

**AERIAL AND GROUND SURVEYS TO QUANTIFY SEABIRD AND
MARINE MAMMAL CARCASSES ALONG THE COASTLINE OF
BERING LAND BRIDGE NATIONAL PRESERVE AND CAPE
KRUSENSTERN NATIONAL MONUMENT, 2020–2024**

FINAL REPORT

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EXECUTIVE SUMMARY

- This study was designed to collect aerial and ground survey data to quantify the number of seabird and marine mammal carcasses on the beaches of the Bering Land Bridge National Preserve (BELA) and Cape Krusenstern National Monument (CAKR), Alaska.
- Aerial surveys were used to cover a large area of coastline (144 km in BELA and 104 km in CAKR) and ground surveys (0.5 km per survey) were conducted to provide more detailed information on searcher efficiency of carcasses from the air (searcher efficiency), species composition of carcasses, and to attempt to estimate rates of carcass persistence.
- The original survey design used a biologist and a pilot as the survey crew, but the surveys were modified due to the Covid-19 global pandemic, poor weather conditions, and limited pilot availability. As a result of these factors, biologists only accompanied the pilots on two of the 8 surveys. These survey modifications greatly limited our ability to collect data on searcher efficiency and no carcass persistence estimates were made. Pilots flew 8 complete or partial surveys; 2 surveys in 2020, 2 surveys in 2021, 3 surveys in 2022, no surveys in 2023, and 1 survey in 2024.
- The coastline of BELA was delineated into 3 survey areas (Ikpek Lagoon, Cowpak Lagoon, and Cape Espenberg). Only one survey of CAKR was completed due to limited pilot availability and more restrictive permits. That survey was conducted in July 2022.
- Aerial surveys of the coastline were flown in a Piper “Supercub” aircraft, a single-engine with two-seats flying approximately 50 m above ground level. The pilot or observer recorded the number of seabird and marine mammal carcasses observed for each 4-km segment of coastline. During each survey, the plane landed at 4–5 locations, and the pilot or survey crew searched 500-m ground transects. All carcasses observed during ground surveys were photographed and some birds were tagged with wooden numbered tags to assist in species identification and estimating carcass persistence.
- During 2020, we flew 2 surveys of the BELA coastline (5 and 13 August). During the first survey, the pilot observed no seabird carcasses and 2 marine mammal carcasses from the air and 2 seabird carcasses while conducting the ground survey. During the second survey, the pilot recorded 29 seabird and 7 marine mammal carcasses from the air and 13 seabird

carcasses and one marine mammal carcass from ground plots. The first survey was conducted by a different pilot prior to finalizing the study methods, therefore the second survey likely represented a more accurate description of carcass densities.

- During 2021, we flew 2 surveys of the BELA coastline (27 June and 22 August). During the first survey the pilot recorded 39 seabird and 14 marine mammal carcasses from the air and 12 seabird carcasses from the ground. During the second survey, the pilot recorded 211 seabirds and 2 marine mammals from the air and 30 seabird carcasses from the ground. An additional 609 seabird carcasses and 5 marine mammal carcasses were observed outside of the survey area. Due to a failure involving data collection software, not all ground survey data from the second survey were recorded.
- During 2022, three surveys of the BELA coastline were conducted on 29 June, 16 July, and 12 September and one survey of the CAKR coastline was conducted on 15 July. An ABR biologist was present for the surveys conducted in July. On 29 June, only 5 seabird carcasses and 2 marine mammal carcasses were observed on transect during the aerial survey. On 15 July, 8 seabird carcasses and 1 marine mammal carcass were observed during the aerial survey of the CAKR coastline. On 16 July, 57 seabird carcasses and 40 marine mammal carcasses were observed during the aerial survey. On 12 September, 66 seabird carcasses and 12 marine mammal carcasses were observed during the aerial survey. Only 2 seabird carcasses were observed during the ground surveys in July and 17 seabird carcasses were found during the ground surveys in September.
- During 2023, no surveys were flown. Large amounts of driftwood were present all along the study area coastline making surveys impossible to fly safely and effectively. There were few landing spots available, and it is likely carcasses have been difficult to observe. The driftwood may have been deposited as a result of Extratropical Typhoon Merbok in September 2022.
- During 2024, we flew 1 survey of the BELA coastline (17 July) with a pilot and an ABR observer. The survey crew recorded 230 seabird and 12 marine mammal carcasses from the air and 29 seabird carcasses from the ground. A second survey was canceled due to poor weather.

- Based on 65 seabird carcasses that had data from both aerial and ground surveys, we estimated that aerial surveys had a searcher efficiency of 47.7% (95% CI = 35.5–59.8%). We were not able to estimate carcass persistence from the available data. No tagged birds were relocated on subsequent surveys, but repeated surveys were limited in number and the period of time between surveys was often long.
- We compared the density of seabird carcasses observed during aerial surveys to the density of carcasses observed during ground surveys and found wide variability among surveys. Estimated carcass densities during ground surveys were much higher (2–27 times higher) than densities from aerial surveys suggesting that aerial carcass sightability may be very low under some conditions.
- We summarized avian carcass data from citizen science Coastal Observation and Seabird Survey Team program of seabird carcass (COASST; www.coasst.org) ground surveys conducted near Shishmaref, Alaska 2009–2019 for comparison with our data collected from aerial and ground surveys 2020–2024.
- We estimated carcass persistence near Shishmaref, Alaska using tagged bird data from the citizen science COASST ground surveys conducted in 2009–2019. We estimated that mean carcass persistence of carcasses found during surveys was 4.38 days (90% CI = 3.11 –6.05 days) and carcass persistence was longer in July than in June or August.
- We summarized survey results conducted by the National Park Service for one aerial survey and multiple ground surveys in September 2017.
- Aerial surveys appear to be an efficient method to survey seabird and marine mammal carcasses over a large area of coastlines in western Alaska but require overcoming limitations regarding weather conditions and pilot availability and there is still considerable uncertainty about the magnitude and factors affecting carcass sightability. Nevertheless, we were able to identify a large mortality event that occurred in late summer 2021 and a possible large mortality event in mid-summer 2024. Additional surveys with a pilot and an observer are necessary to estimate searcher efficiency during aerial surveys and repeat surveys or other methods are required to estimate carcass persistence between surveys.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	ii
TABLES	v
FIGURES	vi
APPENDICES	vii
ACKNOWLEDGMENTS	vii
INTRODUCTION	1
METHODS	3
AERIAL SURVEYS.....	4
GROUND SURVEYS	4
RESULTS	6
SEARCHER EFFICIENCY ESTIMATION	18
CARCASS PERSISTENCE ESTIMATION	23
DISCUSSION	25
LITERATURE CITED	29

PLATES

Following page 30

TABLES

Table 1. Seabird carcasses recorded during aerial surveys of Bering Land Bridge National Preserve and Cape Krusenstern National Monument, Alaska, 2020–2024.	7
Table 2. Species of seabird carcasses recorded during ground surveys conducted in Bering Land Bridge National Preserve, Alaska, 2020–2024.	8
Table 3. Numbers of marine mammal carcasses recorded during aerial surveys conducted in Bering Land Bridge National Preserve, Alaska, 2020–2024.	12

Table 4.	Species of marine mammal carcasses recorded during aerial and ground surveys conducted in Bering Land Bridge National Preserve, Alaska, 2020–2024.....	12
Table 5.	Numbers of seabird carcasses recorded during aerial surveys and ground surveys conducted in Bering Land Bridge National Preserve, Alaska, 2020–2024.....	23
Table 6.	Comparison of aerial and ground-based estimates of seabird carcass density in Bering Land Bridge National Preserve, Alaska, 2020–2024. Densities were used to calculate the percent of ground density observed during aerial surveys and the correction factor to adjust aerial densities to densities observed during the ground surveys.....	24

FIGURES

Figure 1.	Southern Chukchi Sea showing major ocean currents and seabird colonies.....	2
Figure 2.	Locations of 4-km segments for aerial surveys of coastline in Bering Land Bridge National Preserve and Cape Krusenstern National Monument.	5
Figure 3.	The number of seabird and marine mammal carcasses observed during an aerial survey conducted 13 August 2020.	9
Figure 4.	The number of seabird carcasses observed during ground surveys conducted on 13 August 2020 and 27 June 2021.	10
Figure 5.	The number of seabird and marine mammal carcasses observed during an aerial survey conducted 27 June 2021.....	11
Figure 6.	The number of seabird and marine mammal carcasses observed during an aerial survey conducted 22 August 2021.	14
Figure 7.	The number of seabird carcasses observed during ground surveys conducted on 22 August 2021 and 29 June 2022.	15
Figure 8.	The number of seabird and marine mammal carcasses observed during an aerial survey conducted 29 June 2022.....	16
Figure 9.	The number of seabird and marine mammal carcasses observed during an aerial survey conducted 15–16 July 2022.	17
Figure 10.	The number of seabird carcasses observed during ground surveys conducted on 15–16 July 2022 and 12 September 2022.....	19
Figure 11.	The number of seabird and marine mammal carcasses observed during an aerial survey conducted 12 September 2022.....	20
Figure 12.	The number of seabird and marine mammal carcasses observed during an aerial survey conducted 17 July 2024.	21
Figure 13.	The number of seabird carcasses observed during ground surveys conducted on 17 July 2024.	22

APPENDICES

Appendix A.	Summary of COASST data from Shishmaref beaches 2009–2019.....	34
Appendix B.	Surveys conducted in September 2017 by the National Park Service.....	43
Appendix C.	Protocol for monitoring seabird carcass deposition along the coast of Bering Land Bridge National Preserve.....	45
Appendix D.	Ground survey observations form.....	64
Appendix E.	Coding on forms	67
Appendix F.	Wooden Tag Protocols.....	71

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INTRODUCTION

Seabirds are ecologically important and visible indicators of ocean conditions and the health of coastal subsistence resources critical to communities within Bering Land Bridge National Preserve (BELA) and Cape Krusenstern National Monument (CAKR). The many seabird colonies of the Chukchi Sea and Norton Sound regions are used by more than one million ground-nesting, cliff-nesting, and crevice- and burrow-nesting species (Figure 1). Despite the historically high marine productivity of Hope Basin (Grebmeier et al. 2006), the density of seabirds in Alaska waters has declined 2% per year over the past 40 years (USGS 2015). This steady decline has been punctuated by large die-offs of substantial numbers of seabirds, and the frequency of these events has increased in recent years, concurrent with warmer ocean temperatures (Cavole et al. 2016, Renner et al. 2024). In August 2017, dead and dying seabirds, mostly Short-tailed Shearwaters (*Ardenna tenuirostris*), were reported from Shishmaref, Alaska, south to the Pribilof Islands. A National Park Service (NPS) survey of BELA and CAKR coasts conducted in September 2017 documented dead seabirds on the beaches in both parks. Given projections of continued ocean warming, increased vessel traffic, and possible oil and gas development in the Arctic, it is increasingly important to quantify the frequency and intensity of seabird die-offs (Kaler and Kuletz 2022). Developing baseline information on carcass deposition as well as a consistent and repeatable protocol to quantify seabird carcasses on the Arctic coast is necessary to identify and respond to future seabird die-off events.

The number of seabird carcasses found along a coastline during a search is a function of (1) the rate and pattern of carcass deposition on beaches, (2) the persistence of those carcasses on a beach, and (3) the probability that a carcass will be detected by an observer (Byrd et al. 2009). Carcass deposition patterns along beaches are indicative of seabird mortality but are strongly influenced by ocean currents, tides, and winds (Camphuysen 1998, Wiese and Robertson 2004, Munilla et al. 2011, Tavares et al. 2016). Large seabird mortality events often occur later in the summer (Kaler et al. 2022), but weather conditions during that period can be poor for multiple days in a row.

In 2018, ABR, Inc.—Environmental Research & Services (ABR) collaborated with NPS to develop protocols for surveys of seabird carcass deposition (Gall and Prichard 2018), with fieldwork proposed to start in 2019. At that time, it was assumed that biologists would travel to Kotzebue and fly with pilots to conduct the surveys. The objectives of the study were to:

1. Count the number of seabird and marine mammal carcasses along the coasts of BELA and CAKR.
2. Estimate the probability that a carcass is detected from the air, given that it is located on the ground.
3. Estimate the persistence of carcasses on the beaches during summer.

Due to the public health concerns associated with transmission of the coronavirus, it was not feasible for biologists to join the surveys in 2020 and 2021. Instead, local pilots conducted the seabird carcasses surveys directly, or in one case with a local observer, thus reducing the risk of viral transmission in remote communities. In 2022, we conducted one survey with a biologist as the observer and 2 additional surveys with the pilot as observer. In 2023, no surveys were conducted due to large amounts of driftwood that was present all along the BELA coast making landing and seeing carcasses very difficult. In 2024, one survey was completed with an ABR observer, but additional surveys were not able to be flown. A second survey was canceled due to poor weather and could not be rescheduled due to persistently poor weather and limited pilot availability. Although we collected data critical to monitoring marine resources in the southeastern Chukchi Sea, we were limited in addressing the second and third objectives by the constraints of conducting most surveys without an observer.

METHODS

The original study design used a combination of aerial surveys and ground surveys to enumerate carcasses on the beach and estimate the searcher efficiency (sightability of carcasses from the air) and the length of time carcasses remain on the beach (carcass persistence; Gall and Prichard 2018). In 2020–2024, surveys focused on counting carcasses along the coast in a repeatable manner using a consistent protocol. These estimates will provide a useful metric of

carcass deposition that can be used in conjunction with other information to assess patterns and trends in seabird mortality in the southeastern Chukchi Sea.

AERIAL SURVEYS

A pilot flew a Piper “Supercub” aircraft along the coastline maintaining an altitude ~50–100 m above ground level (agl), a speed of ~90 km/h, and positioned the plane so that they could see the beach from the water line to the wrack line. The pilot maintained a daily flight log documenting start/stop times and survey conditions. The coastline was divided into 4-km segments and the pilot or observer recorded the number of seabird and marine mammal carcasses observed in each segment (Figure 2). Carcasses were identified to species, or the lowest taxonomic level possible. The mean tide range at Shishmaref, Alaska is ~23 cm, therefore tide stage was not used as a factor in determining survey timing.

GROUND SURVEYS

Pilots landed at 4–5 locations along the BELA coast and 1 location of the CAKR coast to conduct ground surveys of 500-m transects of coastline. These transects along the BELA coastline were spread out evenly among the 3 survey areas (Ikpek Lagoon, Cowpak Lagoon, and Cape Espenberg) and selected by the pilot in an area where landing could be conducted safely (Plate 1). An effort was made to survey the same locations on each visit to get information on carcass persistence. Ideally, ground survey areas would be resurveyed several days after the initial survey, but this did not occur due to logistical constraints. The pilot or survey crew (pilot and observer/biologist) walked the survey areas to get an accurate count of carcasses present between the wrack line and the water line. The pilot or survey crew surveyed the 500-m segment by walking away from the plane and recording and tagging carcasses observed along the way. On the return, any additional carcasses that were missed on the first pass were recorded and tagged (Plates 2–3). If the beach was wide (> 100 m wide), the half closer to the water was surveyed in one direction and the half closer to the wrack line was surveyed in the other direction. We compared the number of carcasses observed from the air with the number of carcasses observed from the ground along each 500-m transect to estimate searcher efficiency. We also calculated the total estimated density of carcasses from aerial surveys and compared the results to the estimated density from ground survey data as an alternate method to estimate searcher efficiency.



Figure 2. Locations of 4-km segments for aerial surveys of coastline in Bering Land Bridge National Preserve and Cape Krusenstern National Monument.

Pilots filled out the survey conditions data on a tablet using the NPS Park Observer app (<https://github.com/AKROGIS/Park-Observer>) for digital data entry at the beginning of the survey. This app also recorded a GPS trackline for the survey. Pilots or observers recorded the following data when carcasses were found, 1) waypoint; 2) species; 3) number of individuals; 4) number of photos; 5) whether or not the carcass was previously marked; 6) distance of carcass from water line; 7) substrate in the area; 8) signs of scavenger activity (e.g., intact, extremities missing, organs missing); and 9) carcass freshness (e.g., fresh, beginning to rot, slimy, only feathers and bones, only bones).

RESULTS

Due to poor weather and pilot scheduling limitations, we were only able to conduct a total of 8 surveys; 2 surveys in 2020, 2 surveys in 2021, and 3 surveys in 2022, and 1 survey in 2024. The original study design envisioned at least 4 surveys per year (at least two survey periods with 2 repeat surveys each). Although the pilots were able to conduct surveys without an observer, when necessary, it was challenging to complete all the tasks without an additional observer. No surveys of CAKR were conducted in 2020, 2021, and 2024 because of delays in permitting and weather constraints. In 2022, we were able to complete 3 surveys, including 2 of the BELA coastline and one survey of both the BELA coastline and the CAKR coastline. Due to logistical and weather limitations, a biologist was only able to accompany the pilot on the July surveys (one survey of CAKR and one survey of BELA). In 2023, no surveys were conducted due to large amounts of driftwood that was present all along the BELA coast making landing and seeing carcasses very difficult. In 2024, the abundance of driftwood was low enough to allow surveys, but a single survey of the BELA coast was conducted on 17 July. Additional surveys were not completed due to poor weather and limited pilot availability.

During the first survey conducted on 5 August 2020, no seabird carcasses were observed during the aerial surveys (Table 1), but 2 seabird carcasses (a Northern Fulmar [*Fulmarus glacialis*] and a Short-tailed Shearwater [*Ardenna tenuirostris*]) were observed in the Ikpek Lagoon area during ground surveys (Table 2). One walrus carcass (*Odobenus rosmarus*) and one unidentified whale carcass were observed during the aerial survey (Tables 3–4). This survey was

Table 1. Seabird carcasses recorded during aerial surveys of Bering Land Bridge National Preserve and Cape Krusenstern National Monument, Alaska, 2020–2024.

Year	Survey Date	Ikpek Lagoon	Cowpak Lagoon	Cape Espenberg	Cape Krusenstern	Total
2020	5 August	0	0	0	–	0
	13 August	5	19	5	–	29
2021	27 June	20	16	3	–	39
	22 August	198	4	9	–	211 ^a
2022	29 June	3	2	0	–	5
	15–16 July	16	28	13	8	65
	12 September	45	12	9	–	66
2024	17 July	57	112	61	–	230

^a An additional 609 seabird carcasses were observed out of the study area.

conducted with a different pilot and before the protocols were finalized, so it is likely that the aerial survey results were incomplete.

During the second survey conducted on 13 August 2020, 29 seabird carcasses were found during the aerial survey, with most carcasses located in the Cowpak Lagoon area (Figure 3; Table 1). Thirteen seabird carcasses were found during ground surveys including 3 puffins, 4 shearwaters, 1 Least Auklet (*Aethia pusilla*), 4 murre (Uria spp.), and 1 unidentified seabird (Table 2; Figure 4). All the seabird carcasses found on the ground were also observed during the aerial survey. Five walruses and 2 whales were observed during aerial surveys (Figure 3; Tables 3–4), one of the walrus carcasses was located on an aerial-survey transect and observed on the ground as well.

Two surveys were conducted in 2021, with the first occurring on 27 June and the second occurring on 22 August. During the first survey of 2021, a total of 39 seabird carcasses were observed during the aerial survey with most found in the Ikpek and Cowpak Lagoons areas (Figure 5; Table 1). Twelve seabird carcasses were observed during ground surveys, with most (75%) being Horned Puffins (*Fratercula corniculata*; Table 2; Figure 4). Fourteen different marine mammal carcasses were observed during the aerial survey (Figure 5; Table 3) including 3 walruses, 1 spotted seal (*Phoca largha*), 5 unidentified seals, 4 unidentified whales, and 1 unidentified marine mammal (Table 4). A local observer accompanied the pilot during this survey and assisted with data collection.

Table 2. Species of seabird carcasses recorded during ground surveys conducted in Bering Land Bridge National Preserve, Alaska, 2020–2024.

Species	Scientific Name	2020		2021		2022			2024	Total
		5 August	13 August	27 June	22 August	29 June	15–16 July	12 Sept.	17 July	
Black-legged Kittiwake	<i>Rissa tridactyla</i>	0	0	1	1	0	1	4	5	12
Common Murre	<i>Uria aalge</i>	0	0	0	1	0	0	0	0	1
Horned Puffin	<i>Fratercula corniculata</i>	0	2	9	1	0	0	0	1	13
Tufted Puffin	<i>Fratercula cirrhata</i>	0	1	0	2	0	0	0	0	3
Crested Auklet	<i>Aethia cristatella</i>	0	0	1	8	0	0	1	10	20
Parakeet Auklet	<i>Aethia psittacula</i>	0	0	1	0	0	0	0	0	1
Least Auklet	<i>Aethia pusilla</i>	0	1	0	8	0	0	0	0	9
Northern Fulmar	<i>Fulmaris glacialis</i>	1	0	0	0	0	0	0	0	1
Short-tailed Shearwater	<i>Ardenna tenuirostris</i>	1	4	0	5	0	1	11	0	22
Thick-billed Murre	<i>Uria lomvia</i>	0	1	0	0	0	0	0	0	1
Unidentified auklet	<i>Aethia</i> spp.	0	0	0	3	0	0	0	0	3
Unidentified cormorant	<i>Urile</i> spp.	0	0	0	1	0	0	0	0	1
Unidentified gull		0	0	0	0	0	0	0	2	2
Unidentified murre	<i>Uria</i> spp.	0	3	0	0	0	0	0	0	3
Unknown seabird		0	1	0	0	0	0	1	11	13
Total		2	13	12	30	0	2	17	29	105

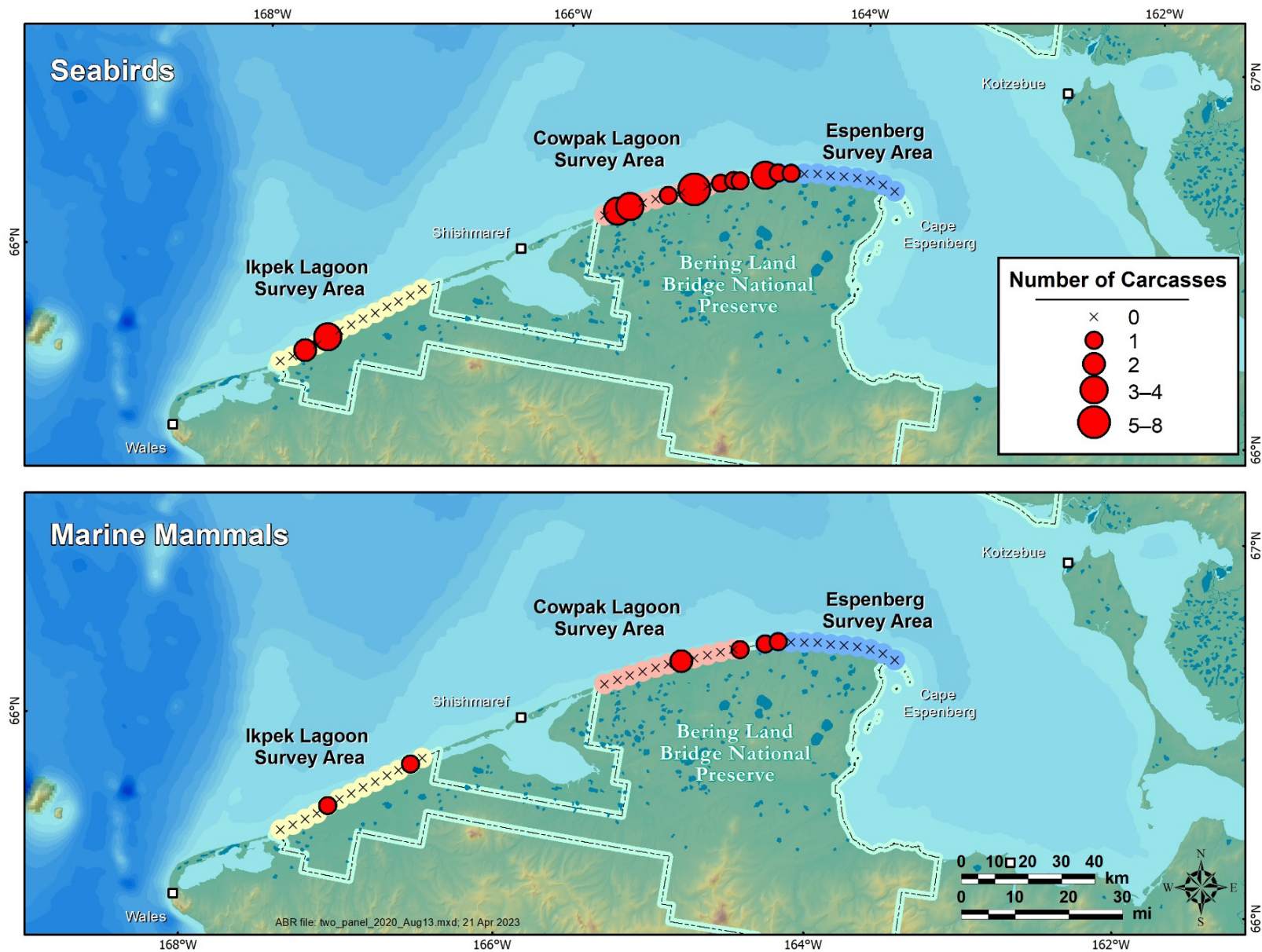


Figure 3. The number of seabird and marine mammal carcasses observed during an aerial survey conducted 13 August 2020.

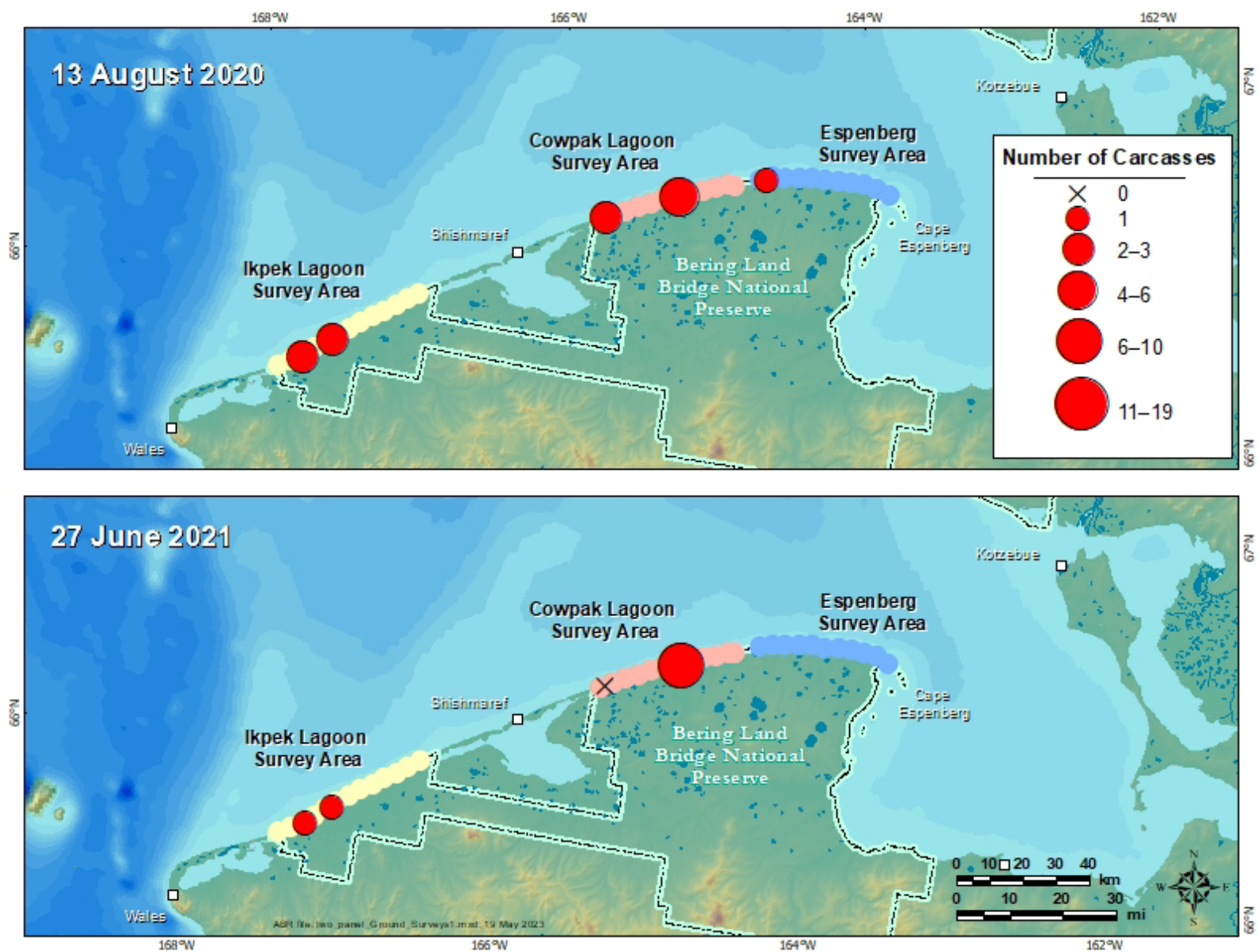


Figure 4. The number of seabird carcasses observed during ground surveys conducted on 13 August 2020 and 27 June 2021.

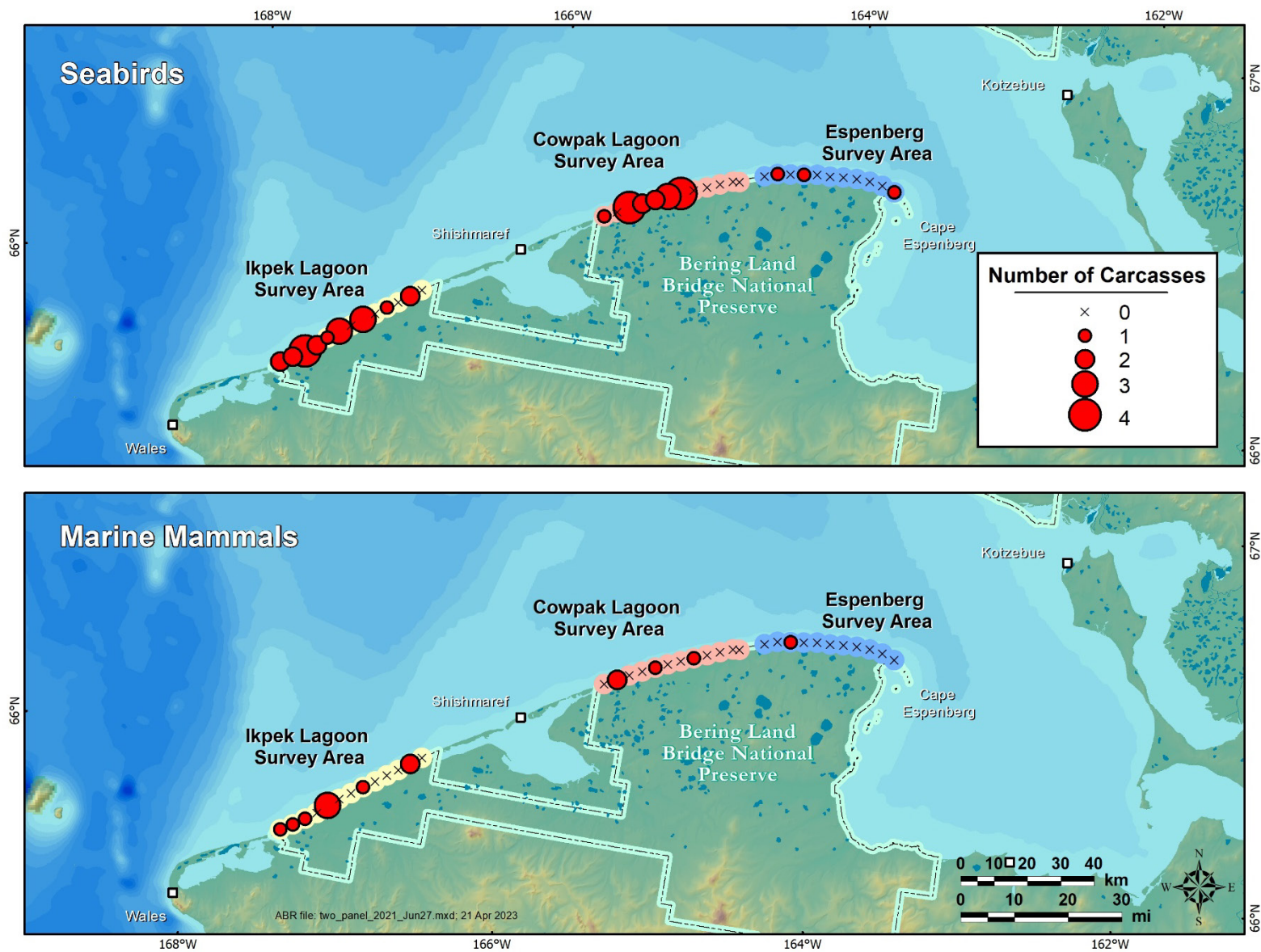


Figure 5. The number of seabird and marine mammal carcasses observed during an aerial survey conducted 27 June 2021.

Table 3. Numbers of marine mammal carcasses recorded during aerial surveys conducted in Bering Land Bridge National Preserve, Alaska, 2020–2024.

Year	Survey Date	Ikpekk Lagoon	Cowpak Lagoon	Cape Espenberg	Cape Krusenstern	Total
2020	5 August	0	1	1	—	2
	13 August	2	3	2	—	7
2021	27 June	9	4	1	—	14
	22 August	0	0	2	—	2 ^a
2022	29 June	0	2	0	—	2
	15–16 July	20	11	9	1	41
	12 Sept.	10	1	1	—	12
2024	17 July	4	2	6	—	12

^a An additional 5 marine mammal carcasses were observed out of the study area.

Table 4. Species of marine mammal carcasses recorded during aerial and ground surveys conducted in Bering Land Bridge National Preserve, Alaska, 2020–2024.

Species	Scientific Name	2020		2021		2022			2024	Total
		5 August	13 August	27 June	22 August	29 June	15–16 July	12 Sept.	17 July	
Walrus	<i>Odobenus rosmarus</i>	1	5	3	1	2	23	6	7	48
Spotted Seal	<i>Phoca largha</i>	0	0	1	1	0	0	0	0	2
Bearded Seal	<i>Erignathus barbatus</i>	0	0	0	0	0	1	0	0	1
Harbor Porpoise	<i>Phocoena phocoena</i>	0	0	0	0	0	1	0	0	1
Unidentified Seal		0	0	5	0	0	14	0	2	21
Unidentified Whale		1	2	4	0	0	2	1	3	13
Unidentified		0	0	1	0	0	0	5	0	6
Total		2	7	14	2	4	41	12	12	92

During the second survey of 2021, a total of 211 seabird carcasses were found with most (93.8%) located in the Ikpek Lagoon area (Figure 6; Table 1). A total of 30 seabird carcasses were found on the ground surveys, all were in the Ikpek Lagoon area. Crested Auklets (*A. cristatella*), Least Auklets, and Short-tailed Shearwaters were the most common species found on this survey (Table 2; Figure 7). In addition to the 211 seabird carcasses observed on survey transects, another 609 carcasses were found out of the survey area, primarily between Wales and the Ikpek Lagoon area (Figure 6). Much of the beach in the Cowpak Lagoon and Cape Espenberg survey areas was reported to be heavily eroded, which may have resulted in fewer carcasses than expected being present. A total of 12 seabird carcasses were observed from the air in the ground survey transects and 19 carcasses were found from the ground.

One walrus and one spotted seal carcass were observed in the Cape Espenberg survey area (Figure 6; Tables 3–4) and another 3 walruses and 2 unidentified seals were observed outside of the survey area. During this survey (22 August 2021), data was not successfully recorded on the iPad and therefore available survey results were limited to the aerial survey numbers recorded on a paper data sheet and photographs of seabird carcasses observed on the ground surveys.

Three surveys were conducted in 2022, with the first occurring on 29 June, the second occurring on 15–16 July, and the third occurring on 12 September. During the first survey of 2022, there were 5 seabird carcasses observed during the aerial survey with all being found in the Ikpek Lagoon and Cowpak Lagoon areas (Figure 8; Table 1). No seabird carcasses were observed during ground surveys (Table 2; Figure 7). Only 2 marine mammal carcasses, both walrus carcasses, were observed during the aerial survey (Figure 8; Tables 3–4).

During the second survey of 2022, the CAKR area was surveyed on 15 July and the BELA areas were surveyed on 16 July. A biologist participated in both surveys. A total of 8 seabird carcasses were observed during the aerial survey of CAKR and 57 seabird carcasses were observed during the aerial survey of BELA with the highest numbers occurring in the Cowpak Lagoon area (Figure 9; Table 1). Only 2 seabird carcasses, a Black-legged Kittiwake (*Rissa*

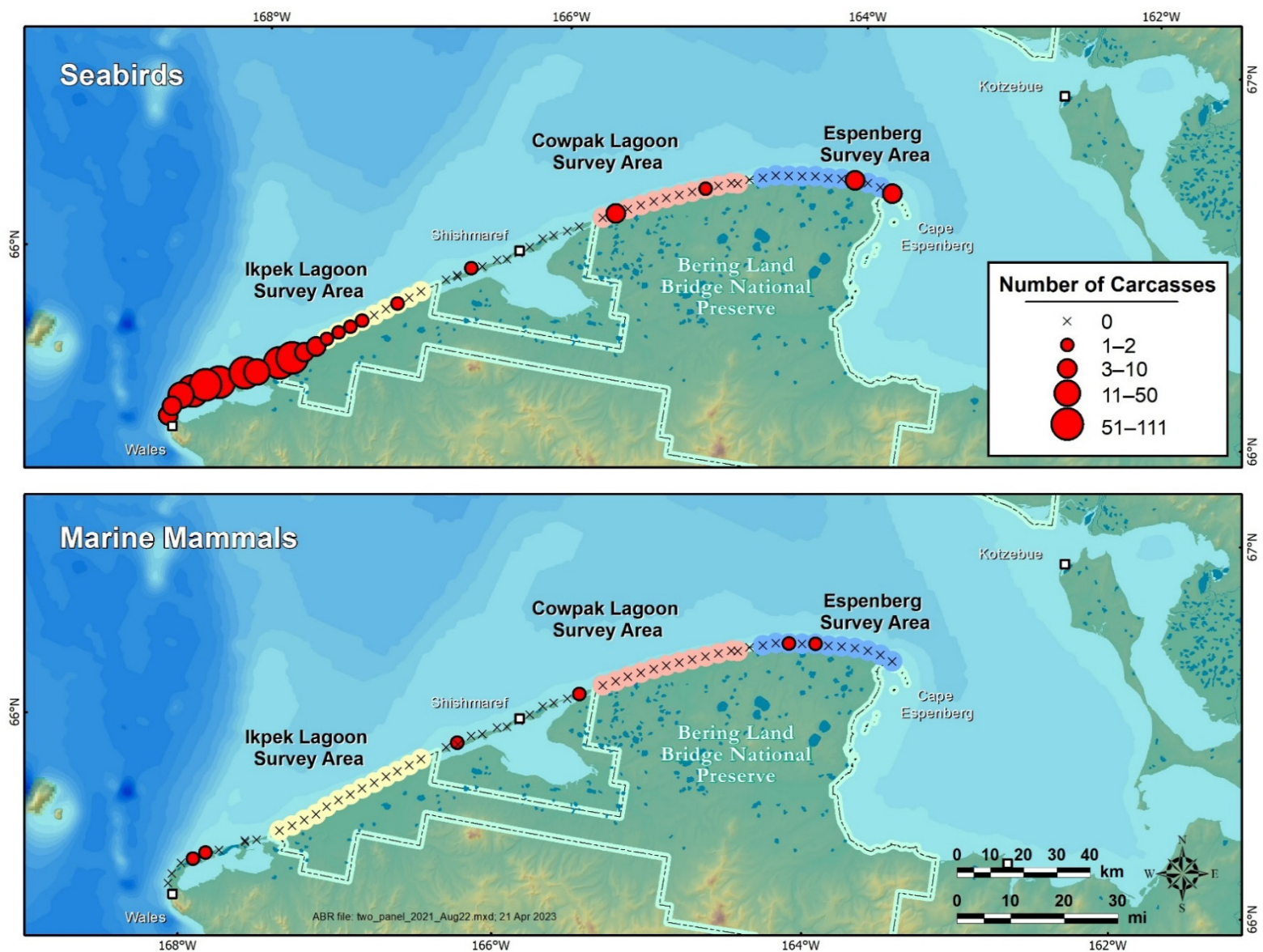


Figure 6. The number of seabird and marine mammal carcasses observed during an aerial survey conducted 22 August 2021.

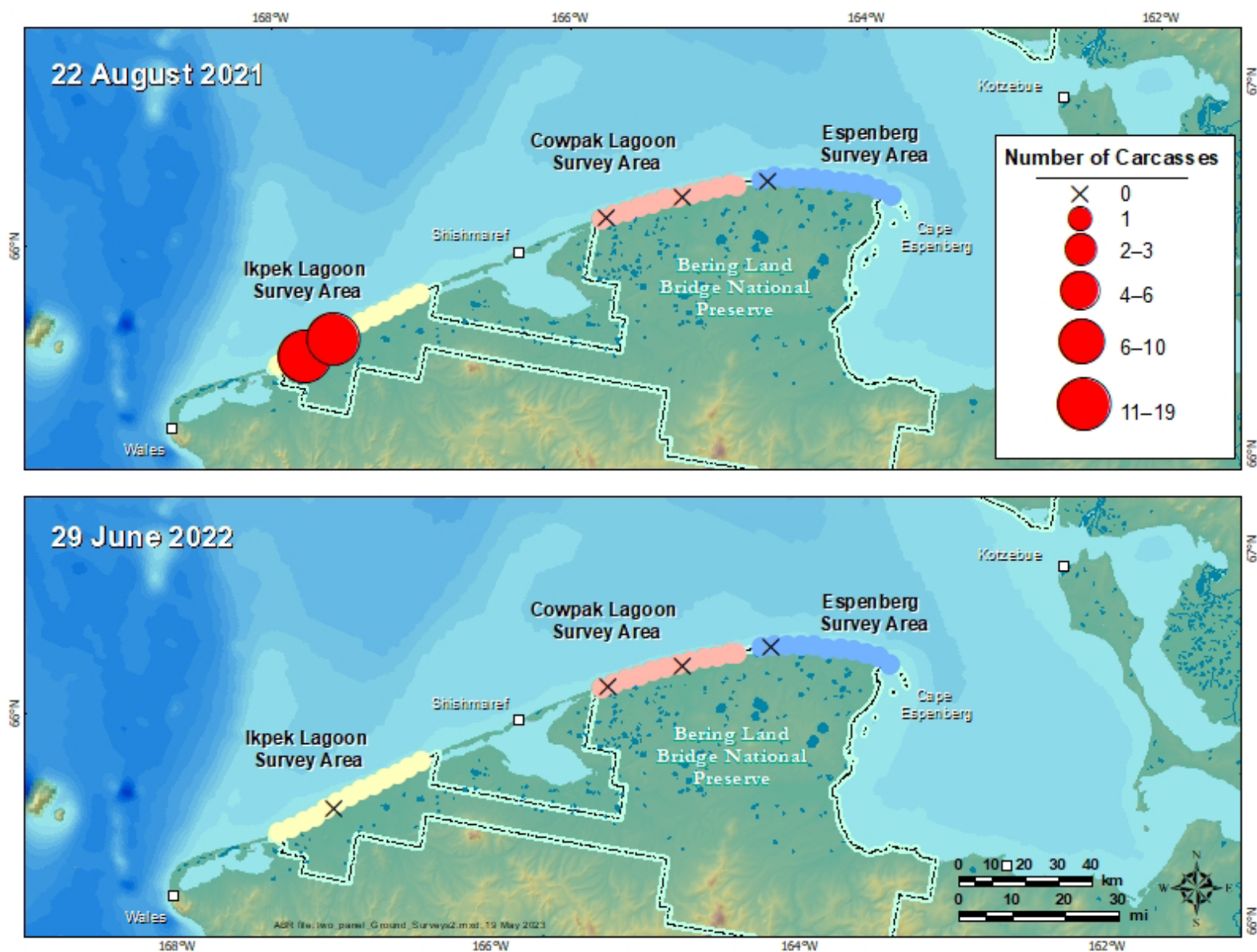


Figure 7. The number of seabird carcasses observed during ground surveys conducted on 22 August 2021 and 29 June 2022.

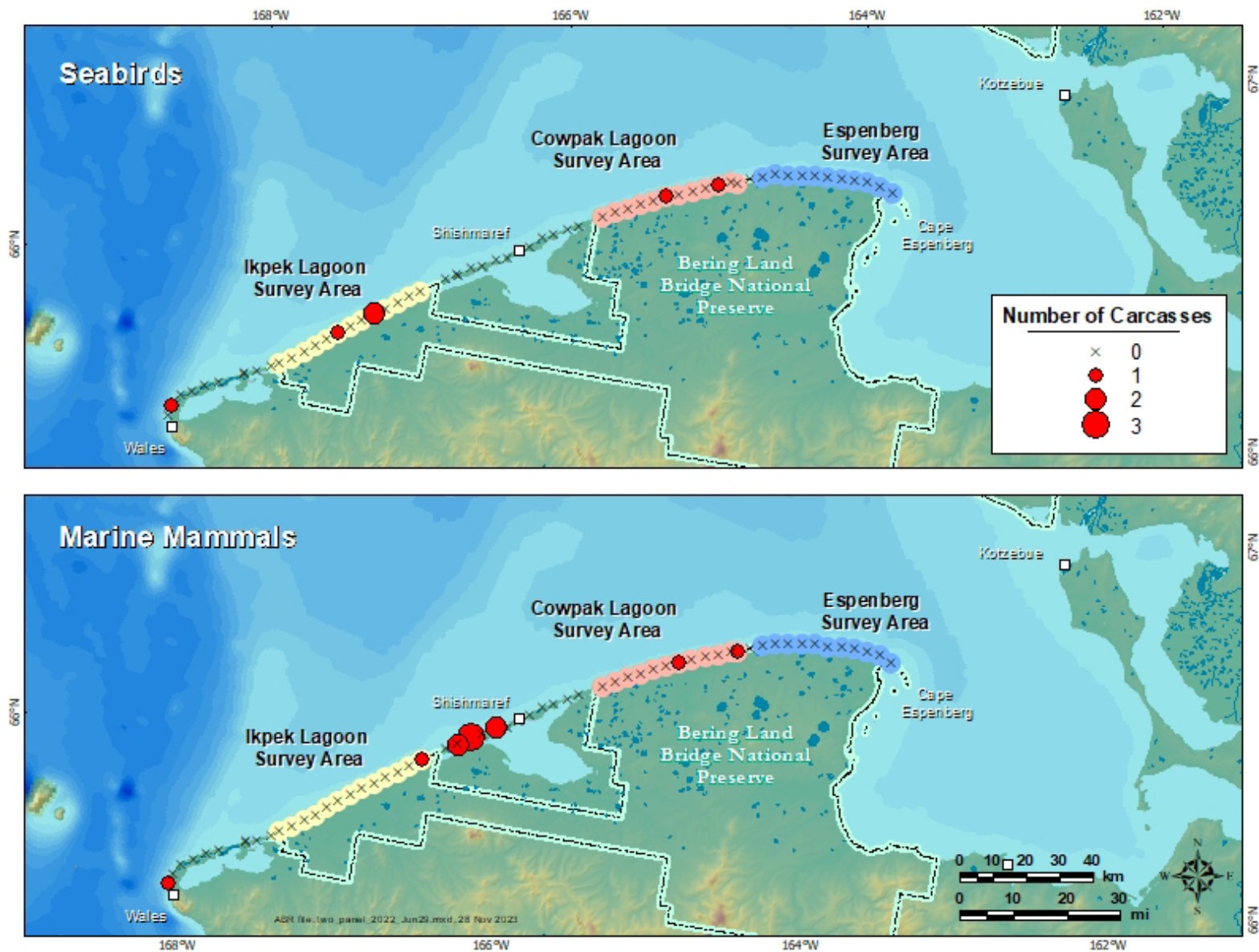


Figure 8. The number of seabird and marine mammal carcasses observed during an aerial survey conducted 29 June 2022.

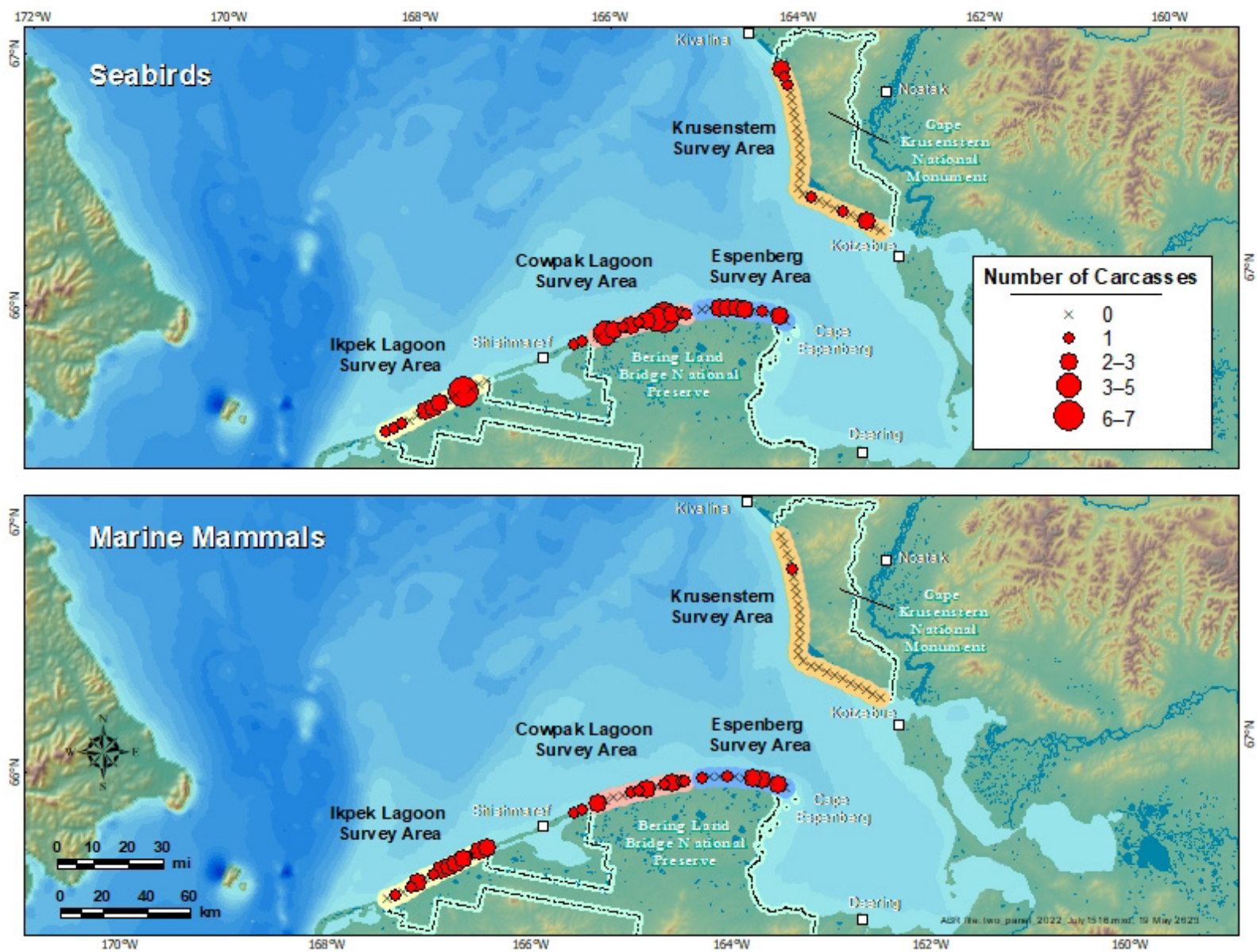


Figure 9. The number of seabird and marine mammal carcasses observed during an aerial survey conducted 15–16 July 2022.

rydactyla) and a Short-tailed Shearwater, were observed during ground surveys (Table 2; Figure 10). A total of 41 marine mammal carcasses were observed during the aerial survey (Figure 9; Table 3). The marine mammal carcasses included 23 walrus, 14 unidentified seals, 2 unidentified whales, 1 bearded seal, and one harbor porpoise (Table 4).

The third survey of 2022 was conducted on 12 September by the pilot without an observer. A total of 65 seabird carcasses were observed during the aerial survey of BELA with the highest numbers occurring in the Ikpek Lagoon area (Figure 11; Table 1). A total of 17 seabird carcasses, mostly Short-tailed Shearwaters and Black-legged Kittiwakes, were observed during ground surveys (Table 2; Figure 10). A total of 12 marine mammal carcasses were observed during the aerial survey with most in the Ikpek Lagoon survey area (Figure 11; Table 3). The marine mammal carcasses included 6 walrus, 1 unidentified whale, and 5 unidentified marine mammals (Table 4).

During 2024, a single survey was flown on 17 July. This survey was flown with an ABR observer. We were unable to complete additional surveys due to poor weather and limited pilot availability. A total of 230 seabird carcasses were observed during the aerial survey with 57 in the Ikpek lagoon, 112 in the Cowpak Lagoon, and 61 in the Cape Espenberg survey areas (Table 1; Figure 12). These carcasses were largely Black-legged Kittiwakes and Crested Auklets (Table 2). A total of 12 marine mammal carcasses were observed during the aerial survey (Table 3), including 7 walruses, 3 whales, and 2 seals (Table 4). A total of 29 seabird carcasses, mostly Crested Auklets and Black-legged Kittiwakes, were observed during ground surveys (Table 2; Figure 13). A total of 12 marine mammal carcasses were observed during the aerial survey with most in the Cape Espenberg and Ikpek Lagoon survey area (Figure 9; Table 3). The marine mammal carcasses included 7 walrus, 3 unidentified whales, and 2 unidentified seals (Table 4).

SEARCHER EFFICIENCY ESTIMATION

Data available to estimate searcher efficiency (the number of carcasses observed from both aerial and ground surveys of the same area) were not collected for all surveys, but data were available from 5 surveys (Table 5). For all the data available for searcher efficiency estimation, 65 seabird carcasses were found on the ground during ground surveys and 31 of these carcasses were also previously observed from the air during the corresponding aerial survey. This equates

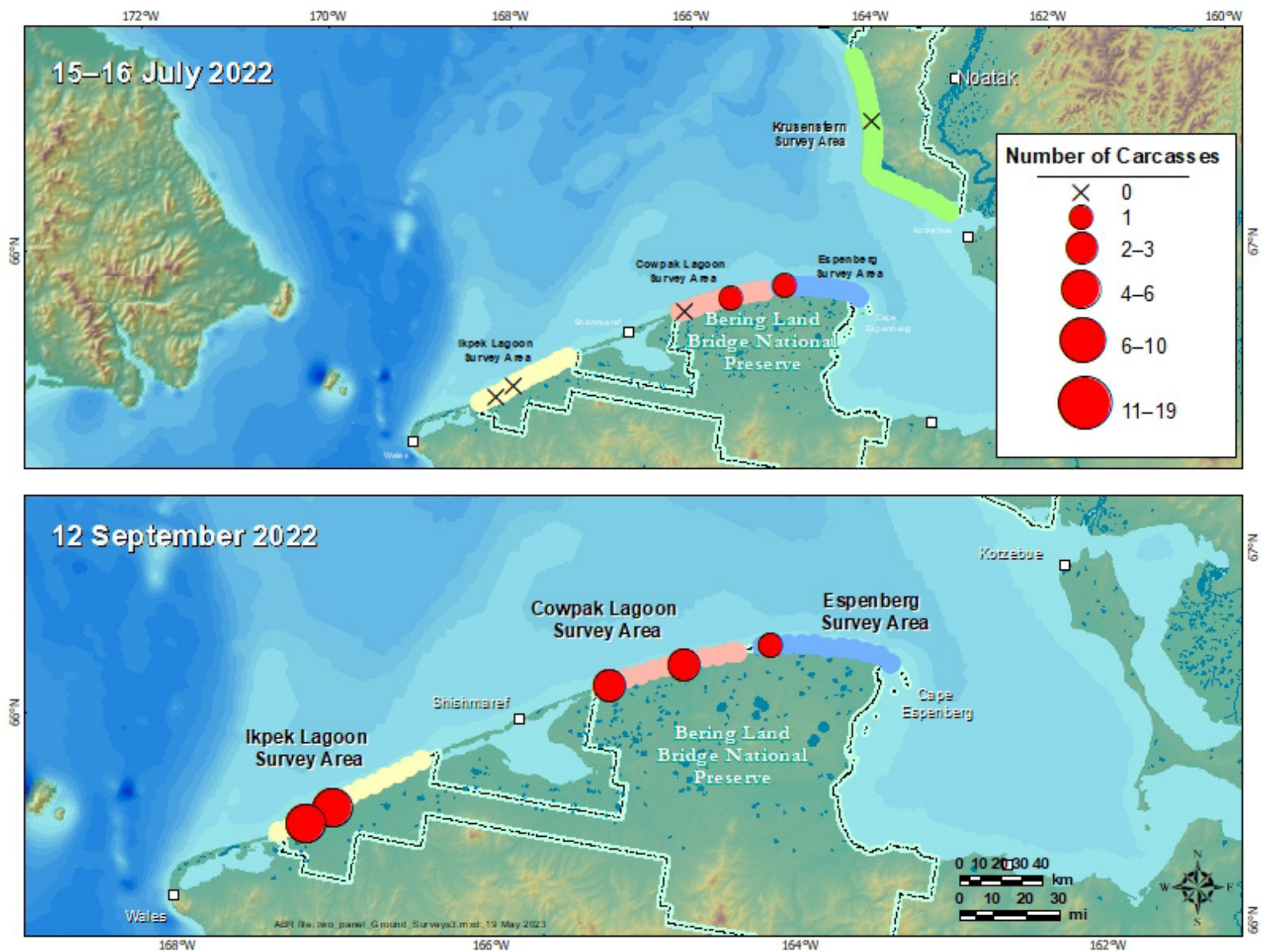


Figure 10. The number of seabird carcasses observed during ground surveys conducted on 15–16 July 2022 and 12 September 2022.

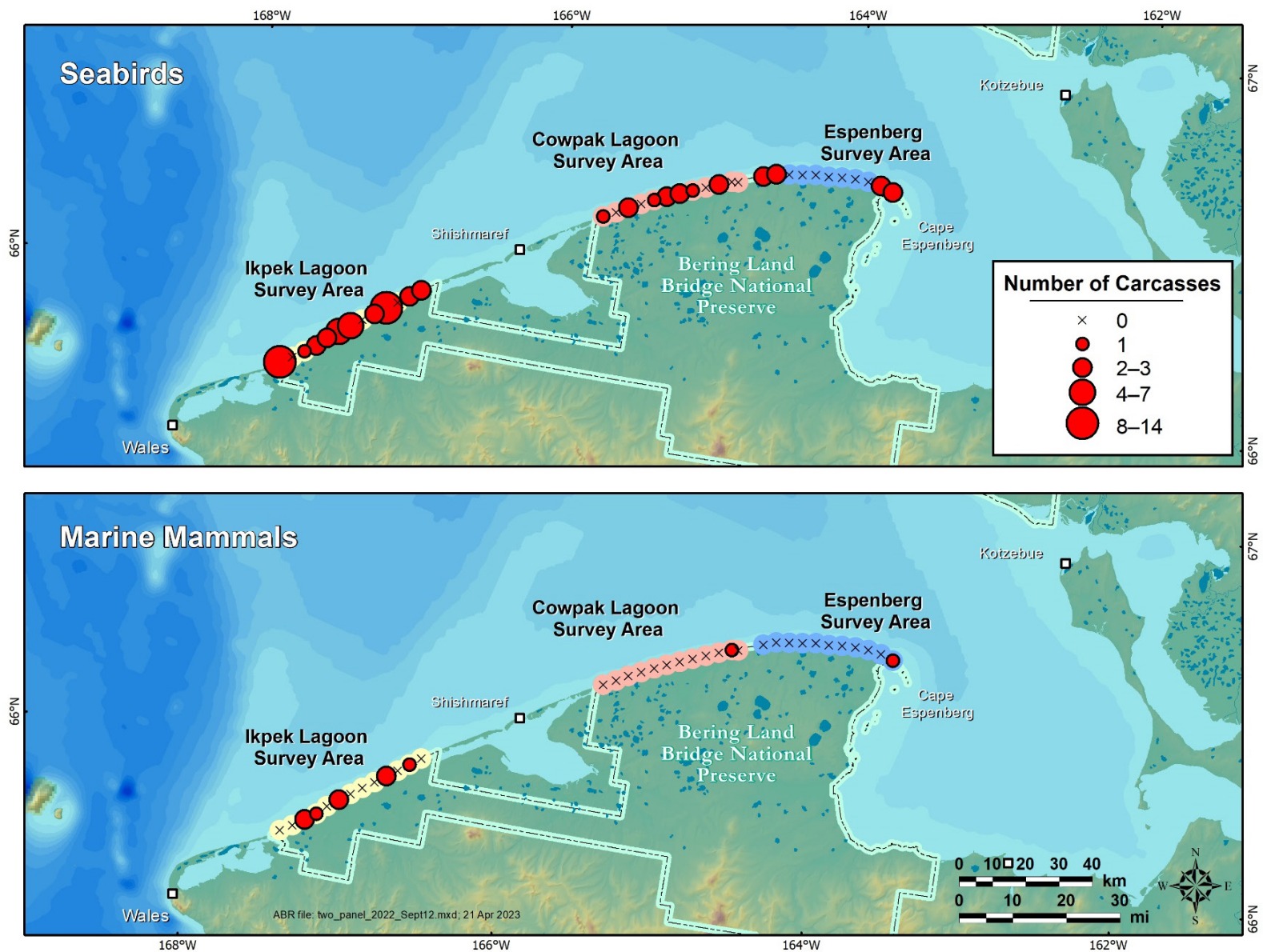


Figure 11. The number of seabird and marine mammal carcasses observed during an aerial survey conducted 12 September 2022.

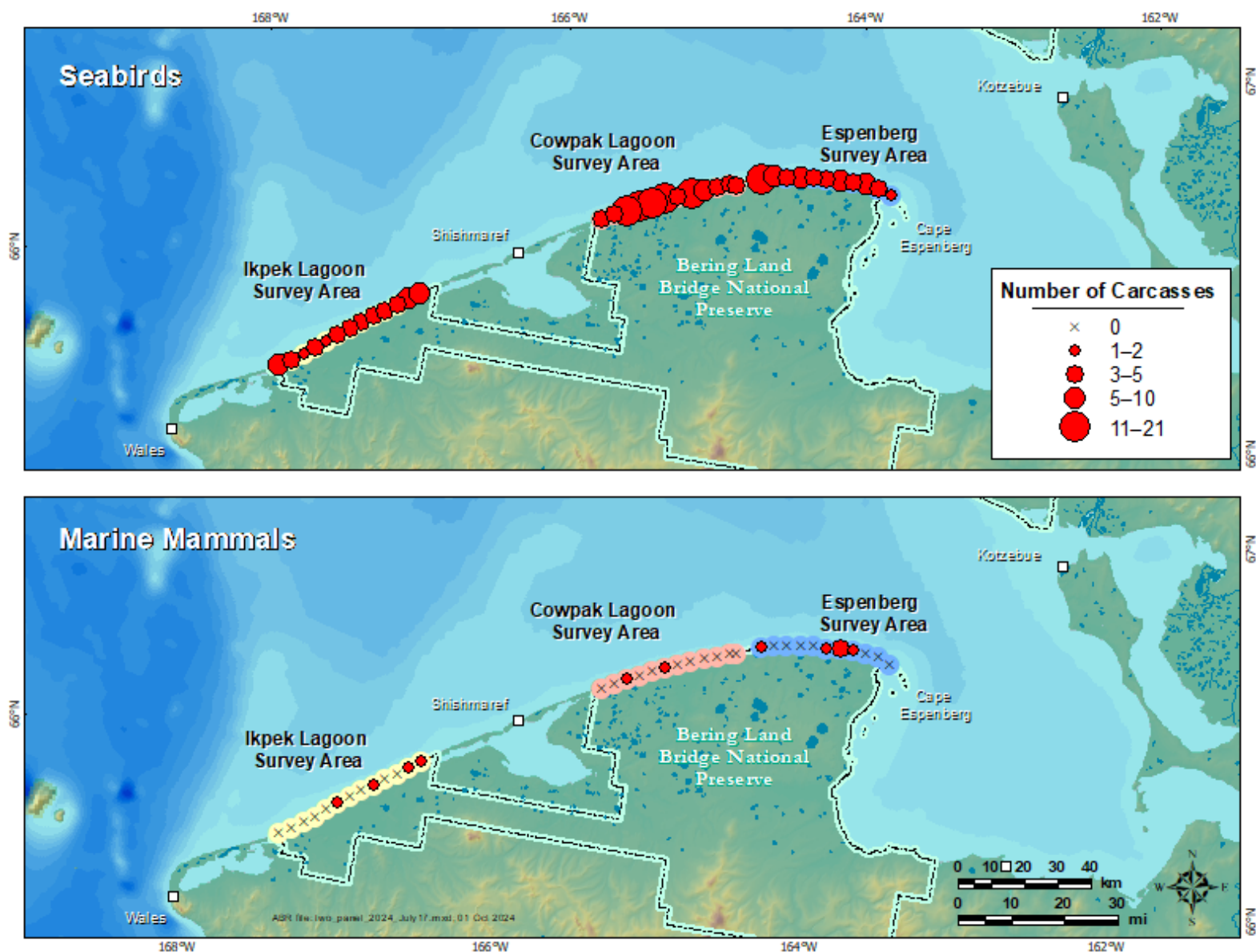


Figure 12. The number of seabird and marine mammal carcasses observed during an aerial survey conducted 17 July 2024.

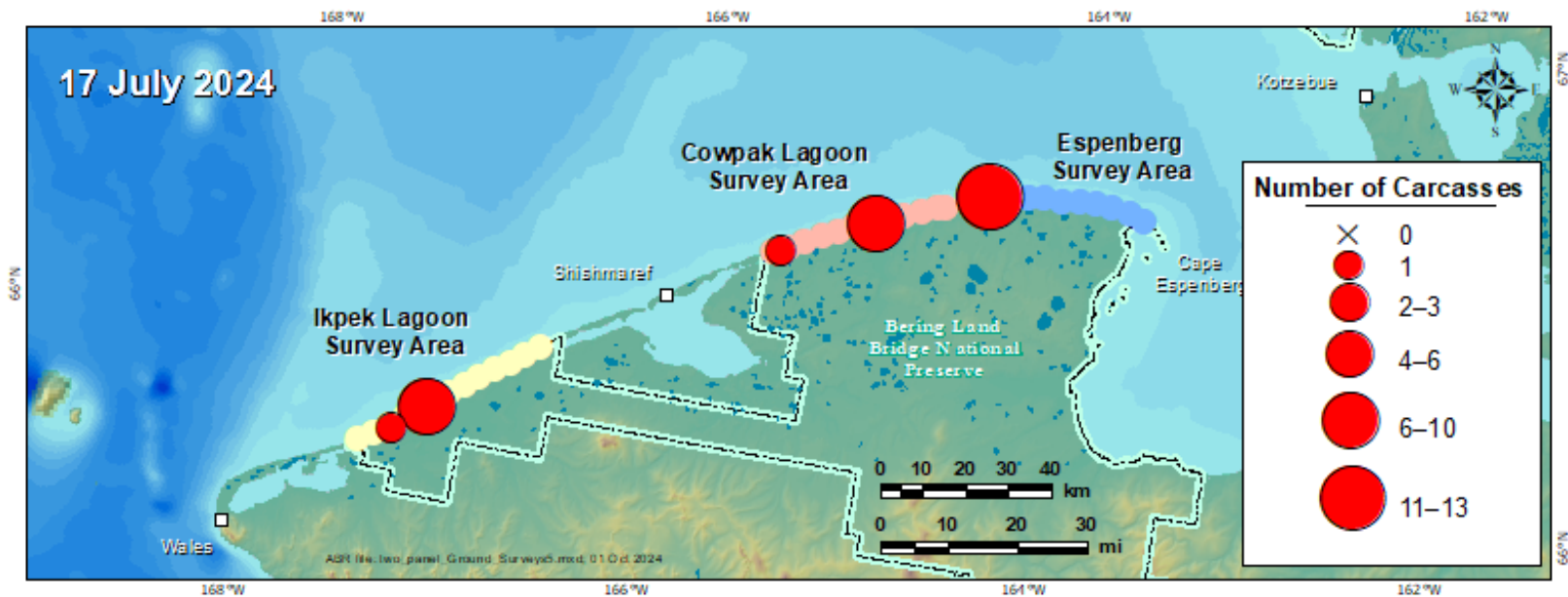


Figure 13. The number of seabird carcasses observed during ground surveys conducted on 17 July 2024.

Table 5. Numbers of seabird carcasses recorded during aerial surveys and ground surveys conducted in Bering Land Bridge National Preserve, Alaska, 2020–2024.

Year	Survey Date	Aerial Survey	Ground	Percent Observed by Air
2020	5 August	0	2	0
	13 August	13	13	100
2021	27 June	–	–	–
	22 August	12	19	63.2
2022	29 June	–	–	–
	15–16 July	0	2	0
	12 Sept.	–	–	–
2024	17 July	6	29	20.7
Total		31	65	47.7

to an estimated searcher efficiency of 47.7% (95% CI = 35.5–59.8%), suggesting that the aerial survey crew was able to detect approximately 48% of all carcasses recorded during ground searches.

We calculated and compared the estimated density from aerial surveys and ground surveys as a second method to estimate searcher efficiency. The estimated density from aerial surveys was generally much lower than that estimated density from ground surveys (Table 6). The estimated density calculated from aerial surveys was between 3.87 and 49.48% of the estimated density calculated from ground surveys (Table 5). Overall surveys combined, the density calculated from ground surveys was about 10 times higher than the density calculated from aerial surveys and the estimated percentage of carcasses observed from the air based on this comparison was 9.59% (Table 6).

CARCASS PERSISTENCE ESTIMATION

Seabird carcasses on the beach can be removed by scavengers, washed out to sea, or covered by sand or other debris. The original study design required repeated surveys conducted several days apart to collect data on how long carcasses remained on the beach (Gall and Prichard 2018). Due to the lack of biologist observers and the limited number of surveys conducted, however, no reliable information on carcass persistence was collected. Pilots or observers tagged carcasses during the second survey in 2020, both surveys in 2021, the second survey in 2022, and the 2024 survey. No tagged seabird carcasses were subsequently relocated, suggesting that carcasses may

Table 6. Comparison of aerial and ground-based estimates of seabird carcass density in Bering Land Bridge National Preserve, Alaska, 2020–2024. Densities were used to calculate the percent of ground density observed during aerial surveys and the correction factor to adjust aerial densities to densities observed during the ground surveys.

Survey Type	Area	km	2020	2021		2022			2024	Total
			13 August	27 June	22 August	29 June	15–16 July	12 Sept.	17 July	
Aerial Density	Ikpek	52	0.10	0.38	3.81	0.06	0.31	0.87	1.10	0.95
	Cowpak	48	0.40	0.33	0.08	0.04	0.58	0.25	2.33	0.57
	Espenberg	44	0.11	0.07	0.20	0.00	0.30	0.20	1.39	0.32
	BELA Total	144	0.20	0.27	1.47	0.03	0.40	0.46	1.60	0.63
Ground Density	Ikpek	1	5.00	2.00	30.00	0.00	0.00	11.00	8.00	8.00
	Cowpak	1	7.00	10.00	0.00	0.00	1.00	5.00	8.00	4.43
	Espenberg	0.5	2.00	–	0.00	0.00	2.00	2.00	26.00	5.33
	BELA Total ^a	2.50	5.20	6.00	12.00	0	0.80	6.80	11.60	6.06
% Observed by Air ^b			3.87	4.51	12.21	–	49.48	6.74	13.77	10.43
Correction Factor ^c			25.82	22.15	8.19	–	2.02	14.84	7.26	9.59

^a The estimated density for Bering Land Bridge National Preserve calculated by weighting the average by the proportion of km of coastline surveyed by air in each area.

^b The estimated density calculated from aerial transects divided by the estimated density from ground transects *100.

^c The number to multiply aerial survey densities by in order to make them equal the estimated ground density.

not typically remain in place for long periods of time. The fact that carcasses may move within the study area adds a large complication for using carcass persistence information to estimate total carcass deposition but further work is needed to determine how carcasses move, are scavenged, or buried by sand.

Estimates from Coastal Observation and Seabird Survey Team (COASST) program of seabird carcass (www.coasst.org) surveys conducted near Shishmaref, Alaska 2009–2019 suggest that carcass persistence is low (4.38 days; 90% CI = 3.11–6.05 days; Appendix A). Carcass persistence also varied by month with persistence being higher in July (11.13 days; 90% CI = 8.51–14.27 days; Appendix A) than in June (2.93 days; 90% CI = 1.64–5.00 days; Appendix A) or in August (3.58 days; 90% CI = 1.78–6.24 days; Appendix A). Although the data was somewhat limited and often had long stretches between surveys, there was not strong evidence of differences by year, beach, or species type (Appendix A).

DISCUSSION

The original study design for coastline carcass surveys required multiple sets of surveys (e.g., 2 to 3 survey periods with 2 repeated surveys each period) per summer to estimate carcass numbers, detection probability, and persistence. That design had to be scaled back in design and frequency due to a combination of complications caused by the Covid-19 pandemic that prevented travel to Kotzebue, persistent poor weather, and limited pilot availability. Only 1–3 single surveys were conducted per year, most often with only the pilot, no surveys were completed in 2023 due to extensive driftwood on the beaches. During 2023, driftwood covered large areas of the BELA beaches making landing and observing carcasses difficult. The driftwood was likely deposited as a result of Extratropical Typhoon Merbok that hit the west coast of Alaska in September 2022. By summer 2024, this driftwood had been shifted enough to allow surveys to be conducted.

A biologist observer accompanied the pilot on 2 surveys (15–16 July 2022 and 17 July 2024) and a local observer accompanied the pilot on one survey (27 June 2021). While the pilots were able to conduct the survey and collect the most important data without an observer, collecting all the data and safely flying the plane was a difficult task for one person. Additionally, digital data collection failed on one survey conducted without an observer.

While data on the number of carcasses observed from the air and ground surveys was reliably collected, data on searcher efficiency was more limited. Because there were no repeated surveys (i.e., surveys repeated within 1–3 days), we also did not collect adequate information on carcass persistence to estimate a rate of carcass removal. Despite all the challenges involved in the implementation of the study during 2020–2024, the survey results indicate that aerial surveys provide an effective method to identify large seabird and marine mammal mortality events over a large and remote area. Combining aerial surveys with ground surveys provides additional information on searcher efficiency and on the species of carcasses present in the area.

Our 2 estimates of searcher efficiency gave divergent results. The estimate derived from surveying a ground transect from both the air and the ground should give the most accurate estimate and suggested that we had fairly good searcher efficiency of 47.7%, however this was based on a small sample of transects where both data types were collected. The comparison of densities from ground surveys and aerial surveys suggested that there was a much lower searcher efficiency and it varied widely among surveys (3.9% – 49.5%), however the carcass densities could be different in the aerial and ground survey areas. The distribution of carcasses was patchy and it is possible that the ground survey transects tended to be in areas with higher rates of deposition. The ground survey locations were selected to be spread across the survey areas but limited to locations where an airplane could land easily and safely. This limitation on the location of ground transects could have led to the selection of areas with high carcass numbers. It is also possible that actual searcher efficiency varies widely based on the recent history of storms in the area. During some of the surveys many carcasses were partially buried in the sand, and therefore difficult to see from the air. If recent storm activity partially covered carcasses in the sand or in the wrack line, then searcher efficiency would be expected to be low. In addition, some species of seabirds are more likely to be detected from the air. During the 2024 survey, Black-legged Kittiwakes were a large portion of the observed seabird carcasses and should be more easily detected than smaller darker species.

COASST ground surveys for avian carcasses were conducted on beaches near Shishmaref from 2009–2019 (Appendix A) and recorded a mean density of 3.96 birds/km (Table A1), with annual total densities ranging from 1.35–18.65 birds/km (Table A2), although there were large

annual differences in the number of surveys conducted. This range of densities is generally similar to the densities we recorded on ground surveys (Table 6).

During the survey conducted on 22 August 2021, a total of 820 seabirds were observed from the air (including areas outside of the survey area). By applying the estimate of searcher efficiency from aerial and ground surveys of the 0.5 km transects, we estimate that there were 1,181 (95% CI = 971–1,507) seabird carcasses on the coastline at the time of the survey. It would be much higher using the searcher efficiency of 13.53, based on the density of seabird carcasses observed during ground surveys (Table 5). In either case, this represents a sizable mortality event involving multiple seabird species. Being able to compare these numbers with previous surveys conducted using repeatable methods provides a good indication of how the size of this mortality event compares with baseline levels of seabird carcass deposition during this period.

We were unable to get any information on carcass persistence from these surveys, but we were able to estimate it from COASST data collected in the area during 2009–2019. It is likely that seabird carcass persistence is influenced by both scavengers and storms that wash away or cover up seabird carcasses. Strong storms are a frequent occurrence in this area and seabird carcasses were often partially buried in the sand. Because of the episodic nature of storm events, correcting carcass counts for carcass persistence is much more difficult than it is for surveys in locations where scavenging is the only source of carcass loss. The carcass persistence estimates from the COASST data suggest that most carcasses are only present for several days after being found, this suggests that carcass counts are largely reflecting recent deposition of carcasses and may be substantially underestimating the total number of carcasses deposited. Time-lapse camera traps may provide another option to assess carcass persistence over the course of the summer from both scavengers and storm surges, but it would likely require a large effort to produce useful correction factors for carcass persistence.

We recommend that surveys should focus on getting accurate counts of the number of carcasses present at beaches at the time of the survey. When possible, survey conditions should be kept consistent to minimize factors that may complicate comparisons among surveys. Surveys should be flown long enough after large storm surges to allow additional carcasses to wash up. Standardizing the length of time to wait after a large storm could improve survey consistency. The use of data from camera traps or community beach surveys could provide useful information

on the timing and magnitude of storm events that impact carcass numbers. Having more local COASST information on carcass deposition rates could allow for more targeted surveys to be conducted after large die-offs are suspected to have occurred.

We also recommend that surveys should have an observer in addition to the pilot whenever possible. Having a biologist or local observer on the surveys can improve carcass detection and the accuracy of carcass locations and also provides 2 people for the initial ground surveys and tagging of carcasses. Due to the persistent issues with poor weather conditions and limited pilot availability, finding local observers may be a better option than flying in a biologist for each survey. Aerial surveys that collect high-resolution imagery may potentially provide reviewable survey data, although at much higher cost for the data collection and processing than using real-time observers.

Even without a carcass persistence estimate, the number of carcasses present at any one time can be quantified and tracked across seasons and years. The high number of carcasses observed on the survey conducted 22 August 2021 indicates that these surveys can identify large mortality events. During that survey, the carcasses were almost entirely in the western portion of the survey area as well as farther west and outside the survey area, indicating that surveying the complete northern coastline of the Seward Peninsula may be helpful for detecting some mortality events within BELA. These data can be combined with other coastal carcass surveys to identify and monitor large-scale bird and marine mammal mortality events.

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Plate 1. A photograph of the Bering Land Bridge National Preserve coastline taken 16 July 2022.



Plate 2. A photograph of 2 horned puffin carcasses observed during a ground survey on 27 June 2021.



Plate 3. A photograph of a walrus carcass observed during a ground survey on 16 July 2022.

Appendix A. Summary of COASST data from Shishmaref beaches 2009–2019.

The Coastal Observation and Seabird Survey Team (COASST) is housed at the University of Washington and uses citizen science to collect information on marine resources and local ecosystems along northeastern Pacific beaches (<https://coasst.org/>). This includes avian carcass surveys along beaches. The beaches along Sarichef Island on either side of Shishmaref, Alaska were searched by local volunteers during 2009–2019 (Table A1). During that time, there were 52 surveys of the beaches conducted for a total of 101.8 km searched. A total of 403 avian carcasses were found for a total average density of 3.96 carcasses/km (Table A1). The highest carcass density for an individual month occurred in June 2018 when 18.65 carcasses/km were found (Table A2). The most common species found was Short-tailed Shearwaters with 75 birds found (18.6% of all birds; Table A3), although there were 85 murres of 2 species reported (21.1%).

In addition to summarizing the carcass counts, we used the program GenEst (Dalthorp et al. 2018, Simonis et al. 2018) to estimate carcass persistence for carcasses located along the 2 beaches searched repeatedly by COASST volunteers. GenEst uses the timing of the last location of the bird (in days since tagging) and the timing of the first absence (in days since tagging) to estimate the pattern of carcass persistence (Dalthorp et al. 2018). We first determined which carcasses were tagged at beaches that were searched again during the same year so that those carcasses would have been relocated in at least one subsequent search if they remained in the area (assuming 100% detectability of carcasses). There was a total of 188 carcasses that fit this definition. We dropped one carcass found in 2016 from the analysis because it was the only carcass from 2016 in the data set which complicated analyses, leaving a final data set of 187 carcasses (Table A4).

We also grouped the carcasses into the following broad species categories, gulls, murres, shearwaters/auklets/petrels, ducks/geese, and other/unknown) with adequate numbers of carcasses for analyses. There was a total of 67 gulls, 30 murres, 31 shearwaters/auklets/petrels, 25 ducks/geese, and 35 other/unknown. To estimate carcass persistence, we tested all combinations of these variables to determine the best single variable model for year, month, beach, and species type using program GenEst. We did not have adequate data to test models with more than one factor in a model simultaneously. For each analysis, we tested all 4

persistence distributions included in the software (Weibull, lognormal, loglogistic, and exponential). All models were compared using multimodel inference with Akaike's Information Criterion adjusted for small sample sizes (AICc' Burnham and Anderson 2004) and we calculated the Akaike weight to determine the probability that each model was the best model in the candidate model set.

The results of the carcass persistence analyses indicated that the Weibull distribution was the best distribution to model the persistence of carcasses on these 2 beaches. When we compared models with a Weibull distribution, it showed that a model with month influencing both the scale and location parameters of the Weibull distribution was clearly the best model in candidate model set (Table A5) and it had a 95% chance of being the best model in the candidate model set (Akaike Weight=0.95).

Carcass persistence in the area was estimated to be low (Figure A1). The median carcass persistence estimates ranged from 2.93 days in June (90% CI=1.64 – 5.00; Table A6) to 11.13 days in July (90% CI=8.51 – 14.27; Table A6). The overall estimate was 4.38 days (90% CI=3.11 – 6.05; Table A6). The probability that a carcass that was deposited at a random time during a 7 day window would still be present at the end of the week was 0.589 overall (90% CI =0.515 – 0.671; Table A6) and the probability that a carcass that was deposited at a random time during a 28 day window would still be present at the end of the 28 days was 0.276 overall (90% CI =0.234 – 0.326; Table A6).

Although the available data are somewhat sparse and there were often long stretches of time between surveys, the results of these analyses suggest that carcass persistence in the Shishmaref area is low, especially in June and August. It is unknown how representative these results are of the BELA area as a whole. While Shishmaref is near the center of the BELA coastline, there could be different predator densities near the community. It is also unknown if most carcasses are being removed by predators or being removed or buried by storms. These carcass persistence estimates are based on persistence from the time they are found on the beach, not when they were deposited on the beach, this could potentially cause the estimates to be biased high for at least 2 reasons. First, newly deposited carcasses may be scavenged at a higher rate, so they would be less likely to be found and tagged initially. Secondly, there may be heterogeneity among carcasses in how attractive they are to predators, some old carcasses that are deposited on

the beach may be unattractive to scavengers and therefore remain for long periods of time resulting in both a higher probability of being tagged and a higher probability of being relocated. This potential bias could be partially corrected if the carcass persistence analyses included carcass condition, but those data were not available. Both of these potential biases would be less of an issue if the major factor leading to carcass removal was storms, not predators.

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Table A1. Numbers of avian carcasses recorded during COASST ground surveys of beaches near Shishmaref, Alaska by month, 2009–2019.

Month	Number of Surveys	Km Searched	Total Birds	Density (birds/km)
June	23	41.8	174	4.16
July	12	22.7	59	2.60
August	13	29.9	116	3.88
September	4	7.4	54	7.30
Total	52	101.8	403	3.96

Table A2. Numbers of avian carcasses recorded during COASST ground surveys of beaches near Shishmaref, Alaska by year and month, 2009–2019.

Year	Month	Number of Surveys	Km Searched	Total Birds	Density (birds/km)
2009	June	3	5.3	21	3.96
	July	5	9.5	21	2.21
	August	3	5.3	6	1.13
	September	1	2.1	1	0.48
	Total	12	22.2	49	2.21
2010	June	1	2.1	6	2.86
2011	June	2	3.7	5	1.35
2012	June	1	1.6	4	2.50
2013	June	3	5.3	14	2.64
	July	3	5.3	19	3.58
	August	1	1.6	4	2.50
	September	1	2.1	24	11.43
	Total	8	14.3	61	4.27
2015	June	7	12.7	25	1.97
	July	1	2.1	11	5.24
	August	2	3.7	13	3.51
	September	1	1.6	4	2.50
	Total	11	20.1	53	2.64
2016	June	1	2.1	1	0.48
	August	2	3.7	12	3.24
	Total	3	5.8	13	2.24
2017	July	1	2.1	5	2.38
	August	5	15.6	81	5.20
	September	1	1.6	25	15.63
	Total	7	19.28	111	5.76
2018	June	2	3.7	69	18.65
2019	June	3	5.3	29	5.47
	July	2	3.7	3	0.81
	Total	5	9	32	3.56

Table A3. Numbers avian carcasses recorded during COASST ground surveys of beaches near Shishmaref, Alaska by species, 2009–2019.

Species	2009	2010	2011	2012	2013	2015	2016	2017	2018	2019	Total Birds	Percent
Short-tailed Shearwater	1	0	0	0	21	7	3	43	0	0	75	18.61
Unknown Murre	0	0	0	0	3	5	0	5	39	1	53	13.15
Black-legged Kittiwake	17	0	2	0	8	6	2	1	6	6	48	11.91
Glaucous Gull	15	0	1	3	5	4	2	1	4	0	35	8.68
Unknown Species	1	0	0	0	3	6	0	13	1	1	25	6.20
Northern Fulmar	0	0	0	0	0	1	0	23	0	0	24	5.96
Thick-billed Murre	0	0	0	0	0	3	0	1	8	5	17	4.22
Common Murre	3	0	0	0	1	1	0	1	3	6	15	3.72
Unknown Tubenoses: Petrels	0	0	0	0	0	0	1	12	0	0	13	3.23
Pomarine Jaeger	2	0	1	1	0	2	0	0	3	0	9	2.23
Snow Goose	0	0	0	0	2	0	0	0	4	3	9	2.23
Northern Pintail	2	0	0	0	1	5	0	0	0	0	8	1.99
Greater White-fronted Goose	3	3	0	0	1	0	0	0	0	0	7	1.74
Unknown Gull	1	0	0	0	1	2	0	3	0	0	7	1.74
Horned Puffin	0	0	0	0	1	0	0	4	0	2	7	1.74
Arctic Tern	4	0	0	0	1	0	0	0	0	0	5	1.24
Unknown Auklet	0	0	0	0	0	2	0	1	0	2	5	1.24
Common Eider	0	1	0	0	2	1	0	0	0	0	4	0.99
Crested Auklet	0	0	0	0	2	0	0	0	0	2	4	0.99
Large Immature Gull	0	0	0	0	1	1	2	0	0	0	4	0.99
Black Guillemot	0	0	0	0	0	0	0	0	1	2	3	0.74
Cackling Goose	0	0	0	0	2	1	0	0	0	0	3	0.74
Unknown Jaeger	0	0	0	0	2	1	0	0	0	0	3	0.74
Unknown Alcids	0	0	0	0	0	0	0	2	0	0	2	0.50
Herring Gull	0	0	0	0	2	0	0	0	0	0	2	0.50
Unknown Larid	0	0	0	0	0	0	2	0	0	0	2	0.50
Parakeet Auklet	0	0	0	0	0	0	0	0	0	2	2	0.50
Common Raven	0	0	0	0	1	0	0	0	0	0	1	0.25
Unknown Eider	0	0	0	0	0	0	0	1	0	0	1	0.25
Green-winged Teal	0	0	0	0	0	1	0	0	0	0	1	0.25
Long-tailed Duck	0	0	0	0	1	0	0	0	0	0	1	0.25

Table A3. Continued.

Species	2009	2010	2011	2012	2013	2015	2016	2017	2018	2019	Total Birds	Percent
Unknown Goose	0	0	0	0	0	1	0	0	0	0	1	0.25
Unknown Puffins	0	0	0	0	0	0	1	0	0	0	1	0.25
Red-breasted Merganser	0	1	0	0	0	0	0	0	0	0	1	0.25
Red-throated Loon	0	0	0	0	0	1	0	0	0	0	1	0.25
Sabine's Gull	0	0	1	0	0	0	0	0	0	0	1	0.25
Semipalmated Plover	0	1	0	0	0	0	0	0	0	0	1	0.25
Unknown Shearwater	0	0	0	0	0	1	0	0	0	0	1	0.25
Willow Ptarmigan	0	0	0	0	0	1	0	0	0	0	1	0.25

Table A4. Numbers avian carcasses recorded during COASST ground surveys of beaches near Shishmaref, Alaska and used in analysis of carcass persistence, 2009–2019.

Year	Month	East	West	Total Birds
2009	June	11	10	21
	July	7	14	21
	August	4	1	5
	Total	22	25	47
2013	June	13	2	15
	July	8	11	19
	Total	21	13	34
2015	June	16	9	25
	July		11	11
	August	10		10
	Total	26	20	46
2017	July		5	5
	August	17	9	26
	Total	17	14	31
2019	June	13	16	29
	Total	13	16	29
Total	Total	99	88	187

Table A5. Model selection results for analyses of carcass persistence of avian carcasses recorded during COASST ground surveys of beaches near Shishmaref, Alaska, 2009–2019. All models used a Weibull distribution to model carcass persistence.

Variable	Location Formula	Scale Formula	AICc	Δ AICc	Akaike Weight
month	1 ~ Month	s ~ Month	229.73	0	0.95
month	1 ~ Month	s ~ constant	238.16	8.43	0.01
Intercept	1 ~ constant	s ~ constant	238.8	9.07	0.01
Beach	1 ~ Beach	s ~ Beach	239.69	9.96	0.01
Beach	1 ~ constant	s ~ Beach	239.97	10.24	0.01
month	1 ~ constant	s ~ Month	240.2	10.47	0.01
Beach	1 ~ Beach	s ~ constant	240.46	10.73	0.00
Year	1 ~ Year	s ~ constant	241.75	12.02	0.00
Species	1 ~ SpeciesType	s ~ constant	242.03	12.3	0.00
Species	1 ~ constant	s ~ SpeciesType	243.46	13.73	0.00
Year	1 ~ constant	s ~ Year	245.12	15.39	0.00
Species	1 ~ SpeciesType	s ~ SpeciesType	247.2	17.47	0.00

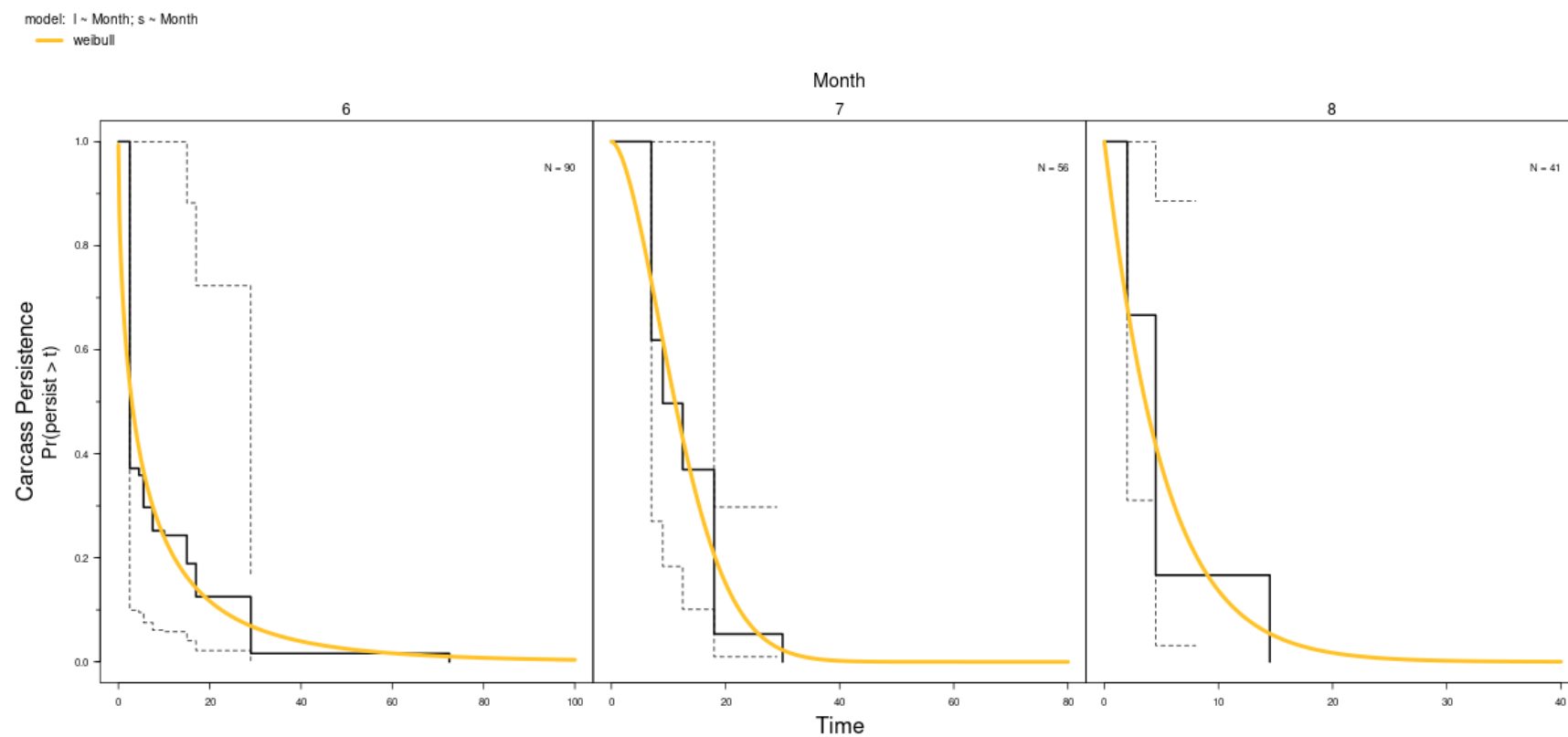
Table A6. Carcass persistence estimates (in days) and probability of being present after 7 days and 28 days estimated by analyses of avian carcasses recorded during COASST ground surveys of beaches near Shishmaref, Alaska, 2009–2019.

Month	n	Median Carcass Persistence	90% CI	r (7 days) ¹	90% CI	r (28 days)	90% CI
June	90	2.932	(1.643 – 5.000)	0.504	(0.414 – 0.616)	0.242	(0.190 – 0.312)
July	56	11.133	(8.514 – 14.273)	0.895	(0.798 – 0.961)	0.434	(0.353 – 0.531)
August	41	3.583	(1.782 – 6.242)	0.548	(0.402 – 0.756)	0.180	(0.122 – 0.285)
Overall	187	4.381	(3.112 – 6.048)	0.589	(0.515 – 0.671)	0.276	(0.234 – 0.326)

¹ The probability that a carcass that is deposited within a 7 day period is still present in the area at the end of the 7 day period.

² The probability that a carcass that is deposited within a 28 day period is still present in the area at the end of the 28 day period.

Figure A1. Carcass persistence graphs for the best model of carcass persistence of avian carcasses recorded during COASST ground surveys of beaches near Shishmaref, Alaska, 2009–2019.



i

Appendix B. Surveys conducted in September 2017 by the National Park Service.

During 24–27 September 2017, National Park Service employee Stacia Backensto conducted an aerial survey of BELA and a series of ground surveys in both BELA and CAKR. While these surveys did not use the exact methods employed in subsequent surveys, they do provide additional information on seabird carcasses along BELA and CAKR beaches as well as information on the efficacy of aerial surveys for seabird carcasses. Unfortunately, while there is good information on the carcasses found, the survey areas searched are not always clear from the available data.

Aerial Surveys

On 24 September 2017, an aerial survey of the beaches in and around BELA from Wales, Alaska to Kotzebue, Alaska was conducted. A total of 168 seabird carcasses were recorded between Wales and Cape Espenberg, a distance of approximately 230 km for a carcass density of 0.73 carcasses/km. No carcasses were observed between Cape Espenberg and Kotzebue.

Ground Surveys

BELA

On 24 September 2017, two ground surveys were conducted during the aerial survey, one survey estimated to be approximately 350 m long in the Ikpek Lagoon area recorded 15 carcasses, including Common Murres, Short-tailed Shearwaters, Northern Fulmars, unknown Auklets, and unknown species. This corresponds to a carcass density of 42.86 carcasses/km, however the length of the transect is not certain. On a second walking survey of unknown length in the Espenberg area there was a total of 6 carcasses reported (4 known or likely Short-tailed Shearwaters, 1 Horned Puffin, and 1 carcass of unknown species).

On 26 September 2017, five ground surveys were conducted in the Ikpek Lagoon area. The length of these ground surveys is unclear, but they all were at least 200 m in length. The carcass counts from these 5 surveys were: 1) no carcasses, 2) no carcasses, 3) 1 Black-legged Kittiwake, 2 Short-tailed Shearwaters, 1 unknown gull and 1 unknown species), 4) 2 Short-tailed Shearwaters and 2 unknown auklets, and 5) 5 Short-tailed Shearwaters and 2 unknown gulls.

CAKR

On 9/25/2017 two ground surveys on CAKR beaches were conducted. One survey covered approximately 1.35 km and 4 carcasses of unknown species were recorded. The second survey covered approximately 1.15 km and 4 Short-tailed shearwater carcasses were recorded.

On 9/26/2017 there were 4 ground surveys of CAKR conducted with an ATV, all four were approximately 1.6 km long. The carcasses found during these 4 surveys included: 1) 2 Black-legged Kittiwakes, 2) 1 Common Murre, 3) no carcasses, and 4) one Black-legged Kittiwake, a Short-tailed Shearwater, and a carcass of unknown species. There was also a walking survey of approximately 2.14 km. On the walking survey there were 10 carcasses found. Those carcasses

included 3 Black-legged Kittiwakes, one unknown gull, 4 known or likely Short-tailed Shearwaters, and 2 carcasses of unknown species.

On 9/27/2017, a total distance of 3.4 km was surveyed on the ground and a total of 16 carcasses were reported. The carcasses included 4 Black-legged Kittiwakes and 12 carcasses that were known or suspected Short-tailed Shearwaters.

Appendix C. Protocol for Monitoring Seabird Carcass Deposition Along the Coast of Bering Land Bridge National Preserve.

PROTOCOL FOR MONITORING SEABIRD CARCASS DEPOSITION ALONG THE
COAST OF BERING LAND BRIDGE NATIONAL PRESERVE

Prepared for

**Golden Eagle Outfitters,
Arctic Backcountry Flying Service,
and National Park Service**

4175 Geist Road
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Prepared by

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Alex K. Prichard

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P.O. Box 80410
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Version 1.4
February 24, 2025

Version History:**1.1 Updates**

- Added iPad batteries to gear list
- Added marine debris to survey log
- Added Yarn color to survey log

1.2 Updates

- Replaced COASST yarn with wooden tags
- Added Cape Krusenstern

1.3 Updates

- Added Highly Pathogenic Avian Influenza precautions

1.4 Updates

- Removed year-specific instructions

Objective: Seabirds are ecologically important and visible indicators of ocean conditions and the health of coastal subsistence resources critical to communities within Bering Land Bridge National Preserve (BELA). The goal of this project is to conduct economically and logistically feasible monitoring of seabird carcass deposition along the BELA coastline that will establish baseline levels of carcass density, be useful for monitoring annual trends, and identify potential mass seabird die-off events in the southern Chukchi Sea. While raw carcass counts along the shoreline can provide an index of seabird mortality, robust estimates of seabird mortality require adjusting raw carcass counts for detection and persistence probabilities. This protocol provides monitoring methods that provide:

- Counts of seabird carcasses on beaches along the BELA coastline
- Data to estimate detection probabilities of aerial surveys
- Data to estimate carcass persistence

Methods: This study will attempt to conduct up to 5 surveys of the coastline of BELA and opportunistically survey the coastline in CAKR to assess the number of seabird carcasses present during late summer and fall (July–September) in the area. The main metric will be counts of carcasses along distinct shoreline segments, but periodic ground surveys will provide additional information that can be used to assess the number of carcasses missed during aerial surveys (searcher efficiency) and the length of time carcasses remain on the beach and visible before being scavenged, covered, or washed away (carcass persistence). These protocols may be updated based on the experience of initial surveys.

STUDY AREA AND ACCESS

We assume that the survey pilot will be based out of Kotzebue and will depart from and return to Kotzebue for each survey day. Surveys are expected to take approximately 6 hours. A checklist for all gear required for the survey is included in Appendix A. The team should also carry equipment for staying in an outlying community or camping in the event of poor weather, mechanical issues, or an emergency. Survey effort will be focused on the BELA coastline between Wales and Cape Espenberg (Figure 1). Areas around Shishmaref will have to be avoided due to concerns about low-flying aircraft. It will be imperative to coordinate with city and tribal governments prior to flying the surveys. Surveys should be conducted when conditions permit good visibility of carcasses (e.g., low wind, limited glare). The weather conditions before, during, and between surveys should be monitored and recorded to assess the timing of storm events that may affect carcass visibility or presence before or between surveys. The survey crew should fill out a daily aerial survey log for each day of surveys (Appendix B).

We have divided the survey area into 3 approximately equal area sections (Ikpek, Cowpack, Espenberg; Figure 1). For each of these 3 areas, the survey crew should establish a primary and possibly a secondary ground survey location along the shoreline in locations where landing can be conducted safely to conduct ground-based surveys of 500 m transects. Therefore, during each survey of BELA, the plane should land at 3–6 locations (all three primary ground survey locations and secondary ground survey locations as time allows). Prior to landing, the area (~500m) should be surveyed by air and the total number of carcasses observed on this ~500m section of shoreline recorded. The start and end point of this 500m survey should be recorded with a handheld GPS. The survey crew should then land and conduct a ground survey in order to get an accurate count of carcasses present between the wrack line and the water. Aerial survey locations can be recorded on paper data sheets and ground survey results can be recorded on the iPad data collection app.

SURVEY METHODS

AERIAL SURVEY

The aircraft should maintain a constant altitude (50–100 m agl) in order to maintain a constant area under the plane. The pilot should position the plane be able to watch the wrack line

and record the number of carcasses observed along each 4 km coastline segment. A gpx file with waypoints and routes has been prepared to load on the pilot's GPS in order to identify 4 km transects.

During aerial surveys, the survey crew will record, at a minimum, the following information on a paper data sheet, a tablet and/or in a digital voice recorder:

1. Transects Waypoints, these are identified as start and ending waypoints for 4 km segments.
2. Total carcass count
3. Also record any marine mammal carcasses observed.

A data sheet can be found in Appendix C. This appendix also includes data sheets that already include transect information for the three areas that can be used. The tallywhacker can be used to count the number of carcasses during a 4 km segment.

Prior to ground surveys conduct an aerial survey of the approximate ground survey location. Take a waypoint at the landing location and a second waypoint about 500 m farther and record the total number of carcasses observed. Aerial surveys of these 500 m ground survey locations can be added to the bottom of the data sheet using the waypoint locations from the airplane's GPS. Be sure to submit the GPS data following the survey.

GROUND-BASED SURVEY

Ground-based surveys should be conducted on the primary ground survey locations for each of the four survey areas (Ikpek, Cowpack, Espenberg, and Krusenstern) and on secondary ground survey locations for each area as time allows. These 500m areas should be surveyed on the ground by the survey crew in order to get an accurate count of carcasses present between the wrack line and the water line. An effort should be made to survey the same locations each survey in order to get information on carcass persistence. Segments to be sampled should be selected by

the pilot in an area where landing can be conducted safely. The survey crew will survey a 500m segment by walking out and marking carcasses along the way. On the return add any additional carcasses that were missed. If the beach is wide, the lower half can be surveyed in one direction and the upper half can be surveyed in the other direction.

The orange medical bag can be kept in the plane and used to resupply the smaller survey bag. Survey crews should fill out the survey conditions data on the tablet using an app for digital data entry at the beginning of the survey (see app use instructions). This app will also record a GPS trackline for the survey. When carcasses are found, the survey crew should record the required information on the app. Survey crews should also have hard copies of the data sheets (Appendix D) and coding instructions (Appendix E) in the plane in case of tablet failure. Record the following as prompted by the app (see Appendix E for details).

- Waypoint
- Species
- Number of individuals
- Number of photos
- Previously tagged
- Newly tagged
- Distance of carcass from water line
- Substrate in area
- Scavenger activity (e.g., intact, extremities missing, organs missing)
- Freshness (e.g., fresh, beginning to rot, slimy, only feathers and bones, only bones)

After filling out the data form:

1. Collect feather sample as described below (up to 20 samples per location).
 - a. if possible collect a wing, a pinch of feathers from the breast (~10), and a pinch of feathers (~20) from the throat of murres or auklets or the head of kittiwakes. Place the wing in a Ziploc bag and put the feathers in an envelope and place in the ziploc bag. Label the feathers with species (if known), location, date, and your initials. These samples are a lower priority if short on time.

2. Collect 2-3 fresh bird carcasses if they exist at each landing and record location and date on the bags
 - a. If they've been scavenged or have an opening in the body cavity, they are not fresh enough to collect
 - b. If small fish or marine invertebrates like krill are also present, please collect and record date and location on the bags (up to 20/each if possible, at each landing)
3. If the carcass is not collected and wasn't previously marked, mark the carcass with COASST wooden tags. Use wooden tags for the correct study area (BELA or CAKR) and use the numbers in order from lowest to highest. Place around the wing if carcass is intact, if wings are not present, put around the foot. If COASST wooden tags are not available, clip a wing to indicate the carcass has been previously found.
4. Take a picture(s) of the carcass(es), try to show the wings and feet. Place the COASST Card with the location written on it in the photo. Multiple carcasses in the same location can be recorded and photographed together.

If large numbers of carcasses are present, record full information for at least 10 carcasses, take photos of as many carcasses as possible, and record the total number of carcasses on the survey. If necessary due to a large number of carcasses, decrease the length of the survey area from 500m to a shorter distance.

SAFETY ISSUES

The pilot should adjust the survey plan in response to weather conditions or other factors that influence flight safety. All required flight tracking and safety protocols should be followed.

There is some concern about the possibility of contracting avian influenza through contact with infected wild birds. Due to the prevalence of highly pathogenic avian influenza (HPAI), some extra safety precautions should be followed to avoid exposing observers to HPAI or spreading HPAI to other avian populations. In particular, you need to avoid getting fluids (feces, mucus, saliva, or blood) from a bird on or in you. Do not eat, smoke, or drink after handling a bird until you have disposed of your protective equipment and have washed your hands and face

with soap and water or with an alcohol-based sanitizer (e.g., Purell®). You also should wear a mask, gloves, and goggles and/or a face shield to avoid breathing any aerosolized fluid droplets. The precautions described below are designed to enable you to handle dead birds without increasing your risk of infection. Remember: BE SAFE WHEN HANDLING LIVE OR DEAD BIRDS!

Before approaching within 3 m of any carcass, put on surgical gloves, a face mask, and goggles and/or face shield. Once you have described the location and status of the carcass and taken digital pictures, mark the carcass:

1. Take off the rubber gloves by turning them inside-out as you pull them off your hands; place them in a Zip-lock bag. Leave this bag open for your mask.
2. Take off your mask and place it in the Zip-loc bag, along with your gloves. Seal the bag and dispose of in regular trash.
3. Wipe your hands and other surfaces (e.g., Sharpie pens, pencil) clean with an alcohol-based disinfectant (hand sanitizer).
4. Before eating, drinking, or smoking, thoroughly wash your hands and face with soap and clean water or wipe them down with an alcohol-based disinfectant.

AFTER COMPLETING THE SURVEY

1. Download the data from the iPad and download the plane's GPS track and waypoints.
2. Scan or photograph all paper data sheets.
3. Send electronic data to aprichard@abrinc.com
4. Store feather samples and freeze carcasses collected until they can be shipped (coordinate with NPS).
5. Send comments, problems, or suggestions for improvement to agall@abrinc.com

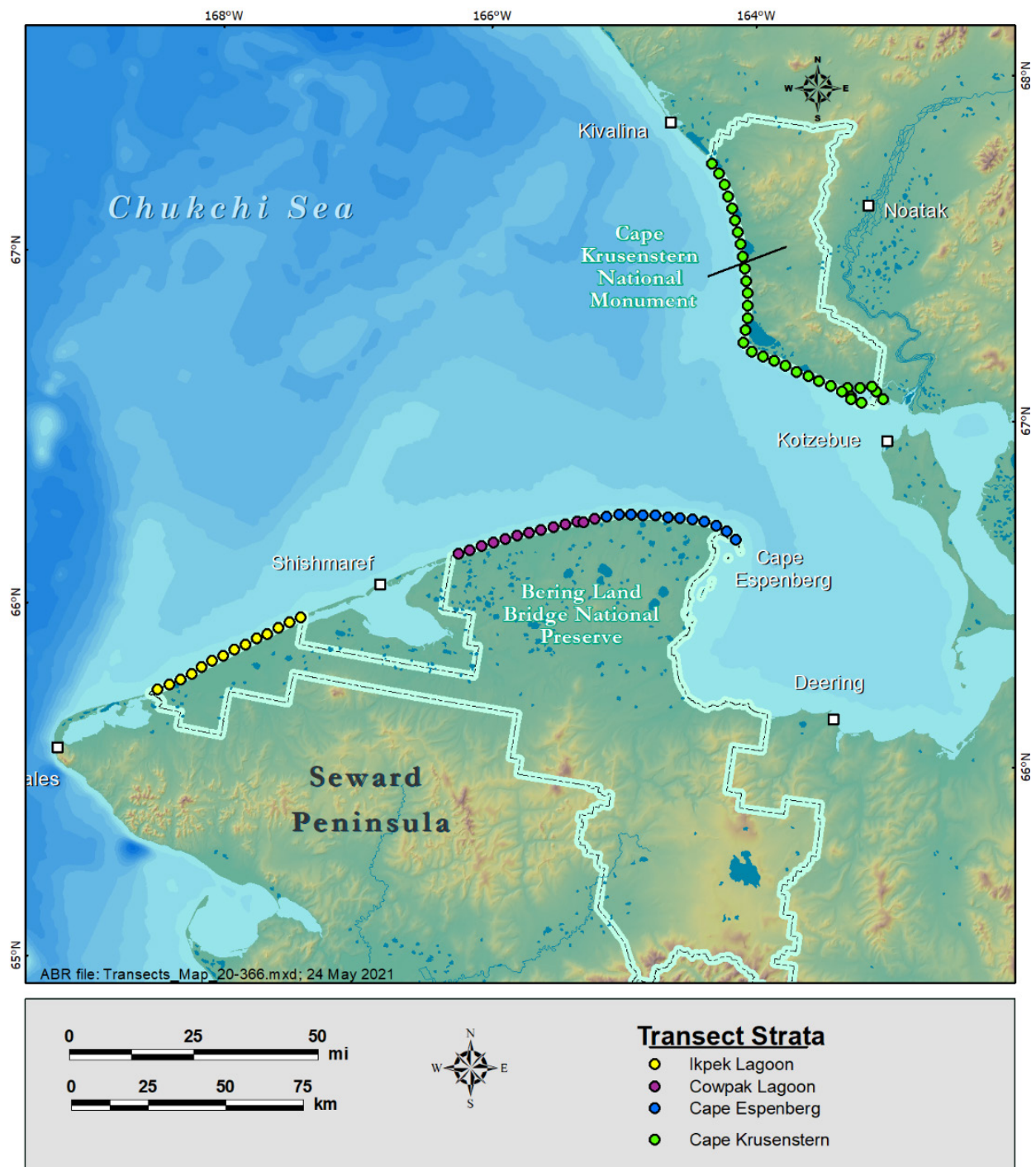


Figure 1. Start and endpoints of 4-km transects within 3 strata for an aerial survey of seabird carcasses in and near Bering Land Bridge National Preserve, Alaska.

GEAR LIST FOR SEABIRD CARCASS SURVEYS

- ☐ iPad tablet with data collection app
- ☐ Charging cords
- ☐ Collection permit
- ☐ Protocol form
- ☐ Data Forms and Coding sheets
- ☐ Clip board
- ☐ Clicker (tallywhackers) for counting (1)
- ☐ 2 pencils
- ☐ Safety gloves
- ☐ Masks =
- ☐ Goggles and/or Face Shield
- ☐ Sanitizer wipes
- ☐ Bottle of hand sanitizer
- ☐ COASST wooden tags
- ☐ Shears
- ☐ Grease Pencils
- ☐ Envelopes for feather collection
- ☐ COASST data collection card
- ☐ Duct Tape
- ☐ Sharpie markers (at least 2)
- ☐ Ziploc Bags for feathers (at least 20)
- ☐ Trash Bags
- ☐ Camera
- ☐ Hand-held GPS
- ☐ Emergency gear

- Instructions for iPad app use and extra iPad batteries

Appendix B. Aerial Survey Daily Survey Log

NPS SEABIRD CARCASS DAILY SURVEY LOG

Date _____ Observer/Pilot _____

Aircraft _____ Air Service _____

DEPARTURE TIME _____ RETURN TIME _____ FROM _____

Flight speed _____ Altitude (agl) _____

Visibility (miles) _____ Cloud height _____ Cloud Cover (%) _____

Wind: Direction _____ Speed _____ Snow Cover (%) _____

Precipitation _____ Temp (F°) _____

Beaufort sea conditions _____

Observation conditions (1–5; see coding instructions) _____

Marine Debris

Ikpek ☐less than usual ☐usual ☐a bit more ☐a lot more

Cowpak ☐less than usual ☐usual ☐a bit more ☐a lot more

Espenberg ☐less than usual ☐usual ☐a bit more ☐a lot more

Krusenstern ☐less than usual ☐usual ☐a bit more ☐a lot more

Refueling/rest/ground search stops:

Stop time _____ Start time _____ Location(Waypts) _____

Stop time _____ Start time _____ Location(Waypts) _____

Stop time _____ Start time _____ Location(Waypts) _____

Stop time _____ Start time _____ Location(Waypts) _____

Stop time _____ Start time _____ Location(Waypts) _____

Stop time _____ Start time _____ Location(Waypts) _____

Remarks _____

Appendix C. Aerial survey observations form

PAGE

PAGE OF
OBSERVER

[illegible]

**NPS AERIAL SEABIRD CARCASS SURVEY (Ikpek)
SURVEYS**

FIXED-WING

DATE (DD/MM/YY) ____/____/____

PAGE ____ OF ____

TIME BEGIN

TIME END

PILOT

OBSERVER

Area (Ikp/Cow/Esp/K rus)	Length (4 km/0.5 km)	Waypt Start	Waypt End	Total no. Carcasses	Marine Mammal Carcasses	Comments
Ikpek	4	12	13			
Ikpek	4	13	14			
Ikpek	4	14	15			
Ikpek	4	15	16			
Ikpek	4	16	17			
Ikpek	4	17	18			
Ikpek	4	18	19			
Ikpek	4	19	20			
Ikpek	4	20	21			
Ikpek	4	21	22			
Ikpek	4	22	23			
Ikpek	4	23	24			
Ikpek	4	24	25			
Ground 1	0.5	Ik_1_w	Ik_1_e			
Ground 2	0.5	Ik_2_w	Ik_2_e			

NPS AERIAL SEABIRD CARCASS SURVEY (Cowpack)

FIXED-WING SURVEYS

PAGE

OF _____
 DATE (DD/MM/YY) ____/____/____
 TIME BEGIN _____ TIME END _____

PILOT _____

PAGE ____ OF ____
 OBSERVER _____

Area (Ikp/Cow/Esp/K rus)	Length (4 km/0.5 km)	Waypt Start	Waypt End	Total no. Carcasses	Marine Mammal Carcasses	Comments
Cowpak	4	39	40			
Cowpak	4	40	41			
Cowpak	4	41	42			
Cowpak	4	42	43			
Cowpak	4	43	44			
Cowpak	4	44	45			
Cowpak	4	45	46			
Cowpak	4	46	47			
Cowpak	4	47	48			
Cowpak	4	48	49			
Cowpak	4	49	50			
Cowpak	4	50	51			
Ground 1	0.5	Cow_1_w	Cow_1_e			
Ground 2	0.5	Cow_2_w	Cow_2_e			

NPS AERIAL SEABIRD CARCASS SURVEY (Espenberg)

FIXED-WING SURVEYS

PAGE

OF
DATE (DD/MM/YY) ____/____/____
TIME BEGIN TIME END

PILOT

PAGE ____ OF ____
OBSERVER

Area (Ikp/Cow/Esp/Krus)	Length (4 km/0.5 km)	Waypt Start	Waypt End	Total no. Carcasses	Marine Mammal Carcasses	Comments
Espenberg	4	52	53			
Espenberg	4	53	54			
Espenberg	4	54	55			
Espenberg	4	55	56			
Espenberg	4	56	57			
Espenberg	4	57	58			
Espenberg	4	58	59			
Espenberg	4	59	60			
Espenberg	4	60	61			
Espenberg	4	61	62			
Espenberg	4	62	63			
Ground 1	0.5	Esp_1_w	Esp_1_e			

NPS AERIAL SEABIRD CARCASS SURVEY (Krusenstern)
FIXED-WING SURVEYS

PAGE

 OF _____
 DATE (DD/MM/YY) ____/____/____
 TIME BEGIN _____ TIME END _____

PILOT _____

 PAGE ____ OF ____
 OBSERVER _____

Area (Ikp/Cow/Esp/Krus)	Length (4 km/0.5 km)	Waypt Start	Waypt End	Total no. Carcasses	Marine Mammal Carcasses	Comments
Krusenstern	4	200	199			
Krusenstern	4	199	198			
Krusenstern	4	198	197			
Krusenstern	4	197	196			
Krusenstern	4	196	195			
Krusenstern	4	195	194			
Krusenstern	4	194	193			
Krusenstern	4	193	192			
Krusenstern	4	192	191			
Krusenstern	4	191	190			
Krusenstern	4	190	189			
Krusenstern	4	189	188			
Krusenstern	4	188	187			
Krusenstern	4	187	186			
Krusenstern	4	186	185			
Krusenstern	4	185	184			
Krusenstern	4	184	183			
Krusenstern	4	183	182			
Krusenstern	4	182	181			
Krusenstern	4	181	180			
Krusenstern	4	180	179			
Krusenstern	4	179	178			
Krusenstern	4	178	177			
Krusenstern	4	177	176			
Krusenstern	4	176	175			
Krusenstern	4	175	174			
Ground 1	0.5					
Ground 1	0.5					

Appendix D. Ground survey observations form
(Backup in case App is not working)

NPS BEACHED BIRD GROUND SURVEY LOG (BACKUP FOR APP) PAGE ____ OF ____

Date (day/month/year): _____ **Pilot/Observer(s):** _____

Survey Area (Ikp, Cow, Esp, Krus) _____ **Survey Location (Waypoints)** _____

Cloud cover: 0 / 10% / 20% / 30% / ... 100% _____

Wind-Beaufort Scale (0-7) _____ **Wind direction (E, NE, N, NW...)** _____

Temperature (°F) _____

Precipitation: none / fog / drizzle / rain / snow / other _____

Comments _____

Carcasses 1st pass: _____ **New Carcasses 2nd pass:** _____ **Total Carcasses:** _____

Time start : _____ **Time turnaround:** _____ **Time end:** _____

Ground Survey Carcass Information (Backup continued)

Page ____ of ____

Date (day/month/year): _____ **Time**: _____

Waypoint _____ **Species** _____ **# of Individuals** _____ **# of Photos** _____

Previously tagged? Yes / No **If yes, wooden tag number (or other)** _____

Tagged this time? Yes/No **If yes, wooden tag number** _____

Distance from water line: _____ m

For the fields below, circle ONE description or write in the blank if none of the options apply.

Sex: male / female / unknown

Age: chick / subadult / adult / unknown

Status: alive / dead

Immediate Area (within 5 steps of the carcass): sand / vegetation / other _____

Carcass collected? Yes/No

Feathers collected? Yes/No

SCAVENGER ACTIVITY

- 0 intact with no sign of scavenging
- 1 wing, head, and/or feet missing
- 2 soft parts, muscles, and/or organs missing
- 3 just skeleton and feathers remain
- 4 just feathers remain

Carcass condition comments:

FRESHNESS

- 0 fresh; no smell or signs of decomposition
- 1 rotten smell detected
- 2 rotting is advanced
- 3 flesh is slimy; tissues unrecognizable
- 4 only feathers and bones remain
- 5 only bones remain

Evidence of scavengers / predators / raptor or raven or gull nests:

Appendix E. Coding on forms

CODING—NPS SEABIRD CARCASS SURVEYS

31 July 2020

NPS SEABIRD CARCASS DAILY SURVEY LOG CODES

DATE: Write as DD/MM/YY. For example, 25 May 2018 would be written as 25/05/18.

OBSERVER AND/OR PILOT: Write full names.

DEPARTURE/RETURN TIME: Write in 24-hour clock, without a colon (e.g., 1:38 PM would be written as 1338). Remember—midnight is 0000 h, **not** 2400 h.

LOCATION: Can be coordinates or waypoint number, depending on data collection method used

VISIBILITY: Distance in miles at which observer can see clearly. 0-10 miles.

CLOUD HEIGHT: Estimate cloud height in ft agl

CLOUD COVER: Estimate percent of sky covered with clouds, to the nearest 10%

WIND DIRECTION: in degrees or cardinal direction.

WIND SPEED: In miles per hour

SNOW COVER: Estimate percent of ground covered with snow, to the nearest 10%

COASST WOODEN TAG NUMBER: The number on the COASST wooden tag used to mark carcasses

MARINE DEBRIS: Summarize the relative amount of marine debris (trash) in each segment.

PRECIPITATION:

blank = unknown/default

0 = none	6 = snow flurries (intermittent)
1 = fog	7 = light snow (continuous)
2 = drizzle (heavy mist)	8 = heavy snow
3 = light rain (continuous drops of rain)	9 = sleet
4 = heavy rain	10 = hail
5 = scattered showers	11 = mixed precipitation

AIR TEMPERATURE: In degrees F

SEA STATE (Beaufort scale):

Beaufort scale	Wind		Wave ht (ft)	Description
	(mph)	(kt)		
0	0–1	0–1	0	<u>Calm</u> : sea smooth and mirror-like.
1	1–3	1–3	$\frac{1}{4}$	<u>Light air</u> : scale-like ripples without wave crests.
2	4–7	4–6	$\frac{1}{2}$	<u>Light breeze</u> : small, short wavelets; crests have a glassy appearance and do not break.
3	8–12	7–10	2	<u>Gentle breeze</u> : large wavelets; some crests begin to break, but foam is glassy; occasional whitecaps.
4	13–18	11–16	4	<u>Moderate breeze</u> : small waves that become longer; fairly frequent whitecaps.
5	19–24	17–21	6	<u>Fresh breeze</u> : moderate waves taking a more pronounced long form; many whitecaps; there also may be some spray.
6	25–31	22–27	10	<u>Strong breeze</u> : large waves begin to form; whitecaps are extensive and everywhere; some spray.
7	32–38	28–33	14	<u>Near gale</u> : sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind; spindrift begins.

OBSERVATION CONDITIONS: Your qualitative estimate of how easy it is to see carcasses on the beach; this estimate depends on precipitation, sun position, air turbulence, and other factors. Record at the beginning of each survey effort or when conditions change.

1 = poor	3 = good/moderate	5 = excellent
2 = fair	4 = very good	

NPS AERIAL SEABIRD CARCASS SURVEY CODES

AREA

Ikp = Ikpeki Lagoon area (Waypoints 12-25)

Cow = Cowpack Lagoon (Waypoints 39-51)

Esp = Cape Espenberg (Waypoints 52-63)

Krus = Krusenstern (

LENGTH

4 = 4 km, established 4 km survey segments

0.5 = 500 m long aerial survey of ground survey location

Waypt Start

Waypoint of start of survey segment. These are established waypoints for 4 km segment or a new GPS recorded by the pilot for the 0.5 km segments.

Waypt End

Waypoint of end of survey segment. These are established waypoints for 4 km segment or a new GPS recorded by the pilot for the 0.5 km segments.

TOTAL NUMBER CARCASSES: Total number of carcasses for that segment of coastline.

COMMENTS: Add additional details as time allows (e.g., size, color, species).

SIZE

L = Large (e.g., murre or larger) or

S = Small (e.g., Crested Auklet or smaller).

All waterfowl are Large. All auklets and murrelets are Small.

COLOR (dominant visible color of the carcass)

W = light or white

D = dark

GROUND SURVEY OBSERVATION CODES

Fill out one **NPS BEACHED BIRD GROUND SURVEY LOG** for each ground survey

Fill out one **GROUND SURVEY CARCASS INFORMATION** form for each carcass or group of carcasses

Waypoint—Take a waypoint of location with hand-held GPS

Species—Record the species if known

of individuals—Record the number of individual birds in group

of photos—Number of photos taken or file numbers of photos

Previously tagged (Yes/No)—Does carcass have a wooden tag/yarn/clipped wing from a previous survey?

Tag description—Describe tag

Distance from water line—Estimate distance from carcass to ocean in meters

Immediate Area—pick the predominant substrate within 5 steps of the carcass (Sand/vegetation/Other)

Appendix F. Wooden Tag Protocols

Tagging Carcasses

Instead of yarn, we will use the enclosed numbered, wooden tags. There is 1 set spanning 1-99 for BELA (1-39 on the metal ring and 40-99 on the blue cord) and 1 for CAKR (15-30 on the metal ring and 31-99 on the red cord). Begin at the lowest number and work through the sequence with each subsequent bird encountered. Twine with clippers is included. All materials are biodegradable.

1. Thread twine through the tag; double knot or hitch to secure.
2. Record the body part you tagged in the comments field on the iPad.



set

Body Part Tagging Priority

1st Right wing: On the upper wing, separate the secondaries, creating a gap to thread the ties through.

2nd Left wing

- Only wings left? Tie them together to minimize finding them separated in the future.

3rd Leg Secure the tag between joints to ensure it doesn't slip off.

4th Bill Secure the tag behind any bumps or edges on the bill to prevent slipping.

