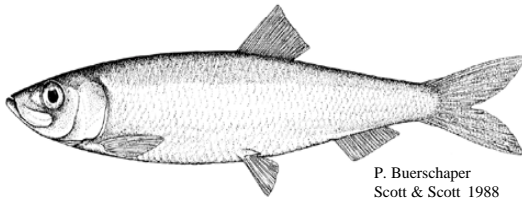
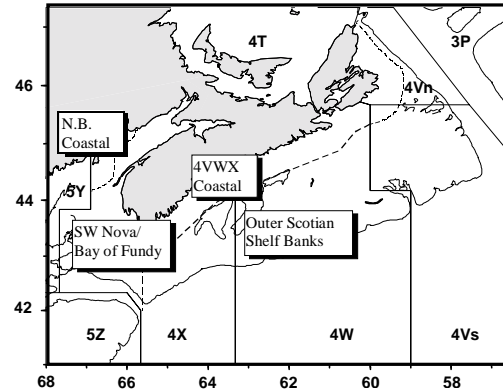


Maritimes Region



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 areas in close proximity, with similar spawning times, and which share a larval distribution area are considered part of the same complex – and undoubtedly have much closer affinity than spawning areas 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 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 1998, the herring stock assessment and related research has been enhanced by a number of projects undertaken with the assistance of the fishing industry. In particular the purse seine and gillnet organizations have been working through the Pelagics Research Council (PRC), an organization created by the herring and mackerel fishing industry, which sponsors and promotes research to improve the biological basis for management. In 1999, PRC projects focused on further development and implementation of hydroacoustic surveys, tagging, and documentation of fleet activity.

Summary

SW Nova Scotia/Bay of Fundy Spawning Component

- Spawning stock biomass (SSB) was estimated from acoustic surveys of spawning grounds to be about 500,000t.
- Age composition has expanded in recent years but the population still contains a small fraction of fish older than the 1992 year-class (age 7).
- Large amounts of spawning fish were documented on German Bank but fewer herring were recorded in Scots Bay and on Trinity Ledge spawning areas than in recent years. There was no evidence of spawning on the Seal Island grounds,

and the Trinity Ledge spawning group remains low.

- Catches in the year 2000 at the level of recent years (<100,000t) should result in $F < F_{0.1}$.

Offshore Scotian Shelf Banks

- The 1999 herring fishery landed 12,840t, higher than in 1998 but substantially lower than in 1997.
- Age composition from the fishery showed a dominant 1993 year-class.
- The July bottom trawl survey continued to indicate a general increase in abundance and widespread distribution of herring on the banks west of Sable Island. Herring were also prevalent in the silver hake fishery.
- The initial catch level for 2000 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 problem of 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 is continued concern for the status of the Bras d'Or Lakes spawning herring, and it is again recommended that there be no fishery on the spring spawning component.

SW New Brunswick Migrant Juveniles

- Approximately 18,200t of herring, considered to be a mixture originating

primarily from Subarea 5, were landed in the traditional New Brunswick weir and shutoff fishery.

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 1999a).

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”).
 - specific parameters have yet to be defined.

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 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	1970-	1980-	1990-	1996	1997	1998	1999
	1979	1989	1995				
	Avg.	Avg.	Avg.				
4WX SW NS TAC	106	106	135	57	57	90	105
4WX SW NS	131	131	115	58	56	78	78
4VWX Coastal NS	<1	<1	1	2	3	4	7
Scotian S. Banks	30*	<0.1	<0.1	12	20	6	13
SW NB	26	24	28	16	21	20	19
Total Landings	-	-	-	88	100	108	117

*average 1970-73

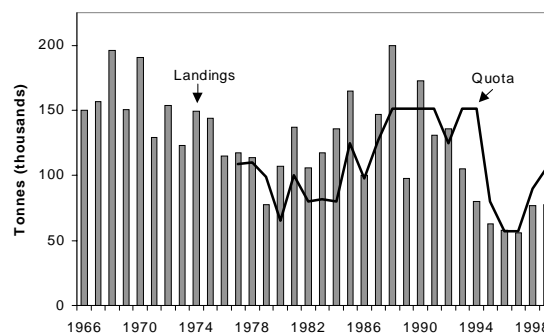
SW NOVA SCOTIA/BAY OF FUNDY SPAWNING COMPONENT

The Fishery

The 1999 TAC for this component was established at 105,000t (an increase from 90,000t in the previous year). Eighty percent was allocated to the mobile gear sector and 20% to the fixed gear sector in the usual manner. Four thousand tonnes of the mobile gear sector quota (100t per license) were held until the vessels contributed to surveying.

Total landings from this component in 1999 (77,550t) were similar to those in 1998 (78,140t). Landings by the purse seine sector (70,430t) were approximately 1,000t

lower than in 1998. Landings by the gillnet sector (1,660t) were 25% lower than the previous year. Landings from Nova Scotia weirs (5,460t) were 20% higher than in 1998. Reduced landings in the gillnet sector, and failure to catch the entire quota were considered to be the result of several factors. These include distribution of quota in relation to market in the purse seine sector, reduced roe market for gillnet sector, quota saved to end of season and lost due to bad weather, and fish size in relation to market.

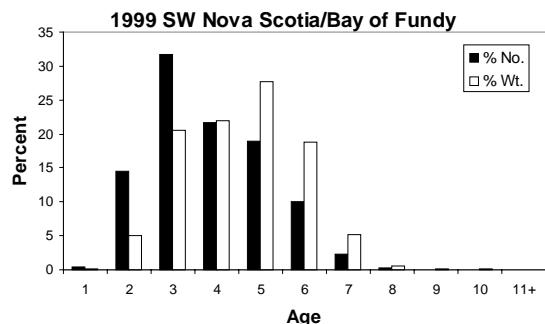


The in-season management approach, involving ongoing discussion and review of the fishery, continued. Again, fishing on most spawning aggregations operated under a “survey, assess, then fish” protocol, in which spawning aggregations were surveyed and a fraction of the biomass was made available to the fishery.

The distribution of herring from fishery information was as expected and similar to periods when the biomass was at moderate to high levels. Herring were found on the usual summer feeding and prespawning areas, but were absent from the Seal Island spawning ground, and less abundant than historically on Trinity Ledge, Spectacle Buoy and perhaps Scots Bay spawning grounds. As has been the case in recent years, catches from the 4W winter fishery were low.

Age composition of the catch was dominated for the second year by the 1996

year-class (at age 3) in number. In weight, the 1994 year-class (at age 5) was dominant. The 1992 and 1993 year-classes (ages 7 and 6) made up 12% of the catch by number and 24% by weight.



Resource Status

Acoustic surveys were undertaken on major spawning areas and some of the major fishing areas in cooperation with the fishing industry using the acoustic equipment on commercial vessels. In spite of a proposed survey plan, and a holdback of quota (100t per license) to encourage participation, there was incomplete coverage of the spawning grounds. There were several contributing factors, including bad weather and resistance among some fleet members to participate in or complete surveys.

Acoustic surveys from the spawning grounds documented approximately 505,700t of spawning herring. Due to the incomplete coverage, there remains the problem of direct comparison of surveys from year to year.

Location	1997 Observed	1998 Observed	1999 Observed
Scots Bay	160,100	72,500	41,000
Trinity Ledge	23,000	6,800	3,900
German Bank	370,400	440,700	460,800
Spectacle Buoy	15,000	1,300	no survey
Total	568,500	521,300	505,700

The historical development of the stock was illustrated using a sequential population analysis in which the 1999 spawning stock

biomass was set approximately equal to the tonnage observed by acoustic surveys. This demonstrated an increase in spawning stock biomass which is generally agreed to have occurred since 1994, however there are inconsistencies between the apparently large increase in recent years and what has been documented in the acoustic surveys.

The age composition has expanded since 1995 and 1996 when the fishery relied almost exclusively on recruiting year-classes. As has been previously observed, there are few fish older than the 1992 year-class. The 1996 year-class was strong as predicted.

Again in 1999 the TAC was not caught, but this is attributed primarily to factors other than resource status.

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. Uncertainty may arise from assumptions concerning the duration of herring on spawning grounds, target strength estimates and the spatial coverage of surveys in relation to the extent of spawning.

The spawning stock appears from acoustic surveys to have increased from the low experienced about 1994 to above 520,000t in 1998, and to have been at least 500,000t in 1999. The historical view from the sequential population analysis indicates a rapid increase in spawning stock biomass in recent years, and this is difficult to rationalize with the acoustic estimates. It is hypothesized that the 1999 acoustic estimate was an underestimate due to incomplete

survey coverage, however there were more recording units in 1999 and as much effort put into surveying in 1999 as in 1998.

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 and maintenance of SSB at moderate to high levels is assumed to account for these interactions.

In the last assessment, there was a preliminary analysis of the distribution of humpback and finback whales (predators of herring) in the month of August, which indicated that there had been fewer animals near the Long Island shore of Nova Scotia from 1995 - 1998 than in the early 1990's. Whales were, however, abundant in the Long Island shore area again in 1999.

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

Outlook

Acoustic surveys estimated more than 500,000t of herring on spawning grounds. Surveys and fishing confirmed the presence of large amounts of herring on German Bank. Less herring were recorded in surveys of Scots Bay and Trinity Ledge spawning areas than in previous years. While some of this apparent reduction may have been due to incomplete survey coverage, the SSB observed at Trinity Ledge in recent years remains below historic levels and the apparent reduction in SSB in Scots Bay is cause for some concern. There remains concern that there was no spawning

observed in the traditional Seal Island area and limited spawning observed at Spectacle Buoy.

Substantial aggregations of herring were documented outside the spawning areas. The geographical distribution of herring during the summer feeding period was as expected from observations in previous years when the stock was at moderate to high abundance.

Recent assessments of this component suggested that fishing mortality should remain below $F_{0.1}$ for a number of years in order to rebuild spawning stock biomass in all spawning areas and expand the age composition. The stock size appears to have increased since 1994, and there has been a substantial contribution to SSB by the large 1996 year-class, but there is insufficient spawning in several traditional areas, and a lack of old fish in the population. Catches similar to those of the past two years (less than 100,000t) and use of the "survey, assess, then fish" protocol on spawning grounds should generate F less than $F_{0.1}$. This should allow continued growth of the stock and further expansion 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. Spreading the catch appropriately among spawning components in proportion to their relative size should be strictly adhered to particularly in Scots Bay and Trinity Ledge where the 1999 observed SSB was low.

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. A plan for “structured surveys” has been proposed.

Initial results from the tagging program indicate at least some affinity between the winter aggregations off Chebucto Head and the SW Nova Scotia/Bay of Fundy spawning component. The affinity of these overwintering aggregations will be documented further with expected tag returns in the next few years.

OFFSHORE SCOTIAN SHELF BANKS SPAWNING COMPONENT

The Fishery

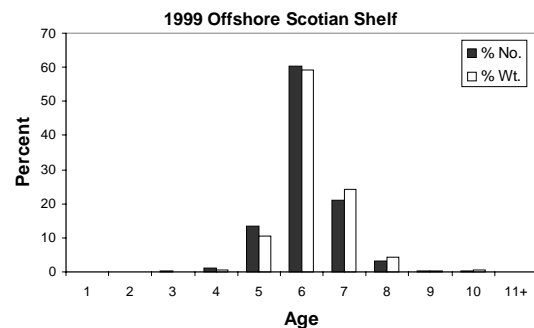
A foreign fishery during the period 1963-1973 is estimated to have removed as much as 60,000t in a single year from the offshore Scotian Shelf banks. There had been little effort or herring catch after the extension of jurisdiction in 1977 until 1996 when a fishery was initiated by the 4WX purse seine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

The 1999 fishing activities in the offshore occurred from May 25 to June 17, a shorter fishery (24 days) than in the previous year (55 days). Landings in 1999 (12,840t) were higher than in 1998 (5,580t), but substantially lower than in 1997 (20,260t). Fishing activity focused primarily on the Patch and Bullpen areas. The end of fishing activities in 1999 was related to factors other than availability of fish.

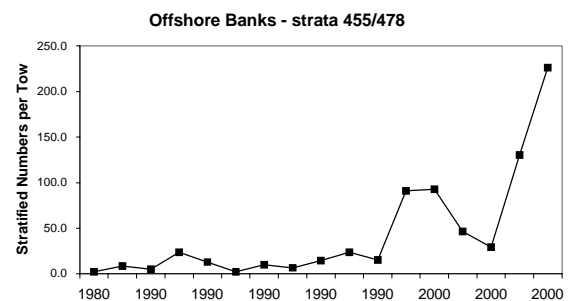
Herring were prevalent by-catch in the silver hake fishery.

Resource Status

The 1999 offshore banks fishery was dominated both in number and weight by the 1993 year-class (age 6, about 60% by both number and weight). The age structure was consistent with the previous year, and was again composed almost exclusively of the 1991 through 1994 year-classes.



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 recently. Offshore herring catches during the 1999 July bottom trawl survey (226 fish per standard tow) were the highest in the 17 year time series where the same vessel and gear have been used. Herring were widely distributed on banks west of Sable Island.



The only survey of the Patch area by members of the purse seine fleet on June 10, 1999 documented 22,400t. The DFO research survey in November 1999

documented 1,400t on the Patch and 1,600t on Mackenzie Spot.

Management Considerations

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

The initial catch level for 2000 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 before any extension of the fishery occurs.

The fishery in 1999 focused on the Patch and the Bullpen fishing grounds. Since the evidence for increased abundance is derived from consideration of the entire offshore banks area, it would be beneficial to spread the fishing effort and surveying.

There remains insufficient documentation of the stock size, distribution and spawning behaviour of this component. Industry, Science and Management are encouraged to continue to work together to improve the biological basis for management.

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

The Fishery

There has been an increase in the number of active gillnet licenses in recent years, and roe fisheries have developed in three areas. This was the fourth year of the fishery on spawning fish east of Halifax and the third year of gillnet roe fisheries off Little Hope and Glace Bay.

Recorded landings by the gillnet fishery along the coast of Nova Scotia totalled 7,350t in 1999, an increase of 75% from 1998 (4,190t) and 150% from 1997 (2,970t).

Landings (t)				
	1996	1997	1998	1999
East of Halifax	1,280	1,520	1,100	1,630
Little Hope	-	490	1,170	2,920
Glace Bay	-	170	1,730	1,040
Bras d'Or Lakes	170	160	120	30

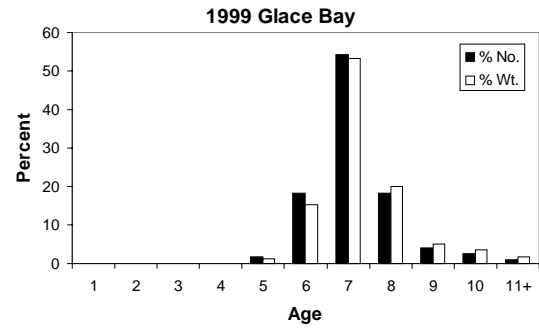
Resource Status

Several aspects of this component and its fishery were documented last year in a questionnaire survey of fishers conducted by DFO Science and the Pelagics Research Council. With the implementation of mandatory log records in 1997, the landings in the inshore fishery are being documented with improved accuracy, however, apart from a few areas, there remains insufficient information to evaluate stock status. The major fisheries of this component are discussed below.

East of Halifax

The October roe fishery lasted from September 27 to October 22, 1999 and landed 1,630t. Three surveys resulted in the documentation of approximately 20,000t of spawning herring.

The Eastern Shore Fishermen's Protective Association made arrangements for a seiner from Cape Breton to tag fish off the Eastern Shore. A total of 1,896 tags were applied and length frequency and detailed samples were taken. The fishery was dominated by ages 6 and 7.

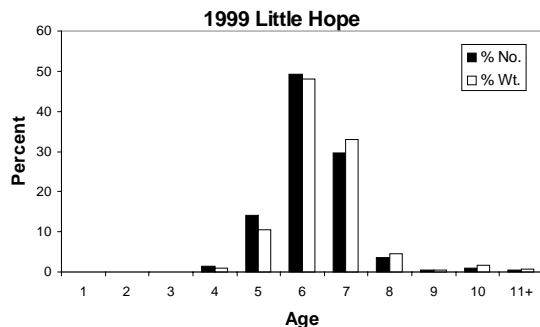


Little Hope

The fishery occurred in the Little Hope area, southwest of Liverpool, N.S., from September 16 to October 14, 1999. A total of 2,920t was landed by gillnet fishers, an increase of one and a half times from 1998 and five times from 1997.

Two surveys of the area resulted in a biomass estimate of 15,800t.

Landings were dominated by the 1993 year-class (age 6 – almost half the catch), followed by the 1992 year-class.



Glace Bay

The fishery off Glace Bay, Cape Breton lasted from September 3 to October 4, 1999. Landings were 1,040t, a decrease of 40% from 1998 due largely to poor market conditions. The 1999 fishery occurred mostly on the Red Grounds off Sydney Mines, with some landings further east.

A mapping survey conducted using a single vessel resulted in a biomass estimate of 2,000t.

The 1992 year-class (age 7) was dominant, followed in importance by the 1991 and 1993 year-classes.

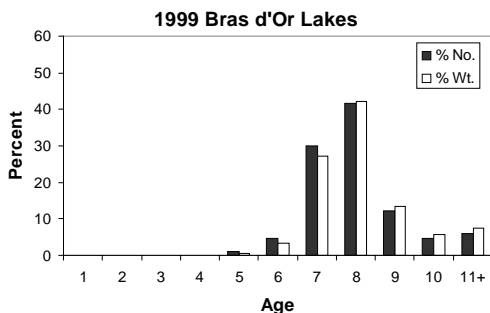
Bras d’Or Lakes

Landings in the spring gillnet fishery in 1999 were 30t, a considerable reduction from 1998. This decrease can be attributed largely to management restrictions which closed many of the traditional fishing areas on spawning grounds and reduced fishing effort.

Six surveys were conducted in the Bras d’Or Lakes in 1999. The observed biomass of 480t is considered to be small in relation to the historical size of the recorded landings which peaked at 400t in 1987.

There was no apparent decrease in the number of spawning locations between 1998 and 1999 and an increase from 1996 and 1997. Spawning was still absent at many of the traditional locations including the St. Peters area and much of West Bay.

The 1991 year-class (age 8) was most prevalent followed by the 1992 year-class (age 7).



As in previous years, a herring fishery was conducted in August and September. The landings from this fall fishery were also about 30t.

Management Considerations

Since 1996 there has been pressure to develop the inshore fisheries, especially for roe. Research efforts and changes to management have improved knowledge in some areas, but few of the spawning areas have been studied. The lack of knowledge of specifics of stock structure, lack of documentation of the historical fishery, and limited survey information preclude evaluation of current fishing mortality. Individual spawning groups within this component are vulnerable to fishing because of their relative small size and proximity to shore.

As in the past three 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”* (DFO 1999b).

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

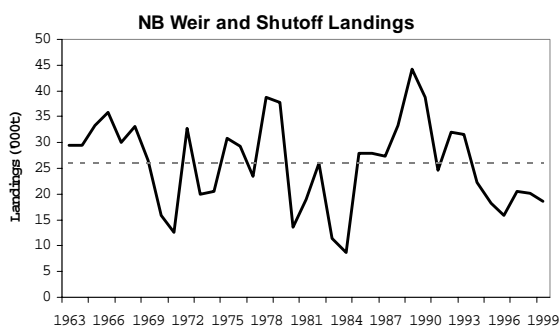
In 1999, landings from the Little Hope area amounted to 18% of the surveyed biomass and were one and a half times higher than the previous year. Such an increase in landings, in the absence of increased knowledge of fishing mortality, is a concern.

It was noted in 1997, 1998 and 1999 that the status of herring in the Bras d'Or Lakes was cause for concern. This year there have been some signs that indicate that the restrictive management measures are having a positive effect, but spawning is still absent from some traditional areas and the observed biomass of 480t is considered low. For the third 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”* (DFO 1999b).

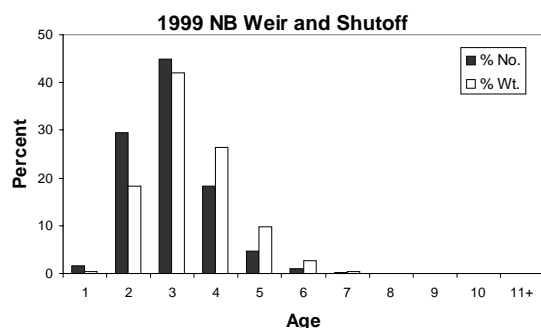
SW NEW BRUNSWICK MIGRANT JUVENILES

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 fish originating primarily from Subarea 5 spawning components, and have therefore been excluded from the 4WX (SW Nova Scotia/Bay of Fundy) 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. The 1999 catch of 18,200t, was somewhat lower than that of the previous year (20,100t), and below the 36 year average of about 26,000t.



Sampling of this fishery has been extensive. The 1999 catch was dominated by the 1996 year-class (age 3) which made up over 40% of the catch by number and by weight. Ages 4+ made up 25% of the weir catch by number.



The recent US management plan assumes that all of the juvenile herring from this fishery originate from the US “coastal complex” (5Y+5Z) which is considered to be at high abundance.

For More Information

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