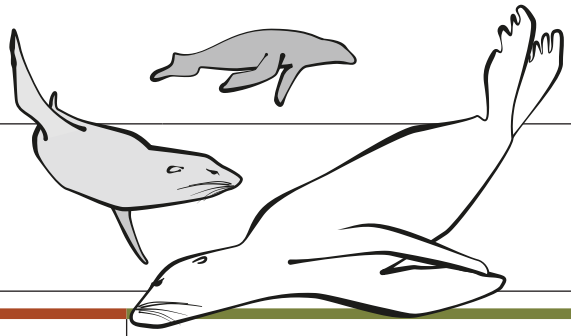
LESSON FIVE

How do fur seals dive?



Subject Area(s): Life science	**Grade Levels:** K-6	Presentation – 10 minutes Activities – variable

Lesson Topics:	Fur seal diving
Learning Objectives:	Students will: • investigate adaptations of seals to water • compare insulating qualities of air and blubber

Focus Questions	• How are pinnipeds adapted to the water? • How do they dive? • Why do we want to know how deep fur seals dive?
Key words:	blubber, body shape, forage, adaptation

ACTIVITIES		ALASKA STANDARDS				
		Math K–3	Math 4–6	Science 3–6	Minutes	Grades
Activity 5.1	Blubber Mitt	1.MD.7 2.MD.9 3.MD.4, 3.MD.6	4.MD.6 5.MD.4 6.SP.1-5	SA1.1–1.2 SA2.1 SC2.2 SG2.1	10	K–6
Activity 5.2	Waiting to Inhale	3.MD.4 3.MD.6	4.MD.6 5.MD.4 6.SP.1-5	SA1.1–1.2 SA2.1 SC2.2 SG2.1	10	3–6
Activity 5.3	Exhale and Dive	3.MD.4 3.MD.6	4.MD.6 5.MD.4 6.SP.1-5	SA1.1–1.2 SA2.1 SC2.2 SG2.1	10	K–6

NOTE: It works well to set each activity up as a station; divide the class into three groups and have the groups rotate through the stations. Afterwards, the class can discuss their results.

Targeted Alaska Grade Level Expectations (GLEs)

Math

MD Measurement and Data

SP Statistics and Probability

Science

Science as Inquiry and Process

SA1 Students develop an understanding of the processes of science used to investigate problems, design and conduct repeatable scientific investigations, and defend scientific arguments.

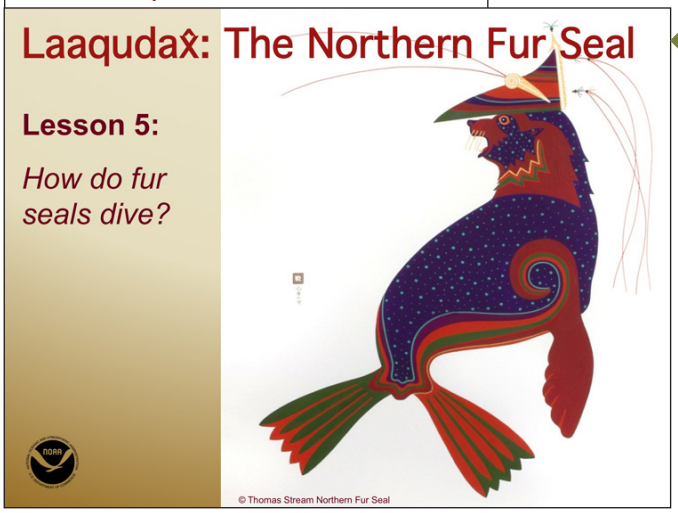
SA2 Students develop an understanding that the processes of science require integrity, logical reasoning, skepticism, openness, communication, and peer review.

Concepts of Life Science

SC2 Students develop an understanding of the structure, function, behavior, development, life cycles, and diversity of living organisms.

History and Nature of Science

SG2 Students develop an understanding that the advancement of scientific knowledge embraces innovation and requires empirical evidence, repeatable investigations, logical arguments, and critical review in striving for the best possible explanations of the natural world.



Lesson 5 contains a brief overview of how seals are adapted to the water and how they are adapted to dive, how deep they dive, and what we can learn from this information.

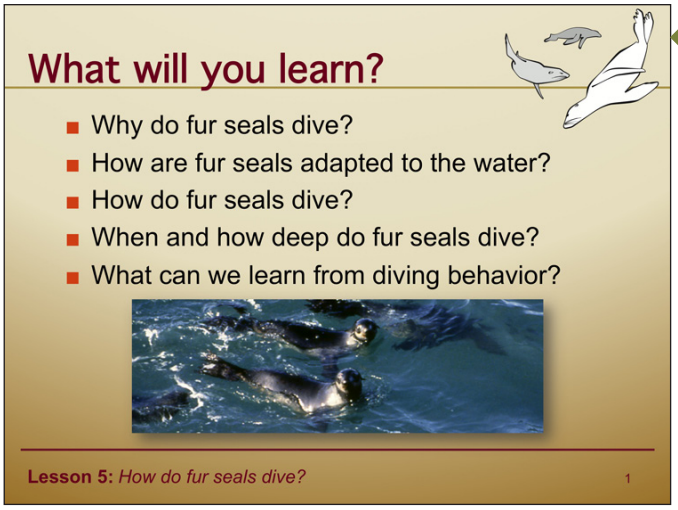
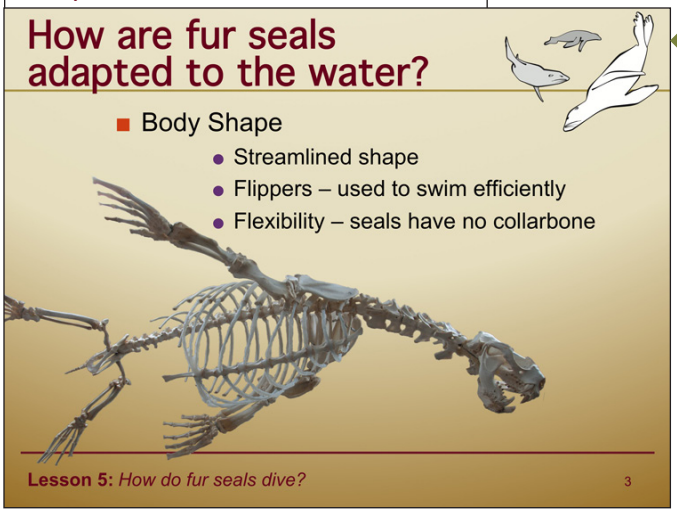


Photo: NOAA/NMFS/AFSC/NMML, Observer Training PowerPoint

Fur seals dive primarily to search for food, and while traveling.

Photo: Paul Hillman, NOAA Ocean Media Center

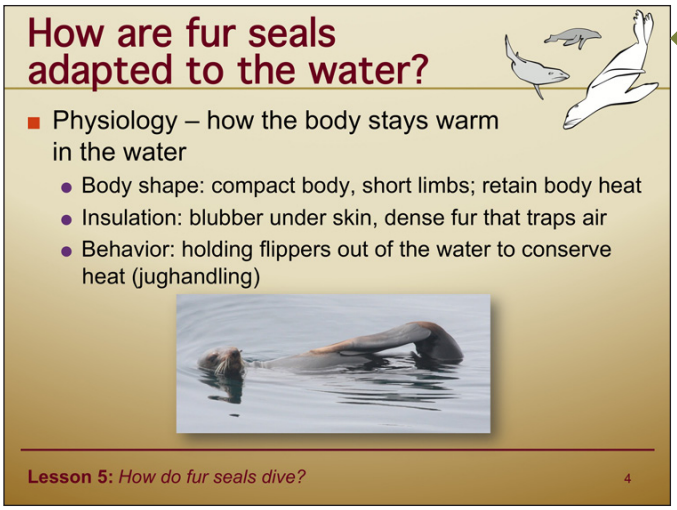


Pinnipeds spend over half their lives in the water, so their bodies are adapted to the water in many ways. The next several slides give an overview of some of the major adaptations to the water: body shape, ability to stay warm in water and cool on land, ability to see and hear underwater.

Pinnipeds have a streamlined body shape with relatively short, wide flippers (compared to the legs of a terrestrial animal like a horse). The body is also very flexible.

- Because of the sleek, streamlined body, seals can move swiftly through the water with little drag. The ears and tail are small so that they don't cause resistance in the water.
- Flippers help efficiently propel the body through water, which is denser than air (and therefore requires more effort to move through).
- Because the seal's body is extremely flexible, it can maneuver easily when swimming underwater. This flexibility also helps seals be effective underwater predators.

Source: Riedman, M. 1990. The Pinnipeds.
Photo by: Lisa Hiruki-Raring, NOAA/AFSC (edited by Rebecca White, NOAA/AFSC)

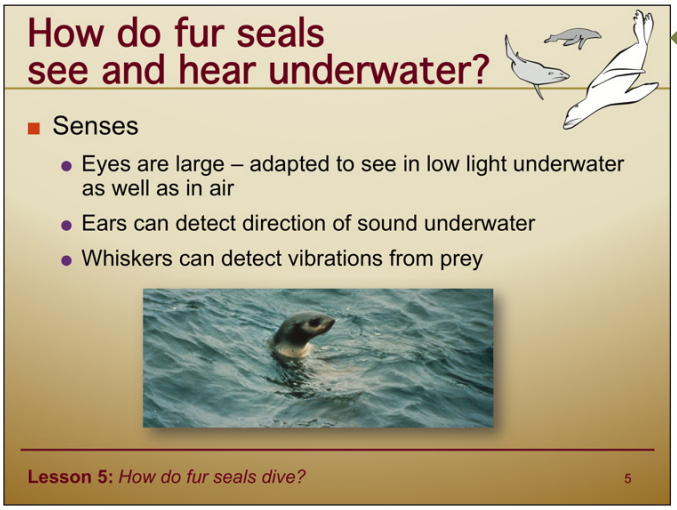


Ocean water is cold – the body loses heat 25 times faster in water than it does in air. Pinnipeds must keep their body temperature close to 100° F (38° C) in ocean water that may be only 30°-40° F (0-5° C).

To allow pinnipeds to regulate their temperature in water and to conserve heat, they have the following adaptations:

- **Compact body and short limbs** – body size is also relatively large (there are no seals as small as a mouse), as large bodied mammals chill less quickly than small ones. Less heat is lost from a compact body with short limbs.
- **Blubber and dense fur** – minimizes heat loss in the water. Fat insulates animals from cold and stores energy for when seals fast. Fur seals have two layers of fur: flattened protective outer guard hairs and thick, fine underfur to protect against cold. The underfur traps air, which insulates the body from cold.
- **Behavior** – fur seals hold their flippers out of the water (called "jughandling") to conserve heat in the cold water. Seals also have a network of small blood vessels in their flippers that allow heat to be kept close to the core of the body.

Source: Riedman, M. 1990. The Pinnipeds.
Photo: Robert Pitman, Protected Resource Division/SWFSC/NOAA



Seals can see well both underwater and in air. Their eyes are large in relation to their body size and are adapted to seeing in low light levels.

Seals have good underwater hearing. They can tell which direction a sound is coming from, the same way that people do.

Long, sensitive whiskers appear to help pinnipeds "feel" vibrations of prey in the water, especially when visibility is poor. Whiskers may also help seals navigate underwater.

Source: Riedman, M. 1990. The Pinnipeds.
Photo: NOAA/NMFS/AFSC/NMML Observer training PowerPoint

How do fur seals dive?

- Seals exhale and hold their breath during dives
- Nostrils automatically close
- Heartbeat slows
- Eyes stay open
- Ears close

Lesson 5: *How do fur seals dive?* 6

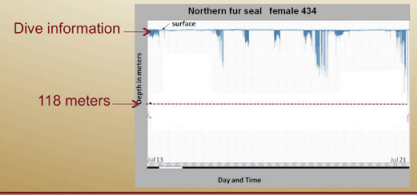
Air-breathing mammals like pinnipeds must be able to take in enough oxygen while they dive for food. Most eared seals dive to relatively shallow depths of 150-200 meters (compared with 1000-1200 meters for other seals and cetaceans). Seals have to adapt to the pressure of deep dives (as depth increases, the water pressure increases) and conserve oxygen while diving.

- A seal exhales at the beginning of a dive and holds its breath during a dive. That way, its lungs are only partially filled with air, and it can dive more easily. A seal also does not have many air spaces in the body, and its ribs are flexible and can flatten the lungs during a dive.
- The seal's nostrils automatically close.
- The seal's blood circulation becomes restricted to only essential organs and tissues: the brain, the heart, and a few other vital organs, and the heartbeat slows down.
- The seal's muscles have a large amount of myoglobin, a substance that stores oxygen.
- The seal's eyes stay open so that it can see prey underwater.
- Ears close during a dive.

Source: Riedman, M. 1990. The Pinnipeds.
Photo: Paul Hillman, NOAA Ocean Media Center

When and how deep do fur seals dive?

- Fur seals dive to 150-200 m (492-656 ft)
- Average dives are 2.2 minutes
- Longest dive is 7.6 minutes
- At night most fur seals dive to shallow depths



Lesson 5: *How do fur seals dive?* 7

Fur seals dive to different depths depending on their prey.

This graph shows dive data from a recorder placed on a female northern fur seal. The x-axis along the bottom is date and time. The y-axis is depth in meters with the surface (0 meters) at the top. The data show that this fur seal dove mostly at night.

Source: Gentry, R. 1998. Behavior and ecology of the northern fur seal.

How do fur seals stay cool on land?

- Seals are adapted to stay warm in the water
- On land they need to cool themselves.
  - Pant to cool
  - Flippers have no insulating fur
  - Hind flippers are very long – more surface area to lose heat
  - Hind flippers are held up in the air and waved
  - Flippers are waved to cool the blood, not to fan the body

Lesson 5: *How do fur seals dive?* 8

On land, pinnipeds have the problem of keeping cool, while still having all the adaptations that allowed them to stay warm in the water.

Fur seals cool off in several ways:

Panting - Most mammals have sweat glands which allow them to cool the body by evaporation of sweat. Panting is a form of sweating. The tongue is cooled as water evaporates off the surface. Northern fur seals are the only marine mammal that pants.

Flippers – the hindflippers are very long, and neither hind nor foreflippers have fur. A fine network of blood vessels in the flippers allows for exchange of heat; when the seal is in cold water, heat in the blood can be kept near the core of the body, but when the seal is hot, the warmth in the blood goes out to the flippers and can be released to the environment when the seal waves its flipper in the air. When the seal waves its flipper, the blood is cooled and heat is released from the body. The cooled blood then goes back into the body from the flipper.

Source: Riedman, M. 1990. The Pinnipeds., p. 19 (panting), 20 (flippers)
Photo: Rolf Ream, NOAA/NMFS/AFSC/NMML

What can we learn from diving?

- When, where, how often, and how deep seals are diving
- Competition with fisheries and risk of bycatch of seals in fisheries

Lesson 5: *How do fur seals dive?* 9

By attaching instruments to seals, scientists can find out location of dives (where seals are foraging, or where they travel), time of day (when seals are diving), frequency of diving (some seals dive more often at night than during the day), depth of dives (depth can give information on the prey targeted by seals).

From dive locations and depths, scientists and managers can see if seals are feeding in areas where fisheries are active.

Photos: adult male — Jeremy Sterling, NMML/AFSC/NMFS/NOAA
pup – Jason Baker, NMML/AFSC/NMFS/NOAA

How do we know?

- Instruments on seals
  - **Time-depth recorders** (TDRs) give time and the depth of dives
    - instrument must be retrieved
    - less expensive but doesn't collect location information
  - **Satellite-linked instruments** transmit dive and location data via satellites to computers
    - no instrument retrieval
    - more expensive
  - **GPS tags** record location
    - Must be combined with TDR
  - **Cell phone tags**
    - Can be used in more populated areas (not the Bering Sea!)

Lesson 5: *How do fur seals dive?* 10

Things to think about when putting an instrument on an animal:

- Size of instrument compared to the size of the animal (scientists couldn't tag pups until the tags were small enough that they wouldn't affect the pup's ability to swim). If the tag is too big, the animal's ability to move around (swim, walk) is affected.
- Attachment method. The first instruments were attached by harnesses on the animals, which were bulky and caused a lot of drag in the water. Currently, instruments are attached with glue to the fur of the seal.

Photo: Rolf Ream, NMML/AFSC/NMFS/NOAA

Summary

- Fur seals dive to eat
- Fur seals can see and hear underwater
- Their bodies are adapted to being in cold water
- The average dive is 2.2 minutes

Lesson 5: *How do fur seals dive?* 11

LESSON FIVE | SCIENCE/MATH ACTIVITY 5.1 | Grade Level K–6

Blubber Mitt

OBJECTIVE

Students will investigate how blubber helps marine mammals stay warm in cold water by experiencing first hand the discomfort of cold water and the insulating properties of a blubber mitt.

TIME REQUIRED

10 minutes

BACKGROUND

Like humans, marine mammals are warm-blooded animals. Although they live in some of the coldest environments on earth they still maintain a constant body temperature. Most marine mammals have blubber. Blubber is a thick layer of fat under the skin that acts as insulation against the cold ocean water. Almost all marine mammals need the insulating properties of blubber to stay warm. Blubber is firmer and far thicker than the fatty tissue of land mammals and is laced with connective tissue. Unlike fur, blubber does not compress when the animals dive deep to feed. Whales, dolphins, and walrus depend primarily on blubber to keep warm; sea lions and seals depend on both blubber and fur.
Blubber is such an effective insulator that marine mammals must guard against overheating.

MATERIALS

For each team of 3 students:

- 2 one-gallon or one-quart resealable freezer bags (no zipper bags)
- 36 oz. of vegetable shortening
- spatula
- duct tape
- towels
- ice
- 2 digital thermometers
- bucket or tub
- water
- graph paper
- bubble wrap

Optional

- feathers
- wool
- sweatshirt
- fleece
- Styrofoam packing peanuts

Introductory Discussion

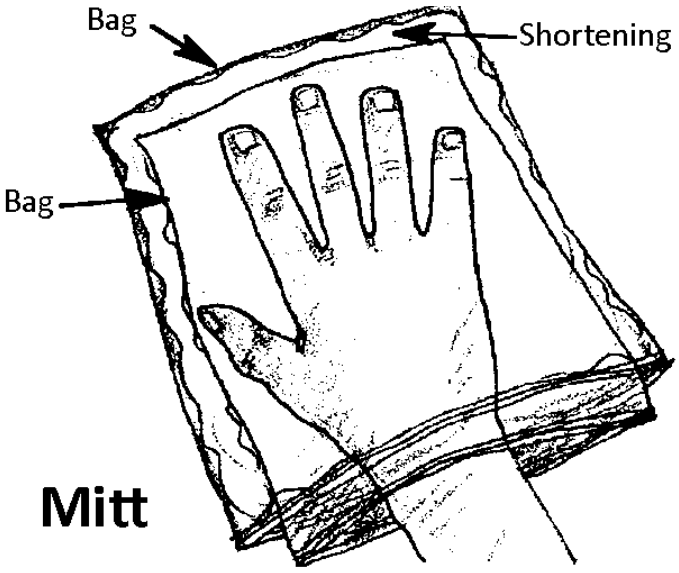
- Ask students how marine mammals stay warm in the water.
- Talk about how humans stay warm in cold water.
  - Divers wear wet suits or dry suits.
- Introduce the concept of blubber and fur that marine mammals use to keep warm.

PROCEDURES

Either you or your students will need to make blubber mitts. If you can stand the mess, consider having your students make the mitts. Once a class set of mitts is constructed, you can use them year after year. Students can work in groups of 3 or more.

Make the blubber mitts

1. Fill one plastic bag with enough shortening to coat all of the surfaces.
2. Turn the second bag inside-out and insert it into the first bag. Try to keep the seals free of shortening to allow for a better grip. Zip the tops together.
3. Use duct tape on the seals to prevent water from entering the blubber mitt.



Make the control mitts

- Follow the procedure above but leave out the shortening.

Prepare the cold water.

- Fill a bucket or cooler with ice water. The container should be large enough to hold two mitts at the same time.

PROCEDURES continued

K-1

Test how well each mitt insulates against the cold water.

1. Put one hand in each mitt.
2. Place both mitts in the cold water for 60 seconds.

Record which hand feels colder.

Grades 2-6

Measure the temperature in the blubber mitt and in the control

Worksheet 5.1.1 (see below) in groups of three.

1. Have students predict which mitt will be warmer.
2. Put the blubber mitt and control mitt in the ice water. Make sure the ice water does not get inside the mitts.
3. Assign tasks or allow students to volunteer for a task.

   Tester — holds the blubber mitt and control mitt so that the temperature can be measured in each.

   Temperature measurer — uses the digital thermometer to record the temperature.

   Data recorder — records the temperature on the data sheet.
4. Rotate roles among students so that the group gets three measurements and each student has a turn in each role.
5. Have students calculate the average temperatures from their three trials, compare the results from the blubber and control mitt, and write a conclusion about which mitt provides the most insulation.

DISCUSSION

- Discuss the results. Which material provided the best insulation and why?
- Were there any surprises? Did the students predict that a material would not provide insulation when it actually did?
- What are other materials that could be used? How do other animals stay warm?
- Was there anything that affected the outcome? (For example, if cold water got into the blubber mitt, it would affect the temperature recorded in the mitt). Think about how this could happen in an animal with blubber (e.g. the animal gets an injury and coldwater gets past the blubber).

EXTENSION

1. Have students create their own ‘survival mitt’ by substituting other materials for the shortening in the mitt, such as Styrofoam packing peanuts, feathers, or wool, etc. retry the experiment, and compare results.
2. Create a mitt that has air or bubble wrap between the two layers of plastic bag. Compare results to the blubber. Northern fur seals and sea otters trap bubbles of air in their fur to insulate them against the cold water.
3. Grades 5-6: Research how northern fur seals stay cool on land. See also Lesson 5 PowerPoint slide #8.

The Blubber Mitt activity is a lesson adapted with permission, from the award-winning FOR SEA family of curriculum guides for grades 1–2, available from FOR SEA Institute of Marine Science, Indianola, Washington 98342 (http://www.forsea.org)

ACTIVITY 5.1 WORKSHEET 5.1.1 Blubber Mitt

Student 1 name: _____

Student 2 name: _____

Student 3 name: _____

Prediction: Which mitt will provide the most insulation? (Which mitt will be warmer?)

_____

Data Table: Temperature inside mitt

	Blubber Mitt Temperature	Control Mitt Temperature
Trial 1		
Trial 2		
Trial 3		
Average		

Conclusion:

_____

_____

_____

Additional observations (What affected the outcome?)

_____

_____

_____

LESSON FIVE SCIENCE/MATH ACTIVITY 5.2 Grade Level 3–6

Waiting to Inhale!

OBJECTIVE

Students will learn how long fur seals hold their breath when they dive.

TIME REQUIRED

10 minutes

BACKGROUND

INSTRUCTOR: This is an activity that should not be done at home or unsupervised. Instructors should take precautions to warn students that this activity should be done only at school.

Air-breathing mammals like pinnipeds (seals, eared seals and walruses) must be able to take in enough oxygen to survive while they are underwater diving for food. Most eared seals (fur seals and sea lions) dive to depths of 150-200 meters while other seals can dive to 1,000-1,200 meters. Fur seal dives are short for pinnipeds, averaging two to nine minutes. Because they have larger bodies, males can dive longer than females.

MATERIALS

- Worksheet 1 (grades 3-6)
- Table 1 (grades 5-6)
- Worksheet 2 (grades 5-6)
- Worksheet 3 (grades 5-6)
- Timer (clock with second hand, or stopwatch)
- Student basic 4 function calculators

PROCEDURE FOR GRADES 3-4

1. Ask what kinds of adaptations pinnipeds have for diving. Ask the students what they do when swimming (e.g. hold breath, open eyes underwater, use arms to propel, use legs to push).
2. Hand out Activity 5.2 Worksheet 1. Each student makes a prediction: how long can they hold their breath? Record the prediction on their worksheet.
3. Have students work in pairs. One student will hold his or her breath; the other student will record the length of time that the first student can hold his or her breath. Repeat three times, then switch.
4. Graph results as a class.
5. Compare predictions to their actual results
6. Discuss and write a conclusion sentence. "I conclude that I held my breath 10 seconds longer than I predicted…"
7. Show the students Table 1 (average and maximum dive duration of male northern fur seals) and talk about whether the students were able to hold their breath as long as fur seals hold their breath to dive.

PROCEDURE FOR GRADES 5-6

Follow steps 1-6 above.

8. Once all students have compared their predictions to their results, hand out Activity 5.2 Worksheet 2. Have students write down their average and maximum breath-hold durations and make a prediction about whether they can hold their breath longer than a fur seal.
9. Hand out Table 1 or show it on the overhead projector. Have students compare their individual breath-hold duration with male fur seal dive durations and write a conclusion based on their prediction. Have students calculate mean and median dive durations of the fur seal data.
10. The class will fill out Activity 5.2 Worksheet 3 as a group, either on the whiteboard or as an overhead projection. Students will have to convert their times to decimal minutes if they recorded them as minutes and seconds.
    a. For times recorded as Minutes:Seconds (MM:SS) , take the seconds (SS) and divide by 60, then add to the minutes (MM).
    b. Example:
        i. 89 seconds = 1 minute 29 seconds
        ii. Divide seconds by 60: 29÷60=0.48
        iii. the amount would be written 1.48 minutes
11. Calculate a class average breath-holding duration (average of all the students) and maximum breath-holding duration (average of the students' individual maximum durations). Compare with the average and maximum dive duration of the fur seals.

DISCUSSION

- What was the class average for breath-holding?
- How did it compare to the average northern fur seal breath-holding?
- Why can fur seals hold their breath so much longer than humans?

Most mammals have hemoglobin, a molecule in red blood cells that carries oxygen. Seals and cetaceans also store oxygen in a molecule called myglobin which is in the muscles. Seals also have a lot of blood compared to other mammals (about 12% of their body weight; a person has about 7% of their body weight composed of blood). So, seals have lots of hemoglobin and myoglobin to carry oxygen, which they use when they are diving.

EXTENSION

- Have the students look up dive durations of other animals (otters, whales, other seals) and compare them to their own breath-holding durations.
- If several classes do the same exercise, have them compare results. Bigger fur seals can dive longer and deeper because they have bigger bodies (and therefore more capacity to hold oxygen in their blood). Does this pattern hold with students, too?

RESOURCES

Video camera reveal marine mammals take a laid-back approach to deep diving
UC Santa Cruz Currents online, http://www1ucsc.edu/currents/99-00/04-10/dive.html

Marine Mammals–Marinebio.org
http:/marinebio.org/oceans/marine-mammals.asp

ACTIVITY 5.2 WORKSHEET 5.2.1 Waiting to inhale!

Student 1 name:_____

Student 2 name: _____

Prediction: How long can you hold your breath?

Student 1:_____

Student 2:_____

Data Table: Length of time holding breath (in seconds)

	Student 1 Name:	Student 2 Name:
Trial 1		
Trial 2		
Trial 3		
Average		

Conclusion:

Student 1:_____

_____

_____

Student 2:_____

_____

_____

ACTIVITY 5.2 EXAMPLE 5.2.1 Waiting to inhale!

Student 1 name: Student 1

Student 2 name: Student 2

Prediction: How long can you hold your breath?

Student 1: Student 1 60 seconds

Student 2: Student 2 75 seconds

Data Table: Length of time holding breath (in seconds)

	Name: Student 1	Name: Student 2
Trial 1	49	79
Trial 2	56	85
Trial 3	58	89
Average	54 seconds	84 seconds

Conclusion:

Student 1: I conclude that my prediction was very close to how long I could actually hold my breath.

Student 2: I conclude that I could hold my breath longer than I predicted.

ACTIVITY 5.2 **TABLE 5.2.2** Waiting to inhale!

How long do male northern fur seals dive?

Average and maximum dive durations for male northern fur seals. Dive durations are shown in two units: in minutes and seconds, and in decimal minutes. Decimal minutes are used by scientists for calculating mean and median durations.

Male #	Average dive duration (minutes:seconds)	Maximum dive duration (minutes:seconds)	Average dive duration (decimal minutes)	Maximum dive duration (decimal minutes)
1	3:40	6:17	3.67	6.28
2	5:25	8:14	5.42	8.23
3	5:39	8:59	5.65	8.99
4	3:34	5:10	3.56	5.17
5	2:56	5:16	2.94	5.26

ACTIVITY 5.2 WORKSHEET 5.2.2 Waiting to inhale!

Comparing your results to northern fur seal dive durations.

What was your average breath-holding duration? _____

What was your maximum breath-holding duration? _____

Prediction 1: Do you think you can hold your breath longer than a fur seal? _____

Look at Table 5.2.2.
Calculate the mean and the median duration for the following:

	Mean duration (decimal minutes)	Median duration (decimal minutes)
Male fur seals — Average dive duration		
Male fur seals — Maximum dive duration		

Conclusion: _____

_____

_____

_____

ACTIVITY 5.2 **EXAMPLE 5.2.2** Waiting to inhale!

Comparing your results to northern fur seal dive durations.

What was your average breath-holding duration? 54 seconds (0:54)

What was your maximum breath-holding duration? 58 seconds (0:58)

Prediction 1: Do you think you can hold your breath longer than a fur seal? NO

SHOW THIS TABLE TO STUDENTS – available on separate page

Table 5.2.2. How long do male northern fur seals dive?

Average and maximum dive durations for male northern fur seals. Dive durations are shown in two units: in minutes and seconds, and in decimal minutes. Decimal minutes are used for calculating mean and median durations.

Male #	Average dive duration (minutes:seconds)	Maximum dive duration (minutes:seconds)	Average dive duration (decimal minutes)	Maximum dive duration (decimal minutes)
1	3:40	6:17	3.67	6.28
2	5:25	8:14	5.42	8.23
3	5:39	8:59	5.65	8.99
4	3:34	5:10	3.56	5.17
5	2:56	5:16	2.94	5.26

Calculate the mean and the median duration for the following:

	Mean duration (decimal minutes)	Median duration (decimal minutes)
Male fur seals — Average dive duration	4.25	3.67
Male fur seals — Maximum dive duration	6.79	6.28

Conclusion: My prediction that I could not hold my breath longer than a fur seal was correct. My maximum breath- hold duration was 58 seconds and some male fur seals can hold their breath over 8 minutes.

ACTIVITY 5.2 WORKSHEET 5.2.3 Waiting to inhale!

Comparing students' breath-holding duration with fur seals' dive duration.

Fill out the following table as a class. For fur seal dive durations, use data from Table 5.2.2.

Male #	Average dive duration (decimal minutes)	Maximum dive duration (decimal minutes)	Student Name	Average breath-holding duration (decimal minutes)	Maximum breath-holding duration (decimal minutes)
1					
2					
3					
4					
5					
Average:			**Average:**		

ACTIVITY 5.2 EXAMPLE 5.2.3

Comparing students' breath-holding duration with fur seals' dive duration.

Fill out the following table as a class. For fur seal dive durations, use data from Table 5.2.2.

Male #	Average dive duration (decimal minutes)	Maximum dive duration (decimal minutes)	Student Name	Average breath-holding duration (minutes:seconds converted to decimal minutes*)		Maximum breath-holding duration (minutes:seconds converted to decimal minutes*)	
1	**3.67**	**6.28**	Student 1	0:54	**0.95**	0:58	**0.97**
2	**5.42**	**8.23**	Student 2	1:24	**1.40**	1:29	**1.48**
3	**5.65**	**8.99**	Student 3	1:05	**1.08**	1:10	**1.17**
4	**3.56**	**5.17**	Student 4	1:00	**1.00**	1:10	**1.17**
5	**2.94**	**5.26**	Student 5	1:15	**1.25**	1:30	**1.50**
Average:	**4.25**	**6.79**	**Average:**		**1.14**		**1.26**

**** decimal minutes are in bold***

LESSON FIVE SCIENCE/MATH ACTIVITY 5.3 Grade Level 3–6

Exhale and Dive!

OBJECTIVE

Students will investigate adaptations that seals use when they dive

TIME REQUIRED

10 minutes

BACKGROUND

Air-breathing mammals like pinnipeds (seals, eared seals and walruses) must be able to take in enough oxygen to stay conscious while they dive for food. Most eared seals dive to depths of 150-200 meters (shallow compared to other pinnipeds that can dive to 1,000-1,200 meters, but deep compared to humans!). Pinnipeds have to adapt to pressure of deep water as well as conserve oxygen while they dive.

MATERIALS

5 gallons bucket of water or large chest cooler
1-quart sealable plastic sandwich bags (2 per group)
Yardstick (optional)

PROCEDURE

- Hand out worksheet.
- Mark the bucket or cooler with marks showing ¼, ½, ¾ full, or use a yardstick in the bucket
- Fill the bucket or cooler with water
- Blow up one plastic bag with air, then seal it closed. It helps to tape the bag closed.
- Seal the second plastic bag without putting any air in it.
- Ask the students to predict which bag can be pushed farther under the water, and to write their prediction in the worksheet.
- Do three trials of pushing each bag into the bucket, and recording how far down it can be pushed down
- Have students write their conclusions
- Discuss results (see below)

DISCUSSION

- What were the results that were seen?

  Bag #2, the empty bag, went underwater easier than bag #1.

- Ask students if they have ever dived underwater. Did they take a big breath and hold it when they went underwater?
- Tell students that seals don't take a big breath and hold it. Instead, they exhale and empty their lungs when they dive, so they can go down easier. The lungs are like the plastic bags; when you fill your lungs and hold your breath, it's like the bag full of air. Seals' lungs when they exhale are like the empty bag.
- So what do seals use for air?

  Most mammals have hemoglobin which is a molecule in red blood cells that carries oxygen. Pinnipeds and cetaceans also store oxygen in a molecule called myglobin which is in the muscles and also have a lot of blood compared to other mammals (about 12% of their body weight, compared to a person who has about 7% of their body weight composed of blood). Seals can store 3 times as much oxygen in their bodies as humans, because of:

  - more hemoglobin in the blood
  - myoglobin in muscle
  - more blood in the body (up to twice as much as humans).

- Would you be able to dive for very long if you exhaled before diving?

  No, because humans do not have as much hemoglobin in their blood as seals do, and humans have very little myoglobin in their muscles to store oxygen.

ACTIVITY 5.3 WORKSHEET 5.3.1 Exhale and Dive!

Bag 1: full of air

Bag 2: empty

Which bag can be pushed farther underwater?

Prediction: _____

_____

_____

_____

Data:

	Distance underwater	
Trial #	**Bag # 1**	**Bag #2**
1		
2		
3		

Conclusion: _____

_____

_____

_____

ACTIVITY 5.3 **EXAMPLE 5.3.1** Exhale and Dive!

Bag 1: full of air

Bag 2: empty

Which bag can be pushed farther underwater?

Prediction: I predict that bag #2 can be pushed farther underwater because the air in the other bag will make it float.

Data:

	Distance underwater	
Trial #	**Bag # 1**	**Bag #2**
1	¼	All the way to the bottom
2	¼	All the way to the bottom
3	½	All the way to the bottom

Conclusion: My prediction was correct – bag #2 was pushed to the bottom each time while bag #1 only went part way down the bucket.