Population Growth

Integrated Science (H)

The Sea Otter, *Enhydra lutris*, historically ranged all along the Pacific Rim, from Baja California to Asia. Unlike other marine mammals that use blubber to maintain a constant body heat in the cold ocean, otters have instead a fur so thick it repels water. Not surprisingly, otters were hunted to near extinction by the turn of the twentieth century. A group of about 50 survivors were discovered in Big Sur in 1938, and from this founding group, today’s central coast population of about 3000 **Southern Sea Otters**, *Enhydra lutris nereis,* is derived.

The **biotic potential** of a population reflects the number of individuals that results from **exponential growth** in the absence of limits. For **K-selected species** like the otter – large animals with a long life expectancy and a small number of offspring that the provide extended care for – the exponential growth period is brief, as limits check the population size by establishing a **carrying capacity**. This results in a **logistic growth** pattern, which starts slow, grows rapidly for a brief time, then tapers off to maintain a somewhat stable populations size. Of course, in reality there are many limits on a population’s growth, not all of which are known or understood, and there is no guarantee a population will experience exponential growth or reach carrying capacity.

Methods:

The actual count data for 1985 was 1,360 Southern Sea Otters. I used the following assumptions based on some research on this sub-species: a 20% mortality rate; 25% juveniles and young adults who do not yet successfully reproduce; 1 pup produced per year per breeding pair; and a life span of 15 years. These assumptions yield a growth rate of 9.1% per year.

1. Population Model #1: Biotic potential

  *Use Excel or Sheets and the exponential formula below to generate data for a model of the*

 *Southern Sea Otter population’s biotic potential.*

a. Exponential growth formula: A = P(1 + r)t

 where:

* ***P*:** The original amount of seals

***t*:** time – the number of years in the future you want the prediction for

 ***(1 + r)*** is the ***growth factor***, with *r* as % changed to decimal form

***A***: population size at the specified time (solve for this)

1. Generate data beginning with the 1985 census population size of 1,360.

Use the formula *=P\*(1+r)^t* to calculate the 1990 population size.

Drag the formula to fill the 1995 cell. Change *t* to 10 years.

Continue to generate data every 5 years, to 2015.

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The actual count data for 1985 was 1,360 Southern Sea Otters. I used the following assumptions based on some research on this sub-species: a life span of 15 years, a growth rate of 9.1% per year, a carrying capacity of 15,000 otters, and a 1990 population size of 2102.

1. Population Model #2: Logistic Growth

*Use the* ***Logistic Growth calculator*** *at the link below to generate data.*

[*http://stats.areppim.com/calc/calc\_scurve.php*](http://stats.areppim.com/calc/calc_scurve.php)

* 1. For **known data**, use the actual data for 1985, 1,360 otters, and the 1990 data generated from your partners exponential growth data.
	2. Historic estimates of the population size of *Enhydra lutris* off the central coast of California are estimated at 15,000. Use this figure for the **saturation** (upper limit).
	3. Set the **forecast horizon** for 2060, 75 years in the future
	4. Click ‘**calculate the values of the S curve’**. Scroll to data below.
	5. Copy and paste data into Excel or Sheets; use to generate a line graph.

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Effort has been made to collect an actual count census of the Southern Sea Otter population since 1982. The total population data in the table below are three year running averages [i.e. (1983+1984+1985)/3], to minimize the effect of annual fluctuations in the data due to variation in environmental conditions. Spring pup data is included; pups are also counted in the fall and compared, allowing researchers to quantify early pup mortality.

1. Actual data: Population size; # of spring pups
	1. Graph both sets of data in the table below

|  |  |  |
| --- | --- | --- |
| *Year* | *Three year running average*  | *Pups/year**spring census* |
| **1985** | **1313** |  **242** |
| **1990** | **1755** | **214** |
| **1995** | **2325** | **282** |
| **2000** | **2181** | **264** |
| **2005** | **2688** | **318** |
| **2010** | **2711** |  |
| **2015** | **3254** | **476** |

 *Source: US Fish and Wildlife Service via Friends of the Sea Otter.org*

# TEXT 1: Threats to Southern Sea Otters Taking a Toll on Population Growth: Part 1

Integrated Science (H)

Mark up the text: circle/define new vocab, underline sources, highlight & paraphrase threats acting on the otter population

As this year’s Sea Otter Awareness Week kicked off at the end of September, U.S. Geological Survey (USGS) released its 2014 southern sea otter population report. Each year, scientists and advocates hope that the report will indicate significant progress in population growth. It appears, however, that despite significant efforts to recover the species, population growth has stalled. The recently released 2014 USGS southern sea otter population report shows sea otter numbers holding steady in California at 2,944. This is just slightly higher than last year’s count of 2,939 sea otters in California.

One explanation is that the otter’s primary habitat range along the central California coast can’t support any more sea otters. The area may already be supporting the maximum number of otters possible given available food, resources and space. Only so many sea otters can live in the smaller, central coast range before there is serious competition for food, which can place significant pressure on the population’s ability to increase in size. The only solution for sea otters is to expand their range to the north and south, giving them more room to spread out and allowing their numbers to climb. Unfortunately, sea otters don’t seem to be continuing their southern range expansion beyond Point Conception, off Gaviota State Beach. And fewer and fewer otters have been counted each year in the southern portion of the population’s range, from Cayucos to Gaviota.

Researchers are well aware that sea otters along the central coast seem to be having a hard time moving to the north and south. To shed some light on why this may be, we need to look at two major threats to southern sea otters that seem to be increasing: predation from sharks and the spread of disease.

Shark bites are the leading cause of death for southern sea otters. For many years, shark predation on sea otters has significantly prevented the population from expanding past Pigeon Point, the current northern tip of their range. Though sharks don’t typically make a meal out of sea otters, researchers believe they bite the animals when mistaking them for their normal prey like seals and sea lions. Most sea otters bitten by sharks either die from the encounter itself or from infection of their wounds.

Over the last ten years, there has been a dramatic increase in the number of sea otter shark bites, mainly as a result of more encounters in the southern portion of their range, from Cayucos to Point Conception. Researchers are trying to determine why there has been an increase in encounters between sharks and sea otters in this region.

Conflicts between sharks and sea otters, however, are just a part of the natural marine ecosystem, and exist for sea otter populations throughout the Pacific Ocean.

Stewart, Haley. "Threats to Southern Sea Otters Taking a Toll on Population." *Defenders of Wildlife Blog*. N.p., 04 Nov. 2014. Web. 06 Apr. 2017.

# TEXT 2: Threats To Southern Sea Otters Taking A Toll On Population Growth: Part 2

Integrated Science (H)

Mark up the text: circle/define new vocab, underline sources, highlight & paraphrase threats acting on the otter population

What is of great concern is the growing threat posed to southern sea otters by disease and infection, which is now thought to be closely linked to human activity along the California coast.

Disease is a major factor stunting sea otter population growth and range expansion. Each year, up to 40% of sea otter deaths are directly linked to infectious diseases caused by things like parasites, bacteria, and fungi. Many of these diseases are caused or exacerbated by runoff from land-based pollution.

A similar threat is associated with toxic algal blooms in freshwater ecosystems near the coast. Algal blooms are overgrowths of algae that are caused by higher water temperatures and nutrient concentrations—conditions that are often a result of agricultural runoff of elements like nitrogen and phosphorus. Summer droughts (certainly an ongoing problem for California) and increased salinity also contribute to algal blooms.

Some algal blooms are particularly dangerous because they can produce toxins, like microcystin, for example, that are harmful to humans and wildlife. Recently, scientists have discovered that the toxins produced by blooms in California’s coastal freshwater ecosystems can travel long distances, ending up in our coastal marine ecosystems such as Monterey Bay. The microcystin toxin has been found in fish, mussels, crustaceans and other invertebrates throughout many of California’s coastal marine ecosystems. Unfortunately, sea otters consume many of these species and, as a result, suffer from microcystin poisoning. Microcystin causes significant liver disease in sea otters, offering them very little chance of survival, especially when coupled with other threats. Researchers believe that the majority of sea otter deaths associated with this toxin have occurred since 2005, meaning there have been more and more toxins from freshwater algal blooms reaching the shore. This may be due in part to climate change impacting water conditions.

Natural resource managers and climate change researchers are still trying to understand just how climate change will impact California’s ecosystems. Still, projections show increasing changes to coastal habitats such as sea level rise, higher water temperatures, and increased ocean acidity. These will undoubtedly impact sea otters and their habitats along the California coast. For example, ocean acidification can reduce some marine species’ ability to produce and maintain shells. Without a strong, natural protection, these species may no longer be able to survive and reproduce. This is a big issue for sea otters, which eat large amounts of shelled creatures such as mussels and clams.

Stewart, Haley. "Threats to Southern Sea Otters Taking a Toll on Population." *Defenders of Wildlife Blog*. N.p., 04 Nov. 2014. Web. 06 Apr. 2017.

# TEXT 3: Where Have All the Sea Otters Gone? *Excerpt* III. Present Day Concerns and Protections of Sea Otters

Integrated Science (H)

Mark up the text: circle/define new vocab, underline sources, highlight & paraphrase threats acting on the otter population

During the 1970’s and 80’s, the sea otter population rapidly increased and showed signs of possibly retuning to its original carrying capacity.  However, during the past 20 years the population has been declining again from its approximate high of 90,000 in 1985 to only a few thousand individuals today.  The California sea otter seems to be the hardest hit with only 2,139 left as of October 5, 2006.   Since the sea otters are no longer being killed for the fur trade, it is important to learn what is causing their species, which was recently 90,000 strong, to be depleted so fast while they are protected by the MMPA and the ESA.

One of the main reasons for the rapid decline in the sea otter population is disease.   One-quarter of the 281 sea otters found dead last year have been linked “to a pair of protozoan parasites, Toxoplasma gondii and Sacrocystis neurona, that are known to breed in cats and opossums.”  Now how the parasites are making there way into the ocean in the first place is a sort of mystery that needs to be solved.   Some suggest that the cause stems from those Californians flushing used kitty litter down the toilet.  Luckily Governor Schwarzenegger recently signed a bill that required all cat litter sold in California to carry a warning label “advising cat owners not to dump their pet’s droppings into toilets or storm drains” and raised the maximum fine for harming any sea otter to $25,000.

Other diseases which are also currently causing the deaths of California sea otters include thorny-headed worms dropped into the ocean by seabirds, toxic algae blooms triggered by urea, a key ingredient in fertilizer, and even PCBs accumulated by the shellfish which the sea otters eat.

Another major cause of decline in the sea otter populations stems from the nations bloodline, oil.   Although there has not been a major oil spill off the coast of the U.S. since February, 1990, when an American Trader leaked 300,000 gallons of crude oil polluting Bosa Chica, one of southern California's biggest nature preserves, the effects of that spill still being felt today.   Since acute oil exposure in sea otters results in lung, liver, and kidney damage, the effects of the oil may not harm the otters until years after they have encountered it.   Also, other sources of oil pollution may be continuing to cause problems for the sea otters such as offshore drilling, onshore pipelines, leaky oil tankers, and the dumping of sea water used to wash out the tankers back into the ocean.

Other less major causes of death for sea otters include natural predators, boat props, gill nets and poaching.   Luckily only four sea otters were poached in the last 14 months and less than 100 have been caught by gill nets in over three years.

Kuipers, Matthew. "Full Title Name:  Where Have All the Sea Otters Gone?" *Animal Law Legal Center*. Michigan State University, Jan. 2007. Web. 06 Apr. 2017.