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Scott & Scott 1988

4VWX Herring

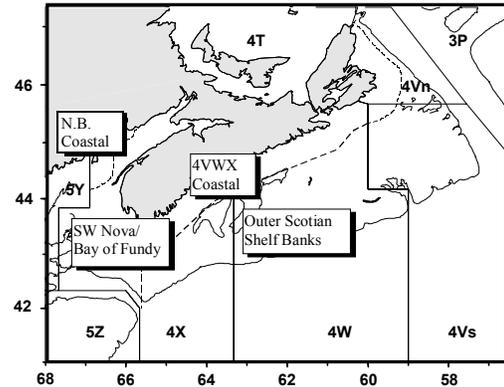
Background

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 2002 documented a total of 543,000t of spawning stock biomass (SSB) in this component.
- More spawning fish were documented on German Bank 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 4) was confirmed 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 an ideal age composition and maintenance of spawning on all spawning grounds have not been met.
- Recent good recruitment is expected to result in continued positive development of SSB, age composition and re-occupation of spawning grounds with catch levels of recent years. Increasing catches may still result in improvement but at a lower rate; however, a large increase in catches could compromise improvement.

Offshore Scotian Shelf Banks Spawning Component

- The 2002 herring fishery landed 7,000t, about 5,000t less than in 2001.
- The 2002 fishery was dominated by the 2000 year-class (age 2) in number and the 1996 and 1997 year-classes (ages 6 and 5 respectively) by weight.
- The DFO 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 2003 should not exceed the 12,000t reference value used in the recent fishing plans.

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 new coastal spawning fisheries 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 related to the absence of spawning from some traditional areas 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 12,000t 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 the lowest since 1983 and there is concern for this component.

Objectives and Management

The 1999-2002 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).

Three conservation objectives developed and reviewed in 1997 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 (000's t)

Year	Avg.		2000	2001	2002
	1980-89	1990-99			
4WX SW NS TAC	106	112	100	78	80
4WX SW NS	131	96	85	72	77
4VWX Coastal NS	<1	4	4	6	10
Scotian S. Banks	<0.1	13	2	12	7
SW NB	24	24	17	20	12
Total Landings	155	137	108	110	106

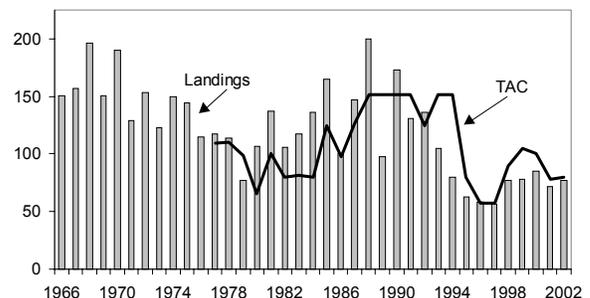
SW NOVA SCOTIA/BAY OF FUNDY SPAWNING COMPONENT

The Fishery

The 2002 catch limit for this component was 80,000t, an increase of 2,000t 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 2002 (77,050t) were similar to those of the past 4 years. Landings by the purse seine sector (75,520t) were approximately 9,500t higher than in 2001. Landings by both the gillnet sector (390t) and the Nova Scotia weirs (1,140t) were lower than in 2001.

Landings and TAC (000's t)



The temporal and spatial distribution of the purse seine fishery was generally as expected. The largest purse seine fisheries occurred on the German Bank

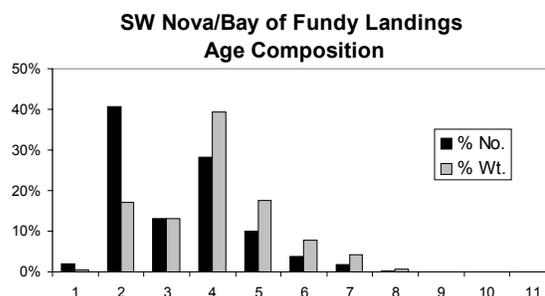
and Scots Bay spawning grounds, and on summer feeding fish off Long Island, N.S. and around Grand Manan. Catches were up on Gannet /Dry Ledge, Grand Manan and Lurcher Shoals. There was a decrease in catch on the Long Island shore area.

During the 1970's and 1980's, a large fishery took place on over-wintering aggregations in Chedabucto Bay. In 2002 however, there was no fishing effort in this area as traditional vessels were successfully fishing elsewhere. There was a small fishery of 370t on over-wintering herring in January 2002 off Halifax Harbour (Chebucto Head).

A small gillnet fishery that took place in the traditional areas (in June on the Spectacle Buoy area and in Sept. on Trinity Ledge) landed only 390t. There have 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 lower than in 2001, and are attributed to problems in availability of fish to the gear.

The 1998 year-class (at age 4) again dominated the catch at age by weight with about 40% of the weight of herring landed, while the 2000 year-class (at age 2) dominated by number in the catch. The recruiting 1998 year-class was taken throughout the season and dominated most gear types and areas and months except for gillnet where the mesh size used avoids their capture. The 2000 year-class was seen mostly in May-June and Oct-Nov in the Grand Manan banks, and south of German Bank near Browns.



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.

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 (000's t)

Location	1997 [^]	1998 [^]	1999	2000	2001	2002
Scots Bay	160	73	41	106	164	141
Trinity Ledge	23	7	4	1	15	8
German Bank	370	441	461	356	191	393
Spec.* (spring)	15	1	0	0	1	
Total	569	521	506	463	370	542
Spec.* (fall)					88	
Seal Island					3	1
Browns Bank					46	
Overall Total					507	543

[^] 1997 and 1998 not comparable in coverage with 1999-2002

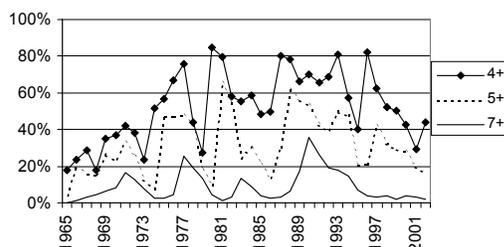
* Spec. - Spectacle Buoy

In 2002, SSB of 542kt was recorded in these standard areas. More spawning fish were documented on German Bank 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.

A summary of daily fishery information compiled by the Herring Science Council and DFO showed 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.

The dominance of the 1998 year-class (age 4) throughout the fishery in 2002 confirmed that it is a strong year-class. These fish were taken throughout the fishing season and were dominant in landings from all gear types. The precise strength of the recruiting 2000 year-class (age 2) is not known but there are indications that it may be strong. In contrast, 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.

SW Nova/Bay of Fundy Catch at Age



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	
Spawning location	Spawning seen for second year on Seal Island after several years of absence	
Spawning: relative amount	Documented SSB highest in recent years with comparable surveys. More SSB observed on German Bank than in previous year	SSB well below historical levels on Trinity and Seal Island
Size/Age composition	Strong recruiting 1998 year-class; indications that 2000 year-class may be strong	Few fish older than age 7; 1999 year-class appears weak
Distribution	As expected in most key over-wintering, summer feeding and spawning areas	
Relative fish abundance	Lots of fish, good catch rate and trip success	
Physiology, condition and 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.

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 so as to meet the explicit biological objectives of management.

In 2000 there appeared to have been a deterioration in stock status (DFO 2001). It was noted that there was little, if any, evidence of rebuilding of this population in the recent past when catches were between 77,000t and 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 2001, with a reduced catch limit, there were some positive developments (including the reappearance of spawning on Seal Island and signs of a

strong 1998 year-class). There remained some negative biological signs (including an apparent decrease in SSB on German Bank, an absence of older fish in the entire population and SSB on Trinity and Seal Island spawning areas less than historical levels).

In 2002 there were additional positive developments. Surveys of German Bank documented approximately 400,000t, an amount much greater than last year and more consistent with expectations from previous observations. Spawning was observed for a second year on the Seal Island grounds. The 1998 year-class was confirmed to be strong, and there are signs that the 2000 year-class may also be strong.

Despite these positive developments, some of the conservation objectives specified for this fishery are not being fully met. While there is evidence of good recruitment, the population contains fewer older fish than would be expected of an ideal age distribution. The rapid decline in year-classes (failure to reach older ages) is a sign of continued high total mortality. While there is spawning on Trinity Ledge, and a small amount of spawning was observed for the second time in recent years near Seal Island, the SSB on both Trinity Ledge and Seal Island is well below historical levels.

The 2002 evaluation stated: "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".

There has been substantial progress against these objectives in 2002 with an

overall increase in SSB, an increase of SSB on German Bank and maintenance of SSB on Scots Bay spawning grounds. The strong 1998 year-class is expected to improve age composition in the future.

Recent good recruitment is expected to result in continued positive development of SSB, age composition and re-occupation of spawning grounds with catch levels of recent years. Increasing catches may still result in improvement but at a lower rate; however, a large increase in catches could compromise improvement.

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.

Acoustic surveys have become critical to stock status evaluation. Surveys conducted in 2002 conformed to the proposed survey design. It is important that there be continued attention to coverage and survey design, in order to assure year-to-year consistency in these surveys in all spawning areas.

OFFSHORE SCOTIAN SHELF BANKS SPAWNING COMPONENT

The Fishery

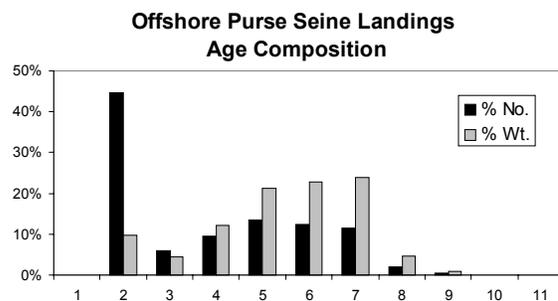
A foreign fishery during 1963-1973 is estimated to have removed as much as 60,000t per year from the offshore

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 2002 fishery on the Scotian Shelf Banks was smaller than in 2001 with landings of 7,000t, about 5,000t less than 2001. 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 2002, 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 80t.

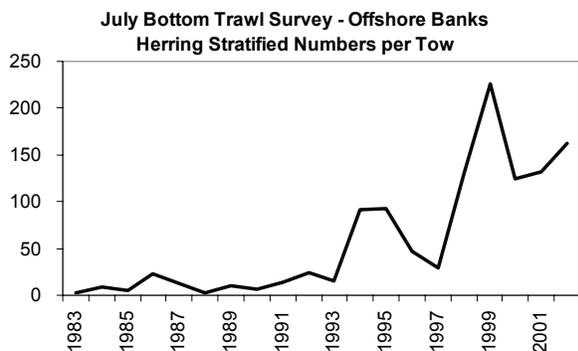
Age composition from the fishery was dominated by the 2000 year-class (age 2) in number and the 1996 and 1997 year-classes (ages 6 and 5, respectively) by weight.



Resource Status

Previous results from the DFO July 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 from this survey in 2002 were the second highest in the 33-year time series, with an average of 163 fish per standard tow. Survey catches of the past five years have been the highest on record (and in

the 20 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 2003 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 seventh year for a fishery on spawning fish east of Halifax and the sixth year of gillnet roe fisheries off Little Hope and Glace Bay.

Landings (000's t)

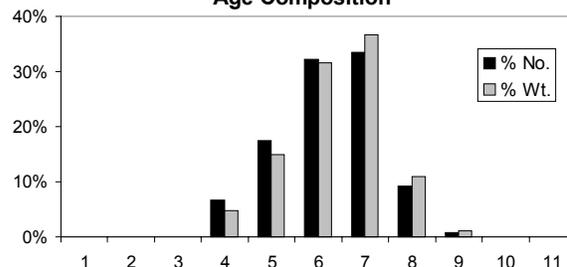
	'96	'97	'98	'99	'00	'01	'02
East of Halifax	1.3	1.5	1.1	1.6	1.4	1.9	3.3
Little Hope		0.5	1.2	2.9	2.0	2.9	4.0
Glace Bay		0.2	1.7	1.0	0.8	1.2	3.1
Bras d'Or	0.2	0.2	0.1	0.0	0.1	0.0	0.0
Total	1.5	2.3	4.1	5.6	4.3	6.0	10.4

Recorded landings (10,000t) in 2002 in the four major gillnet fisheries along the coast of Nova Scotia were higher for all fishing areas (except for Bras d'Or Lakes which was closed).

East of Halifax

The roe fishery in September and October landed 3,300t. Sampling was limited and indicated that the catch was composed mainly of the 1995 and 1996 year-class (age 6-7).

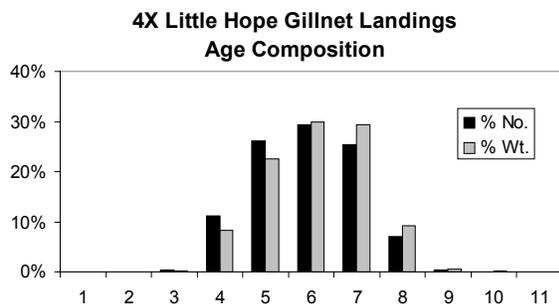
4W Eastern Shore Gillnet Landings Age Composition



Acoustic surveys undertaken by the Eastern Shore Fishermen’s Protective Association in October 2002 resulted in an SSB of 41,450t, the highest for the area to date.

Little Hope

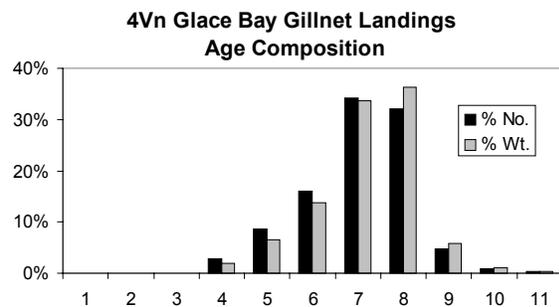
The fishery occurred in the Port Mouton/Little Hope area in September and October. Sampling indicated that the catch was composed primarily of 1995-1997 year-classes (ages 5-7).



A total of 4,000t of herring were landed. An acoustic estimate of 56,000t SSB is the highest for this area to date. The estimate was made from an automated acoustic recorder used during the fishery and over four survey nights.

Glace Bay

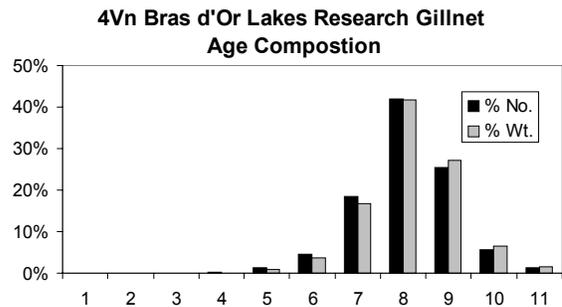
The fishery off Glace Bay, Cape Breton took place in September and October. Landings were up, at 3,100t. Fish aged 7 and 8 (1994 and 1995 year-class) dominated the catch.



A single mapping survey documented only about 7,700t 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 2002 with samples taken for length and age.



In 2002 no acoustic surveys were conducted in the Bras d’Or lakes to document the abundance of spawning herring.

Outlook and Management Considerations

There is no overall quota for the coastal Nova Scotia spawning component 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.

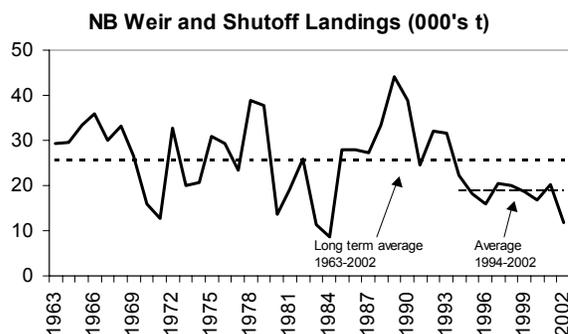
Management approaches and recent research efforts have improved knowledge in these three areas, but there has been no increase in knowledge in adjacent areas. The lack of knowledge on the specifics of stock structure, lack of documentation of the historical fishery, and limited survey information preclude 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 new coastal spawning areas 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 fisheries 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 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.

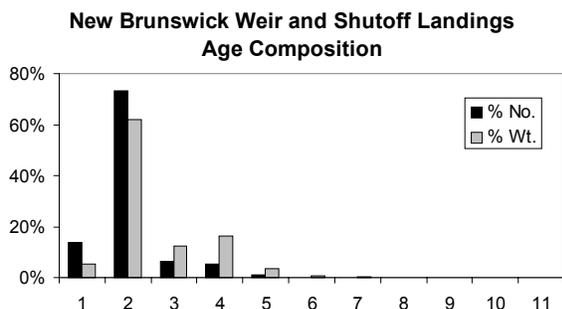


The number and distribution of active weirs have decreased over the past decade, due in part to the conversion of sites to aquaculture, as well as the reduction in landings over the past decade in the Passamaquoddy Bay area.

Approximately 12,000t of herring were landed in the traditional New Brunswick weir and shutoff fishery. Landings in 2002 were the lowest since 1983 and there is concern for this component. There is need for more scientific research on this. Industry observations indicate an abundance of herring in the vicinity of the weirs.

The 2002 catch was dominated by the 2000 year-class (age 2), which made

over 70% of the catch by number and 60% of the catch by weight.



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