

Windjammers to Eighteen Wheelers: The Impact of Changes in Transportation Technology on the Development of British Columbia's Fishing Industry*

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Introduction

The development of a natural resource-based export industry on the sparsely populated northwest coast of North America in the late nineteenth century would certainly depend on the establishment of viable transportation links with its markets. The industry's evolution would be heavily influenced by the evolution of transportation facilities and technology. This, obviously, is a role that transportation has played in the development of British Columbia's fishing industry. With an initially small local market, the establishment of an industry required export markets. Only when the relative costs of production, including transportation costs, provided a comparative advantage did development proceed. With the necessary capital, technology and entrepreneurship the industry was able to expand, following a pattern similar to other Canadian export commodities or staples.

A less obvious role of transportation in development is that within the industry itself. When fish are caught their perishability dictates that some form of processing and preservation take place very quickly. This usually requires moving the fish from the fishing area or ground to a processing point. In some cases this is an easy task since the fish are obliging and dependable enough that processing plants can be located practically in sight of the fishing grounds. The usual trade-off, however, is that labour and other inputs must then be moved to the processing plant. In other cases, variable fish migrations, changing seasonal availability, and depletion of stocks mean a continuous search for fish and changing patterns of transport from the grounds to the plant.

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Of course, transportation costs, technology, and availability are not the only forces shaping development. Markets and prices have exerted various pulls, other forms of technological change have altered capabilities, and public policy has continually shaped the industry as it determined when, where, and how exploitation of the resource could take place. The common property or open access quality of a fishery has also provided a unique, if troublesome, dimension to the industry. Since the fish, before capture, are held in common or available to all, there are no safeguards to regulate fishing effort and no incentives for individual fishermen to conserve the resource. Therefore, effective management of the resource and regulation of the harvest requires that controls be imposed through government intervention in the industry.

This paper discusses the link between changes in transportation technology and development for four species: salmon (*Genus Oncorhynchus*), halibut (*Hippoglossus stenolepis*), herring (*Clupea harengus pallasii*) and pilchards (*Sarclinops sagax*). Each is or has been important in the British Columbia industry. Each illustrates roles transportation can take in the development of a fishery. Although discussed under separate headings, there are important economic relationships between these fisheries: many fishermen, vessels, and processors are involved with more than one species. Transportation systems and technology developed for one fishery are often used in others.

Salmon

Salmon are almost synonymous with commercial fishing in British Columbia. They were the first species to be commercially exploited and have always ranked first in value of landings. Salmon are anadromous: born in fresh water, they later migrate to the ocean, where they spend the majority of their life before returning up rivers and creeks to spawn. During the migration to and up rivers and streams the fish are very susceptible to capture; even the simplest techniques are successful.

A demonstration of the possibilities for a commercial fishery was first provided on the Pacific coast of the United States. Beginning in the 1860s, initially on the Sacramento River in California and later on the Columbia and other rivers, Americans began canning and exporting salmon. Small shipments were made to Australia in 1864 and 1865 and, in the following years, to other Pacific countries. However, it was not until the opening of the English market in 1871 that a significant export market was estab-

lished.¹ Canning was an excellent preservation process for salmon, providing an attractive food product and allowing long distance shipping of the preserved fish.

The commercial link between the west coast of North America and Great Britain was initially established to export wheat from California, Oregon, and Washington. This trade, by sailing ship around Cape Horn, was an active one with, for example, 240 ships chartered in 1869 to carry wheat from San Francisco to Great Britain. British firms established branches and subsidiaries on the North American west coast for commodity trading, ship chartering, and insurance brokering.² Canned salmon was a product which could follow this route, particularly since ships bound from Britain to North America could bring in tin plate for salmon cans.

Long distance ocean shipping was encouraged and expanded in the last half of the nineteenth century by declining freight rates. North attributes the decline to decreased costs of ship construction, increased utilization of ships, improved knowledge of winds and currents, and technological improvements in sail and steam. The decrease was not always due to the introduction of steamships, since some of the most substantial declines occurred in periods when sailing ships dominated the long hauls, such as those around Cape Horn. After 1885, however, with the development of the compound engine, steamships gained supremacy and exercised a decisive influence on the fall in freight rates.³

In British Columbia, salmon canning for export did not begin until the early 1870s, partly because of the difficulty of access to major export markets.⁴ The first canneries were located on the Fraser River, the major B.C. salmon river and conveniently close to settlements. Fishing was done

¹ Early American canners and markets are discussed in P. W. O'Bannon, "Technological Change in the Pacific Coast Canned Salmon Industry" (Ph.D. thesis, University of California at San Diego, 1983).

² One such firm is discussed in M. Rothstein, "A British firm on the American west coast 1864-1914," *Business History Review* 37 (Winter 1963): 392-415. This trade route is discussed in R. Paul, "The Wheat Trade Between California and the United Kingdom," *Mississippi Valley Historical Review* 45 (Dec. 1958): 391-412 and H. K. Ralston, "Patterns of Trade and Investment on the Pacific Coast 1867-1892: The Case of the British Columbia Salmon Canning Industry," *BC Studies* 1 (Winter 1968-69): 37-45.

³ D. North, "Ocean Freight Rates and Economic Development 1750-1913," *Journal of Economic History* 18 (Dec. 1958): 537-55.

⁴ In the 1860s Victoria, the only seaport in B.C., received just occasional visits from sailing vessels. According to Henry Doyle, an early canner, exporting canned salmon would have meant shipping by steamer to Victoria, trans-shipping to steamers for San Francisco, and trans-shipping again to sailing ships. (Henry Doyle, "The Rise and Decline of the Pacific Salmon Fisheries," Ms., University of B.C., Special Collections Division).

from oar-powered skiffs with gillnets, set perpendicular to the river flow to entangle the fish. The fishermen operated close to the cannery, allowing them to deliver their catch directly to it. The canning process itself was slow and primitive. All operations, including can making, were done by hand.⁵

The financial centre of the industry was Victoria, where commission merchants provided financing and acted as brokers for the output or pack.⁶ Victoria was also the major port of British Columbia, regularly visited by ocean-going ships. Canned salmon was shipped by coastal or river steamer to Victoria and trans-shipped to ocean-going ships for export.

In 1877 canneries began to be established in northern British Columbia on the rivers, inlets, and streams used by the migrating salmon. This decentralized locational pattern was determined by the transportation capabilities of the era. Virtually no capacity existed for moving raw fish, so supplies of salmon could only be secured by building canneries as close as possible to the fishing grounds. The building and operation of a cannery in northern British Columbia was a major exercise in logistics.⁷ The cannery sites chosen were often well-removed from established communities and surface transportation routes, requiring that all supplies and staff reach the plant by ship from Vancouver or Victoria. Thus, the transportation link determined cannery location since each cannery required access to tidewater and berthing facilities for coastal freight and passenger steamers. Providing a wharf in water deep enough for coastal steamers was often a problem with the large tidal range of some of the coastal inlets. The major rivers, the Skeena and Nass, were navigable in their lower reaches, allowing canneries to be built on the rivers themselves.

With the earliest canneries located immediately adjacent to the fishing grounds, the fishermen, even without any mechanical power, could deliver their catch directly to the canneries. Inevitably, however, competition for fish meant that fishermen were operating further and further from the cannery. A system of tenders developed to collect fish from the fishermen.⁸

⁵ Discussions of the early history of the industry are available in W. A. Carrothers, *The British Columbia Fisheries* (Toronto: The University of Toronto Press, 1941), C. Lyons, *Salmon: Our Heritage* (Vancouver: Mitchell Press, 1969), H. K. Ralston, "The 1900 Strike of Fraser River Sockeye Salmon Fishermen" (M.A. thesis, University of British Columbia, 1965) and G. Strong, "The Salmon Canning Industry in British Columbia" (B.A. essay, University of British Columbia, 1934).

⁶ Adequate financing was essential since the long, slow trip to and from Great Britain meant an eighteen-month cycle from the ordering of tinplate to the sale of the pack.

⁷ See E. Cepka, "West Coast Vernacular Canneries," *Architect's Forum* 4 (Sept.-Oct. 1981): 17-19 for a description of a typical cannery and its construction.

⁸ D. Stacey, "Technological change in the Fraser river canning salmon industry" (M.A.

Starting in 1877 on the Fraser River, steam-powered tugs towing scows loaded with fish and freighters with fish stowed in the hold or in boxes on deck were used. No ice or other form of preservation was needed because of the short run to the canneries. In 1881 the system further evolved with the use of fishermen's camps at favourable locations on the river. Catches were delivered to scows at the camps, and the scows picked up by the steam tenders and towed to the canneries. The tenders also increased the mobility of the gillnet fleet by towing gillnetters to and from the fishing grounds.

Despite these developments, the initial growth of the industry was slow. Primitive and labour-intensive technology, labour scarcity compounded by competition for workers from mining "rushes" and railway construction, inadequate financing, and expansion in other areas of the Pacific coast all limited the industry's development in the 1870s and early 1880s. However, in the late 1880s new companies, with new sources of financing, several company mergers, and improved markets accelerated growth. The new firms opened offices in Vancouver and New Westminster, and the role of the Victoria commission merchant declined.

Completion of the Canadian Pacific Railway in 1885 spurred the development of Vancouver as a port. Cargoes began to be shipped directly from the mainland. The sailing ship "Titania" made the first direct voyage from London to Vancouver in 1889. After discharging, she was towed to Steveston on the Fraser River, the site of several canneries, and loaded canned salmon. She left Steveston on 28 September 1889 under tow for Victoria, where further cargo was loaded. She was then towed through the Strait of Juan de Fuca to the open Pacific.⁹ Loading of ocean-going ships alongside the Steveston canneries had begun. At one time in 1895, fourteen ships were reported to have been waiting off Steveston for cargoes. The role of the windjammers was short, however. By 1905 they had been largely replaced by steam-powered ships.

In the 1890s established firms expanded and, with few barriers to entry, new firms were attracted into the industry. By 1901, however, it was

thesis, University of British Columbia, 1977), discusses the evolution of this type of vessel. In 1896 twenty-six tenders were operating on the Fraser river.

⁹ Information on this voyage of the "Titania" is from the Vancouver Maritime Museum exhibit "Passage from Sail to Steam" (January 1986) and J. E. Forester and A. D. Forester, *Fishing: British Columbia's Commercial Fishing History* (Saanichton, B.C.: Hancock House, 1975). Starting in the late 1880s, navigation on the lower Fraser River was improved by the use of training works and dredging to control the position and depth of the main channel. See Canada Dept. of Public Works, *Environmental Impact Statement of Proposed Improvements to the Fraser River Shipping Channel* (Vancouver: Beak Consultants, 1981).

apparent that the industry had over-expanded. A large pack was produced, but a glut on export markets and quality problems made it difficult to sell. Many canners found themselves in financial difficulty and were persuaded to merge into the British Columbia Packers Association. Over half of the canneries operating in 1901 were brought into one company, some being closed and others expanded.

The completion of the Canadian Pacific Railway was of limited benefit to canners but very beneficial to the fresh and frozen salmon business. The Canadian domestic market for canned salmon was small, absorbing less than ten percent of the pack at that time, but the transcontinental railway meant that the market for fresh salmon could be expanded. Cold storage plants were first established in the late 1880s and fish shipped to the American and Eastern Canadian markets.

The completion of a second transcontinental railway, the Grand Trunk Pacific, to Prince Rupert in 1914 further expanded the market possibilities for fresh and frozen salmon. For example, frozen fish could now be shipped from northern B.C. to Liverpool, England in fourteen days. Improvements in fish handling and freezing, coupled with the development of the transportation, storage, distribution, and retailing network, gradually expanded the fresh and frozen sector of the industry.¹⁰

As further encouragement to the consumption of fresh fish, the federal government, starting in 1908, offered to pay one-third of the express charges on less-than-carload shipments of fresh fish to the prairie provinces. The hope was that the demand for fresh fish would be sufficiently stimulated that shipments could be made in carload lots, where charges per pound were lower — an objective achieved in 1913. In 1917 the subsidy was discontinued for salmon and halibut but increased to two-thirds of all transportation charges on other fish. The programme ended in 1919. It is an illustration of how markets may develop when transportation costs are lowered.¹¹

Mechanization and expansion characterized the canned salmon sector from 1903 to 1927. Stacey describes the 1903 to 1913 period as the period of transition from manual to mechanized canning.¹² The development and adoption of mechanized processes, particularly the fish butchering machine and the solderless or sanitary can, increased the output of a

¹⁰ *Pacific Fisherman*, July 1915 reported that the Canadian Express company had purchased twenty refrigerator cars, specifically for the fish service out of Prince Rupert.

¹¹ Information on this programme may be found in various annual reports of the Departments of Marine and Fisheries and the Department of Naval Service.

¹² See Stacey, 1977.

canning line and helped the industry overcome its chronic labour shortage problems.

Small internal combustion engines were adopted in gillnetters, first on the Fraser River and later in northern waters.¹³ As the gillnetters became more mobile, a fleet of small gasoline-powered tenders or collectors developed to pick up the fish from the gillnetters and deliver to the canneries. The gasoline-fuelled internal combustion engine, with its smaller size, lower labour requirements, and ease of starting, was much superior to the steam engine for these small vessels. The marine internal combustion engine also allowed the development of purse seining, a fishing method in which the fish are encircled.

Mechanization was one of the factors encouraging entry into the industry and the expansion of output in this period. Although mechanized canning may raise the initial cost of entry, it eventually makes entry easier by eliminating labour shortages. Mechanization for purse seining allowed the exploitation of the pink and chum species, for which markets were developing.¹⁴ High prices, ready markets, and the availability of good sites encouraged the building of more canneries.¹⁵ Perhaps inevitably, the industry again over-expanded, and another series of mergers occurred in 1928.

The establishment of canneries in many isolated coastal locations provided a stimulus for the development of coastal shipping. The sparse population in northern coastal areas, the seasonality of the industry, and the long distances involved meant that canners had to transport fishermen, cannery workers, and supplies north in the spring, canned salmon south in the summer and fall, and fishermen and workers south at the end of the season. The largest fleets were those of the Union Steamship Company of British Columbia and the British Columbia Coast Steamship Service of the Canadian Pacific Railway, both beginning service in the 1890s. For over fifty years these companies and others provided regular passenger and freight service to the communities, settlements, logging camps, mills, mines, and canneries on the British Columbia coast.¹⁶

¹³ By 1913 over 80 percent of Fraser River gillnetters were motorized. Federal regulations prohibited motorized gillnetters in northern waters until 1924.

¹⁴ Before 1903 the salmon canned were almost exclusively sockeye, the species with the reddest colour and highest oil content. Later, particularly during World War I, markets developed for canned pink and chum salmon. The output of sockeye was drastically reduced after rock slides on the Fraser River in 1913 and 1914. The slides may be regarded as a negative impact of transportation since they were due to railway construction.

¹⁵ The peak number of canneries was eighty-four in 1917.

¹⁶ Detailed histories of these companies are available in N. Hacking and W. K. Lamb,

Most of the ships used were built specifically for the coastal routes. Typically they carried both passengers and freight and were steam powered. The "Camosun" of the Union Steamship Company, in service from 1905 to 1936, is a good example, with berths for 68 passengers, room for 120 as deck passengers, and capacity for 270 metric tons of cargo.¹⁷ She was 193 feet long and travelled at twelve knots. Rushton describes the role of this ship:

... the northern canning industry expanded rapidly and every spring the Camosun carried several hundred ... workers to the twenty-five fish plants on Smith's Inlet, Rivers Inlet, and the Skeena and Nass Rivers. The main packing season from July to October found the vessel loaded down with salmon and frozen fish.¹⁸

From the 1890s to the 1940s the cannery business was profitable for these companies. In his history of the Union Steamship Company, Rushton mentions the "profitable logging and cannery runs" and "the most profitable northern run — the key Skeena and Nass River cannery route."¹⁹

The expansion of the industry in the early 1900s also meant expansion of the fishing grounds and attempts to transport raw fish. An example is the transport of fish from the Strait of Juan de Fuca purse seine fishery to canneries on Alberni inlet and the Fraser River, beginning in 1912. Ice for fish preservation during transport was beginning to be available at certain coastal locations. In the 1920s, canners, in trying to maximize the output of their plants, attempted further movements of fish. However, lack of the appropriate technology and capacity meant the industry sometimes over-extended itself and poor quality fish arrived at the canneries. The federal government, attempting to improve quality, imposed regulations restricting fish transport.²⁰

The Princess Story (Vancouver: Mitchell Press, 1974), G. Rushton, *Whistle Up the Inlet* (Vancouver: J. J. Douglas, 1974) and R. Turner, *The Pacific Princesses* (Victoria: Sono Nis Press, 1977).

¹⁷ Many of the vessels also had cold storage compartments for frozen fish.

¹⁸ Rushton, 47.

¹⁹ Rushton, 51 and 89.

²⁰ Between June 1928 and July 1930 the transfer of salmon between the Queen Charlotte Islands and the mainland and between the north and south districts was prohibited, unless the fish were gutted and iced (Public Archives of Canada, Vancouver Federal Records Centre, Records of the Department of Fisheries, RG23, Accession 84-85/278, Box 500479, file 10-5-12-1 v. 4). In 1933 no certificate of inspection was issued for salmon that were not landed at a cannery within twenty-four hours of being caught, excepting fish that had been gutted and iced immediately after being caught (*Pacific Fisherman*, March 1933 and February 1934).

After 1928 the closing of canneries as a result of company mergers coupled with technological improvements led to steady growth in the industry's ability and need to transport raw fish. Expansion of cold storage and freezer facilities meant increased availability of crushed ice, a refrigeration agent essential to any transportation of the extremely perishable raw fish. The diesel engine had been perfected for marine use in the early 1920s, significantly lowering vessel propulsion costs. With these two innovations a fleet of vessels, referred to as packers or tenders, developed to carry salmon from the fishing grounds to the processing plants. No longer was there a need to have a cannery adjacent to every fishing ground. Fish from several areas could be processed at a central point. Cost savings resulted with fewer plants and better utilization of those remaining.

Although it was now possible to move raw fish from one end of the B.C. coast to the other, most movements were considerably shorter. Packers received fish directly from fishing vessels or indirectly from collectors or camps. The storage and refrigeration of the fish were simple. Each packer's hold was divided into a number of pens with removable partitions. Crushed ice was added as the fish were placed in a pen and the sides of the pen put into place. A layer of top ice was added. The fish were cooled by contact with the ice and the trickling down of melted ice water. A packer would return to a cannery within four or five days, usually much less, of starting to load fish. While some boats were built specifically for fish packing, many were conversions from other uses — tugboats, seiners, and even yachts. Packers were also used to bring boxed and iced troll-caught fish to the major cold storages.

Low prices and limited markets during the depression of the 1930s ended further expansion, encouraged the closing of some canneries, and restricted output. Much of the equipment in the closed canneries was transferred to those in operation; many of which were rebuilt with facilities, such as ice plants, added. Active markets returned in 1939 with the heavy war-time demand for food. To make better use of limited manpower and equipment, many companies concentrated operations and cooperated in packing and processing. By 1945, only twenty-nine canneries were in operation.

A difficult market adjustment faced canners after 1945. Great Britain limited imports, primarily because of foreign exchange restrictions. Further centralization of processing occurred through consolidation and merger. The number of canneries was reduced to eighteen in 1956.

The reduction in the British demand for salmon resulted in an increased emphasis on the domestic market. Rail transport could be used for the

Canadian market. Export markets continued to be serviced primarily by ocean transport.

One legacy of the Second World War was a large number of surplus wooden naval craft which could be converted into fish packers. These were fitted with high-speed diesel engines and reduction gears, saving both weight and space in comparison with the first-generation low-speed diesels. Most of these conversions are still in service, providing the core of the present packer fleet. Currently, fish packers carry from 25 to 200 metric tons of fish with a crew of three to ten.

A consolidated processing sector with increased fish transportation capability was further facilitated by the development of a coastal communications system. Marine radio telephones, allowing two-way communication between vessels and shore stations, were first adopted in 1938. By 1939, 50 vessels were equipped, by 1944, 160 vessels, and by 1951, 1,500 vessels.²¹ Presently, virtually all fishing craft of any size are equipped with at least one radio telephone. This communication system aids fishermen in moving to the best fishing areas and allows the packing fleet to be dispatched to those areas where it is most needed. Since the runs of fish are to some extent unpredictable, it is important that transportation plans be flexible and processors have the ability to match the supply of fish with transportation capacity.

While the fishing industry's internal transportation capacity expanded, the 1950s were a period of decline for the coastal steamship services. Fragmentation of the coastal transportation market as air, road, and tug and barge services improved; the decline in many coastal communities, partly due to cannery closings; and more use by fish processors of their own fleets all contributed to the unprofitability of regular steamship service.²²

The pattern of centralized canneries serviced by a highly developed fish transportation sector was firmly set by a further technological change, the perfection and adoption of refrigerated sea water as a medium for the cooling and storage of fish. Crushed ice, although satisfactory for fish preservation during transport, had several drawbacks. Obtaining ice was the first problem. Packers had to start each trip by taking on ice, predicting the amount of ice required was difficult, and ice shortages occurred during heavy runs. The icing process itself was slow, labour-intensive, and

²¹ *Western Fisheries*, Vancouver, May 1939, October 1944, and November 1951.

²² Currently, many smaller coastal communities have poor transportation service. See Centre for Transportation Studies, *Transportation Needs and Availability in the Northern Coastal Communities of British Columbia* (Vancouver: University of British Columbia, 1977) for a discussion of this problem.

subject to variation in care and thoroughness. Fish quality could deteriorate as the first fish loaded were crushed by the ice and fish above them and by the crew working in the hold. The minimum temperature of iced fish was 39° F, not sufficient to kill bacteria.

The refrigerated sea water system overcame many of these problems. As the name implies, cold sea water is used to cool and hold the fish.²³ Water-tight tanks built into the packer are filled with sea water, the sea water is cooled to within one degree of its freezing point by pumping through a heat exchanger, and the fish are loaded into the chilled sea water. Once the fish are cooled, the sea water need no longer be circulated through the heat exchanger as the thermal inertia of the large mass of fish and water prevents any significant temperature rise.

Although the installation of a refrigerated sea water system can most easily be done while a vessel is under construction, it is quite feasible to convert ice packers to refrigerated sea water packers. The holds are divided into water-tight tanks and the appropriate piping, circulating pumps, heat exchangers, and refrigeration units installed.

The major development of this system was carried out at the Vancouver Technological Station of the Fisheries Research Board of Canada.²⁴ The first salmon packer was equipped with refrigerated sea water in 1955. The system was not rapidly adopted in Canada but was installed on a number of salmon packers operating in Alaska. Roach et al., state that it was not until 1961, with the conversion of the vessel "Western Express," that the usefulness of this technology was demonstrated commercially. After that, systems were widely installed so that, by 1967, most salmon destined for canning in British Columbia were carried in refrigerated sea water-equipped vessels.²⁵

²³ See S. Roach, J. Harrison, and H. Tarr, *Storage and transport of fish in refrigerated sea water* (Ottawa: Fisheries Research Board of Canada, 1961), S. Roach, H. Tarr, N. Tomlinson, and J. Harrison, *Chilling and freezing salmon and tuna in refrigerated sea water* (Ottawa: Fisheries Research Board of Canada, 1967) and S. Roach and G. Gibbard, *Standards for an R.S.W. system* (Vancouver: Fisheries Research Board of Canada, 1976) for detailed descriptions of the system and discussions of the research involved.

²⁴ The Canadian research programme began in 1952. Before then some work had been done in the United States and other places on the use of refrigerated sea water for storing fish on shore.

²⁵ By 1976, 140 vessels, mostly packers, had refrigerated sea water systems. The system was also installed on barges for salmon and herring packing and on some seiners, trawlers, trollers, and gillnetters. Improvements in the system were made to ensure uniform cooling of the fish. By partially freezing the fish, some refrigerated sea water equipped packers have been used to bring salmon from Bristol Bay, Alaska, a ten-day journey. Some trollers have installed freezer systems, allowing them to remain at sea for long periods.

Refrigerated sea water has proven to be a superior technique for fish transport. In comparison with standard icing, fish quality is improved; crushing and ice pitting is eliminated, chilling is more rapid and uniform, bacteria counts are reduced, and the fish are subject to a washing effect, eliminating any coating with blood and slime. Cost savings, once the system is installed, come from reduced fish shrinkage, the ability to hold fish longer, and increased carrying capacity as the water takes up less space than the comparable ice and partitions in the hold. Labour is saved in loading, when the fish are simply slid into the tanks, and unloading, when fish pumping systems may be used. However, the system does require additional skills in the crew. The simple manual system of icing has been replaced by a complex mechanical system requiring care and attention in operation and maintenance.

Another fish preservation system, the chilled sea water system, was developed for situations where vessel size or cost considerations made installation of the refrigeration compressor and auxiliary engine needed for the refrigerated sea water system impractical. Sea water is added to ice in a watertight fish hold to form a slush. The fish are loaded and the mixture of ice, water, and fish is agitated by compressed air released at the bottom of the hold to chill the fish. Once the fish are uniformly chilled the air need only be turned on occasionally to maintain a uniform temperature. The system has been widely installed. It maintains fish quality, is simple to operate, has a relatively low capital cost, but does require that ice be obtained before fish are loaded.²⁶

Until relatively recently, technical innovations were based on the movement of fish by water transport. This was the only feasible mode from isolated fishing areas. However, the extension of the British Columbia highway network has now permitted the trucking of salmon. A road to the west coast of Vancouver Island was opened in 1959. Troll-caught salmon for the fresh and frozen markets could now be brought to the Vancouver Island west coast ports of Tofino and Ucluelet and taken by truck to final processing points. This is particularly advantageous for these markets where volumes are not large and quick distribution is important. Extension of the highway network to northern Vancouver Island further expanded truck transport of salmon.

The opening of roads to the north and west coasts of Vancouver Island facilitated the establishment of fresh and frozen salmon processing plants

²⁶ See F. Lee, *Design and operation of chilled sea water systems* (Canadian Technical Report of Fisheries and Aquatic Sciences No. 1363, 1985) for detailed information on this innovation. It is popularly known as the "champagne system."

at ports near certain fishing grounds. The locational advantages to these processors were improved quality, less shrinkage, and a reduction in the weight of product transported. Smaller supply-oriented fresh and frozen plants are able to operate efficiently since, compared to canning, there appear to be fewer economies of scale in fresh and frozen processing. These plants may also be used to process other species available locally.²⁷

Increasing amounts of salmon were allocated to the fresh and frozen market in the 1970s as the demand for these products expanded.²⁸ To move this output to the final market, more use was made of refrigerated transport such as refrigerated multi-modal containers.

The history of salmon transportation, both within the industry and as a link to final markets, covers over a century of technical innovation and adaptation. From sailing ships (or "windjammers") to trailer trucks (or "eighteen wheelers"), changes in transportation technology have had an impact on the development of the salmon industry in B.C. Long haul ocean transport provided the initial access to markets for the products of a distant colony, cannery expansion encouraged coastal shipping, the development of raw fish transport systems facilitated cannery consolidation, and highway building improved access to markets.

Halibut

While the salmon industry, facilitated by innovations in transportation, tended to centralize, the halibut industry, also facilitated by innovations in transportation, has shown a tendency to decentralize. One reason is the nature of the resource. Halibut are a demersal fish, living on or near the ocean bottom. The major concentrations and thus the major fishing grounds for Pacific halibut are on the continental shelf off the coasts of British Columbia and Alaska. While the salmon fisheries are based on waiting for the fish to migrate inshore, halibut fishermen have to move out of sheltered waters to areas in which the fish concentrate.²⁹

²⁷ *Western Fisheries*, March 1965, discusses the development of truck transport from the Tofino-Ucluelet area. See E. Pinkerton, "The Fishing-Dependent Community" in P. Marchak, N. Guppy, and J. McMullan (eds.), *Uncommon Property* (Toronto: Methuen, 1987) for a discussion of fishing and fish processing in the Tofino area.

²⁸ See S. Garrod, "The Production and Distribution of B.C. Salmon in the World Context," in Marchak, Guppy, and McMullan for a discussion of world salmon markets since 1950.

²⁹ For the history of this industry see F. H. Bell, *The Pacific Halibut, the Resource and the Fishery* (Anchorage: Alaska Northwest Publishing, 1981), J. Crutchfield, *The Pacific Halibut Fishery* (Ottawa: Economic Council of Canada, 1981), L. Dean, "The Eastern Pacific Halibut Fishery 1888-1972: An Evolutionary Study of the Spatial Structure of a Resource-based Complex" (M.A. thesis, University of

Halibut, because of its high water content, is not suitable for canning and could not follow the same processing-transportation pattern as salmon. The species must be marketed fresh or frozen; which, before the wide acceptance of frozen fish, meant fresh markets were the only ones available. Rapid and reliable transportation to these markets, in the form of the transcontinental railways, stimulated the early fishery. Unfortunately, uncontrolled fishing in nearby waters depleted stocks and expansion to more distant grounds was necessary.³⁰ This was possible when technological improvements gave fishing vessels an increased range, fish freezing technology improved, and a coastal transportation network developed.

Commercial fishing for halibut began with fishing on inshore grounds for local markets.³¹ However, expansion was limited until the completion of transcontinental railways provided a way of shipping fresh halibut east, where Atlantic halibut had established a market. The first shipments east were made from Tacoma, Washington in 1888 over the recently-completed Northern Pacific Railroad. Success was mixed; market prices were often low due to competition with Atlantic halibut, the ice used to chill the fish was expensive and scarce, and the railways were inexperienced in handling fish. Low returns and poor fish quality were common. However, with a decline in the availability of Atlantic halibut, transportation and market conditions improved. More dealers became interested in Pacific halibut, handling was better, and freight rates were lowered as volume increased.

The first shipments from British Columbia were made in 1892 from New Westminster.³² After 1895, shipments were made from Vancouver because of the difficult up-river navigation to New Westminster and the better handling facilities in Vancouver. Perhaps because of the early problems in the U.S., the CPR went to some trouble to ensure satisfactory shipments. Six refrigerator cars were built specifically for shipping halibut

British Columbia, 1973), International Pacific Halibut Commission, *The Pacific Halibut: Biology, Fishery, and Management* (Seattle: The Commission, 1978), W. Thompson and N. Freeman, *History of the Pacific halibut Fishery* (Vancouver: International Fisheries Commission, 1930) and A. Thompson, "The Pacific Halibut Fishery 1888-1974" (M.A. thesis, Central Washington State College, 1975).

³⁰ Halibut stocks are very vulnerable to fishing because of their slow growth rate and long period to sexual maturity.

³¹ Some shipments in ice were made from Puget Sound, Victoria, and the west coast of Vancouver Island to San Francisco using schooners and scheduled steamships. For Canadians, these do not appear to have been financially successful.

³² The first cold storage plant opened in New Westminster in 1886 or 1887. By 1895, four cold storage plants were operating in B.C. (D. Stacey, "Refrigeration Technology," Ms., n.d.).

and were attached to the fastest transcontinental trains, with icing en route. Carrothers reports that no shipping charges were to be paid if the fish arrived spoiled.

The first B.C. halibut shipped were collected by small steamship from native Indian fishermen on the northern coast of British Columbia. In November 1893 a fishing station was established near Hecate Strait and several small open boats stationed there. The halibut were iced in boxes and taken to the railhead. Other fishing camps were established, inevitably the grounds easily accessible from shore were depleted, and it was necessary to move off-shore. In 1894 the steamers towed the fishing boats to new banks, and in 1895 fishing dories were carried aboard the steamships.

The use of dories from steamships or "steamers" was to dominate halibut fishing in British Columbia for the next twenty years. These steamers, owned by fish processing companies, were among the largest vessels ever used for fishing in British Columbia. They carried eight to fourteen dories and had a capacity for 70 to 140 metric tons of iced halibut. Most were converted trawlers. The actual fishing was done by ground lines set from the dories.³³

The use of these relatively large steam-powered vessels was a result of the state of the resource, the technology available, and the markets. Fish were abundant in shallow water and could be easily caught with manual fishing methods, no mechanical devices were available for handling the gear, the steam engine was the most reliable source of power for larger vessels, and the iced fish had to be rapidly brought to port in order to remain fresh after a week's rail trip to eastern North American markets. Initially fishing was only done during the winter, when Atlantic catches were lower and prices higher. The cooler weather also made shipping easier. Later, with a decline in the abundance of Atlantic halibut, fishing was done all year.

With the major market in the eastern United States, the development of the Canadian industry was hindered by an American tariff.³⁴ To overcome this disadvantage, the New England Fishing Company, after 1897, was allowed to land fish in Vancouver from American vessels and to ship in bond to U.S. markets. Their fleet, although mostly Canadian crewed, was partly American and partly Canadian registered, in proportion to the

³³ The early American halibut fleet was made up of both steamers and sailing schooners. Sailing schooners could be used by the Americans since their trip to the fishing grounds was mostly on the open ocean.

³⁴ As a result of the tariff the American fleet grew much more rapidly than the Canadian. A large proportion of the American catch was actually taken off the B.C. coast.

markets available in each country. The tariff was removed in 1913 with a consequent stimulation in the growth of the Canadian fleet.

After a period in which the market limited development, the resource now began to influence development. By 1910 nearby coastal fishing grounds, such as Hecate Strait, were depleted. To maintain landings, expansion to Alaskan waters was required. This was facilitated by technological changes in fishing vessels and methods, and by the opening of more northerly landing and processing points.

In 1912 and 1913, a number of innovations were adopted which allowed smaller vessels to fish profitably despite lower yields. Electric lights permitted fishing at night, powered anchor winches facilitated anchoring on the fishing grounds, and improved pilot house controls aided vessel manoeuvring. Most importantly, the powered gurdy for hauling the long lines was adopted, facilitating fishing directly from the vessel. This allowed more flexible setting of the gear, fishing in adverse weather, deeper fishing, and more rapid handling of the gear.³⁵ The steamer fleet, suitable for the period of fishing high densities of fish in shallow water, declined. By 1920 a new fleet of smaller vessels powered by internal combustion engines dominated the fishery.

A further improvement in the ability of the fleet to operate on distant fishing grounds was the adaptation of the diesel engine to marine propulsion, replacing the gasoline engine.³⁶ Thompson reports that a diesel was first installed in a halibut vessel in 1921 and was widely adopted by 1923. Operating costs and fuel requirements were reduced and vessel speed increased. Fishing was now feasible on new grounds in the western part of the Gulf of Alaska, allowing landings to be maintained even as existing grounds were depleted.³⁷ A further improvement in fish transportation was the adoption, starting in 1925, of supplementary mechanical refrigeration in fish holds to lower temperatures and conserve ice.

Completion of the Grand Trunk Pacific Railway to Prince Rupert in 1914 further encouraged the north-westerly extension of the fishery.³⁸ A northern railhead was now available, saving vessels fishing Alaskan waters

³⁵ The abandonment of dories also improved fishermen's safety.

³⁶ The first diesels were the heavy-duty low-speed type. Later, after 1945, high-speed diesels were adopted; they were lighter and smaller, increasing vessels' carrying capacity.

³⁷ Thompson and Freeman believe that this improvement in transportation technology was important in reducing opposition to the signing of a conservation treaty on halibut. Fishermen were no longer solely dependent on the eastern Gulf of Alaska banks, the banks most likely to be affected by conservation measures.

³⁸ A major cold storage plant was also constructed in Prince Rupert.

a two- or three-day trip to railheads at Vancouver and Seattle. Fishing time and vessel range could be extended. Most of the developing Canadian fleet was based in Prince Rupert. Landings at the port were further increased in 1915, when the Canadian government allowed American vessels and dealers to unload and ship halibut in bond, waived the duty on fuel, and allowed American vessels to take on ice, bait, fuel, and crews. In later years Prince Rupert also was a receiving point for packers with halibut from camps servicing small vessels fishing for halibut.

Other landing ports were opened in Alaska as fishing expanded north and west.³⁹ There was generally, however, a time lag between the extension of fishing and the establishment of ports near the grounds.⁴⁰ Canadian fishermen also landed at these American ports after this privilege was extended in 1918. As more landing points were established smaller boats entered the industry and the larger boats could unload and resume fishing more quickly. Transportation links such as the Alaska highway and the Alaska ferry system further facilitated the decentralization of landings. By 1975, 31.4 per cent of landings were in western Alaska and 23.7 per cent were in southeastern Alaska. Landings at these areas were then shipped south. Several smaller landing and provisioning points were also established in British Columbia.⁴¹

No conservation measures were in force in the early years of the fishery until the obvious and continuing depletion of the stock led to the signing of a treaty between Canada and the U.S. in 1923 and assumption of control of the fishery by the International Fisheries Commission in 1932.⁴² The fishing grounds were subdivided and opening dates and area quotas established. One effect of these regulations was an increased intensity of fishing as fishermen competed for the limited amount of fish available after the opening date. To offset this the fishermen voluntarily agreed to limits on the catch of each vessel, based on crew size, and to "lay-over" or refrain from fishing for a period between trips. For larger vessels the

³⁹ The first cold storage plant in Alaska was opened in 1907. After the steamer era most halibut boats were owned by individual fishermen, allowing them to land at the port of their choice.

⁴⁰ Dean discusses this point.

⁴¹ Among these were Namu, Klemtu, and Butedale on the central coast and Bull Harbour and Kildonan on Vancouver Island. They handled smaller boats, not equipped for the trip to a major port, later shipping the fish to Vancouver or Prince Rupert.

⁴² The Convention of 1923 was the first international agreement for the joint management of a marine fishery and was the first international agreement signed by Canada independent of Great Britain. The Commission was re-named the International Pacific Halibut Commission in 1953.

optimum point of landing was now changed. Since fishing time was not being lost, it became worthwhile to take advantage of higher prices at southern ports. The voluntary lay-over programme was discontinued in 1942, resulting, as the fleet expanded, in a drastic shortening of the fishing season and increasing pressure on fishermen to land at the nearest available port.⁴³ These tendencies were countered by changes in regulations in 1953 which further sub-divided areas and staggered opening dates and by the resumption of the voluntary lay-over programme in 1956.

With more of the fish landed in Alaska in a shorter season, an increasing proportion of halibut has been frozen. Fresh markets could not be serviced from the remote Alaskan ports, and freezing helped to avoid sharp price declines with a glut of landings. The frozen fish could be easily transported from the landing port to a port on the rail or highway network. Initially, freezing methods were crude and frozen fish were not widely accepted. However, technological improvements in freezing and storage, improvements in the distribution and retailing of frozen foods, and increased sales of pre-packaged frozen portions have encouraged and facilitated freezing. By 1939, 40 per cent of landings were frozen, and currently approximately 70 per cent of the Canadian catch is frozen.

Halibut landings reached a peak in the early 1960s with Canada taking about half of the catch. Unfortunately, trawling operations by other nations in the Gulf of Alaska and the Bering Sea began taking very large by-catches on halibut, even though they were primarily interested in other lower-valued species. Halibut stocks and catches declined dramatically. Foreign trawling was effectively limited in 1976 with the passage of extended jurisdiction legislation by both Canada and the United States establishing 200-mile fishing limits. Both the U.S. and Canada later prohibited the other's fishermen from fishing for halibut in their waters. This had a much more severe impact on Canadian fishermen since two-thirds of the Canadian catch since 1969 had come from Alaskan waters. Thus, the Canadian halibut fishery is now restricted to Canadian waters although catches can still be sold at American ports.

Perhaps more than any other, the halibut fishery has been shaped by the development of transportation capabilities. Completion of the trans-continental railways was a necessary prerequisite to the beginning of a stable commercial fishery. Without the link to eastern markets, fishermen were restricted to limited local and west coast markets. In the manual fishing era the design of the fishing vessels themselves was influenced by

⁴³ In 1952 there was only a thirty-six day season in the southeast Alaska-B.C. area and a seventy-seven day season in the western Alaska area.

the need to rapidly transport large volumes of fish to the railheads. With the depletion of nearby grounds, the successful adoption of mechanical fishing aids and the diesel engine allowed exploitation of distant grounds. The ability to freeze and store fish at the more remote ports and the transportation and distribution network developed for frozen fish has accommodated the concentration of fishing and landings in Alaska.

Herring

British Columbia herring have been used in a variety of forms, from low-valued oil and meal to an expensive luxury food using the roe or eggs. Herring have also been used fresh, salted, canned, pickled, and for bait. Each use has evolved because of changes in markets, transportation capabilities, resource availability, and government policy. Each use has required changes in production capabilities and transportation patterns. The species has often provided the largest volume of fish landed in British Columbia but has always ranked behind salmon in total value of landings.⁴⁴

Fishing for herring is normally done during the fall and winter. The adult fish move inshore at this time, spawning in the spring on or near the shoreline. Commercial fishing began in the late nineteenth century with catches being used for halibut bait and local food markets. Most fishing was done close to the markets, particularly Vancouver. A relatively small food fishery has continued to the present day, usually close to processing plants in order to deliver fish of suitable quality.

The first major export was for dry-salted herring. The market for this product was in the Orient and was initially developed in 1904, when reliable steamship service was available across the north Pacific, a route in which the cool weather encountered would help retard spoilage. Dry-salting is a simple operation, requiring only a minimal amount of equipment. Whole herring are mixed with salt in large tanks, cured for a week with occasional stirring, removed from tanks, drained, and packed with additional salt in 400-pound wooden boxes.⁴⁵ Preservation occurs through

⁴⁴ For the history of this fishery see Foodwest Resource Consultants, *The British Columbia Herring Industry* (Victoria: Marine Resources Branch, 1979), A. Hourston and C. Haegele, *Herring on Canada's Pacific Coast* (Ottawa: Canada Dept. of Fisheries and Oceans, 1980), A. Tester, *The Herring Fishery of British Columbia* (Ottawa: The Biological Board of Canada, 1935) and J. Wilen, *The British Columbia Roe Herring Industry* (Ottawa: Economic Council of Canada, 1981).

⁴⁵ Initially the product was packed in a variety of sizes. Only after regulations were imposed by the federal government was curing and packaging standardized. See Annual Report of the Fisheries Branch for 1922 (Canada Dept. of Marine and Fisheries, Ottawa: King's Printer 1923).

dehydration of the fish and permeation of the salt. By 1909, a catch of over 27,000 metric tons was being salted, mostly on the lower east coast of Vancouver Island and the adjacent islands. Gillnetting was the major fishing method. Seining came into extensive use in 1910, allowing increased landings. The fishing expanded to the west coast of Vancouver Island, and over 77,000 metric tons were salted each year between 1919 and 1929. However, political turmoil in the Orient, competition from salt fish produced in the Orient, low prices during the depression of the 1930s, a lack of orderly marketing, and the use of herring for other purposes caused a decline in the 1930s. Dry salting ceased during World War II and only small quantities were salted after 1945.

In an era before the development of the larger packer fleet with the capacity to rapidly transport large volumes of fish, the salteries were constructed close to the fishing grounds.⁴⁶ This ensured the freshness of the herring, a prime consideration in the quality of the product, and allowed simple methods of transporting the raw fish to be used.⁴⁷ Scows were the preferred method because of their ease of loading and unloading. In the more protected east coast of Vancouver Island fishery, well scows, which carried the fish in the hulls, were often used, while on the west coast of Vancouver Island deck scows, which carried the fish above the hulls, were used. The deck scows were then towed by tenders to the salteries. If scows were unavailable or if particularly adverse weather was expected, the fish could be loaded into the holds of the tenders or seine boats. Once the herring were salted and boxed, barges and coastal steamers were used to assemble the boxes at the major export ports.

The third phase of the herring industry was the reduction fishery. Reduction, a process by which the fish are broken down or "reduced" to meal and oil, was first permitted by the federal government in 1925 in response to an increased demand for fish meal and oil. The use of herring for reduction was restricted by quotas and was to be permitted only in areas where the fish were not extensively used for other purposes. The first fishing for reduction was in the Prince Rupert district. Fishing was later extended to the west coast of Vancouver Island, where the boats, equipment, and processing plants from the pilchard fishery could be used.⁴⁸

⁴⁶ A 1937 report (*Pacific Fisherman*, October 1937) stated that thirteen salteries were operating on the east coast of Vancouver Island and vicinity and five salteries on the west coast, even though dry-salting was in decline in this period.

⁴⁷ Tester states that regulations required that herring be in the salting tanks within twenty-four hours of being caught.

⁴⁸ Pilchards were fished in the summer and herring in the winter. In 1933 and 1939, with the failure of pilchards to appear, increased amounts of herring were allowed for reduction.

The use of herring for reduction offset the declining output of dry-salt herring during the 1930s. Throughout the 1930s and 1940s fishing expanded into new areas until, by 1950, all stocks were being exploited. Landings climbed to 100,000 metric tons by the 1937-38 season and remained at that level until 1948, after which herring fishing was predominantly for reduction. A record 240,000 metric tons were caught in 1962-63. Unfortunately, the resource could not support this large fishing mortality, and in 1967, after strong evidence of depletion, the fishery was closed.

Most reduction plants, aside from some established on the west coast of Vancouver Island for pilchards, were on the same sites as major salmon canneries. Supporting facilities and a labour force could be shared and salmon wastes or offal could be processed in the reduction plant. As canneries were consolidated, so were reduction plants, for many of the same reasons. Company mergers lowered the number of firms, technological improvements made the reduction process more capital-intensive, economies of scale became possible and necessary with the relatively low-valued outputs, and the ability of the industry to rapidly and reliably transport large volumes of raw fish increased with growth in the packer fleet and the use of larger seine vessels.⁴⁹

The herring packer fleet was mostly made up of the larger salmon packers. The opportunity to pack salmon in the summer and herring in the winter encouraged expansion of this fleet, particularly after 1945. At the same time the average size and carrying capacity of seine vessels increased as combination vessels for seining and longlining were built, fleet renewal took place with increasing attention to crew comfort, vessels were purchased from the depleted California sardine fishery, and federal government subsidies were offered for vessel construction. By the early 1960s the carrying capability of the average seiner had grown to such an extent that it was possible to operate the reduction fishery without most of the packer fleet.

With a low value-per-unit-of-weight product the reduction fishery was in a situation similar to other primary producers in B.C. — the costs of transporting the product to a market were crucial in determining the success of the industry. This was particularly true in the 1950s and 1960s, when reduction fisheries expanded in other parts of the world, increasing competition in the important U.S. market. According to Deutsch et al.,

⁴⁹ The addition of waste water or "stickwater" evaporators to increase recovery rates and reduce pollution was one of the major capital improvements.

the herring reduction fishery was the fishing industry most affected by increases in railway freight rates after 1945.⁵⁰

Superimposed on both the dry-salt and reduction fisheries was a canned herring fishery. British Columbia canned herring normally found it difficult to compete with canned fish of similar species from other areas because of higher production and transportation costs, except during wartime when many competitive fishing areas were closed. During World War I, up to two-thirds of the landings were used for food, with large canned packs from 1915 to 1919. Smaller packs are reported in the 1920s and 1930s until World War II, when very large packs were again made, usually at the larger canneries. Canned herring was also produced in the immediate post-war years for relief organizations.

The current phase of the herring fishery, that for herring eggs or roe, began in 1971. Japan removed its import restrictions on foreign herring roe products and, the resource having been rebuilt, limited fishing was allowed. The fishery for this luxury product turned out to be extremely lucrative and quickly attracted many participants. Since the objective of fishing is the herring roe or eggs, fishing only occurs during the spawning period.⁵¹ Despite the concentrated fishing, more than adequate packing capacity is available on tenders and seiners.⁵² Refrigerated sea water systems have also proven useful here by preserving the quality of the roe during transport. Processors, to avoid gluts during the short fishing season, freeze much of the herring for processing at a later date. Processing, a relatively simple operation, consists of brining, grading, and packaging. The roe is exported to Japan as a bulk, semi-processed product where the final grading, bleaching, and packaging take place. The use of cold storage facilities, the adaptability of existing processing facilities for herring roe, and the large raw fish transporting capacity have all encouraged the concentration of processing in the lower mainland and Prince Rupert areas.

Throughout its varied history the herring fishery has been shaped by transportation. Fishing for food herring has been restricted to areas close to markets or processing points to ensure freshness, salteries were located near fishing grounds partly because of a lack of transportation capacity, the large-scale post-1945 reduction fishery was only possible with the

⁵⁰ J. Deutsch et al., *Economics of Primary Production in British Columbia* (Vancouver: University of British Columbia, 1959).

⁵¹ Fishing is timed to coincide with the maximum level of roe in the female herring. Openings for fishing are usually short, occasionally only fifteen minutes. Spawning occurs at different times at various locations on the coast within a six-week period.

⁵² In fact there is a serious over-capacity problem.

ability to transport large volumes of raw fish, and the concentrated roe fishery is facilitated by the large fleet of seiners and packers.

Pilchards

Pilchards were a major fishery on the west coast of Vancouver Island between 1925 and 1945.⁵³ Pilchards are older Pacific sardines which migrate north to British Columbia in the summer. A large fishery was carried on in California and smaller catches made in Washington and Oregon. The species was first exploited in B.C. in 1917 with a small canned pack. However, the canned product only found limited markets due to competition from canned fish of similar species. Pilchards were not suitable for salting or fresh markets.

Thus, it was only in 1925 after the federal government removed its prohibition on reduction of the fish to meal and oil that the industry could expand. Both the technology for reduction and markets for fish meal and oil had been developed in the United States. Optimism prevailed and expansion was rapid.⁵⁴ By June 1926 fifteen reduction plants were established, and by 1929 twenty-nine plants had been built. Landings increased from 1,240 metric tons to 78,310 metric tons in 1929.

The plants were all built in close proximity to the fishing grounds on the west coast of Vancouver Island, from Barkley Sound in the south to Quatsino Sound in the north. Transportation costs were clearly an important determinant of the location of these plants. Moving the output of the reduction process, meal and oil, was easier than moving the raw fish. The meal and oil could be stored and moved when convenient, while large volumes of perishable fish were only available during a short three-month fishing season. Furthermore, the capacity to transport the raw fish any distance was not available, while the fish meal and oil could be moved by coastal freighter.⁵⁵ Initially some difficulty in providing adequate transportation for the industry occurred, but a 1926 report indicated that sev-

⁵³ The best historical accounts of this fishery are in J. Hart, *The Pilchard Fishery of British Columbia* (Ottawa: The Biological Board of Canada, 1933) and various issues of *Pacific Fisherman*.

⁵⁴ The 1925 report of the B.C. Commissioner of Fisheries (Victoria: King's Printer, 1926) captured the optimism of the industry but warned of the uncertainty involved: "Investors claiming to have made exhaustive investigations as to the supply of pilchards in the open sea of the Vancouver Island coast express the opinion that the supply is virtually inexhaustible. Their investments express their confidence. The pilchards of the west coast are pelagic spawners and little of their life-history is known."

⁵⁵ The pilchard industry operated before large packer fleets were available.

eral steamships were having pilchard oil tanks installed and would be making more frequent trips to the west coast of Vancouver Island.⁵⁶ An additional locational consideration was that the reduction plants could often be attached to already established salmon canneries and share support facilities and a labour force.

Fishing was initially carried out by small seiners in the inlets. By 1928, however, increased pressure on the resource meant that fishing in unprotected areas on the open ocean was necessary. This required the construction of a number of large seine vessels and tenders for harvesting and transporting the fish to the processing plants. Some of these vessels were among the first to be equipped with radio-telephones.

Landings declined after 1929. Prices for meal and oil fell during the depression of the 1930s, several companies failed, the United States increased its tariff on oil in 1934, and the fish failed to appear in their usual numbers in 1933 and 1939. World War II, with its increased demand for food, saw a large output of canned pilchards and a temporary increase in landings. After 1945, however, production dropped precipitously due to a lack of fish, and by 1948 pilchards were no longer present in commercial quantities. It is generally agreed that over-fishing, particularly in California, from the late 1920s to the late 1940s was responsible for the decline in landings.⁵⁷

Conclusions

Obviously, as with all regional export industries, the development of the British Columbia fishing industry would not have been possible without the ability to move its finished products to markets. Less obviously, but just as critical to development, was the industry's ability to move its essential input, raw fish, from the fishing grounds through processing to a point of export. The specific fisheries discussed here illustrate a variety of solutions to these two transportation linkages necessary for a viable industry.

No single conclusion, however, can be drawn about the impacts of transportation costs and technology on a fishery. For salmon, transportation improvements encouraged centralization of processing while, for halibut, developments in transportation technology facilitated decentralization of processing. Without diminishing the role of transport, it should

⁵⁶ *Pacific Fisherman*, June 1926.

⁵⁷ See M. Culley, *The Pilchard, Biology and Exploitation* (Oxford: Pergamon Press, 1971) for a discussion of the evidence on over-fishing.

be remembered that varying patterns of development are also a function of other economic, biological, social, and political influences. What is common is that, however the pattern of industry development and transportation linkages evolves, the transport facilities and technology had to be available at a cost sufficient to allow the industry to compete in its external markets.

Established freight rates and carriers were used to export the processed fish. Since processed fish is normally a relatively low-bulk, high-value commodity, no export routes or facilities were ever specifically established for the industry, although the movement of fish products was certainly welcome business. This meant that development could not proceed before the necessary transportation links were completed. For example, Pacific halibut, although known to be abundant, could only be sold in the eastern North American market after the completion of transcontinental railways.

Internal industry transportation presented a variety of problems. In most cases technology developed elsewhere was adopted. Only in the cases of refrigerated and chilled sea water can the B.C. industry be said to be an innovator.

Fishing industries are usually classified as resource, as opposed to market, oriented. Fish processing and preservation can never stray too far from the ocean. The degree or intensity of resource orientation, however, can vary, as has been discussed here. Early salmon canneries were located as close as possible to the fishing grounds, while halibut fishermen have fished in the Bering Sea and unloaded in Vancouver. The critical determinants of these developments were transportation costs and technology. When feasible, fish harvesting and fish processing can be separated by a considerable distance.

Although the improvements in transportation technology discussed here have certainly helped the industry maintain output and remain competitive, they have not always had the effects on the efficiency of the industry that might be expected. The reason is the common property or open access nature of the resource. While an innovation such as the marine diesel engine may lower costs for an individual fisherman, it will not necessarily lower total industry costs. Lower costs initially increase net incomes. This attracts more vessels and fishermen, eventually raising the total cost of harvesting the resource to the previous level. Any economic rent which emerges because of cost-saving transportation technology, if not captured by a public authority through increased fees or taxes, simply looks like excess profits to potential entrants, encouraging them to enter the industry.