Atlantic hagfish (Myxine glutinosa) meaning gluey slime

Common Names: Northern hagfish, slime hag, and slime eel.

Description, Distribution and Biology

Hagfish are elongated, eel-shaped, bottom dwelling marine organisms. They are characterized by soft scaleless skin and by four pairs of tentacles (barbels) surrounding the mouth and opening for the nasopharyngeal duct, which is used in respiratory water intake. The mouth of hagfish contains a protractable and retractable orange coloured cartilaginous plate that bears two sets of sharp teeth often referred to as the 'rasping tongue'. The tongue used grasps and burrows into food resources. The skeleton of hagfish is made entirely of cartilage with 5 to 15 pairs of gills. This species is jawless and lacks both a sympathetic nervous system and spleen.

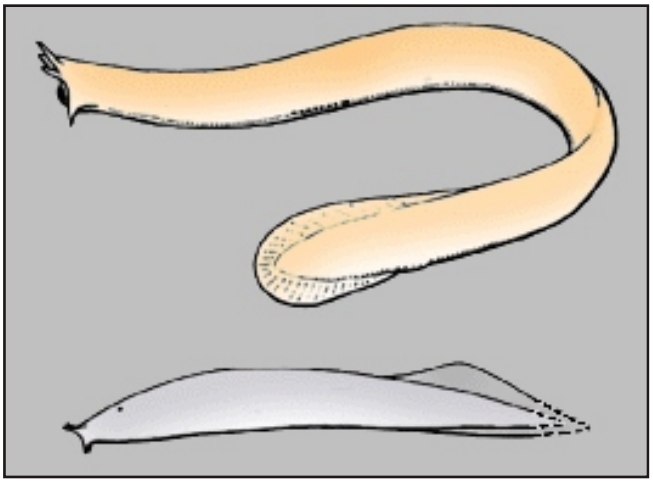

Figure 1. Atlantic Hagfish. Source: Philipee Muséum National d'Histoire NaturelleJanvier

Hagfish have poorly developed eyes that are covered by skin and a layer of muscle and are considered nocturnal creatures with a superior sense of touch and smell. The hagfish has no true fins except for a primitive tail fin, which is created by a fold in the skin. Often referred to as slime eels, hagfish have numerous specialized glands located on either side of their abdomen that produce enormous quantities of mucus or 'slime' when it is stressed or provoked. Tiny fibres reinforce the slime making it strong and difficult to remove for protection against predators. The hagfish will escape its slime cocoon by tying itself in a knot and then passing the knot down the length of its body in order to wipe the slime away. Hagfish vary in colour from a mottled grey-brown to a red-grey upper and a white to pale grey on the underside (Fig. 1) Hagfish will typically grow to 40.6 to 81.3 cm in length. Variations in body colour correspond to changes in the colour of the sea bottom.

Atlantic hagfish (*Myxine glutinosa*) is a cold water species that prefers a soft muddy bottom and lives at depths of 30 to 1200 m or more. Hagfish require high salinity (approximately 30 ppt or more) and low temperatures associated with deeper water and are usually found half-concealed in the bottom sediment. They are widely distributed in the Arctic Sea southward along both coasts of the north Atlantic. In the eastern Atlantic it continues southward towards Morocco and the Mediterranean Sea. In the northwest Atlantic, hagfish are distributed from Greenland through the Gulf of St

Lawrence, around the southern areas of Nova Scotia and New Brunswick, on the west and south coast of Newfoundland and Labrador and southward to New York, with one specimen recorded as far south as North Carolina (Fig. 2). High-density populations are common throughout eastern Canada, particularly in Passamaquoddy Bay, New Brunswick, where a trap set at 50m could catch upwards of 500 hagfish in a single night.

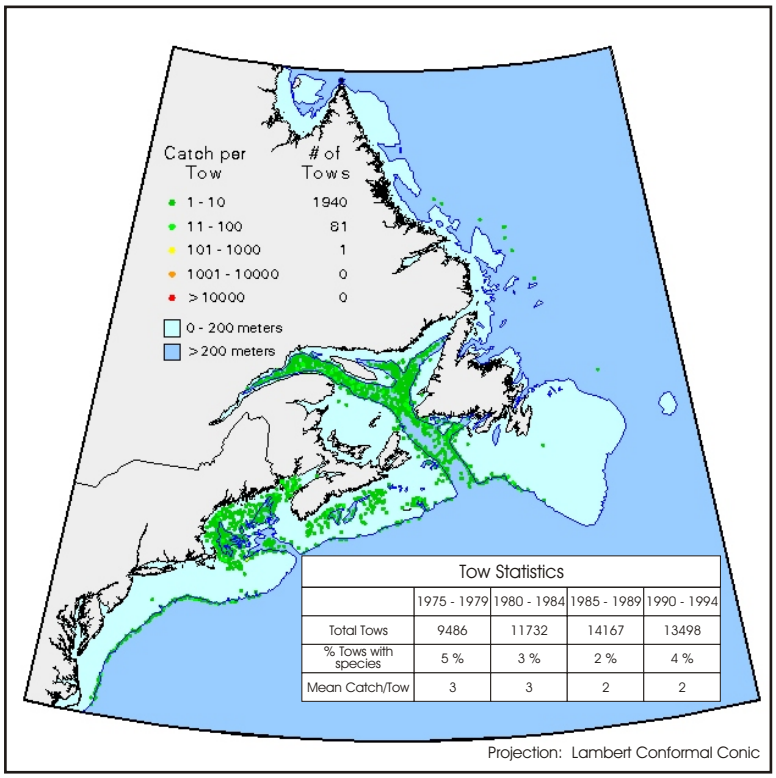

Figure 2. East Coast of North America Strategic Assessment Project. Distribution of Atlantic hagfish. Source: Science Sector, Department of Fisheries and Oceans, Canada Office of Ocean Resources Conservation and Assessment, National Oceanic and Atmospheric Administration, USA

Details of the reproduction cycle of hagfish is limited. There appears to be no predetermined time for spawning and it is believed to occur anytime throughout the year. Although hagfish are not functional hemaphrodites, sexually mature individuals do possess underdeveloped gonadal tissue of the opposite sex. Females, which typically out number males 100 to 1, produce anywhere from 1 to 30 eggs at a time. The eggs are usually white and oval in shape and can vary in size from 20 to 70 mm in length. The eggs also have hooked filaments at either end, which enables them to lock together. Fertilization occurs externally after the eggs or sperm are released from the abdominal cavity through a large pore into the cloaca, which is an excretory compartment that also collects and expels urinary and digestive wastes. There is no conclusive information regarding when, where and how fertilization occurs. Hagfish eggs are seldom captured in the wild but have been found in the Bay of Fundy, on the Georges Bank, and off the south coast of Newfoundland and Labrador. Given the lack of undamaged egg specimens for analysis, the embryonic development stage of this species is largely unknown. Rate of growth is unknown and it is impossible to age them, however it is known that newly hatched hagfish resemble the adults and therefore do not have a larval stage.

The Atlantic hagfish feeds predominantly on dead or injured organisms by consuming the internal organs and flesh until only the bones and some skin remain. When feeding on large carcasses such as whales, the hagfish will usually enter the body through the mouth, anus or gills. Although they have few known enemies, small hagfish have been discovered in the stomachs of cod and hake and some hagfish eggs were removed from the stomachs of halibut caught on the eastern Sable Bank. However, many predators of hagfish will actually suffocate as a result of the protective slime excreted by the organism, thus providing the intended victim with an easily captured meal. As a scavenger of dead or dying organisms, the hagfish has to compete with other scavengers for food resources.

Harvesting and Management

Figure 3. Hagfish Trap. Source: Philip Walsh, Marine Institute, Memorial University of Newfoundland and Labrador, St. John's, NL

Hagfish have been traditionally harvested using a baited Korean trap, called a tongbal. This trap is constructed of a moulded plastic cylinder measuring 12.7 cm in diameter and 61 cm in length with 0.86 cm diameter escapement holes (Fig. 3). There is a single removable funnel fitted in one end, which allows access to the contents of the trap, however the smaller size Korean traps were often filled with hagfish and prompted experimentation with larger designs. Harvesters began using traps modified from 4 to 6 gallon plastic buckets. Holes were drilled in the sides of the bucket and a single funnel from a Korean trap was fitted into the lid. Eventually harvesters constructed traps from 30 to 55 gallon buckets. These traps can have varying size, number, and placement of escapement holes and often use more than one funnel.

The type and size of bait, number of traps set, and soak time vary according to harvester. Common bait types include mackerel, herring, cod, sardine, smelt, squid, rockfish and cuttlefish. The type of bait used is critical to fishing success since hagfish have a highly developed sense of smell. Gear is typically fished anywhere from 82.3 to 366 m and optimal fishing time is during the evening and night. Information on preferred season, substrate, fishing technology, soak time and bait is limited. However, a study conducted on the west coast hagfish fishery by the Washington Sea Grant Program made a number of important conclusions. First, 5-gallon bucket traps with two entrance funnels from Korean traps and with 1.1 cm escapement holes limited to the lid and bottom are recommended. Second, a soak time of 12 and 24-hours produced more efficient catch rates. Third, optimal bait concentration for a 5-gallon bucket trap is approximately 1 pound of bait per gallon. Finally, reports suggest that fishing at depths of 183 m or less on soft muddy bottoms will capture more and larger hagfish.

There is currently no management plan for hagfish fisheries. Hagfish have a low rate of production and are therefore subject to overfishing, which has been observed in both Korea and the United States. Future management will have to incorporate principles such as size selectivity and exclusion zones to maintain a viable industry.

Processing and Marketing

Historically, hagfish have been exploited in the western Pacific Ocean as a food source, a light leather alternative, and a cleaner manufactured from the protective slime. More recently, hagfish have been harvested primarily for a leather substitute and for biomedical research. This species has also been extensively studied because it is the most primitive of living vertebrates.

Handling and holding procedures on-board the vessel and during transport to processing facilities is vital to product quality. Hagfish should be transferred immediately after harvesting to an iced seawater mixture (Fig. 4), which is maintained at approximately 0°C, in order to minimize potential skin damage from biting and bacterial and enzymatic degradation as a result of stress. Dorsal holes (tears) greater than 0.5 mm and bites reduce the valve of the skin. An optimal holding density for hagfish on-board a vessel is estimated at 45 to 68 kg per 55-gallon barrel containing roughly 25 to 30 gallons of an ice/seawater mixture. The application of 1.1 cm escapement holes eliminates size sorting thereby reducing handling time and improving product quality. Larger hagfish are required for skin tanners and typically manufacturers accept any hagfish that is 30.5 to 36 cm or greater. The key element to product quality for the skinning and tanning process is keeping the organism alive because the fresher the skin the more its quality is preserved.

Figure 3. Hagfish in iced seawater mixture. Source: Philip Walsh, Marine Institute, Memorial University of Newfoundland and Labrador, St. John's, NL

The main market for hagfish skin and meat is Korea. The tanning process was developed from a similar procedure used in tanning cattle hides using a chemical solution. The tanning procedure and development of a formula took at least four years to create and is closely guarded within the country. Hagfish is also popular in many Asian restaurants and grocery stores in the United States and is common in sushi bars in Europe and Japan. Hagfish is frequently demanded as either whole frozen, block or live shipment. Market values for hagfish products vary according to season, availability, and quality and often fluctuated throughout the year.

Commercial Status

There has never been a traditional commercial fishery for Atlantic hagfish in this province. A decline in the Korean and Japanese hagfish fisheries during the late 1980s and early 1990s led to the development of a limited fishery for Pacific hagfish (*Eptatretus stoutii*) on the west coast of Canada and the United States. However, quality issues and lack of information regarding fishing gear and techniques hampered development of the West Coast fishery. Around the same time, a hagfish fishery emerged on the eastern seaboard of the United States. The Korean hagfish industry was desperate to identify a new source of high quality skins and with the development of this new fishery in New England their needs were satisfied.

In March 1990, an exploratory hagfish fishery was proposed for the 3Pn region (south coast) of Newfoundland and Labrador to determine the extent of the commercial hagfish population. This experiment has led to numerous discussions regarding the economic potential of this fishery for the province, particularly with the growing demand for hagfish from the eastern seaboard and on the west coast of the United States and Canada.

Constraints and Future Development

As with any emerging fishery there are many development constraints. First, there is a general lack of knowledge surrounding this species, especially in terms of growth, reproduction and occurrence in Newfoundland and Labrador waters. However, current resource assessments are being carried out on the slope of the Grand Banks. Second, harvesting techniques are not widely known by local fishers and there are some concerns over initial gear costs. Third, although any processing facility in the province that carries an under-utilized species processing license is able to process hagfish, many plants may not be willing to invest in equipment and packaging material. Fourth, the main market for Atlantic hagfish, which is Korea, is limited, distant and requires a year-round consistent supply. Finally, being a new fishery there are no restrictions on fishing effort and no proper guidelines for resource management.

Future development of this fishery will require a number of technical initiatives and management strategies. First, there needs to be scientific research conducted on growth, reproduction and biomass of hagfish, which may require the application of exploratory licences. Second, additional information and research must be collected on processing and harvesting techniques, particularly in improving product quality through proper harvesting and handling procedures. Third, the industry, must investigate other potential markets, including the development of domestic tanneries. Finally, the industry needs to implement harvesting restrictions through size restrictions, and rotation of fishing areas over a three-year cycle.

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The $10 million Fisheries Diversification Program is part of the $81.5 million Canada-Newfoundland Agreement respecting the Economic Development Component of the Canadian Fisheries Adjustment and Restructuring Initiative, announced in August, 1999. The main thrust of the Fisheries Diversification Program is industry-wide research and development initiatives that reflect the economic development priorities of the Newfoundland and Labrador fishing industry.