

Sea otters' tool use leaves behind distinctive archaeological evidence

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Wild sea otter at Bennett Slough Culverts opening mussels using emergent anvil stone. Credit: Monterey Bay Aquarium, Jessica Fujii. Haslam *et al.* 2019. Wild sea otter mussel pounding leaves archaeological traces. *Scientific Reports*.

An international team of researchers has analyzed the use by sea otters of large, shoreline rocks as "anvils" to break open shells, as well as the resulting shell middens. The researchers used ecological and

archaeological approaches to identify patterns that are characteristic of sea otter use of such locations. By looking at evidence of past anvil stone use, scientists could better understand sea otter habitat use.

Sea otters are an especially captivating marine mammal, well known for their use of rocks to break open shells. Sea otters are estimated to have once numbered between 150,000-300,000 individuals and their range stretched from Baja California, Mexico, around the northern Pacific Rim to Japan. Their numbers were dramatically reduced by the fur trade. In California, the southern sea otter population was reduced to around 50 individuals, but a massive conservation effort has resulted in increasing their numbers to around 3000 today. However, the southern sea otter is still considered threatened.

Sea otters are unique for being the only marine mammal to use [stone tools](#). They often use rocks to crack open shells while floating on their back, and also sometimes use stationary rocks along the shoreline as "anvils" to crack open mollusks, particularly mussels. A joint project including the Max Planck Institute for the Science of Human History, the Monterey Bay Aquarium and the University of California, Santa Cruz, among others, has resulted in a first-of-its-kind interdisciplinary study published in *Scientific Reports*, combining ten years of observations of [sea otters](#) with archaeological methods to analyze sea otter use of such [anvil](#) stones, also known as emergent anvils.

Researchers spent ten years between 2007-2017 observing sea otters consuming mussels at the Bennett Slough Culverts site in California. Their analysis identified that mussels were the most common prey eaten at the site and were the only prey for which the sea otters used stationary anvil stones. The sea otters used such stones for about 20% of the mussels they consumed.

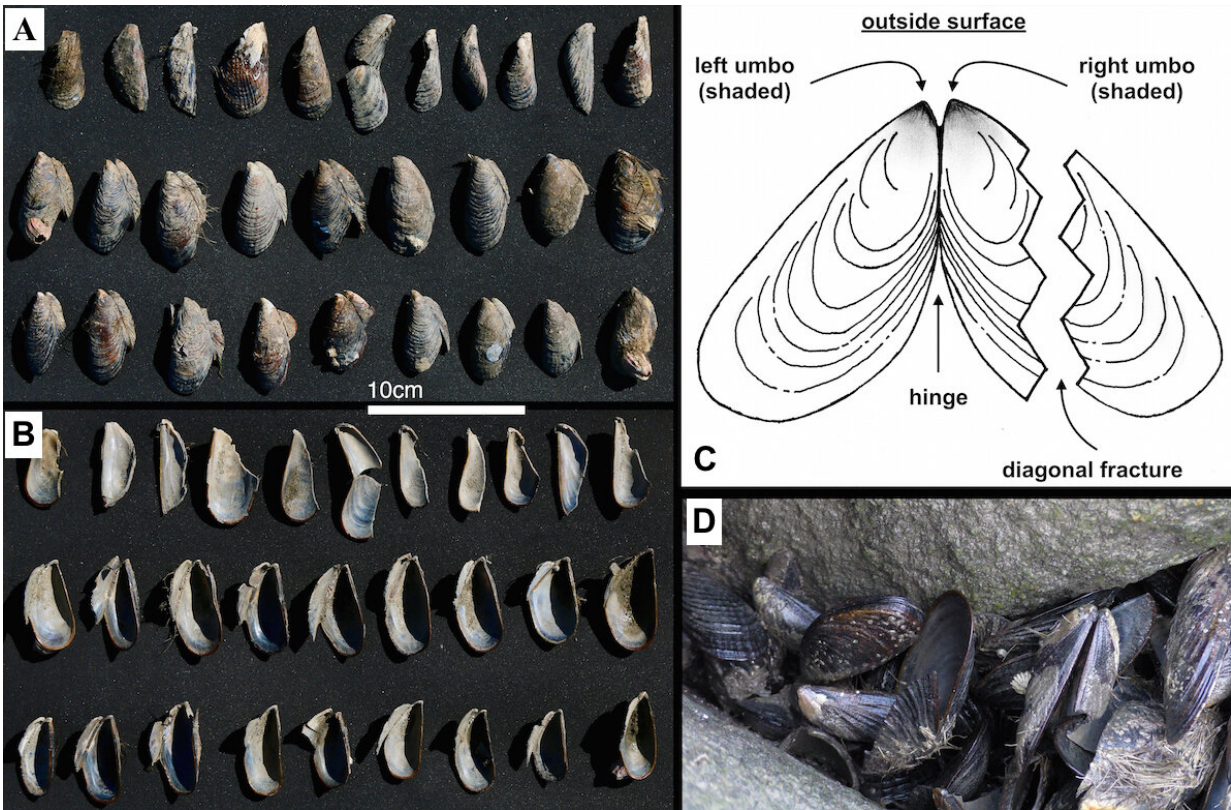
Interestingly, careful analysis of the stationary anvil stones using

archaeological methods showed that their use resulted in a recognizable damage pattern that was distinguishable from what would be caused by human use. For example, the sea otters preferentially struck the mussels against points and ridges on the rocks, and struck the rocks from a position in the water, rather than from the land or from on top of the rock.

In addition to the stones themselves, the researchers also carefully analyzed the mussel shells left around the stationary anvils. The researchers took a random sample of the [shell](#) fragments from these shell middens, which likely contained as many as 132,000 individual mussel shells. They found an extremely consistent damage pattern, with the two sides of the mussel shell still attached, but a diagonal fracture running through the right side of the shell.

"The shell breakage patterns provide a novel way to distinguish mussels broken by sea otter pounding on emergent anvils from those broken by humans or other animals," explains Natalie Uomini of the Max Planck Institute for the Science of Human History. "For archaeologists who excavate past human behavior, it is crucial to be able to distinguish the evidence of sea otter food consumption from that of humans."

In combination with analysis of videos they took of the otters using the anvils, researchers could see that the otters held the shells evenly in both paws, but when striking the shell against the anvil tended to have their right paw slightly on top. Though the total number of otters observed was small, these results suggest that otters may exhibit handedness, or "pawedness," as do humans and many other mammals.



Mussel shell breakage patterns at the Bennett Slough Culverts site. (A) Outer and (B) inner faces of each valve; (C) drawing of the exterior of a mussel shell showing the typical sea otter breakage pattern (illustration by Neil Smith); (D) broken mussel shells in situ. Credit: Image (C): Neil Smith; Images (A), (B), & (D): Michael Haslam. Haslam *et al.* 2019. Wild sea otter mussel pounding leaves archaeological traces. *Scientific Reports*.

The researchers hope that the study will be useful for archaeologists working with coastal populations, as a way to distinguish between human and sea otter use of rocks and consumption of marine resources. Additionally, the research could be helpful in future studies of the geographic spread of stationary anvil use throughout the former sea otter range, and how far into the past this behavior extends.

"Our study suggests that stationary anvil use can be detected in locations previously inhabited by sea otters. This information could help to document past sea otter presence and diet in locations where they are currently extirpated," explains Jessica Fujii of the Monterey Bay Aquarium.

"More broadly," she adds, "the recovery of past animal behavioral traces helps us to understand the evolution of behaviors like stone anvil use, which is rare in the animal kingdom and is extremely rare in marine animals. We hope that this study establishes a new path for the growing field of animal archaeology."

More information: Wild sea otter mussel pounding leaves archaeological traces, *Scientific Reports* (2019). [DOI: 10.1038/s41598-019-39902-y](https://doi.org/10.1038/s41598-019-39902-y)

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