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Aerial Surveys of Harbor Seals (*Phoca vitulina richardii*) in Iliamna Lake, Alaska

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Aerial Surveys of Harbor Seals (*Phoca vitulina richardii*) in Iliamna Lake, Alaska

Results from Surveys Conducted by
NOAA, National Marine Fisheries Service
in Fall 2022 and 2023

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Background

Pacific harbor seals (*Phoca vitulina richardii*) are one of the most common marine mammals that inhabit coastal and estuarine waters of the eastern North Pacific, ranging from the Aleutian Islands of Alaska to the Baja California Peninsula of Mexico (Rice 1998). Harbor seals are considered non-migratory and typically stay near their natal area. In Alaska, NMFS and its co-management partners recognize 12 separate stocks of harbor seals based primarily on genetic structure (Muto et al. 2022). Seals that reside in Iliamna Lake, Alaska, are currently considered part of the Bristol Bay stock of harbor seals (Fig. 1). These animals are one of only two populations of freshwater harbor seals in the world (Fig. 2). The Ungava seal (*Phoca vitulina mellonae*) is the other freshwater harbor seal and is found within the lakes of interior northern Quebec, Canada (Smith et al. 2006), with abundance estimates ranging from 50 to 600 individuals (Fisheries and Oceans Canada 2018).

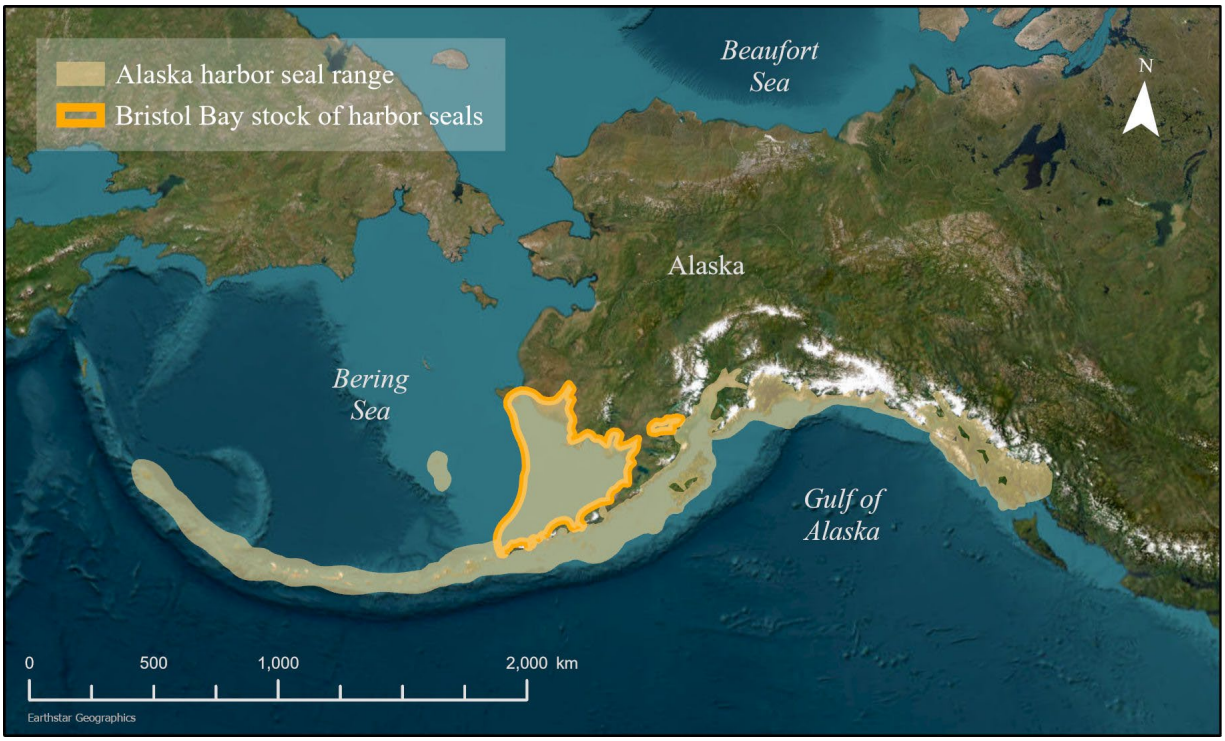

Figure 1. -- Geographic range of harbor seals in Alaska shown in light orange shading, highlighting the boundary of the Bristol Bay stock in dark orange.

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 largest freshwater lake in Alaska at approximately 128 km (80 mi) long with an area of 2,622 km^2 (1,012 mi^2) and a maximum depth of 301 m (988 ft) (Spafard and Edmundson 2000). The lake is connected to Bristol Bay in the Bering Sea by way of the Kvichak River, and it contains a number of islands and islets.

Figure 2. -- Harbor seals hauled out on a sandy beach in Iliamna Lake, Alaska (59°45”N 154°26”W), on 30 August 2023. Photo taken under NMFS Permit No. 23858.

To understand the ecology of harbor seals in Iliamna Lake, projects combining Indigenous and local knowledge, 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 and are the foundation for our estimates of population abundance and trend in the lake. Since 1984, flights have been conducted over Iliamna Lake on an intermittent basis by local, state, and federal agencies (Boveng et al. 2018). NOAA’s National Marine Fisheries Service’s Marine Mammal Laboratory (MML), a division within the Alaska Fisheries Science Center’s (AFSC), began a more consistent survey schedule in 2005 and has since conducted 14 years of surveys of Iliamna Lake (in 2005, 2008–2015, 2017–2019, and 2022–2023).

Daily counts of harbor seals from all agencies from 1984 to 2019, have ranged from no seals observed to 358 seals observed (Fig. 3), and the current population is considered to be relatively stable at approximately 400 individuals (Boveng et al. 2018). In this report, we summarize results from the most recent surveys that were conducted in the fall of 2022 and 2023.

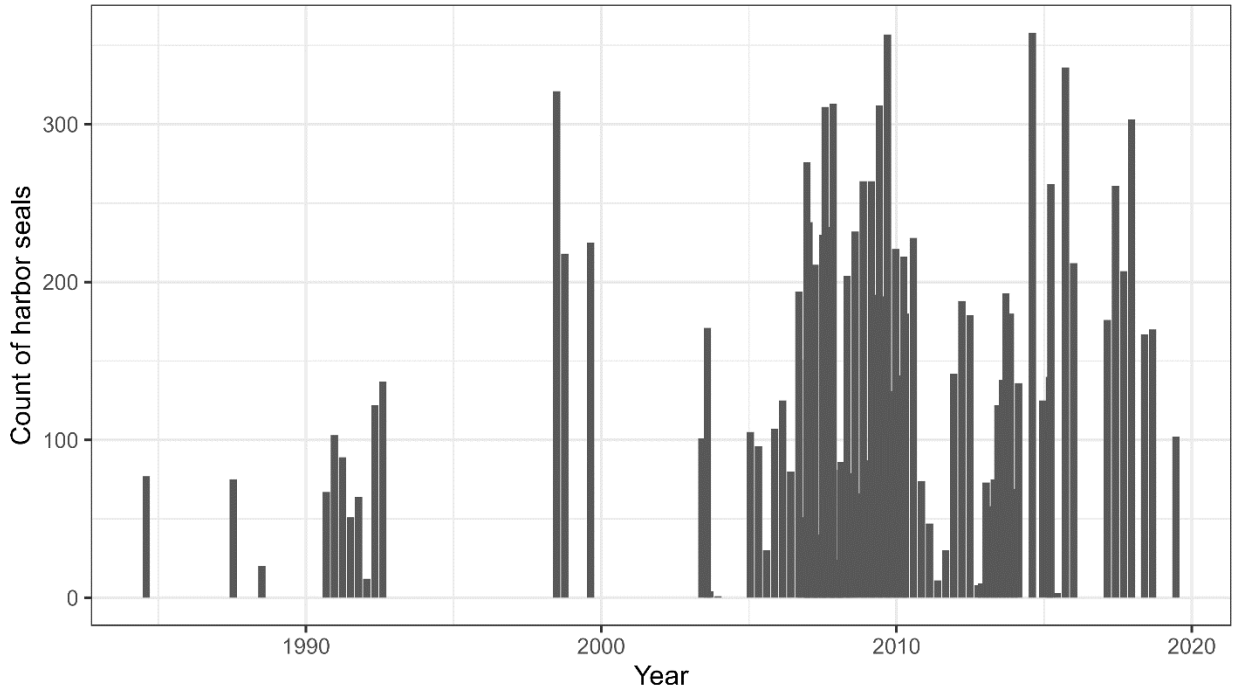

Figure 3. -- Daily counts of harbor seals, excluding pup counts, in Iliamna Lake, Alaska, from aerial surveys conducted by local, state, and federal agencies from 1984 to 2019.

Methods

In the fall of 2022 and 2023, a team of two pilots (NOAA Corps) and two biologists (AFSC) conducted aerial surveys of Iliamna Lake, Alaska, from a De Havilland Twin Otter fixed-wing aircraft owned and maintained by NOAA's Aircraft Operations Center. We surveyed each known harbor seal haul-out site within previously established Seal Survey Units (SSUs) that encompass the coastline (Fig. 4) (https://www.fisheries.noaa.gov/inport/item/17349). All known haul-out locations used by harbor seals in Alaska are based on local knowledge and historical aerial surveys, and they are maintained and regularly updated in a database managed by the Polar Ecosystems Program within the MML (https://www.fisheries.noaa.gov/inport/item/26760). Survey effort during harbor seal aerial surveys was based on the following categories and criteria: "full survey" when all known haul-out sites within an SSU were surveyed; "partial survey" when known haul-out sites were missed within an SSU, due to low clouds or turbulent weather conditions; and "full reconnaissance survey" when the entire coastline within an SSU was observed. To navigate throughout the survey area, locate each known haul-out location, and efficiently communicate with the pilots, we used aviation planning software (ForeFlight, Houston, TX; https://foreflight.com/) installed on tablet computers.

During each survey, we flew at a target altitude of 229 m (750 ft) and a survey speed of 100 kt, and we recorded our geographic position data with two GPS devices (Stratus 3 ADS-B Receiver,

https://stratusbyappareo.com/products/stratus-ads-b-receivers/; and Bad Elf GPS Pro, https://bad-elf.com/pages/be-gps-2200-detail/): one to serve as our primary flight track and the other to serve as a backup flight track. We took oblique photographs from a removable side window in the aircraft using a digital single-lens reflex camera (Nikon D700 or D850) with an 80–400 mm zoom lens. Our camera was equipped with a GPS geotagger (di-GPS, Dawn Technology Limited) that embedded GPS metadata within each image which ensured synchronized date-time information between the camera and the other GPS loggers. Due to aircraft orientation and interference with satellite signals, the GPS geotagger that is attached to the camera does not always provide consistent location data for each image. To account for this, we used the GPS date-time recorded to the image metadata by the di-GPS to extrapolate locations from the primary GPS flight track.

To analyze our digital imagery, we used open source geographic information system software (QGIS, https://www.qgis.org/) to view the spatial location of each photograph. In conjunction with the geospatial information, we reviewed all photographs in image management software (ACDSee Pro 10XE) on high-resolution monitors and selected the best non-duplicative image, or series of images, to be used for counting seals at each haul-out location. We imported each image to be used for counts into a custom map template connected to our survey database. Within each map, we digitized points on each seal in the image and recorded supplemental information, such as behavioral responses to the aircraft, to each point's attributes. Each digitized point was linked to and saved in our database. For archival purposes, we also exported each map with digitized points as a separate standalone image.

We designated only one age class of harbor seals (i.e., non-pups) in our image-based counts. Non-pups are composed of adults, juveniles, and weaned young-of-the-year. Pups are defined as maternally-dependent young-of-the-year and are identified as small, typically lighter-colored seals in close proximity (touching or < 1 body length) to a larger seal that is presumed to be the mother. Pups in Alaska are born primarily in June and July. By August and September, 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. Given this ambiguity, we classified all counts from these surveys as non-pups.

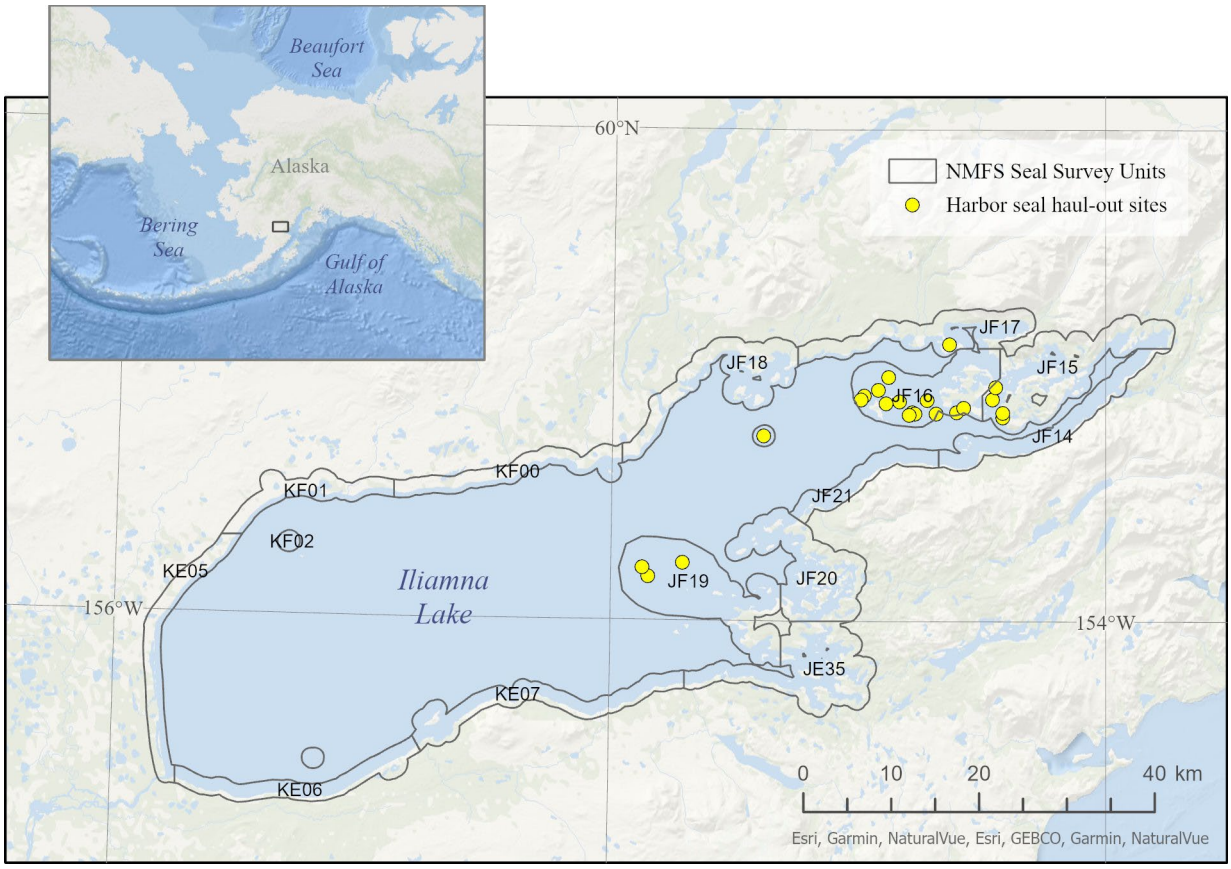

Figure 4. -- Map of Iliamna Lake, Alaska, showing NMFS Seal Survey Units (SSUs) labeled with their alphanumeric identifiers. Known harbor seal haul-out sites are shown as yellow points.

Results

In 2022 and 2023, we completed a total of four aerial surveys of Iliamna Lake, Alaska. In 2022, three surveys were conducted on 15 August, 21 August, and 6 September, and in 2023, one survey was conducted on 30 August. Flight times ranged from 2.9 to 4.5 hours per survey with a total of 14.6 hours of flight time, and survey distances ranged from 644 to 964 km with a total of 3,339 km flown (Table 1). In 2022, weather on 15 August consisted of partly cloudy skies, no precipitation, air temperatures in the 50s °F, and wind speeds from 5 to 15 mph. Weather on 21 August was similar, with the exception of higher winds ranging from 32 to 38 mph, which resulted in a number of haul-out locations being awash in surf. On 6 September, skies were overcast with rainfall, temperatures were in the 40s °F, and wind speeds were from 5 to 15 mph. Anecdotally, on 6 September, the water level in the lake appeared high resulting in less haul-out space available at many of the known haul-out locations. In 2023, weather on 30 August was partly cloudy with air temperatures in the 50s °F and winds speeds ranging from 26 to 39 mph. Flight tracks and effort completed for each survey are shown in Figures 5–8.

For all four surveys combined, we took 160 photographs of harbor seals in Iliamna Lake, and after review, selected 25 images as the best non-duplicative images to use for counts. Daily counts of harbor seals in Iliamna Lake ranged from a minimum count of 57 animals on 6 September 2022 to a maximum count of 376 animals on 30 August 2023 (Table 2). Counts for each haul-out location and survey unit are summarized in Table 3 and Figures 9–12.

Table 1. -- Summary of effort from aerial surveys of harbor seals in Iliamna Lake, Alaska, conducted by AFSC during the fall of 2022 and 2023.

Survey Date	Flight Time (h)	Flight Distance (km)	Notes
08-15-2022	4.5	911	full recon survey of lake
08-21-2022	2.9	644	known haulouts surveyed
09-06-2022	3.2	820	known haulouts surveyed
08-30-2023	4.0	964	known haulouts surveyed
Total	14.6	3,339	

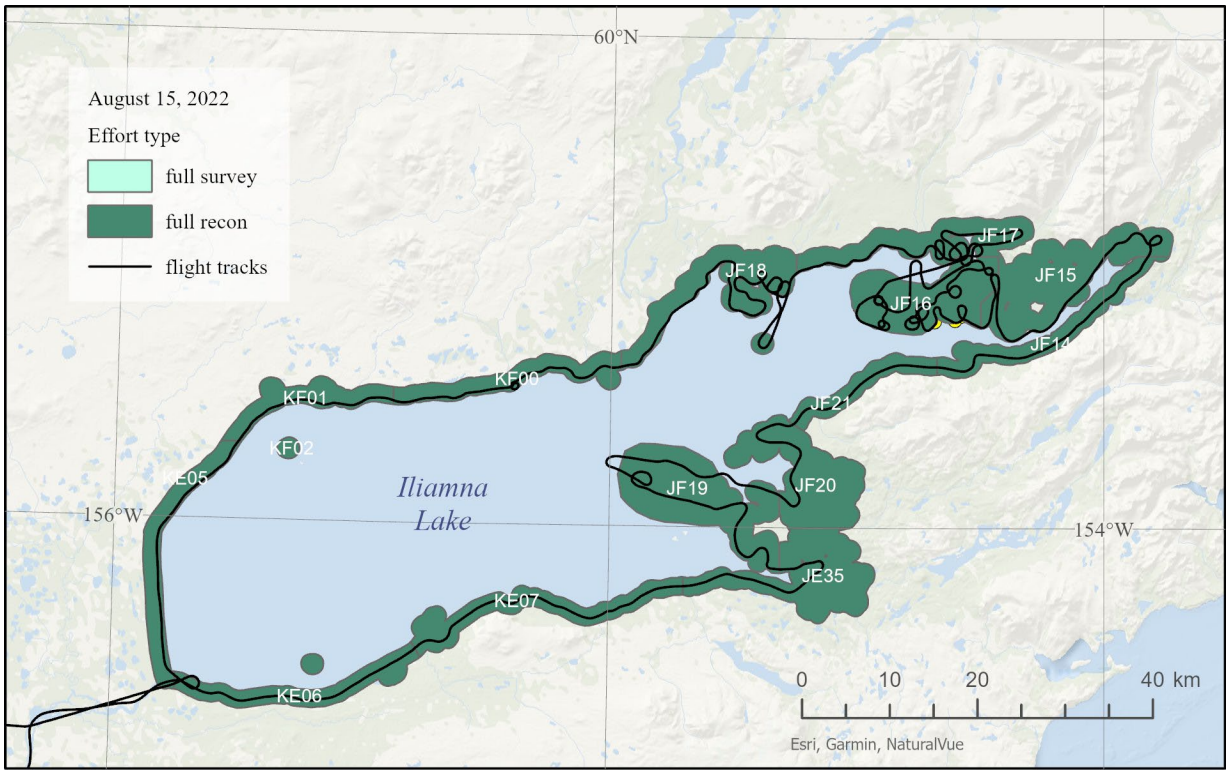

Figure 5. -- Flight tracks and effort conducted in Iliamna Lake, Alaska, by AFSC on 15 August 2022.

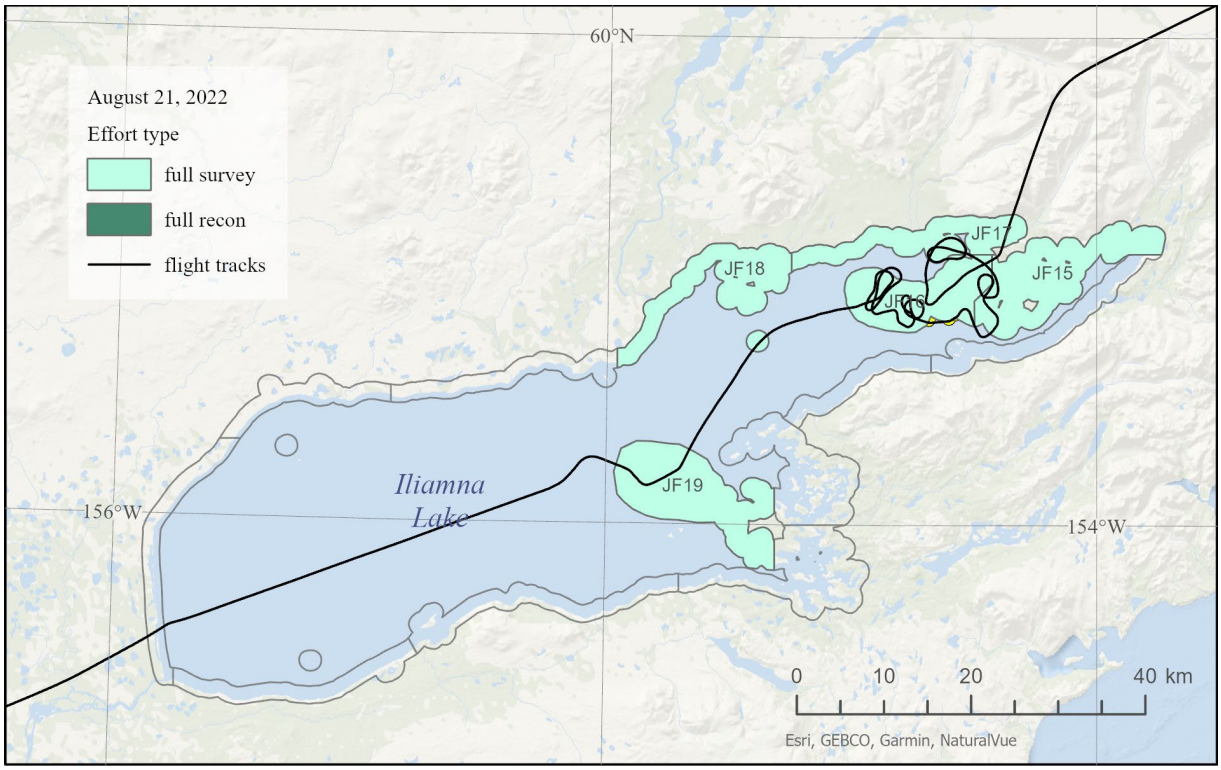

Figure 6. -- Flight tracks and effort conducted in Iliamna Lake, Alaska, by AFSC on 21 August 2022.

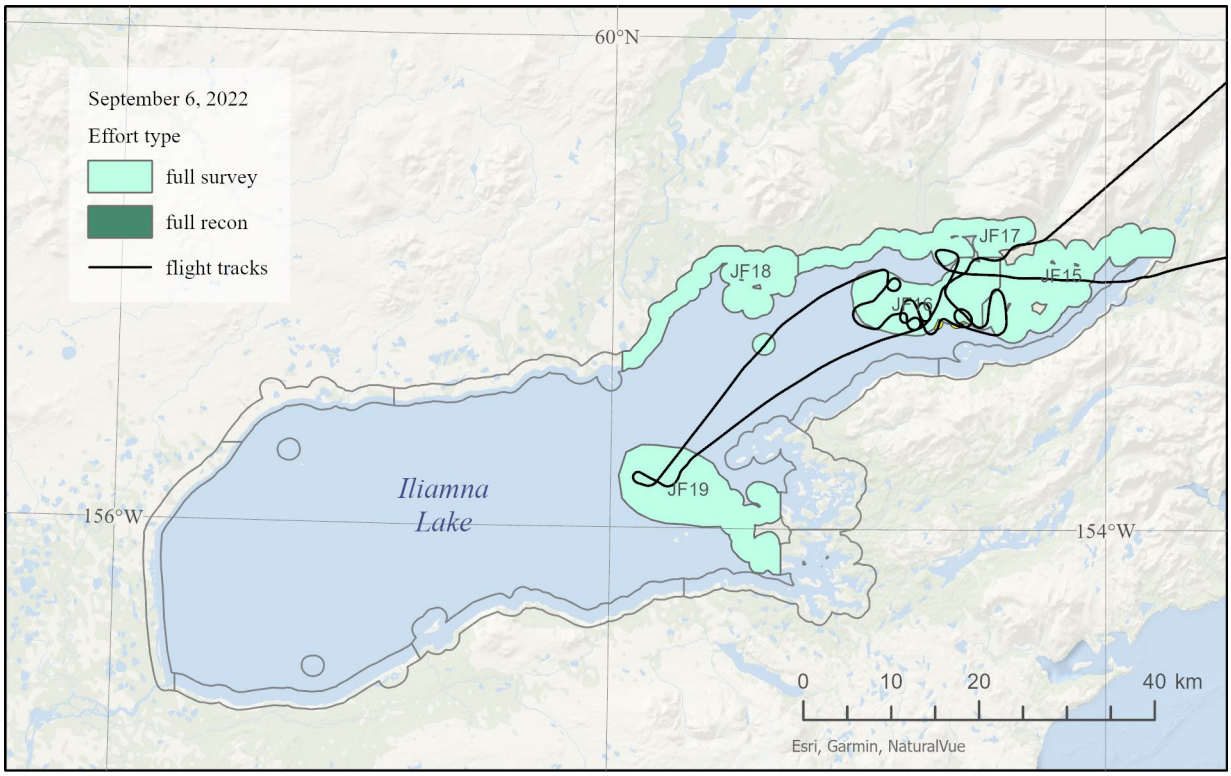

Figure 7. -- Flight tracks and effort conducted in Iliamna Lake, Alaska, by AFSC on 6 September 2022.

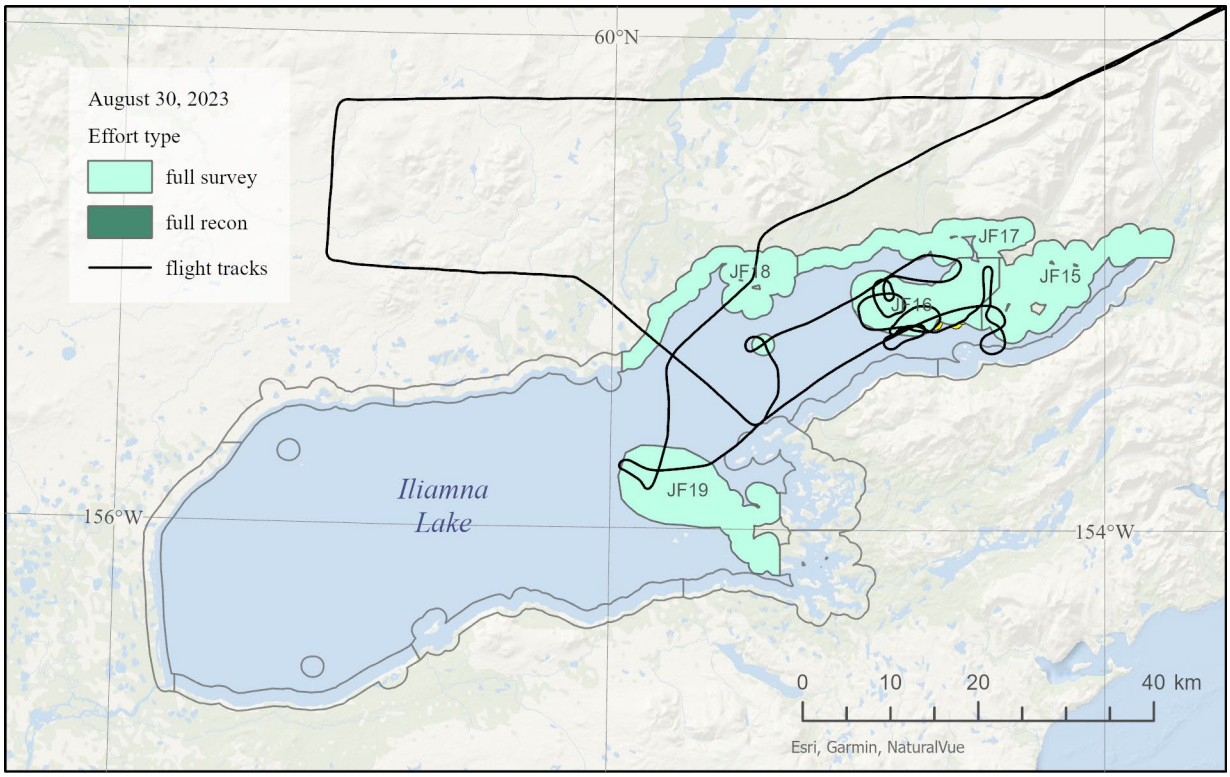

Figure 8. -- Flight tracks and effort conducted in Iliamna Lake, Alaska, by AFSC on 30 August 2023.

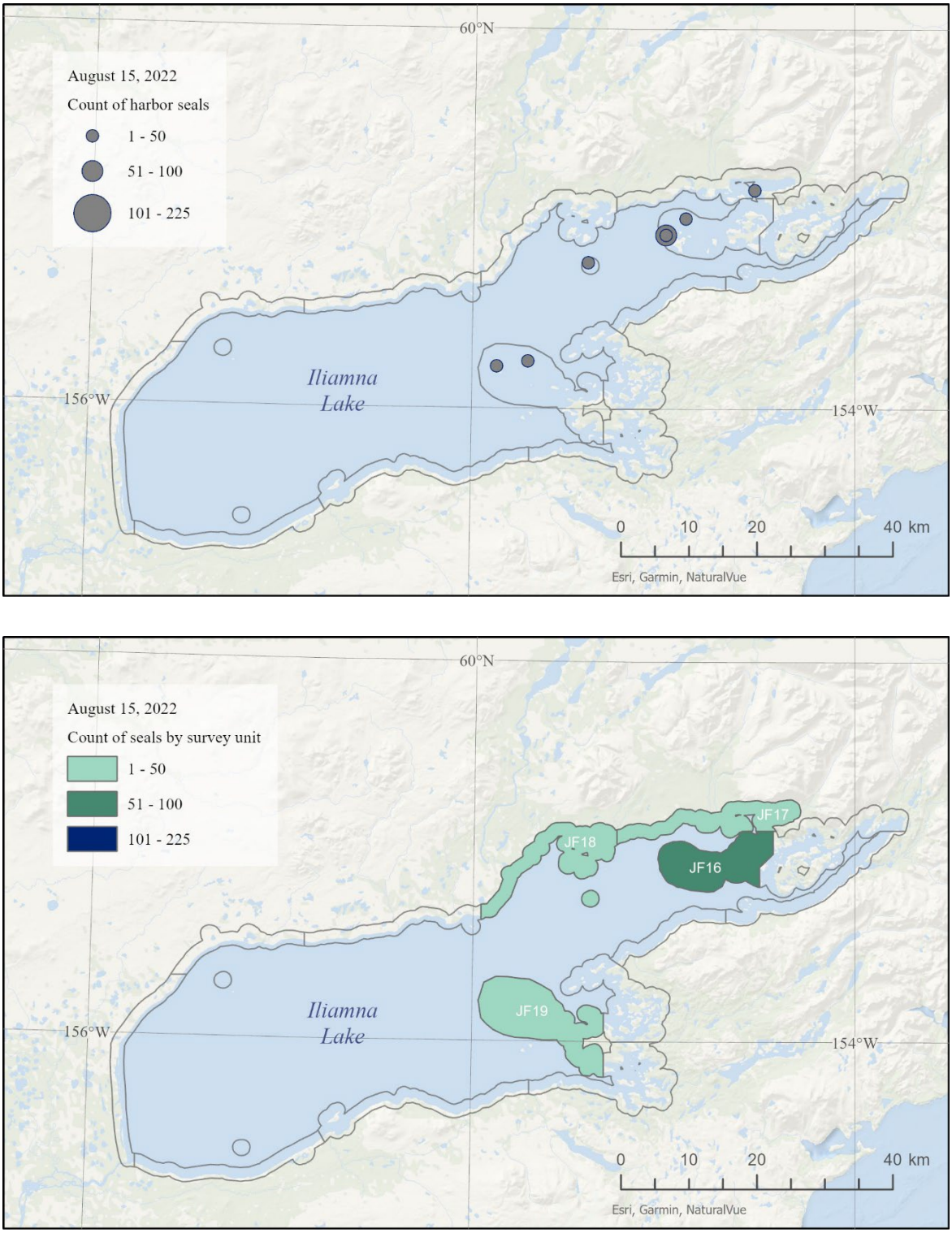

Figure 9. -- Counts of harbor seals by haul-out location (top) and survey unit (bottom) in Iliamna Lake, Alaska, from aerial surveys conducted by AFSC on 15 August 2022.

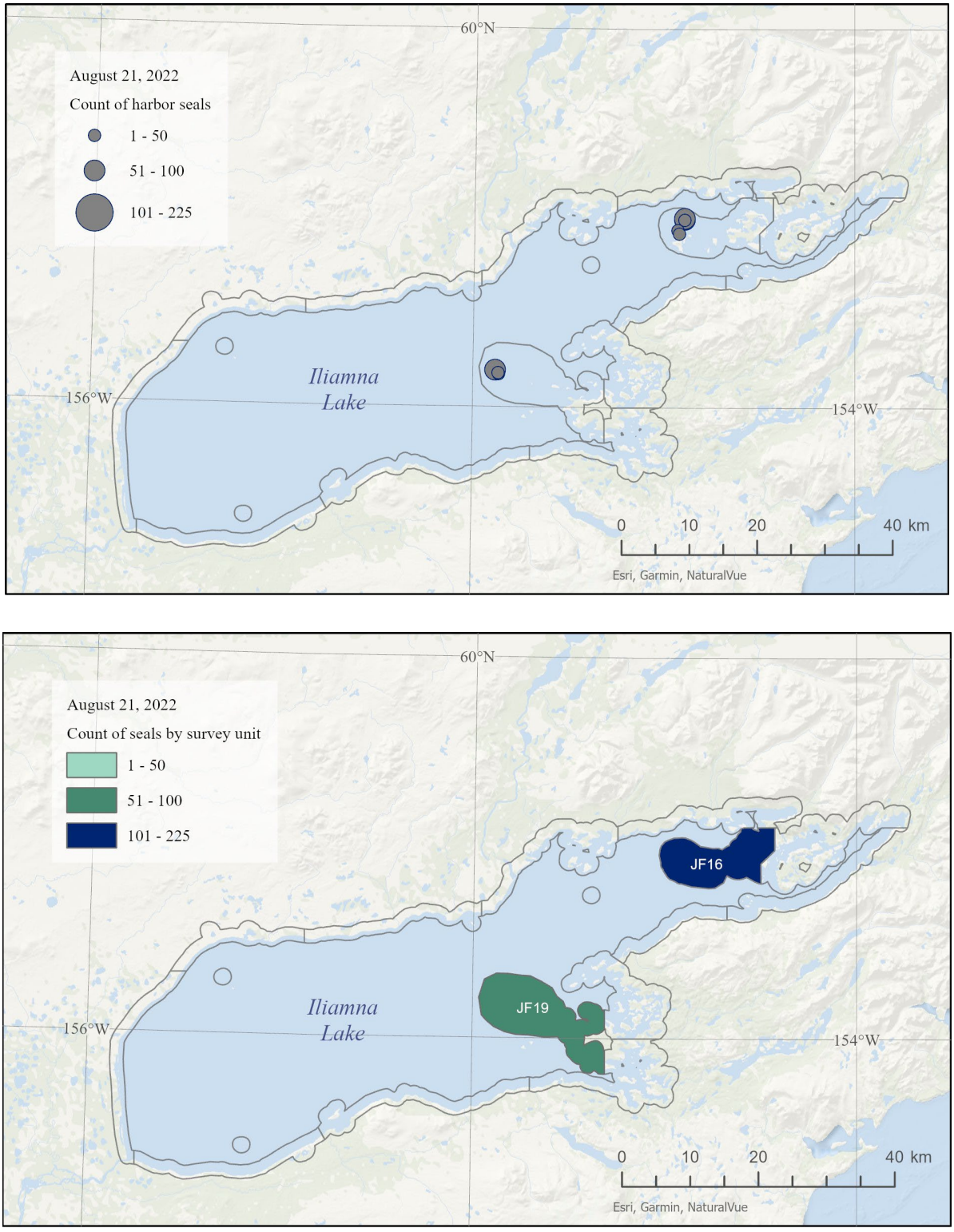

Figure 10. -- Counts of harbor seals by haul-out location (top) and survey unit (bottom) in Iliamna Lake, Alaska, from aerial surveys conducted by AFSC on 21 August 2022.

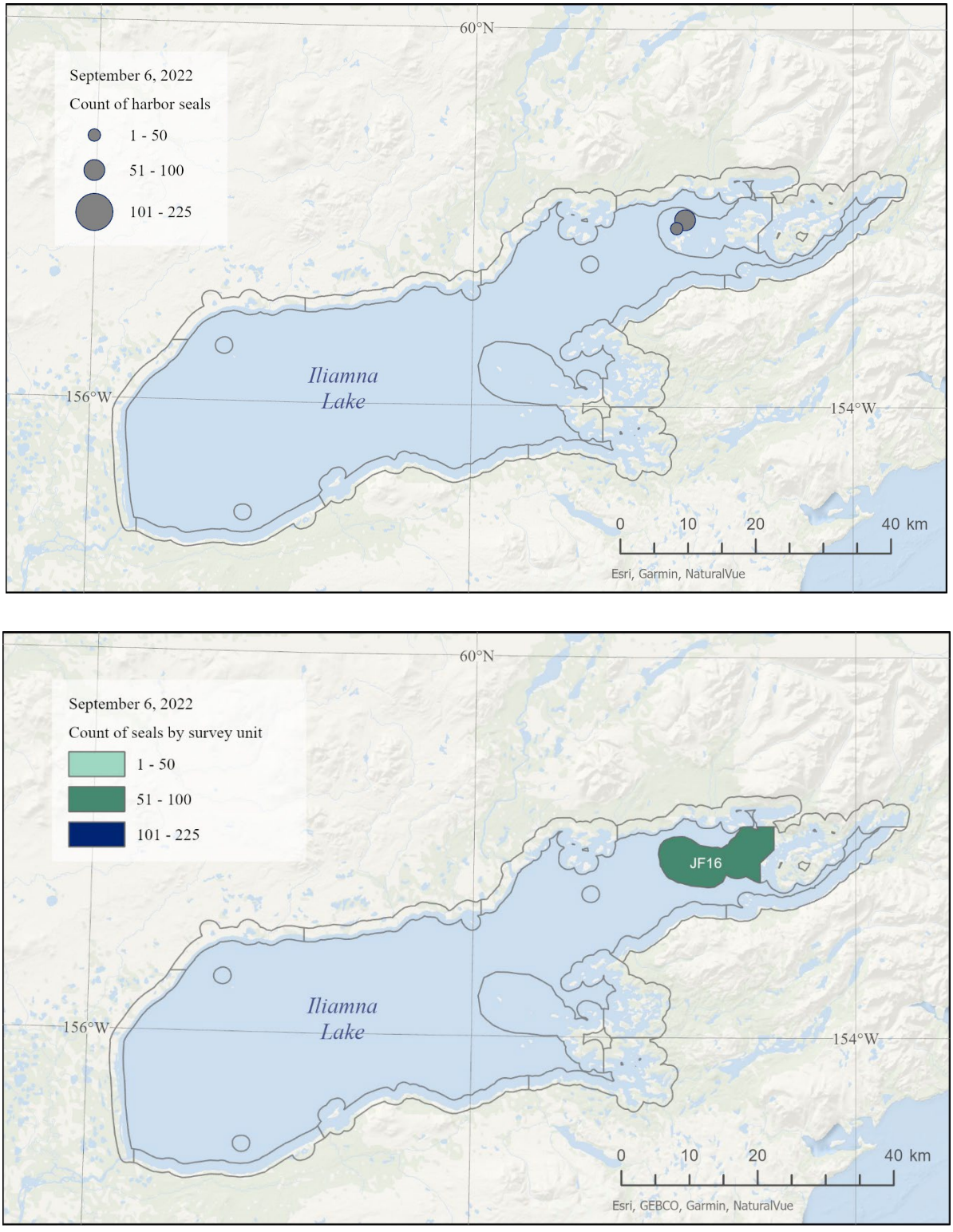

Figure 11. -- Counts of harbor seals by haul-out location (top) and survey unit (bottom) in Iliamna Lake, Alaska, from aerial surveys conducted by AFSC on 6 September 2022.

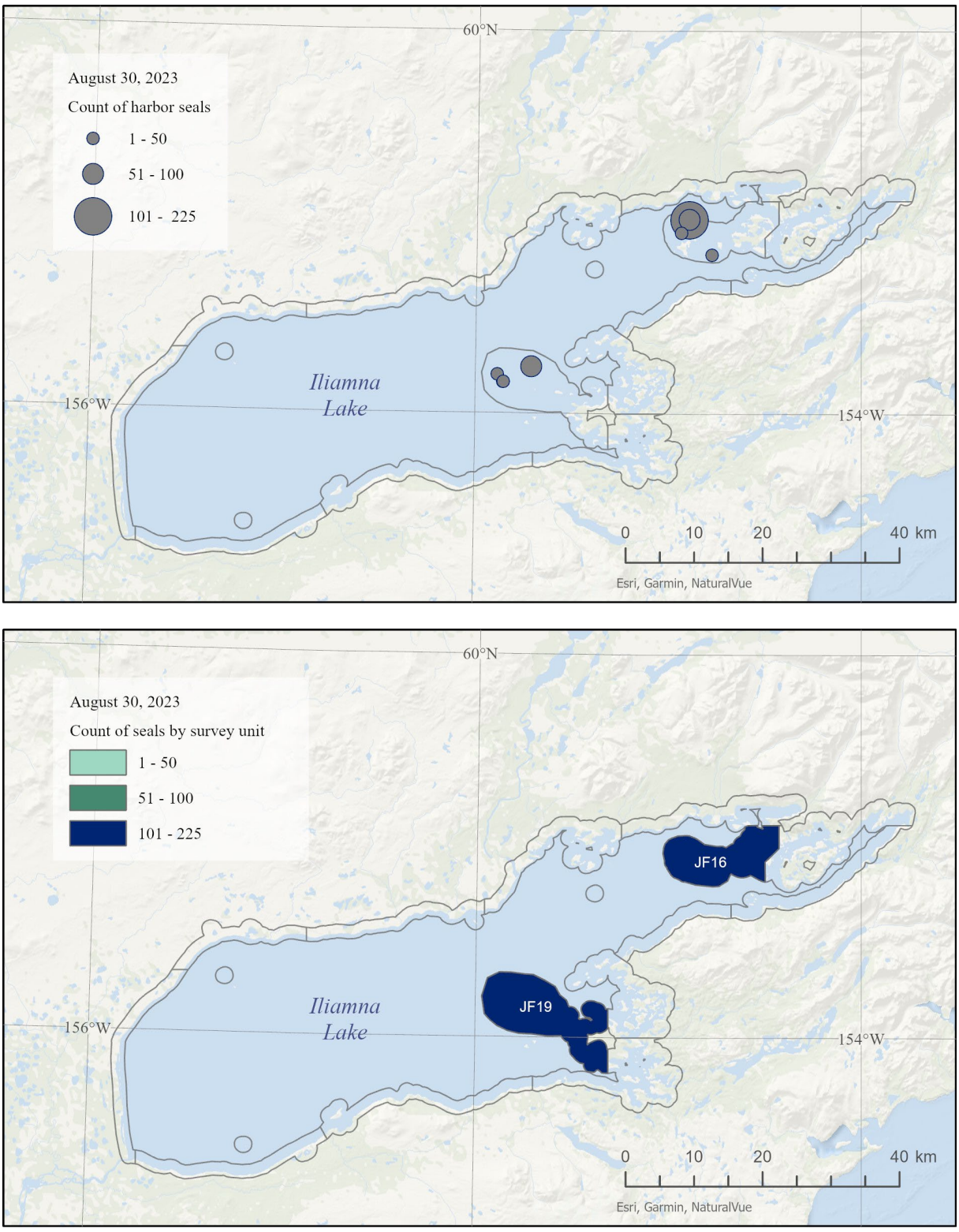

Figure 12. -- Counts of harbor seals by haul-out location (top) and survey unit (bottom) in Iliamna Lake, Alaska, from aerial surveys conducted by AFSC on 30 August 2023.

Table 2. -- Daily counts of harbor seals in Iliamna Lake, Alaska, from aerial surveys conducted by AFSC during fall of 2022 and 2023. All counts are of one age class (i.e., non-pups). Auxiliary counts (i.e., counts of harbor seals made during the flight that were not captured in photographs) were recorded for 14 harbor seals and are included in totals.

Survey Date	Count of Harbor Seals
08-15-2022	107
08-21-2022	283
09-06-2022	57
08-30-2023	376

Table 3. -- Daily counts of harbor seals by survey unit in Iliamna Lake, Alaska, from aerial surveys conducted by AFSC during fall of 2022 and 2023. All counts are of one age class (i.e., non-pups). Auxiliary counts (i.e., counts of harbor seals made during the flight that were not captured in photographs) were recorded for 14 harbor seals and are included in totals.

Survey Date	Survey Unit	Count of Harbor Seals
08-15-2022	JF16	60
08-15-2022	JF17	2
08-15-2022	JF18	2
08-15-2022	JF19	43
08-21-2022	JF16	194
08-21-2022	JF19	89
09-06-2022	JF16	57
08-30-2023	JF16	225
08-30-2023	JF19	151

Summary

In 2022, notable aspects of the surveys in Iliamna Lake included the variable range in daily counts of harbor seals, with a minimum daily count of 57 seals observed on 6 September and a maximum daily count of 283 seals observed on 21 August. The low count on 6 September also coincides with our observation of an apparent high level of water in the lake. This observation was based on a number of known haul-out locations having seemingly less area above land for seals to haul out on than normal. Interestingly, on 21 August when we observed the highest daily count of 283 harbor seals, we also encountered the highest wind speeds which were consistently over 30 mph. Despite a number of haul-out sites being awash in surf due to high winds during this survey, we still observed the highest count of seals. During all three surveys that we conducted in 2022, the highest concentrations of seals were in survey unit JF16, in the northeastern region of the lake. In 2023, we were only able to conduct one survey of the lake on 30 August. However, this survey resulted in the highest count of harbor seals (n = 376) between the two years. It also now represents the highest daily count of non-pups in our entire dataset

(that includes counts starting in 1984), which had a previous maximum daily count of 358 seals recorded in 2014. Similar to the survey on 21 August 2022, the survey in 2023 also occurred during higher winds (> 25 mph). Harbor seals were again in highest concentrations in survey unit JF16 as well as JF19.

Aerial surveys of harbor seal haul-out sites throughout Alaska are conducted in most years and provide information on trends in abundance. Due to the large geographic range of harbor seals throughout the state, consistent annual surveys of Iliamna Lake are not always possible due to funding priorities and constraints. When surveys do occur, data are included in models that derive abundance estimates at the survey unit and stock level. We expect to have updated abundance estimates for all harbor seal stocks in Alaska, including the Bristol Bay stock, which currently includes seals in Iliamna Lake, by the fall of 2023. These updated numbers will be included in the Alaska Marine Mammal Stock Assessment Reports (SARs). Abundance estimates of harbor seals are important in that they allow us to better understand population dynamics and they aid in decision-making processes used for resource management.

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Citations

Boveng, P. L., Ver Hoef, J. M., Withrow, D. E., & London, J. M. (2018). A Bayesian analysis of abundance, trend, and population viability for harbor seals in Iliamna Lake, Alaska. Risk Analysis 38(9): 1988–2009. https://doi.org/10.1111/risa.12988

Burns, J. M., Van Lanen, J. M., Withrow, D., Holen, D., Askoak, T., Aderman, H., O'Corry-Crowe, G., Zimpelman, G., & Jones, B. (2016). Integrating local traditional knowledge and subsistence use patterns with aerial surveys to improve scientific and local understanding of the Iliamna Lake seals. Alaska Department of Fish and Game, Division of Subsistence. Technical Paper No. 416, Anchorage. 182 p.

Fall, J. A., Holen, D. L., Davis, B., Krieg, T., & Koster, D. (2006). Subsistence harvests and uses of wild resources in Iliamna, Newhalen, Nondalton, Pedro Bay, and Port Alsworth, Alaska 2004. Alaska Department of Fish and Game, Division of Subsistence. Technical Paper No. 302, Juneau.

Fisheries and Oceans Canada. (2018). Recovery strategy for the harbour seal, Lacs des Loups Marins subspecies (*Phoca vitulina mellonae*). Species at risk act recovery strategy series. Fisheries and Oceans Canada, Ottawa. v +28 p. https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/recovery-strategies/harbour-seal-lacs-loups-marins.html

Hauser, D. D. W., Allen, C. S., Rich, H. B., & Quinn, T. P. (2008). Resident harbor seals (*Phoca vitulina*) in Iliamna Lake, Alaska: Summer diet and partial consumption of adult sockeye salmon (*Oncorhynchus nerka*). Aquatic Mammals 34(3): 303–309.

Mathisen, O. A., & Kline, T. C. (1992). Harbor seals in Iliamna Lake, Bristol Bay, Alaska Report JCFOS 9204, 9 p. Juneau Center for Fisheries and Ocean Sciences, University of Alaska Fairbanks, Juneau.

Muto, M. M., Helker, V. T., Delean, B. J., Young, N. C., Freed, J. C., Angliss, R. P., Friday, N. A., Boveng, P. L., Breiwick, J. M., Brost, B. M., Cameron, M. F., Clapham, P. J., Crance, J. L., Dahle, S. P., Dahlheim, M. E., Fadely, B. S., Ferguson, M. C., Fritz, L. W., Goetz, K. T., … Zerbini, A. N. (2022). Alaska marine mammal stock assessments, 2021. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-441, 295 p. https://doi.org/10.25923/ctrj-9w44

Rice, D. W. (1998). Marine Mammals of the World: Systematics and Distribution. Special Publication No. 4, The Society for Marine Mammalogy.

Smith, R. J., Cox, T. M., & Westgate, A. J. (2006). Movements of harbor seals (*Phoca vitulina mellonae*) in Lacs des Loups Marins, Quebec. Marine Mammal Science 22(2): 480–485. https://doi.org/10.1111/j.1748-7692.2006.00024.x

Spafard, M. A., & Edmundson, J. A. (2000). A morphometric atlas of Alaskan lakes: Cook Inlet, Prince William Sound, and Bristol Bay areas. Regional Information Report No. 2A00-23. Alaska Department of Fish and Game, Commercial Fisheries Division, Anchorage, AK.

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