WhaleNet's Satellite Tagging Observation Program

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. Students and educators work in conjunction with international research organizations such as the New England Aquarium in Boston, Massachusetts; the National Aquarium in Baltimore, Maryland; the Mingan Island Cetacean Study in Longue Pointe de Mingan, Quebec; the Duke University Marine Lab, in Beaufort, North Carolina; the Gray's Reef National Marine Sanctuary, in Savannah, Georgia; and Allied Whale, College of the Atlantic in Bar Harbor, Maine. Students and educators can access and use the data and information from these satellite tags through WhaleNet.

WhaleNet makes available information from as many as 12 satellite tags each year. Already in the satellite tag archives are data from a Northern Right Whale named "Metompkin" that became entangled in fishing equipment off the coast of Georgia; two blue whales feeding in the Gulf of St. Lawrence; two hooded seals "Stephanie" and "Kiwi", on their migrations to polar waters; one elephant seal "Mac" diving off the California coast; three loggerhead turtles "Aerial", "Annie" and "Isabelle" swimming off the southeast U.S. near their nesting areas; and a number of harbor porpoises in the Bay of Fundy .

As WhaleNet progresses they hope to have more satellite tags on right whales, blue whales, humpback whales, fin whales, and sperm whales. They are also planning to tag more harbor and hooded seals, when released by the New England Aquarium and the New Jersey Marine Mammal Stranding Network.

To access satellite tracking data go directly to the following website:
http://whale.wheelock.edu/whalenet-stuff/stop_cover.html

To access blank maps for tracking activities visit the following website:
http://whale.wheelock.edu/whalenet-stuff/MAPSindex/

The Importance of Satellite Tracking for Marine Mammals

If we can determine where the whales and marine mammals travel, where they feed and where they give birth, more informed decisions can be made about how humans use these same areas. For example, war games and other military maneuvers can be moved from critical habitats. Commercial uses of the ocean can be managed more effectively, such as moving navigation channels, controlling when the channels are used, limiting the speed of vessels or providing early warning information for mariners so they can avoid disturbances or collisions. The Right Whale Early Warning System is an example of how this information can be collected and used.

Learning more about the diving behavior of marine animals can reveal whether an animal is at risk of becoming entangled in certain types of fishing gear. Fishing management decisions can then be made about where and when to fish to minimize incidental catch and mortality of whales and other marine mammals.

With the recent advances in electronic sensors and transmitters, marine mammal tags have taken a quantum leap in the amounts and types of data they can provide. Tags with a variety of sensors can be attached to animals to learn about the biology of the animal and about the environment in which the animal lives. (Watch WhaleNet's movie on the tagging of sperm whales in the Azores.)

In addition, satellite tag studies have been conducted on released rehabilitated animals that were rescued after stranding. Although these animals may not behave as if they are fully wild, the tags can provide information about the animal after release, such as its survival. Also these tags provide an opportunity to test the satellite transmitters, and to correlate the tag's data with oceanographic and remote sensing data collected from other sources. Ten months of data was sent by the satellite tag on Stephanie, a hooded seal rehabilitated by the New England Aquarium.

With the use of satellite tags, we gain important insights into the animal's use of its habitat, range of movements, birthing areas and more. This gives us more insights into the natural history of the animal and enables more intelligent and meaningful decisions about our uses of the oceans. Understanding the full range of an animal's habitat requirements can allow us to better manage and protect those areas, which will increase the potential for recovery and for an improved coexistence in this shared marine environment.

Satellite Tag Data Analysis Guidelines

How to interpret the satellite tagging data and use it to analyze the animal's behavior and position

Example SEAL Data Reading:	**Example WHALE Data Reading:**
21215 Date : 20.02.97 05:55:37 LC : 0 IQ : 45 Lat1 : 51.254N Lon1 : 50.136W 146, 144, 93, 188 09, 172, 15, 18 05, 56, 57, 121	Date : 04.09.02 04:43:36 LC : 0 Latt1: 48.275N Lon1: 69.232W

Key to the data header - the first two lines of the reading:
21215 =satellite tag identification number
Date: 20.02.97 = 20 Feb. 1997
05:55:37 = Time in Greenwich Mean Time, GMT (hour:minute:second)
LC & IQ reflect transmission quality

LC just stands for Location Class. Location Classes of 0 and up are the best (derived from 4 or more messages)- a Class 0 is good to within between 1,000 and 5,000 meters. Classes 1,2,3- get consistently more accurate. The letter classes are given no estimate of error, but the A's are better than the B's etc. It appears that some of the letter class locations are pretty good (i.e. several fixes over a short period are quite similar), but then others vary wildly- especially the longitude.

Lat1 and Long1 indicate position/fix

Key to the series of numbers at the end of the reading: *(Seal data includes dive depth information.)*
This series of numbers is the dive data. There should be a series of 4, 8 or 12 numbers. All of the numbers in the series should add up to even multiples of 256. If they don't, then the message was incomplete or garbled somehow.

Therefore, the first thing to do is add up all of the numbers and divide the sum by 256. If you get a number with no remainder the message is good.

The first number in the series is an identifier, that tells you what type of message you are getting. If the number is even, the message is a status message. Status messages should be a series of twelve numbers, all of which tell something about the tag. (If the number is odd go to histograms, below.)

Status message numbers from left to right:
1. The first number is also the deepest depth recorded by the tag in the past 24 hours (midnight to midnight). To get the actual depth you multiply that number by 4 (the depth resolution for the tag) and ...viola ...depth in meters (to convert it to feet divide it by .3048)

2. Time at surface for the past 6-hour period (multiply by 90 to get the surface time in seconds).

3&4. The number of messages sent by the tag so far (multiply by 256 and add to #4).

5. Pressure sensor status (should be around 10).

6. Battery voltage (multiply by .064). The voltage should be around 11-12 volts, below 7 it is bye bye tag.

7. Sea water resistance at depth, checks the status of the sea water switch and is supposed to be around 20.

8. Surface time for the 6 hours before #2 (multiply by 90 for time in seconds).

9, 10, 11 Time (hours, minutes and seconds) for the tag's clock. This should be pretty close to the satellite time in the message header. The tag clock will drift a bit (more so when it is cold). If it is way off there is big trouble.

12. Checksum - this number adjusts the total of the numbers so they are evenly divisible by 256

If the number is not even then it is a data histogram.

The first number is still an identifier that tells you whether it is a depth, duration or time at depth message. The tag stores data from four six hour time periods (while collecting the current data). The first number also tells you which time period the data was collected in, and if the tag was "wet" or "dry".

This tag is programmed to think it is dry when it sends five signals without wetting the salt water switch (about 7 minutes out of the water). Numbers between 65 and 95 are "dry", numbers between 97 and 127 are "wet".

There are twenty-four possible messages (4 time periods X 3 kinds of messages, depth, duration, time at depth, X 2 wet, or dry). (Actually it is even more complicated because, to save power, if a histogram has enough 0 values it will be sent as a 4 byte rather than an 8 byte message).

Try interpreting the following examples, and use these data to work on questions and activities.

4 Example SEAL Data Entries	*4 Example WHALE Data Entries*
> 21215 Date : 12.11.96 08:58:10 LC : A IQ : 00 > Lat1 : 67.247N Lon1 : 60.383W > 206 137 41 110 > 10 171 14 100 > 09 01 38 187	Date : 06.09.02 04:43:36 LC : 3 Latt1: 48.577N Lon1: 69.938W
> 21215 Date : 15.02.97 21:57:19 LC : A IQ : 00 > Lat1 : 49.347N Lon1 : 48.717W > 164 13 90 222 > 10 175 14 12 > 22 00 11 35	Date : 07.09.02 04:43:36 LC : 1 Latt1: 48.620N Lon1: 69.920W
> 21215 Date : 18.02.97 07:58:21 LC : 2 IQ : 60 > Lat1 : 50.994N Lon1 : 49.885W > 156 23 92 21 > 10 173 15 17 > 08 02 59 192	Date : 08.09.02 04:43:36 LC : B Latt1: 48.472N Lon1: 69.023W
> 21215 Date : 20.02.97 10:20:18 LC : 0 IQ : 47 > Lat1 : 51.104N Lon1 : 50.277W > 146 158 94 112 > 10 177 15 144 > 10 27 05 126	Date : 08.09.02 04:43:36 LC : 0 Latt1: 48.503N Lon1: 69.113W

Many more data entries can be found here: http://whale.wheelock.edu/whalenet-stuff/stop_cover_archive.html

Satellite Tag Data Analysis: Example

Data reading
21215 Date : 20.02.97 05:55:37 LC : 0 IQ : 45
Lat1 : 51.254N Lon1 : 50.136W
146, 144, 93, 188
09, 172, 15, 18
05, 56, 57, 121

Tag Data Analysis: key to the data header (first 2 lines)

Satellite tag # = 21215, Date is Feb. 20, 1997,
LC ("location class") = 0-1, i.e. position is accurate to within 1,000 to 5,000 meters or better.
Lat1 : 51.254N Lon1 : 50.136W: The cetacean is at Latitude 51.254 degrees North and Longitude 50.136 degrees West.

Which ocean is this? [North Atlantic Ocean]
Find the position on a world map. [Grand Banks, off Newfoundland]

Tag Data Analysis: key to the dive data – the series of numbers at the end (last 3 lines)

146, 144, 93, 188; (sum = 571)
09, 172, 15, 18; (sum = 214)
05, 56, 57, 121; (sum = 239)

sum of all 3 series = 1024; 1024/256 = 4.00. Because there is no remainder, the message is good.

First no. in the series is an "identifier." Because 146 is an even number, this is a "status message."

Translating the numbers in the status message to real data:

1. Depth: Multiply 1st number in series (146) by 4 (depth resolution of the tag) to find the bottom limit of the deepest dive in the past 24 hours (in meters): 146*4 = 584 m.
How many feet = 584 m? [1 m = 3.28 feet] Multiply 584 m by 3.28 = 1, 916 feet

2. Time at surface for past 6-hour period (in seconds) – 2nd number (144):
Multiply 144*90 = 12,960 sec. *How many hours?* 1 hour = 3,600 sec., so 12,960 sec. = 3.6 hours

3&4. N**umber of messages** sent by the tag so far (Add #3+#4, multiply by 256 and add to #4):
(93+188)*256 = 71,936. 71,936+188 = 72,124 messages

5. Pressure sensor status = 9.

6. **Battery voltage** = 172 * 0.064 = 11. *Is the tag's power supply still good?* [Yes. Voltage is close to max.]

7. Seawater resistance of tag's seawater switch = 15. *Is it ok?* [not great; "supposed to be around 20"]

8. Time at surface for the 6-hour period (in seconds) prior to #2:
Multiply 18*90 = 1,620 sec. How many hours? 1 hour = 3,600 sec., so 1,620 sec. = 0.45 hours
(Can you suggest reasons why the surface times in the 2 6-hour periods were so different?)

9, 10, 11. Time (h,m,s) of tag's clock = 05:56:57

a) *How does this compare with the satellite time recorded in the message header?*
[Recorded satellite time is 05:55:37, so it is close.]

b) *Is this almost 6:00 in the morning or in the afternoon?*
[morning – these are 24 hour clocks, so 1:00 pm = 13:00, midnight = 24:00.]

c) *Why use a 24-hour clock?* [To be sure there is no confusion about a.m. / p.m.]

d) The recorded time is Greenwich Mean Time. What does that mean?
[Greenwich Mean Time (GMT) is sometimes called Greenwich Meridian Time because it is measured from the Greenwich Meridian Line at the Royal Observatory in Greenwich, England. GMT has been used as a standard time for recording data anywhere in the world since 1884. This avoids errors and confusion that would arise if everyone recorded events in local time.

e) *What time is 05:56:57 GMT in Los Angeles?*
Pacific Standard Time (PST) = GMT minus 8 hours. Pacific Daylight Time (PDT) = GMT minus 7 hours.
[05:56:57 GMT on Oct. 14 = 22:56:57, or 11:56:57 PM, PDT]

WhaleNet STOP Data Suggested Questions and Activities

1. How far does the animal travel in a day? (average) A week? A month? How many miles did it travel on its northward migration? How far has it traveled since it was tagged? The Distance Generator can be used to determine the distance and heading between any two fixes.

2. After working with the latitude/longitude figures for your marine animal, what are your thoughts on its journey? In what direction is the animal traveling? Why do you think it is traveling in this direction? If it is migrating why is it taking this route/going to this destination? Why do these animals travel/migrate? Why is the animal in this area? Is there much human activity in this area? If so, what kind? What impact or effect might this human activity have on this whale population?

3. What is the animal's average rate of travel? The scale of distance is one nautical mile equals one minute of latitude. So if one degree equals 60 minutes of latitude, how many nautical miles equal one degree of latitude? Five degrees of latitude?

4. What conclusions can you reach about the animal's movements using this data? What conclusions can you not reach about the whale's movements?

5. The atmospheric pressure (atm) exerted upon us at sea level is about 14.7 lbs/square inch (760 mm Hg). When a person dives the pressure exerted by the water increases by 1 atm for each 10 meters (30 ft) the person goes down. Identify the deepest dive made by the marine animal. What is the approximate pressure exerted at that depth?

6. Create a table including date, latitude and longitude, time and depth of dives for your animal.

a. Plot the locations of the dives over 400 meters. At what location did the animal make most of its deepest dives? What is the depth of the water at that location? What is the depth of the water at that location? Was there any pattern to the dive locations? Note: You can use a navigation chart, download a map from WhaleNet, or use the Map Generator link on WhaleNet.

b. List the times of day when the animal made its deepest dives. Is there a specific time of day, or range of times, when it made its deepest dives? Why does the animal most frequently dive deeply at this time?

c. Calculate the percent of dives made at each specific depth range. Make a pie chart/graph of the percent frequency of each dive depth range. In what depth of water is it most of the time? Why does the animal most frequently go to this depth?

d. What type of graph would best represent the percent of the frequency at each dive depth vs. the dive depth range? A bar graph? A line graph? A pie graph? Graph the results using each method. How does one determine which type of graph is best in a specific situation? Note; When using a line or bar graph, the normal procedure is to place the independent variable on the x-axis and the dependent variable on the y-axis.

7. What percent of time does the animal spend at the surface?

8. Does the animal spend more time at the surface in a specific location?

9. What other questions do you have about your animal? How could you find the answers? What other information would you need?

10. Why use satellite tags? Why use satellite tags with whales or marine animals?

11. Are satellite positions always accurate? Why or why not? What precautions must you take as a researcher to insure accuracy?

12. What information is missing?