Distribution and Abundance of Kittlitz's Murrelets Along the Outer Coast of Glacier Bay National Park and Preserve

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Abstract. We conducted at-sea surveys in July 2003 and 2004 to describe the distribution and abundance of Kittlitz's Murrelets from Pt. Carolus to Yakutat, a previously unsurveyed area. Surveys were conducted aboard a 20 m vessel or a 5.5 m skiff, depending on sea conditions, and used a GPS-integrated computer system to record observations. Survey transects included nearshore and pelagic environments. Along the exposed outer coast, continuous systematic sampling and adaptive cluster sampling methods were used to estimate density of birds. All birds were counted within a fixed-width transect (300 m for large vessel and 200 m for small skiff), and distance was estimated to each murrelet observation. Kittlitz's distribution was patchy along the outer coast, with concentrations near Icy Point, mouth of Lituya Bay, and Cape Fairweather. Densities (birds per km^2±SE) of Kittlitz's Murrelets were highest near Icy Point (4.77±0.62) and the mouth of Lituya Bay (2.90±0.59). Mean density was highest at and within 10 fathoms of depth and at least 200 m from shore. We estimated the population size (N±SE) of Kittlitz's Murrelets in our restricted study area to be 578±61 birds. We suggest that this region may contain a previously unknown but significant portion of the Alaska Kittlitz's Murrelet population.

Introduction

The Kittlitz's Murrelet (*Brachyramphus brevirostris*) is one of the rarest and least understood seabirds in the world. Few surveys have documented distribution and abundance of Kittlitz's Murrelets. Breeding distribution of this species is largely undefined, with the majority of the breeding population in Alaska and small populations in the Russian Far East. Summer records of birds at sea, presumed to be breeding nearby, indicate the species range extends from the Okhotsk Sea, throughout the Bering Sea, and highest densities are reached in the northern Gulf of Alaska (GOA; Day and others, 1999); however, few nest records exist to confirm breeding areas. The world population of Kittltiz's Murrelets was recently estimated to be between 9,500 and 26,500 birds (U.S. Fish and Wildlife Service, 2004).

Limited data exist to assess the conservation status of Kittlitz's Murrelets. Research on this rare seabird has been concentrated in Prince William Sound and Glacier Bay where the highest densities of this species were thought to exist (Kendall and Agler, 1998). Replicated surveys conducted in these areas have suggested extreme declines of Kittlitz's Murrelets. Between 1991 and 1999/2000, data collected in Glacier Bay suggest that the population has declined by more than 80 percent (Robards and others, U.S. Geological Survey, written commun., 2003). Trend data from Prince William Sound describe slightly greater declines of 84 percent (Stephensen and others, 2001; U.S. Fish and Wildlife Service, 2004). In response to documented declines at these and two other sites, the U.S. Fish and Wildlife Service listed the Kittlitz's Murrelet as a candidate species under the Endangered Species Act in May 2004 (69 FR 24875 24904).

The objectives of our research were to describe the current distribution and abundance of Kittlitz's Murrelets from Pt. Carolus to Yakutat (fig. 1), a previously unsurveyed area, and to refine at-sea survey methods along this exposed coastline. In this paper, we summarize the results of our work conducted in 2003 and 2004.

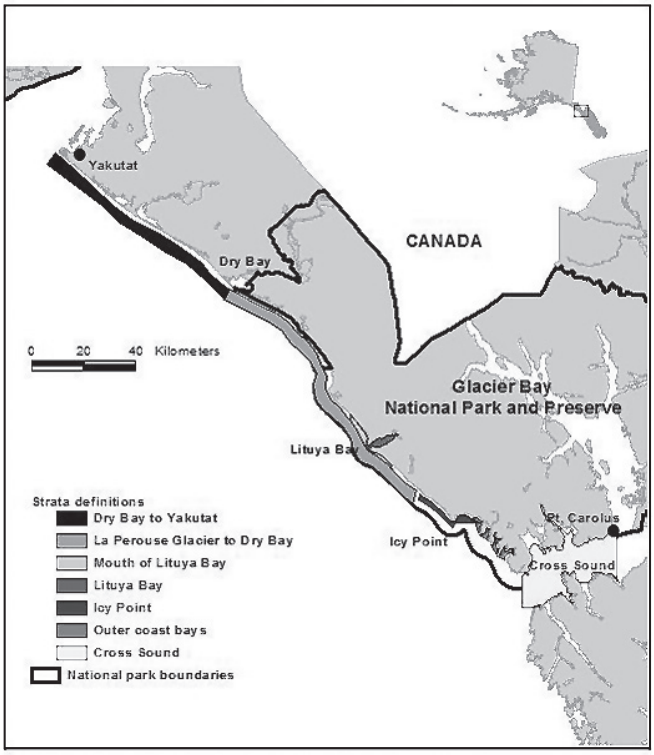

Figure 1. Study area by stratum surveyed July 3-11, 2003 and July 6-15, 2004.

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Methods

We defined seven strata based on geographic location and bathymetry (fig. 1). We used a systematic sampling design with adaptive cluster sampling in areas of high murrelet densities. Our sampling unit was individual transects (n=116), which were of unequal length, at least 1.6 km apart, and were assumed to be independent of one another. Shoreline transects ran parallel to shore and covered waters less than 200 m offshore. Transects in waters greater than 200 m from shore were perpendicular to shore, followed a sawtooth (i.e., zigzag) pattern, or were parallel to shore depending on water depth.

Along the exposed outer coast, we stratified our study area by three water depths: less than 10 fathoms, 10 fathoms, and greater than 10 fathoms. We chose 10 fathoms as a boundary because this depth is often included on marine charts and is an acceptable depth for the larger vessel (see below) to navigate safely. Transects surveyed that were less than 10 fathoms in depth extended to within 200 m from shore and 150 m from the 10 fathom line. At the 10 fathom line, transects followed this depth continuously and transect width was 300 m. Transects surveyed that were greater than 10 fathoms in depth extended from 150 m from the 10 fathom line to 5.56 km (3 nautical miles) offshore. This distance from shore denotes the territorial sea boundary and is also often noted on marine charts.

We conducted at-sea surveys from July 3-11, 2003, and July 6-16, 2004, using methods similar to Gould and others (1989). We used line transect survey methods (Buckland and others, 2001) assigning each observation to a 25 m distance bin. For all shoreline and offshore transects in protected bays or under calm sea conditions, we used 5.5 m hard-hulled skiffs with two observers and boat operator, and transect width was 100 m either side of and ahead of the skiff. Otherwise we used a 20 m vessel, and two observers at the bow recorded all birds 150 m either side of and ahead of the vessel. We recorded all observations using a GPS-integrated voice recording system (Program SURVEY, J. Hodges, U.S. Fish and Wildlife Service, Juneau). For all murrelet observations, we recorded number in group, behavior (e.g., on water, flying, foraging), and the distance bin. Every 30 minutes we also recorded weather, sea and ice conditions, swell height, wind speed and direction, and water temperature and clarity. All observers were trained in bird identification and distance estimation prior to the surveys, and observers rotated every 2-3 hours to stay alert and focused.

We used program DISTANCE (Thomas and others, 2002) to model the probability of detection and effective area sampled because it provides a very powerful and flexible set of detection functions. DISTANCE uses a key function to approximate the probability of detection at distance r, $g(\pi r^2)$, and improves the fit with a series expansion term (Thomas and others, 2002). An advantage of using DISTANCE is that it employs Akaike's Information Criterion (AIC) to select the most parsimonious model from a set of potential models for $g(\pi r^2)$(Burnham and Anderson, 2002; Thomas and others, 2002). We used AIC to select the uniform detection function with a simple polynomial series expansion term to model $g(\pi r^2)$ for Kittlitz's Murrelets (Buckland and others, 2001). We included survey platform, observer, cluster size, and weather and sea conditions as additional covariates when modeling the detection probability. Density, population, and associated variance estimates for each stratum were pooled across all transects and weighted by transect length (Cochran, 1977). The overall population estimate and variance for the study area was pooled across all strata (Cochran, 1977).

Results

Over the two year period, we observed 600 Kittlitz's Murrelets and 528 *Brachyramphus* Murrelets (unable to identify birds to species) on transect. The distribution of Kittlitz's Murrelets was centered between Lituya Bay and Cape Fairweather, with large clusters of birds near Icy Point (fig. 2). Only a few birds were observed north of Dry Bay. Most birds were close to shore along the exposed outer coast, but few were in protected bays.

Density estimates (D±SE) were highest in the Icy Point stratum (4.77±0.62 birds/km^2), followed by the mouth of Lituya Bay (2.90±0.59 birds/km^2) and La Perouse Glacier to Dry Bay (2.20±0.20 birds/km^2; fig. 3). Variance in the density estimates was comprised mostly (>90 percent) of variance in the encounter rate (not variance in the detection probability). The overall population estimate (N±SE) for the entire study area was 578±61 birds. Population estimates were highest in the La Perouse Glacier to Dry Bay stratum (249±35 birds), followed by Icy Point (155±33 birds). Density and population estimates were lowest in the Outer coast bay, Cross Sound, and Lituya Bay strata (fig. 3).

Mean densities along the exposed coastline were highest, but most variable, at or within 10 fathoms of depth (fig. 4a). Few Kittlitz's Murrelets (<1 percent of observations) were observed within 200 m from shore, and consequently, mean density was lowest in the nearshore sub-stratum (fig. 4b).

Discussion and Conclusions

Kittlitz's Murrelets generally are associated with glacial fjords, tidewater glaciers, and recently deglaciated areas (Day and others, 1999), and in Southeast Alaska, this species was thought to be restricted to Glacier Bay and glaciated fjords on the mainland (Day and others, 1999). With these surveys, we demonstrate that not only are Kittlitz's Murrelets present in very exposed areas, but also densities in these areas may even exceed those in more protected, inner fjords (see U.S. Fish and Wildlife Service, 2004). We conclude that this species uses a greater variety of habitats than previously acknowledged.

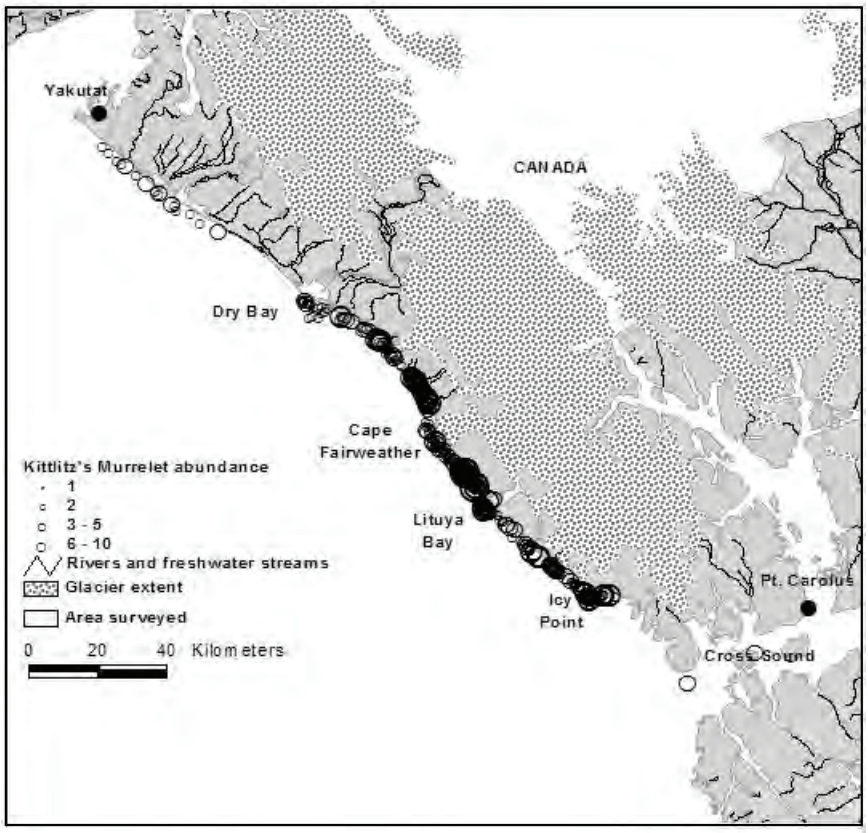

Figure 2. Distribution and abundance of Kittlitz's Murrelets surveyed during July 3-11, 2003 and July 6-15, 2004. Glaciers in northern Cross Sound are receding, while glaciers at Cape Fairweather and Icy Point are thinning. The only advancing glaciers in this study area are located in Lituya Bay.

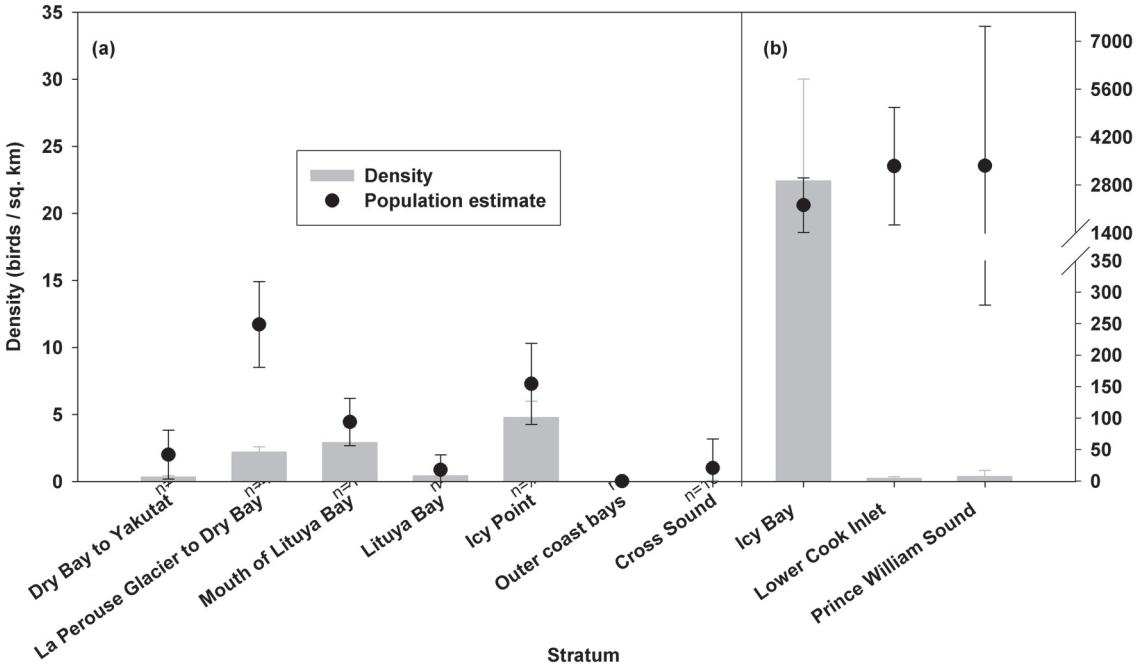

Figure 3. Density and population estimates of Kittlitz's Murrelets for (a) seven strata surveyed during 2003 and 2004, and (b) three other regions in Alaska. Error bars represent 95% confidence intervals: n equals the number of transects in stratum ([1]U.S. Fish and Wildlife Service, unpubl. data; [2]Kendall and Agler 1998. In 2004, PWS population=758 birds [U.S. Fish and Wildlife Service, unpubl. data]).

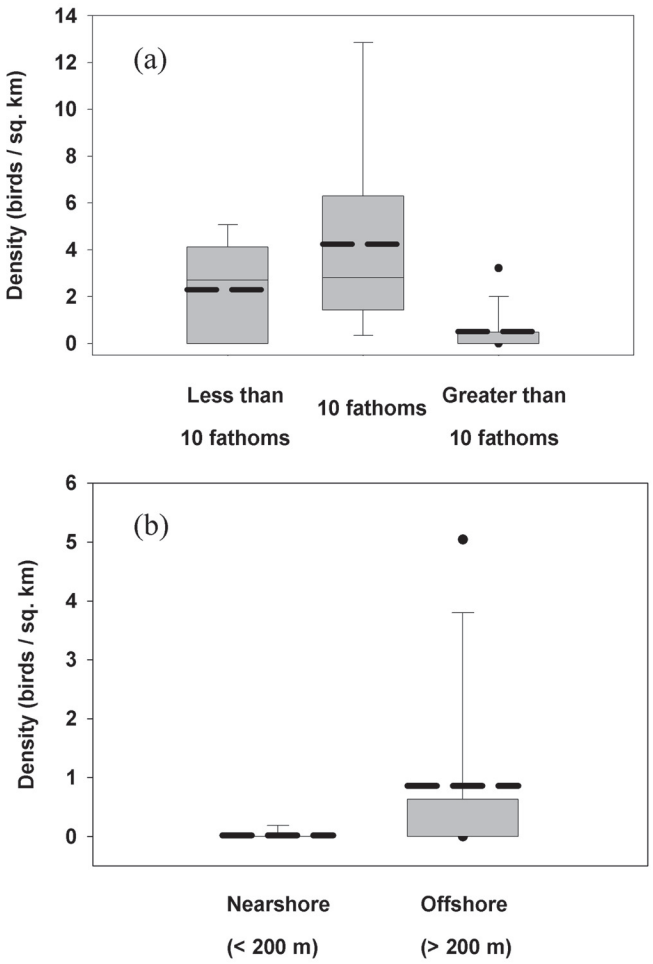

Figure 4. Box plots describing mean density of Kittlitz's Murrelets (a) at three depth categories and (b) on nearshore (within 200 m from shoreline) and offshore (greater than 200 m from shoreline) transects. Whiskers represent 95% confidence intervals, mean density is denoted by dashed line, and median density by solid line.

The majority of birds observed along the outer coast during this study were close to shore in shallower waters, but very few birds were present in protected bays. For example, the mouth of Lituya Bay had a high density of birds, but only two Kittlitz's were observed inside Lituya Bay. This may be because the Lituya Bay basin is quite deep (maximum 153 m), whereas a shallow sill at 15 m depth occurs at the mouth of the bay. Low densities and numbers of birds were recorded in waters greater than 10 fathoms in depth, and waters within 200 m of shore. The distribution of Kittlitz's decreased dramatically just beyond the 10 fathom line. In Prince William Sound, Kittlitz's preferred nearshore (<200 m) habitat, although the proportion of offshore transects to nearshore transects was low (Day and Nigro, 2000). However, less than 1 percent of our Kittlitz's observations were within the nearshore sub-strata. In our study area, nearshore surveys produced little information, given survey effort, regarding abundance of Kittlitz's Murrelets. Our results illustrate that future surveys along the outer coast should focus survey efforts within waters less than or equal to 10 fathoms in depth, and waters greater than 200 m from the shore.

High densities of Kittlitz's were recorded near Icy Point, but few birds were observed north of Dry Bay where the glacial ice is further from the shoreline (Icy Point: min. distance to ice=0 km, max. distance=12.3 km; Dry Bay: min. distance—12.4 km, max. distance=33.6 km). The combination of shallow, but turbid or exposed, water and glacial-affected water seems to be important for this species (Day and others, 2000), but mechanistic understanding of this relationship is unclear. In Prince William Sound, changes in the abundance and distribution of Kittlitz's murrelet indicate that this species prefers waters associated with stable or advancing glaciers, as opposed to receding glaciers (Kuletz and others, 2003). However, this and other studies of Kittlitz's were conducted in protected, deepwater fjords, and little is known about the association between glacial runoff and Kittlitz's along more exposed, relatively shallow coastlines. Notably, glaciers in Lituya Bay are currently advancing, La Perouse and Fairweather Glaciers are thinning, and Brady Glacier (near Taylor Bay) is retreating (R. Motyka, Geophysical Institute, University of Alaska, Fairbanks, oral commun.). To increase our understanding of at-sea habitat requirements for this species, future research should investigate the biological link between Kittlitz's distributions and glacial outflow in the unique habitat of the exposed outer coast.

Densities of Kittlitz's Murrelets estimated during this study are comparable to those estimated in other areas of Alaska (fig. 3), but population estimates are lower (Kendall and Agler, 1998) because extrapolation of the data is difficult. Although we observed many Kittliz's within 10 fathoms of depth near the mouth of Lituya Bay, we were unable to survey the entire coastline at depths less than 10 fathoms because of logistical constraints (e.g., lack of a safe anchorage, safe navigation of boat). Therefore, we consider our estimate to be a minimum estimate for the outer coast. We successfully identified Kittlitz's "hotspots" to be near the mouth of Lituya Bay, Cape Fairweather, and Icy Point.

Management Implications

As a candidate species under the Endangered Species Act, the distribution and abundance of Kittlitz's Murrelets will require continued monitoring and assessment. Data summarized here will assist in management of a unique resource of the outer coast of Glacier Bay National Park and Preserve. While this area does not experience heavy visitor use, it is susceptible to oil spills and increased boat traffic. In addition, since little disturbance occurs in our study area, Kittlitz's Murrelet populations along the outer coast may help managers and biologists determine reasons for decline. These data also will aid in identifying critical habitat for this species should a recovery plan be necessary.

Acknowledgments

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