Migration

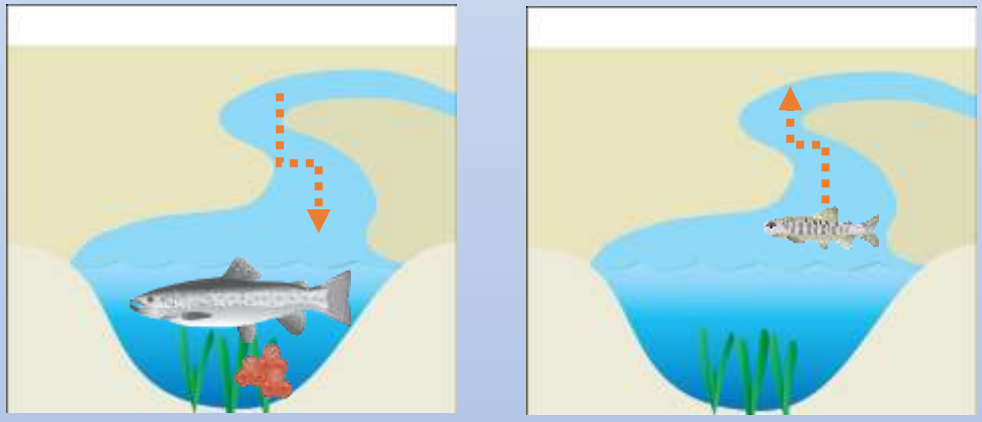
— Types of migration —

Migration is the movement of animals on a regular basis. Some migrations may occur within a day, some migrations occur annually. Often fish will migrate to feed, reproduce or as part of the life cycle and a significant portion of a stock will migrate at the same time. **Immigration** is the movement of animals into a population, while **emigration** is the movement of animals out of a population.

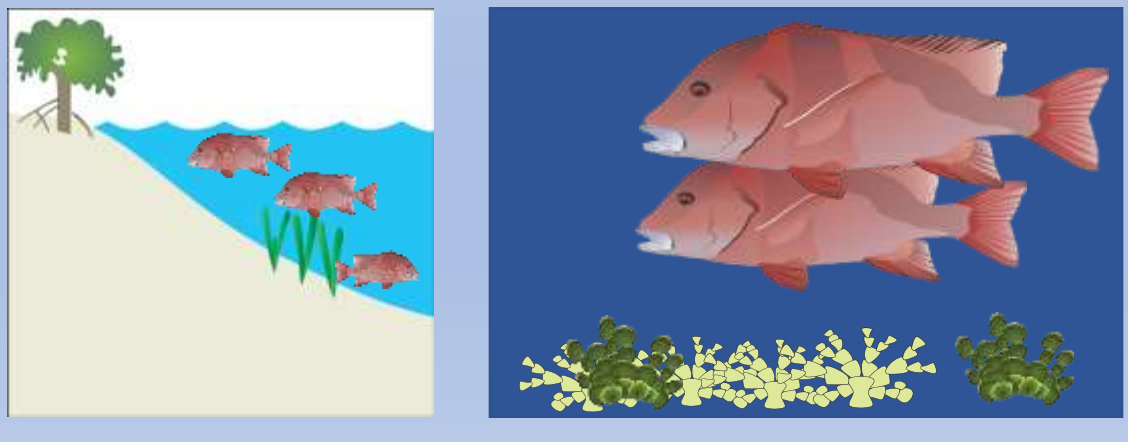
There are several types of migration:

Seasonal: Fish that seasonally migrate often are following a food source, ocean currents or temperature changes. Seasonal migrations can last several months.

Spawning: Fish migrate to have more successful reproduction. Sometimes this means returning to the rivers and streams where they hatched.



Salmon will migrate up streams to spawn. The young that hatch will navigate back to the ocean and only return to the stream when mature to spawn.

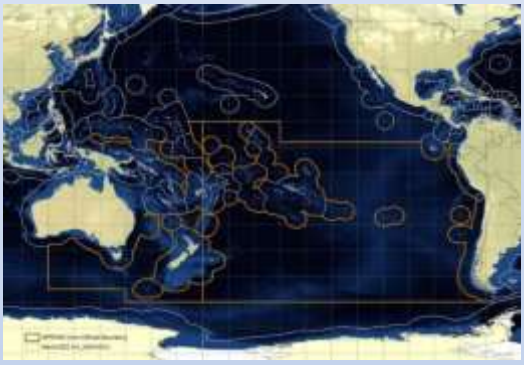


Red emperor spawn in deep, offshore habitats and their young drift inshore to grow up in safer nursery environments near mangroves and seagrass habitats, eventually returning to deeper habitats as they grow.

Migration

— Types of migration —

- **Highly migratory species**: fish that have wide geographic distributions and move between the jurisdictions of multiple countries. This presents extra challenges for management as decisions made in one country might affect the stock as it migrates beyond the country's fishing boundaries. Many highly migratory species are high value, sought-after species such as tuna and swordfish. Some of these species spend time in the 'high seas', areas not allocated to a country, and some stocks are termed straddling or transboundary stocks.



- **Vertical**: many fish participate in a daily vertical migration. Plankton, a source of food for many fish, move up to the surface at night and then to the seafloor during the day. Fish feeding on the plankton will follow this pattern.

- **Diadromous**: fish move between saltwater and freshwater (e.g. bull sharks)
- **Anadromous:** fish move from saltwater to freshwater (e.g. salmon)
- **Catadromous:** fish move from freshwater into marine environment (e.g. eels, barramundi, Australian bass).

Illustrations courtesy of the Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/symbols/)

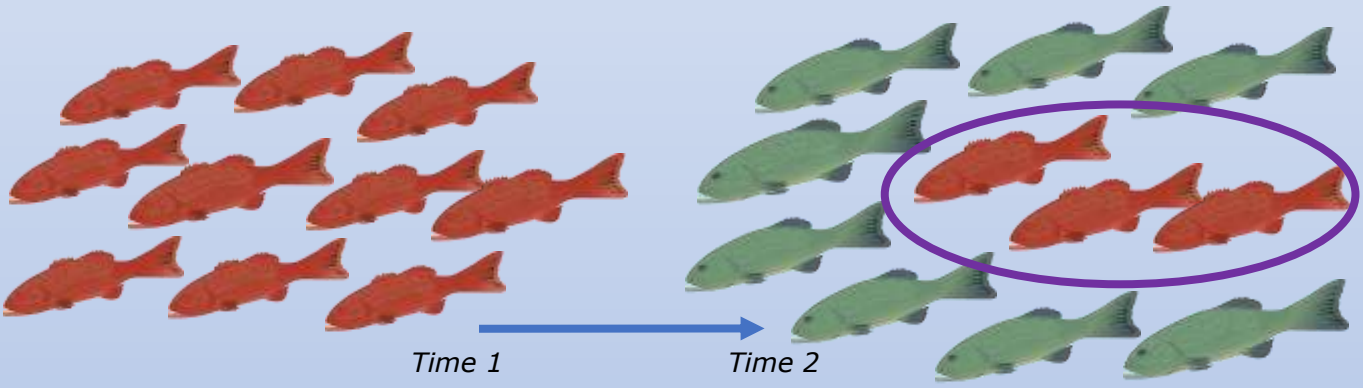
Migration

Measuring migration

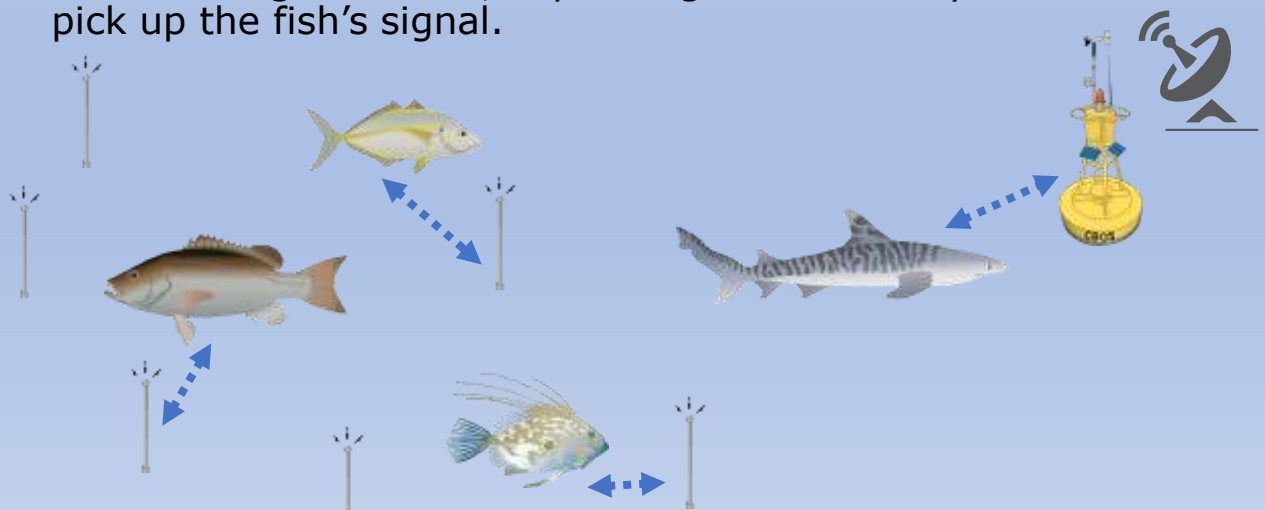
Tracking animals in aquatic environments is not easy and methods often require large effort or funding.

Some methods to measure migration:

Tag-recapture: A portion of the population is captured, **tagged** and then released. Later, after the population has re-distributed, another portion is captured and the number of tagged individuals **recaptured** is counted. This gives an estimate of the individuals that have survived based on the capture probability, or what proportion of the population has moved to a particular area.



- **Acoustic tracking**: An acoustic (sound-emitting) tag is placed either internally in or externally on the fish. Scientists can either actively (follow the tagged fish) or passively 'listen' to the fish as it moves using an array of **underwater acoustic receivers**. When a tagged fish moves close enough to a receiver, it will create a signal. Researchers can then track fish migrations over short or long distances, depending on how many receivers can pick up the fish's signal.



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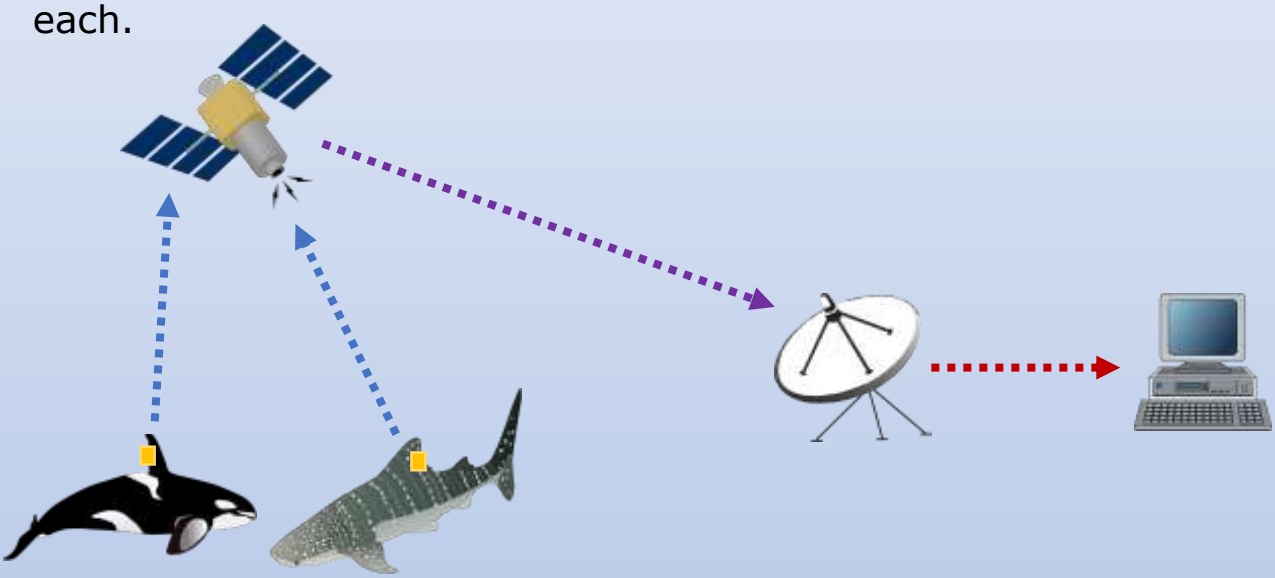
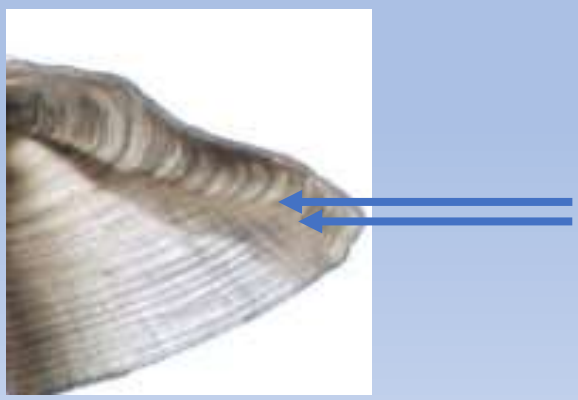
Migration

Measuring migration

- **Satellite tags**: A transmitter-tag attached to an animal can send signals to an array of satellites in orbit and relay the signal back to researchers. This technique is good for animals that migrate long distances. Animals have to come to the surface to send the signal. Alternatively, archival tags will accumulate data and pop-off after a certain programmed amount of time, where it floats to the surface and is retrieved for the researcher to download the data. Satellite tags can cost thousands of dollars each.



- **Otolith chemistry**: Scientists can measure the timing of migration by looking at how and where the chemistry changes in the fish ear-bone (otolith). By comparing the chemical composition at different sections of the otolith to the chemical composition in different water bodies (e.g. bays and inlets) the timing of migration, including the frequency and duration can be determined. This is an expensive technique, limiting how many samples can be analysed.



The otolith grows layers over time, similar to tree-rings. By looking at how the chemistry changes throughout the otolith, scientists can find which water bodies the fish lived in, and how long they stayed there.

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