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Northeast Multispecies Fishery Management Plan Resource: American plaice (Hippoglossoides platessoides)

Bibliography

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Background & Scope
The Northeast Multispecies Fishery Management Plan (FMP) was implemented in 1986 to reduce fishing mortality of heavily fished groundfish stocks and to promote rebuilding to sustainable biomass levels. Thirteen species are managed through plan amendments and framework adjustments to the original plan, including: Atlantic cod, haddock, yellowtail flounder, American plaice, witch flounder (grey sole), winter flounder (black back), Acadian redfish, white hake, Pollock, windowpane flounder, ocean pout, Atlantic halibut, and the Atlantic wolffish. This bibliography focuses on American plaice, and is intended as a primer and reference resource for staff of the National Marine Fisheries Service, Greater Atlantic Regional Fisheries office. It is organized into four sections: Biology (life history), Ecology (interaction with the environment), Fishery, and Management.

Section I – Biology
Section one is intended to provide an overview of the life history of American plaice. The research in this area is a compilation of basic facts including size, diet, habitat, maturation, fecundity and reproduction, as well as current research on American plaice Biology.

Section II – Ecology
Section two is intended to provide an overview of research relating to the Section two is intended to provide an overview of how American plaice interacts with the environment. The citations in this area focus on how temperature and changes in the environment can impact American plaice.

Section III – Fishery
Section three is intended to provide an overview of the American plaice fishery. It is divided into two sections: Historical and Modern. The Historical section contains resources on the early American plaice fishery. The Modern section contains scientific publications about the current state of the American plaice fishery.

Section IV – Management
Section four is intended to provide an overview of the management of American plaice. It includes relevant research concerning plans and policies intended to assess and protect the American plaice population.

Sources Reviewed
The following databases were used to identify sources: Clarivate Analytics' Web of Science: Science Citation Index Expanded; Elsevier's Science Direct, BioOne Complete; ProQuest Science and Technology, including AFSA; JSTOR, and Lexis Advance, in addition to web searches. Only English language materials were included. Priority was given to publications focusing on wild populations in the Atlantic region with a focus on the Gulf of Maine-Georges Bank region, which is managed by the U.S. and Canadian sources

Section I: Biology

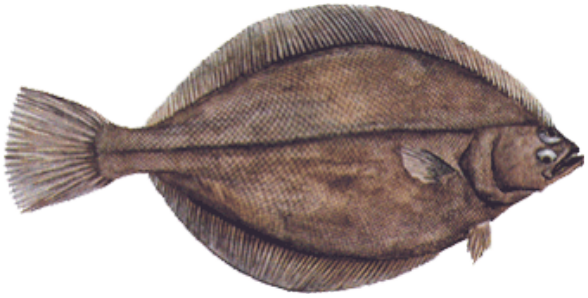


Image from:
https://www.greateratlantic.fisheries.noaa.gov/nero/fishermen/images/Multispecies/images/american-plaice.gif

Scientific name: American plaice (Hippoglossoides platessoides)

Also known as: Hippoglossoides platessoides, commonly known as American Plaice, is a member of the Pleuronectidae, or right-eyed or "right handed" flounders and is known commercially as flounder, sole, dab, Plie canadienne (French), and long rough dab.

Region: In the western Atlantic, American plaice are distributed along the Northwest Atlantic continental shelf from the outer coast of southern Labrador, south from Hamilton Inlet, Newfoundland, on the Grand Banks, in the Gulf of St. Lawrence, west and south to Cape Cod and as far south as Montauk Point, NY., in relatively deep waters. The greatest commercial concentrations exist between 90 and 182 m (50 and 100 fathoms). Off the U.S. coast, American plaice are managed as a single stock in the Gulf of Maine-Georges Bank region.

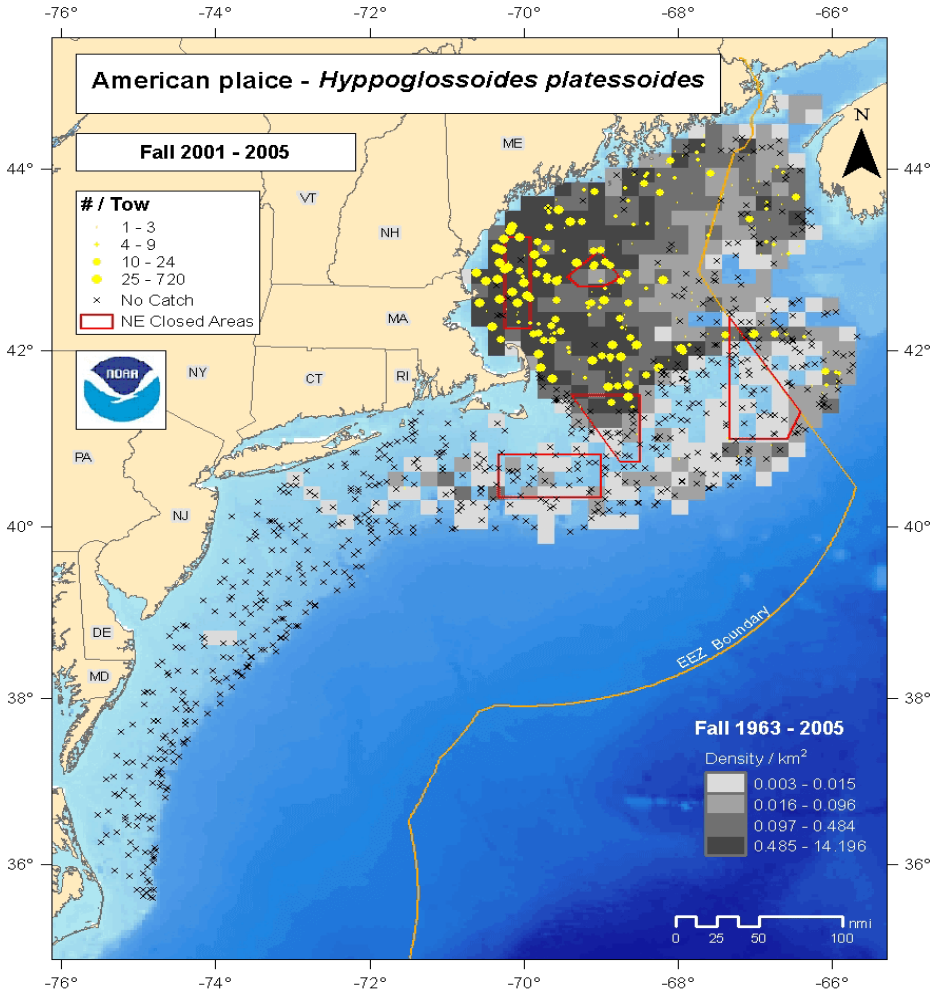
Habitat: American plaice live in relatively deep waters on the sediment. Although their normal habitat is at or near the ocean floor, they are considered benthic feeders and they frequently migrate off the bottom at night in pursuit of prey.

Behavior: American plaice are a relatively sedentary, non-schooling species and burrows in sediment to escape predators and to ambush prey.

Size: relatively slow growing; 3 year old fish are normally between 22 and 28 cm (9 to 11 in.) in length, and weigh between 90 and 190 g (0.2 to 0.4 lb.). After age 4, females grow faster than males. American plaice from Georges Bank have faster growth than fish from the Gulf of Maine. Adults in the Gulf of Maine and Georges Bank area can reach lengths of 60-70 cm.

Physical Description: American place is a large mouthed flat fish with a laterally flattened body, a rounded caudal fin, a generally small head with relatively large mouth and a jawbone that extends to below the mouth. In American plaice, both eyes are found on the right side of the head and the animal lies on its left side. The eyed side is typically a reddish-brown to grayish brown, allowing for camouflage in the sediment, whereas the blind side is white.

Relative Distribution and Abundance of American plaice in the Northwestern Atlantic Derived from the NEFSC Fall Bottom Trawl Surveys



Relative species abundance and distribution from NEFSC bottom trawl survey by time block and relative species density for the full time series.

https://www.nefsc.noaa.gov/sos/spsyn/fldrs/plaice/animation/fall/

Lifespan: American plaice species in the Gulf of Maine and Georges Bank area can attain ages greater than 20 years.

Diet: American plaice are opportunistic feeders, flexible in their dietary habits, which consists of a combination of small benthic crustaceans, echinoderms, cnidarians, and polychaetes. Diets of adults are primarily echinoderms, chiefly sand dollars, sea urchins, and brittle stars. The diets of plaice collected during Northeast Fisheries Science Center (NEFSC) bottom trawl surveys (1973-2001) were dominated by echinoderms; arthropods, annelids, and mollusks.

Predators: American plaice larvae are consumed by redfish and larger plaice (adults >35cm) are preyed on by cod, halibut, goosefish, spiny dogfish, Greenland sharks, grey seals and harbor seals.

Reproduction: The spawning seasons are geographically connected with latitude, where spawning occurs in the southern limits first, followed by the northern region. Spawning occurs in spring, generally during March through May. Eggs are smooth, nonsticky, spherical, and buoyant with a large sac that allows the egg to float near the surface for about 2 weeks, and thus can be transported far from where it was shed. The number of eggs produced by an individual female plaice depends on body size. A 30 cm female can produce as many as 400,000 eggs, while a 60 cm female can produce more than one million eggs. Maturation begins between ages 2 and 3, but most individuals do not reach sexual maturity until age 4.

Barot, S., Heino, M., Morgan, M. J., & Dieckmann, U. (2005). Maturation of Newfoundland American plaice (Hippoglossoides platessoides): long-term trends in maturation reaction norms despite low fishing mortality? *ICES Journal of Marine Science*, *62*(1), 56-64. https://doi.org/10.1016/j.icesjms.2004.10.004

To interpret long-term trends in age and size at maturation, new statistical methods have recently been devised for estimating probabilistic maturation reaction norms based on data collected for the management of fisheries. Here we apply these methods to three Newfoundland stocks of American plaice (NAFO Divisions 2J3K, 3LNO, 3Ps) and report a clear long-term shift in the maturation reaction norms of these stocks towards maturation at younger age and smaller size. Theory predicts that such trends could result from fishing acting as a selective force, inducing evolutionary changes in the life histories of exploited populations. Matching long-term trends in maturation reactions norms have already been documented for several stocks that have experienced high fishing pressures (Gulf of Maine and Georges Bank cod, Northeast Arctic cod, North Sea plaice). Our results add a new dimension to these earlier findings: since fishing pressures for two stocks of Newfoundland plaice (2J3K and 3Ps) have been relatively low, our results imply that fishing is likely to result in the evolution of life histories even when fishing mortality is low, or that natural mortality has played an important role in determining selective pressures in these populations. Both options suggest that conditions for rapid life-history evolution in exploited stocks are less restrictive than previously appreciated.

Johnson, D. (2004). Essential fish habitat source document: American plaice, Hippoglossoides platessoides, life history and habitat characteristics. *NOAA Technical Memorandum NMFS-NE 187.* https://repository.library.noaa.gov/view/noaa/4041

In U.S. and Canadian waters, American plaice is regarded as a sedentary species migrating only for spawning and feeding. Results from tagging studies have indicated only minor distances in migration. Most recaptured plaice were less than 30 miles from the tagging site and approximately 7-8 years after tagging. In Canadian waters, American plaice tend to occupy a wide depth range, often migrating to deeper offshore locations in the winter and returning to shallower water by spring. They have been captured at depths of 700 m; typically, the largest commercial catches occur between 100 - 200 meters at a temperature < 1.0°C.

MacKinnon, J. C. (1972). Summer storage of energy and its use for winter metabolism and gonad maturation in American plaice (Hippoglossoides platessoides). *Journal of the Fisheries Board of Canada*, *29*(12), 1749-1759. https://doi.org/10.1139/f72-276

American plaice (*Hippoglossoides platessoides*) in St. Margaret's Bay, Nova Scotia, had an annual energy storage cycle in which a mature 35 cm female stored 92 kcal during the summer period and used this energy for metabolism (72 kcal) and gonad maturation (20 kcal) in winter months. An additional 21kcal was stored in the ovary during the summer period. These energy changes occurred in a fish with a total energy content of approximately 300 kcal and an annual energy increment of 51kcal due to growth in length. The annual energy variation in immature females and males was less than in mature females. A comparison of summer production (143 kcal, excluding gonad energy) with net annual production (51 kcal) for a 35 cm female plaice indicated that higher yields would be obtained by harvesting at the end of the summer period than by taking the same fish at the end of the overwintering period

Morgan, M. J. (2004). The relationship between fish condition and the probability of being mature in American plaice (Hippoglossoides platessoides). *ICES Journal of Marine Science*, *61*(1), 64-70. https://doi.org/10.1016/j.icesjms.2003.09.001

Fish condition can be related to a population's reproductive potential in a variety of ways. The relationship between condition and the probability of being mature (adult) was examined in three populations of American plaice (Hippoglossoides platessoides). The effect of condition was tested after first removing the known effects of age and length. Neither relative liver condition nor relative body condition significantly affected the probability of male American plaice being mature, but there was a significant positive effect of both condition indices on the probability of being a mature female. However, the additional variation explained by female condition was small when compared with the combined effect of age and length. Condition is related to the age and size at which fish attain adulthood. Variation in fish condition will have a direct impact on the spawning stock biomass of a population through differences in the maturation schedule of cohorts with differing condition.

Rideout, R. M., & Morgan, M. J. (2007). Major changes in fecundity and the effect on population egg production for three species of north-west Atlantic flatfishes. *Journal of Fish Biology*, *70*(6), 1759-1779. https://doi.org/10.1111/j.1095-8649.2007.01448.x

Temporal and spatial variability in fecundity was investigated for three species of north-west Atlantic flatfishes: American plaice Hippoglossoides platessoides, yellowtail flounder Limanda ferruginea and witch flounder Glyptocephalus cynoglossus. Significant log10 linear relationships existed between fecundity and total length (LT) for all three species and for all combinations of area (NAFO regulatory areas) and year. Fecundity differed between areas for yellowtail flounder and witch flounder and changed significantly for all three species since the last reported fecundity studies in the region 30–40 years ago. Three populations experienced decreases in fecundity (3LNO American plaice and yellowtail flounde1r, 3Ps witch flounder), one experienced an increase (3NO witch flounder) and one did not change (3L witch flounder). Significant yearly variability in fecundity at length and relative fecundity existed for all three species within the 6 year sampling period (1993–1998). Estimates of population egg production based on new and historic fecundity data revealed that using the old, invariant fecundity and LT relationship resulted in overestimation of total annual egg production by up to 24% for 3LNO American

plaice and as high as 41% for 3LNO yellowtail flounder. These results clearly demonstrate the variable nature of fecundity for flatfishes in Newfoundland waters and suggest that the use of an invariant fecundity and LT relationship may result in inaccurate estimates of stock reproductive potential.

Winger, P. D., He, P., & Walsh, S. J. (1999). Swimming endurance of American plaice Hippoglossoides platessoides) and its role in fish capture. *ICES Journal of Marine Science, 56(3)*, 252-265. https://doi.org/10.1006/jmsc.1999.0441

Using a swimming flume, swimming endurance was examined across a range of fish sizes (14–44 cm) and water temperatures (0.2 to 9.7degrees C). The results showed that both fish length and water temperature had a negative effect on the endurance hazard rate. This is equivalent to an increase in the probability of American plaice achieving a given endurance with increasing fish length and water temperature. Probability curves for the distances the fish would be capable of swimming were calculated for different fish sizes and water temperatures. The findings suggest that the herding efficiency of American plaice by bottom-trawl sweeps may be largely size and temperature-dependent. The results of the failure time analysis revealed that both fish length and water temperature had a significant effect on the endurance hazard rate. The studies concluded that the aerobic scope of certain flatfish species may be insufficient to allow them to swim at what are theoretically their most optimal swimming speeds. Over long distances, flatfish may adopt anaerobic swimming strategies such as bursting followed by periods of rest to counter balance the accrued oxygen debt. The findings from this study have shown that American plaice are capable of employing different combinations of swimming strategies and that the ability to employ certain strategies appears to be somewhat dependent on fish length. Size- and temperature-dependent swimming endurance of American plaice may affect the selectivity and efficiency of bottom trawls used as survey instruments. Temporal and spatial changes in bottom temperature are expected to influence swimming capability and thus vulnerability to survey trawl capture. Systematic variation of this nature should result in a reduction in the levels of precision of the survey catch-at-age data and therefore increase the error in estimates of population abundance and size composition of plaice.

Section II: Ecology

Bowering, W. R., Morgan, M. J., & Brodie, W. B. (1997). Changes in the population of American plaice (Hippoglossoides platessoides) off Labrador and northeastern Newfoundland: a collapsing stock with low exploitation. *Fisheries Research*, *30*(3), 199-216. https://doi.org/10.1016/S0165-7836(96)00568-1

Changes in the population dynamics of American plaice off southern Labrador and eastern Newfoundland (NAFO Subarea 2 and Division 3K) for the period 1977–1994 were investigated. Since the mid 1980s the population has declined dramatically and by the 1990s the stock had essentially collapsed. A higher proportion of what remained of the stock was found in deeper and warmer water than had previously been observed, coincident with a period of unusually cold ocean conditions. During the period of the greatest reductions in population size, the proportion of older, spawning-age fish declined much more rapidly than the younger ages and this decline was accompanied by a slight decrease in mean size at age. Also associated with these observations were declining trends in both size and age at maturity. Although exploitation has always been low, the fishery for American plaice in NAFO Subarea 2 and Division 3K has been regulated since the early

1970s. For the period investigated the average annual commercial exploitation rate was less than 2% with negligible bycatch in other fisheries. We conclude, therefore, that the collapse of this stock was not a result of fishing mortality. The causal mechanism for the decline remains unclear although unusual environmental conditions during the period continue to be investigated in relation to the observed changes in this population.

Brodziak, J., & O'Brien, L. (2005). Do environmental factors affect recruits per spawner anomalies of New England groundfish? *ICES Journal of Marine Science*, *62*(7), 1394-1407. https://doi.org/10.1016/j.icesjms.2005.04.019

We evaluated the influence of environmental factors on recruits per spawner (RS) anomalies of 12 New England groundfish stocks. Nonparametric methods were used to analyze time-series of RS anomalies derived from stock-recruitment data in recent assessments. The 12 stocks occur in three geographic regions: the Gulf of Maine (cod Gadus morhua, redfish Sebastes fasciatus, winter flounder Pseudopleuronectes americanus, American plaice Hippoglossoides platessoides, witch flounder Glyptocephalus cynoglossus, and yellowtail flounder Limanda ferruginea), Georges Bank (cod, haddock Melanogrammus aeglefinus, and yellowtail flounder), and Southern New England (summer flounder Paralichthys dentatus, yellowtail flounder, and winter flounder). Randomization tests were applied to detect years when RS anomalies were unusually high or low for comparison with oceanographic conditions such as the 1998 intrusion of Labrador Subarctic Slope water into the Gulf of Maine region. The response of the RS anomalies to temperature variation also differed among stocks (Figure 6). For American plaice, the RS anomaly response was convex, with increasing values of the first principal component of temperature.

Kleisner, K. M., Fogarty, M. J., McGee, S., Hare, J. A., Moret, S., Perretti, C. T., & Saba, V. S. (2017). Marine species distribution shifts on the US Northeast Continental Shelf under continued ocean warming. *Progress in oceanography*, *153*, 24-36. https://doi.org/10.1016/j.pocean.2017.04.001

The U.S. Northeast Continental Shelf marine ecosystem has warmed much faster than the global ocean and it is expected that this enhanced warming will continue through this century. We project a loss in suitable thermal habitat for key northern species including Acadian redfish, American plaice, Atlantic cod, haddock, and thorney skate, but potential gains for some species including spiny dogfish and American lobster. Our results provide critical information on the potential for suitable thermal habitat on the U.S. Northeast Shelf for demersal species in the region, and may contribute to the development of ecosystem-based fisheries management strategies in response to climate change.

Macdonald, J. S., Waiwood, K. G., & Green, R. H. (1982). Rates of digestion of different prey in Atlantic cod (Gadus morhua), ocean pout (Macrozoarces americanus), winter flounder (Pseudopleuronectes americanus), and American plaice (Hippoglossoides platessoides). *Canadian journal of fisheries and aquatic sciences*, *39*(5), 651-659. https://doi.org/10.1139/f82-094

Stomachs of ocean pout (Macrozoarces americanus), Atlantic cod (Gadus morhua), winter flounder (Pseudopleuronectes americanus), and American plaice (Hippoglossoides platessoides) were removed and dissected 5, 12, 20, and 30 h after the fish had fed voluntarily to test the evacuation

rates of three different prey species. Two evaluation procedures were used: a visual index of recognizability, and a graphical analysis of percent of each prey recovered versus time since feeding. Three decay models were tested for goodness of fit to the evacuation data. The polychaete worms were the first to become unrecognizable, followed by amphipods. These species showed significantly different rates of evacuation when compared with the bivalves which were recognizable for the longest time. The exponential decay curve gave the best overall fit to the data. However, a linear model gave a good or better fit to the decay rate of the bivalve. The evacuation rates of different prey should be considered in estimating daily rations of fish in their environment.

Morgan, M. J., & Colbourne, E. B. (1999). Variation in maturity-at-age and size in three populations of American plaice. *ICES Journal of Marine Science*, *56*(5), 673-688. https://doi.org/10.1006/jmsc.1999.0487

American plaice (Hippoglossoides platessoides) is a flatfish species that has a wide distribution throughout the North Atlantic. Variability in age and size at maturity was examined for cohorts of American plaice from the early 1960s to early 1990s for the three main stocks off the coast of Newfoundland, Canada. Large changes in age and size at maturity have occurred among cohorts since the 1960s, with males and females of all three stocks maturing at an earlier age and smaller size in the latter part of the time period. Maturation was most closely related to total population abundance over the life of a cohort, with cohorts maturing at an earlier age and smaller size when population size was low. Cohorts which experienced higher temperatures appeared to mature earlier and smaller as did cohorts which experienced increased juvenile growth and increased adult mortality.

Swain, D. P., & Morgan, M. J. (2001). Sex-specific temperature distribution in four populations of American plaice Hippoglossoides platessoides. *Marine Ecology Progress Series*, *212*, 233-246. http://www.jstor.org/stable/24864190

In the American plaice Hippoglossoides platessoides, the sexes differ in size at age in most populations, with females being larger. Because of the links between growth, ration and temperature, differences in temperature selection might be expected between the sexes in species with dimorphic growth, with the sex with the higher growth rate selecting higher temperatures. Temperature selection has also been predicted to be density-dependent in fishes, with fish occupying colder temperatures at higher levels of abundance. We examined these aspects of temperature selection in 4 populations of American plaice: the southern Gulf of St. Lawrence population and 3 populations off Newfoundland (Labrador and NE Newfoundland, Grand Bank and St. Pierre Bank). Throughout the 1970s and most of the 1980s plaice occupied cold water relative to that available in all of the areas surveyed. In all 4 populations, females tended to occupy warmer water than males. Differences between the sexes in temperature selection and in length at age both tended to be greatest in the southern Gulf population during this period. However, there was no correspondence among populations in these differences in the early 1990s, when distribution of the Grand Bank and St. Pierre Bank populations shifted sharply into warm water and the difference in temperature distribution between the sexes increased dramatically in these populations. These shifts to warmer water may be related to density-dependent effects on temperature preference. There was a strong negative relationship between the temperatures occupied by plaice and their relative abundance in the 3 Newfoundland populations but not in the southern Gulf population.

Section III: Fishery

Historical: In Canadian waters, American plaice have been exploited since the start of the otter trawl fishery in 1947. In U.S. waters, the fishery for American plaice started to develop around 1975 in the Gulf of Maine as the abundance of other commercially desirable flatfish, such as yellowtail flounder, winter flounder, and summer flounder, began to decrease. Prior to 1973, the primary use of American plaice caught on Georges Bank was for bait. According to Terceiro (2017), a source of uncertainty in the *Operational Assessment of 19Northeast Groundfish Stocks, Updated Through 2016* report is the estimates of historical landings at age, prior to 1984, and the magnitude of historical discards, prior to 1989 as well as the historical age composition of the surveys. The retrospective pattern remains a source of uncertainty.

Committee on the Status of Endangered Wildlife in Canada. (2009). *COSEWIC assessment and status report on the American Plaice Hippoglossoides platessoides, Maritime population, Newfoundland and Labrador population and Arctic population, in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 74 pp. http://sararegistry.gc.ca/virtual_sara/files/cosewic/sr_american_plaice_0809_e.pdf

This population occurs in the Gulf of St. Lawrence, the Scotian Shelf, the Bay of Fundy and Georges Bank. A relatively sedentary, non-schooling species, it was likely once the most abundant flatfish in the northwest Atlantic. Over a 36 year time series (about 2.25 generations) abundance of mature individuals has declined about 86% in the Gulf of St. Lawrence, and 67% on the Scotian Shelf. Overfishing is a major cause of the decline, but an apparent increase in natural mortality in the 1990s, when the largest part of the decline occurred, may also have contributed. The decline appears to have ceased in the Gulf but may be continuing on the Scotian Shelf. There are small ongoing directed fisheries in the Gulf with a quota in the south but no quota management in the north. On the Scotian Shelf and in the Bay of Fundy, this species is managed together with other flatfishes as a multispecies stock and there are no specific management measures to ensure sustainability.

O'Brien, L. (2006). Status of fishery resources off the Northeastern US: American plaice*. Northeast Fisheries Science Center: NEFSC Resource Evaluation and Assessment Division, Woods Hole, Massachusetts*. https://www.nefsc.noaa.gov/sos/spsyn/fldrs/plaice/archives/09_AmericanPlaice_2006.pdf

During 1972-1976, total commercial landings averaged 2,300 mt, and increased during 1979-1984 to an average of 12,700 mt (Figure 9.2). Landings have since generally declined, with the exception of 1991, when the large 1987 year class recruited to the fishery. Total landings of Gulf of Maine-Georges Bank American plaice were 1,711 mt in 2004, the lowest since 1962. USA landings account for about 98% of the total landings in recent years (2002-2004) with Canada accounting for the remainder.

Terceiro, M. (2017). 10 Gulf of Maine-Georges Bank American plaice. *Operational Assessment of 19 Northeast Groundfish Stocks, Updated Through 2016*, *1*(9,913), 8-717. https://doi.org/10.7289/V5/RD-NEFSC-17-17

This assessment of the Gulf of Maine-Georges Bank American plaice (Hippoglossoides platessoides) stock is an operational update of existing 2012 benchmark assessment (O'Brien et al. 2012). Based on the previous assessment the stock was not overfished, and overfishing was not occurring. This 2017 assessment updates commercial fishery catch data, research survey indices of abundance, the analytical VPA assessment model, and reference points through 2016. Additionally, stock projections have been updated through 2020.

Modern: Off the U.S. coast, American plaice are managed as a single stock in the Gulf of Maine-Georges Bank region. The U.S. American plaice fishery is managed under the New England Fishery Management Council's Northeast Multispecies Fishery Management Plan (FMP). As in recent assessments for Gulf of Maine-Georges Bank American plaice the stock status remains as not overfished and overfishing not occurring.

O'Brien, L. and J. Dayton (2012). E. Gulf of Maine - Georges Bank American plaice Assessment for 2012 in *Northeast Fisheries Science Center 2012 Assessment or Data Updates of 13 Northeast Groundfish Stocks through 2010*. *Northeast Fishery Science Center Reference Document 12-06*, pp. 361-411. https://www.nefsc.noaa.gov/publications/crd/crd1206/americanplaice.pdf

The Gulf of Maine – Georges Bank American plaice stock is not overfished and overfishing is not occurring as determined by the retrospective bias-adjusted model output. The stock is not above the biomass target. The stock status remained unchanged since the 2008 assessment. Commercial catch has declined since 2003. Sources of uncertainty include: Age composition of landings (1980-1984); estimated using NEFSC age keys Historical discards, prior to 1989; Discard estimation of small mesh fishery catch at age, given the lack of length frequency samples; Retrospective pattern of F,SSB and recruitment.

Terceiro, M. (2017). 10 Gulf of Maine-Georges Bank American plaice. *Operational Assessment of 19 Northeast Groundfish Stocks, Updated Through 2016*, *1*(9,913), 8-717. https://doi.org/10.7289/V5/RD-NEFSC-17-17

State of Stock: Based on this updated assessment, the Gulf of Maine-Georges Bank American plaice (Hippoglossoides platessoides) stock is not overfished and overfishing is not occurring (Figures 49-50). Retrospective adjustments were made to the model results. Spawning stock biomass (SSB) in 2016 was estimated to be 13,351 mt which is 99% of the biomass target for this stock (SSBMSY proxy = 13,503; Figure 49). The 2016 fully selected fishing mortality was estimated to be 0.111 which is 51% of the overfishing threshold proxy (FMSY proxy = 0.216; Figure 50).

Status Recommendation: Based on this updated assessment, the panel supports the conclusion that the Gulf of Maine-Georges Bank American plaice stock is not overfished and over fishing is not occurring. In addition to the current fishing mortality being relatively low, a spike in recruitment in one year (2013) has contributed to an increase in spawning stock biomass. This stock is currently in a rebuilding plan with a deadline of 2024, and was very close to target biomass in 2016. However, spawning stock biomass is projected to decrease in the short term, even at current fishing rates.

Section IV: Management

Northeast Fisheries Science Center. (2017). Operational Assessment of 19 Northeast Groundfish Stocks, Updated Through 2016. U.S. Department of Commerce, *Northeast Fishery Science Center Reference Document 17-17*. https://doi.org/10.7289/V5/RD-NEFSC-17-17

The U.S. American plaice fishery is managed under the New England Fishery Management Council's Northeast Multispecies Fishery Management Plan (FMP). Under this FMP, American plaice are included in a complex of 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 attain and remain at or near target biomass levels. As in recent assessments for Gulf of Maine-Georges Bank American plaice the stock status remains as not overfished and overfishing not occurring.

Terceiro, M. (2017). 10 Gulf of Maine-Georges Bank American plaice. *Operational Assessment of 19 Northeast Groundfish Stocks, Updated Through 2016*, *1*(9,913), 8-717. https://doi.org/10.7289/V5/RD-NEFSC-17-17

The Gulf of Maine-Georges Bank American plaice assessment could be improved with updated studies on growth of Georges Bank and Gulf of Maine fish. Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future. The Gulf of Maine-Georges Bank American plaice assessment could be improved with updated studies on growth of Georges Bank and Gulf of Maine fish. A difference in growth rates between Gulf of Maine and Georges Bank fish has been documented; however, historical catch data for Georges Bank may not be sufficient to conduct a separate assessment. The panel recommends continuation of research on growth rates and implications for stock structure. The growth rate difference actually may not persist in the most recent years so this could all be explored further in a benchmark review. Finally, the panel recommends further research and consideration of survey catchability estimates.

Morgan, M. J. (2008). Integrating reproductive biology into scientific advice for fisheries management. *Journal of Northwest Atlantic Fishery Science, 41:* 37–51. http://journal.nafo.int/dnn/Volumes/Articles/ID/417/Integrating-Reproductive-Biology-into-Scientific-Advice-for-Fisheries-Management

American plaice populations from the waters off the east and south coasts of Newfoundland and Labrador provide an excellent example of both inter and intra population variation in maturity Changes in maturity schedules at age and length have been linked with changes in abundance in numerous studies. Increased resources, available to individuals at low population size, results in an increase in growth rate (i.e. density dependent growth response) and is thought to result in maturation at a younger age The data that exist on maturity can easily be incorporated into stock assessment by including their estimates in the calculation of spawning stock biomass.

Morgan, M. J. (2017). Understanding biology to improve advice for fisheries management. *ICES Journal of Marine Science, fsx229*. https://doi.org/10.1093/icesjms/fsx229

Variation in maturity at size and age has proven to be an important component of changing productivity in many populations, with major implications for fisheries management. The American plaice stock on the Grand Bank declined substantially during the 1980s, dropping by almost 90% by the early 1990s. At the same time, temperature on the Grand Bank was very low and it was thought that this may be playing a role. My initial work in fisheries research was on the possible impact of low temperatures on American plaice mortality and distribution (Morgan and Brodie, 1991; Morgan 1992, 1993). This work provided some of the rationale for a change in natural mortality in the assessment model for the stock several years later, increasing from 0.2 to 0.53 for a 7-year period (Morgan and Brodie, 2001). It is clear that incorporating biological variation has major impacts on the scientific advice provided for fisheries management, both in terms of reference points and stock status. Several studies show that the amount of biological complexity included in calculating reproductive potential impacts estimates of fishing mortality and biological limit reference points (Murawksi et al., 2001; Morgan, 2008; Brooks, 2013; Morgan et al., 2014a, b). Work on American plaice as part of the development of the precautionary approach for this stock is an excellent example. Model estimates of maturity at age by cohort from survey data were used to calculate SSB, rather than applying the standard knife edge maturity assumption previously used. As a result of large changes in maturity at age, the limit reference point for this stock changed from 150 000 to 50 000 t.

Morgan, M. J., Brodie, W. B., & Kulka, D. W. (2002). Was over-exploitation the cause of the decline of the American plaice stock off Labrador and northeast Newfoundland? *Fisheries research*, *57*(1), 39-49. https://doi.org/10.1016/S0165-7836(01)00331-9

The population of American plaice in the waters off Labrador and on the northeast Newfoundland shelf declined substantially during the mid to late 1980s, early 1990s at a time when reported catches were very low. An earlier study examined the overlap in distribution between American plaice and cod in research vessel survey data and concluded that unreported bycatch in the cod fishery could explain the decline of [Canadian] portion of stock of American plaice. We evaluate the method proposed in that study and use reported and observer estimates of catch to investigate potential catch levels relative to survey estimates of population biomass. This method does not appear to be a good predictor of American plaice bycatch in the cod fishery as most of the regressions were not significant and it requires extrapolation well beyond the range of the data used to build the regressions. Furthermore, there was little overlap between the extent of the commercial cod fishing grounds and the distribution of American plaice in the autumn surveys. For this stock, catch to survey biomass ratios were low regardless of the source of information used to estimate catch and suggest an exploitation rate that should be well below sustainable levels. These analyses support the conclusion that fishing was not the cause of the decline in this population of American plaice.