plants and producing sukumo to preserve the traditional method of indigo dyeing. He passes on his knowledge to many artists and young students and strives to preserve the traditional way of dyeing Japanese fabrics.

Katazome, is a traditional Japanese textile process using a *katagami* or stencil pattern for dying textiles used for printing Kimonos. The technique utilizes a resist paste made from rice flour that is passed through the *katagami* stencil onto fabric before dipping into the indigo vats (Figure 18). The paste resists dyes and once removed after dyeing the patterns and imagery from the stencil are revealed. *Katagam*i paper (Figure 19 Traditional Katagami stencil Figure 20 Indigo katazome dyed fish skin by Elisa Palominois made from several layers of handmade mulberry paper lacquered together with fermented persimmon juice acting as a tannin to waterproof and strengthen the paper.

Figure 21 and 22 Replica of an Ainu fish skin robe made with indigo katazome dyed fish skins

Figure 23 and 24 Replica of an Ainu fish skin robe made with indigo katazome dyed fish skins

The fish skin robe replica (Figures 21 to 24) was sewn by Vanna Bellini, former head of Valentino's

Haute Couture atelier in Rome, a pattern maker and garment technologist with over 50 years' experience working for the ready-to-wear and Haute-Couture collections at Armani, Ferre, Versace and many others. The garment was constructed according to the fish skin shape; every skin fitted with the next and nothing was wasted. The natural appearance of the fish skins served as an inspiration in the sewing process of this fish skin robe. We used the contrast of the white skin of the fish belly against the dark skin of the dorsal area (Figure 24). Specific design references within the body of the garment, like belt and kimono sleeve, were created by contrasting the light and dark areas of the fish skin.

Methodologies of Land Acknowledgment

Issues of cultural appropriation were carefully considered during the research process. The intention was to preserve and disseminate the Ainu cultural heritage connected with fish skin, but in so doing, it was essential to try to avoid any form of cultural appropriation. This refers to the taking of someone else's culture— their intellectual property, artefacts, art form, style —without their permission (Vézina, 2019).

Fashion has been criticized for constantly taking inspiration from Indigenous communities, from materials to designs (Vézina, 2019). Fish skin knowledge sharing does have the potential to be seen as detrimental to Indigenous communities since it is their own traditional knowledge passed down by many generations.

The researcher Elisa Palomino used Shaginoff's methodologies of Land Acknowledgment (Shaginoff, 2021) publicly recognizing the Ainu Indigenous peoples whose traditional fish skin craft was studied. In her research, she covered: recognizing the Ainu Indigenous Peoples, consulting with Indigenous-led organizations and educating oneself on the Indigenous histories.

The researcher openly discussed the paper with Kenji Sekine, Ainu language instructor and curator of the Nibutani Ainu Culture Museum, and Maki Sekine, Ainu artist, instructor of Ainu decorative embroidery at the Nibutani Ainu Culture Museum and daughter of one of the last remaining elm bark weavers on the island of Hokkaido. In 2018 Kenji collaborated with Elisa Palomino to set up a fish skin tanning workshop in Nibutani with local artisan Shigehiro Takano and fashion students from Japanese universities to encourage students to produce fish skin artefacts using traditional skills used by Ainu ancestors, examining design practice within contexts of social innovation for sustainability. Following Kenji's guidance a number of changes were made in the title of the paper, and the naming of Ainu artefacts mentioned, especially when different cultural references are used in conjunction such as Katazome indigo dyeing technique, which is a Japanese technique, and the fish skin robe which is Ainu. The ongoing dialogue and relationship with Kenji Sekine and the Ainu community of Nibutani is a great example of how researchers can connect with local and international institutions that strengthen connections with people, cultures and history worldwide.

Conclusions

This paper explored the use of fish skin for the construction of contemporary garments inspired by ancient tradition shared by many coastal Arctic societies, and specifically by Ainu Indigenous Peoples of Hokkaido Island (Japan).

The global production of fish has been steadily increasing over the last decade and is expected to continue rising, producing a substantial amount of fish skin as waste. There is real urgency to find solutions for the use of fish skins; existing practices which include the disposal of skins in marine waters exposes local ecosystems to environmental risks such as disease outbreaks and oxygen depletion, both caused by the decomposing organic waste. Currently only a small percentage of these skins are processed into leather, whereas looking to the past we realize that tanning fish skins was a thriving ancient tradition, which can provide us with multitude of knowledge and inspiration. Our goal in this work is to show the potential of fish skins as a relevant new material for fashion, which has its roots in ancient tradition yet utilizes the most advanced technological tools available at our disposal. New materials coupled with a digital platform creates exciting opportunities for craft practitioners to forge new ways of working with traditional processes, while still honouring those traditions. The ever-increasing prevalence of technology enables information about traditional craft techniques to become easier to access and learn about.

Ainu Indigenous Peoples produced their fish skin robes with limited tools and materials, often crafting them by the light from an oil lamp. This may not resonate with contemporary fashion today, but the idea of creating the replica of an Ainu fish skin robe with the combination of different digital technologies and applications can appeal to young designers avid for combining traditional craft techniques and digital technologies.

The unique features of the software used throughout this work, were examined in terms of their integrated nature, which was shown to be used creatively in the fashion design process. In parallel to enabling us to closely study the ancient artefacts, digital tools were implemented to showcase the integration of fish skins in contemporary fashion. Initially, as distinct modules assembled to form continuous surfaces uniquely suited for garment construction. We then showed the potential of using parametric tools for material conservation, zero waste integration of fish skins in garments. We next used animation tools for situating fish skin designs in a traditional context to evoke the emotional and aesthetic values that are associated with these garments. Finally, a comparison was made between the digital garment and the analogical one. Experimentation in the fields of fashion design crossing digital tools with analogical activities are key to develop more sustainable fashion practices.

Designers need to implement emerging prototyping/manufacturing technologies. The integration of digital prototyping for product development does not only impact manufacturing processes, but potentially affects all stages of the industry, from design to consumption. Digital technologies do not substitute traditional technical fashion knowledge, they support each other and enable innovation, while traditional knowledge is highly needed. The fashion industry's future lies in implanting these digital technologies models, leading to a greatly improved ecological industry. Integrating technology like digital design systems with traditional craft techniques will improve the fashion cycle and facilitate the new business model. Designers will need to become part of this proposed change, seen as creative drivers for reshaping fashion in this way.

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Paper 10: The Case of Fish Skin

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CHAPTER 9

The Case of Fish Skin

A Historical Material Assimilated as an Innovative Sustainable Material for Fashion

Elisa Palomino and Katrín María Káradóttir

Abstract

The use of fish skin to create articles of clothing is an ancient tradition in Arctic societies located along rivers and coasts, and there is evidence of fish skin leather production in Scandinavia, Alaska, Hokkaido, Japan, Northeast China, and Siberia. This chapter is a study of northern indigenous fish skin heritage and builds connections among anthropology, ethnography, and material culture to address current global issues of fashion sustainability. It critically examines the historical application of the fish-skin craft and investigates the relationship of Arctic indigenous people with fish and the environment, fish skin fashion in the Arctic, the importance of women in fish skin art, the disappearance of the craft. Another topic is how the use of fish skin by aboriginal Arctic people has recently been assimilated as an innovative sustainable material for fashion because of its low environmental impact. Fish skins are sourced from the food industry, using waste, applying the principle of circular economy. The case study of the fashion designer John Galliano’s use of fish leather for garments in his Autumn/Winter 2002 collection is presented, situating the use of fish leather within the context of the luxury industry. The skins were sourced at Atlantic Leather, the world’s biggest fish skin tannery, based in Iceland, and the authors describe the contemporary use of fish skin in the fashion industry. The research proposes the sustainable development of fish skin as an innovative raw material for the fashion industry in order to encourage more sustainable fashion practices. A qualitative methodology has been employed for its relevance in studying evolving processes. An arts-based inquiry was chosen to create new knowledge conceived by those who actively participate in its making. Methodologically, the approach was practice-led. Emphasis was placed on ‘hands on interaction’ with the fish skin and processes.

Keywords

Artic – Indigenous Peoples of the Arctic – fish skin craft – traditional knowledge – food industry by-product – waste – fashion – haute couture – sustainable materials – John Galliano

1 Introduction: Historical Context

The use of fish skin to create articles of clothing is an ancient tradition shared by Arctic societies along rivers and coasts. The area covers the communities in the northern worlds to their complete circumpolar extent, from Iceland to the Sami region in Scandinavia – Sweden, Norway, and Finland – through the Russian Far East, Northeast China, the traditional Ainu islands of Hokkaido in Japan and Sakhalin in Russia, to the North American Arctic in the east. The natural resources available locally influenced the traditional Arctic lifestyle and economic activity. Even the location of settlements was determined by fishing. Arctic people settled by the seashore, gulfs, and river mouths where fish were abundant, near lagoons, and in the middle of the islands close to the spawning rivers.[1]

Before synthetic fibres were invented, people clothed themselves with local natural materials available in their surroundings.[2] People in the coastal regions sourced their materials from animals that were necessary for their survival, such as salmon, and they used their skins as a clothing material.[3] With the abundance of fish in the Arctic rivers and with the Indigenous Peoples' close affinity to the land and its resources, it followed naturally for fish skin to become widely used as a 'fabric' in the construction of garments.[4] According to the anthropologist Sergei Shirokogoroff, the adaptation to the local conditions and needs of a hunting-gatherer mode of life is done using the materials found-at-hand, in the most economical way.[5] Until the first decades of the twentieth century, Arctic people lived mainly by fishing and hunting. Despite the commercial contacts that gave them access to cotton and silk fabrics, the use of animal skins, in this case fish skin, was still used until very recently.[6]

Clothing in cold areas must above all meet the basic needs of humans, protecting them from snow, frost, wind, and rain. Fish skin meets these requirements, for it is light, solid, durable, and waterproof, while retaining the heat which is essential in harsh Arctic climatic conditions.[7] Coats made of fish skins were used as everyday indoor garments for both women and men. For the outdoor activities, several coats were worn at once, and, in very cold weather, they were worn over furs, as protection against wind and moisture.[8]

[1] SPb-Ainu Project Group, *Ainu Collections of Peter the Great museum of Anthropology and Ethnography Russian Academy of Sciences Catalogue* (Tokyo: Shofukan Hokkaido Kikanshi-insta tsusho, 1998).

[2] Jiao Feng, 'Keeping the Legend of the Fish Skin Tribe Alive.' *China Today*. 59, no. 12 (2010), accessed 16 October 2018 from: http://www.chinatoday.com.cn/ctenglish/se/txt/201202/02/content_423289.htm

[3] Gudmund Hatt, *Arctic Skin Clothing in Eurasia and America: An Ethnographic Study* (Wisconsin: University of Wisconsin Press, 1969).

[4] William Fitzhugh, *Inua: Spirit World of the Bering Sea Eskimo* (Washington D.C: Smithsonian Institution Press, 1982).

[5] Sergei Shirokogoroff, *Psychomental Complex of the Tungus* (London: Kegan Paul, Trench, Trubner & Co., 1935).

[6] Daria Cevoli and Elena Glebova, *Esthétiques de l'Amour* (Paris: Flamarion, 2015).

[7] Ibid.

[8] Ibid.

2 Disappearance of the Craft

There are several reasons for the disappearance of the fish skin craft. Overfishing and water pollution have caused fish stocks to drop, and many Arctic aboriginals have turned to farming and tourism to make a living.[9] Sustainable practices were applied in salmon fishing by Arctic communities for thousands of years but discarding this principle in modern times has led to the excessive depletion and near extinction of these species.

Salmon has been of great importance to the local economies and to the aboriginal cultures of Native North Atlantic in the USA and Canada, Northeast China, Japan, and Russia, but national governments similarly mistreated the local populations by, among other things, limiting or restricting their access to traditional fishing trying to force them to adopt non-traditional ways of life such farming through assimilation.[10]

The shortage of raw materials and better access to modern materials like cotton and silk have also challenged the preservation of the fish skin craft. Moreover, recently, women, who were responsible for the production of garments, had other priorities and had to substitute fish skin with less time-consuming materials available in the stores that possessed "the same" qualities. In this way, traditional knowledge rapidly lost its importance.[11]According to Shirokogoroff, if a natural resource is reduced, the skills and technology connected to it may be lost.[12] This is seen in contemporary fashion practices as well, where new cheaper materials are incorporated, and older garments and processes disappear.

The use of alternative materials such as fish skin (Illustration 1), has the potential not only to serve our material needs but also reduce resource consumption of overconsumed materials such conventional leather and could lead to more locally sensitive production, more regional sourced materials, more local jobs, and healthier and socially robust environments.[13]

3 Arctic Indigenous People: Their Relationship with Fish and the Environment

The relationship with fish plays an important role in maintaining the identities of Artic indigenous people and creating important ties with their environment. In Arctic indigenous cultures, people have fished sustainably for thousands of years. They employed fishing practices that simultaneously harvested and maintained fish populations. They took just what they needed to spend the winter, making sure they did not waste anything. In respect for the fish, they used every bit of it: the head, the insides, the bones and the skin.[14] From Indigenous Peoples, we learn that there is a way to honour the killed animal by making something beautiful of its skin.

Fish, the "daily bread" of the Arctic ethnic groups, also takes a fundamental place in the spirituality of these peoples, and their ancient myths emphasise how life comes from

[9] Lin Qi, 'Look Who's Tipping the Scales in Favour of Skinny Suits,' *China Daily* (2007), accessed 16 October 2018 from: http://www.chinadaily.com.cn/cndy/2007-07/10/content_5422759.htm.

[10] Judith Roche and Meg McHutchison, *First Fish, First People: Salmon Tales of the North Pacific Rim* (Washington: University of Washington Press, 1998).

[11] Torunn Klokkernes, *Skin Processing Technology in Eurasian Reindeer Cultures.* PhD Dissertation. (Denmark: Langelands Museum, 2007).

[12] Shirokogoroff, *Psychomental Complex of the Tungus.*

[13] Kate Fletcher, *Sustainable Fashion and Textiles; Design Journeys.* 2nd ed. (London: Earthscan, 2014).

[14] Pat Hickman, *Innerskins/Outerskins: Gut and Fish Skin* (San Francisco: The San Francisco Craft and Folk-Art Museum, 1987).

FIGURE 9.1 Salmon Fish Skins at Atlantic Leather Tannery © 2019, AVIGAIL REINER

water.[15] In the animist thought of the Arctic, humans appear only as a typology of being amongst others. There is no concept of hierarchy amongst species, human and animal. People and nature constitute one single whole. From this awareness of a unity of essence between beings, flows the respectful relations of humans with nature.[16]

Unfortunately, the Arctic is undergoing dramatic climate changes, threatening Indigenous Peoples, impacting their food security and traditional knowledge systems as they rely on fishing activities for their physical, cultural and spiritual well-being. Nowadays, the dominant, rational, mechanistic worldview positions humans as separate from and in control of nature and animals. This thinking had led to an overstepping of nature's limits.[17]

According to Edwina Ehrman, Curator of Textiles and Fashion at the V&A, everything we wear is fashioned from the raw materials found in the world around us, but we are less in touch with "real" nature than ever before. We need to think more deeply about the relationship between fashion and nature, since fashion's demands threaten

[15] Cevoli and Glebova, *Esthétiques de l'Amour.*

[16] Ibid.

[17] Dilys Williams, *Ten Years of Centre of Sustainable Fashion* (London: CSF, 2018).

the environment and endanger flora, fauna and human communities.[18] If fashion is to contribute to our happiness, we need to find ways in which we can harmonise with nature through fashion, bypassing the need to take more from nature.[19]

4 Fish Skin as an Innovative Sustainable Material for Fashion

It is of vital importance to understand how fashion, which can be such a magnificent manifestation of being human, has deviated from the fundamental human goal of thriving to biodiversity loss and ecosystem degradation. We need to examine the production and processing of raw materials in the fashion business and to address the effect they have on the environment and the earth's flora and fauna.[20]

The use of fish skin by aboriginal Arctic people has recently been assimilated as an innovative sustainable material for fashion due to its low environmental impact. Fish skins are sourced from the food industry, using waste and applying the principle of circular economy. None of the fish used to make this alternative leather are farmed for their hides (Illustration 2). They require no extra land, water, fertilisers, or pesticides to produce them

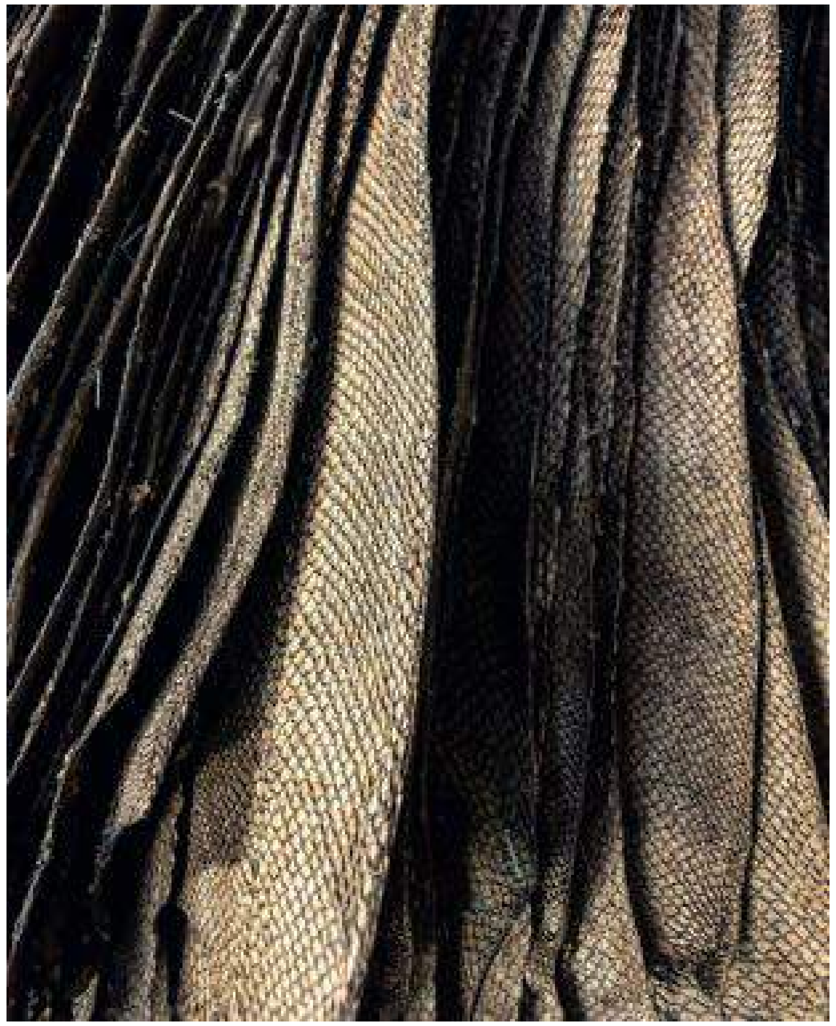

FIGURE 9.2 Salmon fish skins through the tanning process at Atlantic Leather tannery © 2019, AVIGAIL REINER

[18] Edwina Ehrman, *Fashioned from Nature* (London: Victoria & Albert Museum, 2018).

[19] Williams, *Ten Years of Centre of Sustainable Fashion*.

[20] Ehrman, *Fashioned from Nature.*

and they have low environmental impact, unlike conventional leather.[21] The processing of fish skin leather avoids throwing the fish skins into the ocean and can significantly reduce marine pollution and sustainably protect marine ecosystems in order to achieve healthy and productive oceans.

In luxury fashion, innovation, new materials, and traceability are critical. A traceability system, defined by ISO (9001:2015), records and follows the trail as products, parts, materials, and services come from suppliers and are processed and ultimately distributed as final products and services. Many luxury brands are waking up to possibilities in material innovation and sustainability. The innovation consist on researching which raw materials could be used that are sustainable and biodegradable.

According to Kate Fletcher, the fashion sustainability scholar, a strategy of materials diversity aims to temper the fibres market dominance so that alternative, more resource-efficient and culturally responsive fibres can flourish.[22] This strategy of materials diversity involves replacing some of the dominant or high-impact materials such cow leather with alternatives such as low-chemical vegetable tanned fish leather (Illustration3).

5 The Importance of Women and Fish Skin in the Arctic

For centuries, skin processing in Arctic cultures has been an important craft and economic activity related to the women's sphere. Knowledge is passed down through generations, mainly through the female side of the family. These women represent their community, are

FIGURE 9.3 Bark tree vegetable tanned fish skin © 2018, KATRIN KÁRADÓTTIR

[21] Bel Jacobs, 'The Future of Leather is Plant-Based,' *HowNow Magazine*, 22 June 2018, accessed 19 September 2019, https://www.hownowmagazine.com/innovation/2018/6/22/the-future-of-leather-is-plant-based).

[22] Kate Fletcher, *Sustainable Fashion and Textiles; Design Journeys.* 2nd ed. (London: Earthscan, 2014).

strong tradition bearers of knowledge of traditional fish-skin tanning technology and are artists in their field.[23] In the past, almost anyone could acquire fish. Women, children, and the elderly were all capable of setting nets to harvest fish from the sea and rivers.[24] Fish skin garments gave women the freedom to provide themselves the raw material and making the garments by themselves. In contrast, when making garments out of other animal hides, women did all the construction while the responsibility of the male hunters was to provide the raw materials.

The transformation of animal skin into clothing was the result of a process of both secular and spiritual know-how. Women were said to be in a sacred contact with the fish while making fish skin garments. Women seamstresses were the catalysts for this "magic" of daily life that they had learned to master from an early age, from time-held traditions.[25] According to Daria Cevoli, Curator in charge of Asian Collections at the Musée du Quai Branly, Paris, the woman who cuts the fish and scrapes it, enters into a close relationship with the material in a long, physical process. In this work of preparation and sewing of clothing using the fish skin, the thoughts, the fears, and the hopes of the women and the entire community of humans are present. This invisible magic is crafted onto the fish skin adorning it with colours, shapes and motifs (Illustration 5).[26]

FIGURE 9.4 Gilyak woman marriage coat from the lower Amur river region, Made of 60 pacific salmons. V&A Museum. Ca. 1900. © 2019, ELISA PALOMINO

Likewise, in contemporary fashion by cultivating an emotional and experiential connection between person and object, we can disrupt our dependency on consumption of new goods to construct meaning and our sense of self.[27] In haute couture, the treasured

[23] Klokkernes, *Skin Processing Technology in Eurasian Reindeer Cultures*.

[24] Fran Reed, 'Part Two,' *Arctic Clothing of North America -Alaska, Canada, Greenland* (Montreal: McGill Queens University press, 2000).

[25] Cevoli and Glebova, *Esthétiques de l'Amour.*

[26] Ibid.

[27] Jonathan Chapman, *Emotionally Durable Design: Objects, Experiences and Empathy*.(London: Earthscan, 2005).

petites mains (tiny hands), are women artisans who labour in local Parisian workshops, that have changed little in a century, doing the elaborate handwork that transforms a designer's dress into a sumptuous showpiece of luxury. The *petites mains* are part of a community of artisans making the magic of the couture come true season after season.

6 Fish Skin Fashion in the Arctic

Fashion is a universal human passion that finds strong expression in native cultures.[28] The Arctic fish skin clothing is a feast of high fashion, combining economy and harmony of materials and textures. Seamstresses prepare and assemble skins of different species, with ancestral know-how. Garment construction is done according to the fish skin shape, every skin is fitted to the next like a puzzle where nothing gets wasted. Long ago, these ancestral artisans mastered the contemporary concept of zero waste in cutting, an alternative pattern making technique where the pattern pieces are fit together so that no fabric is wasted during the cutting phase. Each item of fish skin clothing is prepared to exalt the surface rendering of the scales, the flexibility of the texture, the play of colours and lights, conscious of working on formerly living creature. The end result could be light and fluid like silk, heavy and fluffy like fur, or translucent and hard like a carapace.[29]

Traditional fish skin clothing was designed as a protection against the weather, but also as a symbolic barrier. Clothes were adorned with protective patterns, especially on the back, acting as a protective shield against the evil spirits, thought to arrive from behind without being seen. For Arctic Indigenous Peoples, the motifs and ornaments, like the art of arranging them, would have the purpose to please spirits.

Cevoli recognises that the fish skin designer/seamstress is therefore endowed with a powerful skill. She uses her knowledge in the sense of a balance between visible and invisible realities for the well-being of those around her. In this sense, a good seamstress is always perceived as a woman with a special talent, particularly recognised and put forward in these societies. The use of embroidery could even help the dead person find, alone in the absence of a shaman, the path to the world of the dead. [30]

In the world of haute couture fashion, not only the creativity and innovation of the fashion designer is key to the development of a collection, but the capability of an echelon of *petites mains* behind the designer. Like the Arctic fish skin craftspeople, Paris couture houses are part of a tight community of traditional artisans who are responsible for the production of the seasonal collections. Unfortunately, these incredibly skilled women are slowly losing their rank and status amongst Parisian fashion houses as well as their artisanal methods. Their noble craftsmanship and their respect for tradition is dying against cheaper materials and newer processes.

Likewise, the fish skin handcraft is in danger of extinction. Handmade traditional fish skin clothing has become, in many Arctic societies, special occasion attire. As market goods have replaced traditional fish skin clothing, the skills needed to create these remarkable items have diminished. The making process of this traditional handcraft is so complicated that it is difficult to accomplish without specialized training and this will hinder the inheritance of the craft to a certain extent.

[28] William Fitzhugh and Valerie Chaussonnet, *Anthropology of the North Pacific Rim*.(Washington: Smithsonian Institution Press, 1994).

[29] Cevoli and Glebova, *Esthétiques de l'Amour.*

[30] Ibid.

7 Case study: The Use of Fish Skin by John Galliano

This research draws on one of the author's (Palomino) previous industry experience as a fashion designer working in the luxury industry for John Galliano. For the prêt-à-porter Autumn/Winter 2002 collection, we designed fish leather garments and accessories. We used salmon, perch, and cod skins sourced at Atlantic Leather, the world's biggest fish skin tannery, based in Iceland, situating the use of fish leather within the context of the luxury industry.

In 2002, Galliano had reached the status in LVMH for a substantial budget for actual research travel, as opposed to imaginary travel through library sources, visiting China, Japan, India and Russia, creating more ambitious collections, stimulated by the colours, shapes and textures that he saw.[31]

His Autumn/Winter 2002 collection was inspired by a family of Inuit travelling back in time to a 1950s Christian Dior's catwalk. The notion of nomadic tribes, gathering garments like mementos, pervades this collection. Galliano combined 1950s silhouettes with eclectic materials such fish skin, bleached denim, knits brocades, and patchworks. A diversity of techniques was employed on top of this materials - plissé, embroidery, and hand-painting.

Financial support from the LVMH group for Galliano's collections provided him with the creative freedom to experiment with materials and volumes. The Galliano brand was a laboratory to explore new ideas which were subsequently revisited at Christian Dior prêt-à-porter and haute couture collections.

FIGURE 9.5 Atlantic leather fish skin tannery © 2019, AVIGAIL REINER

Once the season theme was shared by John with the members of his team, the starting point for the creation process was the fabric selection. Both at Galliano and Christian Dior, John used the most sophisticated fabrics and the rarest materials. During the 2001 winter season, the Icelandic Atlantic Leather tannery, showed his exotic fish

[31] Claire Wilcox, *John Galliano: Unseen* (London: Thames & Hudson, 2017).

leather for the first time at Premiere Vision fabric fair.

Atlantic Leather, located on the north coast of Iceland, has processed fish leather since 1994, based on the ancient-Icelandic tradition of making shoes from the skins of catfish (Illustration 6). The tannery supports local economies by sourcing from sustainably managed Nordic fish farming. The manufacturing of fish skin leather works with three aspects of sustainability: the economic benefit of creating value from waste, the social benefit of reconciling sustainability with fashionably exotic fish skin, and the environmental benefit of producing skins without damaging biodiversity or endangering animals.

Galliano's fabric buyer's role was to inspire John with her fabric choice every season, a difficult task since he had access and had already used the most beautiful and sophisticated fabrics available in the market. That season, Marie Cecile Genin, the fabric buyer at John Galliano's studio, managed to excite John with the choice of fish skin as a new material, which fitted perfectly with the Inuit theme, and the exotic but humble skins were used in skirts, trousers and bags across the collection (Illustration 7). Later, the fish skins were enhanced through traditional hand embroideries done by the treasured *petites mains*, artisans from the historical embroidery workshops of Lesage and Lemarié.

FIGURE 9.6 John Galliano's prêt-à-porter Autumn/Winter 2002 collection. Atlantic Salmon skin jacket
© 2002, PATRICE STABLE

Similarly, to the garments made by the fish skin artisans, Galliano's outfits offered the clients a unique work of art, where empathy and engagement was encouraged.[32]

8 Conclusion

In this chapter we have shown how contemporary fashion can incorporate alternative raw materials such fish leather. We hope that our research contributes to the emerging field of sustainable fashion design and encourages the fashion business to make better decisions regarding new materials. It aims to develop new knowledge and practices to bring sustainability changes in fashion.

We conclude that the use of alternative materials, such fish skin, has the potential not only to serve our material needs but also reduce the use of over-consumed materials, such conventional leather, and could lead to more locally sensitive productions. With the correct use of fish skin in the fashion industry, the rise of fish skin as a new by-product raw material for fashion could contribute to the sustainable development and future growth of the aquaculture and fashion industries.

We have also identified the historical fish skin context and its connection to contemporary fashion haute couture practices.

We conclude that it is possible to introduce new designs into fish-skin craft. Innovations can provide bigger visibility to this craft which will disappear unless there are new interventions that support it.

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Paper 11: Patagonian fish skin tanning processes

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Patagonian fish skin tanning processes

Gabriel Fabián Trachter
Secretaria de Pesca de la provincia de Chubut, Argentina +54 9 11 4160-9151
fabiantrachter@hotmail.com

Elisa Palomino
Central Saint Martins, University of the Arts, London, UK +44 7404430210 e.palomino@csm.arts.ac.uk

Gustavo Adrian Defeo
Ars Tinctoria s.r.l. analytical laboratory, Santa Croce sull'Arno, Italy +39 348 8924726 g.defeo@arstinctoria.it

Abstract
The ancient tradition of using fish skin to create clothing and accessories is shared by several coastal Arctic societies as part of their subsistence lifestyle depending on aquatic resources for nourishment and clothing.

Antarctica has no population, but the Tehuelches, Selk'nam, Yámanas and Alakaluf are some of the world's southernmost Indigenous Peoples closest to Antarctica. They live in the Patagonian region of southern Argentina, Chile, including Tierra del Fuego islands. They fish and hunt animals whose migrations in the Antarctic are a critical component of their survival.

There is not much literature regarding the use of fish skin by the Patagonian Indigenous Peoples, but they were known for the use of sea cow hides to make clothes and blankets to keep them warm and protected against the elements. The Tehuelche women spread them with chewed liver and then tan them by hand, rubbing them vigorously.

This paper evaluates the traditional fish skin tanning process used by agronomist Gabriel Fabian Trachter, this is a project promoted by the Secretary of Fisheries of the Province of Chubut in Patagonia, using a process easily adaptable to any location. The tanning was done with Mimosa extract and without any machines, allowing the development of fish skin tanning in areas with electricity deficit. The method does not intend to discard the use of drums, vats or drying tanks, but to show that it is also possible to tan without them. The results were tested at Ars Tinctoria laboratory to identify the potential of this traditional tanning process with a very low environmental impact.

Keywords: Fish skin, Traditional tanning**,** Patagonian Indigenous Peoples, Antarctica.

The use of hides and skins by hunter-gatherer societies

The use of fish skin for the construction of garments is an ancient tradition shared by Arctic societies along rivers and coasts. The specific Arctic groups with historical evidence of fish leather production are the Alutiiq, Yup'ik and Athabascan of Alaska; the Nivkh, Nanai and Ulchi Siberian peoples; the Ainu from Hokkaido Island, Japan and Sakhalin Island, Russia; the Hezhen from northeast China; and Icelanders (Palomino, 2021).

The use of hides and skins by Patagonian Indigenous hunter-gatherer societies has been widely corroborated based on ethnographic information and archaeological records (Parmigiani, 2014). The study of leather technology, one of the practices that distinguished the Indigenous peoples of Patagonia, can provide valuable information to deepen the interpretation of their culture (Marchione, 2013) and contributing to contemporary vegetable tanning techniques for leather. With the objective of obtaining information on the leather technology shared and transmitted by the Indigenous populations that inhabited the Patagonia region, data obtained from ethnohistorical and ethnographic sources on these hunter-gatherer cultures are explored in this paper.

Patagonia, including Tierra del Fuego, is a huge territory, dominated in the west and south by the rugged Andean Mountain chain, and in the east by dissected plateaux giving way to low plains (figure 1). The continuous marine waterway of the Stretch of Magallanes separates Patagonia from Isla Grande de Tierra del Fuego, and the Canal Beagle cuts Tierra del Fuego from the outer islands (McCulloch, 1997).

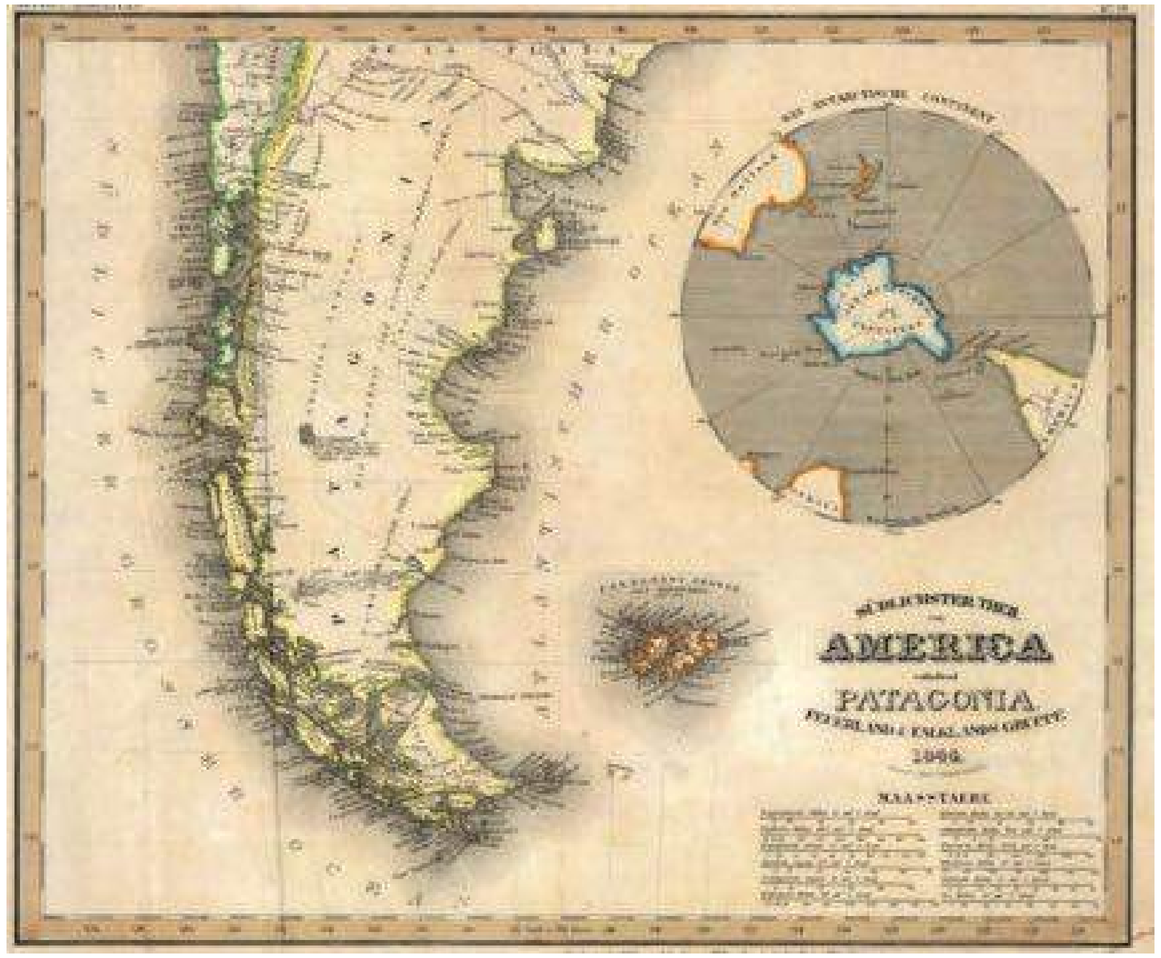

Fig. 1: Map of Patagonia, Tierra del Fuego, Falklands and Antarctic Continent. Radefeld, Carl Christian Franz, 1788-1874. David Rumsey Historical Map Collection.

The settlements in Patagonia involving the exploitation of marine resources date back to at least the 6th millennium BCE (Emperaire, 1963). The diet of these hunter-gatherer-fisherman groups was based on the marine resources available (pinnipeds, fish and seabirds) and land resources such Guanaco (Lama guanicoe) and Nandu (Rhea americana). These groups developed navigation and hunting technology at sea that allowed for a very efficient capture, as well as the systematic use of all the raw materials provided by these preys, such bones to make tools for tanning and the use of hides and skins for clothing and footwear (Orquera, 1999).

The tradition of skin and hide tanning in Patagonia combines ancestral traditions scattered in different geographical areas. The Tierra del Fuego region was inhabited by groups of hunter-gatherer-fishermen who navigated skilfully in canoes throughout the islands. These groups were the Alakaluf (figure 2), who occupied the western sector of the Beagle Channel and the southern shores of the Strait of Magellan, and the Yámanas, who inhabited the central and eastern sector of the Beagle Channel and the islands extending south to Cape Horn (Parmigiani, 2014). They lived in small family groups with camps close to the coast exploiting the resources provided by the environment, including fishing. The Selk'nam living in the central and northern part of the Isla Grande of Tierra del Fuego were not seafarers or deep-sea hunters, however, they valued sea cow hides, which they used especially for making strong straps to carry cargo (Gallardo, 1910).

The ethnographic information about the Tierra del Fuego hunter-gatherer-fishermen, shows the importance of the exploitation of marine mammals. Regarding the use of hides, it has been documented that the fur of the seal (Arctocephalus australis) was used to make various items and for exchange with other hunter-gatherers' groups (Parmigiani, 2014). The 16th century chronicles from travellers mention the use of the seals' skins for clothing, canoes and huts. F. Cortés Ojeda, in 1558, mentions an encounter with a group of men whose clothes were made with sea cow hides (Gusinde, 1974). Written sources on the Tierra del Fuego canoeists refer to the variety of skins that were used to make different goods, including clothing, footwear, household goods, bags, containers, and ropes. Many of them refer in particular to pinniped skins, which have even been used for body coverings in funerary practices (Emperaire, 1963). After contact with European navigators, the skins and artefacts made from them were taken to Europe to be part of museum collections and to inform about the diversity of Tierra del Fuego's fauna (Parmigiani, 2014).

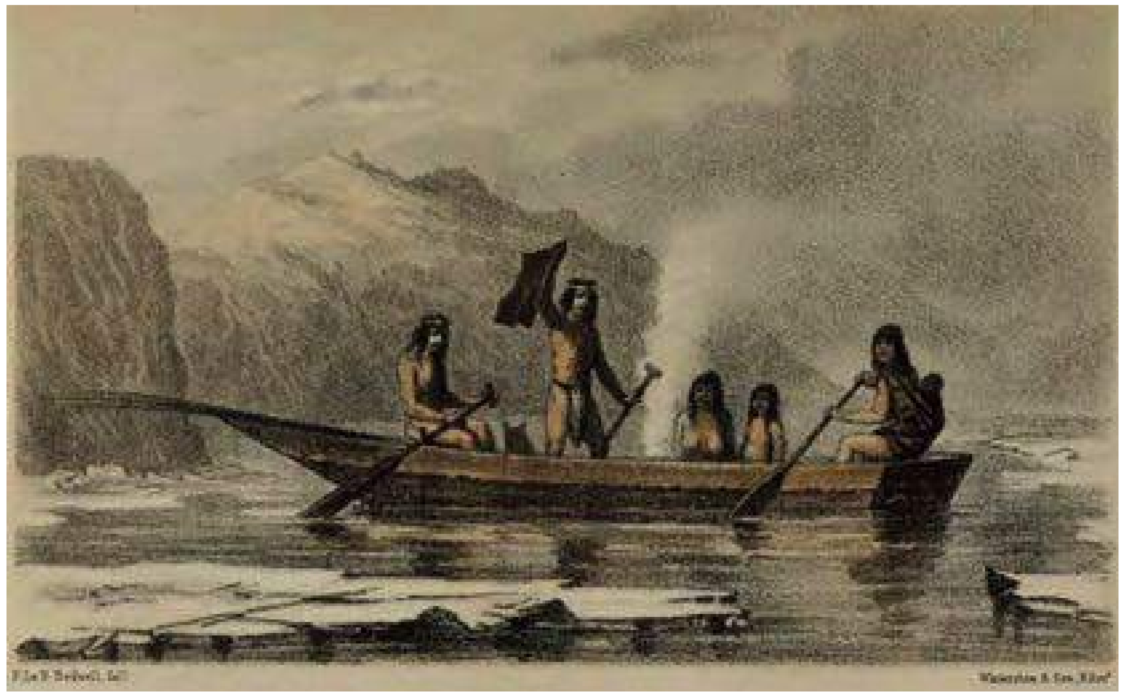

Fig 2: Alakaluf family in their canoe 1871.

The Tehuelches, the tribes of the Patagonia area stretching from the Strait of Magellan to the Negro River, clothed themselves with short-sleeved shirts, made of overlapping sea cowhides and guanaco hides (figure 3). This garment was generally tight at the waist and in the combats, they acted as armour (Guinnard, 2007).

There is little information available on how marine mammal skins were processed, apart from few ethnohistorical descriptions of the techniques used by Tierra del Fuego canoeists. The information indicates that in the past men would oversee the hunting, skinning and cutting up the animals but the depositaries of all the knowledge linked to the tanning, scraping, oiling and sewing the artefacts were women, and this knowledge was passed on amongst women and from one generation to the next (Gómez Otero, 1996).

Ethnographic sources provide data on the use of different elements for tanning the hides: fat, raw liver, liver cooked with salt, and/or with alum dissolved in water (Musters, 2005). The Tehuelche women in charge of the manufacture of leather blankets made from sea cowhides spread them with chewed liver and they tan them by rubbing them vigorously (Guinnard, 2007).

Fig 3: Tehuelche chief wearing a Guanaco leather blanket

Fig 4: Alakaluf Fuegians, dressed in guanaco skins 1882

Patagonian fish skin tanning process

There is not much literature regarding the use of fish skin by the Patagonian Indigenous Peoples, but this paper presents the reconstruction of a leather technology tanning process from the central-northern Patagonian region. The project aims the rediscovery, preservation, reproduction, and enhancement of ancestral techniques, respectful of local traditions.

The aim of the research was to identify the biochemical logic of the traditional Patagonian tanning process using natural principles with a very low environmental impact in order to introduce them in a near future to contemporary industrial tanning, reducing the supply of chemicals, the environmental impact, generating cleaner water and less CO_2. To evaluate the process, samples of salmon leather were undertaken using skin processing technology based on traditional knowledge from Patagonian communities.

The Patagonian fish skin tanning process is part of a community-based project grounded in the desire to create greater access to Argentinian fish skin knowledge. The project is led by Gabriel Fabián Trachter (figure 5), an agronomist engineer with vast knowledge on fish skin tanning techniques. Since 2016 he has developed and taught many courses on fish skin removal, conservation and tanning techniques in National Universities and job training programmes. He has

published a large amount of bibliographic material on the tanning of non-traditional skins and has also worked as manager and technical consultant of several industrial tanneries.

The treatment of the fish skins has been done with natural processes and products free of harmful chemicals, using low technology methodologies, which can be appropriated by small entrepreneurs, with an optimal use of inputs such as water, energy, and chemicals, and minimising the amount of waste generated in the tanning process, all of which are pillars of a cleaner production. The project promotes a responsible sustainable management of water and renewable resources, with a commitment to climate change. The project has been developing and rescuing steadily traditional Patagonian tanning and dyeing processes facilitating the creation of new knowledge about the fish skin craft and connecting across the Patagonian communities. The tanning and dyeing techniques of the skins has been carried out according to the traditional techniques of the inhabitants of Patagonia Argentina using autochthonous plants for tanning and dyeing as well as using Mimosa, a commercial source of vegetable tanning agent from Brazil. The project has been developed at Rawson, the capital of the Argentine province of Chubut, in Patagonia and has been directed to local communities from disadvantaged backgrounds from the remote rural areas of Rada Tilly, Sarmiento, Camarones, Rawson, Trelew and Puerto Madryn in in the province of Chubut, Patagonia.

Fig 5 to 7: Gabriel Fabián Trachter, an agronomist engineer Secretaria de Pesca de la provincia de Chubut tanning the salmon skins

The process of the fish skin traditional tanning is complicated and relatively difficult to accomplish without specialized training. The risk of disappearance of this local craft is also linked with overfishing and water pollution. Patagonian local people had applied sustainable practices in fishing for years but discarding this principle in modern times has led to the depletion of certain species. Climate change has also impacted fishing in the area. As this natural resource is reduced, the skills and technology connected to it are in increased danger of being lost (Palomino, 2021).

The project is guided by:
-Ecologically sustainable procedures, using tanning products derived from the local flora.
-Socially sustainable values, revitalising both artisanal production methods and respecting the customs of the Patagonian region.
-Economically sustainable practices, promoting the connection between artisanal manufacturing and semi-industrialised techniques.

The Patagonian fish skin project urges communities to reflect on current overconsumption and waste, to recuperate and upcycle. The aim is to learn a traditional craft with low-tech approaches and to produce a new material using the discarded fish skins from their daily diet and tanning materials available from local flora, creating a reciprocity between craftsmanship and innovation. Fish skin tanning practices have the potential to offer important opportunities in (re)connecting Patagonian communities with common cultural heritage.

Mimosa tanning process

The salmon skins were tanned with mimosa. The mimosa tannin is obtained from the bark of a tree (Acacia mearsnii), it is a polyphenol, of small particle size, which facilitates the penetration inside the leather that is being tanned, avoiding that it fixes superficially, which would give if this happened, a hardened leather and without being tanned in its interior. The colour it gives to the skins, allows them to be dyed in a wide range of shades, which even without having the same affinity with the various dyes that Chromium has, gives results that can hardly be obtained with some other sources of vegetable tanning agents.

An interesting aspect of the wood that provides this tanning extract is that in its bark, from which the commercial product called Mimosa is extracted, there is between 20 to 30% of tannin, with a large amount of active OH groups in this polyphenol, providing a good affinity to combine with the collagen of the fish skin.

The commercial use of this Acacia can be done very fast, within seven to ten years after planting, and the heartwood can also be used for other purposes. As it belongs to the Leguminosae family, it can also incorporate atmospheric nitrogen into the soil through the association of diastrophic bacteria (rhizobia) with its roots.

As with all tannins, the pH of fixation and penetration into the raw skin should be acidic, and it is better to use weak acids such as formic or lactic acid. In addition to the supply of these provided by the chemical synthesis industries, this project is advancing in the possibilities of processing in the same establishment where the hides are processed, through simple microbiological techniques (figure 8). The microbiological pickling of the fish skins was carried out using acidification with bacteria instead of lactic acid. To reach the desired pH, the water was acidified with ferments made with bacteria. These microorganisms started to develop lactic acid and a pH4 was reached with the activity of the bacteria.

Fig 8 and 9: Microbiological pickling of the fish skins

The use of mimosa extract to tan the fish skins had the objectives of transforming the skin into leather by the formation of chemical bonds between the tannin and the collagen and the filling of the skins to improve their qualities. Using basic infrastructure and the appropriate chemical products, salmon skins suitable for any manufacturing industry were obtained. By knowing the tanning techniques, how salmon skins react to them and taking into consideration not to produce negative impacts on the environment, good results can be obtained. Likewise, if the local tanners are committed with the work they are doing, they can do it without the usual machines, which allows this activity to be carried out in areas with electricity deficit. The method does not intend to discard the use of drums, vats or drying tanks, but to show that it is also possible to tan, under certain conditions without them.

The tanning included comparative fatliquoring tests, to explain the reasons for some common defects in these skins and to show some particularities of salmon, which differentiate them from other fish species in the processes.

The fish leather was dyed without using drums, but with a lot of hand movement and rubbing the skins, so the fibres of the skins are loosened, and, in this way, there are no stains produced by sectors that react differentially with the dye. The oiling was done in a bath, with agitation during 40 min. and fixation with formic acid for 15 min. The oils used were soybean based and a mixture of soybean and fish oil.

The comparison for this type of skins between the fatliquor with soy lecithin and the mineral fatliquor is largely in favour of the former in terms of softness to the touch, flexibility, and fullness, it is also possible to achieve these results by applying this fish oil or another of animal origin manually on the underside and possibly on the grain side, thus giving other characteristics. From previous experience, oils of animal origin also have excellent results.

All the processes of the wet phase and tanning processes, were carried out by immersion with manual movement, thus replacing the action of the drums.

The tanned salmon skins have the particularity of providing a good shine when polished. The shine finished of the skins (figure 11) is the result of the friction given using a polishing machine (figure

10) with a mechanical arm and a cylindrical agate stone. If this tool is not available, it can be done by hand with smooth stones or glass bottles. Salmon has a good reaction to polishing, without the need to apply finishing products, such as modified caseins. In this case, no casein or other finishing products were used.

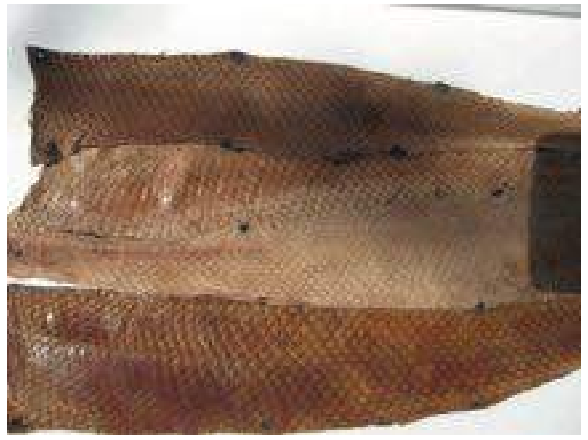

Fig 10: Polishing machine with a mechanical arm and a cylindrical agate stone

Fig 11: Polished salmon skins

Fisheries waste in Patagonia

Fishery waste has increasingly been incorporated into the value chain of fishery products in countries like Iceland, generating new lines of industrial production of high value-added products.
Currently, in various parts of the world, fish waste, consisting of skins, viscera, and bones, is used to produce by-products, including fish meal for animal consumption and other products such as protein concentrates, pharmaceuticals, fertilisers, glues, gelatine, and oils to tan skins (Palomino, 2020).

In Argentina, most of the companies dedicated to fish processing do not make use of the fish waste, despite the fact that the technology exists to do so on both an artisanal and industrial scale, making them a material that could be integrated as a primary or secondary input in the manufacture of clothing and accessories, and bringing together actors to integrate tanned skins from marine and inland water fish into the food value chain generating high value-added products.

The fish skins used in this project have been collected from a freshwater fishing company in Musters Lake in Sarmiento, Chubut. The skins were supplied by an artisanal commercial fisherman (figure 12) who catches rainbow trout, perch and silverside. He goes fishing daily and has several gill nets that he collects and re-sets.

Fig 12: Freshwater fishing company in Musters Lake in Sarmiento, Chubut, Patagonia.

Fig 13: Filleting the rainbow trout.

Based on the recognition of the diverse geographical conditions of Argentina and its regional fish fauna, the use of different species could benefit the fish leather business. Thus, the northern region of the country could provide skins from river fish, while the eastern coastline could provide fish from brackish waters; and from the south, fish from lakes and meltwater rivers. Each type of skin could have its own palette and textures that reflect the indigenous cultural repertoire of each community.

The market study of Patagonian fish leather, carried out by the local INTI agency (National Institute of Industrial Technology) made possible to explore and measure the market need for products made from fish leather, estimating the prices at which they could be sold and detect the channels through which they could be marketed.

The improvements and simplifications in the tanning processes and the changes towards the use of organic products in tanning that have been implemented in this project, allows the adaptation of these materials to the new market trends that seek the use of raw materials with certificates of good environmental practices.

Test Results

Several tests were carried out to understand the mechanical, tensile strength and physical properties of the tanning methods, their resistance to breakage under tension or how well the skin will perform in vigorous use. By testing the results obtained with different Patagonian fish skins tanning techniques, we gained a better understanding of their physical properties and their limitations.
The mimosa tanning technique allows fish skin to becoming a truly all-purpose material, able to be adopted for its practical as well as aesthetic capacities. The tensile strength of fish skins was tested in a dynamometer considering the acceptable values needed for different applications, sampling probes parallel and perpendicularly to backbone.

Report AN3861-21/1 Re-oiled vegetable tanned leather - dyed brown.
The resistance to tearing was good, considering the low leather thickness (0.41 mm). Normally, the minimum acceptable value of resistance to tearing is 20 N. The leather has a good resistance to tearing.

Report AN03860-21/1 Salmon leather 1 - Mimosa tanned, brown dyed, polished with agate stone.
It has much better tear resistance (51N), almost twice as much as the previous one. The media thickness measured was 0,57 mm, giving a specific tear resistance value obtained reached 96,5 N/mm, which is an interestingly high value.
Regarding Martindale abrasion, the result was low due to the scales pockets (like snakes' skins).

TEST N. 2 - Leather — Physical and mechanical tests — Determination of tear load — Part 2: Double edge tear

OPERATING CONDITIONS: (23±2) °C , (50±5)% R.H. - N° of tested specimens: 3 parallel to the backbone, 3 perpendicular to the backbone

INSTRUMENT: Electronic dynamometer

PARAMETER	RESULT	MEASURING UNIT
medium thickness - parallel to the backbone	0,57	mm
medium thickness - perpendicular to the backbone	0,52	mm
arithmetic mean of medium thickness - parallel to the backbone / perpendicular to the backbone	0,55	mm
Average load of the parallel tear to the backbone	42	N
Average load of perpendicular tear to the backbone	59	N
Arithmetic average of the average load - parallel / perpendicular	51	N

Fig 13: Physical and mechanical tests. Determination of tear load.

The tensile strength of fish skins was tested applying sampling parallel to backbone and perpendicularly. The analysis of the results shows that the smallest marginal stresses occur along the backbone of fish skins and the smallest marginal deformations occur perpendicularly. This distribution of strength properties differs from the distribution of strength properties in bovine hides. The orientation of collagen fibres in a linear direction is adapted to the aquatic environment of the fish, therefore fish leather is found to be more stretchable along its length than width (Palomino, 2021).

From the results of the tests carried out on these salmon leathers, it is clear that the tear resistance is very high considering mammals leathers of that thickness, while when polished with a machine with mechanical arm and stone, this value increases almost twice as much, possibly as a consequence of the crushing of the fibres, product of the mechanical action carried out by the machine, which also produces a better dispersion of the oil incorporated in the leathers, in the oiling process. The excellent tear resistance observed is due to the peculiar fibre's orientation typical of fish skins. In other projects fish skins were already used in the footwear and leather goods industries, among others, with excellent results in terms of resistance to traction and to tearing.

Conclusions

Skin processing technology is based on traditional knowledge of materials: the knowledge to physically manipulate materials to acquire the properties that are needed for a specific purpose, and the ability to adapt materials and methods according to current conditions (Klokkernes,2007). Through this research we have identified the biochemical logic of the Patagonian traditional fish skin tanning process using natural principles with a low environmental impact. These traditional, environmentally friendly techniques can be used in combination with modern technology reducing the supply of chemicals, generating cleaner water, less CO_2 and minimising the environmental impact of current fish leather production.

The vegetable tanning of fish leather is time-consuming compared to industrial tanning and needs a different set of skills. However, it has unique properties. Regarding the hypothesis about the possibility of continuity in the practice of leather working between pre-Hispanic populations and ethnographic and ethnohistoric groups, the analysis carried out provides elements to sustain that the technical knowledge - the "know-how" - has remained in place until modern times. This work has allowed us to delve into an underdeveloped subject in reference to leather technology and its approach from ethnohistory. This proposal and the methodology used can be improved and expanded, which will enable a much richer and deeper approach to the ways of life in Patagonia's past. This paper aims to document Patagonian fish skin knowledge systems and practices which are in danger of disappearing. The paper shares fish skin skills and tanning practices that remote Patagonian communities are currently developing.

The project aims to strengthen knowledge networks between Patagonian craftspeople, disadvantaged communities and local artists. The project hopes to preserve the fish skin craft and contribute to sustainability practices through the study of the material and the transmission of fish skin tanning skills.

The fish skin manufacturing process has brought to light also finished objects such mate holders, wallets, and shoes. The adaptation of the production processes for their subsequent manufacture in the place of origin of the fish waste raw material has increased the development of local industry with the added value of aesthetic traces that carry their designation of origin so local communities can replicate them for their further commercialisation.

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