

American Eel

(*Anguilla rostrata*)



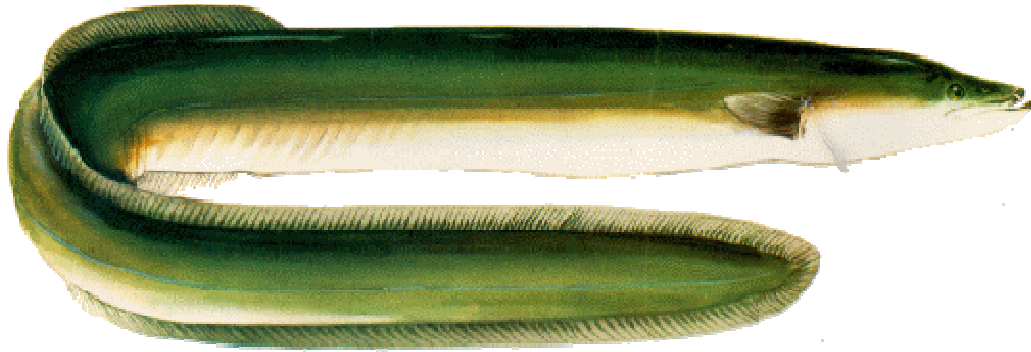
Abstract

The American eel (*Anguilla rostrata*) is a freshwater eel native in North America. Its smooth, elongated, “snake-like” body is one of the most noted characteristics of this species and the other species in this family. The American Eel is a catadromous fish, exhibiting behavior opposite that of the anadromous river herring and Atlantic salmon. This means that they live primarily in freshwater, but migrate to marine waters to reproduce. Eels are born in the Sargasso Sea and then as larvae and young eels travel upstream into freshwater. When they are fully mature and ready to reproduce, they travel back downstream into the Sargasso Sea, which is located in the Caribbean, east of the Bahamas and north of the West Indies, where they were born (Massie 1998). This species is most common along the Atlantic Coast in North America but its range can sometimes even extend as far as the northern shores of South America (Fahay 1978).

Context & Content

The American Eel belongs in the order of Anguilliformes and the family Anguillidae, which consist of freshwater eels. The scientific name of this particular species is *Anguilla rostrata*; “Anguilla” meaning the eel and “rostrata” derived from the word rostratus meaning long-nosed (Ross 2001).

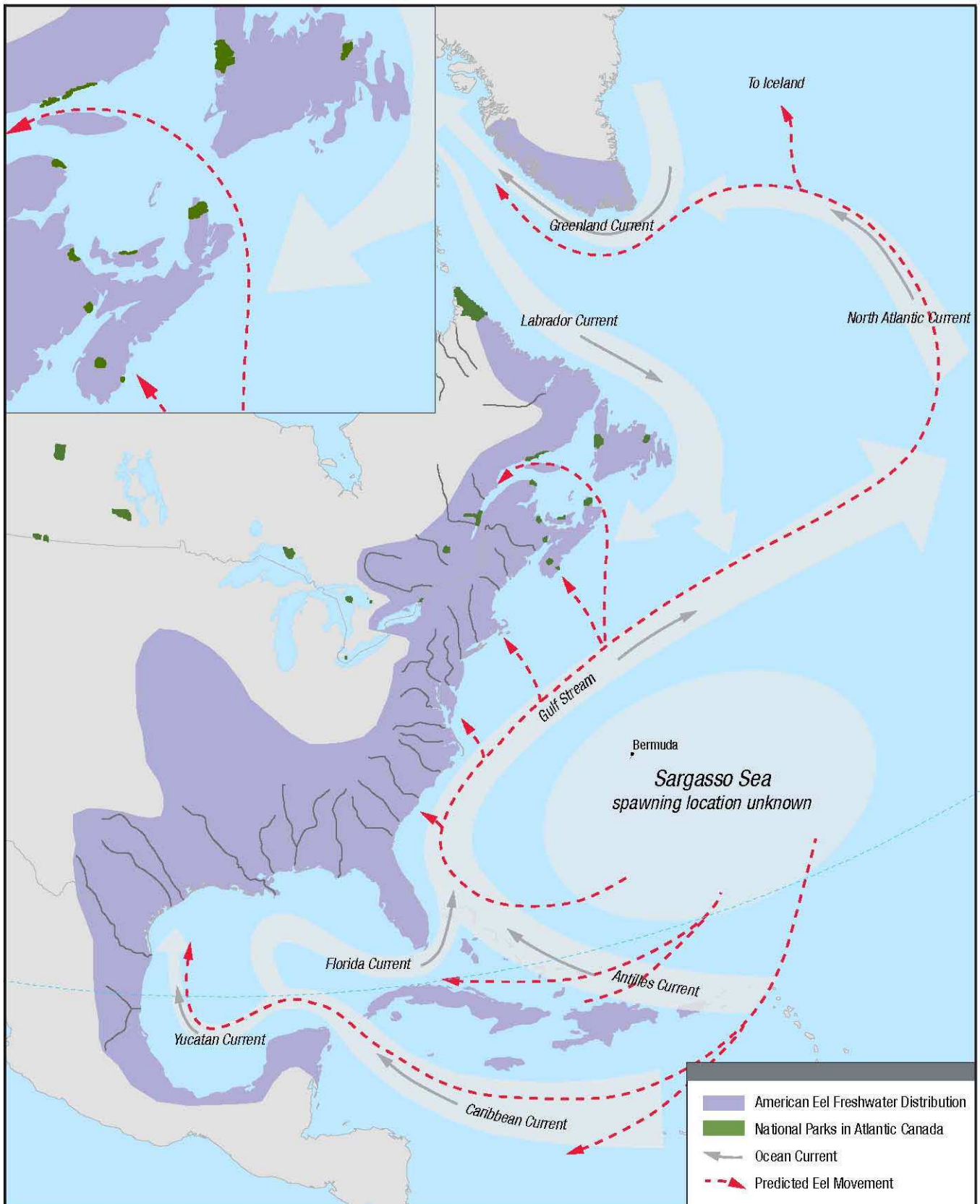
General Characteristics



The American Eel goes by many common names; some names that are more well-known include: Atlantic eel, black eel, Boston eel, bronze eel, common eel, freshwater eel, glass eel, green eel, little eel, river eel, silver eel, slippery eel, snakefish and yellow eel. Many of these names are derived from the various colorations they have during their lifetime. Some very general characteristics of this species include an elongated body with a terminal mouth. Though they do not possess pelvic fins, their anal and dorsal fin are both confluent with the caudal fin which extends approximately two-thirds of its body. The scales on an American Eel are very small and embedded, but these scales only appear at about three to five years of age. The American Eel can reach up to 1.2m (4 ft) or larger, but the average length tends to be around 264 to 726mm (10-29 inches). Males tend to be smaller than females. The maximum weight of an eel is considered to be about 6kg (15 lbs) (Fahay 1978).

Eels come in a variety of colors but when they are in the larval stage, they are nearly transparent. As they mature into adulthood they gradually change into their most recognizable coloration, which is a yellowish-brown. Older eels become slightly more silver ventrally with a darker dorsal as they migrate toward their spawning location (Ross 2001).

Distribution



The American Eel is largely widespread throughout the Gulf of Mexico basin, but also occurring in the Coastal Rivers, Lake Pontchartrain and drainages from Pascagoula, Pearl and Tombigbee. It has also been documented in the lower MS north, lower MS south and Yazoo drainages within the Mississippi River Basin (Ross 2001). Geographically, American Eels are even more widespread outside and around the United States. More regions where this species occur include The western North Atlantic (from southern and western Greenland), Newfoundland, Prince Edward Island, Gulf of St. Lawrence, Gulf of Maine, along the Atlantic coast of the United States, the Gulf of Mexico to Panama, northern Mexico, the north coast of South America, and in the West Indies and Bermuda. Bertin (1956) reports the latitudinal range to be between 5° and 62°N. Adult eels are found in brackish and freshwater estuaries, coastal streams and land-locked lakes (Fahay 1978).

Distribution is primarily determined by the course of the Gulf Stream current and several currents which disperse the larvae and juveniles, also known as elvers, along the coasts. Further distribution depends on accessibility of freshwaters and on transplantations which are readily accomplished due to ease with which eels may be transported. All areas within freshwater or along the coast typically contain eels if they contain fish. This includes all waters from warm, saline estuaries to cold, fresh trout-streams in mountainous areas (Fahay 1978)

Form & Function

Some of the most prominent and memorable features of eels are their elongated bodies as well as the dorsal and anal fins usually merging together with the caudal fin. They are typically cylindrical in shape for most of the body but taper and flatten a bit toward the tail. American Eels have very small, granular teeth. They have a very slimy appearance but actually have small, embedded scales that do not overlap, so they appear scaleless.

Morphologically there are some characteristics that make American Eels quite different from any other species of eel. The total number of vertebrae is 103 to 111. There is an average maximum value of distance between verticals through anus and origin of dorsal fin, 9.1% in total length. Their premaxilla is fused with the ethmoid, making the upper jaw bordered by both a maxillary and a ethmopremaxillary block. Their lower jaw is projecting and the gill openings are quite small and slit-like. They need a pumping mechanism for branchial current, so in order for that to occur and be effective, the mouth and gill chambers must be widely separated. The posterior placement of their gills results in posterior placement of the pectoral girdle which loses attachment to the skull (Fahay 1978)

Young eels are in a neutral stage, since their sex is not yet differentiated. Scales first appear on the mid-body and caudal regions at a length of 16cm. Scales on the anterior region first appear at 17cm. The entire body is fully scaled at 21cm. Coloration changes with stage of development, thus a very young eel on reaching fresh water acquires a grey pigmentation over the entire body. After several years, the immature eel reaches approximately 1m in length (2-4 ft) and acquires a yellow-green color, darker on the back. Some individuals with an orange-pink tint are sometimes found. At the onset of sexual maturity, the eel acquires a metallic, bronze-black sheen, and the pectoral fins change from yellow-green to black. Also at this stage, the phenomenon known as the "migratory livery" happens which means the eel is fattened, apparently in preparation for the migration of moving from freshwater to saltwater to breed (Fahay 1978).

Similar Species

A similar species to the American Eel is the European Eel, also known as *Anguilla anguilla* (Massie 1998). This particular species is typical for the waters of Western Europe. This species has been found to also spawn in the same sea, Sargasso, as its similar species, the American Eel. Distinctions between these two species can be made from morphological characteristics, such as amount of vertebrae, as well as molecular markers. Although they are recognized as two distinct species, it remains unclear which mechanisms play a role in species separation during larval drift and what orientation mechanism is used during migration in the open sea. (Van Ginneken 2005)

Ontogeny & Reproduction



The spawning season of American Eels typically lasts from February to April in the Southern Sargasso Sea. The larvae, officially called leptocephali, are carried by the ocean currents, primarily by the Gulf Stream and then distributed along the Atlantic Coast. The larval stage of this eel looks drastically different than its fully matured form. They appear so different in fact, that when first discovered, it was speculated that they were a completely different species of eel. They have small, transparent heads but significantly larger teeth that are thought to be used for predation among small, gelatinous organisms.

As they enter coastal waters they begin to grow into their juvenile stage, which many call glass eels. They earn this name through their silver-like coloration and long, thin bodies. It is during this stage of their lives that they begin attempting to enter freshwater. In order to bypass this journey as easily as possible, the juveniles remain near the bottom on the ebb tides and then move into the water column on the flood tides. Along the northern Atlantic Coast, despite the variation of water conditions when these tides are interchanging, the eels actually rely on a biological clock for when to time their movements into the water column from the tides. With increasing pigmentation, the young glass eels turn into what is known as "elvers", which may either remain in coastal waters or continue moving further into freshwater (Ross 2001).

It has been studied that females are typically in freshwater and higher latitudes while the majority of males reside exclusively in salt or brackish water (Fahay 1978). The major

growth phase, termed the “yellow eel” lasts from three to over twenty years, depending upon latitude and whether the eel is male or female. Sometime between those three to twenty years the eels finally reach their maturity and begin their migration to the sea. Around this time, the eyes become enlarged and the body coloration becomes silvery, hence the name given to them at this stage - “silver eels” (Ross 2001). This trait of developing enlarged eyes was typically only found in the similar species, *Anguilla anguilla* or the European Eel, but has been discovered in the American Eel as well. This adaptation is speculated to appear in preparation of travel into dark ocean depths (Fahay 1978).

Typically, a mature female produces a very large number of small eggs, with estimates ranging from 500,000 to 4 million eggs. These eggs average from 0.01 to 0.24 mm in diameter. Feeding activities for the adults typically lessen with the onset of maturity and upon later stages of downstream migration the gut may even degenerate (Ross 2001). Adults die after spawning, and the larvae spend the next year drifting and swimming with the Gulf Stream then move east into northern coastal waters, where the journey and life cycle of a newly born brood begins (Massie 1998).

Ecology

Overall, there have been very few studies undertaken to determine the ecology of the American Eel in inland or coastal waters (Ford 1986). Ford (1986) focuses on mostly inland and some coastal populations of the American eel in the United States. Density estimates for American Eel populations have been obtained by capture-marking techniques and include >300 fish ha⁻¹ in a brackish water area in Rhode Island and 232-636 fish ha⁻¹ in an inshore area of a Vermont lake. Due to studies having issues “homing” the eels, recently it has been concluded that American Eels establish home territories for a short period of time, in between erratic movements from area to area (Ford 1986). Because of their high temporal and geographic variability in many life history traits, it is still difficult to completely determine their ecology.

Though their life history traits and strategies are still being studied, it is believed that this high plasticity in biological characteristics and environmental requirements may be fundamental to the success of this panmictic and semelparous species (Jessop et al. 2002). Jessop et al. (2002) hypothesized and concluded that there are perhaps several different life history traits to the American Eel. As mentioned earlier in the paper, the geographical location of the American Eel varies greatly. Some, mostly female, eels tend to live in freshwater while others, typically male, prefer to reside in salt or brackish water. Jessop et al. (2002) showed in the East River, Nova Scotia that Otolith Sr:Ca ratios varied consistently at various life history stages and in response to different environmental salinities. At less than a year old, elvers that migrated to the river grew less than those that remained in the estuary, but with less than two years, the growth of the eels in freshwater did not differ from that in the estuary, mainly because of the high variability in otolith growth rate at this age and the small sample size. Although most silver eels from the East River are derived from elvers that entered the river from the estuary shortly after continental arrival, about 25% were derived from juvenile eels

that spent one year or more in the estuary before entering the river. The annual mortality rate of elvers in the river is 99.5% (Jessop et al. 2002).

Another study done in the Chesapeake Bay area further investigates the food habits and seasonal abundance of the American Eel. American Eels are typically less abundant in winter because the eels become inactive and “hole-up” or hibernate in mud bottoms during the winter. American Eel feeding typically occurs at night and their diet in the Chesapeake Bay area has shown to be primarily small fish, shrimps, crabs, bivalves, lobsters and small crustaceans along with a small percentage of annelids, echinoderms, mollusks and eelgrass. Other areas that have been studied showed similar diets with the most popular prey consumed is crustaceans. Smaller individuals contained mainly amphipods, isopods, and worms. Levinton (1971) showed that the subtidal, deposit feeding bivalve *Macoma tenta*, also known as the elongate macome, actually possesses a feeding periodicity that protects it from predation (Wenner 1975).

Behavior

Very few studies have been done on the behavior of the American Eel, but Helfman (1986) showed that American Eels in a Florida cave-spring have distinctive day versus night differences in distribution and activity. Larger eels occurred deeper at all times. Eels were nocturnally active, and changed over between behavior modes roughly at dusk and dawn. Changeover at dusk involved movement from deeper regions of low food to shallower regions of high food concentration, with smaller eels more likely to migrate.

Typically they will leave the cavern to forage in the evening or around sunset and return in the morning from their late-night foraging excursion (Helfman 1986). There is still much speculation and research on the behavior of American and European Eels occurring so it is difficult to confirm anymore behavioral traits. Even in this research, Helfman explains that while this is applicable and true about the eels in this particular cave, more research must be conducted to determine whether this applies to other eels in different locations (Helfman 1986).

Conservation



The conservation status of the American Eel, in Mississippi in particular, is apparently secure. Though there are variations in abundance from year to year, the changes are likely due more to oceanic current patterns impacting the recruitment of larvae from the Sargasso Sea, rather than to local conditions. In some cases, upstream movement of eels could be impeded by dams. The American Eel is doing so well in some places, namely the Chesapeake Bay area and along the Atlantic Coast, that it supports a commercial fishery. Most of the eels harvested commercially are shipped to Europe or Japan, rather than being consumed in the United States. In Mississippi, they have been experimentally cultured for export of their hides, which are later made into eelskin items abroad. In many countries, eels are actually considered a culinary delicacy and yet in others they are often considered pests, especially by fishers.

Works Cited

Fahay. M.P., 1978, Biological and Fisheries data on American Eel, *Anguilla rostrata* (LeSueur), *Technical Series Report No. 17* (6-62), <http://www.nefsc.noaa.gov/publications/series/shtsr/shltr17.pdf> (February 12, 2013)

Ford. T.E., and Mercer. E., 1986, Density, size distribution and home range of American Eels, *Anguilla rostrata*, in a Massachusetts salt marsh, *Environmental Biology of Fishes*, (Volume 17, Issue 4, 309-314 pp), <http://link.springer.com/article/10.1007/BF00001497> (February 12, 2013)

Helfman. G.S., 1986, Diel Distribution and Activity of American Eels (*Anguilla rostrata*), in a Cave-spring, *Canadian Journal of Fisheries and Aquatic Sciences*, <http://www.nrcresearchpress.com/doi/abs/10.1139/f86-198#.UVRIkReyApl> (February 12, 2013)

Jessop. B.M., Shiao. J. -C., Iizuka. Y., and Tzeng. W. -N., 2002, Migratory behaviour and habitat use by American Eels, *Anguilla rostrata* as revealed by otolith microchemistry, *Marine Ecology Progress Series*, (Volume 233, 217-229 pp), http://www.earth.sinica.edu.tw/~EPMA/papers/2002/Jessop_etal%20MEPS233%202002.pdf (February 12, 2013)

Massie. F., 1998, *The Uncommon Guide to Common Life of Narragansett Bay*, Save the Bay, Inc, Rhode Island, 254 p.

Ross. R.T, Brenneman. W.M., Slack. W.T., O'Connell. M.T., and Peterson. T.L., 2001, *Inland Fishes of Mississippi*, Mississippi Department of Wildlife, Fisheries, and Parks, Singapore, 624 p.

Van Ginnekin. V.J.T., and Maes. G.E., 2005, The European Eel (*Anguilla anguilla*, Linnaeus), its Lifecycle, Evolution and Reproduction: A Literature Review, *Reviews in Fish Biology and Fisheries*, (Volume 5, Issue 4, 367-398 pp), <http://link.springer.com/article/10.1007/s11160-006-0005-8> (February 12, 2013)

Wenner. C.A., and Musick. J.A., 1975, Food habits and seasonal abundance of the American Eel, *Anguilla rostrata*, from the lower Chesapeake Bay, *Chesapeake Science*, (Volume 16, Issue 1, 62-66 pp), <http://link.springer.com/article/10.2307/1351085> (February 12, 2013)