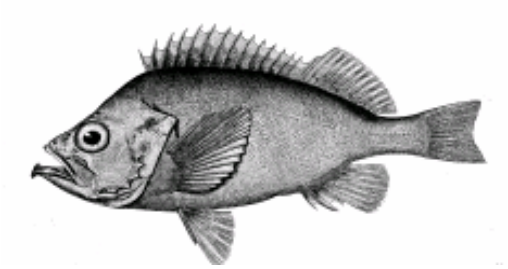

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Acadian Redfish

by

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Distribution, Biology and Management

Three species of *Sebastes* are common in the Northwest Atlantic. The Acadian redfish, *S. fasciatus* Storer, (Robbins et al. 1991a) and the deepwater redfish, *S. mentella* Travin, are virtually indistinguishable from each other based on external characteristics. Both species are considered as beaked redfish based on the presence of a prominent tubercle on the anterior mandible (Klein-MacPhee and Collette 2002). The third species, the golden redfish, *S. norvegicus* Ascanius, (formerly *S. marinus*, see Robins et al. 1991b) can be distinguished from the beaked redfishes based on external characteristics, notably a greatly diminished tubercle.

Visual separation of Acadian redfish and deepwater redfish can be accomplished reliably by counting the number of soft rays in the anal fin (Ni 1982) and internal examination of the passage of the extrinsic gas bladder musculature between the 2nd, 3rd and 4th ventral ribs (Ni 1981; see Hallacher 1974). The two species can also be distinguished genetically by the genotype at the malate dehydrogenase locus (*MDH-A**) (Payne and Ni 1982; McGlade et al. 1983). In general, deepwater redfish are predominant in the northernmost reaches of the Northwest Atlantic, extending from the Gulf of St. Lawrence and the Grand Banks of Newfoundland across the North Atlantic to European waters (see Atkinson 1987 for a general review). Acadian redfish and deepwater redfish co-occur in the Gulf of St. Lawrence and the Laurentian Channel, where introgressive hybridization occurs between the two species (Roques et al. 2001), and on the Grand Banks and the Flemish Cap. Morphometric studies have shown that, within the Gulf of St. Lawrence, deepwater redfish have a more fusiform body shape than Acadian redfish (Valentin et al. 2002). Deepwater redfish are less prominent in the more southerly regions of the Scotian Shelf and appear to be virtually absent from the Gulf of Maine where Acadian redfish appear to be the sole representative of the genus *Sebastes* (Sevigny et al. 2003). Acadian redfish inhabiting the waters of the Gulf of Maine and deeper portions of Georges Bank and the Great South Channel are managed as a unit stock in US waters (Figure 3.1).

Acadian redfish are long-lived, exhibiting ovoviviparous reproduction and are characterized by low fecundity and natural mortality rate. The testes of the males ripen in the autumn and mating occurs in late autumn and early winter (Kelly and Wolf 1959; Pikanowski et al. 1999). Fertilization of the ripe eggs is delayed until spring and larval extrusion generally occurs from late spring through July and August as incubation requires between 45 and 60 days (Kelly et al. 1972; Kelly and Wolf 1959). Generally, between 15,000 and 20,000 extruded larvae are produced per female during each spawning cycle (Kelly et al. 1972).

United States commercial fisheries for Acadian redfish are managed under the New England Fishery Management Council's Northeast Multispecies Fishery Management Plan (FMP). Under this FMP redfish are included in a complex of 15 groundfish species that has been managed by time/area closures, gear restrictions, minimum size limits, and, since 1994, direct effort controls including a moratorium on permits and days-at-sea restrictions under Amendments 5, 7 and 13 to the FMP. Amendment 9 established initial biomass rebuilding targets (Anon. 1998) and defined control rules which specify target fishing mortality rates and corresponding rebuilding time horizons. Amendment 13 implemented formal rebuilding plans within specified time frames based on revised biomass and fishing mortality targets derived by the Working Group on Re-evaluation of Biological Reference Points (NEFSC 2002). The goal of the management program is to reduce fishing mortality to levels which will allow stocks within the complex to initially rebuild above minimum biomass thresholds, and, ultimately, to remain at or near target biomass levels. The information provided herein reflects the results of the most recent peer-reviewed assessments for the Gulf of Maine - Georges Bank stock of Acadian redfish (NEFSC 2005).

The Fishery

Acadian redfish have supported a substantial domestic commercial fishery in the Gulf of Maine and on Georges Bank (Great South Channel) (Northwest Atlantic Fisheries Organization [NAFO] Subarea 5) since the 1930s, when the development of freezing techniques enabled a widespread distribution of the frozen product throughout the country. Landings rose rapidly from less than 100 metric tons (mt) in the early 1930s to over 20,000 mt in 1939, peaking at 56,000 mt in 1942, then declined throughout the 1940s and 1950s (Table 3.1, Figure 3.2). As landings declined in local waters, fishing effort began to expand to the Scotian Shelf and the Gulf of St. Lawrence (NAFO Subarea 4), and finally to the Grand Banks of Newfoundland (NAFO Subarea 3). This expansion continued throughout the 1940s and early 1950s, culminating in a peak USA catch of 130,000 mt in 1952. By the mid-1950s, redfish stocks throughout the Northwest Atlantic were heavily exploited (Atkinson 1987), and total landings began to decline in all Subareas. Landings from the Gulf of Maine increased temporarily during the late 1970s, but have been declining throughout the 1980s and 1990s. Recent landings from this stock have remained at their lowest level since the directed fishery commenced in the 1930s.

This fishery has been prosecuted almost exclusively by large (> 150 gross registered tons) otter trawlers fishing out of Maine and Massachusetts ports. Although Acadian redfish have been harvested primarily by domestic vessels, distant water fleets took considerable quantities for a brief period during the early 1970s, at times accounting for 25-30% of the total Subarea 5 redfish catch. Traditionally, the directed fishery for redfish in the Gulf of Maine was prosecuted by vessels using otter trawls with relatively small mesh in the range of 70-80 mm. In 1977 the

minimum allowable mesh size increased from 114 to 130 mm and by 1994, the minimum mesh size had increased to 152 mm. These mesh restrictions, combined with low biomass and truncated size and age structure of the redfish stock, have effectively eliminated the prosecution of a fishery since the mid 1980s.

The age composition of the 1969 – 1985 landings shows a sharp discontinuity in the age structure of the population created by infrequent recruitment after the 1960s (Figure 3.3). This is in contrast to a more uniform age structure in the 1970s resulting from a series of moderate year classes produced in the 1950s and 1960s. The most striking feature is the singular presence of the 1971 year class advancing through the fishery since 1976, followed by the entrance of the 1978 year class during 1983-1985. By the early 1980s, the fishery had become dependent on a few relatively strong year classes and recruitment appeared to have diminished considerably.

Research Vessel Survey Indices

Trends in total abundance and biomass based on autumn NEFSC research vessel surveys are similar (Figure 3.4). Relative abundance of redfish declined sharply from peak levels over of 100 fish per tow in the late 1960s and early 1970s to generally less than 10 fish per tow during the mid-1980s through mid-1990s. The decline in biomass has been of the same order. A slight increase in abundance and biomass occurred between the mid-1980s and 1990s followed by a sharp increase in autumn 1996, followed by relative stability at these higher levels during the past decade. Age composition data from the NEFSC autumn research vessel surveys clearly illustrate recruitment patterns and changes in age structure of the population (Figure 3.5). In 1975 the population still appeared to exhibit a relatively broad age structure. The 1971 year class is prominently featured in 1975 followed by the 1978 year class in the early 1980s; these two year classes continued to dominate the demographics of the population through the 1980s. More recently, the 1985 and 1992 year classes appear most prominent. Despite this improvement in recent recruitment, the age structure of the population during the late 1990s and early 2000s remains severely truncated compared to the 1975 and earlier period.

Assessment Results

Fishing mortality on Acadian redfish has generally remained quite low compared to many other species. Average fully recruited fishing mortality remained between 0.05 and 0.15 from the 1940s through the 1960s even as landings also declined (Figure 3.6). Fishing mortality increased substantially during the 1970s and early 1980s, peaking at 0.29 in 1982. With the disappearance of the directed fishery shortly thereafter, fishing mortality declined sharply, reaching extremely low levels during the 1990s and 2000s.

The spawning stock biomass of redfish declined from over 500,000 mt in the early 1940s, shortly after exploitation commenced, to 120,000 – 130,000 mt between 1957 and 1971 (Figure 3.7). Spawning biomass declined further to very low levels of less than 30,000 mt during most of the 1980s and early 1990s before increasing to almost 180,000 mt in 2004.

Recruitment at age 1 remained relatively constant for about two decades from the mid 1940s through the mid 1960s, averaging about 60 million fish (Figure 3.7). Following this period of

relative stability, strong or moderate year classes appeared infrequently until the 1990s when moderate to strong year classes once again appeared on a more regular basis. The largest year classes in the almost 60 yr series are those of 1971 (246 million fish at age 1) and 1992 (281 million fish at age 1).

Biological Reference Points

The relationship between spawning stock biomass and recruitment for Gulf of Maine – Georges Bank Acadian redfish over the period covering the 1944-2003 year classes is illustrated in Figure 3.8. After a decades-long decline in spawning biomass from virgin stock conditions in the 1940s interspersed with alternating periods of either stable or infrequent appearance of moderate to strong year classes, the stock has begun to rebuild. The very strong 1992 year class was produced from one of the lowest spawning biomasses and the stock is now producing a series of moderate year class as biomass continues to build.

Survival ratios, recruits per unit of spawning biomass (Figure 3.9), also illustrate the relatively high survival of the dominant 1971 and 1992 year classes as well as the moderate 1978 and 1989 year classes.

MSY-based reference points were last calculated by the Working Group on Re-evaluation of Biological Reference Points (NEFSC 2002) using data and results from the 2001 assessment (Mayo et al. 2002). A complete description of the approach is given in NEFSC (2002). The MSY-based reference points calculated using this method are given in Table 3.2.

Summary

It was determined (NEFSC 2002) that the stock could not be rebuilt to B_{MSY} by 2009 even at F=0.0. Therefore, the rebuilding scenario invoked a 10 year plus 1 mean generation time (31 years for Acadian redfish) to achieve rebuilding. This results in an Frebuild = 0.013. Based on the results from the 2005 assessment (NEFSC 2005), spawning stock biomass in 2004 is estimated at 175,800 mt, 74% of B_{msy} and F in 2004 is estimated at 0.002, well below F_{msy}. Thus, the stock is not overfished and overfishing is not occurring.

Table 3.1 Recreational and commercial landings of Acadian redfish (thousand metric tons).

Category	1986-95 Average	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
U. S. Recreational	-	-	-	-	-	-	-	-	-	-	-
Commercial											
United States	1.0	0.3	0.3	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.6
Canada	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Nominal Catch	1.0	0.3	0.3	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.6

Table 3.2 MSY-based Reference Points for Gulf of Maine – Georges Bank Acadian redfish.

MSY	=	8,235mt
B_{MSY}	=	236,700 mt
F_{MSY} = 0.04	=	$F_{50\%}$ MSP

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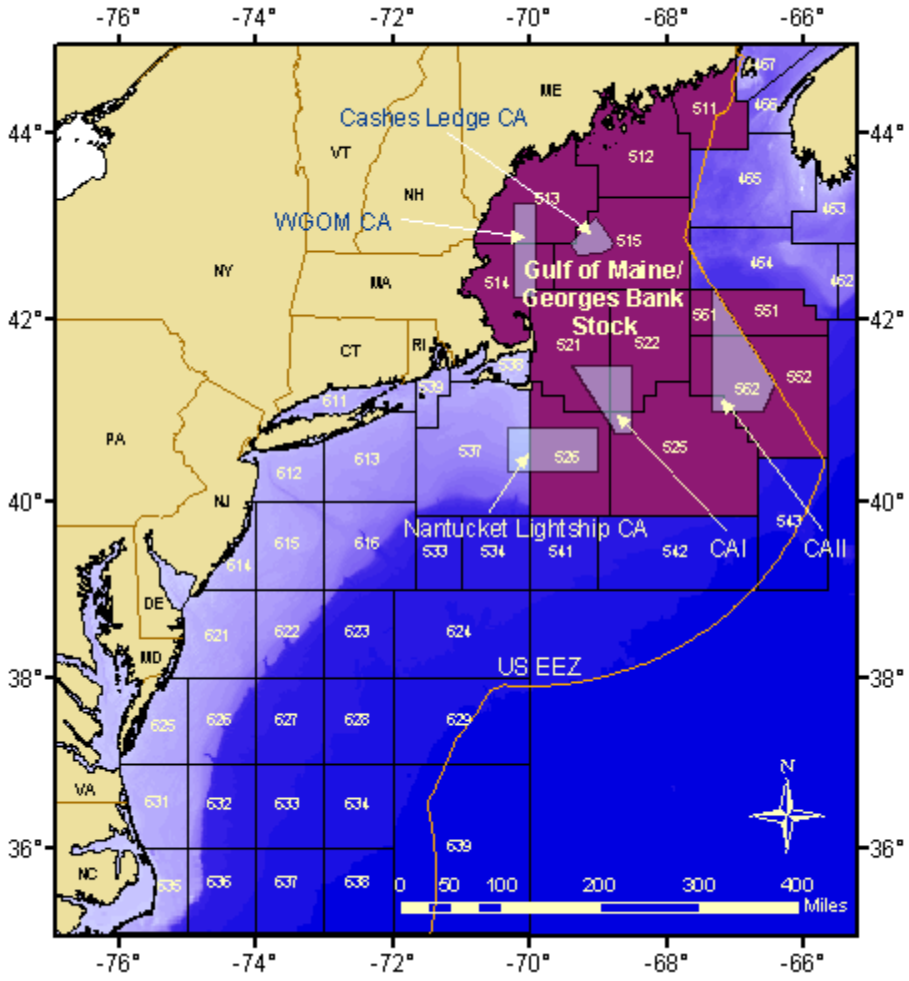

Figure 3.1. Statistical areas used to define the Gulf of Maine/Georges Bank Acadian redfish stock.

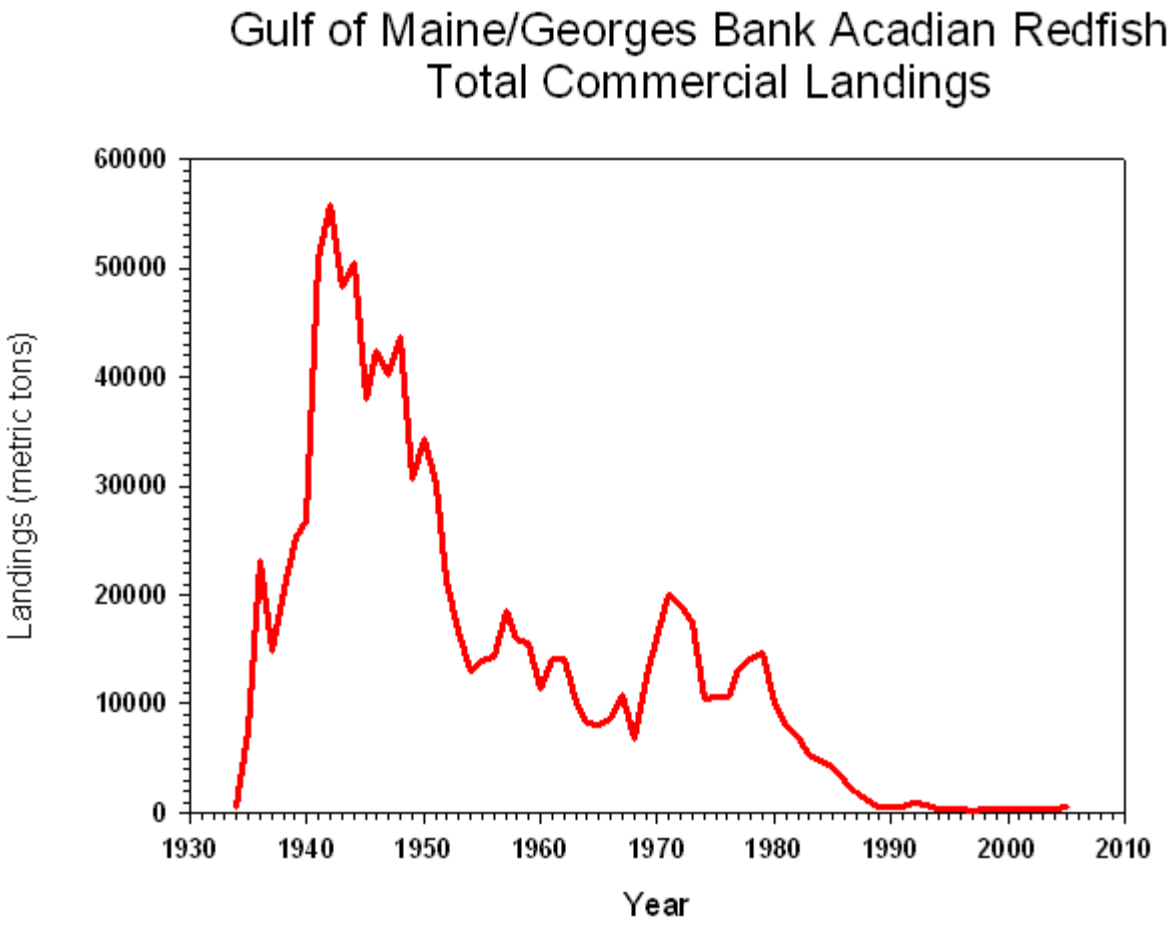

Figure 3.2. Total commercial landings of Georges Bank/Gulf of Maine Acadian redfish (NAFO Subarea 5), 1934-2005.

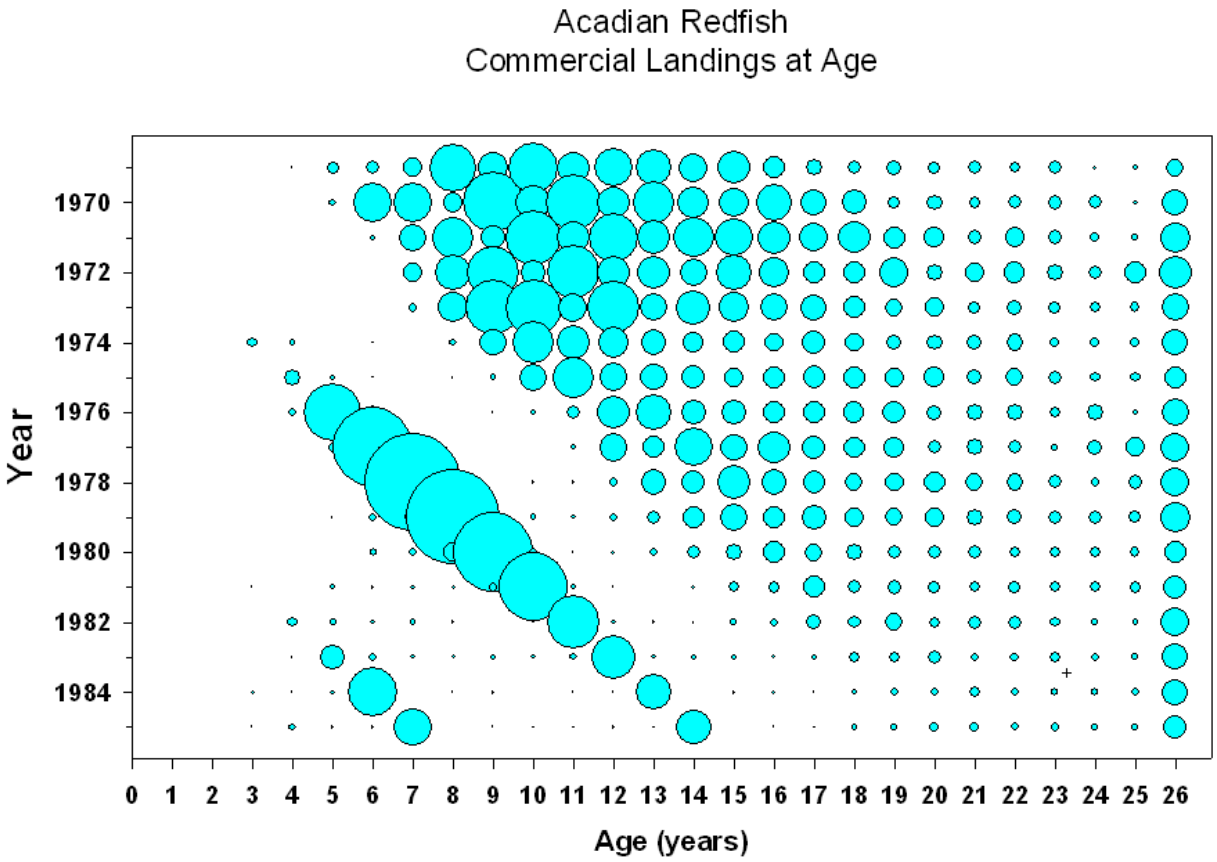

Figure 3.3. Age structure of the Acadian redfish commercial landings, 1969-1985.

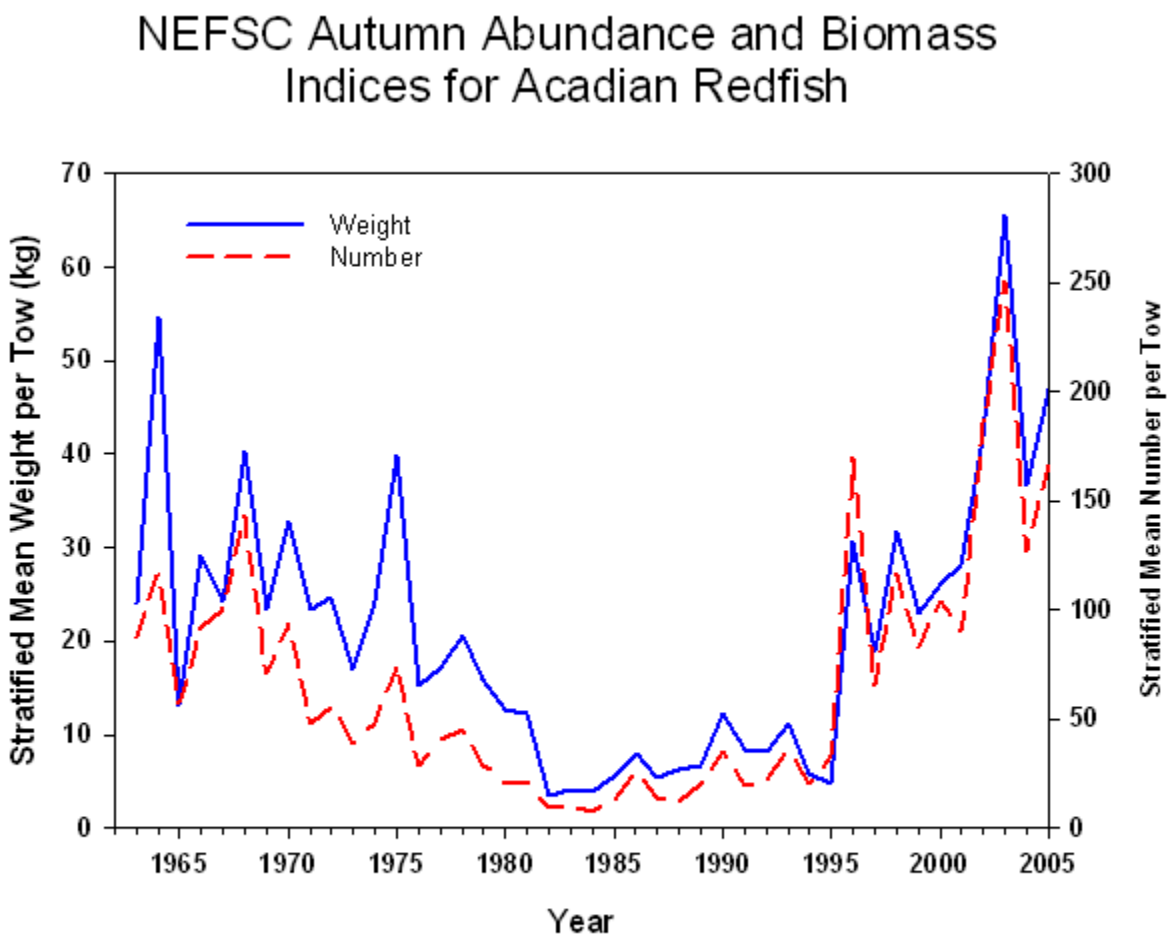

Figure 3.4. Acadian Redfish Stratified Mean Catch per Tow NMFS Autumn Bottom Trawl Survey.

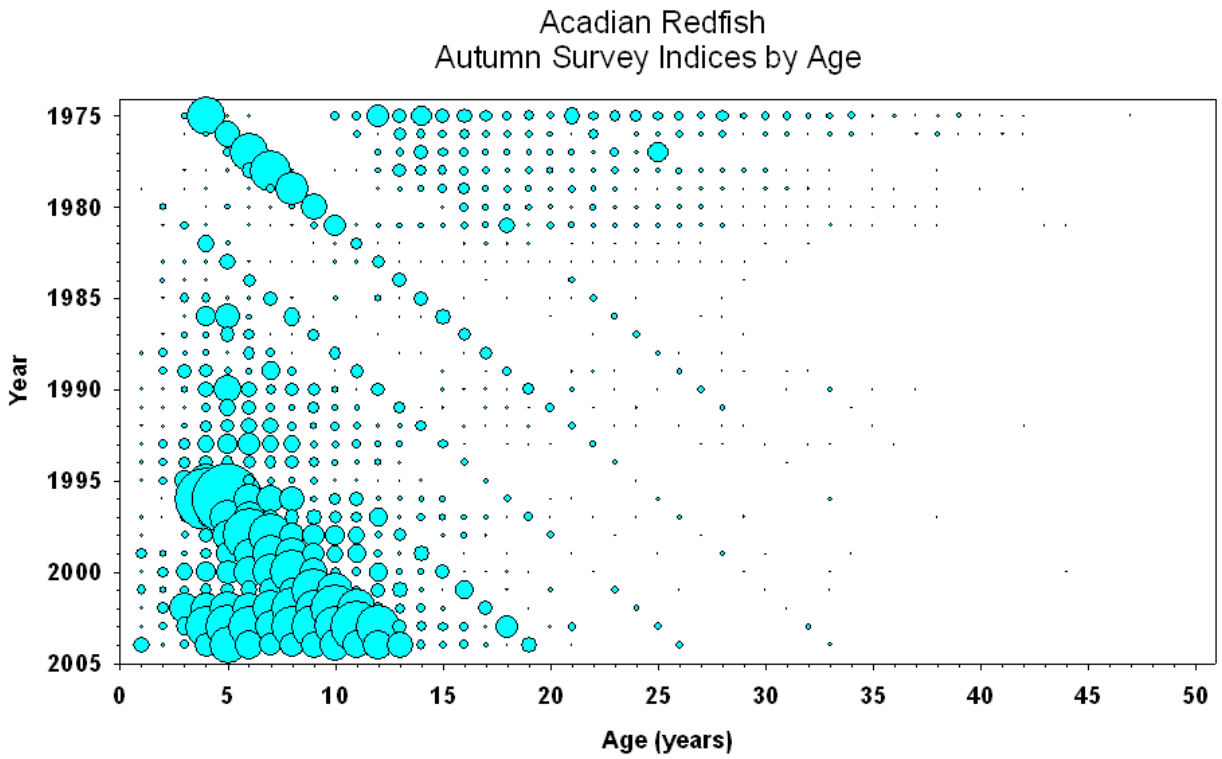

Figure 3.5. Age structure of the Gulf of Maine/Georges Bank Acadian redfish population as indicated by autumn research vessel survey indices of abundance, 1975-2004.

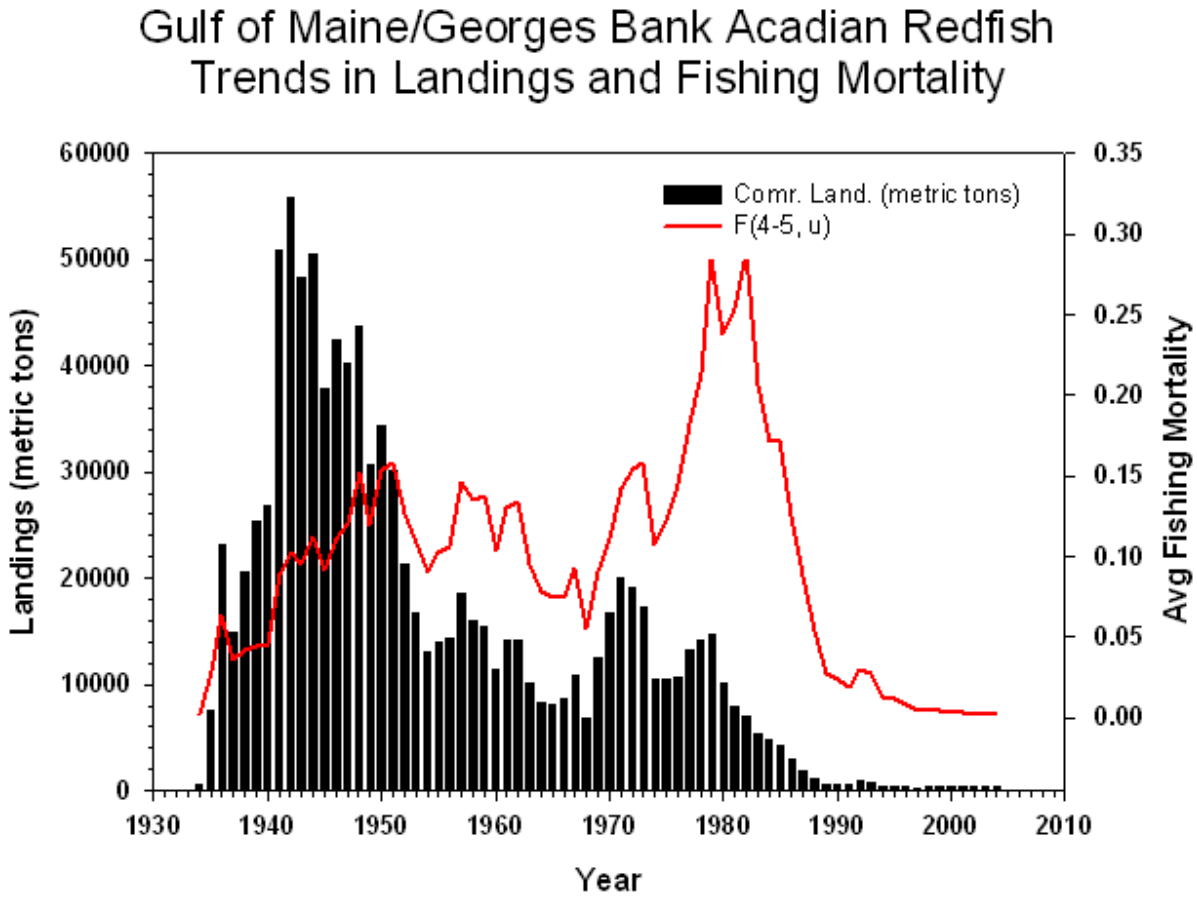

Figure 3.6. Trends in landings and fishing mortality for Gulf of Maine/Georges Bank Acadian redfish.

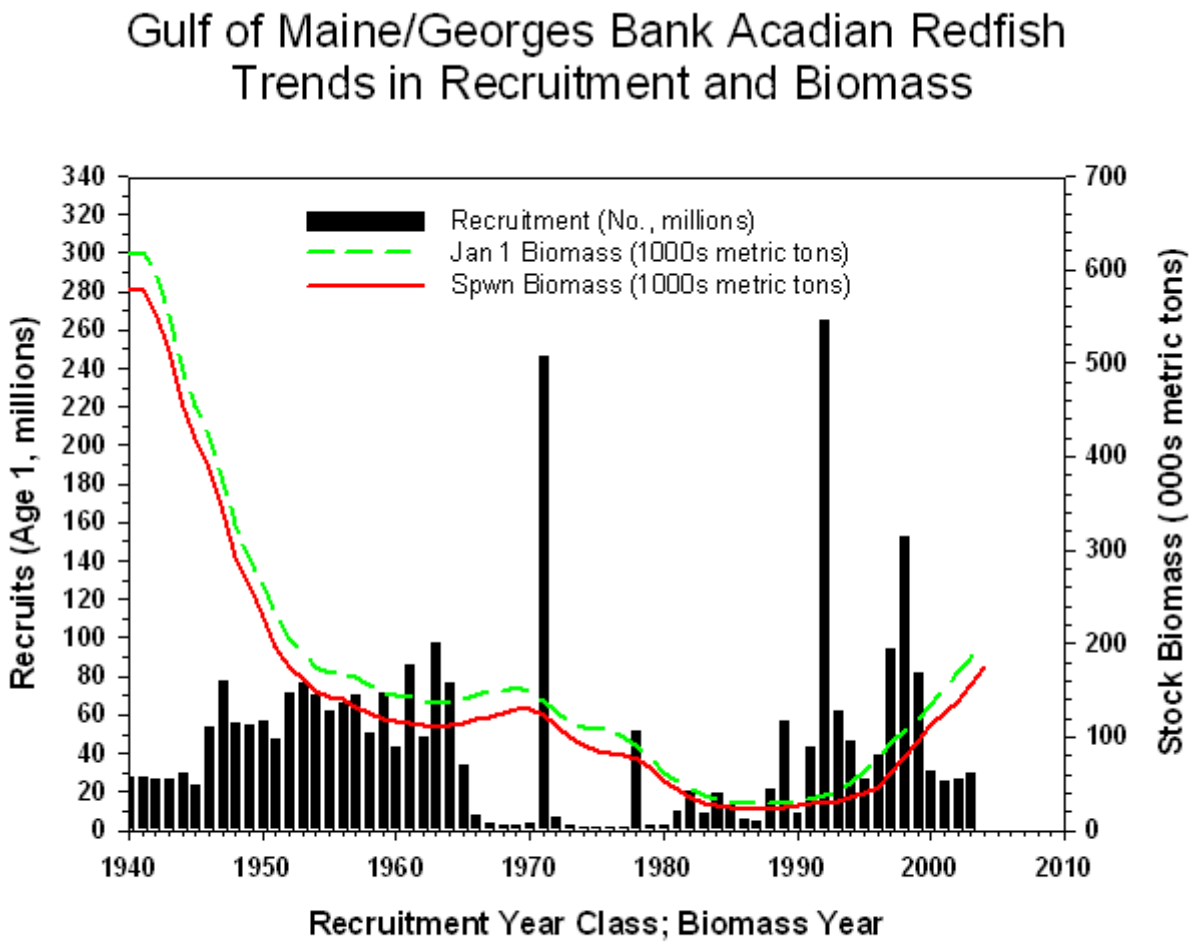

Figure 3.7. Trends in recruitment (age 1) and biomass for Gulf of Maine/ Georges Bank Acadian redfish.

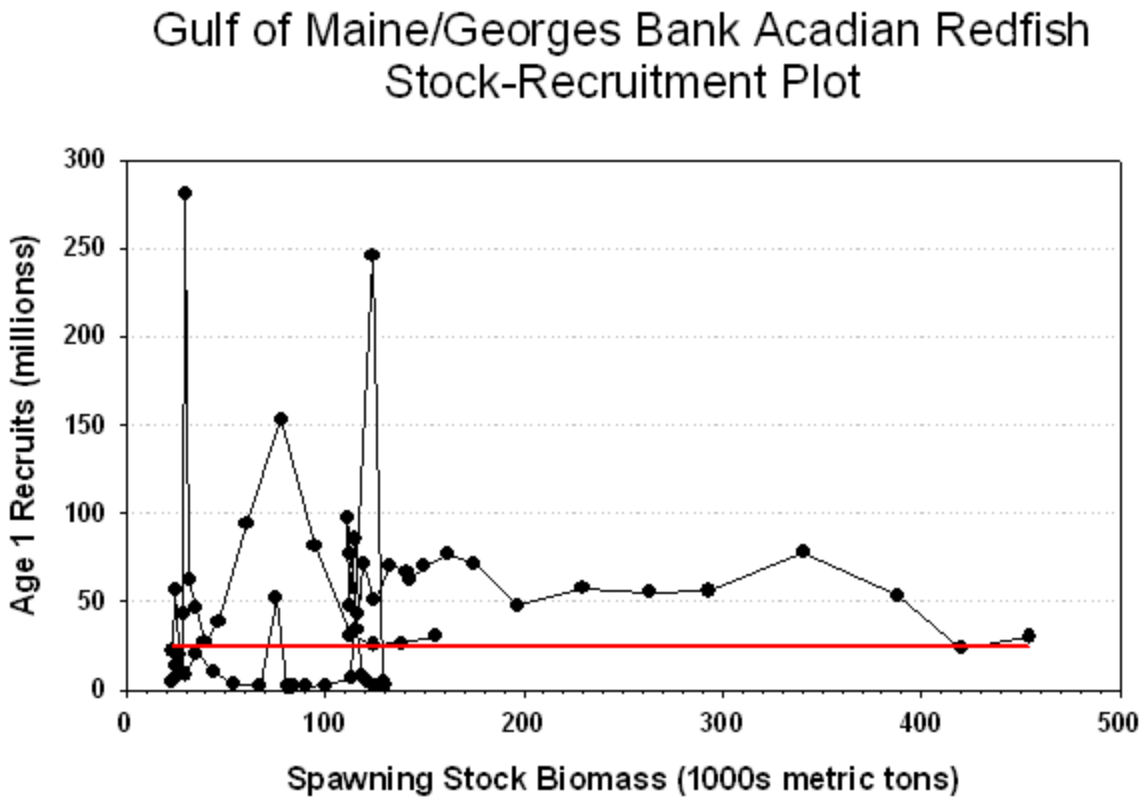

Figure 3.8. Spawning stock-recruitment scatterplot for Gulf of Maine/ Georges Bank Acadian redfish. The solid horizontal line represents the geometric mean recruitment.

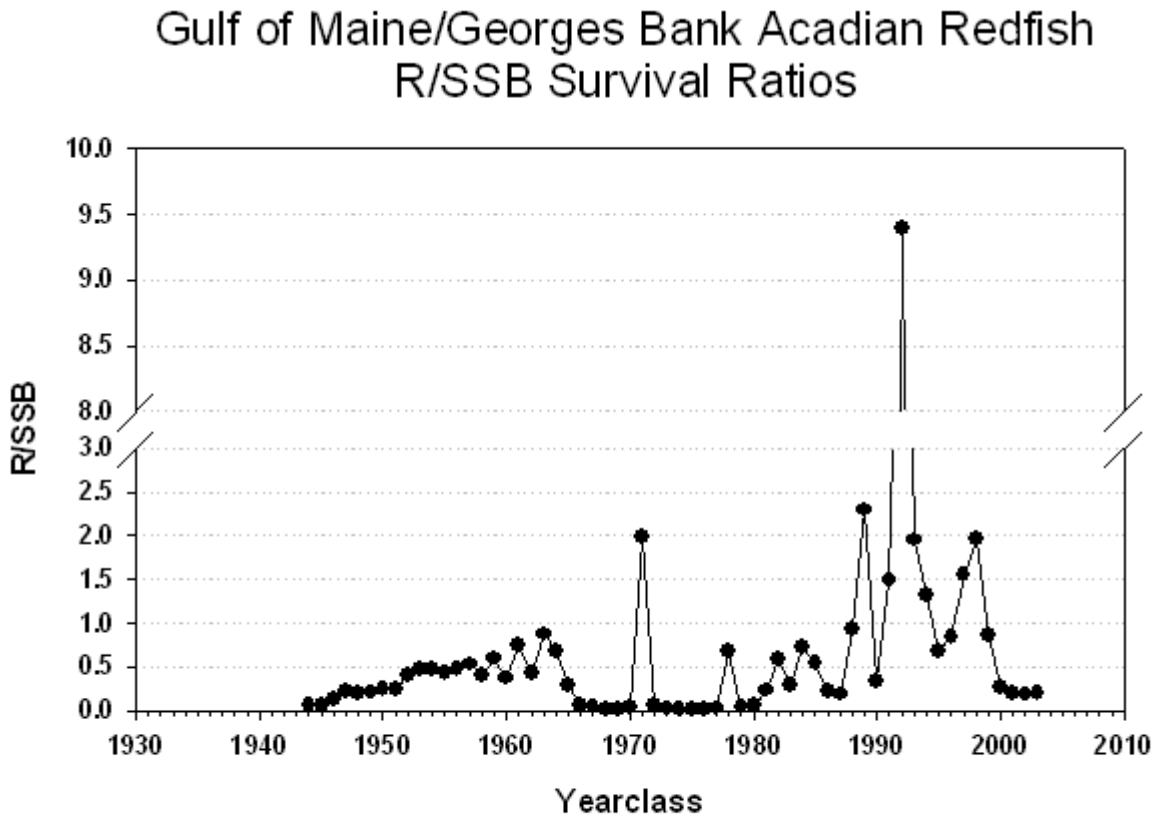

Figure 3.9. Trends in survival ratios (R/SSB) for Gulf of Maine/ Georges Bank Acadian redfish.