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Serendipity in a salt marsh: detecting frequent sea otter haul outs in a marsh ecosystem

Sea otters live dangerously. The smallest of marine mammals has dense fur but no blubber, and must take in an enormous number of calories each day to stay warm and balance metabolic costs (Morrison et al. 1974, Yeates et al. 2007). Along the open coast in places like Monterey Bay, California, near the center of the recovering southern sea otter (*Enhydra lutris nereis*) range, starvation is not uncommon, particularly for nursing mothers that must not only meet their own caloric needs but those of their pups (Thometz et al. 2014). Anything that can help tip the balance to keep an animal from going into the red, on a metabolic balance sheet, will help an otter survive.

Hauling out, the act of leaving coastal waters to rest on the shore, can have a big benefit to sea otters. As any swimmer knows, one loses body heat much faster in water than in air. In Alaska, particularly on the Aleutian Islands, northern sea otters regularly haul out, sometimes in large groups (Riedman and Estes 1990). However in California, southern sea otters are only rarely observed hauling out, mostly in secluded spots during darkness (Faurot 1985), and there have been no extended observational studies of the behavior of hauled out otters in the wild. Indirect evidence of hauling out has been gleaned from temperature loggers attached to otters, since air temperatures are notably warmer than the cold waters along the California coast (Tinker et al. 2013). This indirect evidence suggests open coast otters haul out fairly rarely (4.1% of the time in Monterey, 0.4% of the time along the Big Sur coast).

We have found that sea otters in Elkhorn Slough, the largest estuary within the range of the recovering southern subspecies, frequently haul out on protected salt marshes for extended periods (Fig. 1). They do this even in the middle of the day: the behavior seems to be driven more by tides than time of day, with the otters entering the flooded tidal creeks during high tides and resting on the marsh until the tide drops again. To our knowledge, this is the first report in the literature of sea otters using marshes to haul out anywhere in the range of the species. Our discovery of how extensively otters haul out on salt marshes was serendipitous, as are many ecological surprises (Doak et al. 2008). Indeed, the role of serendipity is highlighted in a recent memoir by a leading sea otter ecologist (Estes 2016). We began monitoring an expanse of salt marsh and tidal creeks to ensure there was no disturbance to marine mammals resulting from a nearby restoration project. Since we had to watch all day long, during construction hours, we found a nearby hill that provided a broad vantage point for observing the marsh, creeks, and restoration site (Fig. 2). It turned out this was a game changer in our common perception of sea otter behavior. If you approach otters in the salt marsh ecosystem by boat or on foot, they quickly scatter. However, looking from above, with telescopes from our hill, we were able to observe their undisturbed behavior.

Following the completion of the restoration project, our team of citizen scientists has continued intensively monitoring this salt marsh ecosystem from the adjacent hill. What we observe is that otters spend about a third of the time spent in this tidal creek network hauled out on the marsh. Their haul out time mostly appears to consist of resting, with just a bit of grooming at the start and end of a haul out period. We sometimes observe

Fig. 1. Sea otter on salt marsh at Elkhorn Slough, California, USA. (Photos: Ron Eby). [Color figure can be viewed at wileyonlinelibrary.com]

FIG. 2. Hill vantage point from which citizen scientists observe sea otters in marsh ecosystem. Author R. Eby on right, author R. Scoles on left, with third volunteer R. Chaffin in center. (Photo: Kerstin Wasson). [Color figure can be viewed at wileyonlinelibrary.com]

solitary, territorial males hauled out. More commonly, we see groups of about six, but up to a dozen females hauled out together. About one-quarter of the otters that frequent the creek are mothers with pups, suggesting this is an important nursery area. We have witnessed one birth from our hill vantage, and documented multiple newly born pups on a remote camera. Mothers carry their younger pups ashore, while larger pups are able to go ashore on their own. Mothers groom and nurse their pups while hauled out, but spend most of the time resting with them.

Since Elkhorn Slough is the first estuary to be extensively recolonized by southern sea otters (Feinholz 1998), it is impossible to know whether the hauling out behavior observed there is typical of historic otter use of salt marshes. Elkhorn Slough was colonized by a small group of non-resident males in the mid-1980s; by the mid-1990s females and pups were common too, with numbers in the estuary steadily increasing. The next large estuary to the south, Morro Bay, is used by sea otters near the mouth area away from salt marshes. The otters appear to be moving up the estuary and so we may soon have a second example of salt marsh use there. Sea otters certainly used salt marsh ecosystems historically (Ogden 1941), and San Francisco Bay was a focal area for the hunting of otters that nearly resulted in their extirpation. Early records mention hauled out otters in the estuary, but do not specify whether they were on marsh or other habitat (Ogden 1941). It is possible that hunting pressure, in historic or even pre-historic times, resulted in wariness about daytime haul out behavior. Now that this pressure has been removed through various legal protections (e.g., Marine Mammal Protection Act of 1972), daytime haul out in marshes may be increasing, as a learned behavior or due to a relaxing of natural selection against hauling out following the cessation of hunting.

What accounts for the surprising frequency with which we observe hauled out sea otters on the salt marsh? One contributing factor may be ease of detection: estuarine habitat allows for better detection of this behavior than the open coast, where otters are typically hidden among rocky inlets to which there is poor line of sight by human observers (Faurot 1985). Away from the rocky intertidal, there are more hills with direct sightlines of the intertidal shore.

However, not only is hauling out easier to see, it really does seem to happen more often on marshes, especially in the daytime, than in adjacent open coast habitats; we estimate an order of magnitude more time is spent hauled out at Elkhorn Slough than what has been reported on average for open coast otters in central California (Tinker et al. 2013). We hypothesize that this may simply be due to the high availability of ideal haul out habitat close to foraging grounds. Otters prefer low relief shores sheltered from surf for hauling out (Faurot 1985), and virtually the entire tidal creek and salt marsh ecosystem of Elkhorn Slough offers such habitat. On the open coast, near the kelp beds otters use for foraging, there are few sheltered, accessible haul out opportunities. In support of this hypothesis, we have found that harbor seals and sea otters haul out in different parts of the salt marsh at Elkhorn Slough, while they tend to use the same pocket beaches and flat rocky shelves along the open coast (Faurot 1985): the ample real estate in the salt marsh allows for separation of the species, but the limited availability on the open coast leads to joint haul out. If this hypothesis is correct, then future colonization of other salt marsh ecosystems by sea otters should offer the same extensive haul out opportunities and resultant thermal benefits as provided at Elkhorn Slough.

A second hypothesis for the high frequency of haul outs observed on Elkhorn Slough salt marshes is the low level of human disturbance. In Alaska, sea otters haul out more commonly on remote islands than in mainland areas where predation by wolves and bears poses a real risk, and sea otters haul out less after humans begin frequenting the area (Riedman and Estes 1990). In California, there are no wolves or bears along the shore, but many parts of the open coast are frequented by humans and their dogs. For instance, on the Monterey peninsula there are some sheltered pocket beaches near kelp forests, and these are sometimes used as haul out areas by sea otters, but almost exclusively during darkness, when human visitors are absent (Faurot 1985). In contrast, very few humans venture on the salt marshes of Elkhorn Slough, which are quite inaccessible, and largely part of marine protected areas. The high frequency of daytime haul outs may thus be directly linked to the low level of human disturbance. This hypothesis is supported by our observations that the highest numbers of hauled out

otters are found in the salt marshes of the Elkhorn Slough National Estuarine Research Reserve, which is off limits to the general public. We have observed far fewer otters hauled out during daytime along other tidal creeks in the estuary, and attribute this to the high numbers of kayakers in these creeks. The metabolic advantages of hauling out on the salt marsh may thus only be fully achieved in refuge areas off limits to human disturbance. As other salt marsh ecosystems are colonized by sea otters in the future, it might be wise to consider limiting human access to some areas to enable sea otters the benefits of daytime haul out.

A final hypothesis for the difference in haul out frequency at Elkhorn Slough relative to the adjacent open coast is that it is a function of the greater density of otters within the estuary. In Alaska, sea otters frequently haul out in groups (Riedman and Estes 1990). Since the otters are vulnerable to predators while on land, where they move slowly and awkwardly, there may be benefits to group haul out, with more ears available to listen for and detect approaching danger. There are very high densities of non-territorial males near the mouth of Elkhorn Slough, in the Moss Landing Harbor area, and these haul out together in large numbers on a beach (Maldini et al. 2012). In the salt marsh creek network where we spend the most time observing, females haul out in groups, and perhaps this safety in numbers is only possible because this estuarine habitat has the highest known density of females and pups in the range of the southern sea otter. However, we also observe territorial males hauling out alone along various tidal creeks in the estuary, so the safety-in-numbers hypothesis cannot explain their haul out behavior. The three hypotheses we have developed are not mutually exclusive, and we suspect that future studies may find support for multiple contributing factors correlating with haul out frequency.

Until now, there have been few opportunities for researchers to conduct extended observations of hauled out sea otters in the wild. We have now installed cameras near otter haul out areas in Elkhorn Slough.[1] The real-time images from these cameras are viewed by over 10,000 different people per year, building public support not only for sea otters but for the salt marsh ecosystems they inhabit. Suddenly a little-known behavior has become very easy to observe. Future studies could use salt marsh ecosystems as a platform for examining the context- and condition-dependence of haul out behavior. For instance, our observations suggest that factors such as weather, tide levels, gender and reproductive stage affect probability of haul out. Thus, not only do salt marsh ecosystems provide sea otters ample habitat to rest while hauled out rather than in the cold water, they also offer novel opportunities for researchers to investigate haul out behavior.

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[1] http://www.elkhornslough.org/ottercam/