Hawaiian monk seal diving behavior


Diving behavior of Hawaiian monk seals was studied to gain an understanding of their use of the marine habitat. Radio tags and maximum-multiple-depth recorders (MMDR) were attached to seven adult male monk seals at Lisianski Island. 24-h automatic monitoring of radio tag provided a detailed record of hauling out activity on the island's beaches. Over 4800 individual dives by six animals were recorded by the MMDR system. The majority (59%) of dives were in the 10-40 m depth range, the remaining dives were to depths generally greater than 40 m, with 13 dives to at least 121 m. Monk seal prey items were identified from examination of seal scat and included fish otoliths, cephalopod beaks and invertebrate exoskeleton fragments. The prey assemblage was benthic; the majority of prey were shallow water forms and a smaller number of species were deep water forms. The depth at which the prey were taken generally agreed with the distribution of monk seal dive depths recorded. This information indicated that Hawaiian monk seals depend entirely upon the food resources found over the reef surface and slopes while at rookery islands during the breeding season.

1. Introduction

The endangered Hawaiian monk seal Monachus schauinslandi has breeding populations restricted to atolls of the Northwestern Hawaiian Islands. The species appears to have declined in numbers by about one-half between 1958 and 1978 and the center of abundance has shifted from the atolls in the western portion of the range to those at the eastern extreme of the breeding range (Johnson et al. 1982). Conservation efforts by the U.S. National Marine Fisheries Service include consideration of designating critical habitat under terms of the U.S. Endangered Species Act. The rookery beaches were to be included as part of critical habitat. The fact that monk seals are known to feed on benthic or reef-dwelling fishes and invertebrates argued for including marine habitat within the critical habitat, but no information existed on the depths to which monk seals commonly dive in search of prey. The need to preserve an abundant prey assemblage for monk seals was countered by an intense interest in developing commercial fisheries in the inner reef and reef slope waters. The seaward extension of the boundary of critical habitat became a major point of contention with commercial fisheries interests not wanting to be excluded from fishing any nearshore waters and resource managers recognizing that the protection of food resources within critical habitat would be essential to recovery of the endangered monk seal.

Our study was an attempt to obtain a series of dive records from feeding monk seals to provide a data base from which a seaward boundary of critical habitat could be designated. In addition we were interested in testing radio tags for determining the proportion of time animals spend ashore. This was needed to adjust census figures as an estimation method for population size.

2. Materials and methods

The study was conducted at Lisianski Island (26°02'N, 174°04'W) from 4 May through 11 June 1980. Adult male seals were selected for instrumentation because they remain on or near the rookery islands during most of the pupping season which extends from March through June. Males normally go to sea in the evening, feed during
3. Results

Dive recorders were attached for 2 to 20 days for an aggregate of 94 days. The dive recorder for one animal was inoperative. Six animals accomplished 4817 dives in 60 day or night periods at sea (Table 1) for an average of 80 dives/period at sea. The majority (59%) of dives were in the 10–40 or 10–30 meter range, with the remaining 41% of dives being in depths beyond the 30 to 40 meters upper threshold of the first register to depths up to at least 121 m. Only three animals were away from the island two or more nights and these were the only seals that dove to depths greater than 40 m. Due to an extensive reef system of Lisianski Island, the seals must swim 10–21 km from the island to reach water 40 m deep.

Radio tags functioned well and allowed location of instrumented males when they were ashore. The average time ashore during daylight hours for 6 reproductive adult males was 16% during the hour following dawn, then gradually increased to 35% between 1100–1200 hours, and decreased to 21% in the hours preceding darkness. The proportion of time individual reproductive males were ashore varied from 13% to 40% of total daylight hours. A single nonreproductive adult male exhibited a pattern unlike the reproductive males. He spent 43% of daylight hours ashore but was ashore early morning and late evening and was frequently in the water from 1100–1600 hours.

To assess food habits of monk seals during the study, we collected fresh scats which were soaked for 12 to 24 h in sea water to which was added 1 g liquid detergent. The liquefied scats were then run through a set of two nested sieves measuring 2.36 mm and 0.71 mm. Mard parts such as fish otoliths, bone, teeth, and scales, cephalopod beaks, and exoskeleton of lobster were removed from the scats and stored in alcohol for later identification. Fish otoliths were identified by John E. Fitch, California Department of Fish and Game, and cephalopod beaks by Clyde Roper, U.S. Museum of Natural History, Smithsonian Institution.

Table 1. Activity of adult male Hawaiian monk seals instrumented with dive recorders and radio tags, Lisianski Island, May–June 1989

<table>
<thead>
<tr>
<th>Tag</th>
<th>radio freq (MHz)</th>
<th>Dive record days</th>
<th>Proportion of daylight hours ashore</th>
<th>At sea (day/night)</th>
<th>Dives recorded</th>
<th>Number</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>164.192</td>
<td>2</td>
<td>2</td>
<td>0.21</td>
<td>0/2</td>
<td>108</td>
<td>10–40 m</td>
<td></td>
</tr>
<tr>
<td>164.139</td>
<td>7</td>
<td>7</td>
<td>0.20</td>
<td>0/5</td>
<td>11</td>
<td>10–40 m</td>
<td></td>
</tr>
<tr>
<td>164.228</td>
<td>10</td>
<td>10</td>
<td>0.43</td>
<td>0/0</td>
<td>7</td>
<td>10–40 m</td>
<td></td>
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<tr>
<td>164.161</td>
<td>18</td>
<td>18</td>
<td>0.23</td>
<td>2/165</td>
<td>135</td>
<td>41–89 m</td>
<td></td>
</tr>
<tr>
<td>164.099</td>
<td>18</td>
<td>18</td>
<td>0.40</td>
<td>1/4</td>
<td>1408</td>
<td>10–40 m</td>
<td></td>
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<tr>
<td>164.053</td>
<td>18</td>
<td>18</td>
<td>0.13</td>
<td>6/11</td>
<td>75</td>
<td>10–30 m</td>
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<tr>
<td>164.139</td>
<td>7</td>
<td>7</td>
<td>0.20</td>
<td>0/5</td>
<td>935</td>
<td>31–90 m</td>
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<tr>
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<td>18</td>
<td>18</td>
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<td>1/4</td>
<td>669</td>
<td>61–120 m</td>
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<tr>
<td>164.161</td>
<td>18</td>
<td>18</td>
<td>0.23</td>
<td>2/165</td>
<td>13</td>
<td>121–175 m</td>
<td></td>
</tr>
</tbody>
</table>

1Nights are tallied if animal was at sea from dark to midnight, midnight to dawn, or during both periods, days were tallied if animal was at sea from dawn to noon or noon to dark. Includes 2 absences of a night, day, and another night.
2Includes 3 absences of 4 successive days and 3 nights, and one absence of a night, day, and another night.

4. Discussion

Lisianski Island is located on the north end of Neva Shoals—an extensive shallow water area which extends primarily south of the island. To reach the 10 meter isobath, the minimum diving depth recorded, animals needed to be from 1 to 13 km from land. Beyond Neva Shoals there are extensive coral flats within the 10–40 meter depth range where male monk seals were diving and feeding. The 40-m isobath generally delineates the outer edge of the reef. A substantial portion of the recorded dives, those beyond 30 m, reflect animals...
diving along the reef slope.

These are the first dive records for the Hawaiian monk seals. They suggest a pattern of generally shallow dives, yet the dives in excess of 121 m by one animal are moderately deep for pinnipeds. Several species have been recorded to dive beyond 150 m: a northern fur seal (Callorhinus ursinus) female to 190 m (Kooyman et al. 1976), a California sea lion (Zalophus californianus) male to 250 m (Ridgway 1972), a Weddell seal (Leptonychotes weddelli) to 600 m (Kooyman 1966). When compared to the dive depths accomplished by those species the 121 m (or greater) dives recorded in this study may be considerably less than the maximum diving capability of the Hawaiian monk seal.

The deep dives recorded in this study support a single diving record for the Mediterranean monk seal Monachus monachus which was caught on the hook of a tuna gear set at a depth of 75 m at Cintra de Lobos, Madeira in 1957 (Sergeant et al. 1978). There had been some question as to whether that animal might have been hooked while the gear was being set, but in light of the demonstrated diving capabilities of the Hawaiian monk seal, it is probable that the Mediterranean monk seal was caught while the gear was at depth.

Determination of the proportion of time spent ashore for adult males during daylight hours is difficult because of their tendency to lay between a female and the water’s edge with their rear flippers immersed in the water. When the transmitter antenna is in wet sand or under water, the signal is attenuated and no signal is received, yet the male is almost entirely ashore. Therefore, the radio tag record underrepresents the actual proportion of time ashore.

Results of the scat collection indicate that the Hawaiian monk seal feeds heavily on reef fishes. The fish found most frequently and in highest numbers were conger eels (Congridae), surgeon fish (Acanthuridae), and wrasses (Labridae) which prefer shallow, benthic habitats. Less numerous were brotulids (Brotulidae) and cusk eels (Ophididae) which are probably found in both shallow and deep, benthic habitats, and lizard fish (Synodontidae) were the only prey species from a deep water, benthic habitat. The habitat depth of the identified prey is consistent with distribution of the monk seal dive depth records. During the breeding season monk seals apparently depend entirely on the food resources found on the coral reefs, sandy flats, and deeper reef slopes. A designation of critical habitat which included all waters from island shorelines to the reef slope edge is justified by the marine habitat utilization data obtained in our study. Setting the seaward boundary of critical habitat at 20 fathoms would include most of those waters and provide a consistent boundary which could be easily detected by vessel operators approaching the rookery islands of the Hawaiian monk seal.

References


C.C. Thomas, Springfield, Ill.