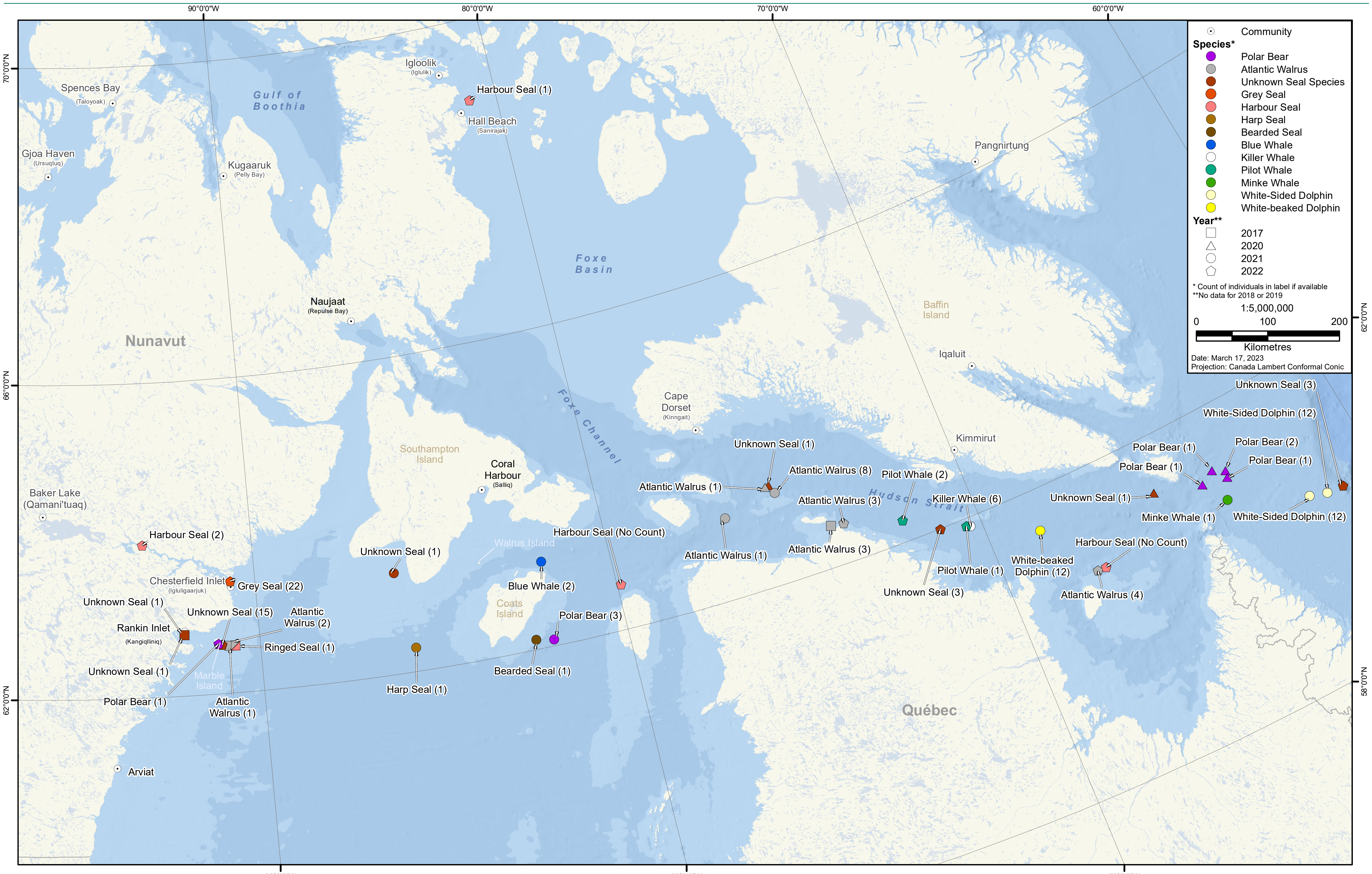

Figure 3.2-6: Incidental Observations of Marine Mammals, 2017 to 2022

Table 3.2-4: Number[1] of Marine Mammals Observed during Surveys and Incidentally[2] between 2017 and 2022[3]

Species	2017	2019	2020	2021	2022	Total
Bowhead whale	-	3	-	-	-	**3**
Fin whale[4]	-	1	-	1	2	**4**
Killer whale	-	8	-	6	-	**14**
White-beaked dolphin	-	-	15	12	-	**27**
Unknown dolphin species	-	-	15	5	-	**20**
Harp seal	-	4	-	2	-	**6**
Harbour seal	-	-	1	9	5	**15**
Ringed seal	1	-	-	1	-	**2**
Unknown seal	2	-	4	29	37	**72**
Atlantic Walrus	6	-	4	10	8	**28**
Polar bear[4]	-	1	8	3	1	**13**
Blue whale[4,5]	-	-	-	2	-	**2**
Minke whale	-	-	-	1	-	**1**
White-sided dolphin	-	-	-	24	-	**24**
Long-finned Pilot Whale	-	-	-	-	3	**3**
Beluga whale	-	-	-	11	-	**11**
Unknown Whale	-	-	-	-	1	**1**
Grey Seal	-	-	-	-	22	**22**
Bearded seal	-	-	-	6	82	**88**
Total	9	17	47	122	161	**356**

[1] *Numbers are given as individuals observed not number of separate sightings.*

[2] *Marine mammals observed both during dedicated surveys and off-effort are included in the table. Note that all sightings in 2017 were incidental, in 2019 were during dedicated surveys, and during 2020 through 2022 were both during surveys and incidental.*

[3] *No sightings were recorded in 2018.*

[4] *Species listed on Schedule 1 of the federal* Species at Risk Act *(SARA).*

[5] *It is possible that the blue whale sighting was not identified properly while on the vessel, as it would be a rare occurrence for a blue whale to be recorded in Hudson Bay.*

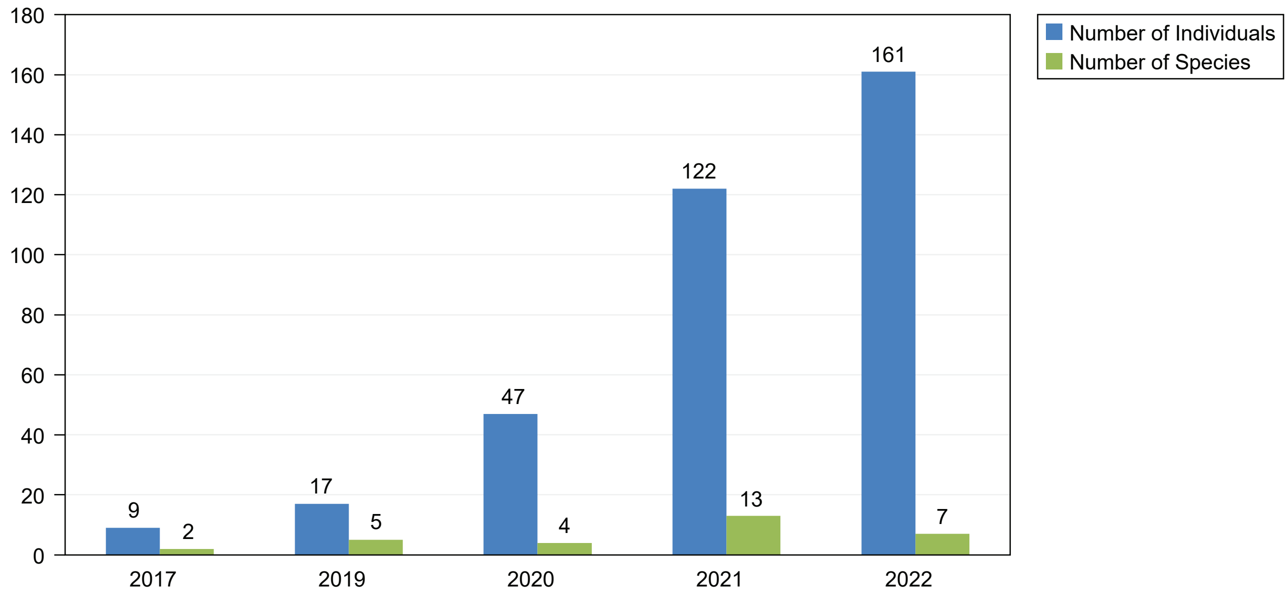

Figure 3.2-7: Number of Marine Mammal Individuals and Number of Species Observed, 2017 to 2022

3.3 Seabird Observations

3.3.1 Survey Effort

Seabird surveys have been conducted since 2018. Surveys were conducted in 2022 by dedicated MMSOs between Hudson Straight and Rankin Inlet/Helicopter Island between July 4 and November 10 on board various Groupe Desgagnés and Woodward vessels. In 2022, 163 transects with known distance effort were surveyed while the vessel was moving, with 10,423 km of seabird survey distance recorded over 98 hours (Table 3.3-1; Figure 3.3-1). An additional 19 hours of stationary surveys were conducted while the vessel was anchored (Table 3.3-2).

Some surveys did not have effort recorded; surveys without spatial effort did not have location coordinates recorded at the start and/or end of the surveys, while surveys without temporal effort did not have the start and/or end times recorded. Surveys without spatial effort were not used for analysis (Table 3.3-1). Appendix E summarizes all seabird surveys and Appendix F summarizes all seabird sightings.

Spatial effort for moving surveys increased with each survey year, with 2022 having the highest spatial effort (Table 3.3-1). Spatial effort in 2022 was nearly one and a half times the effort of 2021, and more than triple the effort of earlier years of surveying (Table 3.3-1). Contrary to spatial effort, 2022 had the lowest temporal effort for moving surveys. The change in temporal effort is likely attributed to the change in survey methods in 2022, which involved successful implementation of six short consecutive survey periods opposed to one long survey period. Additionally, low temporal effort may be due to vessels moving faster, covering more distance during a survey.

Stationary vessel surveys were conducted in similar numbers as recent years, however 70% of surveys did not have a time recorded (105 surveys with no effort; Table 3.3-2). The number of stationary vessel surveys with effort in 2022 were roughly 60% lower than 2020 and 2021 (Table 3.3-2).

3.3.1.1 Environmental Variables and Weather Conditions during Surveys

Key environmental variables that have the potential to impact seabird detection were plotted for visual assessments of trends in detection (Figure 3.3-2). Detections varied across weather conditions and years without clear trends in most cases; this indicates that detectability was not greatly affected by variable weather conditions. Detections appear lower in some severe adverse weather, including snow, gale force winds, and very rough sea states (Figure 3.3-2). However, there were relatively few surveys conducted in these adverse conditions, making trends difficult to determine; these observations only represent a handful of the thousands of detections recorded across all years of surveys, so it is unlikely that the overall detection estimates are impacted by weather variables. Models were created without covariates like weather variables due to low sample sizes restricting model fit. However, visual assessment indicates this omission is not likely impacting model results.

3.3.2 Moving Vessel Seabird Observations 2018 to 2022

Analyses included only on-transect sightings and did not use re-sightings of the same birds. Table 3.3-3 summarizes samples sizes for surveys, detections (groups) and individuals (total number of birds). The average number of detections and the average number of individuals per detection varies across years and survey type (stationary/ moving). The number of seabird detections during moving vessel surveys was highest in 2022 compared to other years (n = 535; Table 3.3-3). However, the average number of individuals per detection in 2022 was 60% lower than 2019 through 2021, but comparable to detections in 2018. This indicates that seabirds were recorded in much smaller group sizes in 2022.

Table 3.3-1: Temporal and Spatial Effort for Moving Vessel Seabird Surveys, 2018 to 2022

Year	Temporal Effort			Spatial Effort		
	Effort (hr)	No. of Transects with Effort	No. of Transects with No Effort[1]	Effort (km)	No. of Transects with Effort	No. of Transects with No Effort[2]
2018	139.87	72	7	407.1	33	46
2019	119.85	87	4	2,290.8	79	12
2020	111.88	84	14	3,614.8	79	20
2021	173.87	173	24	7,176.7	170	27
2022	98.47	182	46	10,423.3	163	65

[1] *Surveys without distance effort did not have location coordinates recorded at the start and/or end of the surveys.*

[2] *Surveys without temporal effort did not have the start and/or end times recorded.*

Table 3.3-2: Temporal Effort for Stationary Seabird Surveys, 2018 to 2022

Year	Effort (hr)	No. of Points with Effort	No. of Points with No Effort[1]
2018	18.75	5*	0
2019	19.82	15	27
2020	152.00	104	40
2021	152.37	111	3
2022	19.65	41	105

** Surveys in 2018 did not include locations; therefore, these observations were not used in analysis.*

[1] *Surveys with No Effort did not have start and/or end times recorded.*

Table 3.3-3: Seabird Survey Sample Sizes for Moving Vessel and Stationary Surveys, 2018 to 2022

Year	Moving Vessel Surveys				Stationary Vessel Surveys			
	Transects	Detections	Individuals	Avg. Indiv/ Detection	Points	Detections	Individuals	Avg. Indiv/ Detection
2018	33	150	574	3.82	5	0*	0*	-
2019	79	271	1,639	6.04	42	22	24	1.09
2020	79	116	683	5.89	144	103	536	5.20
2021	170	459	2,850	6.21	115	145	1,268	8.74
2022	163	535	2,006	3.75	142	131	764	5.83

** Locations were not given for 2018 stationary vessel data. Therefore, these observations were not used in analysis.*

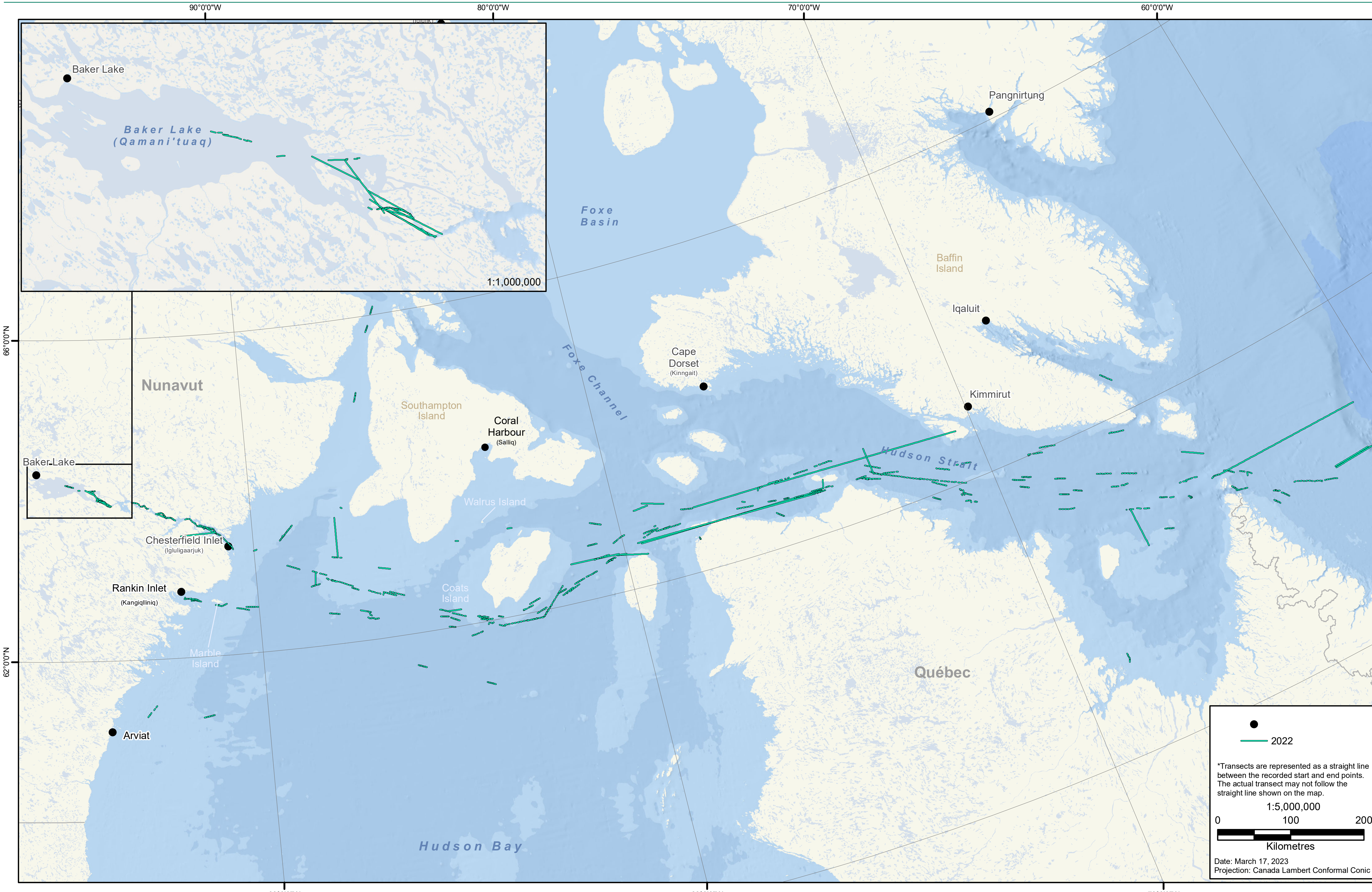

Figure 3.3-1: Moving Transect Seabird Survey Effort, 2022

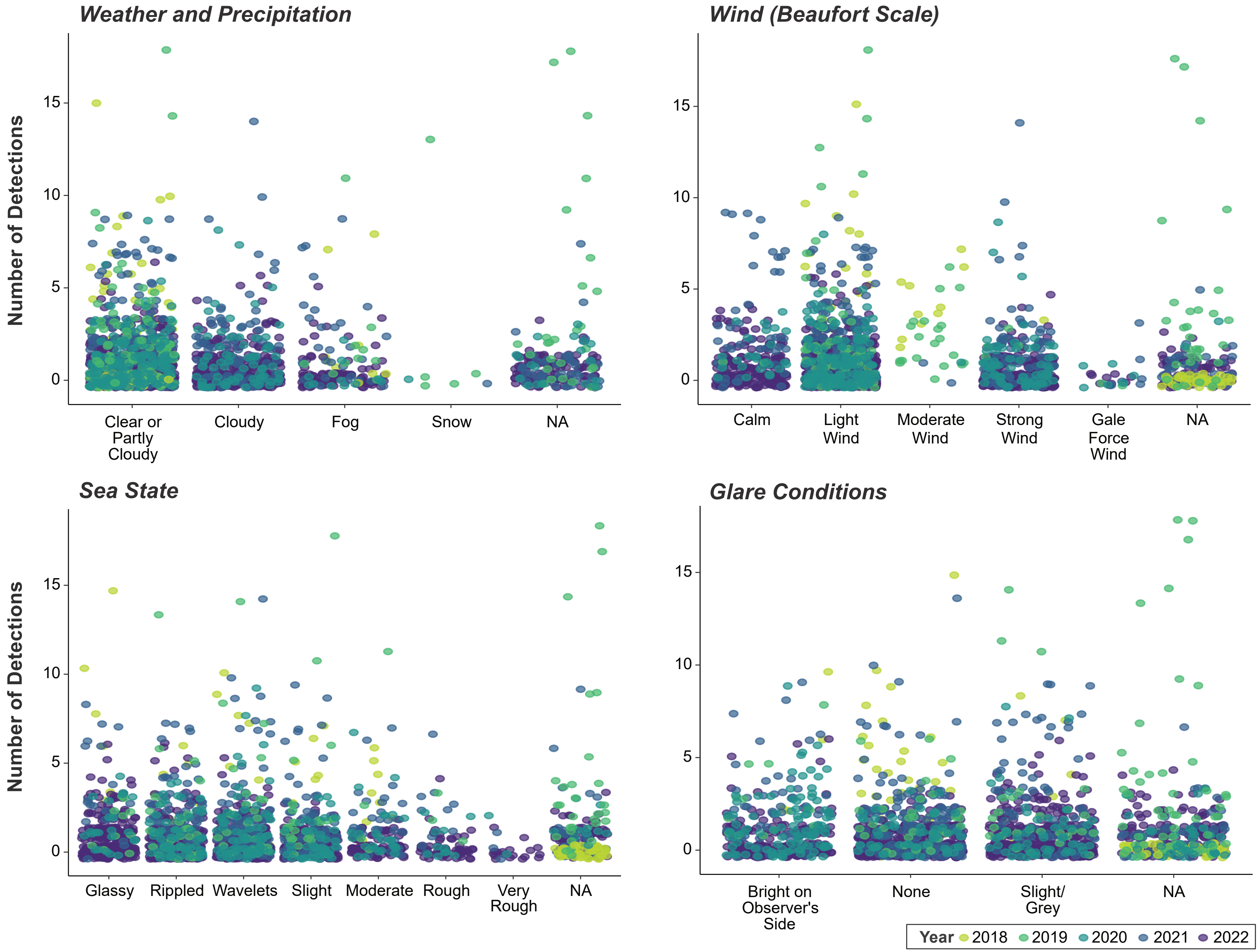

Figure 3.3-2: Weather Variables Summarized by Seabird Detections

3.3.2.1 Species Present

Compared to previous yearly sightings, the 2022 survey year had the second highest number of individuals birds recorded, with a total of 2,328 individual birds belonging to 27 known species and five unknown species (Table 3.3-4). Across all five years of surveys between 2018 and 2022, 8,624 individual birds belonging to 38 known species and nine unknown species have been recorded during moving vessel surveys (Table 3.3-4; Figure 3.3-3).

There were no new species recorded in 2022 during moving vessel surveys. The most common species recorded in 2022 were northern fulmar (n = 678), razorbill (n = 235), herring gull (n = 178), and common murre (n = 161). For the second year, common murre were reported in large numbers; while they can occur in the eastern portion of the shipping zone near Newfoundland, they are not common through the majority of the survey area. It is possible that identifications of common murre were actually thick-billed murre, which occur throughout the survey area. Across all years, thick-billed murre and northern fulmar are consistently among the most commonly recorded species. Potential mis-identifications of species which are out of range have occurred in previous years, but typically in low numbers, such as records of great cormorant and great shearwater (Table 3.3-4).

3.3.2.2 Distance Analysis: Seabird Detection and Density Estimates

Distance analysis was conducted for moving vessel surveys in each year between 2019 and 2022 and all years combined (2018 to 2022). No distance model was fit independently for 2018 due to a low number of surveys.

As described in the methods, seabird observations were analyzed using distance analysis, which accounts for the fact that animals are easier to see when they are closer to the observer. The first step in this analysis is to examine whether the detectability curve (the change in detectability with distance from observer) and the detection estimate (probability of detecting a bird within the 300 m survey area) is the same between years.

Model fitting was mostly consistent across years, indicating that the detectability curve was the same between years of the study (according to AIC rankings and detectability estimates; Appendix G). The best model fits in all years were hazard rate functions, which means that detection remains high at closer distances (i.e., birds are just as likely to be detected within 100 m of an observer) but drops off steeply as distance increases. Detectability estimates were also consistent between years, ranging from 0.337 in 2020 to 0.500 in 2022 (Table 3.3-5). A higher detection estimate indicates that seabirds are more likely to be seen and recorded, even if they are a greater distance away from the ship/observer. The detectability estimate itself is not a key result, but consistency in estimates indicates that data are similar across years. In 2022, the standard error of the detectability estimate was much higher (0.25 compared to 0.021-0.056 in other years; Appendix G). The higher standard error is likely due to the volume of survey intervals with no observations in 2022, given that data were split into five-minute survey windows rather than broader 30-minute surveys. A larger volume of short surveys with fewer observations per survey may have altered the variability in the survey data, which is reflected in the higher standard error estimate.

The second part of distance sampling is to estimate the density, in this case the density of seabirds, accounting for the lower detectability with greater distance. Predicted seabird densities varied across years, with the highest density predicted in 2019 (1.879 birds/ km^2), which was nearly four times higher than the lowest predicted density in 2022 (0.473 birds/ km^2; Table 3.3-5). The differences in estimated density are a reflection of variability in the effort and number of birds detected between years. The spatial effort of surveys in 2022 was higher than all previous years, but the number of seabirds recorded was similar to recent years (see Tables 3.3-1 and 3.3-3), which translates to a much lower estimated seabird density in 2022.

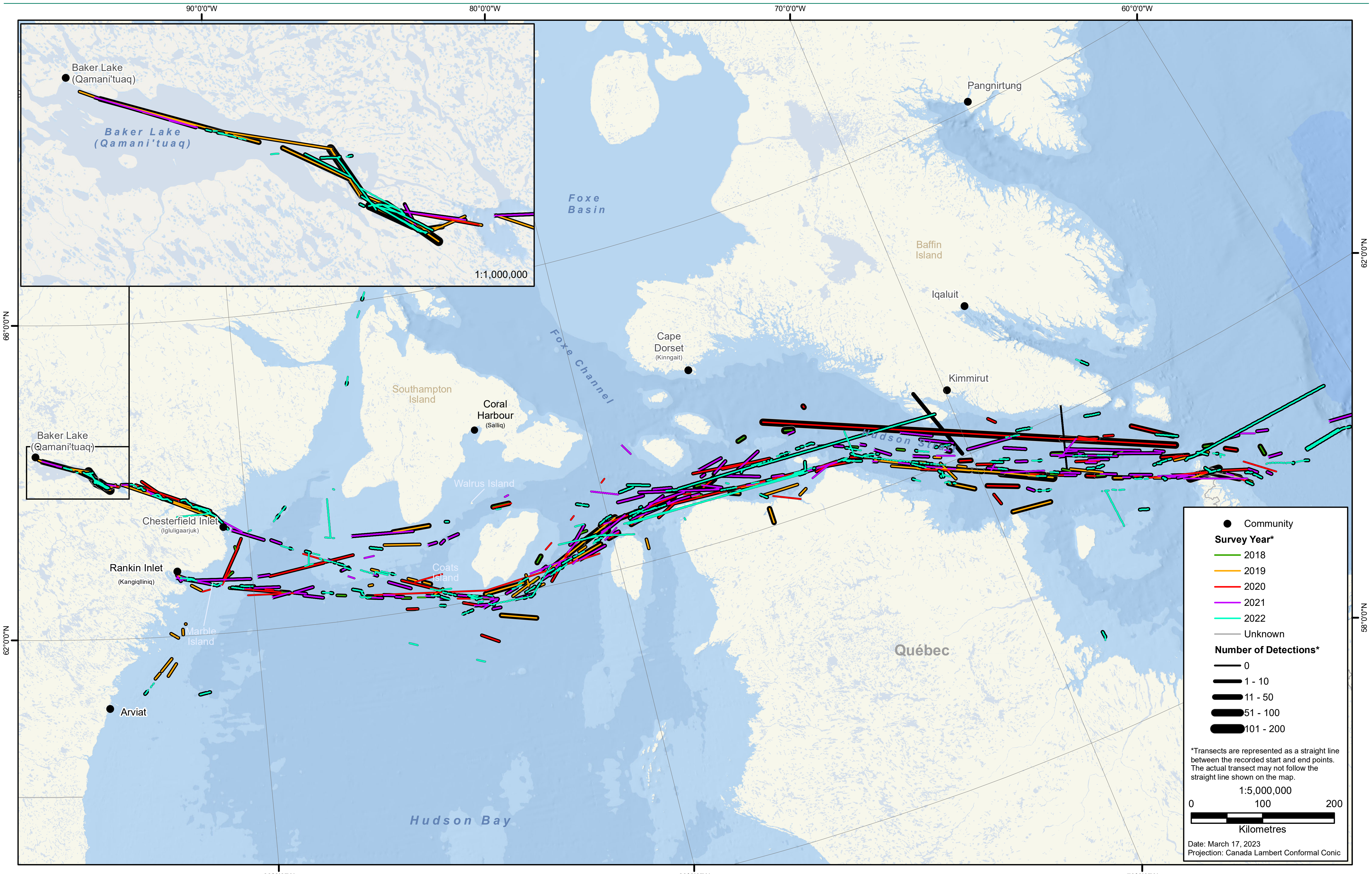

Figure 3.3-3: Seabird Detections during Moving Vessel Surveys, 2018 to 2022

Table 3.3-4: Bird Species Recorded during Moving Vessel Seabird Surveys, 2018 to 2022

Species	Scientific Name	2018-2019	2020	2021	2022	Total
Arctic Tern	*Sterna paradisaea*	0	0	5	0	**5**
Bald Eagle	*Haliaeetus leucocephalus*	2	0	1	1	**4**
Black-legged Kittiwake	*Rissa tridactyla*	12	3	0	0	**15**
Black Guillemot	*Cepphus grylle*	151	0	6	61	**218**
Black Scoter	*Melanitta americana*	4	2	4	2	**12**
Cackling/Canada Goose	*Branta hutchinsii/ canadensis*	100	0	15	8	**123**
Common Eider	*Somateria mollissima*	16	81	76	5	**178**
Common Loon	*Gavia immer*	33	2	10	5	**50**
Common Murre	*Uria aalge*	40	3	538	161	**742**
Dovekie	*Alle alle*	103	19	87	41	**250**
Glaucous Gull	*Larus hyperboreus*	175	33	77	15	**300**
Great Cormorant	*Phalacrocorax carbo*	0	8	1	2	**11**
Great Shearwater	*Puffinus gravis*	0	1	0	1	**2**
Great Skua	*Stercorarius skua*	0	48	1	2	**51**
Harlequin Duck[1]	*Histrionicus histrionicus*	10	0	0	0	**10**
Herring Gull	*Larus argentatus*	288	73	111	178	**650**
Iceland Gull	*Larus glaucoides*	78	4	30	3	**115**
Ivory Gull[2]	*Pagophila eburnea*	2	0	0	0	**2**
Leach's Storm-petrel	*Oceanodroma leucorhoa*	8	0	16	5	**29**
Least Sandpiper	*Calidris minutilla*	5	1	0	0	**6**
Long-tailed Duck	*Clangula hyemalis*	7	0	14	7	**28**
Long-tailed Jaeger	*Stercorarius longicaudus*	7	0	1	5	**13**
Manx Shearwater	*Puffinus puffinus*	3	0	122	6	**131**
Northern Fulmar	*Fulmarus glacialis*	196	300	391	678	**1565**
Parasitic Jaeger	*Stercorarius parasiticus*	0	14	25	7	**46**
Peregrine Falcon	*Falco peregrinus*	3	1	3	0	**7**
Pomarine Jaeger	*Stercorarius pomarinus*	8	48	1	24	**81**
Razorbill	*Alca torda*	0	2	63	235	**300**
Red-breasted Merganser	*Mergus serrator*	0	2	5	4	**11**
Ruddy Turnstone	*Arenaria interpres*	1	0	0	0	**1**
Sabine's Gull	*Xema sabini*	4	5	0	0	**9**
Snow Goose	*Chen caerulescens*	542	10	1	32	**585**
Snowy Owl	*Bubo scandiacus*	1	0	7	0	**8**
Sooty Shearwater	*Ardenna grisea*	0	2	9	15	**26**

Species	Scientific Name	2018-2019	2020	2021	2022	Total
Thayer's Gull	*Larus thayeri*	5	1	0	0	**6**
Thick-billed Murre	*Uria lomvia*	369	90	800	84	**1,343**
White-winged Scoter	*Melanitta deglandi*	0	5	3	0	**8**
Wilson's Storm-petrel	*Oceanites oceanicus*	31	0	23	4	**58**
Unknown Bird		87	0	101	2	**190**
Unknown Duck		103	3	73	40	**219**
Unknown Falcon		1	2	2	0	**5**
Unknown Goose		0	0	6	1	**7**
Unknown Gull		82	152	108	234	**576**
Unknown Hawk		2	0	1	0	**3**
Unknown Jaeger		3	0	0	0	**3**
Unknown Murre		0	43	113	460	**616**
Unknown Sandpiper		6	0	0	0	**6**
Total		**2,488**	**958**	**2,850**	**2,328**	**8,624**

[1] *Species listed as Special Concern on Schedule 1 of the federal* Species at Risk Act *(SARA).*

[2] *Species listed as Endangered on Schedule 1 of the federal* Species at Risk Act *(SARA).*

Table 3.3-5: Detection and Density Estimates by Year (2019 to 2022) during Moving Vessel Surveys

Year	Detection Estimate	Detections 95% CIs[1]	Density (birds/ km^2)	Density 95% CIs[1]
All Years	0.419	0.374 – 0.465	0.917	0.822 – 1.022
2019	0.426	0.316- 0.537	1.879	0.421- 3.170
2020	0.337	0.272- 0.402	0.701	0.421- 1.169
2021	0.425	0.385- 0.465	1.072	0.509- 2.261
2022	0.500	0.450 – 0.551	0.473	0.427 – 0.523

[1] *Confidence Intervals (CIs). Values indicate the range in which 95% of samples fall.*

Variability in the number of birds detected is driven by several elements, including random occurrence of large flocks (e.g., 100 to 200 birds), observer experience, local habitat variation near islands or channels, and time of day. These are differences in the number of birds encountered/recorded, rather than true differences in regional bird abundance. Therefore, the density estimate for all years of data together is likely the most accurate.

3.3.3 Stationary Vessel Seabird Observations 2019 to 2022

3.3.3.1 Species Present

A total of 2,592 individuals from 29 known species and eight unknown species were recorded during stationary vessel surveys from 2019 to 2022 (Table 3.3-6, Figure 3.3-4). Nearly 50% of records were from 2021 (n = 1,268 individuals), and the remaining records were almost all from 2022 (n = 764) and 2020 (n = 536). In 2022, several species were recorded for the first time during stationary surveys, including dovekie, long-tailed duck, and parasitic jaeger; however, all were species that have been previously recorded during the moving vessel surveys (Table 3.3-6). The most common species recorded in 2022 were unknown gull (n = 206), snow goose (n = 182), and cackling/Canada goose (n = 90; Table 3.3-6). Snow goose was also among the most common species recorded in 2020 and 2021. Geese are likely recorded more frequently in stationary vessel surveys because many of these occur near shores, opposed to moving vessel surveys which happen throughout the open water areas.

Table 3.3-6: Bird Species Recorded during Stationary Vessel Seabird Surveys, 2019 to 2022

Species	Scientific Name	2019	2020	2021	2022	Total
American Crow	*Corvus brachyrhynchos*	0	1	0	0	**1**
Arctic Tern	*Sterna paradisaea*	0	1	0	0	**1**
Black-legged Kittiwake	*Rissa tridactyla*	0	8	0	0	**8**
Black Guillemot	*Cepphus grylle*	1	4	17	48	**70**
Black Scoter	*Melanitta Americana*	2	0	9	8	**19**
Cackling/Canada Goose	*Branta hutchinsii/ canadensis*	0	25	447	90	**562**
Common Eider	*Somateria mollissima*	0	8	3	11	**22**
Common Loon	*Gavia immer*	0	0	2	2	**4**
Common Murre	*Uria aalge*	0	0	20	2	**22**
Dovkie	*Alle alle*	0	0	0	17	**17**
Glaucous Gull	*Larus hyperboreus*	4	18	6	16	**44**
Great Cormorant	*Phalacrocorax carbo*	0	0	1	0	**1**
Great Skua	*Stercorarius skua*	0	0	2	0	**2**
Herring Gull	*Larus argentatus*	6	64	41	64	**175**
Iceland Gull	*Larus glaucoides*	0	0	2	19	**21**
Leach's Storm-petrel	*Oceanodroma leucorhoa*	0	1	1	0	**2**
Long-tailed Duck	*Clangula hyemalis*	0	0	0	2	**2**
Northern Fulmar	*Fulmarus glacialis*	2	170	147	45	**364**
Parasitic Jaeger	*Stercorarius parasiticus*	0	0	0	1	**1**
Peregrine Falcon	*Falco peregrinus*	3	5	0	0	**8**
Pomarine Jaeger	*Stercorarius pomarinus*	1	4	5	1	**11**
Razorbill	*Alca torda*	0	3	0	7	**10**
Red-breasted Merganser	*Mergus serrator*	0	0	1	1	**2**
Sandhill Crane	*Grus canadensis*	0	1	0	0	**1**

Species	Scientific Name	2019	2020	2021	2022	Total
Snow Goose	*Chen caerulescens*	0	176	419	182	**777**
Snowy Owl	*Bubo scandiacus*	0	1	0	0	**1**
Thick-billed Murre	*Uria lomvia*	0	17	0	3	**17**
White-winged Scoter	*Melanitta deglandi*	0	2	0	0	**2**
Wilson's Storm-petrel	*Oceanites oceanicus*	0	0	2	0	**2**
Unknown Bird		1	0	35	0	**36**
Unknown Duck		0	0	48	23	**71**
Unknown Falcon		0	2	0	0	**2**
Unknown Goose		0	0	0	7	**7**
Unknown Gull		4	17	59	206	**286**
Unknown Hawk		0	0	1	0	**1**
Unknown Murre		0	6	0	9	**6**
Unknown Sandpiper		0	2	0	0	**2**
Total		**24**	**536**	**1,268**	**764**	**2,592**

3.3.3.2 Distance Analysis: Seabird Detection Estimate

Stationary vessel surveys had lower sample sizes and, therefore, limited model fitting capabilities. Distance models were run for 2020, 2021, 2022 and for all years combined (2019 through 2022), though very little data were collected in 2019.

Only detection estimates were calculated for stationary vessel surveys. Density estimates could not be calculated because stationary effort requires repeated surveys at the same locations. While several of the stationary vessel surveys were conducted at anchor in Rankin Inlet, the sample size is currently too small for modelling. However, with additional sampling modelling for a density function may be possible in future years.

Detection estimates indicate the relative likelihood that a seabird will be detected within the survey area if it is there, taking into account the lower detectability when birds are farther away from the observer. A higher detection estimate indicates that seabirds are more likely to be seen and recorded, even if they are a greater distance away from the ship/observer.

The three key model selections were fit to estimate how quickly detectability changes with distance from the observer. Of the three model selection functions, hazard-rate models performed the best by AIC rating for all years of data combined (Table 3.3-7). However, the detection estimates for the top four AIC rated models were low (0.027 – 0.036; Table 3.3-7) with relatively high standard errors, making the detection estimates unpredictable and indicating poor model fit. Therefore, the half-normal model was selected as the most representative for all years of data because it indicated a reasonable detection estimate and standard error (Table 3.3-7). The half-normal model estimates that detection decreases gradually with greater distance from the observer. Although the model fitting was less consistent for the stationary vessel data compared to the moving vessel surveys, detection estimates for stationary vessel surveys were consistent between years, suggesting that results are likely reliable (Table 3.3-8).