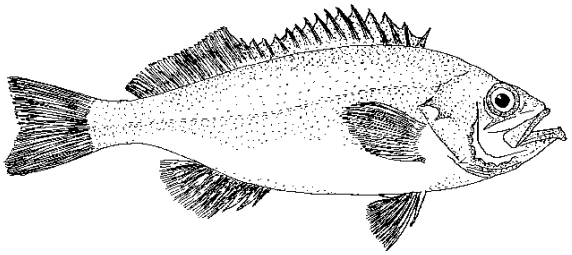

Status of Redfish Stocks in the Northwest Atlantic: Redfish in Units 1, 2, and 3, and in Division 3O

Background

Redfish assessments in Units 1, 2 and 3 and Division 3O have been reviewed annually at zonal meetings since 1995. Following the redefinition of redfish management units in 1993, it became evident that these various management units were closely linked, and that there was a need to co-ordinate the research and assessment of these resources.

Results of the recently concluded Science Strategic Funding Project on Redfish have provided additional information on the links between redfish in these areas but also point to many yet unresolved questions. This emphasizes the need for continued close co-operation and collaboration between all groups interested in these resources.

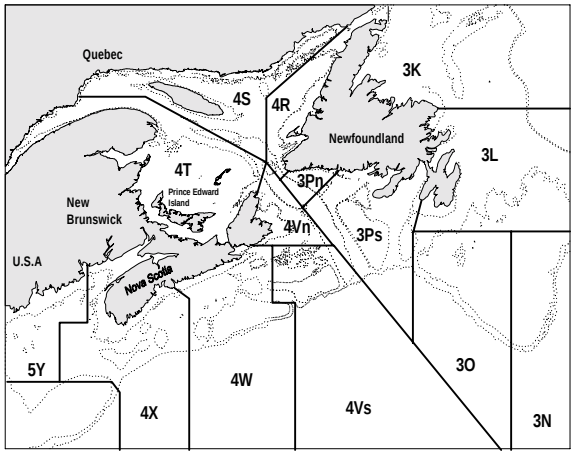

Figure 1. Map of the Northwest Atlantic.

Redfish Overview

Redfish, also known as ocean perch or rosefish, belong to a group of fish that are commercially exploited in both the Atlantic and Pacific Oceans. They occur on both sides of the Atlantic Ocean in cool waters (3° to 8° C) along the slopes of banks and deep channels in depths of 100-700 m. In the west Atlantic, redfish range from Baffin Island in the north to waters off New Jersey in the south.

Three species of redfish are present in the Northwest Atlantic (*Sebastes mentella, S. fasciatus* and *S. marinus* [=*S. norvegicus]*). These three species are similar and are nearly impossible to distinguish by their appearance. They are not separated in the fishery, and they are managed together.

Except for the area of the Flemish Cap, *S. marinus* is relatively uncommon. Along the continental shelf and slope, *S. mentella* range predominantly from the Gulf of St.Lawrence northward whereas *S. fasciatus* range predominantly from the southern Grand Banks to the Gulf of Maine. The range of both species overlaps significantly only in the Laurentian Channel area (Unit 1

and Unit 2). *S. mentella* is generally distributed deeper than *S. fasciatus*.

The **presence of a genetic hybrid in Units 1 and 2** has also recently been confirmed. While genetically distinct, it is more similar to *S. mentella* than *S. fasciatus*.

Redfish are **slow growing and long lived**. Specimens have been aged to at least 80 years. *S. fasciatus* does not grow as fast as *S. mentella*, although the differences in growth rate become apparent only after about age 10. In both species, females grow faster than males after about age 10.

Growth is also usually faster in southern areas than in northern areas.

Unlike many other fish species, fertilisation in redfish is internal and **females bear live young**. Mating is believed to occur in the fall and females carry the developing young until the spring when they are released from April to July. *S. mentella* release their young a month earlier than *S. fasciatus*. There have been suggestions that stress (such as fishing) on females prior to larval release may affect larvae survival.

Recruitment success in redfish is extremely variable, and significant year-classes have been observed at intervals from 5 to 12 years apart. The differences between strong and weak year-classes appear to be somewhat less in the southern part of the range of redfish. Recent laboratory studies suggest that larvae survival is greatest at medium prey densities.

In Unit 1, some year-classes that appeared strong at young ages in research surveys have subsequently disappeared rapidly before contributing to the adult population. This occurred for the 1964, 1974 and 1988 year-classes. Reasons for these disappearances remain unknown, although it has been determined that the 1988 year-class was predominantly *S. fasciatus*.

In addition to being found near the bottom, redfish are often distributed well up in the water column. Fisheries take place using both bottom and mid-water trawls. The vertical distribution of redfish in the water column varies both diurnally and seasonally, which affects catches in both commercial fisheries and research surveys.

On average, redfish take approximately 6 to 8 years to reach the minimum fishable size as dictated by small fish protocols in Conservation Harvesting Plans (22 cm).

At present, there are eight (8) redfish management areas in the Northwest Atlantic: Subarea 2 + Division 3K, Divisions 3LN, Division 3O, Division 3M (Flemish Cap), Unit 1 (Gulf of St. Lawrence), Unit 2 (Laurentian Channel), Unit 3 (Scotian Shelf) and Gulf of Maine (Subarea 5).

The current management units are thought to be more biologically appropriate than stock boundaries used in the 1980s. Nonetheless, uncertainty remains about the amount of exchange among units, most particularly between Unit 1 and Unit 2. While there are clear genetic differences for both species between Unit 1 and Unit 2 and adjacent management units, neither species is genetically distinct between these 2 management units. The ‘hybrid’ is also found in both units but not elsewhere.

Also, the temperature preference for redfish in Units 1 and 2 is about the same, being between about 4.5 – 6.0 C, in Unit 3 it is somewhat warmer at about 5.5 – 7.0 ^{o}C.

Canada has prosecuted redfish fisheries since the late 1940s. The most commonly fished areas have been Subarea 2 + Division 3K, as well as Units 1, 2 and 3.

Assessment and management strategies employed for redfish stocks have routinely been the same as those applied to other

groundfish, both in Canada and elsewhere. Reference levels for sustainable exploitation of Canadian Atlantic redfish stocks are based on $F_{0.1}$ (12% exploitation rate) and F_{MAX} (24%) or MSY (maximum sustainable yield) and 2/3 the effort at MSY. These estimates of sustainable exploitation rates assume that natural mortality is 0.1 (about 8% of redfish will die each year from causes other than fishing).

Some other jurisdictions that manage species of *Sebastes* assume lower natural mortality rates (0.05 or even lower), on the basis of directed research and the presence of old *Sebastes* in research and commercial samples. Comparable studies have not been completed for *Sebastes* in the Canadian Atlantic, and the assumption that M=0.1 has been used for these stocks for over 30 years. As a result, the reference exploitation levels for Canadian Atlantic *Sebastes* stocks are high, compared to some other parts of the world, and the $F_{0.1}$ reference exploitation rate of 12% of total exploitable biomass should be considered an upper limit for conservation.

A minimum legal fish size of 22 cm was introduced in redfish fisheries, first in 1995 in Division 3O, and in 1996 to the other management areas.

Because of their biology, the pattern of recruitment, and the presence of two or three species currently indistinguishable on a routine basis, management strategies and tools developed for other groundfish are not easy to apply and may not be appropriate for redfish. There is a need to develop new approaches, specific to redfish, to better understand and manage these stocks.

During the early 1990s, with the decline of other groundfish, many sectors of industry showed renewed interest in redfish. This was particularly true in the Gulf of St. Lawrence (Unit 1), off Newfoundland's south coast (Unit 2) and in the Scotian Shelf area (Unit 3). Although Division 3O has been traditionally avoided because of small fish, interest in fishing this area has increased as well. Subsequently, Unit 1 was closed to directed fishing.

Industry is increasingly concerned that there has been no directed DFO survey for redfish in Unit 2 for the past 2 years now. Although industry continues to conduct a survey for redfish in this area, they re-iterated that they do not want to replace DFO surveys but to compliment them.

In addition, the industry survey only measures the exploitable biomass whereas DFO surveys also measure recruitment. This later point was considered especially important in that the last DFO survey in 1997 indicated that the 1994 year-class might be relatively strong. It was important, from an industry perspective, that this be closely monitored since the medium to long term future of the fishery in this area could be very dependent on this year-class.

Redfish Multidisciplinary Research Program

Prior to the assessment meeting itself, 2 days were spent reviewing results to date from the 3-year special redfish project. A number of the findings and conclusions as they relate to redfish species identification and differentiation, growth and maturity, distribution, and reproduction have been incorporated in the preceding text.

In addition, **acoustics research** being carried out as part of the project has provided new insights to redfish distribution in the water column and near bottom. This research will advance our knowledge in use of this technique to count redfish as well as aid in interpretation of results from

commercial fisheries and the more traditional bottom trawl surveys.

Examination of data in exploring possible reasons for the **disappearance of the 1988 year-class** did not result in a satisfactory explanation. It doesn't seem that bycatch in the shrimp fishery was responsible, nor is there evidence of movement out of the Gulf. The study did reveal that currently estimated predation by seals has tripled since the early 1970's, and estimated consumption during the 1990-1993 period may have been as high as 80,000 t annually. This clearly needs further investigation.

As noted previously, **genetic work**, carried out as part of the project, did indicate that genetic separation of redfish of both species can be shown between Unit 1/Unit 2 combined and Unit 3, and Unit 1/Unit 2 combined and Division 3O and areas further north.

In Unit 3 there were indications of differences between the Scotian Shelf and Gulf of Maine for *S. fasciatus*. This emphasized the need to ensure continued monitoring of the distribution of catches and effort between these areas but further study is required before any consideration of possible changes to the current management strategies.

Redfish (*S. mentella*) in Unit 2 and Division 3O were shown to be different although increased sampling from Division 3O is needed, especially for *S. fasciatus*.

Sufficient mixing of both *S. mentella* and *S. fasciatus* takes place between Units 1 and 2 so as to make them indistinguishable between the two areas. In addition, the 'hybrid' is found in both areas but has not been seen elsewhere.

The implications of the mixing between Units 1 and 2 are still unclear. However, they require careful consideration and clarification in the context of future management. A number of important questions related to issues such as 1) the extent of mixing required to remove apparent genetic differences (there are indications that it might be as low as <5%), 2) the life stage when mixing occurs (larvae, juveniles, adults), 3) the direction of the mixing (one way or bi-directional), 4) location(s) and timing of mating in the fall, 5) the dependence or independence of components in the two areas, all need to be addressed.

We need to be able to put the results of this work as well as follow-on analyses and studies in the context of current management practise in order to understand the implications of, and risks associated with what we are currently doing compared to alternate approaches.

It was considered important by participants that scientists, industry and managers be brought together to discuss the specific questions that need to be posed and to determine their priority. Some answers may already exist in scientific or industry datasets, and it is important that this be explored as a first step. It was also pointed out that some work on these issues is still ongoing. It was emphasized that any remaining work should be concluded as quickly as possible so the results can be incorporated in future planning.

Considerable discussion focussed on the approach to take for the 1999 assessment regarding Units 1 and 2 in light of the new information on stock mixing. It was agreed that for now, assessments of the resource in Unit 1 and Unit 2 should proceed as in the past but that priority should be given to addressing questions as outlined above so as to be able to incorporate all the information in the most appropriate manner during the 2000 assessments. For the current

assessments, new information has been incorporated as appropriate, and reflected in the individual stock reports.

For more information

What follows includes information specific to four redfish stocks (Units 1, 2, 3, and Division 3O). The material was prepared during a Zonal Assessment Meeting held in Moncton during 18-19 November 1999.

In past reports, reference has been made to "**relative exploitation rates**," that is the ratio of catch or TAC to survey biomass estimates. Attempts were made to ensure the proper interpretation of these calculations as well as to indicate the inappropriateness of comparisons across species or between areas where surveys are conducted using different gears due to differences in catchabilities between gears and species.

Nonetheless, considerable confusion and misinterpretation still exists regarding the "relative exploitation rate" terminology such that its use as part of the redfish assessments, has been discontinued.

Members of industry participated in these reviews as well as the meeting held earlier in the week to discuss results of the Multidisciplinary Research Project. They contributed significantly to the interpretation of data that were presented during both meetings.

Evaluations of the individual management units follow.

Unit 1 Redfish

Background

Redfish in the Gulf of St. Lawrence was previously managed as Divisions 4RST. In 1993, Subdivisions 3Pn and 4Vn , from January to May, were included in the management unit to take into account the winter migration of redfish in these areas.

The directed redfish fishery in Unit 1 was closed in 1995 due to low stock abundance and the absence of significant recruitment since the early 1980s.

In response of the FRCC recommendations for 1998 to gather more information on Unit 1 redfish, Redfish Industry Surveys (RIS) were established with two components : scientific surveys and indexed fishing trips. A maximum catch of 1,000 t was permitted in 1998 that was increased to 2,000 t in 1999.

Summary

- DFO research survey biomass index is stable at a low level since 1995.
- Sentinel fishery surveys indices are stable during the same period.
- GEAC grid survey catch rate index was lower in 1999 due to a decrease observed in division 4T.
- Overall, the prognosis for this stock remains poor for the foreseeable future.

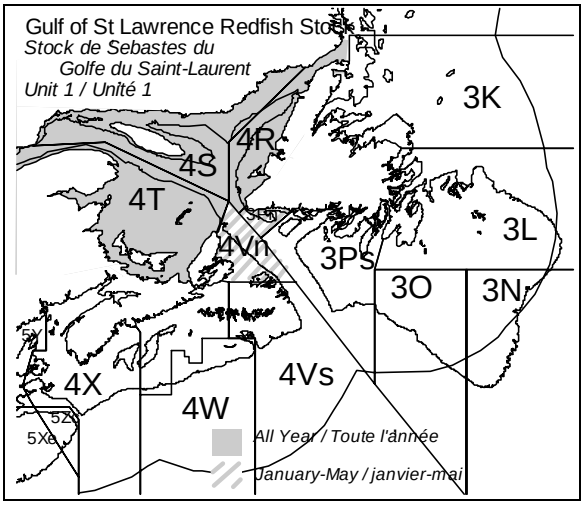

Figure 2: Map of the Gulf of St. Lawrence and nearby regions showing Unit 1 redfish stock.

The Fishery

The redfish fishery in the Gulf of St. Lawrence has been characterized by two periods of high exploitation; the first one at the beginning of the 1970s and the second in the 1990s (Figure 3). These two periods are closely linked to the recruitment of strong year-classes. Following these peaks, landings dropped rapidly. For the most recent years, landings decreased from 77,000 t in 1992 (old management units) to about 19,500 t in 1994. The TAC for Unit 1 redfish was set at 60,000 t in 1993 and reduced to 30,000 t in 1994. The directed redfish fishery in Unit 1 has been closed since 1995 due to low stock abundance and the absence of strong recruitment since the early 1980s.

Landings (thousand tonnes)

Year	70-76 Avg.	77-94 Avg.	1995	1996	1997	1998	1999[1]
TAC	-	-	0	0	0	1[2]	2[2]
Can.	78.6	38.8	0	0	0	0.3	1
Others	3.3	0	0	0	0	0	0
Total	81.8	38.8	0	0	0	0.3	1

[1] Provisional to November 1999
[2] Redfish Industry Surveys

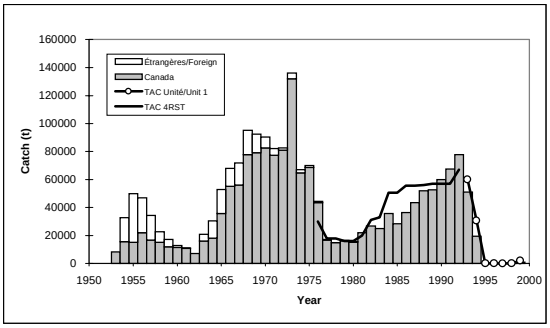

Figure3: Landings and TACs in tons.

Resource Status

Since 1990, **stratified-random groundfish surveys** have been conducted in 4RST in August-September on the *Alfred Needler* (Figure 4). The **biomass index** from these surveys declined consistently from 1990 to 1995. From 1996 to 1999, the index remained stable at a low level. A comparison to the 1984-1989 *Lady Hammond* index series showed that the peak of abundance was in 1988 and the biomass index has been declining since then.

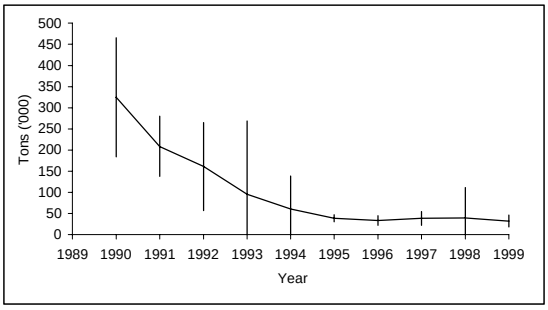

Figure 4. DFO Research survey biomass index (in thousands of tons).

During the period of decline, the distribution of redfish became more restricted and concentrations are now mainly found in the Cabot Strait area (Figure 5) in Division 4R and Subdivision 3Pn (considered as part of Unit 2).

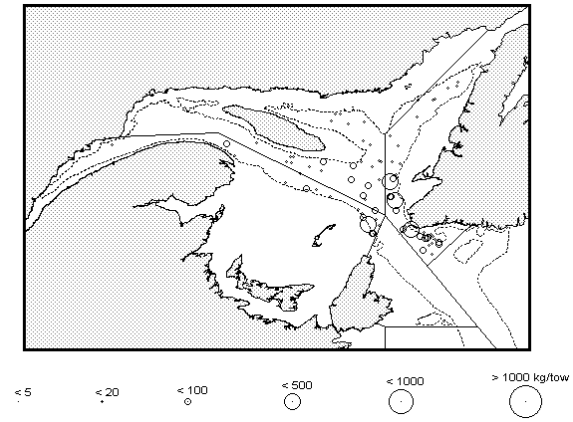

Figure 5. Redfish catch distribution on DFO research survey in August 1999.

Numbers-at-length from the summer surveys (Figure 6) for the period 1990 to 1999 indicate the presence of only **two important modes**, corresponding to the 1980 and 1988 year-classes. The 1980 year-class dominated the fishery catches in the late 1980s and at the beginning of the 1990s. Surveys indicate that the **1988 year-class declined rapidly after 1991**. Since 1994, it almost disappeared from survey catches prior to attaining adult sizes.

A new year-class (1996) was first seen in the survey in 1998. Although it is substantially less abundant than the 1988 year-class when it first appeared, the 1996 year-class is the most abundant observed for the last 6 years. However, anal fin ray counts of this year-class indicate that like the 1988 year-class, the majority of the fish are *S. fasciatus*. If year-class disappearance is species related then the 1996 year-class may also fade away before attaining adult sizes.

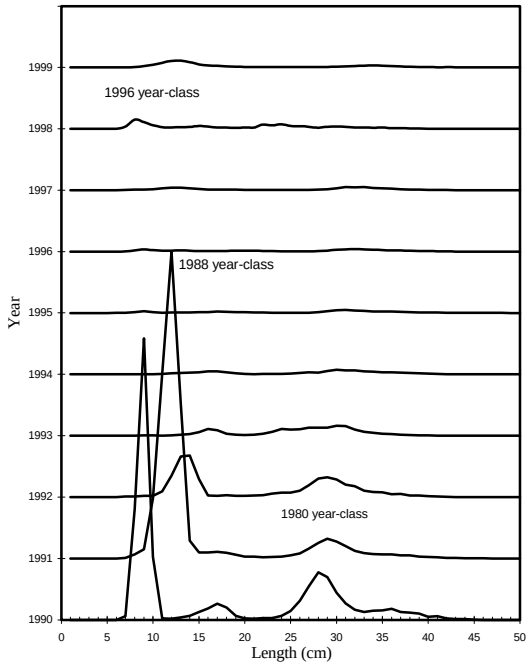

Figure 6. Size compositions from the summer research survey (1990-1999).

Redfish Industry Surveys were established in 1998 to collect additional information on the status of the stock and redfish distribution.

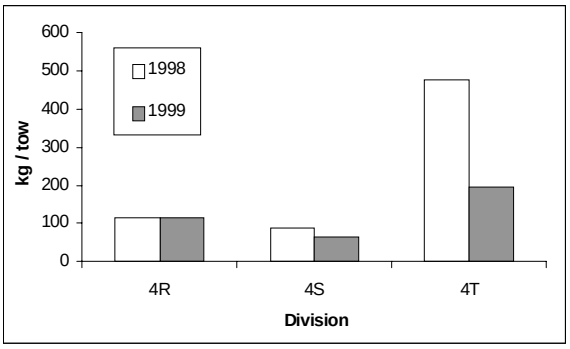

Figure 7. Redfish mean catch by division observed on the GEAC grid surveys in 1998 and 1999.

Catch rates in the **grid survey component** (by GEAC) were lower in 1999 than in 1998, in particular in division 4T (Figure 7). As in 1998, highest catches were observed in Division 4T and Subdivision 4Vn (considered part of Unit 2) and redfish were mainly distributed in the Laurentian Channel south and east of Anticosti Island.

The **Indexed Fishing Trips component** was conducted by over 10 otter trawlers in the summer of 1999 in divisions 4RST using a bottom trawl similar to gear used in the fishery prior to 1994. Several vessels (average 4) were active at any one time. Most of the fishing activity took place in July and August along both slopes of the Laurentian Channel south east of Anticosti Island. As in 1998, CPUE dropped at the end of the summer.

Standardized catch rates of vessels larger than 100 feet were lower then prior to the closure of the fishery (Figure 8). Standardized catch rates of smaller trawlers were also low in comparison to those observed before the closure of the directed fishery. Most of the vessels stopped index fishing trips at the end of August and beginning of September because of the difficulty in finding redfish in the Gulf.

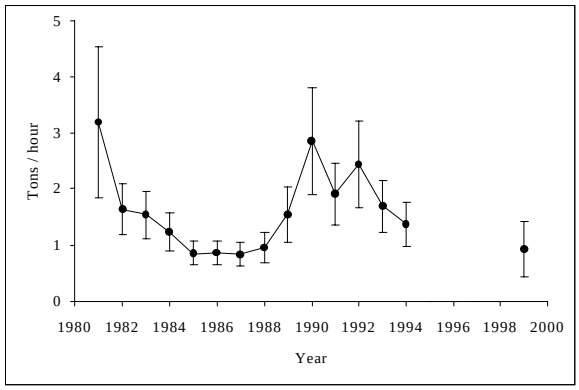

Figure 8. Standardized catch rates (CPUE) of vessels > 100 feet , using bottom trawl between May and October, in the commercial fishery (1981 to 1994) and indexed fishing trips (1999).

The large sizes of the redfish caught during indexed fishing trips indicates that they were mainly from the 1980 year-class, which sustained the fishery at the beginning of the

1990s. There were minimum contributions of the subsequent year-classes.

Ten **sentinel surveys** targeting 4RS3Pn cod have been conducted by small otter trawlers since August 1995 that provide information on Unit 1 redfish since Division 4T is also covered. Five of these surveys were conducted in the summer (July-Aug. 1995 and July in 1996-99) and five in the fall (November 1995 and October 1996-99) when the migration of Unit 1 redfish toward the entrance of the Gulf might have started.

These surveys show a more or less stable abundance since 1995 (Figure 9). In 1999, one set in Division 4S accounts for the high confidence intervals.

For the **summer series**, biomass indices from the sentinel surveys are 2 to 3 times higher than those from the survey on the *Alfred Needler*, which is conducted about one month later. The difference might be due to gear and survey design differences that may affect redfish catchability. Also, changes in the availability of redfish to the fishing gear between July and August might occur due to movement vertically in the water column, horizontally out of the survey area or both.

Biomass indices from the **fall sentinel surveys** were much lower than from the summer surveys. This difference could be attributed to a combined effect of movement of redfish in the Cabot Strait area and changes in the seasonal availability of redfish to bottom trawls.

Length frequencies from all the sentinel surveys showed that larger fish were caught in the fall surveys. Also, the 1996 year-class was sampled for the first time during the summer survey in 1999.

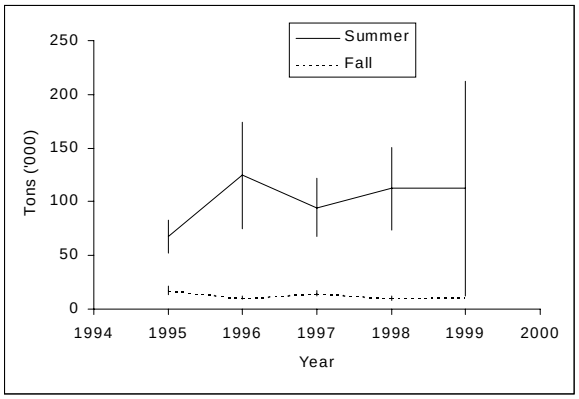

Figure 9. Sentinel fisheries surveys biomass index (in thousands of tons).

A **comparison of the research, sentinel and industry surveys** shows that the **distribution** of catches in early years of the research surveys were similar to those seen in July-August sentinel and grid industry surveys, but, from 1993, distributions were more similar to October-November sentinel surveys. Thus, the research survey may be measuring both reduced abundance and earlier migration. Nonetheless, the reduction in abundance in the early 1990s was clearly substantial.

Industry perspectives

Industry participants agree that the abundance of the stock is lower than at the beginning of the 1990. Also, some fisherman involved in the indexed fishing trips program were disappointed with the results of the summer investigations as they encounter low catch rates and observed limited distribution of redfish in the Gulf as compared to the historic pattern. To explain the reduced catch rates observed at the end of the summer, industry put forward two possible scenarios: the fish may have begun to move out of the Gulf or they may have moved up in the water column or dispersed over a wider area.

Some participants mentioned that the winter migration of redfish out of the Gulf could

extend south of Subdivisions 3Pn and 4Vn and Gulf redfish might be caught in the Unit 2 winter fishery in statistical areas immediately adjacent to 3Pn (3Psa, 3Psd).

Sources of uncertainty

It is uncertain how the changes in distribution as described in the Industry perspectives affect the survey indices in the summer and fall.

The **results of genetic studies** presented at the workshop on the Multidiciplinary Program on Redfish indicated that, while redfish from Units 1 and 2 could be easily separated from adjacent areas, there were no differences in the genetic profile of populations in Units 1 and 2 for both species of redfish which occur there. In addition, there is a 'hybrid' form found in both areas but has not been seen elsewhere.

These studies imply that interbreeding among redfish in Units 1 and 2 occurs at a rate sufficient to render the populations genetically indistinguishable, although this rate could be low. The implications of this mixing between Units 1 and 2 are still unclear and require careful consideration and clarification in the context of future management. There is a need to be able to put the results of current work as well as follow-on analyses and studies in the context of current management practise in order to understand the implications of, and risks associated with what we are currently doing compared to alternative approaches.

Finally, due to the disappearance of the 1988 year-class, identified as *S. fasciatus*, it is uncertain if the 1996 year-class will survive and contribute to the adult population given it is also identified as *S. fasciatus*.

Outlook

After the decline of the **biomass index** from the DFO research survey at the beginning of the 1990s, it has **stabilized at a low level** since 1995. The 1999 DFO summer survey biomass estimate is one of the lowest of the series.

The Sentinel survey biomass indices are also showing a stable abundance since 1995. The new year-class (1996) observed in the DFO research survey since 1998 and in the sentinel fishery survey in 1999 may be stronger than those of previous years in the 1990s based on two years of survey, but its strength is very low in comparison to the 1988 year-class that disappeared from the population. Moreover, this year-class would not recruit to the adult population until approximately 2005. Overall, the prognosis for this stock remains poor for the foreseeable future.

For further information

Morin, B. , B. Bernier and R. Camirand 1999. The status of redfish in Unit 1 (Gulf of St. Lawrence). DFO CSAS Res. Doc. 99/132.

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Unit 2 Redfish

Background

The Unit 2 management unit for redfish was implemented in 1993. The resources in this area (NAFO 3Ps4Vs, 3Pn4Vn-June to Dec. 4W$_{fgj}$) were previously managed separately as a 3P stock and part of a 4VWX stock.

The first quota for Unit 2 in 1993 was 28,000 t. TACs were reduced successively to 10,000 t for 1996 as a conservation measure and maintained at that level to 1997. The TAC was raised to 11,000 for 1998 and initially to 12,000 t for 1999.

In 1995 area/season closures were implemented to (i) minimise possible overlaps with Unit 1 redfish given a lack of understanding of redfish migration patterns and (ii) allow for a period when peak spawning of females is likely to occur. A small fish protocol, currently at 22 cm (10 inches), was initially established at 25cm for 1996 aimed at protecting the 1988 year-class as it appeared this would be the major contributor to the fishable population.

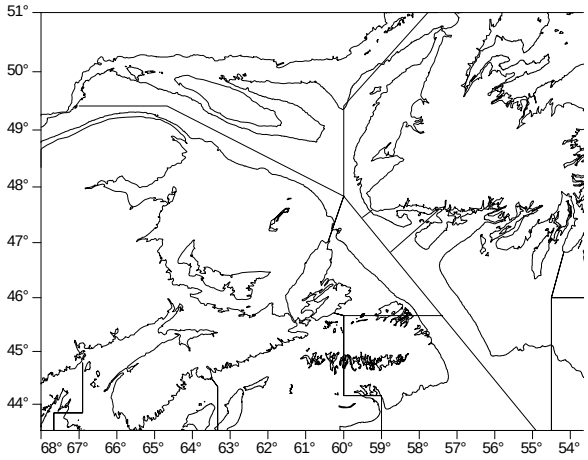

Figure 10: Map showing Unit 2 management area for redfish.

Summary

- Combined DFO and industry surveys suggest stability from 1994 - 1999.
- The 1988 year-class is gradually replacing the 1980 year-class in the adult population.
- Adult population expected to decline since 1988 year-class not as strong as 1980 year-class.
- Consideration should be given to a reduction in catches for the next fishing year (2000/2001).
- Questions remain concerning stock structure and mixing in Unit 1 and Unit 2.

The Fishery

From 1960 to 1968, **landings** averaged about 20,000 t, but then increased to an average of 43,000 t up to 1975 mainly due to increased catches by foreign fleets. Catches then declined to the lowest on record in 1984 at 8,100 t. Since then, catches steadily increased to 27,000 t by 1993 but declined subsequently to about 10,000 t in 1997 due to reductions in TACs (Figure 11). Catch

increased to about 11,000 in 1998 matching a similar increase in TAC. Up to the early November 1999, about 10,000 t had been taken. There was an upward adjustment of the TAC to 18,240 t made at mid-year 1999 to allow for the transition to an April 1, 2000

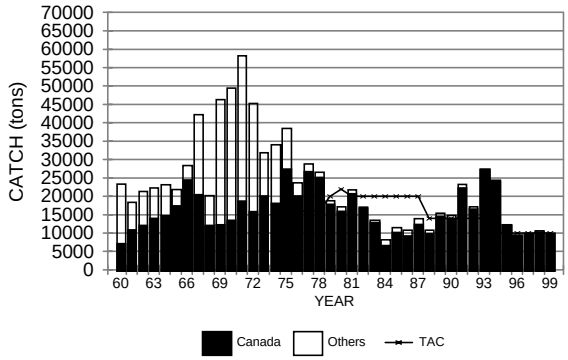

Figure 11: Reported catches and TACs (in tons).

to March 31, 2001 based TAC.

Landings (thousand tonnes)

Year	70-76 Avg.	77-94 Avg.	1995[1]	1996[1]	1997[1]	1998[1]	1999[1]
TAC	-	-	14	10	10	11	12
Can.	21	17	12	9	9	9	9.3
Others	20	1	0	0	0.2	0.2	0.3
Total	41	18	12	9	9	9	10

[1] Provisional, 1999 to November 5.

Since declaration of the 200-mile limit in 1977, catches have been taken mainly by Canadian fleets. Maritimes vessels have generally accounted for the majority of landings from Subdivisions 4Vs and 4Vn whereas Newfoundland vessels concentrated in Subdivisions 3Ps and 3Pn.

Since 1996, a significant portion of the total catch was taken in the first quarter, primarily from 3Ps and 4Vs.

Sampling of the fishery in 1999 indicated that the majority of the catch was comprised of fish between about 30 cm (12 inches) and 35 cm (14 inches), the bulk of which is predominantly the 1980 year-class. This is very consistent with the 1998 fishery. The 1988 year-class was present in the catches with a peak size of about 25 cm (10 inches).

Resource Status

Indices of Stock Size

Summer is when redfish in this area are considered to be most separated from Unit 1 fish. A **DFO research surveys series** conducted in Subdivisions 3Ps, 3Pn, 4Vs and 4Vn during summer from 1994-1997 has formed the basis for evaluation of stock status in recent years. This survey was not carried out in 1998 or 1999. The **total biomass index** (all fish sizes - thousands of metric tons) from these surveys has been:

DFO	1994	1995	1996	1997
Index	239	209	196	214

The results suggest that **stock size remained stable** between 1994 and 1997.

Length compositions from these surveys were dominated by two modes, the peaks of which were 23-24 cm (about 9 inches), corresponding to the **1988 year-class** and 31-33 cm (about 13 inches), corresponding to the **1980 year-class** in 1997. The 1997 survey also indicated a relatively strong abundance of fish at 12 cm (about 5 inches), corresponding to the **1994 year-class**. It was primarily caught in 3Pn, whereas the 1988 year-class, when first caught, was present over a much wider area. Industry did report that during the 1998 fishery, small redfish (possibly the 1994 year-class) were found in parts of both 3Ps and 4Vs.

Results of **three other departmental stratified-random groundfish surveys** are available, but these are of limited value in determining the status of the Unit 2

resource. Each survey covers only part of the entire area where the resource occurs. This makes it difficult to interpret apparent trends over time because they may not be reflective of changes occurring throughout the entire management unit but may reflect movement into and out of the surveyed areas. Nonetheless, these series are consistent with the Unit 2 survey in terms of size composition and general trends. Based on examination of these surveys, the **1988 year-class** appears to have declined substantially through the 1990s.

In September 1999 an **industry stratified-random survey** for redfish was conducted by GEAC in Unit 2. This was the third such survey in as many years. The 1997 survey was conducted in early December and the 1998-1999 surveys in August and September. Fishing was conducted using a typical commercial gear with 108 mm mesh in the codend. Thus, the survey sampled the commercial portion of the population. The biomass index (commercially exploitable fish sizes) (thousands of metric tons) is as follows:

GEAC	1997	1998	1999
Index	240	222	94

Although the 1997 survey was conducted during a different season and with some possible overlap with Unit 1, combined they suggest stability between 1997 and 1998, like the DFO surveys showed for 1994-1997.

Although the biomass estimate in 1999 was only about half of the previous estimates, a high interannual variability in survey estimates is not unusual and a single estimate should not be given much weight.

The surveys indicated the presence of both the **1980 and 1988 year-classes**. In all surveys, the relative proportion of the 1988 year-class in the catches was lower than the 1980 year-class.

Industry Perspectives

Because of changes in fishing patterns brought about by redefinition of management units in 1993, seasonal closures introduced in 1995, and small fish protocols (minimum size of 22 cm), industry has difficulty relating current fishing to past experiences.

From 1997-1999 fishing took place throughout different areas within the management unit depending on the fleet, and industry considers that the fishery was very successful in these years.

There have been little to no difficulties encountered as a result of the small fish protocol. At present, the majority of the fish caught are in the 32-35 cm (13-14 inch) range.

One fleet's experience in the fall of 1999 has been that concentrations of fish in 3Psd, has been smaller than previous years. They also related that their fishing experience in 1999 in 4Vsc was consistent in terms of catch rate and size as related to the recent years.

Market demand for larger fish will likely result in continued targeting of the 1980 year-class even though the 1988 year-class is of commercial size.

Sources of Uncertainty

The commercial fisheries continue to target the 1980 year-class. Although the absolute size of the 1988 year-class is unknown, it is now largely exploitable but its relative strength in all surveys still suggest it is not as large as the 1980 year-class which has already contributed nine years of yield. Therefore, there is reduced expectation

about the overall yield that the 1988 year-class may produce.

It remains uncertain whether the 1994 year-class, first seen in 3Pn during the 1997 DFO summer survey, and noted by industry in some parts of 3Ps and 4Vs in recent fisheries, is strong. The GEAC industry survey is designed to give specific information regarding the commercially exploitable portion of the biomass. It is important to be able to monitor and measure relative year-class strengths for a number of years as has been achieved in the past using departmental surveys over the whole area in order to better forecast the future for this resource.

We are at a point in time where it is important to fully understand the relative strengths of the 1980, 1988 and 1994 (and subsequent) year-classes if we wish to look beyond a year or two in considering the future trajectory of this resource. Without information from an annual summer DFO survey, this is not possible.

The results of genetic studies presented at the workshop on the Multidiciplinary Program on Redfish, indicated that while redfish from Unit 1 and Unit 2 could be easily separated from adjacent areas, there were no differences in the genetic profile of populations in Unit 1 and Unit 2 for both species of redfish which occur there. In addition, there is a 'hybrid' form found in both areas that has not been seen elsewhere.

These studies imply that interbreeding among redfish in Unit 1 and Unit 2 occurs at a rate sufficient to render the populations to be genetically indistinguishable, and although this rate could be low, these require careful consideration and clarification in the context of future management. There is a need to be able to put the results of current work as well as follow-on analyses and studies in the context of current management practise in order to understand the implications of, and risks associated with what we are currently doing compared to alternative approaches.

Outlook

Current commercial catches, including those to date in 1999, are composed primarily of the 1980 year-class that has been fished for about nine years now. The 1988 year-class is now fully available, based on size, to the fishery, but in 1999 was not exploited to the extent predicted due to market conditions that resulted in targeting for larger fish.

It is likely that market demand for larger fish will continue resulting in continued targeting of the 1980 year-class.

Current information suggests however, that since the 1988 year-class is not as strong as that of 1980, current adult biomass will decline and present catch levels will not be sustainable. Therefore **consideration should be given to a reduction in catches in the next fishing year (2000/2001) in response to this anticipated decline.**

There are some indications that the 1994 year-class may be relatively strong, but renewed monitoring will be required to clarify this. This year-class would not contribute to the commercial fishery until about 2004, but knowledge of its strength is important in any consideration of longer-term resource status. Renewed monitoring of pre-recruit year classes would be required to clarify this.

For Further Information

Power, D. 1999. The status of Redfish in Unit 2. CSAS Res. Doc. 99/155.

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Unit 3 Redfish

Background

The Unit 3 management area for redfish was first implemented in the 1993 Groundfish Management Plan with a quota of 10,000 t. Redfish in this area were previously managed as part of a larger 4VWX management area.

Redfish in Unit 3 are primarily caught in the basins and at the edge of the Scotian Shelf by otter trawlers using 90 mm mesh. Regulations limit the bycatch in NAFO division 4X of other groundfish species to 10 % by weight of redfish caught and the bycatch in NAFO divisions 4VW to 2 % by weight each of cod and haddock.

Summary

- Landings continue to be about 5,000 t annually.
- Fishing is widespread and success in 1999 is about average for the 1990s.
- DFO summer biomass estimates in recent years are close to the long term average.
- Indications of good recruitment continue to be shown by the DFO summer surveys.
- Small redfish are being avoided by the commercial fleets.
- Exploitation level is fairly low.

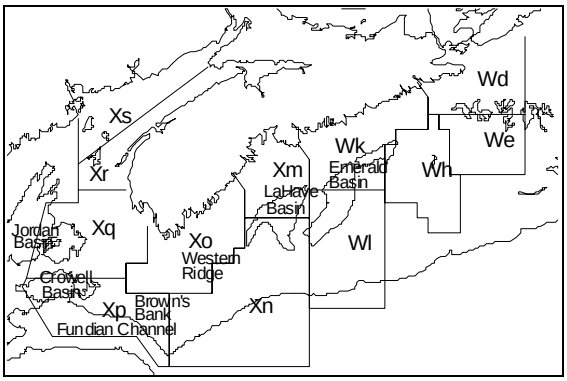

Figure 12: Map of the Scotian Shelf showing Unit 3 redfish stock area.

The Fishery

Landings (thousands of tonnes)

Year	70-79 Avg	80-89 Avg	90-94 Avg	95[2]	96[2]	97[2]	98[2]	99[3]
TAC				10.0	10.0	10.0	10.0	9.0
Canada	4.1	4.4	3.5	4.8	4.8	6.3	5.8	4.1
Foreign	5.7[1]	0.5	0.1	+	+	0.1	+	+
Total	9.7	4.9	3.6	4.9	4.8	6.4	5.8	4.1

[1] 1970-79 foreign landings exclude up to 4,420 t/yr on average not assignable to statistical unit area
[2] Provisional
[3] Provisional to the end of Oct 1999.

Redfish landings from Unit 3 (Figure 13) gradually increased from the late 1970s, peaking at almost 7,000 t in 1986 followed by a decline to about 2,000 t in 1991. Landings peaked again in 1997 at about 6,000 t. Landings for 1998 were about 5,800 t, well below the 10,000 t TAC. In 1999, the TAC was reduced to 9,000 t. The provisional catch to the end of October was about 4,100 t and was lower than for same period in 1998 (5,000 t).

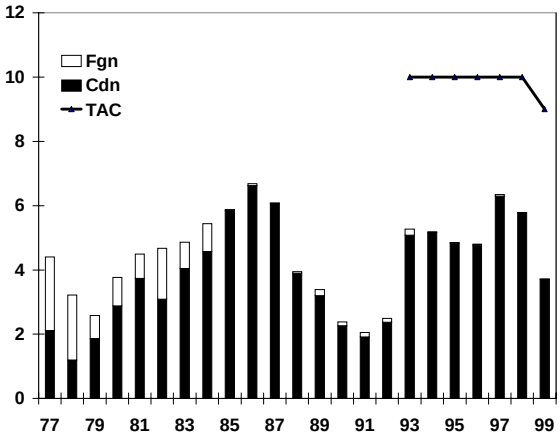

Figure 13: Canadian, foreign landings and TACs (to Oct. 1999 in thousands of tons).

In 1998, small otter trawlers (<65'), fishing almost entirely in the Crowell and Jordan basin portions of the Gulf of Maine, took most of the reported catch. In 1999 (to October), small otter trawlers fishing in the same location again took most of the catch (Figure 14).

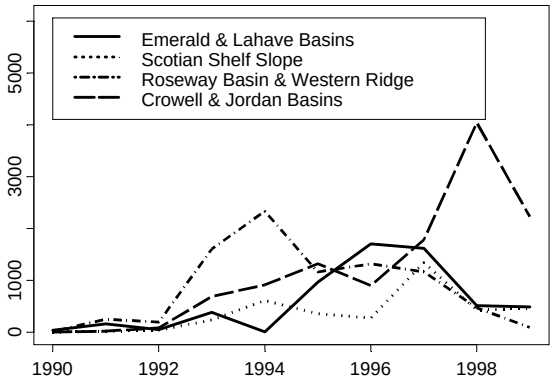

Figure 14: Small otter trawler catch by fishing location and year (tonnes).

In 1996, DFO Operations began to use 22 cm as the **minimum size** for its Conservation Harvesting Plans. Percentages by number of redfish landings under this size were:

	93	94	95	96	97	98	99 (to July)
%<22cm	4	15	15	10	6	7	6

Following an FRCC recommendation, the **small redfish protection area** located north of Brown's bank (known as the 'Bowtie') was redefined in early 1998 (Figure 15). Landings from that general area (4Xo) were very low through all of 1998 and into 1999.

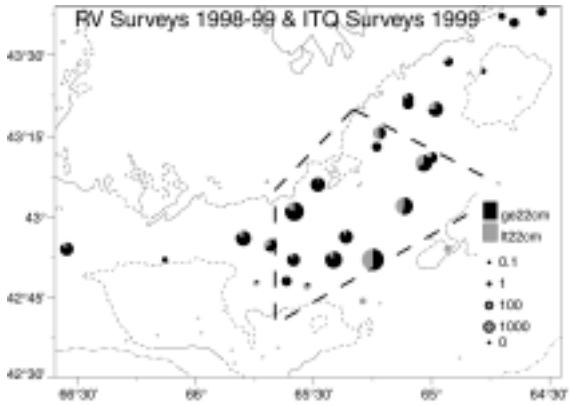

Figure 15: The new 'Bowtie' area with DFO and Industry survey size composition data for 1998-99.

A number of areas have been closed to redfish fishing to avoid **bycatches** of other species, in addition to limits on percentage bycatch. Pollock as a percent of the redfish catch accounts for most of the reported bycatch in Unit 3 and has increased steadily since 1994 (Figure 16).

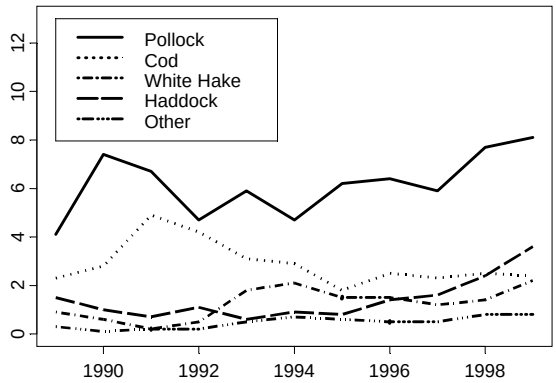

Figure 16: Bycatch by species for 1989-99 (%).

The highest by-catch rates for pollock were in Crowell and Jordan basins, but generally neither industry nor management has considered the situation there to be a problem because most of this bycatch consisted of legal sized fish and was counted

towards the vessels' quota. Observer data for 1998-99 show much higher bycatch rate for pollock than do commercial statistics but these data are too limited to allow extrapolation to the fleet as a whole.

Industry Perspective

Several captains who had successfully fished for redfish in recent years were no longer doing so because of reduced demand at the processing plants for small redfish commonly found in Unit 3. Most captains of small otter trawlers remain concerned over the continued concentration of fishing effort in Crowell and Jordan basins in 1999.

The active captains indicated that the catch rates of market sized redfish were not as good as in 1998 therefore resulting in higher bycatch rates. Captains were not as concerned as in 1998 over the lower catch rates encountered in the eastern part of the management unit (Emerald and LaHave basins) as they were able to find some new areas of good fishing.

Some captains claim that small mesh gear fishing could be safely extended northward from 43° 30' to 43° 40'. Most captains have responded favorably to the 'Bowtie' closed area revisions particularly since processing plants will pay little or nothing for very small redfish.

Resource Status

The increase in **catches** after 1992, resulted from an increase in fishing effort by small otter trawlers, reflecting decreased fishing opportunities for more valuable species, and not an increase in redfish abundance. The decrease in catches since 1996, resulted from a decrease in effort by these same vessels, reflecting decreased demand at the processing plants for the smaller fish and not a decrease in redfish abundance.

The **extent of area** occupied by small otter trawlers directing for redfish (main species caught) has expanded since 1990 with some stabilization in the most recent years.

Fishing success of small otter trawlers (Figure 17) to the eastward (LaHave and Emerald basins) improved in 1999 over 1998, mainly due to the discovery of new fishing locations. The sharply reduced **fishing success** in Roseway Basin and Western Ridge is due to the reduced effort associated with captains and plant operators avoiding the very small fish in that area. Fishing success along the shelf edge was about the same as 1998 while it did decline slightly to the westward in Crowell and Jordan basins. The continued high proportion of catch to the westward resulted mainly from the sustained concentration of fishing effort there.

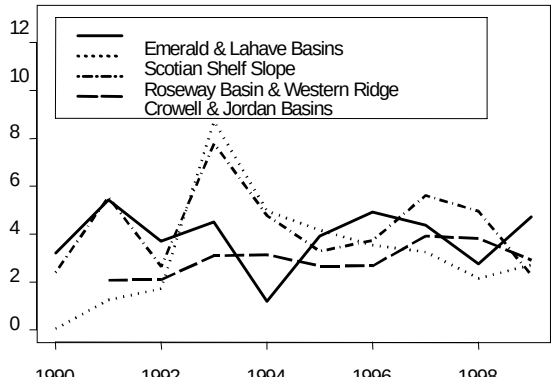

Figure 17: Small otter trawler catch rate by fishing location (tonnes per day).

New **genetic research results** confirm that Unit 3 redfish are almost exclusively *S. fasciatus* and belong to a separate stock from *S. fasciatus* in Units 1 and 2. There is also an indication of a genetic separation between Scotian Shelf and Gulf of Maine populations.

DFO research vessel survey estimates of **population biomass** (< 200 fm) in the management unit, although highly variable

between years, show no trend over time (Figure 18).

Redfish smaller than commercial size do not contribute greatly to this biomass estimate, so survey biomass can be taken as an indicator for the size classes fished commercially. However, survey biomass underestimates the actual biomass on which the commercial fishery is based, as not all of the commercial sized fish are available to the survey gear, and some are outside the survey area (deeper than 200 fm).

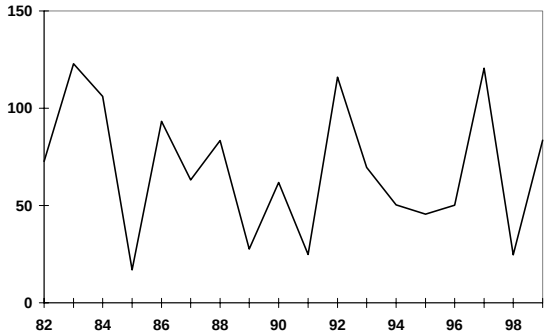

Figure 18: Biomass index from summer survey (in thousands of tonnes).

The **joint DFO Science/Industry survey** in Division 4X provides biomass estimates similar to the research vessel survey for that area, but the estimates are less variable. The Industry surveys indicate abundance in 1999 similar to previous years. USA surveys of the Gulf of Maine and Georges Bank, which include Crowell and Jordan basins, have shown a major increase in resource abundance in 1996-98.

In recent years, there have been more small fish, particularly in the area north and east of Brown's Bank (Figure 19).

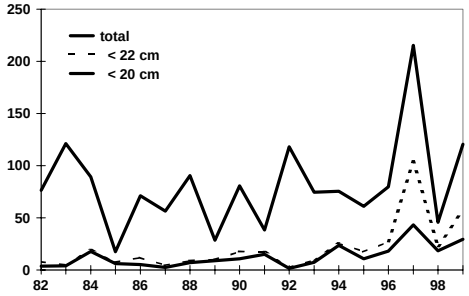

Figure 19: Survey numbers per tow by size class.

The ratio of recent catches compared to DFO survey biomass estimates indicates that **exploitation** is low and probably does not exceed $F_{0.1}$.

Sources of Uncertainty

The new genetic information needs to be more closely examined, and additional research may be required, before its full implications with regard to stock structure in Unit 3 are understood. No additional management interventions appear to be required at this time, however the distribution of fishing should continue to be monitored closely.

Although the US bottom trawl surveys in the Gulf of Maine obtained much higher catch rates in 1996-98 than previously, the trends in size composition are inconsistent with the interpretation that this resulted from increased recruitment to the fishable stock. These data require more detailed examination before much weight is put on them to determine Unit 3 resource abundance.

Outlook

DFO research vessel surveys indicate stability in the population biomass within the management unit and improved recruitment particularly in and around Roseway Basin and Western Ridge. This recruitment, although promising, has not yet

resulted in a detectable increase in the population biomass, but combined with the low exploitation rates which currently prevail, should result in fishing and stock conditions in 2000-01 being very much the same as in recent years.

There is no biological or fishery basis to suggest a need for change in the management of the resource at this time.

For Further Information

Branton, R. 1999 Update on the Status of Unit 3 redfish: 1999. DFO CSAS Res. Doc. 99/152.

Branton, R. and J. Black 1999. 1999 Summer Groundfish Survey Update for Selected Scotia-Fundy Groundfish Stocks: 1999. CSAS Res. Doc. 99/151.

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Division 3O Redfish

Background

Historically, Canadian industry has not had a great deal of interest in redfish in this area because of the relatively small sizes of fish found in the areas with trawlable bottom. Recent declines in other groundfish resources and the marketability for small redfish have resulted in increased interest in fishing in this area.

The TAC is set by Canada and imposed on domestic fleets and countries that have had bilateral trade agreements.

A TAC of 16,000 t was first imposed on this stock in 1974. The TAC was increased in 1978 to 20,000 t and generally remained at that level through to 1987. The TAC was reduced in 1988 to 14,000 t and maintained there until 1994 when it was lowered to 10,000 t as a precautionary measure. This TAC level has remained in effect to 1999.

A small fish protocol at 22 cm was implemented inside the 200 mile limit in 1995. The current TAC is divided into a Canadian quota (8,500 t), and a French (St. Pierre et Miquelon) quota (1,500 t).

About 10% of the stock area lies outside Canada's 200 mile Exclusive Economic Zone (EEZ) and subject to unregulated fisheries. Between 1985 and 1995, estimates of unreported non-Canadian catches have ranged between 400 t (1995) and 24,000 t (1988) From 1991 to 1996 the average has been 1100 t. An estimate for 1997 was close to zero but about 700 t was estimated for 1998.

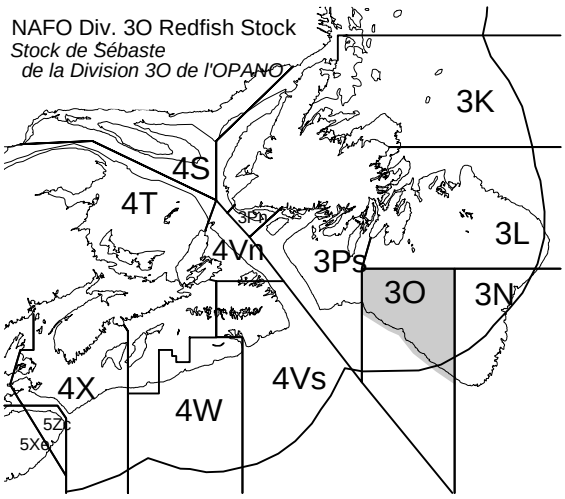

Figure 20: Map showing Division 3O redfish stock area.

Summary

- Pre-recruit redfish, tracked by surveys during 1990s has now reached a size where it contributed to the 1998 and 1999 commercial catches.
- Catches lower in 1999 due to market conditions with lack of interest in smaller redfish.
- Although variable, recent survey results suggest that catches of about 10,000 t are not likely to generate fishing mortality in excess of $F_{0.1.}$

The Fishery

Nominal catches (Figure 21) have ranged between 3,000 t and 35,000 t since 1960. Up to 1986 catches averaged 13,000 t, increased to 27,000 t in 1987 with a further increase to 35,000 t in 1988, exceeding TAC's by 7,000 t and 21,000 respectively. Catches declined to 13,000 t in 1989, and were about this amount annually through to 1993. The decrease of the catch in 1994, at about 5,400 t was related to a reduction in foreign allocations. Since 1995 Canada has increased activity, accounting for

catches between 2,000 and 9,000 tons annually. Total catches since 1996 have averaged 10,000 tons.

Catches (thousand metric tonnes)

Year	70-76 Avg.	77-94 Avg.	1995[1]	1996[1]	1997[1]	1998[1]	1999[1]
TAC[2]	-	18	10	10	10	10	10
Can.	1	1	0.2	7	3	9	2
Others[3]	14	13	3	3	3	5	7
Totals	15	15	3	10	5	14	9

1 Provisional
2 Canadian domestic TAC
3 Includes estimates of unreported catch

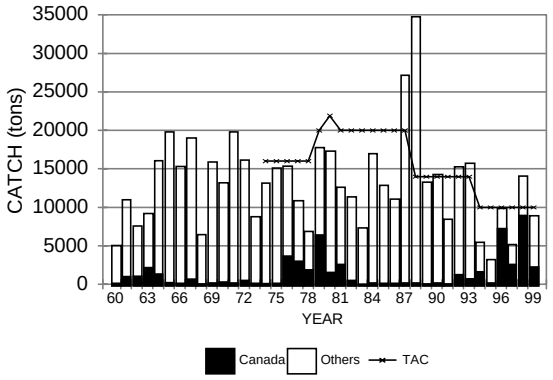

Figure 21: Nominal catches of redfish in Division 3O.

Russia predominated in this fishery until 1993. From 1985 to 1993 Russian catches ranged from 3,800 t to 7,200 t. Russia and Cuba, impacted by the reduction and eventual elimination of foreign allocations by Canada, has not fished since 1995 and 1993 respectfully.

Catches by Portugal, which began fishing in the limited stock area outside the EEZ in 1992, peaked at 4,700 t in 1995, declined to 900 t by 1997 and increased to 1,900 t in 1998. Spain who had taken less than 50 tons before 1995, caught 1,200 t in 1997 and 1,900 t in 1998. Up to the end of September 1999, EU countries had reported about 7,000 t taken. The information is not yet available by country.

Canada, which has had limited interest in a fishery in this area because of the small sizes of redfish encountered, landed less than 200 t annually from 1983-1991, took 1,600 t in 1994, but only about 100 t in 1995. The fluctuation in Canadian catches between 2,000 tons and 9,000 tons since 1995 is due to a varying market for redfish sizes near the small fish protocol limit of 22 cm.

The fishery has occurred primarily in the second and third quarters of the year since 1983. Recent Canadian catches have been taken during the second half of the year. The predominant means of capture from the mid-1970s to the early 1980s was the bottom otter trawl. Since 1984, there has been an increase in the use of midwater trawls although bottom trawl catches still dominate.

Information on **size distribution** from the 1999 fishery to date indicated the predominant catch was from 22–30 cm. Length distribution information available from Portuguese sampling showed that the bulk of the 1998 Portuguese catch consisted of fish from 21cm to 26 cm, consistent with other sampled fisheries.

Resource Status

Stratified random groundfish surveys have been conducted in the spring and fall in Division 3O since 1991, with coverage to depths down to 730 m.

The **spring index** suggests that the stock may have increased since the early 1990s, but has stabilized at around 100,000 t since 1994. The low 1997 value is considered a sampling anomaly. The fall survey generally supports this pattern. The additional 1999 survey information for both spring and autumn has not altered this perception.

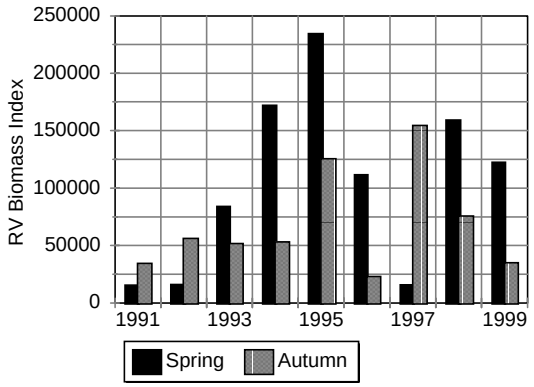

Figure 22: Research survey results for redfish in Division 3O (1995-1999 results are from Campelen trawl).

Historically, the surveys catch fish in the 10 cm to 25 cm range. Prior to 1998, the surveys were considered to have sampled different size groups than the commercial fishery because the commercial catch was generally comprised of fish greater than 25 cm. Beginning in 1998 however, there has been greater overlap in the size distributions from the surveys and commercial fishery because the fishery has been targeting smaller size groups.

There is concern that there has been little sign in the recent surveys of size groups smaller than 17 cm. despite using the Campelen trawl which is very effective at catching small redfish.

Industry Perspectives

The reduced Canadian catch in 1999 is primarily a result of limited market interest in smaller sized fish (22 cm to 25 cm).

Some industry participants have expressed concern that the small fish protocol is too small and should be raised. This is related to possible connections between redfish in this and the adjacent Unit 2 related to recruitment.

Sources of Uncertainty

It is still not possible to describe overall trends in total stock size, or estimate the current size of the fishable portion of the population, nor is possible to determine current fishing mortality rate.

Current data suggest that redfish in this area are predominantly *S. fasciatus*. However, this needs further study. In addition, the affiliation of redfish in Div. 3O to those in adjacent areas remains unclear.

Outlook

Although variable, recent survey results suggest that catches of about 10,000 t are not likely to generate fishing mortality in excess of $F_{0.1}$.

Before 1998, the surveys were considered to have been monitoring pre-recruits to the fishery and tracked a relatively strong year class which in recent years caused problems for industry in complying with the small fish protocol. This year-class has now reached a size where it contributed to the 1998 and 1999 commercial catches. The Canadian fishery will continue to target this yearclass in the future. There is concern, however, about the poor sign of subsequent recruitment (less than 17 cm). It is also important to consider that length at 50% of the males are mature is about 21 cm, whereas 50% of females do not reach maturity until about 28 cm.

For Further Information

Power, D (1999). The status of redfish in Division 3O . CSAS Res. Doc. 99/156.

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