Norwegian College of Fisheries

# Arctic Circular Seafood Synergies: Beyond the Bottom Line

*Perspectives on Full Utilization & Local Processing in Alaska & Norway*

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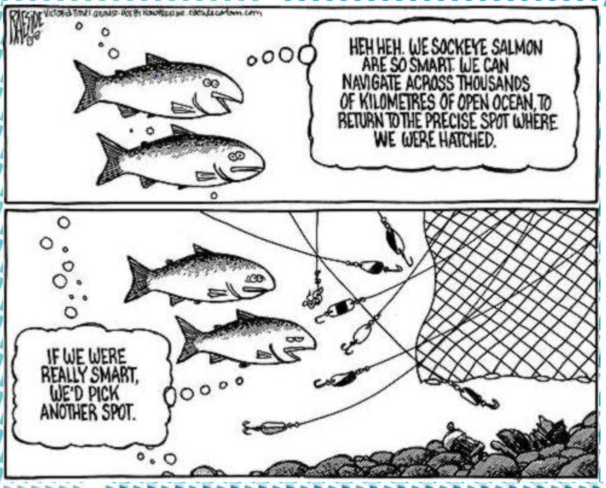


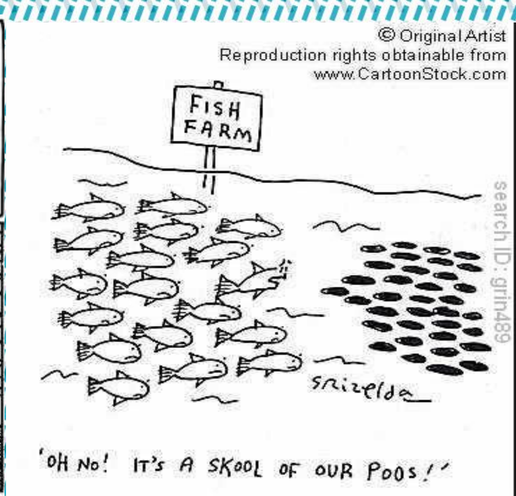

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Thank you to all that helped me with this research. This thesis research design and method taught me that all data has associated findings and as the researcher it is up to me to decide how to puzzle piece it together to a meaningful result. In the end of the day, I found that I enjoyed the task of this thesis, but my preference is working as a team. Any help and any engagement from peers and experts led this thesis to be a positive learning experience. Coming from a hard science background, both professionally and educationally, this was new waters to navigate and thank you for support and patience while I learned to keep my head above water and float a new type of boat. As they say, “A rising tide floats all boats.” This may be a problem, especially for our Dutch friends that live in a country that resides 1/3 under sea level. A more appropriate expression as I learned though this thesis, “Let’s find our appropriate boat as the tide rises, so we can all float.”

# Executive Summary

Alaskan wild salmon and Norwegian farmed salmon represent the largest share of their respective global harvests of salmon by volume, yet both are exporting the majority of their harvests and byproducts for processing and are thereby missing out the potential to create local circular production systems for more environmentally sustainable processing1. Alaskan salmon and Norwegian aquaculture have an opportunity to contribute to objectives of blue growth by shifting towards circular production systems.

The purpose of this study was to investigate why Alaska and Norway, rather than seeking full utilization of harvests, export for further processing and recommend how they can align their future strategies to move in the direction of local, full utilization of byproducts and thereby contribute to the objectives of blue- and circular economies. This study collected primary data from fishery stakeholders in the form of surveys and semi-structured interviews from Alaska, Norway, and Iceland.

This thesis recommends collaboration strategies between Alaska and Norway, rooted in the 4-step value chain of harvest, production, trading, and consumption, which excludes exporting for further processing. This is to be achieved via the harvest and production steps through the themes of economies of scope, controlling the processing lines, efficient production lines for coproducts/byproducts, and innovation related to energy and automation. Collaborations related to trading and consumption includes sustainable branding for full utilization, market coordination for diversifying secondary products, and certifications of the workforce/production lines. It is in the interest of both Alaska and Norway to make haste in changing their processing and exporting practices in the favor of environmental stewardship and not just short-term economic gains. Both locations are in positions of diminishing advantage as the purchasers of their byproducts continue to strengthen their competitive advantages on the resources use and sale.

[1] Salmon export for reprocessing: average over 2013-2016, 70% in Alaska and 81% in Norway; Alaska harvest: 2017 ~36%, Norway harvest ~55% of global volumes (Alaska Department of Fish and Game, 2018, "COAR"; Nærings- og Fiskeridepartementet, 2018, “Biomassestatistikk"; Nystoyl, 2018, slide 4-5).

# Conversions/Abbreviations

| | |
|---|---|
| 1 metric ton (or tonnes) = | 2,205 pounds, this thesis refers to metric tons throughout this document as “tons” |
| 1 million pounds = | 454 metric ton |
| NOK = | Norwegian kroner (national currency) |
| USD = | United States dollar |
| US or USA= | United States (of America) |
| 1 NOK = | $0.12 USD (April 29$^{th}$, 2019) |
| $1 USD = | 8.66 NOK (April 29$^{th}$, 2019), this thesis uses only $ and is referring to USD |
| 1 US mile = | 1.6 km |
| 1 km = | 0.62 mi |
| K = | 1000 |

# 1 Introduction

We live in a time where economic development in ocean and coastal regions are to abide by the evolving concept called the ‘blue economy.’ Blue economy means to connect economic uses of the ocean with sustainable ecosystems and environmental conditions to benefit local communities (Michel, 2016, p. xviii). The global community is promoting sustainable ‘blue’ practices and ways to minimize waste. Since 2015, the United Nation (UN) promotes Sustainable Development Goals, such as SDG 12 “Responsible consumption & production” and SDG 14 “Life below water (United Nations [UN], 2015, p. 14).” Similar to the green movement with “corporate sustainability,” there is a ‘blue’ initiative with “corporate ocean sustainability” that is gaining traction in the last decade (World Bank and United Nations Department of Economic and Social Affairs, 2017; World Ocean Council [WOC], 2018; Dyllick, Hockerts, & Thomas Dyllick, 2002; Gierckske, E, n.d.). To further conceptualize sustainable practices and tackle how to internalize detrimental environmental externalities, a concept of circular economy (CE) is quickly gaining force, especially in the European Union (EU) (Binet, n.d.; de la Caba et al., 2019; European Commission, 2019). CE strives to curtail the detrimental environmental travesties associated with increased global consumption and capitalistic up-scaling/out-sourcing behaviors in linear production models. The circular systems shall minimize environmental impacts by creating closed production loops and/or enable the efficient re-use of outputs, byproducts and waste flows from production, harvest, and processing (Ellen MacArthur Foundation [EMF], 2012). The circular economy builds on blue economy principles, where “natural systems cascade nutrients, matter and energy – waste does not exist. Any byproduct is the source for a new product” (“Principles - The Blue Economy,” n.d, para. 4).

Alaska and Norway represent resource-rich Arctic regions that are relatively scarcely populated with seafood playing an intricate role in their social and cultural heritage (Alaska Seafood Marketing Institute [ASMI], 2016); Norwegian Seafood Council [NSC], 2018). Both Arctic regions have ample access to the ocean and have globally significant seafood harvests. The small local population and abundant harvests allow for both areas to export most of their seafood products (McDowell Group, 2015; ASMI, 2016; NSC, 2018). As both Arctic areas diversify their non-renewable mineral/petroleum-based economies, the seafood industry has gained financial strength in recent decades (McDowell Group, 2015; ASMI, 2019; Mellemvik & Raspotnik, 2019; NSC, 2018).

Both Arctic areas focus on the seafood harvest production and have branded sustainable managed fisheries, as there are potentially economic, environmental and social benefits in focusing beyond the harvest and engaging in the complete value chain from catching the fish to consumption. As of today, both areas are production-oriented (focus on maximizing harvest), and a transition towards market-oriented, and eventually circular-oriented production will align Alaska and Norway in a way that reflects sustainability practices of the complete value chain. Market-oriented means that the industry matches their products to the available markets so that companies, prices, and production are controlled naturally by the demand for goods and services. In contrast, a circular-oriented industry will not focus on selling the fish product as such but would focus on selling the service of sustainable practices from harvest to consumption and thus utilizing the whole fish in many products. This means chain of custody (COC) sustainability is as important as sustainable harvesting practices. COC refers to the steps between the harvest and the consumer. (PwC Seafood, 2018; Time, 2016, EMF, 2012; Chawla, 2016). In addition, creating several market streams and minimizing waste is a critical component to the cascading design promoted in the blue and circular economies (Wautelet, 2018). Through this approach, areas of the initial processing of the fish are favored to find further market streams and therefor favoring the local economy of Alaska and Norway.

The USA and EU are the world's largest markets for seafood import and are the major markets for Alaska and Norway. In 2014, these seafood markets imported USD$20.3 billion and $28.1 billion, respectively (Food and Agriculture Organization of the UN [FAO], 2016, p. 54). Alaska's harvest provides more than 60% of USA's seafood (Alaska Maritime Workforce Development Plan, 2014, p.1). An upwards of 70% of Norwegian salmon is sold to the EU market (Ministry of Trade, Industry and Fisheries, 2018, para. 2). These two consumer markets are showing trends that COC is of high importance. This means consumers are possibly willing to pay more for products with sustainable labelling that ensures traceability of sustainable practices throughout the process of providing the fish to the consumer (Marine Stewardship Council [MSC], 2017). In the US, chain restaurants, retailers and wholesalers show concern related to verification of sources and COC (Seafood Choices Alliance, 2007, p.21). Alaska and Norway can address these concerns by adjusting their industry approach to focus on the complete value chain (harvest to final consumer), instead of the current situation that focuses on maximizing the harvest volume and not the full utilization.

Both areas promote their sustainable harvest practices in their market strategy; however, both areas do not control the utilization of this critical renewable resource as they export the fish abroad for further processing and thus are losing the benefits of the cascading design of locally utilizing all the byproducts promoted in blue – circular economies (McDowell Group, 2019; ASMI, 2012; NSC, 2017). This thesis explores possible synergies between Alaska and Norway to aid in the transition towards a circular-oriented seafood industry for economic, environmental and social reasons, with a focus on salmon. Salmon has a unique market and management position for finding value-added synergies by being a highly valued trading commodity on the global seafood market and by having local management. Both Alaska and Norway share the majority of their other fisheries with other federal/international bodies; whereas Alaska's Pacific salmon fishery is managed primarily by Alaska and Norway's Atlantic salmon is farmed and thus nationally managed (ASMI, 2012, p. 6; Norwegian Ministry & of Fisheries and Coastal Affairs, 2007). However, to identify potential value-added opportunities associated in processing, it is important to look at additional fisheries, such as white fish, to establish economies of scale for full utilization. Coordinating processing with other local fisheries helps to minimize operation costs in cascading processing lines, where similar processing techniques are applied.

Full utilization and local processing are fundamental aspects of engaging in the complete value chain with sustainable practices. Full utilization refers to utilizing all of the fish with no leftovers, as in byproducts. Full utilization requires secondary processing, which is additional processing to create other products beyond the primary product. In the human consumption fish industry, the primary product is often a fillet. Secondary products are commonly forms of fish meal and oil (Peter J. Bechtel, 2003; McDowell Group, 2017; PwC Seafood, 2018). The additional raw material left over after creating a product is considered a byproduct. Byproducts are used as input to secondary processing. If full utilization is achieved, then there are no byproducts and the processing is considered a closed-loop production (Wautelet, 2018).

There is little published data that describes synergies between fishing regions that outlines current harvest processing volumes in terms of primary and secondary products, and connects it to full utilization and local processing with sustainable practices along the value chain in the seafood industry (Browning, 2009; DNV GL Group, 2015; Ibrahim, 2018; PwC Seafood, 2018; Siwa Msangi, Mimako Kobayashi, Miroslav Batka, 2015; Wenzel, Gass, D'Iorio, & Blackburn, 2013; Ziegler et al., 2013). Therefore, this thesis studies how Alaska and Norway can best align their salmon byproduct collaboration to maximize circular economy synergies for the benefit of local processing and full utilization. To address this, several sub-questions will be answered. First, to get an understanding of the volume of byproducts and level of utilization, and thereby the potential that lies in maximizing circular economy synergies between Alaska and Norway, we need to establish 1) the current salmon and white fish processing volumes and the local associated byproducts. To further assess the potential synergies within the industry, we need to establish 2) how stakeholders in the two locations perceive seafood processing and potential for increasing local utilization. To further assess the potential synergies based on sustainable practices, we need to establish 3) how Alaskan and Norwegian stakeholders perceive limitations or growth in the current and future levels of local processing and utilization in their fishery based on the principles of sustainability. This explores how companies increase utilization and local processing, which is exemplified through three reference cases. Finally, the overall thesis question, which is based on the previous four research questions, will discuss 4) how Alaska and Norway can align their future strategies and find synergies to move in the direction of full utilization of byproducts and thereby contributing to the objectives of the blue- and circular economy.

This thesis is organized as follows: Chapter 2 gives background information that describes the Alaska/Norway salmon industries in terms of the different sustainability factors of economic, environmental, social and institutional. Chapter 3 explains the methodological framework of an abductive research approach in a mixed methods study. Chapter 4 outlines the theoretical framework and discusses the sustainability pillars and development goals in a blue- and circular economy. Chapter 5 presents the results related to the four research questions, before these are merged and discussed in Chapter 6. Concluding remarks are found in Chapter 7.

# 2 Background Information

The purpose of the background chapter is to add global perspective to particular aspects of the current economic, social, environmental, and institutional framework surrounding Alaska and Norway salmon in light of blue, circular economy issues. This chapter lays the groundwork to the application used in the theory and interpretation of the results. These two Arctic fishing regions have unparalleled blue economy potential by shear access to the ocean and population size.

In addition, there is a recent collaboration project that can aid in coordination efforts. This project, the AlaskaNor project, aligns well with the motives of this thesis as the purpose is not only to "enhance knowledge among relevant stakeholders and decisions-makers" but also "targets efforts to bring the two regions closer together, setting the path for future collaboration between businesses on both sides of the Arctic Ocean" (Mellemvik & Raspotnik, 2019). The AlaskaNor team is situated by the High North Center for Business and Governance at Nord University in Bodø and is funded by the Norwegian Ministry of Foreign Affairs and Nordland County. The AlaskaNor website explains "no knowledge has been shared or even attained yet concerning the opportunities for both regions to mutually tackle the manifold challenges of regionally developing their blue economy. AlaskaNor aims to addresses this knowledge gap" ("What Is AlaskaNor?," n.d., para1). AlaskaNor's key objective is to improve knowledge concerning the blue economy in Alaska and Northern Norway and in turn enhancing related knowledge among relevant stakeholders and amongst decisions-makers. This will be accomplished by developing knowledge in four work packages dealing with various aspects of the blue economy (Phase I), synthesizing these findings in collaboration with stakeholders in Alaska and North Norway (Phase II), and targeting decision-makers in Washington, D.C. and Oslo with policy recommendations (Phase III). One of the work packages is "fisheries and smart communities" that relates directly to this thesis. This project runs from September, 2018 to July, 2021 and confirms the relevance of this thesis' motivation of working towards synergies of blue economy growth.

Alaska and Norther Norway contain many small coastal villages that fisheries are an essential backbone to their lifestyle. Both areas are relatively scarcely populated and have extensive coastlines compared to the rest of the continental USA and EU.

*Table 1: Geographic and population information for Alaska and Norway.*

| | Alaska | Norway |
|---|---|---|
| Total size (km2) | 1.72 million | 0.385 million / with Svalbard 0.447 |
| Coast Line (km) | 10,690/ 55,000 with islands | 2,500 without 29,000 with fjords; 58,000 with Svalbard |
| Population (2017) | 740,000 | 5.26 million |
| Pop/square Km | 0.43 | 13.66 |

Table 1 shows the total size, coastline, population and population per km$^2$ for Alaska and Norway. Both countries have extensive coastline, resulting in the largest in the USA and Europe, respectively (World Atlas, 2018a; 2018b). Alaska has approximately 1 person per 2 km$^2$ and Norway has over 20 times more with almost 14 people per km$^2$. These are significantly lower population densities compared to China, where the bulk of the further fish processing occurs, where there is more than 20,000 people per km$^2$ (International Monetary Fund, 2019).

## 2.1 Harvest Volumes

Alaska and Norway have global volumes in salmon and white fish. The associated trade value and direct harvesting labor represent important economic and social aspects to the regions. Alaska Pacific salmon and Norway's farmed Atlantic salmon are compared to global harvests. The harvest volumes, associated jobs, and export value (ex-vessel[2]) are then compared between Alaska and Norway. White fish, which in contrast to Salmon represents only marine capture fisheries for both Arctic regions are also discussed.

After a commercial wild fish is caught in Alaska or Norway, it is taken to a processor for primary processing. In Alaska, this is the ex-vessel transaction and in Norway the transaction with the Norwegian Fishermen's Sales Organization (Norges Råfisklag).

[2] This is the value/volume directly to the fishermen in the first transaction. The dollar amount received by fishermen for their catch when delivered to a processor. This includes both initial payments and any bonuses or year-end adjustments paid by processors (Adapted from McDowell Group, 2015).

*Table 2: Alaska Pacific salmon and Norway's farmed Atlantic salmon compared to global harvest volumes.*

| Pacific salmon | Global | Alaska | AK/Global |
|---|---|---|---|
| | (hundred thousand tons) | | % |
| Average 2003-2012 | 9 | 2.3 | 26 |
| 2014 | 8.2 | 2.4 | 29 |
| 2017 | 9.2 | 3.3 | 36 |
| Source Notes | Nystoyl, 2018 | ADFG (COAR), 2018 | |
| Farmed Atlantic Salmon | Global | Norway | Norway/Global |
| | (million tons) | | % |
| Average 2003-2011 | 1.4 | 0.7 | 50 |
| 2014 | 2.2 | 1.3 | 59 |
| 2017 | 2.2 | 1.2 | 55 |
| Source Notes | Nystoyl, 2018 | Fiskeridirektorate | |

Table 2 considers marine capture fisheries (wild-caught) for Pacific Salmon and aquaculture (farmed) for Atlantic salmon. Alaska's Pacific salmon consists of 5 species and the total harvest is 25 to 40% of the global Pacific salmon harvest. Alaska's contribution (Alaska Department of Fish and Game, 2018, "COAR") to the global Pacific salmon harvests averaged over the years 2003-2012 (Nystoyl, 2018, slide 5) was 26%. Alaska's harvest is between 200 to 350 thousand (K) tons per year. The major variations of Alaska Pacific salmon harvest depend on the biannual fluctuations of the Pink salmon (*Oncorhynchus gorbuscha*) (Alaska Department of Fish and Game, 2018). 2014 was a low year for Pink salmon, while 2017 was a high year. Alaska's contributed 36% of the global wild Pacific salmon in 2017. When looking at the individual species, Alaska salmon is significant. The main competing supply of wild salmon is from Russia, Japan, and Canada. Since 2010, sockeye (*Oncorhynchus nerka*) from Alaska has accounted for about 70 % of the global wild sockeye salmon harvest. Alaska pinks have composed 43% of the wild pink salmon harvest, and Alaska chums (*Oncorhynchus keta)* have accounted for approximately 20% of the global wild chum harvest (McDowell Group, 2019, slide 9). Alaska is a dominating global harvester of wild Pacific salmon.

Norwegian salmon is farmed is approximately a factor of 4 to 6 larger harvest volumes than Alaska's wild caught Pacific salmon (Table 2). This farmed Atlantic salmon (*Salmo salar*) represents around 50 to 60% of global Atlantic salmon production. Norway's contribution (Nærings- og Fiskeridepartementet, 2018, "Biomassestatistikk") to the global Pacific salmon harvests averaged over the years 2003-2011 ( Nystoyl, 2018, slide 4) was 50%. In 2012, the global production of farmed salmon increased dramatically. The 2003-2011 global average harvest was 1.4 million tons per year and in 2012, it increased to over 2 million tons. Since

2012, Norway has farmed between 1.2 to 1.3 million metric tons of salmon (Nærings- og Fiskeridepartementet, 2018, “Biomassestatistikk”) and contributes over 50% of the global farmed Atlantic harvests. Norway is a dominating global harvester of farmed Atlantic salmon.

*Table 3: Comparison of Alaska wild salmon and Norway's aquaculture industry.*

| Wild Salmon/ Aquaculture | Alaska 2013-2014 | Norway 2014 | Difference (max/min) ratio | Source Notes |
|---|---|---|---|---|
| Harvested Fish (hundred thousand tons) | 2.8 | 13.7 | 5 | McDowell, 2015 & Karlsen et al, 2018, Richardsen et al, 2016) |
| Direct FTE Jobs (thousands of fishermen) | 18.4 | 9.6 | 2 | |
| Fish/Job (tons) | 15 | 143 | 10 | |
| Direct Income ($US million) | 300 | 917 | 3 | |
| $ per ton | 1.07 | 0.67 | 2 | |
| Notes | 1 NOK = $0.12 | | | |

When comparing Alaskan wild and Norwegian farmed salmon industries, there are some assumptions to be made to compare different types of fisheries (Fiskeridirektoratet, 2019, ; Karlsen, 2019b; McDowell Group, 2015; Norwegian Seafood Council, 2018). Table 3 looks at the average values for 2013 and 2014 for Alaska to offset the biannual fluctuations (McDowell Group, 2015, pp. 10-12)[3]. The direct impacts occurring in the Alaska salmon industry include commercial fishing and seafood processing. In Norway, for ease of consistency in reporting, this thesis uses the total aquaculture values that includes a small percentage of Rainbow trout (Karlsen et al., 2019, table “Employment” “Value Added”). In 2014, the total farmed volumes from Atlantic salmon was 12.6 hundred K tons, indicating that salmon contributes over 90% to Norwegian’s total aquaculture volumes of 13.7 hundred thousand tons. (Richardsen et al., 2016, p. 36). The direct impacts for Norway use the parts of the value chain defined for smolt and edible fish production as slaughtering, processing, and wholesale, export. Norway’s aquaculture production is 5 times more than Alaska’s wild salmon harvest and employs ½ of the people (Barentswatch.no, 2019). The direct income associated with Norway is thus 3 times as large as Alaska’s. The value in US dollars that Alaska receives per ton wild salmon is

[3] There are more recent volumes and values found for Norway at Barentswatch.no, these years are used due to the available compiled data found for Alaska.

approximately 1/3 more than Norway for its aquaculture as shown in the compiled 2014 data in Table 4.

*Table 4: Alaska's pollock and Norway's Atlantic cod compared to global harvest volumes.*

| Alaska pollock | Global | Alaska | AK/Global |
|---|---|---|---|
| | (million tons) | | % |
| Average 2003-2012 | 2.9 | | 52 |
| 2014 | 3.2 | | |
| Average 2013-2016 | | 1.5 | |
| Source Notes | FAO, 2016 | McDowell, 2019 | |
| **Atlantic cod** | **Global** | **Norway** | **Norway/Global** |
| | (hundred thousand tons) | | % |
| Average 2003-2012 | 9.0 | 4 | 44 |
| 2014 | 13.7 | 5.3 | 39 |
| 2017 | | 4.7 | |
| Source Notes | FAO, 2016 | Råfisklag, 2017 | |

Table 4 lists the marine captured harvest volumes for Alaska's pollock and Norway's Atlantic cod, and how they both represent large global shares of total volume in their respective fisheries. Alaska Pollock (*Theragra chalcogramma*) is one of the largest global fisheries by weight and approximately 50% is fished in Alaskan waters[4] (FAO, 2016, p. 14; McDowell Group, 2019, slide 3). The average 2013 to 2016 Alaska Pollock harvest was 1.5 million tons per year (McDowell Group, 2019, slide 3). As shown in Table 4, the harvest volume of Alaska Pollock is over 3 times larger than Norway's Atlantic cod (*Gadus morhua).* Norway's Atlantic cod is approximately 30 to 40% of the global fished Atlantic cod (FAO, 2016, p. 14; Norges Råfisklag, 2018, p. 85). Since 2013, Norway's marine captures of Atlantic cod are between 450 to 550 K tons per year (Norges Råfisklag, 2018, p. 85). These two marine captured white fish fisheries are also at global levels for Alaska and Norway in addition to their salmon.

The ex-vessel value for Pollock in 2013 was \$0.59 per ton fish and in 2016, it decreased to \$0.33. While the harvest has increased more than 70% since 2010, the total value has increased only 45%. Reduced value for roe is a primary factor (McDowell Group, 2019, slide 18). In

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[4] 50% assumes the global harvest volumes averaged over 2003 to 2012 and Alaska's harvest volumes averaged over 2013 to 2016. The same time-frame was not found in literature.

contrast, Norwegian Atlantic cod receives substantially more at $0.97 in 2013 and $1.70 in 2016[5]. In terms of marine capture harvest values and associated fishermen for Alaska (averaged over 2013 to 2014) and Norway (2014), a Norwegian fisherman averages 209 tons of fish while an American in Alaska averages 82 tons of fish. Norway has less fishermen and earns more per ton for these species (McDowell Group, 2019, slide 4; Norges Råfisklag, 2018, p. 85). This means that an Alaskan fishermen averages less than 40% of a Norwegian in terms of catch by weight and with a lower price per ton, it leads to lower earnings (FAO, 2016, table 11; McDowell Group, 2015, pp.12 & 27 ).

## 2.2 Salmon as Unique Resource

This section describes how salmon represents a unique resource in terms of management and trade opportunities for Alaska and Norway, by outlining some institutional and economic aspects (Alaska Department of Commerce, Community, 2016; Nærings- og Fiskeridepartementet, 2018).

Salmon is the only fishery in Alaska under state jurisdiction (Kreiss-Tomkins & Redick, 2018). Alaska's other fisheries, such as Pollock, have federal and international bodies in their management structure (ADFG Commercial fisheries). Similarly, around 90% of Norway's wild capture fisheries are shared stocks with neighbouring countries, meaning their jurisdiction is shared between other nations and international bodies (Norwegian Ministry of Fisheries and Coastal Affairs, 2007, p. 8). The Norwegian farmed salmon industry is entirely nationally managed.

In global terms, salmon is the highest value traded fish (FAO, 2016, p. 64). The share of salmon, which includes both farmed and captured and is grouped with trout and smelts, in world trade has increased strongly in recent decades. It became the largest single fish commodity by value in 2013 with 16.6% share of seafood world trade. However, although salmon has the highest trade value, it has only 7.2% share of world trade (FAO, 2016, p. 65).

Overall, demand is growing steadily for fish. In 2016, FAO mentions that this is particularly true for farmed Atlantic salmon. Prices of farmed salmon have fluctuated during the last two

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[5] Atlantic cod uses 1 NOK equals $0.12 and no inflation correction for all values

years, but overall remained at high levels, especially for Norwegian salmon. In contrast, Chile, the second major producer and exporter, the industry is facing declining prices and increasing production costs. In addition to farmed production, catches of wild Pacific salmon have been particularly good during 2015, especially in Alaska. The total recorded wild harvest was the second highest of all time. According to the FAO, Alaska's plentiful harvests drove down prices for all the major wild-caught species (2016, p. 65).

Salmon is the most important species for Alaska and is has the greatest economic impact (jobs, income, and total value) among all species in the Alaska seafood industry. Salmon's total contribution to the national economy in 2014 included approximately 38,400 full-time equivalent (FTE) jobs, totaling $7.1 billion ($2.0 billion in annual labor income and $5.1 billion through processing) (McDowell Group, 2015, p.28). In contrast in 2014, the Norwegian aquaculture industry, when including the ripple effect also known as indirect jobs, provides 27,900 FTE jobs and totaling $14.4 billion (120 billion NOK). The contribution of labor is not reported separately (Karlsen, 2019a, " Utvikling i sysselsetting 2004-2018" "Utvikling i produksjonsverdi 2004-2018"). Alaska employs more people in Pacific salmon than Norway's aquaculture industry and generates half the amount of production value. Since 2016, Norway has a production value of approximately $24 billion (200 billion NOK) (Karlsen, 2019a, "Utvikling i produksjonsverdi 2004-2018").

## 2.3 Sustainability Marketing and Major Consumer Markets

Sustainability certification is sold as a tool that enhances reputation, improves management, improves dialogue with stakeholders, protects livelihoods, accesses to new markets and secure markets. Tying sustainable harvesting practices to the marketing schemes via branding marks environmental stewardship with the economic benefits of ecolabeling.

Alaska and Norway are engaging in global sustainable certifications programs, branding their seafood as sustainable through their marketing institutions and initiating global sustainable salmon practices though the private sector (ASMI, 2019; Aquaculture Stewardship Council [ASC], 2013; Asche, Roll, Sandvold, Sørvig, & Zhang, 2013; Federation, 2017; Marine Stewardship Council [MSC], 2019.; UN Global Compact, n.d.-a). Two of the main seafood certifications employed are Marine Stewardship Council (MSC) and Aquaculture Stewardship Council (ASC). MSC and ASC have two types of certifications: fishery/farm certification and chain of custody (COC). The first certifies the fisher that is engaged in a sustainable, well managed certified fishery. The second type is the COC, which represents the value chain after the fish is harvested and brought to the consumer.

There is a total of 213 fisheries certified globally and Alaska represents 4% of certified fisheries. MSC began in 1999 and in 2000 the first fisheries became MSC certified and the blue fish ecolabel appears on first products. In Alaska, there are 9 fisheries certified: Gulf of Alaska- flatfish, pollock, salmon, cod, sablefish, halibut; Bering Sea & Aleutian Islands- pollock, cod, flatfish; and Western Bering Sea- cod & halibut longline in assessment. The bulk of Norway's wild fisheries are also MSC certified, including its Atlantic cod

Globally as of January 2019, there are 534 Atlantic farm salmons using ASC. Norway represents 58% of the ASC farms. The ASC began in 2012 and currently has 762 certified farms. In Norway, there are 176 salmon farms in assessment and 137 certified, totaling 313 farms. As of 2017, a little over 15% of the total farms in Norway are within the ASC certification scheme.

The COC certification approves the practices through the first buyer, wholesaler, to the processor and retailer. A business applies for the COC certification for operations that it is engaged in and not the complete COC value chain (MSC, 2017, p. 16). This was the main complaint by the restaurant chefs in a American survey in 2015, as they claimed that handling of the fish throughout the COC was poorly understood due to COC branding only representing parts of the chain (Seafood Choices Alliance, 2007, p.21). In Alaska for COC, there are 36 companies certified (valid), of which 2 are in secondary production (MSC, 2019, "track a fishery"). In Norway for COC, there are 70 companies certified (valid) and no information is given about if the suppliers provide secondary products (ASC, 2019, "find a supplier").

The rapid increase in the number of private certification schemes and their diversity has raised costs and confusion along the seafood value chain (FAO, 2016, p. 91). In response, some governments have created public certification schemes, for example Iceland Responsible Fisheries, Marine Eco-Label Japan, Alaska Seafood, and Norway's "Country of Origin" Label (FAO, 2016, p. 92). Alaska Seafood Marketing Institution (ASMI) chose Responsible Fisheries Management (RFM) certification program outlined by the FAO, because it meets the highest benchmarks for credible certification and has no logo license fees. Global Sustainable Seafood Initiative's (GSSI) recognizes the Alaska Certification Program of RFM. GSSI is a global, multi-stakeholder platform for collaboration and knowledge exchange to address sustainability challenges (website). This recognition demonstrates that Alaska RFM is in alignment with all 143[6] applicable Essential Sustainable Components, which outline the sustainable aspects required in the government, operational and fishery certification schemes (GSSI, 2015, p.1). There are 70 registered certified companies under ASMI's RFM and uses the Alaska ecolabel (ASMI, 2018).

Norwegian Seafood Council (NSC) has also taken its own sustainability promotion campaign called the "country of origin" label that was released in April 2017. The intentions are to use the new label as guarantor of the world's best seafood. Renate Larsen, CEO of NSC, describes the objective of the label "to build a brand the whole seafood industry can be proud of" (Sjømat Norge, 2018, para. 3). The "origin" label is to encompass the uniqueness of Norway's cold, pristine seas, sustainable management and long traditions of creating new innovations.

The Norwegian salmon farming company, Cermaq, is the founding member of Global Salmon Initiative (GSI) (UN Global Compact, 2018). This initiative was launched in 2013. GSI is an industry initiative aiming to find solutions to common sustainability challenges in the salmon industry. As of April 2018, it represents 17 companies accounting for over 50% of global salmon production (primarily Norwegian farm salmon companies). GSI works actively to solve industry challenges on three areas: feed and nutrition, biosecurity and standardization. Cermaq is an example how the salmon private sector is aligning themselves with global sustainable networks.

The main consumer markets for Alaska and Norway are the US and the EU. As explained above, both of these markets express concerns of sustainable fishing practices from harvest to COC. Table 5 illustrates that the EU and the USA are large markets for seafood import with $28.1 billion and $20.3 billion, respectively (FAO, 2016, p. 7). These two markets receive the bulk of Alaska and Norway salmon final sales products. For all Norwegian seafood products, the EU market represents around 60% of the final consumer market (Nærings- og Fiskeridepartementet, 2018, para. 3). The farmed salmon contribution is upwards of 70% (Moe,

[6] As of July 12th, 2016 (https://www.alaskaseafood.org/wp-content/uploads/2016/07/Final-Press-release-ASMI-Recognition_071216.pdf)

2017). The U.S. domestic market is the largest market by estimated final sales for Alaska at 35%, but foreign processors play a large role, accounting for an estimated 2/3 of final production value (McDowell Group, 2015, p. 29). In 2014, 63% of Alaska's seafood final sales and 90% for Norway's farmed salmon were accounted for between the EU and US markets.

*Table 5: 2014 Total seafood import by important markets to Alaska and Norway.*

| 2014Total Seafood | | Alaska Seafood | Norway Salmon |
|---|---|---|---|
| Country / Area | Import $billion | % of total sales | |
| EU | 28.1 | 29 | 72 |
| USA | 20.3 | 34 | 18 |
| Japan | 14.8 | 24 | 2 |
| Other | 77.4 | 13 | 8 |
| World | 140.6 | 100 | 100 |
| Source Notes | McDowell, 2015; estimates from Moe, 2016 & Norgessjømat, 2018 | | |

## 2.4 Byproducts

This section addresses byproducts. The primary and secondary (or further) production processes can yield materials other than the planned end item. These additional outputs are referred to as coproducts or byproducts. The coproducts and byproducts may be reused, sold at a profit, disposed at no financial penalty or disposed of at a cost. Coproducts are usually produced the same time as the primary product and are desirable secondary outputs that can be sold or reused profitably. An example is Norwegian cod heads for human consumption ("Norges sjømatråd," n.d., own translation). Byproducts are unavoidable secondary outputs that may be sellable or usable, or they may be waste that must be disposed of at a cost (Bimbo, 2009; de la Caba et al., 2019; Rustad, 2003). An example of this is the diseased or dead fish in aquaculture. Fish is highly perishable and can spoil more rapidly than almost any other food; thus, can quickly become unfit for human consumption through microbial growth, chemical change and breakdown by endogenous enzymes (FAO, 2016). The post-harvest handling, processing, preservation, packaging, storage measures and transportation of fish require care to maintain the quality and nutritional attributes of fish and avoid waste and losses.

This section addresses the global social concern to turn byproducts towards human consumption products; explains the institutional background in Alaska and Norway for level of utilization for salmon; asserts the environmental concern for the current status of export for reprocessing; and addresses the economic opportunity for Alaska and Norway to retailers of secondary products are looking to buy fishmeal and oil from sustainable sources.

Fisheries and aquaculture production are heterogeneous in terms of species and product forms. Figure 1 illustrates the potential byproduct volume of salmon in Alaska and Norway in the recent years of 2012-2017.

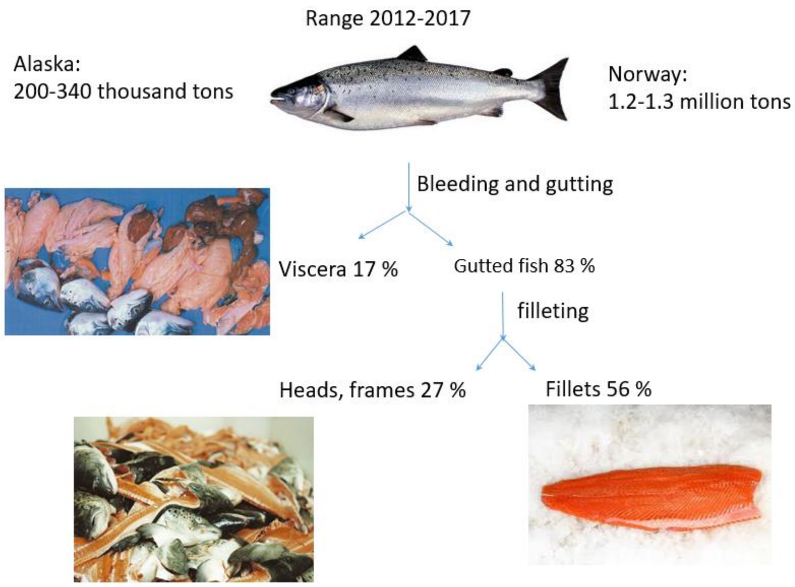


*Figure 1: The average weight % of the different parts of a farmed Atlantic salmon (adapted from R. Olsen, 2017).*

Each processing step after harvest results in associated byproducts. Figure 1 shows a potential of 44% by weight of salmon byproducts associated with skinless fillet. If the primary product is only bleeding and gutting the salmon, the associated byproducts would only be 17% by weight. Norway has approximately a factor of 5 times larger harvest volume than Alaska and thus a larger potential of byproduct volumes.

The versatility of fish products creates also a versatile consumer market. What one country or culture considers waste, another considers a delicacy. The seafood processing industry is a technology-driven, complex system of matching supply to demand to be able to fully utilize the fish before the fish becomes rotten. Preservation and processing techniques can reduce the rate at which spoilage happens and thus allow fish to be distributed and marketed globally as a human coproduct. An essential step in up-grading byproducts to coproducts for human consumption is to have certification systems in the processing steps to ensure no spoilage of the fish. Examples of these certifications schemes are Good Manufacturing Practice (GMP) and the Hazard Analysis and Critical Control Point (HACCP) use in food production (Olsen, Toppe, & Karunasagar, 2014). Due to facility space or uneven input levels of the harvest, many processing factories preferred method for the byproduct is silage. The conservation of a biological resources is ensiling as in creating fish silage. A common way to create silage is to grind up the byproducts and add an acid to stabilize the fish byproducts to a lower pH that most microorganisms are unable to grow. The most common organic acid used is formic acid (Seliussen, 2016), but acetic and lactic acid is also sufficient.

In global terms, the share of world fish production utilized for direct human consumption has increased significantly in recent decades, from 67% in the 1960s to 87% in 2014 with more than 146 million tons. The remaining 21 million tons was destined for non-food products. 15.8 million ton (76%) of this non-food products was reduced to fishmeal and fish oil. Fishmeal is the crude flour obtained after milling and drying fish or fish parts. Fish oil is usually a clear brown/yellow liquid obtained through the pressing of the cooked fish. Whole fish, fish remains, or other fish byproducts produce fishmeal and fish oil (FAO, 2016).

Seafood processors work towards receiving the highest market value for their byproducts. Figure 1 shows the potential value of established salmon byproduct market streams for Alaska and Norway. The value pyramid illustrates the hierarchy of the product categories based on the value of the end product. Each step in the pyramid represents increased value of the end product, while the production volume decreases. The figure also illustrates the need for economies of scale for lower tier products. There is additional handling and preparation of the byproduct to climb the pyramid of products. Both Alaska and Norway have regulations in place to ensure that no harmful byproducts is used towards human consumption (Animalieproduktforskriften, 2016, avsnitt 2(e); Divsion of Environmental Health, 2019, “Food Safety & Sanitation Program”). Norway does not have the lowest tier in their aquaculture industry, except for their blood water (adapted from PwC, 2018).

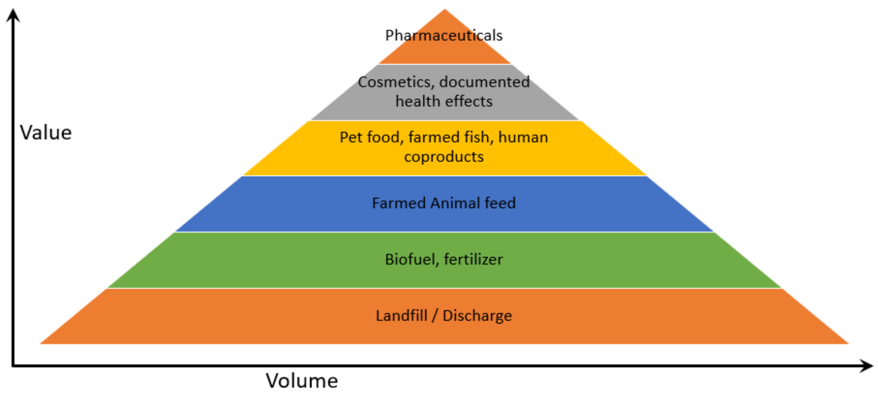


*Figure 2: Value pyramid of established salmon byproduct market streams (adapted from PwC, 2018).*

Both Alaska and Norway have examples of economically successful byproduct companies as a result of institutional regulations. Kodiak was designated a seafood processing center in 1974. Prior to this designation, there was visible environmental seafood discharge problems affecting the town's population. The Alaska Department of Environmental Conservation (DEC), through the authority of the Environmental Protection Agency (Region 10) and the Clean Water Act, mandated the Kodiak plants to handle seafood processing waste. The result was the formation of the cooperative Kodiak Fishmeal Company (KFC). KFC began operation in 1995 and is jointly privately owned by a group of processors with Kodiak plants. The shareholders today are different than the original, but the concept is the same. Each processing facility delivers its byproducts to the communal fish meal plant that creates marketable secondary products. The processing facilities that are not owners have to pay a marginal amount to dispose of their byproducts (Kodiak Fishmeal Company, n.d.; McDowell Group, 2017). The DEC set standards for the high-capacity shoreside plants to handle seafood processing waste in a way similar to that accomplished by the City of Kodiak. The general system to date is raw fish processing waste generated from human food processing lines are ground, cooked, and made into four standard coproducts: fish protein meal, fish oil, bone meal, and stickwater (Bechtel, Smiley, & Alaska Sea Grant College Program., n.d.). An estimate of the salmon utilization is explained in the results for Alaska.

In Norway in the early 1980s, salmon farmers were plagued by their excess of byproducts that was considered pollution and biological threat for the farmers. As explained by an industry expert, there was a discharge fee introduced to the fish farm industry in the early 1990s. Salmon farmers approached Hordafor AS to assist with the fish waste. From the early 1990s, Hordafor collected only around 9 K tons of fish byproducts compared to its current 200 to 300 K tons (Seliussen, 2016).

Both Alaska and Norway use other countries for further processing than the end-product consumer countries. China is Alaska's largest seafood export market in terms of tonnage and value, accounting for 35% of the volume and 27% of export value in 2015. Of these exports, approximately 80 to 90% are sold to secondary processors which re-export end products to other global markets, primarily in Europe, the U.S., and Japan. Most of Alaska's exports to China consists of frozen headed/gutted (H&G) fish, which are then filleted in China where labor costs are considerably lower (ASMI, 2016, p.1). Norway also uses China along with many Eastern European counties for further processing (Ziegler et al., 2013). The operational cost is lower in the other countries than the harvest location and thus economically preferable (Bimbo, 2009; Nystoyl, 2018; PwC Seafood, 2018); however, the question is whether environmental standards as equally high in the middleman processing country. Although byproduct material is from certified, sustainable fisheries; the trend of exporting seafood for further processing causes disconnect and loss of control of the processing lines and thus assurance of high environmental standards in along the value chain.

As for retailers of secondary products, they too demand fishmeal and oil from sustainable sources. The international organization that represents producers of fishmeal and oil has published and presented several papers addressing the sustainability of feed fisheries and the responsible supply chain. Retailers need to make sure their feed are coming from recognized sustainable sources. Hence, there is a push to use byproducts, instead of reduction fisheries to not compete with direct human consumption markets (Fishmeal Information Network, 2008). Thus, there is a global trend to secure the demand for secondary products from sustainable harvests. With Alaska and Norway's sustainable harvests, there is an opportunity for both regions to take an active stance of providing nutritional coproducts, coordinate the already established processing plants to further create coproducts/byproducts, take control of the processing lines by not exporting for further processing, and market their sought after byproducts to to retailers of secondary products.

The current harvest processing and byproduct utilization volumes are reported/estimated and reviewed for Alaska and Norway in chapter 5.1.

# 3 Methodological Framework

## 3.1 Research Approach

There are three primary research approaches: deductive, inductive, and abductive (Costa, Lucas Soares, & Pinho de Sousa, 2017; Kovács & Spens, 2005; Mark Saunders, 2007; Sønvisen, 2013). Deductive reasoning takes a general rule or theory and proves it to be always true in the specific conclusion, as in testing hypothesis. Inductive reasoning takes specific observations and defines a general conclusion that may be true for all. In general, it produces theory from data. Abductive reasoning is used when there are incomplete observations and a best prediction that may be true is offered by the researcher. The overall structure of this thesis is built upon abductive reasoning as shown in Figure 3.

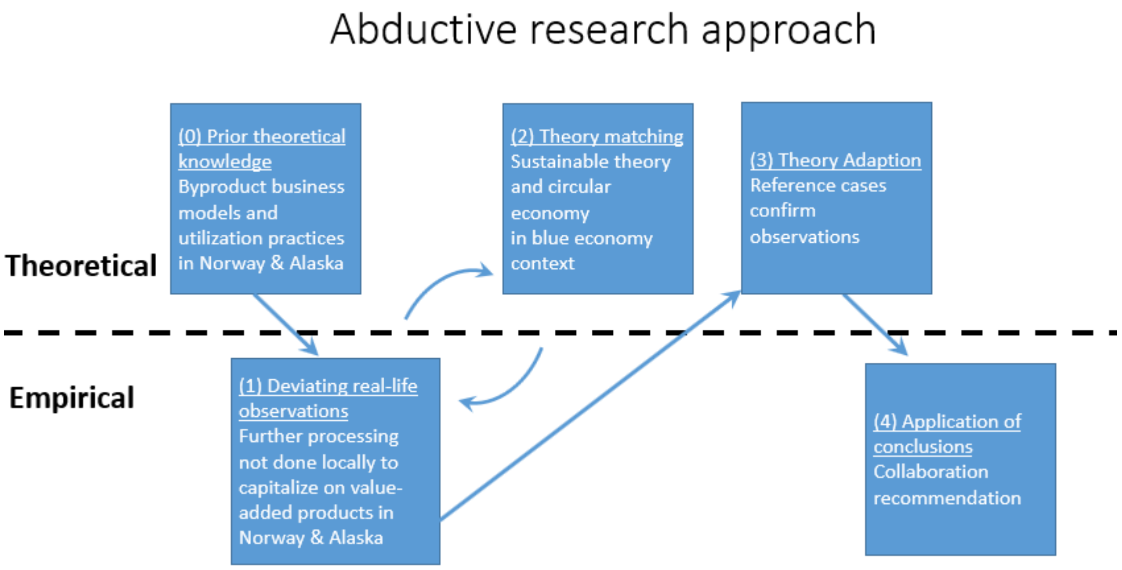


*Figure 3: Abductive thesis approach. Circular arrows represent iterative steps in the research design. Adapted from (Kovács & Spens, 2005).*

Figure 3 illustrates the abductive approach of this thesis. The initial theoretical knowledge (step 0) is applied in a literature review. In this thesis, step 0 dealt with information found from conference reports, scientific journals, and secondary processing companies' annual reports. The initial knowledge gained from the literature review was that byproduct companies are profitable. Step 1 is deviating observations that further processing is happening in areas outside the harvest area or the end markets as I have noticed when traveling in Northern Norway and coastal communities in Alaska and discussing with stakeholders involved with salmon byproducts. This is complexing, if byproducts utilization is profitable, then why wouldn't the harvest areas want to control the processing lines to maximize byproduct utilization. Step 2 illustrates the iterative process that matched the deviating observations with the appropriate theories to explain why the deviations are not the preferred situation. This step included other research approaches. This thesis used deductive reasoning to design the survey with questions based on sustainability theory with the assumption that economic sustainability trumps social and environmental sustainability.  Inductive reasoning was used to finding patterns in the survey responses and produced theory to support the observations that economics was the primary factor for the Alaskan and Norwegian stakeholders to not pursue full utilization and local processing. Step 3 uses the adapted theories of blue and circular economy to apply them to businesses that are pursuing byproduct utilization and confirmed the theories relevance to promote local processing and full utilization. Step 4 applies the learned information of theory matching to explain the real-life deviations and recommended collaboration strategies for Alaska and Norway.

## 3.2 Mixed Method Research Design

This thesis used a mixed methods design. A mixed methods design is appropriate when the quantitative and the qualitative approach, each by itself, is inadequate to best understand a research problem and the strengths of both quantitative and qualitative research (and its data) will provide the best clarity (Creswell, 2014). Mixed methods involve the collection and "mixing" or integration of both quantitative and qualitative data in a study.

This thesis is inspired by convergent parallel mixed methods. This method is used when the researcher converges or merges quantitative and qualitative data to provide a comprehensive analysis of the research problem.  The investigator collects both types of data roughly at the same time and integrates the information in the interpretation of the overall results. Contradictions or incongruent findings are discussed and further scrutinized in this design. Convergent parallel design consists of four steps: design and collect both types of data in parallel; analyze both types of data in parallel; merge the two sets of results in point of interface; and interpret the merged results (Creswell, Plano Clark, & Los Angeles, 2011). Although convergent design was the preferred method for this thesis, the collecting and analyzing of both quantitative and qualitative data in parallel was not possible as a single researcher, thus aspects of the explanatory sequential mixed methods are employed (Creswell et al., 2011). Explanatory sequential mixed methods is used when the researcher first conducts quantitative research. The investigator analyzes the quantitative data and augments the results with explaining them with the qualitative research (Creswell, 2014). This method is used for identifying stakeholder groups by their seafood perceptions in answering research question 3.

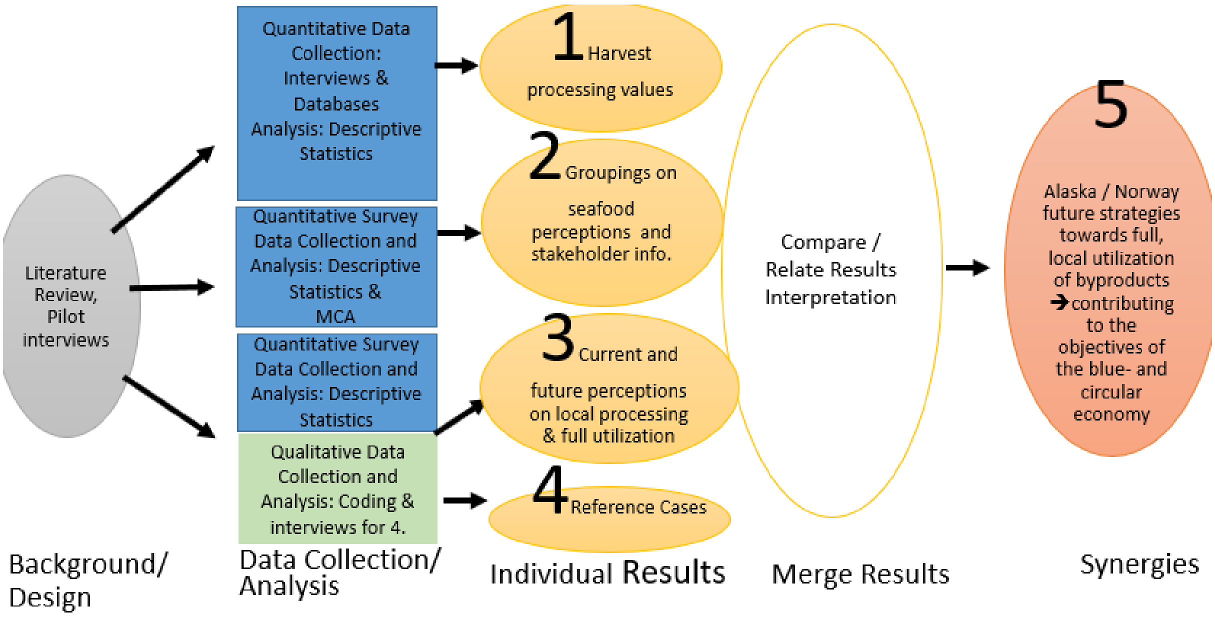


*Figure 4: Mixed method research design in terms of research questions. Adapted from (Creswell et al., 2011).*

Figure 4 illustrates the construction of the mixed method design for this thesis in terms of the four research questions and the thesis question (#5) from left to right from background/design; data collection and analysis; individual results; to merging of results and recommendation of synergies. Individual results are the collected data and analysis reported in the four sections of the result chapter (5 Data Results).

The background/design step consisted of the literature review and pilot interviews necessary to create the survey. Unlike convergent parallel design, where the first step is design and collect both types of data in parallel, this thesis used a large portion of its time in design and thus separated the steps. The literature review began in January 2018 and the pilot interviews occurred in summer 2018.

The second step of data collection/analysis indicate the types of data collected and analyzed to produce the results for the research questions. All research questions qualified the quantitative results with quotes provided by the interviewees; however, Figure 4 shows the dominating type of data used to answer the questions. The blue color illustrates quantitative method and the green color represent qualitative method: these are explained further in the next section.

The third step of individual results are indicated by the circled numbers. They correspond to the research questions and include a short description under the numbers in Figure 4. Question 1 corresponds to yellow oval 1 and used a mixed of qualitative interview data and quantitative literature data. Question 2 and corresponds to yellow oval 2 and used quantitative survey data. Research question 3 was how Alaskan and Norwegian stakeholders perceive limitations or growth in the current and future levels of local processing and utilization in their fishery based on the principles of sustainability. This explored how companies increase utilization and local processing, which is exemplified through three reference cases. For simplicity in displaying the results, research question 3 is broken up into two results, first the informant responses from the survey (yellow oval 3) that used both quantitative and qualitative data. Second, yellow oval 4 described the reference cases and used qualitative interview data and literature. The data collection of interviews and surveys occurred January 2019 to April 2019.

The fourth step is the point of interface of these first four results and are merged and interpreted as input results to answer red oval 5 – the overarching thesis question, which conveys the method and content of the study (Tashakkori & Creswell, 2007). The merging of the results is done in the discussion chapter (6.1 Currently Loosing the Competitive Advantage

### 3.2.1 Case Study with Data triangulation

The general form of this research is case study. Case studies are a design of inquiry found especially in evaluation fields (Yin, 2009, 2012). The researcher develops an in-depth analysis of a case of a process or activity for one or more individuals. According to Yin (2009), cases are bounded by time and activity and the researcher collects detailed information using a variety of data collection procedures. The case for this thesis is identifying the reasons for the current harvest processing volumes in terms of byproduct utilization and local processing. Stakeholders involved in fisheries in Alaska and Norway were the individuals for this case study.

I strived to give a holistic account to the research themes via triangulation of data sources. A holistic account entails I developed a complex picture of the problem or issue under study. This involved reporting multiple perspectives, identifying the many factors involved in a situation, and addressing the larger picture that emerges (Creswell, 2014). I attempted to simplify the complexity through visual models. A visual model of many facets of a process or a central phenomenon aids in establishing this holistic picture as is used through the imagery in the adapted theories and merged results (Verdinelli & Scagnoli, 2013).

The choice of triangulation was to corroborate the results in this little researched study area. To obtain a rich description of the seafood local processing lines and byproduct utilization, the multi-method approach of triangulation of data sources was chosen (Sønvisen, 2013). The data sources are interviews, survey, and literature. Interviews and surveys are collected by this thesis' research meriting them as primary data sources. While literature is a secondary source and data compiled by others (Burke, 2016).

The qualitative interviews were semi-structured in form and there were 36. Each interview lasted between 30 minutes to 3 hours. The average (mean) time was 65 minutes when rounded to the nearest 5-minute interval. This thesis did not collect personal data, as it was not the personal information that was of interest, but rather the view of the person on industry issues (hence, we do not collect name, age only in very broad terms). Most of the interviews were recorded. They were not transcribed, but only used to pre-fill the responses on the online survey. Pre-filled responses are when I conduct the interview covering the survey and filling in the responses for them. The email confirmation allowed interviewees to review, update and confirm the pre-filled responses. The email is collected to follow-up with participants to review and confirm the electronic survey responses before this research used them in the analysis. The email is removed from the data-set, and the responses are made anonymous with rules of processing of personal data in accordance to the Norwegian Data Protection Services (NDPS, NSD in Norwegian). Each informant is referenced as a number and a minimum of quotes are used from each informant to avoid revealing identity. This method provided qualitative data without transcribing the interviews and did not merit an application to the NSD system. The informant number used refers to the order in which respondents verified their responses and not the order in which the survey was administered. This is done to further hide the identity of the participants.

The survey was completed by 56 participants. The survey consisted of quantitative and qualitative questions. There was 93% average response to the 42 questions that covered stakeholder background and seafood perception information. The final survey used Google

Forms as its platform. The online platform was chosen as an easy way to update the survey, do pre-filled responses, and use email to confirm the survey responses. All the data was explored. Table 6 illustrates themes as related to the defined case study activities; the survey question number and type; the number of respondents and research topics. The variable name used for this thesis is shown as the bold word in “Topic” column of Table 6. The final survey used is found in the Appendix.

The literature review was used for background information, method/theory development and a source for complimentary qualitative/quantitative data to the primary data. The literature used included educational books; published conference proceedings; scientific journal/articles; official government, organization and company websites; and published databases and consulting reports. The sources are referenced when used.

*Table 6: Overview table of organized survey data by theme, the associated survey question number (#), type of question, the number of responses (N), and the topic. The variable name used is shown as the bold word in "Topic" column.*

| Section | Theme | Survey | | Responses | Topic |
|---|---|---|---|---|---|
| | | # | ? type | N | |
| Stakeholder Information (14 ) | Occupational history | 3 | Multiple choice (MC), check all that apply | 56 | **Stakeholde**r type |
| | | 4 | | 56 | **Years** in fisheries |
| | | 5 | | 56 | Work with **by-products** |
| | | 6 | | 51 | **Which** fisheries |
| | | 7 | | 51 | Operating **region** |
| | | 16 | Short answer | 56 | Most familiar **fishery** |
| | Level of dependency | 8 | MC, all that apply | 53 | Fishery **relationship** |
| | | 9 | | 52 | Generational continuation |
| | | 10 | | 36 | **Network** affiliation |
| | | 13 | Scale 0-10 | 51 | **Cultural**ly dependent |
| | | 14 | | | **Social**ly dependent |
| | | 15 | | | **Financial**ly dependent |
| | UN financial sustainability | 11 | MC, all that apply | 56 | **PRI** (Principles for Responsible Investment) |
| | | 12 | | | **SSE** (Sustainable Stock Exchange) |
| Perception of Seafood Industry (16) | Utilizing residual raw material (fish waste) | 17 | Likert Scale 1-5: 1.Strongly agree, 2.Partially agree, 3.Neutral, 4.Partially disagree, 5.Strongly disagree, 6. No opinion / Don't know | 56 | **Location** |
| | | 18 | | | **Gender** |
| | | 19 | | | **Many** options |
| | Promoting full utilization as sustainability | 20 | | | Financial **Gain** |
| | | 21 | | | **Rural** jobs |
| | | 22 | | | **UN** SDGs assist |
| | | 23 | | | **SDG** 12 & 14 pertinent |
| | | 24 | | | Sustainability **marketing** |
| | Local processing | 26 | | | Increased **utilzation** helps branding |
| | | 27 | | | Sustainability **branding** helped me |
| | | 28 | | | Re-processing **export** constant |
| | | 29 | | | **Wild** catch constant |
| | | 30 | | | **Farm** seafood increase |
| | Innovation / Entrepreneurship as solution | 32 | | | **Loss** of value |
| | | 33 | | | **Employ**ment opportunity |
| | | 34 | | | **Innovation** encouraged |
| Seafood Downstream Structure (10) | Sustainability Baseline | 25 | Scale 1-4 | 55 | **Entrep**reneurship= local utilization |
| | | 31 | | | Supportive **community** |
| | Primary products | 35 | Scale 10-100% | 48 | Full utilization |
| | | 36 | Short answer | 46 | Local Processing |
| | Downstream products | 37 | Y/N, short answer | 42 | Weight % by volume used towards **primary** product |
| | | 38 | | 42 | Species and product form |
| | | 39 | | 37 | By-product **pyramid** |
| | In 5 years | 40 | Long answer | 47 | Full utilization and local processing |
| | In 20 years | 41 | | 48 | |
| | Inn / Ent as solution | 42 | | 45 | Innovation and entrepreneurship assisting |

### 3.2.2 Informant Selection and General Survey Design

In the case of survey/interview data collection, mixed methods reflect participants' point of view. The two types of data allow a voice to study participants and ensures that study findings are grounded in participants' experiences (Wisdom & Creswell, 2013). Convergent research designs collect qualitative and quantitative data in parallel from different informant groups (Creswell et al., 2011). Due to the time constraint and being a single researcher for this study, this was not possible to have separate informant groups. This thesis used the same informants for both quantitative and qualitative methods.

Table 7 illustrates the number of participants by location used in the survey collection and of those who participated in interviews.

*Table 7: Survey and interview participants by location.*

| | Survey | Interview | |
|---|---|---|---|
| | # | Yes | No |
| Alaska | 31 | 28 | 5 |
| Iceland | 2 | 1 | 1 |
| Norway | 23 | 7 | 17 |
| Total | 56 | 36 | 23 |

There was a total of 56 answered surveys with a little over half from Alaska fishery stakeholders. Although many of the stakeholders do not reside or come from Alaska, Iceland, or Norway, each stakeholder is grouped to the research fishing areas in which they have their primary work experience related to fish. There was a total of 36 interviews. There are 3 interviews that did not participate in taking the survey: 2 Alaska, 1 Norway. These interviews are not included in the qualitative coding analysis for consistency in the merged results; however, their insights are used to qualify quantitative results. The informant sampling pool is the same for the interviews and the surveys. Although, many mixed methods studies use separate sampling groups f to ensure independent results from one another (Creswell, 2014; Gubrium, 2012; Johnson, 2017), this was not not possible due to limited time and resources.

Overall, the informants[7] consisted of an experienced group in terms of work years and positions. There were 21 stakeholders with over 20 years work experience in the fishing industry: 14 from Alaska, 5 from Norway, and 2 from Iceland. Over 55% of the stakeholders

[7] The words "informants" and "stakeholders" are used interchangeably in this thesis.

had over 10 years work experience. In terms of different types of work experience within the fishing industry, approximately 70% (39) of the stakeholders have held several positions.

Based on regions, Southern Alaskan (Bristol Bay, Southcentral and Southeast) and Northern Norway (Nordland and Troms region) are most represented 26/31 and 17/23, respectively for the surveys. All stakeholders that are categorized as "Alaska Fisheries" have experience with a Pacific salmon fishery. In summary, 46/56 or 82% surveyed stakeholders have work experience within salmon. Bristol Bay Sockeye salmon has additional insight with it being the area of the harvest processing exercise and it represents 18/31 Alaskan surveys and 18/28 interviews. In conclusion, this thesis gathered the most information about Bristol Bay salmon for Alaska and Northern Norway farmed salmon.

The Icelandic stakeholders are included due to the initial pilot interviews in Alaska, which revealed that Alaska stakeholders are willing to share more information if there is a transparent gain for them and if I took an active role as an interviewer to engage the discussion surrounding the themes. In the case of this research, the gain was information exchange. This caused the initial survey to be filled with information about Norway and a little about Iceland. The Alaskan informants were curious to compare with a country many have viewed as a rival since the salmon crash of early 2000s, when farmed salmon flooded the market (Informant 1, 2019). Iceland was brought up as a solution model by the first three interviewees to maximize utilization of byproducts (Informant 1-3, 2019). Both Icelandic interviewees have over 20 years fisheries experience from Iceland with focus on full utilization.

The informant selection began in Alaska with the first five interviewees that were key informants to the seafood industry with over 20-years work experience. They were contacted via common contacts and agreed to a meeting based on personal connections. Instead of researching each interviewee, the snowball effect method was used of letting each interviewee recommend the next (Sønvisen, 2013). The snowball effect allowed for me to use other people's social networks to identify informants in a short time period; however, there are chances that key informants were overlooked by existing in other social circles. The snowball effect was used to gather the first 40 survey responses.

The next set of interviewees and survey respondents were sought out to fulfill the broader focus in sustainability issues. The nature of the sustainability theory means that the informant selection needs individuals to have focus beyond the economics of the defined activities (Msangi, Kobayashi, Miroslav & Batka, 2015). These interviewees were thus investors and economic developers that have a close relationship to the ocean. They come from the Netherlands, a developed nation similar to Alaska and Norway and have or are pursuing work experience in either Alaskan or Norwegian salmon. In contrast to Alaska and Norway, Netherlands has limited geographic space and natural resources and therefore these informants should have different perspective. The Netherlands is faced with climate change problems daily with almost a third of its country under sea-level[8]. The concept of waste is becoming archaic for them, because waste is now seen as a resource as input for other products. The largest ocean cleanup project hales from the Netherlands.[9] The sought out Dutch interviewees resulted in further insights in the circular economy, which is a culminating theory that is used to build the synergies for this case study.

## 3.3 Quantitative Method

### 3.3.1 General about Quantitative Method and Thesis Application

Quantitative methods use numerical data. The analysis techniques, such as graphs, charts and statistics allow meaningful information to be conveyed. Quantitative analysis helps to explore, present, describe and examine relationships and trends within data (Saunders, Lewis, & Thornhill, 2009).

Quantitative data is used to answer research question 1, 2, and 3. Question 1 deals with harvest processing volumes, and the interview data from the Alaska interviewees provided salmon byproduct utilization percentages and the rest of the harvest processing volumes were found in literature data. Question 2 explored seafood perceptions and built a typology of the stakeholders based on the survey data. Question 3 addressed the current and future perceptions of seafood processing and used ranking questions from the survey.

### 3.3.2 Literature Review

The quantitative data from literature is the use of public databases. The first research question addressed the current harvest processing volumes for Alaska and Norway. The information for

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[8] https://www.holland.com/global/tourism/information/dutch-water-facts.htm Accessed 4/30/2019.

[9] { HYPERLINK "https://www.theoceancleanup.com/"} Accessed 4/30/2019.

Norway was found via reports and official government and research websites (Fiskeridirektoratet, 2019; Karlsen, 2019; Norges Råfisklag, 2018; PwC Seafood, 2018; Richardsen et al., 2017). All but one of these sources, “Barentswatch.no” (Karlsen, 2019) are published in Norwegian. The data preparation included a translation step performed by the researcher.

The Alaska harvest processing volumes are found by a combination of doing literature review and performing a data compilation exercise with public databases and insights from key informants through this thesis interviews. The literature review foun numbers that are compiled from several sources (Bimbo, 2009, 2011; Crapo et al., 2004; McDowell Group, 2017, 2019). The data compilation exercise that was used to understand salmon byproduct utilization in Bristol Bay used several sources (Alaska DEC, 2019; Alaska Department of Fish and Game, 2018; Cotten & Kelley, 2017; Department of Fish and Game, n.d.; Division, 2018; Poetter & Shriver., 2018).

### 3.3.3 Data Collection and Preparation

The quantitative survey data collected closed-ended questions that are quantified to identify factors that influence an outcome or understand the best predictors of outcomes (Gubrium, 2012; Martín-López, Montes, & Benayas, 2007). To explore stakeholder perceptions (question 2 and 3), the survey design used Likert scale questions and ranking questions. Likert scale questions are a common survey form and fitting for gauging perceptions (Gubrium, 2012; Harpe, 2015; Martín-López et al., 2007; Ordoñez-Gauger, Richmond, Hackett, & Chen, 2018; Sønvisen, 2014). The ranking questions are preferred to establish a comparison between the sustainability factors for today’s harvesting processing volumes. Table 7 outlines the 16 Likert scale questions and from here on these are referred to as the “perception survey.” They are used to collect information about perceptions of the current seafood byproduct structure. These questions have 100% response record, as all 56 respondents asked answered the survey. When designing the perception survey, I assessed if they were to be bipolar or unipolar. Bipolar splits attitudes on two sides of neutrality, such as “love” vs. “hate.” Unipolar provides the range of possible answers that goes from “none” to the maximum. The latter, a unipolar scale, is preferable in most cases (Harpe, 2015). This thesis used unipolar questions.

The ranking questions used the sustainability theory to build questions for the survey and then rank the respondent’s relationship to economic, social, environmental, and institutional[10] sustainability. The perception of the stakeholders to the current harvesting processing situation is based on two ranking questions from the survey, dealing with local processing and full utilization. The question form is as follows:

> "Rank (1 to 4) how you perceive the following factors (Economics, Environment, Social, Institutional) are prioritized in your fishing industry in terms of full utilization. You can rank the factors with the same weight by giving the same number. (1 is highest priority)"

The survey collected 30 Alaskan responses and 24 Norwegian responses.

In the data preparation, the data is reviewed, confirmed, organized, and explored (Gubrium, 2012). Reviewing the data included checking for blanks, repetition of responses, filled responses represent correct interviewee, and collect the "other" responses on each question. This step showed which data was missed in the Google Forms survey and which respondents I needed to follow-up with to collect more answers. Organizing the data included manually sorting the data to the appropriate sections and themes to answer the research questions.

### 3.3.4 Analysis

The main analysis tools used in this thesis were descriptive statistics and MCA. Descriptive statistics and MCA are rooted in the inductive research strategy, where a specific observation is made and a general conclusion may be true (Kovács & Spens, 2005). Descriptive statistics usually refers to a summary statistic that quantitatively describes or summarizes features of a collection of information. Descriptive statistics are often presented for survey data to show sample size, the central tendency (e.g. mean) of the response and measures of variability or dispersion (e.g. standard deviation) (Creswell, 2014; Johnson, R. B., &Christensen, 2000; Sheard, 2018).

The color coding for presenting the perception survey responses used the Traffic Light System (TLS): where positive responses are green; neutral responses are yellow; the negative responses are red; and no opinion responses are grey. Green means that the respondents are positive to more local processing and more byproduct utilization. By using an established system, the visual presentations induce interpretations by their readers (Verdinelli & Scagnoli, 2013). The TLS was used again in answering the thesis question, which kept the graphics consistent.

The ranking responses were presented in normalized graphs. Normalizing the responses was done in three steps: First, I disregarded the no opinion response and summing the number of each of the 1, 2, 3 or 4 responses. Second, I divided by the total number of opinionated responses and then divided by the sustainable factor that had the highest ranking (as in lowest accumulative value). Third, I divided by 1 and then multiply by 100 to find the percentage of the sustainable factor.

The Multiple Correspondence Analysis (MCA) required further data preparation in the analysis steps. The MCA used eight variables: four perception questions and four background questions describing the stakeholders. Perception questions with variation in the responses were used as active input to the MCA (Table 8). For ease of interpretation of the perception questions, the Likert scale was transformed from 6-scale to 3-scale. The 6-scale (from strongly agree (1) to strongly disagree (5), was transformed into a 3-scale (3-scale: 1. agree, 2. neither/nor and 3. disagree), whereas neither/nor represents the neutral and don't know responses.

*Table 8. The eight input variables for MCA: four Likert scale questions and four stakeholder background questions.*

<table>
<tr><th colspan="2">Variable</th><th rowspan="2">Desciption of Options</th></tr>
<tr><th>Name</th><th>Description</th></tr>
<tr><td rowspan="6">Years</td><td rowspan="6">Amount of years in commercial fisheries</td><td>>0 to 5</td></tr>
<tr><td>6 to 10</td></tr>
<tr><td>11 to 15</td></tr>
<tr><td>16-20</td></tr>
<tr><td>Over 20</td></tr>
<tr><td>Not yet, but plan to</td></tr>
<tr><td rowspan="4">Stakholder</td><td rowspan="4">Stakholder types grouped to 4 options</td><td>Fish= Fisherman/ Farmer</td></tr>
<tr><td>Lead= Leader/ Economic Developer/ Investor</td></tr>
<tr><td>Research= Researcher/ Student/ Professor</td></tr>
<tr><td>Process= Processor</td></tr>
<tr><td rowspan="5">Fishery</td><td rowspan="5">Based on answers from "Which fishery are you most familiar with?"</td><td>Alaska fisheries</td></tr>
<tr><td>Alaska salmon</td></tr>
<tr><td>Farm salmon</td></tr>
<tr><td>Norwegian fisheries</td></tr>
<tr><td>White fish</td></tr>
<tr><td rowspan="3">Location</td><td rowspan="3">Location of primary work experience</td><td>Alaska</td></tr>
<tr><td>Norway</td></tr>
<tr><td>Iceland</td></tr>
<tr><td>Export</td><td>The current level of exporting salmon for reprocessing out of Alaska/Norway will remain constant (15-year time-frame).</td><td rowspan="4">1-2 = Agree 1; 3,6 = NeitherNor 2; 4-5 = Disagree 3</td></tr>
<tr><td>Gain</td><td>There is financial gain by reducing post-harvest losses.</td></tr>
<tr><td>Rural</td><td>Iceland’s increase of byproducts and of higher-value byproducts has helped promote jobs in rural areas</td></tr>
<tr><td>Utilization</td><td>Increasing fish utilization helps with sustainability branding (ASC/MSC/RFM)</td></tr>
</table>

One of the background variables was called “Fishery” (Table 8). This was created by transforming the responses to the open-ended question, “which fishery are you most familiar with?” to one of the five groups: Alaska Fisheries (15 respondents); Alaska Salmon (13); Farm Salmon (11); Norwegian Fisheries (7); and White Fish (10). Alaska fisheries and Norwegian fisheries refer to stakeholders that work at the state-level /national-level, meaning they are researchers or consultants that have work that concerns the entire state/country.

MCA models are developed to fit the data (inductive reasoning) instead of fitting data to models (deductive reasoning). The main reasons for choosing MCA was that it allows for the inclusion of nominal categorical variables, such as the stakeholder variables in the survey of fishery and location. In addition, MCA offers a better visualization of the results (Sønvisen, 2014). MCA detects and represents underlying structures in a large set of categorical and numerical data in one display. It does this by representing data as points in a low-dimensional Euclidean space, meaning associations between two or more qualitative variables are examined to produce a low-dimensional map where similar objects are clustered. The procedure thus appears to be the counterpart of principal component analysis (PCA) for categorical data and can be viewed as an extension of simple correspondence analysis (CA) (Hervé & Dominique, 2007).

In this research, stakeholders are clustered by their responses and background information, creating secondary processing types. The origin of the map reflects the average response, and stakeholders' variable's distance from the origin reflects the variation from the average. MCA is performed by applying the CA algorithm to an indicator matrix. An indicator matrix is individuals by variables matrix, where the rows represent individuals and the columns are dummy variables representing categories of the variables (Kassambara, 2017). Analysing the indicator matrix allows the direct representation of individuals as points in geometric space. In the indicator matrix approach, associations between variables are uncovered by calculating the chi-square distance between different categories of the variables and between the individuals (or respondents). These associations are then represented graphically as the previously mentioned low-dimensional Euclidean maps. Oppositions between rows and columns are then maximized to uncover the underlying dimensions that differentiate the central oppositions in the data, in doing this creating the "secondary processing types." As in factor analysis or PCA, the first axis is the most important dimension, the second axis the second most important, and so forth, in terms of the amount of variance accounted for. The number of axes to be retained for analysis is determined by calculating modified eigenvalues (Hervé & Dominique, 2007; kassambara, 2017). The software of R and an excel add-in called, XLSTAT, were used to perform the MCA.

## 3.4 Qualitative Method

### 3.4.1 General about Qualitative Method and Thesis Application

The qualitative data collected open-ended questions that were analyzed to explore and understand a concept or phenomenon, because little research has been performed in this field of connecting local processing to full utilization. Qualitative research is especially useful when the researcher does not know the important variables to examine, the topic is new, or the subject has never been addressed with a certain sample or group of people (Creswell, 2014; Lamont & White, n.d.). Qualitative research examines the "breadth and depth of phenomena to learn more about them (Johnson, 2017)." Qualitative methods use text and image data, have unique steps in data analysis, and draw on diverse designs (Creswell, 2014). The absence of numeric data and direct measures causes qualitative data analysis more susceptible to biased interpretation or subjective manipulation (Lazar, Feng, & Hochheiser, 2017). For this reason, it is essential to adopt well established procedures and techniques to ensure high-quality analysis that is both valid and reliable. This thesis minimized the biased interpretation by employing a case study that used a triangulation of data to develop a consistent story.

Qualitative data is used to support and elaborate on the perceptions of the informants. The free-form responses from the informants provide further information dealing with seafood processing in general and the case study's full utilization and local processing in research question 3. The identified reference cases that highlighted businesses engaging in increasing utilization and local processing used a qualitative method to select the businesses. The reference cases (businesses) are selected by the criteria that at least five interviewees mention them when discussing the thesis themes. Reference cases are selected for Alaska, Norway, and Iceland. This research chose to pick reference cases that the interviewees selected when discussing local processing and full utilization. The reason for doing this was to limit the scope of potential byproduct businesses and use the interviewees ground knowledge to zone in on businesses that are already taking a progressive direction in the research themes. This helped to go into depth and understand the patterns found in the statistics from the quantitative responses.

### 3.4.2 Literature Review

The qualitative literature data is used in the background information and the reference cases.

The information gathered about the reference cases are primarily based from the company's own website and published literature. The Norwegian case includes some prior interview information.

The purpose of the literature is to elaborate on insights provided by the interviewees and to build a background understanding on the topics.

### 3.4.3 Data Collection and Preparation

The survey design used the three open-ended survey questions as the primary source of qualitative data collection. These questions address seafood perspectives on short term (5-years) and next generation (20-years) in local processing and full utilization and how innovation/entrepreneurship influence the perceived trends. The design of the thesis question of "how Alaska and Norway can align their future strategies and find synergies to move in the direction of full utilization of byproducts and thereby contributing to the objectives of the blue- and circular economy" is rooted in the theoretical framework (sustainability, blue and circular economy). These theories suggest that innovative ideas lead to sustainability and entrepreneurship leads to systematic change (see 5.3 Purposes and Application) and thus this was the reason of designing the qualitative survey to include the innovation/entrepreneurship theme. The qualitative survey input data collected is from 29 respondents for Alaska and 18 respondents for Norway.

### 3.4.4 Analysis

In qualitative analysis, the researcher needs to develop a set of coding categories that accurately summarizes the data or describes the underlying relationships or patterns hidden in the data (Creswell, 2014). The qualitative analysis applied in this thesis is inspired by grounded theory; however, due to its variation regarding its implementation process and guidelines, this thesis employs an adapted version for its coding (Creswell, 2014; Lazar et al., 2017). Bernard (1996, p. 6) describes grounded theory as "a set of techniques for (1) identifying categories and concepts that emerge from text, and (2) linking the concepts into substantive and formal theories."

The coding analysis done in this research used two steps. The first step used the quantitative MCA results to see if stakeholder groups could be identified by their perceptions towards byproduct utilization and thereby build a coding method for the qualitative work. The MCA results indicated that "location" was the main active variable defining the groups. Hence, location was used as the first step to categorize the qualitative questions into geographic groups: Norway and Alaska. The second step, inspired by grounded theory Bernard (1996) was used for circular economy (CE) theory. CE was used as theoretical input to the coding. The Alaska and Norway responses were separated into three categories: status, enablers and barriers. Status refers to the responses that give present day indications on the level of utilization and local processing. The enablers and barriers are correlated to the circular economy themes as outlined by (Zagragja, Rydningen, Jacob, & Pedersen, 2016) (see Appendix for tables). Enablers are the responses that support CE design and promote increased utilization/local processing. Barriers are that of the opposite.

The interview data was used to define the reference cases and to give additional qualified insight to the research themes.

## 3.5 Generalization, Reliability and Validity

It is difficult to say that the sample group represents the general seafood industry of these two areas. By the Alaskan numbers (N) alone, if we say there are around 40,000 seafood jobs (McDowell Group, 2013, 2015) and my thesis sampled 23 that is around 0.06% of the population pool. By including the semi-structure interviews, the extent of each survey respondent could be subjectively qualified as to the reach and power each of the respondents sampled (Gubrium, 2012). This means that I cannot generalize to individuals who do not have the characteristics of participants (Creswell, 2011). For this reason, I restrict claims about groups to which the results can be generalized as in the interviewed Alaskan salmon fishermen reflect all Alaskan salmon fishermen.

An advantage of developing a case study is that you gain depth of a study area (Yin, 2009). Even if the sample number or the merit of the key informants are lacking for this thesis, there was a triangulation of data employed to gain supporting data for the case study. Furthermore, this case study coincides with other ongoing efforts that can help strengthen the validity of the findings. That effort being the collaboration project between Northern Norway and Alaska via AlaskaNor.

The estimates for available byproducts and utilization are more valid for Norway. The Alaska estimates required relying on several sources that were not specifically suited for these research themes. The Norwegian estimates are based on annual publications that use more industry knowledge with surveys than I was able to do with this thesis. In addition, the Norwegian research is done by a team of experts in a methodology that dates back to 1991 (Richardsen et al, 2017, pg. 11).

In order to produce high-quality coding, multiple coders are usually recommended to code the data, but for this research seeing that there was only one researcher, this was not done

(Manderbacka & Jylha, 2000). Reliability control measures should be calculated and evaluated throughout the coding process (Lazar et al., 2017). The coding exercise of this thesis are reviewed by both advisors, but otherwise not controlled.

The main advantages of using Multiple Correspondence Analysis (MCA) is that it may be applied to categorical data and that the graphical display is more intuitive than most other similar methods (Sønvisen, 2014). A disadvantage of MCA is that the results are only as good as the data allows. This may be especially problematic in self-reporting, as part of the survey is problematic in terms of objectivity and reliability.

The validity using the convergent approach should be based on establishing both quantitative validity and qualitative validity for each database (Creswell, 2014). There was validity in the construction of the quantitative data by not using data analysis that was not appropriate for the sample size and lack of variance. There was validity in the qualitative method by employing triangulation of data sources.

In qualitative data, it is critical to address the validity of the data collected. There are internal and external threats to validity. Internal validity threats are experimental procedures, treatments, or experiences of the participants that threaten the researcher's ability to draw accurate inferences from the data about the population in an experiment (Creswell, 2014). This research has the internal threat of selection. Participants can be selected who have certain characteristics that predispose them to have certain outcomes. To minimize this, participants that represented different parts of the seafood value chain were selected. This allowed for several seafood processing work relationships to be represented. External validity threats arise when experimenters draw incorrect inferences from the sample data to other persons, other settings, and past or future situations. The interaction of selection and treatment is at stake in this study.

## 3.6 Limitations/Challenges and Strengths

There are limitations to mixed methods studies. They are challenging to implement, especially when they are used to evaluate complex models or phenomenon with little collected data or research (Wisdom & Creswell, 2013). By collecting several types of data increases the complexity of evaluations. Mixed methods studies are complex to plan and conduct. They require careful planning to describe all aspects of research, including the study sample for qualitative and quantitative phases, timing, and the plan for integrating data. The following outlines the challenges encountered when employing a mixed method for this thesis.

The complexity of the research themes merited an extensive literature research for the background information in conference material, websites, official political documents, and scientific publications. The lack of reporting styles, units and relying on already compiled data (secondary data) made the confidence in the numbers difficult to address in this thesis timeframe. This means the numbers in the background information are estimates and used as relative values for comparison of the Alaskan and Norwegian fisheries. This background information is important to establish a current picture surrounding the research themes, but there are unidentified errors in the reported values due to the lack of not compiling most of the background data myself and relying on other sources.

Mixed method research relies on a multidisciplinary team of researchers or the primary researcher gaining expertise in handling the different types of data. This often requires a scholarly literature search that encompasses a larger breadth of research topics than if only one type of data is used (Creswell, 2014; Wisdom & Creswell, 2013). Even though I started my thesis before most of my peers and I thought I had limited the scope, it was too ambitious in hindsight to be performed in the tight timeframe.

In the data collection and preparation, there was a limitation with the free software employed (Google Forms) for the surveys. This free platform chopped responses, removed text and had little flexibility for analysing within the platform. The data collection was tedious as many of the longer answers are clipped when the respondent confirmed the pre-filled responses. One participant filled out long responses herself, but I didn't receive them. Hence, many responses were incomplete and required follow-up.

Limitations and critics of the Likert scale is that the distance between two response categories may not be similar. The distance from "Strongly disagree" to "Disagree" may not be the same as the distance from "Agree" to "Strongly agree". Previous studies looking at the effects of changing measurement levels (as in interval to ordinal) or modifying the distance between categories in ordinal measures suggest that these differences are relatively unimportant (Harpe, 2015). As mentioned previously, most people will tend to agree rather than disagree, referred to as acquiescence response bias (Gubrium, 2012). An advantage of my survey design with more positive responses is that I had qualitative questions that allowed for the respondents to elaborate their meanings.

In quantitative analysis, descriptive statistics was one of the only options. The largest challenge to the quantitative data generated from the survey was the lack of variance. There was not enough explanation of the little variance explained by only a few components when looking at all the discrete, interval data generated by the Likert Scale questions. The original plan was to employ factor analysis and augment the results with inferential parametric analysis. This method deemed inadequate on this data set due to lack of variation and sample size. Even non-parametric analysis was difficult for this reason. The common Chi squared test of independence often used for social sciences (Gubrium, 2012; Johnson, R. B., &Christensen, 2000; Martín-López et al., 2007) was not possible due to the lack of population (survey respondents) and lack of variation in the responses. It is difficult to generalize the results and argue that the sample group represents the general seafood industry of these two areas.

A disadvantage for MCA is that there is more than one interpretation of the resulting analysis, thus subjectivity is a concern. Additionally, one cannot identify causality using MCA. For causality, other types of analysis must be applied (kassambara, 2017).

A limitation of the researcher is that I was to design my first survey in a short time period with little guidance. The survey design and execution could be difficult to reproduce, because of the several different methods used to gather the survey data (Sudman, Bradburn, & Schwarz, 1996). For example, some of the Likert Scale questions did not have the description on them and participants answered in the opposite direction. This caused an additional follow-up procedure to confirm responses. In addition, my in-person interviews should have elaborated on the confidentiality of the responses and how the results will hide the participant. The lack of transparency in my work caused one participant to be sceptical. However, the admittance of my nativity to this field allowed several other participants to show empathy and willingness to contribute. The survey design could be improved as I realized in some interviews. Some questions needed more explaining/coaxing. There are some bad questions, because they are not self-explanatory (Creswell et al., 2011).

I had a large amount of questions in the survey, which has the benefit of pursuing different angles to tackle this conundrum of byproduct utilization. However, this had the downfall of informant fatigue and too much data to investigate. I countered my limitations as new to social science by sifting through all the response data, before deciding which analysis to be included in this thesis. This allowed me to learn from my limitations and apply my learnings to the next research of this type.

# 4 Theoretical Framework

## 4.1 Global Pertinence

This thesis uses sustainability and circular economy (CE) theory in a blue economy (BE) context. The theories are tied to organizational efforts that gives the theory practical modern-day pertinence within the research themes. For BE, there are global organizations coordinating a standard definition. This in itself indicates global traction and road maps to action plans (World Bank and United Nations Department of Economic and Social Affairs, 2017). The collaboration project between Northern Norway and Alaska (AlaskaNor) indicate seafood industrial traction within the case study and relevance for the blue economy, as the AlaskaNor team, wrote in the Alaska newspaper (Anchorage Daily News), we are "[l]ooking at growth opportunities in the blue economy (Mellemvik & Raspotnik, 2019, Op-Ed para. 9)."

At the forefront of sustainability definitions and promoting agendas is United Nation (UN). The UN Sustainability Development Goals (SDGs) indicate the real-life roadmap application at the global setting. "Corporate Ocean Responsibility" introduced by the World Ocean Council (WOC) represents economic sustainability for the private sector in the BE to act in accordance with social and environmental sustainability (WOC, 2019, para. 1).

CE is gaining traction within political governance, especially in Europe. The European Commission launched an Action Plan to support the EU's transition to a CE in 2015 (European Commission, 2015). In 2019, the Informal European Commission Export Group suggests how to support CE projects by improving access to finance and thereby accelerating the transition to the CE (European Commission, 2019, pg. 8). The EU marks global consumer traction in CE as it is the largest global seafood importer.

## 4.2 Definitions

The BE terminology has been around for decades (Chawla, 2016). To help consolidate its definition and efforts the UN, the World Bank and 15 other global stakeholders released a 50-

page report, “The Potential of the Blue Economy” (World Bank and United Nations Department of Economic and Social Affairs, 2017). The report identified five types of activities: harvesting and trade of marine living resources; extraction and use of marine non-living resources; use of renewable non-exhaustible natural forces (blue energy); commerce and trade in and around the oceans; and those activities that indirectly contribute to the economy, such as carbon sequestration, coastal protection, waste disposal and biodiversity. A reoccurring theme when discussing, the blue growth concept is the need of cross-disciplinary integration and stakeholder participation (Mazzarella et al., 2017, pg. 177). In terms of management, it calls for more holistic management of complex marine social-ecological systems. It demands a pragmatic approach that is goal- and solution-oriented, realistic, and practical (Burgess, Clemence, McDermott, Costello, & Gaines, 2018, pg. 331 ).

Gunter Pauli initiated a BE effort in 2004 as "ZERI in Action" that highlights case studies. Pauli has an open sourced website with all his copyright material that “inspires the young at heart and in age to become entrepreneurs who want to make a difference” to operate within “the responsibility to navigate between fantasy and reality, over vision” (Pauli, 2016, par. 1). To date there are 112 cases that celebrate innovations of the scientists and the entrepreneurs, focusing on a breakthrough technology with BE principles. There are no cases showcased in Alaska or Norway (Pauli, 2016, “map”). There are 21 principled defined in Pauli’s BE Zeri´s philosophy in action, “where the best for health and the environment is cheapest and the necessities for life are free thanks to a local system of production and consumption that works with what you have” (Pauli, 2016, “principles”). The thesis applicable principles of this philosophy are addressed in the next section and in the conclusion.

In 1987, the Brundtland commission coined the term “sustainable development” (Brundtland, 1987) to describe development which meets the present need without compromising the future generation. The three pillars are more a detailed conceptualization of the sustainable development (UN, 1992, Fig. 2). The three pillars represent economic, environmental and social sustainability. Sustainability is achieved when all three pillars work in unison and are equally weighted. The pillars are interconnected with intergenerational equity, and dynamic efficiency (UN, 1992, pg. 1). This means the consumption of resources will vary because of behaviour, technology, and availability (Thatcher, 2013). The sustainability values are future-oriented and collaborating across disciplines in the solution to balancing the pillars (Hammer & Pivo, 2017;

Tavanti, 2010). There have been several developments of the pillars with the addition of a fourth pillar of cultural sustainability. Other scholars define it at a concentric model that describes the factors as overlapping circles with additional factors as institutional, cultural and values being bonding circles (Tavanti, 2010). The United Nations Commission on Sustainable Development (CSD) introduced the “institutional” dimension for identifying the indicators, methods and measurements of sustainability (UN, 2002).

Economic sustainability means a business must be profitable without trumping the other pillars. Economic pillar relates to growth, profit, cost-saving, research and development. The economic dimension includes cultivating markets that promote dematerialization; sourcing environmentally friendly raw materials; developing and utilizing environmentally friendly technology; and, expanding the idea of business ethics to incorporate sustainability principles (Turner, 2014, p.3). For businesses, activities under this pillar include corporate compliance, proper governance and risk management (Beattie, 2019, para. 9). Pertaining to this thesis, there are two aspects brought forth: financial gain and corporate compliance. The financial gain is expressed by harvest volume as export trade and in additional byproduct use. Corporate compliance is encouraged by global groups such as The Economist Group’s World Ocean Initiative that imagines an ocean in robust health, and with a vital economy (The Economist Group, 2018 para. 1) and the World Ocean Council that brings together the international business alliance for corporate ocean responsibility (WOC, 2019, para. 1).

Environmental sustainability relates to natural resource use, pollution prevention, and biodiversity (Elkington, 1997, p. 1.). It includes reducing the carbon footprint, packaging waste, water usage and the overall effect on the environment. The environmental dimension of sustainability emerges from assessing the capacity of the earth to sustain industrial activity, population growth, resource use, and curb pollution. For businesses, activities under this pillar include energy efficiency and renewable input material (Beattie, 2019, para. 5). According to Tavanti, “Environmental sustainability implies the conservation and responsible utilization of the natural capital;” and thus “means the extraction of renewable resources should not exceed the rate at which they are renewed, and the absorptive capacity to the environment to assimilate wastes should not be exceeded” (2010, para. 8). Pertaining to this thesis, environmental sustainability relates to the harvesting practices. Harvests do not exceed the rate at which they are renewed for the wild harvest and do not interfere with other living species rates for the aquaculture industry. The environmental stewardship of Alaska and Norway's harvesting practices are expressed through their sustainability goals via certification schemes (ASMI, 2012; NSC, 2017). This thesis argues that the environmental sustainability related to processing practices, as in exporting abroad for further processing and local seafood discharge in the form of byproducts are overlooked in Alaska and Norway compared to their sustainable harvesting practices.

Social sustainability relates to standard of living, education, jobs, and equal opportunity. The social dimension includes social justice: socioeconomic differences among populations within a single nation in part by focusing on health, education, skills, and wealth-creation potential. For businesses, it's the support and approval of its employees, stakeholders and the community in which it operates (UN, 1992; Elkington, 1997; Turner, 2014; Beattie, 2019). Pertaining to this thesis, the social sustainability aspects explored is local labor and local social structures that support innovation/entrepreneurship. Labor is expressed as number of local jobs associated to the harvest and processing in Alaska/Norway. Innovation/entrepreneurship is explored though the perceptions of the thesis respondents. Other social aspects are brought forth by the interviewees: education, health care, and certification schemes that ensure a labor force that understands their contribution to the complete fish value chain.

The structure of the thesis adapts the three sustainability pillars (economic, environmental, and social) to fisheries science and includes a fourth pillar, institutional (Charles, 2008; De Young, Charles, Hjort, & Food and Agriculture Organization of the United Nations., 2008) as a data collection tool. (UN 1992, 2012). An institutional framework for sustainable development serves to strengthen the other three dimensions and lays the groundwork to balance the other pillars (UN, 2012). Fisheries management serves as this framework and includes the laws, regulations, taxes, incentives, permitting, and penalties associated with the fisheries business.

The UN introduced 17 Sustainable Development Goals (SDGs) in 2016, as a goal to reach the 2030 Agenda for Sustainable Development plan. The UN strives with these Goals to globally mobilize efforts to end all forms of poverty, fight inequalities and tackle climate change, while ensuring that no one is left behind (UN, 2016). The goals that are of particular importance to this thesis are SDG 2 (zero hunger); SDG 8 (decent work and economic growth); SDG 12 (responsible consumption and production); SDG 13 (climate action); SDG 14 (life below water); and SDG 17 (partnerships for the goals).

In terms of fisheries, zero hunger (SDG 2) refers to end hunger, achieve food security and improved nutrition. This reflects to minimize food waste as in utilizing byproducts and converting them to coproducts when possible. Fish serve as a healthy source of proteins (FAO, 2016, p.ii). SDG 8 is further explained by the UN as to promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all. SDG 12 is explained as to ensure sustainable consumption and production patterns. This refers to decoupling economic growth from resource use. In fisheries, this means to coordinate harvest/production of the fish to the end-user consumption. This relates to maximizing utilization of the fish and assuring consumption and not waste of the fish. Climate action (SDG 13) refers to taking strong action against human-induced detrimental impacts on the ecology (ex. reduce natural biodiversity). These impacts are vast and globally not agreed upon, however a common addressed impact is releasing greenhouse gasses. Transportation has associated negative climate impacts via releasing greenhouse gasses. Life below water (SDG 14) is essentially the definition of BE. The UN defines it as to conserve and sustainably use the oceans, seas and marine resources for sustainable development. The UN further defines SDG 17 as to strengthen the means of implementation and revitalize the global partnership for sustainable development (UN "SDGs", 2019).

Circular economy (CE) is an industrial system that is restorative by intention and design, where products are designed for ease of recycling, reuse, disassembly and remanufacturing (Wijkman & Skånberg, 2016). It is an economy with closed material loops (Wautelet, 2018). It is the alternative to the traditional linear model of growth that operates by 'take, make & dispose' mentality that has dominated the global economy so far. The CE concept has gained momentum both among scholars and practitioners (Kirchherr, Reike, & Hekkert, 2017).

The Ellen MacArthur Foundation (EAF) stands as a basis for promoting and defining CE since its launch in 2010 (EAF "mission", 2010). The essential concept at the core of the circular economy is to ensure we can unmake everything we make. CE aims to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources and designing waste out of the system. CE transitions to renewable energy sources and the circular model builds economic, natural, and social capital. The three underpinning principles are to design out waste and pollution, keep products and materials in use and regenerate natural systems.

An important quality of the circular model is that it distinguishes between technical and biological cycles. Consumption happens only in biological cycles, where food and biologically-based materials (such as fish) are designed to feed back into the system through processes like decomposing and providing nutrients to the ocean. However, there are cycles in the model that allow items, like fish, to be recirculated and their economic value to increase. The biologic cycles are to be operated as a regenerative living system. Technical cycles recover and restore products, components, and materials through strategies like reuse, repair, remanufacture or (in the last resort) recycling.

The longer a product can cycle in the system, the more value is created. There are four sources of core economic value creation: inner circle by circling longer; cascaded use; inbound material/product substitution; and pure, non-toxic, or at least easier-to-separate inputs and designs. The seafood industry excels in the cascading design. The power of cascades uses an arbitrage opportunity in the cascading of products, components and materials. The arbitrage value lies in how cascading across different product categories leads to lower marginal costs of reusing the cascaded material, versus using virgin resources and their embedded costs of labor, energy, and material (Ellen MacArrthur Foundation, 2012). This can be interpreted as using the same fish factory, but instead of producing one primary product for human consumption, produce several out of the same fish or produce a primary during the high season, but store the byproducts for secondary production at a later stage. In general, diversifying products to fully utilize the fish adds in cascading cycles. The valorization of abundant and available bio-waste with high potential to manufacture value-added products is the first step to close the loop between waste and consumption in line with the main goal of the CE (de la Caba et al., 2019).

A recent Norwegian study has done a literature review to address how collaborations can assist towards CE. Done correctly in the lens of CE, collaboration stands as a great competitive advantage through leveraging on complementary resources in a future-proof method (Zagragja et al., 2016).

## 4.3 Purposes and Application

The concepts of cascading design and sustainable practices found in the blue- circular economy fulfill the purpose of the thesis ~~is~~ to support collaboration between Alaskan and Norwegian salmon resources to achieve full utilization as profitable, promoting byproducts to coproducts, and encouraging local engagement within the complete value chain. The cascading design~~ed~~ previously explained (Ellen MacArrthur Foundation, 2012) is adopted from the BE (Wautelet, 2018, Figure 4) principles “that natural systems cascade nutrients, matter and energy – waste does not exist. Any byproduct is the source for a new product” (Pauli, 2016, “principles”). Operating in cascading systems mean to use the materials and energy available from the natural systems. This means cascading systems favour locally available resources and seeing that Alaska and Norway are abundant with their salmon resource, they are favoured to benefit from the cascading concept. Alaska and Norway have the opportunity to help one another to encourage innovative behaviour and coordinate seafood product diversity to ensure their industries grow with “entrepreneurs who do more with less. Nature is contrary to monopolization” (Pauli, 2016, “principles”). The synergy between Alaska and Norway will be that they gain the competitive edge of byproduct/coproduct salmon industry, in contrast to the areas that currently do the further processing of their salmon resource. Instead of thinking that byproducts are a waste and “economies of scale” are necessary for action, the BE thought processes encourage~~s~~ “economies of scope.” This means to find synergies and symbiosis with partners to transform waste to resource. BE is inspired by nature where “one natural innovation carries various benefits for all.” (Pauli, 2016, “principles”). Alaska and Norway have many similar natural attributes being both Arctic fishing regions, which means they can benefit by sharing in innovative solutions.

Sustainability defined by CE (adopted from performance economy (Wautelet, 2018, Figure 4)) favors closed-looped production and selling products as a “service.” Alaska and Norway’s service is “sustainable practices” that are in line ~~align~~ with the triple bottom line concept and follows the SDGs. The synergy between Alaska and Norway is to coordinate a systematic change in their current linear thought process of “harvest-oriented” to “circular-oriented

Three figures are adapted from the theories to provide the following: the vision; a data collection tool; and the strategy for future collaborations between Alaska and Norway.

The vision that connects the balanced sustainable pillars to a circular process is shown in Figure 5. It takes the SDGs to explain how local processing and full utilization are circularly integrated to reach a sustainable fishery. The purpose of this figure is to illustrate that the salmon byproducts is from certified, sustainable fisheries, processed for human consumption, so the quality standard is high and this trend of exporting seafood for further processing causes a disconnect of controlling the processing lines.

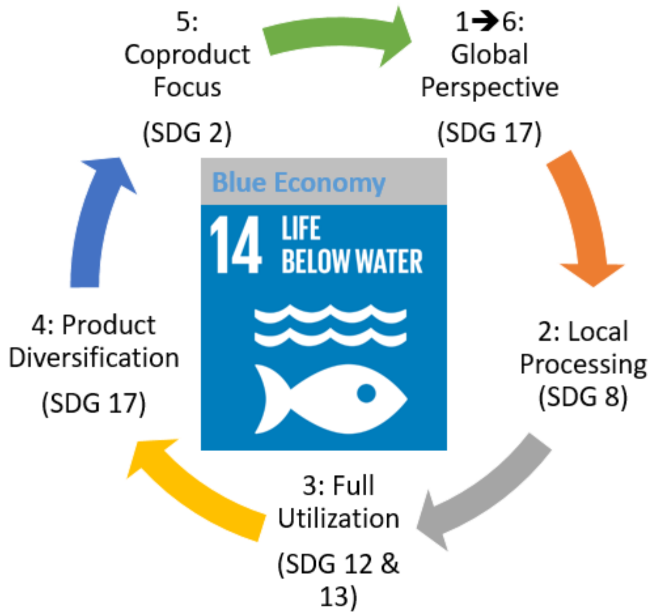


*Figure 5: Circular diagram showing the connection of local processing and full utilization in terms of seven UN Sustainable Development Goals (SDGs).*

Figure 5 shows the circular linkage of full utilization and local processing centered on the blue economy, as in SDG 14 of life below water.

The first step is if Alaska and Norway have the vision of seeing their resource as this connected loop of local processing and full utilization, then they can align their future strategies to move in the direction of full utilization of byproducts and thereby contributing to the objectives of the blue- and circular economy. This will set both areas as having global perspective via SDG 17.

SDG 8 is decent work and economic growth and with a valuable resource as salmon, this can be used to provide healthy, local workplaces. The economic growth arises by at least two ways. First, the local connection of engaging in end products allows for local adaptions to ensure market stability; thus, product innovation and entrepreneurship is a possible result that causes economic growth (EMF and IDEO, 2018). Second, by not exporting the fish for further processing allows the ability to engage in high valued secondary products found in pharmaceuticals and medical applications. With not having access to the lost byproducts, it is difficult to adapt the secondary product to other uses of possibly higher value (PWC, 2018).

By processing the salmon in as many end products at a local level as possible, then one knows that the salmon is being fully utilized in environmentally friendly ways. This is the case for Alaska and Norway that have certifications schemes and institutional standards of responsible harvesting and presumably the case for their processing practices. This represents SDG 12 of responsible consumption and production and SDG 13 of climate change. By sending the salmon to a country of lower operation costs to do the processing and then further sending the salmon to the final market, one disengages in the treatment of byproducts and countries with lower operating costs may also have lower environmental standards for disposal and or utilization. As for climate change, there is an additional transportation step. For Arctic countries that are often far from the consumer market, the transportation is often long distances, such as Alaska sending its fish to China for processing to sell in the US or Norway sending its fish to Eastern countries to sell to the EU (Nystoyl, 2018).

SDG 17 as defined by the UN as partnership for the goals helps product diversification in Alaska and Norway by building a collaborative partnership. As the sustainable harvesters of the salmon, Alaska and Norway can coordinate and collaborate with their product diversification. A strong partnership between these fishing nations can assure to maximize the potential of their renewable resource, so they do not flood markets and can focus on building niche markets for byproducts. By focusing the byproduct to coproduct status, the industry supports SDG2 of end hunger, and minimize food waste.

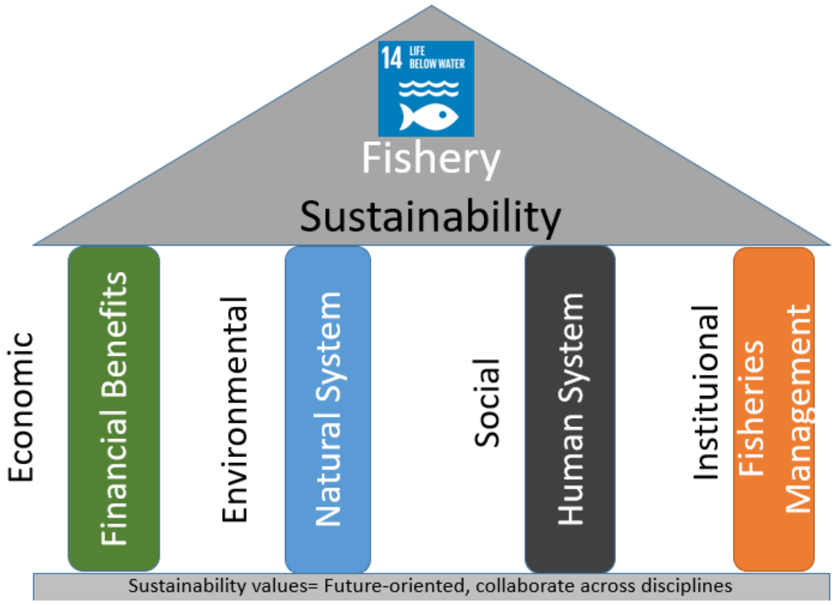


*Figure 6: Sustainability pillars for fisheries (adapted from UN,2012 and Charles, 2008).*

Figure 6 illustrates the adapted model. The overall theme is the SDG 14 (life below water) that focuses on the blue economy activity of fishery sustainability. The economic pillar focuses on the financial benefits. Export value and sustainable branding to secure markets qualify under the economic pillar. The environmental pillar refers to the activities that combat human-induced climate degradation, like over eutrophication of a water mass by fish byproduct discharge. Social pillar refers to a framework of standard of living, education and jobs that contribute to the community wellbeing. The institutional pillar should be the supportive framework to allow stability to the other pillars. If the institutional pillar is not meeting that goal and acts as a barrier to TBL sustainability, then grass-roots efforts coordinated with global partnerships can fulfil this gap and enable the change. Synergy between Alaska-Norway is to cooperate to create policies, law that enable TBL sustainability in fisheries/aquaculture.

Figure 7 depicts the chain of custody steps in more detail with the description of each step outlined and the potential for secondary processing coordination. This figure is adapted from the established sectors defined in “The 2018 Annual Economic Report on EU Blue Economy” and in the 2018 Norwegian salmon report on increasing local processing and byproduct utilization (PwC Seafood, 2018, own translation)).

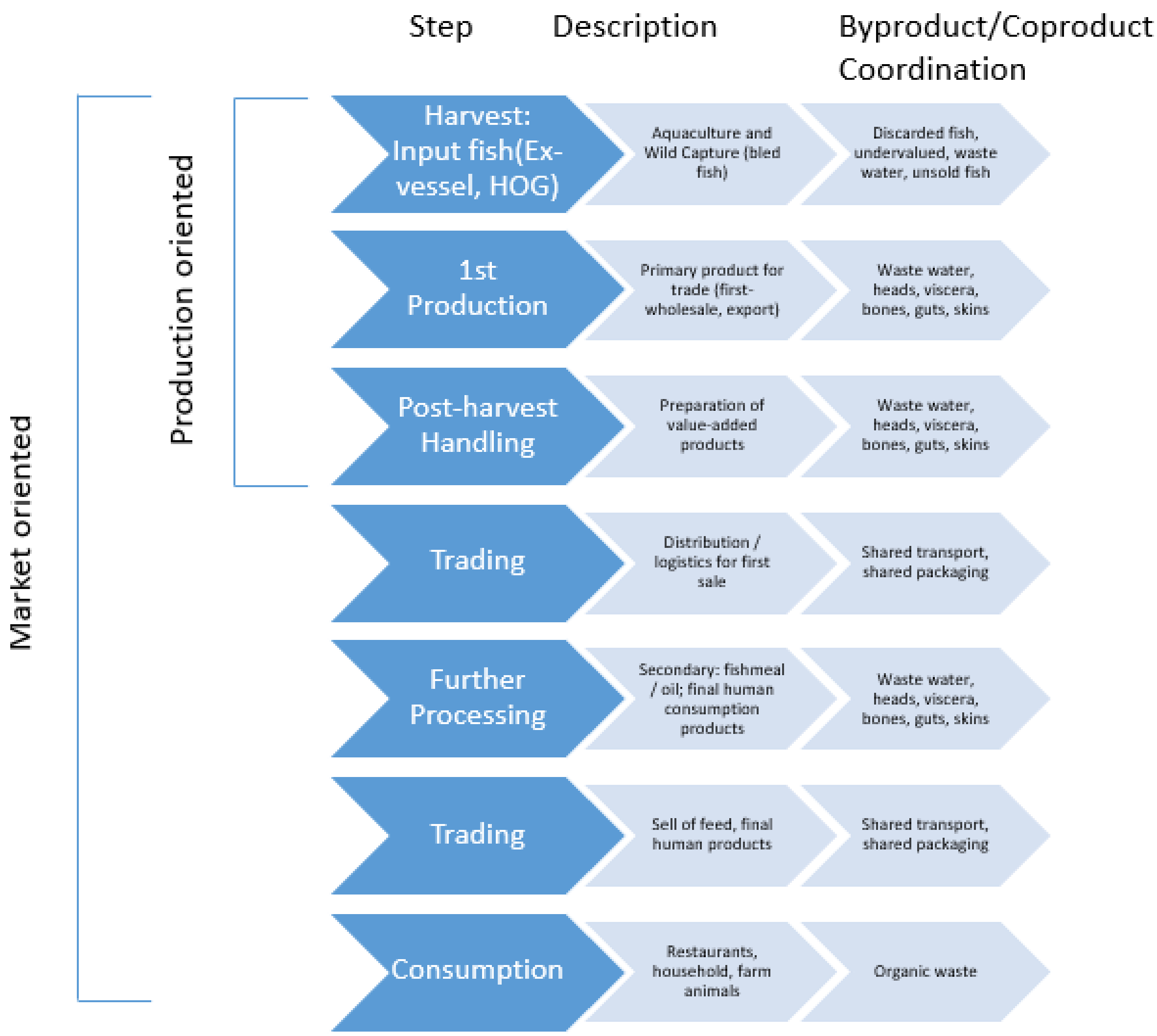


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*Figure 7:Fishery value chain with secondary processing coordination outlined in each step (adapted from "The 2018 Annual Economic Report on EU Blue Economy" and PwC Seafood, 2018).*

Figure 7 is read from left to right, where each step is in dark blue and has the associated description and byproduct/coproduct opportunities in light blue. There are 7 steps outlined from harvest to consumption. A production-oriented company focuses on the first 3 steps of harvest, initial production, and post-harvest handling (PwC Seafood, 2018, p. 18, own translation). A market-oriented company looks at the additional four steps of trading, further processing, trading, and consumption (PwC Seafood, 2018, p. 19, own translation). The chain of custody steps would be simplified in the circular oriented business, where initial production and further production are combined either by the same company or by geographic area. This combination allows there to be only one trading step that organizes all the diversified products to their consumer markets. However, circular oriented businesses are only successful if all aspects of the business model pursues four main goals: product-life extension, long-life goods, reconditioning activities, and waste prevention (Stahel, 2008). Successfully reaching the benefits of circular-oriented services takes constant coordination and adaption to the aforementioned four goals to win over holistic consumer markets that are committed to a service of sustainable practices instead of a product (Burgess et al., 2018).

The purpose of Figure 7 is to relate the current Alaskan and Norwegian production-oriented salmon industry to a theory that encourages engagement of the whole value chain, and thereby confirming the circular vision defined in Figure 5 and thereby providing additional economic, environmental and social prosperity.

CE business models are circular-oriented, which means there is an importance of selling services rather than products. Service-oriented business models stems from a 1976 research report to the European Commission 'The Potential for Substituting Manpower for Energy" written by architect and industrial analysts (Wautelet, 2018, p.2). The circular-oriented business models build on concepts from "performance economy" (Stahel, 2008). This idea is in alignment with SDG 12 that calls for decoupling economic growth from resource use (UN SDG). In application, this means a fishing company could apply the service of guarantying sustainable practice throughout the complete value chain and cut costs by removing steps in the value chain. Circular oriented services are essentially going one step further in a more holistic direction than market-oriented services (Binet, n.d.; Economou, 2018; European Commission, 2019; Ibrahim, 2018; EMF and IDEO, 2018).

# 5 Data Results

This thesis investigated how Alaska and Norway can best align their salmon byproduct collaboration to maximize circular economy synergies for the benefit of local processing and full utilization. To address this alignment, the theoretical framework established a circular vision that connected local processing to full utilization by using the UN SDGs. This vision is based on sustainable practices and was the basis to design the perception survey and semi-structured interviews to answer the four research questions.

The following chapter answered the research questions in the following manner. First, to get an understanding of the volume of byproducts and level of utilization, we established 5.1) the current white fish and salmon processing volumes and the local associated salmon byproduct utilization. To further assess the potential synergies within the industry, we established 5.2) the current seafood processing perceptions and investigated typology. To estimate the potential synergies based on circular-blue economy practices, we established 5.3) how Alaskan and Norwegian stakeholders perceive limitations or growth in the current and future levels of utilization and local processing in their fishery based on sustainable factors. To understand which companies are enabling growth in utilization and/or local processing, we had the stakeholders establish 5.4) reference cases in Alaska, Norway, and Iceland and we described them.

## 5.1 Current Processing Volumes and Potential Available Byproducts

Figure 8[11] illustrates the total harvest (blue columns) in Alaska's wild salmon and white fish and Norway's aquacultured fish (primarily salmon) and white fish that are averaged over the recent years of 2013-2016. These volumes are comparable by weight, as the harvest volumes was 2.2 million tons for Alaska and 2.1 million tons for Norway (McDowell, 2019, slides 3-6; Richardsen et al, 2017, p.3)[12]. Figure 8 shows two categories each for Alaska (AK) and Norway (Nor) of whitefish and then salmon/aquaculture. Each category is described in terms of the total

[11] Table shown in Appendix

[12] Total harvest volumes for Norway are based on live fish weight and Alaska are ex-vessel weight. See **Error! Reference source not found. Error! Reference source not found.**

harvest (blue columns), the potential byproducts from a skinless fillet as the export product (red columns), the available byproducts from the current export products (orange columns), and the estimated utilization on available byproducts (purple columns). Each category is explained and comparisons are made between Alaska and Norway.

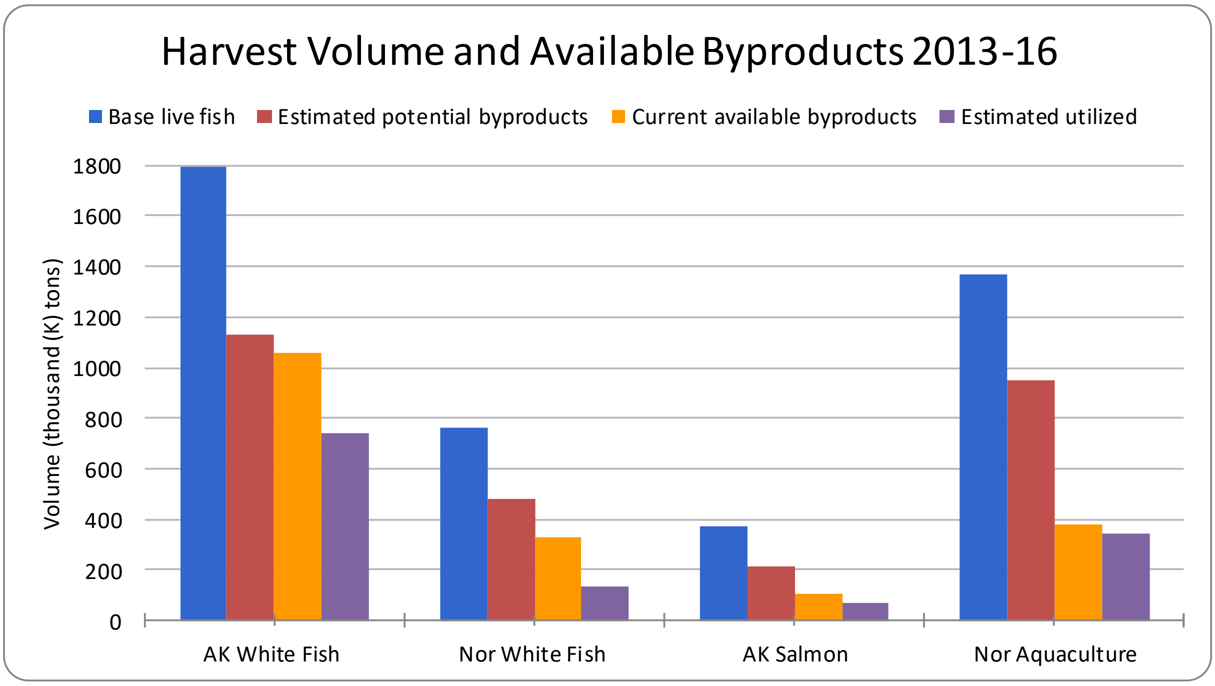


*Figure 8: Current harvest volumes by weight for Alaska (AK) and Norway (Nor) for white fish and salmon in terms of total harvest, current available residual raw material, available byproducts from a skinless fillet and estimated used residual raw material (See 3.5 Processing Volumes for* reference list).

### 5.1.1 Alaskan and Norwegian White Fish

Figure 8 blue column: AK White Fish represents Alaska Pollock and Pacific cod. The Alaskan volumes were from ex-vessel volumes, which means the fish is sometimes bled. Only the high value fishes such as halibut, black cod, and some salmon are bled (Informant 5, 2019). Alaska's volumes were already compiled data that averaged over 4 years from 2013-2016. The original author explained that the 4-year time-frame was to accommodate the natural fluctuations associated with marine captured harvests and thus this research could not observe annual utilization trends (McDowell, 2019, slides 3-6).

Figure 8 red column: I found no supporting information that gives a percent of what is most common final product form for Alaskan and Norwegian finfish products. This research made the gross assumption that a skinless fillet represents primary product for final consumption. This assumption is based on the major consumer markets for both Alaska and Norway are the

USA and EU and these markets have a skinless fillet as a primary consumption product (FAO, 2016, p. 154). The skinless fillet byproduct estimates are used as a comparison to Alaska's/Norway's current processing lines employed to process fish for export. This research assumed that producing a skinless fillet as an export means that Alaska/Norway has full control of the processing lines from harvest to consumption and its associated byproducts. The amount of byproducts estimated available for a whitefish skinless fillet are calculated with the following assumptions (Crapo et al., 2004). For, the fish delivered to the processor is 'round' or whole and usually not bled (Informant 5, 2019). The skinless fillet for an Alaskan Pollock is 34% (Crapo et al., 2004, p. 9) and for a Pacific cod is between 32-39% (J-cut is 32 and V-cut is 39, p. 3). This thesis assumed 37% yield for a skinless fillet for both Alaska and Norway's white fish, which represents a 63% byproduct yield.

Figure 8 orange column: The current available byproduct volumes are estimated by disappearance calculations for Alaska. Disappearance calculations assume that the available byproducts are the difference between the ex-vessel volumes and the wholesale volumes (export volumes) (McDowell Group, 2019, slide 3,4). Based on the disappearance calculations, the available byproducts for white fish is 59% of its harvest volume (McDowell Group, 2019, slide 3,4).

Figure 8 purple column: Alaska's white fish estimated utilization of available byproducts is based on the fish oil consumption. Pollock livers are around 11% of the fish's weight and are 50% lipids (P J Bechtel, 2003; Forster, Babbitt, & Smiley, 2005). If the catch represents around 200 K tons of liver, then the estimated amount of oil would be around 100 K tons. Previous research assumes that all the fish oil is being used either as local energy (80 K tons) by blending with diesel or being sold (20 K tons) (McDowell et al., 2017, p.19-22). The volume of white fishmeal is around 80 K tons (McDowell Group, 2017, p.25), with a conversion rate of 5:1 (Bimbo, 2009, p.242) of byproducts to fishmeal, fishmeal accounts for 420 K tons of white fish byproducts. Seeing that there is not more fish meal sold and most of the oil is locally consumed, the solids that are a byproduct of the oil production are presumably discharged in the ocean. For these reasons, this thesis estimates 70% of the whitefish byproducts are used by fishmeal and oil production.

Figure 8 blue column: The Norwegian whitefish considered is Atlantic cod, haddock, saithe, halibut, ling, tusk, and wolf fish, where Atlantic cod represents over 65% in the time period 2013-2016 (Råfisklag, 2017, p.85). The Norwegian volumes used base live weight, which the blood is assumed to be 2.6% of the total live weight (Richardsen et al, 2017, p.3 & 48). Unlike Alaska, Norway's volumes are available each year and the harvest volumes were extracted from four publications (Olafsen, Richardsen, Strandheim, & Kosmo, 2014, p.3; Richardsen et al., 2017, p.3; Richardsen, Nystøyl, Strandheim, & Marthunussen, 2015, p.3, 2016, p.3). These four years are arithmetically averaged. Due to pre-described groupings in publications, these are the most comparable recent volumes for total harvest.

Figure 8 orange column: For Norway, the available byproduct volumes are published with the total harvest volumes (Olafsen, Richardsen, Strandheim, & Kosmo, 2014, p.3; Richardsen et al., 2017, p.3; Richardsen, Nystøyl, Strandheim, & Marthunussen, 2015, p.3, 2016, p.3). An important difference in available byproducts between marine capture and aquaculture is there is no reported fraction of self-dead fish due to diseases in marine capture. The diseased fish in aquaculture is category II fish (Cat II) and are not allowed to be used towards human consumption (Richardsen et al., 2017, p. 26). This allows for more local available byproducts from aquaculture than marine capture when considering the same local processing lines for export. For this reason, the Cat II fish are addressed in explaining the results.

Figure 8 purple column: In Norway, the utilization volumes are taken from two publications (Olafsen, Richardsen, Strandheim, & Kosmo, 2014, p.53; Richardsen et al., 2017, p.52).

### 5.1.2 Alaskan Salmon and Norwegian Aquaculture

Figure 8 blue column: "AK Salmon" include the five Pacific salmon species (McDowell, 2019, slides 3-6).

Figure 8 red column: The skinless fillet for pink salmon is 42% (Crapo et al., 2004, p. 11) and sockeye is 46% (Crapo et al., 2004, p. 13). This thesis assumes 44% yield for a skinless fillet for both Alaska's salmon and Norway's aquaculture industry, thus 56% byproduct yield.

Figure 8 orange column: Based on the disappearance calculations, the available byproducts for salmon is 27% of its harvest volume (McDowell Group, 2019, slide 3,4).

Figure 8 purple column: To estimate Alaskan utilization of the current available salmon byproducts, this thesis used interview data from key informants (six interviews) and a published report (McDowell Group, 2017). The average estimates of percent of utilization of salmon byproducts by the interviewees were 40% for fish meal, 20% for minced, 5% for fertilizer, and 35% discharged to the ocean. Minced products can either be minced fresh or flash frozen as input for pet food or a step towards silage or other product forms. These key informants' estimate that around 65% of the salmon byproducts are utilized. Using the same rule applied to the white fish that 5 tons of byproducts create 1 ton of fishmeal and yield a nominal 2% of fish oil. According to the McDowell Group, there is 13.6 K tons of salmon meal and 1.4 K tons of oil (2017, p. 20, table 8). Using the same general conversion rate of 5:1(Bimbo, 2009, p.5), the 2015 volumes reflect approximately 62% of the total 110 K tons. The interviewee estimate agrees with the results provided by the McDowell Group for the 2015 seafood season with the percent utilized; however, varies with the discussed product types. In conclusion, this thesis generalized the product forms and assumed that approximately 65% of the salmon byproducts are used for fishmeal, oil, fertilizer, or input ingredients to secondary processing and 35% is discharged to the ocean.

Figure 8 blue column: The aquaculture fish consist of both Atlantic salmon and Rainbow trout, where salmon represents approximately 90% of the aquaculture volumes (Richardsen et al., 2017, p. 26).[13]

### 5.1.3 Alaskan/Norwegian Comparison

Alaska has over twice the white fish harvest as Norway (1796 vs. 760 K tons), while Norway has over four times the harvest volume of salmon than Alaska (1367 vs. 375 K tons). If these harvest volumes were processed as skinless fillets in Alaska/Norway, the associated byproducts would be considerably more for Alaskan salmon and Norwegian white fish and aquacultured fish. Alaskan salmon would have over twice the amount of byproduct volumes (210 K potential tons vs 102 K current tons). The Norwegian aquacultured fish would have the largest potential byproduct gain with a factor of 2.5 (from 378 to 953 K tons).

[13] In 2016: 1.234 million tons of Atlantic salmon / 1.394 million tons of aquaculture fish= 89%

Alaska and Norway have the most potential volumes of byproducts in salmon/aquaculture industry from today's export forms compared to a skinless fillet. Alaska gains ~100 K tons from further local processing for salmon and ~80 K tons in the white fish industry. Even though the white fish industry is almost 5 times larger harvest volumes, it yields less potential utilized byproduct volumes in Alaska. Similarly, Norway would gain ~150 K tons for white fish and 575 K tons in aquaculture industry when comparing today's primary export product to that of a skinless fillet.

Figure 9 used the same volumes as defined in Figure 8 to visually highlight how the current local byproduct utilization in Alaska and Norway is related to the export product forms. This graph compares the current estimated utilization of today's available byproducts (x-axis) to the potential bypoducts from a skinless fillet (y-axis). The percentages of each harvest reflect (estimated utilization/current available byproducts, estimated utilization/skinless fillet byproducts); whereas the estimated utilization value remains the same for each point and the denominator changes. The black diagonal line represents full control of the fish processing steps towards a skinless fillet and the star represents the ideal situation of full control of the processing and full utilization of the harvests, where there would be no byproducts and be considered a closed-loop production in CE (Wijkman & Skånberg, 2016).

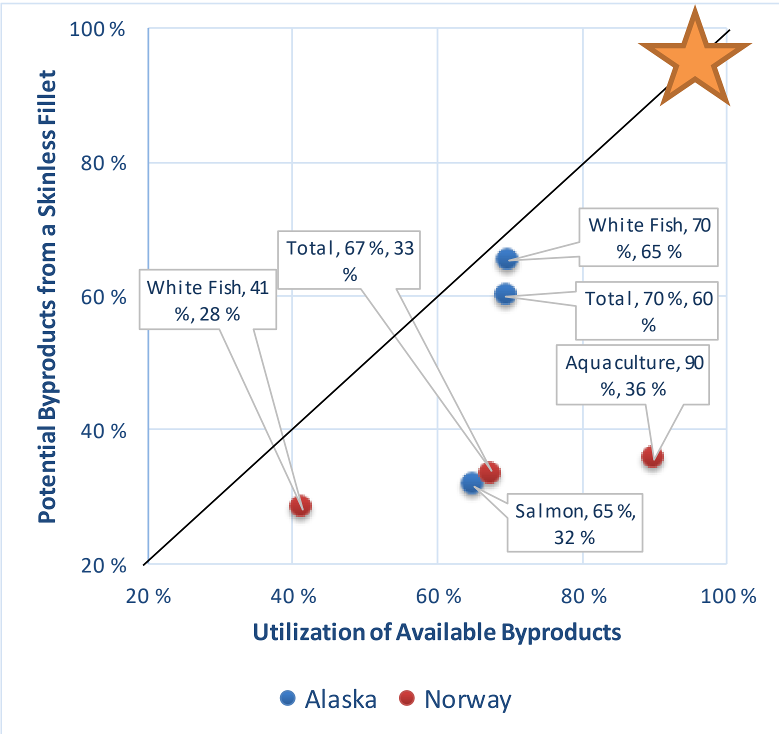


*Figure 9. Alaska/Norway's utilization of available byproducts verses the potential byproudcts when controlloing. Values taken from inderect and direct sources. See 3.5.1.*

Both Alaska and Norway utilize approximately 70% of their available byproducts from white fish and salmon/farmed fish. The farther the distances the points in Figure 9 are from the diagonal line, the larger the potential of gaining more byproducts is from exporting a skinless fillet (which reflects controlling the processing lines and engaging in local processing). Approximately 70% of the Alaska white fish byproducts are utilized and the current export product is similar to that of a skinless fillet. In Norway, 41% white fish byproducts are utilized and the current export product is not similar to that of a skinless fillet. The Norwegian white fish byproduct volumes would increase by nearly 50% (from 329 to 479 k tons) if the export product was a skinless fillet.

Norway's aquaculture posed the largest gain. In 2013-2016, category II fish averaged 18% of the byproducts and varied from 14 to 21% (Olafsen, Richardsen, Strandheim, & Kosmo, 2014, figure 5-12; Richardsen et al., 2017, figure 5-12; Richardsen, Nystøyl, Strandheim, & Marthunussen, 2015, p.3, 2016, figure 5-12). The category II fish percentage is included in both the potential and available byproduct volumes. After removing the category II fish from the harvest volume, there was the stark result that 81% of the fish are being sent abroad for further processing. When considering the category II fish, the current utilization of byproducts represented only 36% of the potential total from a skinless fillet. Similar to Norway, Alaska salmon industry exported 73% of its harvest to further processing to outside the state, reflecting the current utilization of byproducts as 32% of the total potential.

### 5.1.4 Primary and Secondary Salmon Products

The primary processing product for export is crucial to understand the available associated byproducts and their quality, and thus aid in investigating value added opportunities for secondary products. Alaska's salmon utilization focused on the Bristol Bay region due to its global position in its wild sockeye fishery, its substantial harvest volumes that represent ~20% of Alaska's total salmon harvest (ADFG, 2018, "COAR"), and its successful sustainable branding (Alaska Seafood Marketing Institute, 2019). The 2017 Bristol Bay sockeye salmon primary export forms were 71% H&G (head-off & gutted) and 29% fillet (ADFG, 2018; Alaska Department of Revenue - Tax Division, 2017). The Norwegian farmed salmon was similar to Alaska's primary export forms, where approximately 80% of the salmon is exported for further processing as head-on and gutted and 20% as fillets (PwC Seafood, 2018, p.17-20, own translation).

The 2017 Bristol Bay sockeye salmon export forms were estimated using a tax report and a public database (Alaska Department of Revenue-Tax Division, 2017; ADFG, 2018, "COAR"). Figure 5 shows the Bristol Bay management area that covers 9 major river systems and is divided into 5 management districts (Naknek-Kvichak, Egegik, Ugashik, Nushagak, and Togiak).

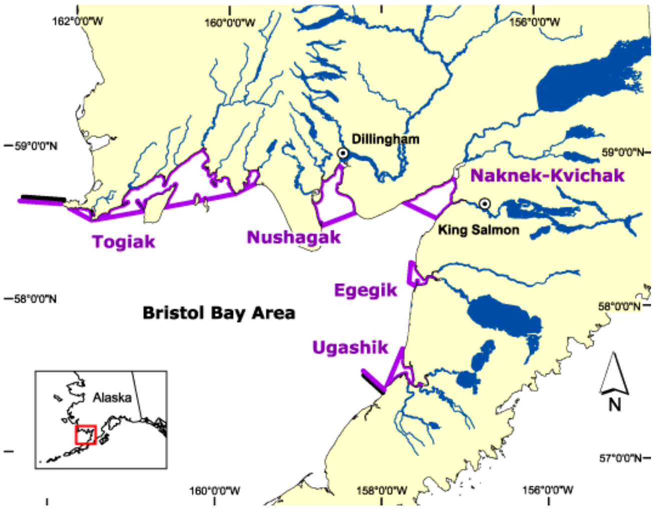


*Figure 10: Bristol Bay management areas (ADFG,2018).*

The Department of Revenue "Annual Alaska Salmon Production Report" provides weight volumes of six process forms (fresh headed & gutted (H&G); frozen H&G; frozen fillet; roe; and thermally processed products) of salmon species and region. The thermal products are assumed to have undergone filleting, as in the byproducts are head, guts, skin, bones, and fins. "Commercial Operator's Annual Reports (COAR)" is the result of the transactions between the first buyer of raw fish, persons who catch and process fish, and persons who catch and have fish processed by another business. COAR reports[14] generalize the processing forms to frozen, fresh, canned or other (Alaska Department of Fish and Game, 2018; Alaska Department of Revenue - Tax Division, 2017).

The estimated product forms for Bristol Bay sockeye salmon harvest for 2017 are shown in Figure 11. The total harvest volume is 64.7 K tons (ADFG, 2018, "COAR").

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[14] In all public databases, individual processor's harvest values and capacities are protected as confidential information under Alaska statute (AS 16.05.815(a)).

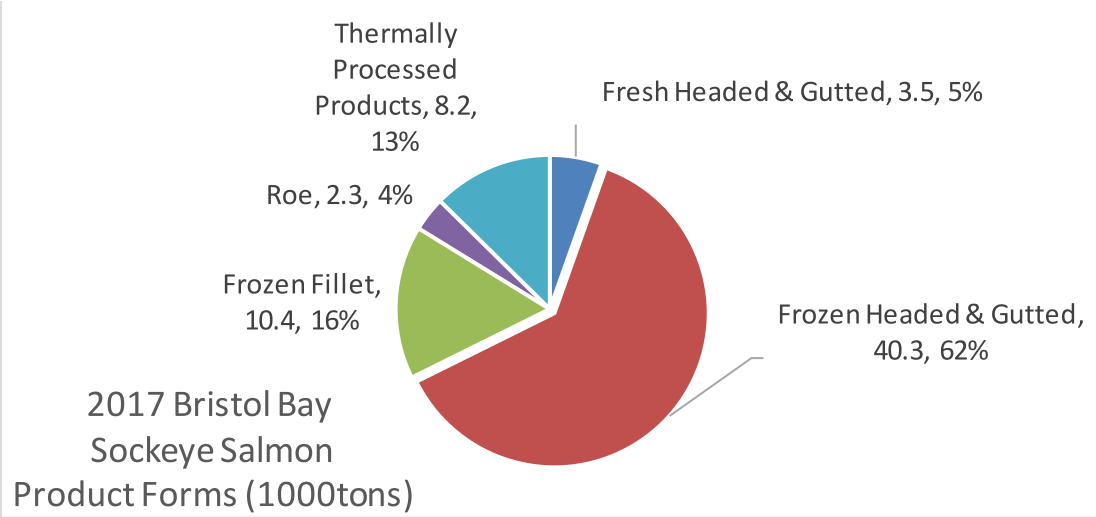


*Figure 11: Bristol Bay Sockeye salmon product forms in 2017 by weight volume (Adapted from Alaska Department of Revenue-Tax Division, 2017; ADFG, 2018, COAR-salmon).*

Figure 11 illustrates the 2017 Bristol Bay Sockeye salmon product forms in (1000 tons) in a pie chart. Each product forms states the volume and the percent of the total harvest export forms. For example, frozen fillet is 10.4 K tons and represents 16% of the total harvest export forms. The H&G product forms account for 71% of the total harvest, when including roe as a coproduct, and 29% is considered fillet[15].

This thesis made use of discharge permits and product types from tax reports from one of the main contributing districts, Naknek-Kvichak[16] in Bristol Bay to confirm the general primary product forms and the available processing lines for secondary forms of the land-based estuary factories (Cotten & Kelley, 2017, Table 4; Esri, 2019, Alaska DEC Seafood Processing). Discharge permits regulate the amount of allowable discharge of byproducts into the ocean for an established seafood processing line for all types of fish. The information from the discharge permits are used to assess the established processing lines and to make speculations about institutional pressure to decrease the amount of byproduct discharge.

[15] The thermally processed products were not given as weight volume, nor were they further explained in terms of processing forms. The thermal product volume is estimated by subtracting the five defined products forms (Department of Revenue) from the total COAR volume.

[16] Referred as Naknek from this point

This thesis found there is no regulatory pressure to use byproducts and there are production lines for coproducts/byproducts in place in many of the facilities without associated public data.[17] Naknek fishing port has a 20-year average (1997-2016) of approximately 16 K tons of sockeye harvested, which is approximately 1/3 of Bristol Bay's 20-year average. The current (2019) accumulative discharge permits of all the nine land-based estuary plants in Naknek was set at 26 K tons (Cotten & Kelley, 2017, Table 4; Poetter & Shriver, 2018, Table 1; Esri, 2019, Alaska DEC Seafood Processing). Seeing that sockeye is the largest contributing species, the discharge allowance is considered too high to promote byproduct utilization. Moreover, the Naknek land-based estuary processing plants have several product forms that are not reported in the COAR or the tax data; such as coproducts of bellies or byproducts of oil, and thus utilization estimates are difficult based on available public data.

Bristol Bay sockeye fisheries is a wild salmon fishery with no hatchery enhancements and has the bulk of its harvest occurring in a 4-week window (week 26-30, Bimbo, 2009). The short harvesting window and large volumes could pose a challenge for local processing and fish utilization, and therefore made this an interesting area. The choice of the export form and additional products depended on facility capacity. For instance, if the harvest season is heavy and short, then facilities do not have the capacity to engage in additional products (Informant 12, 2019). Furthermore, harvest forecasts are quite reliable and byproduct utilization is occurring in all the major production factories where market streams are established (Informant 12, 2019). Additionally, as the season is very intense, cooperation and coordination is limited between the fishermen, tenders, and processing plants (Informant 6, 2019).

To summarize, the volume and types of primary and secondary products for Alaska salmon depend on the production capacity of the facilities. There is lack of readily available byproduct data in Alaska, and the Bristol Bay exercise highlighted that the estimated utilization may vary year to year depending on the intensity of the harvest season and facility capacity. Moreover, there is a lack of reporting for salmon byproduct utilization.

[17] 5/9 factories produce products for which this research could not find associated volumes. 3 factories have minced as a certified process. 1 factory produces salmon oil and 2 others sell bellies.

For Norway, the investigation of the current salmon secondary products used published data based on 2016 harvest volumes (Richardsen et al., 2017, p.7,8, & 29, own translation). Unfortunately, this report grouped white fish, pelagic fish, crustaceans, and aquacultured fish in the results of secondary products created by byproducts, instead of breaking up each sector. Seeing that the current utilized byproducts of the aquaculture sector is the largest at 53% (Richardsen et al., 2017, Figure 5-18, own translation), these results are valid for investigating how Norway utilizes its salmon byproducts to create secondary products.

Some fish byproducts went directly to human consumption as coproducts (for example, dried cod heads), but most of the fish byproducts went through some type of secondary processing. Almost half of the seafood byproducts is turned to silage. The traditional fishmeal and oil production made up 20% of the byproducts. The large and stable volume from aquaculture has led to the growing internal industry of processing fresh fish byproducts for extraction of fresh salmon oil and protein hydrolysate. These fresh products are now of similar volume as the traditional fishmeal and oil, which was around 140 K tons, accounting for ~20% of the total secondary products and are sourced from farmed salmon (Richardsen et al., 2017, p. 7, own translation).

The byproducts are converted to the following secondary products as shown in Figure 12. The 400 K tons of byproducts from aquaculture in 2016 are primarily from viscera (guts) with 145 K tons (36%), category II fish 84 K tons (21%), and blood 35 K tons (9%). The fish frames, heads, skin, and cut-offs are minor fractions that make up the rest of the available byproducts (Richardsen et al., 2017, p. 26 & 29, own translaiton). The energy fraction of 22% and fur farm feed was primarily from the category II fish as input. The viscera was used as input in all the other fractions.

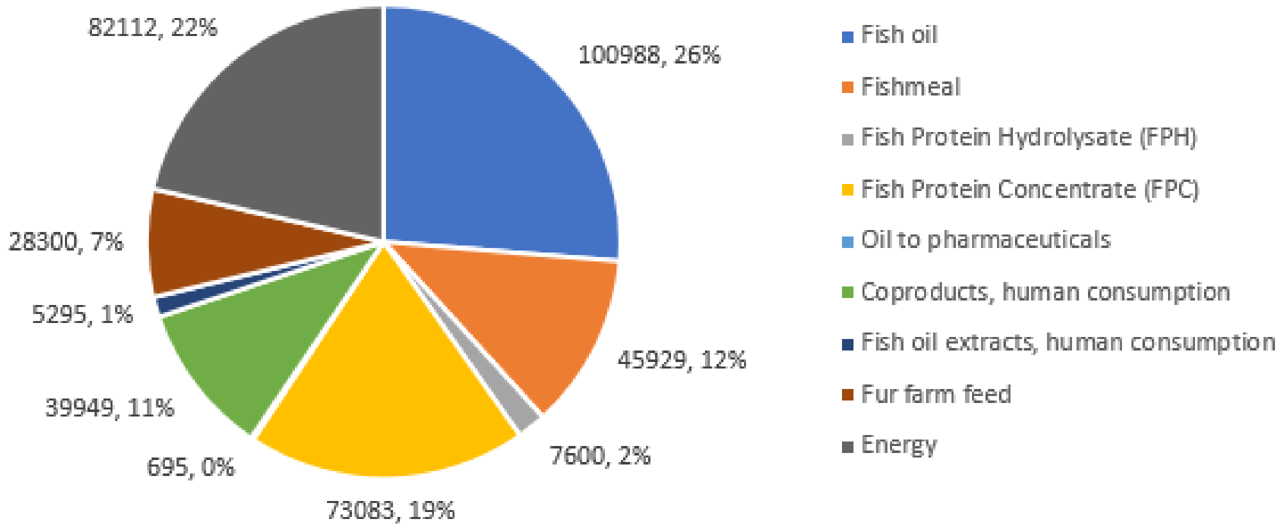


*Figure 12: Processing lines for seafood byproducts in Norway in 2016 by metric tons. (Richardson et al., 2017, p.8, own translation).*

The intention of this thesis was to create a similar pie chart to Figure 12, but only consisted of salmon. Due to the lack of available data for Alaska, it was not possible to put volumes and percentages on secondary products. In Norway, it was not possible to only display the farmed salmon secondary products. This exercise represented a failed attempt to define volumes of secondary salmon products and furthermore highlighted the lack of available data. Even as a failed attempt, there were many observations gathered describing primary and secondary products in Alaska and Norway that are crucial for understanding the current harvest processing volumes.

## 5.2 Seafood Processing Perceptions and Typology

As established in the previous section, Alaska and Norway exported upwards of 70% of their salmon harvest for further processing (2013-2016). Based on current available salmon byproducts, Alaska utilized 65% and Norway 90% of the byproducts from the primary products. As shown in 5.1, if these two fishing areas exported their salmon as a skinless fillet, the current byproduct utilization reflected only 32% and 36% of the potential total byproducts, respectively. Seeing that there is potential gain for more byproduct utilization for both Arctic fishing areas by controlling the processing lines and not exporting for further processing, it was important to investigate the current perceptions on seafood processing to understand the reason why exporting for further processing is occurring. The perception survey represented 56 stakeholders from the following fisheries: 7 Alaskan white fish, 13 Alaskan wild salmon, 7

Norwegian farmed salmon, 15 Alaskan fisheries and 10 Norwegian fisheries. The last two categories reflected stakeholders that worked with all fisheries from the entire state/country. The results to the perception survey are visually presented in bar graphs. Typology was done using Multiple Correspondence Analysis (MCA) for the purpose to find if there are certain groups that are more willing to pursue full utilization and local processing.

The perception survey results of the 16 questions were divided into economic, environmental, and social sustainability themes that reflected the circular vision as described in Chapter 4.3. This vision assumed that more local processing allowed for increased options in byproduct utilization. Each statement was rated by the informant on a six point scale from strongly or partially agree, neutral, partially or strongly disagree, or no opinion. The responses to the 16 questions are colour coded using the Traffic Light System (TLS): Positive responses of "green" reflect direction towards the circular vision of more local processing and more byproduct utilization; whereas "red" indicate resistance to this[18].

[18] When stating the percentages of response in **Error! Reference source not found.**, this research used "agree" to refer to both the green colours and "disagree" to refer to both the red colours. "Neutral" represented both yellow and grey, unless stated otherwise.

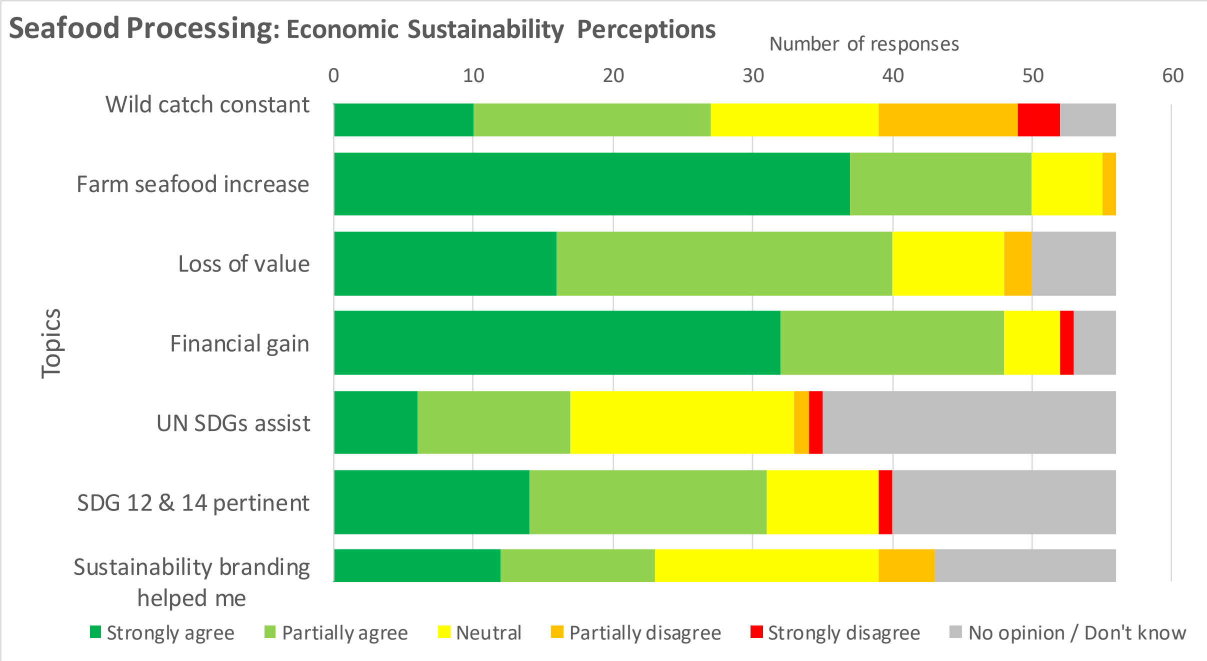


*Figure 13: Bar graph of economic sustainability perceptions for seafood processing of the 56 survey participants.*

In terms of economic sustainability, the respondents agreed to a large extent that farm seafood would increase (89%) and that there would be financial gain (81%) by reducing post-harvest losses. 71% agree that there is a significant loss of value in today's raw material flows for the two Arctic fishing areas. Approximately 50% of the stakeholders feel that wild harvest will remain constant, and the other 50% are evenly distributed between believing there will be significant fluctuations and neutral responses. The two statements related to the UN SDGs had a generally high number of neutral responses. 66% of the stakeholders gave a neutral response to the statement, “the UN SDGs assist in promoting full utilization” with the majority of those responses being “no opinion/don't know.” The next statement read “SDG 12, Responsible Consumption & Production, and SDG 14, Life Below Water, relate directly to full utilization in the seafood industry.” After explaining to the survey respondents that had an interview that they were to respond to their literal interpretation of the SDGs and not their familiarity with SDGs, the results showed a 55% agreement.

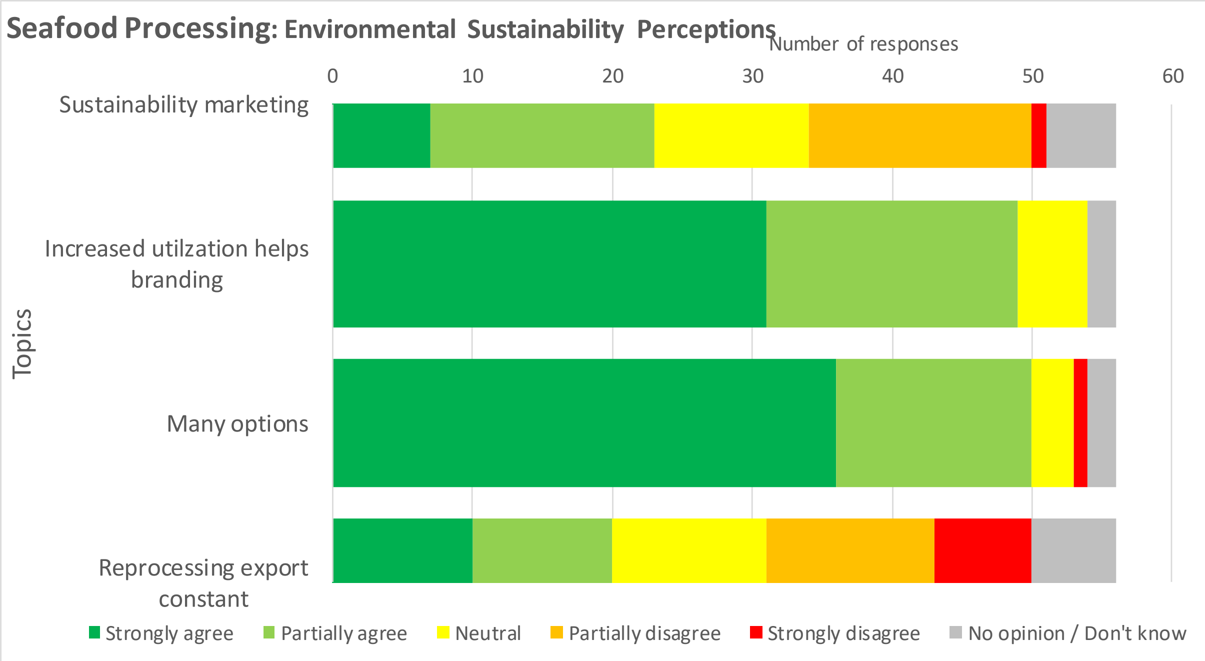


*Figure 14: Bar graph of environmental sustainability perceptions for seafood processing of the 56 survey participants.*

In terms of environmental sustainability, the respondent were most positive to statements that increased utilization would help branding (over 85%) and there would be many options (over 90%) for utilizing the byproducts (wastes) generated by the seafood industry. Less than half of the stakeholders (41%) agree that the branding schemes promote full utilization, and 30% disagree. For the ones that disagree, ½ half of the Icelandic stakeholders (n=2), 1/3 of the Alaskan stakeholders (n=31), and ¼ of the Norwegian stakeholders (n=23). “The current level of exporting salmon for re-processing out of Alaska/Norway will remain constant (15-year time-frame)” received varying responses. 36% of the stakeholders believe that further processing for their fishery/farm will continue to be similar to today’s situation and 34% disagreed.

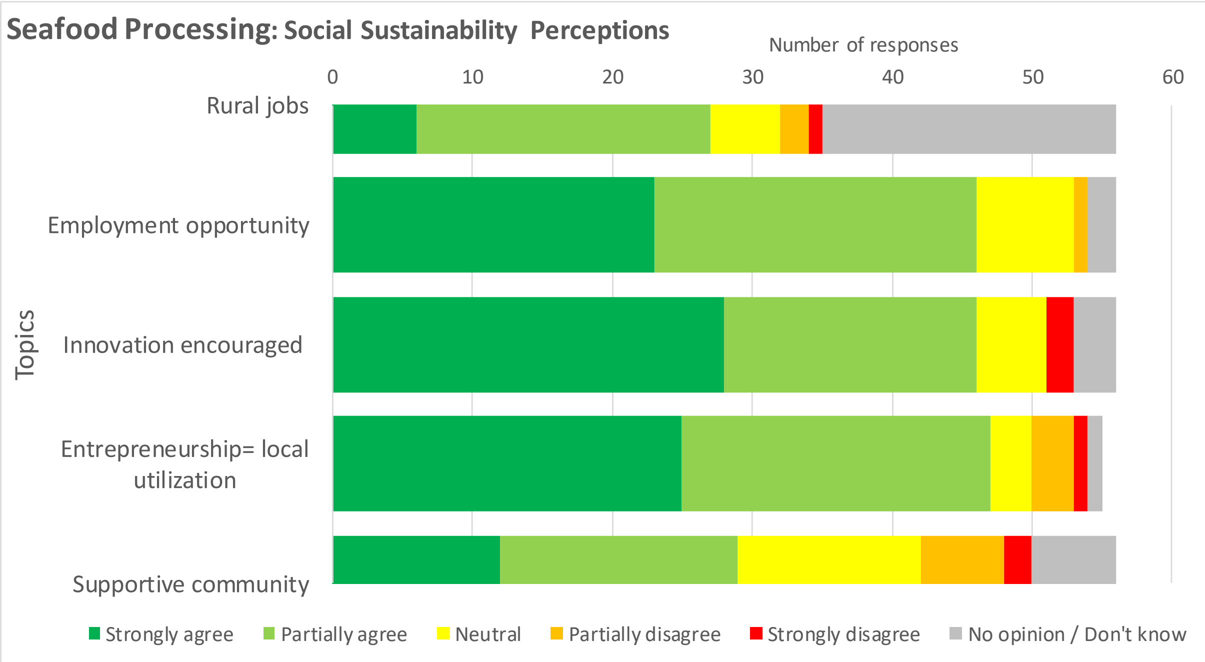


*Figure 15: Bar graph of social sustainability perceptions for seafood processing of the 56 survey participants.*

Finally, in terms of social sustainability, respondents agreed to a large extent that there would be substantial employment opportunities (85%) by increasing local processing. It was primarily the Norwegian stakeholders that represented the 15% without an opinion on increased employment. Upwards of 80% of the respondents agreed that innovation is encouraged in their workplace and that entrepreneurship leads to increasing local utilization. The respondents agreed (56%) that their "community supports innovation and entrepreneurship." It was the Alaskan stakeholders that did not agree about a supportive community, where no Norwegians shared the same sentiments The "Rural jobs" statement read "Iceland's increase of byproducts and of higher-value byproducts has helped promote jobs in rural areas." This question required familiarity with Iceland and this could explain the 46% neutral response.

The general result from the perspective survey was positive responses. The two questions that received the most positive responses of nearly 90% were that the seafood farming industry will increase and that there are many options for byproduct utilization. The two questions with the most disagreement of over 30% was that the amount of fish exported for further processing will remain constant and that current sustainability marketing promotes full utilization. The two questions with the most neutral responses were that UN SDGs assist in promoting full utilization and local processing (66%) and that sustainability branding has helped me (52%).

To investigate patterns in the responses, a MCA was performed on questions related to the following sustainability factors: economic (financial gain to utilize byproducts); environmental (increase utilization helps branding; exporting for further processing remains constant) and social (rural work opportunities via byproduct utilization shown by Iceland). The stakeholder properties (variables) used to describe the respondent characteristics included years in commercial fisheries, location (Alaska/Norway/Iceland), fishery (white fish, wild salmon, farmed salmon, Alaska fisheries, Norway fisheries), and stakeholder type (Fish=Fisherman/ Farmer; Lead=Leader/ Economic Developer/ Investor; Research=Researcher/ Student/ Professor; Process=Processor).

Figure 16 shows the resulting typology in an asymmetric variable plot. There were five identified stakeholder categories based on the eight variables, where Stakeholder E is in the center and thus the most common type in the material. The two factors (F1) and (F2) were sufficient to retain 52% of the total inertia (variation) contained in the data. F1 accounted for 37% of the inertia and the top four variables by order of contribution from largest to smallest were Location (27%), Fishery (23%), Stakeholder (16%) and Years (12%). F2 accounts for 15% of the inertia and the top four variables by order of contribution from largest to smallest were Years (25%), Location (15%), Fishery (13%), and Utilization (11%).

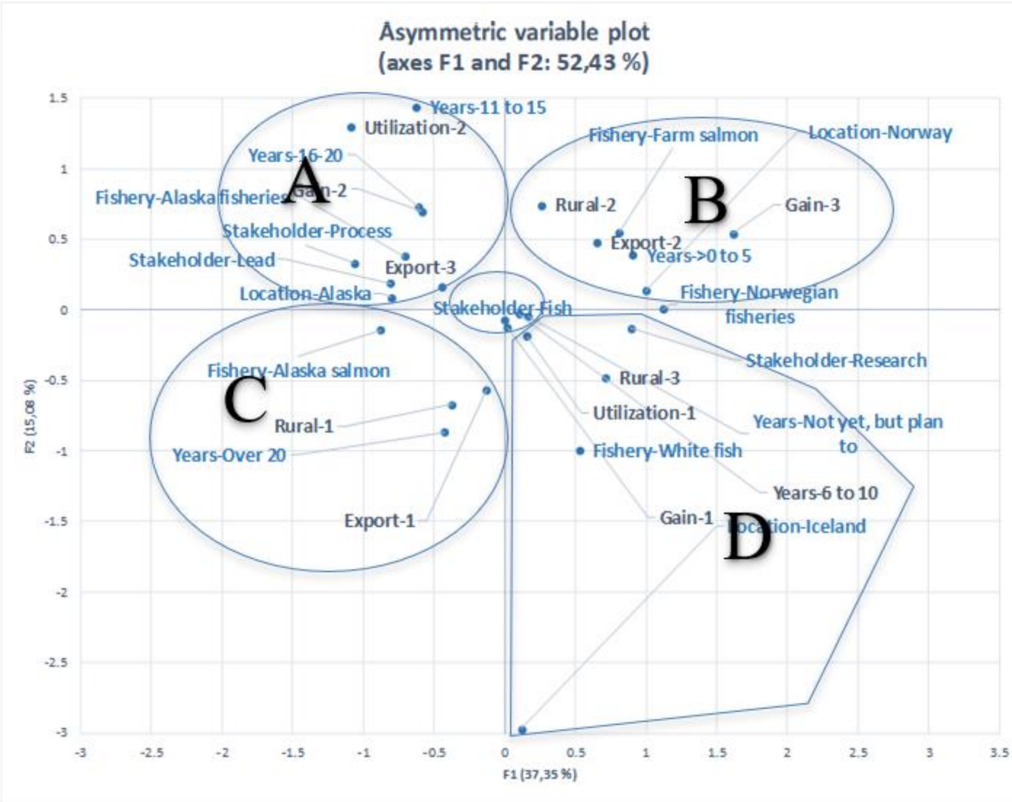


*Figure 16: Asymmetric variable plot with 4 stakeholder and 4 perception variables. A-E stakeholder categories identified. E is in the center.*

The following will explain Figure 15 and the types produced by the MCA. The categories (A-E) differentiated themselves on the four perception variables. Category A and D agreed with the environmental sustainability statements: A- agreeing there will be change of export for reprocessing and D- agreeing that increased utilization helps branding. Category B did not differentiate itself by agreeing with any of the sustainability themes. Category C identifies with social sustainability that increased utilization provides more local, rural jobs. Category E represents the most common answers, as it is at the origin of the variable plot, and it agrees with the economic sustainability that there is financial gain in reducing post-harvest losses. I will also give the types a name that characterizes the type and qualify the sentiments with quotes.

**Stakeholder A: Environmental Sustainability "Inevitable export changes"**

This stakeholder was more likely to live or be associated with Alaska and be involved with Alaskan fisheries, meaning they do not deal with one region or district, but the whole state of Alaska (Location-Alaska, Fishery-Alaska fisheries). This type of stakeholder was also likely to have a medium-long length work experience (11 to 15 years, and 16 to 20 years) and work with processing (Stakeholder-process), or leadership, investment or being a developer (Stakeholder-Lead). This stakeholder was more likely to disagree that further processing outside of the state will remain constant (Export-3) and was neutral in terms of increased utilization (Utilization-2) will help sustainability branding. The naming referred to the belief that the rate of further processing will shift, but I believe these sentiments are not based in environmental stewardship, but in other underlying factors based illustrated by the following quotes. One interviewee from this category explained "[l]ocal value-added processing should continue to increase, particularly if global trade disruptions persist" (Informant, 7). His comment referred to China/USA trade relationships. Another stakeholder explained, “[t]here needs to be more cooperation with the industry (e.g. plants), government, academia, economic development initiatives and local workforce in the fishing industry to realize more utilization and local processing” (Informant 25, 2019). He further explained, “Alaska needs to invest in its innovation/entrepreneurial ecosystem to foster and support new ideas, processes and products to increase the value of ocean-based resources.” Informant 7 attributed the change for reprocessing to trade wars and Informant 25 believed in a change, but expected it to be difficult for Alaska to handle with the lack of State coordination.

**Stakeholder B: “Disengaged to the circular vision”**

This stakeholder was more likely to live or be associated with Norway (Location-Norway) and be involved in salmon farming (Fishery-Farm salmon). This stakeholder was likely to have short work experience (less than 5 years). In terms of perceptions, stakeholder B disagreed that there is a financial gain in reducing post-harvest losses and does not have an opinion whether export for further processing abroad will remain constant or whether Iceland’s increase in byproducts has helped promote jobs in rural areas. The latter sentiment is farmer qualified why he did not agree with the statement on the perception survey that read, “Iceland’s increase of byproducts and of higher-value byproducts has helped promote jobs in rural areas.” This respondent explained “[a] change in the regulation system (institutional change) to address production zones will lead to social implications to smaller companies and local hiring” to a larger extent than byproduct utilization (Informant 2, 2019). Informant 2 felt that institutional regulations with salmon farm harvest permits will be the underlying factor to increase rural jobs and not byproduct utilization. The circular vision of this thesis argues that it is the corporate responsibility of the industry to take the environmental stewardship of pursuing circular systems, even if the institutional framework is not enabling the change. This stakeholder category warranted the name “disengaged to the circular vision,” seeing that this group did not voice an opinion on further processing or rural job creation, and furthermore felt there was no financial gain with reducing post-harvest losses. Reducing post-harvest losses are essential for the circular vision because in sustainably managed fisheries, minimizing post-harvest losses is a key component. This disconnect could be due to that Norwegians feel satisfied with their almost 100% utilization in the farmed salmon industry and do not feel the pressure of the environmental stewardship to not export for repocessing.

**<u>Stakeholder C: Social Sustainability “Disenchanted industry”</u>**

This category was more likely to be involved with Alaskan salmon industry (Fishery-Alaska salmon) and has long work experience (over 20 years). This stakeholder was more likely to agree that exporting for further processing will remain constant and that Iceland’s increase of byproducts and of higher-value byproducts has helped promote jobs in rural areas. This group has experienced many high and low seasons for Alaska salmon within a 20-year time and even though they felt engaging in better byproduct utilization would be beneficial to rural employment, they are disenchanted that a change will happen with exporting for further processing. As explained by a long-time salmon fisherman, “I have no expectations for drastic change in local processing or byproduct utilization unless a regulatory mandate” (Informant 44, 2019). On the same note, a researcher/processor explained “[t]he industry is driven by the bottom line. Costs of operation and revenue stream dictate industry behaviour. If there is a change by the EPA [Environmental Protection Agency] and DEC [Department of Environmental Conservation] on the discharge, then the industry will react” (Informant 56, 2019). An economic developer/ community leader with her whole professional career related to fisheries (over 20-years) expressed "[h]opefully more of the fish is produced locally, but I fear that large amounts of fish, both wild and farmed will be sent unprocessed and frozen to low-cost countries” (Informant 12, 2019). The naming of “Stakeholder C” referred to the sentiments that industry change of more local processing and increased utilization will not arise from within the fishing industry. As informant 56 explained the industry is reactive to outside institutional changes. Hence the Alaska fishing industry is perceived as passive, instead of proactive for increasing local processing and capitalizing on byproducts.

**Stakeholder D: Environmental Sustainability "Byproduct vision"**

Stakeholder D, lives or is associated with Iceland (Location-Iceland) and is involved in the white fish industry (Fishery-White fish). This stakeholder was more likely to agree that increasing utilization helps branding (Utilization-1) but disagreed that Iceland's increase of byproducts and of higher-value byproducts has helped promote jobs in rural areas (Rural-3). It was made up of stakeholders familiar with or from Iceland and of people that believe increasing utilization helps branding. This thesis used Iceland as an example to explore stakeholders' opinions on rural job creation from utilizing more byproducts. According to the Iceland Ocean Cluster (IOC), the increase of byproduct utilization in the Icelandic fisheries led to an independent industry creating approximately 6-700 direct jobs and an annual value that exceeds USD $500 million. IOC claimed many of these jobs are in rural areas (Iceland Ocean Cluster, 2018, para. 3). In 2019, IOC found that there are 48 companies focused mainly on developing products from fish byproducts (Iceland Ocean Cluster, 2019, para. 1). This category stood in contrary to the expected answer of agreeing of the increased local jobs in Iceland, seeing that the stakeholders in this category were familiar with Iceland. This paradox is qualified by a Norwegian government agent that said "[e]verywhere in Iceland, besides Reykjavík is considered rural. Icelandic fisheries are reported as regional Iceland and greater Reykjavík. Approximately 80% of the jobs are in regional Iceland" (Informant 31, 2019). According to informant 31, the rural statement is invalid when most of the country is considered rural. One stakeholder from Iceland in this category agreed to the statement of rural job creation and explained that the "[d]esire to live year-round in rural locations with seasonal industry, [causes] a willingness to be creative." She continued "[I]t has been the smaller towns that yield a large portion of the entrepreneurs [as] [t]hey are the smaller operations that can easily test different processing lines" (Informant 23, 2019). Although I referred to full utilization sustainability branding as an environmental sustainability theme, the sentiments expressed qualified its importance towards social benefits. Seeing that the underlying motivation for increased byproduct utilization is beyond the bottom line (economics), this category enables progression towards the circular vision and called "Byproduct vision."

**Stakeholder E: Economic Sustainability "Middle of the pack hope"**

Finally, stakeholder E, positioned in the origin of the map and therefore closest to the average response of all informants, was more likely to be working as a fisher (Stakeholder-fish, Stakeholder-Norwegian fishery), or had not joined the fisheries or aquaculture business yet, but plans to do so or had medium work experience (6 to 10 years). This stakeholder was more likely to agree that there was financial gain in reducing post-harvest losses (Gain-1). There is a conscious sentiment to this category that they are hopeful for alignment with circular-blue economy practices that strive for sustainable behaviour. A Norwegian planning to enter aquaculture explained "[p]ersonally, I try to not fish more than I will eat and use as much [of] the fish as possible" (Informant 1, 2019). He further addressed the state of the farmed salmon in Norway "I am positive that the industry will gain traction in both full utilization and local processing." A Bristol Bay fisherman with 6-10 years work experience explained, "[t]here will be a push from many consumer markets for a more holistic approach to the chain of custody and fishery management. Bristol Bay will probably be at the forefront for Alaska due to its successful branding that is built on sustainability" (Informant 47, 2019). Stakeholder E has less work experience and more hope for near-future changes for the benefit of sustainable practices. As this type is situated in the middle of the figure, it is also the type with the characteristics most commonly found in the material (hence at origin). This category showed that economic sustainability was the driving factor to today's status of export for reprocessing. This confirmed the original belief of this thesis that economics is the main factor. Interviews showed that there is industry change towards less re-processing, but these sentiments are also driven by economic motivation. As explained by a Norwegian researcher that believed increased local processing with automation will increase local jobs. He explained "[t]he future will be automated. Robots cost the same in Poland. There will still be more jobs with automation with all the needed adaptations and follow-ups of machines" (Informant 39, 2019).

## 5.3 Alaska/Norway Perceptions on Full Utilization and Local Processing

The previous section about seafood processing perceptions revealed an overall positive response to topics that promote byproduct utilization and local processing. The categories defined by typology confirmed that the most-common motivation is related to economic sustainability that increased byproduct utilization can occur with increased automation, instead of environmental stewardship or social responsibility to the labor force. Furthermore, there was one category, Stakeholder B "Disengaged to the circular vision," that did not differentiate itself by agreeing with any of the statements related to the triple bottom line: economic, environmental, and social. This category is of dire concern, because it represented the future generation of salmon farmer with work experience of less than 5 years. To further understand the sentiments related to the circular vision of the interviewed stakeholders, a coding exercise was performed. The open-ended survey questions used addressed seafood perspectives on short term (5-years) and next generation (20-years) in local processing and full utilization and how innovation/entrepreneurship influence the perceived trends: Alaskan (n=30) and Norwegian responses (n=24).

The coding exercise separated each sentiment found in the responses to the open-ended questions and coded them to three categories: perceptions related to the current status of seafood processing, barriers impeding the transition towards a circular economy, and enablers/transition towards circular economy (See Appendix). The perceptions related to the current status are further quantified using two quantitative ranking questions that had the stakeholders rank sustainable factors for full utilization and local processing. This additional quantitative information aided in understanding what are the current driving factors that dictate Alaska and Norway to engage in export for reprocessing.

### 5.3.1 Current Perceptions of Seafood Processing

The sustainable ranking questions are illustrated through normalized graphs. The stakeholders were asked to rank the four sustainable factors on a four-point scale, with the option of ranking them as equal priority as in all at "1" in sustainable unison, and an option of "no opinion."[19] This means a choice of "1" represented the driving factor to today's local seafood processing situation and "4" represented the factor of least importance. The responses were separated by location and the sustainable factor ranked the highest priority was set at 100% (See Methods). Economics was the driving factor for both Alaskans and Norwegians for both byproduct utilization (Figure 17) and local processing (Figure 18). By normalizing on the economic response, it was easier to see the relative difference between the other sustainable factors. As explained in Ch. 4.3, the four factors were to represent the four pillars of fishery sustainability. The economic pillar focused on the financial benefits, as in export value and sustainable branding to secure markets. The environmental pillar referred to the activities that combat

[19] The non-normalized data is found in the appendix.

human-induced environmental degradation, like discharging fish byproducts to an area with little mixing causing over eutrophication. Social pillar referred to standard of living, education and jobs that contribute to the community wellbeing. Institution referred to the fisheries management system with laws, policies, taxes, regulations and enforcements. The above definitions were used with the interviewed stakeholders.

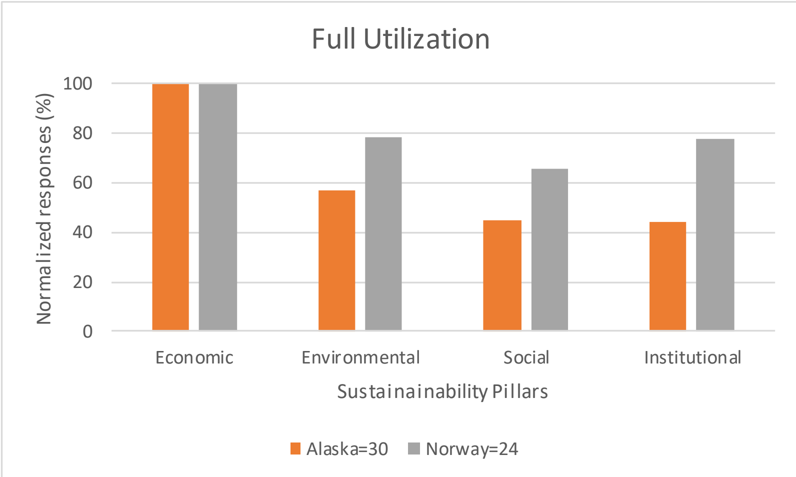


*Figure 17: Normalized rating responses on sustainability pillars for Alaska and Norway on the theme "full utilization."*

Figure 17 shows that the largest difference between the two fishing regions was the institutional factor, where Alaskans felt it was less than half as important as the economics (44%), but more importantly perhaps that it was ranked half as important by Alaskans compared to Norwegians Alaskans rate the social factor (standard of living, education, jobs) at par with the institutional, while environment (57%) is next important after economics (57%). In terms of full utilization, Alaskans feel the other factors behind economics weigh little on byproduct utilization (mean=49%) compared to Norwegians (mean=74%). This means Alaskans agree more that economics is the driving force, while Norwegians felt the other sustainability factors do effect their processing behavior. Norwegians felt their laws and regulations institute a strong framework for byproduct utilization (77%), it was not more than the environmental factors (79%). Note that the social factor was the least important at 65% for the Norwegians.

Of the twenty-nine Alaskan stakeholders, e eleven believe there will be no change in the utilization and local processing situation within the next 5 years, unless there is a drastic change only from regulatory mandate. According to half of the Alaskan? interviewees, the underlying problem to utilization is related to the economic pillar: rural Alaska energy costs are high, causing high local operation costs. As stakeholders with vast experience in the industry explained “holding costs are likely the largest driver of increased utilization on the local level" (Informant 38, 2019) and “The industry is driven by the bottom line” (Informant 56, 2019).

Similar to Alaska, most Norwegian stakeholders felt there would be no change in utilization and local processing when expressed together within the next 5-years. As described by a researcher, “today, the utilization is near 100 % in the salmon industry and pelagic fisheries, and 60 to 70 % in demersal species” (Informant 8, 2019). A Norwegian marketing consultant felt with more sustainable branding and including branding on "maximizing the full use of salmon i.e byproduct" will help with both utilization and local processing (Informant 26, 2019).

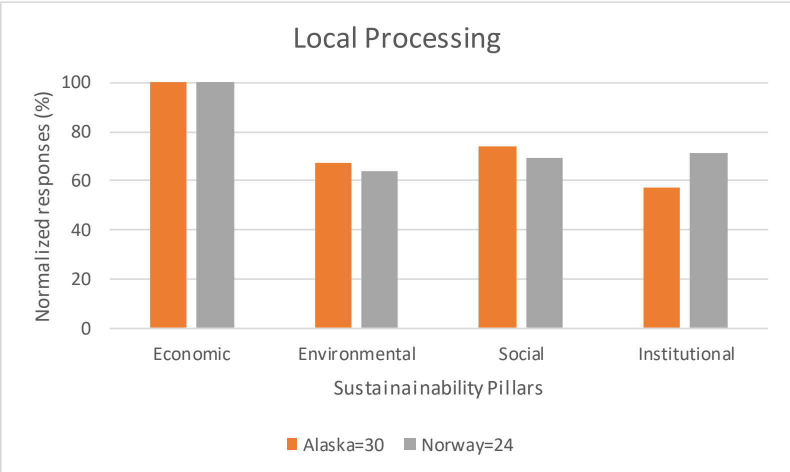


*Figure 18: Normalized rating responses on sustainability pillars for Alaska and Norway on the theme “local processing.”*

Figure 18 illustrates the perceptions on local processing for Alaska and Norway that differ from why there is not full utilization. The only similarity was that Alaskans (n=30) and Norwegian (n=24) stakeholders felt that economics were the driving factor. An Alaskan economic consultant explained that “while local processing will continue to grow, the event of local processing increases will largely depend on reduced energy costs and increased mechanization of processing facilities” (Informant 7, 2019). The importance of economics for operation cost and need for automation were mentioned by both Alaskan and Norwegian stakeholders (refernces).

The largest difference between the two locations was the institutional factor. Alaska rated its institutional framework higher for local processing than full utilization (58% vs. 44%).

Alaskans believed the institutional framework more important for increasing local processing, rather than moving towards full utilization. In contrast, Norway rated its institutional framework weaker in local processing versus full utilization (71% vs. 78%). Norwegians believed their byproduct utilization as sufficient and their ability to increasing local processing as marginal. Overall Alaskans felt the other sustainability factors behind economics had a stronger effect on local processing versus full utilization (mean=66% vs. 49%) compared to Norwegians (mean=68% vs. 74%). Both the environmental and the social factors are rated higher in Alaska than Norway for local processing. The social sustainability factor has the largest difference in its ratings from full utilization to local processing, where Alaskans felt it plays the next vital role after economics and Norwegians rate it on par with the other sustainability factors.

Alaskan stakeholders qualified their opinions towards the lack of institutional infrastructure that affect the social sustainability of the workforce in their own words. An Alaskan researcher/economic consultant that was born into a fishing family explained that there is a "lack of a stable centralized community for research, development, entrepreneurship, and vocational training. Building this type of network/community is fighting upstream" (Informant 45, 2019). The social pillar through labour was subpar as a lifelong Alaskan fisherman/researcher (over 35 years' work experience) explained that "[t]he workforce in Alaska is challenged. With no professional certifications necessary, education and training are sporadic and considered optional. Most industry employees are independent, self-reliant and self-taught" (Informant 44, 2019). Along the same sentiment, a processor pointed out "local processing depends on lots of things including universal health care" (Informant 25, 2019). A Kodiak interview revealed that out of the 12 processing factories in town, he knows of only one that gives healthcare to its employees (Informant 33, 2019). The majority of Alaskan stakeholders agreed upon the importance of fishing and processing for rural communities, as it occurs primarily outside of urban centers and is a critical source of employment for rural Alaska. However, as an interviewee in charge of hiring people in Bristol Bay for processing explained, "there is more work than qualified people" (Informant 51, 2019). This predicament would make it difficult to increase local processing without increasing automation.

Norwegian stakeholders expressed that there is slow progression in increasing of local processing in today's situation. A stakeholder with over 20 years' work experience including fish farmer, cod fisher, and researcher stated, "I hope local processing will emerge way above the levels of today. However, this is dependent on several factors like EØS [EEA; European Economic Area] legislation, toll barriers and the level of local investments and ownership" (Informant 6, 2019).

### 5.3.2 Barriers Impeding the Transition towards a Circular Economy

The identified barriers impeding the transition towards a circular economy for Alaskan stakeholders consisted of cultural resistance, regulations, and commodity/energy prices (See Appendix). These are further classified as the lack of the following: a clear vision that connects local processing and full utilization, industry collaboration that promotes economy of scope (not economy of scale), social infrastructure (healthy labor conditions with qualified labor), investments, transparency, and incentives. The lack of vision is at the core of cultural resistance with perceiving that "full utilization and local processing are not linked" (Informant 25, 2019). As Bristol Bay fisherman explained the "[i]ndustry is retroactive, instead of proactive" (Informant 46, 2019). This mind-set of waiting to react to outside change, instead of creating change is considered cultural resistance (Zagragja et al., 2016). Another Bristol Bay fisherman confirmed this sentiment of outside industry pressure that "drastic change only comes from regulatory mandate" (Informant 44, 2019). The Alaskan stakeholders expressed that harvest volume and seasonality control full utilization; instead of mentioning the social and logistical infrastructure or business models as other main factors.

For local processing, Alaskan's expressed economics and available labor as the main driving factors. "The supply chain will have to work together to address the difficult logistics in Alaska" and there is lack of collaboration with the "many disjointed entities, every man for themselves attitude" (Informant 53, 2019). In a cascading design that underpins the circular economy and is based from blue economy definitions (Wautelet, 2018), Informant 53 highlighted a major barrier that industry collaboration does not look for symbiosis to addresses their secondary products to fit an economy of scope. This means that the goal is to minimize waste, close production loops and apply solutions to reach this scope and not be impeded by the barriers that byproduct utilization cannot occur without economy of scale. As for regulation barriers, the current discharge permits are not strict enough to induce a radical change in utilization. There is a lack of social infrastructure that is mentioned above in the previous section and related to the education, certification, and health benefits of the workforce. Stakeholders expressed there is a lack of investment due to the fishing industry being volatile with market prices and harvest levels fluctuating each year, some species more than others. However, the lack of investment in full utilization and local processing can be due to the lack of incentives or public support. As a business leader in the fish processing sector of more than 20 years explained, “Alaska is abundant with its fish resource” and therefore there is no need to “try to get more out of it” (Informant 15, 2019). There is not incentive to invest in a possible less valuable secondary product, when the primary product is abundant. There was mention of lack of public investment, where “Alaska could invest more into innovation through assets like the Kodiak Seafood and Marine Science Center. The state is embroiled in a financial debate and invests little in public benefits, thus not encouraging innovation” (Informant 44, 2019).

Norway’s identified barriers to circular vision consisted of cultural resistance, regulations, and lack of local investment/ownership. Like Alaska, Norwegian stakeholders were most concerned about the economics in a production-oriented market. The cultural resistance related to industry collaboration that promotes economy of scope (not economy of scale). Norwegians identified as production-oriented and attributed their byproduct utilization success to economies of scale, which is a linear industrial thought process. Circular thought process focuses economies of scope. A Norwegian researcher explained the “industrial scale of Norwegian salmon farming has been vital, i.e. large volumes, stable output means lower risk for investment into processing due to lower variance in landings - as with harvest fisheries” (Informant 8, 2019). He further explained that 100% local processing is unrealistic but “… will increase in Norway, not likely to 100 % due to cost level in Norway, and market demand for super fresh - even live products.”

“Regulations that favor processed products in the European Economic Area will change the processing structure in Norway” (Informant 2, 2019). The Norwegians stakeholders agreed that the lack of local investment is primarily due to the high operational cost for Norwegian processing.

### 5.3.3 Enablers/Transition towards a Circular Economy

In both Alaska and Norway, there were coded more enablers than barriers.

The identified enablers for the circular vision for Alaskan stakeholders consisted of collaborative platforms/clusters, regulations, education, financing, technology and innovation, and security of supply,  Collaborative platforms/clusters referred to outside market exposure that changes mind-set and market strategies. Influence from Arctic, Regional USA, and European were attributed to affect Alaskan's mind-set. A byproduct user in Alaska explained "Alaska will see its own commodity as finite, instead of abundant. Iceland's general population seem like they are responsible consumers and take pride in Iceland sourced resources, like their cod" (Informant 54, 2019). This identified shift from abundance to finite will promote collaborative platforms/clusters to get more out of less, such as Iceland.  "In PNW [Pacific Northwest], there are signs of not treating the residual raw material as waste, but as a resource. Seeing that the majority of the fish landed in the major west coast ports are from Alaska, I would believe that the pressure of not discharging will be felt there within 20 years" (Informant 22, 2019) "There will be pressure from Seattle and Europe to discard less and this will cause additional regulations or incentives in the industry" (Informant 24, 2019). Outside influence will affect the regulations and cause stricter discharge allowances. The technology and innovation are seen in the new processing plants, such as Silver Bay.

Security of supply relates to being in harmony with the environment and employing sustainable harvesting practices and being able to make products throughout the complete value chain. This does not refer to having the same volume of harvest each year. The market strategy that allows for complete value chain suggested to increase both local processing and utilization was direct marketing by the fisherman as it will "broaden the base of people that interact with the market" (Informant 11, 2019). "Coordination to improve direct marketing (regulations/infrastructure), so that fishermen have a relationship with the market will help create small businesses that would potentially aid in local and further processing" (Informant 44, 2019). An example and verification of the benefits of direct marketing was provided as "VFDA [Valdez Fisheries Development Association] allows for direct marketing and small companies to form under its nested processor permitting. Yummy Chummy with Brett Gibson is an example of downstream innovation" (Informant 11, 2019).

The regulations around discharge permits could already cause utilization action. Although this research did not find the criterion for when/how discharge permits are reviewed, a stakeholder in Kodiak testified that "discharge permits are reviewed, like the one in Kodiak where there are complaints about the visible sheen on the water from the Kodiak Meal Plant" (Informant 56, 2019). Stakeholders felt that the regulations around discharge permits are affecting new facilities. Where there is growth in the processing side of the fishery, "[n]ewer facilities have the ability of building infrastructure that incorporate several product forms for more of the fish, such as Silver Bay in Valdez" (Informant 24, 2019). Silver Bay was referenced repetitively as a leader in utilization (references to those that said so). As a Southcentral fisherman accounted, "Silver Bay is proactive with its byproduct handling, while others are reactionary. By leading by example, the others will follow" (Informant 47, 2019).

The identified enablers for the circular vision for Norwegian stakeholders consisted of new economic framework, collaborative platforms/clusters, regulations, education, financing. Marketing and economic analyst stakeholders recognized that the new economic framework that followed the sustainability certification standards and the recent global industry innovation in mechanized processing will cause an increase in utilization. "The regulatory system that addresses production zones is not currently connected with local processing lines, but focus on lice counts and harvest volumes" (Informant 2, 2019). This may "change to include local processing for granting permits (Informant 39, 2019). In October 2017, the Norwegian Government introduced a new initiative for predictable and sustainable growth in the aquaculture industry called "the traffic light system." Traffic Light System (TLS) is found in many forms throughout the fisheries management, including health of state of stock and economic importance of stock (Gullestad et al., 2017). The 2017 TLS in farmed fish is the first of its kind for Norway[20].

The regulatory system for export has higher tolls for processed fish. This may change as the "EU is taking active strides towards circular economy initiatives, where it tries to minimize unused byproducts" (Informant 32, 2019). The educational changes consisted of the consumer behavior and circular economy initiatives. An economic analysist observed that there is a "conscious behavior on the complete chain of custody" (Informant 29, 2019). In addition, a Norwegian researcher of over 20-years explained there seems to be a new "local/global

[20] TLS uses a tangible indicator of sea lice count to determine the allowable production rate. The initiative divides the Norwegian coast line into 13 production areas, and labels them green, yellow or red, depending on their count of sea lice. If an area is green, fish farmers are offered a 6% growth opportunity every second year. Yellow areas are kept constant. Red areas are not allowed to grow and are under possible reduction measures (Nærings- og Fiskeridepartementet, 2015).

financial support" for "entrepreneurs that strive for circular business models" (Informant 6, 2019).

## 5.4 Reference Cases

These reference cases are used to answer the research question, "Which businesses are at the forefront of byproduct utilization and/or local processing?" The companies/businesses that were chosen as the reference cases were suggested by the informants as progressive players to increase utilization and/or local processing. Alaskans chose Silver Bay Seafood's LLC for its social sustainability aspects. Norwegians chose Hordafor AS for its actual byproduct utilization. An Icelandic company was mentioned 5 times, meriting it to also be showcased as a reference case. The Icelandic company, Kerecis, represented how local entrepreneurs innovate high-valued secondary products when the national strategy of Iceland markets full utilization as a part of its sustainability strategy.

The Alaskan interviewees stated that Silver Bay Seafood's LLC has a different type of ownership structure than others in the industry, they are a relatively new player that established themselves quickly as a major what?, and they have a vision to be a better place to work than their competitors. Norwegian interviewees felt Hordafor AS was at the right place at the right time when the farm industry needed a solution for their byproduct discharge. They have a logistical infrastructure established that would be easy to handle more byproducts or adapt to create other product forms with the byproducts. Hordafor is set-up to be economically successful with its current products and if there is legislation change for more local processing, they can easily respond. The Icelandic and Norwegian stakeholders believe Kerecis reflected the Icelandic industry's united focus to create innovative, high-valued product forms for their byproducts. They mentioned the vision/industry drive is a result of the financial crisis and Total Allowable Catch (TAC) reduction, so the Icelanders were forced to make more from less. The high valued product means high risk, and this is taken with a high amount of collaboration and coordination. The following will give a general description of each of the reference cases to supplement information to the above points made by the interviewees and in the discussion, aspects of these reference cases show how the "circular vision" can be made a reality.

### 5.4.1 Silver Bay Seafood (Alaska)

Silver Bay Seafood is a different type of processing company in Alaska in the sense that it is owned by fishermen who represent over 80% of its committed fishing effort. It began in 2007 as a single salmon processing facility in Sitka, Alaska. Today, Silver Bay is one of the largest seafood companies in Alaska, operating five processing facilities throughout Alaska, including Naknek in Bristol Bay. The areas of operation are shown in Figure 19. Since 2014, Silver Bay has been 12.5% owned by South Korea's Dongwon Industries, and this deal may have assisted in buying the California processing facility from United Coast Seafoods that specialized in squid (Undercurrent News, 2016). Silver Bay represents an integrated processor of frozen salmon, herring and squid products for domestic and export markets (Silver Bay Seafoods, 2018).


*Figure 19: Location of the facility plants in Alaska for Silver Bay Seafoods LLC (Silver Bay Seafoods, 2018).*

In its website, Silver Bay explains its "primary strength is in its combination of having state of the art processing plants and favourable logistics to support its operations; competent management and key personnel; an established fish buying system; and ownership by fishermen (Silver Bay Seafoods, 2018)." The vision of the company uses an internally coined/branded term, "Silver Bay Experience." This experience is unparalleled service and an exceptional work environment while promoting company profitability. They believe through sound management, innovation, and teamwork, Silver Bay provides their fishermen owners, and employees the "Silver Bay Experience." The values are to "always aim higher, be accountable and be stronger together." These values mean to challenge yourself each day to look for ways to excel at your job, take ownership for your role in the success of Silver Bay and trust in the power of teams working towards a common goal where members are valued, supported and empowered.

The latest Alaska facility is the one in False Pass that opens for the 2019 fishing season. Silver Bay calls it "a new state-of-the-art plant." It is positioned to process salmon, Pollock, and cod delivered by the Silver Bay Seafoods fleet from both the Gulf of Alaska and Bering Sea (Silver Bay Seafoods, 2018)

Working as a processor on a fillet line is a demanding job in the seasonal fisheries. Silver Bay is a fishermen owned company, not a processor owned company. The other larger companies are not owned by fishermen that provide their own company's catch (Kreiss-Tomkins & Redick, 2018). To understand how this different ownership regime that promotes values as "be accountable" on the processing lines plays out in practice, this thesis compared their payment structure and read employee reviews to see if Silverbay provided better social sustainability to its employees.

As published on their website, as of June 1, 2018, the starting wage for processors is set at $13.00/hour. Returning processors who have 1501 hours of work experience will earn $14.00/hour and experienced processors who have 2601 hours of work experience will earn $15.00/hour. In comparison to other interviews that state processing jobs in Kodiak vary from $10 to $12 hour, Silver Bay pays slightly higher. The benefits are not listed on the website, but the pay scale is transparent and straightforward. This translates into a secure work situation. An online job review platform found that out of 88 reviews, 77% of the employees felt they were paid fairly (Silver Bay employees, 2019). The processing line work requires long back-to-back 16-hour shifts. One employee commented that it, "depends on how much fish are caught. Depending on your department you will most likely be working 16 hours 2 weeks into the season. To start most departments will work 8-12 hours. It will decline as season progresses until cleanup of plant that lasts 1-2 weeks." (Silver Bay employees, 2019, "comment 3").

In summary, Silver Bay Seafood seems to be unique in its cooperative business model that it is fisherman owned. Its new facilities provide automated processing lines. It has a vision of social sustainability through its "silver bay experience" that all employees are valued and contribute to the fate of the company. The wages are slightly higher than other processing wages and are transparently shown on the website. Silver Bay appears to give better social sustainability to its employees and in turn this would mean a stable workforce for local processing. A stable workforce was an identified barrier in the previous section for byproduct utilization that Silver Bay may have a competitive advantage and hence its strong growth in processing facilities.

### 5.4.2 Hordafor AS (Norway)

Hordafor AS was established in 1983 with the intent to capitalize on the resulting byproducts from production of capelin roe and pelagic fish. To this day, Hordafor specializes in marine byproducts, but now it is in the farmed industry of salmon and trout. The Hordafor AS Group consists of Hordafor, Aquarius AS, P/f Biotech, and North Capelin Honningsvåg AS. The raw material for these companies in the same order are the following byproducts: farmed salmon and trouts; pelagic and white fish, white fish; and lastly, herring and capelin. Figure 20 displays the structure and focus of the company.

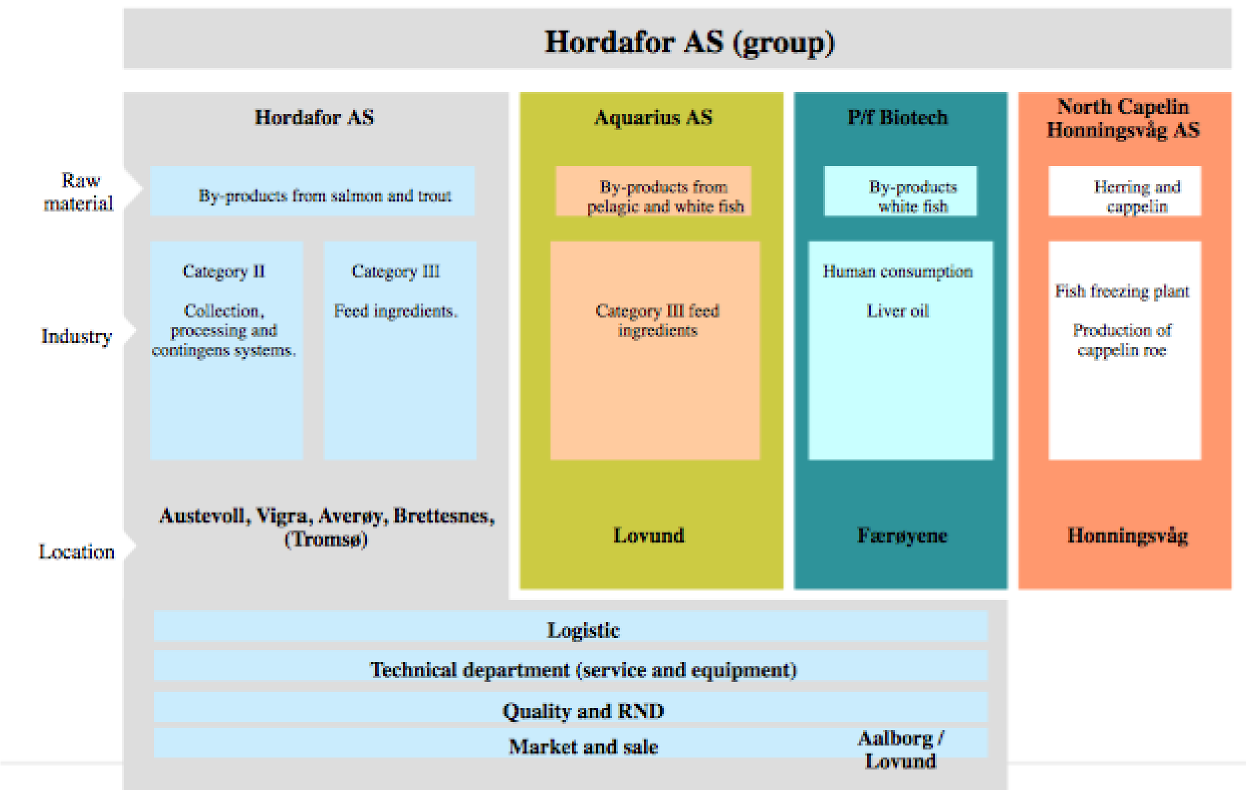


*Figure 20: Current business structure of Hordafor AS group with inputs of raw material, targeted industry, and facility location (Seliussen, et al., 2016).*

Hordafor is Norway's largest seafood byproduct company. With its daughter company, Aquarius AS, the company processes 200 to 300 K tons of fish byproducts annually (Seliussen, 2016). The company consists of around 100 employees and covers the total vertical value chain of seafood byproducts (Proff, 2018).

In the early 80s, salmon farmers were plagued by their excess of byproducts that was considered pollution and biological threat for the farmers. As explained by an industry expert, there was a discharge fee introduced to the fish farm industry in the early 90s (Informant 58, 2019). Salmon farmers approached Hordafor to assist with the fish waste. From the early 90s, Hordafor collected only around 9 K tons of fish waste compared to its current 200 to 300 K tons (Seliussen, 2016). Cat II fish require special handling and Hordafor has the required technical knowledge, certification, and equipment to remove these fish from site. The business prides themselves in being a complete provider of all the logistics and equipment needed for handling of fish byproducts (Hordafor.no, 2018).

The basic inputs to the business model are the following. Salmon factories create fish silage that Hordafor collects by boat. Hordafor pays marginal amounts to the factory per kg (Informant 58, 2019) for silage generated from human consumption (Cat III) products and creates higher value products of fish protein concentrate (H-pro®) and salmon oil (H-oil®) at their processing plant in Austevoll. These two trademarked products are used as input ingredients to agriculture feed and sold to industry customers in Asia and the rest of Europe. Hordafor also collects the Cat II fish with special boats that farmers have to pay a gate fee to dispose of. Hordafor sells the Cat II products as input to different markets, such as Danish swine and Finnish fur farm feed ingredients and bioenergy (Informant 59, 2019).

Hordafor established itself with transportation logistics of pick-up and storage of silage. They have 6 boats, 4 with special handling tanks for Cat II, and storage facilities from Southern Norway, Egersund, to Northern Norway, Honningsvåg. This distance between the facilities by car is approximately 2,500 km. In addition, Hordafor develop and delivers complete silage packages to the market (Seliussen, et al., 2016). The largest boat can carry 2,500 tons. Figure 21 shows a map of Norway and how Hordafor has strategically set-up storage units and processing plants to ensure effective logistics from collection to production to distribution of the byproducts. Hordafor has been buying up other competitors, like Akva-Ren AS, that was a silage operator in Northern Norway (Informant 8, 2019).

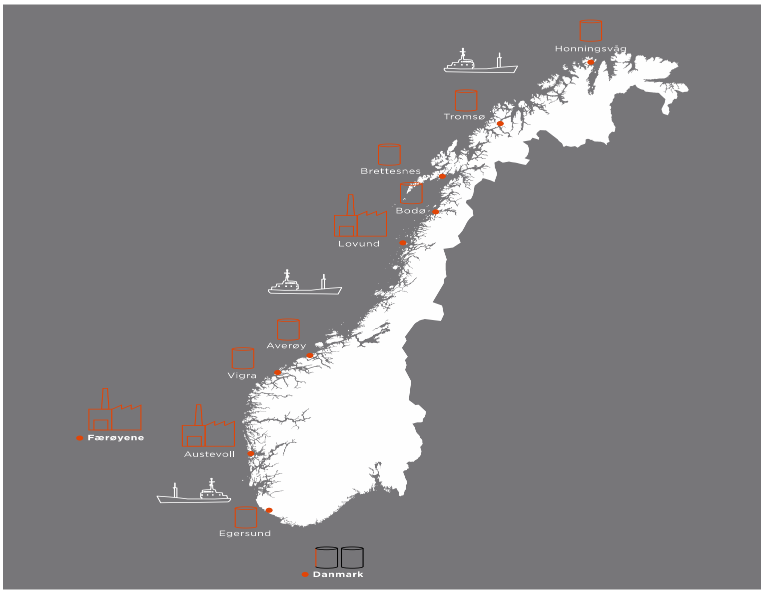


*Figure 21: Map showing Hordafor AS storage tanks and processing facilities.*

In summary, by having the complete logistics of transport, production, and sale of aquaculture byproducts from both the healthy and diseased fish allows Hordafor to provide a service to the farmers of collection of 100% of the unwanted byproducts. Seeing that discharging is not an option for farmers and that handling of diseased fish is strict in the sense of not mixing it with any human consumption products, Hordafor was an early entrant to solve the problems of handling byproducts for the farmers. As an early entry, it's been able to control the market share and build an infrastrure of transportation and holding tanks that can handle the entire coast of Norway. Essentially, Hordafor has helped transform the Norwegian salmon farming industry to nearly 100% product use.

### 5.4.3 Kerecis (Iceland)

The Iceland reference case of Kerecis is an interesting case, because it is a high-risk, high-value product. Essentially, Kerecis uses technologies based on fish skin and Omega3 polyunsaturated fatty acids as medical device for tissue regeneration. Kerecis is the creator, manufacturer and patent holder of this revolutionary fish-skin-based therapeutic products that improves the healing process of chronic human wounds and repairs tissue damage.

Kerecis began in 2009 as a research project in Isafjordur, Iceland. Isafjordur is a town in North West Iceland, 50 km south of the Arctic Circle and 400 km north of the capital, Reykjavik. It is the largest town in the Westfjords peninsula, with approximately 2600 inhabitants.[21] The company's founder and CEO, Fertram Sigurjonsson, was also the inventor of the technology. The company started commercial operations in 2013. In 2019, the company acquired the Swiss life-science company, Phytoceuticals.

The company's headquarter and manufacturing plant is in Isafjordur. They operate a research center in Reykjavik and have their sales & marketing office near Washington, D.C., USA. Kerecis is privately held by Icelandic, American, British and French shareholders. Half of the shareholders are the original founders of the business, with the other have consisting of private investors and family funds. Kerecis has secured itself in the US market by participating in several U.S. Department of Defence funded projects. The company is committed to developing better remedies for injured American servicemen and women that have suffered life-threatening burn wounds. Kerecis technology is patented in the United States and more than 40 other countries. The initial Kerecis product, Kerecis Omega3 Wound, has been approved by the FDA and European regulatory authorities for wound healing. The Kerecis technology has also been approved for use as a surgical buttress (Kerecis Omega3 SecureMesh). They publicly advertise on their website that they are actively seeking future licensing and distribution partners to launch these proprietary devices in markets around the world (Kerecis, 2019).

According to globenewswire.com, Kerecis was named Iceland's fastest growing startup in 2017 by the Icelandic Growth Consortium. The Icelandic Growth Consortium consists of the Federation of Icelandic Industries, Iceland Startups, University of Reykjavik and the Icelandic Research Institute. The award acknowledges three properties about Kerecis: fastest revenue growth year-to-year compared to the other nominated startups, spends more than 20% of its revenue on research and development activities, and that its founders still retain a significant stake in the company. The article notes that the "fish skin used in Kerecis's products derives from wild and sustainable fish stock caught in pristine Icelandic waters and processed with 100% renewable energy in a township at the polar circle (Kay Paumier, 2017)."

In summary, Kerecis is a research driven high-valued start-up, where the developer is the founder. The company is situated in a rural town of 2600 people that is 400km north of the

[21] https://www.westfjords.is/en/moya/toy/index/town/isafjordur Accessed 20.05.2019

capital. Even with the distance to the city-hub, Kerescis has been able to be recognized as Iceland's fastest growing start-up in 2017. Its success appears to be due to its strategical research collaborations with market-users, such as the US military. The sales and marketing office is not local and located in the US, while the manufacturing plant is local. The acclaimed praise of the company focusses on sustainable factors, such as the sustainable managed cod stock used as input and that the processing plant uses 100% renewable energy.

# 6 Discussion

The thesis question asks how Alaska and Norway can align their future strategies to move in the direction of full utilization of byproducts and thereby contributing to the objectives of the blue- and circular economy. This question is answered in this chapter by merging and interpreting the results in relation to current seafood processing practices and the circular vision. Then recommendations are made to align collaboration strategies between Alaska and Norway to increase sustainability in the industry. Finally, limitations to the suggested recommendations are addressed.

## 6.1 Currently Loosing the Competitive Advantage

Although Alaska and Norway are favoured locally to benefit from the BE principle of cascading designs due to their abundant salmon resources (Pauli, 2016, “principles”), this will not happen with their current production practices of exporting for further processing and not utilizing all byproducts (specifically Alaska). Alaska and Norway are operating as production-oriented regions for primary products and not secondary products and missing out on the complete value chain where “Any byproduct is the source for a new product” (Pauli, 2016, “principles”). The current situation causes a negative feedback loop as illustrated in Figure 22. The negative feedback loop refers to that the current processing practices will continue to reduce the value of the secondary products and therefor impede local seafood byproduct utilization.

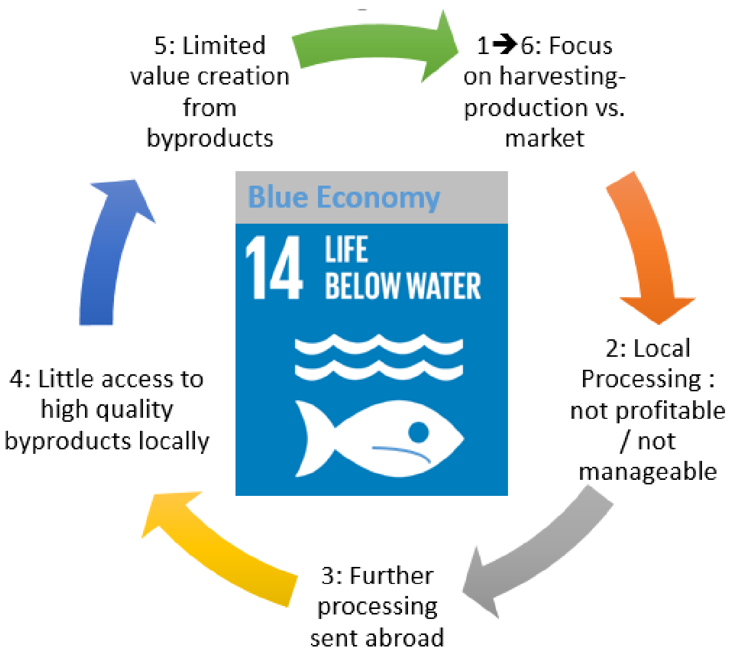


*Figure 22: Current situation in Alaska and Norway when connecting local processing to byproduct utilization in the seafood industry, specifically salmon (Adapted using UN SDGs (UN, 2015; PwC Seafood, 2018))*

Starting with Step 1 in Figure 22: "Focus on harvesting-production" refers to how stakeholders focus more on the harvest and production rather than market and value-creation that lies in the market for byproducts. "Alaska is abundant with its fish resource" (Informant 15, 2019) and "Norway gains more by increasing its production of farmed salmon" (Informant 5) are statements that confirm the abundant, production-oriented mind-set that was suggested by previous work (Bimbo, 2009; PwC Seafood, 2018). Being production-oriented yields a limited amount of available byproducts.

In today's fish value chain, production oriented refers to harvest, the first processing form, and post-harvest handling. In Alaska, the fisherman catches the fish and sells it to a processor, and byproducts associated with this can be discarded fish, undervalued waste water from slaughtering/cleaning the fish, and in the worst scenario unsold fish that becomes perishable. The first processing form is the wholesale product, which is gutted and the primary export product of Alaska (head-off) and Norway (head-on). Thus, with a focus mainly on harvest and a wholesale that required further processing, byproducts volumes are not optimized and neither are the value-added potential that lies within them.

The lack of local processing is reflected in the preferred export forms that require further processing. Alaska's salmon utilization of the available byproduct volumes from the export forms are difficult to document by public data as shown with the Bristol Bay exercise (Found in Section 5.1.2 and 5.1.4). The recent Norwegian study that the export forms requiring further processing "represents a significant leakage of potentially valuable raw material for the Norwegian marine industry" (PWC Seafood, 2018, p. 7, own translation). Norway's near 100% utilization of its farmed salmon is not as impressive when looking at potential volume of byproducts. Averaging 2013-2016 processing volumes, the edible farmed fish sent for export represented 81% of the total harvest volume, signifying a large portion is being sent for further processing abroad. Unimpressively, Norway utilizes only 36% of the total byproducts, where the dead/diseased fish represented half of the byproducts (Mordal, 2019, 5.1).

Step 2 of Figure 22 reflects the reasons why there is not an increase in local processing, as it is perceived as "Not profitable / not manageable". The cost of production in Alaska is higher than in other countries or the continental US due to the operating costs associated with labor, energy, and the remote nature of Alaska ports (McDowell Group, 2017, p. 93). In Norway, labor costs were attributed as a major cost. When the processing lines are not automated, fish processing jobs require intense, manual labor and demanding schedules with uneven harvest supplies. The minimum hourly wage in Alaska as of January 1st, 2019 is $9.89 compared to continental USA of $7.25 (ref). The Alaska interviewees stated the current hourly wage associated with processing lines were between $10-$15 (See Section 5.4.1). There is no minimum wage in Norway, but many sectors have collective agreements, like fish processing (Arbeidstilsynet, 2019). There is high hourly wage in Norway compared to Alaska, where skilled workers receive $23.06 and production workers $21.68 (Arbeidstilsynet, 2019, table xx).

For Alaska, local processing is not manageable with the limited space, time, and employees associated to the harvest seasons. As explained in Section 5.3, an informant felt there is more processing work in the harvesting season than there are employees. Informants explained that the workforce is crippled by the lack of certification/standards that cause a lack of education, processing work is demanding and health benefits are not in place. For Norway, the current system is already profitable and there were little environmental and social incentives to increase local processing. Automation through robots was mentioned as an economic incentive to increase local processing, because the price of machines cost similar amounts in Poland or Norway and then labor cost be less of an issue. The machines would be the major cost. Informants explained that there has been a super-profit in farmed salmon as an export resources and change to increase different export forms are economically driven by trade regulations that tax more for processed seafood.

Alaskans feel that local processing will steadily continue to grow, but not due to the change of the wholesale product forms, but due to the increase of utilization. A change in regulation to the discharge permits are the only way to make a significant increase in utilization in the next 5-years. A state-wide economic consultant explains, "[i]ncreased utilization will continue to occur due to sustainability certification standard enhancements and innovation" (Informant 7,2019). However, some stakeholders express that current export trends to China will change due to trade disruptions and thereby more local production will occur. The presidents of the US and China are engaged in a trade war (Swanson, 2018) and this brings uncertainty to Alaska's seafood relationship with China. China is Alaska's largest seafood export market in terms of tonnage and value, accounting for 35% of the volume and 27% of export value in 2015 (ASMI, 2016, p.1). The event of local processing increases largely depend on reduced energy costs and increased mechanization of processing facilities. As one community Bristol Bay leader explained, "[t]here is more work than qualified people" (Informant 51, 2019). Providing more jobs may not be what Alaska needs, but providing more qualified labor. In summary, Alaska is looking for reduced energy costs, more automation, and more qualified labor. The local processing trends will slowly increase, and sustainability certifications is adding pressure to byproduct utilization.

Norwegian stakeholders feel changes in Norwegian and EU regulation and automation will help increase local processing. Many stakeholders believe that it is steadily increasing; however, from the years 2013 to 2016, the percent ratio between byproducts and live weight is relatively constant 27.6% +-1% (Richardsen et al., 2017, Figure 5-10). Pre-rigor filleting is supposedly becoming more common and allowing for more byproducts in Norway A barrier expressed by an industry expert with over 20 years' work experience including fish farmer, cod fisher, and researcher states, "I hope local processing will emerge way above the levels of today. However, this is dependent on several factors like E[U] legislation, toll barriers and the level of local investments and ownership" (Informant 6, 2019). As described by the official Norwegian Customs, there are preferential trade in fish and seafood with the EU. In the case of salmon, there is 2% tariff for whole salmon and 13% for smoked salmon in the EU market. Tariffs on highly processed fish (prepared meal) are relatively high in most markets (Nærings- og

Fiskeridepartementet, 2018; Norwegian Customs, n.d.). Automation will bring more local processing. “Robots cost the same in Poland,” therefore with a future heading towards more automation, it is best to invest now to have the market advantage. This same stakeholder further explains, “[t]here will still be more jobs with automation with all the needed adaptations and follow-ups of machines.” As it is today, the

> “slaughterhouses in this county are positioned close together; however, located in three different municipalities. It does not make financial sense to have the slaughterhouses for the companies that share its cost, but the social benefits and acceptance of the company providing local jobs allows for the companies to be granted more licenses to grow their farms and have overall more profit” (Informant 50, 2019).

In summary for Norway, the industry will adapt to more local processing if regulations are set forth by the national government or if the EU trade agreements make it more cost-benefit. The stakeholders that see the future as automated are worried that the current lack of local processing investment will allow other countries to gain the competitive edge in secondary processing. These stakeholders feel labour costs are not as important of an issue, due to the machines being the main cost.

Step 3 in Figure 22 “Sent abroad for further processing ” causes local competitive disadvantages in processing and gives the global message that Alaska and Norway do not take environmental stewardship in their harvests by not considering the complete value chain. Seafood products, and especially salmon are increasing in value (FAO, 2016). Sustainably harvested fish meal and oil are prefered and increasing in value (Fishmeal Information Network, 2008; proff.no, 2018). As explained by an Alaskan, “in our partner meal plant (last 15 years) and our solely owned Southeast plant, fish meal and oil is profitable” (Informant 47, 2019). This means by continuing export for futher processing, Alaska and Norway are strengthening the competitive advantages to other secondary processing plants and losing the chance to have the expertice and market share in secondary processing. It will be China, the continental US, Eastern Europe and other EU countries that build the relationships with the buyers and control the further trading of the sustainably harvested salmon.

In Step 4 in Figure 22 “Little access to high quality byproducts locally” are the result of not building local processing lines that utilize the whole fish to the end-consumer product. Even though human food should be the priority of secondary products (SDG 2), both Alaskan and Norwegian stakeholders expressed interest in the higher-valued pharmaceutical/proven medical effects products. Several stakeholders went into great detail of the potential of byproducts in the fish heads. For example, an Alaskan researcher sees large potential in "biochemicals isolated from the waste stream… such as hormone releasing factors that are found in fish brains and are likely to have molecular structures closely allied with human hormone releasing factors" (Informant 33, 2019). The handling of the byproducts determines its quality and thus by not focusing on their use, one loses on the byproduct itself to further processing or the quality to lack of processing lines.

Step 5 in Figure 22 is called "Limited value creation from the byproducts". Without the potential 100 K in Alaska and the 575 K tons in Norway of byproducts (Mordal, 2019, 5.1), there is less volume for more companies to engage in their own secondary production lines. Only the major companies have the economy of scale. For Alaska, Kodiak Fishmeal Company (KFC) is an example of the cooperative model for secondary products that minimizes discharge of byproducts for smaller processing plants; however, most ports do not have this type of solution. In the case of Norway, that has two major secondary production companies (Hordafor and Scanbio), the small and medium sized farms can deliver their silage to them, and thus all associated byproducts are accounted for besides the blood water. In addition with versatility of a cascading design that produces several products in its local location of harvest, there is the potential of more local jobs. Today, there is a lack of access to sufficient byproduct volume of high quality for the secondary production companies to be able to scale up production of higher valued product, and thus silage is the chosen method (PwC, 2018, p. 19, 67, own translation). Higher valued products need more care in handling and often need to be fresh and processed immediately (Olsen et al., 2014).

Step 6 in Figure 22 "Perspective on harvesting-marketing" is the next level for Alaska and Norway in its transition towards CE, where it moves from production-oriented to market-oriented. If the progression towards market-oriented is not taken, then byproducts will continue in the negative feedback loops of Figure 22. Market-oriented means to adjust strategy to fulfill the market needs. Being market-oriented implies to be exposed to and understand the full value chain. In the current export for reprocessing model, these are the additional four steps of trading, further processing, trading and consumption. Transitioning towards a CE requires coordination and change in mind-set. Fortunately for both Alaska and Norway, the stakeholders in this thesis agreed that their fisheries are fast to adapt if the economics are there. If the institutional framework does not provide the enabling background, then reference cases can lead by example.

Through the reference cases, Silver Bay Seafood show improvements in its social sustainability aspects. Hordafor AS show a byproduct utilization model to account for a large coastal area. Kerecis, represented how local entrepreneurs innovate high-valued secondary products when the national strategy of Iceland markets full utilization as a part of its sustainability strategy.

There are companies (such as the reference cases) that are moving towards circular production systems (closed-loop and cascading designs), but this transition needs to happen faster to secure the competitive edge that Alaskan and Norway have as the harvesters. A collaborated effort between Alaska/Norway that operates with circular economy business models will realize that transparency, sharing data, and encouraging innovation and entrepreneurship is an answer to speed up the transition. First and foremost, there is the current AlaskaNor project that has the main goal of addressing policies and regulations that lasts until July, 2021.

## 6.2 Implications and Recommendations to move towards Circular Production Systems

For Alaskan salmon and Norwegian aquaculture to fulfill its considerable potential as a contributor to sustainable blue growth, there needs to be a shift towards circular production systems. Circular systems minimise environmental impacts by creating closed production loops and/or enabling the efficient re-use of outputs, byproducts and waste flows from production, harvest, and processing. Implementing such processes create triple bottom line sustainability associated with the EU’s Blue Growth Agenda and the UN’s SDG 12 and 14 goals. Both Arctic regions benefit by minimising environmental impacts, increasing production and economic efficiency, and supporting inclusive industries that support coastal and regional economies. Furthermore, these ‘blue’ initiatives are creating more conscientious consumers and this in turn will increase the value of seafood byproducts and coproducts for Alaska and Norway.

Alaska and Norway effect one another’s consumer bases as explained by an informant “Alaska wild salmon is only going to become more popular. Farmed salmon has increased the pie of consumers” (Informant 47, 2019). Alaskans feel "[t]he farmed salmon will increase, but the wild salmon is a finite resource with unique proteins. Its value will increase with demand and this will also cause the residual raw material to also be worth more" (Informant 33, 2019). Both Alaska and Norway have environmental groups from their receiving markets and local citizens concerned with dumping and non-sustainable practices, where a move in increasing processing and utilization could assist in its branding and social acceptance.

Figure 23 illustrates is the opposite of Figure 20 and shows a positive feedback loop. It is based on collaboration strategies for Alaska and Norway seafood industry (specifically salmon) to maximize utilization of byproducts in alignment with blue/circular sustainable practices. Figure 23 reflects a positive feedback loop of five steps related to byproduct utilization and local processing.


*Figure 23: Recommended collaborating situation to strengthen Alaska and Norway's byproduct utilization and local processing in salmon.*

In Figure 23 Step 1 of "Industry circular vision" and Step 2 "Institutional framework" are interrelated steps that can occur in parallel or independent of one another. The "Industry circular vision" refers to the circular linkage of full utilization and local processing centered on the blue economy, as in SDG 14 of life below water. The "Institutional framework" are the taxes, incentives, and permits related to fisheries management and trade. There was identified a lack of circular vision in both the Alaskan and Norwegian stakeholders. This is primarily due to the current positive economic situation in both Alaska and Norway in their production-oriented schemes with their salmon. Salmon is Alaska's most important species in terms of job creation and value: total contribution 38,100 jobs and $ 5 billion dollars (McDowell Group, 2015, p. 11). Norway has a super profit in farming, so there has been investment in activities that increase harvest volume: increase growth and reduce shrinkage/mortality (PWC, 2018, p. 19, own translation). There are not obvious (for the non-circular businesses) economic incentives to maximize the utilization of the salmon in the current situation of an abundant and profitable industry. However, this is a rather short term perspective. For long term sustainability it is therefore important to look towards other countries like Iceland and Netherland that experience a scarcity of resource and land and adjust towards circular businesses. As explained by a Dutch interviewee that works with finding financial investments for circular-driven businesses, the institutional framework

> "should be the enabling background framework that allows for full utilization and local processing. If that is in place, then the economic, social, and environmental gain will follow in unison. If the institutional framework does not enable full utilization and local processing, then grassroots efforts and larger networks (globally UN:SDG 12) will have to be the backing of this missing pillar" (Informant 28, 2019).

This recommendation means for Alaska and Norway that if the institutional measures are not in place to adapt to the circular vision, as mentioned by both Alaskan and Norwegian informants, there can be grassroot efforts within the industry through the suggested collaboration synergies that will transition the current production-oriented industries towards circular. As mentioned through the reference cases, there are companies promoting full utilization and thinking beyond the bottom line, but the industry reality of exporting the majority for reprocessing needs a drastic systematic change that comes from regional and global collaboration efforts aligned with circular production systems.

Figure 23-Step 3 "Circular business models: from market to circular" refers to first transitioning from production-oriented to market-oriented businesses and further towards a circular orientation. Direct marketing strategies for fishermen were suggested for Alaska by the interviewees, and  cooperative models for smaller to medium-sized processing facilities were

suggested by previous literature for both Alaska and Norway (McDowell Group, 2017, pg. ; PwC Seafood, 2018, pg. , own translation).

CE business models are circular-oriented, which means there is an importance of selling services rather than products. Service-oriented business models stems from a 1976 research report to the European Commission 'The Potential for Substituting Manpower for Energy' written by architect and industrial analysts (Wautelet, 2018). The circular-oriented business models build on concepts from ‘performance economy’ (Stahel, 2008). This idea is in alignment with SDG 12 that calls for decoupling economic growth from resource use (UN SDG). In application, this means a fishing company could apply the service of guarantying sustainable practice throughout the complete value chain and cut costs by removing steps in the value chain. Circular oriented services are essentially going one step further in a more holistic direction than market-oriented services (Binet, n.d.; Economou, 2018; European Commission, 2019; Ibrahim, 2018; EMF and IDEO, 2018).

Many countries are addressing the benefits and how to transition into a circular economy. Even Confederation of Norwegian Enterprise (NHO) recognizes the potential for Norwegian firms to utilize residual waste streams and raw materials (NHO, 2016). The Norwegian government has appointed an expert committee to propose a national strategy to promote “green competitiveness” towards 2030 and the low-emission-society in 2050 (Regjeringen, 2015). One of the studies estimates that a transition to a circular economy in Norway can create 40,000 new jobs, reduce the carbon emissions by approximately 7 % and improve the trade balance by 2% (Wijkman & Skånberg, 2016). There is an estimate of over $1 trillion in business value by creating circular economy manufacturing by 2030 globally (UN, 2017). Transitioning to a circular industrial model in the fishing industry needs institutional collaboration with research and business stakeholders. There needs to be incentive programs to promote circular behavior.

The largest fish consumers, the EU, are making strong efforts towards CE. The European Commission adopted a comprehensive report on the implementation of the 2015 Circular Economy Action Plan this March 2019. The report presents the main achievements under the Action Plan and sketches out future challenges to shaping the economy and paving the way towards a climate-neutral, circular economy where pressure on natural and freshwater resources as well as ecosystems is minimized (European Commission, 2019). A report titled

“Accelerating the transition to the Circular Economy” outlines the plans of improving access to finance for circular economy projects. There are recommendations to financial institutions, project promoters and policy makers. There is now an interactive website that draws on the progress and collaboration of these three pillars (economic, environmental, and social) that need to change simultaneously to transition to this radical model (European Commission, 2019).

Figure 23-Step 4 “Social and financial capital” refers to the alignment of the circular vision with that of other global agendas. This alignment allows for potential expertise-exchange and ear-marked investment. There are global efforts and associated financial measures in place that aid in transition to circular production systems (See Appendix for Tables). A few of particular interest are described. The Global Compact launched in 2000 with the mission to align all companies’ operations and strategies with ten universally accepted principles in the areas of human rights, labour, environment and anti-corruption, and to take action in support of UN goals and issues embodied in the SDGs (UN, 2017). The Global Compact is a leadership platform for the development, implementation and disclosure of responsible corporate practices. It is the largest corporate sustainability initiative in the world, with more than 9,500 companies and 3,000 non-business signatories based in over 160 countries (UN, 2017).

The “World Ocean Summit” that has convened six years annually from 2013 to 2019. It brings together political leaders and policymakers, heads of global business, scientists, NGOs and multilaterals from across the globe. The Economist Group hosts the conference and started it with their own “World Ocean Initiative.” The aim is to provide a forum for discussion amongst a more diverse and representative participation on the future of the ocean, build greater collaboration across regions and connect the world to new ideas and perspectives. This conference appears to attract high-level business leaders with 50% of the 2018 attendees representing Founder/ VP/ Director/ Head/Manager positions. In 2019, 900 representatives of government, business, science and civil society from over 60 countries attended (Economist, 2019).

The “Sustainable Ocean Summit” (SOS) conferences focus on the private sector. The conferences are hosted by the World Ocean Council (WOC) that was initiated by the US-based Sustainable Ocean Alliance (SOA). The 7$^{th}$ SOS conferences happened this fall in Paris, France. The 2018 SOS conference in Beijing, China brought together 250 participants from the ocean business community of 30 different nationalities. The WOC represents a global, cross-sectoral ocean industry leadership alliance committed to "Corporate Ocean Responsibility," developed by and for the private sector. The SOA advances the impact of start-ups, social enterprises and youth-centered initiatives that are developing solutions to protect and sustain our ocean. SOA's pipeline of ocean leaders, ages 16-35, is cultivated through a chapter-based model, led by students at the high school and college levels, as well as by young professionals (Council, 2018).

The longest going conference out of this list is the "International People and the Sea Conference" that had its 10th year this past summer. It is hosted by the Centre for Maritime Research (MARE) established in 2000 by the University of Amsterdam and SISWO (Netherland's Institute for Social Science Research). MARE now has four institutional partners, located in three countries of Europe, one of them being the Norwegian College of Fisheries in Tromsø, Norway. The Netherlands has been pivotal in ocean related topics and solutions towards internalizing externalities. These conferences are linked directly to creating marine policies. The jubilee conference, which was preceded by a policy day (June 24, 2019) and flanked by other events, takes time as its theme, as in now is the time for action (ref).

This past March, 2019, the "Circular Economy Stakeholder Conference: Success Stories and New Challenges" hosted by the European Commission and the European Economic and Social Committee  marks one of the several conferences related to the "EU Circular Economy Action Plan" that was adopted in 2015. This plan is an interactive call for action. Even the website serves as transparent, adaptive and easy to engage with engine to further the cause of circular economy. There are public search engines for good practices, strategies, knowledge, commitments, and dialogue surrounding circular economy.

There is financial framework brought forth by the Economist Group and the World Ocean Council. In addition, the World Bank has focused investing in blue economy projects, the European Commission has developed a blue-growth strategy and FAO has launch a blue growth initiative (European Commission, 2018; FAO, 2016; "The potential of the Blue Economy | Voices," n.d.). The UNs SDGs and Global Compact are revolutionizing sustainable business practices. UN-supported Principles for Responsible Investment (PRI) and Sustainable Stock

Exchange Initiative (SSE) are two tools that build the financial framework to help investors and companies engage in sustainable business.

At the most recent "World Ocean Summit", they reported that at the end of October 2018, the Republic of Seychelles launched the world's first sovereign blue bond. The bond raised $15 million from institutional and impact investors and will be used to support sustainable marine and fisheries projects. The Economist Group expects this bond to catalyse other issuers (Economist, 2019). (See Appendix for more information).

Figure 23-Step 5 "Local increase in welfare" refers to the hopeful positive effect on the welfare of coastal communities by the industry taking the first four prescribed steps. This thesis found little published empirical data on circular economy and fisheries (de la Caba et al., 2019; Economou, 2018), and little published data on social sustainability indicators in fisheries. In Norway, there is a project called "Bærekraftportal for norsk havbruk[22]" which means sustainability portal for Norwegian aquaculture that addresses local welfare. Based on the three reference cases, there are different social welfare themes and business models that can inspire the Alaskan and Norwegian stakholders. Alaska's Silver Bay Seafoods represents a different cooperative business model in the marine capture sector compared to its rivals. Owned by fishermen that represent over 80% of its committed fishing effort, Silver Bay has established five processing facilities throughout Alaska since its start in 2007. Its new facilities represent more automation, processing lines and a focus of local hire that is built on the vision of "Silver Bay Experience." The Silver Bay vision has many social sustainable qualities of valuing and empowering each worker and to focus on local hire. There were some aspects of transparency though their pay scale. Other social benefits were not found or compared to its rivals. This model may not exist in Norwegian's marine capture and thus may serve as inspiration. Norway's Hordafor represents a company that processes 200 to 300 K tons of fish byproducts annually. It has logistics in place to cover Norwegians coast for secondary processing. It has 6 boats with up to 2,500 ton carrying capicity and storage facilities along the coast covering over 2,500 km. Hordafor represents a B2B coordination to allow for nearly 100% utilization in the farmed fish sector. Interviewed Alaskan stakeholders say Alaska lacks logistics, collaboration,

[22] https://nofima.no/prosjekt/bkb/ Accessed 1.11.2019

and infrastructure. Learnings from a company, such as Hordafor are relevant. Iceland is not in the same situation as Norway and Alaska that consider their fish resource as abundant and focus on increasing/maintaining harvest levels. Kerecis serves as an example of the company's form with there are drivers of transition to CE in place as in a limited resource and an united effort to create more from a resource. Kercis was able to create a high-risk, high-value products with its processing and ownership being locally anchored in rural Iceland.

### 6.2.1 Alaska and Norway Synergies for Collaboration

First and foremost, it is important to work towards circular economy business models. The popularity of CE will cause customer changes in sustainability practices that are holistic and cover the complete value chain. Figure 24 represents the suggested value chain for circular-oriented fishing industry. Instead of the current day's 7-step value chain (See Section 4.3) with further processing occurring in locations that are not the harvesters nor the consumers, this value chain model has only 4-steps. More coordination, collaboration and adaptation are necessary to transition to this model. The collaboration strategies for stable production (as in economy of scope), controlling the processing lines, coproducts/byproducts, and innovation related to energy and automation for the first two steps of harvest and production in the Figure 24 model. The latter two steps of trading and consumption, I suggest collaborating on sustainable branding, market coordination, and certifications.

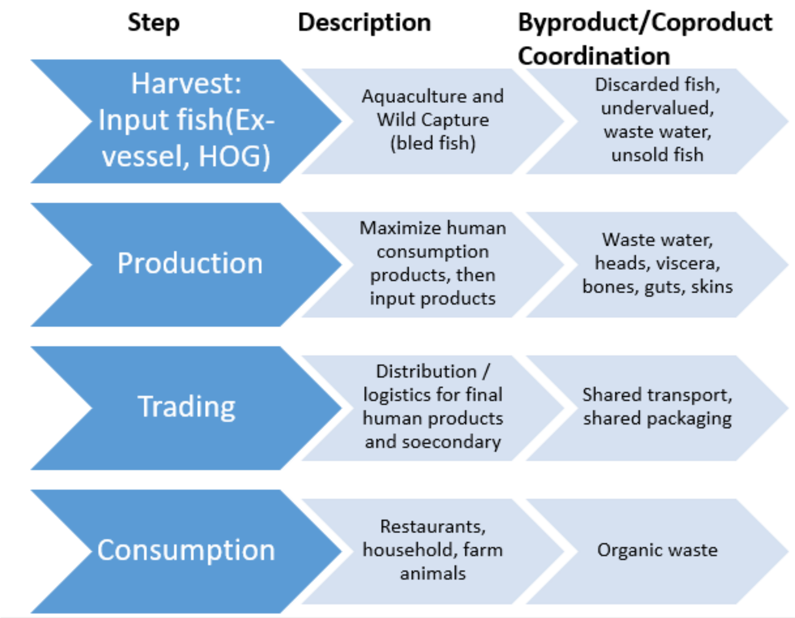


*Figure 24: Fish value chain in a circular-oriented industry (adapted from concepts from "The 2018 Annual Economic Report on EU Blue Economy" and PwC Seafood, 2018).*

In 2017, the total fishing catch was 84.4 K tons in Bristol Bay. Sockeye accounted for 64.7 K tons while the next largest species of herring contributed 15.9 K tons. The 20-year average sockeye harvest (1997-2016) are the following for the various districts (as reported in millions of fish): Naknek-Kvichak is 8.0; Egegik is 6.7; Ugashik is 2.8 and; Nushagak 6.4; and Togiak is 0.6 (Cotten & Kelley, 2017, Table 4). The 2017 harvest for those areas are of similar values (*St.Dev <1*) except for Nushagak that had an anomaly of 24.1 million fish, which was the highest recorded run on record for Bristol Bay. 24.1 million fish (2017) compared to 6.4 million fish (20-year average) is almost 4 times as many and highlights the challenge of wild harvest volumes being unstable. As shown by comparing the 20-year average to the 2017 fish counts, there is small variations with the chance of having anomalies as seen in Nushagak.

Operating in economy of scope (based on cascading design), on receives stable production because you are focused on full utilization of the harvest. As long as the harvest is available, there is a secure resource of products to create several processing lines. The stable production in a marine capture with its natural cycles means to guarantee products to consumer markets and thus secondary products play a crucial role and undervalued and unsold fish are not existent. As seen with Norway's farmed fish, the large and stable volume has led to the growing internal industry of processing fresh fish byproducts for extraction of fresh salmon oil and protein hydrolysate. This was an economy of scale and not an economy of scope. Both Alaska and Norway have the benefit of having the harvests, so secondary products can be processed fresh. Norwegian fresh products are now of similar volume as the traditional fish meal and oil, which is around 140 K tons, making up around 20% (Richardsen et al., 2017). Processing fresh materials requires large capital investment for facility and logistics for instantaneous processing after slaughter, but producer higher value products (PwC Seafood, 2018). This can be done by altering the production line or in the case of a seasonal fishery, innovative ideas such as the Norwegian cod hotels that are currently not perceived as a success (Norway exports, 2014).

Cod hotels are used to extend the seasonality of the fishery and have a longer time to produce high-quality products. The fish is caught live and held in a nearby pin, where any damages the fish endured in being caught is given time to restore naturally. The fish is then processed at a higher quality and allowing it to heal from being catched. In addition, the fish can be harvested at a staggered time that maximizes its value in the market. Instead of flooding the market with an abundant catch.

Controlling the processing line means to exporting for reprocessing and produce products for the consumer market. This will allow Alaska salmon to have twice the amount of available byproduct volumes (102 current tons vs 210 potential tons) and Norway farmed salmon two and a half times more (378 current tons vs 953 potential tons). The high degree of perishability, creates a technology-driven, complex system of matching supply to demand to be able to fully utilize the fish.

Produing products at the origin keeps the quality of the raw material. Preservation and processing techniques can reduce the rate at which spoilage happens and thus allow fish to be distributed and marketed globally as a human co-product. Alaska should focus on its main market of the US and Norway to the EU, and then coordinate with one another for other countries to ensure full utilization takes place.

Seeing that Alaska and Norway should focus on different markets, they can collaborate on coproduct/byproduct ideas that diversify their products and increases their utilization. The versatility of fish products creates also a versatile consumer market. What one county or culture considers waste, another considers a delicacy. In general, diversifying products to fully utilize represents cascading production when done in harmony with local environment and thus shows environmental stewardship. In terms of sustainable harvesting, Alaska and Norway can be seen that it is a must to close some of the production loops. As both fishing states are realizing and working hard to prevent to not overfeeding the sea with nutrients in the form of byproduct discharge. The valorization of abundant and available biowastes with high potential to manufacture value-added products is the first step to close the loop between waste and consumption in line with the main goal of the CE (de la Caba et al., 2019).

Innovation related to energy and automation will reduce energy costs and assist in pursuing reusable energy in lines with CE. Possible energy collaborations can be with bioenergy, hydropower related to waterfalls, improved water pumps, and battery systems. The operational costs and labor market will both benefit by increasing automation. This is a catch 22, due to the technical resources in a CE are to be responsibly used. The sustainability branding of the complete value chain will only be effective if the businesses pursue energy efficient and responsibly driven technologies. Innovations that adapt current machines or can recycle from other industries are preferable. Both Alaska and Norway have an oil and gas industry that has a large source of machinery. Tapping into how to cross-over technologies and machinery from oil/gas to fisheries help both areas.

Alaska Pollock fish meal/oil production is an example of how Alaskan/Norwegian partnerships to reduce rural energy costs will create symbiotic effects. The byproducts of Pollock represent the bulk of Alaska's fish meal/ oil production with 81% of meal and 95% of oil by volume in 2015. Due to the high rural energy costs, approximately 75% of fish oil produced in Alaska is blended with diesel fuel and burned in diesel generators powering shore-side plants and large fishing/processing vessels, thus not sold (McDowell Group, 2017, p.19-22). This type of utilization is not going towards human consumption and thus not working towards the vision of using byproducts towards coproducts when possible. However, the energy costs are of a serious issue and burning the fish oil has an important function to allow for the local processing. Innovation that allows for lowering rural energy costs will in turn free up this byproduct resource.

Collaboration strategies in the trading and consumption steps in Figure 24 are sustainable branding for chain of custodies/full utilization, market coordination in product diversification with focus on coproducts, and certifications related to production lines and workforce. Sustainability branding is an enabler to connect the environmental component to the economic. Environmental stewardship of ecolabling has become confusing with several schemes (FAO, 2016, p.93). Additionally, there are several labels to cover the whole value chain (harvest vs. chain of custody in MSC, ASC). Having a successful marketing scheme that focuses on the full value chain is essential for transitioning from production to market-oriented. Alaska includes full utilization in its marketing schemes, while Norway focuses more on the sustainability harvesting. Alaska Seafood Marketing Institute (ASMI) publishes on its website that

> "seafood producers use the materials that are left over to increase the value and create diversity in the marketplace for Alaska seafood. Some of the innovative ways Alaska increases the utilization of fish is through research and development in fishmeal, fish oil, pet food and many more alternative applications" (ASMI, 2019, para. 6).

As Renate Larsen, the CEO of Norwegian Seafood Council writes, "Norway can and will play an important role in sharing knowledge on how seafood can be produced in a safe, controlled and sustainable way" (NSC, 2017, p. 5). The aquaculture industry addresses the environmental factors of farmed salmon escaping from facilities and salmon lice (NSC, 207, p. 5), but not the processing lines. A Norwegian marketing consultant feels with more sustainable branding and including branding on "maximizing the full use of salmon i.e byproduct" will help with both utilization and local processing (Informant 26, 2019). This thesis found that only half of the stakeholders felt there was financial gain in sustainability branding. For Alaska, it was people related to the Bristol Bay fisheries and most of the researchers. For Norway, it was people that deal with trading, marketing consultants and less than half of the researchers. The ability of successful sustainable branding and progress in sustainable practices is identified as decoupling of resources in CE (Wautelet, 2018; Zagragja et al., 2016). The marketing strategy can sell the service of ensuring full utilization and sustainability throughout the complete value chain, instead of a single product from the fish or processing step.

In a transition towards controlling the processing lines and selling a sustainable service, not just a sustainably harvested fish, Alaska and Norway need to coordinate their markets. Both are global players in the salmon industry, and thus without coordination, they can flood one of another's market. With coordination, they can help build up niche markets that will help them increase coproducts in their production lines and increase value of byproducts. This thesis found that stakeholders voiced more interest in higher-value byproducts (moving up byproduct pyramid-See Appendix), and seeing that the diets of Alaskan and Norwegian fish are different, they possess different nutritional/pharmaceutical properties

While Alaska and Norway move towards automating their processing lines, there will be an increased amount of technical skills needed for the workforce. Collaboration in terms of certification schemes to ensure skilled workers is of great importance for social sustainability. As noted in this thesis, "[t]he workforce in Alaska is challenged. With no professional certifications necessary, education and training are sporadic and considered optional. Most industry employees are independent, self-reliant and self-taught" (Informant 44, 2019). This thesis concluded that a Norwegian processor was paid twice the hourly wage as an Alaskan. Possibly, there are synergies to find how to improve the social system for Alaska that allows its fishery employees to have benefits, like health care. A Kodiak interview revealed that out of the 12 processing factories in town, he knows of only one that gives healthcare to its employees (Informant 33, 2019).

In addition to the above recommendation for Alaska/Norway collaborations, there are two other critical opportunities. Collaborative platforms can help at gaining momentum on strengthening Alaska's logistical/institutional infrastructure and Norway's high tariff on processed seafood to its main market, the EU. Conferences and collaborations like the Centre for Maritime Research (MARE) that draws on several institutional partners and are linked directly to creating marine policies with their conferences stand for ways to make institutional transitions towards a circular economy. This could be the same opportunity for Alaska and Norway via AlaskaNor project or the Arctic Frontiers Conference. This thesis found that Alaska needs stricter discharge regulations to promote utilization, where Norway could assist, seeing that even the blood water has institutional mandates to be treated before released in the ocean (Sintef Ocean, 2018, para. 2). For Norway, the super-profit period will not last forever for its farmed salmon and its projected increase of harvest may happen. To be robust and to make the appropriate adjustments when the farmed salmon saturates its markets with its main export products, Norway needs bargaining power with the EU. By aligning with CE practices and engaging in CE partnerships with Alaska, Norway can prove that lower tariffs on processed products will help on full utilization and minimizing waste. On political terms, the EU should agree as they are leading the charge of transitioning to CE.

## 6.3 Limitations to this Study

There are always limitation to a study. There are limitations in the informant group, the seafood processing data, the gathered information on social sustainability, and the choice of recommended collaborations.

The synergies are partially based off the informants surveyed. This means that in terms of regions, Southern Alaskan (Bristol Bay, Southcentral and Southeast) and Northern Norway (Nordland and Trøms region) are most represented 26/31 and 17/23, respectively for the surveys. Bristol Bay Sockeye salmon has additional insight with it being the area of the harvest processing exercise and it represents 18/31 Alaskan surveys and 18/28 interviews. In conclusion, this thesis gathered the most information about Bristol Bay salmon for Alaska and Northern Norway farmed salmon.

Compiling comparable seafood processing data for Alaska and Norway was difficult. I tried to elaborate in the methods section how I found each of the volumes. The data collected for wild salmon and farmed salmon are quite different. For example, the harvest volumes and the associated available byproducts for Alaska did not include bycatch or unsold fish; whereas, for Norway the harvest volumes and available byproducts included the dead/diseased fish. This discrepancy was not accounted for. There could have been other gross generalizations when comparing the Alaskan and Norwegian data-sets that were overseen.

Social sustainability is a complex sustainability pillar that was only briefly explained. The survey used a question to gauge how the stakeholders felt about rural employment from byproduct utilization that was linked to their knowledge to Iceland. This may have affected the responses in terms of their familiarity with Iceland and not their perceptions on rural employment. It is difficult to understand the underlying reasons for an unqualified labor force or the reasons why more jobs in farmed salmon industry are not prioritized. The synergies only gave general suggestions to social sustainability factors.

The overarching recommendation is to control the processing lines to gain access to more byproducts and assure full utilization. However, the implications/consequences of removing the middleman country was not investigated. It could be possible that doing further processing in China results in more of the salmon is used towards human consumption as a coproduct than if it was processed in its harvested area.

# 7 Conclusion

## 7.1 Main Findings

The purpose of this study was to investigate why Alaska and Norway engage in export for further processing and come with recommendations for how they can align their future strategies to move in the direction of local, full utilization of byproducts and thereby contribute to the objectives of blue- and circular economies. This study collected primary data from fishery stakeholders in the form of 56 surveys with 42 quantitative/qualitative questions (Alaska (31), Norway (23), and Iceland (2)) and 36 semi-structured interviews (Alaska (28), Norway (23), and Iceland (1)) and did literature reviews to be able to recommend collaboration strategies between Alaska and Norway. Answers to the following research questions built the basis to the recommendation.

1) the current salmon and white fish processing volumes and the local associated byproducts

2) the current perceptions on seafood processing based on location and stakeholder type

3) how Alaskan and Norwegian stakeholders perceive limitations or growth in the current and future levels of local processing and utilization in their fishery based on sustainable factors.

Currently, both Alaska and Norway use other countries for further processing than the end-product consumer countries. Averaging over the years 2013-2016, Alaska exports approximately 70% of their 375 K ton salmon harvest for further processing to countries such as China. Norway exports 81% of its farmed salmon for further processing of their approximately 1-million-ton harvest.[23] By not engaging in local processing to export salmon directly to the consumer markets, Alaska loses 108 K tons of the estimated 210 K potential tons. Norway loses a whopping 575 K tons of the estimated 953 K potential tons. Alaska's volumes do not reflect bycatch or unsold salmon. Norway's volume includes their second most important available byproduct fraction of dead/diseased fish, which are not allowed for human consumption. Alaska utilizes an estimated 65% of their available byproducts and Norway

[23] 1 million ton assumes category III (for human consumption) farmed salmon.

utilizes 90%; however, the volume utilized represents only 1/3 of the estimated potential byproducts.

The current perceptions are economic sustainability drives the industry behaviour and therefore there are not apparent incentives to maximize utilization of the salmon. Both Alaskan and Norwegian stakeholders confirm this sentiment: The current economic situation is positive for both Alaska and Norway in their production-oriented schemes with their salmon. Salmon is Alaska's most important species in terms of job creation and value: total contribution 38,100 jobs and $ 5 billion dollars (McDowell Group, 2015, p. 11). Norway has experienced a super profit in salmon farming with its stagnant production. There has been investment in activities that increase harvest volume: increase growth, reduce shrinkage/mortality (PWC, 2018, p. 19, own translation). Focusing on harvesting and production, instead of the complete value chain from harvest to customer, has been economical for Alaska and Norway. However, this production-oriented mind-set does not satisfy triple bottom line growth.

The limitations or growth in the current and future levels of local processing and utilization vary between Alaska and Norway. Alaska struggles with high rural energy costs; disjointed entities between the fishermen, tenders, and processors; lack of qualified workforce; lack of environmental regulations to promote less discharge; unstable funding to educate, certify the workforce; and lack of coordination within the state's industry. Norway struggles with lack of incentives with the super-profit making it lucrative business for farm permit holders; difficulties in increasing harvest due to salmon diseases, high labor costs, which are twice that of Alaska production employees; and the higher tariff on processed seafood to their main market of the EU. However, through collaborative global platforms (Economic Group, World Ocean Council, Sustainable Ocean Alliance, UN) and established partnerships (AlaskaNor project between Northern Norway and Alaska to stimulate blue growth, Arctic Frontiers) transitions from production-oriented to market-oriented and eventually circular-oriented are possible.

Even though the operational cost is lower in the other countries than the harvest location and thus economically preferable (Bimbo, 2009; Nystoyl, 2018; PwC Seafood, 2018); Are the environmental standards as equally high where the further processing occurs? Alaska and Norway could show more environmental stewardship by engaging in circular production systems. Circular systems minimize environmental impacts by creating closed production loops and minimize discharge or use of harmful chemicals.

The popularity of circular economy will cause customer changes in expected sustainability practices that are holistic and cover the complete value chain, not just harvesting in the main retail markets. The EU is the world's largest seafood importer at $28.1 billion in 2014 (FAO, 2016, p. 54) and is leading the institutional traction for circular economy businesses. This past March 2019, the "Circular Economy Stakeholder Conference: Success Stories and New Challenges" hosted by the European Commission and the European Economic and Social Committee marks one of the several conferences related to the "EU Circular Economy Action Plan" that was adopted in 2015. Switching from the current day's 7-step value chain with further processing occurring in locations that are not the harvesters nor the consumers, this thesis suggested a 4-step value chain for a circular-oriented fishing industry.

The recommended collaboration strategies between Alaska and Norway consist along the 4-step value chain of harvest, production, trading and consumption. In the first two steps, collaborations related to economy of scope, controlling the processing lines, efficient production lines for coproducts/byproducts, and innovation related to energy and automation. The latter two steps of trading and consumption, the recommended collaboration are on sustainable branding, market coordination, and certifications. This thesis outlined several suggestions in which collaborations can exist and references business cases that are at the forefront of full utilization and/or local processing: Alaska's Silver Bay Seafoods, Norway's Hordafor, and Iceland's Kerecis. For example, ideas like "cod hotels" could be transferrable from Norway to Alaska to assist in promoting circular production systems that go beyond the bottom line of economics.

Salmon is the highest valued traded fish (FAO, 2016, p.64). Alaskan and Norwegian salmon are locally managed, sustainably harvested, and certified. Retailers of secondary products are looking to buy fishmeal and oil from sustainable sources and secondary processing companies in Alaska and Norway are profitable.

It is time to turn the tides and leave the old ways of the industry being retroactive, instead of proactive. The clock is ticking, and this means by continuing export for futher processing, Alaska and Norway are strengthening the competitive advantages to other processing plants and losing the chance to have the expertice and market share in secondary processing. It will be China, the continental US, Eastern Europe and other EU countries that build the relationships with the buyers and control the further trading of the sustainably harvested salmon.

## 7.2 Suggestions to Future Work

Since there is little scientific research on circular economy in seafood industry, I have had to resort to less scientific reports and apply general concepts to support this thesis (de la Caba et al., 2019; Kirchherr et al., 2017; Wijkman & Skånberg, 2016; Zagragja et al., 2016). I ask for the reader to recognize the delimitations of this research and appreciate the method and results thus far. This work is only the beginning in this field of Alaska Norway synergies in controlling seafood processing lines and builds on previous work. This research serves as parallel work to find solutions towards business models that serve a holistic purpose of social, environmental, and economic goals in a balanced, adaptive framework.

Although Alaska and Norway have many identified synergies, there needs to be locally customized solutions to comply with circular-production systems. A next step to this research to further identify symbiotic collaborations is to study pertinent areas like Kalundborg Symbiose in Denmark. This circular industrial park is a unique public-private partnership facilitating sustainable smart business that has input from Norway's seafood industry for its biogas facility and uses Norwegian businesses in its oil-refinery facility.

This thesis found that the institutional framework lacked in both Norway and Alaska to encourage the circular vision of linking utilization with local processing, and thus public-private partnerships that tie international connections with Alaska and Norway will strengthen this cause. This thesis identified the AlaskaNor project, Arctic Frontiers, and cluster relationships, but there are many more. A future study identifying established Alaska/Norway partnerships will assist with coordinating efforts. In addition, a study that investigates all the Norwegian businesses that are investing in salmon farms closer to the American consumer market and argues that investing in Alaskan wild salmon operations are of better interest to satisfy the triple bottom line in the blue economy would be of pertinent interest.

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# Appendix

## Survey Final Version

The below is a copy of the GoogleDoc Quiz used to collect and confirm survey responses. The GoogleDoc Quiz can be downloaded as a PDF. The following is a copy/paste of the PDF. The figures are not included, because there are no new figures from that of the first version.

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# Introduction

Hello Believers of the Blue Economy,
My name is Merrick Mordal. I am reaching out to you for your expertise in the blue economy and I value your insight. I would deeply appreciate you filling out this survey to help advance the reduction of postharvest losses and increase local employment by adding value.
I am from Alaska and have lived the last 10 years in Norway. I am a second-year master's student in the program "International Fisheries Management" at Norwegian College of Fisheries in Tromsø.
This informative survey is a part of my master's thesis that explores the timing for Alaska and Norway to focus on increasing the local processing of fish and capitalizing on the byproducts, especially in the salmon sector. The information provided will be made anonymous, will only be used academically, and will be shared with you before publishing. Please feel free to contact. Merrick Mordal
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Skype name: merrickjohnston83
+1 (907) 727-2067 (until Feb 19th) +47 46945408 (after Feb 19th)

1. **Email address (kept confidential)**
2. **Name (kept confidential)**
3. **How would you describe yourself as a stakeholder in the commercial fisheries? (Check as many that apply)**

*Check all that apply.*
Fisherman/fisherwoman/farmer
Economic Developer/ Investor
Processor
Consumer
Leader (ex. politician, community)
Researcher
Buyer
Student/Professor
Other:

4. **How many years have you worked in or with commercial fisheries?**

*Check all that apply.*
>0 to 5
6 to 10
11 to 15
16-20
Over 20
Not yet, but plan to
Other:

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5. **Are you handling, processing, trading or conducting research in fishery byproducts (i.e. fish waste)?**

*Check all that apply.*
Yes, in the fishing industry
No, but have in another industry
No

No, but would like to
Other:
6. **Which fishery (fisheries) are you commercially involved with? (Check as many that apply)**
*Check all that apply.*
Alaska- salmon with hatcheries
Alaska- salmon without hatcheries
Alaska- pollock
Alaska- Pacific cod
Alaska- other
Norway- farmed salmon
Norway- cod
Norway- herring, mackerel, blue whiting and capelin
Norway- other
Iceland- cod
Iceland- other
Other:
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7. **Which region(s) do you operate in?**
*Check all that apply.*
AK: Arctic-Yukon-Kuskokwim
AK: Bristol Bay
AK: Prince William Sound
AK: Other in Central (Copper River, Cook Inlet)
AK: Kodiak
AK: Other in Westward (Bering S, Chignik, AK peninsula)
AK: Juneau/Yakutat
AK: Craig/Ketchikan
AK: Other in Southeast (Sitka, Peter.)
Finmark
Troms
Nordland
Trøndelag
Møre & Romsdal
Sogn & Fjordane
Hordaland
Rogaland/Agder.
Iceland
Other:
8. **What is the relationship with your fishery?(check all that apply)**
*Check all that apply.*
Family connection
Job opportunity
Cultural identity
Appealing lifestyle
Coincidence
Other:
9. **Do you expect future generations in your family (immediate/extended) to continue in the fishing industry?**
*Check all that apply.*
Yes, in the same fishery
No, but in the fishing industry
No
Not sure
Other:
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10. **Are you affiliated with any of the following organizations? Cross off all that apply.**
*Check all that apply.*
United Nations
NCE Seafood Innovation Cluster

United Fishermen of Alaska
Alaska Ocean Cluster
Iceland Ocean Cluster
Global Salmon Initiative (GSI)
Global Sustainable Seafood Initiative
Other:
11. **Have you heard of Principles for Responsible Investment (PRI)?**
*Check all that apply.*
Yes, but not in fishing
Yes, and in fishing industry
No
Not sure
Other:
12. **Have you heard of Sustainable Stock Exchange (SSE)?**
*Check all that apply.*
Yes, but not in fishing
Yes, and in fishing industry
No
Not sure
Other:
13. **How culturally dependent are you on your fishery (including personal, subsistence, and commercial) on your livelihood? Please check off from 0 to 10, where 10 means 100%.**
*Mark only one oval.*
0 1 2 3 4 5 6 7 8 9 10
Little to no
relationship
100%
connected
14. **How socially dependent are you on your fishery (including personal, subsistence, and commercial) on your livelihood? Please check off from 0 to 10, where 10 means 100%. 3 spheres: 1 nuclear, 2 community, 3 professional**
*Mark only one oval.*
0 1 2 3 4 5 6 7 8 9 10
Little to no
relationship
100%
connected

15. **How financially dependent are you on your fishery (including personal, subsistence, and commercial) on your livelihood? Please check off from 0 to 10, where 10 means 100%.**
*Mark only one oval.*
0 1 2 3 4 5 6 7 8 9 10
Little to no
relationship
100%
connected

# Opinion of byproduct industry

16. **Which fishery are you most familiar with?**
Please check off your opinion for the next 15
questions related to this fishery.
17. **There are many options for utilizing the byproducts (wastes) generated by the seafood industry.**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
6. No
opinion
/ Don’t

know
18. **There is financial gain by reducing post-harvest losses.**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
No
opinion
/ Don't
know
19. **Iceland's increase of byproducts and of higher-value byproducts has helped promote jobs in rural areas.**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
No
opinion
/ Don't
know
20. **The United Nation Sustainable Development Goals (SDGs) assist in promoting full utilization.**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
No
opinion
/ Don't
know
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21. **SDG 12 "Responsible Consumption & Production" and SDG 14 "Life Below Water" relate directly to full utilization in the seafood industry.**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
No
opinion
/ Don't
know
22. **The sustainable branding used by Alaska and Norway for marketing purposes promotes full utilization.**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
No
opinion
/ Don't
know
23. **Increasing fish utilization helps with sustainability branding (ASC/MSC/RFM)**
*Mark only one oval.*
1 2 3 4 5 6
Strongly agree Partially agree Neutral
Partially disagree Strongly disagree

No
opinion
/ Don’t
know

24. **Sustainability branding has financially helped me.**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
No
opinion
/ Don’t
know

25. **Rate (1 to 4) how you perceive the following factors are prioritized in your fishing industry in terms of full utilization. You can rate the factors with the same weight by giving the same number. (1 is highest priority)**
*Mark only one oval per row.*
1 2 3 4 Not sure
Financial
Environmental
Social
Institutional



26. **The current level of exporting salmon for reprocessing out of Alaska/Norway will remain constant (15-year time-frame).**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
No
opinion
/ Don’t
know

27. **Today's raw material flows represent a significant loss of value for Norway/Alaska.**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
No
opinion
/ Don’t
know

28. **There are substantial employment opportunities by increasing processing locally.**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
No
opinion
/ Don’t
know

29. **The amount of wild catch harvest will remain constant (within 15% in 15-year time-frame).**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly

disagree
No
opinion
/ Don’t
know
30. **Aquaculture/Mariculture harvest will increase. (15-year time-frame).**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
No
opinion
/ Don’t
know

31. **Rate (1 to 4) how you perceive the following factors are prioritized in your fishing industry in terms of local processing. You can rate the factors with the same weight by giving the same number. (1 is highest priority)**
*Mark only one oval per row.*
1 2 3 4 Not sure
Financial
Environmental
Social
Institutional
32. **Innovation is encouraged in my work position.**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
No
opinion
/ Don’t
know
33. **Entrepreneurship leads to increasing local utilization.**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
No
opinion
/ Don’t
know
34. **My community supports innovation and entrepreneurship.**
*Mark only one oval.*
1 2 3 4 5 6
1.Strongly agree 2.Partially agree
3.Neutral 4.Partially disagree 5.Strongly
disagree
No
opinion
/ Don’t
know

# Current fish byproduct structure

# Figure 1- Salmon as an example to explain the weight percentage from live weight to primary fillet product (Olsen, 2017)

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35. **The resulting byproductsdepends on how much of the fish is used for the primary product. The Figure 1 example is 56% of the total weight. In the fishery or processing facility you are most familiar with, what is approximately the weight % by volume used towards the primary product.**

*Mark only one oval.*

1 2 3 4 5 6 7 8 9 10

10 % 100%

36. **What species and product form did you refer to in the previous question?**

# Figure 2- Simplified pyramid showing value and volume in established byproduct salmon markets.

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37. **Is there anything missing in Figure 2's byproduct pyramid in your fishery? (Y/N) Explain___________________**

38. **Do you have any innovative ideas for residual raw material (fish waste) use in your fishery? (Y/N) Explain___________________**

39. **Have you taken any action on your idea? (Y/N) Explain_______________________________**

# Full utilization, local processing

40. **How do you perceive your fishery in 5 years in terms of 100% (full) utilization and local processing?**

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41. **How do you perceive your fishery in 20 years in terms of 100% (full) utilization and local processing?**

42. **How do you perceive innovation and entrepreneurship in assisting in full utilization with local processing?**

X

# Circular Economy Coding

*Table 9: Barriers impeding the transition towards a circular economy. The table lists barriers that impede the transition to a circular economy, identified in various literature (Taken from Zagragja et al., 2016).*

| Theme | Notion | Source |
|---|---|---|
| Cultural resistance | Risk aversion, extra effort. | (EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Tukker, 2015) |
| Current product design | Both financial incentives and legal systems support the linear economy. | (EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Tukker, 2015; Leising, 2016; Matthies, et al., 2016; NHO, 2016) |
| Commodity and energy prices | Subsidization of non-renewable commodities and energy. | (EMF, 2012; Lacy & Rutqvist, 2015; Webster, 2015) |
| Lack of transparency | Environmental costs not reflected in product prices. | (EMF, 2012; Leising, 2016) |
| Investments | The transition demands large up-front investments. | (Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Webster, 2015; Leising, 2016; Wijkman & Skånberg, 2016) |
| Shareholder Power | Limited liability. Demand short-term profit. | (Barton, 2011; EMF, 2012; Barton & Wiseman, 2014; Glass, Cook, & Ingersoll, 2015; Leising, 2016) |
| Infrastructure | Information exchange systems, reverse logistics issues. | (EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Leising, 2016) |
| Education | Limited knowledge on the benefits of of CE. | (EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Tukker, 2015; Leising, 2016) |
| Technology and Innovation | Lack of high-tech collection and separation systems. Focus on fossil fuels and linear technologies. Lack of investment. | (Braungart & McDonough, 2009; Mathews & Tan, 2011; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Leising, 2016) |
| Lack of Collaboration | Knowledge transfer, resource origin. | (EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013) |
| Financing | Incentives, tax reductions. | (Geng & Doberstein, 2008; Mathews & Tan, 2011; EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Tukker, 2015) |
| Bio-side Suppliers | Suppliers of raw materials have an advantage over those of residual raw materials. | (Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013) |
| Product Components | Used components more expensive than the resale margin. | (Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013) |
| Regulation | Inefficiencies, inconsistencies, risk-aversion. | (Yong, 2007; Geng & Doberstein, 2008; Mathews & Tan, 2011; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Matthies, et al., 2016; NHO, 2016; Sauvè, Bernard, & Sloan, 2016) |

*Table 10: Enablers of circular economy. The table lists enablers of circular economy, identified in various literature (Taken from Zagragja et al., 2016).*

| Theme | Notion | Source |
|---|---|---|
| Collaborative Platforms | Cross-chain and cross-sector collaboration. | (Braungart & McDonough, 2009; EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Sempels, 2014; Vanner, et al., 2014; Jordens, 2015; Lacy & Rutqvist, 2015; Tukker, 2015; Ghisellini, Cialani, & Ulgiati, 2016; Leising, 2016) |
| Financing | Availability of financing and risk management tools. | (Ingebrigtsen & Jakobsen, 2007; EMF, 2012; Vanner, et al., 2014; Matthies, et al., 2016; NHO, 2016) |
| Regulation | Regulations in areas such as taxation and tariffs, and incentives systems. | (EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Vanner, et al., 2014; Matthies, et al., 2016; NHO, 2016; Sauvè, Bernard, & Sloan, 2016; Wijkman & Skånberg, 2016) |
| Education | Raising awareness about CE and its implications, and incorporating CE concepts in education curricula. | (EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; NHO, 2016; Sauvè, Bernard, & Sloan, 2016) |
| A New Economic Framework | Changes to existing fiscal system, measurement systems. | (Ingebrigtsen & Jakobsen, 2007; EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Webster, 2015; NHO, 2016; Sauvè, Bernard, & Sloan, 2016; Wijkman & Skånberg, 2016) |
| Technology and Innovation | Technology development, improved materials, and labor and energy efficiency. | (Ingebrigtsen & Jakobsen, 2007; EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Tukker, 2015; Lacy & Rutqvist, 2015; NHO, 2016; Wijkman & Skånberg, 2016) |
| Security of Supply | Long term security of supply of resources. | (Ingebrigtsen & Jakobsen, 2007; EMF, 2012; Leising, 2016; NHO, 2016) |
| Decoupling of resources | Economic growth independent of increased use of energy and resources, and environmental pressure. | (EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Jordens, 2015; Leising, 2016; Wijkman & Skånberg, 2016) |
| Clusters | Logistics, infrastructure, communication. | (EMF, 2012; Vanner, et al., 2014; Leising, 2016; NHO, 2016) |

*Table 11: Drivers of a transition to circular economy. The table lists drivers of a transition to circular economy, identified in various literature (Taken from Zagragja et al., 2016).*

| Theme | Notion | Source |
|---|---|---|
| Resource scarcity | Trade barriers, high prices, price volatility. | (EMF, 2012; Leising, 2016; NHO, 2016) |
| Price volatility | High and unsecure resource prices. | (EMF, 2012; Leising, 2016) |
| Financial crisis | Companies need to save costs, price volatility. | (Leising, 2016) |
| Regulation | Increased costs on linear processes. | (Ingebrigtsen & Jakobsen, 2007; Yong, 2007; Mathews & Tan, 2011; EMF, 2014; Ghisellini, Cialani, & Ulgiati, 2016) |
| Performance Economy | From ownership to services. | (Tukker, 2015; EMF, 2014; Sempels, 2014; Stahel, 2014; Lacy & Rutqvist, 2015; Leising, 2016) |
| Infrastructure | Increased urbanization means simple logistics, and reverse logistics becomes more cost effective. | (EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Leising, 2016; NHO, 2016) |
| New Business Models | Business models that encourage to buy a service rather than a product. | (EMF, 2012; Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013; Sempels, 2014; Lacy, Keeble, & McNamara, 2014; Matthies, et al., 2016; NHO, 2016) |
| Reverse Cycle | Less energy intensive. | (EMF, 2012) |
| Climate Change | Ecological footprint. | (NHO, 2016; Wijkman & Skånberg, 2016) |

*Table 1: Alaska fisheries 5-year perspective on status and barriers coded to circular economy for 29 respondents.*

| Alaska Fisheries 5-years: 29 respondents | | | | | |
|---|---|---|---|---|---|
| Coding Group | # | Theme | "Quote" / Topic | Ocurrence | CE Theme |
| Status | 1 | Utilization and local processing | No change | 11 | |
| | 2 | | Minor progress | 2 | |
| | 3 | | Slow and steady increase with both | 1 | |
| | 4 | | Increased with increased focus, new markets and technology. | 1 | |
| | 5 | | Producers and consumers mind-set will change within 5 years, increasing focus to improve | 1 | |
| | 6 | | Noticeable change at 10 years, not 5 | 1 | |
| | 7 | Utilization | 80-90% | 2 | |
| | 8 | | 65% | 1 | |
| | 9 | | "Increase in offal utilization with lover Yukon processors" | 1 | |
| | 10 | | "In five years we will have relative full utilization of harvested fish from a wide variety of species. Minimally, after removing the fillets for sale as human food. Other parts will be sold as more “exotic foods”: Fish Heads to China principally, Cod Testes to South Korea, Crustacean shell transformed into Chitosan for sale to Industrial manufacturers of flocculants. There are a number of other examples." | 1 | |
| | 11 | Local Processing | Steady increase | 1 | |
| | 12 | Harvest | "Expect steady declines of runs and increased dependence on hatchery salmon" | 1 | |
| Coding Group | # | Theme | "Quote" / Topic | Ocurrence | CE Theme |
| Barriers | 1 | Mind-set | "Industry is retroactive, instead of proactive" | 3 | Cultural resistance |
| | 2 | | Full utilization is driven by the volume and length of season, as a result of those factors we have some areas with 100% utilization and some with less. | 2 | |
| | 3 | | "Local processing is driven by economics and available labor, I don't see 100% local processing as a realistic goal." | 1 | |
| | 4 | | Full utilization and local processing are not linked | 2 | |
| | 5 | | "The industry is driven by the bottom line. Costs of operation and revenue stream dictate industry behavior." | 3 | |
| | 6 | | Drastic change only from regulatory mandate | 5 | |
| | 7 | Permitting | Government permitting is the bottleneck now for getting more seaweed farms up and going. This will probably continue to be the problem with the state budget cuts in the near future. | 1 | Regulation and or Institutional Infrastructure |
| | 8 | Operating costs | Rural Alaska energy costs | 9 | Commodity and Energy prices |

*Table 2: Alaska fisheries 5-year perspective coded to circular economy enablers for 29 respondents.*

| Alaska Fisheries 5-years: 29 respondents | | | | | |
|---|---|---|---|---|---|
| Coding Group | # | Theme | "Quote" / Topic | Ocurr. | CE Theme |
| Enablers | 1 | Regulatory mandate | "If there is a change by the EPA and DEC on the discharge, then the industry will react." | 8 | Regulation |
| | 2 | | Disposal permits becoming more difficult and new facilities must abide by changing standards. "Such as Silver Bay in Bristol Bay." | 4 | |
| | 3 | New players | "where there is growth in the processing side of the fishery. Newer facilities have the ability of building infrastructure that incorporate several product forms for more of the fish, such as Silver Bay in Valdez" | 5 | Financing |
| | 4 | | More automation and value-added production lines | 2 | |
| | 5 | Established market streams | Facilities with minimal discharge have established market streams. Ex. Block freeze for pet food and recover fish oil | 3 | Collaborative Platforms |
| | 6 | Mind-set | "I hope there is to be 1 or more secondary processors in Bristol Bay" | 3 | Education |
| | 7 | | "The whole fish is a super food." [fishermen] | 2 | Decoupling of resources |
| | 8 | Handling | "The care of the fish from catch to harvest has improved tremendously since I started." | 2 | Education |
| | 9 | Environmental concern | Over nutrification, need to reduce discharge | 3 | |
| | 10 | Local environmental concern | "Local community notices that the amount of ocean discharge is not a solution. There has the been the fertilizer project at Dillingham, but Naknek needs further solutions." | 2 | Education- Local public action, Collaborative Platforms / Clusters |
| | 11 | | "Discharge permits are reviewed, like the one in Kodiak where there are complaints about the visible sheen on the water from the Kodiak Meal Plant." | 1 | |
| | 12 | Branding | "There is a general branding awareness and everyone wants to continue with high quality of sockeye." | 3 | Collaborative Platforms |
| | 13 | Industry knowledge sharing | "to incorporate more efficient utilization practices in processing" | 2 | Clusters |
| | 14 | Stakeholder Education | "Local processing becomes more and more important as one ascends the value chain for these products [byproduct pyramid]. Isolation of brain biochemicals might require working on board ships." | 1 | Decoupling of resources |
| | 15 | Untapped potential | "Finally above human food in value would be biochemicals isolated from the waste stream, biochemicals such as hormone releasing factors that are found in fish brains and are likely to have molecular structures closely allied with human hormone releasing factors." | 1 | |
| | 16 | New industry | Seaweed as an upcoming industry for the state. | 1 | New Business Models |
| | 17 | New workforce generation | "Upcoming generation realize the benefits of high quality products" | 1 | Education |
| | 18 | Fiscal constraints | "With the economic down-turn and cuts in state budget, I foresee our oil & gas dependent state to try and diversify in other industries. It will need to engage in value added ventures to offset the oil and gas tax deficit." | 1 | Financial Instability (not crisis) |
| | 19 | Standards | "Increased utilization will continue to occur due to sustainability certification standard enhancements and innovation." | 1 | A New Economic Framework |
| | 20 | Operation costs | "Local value-added processing should continue to increase, particularly if global trade disruptions persist." | 2 | International trade volatility |
| | 21 | Demand increase | "Alaska wild salmon is only going to become more popular. Farmed salmon has increased the pie of consumers." | 1 | Financing |
| | 22 | | "The farmed salmon will increase, but the wild salmon is a finite resource with unique proteins. Its value will increase with demand and this will also cause the residual raw matrerial to also be worth more." | | |
| | 23 | Sustainably managed | Abundant resource | 1 | Security of Supply |
| | 24 | Lead by example | "As shown in our partner meal plant (last 15 years) and our solely owned Southeast plant, fish meal and oil is profitable." | 2 | Clusters |
| | 25 | Some Infrastructure in place | "The city owns the grind shack in Homer. It is illegal to dump carcasses within the 3 mile limit. The grind shack seems to work well for the sport and subsistence catch." | 1 | Clusters |
| | 26 | New players | "If there was a commercial processing facility in addition to Coal point, there would be more waste. I think a local processing facility is in the cards seeing that the majority of the Lower Cook Inlet catch is within a 4 hour boat ride from Homer." | 1 | Current growth in production facilities (Infrastructure) |
| | 27 | Adaptive Industry | "Our fisheries in Alaska will have made great strides in individually understanding how companies could incorporate more efficient utilization practices in their processing." | 1 | Collaborative Platforms / Clusters |

*Table 3: Alaska fisheries 20-year perspective on status and barriers coded to circular economy for 29 respondents.*

| Alaska Fisheries 20-years: 29 respondents | | | | | |
|---|---|---|---|---|---|
| Coding Group | # | Theme | "Quote" / Topic | Ocurr. | CE Theme |
| Status | 1 | Utillization and local processing | Optimistic | 2 | |
| | 2 | | No change without outside pressure | 3 | |
| | 3 | | "Increase in offal utilization with lover Yukon processors" | 1 | |
| | 4 | Utillization | at least 50% | 1 | |
| | 5 | | 70% | 1 | |
| | 6 | | Close to 100% | 5 | |
| | 7 | | No change | 2 | |
| | 8 | | Utilization depends on energy cost, investments in R&D | 2 | |
| | 9 | Local Processing | Remain limited | 2 | |
| | 10 | | "I expect a local commercial processor and more direct marketing to tourists in the summer. " | 2 | |
| | 11 | | "Hopefully more of the fish is produced locally, but i fear that large amounts of fish, both wild and farmed will be sent unprocessed and frozen to low-cost countries." | 1 | |
| | 12 | | Increase: "While local processing will continue to grow, the event of local processing increases will largely depend on reduced energy costs and increased mechanization of processing facilities." | 3 | |
| | 13 | Harvest | "Additional dependence on hatcheries" | 1 | |
| Coding Group | # | Theme | "Quote" / Topic | Ocurr. | CE Theme |
| Barriers | 1 | Logistics | "The supply chain will have to work together to address the difficult logistics in Alaska." | 4 | Lack of Collaboration / Infrastructure |
| | 2 | Research & Development Investments | "There needs to be a strong research and development effort that is funded by both the public and private." | 4 | Investments |
| | 3 | Lack of collaboration | "As of today, there are many disjointed entities, every man for themselves attitude that will probably change with less discharge." "There needs to be more cooperation with the industry (e.g. plants), government, academia, economic development initiatives and local workforce in the fishing industry to realize more utilization and local processing. " | 3 | Lack of Collaboration / Shareholder Power / Interfirm transactions |
| | 4 | Lack of Social Infrastructure | "lack of a stable centralized community for research, development, entrepreneurship, and vocational training. Building this type of network/community is fighting upstream." | 3 | Infrastructure |
| | 5 | Price Volatility | "The fishing industry is volatile with market prices and harvest levels fluctuate each year, some species more than others." | 2 | Investments |
| | 6 | Lack of investment /ownership | "Alaska needs to invest in its innovation/entrepreneurial ecosystem to foster and support new ideas, processes and products to increase the value of ocean-based resources." | 2 | Investments / Education |
| | 7 | Lack of vision | "Local processing takes thought out long-term plans and more investment on infrastructure. This will not come with out invested interest." | 2 | Lack of Collaboration / Shareholder Power |
| | 8 | Operational Cost | Energy costs in rural Alaska | 5 | Commodity and energy prices / Financing |
| | 9 | Workforce | "local processing depends on lots of things including universal health care" | 2 | Social Infrastructure |
| | 10 | Mind-set: No need for change | "Alaska is abundant with its fish resource. The industry is established." | 1 | Resource abundance |
| | 11 | Mind-set: Pragmatic, Not Performance Economy | "You need economies of scale. If the economics are there to process and use more, then the industry will adapt." | 1 | Cultural Resistance / Incentives |
| | 12 | National Tax Regime | "If there is a change in the Jones Act, then the picture would be different." | 1 | Lack of Transparency |
| | 13 | Little Innovation | Alaska introduces little local innovation | 1 | Social Infrastructure |
| | 14 | Lack of vision | I think 20 years is too far ahead to have any reasonable opinion. | 1 | Lack of Collaboration |

*Table 4: Alaska fisheries 20-year perspective coded to circular economy enablers for 29 respondents.*

| Alaska Fisheries 20-years: 29 respondents | | | | | |
|---|---|---|---|---|---|
| Coding Group | # | Theme | "Quote" / Topic | Ocurr. | CE Theme |
| Enablers | 1 | Mind-set: Generational | Concerned upcoming generation | 1 | Collaborative Platforms / Clusters |
| | 2 | Mind-set: Consumer | "There will be a push from many consumer markets for a more holistic approach to the chain of custody and fishery management." | 2 | Collaborative Platforms / Clusters |
| | 3 | Mind-set: Arctic | "Alaska will see its own commodity as finite, instead of abundant. Iceland's general population seem like they are responsible consumers and take pride in Iceland sourced resources, like their cod." | 2 | Collaborative Platforms / Clusters |
| | 4 | Mind-set: Regional | "There will be pressure from Seattle and Europe to discard less and this will cause additional regulations or incentives in the industry.""In PNW, there are signs of not treating the residual raw material as waste, but as a resource. Seeing that the majority of the fish landed in the major west coast ports are from Alaska, I would believe that the pressure of not discharging will be felt there within 20 years." | 4 | Collaborative Platforms / Clusters |
| | 5 | Mind-set: European | "the changes in 20 years will come from Seattle and Europe." | 3 | Collaborative Platforms / Clusters |
| | 6 | Established Infrastructure | Established fish meal plants will do more up front sorting. | 2 | Infrastructure |
| | 7 | Product Appreciation | "I think there will be more protein extraction from the fish products." | 5 | Education |
| | 8 | Branding | "Bristol Bay will probably be at the forefront for Alaska due to its successful branding that is built on sustainability." | 3 | Decoupling of resources / Collaborative Platforms |
| | 9 | New Industry | Within 20 years, there should be some evidence of economic success of the seaweed industry. With the success, the institutional framework will come in place and with seaweed, local processing is mandatory. | 1 | Technology and Innovation |
| | 10 | Collaboration | "In 20 years, there will be some shared practices on how to more efficiently utilize our resources with automated processing practices" | 2 | Collaborative Platforms / Technology and Innovation |
| | 11 | Research & Development | "potentially more strides in seafood science to diversify our markets and utilize more of the harvested product." | 1 | Technology and Innovation |
| | 12 | Mind-set: Industry pressure | "Silver Bay is proactive with its byproduct handling, while others are reactionary. By leading by example, the others will follow." | 2 | Collaborative Platforms |
| | 13 | Regulation | "full utilization driven by EPA regulations" | 2 | Regulation |

*Table 5: Alaska fisheries perspective for 26 respondents on status to innovation and entrepreneurship. Enablers and barriers coded to circular economy.*

| Alaska Innovation & Entrepreneurship: 26 responses | | | | | |
|---|---|---|---|---|---|
| Coding Group | # | Theme | "Quote" / Topic | Ocurrence | CE Theme |
| Status | 1 | Innovation and Entrepreneurship | Essential: "Essential for value-added projects and will help increase the local market by having local businesses forming." "I/E gain traction in not only local production, but local consumption, it is essential for a small business environment to be catered to." | 5 | |
| | 2 | | Helpful: " having a positive influence on all areas of the seafood industry." | 2 | |
| | 3 | | Dependent on labor: motivation & eduacation | 2 | |
| | 4 | | Alaska slowly improving | 1 | |
| | 5 | | Inevitable: Follow existing industry and fill gaps | 1 | |
| | 6 | Entrepreneurship | "Bristol Bay entrepreneurial is low in current state, but may grow with market growth. Specialty stores and resturaunts." | 1 | |
| | 7 | Local Processing | Full utilization will come by itself, because sockeye is such a valuable source of proteins. Being it processed locally will not happen on its own. | 1 | |
| | 8 | | " If we are to increase local processing both of these factors will be important, and hopefully working on increasing local involvement, investments and industry." | 1 | |
| Coding Group | # | Theme | "Quote" / Topic | Ocurrence | CE Theme |
| Enablers | 1 | Innovation | Innovation to significantly lower energy costs | 5 | Technology and Innov. |
| | 2 | Lack of value chain exposure | "It's important to broaden the base of people that interact with the market." "Coordination to improve direct marketing (regulations/infrastructure), so that fishermen have a relationship with the market will help create small businesses that would potentially aid in local and further processing." | 5 | Collaborative Platforms / Clusters |
| | 3 | Public Investment | "Alaska could invest more into innovation through assets like the Kodiak Seafood and Marine Science Center. The state is embroiled in a financial debate and invests little in public benefits, thus not encouraging innovation." | 4 | Shareholder power / Lack of transparency / Regulation / Infrastructure / Lack of Collaboration |
| | 4 | Lack of coordination | "As for secondary processing, it may require more B2B coordination." | 3 | Investments / Infrastructure |
| | 5 | Rural populations | Desire to live year-round in rural locations with seasonal industry, willingness to be creative | 2 | Collaborative Platforms / Clusters |
| | 6 | Inefficient transportation | "Seems there is possibility to have more processing done locally instead of having fish exported for processing and then re-imported to the US market." | 2 | Collaborative Platforms / Clusters |
| | 7 | Community Infrastructure | "The VFDA allows for direct marketing and small companies to form under its nested processor permiting. Yummy Chummy with Brett Gibson is the only example of secondary innovation yet. With more users, more utilization and processing will happen." "KSMSC" | 2 | |
| | 8 | Research grants | "Several initiatives are aimed at this utilization and research grants are often given to this end." | 2 | Collaborative Platforms / Financing |
| | 9 | Existing Secondary Markets | Innovation for more efficient, higher quality to make manufacturer more profitable | 2 | Education |
| | 10 | Labor | "The workforce in Alaska is challenged. With no professional certifications necessary, education and training is sporadic and considered optional. Most industry employees are independent, self-reliant and self taught." | 2 | Collaborative Platforms / Clusters |
| | 11 | Mind-set | "If it is profitable, I can see people doing it." | 2 | Collaborative Platforms / Clusters |
| | 12 | Rural populations | "As seen in Iceland, it has been the smaller towns that yield a large portion of the entrepreneurs. They are the smaller operations that can easily test different processing lines." | 1 | Collaborative Platforms / Clusters |
| Coding Group | # | Theme | "Quote" / Topic | Ocurrence | CE Theme |
| Barriers | 1 | Restructuring industry ownership | Privatizing the industry will be the only way to make full utilization profitable and sustainable | 1 | Education |
| | 2 | Catering I/E | This means local market places, business competitions with attached investments, and private/public support. | 1 | Regulation |
| | 3 | Lack of competition in processing | Introduce applicable value-added concepts to the local processing efforts. | 1 | A new economic framework |
| | 4 | Potential for new applications | Rare biochemicals in fish, require innovation and talented entrepreneurs | 1 | Shareholder Power |
| | 5 | Institutional Structure | "Not as important as focusing on some of the core underlying factors hampering business activity in these areas. They have to be addressed to spur innovation and entrepreneurship. The industry is set up in so many ways right now to stifle innovation and entrepreneurship." | 1 | Collaborative Platforms / Clusters |
| | 6 | Operational costs | " Economics - holding costs are likely the largest driver of increased utilization on the local level." | 1 | Collaborative Platforms / Clusters |

*Table 6: Norwegian fisheries 5-year perspective for 18 respondents on utilization and local processing. Enablers and barriers coded to circular economy*

| **Norwegian Fisheries 5-years: 18 respondents** | | | | | |
|---|---|---|---|---|---|
| Coding Group | # | Theme | "Quote" / Topic | Ocurrence | CE Theme |
| Status | 1 | Utillization and local processing | no change | 2 | |
| | 2 | | Good | 1 | |
| | 3 | | a bit more | 1 | |
| | 4 | Utillization | 70% utilization | 1 | |
| | 5 | | Today 100 % in salmon industry and pelagics. 60 - 70 % in demersal species. Will be close to 100% totally in 5 yr | 3 | |
| | 6 | | Everything is used for salmon besides blood water today | 3 | |
| | 7 | | Small increase with white fish utilization | 2 | |
| | 8 | | improving, 80% total utilization | 1 | |
| | 9 | | 100% farmed fish utilization | 1 | |
| | 10 | Local Processing | Local processing increase moving slowly | 2 | |
| | 11 | | "Hopeful, but sceptical to processing increase" | 1 | |
| | 12 | | Local processing will increase in Norway, not likely to 100 % due to cost level in Norway, and market demand for super fresh - even live products. | 1 | |
| | | | | | |
| Enablers | 1 | Trading policies | "EU policies mostly dictate remaining opportunities for fish utilization" | 1 | Regulation |
| | 2 | Cunsumer Standards | "Personally try to not fish more than I will eat and use as much as the fish as possible. I hope the industry is similar." | 1 | Education |
| | 3 | Branding | More sustainable branding & including branding on "maximizing the full use of salmon i.e byproduct." | 1 | Collaborative Platforms |
| | 4 | Mind-set | Increasing fish utilization when done properly with balanced sustainable pillars will bring long-term benefit for the fishing industry. As for the pillars, the society pillar that is broken up into two pillars for this survey: social and institutional, should be noted. The institutional framework (taxes, incentives, permits) should be the enabling background framework that allows for full utilization and local processing. If that is in place, then the economic, social, and environmental gain will follow in unison. If the institutional framework does not enable full utilization and local processing, then grassroots efforts and larger networks (globally UN:SDG 12) will have to be the backing of this missing pillar. | 1 | Decoupling of resources |
| | 5 | Technology | Currently involved with a project to extract proteins from blood water. Method and technique will probably take traction in the industry within 5 years. | 1 | Technology and Innovation |
| | | | | | |
| Barriers | 1 | Market demand | market demand for super fresh - even live product, means no local processing | 1 | Regulation |
| | 2 | Operation Cost | High operational cost for Norwegian processing | 1 | Financing |

*Table 7: Norwegian fisheries 20-year perspective for 18 respondents on utilization and local processing. Enablers and barriers coded to circular economy.*

| Norwegian Fisheries 20-years: 18 respondents | | | | | |
|---|---|---|---|---|---|
| Coding Group | # | Theme | "Quote" / Topic | Ocurrence | CE Theme |
| Status | 1 | Utillization and local processing | not bad | 1 | |
| | 2 | | Improvement | 1 | |
| | 3 | Utillization | "90 % - but depending if reserach show an effect on seabird population" | 1 | |
| | 4 | | 80% total utilization | 1 | |
| | 5 | | 100% | 8 | |
| | 6 | Local Processing | Slow Progress | 3 | |
| | 7 | | Local processing will increase in Norway, not likely to 100 % due to cost level in Norway, and market demand for super fresh - even live products. | 1 | |
| Enablers | 1 | Mind-set: Industry | Hopeful | 5 | Collaborative Platforms / Clusters |
| | 2 | Mind-set: Consumer | Ethically Important | 1 | |
| | 3 | Mind-set: Industry | Crucial to strive towards both | 1 | |
| | 4 | Regulation | Traffic Light System (TLS) possibly cause more local processing | 1 | Regulation |
| | 5 | Regulation | "A change in the regulation system (institutional change) to address production zones. This will lead to social implications to smaller companies and local hiring." | 1 | Regulation |
| | 6 | Regulation | "It takes law,... | 1 | A New Economic Framework |
| | 7 | Education | "conscious behavior on the complete chain of custody,... | 1 | Education |
| | 8 | Education | "entrepreneurs that strive for circular business models... | 1 | Education |
| | 9 | Financing | "local/global financial support" | 1 | Financing |
| Barriers | 1 | Regulation | "I hope local processing will emerge way above the Levels of today. However, this is dependent on several factors like EØS legislation,… | 1 | Regulation |
| | 2 | | " toll Barriers...and | 1 | |
| | 3 | Financing | "the Level of local Investments and ownership." | 1 | Financing |

*Table 8: Norwegian fisheries perspective for 18 respondents on innovation and entrepreneurship. Enablers and barriers coded to circular economy.*

| Norwegian Fisheries Innovation / Entrepreneurship: 18 respondents | | | | | |
|---|---|---|---|---|---|
| Coding Group | # | Theme | "Quote" / Topic | Ocurrence | CE Theme |
| Status | 1 | Innovation and Entrepreneurship | Important | 7 | |
| | 2 | | Absolutely necessary | 3 | |
| | 3 | | "We need People who know the business well and are not afraid to take some risks" | 1 | |
| | 4 | | I am not sure on the social aspects. | 1 | |
| | 5 | | "unsure, but hopefully more assist in production of byproducts" | 1 | |
| | 6 | | "There is a super-profit on Norwegian salmon, because the demand is growing and the supply has been stagnant since 2011/12. There is an artificial production freeze. There can be drastic changes in the years to come in this cyclical industry." | 1 | |
| Enablers | 1 | Mind-set: Industry | Fundamental & important | 10 | Collaborative Platforms / Clusters |
| | 2 | Mind-set: Sustainable Movement | "Innovation and entrepreneurship should be the key drivers to accelerate full utilization with local processing (to create profit to be proud of - create sustainable and social impact)" | 1 | |
| | 3 | Innovation | "There are many problems that needs to be solved to get full utilization. Mobile factories, better technology for freezing the material to keep the freshness, new enzymes." | 1 | Innovation |
| | 4 | Innovation | "I think robotics is a key when it comes to full utilization in Norway." | 3 | Innovation |
| | 5 | Coordinated Industry | "The industry is fast to adapt to structural changes. For example, in terms of sea lice and medical treatment, the industry reduced its use of hydrogen peroxide by almost 90% from 2014 to 2018." | 1 | Collaborative Platforms / Clusters |
| | 6 | Economies of Scale | "The industrial scale of Norw. salmon farming has been vital, i.e. large volumes, stable output means lower risk for investment into processing due to lower variance in landings - as with harvest fisheries." | 1 | Security of Supply |
| | 7 | Coordinated Industry | "If the economics are there for local processing, the industry will adapt." | 1 | Education |
| | 8 | Education | "entrepreneurs that strive for circular business models… | 1 | Education |
| | 9 | Financing | "local/global financial support" | 1 | Financing |
| Barriers | 1 | Regulation | "As of now, there is a punishment toll for sending processed products to EU, the largest consumer. It can make more sense to send full fish to Poland for processing and then sent to EU." | 1 | Regulation |
| | 2 | | Better incentives and some control/restriction. | 1 | |
| | 3 | Interplay between sectors | Innovation and entrepreneurship are (of course) absolutely vital to achieve full utilization. Also in interaction with innovation "climate" in general - interplay between sectors. | 1 | Collaborative Platforms / Clusters |

# Figures and Tables

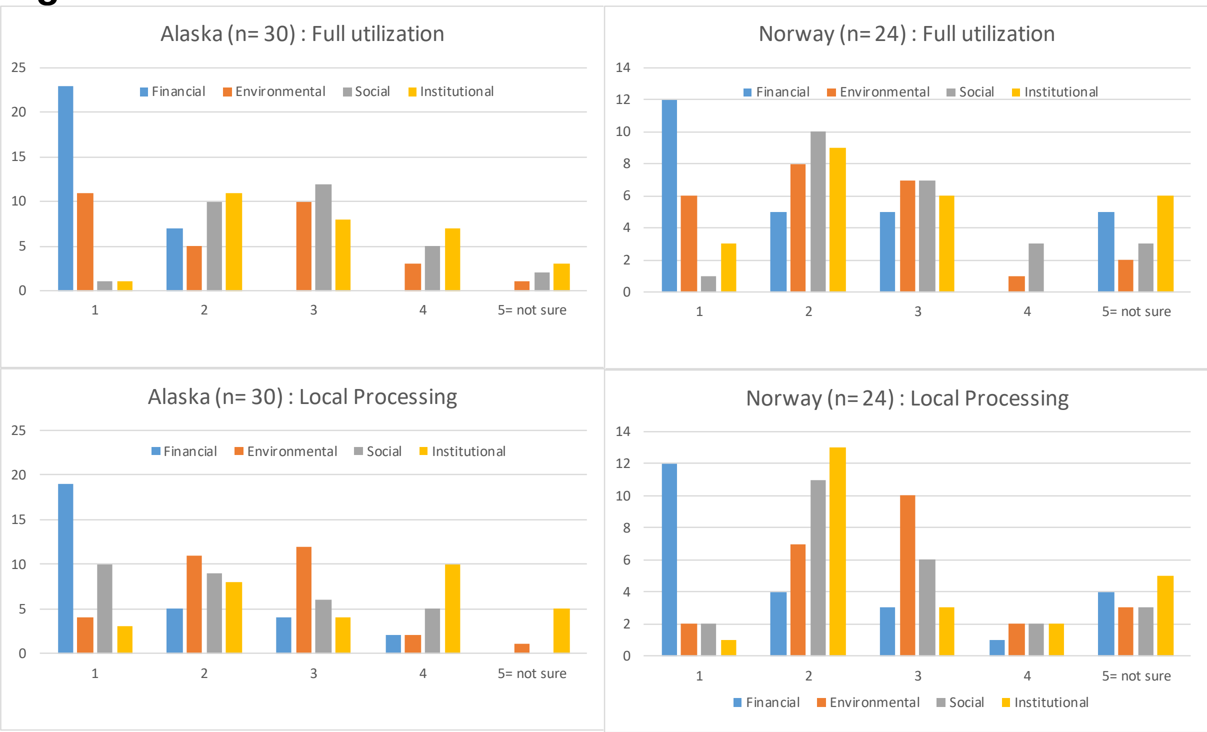


*Figure 25: Ranking responses on sustainability pillars for Alaska and Norway on the themes "local processing" and "full utilization."*

*Table 9: Six global conferences instigating movement in sustainable, 'blue,' circular economies.*

| Conference Title | Date | Location | Organizers | Iniative | Participation | Thesis Notes | Link |
|---|---|---|---|---|---|---|---|
| The First Annual Ocean Conference | 24-28 September, 2017 | UN Headquarters , New York | UN | SDG Goal 14. LIFE BELOW WATER | over 4000 participants and a call to action for the 193 Member States | Conserve and sustainably use of the oceans, seas and marine resources for sustainable development on World Oceans Day. Purpose to be game changer with broad engagement. | https://oceanconference.un.org/ |
| Sixth Our Ocean Conference 2019 | 24-25 OCTOBER 2019 | Oslo, Norway | International Institute of Sustainable Development | SDG Goal 14. LIFE BELOW WATER | in 2017 hosted by the European Union in Malta ended with participants announcing over €7 billion in commitments related to an array of ocean issues | Financial traction with involved member states. | http://sdg.iisd.org/events/our-ocean-conference-2019/ |
| Sixth World Ocean Summit | March 5th - 7th 2019 | St Regis Saadiyat Island Resort, Abu Dhabi, UAE | The Economist Group | World Ocean Iniative | 900 representatives of government, business, science and civil society from over 60 countries | Bring together political leaders and policymakers, heads of global business, scientists, NGOs and multilaterals from across the globe to discuss future of the ocean. | https://www.woi.economist.com/world-ocean-summit/ |
| The 7th Sustainable Ocean Summit (SOS) | 20 – 22 Nov 2019 | Paris, France | World Ocean Council (WOC) / started by Sustainable Ocean Alliance (SOA)- based in the USA | Corporate Ocean Responsibility / Innovation and entrepreneurs hip to fascilitate change | 250 participants from the Ocean Business Community of 30 different nationalities in China for 2018. | WOC a global, cross-sectoral ocean industry leadership alliance committed to "Corporate Ocean Responsibility", developed by and for the private sector. SOA advances the impact of start-ups, social enterprises and youth-centered initiatives that are developing solutions to protect and sustain our ocean. SOA's pipeline of ocean leaders, ages 16-35, is cultivated through a chapter-based model, led by students at the high school and college levels, as well as by young professionals. | https://www.oceancouncil.org/about-us/<br>https://soalliance.org/past-events/summit-2017/ |
| 10th International People and the Sea Conference | June 25-28, 2019 | Amsterdam, The Netherlands | The Centre for Maritime Research (MARE) | MARE was established in 2000 by the University of Amsterdam and SISWO (Netherland's Institute for Social Science Research). MARE now has four institutional partners, located in three countries of Europe. Includes Tromsø College of Fisheries | | Netherlands has been pivotal in ocean related topics and solutions towards internalizing externalities. Conferences are linked directly to creating marine policies. | http://www.marecentre.nl/2019-people-the-sea-conference/ |
| 2019 Circular Economy Stakeholder Conference: Success Stories and New Challenges | March 6 and 7, 2019 | Brussels, Belgium | The European Commission and the European Economic and Social Committee | EU Circular Economy Action Plan | Adaptive website for public with search engines based on good practices, strategies, knowlege, commitments, and dialougue | 4th conference of its kind after the European Commission in 2015 released the Circular Economy Action Plan | https://circulareconomy.europa.eu/platform/en |

The financial structure is addressed in the individual sections. Table 10 outlines how each of these global conferences relate to financial frameworks in the context of blue economy, sustainability and circular economy.

*Table 10: The financial framework related the global movements in the blue economy, sustainability and circular economy.*

| Theory Section | Blue economy | | Sustainability | | Circular economy | |
|---|---|---|---|---|---|---|
| **Finacial Framework** | Align investment, learn from 'green movement' | Business structure, Ocean Investment Platform / Accelerator programs | Principles for Responsible Investment (PRI) & Sustainable Stock Exchange (SSE) | Member commitments | Institutional transition | Circular economy finance support platform |
| **Organizers** | The Economist Group | World Ocean Council (WOC) / started by Sustainable Ocean Alliance (SOA)-based in the USA | UN | International Institute of Sustainable Development | The Centre for Maritime Research (MARE) | The European Commission and the European Economic and Social Committee |
| **Iniative** | World Ocean Iniative | Corporate Ocean Responsibility / Innovation and entrepreneurship to fascilitate change | SDG Goal 14. LIFE BELOW WATER | SDG Goal 14. LIFE BELOW WATER | Social science research and Marine policies | EU Circular Economy Action Plan |