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The 1989 Canadian Fishery For Silver Hake

V. Bradshaw[1], D. Waldron[1], M. Showell[1], K. Spencer[2], P. Noseworthy[3], J. Raymond[4], G. Scott[4] and D. Lemon[1]

1. Department of Fisheries and Oceans, Halifax, N.S.
2. Canadian Institute of Fisheries Technology, Halifax, N.S.
3. Tavel Ltd., Dartmouth, N.S.
4. Nova Scotia Department of Fisheries, Halifax, N.S.

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THE 1989 CANADIAN FISHERY FOR SILVER HAKE

by

V. Bradshaw[1], D. Waldron[1], M. Showell[1],
K. Spencer[2], P. Norsworthy[3], J. Raymond[4],
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1. Department of Fisheries and Oceans, Halifax, N. S.
2. Canadian Institute of Fisheries Technology, Halifax, N.S.
3. Tavel Ltd., Dartmouth, N. S.
4. Nova Scotia Department of Fisheries, Halifax, N. S.

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ABSTRACT

Bradshaw, V., D. Waldron, M. Showell, K. Spencer, P. Norsworthy, J. Raymond, G. Scott and D. Lemon. 1990. The 1989 Canadian fishery for silver hake. Can. Ind. Rep. Fish. Aquat. Sci. No. 203: viii + 37 p.p. + 5 Appendices.

Since the 1970's, the government of Canada and the government of the Province of Nova Scotia have been attempting to develop a domestic silver hake fishery. Silver hake (Merluccius bilinearis) is a gadoid species, as are cod and haddock; however, it is a much smaller fish. Until recently, stocks of the larger gadoids were sufficient to keep the Canadian groundfish industry well supplied. This report briefly summarizes our past efforts to develop the silver hake fishery and also presents a detailed account of the 1989 projects involving harvesting, processing and marketing of Canadian silver hake. Background information on foreign vessel fisheries for silver hake in Canadian waters and on the U.S.A. fishery for silver hake is also provided. Data on catches, harvesting effort, size frequency distributions of the catch and bycatch, vessel and gear information, fish plant production information and surimi trials are presented in the main text and in a series of Appendices. The report concludes with a series of 12 recommendations in the areas of silver hake harvesting, processing, marketing and policy.

ACKNOWLEDGEMENTS

On behalf of the Department of Fisheries and Oceans and the Nova Scotia Department of Fisheries, we wish to express our sincere appreciation to all of those who contributed their time, staff, expertise and equipment to the 1989 silver hake projects described in this report.

First and foremost, we wish to thank the Nova Scotia Dragger Fishermen's Association and the vessel Captains and crews who harvested the silver hake: Greg Morrell, Daniel LeBlanc, Julien LeBlanc and the crews of their vessels, the Ocean Swell, the Cape Mariner and the Sylvia Lynn II, for their efforts, perseverance and bravery, especially in the face of severe offshore weather conditions. We also wish to extend our sincere thanks to: the Captains and crews of the vessels from the Maritime Fishermen's Union who participated — Joey Nickerson, Brayton Nickerson, Dick Fevens, Bobby Amirault, the crews of Patches I, Jeremy and Sisters, Jasamin's Pride, and the Bayliner; Captain Raymond Deveau and crew of the Island Princess for their voluntary and successful experimental trip to harvest silver hake; Clifford Hood, Brian Giroux and John Davis for their assistance with the contractual arrangements; Marr Seafoods (Canada and U.K.) for its participation and assistance with the harvesting and contractual arrangements - especially Richard Lander and Harry Harrison; the Captains and crews of the participating Soviet vessels, the Ambarchik and the Leningradskya Pravda, for their patience and assistance to the Canadian fishermen; and Vladimir Fedorenko for his guidance during joint meetings with the Soviets and Canadians involved in the fishery.

Special thanks go to Karlsen's Shipping Company Ltd. and staff of the New Harbour fish plant for their co-operation and enthusiasm before, during and after the processing trials. Martin Karlsen, George Myra, and Lapean Awalt are especially thanked for their help with arrangements, logistical and contractual, in this regard.

We also extend our appreciation to the following contributors: Innovac Technology Inc. for their co-operation and use of the portable Transvac fish pump, with special thanks to Mr. D. Judge and his able staff for all their help which was generously volunteered; Fisheries Resource Development Ltd. (a Division of National Sea Products) for the loan of a demonstration fish washer and fish boxes; Fishmore for their help and advice regarding the use of their scales and efforts toward the development of a heading and gutting machine; and ABCO Industries for quickly responding to our request for modifications and repairs to the processing equipment and line.

Very special thanks go to Baader Canada Ltd. and their parent company, Nordischer Maschinenbau Rud. Baader GMBH and Company KG. Baader management in Germany and in North America showed great enthusiasm for the project and were good enough to lend a 182-filleting machine and associated equipment for processing trials. This machine represents the state-of-the-art in mechanized fish processing equipment. The

firms also provided valuable technical advice and the services of one of their engineers, Lothar Werkmuller. Mr. Werkmuller (Baader, Germany) took part in the processing trials in Nova Scotia and his expertise was greatly appreciated. Mr. Austin Kerr, Vice President Baader Canada Ltd., and Mr. Dietrich H. Moeller, Sales Manager of Baader GMBH were extremely helpful and went out of their way to make the project work.

The Captain and crew of the Japanese surimi research vessel Shinkai Maru and the Directors of the Japanese Marine Fishery Resource Research Center are thanked for their hospitality to Canadian visitors and observers aboard their research vessels and for their willingness to share their experimental silver hake harvesting and surimi production results. Yoshifumi Wada is thanked in this regard for his assistance with these arrangements.

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1.0 Introduction

In the last decade the federal and provincial government and the Scotia-Fundy fishing industry have been attempting to develop a domestic silver hake fishery. Throughout and proceeding this period, only foreign vessels were directing for the species on a commercial basis. Silver hake is a gadoid species, as are cod and haddock, however, it is a smaller type of fish. It is caught using small mesh gear (60 mm) and the directed fishery for this species is restricted to seaward of the small mesh gear line in what is known as the Silver Hake Box (Figure 1). The simplest explanation for this difference in approach to silver hake is that Canadian effort has developed around the larger gadoids, i.e. cod and haddock, and sufficient stocks of these "traditional" species have been available, until recently, to keep the Canadian groundfish industry well supplied. There was insufficient motivation to invest in modifying our harvesting and processing equipment and practices such that silver hake could be fished and handled profitably, and markets were not developed.

However, the situation with the traditional species groundfishery has recently changed for the worse and Canadians must seriously direct more effort to the development of a domestic silver hake fishery. This report briefly summarizes our past efforts to do so, then presents a detailed account of our most recent (i.e. 1989) attempt to harvest, process and market Canadian silver hake. A few paragraphs on the biology and distribution of silver hake or "whiting" (Merluccius bilinearis) and some background on the foreign silver hake fishery are also provided.

2.0 Biology and Distribution of Silver Hake

There are five species of Merluccius present in the western Atlantic, two of which occur off of Nova Scotia, Newfoundland and New England - M. bilinearis (silver hake) and the somewhat larger and relatively scarce M. albidus (white or offshore hake).

Silver hake constitutes the largest biomass of a single gadoid species that we have in the waters off of Scotia-Fundy. It is a deepwater species which has a temperature range of 1-13°C with a preferred range between 7°C and 10°C (Scott, 1982). The average winter bottom temperature on the Scotian Shelf is between 1 and 6°C. In winter, part of the silver hake population is found in the deep basins of the Scotian Shelf (Waldron, 1983) and the Gulf of Maine (Almeida, 1985) where temperature range from 4-8°C. The major portion of the silver hake stock resides in the deeper slope waters off Nova Scotia and the northeast coast of the USA in the deep basins and channels of the Gulf of Maine (Almeida, 1985 and Waldron et al., 1982)[1]

During the summer, the major portion of the population (42%) is found in waters from 100 - 149 m. Silver hake are seldom present (<1%) in waters deeper than 200m while 11.5% are in waters shallower than 50m during the summer months. Figure 2 depicts the Spring and Fall distribution of Scotian Shelf silver hake.

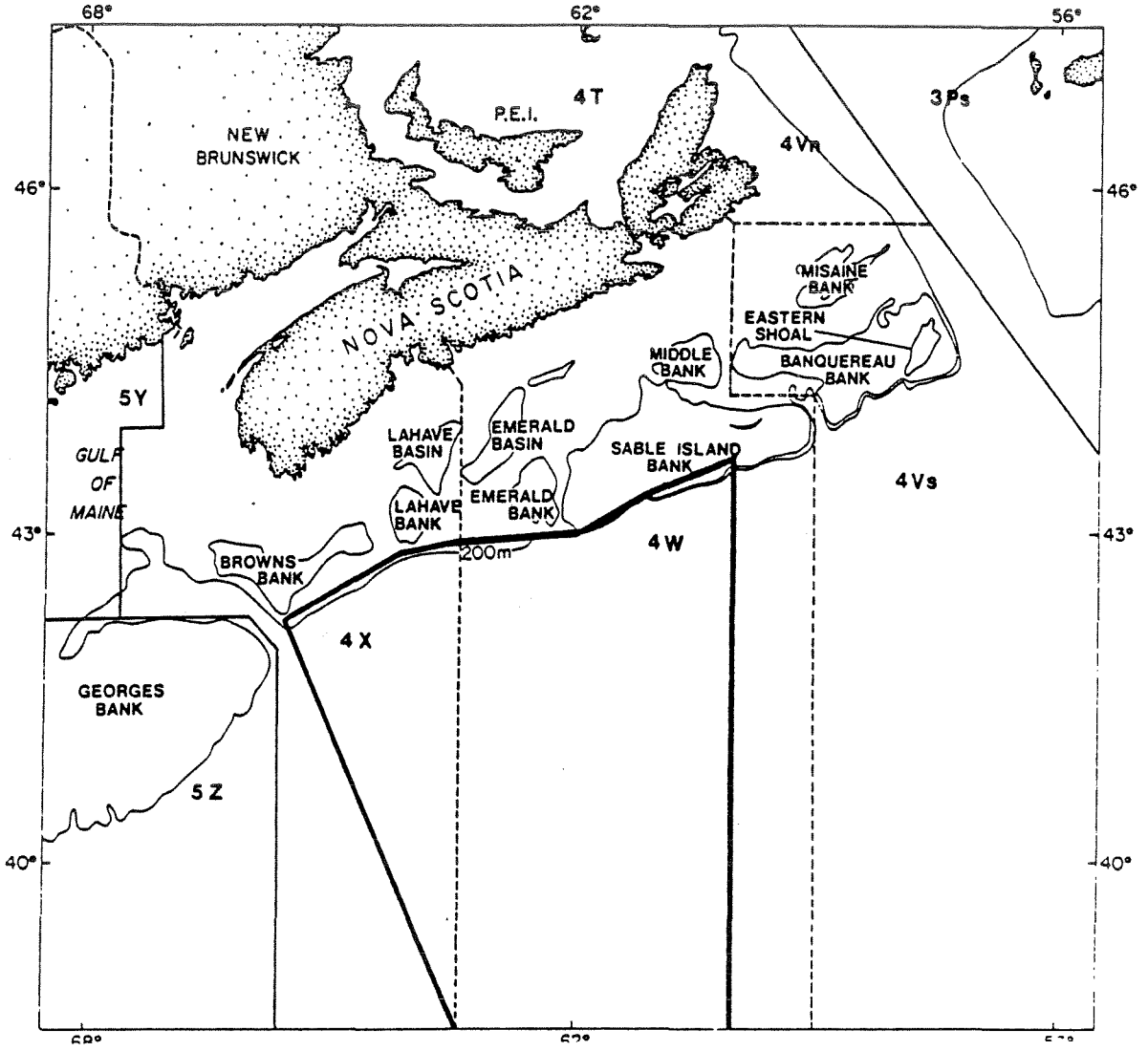
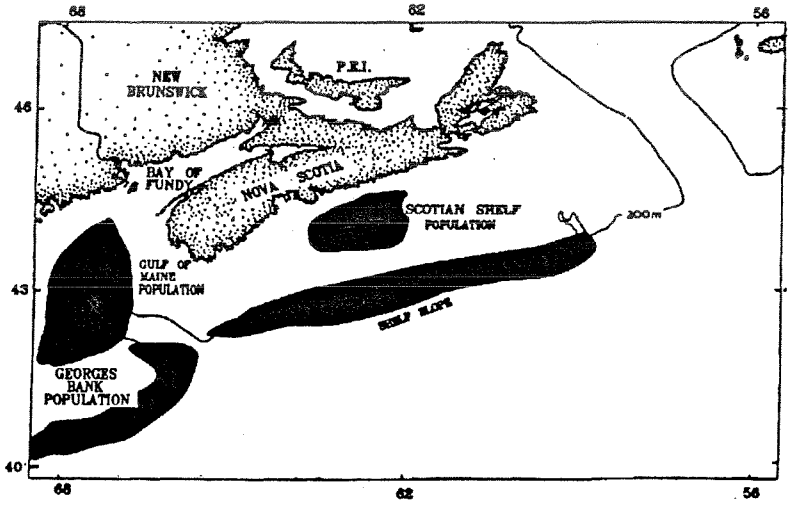
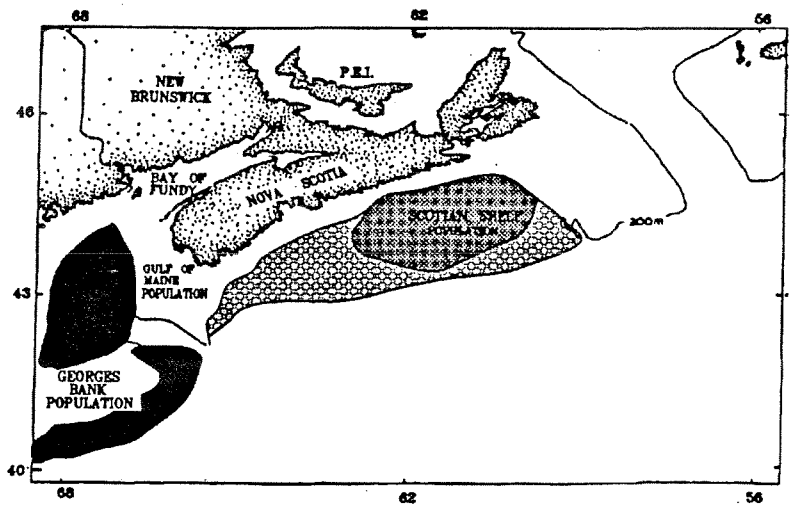


Figure 1

The Silver Hake Box and the Small Mesh Gear Line



Spring



Fall

Figure 2

Spring and Fall distribution of Scotian Shelf silver hake.

3.0 History of Silver Hake Management and Foreign Fishing

Management began in 1958 (ICNAF)*, but quotas and stock boundaries were not imposed until 1973/74. Four stocks, as "Management Units" have been defined as a result of biological studies by Soviet, American and Canadian researchers:[2]

1.	The Scotian Shelf stock	(4VWX)
2.	The Gulf of Maine stock	(5Y)
3.	The Georges Bank stock, and	(5Ze)
4.	The Southern New England - Middle Atlantic stock	(5Zw and 6)

Since 1977, these stocks have been managed separately by Canada and the United States.

3.1 The Small Mesh Gear Line

The first active silver hake fishery in Canadian waters began in 1961 with the arrival of the Soviet fishing fleet. Historically, the fishery operated from March to early October with minimal catches occurring earlier and later in the year. The most active fishing areas were the slope waters of the Emerald and Sable Island Banks. However, concern over the low levels of certain fish stocks, particularly haddock, on the Scotian Shelf prompted ICNAF in 1976 to review the distribution of the silver hake fishery in relation to other groundfish. Of the three areas actively fished for silver hake, the one along the edge of the Scotian Shelf appeared to have the least overlap of distribution with other commercial groundfish species.

To allow fishing for silver hake, but avoid haddock by-catch problems, particularly in the winter when the haddock were aggregated in deeper waters in spawning-related concentrations, it was decided that certain areas had to be protected from November to March/April, up to depths of 155m. The result of this concern was an ICNAF regulatory proposal to restrict silver hake fishing on the Scotian Shelf, using small mesh gear (60mm), to the area south and east of a bathymetric contour along the Shelf's edge, during the time period of April 15 - November 15 each year. This line became known as the Small Mesh Gear Line (SMGL) (Figure 1). When Canada declared a 200 mile Economic Management Zone in 1977, the ICNAF recommendations for the silver hake fishery were accepted and codified in the Canadian Foreign Fishing Regulations. In addition, regulations were introduced to increase the trawl cod-end mesh size from 40mm to 60mm and limit the by-catch of haddock to less than 1%. Other important commercial species were restricted to a by-catch less than 10% of the total weight aboard the vessel.

3.2 Foreign Fleet and Catch Statistics

Historical data on foreign catches of silver hake in Canadian waters are shown in Table 1. The data show that Soviet fleets have successfully exploited the silver hake stock in NAFO Region 4 (i.e. 4VWX) for more than 25 years. Cuba is a relative newcomer, but their

*International Commission for the Northwest Atlantic Fisheries

Table 1

Foreign Fishery Statistics

Annual Catches of Silver Hake - NAFO Region 4

	Total Catch (m.t.)	Cuba Catch (m.t.)	USSR Catch (m.t.)
1958	38		
1959	2,000		
1960	187		
1961	2		
1962	8,854		8,825
1963	123,028		123,023
1964	81,147		81,147
1965	50,022		49,987
1966	10,323		10,323
1967	2,477		2,476
1968	3,471		3,441
1969	46,323		46,323
1970	169,045		168,916
1971	128,657		128,633
1972	114,048		113,774
1973	298,621		298,533
1974	95,745		95,371
1975	116,286		112,566
1976	97,184		81,216
1977	34,650	1,863	32,088
1978	48,547	3,477	43,907
1979	51,306	1,769	44,909
1980	42,532	2,280	39,491
1981	39,351	651	38,699
1982	59,066	11,973	46,159
1983	34,259	7,488	25,768
1984	73,288	14,504	56,448
1985	76,017	17,682	56,866
1986	82,635	16,041	66,531
1987	60,978	20,217	40,616
1988	74,458	8,993	65,465
1989	86,437	14,451	71,986

Notes: 1. Figures for 1987-89 are preliminary
2. Experimental fishing by the Japanese fisheries research vessel, Shinkai Maru, was conducted in April 1989; catch was 193 mt.

Sources: i) As reported by foreign vessels to ICNAF (1958 - 1976)
ii) As reported by foreign vessels to DFO Quota Monitoring (1977 - 1989)

catching ability has improved, as well as their allocations, from <5% to approximately 20% of the foreign effort. The Soviet fleet has consistently caught the lion's share of the catch. In 1973, the USSR catch was almost 300,000 mt; this was at a time when Soviet fishing vessels were permitted to fish on the Scotian Shelf itself.

The foreign fleet consists of factory freezer trawlers (FFT's) in the 100 m LOA (length-over-all) range. A comparison with the Canadian vessels used in 1989's experimental fishery is given in Table 2. Table 3 lists the specifications for trawls in use by the Soviets (as well as those used by American and Canadian vessels directing for silver hake).

The foreign catch in the silver hake box normally is very "clean" (low by-catch, <5%) due to the high biomass and schooling nature of silver hake at that time in that location. The Soviet and Cuban vessels essentially limit on-board processing to frozen headed and gutted fish (H&G), fishmeal and whole fish blocks. However, the quality of the gutted Cuban product is not high in terms of the amount of gut removed. Some canning of the fish is done ashore later. They appear to sell primarily to their own domestic markets with a small portion also going to other markets for hard currency.[3] Due to their high catch rates and low production costs, the flesh cost of silver hake is low for the foreign fleet and the species is profitable to fish for the foreign FFT's.

In April of 1989, a Japanese research vessel was permitted to fish for silver hake in Canadian waters for the first time. These fishermen were reasonably successful in catching the fish considering it was their first attempt and they were only here one week. They were somewhat disappointed that their daily catches were not as high as the Soviets'.

3.3 The United States Fishery for Silver Hake

There also has been an active commercial "whiting" (silver hake) fishery in the U.S. by American vessels since the 1930's and foreign (Soviet) fleets began catching silver hake on Georges Bank in 1962.[4] However, in recent years foreign vessels have been permitted to fish for silver hake in U.S. waters only on condition that "linkages" to direct benefits for U.S. vessels and processors existed. American vessels have usually been small wetfish trawlers fishing for the frozen product and the U.S. fresh fish market. (Some of this catch also reaches our fresh fish markets in Toronto and Montreal). Table 2 includes vessel specifications for the two boat types used in the New England-based American silver hake fishery. One of the trawl types used by American vessels fishing for hake is described in Table 3. The foreign vessels fishing for silver hake in American waters have primarily been the same types as those used in Canadian waters.

Table 2

Silver Hake Fisheries

Vessel Comparisons

	Canada 60' - 65' Wetfish Bottom Trawl	USSR Bottom Trawl	Cuban RIO Class Bottom Trawl	USA Bottom Trawl	
				Group 1	Group 2
Length (ft)	60 - 65	280	348	35 - 50	80 - 90
Tonnage	80 - 100	2000 - 3000	4000	50	100 - 120
Horsepower	500	2000 - 2400	3000 - 4000	-	450 - 650
Capacity (m.t.)	50	700	1000	-	120 - 150
Trawling Speed (knots)	3.5	4.0	4.0	2.5 - 3.0	3 - 4
Sea Days Per Trip	2 - 4	60 - 90	45 - 60	1 day	3 - 4 days
Crew	3 - 4	100	100	-	3 - 4
Fishing Area (NAFO)	4	4	4	5 & 6	5 & 6
Average Depth (approx.)	> 200 m	> 200 m	> 200 m	$\sim$ 25 m	-

Note: Adapted from Exhibit 1.3 in "Report on Experimental Silver Hake fishery, Scotia Fundy 1987" by Tavel Consultants, submitted to the Silver Hake Experimental Fishery Steering Committee, January 1, 1988.

TABLE 3

Silver Hake Fisheries - Trawl Comparisons

Trawl Specifications	Trawl Types				
	Trawl #2283 (Soviet)	Hake 4M (Soviet)	Shuman 444 x 16 (USA)	Shuman 360 x 16 (USA)	Gourock 440 Tristar (Canada)
Headrope Length (meters)	41.7	28	34.5	29.6	27.1
Footrope Length (meters)	43.6	24	41.6	38.8	35.5
Perimeter of Mouth of Trawl (meters)	79.2	-	65.0	55.7	-
Horizontal Opening (meters)	24-26	-	20.8	19.4	15.2
Vertical Opening (meters)	7.0-6.2	6.7	5.5	4.6	9.1
Twine Surface Area (square meters)	-	-	69.9	50.4	70
Suggested Towing Speed (knots)	3.0-4.5	4.0-.4.5	3.5-4.0	3.5-4.0	3.0
Weight of Trawl - excluding cod-end and doors (kg)	342.7	-	400	390	400

Note: Table adapted from Table 12 in "The Silver Hake Fishery on the Scotian Shelf 1982-86", Observer Program, Scotia-Fundy Region, Department of Fisheries and Oceans, circa 1987.

Most of the American fishery takes place close to shore in the Gulf of Maine, or along the New England coastline (~3 miles from shore) but there is also a scientifically monitored fishery located on the American side of Georges Bank (Cultivator Shoals). These are both shallow water fisheries compared to the Canadian fishery. In 1965, the Soviet catch in U.S. waters was almost 300,000 mt as it was in Canada in 1973.[5] This compares with a 1965 USA domestic catch of 29,000 mt. Since that time, however, both the foreign and domestic catches in U.S. waters have decreased substantially. The total commercial silver hake catch (domestic and foreign) in American waters in 1988 was 15,800 mt and for the first part of 1989 (January - May) it was 6,500 mt.[6]

An experimental commercial fishery is being conducted by the Americans on Georges Bank, and is in its second year. It employs domestic vessels, some with technicians on board, to collect information on the fishery in a scientific manner. In 1988 (July - October), a total of 2,270 mt were caught with a by-catch of regulated species (white hake and cod) of 1.4% and a combined by-catch of other non-regulated species, including discards, of 24%. The overall discard rate was 18.2% and the primary species discarded were red hake, skate, squid, herring and dogfish. The average length of the silver hake caught was 28.95 cm.[7]

4.0 Background on Previous Canadian Efforts to Develop a Silver Hake Fishery

Canadian fisheries development efforts for silver hake can be traced back for almost 20 years. In the early and mid-1970's, efforts to harvest the fish were made using 120 - 130' domestic vessels, but the economics dictated against further development at that time. Research was also conducted into the handling requirements and storage stability of the fish. These studies showed that the susceptibility of silver hake to deterioration (at -10°C) is similar to cusk, is slower than red hake, but faster than cod and haddock. At -26°C storage, negligible deterioration occurred even when stored for up to six months.[8]

In 1987, an experimental harvesting/processing project was conducted using one 65' dragger, outfitted with redfish gear, and a consortium of processors, known as Seafreeze. Due to time delays and some gear problems, only 800 lbs. of silver hake were caught. In addition, a Cuban factory freezer trawler was chartered and 175 mt were landed in late August at Shelburne, N.S. for reprocessing. However, the silver hake as received from the Cubans did not stand up very well to reprocessing.[9]

In 1988, a second experimental fishery was conducted using two 65' draggers who planned to sell over-the-side (OSS *) to a Soviet processing vessel. The Canadian draggers were rigged with U.S.A. trawls used for silver hake, (see "Shuman Trawls" in Table 3) rather than the redfish gear used in 1987.

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*Over-the-side sales (OSS) to foreign vessels arranged through a Canadian "foreign partner" as intermediary constitute a type of "joint-venture".

They were also equipped with joint-venture cod-ends to enable them to sell their catch over-the-side to the Soviet vessel (via a foreign partner) through cod-end transfers. A total of 45 mt were caught of which 37 mt were transferred to the Soviet vessel. There was a negligible by-catch, but fishing by the Canadian vessels ended early because it became apparent that the trawls were not fishing effectively. Subsequently, flume tank tests on one of the trawls revealed the likely problem (the cod-ends had not been attached to the trawl bellies properly), but damage to the nets during the gear trials which followed on the Scotian Shelf brought an end to the 1988 harvesting attempt.

In addition to this experimental fishery using inshore vessels, an offshore quota of silver hake was set aside for developmental purposes to enable the offshore sector to establish a Canadian presence in this fishery. The criteria for the offshore proposals and for allowing joint ventures with foreign partners were not approved until close to the start of the spring fishery. Because of this and because certain proposals simply did not meet the criteria, no offshore project went ahead in 1988.

5.0 The 1989 Foreign Fishery for Silver Hake in Canadian Waters

The 1989 Scotia-Fundy Management Plan set the TAC for the Scotian Shelf stock at 135,000 mt. Of this, 90,000 mt were allocated to the foreign fleets.

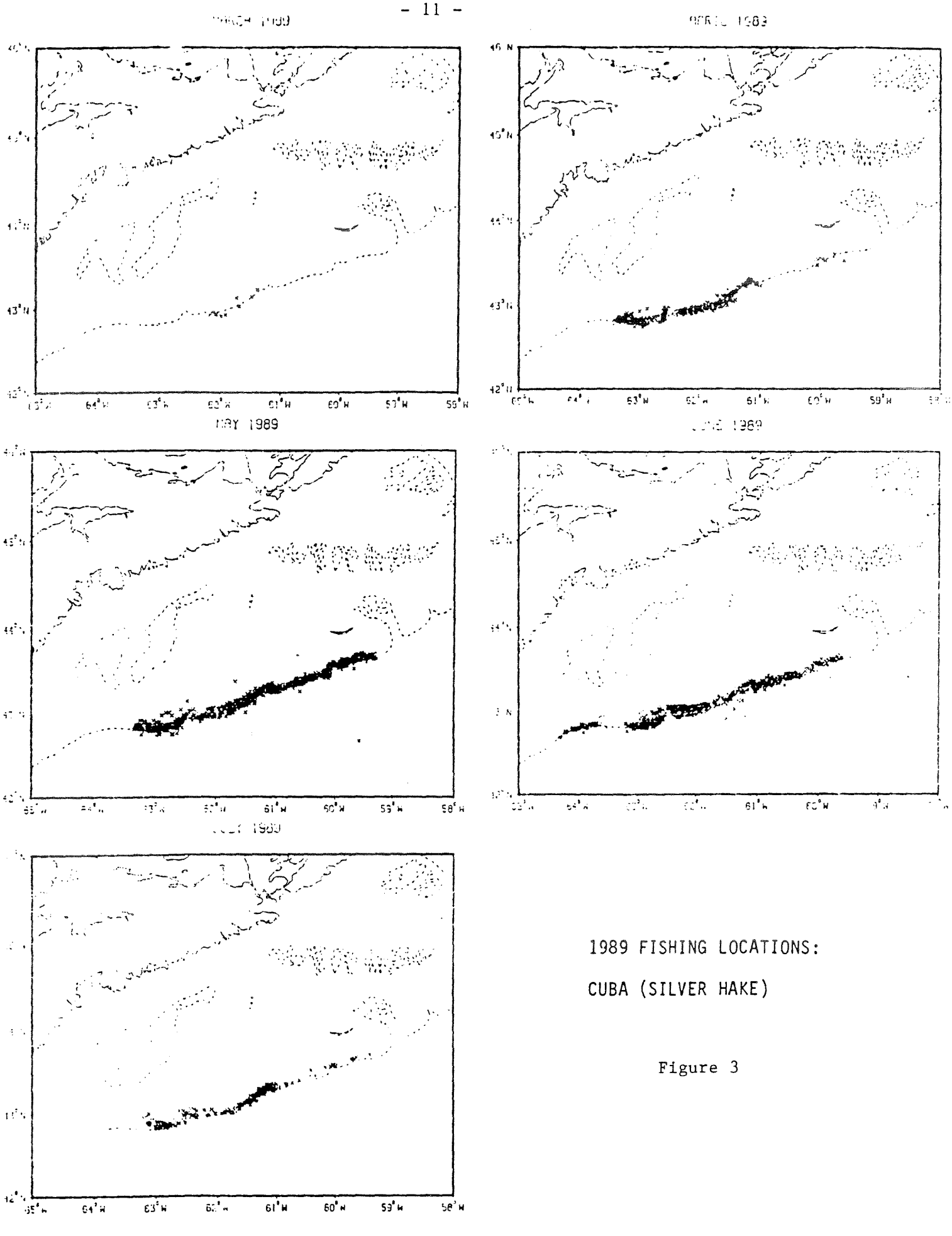
The foreign fishery began on March 15 with 2 Cuban and 2 Soviet vessels operating under an experimental permit. The normal fishing season began on April 1 and lasted until the end of July, 1989. In total, there were 9 Cuban and 43 Soviet fishing vessels active during the fishery.

The fishery began in the vicinity of Dawson Canyon and spread from there over the duration of the fishery. The largest concentration of vessels was around both the Verril and Dawson Canyons throughout the fishery. Figures 3 and 4 show the foreign fishing locations in the 1989 silver hake fishery.

The total catch of silver hake by the foreign fleets was 85,752 mt. Over 50% of their 1989 silver hake catch was taken by the middle of May. By the end of June, the total catch of silver hake was levelling off. Additional effort expended by the fleets resulted in minimal catch, as illustrated in Figures 5 and 6.

The data for the 1989 foreign silver hake catch, by-catch and hours fished (effort) are tabled in Appendix II. As in previous years, the USSR fleet accounted for the bulk of the foreign catch and effort. Catch per unit effort (CPUE) peaked in March at nearly 18 tons per hour for the Soviet fleet and 12 tons per hour for the Cuban fleet. Peak catch rates were observed in mid-April and early July; overall, they systematically declined from March until the end of the fishery in August.

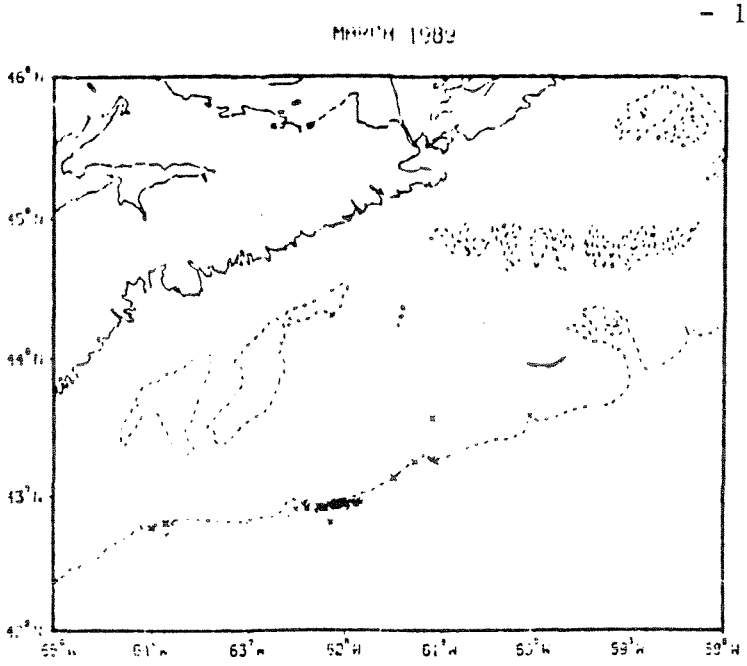
Since 1987 there has been 100% Observer coverage on all foreign fleets off Nova Scotia. Data on catches and by-catches collected by the Observers are currently incorporated in both the 4TVW Haddock and 4VsW Cod assessments. Weekly by-catch data for 1989 suggests that by-catch increased as the availability of silver hake decreased. The by-catch of haddock in the Cuban

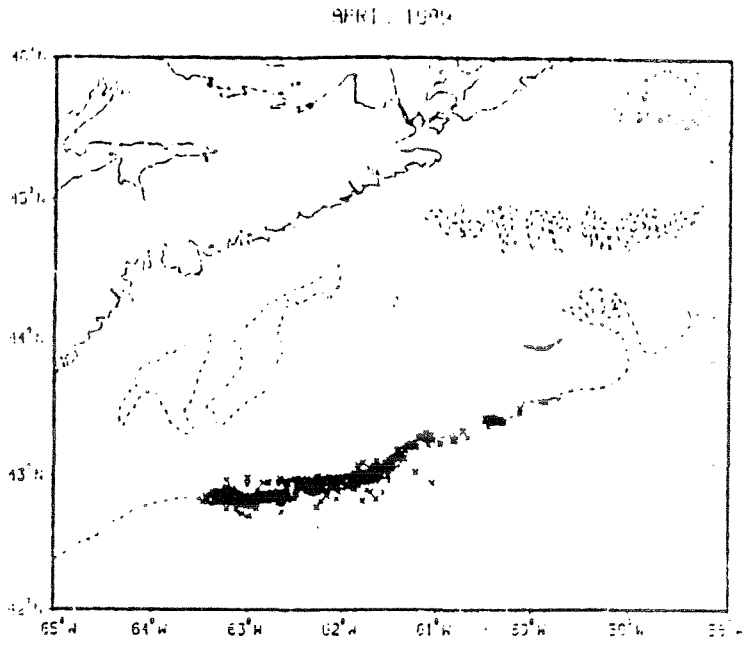


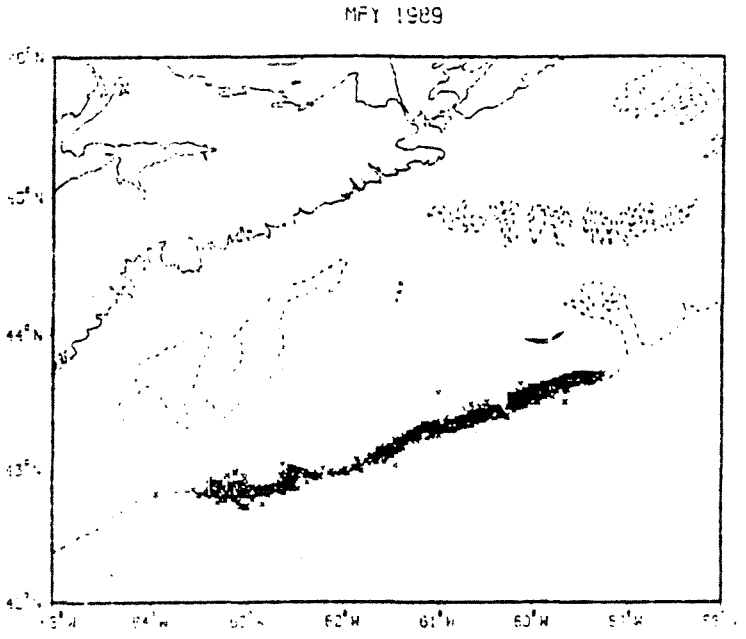
1989 FISHING LOCATIONS:

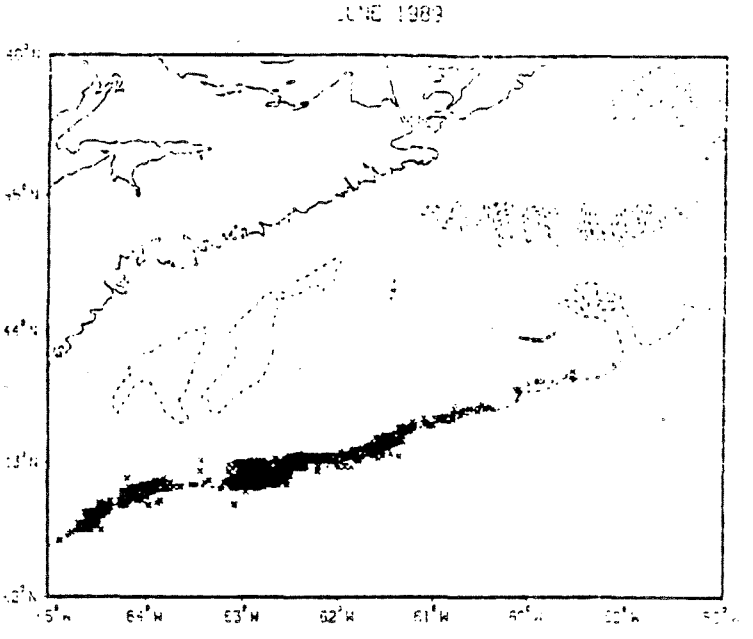
CUBA (SILVER HAKE)

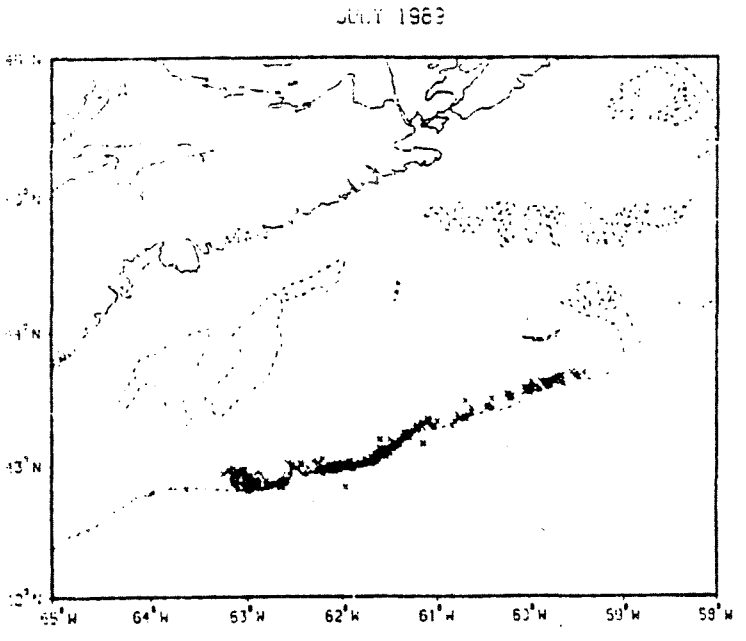
Figure 3











1989 FISHING LOCATIONS:

USSR (SILVER HAKE)

Figure 4

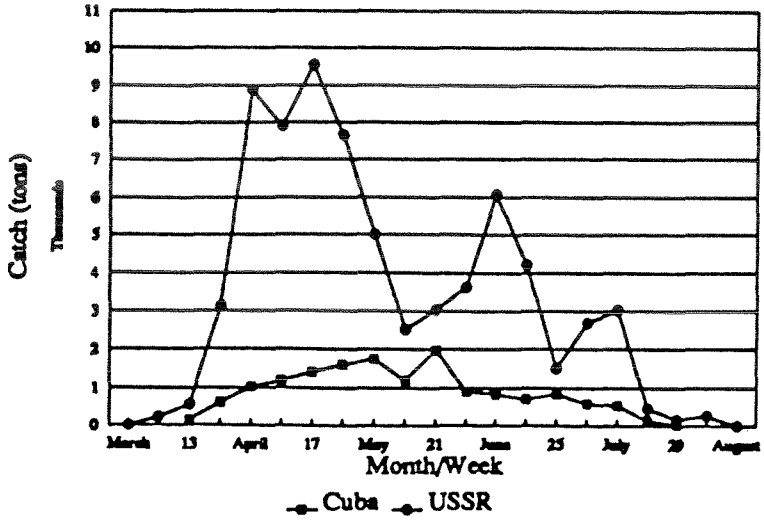


Figure 5

Observed 1989 Catch (Foreign) of Silver Hake

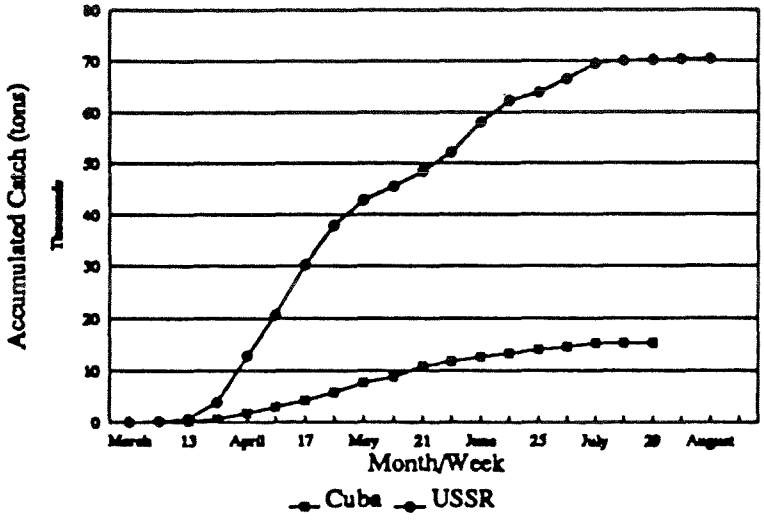


Figure 6

Observed 1989 Accumulated Catch (Foreign) of Silver Hake

and Soviet fisheries was slightly above the regulated 1% level beginning in late April and continued to the end of the season. Pollock and cod by-catch levels were below the regulated levels. The total by-catch observed in the 1989 silver hake fishery was within the regulated levels.

6.0 1989 Canadian Fishery and Processing Project - Description

In November 1988, the Groundfish Management Plan for 1989 set the following TAC, allocations and quotas for silver hake:

TAC			135,000 mt
Foreign		90,000	
Canada		45,000	
Developmental		**40,000**	
Competitive		5,000	
Vessels < 100'	3,000		
Vessels > 100'	2,000		

In December 1988, a special meeting of the Industry Advisory Committee on Silver Hake was convened in Halifax, Nova Scotia and the following criteria were established for participants in the Canadian fishery for 1989:

i) Canadian vessels only (no foreign charters)
ii) Possession of a valid groundfish licence required
iii) By-catch of regulated species would apply against groundfish quota.

In addition, the use of over-the-side sales was approved in principle for vessels fishing under the Developmental quota.

By the December 23, 1988 deadline, seven offshore vessel proposals had been received, but none of these met the above-mentioned criteria. Two inshore proposals also had been received; both of these were eventually approved, as follows:

- Nova Scotia Dragger Fishermen's Association (NSDFA) - 35,000 mt, involving Soviet OSS vessels and a Canadian foreign partner

- Maritime Fishermen's Union (MFU) - 5,000 mt; also involving Soviet OSS vessels and a Canadian foreign partner.

In addition to these joint-venture arrangements, a pilot project was developed with the assistance of the NSDFA and Karlsen's Shipping Company Ltd., a local fish processor, to land and process some of the silver hake caught offshore by the Canadian vessels (65' draggers). This project was funded under the Canada-Nova Scotia ERDA * Fisheries Sub-agreement. Total cost was about $205,000.00, which includes the cost of modifying vessel and plant gear for harvesting and processing silver hake.

Between January and April 1, 1989, contractual agreements were finalized between the various Parties involved, including DFO, N.S. Fisheries, the NSDFA, the MFU, the Soviets and the foreign partner in the joint-ventures, Marr Seafoods.

* Economic Regional Development Agreement.

In addition, a proposal to utilize a Japanese research vessel to fish and process silver hake was approved by the Department. Experimental inshore fishing for silver hake, using a Canadian inshore vessel under scientific charter, also was begun.

In summary, Canadian efforts in 1989 consisted of these components, which will be described on following pages:

- use of inshore vessels (65' and 45' draggers) for harvesting in the silver hake box and for transfers to Soviet vessels in over-the-side sales
- onshore processing of fresh silver hake into traditional groundfish products
- market testing of traditional groundfish products made from silver hake
- surimi production and testing, using Canadian-caught and Japanese-caught silver hake
- inshore experimental fishing using a 45' dragger

6.1 Harvesting

6.1.1 Fishing Gear and Vessel Preparation

The Department of Fisheries and Oceans and the Nova Scotia Department of Fisheries agreed to assist both inshore groups, the NSDFA and the MFU, with appropriate gear and vessel modifications, up to a fixed number of vessels, to prepare their boat trawls and cod-ends for fishing for silver hake. Participating vessels were selected by the NSDFA and the MFU. This year, it was decided to use the vessels' regular bottom trawls, modified with small-mesh liner, and keep the Shuman trawls used in 1988 on reserve. Specialized mesh had to be obtained from the West Coast (60 mm) to line the bellies of the trawls and the entire cod-ends. The cod-ends used in 1988 (see Figure 7) were used again in 1989, with a few modifications. Additional "joint-venture" cod-ends also had to be prepared and lined with the 60 mm mesh. All cod-ends had to be detachable from the fishing vessel so they could be floated over to and retrieved by the Soviet processing vessel, emptied of the catch, then returned to the fishing vessel.

The major modification made to the 1988 cod-end design involved securing the 60 mm liner to the outer bag along four seams running the full length of the cod-end. Also, extra warp was required for fishing at the great depths encountered in the silver hake box ($\sim$250 m on average in the early part of the fishery). The holds of the three 65' draggers had to be modified to make them water-tight, in order to test the use of a fish pump unloading system for the portion of their catch that would be landed at the New Harbour plant.

6.1.2 Experimental Inshore Fishing

In August, 1989, a single 45' vessel (the Jeremy and Sisters) was chartered to conduct scientific trials for silver hake, fishing shoreward of the silver hake box. Studies are ongoing. The intent is to test the success of smaller vessels using different types of gear in

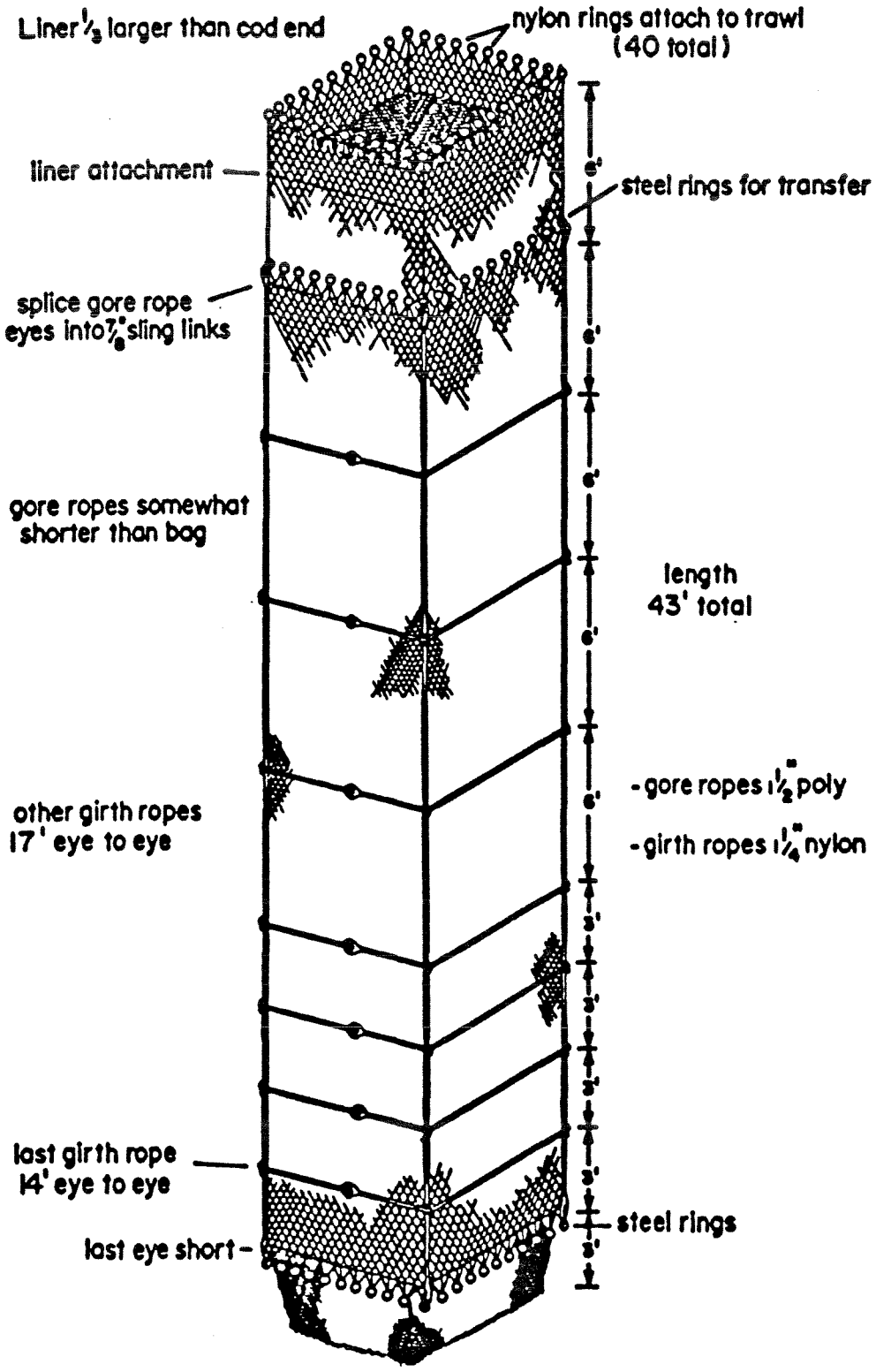


Figure 7

Cod-end Used in the 1988 Experimental Silver Hake Fishery (Further modifications (see text) were made in 1989).

different inshore locations and to determine the potential for by-catch of other regulated groundfish species. The long-term objective is to look at the potential for a successful inshore silver hake fishery. Data from the first two locations fished to date are available and will be presented later in this report. The two locations are George's Banks (to compare our results with those of the U.S. fishery on George's) and Brown's Bank. Future sites may include Emerald and LeHavre Basins.

The gear employed was a # 5 Safari Trawl (with rockhopper) modified by adding a 60 mm mesh liner.

6.2 Processing

6.2.1 Processing Pilot Project: Preparations

The Karlsen's Shipping Company Ltd. fish plant at New Harbour, Nova Scotia (Lunenburg County), which is normally used for processing pelagic species (herring and mackerel), was temporarily equipped with a Transvac pumping system for fish offloading, and a groundfish processing line. Numerous companies provided equipment and/or personnel either free of charge, or at very reduced rates, to assist with the experimental processing of fresh silver hake. However, some of the machinery available was not entirely suitable to the species and a relatively large percentage of the work had to be done manually. A list of the additional groups and their contributions is presented below:

Transvac (fish offloading system and technicians)
Baader (heading and filleting machine 182; and technician)
Fishmore (heading and gutting; and technician)
National Sea (fishwasher)
Nova Scotia Fisheries (La Pine gutting machine)
Fisheries and Oceans (XACTIC boxes)

Arrangements were made with the Captains of the three NSDFA draggers participating in the OSS fishery that they would land the last tow or two fished in the silver hake box just prior to returning to port for fuel and supplies. It was hoped that this could be arranged on a rotating basis amongst the three Canadian trawlers such that every 3 - 4 days one of the trawlers would be landing iced fish that was no more than 24 hours post-mortem. The trawler would then re-supply and return to the silver hake box to fish once again for its OSS arrangement with the Soviets.. In this way, the Soviet vessel would never have fewer than two Canadian vessels supplying it with fish.

6.2.2 Surimi Production Trials

Surimi is a highly processed form of fish, usually of white-fleshed species, consisting mainly of protein and water. It was developed by the Japanese, using Pacific pollock as the standard. It is the malleable intermediary product in the processing of "artificial" crab legs, lobster and scallops, for example, which are produced after flavorings and colorings have been added. These "imitiation shellfish" end-products technically are referred to as "seafood analogs".

The Canadian Institute of Fisheries Technology (CIFT) on the Halifax campus of the Technical University of Nova Scotia was contracted to conduct surimi production tests using fresh silver hake. CIFT staff were to monitor surimi trials at sea done aboard the Japanese surimi research vessel and evaluate the quality of the Japanese product. They also were to conduct production trials at CIFT in Halifax using fresh silver hake caught by the Canadian draggers and processed at the Karlsen plant.

6.3 Marketing Targets

Location of customers on a paying or trial basis was primarily arranged through the marketing section of the N.S. Department of Fisheries although DFO also facilitated some transactions. Both domestic and foreign clients were to receive various silver hake product forms such as frozen headed and gutted fish (H&G), fresh and frozen fillets, smoked fillets, and salted H&G. Also, a "product introduction" media event was planned for the Halifax Sheraton Hotel where chefs would be invited to compete to produce a prize-winning silver hake dish using fish processed at the Karlsen plant.

Preliminary market research was done to identify packs and products which held market potential. Contacts were made with several U.S. companies who trade in "whiting" (silver hake). In addition, products which would have specific application for markets in the Far East were researched. Standard packaging for the major product sold in the U.S. was obtained from a U.S. company. The advice received indicated that a branded product in a box with attractive packaging was essential. The size required for individual fish was 6 - 9 oz. after head removed, packed in 5 lb. cartons. It was clearly stated that product smaller than this size would be difficult, if not impossible, to move.

Information received from Spain indicated that any sizes under 0.8 Kilograms is not acceptable to the market. Samples were sent to an importer to obtain the company's evaluation of the quality of the product. The commercial trade officer at the Canadian Embassy in Madrid assisted in this effort.

After talking with traders in the U.S., it was clear that fillets under 2 oz. were too small for anything other than formation into solid fishblocks. The smallest size acceptable for an individual fillet was 4 - 6 oz. There are whiting fillets from Chile sold in this size range.

The best product potential appeared to be for the H & G product packed in 5 lb. cartons; it is sold in the southern U.S. as a cheap food item. Indications were that St. Louis is probably the single biggest market in that region. All major frozen fish distributors in Boston handle the product supplied by Chile and Argentina. Price for this product ranges from 32¢ U.S./lb. to 42¢ U.S./lb. delivered, cold storage, New England.

7.0 Results

7.1 Harvesting Results

7.1.1 General

Due to weather problems, a few additional alterations required for the gear, and to the late arrival of the first Soviet processing vessel, the Ambarchik, Canadian harvesting efforts did not get underway in earnest until April 12th instead of the planned start date of April 1, 1989.

Also, the Soviets sent two processing vessels rather than the single ship that was expected. Neither of the Soviet vessels were licensed to fish, so that any downtime experienced by the Canadian trawlers was transmitted to the two Soviet processing vessels. During the period that the Canadian vessels were directing for silver hake, (April 12 - May 11), there were only 14 active fishing days for the 65' draggers, so that significant downtime was experienced by the Soviet processors which were capable of operating on a 24 hour basis in all but the severest weather conditions.

The Canadian vessels, rather than fishing on the anticipated rotating basis, ended up fishing as a fleet on a trip basis - either all three vessels were fishing in the box or all three were landing fish at the New Harbour plant. The main reasons for this were bad weather or low catches which, at first was taken as indication that further gear modifications were necessary to the cod-end and trawl bellies.

7.1.2 Total Canadian Catch and Catch per Unit Effort (CPUE)

Data pertaining to the Canadian harvest were available from several sources:

(i) the DFO Observer Program for all OSS transfers to the Soviets and for most of the onshore landings at the Karlsen plant;
(ii) the Captains' hails for onshore landings;
(iii) the Karlsen fish plant sales slips for onshore landings;
(iv) the Marr Seafoods foreign licence reports to DFO on total OSS transfers and total production on board the Soviet vessels.

Although these various sources of information on the catch are generally in agreement, none of them exactly matches the others; also, some data on the OSS transfers are still forthcoming and data linking specific Canadian tows with specific cod-end weights were not adequately recorded. The record of the total Canadian harvest is, therefore, presently incomplete. Of the various sources, the DFO Observer data set is the most complete and has been used to derive the following statistics about the 1989 Canadian silver hake harvest. Additional data and figures are presented in Appendix III of this report.

Figure 8 illustrates the fishing locations of the Canadian silver hake fleet in 1989, and shows that these locations were similar to those used by the foreign fleets.

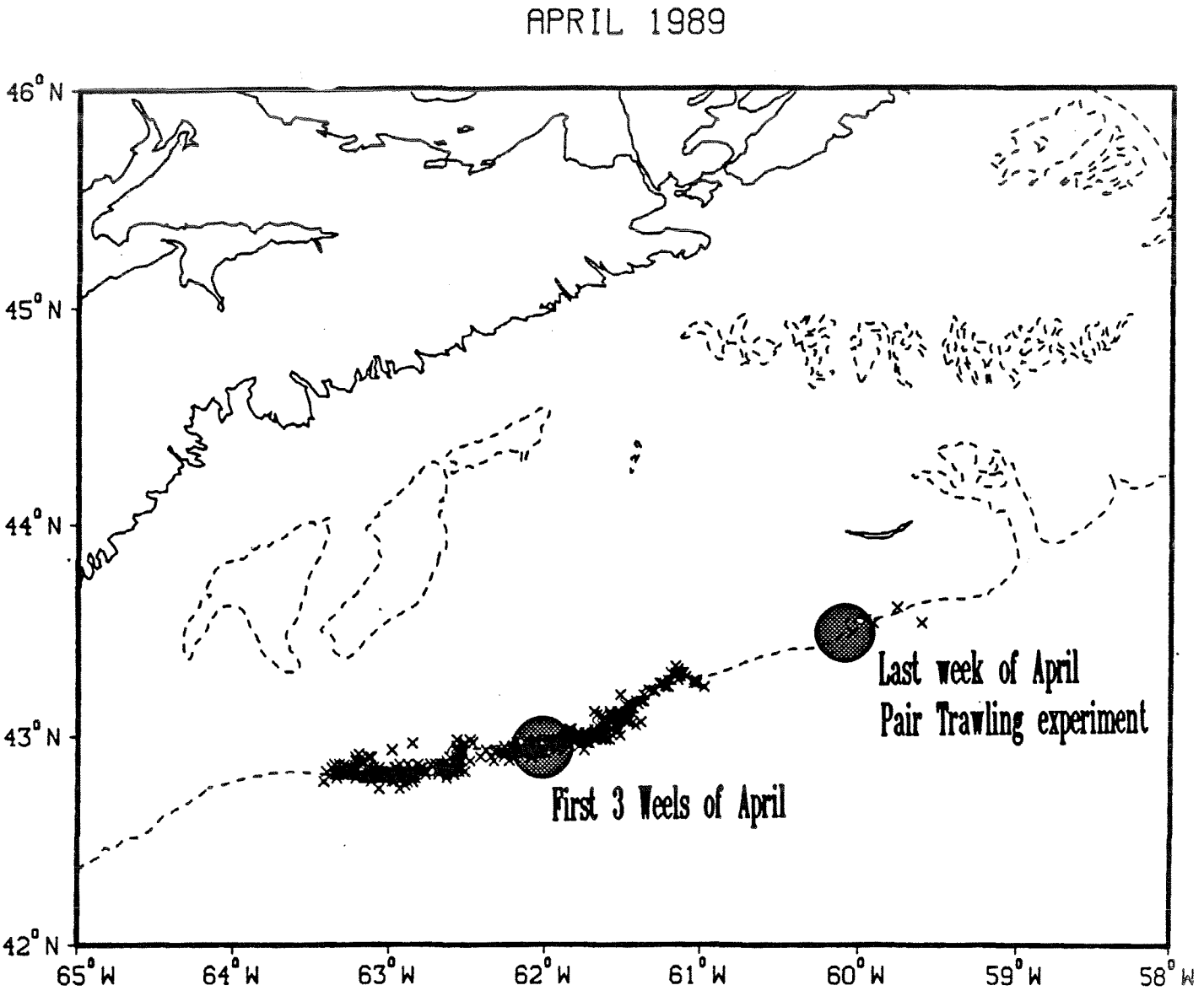


Figure 8

1989 Fishing Locations of the Canadian Silver Hake Fleet

Table 4 shows the weekly breakdown of the Canadian harvest, including by-catch; the total silver hake harvest was 291 metric tonnes.

Table 4

Weekly Catches of the 1989 Domestic Silver Hake Fishery (mt)

Week of	Silver Hake	Cod	Haddock	Pollock
April 9	34.345	.070	.195	.298
April 16	191.860	.038	.413	9.121
April 23	45.738	.030	.500	13.433
April 30*	19.550	.050	2.667	.332
Total	291.493	.188	3.775	23.184

*Pair trawling experiment

Silver hake made up 91.4% of the total catch. The other species made up approximately 10% of the total catch. The foreign fishery catch composition during the same time period was very similar.

Table 5 shows the CPUE calculated for the Canadian fleet using DFO Observer data. The observed catch rates for the Canadian draggers were below those observed for the commercial foreign fleet. These data, of course, represent averages. On occasion, the Canadian trawlers were able to bring in cod-ends weighing more than 10 metric tonnes after a three hour tow which would put the CPUE up as high as 3^{+} mt/hour.

TABLE 5

Catch Per Unit Effort for the
1989 Silver Hake Fishery
(metric tonnes/hour)

Week of	Domestic CPUE	Foreign CPUE
April 9	0.5	4.5
April 16	1.1	6.6
April 23	0.6	3.0
April 30*	1.2	4.7

* Pair trawling experiment

The domestic American fishery on Georges Bank in 1988 had an overall CPUE of 1.4 mt/hour[7] which is almost double the Canadian average of 0.85 mt/hour. However, the U.S.A. fishery is conducted in much shallower water, closer to home port of the fishing vessels and over a longer time period. The Soviet CPUE has ranged as high as 18.8 mt/hour and Cuba, during those same years, averaged 2 mt/hour. However, the total number of hours fished is significantly higher for the Americans, Soviets and Cubans than it was for the Canadians. Therefore, on a "total fishery" basis, the catch per vessel by the American and foreign fleets would be significantly higher than Canadians were able to achieve in 1989.

The Japanese surimi research vessel was fishing for silver hake for the first time in our waters and was of a size comparable to or larger than that of the Soviet trawlers. This vessel caught a total of 192.8 mt of silver hake in 18 sets, averaging 5 hours/set over six days, fishing in depths of 155 - 307 m. A rough estimate of the Japanese CPUE is 2.1 mt/hour.

Two of the Canadian vessels, the Ocean Swell and the Sylvia Lynn II, tried pair trawling in the silver hake box on one occasion. The Captains felt this was successful - the catch of silver hake was so large, it threatened to burst their net and cod-end - but they also felt that pair trawling was too dangerous a practice in amongst the fleet of more than 40 foreign vessels intensively fishing in the area. They concluded, however, that the increased towing speed achieved by pair trawling was responsible for their increased catch.

The four 45' vessels which also briefly attempted to fish for silver hake in the box did not meet with much success, although some of them caught about 0.5 mt per tow.

Table 6 summarizes additional data and statistics relevant to the 1989 Canadian fleet and harvest.

7.1.3 Size and Quality of Fish Caught

Historically, the catch of silver hake in the 4VWX fishery has targeted primarily on one or two age classes, and this pattern has remained consistent in 1989. In the foreign catch a modal length of 30 cm was predominant in all months of the fishery. This represents the catch of age 3 fish. A smaller, second peak was seen in June and July, which was indicative of age two fish reaching a size where they were recruited to the fishery. The size distribution of silver hake in the domestic fishery in April very closely resembled that for the foreign fishery, with a modal length of 29-30 cm. Figures showing these size ranges for the 1989 fishery can be found in Appendix II. This modal size is also similar to the average size in the 1988 U.S.A. Georges Bank Culivator Shoals fishery[7]. The average weight of silver hake caught in the 1989 Canadian fishery was 225 gm.

The quality of Canadian-caught silver hake which was transferred to Soviet vessels presumably was acceptable, as no fish were rejected. The only Soviet complaint concerned the low quantities of fish transshipped overall. For more detailed information on the size and quality of fish landed for processing at New Harbour, N.S., the reader is referred to Section 7.2 and Appendix III of this report.

7.1.4 Experimental Inshore Fishing

Fig. 9 and 10 show the frequency of occurrence of various size ranges of silver hake within the total experimental catch, using the 60-mm lined #5 Safari trawl at the two locations fished. There may be an average size difference between the two areas, with the Georges Bank silver hake being larger than those caught on Browns Bank, but approximately the same size as those caught in the commercial fishery in the silver hake box. The average weight of the silver hake in the Georges Bank sample was 232 gm and in the Browns Bank sample, it was only 88 gm. These can be compared with the average weight of fish caught in the commercial fishery noted previously (225 gm). The reader is cautioned, however, that the data for Georges and Browns Banks are based on a very small amount of fish and hence, the statistics on size are not "conclusive". The data from these two trials are summarized in Table 7.

Table 6

Summary of Canadian Harvesting Efforts

1989 Silver Hake Fishery

Type & Number of Vessels	Number of Fishing Days	Avg. Duration of Tow	Avg. Number of Tows/Day	Total Number of Tows/Fleet	OSS[2] transfers (mt)	Silver Hake Landed for Processing mt)	Total Silver Hake Catch (mt)	By-catch (& %)	Average Catch per Unit Effort
3 x 65' Draggers	14	3 hours	3	~80	223	68	291	27.6 (8.5%)	0.85 mt/hr
4 x 45' Draggers	1 - 2	-	-	-	-	-	1	-	-
100' 1 x Dragger	1	½ Hour to 1 Hour	-	1	-	4	4	8 [4]	4 - 8 mt/hour

Notes: 1) Tabled data are a compilation of data from the following sources and will not match exactly those data that are from a single source: DFO Observer Program
MARR Seafoods
Karlsen Shipping Co. Ltd.
Vessel Logs.

2) OSS = "Over-the-side" = tonnage of fish transferred at sea for sale to the Soviet processor vessels.

3) The Captains initially maintained detailed accounts of dates, locations and duration of tows, but the matching cod-end contents were not available in the Canadian logs because the cod-ends were transferred directly to one of two Soviet vessels.

4) 1 tow only, on a trial basis, under the competitive quota, by the Island Princess, fishing with the <65' vessels, April 28, 1989. "By-catch" shown was applied against quota.

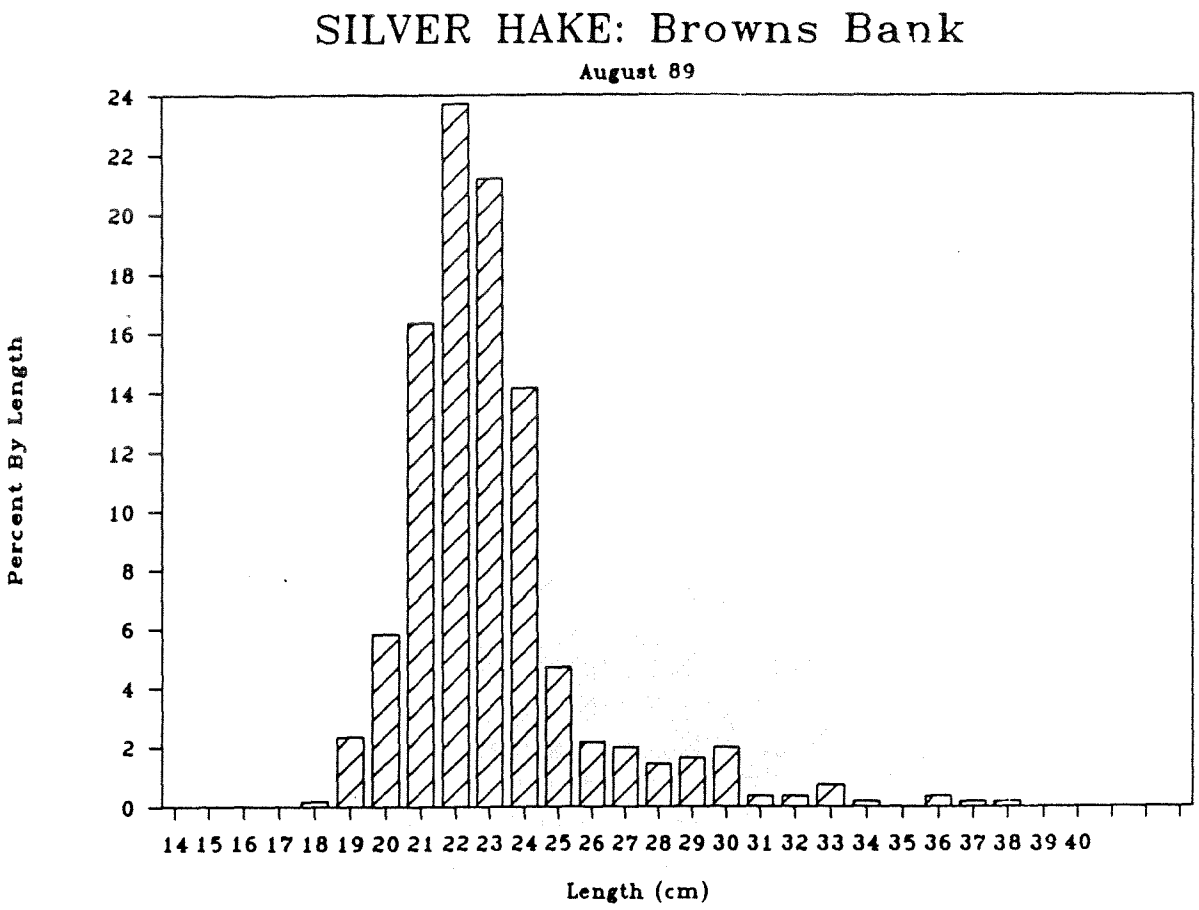


Figure 9

Data from two experimental tows for silver hake on Browns Bank, August 1989.

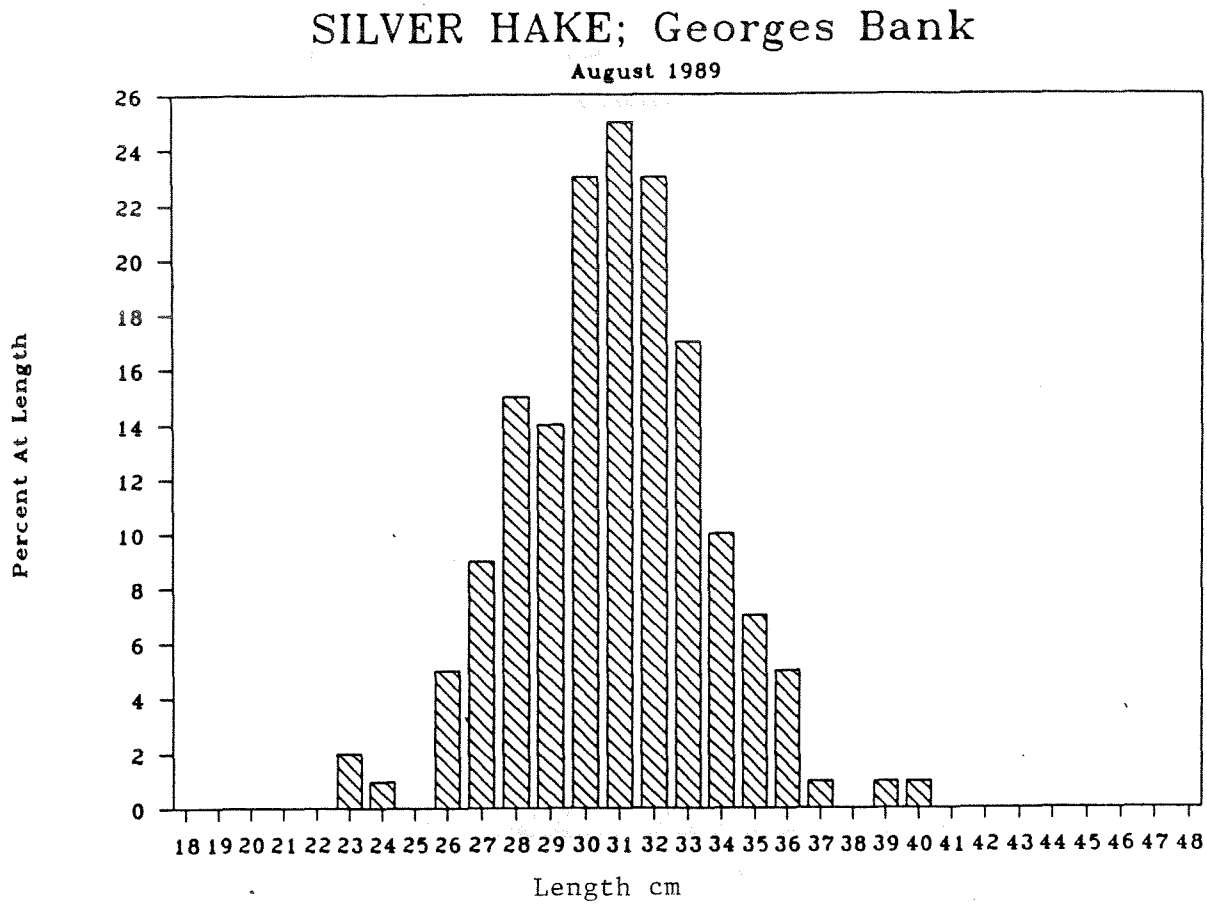


Figure 10

Data from one experimental tow for silver hake on Georges Bank, August 1989.

Table 7
Preliminary Results
Experimental Inshore Fishing - August, 1989
(#5 Safari Trawl with 60 mm liner; Towing Speed ~3 kn)

Location		Brown's Bank		George's Bank
Set #		1	2	6
Co-ordinates (Start of tow)		42°34'N 66°00'W	42°33'N 66°04'W	42°09'N 66°48'W
Date		Aug. 3/89	Aug. 3/89	Aug. 11/89
Depth (m)		102-198	102-198	55-157
Total Catch (kg)		1200	1400	450
Proportion of catch that was Silver Hake	(kg)	1090	820	85
	(%)	90.8	58.6	18.9
Weight of Silver Hake Sub-Sample (kg)		32	17	37
# Fish in Sub-sample		356	196	159
Average Weight/Silver Hake (gm)		89.9	86.7	232.7
Predominant Length of Silver Hake in sub-sample (cm)		23	22	31
By-Catch (species and as % of Total Catch)		Red Hake 4.2% Lobster 2.1% Skate 1.7%	Lobster 15.4% Argentine 12.9% Red Hake 5.7%	Haddock 72% Cod 6.6%

The amount of by-catch taken in these few experimental trawls was not encouraging, as Table 7 reveals. However, further scientific field trials with chartered fishing vessels will be necessary to adequately determine the potential for a by-catch problem at various times of the year.

7.2 Processing Results

7.2.1 Onshore Processing Pilot Project: Karlsen's Fish Plant, New Harbour, N.S.

Table 8 summarizes the amounts and types of products and identifies most of the consumer end-points resulting from the April - May, 1989 onshore processing pilot project at New Harbour, N.S. A detailed report was prepared by Tavel Consultants who, under contract to DFO, monitored and evaluated the silver hake processing pilot project. The reader is urged to refer to Appendix IV and read the Tavel report in its entirety. General comments are provided below.

The Transvac unloading system worked very well. The fish stood up to conventional ice storage better than expected, and a comparison with the single delivery of refrigerated seawater-stored fish (RSW) surprisingly showed no difference in quality. There was some pinkish coloration to areas of the flesh in some of the fish, both in conventionally-iced and RSW fish. This was initially believed to be evidence of bruising during the long tows (3 hours on average); however, as this was also evident in the RSW fish which reportedly was hauled on board after a ½ hour tow, another potential cause may have been the large cod-ends being hauled in most cases (7 - 11 tons/cod-end/3 - 5 hour tow at the peak of the fishery). Boxed fish stored on ice were slightly better in quality when landed, but the discoloration was still evident. Processed fish products were of excellent to good quality. A table on the processing economics has been brought forward from the Tavel Report (Table 9). Processing costs during the pilot project were relatively high, due in part to the high amount of manual labour used in the processing line.

7.2.2 Silver Hake Surimi Trials (Canadian and Japanese)

As earlier mentioned, surimi is also known as "imitation shellfish" and as a "seafood analog". The industry standards for seafood analogs were developed using Alaskan pollock and are not entirely suitable for the types of protein found in the flesh of other species of fish, even other whitefish like silver hake. However, for the purpose of assisting the reader in interpreting the reports provided in Appendix V on the surimi trials conducted in 1989 using Canadian silver hake, the following "standard specifications" are provided:

Recommended Values for Good Quality Alaska Pollock Surimi[10]

Specifications:	Moisture :	75.0% $\pm$ 0.5%
	Fat Content:	Low
	Color:	White or light
	Odour:	Minimal
	Flavour:	Bland
	Gel-forming Ability:	Strong, Highly Functional
	Gel Strength:	$\geq$ 600 g.cm
	Torsional Strain:	$\geq$ 2.0
	Torsional Stress:	40 - 50 KPa
	Few Impurities, e.g. dark pieces of skin or membranes	

Table 8

Summary of Silver Hake Test Production at Karlsen Fish Plant, April - May 1989

		QUANTITY			CONSUMER/PURPOSE
		POUNDS		METRIC TONNES	
Fish Landed	Silver Hake	149,955	lbs.	68.06	-
Fish Processed		100,800	lbs.	45.77	-
By-catch	Cod & Pollock	2,612	lbs.	1.18	-
Fish good but too small; to fishmeal		35,787	lbs.	16.25	
Fish poor: to fishmeal:		8,050	lbs.	3.66	
PRODUCTS					
H&G (5 lbs.)		8,840	lbs.	4.02	U.S.A. & Spain (100)
H&G (20 kg./ 44 lbs. boxes)		40,744	lbs.	18.50	UK, (27,000 lbs. shipped) Pet Food U.S.A. (13,700 lbs. shipped)
Skin off Fillets in 16½ lb. blocks		544.5	lbs.	0.25	-
Skin on Fillets (5 lb. layer pack)		780	lbs.	0.36	TUNS (550) (for Surimi)
Skin-on Fillets shatterpack: (4 lbs. fish in 5 lbs. boxes)		41	lbs.	0.01	-
Skinned Fresh Fillets for Surimi		719	lbs.	0.33	TUNS (for Surimi)
H&G (salted)		600	lbs.	0.45	-
Head on Gut out		20	lbs.	0.01	MARR Seafoods
H&G (Smoking)		220	lbs.	0.10	Mike Drebot (N.S. Fisheries)
Round (Smoked)		1,000	lbs.	0.46	Mersey Point Fish Products; Cliff Outhouse
Round (Frozen)		704		0.32	Rodman; Allen (Iceland); sample test
Round (Fresh)		1,000	lbs.	0.46	Air freight to Ontario & D'Eon Fisheries
Round Small, Frozen (Bait)		2,200	lbs.	1.00	Tavel
Total Products		57,375.5	lbs.	26.05 tonnes	

YIELD

Plant estimates:

#1 $\frac{\text{PRODUCT}}{\text{Good Quality Fish landed}} \times 100$ = 40.28%

#2 $\frac{\text{PRODUCT}}{\text{Fish Processed for Eating}} \times 100$ = 57.00%

Table 9

(from Appendix III of this report)

Estimated Direct Cost of Processing
for an Industrial Silver Hake Operation
(after size-sorting to remove small fish)

Processing Economics
($/Finished Kg)

	Pack					
	5 lb H&G 3-5 oz	**5 Lb H&G 5 oz +**	**H&G Petfood**	**Fillet Block**	**Fillet Layer**	**Whole Petfood**
Raw Material Cost	0.33	0.33	0.33	0.33	0.33	0.33
Yield	62 %	62 %	63 %	30 %	33 %	98 %
Gross Raw Material	0.53	0.53	0.52	1.10	1.00	0.34
Labour Cost	0.30	0.25	0.23	0.39	0.35	0.05
Packaging Material	0.12	0.12	0.02	0.04	0.09	0.05
Total Direct Cost	0.95	0.90	0.77	1.53	1.44	0.44

Notes : 1) Labour rate at $10 per person hour
2) No manufacturing or fixed overhead included

In April and May of 1989, both the Japanese Marine Fishery Resource Research Center (JAMARC) and the Canadian Institute of Fisheries Technology in Halifax, N.S. (CIFT) conducted surimi production trials using fresh silver hake harvested in the silver hake box off of Nova Scotia. The CIFT trials used fish landed and filletted at the Karlsen fish plant at New Harbour, N.S. In the case of the Japanese trials, the fish was caught and processed by the JAMARC vessel at sea and processing almost always was done within 24 hours of the fish being harvested. In the case of the Canadian trials, the freshest fish available was approximately 45 hours old (i.e. post-mortem) and the oldest raw material lots were approximately 160 hours post-mortem, or 6½ days old.

Detailed methods and results of both studies can be found in Appendix IV. The overall conclusion from both studies, however, was that Canadian silver hake can be manufactured into good quality surimi with white color and excellent sensory attributes. Nonetheless, further work is required to establish optimal methods for harvesting, handling and processing this species into surimi.

7.3 Marketing - Results

7.3.1 Traditional Products

Various product forms were distributed to clients in Nova Scotia, Ontario, England, the U.S.A., Spain and Korea.

The feedback received from these customers has been limited, but encouraging. The H & G frozen and the smoked products were well received, insofar as product quality is concerned. Fresh fillets skin-on were of good quality and appearance, but the skinned fillets tended to fall apart (they did, however, produce an excellent surimi product). Some of the feedback regarding prices that can be obtained is not encouraging. For example, in the pilot project, a premium frozen H & G product cost 40¢/lb. to process, but the buyer paid only 27¢/lb. It must be remembered that the sale was on a trial basis and the product was produced with an impractically high proportion of manual labor.

The product packed in 5 lb. cartons was mainly 6 - 7 oz. per individual H & G fish; this was at the smaller end of the market range. The product was eventually sold for 20¢ US/lb.

Samples were sent to Korea on October 30, 1989, but there has been no formal response as yet. Similarly, samples shipped to Spain on October 30th have resulted in no formal response.

7.3.2 Surimi

No attempts were made to market silver hake surimi in 1989.

8.0 Discussion and Conclusions

8.1 Harvesting - Discussion and Conclusions

8.1.1 Over-the-Side Sales (OSS)

(i) Catch and Transfers

The Canadian fishery ran from April 12 to May 11, 1989. Due to technical and weather-related problems which affected the three vessels in the 65' dragger fleet, there were only 14 fishing days or less during that period. However, at the peak of their fishing, they were transferring up to 11 tons of silver hake at a time to the Soviets. Nevertheless, the OSS was unsatisfactory from the Soviets' point of view.[11] Both they and their foreign partners in the joint-venture, MARR Seafoods, have expressed their desire to see the Soviet vessels allowed to fish for silver hake for themselves on days when the Canadian catcher vessels cannot deliver fish to them. Approximately 223 tonnes were sold OSS and an additional 68 tonnes were stowed on ice for landing at New Harbour, N.S. for a total catch of 291 mt. This contrasts with the total amount of 40,000 mt which was allocated. By-catch overall was approximately 8.5%, which was much higher than that experienced by the foreign fleet which, however, fished more consistently and for more days. Even so, the vessels in the adjacent Soviet fishing fleet occasionally had by-catch problems, primarily with pollock; dogfish also caused problems for both the Canadians and foreign fleets, and could be an occasionally recurring problem for the silver hake fishery - unless a dogfish market were to be developed. For a Canadian fishery of longer duration, the by-catch would be expected to be no greater than that experienced by the foreign fleet, which was within acceptable limits.

(ii) Gear

The development of and modifications made to the Canadian vessels' towing gear (longer warps; 60 mm mesh, lined joint-venture cod-ends attached along four seams the full length of the cod-end; 60 mm sections added to the trawl bellies) appeared to catch fish well when fish were schooling. The joint-venture cod-ends also transferred well to the Soviet processing vessels and back again to the Canadian draggers. However, our fishermen were not able to match the foreign fleet on a CPUE basis. This may have been related to the maximum towing speed achievable by these relatively small vessels towing heavy gear, with increased drag (due to the small mesh) in the great depths encountered in the silver hake box. The single experiment with pair trawling undertaken by two of the 65' draggers and a single "comparison tow" by the 100' dragger fishing alongside of the 65' vessels point toward towing speed as a problem to be overcome if the inshore/midshore fleet is to participate in the spring silver hake fishery more successfully. It is now believed by some that an effective towing speed of 4 knots/hour is required. To enable a midshore vessel to fish for silver hake in an economically viable manner at that time of year, consistently high catch rates would be a necessity on those days that are "fishable" from a weather point of view.

With regard to the 45' vessels (which did catch silver hake, albeit in small amounts) it is likely that weather would be as great a constraint on them, or greater, as on the 65' vessels.

(iii) Conclusion

The potential for developing a domestic silver hake fishery in the silver hake box using inshore vessels (<65') does not appear to be good, either from an economic or a safety point of view. Although our inshore vessels can catch the hake, they probably cannot do so in sufficient quantity on a consistent basis in the spring silver hake box fishery. There is also concern about the safety of the vessels and crews fishing at that location, at that time of year. It is possible, however, that additional gear research might improve the CPUE of the inshore vessels in the silver hake box.

8.1.2 Communications

Ship-to-shore communications with the vessels were often difficult, partially due to the distances involved and partially due to scheduling problems between the parties trying to communicate. More often than not, status reports, estimated times of arrival, etc. had to be relayed through the homes of the vessel Captains which caused time delays and, although very helpful, was less than satisfactory for most of the parties involved. DFO had Observers on the vessels most of the time and these communications were more regular, but because of the rigid reporting schedule that is required by the Observer Program, this also was only partially satisfactory for those on land wishing to monitor the events offshore (from a non-regulatory point of view). In general, there were far fewer problems encountered when the vessels tried to reach shore than when shore tried to reach the vessels. If future experimental fisheries are planned, a communication plan should be developed and adhered to by all parties.

DFO Observers on board the two Soviet processing vessels had been provided with hand held VHF radios which they found to be very useful for communicating catch and related information to each other. The Observers on the Canadian vessels were not provided with these radios, and this may have been a constraint on full, at-sea, communications amongst the Observers. Also, had all Observers been so equipped, it would have made it easier to relate the data on specific cod-ends being transferred to the Soviet processing vessels with the data on specific tows (location, depth and duration) being conducted by the Canadian catcher vessels.

8.1.3 Landed Fish Quality (Stowage and Offloading)

Conventionally-iced fish proved to be an acceptable means of storing silver hake for H & G filletting and even for surimi processing, provided the catch was landed and processed within four or five days of being caught. Quality differences were noted in fish stored longer than this. Quality was enhanced in boxed fish when compared with penned fish. Although RSW-stored fish were not any better in quality than ice penned fish, this was contrary to expectations and cannot be considered "conclusive evidence" as there was only one trial and it was done without standard scientific controls.

The Transvac offloading system worked well and probably contributed to the better than expected quality of the fish, even at 4 to 7 days post-mortem.

8.1.4 Experimental Inshore Fishing and Gear Trials

The experimental fishing being conducted shoreward of the silver hake box, using a single 45' dragger has shown that a regular Safari trawl lined with 60 mm mesh can catch silver hake. Further study is needed to determine whether the quantities caught are representative of what is in the area, where the best inshore areas are, and what the by-catch levels would likely be in a full scale fishery.

8.2 Processing - Discussion and Conclusions

8.2.1 Traditional Products

The fish product is promising, but security of supply is critical to developing the fishery whether through onshore processing or OSS arrangements. Larger vessels in the 100' LOA range, at least, appear to be key to this security of supply for harvesting in the silver hake box. However, if the vessel used were to become too large, perhaps any larger than 130' LOA, then fish prices for fresh round silver hake would have to increase substantially above the $155.00 - $175.00 per tonne paid in 1989, to economically operate that size of vessel.[12]

Additional development and testing of processing equipment designed to handle this small gadoid species is required. Success on this point would likely result in substantially reduced costs when compared with the costs of production encountered in the pilot project. Production costs could be significantly reduced once suitable processing equipment is developed. The Karlsen plant manager has stated that machinery is required that would:

(i) process 20 mt/8 hour shift, and
(ii) bring production cost down to 5-6¢/lb. for H & G production.

An additional factor in the processing of silver hake is the size range of the fish; length at catch ranges from 15 cm to >40 cm, with the largest, most numerous size "classes" being 24 - 30 cm classes[9]. Fish under 23 cm were still numerous, but too small to process other than for fishmeal in the pilot project. Of the total fish landed, this meant that total product yield was 40%, if one excludes fishmeal as a product. The yield of edible product based on fish processed for edible product was good, however - at almost 60%.

8.2.2 Surimi

Fresh silver hake, four days post-mortem and properly iced, produced good surimi. Further development is required to define the optimum surimi process and handling requirements for this species and for end-product development.

8.3 Marketing - Discussion and Conclusions

8.3.1 Traditional Products

The quality of the products was quite acceptable but the size of the fish presently restricts the marketing possibilities. The H & G product of the 6 - 7 oz. size is at the small end of the range for the southern U.S. market. Product packed for the U.K. as pet food was received and well accepted, but at a price too low to result in future business. Additional market research and aggressive marketing techniques, with follow-up, are required.

8.3.2 Surimi

The good quality of the surimi produced from silver hake, and the high potential for its further improvement through further production research, warrants the commencement of market opportunity research.

9.0 Recommendations

Harvesting

1. Canadian expertise in silver hake harvesting continue to be developed but without increasing the overall capacity of the groundfish fleet.

2. The offshore sector should be encouraged to participate in developing this fishery in view of the constraints encountered by inshore vessels in the silver hake box in the spring due to weather and, possibly, towing speed.

3. The inshore sector should be utilized in further experimental fishing,fully monitored by DFO, for silver hake at various times of the year shoreward of the silver hake box. The purpose would be to determine optimum locations and potential by-catch problems, with a long-term view toward developing an inshore silver hake fishery.

4. OSS Arrangements via foreign partners should continue to be viewed as a valuable tool in developing the Canadian silver hake fishery.

5. For purposes of monitoring of catch and maintenance of records, improved co-ordination of Observer logs, Canadian captains' logs and Productions and Sales Records is required. To adequately monitor Catch per Unit Effort, individual cod-ends transferred to OSS vessels should be number-coded, and this number recorded in the Canadian vessel logs and the DFO Observer notes, against the relevant information on tow times, location, species and weights.

6. DFO Observers on board all OSS vessels (domestic and foreign) should continue to be equipped with hand-held radios. A good communication plan is required to monitor future "experimental/commercial" fisheries, and should involve the Captains of the Canadian vessels, all DFO Observers, the foreign partner representatives ashore and at sea, fish plant manager, and DFO staff.

7. The source of the pinkish coloration which may be bruising that was found in the Canadian caught silver hake of both the 65' and 100' draggers should be investigated; smaller loads per tow may be one solution.

Processing

8. Further investigation into the comparison of landed fish quality between conventionally-iced and RSW fish needs to be done.

9. Government-industry efforts to develop appropriate processing equipment to process silver hake onshore should continue.

10. Further silver hake surimi production trials, including end-product development, should be encouraged.

Marketing

11. Comprehensive market studies exploring a wide range of possible silver hake products should be undertaken and future marketing plans should include follow-up measures, possibly on site, where feasible.

Policy

12. Regulatory and policy issues affecting or potentially affecting the development of a Canadian silver hake fishery should be examined. For example, to develop Canadian expertise in processing silver hake, foreign vessel sales to Canadian processors could be considered. Also, linkages on a "same species" basis could be considered, to encourage future joint-ventures.

References/Notations

1. Scott, 1982, Waldron, 1983, Almeida, 1985 and Waldron et and al, 1982. Complete citations are provided in Appendix III.

2. Conover et al., 1961, Konstantinov and Noskov, 1966 and 1969, Nichy, 1969, Halliday, 1973, Kohler, 1968, Sarnits and Sauskan, 1966 and Sauskan, 1964. Complete citations are provided in Appendix III.

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4. Anderson, E. D., F. E. Lux, and F. P. Almeida. The Silver Hake Stocks and Fishery off the Northeastern United States. In The Hakes, Marine Fisheries Review, National Oceanic and Atmospheric Administration, National Marine Fisheries Service; W. Hobart, Managing Editor. Vol. 42 (1), January, 1980.

5. Combs, E.R., Inc. Venture Analysis and Feasibility Study Relating to Whiting and Atlantic Mackerel. Report prepared for the New England Fisheries Development Program and the National Marine Fisheries Service, Contract No. 03-7-073-35121. December, 1977.

6. Jaffe, E. M., Resource Management Specialist, National Marine Fisheries Service, personal communication, October 1989.

7. Almeida, F.P., T.S. Burns and S. Chang. The 1988 Experimental Whiting Fishery: A NMFS/Industry Co-operative Program. National Marine Fisheries Service manuscript report 1988/89.

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9. Tavel Ltd. Report on Experimental Silver Hake Fishery - Scotia-Fundy 1987. Submitted to the Silver Hake Experimental Fishery Steering Committee, January 1988.

10. Specifications provided by K. Spencer, Canadian Institute of Fisheries Technology, Technical University of Nova Scotia, Halifax, NS.

11. MARR Seafoods - Richard Lander, personal communications, 1989.

12. Karlsen Shipping - Martin Karlsen, personal communciations, 1989.

Appendix I

Lists of Participants in Silver Hake

Developmental Fisheries

1987 - 1989

List of Participating Vessels and Captain/Owners

Nova Scotia Dragger Fishermen's Association (Developmental Quota)

Vessel	**Captain/Owner**
Ocean Swell	Greg Morrell
Cape Mariner	Daniel LeBlanc
Sylvia Lynn II	Julien LeBlanc

Maritime Fishermen's Union (Developmental Quota)

Jeremy and Sisters	Brayton Nickerson
Patches I	Joey Nickerson
Jasamin's Pride	Dick Fevens
Bayliner	Bobby Amirault

100'Dragger (Competitive Quota)

Island Princess	Raymond Deveau

Participant Groups in the Developmental

Silver Hake Fisheries 1987 - 1989

1. Nova Scotia Dragger Fishermen's Association (NSDFA)
2. Maritime Fishermen's Union (MFU)
3. Karlsen Shipping Company
4. MARR Seafoods Ltd.(MARR)
5. Tavel Consultants
6. Cansov Marine Products Ltd.
7. Fisheries Products International
8. Soviet and Cuban fishing/processing vessels
9. Eldorado Seafoods
10. Fisheries Products International
11. Seafreeze Corportion, a consortium of the following inshore processing companies:
    - Sweeney Fisheries
    - Sable Fish Packers
    - Comeau Seafoods
    - Cape Ann Seafoods
    - Arctic Fisheries
    - Continental Seafoods
    - R. I. Smith
    - Seafoods Producers Association of Nova Scotia
    - Connors Seafoods
    - Eastside Fisheries
12. Nova Scotia Department of Fisheries (NSDF)
13. Department of Fisheries and Oceans (DFO)

Appendix II

Scotian Shelf Silver Hake:
Biology and 1989 Commercial Fishery Description

by

D. E. Waldron, M. A. Showell and P. A. Comeau

Marine Fish Division, Dept. of Fisheries and Oceans

Bedford Institute of Oceanography, P. O. Box 1006, Dartmouth,

Nova Scotia, Canada B2Y 4A2

May 1990

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Marine Fish Division, Department of Fisheries aand Oceans
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General Biology

Silver hake (Merluccius bilinearis, Mitchill, 1814), sometimes referred to as whiting, is a member of the class Pisces (Osteichtyes), order Anacanthini, and family Gadidae. The presence of one as opposed to two or three anal fins makes the Merlucciidae readily distinguishable from other gadoids such as cod, haddock and pollock. Various species of Merluccius are found throughout the world's oceans generally in temperate waters and around upwellings in some tropical areas. In the eastern Atlantic from Norway to South Africa there is a large stock complex composed of seven varieties either classified as subspecies of Merluccius merluccius (Franca, 1960 and Jones, 1974) or as a separate species.

Several of the hake stocks along the eastern Atlantic support major fisheries. In particular the European hake, Merluccius merluccius, found along the coast of Western Europe is the third largest groundfish fishery in the area producing 80,000 metric tons annually. Another species, Merluccius capensis found off the West African coast provides a large fishery to Namibia and South Africa.

There are five species of Merluccius in the western Atlantic (Bullock, 1980). Two species, M. albidus and M. bilinearis, are present in the northwest Atlantic. Merluccius albidus, commonly referred to as the offshore hake, is similar in appearance but often larger than M. bilinearis. Only the larger members of this species have been observed in research vessel and commercial catches off Nova Scotia (Waldron and Fanning, 1986). Merluccius albidus have a bluish back in contrast to the dark grey back of M. bilinearis. Speciation is confirmed by counting the number of gill rakers on the first gill arch. M. albidus has 9-11 gill rakers while M. bilinearis has 15-22 gill rakers. Bigelow and Schroeder (1955) propose that M. albidus caught in Nova Scotian waters are rare and definitely at their northern extreme.

Silver hake is a deep water species inhabiting an area from Cape Hatteras to the Grand Banks including the Gulf of St. Lawrence (Bigelow and Schroeder, 1953 and Leim and Scott, 1966). The major portion of the population (42%) is found in waters from 100-149m during the summer (Scott, 1982). Silver hake were seldom present (< 1%) in waters deeper than 200m while 11.5% were in waters more shallow than 50m.

Silver hake have a temperature range of 1-13^{0}C with a preferred range between 7^{0}C and 10^{0}C (Scott, 1982). The average winter bottom temperature on the Scotian Shelf is between 1 and 6^{0}C. At this time of year part of the silver hake population are found in the deep basins of the Scotian Shelf (Waldron, 1983) and the Gulf of Maine (Almeida, 1985) where the temperature is 4-8^{0}C. The major portion of the silver hake stock resides in the deeper slope waters off Nova Scotia and the northeast coast of the USA (Almeida, 1985 and Waldron et al., 1982). As spring approaches the population moves into the more shallow waters of the Scotian Shelf (Figure 1).

Historical Fisheries Management

Fisheries management of silver hake in the northwest Atlantic commenced in 1958 under the International Commission for the Northwest Atlantic Fisheries (ICNAF). Quotas and stock boundaries were first imposed by ICNAF in 1973 for Subarea 5 and Statistical Area 6 and in 1974 for Subarea 4 (Anon., 1972, 1973). Since 1977 the silver hake stocks have been managed separately by Canada and the United States.

Four stocks were defined as a result of several biological studies conducted by Soviet, American and Canadian researchers (Conover et al., 1961, Konstantinov and Noskov, 1966 and 1969, Nichy, 1969, Halliday, 1973, Kohler, 1968, Sarnits and Sauskan, 1966 and Sauskan, 1964). Those management units were:

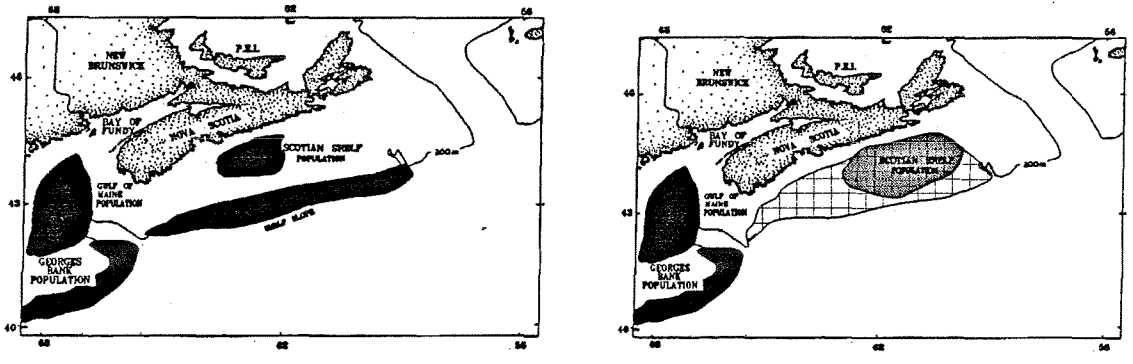
1. The Scotian Shelf (Subarea 4VWX) stock,
2. The Gulf of Maine (Subarea 5Y) stock,
3. The Georges Bank (Subarea 5Ze) stock, and
4. The Southern New England - Middle Atlantic stock (Subarea 5Zw and Statistical Area 6).

An active Scotian Shelf silver hake fishery commenced in 1961 with the arrival of the Soviet fishing fleets. Peak catches occurred in 1963 (123,000 t), 1970 (169,000 t) and the largest in 1973 (300,000 t). Historically the fishery operated from March to early October with minimal catches occurring earlier and later in the year. The most active fishing areas were and still are the slope waters of the Emerald and Sable Island Banks (Figure 1).

Concern over the low levels of certain fish stocks on the Scotian Shelf prompted a 1976 meeting of the ICNAF Standing Committee on Research and Statistics (STACRES) to review the distribution of the silver hake fishery in relation to other groundfish (Anon., 1977). Three areas were identified as being actively fished for silver hake. In one area, along the edge of the Scotian Shelf, Canadian research survey results indicated the least overlap in distribution with other commercial species. The committee noted however that:

> "... the northern limit of this fishery area is critically important, as the haddock could be subjected to by-catch problems, particularly in the winter when they are aggregated in prespawning and spawning concentrations. These aggregations can occur to a depth of 155 m (85 fath.) in winter (November to March or April inclusive), depending on hydrological conditions. However, in summer (May to October inclusive), haddock occur in shallow areas, and fishing for silver hake along the edge of the continental shelf in depths as shallow as 120 m (65 fath.) would avoid the main areas of haddock distribution".
>
> (Anon., 1977)

Based on this advice, ICNAF made the following regulatory proposal for the Scotian Shelf silver hake fishery: fishing with small meshed gear (60mm) will be permitted in an area south and east of a line defined along the edge of the Scotian Shelf and will occur between April 15 and November 15 of each year (Waldron and Sinclair, 1984). This line has become known as the Small Mesh Gear Line (SMGL) (Figure 1). When Canada declared a 200 mile Economic Management Zone in 1977, the ICNAF recommendations were accepted and codified in the Canadian Foreign Fishing Regulations. In addition regulations were introduced to increase the trawl codend mesh size from 40mm to 60mm and limit the by-catch of haddock to less than 1%. Other important commercial species were restricted to a by-catch less than 10% of the total weight aboard the vessel.



Spring Fall

Figure 1. Spring and Fall distribution of Scotian Shelf silver hake.

1989 Foreign Fishery

Distribution of fishery

The 1989 Scotian Shelf silver hake fishery began on March 15 with 2 Cuban and 2 Soviet vessels operating under an experimental permit. The normal fishing season began on April 1 and lasted until late July, 1989. In total, there were 9 Cuban and 43 Soviet fishing vessels active during the fishery.

The fishery began in the vicinity of Dawson Canyon and spread east and west along the shelf break in area 4W (Figure 2, a&b). Spatial distribution of the fishery reached a maximum in June, although the largest concentrations of vessels were always in the vicinity of Verril and Dawson Canyons. Fishing effort was primarily concentrated in area 4W, although both the USSR and Cuba expanded into area 4X in June (Figure 2, a&b).

Catch

The total catch of silver hake by the foreign fleets was 85,752t or 63.52% of the 135,000t TAC assigned by Canada (Table 1). Over 50% of the 1989 silver hake catch was taken by the middle of May (Figure 3a). Weekly catch of silver hake peaked in mid April for the USSR, late May for Cuba (Figure 3b). Past the end of June, additional effort expended by the fleets resulted in minimal catch.

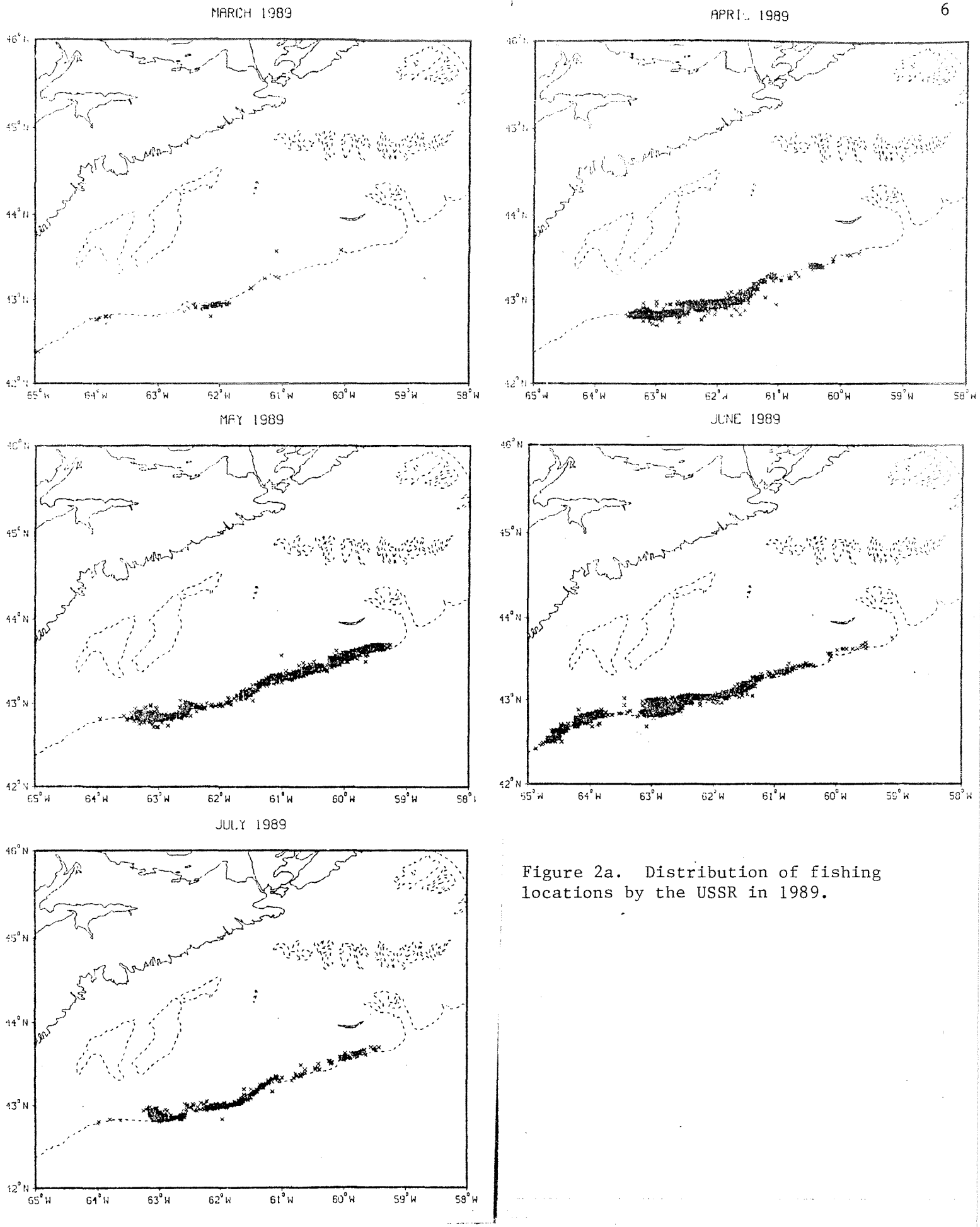
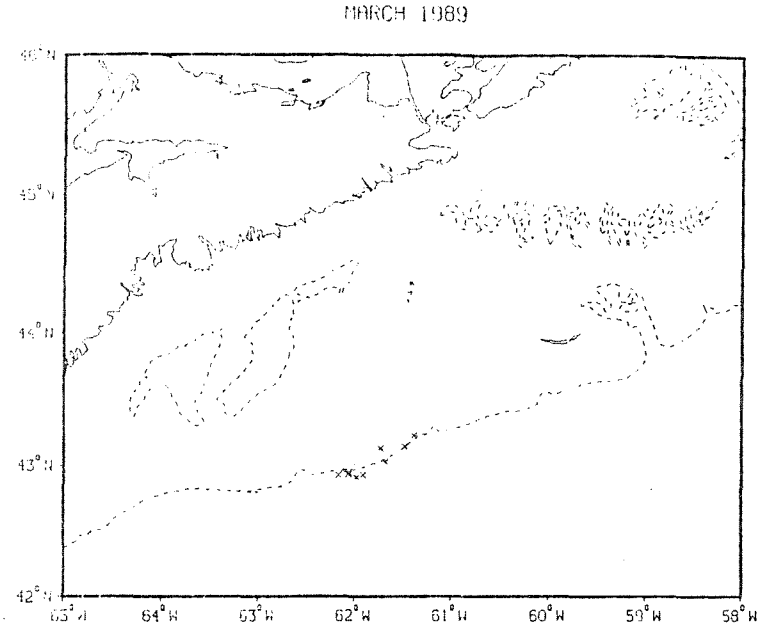
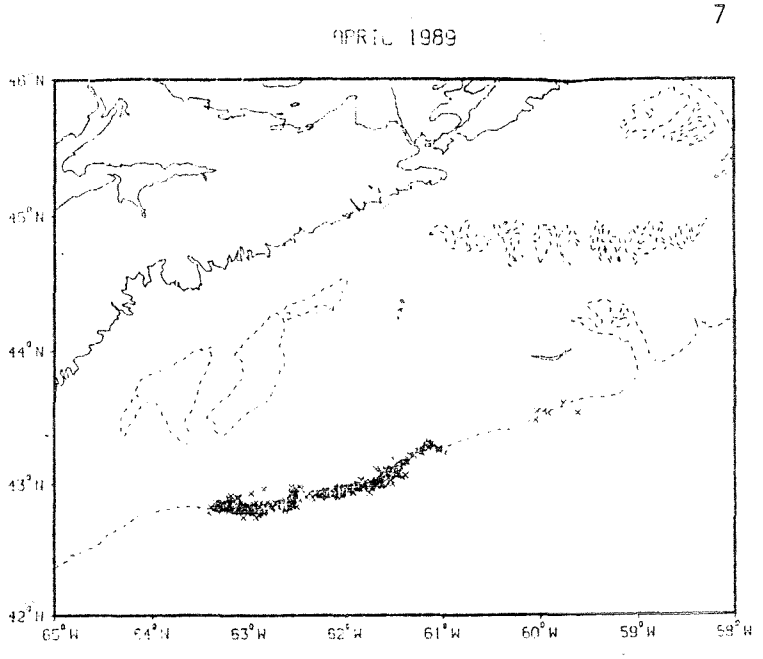
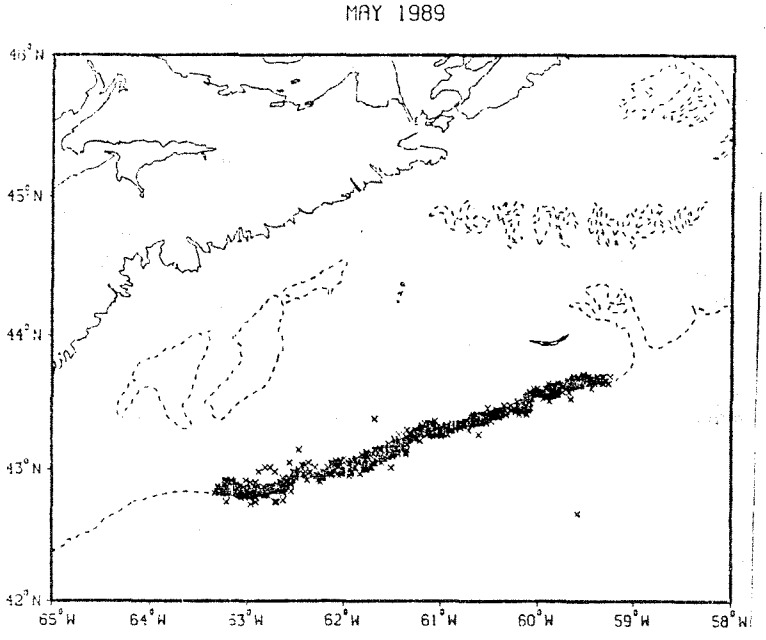
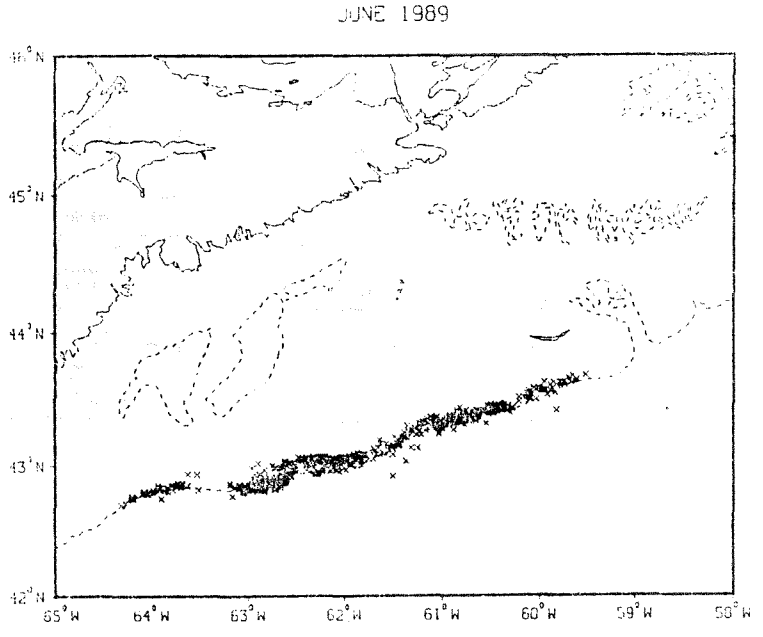


Figure 2a. Distribution of fishing locations by the USSR in 1989.









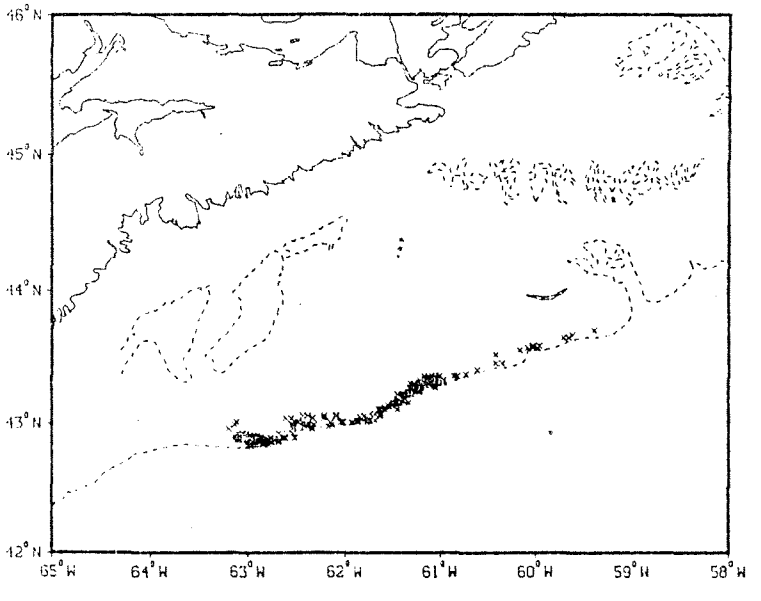


Figure 2b.: Distribution of fishing location by Cuba in 1989.

Table 1. Catch and effort expended in the 1989 silver hake fishery.

Country	Month	Week of Year	Effort (hours)	Catch					
Cuba				Silver hake	Cod	Haddock	Pollock	Redfish	Flounder
	March	11							
		12							
		13	13.24	152.61	0.71	3.3	0.08	0.675	0.015
		14	116	603.033	0.697	0.05	2.48	8.73	0.371
	April	15	192.3	1003.584	1.386	0.522	24.644	22.554	0.536
		16	286.94	1179.144	1.581	3.062	51.994	7.47	0.46
		17	201.64	1409.139	0.373	1.682	31.222	3.786	0.284
		18	263.68	1590.404	7.089	39.972	50.104	0.831	2.563
	May	19	556.66	1739.877	5.799	31.894	123.045	2.251	3.215
		20	512.57	1190.054	1.227	10.985	36.051	1.561	1.409
		21	620.69	1987.916	2.45	28.3	69.115	0.557	3.753
		22	609.29	880.52	7.214	16.975	112.498	0.793	2.287
	June	23	518.84	833.074	10.968	30.773	10.607	0.375	3.925
		24	345.9	700.845	3.244	13.395	28.019	0.073	0.311
		25	390.86	816.359	0.766	7.005	3.55	0.011	0.66
		26	266.15	588.026	1.583	6.194	2.859	0.072	0.403
	July	27	352.77	532.824	0.97	8.941	15.607	0.301	1.361
		28	223.21	146.824	1.455	7.505	7.94	0.084	1.244
		29	39.01	22.642	0.59	3.503	20.298	0.05	0.818
Sum			5470.74	15354.23	47.512	210.555	569.815	50.124	22.797

Table 1. Catch and effort expended in the 1989 silver hake fishery (Cont.).

Country	Month	Week of Year	Effort (hours)				Catch		
USSR				Silver hake	Cod	Haddock	Pollock	Redfish	Flounder
	March	10			0.309439	1.371315	3.711126		
		11	11.41	13.116	0.126	0.06	0.048	0.5	0.015
		12	46.5	205.904	0.13	0.053	2	1.333	0.116
		13	30.48	562.8	0	0	0	1.443	0.01
		14	476.48	3126.58	0.052	0	0.372	21.246	1.497
	April	15	1600.03	8867.986	6.304	4.519	57.937	72.413	8.466
		16	1776.23	7891.45	9.202	17.073	344.772	14.436	2.781
		17	1194.13	9535.946	2.254	12.043	162.233	66.038	0.416
		18	1311.69	7648.242	38.892	176.817	230.762	11.151	8.492
	May	19	1398.42	5001.146	19.078	59.999	501.052	17.019	5.833
		20	1003.54	2508.719	5.311	25.775	101.409	14.87	1.175
		21	992.41	3055.087	4.915	34.623	50.814	3.379	4.534
		22	1746.95	3620.134	10.421	28.716	93.679	5.842	5.039
	June	23	1829.41	6061.869	12.466	37.795	73.671	6.394	6.417
		24	1374.35	4214.181	13.844	33.038	49.079	0.456	0.806
		25	880.97	1499.944	15.539	22.081	23.439	0.019	1.104
		26	1106.16	2672.724	14.857	22.991	26.753	0.618	1.207
	July	27	582.49	3021.376	2.612	8.585	2.082	0.064	0.043
		28	623.06	472.138	1.064	5.456	19.87	0.438	2.338
		29	390.57	156.056	15.61	18.683	1.605	0.21	3.984
		30	318.41	262.557	0.978	3.608	1.55	0.282	2.359
	August	31	12.49	1.875	0.125	1.325	2.8	0.005	0.155
Sum			18693.69	70397.95	173.655	511.915	1743.127	238.151	56.632

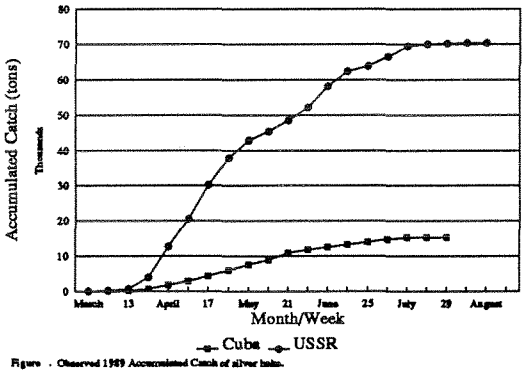


Figure 3a.

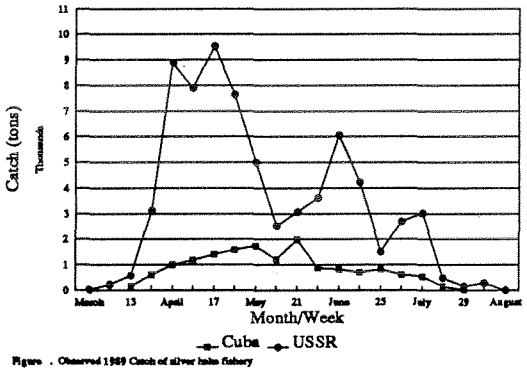


Figure 3b.

Effort

The amount of effort expended in the fishery was measured in both days and hours fished. For relative abundance purposes, effort is more reliably reflected in the hours fished rather than days fished, since the number of hours fished per day depends upon the amount of catch, processing capacity and weather to mention a few. For the remainder of this paper, hours fished is synonymous with effort.

Of the two countries fishing in 1989, the USSR accounted for 77.4% of the fishing effort, while Cuba accounted for 22.6% of the 24,165 hours observed Figure 4, a&b). This distribution is similar to that observed in previous years.

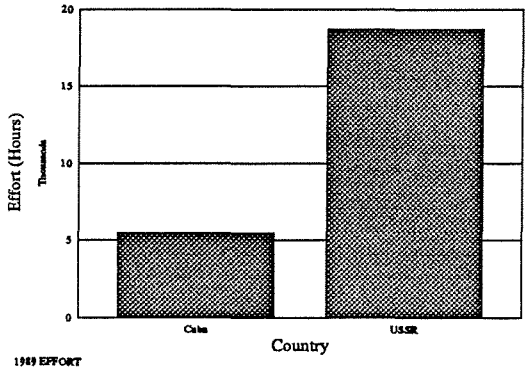


Figure 4a.

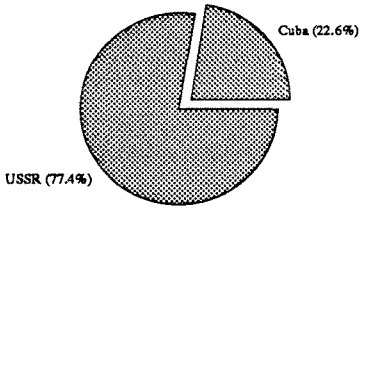


Figure 4b.

Weekly effort by the USSR displayed two peaks, one early in April and another early in June (Figure 5). Fishing effort by Cuba peaked in late May (week 21). Effort decreased steadily through July, with the fishery ending in week 31 (Figure 5)

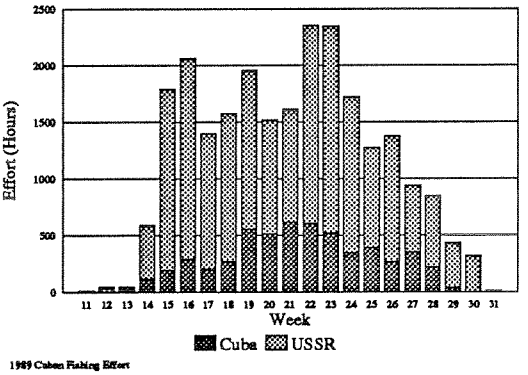


Figure 5.

Catch per unit of effort for silver hake peaked in March at nearly 18 tons per hour for the Soviet fleet and 12 tons per hour for Cuban fleet. In addition, peak catch rates were observed in mid April and early July. Overall, catch rates systematically declines from March until the end of the fishery in August.

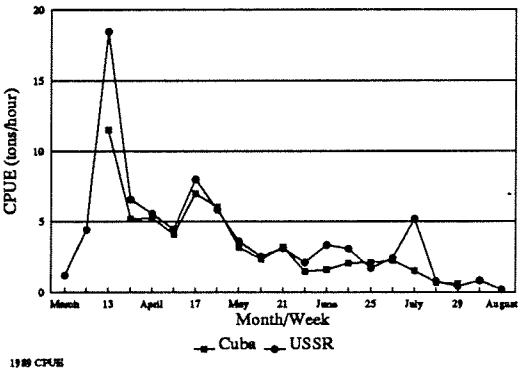


Figure 6.

By-Catch

By-catch of regulated species is always of major concern in the foreign silver hake fishery. Firm by-catch regulations are in place and enforced by the presence of Canadian Observers. Since 1987 there has been 100% Observer coverage on all foreign fleets fishing off Nova Scotia. Data collected by the Observers are currently incorporated in both the 4TVW Haddock and 4VsW Cod assessments.

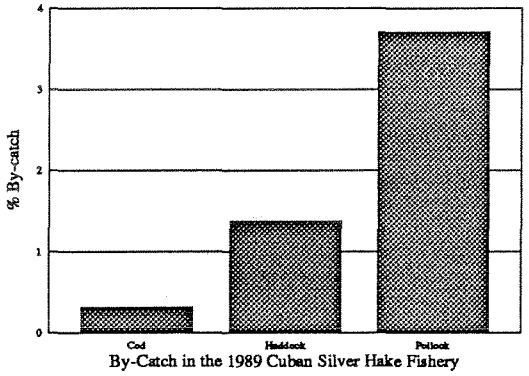


Figure 7a.

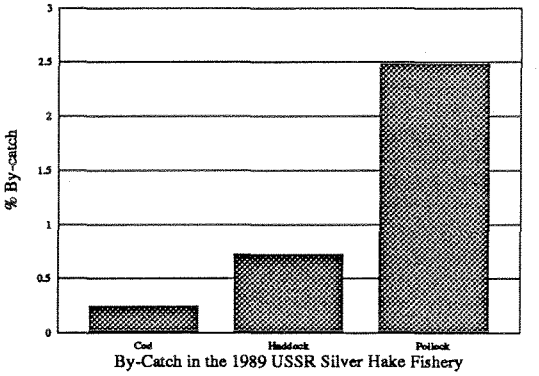


Figure 7b.

Overall, by-catch in the silver hake fishery was relatively low. Percentage bycatch by species, for the fishing period are presented in Figure 7, a&b. The haddock by-catch by Cuba was the only category which exceeded the regulated level.

Examination of incidental catch by week suggests that by-catch increases as the availability of silver hake decreases (Figure 8 a&b). The by-catch of haddock in the Cuban fishery rises above the 1% level beginning in late April, and continues to exceed this limit until the end of the season. Cod by-catch followed a similar trend, although levels stayed below the regulated percentage.

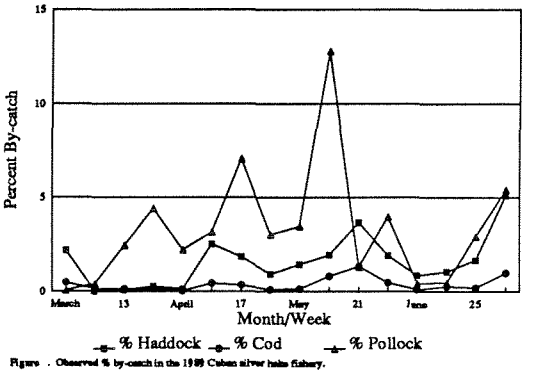


Figure 8a.

Similarly, the weekly by-catch of haddock in the Soviet fleet was again slightly above the regulated 1% level in the later part of April. However, in total the haddock by-catch by the USSR was below 1%. As observed in the Cuban fishery, pollock and cod by-catch levels were below the regulated levels.

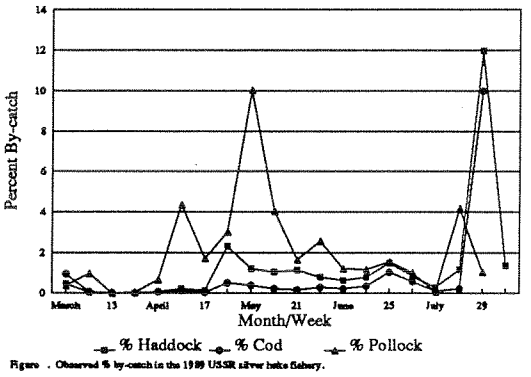


Figure 8b.

As a general observation, the by-catch experienced by both the Cuban and Soviet fleets were below the regulated levels, which is positive testimony to the effectiveness of the Scotia-Fundy Observer Program and the management of this fishery by the Department of Fisheries and Oceans in the Scotia-Fundy Region.

1989 Domestic Fishery

Fleet Activity And Catch Distribution

The 1989 Domestic fishery was conducted on an experimental basis during the month of April (13 days) and early May (2 days). The major area of concentration was along the Scotian Shelf edge, amongst the foreign fleets (Figure 9).

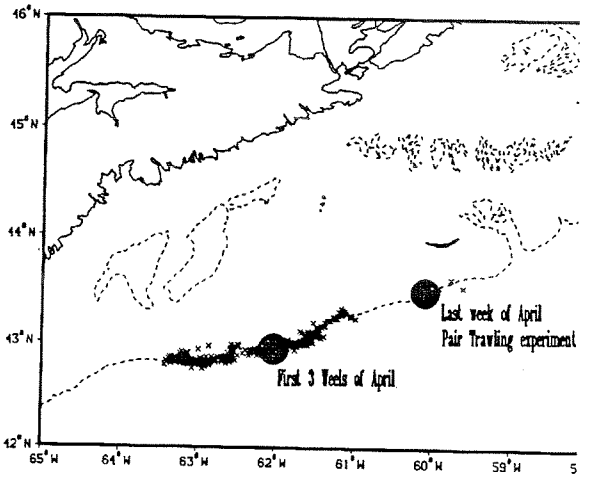


Figure 9. Map showing distribution of foreign (x) and domestic (circles) during the month of April 1989.

Two experiments were conducted; the first consisted of codend transfers between < 65' domestic vessels and a Soviet commercial trawler, using bottom otter trawls. For the second experiment, the domestic vessels worked together in pair trawling, with codend transfers to the same Soviet vessel.

Catch and By-Catch

The species catch was primarily silver hake (291 tons). Complete details of by-catch are not available at this time because of difficulties in correlating observed catch aboard the domestic vessel and that reported for the same catch aboard the receiving vessel. The available information is presented in Table 2 (below).

Table 2. Breakdown of catch (tons) by week for the 1989 Canadian silver hake fishery.

Domestic Weekly Catches				
Week	Silver hake	Cod	Haddock	Pollock
15	34.345	.070	.195	.298
16	191.860	.038	.413	9.121
17	45.738	.030	.500	13.433
19[1]	19.550	.050	2.667	.332
Total	291.493	.188	3.775	23.184

[1] Pair trawling experiment

For the period studied, silver hake made up 91.4% of the total catch. The other species made up approximately 10% of the total catch. The foreign fishery catch composition during the same time period was very similar.

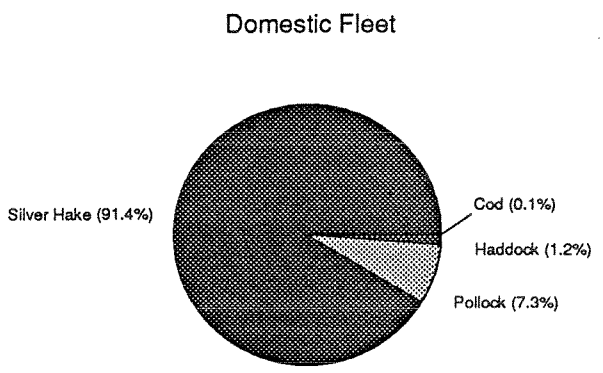


Figure 10a. Domestic catch composition.

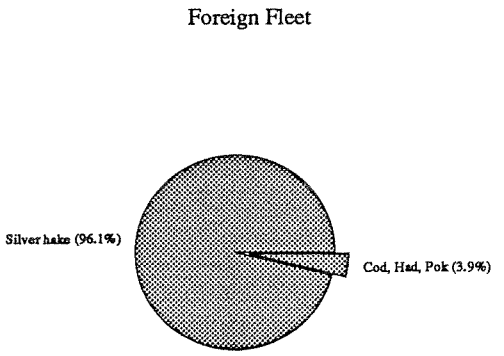


Figure 10b. Foreign catch composition.

Catch Rates

The Observed catch rates for the single vessel experiment were below that observed in the foreign fleet, as presented in Table 3.

Week	Domestic CPUE	Foreign CPUE
15	0.5	4.5
16	1.1	6.6
17	0.6	3.0
19[1]	1.2	4.7

[1] Pair trawling experiment

Table 3. Breakdown of catch per unit of effort (tons/hour) for the 1989 Canadian silver hake fishery. Catch rates from the foreign fishery for vessels fishing in similar areas at the same time are provided for comparison purposes.

Length Composition of Catch

Silver Hake

Historically, the catch of silver hake in the 4VWX fishery has targeted primarily on one or two age classes, and this pattern has remained consistent in 1989. In the foreign catch a modal length of 30 cm was predominant in all months of the fishery (Figure 11). This represents the catch of age 3 fish. A smaller, second peak was seen in June and July. This is indicative

of age two fish reaching a size where they are recruited to the fishery. The size distribution of silver hake in the domestic fishery (April) very closely resembles the foreign fishery, with a modal length of 29-30 cm. (Figure 12).

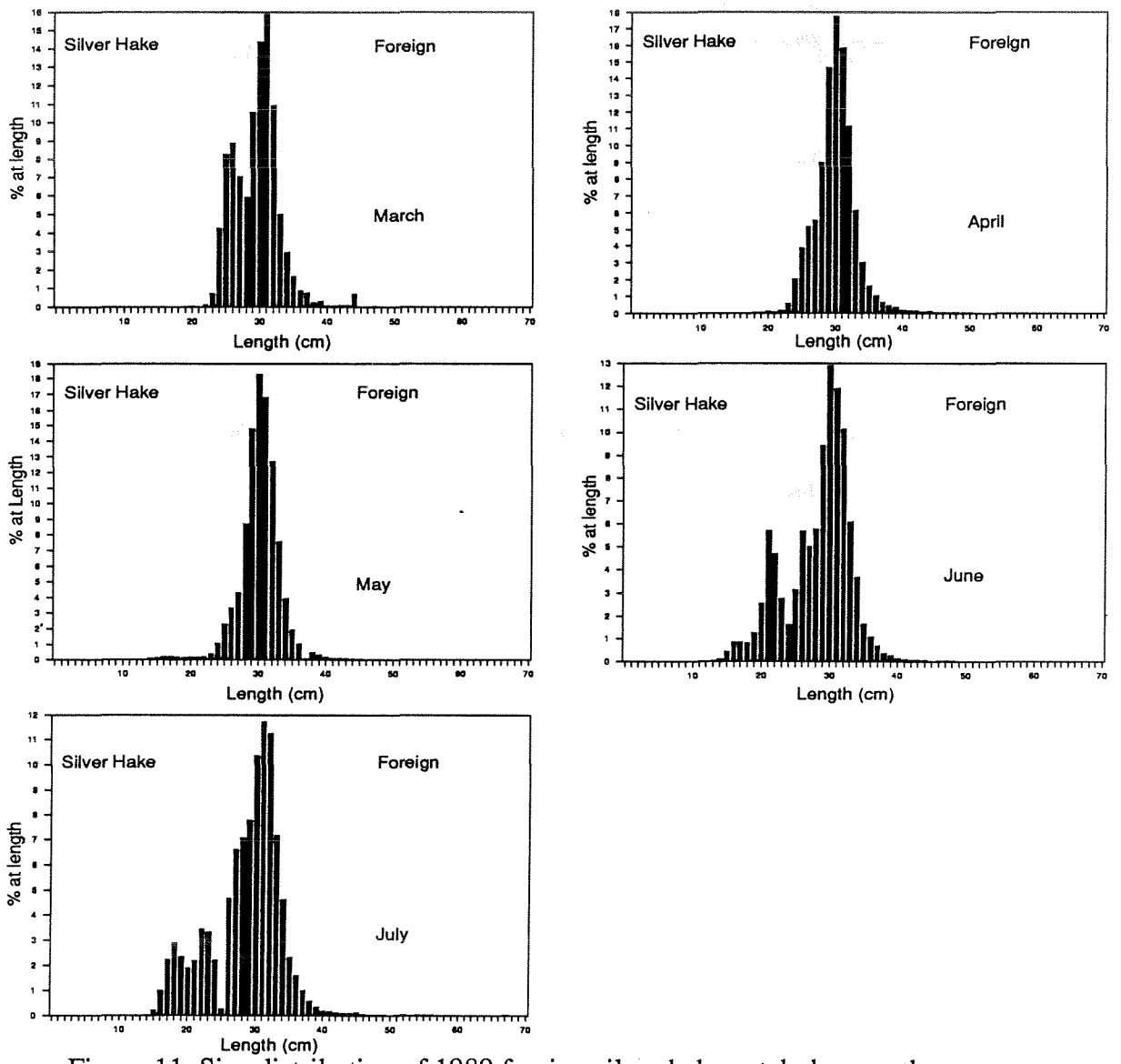


Figure 11. Size distribution of 1989 foreign silver hake catch, by month.

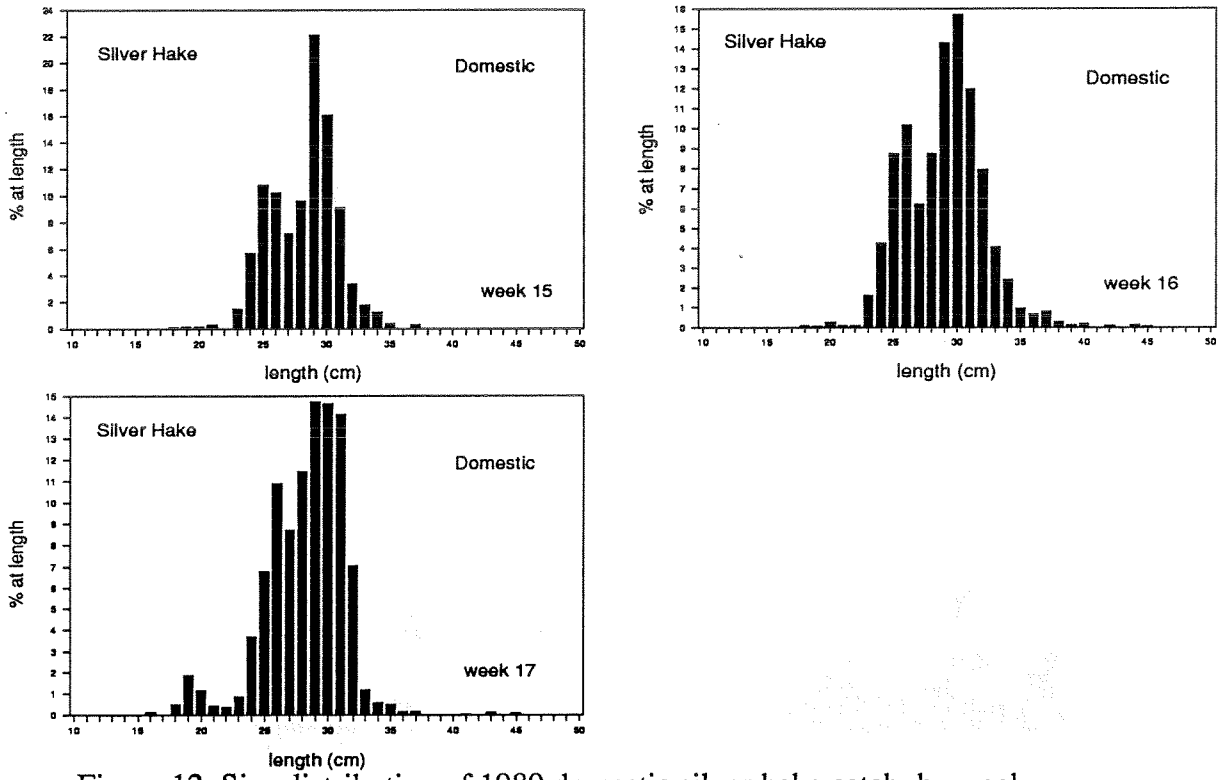


Figure 12. Size distribution of 1989 domestic silver hake catch, by week.

Haddock

By-catch of this species by foreign vessels is of concern for the overall management of the fishery, and high by-catch of this species has prompted the closure of the fishery in the past. Size distribution of the catch was seen to vary over the course of the fishery (Figure 13). In the early months of the fishery a modal length of 31 cm (age 2) predominated in the catch, with additional peaks at 20 (age 1) and 48 (age 3) cm. However, from June to the finish of the fishery, higher proportions of age 1 fish were seen. Large haddock (40+ cm) generally occurred in small proportions, except for May. Again, the size distribution of the domestic haddock catch in April very closely mirrors that of the foreign fishery (Figure 14).

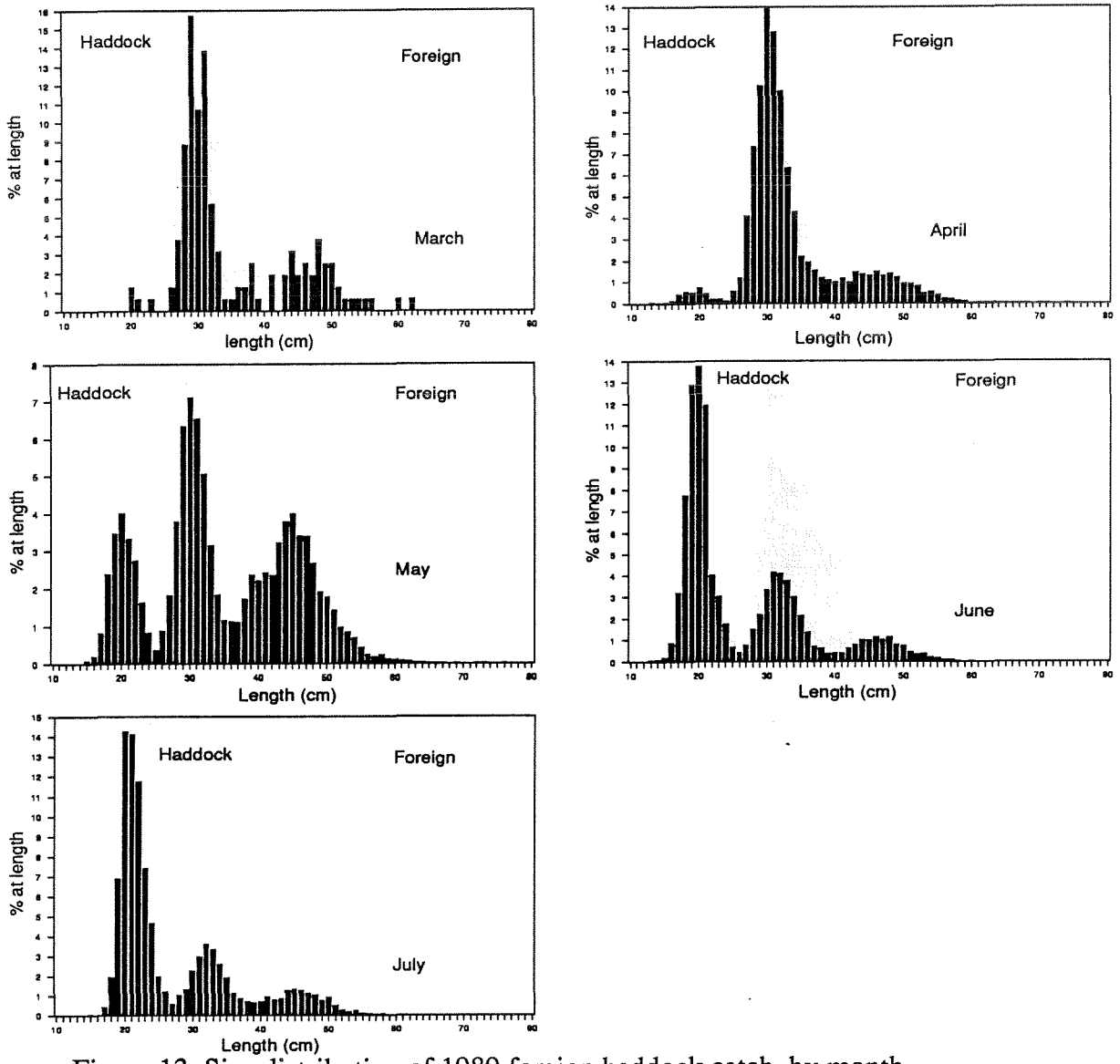


Figure 13. Size distribution of 1989 foreign haddock catch, by month.

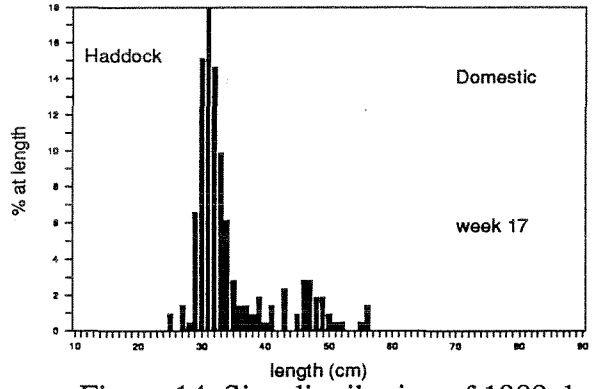


Figure 14. Size distribution of 1989 domestic haddock catch, by week.

Cod

The distribution of this species was also seen to change over the course of the fishery Figure 15). In April the majority of cod in the catch were greater than 45 cm in length. However, from May on the length distribution shifted substantially towards the smaller length groups, with a modal length of 35-45 cm.

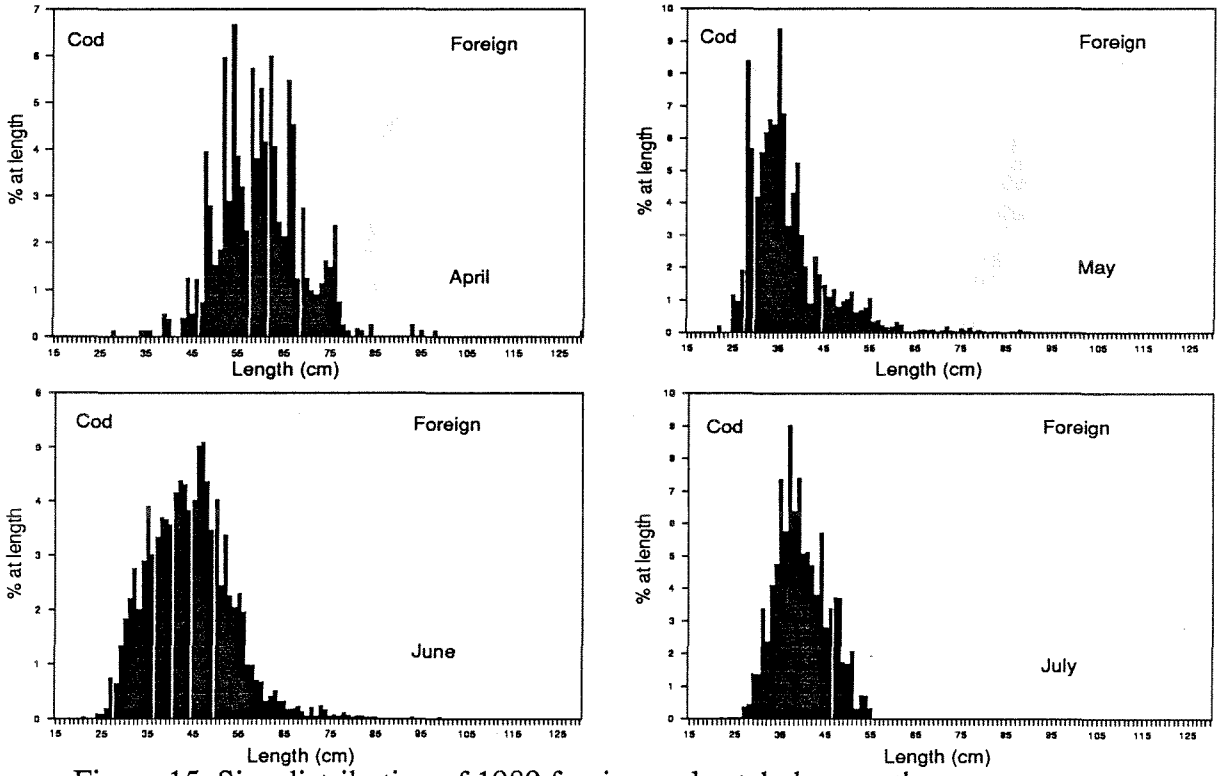


Figure 15. Size distribution of 1989 foreign cod catch, by month.

Pollock

A peak of 41-42 cm fish was seen for all months of the fishery, representing age 2-3 fish (Figure 16). Larger fish (55+ cm) were a high proportion during April, but declined steadily through the fishery and were totally absent in July. The distribution of this species in the domestic fishery differed from that of the foreign in that the modal length was slightly higher (Figure 17).

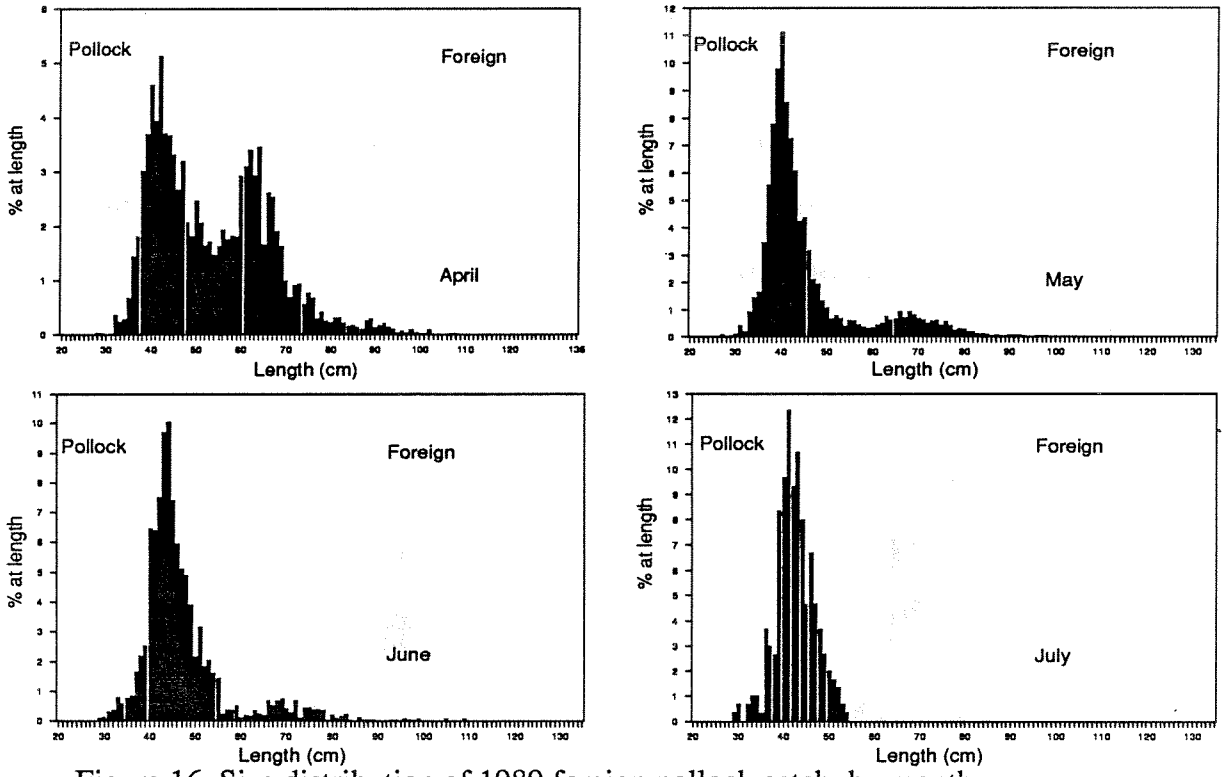


Figure 16. Size distribution of 1989 foreign pollock catch, by month.

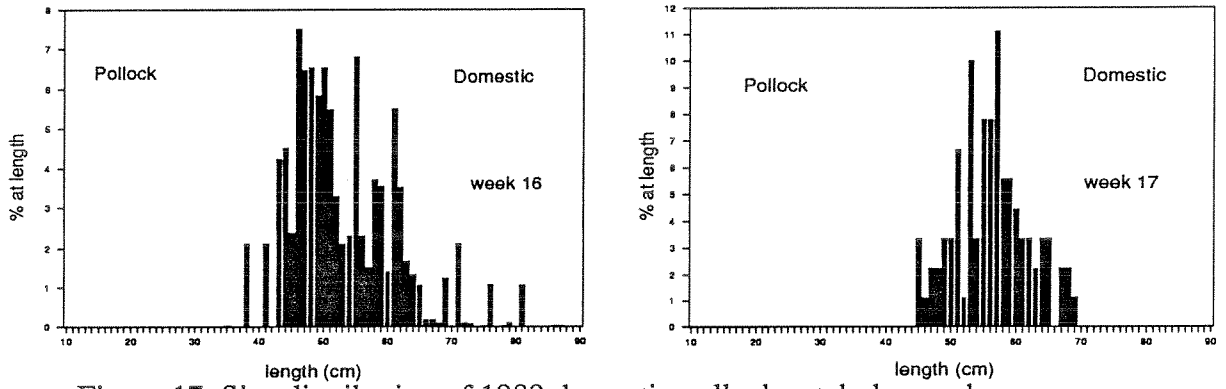
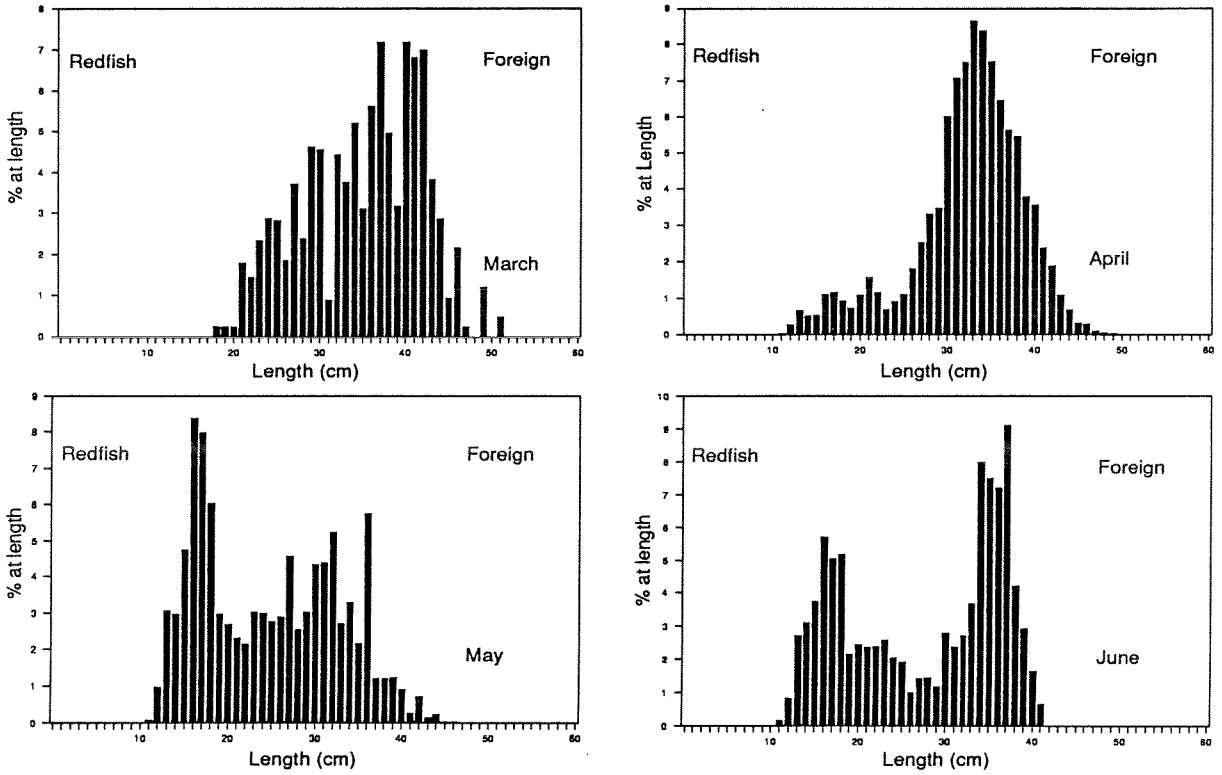


Figure 17. Size distribution of 1989 domestic pollock catch, by week.

Redfish

The size distribution of this species resembled that of pollock over the course of the fishery Figure 18). Larger size classes predominated in the early months of the fishery, but were gradually supplanted by smaller fish by July.

No length frequency samples were available from the domestic fishery for comparison.



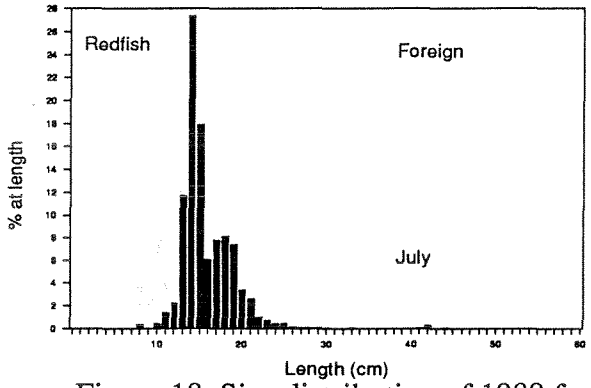


Figure 18. Size distribution of 1989 foreign redfish catch, by month.

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APPENDIX III

Report on Onshore

Silver Hake Processing

Pilot Project

at

the Karlsen Fish Plant

New Harbour, N.S.

April/May, 1989

by

P. Norsworthy

Tavel Ltd.

November 1989

Commercial production of silver hake was completed at Karlsen Shipping Company Limited located in New Harbour, N.S.. Exhibit 1.1 presents a production chronology from 1989 efforts.

Exhibit 1.1 **Production Chronology (kg)**

Date	Landings	Meal	Packed (kg) H & G Petfood	H & G 5 's	Fillet Block	Fillet Other	Other	Total
April 17	9,911	5,550	2,595	48		88		2,731
April 18	8,868	2,132	2,934	628	37	11	274	3,884
April 22	12,859	2,857	4,431	1,376	120	59		5,986
April 24	8,822	3,447	2,275	660	90	125		3,150
April 25	3,062	1,719	160	256			363	779
April 29	4,145	3,519		363				363
May 1	10,410	2,948	3,133	188			1,089	4,410
May 2	10,069	1,724	2,594	524	37	206	314	3,667
May 11	4,990	816	1,258	313	285		474	2,330
	73,136	24,712	19,380	4,356	569	481	2,514	27,300

Source : Karlsen Shipping production and inventory records

Lot samples were procured from various harvesting and storing methods to assess product quality using DFO Recommended Dockside Grading Practices. As Exhibit 1.2 shows much of the product was of "Grade B" quality due mostly from bruising and discolouration and secondly from texture.

Exhibit 1.2 **Landed Quality Profile**

Stowage Method	Gear Type	Sample Size	Caught Age (hours)	Grade A	B	C	R
Penned	Otter Trawl	110	56	32 %	63 %	5 %	0 %
Boxed	Otter Trawl	20	40	10 %	75 %	15 %	0 %
RSW	Otter Trawl	19	65	0 %	94 %	6 %	0 %
Penned	Pair Trawl	40	12	35 %	60 %	5 %	0 %

Due to harvesting constraints long tows, 3-4 hours, were encountered, thus crushing the fish in the codend leading to most of the downgrading. The product texture was very good (1 % "C" grade) considering the caught age of some of the samples.

Storage tests using circulated and non circulated chilled seawater (CSW) were conducted for penned product. The product was held until a total caught age of 5.5 days with only 25-30 % of the product being downgraded to "C" and no occurrences of reject samples. Exhibit 1.3 illustrates the findings.

Exhibit 1.3 **Product Holding Test**

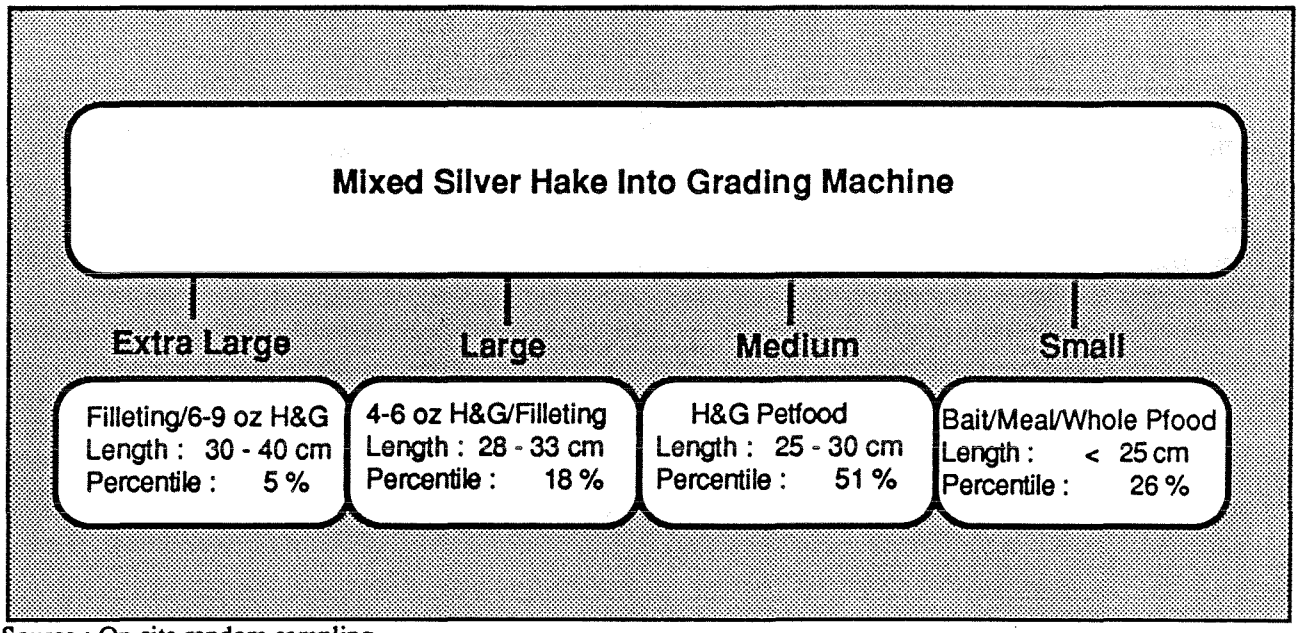
Stowage Method	CSW	Sample Size	Caught Age (hours)	Grade A	Grade B	Grade C	Grade R
Penned	Recirculated	20	88	0 %	75 %	25 %	0 %
		20	112	0 %	80 %	20 %	0 %
		20	136	10 %	75 %	25 %	0 %
Penned	Not Recirculated	20	88	5 %	70 %	20 %	0 %
		20	112	0 %	100 %	0 %	0 %
		20	136	0 %	70 %	30 %	0 %

Wetfish Processing

All participating midshore vessels modified their traditional penned holds to accommodate flooding, facilitating the use of a Transvac, supplied by Innovac Corp., wetpump unloading system. The catch was pumped from the hold, using a saltwater medium, to a de-watering box in the plant via a 10" hose, and transported directly to processing or stored in a chilled seawater mixture in Xactics containers until processing.

All silver hake products were graded using a Baader 485. This device sorted the catch into 4 sizes, each of which were suitable for different processes. Exhibit 4.4 details the distribution of product to the filleting, heading and gutting (H&G), and bait packs.

Exhibit 1.4 **Process Distribution**



Source : On site random sampling

Filleting Operations

A Baader 182 whitefish filleting machine was used to fillet 28-40 cm. fish. This filleting machine was constructed for the European blue whiting and Alaskan pollack fisheries. Modifications were completed to accommodate the unique bone structure of the fish versus other gadoid species.

The filleting line is capable of producing 100-120 units per minute offering skin on yields of 38-40%. Smaller silver hake, 24-28 cm., was tested; however, some 20% of the product fell to the offal belt while transferring from the heading unit.

The low percentage (20 %) of suitable size product for filleting, with the equipment tested, is the largest constraint for feasibility. the volumes required with given margins to offer payback are presented in the following table.

Exhibit 1.5 **Baader 182 Payback**

	Gross Margin %				
	10 %	20 %	30 %	40 %	50 %
Gross Margin/Finished MT	220	440	660	880	1,100
Gross Margin/Whole MT	77	154	231	308	385
Finished MT Required	3,504	1,752	1,168	876	701
Whole MT Processed	10,013	5,006	3,337	2,503	2,002
Whole MT Harvested	50,065	25,030	16,685	12,515	6,673

Notes :
1) Cost of equipment includes $450 k capital and 10% maintenance per year
2) Total cost of equipment in perpetuity is $771
3) Percentile of harvest available for fillets is 20 %
4) No manufacturing or fixed overhead costs are included .

The filleting capacity is approximately 22 MT of whole product per day. The payback period would be 150 shifts at a 30% margin. This would translate into a payback of 2-3 years at 3 months operating per year. The problem would be in obtaining enough TAC to harvest the amounts necessary to provide the volumes of large fish required for the filleting operation.

The skin on fillets were skinned using a Baader 52 whitefish skinning machine. The fillets have a fat layer, as other hakes, under the skin. Deep skinning and conventional skinning techniques were testing yielding 81% and 92% respectively of the skin on weight. The deep skinning process caused extensive textural damage, 50-80% of fillet area, regardless of grade leaving the product suitable for block only. Conventional techniques provided premium product from grade "A" raw material and some grade "B". The fish can become soft at 4 days old and difficult to skin effectively.

Trimming is required for most fillets due to skin remaining, bruising and fin bones. The major problem was skin remaining on the fillet during conventional skinning. The skinning machine had been set to optimize yields thus reducing the skin loss. This could be overcome by skinning slightly deeper but would result in a lower recovery of 90%.

Trimmed yields during testing of conventional skinned product was 75% of skinless weight. Trimmed yields for industrial production of conventional skinned fillets would be in the 80-90% range, and deep skinned product in 90-95% range. The yield loss is high considering that no boning of the product is required; however, for an industrial operation all fillet would be from machine filleting lines and therefore would have a considerable number of defects comprising of fin rays, skin, and nape.

The final packs processed from the filleting operation include :

- deep skin fillet block
- conventional skin fillet block
- conventional skin layer pack 2-4 oz.
- skin on layer pack 2-4 oz.

The deep skin block is comprised of small poor texture fillets which would sell as standard grade in U.S. block markets. The conventionally skinned product was of better quality and could be marketed as a premium block. The silver hake blocks would have to compete with other low value block products such as Alaskan Pollack and South American Whiting, $0.80-0.85 US $.

The layer pack products were of excellent quality and a suitable size for skinless institutional portion pack,, $0.90-1.00 US $, or skin on for the UK fish and chip market $1.10-1.25 Cdn. $.

Headless and Gutted (H&G) Operations

H&G production was completed on all but less than 25 cm raw material. At the time of commercial production no equipment had been identified that could successfully head and eviscerate silver hake; therefore, the heading operation was done exclusively by hand and the evisceration by hand and by machine using a LaPine M-020 gutting machine.

Scaling of silver hake using a Simor fish scaler was tested. The machine works on a cam system which pulls the fish thorough the scaling heads. The cams however had been designed for larger fish and caused considerable damage to the silver hake. During experiments it was observed that very little scale remained on the material before going thorough the scaling machine. This is thought to have been caused by the fish chafing while in the codend.

Hand heading was performed in similar fashion as mackerel heading whereby the fish is held fin up and the head removed from the body by manually cutting as close to the head as possible keeping the loin intact. The heading losses were in the 33% range with no noticeable loss difference according to size of product.

The LaPine M-020 was used to eviscerate the headed product at rates of 50-60 fish per minute with two operators. This machine is suitable for various sizes but has a tight operating range where the fish are eviscerated effectively removing the majority of black nape. The machine adjustments are very easy to perform with a changeover time of less than one minute.

Industrial production of H&G silver hake products could be expected to yield 60-63.5% recovery depending upon the product size and heading methods used. The labour component in commercial production this year was excessive given the lack of processing equipment used; however, for industrial production a combined heading and gutting device would be the most economical method of producing. There are companies that have expressed interest in modifying similar equipment used in other fisheries for silver hake. The machine capacities should be in the 100-120 fish per minute capacity using two front end operators.

There were various types of H&G products produced including :

- 5 lb. H&G 4-6 oz.
- 5 lb. H&G 6-9 oz.
- 20 kg H&G Petfood
- H&G Brined
- H&G Smoked

All human food packs were done in a white naped H&G fashion. It was necessary to do scrubbing to the material processed in the LaPine gutting machine to remove black nape and entrails.

After gutting and/or scrubbing all H&G products were washed in a Whirlpool batch washer before packing.

The 5 lb. commercial packs were packed in a long pack fashion and overwrapped to reduce freezing loss. The majority of these packs were of the 4-6 oz. size due to limited quantities of 6-9 oz. product. The finished pack quality was good with scale only remaining along the base of fins and some flesh punctures encountered.

The H&G petfood was prepared in both white nape and black nape fashion and packed in 20 kg. boxed with an overwrap. It is not necessary however to sell this product in a cartoned form. A plastic wrapped finished product is all that is required to supply this market making vertical plate freezers very suitable for this production (similar to herring bait packs).

Limited quanitities of brined and smoked H&G silver hake were processed to determine finished product qualities and processing requirements. The final packs were very appealing and would be suitable for specialty markets.

Other Processing

Small silver hake, less than 25 cm., were processed into 20 kg whole petfood and a 20 kg bait pack. These are low value products; however, they do offer a better return than processing this product into meal. Successful marketing of these smaller products are key in the overall economic feasibility of this fishery because the small fish constitute a high percentage of the catch (25%).

Minced product from H&G silver hake was processed; however, there were significant quantities of skin remaining in the final product giving the block a very dark texture compared to conventional minced products.

Processing Direct Costs

The following exhibit presents the estimated direct cost of processing silver hake into various fillet and H&G packs for an industrial operation. An industrial operation for H&G production would include using the following equipment Transvac unloading, grading machine and a heading and gutting machine. The filleting operation is based on using the same front end equipment a a filleting and skinning machine.

Exhibit 1.6 **Processing Economics ($/Finished Kg)**

	Pack					
	5 lb H&G 3-5 oz	5 Lb H&G 5 oz +	H&G Petfood	Fillet Block	Fillet Layer	Whole Petfood
Raw Material Cost	0.33	0.33	0.33	0.33	0.33	0.33
Yield	62 %	62 %	63 %	30 %	33 %	98 %
Gross Raw Material	0.53	0.53	0.52	1.10	1.00	0.34
Labour Cost	0.30	0.25	0.23	0.39	0.35	0.05
Packaging Material	0.12	0.12	0.02	0.04	0.09	0.05
Total Direct Cost	0.95	0.90	0.77	1.53	1.44	0.44

Notes : 1) Labour rate at $10 per person hour
2) No manufacturing or fixed overhead included

APPENDIX IV

Reports on 1989 Silver Hake Surimi Trials

SILVER HAKE SURIMI TRIALS ON BOARD THE SHINKAI MARU

By:

K.E. Spencer[1] and D.W. Lemon[2]
[1]Canadian Institute of Fisheries Technology
P.O. Box 1000
Halifax, Nova Scotia B3J 2X4

[2]Fisheries Development and Fishermen's Services Division
P.O. Box 550
Halifax, Nova Scotia B3J 2S7

INTRODUCTION

The Japanese Marine Fishery Resource Research Center (JAMARC) with permission and assistance from the Department of Fisheries and Oceans (DFO) conducted a six day feasibility study on the production of surimi from silver hake (Merluccius bilinearis). The processing trials were carried out by the Japanese research vessel, the Shinkai Maru, in NAFO fishing divisions 4W-L and 4W-J, during the week of April 17-22, 1989. The Japanese described the Shinkai Maru as a 5,000 PS horsepower stern trawler equipped with freezing, fish meal and surimi plants. Maximium processing capasity of the vessel was estimated at 200 t (tons) of fish per day. Maximum surimi production was approximately 9 t per day. Maximum fresh water output totalled 90 t daily, i.e., 30 t from an engine room evaporator and 24 t, 24 t, and 12 t from each of three reverse osmosis filtration units. Additional ship specifications included, gross tonnage: 3,395.12 t, overall length: 100.6 meters, width: 16.0 meters, height: 10.0 meters. The ship's crew consisted of 40 men, many of whom worked as deck hands as well as machine operators in the surimi plant.

PROCESSING TRIALS

The primary objective of the study was to evaluate the potential of silver hake as a raw material for surimi. As such, the investigation focused strictly on the harvesting and handling of this species, while processing of the by-catch was treated as a secondary concern. Bottom trawls with either 60 or 120 mesh gear in the cod end were used throughout the trip. Fishing depths ranging from 155 to 307 meters; towing times ranged from 3 to 7.5 hours.

An estimated 212,600 kg of fish, including ≈192,800 kg of silver hake, were hauled in 18 sets over the six days. Production included 24,620 kg (1231 cases) of silver hake surimi, 14,350 kg (410 bags) of fish meal and 10,120 kg of dressed fish, i.e., 7436 kg pollock, 902 kg monkfish, 880 kg white hake, 396 kg shad, 286 kg cod, 110 kg red hake, 88 kg halibut and 22 kg haddock. Yields of surimi and fish meal were estimated at 12.8% and 7.5%, respectively.

Throughout the investigation, surimi was produced by a semi-continuous batch process, as shown in Figures 1 and 2. Head-off, washed silver hake were deboned to prepare a mince which was then mixed with fresh water for several minutes in order to purify the muscle proteins and extract undesired compounds, e.g., water soluble proteins, pigments and lipids. The mince-wash water slurries were dewatered via two rotary dewatering screens and finally dehydrated in a three meter long single screw press. Subsequently, the tissues were refined through a meat strainer with 2 mm holes, blended with stabilizing ingredients (5% sorbitol, 4% sugar, 0.3% Erco - 54), packaged in bags (10 kg) and frozen. Minimum residence time in the plate freezer was six hours, after which the surimi was removed from the freezer trays, packaged in cardboard cartons (20 kg) and loaded into the ship's frozen storage hold.

Silver hake were processed as efficently as possible after harvesting. The longest holding period prior to usage was estimated at 26 hours fish post-mortem age. Optimal product yields were achieved if the fish were allowed to go through rigor-mortis before deboning (Mr. Akira Tanaka, Chief Scientist of the Shinkai Maru).

Temperatures were strictly controlled throughout the manufacturing operation. Fish in the holding rooms were ≈2°C; processing sea water and fresh water were chilled to ≈2°C; the mince-wash water slurries averaged 2°C; temperature of the refined mince was usually ≤5°C. The maximum temperature of the fish/surimi prior to freezing was consistently ≤10°C.

Two crews of eight to ten men working 12 hour shifts were required to permit continuous operation of the surimi line. Total processing time (from fish nobbing/cutting to surimi packaging) was estimated at ≈55 min. The slowest single step in the process was the screw press dehydration which required ≈40 min. Generally, ≈1,500 kg of fish were utilized per hour, which resulted in a production of ≈4,200 kg of surimi each day.

RESULTS AND DISCUSSION

Analyses of samples taken during the study indicated that silver hake has strong potential as a resource for high quality surimi. Functional properties of the product were comparable those exhibited by Alaska pollock (Theragra chalcogramma), which is currently the predominant resource species for both the Japanese and North American surimi industries. Moisture content of the silver hake surimi averaged 77.3%, which is ≈2% greater than the amount recommended by National Fisheries Institute (USA) standards. Consequently, protein content of the surimi produced on the Shinkai Maru was slightly low (13.8%), while the fat content average 1.4%.

Gel-forming ability of silver hake processed at ≤24 hours post-mortem age was considered acceptable for the production of Japanese surimi-based products. In comparison to Alaska pollock surimi from shore based processing plants, silver hake surimi displayed marginally lower gel strength, equivalent resiliency (as measured by the fold test) and firmness or puncture force resistance (see Table 1). Torsional true strain values,

which are a measurement of gel cohesiveness, showed that silver hake surimi was superior to typical Alaska pollock samples in this characteristic. Shear stress scores indicated that Alaska pollock and silver hake gels were equally strong.

Sensory attributes of the silver hake surimi were rated as excellent. Cooked samples were light in color and had a mild seafood flavor without off flavors or aromas. Product appearance was considered very acceptable; although, whiteness or brightness as measured by the color L value was slightly lower than that of Alaska pollock.

TABLE 1. FUNCTIONAL PROPERTIES OF ALASKA POLLOCK AND SILVER HAKE SURIMI

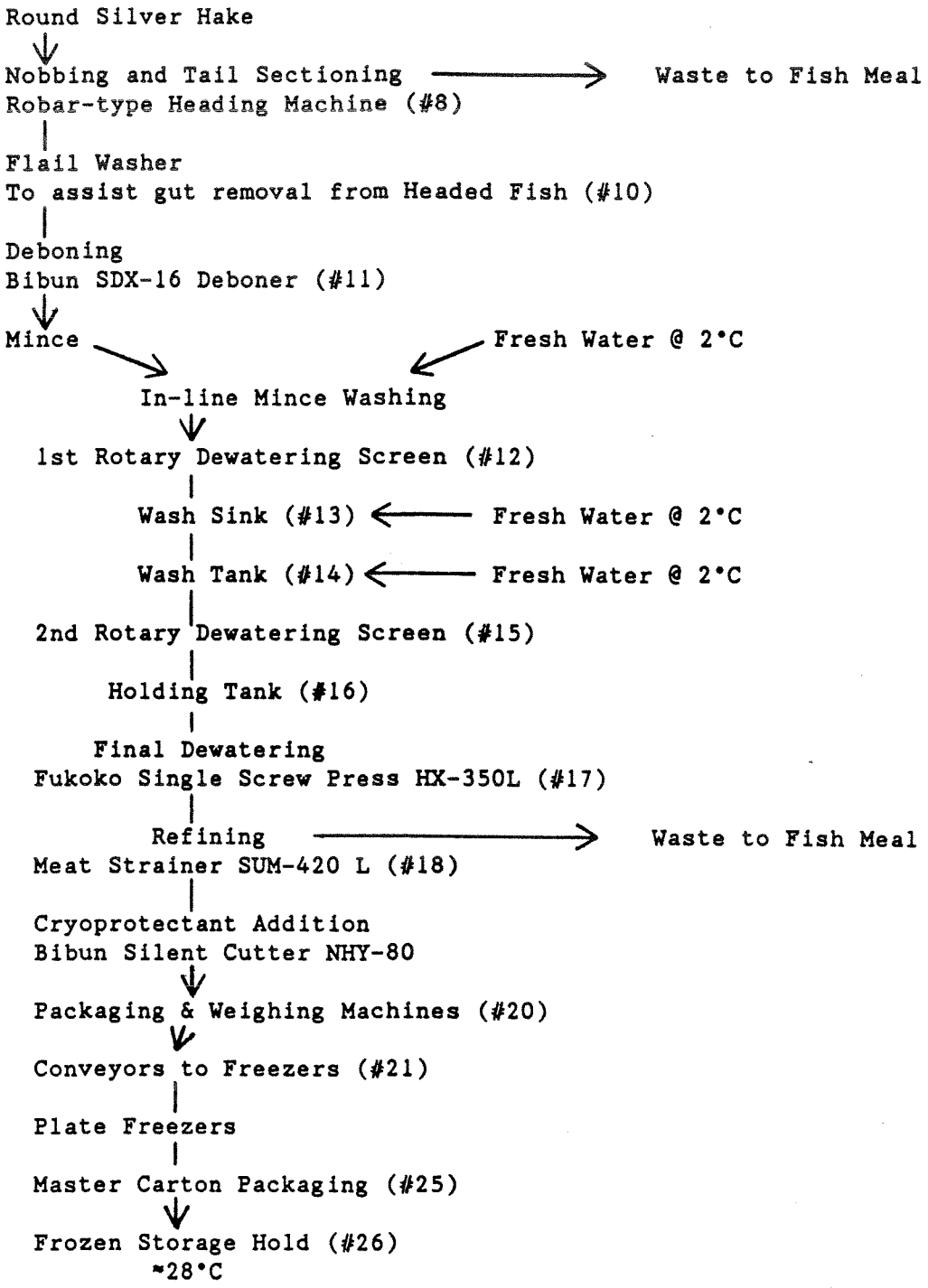
	ALASKA POLLOCK		SILVER HAKE
	Japanese High Quality Surimi	Alaska Pacific Seafoods, Inc. 1986 Production	Shinkai Maru Trial Product
Moisture (%)	76.1 ± 0.2	76.7 ± 1.7	77.6 ± 0.2
Fold Score	6	6	6
Punch Force (g)	930 ± 19	440 ± 87	453 ± 71
Punch Deformation (mm)	16.9 ± 0.5	13.9 ± 1.4	13.1 ± 2.2
Gel Strength (g.cm)	1564 ± 85	617 ± 153	602 ± 198
Gel Stiffness (g/cm)	542 ± 57	317 ± 56	347 ± 16
Shear Stress (kPa)	76.5 ± 6.8	49.4 ± 11.5	64.8 ± 7.4
True Strain	2.3 ± 0.5	2.2 ± 0.3	2.8 ± 0.2
Rigidity (kPa)	33.8 ± 4.2	22.9 ± 5.6	17.2 ± 1.1
Color L Value	82.1 ± 0.1	77.3 ± 1.1	74.2 ± 1.3
pH	6.7	7.3	7.1

CONCLUSIONS

The feasibility of using silver hake a raw material for surimi was studied during a six day investigation on board the Japanese research vessel the Shinkai Maru. Results of the trial indicated that this species has strong potential as a resource for high quality surimi; however, further work is required to establish optimal methods for manufacturing silver hake surimi.

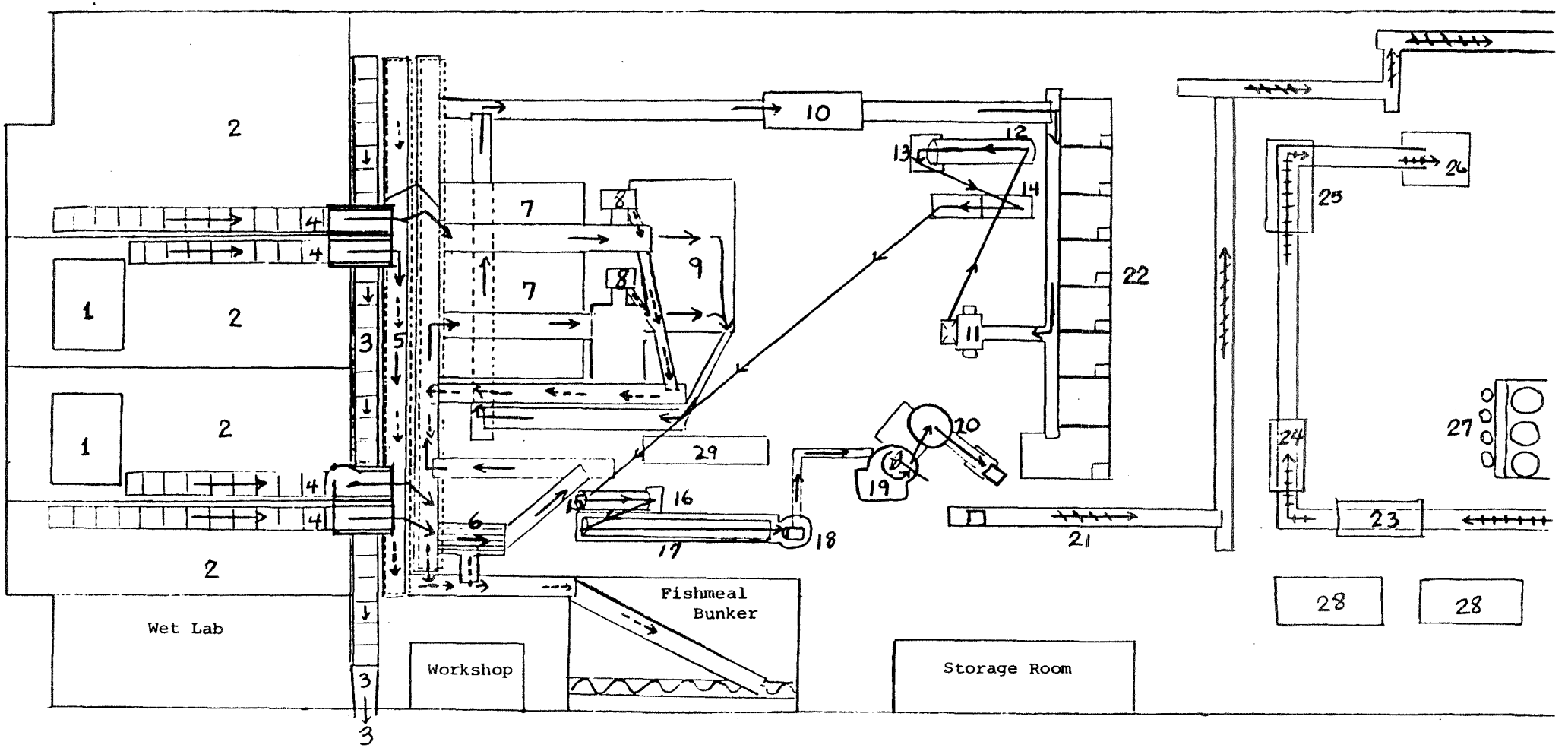
Key parameters in the utilization of silver hake include the identification of successful techniques for harvesting and handling the species. The majority of silver hake caught during the Shinkai Maru experiment were ≈25 cm in length, which was smaller than the average size reported by DFO, i.e., 30-34 cm. Due to the size, it was impossible to mechanically fillet the fish. Consequently, head-off, partially gutted silver hake were used as raw material for surimi production. The Japanese speculated that surimi made from silver hake fillets would be superior to that produced during the study and expressed keen interest in accessing equipment which would allow for the efficient filleting of silver hake.

FIGURE 1. SURIMI PROCESS ONBOARD THE SHINKAI MARU



N.B. Numbers in parentheses indicate equipment shown in Figure 2.

FIGURE 2. SHINKAI MARU FACTORY DIAGRAM



SHINKAI MARU FACTORY DIAGRAM

Equipment Number Code

1. Fish doors from trawl deck
2. Fish tanks
3. Discard belt and chute
4. Conveyors from fish tanks to sorting belts
5. Main sorting belt to sizing shoot (#6) or direct to heading machine holding tanks (#7)
6. Sizing chute
7. Storage or holding tank for heading machines (#8)
8. Robar-type heading machines
9. Wash tub for headed product
10. Flail washer to remove guts from headed fish
11. Bibun SDX-16 Deboner - mincing machine with fresh water inlet
12. Rotary Dewatering Screen #1
13. Wash sink with float activated fresh water inlet
14. Wash tunnel with fresh water inlet
15. Rotary Dewatering Screen #2
16. Holding tank
17. Fukoko HX-350L Single Screw Press
18. Meat Strainer Refiner SUM-420L
19. Bibun NHY-80 Silent Cutter
20. Hopper for packaging filler
21. Conveyor to plate freezers
22. Packing & weighing stations for products other than surimi (by-catch)
23. Freezer tray defroster
24. Glazing tunnel

25. Carton glueing machine

26. Freezer hold

27. Hollosep sand & fiber filter reverse osmosis water purifier

28. Hollosep fiber filter reverse osmosis water purifiers (2 units)

29. Filleting machine for large sized fish

SILVER HAKE SURIMI PROCESSING TRIALS

By:

K.E. Spencer, C. Hotton, M.A. Tung[1] and D.W. Lemon[2]
[1]Canadian Institute of Fisheries Techology
P.O. Box 1000
Halifax, Nova Scotia B3J 2X4

[2]Fisheries Development and Fishermen's Services Division
P.O. Box 550
Halifax, Nova Scotia B3J 2S7

INTRODUCTION

In the past few years the Canadian government and fishing industry has directed increased attention to the potential of underexploited species, not only because of a growing market demand for high quality seafoods but also because of declining harvests of traditional groundfish stocks. Further incentives to achieve optimum use of national resources include a desire to see the fishing industry develop from one that deals primarily with harvesting and distribution of raw materials into one which manufactures processed products with "added value".

The development of a Canadian silver hake (Merluccius bilinearis) fishery which is estimated to have sustainable harvests of approximately 135,000 to 200,000 tonnes (t) annually, was undertaken in a recent project supported by both the federal and provincial governments. Over the past 25 years the majority of silver hake caught in Canadian fishing zones were harvested by foreign factory trawlers. However, in 1989, 45,000 t of the 135,000 t total allowable catch quota were allocated to Canadian draggers fishermen with vessels ranging from less than 45 feet to 65 feet in length. Silver hake caught by the Canadian vessels were either transferred at sea to Soviet factory freezer trawlers or delivered to Karlsen Shipping Company, Ltd. in New Harbour, Nova Scotia for processing into a variety of products including head-off gutted fish, skin-on fillets, regular skinned fillets and deep skinned fillets. Additionally, the feasibility of producing surimi from silver hake harvested by Canadian vessels was evaluated in experiments conducted by the Canadian Institute of Fisheries Technology Techology (CIFT) at the Technical University of Nova Scotia (TUNS). Ten trials, utilizing fish ranging from two to seven days post-mortem age at the time of processing were completed. The processing methods, analytical techniques and results of the silver hake surimi research are detailed in this report.

METHODS AND MATERIALS

Fish utilized in the project were landed by four vessels, i.e., the "Ocean Swell", the "Sylvia Lynn", the "Cape Mariner" and the "Island Princess", which had been equipped specifically for catching silver hake. Raw materials, in the form of skin-on, skinned and deep skinned fillets were procured directly off the production lines at the Karlsens Shipping Company plant in New Harbour, N.S., iced and delivered to TUNS for immediate utilization or processed into surimi on the following day. Table 1 lists the age and description of the fish used during the project while the experimental processing methods are detailed in Figures 1 through 4.

Silver hake surimi was manufactured in the food science pilot plant at CIFT, Generally, small scale trials utilizing approximately 55 kg of fish mince and traditional Japanese "tank and paddle" mince washing techiques were employed. Processing parameters, e.g., raw materials, mince-wash water ratios, pH, temperature, duration and frequency of washing, additives and cryoprotectant formulae were manipulated as required. Throughout the investigation variables which may have affected the products' attributes were closely monitored; deboned mince and the resultant surimi samples were tested for: protein, lipid, moisture content and pH (Woyewoda et al., 1986).

Functional properties of surimi were tested by the procedures of Lee (1984), as well as those recommended by the Technical Subcommittee of the National Fisheries Institute Surimi Committee (1987). Gel preparations were made with partially frozen (tempered) surimi and 2% NaCl in a vacuum chopper (VCM-12, Stephan Machinery Canada Limited, Mississauga, Ontario). The resultant surimi-salt sols were extruded into 30 and 21 mm (i.d.) tubes which were sealed and then allowed to "set", i.e., gel, at various time/temperature regimes. The four gel-setting treatments tested were:

90° - 90°C for 30 min
40°/90° - 40°C for 30 min followed by 90°C for 20 min
2°/90° - 2°C for ≈20 h followed by 90°C for 20 min
RT - Ambient Room Temperature ≈25°C for 20 h.

Cooking at 40°C and 90°C was carried out in water baths, after which the gels were immersed in ice water, chilled and analyzed within 48 h. Tests for gel-forming ability included: fold score (Toda et al., 1971); gel strength, Instron punch test (Lee, 1984); cohesiveness, Instron compression test (Kim et al., 1987) and torsional stress, strain and rigidity (Lanier, 1985). Color of cooked and uncooked surimi gels was measured with a Colormet Spectrophotometer (Metron Instruments Inc., St. John's, NF). Sensory characteristics of the products were assessed informally by noting the odor of rheological test specimens.

RESULTS AND DISCUSSION

Analysis of the samples prepared during the project indicated that silver hake has strong potential as a resource for high quality surimi. The highest quality products displayed functional characteristics similar to those of Pacific pollock surimi manufactured in shore-based processing plants. Although gel-strength values of the experimental samples were lower than those recommended for SA grade surimi, it is anticipated that further research and development will show that silver hake may be utilized to produced to surimi acceptable for the production of simulated shellfish, e.g., surimi-based crabmeat, scallops and shrimp.

Freshness of the raw materials was an important criterion influencing functional performance of the products. During these experiments, the freshest fish available for testing were caught ≈45 h prior to processing (lots Shk-21 and Shk-22), while the oldest raw materials were ≈160 h post-mortem when used for the production lots Shk-16, 16A and Shk-17. Torsional strain measurements indicated that the functional quality of silver hake proteins deteriorated with increasing post-mortem age of the raw materials. Surimi from fish held in ice or refrigerated sea water for two to three days prior to processing was superior to that from silver hake iced for six/seven days.

The various processing methods had little impact upon the resultant surimi quality; however, the three cycle mince washing processes were considered more successful than the two cycle methods employing a 1 to 5 mince/wash water ratio. A trial conducted on May 12, 1989 which included mince washed at both 4°C (Shk-21) and 12°C (Shk-22) indicated that both temperatures resulted in similar quality products. Improvements in quality were achieved by sequential refining of the washed and dewatered minces which ultimately resulted in a first grade (once refined) and second grade (twice refined) product. All three fillet styles, i.e., skin-on, deep skinned and regular skinned fillets, were considered very acceptable for producing surimi with excellent color and sensory characteristic. Cooked silver hake surimi gels were white and had a very mild, pleasant, seafood flavor and aroma.

CONCLUSIONS

The feasibility of using silver hake as raw material for surimi was studied in pilot plant scale processing trials conducted at the Technical University of Nova Scotia. Fish ranging from approximately two to six days post-mortem age, were landed at Karlsens Shipping Company, Ltd. in New Harbour, Nova Scotia, processed into fillets and then delivered to CIFT for further processing into surimi. Various processing protocols and parameters were evaluated in reference to their impact upon surimi composition and functional quality.

Results of the research indicated that silver hake harvested by dragger fishermen and subsequently delivered to shore-based processing plants could be manufactured into good quality surimi with white color and excellent sensory attributes. Fish post-mortem age was an important factor influencing the gel-forming ability of silver hake surimi, i.e., the freshest raw materials (~2 days post-mortem age) resulted in a product with the highest torsional strain values (cohesiveness), whereas surimi from fish held on ice for seven days prior to processing exhibited reduced functionality. Overall, the investigation showed that silver hake has strong potential as a resource for high quality surimi; however, further work is required to establish optimal methods for harvesting, handling and processing the species.

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Table 1. Raw Materials in the Silver Hake Surimi Trials

Processing Date	Fillet Style	Post-Mortem Age when Landed (h)	Fishing Vessel	P-M Age when Processed (h)	Surimi SHk #
18/4/89	Deep-skinned	40-45	Ocean Swell	~63	10,11
18/4/89	Deep-skinned	40-45	Ocean Swell	~67	12,13
25/4/89	Deep-skinned	60-65	Sylvia Lynn	~80	14
25/4/89	Deep-skinned	60-65	Sylvia Lynn	~85	15
02/5/89	Skin-on	130-140	Cape Mariner	~160	16,16A
02/5/89	Skin-on	130-140	Cape Mariner	~164	17
02/5/89	Skinned RSW fish	65-70	Island Princess	~73	18
03/5/89	Skinned RSW fish	65-70	Island Princess	~84	19
12/5/89	Skin-on	36-40	Ocean Swell	~45	21,22

RSW: Refrigerated Seawater stored fish

Table 2. Composition of Mince and Surimi from Fresh Silver Hake
Raw Material: Skin-on, Skinned and Deep Skinned Fillets Pilot Plant Trials: SHK-10 through SHK-19, 21, 22

PROCESSING					RAW MATERIAL					SURIMI			
Code	Date 1989	Method	2nd Cycle Grade	Refiner Grade	Post-Mortem Age (h)	H_2O % (s.d.)	Fat % (s.d.)	Proteins % (s.d.)	pH	H_2O % (s.d.)	Fat % (s.d.)	Protein % (s.d.)	pH
SHK-10	18/4	1	3	1	63	83.07 (0.56)	2.14 (0.25)	15.27 (0.82)	7.4	75.49 (0.11)	1.48 (0.18)	15.74 (0.19)	6.7
SHK-11				2	63					75.66 (0.08)	2.14 (0.06)	15.16 (0.04)	6.8
SHK-12	18/4	1	2	1	67	83.24 (0.49)	1.88 (0.12)	15.35 (0.34)	7.0	76.43 (0.06)	1.62 (0.07)	15.17 (0.15)	6.8
SHK-13				2	67					76.23 (0.11)	2.11 (0.11)	14.95 (0.02)	6.9
SHK-14	25/4	1	4	1	80	84.00 (0.55)	2.49 (0.14)	13.84 (0.20)	7.1	75.41 (0.02)	1.99 (0.05)	15.47 (0.13)	6.7
SHK-15	25/4	2	3	1	85	82.70 (0.22)	2.78 (0.24)	14.93 (0.06)	6.9	76.92 (0.05)	1.68 (0.03)	14.33 (0.15)	6.9
SHK-16	2/5	1 1st half	3	1	160	78.65 (1.08)	5.09 (0.34)	14.96 (1.49)	7.0	74.86 (0.02)	2.85 (0.04)	15.33 (0.56)	6.8
SHK-16A		2nd half		1	160					77.10 (0.08)	3.51 (0.06)	13.12 (0.25)	6.8
SHK-17	2/5	2	3	1	164	85.34 (0.25)	3.35 (0.36)	13.73 (0.52)	7.0	75.71 (0.13)	2.68 (0.07)	14.66 (0.47)	6.8
SHK-18	2/5	1	3	1	73*	80.95 (0.14)	4.95 (0.58)	15.77 (0.17)	7.0	75.20 (0.09)	3.37 (0.16)	14.23 (0.05)	6.9
SHK-19	3/5	3	3	1	84*	80.81 (0.78)	4.70 (0.23)	16.13 (0.13)	7.2	74.41 (0.02)	3.82 (0.08)	15.62 (0.11)	6.7
SHK-21	12/5	4	4	1	45	81.18 (0.93)	4.65 (0.30)	12.24 (0.72)	7.0	74.65 (0.15)	3.65 (0.04)	14.52 (0.13)	6.9
SHK-22			12	1	45					74.86 (0.20)	3.43 (0.03)	14.30 (0.15)	6.9

* RSW held fish (s.d.) - Standard Deviation

Table 3. Properties of Surimi from fresh Silver Hake.

Mean values and standard deviations (s.d.)

Product Code Shk #	Fish Age (h)	Protein, % (s.d.)	Stress, kPa (s.d.)	Strain (s.d.)	Rigidity, kPa (s.d.)	Gel Strength, g.cm (s.d.)	Color L value
10	63	15.74 (0.19)	64.15 (6.38)	2.92 (0.23)	21.94 (1.24)	558.4 (26.5)	79.5 (1.4)
11	63	15.16 (0.04)	72.36 (4.66)	2.89 (0.14)	25.12 (2.23)	219.7 (14.0)	80.6 (3.6)
12	67	15.17 (0.15)	73.31 (8.91)	2.97 (0.26)	24.63 (1.49)	598.4 (279.4)	79.8 (1.2)
13	67	14.95 (0.02)	81.53 (2.87)	3.25 (0.20)	25.12 (1.72)	525.3 (162.3)	81.1 (81.1)
14	80	15.47 (0.13)	89.67 (7.11)	3.00 (0.11)	29.89 (1.26)	526.3 (104.4)	81.9 (1.7)
15	85	14.33 (0.15)	64.46 (4.64)	2.88 (0.09)	22.43 (1.49)	570.5 (37.0)	83.0 (0.9)
16	160	15.33 (0.56)	63.99 (2.74)	2.66 (0.13)	24.03 (0.59)	236.9 (35.1)	75.9 (0.3)
16A	160	13.12 (0.25)	35.39 (1.80)	2.56 (0.04)	13.85 (0.62)	148.0 (9.0)	77.6 (0.4)
17	164	14.66 (0.47)	47.72 (2.60)	2.34 (0.08)	20.42 (0.57)	313.2 (47.1)	23.5 (0.5)
18	73*	14.23 (0.05)	51.35 (7.58)	2.52 (0.29)	20.36 (2.15)	238.9 (74.6)	78.7 (0.3)
19	84*	15.62 (0.11)	62.88 (6.46)	2.82 (0.26)	22.32 (1.08)	698.5 (25.8)	80.1 (1.7)
21	45	14.52 (0.13)	64.46 (4.66)	3.39 (0.08)	18.98 (0.98)	331.7 (128.4)	80.3 (1.1)
22	45	14.30 (0.15)	61.62 (3.87)	3.27 (0.34)	18.90 (0.97)	401.1 (123.8)	79.7 (1.3)

* RSW stored fish

Gels cooked @ 40°/90°C

FIGURE 1. CIFT SURIMI PROCESS # 1 FOR LEAN SPECIES

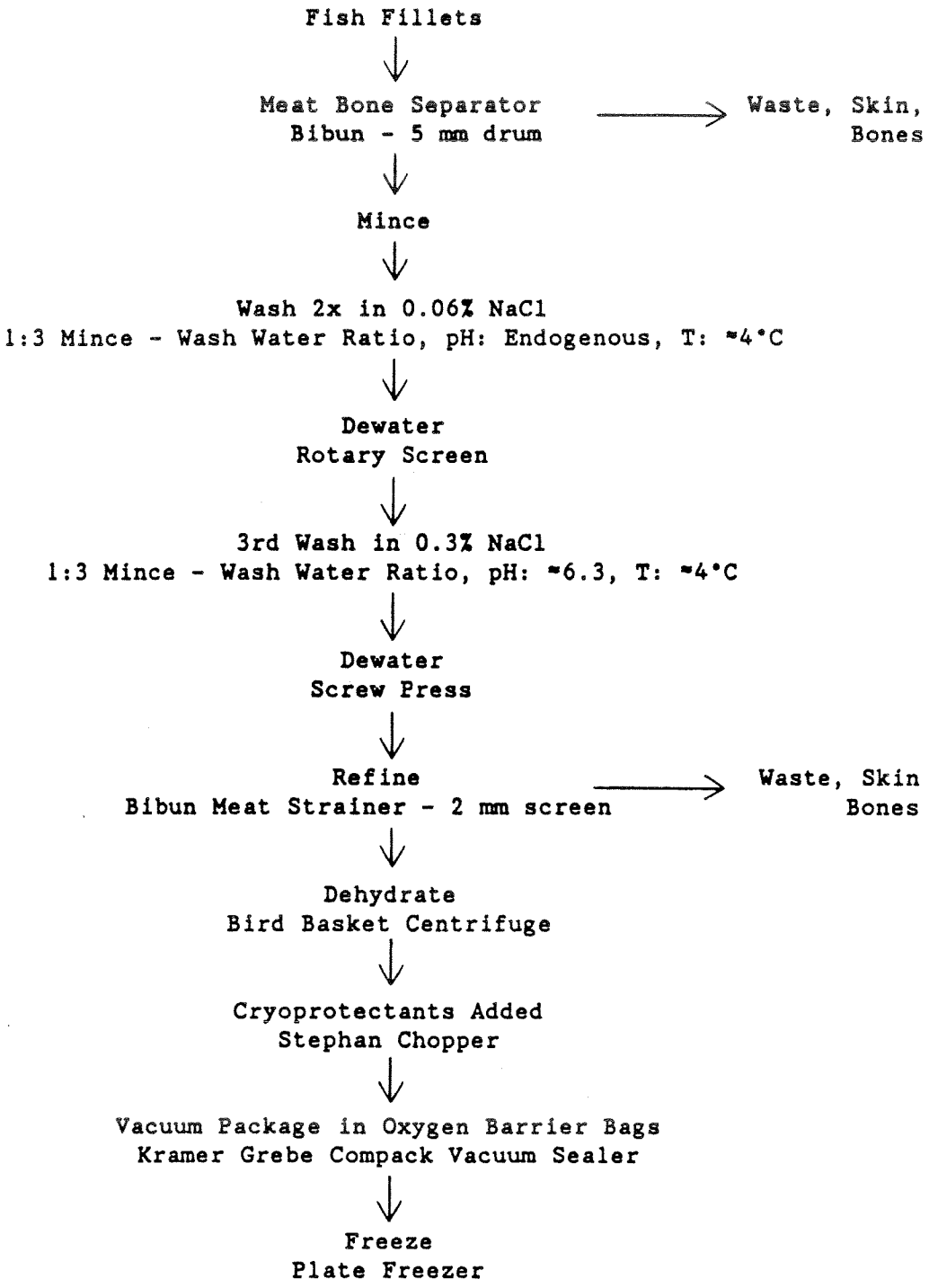


FIGURE 2. CIFT PROCESS # 2 FOR LEAN SPECIES

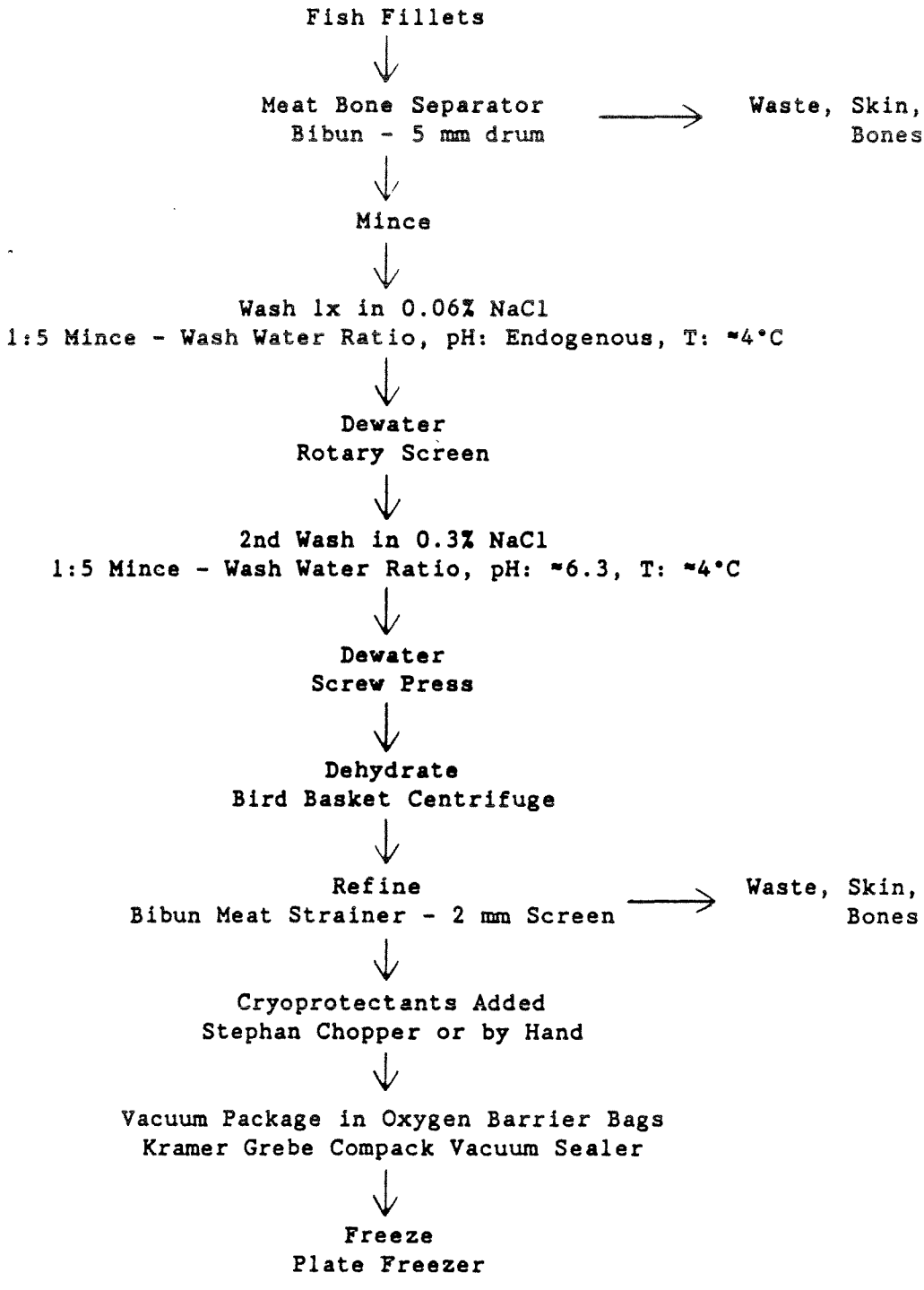


FIGURE 3. CIFT SURIMI PROCESS # 3 FOR LEAN SPECIES

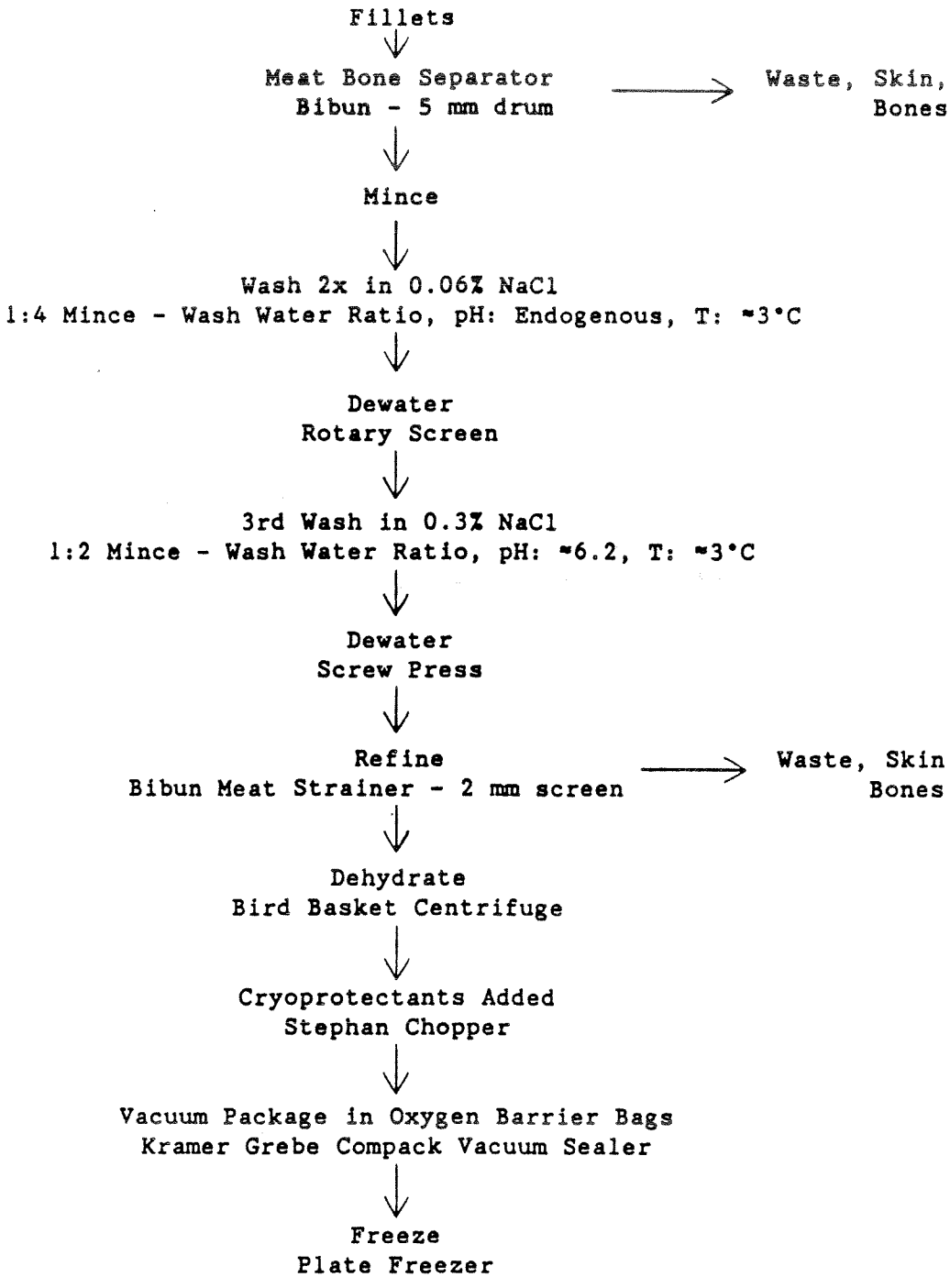
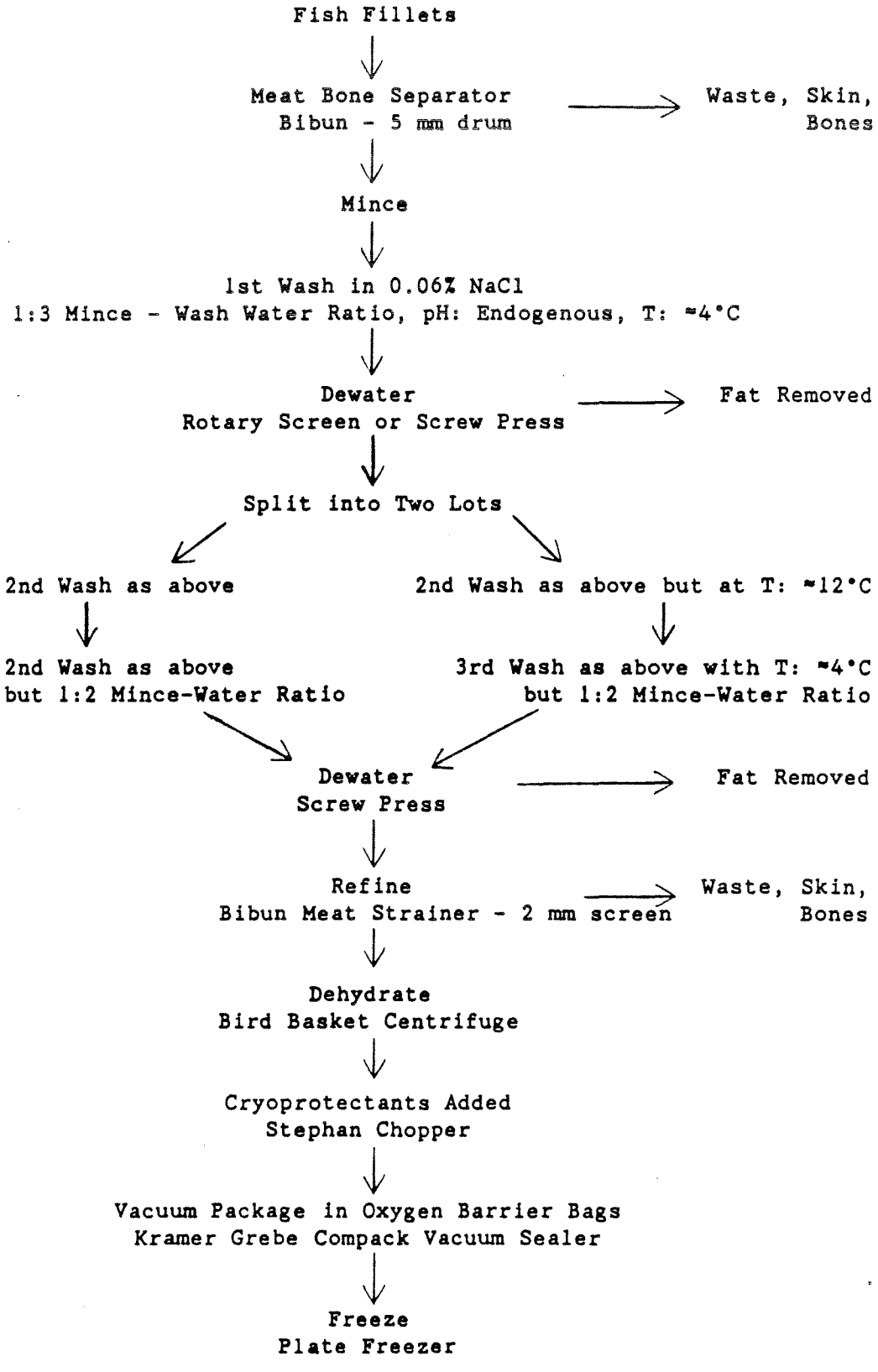


FIGURE 4. CIFT SURIMI PROCESS # 4 - SPLIT PROCESS



APPENDIX V

Point-Form Summary of Canadian Silver Hake Fisheries Development

1. History
2. Advances Made

1. HISTORY

DOMESTIC SILVER HAKE FISHERIES DEVELOPMENT

1. **FOREIGN FISHERIES**: - ANNUAL CATCH IN THE 70,000 MT range since 1965; low by-catch. (EASTERN BLOC COUNTRIES)

   - ABUNDANT GADOID
   Avg. Length in the fishery (30cm; 12")

2. **CANADIAN EFFORTS**:

Early 1970's:	Vessels	Studies	Results	Problems
	- offshore (120-130')	harvesting; storage stability	- similar to cusk	not economic -
- 1987	- inshore (1 x 65')	harvesting	~ 800 lbs	red fish gear
	- foreign charter (1 Cuban) by SeaFreeze	re-processing	poor	-
- 1988	- inshore (2 x 65')	harvesting;	45 mt	USA gear
	- OSS (1 Soviet)	joint-venture	37mt*	transfers; amount of fish
	-	- Cuban vessel visit	info	-
	-	- West Coast visit	info	-
	- Onshore processing	- Surimi	poor	- age post-mortem

*OSS tonnage is included in the preceding total for that year.

.../2

- 1989	Vessels	Studies	Results	Problems
	- inshore (3x65's)	harvesting	291 mt	- vessel speed? gear?
	- inshore (4x45's)	harvesting	1 mt	
	- offshore (1x95')	harvesting	4 mt (1 x 1/2hr. tow)	- none
	- OSS (2 Soviets)	joint-ventures	293 mt*	- amount of fish
	- Onshore processing	Traditional products	- 68 mt - good to excellent - TRANSVAC	- lg.% to meal - small fillets - manual - H&G and fillet -bruising? (incl. RSW)
	- "	Surimi (CIFT) (JAPANESE)	good to very good	-
	- Product Intro-duction Event (Halifax)	Marketing/ Public relations	excellent	-
	- EXPT'L INSHORE (1x45)	harvesting inshore	~ 3 mt	By-catch

*OSS tonnage is included in the preceding total for that year.

2. ADVANCES MADE

- WEATHER CONSTRAINS <65's for OSS

- SPEED OR GEAR: SOME CONSTRAINTS FOR < 65's

- 95 VESSEL : NO PROBLEMS

- OSS TRANSFERS WENT WELL/J.V. COD-ENDS

- TRANSVAC SYSTEM WORKED WELL

- LANDED QUALITY (ICE STORAGE) GOOD

- BRUISING?

- FISH SIZE-SORTING REQUIRED FOR PROCESSING

- MECHANCIAL FILLETING AND H & G POSSIBLE

- TRADITIONAL PRODUCTS QUALITY: GOOD - EXCELLENT*

  * SKINNED FILLETS: SOFT

  TRADITIONAL PRODUCTS SIZE: MARKET CONSTRAINT/(PRICE)

- SURIMI: GOOD TO VERY GOOD