

# Pelagic Seabirds of San Juan Channel

Fall, 2012

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## **Abstract**

Seabirds play important ecological roles and are indicators of ecosystem health and change. They are thought to be in decline in the Salish Sea. Seabirds were counted in San Juan Channel during fall 2012. This study focuses on the community composition as well as the distribution and within-season change among the dominant families. Fall 2012 was compared to data from previous years going back to 2006 to assess community stability and changes in abundance and found no evidence of continued decline in San Juan Channel.

## **Introduction**

In a marine ecosystem, most of the flora and fauna occur underwater making them and their ecological interactions difficult to observe. The exceptions in these habitats are the highly visible seabirds. Seabirds act at multiple trophic levels, and because they are sensitive to bottom-up controls, they are strong indicators of ecosystem changes (Aebischer et al. 1990). Because they feed pelagically and breed terrestrially, they also link ecosystems that are spatially distinct (Piatt & Sydeman 2007).

The San Juan Archipelago is an oceanographically complex island cluster in the Salish Sea where oceanic and freshwater inputs combine with current-inducing bathymetry to create highly productive and ecologically rich waters. These factors attract a large and diverse community of seabirds in all seasons.

Autumn brings major changes to the seabird community in the San Juan Islands. As summer ends, south-migrating species like California and Heermann's Gulls begin to leave (Sibley 2000). Meanwhile, the protection from winter storms offered by the rain shadow of the Olympic Mountains attracts birds from the north. These may be year-round residents whose

populations are augmented by migrants, as with the Marbled Murrelet (Marhsall 1988), or species which are uncommon in the area during warmer seasons, such as the Ancient Murrelet (Sibley 2000, Gaydos & Pearson 2011).

There is evidence that seabirds in this region are in perilous decline. Estimates range from 29% to 47% decline in total number of birds in the area since the 1970's (Bower 2009, Gaydos 2005). Some species are thought to be failing more quickly than others: "of the 37 most common overwintering Salish Sea species, 14 showed significant decreases, including decreases of more than 50% for 11 species (Bower 2009)," potentially cause by habitat loss, fishery bycatch, and climate effects on prey availability.

The objectives of my study were to characterize the seabird community in San Juan Channel for autumn 2012 in terms of abundance, composition, distribution, and changes over the season and to characterize the trends in these elements since 2006.

## **Methods**

### *Study Site*

The bird surveys for this study were performed by PEF apprentices from September 28th through November 14<sup>th</sup>, 2012 along the same strip transect as previous years. Our 21.5 km transect ran down the center of San Juan Channel from Yellow Island in the north to the edge of the Strait of Juan de Fuca in the south (Fig 1). Seven surveys were performed, each consisting of two transects, one north to south and one south to north.

### *Survey Method*

Our surveys were carried out from the bow of the 58 foot *R/V Centennial*, roughly 3 meters above the waterline. The vessel maintained an average speed of approximately 8 knots. Teams of two observers and one recorder covered each side of the vessel over 90° arcs from right ahead to directly abeam. The transect extended 200 m to each side of the vessel for a total strip width of 400 m. Using binoculars, birds were identified to species when possible.

### *Data Analysis*

For summary statistics, I report  $\bar{x} \pm 95\%$  confidence interval. I calculated densities using the following equation:

$$density = \frac{\# \text{ birds}}{\text{transect area (km}^2\text{)}}$$

## **Results**

### *Community Composition*

During fall 2012, we observed 20,183 birds on transect in San Juan Channel for a mean seasonal density of  $167.63/\text{km}^2 \pm 43.16$  CI. We identified 39 bird species from 11 families. Six of these families were dependent on the pelagic marine environment and abundant enough to influence the seabird community. Families Alcidae, the auks, and Laridae, the gulls, were the most abundant, jointly representing 91% of birds surveyed (Fig 2).

The ten most abundant observed species included four auks, five gulls, and one loon (Table 1). No ducks, grebes, or cormorants were among the ten most abundant species. Throughout autumn 2012, auks were distinctly the predominant family and were most heavily represented by the Common Murre (*Uria aalge*, Fig 2). The seasonal mean for the Common Murre ( $66.00/\text{km}^2 \pm 32.28$  CI) was nearly four times that of the second most abundant Glaucous-

winged Gull ( $16.83/\text{km}^2 \pm 4.01$  CI) and ten times that of the seventh most abundant Ancient Murrelet ( $6.45/\text{km}^2 \pm 5.04$  CI).

#### *Within-Season Variation*

Over the course of fall 2012, changes in seabird abundance were species specific and fell into four broad categories: decrease, pulse, mid-season increase, and no change. Heermann's Gull (*Larus Heermanni*) and California Gull (*Larus californicus*) abundances showed net decreases and their numbers declined to absence over the course of the season. Populations of the Glaucous-winged Gull and Mew Gull (*Larus canus brachyrhynchus*) displayed a pulse pattern with a midseason peak and overall net gain in abundance (Fig 3). The Ancient Murrelet (*Synthliboramphus antiquus*) was uncommon at the start of the season with a mean density of  $0.73/\text{km}^2 \pm 0.50$  CI from September 28<sup>th</sup> until October 23<sup>rd</sup>, but then numbers abruptly rose to a mean density of  $14.09/\text{km}^2 \pm 3.04$  CI from October 30<sup>th</sup> until November 14<sup>th</sup>. The Common Murre likewise showed an apparent trend towards growing numbers over the fall interrupted by a spike on October 10<sup>th</sup> (Fig 4). The Marbled Murrelet (*Brachyramphus marmoratus*) and the Rhinoceros Auklet (*Cerorhinca monocerata*) showed no apparent net changes and had stable patterns across the season. The Bonaparte's Gull (*Chroicocephalus philadelphia*) did not follow a discernible pattern and numbers were volatile throughout the season; on three nonconsecutive survey dates they were observed at less than  $1/\text{km}^2$ , otherwise they were regularly observed at  $15/\text{km}^2$  or greater.

#### *Distribution*

Most gull species did not display significant differences in distribution, but one pattern did arise. The Glaucous-winged Gull was common throughout the transect but was statistically

significantly more abundant in zone 5 than in zones 1, 2, and 4 (Fig 6). The Mew Gull displayed similar behavior, appearing in zone 5 significantly more than in zones 1 and 2.

Two distribution patterns appeared in the alcids. The Marbled Murrelet and Rhinoceros Auklet displayed a bell curve distribution. They appeared most in zone 3, and the appeared in zones 2-5 significantly more than zones 1 and 6 (Fig 6, Fig 7). The Common Murre and Ancient Murrelet appeared with increasing frequency along the transect from north to south with significantly higher densities in southern zones.

#### *Interannual Variation*

Autumn seabird abundance in San Juan Channel tended to be higher from 2010 – 2012 than from 2006 – 2009 (Fig 9). The lowest abundance was in autumn 2007 with a mean seabird density of  $42.00/\text{km}^2 \pm 14.40$  CI. The highest was in autumn 2010 with  $178.00/\text{km}^2 \pm 48.00$  CI.

Community composition has not varied significantly since 2006. The Common Murre and Glaucous-winged Gull have consistently been the predominate species (Table 2). The Common Murre had a mean density of  $11.20/\text{km}^2 \pm 3.85$  CI from 2006 – 2009 and rose to a mean density of  $54.19/\text{km}^2 \pm 23.22$  CI from 2010 – 2012 (Fig 10A). The Glaucous-winged Gull stayed relatively stable at a mean density for all years of  $16.68/\text{km}^2 \pm 4.26$  CI.

The Mew and Heermann's Gulls, Ancient and Marbled Murrelets, Pacific Loon (*Gavia pacifica*), and Surf Scoter (*Melanitta perspicillata*) have reliably appeared in the middle or bottom of the top ten list. The Mew and Heermann's Gulls have had stable abundances over this time period with slight net gain but without large fluctuations. (Fig 10B). The Marbled Murrelet was not among the ten most abundant species in 2008 and 2008, but their actual abundance changes ran parallel to those of the Pacific Loon. The Ancient and Marbled Murrelets and Pacific Loon all showed apparent trends of increasing abundance (Fig 10C). The Surf Scoter has steadily

moved down the list from seventh in 2006 and 2007 to tenth in 2008 – 2010 and dropping below tenth most abundant recently in 2011 and 2012, but actual abundance stayed stable around a mean density of  $1.76/\text{km}^2 \pm 0.51$  CI.

Bonaparte's Gull and the Rhinoceros Auklet have appeared in the top ten inconsistently. Bonaparte's Gull was third most abundant in 2006, 2008, 2011, and 2012, but was eighth in 2010 and did not make the list in 2007. The Rhinoceros Auklet has displayed similar fluctuation, falling off the list in 2007 but rising to second most abundant and outnumbering the Glaucous-winged Gull in 2010. Actual abundance of these species was likewise highly variable from year to year (Fig 10D). Bonaparte's Gull densities ranged from  $0.48/\text{km}^2$  in 2007 to  $16.30/\text{km}^2$  in 2012. Rhinoceros Auklet densities ranged from  $0.58/\text{km}^2$  in 2007 to  $28.21/\text{km}^2$  in 2010.

Changes in mean autumn seabird abundance from year to year reflect species specific changes. Mean changes from 2006 – 2009 correlate with changes in abundance of the Glaucous-winged Gull, the Mew Gull, and the Ancient Murrelet. Mean changes since 2010 correlate with abundance changes in the Common Murre, Rhinoceros Auklet, and Heermann's Gull.

## **Discussion**

### *Seabird Community*

The high abundance of the auk and gull families during fall 2012 was due to high abundance across local species in those families. High numbers of the Common Murre contributed to the predominance of family Alcidae, but three other alcids also appeared among the top ten. In the gull family, all five members of genus *Larus* spotted during surveys were among the top ten most abundant species. 91% of birds this season fell into these two families, as did 9 of the 10 most abundant species.

Likewise, the less plentiful grebe, duck, and cormorant families had lower abundance across species. In some previous PEF studies, unidentified cormorants were calculated as a combination of Pelagic Cormorants (*Phalacrocorax pelagicus*) or Brandt's Cormorants (*Phalacrocorax penicillatus*), increasing the abundance of these species. I opted against this because the difficulty of species level identification in this family leaves me unconvinced of the accuracy of their relative abundance.

#### *Within Season Variation*

The weekly changes in species abundance have two possible explanations: small scale local movements of individuals in and out of the transect area due to tidal and daily weather conditions, or the large scale inter-regional migrations of populations that happen each fall. For example, the elevated abundances seen in almost all species on October 10<sup>th</sup> must be due to local conditions, but the steady decline of the California Gull across the season must be a species-specific migratory pattern.

The mid-season in Glaucous-winged and Mew Gull populations in San Juan Channel was probably a migratory pulse of individuals from British Columbia. While some continued south, some of these birds stayed in the area and contributed to the net increases in the local populations.

The peak in Heermann's Gull abundance on October 23<sup>rd</sup> is unlikely to represent a migratory pulse, however. Unlike Glaucous-winged and Mew Gulls, Heermann's Gulls were at the northern end of their range in our study site (Lewis & Sharpe 1987). It appears nearly all Heermann's Gulls returned south as their numbers steadily declined to 0.29/km<sup>2</sup> by the end of the study. California Gull numbers also fell to zero as they left the area, but without the peak on

October 23<sup>rd</sup> seen in the other gulls. In fact, by that point, nearly all California Gulls had left San Juan Channel, as is typical of the species (Lewis & Sharpe 1987).

Bonaparte's Gull displayed the greatest intraseasonal volatility. It followed a more extreme version of the weekly pattern seen in the family as a whole, with the exception of October 30<sup>th</sup> when their abundance rose while that of the other gulls fell. The Bonaparte's Gull's small size makes it especially mobile and especially sensitive to storms and high winds, and it tends to aggregate and travel in flocks. This means it is more likely than other gulls to enter or leave an area en masse based on small scale factors. The three surveys on which we observed the Bonaparte's Gull at less than 1/km<sup>2</sup> also all had reduced abundances in at least three of the four other gull species, suggesting their absences were due to local conditions, not migratory pulses.

The Common Murre exhibited weekly patterns comparable to the gulls early in the season, but without the apparent decline at the end of the season. Instead they showed a massive net increase; because the first survey on September 28<sup>th</sup> was the only near-zero observation of Common Murres, there is strong evidence of an inter-regional migration, but their week to week variability makes it difficult to determine if it was an acute event between September 28<sup>th</sup> and October 10<sup>th</sup> or happened continuously throughout the season.

The Ancient Murrelet displayed the clearest example of migration into the area. They arrived from northern breeding colonies (Sibley 2000) in large numbers in late October and stayed abundant through the end of the study.

In contrast to their expected behavior, neither the Rhinoceros Auklet or Marbled Murrelet had net change over the season. Marbled Murrelets from British Columbia and Alaska are known to migrate south and typically supplement the resident population of the Salish Sea (Lewis & Sharpe 1987, Sibley 2000), but this migration was not evident in the data for fall 2012.

Conversely, the Rhinoceros Auklet was expected to leave the area in late September but the population was nearly unchanged throughout the season.

While local conditions led to fluctuations across species from week to week, over the course of the fall season each species' migratory pattern was unique.

### *Distribution*

The dynamic and variable bathymetry of San Juan Channel led to distinct trends of distribution among some seabird species. Zones in the north of the channel were generally more protected from weather and had slower currents, while zones towards the south end of the channel were more exposed and tidally energetic.

Mew and Glaucous-winged Gulls aggregated in zone 5, a weather exposed area in the south end of the transect encompassing Cattle Pass, a bottle neck that created high currents when tides rapidly moved large quantities of water between Griffin Bay and the Strait of Juan de Fuca. These tidal effects have been shown to attract seabirds to this area due to increased access to prey. (Zamon 2003).

Alcids species showed increasing abundance moving south from zone 1 to zone 3. The complex currents zone 3 created by the intersection of San Juan Channel and Upright Channel made it a very popular zone for all alcids. The Common Murre and Ancient Murrelet, both highly pelagic species, continued to rise in abundance as the transect moved south and became less sheltered. Both species had their highest densities in zone 6 in the wide open Strait of Juan de Fuca, fully outside protected San Juan Channel.

### *Interannual Variation*

The mean total abundance of seabirds in San Juan Channel during autumn has been significantly higher in each of the last three years than in two of the previous four, and this year

had significantly greater abundance than three of those four. The Common Murre and Glaucous-winged Gull have consistently been the top two predominant species. The Glaucous-winged Gull has fluctuated little compared to the Common Murre, whose mean density the past three years has been five times higher than the previous four. It is possible that PEF has surveyed on unusually abundant days like October 10<sup>th</sup> or November 14<sup>th</sup> of this year more often in the past years by chance, but this does not plausibly explain the trend in full. Even a day on the low end of the typical range this season had nearly four times the average Common Murre density from 2006 – 2009. Common Murre predominance in the channel seems to be increasing.

The species consistently appearing in the range of the list represent a stable community over the past seven years. Heerman's Gull, the Mew Gull, the Ancient Murrelet, and the Pacific Loon have each been on this list in all years. Considering the conservation status of the Marbled Murrelet, it is initially concerning that they sometimes fell off the top ten list. The close correlation between the interannual variation of the Marbled Murrelet and Pacific Loon indicates this species is actually very stable in this area. Similarly, there was apparent decline in the Surf Scoter relative to the top ten list while its actual abundance remained nearly constant between years. These changes actually reflect changes in abundance of other species.

The species with the most variation, the Bonaparte's Gull, has shown the same unpredictability from year to year as from week to week. They were 3<sup>rd</sup> most abundant in 2006 and 2008, but did not make the list in 2007 when their density for the whole fall season was less than 0.5/km<sup>2</sup>. Similar volatility was seen in 2010 when nearly every species had a highly abundant year but Bonaparte's Gulls had a below average seasonal abundance. A few chance days without Bonaparte's Gulls like October 17<sup>th</sup> can significantly drag the species' seasonal

average down, and likewise a few chance days with high abundance like October 30<sup>th</sup> can cause their seasonal average to skyrocket.

Rhinoceros Auklets have had comparable volatility. They were 2<sup>nd</sup> most abundant in 2010, displacing Glaucous-winged Gulls, but the year before they did not make the list, nor did they in 2007. Unlike Bonaparte's Gulls, however, Rhino Auklet boom years like 2010 and 2012 were also boom years for many other species, particularly the Common Murre and Heermann's Gull. Also unlike Bonaparte's Gull, the Rhinoceros Auklet appeared unwaveringly throughout the season without a single boom or bust day. Their abundance changes from year to year do seem to reflect differences in the migratory population, not local day to day conditions.

The interannual changes were driven by different species in early study years. From 2006 – 2009, fluctuations in Glaucous-winged Gull, Mew Gull, and Ancient Murrelet abundance seem to have had the greatest effect on the mean. From 2010 – 2012, the mean has been most influenced by Common Murre, Rhinoceros Auklet, and Heermann's Gull abundance. The increases in these species in recent years may be tied to large oceanographic trends. 2010 – 2012 have been cool to neutral years for the El Niño–Southern Oscillation (NOAA 2012) and increasingly cool years for the Pacific Decadal Oscillation (Mantua 2012). These affects may be cooling the inland water of San Juan Channel and drawing in greater numbers of bird from the coast and elsewhere.

### *Conclusions*

Intraseasonal changes in abundance were species specific, with some species leaving the region while others entered from the north. Distribution patterns were also species specific with some seen more in protected areas and some more abundant in exposed and high current areas.

Seabird abundance in San Juan Channel was high this year and recent years compared to previous PEF studies. There was also a stable composition of community where highly abundant years were correlated with multiple species. This stands in contrast to the declines predicted in seabirds of this region. There is no evidence of loss of pelagic seabird communities in the San Juan Channel over the last seven years, and perhaps indication that some species are increasing in the area.

### **Acknowledgements**

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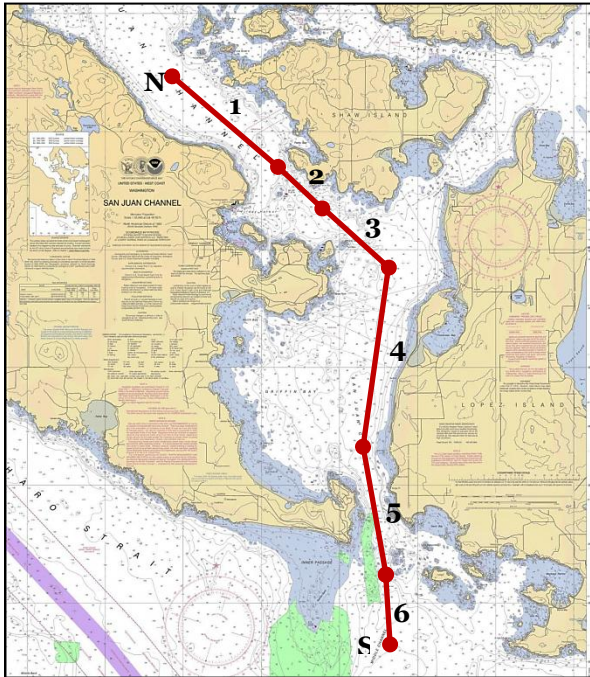
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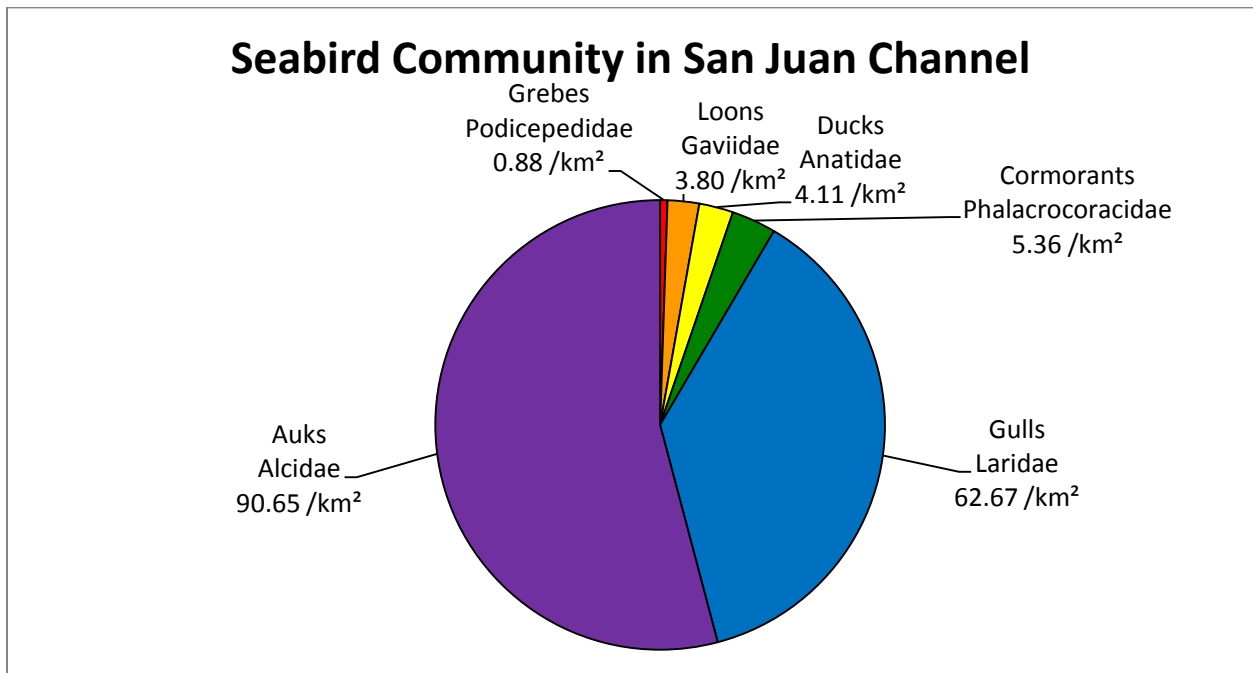
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## Figures and Tables



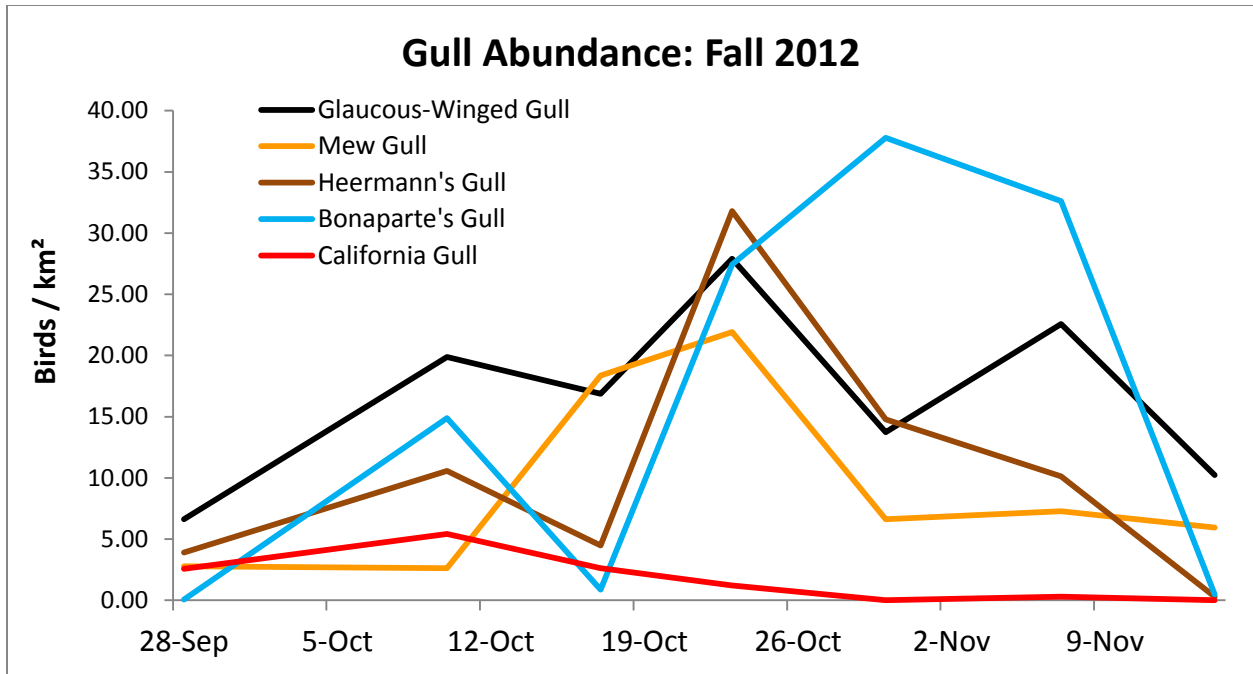
**Figure 1:** PEF transect route through San Juan Channel.



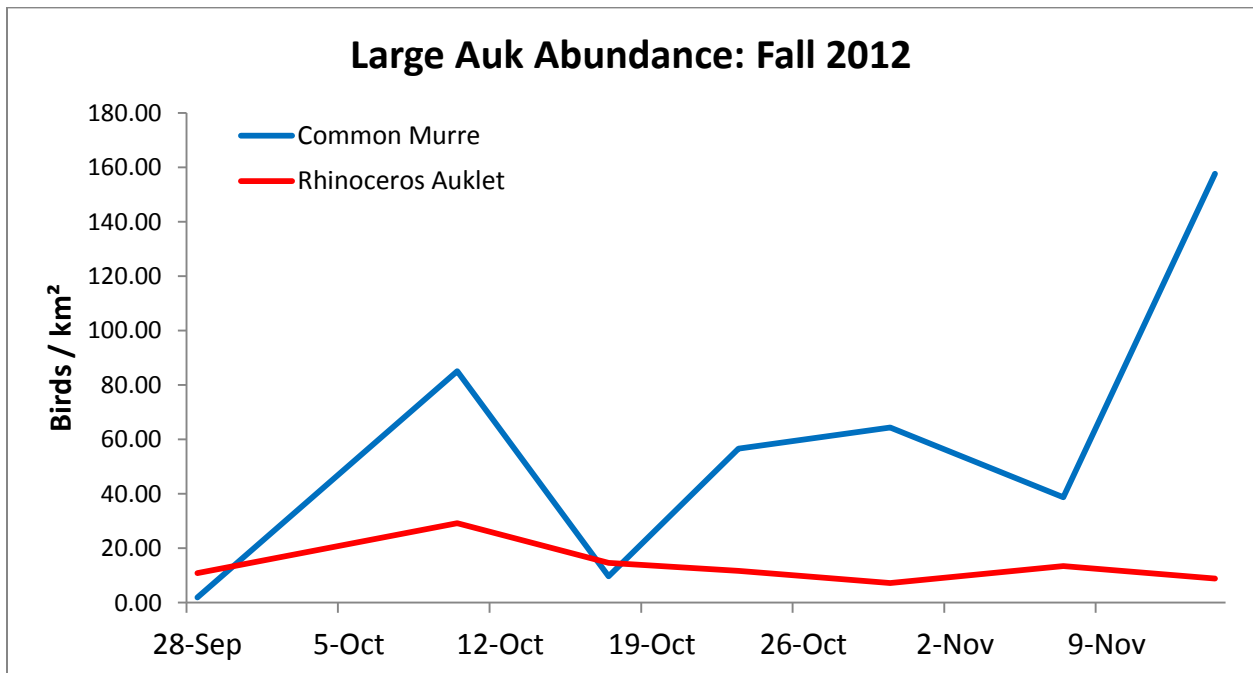
**Figure 2:** Seabird Community in San Juan Channel by family. Densities reflect averages over the entire fall season and include all individuals positively identified to family level, even if species identification was not possible.

**Table 1:** The ten most abundant species in San Juan Channel during fall 2012 by mean density/km<sup>2</sup> for the fall season.

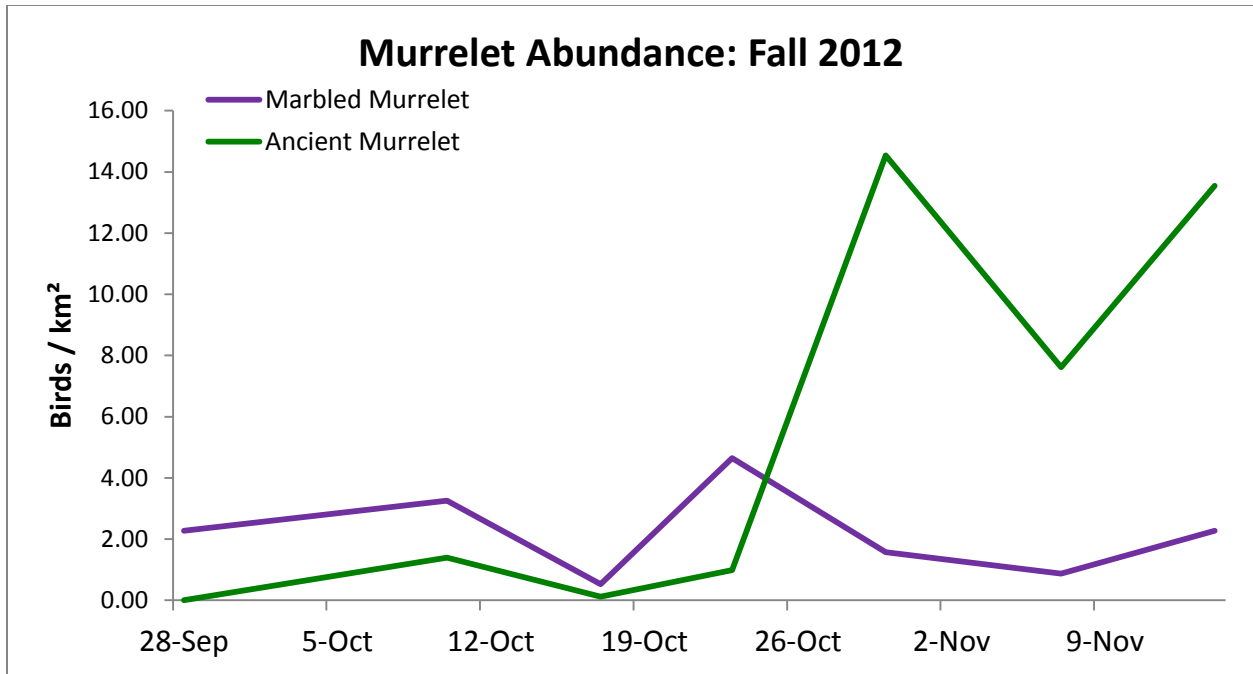
Rank	Species	Density per km <sup>2</sup>	95 % Confidence Interval
1	Common Murre	66.00	±23.22
2	Glaucous-Winged Gull	16.83	±4.26
3	Bonaparte's Gull	16.30	±7.33
4	Rhinoceros Auklet	14.44	±4.32
5	Heermann's Gull	10.85	±1.60
6	Mew Gull	9.36	±3.11
7	Ancient Murrelet	6.45	±2.05
8	Pacific Loon	3.58	±1.41
9	Marbled Murrelet	2.79	±1.31
10	California Gull	1.73	±0.51



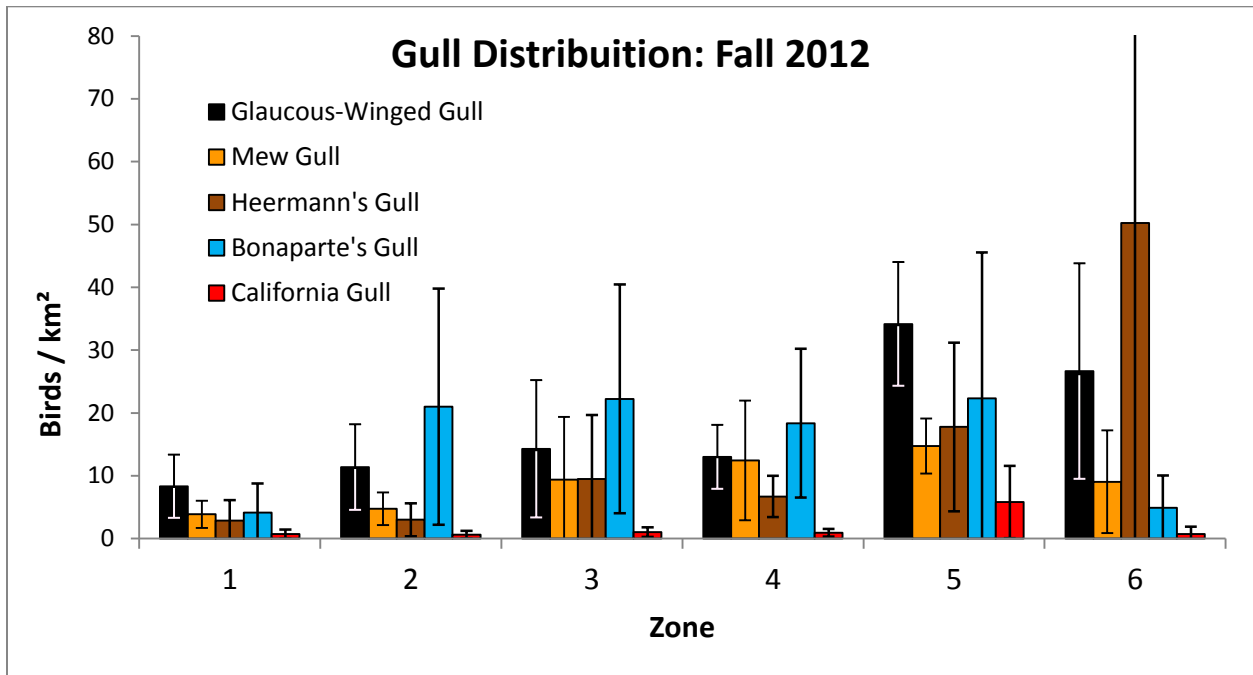
**Figure 3:** Changes in gull abundance by species over the season. Values represent the means of surveys conducted on the same day.



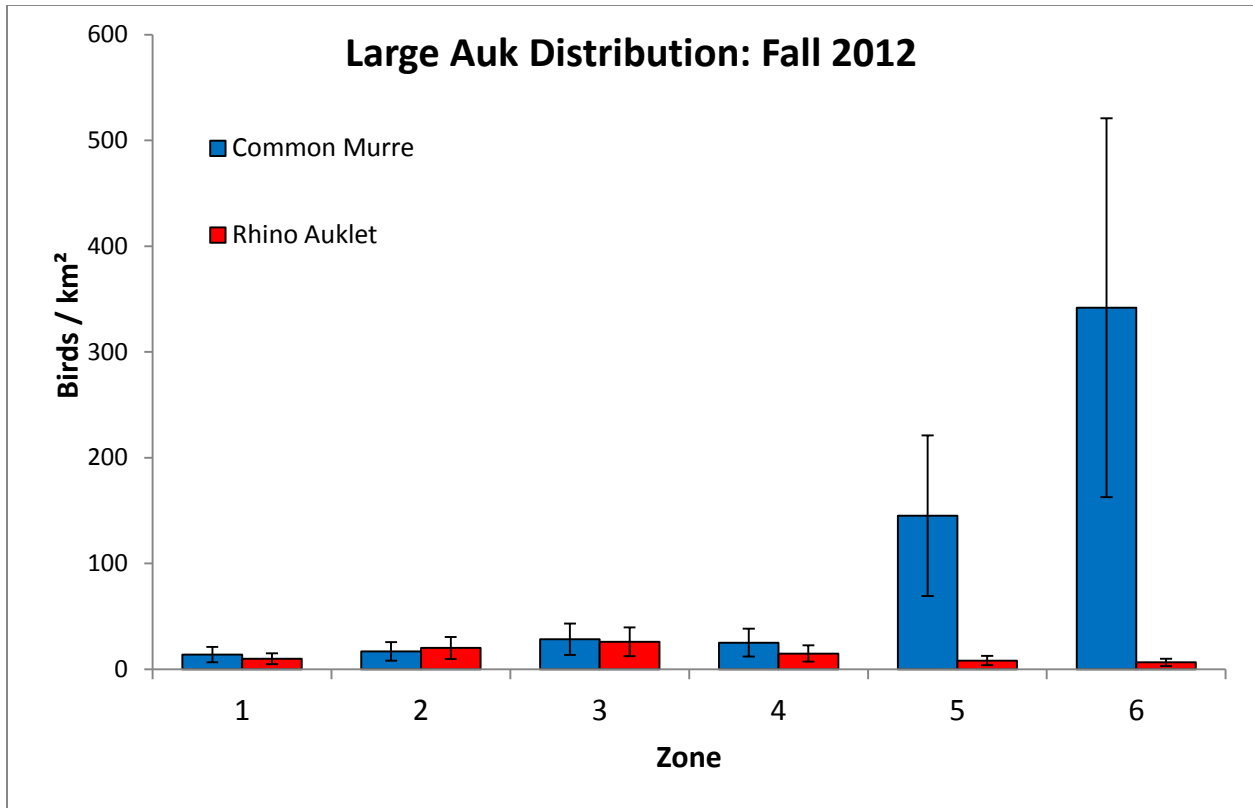
**Figure 4:** Changes in alcid abundance by species over the season. Values represent the means of surveys conducted on the same day.



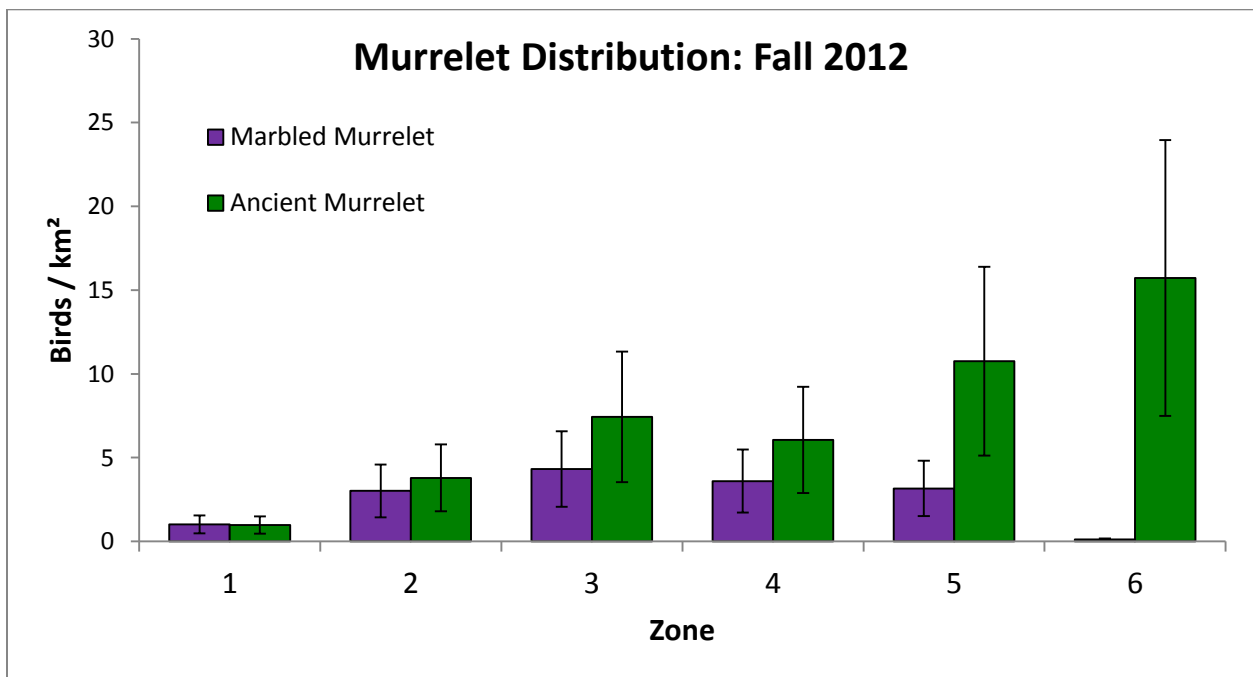
**Figure 5:** Changes in alcid abundance by species over the season. Values represent the means of surveys conducted on the same day.



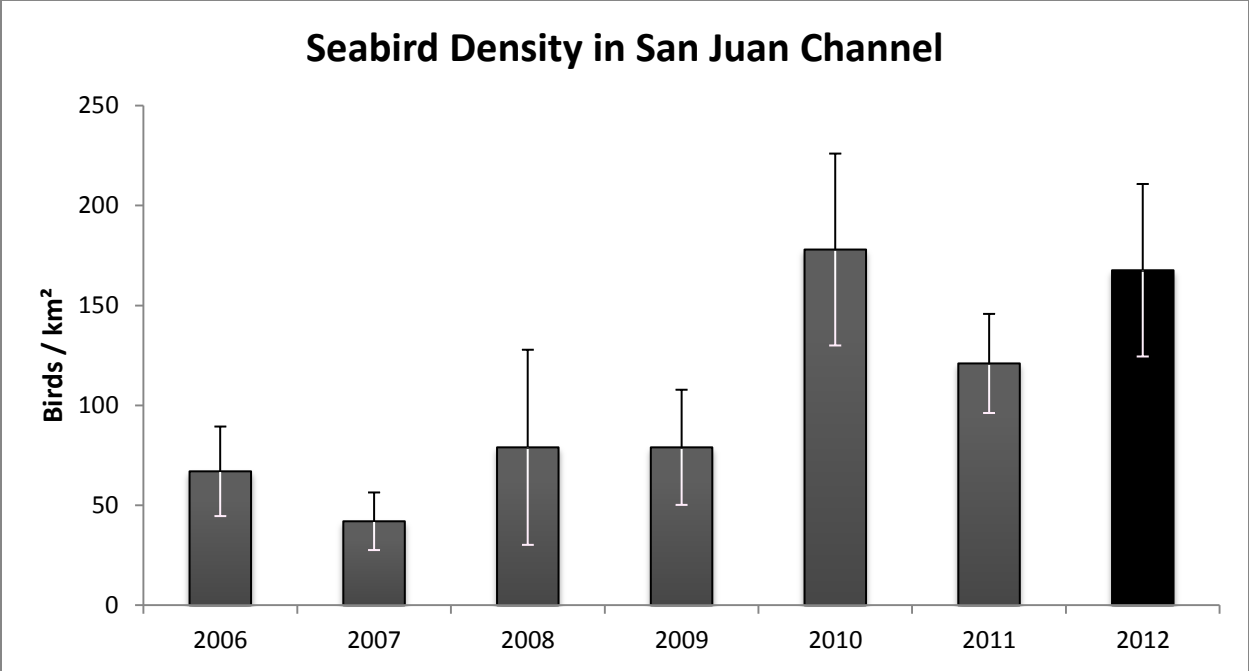
**Figure 6:** Distribution of gulls by species and zone. Densities are mean birds/km<sup>2</sup> over the whole season. Error bars are 95% confidence intervals.



**Figure 7:** Distribution of alcids by species and zone. Densities are mean birds/km<sup>2</sup> over the whole season. Error bars are 95% confidence intervals.



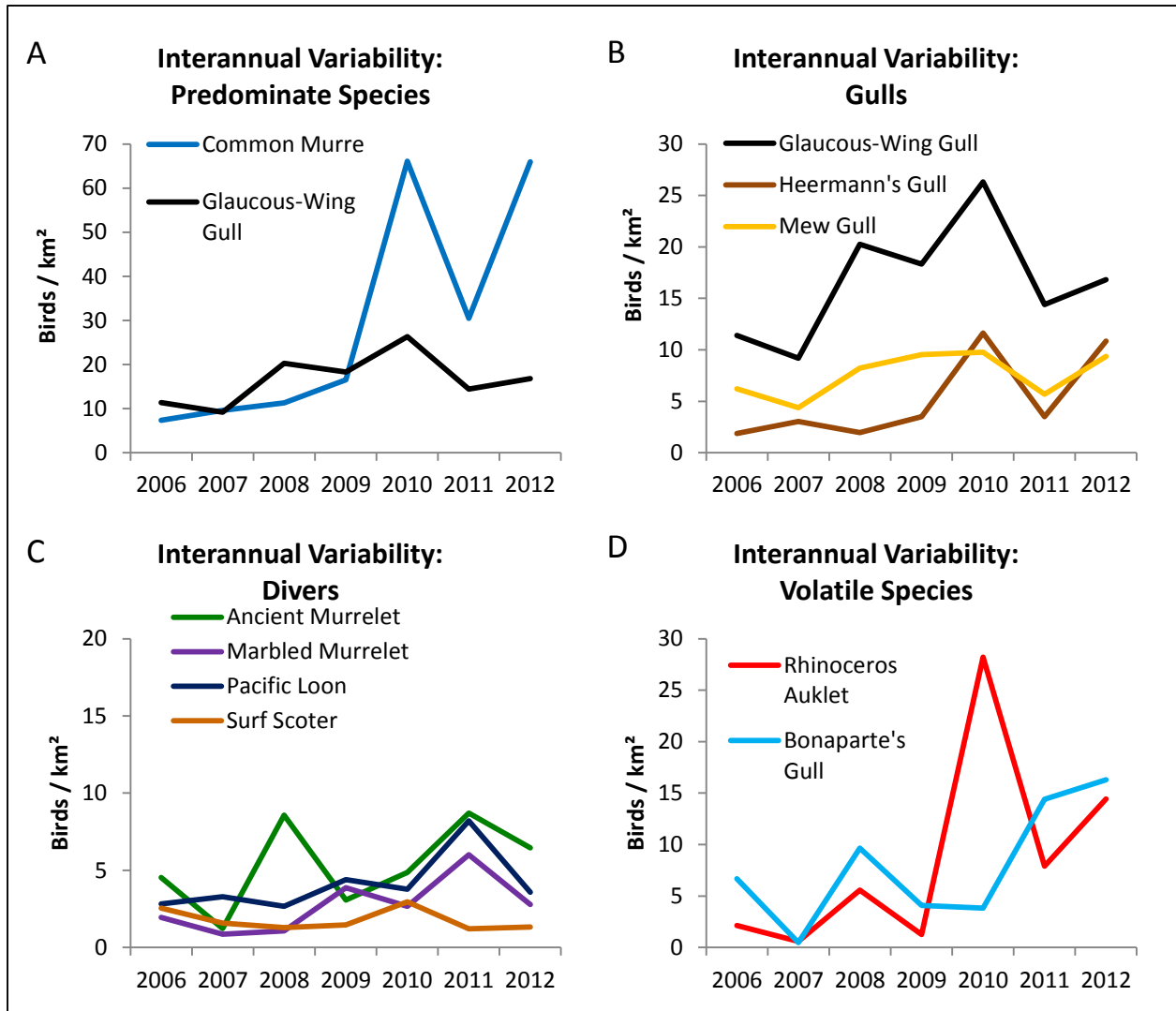
**Figure 8:** Distribution of alcids by species and zone. Densities are mean birds/km<sup>2</sup> over the whole season. Error bars are 95% confidence intervals.



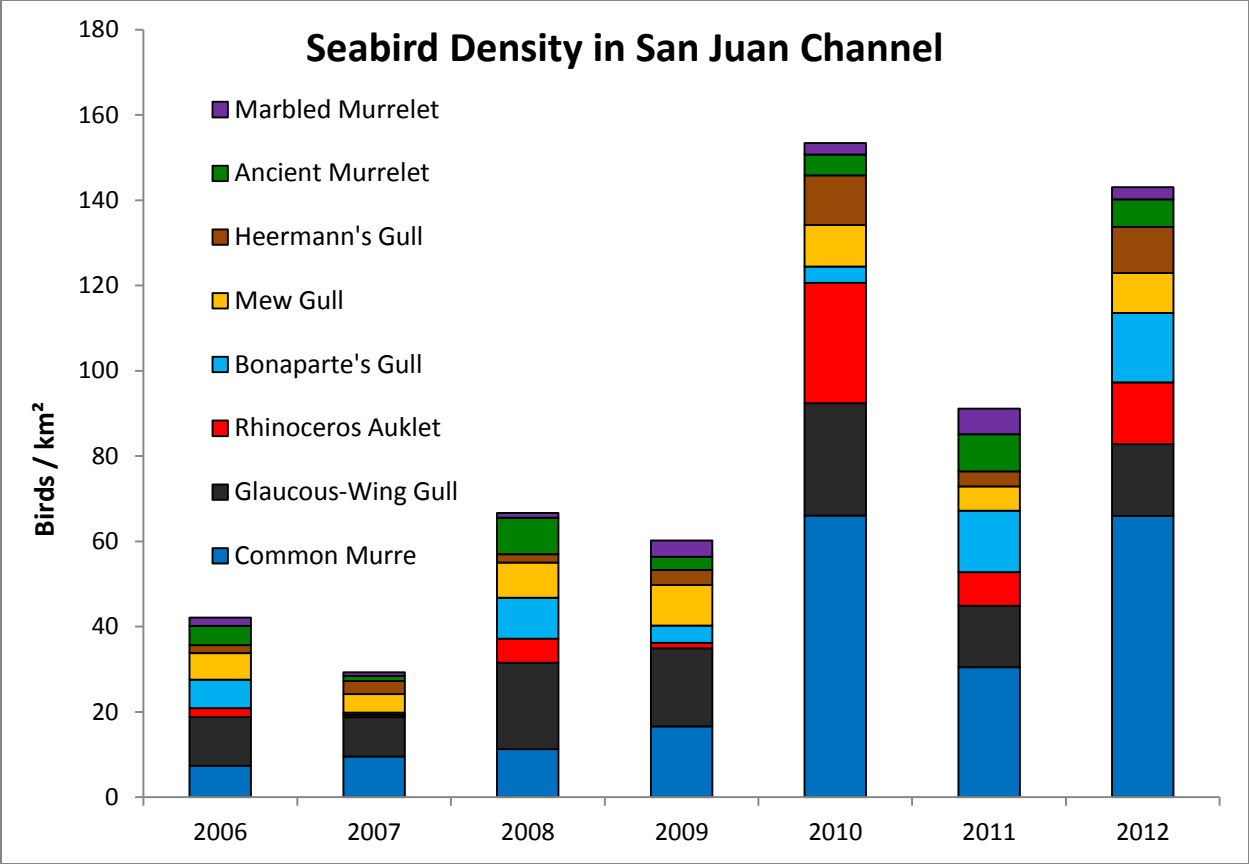
**Figure 9:** Mean density of seabirds by year. Values reflect the mean of all seabirds in the transect area during the fall season. Error bars are 95% confidence intervals.

**Table 2:** Ten most abundant species by year. Blue = predominant species, green = consistently appearing species, red = volatile species.

	2006	2007	2008	2009	2010	2011	2012
1	Glauous-Winged Gull	Common Murre	Glauous-Winged Gull	Glauous-Winged Gull	Common Murre	Common Murre	Common Murre
2	Common Murre	Glauous-Winged Gull	Common Murre	Common Murre	Rhinoceros Auklet	Glauous-Winged Gull	Glauous-Winged Gull
3	Bonaparte's Gull	Mew Gull	Bonaparte's Gull	Mew Gull	Glauous-Winged Gull	Bonaparte's Gull	Bonaparte's Gull
4	Mew Gull	Pacific Loon	Ancient Murrelet	Brandt's Cormorant	Heermann's Gull	Ancient Murrelet	Rhinoceros Auklet
5	Ancient Murrelet	Heermann's Gull	Mew Gull	Pacific Loon	Mew Gull	Pacific Loon	Heermann's Gull
6	Pacific Loon	Brandt's Cormorant	Rhinoceros Auklet	Bonaparte's Gull	Brandt's Cormorant	Rhinoceros Auklet	Mew Gull
7	Surf Scoter	Surf Scoter	Pacific Loon	Marbled Murrelet	Ancient Murrelet	Brandt's Cormorant	Ancient Murrelet
8	Rhinoceros Auklet	Ancient Murrelet	Brandt's Cormorant	Heermann's Gull	Bonaparte's Gull	Marbled Murrelet	Pacific Loon
9	Marbled Murrelet	Marbled Murrelet	Heermann's Gull	Ancient Murrelet	Pacific Loon	Mew Gull	Marbled Murrelet
10	Heermann's Gull	Double-Crested Cormorant	Surf Scoter	Surf Scoter	Surf Scoter	Heermann's Gull	California Gull



**Figure 10:** Interannual variability by species. Values reflect the mean of a species in the transect area during the fall season that year.



**Figure 11:** Histogram of seabird abundance by species and year. Bars reflect mean abundance of a species in the transect area during the fall season that year.