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Aerial Surveys of Freshwater Harbor Seals In Iliamna Lake, Alaska: 2017–2018

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AERIAL SURveys OF FRESHwater HaRBOR sEALS in ILIAMNA LAKE, ALASKA: 2017–2018

by

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# CONTENTS

INTRODUCTION ..................................................................................................................................... 1

METHODS................................................................................................................................................ 2

Survey Flights ........................................................................................................................................2

Image Analysis ...................................................................................................................................... 4

RESULTS.................................................................................................................................................. 5

DISCUSSION ......................................................................................................................................... 12

ACKNOWLEDGMENTS ....................................................................................................................... 15

CITATIONS............................................................................................................................................ 17
INTRODUCTION

In contrast to their saltwater relatives, seals that inhabit freshwater environments year-round are rare. There are only five populations of freshwater seals that exist in the world, and there are only two populations of freshwater harbor seals (*Phoca vitulina*). One of those two freshwater harbor seal populations resides in Iliamna Lake, Alaska. Iliamna Lake is located in southwestern Alaska, at the north end of the Alaska Peninsula between Kvichak Bay to the west and Cook Inlet to the east. It is the state’s largest freshwater lake at approximately 128 km (80 mi) long, covering an area of 2,622 km² (1,012 mi²), and it has a maximum depth of 301 m (988 ft) (Spafard and Edmundson 2000). The lake is connected to the Bering Sea and Bristol Bay via the Kvichak River and it encompasses several islands and islets.

The seals that reside in Iliamna Lake are currently designated by the National Marine Fisheries Service as part of the Bristol Bay stock of harbor seals, one of 12 separate stocks of harbor seals that have been identified in Alaska (Muto et al. 2018). The portion of the Bristol Bay population that inhabits Iliamna Lake, however, is small and consists of approximately 400 individuals (Boveng et al. 2018). During summertime, the harbor seals take advantage of some of the largest salmon runs in the world to feed on fish that use the lake as a spawning ground (Hauser et al. 2008). During winter, the lake is typically covered in ice but the seals make use of leads, pressure cracks, and other areas of open water as well as open spaces under the ice along shorelines for access to the air for breathing (Burns et al. 2016). The seals are an important subsistence resource for several communities that live along the perimeter of the lake, but there is concern that this resource may be impacted by development activities proposed for the area. The uniqueness of their isolation from saltwater harbor seals, along with their nutritional and cultural importance to nearby communities, have highlighted the need to learn more about this population of freshwater seals.

To understand the ecology of harbor seals in Iliamna Lake, projects combining Local Traditional Knowledge (LTK), opportunistic data collection, and modern survey techniques have been initiated over
the past few decades (e.g., Boveng et al. 2018, Burns et al. 2016, Fall et al. 2006, Hauser et al. 2008, Mathisen and Kline 1992). Aerial surveys have been one such effort to locate and enumerate seals in the lake to gather baseline information about the distribution and abundance of the population. Since 1984, flights have been conducted over Iliamna Lake on an intermittent basis by local, state, and federal agencies (Boveng et al. 2018). Scientists at the Marine Mammal Laboratory (MML), a division of NOAA-NMFS’ Alaska Fisheries Science Center, began a more consistent survey schedule in 2005 and have since conducted 11 years of surveys over Iliamna Lake (in 2005, 2008–2015, and 2017–2018). In this report, we summarize results from aerial surveys of harbor seals in Iliamna Lake conducted by the MML’s Polar Ecosystems Program in the spring and summer of 2017 and the summer of 2018.

**METHODS**

**Survey Flights**

During the 2017–2018 field seasons, we conducted aerial survey flights over Iliamna Lake, Alaska (Fig. 1) from a De Havilland Twin Otter fixed-wing aircraft. Our team consisted of two pilots and two to three biologists. During one flight, we were joined by a local representative from the Igiugig Village Council. To consider a flight complete with full survey effort, we surveyed each known harbor seal haul-out site within predesigned survey units (Fig. 1). Known haul-out sites were previously documented from local knowledge and historical aerial surveys, and they are retained in our statewide haul-out location database. Currently, all known haul-out sites are distributed within four survey units on the eastern side of the lake. In addition to surveying each known haul-out site, we regularly circumnavigate the entire lake during one flight to survey its perimeter and drainage tributaries for any new haul-out sites. To navigate throughout the lake, locate each known haul-out site, and efficiently communicate with the pilots, we used an integrated navigation application (ForeFlight) installed on tablet computers.
Figure 1. -- Overview of Iliamna Lake, Alaska study area showing survey unit boundaries and known harbor seal haulout locations. Basemap contents are courtesy of Esri, Garmin, GEBCO, NOAA NGDC, and other contributors.

We planned flights to coincide with the best weather available in the mid- to late afternoon when we expected the highest number of seals to be hauled out. During each survey, we flew at a target altitude of 244 m (800 ft) and a survey speed of 100 kt, and collected our geographic position data with a small Global Positioning System (GPS) device (Bad Elf GPS Pro). We took oblique photographs from a removable side window in the aircraft using a digital single-lens reflex camera (Nikon D700) with an 80–400 mm zoom lens. Our cameras were equipped with Bluetooth devices (Foolography: Unleashed D200+ Bluetooth Module) to enable a Bluetooth connection between the camera and our GPS device. This allowed GPS data to be wirelessly embedded in each photograph that we took.
**Image Analysis**

To analyze our digital imagery, we used a geographic information system application (QGIS) to view the spatial location of each photograph. In conjunction with the geospatial information, we reviewed all images in an image viewing program (ACDSee Pro 10) on high-resolution monitors and selected the best image, or series of images, to be used for enumerating seals at each haul-out location. We imported each image that we selected into a custom designed map template that was connected to our survey database. Within each map, we digitized individual points on every seal in the image (Fig. 2), and added supplemental information such as age class, occurrence in water, and disturbance from the aircraft to each point’s attributes as needed. Each digitized point was linked to and saved in our database. For archival purposes, we exported each map with digitized points as a separate image.

We distinguished two age classes of harbor seals (pups and non-pups) in our image-based counts. Pups were defined as maternally-dependent young-of-the-year and were identified as small, typically light-colored seals in close proximity (touching or < 1 body length) to a larger seal, presumed to be the pup’s mother. Pups in Iliamna Lake are born primarily in June and July, and estimates from previous surveys indicate that the peak in numbers of harbor seal pups on shore in Iliamna Lake is between 12 July (Boveng et al. 2016) and 20 July (Boveng et al. 2018). By August, most of the pups are independent of, and spaced farther from their mothers, and they are difficult to distinguish in aerial photographs from juvenile seals born in the previous year. Therefore, we reported counts outside of June and July simply as non-pups, composed of adults, juveniles, and weaned young-of-the-year.
RESULTS

During the 2017 field season, we conducted four flights over Iliamna Lake on 20 June and 6, 19, and 21 August (Fig. 3). During the 2018 field season, we conducted two flights over Iliamna Lake on 15 and 16 July (Fig. 4). All known haul-out sites were surveyed during good weather conditions (i.e., partly cloudy to overcast skies, no more than light drizzle precipitation, winds ranging from < 4 to 22 kt, and temperatures ranging from 4° to 21° C or 39–70°F). In addition to surveying all known haul-out locations on 21 August 2017, we also circumnavigated the lake to survey its entire perimeter for new haul-out locations.

In 2017, we took a total of 446 photographs during all four flights combined. The number of photographs taken during an individual survey ranged from a minimum of 74 images to a maximum of 160 images. Of all images taken, we selected 51 photographs as having the best quality to count seals. The number of photographs used to count seals for an individual survey ranged from 7 images to 21 images. In 2018, we took a total of 66 images of sites at Iliamna Lake, with a minimum of 20 images and a maximum of 46 images taken per survey. Of all images taken, we selected 12 photographs as having the best quality to count seals, with a minimum of 4 and a maximum of 8 images used per survey.
Our harbor seal counts for 2017 ranged from a minimum daily count of 209 seals on 19 August to a maximum daily count of 312 seals on 21 August (Fig. 5). Pups (n = 53) were observed on the single flight in June. In 2018, our minimum daily count was 202 seals on 15 July and our maximum daily count was 210 seals on 16 July (Fig. 6). Pups were observed on both flights in July. The distribution of seals among the four survey units with known haul-out locations varied on each survey, but high counts (> 180 seals) were consistently found in the northeastern corner of the lake in 2017 (Fig. 7) and in the north-central and northeastern portions of the lake in 2018 (Fig. 8).
Figure 3. -- Aircraft tracklines and effort completed within each survey unit for each flight conducted during harbor seal aerial surveys of Iliamna Lake, Alaska in 2017. Panels show tracklines flown and effort completed on 20 June (A), 6 August (B), 19 August (C), and 21 August (D). Basemap contents are courtesy of Esri, Garmin, GEBCO, NOAA NGDC, and other contributors.
Figure 4. -- Aircraft tracklines and effort completed within each survey unit for each flight conducted during harbor seal aerial surveys of Iliamna Lake, Alaska in 2018. Panels show tracklines flown and effort completed on 15 July (A) and 16 July (B). Basemap contents are courtesy of Esri, Garmin, GEBCO, NOAA NGDC, and other contributors.
Figure 5. -- Total numbers of pup and non-pup harbor seals counted on each flight during aerial surveys of Iliamna Lake, Alaska in 2017. Bar colors indicate proportions of pups and non-pups. Counts include seals both hauled out and swimming near haul-out locations.

Figure 6. -- Total numbers of pup and non-pup harbor seals counted on each flight during aerial surveys of Iliamna Lake, Alaska in 2018. Bar colors indicate proportions of pups and non-pups. Counts include seals both hauled out and swimming near haul-out locations.
Figure 7. -- Total numbers of harbor seals counted in each survey unit flown during aerial surveys of Iliamna Lake, Alaska in 2017. Panels show counts on 20 June (A), 6 August (B), 19 August (C), and 21 August (D). Counts include harbor seals of all age classes, and seals both hauled out and swimming near the haul-out locations. Basemap contents are courtesy of Esri, Garmin, GEBCO, NOAA NGDC, and other contributors.
Figure 8. -- Total numbers of harbor seals counted in each survey unit flown during aerial surveys of Iliamna Lake, Alaska in 2018. Panels show counts on 15 July (A) and 16 July (B). Counts include harbor seals of all age classes, and seals both hauled out and swimming near the haul-out location. Basemap contents are courtesy of Esri, Garmin, GEBCO, NOAA NGDC, and other contributors.
DISCUSSION

As is typical for harbor seals throughout the species’ range, our counts of seals hauled out around Iliamna Lake varied substantially among survey dates. Between both survey years, the highest daily count of harbor seals in the lake occurred in 2017 during late August, when we observed 312 seals. The timing of our maximum daily count coincides with the molting period when we would expect the highest number of seals to be hauled out. However, our lowest daily count for 2017 also occurred in late August only two days prior to our maximum daily count. Between both survey years, the lowest daily count of harbor seals occurred in 2018 during July, when we observed 202 seals. While we report on the number of seals observed during each survey of Iliamna Lake, we emphasize that each total represents a raw count, uncorrected for seals that may have been hauled out but not seen or seals that were underwater and not visible. The considerable variation in counts between days and years underscores the need to conduct multiple surveys.

It is also common for the spatial distribution of harbor seal counts to vary substantially. Among the four surveys that were conducted in 2017, the distribution of seals varied between survey units, but seals were consistently found in the largest numbers in the northeastern corner of the lake. Seals maximizing use of the upper east end of the lake has been observed by local residents and documented during previous aerial surveys (Burns et al. 2016). In 2018, seals were more abundant in both the north-central and northeastern portions of the lake, with more seals being observed in the north-central area than were observed there in 2017. Factors that could potentially be responsible for daily, seasonal, and annual differences in the seals’ distribution include variations in the distribution of prey, wind conditions, seals’ preferences for haul-out sites during pupping and molting, and history of disturbance by human activities. During the one flight in which we were able to circumnavigate the lake to inspect its perimeter, we found no new haul-out locations.
The information gathered during the surveys described in this report continues to build on our understanding of this freshwater population of harbor seals. To effectively monitor and manage the harbor seals in Iliamna Lake, we plan to extend aerial surveillance in future years as resources allow.
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CITATIONS


