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Northern Shrimp

by

Josef Idoine

Distribution, Biology and Management

Northern or pink shrimp, *Pandalus borealis*, occur in boreal waters of the North Atlantic, North Pacific, and Arctic Oceans. In the Gulf of Maine, northern shrimp are considered to constitute a unit stock. They inhabit soft mud bottom at depths of approximately 10 to 300 m (2 to 165 fathoms), most commonly in the cold waters of the southwest Gulf of Maine (Figure 33.1). The Gulf of Maine is the southern limit of the northern shrimp distribution in the North Atlantic, and temperature affects growth and development rates and reproductive success in the stock.

Northern shrimp are hermaphroditic, maturing first as males at roughly 2½ years of age and then transforming to females at about 3½ years of age. In the Gulf of Maine, spawning begins in offshore waters in late July. In late autumn and winter egg bearing females move inshore, where the eggs hatch. Juveniles remain in coastal waters for a year or more before migrating to deeper offshore waters, where they mature as males. The exact extent and location of these migrations is variable. Males undergo a series of transitional stages before maturing as females. Some females may survive to repeat the spawning process in succeeding years. Natural mortality seems to be most pronounced immediately following hatching. Most shrimp do not live past age 5.

The Gulf of Maine fishery for northern shrimp targets females and is managed through an interstate agreement between the states of Maine, New Hampshire and Massachusetts. The management framework evolved between 1972-1979 under the auspices of the State/Federal Fisheries Management Program. In 1980, this program was restructured as the Interstate Fisheries Management Program (ISFMP) of the Atlantic States Marine Fisheries Commission (ASMFC). The Fishery Management Plan (FMP) for Northern Shrimp was approved in October 1986 (FMR No. 9., ASMFC), and Amendment 1 to the FMP enacted May 2004 (FMR No. 42). Amendment 1 established and expanded the tools available to manage the fishery. The goal of Amendment 1 is “to manage the northern shrimp fishery in a manner that is biologically, economically, and socially sound, while protecting the resource, its users, and opportunities for

participation by all stakeholders.”

Within the ISFMP structure, the Northern Shrimp Technical Committee (NSTC) provides annual stock assessments and related information to the ASMFC Northern Shrimp Section. Annually, the Section decides on management regimes after thorough consideration of the NSTC stock assessment, input from the Northern Shrimp Advisory Panel and comment from others knowledgeable about the shrimp fishing industry.

Fishing seasons can occur from December through the following May with the allowable fishing days set by the ASMFC northern shrimp Section. Landings in 2004 (a 40-day season) were 1,949 mt, with 2553 mt in a 70-day season in 2005. The 2006 140 day season landings were 1877 mt. These are all well below the 1969 – 1972 average of 11,400 mt.

At its Fall 2006 meeting, the Northern Shrimp Section approved a 151 day 2007 fishing season, for both mobile and trap gear, that will be open seven days a week from December 1, 2005, through April 30, 2006.

The Fishery

A directed otter trawl fishery for northern shrimp in coastal waters of the Gulf of Maine began during the winter months in the 1930s. Landings peaked at 12,800 mt in 1969 with the expansion of an offshore, year-round fishery; but markedly declined in the mid-1970s and a fishery closure was enacted in 1978 (Figure 33.2). Thereafter, landings increased steadily to over 5,000 mt by 1987. Landings ranged from 2,300-4,400 mt between 1988-1994, and then rapidly increased to 9,200 mt in 1996. Landings declined between 1996 and 2002 but increased afterwards. Landings in the 2003 38-day season were 1,211 mt, 1,933 mt (preliminary data) in a 40-day season in 2004 and 2,146 mt (preliminary data) in the 70-day season in 2005 (Table 33.1).

Maine accounted for 84% (1,808 mt) of the 2005 season while New Hampshire and Massachusetts landed 14% (290 mt) and 2% (48 mt), respectively. This distribution of landings among states is similar to recent years, but has shifted since the 1980's when Massachusetts accounted for about 30% of the total, (Figure 33.3). Most shrimp in the Gulf of Maine are landed by otter trawls, although traps accounted for 4 – 20% of the annual landings during 2000 - 2005.

There has been no northern shrimp fishery in the Canadian portion of the Gulf of Maine since the early 1970s.

Research Vessel Survey Indices

Biomass of the northern shrimp stock is monitored in the NEFSC autumn bottom trawl survey and the ASMFC summer shrimp survey. The NEFSC autumn survey biomass index declined in the early and mid-1970s, remained relatively stable from 1980 to 2001 and has since slightly increased (Figure 33.4). A joint State-Federal shrimp survey has been conducted from the summer of 1984 to present. Biomass and abundance indices from this series are the major source of information used in an annual assessment by the ASMFC northern shrimp Technical

Committee. These indices are similar in trend to those from the NEFSC autumn bottom trawl series. They are relatively stable from 1984 – 1990 then decline throughout the 1990s. Until 2003 the summer indices remained low and have increased in the last 3 years. (Figure 33.4) . Exploitation rates, calculated during fishing seasons, increased from 20 to 38% between 1985 and 1995, peaked at 60% in 1997 before declining to 6% during 2002 (Figure 33.5). The drop in exploitation rate is consistent with the decline in nominal effort during the same period. Since that time, exploitation has increased to 15%. Exploitation rates at or near the 1997 level occurred at the time of the stock collapse in the mid-1970s.

Assessment Results

Estimates of abundance, biomass, recruitment and fishing mortality are available from the most recent (2006) analytical stock assessment (Figure 33.6). The assessment focuses on estimates from a Collie-Sissenwine Analysis (CSA) (Collie and Sissenwine 1983; Collie and Kruse 1998). This relies on the joint State-Federal shrimp survey, limiting the period of analysis to 1985 to present . During this period, abundance and biomass were high during the late 1980s, declined in the 1990s but have since increased to the highest levels of this period. When compared to the surplus production model (ASPIC) used to corroborate results from CSA, the current estimates are at the level of the late 1960s (Figure 33.7).

Annual estimates of fishing mortality (F) (expressed as “harvest rate” derived F’s) were relatively stable between 1985 and 1994 at about $F = 0.22$ (17% exploitation rate), peaked at 1.12 (61% exploitation) in the 1997 season, and then decreased to 0.07 (6% exploitation), due in part to a short fishing season and poor stock conditions (Figure 33.8). Fishing mortality from 2003 – 2005 has been about 0.20, the same level as in the late 1980s.

Because of a lack of detailed information about discards, no analyses of discarding were conducted in the recent assessment.

Biological Reference Points

Fishing mortality and biomass reference points (Table 33.2) for northern shrimp were developed in 2004 (NSTC 2004) and adopted by AMFC (ASMFC 2004). F_{Target} was estimated to be 0.22 based on the average estimates from 1985 through 1994, which represents a relatively stable period covered by the assessment series. $F_{\text{Limit}} = 0.6$ represents the level of fishing mortality that would reduce egg production below 20% of maximum (NSTC 2006). This level of fishing is comparable to that preceding the stock collapse in the late 1970s. The stock biomass threshold of $B_{\text{Threshold}} = 9,000$ metric ton and limit of $B_{\text{Limit}} = 6,000$ metric ton are based on historical abundance estimates and response to fishing pressure. Biomass dynamics during 1985 through 2006 are shown in Figure 33.8.

Summary

Landings in the Gulf of Maine northern shrimp fishery declined from a high of 9,200 mt in 1996 to a low of 424 mt in 2002, the result of reduced fishing. Since then, landings have increased to 2,146 mt in the 2005 season. The number of fishing vessels and trawl trips declined from about

310 and 10,734 respectively in 1997 to 153 and 2,590 in 2005 (although vessel reporting, particularly from the Maine small boat fleet, has probably improved). Fishing mortality rates declined from 0.87 in 1997 to 0.19 in 2005, and is currently below the 1985-1994 average (the target F in the FMP).

Exploitable biomass declined from 15,800 mt in 1996 to a time series low of 5,800 in 2000. Since then the biomass estimate has increased to 28,000 mt in 2006, the highest value in the assessment, and above the biomass reference point. The estimated biomass to the fishing year 2007 is 71,500 mt.

Table 33.1 Recreational and commercial landings of Northern shrimp (thousand metric tons)..

Category	1987-96 Average	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
U. S. Recreational	-	-	-	-	-	-	-	-	-	-	-
Commercial											
United States	4.4	7.1	4.2	1.8	2.4	1.3	0.4	1.2	1.9	2.6	1.9
Canada	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-
Total Nominal Catch	4.4	7.1	4.2	1.8	2.4	1.3	0.4	1.2	1.9	2.6	1.9

Table 33.2 Fishing Mortality and Biomass reference points for Gulf of Maine northern shrimp.

$F_{\text{Target/Threshold}}$	=	0.22
F_{Limit}	=	0.6
$\text{Biomass}_{\text{Threshold}}$	=	9000 mt
$\text{Biomass}_{\text{Limit}}$	=	6000 mt

For further information

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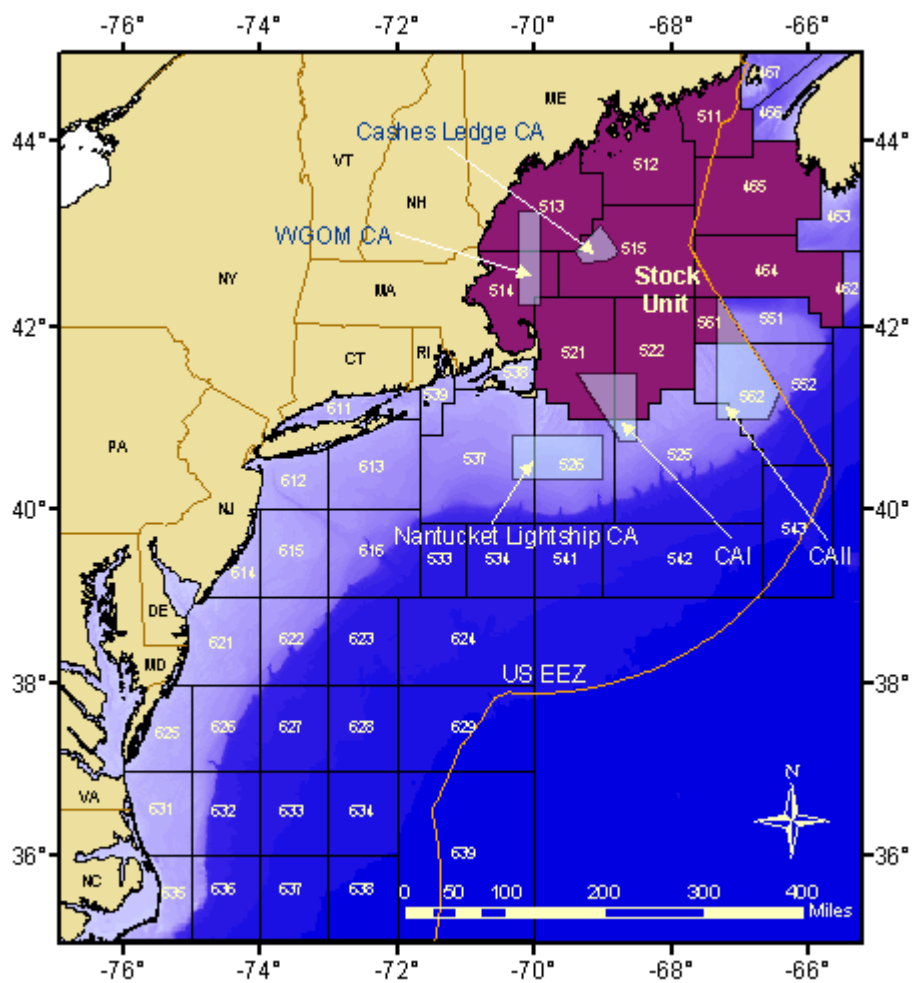


Figure 33.1. Statistical areas used to define the northern shrimp stock.

Northern Shrimp Total Commercial Landings in the Gulf of Maine

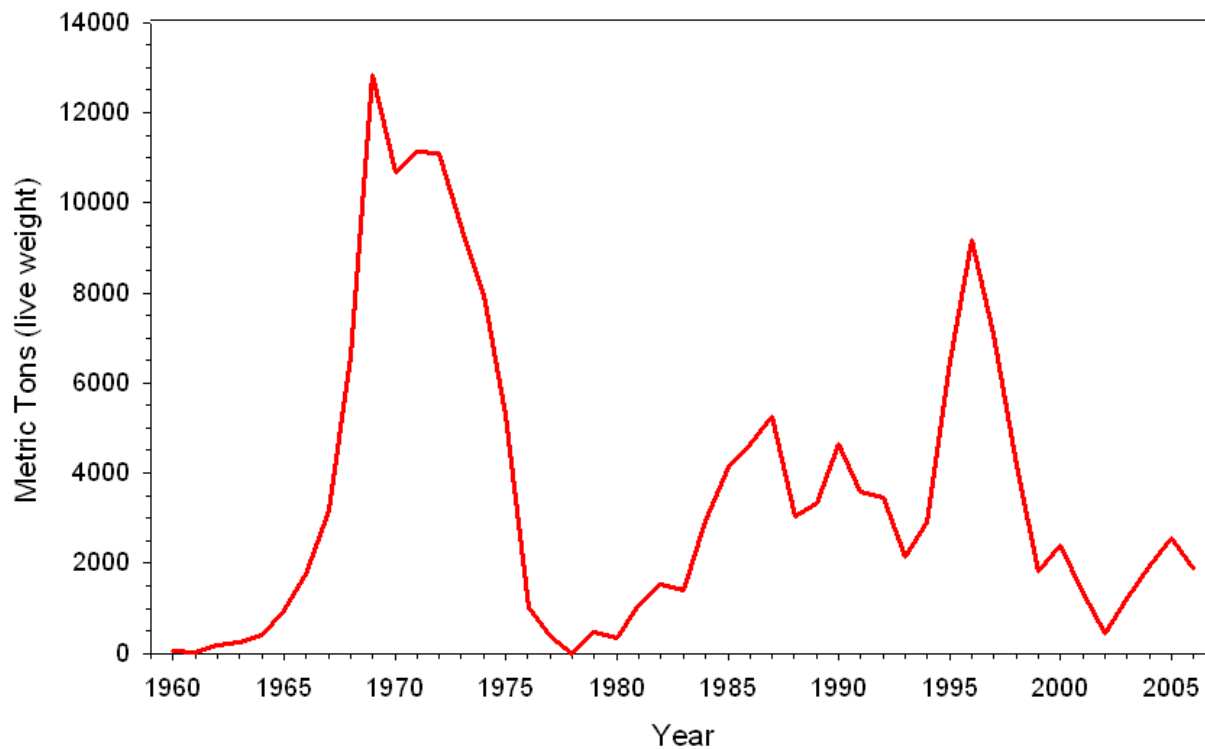


Figure 33.2. Total commercial landings of northern shrimp in the Gulf of Maine, 1960-2006.

Northern Shrimp Commercial Landings by State

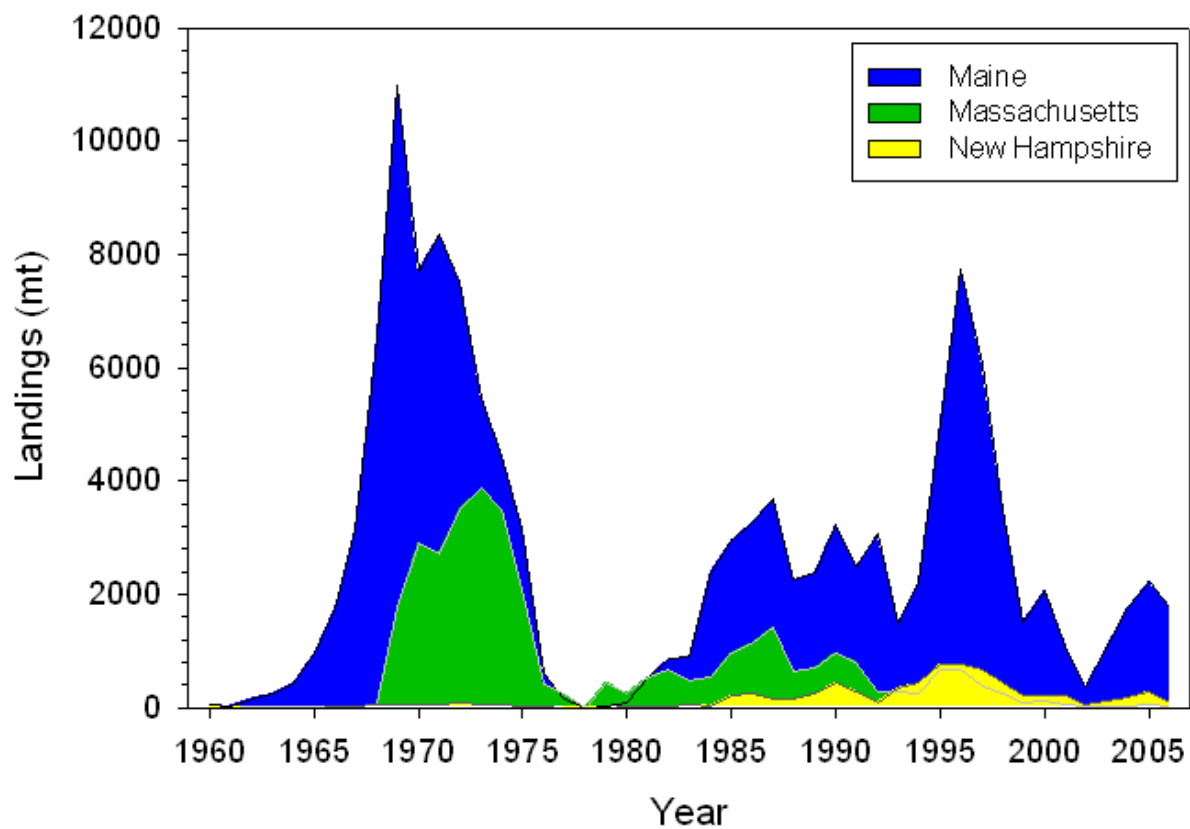


Figure 33.3. Total commercial northern shrimp landings by state, 1960-2006

Northern Shrimp Survey Biomass Indices

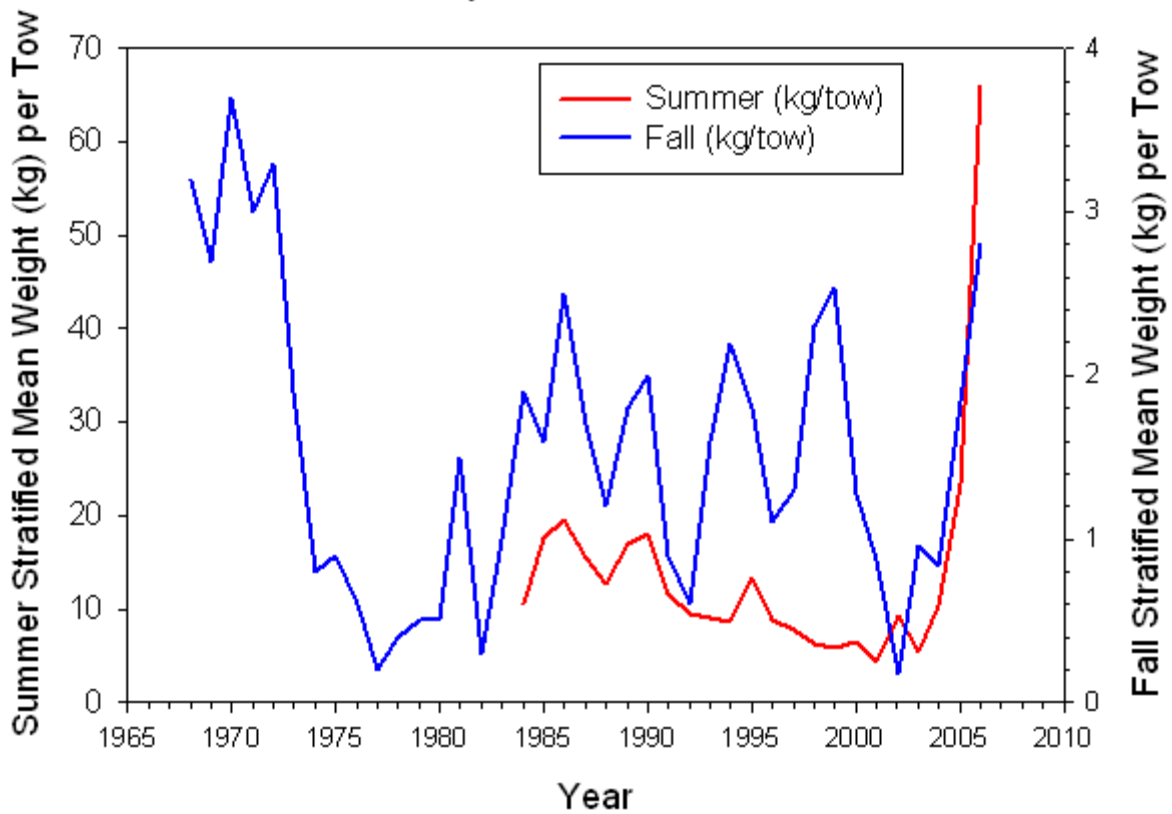


Figure 33.4. Mean weight per tow (kg) from NEFSC autumn bottom trawl and joint state/federal summer surveys.

Northern Shrimp Exploitation Rate



Figure 33.5. Exploitation rates for GOM northern shrimp 1985-2006 fishing seasons.

Northern Shrimp Total Abundance and Biomass

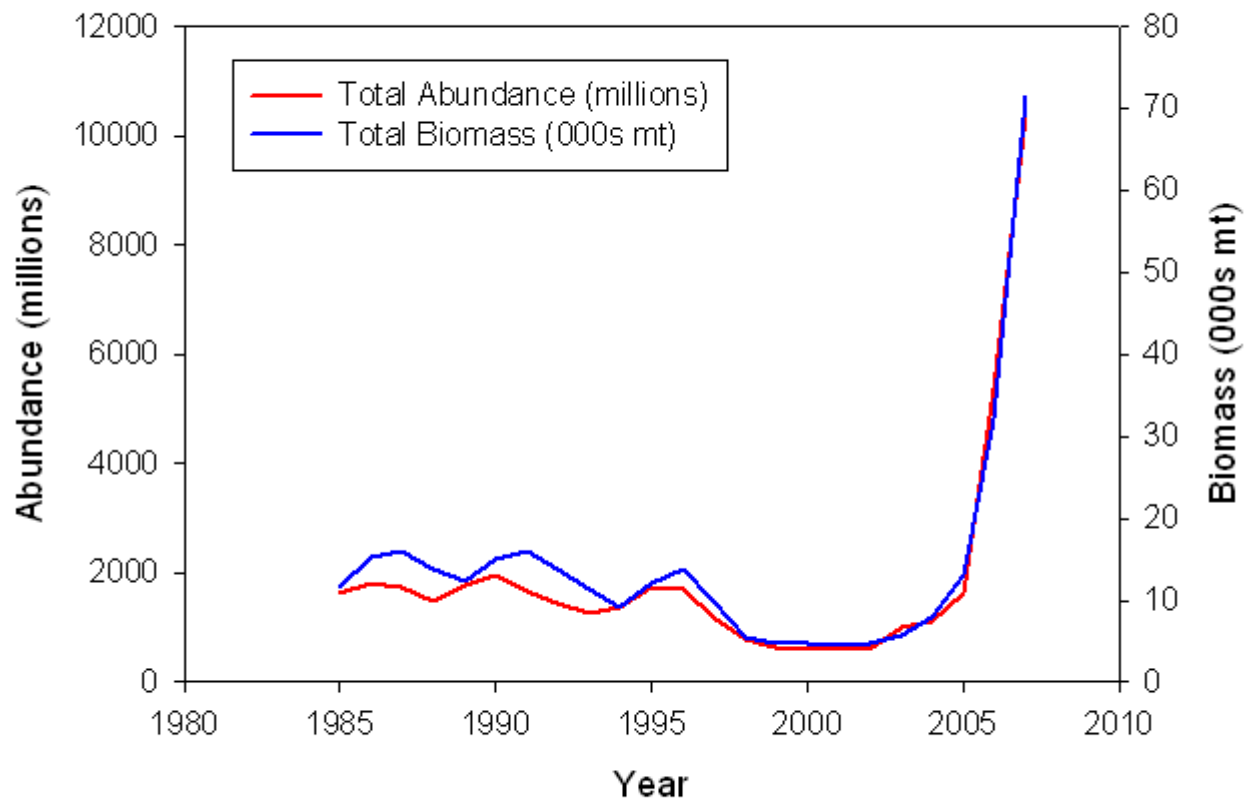


Figure 33.6. Estimated total abundance and biomass for GOM northern shrimp 1985-2006 fishing seasons.

Northern Shrimp Biomass Estimates from CSA and ASPIC Models

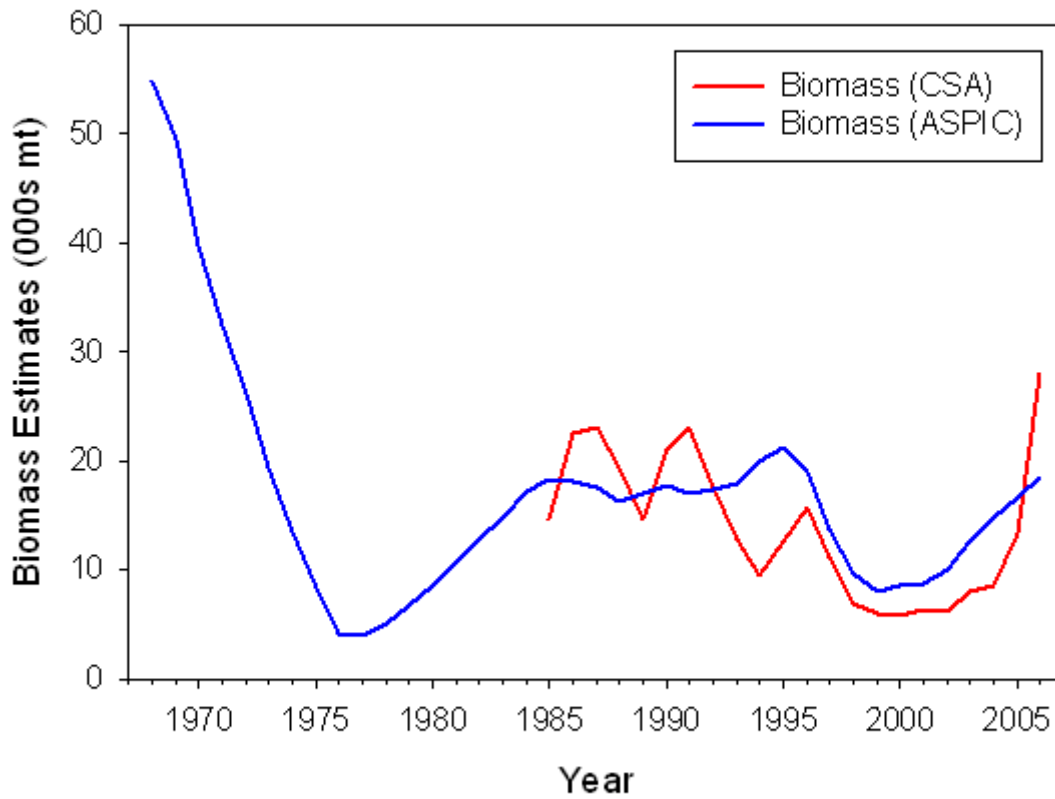


Figure 33.7. Estimated biomass for GOM northern shrimp (CSA and ASPIC) 1968-2006 fishing seasons.

Northern Shrimp Biomass and Fishing Mortality

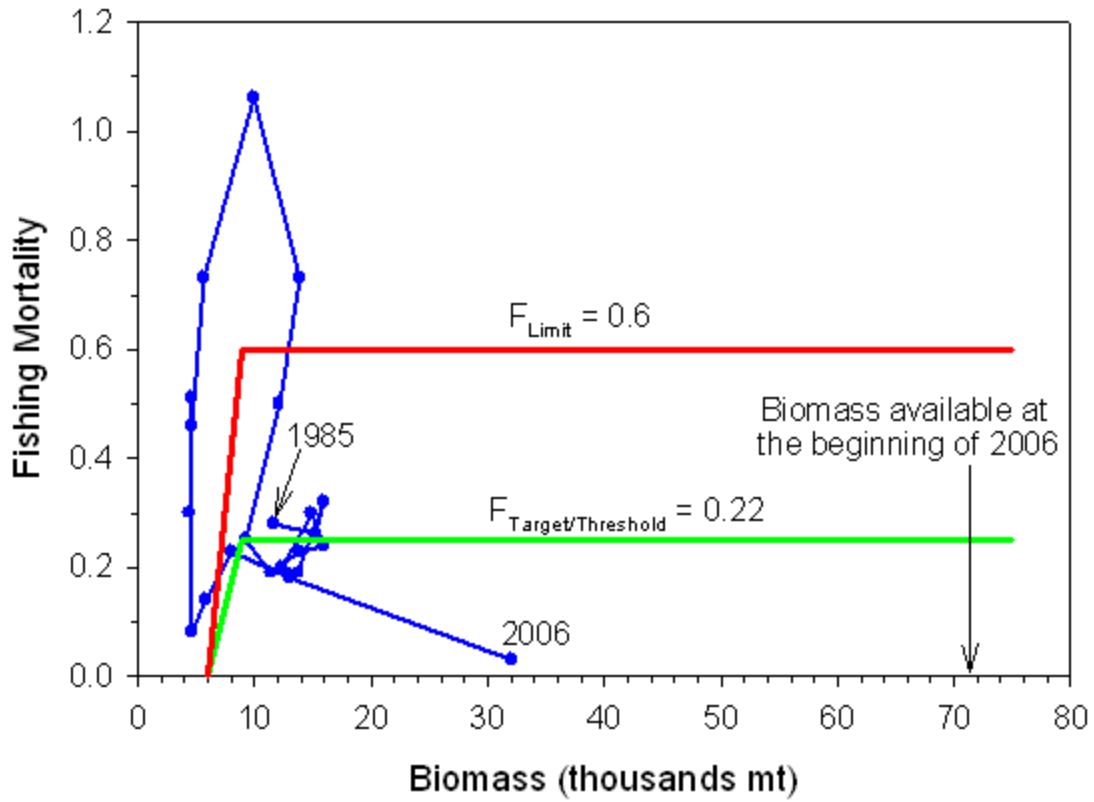


Figure 33.8. Biomass dynamics of the Gulf of Maine northern shrimp fishery with fishing mortality and biomass reference points for fishing years 1985 through 2006.