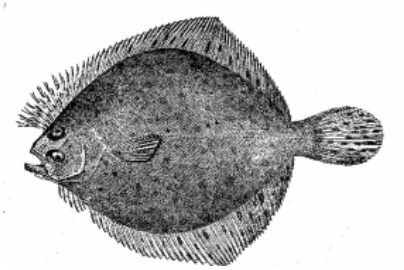

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Windowpane flounder

by

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Distribution, Biology and Management

Windowpane or sand flounder, *Scophthalmus aquosus*, is a thin-bodied, left-eyed flatfish species distributed in the northwest Atlantic from the Gulf of St. Lawrence to Florida (Bigelow and Schroeder 1953). Windowpane prefer sandy bottom habitats and are most abundant from Georges Bank to the southern tip of Virginia. Windowpane occur in bays and estuaries at depths from the shoreline to 60 m. On Georges Bank, the species is most abundant on the shoals (depths < 60 m) during late spring through autumn but overwintering occurs in deeper waters out to 366 m (Chang et al. 1999).

In USA waters, windowpane flounder are assessed and managed as two stocks (Figure 12.1**)**, Gulf of Maine/Georges Bank (GOM-GB) and Southern New England/Middle Atlantic (SNE-MA), based on differences in growth rates (Thorpe 1991), size at maturity, and relative abundance trends. The median length at maturity (L_{50}) is 22.5 cm for females from the northern stock and 21.2 cm for females from the southern stock (O'Brien et al. 1993). The maximum length of windowpane flounder collected in NEFSC bottom trawl surveys during 1963-2004 is 51 cm for the GOM-GB stock and 48 cm for the SNE-MA stock. Fish from Southern New England attain a maximum age of about eight years and females reach maturity between three and four years of age (Moore 1947). With the exception of Georges Bank, a split spawning season with peaks in spring and autumn occurs in most coastal areas between Virginia and Long Island (Chang et al. 1999). Spawning occurs in the southern Mid-Atlantic Bight during April or May and on Georges Bank during July and August and then reoccurs in a north to south direction with a second peak in October or November depending on latitude (Morse and Able 1995). During the first year of life, spring-spawned fish have significantly faster growth rates than autumn-spawned fish, which may result in differential natural mortality rates between the two cohorts (Neuman et al. 2001).

Windowpane flounder are managed under the New England Fishery Management Council's Northeast Multispecies Fishery Management Plan (FMP). Under this FMP, windowpane are

included in a complex of 15 groundfish species managed by time/area closures, gear restrictions, minimum size limits, and, since 1994, by direct effort controls including a moratorium on permits and days-at-sea restrictions. The goal of the management program is to reduce fishing mortality to allow stocks to rebuild above minimum biomass thresholds and to attain and remain at or near target biomass levels.

Windowpane flounder are caught primarily in bottom trawls. Directed fisheries have only occurred sporadically, presumably a result of the species' thin body. Recreational catches are insignificant. A directed commercial fishery developed during World War II when landings increased from 20 mt in 1943 to 165 mt in 1945 (Moore 1947). During the 1950s, windowpane flounder were harvested as part of a Southern New England mixed species industrial fishery in which catches were processed for meal (Edwards and Lux 1958). A directed fishery developed in 1975 on Georges Bank as a result of a decline in yellowtail flounder catches and increased abundance of windowpane flounder (Lange and Lux 1978). During 1985-1998, most windowpane flounder landings were from the GOM-GB stock, but since 1999, most landings have been harvested from the SNE-MA stock. The information provided herein reflects the results of the most recent peer-reviewed assessments for the two windowpane flounder stocks (Mayo and Terceiro 2005).

GULF OF MAINE/GEORGES BANK WINDOWPANE FLOUNDER

The Fisheries

Landings of GOM-GB windowpane flounder declined between 1976 and 1980, increased sharply to 2,100 mt in 1985, and then stabilized between 1,100 mt and 1,800 mt during 1986-1990 (Figure 12.2). In 1991, landings peaked at 2,900 mt but subsequently declined to 50 mt in 1999. High landings during the early 1990's probably reflected an expansion of the fishery to offshore areas, as well as targeting of windowpane flounder as an alternative to reduced groundfish stocks. During 2001-2005, landings were at the lowest levels on record, ranging from 12 to 45 mt (Table 12.1).

Discards of GOM-GB windowpane flounder have never been quantified. However, it is likely that discards are now an important source of mortality as recently there has been no directed fishery.

Research Vessel Survey Indices

Relative biomass indices (stratified mean weight (kg) per tow) of GOM-GB windowpane flounder in NEFSC autumn bottom trawl surveys are highly variable and ranged between 0.16 and 1.56 kg per tow during 1972-1983 (Figure 12.3). Following a time series peak of 2.14 kg per tow, in 1984, biomass indices declined to 0.17 kg per tow in 1991, then increased to 1.66 kg per tow in 1998, but have since declined again to 0.78 kg per tow in 2005.

Assessment Results

The marked decline in landings during 1991-1999 was followed by a steady increase in the

NEFSC relative biomass index. In recent years, however, the survey indices have slightly declined indicating that discards may be affecting stock abundance.

A relative exploitation index (F proxy) was computed as the annual landings divided by the annual NEFSC autumn survey biomass index. Relative exploitation indices have been declining since reaching a peak in 1991 (Figure 12.4).

Biological Reference Points

Biological reference points for GOM-GB windowpane flounder (Table 12.2) were derived from survey-based proxies of biomass and exploitation rates and are based on an MSY estimate of 1,000 mt. The proxy MSY estimate was based on the observation that stock size (NEFSC autumn survey relative biomass indices) declined when landings exceeded 1,000 mt and visa versa. A biomass dynamics model could not be used to estimate MSY due to the lack of contrast in the landings and survey time series (Applegate et al. 1998). The median NEFSC autumn survey index during 1975-1987 (0.94 kg per tow) was chosen as a B_{MSY} proxy value because relative exploitation indices were low during this time so stock biomass was assumed to be between B_{MSY} and the carrying capacity (Applegate et al. 1998). The threshold F is defined as an F_{MSY} proxy (= 1.11) when the NEFSC autumn survey index is greater than the B_{MSY} proxy and declines linearly to zero at 50% of the B_{MSY} proxy (= 0.47 kg/tow). The target exploitation index is defined as 60% of the F_{MSY} proxy (= 0.67) when the autumn survey index is greater than 0.94 kg/tow and declines linearly to zero at 0.47 kg/tow.

Summary

Stock status was assessed by comparing the average relative exploitation index and the average relative biomass index, during 2002-2004, to the biological reference points. The 2002-2004 autumn survey mean biomass index was 0.78 kg/tow (above half of the B_{MSY} proxy) and the 2002-2004 mean exploitation index was 0.02 (below the F_{MSY} proxy). Therefore, during 2002-2004, the stock was not overfished and overfishing was not occurring (Mayo and Terceiro 2005).

Table 12.1 Recreational and commercial landings of Gulf of Maine-Georges Bank windowpane flounder (thousand metric tons).

Category	1986-95 Average	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
U. S. Recreational	-	-	-	-	-	-	-	-	-	-	-
Commercial											
United States	1.4	0.7	0.4	0.4	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Canada	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-
Total Nominal Catch	1.4	0.7	0.4	0.4	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Table 12.2 MSY-based reference points for Gulf of Maine-Georges Bank windowpane flounder.

MSY-based Reference Points

MSY	=	1,000 mt
B_{MSY} proxy	=	0.94 kg per tow
F_{MSY} proxy	=	1.11

SOUTHERN NEW ENGLAND/MIDDDLE ATLANTIC WINDOWPANE FLOUNDER

The Fishery

During the 1950's, landings of SNE-MA windowpane flounder occurred in the Southern New England industrial mixed species fishery and were as high as 924 mt per year (Edwards 1958). Landings ranged between 500 and 900 mt during 1975-1981, then increased sharply to a record high of 2,100 mt in 1985 (Figure 12.5). Thereafter, landings steadily declined to 100 mt in 1995 (Table 12.3). During 1996-2001, landings ranged between 100 and 200 mt, then declined further and reached a record low of 25 mt in 2005.

Discards of SNE-MA windowpane flounder have never been quantified. However, it is likely that discards are now an important source of mortality as recently there has been no directed fishery.

Research Vessel Survey Indices

Relative biomass indices (stratified mean weight (kg) per tow) of SNE-MAB windowpane flounder in NEFSC autumn bottom trawl surveys declined between 1963 and 1975, from a peak of 1.99 kg per tow to 0.14 kg per tow (Figure 12.6). In 1982, biomass indices increased to 0.87 kg per tow then declined to the lowest level on record in 1993. Thereafter, biomass indices remained stable at a very low level and ranged between 0.10 and 0.34 kg per tow.

Assessment Results

A relative exploitation index (F proxy) was computed as the annual landings divided by the annual NEFSC autumn survey biomass index. Relative exploitation indices peaked in 1993 and have since been very low (Figure 12.7).

Biological Reference Points

Biological reference points for SNE-MAB windowpane flounder (Table 12.4) were derived from survey-based proxies of biomass and exploitation rates, and are based on an MSY estimate of 900 mt derived from a biomass dynamics model (Applegate et al. 1998). The biological reference points were subsequently revised based on a stock replacement ratio analysis, but the target reference points were not revised (NEFSC 2002). The threshold F is defined as an F_{MSY} proxy (= 0.98) when the NEFSC autumn survey index is greater than the B_{MSY} proxy of 0.92 kg per tow and declines linearly to zero at 50% of the B_{MSY} proxy (= 0.46 kg/tow).

Summary

Stock status in 2004 was assessed by comparing the average relative exploitation index and the average relative biomass index, during 2002-2004, to the biological reference points. The 2002-2004 autumn survey mean biomass index was 0.19 kg/tow and the 2002-2004 mean exploitation index was 0.37. Therefore, during 2002-2004, the stock was overfished but overfishing was not occurring (Mayo and Terceiro 2005).

Table 12.3 Recreational catches and commercial landings of Southern New England-Middle Atlantic windowpane flounder (thousand metric tons).

Category	1986-95 Average	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
U. S. Recreational	-	-	-	-	-	-	-	-	-	-	-
Commercial											
United States	0.8	0.2	0.1	0.1	0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1
Canada	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-
Total Nominal Catch	0.8	0.2	0.1	0.1	0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1

Table 12.4 MSY-based reference points for Southern New England-Middle Atlantic windowpane flounder.

MSY-based Reference Points		
MSY	=	900 mt
B_{MSY} proxy	=	0.92
F_{MSY} proxy	=	0.98

For further information

Applegate, A., S. Cadrin, J. Hoenig, C. Moore, S. Murawski and E. Pikitch. 1998. Evaluation of existing overfishing definitions and recommendations for new overfishing definitions to comply with the Sustainable Fisheries Act. Final Report, Overfishing Definition Review Panel. New England Fishery management Council, Newburyport, Massachusetts. 179 pp.

Bigelow, H. B., and W. C. Schroeder. 1953. Fishes of the Gulf of Maine. Fish. Bull., U.S. Fish. Wildl. Serv. 74 (53), 577 p.

Chang, S., P. L. Berrien, D. L. Johnson, and W. W. Morse. 1999. Essential Fish Habitat Source Document: windowpane, *Scophthalmus aquosus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-137. 32 p.

Edwards, R. L. 1958. Species composition of industrial trawl landings in New England, 1957. Spec. Sci. Rpt., Fish. No. 266.

Edwards, R. L. and F. E. Lux. 1958. New England's industrial fishery. U. S. Dept. Int., Fish and Wildlife Service, Comm. Fish. Rev., 20(5).

Lange, A. M. T. and F. E. Lux. 1978. Review of the other flounder stocks (winter flounder, American plaice, witch flounder and windowpane flounder) off the Northeast United States, August 1978. Northeast Fisheries Center Lab. Ref. Doc. 78-44.

Mayo, R. K. and M. Terceiro. 2005. Assessment of 19 Northeast groundfish stocks through 2004. 2005 Groundfish Assessment Review Meeting (2005 GARM). Northeast Fisheries Science Center, Woods Hole, Massachusetts, 15-19 August 2005. U.S. Dep. Commer., Northeast Fish. Sci. Cent. Ref. Doc. 05-13; 499 p.

Moore, E. L. 1947. Studies on the marine resources of Southern New England, VI: The sand flounder, *Lophopsetta aquosa* (Mitchill); a general study of the species with special emphasis on age determination by means of scales and otoliths. Bull. Bingham Oceanogr. Collect. 11(3):1-79.

Morse, W. W. and K. W.Able. 1995. Distribution and life history of windowpane, *Scophthalmus aquosus*, off the northeastern United States. Fish. Bull., U.S. 93: 675-693.

Neuman, M. J., D. A. Witting and K. W. Able. 2001. Relationships between otolith microstructure, otolith growth, somatic growth and ontogenetic transitions in two cohorts of windowpane. J. Fish. Biol., 58: 967-984.

NEFSC [Northeast Fisheries Science Center]. 2002. Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish. 2002. Re-evaluation of biological reference points for New England groundfish. Northeast Fish. Sci. Cent. Ref. Doc. 02-04; 395 p.

O'Brien, L., J. Burnett, and R. K. Mayo. 1993. Maturation of nineteen species of finfish off the northeast coast of the United States, 1985-1990. NOAA Tech. Rpt. NMFS 113, 66 p.

Thorpe, L. A. 1991. Aspects of the biology of the windowpane flounder, *Scophthalmus aquosus*, in the northwest Atlantic Ocean. M.S. Thesis, Dept. of Forestry and Wildlife, Univ. of MA, Amherst, MA, 85 p.

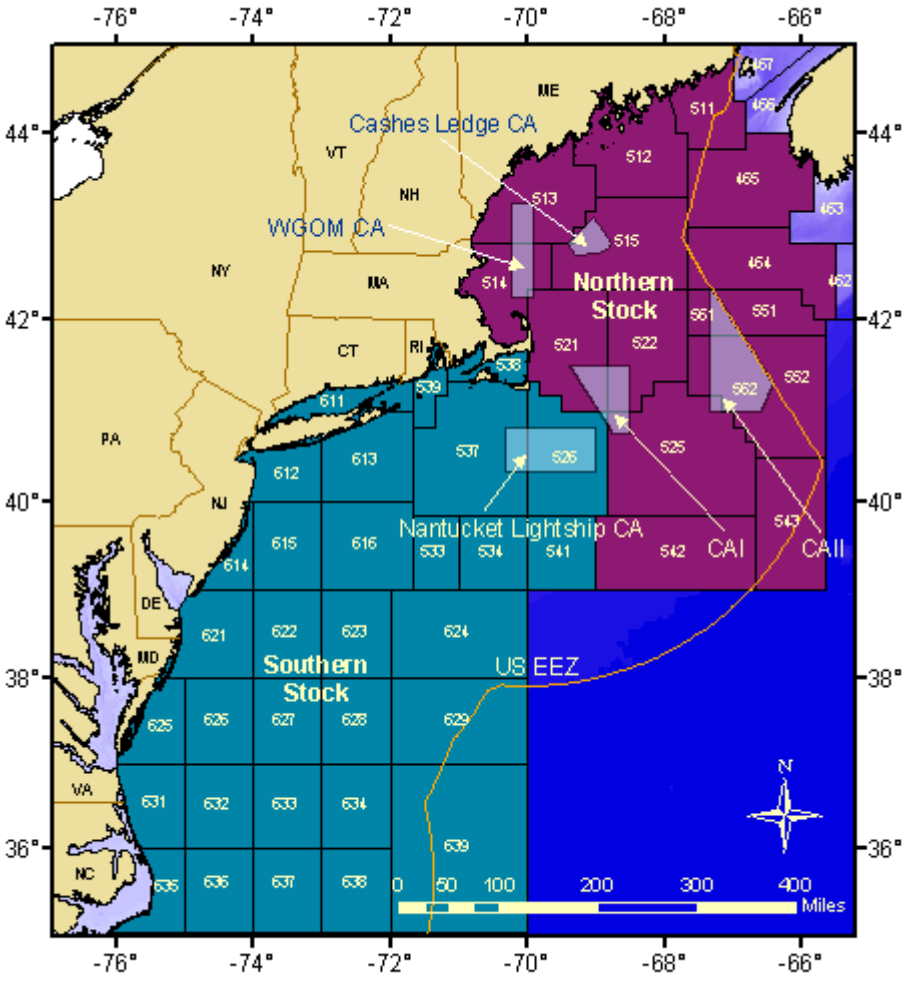

Figure 12.1. Statistical areas used to define the northern and southern windowpane flounder stocks.

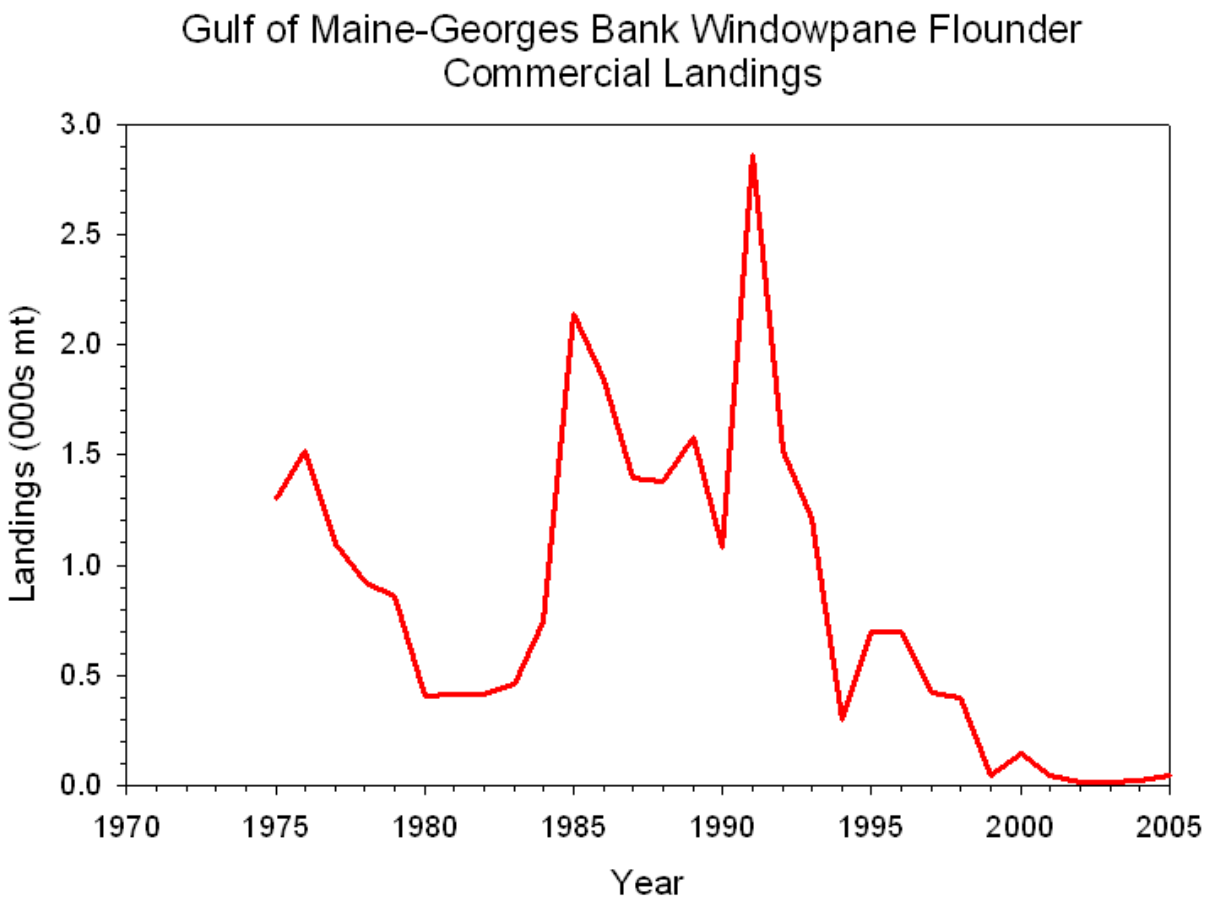

Figure 12.2. Commercial landings (000's mt) of Gulf of Maine-Georges Bank windowpane flounder.

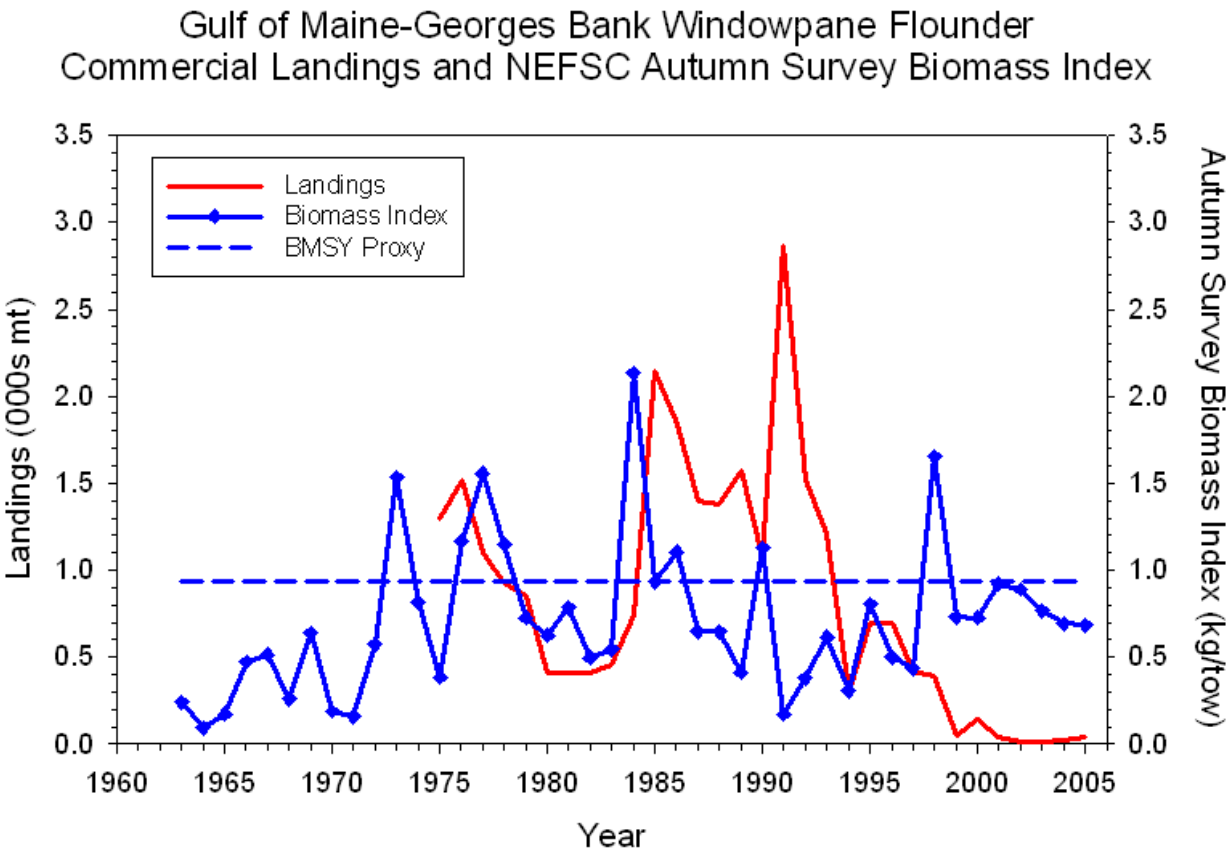

Figure 12.3 Commercial landings (000's mt) and autumn survey biomass indices (kg/tow) of Gulf of Maine-Georges Bank windowpane flounder.

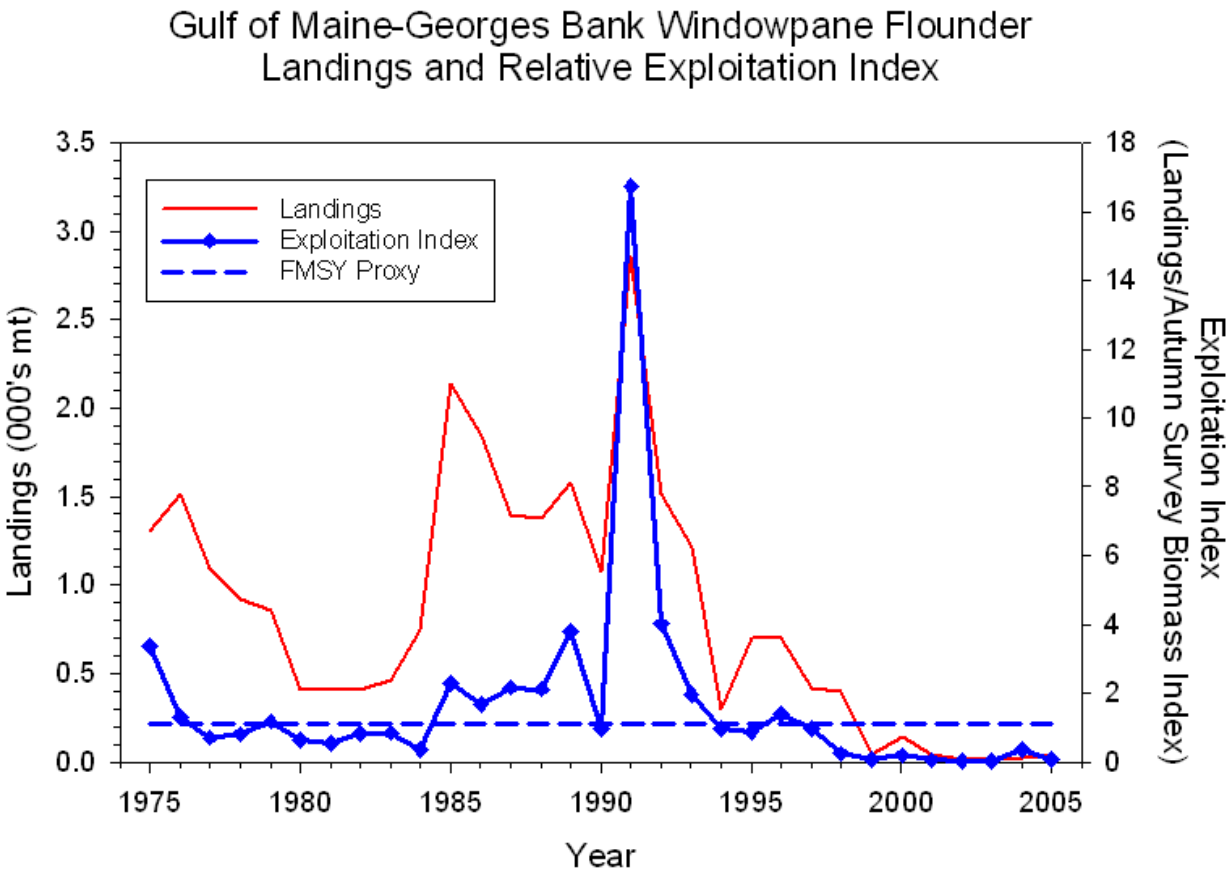

Figure 12.4 Relative exploitation indices (landings/autumn survey biomass index) and commercial landings (000's mt) of Gulf of Maine-Georges Bank windowpane flounder.

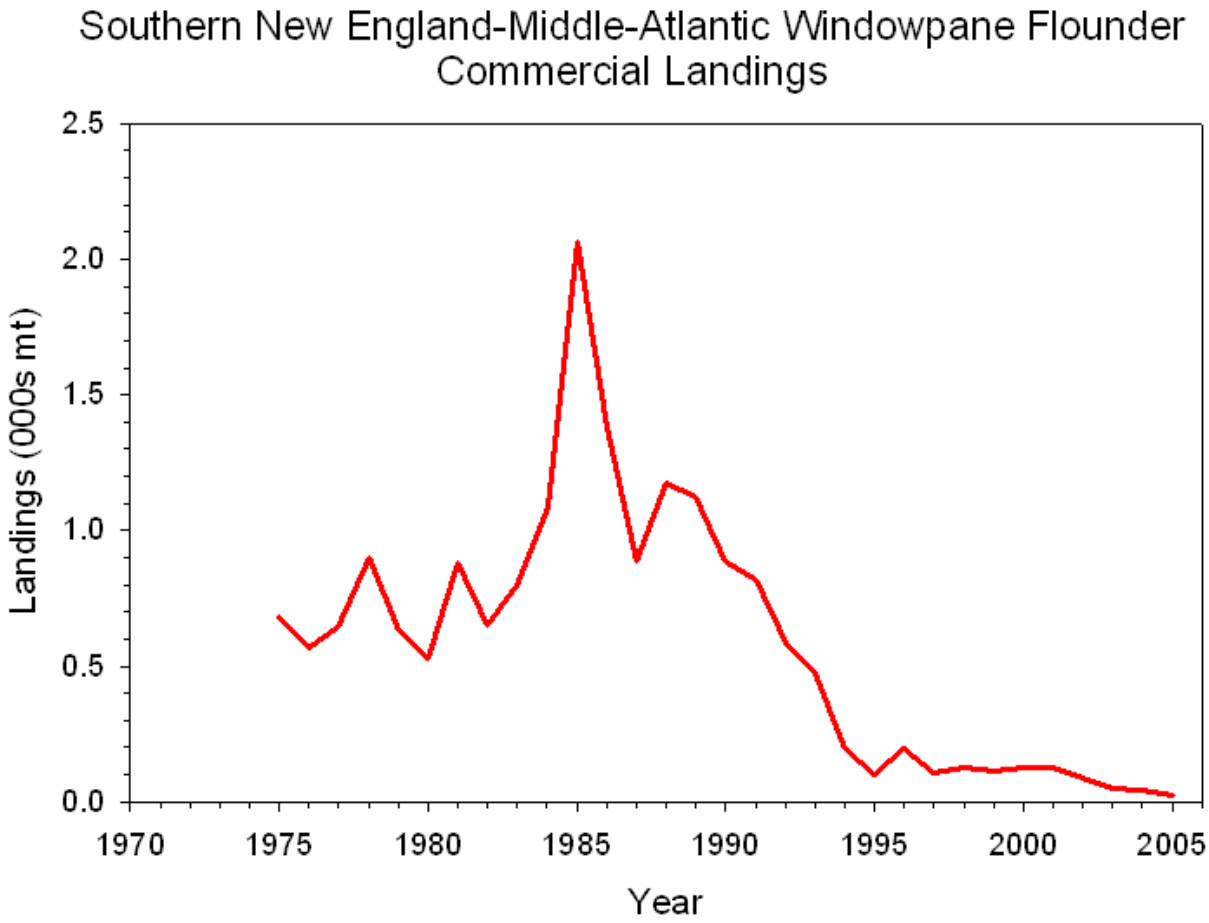

Figure 12.5. Commercial landings (000's mt) of Southern New England-Middle Atlantic windowpane flounder.

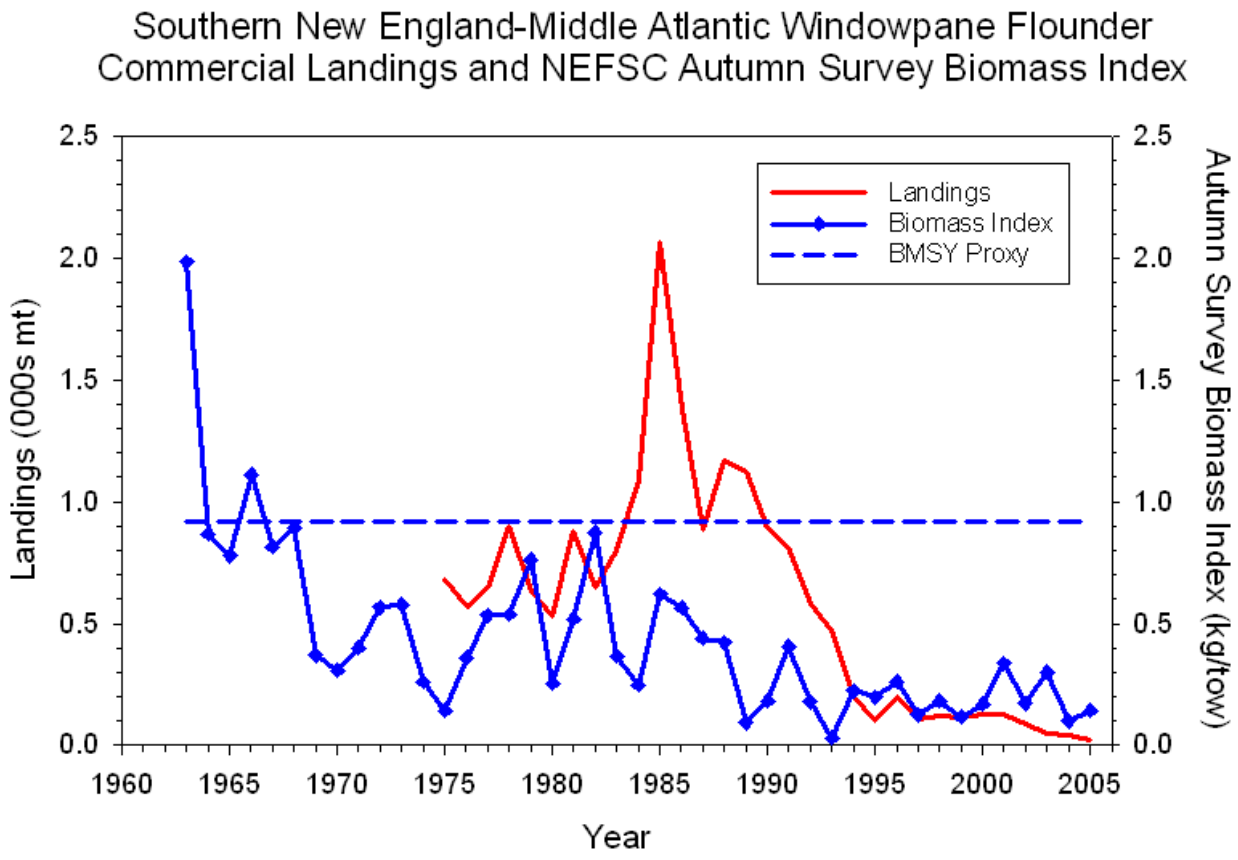

Figure 12.6 Commercial landings (000's mt) and autumn survey biomas indices (kg/tow) of Southern New England-Middle Atlantic windowpane flounder.

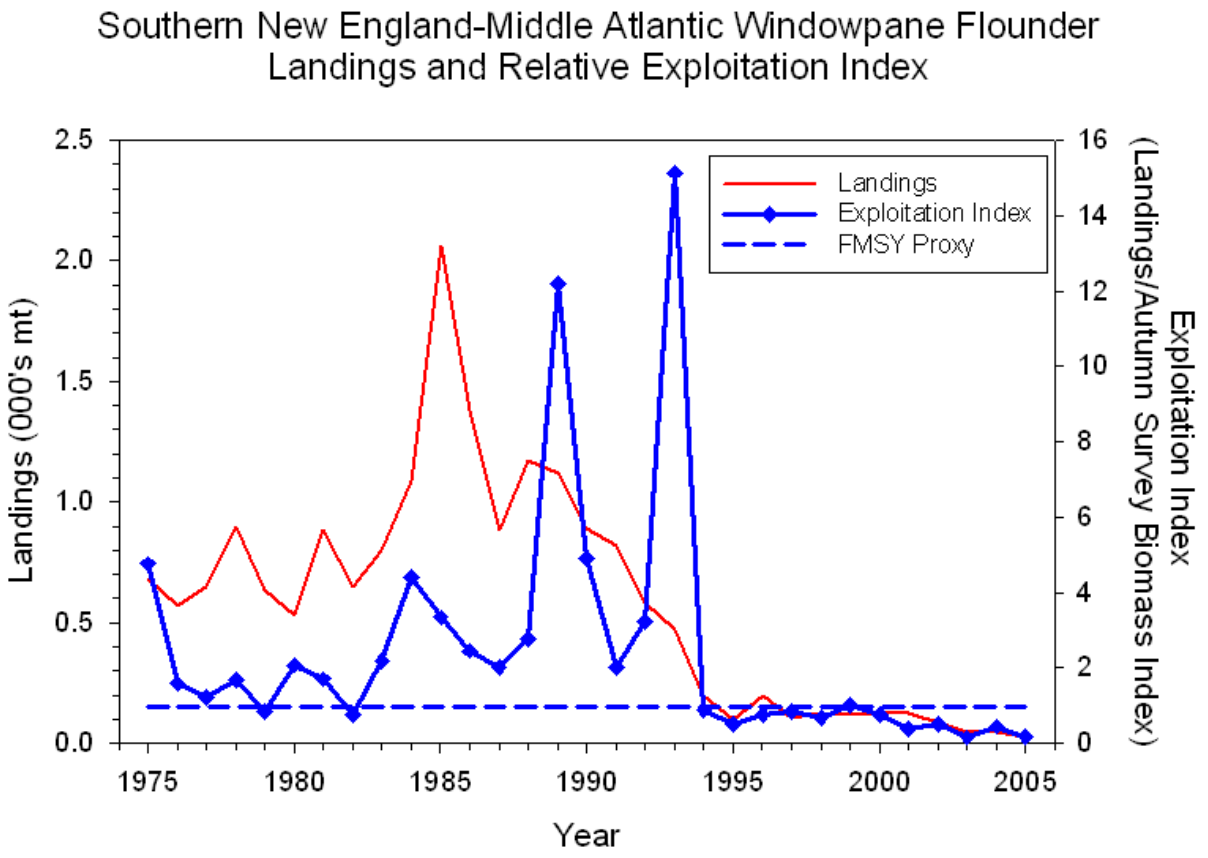

Figure 12.7 Relative exploitation indices (landings/autumn survey biomass index) and commercial landings (000's mt) of Southern New England-Middle Atlantic windowpane flounder.