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100% GREAT LAKES FISH MARKET DEMAND REPORT

Prepared for Great Lakes St. Lawrence Governors and Premiers by Iceland Ocean Cluster

ICELAND OCEAN CLUSTER

IVEY | Centre for Building Sustainable Value

Executive summary

Report background

The Iceland Ocean Cluster initiated the 100% Fish program within Iceland, trying to do more with less. This movement increased the use of cod, from using less than 50% of each fish, to using over 90%. This idea has been successfully adapted and adopted by the 100% Great Lakes Fish program and is gaining attention and recognition internationally, with increasing interest in the types of products and markets that can further support this endeavor.

This report is a high-level analysis of global and regional demand for potential new products made from fish sides streams of Great Lakes fish and serves as a timely addition to the 100% Great Lakes Fish program. The focus product value chains include fertilizer, fish meals and oil, collagen, protein hydrolysates, and leather, highlighted by previous project reports and activities (figure 1). The findings will be valuable to determine the most promising products for development based on the market demand. Ultimately supporting the development of new 100% Fish products for the region.

Figure 1. The value pyramid for full utilization of seafood products, from high biomass, lower value product groups through to low biomass high value product groups.

Report approach

The information in this report is drawn from open source online available data and information. A high-level analysis was performed for market size, market trends, key geographies, segments and pricing, and supply chain. Data collection was similar for global and regional chapters. It is important to note that some information was not available on a regional level and so is only present in the global chapters of this report.

This market demand analysis was produced in collaboration with Iceland Ocean Cluster (global analysis) and the Western University Ivey School of Business (regional analysis). The Ivey Business School team assisted by preparing the regional demand analysis. This was led by final year student Robbie Carey and supervised by Dr. Jury Gualandris and Dr. Paul van der Werf.

Report key findings

Table 1. Key findings market demand analysis.

Product	Global market		Regional Market	
	Market size	CAGR	Market Size	CAGR
Fertilizer	$182.3-208 billion	2.7-3.9%	$1.468 billion	2,37%
Fish meal and oil	$13.87 billion	4.6%	$2.72 billion	7.3%
Pet food	$103.3-126.66 billion	4.4-5.5%	$54.46 billion	5,45%
Protein Hydrolysates	$254.75 million	4.4%	$72.37 million	3.3%
Fish collagen	$1.080 billion	8.94%	$2.60 billion	11.2%
Fish leather	$32.4-58.8 million	15.2-19.9%	$8 million	13.6%

Based on this market demand analysis, pet food can be considered the most promising market, highlighted due to the size and growth rate of the market, both regionally and globally, the accessibility in terms of scale and quality ranges of the market and based on a premium consumer preference for wild-caught sources of pet food ingredient, especially fish. There was likewise high potential for the markets of fish protein hydrolysates, fish meal and fertilizer. These products have the largest market size, a large market share for North America or an already established production in the Great Lakes Region, although in the case of fertilizer and fish meal, necessary volume requirements may be a market access limitation, a limitation that did not exist for fish protein hydrolysate. Fish leather and collagen both present growing markets, although smaller than the others investigated, however, for the Great Lakes, these products may have a longer route to market, as an established supply chain, standardization of production, and existing domestic demand (in the case of fish leather) are lacking, and quality requirements in both cases are high, presenting barriers. However, these markets are interesting for future development if the current barriers are successfully addressed.

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Methods

Similar methods were used for the global and regional chapters of this report. However, some information is not relevant on a regional level and therefore differs from the global content. Any paragraphs that only apply to the global or regional part of the report are indicated between brackets.

Research and Data Gathering

All initial data to inform this report was collected using internet search engines. Relevant prompts were used to search for information. Data collection was similar for both global and regional information. However, research on a regional level were supplement by using generative AI to scan large quantities of data for specific information. Resources obtained from generative AI were manually verified for accuracy and credibility before being compiled into the report.

Market Size

A high-level analysis of the size of each market, over time, including compound annual growth rate (CAGR), was performed. The purpose of the market size analysis is to provide a basis for understanding the relative size of the commercial opportunities in each market. Naturally, this concerns the global market size in the global chapters. In the regional chapters it is the size of the North American market, though for select markets, approximations of the North American proportion of global demand were made.

Trends (global)

A high-level analysis of market trends was executed for each market. This analysis is meant to inform about the newest developments and possible trends in the market. Relevant drivers and constraints are indicated. Key players were identified based on various factors, including market share, growth potential, innovation, competitive strategies, and their influence on consumer demand trends

Quality Expectations (regional)

A high-level analysis of the quality specifications (i.e., fish material quality expectations) required by each end market was completed. This analysis is meant to provide readers with a basis for understanding the relative complexity of each end market, as well as to identify any barriers to entry created by quality specifications.

Key Geographies

A high-level analysis of each market on a geographical level was performed. The purpose of this analysis is to understand where the biggest markets are located and who the key players (i.e., manufacturers, producers), in each market are. On a regional level, the utility of this chapter is twofold. It guides users as to how many producers exist in the Great Lakes region. Secondly, it provides a starting point for users to contact producers regarding the sale of fish materials.

Segments and pricing

A high-level analysis of the segments within each market was performed on a global level. The most important segments are highlighted within each chapter. Besides this, information on pricing was provided if available. This information ranges from unit prices to global price trends for a product category. All prices are in US dollars unless otherwise noted.

Supply chain

A high-level analysis of the supply chain for each global market was performed. Each supply chain is described to provide an overview of how a product comes to market.

Fertilizer Market

Fertilizer is a product that contains plant nutrients including nitrogen, phosphorus, and potassium that stimulate plant growth (1). Fertilizer can be divided into multiple categories. The most relevant for this analysis is organic fertilizer. Organic fertilizer is derived from natural resources (e.g. plants or animals) (2). Fish material may be used in these fertilizers as an ingredient because of the high concentrations of beneficial nutrients. Fish fertilizer can be included under categories of both organic fertilizer and nitrogen-based fertilizer, so both have been included herein. Fish fertilizer is commonly sold as an emulsion and is created through hydrolysis, a process that breaks down proteins into peptides that are more readily absorbable by plants (3).

Global Fertilizer Market Demand

Market Size

Globally, the fertilizer market has experienced stable growth over the last 20 years, with a value at approximately $100 billion in the year 2024. In the same period, the compound annual growth rate (CAGR) was approximately 3.3% (4). A similar growth is expected over the next 6-10 years. Estimates of the current market size range from $182.3 billion (5) to $208 billion (6), averaging $200 billion (5; 6; 7; 8). Corresponding CAGR estimates vary between 2.7% (8) to 3.9% (7). The market value of fish emulsion fertilizers, which was $0.79 billion in 2020 is projected to climb up to $1.12 billion by the year 2028, corresponding with a CAGR of 4.5% (9).

Trends in fertilizer market

Due to population growth and associated increased demand for food, the fertilizer market is expected to continue to grow (6). Besides that, consumer behavior is driving the market for more environmentally friendly and sustainable food production, increasing the demand for organic fertilizer (6; 10).

A possible restraint for the organic fertilizer market could be the nutrient profile, which is generally lower when compared to synthetic fertilizer (10). However, there is a positive trend in organic farming, driving the organic fertilizer market, by increased regulations for organic agriculture (10). Key global actors are shown in (figure 1)

Haifa Group	Bunge Limited
Nutrien Ltd.	Israel Chemicals Ltd.
Yara International ASA	Indian Farmers Fertilizer Cooperative Ltd.
Sumitommo Chemical Co. Ltd.	Gemlik Fertilizer Inc.

Figure 1. Key actors on the global scale in fish emulsion fertilizers market (6).

Key Geographies

The fertilizer market is a global market with many of the biggest economies exporting or importing large quantities of fertilizer. The biggest exporters of nitrogen-based fertilizers, which is the most common fertilizer, are the Russian federation, (7,2 million metric tons (m.m.t.)) and China (6,77 m.m.t.) (11) (figure 2). The biggest importers of nitrogen-based fertilizer include Brazil (6,64 m.m.t.), India (4,97 m.mt.) and the United States (3,4 m.m.t.) (11). The US is importing nearly 20% of all its fertilizer (12).

If President Trump increases tariffs on imported goods, this will lead to a price increase for imported fertilizer (13). On the other hand, this could simultaneously create opportunities in the domestic fertilizer market (13).

Figure 2. Indication of continents with highest nitrogen-based fertilizer market share.

Like the nitrogen-based fertilizer market, the Asia-Pacific region is the largest market for organic fertilizers, accounting for 42% of organic fertilizer production globally (figure 3) (6). Following the Asia-Pacific region, the European and North American markets are the next largest, with market shares of 28% and 22%, respectively (figure 3) (6).

Figure 3. Indication of continents with highest organic fertilizer market share.

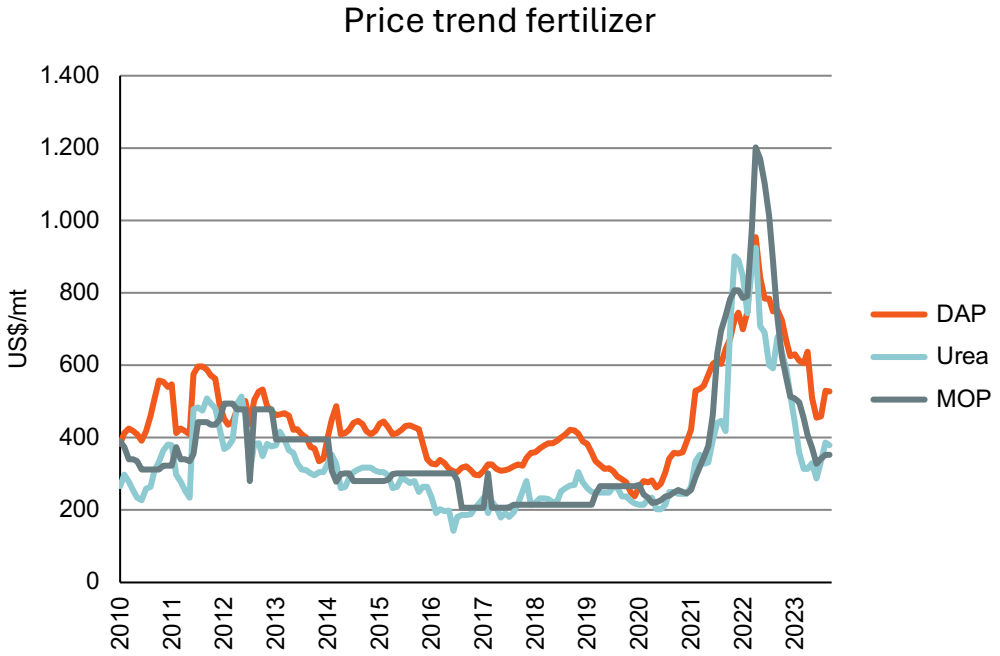
Segments and pricing

Segments

Fertilizer can be split into various segments, the most important ones being form (dry or liquid), application, or by product (organic or inorganic) (6). For fertilizers derived from fish material, form and product are the most interesting segments to highlight. By form, fertilizers can be produced in a dry or liquid form. Dry fertilizers are widely used due to their relative cost-effectiveness, ease of transport, and long shelf life. Consequently, dry fertilizer accounts for the largest market share (6). Liquid fertilizers, like fish emulsion fertilizers, on the other hand, are preferred for their rapid nutrient availability and uniform application in precision agriculture (14). Considering product, organic and inorganic fertilizer can be distinguished. In 2023, the organic segment accumulated the largest revenue (6).

Pricing

Fertilizer prices reached a record height in 2022, but since then have fallen closer to the average from earlier years (graph 1) (15). The peak in 2022 might be attributed to a combination of the increase in natural gas prices, shipping prices and crop prices. However, the main driving factor was the increase in input costs. A 1% increase in the price of natural gas is associated with a 0,86% increase in the price of composite fertilizer (16). Since 2022, fertilizer input costs have declined, but remain higher than before (17).



Graph 1. Price trend for fertilizer 2010-2023.
DAP = diammonium phosphate; MOP = muriate of potassium (15) (18).

There is no index available for the global price of organic or fish emulsion fertilizer. However, price indications are provided for some prominent companies selling fish emulsion fertilizer (table 2).

Table 2. Price indication for fish emulsion fertilizer products.

Product	Type	Price
Drammatic ONE Organic Liquid Fertilizer 4-1-1 (19)	Fish emulsion fertilizer	$41 / gallon
Alaska Organic Gardening Fish Emulsion Fertilizer (20)	Fish emulsion fertilizer	$30 / gallon
Fertilome Fish Emulsion Fertilizer Liquid Plant Food (21)	Fish emulsion fertilizer	$19 / 1lb

Supply chain

The fertilizer supply chain begins when raw materials are collected, including fish material (figure 4). Materials are generally processed in separate production plants and shipped to storage facilities where materials can be blended to create the right composition. These blends are sold in wholesale and retail. Agricultural companies are most likely to buy directly from wholesalers, whereas consumers are more likely to buy from retailers. (22)

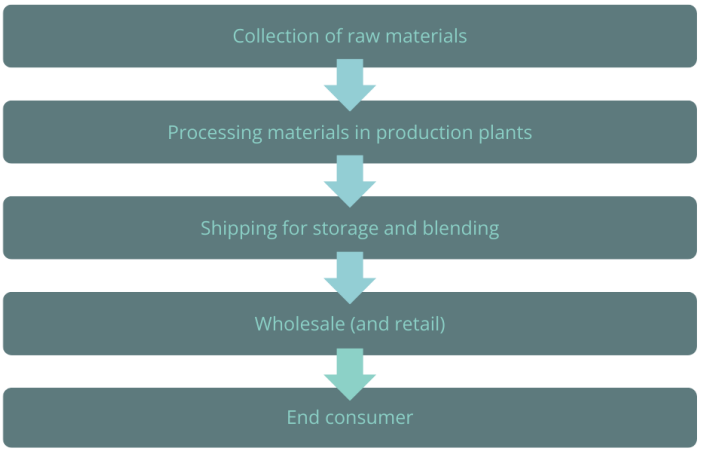


Figure 4. Fertilizer supply chain.

Regional Fertilizer Market Demand

Market Size

The organic fertilizer market in North America was valued at $1.468 billion in 2023 with a projected CAGR of 2.37% until 2034 (23). Fish fertilizer is likely a small portion of that market.

Quality Specifications

Dramm states that fish material must be refrigerated until pick-up and that it is absent of trash or debris. Moreover, the offal must be from wild-caught fish and free from preservatives (24). This specification is likely derived from the heightened consumer perception associated with high-quality and natural fish, meaning there are fewer non-wild-caught fish.

Fish fertilizer producers generally appeal to the organic market, which means they must adhere to Organic Materials Review Institute (OMRI) standards. The OMRI handbook outlines that fertilizers are screened for use of synthetic materials, pathogen content, and more (25). This implies that fisheries should expect significant testing, and expectations regarding the purity or lack of contamination of supplied fish material.

Key Geographies

Most North American fish fertilizer manufacturers are in ocean and coastal areas, including British Columbia, or coastal states such as California, Massachusetts, and Georgia.

There are a few fish fertilizer producers in the Great Lakes region. The most prominent liquid fish fertilizer producer in the Great Lakes region is Drammatic (Dramm) Corp. In 2016, their facility, located in Algoma (Wisconsin), processed over 5 million pounds of fish material and produced more than 550,000 gallons of fertilizer. The company sources its fish material from local fisheries, fish cleaning stations, and fish markets across the Midwestern United States and Canada. Dramm recently received a $776,000 grant to expand production capacity in its Algoma plant (26).

GreenStreme by Bektra is a fish hydrolysate fertilizer produced in Barrie, Ontario. GreenStreme sources rainbow trout from a facility in Owen Sound, Ontario (27).

Evergreen Liquid Plant Foods is based in Bresleau, Ontario. It is an independent, family owned and operated company that produces Organic Gem - a line of liquid fish fertilizer (28).

Acti-Sol is a natural fertilizer producer based in Notre-Dame-du-Bon-Conseil, Quebec. The company generates an estimated annual revenue of $6.5 million CAD and sells several lines of fertilizer, including a fish-based fertilizer (29).

Segments and pricing

With regards to the payment that fish processors could expect to receive for supplying offal, Dramm Corp. states that it will cover shipping costs and suppliers may be eligible for a stipend per pound (30). This suggests that remuneration is not guaranteed and is likely determined on a case-by-case basis.

To give an idea of the unit price charged to end consumers, Dramm sells 2.5-gallon containers of fish fertilizer for $98.54.

Fish Meal & Oil Market

Fish meal is conventionally used as an ingredient in animal feed (31). It is usually produced from whole fish or fish processing by-products and generally has a high protein content and bioavailability – the degree of ease with which the nutrients can be absorbed (32; 33). The production of fish meals is achieved by cooking fish materials, then pressing them to separate the oils and liquids from the solids. This material is then dried and ground into a powder (32). Fish meals are widely used in the aquaculture industry due to a balanced amino acid profile and high digestibility, allowing optimal growth for harvested species in the aquaculture industry (34). Fish meals and oil are produced during the same process and sold into the same markets, therefore trends relevant for fish meals are also relevant for fish oil.

Global Fish Meal & Oil Market Demand

Market Size

The market size of fish meal was valued between $5.6 to $10.2 billion in 2024, with an average of $7.9 billion (35; 36; 37). The corresponding CAGR is expected to be 4.4% to 7.3% (35; 36; 37). A stable growth is forecasted in the fish meal market over the next 5-10 years. This growth is related to increased demand of fish meal as a protein source for livestock, agriculture, and aquaculture (35). The combined fish meal and fish oil market has also shown stable growth. In 2023, the market was valued at $13.87 billion and the expected CAGR is 4.6% until 2032 (38).

Trends in fish meal market

The aquaculture industry is considered a main driver in the fish meal and oil market. The increasing global demand for high-quality seafood has propelled aquaculture production, which, in turn, has increased the need for high nutrient ingredients (35; 37). Furthermore, fish meals are appreciated by fish farmers for their contribution to optimal growth of fish (35). Key global actors are shown in (figure 5).

A focus on environmentally friendly practices is also a significant driver for the fish meal market. Fish meals are favored as a natural alternative to synthetic feed ingredients (35; 37). Besides that, it is considered a safer choice for feed production in terms of heavy metal concentration compared to conventionally cultured seafood (35).

A potential restraint for market growth, related to the environment, could be increased regulation for fisheries practices, decreasing the total number of fish landed, increasing the importance of full utilization of each fish (39).

FF Skagen	Pesquera Diamante SA
The Scoular Company	Pesquera Exalmar S.A.A
Omega Protein Corporation	Austral Group S.A.A
Oceana Group Limited	Copeinca
Pelagia	Triplenine Group A/S

Figure 5. Key actors on the global scale in the fish meal market (35).

Key Geographies

In 2023, the Asia Pacific market was the global leader in fish meal production (42%) (figure 6). The Asia Pacific fish meal market is also expected to grow rapidly over the next 5-10 years due to the rapid growth of the aquaculture sector.

Figure 4. Indication of continents with highest fish meal market share.

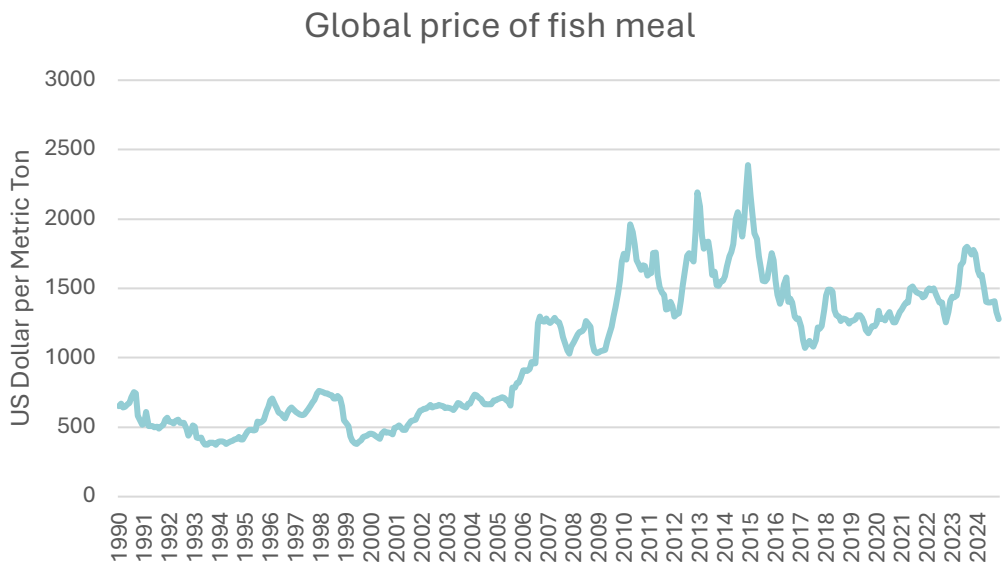
Segments and pricing

Segments

The fish meal market is generally segmented into source and livestock (35; 38; 40). Fish-meal is mostly made from small pelagic fish and by-catch, unwanted or unintentionally caught fish, and cut-offs (33; 35). Besides that, the product can be segmented into feed for livestock groups such as aquaculture species, poultry, swine and ruminants (41). Aquaculture is the largest market, which is most likely linked to the growing demand for farmed fish (41). Other livestock industries utilize fish meal as a supplementary protein source (42).

Pricing

Fish meals are predominantly sold business to business. The global price of fish meal is provided below (graph 2). Key price milestones include a steep rise between 2008 and 2010 due to increased aquaculture demand in China (43). Furthermore, fish meal reached a record-high price of over $2000 per metric ton during El Niño events in 2014-2016, which caused a sharp reduction in anchovy harvests (42). Lastly, between 2020 and 2023, a stabilization was observed around $1300–$1800 per metric ton as supply chains recovered from pandemic disruptions (15).



Graph 2. Global price of fish meal (44).

Supply chain

The fish meal supply chain is straightforward and starts with sourcing of the raw material, mainly fish offal, from fisheries or aquaculture (figure 7). Production starts in the fish meal processing plant, where it is distributed to wholesalers and the end consumer.

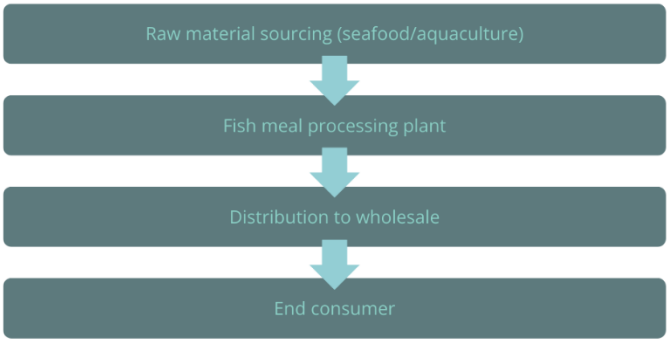


Figure 5. Fish meal supply chain.

Regional Fish Meal Market Demand

Market Size

Based on a 28.6% market share of the global market, the fish meal market in North America was valued at $2.72 billion in 2023, with a projected CAGR of 7.3% until 2030 (35).

Quality Specifications

As with the other markets, the primary concern for manufacturers of fish meal and oil is proper refrigeration to avoid spoilage (45). The Global Standard for Responsible Supply of Marine Products contains a list of guidelines for fish by-products in the fish meal supply chain (46). These guidelines relate to the eligibility for the Responsible Supply certification to which over half of the world's fish meal producers adhere (47).

Quality specifications state that fish by-products must come from fish intended for human consumption, the fish must not be an endangered species, the fish shall show no signs of clinical disease. There are several guidelines that relate to shipment and labeling that should be referred to when supplying fish materials to fish meal processors (46).

Key Geographies

Aquatic Protein LLC is based in Beardstown, Illinois. It is a producer of fish meals and fish oil using a priority patented process to which it holds the exclusive license for all aquatic species. The plant runs year-round and sources raw material from numerous surrounding states. It markets its products into the pet food, aquaculture, and organic feed and fertilizer segments (48).

Nearby the Great Lakes region, Omega Protein, one of the largest fish meal processors in the United States, operates a facility in Reedville, Virgina. The company states that it harvests and processes menhaden, a species of small coastal fish (49). On the west coast, Scoular's Encompass brand operates a fish meal processing facility based out of Warrenton, Oregon. Encompass built its facility in collaboration with two seafood companies with the intention of processing the trimmings of these two companies (50).

Segments and pricing

There was no readily available public information on the revenues that would be received from the delivery of fish materials to fish meal and oil producers.

Pet Food Market

Pet food is intended to provide pets with the necessary nutrients to live and stay healthy. A variety of protein sources are used in pet food, including beef, chicken, lamb, and fish. Ingredients often include a source of protein to fulfill dietary needs and for flavours that are highly palatable for domesticated animals. Fish is a popular protein for pet foods because of its richness in omega-3 fats which is associated with coat and skin health benefits (51).

Global Pet Food Market Demand

Market Size

The global pet food market has experienced steady growth in previous years (52). Estimates of the global market size of pet food vary from $103.3 billion to $126.66 billion (52; 53; 54; 55), averaging $118.1 billion. The CAGR ranges from 4.4% to 5.5%, forecasted until 2030-2034 (52; 53; 54; 55). A report specifically on fish-based pet foods estimates that market size at $1.4 billion in 2022 with a CAGR of 15.7% until 2030 (51).

Trends in the pet food market

Currently, the pet food market is mainly driven by an increase in pet ownership, directly increasing the demand for pet food (52; 54; 55). Furthermore, increased welfare and social importance of pets is also considered a driver, both for the global pet food market, as well as the fish-based pet food market (51; 52; 53; 55). As a result, people tend to prefer premium products to feed their pets (52; 55), which most likely is also associated with a growing market of pet supplements (56). On the other hand, the price of the product is considered a restraint for some consumers (54; 55). Recently, a positive trend has been observed in organic pet food, which is likely to dominate the global fish-based pet food market (51; 53). Nevertheless, organic pet food could also be the segment most likely to experience restraints concerning the high price (57). Key global actors in the global pet food market are shown (figure 8), and key global actors in the fish-based pet food market are shown in (figure 9).

Nestle S.A. (Switzerland)	Heristo AG (Germany)
Mars Incorporated (U.S.)	LUPUS Alimentos
The J.M. Smucker Company (U.S.)	Merrick Pet Care, Inc. (U.S.)
Hill's Pet Nutrition	WellPet LLC (U.S.)
Colgate-Palmolive Company (U.S.)	Tiernahrung Deuerer GmbH (Germany)
General Mills, Inc. (U.S.)	Total Alimentos
Diamond Pet Foods (U.S.)	The Hartz Mountain Corporation

Figure 8. Key actors on the global scale in the pet food market (52; 53; 55)

Orijen	Blue Buffalo
Wild Earth	WellPet
CANIDAE	Nestlé Purina PetCare
Merrick Pet Care	Mars Petcare
Ainsworth Pet Nutrition	Hill's Pet Nutrition

Figure 9. Key actors on the global scale in the fish-based pet food market (51).

Key Geographies

North America held the highest market share for pet food and supplements in 2023 (44%), followed by Asia Pacific (28%) and Europe (20%) (figure 10) (54).

Figure 10. Indication of continents with highest pet food market share.

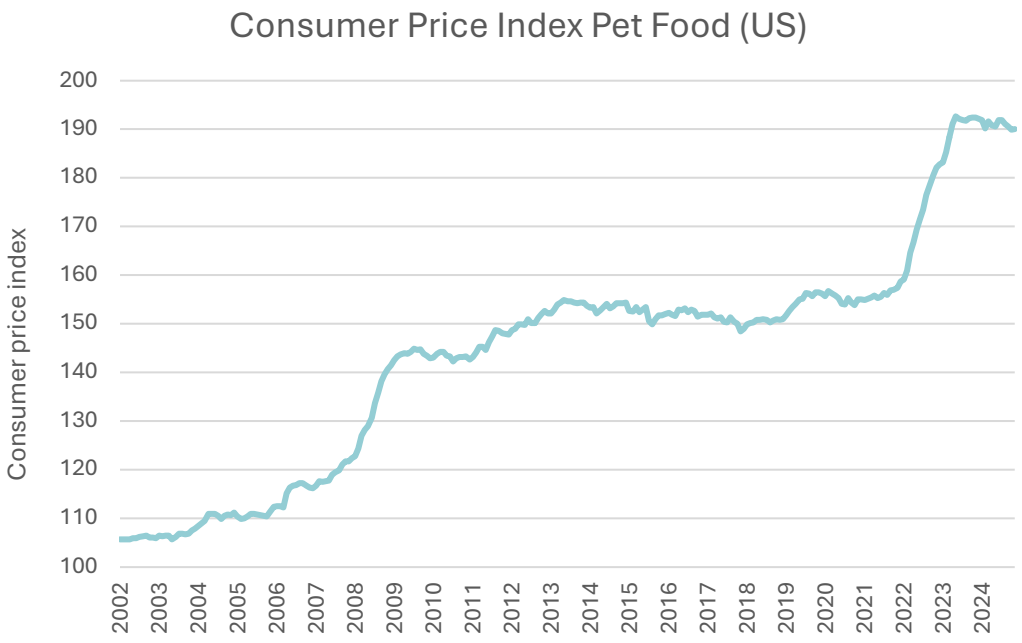
Segments and pricing

Segments

The pet food market can be divided into several segments, for instance conventional and organic pet food (51). Segments can also be based on the type of pet, type of product or packaging (dry, wet, canned, snacks etc.), or ingredient type (e.g. animal or plant derived). Among these, ingredient type is particularly important, as it directly impacts nutritional value, consumer preferences, and the exploration of sustainable alternatives in pet food production (52). Currently, the biggest market share is obtained by animal-derived pet foods (52; 55). In this type of pet food, fish meal, poultry meal, and animal meal are widely used (55).

Pricing

The consumer price for pet food increased steeply between 2020 and 2023 (graph 3). Since then, the consumer price stabilized according to the consumer price index (CPI). The main contributor to the steep increase in CPI was the increase in gas prices (58).



Graph 3. Consumer price index for all urban consumers: pet food in US City Average (59).

With many producers of pet food, and many different products, it is complicated to provide price indications. Price indications of several fish-based dog and cat food are listed below, though this list is not extensive (table 3).

Table 3. Price indication for fish-based pet food.

Product	Type	Price
Halo Holistic Complete Digestive Health Wild-Caught Salmon & Whitefish (60)	Dog food (Dry, Adult)	$85 / 21-lb bag
Wholesomes Fish Meal & Rice Formula (61)	Dog food (Dry, Adult)	$52 / 40-lb bag
Purina - Pro Plan Sport High Protein Salmon and Cod (62)	Dog food (Wet, Adult)	$40 / 12 cans
Purina Fancy Feast Dry Cat Food with Ocean Fish and Salmon (63)	Cat food (Dry)	$10 / 3-lb bag
Applaws Natural Wet Cat Food, 16 Count, Limited Ingredient Canned Wet Cat Food, Fish Variety Count in Broth (64)	Cat food (Wet)	$30 / 32 cans
ACANA Highest Protein Dry Cat Food, Wild Atlantic, Grain Free Saltwater Fish with Freeze-Dried Liver Recipe (65)	Cat food (Dry)	$55 / 10-lb bag

Supply chain

The pet food supply chain consists of several stakeholders (figure 11). First, the ingredients for pet food are produced by various suppliers. In the case of fish-based pet food, the raw ingredients could be supplied by the fisheries, and fish processing facilities. Following this, pet food ingredient producers create the actual ingredients from this raw product. The ingredients are then sent to a pet food manufacturer, who will eventually distribute the products to warehouses, retail and online stores. These enterprises will sell the product to the consumer. (57)

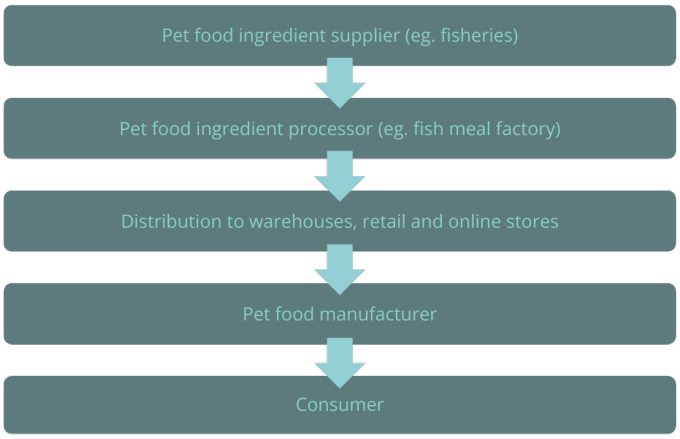


Figure 11. Pet food supply chain.

Regional Pet Food Market Demand

Market Size

The pet food market in North America was valued at $54.46 billion in 2024 with a projected CAGR of 5.45% until 2029 (55).

Quality Specifications

A general specification observed across most pet food brands is that fish is wild caught. This is standard across many of the large pet food brands in North America. Many also specify that fish is ocean caught, which presents a potential barrier to fish processors in the Great Lakes region. Open Farms states in its FAQ section that the company ensures quality by maintaining traceability within its supply chain and partners are audited by third party organizations. Open Farms also specifies that test results are received from all suppliers prior to delivery being accepted (66).

A generally observed trend across the pet food industry is that fish ingredients favour ocean-sourced and wild-caught fish because of the beneficial consumer perception.

Key Geographies

Several pet food manufacturers operate on the Canadian side of the Great Lakes, particularly in Ontario, offering fish-based options for pets. Lifetime Pet Food, in St. Marys, Ontario, offers a "Fish & Oatmeal" recipe made with lake whitefish and menhaden fish meal (67). The Great Canadian Pet Food Company, located in Moorefield, Ontario, provides a "Whitefish 25/15" formula for dogs, using locally sourced ingredients (68). Additionally, ProSeries Ultra Health Pet Food, headquartered in Fredericton, New Brunswick, manufactures a "Fish and Rice" formula tailored for pets with food sensitivities (69).

Furthermore, there are several examples of US pet food manufacturers outside the Great Lakes region. Blue Buffalo has several fish-based pet food lines that are produced in Richmond, Indiana. This plant, one of two in the states that Blue Buffalo mentions, has capacity to produce over 1 million pounds of dry pet food per day (70). Diamond Pet Food is a manufacturer in Rushville, Indiana. Diamond Pet Food had sales of over $1.5 billion in 2022 (71). Nestle Purina Pet Foods owns and operates a manufacturing plant in Mechanicsburg, Pennsylvania (72). Open Farm manufactures pet food, also uses fish ingredients, and has a facility in Minnesota (73). Evanger Pet Food has a manufacturing facility in Markham, Illinois (74). Lastly, Elmira Pet Products, based in Elmira, Ontario, is the largest private label pet food producer in Canada and likely produces fish-based lines of pet food (75).

Segments and pricing

There was no readily available public information on the revenues that would be received from the delivery of fish materials to pet food producers.

Protein Hydrolysate Market

Fish protein hydrolysates (FPH) are referred to as breakdown products, obtained from fish proteins consisting of peptides and amino acids, like collagen. FPH are mainly acquired through treatment of fish meals or its residues with chymotrypsin, trypsin, and other enzymes under controlled temperatures.

Predominantly, FPH are produced by utilizing lean fish or processed waste residues, which provide a range of essential micronutrients such as omega-3 fatty acids, minerals (zinc, calcium, phosphorus), amino acids, and vitamins (A, D, and B). Overall, FPH contains around 81% to 93% protein, 1% to 8% moisture, and less than 5% fat. The result is a liquid or dry FPH that has industrial uses including milk substitutes, protein supplements, and stabilizers. Therefore, FPH are promising to contribute strongly towards balancing the global supply chain. (76) Additionally, it can also be used in aquaculture feed, due to its ability to increase feed intake and the digestion of nutrients.

Global Protein Hydrolysate Market Demand

Market Size

The global FPH market was valued at approximately $254.75 million in 2022 and is projected to reach $359.76 million by 2030, growing at a CAGR of 4.4% during the forecast period (77).

Trends in protein hydrolysate market

Two major trends are shaping demand and driving growth in the protein hydrolysate market. Firstly, there is a growing consumer preference for protein powders and liquids as part of a healthier lifestyle (76; 78). Fish protein hydrolysates are particularly attractive due to their high nutritional value, excellent bioavailability, and sustainable sourcing (78). With an increased focus on health and environmentally friendly choices, fish-based protein is emerging as a premium option that aligns with consumer values. Secondly, the rapid expansion of the aquaculture industry is boosting the demand for protein hydrolysates as a key ingredient in animal feed (77; 78; 79). Their digestibility and rich amino acid profile makes them ideal for supporting the growth and health of farmed fish and other aquatic species (79). As aquaculture continues to expand to meet global seafood demands, fish protein hydrolysates could play a critical role in improving feed efficiency and sustainability. The key global actors are shown in (figure 12)

Sopropeche, Symrise	Neptune's Harvest
Copalis Sea Solutions	E.F.S – Holland
Shenzhen Taier	SAMPI
Bio-Marine Ingredients Ireland	White Swan Pharmaceutical
Kemin Industries, Inc.	

Figure 12. Key actors on global scale in fish protein hydrolysate market (76).

Key Geographies

The Asia Pacific region dominates the global fish protein hydrolysate market. Market value was estimated at $170 million in 2022 (figure 13). Both developed and developing countries in the Asia Pacific region witness growth in urbanization, coupled with the rising middle-class population, offering several opportunities for market players. (78)

North America accounts for the second-largest share of the fish protein hydrolysate market, accounting for nearly 30% market share (78). The market is expected to grow due to high product demand related to rising awareness about weight management, disease prevention, and physical, as well as mental health. In addition, the growing food & beverage industry and increasing middle-class population coupled with high-income levels are expected to drive the product demand over the forecast period. (79)

Figure 13. Indication of continents with highest protein hydrolysate market share.

Segments and pricing

Segments

The global protein hydrolysate market is generally segmented based on source, form and application. Based on form, the market is segmented into powder and liquid. The powder segment is projected to lead the market owing to its easy application in various products, long shelf life, ease of storing as well as smooth incorporation into food formulations. Moreover, compared to liquid hydrolysates, powders can better withstand high pressure and temperatures during processing. Additionally, the rising use of powdered FPH is expected to drive market growth. Based on application, the global FPH market is segmented into food & beverage, pharmaceuticals, animal feed, agriculture, and personal care & cosmetics. Among these, animal feed is the dominating segment in the global FPH market. The food & beverages segment is counted as the fastest-growing segment, owing to manufacturing sports supplements and functional food products for improved performance. (76)

Pricing

The price of FPH products can vary between different geographies and segments. Besides that, it is difficult to access pricing for animal feed as it is mainly based on request. Below are a few examples of product pricing for different protein hydrolysates (table 4).

Table 4. Price indication for fish hydrolysate products.

Product	Type	Price
Fish Hydrolysate Liquid by AA Baits (UK) (80)	Liquid hydrolysate	$6 / 500ml
Fish Hydrolysate Liquid by Baitworks (UK) (81)	Liquid hydrolysate	$10 / 300ml
Fish Hydrolysate by Unbroken (Iceland/Norway) (82)	Powder/Tablet	Starting at $14.5 / 65g

Supply chain

Before protein hydrolysate enters the market, several supply chain steps are needed (figure 14). The raw material, fish offal, is collected and is pre-treated for extraction. After extraction the product can be formulated and manufactured. The chain ends with the distribution of the product and sales to consumers.

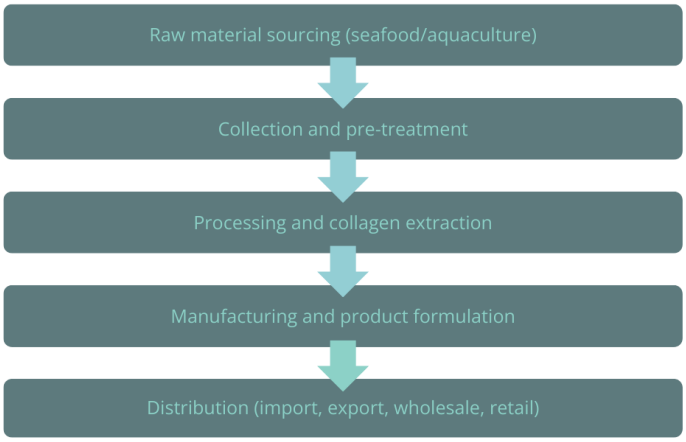


Figure 14. Protein hydrolysates supply chain

Regional Protein Hydrolysate Market Demand

Market Size

The FPH market in North America was valued at approximately $72.37 million in 2024, with a projected CAGR of 3.3% until 2034. There was no explicitly available market size for North America, so this was calculated as 22% market share of the global FPH demand (83).

Quality Specifications

As with other consumables, products sold to end consumers that include FPH are subject to specifications imposed by the Food and Drug Administration in the USA and Health Canada's Food and Drug Regulations.

To conform with these specifications, companies producing FPH have expectations of suppliers in line with or more stringent than regulatory bodies. Similarly to the previous markets, specifications of raw materials can relate to foreign substances, pathogens, and toxic compound concentration limits.

Key Geographies

Roxlor, based in Delaware, USA, is a producer of fish protein isolate (FPI) (which includes protein and some fat) derived from salmon. Their products are sold in North America (84). This appeared to be the only firm that produces FPI/FPH, near the Great Lakes region.

Segments and pricing

Determining a price for fish materials provided to FPH producers presents several challenges. FPH is generally an ingredient that is sold between businesses, rather than being sold directly to end consumers. As a result, there was no readily available public information on the revenues that would be received from the delivery of fish materials to FPH producers.

Fish Collagen Market

Collagen is a structural protein that forms connective tissues and is the most abundant protein in the human body (85). Collagen is primarily used in the cosmetics and biomedical industries (86). Collagen for consumption by humans can be extracted from mammal tissues, such as bovine or porcine, though collagen derived from fish is favored due to religious limitations and potential diseases presented by mammal derived collagen. The most preferred form of fish collagen is hydrolyzed collagen, meaning that the proteins have been broken down into smaller units called peptides. These peptides have a higher bioavailability than the full collagen protein units (87).

Global Fish Collagen Market Demand

Market Size

The global market is primarily using marine sources of fish collagen, so this was used to evaluate market size. Market size was valued at $1.080 billion in 2023 and is projected to grow from $1.167 billion in 2024 to $2.316 billion by 2032, exhibiting a CAGR of 8.94% during the forecast period (88).

Trends in the fish collagen market

The fish collagen market is driven by several key consumer trends and marine collagen is currently the primary source. A continuous increase in urbanization and change of lifestyle patterns are expected to boost the market leading to a rising demand for healthy foods that contain functional nutrients, produced by the nutraceutical industry. (88) Other market drivers are related to health and lifestyle, for instance, increased demand for solutions to address age-related health issues (89). Moreover, the cosmetic industry uses collagen as a natural ingredient in their formulation whilst also having a moisturizing function (88). Simultaneously, marine collagen products are becoming more widely available to consumers (89).

Furthermore, the rising trend of companies adopting sustainability strategies is expected to drive marine collagen market growth. Sustainably sourced seafood is becoming a priority for more and more consumers, making it more important for companies to provide transparency in product labeling. (88)

In addition to human applications, the growing popularity of fish collagen supplements for pets is supporting market growth. Pet owners are becoming aware of fish collagen's advantages for their pets. (89)

A major restraint for the marine collagen market is the high cost for development and production that is associated with using high-end technologies (88). The key global actors are shown in figure 15.

Weishardt Group	Darling Ingredients Inc.
Seagarden AS	Amicogen, Inc.
Vital Proteins LLC	Italgelatine S.p.A
Ashland	Gelita AG

Figure 15. Key actors on global scale in marine collagen market (90).

Key Geographies

As with FPH, the Asia Pacific region dominated the marine collagen market with a market share of 40.85% in 2023 (figure 10) (88). This region is expected to have the highest growth rate due to investments by manufacturers (88). Other big markets for marine collagen are North America and Europe (88). Key geographies are shown in figure 16.

Figure 16. Indication of continents with highest marine collagen market share.

Segments and pricing

Segments

The marine collagen market can be segmented by category (fish, algae, others), source (bones and tendons, skin, other), form and application. By category, the largest market share is obtained by fish-based marine collagen. (88) Besides that, collagen is mainly sourced from bones and tendons, as these contain the highest amount of collagen (88; 91). Based on form, the market is segmented into powder and liquid, with powder holding the largest share. Powder-based marine collagen products are highly popular because of their use in dietary supplements, skincare and other applications. (88)

Pricing

The price points for different marine collagen products and applications can vary. A few examples of price points for various marine collagen products are listed below (table 5).

Table 5. Price indication for marine collagen products.

Product	Type	Price
CORREXIKO Marine Collagen (92)	Powder	$108 / 1kg tub
Applied Nutrition Marine Collagen (93)	Powder	$38 / 300 g
Proto-col's Marine Beauty Collagen (94)	Liquid	$53 / 15 sachets
KIKI Health Marine Collagen Beauty Blend (95)	Powder	$26-51 / 200g

Supply chain

The supply chain for marine collagen is comparable to that of FPH (figure 17). The raw material, fish offal, is collected and prepared for collagen extraction using a pre-treatment. After extraction, the product can be formulated and manufactured. The chain ends with the distribution of marine collagen products and sales to consumers.

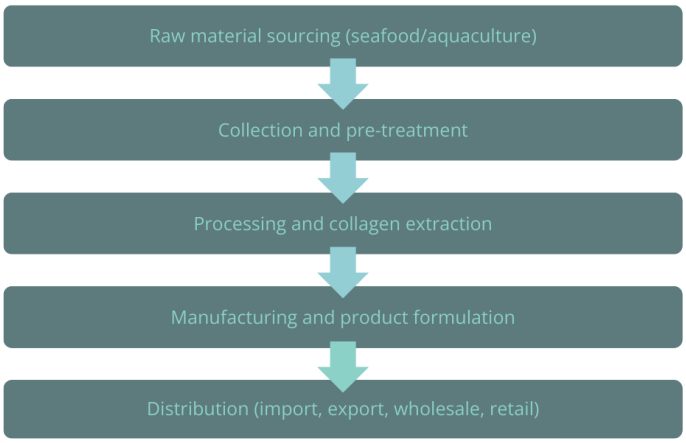


Figure 17. Marine collagen supply chain.

Regional Marine Collagen Market Demand

Market Size

The collagen market in North America was valued at $2.60 billion in 2023, with a projected CAGR of 11.2% until 2030 (96).

Quality Specifications

The largest markets for collagen are pharmaceuticals, cosmetics and the biomedical industry, all of which have high end-consumer quality expectations (97). Each of these markets has specific regulatory requirements for products to maintain the health and safety of end-consumers. The Good Manufacturing Practice guidelines are established quality expectations placed on pharmaceuticals, cosmetics and food products. These are governed by the Food and Drug Administration in the United States and by Health Canada in Canada. The guidelines suggest practices such as raw material testing, sanitation, limits on foreign materials, etc. (98). Considering the high cost of poor quality to the pharmaceutical industry, producers in this market generally have high quality expectations (99). The implication for fisheries is that collagen producers likely expect fish materials to contain minimal pathogens and be free of foreign materials.

Key Geographies

There are several collagen producers that operate in North America, offering a range of products and sourcing options. Nitta Gelatin, established in 1979, operates a manufacturing facility in Ontario, California (100). They provide collagen and gelatin for the food, pharmaceutical and supplement markets and accept bovine and porcine sources but not fish. Gelita AG, a global leader, operates a facility in Calumet City, Illinois (101). They produce collagen peptides for health, nutrition, and cosmetic applications and accept fish as a source. Nippi Collagen NA Inc., specializing in marine collagen peptides, operates out of Vancouver, British Columbia, and exclusively uses fish as its source (102). Vitaquest International, with a production facility in New Jersey, manufactures custom collagen supplements from bovine sources but does not accept fish (103). SB Edge Supplements, based in Iowa, specializes in Type II collagen from North American USDA-inspected bovine sources, with no fish products (104).

Segments and pricing

There was no readily available public information on the revenues that would be received from the delivery of fish materials to collagen producers.

Fish Leather Market

Fish leather is an emerging market, although the process of making leather from fish skins has existed for hundreds of years, especially in native communities. This might provide the explanation for minimal use of fish leather in society today, due to its association with the lasting impacts of colonialism (105). Fish skin can be processed into leather that is stronger than bovine leather when comparing leathers of same thickness and requires fewer chemicals (106).

Global Fish Leather Market Demand

Market Size

Estimates of the current global market size of fish leather vary between $32.4 million and $58.8 million (107; 108; 109; 110). Associated CAGR's varied between 15.2% and 19.9% (107; 108; 109; 110). One estimate was significantly higher at $105.9 million, with a lower CAGR at 2.9% (111).

Trends in fish leather market

Several trends can be identified in the fish leather market. The main driver of the global fish leather market is an increase in consumer awareness. As sustainability becomes more important, fish leather can provide a sustainable alternative to traditional leather as it is a by-product of the fish industry (107; 108; 110; 111). Besides that, consumers are also more interested in luxury goods, further driving the fish leather market (108; 110). An important trend is the collaboration between designers and artisans, as well as scientists, the fashion industry and fisheries (107; 110). This will increase the likelihood of meeting consumer demand for fish leather.

An important restraint of the fish leather market is the limited access to the skins and variations in skins that are used for leather (107; 108; 110; 111). This variation in supply makes it difficult to achieve consistent quality and increases manufacturing costs (110; 111). Other restraints mentioned are the acceptance of fish leather by consumers, and the environmental impact of the chemicals used in tanning (107). Nevertheless, the innovation of improved and more sustainable fish tanning techniques is an observed trend (107; 108; 110). The key global actors are shown in (figure 18).

Salmo Leather GmbH (Germany)	Nordic Fishleather Iceland (Iceland)
Nova Kaeru (Brazil)	ICTYOS (France)
Kalaparkki oy (Finland)	Searious Fish Leather (Netherlands)
Shadi Leather (Portugal)	Atlantic Leather Products Inc
Felsie (Netherlands)	Proxima Universal s.r.o.

Figure 18. Key actors on global scale in fish leather market (107; 109; 110; 111).

Key Geographies

Europe is the leader in the fish leather market (figure 19) (107; 111). Within Europe, Italy is the country with the highest market demand (107).

Figure 19. Indication of continents with highest fish leather market share.

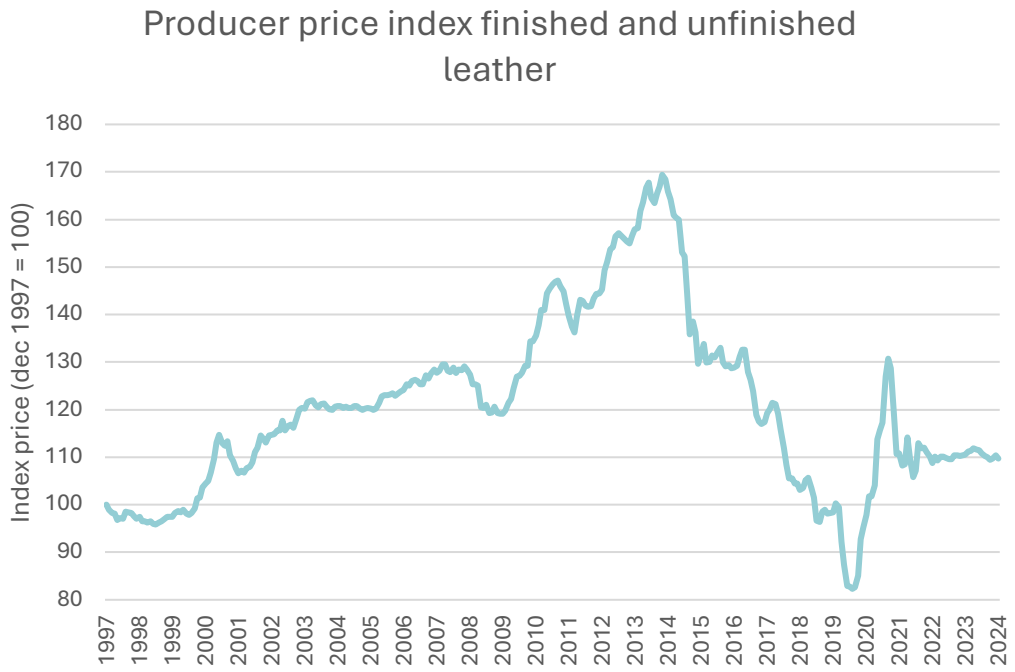
Segments and pricing

Segments

Market segments can be divided by fish species (107; 111). Furthermore, the market can be segmented by application, for instance fashion, automotive, furniture and accessories (111). Currently, most fish leather is created from salmon skin (107; 111). Salmon leather, specifically, is prized for its unique texture, durability and aesthetic appeal, making it a popular material in several industries (111). Considering application, fish leather is considered a sustainable alternative to traditional leather, especially in the fashion industry (112). Fish leather is most often used for the creation of handbags, wallets and footwear (112). Likewise, the automotive industry uses fish leather as a premium material for upholstery and interiors (111).

Pricing

There is limited available data regarding pricing of leather, and in particular fish leather. However, the producer price index (PPI) for hides, skins, leather and related products (finished and unfinished leather) can provide some information. The past few years, the PPI was stable, which occurred after a steep increase starting around 2008 and a decline between 2014 and 2020 (graph 4) (113).



Graph 4. Producer price index by commodity: hides, skins, leather and related products (finished and unfinished leather) (113).

As mentioned, fish leather can be used to create several products, which vary widely in price. To provide an idea of the price of fish leather, price indications from several retailers of fish leather pieces from different species were collected (table 6).

Table 6. Price indication for fish leather.

Product	Type	Price
Leather House Salmon leather (114)	Piece – traditional tanning	$15 / piece
Leatherbox Spotted Wolffish (115)	Piece – traditional tanning, medium size, silk gloss	$23 / piece
Fiskur Leather (116)		
- Tilapia	Piece – traditional tanning	$12 / piece
- Cod	Piece – traditional tanning	$16 / piece
- Wolffish	Piece – traditional tanning	$32 / piece
- Salmon	Piece – traditional tanning	$24 / piece
- Salmon	Piece – chrome-free tanning	$30 / piece

Supply chain

The fish leather supply chain starts within the fisheries and aquaculture (figure 20). From here on, the fish move to a processing plant, where the skins are taken off and possibly further processed before going to the tannery. (117)

Hereafter, the steps are the same as the traditional leather industry. Leather pieces are sold to producers of consumer goods, for instance designers or furniture manufacturers. The supply chain ends at the warehouses and retail stores of these different consumer goods, who will sell it to the consumer. (118)

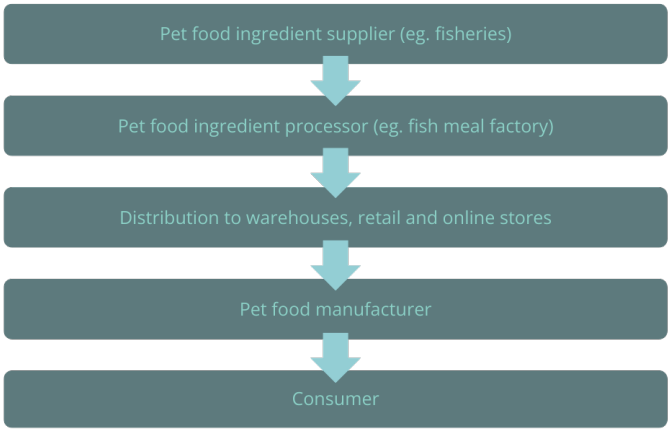


Figure 20. Fish leather supply chain.

Regional Fish Leather Market Demand

Market Size

The fish leather market in North America is estimated at $8 million with a projected CAGR of 13.6% until 2030. The fish leather market size for North America was calculated at 40% of the global demand (111; 119).

Quality Specifications

Texture, size and strength are three primary factors that determine what species of fish skin is preferred. Aligned with this, salmon, cod and tilapia are the most used fish skins (120). Unlike cow leather, fish leather's usability is limited by the size of fish skins that can be sourced. There are no further online sources to guide this analysis, though intuitively, producers would likely expect that the skins are undamaged and intact, without scarring. If producers were operating at a large scale, they may expect that the skins be separated from other materials and be the sole fish material provided.

Key Geographies

The fish leather market in the Great Lakes region and North America is small, and there do not appear to be any large-scale producers. It remains a niche market with small producers that have limited capacities. In the Great Lakes region, the only known producer that sells fish leather is Fiskur Leather, based in Mora, Minnesota (121).

Segments and pricing

Due to the lack of established producers or notable supply chains for fish leather in the Great Lakes region, there is no ability to determine the price fish processors may expect to receive for selling fish skin to fish leather producers. The end selling price of fish leather by Fiskur Leather in Mora, Minnesota, is $36 per 0.8 square foot (121).

Conclusion

There are strong markets for each of the value chains investigated in this market demand analysis. The largest markets identified in terms of their overall value were fertilizer, pet foods and fish meals & oil. For fertilizer and fish meals and oils, these also tend to be the highest volume demanding sectors, but both have stable markets globally. For fertilizers, the economically most interesting market is likely to be fish emulsion fertilizers, which obtain a high market price. It is notable that the United States currently imports 20% of fertilizer and incoming policy suggests that tariffs on imported goods may support more domestic sourcing of fertilizer, creating opportunities for domestic producers. For fish meals, the quality and marketing of these ingredients will be key market considerations.

Pet food is a large market with a globally strong growth rate, which is even stronger regionally. This should be considered as a very interesting market for fish producers or fish supply chain actors, since the greatest growth trends were found to be connected to fish-based pet foods. This market also offers a range of potential volume suppliers and a range of different qualities that can offer flexibility to producers. The premium pet food market shows especially strong trends and consumers favor wild-caught fish sources over farmed which would suit the Great Lakes region well. Since prices for premium products and requirements can be high, and the volumes do not need to be as large as for fish meals or fertilizer, this may suit product development in the Great Lakes well.

Fish protein hydrolysates have a moderate market though significantly smaller than the high-volume products of fish meal, fertilizer and pet food. It is an interesting market, though, for the Great Lakes region as the strong growth rate of this market and the opportunities to reach the health and wellness markets, which themselves have a high growth trend, is very interesting. North America already has a strong market share, and this supply chain is already established in the Great Lakes region. Additionally, the multiple end markets linked to this product provide flexibility for diversified production, supply chains and volumes for more premium products.

Fish collagen and fish leather present two emerging markets that can be accessed on small scales, particularly at the regional level. The marine collagen market, which we can consider as indicative of the fish collagen market, already has a strong growth trend and an existing stable market in North America. The limited current production in the Great Lakes region may mean additional time and cost in launching a new product and supply chains to access the market. Since quality is closely related to the pricing, this will likely take time to ensure. Despite this, the market is promising for a well-developed, high quality fish collagen product. The fish leather market is the smallest of all those investigated in this report and has the strongest, larger-scale markets in Europe. However, anecdotally, there is strong interest in North America for such products, although data for local and artisanal products was more difficult to capture within this report.

A limitation of this report is that it was only possible to use publicly available, secondary sourced data. Nonetheless, the secondary data collected serves as a strong foundation to highlight potential end markets. For further research of specific markets, primary data could be collected to further understand the possibilities and challenges. The two sub-sections of the report that would most benefit from the collection of primary data are the quality specifications and pricing, especially at the regional level. Communications and interviews with producers in each end market would be the first step in collecting primary data. An inquiry should be made regarding each company's specifications and the unit price that suppliers might expect for their fish materials.

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