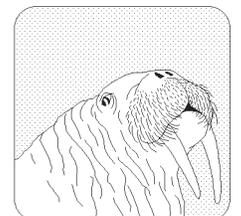
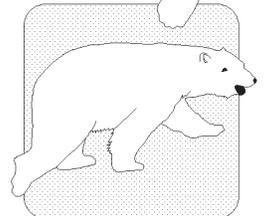
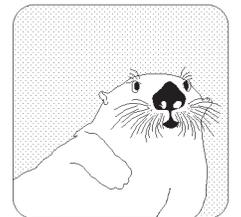
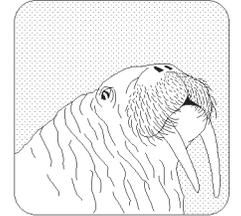
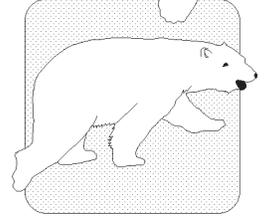
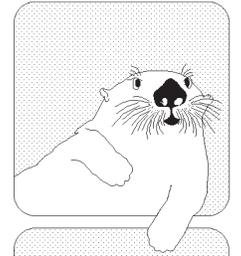


Aerial Surveys of Sea Otters in Yakutat Bay, Alaska 2005

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February 2007

MARINE MAMMALS MANAGEMENT
Fish and Wildlife Service
Region 7, Alaska
U.S. Department of the Interior



**Technical
Report
MMM 2007-01**



AERIAL SURVEYS OF SEA OTTERS (*Enhydra lutris*)
IN YAKUTAT BAY, ALASKA, 2005

BY

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ABSTRACT

Extensive commercial harvests of sea otters occurred from the mid-1700s through the 1800s which drastically reduced the population and eliminated them from much of their range. Sea otters were subsequently protected by the International Fur Seal Treaty in 1911. Sea otters were believed to have been extirpated by the early 1900s in Yakutat Bay, located near the northern extent of the southeast Alaska stock. In an effort to recolonize the population, sea otters were translocated to Yakutat Bay in 1966. Current sea otter distribution and abundance data from Yakutat Bay are needed to address potential management concerns regarding oil and gas development, subsistence hunting, and fisheries conflicts within the region. We conducted replicate aerial surveys of sea otters using established methods in April 2005 within the Yakutat Bay area. Our estimate of the overall sea otter population of Yakutat and Disenchantment Bays, and Russell and Nunatak Fjords is $1,582 \pm 528$ animals. The sea otter population has both increased in abundance and expanded its range since the last complete aerial survey of the area in 1995 when an estimated 404 otters inhabited the entire Yakutat Bay area. The annual rate of increase in Yakutat between the 1995 and 2005 aerial surveys was 14.6% per year, could be a result of reproduction alone. Based on this growth rate, current harvest numbers, and historic levels the northern sea otter population in Yakutat Bay should continue to increase and expand its distribution. We recommend regular aerial surveys to monitor this population and that these surveys sample a greater proportion of the low density stratum to account for the mobility of otters between the east and west coasts of the bay. In addition, we advocate increasing the sampling intensity of replicate surveys to improve the precision of replicate estimates. We also suggest that an aircraft with a lift flap design, such as the Aviat Husky, not be used for this type of survey in the future due to safety concerns associated with intensive search units used in this survey method.

INTRODUCTION

Prior to the mid-1700s, sea otters *Enhydra lutris* occurred in large numbers in coastal areas of Japan, Russia (Kamchatka), the United States (Alaska, Washington, Oregon, and California), Canada (British Columbia), and Mexico (Lensink 1962, Kenyon 1969). Extensive commercial harvests of sea otters occurred from the mid-1700s through the 1800s which drastically reduced the population (Bancroft 1959, Lensink 1962, Kenyon 1969) and eliminated them from much of their range (Kenyon 1969, Riedman and Estes 1990).

Sea otters were subsequently protected by the International Fur Seal Treaty in 1911. In the absence of harvest pressure, the population expanded from 11 remnant groups to re-colonize much of the former sea otter range. Despite legal protection, no remnant colonies of sea otters existed in southeast Alaska. As part of efforts to re-establish sea otters in portions of their historical range, otters from Amchitka Island and Prince William Sound were translocated to other areas (Jameson et al. 1982). These translocation efforts met with varying degrees of success. From 1965 to 1969, more than 400 sea otters (89 percent from Amchitka Island in southwest Alaska, and 11 percent from Prince William Sound in southcentral Alaska) were translocated to multiple sites in southeast Alaska (Jameson et al. 1982). In the first 20 years following translocation, these populations grew in numbers and expanded their range (Pitcher 1989), and is now considered a unique population stock, ranging from Cape Yakataga to Dixon Entrance (Gorbics and Bodkin 2001).

Sea otters in Yakutat Bay, located near the northern extent of the southeast Alaska stock, were believed to have been extirpated by the early 1900s. In 1966, 10 sea otters from Montague Island, Prince William Sound, were translocated to Yakutat Bay (Calkins and Schneider 1985; K. Schneider unpubl. data). Surveys conducted by the Alaska Department of Fish and Game (ADF&G) in 1970 recorded 15 sea otters within Yakutat Bay (Calkins and Schneider 1985). By 1985, biologists at ADF&G speculated approximately 50 sea otters inhabited Yakutat Bay (Calkins and Schneider 1985). The last survey flown in the area was in 1995-96 by the U.S. Fish and Wildlife Service (Doroff and Gorbics 1998). The 1995 survey estimated a population of 404 otters for Yakutat and Disenchantment Bays, and Russell and Nunatak Fjords. At the time of this survey, there appeared to be unoccupied habitat within Yakutat Bay, and additional population growth was expected.

As sea otters continue to re-colonize the southeast population stock, resource management concerns have arisen, including: 1) effects of oil and gas development and transport along the Gulf of Alaska coastline; and 2) conflicts between commercial and Native subsistence shellfisheries and sea otters. In order to address these management concerns, current and complete population estimates for the southeast population stock of northern sea otters are needed. This report presents the results of a survey for sea otters that was conducted in Yakutat Bay during April 2005. The remainder of the southeast stock, exclusive of Yakutat Bay, were last surveyed in 2002 and 2003 by the U.S. Geological Survey (Bodkin and Esslinger 2006).

METHODS

Study area

The study area is located along the northeastern Gulf of Alaska and included the waters of Yakutat Bay (940 km²), Disenchantment Bay (north of Point Latouche; 45 km²), Russell Fjord (151 km²), and Nunatak Fjord (41 km²) (Figure 1). Yakutat Bay opens to the Gulf of Alaska and terminates at the Hubbard Glacier at the head of Disenchantment Bay. Yakutat Bay is 35 km across at its widest and 5 km across at its narrowest in Disenchantment Bay. Russell and Nunatak Fjords are marine waters but had previously been freshwater lakes. Much of the area in the region has been designated as wilderness and is part of the Russell Fjord Wilderness (Tongass National Forest), Wrangell - Saint Elias National Park and Preserve, or Alaska Maritime National Wildlife Refuge). The U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service have the responsibility to manage lands and trust resources within these areas. The town of Yakutat (59° 32.9' N, 139° 43.8' W) is the only community in the vicinity.

Survey Methods

The survey platform was an Aviat Husky (a fixed-wing, single-engine aircraft with tandem seating). The survey methodology followed Bodkin and Udevitz (1999), consisting of a stratified random sampling of parallel 400 m-wide strip transects, overlaying the study area and oriented perpendicular to the coastline. To allocate survey effort in proportion to expected sea otter abundance, we separated the survey area into high and low density strata. The high density stratum extended from shore to 400 m seaward or to the 40 m depth contour, whichever was greatest. The low density stratum boundary began at the seaward high density stratum boundaries and extended to 2 km offshore or to the 100 m depth contour, whichever was greater. Bays and inlets less than 6 km wide were sampled with high density strata regardless of water depth. The distance between adjacent transects was 1.2 km in the high density stratum and 8 km in the low density stratum, thereby sampling approximately 33.3 and 5.0 percent of the high and low density strata, respectively.

We developed survey-specific correction factors by conducting intensive search units (ISU) to estimate a correction factor for the proportion of sea otters that were missed by the observer on the strip transects. An ISU consisted of 5 concentric 400 m diameter circles flown within the survey strip. Each ISU was initiated by the sighting of a group (≥ 1 sea otter) only when the time since the previous ISU was > 1 minute. For each ISU, we recorded: 1) whether animals were detected on the strip count or on the subsequent circles within the ISU, 2) location of the group within the ISU, and 3) the behavior of each animal (e.g. diving or non-diving). Sea otters in the initiating group and those that entered the survey area during the course of conducting an ISU were not included in the calculation of the correction factor.

On 16, 17 and 20 April 2005, a complete aerial survey of sea otters was conducted in Yakutat Bay, Disenchantment Bay and Russell and Nunatak Fjords (henceforward known as 'complete survey'). All otter sightings were marked with a latitude and longitude using a handheld Garmin GPS unit. The Nunatak Fjord area had only a single randomly-selected

transect, which was not flown due to wind shear. To document sea otter distribution in this area, we recorded any sea otters observed in route to and from the transect located at the head of the fjord.

From previous surveys of the area, we anticipated that areas of unoccupied sea otter habitat may exist within the study area. Based on the results of the complete survey, we defined a subset of the study area where otters were observed and conducted additional replicate surveys to increase the sample size and obtain a more precise population estimate. We subset the survey effort and sea otters observed during the complete survey within the replicate area as the first replicate survey. We conducted three additional replicate surveys between 22-24 April. Due to weather and time constraints we only surveyed the eastern portion during the fourth replicate survey where the highest concentration of otters had been observed during earlier replicates. Only high density transects from this replicate are included in the analysis because only four very short low density transects were flown due to weather limitations and no otters were seen on these transects.

Data Analysis

We corrected our estimates of sea otter population abundance for detection by applying a mean correction factor calculated from the intensive search units (ISU) that had 2 or more groups of sea otters (the group initiating the ISU is not used in the calculation of the correction factor, see Bodkin & Udevitz (1999) for details). Large groups of sea otters (defined as a raft of ≥ 20 sea otters) were observed until an accurate count or photo was obtained. These complete counts were not considered in the calculation of the correction factor, nor was the correction factor applied to these large groups. The variance in the population estimate includes the variance associated with sea otter density between strip transects and the variance of the correction factor calculated from the ISUs (Bodkin & Udevitz 1999).

We calculated population estimates for both the complete survey and the mean of the replicate surveys. In each instance, we used only the corresponding ISU information for each survey or replicate to develop the correction factor for undetected animals.

RESULTS

During the complete survey no sea otters were observed in Disenchantment Bay and Russell and Nunatak Fjords (Figure 2). The high density replicate survey area was therefore defined on the east side of Yakutat Bay north of Kriwoi Island to the southern end of Disenchantment Bay (opposite Blizhni Point and south of Point Latouche) and along a smaller length of coastline on the west side of Yakutat Bay between Point Manby and the northern edge of Schooner Beach (Figure 3). We also included a section of low density habitat between the two areas of concentration in the replicate survey area. We observed concentrations of sea otters in these areas on all subsequent replicate surveys (Figures 4-7).

During the complete survey, we recorded 39 otters on high density transects, and 2 otters on low density transects (Table 1). No large groups were observed during this survey. Using a correction factor of 9.5, the corrected population estimate for the complete survey was 1,534 (SE=943) otters.

Of the otters observed during the complete survey, 37 of 41 occurred within the replicate survey area (Table 2). The corrected population estimate for the first replicate survey was 1,181 (SE=811). The corrected population estimate for the second replicate was 2,131 (SE=847). Several large groups ranging in size from 19-57 otters were observed in both the high and low density strata during this second replicate, resulting in a higher corrected population estimate than the complete survey. The third replicate survey had the lowest corrected population size of 475 (SE=309). This last result may be partly due to the fact that only a single transect was flown across the bay in the low density stratum, with no otters observed. The corrected estimate for the partial survey conducted as the fourth replicate was 1,339 (SE=752). The mean of the first 3 replicate surveys in Yakutat Bay was 1,262 (SE=479).

Although the results of the complete survey and mean of three replicate surveys were similar (1,534 vs. 1,262), it is not clear which of the two is the more statistically robust estimate of the sea otter population in Yakutat Bay. The complete survey had the broadest coverage in terms of area, but also had an unusually large ISU correction factor. The selection of the replicate survey area did not encompass all known sea otter habitat, excluding several sea otter sightings made during the complete survey. Estimates from the three replicate surveys had a wide range, due primarily to the observation of several large groups in both the high and low density strata during the second replicate and large differences among replicates in estimated detectability of the small groups. As both estimates have certain caveats, we chose to calculate the size of the sea otter population using a third method that makes better use of the available data. Recognizing that there were otters sighted during the complete survey in areas outside the replicate area, we calculated an estimate for that proportion of the study area as 320 animals (SE=221). We next added this value to the mean of the first three replicate surveys (1,262) to arrive at a best estimate of 1,582 (SE=528), which is slightly higher and more precise than the estimate from the complete survey.

DISCUSSION

The results of our survey indicate that the sea otter population has both increased in abundance and expanded its range over the past decade. During the 1995 complete aerial survey of the Yakutat Bay area the corrected population estimate was 404 otters compared to 1,582 otters in 2005. The 1995 estimate was itself determined to be an increase from the previous complete survey in 1987 (Doroff and Gorbics 1998). Although the distribution on the east side of the Bay was comparable between the 1995 and 2005 surveys, in 2005 otters were observed on the western side of the bay in greater numbers. In 1995 only 2 otters were counted on the west side of the Bay (Doroff and Gorbics 1998) but in 2005 we counted from 9-16 otters during replicate surveys using comparable levels of survey effort. It is unclear whether this population is increasing due to immigration, as is the case in Glacier Bay National Park (Bodkin and Esslinger Bodkin 2006), or from reproduction alone. The maximum net productivity rate (R_{MAX}) of sea otters is estimated to be 20% (Estes 1990). The annual rate of increase in Yakutat between the 1995 and 2005 aerial surveys was 14.6% per year, therefore the observed increase could be a result of reproduction alone.

The Sea Otter and Steller Sea Lion Commission (TASSC) have been conducting small boat surveys for sea otters on the eastern side of Yakutat Bay annually since 1999 (Kava and Jack 2005). From 1999-2004, otter counts have ranged from 69-494 otters. Survey timing and effort have varied from year to year making it difficult to determine the population trend over time (Kava and Jack 2005). From our aerial survey, it is known that otters have expanded their range to include the western shore of the bay. Therefore, results of the TASSC skiff surveys do not provide a good estimate of total abundance within Yakutat Bay, as they sample only a portion of the occupied range. Although these skiff surveys were designed primarily for sea otters, the methodology, which samples only a 200 m-wide swath adjacent to shore appears to be poorly suited to this area, where high density sea otter habitat extends further from shore. The limitations of the TASSC skiff survey methods in Yakutat Bay likely explain why our results contradict the conclusion of Kava and Jack (2005) that the sea otter population of Yakutat Bay may be stable or possibly declining.

Despite the increase in the sea otter population in Yakutat Bay over the last 10 years the current abundance remains below the values reported in the area by the fur trade (Doroff and Gorbics 1998). Historically, the habitat in the Gulf of Alaska coastal area supported a large number of sea otters. In the Yakutat Bay area there were reports of Russian expeditions which harvested as many as 2,000 sea otters. La Perouse (1797) speculated in his ship log during an exploration of the Gulf of Alaska coast that a factory could collect 10,000 sea otter skins annually from this region (Cadwell 1986, La Perouse 1797- as referenced by Simon-Jackson and Hodges 1987). The harvest of sea otters by Alaska Natives has been monitored since 1989 by the USFWS through its marine mammal marking, tagging, and reporting program. Between 1995 and 2005, the reported harvest has averaged 16 otters a year from the Yakutat area (U.S. Fish and Wildlife Service, unpublished data). Considering the current harvest levels, along with the observed growth rate of 14% per year, we believe the northern sea otter population is likely to continue to increase in numbers and expand its range in Yakutat Bay. Regular aerial surveys are needed to monitor this population in light of continuing resource conflicts within the southeast Alaska stock of northern sea otters.

Recommendations

This survey method provides a means of comparing population abundance over time and is readily repeatable over longer time intervals (e.g. every 5-10 years). The methodology developed by Bodkin and Udevitz (1999) allows for the calculation of observer and survey-specific correction factors to account for otters not detected by observers. There was considerable variability in the correction factor and the abundance estimates in the replicate surveys. Sea otters are highly mobile and large groups of animals can influence the variation among transects considerably. For example, the high estimate of 2,131 otters on replicate 2 was driven by two factors; 1) this was the only replicate where large groups (number otters > 25) were observed; and 2) some of these were large groups were in low density habitat. Both of these factors resulted in a much higher estimate than the other replicates. During both the 1995 and 2005 surveys otters were observed in low density habitat actively swimming across the bay. We suggest that future surveys of this area sample a greater proportion of the low density stratum to account for the mobility of otters between the eastern and western shores of the bay.

Other observed variation in the population estimates of sea otters is likely due to the clumped distribution of sea otters within Yakutat Bay, where most transects had zero animals while a few had high counts. There may have also been movement of sea otters in and out of the high density survey area from the outer Gulf of Alaska coast or in transit between the east and west coast of the Bay. Variation in the estimated correction factor also affects the corrected population estimate. Bodkin and Udevitz (1999) suggested that at least 30 usable ISUs were needed to calculate a reasonable correction factor from a single replicate. During our surveys, we only obtained 14 usable ISUs during the complete survey, and between 6-14 usable ISUs per replicate. Rather than conducting replicate surveys at the same level of sampling intensity as an initial complete survey of the study area, we advocate increasing the sampling intensity. This will likely increase the precision of replicate estimates by: 1) decreasing the average variation in numbers of otters per transect and 2) increasing the number of usable ISUs and improving precision of the correction factors.

The survey method used requires a fixed-wing, single-engine aircraft with tandem seating. We conducted our survey using an Aviat Husky, an aircraft with a flap design that is considered a “lift flap”. Other tandem-seating aircraft, such as ACA Scouts or Piper Super Cubs have a flap design known as a “drag flap”. When the airflow over the horizontal stabilizer of these two types of designs (lift vs. drag) is disturbed or detached the result is greatly different; when the loss of airflow over the horizontal stabilizer occurs on a drag flap design the nose of the aircraft pitches up slightly but when the airflow is lost on a lift flap design, such as the Aviat Husky has, the nose of the aircraft pitches downward, sometimes severely. We note that wake turbulence was a problem during the execution of the ISUs (calm wind, when the aircraft circles the group five times at a constant altitude and track line), which can result in the separation of airflow over the horizontal stabilizer. For an aircraft with a lift flap design, such as the Husky, wake turbulence increases the risk of a serious accident which could result in the loss of the aircraft and injury to the pilot and observer. Thus we

recommend that the aircraft with a lift flap design should not be used for this type of survey (Paul D. Anderson pers. comm.).

ACKNOWLEDGMENTS

We thank Paul D. Anderson (Migratory Bird Management, USFWS), for his excellent piloting skills during the course of the survey, and Russ Oates (Migratory Bird Management, USFWS) for facilitating this arrangement. Thanks to the Kodiak NWR for use of their Husky airplane and to Butch Patterson for his assistance with the logistics of this loan. George Esslinger and John Haddix assisted in data preparation and computer support for the survey design. We are grateful to Angela Doroff and Mark Udevitz for their review of this report.

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Table 1. Results for a complete aerial survey of sea otters in Yakutat and Disenchantment Bays, and Russell and Nunatak Fjords, April 2005.

Survey Stratum	Group Size ^a	Sea Otters Counted	Area Sampled (km ²)	Density (otters/km ²)	Stratum Area (km ²)	Uncorrected Population Size	Correction factor	Corrected Population Size	Standard Error
High	Small	39	147.14	0.27	454.82	121	9.5	1,145	881
Low	Small	2	50.53	0.04	1034.95	41	9.5	389	336
Total	All							1,534	943

^a small groups (<20) were used to generate the corrected population estimate and large groups (≥20) were treated as complete counts and added into the total estimate.

Table 2. Results for the replicate aerial surveys of sea otters in Yakutat Bay, April 2005.

Replicate	Survey Stratum	Group Size ^a	Sea Otters Counted	Area Sampled (km ²)	Density (otters/km ²)	Stratum Area (km ²)	Uncorrected Population Size	Correction Factor	Corrected Population Size	Standard Error
1	High	Small	36	61.63	0.58	185.59	108	9.5	1,030	795
	Low	Small	1	23.00	0.04	366.25	16	9.5	151	164
	Total	All							1,181	811
2	High	Small	42	61.63	0.68	185.59	126	2.37	300	102
		Large	180		2.92	185.59	542	-	542	231
	Low	Small	9	18.28	0.49	366.25	180	2.37	427	528
		Large	43		2.35	366.25	861	-	861	612
Total	All							2,131	847	
3	High	Small	53	59.12	0.90	185.59	166	2.86	475	309
	Low	Small	0	10.98	0.00	366.25	0	2.86	0.00	-
	Total	All							475	309
4 ^b	High	Small	60	39.22	1.53	125.05	191	7	1,339	752
	Total	All							1,339	752

^a Small groups (<20) were used to generate the corrected population estimate and large groups (≥20) were treated as complete counts and added into the total estimate.

^b Partial survey consisting of high-density stratum of eastern portion of replicate survey area only.

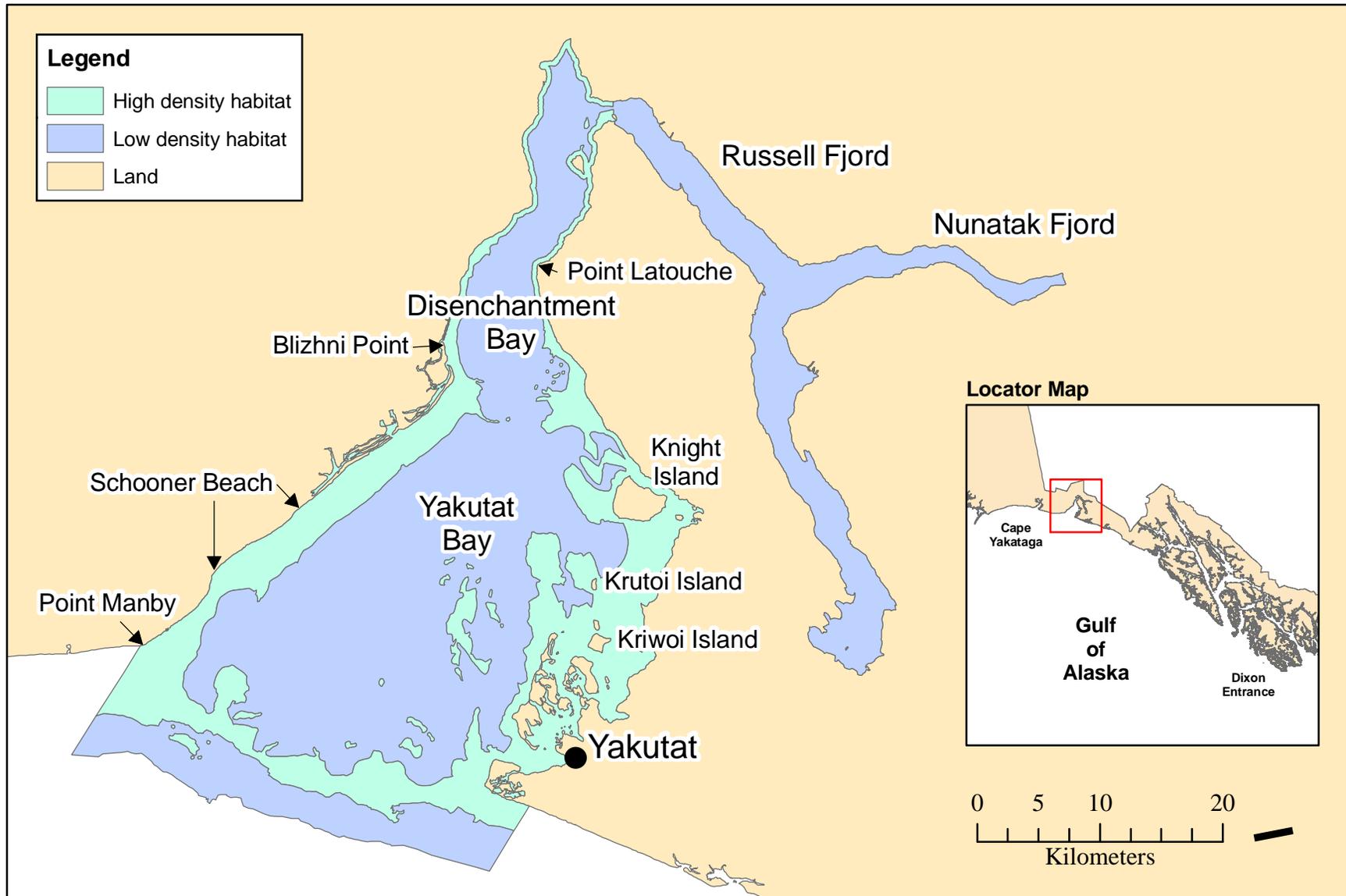


Figure 1. Study area of the April 2005 sea otter aerial survey in the Yakutat Bay area.

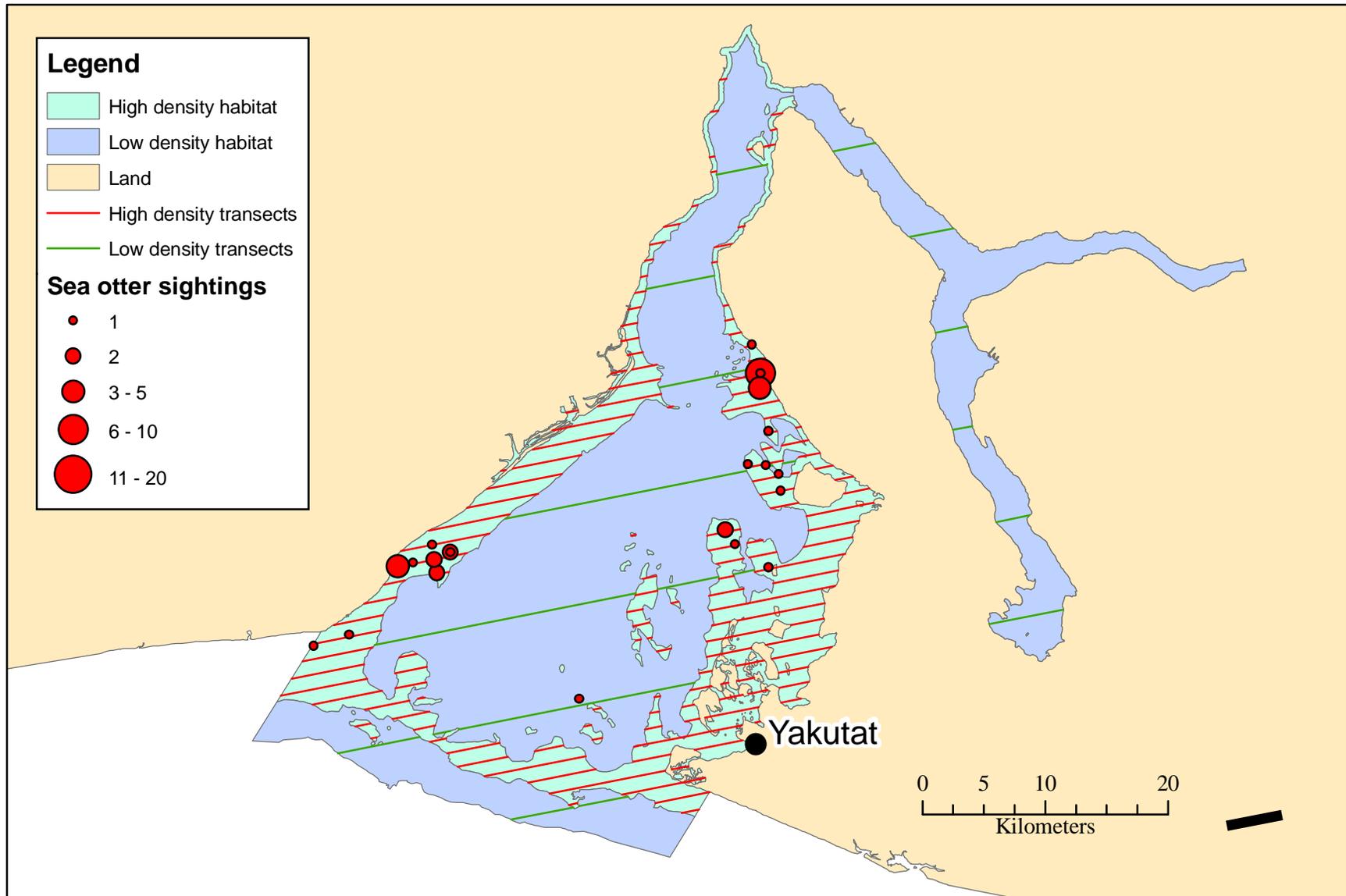


Figure 2. Survey transects and sea otter sightings for the complete aerial survey of Yakutat and Disenchantment Bays, and Russell and Nunatak Fjords, conducted 16, 17, and 20 April 2005.

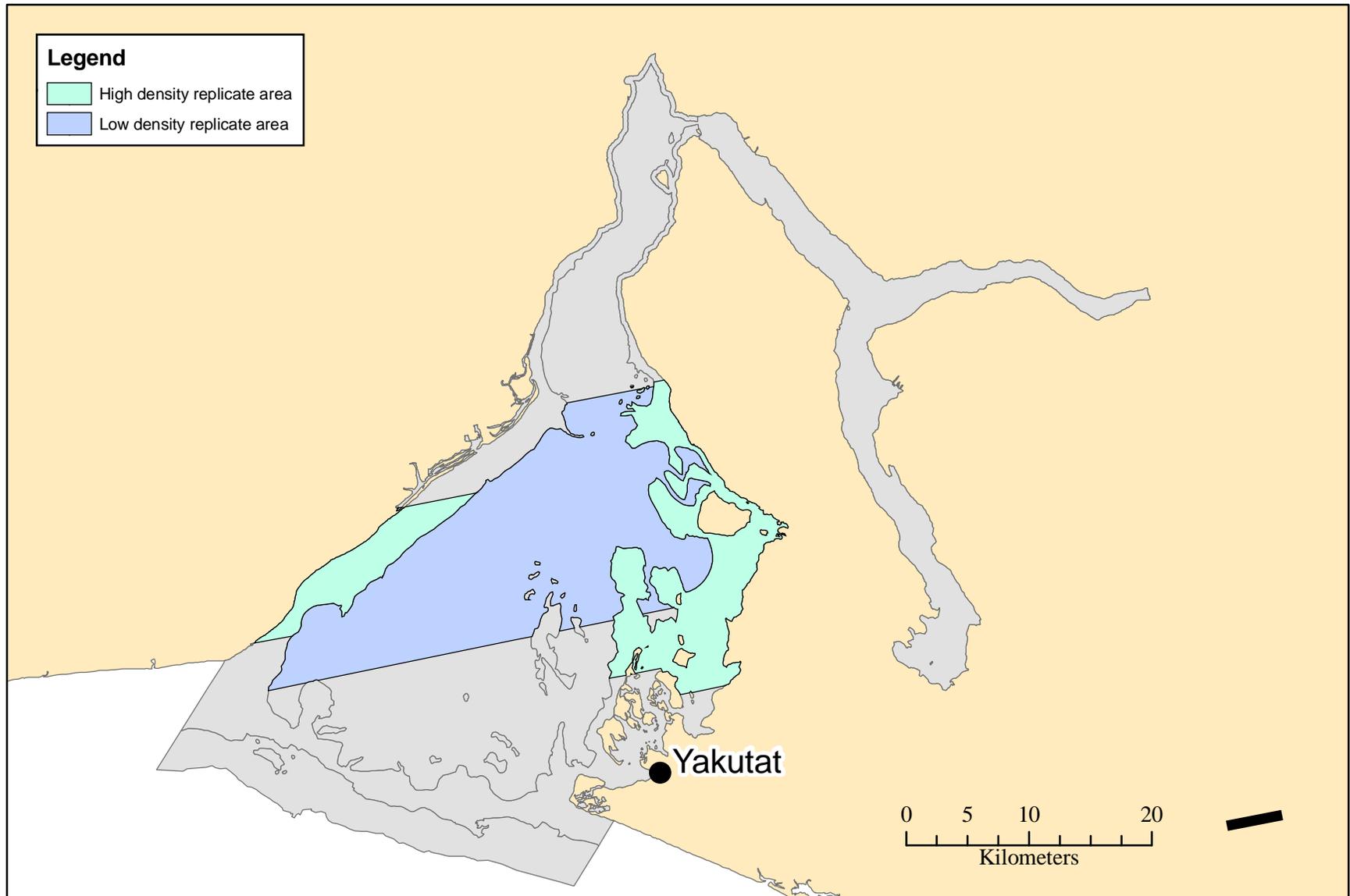


Figure 3. Replicate area for the April 2005 sea otter aerial surveys in Yakutat Bay.

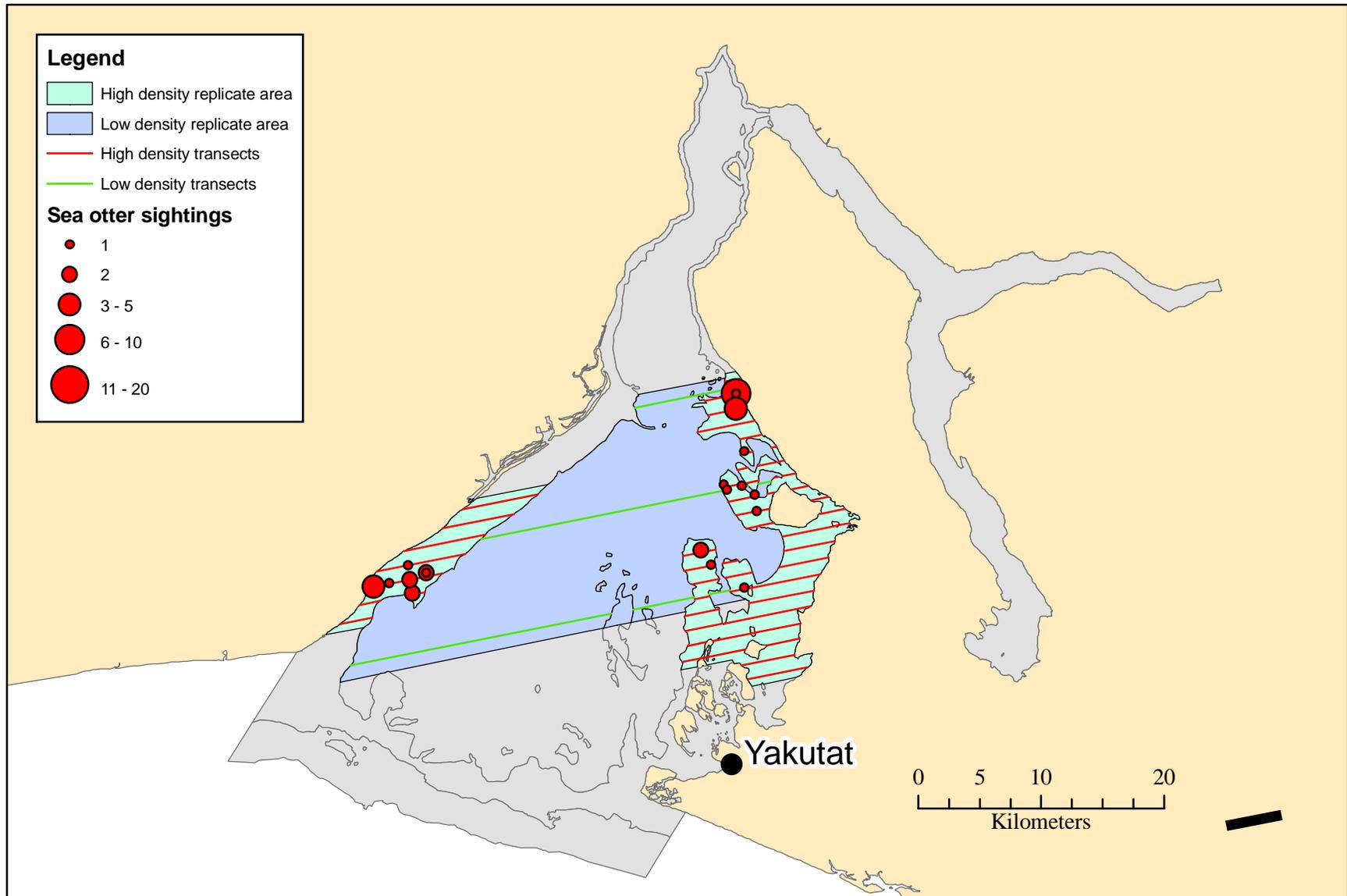


Figure 4. Survey transects and sea otter sightings for the first replicate of the aerial survey of Yakutat Bay conducted 17 and 20 April 2005.

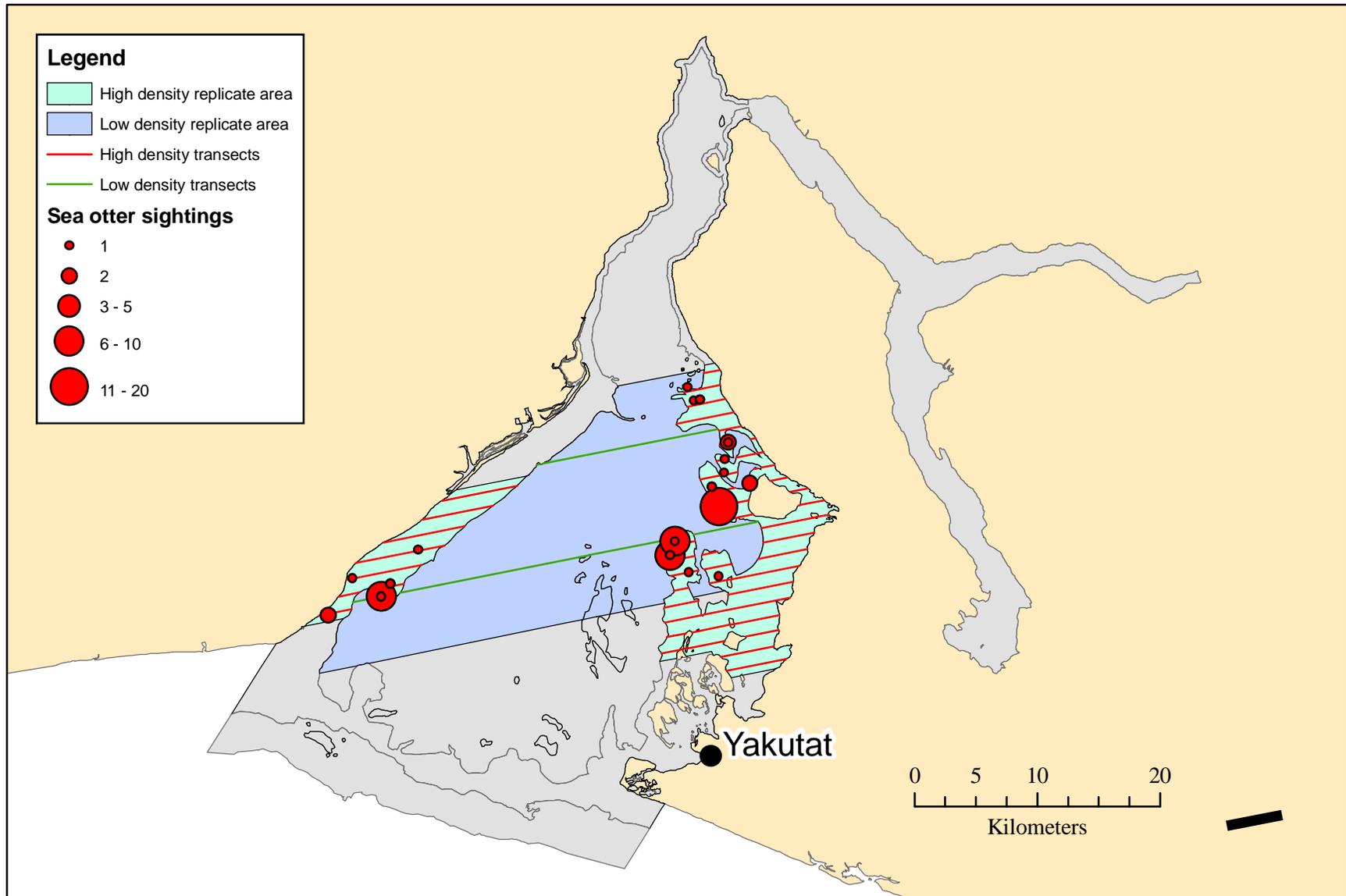


Figure 5. Survey transects and sea otter sightings for the second replicate of the aerial survey of Yakutat Bay conducted 22 April 2005.

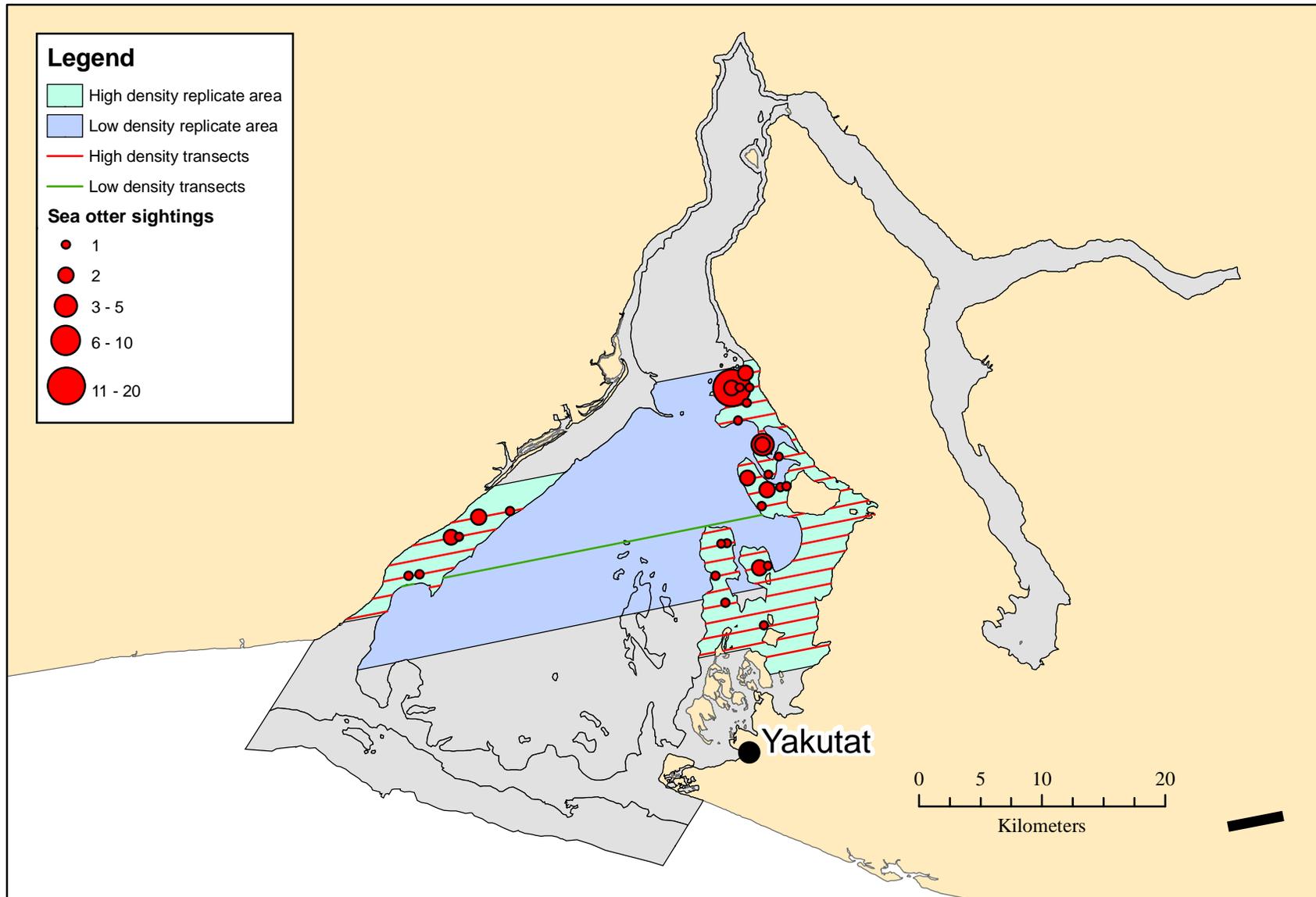


Figure 6. Survey transects and sea otter sightings for the third replicate of the aerial survey of Yakutat Bay conducted 23 April 2005.

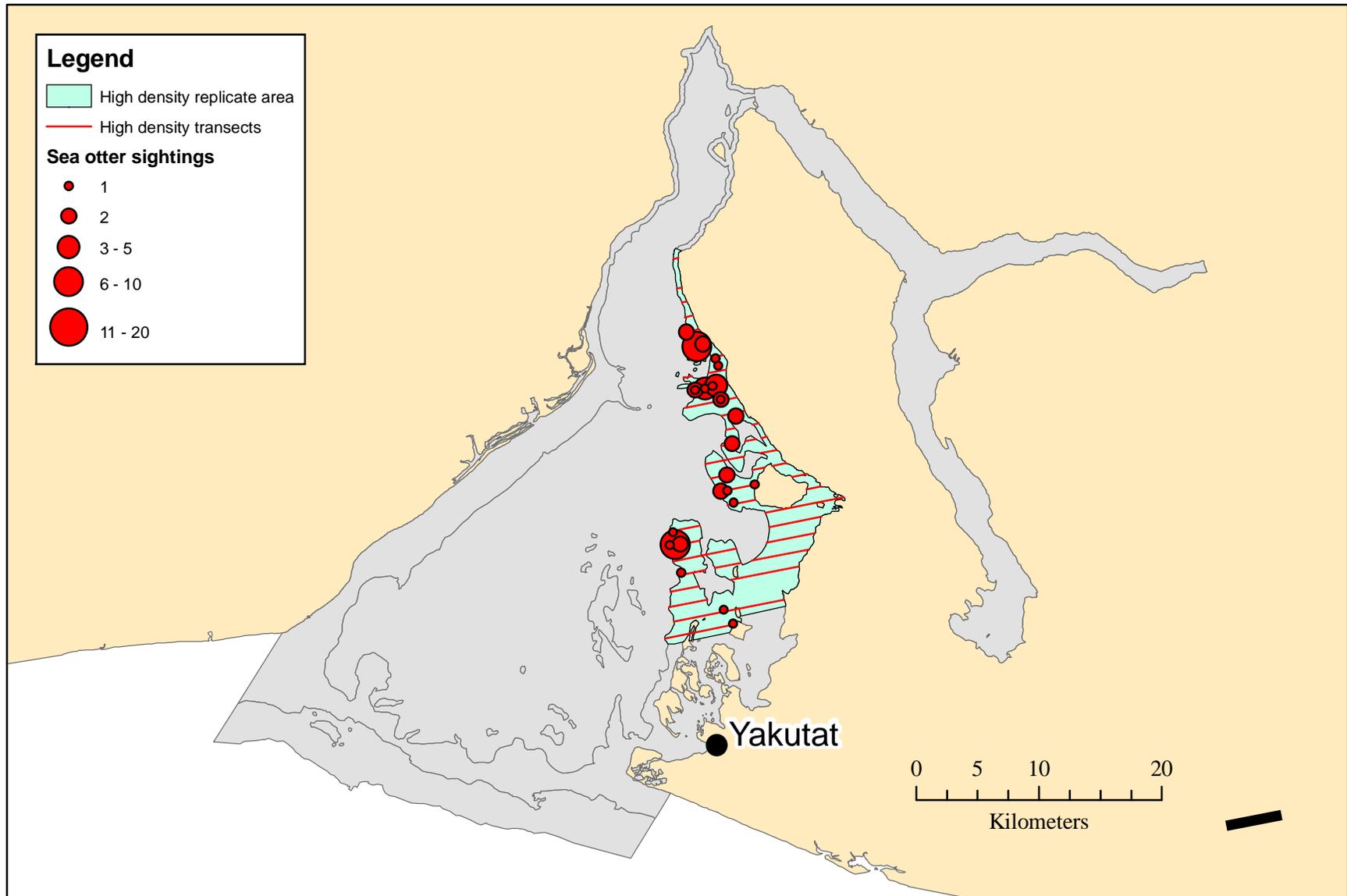


Figure 7. Survey transects and sea otter sightings for the fourth replicate of the aerial survey of Yakutat Bay conducted 24 April 2005.