Distribution, Abundance, and Trends of Harbor Porpoise (*Phocoena phocoena*): Glacier Bay National Park and Preserve and Adjacent Waters of Icy Strait

Marilyn Dahlheim, Alex Zerbini, Janice Waite, and Amy Kennedy
National Marine Mammal Laboratory
Seattle, Washington

Introduction

In 1991, the National Marine Mammal Laboratory (NMML) initiated harbor porpoise *(Phocoena phocoena*) studies aboard the NOAA *R/V John N. Cobb* with survey coverage throughout the inland waters of Southeast Alaska. Between 1991 and 1993, line-transect methodology was used to: 1) define overall distribution patterns and seasonality of harbor porpoise, 2) obtain population estimates of harbor porpoise, and 3) establish a baseline for detecting trends in abundance. Three surveys were carried out each year spanning spring, summer, and fall by a team of six observers. During the years 1994 and 2005 two trips per year were conducted: one either in spring or summer and the other in fall. The objectives of these surveys were to study killer whales and humpback whales in Southeast Alaska. Standard line-transect methodology was not used, but all cetacean species observed were recorded. During this 12-year period, observers reported fewer overall encounters with harbor porpoise. Although this raised concerns, our confidence in these data was low due to lack of quantification of effort, variable number of surveys per year, differences in methodology, and differences in survey coverage and duration.

To fully assess abundance and population trends for harbor porpoise, NMML, with the assistance of the Alaska Regional Office, conducted line-transect surveys in 2006, 2007, 2010, and 2011 using methods comparable to those employed during the early 1990s. In 2006, we successfully completed spring and summer surveys. Mechanical problems aboard the R/V *John N. Cobb* caused cancellation of the fall 2006 survey. In 2007, we successfully completed the spring, summer, and fall surveys. In 2010 and 2011, two successful surveys were completed aboard NOAA charter vessels - one each in summer and fall.

Here we report on the distribution, abundance, and trends of harbor porpoise occupying the waters of Glacier Bay, Icy Strait, Cross Sound, Port Frederick, and Excursion Inlet.

Field Methodology (1991-1993)

Surveys were carried out aboard the NOAA vessel *John N. Cobb.* The ship was 28.36 m (93 ft) long with a bridge height of 4.27 m (14 ft). Line-transect methodology was employed following pre-determined tracklines. During line-transect surveys, sighting data were collected by three observers (one starboard, one port and one recorder). A full observer rotation took two hours, spending 40-minutes at each station. A two-hour rest

period occurred for each observer after each full-watch rotation. There was a complement of six biologists for each survey. Observational teams were not fixed.

Port and starboard observers used 7 X 50 Fujinon binoculars to search from 0 degrees (ship's bow) to 90 degrees. Scanning techniques were standardized with 32 minutes (or 80%) of the 40-minute watch spent scanning with the binoculars and 8 minutes scanning with the naked eye. To reduce fatigue, binoculars were supported by adjustable metal poles which were either hand-held or rested on the observers' hips. The recorder searched for porpoise by scanning both sides of the ship from the bridge with the naked eye. Binoculars were used by the recorder to confirm sighting identifications and numbers. Sightings made by the officers, crew, and off-watch observers were recorded as "off-effort" and were not used in density estimate calculations.

A Magnovox MX200 GPS unit was connected directly to a portable computer on the bridge. The date, time, and position of the ship were automatically entered into a data file every ten minutes and whenever data were entered by the recorder. Search effort was recorded on the computer by marking the beginning and end of each transect. The Beaufort sea state, weather description (rain and fog), visibility index, and observer positions (port, recorder and starboard) were also entered. A new entry was made whenever a course, weather, or personnel change occurred.

When a sighting was made, the recorder entered the following data: angle, number of reticles to the sighting, radar distance (nm) to the shoreline at the same angle of the sighting, the species, the number seen (best, high and low counts), and the direction of travel of the animal(s). The sighting angle was obtained from peloruses mounted on the port and starboard bridge. To obtain distance to a sighting, Fujinon binoculars equipped with internal reticles were used. The number of the reticle to the sighting was obtained by placing the top reticle on the horizon or shoreline and counting down to the location of the sighting. If the sighting fell between reticles, fractions were noted.

Field Methodology (2006, 2007, 2010, 2011)

In 2006 and 2007, the NOAA vessel *John N. Cobb* continued to be used as the survey platform. Unfortunately the NOAA vessel experienced a catastrophic engine failure and was decommissioned in 2008. Therefore in 2010 and 2011, three different charter vessels were used to conduct our surveys: the F/V Steller in July 2010, the F/V Northwest Explorer in September 2010, and the R/V Medeia in June and September 2011. Similar field methods as those conducted in the early 1990s were employed during these surveys and similar geographical areas were examined. For the 2006 and 2007 surveys, sighting data were collected by a team of four observers. A full observer rotation took one and a half hours, spending 30 minutes at each station. In this case, the observer only had a rest period of 30 minutes between watches. In 2010, data were collected by a team of five observers. A full observer rotation took one and a half hours, spending 30 minutes at each station. A rest period of one hour occurred between watches. In 2011, data were collected by a team of six observers rotating through a 30-minute period per station with a 1.5 hour rest period between watches.

To gather positional and navigational information the data computer was either interfaced directly to the ship's GPS system (2006 and 2007) or connected to a portable GPS unit (2010 and 2011). The computer program WINCRUZ was used to record all sighting and environmental data (e.g., cloud cover, wind strength and direction, and sea conditions). All other data collection field methods (i.e., scanning techniques, field equipment) were similar to those conducted in the early 1990s.

Analysis

Detailed abundance and trend analysis is described in both Dahlheim et al. (In prep.) and Zerbini et al. (In prep.), respectively. For this study, five strata were identified for the Glacier Bay/Icy Strait regions (1, 2, 3, 30 and 31, see Figure 1). These five strata were combined when assessing abundance and trends given that we believe harbor porpoise represent one distinct sub-population in this particular region. Stratum 1 includes the western waters of Icy Strait and Cross Sound. Stratum 2 includes the eastern waters of Icy Strait. Stratum 3 represents the waters of Glacier Bay National Park. Stratums 30 and 31 represent the areas of Port Frederick and Excursion Inlet, respectively.

Results

Harbor porpoise were seen throughout the inland waters of Southeast Alaska in clumped distribution. Greater densities were observed in the Glacier Bay/Icy Strait regions (to include Excursion Inlet and Port Frederick) and near Zarembo and Wrangell Islands and adjacent waters of Sumner Strait. These two areas of porpoise concentrations persisted throughout all three seasons and years sampled. Harbor porpoise distribution, seasonal occurrence, and group size estimates are published in Dahlheim et al. (2009).

For the Glacier Bay and Icy Strait areas, eighteen line-transect vessel surveys (4 in spring, 7 in summer, and 7 in fall) were completed. Stratum-specific areas and realized survey effort are summarized in Table 1. Effort tracklines, along with harbor porpoise sightings by season, are depicted for each year in which line-transect surveys were conducted (1991, 1992, 1993, 2006, 2007, 2010, and 2011; Figures 2-8). Although sightings observed in the 2011 season are included here, abundance and trend data for 2011 are currently being analyzed and as such are not included in this report.

Table 2 summarizes stratum-specific and total estimates of density and abundance of harbor porpoise. Areas of high densities were consistently found each year near Glacier Bay and the adjacent waters of Icy Strait. Total abundance, combining the five strata, was highest in 2010 (*N=512*, CV=0.25) and lowest in 2006 (N=191, CV = 0.23), but these are not directly comparable because sampling coverage was different across years.

Population trends (r) for all inland waters of Southeast Alaska (Figure 1) were estimated at -2.9%/year (95% probability interval [PI] = -9.0%/year, + 1.7%/year) with a Bayesian exponential model. The model indicated there is a 93.9% probability that the population is declining (Table 3). Population trend was also estimated for Glacier Bay/Icy Strait at

-0.9%/year (95% PI = - 7.8%/year, + 4.8%/year). This result suggests that there was a slight decline in the harbor porpoise population occurring in Glacier Bay/Icy Strait region between the early 1990s and the late 2000s (the probability of negative trends for this population over this period was 67.4%). It should be noted that we do expect a slight change in both abundance and trend values once the 2011 data are included in these estimates.

Discussion

Two areas within Southeast Alaska inland waters contained annual concentrations of harbor porpoise (Dahlheim et al, 2009). These included Glacier Bay/Icy Strait and the Wrangell/Zarembo Islands areas; a pattern that has persisted over the 20-year course of our study. These distinct, persistent clusters, along with the overall geography of the area, suggest that harbor porpoise inhabiting these two different areas most likely represent distinct sub-populations. Although harbor porpoise within the Glacier Bay/Icy Strait region undoubtedly move frequently among the five northern strata identified in this report, large scale movements most likely don't occur. Small-scale, localized movements by this species have also been reported for other geographical areas (e.g., Washington State waters; Chivers et al., 2002). In comparing data collected recently (2006, 2007, and 2010) to that collected in the early 1990s, a downward population trend is occurring throughout the entire study area. Although there is a probability of a decline in the Glacier Bay/Icy Strait regions (calculated at 67.4%), the probabilities of a decline are much more severe in other areas of Southeast Alaska (e.g., Zarembo and Wrangell Islands and Frederick Sound). The reasons for the negative trends are not well understood and could include bycatch, a change in prey distribution, a decrease in survival or shift in distribution due to habitat degradation, predation, or a combination of these factors. It is noteworthy that a greater decline was observed in areas where gillnet and purse-seine fisheries exist. Currently, the stock structure of harbor porpoise within the inland waters of Southeast Alaska is unknown. If we assume that at least two sub-populations exist within the inland waters of Southeast Alaska as we describe here, this raises even more concerns about the declining trends that are occurring in this area and stresses the importance of protecting and preserving the habitat of Glacier Bay/Icy Strait to ensure the continued existence of this species.

Acknowledgements

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Table 1. Stratum areas and effort allocation during harbor porpoise surveys in Glacier Bay/Icy Strait (1991-1993, 2006, 2007 and 2010). NE = no effort.

Stratum	Area (km^2)	Effort (km)					
		1991	1992	1993	2006	2007	2010
1	492	63	203	284	40	103	65
2	1082	465	510	686	269	403	383
3	585	201	284	256	181	NE	199
30	108	143	95	99	59	NE	57
31	35	19	84	36	11	2	20
Total	2,302	900	1,176	1,361	560	508	724

Table 2. Density and abundance estimates of harbor porpoise in Glacier Bay/Icy Strait.

	Year																	
	1991			1992			1993			2006			2007			2010		
Stratum	*D*	*N*	CV	*D*	*N*	CV	*D*	*N*	CV	*D*	*N*	CV	*D*	*N*	CV	*D*	*N*	CV
1	0.057	28	0.39	0.070	34	0.56	0.265	131	0.42	0.041	20	0.70	0.091	45	0.42	0.169	83	0.36
2	0.135	146	0.25	0.127	135	0.23	0.096	104	0.25	0.072	78	0.38	0.240	259	0.28	0.209	226	0.33
3	0.290	169	0.44	0.261	150	0.53	0.173	101	0.27	0.093	54	0.33				0.328	192	0.52
30	0.205	22	0.79	0.120	12	0.33	0.166	18	0.24	0.201	22	0.61	-	-	-	0.009	1	0.92
31	0.283	10	0.58	0.332	11	0.47	0.620	22	0.39	0.512	18	0.54	0.000	0	0.00	0.302	11	0.81
Total	0.163	376	0.24	0.148	342	0.25	0.163	375	0.19	0.083	191	0.23	0.189	304	0.25	0.222	512	0.25

Table 3. Estimates of harbor porpoise decline within the inland waters of Southeast Alaska between 1991 and 2010.

	Model 1 (without CV add)			Model 2 (with CV add)			Bayes Factor	Model Averaged		
Region	r	95% PI	PD	r	95% PI	PD	Model 2/1	r	95% PI	PD
Overall	-0.025	(-0.042, -0.009)	99.7%	-0.031	(-0.091, 0.021)	92.7%	4.47	-0.029	(-0.090, 0.017)	93.9%
Glacier Bay/Icy Strait	-0.008	(-0.032, 0.018)	71.8%	-0.010	(-0.089, 0.060)	64.2%	1.96	-0.009	(-0.078, 0.048)	67.4%

r = rate of population change, PI = probability interval, PD = probability of decline

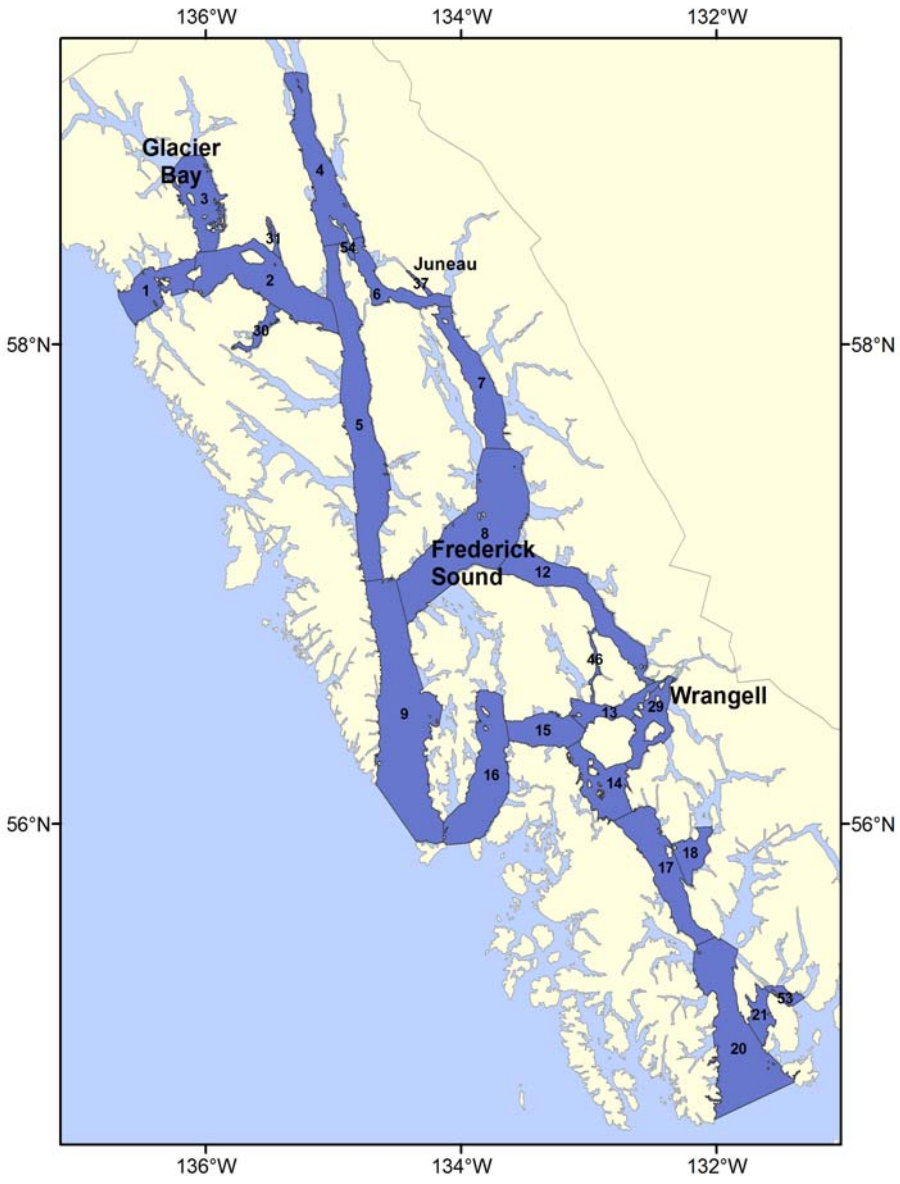

Figure 1. Southeast Alaska study area showing regional strata.

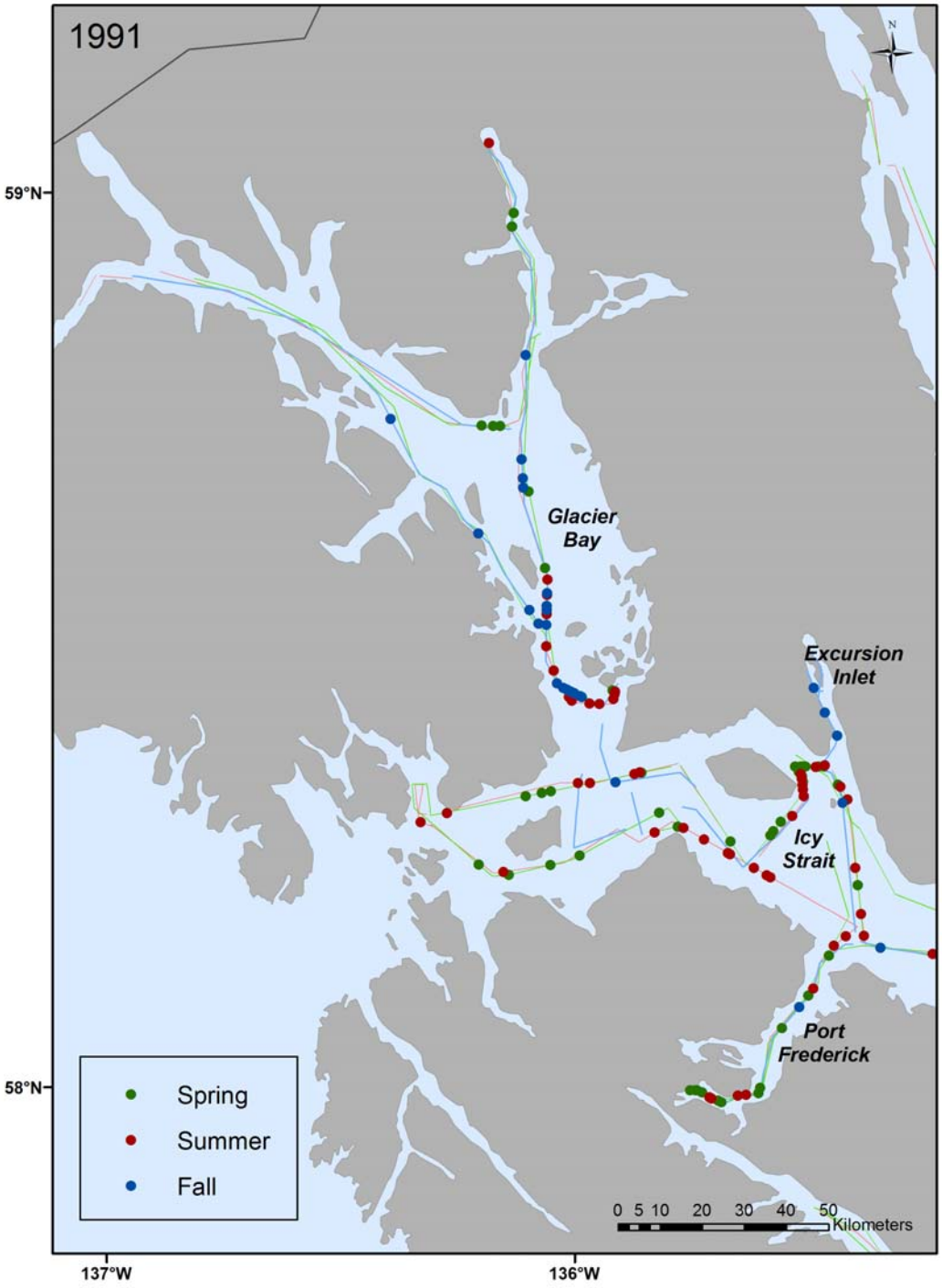

Figure 2. Survey tracklines and seasonal sightings of harbor porpoise (1991).

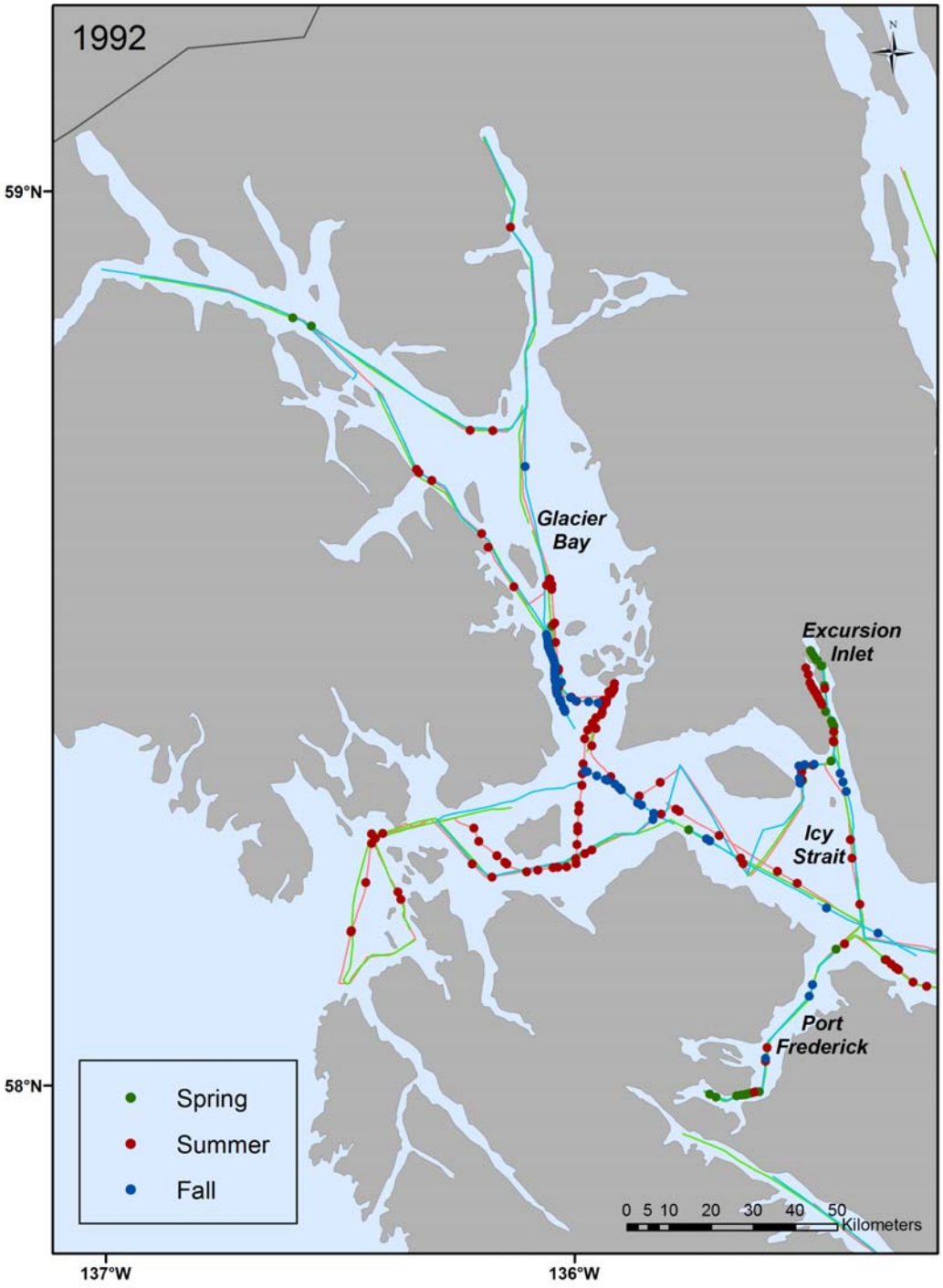

Figure 3. Survey tracklines and seasonal sightings of harbor porpoise (1992).

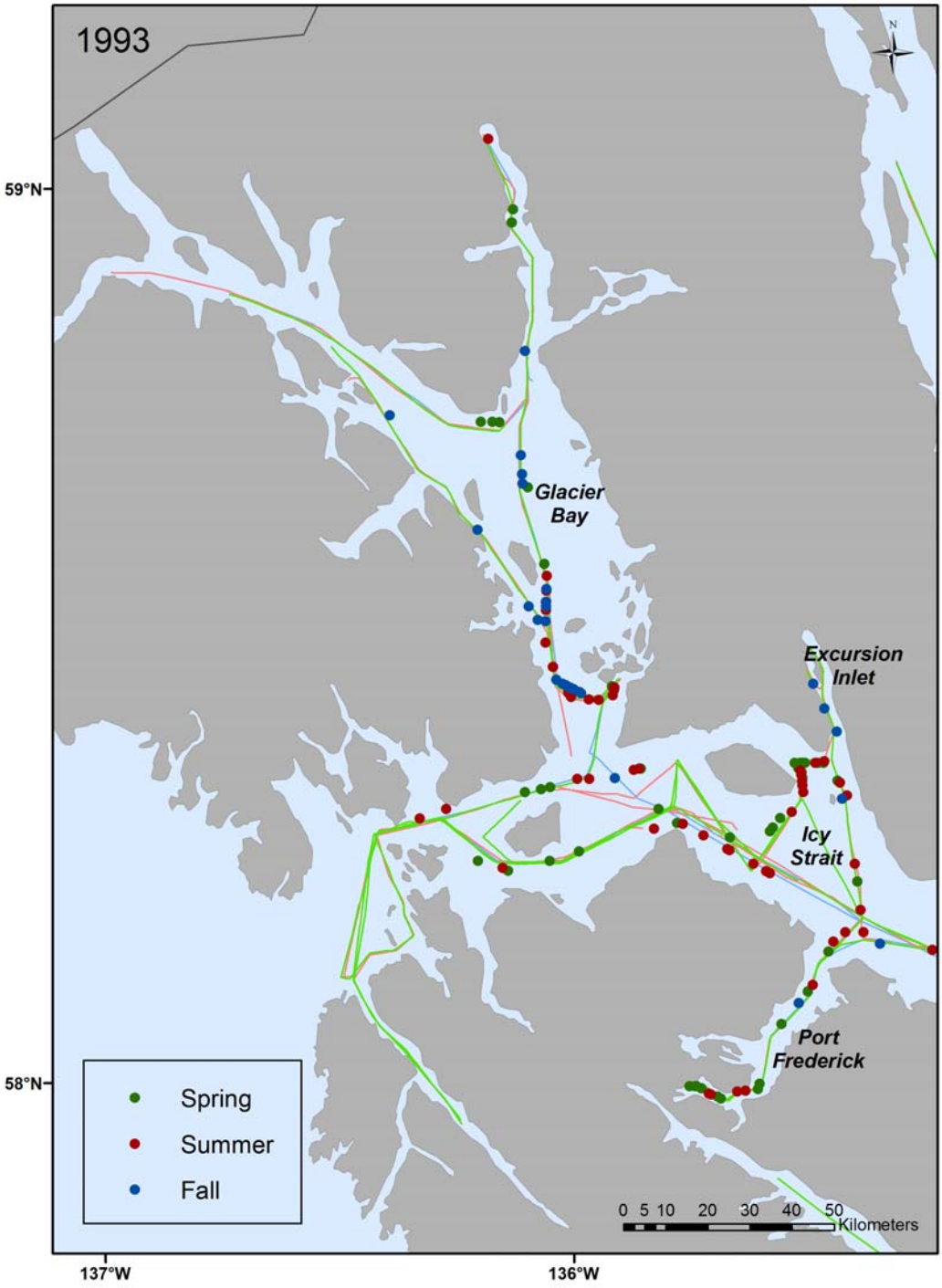

Figure 4. Survey tracklines and seasonal sightings of harbor porpoise (1993).

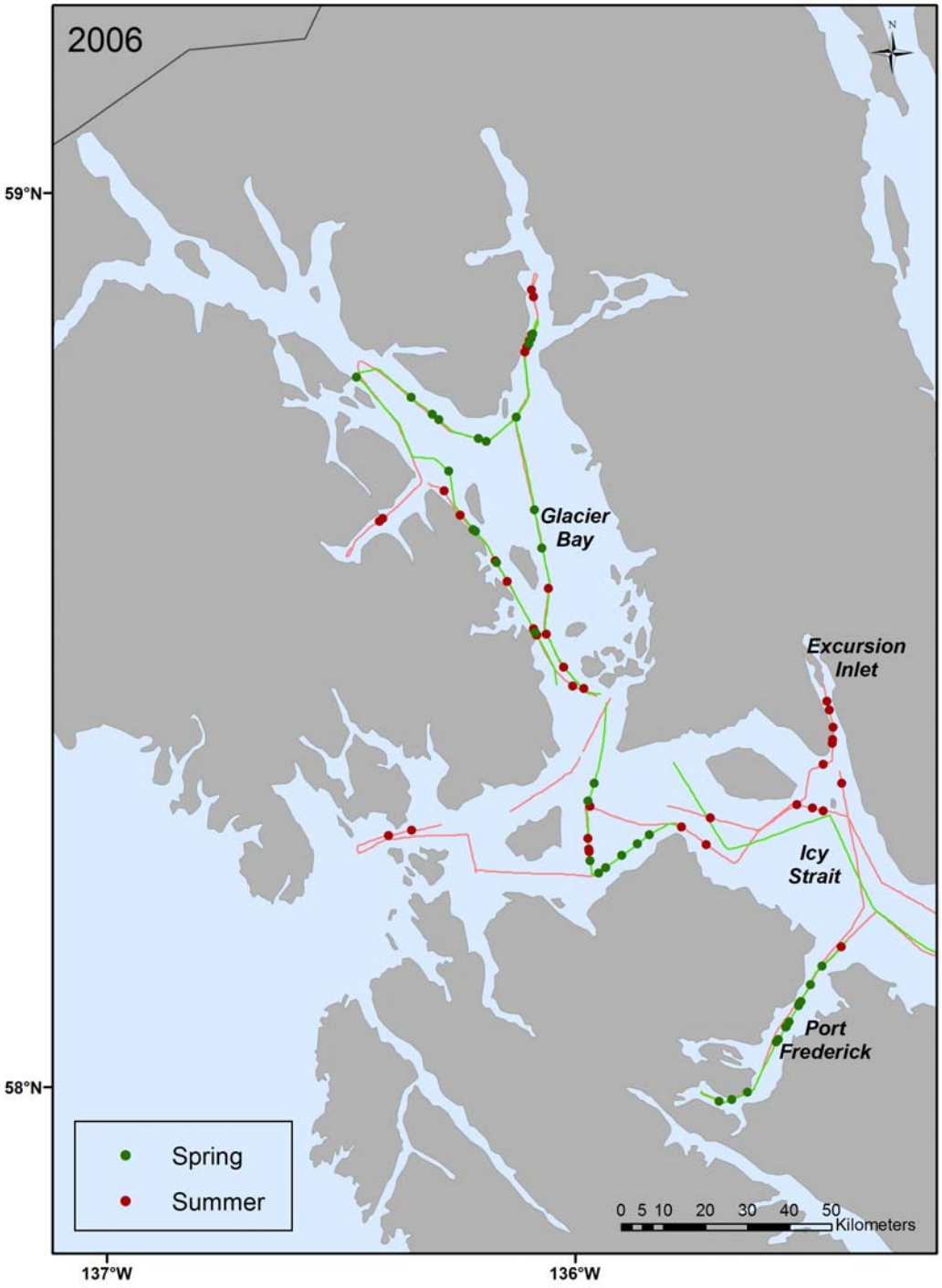

Figure 5. Survey tracklines and seasonal sightings of harbor porpoise (2006).

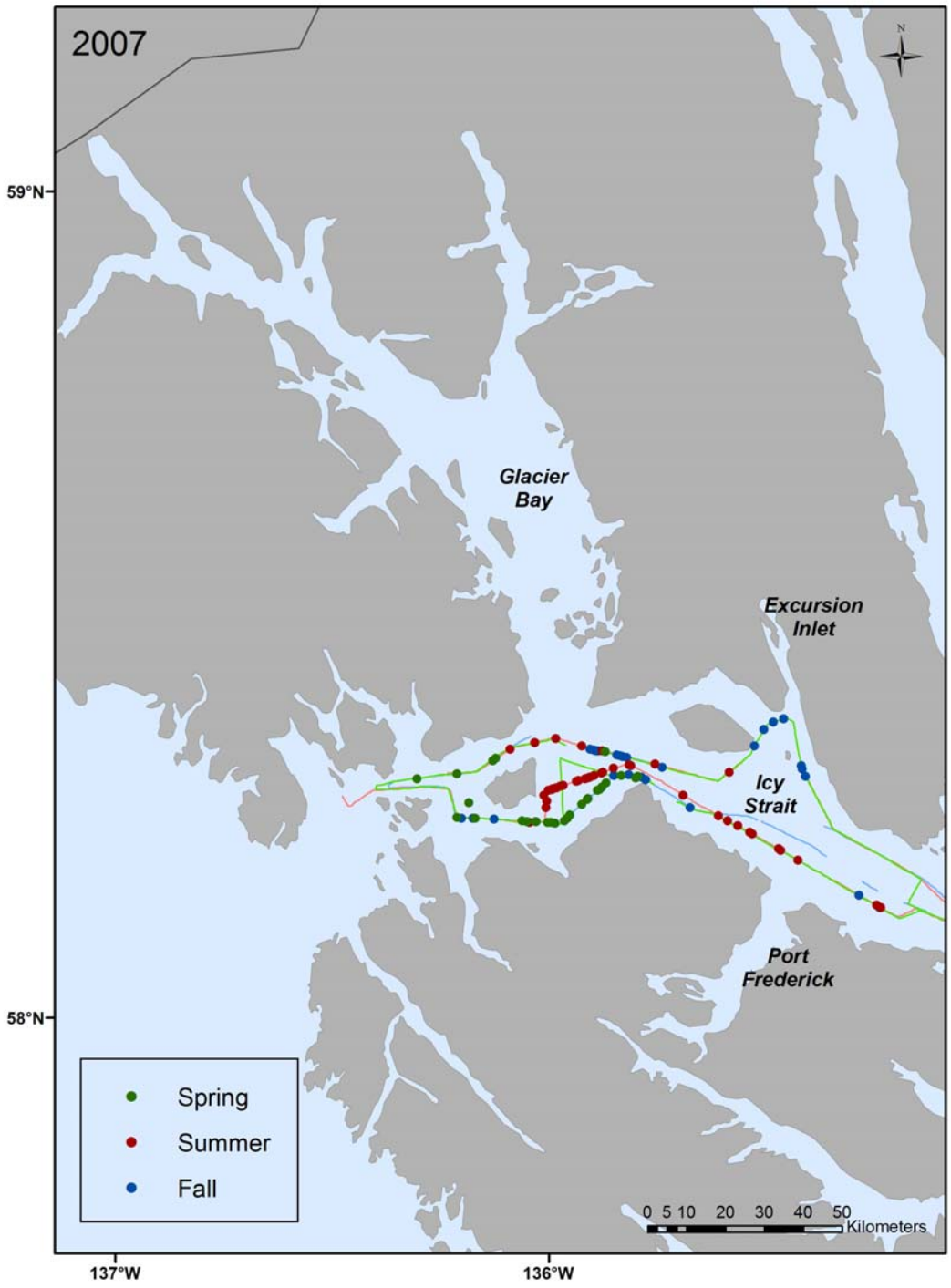

Figure 6. Survey tracklines and seasonal sightings of harbor porpoise (2007).

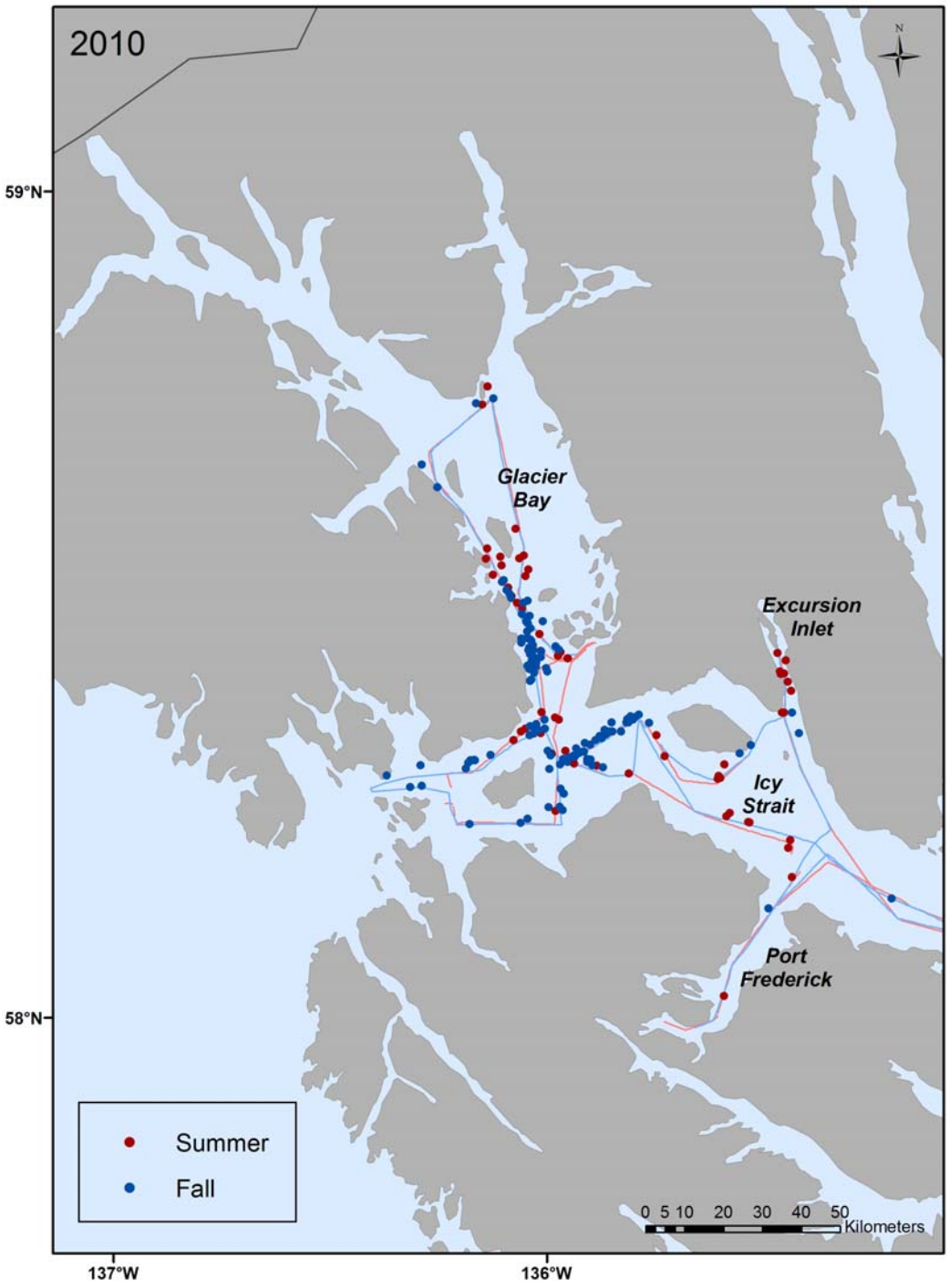

Figure 7. Survey tracklines and seasonal sightings of harbor porpoise (2010).

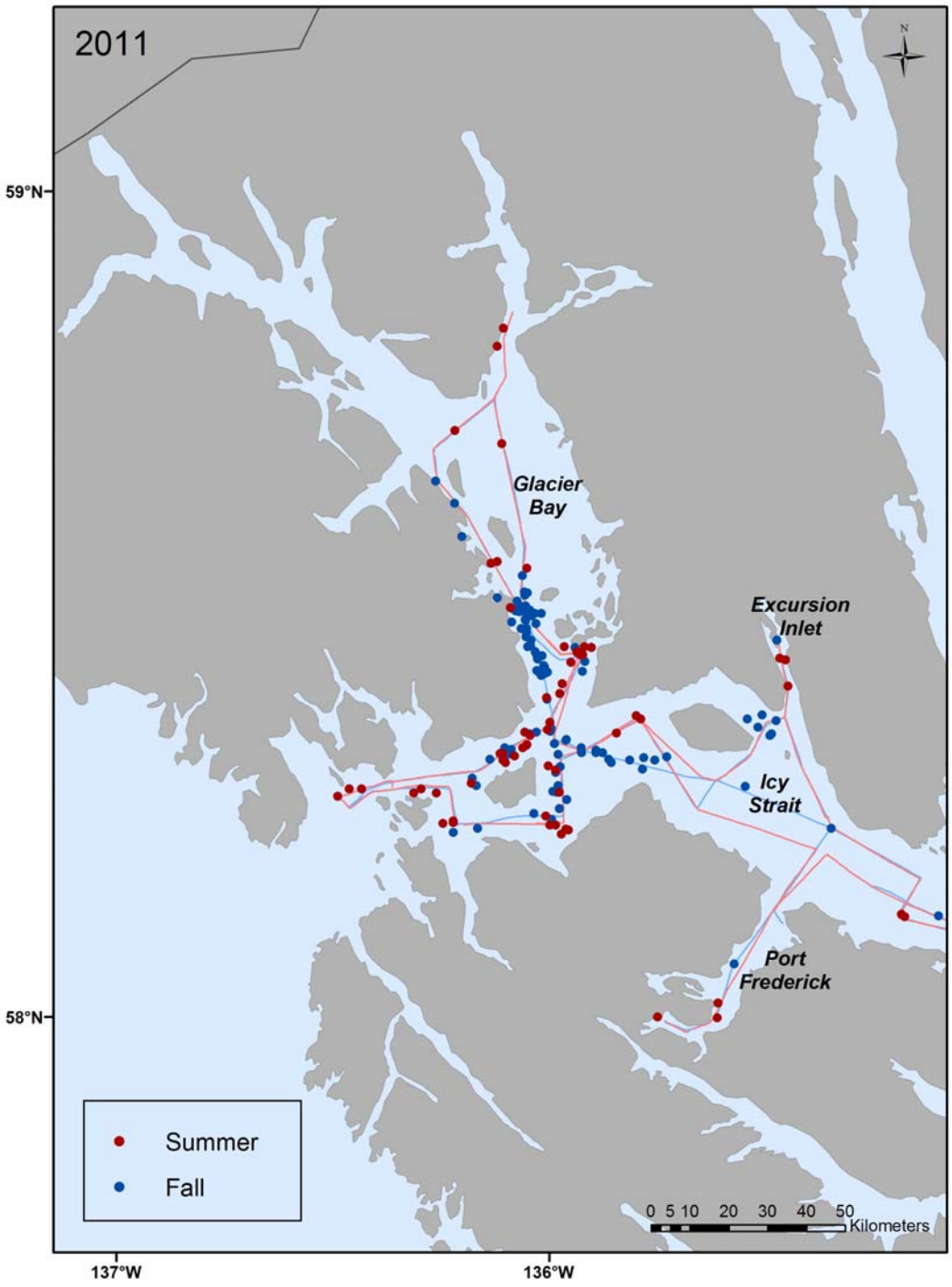

Figure 8. Survey tracklines and seasonal sightings of harbor porpoise (2011).