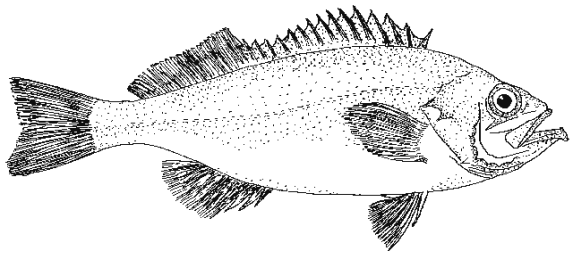

Update on the Status of Redfish Stocks in the Northwest Atlantic: Redfish in Units 1 and 2, and in Division 3O

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. In 2001, Unit 3 were again assessed regionally and the status of the other stocks was update. 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.

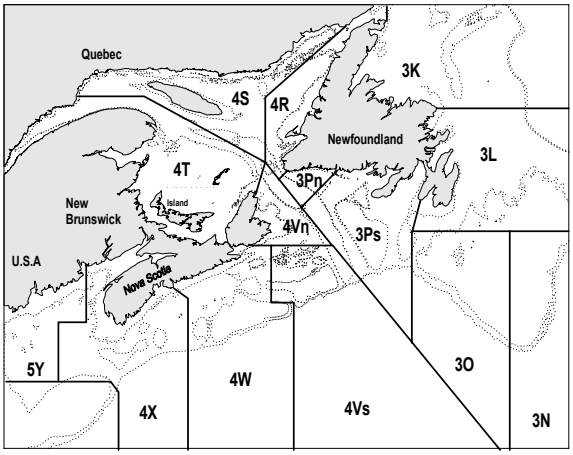

Figure 1: Map of the Northwest Atlantic.

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 nine (9) redfish **management areas** in the Northwest Atlantic: Subarea 2 + Division 3K, Divisions 3LN, Division 3O, Division 3M (Flemish Cap), Unit 1 (Divisions 4RST, 3Pn4Vn- Jan. to May)), Unit 2 (Divisions 3Ps4Vs, 3Pn4Vn- June to Dec., $4W_{fgi}$), Unit 3 (Divisions 4WdehklX)) and Gulf of Maine (Subarea 5) and 1F (South of Greenland).

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. According to these indicators, recent Canadian fisheries appear sustainable. 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.

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.

For more information

Taking in consideration the biological characteristics of redfish (sporadic strong recruitement and slow growth) and the scientific information available, it was agreed for this year to carry out a reduced zonal update with no inter-regional assessment meeting as previous years.

What follows includes information specific to three redfish stocks (Units 1, 2, and Division 3O). The material was prepared within each region and reviewed during a conference call held on November 15 2001. Members of industry participated in the conference call and contributed to the interpretation of the information that was discussed. Conclusions reflect a consensus among all particpants in the call.
Updates 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 and 2001.

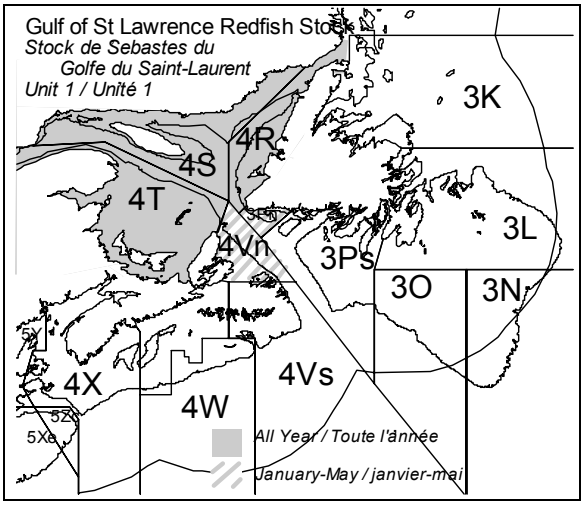

Figure 2: Map of the Gulf of St. Lawrence and nearby regions showing Unit 1 redfish stock.

Summary

Scientific surveys indicate that the stock level is low and stable since the mid 1990's and there is no sign of strong year-classes of juveniles. Catch rates of the index fishery were better in 2001 than previous years particularly for the smaller trawlers. Overall, the prognosis for this stock remains poor for the foreseeable future.

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. The Redfish Industry Survey (RIS) program was put in place in 1998, with two components: **scientific surveys** to develop a new abundance index and **indexed fishing trips** to obtain catch per unit effort (CPUE) data and thereby re-establish the time series of catch rates for the trawlers. The total allowable catch for purposes of the RIS program was 1 000 t in 1998 and 2 000 t for 1999-2001.

Landings (thousand tonnes)

Year	70-76 Avg.	77-94 Avg.	1997	1998	1999	2000	2001[1]
TAC	-	-	0	1[2]	2[2]	2[2]	2[2]
Can.	78.6	38.8	0	0.3	1	1	1
Others	3.3	0	0	0	0	0	0
Total	81.9	38.8	0	0.3	1	1	1

[1] *Provisional to November 2001*
[2] *Redfish Industry Surveys*

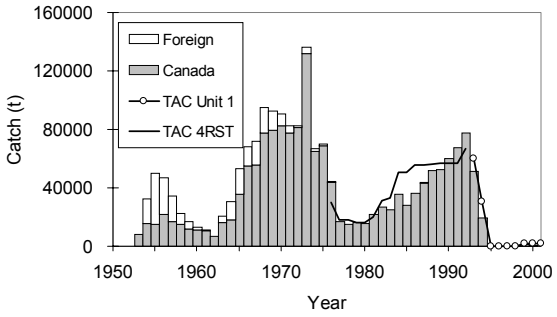

Figure 3: Landings and TACs in tons.

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 2001, 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.

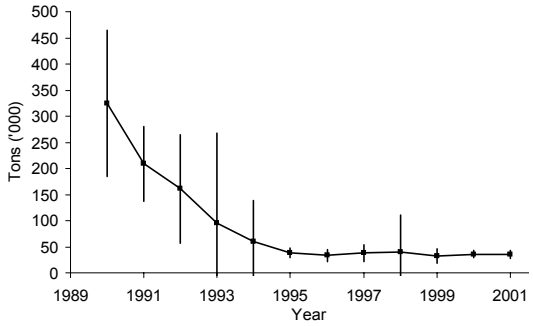

Figure 4: DFO Research survey minimum trawable biomass index (in thousands of tons).

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

Numbers-at-length from the summer surveys (Figure 5) 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.

Since 1996, three new year-classes (1996,1998 and 1999) have been observed in the summer survey catches. The 1996 year-class was first seen in the survey in 1998. Although it was substantially less abundant than the 1988 year-class when it first appeared, the 1996 year-class was the most abundant observed for the last 6 years. However in 2001, the catches of the

1996 year-class fish decreased significantly. Anal fin ray counts (AFC) of these new year-classes in 1999 and 2000 indicated that like the 1988 year-class, the majority of the fish were probably *S. fasciatus*. However in 2001, AFC of the 1996 and 1998 year-classes showed that the fish may be a mix of S. *fasciatus* and *S. mentella*.

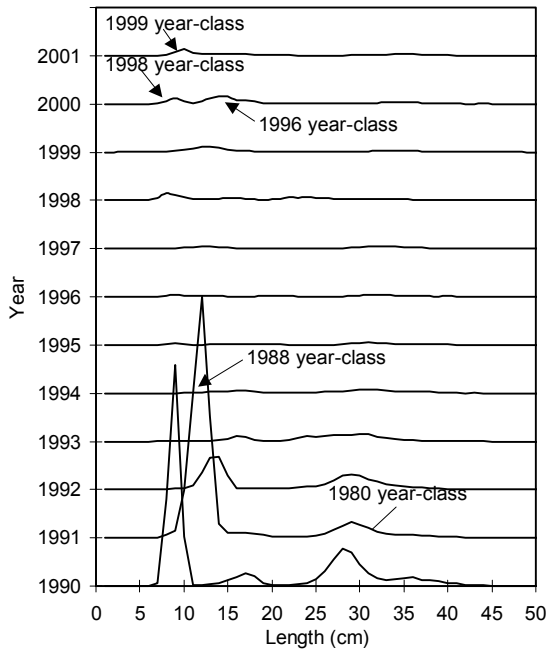

Figure 5: Size compositions from the summer research survey (1990-2001).

Catch rates in the GEAC **grid survey (scientific component of the Redfish Industry Surveys)** show a declining trend in 1999 and 2000 but increased in 2001 to similar level than in 1999 (Figure 6). The increase in catch rates was observed in all Divisions except 4S which had similar catch rates in 2000 and 2001. Geostatistical tools were used to correct for day/night effects on the catch rates and to decrease significantly the variability of the estimates.

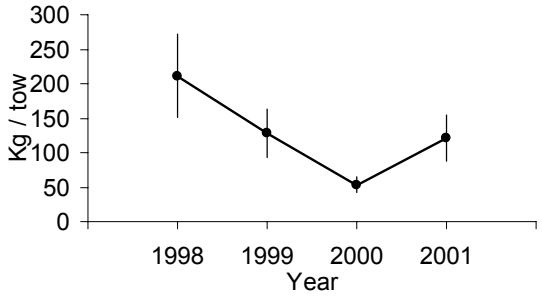

Figure 6: Redfish mean catch rates (kg/tow) observed on the GEAC grid surveys between 1998 and 2001 in 4RST as estimated by geostatistics. The catch rates were corrected for day/night catchability differences.

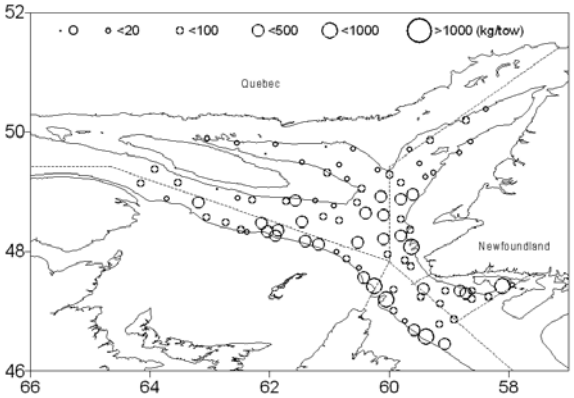

Figure 7. Distribution of redfish catches (kg/tow) observed during the 2001 GEAC grid survey.

Like previous years, highest catches in 2001 were observed in divisions 4T and 4Vn (considered part of Unit 2) and redfish were mainly distributed in the Laurentian Channel south and east of Anticosti Islands (Figure 7).

The **Indexed Fishing Trips (second component** of the Redfish Industry surveys) was conducted by several otter trawlers in the summer and fall of 1999 to 2001 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. Like previous years, most of the vessels stopped index fishing trips at the beginning of August in 2001 because of the decline in their catch rates.

Standardized catch rates of vessels larger than 100 feet were lower then prior to the closure of the fishery (Figure 8). Standardized catch rates in 1999 and 2000 of smaller trawlers were also low in comparison to those observed before the closure of the directed fishery (Figure 9). For both fleets, the catch rates were similar in 1999 and 2000. In 2001, the catch rates indices showed an increase particularly for the smaller vessels. This increase is mainly due to the good catch rates observed by a few small trawlers in 4R particularly in September.

These increases in catch rates in 2001 may not reflect higher abundance of the stock but instead the ability of some fisherman to locate good concentrations of redfish. This explanation is consistent with the higher variability observed in the catch rates observed in 2001.

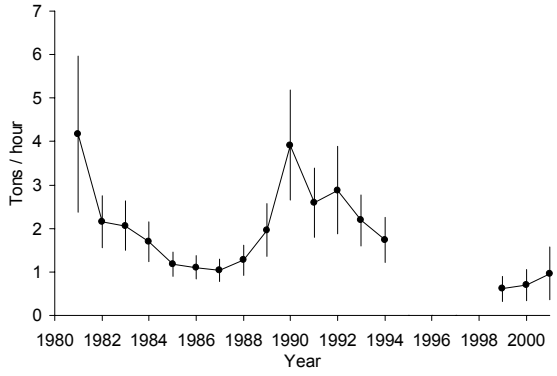

Figure 8: Standardized catch rates (CPUE) of vessels > 100 feet, using bottom trawl between May and October, in the commercial fishery (1981 to 1994) and indexed fishing trips (1999 to 2001).

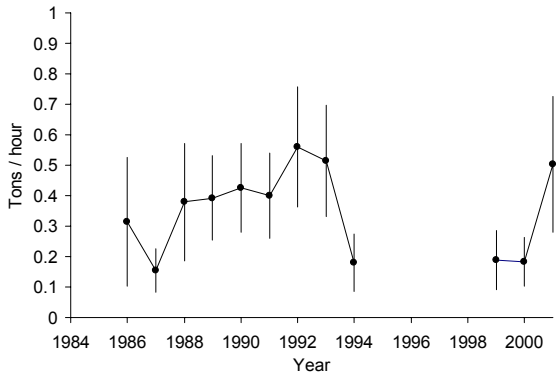

Figure 9: Standardized catch rates (CPUE) of vessels < 65 feet, using bottom trawl between May and October, in the commercial fishery (1986 to 1994) and indexed fishing trips (1999 to 2001).

The large sizes of the redfish caught during indexed fishing trips (Figure 10) 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.

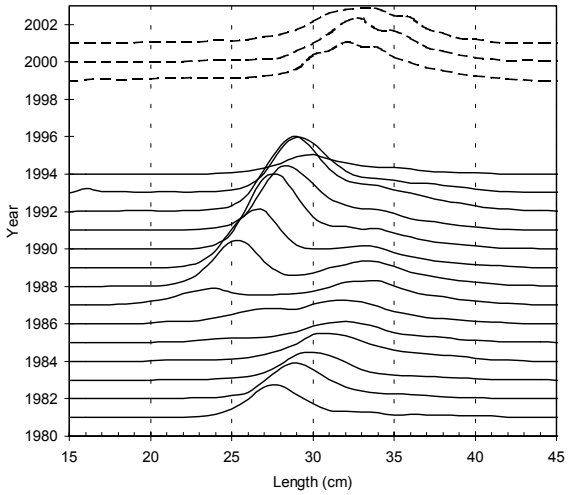

Figure 10. Annual commercial catch (in number) at length. For 1999 to 2001, the frequencies are in percentages because of the low catches.

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. Seven of these surveys were conducted in the summer (July-Aug. 1995 and July in 1996-2001) and six in the fall (November 1995 and October 1996-2000) 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 between 1995 and 1999 (Figure 11)., the 2000 and 2001 values were the lowest of the series for the summer survey.

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 2000. The 1999 year-class is also appearing on the 2001 summer survey catches.

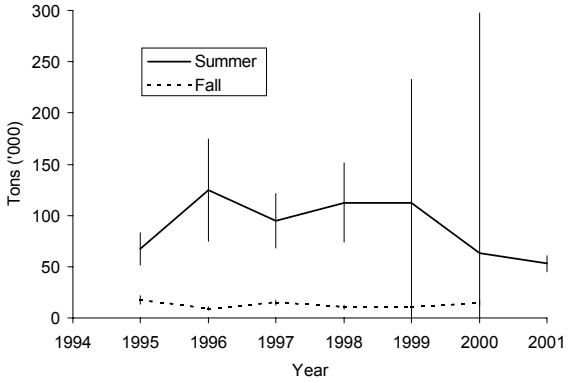

Figure 11: Sentinel fisheries surveys minimum trawable biomass index (in thousands of tons).

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

Some fisherman involved in the indexed fishing trips program felt that their catch rates were similar in 2001 than previous years. Others indicated better catches in division 4R, particularly in September. There were report of some good catches of small redfish in southern 4R in October.

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 would not be 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 current closures in 3Pn and 4Vn from October to December 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 spawning biomass of *S. mentella* is still the remnants of the 1980 year-class in the two Units which is still well represented in the landings. The long term impact of the Unit 2 redfish fishery, 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, 1998 and 1999 year-classes will survive and contribute to the adult population given they were also identified as mainly *S. fasciatus*.

Management considerations

In the last assessment it was mentionned that 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. The observer database for 2000 was analyzed to try to quantify the amount of small redfish that may have been caught during the shrimp fishery. Preliminary estimates showed that these catches were lower (57 tons and 1.8 millions of fish) in

comparison to the numbers observed at the beginning of the 1990 before the Nordmore grid was introduced (average of 27 millions of fish between 1990 and 1992).

Outlook

The outlook from the last stock status report (DFO 2000) stated :

"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. "

The new information presented in this document provides no basis for changing that advice.

For further information

Morin, B. , B. Bernier, R. Camirand, D. Bernier and H. Bourdages 2001. The status of redfish in Unit 1 (Gulf of St. Lawrence). DFO CSAS Res. Doc. 01/01.

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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 and the 2001-2002 TAC was lowered to 8, 000 tons.

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.

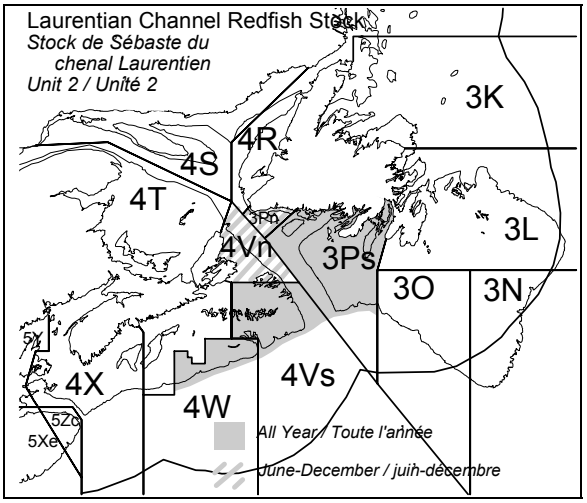

Figure 12: Map showing Unit 2 management area for redfish.

Summary

- DFO surveys between 1994-1997 and 2000 suggest stability. GEAC Surveys support this between 1997-1998 but indicate some decline to 2001. There was no UNIT2 DFO survey in 2001.
- The 2001 GEAC survey indicated the 1988 year class represents 44% of the abundance and 40 % of the biomass. The 1980 year-class represents about 50% of the biomass but only 25% of the abundance.
- The 1980 year-class, which is the greatest component of the spawning population, continues to be well-represented in the commercial catches, but the 1988 year-class comprised a greater portion of the catch in 2001 than previously.
- The 2001 GEAC survey indicates recruitment to the stock from the 1994 and 1998 year-classes 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, catches steadily increased to 27,000 t by

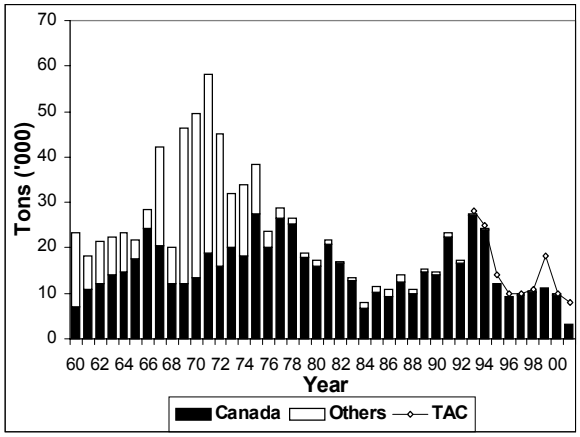

Figure 13: Reported catches and TACs (in tons).

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 before the transition to the April-Mar TAC year beginning in 2000. The 2000-2001 catch was 10,000 tons and Up to early November 2001, about 3,600 t had been taken from the 8,000 t TAC for 2001-2002.

Landings (thousand tonnes)

Year	70-76 Avg.	77-96 Avg.	1997	1998	1999[2]	2000-2001	2001-2002[1]
TAC	-	-	10	11	18.2	10	8
Can.	21	17	9.7	10.2	10.9	9.7	3.6
Others	20	1	0.3	0.4	0.4	0.3	0
Total	41	18	10	10.6	11.3	10	3.6

[1]Provisional to Nov. 7, 2001
[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 of the year, primarily from 3Psd , 3Psg and 4Vsc.

Sampling of the fishery from January to September, 2001 indicated that size compositions varied by area. Overall, year-classes younger than 1980 (fish less than 32cm which were dominated by the 1988 year class) represented about 38% of the catch numbers from January to September, with the remainder being the 1980 year class. In Div. 4V, which contributed 44% of the commercial catch to date, fish less than 32cm comprised about 56% of the catch numbers while in Div. 3P they represented 23% of the catch numbers.

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

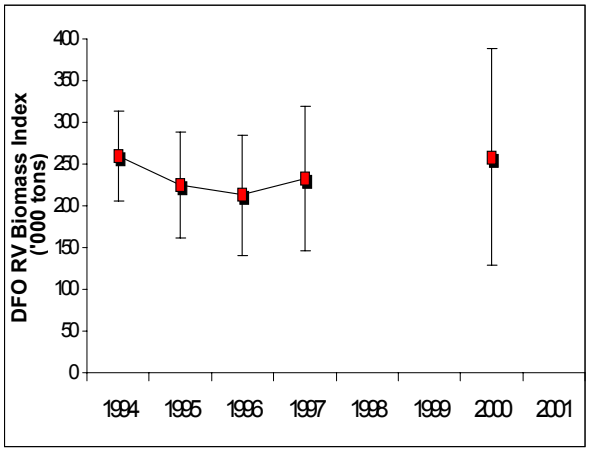

Figure 14: DFO Research survey biomass index

remained stable between 1994 and 2000. There was no DFO survey conducted in

2001. The survey 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 2000 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 2000 survey, (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**. The 1994 and 1998 year-classes represented about 35% of the 2000 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 2000 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.

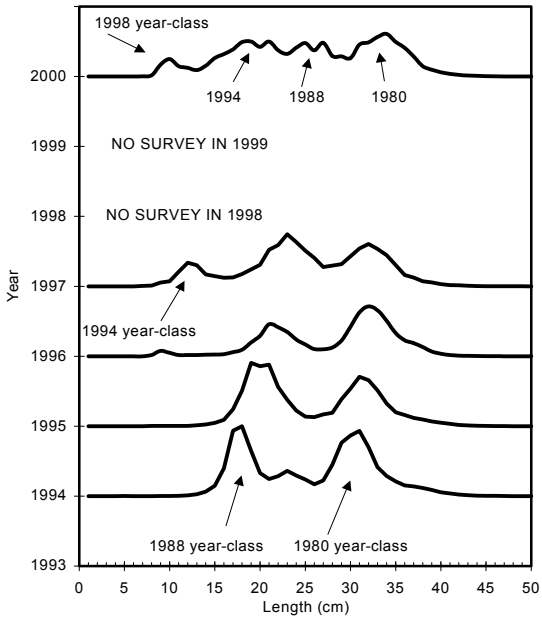

Figure 15: DFO Research survey abundance at length index.

In September 2001 an **industry stratified-random survey** for redfish was conducted by GEAC in Unit 2. This was the fifth such survey in as many years. The 1997 survey was conducted in early December and the 1998-2001 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 and 2001 surveys were conducted with a small mesh liner in the codend to provide a measure of recruiting sizes. The impact of the change in gear 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. The 2001 survey biomass at 141,000 t was 16% lower than 2000 but the survey abundance at 404 million increased by 27%. This indicates

that the estimate of the number of small fish has increased and the number of larger fish have decreased between the 2000 and 2001 surveys (Figure 17).

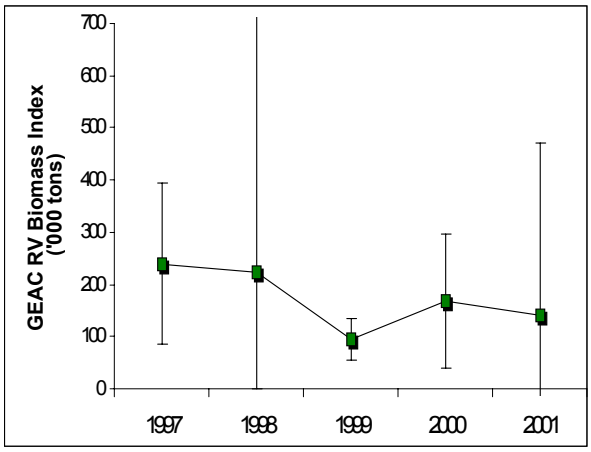

Figure 16: GEAC Research survey biomass index.

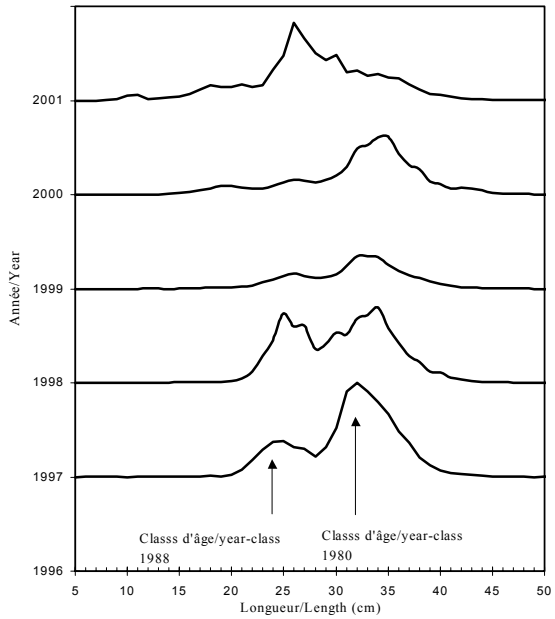

Figure 17: GEAC Research survey abundance at length index.

The surveys have consistently indicated the presence of both the **1980 and 1988 year-classes**. In the surveys to 2000, the relative proportion of the 1988 year-class in the catches was lower than the 1980 year-class. The 2001 survey indicated the 1988 year class dominated the size distribution representing 44% of the abundance and 40 % of the biomass in the 2001 GEAC survey. The 1980 year-class still represents about 50% of the biomass but only 25% of the abundance. The survey also measured the 1994 year class between 18cm-21cm which represented about 9% of the survey numbers. The survey also detected a new pulse of recruitment at 10-11 cm which corresponds to the 1998 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.

Sources of Uncertainty

Although the absolute size of the 1988 year-class is uncertain, it has begun to be targeted and is expected to become an important component of the future fishery. Up to 2000, its relative strength in all surveys suggested it is not as large as the 1980 year-class which has supported the fishery for about 11 years. Therefore, the overall yield that the 1988 year- class may produce, although uncertain, is expected to be lower than the total yield from the 1980 year-class. The causes of the apparent reduction of the strength of the 1988 year-class through the late 1990s, as estimated from two independent survey series, despite low exploitation, also are unknown. The 2001 GEAC survey suggests the 1988 year class is now the dominant year class which causes concern for the remnant 1980 year class.

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 would not be 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 current closures in 3Pn and 4Vn from October to December 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 spawning biomass of *S. mentella* is the remnants of the 1980 year-class in the two Units which is still well represented in the landings. The long-term impact of the Unit 2 redfish fishery on future recruitment to both Units is not known.

The 2000 DFO survey and the 2001 GEAC survey measured 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 but water temperatures in 2001 cooled to values observed in the mid-1990s. The areal extent of relatively warm (>1°C) water in 2001 also declined, and there was an increase in the areal extent of relatively cold (<0°C) water, which covered about 30% of St. Pierre Bank during 2001.

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

Commercial catches to date in 2001 have started to target the 1988 year class but still contain strong representation of the 1980 year-class that has been fished for about 11 years. It is anticipated that the market acceptance of smaller fish will continue to increase, supporting increased use of the 1988 year-class by the fisheries.

The current exploitation rate of Unit 2 redfish is considered to remain fairly low. Although there has been an improvement in the contribution of the 1988 year class in the 2001 fishery, there continues to be a harvest of the 1980 year-class of *S. mentella*, and therefore the decline in SSB is likely to continue. 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 and maintained for 2001-2002. 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, Canadian surveillance 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.

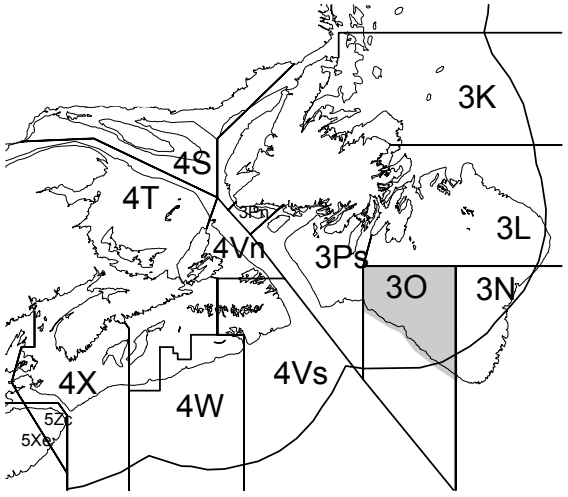

Figure 18: Map showing Division 3O redfish stock area.

Summary

- Pre-recruit redfish, tracked by surveys during 1990s have reached a size where they began contributing to the 1998 and subsequent commercial catches.
- Although variable, recent survey results suggest that catches of about 10,000 t have been sustainable

The Fishery

Nominal catches (Figure 19) 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 from 1998 to the 2001-2002 fishing year have exceeded 12,000 tons each year except for 2000-2001 due to increased foreign activity outside the 200 mile limit.

Catches (thousand metric tonnes)

Year	70-76 Avg.	77-96 Avg.	1997	1998	1999	2000-2001	2001-2002[1]
TAC[3]	-	18	10	10	10	10	10
Can.	1	1.3	2.5	9	2	1.5	3.5
Others[4]	14	13	2.5	5	10	7.3	8.5
Totals	15	14.3	5	14	12	8.8	12

[1]Provisional to Nov 7, 2001
[2]Catch for 1999 TAC adjusted to March 31, 2000
[3]Canadian domestic TAC
[4]Includes estimates of unreported catch

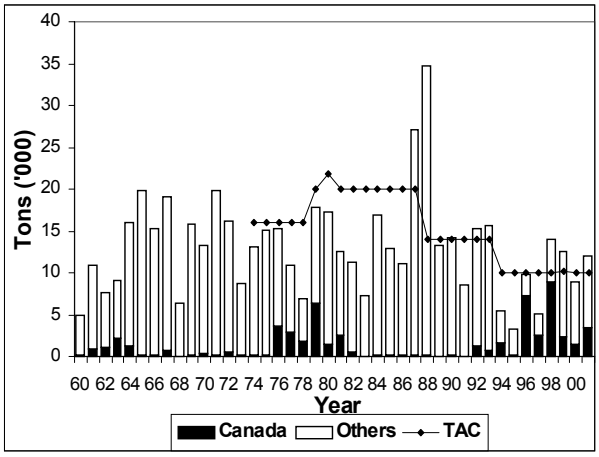

Figure 19: Nominal catches of redfish in Division 3O.

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 did not fished between 1995 and 1999. Russia resumed directed fishing in 2000 and took 2,200 tons but has increased its catch to about 7,700 tons in 2001.

Catches by Portugal, which began fishing in the limited stock area outside the EEZ in 1992, increased to 4,700 tons in 1995, declined to 1,900 tons by 1998. Portuguese catches we at 5,500 tons in 1999 and 4,500 tons in 2000. Catches by Spain, which had taken less than 50 tons before 1995, increased rapidly from 1,200 tons in 1997 to 4,500 tons in 1999 and declined to 3,800 tons in 2000. Up to the end of September 2001, EU countries had reported about 2,400 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. Canadian catches fluctuated between 1,500 t and 9,000 t from 1996 to 2000 due to a varying market for redfish sizes near the small fish protocol limit of 22 cm. Up to Nov. 7, 2001 3,500 tons was taken, an increase of 2,000 tons from the 2000 catch.

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 2001 Canadian fishery to date indicated the predominant catch was from 24–28 cm. Length distribution information available from Portuguese and Spanish sampling programs showed that the bulk of the 2000 Portuguese and Spanish catches consisted of fish from 21cm to 25 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 between 1994 and 1999. The low 1997 value is considered a sampling anomaly. The autumn survey generally supports this pattern (Figure 20). The 2001 survey information for both spring and autumn continues to indicate that stock status has not improved, and may be declining somewhat.

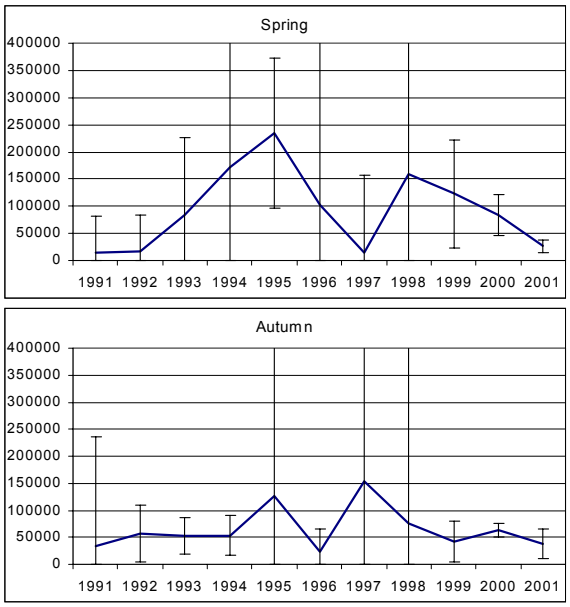

Figure 20: Research survey results for redfish in Division 3O (1995 Autumn-2001 results are from Campelen trawl).

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.

The 2001 autumn survey detected two pulses of recruitment to the stock, one pulse at 13-14cm corresponding to the 1996 year class and one at 9cm corresponding to the 1999 year class. These year classes together represented about 20% of the survey abundance but this estimate was highly influenced by one set conducted in a stratum that represents 28% of the redfish survey area. Further monitoring will be required to confirm the relative strength of these year-classes.

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 in 2000 increased numbers of small fish less than 22cm in catches during October and November. Total landings for some harvesters were below quota levels because of limited markets for 3O perch.

Industry is very concerned that the increasing unrestricted fishing by foreign vessels outside 200 miles may soon have a detrimental impact on this stock and the Canadian fishery, stressing the need to properly control this fishing effort.

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 evaluating 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°C were widespread in waters less than 100 m, and temperatures along the shelf break were frequently as low as 0°C. Incursions of water of about average (1-3°C) along the shelf break were noted in 1993 and 1995, and even warmer bottom waters, up to 4°C, 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°C 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.

Although recruitment to the stock was detected in the autumn 2001 survey, there is considerably uncertainty regarding it's relative strength.

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 has not limited total catches below 10,000 t. Catch for the 2001-2002 fishing year up to November 7 has already exceeded the TAC by 2,000 tons. Catches of this magnitude may not be sustainable.

For Further Information

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

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