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Northeast Multispecies Fishery Management Plan Resource Guide: Atlantic Halibut (Hippoglossus hippoglossus)

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 Atlantic halibut, 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 Atlantic halibut. The research in this area is a compilation of basic facts including diet, lifespan and habitat as well as current research on Atlantic halibut biology.

Section II – Ecology

Section two is intended to provide an overview of how Atlantic halibut interacts with the environment. The citations in this area focus on how temperature, food resources, and geography impact wild Atlantic halibut.

Section III – Fishery

Section three is intended to provide an overview of the Atlantic halibut fishery. It is divided into two sections: Modern and Historical. The Modern section contains information about the current state of the Atlantic halibut fishery. The Historical section contains resources on the pre-2000 Atlantic halibut fishery.

Section IV – Management

Section four is intended to provide an overview of the management of the Atlantic halibut fishery. It includes news articles and research concerning plans and policies intended to protect and restore the Atlantic halibut population.

Sources Reviewed

Along with a web search for news items and other relevant materials the following databases were used to identify sources: Clarivate Analytics' Web of Science: Science Citation Index Expanded, Nexis.com, ProQuest's Science and Technology, and JSTOR. Only English language materials were included. There was no date range specification in order to cover any relevant research, although priority was given to publications focusing on wild populations in the Atlantic region.

Section I: Biology

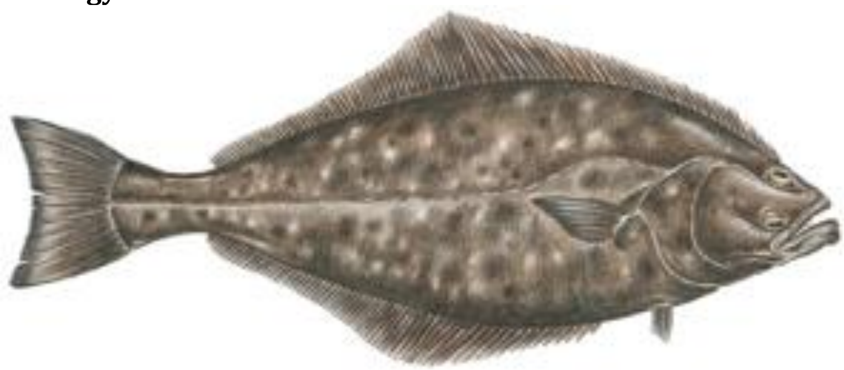


Image from https://www.mass.gov/service-details/learn-about-atlantic-halibut

Also known as: No common alternate names

Habitat: Ocean Floor at depths of 200 meters or greater.

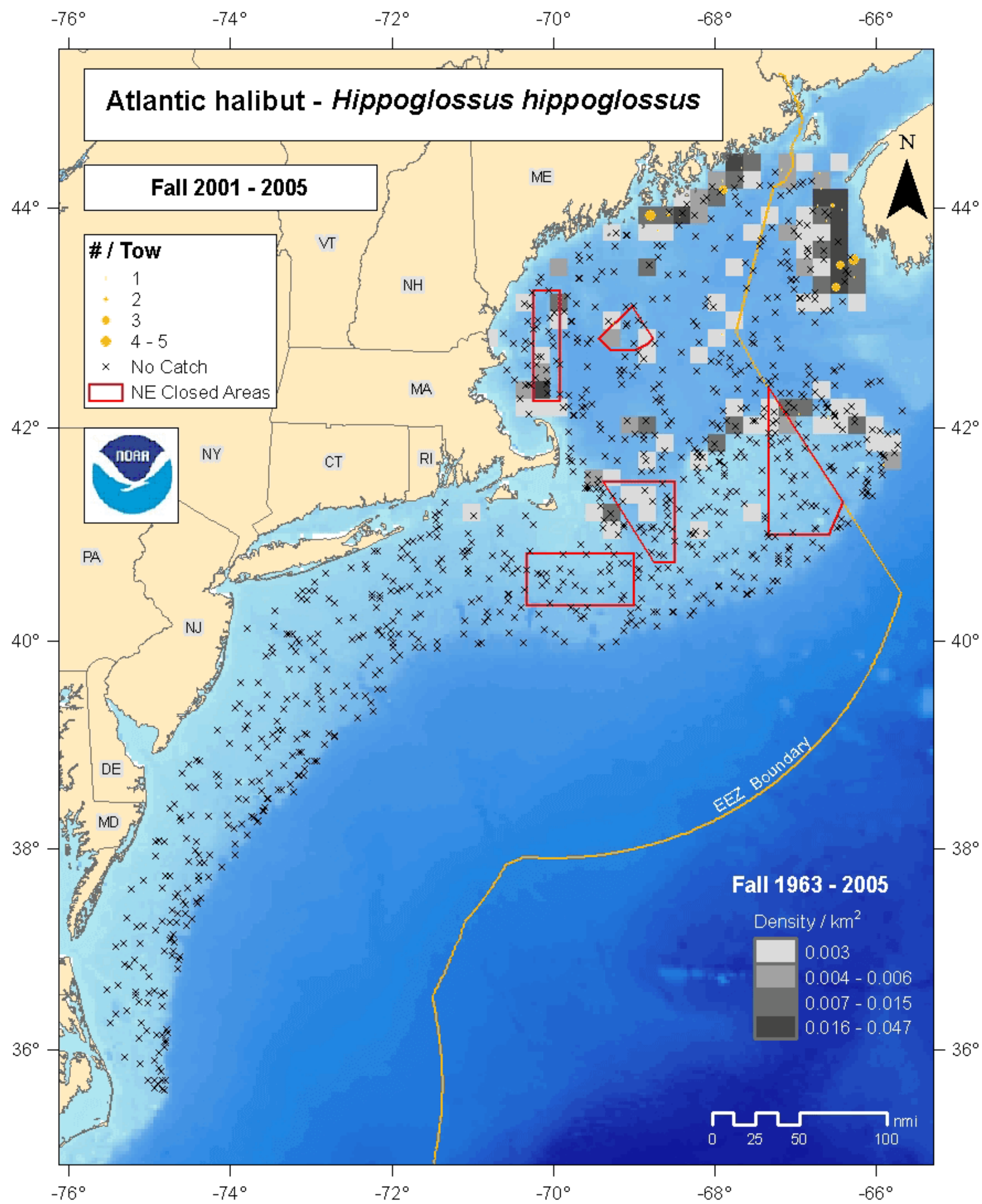
Physical Description: Right-sided flounder, ranging in color from dark brown to light gray. Younger fish are more speckled

Diet: Primarily cod, haddock, and other groundfish. They have also been known to eat lobsters and clams.

Lifespan: Atlantic halibut reach reproductive age from 7-12 years. While halibut as old as 50 years old have been caught, most halibut in the modern era live up to 35 years.

Size: While Atlantic halibut as large as 300 kg have been caught, most halibut in the modern era weigh less than 100 kg, with males smaller than females.

Source: Luca M. Cargnelli, S. J. G., and Wallace W. Morse. (1999). *Atlantic Halibut, Hippoglossus hippoglossus, Life History and Habitat Characteristics*. Retrieved from https://repository.library.noaa.gov/view/noaa/3100



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

Retrieved from: https://www.nefsc.noaa.gov/sos/spsyn/fldrs/halibut/animation/fall/

NOAA National Marine Fisheries Service. (2007). *Species of Concern: Atlantic halibut*. Retrieved from http://www.nmfs.noaa.gov/pr/pdfs/species/atlantichalibut_highlights.pdf

Very little is known about the biology of the northwest Atlantic stocks such as location of spawning events, basic information on egg and larval stages, migratory patterns of juveniles, habitat types utilized by all life stages, and extent of genetic differentiation between stocks.

Olsson, G. B., Olsen, R. L., Carlehog, M., & Ofstad, R. (2003). Seasonal variations in chemical and sensory characteristics of farmed and wild Atlantic halibut (Hippoglossus hippoglossus). *Aquaculture, 217*(1-4), 191-205. https://doi.org/10.1016/s0044-8486(02)00191-6

Quality characteristics of farmed and wild halibut from the period of May to December were investigated by measuring liquid-holding capacity, muscle pH, fatty acid (FA) composition and by a quantitative descriptive sensory analysis. The liquid-holding capacity of farmed halibut muscle varied throughout the season. A significant increase in liquid loss was observed in July and August, indicating that the quality is lower in these months. The liquid loss (LL) increased with decreasing pH at pH lower than 6.3, whereas at higher pH, the LL was independent of ph. In the farmed halibut, the average muscle pH 6.14 varied from 5.90 to 6.64. Average muscle pH in the wild halibut (6.41) varied from 6.33 to 6.49. The fat content in the wild halibut muscle was <0.2% throughout the sampling period, while in the fanned halibut, it varied from 3.5% to 7.4%. The fatty acid composition in the muscles of halibut can be explained by the amount of fat in the muscle and the dietary fatty acids. The fatty acids present in the muscle of wild halibut are consistent with a very low fat content mostly made up by structural phospholipids. Although the proportions of the eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are lower in the farmed than in the wild halibut, the total amounts are much higher. It was evident from a principal component analysis (PCA) of the sensory and chemical data that the differences were mainly seen in textural attributes and that chemical and sensory analysis described the same quality properties.

Godo, O. R., & Haug, T. (1998). *Growth rate and sexual maturity in cod (Gadua morhua) and Atlantic halibut (Hippoglossus hippoglossus)*. Retrieved from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.590.4905&rep=rep1&type=pdf

Variation in growth and reproduction dynamics of fish populations substantially affects production in wild as well as domesticated fish population. Identifying the intrinsic and environmental factors, which influence the dynamics of these traits, is important both for stock assessment methodology and management of wild populations as well as for improving production in aquaculture. In this paper the relationship between growth and maturation of northern cod (Gadus morhua) and Atlantic halibut (Hippoglossoides hippoglossoides) is described using data from spawning locations at the Norwegian coast. Both species show an inverse relationship between immature growth and age/size at first spawning. Long term trends may be connected to climatic changes as well as to the increased exploitation experienced in this century. Short term variation may be caused by abrupt changes in the condition for growth, e.g., due to temperature shifts and/or variation in prey abundance.

Haug, T. (1990). Biology of the Atlantic halibut Hippoglossus-hippoglossus (L, 1758). *Advances in Marine Biology, 26*, 1-70. https://doi.org/10.1016/s0065-2881(08)60198-4

The Atlantic and Pacific halibut are two morphologically similar flatfish forms inhabiting the boreal and subarctic waters in their respective oceans. Until recently, there were disagreements as to the taxonomic status of these two forms. More recent studies, however, using genetically determined electrophoretically detectable protein variants to test for genetic differences, have revealed a genetic difference between Atlantic and Pacific halibut of a magnitude that confirms the treatment of the two taxa as a separate species. In this review I regard the Pacific halibut as a species separate form the Atlantic halibut, and the following is an account of the biology, fishery, and potential for aquaculture of the Atlantic species.

Section II: Ecology

Seitz, M., Evans, M. D., Courtney, M. B., & Kanwit, J. K. (2016). Continental shelf residency by adult Atlantic halibut electronic tagged in the gulf of Maine. *Journal of Northwest Atlantic Fishery Science, 48*, 33-40. https://dx.doi.org/10.2960/J.v48.m713

In the Northwest Atlantic, emerging evidence suggests that different stocks of Atlantic halibut (Hippoglossus hippoglossus) exist in Canadian and U.S. waters. To examine the movement of Atlantic halibut that occupy the Gulf of Maine in U.S. waters during the summer, two types of electronic tags were attached to large adult fish (n = 70) in 2007-2009. None of the recovered tags (n = 12) provided evidence that the fish occupied the relatively deep waters of the continental slope during the winter, where Canadian Atlantic halibut have been shown to spawn. This observation provides additional evidence for the hypothesis that different stocks of Atlantic halibut exist in Canadian and U.S. waters. Furthermore, this observation requires reexamination of the long-standing assumptions made by fisheries scientists that all Atlantic halibut spawn in deep water on the continental slope and that the majority of mature Atlantic halibut spawn annually. This information may be important for understanding the population dynamics of Atlantic halibut in U.S. waters.

Armsworthy, S. L., Trzcinski, M. K., & Campana, S. E. (2014). Movements, environmental associations, and presumed spawning locations of Atlantic halibut (Hippoglossus hippoglossus) in the northwest Atlantic determined using archival satellite pop-up tags. *Marine Biology, 161*(3), 645-656. http://dx.doi.org/10.1007/s00227-013-2367-5

Large Atlantic halibut (Hippoglossus hippoglossus) off the eastern coast of Canada were tagged with pop-up satellite archival transmission tags (N = 17) to track movements, determine ambient depth and temperature, and infer spawning activity. Many halibut showed seasonal movements from deepwater slope areas in fall and winter to shallower feeding grounds on the Scotian Shelf and Grand Banks in summer. Halibut depths ranged between 0 and 1,640 m. Mean temperature of occupation was 4.7 °C. Multiple short-term vertical ascents from a consistent baseline depth, characterized as spawning rises, were identified in seven of the tagged halibut south of the Grand Banks. All presumed spawning rises occurred in multiples of 2-6 events at 2- to 9-day intervals between October and January, spanning an average vertical extent of 50-100 m at depths of about 800-1,000 m. Given the direction and velocity of the slope water currents and the duration of the pelagic stage, the calculated 300-500 km drift of the eggs and larvae would take them onto the Scotian Shelf, as well as into the Gulf of St. Lawrence. Therefore, the location of the presumed spawning grounds is consistent with expectations based on migration compensation theory, the northeasterly migratory patterns of the juveniles, the relatively static distribution of the adults off southern Newfoundland, and the prevailing currents at depth.

Nilsson, J., Kristiansen, T. S., Fosseidengen, J. E., Stien, L. H., Fernö, A., & van den Bos, R. (2010). Learning and anticipatory behaviour in a “sit-and-wait” predator: The Atlantic halibut. *Behavioural Processes, 83*(3), 257-266. https://doi.org/10.1016/j.beproc.2009.12.008

We studied the learning capacities and anticipatory behaviour in a “sit-and-wait” predatory fish, the Atlantic halibut, Hippoglossus hippoglossus. In Experiment 1 two groups of halibut received series of light flashes (conditioned stimulus, CS) that started before delivery of food (unconditioned stimulus, US) and persisted until after food delivery, i.e. delay conditioning. Control groups received unpaired CS and US presentations. The anticipatory behaviour of delay conditioned halibut consisted mainly of take-offs towards the surface shortly after onset of the CS. In Experiment 2 six groups of halibut were trained in three trace conditioning procedures: Two groups with 20s, two groups with 60s and two groups with 120s trace interval. Learning was evident in the 20 and 60s trace groups and in one of the 120s trace groups. In contrast to delay conditioning the anticipatory behaviour of trace conditioned halibut was characterized by subtle movements near the tank floor with orientation towards the CS. The cautious responses of halibut after trace conditioning differed markedly from what is observed in other fish species and are suggested to reflect a “sit-and-wait” foraging strategy that requires the predator to remain undetected until the prey is within lunging range.

Fisheries and Oceans Canada. (2003). Atlantic Halibut in the Gulf of St. Lawrence (4RST)' Update 2002. Retrieved from http://www.dfo-mpo.gc.ca/csas/Csas/status/2003/SSR2003_006_e.pdf

Halibut landings, which were 650 tons (t) in the early 1960s, hit a record low in 1982 at 91 t. Since then, landings have rarely exceeded the 300 t mark, which is equivalent to the precautionary total allowable catch (TAC) established in 1988. Since 1995, Atlantic halibut landings have increased significantly, which is thought to be mainly due to the increased fishing effort by the fixed gear fleet, notably longliners. The current Atlantic halibut management unit for the Gulf, which corresponds to Divisions 4RST, was established in 1987 based on the findings of tagging-recapture studies and by taking into account additional biological data such as size and growth rate. The most recent Atlantic halibut stock assessment was conducted in 2000 (DFO, 2000). This document is an update based on recent data from the fishery and the tagging program.

Fisheries and Oceans Canada. (2001). Atlantic Halibut on the Scotian Shelf and Southern Grand Bank (Div. 4VWX 3NOPs). Retrieved from http://www.dfo-mpo.gc.ca/csas/Csas/status/2001/SSR2001_A3-23e.pdf

The management unit definition (4VWX3NOPs) was based largely on tagging results which indicated that Atlantic halibut move extensively throughout the Canadian North Atlantic with smaller fish moving further than larger fish. Migrations of larger fish were thought to be related to spawning. Studies have shown that the Browns Bank area may be an important rearing area for juvenile halibut and that there is a north-eastward movement of fish as they grow. The geographic range of Atlantic halibut in the Northwest Atlantic extends from the coast of Virginia in the south to the waters off Disko Bay, Greenland in the north. Since the early 1990s, there appears to have been a significant reduction in the numbers of halibut in the northern portion of this range, especially along Labrador Shelf. Although the growth and maturity cycles of Atlantic halibut require further study, it appears that females grow faster than males, and attain a much larger maximum size. Females reach 50% maturity at about 115 cm, while males 50% reach maturity at about 75 cm. In the absence of reliable growth information age at maturity remains uncertain. Present fishing regulations require that all halibut less than 82cm in length be released. Halibut are voracious feeders and up to a length of 30 cm, food consists almost exclusively of invertebrates. Between 30 cm and 66 cm both invertebrates and fish are eaten while halibut over this size eat fish almost exclusively. FRCC recommended increases in TAC in 2000 and 2001, resulting in a current TAC of 1150t. White hake, cusk, cod, and a range of other species, are caught in association with halibut. This has management implications in an ecosystem context. There are recent indications of increased abundance of pre-recruits (fish < 82 cm). Adult halibut have a low catchability to the RV trawl, resulting in highly variable estimates of adult abundance. The halibut longline survey provides the capacity to monitor the halibut population. Halibut longline survey commercial index and fixed station estimates of abundance show little change in population size from 1998 - 2001. The halibut population appears to be relatively stable; however we are unable to determine if current landings are sustainable.

Jonassen, T. M., Imsland, A. K., Fitzgerald, R., Bonga, S. W., Ham, E. V., Naevdal, G., . . . Stefansson, S. O. (2000). Geographic variation in growth and food conversion efficiency of juvenile Atlantic halibut related to latitude. *Journal of Fish Biology, 56*(2), 279-294. https://doi.org/10.1006/jfbi.1999.1159

Higher growth capacity and food conversion efficiency was observed in populations of juvenile halibut from high Hippoglossus hippoglossus compared lower latitudes. In addition, temperature adaptation shown by the lower temperature optimum for growth in the Norwegian population (mean +/- S.E. 12.9 +/- 0.1 degrees C) compared with the Icelandic and Canadian populations (14.2 +/- 0.2 and 13.9 +/- 0.3 degrees C respectively), seems to occur. Overall the data support the hypothesis of counter gradient variation in growth. These results have implications firstly for selection focusing on growth performance in halibut culture; and secondly, for safe prediction of growth, since if counter gradient variation in growth performance occurs one cannot assume automatically that a species will respond to the same set of physiological parameters in the same way throughout its range.

Jonassen, T. M., Imsland, A. K., & Stefansson, S. O. (1999). The interaction of temperature and fish size on growth of juvenile halibut. *Journal of Fish Biology, 54*(3), 556-572. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1095-8649.1999.tb00635.x/epdf

Growth rate of individually tagged juvenile halibut was influenced significantly by the interaction of temperature and fish size. The results suggest an optimum temperature for growth of juvenile halibut in the size range 5-70 g between 12 and 15 degrees C. Overall growth rate was highest at 13 degrees C (1.62% day(-1)). At c. 5 g at the beginning of the experiment, fish at 16 degrees C had the highest growth rate (3.2% day (-1)), but reduced this rate as they grew bigger. At 9 and 11 degrees C, growth rates were equal or only slightly lower during the later stages of the experiment, while the fish at 6 degrees C showed significantly lower overall growth rate (0.87% day(-1)). Optimal temperature for growth decreased rapidly with increasing size, indicating an ontogenetic reduction in optimum temperature for growth. Moreover, a more flattened parabolic regression curve between growth and temperature as size increased indicated reduced temperature dependence with size. Although individual growth rates varied significantly at all times within the experimental temperatures, significant size rank correlations were maintained during the experiment. This indicated an early establishment of a stable size hierarchy within the fish groups. Haematocrit was highest at the highest temperature while Na+/K+-ATPase activity was inversely related to temperature. There was no difference in plasma Na+, Cl- and K+ concentrations among the temperature groups.

Haug, T., & Kjoersvik, E. (1989). Comparative studies of Atlantic halibut (Hippoglossus hippoglossus L.) spawning in different areas. Retrieved from https://search.proquest.com/docview/15632548?accountid=28258

A comparison of reproductive parameters of Hippoglossus hippoglossus is made for various parts of North America, Iceland, the Faroes, and Norway. The males reach sexual maturity at a younger age and smaller size than the females. There are substantial variations in age at which sexual maturity is attained. Halibut maturity is probably more a function of size than of age, i.e. maturity is most probably attributable to observed variations in growth rate. Halibut spawning takes place near the bottom in deep water localities where temperatures and salinities range between 5 and 8 degree C and 34.5 and 35.1 ppt.

Stobo, W. T., Neilson, J. D., & Simpson, P. G. (1988). Movements of Atlantic halibut (Hippoglossus hippoglossus) in the Canadian North Atlantic. Canadian Journal of Fisheries and Aquatic Sciences, 45(3), 484-491. https://doi.org/10.1139/f88-058

The results of Atlantic halibut (Hippoglossus hippoglossus) tagging experiments conducted in Northwest Atlantic fisheries Organization (NAFO) Subareas 3 and 4 between 1958 and 1973 were reexamined. Data from the 230 recaptures indicated a tendency for fish released on the Scotian Shelf to move to the northeast, while fish released on the Newfoundland Grand Bank showed no preferred direction of movement. The Laurentian Channel does not appear to be a barrier to migration for this species. The extensive movement of Atlantic halibut throughout most of the Canadian Northwest Atlantic suggests that a single area would be the most feasible management unit, encompassing the Scotian Shelf and southern Grand Bank regions.

Sutcliff W. H. (1973). Correlations between seasonal river discharge and local landings of American Lobster (Homarus americanus) and Atlantic halibut (Hippoglossus hippoglossus) in Gulf of St. Lawrence. *Journal of the Fisheries Research Board of Canada, 30*(6), 856-859. https://doi.org/10.1139/f73-146

Positive correlations are found between monthly discharge of the St. Lawrence River and annual regional catch of American lobster (*Homarus americanus*) and Atlantic halibut (*Hippoglossus hippoglossus*). Lag periods to account for age at maturity or commercial size permit some predictive possibilities.

Section III: Fishery

Modern: Atlantic halibut was identified as a "Species of Concern" in 2004; Status of Stocks 2016 report lists Atlantic halibut as overfished but not currently subjected to overfishing. At present, recreational fishing of Atlantic halibut is restricted to one fish, minimum 41 inches, per vessel, per trip.

Sources: Fisheries, N. (2018, 3/1/2018). Federal Recreational Fisheries Regulations for the Greater Atlantic Region. Retrieved from https://www.greateratlantic.fisheries.noaa.gov/sustainable/RecFishing/regs/index.html#six

NOAA Fisheries (2017). *Status of Stocks 2016: Annual Report to Congress on the Status of U.S. Fisheries*. Retrieved from https://repository.library.noaa.gov/view/noaa/15620

NOAA National Marine Fisheries Service (2007). *Species of Concern: Atlantic halibut*. Retrieved from http://www.nmfs.noaa.gov/pr/pdfs/species/atlantichalibut_highlights.pdf

Historical: The directed Atlantic halibut fishery in the Georges Bank-Gulf of Maine region began in early 1800s. Fishing grounds included inshore waters of Massachusetts Bay, Nantucket shoals, the coast of Cape Cod, Barnstable Bay and Cashes Ledge. Halibut were apparently exceedingly abundant in Massachusetts Bay with one vessel catching 6.8 mt (15,000 lbs) on a single two-day trip in 1837. Halibut abundance gradually declined on the inshore fishing grounds and the fishing fleets moved on to harvest halibut on Georges Bank in the 1830s and 1840s. By 1848, the Georges Bank halibut fishery was very productive with reports that "Vessels could easily catch a fare of 50,000 pounds [23 mt] of fish in two days." (attributed to Captain Epes Merchant, Goode 1884). The directed fishery in the Gulf of Maine-Georges Bank continued into the early 20th century when the heavily-fished stock appears to have reached the point of collapse.
Reliable records of Atlantic halibut landings from the Gulf of Maine-Georges Bank region begin in 1893. Substantial landings occurred prior to this; however, as the halibut fishery was already in decline by the 1880s. Landings decreased through the early-1900s as components of the resource were sequentially depleted. Annual landings averaged 662 mt during 1893-1940 but experienced a 4-fold decrease to average only 144 mt during 1941-1976. During 1977-2000, annual landings continued to decline and fell to an average of 89 mt per year.

Source: Jon Brodziak, L. C. (2006). *Status of Fishery Resources off the Northeastern: Atlantic Halibut*. Retrieved from https://www.nefsc.noaa.gov/sos/spsyn/fldrs/halibut/

Goode, G. B. (1885). A Brief Biography of the Halibut. *The American Naturalist, 19*(10), 953-969.

An often cited, historical account of the biology and distribution of Atlantic halibut.

Section IV: Management

Ferter, K., Rikardsen, A. H., Evensen, T. H., Svenning, M.-A., & Tracey, S. R. (2017). Survival of Atlantic halibut (Hippoglossus hippoglossus) following catch-and-release angling. *Fisheries Research, 186*, 634-641. https://doi.org/10.1016/j.fishres.2016.05.022

Catch-and-release (C&R) of Atlantic halibut (Hippoglossus hippoglossus) has been heavily debated as a management strategy to reduce fishing mortality of this species while maintaining angling opportunities in Norwegian recreational fisheries. However, little information exists on what proportion of the fish survives post release. To test if C&R affects short- and long-term survival of Atlantic halibut, halibut (>120 cm; N = 11) were caught on angling gear using commonly used fishing lures, and tagged with both pop-up satellite archival tags (PSATs) and acoustic transmitters. Survival was determined by the vertical migration patterns of individuals measured by the tags during individual monitoring periods ranging from 3 to 248 days (median 80 days) after the C&R event. No short-term mortality was observed post release. In terms of long-term survival, eight halibut were confirmed to have survived the monitoring periods while one halibut had insufficient data. For the other two individuals, the acoustic transmitters showed a cessation of vertical movement after 38 and 44 days, which could neither be neither verified nor disproven by the PSAT recordings (due to earlier detachment and tag malfunction of the PSATs). Since premature tag shedding was frequent in this study, it cannot be concluded if the cessation of vertical movement was because of tag shedding or delayed mortality. The results of this study indicate that Atlantic halibut is resilient to C&R angling, and that C&R of Atlantic halibut may be an effective management strategy to reduce fishing induced mortality. However, the effects of severe hooking injuries, impacts on smaller individuals, and potential sub lethal consequences of C&R were not covered in this study, and are still poorly understood. To minimize negative impacts of C&R and to promote fish welfare, fisheries managers are encouraged to implement best practice C&R angling guidelines for Atlantic halibut.

Trzcinski, M. K., & Bowen, W. D. (2016). The recovery of Atlantic halibut: a large, long-lived, and exploited marine predator. *ICES Journal of Marine Science, 73*(4), 1104-1114. http://dx.doi.org/10.1093/icesjms/fsv266

Atlantic halibut (Hippoglossus hippoglossus) have a long history of exploitation in the Northwest Atlantic and have gone through several periods of high biomass followed by a population crash. An assessment model using data collected on the Scotian Shelf and southern Grand Banks shows that the population peaked in 1984, then decreased sharply to a low in 1993. Several management measures were taken during the decline, including reductions in total allowable catch and a minimum size limit. Concurrently, removals by the otter trawl fishery were drastically reduced following the collapse of the cod (Gadus morhua) fishery. In 2003, recruitment increased and continued to be high for 6 years. Fishing mortality rates were moderate in the late 1990s and 2000s and the population increased. By 2009, the Atlantic halibut population was highly productive with both high biomass and high levels of recruitment. The coincidence in the timing of population recovery and management actions indicates that effective management contributed to the recovery of Atlantic halibut.

Shea, G. (2015). Fines for Illegal Fishing of Atlantic Halibut Total Over $1 Million [Press release]. Retrieved from https://advance.lexis.com/api/permalink/37db1987-17f0-4235-95db-daee91b00a06/?context=1000516

Fisheries and Oceans Canada (DFO) is taking a more intelligence-led and longer-term approach to conserving and protecting fishery resources in Atlantic Canada, and its efforts are paying off for the Atlantic halibut fishery in particular. DFO's increased focus on the monitoring of catch and landings of Atlantic halibut has resulted in a long line of convictions, totaling over $1 million in fines and forfeitures over the last five years.

Peros, J. M., Morse, R. Y., Salerno, D. J., Ogilvie, I., & Labaree, J. M. (2014). Reducing Bycatch in New England's Groundfish Sectors: The Development of a Fishing Area Selectivity Tool. *Lowell Wakefield Fisheries Symposium Series* (29), 54. Retrieved from https://search.proquest.com/docview/1751201260?accountid=28258

A lack of real-time data on which to base fishing behavior has significant implications for avoiding bycatch in New England's groundfish fishery. Groundfish sectors-fishing cooperatives created through a transition to catch share management-are subject to time lags in management decisions on bycatch as information is gathered and analyzed. Through support from the NOAA Fisheries Northeast Cooperative Research Program, the Gulf of Maine Research Institute has developed a near real-time spatial/temporal fishing area selectivity tool (FAST) in partnership with the groundfish industry. The project has developed a web-based data portal and mapping tool that enables industry-led bycatch avoidance efforts outside of the regulatory process for harbor porpoise, Atlantic halibut, and windowpane flounder. The tool allows near real-time catch data to be presented with historical catch data, oceanographic information, and management information. The initial project focus in 2010, of providing fishermen with a tool to share individual catch data with other fishermen in order to target allocated species and avoid others, was met with resistance. Initial allocations varied widely among fishermen-and one boat's target species was another's "choke" stock. Many lessons were learned, and the project focus shifted to reduce bycatch on species the entire fleet has a vested interest in avoiding. In New England, bycatch can lead to time/area closures of prime fishing grounds and gear restrictions, severely restricting the fishing industry's ability to fully access the annual catch limits (ACL) of allocated stocks. Work is ongoing, and our fleet-wide approach brings new opportunities and challenges to bycatch avoidance.

Neilson, J. D., Waiwood, K. G., & Smith, S. J. (1989). Survival of Atlantic halibut (Hippoglossus hippoglossus) caught by longline and otter trawl gear. *Canadian Journal of Fisheries and Aquatic Sciences, 46*(5), 887-897. https://doi.org/10.1139/f89-114

To assess the effectiveness of a proposed minimum size limit (81 cm) for Atlantic halibut (*Hippoglossus hippoglossus*) in Canadian waters, the survival of small fish caught in longline and bottom trawl gear was examined using live holding facilities onboard a research vessel and subsequently, in a land-based laboratory. Commercial practices were simulated during fishing operations. Of halibut less than the proposed size limit, 35% of the otter trawl catch and 77% of the longline catch survived more than 48 h. Factors potentially influencing halibut survival (handling time, total catch, fish length, maximum depth fished, and trawl duration) were examined using proportional hazard models. On the basis of those analyses, it was concluded that in bottom trawl sets of duration used in the commercial fishery (≥ 2 h), higher survival times were associated with shorter handling time, larger fish size, and comparatively small total catch weight. Supplemental information on the condition of trawl-caught halibut was also obtained from observers stationed onboard commercial trawlers.