**Background Information**

**Migration** - The large scale movement of an animal species from one place to another. They are usually related to seasonal changes in weather and feeding patterns or mating and breeding patterns. Migration is a response to the instinct for survival.

**Types of Migration:**
- *Irruptive migration* - species move from one place to the next when they’ve exhausted the food supply in one area.
- *Complete migration* - when every member of a species migrates
- *Partial migration* - when some members of a species stay in an area while others migrate
- *Altitudinal migration* - When animals that live at high altitudes move to lower altitudes during colder seasons
- *Removal migration* - migration due to a major change in the environment or climate. This can occur with human development.
- *Seasonal migration* is migration that corresponds with the change in seasons. Most migration fall within this category. Many altitudinal, longitudinal, latitudinal, and reproductive migrations take place when the seasons change.
- *Latitudinal migration* is the movement of animals north and south.
- *Reproductive migration* is the movement of animals to bear young.

**What cues an animal to migrate?**
- Daylight changes - As the days get shorter instincts tell animals to move south.
- Temperature
- Internal Cues - such as fat reserves in the body
- Circadian rhythm - internal calendars that signal the time to migrate

**How do animals navigate when migrating?**
- The sun - starlings and ants
- Landmarks - whales
- Moon and stars - birds
- Scent - salmon finding spawning ground
- Weather - birds fly downwind
- Magnetic field - bats and sea turtles

<table>
<thead>
<tr>
<th>Table 1. Guinness records held by animal migrants</th>
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<tbody>
<tr>
<td>Smallest migrant</td>
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<td>Largest migrant</td>
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<td>Longest mammal migration</td>
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<td>Longest insect migration</td>
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<td>Longest recorded round-trip</td>
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<td>Highest migration altitude</td>
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Source: Hoare 2009, Egevang et al. 2010
Information about marine animal tracking and tagging

Marine animals are widely distributed throughout the ocean. Some migrate and inhabit many different waters while others confine themselves to one small area. Migration is a regular journey between one region and another, usually associated with seasonal changes or breeding and feeding cycles. Polar bears, sea otters, pinnipeds (seals), cetaceans (whales), sirenians (manatees), birds, turtles and many other animals migrate as part of their life cycles.

Why track marine animals?

One of the many goals of animal migration research has been to determine where the animals are going, but researchers also want to know why they are going “there”. Researchers not only look at the animals’ migration but also what is between point a and point b to determine if a species is moving to new locations based on food density, a change in water temperature, and the animal’s ability to adapt to these changes.

Tracking migrations is an important tool to better understand and protect species. For example, Florida manatees are an endangered species, and therefore they need protection. Radio tracking showed that Florida manatees may travel as far as Rhode Island when they migrate. This information suggests that the manatees may need protection along much of the Atlantic Coast of the United States not just in Florida.

Some types of tags used to track animals

Non-electronic

Fin tags (Rototag) The Rototag is a two piece, plastic cattle ear tag which is inserted through the first dorsal fin of a shark. These tags were primarily used by National Marine Fisherie Service (NMFS) biologists on small sharks during the first few years of the Cooperative Shark Tagging Program.

Dart tags (M tag) The dart tag is composed of a stainless steel dart head, monofilament line, and a plastic capsule containing a waterproof legend with return instructions printed in English, Spanish, French, Japanese and Norwegian. These dart tags, in use since 1965, are implanted in the back musculature near the base of the first dorsal fin.

Numbered dart tags from NMFS are sent to volunteer participants on self-addressed return post cards for recording tagging information (date, location, gear, size and sex of shark), along with a tagging needle, tagging instructions, current management information, and shark ID placards. Recoveries of data are made opportunistically by recreational and commercial fishermen. When a previously tagged shark is recaptured, information similar to that obtained at tagging is requested from the recapturer.

Electronic

Archival

Archival tags are small data loggers that record dates, times, swim depths, water temperatures, body temperatures and light levels every few seconds for up to 10 years. Light levels are used to calculate an approximate daily position of the tagged animal based on the time of dawn and dusk and the angle of the sun.

Archival tags can be attached externally or internally and can be programmed to detach. They must be retrieved for their data to be downloaded and are used most commonly on species that have a high likelihood of recapture – either through fishing, or upon return visits to breeding and feeding grounds – such as fish, seabirds, sea turtles and marine mammals.
Species studied with archival tags include:

- **Juvenile Bluefin tuna** - Tagging has shown information about their diving patterns and feeding events (marked by sharp drops in body temperature as food and cold water enter the stomach) as well as Juvenile and adult Atlantic Bluefin tuna migration between spawning grounds and feeding grounds.

- **Sooty shearwaters** migration from New Zealand to feeding grounds off Japan, Alaska and California. Tracks show that shearwaters fly across the entire Pacific Ocean in a figure-of-eight pattern that entails an annual migration circuit of 55 000–75 000 kilometers.

- **Migrations of fish**, such as plaice and cod, and revealed new information on behavior, temperature and population distribution.

*Images of diving and feeding behavior of a southern Bluefin tuna*  
*Credit: CSIRO Australia*

**Pop-up satellite archival**

Pop-up archival transmitting tags are externally placed tags that are pre-set to detach, rise to the surface and transmit data summaries by radio to the Argos satellite network. This network collects, processes and disseminates environmental data, and has a special channel dedicated to wildlife telemetry.

These tags have been deployed on animals such as tuna, marlin, sharks, swordfish, mola mola, halibut, eels and sea turtles. They have shown that White sharks have a mixture of coastal ‘patrolling’ behavior and prolonged, direct coastal and ocean migrations.

**Satellite positioning tags**

Satellite positioning tags are attached externally on animals and transmit a signal either to the Argos satellite system or the GPS satellite system, which determines the position of the tag, providing near real-time tracking of the animal’s movements. Because the tag antenna must be above the water to transmit a signal, these tags are deployed on animals that spend sufficient time at the ocean surface. Some versions of these tags transmit summaries of data on swimming depth, water temperature and salinity.

They are most commonly used on animals such as marine mammals, sea turtles, seabirds and some species of sharks. They are deployed on marine mammals such as elephant seals to track diving behavior and foraging activity, and to build profiles of oceanographic features in remote parts of the world’s southern and northern oceans and map successful foraging locations.

**GSM (GPS) Tags**

GSM tags use the Global System for Mobile communications (GSM) network to transmit recorded data. They can do this when the tagged animal enters coastal waters within the range of a GSM receiver and have so far mainly been used with marine mammals, although trials have been conducted with basking sharks. For animals that come to the surface, accurate positions can be obtained by using a GSM tag in conjunction with Fastloc GPS, which collects the data required for a GPS location within a fraction of a second. Development is less advanced than with tags that transmit to satellite.
Acoustic Tags
Acoustic tags can be attached externally or internally. They transmit a unique code at regular intervals which, when in range, is logged by an electronic receiver on the seabed, or a hydrophone operated from a vessel. They also can transmit water temperature, depth and swim speed.

Acoustic tags commonly are used to record the extent to which an animal uses a particular area, and how this behavior may change over time. They are suited to research on any species to which a transmitter can be attached or implanted without modifying its behavior, such as fish, sharks, crustaceans and squid.

Acoustic receivers, or ‘listening stations’ can record the presence of hundreds of animals tagged with acoustic transmitters with a location accuracy of one to two metres. Their range can be extended to hundreds of kilometers by placing multiple receivers in grids or lines.

Digital acoustic recording tags
The digital acoustic recording tag (D-tag) is a motion and acoustic recording tag attached to the animal by a suction cup (most commonly to whales). It records all sounds made and heard by the tagged animal(s), and also contains a digital compass, a temperature sensor, a pressure sensor to measure dive depth, and a three-axis accelerometer to measure pitch and roll.

D-tags are being used to characterize whale movements and sub-surface behavior, including the kinds of vocalizations used while diving and foraging, and their responses to human activities. Combining D-tag data with geospatial data and bottom topography, gives a three-dimensional picture of how whales react to sounds and assists in forming plans to reduce threats from fishing gear, ship strike, and sonar.

More Information on Marine Animal Migration

- **“Shark Tagging & Tracking: Separating Fact from Fiction”**
  - [http://voices.nationalgeographic.com/2014/01/30/shark-tagging-tracking-separating-fact-from-fiction/](http://voices.nationalgeographic.com/2014/01/30/shark-tagging-tracking-separating-fact-from-fiction/)
- **Ocean specific types of migration:**
Afterschool Project #2 - Marine Animal Migration (continued - page 4)

Marine Animal Tagging Online Resources

**General Tagging**

*Tagging of Pacific Pelagics:* The Global Tagging of Pelagic Predators (GTOPP) program is an international, multidisciplinary collaboration among biologists, engineers, computer scientists and educators, which will allow users to view and interact with animal tracking data, as well as oceanographic datasets, to marine life observation.

  http://www.gtopp.org/

*Ocean Tracks:* Ocean Tracks provides access to authentic data collected by migrating marine animals, drifting buoys, and satellites, along with tools that allow you to display and analyze these data to investigate current and important scientific questions about animal interactions with the ocean environment.

  http://oceantracks.org/

*Wildlife Tracking:* many different marine animals:

  http://www.wildlifetracking.org/googleocean.shtml

*NOAA satellite and information service* (Argos Data Collection System Used for satellite tag tracking):

  http://noaasis.noaa.gov/ARGOS/

**Sharks:**

*NMFS Cooperative Shark Tagging Program*

  http://nefsc.noaa.gov/nefsc/Narragansett/sharks/tagging.html

*OCEARCH:* OCEARCH is a non-profit organization with a global reach for unprecedented research on great white sharks and other large apex predators.

  http://www.ocearch.org/

*Conservation of Migratory Sharks Memorandum of understanding:* The Memorandum of Understanding (MOU) on the Conservation of Migratory Sharks is the first global instrument for the conservation of migratory species of sharks. A good listing of major shark tagging projects

  http://sharksmou.org/shark-tagging-projects

*Tagging of Pacific Pelagics:* The Global Tagging of Pelagic Predators (GTOPP) program is an international, multidisciplinary collaboration among biologists, engineers, computer scientists and educators, which will allow users to view and interact with animal tracking data, as well as oceanographic datasets, to marine life observation.

  http://www.gtopp.org/

*The Ocean Tracking Network:* Enabling international sustainable management of valued aquatic species by providing knowledge of animal movements, survival, and habitats and of how all are linked to environmental conditions. Fostering technological and operational innovation that will revolutionize our management of the ocean.

  http://oceantrackingnetwork.org/

  http://oceantrackingnetwork.org/tracking-blue-sharks/

Learn more at www.BlueWorldTV.com!
Whales, dolphins and porpoises:

WhaleNet: WhaleNet coordinates the Satellite Tagging Observation Program - STOP. The goal is to enable students to participate, with scientists, in unique research using advanced technologies. This unique program uses advanced satellite technology and telecommunications to monitor and research the actual migration patterns and movements of selected species of whales and marine animals.

http://whale.wheelock.edu/whalenet-stuff/stop_cover_archive.html - a listing of archived tag information

http://whale.wheelock.edu/whalenet-stuff/stop_cover.html active tags

NOAA Fisheries: Northwest Fisheries Science Center - Killer whales - The scientists of the Northwest Fisheries Science Center conduct leading-edge research and analyses that provide the foundation for management decisions to protect, recover, restore, and sustain ecosystems and living marine resources in the Pacific Northwest.

http://www.nwfsc.noaa.gov/research/divisions/cb/ecosystem/marinemammal/satellite_tagging/

Center for Coastal Studies: The Humpback Whale Studies Program is the longest continuous research program at CCS. It is also one of the most detailed and long-term studies of a baleen whale population.

http://coastalstudies.org/programs/humpback-whale-research/satellite-tagging/

Pinnipeds (seals and sea lions):

Friends of the Elephant seal: Friends of the Elephant Seal is a non-profit organization dedicated to educating people about elephant seals and other marine life

http://www.elephantseal.org/E-Seals/tagging.html

Sea Mammal Research Unit, St Andrews University: SMRU is a Natural Environment Research Council (NERC) Collaborative Centre that provides the UK’s main science capability in the field of marine mammal biology.

http://smub.st-and.ac.uk/

Northeast Fisheries Science Center: Marine mammal researchers from the Northeast U.S. and Canada plan to capture, tag, sample, and release adult gray seals on Cape Cod as part of ongoing research to learn more about the gray seal population, including their movements, habitat use, health and diet.


Seal Track: Irish researchers from UCC, working with world leading experts in marine mammal research from the Sea Mammal Research Unit in Scotland are using sophisticated tags to study Harbour and Grey seals offshore movements and behaviour. The tags use a novel telemetry system (fast acquisition GPS) together with mobile phone technology to relay the information back to a base phone.

http://sealtrack.ucc.ie/

Alaska Department of Fish and Game Ice Seal & Walrus Research: Four species of Alaskan seals that are associated with sea ice during some part of each year are often called “ice seals.” These are ringed, bearded, spotted, and ribbon seals and they are important species to coastal communities for food and skins and they are important to the Arctic marine ecosystem.

Ice Seal: http://www.adfg.alaska.gov/index.cfm?adfg=marinemammalprogram.icesealmovements


Learn more at www.BlueWorldTV.com!
Manatee:
*Manatee Rescue & Rehabilitation Partnership;* Individual manatee tracking
  http://manatees.mapntracker.com/wildtracks/

Turtles:
*Wildlife Tracking*  
  http://www.wildlifetracking.org/googleocean.shtml

*Seaturtle.org:*  
  http://www.seaturtle.org/

*Euro census of Marine Life*  
  http://www.eurocoml.org/science/european-projects
  http://www.jellyfish.ie/turtle.asp - Leatherback turtle tagging

Fish
*Pelagic Fisheries Research Program, University of Hawaii at Manoa:*  
  http://www.soest.hawaii.edu/PFRP/overview.html

*Tuna Research and Conservation Center:* The Tuna Research and Conservation Center is a collaboration between Stanford University’s Hopkins Marine Station and The Monterey Bay Aquarium. The mission of the Tuna Research and Conservation Center (TRCC) is to advance the knowledge and understanding of tunas and other highly migratory marine fishes through research, education, and conservation.
  http://www.tunaresearch.org/
Research Project

Materials:
- Internet access
- Notebook
- Poster presentation supplies

STUDENTS

Whole after school group: Take all animals that are possible to track and put them into a food web. You can add a critical animal that isn’t listed.

Teams of students: Decide the animal (s) to track.

Research this animal to determine diet, predators, life cycle, habitat and write up a summary of this information.

The checklist below will help you to gather all of the necessary information. Keep a list of your sources for a bibliography.

1. Common and scientific name of the species
2. Where the animal can be found
3. Size and physical description of the animal
4. Feeding behaviors and predator/prey relationships (What does the animal eat? What other animals eat your animal?)
5. The features of the animal’s ecosystem—including living and nonliving things
6. When and where does breeding takes place and how young animals survive.
7. Human or environmental threats to the species
8. Any other interesting or unusual information about your animal
9. The usual migration patterns and routes of your animal if applicable.

Develop a list of possible research questions that will be investigated by looking at the data from tagged animals. Review this list with your teacher to determine your final research question.

You should also generate a hypothesis as to the outcome of the analysis.

Some possible ideas are:
1. Do marine animals migrate?
2. Do all of the animals of a species move together or independently?
3. Do predator and prey move together?
4. What causes a particular animal to migrate?

Review the tracking data from your animal(s). Take notes on these aspects.

1. How far did the animal travel during the time your group was tracking it?
2. Near what political features (countries, states, islands, etc) did your animal travel?
3. What questions do you have about the animal’s movements?
4. Do you need more information?
5. Does analyzing the data answer your research question?
6. What are your conclusions about your research questions? Was your hypothesis correct?

Each small group should present its findings for the marine animal species, migration patterns as a poster presentation and also prepare a short presentation to explain the research. Presentations should be about 3-5 minutes.