Habitat Use and Seasonal Movements of Adult and Sub-Adult Bearded Seals

by
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Bearded seals (*Erignathus barbatus*) are large phocid seals that inhabit shallow circumpolar arctic and subarctic waters that are seasonally ice-covered. Their distribution appears to be strongly influenced by water depth, prey biomass and, to a lesser degree, ice condition. In Alaska waters, bearded seals are distributed over the continental shelf of the Beaufort, Chukchi and Bering Seas between 85°N and 57°N. Bearded seals are benthic feeders, consuming clams, shrimp, crabs, benthic invertebrates, and fish, usually at depths less than 200 m. During the winter in the Chukchi and Bering Seas, these seals are most common in broken pack ice and, in some areas, shore-fast ice. Bearded seals are thought to migrate south and away from the shore with the advancing ice edge in winter. In summer months, most bearded seals are believed to move north again with the receding ice.

Bearded seals are one of the most important subsistence resources for the native people of coastal northern and western Alaska. They are also a key ecological component of arctic and subarctic marine ecosystems, yet surprisingly little is known of their population structure, abundance, or trends. Early estimates of the Bering-Chukchi Sea population of bearded seals ranged from 250,000 to 300,000 animals. Surveys flown from Shishmaref to Barrow, Alaska, during May-June 1999 and 2000 provided preliminary results indicating densities up to 0.652 seals km^2. These densities cannot be converted into an abundance estimate, however, without information on the proportion of the population hauled out during the survey. As adult bearded seals in these areas have never been captured and instrumented with devices for estimating haul-out proportions, a reliable estimate for the abundance of bearded seals is yet to be established, even for this one area that was systematically surveyed.

In preparation for a Minerals Management Service (MMS) study on the environmental impacts of increasing oil and gas development in the Chukchi Sea, in late 2007 the MMS established an interagency (IA) agreement with researchers from the National Marine Mammal Laboratory's (NMML) Polar Ecosystems Program (PEP) which included support to study the seasonal movements and foraging behaviors of adult bearded seals in U.S. waters. Understanding the timing of haul-out behavior, population abundances and trends, foraging behavior, habitat use, and seasonal movements of bearded seals are all of critical importance for developing sound conservation and management plans in response to the potential long-term environmental impacts of climate change and the shorter term impacts of planned oil and gas activities.

Bearded seals may be negatively impacted by offshore oil and gas development as they are strongly associated with the shallow continental shelf zones that would likely be subject to petroleum exploration and extraction. Our ability to predict the nature and severity of impacts is limited, however, by inadequate knowledge of bearded seal habitat use, foraging ecology, and population size. As inhabitants of the broken pack ice and open water zones, bearded seals are vulnerable to impacts of spilled oil, both from direct exposure and from the indirect effects through the benthic organisms on which they feed. In addition, vocalizations, which are critical to bearded seal mating systems, could also be disrupted by industrial noise. Though any industrial impacts on bearded seals could potentially be mitigated or magnified by the effects of climate change, it seems likely that the impacts would be magnified; a loss of suitable sea ice in traditional breeding and molting grounds could isolate bearded seals from suitable benthic prey communities. Indeed, in May 2008 the Center for Biological Diversity filed a pe-

Figure 1. The field team (left to right): Virgil Naylor, John Jansen, Michael Cameron, Henry Goodwin, Noah Naylor, Peter Boveng, John Goodwin, Shawn Johnson and Jeff Barger (Pearl Goodwin, David Barr and Shawn Dahle are not pictured). Photo by Mike Cameron.

tition with the National Marine Fisheries Service to list the bearded seal under the U.S. Endangered Species Act, primarily based on concerns for global warming and the projected loss of sea ice habitat.

A primary reason that bearded seals are less studied than most other seal species is because they are very wary and difficult to approach. Thus, a preliminary goal for PEP researchers was to determine a method for safely and effectively capturing and handling adult bearded seals for sampling and tagging with satellite-linked data recorders (SDRs). In the mid-1990s, researchers in Norway developed a method for capturing bearded seal mother-pup pairs on the ice, wherein a pup is first captured with a hoop net and used to entice its mother back onto the floe for capture in a specialized A-frame net. However, this technique works only with mothers in the early spring when they are with their newborn pup. The SDRs are usually glued to a seal's hair, which is shed during the late spring molt period. Thus, the Norwegian capture technique does not allow the SDR to collect data for more than a few weeks.

From 2004 through 2006, PEP scientists cooperated in a research project with the Native Village of Kotzebue, the University of Alaska Fairbanks, and the Alaska Department of Fish and Game, to develop a technique for capturing young-of-the-year bearded seals in autumn (see *AFSC Quarterly Report*, October-November-December 2006). The method involved setting large-mesh nets perpendicular to the coast of Kotzebue Sound in the shallow, ice-free waters near river mouths where young bearded seals were known to travel and feed. In all, 26 young bearded seals were captured and tagged. The project demonstrated the utility of a focused, collaborative effort between Alaska Natives with local knowledge about the distribution and habits of bearded seals, and scientists with specialized field techniques and analysis expertise. Unfortunately, adult bearded seals do not reliably occupy the same shallow coastal waters as young bearded seals, so this technique is not an effective method for capturing adults.

As part of the IA with the MMS, the PEP, in 2008, consulted with other researchers, members of the Alaska Native Ice Seal Committee, and other Alaska Native subsistence hunters to develop a method for capturing and tagging adult bearded seals after the molt in June. The following is a description of the field work of a pilot study conducted in 2009 and a summary of the preliminary study results.

Field Work

Researchers from the PEP in cooperation with participating subsistence hunters with the Kotzebue IRA (Fig. 1) conducted a 10-day pilot field study during late June-early July 2009 in Kotzebue Sound. Individual bearded seals hauled out on pack ice were slowly approached in small boats, typically causing the seals to enter the water. One or two tangle nets were deployed in water nearby (Fig. 2). These large-mesh (12″-22″ stretch) twisted-monofilament nets were made of 1 to 3 net panels, each 90 ft. long x 24 ft. deep. The float line was made of a 3/4″ diameter foam core wrapped in nylon and the lead line was ¼″ diameter, light enough to allow a captured seal to reach the surface to breathe. The nets were visible to the seals, and some seals, apparently out of curiosity, approached the nets and accidentally became entangled. Entangled seals were restrained alongside one of the small boats and moved to a nearby ice floe for handling, sampling, and tagging. Captured seals were lightly sedated, removed from the net, measured and weighed. Samples of their blood and skin were collected to establish baseline blood parameters and for DNA studies. The seal was then instrumented with two SDRs: a SPOT tag, attached to a rear flipper, and a Mk10 tag, glued to the hair on the seals' head (Fig. 3). The SPOT tag relays information on haul-out timing and long-term movements and will transmit for up to 3 years. The Mk10 tag provides the same information as well as data on the timing and depth of the animal's dives and will fall off when the seal molts during the following spring. Once the glue on the Mk10 tag had cured, each seal was released back into the water near where it was captured.

Two sub-adult and one adult male bearded seals, ranging in weight from 184 to 253 kg. (406 - 558 lbs) were successfully captured and instrumented with SDRs during the 10-day pilot study. The three captured seals are the first adult bearded seals to be instrumented with SDRs in Alaska.

SDR Analyses

SDRs provide information on haul-out behavior. They record "timeline" data that indicate, for every hour, what portion of the hour the seal was hauled out (i.e., the SDR was dry) or at sea (i.e., wet). These timeline data are used to fit a model of haul-out status as a function of date, time of day, and environmental covariates such as local weather. In turn, this haul-out behavior model is used to adjust existing aerial survey counts for the proportion of the population that was underwater and unavailable for counting. Once complete, these adjusted counts will form the basis of future analyses of seasonal changes in seal abundance and distribution.

Bearded seal diving behavior is also monitored by the Mk10 SDRs. Mk10s record the duration and maximal depths of dives and tally the number of dives within predefined depth and duration bins during 6-hour periods (four per day). Mk10s also record the

Figure 2. Shawn Dahle with the Polar Ecosystems Program finishes setting a capture net. Photo by Mike Cameron.

proportion of time spent swimming within the same predefined depth bins during each 6-hour period. The resulting data are used to investigate the seasonal diving behavior of bearded seals. In particular, Mk10 data enables researchers to estimate the time spent swimming or resting near the surface (0-4 m), when seals would be most susceptible to oil. Dive depth data will provide insights into the social and foraging behavior of bearded seals throughout their seasonal cycle, including the pup rearing, mating, and molting seasons when seals spend much of their time engaged in activities other than foraging. During periods when seals appear to be actively foraging, dive depths and frequencies will be evaluated with reference to the best available information on prey locations and densities.

SDRs also provide daily location information which can be analyzed to provide information on seasonal movements and distribution. These data are used to help identify and determine the characteristics and the priority of importance for specific marine habitats associated with key bearded seal life history events such breeding, pup rearing and molting, all of which are believed to require the presence of sea ice as a hauling out platform.

Tracks of animal movements are correlated in space and time, so to investigate resource selection without the influence of autocorrelation, we will simulate 10 tracks per seal by randomly selecting from the pooled distributions of the relative bearings and swim speeds of the instrumented seals. For each point in every track we will obtain the depth, sea ice concentration, and the distances to sea ice, open water, and the coastline. Using logistic regression with a stepwise model selection procedure we will then compare the simulated tracks to those of the tagged seals and obtain a model for describing habitat preference. A similar analysis on young-of-the-year bearded seals revealed the importance of proximity to the ice edge and shallow water depths. Using the SDR records from additional seals we will examine the relative durations of their time spent in different geographic areas and habitats and we may be able to identify hotspots; specific locations of critical importance to a large number of adult bearded seals.

Preliminary Results

Soon after release, all three bearded seals moved out of Kotzebue Sound and followed the Alaska coastline north (Fig. 4). From June through October, all three seals stayed primarily within 50 nautical miles of shore. Though sea ice was rarely present in these areas at this time of year, the seals did not haul out on land, as is typical for this species in Alaska. One sub-adult occupied the region between Point Hope and Point Lay, the other between Point Lay and Wainwright. The adult moved farther west to an area near Prudhoe Bay making occasional trips to the north's deeper, ice-covered waters. As expected, all three seals made repeated foraging dives to the seafloor. These averaged less than 50 m with the adult making the deepest dive to approximately 250 m while occupying the deeper waters of the Arctic basin. Most dives for all seals were 6-10 minutes long, though the adult made a few long dives of roughly 20 minutes. Although the time of day did not seem to affect dive duration, there appears to be a slight trend toward longer dives later in the year. In July, the proximity of sea ice allowed the adult to occasionally haul out. The time hauled out ranged from 4 to 38 hours.

As of November 2009, SDRs from all three seals continue to function properly and transmit information daily via satellite link. As the ice cover returns in autumn and winter, we expect to see all three seals move south into the Bering Sea along with the advancing ice edge, yet remain in the shallow waters of the continental shelf. Owing to the success of this pilot program, we plan to work with other Alaska Native communities in the Chukchi and Bering Seas to identify opportunities to expand the study in 2010 and 2011.

Figure 3. An adult male bearded seal, instrumented with an SDR, just before entering the water. Photo by Mike Cameron.

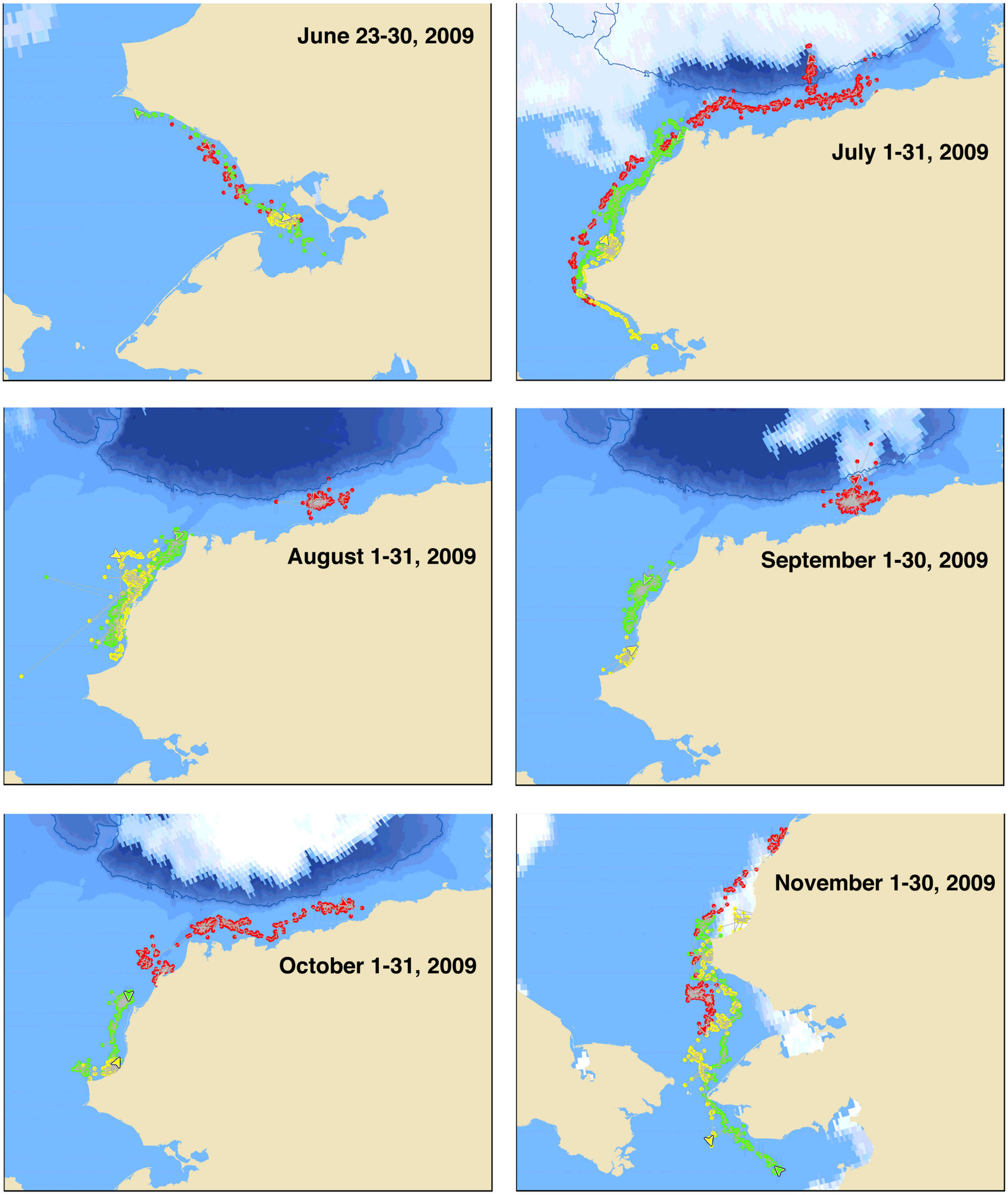

Figure 4. Monthly maps of the seasonal movements of three bearded seals in 2009.