Investigations of Southern Sea Otter Foraging Ecology at the Northern Range Extent
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Introduction
Sea otters (Enhydra lutris) are vital keystone predators within coastal ecosystems. Following near extinction during the fur trade, population recovery has proceeded slowly in California with southern sea otters (E. l. nereis) currently ranging from Pigeon Point in the north to Point Conception in the south. Decades of research have revealed clear and consistent evidence of inverse relationships between sea otter density and prey resource availability: Low density sites have lower diet diversity, while higher density sites have higher diet diversity. In recent years, the southern sea otter range has been contracting at the northern range extent, possibly due to white shark mortality, yet little is known about sea otter foraging and diet diversity in this region; which may be playing a role in local population dynamics. Here, I assessed sea otter foraging behavior at Año Nuevo State Park and compared these data to other sea otter populations throughout California. This information provides valuable insight into prey resource availability, diet diversity, and population status at the northern range edge.

Objectives
- Identify diet composition, diet diversity, and average rate of energy gain for southern sea otters at their northern range extent

Methods
- Directly observed foraging sea otters using spotting scopes. Recorded dive and surface interval times, identified prey captured as well as number and size of prey during foraging bouts
- Foraging data were analyzed to determine diet composition and diet diversity following methods of Tinker et al. 2012
- Previously collected data from other locations in California were used for comparison. Data were sourced from Tinker et al. 2017

Figure 1. Map showing the current study area of Año Nuevo State Park (referred to as Año Nuevo).

Table 1. Sea otter diet diversity evaluated by Shannon-Wiener Index. Higher numbers represent higher diet diversity; lower numbers represent lower diet diversity.

<table>
<thead>
<tr>
<th>Study Site</th>
<th>Shannon-Wiener Index</th>
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</thead>
<tbody>
<tr>
<td>Año Nuevo (ANO)</td>
<td>1.73</td>
</tr>
<tr>
<td>Monterey (MON)</td>
<td>2.31</td>
</tr>
<tr>
<td>Big Sur (BSR)</td>
<td>2.16</td>
</tr>
<tr>
<td>Santa Barbara Channel (SBC)</td>
<td>1.38</td>
</tr>
<tr>
<td>San Nicolas Island (SNI)</td>
<td>1.07</td>
</tr>
</tbody>
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Preliminary Findings
- Sea otter diet at Año Nuevo consists primarily of urchins, followed by clams, crabs, worms, and a small amount of mussels
- Diet composition at Año Nuevo is indicative of a mixed-substrate habitat where sea otters are sourcing prey from both rocky reef and sandy-bottom habitat
- Diet diversity of sea otters at Año Nuevo (S-W Index = 1.73) is higher than other low-density sites.
- Prey capture success rate at Año Nuevo is 61.9%, which is lower than predicted for a low-density site.
- Further data collection will elucidate the average rate of energy gain at the northern range extent

Significance
Results of this study will provide insight into potential reasons for the lack of range expansion in this region. Such information may be vital to management agencies and conservation practitioners focused on facilitating sea otter population recovery

References:
Staedler, M. L. and Estes, J. A. (2014). Correction for Hughes et al., Recovery of a top predator mediates negative eutrophic effects on seagrass: Fig. 2. Ecol. Lett., 17, 1055-1060.

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Figure 2. Map showing the linear density of sea otters along the California coast (Hatfield et al. 2019). Black boxes with 3-letter codes indicate sea otter foraging research study sites. Stacked bars represent the diet composition at each site in proportion of each prey type. Sites with higher density exhibit higher diversity of prey items, while lower diversity sites exhibit lower diversity of prey items.