# Synoptic Aerial Surveys and Abundance Estimates for Ice-associated Seals in US and Russian Waters

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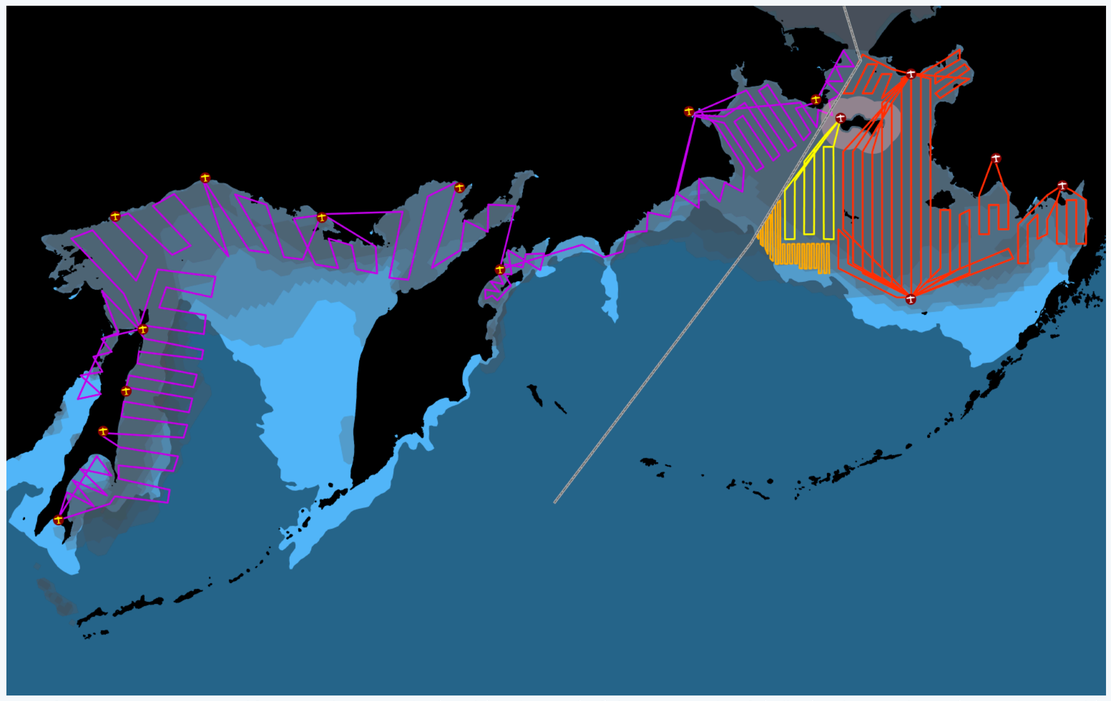
Bearded, spotted and ribbon seals are important subsistence resources for northern coastal Alaska Native communities and are key components of arctic marine ecosystems. They are protected under the Marine Mammal Protection Act and are considered for listing under the Endangered Species Act, yet no current, comprehensive, and reliable estimate of abundance is available for any of the four species.

The distributions of these seals are wide and patchy, and the extent, locations and conditions of their sea ice habitats change rapidly. Any abundance surveys therefore, must cover broad areas throughout their contiguous range and must be completed in a relatively short period of time.

For the last two years, scientists with NOAA's National Marine Mammal Laboratory have been preparing to conduct synoptic aerial surveys of the eastern Bering Sea in tandem with Russian researchers employed to survey the western Bering and Okhotsk Seas.



Map of the survey routes proposed for 2012 and 2013: Russian (purple), Twin Otter (red), longer range aircraft (yellow) and ScanEagle UAS (orange, in 2013 only). The light blue region indicates water depths less than 500 m. The transparent gray fields represent the median ice extent in April from 2007 to 2011.

NOAA Twin Otter

Boeing Scan Eagle

Antonov An38-100

The 2012 and 2013 surveys will be conducted in April to coincide with the reproductive and molting period when the greatest proportions of the seal populations are hauled out on the ice and detectable. Two years of survey effort are required to achieve adequate precision (CV < 0.2) and to ensure that sufficient periods of suitable weather occur during survey period.

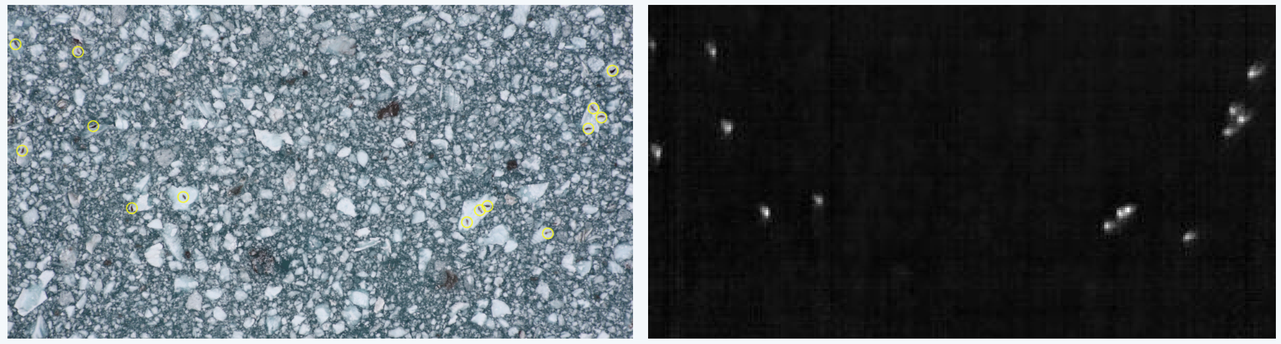
This effort will utilize strip-transect methodology with fixed-wing (manned and unmanned) aircraft equipped with digital photographic and thermal imaging sensors instead of visual observers. In US waters, the primary aircraft will be a NOAA Twin Otter, which is capable of surveying most of the Bering Sea shelf from surrounding airports. Areas inaccessible to the Twin Otter will be surveyed with a second longer range airplane and, perhaps in 2013, a ship-based Unmanned Aircraft System (UAS), the Scan Eagle (Cameron et al. 2009). In Russia, the aircraft will be the Antonov An38-100.

The survey design for US waters includes over 10,000 Nmi of on-effort flight time (22 flights) each year. If used, the UAS could provide an extra 2,000 Nmi in 2013. The survey design for Russia includes over 7,600 Nmi (12 flights) in the Sea of Okhotsk and nearly 4,000 Nmi (6 flights) in the Bering Sea.

## Literature Cited

Cameron, M.F., Moreland, E.E., Boveng, P.L. 2009. Testing a ship-based Unmanned Aerial System (UAS) for surveying the Bering Sea pack ice. AFSC Quarterly Report (May-July 2009)

Ver Hoef. J., Cameron, M.F., Moreland, E.E., Boveng, P.L. In Review. A spatial hierarchical model for abundance of three ice-associated seal species in the eastern Bering Sea. Statistical Methodology.



Paired visual and thermal images of harbor seals on glacial ice collected from an altitude of 800 feet. Yellow circles identify seals on ice corresponding to hotspots in the thermal image.

Each aircraft will be equipped with a thermal imaging sensor (FLIR A325 with the Malahit-M, or the FLIR SC645), to detect the presence of seals on the ice, and high-resolution digital cameras (Canon EOS-1Ds Mark III or Nikon D3X) to identify the species, and perhaps age-class, of the seal.

Aerial photo with a pixel resolution of 1.92cm of a ribbon seal hauled out on the ice.

Field tests suggest that a pixel resolution less than 1.92 cm is required to reliably identify these seals to species, which requires a flight altitude of less than 835 or 1000 ft. depending on the lens used.

Three Canon EOS-1Ds Mark IIIs in the belly-port of a Twin Otter. Two of the cameras are angled to avoid overlap with the third.

Ribbon seal pup instrumented with a SDR to record and transmit the timing of hauling out, seasonal movements and diving behavior.

The Twin Otter will use three digital cameras and thermal sensors, providing a total strip-width of about 340 m when flying at an altitude of 900 ft.

After collecting and analyzing the images, we will develop a hierarchical spatial regression model to estimate the abundance of each species (Ver Hoef. et al., In Review). This model will incorporate important behavioral and habitat covariates such as the timing of animal haul out (as measured from animal-borne satellite linked data recorders, sea ice concentration and water depth.

The recommendations and general content presented in this poster do not necessarily represent the views or official position of the Department of Commerce, the National Oceanic and Atmospheric Administration, or the National Marine Fisheries Service.