



Recovering Sea Otters in a Changing Climate

Created by: Katherine Fitzgerald and Leah Schrodt with the US Fish and Wildlife Service

Background Information:

Long ago, sea otters lived all along the coasts of the North Pacific Ocean from northern Japan to Russia, Alaska, Canada, Washington, Oregon, California, and Baja California in Mexico. For thousands of years, sea otters have been an important part of native cultures throughout their range. Sea otter fur is very thick and warm and was a high commodity in the fur trade starting in the mid 1700's. Before the fur trade their populations were estimated at up to 300,000 individuals across their range. Traders hunted so many sea otters that by the early 1900s, there were only about 2,000 sea otters left in the world and those remaining were found in only a small fraction of their original range. In 1911, the United States, Canada, Russia, and Japan got together and agreed to not hunt sea otters and signed the Northern Pacific Fur Seal Treaty. At that time, there were so few sea otters remaining that it was nearly impossible to find them and the trade in sea otter fur was no longer profitable. Today, there are other laws that have been added aimed at prohibiting hunting sea otters from the southern population in California and the Aleutian population in SW Alaska, like the Marine Mammal Protection Act and the Endangered Species Act. These populations are classified as "threatened." Thanks to these conservation efforts, there are many more sea otters now than there were in 1911, but they still have a long way to go before they are completely recovered. Alaska has the highest number of sea otters in the world. About 50 years ago, they were reintroduced to Washington and Oregon from Alaska. They were also introduced into to several areas in Alaska and Canada. Unfortunately, the population in Oregon didn't succeed, and although a lone sea otter may visit Oregon now and then, they don't live here. The population in Washington did take hold and is growing. California's sea otter population is holding steady at around 3,000. There is an 800 mile gap along the coastline between central California and the west coast of Washington where there still are no sea otters. The USFWS and our partners continue working diligently to recover this important species.

For more information:

- Washington State Sea otters USFWS: <https://www.fws.gov/wafwo/articles.cfm?id=149489662>
- California Southern State Sea otters USFWS:
 - <https://www.fws.gov/ventura/endangered/species/info/sso.html>
 - <https://www.fws.gov/ventura/docs/species/sso/SSO%20Draft%20SAR%202020%201-22%20FOR%20PUBLIC%20REVIEW.pdf>
- Alaska Sea otters USFWS: <https://www.fws.gov/alaska/pages/marine-mammals/sea-otters>
- Elakha Alliance, Sea Otters and Tribal Significance: <https://www.elakhaalliance.org/learn/the-history-of-sea-otters-in-oregon/sea-otters-and-oregons-coastal-native-tribes/#:~:text=For%20at%20least%2010%2C000%20years,the%20people%20along%20Oregon's%20coast.&text=Elders%20from%20throughout%20the%20coast,and%20status%20on%20the%20wearer.>

Talking Point 1: Sea Otters are a Keystone Species

All living things are connected – we are all interdependent upon one another. Some species, like the sea otter, are considered a keystone species because they play an even more important role in keeping an ecosystem healthy. A keystone species is like the top stone (a.k.a., the keystone) in an arch: if that stone gets removed, the entire arch would collapse; so would the ecosystem that sea otters support – the kelp forest. The shelter, food and habitat kelp forests offer support thousands of different forms of life across the globe, including fisheries, mollusks, marine mammals and birds. Sea urchins are one of the sea otter's favorite foods, which is good news for kelp forests – kelp is one of the favorite foods of sea urchins. When sea urchin populations go unchecked, such as when there are no sea otters or other predators to eat them, they devour kelp forests at a rate of 30 feet per month. Without enough natural predators, sea urchins can turn the bottom of the ocean into an underwater desert. A 20 year study has shown that the kelp canopy along the 217 mile coastline between San Francisco and the Oregon border is down more than 90% because of overpopulation of purple sea urchins. Their populations were allowed to go unchecked because of the lack of sea otters and because of the sea star wasting syndrome that hit hard in 2013 and killed many sea stars. Sea stars also prey on sea urchins.

Potential Teaching Props:

- Sea urchin (replica or real)
- Sea star (replica or real)
- Map showing historic sea otter range and present range:
<https://upload.wikimedia.org/wikipedia/commons/f/f7/Sea-otter-map.jpg>

For more information:

- NPS – A Keystone Species: <https://www.nps.gov/glba/blogs/a-keystone-species-the-sea-otter-colonizes-glacier-bay.htm#:~:text=Sea%20otters%20are%20a%20%22keystone,the%20presence%20of%20sea%20otters>
- Elakha Alliance and Keystones Species: <https://www.elakhaalliance.org/learn/sea-otter-science/a-keystone-of-kelp/>

Talking Point 2: Kelp Forests and Seagrasses Store Carbon and Help Mitigate the Harmful Impacts of Climate Change

Kelp forests, like terrestrial forests, absorb a lot of carbon dioxide from the atmosphere; in so doing, they help reduce the impacts of climate change. With sea urchins on the menu, the protection sea otters provide kelp forests is essential. Studies have shown a kelp forest without otters can capture 4.4 megatons of carbon dioxide, whereas a kelp forest with otter protection can capture 8.7 megatons. Kelp forests also need cold, oxygen and nutrient-rich currents to survive. The impacts of a warming ocean and change in ocean biomes are decreasing kelp forests across the globe. With 2020 being the hottest year on record, marine heat waves are now happening twice as often as they did prior to 1982. The presence of sea otters also helps seagrasses, which is another very important ocean plant that helps combat climate change: sea otters eat crabs which eat creatures (like sea hares) that eat algae that grows on seagrass. Too much algae smothers and kills seagrasses. Seagrasses represent less than 0.2% of the seafloor, but they provide up to 10% of the ocean's carbon storage. Though the amount of storage varies by species, some seagrasses can store up to two times as much carbon as the world's temperate and tropical forests!

Potential Teaching Props:

- Kelp replica and/or pictures of a kelp forest
- Plastic aquarium grass to represent seagrass
- Hot water bottle

For more information:

- NOAA Kelp: <https://sanctuaries.noaa.gov/visit/ecosystems/kelpdesc.html>
- OPB Article on the loss of Oregon Kelp Forests: <https://www.opb.org/article/2021/02/25/kelp-forests-oregon-coast-conservation/?fbclid=IwAR3rCjnykaxoNyjXOXDzncrv0peHpivVJ-rEyOeVsjFCHO6w4ICDOc9c1xc>
- Popular Science Article about Loss of California Kelp Forest: <https://www.popsci.com/kelp-deforestation-california/>
- Harvard University Article, *How Kelp Naturally Combats Global Climate Change*: <http://sitn.hms.harvard.edu/flash/2019/how-kelp-naturally-combats-global-climate-change/>
- Yes Magazine article, *What Kelp Forests Can Do for the Climate*: <https://www.yesmagazine.org/environment/2020/07/01/climate-carbon-oceans-kelp/>
- Huffington Post, *Sea Grass is a Vital Weapon Against Climate Change, But We Are Killing It!*: https://www.huffpost.com/entry/seagrass-ocean-climate-change-pollution-florida_n_602ced75c5b6cc8bbf3819ff

Talking Point 3: Sea Otters Need to Eat A Lot!

Unlike most other marine mammals, sea otters don't have a layer of blubber to keep themselves warm. Instead, they have thick fur for insulation and a high metabolism that acts like a furnace. Otter fur is so thick that it includes more than a million fibers per square inch (the densest of any animal) – humans only have about 100,000 on our entire heads! A trapped layer of air is very important for keeping the water from contacting the skin; they can become hypothermic very quickly. You will often see them grooming on the surface of the water, puffing up their fur and trapping more air. Mother otters groom their pups constantly and blow air bubbles into their fur to make sure they stay warm; their babies are so buoyant they can't dive and will pop to the surface like a cork. Most of their lives are spent in the water and they rarely come to shore. They eat, sleep, and even give birth at sea. And, in order to stay warm in the cold ocean water and to keep up with their rapid metabolism, they must eat a lot – up to 25% to 30% of their body weight each day. Mother sea otters need to eat even more to make milk for their pups. In addition to sea urchins, clams, mussels, crabs, sea stars, sea snails, octopus, squid, and rarely fish are also on the sea otter's menu.

Potential Teaching Props:

- Sea otter pelt (if at a zoo or aquarium and they have one available as a teaching prop) – If you don't have access to a pelt, see video listed below
- Sea otter skull replica to show their carnivore teeth and size
- Blubber diagram and/or butter/lard
- Map of sea otter populations
- Shells of clams, mussels, crabs, sea urchins, sea snails, and dried sea stars, package of dried squid, package of dried octopus, and/or octopus squeaky toy.
- Develop grocery lists showing the amount of food a sea otter might eat each day, for example:
 - For a small female, 13 crabs, 27 sea urchins, and 6 sea snails, or

- For a large male, 80 clams, 58 mussels, 24 sea urchins, a scallop, a snail, an octopus, and 7 crabs, or
- For a medium-sized sea otter, 14 crabs, 28 sea urchins, 42 clams, 6 sea snails, and 11 mussels

(These lists are based on actual diet composition in different parts of the sea otter range, plus an estimate of caloric needs. The grocery lists could be written in words, or illustrated using stylized pictures of prey items, or both.)

- Rock to show how sea otters break open shells of clams by putting them on their chest and using a rock as a tool to break them open – They store their rocks in armpit storage pockets

For more information:

- KQED, *Fantastic Fur of Sea Otters*: <https://www.kqed.org/science/25908/the-fantastic-fur-of-sea-otters>
- Monterey Bay Aquarium Video on sea otter fur: <https://www.youtube.com/watch?v=sgFMVRtkpVY>
- Deep Look, *The Fantastic Fur of Sea Otters* Video: https://www.youtube.com/watch?v=Zxqg_um1TXI

Talking Point 4: Ocean Acidification Makes it Harder to Recover Sea Otter Populations

Climate change is greatly impacting the levels of acidity in the ocean. When carbon dioxide is absorbed into ocean water, it makes the ocean more acidic - the ocean's acidity has increased by nearly 30% in the last 150 years. This is called "ocean acidification." Calcifying animals (a.k.a., animals that have shells) like clams, mussels, crabs, snails and oysters, are greatly impacted by increased acidity in the ocean – their shells literally dissolve and become thinner or weaker in more acidic water. Many don't survive. This not only impacts the industries that harvests these resources, but it also takes away food from sea otters, furthering the difficulty in recovering this important species. This is where it comes full circle, because the photosynthesis and carbon storage of kelp and seagrasses that flourish in the presence of otters also reduces ocean acidification.

Potential Teaching Prop:

- Do a scientific experiment: Get two shells and place one in acidic water (add lemon juice or vinegar) and one in plain water. See what happens over time.
 - Shells in Water experiment: <https://web.uri.edu/smiley/files/Shells-in-Acid-LAB1.pdf>
 - NOAA Curriculum: http://www.cisanctuary.org/ocean-acidification/PDFs-WorkshopPage/Impacts%20of%20Carbonated%20Sea%20Water%20on%20Mussel%20and%20Oyster%20Shells_Oct_%202015.pdf
- Bottle or can of carbonated water

For more information:

- NOAA and Ocean Acidification: <https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification>
- USFWS Southern Sea Otter Recovery Plan: <https://www.fws.gov/ventura/endangered/species/info/sso.html>

Talking Point 5: Climate Change Causes Toxic Algae Blooms and May Increase the Spread of Diseases

Toxic Algae Blooms:

Climate change also causes the ocean water to warm. Toxic algae blooms thrive in warmer water, and the occurrence of these blooms is on the rise. They kill off shellfish and fish that sea otters eat. This is the same kind of poisonous algae that can make shellfish bad for people to eat. It is also very toxic to sea otters and many other forms of marine life. These toxic algae blooms also impact marine economies.

Potential Teaching Props:

- Vial or other container with toxic algae look-alike in water, and a skull and crossbones poison label
- Picture(s) of lake and/or beach with toxic algae blooms.
- Hot water bottle

Learn more Algae Blooms and Climate Change:

- EPA Website: <https://www.epa.gov/nutrientpollution/climate-change-and-harmful-algal-blooms>
- NOAA, Harmful Algal Blooms: <https://oceanservice.noaa.gov/hazards/hab/>
 - Red Tide video: <https://oceanservice.noaa.gov/facts/redtide.html>
- UC Davis Study: <https://www.ucdavis.edu/news/ocean-toxin-heartbreaking-threat-sea-otters/>

Spread of Diseases: Additionally a parasite called *Toxoplasma gondii*, which is found in cat feces, is also killing sea otters. This same disease is toxic to unborn human children and babies too. Though not completely understood, climate change is also having impacts on the lifecycle of pathogens like *Toxoplasma gondii*. Climate change induced extreme weather events, like increased flooding, increase the spread of this pathogen into marine environments as it is transferred from our watersheds into the ocean.

Potential Teaching Props:

- Stuffed cat toy depicting where *Toxoplasma gondii* comes from
- Replica cat poop

Learn more about *Toxoplasma gondii* (feline disease killing sea otters):

- UC Davis article on feline disease killing sea otters: <https://www.ucdavis.edu/news/whats-killing-sea-otters-scientists-pinpoint-parasite-strain/>
- Scientific study on the spread of *Toxoplasma gondii* and climate change: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2695550/#:~:text=It%20is%20postulated%20that%20an,using%20Global%20Climate%20Change%20models.>

Talking Point 6: There's A Lot We Don't Know About the Impacts of Climate Change on Sea Otters

We don't know the full extent of how climate change will affect sea otter populations. Sea otters eat lots of different foods, so maybe they will be able to switch to other prey that do better in warmer, more acidic water. We do know that the food chain will change, but we don't know if sea otters will be able to change their diet enough to keep up. The ocean's climate is becoming more variable. There will probably be good years, when lots of food is available, and bad years, when sea otters go hungry. We do know that sea otter populations are already at risk, and their threats many. A few climate change-caused bad years in a row would mean big trouble for the recovery of sea otters.

Talking Point 7: The Good News is We Can Help Sea Otters!

- Curb ocean acidification by reducing our use of oil and gas (“fossil fuels”) that add carbon dioxide into the air.
- Plant more trees that suck carbon dioxide out of the air. This will help curb ocean warming, too.
- Make sure that sea otters have plenty of protected marine habitat to use. They will be able to handle climate-related changes in the food chain better if they aren’t stressed by other things, like oil spills, lack of habitat or overfishing. These protected sites also will create more habitat for kelp to grow.
- Keep cats indoors and deposit their kitty litter in the garbage. This is also safer for many other forms of life that cats kill, including birds, as well as safer for your feline friend. Never flush cat poop; sewage treatment plants don’t remove all of the *Toxoplasma gondii*, which can end up in the ocean water and kill sea otters.

How to Use Teaching Props:

Sea otter pelt (if at a zoo or aquarium and they have one available as a teaching prop) Or Watch the Deep Look video	Sea otters have the densest fur of any animal, with up to one million hairs per square inch! Humans have a total 100,000 on our entire heads. This is why they were hunted to near extinction – it makes a very warm coat – but otters need those coats more than people do! Video: Deep Look, <i>The Fantastic Fur of Sea Otters</i> : https://www.youtube.com/watch?v=Zxqg_um1TXI
Sea urchin (replica or real)	Sea urchins are one of the sea otters favorite foods, which is good news for kelp forests – kelp is one of the favorite foods of sea urchins. When sea urchin populations go unchecked, such as when there are no sea otters to eat them, they devour kelp forests at a rate of 30 feet per month. Without enough natural predators, sea urchins can turn the bottom of the ocean into an underwater desert.
Sea star (replica or real)	Sea stars also prey on sea urchins and help regulate their populations. Combined with the lack of sea otters, sea star wasting syndrome that hit hard in 2013 and killed many sea stars allowed sea urchin populations to increase dramatically. A 20 year study has shown that the kelp canopy along the 217 mile coastline between San Francisco and the Oregon border is down more than 90% because of overpopulation of purple sea urchins.
Blubber diagram and/or butter or lard	It’s important for mammals that live in the ocean to stay warm. Most other marine mammals, like whales and seals, have a layer of blubber

	<p>(which is a kind of fat, like butter or lard) under their skin to keep them warm. Otters don't have blubber. Instead, they use their warm, thick fur coats and they also need to eat a lot of food to help them stay warm. They have a fast metabolism that is like a furnace, constantly burning through their fuel.</p>
<p>Map showing historic sea otter range and present range</p>	<p>https://upload.wikimedia.org/wikipedia/commons/f/f7/Sea-otter-map.jpg</p>
<p>Shells of clams, mussels, crabs, sea urchins, sea snails, and dried sea stars, package of dried squid, package of dried octopus and/or octopus squeaky toy</p>	<p>Just like you probably do, sea otters eat lots of different kinds of food. (But all of the sea otter's food comes from the sea.) Sea otters eat clams, mussels, crabs, sea urchins, sea stars, sea snails, octopus, squid, and other sea creatures, sometimes including fish. Instead of buying their groceries from the store, they find it on the rocks along the shore, on the seafloor, or hidden in the kelp forest.</p> <p>Have you eaten some of these foods? If you've eaten some of the foods, think of how they tasted. Yum!!!!</p>
<p>Grocery lists showing diets for different sizes of sea otters</p>	<p>Sea otters need to eat <i>a lot</i> of food every day to fuel their fast metabolism. How do you feel after exercising a lot? Does it make you hungrier? Sea otters need to eat up to 30% of their body weight daily. How much do you weigh? Do the math – could you eat 30% of your body weight in one day? Mother sea otters need to eat extra to make milk for their pups (the name for their babies).</p> <p>Sea Otter Shopping List:</p> <ul style="list-style-type: none"> ○ For a small female, 13 crabs, 27 sea urchins, and 6 sea snails ○ For a large male, 80 clams, 58 mussels, 24 sea urchins, a scallop, a snail, an octopus, and 7 crabs ○ For a medium-sized sea otter, 14 crabs, 28 sea urchins, 42 clams, 6 sea snails, and 11 mussels <p>(These lists are based on actual diet composition in different parts of the sea otter range, plus an estimate of caloric needs. The grocery lists could be written in words, or illustrated using stylized pictures of prey items, or both.)</p>
<p>Rock for breaking open clams</p>	<p>Sea otters are really smart. They can use tools, like this rock. Many sea otters use a rock to help them open up the shells of their food animals. An otter holds the rock on its chest, then bangs the clam (or mussel, or crab...) on the rock to break the shell open. The otter can store the rock, sometimes along with the food, in a pouch in its armpit.</p> <p>Some otters specialize on a particular kind of food and get really good at finding and opening it. For example, some otters might be really good at digging and cracking open clams. Then they can eat more clams more quickly than they can eat other kinds of food, so as long as there are plenty of clams, it's easy for them to get enough to eat.</p>

<p>Place clams, mussels, snails, and any other bivalves into a box or otherwise remove them from view. Bring out extra dried squid, jellyfish item.</p>	<p>Climate change could change the kinds of food that are available to sea otters. Animals with hard shells, like clams, mussels, crabs, snails, etc., are likely to become less common as the climate changes because ocean acidification dissolves their shell. Octopus and squid might do better. Jellyfish will probably also do better. Has anyone here ever eaten jellyfish? They're edible, but not too nutritious, so an otter might spend more energy catching a jellyfish than it would get from eating it. Eating jellyfish won't be worth the effort for sea otters!</p> <p>Think of your favorite food to get at the grocery store. What would you do if the grocery store stopped carrying it?</p>
<p>Bottle or can of carbonated water</p>	<p>Does anyone like to drink sparkling water? Sparkling water has carbon dioxide dissolved in it, and the bubbles are formed by carbon dioxide gas coming out of the water. When people burn coal or oil to make electricity, or natural gas for heat, or gasoline for driving, that puts carbon dioxide into the air. Then the carbon dioxide from the air dissolves into the ocean water.</p> <p>Have you ever heard that sparkling water might be bad for your teeth? The reason people say that is that sparkling water is acidic, and when you bathe your teeth in something too acidic, the acid can eat away at your teeth. (Probably only flavored sparkling water and sugary fizzy drinks are bad for your teeth-- plain unflavored sparkling water isn't acidic enough to really bother your teeth.) Seawater that has extra carbon dioxide dissolved in it becomes acidic, too, which is called ocean acidification.</p>
<p>Pairs of shells where one is soaked in acidified water and the other was soaked in regular water</p>	<p>As we keep burning fossil fuel, the ocean is getting more acidic, enough to make it hard for shellfish to make a good strong shell. Do an experiment and see what happens with a shell that is soaked for several days in acidic water.</p>
<p>Picture toxic algae bloom</p>	<p>As we keep burning fossil fuel and the air continues to get warmer, the ocean is also getting warmer. There are some kinds of toxic algae that really thrive in warmer water. Has anyone ever gone to the beach to dig clams? (If yes?) Have you ever heard of times when the beach is closed because the clams might be poisonous? That's because of toxic algae. The clams eat the algae, and then they become poisonous for people and otters to eat. Otters might know not to eat poisoned clams. In some places where the clams have a lot of poison in them, sea otters don't eat them. In other places where clams have a little bit of poison in them, sea otters eat them but throw away the most poisonous parts of the clams. So the otters might be able to avoid getting sick from the poison, but it means that they have less to eat.</p> <p>Sometimes there are new kinds of poison that otters don't know how to avoid, and then they might get sick and even die. This happened in California when some toxic algae grew in a lake, then traveled down a river to the ocean and got into the food chain there.</p>
<p>Stuffed cat toy to represent the way</p>	<p>Some kinds of food have parasites in them that can infect sea otters. Climate change can help parasites (and the other animals that carry them)</p>

<p><i>Toxoplasma gondii</i> is spread to sea otters</p>	<p>move into new parts of the sea otter’s range. For example, <i>Toxoplasma gondii</i>, which you might have heard of because it can infect pet cats and even people, has infected sea otters in California, but hasn’t infected sea otters in Alaska until recently.</p> <p>You can help otters by keeping your cat indoors and by throwing kitty litter into the garbage (vs. outside in your yard). Never flush cat poop; sewage treatment plants don’t remove all of the <i>Toxoplasma gondii</i>, which can end up in the ocean water and kill sea otters.</p>
<p>Hot water bottle</p>	<p>The full impacts of climate change on sea otters is not completely known. Maybe they’ll be able to get away with eating less food. And some of their food animals, like octopus and squid, could become more common and make up for there being fewer clams and mussels. In addition to becoming warmer, the ocean’s climate is becoming more variable. There will probably be good years, when lots of food is available, and bad years, when sea otters go hungry. Sea otter populations are small, so a few bad years in a row would mean big trouble for the recovery of this amazing animal.</p>
<p>Kelp frond replica</p>	<p>How can we help make sure sea otters do OK in the future?</p> <p>We can curb ocean acidification by reducing our use of fossil fuels that add carbon dioxide to the air and by planting trees that suck carbon dioxide out of the air. This will help keep the ocean cool, too.</p> <p>We can make sure that sea otters have plenty of protected marine habitat to use. They will be able to handle climate-related changes in the food chain better if they aren’t stressed by other things, like oil spills, loss of habitat or overfishing.</p> <p>Help kelp! Sea otters do better when they have access to kelp forests. Sea urchins eat kelp and sea otters eat sea urchins. So, conserving kelp forests will make it more likely that sea otters can keep eating one of their favorite foods. Kelp forests also do better when sea otters are there. When there aren’t sea otters to eat the urchins, the urchins overgraze the kelp and the kelp forest disappears.</p>
<p>Plastic aquarium grass</p>	<p>The presence of sea otters also helps seagrasses, which is another very important ocean habitat that helps combat climate change: sea otters eat crabs which eat creatures that eat algae that grows on seagrass (like sea hares). Too much algae smothers and kills the seagrass. Seagrasses represent less than 0.2% of the seafloor, but they provide up to 10% of the ocean’s carbon storage. Though the amount of storage varies by species, some seagrasses can store up to two times as much carbon as the world’s temperate and tropical forests!</p>