

**ALASKA BELUGA WHALE COMMITTEE  
REPORT 22-1**

**2022 Bristol Bay Aerial Surveys of Beluga Whales**

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## *Summary*

Aerial surveys were flown by the Alaska Beluga Whale Committee and the Alaska Department of Fish and Game to count beluga whales in the Bristol Bay stock between 9 and 13 July 2022. A total of six surveys were completed. Each survey consisted of flying the coastlines between Dillingham and King Salmon, Alaska, as well as up rivers known to be used by belugas and across wide areas of Nushagak and Kvichak bays. Total survey counts ranged from 133 to 617 belugas. However, two surveys with low counts were not considered reliable due to poor observing conditions. The mean count of the remaining four surveys was  $540 \pm 91$  whales (mean  $\pm$  S.D). Applying correction factors for whales that were present but below the surface (2.62) and for calves that are difficult to see because of a lack of contrast between their color and that of the water (1.18), we estimate a minimum population of 1,669 whales. This number is slightly lower than the estimate determined by aerial surveys in 2016 using the same methods (i.e., 2,040 belugas).

## *Survey area and flights*

Beluga whales of the Bristol Bay stock are known to occupy coastal areas within Nushagak and Kvichak bays and the lower parts of adjacent rivers in the summer months of June and July; very few belugas have been observed more than 0.9 km from shore (Lowry et al. 2008, Citta et al. 2016). Therefore, surveys to count belugas focused on the coastline from the Wood River near Dillingham west to the Igushik River and east along the coastline of Nushagak Bay into Kvichak Bay. The survey continued up the Kvichak River to the Alagnak (also known as the Branch) River, and then down the east coast of Kvichak Bay and up the Naknek River to the survey end at King Salmon (Fig. 1). The plane (an *Aero Commander* owned and operated by Clearwater Air Inc.) was positioned 0.9 km from the waterline at an approximate altitude of 304 m (1000'). In addition to the pilot and co-pilot, two observers and a recorder were present for each flight. One observer was positioned on each side of the airplane at bubble windows that allowed belugas to be counted within a 0.9 km strip on both sides of the plane simultaneously (Fig. 2). If any belugas were observed on the offshore side of the plane, cross lines were flown. In addition, during the first survey of the day, which began at Dillingham and progressed south, a mid-bay line was flown north to begin the coastal survey lines north of Dillingham and then south along the east side of Nushagak Bay. This line covered the mid-bay not covered by the southward coastal survey lines. The tides in Bristol Bay are extreme and because two surveys are flown daily our surveys cover a full range of tides. At low tide there are many mudflats within each bay that reduce the need for cross lines.

Except for the first day (9 July) when a practice survey was flown from Naknek to Dillingham, two surveys were flown daily; the first departed Dillingham and arrived at King Salmon and the second departed King Salmon and arrived at Dillingham (Fig. 1, Table 1). Full surveys were flown on 10, 11, and 13 July; 12, 14, and 15 July were weather days with ceilings below survey altitude and 16 July was also forecast to have low ceilings. Surveys averaged  $2.35 \pm 0.23$  hrs in duration and covered  $567 \pm 55$  km (Fig. 3 and Table 1). Details of commuting, aerial survey, and refueling times are provided in Appendix A.

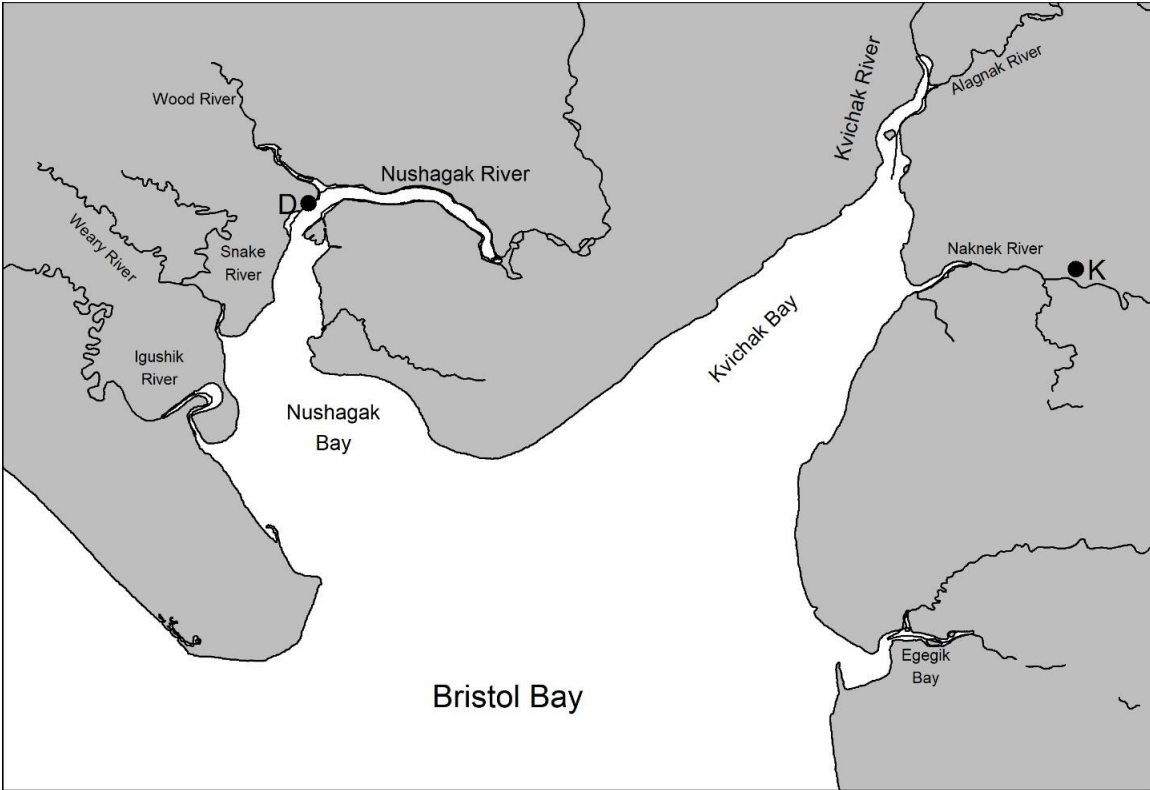


Figure 1. Map of Bristol Bay survey area. Surveys were flown along coastlines and rivers between Dillingham (D) and King Salmon (K).



Figure 2. Interior of Aero Commander from back to front showing recorder, left and right observers and pilot and co-pilot.

Table 1. Summary of survey flights during 2022 aerial surveys of Bristol Bay beluga whales.

Survey	Date and time	Duration (hrs)	Distance flown (km)	Viewing conditions	Whales counted
2	10 July 2022 09:54 – 12:17	2.38	593	Excellent, some glare, ripples	432
3	10 July 2022 13:15 – 15:25	2.16	503	Fair to excellent, ripples	616
4	11 July 2022 10:31 – 13:15	2.73	650	Good to poor, white caps	257*
5	11 July 2022 14:25 – 16:32	2.11	513	Fair to poor, white caps, fog	133*
6	13 July 2022 10:00 – 12:16	2.26	557	Good to excellent, some glare, flat water	496
7	13 July 2022 13:07 – 15:38	2.51	592	Good to excellent, some glare, flat water	617

\*Surveys 4 and 5 from 11 July were not included in estimates of abundance.

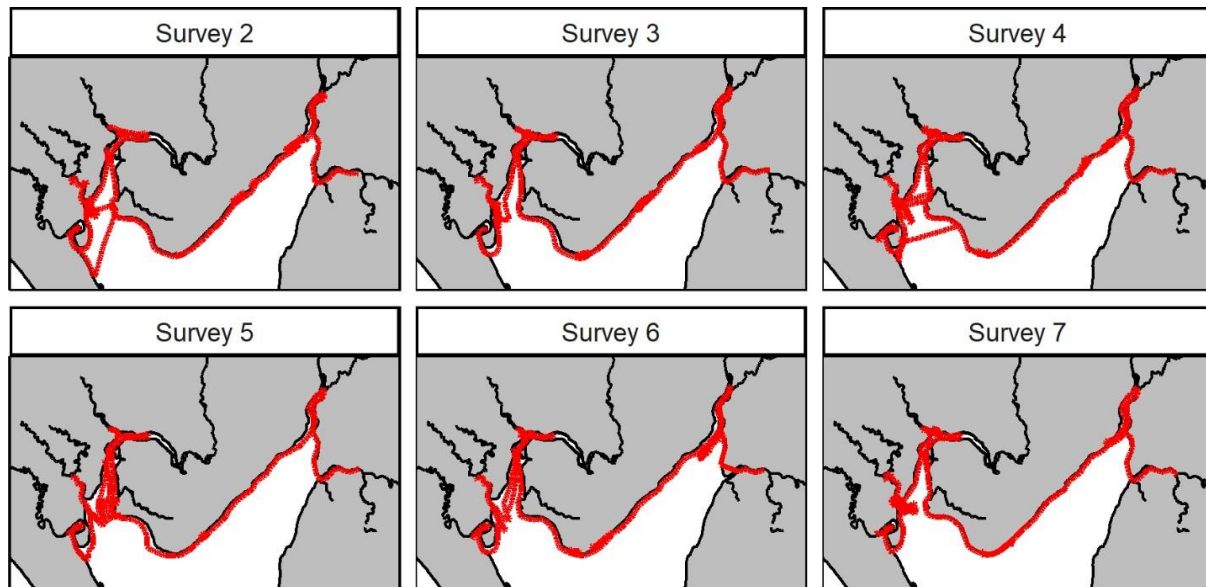


Figure 3. Flight paths for six aerial surveys of Bristol Bay belugas flown 10, 11, and 13 July 2022.

#### *Beluga sightings and estimate of abundance*

Belugas were mostly sighted within 0.9 km of the coastline and at the mouths of rivers and sloughs (Fig. 4). The largest groups were consistently observed at the mouths of the Snake and Wood rivers, as well as along the western coast of Kvichak Bay. Belugas were seldom

observed farther up any of the surveyed rivers, and none were observed up the Naknek River. This distribution is the same as that described in previous aerial surveys (Lowry et al. 2008, Citta et al. 2019), and from satellite tagged beluga whales during the month of July (Citta et al. 2016).

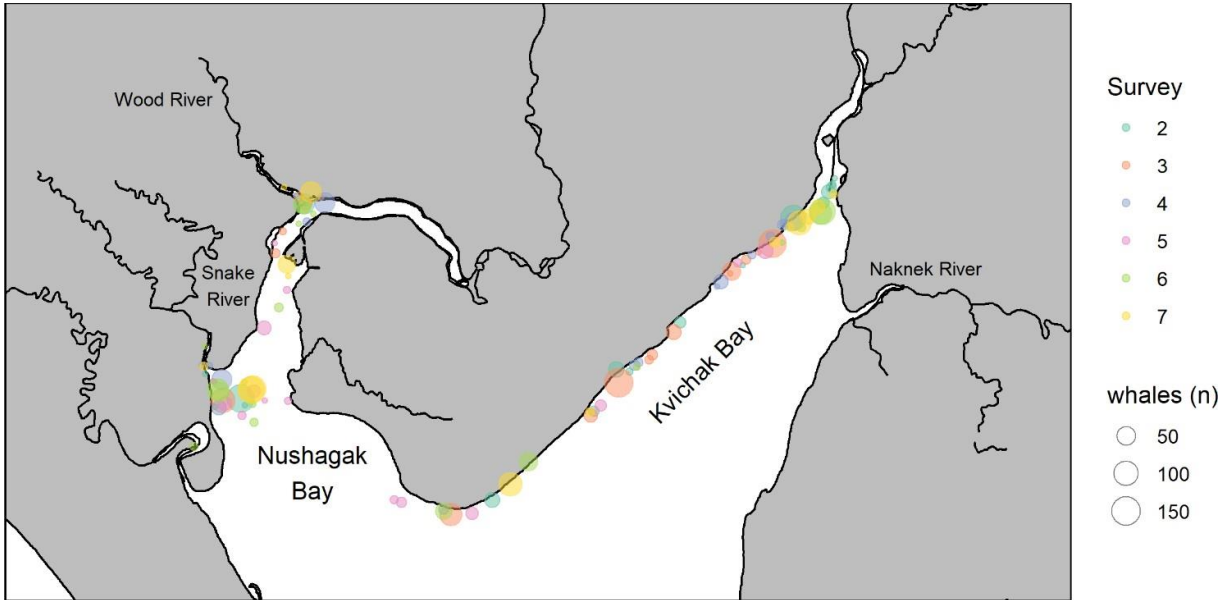


Figure 4. Locations of beluga whale sightings by group size and survey number during 2022 aerial surveys.

The two surveys on 11 July were not considered in the analysis due to poor observing conditions. High winds produced significant white caps and patches of fog below survey altitude, which made sighting belugas difficult. Therefore, counts from four surveys were available to estimate abundance. We counted an average of  $540 \pm 91$  whales (mean  $\pm$  S.D., CV = 0.17, range = 432–617). Two correction factors have been applied to produce previous estimates (see Citta et al. 2019). The first accounts for belugas that were present but below the surface (Frost and Lowry 1995) and the second accounts for gray-colored calves that are difficult to distinguish from the silty water of Nushagak and Kvichak bays (Brodie 1971). In applying these correction factors, our minimum population estimate is  $540 \times 2.62 \times 1.18 = 1,669$  beluga whales.

Using the same methods and correction factors, our 2022 estimate is lower than the estimate from aerial surveys in 2016, which was 2,040 belugas (Citta et al. 2019). Prior analyses of trend showed that aerial survey counts of belugas increased from 1993 to 2005 (Lowry et al. 2008). Growth appeared to plateau with the addition of count data for 2016, as counts for 2016 were similar to counts from 2004 and 2005. Citta et al. (2019) compared a simple linear trend model with a curvilinear trend model that would allow for the rate of growth to decline over time, as appeared to be the case, but the simple linear trend was the better fitting model. Including the 2022 count data, however, resulted in the curvilinear model as the better fitting model (likelihood ratio test,  $F = 7.84$ , d.f. = 1, 37,  $p = 0.008$ ). This model suggests that between 1993 and 2005, the Bristol Bay population was growing, but this growth rate slowed between 2005 and 2016, and although the trend may now be downward, given the 95% C.I., a stable population is an equally likely interpretation (Fig. 5).

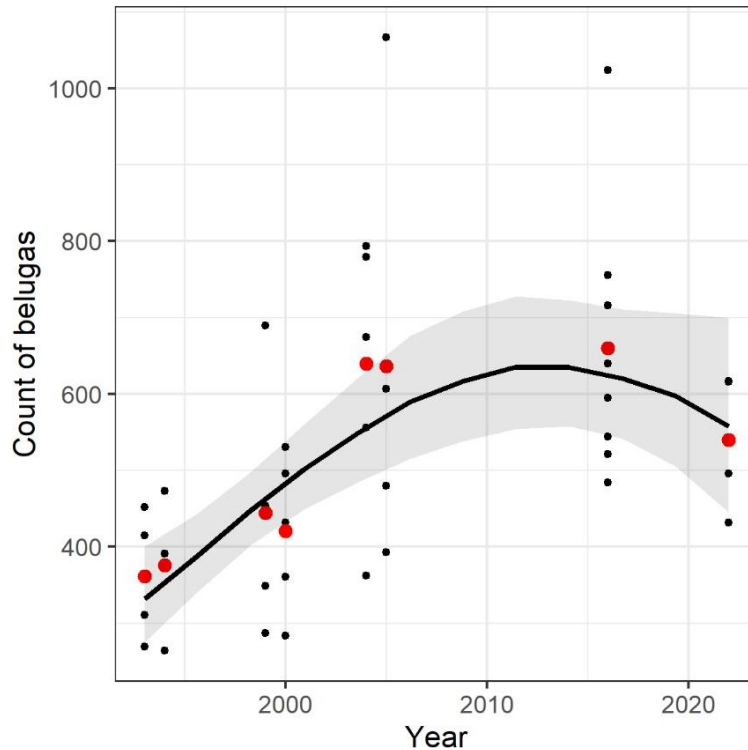


Figure 5. Trend in beluga counts from 1993 to 2022. Black points are actual counts, red points are the mean count for each year, and the black line is the fitted trend ( $\pm 95\%$  C.I. gray shading).

### Discussion

A review of sampling methods that could be applied to improve Bristol Bay beluga surveys was conducted previously and none were found to be helpful or appropriate (see review in Citta et al. 2019). For example, distance sampling, which accounts for the probability of observation declining with distance, is not appropriate because virtually all belugas in replicate surveys were close (within  $\sim 100$  m) to shore (Citta et al. 2019). With so little variation in detection distance there is little information available to fit detection curves (Citta et al. 2019).

The major challenge of this survey continues to be accurately counting large groups (Citta et al. 2019). Most of the belugas counted occur in large groups, therefore variability in the counting of these groups is a major source of variability in total counts. Circling a group was effective if the group covered an area small enough to see belugas in the center of the circle (i.e., if all belugas were within the 0.9 km transect width). If the group covered a larger area, transects were flown and observers counted on both sides. Multiple counts were made until we felt confident a best estimate had been achieved. Factors considered for determining the best count included how well the plane was positioned over the group, the behavior of the group during each pass, and the viewing conditions of the observer (e.g., glare on the water or presence of white caps). Often, the best conditions were aligned with the highest count (Table 2). Despite the challenge of precisely counting large groups, we achieved relatively consistent total counts with a low coefficient of variation (0.17). A proposed alternative method is to video large groups for

counting later (e.g., Sheldon and Wade 2019), however, this would require greater resources and planning to implement, and results would not be comparable with previous Bristol Bay surveys and therefore not useful for trend analysis.

Because so few belugas have been observed away from shore during surveys, we do not believe that we missed belugas by flying fewer cross lines than flown in previous surveys, or that flying fewer cross lines is the reason for our lower count. During prior surveys when all cross lines were flown (1993–2016), only 236 of 21,284 (1%) counted belugas were observed on these lines. The average group size observed on cross lines for all prior surveys was  $2 \pm 1$  and the maximum was 5 belugas. For the 2022 surveys, the only belugas observed farther than 0.9 km offshore occurred during Survey 6 and was a group of 4 belugas. This group was observed during the mid-bay flight line in Nushagak Bay. Further, many sightings that occurred along cross lines were near the coastline, which means these belugas may also have been detected along coastal flight lines and a decision about whether they were previously counted is required. Flying cross lines can add an additional 250 km of flight distance or more to each survey. Despite the substantial increase in effort, few belugas were observed from cross lines, therefore we recommend eliminating or reducing the number of cross lines flown in future surveys.

Record breaking numbers of sockeye salmon (*Oncorhynchus nerka*) returned to Bristol Bay in 2022. It is unknown if this had any effect on the distribution of belugas in Bristol Bay during our survey. The abundance of this prey resource, however, may have allowed additional non-surveyed habitat to be available for foraging in 2022. Reports from local fishermen suggested that belugas are sometimes observed farther south at Egegik Bay during this time of year (Fig. 1). Future surveys should consider adding this area.

Our 2022 abundance estimate of 1,669 suggests the Bristol Bay beluga stock is not increasing, but rather is stable, or possibly declining. Mean counts for 2004, 2005, and 2016 were similar (637–660 belugas counted). Our mean count in 2022 was about 15–20% lower than these estimates (540 belugas counted). It is possible that the lower mean count we achieved is attributable to fewer useable surveys ( $n = 4$ ), and that additional surveys would have provided more opportunities with good survey conditions to achieve higher counts. However, our counts for 2022 had a lower coefficient of variation ( $CV_{2022} = 0.17$ ) than other years (range 0.20–0.47). Because our counts were less variable than in prior years, it is unclear how much additional surveys would have affected our mean count. Our results suggest the Bristol Bay stock of belugas is not likely growing. An additional survey within the next few years is necessary to determine whether the population has stabilized, or if a decline is occurring.

Interestingly, a population estimate of 1,928 belugas resulted from a genetic mark-recapture study conducted in Bristol Bay during 2002–2011 (Citta et al. 2018). The two most recent population estimates from aerial surveys (2016 and 2022) are within the 95% C.I. determined by this alternative method (95% C.I. = 1,611–2,337). Together, the aerial surveys and the genetic mark-recapture study suggest that Bristol Bay has supported ~1,600–2,000 belugas since the 2000s.

Table 2. Counts of groups for which at least one count was > 100 beluga whales. Notes for each count are provided. Final count is in bold text.

Survey	Group location	Count	Details
2	Mouth of Snake River at ~ 10:11	122	First pass, whales counted on both sides by AB + LQ
		104	Second pass, counted by LQ
		<b>139</b>	<b>Third pass, 138 counted by LQ and 1 from AB</b>
		130	Fourth pass, LQ count 130
	Along coast heading E from Nushagak to Kvichak at ~ 11:49	81	First pass, counted by AB
		102	Second pass, counted by LQ
		92	Third pass, counted by AB
		<b>112</b>	<b>Fourth pass, counted by LQ</b>
	3	West coast of Kvichak Bay at ~ 13:39	120
<b>137</b>			<b>Second pass, counted by LQ</b>
Along coast heading W from Kvichak to Nushagak at ~ 13:51		225	First pass, counted by LQ
		178	Second pass, counted by LQ
		95	Third pass, counted by AB
		150	Fourth pass, counted by LQ
		130	Fifth pass, counted by AB
		<b>153</b>	<b>Sixth pass, counted by LQ</b>
Mouth of Snake River at ~ 14:57		47	First pass, counted by AB
		65	Second pass, 15 counted by LQ, 50 counted by AB
		83	Third pass, counted by AB
		<b>103</b>	<b>Fourth pass, counted by LQ</b>
4		Mouth of Snake River at ~ 10:47	118
	95		Second pass, counted by AB, white caps
	<b>61</b>		<b>Third pass, counted by LQ</b>
	28		Fourth pass, 2 counted by LQ, 26 counted by AB
	46		Fifth pass, counted by LQ
	46		Sixth pass, 6 counted by LQ, 40 counted by AB, while flying W transect
6	Mouth of Snake River at ~ 10:09	62	First pass, counted by AB
		73	Second pass, 21 counted by AB, 52 counted by LQ
		<b>132</b>	<b>Third pass, 54 counted by LQ, 78 counted by AB</b> (group was too spread out to fly around and so split by flying up the middle)
	Mouth of Kvichak River ~ 11:40	111	First pass, counted by LQ
		109	Second pass, counted by LQ
		<b>198</b>	<b>Third pass, 79 counted by LQ, 119 counted by AB</b>
		196	Fourth pass, 64 counted by LQ, 132 counted by AB
		187	Fifth pass, 122 counted by LQ, 65 counted by AB

Table 2 continued.

Survey	Group location	Count	Details
7	Along W coast of Kvichak Bay at ~13:28 Mouth of Snake River at ~14:50	<b>141</b>	<b>First pass, 113 counted by LQ, 28 counted by AB</b>
		46	Second pass, 46 counted by LQ, too much glare
		113	Third pass, 109 counted by LQ, 4 counted by AB
		63	First pass, 18 counted by LQ, 45 counted by AB
		162	Second pass, counted by AB
		188	Third pass, 176 counted by AB, 12 counted by LQ
		162	Fourth pass, counted by LQ
		210	Fifth pass, counted by AB from higher altitude (1500') because group spread broadly
		238	Sixth pass, counted by LQ from higher altitude (1500')
		<b>252</b>	<b>Seventh pass, 125 counted by LQ, 127 counted by AB from higher altitude (1500')</b>

### Acknowledgements

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Appendix A. Commuting, aerial survey, and refueling times by date for 2022 Bristol Bay beluga whale surveys.

Date	Survey	Time	Duration	Action
9 July	1	11:44 – 12:57	1 hr 13 min	Commute Anchorage to Naknek River
		12:57 – 14:07	1 hr 10 min	Partial survey from Naknek to Dillingham.
10 July	2	09:50 – 09:54	4 min	Depart Dillingham
		09:54 – 12:17	2 hr 23 min	Survey 2
		12:17 – 12:21	4 min	Land in King Salmon
		12:21 – 13:06	45 min	Refuel in King Salmon
10 July	3	13:06 – 13:15	9 min	Depart King Salmon
		13:15 – 15:25	2 hr 10 min	Survey 3
		15:25 – 15:35	10 min	Land in Dillingham
11 July	4	10:21 – 10:31	10 min	Depart Dillingham
		10:31 – 13:15	2 hr 44 min	Survey 4
		13:15 – 13:25	10 min	Land in King Salmon
		13:25 – 14:15	50 min	Refuel in King Salmon
11 July	5	14:15 – 14:25	10 min	Depart King Salmon
		14:25 – 16:32	2 hr 7min	Survey 5
		16:32 – 16:45	13 min	Land in Dillingham
12 July	-	-	-	No surveys-low ceiling and high winds
13 July	6	09:42 – 10:00	18 min	Depart Dillingham
		10:00 – 12:16	2 hr 16 min	Survey 6
		12:16 – 12:25	9 min	Land in King Salmon
		12:25 – 12:57	32 min	Refuel in King Salmon
13 July	7	12:57 – 13:07	10 min	Depart King Salmon
		13:07 – 15:38	2 hr 31 min	Survey 7
		15:38 – 15:50	12 min	Land in Dillingham
14 July	-	-	-	No surveys- low ceiling and high winds. Forecast for poor weather to continue for several days. Ended survey efforts for 2022.
	-	12:45 – 14:30	1 hr 45 min	Commute from Dillingham to Anchorage