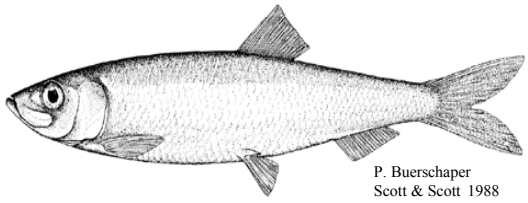
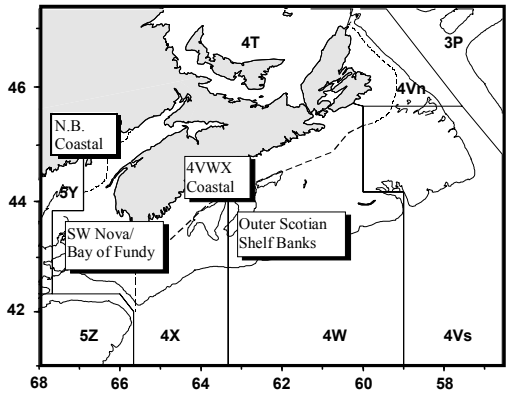


P. Buerschaper
Scott & Scott 1988

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

- Acoustic surveys in 2001 documented a total of 506,890t of spawning stock biomass (SSB) in this component. SSB in standard survey areas (370,340t) has declined for two years (from over 500,000t in 1999) due to a decrease in fish documented on German Bank. An additional 87,500t of spawning fish was documented near Spectacle Buoy and if assumed to be from German Bank, the total for standard survey areas would be near that of 2000. Another 45,800t was documented in a previously unsurveyed area on Brown's Bank.

- More spawning fish were documented in Scots Bay and on Trinity Ledge than in the previous years. There was evidence

of reappearance of spawning on the Seal Island grounds, but this area and Trinity Ledge remained well below historical levels.

- The 1998 year-class (at age 3) appeared to be strong. There were few fish older than age 7 in the catch. Rapid decline of year-classes indicates high total mortality.

- Conservation objectives of maintaining a balanced age composition and maintenance of spawning on all spawning grounds have not been met.

- Even with good recruitment (of the 1998 year-class), maintenance of the catch at recent levels for 2002 may not result in growth in SSB, improvement in age composition and recovery of all spawning grounds.

Offshore Scotian Shelf Banks Spawning Component

- The 2001 herring fishery landed 12,500t, substantially more than in 2000 and about the same as in 1999.

- The 2001 fishery was dominated by the 1999 year-class (age 2) in number and the 1995 and 1996 year-classes (ages 6 and 5 respectively) by weight.

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

- The initial catch allocation for 2002 should not exceed the 12,000t reference value used since 1998.

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 experience 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 this spawning component.

SW New Brunswick Migrant Juveniles

- Approximately 20,200t of herring, considered to be a mixture of fish originating primarily from NAFO Subarea 5, were landed in the traditional New Brunswick weir and shutoff fishery. Landings were up from 2000 and normal in their seasonal timing.

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).

Conservation objectives were developed, reviewed in 1997 and appear in the plan:

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

- 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	Avg. 1980-89	Avg. 1990-99	2000	2001
4WX SW NS TAC	106	112	100	78*
4WX SW NS	131	96	85	72
4VWX Coastal NS	<1	4	4	6
Scotian S. Banks	<0.1	13	2	12
SW NB	24	24	17	20
Total Landings	155	137	108	110

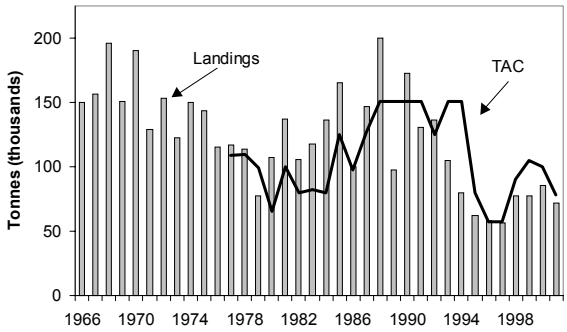
* Catch Limit

SW NOVA SCOTIA/BAY OF FUNDY SPAWNING COMPONENT

The Fishery

The 2001 catch limit for this component was 78,000t, a decrease of 22,000t from the previous year. Eighty percent of the catch limit was initially allocated to the mobile gear sector and 20% to the fixed gear sector, as has been done historically. Some transfer of quota to the mobile fleet occurred late in the season.

Total landings from this component in 2001 (71,570t) were the lowest since 1998. Landings by the purse seine sector (66,000t) were approximately 18,000t lower than in 2000. Landings by both the gillnet sector (1,860t) and the Nova Scotia weirs (3,710t) were higher than in 2000.



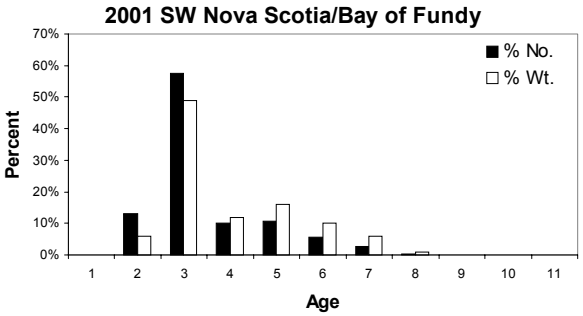
The temporal and spatial distribution of the purse seine fishery was generally as expected, but there were some changes in the relative distribution of effort. The largest purse seine fisheries occurred on the German Bank and Scots Bay spawning grounds, and on summer feeding fish off Long Island, N.S. and around Grand Manan. Catches in Scots Bay, German Bank and on the Nova Scotia Long Island shore were about the same as in the previous year, while catches in the Gannet/Dry Ledge area and around Grand Manan were lower. There was an increase in catch in the N.B. Coastal area and on a new ground, Pollock Point, west of Trinity/Lurcher.

During the 1970s and 1980s, a large fishery took place on over-wintering aggregations in Chedabucto Bay. In 2001 however, there was no fishing effort in this area. There was a limited amount of fishing on overwintering herring in January 2001 and 2002 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) and increased by 1,000t. There had been lower landings in the gillnet sector in recent years because of reduced effort due to lack of market and price, and the success of the recent lobster fishery.

Catches in the Nova Scotia weirs were higher than in 2000, and near the average of recent years.

The 1998 year-class (at age 3) again dominated the catch at age, with over 55% of the numbers and 50% of the weight of herring landed. These young fish were taken throughout the season and dominated all gear types and areas except for gillnet where the mesh size used avoids their capture.



Resource Status

Acoustic surveys were undertaken on the major spawning areas and in some of the major fishing areas. 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. Data were collected from structured surveys and opportunistically during many fishing trips.

Acoustic surveys in 2001 documented 506,890t of spawning stock biomass. More herring were documented in Scots Bay than in either of the two previous years. Some spawning (3,250t) was observed near Seal Island (after several years of little or no spawning). More herring were documented on Trinity Ledge but the SSB observed remains far below historical levels.

While there have been differences in survey coverage in past years, some standard areas have been surveyed consistently and well for the past three years.

Acoustic Survey SSB

Location	1997^	1998^	1999	2000	2001
Scots Bay	160,100	72,500	41,000	106,300	163,900
Trinity Ledge	23,000	6,800	3,900	600	14,800
German Bank	370,400	440,700	460,800	356,400	190,500
Spec.* (spring)	15,000	1,300	0	0	1,140
Total	**568,500**	**521,300**	**505,700**	**463,300**	**370,340**
Spec.* (fall)					87,500
Seal Island					3,250
Browns Bank					45,800
Overall Total					**506,890**

^ 1997 and 1998 not comparable in coverage with 1999-2001
* Spec. - Spectacle Buoy

In 2001, SSB of 370,340t was recorded in these standard areas. There has been a decrease in SSB in these standard areas since 1999 (from 505,700t), however an additional 87,500t of spawning fish was documented near Spectacle Buoy, and if these are assumed to be from German Bank, the acoustic survey total in standard areas for 2001 would be near that of 2000. Another 45,800t were documented in a previously unsurveyed area on Brown's Bank.

The decrease in the biomass in the standard survey area in 2001 was due to a reduction in SSB on German Bank. German Bank was surveyed well and the 2001 surveys are thought to be comparable to those of recent years. Although it remains the largest documented spawning area (about 200,000t), the decrease in SSB since 1999 on German Bank is unexplained and is of concern.

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 amounts (approximately 158,000t) were documented for an overwintering aggregation off Halifax in January 2001.

While the precise strength of the recruiting 1998 year-class is not known it appears to be strong.

As has been noted in previous assessments, there are very few fish older than age 7 in the catch. The rapid decline in the abundance of a year-class implies high total mortality and is consistent with heavy exploitation.

A summary of attributes used previously as biological indicators in this fishery (DFO 1997) indicate both positive and negative signs:

Biological Attribute	Positive	Negative
Spawning time	Normal in most areas; protracted on Trinity	
Spawning location	Spawning reappeared on Seal Island after several years	
Spawning: relative amount	More SSB observed in Scots Bay and Trinity Ledge; some observed on Seal Island	Reduced SSB on German Bank; SSB well below historical levels on Trinity and Seal Island
Size/Age composition	Strong recruiting 1998 year-class	Few fish older than age 7
Distribution	As expected in most key over-wintering, summer feeding and spawning areas	Spawners found north-east of German Bank outside of traditional spawning area.
Relative fish abundance	Lots of fish, good catch rate and trip success	
Physiology, condition & behaviour	Nothing unusual noted; fat content as expected	

Sources of Uncertainty

The evaluation of stock status in this area relies in large part on the spawning stock biomass estimates derived from industry

acoustic surveys. There is considerable variability around acoustic estimates (standard errors are in the range of 15-45%) although studies of individual weir catches indicate that acoustic biomass estimates are within 15% of the amount of fish harvested. Uncertainty may also arise from assumptions concerning the residence time of herring on spawning grounds, target strength estimates and the coverage of surveys in relation to the extent of spawning.

There is uncertainty regarding the strength of the 1998 year-class (age 3). Observed catch information suggests this year-class is widespread and may be large.

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

Recent assessments of the SWNS/BOF spawning component suggested that fishing mortality should remain below $F_{0.1}$ (about 20% exploitation rate), for a number of years in order to rebuild spawning stock biomass in all spawning areas and to expand the age composition.

The last assessment (DFO 2001) suggested that there had been a deterioration rather than improvement in stock status in 2000, and noted that there had been little, if any, evidence of rebuilding of this population in the recent past when catches had been 77,000t – 85,000t. It was suggested that catches for 2001 be reduced to below that of the previous three years and the catch limit was reduced.

In the 2001 fishery, there were some positive developments, but there remain some negative biological signs, and some of the conservation objectives specified for this fishery are not being met. While there is evidence of good recruitment, the population contains fewer older fish than would be expected of a balanced age distribution. The rapid decline in year-class strength is a sign of continued high total mortality. While surveyed SSB was higher in Scots Bay and on Trinity Ledge, and a small amount of spawning was observed for the first time in recent years near Seal Island the SSB on both Trinity Ledge and Seal Island is well below historical levels. Further, there has been a substantial decrease in the total biomass surveyed in index spawning areas resulting from a decrease in SSB on German Bank.

Increased catches in this fishery would be expected to contribute to rapid decline in recruiting year-classes. This would reduce the prospect of positive improvement in age composition and rebuilding SSB.

Improved prognosis for this stock requires an increase in total SSB from standard areas, adequate performance of all major spawning grounds and expanded age composition. Even with good recruitment (of the 1998 year-class), maintenance of the catch at recent levels for 2002 may not result in growth in SSB, improvement in age composition and recovery of all spawning grounds.

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 conservation objectives. 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. Surveys conducted in 2001 conformed with the proposed survey pattern. It is important that there be continued attention to coverage and survey design, in order to assure year-to-year consistency in these surveys.

OFFSHORE SCOTIAN SHELF BANKS SPAWNING COMPONENT

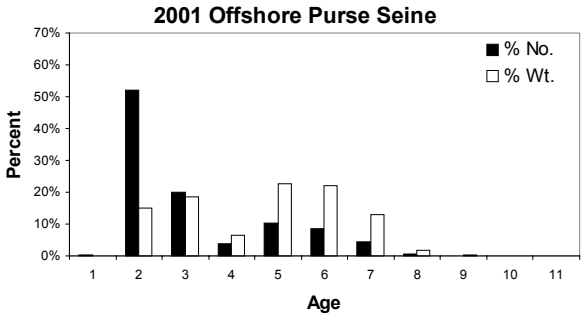
The Fishery

A foreign fishery during the 1963-1973 is estimated to have removed as much as 60,000t per year from the offshore Scotian Shelf banks. Few herring were caught after the extension of jurisdiction in 1977 until 1996, when a fishery was initiated by the 4WX purse seine fleet and 11,700t was taken.

The 2001 fishery on Scotian Shelf Banks was larger than in 2000, with landings of about 12,500t. Fishing took place primarily in May and June, in the vicinity of The Patch as well as in the Western Hole/Roseway Bank areas.

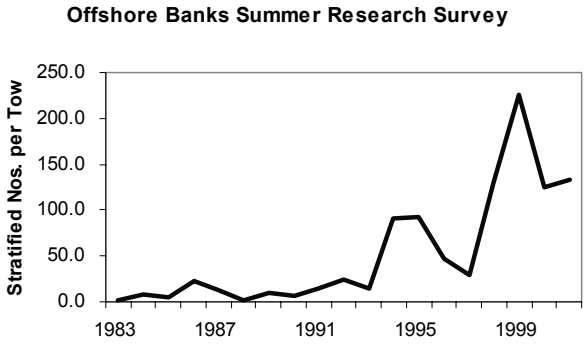
In 2001, herring continued to be a by-catch in the domestic bottom trawl fishery on the Scotian Shelf edge and slope, but the amount was less than 50t. A single midwater trawl vessel was active in the area with catches of about 300t.

Age composition from the fishery was dominated by the 1999 year-class (age 2) in number and the 1995 and 1996 year-classes (ages 6 and 5 respectively) by weight.



Resource Status

A single acoustic survey by the herring fleet on July 4 documented about 145,000t in the area from The Patch to Roseway Bank. Previous results from the DFO summer research bottom trawl survey showed few herring on the Scotian Shelf during the 1970s, increasing amounts during the 1980s and a relatively widespread distribution in recent years. Offshore herring catches from this survey in 2001 were the second highest in the 32-year time series, with an average of 132 fish per standard tow. Survey catches of the past four years have been the highest on record (and in the 19 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.



Outlook and Management Considerations

The summer bottom trawl research survey demonstrates that there is a considerable abundance of herring widely spread over the offshore banks of the Scotian Shelf. Information from previous assessments indicate 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 outlook:

- Recorded 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 2002 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, DFO 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 sixth year for a fishery on spawning fish east of Halifax and the fifth year of gillnet roe fisheries off Little Hope and Glace Bay.

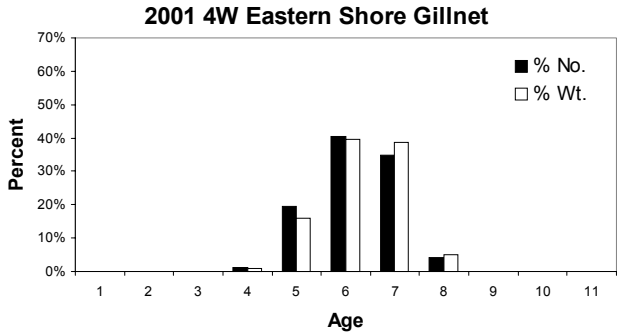
Landings (t)

	1996	1997	1998	1999	2000	2001
East of Halifax	1,280	1,520	1,100	1,630	1,350	1,900
Little Hope	-	490	1,170	2,920	2,040	2,900
Glace Bay	-	170	1,730	1,040	830	1,200
Bras d'Or	170	160	120	30	56	0
Total	1,450	2,340	4,120	5,620	4,276	6,000

Recorded landings (6,000t) in the four major gillnet fisheries along the coast of Nova Scotia were higher for all fishing units (except for Bras d'Or Lakes which were closed) and were approximately the same as in 1999.

East of Halifax

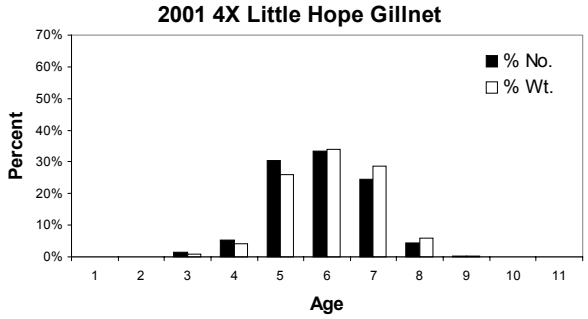
The roe fishery in September and October landed 1,900t. Sampling was limited, but indicated that the catch was composed primarily of 1994-1995 year-classes (ages 7 and 6 respectively).



Acoustic surveys undertaken by the Eastern Shore Fishermen's Protective Association in October resulted in an SSB of 16,700t, the highest for the area to date.

Little Hope

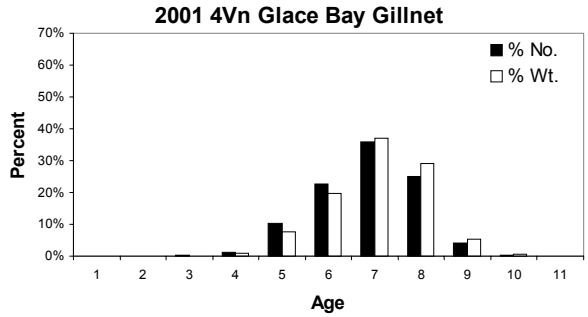
The fishery occurred in the Port Mouton/Little Hope area in September and October. Sampling indicated that the catch was composed primarily of 1994-1996 year-classes (ages 5-7).



A total of 2,900t of herring was landed. An estimate of 21,300t SSB was made from an automated acoustic recorder used during the fishery and over 3 survey nights.

Glace Bay

The fishery off Glace Bay, Cape Breton took place in September and October. Landings were up, at 1,200t. Fish aged 7 (1994 year-class) dominated the catch.



A mapping survey documented about 21,200t for two aggregations of spawning fish off Glace Bay.

Bras d'Or Lakes

The fishery was closed. Limited sampling was undertaken by the Eskasoni Fish and Wildlife Commission in April and May 2001 with four samples taken for length. Survey coverage of the Bras d'Or Lakes spring spawning grounds was limited and no biomass estimates were made.

Outlook and Management Considerations

In coastal Nova Scotia, there is no overall quota, and apart from the areas mentioned above, 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.

As the inshore roe fisheries off Glace Bay, East of Halifax and Little Hope have developed, participants have contributed to sampling and surveying and the fisheries have attempted to follow the 'survey, assess, fish' protocol. Surveys and sampling in these areas improved over previous years and should be continued.

Management approaches and recent research efforts have improved knowledge in these three areas, but there has been no increase 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 five years, it is recommended that no coastal spawning area should

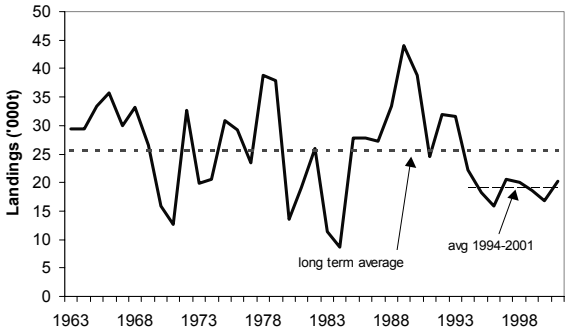
experience a large effort increase until much more information is available on the state of that spawning group. There should be no new fisheries developed when there is uncertainty regarding stock composition and degree of mixing.

It has been noted since 1997 that the status of herring in the Bras d'Or Lakes is cause for concern. Spawning is still absent from some traditional areas and the observed biomass of spring spawners is very low. It is therefore appropriate to reiterate that from a biological perspective, that no fishing take place on this spawning component.

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.

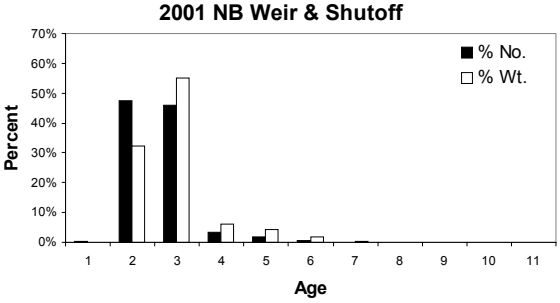
SW NEW BRUNSWICK MIGRANT JUVENILES

The southwest New Brunswick weir and shutoff fishery have relied, for over a century, on the aggregation of large numbers of juvenile herring (ages 1-3) 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 and distribution of active weirs have 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 2001 catch of 20,200t for N.B. weir and shutoffs were higher than 2000 and similar to the average since 1994. Landings by month were also normal in their seasonal timing.

The 2001 catch was dominated by the 1999 year-class (age 2), which made up almost 50% of the catch by number and by the 1998 year-class (age 3) making up over 55% of the catch by weight.



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ISSN 1480-4913

La version française est disponible à l'adresse ci-dessus.

Correct citation for this publication

DFO, 2002. 4VWX Herring. DFO Science Stock Status Report B3-03 (2002).