

Species Spotlight:

American eel: (*Anguilla rostrata*)

Glass Eels by Uwe Kils



A.K.A.: Atlantic eel, common eel, Boston eel, snakefish, bronze eel, black eel, green eel, fresh-water eel, glass eel, elver, silver eel, yellow eel, *Anguilla americana* (Spanish), *Anguille d'Amérique* (French)

Class: Actinopterygii (ray-finned fishes)

Superorder: Elopomorpha

Order: Anguilliformes (eels)

Suborder: Anguilloidei

Family: Anguillidae (freshwater eels)

Genus: *Anguilla* (freshwater eels)

Species: *rostrata*

This month we focus on a fish that is well known to many of us but whose full life cycle is still shrouded in the mystery of the deep sea. The American eel is a catadromous fish species, meaning that they spend the majority of their life in freshwater or estuarine environments and migrate back to the sea to reproduce (as opposed to the anadromous sea-run salmon and herrings that live primarily in the sea and return to freshwater to spawn). Both the larger adults and tiny transparent juveniles of this species accomplish huge feats of migration, rivaling the efforts of great coast-wise and oceanic migrators like the striped bass or the Atlantic bluefin tuna.

Early Research: Misconceptions about eel biology are as old as recorded history itself beginning with Aristotle, who carried out the first known research on eels. He stated in his *Historia Animalium* that eels have no milt or roe and seem to come from the very entrails of the Earth. Pliny stated that eels reproduce by rubbing themselves against rocks whereby the scrapings come to life. Von Helmont attributed the birth of eels to the dews of May mornings. Other authorities concluded that eels originated from the hairs of horses or the gills of fishes.



Eelers on Rocks by Tim Watts

The life cycle and spawning grounds of eels was largely unknown until Danish ichthyologist Johannes Schmidt published his 1925 study, based on over fifteen years of extensive trawling surveys of the Atlantic Ocean, from Greenland to Puerto Rico and the English Channel to Chesapeake Bay. Schmidt collected the transparent and ribbon-like larval stages of eels (known as leptocephali). He correlated the sizes

of the larval forms with their locations and reasoned that the smallest larvae would be closest to the breeding area.

After many long years of study at sea, Schmidt finally worked out that the spawning grounds of American and European eels are located in the Sargasso Sea, an oceanic area near the center of the North Atlantic gyre that is choked with floating rafts of sargassum weed, between the latitudes of 20 to 30 degrees north and the longitudes of 60 to 78 degrees west, or about midway between Bermuda and Puerto Rico and east.

Portuguese sailors named the area for its seaweed since the seaweed's bulbous floats are similar to grapes (sargaco is the Portuguese word for grape). Schmidt also found that the spawning grounds of American and European eels overlap in this region.

Upon spawning, it is assumed that all adult eels perish in the Sargasso Sea, never to return to their fresh-water habitats. Actual mating of either American or European eels has never been observed.

Description: American eels are shaped...well.....eel-like. Their dorsal fins are continuous, with their caudal fins and anal fins forming a fringe lining the posterior end of the body. They have small pectoral fins to help them navigate along river bottoms. They have no pelvic fins. Their scales are small, thin and soft, embedded and cycloid in shape. They possess a sensory lateral line running along each flank of their bodies. Eels can move equally well and forcefully forward and backward. Their snake-like form of locomotion is called "anguilliform" motion.

The American eel is closely related to its cousin, the European eel (*Anguilla anguilla*), but the American eel has fewer vertebrae (averaging about 107 as compared to 114 - 115 vertebrae in the European species), and they differ in chromosome count and in other various molecular genetic markers.

The spawning area of the Japanese eel (*Anguilla japonica*) has been precisely located to the west of the Suruga seamount and their leptocephali are then transported to the west to East Asia by the North Equatorial Current.

Taxonomy of the Family Anguillidae:

Anguilla rostrata.....**American eel**
Anguilla anguilla.....**European eel**
Anguilla australis.....**Short-finned eel**
Anguilla bengalensis.....**Indian mottled eel**
Anguilla bengalensis.....**African mottled eel,**
Anguilla bicolor bicolor.....**Indonesian shortfin eel**
Anguilla bicolor pacifica....**Indian shortfin eel**
Anguilla celebesensis.....**Celebes longfin eel**
Anguilla dieffenbachii.....**New Zealand longfin eel**
Anguilla interioris.....**Highlands longfin eel**
Anguilla japonica.....**Japanese eel**
Anguilla malgumora.....**Indonesian longfinned eel**
Anguilla marmorata.....**Marbled eel**
Anguilla megastoma.....**Polynesian longfin eel**
Anguilla mossambica.....**African longfin eel**
Anguilla nebulosa.....**Mottled eel**
Anguilla obscura.....**Pacific shortfinned eel**
Anguilla reinhardtii.....**Speckled longfin eel**

American eel Life Cycles and Color Phases:

Egg: Spawning is believed to occur in the Sargasso Sea in late winter or early spring (February – July). Female American eels release approximately 15 – 20 million eggs at spawning. Fertilization is external.

During a 1926 expedition to the Sargasso Sea, Marie Poland Fish of the Narragansett Marine Laboratory determined that three fish eggs attached to a crab shell dredged from the bottom were the first ripe eel eggs known to science. They were later hatched into leptocephali in the ship's laboratory.

Leptocephali: The larval, willow-leaf like "leptocephalus" stage is very different in appearance from the adult eel it will eventually become, perfectly transparent, with a small pointed head and large teeth. Leptocephali drift and swim in the upper 900 feet of the water column for several months; growing slowly to a length of 2 – 2.5 inches. In this stage they utilize oceanic currents that drift them towards their fresh-water adult habitats.

American eels may remain in the leptocephalus stage for up to a year, while the European eel (which faces a much longer migration) may take up to 3 years before transforming into its next life stage.

American eel leptocephali, living near the surface, have been found off the Atlantic coast of the U.S. as far north as the Grand Banks, but never east of longitude 50 degrees W.

Glass eel: The transformation to this life stage is somewhat unique in the animal world, whereby the eel actually shrinks in size by both length and width as it begins to take on a more typical eel shape. Glass eels possess laterally compressed transparent bodies housing prominent black eyes, with pink gills and a visible digestive tract.

Elver: The young elvers, averaging from 2 to 3.5 inches in length, after entering into an estuarine environment, begin to develop a gray to greenish-brown pigmentation. Some of the elvers remain in tidal marshes and in the back bays of barrier beaches or in other similar habitats; some even remain along the open coast, especially where there are beds of eel grass. Others migrate into freshwater, some of them ascending the larger rivers for tremendous distances where they find their way into creeks, lakes and ponds; even scaling waterfalls and traversing land to do so (predominately females).

At this early stage, they are active at night and burrow during the day. They move into the water column on flood tides and return to the bottom during ebb tides. Elvers have been shown to be attracted to the odor of brook water and decaying leaf detritus and microorganisms.

Yellow eel: Upon reaching Age 2 and/or attaining a length of 22 to 31 inches, the eels begin to develop a yellow color and a creamy or yellowish-white belly, and are then known as Yellow eels. At this point they are considered to be sexually immature adults.

In their yellow phase, American eels are mainly nocturnal, swimming and feeding at night. Those that remain in the estuarine environment, continue through their life-cycle more quickly than those that travel up into freshwater. Those that do migrate into freshwater tend to live longer and attain much larger sizes. American eels may stay in this life stage for a period of 20 years or more.

Silver eel: At the approach of sexual maturity, which takes place in the fall, the eels that are in fresh water move downstream, traveling mostly at night. It is during this life stage that the eels undergo amazing physical changes enabling them to return to the ocean.

This metamorphosis is a gradual process, transforming the eel from a shallow water bottom dweller to an oceanic traveler.

- The color of the eels' back changes from olive to almost black, while its sides turn silver.

- The eyes of the males grow to twice their previous size and change in sensitivity toward blue, enhancing the eels' vision in deep water.

- The blood vessels feeding their swim bladders increase in number, allowing increased gas deposition and reduced loss of gas, both critical for buoyancy.

- Fat reserves increase to fuel the long ocean swim.

- They now cease feeding, as do those that have been living in the river mouths, bays, and estuaries; in fact, their gut begins to degenerate.

It is not until after they reach salt water that the ovaries begin to mature.

According to recent European research, eels that are delayed, for example due to barriers or rises in temperature, and are unable to complete their downriver migration can actually reverse these physical changes and regenerate their guts.

Robins et al. in 1979 photographed two *Anguilla* eel, believed to be pre-spawn American eel, at depths of about 6,500 feet in the Bahamas.

The color of the American eel can vary widely depending upon the color of the bottom they inhabit. It has been observed that eels become darker if they are found living on a dark muddy bottom, and paler if they are found inhabiting

lighter colored sand areas. In the laboratory, eels have been observed to change from pale to dark in about 1.5 hours, and from dark to pale in a little more than 3 hours, if moved from a white background to a black or vice versa, under a strong light.

It is now generally believed that most of the eels that are caught in fresh water are females. But some of the females remain in salt marshes and harbors, to judge from the large size of many of the eels that are caught there. Males also appear to be much rarer than females in northern waters. Males may have this distribution to ensure rapid maturation and return to the spawning ground. They do not need to be large to produce adequate amounts of sperm and estuaries are good feeding areas. Females require a delayed maturation as a larger body size results in more eggs. Cold northern and inland waters favor this.

There are different stocks of eels recognized in Canadian waters. Lake Ontario eels can be distinguished from those in St. Lawrence River tributaries and the Maritimes by the presence of "Mirex" a chemical used in insecticides. Pollutants are now a convenient method for stock identification but a sad reflection on the state of the environment.



Eel Orgy by Peter Harrison

-

Size: American eels can grow to 4 feet in length and to 16.5 pounds in weight. Full-grown females average only about 2 to 3.5 feet, with the males averaging much smaller sizes. Any eel greater than 18 inches long is most likely a female and one more than 24 inches long is most certainly a female. The smallest mature males ever found were about 11 to 12 inches long, with the smallest mature females running about 18 inches long. The world, all-tackle IGFA angling record for American eel is an 8.5 pound eel caught in Cliff Pond, Massachusetts in 1992.

Range: American eels range from the coasts and streams of West Greenland, Eastern Newfoundland and the northern side of the Gulf of St. Lawrence, south to the Gulf of Mexico, Panama, the West Indies, and (rarely) to the northern coast of South America.

This includes the freshwater drainages of the Mississippi and Great Lakes basins, and the Hudson Bay drainage of Alberta and Saskatchewan (by introduction).

They can also be found in freshwater on the island of Bermuda.

Most individual eels have a relatively small home range. Recent acoustic tagging studies have shown that they rarely move more than 100 yards from the point of original capture. Amazingly, some eels tagged, transported and released up to 10 miles away from the site of capture, navigated their way back to very near the exact spot they were taken from. It has been suggested that American eels use the geoelectrical fields generated by ocean currents for orientation.

In reference to individual range: It has been suggested that larger eels may establish territories in more productive lower marsh areas and thereby restrict smaller eels to smaller high marsh creeks.

The eels' broad geographic range and diverse habitats suggests that they possess very flexible temperature requirements. The preferred temperature for eels is 62 degrees F. Those inhabiting more northern salt marshes, estuaries and tributary streams, mostly lie inactive in the mud during the winter.

Dissolved oxygen requirements for eels have not been thoroughly documented, but eels generally will select waters that possess high oxygen content. The capacity of the adult eel to survive in both air and water is associated with its ability to use both its gills and its skin for oxygenating its blood. Eels will survive better in air than in poorly oxygenated or polluted water.

Male eels generally remain in or near estuaries and tidal creeks, while females will migrate far inland often to the headwaters of river systems. A recent survey of 52 Lake Champlain, VT/NY eels captured and sexed, resulted in all 52 being female.

Habits: Eels can live out of water so long as to give rise to the story that they often travel overland. There is no positive evidence for this. Although, it has been shown through experiments carried out with European eels marked so as to be recognizable if recaptured, that they can carry out journeys as long as 31 miles along underground waterways to reach secluded impoundments. It is this ability that may explain the presence of eels in ponds that have no visible outlet or inlet, and may be many miles from a stream corridor.

American eels can absorb oxygen through their skin as well as their gills, making it possible for them to travel short distances over land, particularly in wet grass or mud, which may help them move around barriers in streams. Eels also can cover their entire bodies with a thick mucous layer (thought to protect them from

salinity changes as well as desiccation), making them nearly impossible to hold in ones hand; giving rise to the phrase, "slippery as an eel."

When kept in captivity, eels are known to a long time. The celebrated Eel of Ross was caught as an elver in a small Scottish river in 1885 and kept in an aquarium until it died in 1949, having lived for a total of 64 years in captivity.

Feeding: American eels depend on a wide range of food at different life stages and in different habitats. At various times and locations they feed on every level of the food chain.

With their relatively weak jaws and many small teeth, eels have developed an unusual feeding process, with food that cannot be consumed whole or readily broken into pieces; holding on with their mouths, adult eels spin their bodies to break apart food, and have been recorded at 6 to 14 spins per second. In comparison, Olympic ice skaters can spin 5 times per second.

Small fish, fish eggs, shrimps, crabs, lobsters, frogs, insects, worms, and smaller crustacea, together with refuse of any kind are consumed by the scavenger-like eels.

Predators of the American eel include: largemouth bass, striped bass, and other fish eating fish (piscivores), as well as other eels, birds of prey such as bald eagles, osprey, large reptiles such as snapping turtles and alligators, and of course; man.

Conservation status: American eels are targeted by fisherman using weirs, baited setlines, pots, fyke nets, eel traps and hoop nets. Some are speared during winter when they are buried in mud, often through holes drilled in ice covered rivers for this purpose. Few recreational anglers directly target eel. For the most part, eels are caught incidentally by hook and line fishermen when fishing for other species although they are often purchased by recreational fishermen for use as bait for larger gamefish such as striped bass, and some recreational fishermen may catch eels and then use them as bait. The bait of choice used to catch eels via pots is horseshoe crab.

There is both substantive data and anecdotal information that suggest segments of the American eel populations have declined in recent years. The cumulative effects of multiple life stage harvest impact the American eel population.

Several factors contribute to the risk that heavy harvest may adversely affect American eel populations:

- American eels mature slowly, requiring 7 to 30+ years to attain sexual maturity.

- Glass eels aggregate seasonally to migrate.
- Yellow eel harvest is a cumulative stress, over multiple years, on the same year class.
- All eel mortality is pre-spawning mortality. Other factors that may contribute to a possible population decline are:
 - Structures impeding upstream and downstream passage (i.e. dams, spillways, hydro-electric power generation).
 - Increased predation.
 - Habitat loss and degradation.
 - Poor water quality.
 - Variable oceanic conditions.

Many state and federal wildlife agencies are presently installing eel ladders to help American eels overcome high dams and other man-made river obstructions.

A recent concern is the newly formed industry of harvesting oceanic sargassum weed. Sargassum seaweed is currently harvested in U.S. waters by trawling. The harvesting of sargassum began in 1976, but has only occurred in the Sargasso Sea since 1987. Since 1976, approximately 44,800 dry pounds of sargassum have been harvested, 33,500 pounds of which were from the Sargasso Sea (SAFMC 1998).

It is unknown whether this harvest is having direct or indirect influences on American eel mortality. Harvesting sargassum has been eliminated in the south Atlantic EEZ and State waters as of January 1, 2001, through a management plan adopted by the South Atlantic Fisheries Management Council. The extent of eel and/or marine turtle bycatch in these operations is unknown.

And of course; global warming may be playing a significant role in American eel decline.

The drift of leptocephalus larvae from the Sargasso Sea toward the Atlantic coast may be impacted by changes in the ocean currents. Such changes have been predicted to be due to global warming. The potential impact on the drift of larvae is unknown at this time. Currents, primary production, and the potential influence of toxins transferred from the adults to the eggs may have varying degrees of influence upon the success of hatch, larval migration, feeding and growth of American eel populations.

Another potential threat to the overall health of the American eel population is a parasite native to marine and freshwater areas of eastern Asia; the non-indigenous, eel swimbladder nematode (*Anguillicola crassus*). Its native host is the Japanese eel (*Anguilla japonica*). This nematode has been documented to

have significant negative impacts on the European eel (*Anguilla anguilla*), and on American eel in Texas and South Carolina.

American eels are managed under an interstate fishery management plan developed by the Atlantic States Marine Fisheries Commission and implemented in 2001. Management regulations vary by state and involve size limits, reporting requirements, gear restrictions and possession limits in both the commercial and recreational fisheries.

The Atlantic States Marine Fisheries Commission issued a press release on March 10, 2004 in regard to actions they feel may be required to protect declining American eel populations. Below is an excerpt from the ASMFC press release:

"The Commission also recommended that the US Fish and Wildlife Service and the National Marine Fisheries Service consider American eel in the Lake Ontario/St. Lawrence River/Lake Champlain/Richelieu River system as a candidate for listing as a Distinct Population Segment under the Endangered Species Act. The Board also recommended that the USFWS and the NMFS consider designating the entire coast-wide stock as a candidate for listing under the ESA."

Total commercial landings of American eel along the U.S. Atlantic coast in 2005 were 427 metric tons, an increase from 324 metric tons in 2004.

Eels should be cleaned with care as their blood has in it a mild neurotoxin which can affect humans but is destroyed in the process of cooking.

Eel, thought to be one of the first "native" foods to be introduced to starving colonists from *The Mayflower*, fell out of popularity in America during the early to mid 20th century. Eels persist today as an extremely popular food item in Europe and Asia, especially in Japan and Spain. Recently, eels have begun gaining favor with American palates again, served mainly as sushi.

Jellied eels are a traditional English dish that originated in the 18th century, primarily in London's East End. The dish consists of chopped eels boiled in a spiced stock that is allowed to cool and set, forming a jelly. It can be eaten hot or cold.

Photo Credits and Permissions:

Glass Eels by Uwe Kils by permission under Wikimedia Commons. Permission is granted to copy, distribute and/or modify this document under the terms of the [GNU Free Documentation License](#), Version 1.2 or any later version published by the Free Software Foundation; with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts.
Subject to [disclaimers](#).

Eel Orgy by Peter Harrison reproduced under Creative Commons Attribution 2.0 License (link to <http://creativecommons.org/licenses/by/2.0/>)

Elverts on Rocks by Tim Watts published with permission of Tim Watts at glooskapandfrog@verizon.net.

References:

This article draws freely from Henry Bigelow and William Schroeder's classic "Fishes of the Gulf of Maine", fishery bulletin 74, Vol. 53 1953, and from Bernard Ludwig Gordon's, "The Secret Lives Of Fishes" 1977 Grosset and Dunlap publishers, New York, NY, two books that any fish lover must have on their bookshelf.

David, S. 2000. "Anguilla rostrata" (On-line), Animal Diversity Web. Accessed January 10, 2009 at:
http://animaldiversity.ummz.umich.edu/site/accounts/information/Anguilla_rostrata.html.

Schweid, David. Consider the EEL. University of North Carolina Press 2002, chapel, Hill & London

<http://www.briancoad.com/NCR/Anguillidae.htm>
<http://www.nefsc.noaa.gov/sos/spsyn/op/eel/>

Rostrata reference:

<http://www.fws.gov/northeast/AmEel/facts.html>
http://www.fws.gov/r5crc/american_eel_program.htm
<http://www.asmfcr.org/speciesDocuments/eel/fmps/eelFMP.pdf>
<http://www.giuliodedeo.it/AFS-Index.html>
<http://www.maine.gov/dmr/rm/eel.html>
<http://www.glooskapandthefrog.org/eel%20challenge.htm>
<http://www.asmfcr.org/speciesDocuments/eel/eelHabitatFactsheet.pdf>
<http://www.asmfcr.org/speciesDocuments/eel/stockStatus.pdf>
<http://www.asmfcr.org/speciesDocuments/eel/eelProfile.pdf>

http://www.asmf.org/speciesDocuments/eel/fmps/addendum%20II_AmericanEel_FINAL.pdf
<http://en.wikipedia.org/wiki/File:Glasseelkils.gif>
<http://query.nytimes.com/gst/fullpage.html?res=9C0CE6DD113DF933A05757C0A9659C8B63&sec=travel>