



Swimming with Sea Cows

Humans and Manatees: Deadly Interspecies Interaction Lesson Plan

by Mellie Lewis

Jonathan Bird travels to Crystal Springs, Florida to examine a unique marine mammal, the manatee. Jonathan finds that while humans reproduce rapidly, manatees reproduce slowly. Humans want to move fast in their boats, manatees move slowly in the water. After millions of years without a natural predator, the manatee now faces many challenges to survive. Jonathan examines some of the problems that humans have caused to a dwindling manatee population.

Science Lesson: Humans and Manatees: Deadly Interspecies Interaction - Based on Webisode 9

Grade Level: 6-8

Time: Two to three (45-50 min) class periods

Introduction

Human impact on the marine environment extends to many areas and is frequently detrimental. This is especially true with the Florida manatee. In 2011, the preliminary report of manatee mortality due to human activity was greater than 26%. This is directly caused by watercraft collision, flood gate and canal lock installations, and other human related activities such as habitat loss, pollution, and loss of sea grass beds.

In this activity, students research the Florida manatee, its habitat, and how human impact has altered the manatee's habitat. Students will examine and discuss a 20-year period of synoptic survey data from the Florida Fish and Wildlife Conservation Commission. From the discussion students will learn why this survey only gives an "estimated" manatee population. Students will examine data from the Florida Fish and Wildlife Conservation Commission, Marine Mammal Pathobiology Laboratory from 1991 through 2011. Using this data, students will create a line graph to analyze the causes of documented manatee deaths over this 20-year period.

Science Standards

National Science Education Standards

Life Science:

- Structure and Function of Living Systems
- Regulation and Behavior
- Populations and Ecosystems

Science in Personal and Social Perspectives

- Populations, Resources, and Environments
- Natural Hazards
- Risks and Benefits

Ocean Literacy Principles

- Principle #6: The ocean and humans are inextricably interconnected.
- Principle #7: The ocean is largely unexplored.

Objectives

- Explain thermal refuges and manatee winter migrations
- Hypothesize the impact of Florida's human population on the West Indian manatee
- Research human and environmental factors that help or hinder manatees
- Learn of new research technology scientists are using to track and learn about the manatees' survival behavior.



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Prior Knowledge

Students should have experience monitoring population changes over time using tables and graphs.

Students should have experience using spreadsheets to create graphs.

Helpful Vocabulary

Aquifer:	Underground lake
Cold Stress:	Cold stress is initiated by cold water and the manatees' limited ability to adapt to low temperature extremes. The cold water shuts down the manatee's internal systems making them unable to eat and breathe.
Fluke:	Tail
Harassment:	Any activity that changes the natural behavior of an animal.
Peduncle:	Where the fluke attaches to the body of the manatee.
Perinatal manatees:	Those animals that are less than 150 cm (60 inches) in total length. This term is used in mortality records to identify manatees that did not die from human related causes.
Sirenians:	The scientific order of aquatic herbivorous mammals that are also known as sea cows.
Watercraft:	Motor boats and jet skis

Manatee Facts

- Adult manatees can weigh up to 3,000 pounds, but they typically weigh around 1,000 pounds.
 - Manatees spend 6-8 hours a day feeding!
 - Manatees communicate using clicks and squeals.
 - Florida manatees can live in freshwater, brackish and saltwater environments. They prefer to swim in waters that are less than twenty feet deep.
 - It is illegal to pet, feed or give water to manatees, as this teaches manatees to approach docks and boats, where they are at risk of being hit by boats.
 - The largest single cause of manatee mortality is collisions with watercraft.
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Activity: Manatee Synoptic Survey Analysis

Materials:

- Computer with Internet access
- Graphing software
- Map of Florida
- Copy of *J. Rooker, Manatee* by Jan Haley
- Graph paper
- Colored pencils

Background

Present day Sirenians are found around the world and include three species of manatees and one species of dugong.

- **West Indian manatees** (*Trichechus manatus*) are found from the southern United States to the northeast coast of Brazil and around islands near these shores. The *Florida manatee* (*Trichechus manatus latirostris*) is a sub-species of the West Indian manatee and is found in and around Florida's waterways. The manatee is native to Florida as evidenced by remains found in fossil records dating back 45 million years ago. The *Antillean manatee* (*Trichechus manatus manatus*) is another sub-species that is found throughout the Caribbean and northeastern South America.
- **The Amazonian manatee** (*Trichechus inunguis*) is found in the fresh waters of the Amazon Basin.
- **The West African manatee** (*Trichechus senegalensis*) is found in the coastal waters and rivers of western Africa.
- **Dugongs** (*Dugong dugon*) are found in regions of the coastal waters of 43 countries within the Indian and Pacific oceans. The largest surviving populations are found in northern Australian waters.
- **The Steller's sea cow** (*Hydrodamalis gigas*) once lived in the Arctic waters of the Bering Strait was first documented by the early explorers of the New World by Captain Bering in 1741. In just 27 years it was hunted to extinction.

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History

Throughout recent history, humans hunted the manatee for its meat, hides and bones. Because of its peaceful, gentle nature it has always been an easy mark. The meat and fat provided a food source for the early inhabitants of the areas where the manatee was found. The tough hide was perfect for leather and cords and the bones were thought to be of medicinal value. The bones were also carved and used for the handles of knives and other tools.

In the past there was speculation that the manatee could be a good livestock animal to be raised for its meat. It is said that Cowpens Key in the Florida Keys was named for a cove where manatees were penned as a food supply. Laws have been passed protecting the manatee from this fate. Also, manatees have such a low reproduction rate that raising them as a food source would not be practical. Female manatees are pregnant for 12-14 months and usually give birth to a single calf measuring about 3-4 feet in length. The calves remain with their mothers for up to two years and do not reach sexual maturity until about 5 years of age for females and 9 years of age for males.

The Florida manatee is listed as an endangered species. Protection of manatees in Florida has been legislatively mandated since 1892. Current state efforts to recover the population are guided by the Florida Manatee Sanctuary Act of 1978, which declared the state to be a refuge and sanctuary for the manatee. Subsequent amendments have given the Florida Fish and Wildlife Conservation Commission (FWC) a wide range of responsibilities. The federally approved Florida Manatee Recovery Plan of 1995 promotes a cooperative effort between federal, state, and local governments to help the manatees.

Anatomy

Florida's manatees are large - typically averaging around 8-10 feet in length and weigh around 1,000 pounds and may reach 13 feet in length and weigh over 3,500 pounds. They are gray aquatic animals with thick, finely wrinkled skin. They have a blunt whiskered snout, a torpedo-shaped body that tapers to a flat, paddle-shaped tail. Two forelimb flippers, with up to four "finger" nails are located near the head. Like all mammals, manatees have hair on their bodies. Although the hair is very sparse it exists in short strands

from the head to the tail. Manatees do not have external ear lobes, eyelids or eyelashes. A thin membrane, called the nictitating membrane, protects the manatees' eyes when underwater. Stiff bristles around the mouth help manatees hold food while eating.

The manatee's digestive system is adapted to process large amounts of this high-fiber, low-protein food. Manatees can eat up to 10 percent of their body weight in aquatic vegetation each day. This is why manatees are so large, not because they have blubber like other marine mammals. The intestines of an adult manatee can measure up to 130 feet in length. It takes seven days for food to pass through this long digestive system. The aquatic plants are mixed with abrasive sand. Over time, sand wears down the manatee's molars, which can make chewing plants difficult. New teeth erupt at the back of the jaw and move forward until the worn-down teeth eventually fall out. Tooth replacement (polyphyodont) occurs throughout the life of the manatee.

The lungs of an adult manatee may exceed three feet in length and extend along the backbone under the protection of the ribs. The length of the lungs helps manatees with buoyancy control and allows the animal to float horizontally and stay underwater for up to 20 minutes at a time. Manatee bones are massive, heavy, and lack marrow cavities in the ribs and the long bones of the flippers. These heavy bones allow the manatee to easily submerge in order to graze on aquatic plants.

Migration

Florida manatees are considered to be somewhat migratory animals. Generally speaking, they are found in shallow, slow-moving rivers, bays, estuaries and coastal water ecosystems of the southeastern United States. They can live in fresh, brackish or salt water. Travel corridors, or passageways, are necessary for manatees to move back and forth between summer and winter habitats or between feeding and resting or calving areas. It has been documented that many manatees have preferred habitats they return to each year.

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In the summer months, manatees travel freely around Florida's rivers and coastal waters and sporadic summer sightings in Alabama, Georgia, and South Carolina are relatively common. A few manatees may range as far west as Texas and as far north as Virginia (one manatee was even documented in Cape Cod, Massachusetts!), but these sightings are rare. In the winter, usually November through March, the manatee population is concentrated primarily in Florida. Water temperatures that fall below 70° F cause manatees to move into warm water refuge areas. Scientists don't know what cues manatees follow, but they seem to know when cold weather is coming and seek warm water areas before it arrives.

Threats

Today manatees in Florida have no natural predators. The major threats to manatees fall into two categories, natural causes and human causes.

Natural Causes: The natural causes of death to the Florida manatee are cold weather and red tide.

Manatees are primarily tropical animals and need warm water in order to survive. They have relatively little body fat, and their metabolic rate is low compared to other marine mammals. Manatees cannot tolerate water temperatures below 68°F for long periods of time. Scientists believe that individuals affected by the cold cannot produce enough metabolic heat to make up for heat loss in the environment. During winters in Florida that have been unusually cold, an increase in manatee mortality has been documented. In

early 2010, more than 400 manatees died, a record number, and most died because of the cold-water temperatures.

So what do manatees do to stay warm when the water temperature drops? They have to swim to somewhere where the water temperatures are warmer – *thermal refuges*, such as springs and power plant water discharge areas.

There are underground lakes called aquifers. Sometimes the water in an aquifer comes up to the surface, creating a spring. Manatees migrate into Florida springs each winter, including Crystal River National Wildlife Refuge, to stay warm when temperatures in surrounding waters fall below 68°F. In general, water from these springs is a constant 72°F and will help keep the manatees warm. If the cold weather lasts for too long, as it did in late 2009 and early 2010, it can make it hard for the manatees to feed as they must leave the spring and travel in cold water to find food.

Power plants have become a source for artificially warmed water for manatees. Since manatees learn to migrate to warm water from their mothers, some young animals do not know where the natural water sites are--they only know to go to the power plants. The problem is that if the power plant is turned off for any reason, the manatees still go there. If there is no warm water they will stay by the power plant regardless and often die. Manatees frequently crowd into power plant basins in the winter when water temperatures in other areas around the plant are cold.

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If it is very cold for three days in a row, state biologists count manatees in cold weather. They fly small airplanes over areas where manatees are gathered and will count how many manatees they see. These aerial surveys are called *synoptic surveys*. This synoptic survey method provides a minimum count of manatees, but it does not provide a population estimate. In December 2009, when there was a long cold spell, more than 5,000 manatees were counted.

Red tide occurs when there is an over abundance of microscopic organisms called *dinoflagellates*. As manatees feed in waters infected by a red tide, they ingest many of these toxic organisms along with the vegetation floating in the water. Red tide is also concentrated by filter feeding organisms such as sea squirts and shellfish. Manatees eat sea squirts living on the blades of seagrasses. Although the toxins do not affect sea squirts directly, the toxin is concentrated in their bodies and vertebrates consuming them could become ill from eating the infected sea squirts. The toxins can also become airborne causing the manatees to inhale them when breathing at the surface. An outbreak of red tide in 1982 was believed to have contributed to the death of 37 manatees. Another outbreak in 1996 red tide was responsible for 151 manatee deaths.

Human Related Causes: Human related causes of manatee deaths are numerous.

Loss of habitat is probably the most serious threat facing Florida manatees. There are about 1,000 people moving to Florida every day and about 80% of these people want to live on or near waterways. The environmental impacts of this growth (pollution, boat traffic, water pollution due to herbicides and surface run-off, loss of sea grass beds due to propellers and dredge and fill operations for new homes) are destroying the habitat necessary to sustain the manatee population.



Florida manatee showing severe damage to its fluke from a boat propeller.

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Manatee deaths are also caused by watercraft. Manatees prefer the shallow waters of the waterways because that is where their food is found. In these shallow waters, manatees are unable to dive deep enough to escape collision with boats. Most Florida manatees are scarred from being hit by boat propellers. Propeller scars are so common that scientist use these scar patterns to identify individual manatees. About half of the manatees killed from boat collisions do not have fresh propeller marks which indicates that they die as much from impact as from the cutting of the propeller. Impact from jet skis can do as much damage to manatees as that caused by boats, as many times the lungs are punctured by a collision with jet skis or boats, causing death.

Another cause of manatee deaths are flood gates and canal locks. Much of the southern portion of Florida was drained for agriculture and the building of homes and businesses. Gates and locks were installed to control water levels and prevent flooding. The tremendous pressure exerted in opening and closing these locks pin down manatees causing them to be crushed or drowned. Today many areas are developing “manatee friendly” systems, which detect the presence of a manatee before operating the lock or gate. In this manner, manatees can be removed from the structure before the danger of injury.

Discarded fishing gear and litter also have a detrimental effect on manatees. Manatees, like other marine animals, are often found with scars or lost limbs due to entanglement in plastic, ropes or nets. As the manatee grows, the plastic becomes embedded in flippers causing infections which can lead to the loss of limbs or death.

Human harassment, or anything that changes manatee’s natural behavior, jeopardizes the survival of the manatee. Because of the manatee’s gentle nature, humans want to feed and play with them. However, manatees are wild animals and must live without the help of humans. If they lose the ability to find food on their own, they will not only die if left alone, but they may not pass on their knowledge to future generations. Humans should limit their encounters to observation from the surface. If a manatee is chased or pursued, it may leave the safe waters of its habitat for a less desirable area. A mother and calf may be separated which could cause the death of the calf.

Monitoring the Manatee Population and Mortality Analysis ***Manatee Tagging***

Manatees are tagged with radio and satellite transmitters to help learn more about their movement. The tag is attached with a belt around the fluke where it attaches to the peduncle. The flexible tether goes to a floating transmitter which does not harm or discomfort the manatee and will break easily if it should become entangled. Unique color combinations on the float identify the individual manatee. Signals from the transmitters have provided scientists valuable information about the migratory patterns of manatees.

Synoptic Surveys

The Florida Fish and Wildlife Commission uses synoptic surveys – winter aerial surveys that cover all of the manatee’s wintering habitats in Florida - to obtain a general count of manatees statewide. The FWC coordinates an interagency team that conducts the synoptic surveys from one to three times each year (weather permitting). These surveys are conducted during the coldest weather of the year (January through March) when manatees move to warm-water sites, such as natural springs, thermal discharges from power and industrial plants, and deep canals.

The current synoptic survey method provides a minimum count of manatees as flights concentrate on areas where manatees are known to gather in large groups during cold weather. It does not provide a population estimate since not all Florida waters are included in the current survey. Therefore, an unknown number of manatees are not counted.

A synoptic surveys is scheduled only if all three of these minimum requirements are met simultaneously:

- Air temperatures forecast to be less than or equal to 49°F near most major manatee aggregation sites on at least 3 of 5 days prior to the survey.
- Water temperature below 68°F near most major manatee aggregation sites.
- No sky conditions forecasted as “mostly cloudy” or “rainy” in the entire survey area.

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Mortality Analysis

The majority of recovered manatee carcasses in Florida are transported to the Marine Mammal Pathobiology Laboratory (MMPL) for a necropsy to determine the cause of death. The MMPL publishes a yearly “Final Manatee Mortality Table” which is used to develop protection plans, land development, boating regulations, and other public policies impacting Florida manatees.

Lesson Procedure

Mind Mapping Activity: Have students construct a mind map, either electronically or with paper/pencil, with the key word being Manatee as a pretest for the lesson. After an appropriate length of time, collect the mind maps and save them.

Reading: Introduce the Florida manatee to the students by reading *J. Rooker, Manatee* by Jan Haley to the class. Afterward in a discussion it can be explained that the students will be learning about the Florida manatee and the many problems it faces in order to survive.

Synoptic Survey:

- Explain what a synoptic survey is and how it is conducted in Florida to estimate the manatee population.
- Have students examine the “Synoptic Survey Data of Florida Manatees 1991-2011. What questions are raised when students look at this data table? (missing years, inconsistent dates, inconsistent survey records per year.)
- Have students hypothesize why there is not data for 1993, 1994, and 2008. Students can check their hypothesis by checking Florida weather during those missing years and comparing the water and air temperature with the “Minimum criteria for conducting the current synoptic survey” provided in the background section of this lesson.

Causes of Manatee Mortality:

- Discuss the human related and natural causes of manatee mortality with students. Ask students to hypothesize the cause of the greatest number of manatee deaths.
- Pass out the “Manatee Mortality in Florida Waters by Cause of Death 1991-2011” and discuss what the totals mean.
- Either in class or as homework assignment have students calculate the yearly percentages for human related causes (HR) and natural causes (NC). (1991 HR = $53 + 9 + 6 = 68/174 = 39\%$; NC = $53 + 1 + 13 + 39 = 106/174 = 61\%$.) Students should record their data in a five-column table; year, HR total, HR percentage, NC total, and NC percentage.
- When the tables have been completed, have a discussion of any unusual or unexpected results.
- In order to see a graphic picture of this data, students can construct a line graph. The “y” axis will show the number of deaths and the “X” axis will show the years from 1991 – 2011. Remind students that they will be using the totals from their table, not the percentages. The completed line graphs should have a title, key, labeled Y and X-axis, and caption.

**Assessment:**

Have students create another manatee mind map. Compare the quality and number of responses on both maps. The second mind map will have many more quality responses on it.

Follow-up and Extensions

Follow up questions:

1. What generalizations can you make from your Manatee Mortality Graph?
2. What could be done to reduce the number of human related causes of manatee deaths?
3. What could be done to make the synoptic survey more accurate?

Going Further

- Have students do a correlation between the number of registered boats in Florida and the increase in water-related manatee mortality over the past 20 years.
- Have students create “Manatee Booklet for Jet Skiers” summarizing the information they have learned in this lesson that is relevant to jet skiers.
- Students in grade eight should use a statistical analysis to decide whether or not there is a significant difference between human related and natural causes of manatee mortality.

<http://myfwc.com/research/manatee/projects/population-monitoring/synoptic-surveys/>



**Synoptic Survey Data of Florida Manatees
1992 to 2011**

Year	Date	Total
1991	January 23-24	1,267
1991	February 17-18	1,478
1992	January 17-18	1,844
1995	January 21-22	1,456
1995	February 06-07	1,823
1996	January 09-10	2,277
1996	February 18-19	2,630
1997	January 19-20	2,241
1997	February 13	1,715
1998	January 29-30	2,018
1999	January 06	1,865
1999	February 23	2,023
1999	March 06	2,360
2000	January 16-17	1,646
2000	January 26-27	2,223
2001	January 05-06	3,300
2002	March 01	1,758
2003	January 09	2,843
2003	January 21-22	3,127
2003	January 26-28	3,016
2004	February 20	2,505
2005	January 26	3,143
2006	February 13-17	3,113
2007	January 30-February 1	2,817
2009	January 19-23	3,802
2010	January 12-15	5,076
2011	January 20 and 24	4,834

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Causes of Manatee Mortality

	Human Related Causes				Natural Causes			
Year	Watercraft	Flood Gate Canal Lock	Other Human	Perinatal	Cold Stress	Natural	Undetermined Source	Total
1991	53	9	6	53	1	13	39	174
1992	38	5	6	48	0	20	45	162
1993	35	5	6	39	2	22	34	143
1994	49	16	5	46	4	33	37	190
1995	42	8	5	56	0	35	53	199
1996	60	10	0	61	17	101	154	403
1997	54	8	8	61	4	42	61	238
1998	66	9	6	53	10	13	71	228
1999	82	15	8	54	5	37	61	262
2000	78	8	8	59	14	37	60	264
2001	81	1	8	61	31	35	106	323
2002	95	5	9	53	17	59	65	303
2003	73	3	7	71	47	102	67	370
2004	69	3	4	72	50	24	51	273
2005	79	6	8	89	31	89	90	392
2006	92	3	6	70	22	81	116	390
2007	73	2	5	59	18	82	66	305
2008	90	3	6	101	27	34	69	330
2009	97	5	7	114	56	37	103	419
2010	83	1	5	97	282	23	208	699
*2011	83	2	2	71	108	19	120	405
Total	1472	127	125	1388	746	938	1676	6472

Note: 2011 data is only from January 1, 2011 through December 02, 2011.

All other years are from January 1 through December 31 of that year.