Fish migration

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Many types of **fish migrate** on a regular basis, on time scales ranging from daily to annually or longer, and over distances ranging from a few metres to thousands of kilometres. Fish usually migrate to feed or to reproduce; in other cases the reasons are unknown.

Many species of salmon are anadromous and migrate long distances up rivers and streams to spawn

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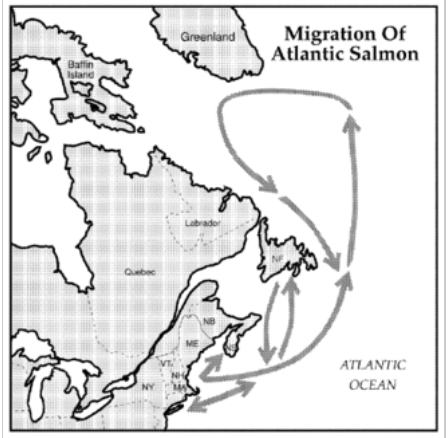
Classification

As with various other aspects of fish life, zoologists have developed empirical classifications for fish migrations.[2] Two terms in particular have been in long-standing wide usage:

- **Anadromous** fishes migrate from the sea up (Greek: ἀνά 'ana', up and δρόμος 'dromos', course) into fresh water to spawn, or stay entirely in sea water and migrate upstream to spawn.[3]
- **Catadromous** fishes migrate from fresh water down (Greek: κατά 'kata', down and δρόμος 'dromos', course) into the sea to spawn, or stay entirely in fresh water and migrate downstream to spawn.[4]



Ocean migration of Atlantic salmon from Connecticut River[1]

In a 1949 journal article, George S. Myers coined the inclusive term ***diadromous*** to refer to all fishes that migrate between the sea and fresh water. Like the two well known terms, it was formed from classical Greek ([dia], "through"; and [dromous], "running"). *Diadromous* proved a useful word, but terms proposed by Myers for other types of diadromous fishes did not catch on. These included *amphidromous* (fishes that migrate from fresh water to the seas, or vice versa, but not for the purpose of breeding), *potamodromous* (fishes whose migrations occur wholly within fresh water), and *oceanodromous* (fishes that live and migrate wholly in the sea).[2][5]

Although these classifications were originated for fishes, they are in principle applicable to any aquatic organism.

Forage fish

Forage fish often make great migrations between their spawning, feeding and nursery grounds. Schools of a particular stock usually travel in a triangle between these grounds. For example, one stock of herrings have their spawning ground in southern Norway, their feeding ground in Iceland, and their nursery ground in northern Norway. Wide triangular journeys such as these may be important because forage fish, when feeding, cannot distinguish their own offspring.

Migration of Icelandic capelin

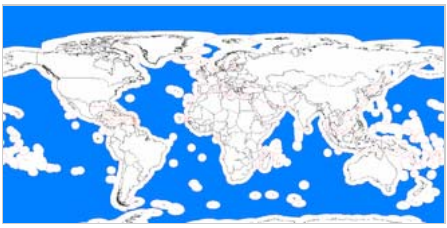
Capelin are a forage fish of the smelt family found in the Atlantic and Arctic oceans. In summer, they graze on dense swarms of plankton at the edge of the ice shelf. Larger capelin also eat krill and other crustaceans. The capelin move inshore in large schools to spawn and migrate in spring and summer to feed in plankton rich areas between Iceland, Greenland, and Jan Mayen. The migration is affected by ocean currents. Around Iceland maturing capelin make large northward feeding migrations in spring and summer. The return migration takes place in September to November. The spawning migration starts north of Iceland in December or January.

The diagram on the right shows the main spawning grounds and larval drift routes. Capelin on the way to feeding grounds is coloured green, capelin on the way back is blue, and the breeding grounds are red.

In a paper published in 2009, researchers from Iceland recount their application of an interacting particle model to the capelin stock around Iceland, successfully predicting the spawning migration route for 2008.[6]

Highly migratory species

The term **highly migratory species** (HMS) has its origins in Article 64 of the United Nations Convention on the Law of the Sea (UNCLOS). The Convention does not provide an operational definition of the term, but in an annex (UNCLOS Annex 1) lists the species considered highly migratory by parties to the Convention.[7] The list includes: tuna and tuna-like species (albacore, bluefin, bigeye tuna, skipjack, yellowfin, blackfin, little tunny, southern bluefin and bullet), pomfret, marlin, sailfish, swordfish, saury and oceangoing sharks, dolphins and other cetaceans.


The high seas, highlighted in blue, are the seas which are outside the 200 mile exclusive economic zones

These high trophic level oceanodromous species undertake migrations of significant but variable distances across oceans for feeding, often on forage fish, or reproduction, and also have wide geographic distributions. Thus, these species are found both inside the 200 mile exclusive economic zones and in the high seas outside these zones. They are pelagic species, which means they mostly live in the open ocean and do not live near the sea floor, although they may spend part of their life cycle in nearshore waters.[8]

Highly migratory species can be compared with straddling stock and transboundary stock. Straddling stock range both within an EEZ as well as in the high seas. Transboundary stock range in the EEZs of at least two countries. A stock can be both transboundary and straddling.[9]

Other examples

Some of the best-known anadromous fishes are the Pacific salmon species, such as Chinook (king), coho (silver), chum (dog), pink (humpback) and sockeye (red) salmon. These salmon hatch in small freshwater

streams. From there they migrate to the sea to mature, living there for two to six years. When mature, the salmon return to the same streams where they were hatched to spawn. Salmon are capable of going hundreds of kilometers upriver, and humans must install fish ladders in dams to enable the salmon to get past. Other examples of anadromous fishes are sea trout, three-spined stickleback, and shad.

Several Pacific salmon (Chinook, coho and Steelhead) have been introduced into the US Great Lakes, and have become potamodromous, migrating between their natal waters to feeding grounds entirely within fresh water.

The most remarkable catadromous fishes are freshwater eels of genus *Anguilla*, whose larvae drift from spawning grounds in the Sargasso sea, sometimes for months or years, before entering freshwater river and streams as glass eels or elvers (see *eel life history*).

Life cycle of anadromous fish. From a U.S. Government pamphlet. (Click image to enlarge.)

An example of a euryhaline species is the bull shark, which lives in Lake Nicaragua of Central America and the Zambezi River of Africa. Both these habitats are fresh water, yet bull sharks will also migrate to and from the ocean. Specifically, Lake Nicaragua bull sharks migrate to the Atlantic Ocean and Zambezi bull sharks migrate to the Indian Ocean.

Diel vertical migration is a common behavior; many marine species move to the surface at night to feed, then return to the depths during daytime.

A number of large marine fishes, such as the tuna, migrate north and south annually, following temperature variations in the ocean. These are of great importance to fisheries.

Freshwater (potamodromous) fish migrations are usually shorter, typically from lake to stream or vice versa, for spawning purposes. However, potamodromous migrations of the endangered Colorado pikeminnow of the Colorado River system can be extensive. Migrations to natal spawning grounds easily be 100 km, with maximum distances of 300 km reported from radiotagging studies.[10] Colorado pikeminnow migrations also display a high degree of homing and the fish may make upstream or downstream migrations to reach very specific spawning locations in whitewater canyons.[11]

Historic exploitation

Since prehistoric times humans have exploited certain anadromous fishes during their migrations into freshwater streams, when they are more vulnerable to capture. Societies dating to the Millingstone Horizon are known which exploited the anadromous fishery of Morro Creek[12] and other Pacific coast estuaries. In Nevada the Paiute tribe has harvested migrating Lahontan cutthroat trout along the Truckee River since prehistoric times. This fishing practice continues to current times, and the U.S. Environmental Protection Agency has supported research to assure the water quality in the Truckee can support suitable populations of the Lahontan cutthroat trout.

See also

- Animal navigation
- Hydrology transport model
- Ocean Tracking Network
- Pacific Ocean Shelf Tracking Project
- Tagging of Pacific Predators
- The Blue Planet

Notes

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7. United Nations Convention on the Law of the Sea: Text (http://www.un.org/Depts/los/convention_agreements/texts/unclos/closindx.htm)
8. Pacific Fishery Management Council: Background: Highly Migratory Species (http://www.pcouncil.org/highly-migratory-species/background/)
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References

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- Appendix A: Migratory Fish Species in North America, Europe, Asia and Africa (http://www.idrc.ca/en/ev-58888-201-1-DO_TOPIC.html) in Carolsfield J, Harvey B, Ross C and Anton Baer A (2004)*Migratory Fishes of South America* World Fisheries Trust/World Bank/IDRC. ISBN 1-55250-114-0.

Further reading

- Ueda H and Tsukamoto K (eds) (2013) *Physiology and Ecology of Fish Migration* (http://books.google.co.nz/books?hl=en&lr=&id=ohwbAAAAQBAJ&oi=fnd&pg=PP1&dq=%22Physiology+and+Ecology+of+Fish+Migration%22&ots=CideKlYj3p&sig=2f90IxqVSKHpV5IyJ5iQKfMAnMI#v=onepage&q=%22Physiology%20and%20Ecology%20of%20Fish%20Migration%22&f=false) CRC Press. ISBN 9781466595132.

External links

- United Nations: Introduction to the Convention on Migratory Species (http://www.cms.int/about

/intro.htm)
- Living North Sea (http://www.livingnorthsea.eu/) – International project on tackling fish migration problems in the North Sea Region
- Fish Migration Network (http://www.linkedin.com/groups?mostPopular=&gid=1215847) – Worldwide network of specialist working on the theme fish migration

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Categories: Ichthyology | Aquatic ecology | Fisheries | Animal migration

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