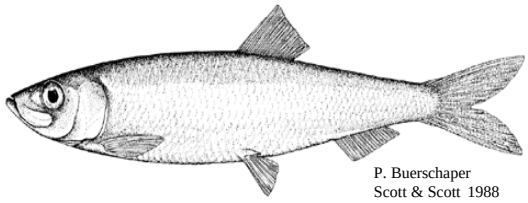
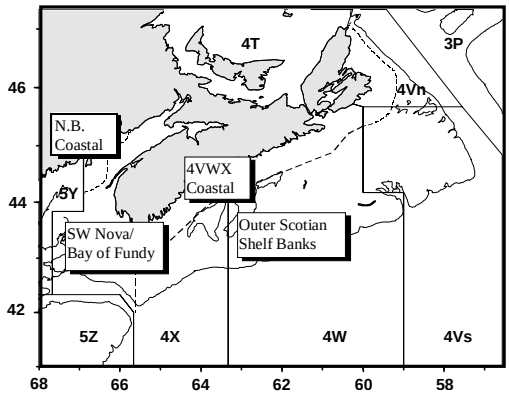


P. Buerschaper
Scott & Scott 1988

4VWX Herring



Background

Atlantic herring is a pelagic species found on both sides of the North Atlantic. Herring 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 contains a number of spawning areas, separated to various degrees in space and time. Spawning areas in close proximity with similar spawning times, and which share a larval distribution area, are considered part of the same complex. These undoubtedly have much closer affinity than spawning areas that 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 as herring migrate long distances and mix outside of the spawning period both with members considered part of the same complex and with members of other spawning groups. 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.*

Each component has several spawning areas, and there is mixing of fish among spawning components. 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 fishing 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 shutoff and trap.

Since 1995, the herring stock assessment and related research has been enhanced by a number of projects undertaken with the assistance of the fishing industry. These include industry sampling of biological characteristics of the catch and acoustic surveys using industry vessels which provide key information for the assessment.

Summary

SW Nova Scotia/Bay of Fundy Spawning Component

- Spawning stock biomass (SSB) was estimated from acoustic surveys of spawning grounds to be about 463,000t (compared to about 500,000t in 1999).

- Greater amounts of spawning fish were documented in Scots Bay, but fewer herring were recorded on German Bank than in 1999. There was no evidence of spawning on the Seal Island grounds, and the Trinity Ledge spawning group remains low.

- Recent age composition of the population has improved relative to 1996 and 1997, but still contains few fish (<2%) older than the 1992 year-class (age 8). The fishery in 2000 was

dominated by juvenile herring (2 year old).

- This evaluation suggests that there has been a deterioration rather than improvement in stock status in 2000 and that the conservation objectives specified for this fishery are not being met. Catches in the year 2001 should be reduced to below that of the past three years.

Offshore Scotian Shelf Banks Spawning Component

- The 2000 herring fishery landed 2,100t, substantially less than in 1999 and the lowest in the five years of this fishery.

- Age composition from the fishery showed dominant 1993 and 1994 year-classes.

- The July bottom trawl survey continued to indicate that herring were widespread and abundant on the banks west of Sable Island.

- The initial catch allocation for 2001 should not exceed the 12,000t reference value used in the recent fishing plans.

- There continues to be the need for industry surveys to estimate abundance.

Coastal Nova Scotia Spawning Component

- Changes to management and recent research efforts have improved the knowledge of the fishery in four of the spawning areas, but there remains a lack of biological and fishery information for much of this component.

- No coastal spawning group should have a large effort increase until information is available on the biomass and biological characteristics of that spawning group. There should be no new fisheries developed when there is uncertainty regarding stock composition and degree of mixing.

- There is continued concern for the restricted spawning distribution and low biomass of the Bras d'Or Lakes spring-spawning herring, and it is again recommended that there be no fishery on the spring spawning component.

SW New Brunswick Migrant Juveniles

- Approximately 17,000t of herring, considered to be a mixture originating primarily from NAFO Subarea 5, were landed in the traditional New Brunswick weir and shutoff fishery. This is slightly lower than in 1999. Landings were particularly low early in the season.

Objectives and Management

The 1999-2001 Scotia-Fundy Herring Integrated Fisheries Management Plan sets out principles, conditions, and management measures for the 4VWX herring fisheries. The main principle stated in the plan is "*the conservation of the herring resource and the preservation of all of its spawning components*" (DFO 1999).

Specific conservation objectives were developed and reviewed in 1997, and the following three objectives appear in the plan:

1) To maintain the reproductive capacity of herring in each management unit:

- persistence of all spawning components in the management unit;

- maintenance of biomass of each spawning component above a minimum threshold;
- maintenance of a broad age composition for each spawning component; and
- maintenance of a long spawning period for each spawning component.

2) To prevent growth overfishing:

- continue to strive for fishing mortality below $F_{0.1}$.

3) To maintain ecosystem integrity/ ecological relationships ("ecosystem balance").

An "in-season" management process, first implemented in the southwest Nova Scotia fishery during 1995, continued to be used widely within the 4VWX management area. The approach encouraged surveying using the commercial fleet under scientific direction prior to fishing ("survey, assess, then fish" protocol) to ensure that effort was distributed appropriately among various components of the stock (particularly among spawning components) according to the relative size and current state of each component. The use of this approach in recent years has improved data collection and enabled modifications to management decisions to be made with the involvement of participants and on the basis of up-to-date information.

Landings (thousands of tonnes)

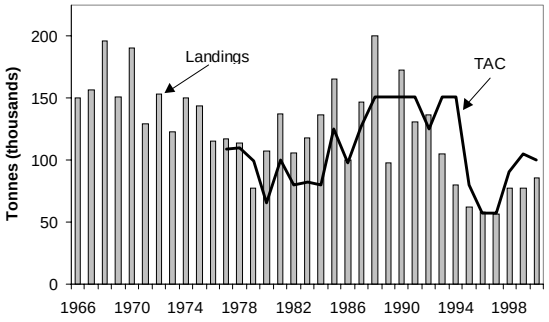
Year	1980-1989 Avg.	1990-1995 Avg.	1996	1997	1998	1999	2000
4WX SW NS TAC	106	135	57	57	90	105	100
4WX SW NS	131	115	58	56	78	78	85
4VWX Coastal NS	<1	1	2	3	4	7	4
Scotian S. Banks	<0.1	<0.1	12	20	6	13	2
SW NB	24	28	16	21	20	19	17
Total Landings	155	142	88	100	108	117	108

SW NOVA SCOTIA/BAY OF FUNDY SPAWNING COMPONENT

The Fishery

The 2000 TAC for this component was established at 100,000t, a decrease of 5,000t from the previous year. Eighty percent of the TAC was initially allocated to the mobile gear sector and 20% to the fixed gear sector, as has been done historically. There was a transfer of quota of 10,000t to the mobile fleet late in the season, but this was not fully utilized due to the late date of the transfer.

Total landings from this component in 2000 (85,250t) were slightly higher than those of 1998 (78,140t) and 1999 (77,550t). Landings by the purse seine sector (83,760t) were approximately 13,000t greater than in 1999. Landings by both the gillnet sector (820t) and the Nova Scotia weirs (700t) were very small and considerably lower than in 1999. Failure to catch the quota can be attributed totally to the low catches by the fixed-gear sector.



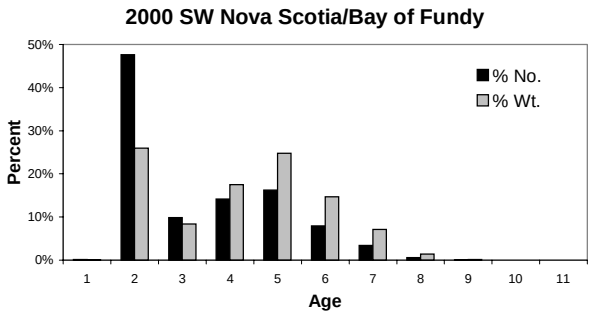
The temporal and spatial distribution of the purse seine fishery was generally as expected, but there were some changes in the relative distribution of effort. The largest purse seine fisheries occurred on the German Bank and Scots Bay spawning grounds, and on summer feeding fish around Gannet/Dry Ledge, off Long Island, N.S. and around Grand Manan.

Catches in Scots Bay and around Grand Manan were considerably higher than in the previous year; while catches in the Long Island area and around Trinity Ledge were lower. In 2000, as in recent years, there was only a limited fishery for herring during the winter months in Chedabucto Bay, where during the 1970's and 1980's a larger fishery took place on over-wintering aggregations. There was a limited amount of fishing on aggregations of overwintering herring in January 2000 and 2001 off Halifax Harbour (Chebucto Head).

The gillnet fishery took place in the traditional areas (in June on the Spectacle Buoy area and in August/Sept. on Trinity Ledge) but the decline in catch noted in recent years continued. Reduced landings in the gillnet sector were attributed primarily to reduced effort in this fishery both due to lack of market and/or price, and the success of the recent lobster fishery.

The reduced catch in the Nova Scotia weirs was unexpected. Almost no herring were taken in May and June when landings have traditionally been greatest. Few herring were taken from weirs inside St. Mary's Bay – weirs that have traditionally fished well early in the season. This is considered to have been due to a change in the distribution of herring as fish were caught throughout this period further offshore.

The 1998 year-class made up over 40% of the numbers and over 20% of the weight of herring landed. These young fish were taken primarily south of Grand Manan and mid-Bay of Fundy off the Long Island Shore. This high fraction of juvenile fish in the catch is more typical of what was caught in the 1960's and early 1970's.



Resource Status

Acoustic surveys were undertaken on the major spawning areas and in some of the major fishing areas using acoustic equipment on commercial vessels, supplemented upon occasion by research vessels. 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. Acoustic recording devices allowed the logging of quantitative data for later analysis. Data were collected from structured surveys and opportunistically during many fishing trips. Survey coverage was the best in the four years this type of survey system has been used, but there was incomplete coverage of Trinity Ledge. Acoustic surveys of the spawning grounds documented approximately 463,000t of spawning herring. While there have been differences in survey coverage over the past four years, the 1999 and 2000 coverage are comparable.

Location	1997 Obs.	1998 Obs.	1999 Obs.	2000 Obs.
Scots Bay	160,100	72,500	41,000	106,300
Trinity Ledge	23,000	6,800	3,900	600
German Bank	370,400	440,700	460,800	356,400
Spectacle Buoy	15,000	1,300	0	0
Total	**568,500**	**521,300**	**505,700**	**463,300**

Surveys and fishing in 2000 confirmed the presence of large amounts of herring both on German Bank and in Scots Bay. More

herring were documented in Scots Bay than in either of the two previous years, but less in other spawning areas. Almost no herring were documented on Trinity Ledge. While survey coverage of that area was poor, it remains obvious that the SSB observed at Trinity Ledge in recent years remains far below historic levels. German Bank was surveyed well in 2000, and the reduction in recorded biomass, compared with earlier years, is of concern. There remains concern over the continued lack of spawning in the traditional Seal Island area and the recent decrease in spawning at Spectacle Buoy.

Fishery information shows the presence of substantial amounts of herring in some areas other than spawning grounds. Herring were abundant on summer feeding areas off south-west Nova Scotia and Grand Manan. Substantial numbers were documented on an overwintering aggregation off Halifax in January. However, fewer herring were caught in the weir fisheries of Nova Scotia or New Brunswick – particularly early in the summer.

Far more herring were taken at age two (1998 year-class) than was expected. This is presumed to have been due to the shift in distribution of effort to the large summer feeding aggregation, which occurred southeast of Grand Manan, the presence of markets that would accept small fish (for canned herring and for bait), and the lack of landings from weirs (on both sides of the Bay of Fundy). The relative strength of this 1998 year-class is not known. As has been noted in previous assessments, there are very few fish older than the 1992 year-class (age 8) in the catch.

Sources of Uncertainty

The evaluation of stock status in this area relies on the spawning stock biomass estimates derived from industry acoustic surveys. In recent assessments, results from acoustic surveys have been used as estimates of minimum spawning stock biomass. There is considerable variability around acoustic estimates. Standard errors around acoustic estimates from major surveys are in the range of 15-45%. Uncertainty may arise from assumptions concerning the duration of herring on spawning grounds, target strength estimates and the coverage of surveys in relation to the extent of spawning.

In the 1999 assessment, there was discussion about the fact that the SSB implied by the acoustic surveys was not consistent with biomass trends from a virtual population analysis. The biomass might have been lower than 500,000t.

There is uncertainty regarding the strength of the 1998 year-class (Age 2). Anecdotal information suggests this year-class may be large. However, if the 2000 increase in catch of age 2 fish is only a redirection of fishing effort, a greater decrease in catch may be required in subsequent years.

Ecosystem Considerations

Herring is prominent in the diet of many fish, birds and marine mammals, and should be managed with these interactions in mind. At present, use of a natural mortality rate of 0.2 and maintenance of SSB at moderate to high levels are assumed to account for these interactions.

Recent management initiatives to protect spawning components are intended to maintain the spatial and temporal diversity of herring spawning.

Outlook

This evaluation suggests that there has been a deterioration rather than improvement in

stock status in 2000 and that the conservation objectives specified for this fishery are not being met. Acoustic surveys documented about 463,000t on spawning grounds, and this is less than the 505,000t documented in comparable surveys in 1999. Spawning remains well below historic levels on Trinity Ledge, and absent from Seal Island. Age composition, while improved over 1996 and 1997, remains restricted with very few fish older than 8 years of age (1992 year-class) in the population. The fishery in 2000 was dominated by 2 year olds.

In recent assessments of the SWNS/BOF spawning component, it has been suggested that removals less than 100,000t would result in fishing mortality below $F_{0.1}$ (about 20% exploitation rate), and that this would be expected to contribute to rebuilding of spawning stock biomass in all spawning areas and expanded age composition. However, there has been little, if any, evidence of rebuilding of this population in the recent past when catches have been 77,000t – 85,000t. Catches for 2001 should therefore be reduced below that of the past three years. The greater the reduction in catch, the greater the expectation that there would be rebuilding of SSB, recovery of spawning grounds, and positive development of age composition.

Management Considerations

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 "survey, assess, then fish" protocol is effective in spreading the catch appropriately among spawning components in proportion to their relative size and is considered an important safeguard at this time of uncertainty and concern regarding stock status.

Acoustic surveys have become critical to stock status evaluation. Where surveys occurred in 2000, they conformed well to the proposed survey pattern. It is important that there be continued attention to coverage and survey design, in order to develop year-to-year consistency in these surveys, as has been proposed.

OFFSHORE SCOTIAN SHELF BANKS SPAWNING COMPONENT

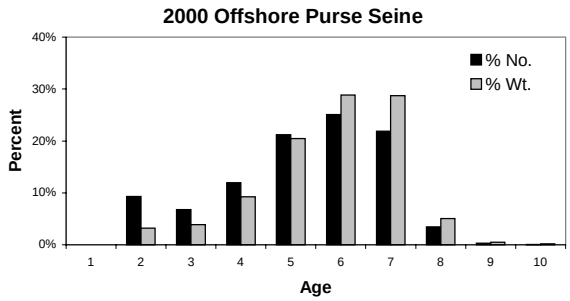
The Fishery

A foreign fishery during the period 1963-1973 is estimated to have removed as much as 60,000t per year from the offshore Scotian Shelf banks. There had been few herring caught after the extension of jurisdiction in 1977 until 1996, when a fishery was initiated by the 4WX purse seine fleet and 11,745t was taken.

The 2000 fishery on Scotian Shelf Banks was smaller than in recent years, with landings amounting to a little over 2000t. Fishing took place primarily in June, in the vicinity of The Patch. The maximum amount of herring documented in acoustic records from fishing vessels working in the area was about 1500t on June 19.

In 2000, there continued to be a by-catch in the domestic bottom trawl fishery on the Scotian Shelf edge and slope, but the amount was considerably less than in 1999.

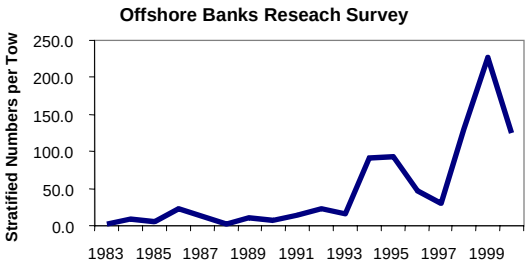
The catch was dominated by 1993 and 1994 year-classes (ages 6 and 7). The same year-classes were dominant in 1999.



Resource Status

Previous results from the summer bottom trawl survey showed few herring on the Scotian Shelf during the 1970's, increasing amounts during the 1980's and a relatively widespread distribution in recent years.

Offshore herring catches during the 2000 July bottom trawl survey were the third highest in the 31-year time series with an average of 124 fish per standard tow. While catches of herring in the survey were considerably lower than in 1999, survey results of the past three years have been the three highest values on record (and in the 18 years in which the same vessel and gear have been used). As in recent years, herring were widely distributed on banks west of Sable Island.



A research vessel acoustic survey of the eastern portion of the Scotian Shelf Oct 20-28 documented approximately 2000t of large herring (mean length 31.5cm) on southern Western Bank.

Outlook and Management Considerations

The results of the annual summer bottom trawl survey demonstrate that there is a considerable abundance of herring, widely spread over the offshore banks of the Scotian Shelf in July. The information from previous assessments indicates the presence of at least some autumn spawning on Western Bank in recent years. There is very little new information to add and no reason to change the previous recommendations that:

- Landings in the foreign fisheries of 13,000t to 60,000t between 1969 and 1973 did not appear to be sustainable.

- The initial catch allocation for 2001 should not exceed the 12,000t reference value used in the recent fishing plans.

There continues to be insufficient documentation of stock size, distribution and spawning behaviour for this component. Industry, Science and Management are encouraged to continue to work together to improve the biological basis for management. There continues to be the need for industry surveys to estimate abundance.

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

The Fishery and Resource Status

There has been an increase in the number of active gillnet licenses in recent years. This was the fifth year for a fishery on spawning fish east of Halifax and the fourth year of gillnet roe fisheries off Little Hope and Glace Bay.

Recorded landings in the four major gillnet fisheries along the coast of Nova Scotia (4,280t) were lower than in 1999 and approximately the same as in 1998.

East of Halifax

The roe fishery in September and October had landings of 1350t. Sampling was very limited, but indicated that the catch was composed primarily of 1992-1994 year-classes (ages 6-8). Acoustic surveys undertaken by Eastern Shore Fishermen's Protective Association on four nights in October resulted in an SSB estimate of 10,870t.

Little Hope

The fishery occurred in the Little Hope area in September and October. A total of 2,040t of herring was landed. An estimate of 5,200t SSB was made from an automated acoustic recorder used during the fishery. No samples were taken for biological analysis.

Glace Bay

The fishery off Glace Bay, Cape Breton took place in September and October. Landings were 830t. Fish aged 7 (1993 year-class) and age 8 (1992 year-class) dominated the catch. There were no surveys.

Bras d'Or Lakes

The fishery was technically closed, but a limited number of fishers were allowed to set nets for samples and could retain catches. Fishing was underway by the last week of March and ended the first week of May, 2000. Effort was concentrated (by regulation) outside of spawning areas. Landings were approximately 60t.

The 1993 year-class (age 7) and 1992 year-class (age 8) dominated the catches. Sampling demonstrated that for most of the fishery, the catch was composed primarily (90%) of autumn spawners. Spring-spawning herring made up only a small fraction of herring caught in several areas that had in the past been known spawning areas (including Groves Point, Malagawash). In only two areas (Baddeck Bay, Eskasoni Harbour) was there evidence of substantial numbers of spring spawners.

Spatial herring surveys undertaken in mid April documented less than 70t of spring spawners.

Outlook and Management Considerations

Since 1996, there has been development of the inshore fisheries in Glace Bay, East of Halifax and Little Hope, primarily for roe. As these fisheries have developed, participants have contributed to sampling and surveying – and the fisheries have attempted to follow the 'survey, assess, fish' protocol. The results of the fisheries in 2000 demonstrate that there needs to be better coordination of surveys and sampling.

This management approach and recent research efforts have improved knowledge in these three areas, but there has been little advancement in knowledge in adjacent areas. The lack of knowledge on the specifics of stock structure, lack of documentation of the historical fishery, and limited survey information preclude evaluation of current fishing mortality for much of this component. Individual spawning groups within this component are considered vulnerable to fishing because of their relatively small size and proximity to

shore. As in the past four years, it is recommended that no coastal spawning area 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.

It has been noted since 1997 that the status of herring in the Bras d'Or Lakes is cause for concern. The information gathered in 2000 does not indicate improvement. Spawning is still absent from some traditional areas and the observed biomass of spring spawners is very low. For the fourth year it is therefore appropriate to advise that 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.

In coastal Nova Scotia, there is no overall quota, and the size and historical performance of various spawning groups are poorly documented. In addition to traditional fisheries for bait and personal use, there are new directed roe fisheries on the spawning grounds. The "survey, assess, then fish (<10%)" protocol is considered useful for spawning components that are considered to be healthy and of sufficient size, but is not practical for all coastal spawning groups.

SW NEW BRUNSWICK MIGRANT JUVENILES

The southwest New Brunswick weir and shutoff fishery has relied, for over a century, on the aggregation of large numbers of juvenile (ages 1-3) herring near shore at the mouth of the Bay of Fundy. These have traditionally been considered to be a mixture of juveniles, 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 has decreased over the past decade, due in part to the conversion of sites to aquaculture, as well as the reduction in landings over the past decade in the Passamaquoddy Bay area. The 2000 catch of 16,830t for N.B. weir and shutoff gears was a little lower than in 1999. Landings were particularly low early in the season, with almost no weir landings in May and June.

The 2000 catch was dominated by the 1998 year-class (age 2), which made up over 75% of the catch by number and by weight.

For More Information

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