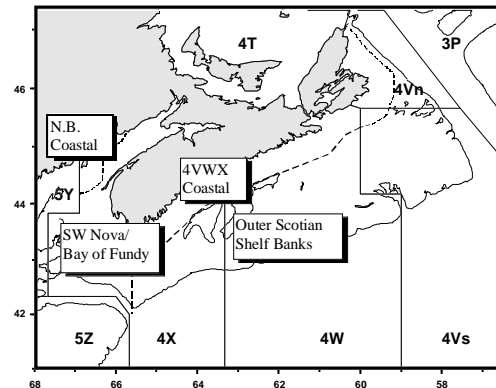


## 4VWX Herring



### Background

Atlantic herring is a pelagic species found on both sides of the North Atlantic. Herring aggregate to spawn in discrete locations to which they are presumed to home. Herring first mature and spawn at three or four years of age (23 to 28 cm or 9 to 11 in), then begin a predictable annual pattern of spawning, overwintering, and summer feeding which often involves considerable migration and mixing with members of other spawning groups. Most fishing takes place on dense summer feeding, overwintering, and spawning aggregations.

The 4VWX management unit is known to contain a number of spawning areas separated to various degrees in space and time. Spawning units in close proximity, with similar spawning times, and which share a larval distribution area (e.g. Trinity Ledge and German Bank in SW Nova Scotia) are considered part of the same complex - and undoubtedly have much closer affinity than spawning units which are widely separated in space or time, and do not share a common larval distribution. Some spawning areas are large and offshore, whereas others are small, and more localised, sometimes very near shore or in small embayments. The situation is complicated further by the fact that herring tend to migrate long distances, and to mix outside of the spawning period with members of other spawning groups. Some spawning areas, are known from fishery sampling, tagging, etc. to have formed the basis for major historical fisheries, while others have not. For the purposes of evaluation and management, the 4VWX herring fisheries are divided into four components:

1. SW Nova Scotia/Bay of Fundy spawning component
2. Offshore Scotian Shelf Banks spawning component
3. Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia spawning component; and
4. SW New Brunswick migrant juveniles.

Recognizing that each component has several spawning areas, and that there is mixing of fish from more than one component, industry and management have explored means of managing the complexity within each component (such as distributing fishing effort among spawning areas according to their relative size) and of taking appropriate account of interaction among components (such as restrictions on some areas of mixing).

Fisheries in the 4VWX area in recent years have been dominated by purse seine, weir and gillnet, with relatively minor landings by midwater trawl, shutoff, and trap.

### Summary

- Spawning stock biomass (SSB) of the SW Nova Scotia Spawning component is estimated from acoustic surveys of spawning grounds to exceed 500,000t. Age composition has improved, but contains a relatively small fraction of fish older than the 1992 year-class. Large amounts of spawning fish were documented on German Bank and in Scots Bay, but spawning was again absent from the Seal Island grounds, and the Trinity Ledge spawning group remains relatively small. The 1998 catch should be less than 100,000t.

- Fishing in the second year of a reactivated Scotian Shelf banks fishery (>25 miles offshore) almost doubled in 1997 to approximately 20,000t. Unlike 1996 when the fishery was concentrated in a small area (“The Patch”), the 1997 fishery was widely distributed, and herring were documented on, and between, several banks. Age composition from both the fishery and research survey showed a dominant 1992 year-class, and a rather narrow age distribution. There is little quantitative information on which to evaluate the status of this stock. The July bottom trawl survey indicated that herring were widespread, but less numerous than in recent years. The 1998 catch should be reduced unless there is very good quantitative information during the fishery which demonstrates that these concerns are unfounded.
- With a few exceptions, the fisheries and stock status of spawning groups along the coast of Nova Scotia remain undocumented. The lack of information precludes evaluation of stock status. As stated last year, no coastal spawning area should have a large effort increase until much more information is available on the state of this spawning group. Improved documentation of these spawning area and fisheries is essential.
- The Bras D’Or lakes spawning component exhibits a continuing state of decline. In 1997 there was a further decrease in spawning locations, an absence of fish in several traditional fishing areas, low levels of larvae, and an intensification of effort in the few, very small remaining areas of herring distribution. From a biological perspective, no fishing should take place on this spawning component in 1998.

### *Objectives and Management*

The 1997 Scotia-Fundy herring integrated fisheries management plan (DFO 1997) set out principles, conditions, and management measures for the 4VWX herring fisheries. The main principle stated in the plan was “the conservation of the ... stock and the preservation of all of its spawning components”.

Specific conservation objectives were reviewed and developed further during 1997. Three objectives and a number of targets within these objectives were defined:

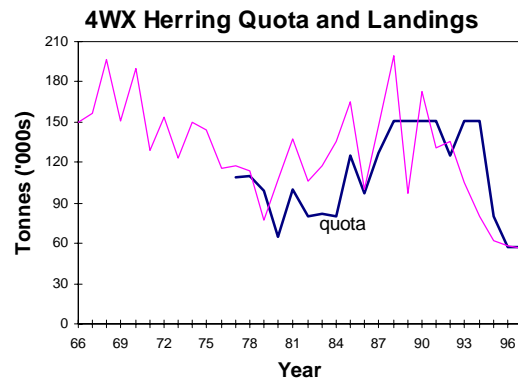
- 1) To maintain the reproductive capacity of herring in each management unit;
  - persistence of all spawning components in the management unit;
  - maintain biomass of each spawning component above a minimum threshold;
  - maintain a broad age composition for each spawning component; and
  - maintain a long spawning period for each spawning component.
- 2) To prevent growth overfishing;
  - continue to strive for fishing mortality below F0.1
- 3) To maintain ecosystem integrity/ ecological relationships (“ecosystem balance”).

Implementation of a precautionary approach requires further definition of target and limit reference points associated with these three objectives. There is insufficient information available at the present time on which to base targets for the objective of maintaining ecosystem integrity.

An “in-season” management process, first implemented in the SW Nova Scotia fishery during 1995 has been extended to other areas and fisheries. The approach encouraged surveying prior to fishing to ensure that fishing was distributed appropriately among various portions of the stock (particularly among spawning groups) according to the relative size and current state of each group. It improved data collection and enabled management decisions to be made with the involvement of participants and on the basis of up-to-date information.

The 1997 management plan extended the Dockside Monitoring Program (DMP) to include some portions of the fixed gear sector for the first time.

This TAC was partitioned in the usual way among the mobile gear (45,144t; 80%) and fixed gear (11,286t; 20%) sectors. The low quota and gear sector allocation formula resulted in a further reduction in **landings** by purse seine (45,042t) for the 1997 fishing season, but an increase in landings by gillnet (6818t) and Nova Scotia weir (4019t) sectors. Total quota landings of 56,117t were the lowest in over three decades.



Landings (thousands of tonnes)

Year	70-79 Avg.	80-89 Avg.	90-94 Avg.	1995	1996	1997
4WX SW NS TAC	106	106	146	80	57	57
4WX SW NS	131	131	125	63	58	56
4VWX Coastal NS	<1	<1	1	0	2	3
Scotian S. Banks	30*	<0.1	<0.1	<0.1	12	20
SW NB	26	24	30	18	16	21
Total Landings	188	156	156	81	88	100

\*average 1970-73

Continuation of the in-season management approach resulted in further improvement in sampling and in ongoing discussion and review of the fishery. Again, fishing on spawning aggregations operated under a “survey, assess, then fish” protocol, in which spawning aggregations were surveyed and predefined conditions had to be met before that part of the fishery was allowed to take place. There were fewer surveys and quantitative estimates made by the purse seine and gillnet fleets in 1997 than in 1996; however two acoustic recording devices installed on purse seiners allowed the collection of more quantitative records.

**SW NOVA SCOTIA/BAY OF FUNDY SPAWNING COMPONENT**

***The Fishery***

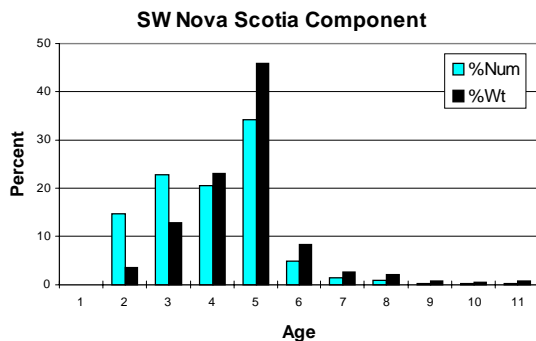
A TAC of 57,000t was established for the SW Nova Scotia spawning component for 1997. The TAC was reduced between 1994 and 1996 from 151,000t to 50,000t. The 1997 TAC was the same as had been allocated the previous year, and was the lowest allocation in the history of the fishery.

The **distribution** of herring as reflected by the fishery during the summer feeding and pre-spawning period were consistent with historical patterns. Surveys and fishing confirmed the presence of large amounts of herring on German Bank and Scots Bay. However, there continued to be an absence of spawning at Seal Island, and although there has been an improvement in the

amount of spawning herring on Trinity Ledge, it remains below historical levels. Large aggregations (>100,000t) which included substantial amounts of pre-spawning and juvenile herring were also documented off Long Island, Nova Scotia and off Grand Manan, New Brunswick.

### Resource Status

The 1992 year-class (age 5) dominated the fishery both in number and weight. Age 3 (1994 year-class) and age 4 (1993 year-class) followed in importance. Age 6+ (1991 and earlier year-classes) made up only a small fraction of the catch (7% by number; 15% by weight). The **age composition** contained fewer age 6+ fish than the average of the previous decade.



**Acoustic surveys** were undertaken of major spawning areas and a few major fishing areas using the acoustic equipment on commercial vessels and a research vessel. Sonars and sounders of the purse seine fleet, and sounders of the gillnet fleet were used to document the number, location and approximate size of herring schools. Two purse seiners were equipped with quantitative recording devices which automatically logged survey results for later analysis.

**Mapping surveys** (vessels without recorders) were quantified using area and a density category (light, medium, heavy) as in the previous assessment. Surveys with automated recorders were edited using standard quantitative acoustics methods and biomass estimates were made using standard target strength relationships.

Fifteen **biomass** estimates from various spawning aggregations are available. These surveys are known to have missed some spawning events and areas. The protocol for surveying spawning areas, as used in the past two years, required a 7 day interval between surveys to avoid the possibility of double counting. Four surveys which were very close in time to others were eliminated from consideration. Applying the minimum 7-day interval was complicated by two cases (Scots Bay and German Bank) where a second survey was undertaken after only 6 days, but with the thought at the time that there had been a replacement of fish in the area. To avoid double counting in these cases the estimate of biomass was reduced by the amount of fish which were ripe but not spawning (stage 5) in the first survey, and which therefore might have been present in the second survey. The sum of the 11 estimates is 568,500 t. Estimates of the standard error for the German Bank surveys were 20% or less. The instrument variability has not been quantified.

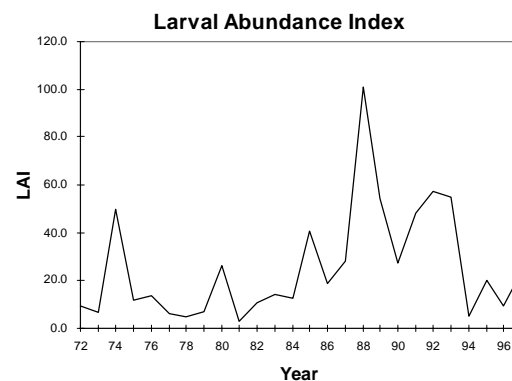
Spawning Area	Date	Survey Type	Estimated Biomass	Amount Attributed to SSB (t)
Spectacle Buoy	Jun 12	A	15,000	15,000
Scot's Bay	Jul 29	A	15,000	15,000
	Aug 05	A,B	44,400	44,400
	Aug 06	B	1,200	
	Aug 11	A	1,700	
	Aug 12	A	35,000	35,000
	Aug 18	B	85,700	65,700*
Trinity Ledge	Sep 01	A	15,000	15,000
	Sep 09	A	1,000	1,000
	Sep 16	A	7,000	7,000
German Bank	Sep 18	B	17,600	17,600
	Oct 03	A,B	215,800	215,800
	Oct 06	B	7,900	
	Oct 08	B	82,700	
	Oct 09	B	194,100	137,000*
				<b>568,500</b>

A = mapping survey

B = purse seine acoustic recording device

\* = This survey discounted by the amount of stage 5 fish in previous survey

The **larval abundance** index (23.3 larvae m<sup>-2</sup>) was higher and the area of larval distribution was greater than it has been the past three years. The larval index was just below the average (25.5), but above the median, of the 26 year time series. The sudden, large drop in larval abundance index in 1994 is difficult to explain.



The same **analytical assessment (SPA) model** used in recent years, which uses larval abundance as an index of spawning stock abundance, was attempted. The analysis showed a weak relationship between the larval abundance index and SSB, poor model resolution, and a strong retrospective pattern, and was not considered to give valid estimates of recent stock size. There remains the need for a more reliable indicator of abundance in order to undertake this type of analysis for this stock.

### *Sources of Uncertainty*

The introduction of recording devices has improved quantification in the acoustics surveys, but there is need for continued improvement in survey coverage (spatial and temporal) and investigation of the duration of spawning.

### *Ecosystem Considerations*

Herring is a prominent species in the diets of many other fish, birds, and marine mammals, and should be managed with these interactions in mind. At present, a natural mortality rate of 0.2 is assumed to account for these interactions. Low fat content and poor condition of herring observed in 1994, thought to be related to an environmental anomaly, have not been observed in subsequent years.

### *Outlook*

The spawning ground surveys indicated an SSB in 1997 of 568,500t, and there is known to have been spawning outside of the survey areas and times from data on the distribution of fishing activity. Modification of the acoustic estimate to account for fishing which took place after the surveys (not more than half of the total catch; 26,000t) results in an end of year SSB that is likely over 500,000t. Substantial areas of prespawning fish were also documented during 1997.

The age composition of this component has improved, but is still narrow, with few fish older than the 1992 year-class. Spawning is occurring in most traditional areas, and large numbers of spawners were documented on German Bank and Scots Bay in 1997. There remains concern that there was no spawning observed in the traditional Seal Island area, and that the Trinity Ledge spawning component has not fully recovered.

The substantial reductions implemented in the past three years seem to have had a positive impact on the rebuilding of this component, and the population appears to be increasing from a low experienced in 1994. Application of the exploitation rate previously used as a guideline for this resource (approx. 20%), with the best estimate of spawning stock biomass of over 500,000t would imply a catch of over 100,000t. In light of the narrow age structure and lack of full occupation of traditional spawning grounds, and since this is only the second year of reliance on the acoustic survey method, the 1998 catch should remain below 100,000t. Conditions should continue to be monitored in 1998 using the in-season management approach.

### *Management Considerations*

The previous assessment of this component suggested that fishing mortality should remain below F0.1 for a number of years in order to rebuild spawning stock biomass and improve age composition. Since the current age composition remains narrow, and a new approach has been used for determination of biomass, fishing below F0.1 would again be prudent.

The in-season management approach, which spreads the effort in the fishery spatially and temporally among spawning components, is seen as beneficial in achieving the objectives related to maintaining spawning potential. The portion of surveyed spawning biomass taken on the spawning grounds should be reduced (below 20%) to reflect what amount of that spawning group has been taken previously and in other areas.

Acoustic surveys have become critical to stock status evaluation. It is important that there be continued improvement in coverage and survey design, and attention to developing year-to-year consistency in these surveys. Additional surveys and biological studies are planned for 1998 in collaboration with the Pelagics Research Council.

## ***OFFSHORE SCOTIAN SHELF BANKS SPAWNING COMPONENT***

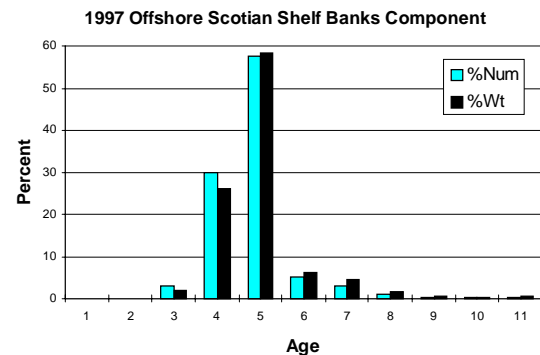
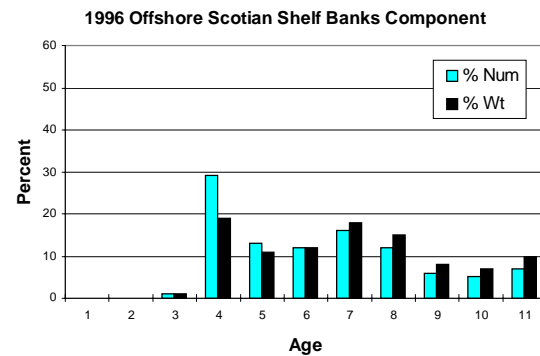
### ***The Fishery***

Herring taken on the offshore Scotian Shelf by foreign fisheries prior to the extension of jurisdiction, were presumed to be part of an overall 4VWX stock. The foreign fishery is estimated to have removed as much as 60,000 tons in a year from the offshore Scotian Shelf banks during the period 1963-1974. Evidence of increasing presence of herring (e.g. in research vessel surveys) and of spawning offshore within the past decade has suggested that there is a discrete offshore spawning component. The presence of spawning herring in catches in 1986 and of larvae in scientific surveys (1991-93, 1997), the consistent presence of large herring on the Scotian Shelf in summer trawl surveys, and broad age distribution of the catch during the 1996 fishery are all consistent with the separate management treatment of the offshore Scotian Shelf banks.

There had been little effort or herring caught after the extension of jurisdiction until 1996, when a fishery was reinitiated by the 4WX purse seine fleet and 11,745 t were taken.

Unlike 1996 when activity was concentrated in the vicinity of "The Patch", the 1997 fishery took place on several banks. Fishing began on May 19 and continued until July 15, with total **landings** of 20,261t. Fish were seen on and between several banks and catches were widely distributed. On most nights, the fleet was distributed widely, spanning distances of approximately 30 - 220 miles. Fish size and condition differed on and between the banks and fat content was very high; greater than 20% at times.

The **catch** in 1997 was composed mostly of two year-classes. Age 5 (1992 year-class) made up almost 60% in both number and weight while age 4 (1993 year-class) contributed approximately 30%. All other ages combined contributed less than 15%. A similar age structure was seen in samples from the July bottom trawl survey of the Scotian Shelf.

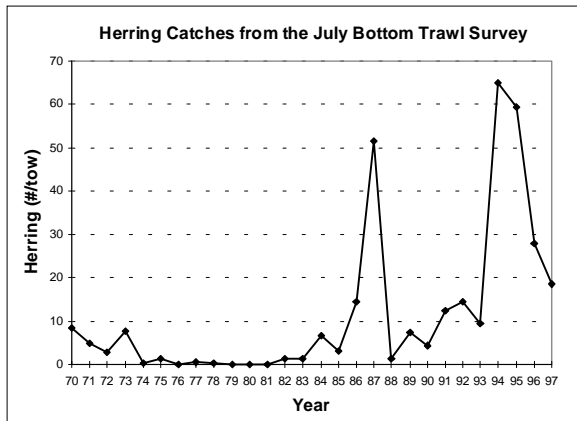


### ***Resource Status and Outlook***

The first broad scale directed **larval survey** for herring on the offshore Scotian Shelf since 1982 was undertaken in November 1997. Preliminary results show the presence of small herring larvae on Western Bank, supporting the current assumption of an offshore spawning component.

Results from the 1997 July **bottom trawl survey** show herring to be distributed widely on offshore Scotian Shelf Banks (as in recent years), but there has been a decrease in

numbers taken by this survey in the past three years.



There is insufficient information on which to base an evaluation of stock status. Industry records show that herring were widely distributed on Scotian Shelf banks in May and June of 1997. Although a considerable amount of herring was seen, there was little quantitative information from the fishery. The decrease in numbers of herring taken in the July bottom trawl survey, and the narrow age composition in the catch are considered to be negative signals. The catch should be reduced unless there is information during the season which demonstrates that these concerns are unfounded.

### ***Management Considerations***

It has been previously recommended that a strategy for assessment and exploration of the Scotian Shelf component be developed. Industry and DFO have reviewed results of the Regional Herring Workshop (February, 1997) and the Workshop on Ecosystem Considerations for Krill and other Forage Fisheries (April, 1997), and have established a committee to investigate the range of possible approaches to improve the management of herring fisheries, including the fishery on the the offshore Scotian Shelf.

Projects to be initiated by the Pelagics Research Council in 1998 will improve the information base on which to evaluate resource status for the next assessment. Of particular interest will be an acoustic survey in the autumn 1998 to document the abundance of spawning aggregations on the offshore banks.

Industry and Management have proposed a two-step approach for this year:

*“The management approach for 1998 will be generally as follows. An initial catch limit will be established following review by RAP, probably in the range between the previous two years catch i.e. 12,000 - 20,000t. After the fish have aggregated sufficiently to survey and prior to the initial catch level being caught, a detailed survey utilizing the recording acoustic equipment will be undertaken by the industry to determine the relative stock abundance. Changes as considered appropriate and in line with the recommendations by RAP, will be made to the initial catch level.”*

The caution expressed in the Outlook (above), suggests that the initial catch limit should be low.

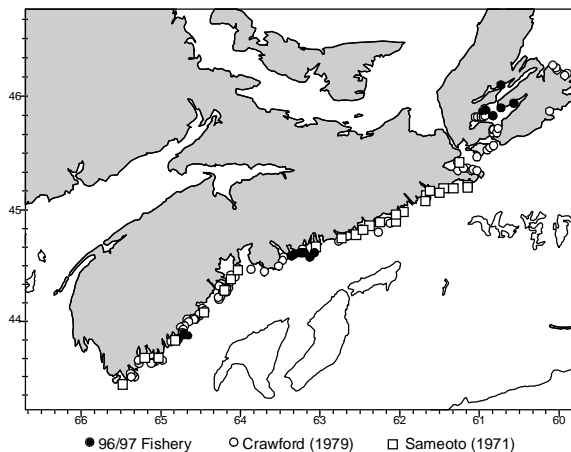
Foreign fisheries took relatively large amounts (as much as 60,000t in a year) from the offshore Scotian Shelf banks during the period 1963-1973. The average recorded catch for the 1970-1973 period was 30,000t, but these fisheries did not demonstrate what level of catch could be sustained. Industry, science and management are encouraged to work together to develop a medium term strategy for assessment and exploitation of the herring on the Scotian Shelf outer banks.



## ***COASTAL (SOUTH SHORE, EASTERN SHORE AND CAPE BRETON) NOVA SCOTIA SPAWNING COMPONENT***

### ***Spawning Areas***

Historical spawning areas have been documented for coastal Nova Scotia. Active spawning in several of these areas has been confirmed in recent years by the data from the 1996 and 1997 fishery. Much of the inshore fishery, particularly the bait fishery, remains undocumented and thus it is likely that other inshore spawning areas exist but are not recorded. There is an urgent need to document the current status of all spawning grounds within this component.



Spawning areas documented from the 1996 and 1997 fishery (closed) and from historical records (open symbols).

### ***The Fishery***

The fishery operates throughout the coastal waters of 4VWX, but information is very limited. This year there has been some improvement in the available information from two areas, Eastern Passage and Little Hope, and a continued improvement in the information from the Bras d'Or Lakes and Glace Bay areas. Since most of the coastal fishery is for bait, a considerable proportion

of the **catch** is unrecorded or poorly documented.

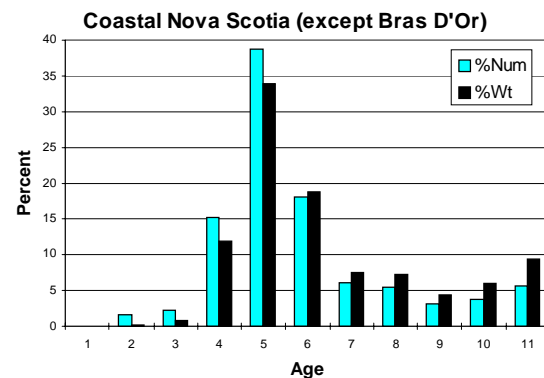
There has been a considerable increase in the number of active gillnet **licenses** in recent years. This was the second year of the fishery on spawning fish east of Halifax and the first gillnet roe fishery off Little Hope in recent years.

**Recorded landings** by gillnet and trap along the coast of Nova Scotia totaled 2,970t in 1997. This included landings of 1,520t from the Eastern Passage area, 170t from the Glace Bay area, 160t from the Bras d'Or Lakes and 490t from Little Hope. This is considered to be an underestimate because bait landings are largely unrecorded.

### ***Resource Status and Outlook***

#### ***Coastal Nova Scotia except Bras d'Or Lakes***

Catches in this component had a broad age distribution dominated by the age 5 (1992) year-class.



One mapping **survey** involving 13 vessels undertaken in the Eastern Passage area on October 9 estimated 15,000 t of herring. There were two mapping surveys of Little Hope. The first on October 14 estimated 3,000-4,000t, while the second on October 23 found no herring.

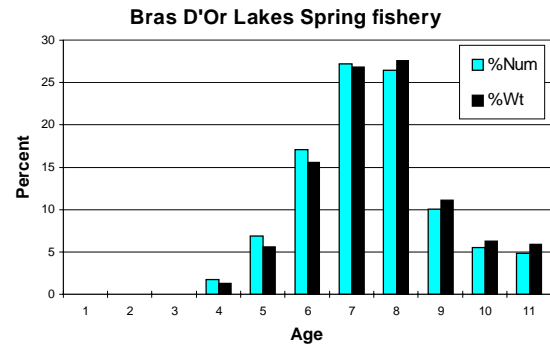
These are still largely undocumented fisheries. The lack of information from this fishery precludes evaluation. Landings for bait may be considerable, from relatively small spawning groups. Without complete landings information and surveys, no evaluation of stock status is possible. It is necessary to improve documentation of the fishery and spawning groups and to improve monitoring of existing fisheries.

There is increasing pressure to develop fisheries (especially for roe), and these new fisheries are being proposed in the absence of knowledge of the current level of fishing pressure or estimates of spawning group status. As in 1997, it is suggested that no coastal spawning group should have a large effort increase until much more information is available on the state of that spawning group. There should be no new fisheries developed when there is uncertainty regarding stock composition and degree of mixing.

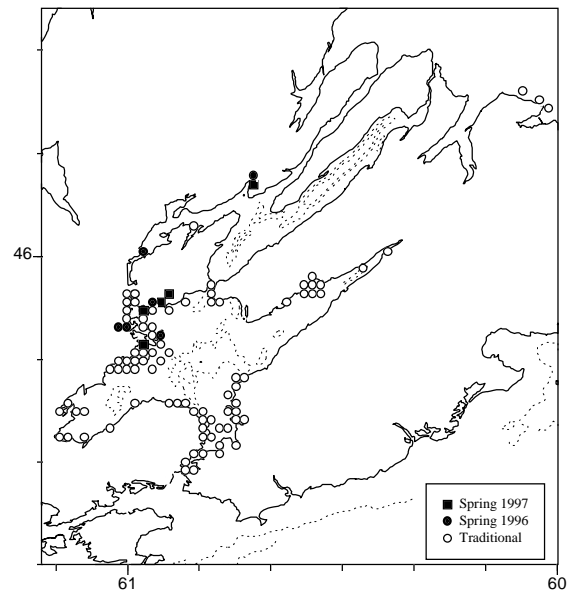
### *Bras d'Or Lakes*

One hundred and sixty four tonnes of herring were landed by fixed gear in the Bras d'Or Lakes during April and May. The fishery began later and was shorter than in recent years. There was a reduction in the number of locations at which herring were caught, an increase in the overall fishing effort and a concentration of catches at a single location. Herring did not appear in the usual fishing locations and there was a shift in effort to the Baddeck Bay area.

The Bras d'Or Lakes spring fishery was dominated by ages 7 and 8 (1990 and 1989 year-classes) while ages 4-6 were less prevalent than expected.



Of particular concern in the 1997 fishery was the further decrease in the number of spawning areas in the Bras d'Or Lakes. In 1996 it was reported that spawning was restricted to only a few of the traditional spawning grounds (1997 4VWX Herring SSR B3-03) and in 1997 spawning was observed at even fewer locations.



Two larval herring surveys of the Bras d'Or Lakes were conducted in 1997. The first survey in mid May was too early in the season, and no larval herring were caught. The second survey from June 20 to 26 caught herring larvae in very small numbers at only 16 out of 53 sets. Larvae were restricted to the northern portion of the lakes. Few larvae were taken in the south (Big Lake), where occasional sampling in the

past 20 years had documented substantial numbers of larvae.

It was noted in the 1997 SSR that the status of herring in the Bras d’Or Lakes was cause for concern. This year with the further decrease in spawning locations, low levels of larvae and the increase in fishing effort, the situation appears to be worse.

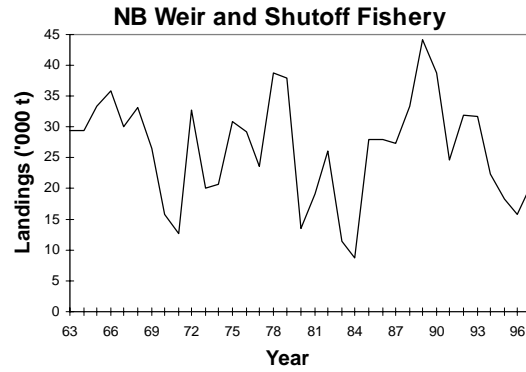
Given continued deterioration in signals from the Bras d’Or Lakes fishery it is preferable, from a biological perspective, that no fishing take place on this spawning component.

**SW NEW BRUNSWICK MIGRANT JUVENILES**

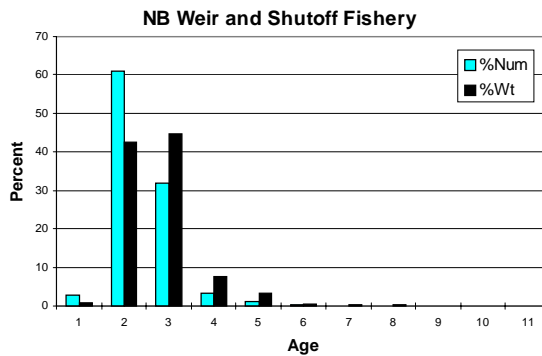
The SW New Brunswick weir and shutoff fishery has relied, for over a century, on the aggregation of large numbers of juvenile herring near shore at the mouth of the Bay of Fundy. These have traditionally been considered to be a mixture juvenile fish dominated by fish originating from NAFO Subarea 5 spawning components, and have therefore been excluded from the 4WX quota. Mature herring (ages 4+) taken in this fishery are considered to be of 4WX origin.

The number of active weirs and distribution of weirs have decreased over the past decade, due in part, to the conversion of sites to aquaculture. The 1997 catch (20,552t) was higher than the previous two years, but below the average (about 26,000t) from this fishery for the past 35 years.

The 1997 catch was, as usual, dominated by age 2 (61% by number; 43% by weight), followed by age 3. Only a small proportion (4% by number, 12% by weight) were ages 4+.



Landings from the SW New Brunswick weir and shutoff fishery; 1963-present



Landings of juvenile herring from this fishery are included in the U.S. “coastal complex” which is considered to be at high abundance. No separate evaluation of this fishery was made.

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