Weddell Seal Dives Suggest a Vertical Ecosystem Shift Concurrent with Seasonal Phytoplankton Blooms

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Understanding the baseline and seasonal activities of top polar predators is a scientific priority given forecasted changes in sea-ice cover. Our objective was to characterize the summer foraging behavior of adult, female Weddell seals (*Leptonychotes weddellii*) in the Ross Sea, Antarctica during 2013-2017. We hypothesized that following the lactation period, seals would increase diving effort to regain body mass prior to their annual molt. To test this hypothesis, we deployed time-depth recorders (TDRs) on the flippers of 57 Weddell seals during the austral summer, including seals that had produced pups in a given year (reproductive; n=34) and seals that had not (non-reproductive; n=23). The tags were recovered between 39 and 436 days later and together comprise more than 135,000 dives from 5,642 seal days. During summer, reproductive seals made many dives of short duration (mean ± standard deviation 48±11 dives day^{-1}, 12±2 minutes, 177±73 meters) whereas non-reproductive made fewer, longer duration dives (22±7 dives day^{-1}, 18±5 minutes, 158±62 meters). Reproductive seals gained mass over summer (0.6±0.5 kg day^{-1}) whereas non-reproductive seals lost mass (-1.0±0.4 kg day^{-1}).

In all years, both reproductive and non-reproductive seals showed a clear pattern during late summer where dive depth gradually shallowed from >400m to <150m, stayed shallow for about two weeks, and subsequently returned to >400m (Figure 1). To investigate feeding activity during this period, we deployed Little Leonardo jaw-accelerometers on five Weddell seals. Depth, bottom time, and number of dive-depth-wiggles were quantified in these seals, and in a larger group that only carried TDRs (n=57 seals). For dives with jaw-accelerometer data, we detected jaw motion events using a surge acceleration amplitude threshold of 0.3g. The number of depth-wiggles was a strong predictor of jaw motion events in each dive (n=519 dives, R^2=0.42) and therefore was used as a proxy for feeding effort. Dive metrics from 10 sequential "shallow-period" days (mid-January) and 10 sequential "deep-period" days (rest of summer) were compared within individuals using a paired t-test. Depth-wiggles were more frequent during "shallow-period" than "deep-period" dives (mean±SD 3.0±0.6 and 2.3±0.5 wiggles min-bottom-time^{-1} respectively; p<0.05), suggesting higher presumed foraging success. We hypothesize that the mechanism driving the pattern in seal diving depth is a vertical migration of fishes, coinciding with the seasonal phytoplankton bloom in late December. Fish distribution changes of several hundred vertical meters could strongly impact short-term food web dynamics. Examining predator feeding behavior in both temporal and spatial contexts allows us to characterize natural ecosystem variation.

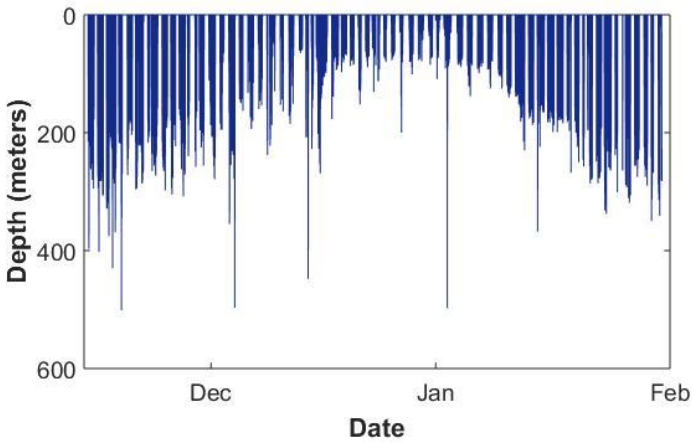

Figure 1. Despite differences in reproductive success, most seals showed a surprising and consistent change in dive depth during summer.