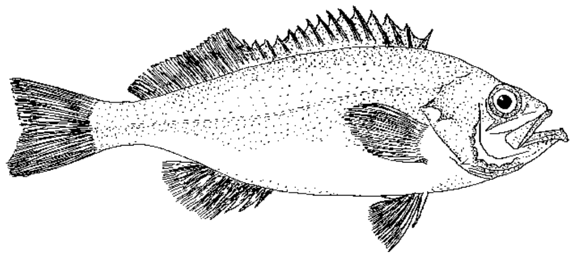

Status of Redfish Stocks in the Northwest Atlantic: Redfish in Units 1, 2, and in Division 3O

Background

Redfish assessments in Units 1, 2 and 3 and Division 3O were reviewed annually at zonal meetings from 1995-1999. In 2000 Unit 3 redfish were assessed regionally, and the other stocks were assessed zonally. 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 Science Strategic Funding Project on Redfish (1996-1999) 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.

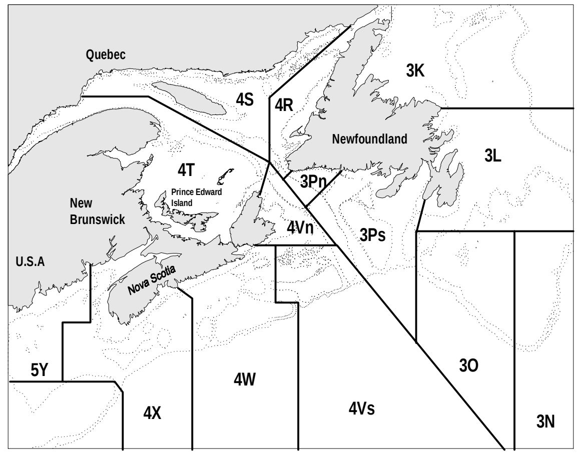

Figure 1: Map of the Northwest Atlantic.

Redfish Overview

Redfish, also known as ocean perch, 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 reproductively viable genetic hybrids in Units 1 and 2** have also recently been confirmed. While genetically distinct, this form 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. Research has found that *S. mentella* in Unit 1 and Unit 2 are not genetically differentiated from each other, nor are *S. fasciatus* different between the two Units. However, for each species there are clear genetic differences between the redfish in Units 1 and 2 combined, and redfish in adjacent 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 were historically the same as those applied to other groundfish, both in Canada and elsewhere. Reference levels for sustainable exploitation of Canadian Atlantic redfish stocks were 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 assumed that natural mortality is 0.1 (about 8% of redfish will die each year from causes other than fishing).

It has proven difficult to estimate absolute values for fishing mortality and exploitation rate for redfish, so management strategies based on $F_{0.1}$ or target exploitation rates have proved unworkable in recent years. Current management has been based on the relationship of historic catches to trends in survey biomasses, and stability of size composition of commercial and research vessel catches. It is preferable to manage on the basis of sustainable harvest rates, but this will not be possible until the ability to estimate biomass and fishing mortality of the stocks improve.

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. Canadian management also includes a closure in May and June in Units 1 and 2, to protect spawning fish. Furthermore, because of the inability to attribute catches to source populations (Unit 1 or Unit 2) in SubDivisions 3Pn and 4Vn in late fall and winter, both have been closed to redfish fishing from November through December since 1995. This closure is intended to protect the portion of Unit 1 redfish which migrate out of the Gulf of St. Lawrence in that period. SubDivisions 3Pn and 4Vn are included in the definition of Unit 1 from January to May, and remain closed in those months as well due to the mortorium on fishing Unit 1 redfish. Concern has been expressed that the fall migration of Unit 1 redfish may have commenced earlier in the latter part of the 1990s, and possibly extended further eastward than the boundary between 3Pn and 3Ps. These concerns prompted the extension of the 3Pn/4Vn closure to include October in 2000.

There are inadequate data to provide a definitive answer to the question posed by the FRCC of whether the timing and extent of migration has changed in recent years, and what closures in 3Pn would give Unit 1 redfish the necessary protection from harvest. The absence of a fishery in this area in late fall and winter make it unlikely that more informative data will become available in the near future. Nonetheless, circumstantial evidence from surveys and fisheries in the Gulf in summer and early fall are consistent with an earlier commencement of migration in recent years. Because industry has not encountered difficulty in taking their allocations without fishing in 3Pn from October through December, it seems prudent to continue the 3Pn closure from October through June, until more is understood of the seasonal migration of redfish in the Gulf. Moreover, both industry experience and recent analyses suggest that the out-migration of redfish from the Gulf may be influenced by water temperatures, which were anomalously cold through the 1990s. If the recent indications that the Gulf has returned to more typical temperatures in 2000 persist, the timing and extent of redfish migration may return to patterns seen in the late 1980s and early 1990s, when the current management units and timing of closures were established. Careful monitoring of oceanographic conditions and redfish distribution in summer and fall during the coming years will be particularly important to ensuring that conservation closures achieve maximum benefits without undue restrictions on harvesting opportunities.

There seems little justification for extending the winter 3Pn closure further eastward. Winter catches from 3Ps-a have been only 1-8% the total catches from 3Ps in the 1990s, and catches from 3Ps-d, although larger than from 3Ps-a, are from the Laurentian Channel, well distanced from the 3Pn – 3Ps boundary. As long as industry continues to fish in similar patterns, there is no evidence that changes to the spatial boundary of the closure to protect Unit 1 redfish would provide additional conservation benefits.

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 concerned about reductions in DFO survey effort for redfish in Unit 2. 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.

The industry surveys prior to 2000 only measured the exploitable biomass whereas DFO surveys also measured recruitment. The 2000 industry survey did use a small-mesh liner in the net, and provided some information about the abundance of pre-recruit redfish.

Redfish Multidisciplinary Research Program

In addition to conclusions from the 3-year high priority multidisciplinary redfish program (1996-99) regarding species differentiation, growth, maturity, distribution, and reproduction already described in the preceding text, there were two other findings worth noting:

- Acoustics research has provided insight into how redfish are distributed throughout the water column thus improving abilities to interpret results from commercial fisheries and bottom trawl surveys.
- Retrospective analyses of historic data, although eliminating bycatch in the shrimp fishery and emigration out of the Gulf as plausible explanations for substantial reduction of the 1988 year-class, did identify seal predation (currently triple that of the early 1970's) as an obvious direction for further investigation.

Some projects, which had received funding from the redfish program, still appear to be ongoing. These projects must be concluded as quickly as possible to permit completion of an overall final report and development of a plan for follow on research, particularly in the area of genetics:

- Lack of differences between both species of redfish and the limited distribution of the 'hybrid' in Units 1&2 calls for continued research in a number of areas: current mixing between Units 1&2; extent of mixing required to remove differences or prevent differences from developing (might be as low as 5%); life stage when mixing occurs (larvae, juveniles, adults); direction of the mixing (one way or bi-directional); location(s) and timing of mating in the fall.
- Differences between *S. fasciatus* on the Scotian Shelf and in the Gulf of Maine portions of Unit 3 and between *S. mentella* in Unit 2 and in Division 3O highlight the need for a more complete basic sampling of these areas.

Unit 1 & 2 assessments have not been fundamentally changed, but rather have been adapted to incorporate many of the new information and issues. Much care is being taken to ensure that the changes in how stock status is assessed are posed in the context of our evolving understanding of the resource and current management practice versus possible alternatives.

Participants at the current meeting expressed an interest the 'Underwater Tagging Equipment' (UTE), being used by Iceland to study movements of oceanic redfish. Availability of this equipment within DFO would clearly provide much needed information on redfish movements throughout the Atlantic Zone. Studies of other species where decompression adversely also affects the survival of tagged fish (e.g. white hake and witch) would also benefit.

For more information

What follows includes information specific to three redfish stocks (Units 1, 2, and Division 3O). The material was prepared during a Zonal Assessment Meeting held in Moncton during 14-16 November 2000.

Members of industry participated in these reviews. They presented new information and contributed significantly to the interpretation of data that were presented during the meeting.

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. Also, subdivisions 3Pn and 4Vn have been close to fishing during November and December since 1995. In 2000, this closure was extended to the month of October.

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 and maintained to this level in 2000.

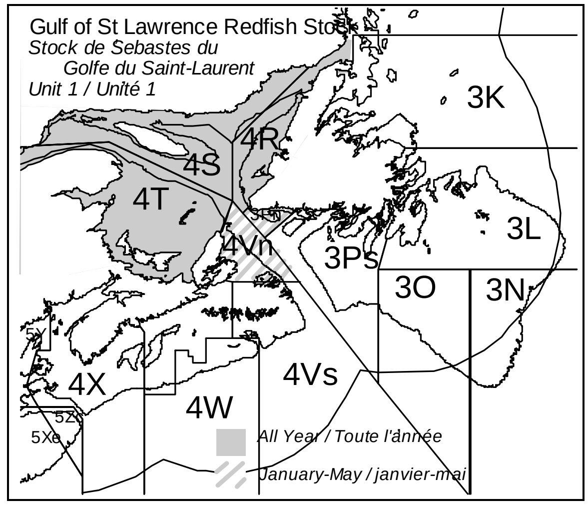

Figure 2: Map of the Gulf of St. Lawrence and nearby regions showing Unit 1 redfish stock.

Summary

- DFO research survey biomass index has been stable at a low level since 1995.
- Two cohorts of juveniles are observed on the DFO research survey in 2000: the 1996 and 1998 year-classes. The majority of the fish of these year-classes are *S. fasciatus* and they appear to be weak in comparison to the 1988 year-class.
- GEAC grid survey catch rate index showed a decreasing trend between 1998 to 2000.
- CPUE from the index fishery were similar in 1999 and 2000 but lower than before the closure of the fishery in 1995.
- Sentinel fishery survey indices are stable during the 1995-1999 period. However, the 2000 summer survey value is about half the 1999 estimate.
- Overall, the prognosis for this stock remains poor for the foreseeable future.

Biology

Larval surveys have been conducted in the Gulf of St. Lawrence for the last four years to study the effect of oceanographic conditions on redfish larvae. Preliminary results of these surveys showed that the majority of the larvae observed were *S. mentella*. This observation is consistent to the fact that the adult population in the Gulf is also mainly from this species. However, the juveniles for the last 20 years (after the 1980 year-class) have been dominated by *S. fasciatus*. This information would suggest a failure of the survival of larvae of *S. mentella* that might be related to the cold temperature regime observed in the Gulf since the end of the 1980's (Figure 3).

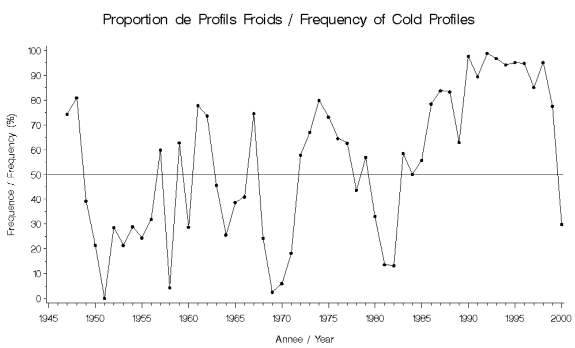

Figure 3: Frequencies of cold temperature profiles (minimum < 0^0 C) in the Gulf of St. Lawrence for the period 1947-2000.

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 4). 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.	1996	1997	1998	1999	2000[1]
TAC	-	-	0	0	1[2]	2[2]	2[2]
Can.	78.6	38.8	0	0	0.3	1	1
Others	3.3	0	0	0	0	0	0
Total	81.9	38.8	0	0	0.3	1	1

[1] *Provisional to November 2000*
[2] *Redfish Industry Surveys*

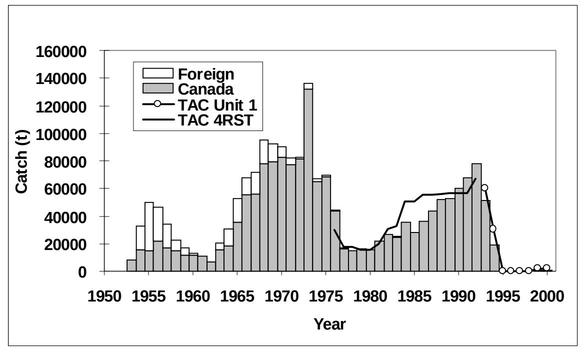

Figure 4: Landings and TACs in tons.

Resource Status

Since 1990, **stratified-random groundfish surveys** have been conducted in 4RST in August-September on the *Alfred Needler* (Figure 5). The **biomass index** from these surveys declined consistently from 1990 to 1995. From 1996 to 2000, 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.

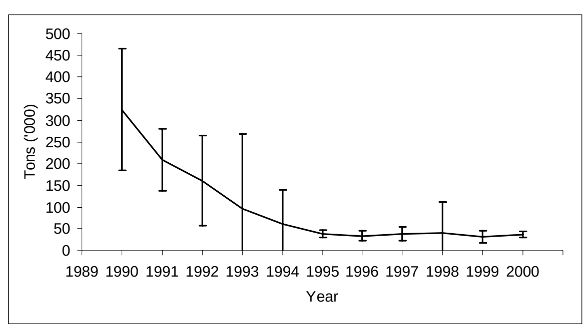

Figure 5: DFO Research survey biomass index (in thousands of tons).

During the period of decline, the distribution of redfish became more restricted and concentrations are now mainly found in the Cabot Strait area (Figure 6) in Division 4R and Subdivision 3Pn (considered as part of Unit 2).

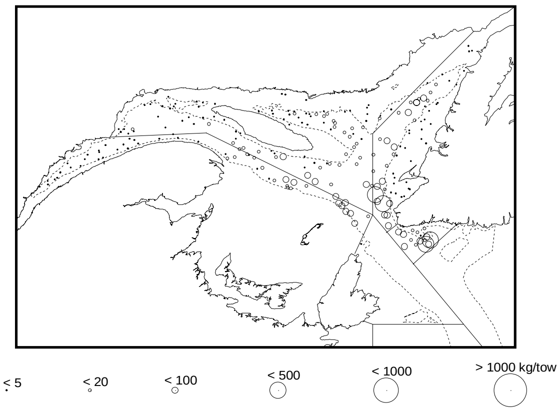

Figure 6: Redfish catch distribution on DFO research survey in August 2000.

Numbers-at-length from the summer surveys (Figure 7) for the period 1990 to 2000 indicate the presence of only **two important modes** at the beginning of the 1990s, 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 has 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. A new year-class (1998) was also observed in the 2000 survey. Anal fin ray counts of these new year-classes 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 and 1998 year-classes may also fade away before attaining adult sizes.

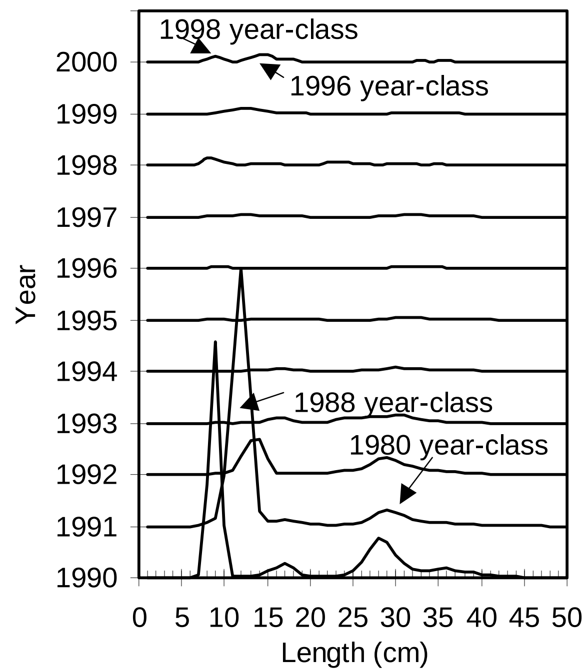

Figure 7: Size compositions from the summer research survey (1990-2000).

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

Catch rates in the GEAC **grid survey component** show a declining trend in 1999 and 2000 (Figure 8). Geostatistical tools were used for the first time to correct for day/night effects on the catch rates and to decrease significantly the variability of the estimates.

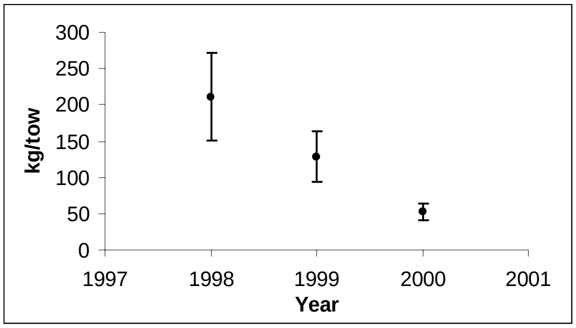

Figure 8: Redfish mean catch rates (kg/tow) observed on the GEAC grid surveys between 1998 and 2000 in 4RST as estimated by geostatistics. The catch rates were corrected for day/night catchability differences.

The **Indexed Fishing Trips component** was conducted by several otter trawlers in the summer and fall of 1999 and 2000 in divisions 4RST using a bottom trawl similar to the gear used in the fishery prior to 1994. Most of the fishing activity took place in between mid-June and July along both slopes of the Laurentian Channel south east of Anticosti Island.

Standardized catch rates of vessels larger than 100 feet were lower then prior to the closure of the fishery (Figure 9). Standardized catch rates of smaller trawlers were also low in comparison to those observed before the closure of the directed fishery (Figure 10). For both fleets, the catch rates were similar in 1999 and 2000. Also, in 2000, most of the vessels stopped index fishing trips at the beginning of August because of the difficulty of finding redfish in the Gulf. Because of the low catch rates, only half of the TAC allowed for this fishery was caught in both years. However, a vessel fishing with a midwater trawl in September 2000 encountered very good catch rates in southern 4R.

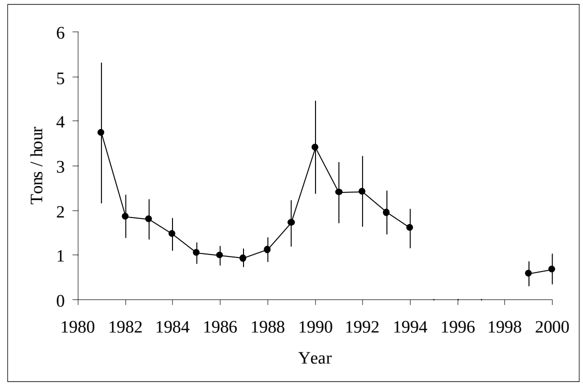

Figure 9: Standardized catch rates (CPUE) of vessels > 100 feet, using bottom trawl between May and October, in the commercial fishery (1981 to 1994) and indexed fishing trips (1999 and 2000).

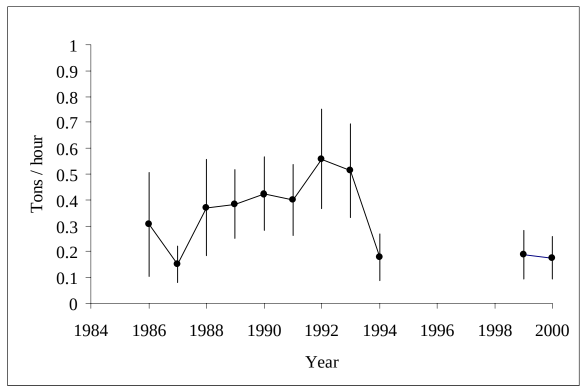

Figure 10: Standardized catch rates (CPUE) of vessels < 65 feet, using bottom trawl between May and October, in the commercial fishery (1986 to 1994) and indexed fishing trips (1999and 2000).

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 from the subsequent year-classes.

Sentinel surveys targeting 4RS3Pn cod have been conducted by small otter trawlers since August 1995. These surveys provide information on Unit 1 redfish because Division 4T is also covered. Six of these surveys were conducted in the summer (July-Aug. 1995 and July in 1996-00) 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 11). However, the 2000 summer survey value is about half the 1999 estimate.

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. These surveys use different gears and follow different survey designs and both factors could effect biomass estimates.

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 and again in 2000.

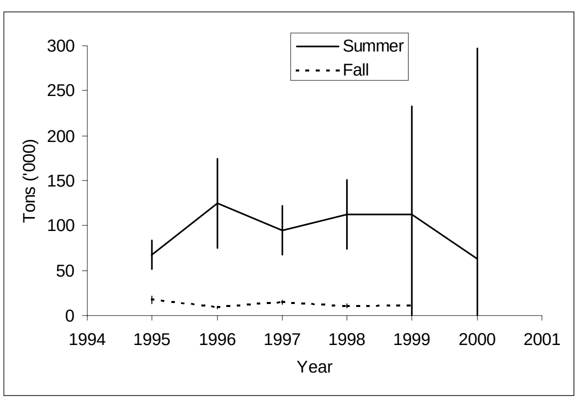

Figure 11: Sentinel fisheries surveys biomass index (in thousands of tons).

A **comparison of the research, sentinel and industry surveys** shows that the **distribution** of catches in early years of the DFO research surveys (beginning of the 1990s) were similar to those seen in July-August sentinel and GEAC grid surveys since 1995. However, from 1993, distributions on the DFO research surveys were more similar to October-November sentinel surveys since the highest catches were limited to in south of division 4R and 3Pn (part of Unit 2 in that period). 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

Many fisherman involved in the indexed fishing trips program were disappointed with the results for the last two years in the summer as they encounter low catch rates and observed limited distribution of redfish in the Gulf as compared to the historic pattern. They observed that some large fish (> 40 cm) were found in deep water in 2000 (200-250 fathoms). From the size and colour of these fishes, they were either *S. marinus* or *S. mentella* from the strong year-classes in the early 1970s. Also, the presence of more worms was observed by many participants to the index fishery.

Some fisherman indicated the presence of by-catch of small redfish during the shrimp fishery in the Esquiman Channel even with the use of the Nordmore grid. This observation may indicate a sign of new recruitment in the redfish population. The observer data on the shrimp fishery should be examined to identify the amount of these by-catches, and if bycatch is significant, measures should be introduced in the shrimp fishery to minimise the impact of this fishery on redfish recruitment.

Sources of uncertainty

The three survey series (DFO research vessel, sentinel and GEAC) give somewhat different perceptions of recent trends in stock status. However, the surveys are conducted at slightly different times, and the redfish are likely to be distributed somewhat differently throughout the Gulf and vertically in the water column during the different surveys. Thus, any changes in seasonal timing of vertical movements or horizontal migrations to and from the Cabot Strait area will be confounded with changes in the abundance of redfish, and it make it very difficult to determine which surveys are providing the most reliable indicator of trends in abundance.

The **results of genetic studies** presented at the 1999 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, these require careful consideration and clarification in at least two aspects of management. Because of the winter mixing and lack of characteristics for separation of redfish from the two Units, it is not possible to allocate the relative impact of late fall and winter fisheries in 3Pn and Cabot Strait, to Unit 1 and Unit 2 stocks. Therefore conservation of both Units requires continuation of measures to prevent significant exploitation of redfish during the period of mixing. More fundamentally, the lack of genetic differentiation of redfish from the two Units, and similarity of past production of strong year-classes raises questions about the degree to which they should be managed as separate units of production. This is a particularly important consideration, because the only known large spawning biomass of *S. mentella* is the remnants of the 1980 year-class in the two Units. The long term impact of the Unit 2 redfish fishery, which presently targets primarily the 1980 year-class of *S. mentella*, on future recruitment to both Units is not known.

Finally, due to the disappearance of the 1988 year-classes, identified as *S. fasciatus*, it is uncertain if the 1996 and 1998 year-class will survive and contribute to the adult population given they are 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 Sentinel surveys biomass indices are also showing a stable abundance during the 1995-1999 period.

The new year-classes (1996 and 1998) observed in the DFO research and in the sentinel fishery surveys may be stronger than those of previous years in the 1990s, but their strengths are very low in comparison to the 1988 year-class that largely disappeared from the population. Moreover, these year-classes would not recruit to the adult population until approximately 2005 to 2007. Overall, the prognosis for this stock remains poor for the foreseeable future.

For further information

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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 t for 1998 and initially to 12,000 t for 1999. There was an adjustment to 18,240 t in 1999 and an extension to March 31, 2000 to allow for the transition to an April 1 to March 31 based TAC. The 2000-2001 TAC was set at 10,000 t.

In 1995 area/season closures were implemented to (i) minimise possible mixed harvests with Unit 1 redfish given a lack of understanding of redfish migration patterns and (ii) allow for a period of closure 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.

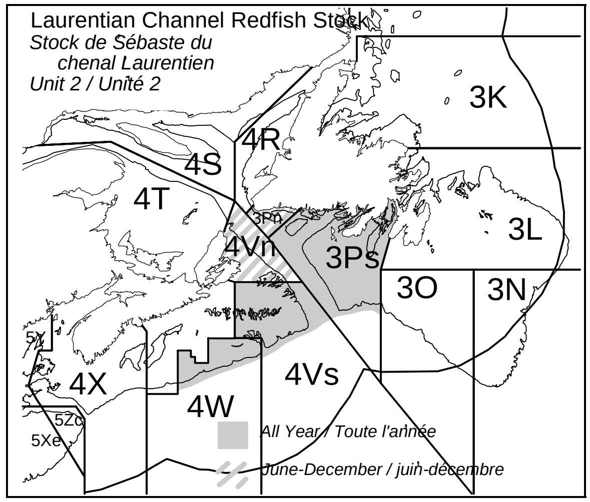

Figure 12: Map showing Unit 2 management area for redfish.

Summary

- DFO surveys between 1994-1997 and 2000 suggest stability. GEAC Surveys support this between 1997-1998 but indicate some decline thereafter.
- The 1988 year-class is increasing its contribution to the adult population but is less abundant than the current size of the 1980 year-class.
- The fishery continues to target the 1980 year-class which is the greatest component of the spawning population. This year-class represented 60% of the 2000 DFO survey biomass.
- The 2000 DFO survey indicates recruitment to the stock from the predominantly 1994 and 1998 year classes accounted for 35% of the survey abundance index but it will be several years before these year-classes contribute to the fishery or spawning biomass.
- 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,

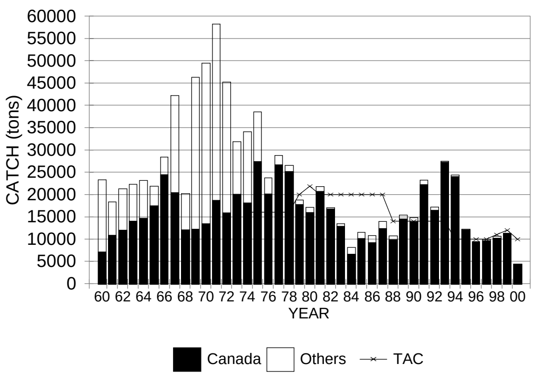

Figure 13: Reported catches and TACs (in tons).

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 13). Catches were about 11,000 t for 1998 and 1999. Up to early November 2000, about 4,400 t had been taken from the 2000-2001 TAC.

Landings (thousand tonnes)

Year	70-76 Avg.	77-95 Avg.	1996	1997	1998	1999[2]	2000-2001[1]
TAC	-	-	10	10	11	18.2	10
Can.	21	17	9.4	9.7	10.2	10.9	4.4
Others	20	1	0	0.3	0.4	0.4	
Total	41	18	9.4	10	10.6	11.3	4.4

[1]Provisional, 2000 to November 2

[2]Catch for 1999.TAC adjusted to March 31,2000.

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, about 50% of the total catch was taken in the first quarter, primarily from 3Psd , 3Psg and 4Vsc.

Sampling of the fishery in 2000 indicated that the majority of the catch was comprised of fish between about 32 cm (13 inches) and 35 cm (14 inches), the bulk of which is predominantly the 1980 year-class. This is very consistent with the 1998 and 1999 fisheries. The 1988 year-class was minimally represented in the catches.

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 trawl survey series conducted in Subdivisions 3Ps, 3Pn, 4Vs and 4Vn during summer from 1994-1997, and 2000 indicated the total biomass index (Fig. 14, all fish sizes - thousands of metric tons) has

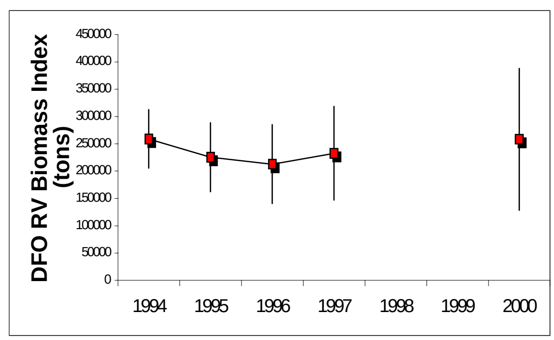

Figure 14: DFO Research survey biomass index

remained stable between 1994 and 2000. The estimates were revised upwards by about 9% for each of the 1994-1997 surveys based on better estimates of trawl performance over the series. There were also 5 additional strata covered in the 2000 survey that extended into the nearshore areas of Hermitage Bay in 3Ps. These strata represented about 4% (10,000 t) of the survey biomass estimate, which is not considered a dramatic affect with regard to the comparability of the survey series.

Acoustic data collected during the survey suggested that in most sets redfish were close to the bottom and the majority were detected within the effective fishing height (4m-5m) of the survey trawl. Mean availability to the trawl was estimated at about 80% for the 2000 survey.

Length compositions from the surveys, (Fig. 15) indicated four modal groups, the peaks of which were 10cm (4 inches), 18-19cm (7 inches), 25-26 cm (10 inches) and 33-34 cm (13 inches) corresponding to the **1998, 1994, 1988** and **1980 year-classes** in 2000. The 1994 and 1998 year-classes represented about 35% of the survey abundance. The 1980 year-class, which has comprised the bulk of the commercial catches in the 1990s, accounted for 30% of the survey abundance but 60% of the survey biomass.

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.

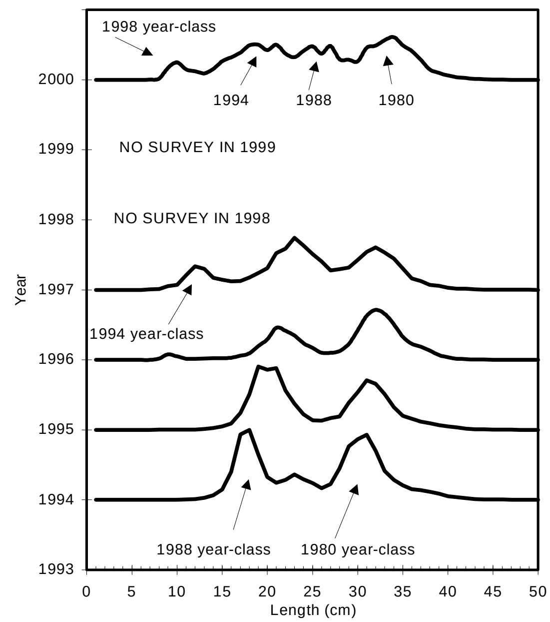

Figure 15: DFO Research survey abundance at length index.

In August 2000 an **industry stratified-random survey** for redfish was conducted by GEAC in Unit 2. This was the fourth such survey in as many years. The 1997 survey was conducted in early December and the 1998-2000 surveys in August and September. For the first three surveys, fishing was conducted using a typical commercial gear with 108 mm mesh in the codend and, thus, sampled the commercial portion of the population. The 2000 survey was conducted with a small mesh liner in the codend to provide a measure of recruiting sizes. The impact on the comparability with the 1997-1999 surveys was minimal. The 1997 survey was conducted during a different season and with some possible overlap with Unit 1. The biomass index (Fig. 16) showed a downward trend particularly since 1998. The low 1999 survey estimate may be partly due to some high density strata not sampled.

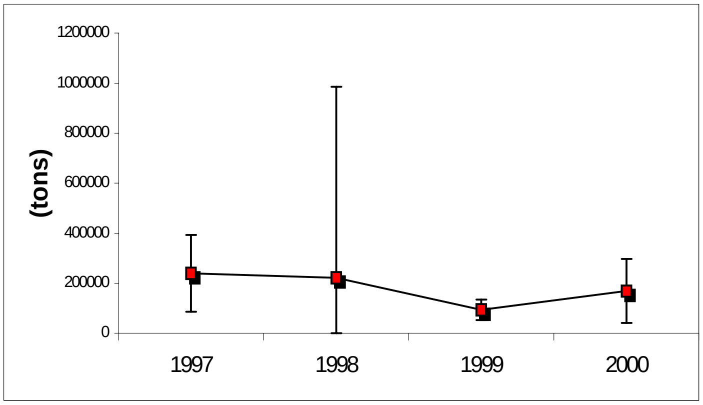

Figure 16: GEAC Research survey biomass index.

The surveys have consistently 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. The 2000 survey also indicated the presence of the 1994 year class but the survey abundance was dominated by the 1980-year class. The 1980 year-class represented 79% of the abundance and 92 % of the biomass in the 2000 GEAC survey.

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.

In 2000, the majority of the large vessel fishery was concentrated in 3Psg and 4Vsc. The catch from 3Psd was less than in the previous three years. Catch rates declined in early winter because of extreme weather at sea. The large vessel fishery for Unit 2 is concentrated from November to early April. Smaller vessels can begin fishing in April but concentrate most of their effort in July through to September in 3Pn and 4Vn. Inshore fishermen reported good catch rates during August and September inside 12 miles close to Port aux Basques. The majority of landings continue to consist of large 30cm plus fish. However, there were reported catches of smaller fish in 3Pn and 4Vsc. Industry also found some concentrations of very large redfish (45cm-50cm) in 3Psa which had characteristics of *S. marinus* rather than very old *S. mentella* but are of less commercial value.

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 uncertain, it is now largely exploitable. Its relative strength in all surveys still suggest it is not as large as the 1980 year-class which has already contributed 10 years of yield. Therefore, there is reduced expectation about the overall yield that the 1988 year- class may produce. The causes of the apparent reduction of the strength of the 1988 year-class as estimated from two independent surveys, despite low exploitation, also are unknown.

The results of genetic studies presented at the 1999 workshop on the Multidisciplinary 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 at least two aspects of management. Because of the winter mixing and lack of characteristics for separation of redfish from the two Units, it is not possible to allocate the relative impact of late fall and winter fisheries in 3Pn and Cabot Strait, to Unit 1 and Unit 2 stocks. Therefore conservation of both Units requires continuation of measures to prevent significant exploitation of redfish during the period of mixing. More fundamentally, the lack of genetic differentiation of redfish from the two Units, and similarity of past production of strong year-classes raises questions about the degree to which they should be managed as separate units of production. This is a particularly important consideration, because the only known large spawning biomass of *S. mentella* is the remnants of the 1980 year-class in the two Units. The long-term impact of the Unit 2 redfish fishery, which presently targets primarily the 1980 year-class of *S. mentella*, on future recruitment to both Units is not known.

The 2000 DFO survey confirmed the presence of the 1994 year class and also detected the 1998 year class. Biological characteristics suggest both these year-classes and the 1988 year-class are predominantly *S. fasciatus*, a shallower water species. The strength of year-classes of *S. mentella* since 1980 is apparently very weak.

Environmental Considerations

Water temperatures in 3Ps and 3Pn in the early 1990's were as much as 1 degree C below average. Starting in 1995, conditions warmed, and the area of the Banks covered with warmer waters also began to increase. In 1999 and 2000, bottom temperatures were warmer than the long-term average. Recent conditions are consistent with more suitable habitat for redfish in Unit 2 and there is possibility of improved recruitment. Possible impacts of warmer water conditions on recruitment will not be apparent in survey data for a few years.

Outlook

Current commercial catches, including those to date in 2000, are composed primarily of the 1980 year-class that has been fished for about 10 years. The 1988 year-class is now fully available, based on size, to the fishery, but has not been 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.

The current exploitation rate of Unit 2 redfish is considered to remain fairly low. However, because the current fishery is targeting almost exclusively the remnants of the 1980 year-class of *S. mentella*, a decline in SSB is expected in the next 1 to 2 years. The prospects for both the stock and fishery in the next few years depend heavily on the degree to which the 1988 year-class comes to contribute to reproductive potential and yield, respectively. This requires careful monitoring over the coming years, and future management actions should be responsive to the results of that monitoring.

For Further Information

Power, D and F. Mowbray. 2000. The status of Redfish in Unit 2. CSAS Res. Doc. 2000/136

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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 improved 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 remained in effect until 1999. There was an adjustment to 10,240 t in 1999 and an extention to March 31, 2000 to allow for the transition to an April 1 to March 31 based TAC. The 2000-2001 TAC was set at 10,000 t. 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 1996 to 1998 the average was 300 t.

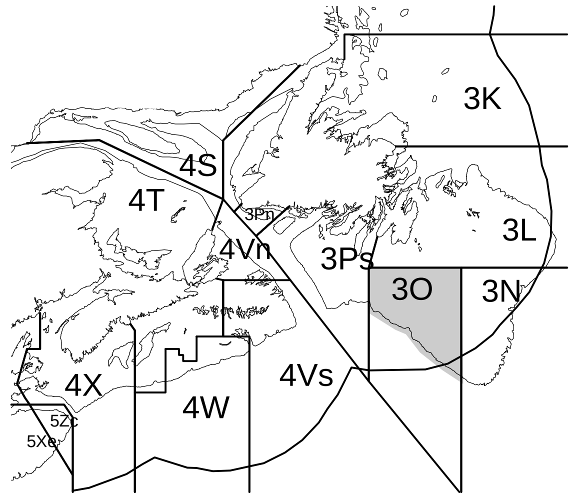

Figure 17: Map showing Division 3O redfish stock area.

Summary

- Pre-recruit redfish, tracked by surveys during 1990s have reached a size where they began contributing to the 1998 and subsequent commercial catches.
- Catches were 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 have been sustainable

The Fishery

Nominal catches (Figure 18) 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 t 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 and catches generally remained at this level through 1997. Total catches in 1998 and 1999 have exceeded 12,500 tons partly due to increased foreign activity outside the 200 mile limit. About 9,000 tons have been taken up to the end of September 2000.

Catches (thousand metric tonnes)

Year	70-76 Avg.	77-95 Avg.	1996	1997	1998	1999[2]	2000-2001[1]
TAC[3]	-	18	10	10	10	10	10
Can.	1	1	7	2.5	9	2	2
Others[4]	14	13	3	2.5	5	10	7
Totals	15	14	10	5	14	12	9

[1]Provisional
[2]Catch for 1999 TAC adjusted to March 31, 2000
[3]Canadian domestic TAC
[4]Includes estimates of unreported catch

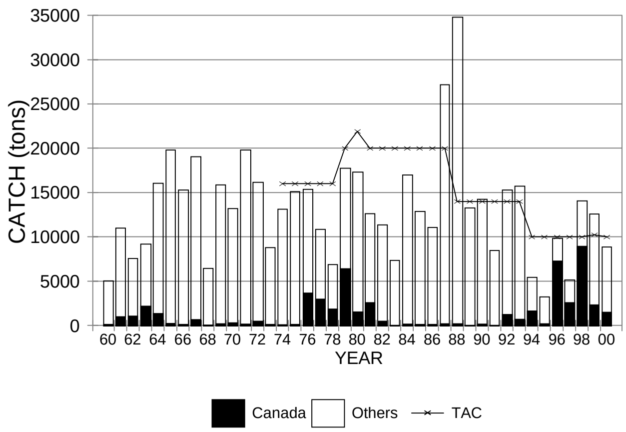

Figure 18: Nominal catches of redfish in Division 3O.

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 have not fished since 1995 and 1993 respectively, but Russia has resumed fishing in 2000.

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 and 5,400 t in 1999. Spain, who had taken less than 50 tons before 1995, caught 1,200 t in 1997 and 1,900 t in 1998 and increased again in 1999 to over 4,500 t. Up to the end of September 2000, EU countries had reported about 5,500 t taken. 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 t and 9,000 t 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 2000 fishery to date indicated the predominant catch was from 22–27 cm. Length distribution information available from Portuguese sampling showed that the bulk of the 1999 Portuguese catch consisted of fish from 21cm to 26 cm.

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 in the early 1990s, but has stabilized at around 100,000 t since 1994. The low 1997 value is considered a sampling anomaly. The autumn survey generally supports this pattern. The additional 2000 survey information for both spring and autumn continues to indicate that stock status has not improved, and may be declining somewhat.

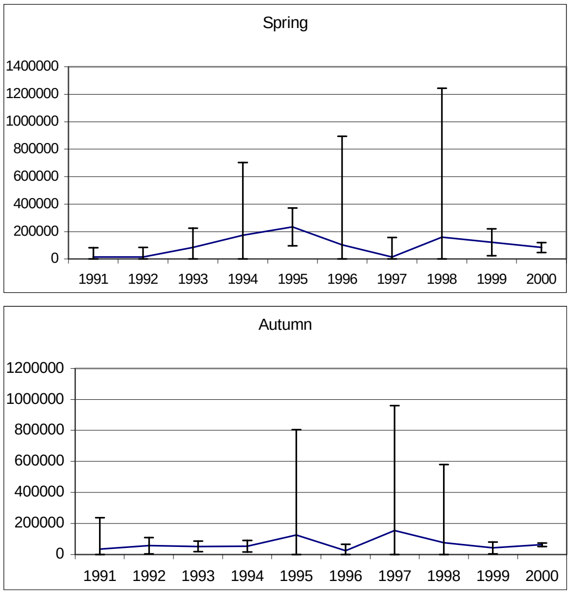

Figure 19: Research survey results for redfish in Division 3O (1995 Autumn-2000 results are from Campelen trawl).

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.

Concern continues that there has been little sign of improved recruitment in the recent surveys despite using the Campelen trawl which is very effective at catching small redfish.

Industry Perspectives

In 2000, the commercial fishery concentrated in 3Oe. Catch rates for some vessels were as high as 8,000 lbs per hour; more than three times 1998 catch rates. The characteristically small perch which have made up this fishery in the past continued to be present in catches. One vessel operator noted increased numbers of small fish less than 22cm in catches during October and November. Total landings were below quota levels because of limited markets for 3O perch. One vessel reported average water temperatures during October in 3Oe of 5.5 degrees C on the bottom and surface temperatures of 15.5 degrees C which is generally higher than previous years, especially for the surface temperature.

Sources of Uncertainty

Although survey length frequencies detect the presence of above average year-classes, such as the 1988 year-class, at small sizes, for other year classes there is little evidence of recruitment until redfish show up at 17-19 cm, despite using the same trawl that has detected fish at 8-9 cm in other areas and tracked them yearly. Hence variation in recruitment is poorly understood and poorly predicted. Likewise surveys and commercial fisheries rarely take redfish greater than 30 cm. It is unknown whether the larger redfish become unavailable to trawl gears, migrate into other areas, or simply cease growing once they reach lengths of 25-30 cm. Together these limitations on survey data mean there is significant uncertainty about the size of the spawning biomass of this stock, and its medium term prospects due to incoming recruitment.

Because it is not possible to describe overall trends in absolute stock size, or estimate the current size of the fishable portion of the population, it is not possible to determine current fishing mortality rate. This means that two common bases for sustainable management of fisheries are not available for this stock.

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.

Environmental Considerations

Bottom temperatures throughout much of 3O, including the shelf break where survey catches of redfish are highest, were as much as a full degree C below the historic average in the early 1990s. Bottom temperatures below 0^oC were widespread in waters less than 100 m, and temperatures along the shelf break were frequently as low as 0^oC. Incursions of water of about average ($1-3^oC$) along the shelf break were noted in 1993 and 1995, and even warmer bottom waters, up to 4^oC, became established along the shelf break in 3O by fall of 1996. These warmer waters expanded widely across 3O in 1998 and 1999, and conditions continued warmer than average in 2000. Studies in other areas have found redfish to prefer water temperatures of 4^oC or higher. Studies elsewhere also suggest that strong year-classes have tended to occur only in warmer years, although warm conditions do not ensure good recruitment. Therefore it seems that the habitat for redfish may have been quite limited in the first half of the 1990s, but conditions have improved substantially in recent years.

Outlook

Historically, the stock has been able to support catches of 10,000 t or more, and biomass has increased under normal recruitment patterns. Although variable, recent survey results suggest that catches of about 10,000 t have been sustainable.

Before 1998, the surveys were considered to have been monitoring pre-recruits to the fishery. The surveys tracked a relatively strong year class which in recent years caused problems for industry in complying with the small fish protocol. In 1998 the last strong year-class reached a size where it began to contribute to commercial catches. The Canadian fishery will continue to target this year-class in the near future. There is concern, however, about the poor sign of subsequent recruitment (less than 17 cm). Careful monitoring of the frequency of redfish between 17 and 22 cm in survey and commercial catches should give advance warning if recruitment to this stock changes either upward or downward sufficiently that management should adjust harvests in response to changed productivity of the stock.

It is also important to consider that 50% of the males are mature at length of about 21 cm, whereas 50% of females do not reach maturity until about 28 cm.

The expanded fishery outside the 200 mile limit means that the TAC may no longer limit total catches at 10,000 t. This could have a detrimental effect on future state of the resource.

For Further Information

Power, D (2000). The status of redfish in Division 3O . CSAS Res. Doc. 2000/137.

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ISSN 1480-4913

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

Correct citation for this publication

DFO, 2000. Status of Redfish Stocks in the Northwest Atlantic: Redfish in Units 1, 2, and in Division 3O. DFO Science Stock Status Report A1-01(2000).