Studying Albatross Migration

Laysan Albatross

California Standards
Investigation and Experimention grades 9-12
1-b. Identify and communicate sources of unavoidable experimental error.
1-c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions
1-d-Formulate explanations by using logic and evidence
1-g Recognize the usefulness and limitations of models and theories as scientific representations of reality
1-k Recognize the cumulative nature of scientific evidence

NATIONAL MARINE SANCTUARIES ™

Studying Albatross Migration

Introduction

The central coast of California is rich in marine life and a major destination feeding ground for many species of seabirds. Many shorebirds migrate along the coast foraging for food in the rich upwelling zones, while some pelagic seabirds migrate from as far away as the southern hemisphere and sub-tropical Pacific to feed in the California region.

Black-footed Albatross are a common pelagic species that visit the waters off the coast of California and Washington to feed. The California current that flows southward along the North American continent is a productive upwelling region. During the upwelling season, nutrients from the cold depths are brought to the surface and stimulate the food web, from microscopic phytoplankton to the great whales.

Objectives

In this activity students will investigate the migratory movements of a female Black-footed Albatross during its breeding season, using telemetry tag data taken from a study in 1998.

Guiding questions

How are albatross migrations tracked? How can migration data be interpreted?

Materials

Activity Procedures

1. Introduce students to Albatrosses and the study of their migration using background information.

2. Introduce students to the Migration Data Sheets and maps 1 and 2. There are two tables of data. One is for data points collected during the brooding part of the season (data sheet 1) and the other for the chick-rearing period (data sheet 2). Notice that map 1 is a close up focusing on the nesting island (this will make it easier to view the data points that are close to the island). Map 2 is a larger view of the North Pacific Ocean. This map will be used for the chick-rearing data set. (You can have them plot the points on the larger map, but the scale is so tiny, the dots will be hard to see)

3. Have students refer to Map 3 (illustration of the national marine sanctuaries in the Northern Pacific Ocean). Have students label the Proposed Northwestern Hawaiian Islands, Hawaiian Island Humpback Whale, Olympic Coast, Cordell Bank, Gulf of the Farallones, Monterey Bay, and Channel Islands National Marine Sanctuaries on Map 2 (larger view of North Pacific Ocean and west coast of US). There are spaces next to each sanctuary to label.

4. Have students graph the location of each transmission and record the transmission number on their map. Plot the brooding data points on Map 1. Plot the "rearing" data points on Map 2. Have students connect the numbers sequentially to show the route of the Albatross.

5. When they have completed their maps, have students answer the questions on the Mapping Albatross Migration Questions handout. Have students refer to graph titled Figure 1, to answer some of the questions.

* Classroom poster of map available at http://cordellbank.noaa.gov/education/teacherresources.html for posting data points on large map.
dimensions are 33"x 43"

Slide show available on CD, please call Jennifer Stock or email to receive a copy
jennifer.stock@noaa.gov or 415-663-1397

Background Information Sheet on Albatross and Migration

(Words in bold are in the glossary)

There are 24 species of albatross, which are the largest of the **Procellariiformes** order, weighing up to 22 pounds. They are magnificent flyers, using their extremely long and narrow wings for extended flight. Albatrosses are **pelagic,** spending months at sea and taking to land only to breed on oceanic islands. These nesting sites can be far from optimal feeding areas, so albatrosses cover thousands of miles during one trip to find food. Their senses are adapted for life at sea, getting rid of salt from ingested seawater, storms, waves, predators, and the challenge of finding food, most of which lives below the surface of the ocean.

Procellariiformes

Albatrosses belong to the order Procellariiformes, which includes fulmars, shearwaters, gadfly petrels, and storm petrels. Tubular nostrils that open externally onto a hooked bill distinguish the order, known as "tube-nosed swimmers". They feed primarily on thesurface on fish, squid, and other marine organisms. Procellariiformes process food into a concentrated energy source with a high caloric content. The high caloric content is necessary to sustain them on long migrations and to feed their young when they return.

Migration

Albatrosses are able to fly long distances without using much energy because they use **dynamic soaring,** a technique that uses wind energy to ride currents without flapping their wings. Black-footed Albatrosses migrate throughout the North Pacific all year, ranging farthest north in the summer months and farthest south in the winter months. A navigational experiment with a Laysan Albatross holds the record for bird homing - the bird found its nest from 4,120 miles away. Black-footed Albatrosses are seen year-round off the California coast. They nest on the Northwest Hawaiian Islands, but continue to travel long distances to upwelling regions off California to feed.

Upwelling

The west coast of North America is a very productive marine environment. The combination of oceanographic conditions, currents, and underwater topographic features support a diverse marine food web. The California current begins off of Washington State. It travels south and mixes in a transition zone off of southern California where warmer waters are moving north. This slow moving, broad current is associated with a process called upwelling. **Upwelling** is when colder, nutrient rich waters from the depths are brought to the surface where they "fertilize" the microscopic phytoplankton during the spring months of the year. The nutrients are from decomposed life and help to stimulate the food web starting with a growth spurt of **phytoplankton**. When the waters are teeming with life, massive amounts of fish eggs, juvenile fishes, gelatinous **zooplankton** and squid attract seabirds like the Black-footed Albatross to feed in this region. There are five **National Marine Sanctuaries** along the west coast of North America set aside to protect areas of biological and cultural significance.

Reproduction

Albatrosses breed on remote islands far away from land, and almost always return to breed on the island on which they hatched. After **fledging** (leaving the nest and its dependence on its parents), they do not return to land for years, until reaching maturity. Albatrosses engage in courtship, which can last as long as two full years. Birds establish a **pair bond** with one other bird, which becomes their life long reproductive partner. Breeding season can last up to eight months and sometimes longer. During that time the parents alternate foraging trips out to sea while the other cares for the bird on the nest. A lot of energy goes into raising an albatross chick. It is thought that to ensure the highest percentage of success for a chick to survive and fledge, only one egg is laid per season. **Brooding** is the time period spent on an un-hatched egg to 18 days after hatching. The time spent caring for the chick is known as **rearing.** This stage can last from 19-140 days after hatching. The mates may only see each other 8-10 days total out of the 8 months, not very romantic by any means!

Studying migration

Until recently, marking birds with identifying bands was the only way to study bird migration. However, because of the low probability of bands being reported, large numbers of banded birds were required to gain a small amount of scattered information. Monitoring bird movements from the ground or by airplane using conventional **telemetry** transmitters was an improvement, but still presented logistical difficulties for studying long-range migration. The new satellite transmitters are more promising. They are small and lightweight enough to be carried by birds, and can show the entire annual movement of a bird. Tags are designed to be no more than 3% of the bird's body weight.

Tagging and Satellites

In 1998 at Tern Island, HI, Albatrosses were outfitted with satellite transmitters while at their nesting sites. Since these birds are best adapted for flight at sea and not walking on land, they were somewhat easy to catch. Each bird was carefully removed from the nest. While attaching the tag, the fertile egg was protected in the wraps of a towel, to protect it from the brutal heat of the sun and predators. Waterproof tape was attached between feathers that remain in their normal position, so the transmitter does not disturb the bird. The transmitter was attached to the tape with Teflon ribbon. The bird was then returned to the nest.

The tag itself is quite small and has an antenna outstretched, just a little big shorter than a dollar bill. **Satellites** orbiting Earth locate the transmitters from space, and relay information to ground receiving stations. Scientists also use satellites to collect other information such as chlorophyll abundance and sea-surface temperature to help understand why Albatrosses and other marine migratory species go where they do. A high concentration of chlorophyll is a good sign that there is a lot of food in the water for animals to eat.

The transmitter that attaches to the wing of the Albatross is shorter than a dollar bill. Picture from The Albatross Project: http://www.wfu.edu/albatross

Data from space

Scientists receive the transmitted data as a series of numbers, beginning with the tag, or ID number, for the bird. They also receive information on the date, time, and location of the bird's transmission. For example:

Bird	Date	Time	Lat (E/W)	Lon (N/S)
51C	5/5/98	14:39:08	24.435	163.734

Here you have the bird's id (51C) and the date and time that satellites took the location, and the **latitude** and **longitude** of the locations. The time is recorded in Greenwich Mean Time, which is also Universal time. **Greenwich Mean Time** is used globally to avoid confusion amongst time zones.

Using the information provided by the satellite tags, researchers are able to track the movement of individual birds. This information provides insight into the life cycle and ecology of the Albatross. Using the data of location, sea surface temperature and chlorophyll abundance, scientists can learn about the types of habitats in which they prefer to feed.

Conservation

Albatross populations have been in decline for a number or reasons. Many birds die because they have mistakenly eaten plastic. If a parent Albatross eats plastic on a foraging trip and returns to the nest to feed its chick, they regurgitate that plastic to their young. Eventually the plastic fills up the young Albatross' stomach and they die of starvation or dehydration. Many skeletons of birds have been found with large amounts of plastic sitting where their stomachs used to be. **Longline fisheries** also propose a direct threat to Albatrosses and other pelagic species. Albatross are visual feeders and will go directly for baited longlines. If they get caught on the line, they will drown. The information gathered with the satellite tags may help better protect Albatrosses and other species at risk sharing these habitats.

Glossary of Terms

Brooding to sit on or hatch eggs

Dynamic soaring flying without expending energy by riding wind currents without flapping

Fledge when the hatched bird is mature enough to leave the nest and its dependence on its parents

Greenwich Mean Time the time in Greenwich, England; used globally to avoid confusion among time zones

Latitude the angular distance north or south from the Earth's equator, measured in degrees, minutes, and seconds of arc

Longitude the angular distance east or west from the Prime Meridian, which passes from pole to pole through England, measured in degrees, minutes, and seconds of arc

Longline fishery a method of commercial fishing using sections of line baited with hooks that can be from 150 to 400 meters in length

National Marine Sanctuaries a network of 13 marine protected areas in the United States managed by NOAA's National Ocean Service since the Marine, Protection, Research, and Sanctuaries Act in 1972

Pair bond two mated animals that mate for life

Pelagic the open area of the ocean that is not associated with the sea floor or coastline

Phytoplankton microscopic plants that photosynthesize to gather energy

Procellariiformes the only bird order (taxonomic category) consisting of entirely marine species; known as "tube-nose swimmers" due to the presence of tubular nostrils that open externally onto a hooked and plated bill

Rearing time spent raising the hatched chick

Satellite artificial manmade objects placed in orbit around the Earth for scientific, technological, and military uses

Telemetry the science and technology of automatic measurement and transmission of data by a remote source to a receiving station for recording and analysis

Upwelling a process that occurs when strong winds blow surface water away from land, and deeper water comes up to the surface to replace it. This creates a highly productive biological community when the deeper water is nutrient rich.

Zooplankton microscopic drifting animals

Extension Activities

Have students research who manages the parts of the ocean, such as state waters, federal waters, and international waters. What types of regulations are in place for managing such a huge part of the planet? What are the laws in prohibiting the dumping of plastic? How do these laws affect wildlife species such as Albatrosses that travel or live far away from land?

Calculate flight distance using the flight distance calculator on the Albatross Project website **http://www.wfu.edu/albatross/gcircle/calcfull.html**

The albatross has an amazing digestive system that concentrates the fats and oils from their food. A food storing lab activity is on this website:
http://www.wfu.edu/albatross/atwork/food_storing.htm

SeaWiFs uses satellite imagery in scientific investigation. There are extensive teacher resources to use this imagery in your classroom. Have your students investigate the SeaWiFs satellite imagery at different times of year. When is chlorophyll abundant and how can you tell from the images? **http://seawifs.gsfc.nasa.gov/SEAWIFS/TEACHERS/**

The U.S. Fish and Wildlife Service protects atolls and islands in the Northwestern Hawaiian Islands where albatrosses breed. To learn about the islands and its inhabitants go to the website: **http://www.midway.fws.gov or http://www.hawaiianatolls.org/index.html**

The Albatross Project came out of Wake Forest University and was the inspiration for this activity. The project is no longer delivering data to classrooms, but has a multitude of activities and background information about albatross. **http://www.wfu.edu/albatross/**

Albatross Adaptations- have some fun with your students and "turn" a student into an albatross using props to introduce students to their adaptations. (Salt extraction, food concentration, long stiff wings, webbed feet, strong olfactory sense, visual feeders, life long pair bond, etc.)

Credits: Wake Forest University, Dave Anderson, Duke University, David Hyrenbach

*Data points used in this activity are not exact, but estimated based on a map created from an albatross study completed in 1998. David Hyrenbach of Duke University generated the map of which the data points were extracted. The project was funded by Wake Forest University and permission was given to use this information.

Maps created by Pam van der Leeden, Cordell Bank National Marine Sanctuary

Book References

Seabirds of Eastern North Pacific and Arctic Waters edited by Delphine Haley. 1984.

Ocean Birds of the Nearshore Pacific by Rich Stallcup. 1990.

The Facts On Files Dictionary of Marine Science by Barbara Charton. 1988.

Eye of the Albatross Visions of Hope and Survival by Carl Safina. 2002.

Locations of a female Black-footed Albatross during Brooding Stage-1998

Data for brooding stage (0-18 days after hatching)

Transmission	Date	Latitude (N/S)	Longitude (E/W)
1	February 5	23.87	-166.28
2	February 6	23.00	-165.75
3	February 6	23.87	-166.28
4	February 8	25.00	-165.98
5	February 11	23.87	-166.28
6	February 11	25.50	-166.10
7	February 12	23.40	-164.56
8	February 13	22.50	-166.28
9	February 14	23.87	-166.28

Migration Data Sheet 2

Locations of a female Black-footed Albatross during chick-rearing stage-1998

Data for chick-rearing stage (19-140 days after hatching)

Transmission	Date	Latitude (N/S)	Longitude (E/W)
10	February 25	29.10	-168.72
11	February 28	38.00	-146.23
12	March 2	43.75	-132.45
13	March 7	43.26	-126.35
14	March 10	46.00	-126.00
15	March 13	39.87	-125.25
16	March 16	35.24	-123.45
17	March 19	32.76	-132.93
18	March 22	27.85	-146.58
19	March 25	23.87	-166.28
20	March 27	27.45	-165.23
21	March 29	33.27	-167.98
22	April 1	26.56	-169.57
23	April 2	23.87	-166.28
24	April 5	32.00	-155.00
25	April 8	34.90	-145.60
26	April 9	45.71	-131.98
27	April 11	41.69	-127.35
28	April 14	37.50	-123.25
29	April 17	30.60	-133.29
30	April 20	28.12	-142.84
31	April 22	31.39	-146.21
32	April 23	28.38	-150.16
33	April 24	23.87	-166.28

A negative (-) sign in front of the Longitude numbers signifies location west of the Prime Meridian which is 0. If you were east of the Prime Meridian the reading would be positive (+).

Mapping Albatross Migration Questions

1. Albatrosses spend 95% of their time at sea, coming to land only to nest in the sub-tropical Pacific. Describe 4 hazards an Albatross may encounter either on shore or at sea. After listing your obstacles, classify the hazard as natural or human-influenced.

1. 3.

2. 4.

2. Why do scientists want to know where albatrosses go during the nesting season?

3. Describe the migration route for the female Black-footed Albatross, based on the maps you generated. Include the beginning and ending locations. How did it vary during the brooding and rearing stages?

4. Did the albatross in this study travel near or through any of the National Marine Sanctuaries?

5. What role do National Marine Sanctuaries play in protecting all marine organisms?

6. Why are international treaties or agreements necessary to protect pelagic (open ocean) species such as the Black-footed Albatross?

7. In a few sentences, summarize what you have learned about satellite tracking programs and their importance to conservation efforts?

Mapping Albatross Migration Questions

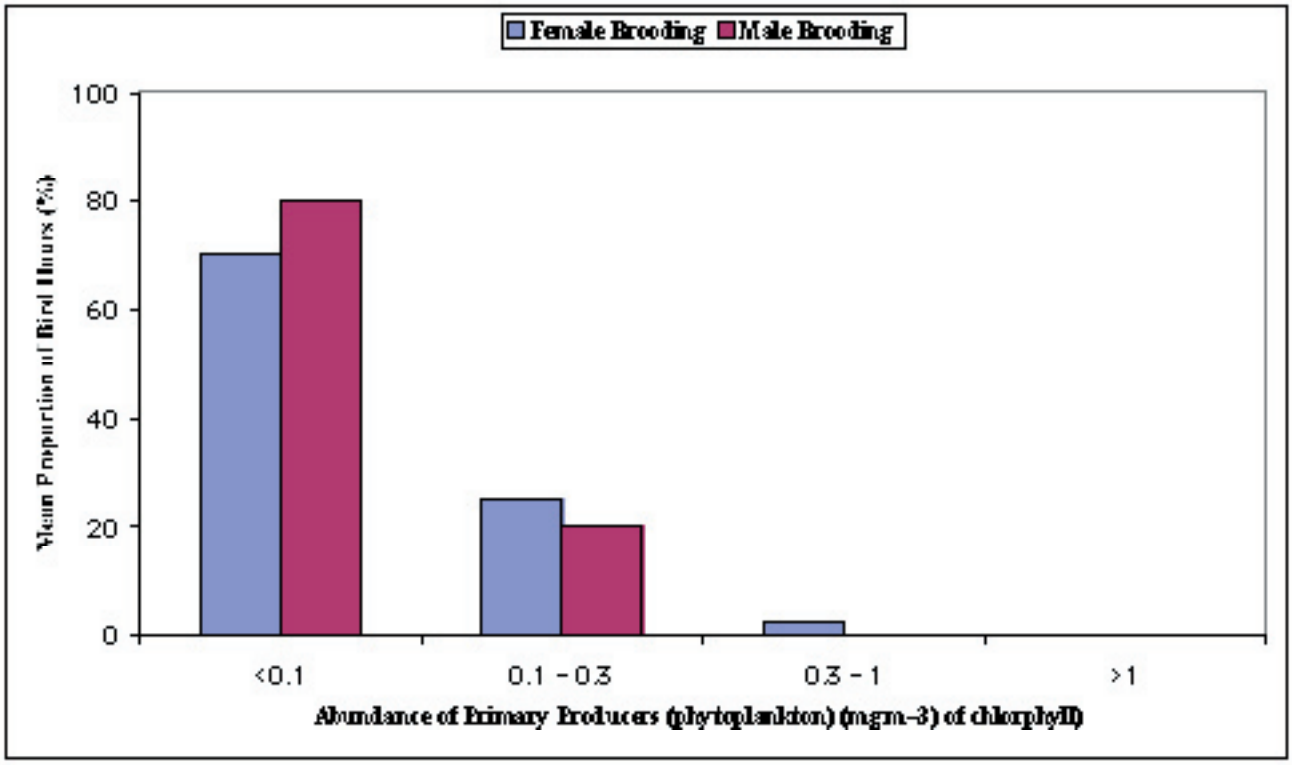
8. Refer to Figure 1, find the information about the female and male Black-footed Albatross during brooding and rearing stages. What parameters do the X-axis and Y-axis stand for?

9. What part of the X-axis has the highest abundance of primary producers?

10. What does a high abundance of primary producers in the ocean indicate?

11. Based on the graphs and the data points you plotted on your maps, what region of the Pacific do you think provides a large food source for the Black-footed Albatross?

12. Why do the Black-footed Albatross migrate to the west coast of the United States only during rearing stages? To answer, compare the proportion of time spent during brooding and rearing stages in areas with high and low abundances of primary producers.



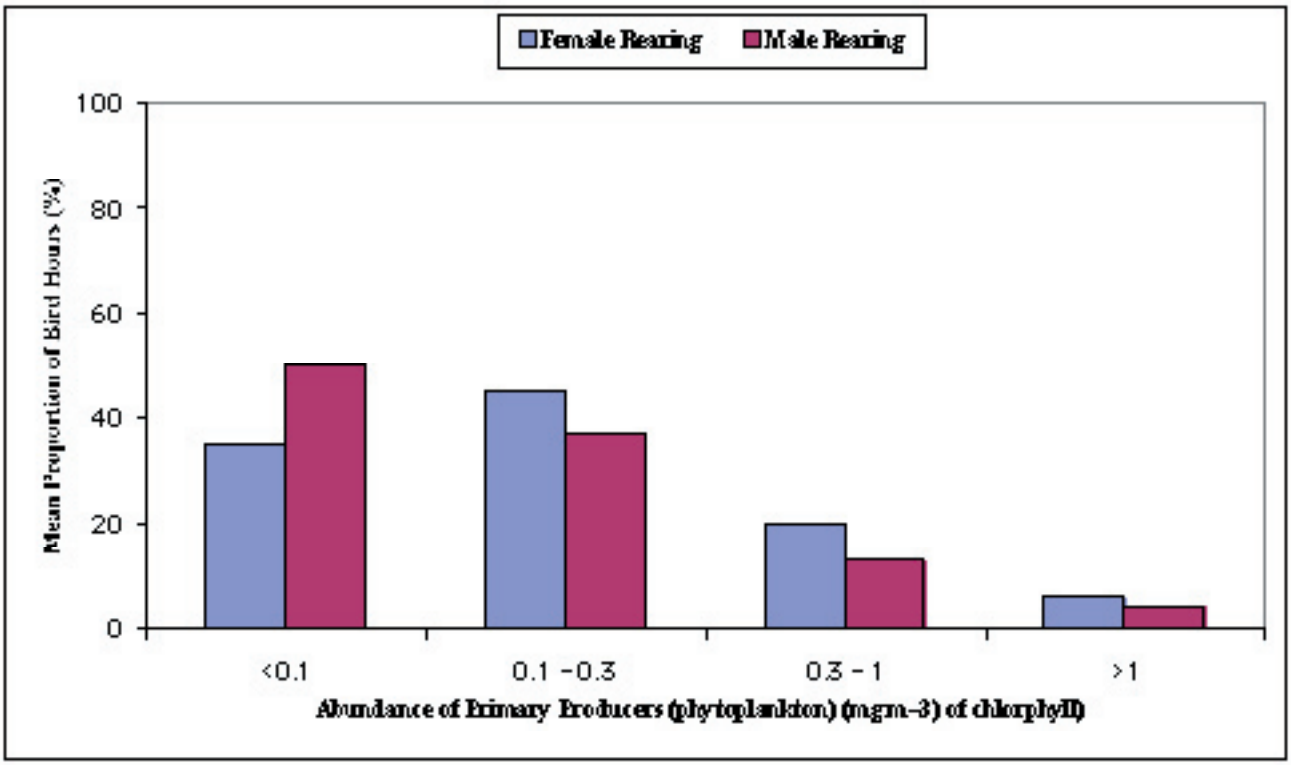


Figure 1
Proportion of time satellite-tracked male and female Black-footed Albatrosses spent in regions with different abundances of primary producers during the brooding and rearing stages. Abundance of primary producers was assessed using monthly averages of chlorophyll concentration from SeaWiFS satellite imagery.

Teacher Answer Sheet to Albatross Migration Questions

1. Albatrosses spend 95% of their time at sea, coming to land only to nest in the tropical Pacific. Describe 4 hazards an Albatross may encounter either on shore or at sea. After listing your obstacles, classify the hazard as natural or human-influenced.

1. Predators – Sharks (natural)
2. Fishing Lines-getting hooked on a baited longline and then drowning (human influenced)
3. Eating plastic and digesting it (human influenced)
4. Since they fly such long distances, battling weather along the way, finding enough food to sustain them and have enough to regurgitate to chick, keeping wings in good shape to be most efficient (natural)
5. Since Albatross form a life long pair bond, if their mate dies, they may or may not find a new mate (natural)

2. Why do scientists want to know where Albatross go during the nesting season?

Very little is known about pelagic bird species and how they survive. Albatrosses nest on tiny atolls and islands in the North Pacific, where their preferred prey items are not present. They leave the nest for days and weeks before returning. Finding out where they go can reveal what type of prey items they prefer and need to sustain themselves. If human activities that are detrimental to the species occur where they feed, that piece of information can help decision makers in conservation efforts.

3. Looking at the maps, describe the migration route for this bird. Include the beginning and ending locations. How did it vary during the brooding and rearing stages?

Students should describe that during the brooding stage, the bird stayed close to the nesting site, not going too far to forage. During the rearing stage, the bird alternated long trips straight to a productive current, with a few shorter trips.

4. Did the Albatross in this study travel near or through any of the National Marine Sanctuaries?

This female came pretty close to Olympic Coast, Cordell Bank, Gulf of the Farallones, and Monterey Bay National Marine Sanctuaries. Black-footed Albatross are regularly seen all along the west coast. Not enough studies have been done to see how much time they spend in one area or another.

5. What role do National Marine Sanctuaries play in protecting all marine organisms?

The National Marine Sanctuaries protect the biological resources and habitats that have been set aside by Congress. The Sanctuaries serve as a trustee to see that these waters are safeguarded from environmental threats, so that they will be healthy for future generations.

6. Why are international treaties or agreements necessary to protect pelagic (open ocean) species such as the Black-footed Albatross?

Pelagic species see no boundaries of management, whereas state, federal, and international treaties manage the oceans. International treaties involve all nations in determining policies that could affect these species.

7. In a few sentences, summarize what you have learned about satellite tracking programs and their importance to conservation efforts?

Satellite tracking programs show us where species migrate to and what types of habitats they live in or temporarily use for reproduction or foraging. Knowing where they go identifies areas that need to be protected.

8. On the graphs, find the information about the female and male Black-footed Albatross during brooding and rearing stages. What parameters do the X-axis and Y-axis stand for?

X-axis: abundance of primary producers, Y-axis: mean percentage of bird hours

9. What part of the x-axis has the highest abundance of primary producers?

The right hand side of the x-axis.

10. What does a high abundance of primary producers in the ocean indicate?

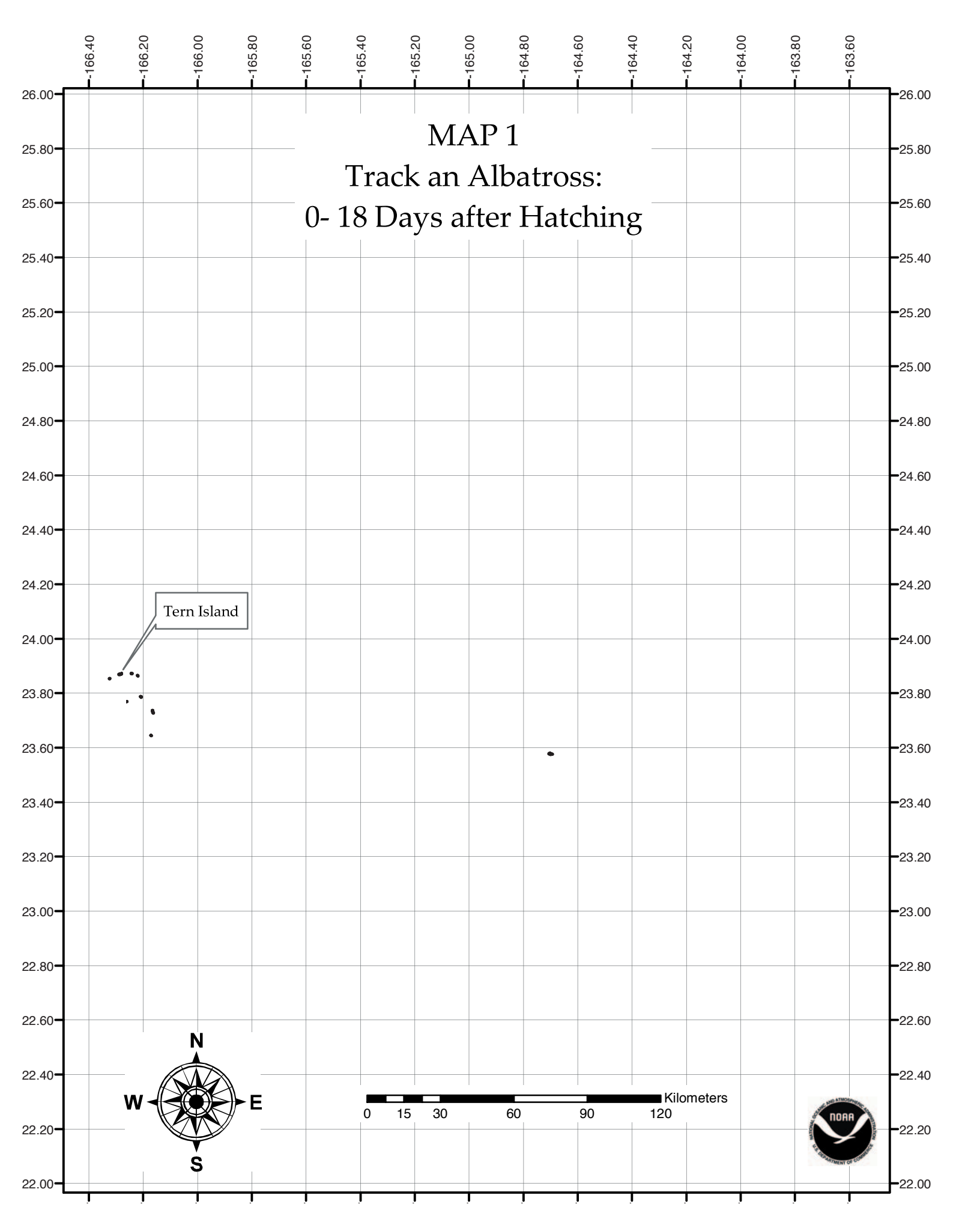
Phytoplankton are the basis of marine food webs and its presence indicates that animals higher in the food web may be abundant, such as zooplankton. For the Black-footed Albatross, when there are high amounts of primary producers in the surface waters, it is likely that there is a high abundance of its prey.

11. Based on the graphs and the data points you plotted on your maps, what region of the Pacific do you think provides a large food source for the Black-footed Albatross?

The west coast of the United States (eastern part of the Pacific ocean) has a high abundance of primary producers because of the California current and upwelling.

12. Why do the Black-footed Albatross migrate to the west coast of the United States only during rearing stages? To answer, compare the proportion of time spent during brooding and rearing stages in areas with high and low abundances of primary producers.

During brooding both males and females spent all of their time in areas with low abundances of primary producers. During rearing, 5-25% of their time was spent in areas with highest abundances of primary producers. The albatross traveled to the more abundant food sources, which are in the upwelling regions off the west coast.


MAP 1
Track an Albatross:
0- 18 Days after Hatching
166.40
166.20
166.00
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22.00
Tern Island
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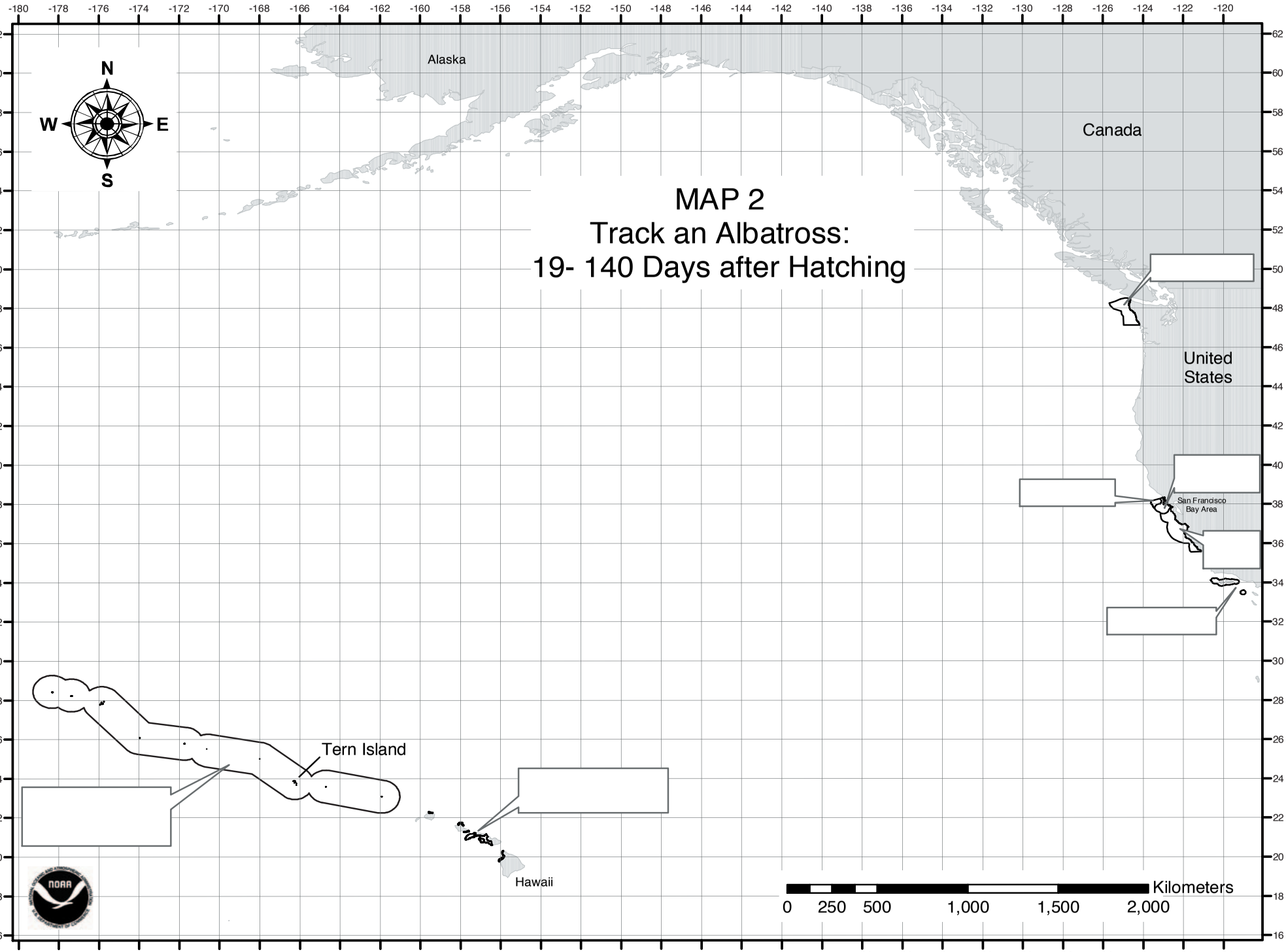
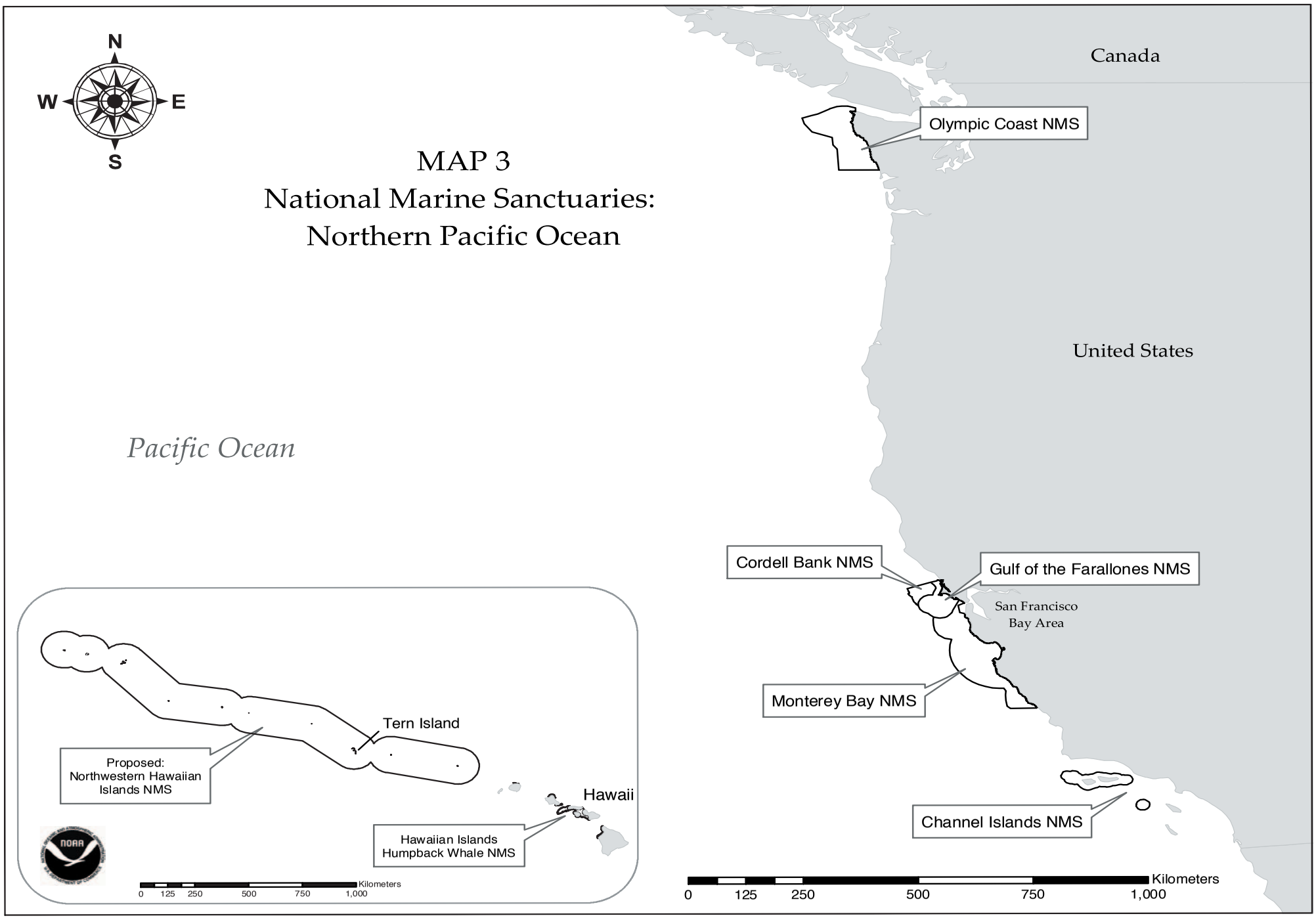
30
60
90
120
Kilometers
NOAA


MAP 2
Track an Albatross:
19- 140 Days after Hatching
Alaska
Canada
United States
San Francisco Bay Area
Tern Island
Hawaii
N
S
E
W
Kilometers
0 250 500 1,000 1,500 2,000
NOAA


N
W
E
S
MAP 3
National Marine Sanctuaries:
Northern Pacific Ocean
Canada
Olympic Coast NMS
United States
Pacific Ocean
Cordell Bank NMS
Gulf of the Farallones NMS
San Francisco
Bay Area
Monterey Bay NMS
Channel Islands NMS
Kilometers
0 125 250 500 750 1,000
Tern Island
Proposed:
Northwestern Hawaiian
Islands NMS
Hawaii
Hawaiian Islands
Humpback Whale NMS
Kilometers
0 125 250 500 750 1,000