Ringed seal (*Pusa hispida*) spatial use, dives, and haul-out behavior in the Beaufort, Chukchi, and Bering Seas (2011-2016)

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Objectives

Collect baseline data on ringed seal spatial movements, characterize their seasonal and annual habitat use, and identify patterns in their diving and haul-out behavior.

Background

- Ringed seals (*Pusa hispida*) are an ecologically important component of the Arctic marine ecosystem, the primary prey of polar bears (*Ursus maritimus*, Amstrup and DeMaster 1988), and an important local nutritional resource for Native peoples.
- Because they are highly ice-dependent, ringed seals may experience negative ecological consequences due to declining sea ice habitat (Stroeve et al. 2014) and increasing commercial shipping and industrial development.
- The degree to which climate and habitat disruption, anthropogenic disturbance, and/or pollution affects ringed seal ecology remains difficult to assess due to limited information available about their behavior and habitat use (see: Burns et al. 1981, Kelly et al. 2010, Harwood et al. 2012).
- A better understanding of ringed seal biology, including their spatial ecology is needed to mitigate future climate and/or anthropogenic disturbances, better inform decision-makers with respect to future economic development in the Arctic, and ensure that subsistence resources are protected for Native Alaskans.

Methods

Ringed seals (n = 37) were captured in summer (2011-2016) near Utqiaġvik, AK, using drift-nets deployed in open water near ice floes (Fig. 1). Captured seals were instrumented with Wildlife Computers Argos satellite transmitters (Fig. 2). Data collected included: daily movements, dive characteristics (e.g. depth, duration), and haul-out periods.

Figure 1. A drift-net is deployed near Point Barrow to capture ringed seals in proximity to ice floes. Note the presence of a seal in the lower left corner.

Figure 2. This adult ringed seal has been affixed with a SPLASH tag and SPOT6 tag affixed to its head and left rear flipper respectively.

Results: Spatial Use

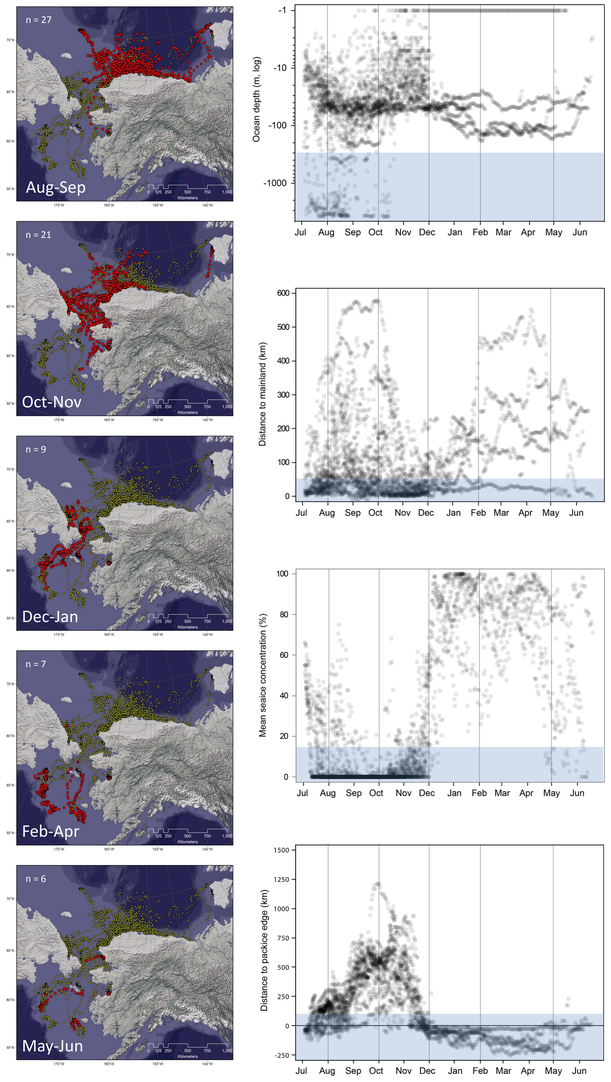

Figure 3 - Seasonal spatial movements and habitat associations. Dots on maps are daily locations estimated by a movement model (CRAWL, Johnson et al. 2008) derived from the Argos tracking data. Red dots are locations during respective monthly periods. Habitat attributes at each daily seal location are shown in the scatter plots. Ocean depth (top scatter plot) is shown with a 300m demarcation between shelf and basin waters. Distance to the mainland coast (islands excluded) is shown in the second scatter plot with a 50 km demarcation for near-shore vs. pelagic. Mean sea ice concentration within a 100km radius is shown in the third plot with a demarcation (15%) between open water and ice. Distance to the edge of the ice pack is shown in the bottom scatter plot with +100km demarcation (negative values represent seal locations that were within the ice pack). Results indicate that ringed seals range extensively across the Beaufort, Chukchi, and Bering Seas. Continental shelf-break areas (<300m) were important and 85% of ringed seals occupied this habitat annually. From November through June, all ringed seals were associated with the shelf. However, during the late summer (August-September), 10 of 27 (37%) marked seals occupied deep basin waters (≥300m) north of the shelf in the Chukchi and Beaufort Seas. Ringed seals were closely associated with sea ice during winter, typically occupying areas within the pack ice.

Results: Dives

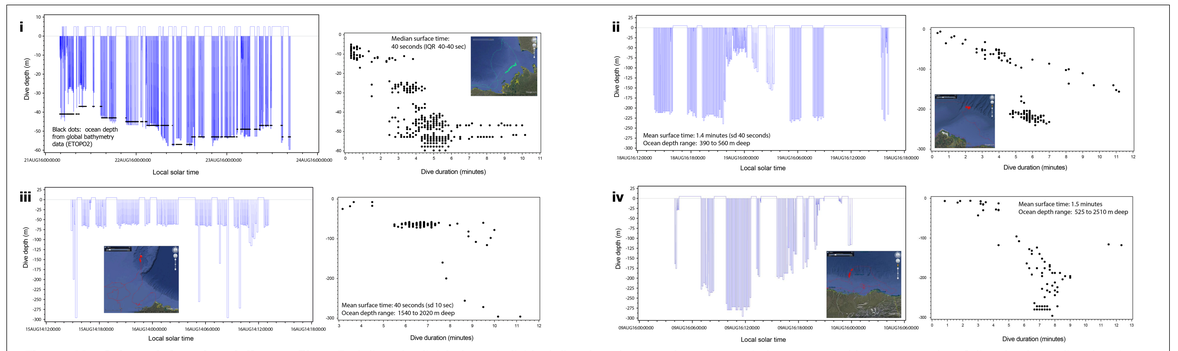

Figure 4A - Selected ringed seal dive profiles. Each line plot (i–iv) shows individual dive data during a short time period accompanied by a scatter-plot of dive depth vs. dive duration. Inset maps show where the dives occurred. When occupying shelf waters, dives were often to the bottom (i). During summer and autumn, some ringed seals traveled off the continental shelf and over the Arctic basin where they occasionally made deep exploratory dives (iii) or sequential dives to repeated depths (ii, iv). Deeper dives were typically longer in duration. These four examples (i-iv) represent a small sample of the >150,000 dive records that have been collected to date.

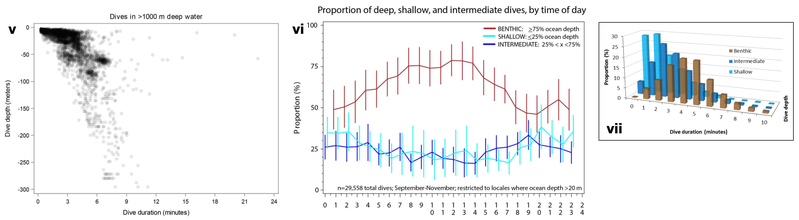

Figure 4B - Ringed seal dive summaries. Scatter plot of dive depths and durations (v) for only those dives when ringed seals were located in areas of "very deep" water (>1000m). Results suggest that, while capable of diving to ~300m, most ringed seal dives in areas of deep water were <100m. The majority of dives were <30m, but depths of ~60m and ~ 90m received repeated use. Line plot (vi), summarizing the proportion of seal dives during autumn by dive-depth category and hour, suggests a diel (daytime) pattern of benthic diving behavior. Dive duration histograms (vii) correspond to the categories in the line plot. These analyses excluded dives in water <20m deep. Dives >12 minutes long may be artifacts of data collection methods.

Results: Haul-out Behavior

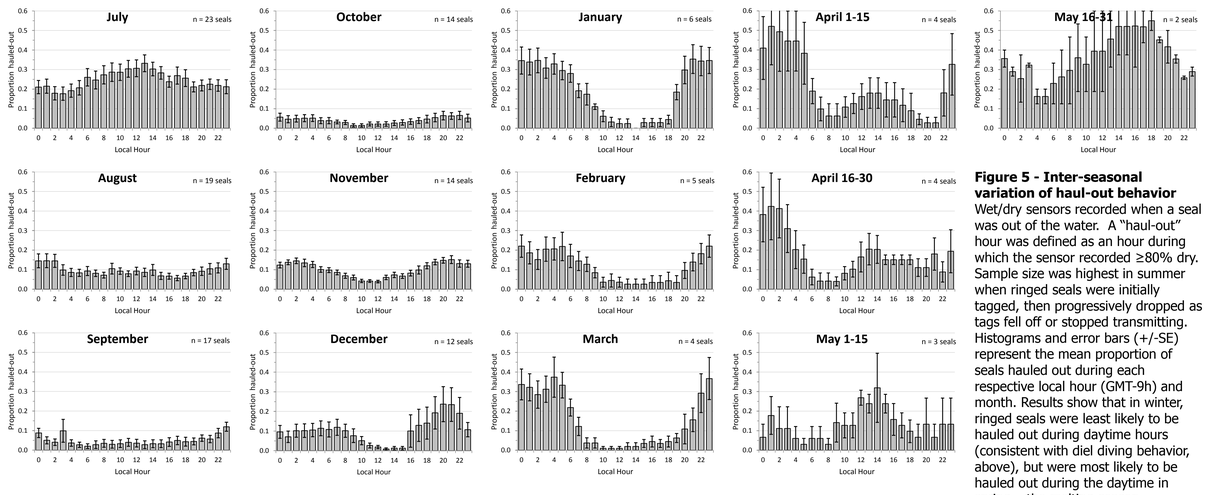

Figure 5 - Inter-seasonal variation of haul-out behavior Wet/dry sensors recorded when a seal was out of the water. A "haul-out" hour was defined as an hour during which the sensor recorded ≥80% dry. Sample size was highest in summer when ringed seals were initially tagged, then progressively dropped as tags fell off or stopped transmitting. Histograms and error bars (+/-SE) represent the mean proportion of seals hauled out during each respective local hour (GMT-9h) and month. Results show that in winter, ringed seals were least likely to be hauled out during daytime hours (consistent with diel diving behavior, above), but were most likely to be hauled out during the daytime in spring – the molting season.

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Citations

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