Researchers study how to improve southern sea otter survival

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A raft of southern sea otters floats around in Moss Landing in Monterey County, Calif. Credit: Ron Wolf

University of Wyoming researchers have been studying how best to bolster the southern sea otter population, which suffers from low genetic diversity and has been further ravaged by Toxoplasma brain disease and

others, shark attacks and illegal shootings by fishermen.

Currently hovering at around 3,000 animals along the California coast, this small subspecies is listed as a threatened species under the federal Endangered Species Act.

"This paper provides analyses and data vitally necessary to southern sea otter recovery," says Holly Ernest, a UW professor of wildlife genomics and disease ecology, and the Wyoming Excellence Chair in Disease Ecology in the Department of Veterinary Sciences and the Program in Ecology. "The paper provides evidence that its genetic diversity is low and staying low. Even with modest increases in population numbers, genetic diversity has not increased."

"Sea otters have recovered in their core area but have not recolonized where they used to be," says Erick Gagne, a former UW postdoctoral researcher who worked with Ernest on the study. "They are currently locked between just off the south of San Francisco Bay to just north of Santa Barbara. They used to go through to Oregon and connect with the northern sea otter."

Currently, the northern sea otters, which are much more abundant, have a territory that ranges from northern Washington up through Alaska.

Gagne, who is now a postdoctoral researcher at Colorado State University, was lead author and Ernest was senior author of a paper, titled "Measures of Effective Population Size in Sea Otters to Reveal Specific Considerations for Wide-Ranging Species," that was published May 1 (today) in *Evolutionary Applications*. The peer-reviewed, open access journal publishes papers that use concepts from evolutionary biology to address biological questions of health, social and economic relevance.

Kyle Gustafson, a UW postdoctoral researcher, also was involved in the study. Researchers from the U.S. Geological Survey, University of California-Santa Cruz, the California Department of Fish and Wildlife, Seattle Aquarium and the Smithsonian Conservation Biology Institute in Washington, D.C., were other contributors to the paper.

In the 1700s and 1800s, there were "a ton of sea otters" located up and down the California coast, and on up to Russia and Japan, Gagne says. Around 1900, southern sea otters, which had been hunted heavily, were thought to be extinct. Approximately 50 southern sea otters were discovered in the Big Sur area in 1938. About 3,000 remain today, Gagne says.

"When you have that large of a reduction, you lose genetic diversity," he says. "As the numbers recover, genetic diversity does not recover as rapidly, leaving the population vulnerable."

Southern sea otters are important to the ecosystem because their diet includes a lot of invertebrates, including sea urchins and abalone, which graze on kelp. If sea otters did not eat these invertebrates, kelp forests, which provide food habitat for multiple species of fish, would be lost, Gagne says.

However, as sea otter populations reach high numbers in the core, the southern sea otters' food supply becomes limited. In turn, this makes it difficult for the animal numbers to increase in their limited core range.

"Some biologists would like to see their (southern sea otter) range expand northward," Gagne says.

While some northern sea otters could be relocated to breed with the southern sea otter population and increase southern sea otter numbers while simultaneously bolster genetic diversity, there is a potential

downside. Northern sea otters could bring diseases with them or could try to swim back north and run into the "shark gauntlet" near San Francisco Bay, Ernest says. Sharks tend to congregate around the region, making it difficult for sea otters to disperse north of the bay.

The southern sea otter is smaller than its similar counterpart, the northern sea otter. The facial structure and skull shape are different between the two, Gagne says.

Studying Effective Population Size

The paper examined one of the methods, known as "effective population size," that is included in the southern sea otter recovery plan. Effective population size is a measure of the individuals that are contributing genetically to the next generation of the species, Ernest explains.

Conservation genetic techniques and considerations of the evolutionary potential of a species are increasingly being applied to species conservation. For example, effective population size estimates are useful for determining the conservation status of species. Yet, accurate estimates of current effective population size remain difficult to obtain, according to the paper.

The paper shows that the way this method is calculated can make important differences in the final effective population size number. The U.S. Fish and Wildlife Service recovery plan uses effective population size to determine when the southern sea otter is to be delisted as a federally threatened species. If Fish and Wildlife use old methods of calculation, the southern sea otter may be delisted too soon for true recovery, Gagne says.

After being hunted to near extinction during the North Pacific fur trade, the southern sea otter has recovered over part of its former range but

remains at relatively low numbers, making it desirable to obtain accurate and consistent estimates of effective population size. Although previous theoretical papers have compared the validity of several methods, comparisons of estimators using empirical data in applied conservation settings are limited.

"Studies like these take decades," says Ernest, who has been studying southern sea otters for 13 years, dating back to her time as a researcher at the University of California-Davis.

For this study, Gagne and Ernest combined 13 years of demographic and genetic data from 1,006 sea otters to assess multiple effective population size estimators, as well as temporal trends in genetic diversity and population genetic structure. Genetic diversity of the southern sea otter was low and did not increase over time, according to the paper. There was no evidence for distinct genetic units, but some evidence for genetic isolation by distance, the paper concludes.

"To get this 13-year data set was really valuable," Ernest says.

Based on their results, Gagne, Ernest and the paper's co-authors recommend the development of new delisting criteria for the southern sea otter. They advise the use of multiple estimates of effective population size for other wide-ranging species, species with overlapping generations or with sex-biased dispersal, as well as the development of improved metrics of genetic assessments of populations.

"We need new measures to assess their genetic well-being," Gagne says. "That's the next step for sea otters and other endangered species."

More information: Roderick B. Gagne et al, Measures of effective population size in sea otters reveal special considerations for wide-ranging species, *Evolutionary Applications* (2018). DOI:

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