

# **ATLAS OF CALIFORNIA CURRENT MARINE BIRD AND MAMMAL DISTRIBUTIONS: VERSION 1**

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## **Executive Summary**

Marine birds and mammals are conspicuous and important marine organisms. They forage on a variety of zooplankton (copepods, euphausiids) and nekton (squid and fish) prey. By virtue of their high energetic requirements and mobility, these top marine predators may serve as indicators of spatial variability in ecosystem functions and dynamics. Herein, we present distribution maps for select resident and migratory marine birds and mammals in three regions of the California Current System (CCS). We summarize long-term datasets collected in conjunction with ongoing fisheries oceanography surveys in the CCS: the California Cooperative Oceanic Fisheries Investigations (CalCOFI) covering the southern California Bight and adjacent waters, the National Marine Fisheries Service Rockfish Recruitment Survey (NMFS-RRS) covering the Gulf of the Farallones and adjacent waters, and the Canadian Department of Fisheries and Oceans Ocean Station Papa program (DFO-Line P) covering the southeastern Gulf of Alaska. We produced annual and seasonal maps for a total of 24 representative marine bird and 9 marine mammal species, which together account for 83% and 93% of all the birds and mammals sighted during these surveys, respectively. These maps provide insights on biogeographic affinities, habitat associations, and “hotspots” of biodiversity and potential predator-prey dynamics. Identifying “hotspots” is potentially valuable in the design of offshore marine protected area networks. Within the study regions, we found apparent “hotspots” near Point Conception, along Monterey Canyon and at Cordell Bank, and at La Perouse Bank off Vancouver Island. We observed strong seasonal changes in the distribution and abundance of birds and mammals, which alters the relative importance of these “hotspots”. The value of “hotspots” for the protection of these far-ranging pelagic species deserves further study.

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## I. Introduction

The California Current System (CCS) is a large, dynamic and spatially heterogeneous marine ecosystem of the North Pacific Ocean (Duda and Sherman 2002). The CCS spans over 3,000 km of latitude, from approximately the northern tip of Vancouver Island, British Columbia (B.C.) to Punta Eugenia, Baja California (Figure 1). Several major physical oceanographic processes, linked to variability in atmospheric pressure cells and the intensity of dominant currents of the CCS, determine ecosystem form and function. These include seasonal, year-to-year, and longer-term (lower-frequency) variability in localized coastal upwelling, mesoscale eddy variability associated with meanders of the California Current itself, and sub-arctic and subtropical water mass intrusions. The strength and juxtaposition of the North Pacific High relative to the Continental Low and Aleutian Low pressure systems determines the phasing and amplitude of winds which force coastal and offshore upwelling and the intensity of the California Current (Chelton and McGowan 1982; McGowan et al. 1998; McGowan et al. 2003). Numerous sites of high primary and secondary productivity provide foraging opportunities for a diverse and abundant marine mega-fauna, including seabirds, marine mammals and large predatory fish. Many of these species are highly-migratory, visiting the CCS from breeding grounds in Alaska (e.g., fur seals, northern fulmars), Baja California (e.g., gray whales), the Western Pacific (e.g., bluefin tuna, leatherback turtles) and as far as the southern hemisphere (e.g., several shearwaters and petrels). Collectively, these living marine resources support vast societal interests, including commercial and recreational fishing and ecotourism.

Despite being a diverse and highly productive ecosystem, marine top predators of the CCS face a variety of threats. Natural variability, exemplified by interannual (e.g., El Niño) and interdecadal forcings, alter CCS food webs, often with demographic consequences to predator populations. This represents a challenge for management as changes in populations must be viewed from the perspective of natural temporal environmental variability. Indications are that CCS marine bird and mammal populations are strongly influenced by these normal environmental perturbations (e.g., Sydeman and Allen, 1999; Mills et al. 2005). Anthropogenic stressors, such as fishing, coastal development, and pollution may directly and indirectly

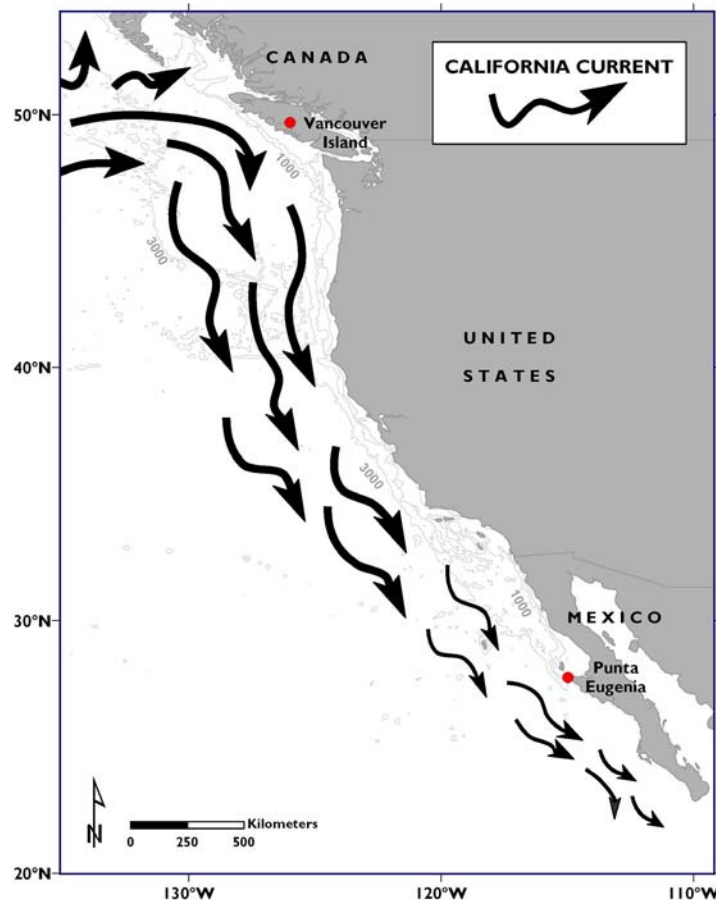


Figure 1. Conceptual map of the California Current.

affect top marine predator populations. Human impacts on marine birds and mammals may also interact synergistically with natural ecosystem variability. For example, the west coast population of Pacific sardine (*Sardinops sagax*) was driven to low levels (and economic extinction) by extensive fishing during a period of adverse climatic conditions for these fish (Chavez et al. 2003). Thus, understanding spatial and temporal variability in ecosystem structure and dynamics and the interactions between natural and anthropogenic impacts has become a central focus of marine conservation in recent time.

In particular, place-based management of ocean resources with time-area closures and protected areas represents one of the newest, albeit controversial, approaches in marine conservation. In the CCS, many initiatives to restore and conserve healthy marine populations and ensure long-term ecological services (e.g., fisheries) are focused on designing and implementing networks of marine protected areas. A logical key first step in designing MPA networks entails determining the distribution and abundance (hence biogeography and aggregation) of marine organisms, and to understand wildlife-ocean habitat associations. Though pelagic systems are inherently different from terrestrial systems, similar concepts for determining key habitats may apply. Predator distributions have been common criteria for the design of protected areas in terrestrial environments. Particularly conspicuous predators may be used as indicators, or “umbrella” species whose protection aids in protecting complex systems.

With partners from NOAA Fisheries, NOAA National Marine Sanctuaries, California Department of Fish and Game, Scripps Institution of Oceanography, and Department of Fisheries and Oceans Canada, PRBO Conservation Science (formerly Point Reyes Bird Observatory) has studied the distributions of marine birds and mammals in the CCS over the past two decades. We have used these extensive datasets to test the hypothesis that areas of persistent biological activity in the open ocean (“ecosystem hotspots”) can be identified and characterized using top predators as indicators of spatial variability. We base this hypothesis on evidence that seabirds and marine mammals aggregate to forage at specific oceanographic habitats, such as fronts, and that these structures are recurrent in space and time due to physical processes (Franks 1992). In the CCS, recent technical papers on marine bird and mammal (and other pelagic nekton) distribution and abundance and “hotspots” include: Ainley et al. (2005), Ford et al. (2004), NCCOS (2003), O’Hara et al. (2006), Reese and Brodeur (2006), Tynan et al. (2005), and Yen et al. (2004, 2005, 2006).

This *Atlas of California Current Marine Birds and Mammals* complements these technical reports and provides an initial synthesis of the information across 3 regions of the CCS. The maps contained within this atlas illustrate the distribution and abundance of select species (see below) by season (where possible) and over all seasons and years (cumulative distribution and abundance). The atlas is intended as a resource for scientists and managers working on pelagic and coastal ocean systems, and as a tool to support ecosystem-based marine conservation strategies.

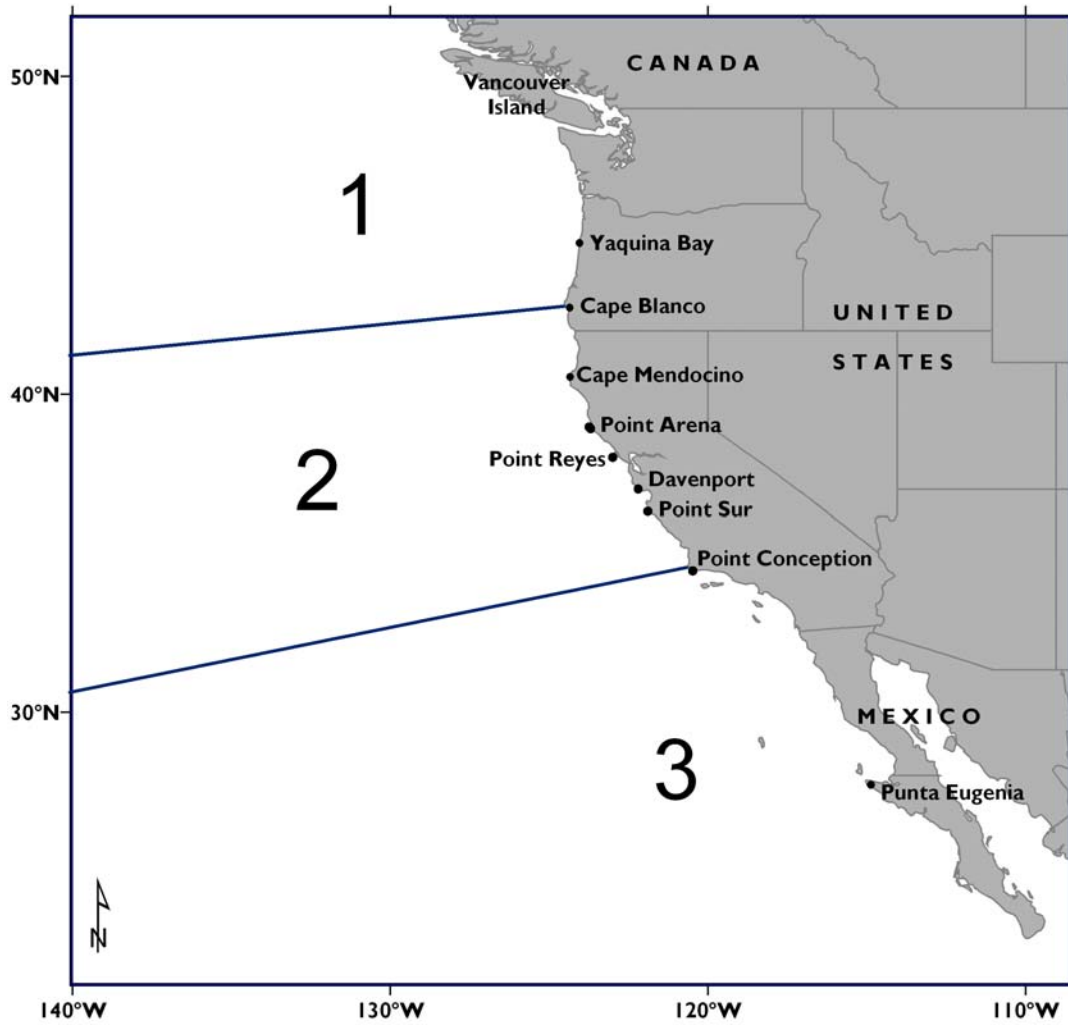
## **II. Study Area**

As noted above, this atlas covers oceanic habitats along the west coast of North America under the direct influence of the offshore California Current, nearshore Davidson Undercurrent, and coastal upwelling. A large slow-moving offshore “river,” the California Current is formed as the eastern leg of the North Pacific Gyre. The intensity of the transport in the California Current varies by season, year, and decade, fluctuating, in part, relative to the position and strength of the North Pacific Current (or West Wind Drift), which traverses the sub-Arctic North Pacific and bifurcates into the Alaska Current and California Current off the B.C. coastline (Chelton and McGowan 1982). While much of B.C. may be considered an oceanographic “transition zone,” we define the extent of the CCS at the northern tip of Vancouver Island, B.C., due to extensive upwelling along this section of the coastline. Based on physical and biological oceanographic characteristics, GLOBEC (1992) subdivided the CCS into three distinct “eco-regions”: (1) southern British Columbia, Washington and Oregon to Cape Blanco; (2) southern Oregon to Point Conception; and (3) southern California and Baja (Figure 2). Due to seasonal and longer-term climate variability, it is recognized that the boundaries of these regions are dynamic and shift under certain oceanographic conditions.

Embedded within these broad eco-regions are smaller mesoscale hydrographic habitats created by meanders, eddies, and jets of the California Current proper, and centers of upwelling are found along the coastline associated with coastal promontories (Strub et al. 1991; Kudela and Chavez 2000). To name a few, major upwelling cells are known at Punta Eugenia (Baja), Point Conception (CA), Point Sur (CA), Point Arena (CA), Cape Mendocino (CA), and Cape Blanco (OR). Within eco-regions, habitat heterogeneity is further defined by underwater topography, or “bathymetric habitats”, such as the continental shelf (Figure 3), and canyons, seamounts and banks (Figure 4). Sub-surface formations influence currents and tidally-based water flows, giving rise to secondary hydrographic features, such as shelf-break fronts or seamount-derived eddies. Zooplankton are known to concentrate close to the sea surface at certain bathymetric and hydrographic features, where they are available to secondary consumers. In this atlas, we consider four depth domains defined as follows: shelf (0-150 m depth), shelf-break (151-300 m depth), slope (301-2000 m depth), and pelagic waters (> 2000 m depth).

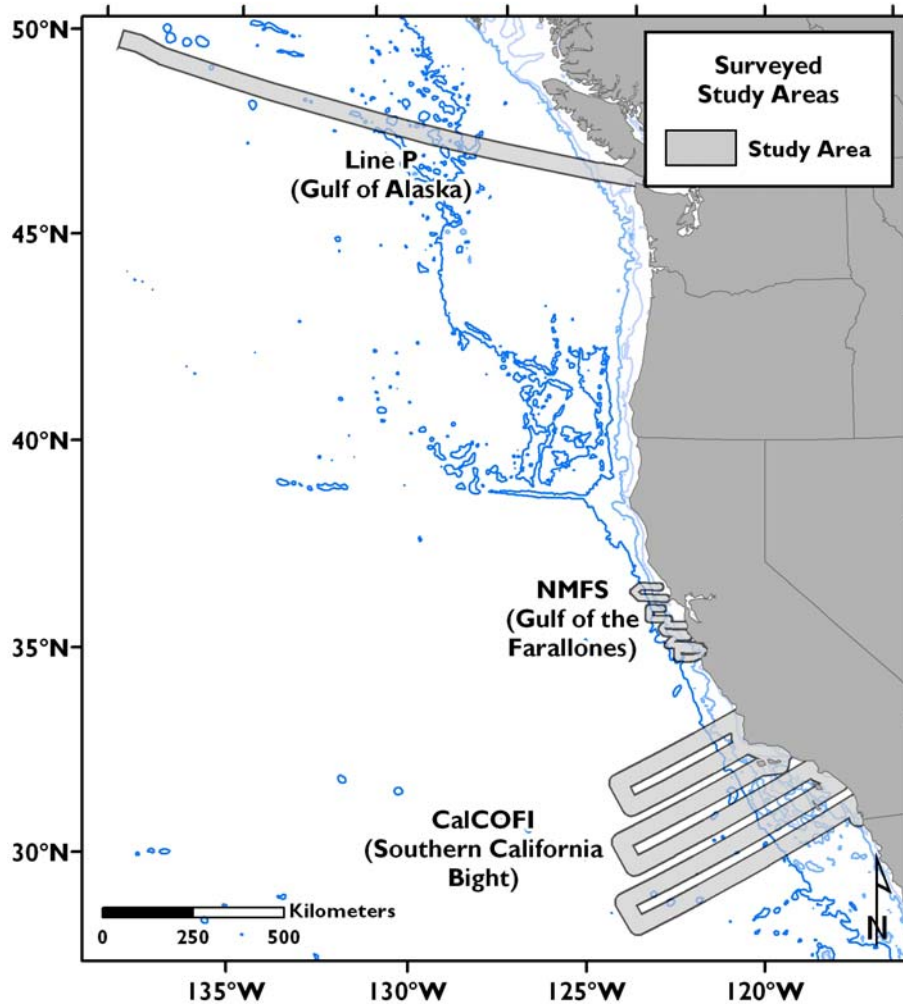
Intense coastal upwelling and the southward advection of cool water along the North American west coast characterize the CCS as a sub-arctic ecosystem (Duda and Sherman 2002), though periodic intrusions of sub-tropical water (sometimes associated with strengthening of the Davidson Undercurrent) during El Niño events can dramatically alter ecosystem productivity and the proportions of sub-arctic to sub-tropical species in the region (Chelton and McGowan 1982; GLOBEC 1992; Lenarz et al. 1995, McGowan et al. 1996, Hyrenbach and Veit 2003, Ford 2004). Biogeographic boundaries for some prey species are associated with these major upwelling centers, especially at Point Conception and Cape Mendocino, California. The juxtaposition of different water masses, atmospheric conditions which promote or limit upwelling-favorable winds (e.g., distribution of the North Pacific High and Continental Low), and the benthic-pelagic interactions at the numerous sea mounts, canyons, and an extensive shelf-break habitat make the CCS one of the most dynamic marine ecosystems in the world.

Figure 2. CCS Eco-Regions as defined by GLOBEC (1992).



### III. Material and Methods: Shipboard Surveys

Figure 3. Three study areas surveyed in the CCS by PRBO and partners over the past 20+ years.



#### III. A.

##### **Line P – Seabird and marine mammal surveys, Environment Canada CCS Region 1: southeastern Gulf of Alaska**

In 1949, oceanographic sampling began on ships used for enhanced weather forecasting off British Columbia, Canada. Since then, vessels from the Department of Fisheries and Oceans (DFO) have followed the same ~1,500 km cruise track from Vancouver Island (48.51°N, 124.81°W) to Ocean Station Papa (50.0°N, 145.0°W) 2-3 times each year (Figure 4a). We refer to this standardized transect as “Line P.” Starting in 1996, Environment Canada, in collaboration with DFO, began regular surveys of marine birds and mammals along Line P. PRBO joined the project in 2000 (K.H. Morgan and W.J. Sydeman, unpublished data; Yen et al. 2005; O’Hara et al. 2006).



Bathymetry along Line P is complex, dropping to a depth of 1000 m approximately 60 km from the coastline. Productivity of the coastal region is enhanced by a constant nutrient supply from the Strait of Juan de Fuca and coastal upwelling (Allen et al. 2001; Whitney et al. 2005). In comparison, the oceanic domain is characterized by gradual deepening, punctuated with scattered deep seamounts and ridges (Figure 4a). With its broad marine habitat coverage, Line P provides substantial spatial coverage for examining seabird and marine mammal distributions in the eastern Gulf of Alaska.

### **III. B.**

#### **NMFS Rockfish Recruitment Survey - NOAA Fisheries/National Marine Fisheries Services CCS Region 2: Gulf of the Farallones**

The National Marine Fisheries Service (NMFS) has conducted annual Rockfish Recruitment Surveys in the greater Gulf of the Farallones (Monterey Bay to Bodega Bay) off central California since 1983 (Figure 4b). PRBO added collection of marine bird and mammal data aboard these cruises in 1985 (Oedekoven et al. 2001, Keiper et al. 2005), though herein we present data from 1997 - present. This region is characterized by a broad continental shelf and complex bathymetry. This complexity is defined by an island chain (the Farallon Archipelago), a shallow seamount (Cordell Bank), a major submarine canyon (Monterey Canyon), and numerous smaller canyons bisecting the continental shelf. The Farallon Archipelago consists of two main islands and numerous sea stacks and islets stretching over approximately 15 km along the outer continental shelf. Cordell Bank, situated 20 km northwest (38.02°N 123.44°W) of the westernmost Farallon islet, is approximately 111 km<sup>2</sup> in area, and reaches to within 35 m of the ocean surface. The Farallon Islands are a National Wildlife Refuge, managed by United States Fish and Wildlife Service (USFWS), and host the largest marine bird and mammal colonies in the contiguous United States. Approximately 300,000 birds of 12 species currently breed there (PRBO and USFWS, unpublished data). In addition, roughly 10,000 pinnipeds belonging to 5 species also reproduce and/or haul out on the archipelago each year (Sydeman and Allen 1999). Waters surrounding the Farallon Archipelago and Cordell Bank are encompassed by the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries, respectively, which are managed by the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service.

Coastal upwelling is particularly strong in the Gulf of the Farallones; the resulting enrichment of surface waters leads to exceptional levels of marine productivity here. Coastal upwelling may occur year-round, with a seasonal peak in the late spring and early summer (Bakun 1975; GLOBEC 1992; Wing et al. 1995). During its peak, a relatively persistent upwelling plume may extend 15–75 km offshore into the Gulf of the Farallones, where it interacts with meanders and eddies along the inner boundary of the California Current (Schwing et al. 1991; Steger et al. 2000). Upwelling in the south of the study area near Monterey Bay is centered off of Davenport, California (Pennington and Chavez 2000). While upwelling events in this region are less vigorous than those to the north, cold, nutrient-rich surface waters from the Davenport upwelling plume advect southward across the mouth of Monterey Bay, stimulating offshore productivity. Localized upwelling also occurs at the edges of Monterey Canyon (Shea and Broenkow 1982).

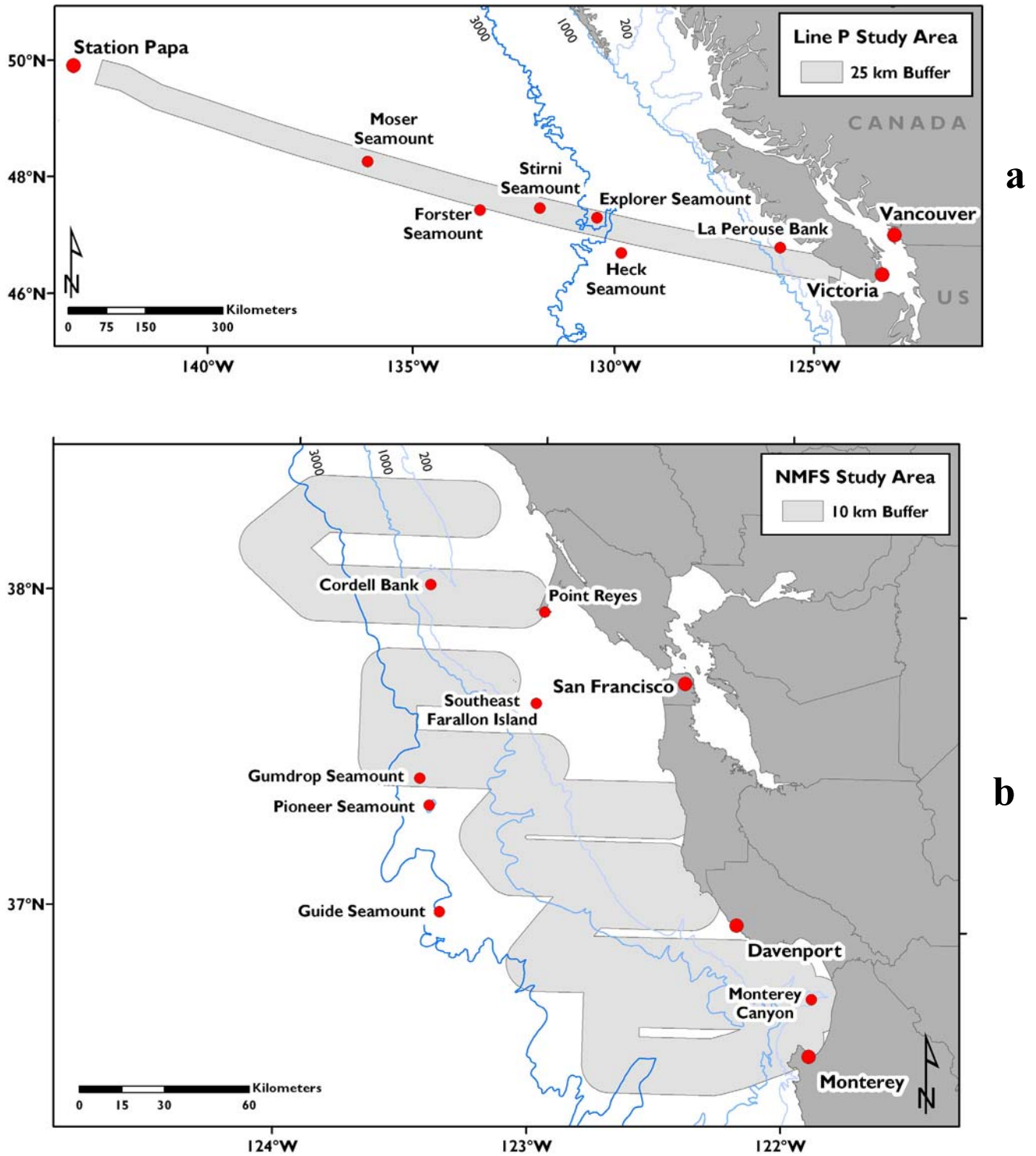
### **III. C.**

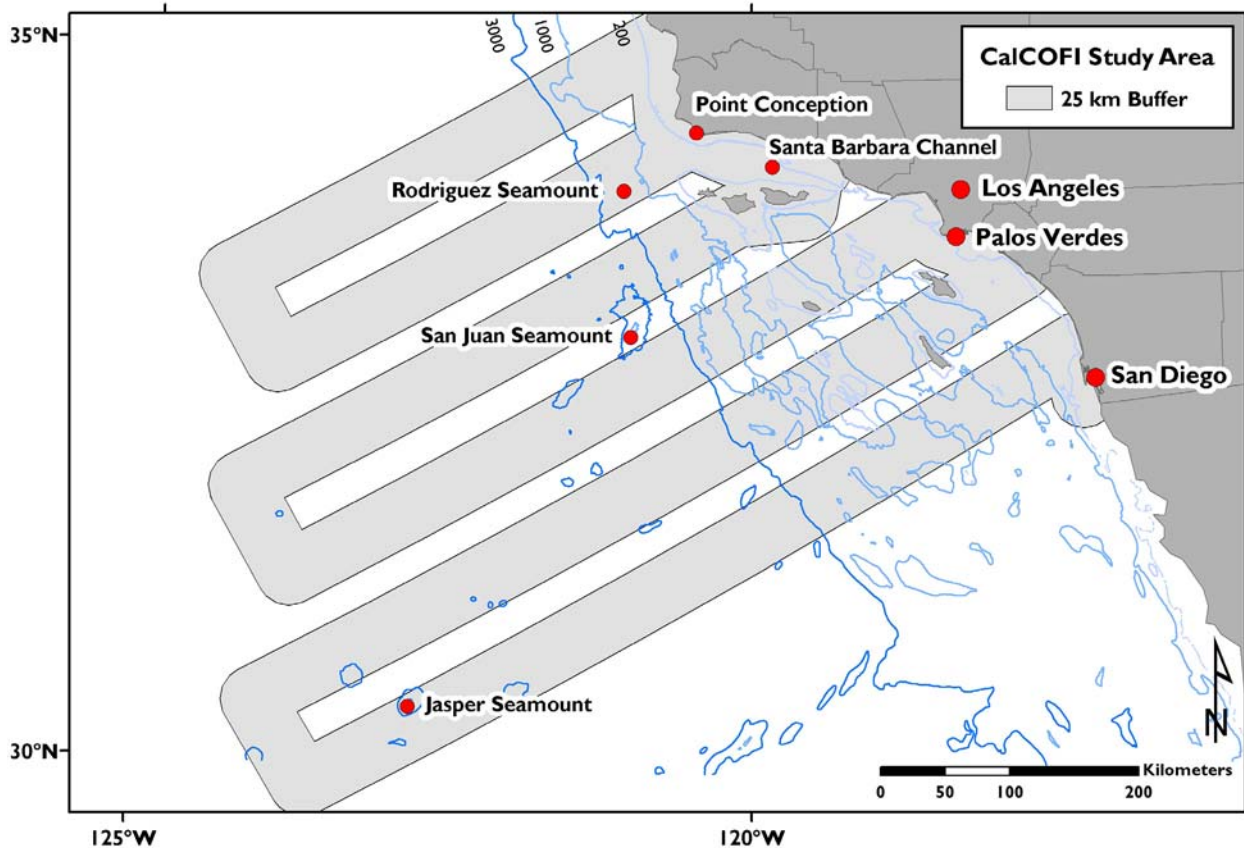
#### **California Cooperative Oceanic Fisheries Investigations (CalCOFI) CCS Region 3: Southern California Bight**

In the southern CCS, the California Cooperative Oceanic Fisheries Investigations (CalCOFI) has been monitoring ecosystem dynamics since 1949 (Bograd et al. 2003; Ohman and Venrick 2003). As part of their research, CalCOFI has established the importance of both coastal and oceanic habitats to a variety of plankton and fish species (e.g., Checkley et al. 2000; Logerwell et al. 2001). Starting in 1987, a long-term observational program for marine birds and mammals was added to seasonal CalCOFI cruises. This program has provided novel understandings of top predator responses to temporal environmental variability in the CCS (e.g., Veit et al. 1997; Hyrenbach and Veit 2003).

In its current form, the CalCOFI survey grid consists of six parallel transects, ranging in length from 470 (northernmost) to 700 (southernmost) km (Figure 4c). This study area encompasses over 300,000 km<sup>2</sup> of the Pacific Ocean, ranging from 30° to 35° N, and seaward from the southern California coast to 124° W. This broad study area covers an array of bathymetric domains including shelf-slope regions and deep pelagic waters as well as a variety of hydrographic habitats (e.g., water masses, mesoscale features). Mesoscale eddies are consistently identified in the region, but are both spatially and temporally variable (Yen et al. 2006). The California Current core, a core of strong equatorward flow through the region, is a prominent hydrographic feature each spring. However, the position and route of the core is substantially variable as its distance from shore can fluctuate inter-annually. Coastal upwelling also occurs in this study area with a major center located at Point Conception. The initiation of upwelling each spring in the region results in development of a strong nearshore equatorward jet yielding strong increases in primary productivity (Lynn et al. 2003). The development of this upwelling jet appears to be independent of the wintertime manifestation of the California Current, which tends to be much further offshore.

Figure 4. Key bathymetric habitats in the 3 study regions. (a) Line P - Gulf of Alaska; (b) NMFS - Gulf of the Farallones; (c) CalCOFI - Southern California Bight.





C

### III. D. Methods

#### Data Collection

We used common techniques for vessel-based censusing of seabirds and marine mammals at sea (Tasker et al. 1984; Buckland et al. 1993). Briefly, for all surveys, one or two observers identified and counted birds and mammals from the flying bridge or the pilot house of a research vessel, from approximately 10 m above the sea surface, during all daylight hours. A hand-held range finder and binoculars were used to ground-truth the width of the survey strip (Heinemann 1981), and only those seabirds that entered a 90° arc from the bow to the beam and out to 250-300 m on the one side with best visibility (e.g., lowest sun glare) were enumerated, assigned behavioral codes (flying, sitting on the water, feeding, ship-attracted), and logged into a field computer (Husky FEX 21 or similar) or on data sheets (Line P only). Ship-attracted individuals were recorded when first sighted, and ignored thereafter. The positions of the boat were time-coded into the survey log periodically and at the beginning and end of each transect using the ship's GPS. Most surveys were conducted while the research vessel was underway at a speed of 10–12 knots (18.6–22.3 km h<sup>-1</sup>). Seabird density was expressed as the number of individuals sighted per unit area surveyed (birds km<sup>-2</sup>). All marine mammals were sighted from the center line to the horizon, and their numbers were expressed as an encounter rate, per km of track line surveyed (mammals km<sup>-1</sup>).

**Table 1. Mapped seabird and mammal species by study area.**

| <b>Seabird Species</b>   | <b>CalCOFI</b> | <b>NMFS</b> | <b>Line P</b> | <b>Mammal Species</b>       | <b>CalCOFI</b> | <b>NMFS</b> | <b>Line P</b> |
|--------------------------|----------------|-------------|---------------|-----------------------------|----------------|-------------|---------------|
| Black Storm-Petrel       | X              |             |               | Blue Whale                  | X              | X           |               |
| Black-footed Albatross   | X              | X           | X             | California Sea Lion         | X              | X           | X             |
| Black-legged Kittiwake   | X              | X           | X             | Common Dolphin              | X              | X           |               |
| Black-vented Shearwater  | X              |             |               | Dall's Porpoise             | X              | X           | X             |
| Bonaparte's Gull         | X              |             |               | Gray Whale                  | X              | X           |               |
| Brandt's Cormorant       | X              |             |               | Humpback Whale              | X              | X           | X             |
| Brown Pelican            | X              |             |               | Northern Fur Seal           | X              | X           | X             |
| California Gull          | X              | X           | X             | Pacific White-sided Dolphin | X              | X           | X             |
| Cassin's Auklet          | X              | X           | X             | Risso's Dolphin             | X              | X           |               |
| Common Murre             | X              | X           | X             |                             |                |             |               |
| Cook's Petrel            | X              |             |               |                             |                |             |               |
| Fork-tailed Storm-Petrel |                |             | X             |                             |                |             |               |
| Glaucous-winged Gull     |                |             | X             |                             |                |             |               |
| Herring Gull             | X              |             |               |                             |                |             |               |
| Leach's Storm-Petrel     | X              | X           | X             |                             |                |             |               |
| Northern Fulmar          | X              | X           | X             |                             |                |             |               |
| Pacific Loon             | X              |             |               |                             |                |             |               |
| Pink-footed Shearwater   | X              | X           | X             |                             |                |             |               |
| Pomarine Jaeger          | X              |             |               |                             |                |             |               |
| Red Phalarope            | X              |             |               |                             |                |             |               |
| Red-necked Phalarope     | X              | X           | X             |                             |                |             |               |
| Rhinoceros Auklet        | X              | X           | X             |                             |                |             |               |
| Sooty Shearwater         | X              | X           | X             |                             |                |             |               |
| Western Gull             | X              | X           | X             |                             |                |             |               |

### **III. E. Mapping and Species Selection**

Seabird and mammal distribution and abundance maps include data from 1987 through 2004. Frequently, additional oceanographic projects were under simultaneous investigation during the cruises; consequently, vessels often deviated from the replicate track line. Therefore, for each study region, only those survey bins that fall within a buffer on either side of the track lines are included here (25 km for Line P and CalCOFI, 10 km for NMFS). A smaller buffer was selected for the NMFS survey due to the close proximity of the replicate parallel cruise tracks. Buffers are illustrated on each species distribution map as a light gray border surrounding the density survey data (see also Figures 3 and 4). Seabird maps include sightings of birds flying, feeding, and sitting. All sightings of mammals were mapped regardless of behavior. Because Line P data were recorded using 5-minute periods, to standardize data as much as possible we grouped CalCOFI and NMFS-RRS continuously-logged datasets into discrete 1.5 km bins (the approximate distance traveled in 5 minutes by a vessel traveling at 10 knots). Mapped data were further restricted to bins at least 1 km in length. For each study area, only those seabird species observed in 30 or more bins per year during at least 3 years of each study were included in the Atlas. Seabird species that met this criterion for 2 of the 3 study areas were mapped for all 3 areas. As there were comparatively fewer records for mammals, species were mapped regardless of sample size. Table 1 summarizes mapped seabird and mammal species by study area. A complete list of all birds and mammals observed during the study period (including those not mapped) may be found in Appendices A - F. A small amount of data was excluded from the mapped dataset. This included an incomplete Line P cruise from winter 2000, NMFS-RRS cruises from 1996 and 2000 that only produced limited information (~4 survey days each), and some “mini-cruises” from late 1997 and 1998 which only covered the southernmost lines of the CalCOFI grid.

### **III. F. Definitions of Seasons**

Defining seasons was challenging as the start and/or end dates of surveys varied from year to year (Table 2). As such, individual cruise data were not classified based on the seasonal definition of the Gregorian calendar, but were assigned a seasonal category (e.g. winter, spring, summer, fall) and mapped accordingly. Seasonal maps differed by study area as not all seasons were sampled in each study area. Line P surveys occurred during winter, summer, and fall; CalCOFI surveys sampled all four seasons; and NMFS Rockfish cruises only took place in spring.

**Table 2. Season/date coverage of study area cruises presented in the atlas.**

| Study Area | Season | Earliest - Latest Dates Sampled | Count of cruises* |
|------------|--------|---------------------------------|-------------------|
| Line P     | Winter | February 5 – March 4            | 7                 |
| Line P     | Summer | May 8 – July 26                 | 9                 |
| Line P     | Fall   | August 15 – September 19        | 7                 |
| NMFS       | Spring | May 4 – June 16                 | 5                 |
| CalCOFI    | Winter | January 5 – March 11            | 15                |
| CalCOFI    | Spring | March 23– May 13                | 18                |
| CalCOFI    | Summer | June 29 – September 18          | 17                |
| CalCOFI    | Fall   | September 13 - November 27      | 18                |

\*Some CalCOFI seasonal cruise counts reflect data from multiple cruises conducted during the same season/year

#### **IV. Distribution Maps**

We present cumulative (all years and seasons) and seasonal distribution maps for select seabirds and most marine mammals. Mapped distributions correspond to the georeferenced midpoints of the survey bins. Seabirds are mapped on the basis of their apparent density (birds km<sup>-2</sup>), whereas the mammal maps are based on their encounter rates (mammals km<sup>-1</sup>). For all maps, the size of the red symbols corresponds to the magnitude of a given species density/encounter rate at that location (higher density = larger symbols). Minimum and maximum densities and encounter rates remain consistent between bird and mammal species, respectively. Appendix G shows survey effort for each study area. Brief species accounts accompany each of the mapped species, followed by related CalCOFI, NMFS, and Line P distribution and abundance maps.

# Breeding Seabirds of the California Current System

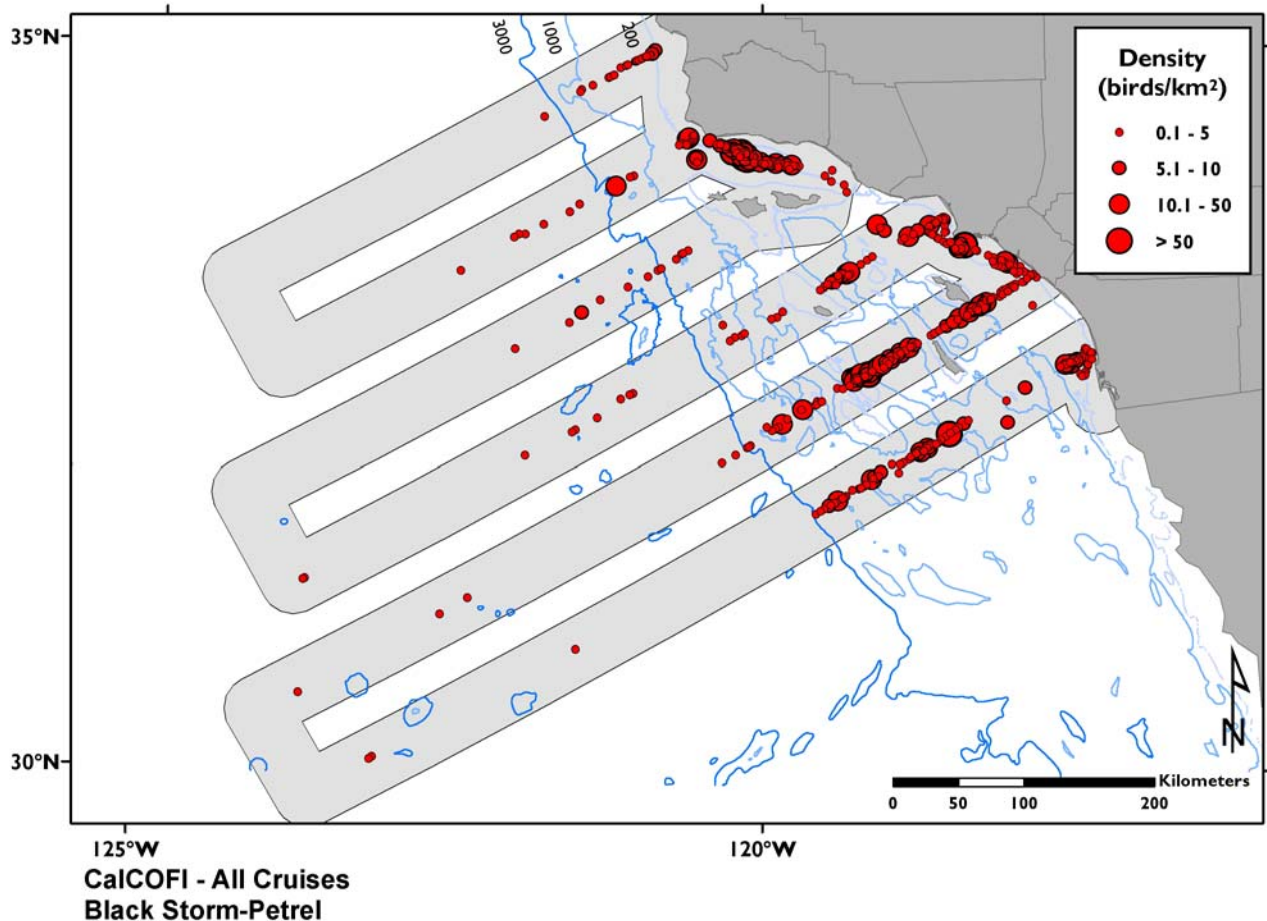


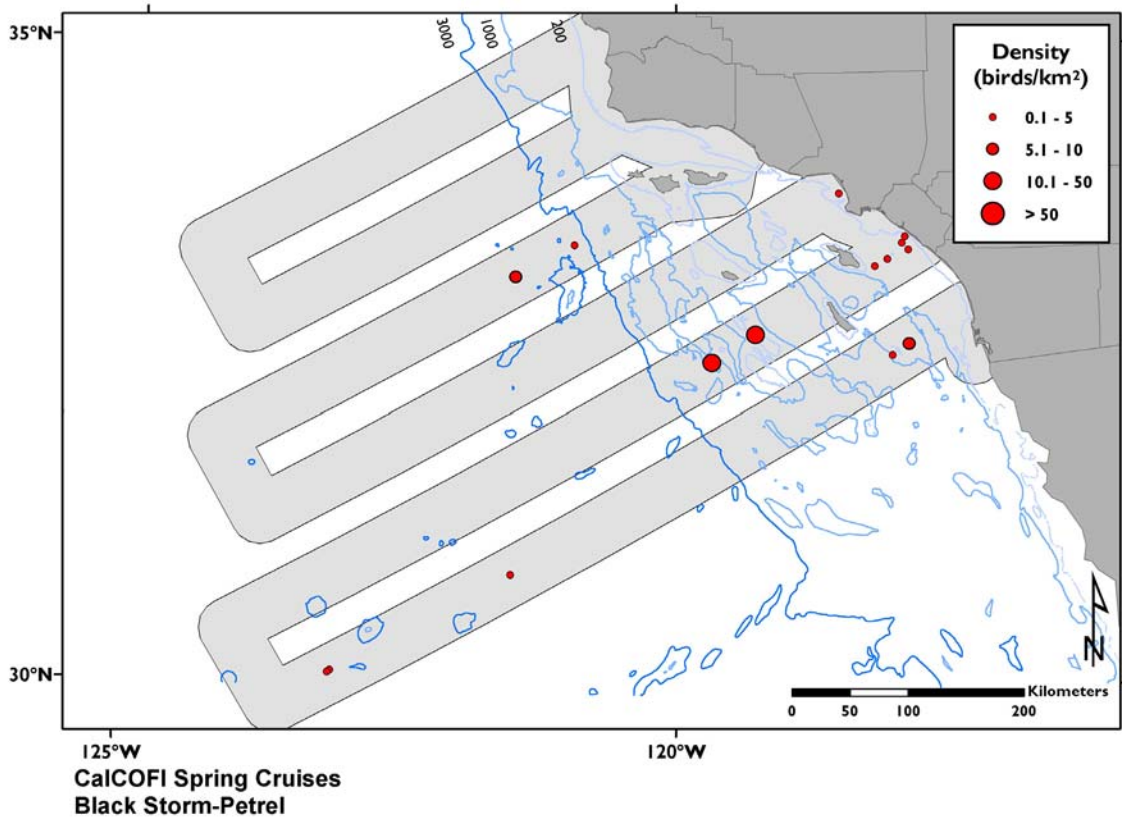
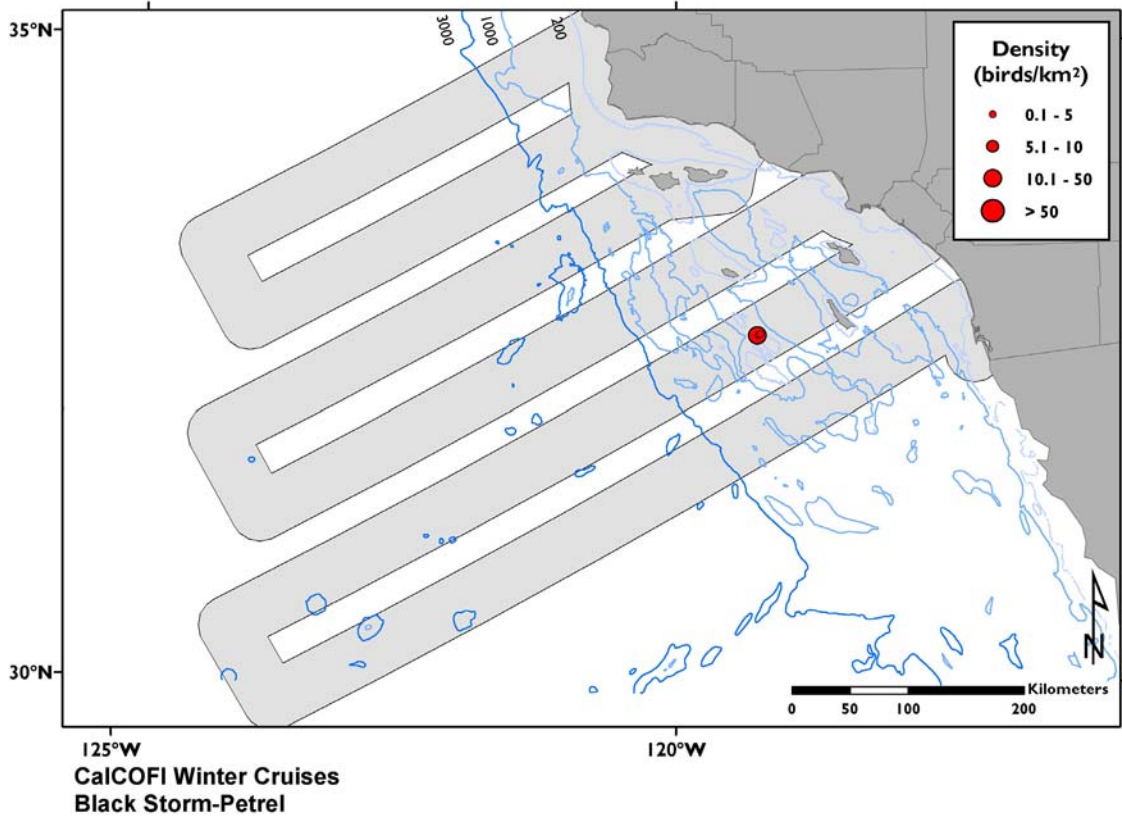
# Black Storm-Petrel

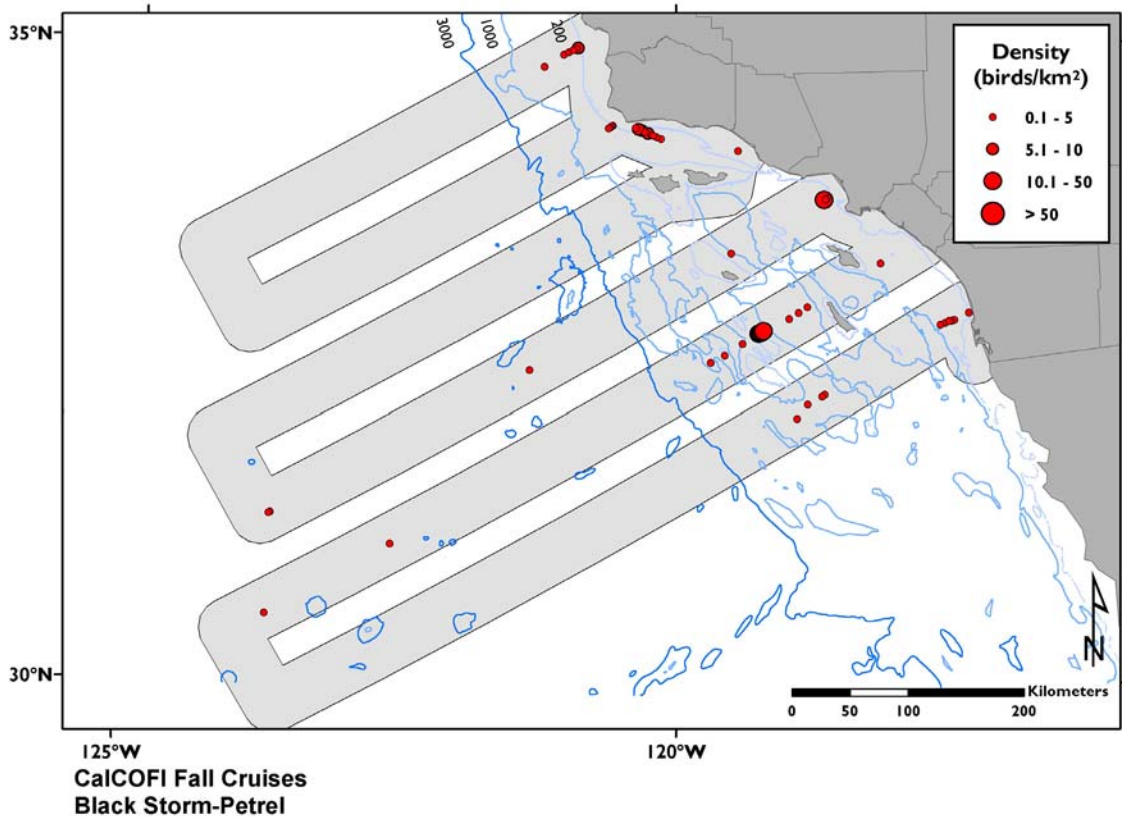
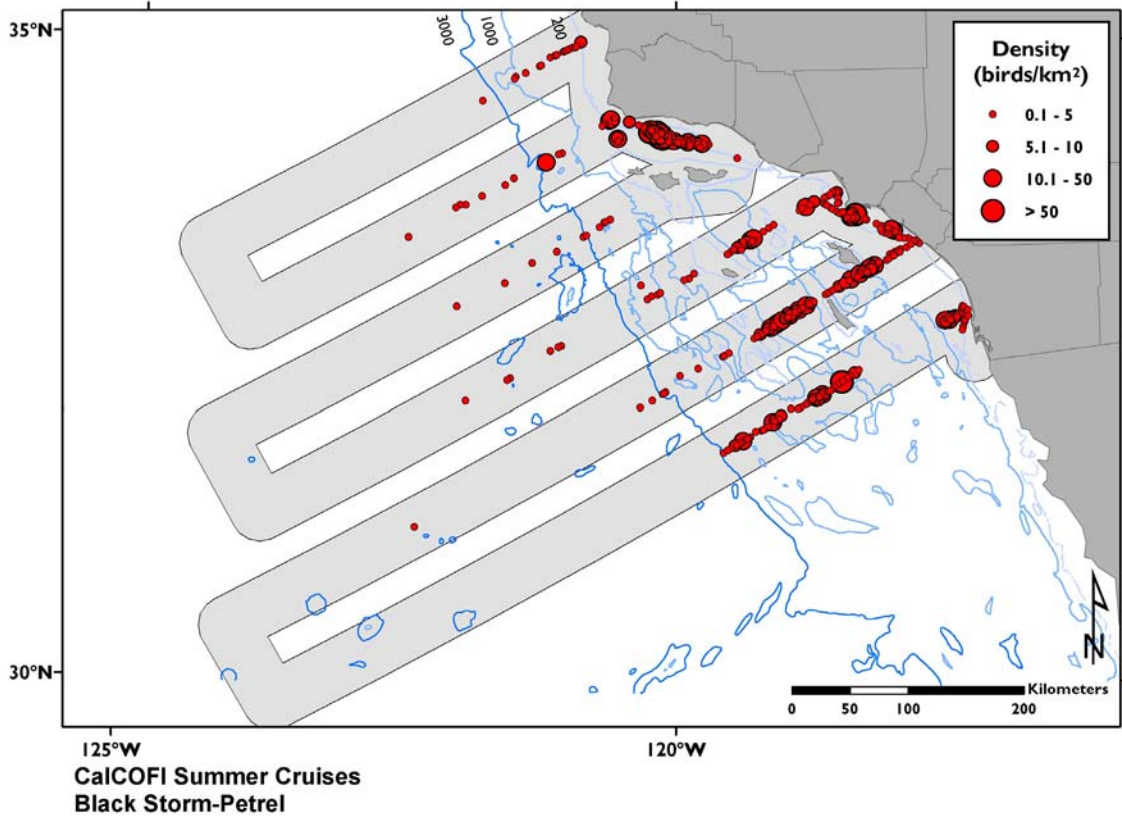
*Oceanodroma melania*



Black Storm-Petrels (BLSP) are endemic to islands off California and Baja California, including the Gulf of California. When not breeding, BLSP disperse both north and south along the coast. This dispersal is well-portrayed in the seasonal distribution maps of the CalCOFI study area with a low frequency of occurrence in all seasons except summer. This species showed a preference for shelf waters. Although little is known about BLSP diet, it likely consists of small fish, squid, and crustaceans found in the upper 1 m of the water column (Ainley and Everett 2001).







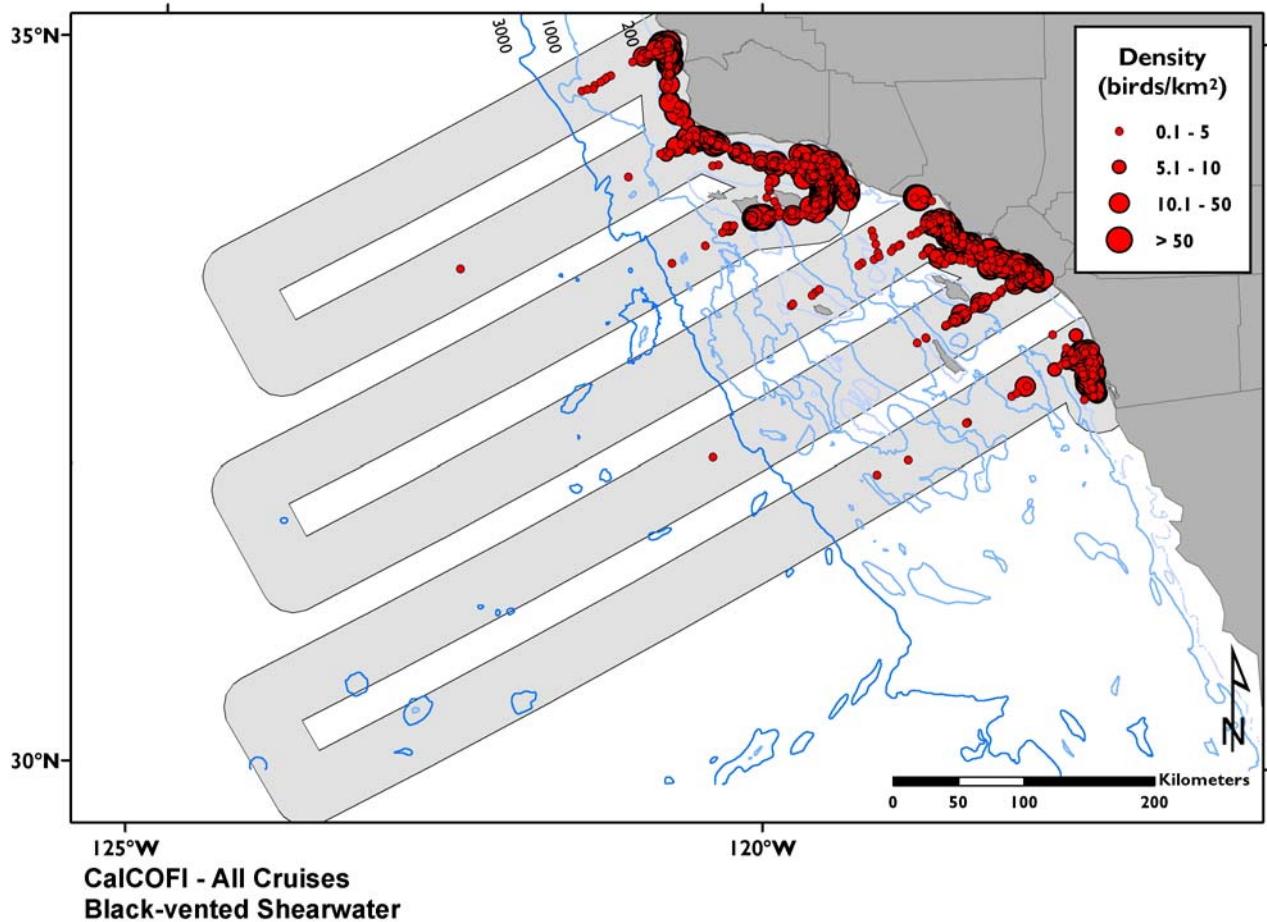


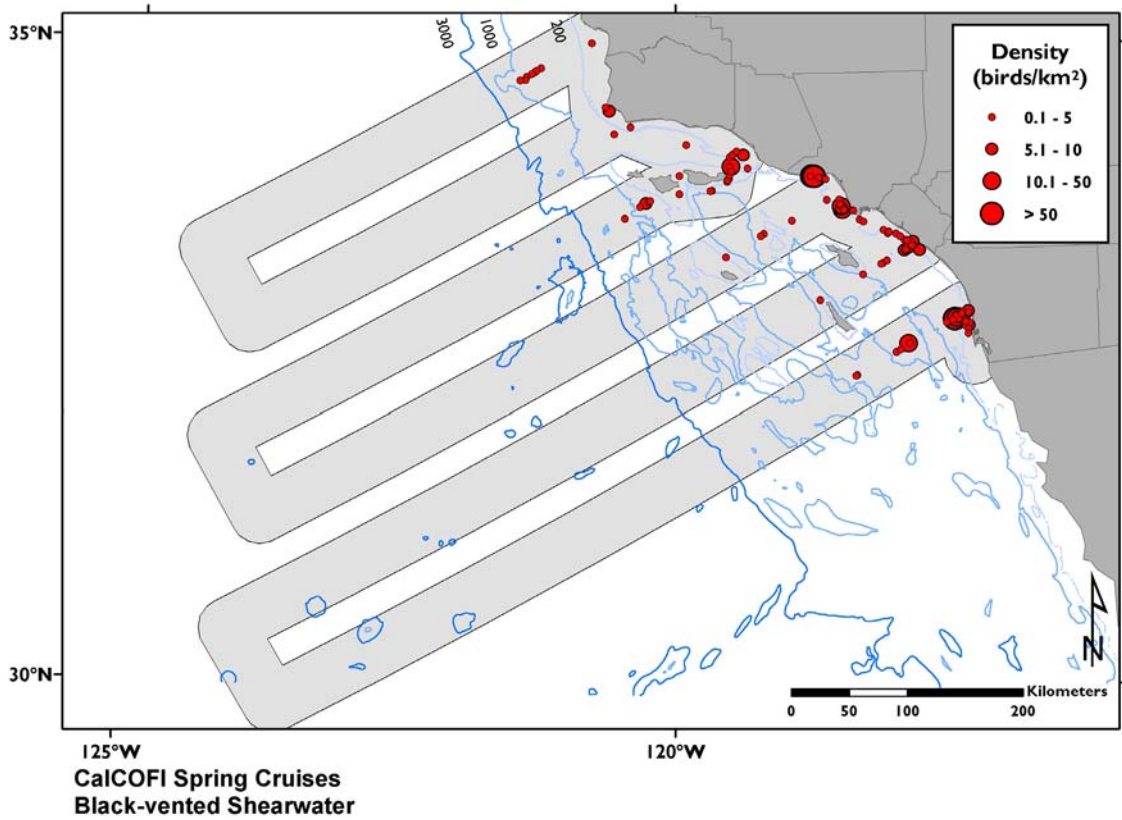
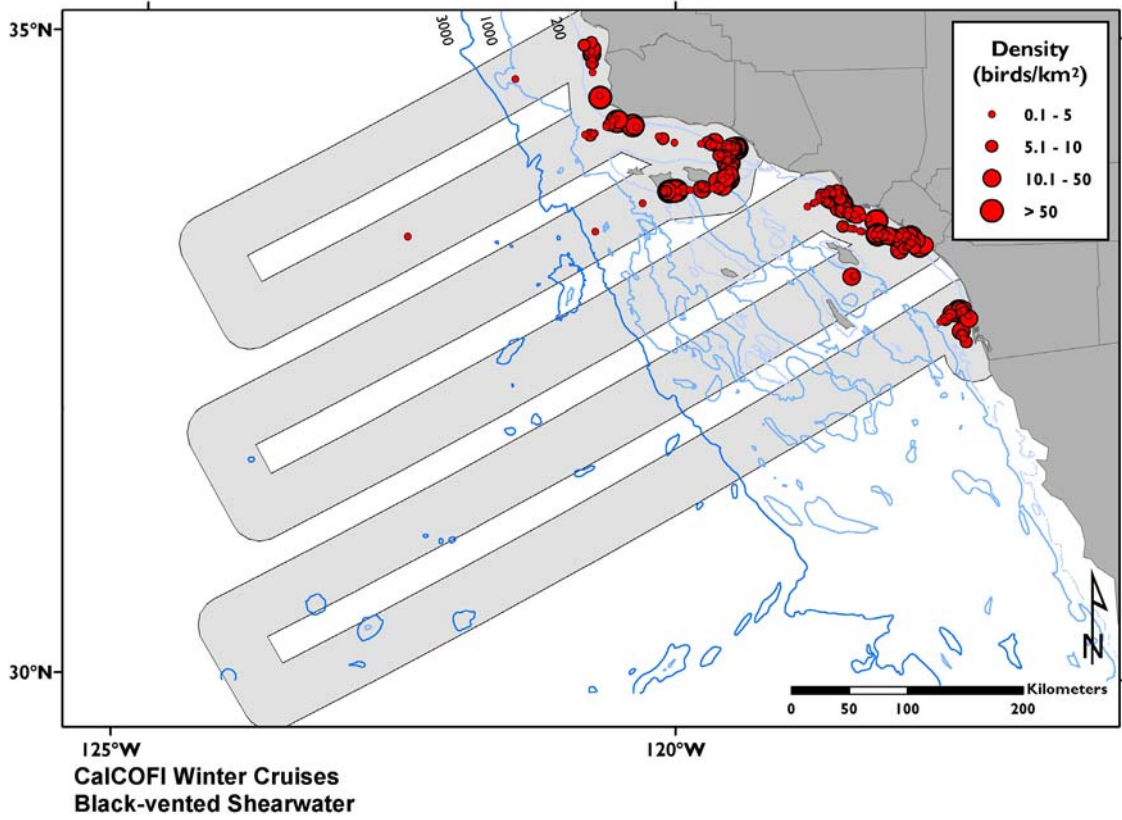
# Black-vented Shearwater

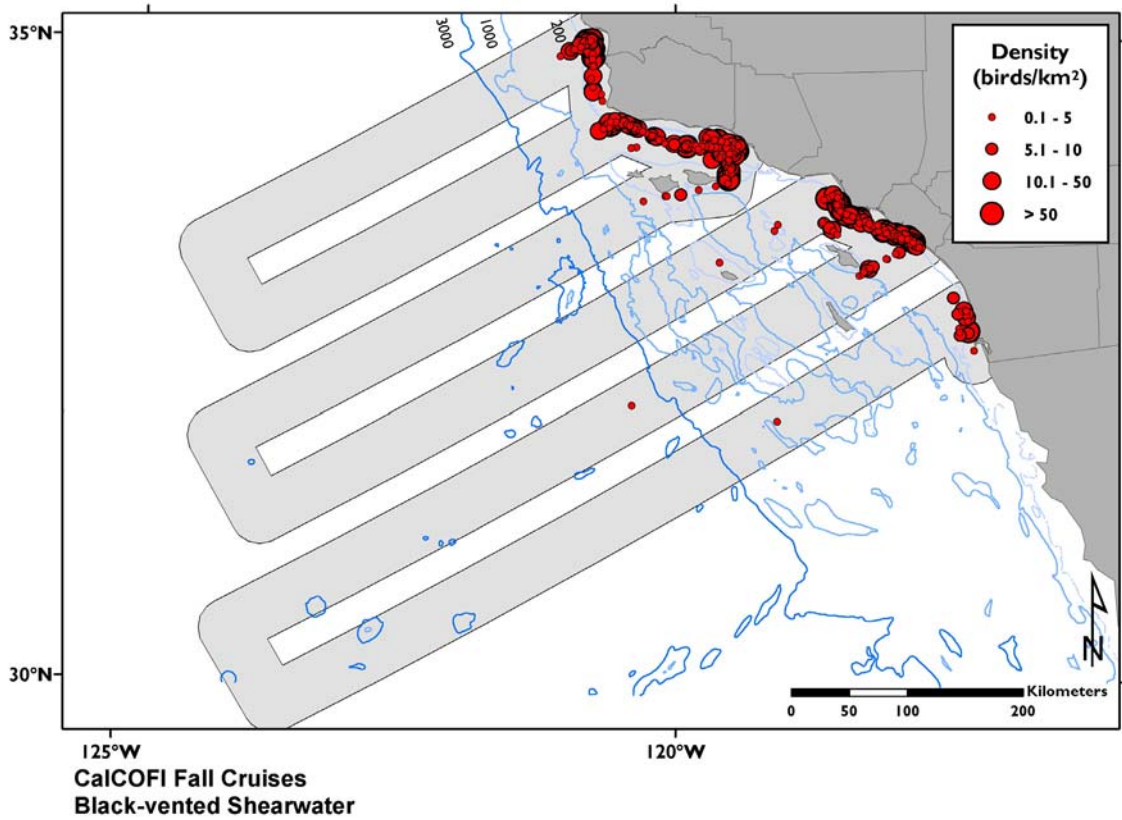
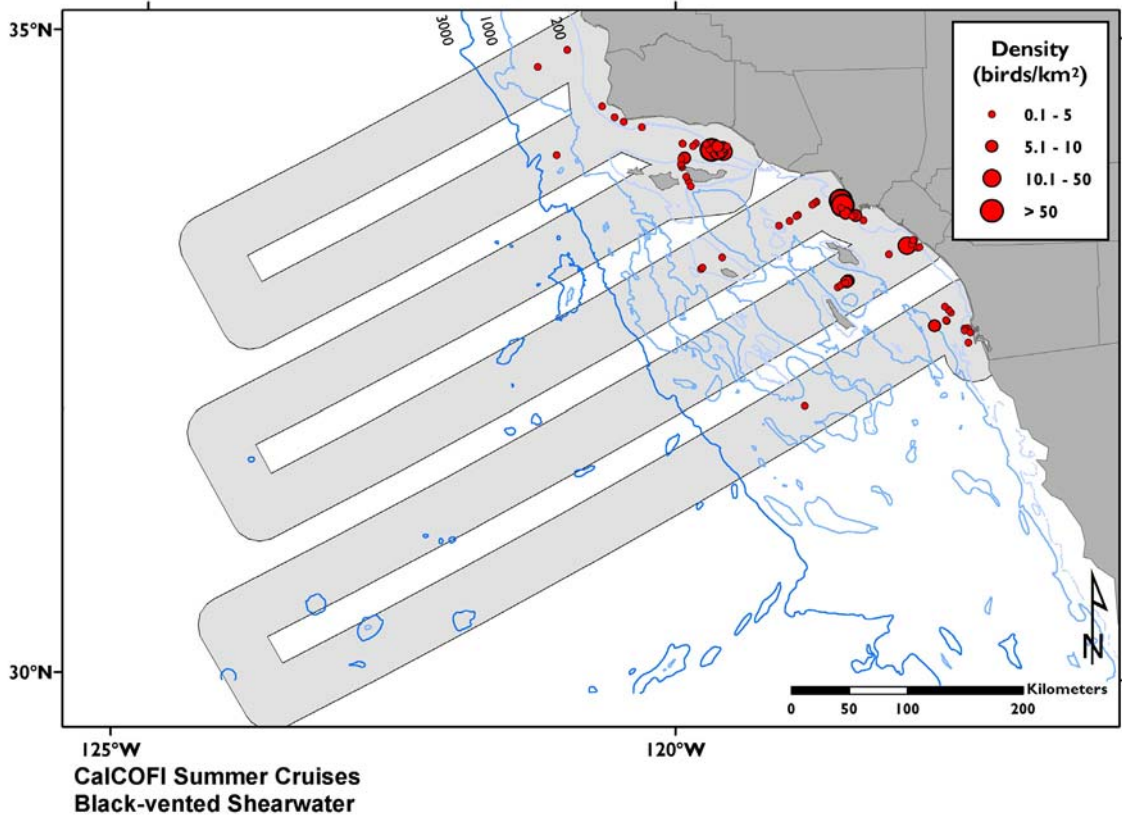
*Puffinus opisthomelas*



Black-vented Shearwater (BVSH) is the only shearwater that breeds in the California Current System. BVSH occur primarily in coastal areas and are found during all seasons in the CalCOFI area. Highest densities were found over shelf waters in fall/winter. This species forages mainly on schooling fish and squid (Keitt et al. 2000).









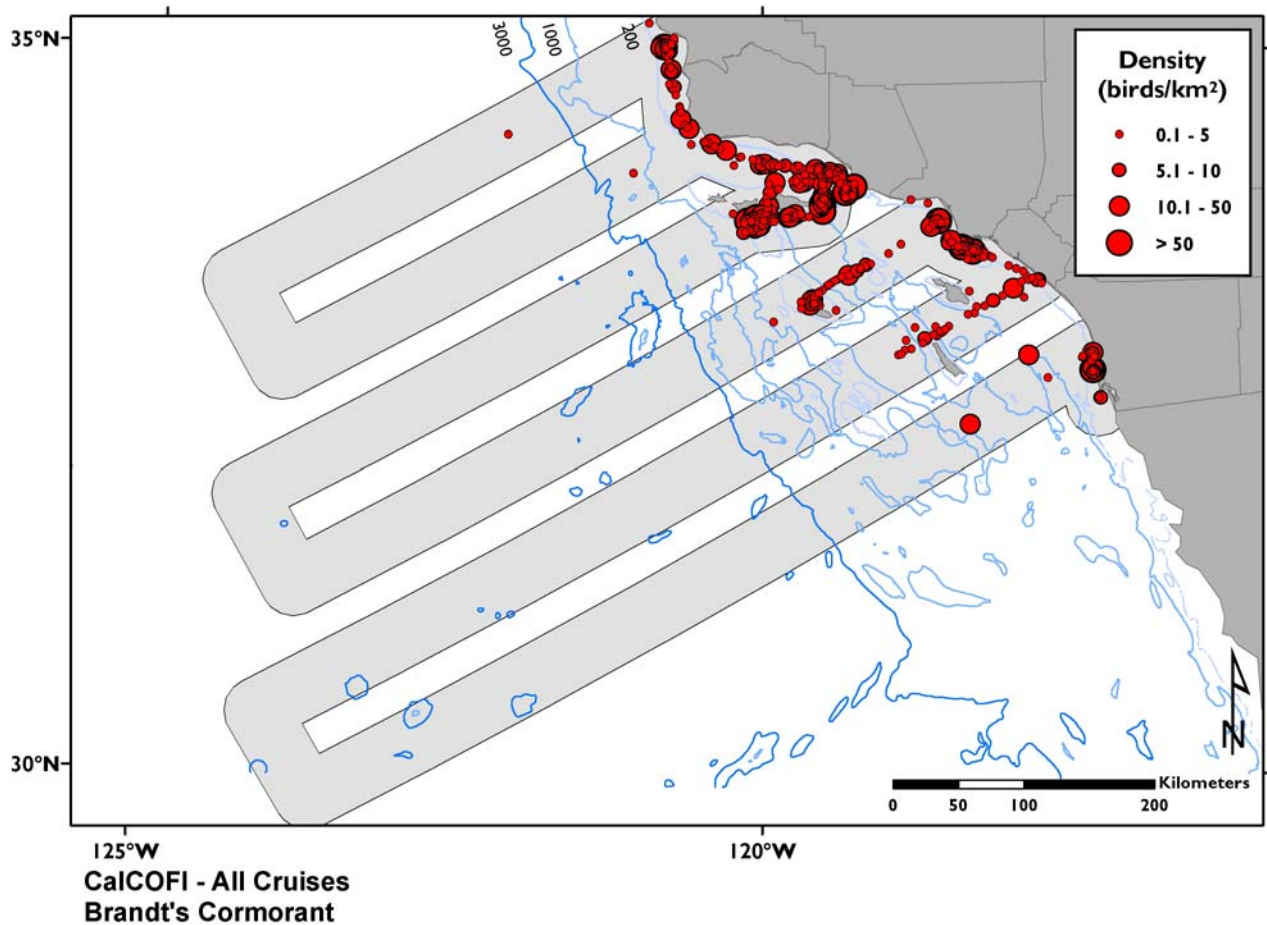


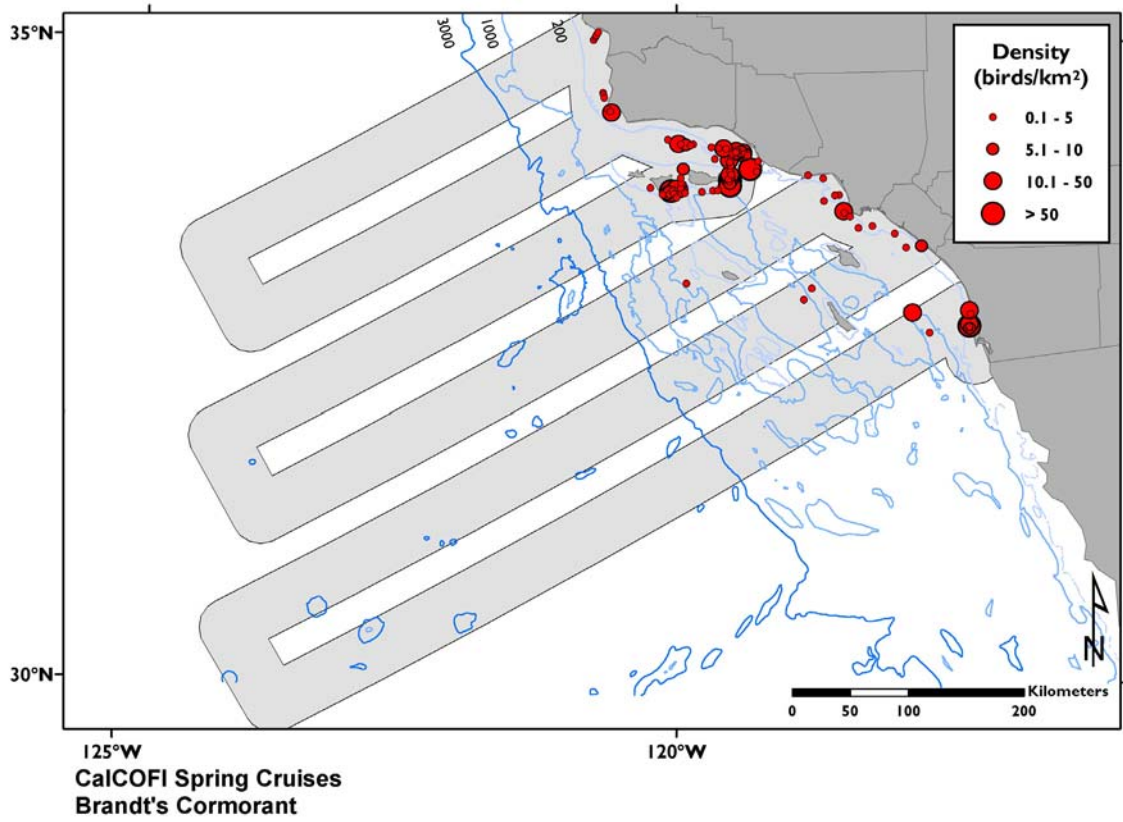
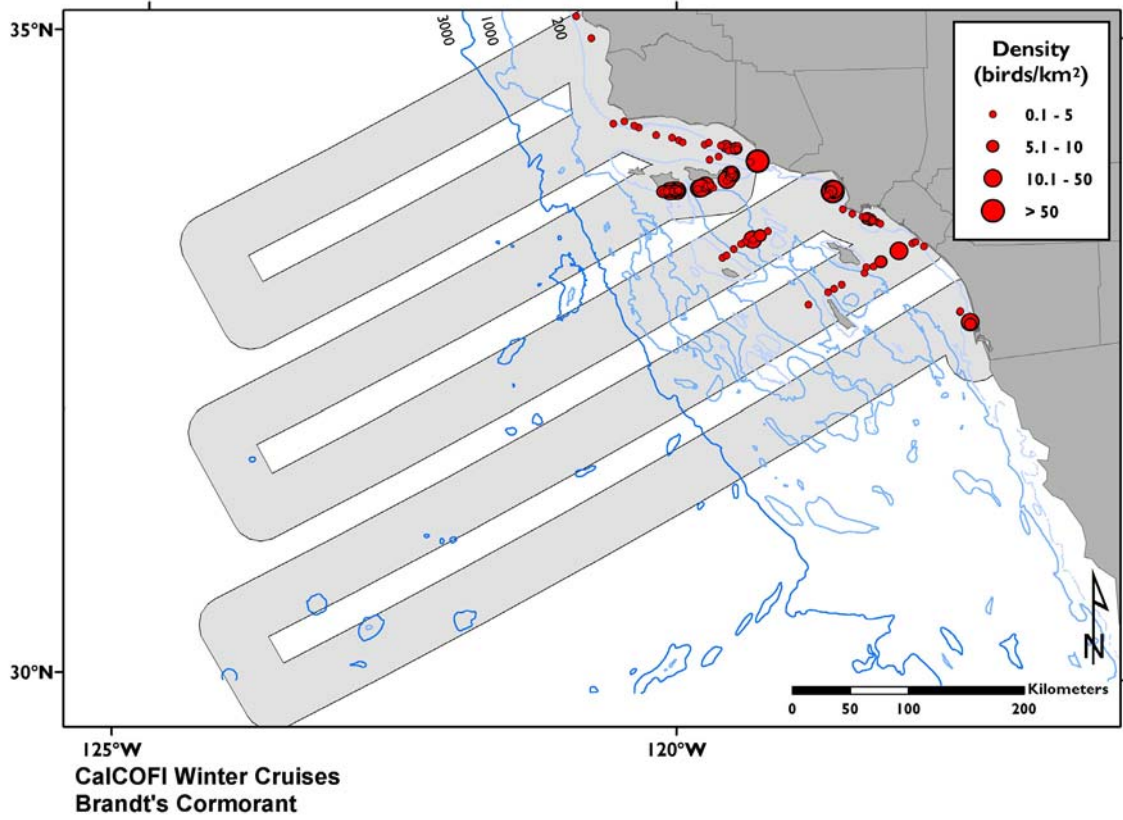
# Brandt's Cormorant

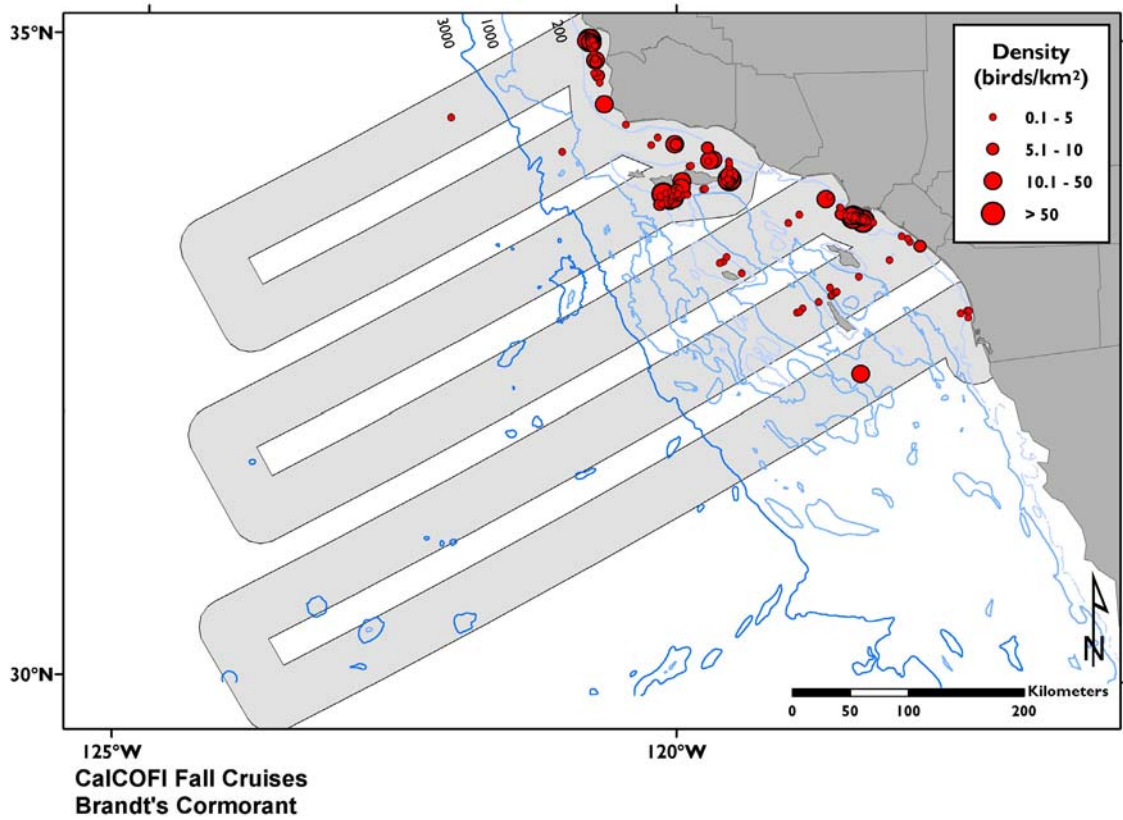
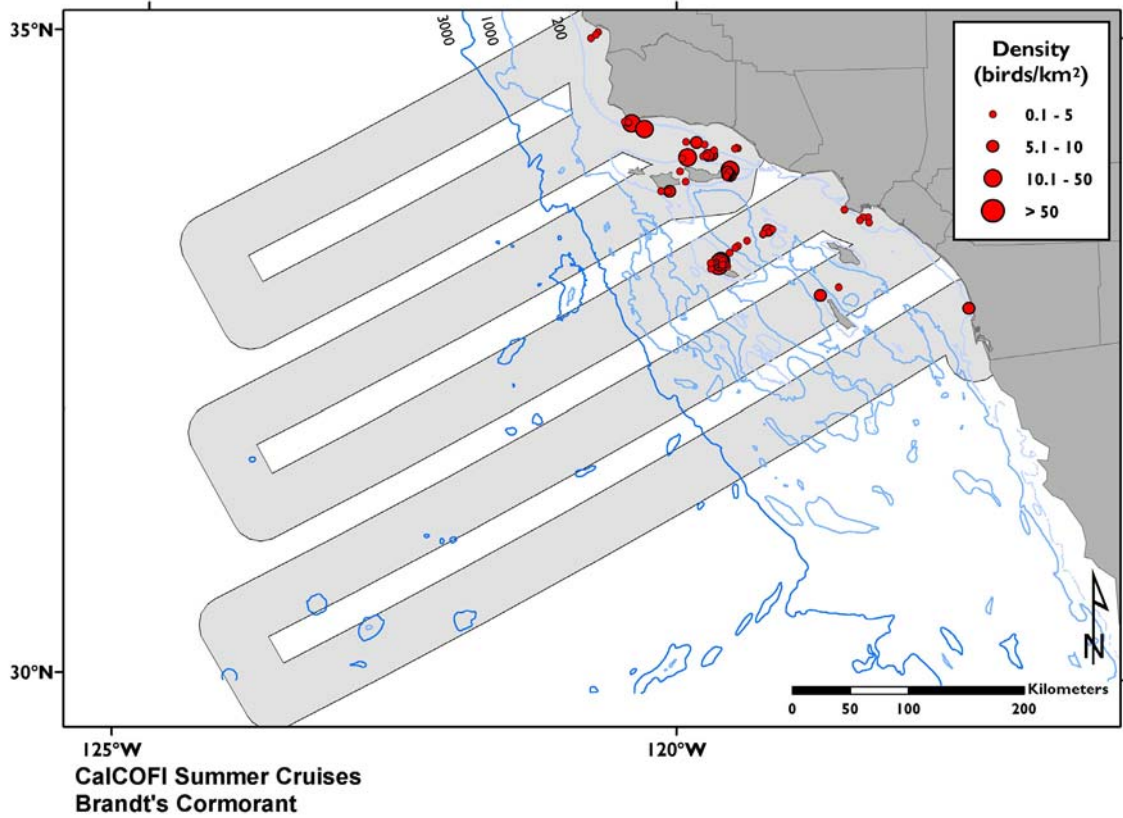
*Phalacrocorax penicillatu*



Brandt's Cormorants (BRCO) are endemic to the west coast of North America. They reach the southernmost extent of their breeding range in Baja California and the northern limit approximately half way up the west coast of Vancouver Island. The at-sea distribution of BRCO in the CCS is considered to be related to upwelling cells, where this species feeds on fish. Relatively high densities of this species were found on the continental shelf during all seasons.







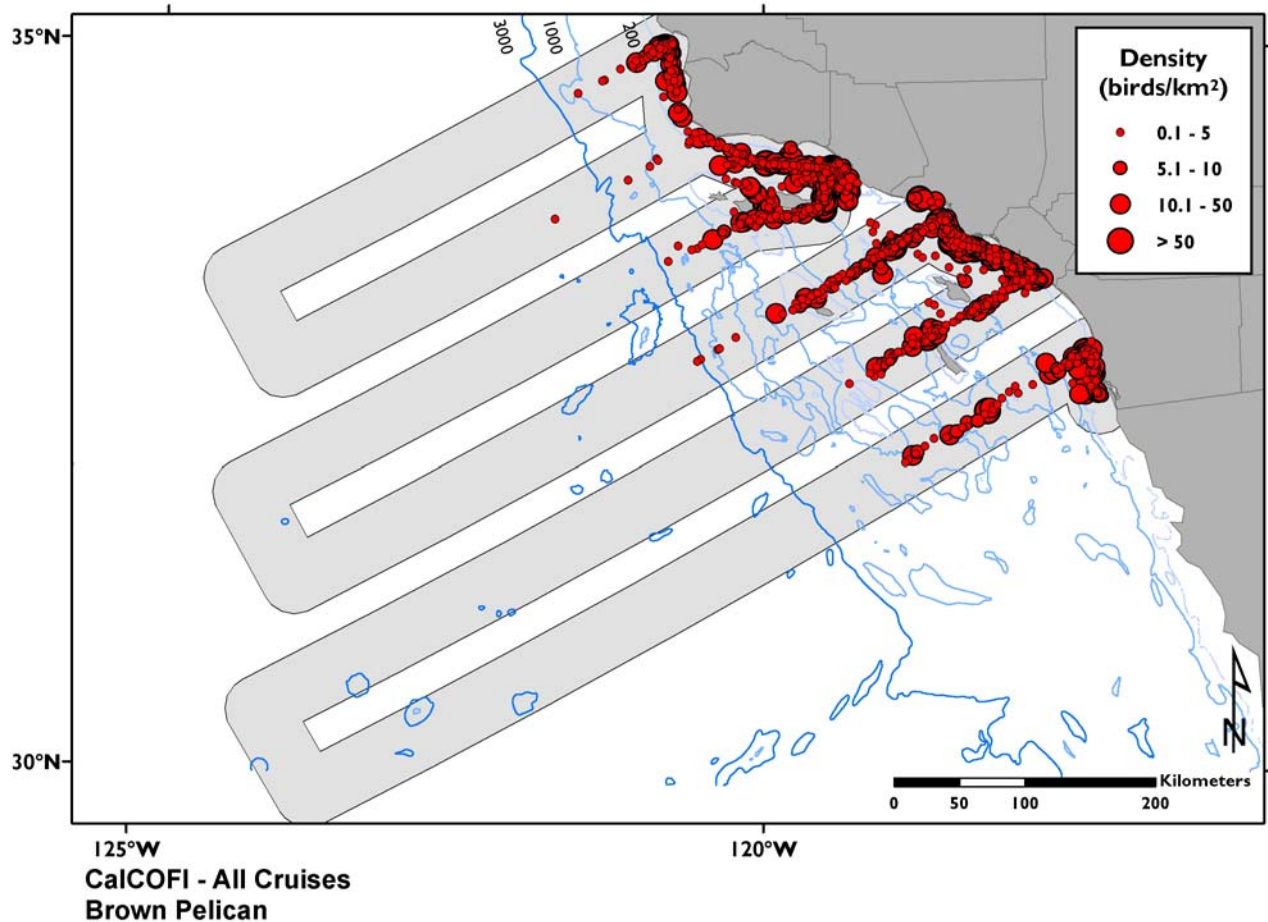


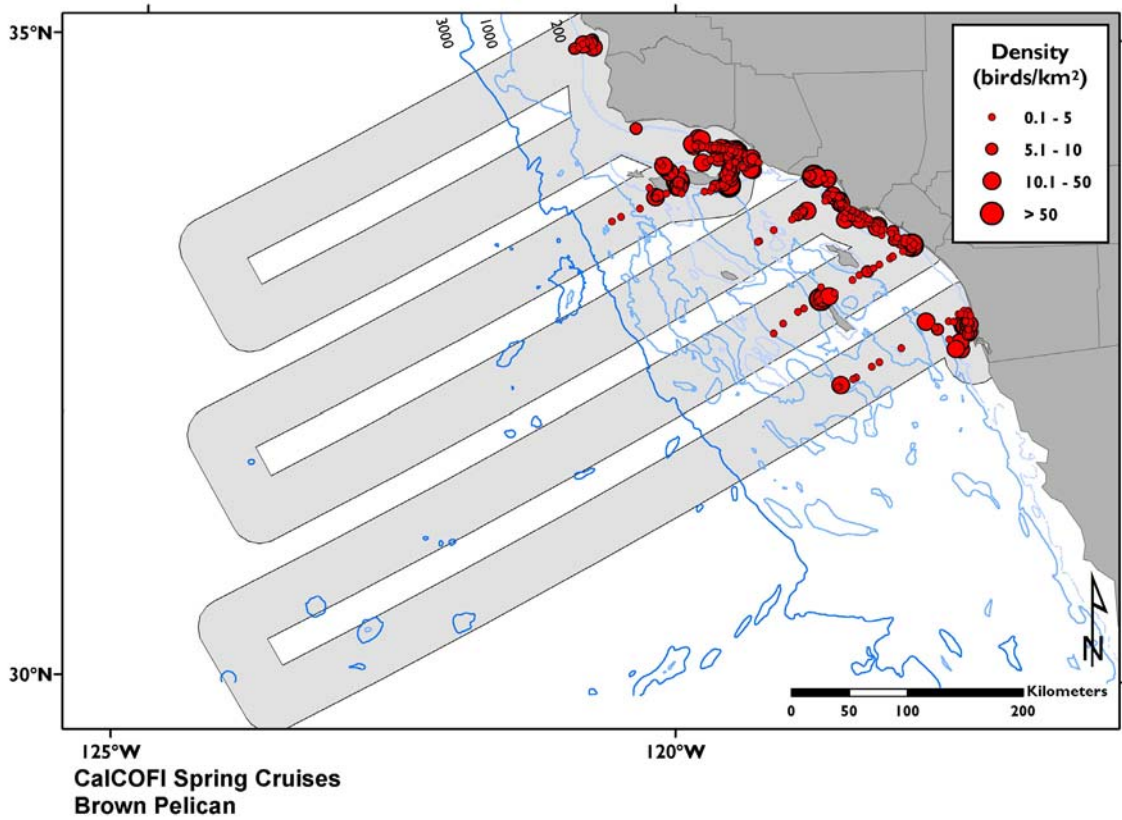
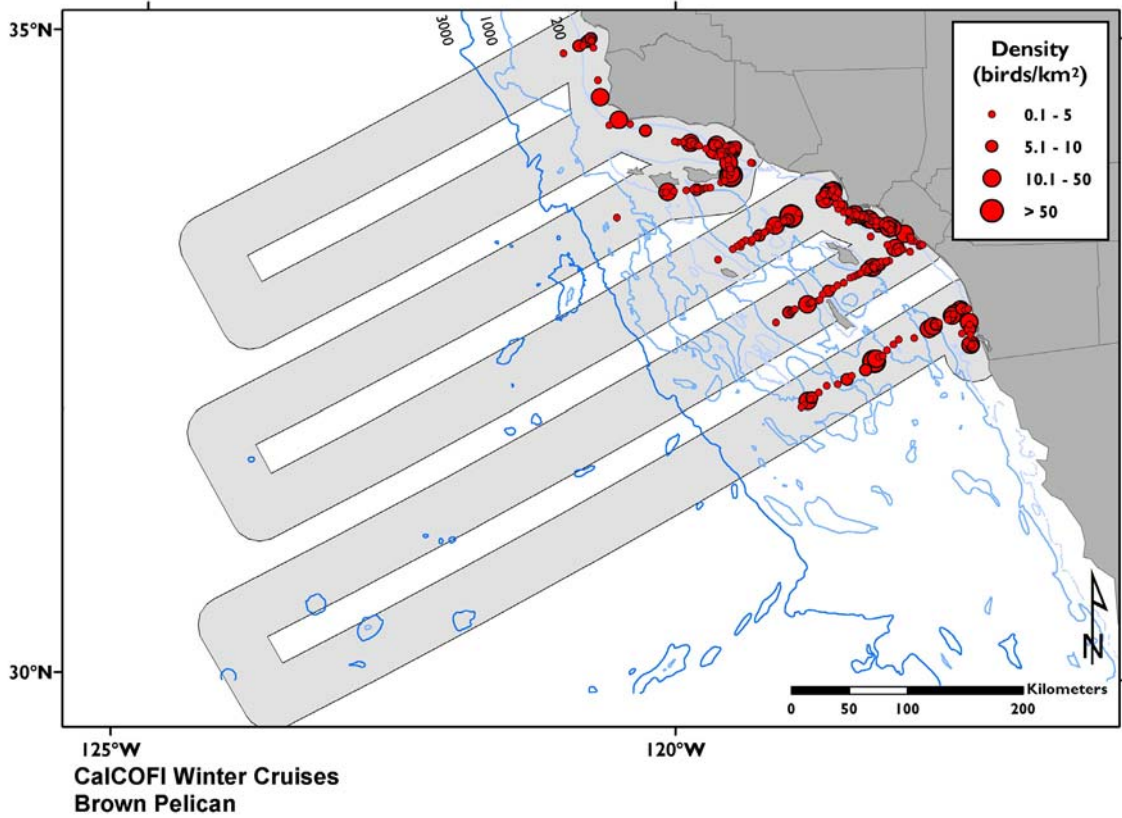
## Brown Pelican

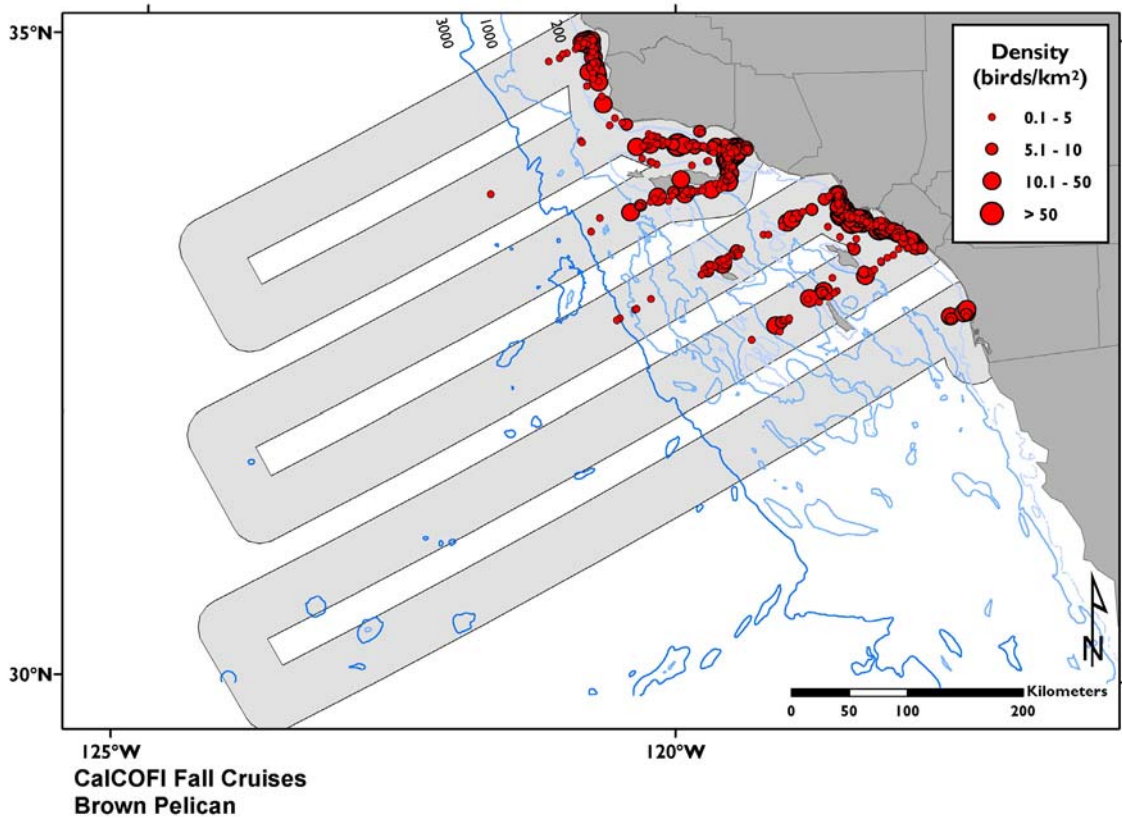
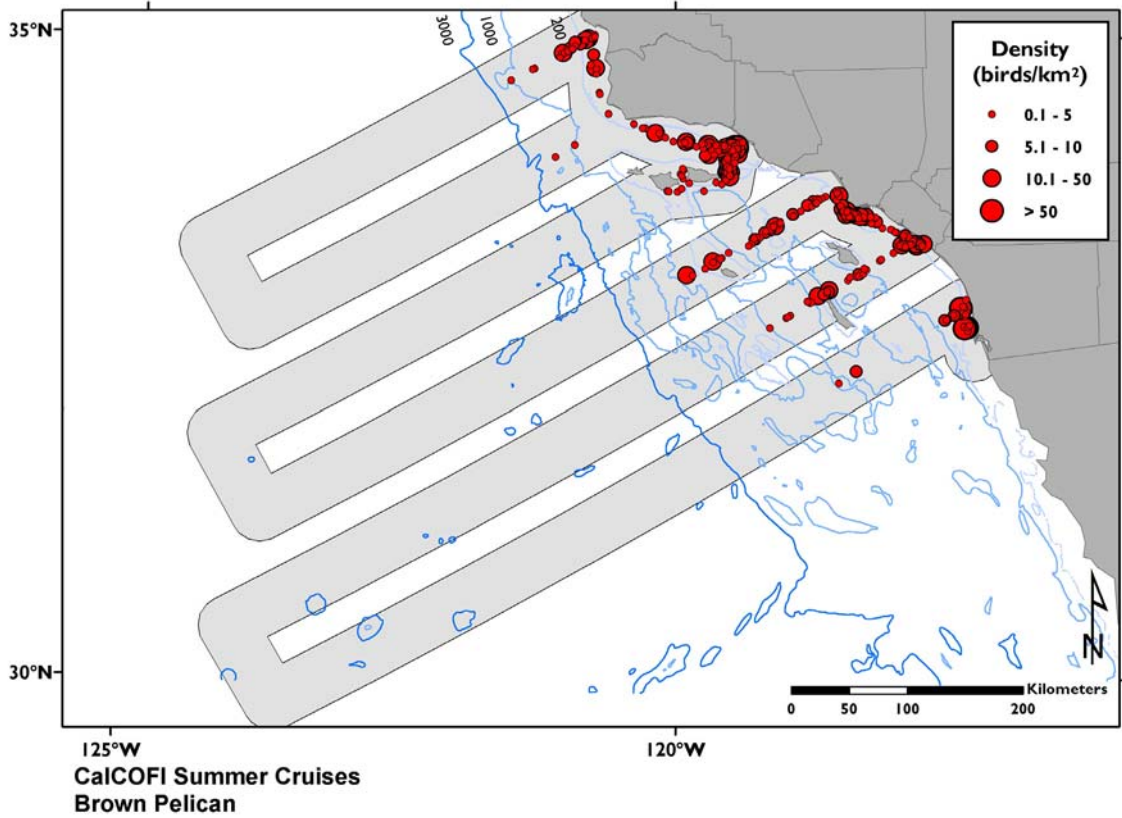
*Pelecanus occidentalis*



The Brown Pelican (BRPE) is a resident of the CalCOFI study area with major breeding colonies found along the coasts of southern California and Baja California. BRPE feed on fish and some invertebrates. High densities of BRPE were found over the continental shelf during all seasons, with highest densities in fall.









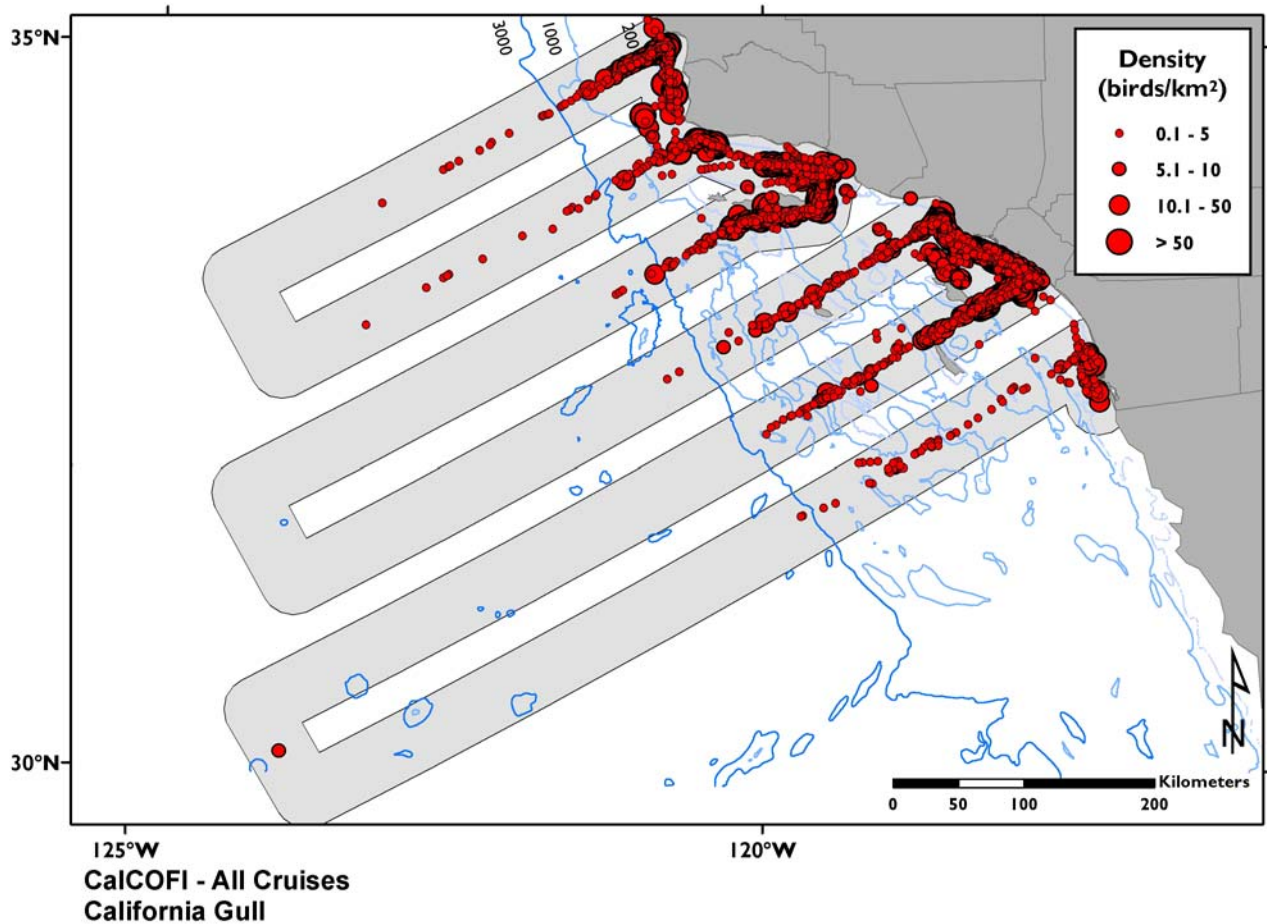


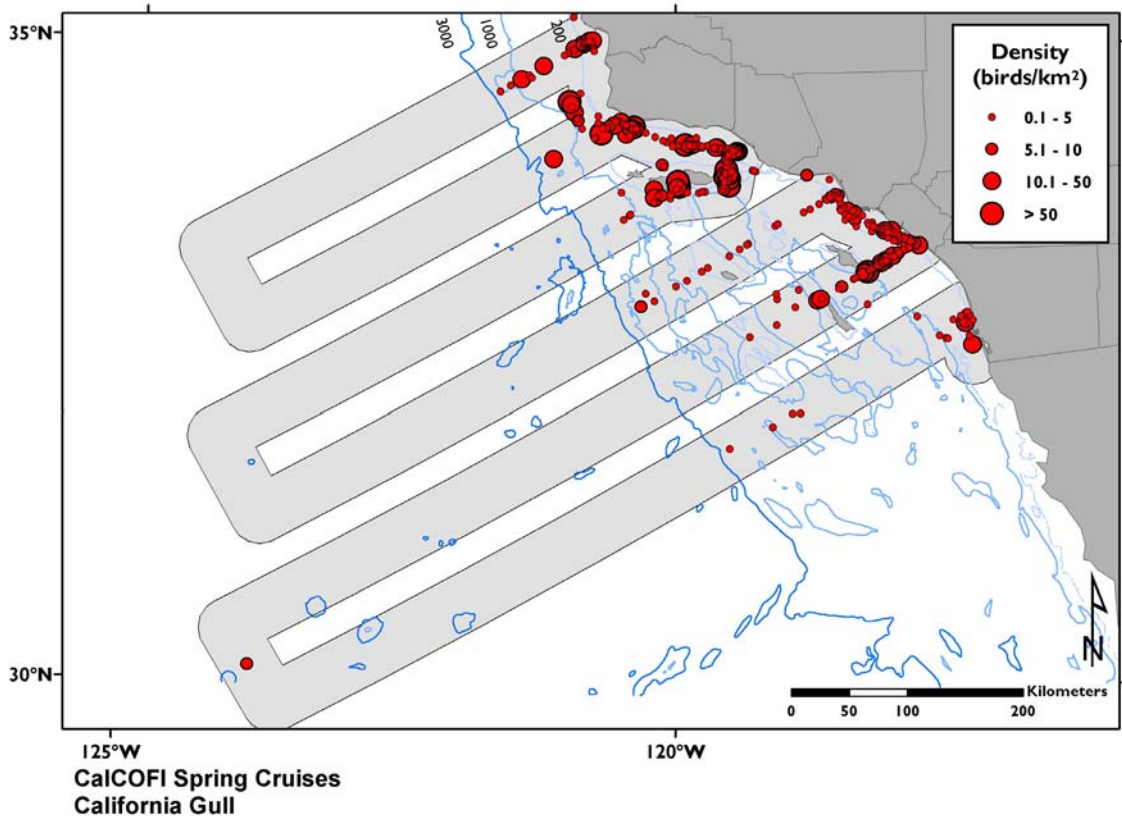
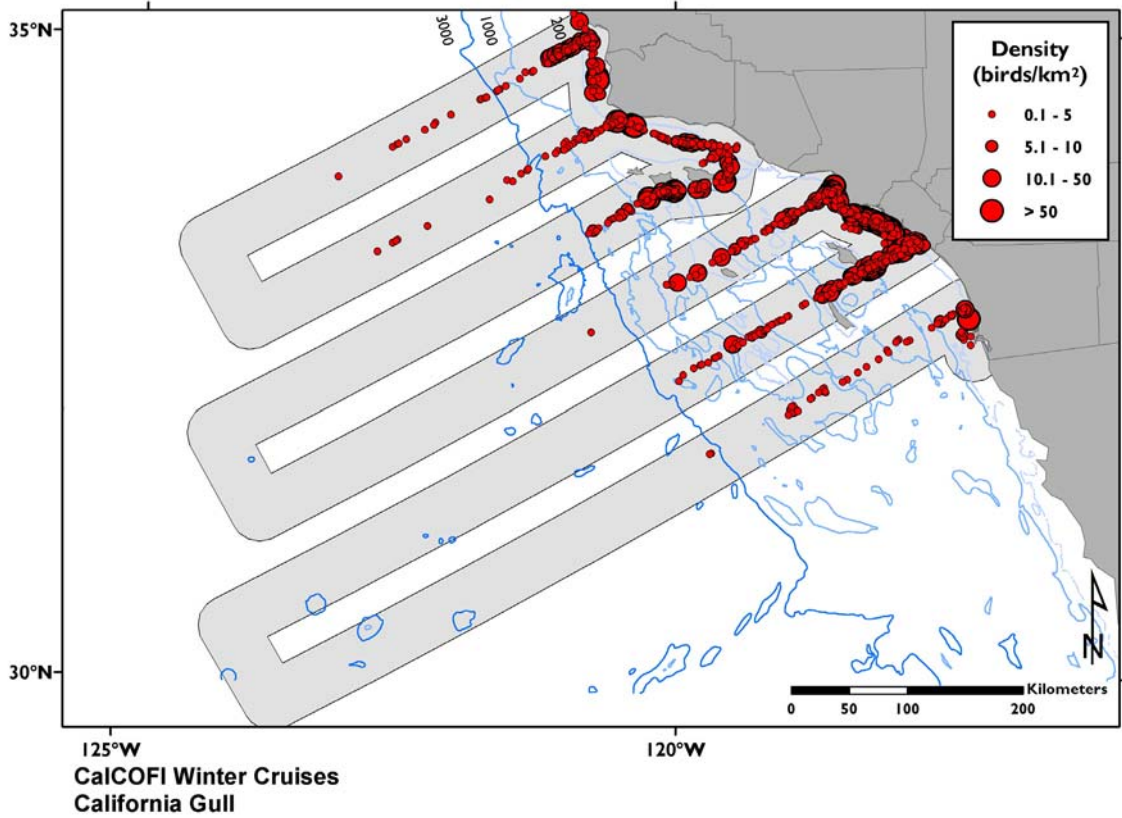
# California Gull

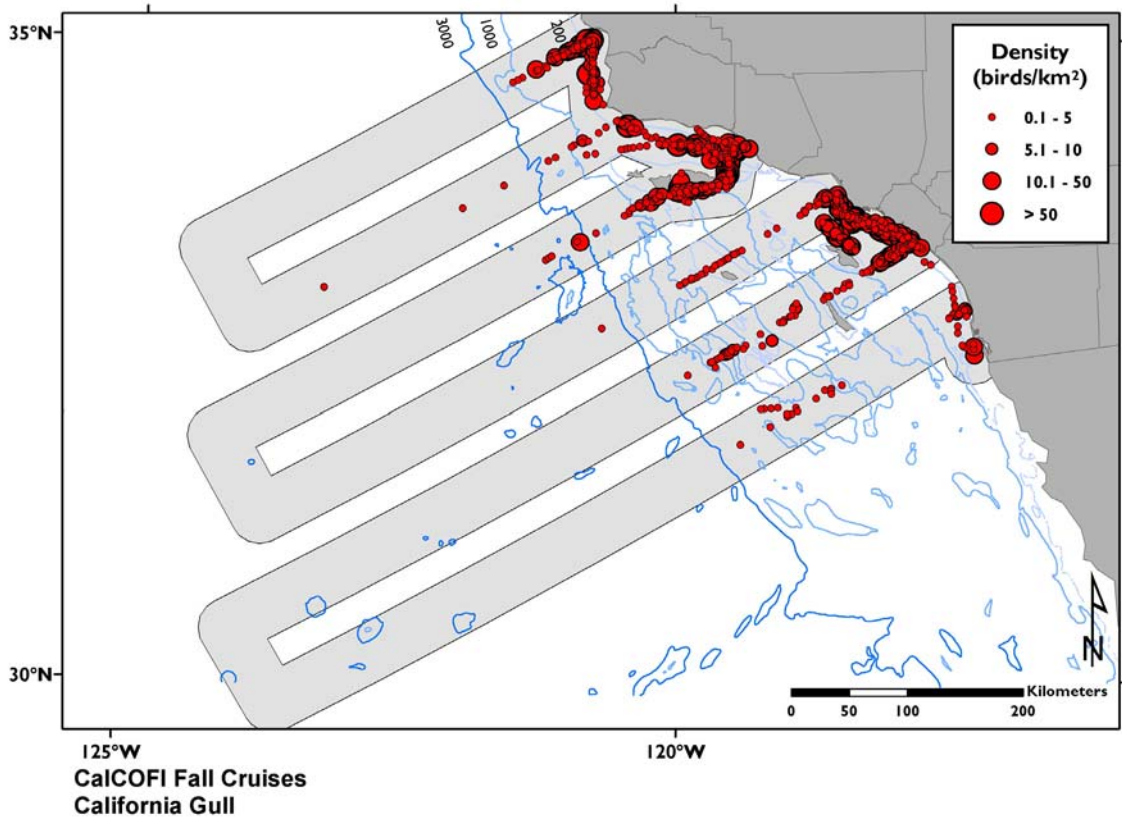
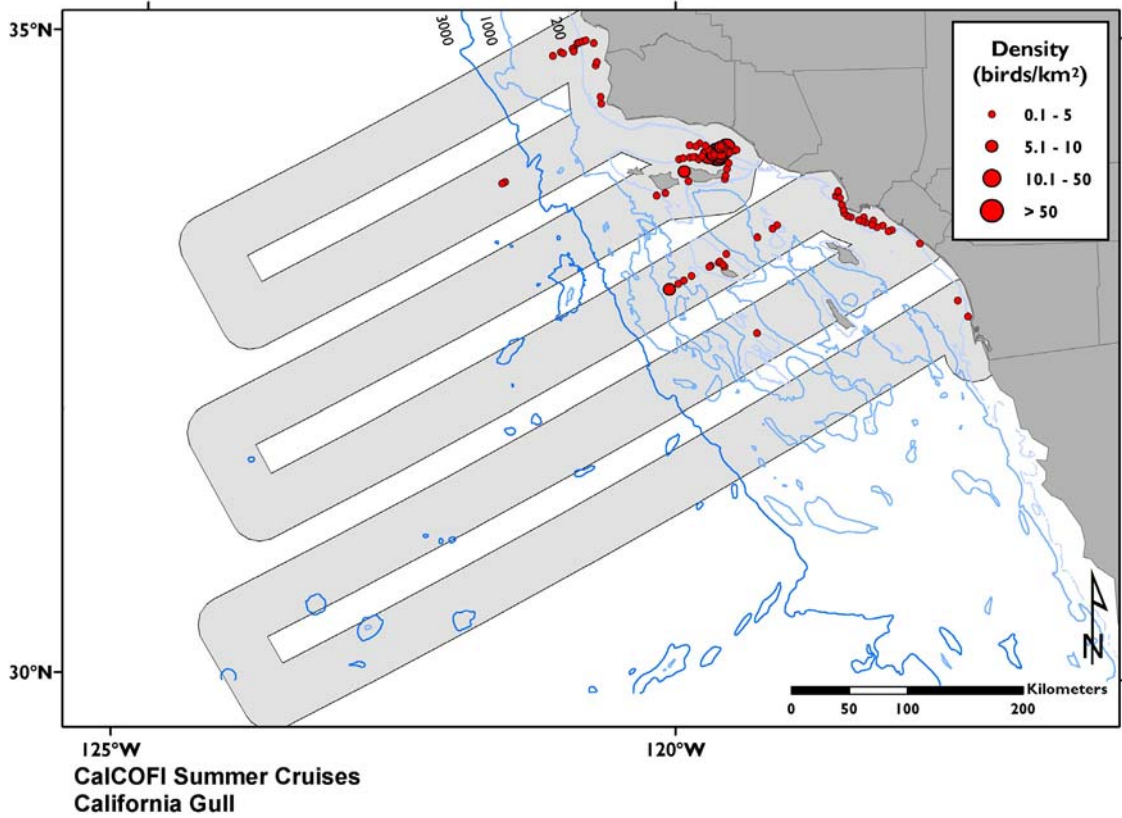
*Larus californicus*

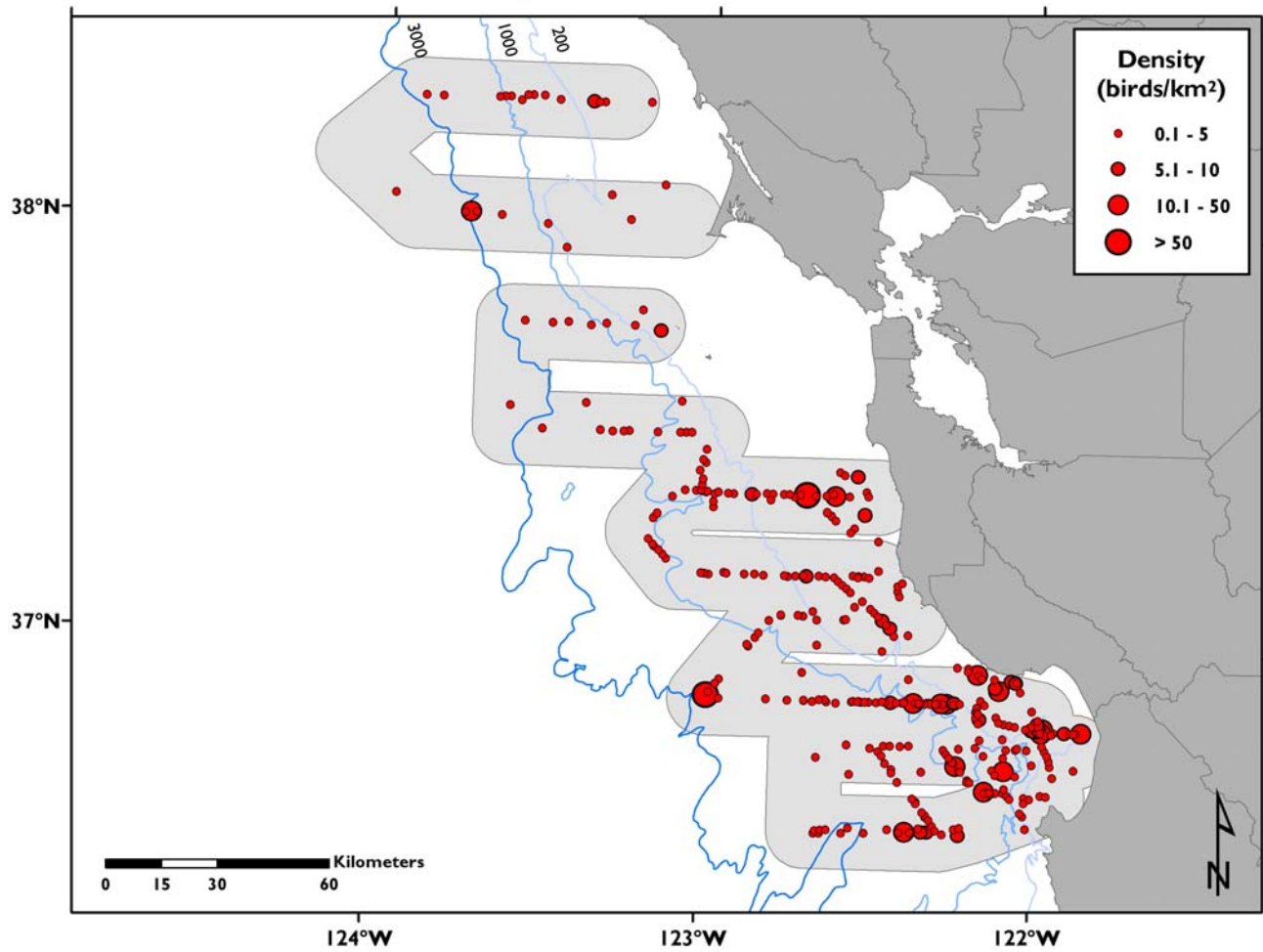


Distribution and abundance of California Gulls (CAGU) in southern California decline in summer when breeding birds migrate inland to nest; the highest densities occur in winter (Winkler 1996). In the CalCOFI study area, highest densities occurred over the continental shelf. Densities in the NMFS study area were roughly equal over the shelf and shelf-break, though birds occurred more frequently in the south. CAGU are opportunistic foragers, consuming almost anything depending on prey availability (Winkler 1996).

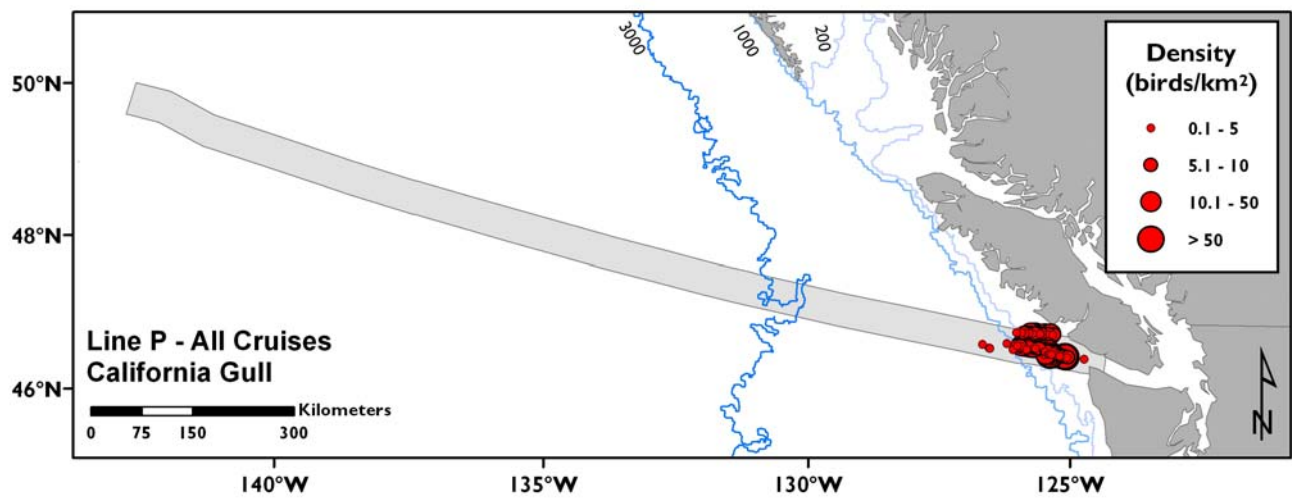




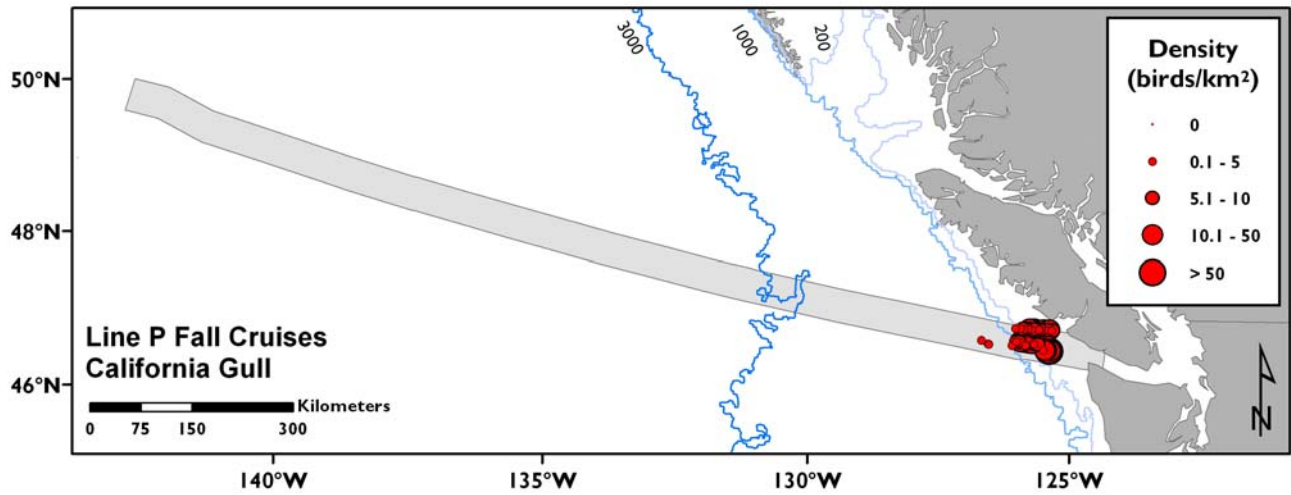
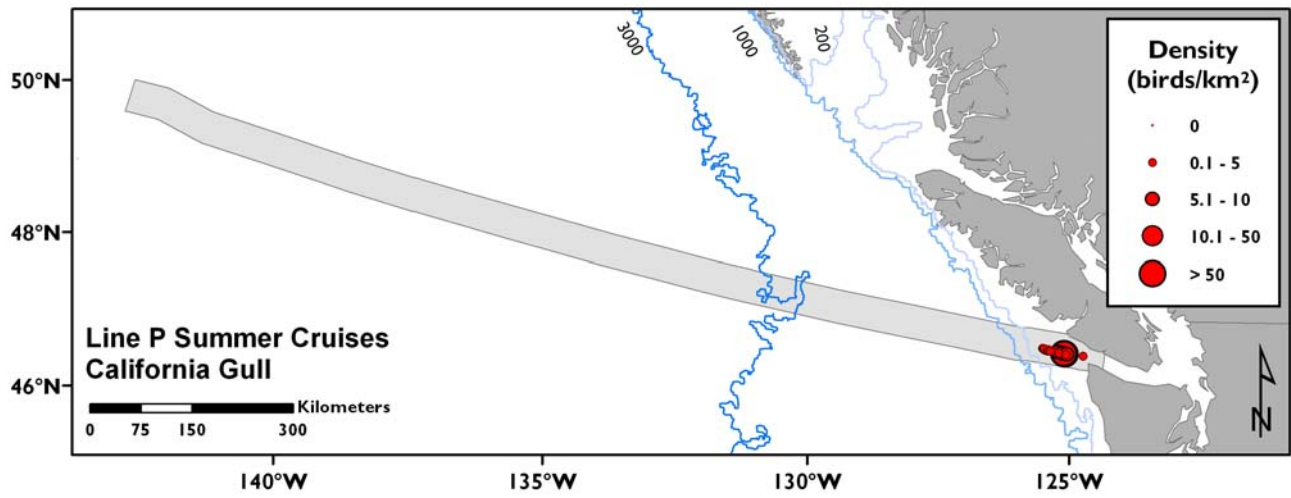
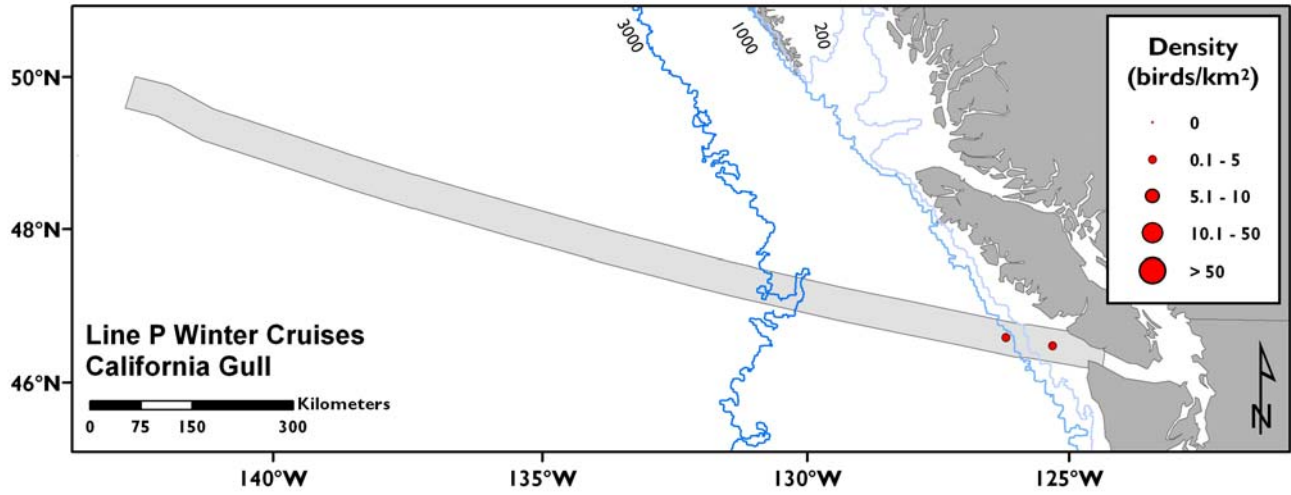




NMFS - All Cruises  
California Gull



Line P - All Cruises  
California Gull



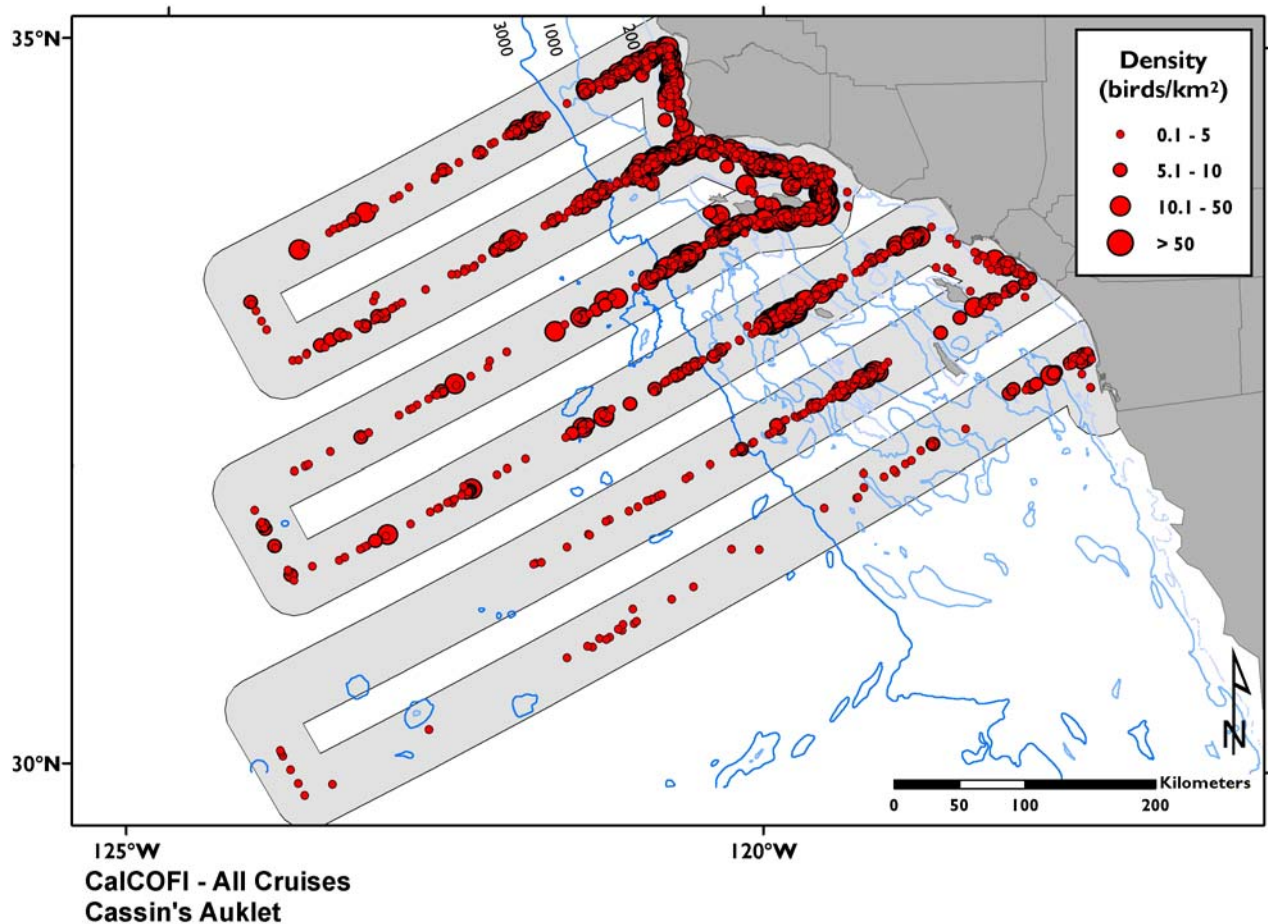


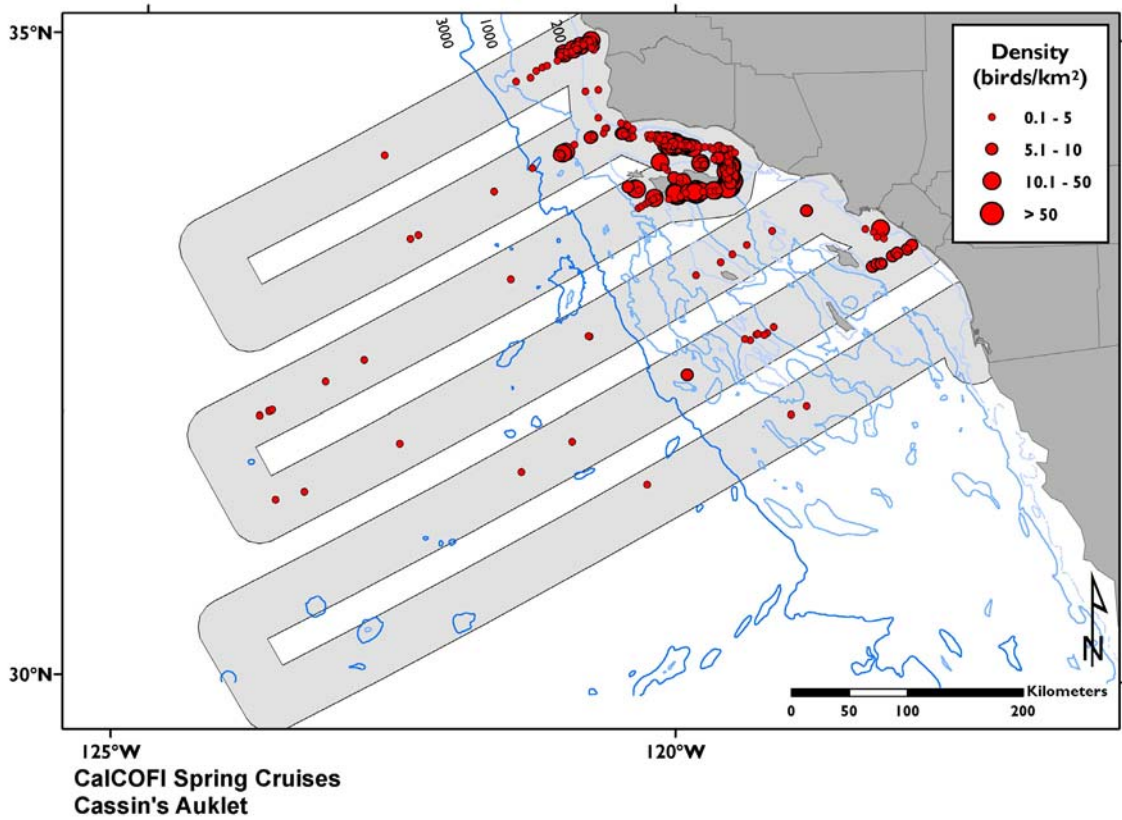
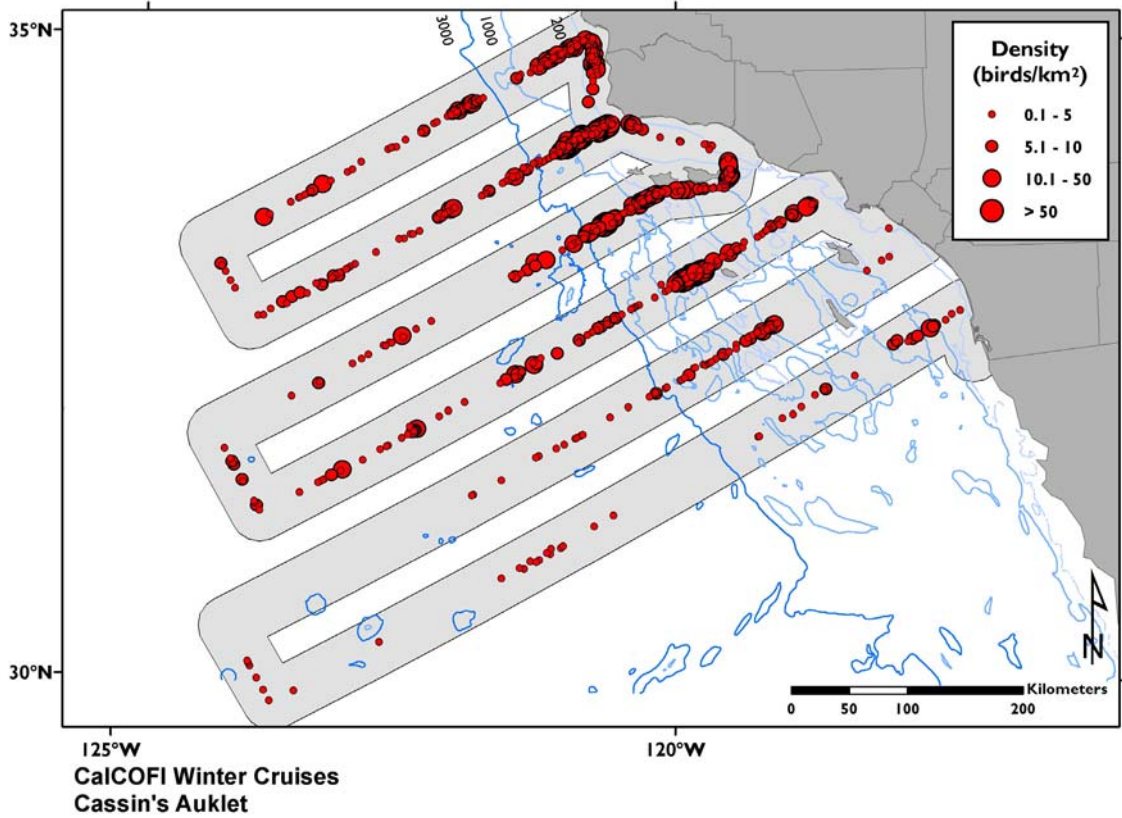
## Cassin's Auklet

*Ptychoramphus aleuticus*

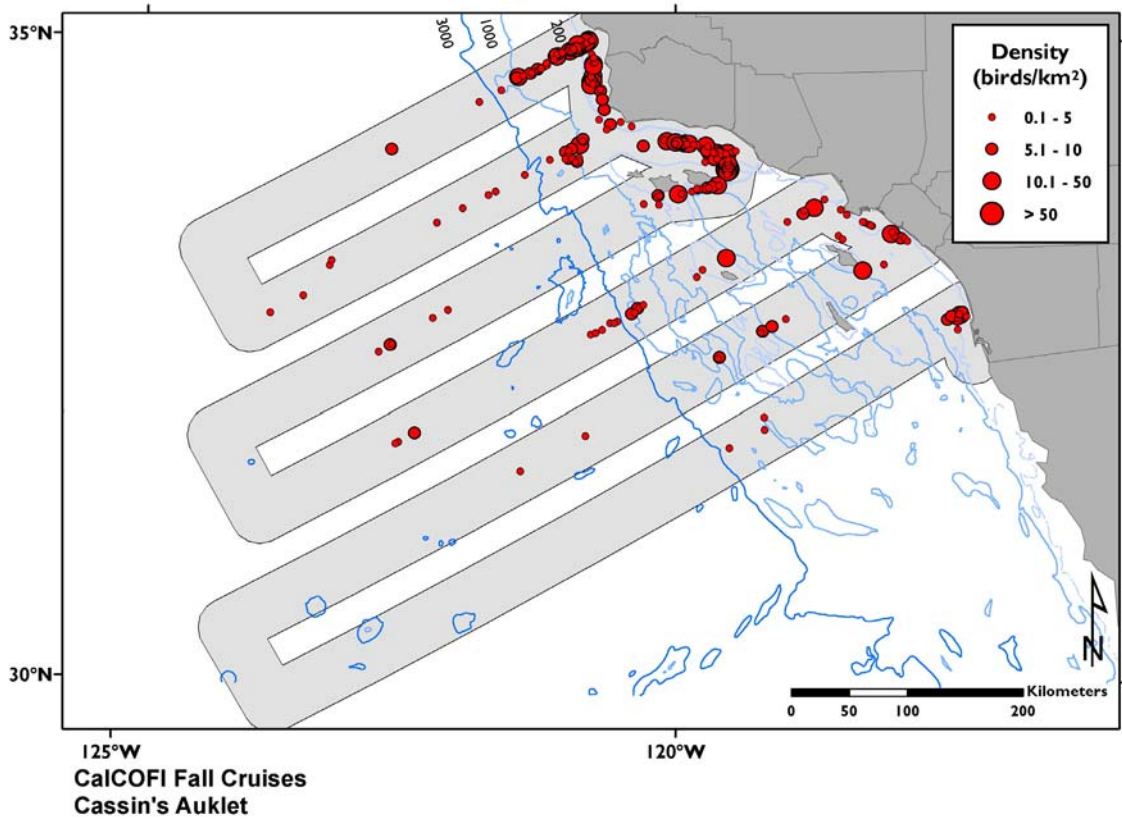
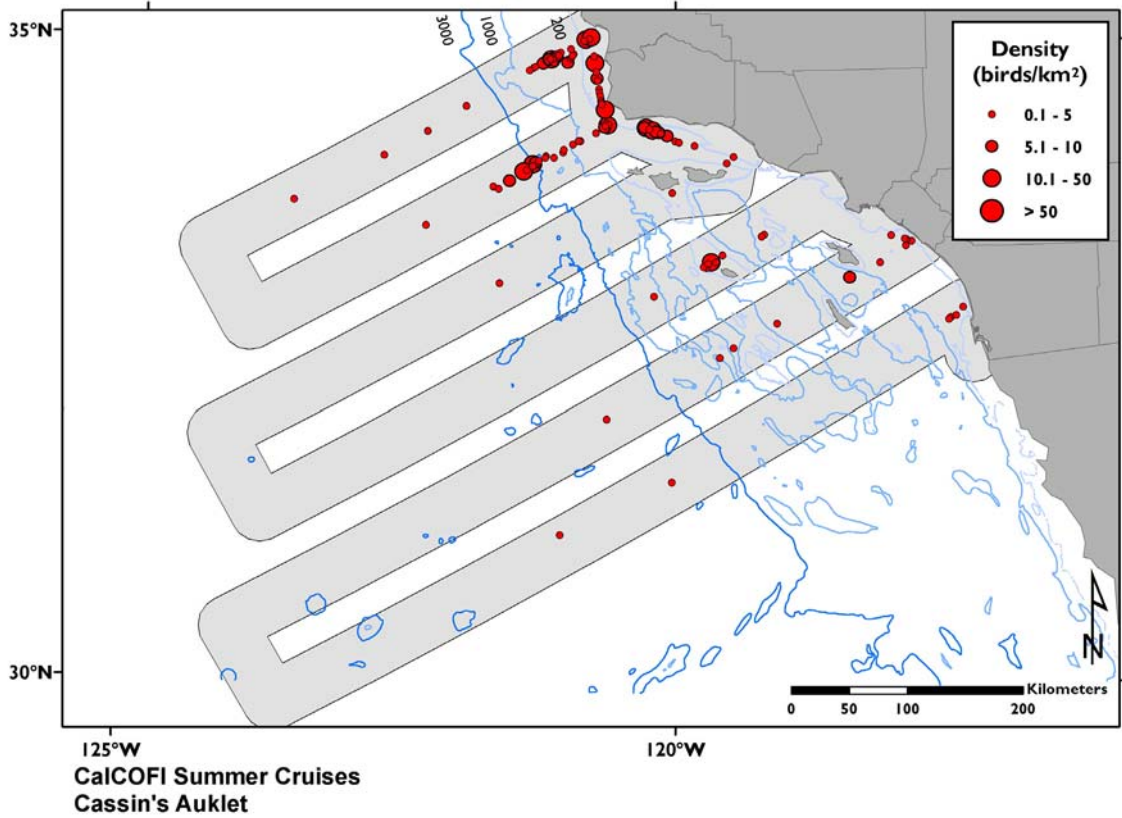


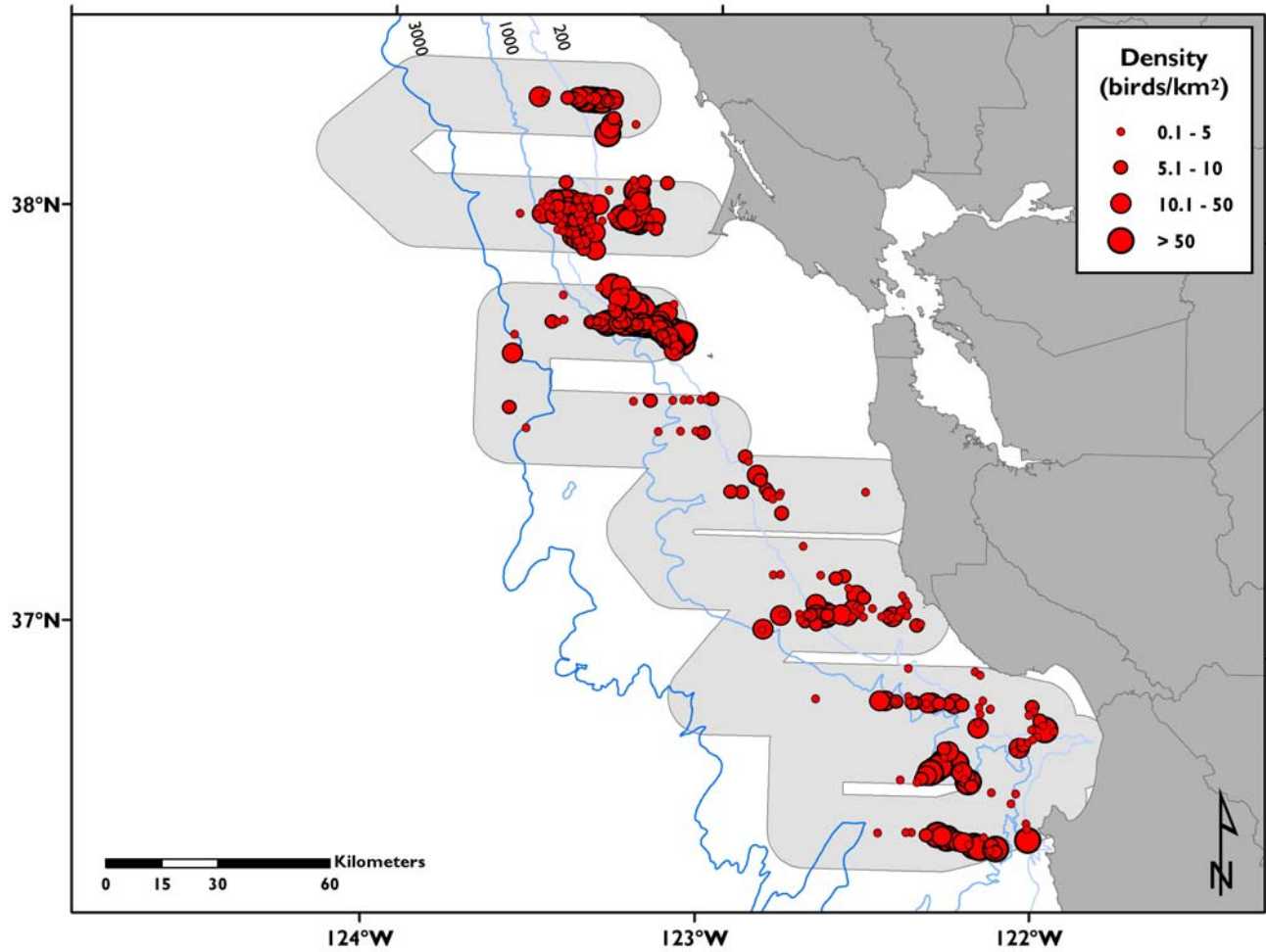
Populations of Cassin's Auklet (CAAU) appear to be declining throughout most of the species' range. Highest CAAU densities in the CalCOFI area occurred over shelf and shelf-break habitats in the winter. Winter distribution of CAAU was primarily pelagic in the CalCOFI area, a trend noted by Briggs et al. (1987); whereas, Morgan et al. (1991) noted that within B.C., CAGU occurred primarily over the outer shelf. Spring surveys in the NMFS study area showed that the highest densities occurred on the continental shelf, with notable aggregations near Cordell Bank, Fanny Shoals, and Monterey Canyon. Prey taken includes small crustaceans, squid and small fish. (Manuwal and Thoresen 1993).



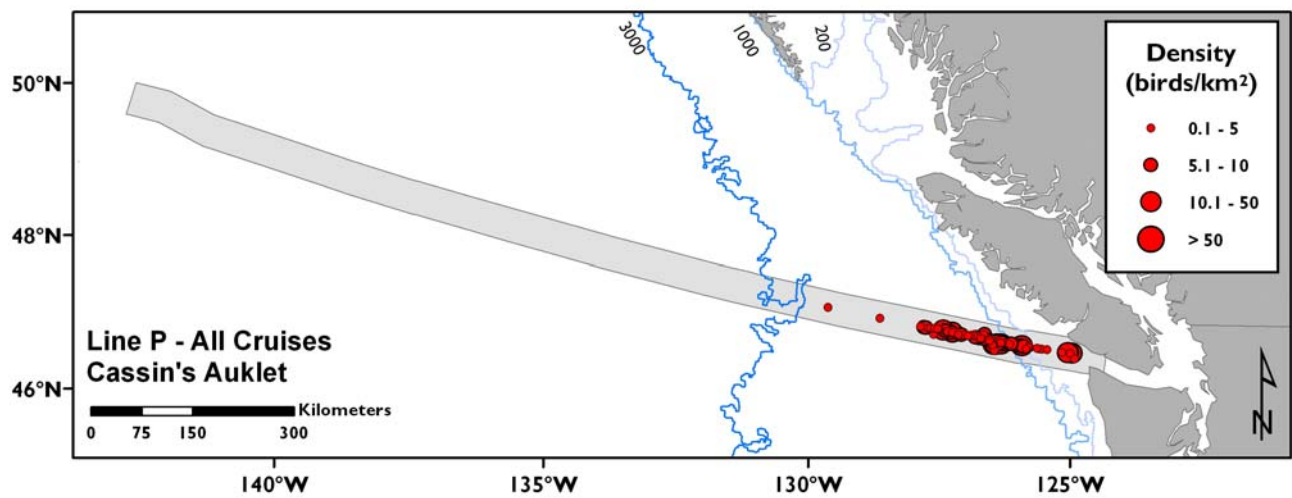




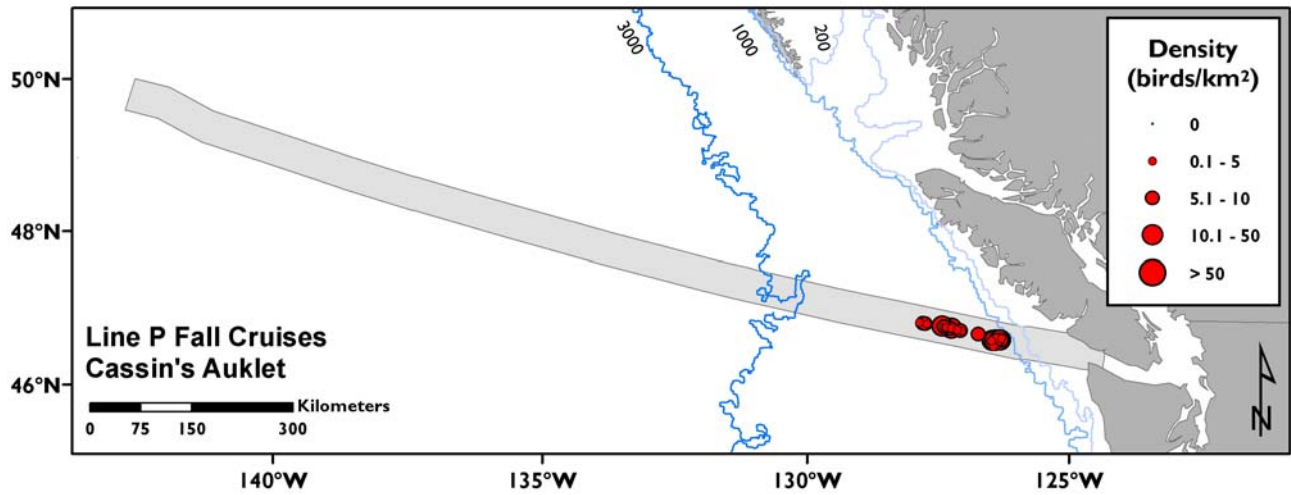
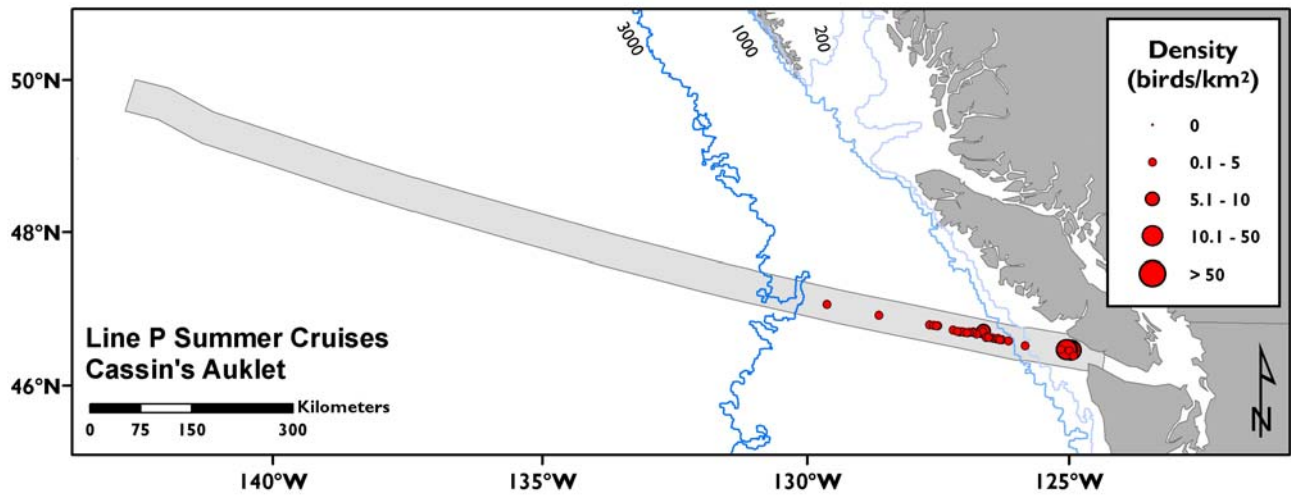
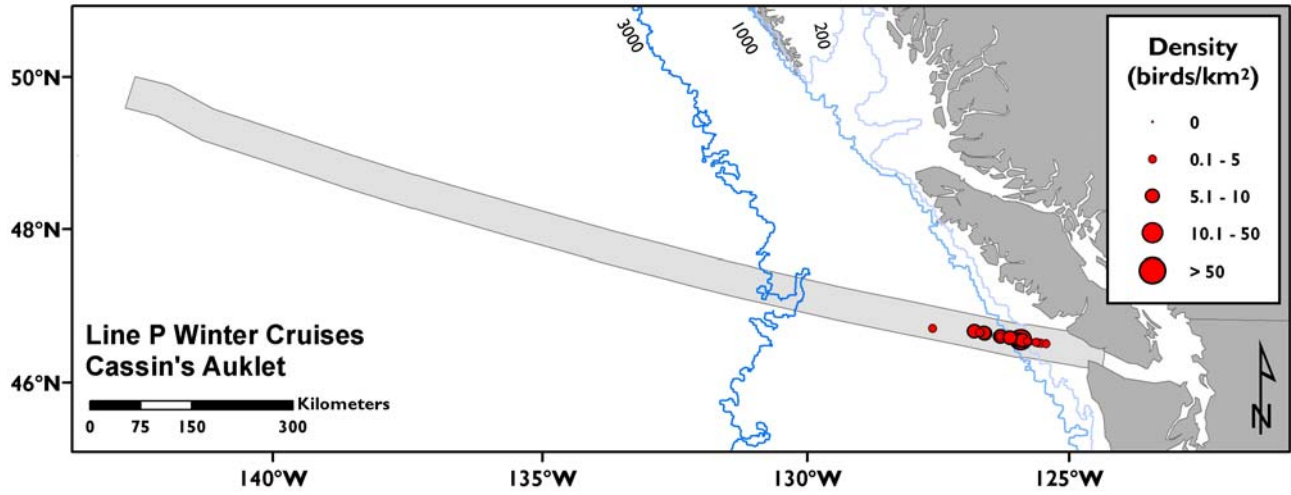




NMFS - All Cruises  
Cassin's Auklet



Line P - All Cruises  
Cassin's Auklet



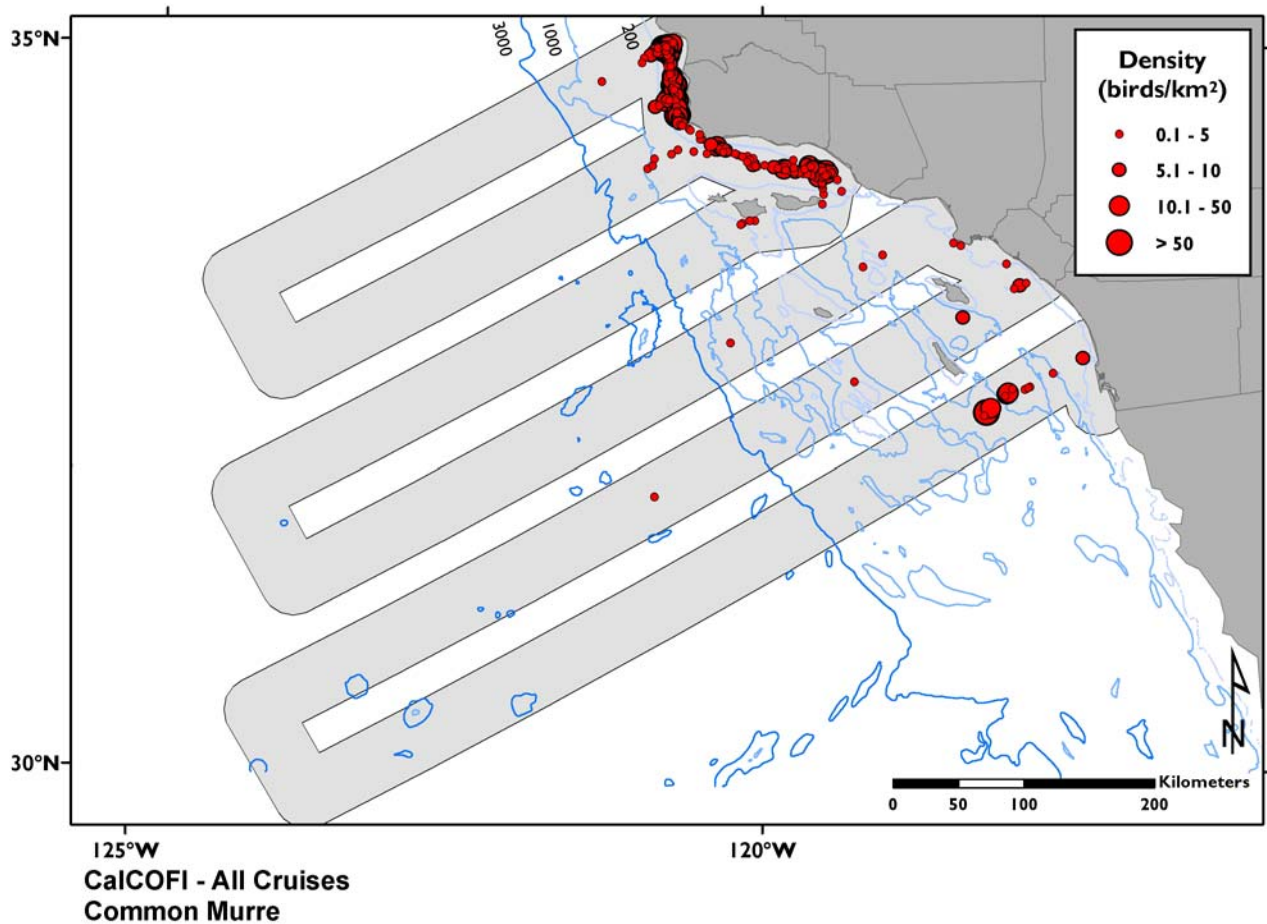


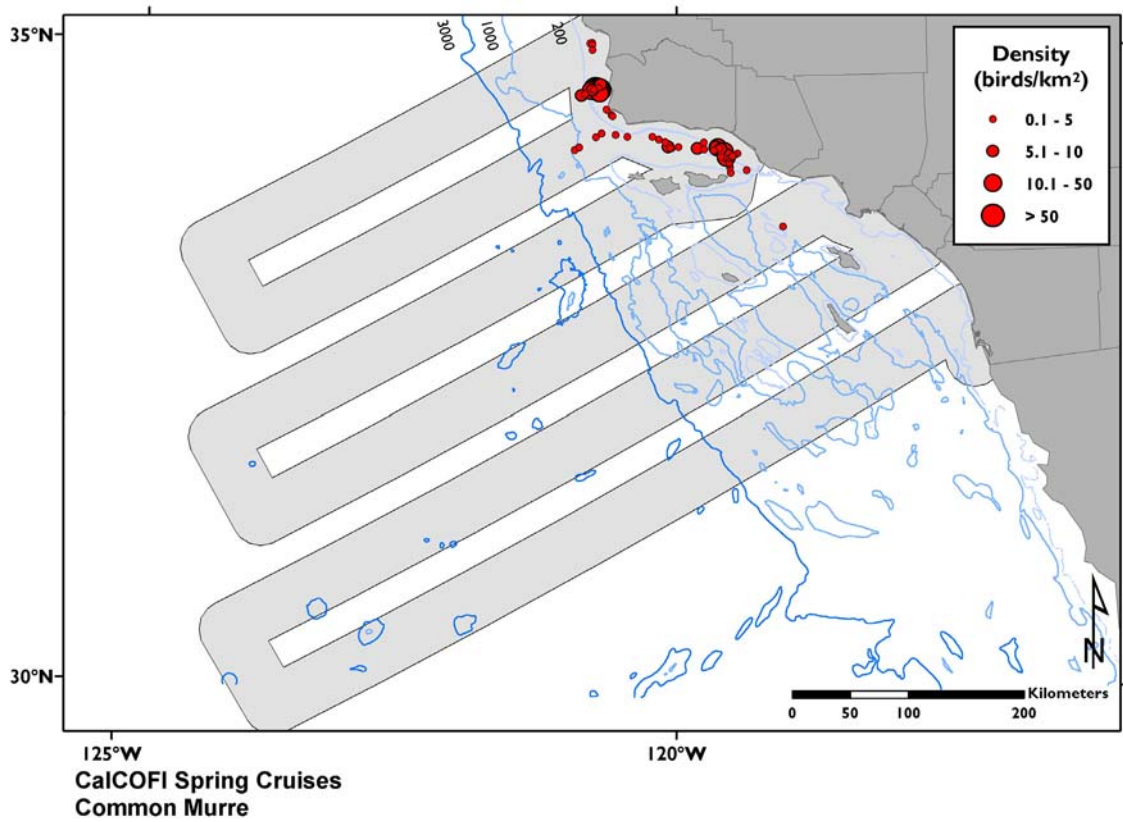
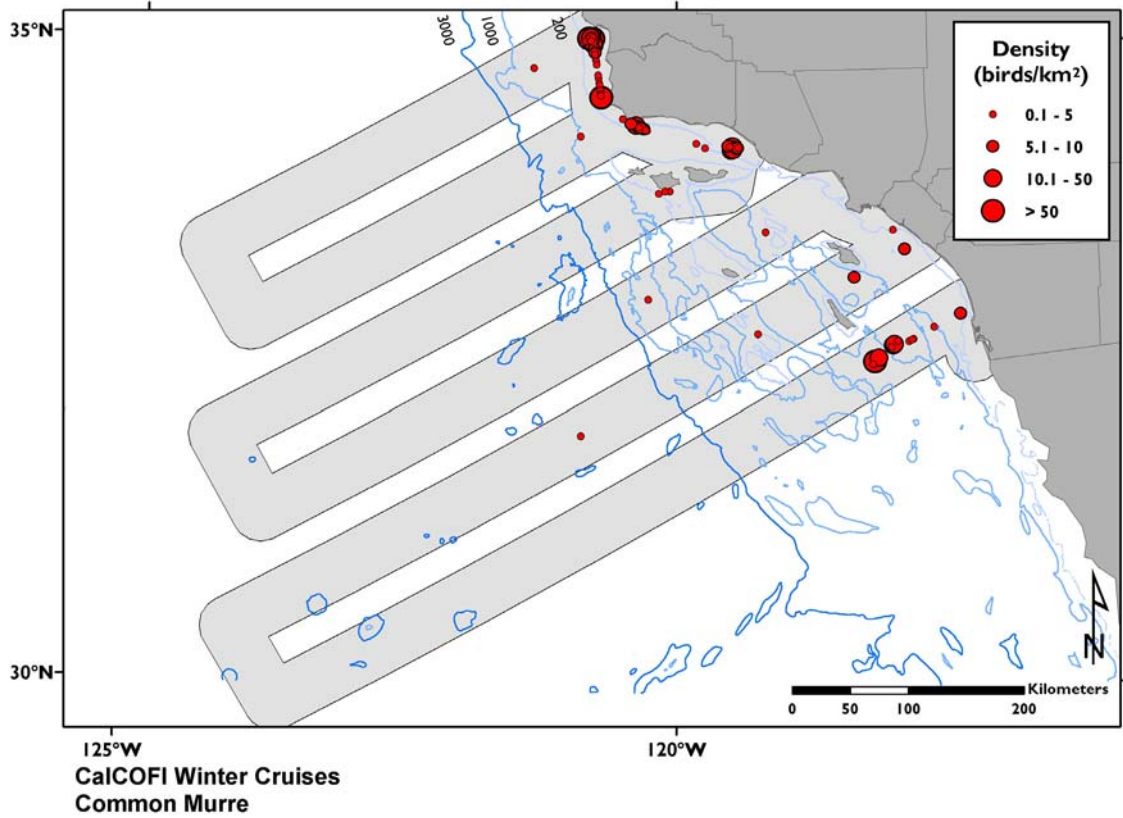
# Common Murre

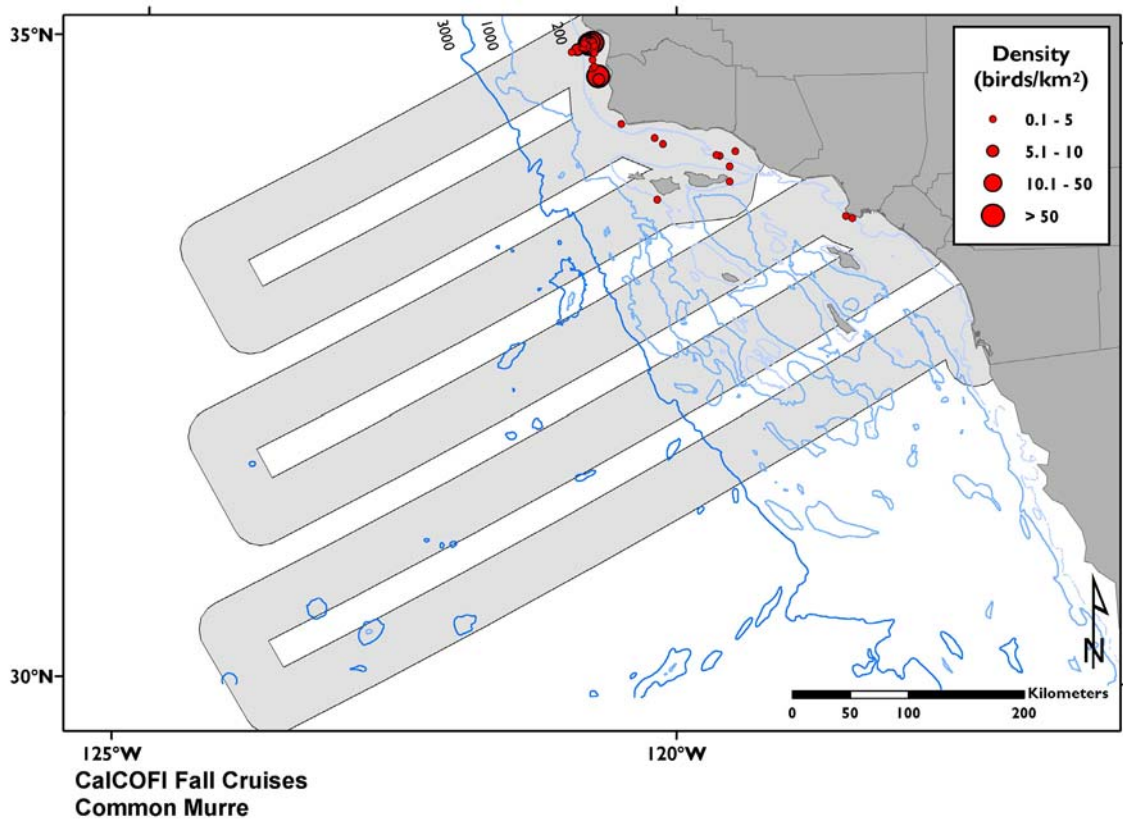
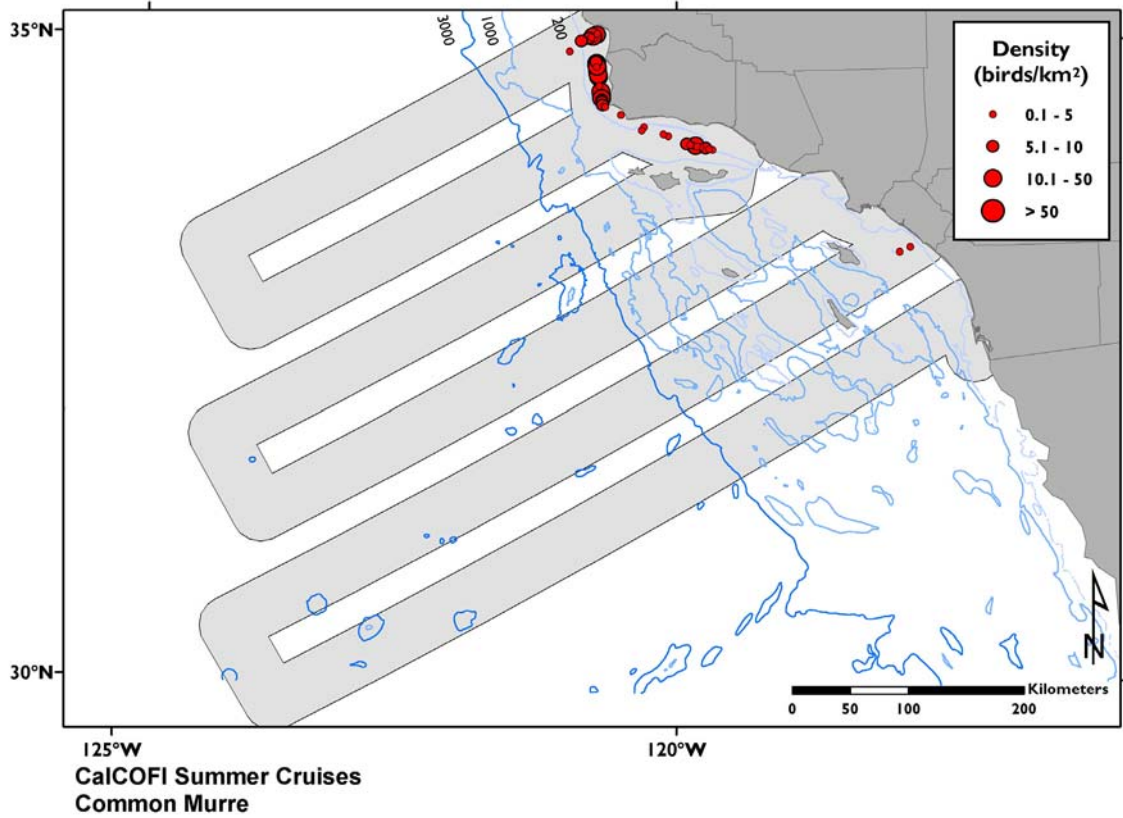
*Uria aalge*

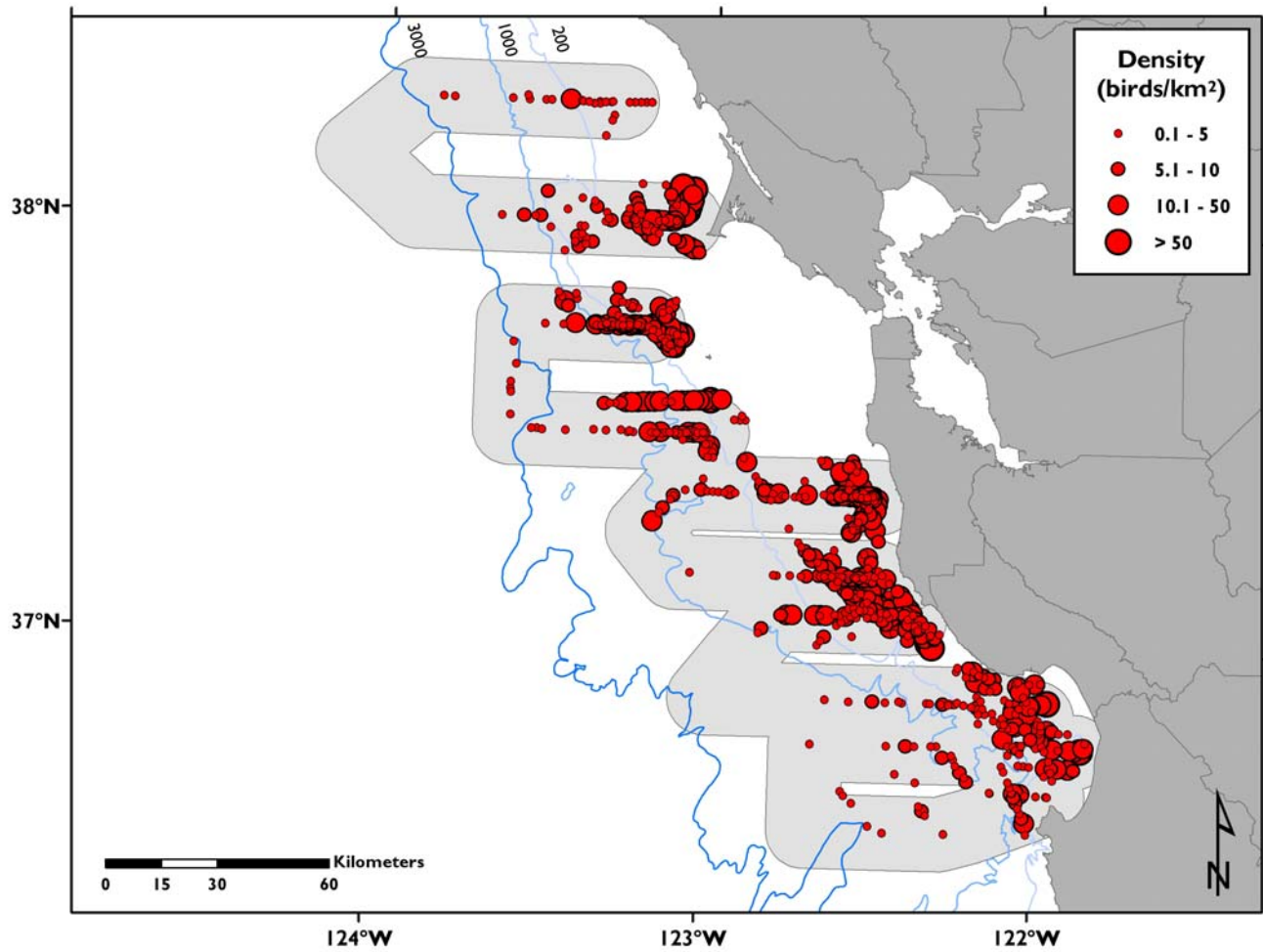


Core California Current System breeding locations of Common Murres (COMU) occur in Oregon and northern California. The annual presence of COMU in the CalCOFI study area was variable, with distributions occurring near Point Conception and Santa Barbara Channel. Spring distributions in the NMFS study area suggested a preference for shelf and shelf-break habitats, with highest densities occurring over the shelf. COMU prey upon fish, euphausiids, and squid (Ainley et al. 2002).

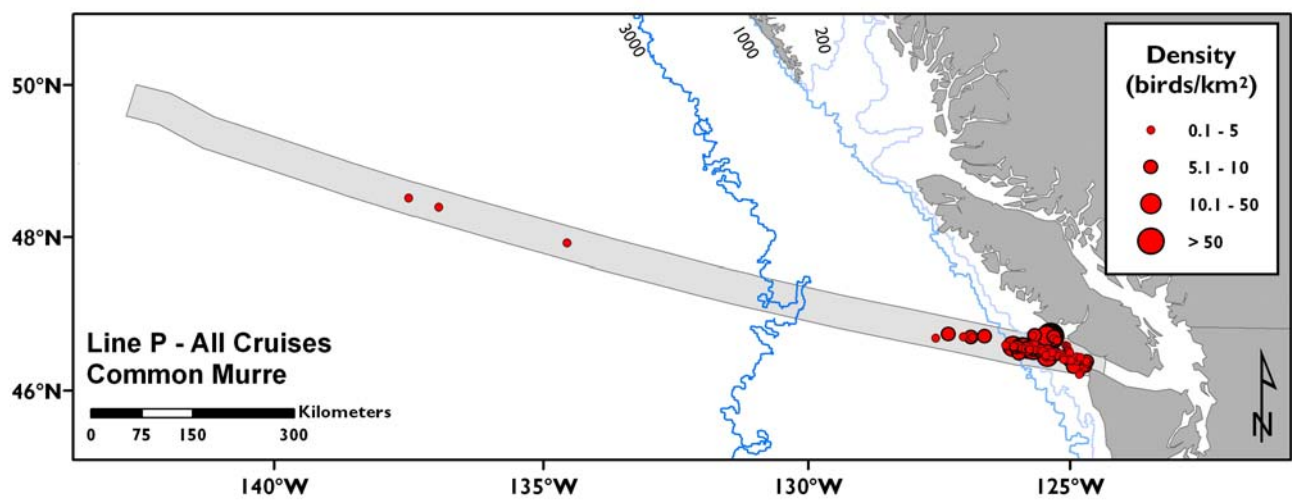






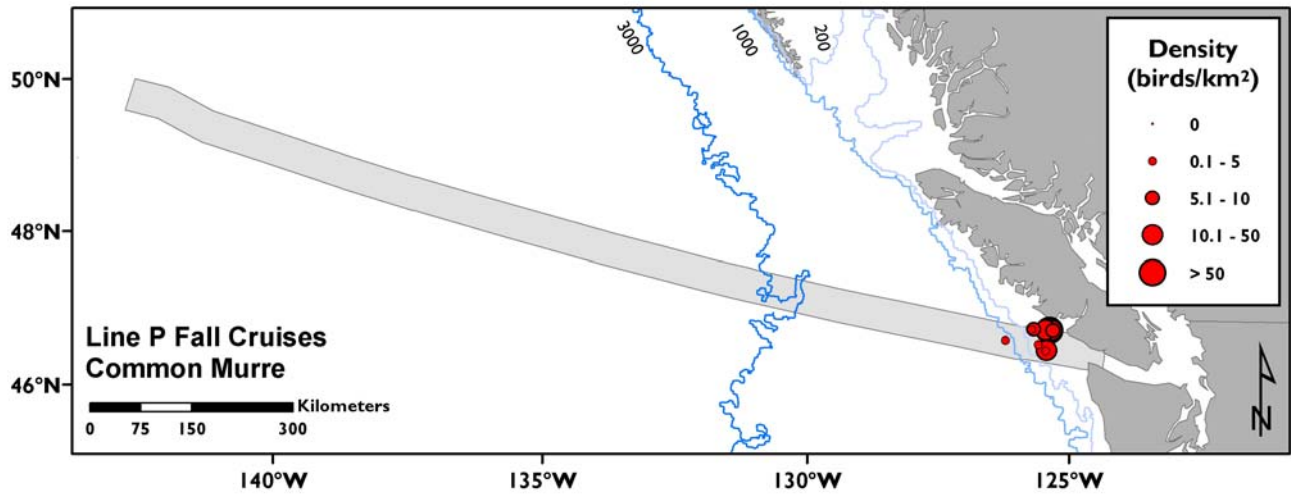
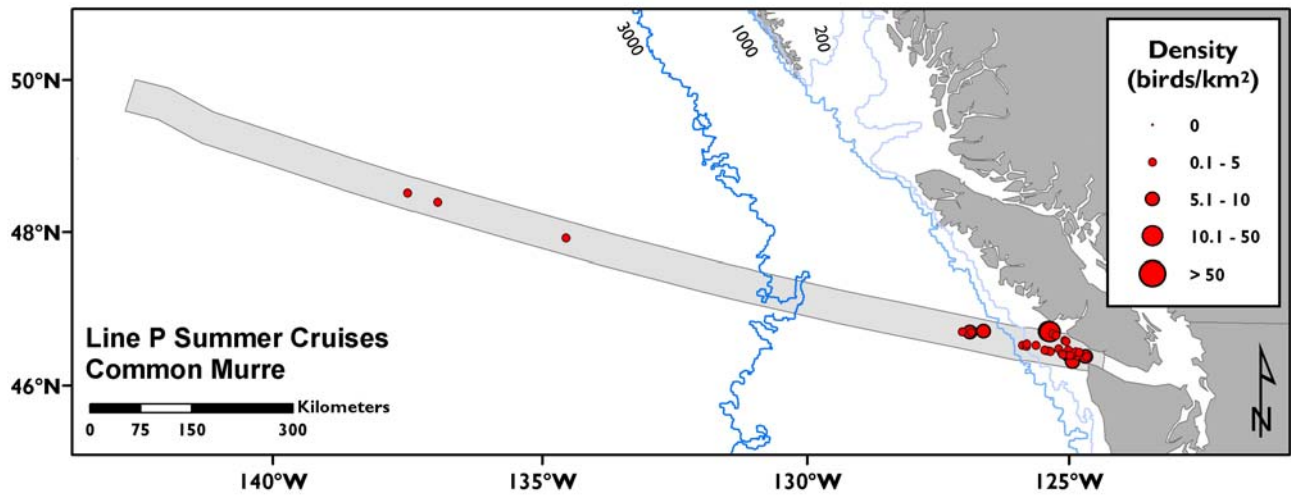
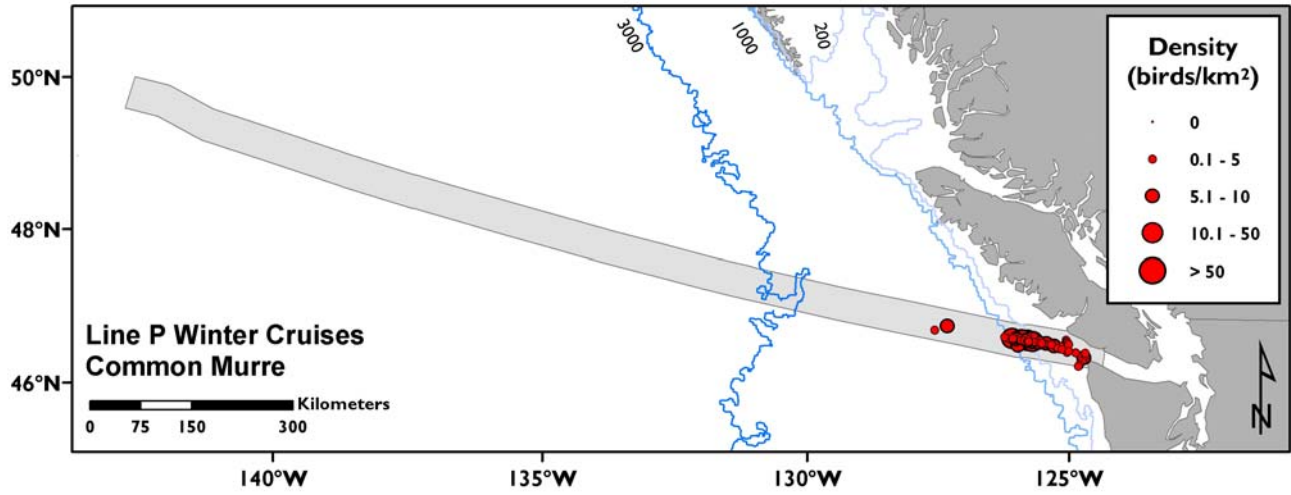


NMFS - All Cruises  
Common Murre



Line P - All Cruises  
Common Murre



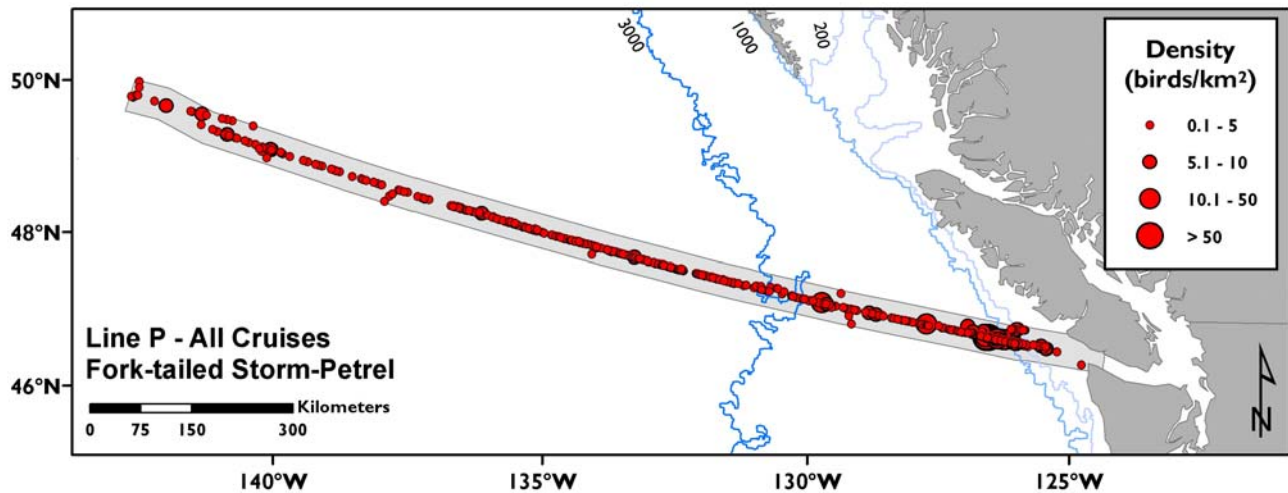


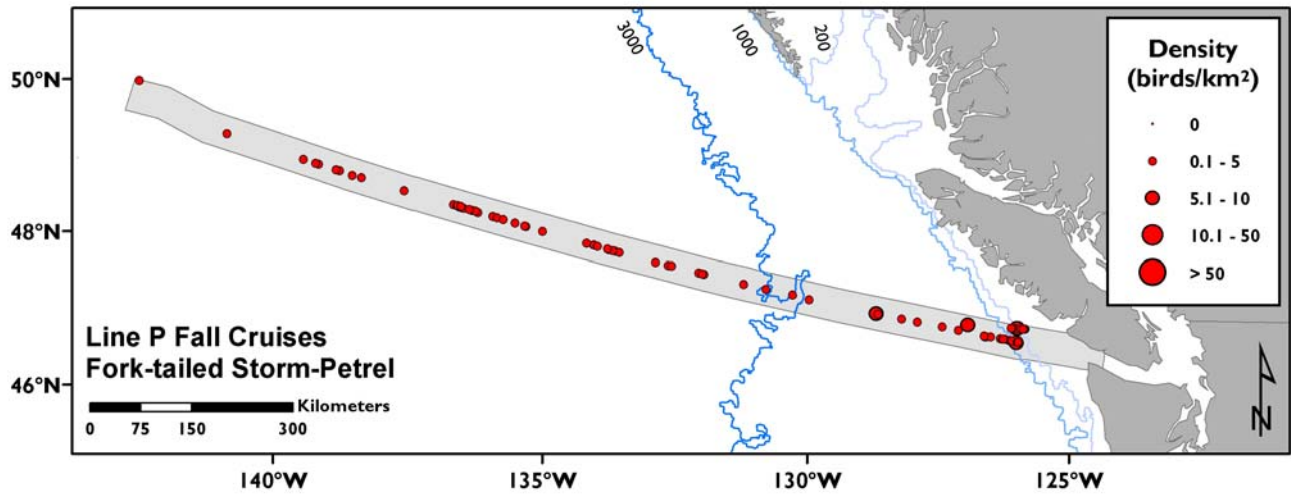
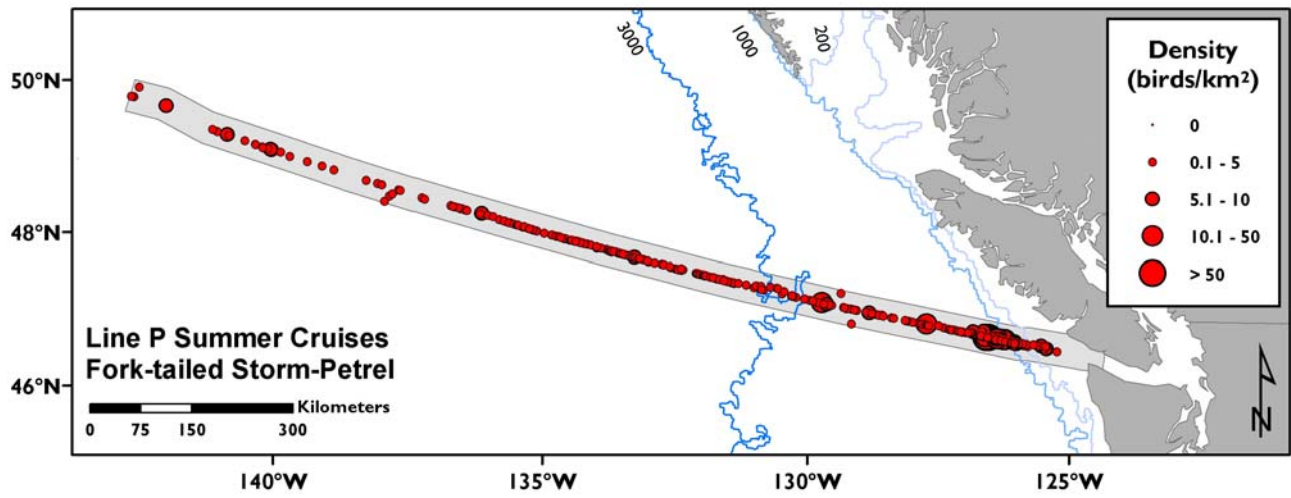
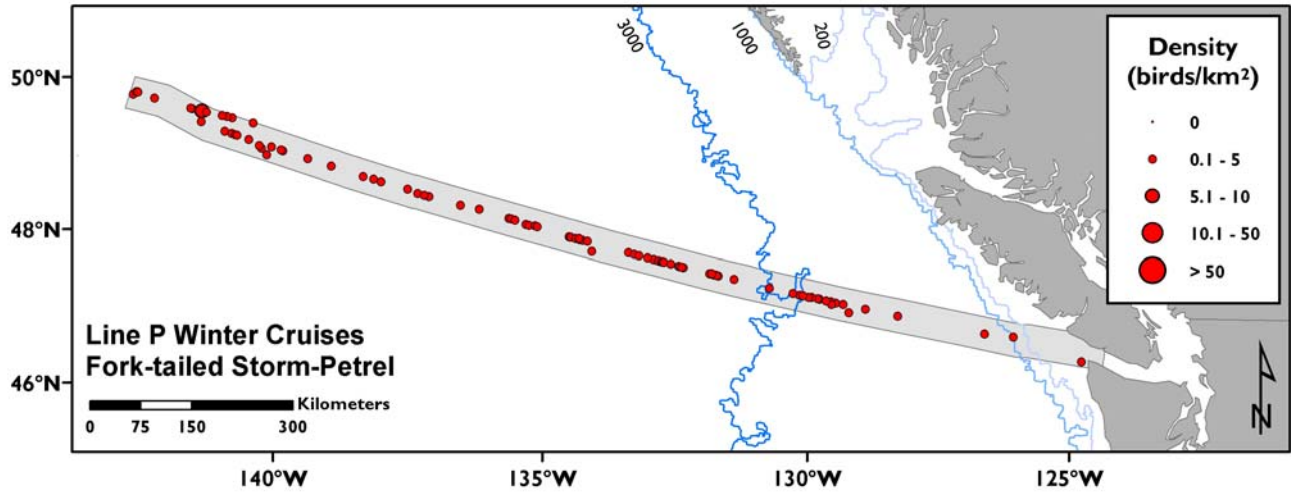
# Fork-tailed Storm-Petrel

*Oceanodroma furcata*



The majority of the Fork-tailed Storm-Petrels (FTSP) within the California Current System breeds in British Columbia (Carter et al. 1992; Rodway et al. 1991). FTSP appear to use a wide range of bathymetric habitats in the Line P study area during all seasons. Higher densities of FTSP occurred over the shelf-break and slope in summer. FTSP relies mainly on surface feeding selecting fish and crustaceans, though it may also scavenge marine mammal carcasses at sea (Boersma and Silva 2001).



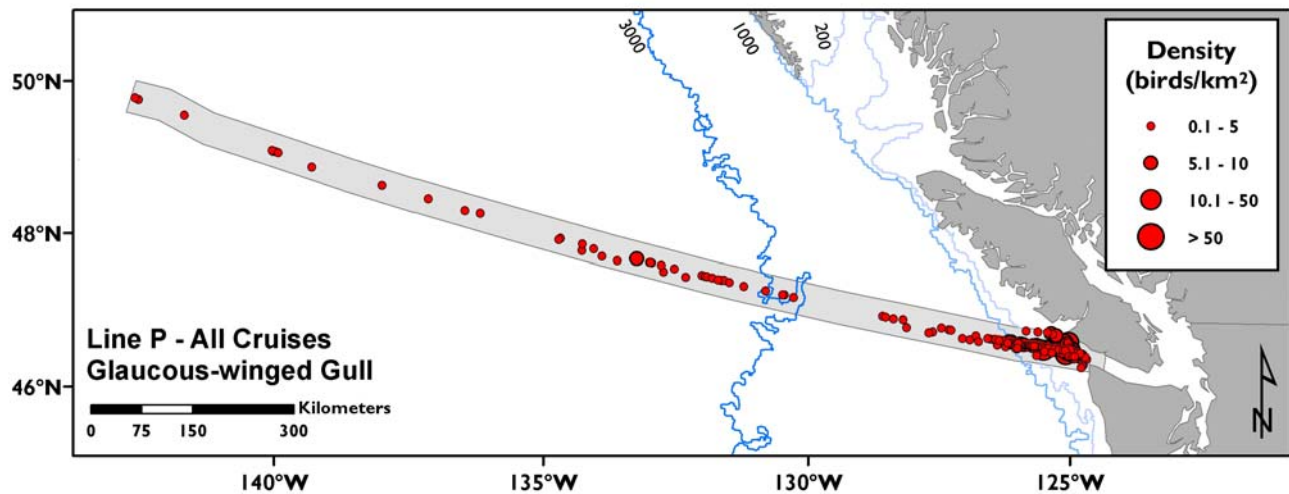


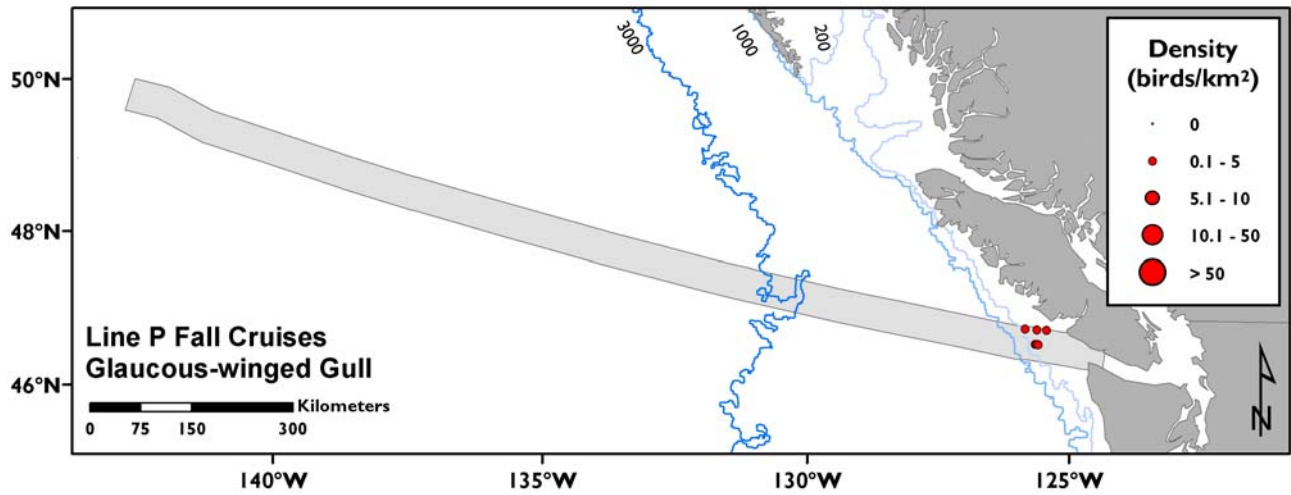
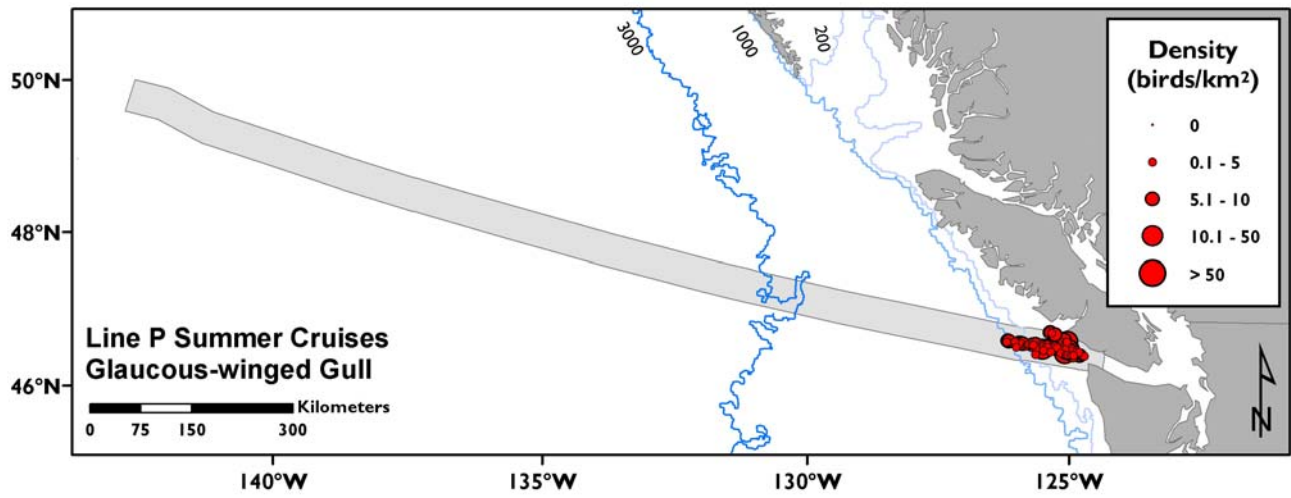
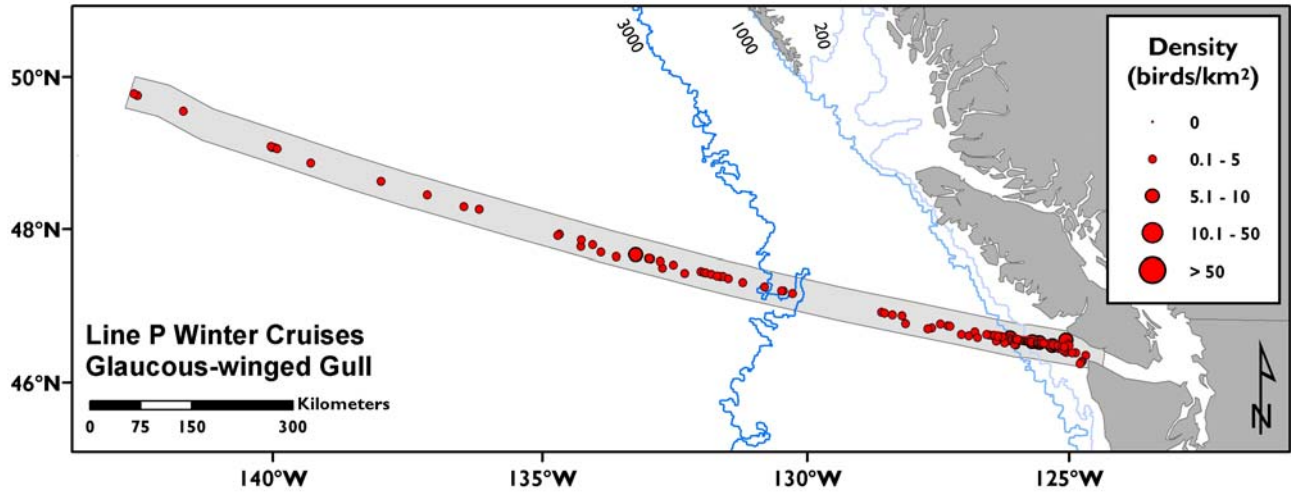
# Glaucous-winged Gull

*Larus glaucescens*



Glaucous-winged Gulls (GWGU) and Western Gulls (WEGU) hybridize in Washington and Oregon. During the winter, GWGU disperse from the continental shelf to deeper waters in the Line P study area. In summer, however, they showed a distinctly coastal distribution. GWGU forage on fish, marine invertebrates, human refuse, and carrion (Verbeek 1993).





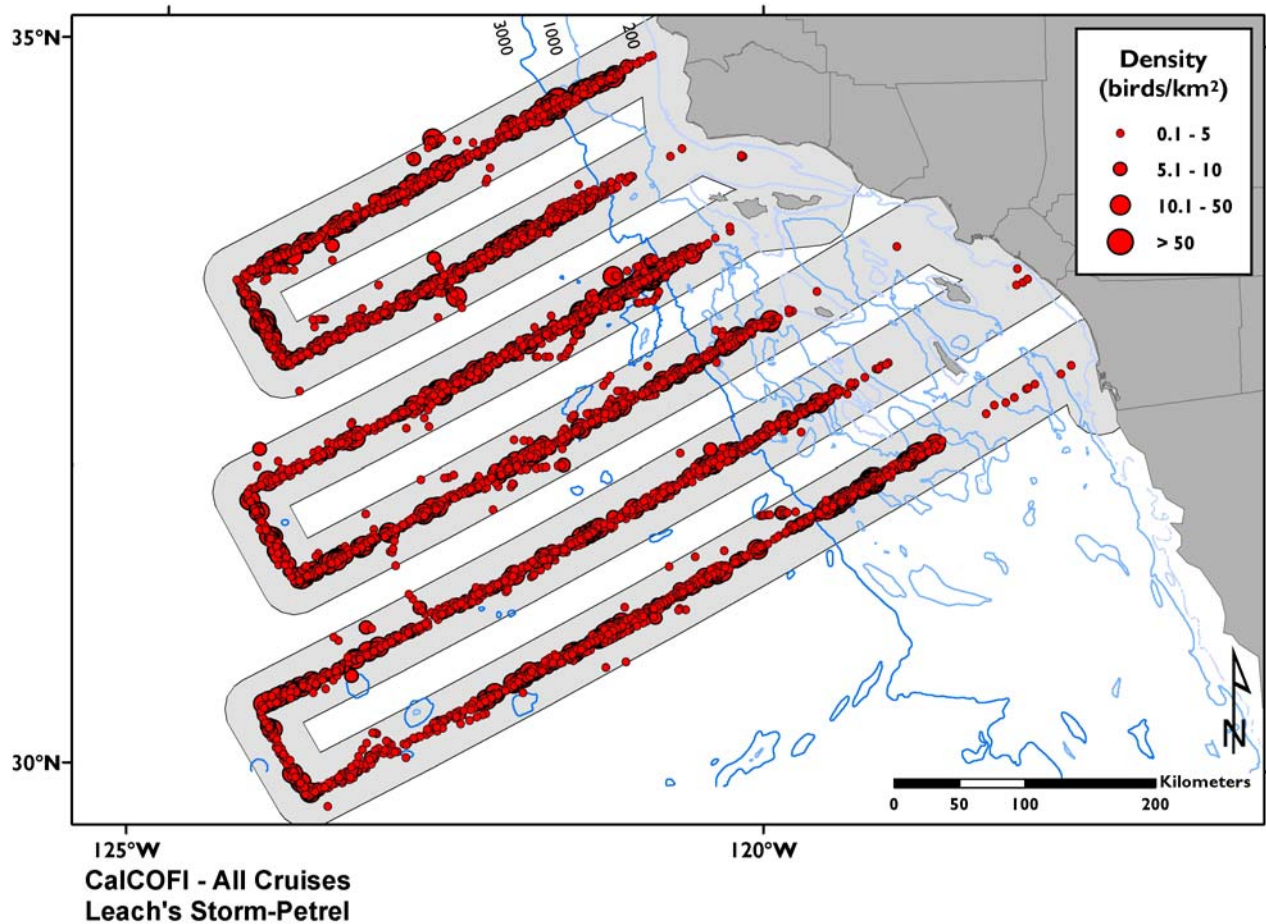


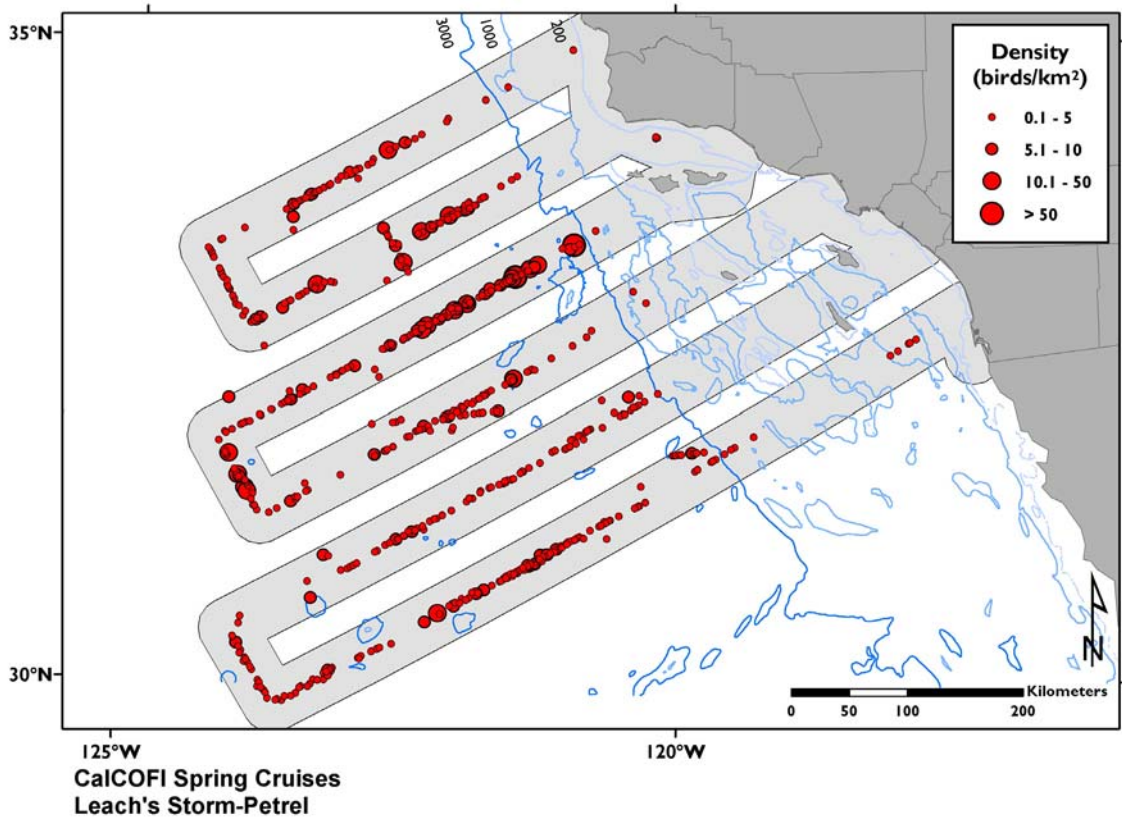
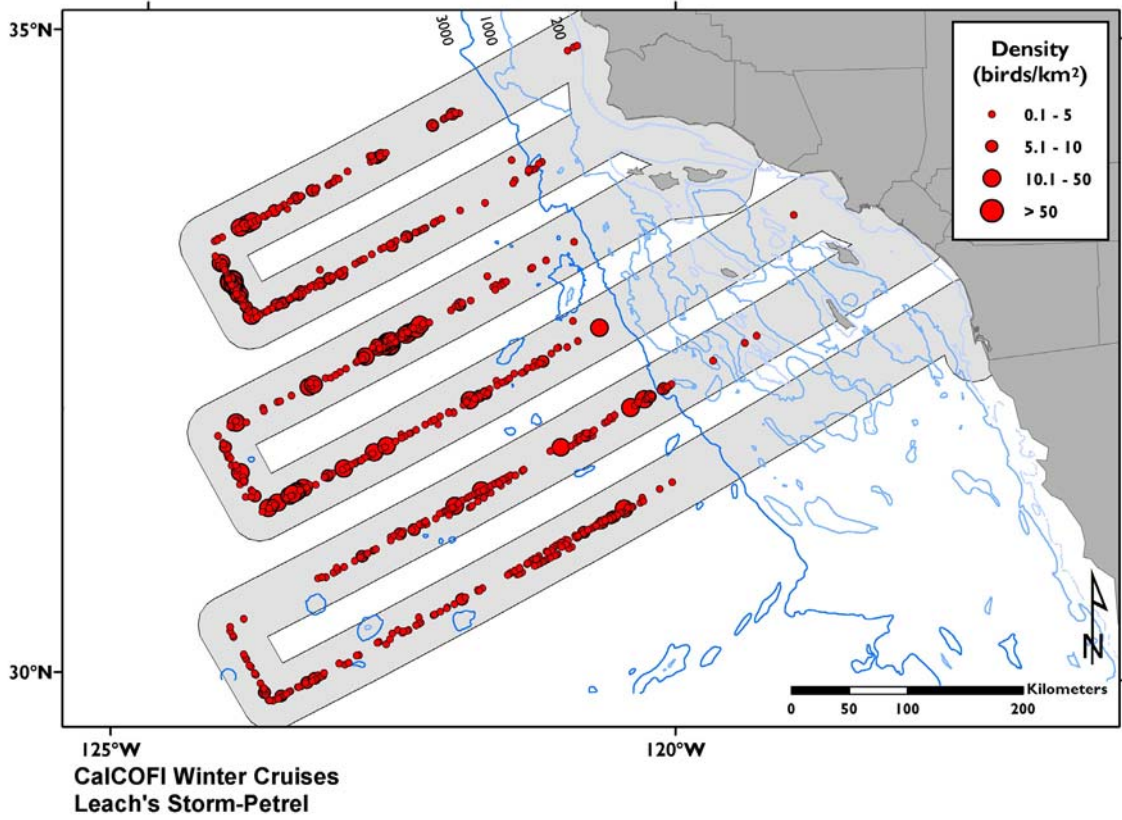
## Leach's Storm-Petrel

*Oceanodroma leucorhoa*

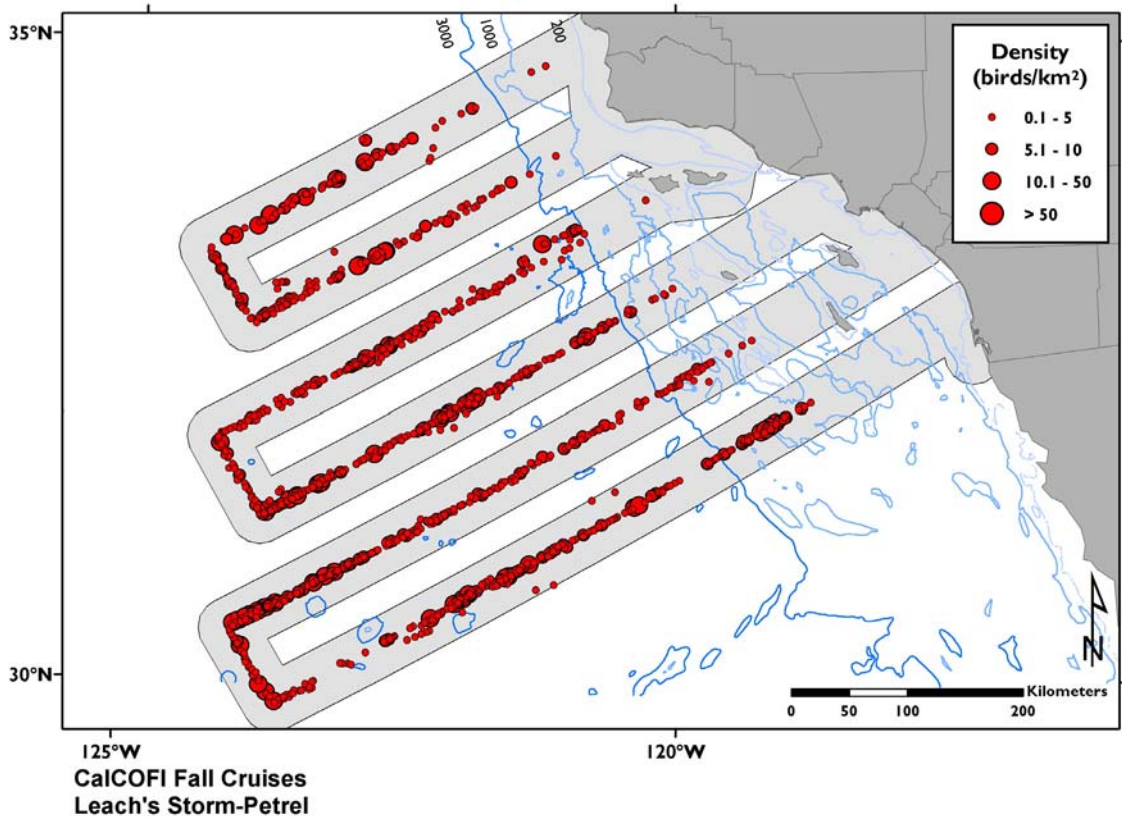
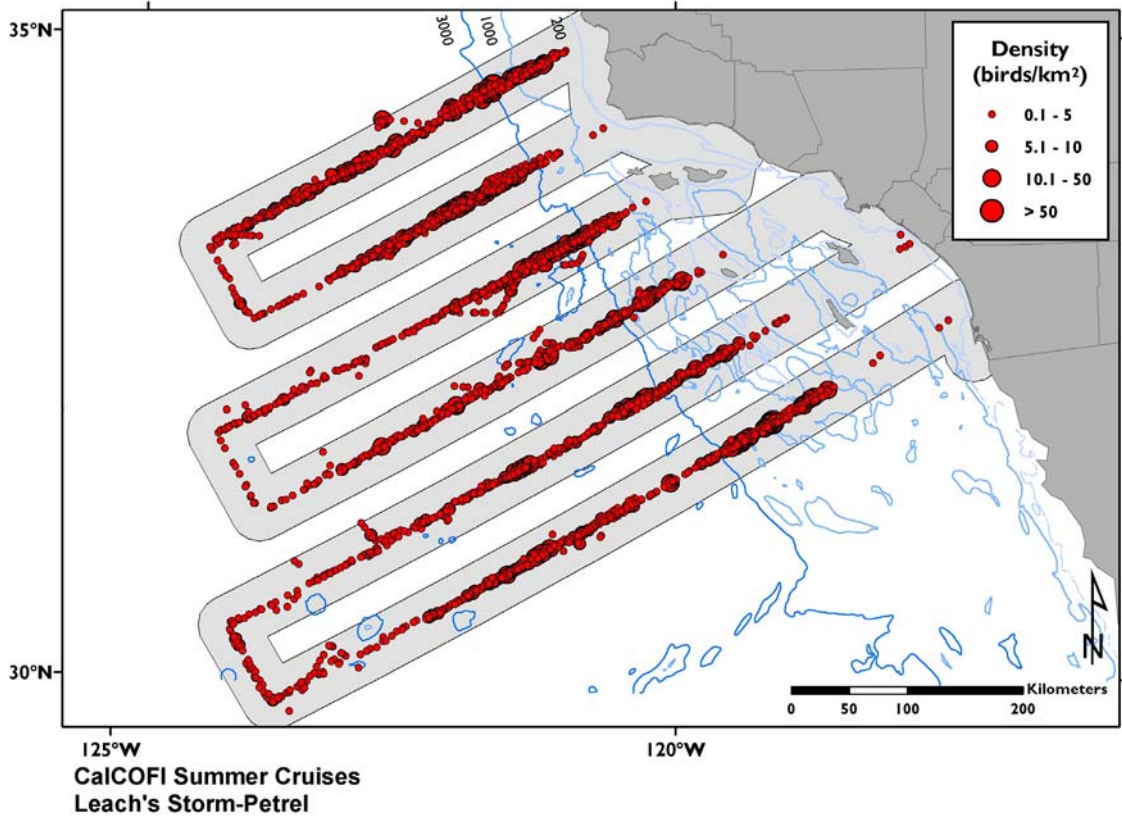


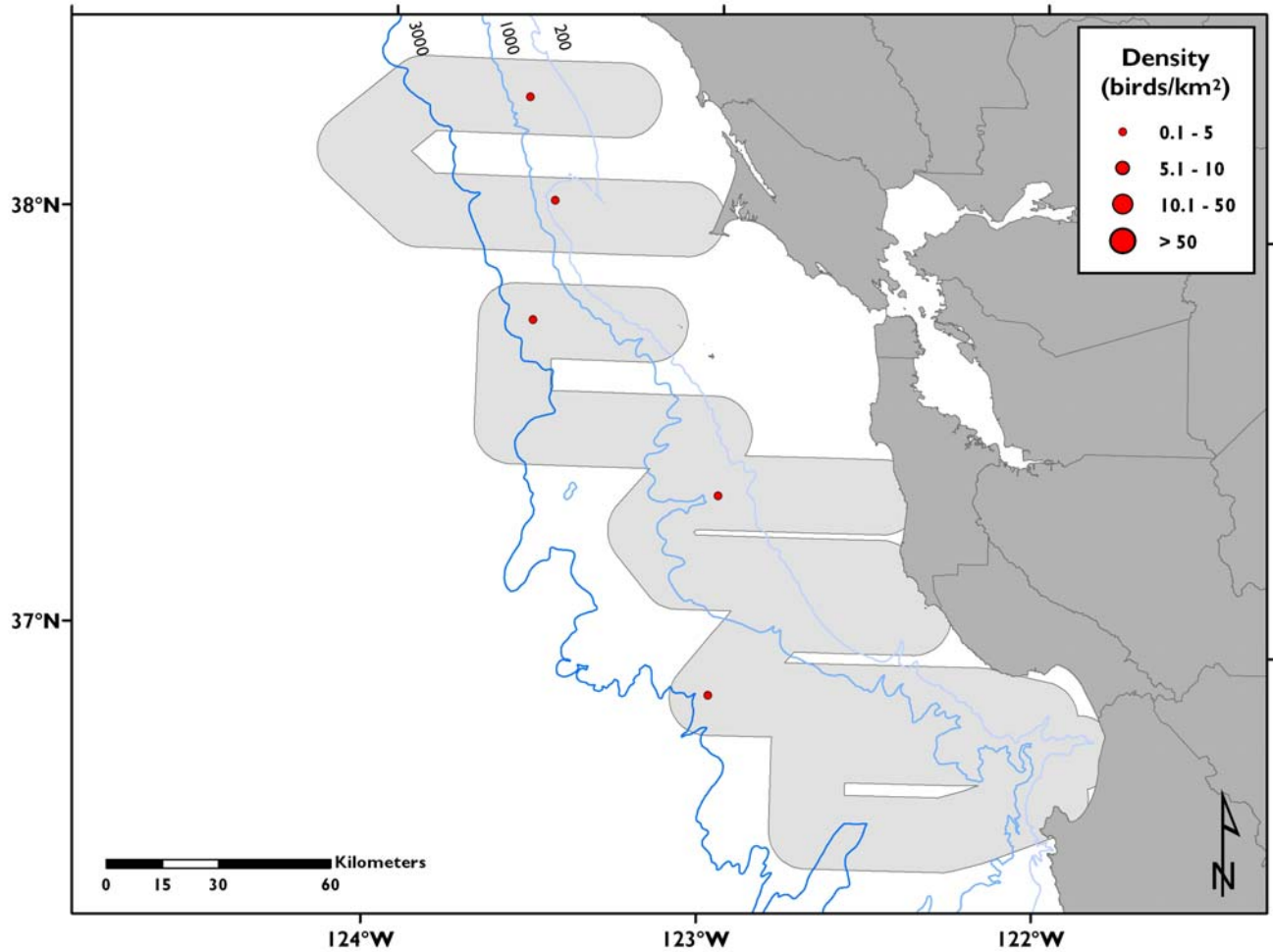
Leach's Storm-Petrel (LHSP) is the most widespread procellariiform in the Northern Hemisphere (Huntington et al. 1996). Although distributions are chiefly pelagic, congregations of this species may be found at fronts and eddies related to upwelling. Distributions of LHSP in the CalCOFI area showed birds over the slope in summer, but the highest densities occurred over pelagic waters. LHSP observed in the Line P area occurred almost exclusively over depths greater than 1000 m in summer and fall (with highest densities on the slope). The species was virtually absent from the Line P area in winter. LHSP feed on zooplankton and micronekton.



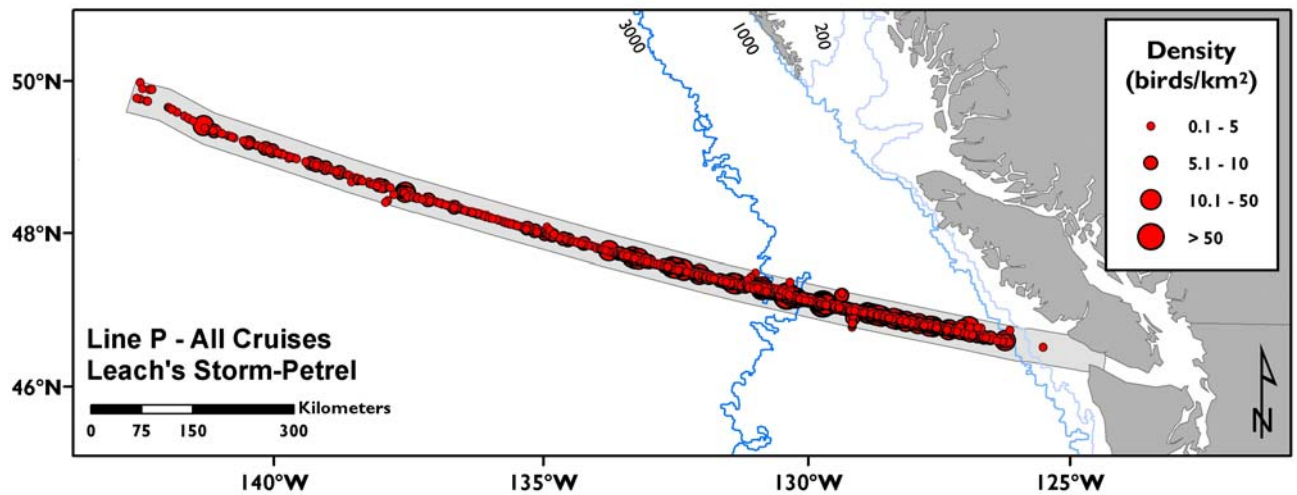




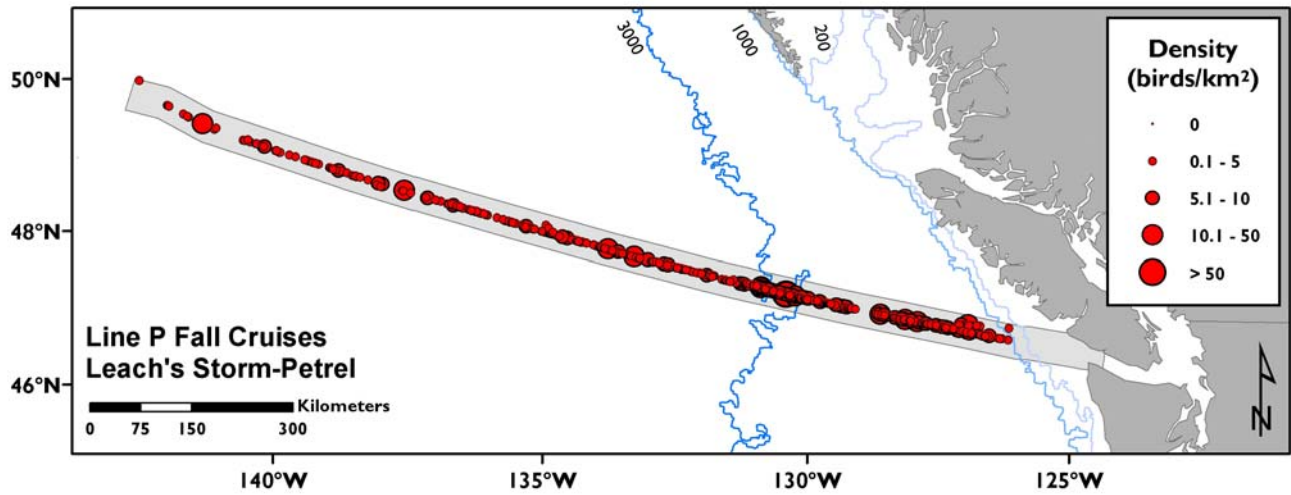
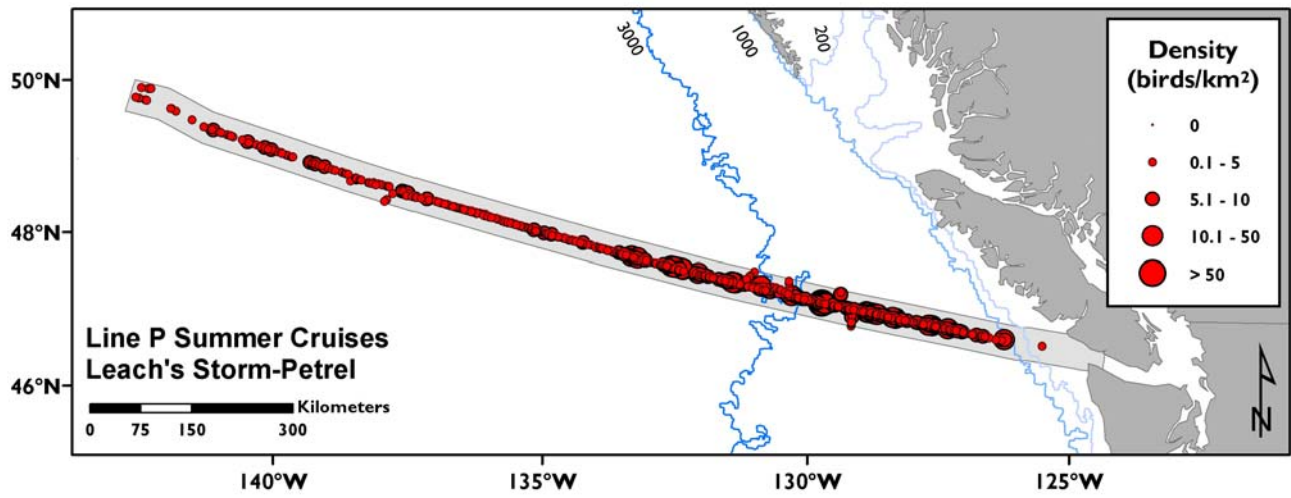
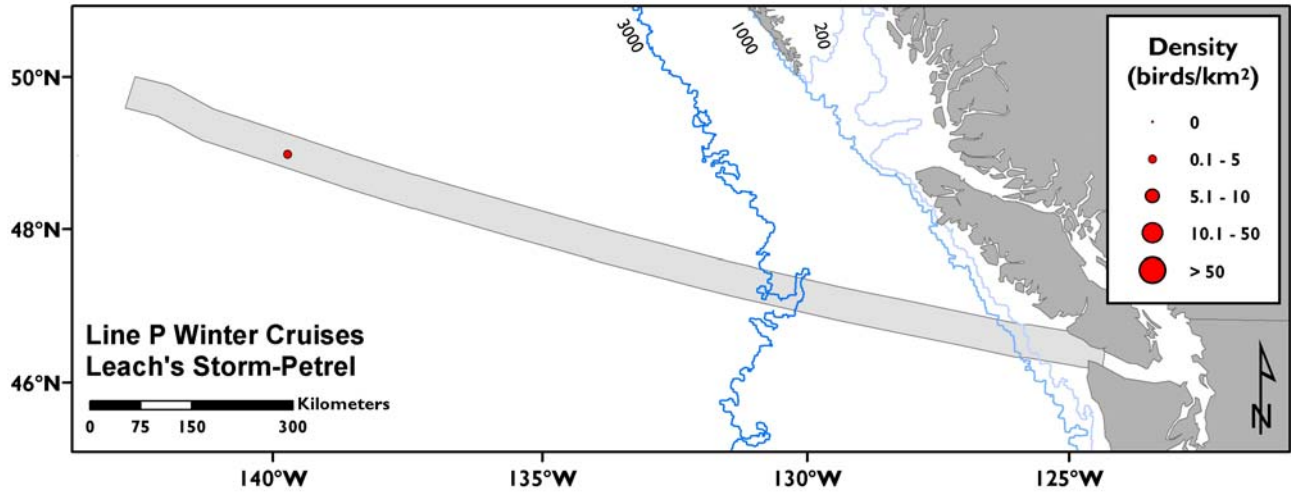




NMFS - All Cruises  
Leach's Storm-Petrel



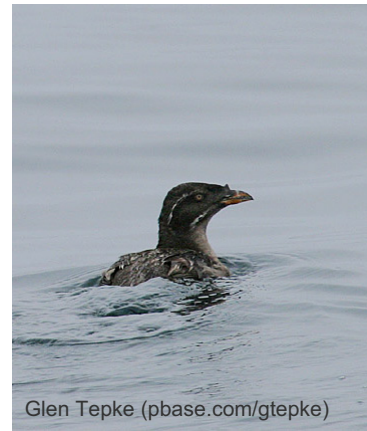
Line P - All Cruises  
Leach's Storm-Petrel



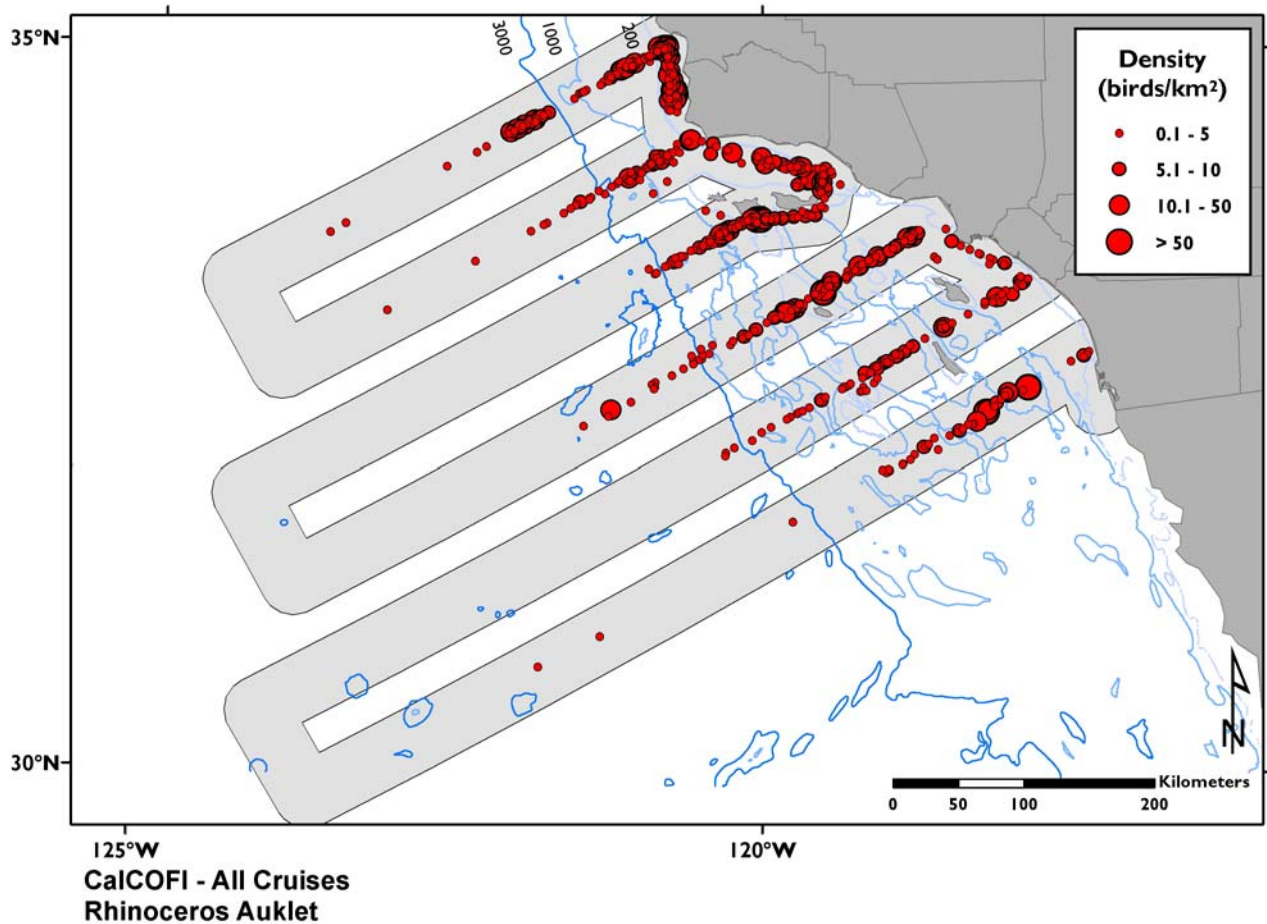


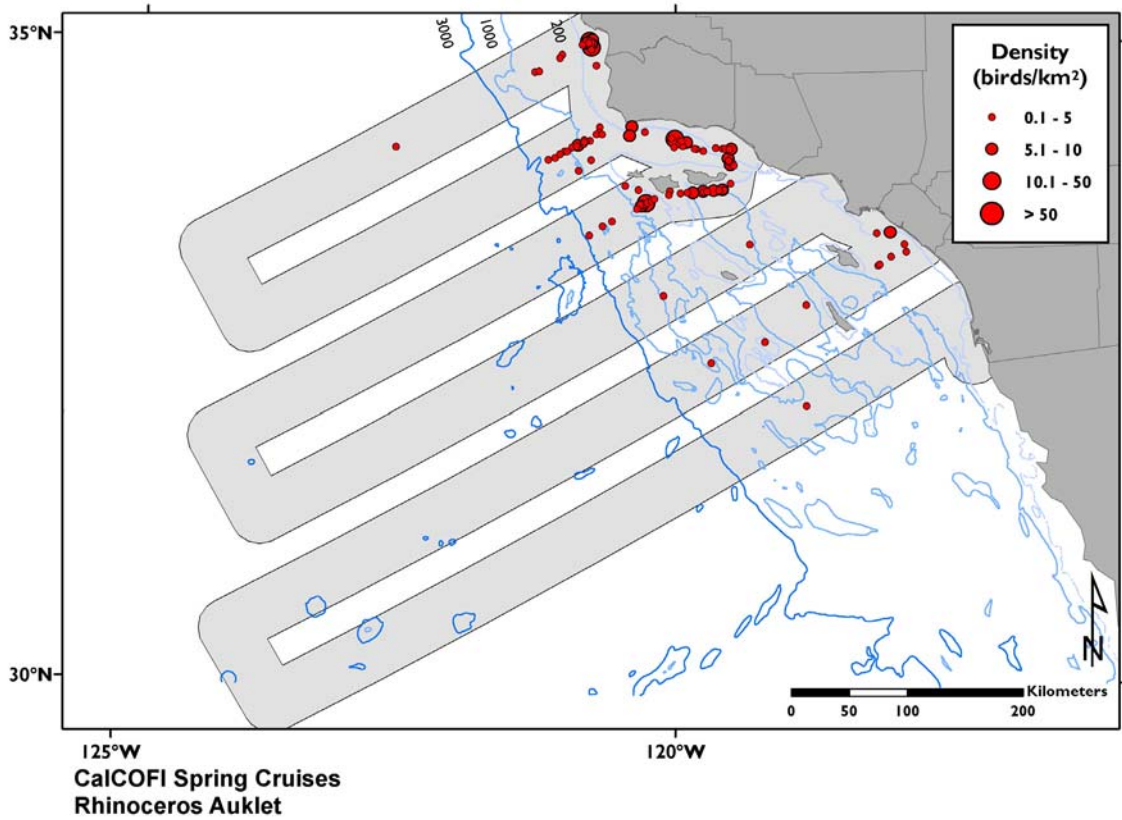
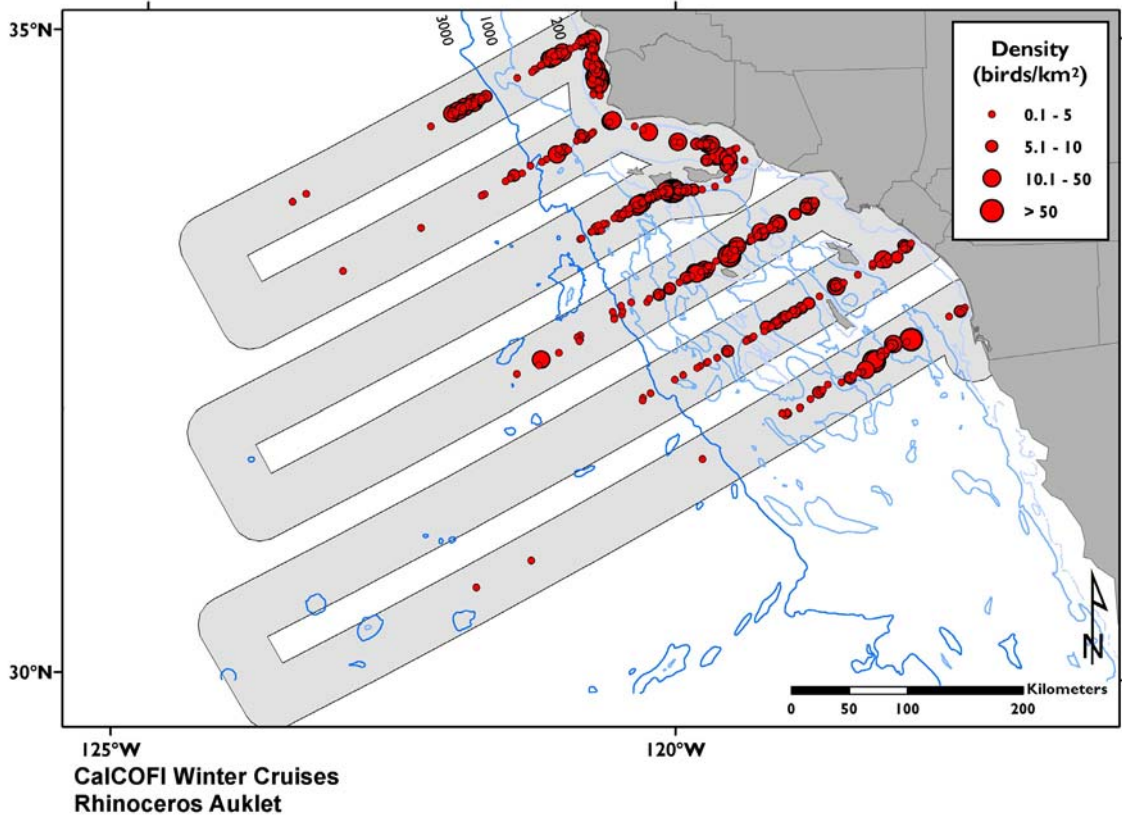
# Rhinoceros Auklet

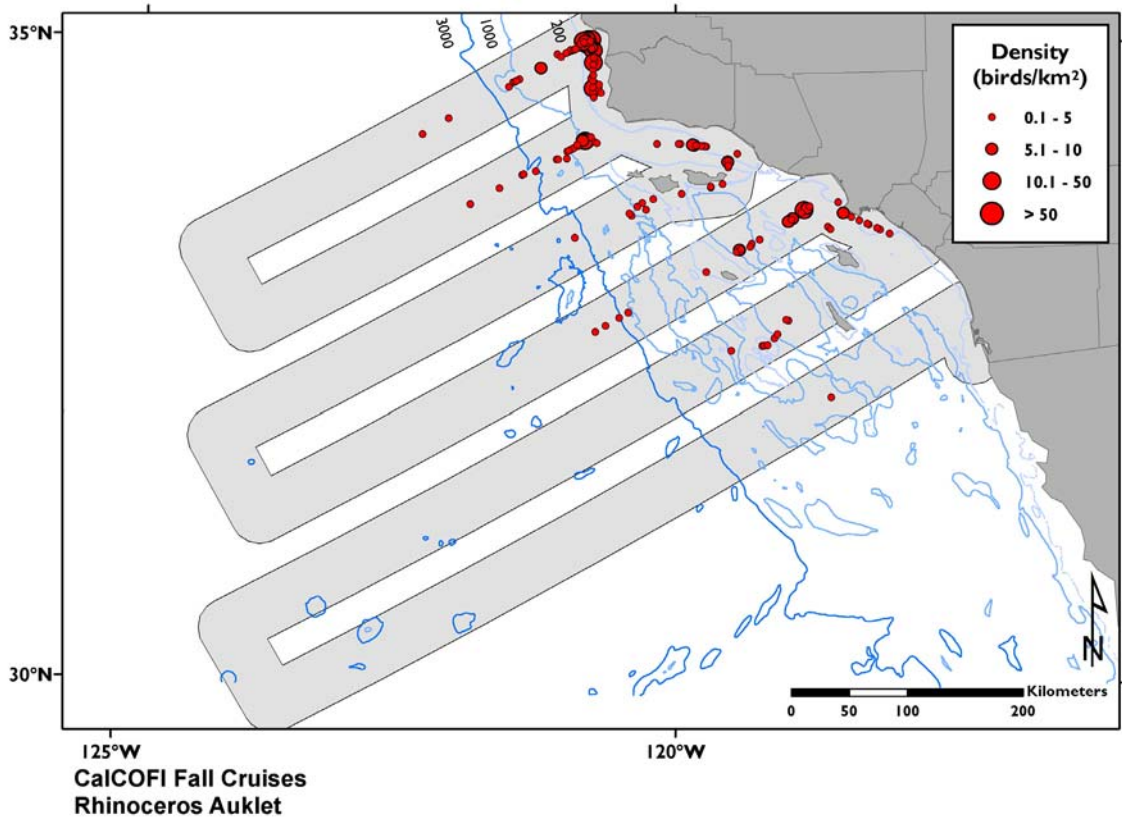
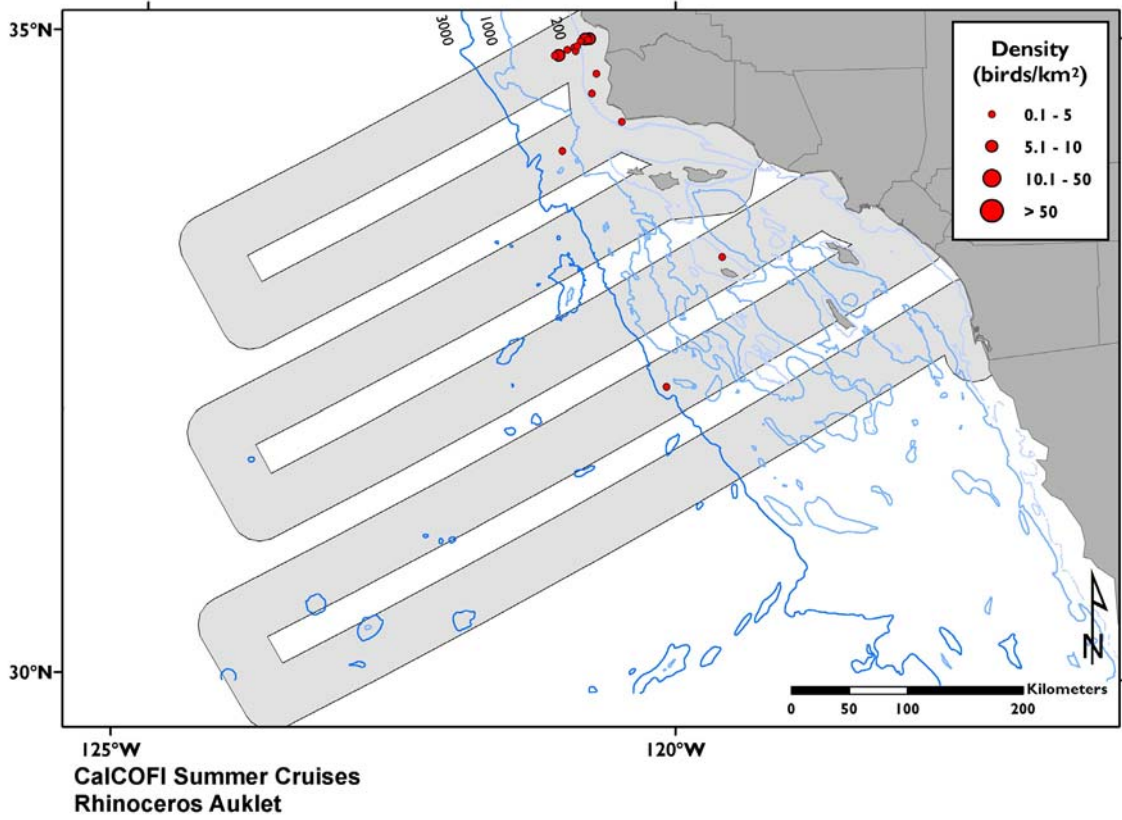
*Cerorhinca monocerata*

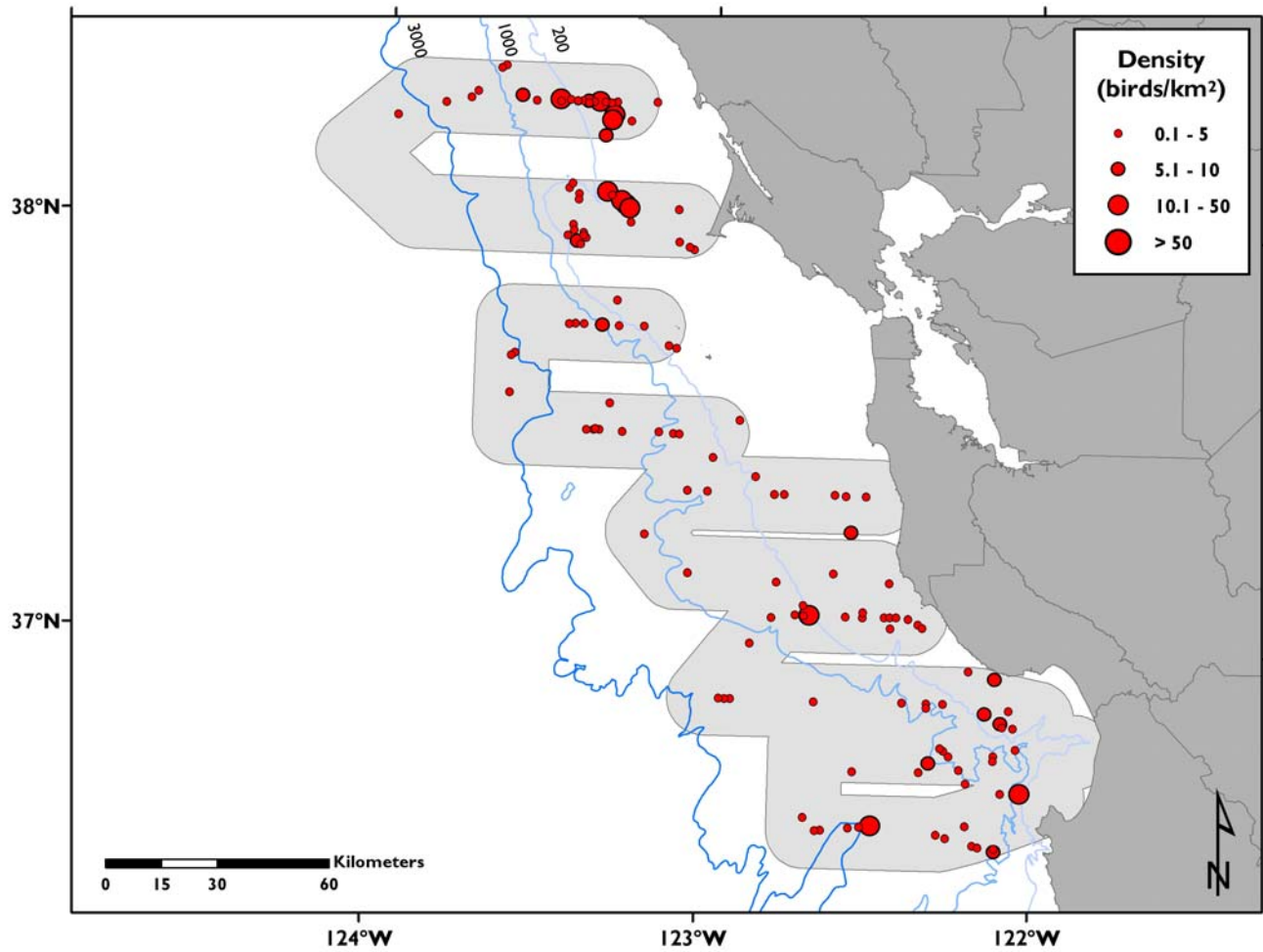


Rhinoceros Auklets (RHAU) were most numerous and extended further south in the CalCOFI study area during winter. In the NMFS study area, spring distributions were variable and did not show a clear pattern. Highest densities of RHAU in both the NMFS and CalCOFI areas occurred over the continental shelf. This contrasts with the findings of Briggs et al. (1987) who stated that RHAU were “commonest in waters seaward of the shelf-break,” but supports Morgan et al. (1991) who found that RHAU tended to concentrate over the shelf and shelf-break off of western Canada. Diet consists primarily of fish though RHAU also consumes euphausiids and squid (Gaston and Dechesne 1996).

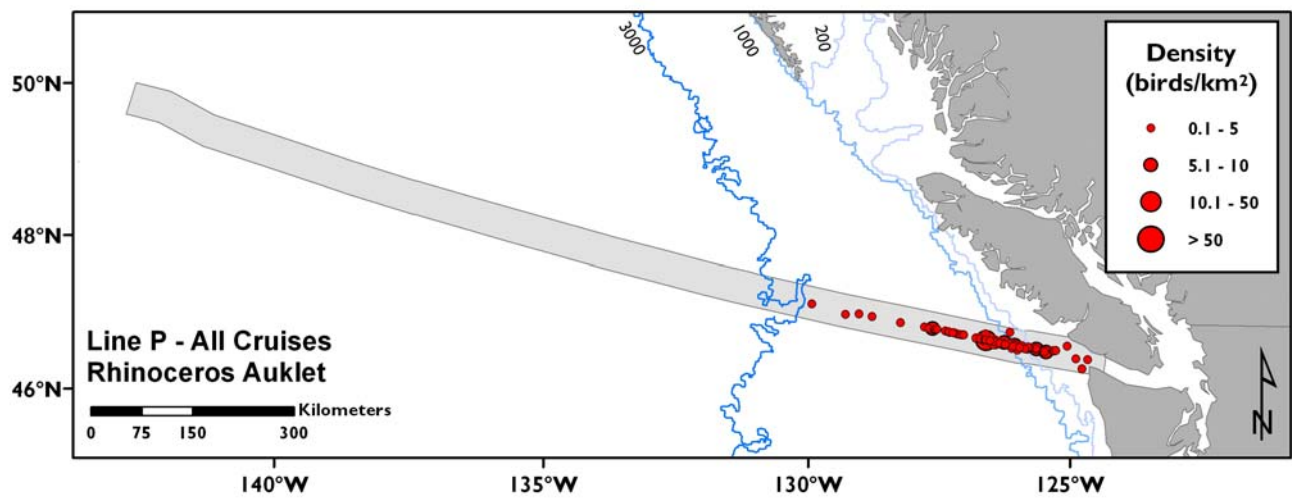






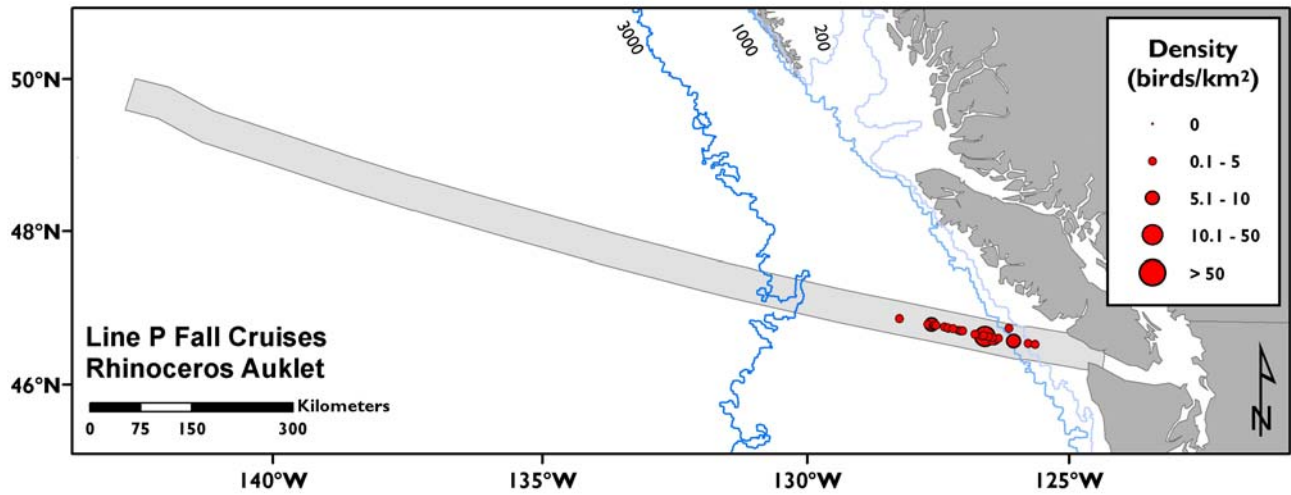
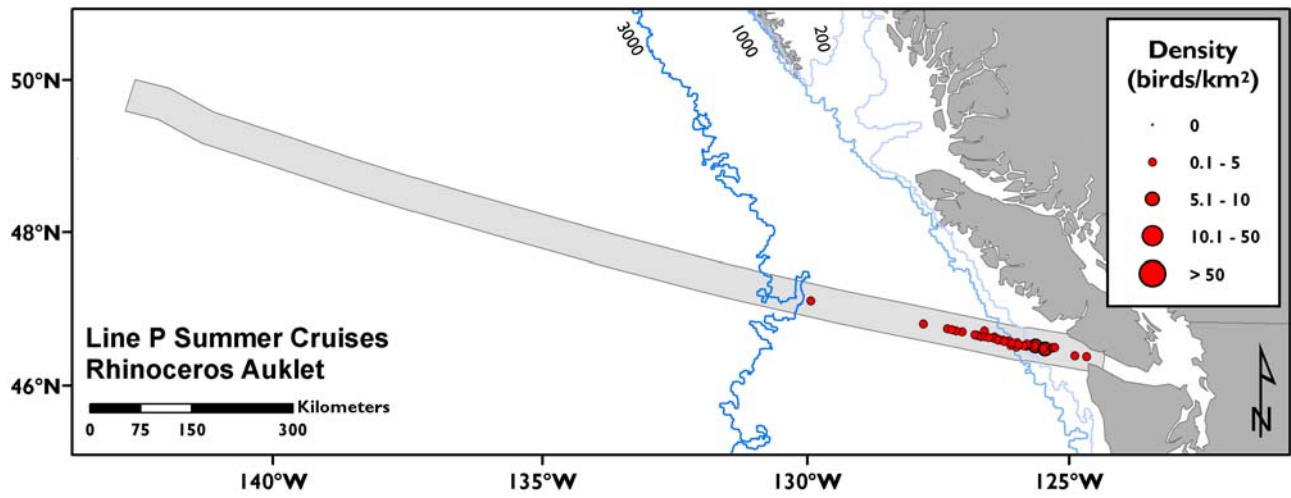
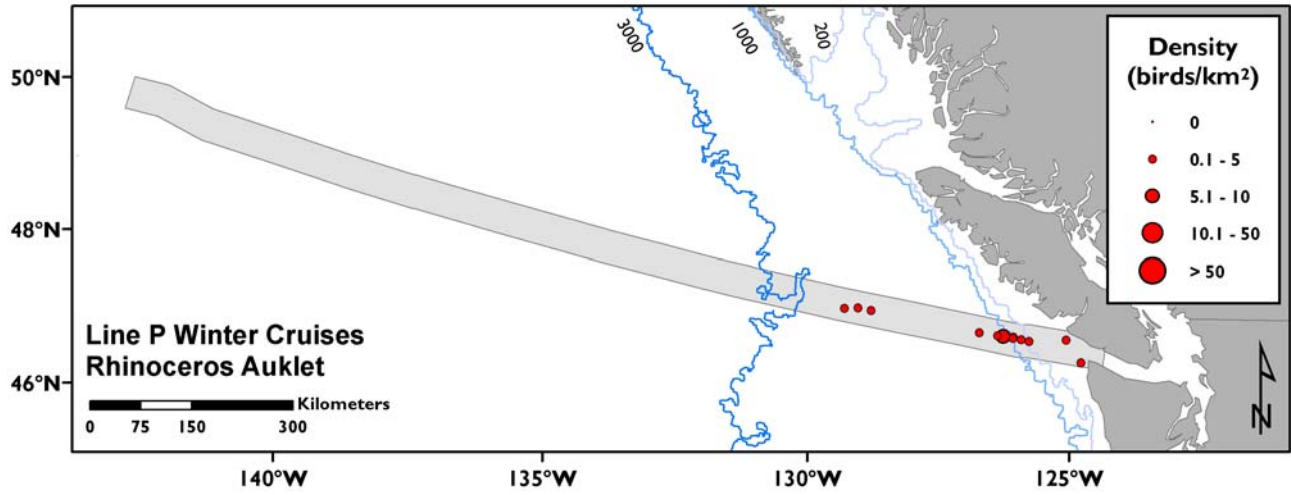


NMFS - All Cruises  
Rhinoceros Auklet



Line P - All Cruises  
Rhinoceros Auklet





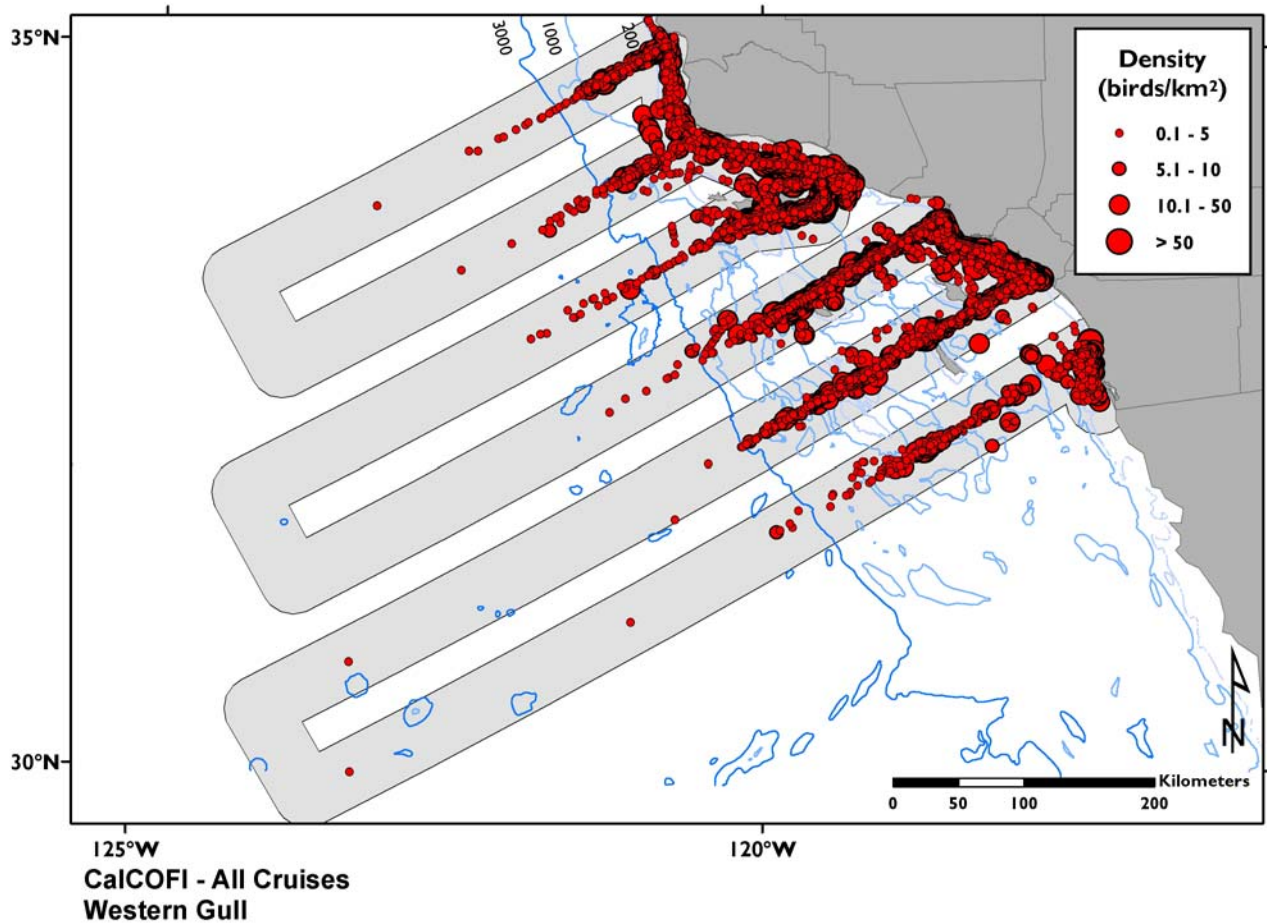


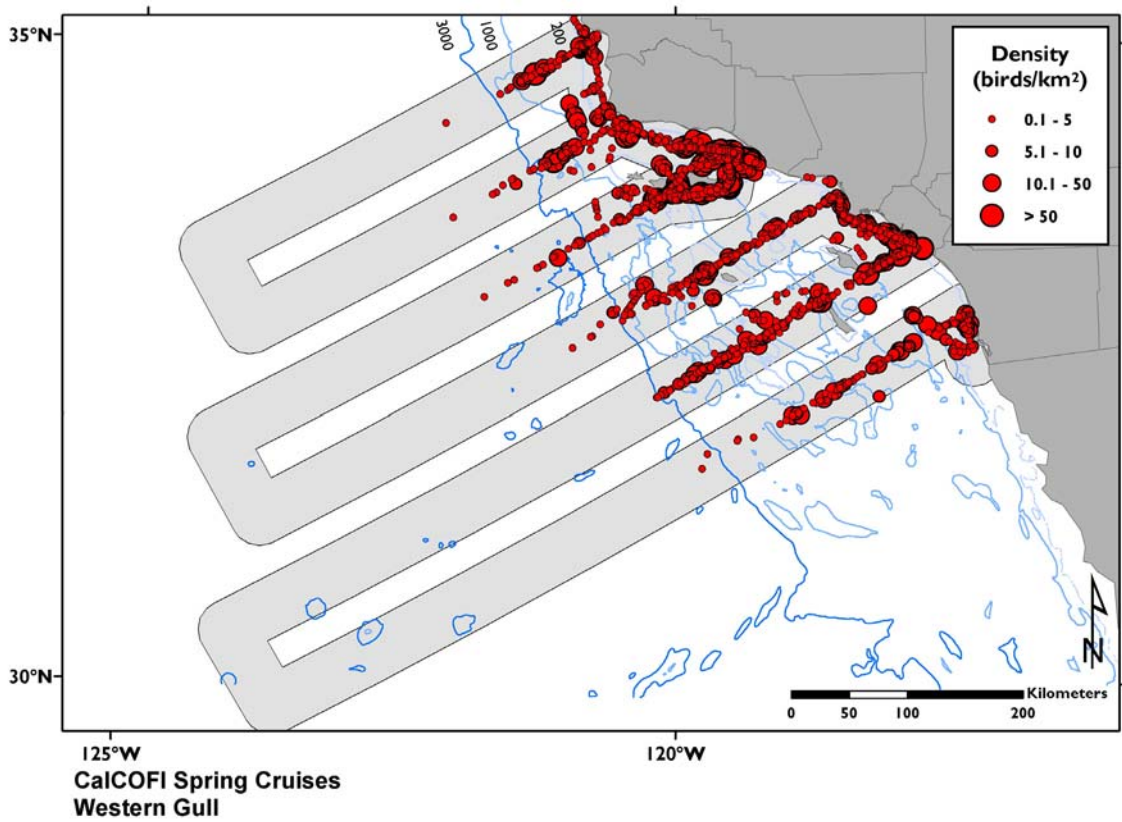
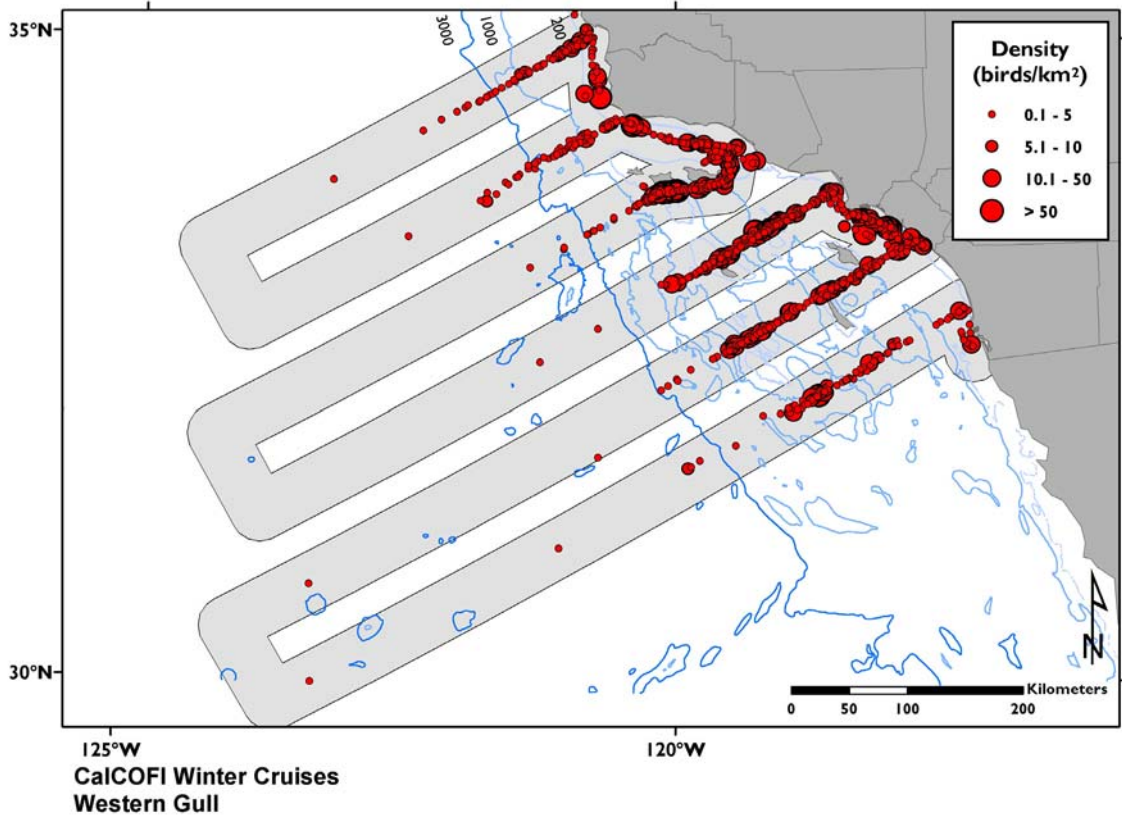
# Western Gull

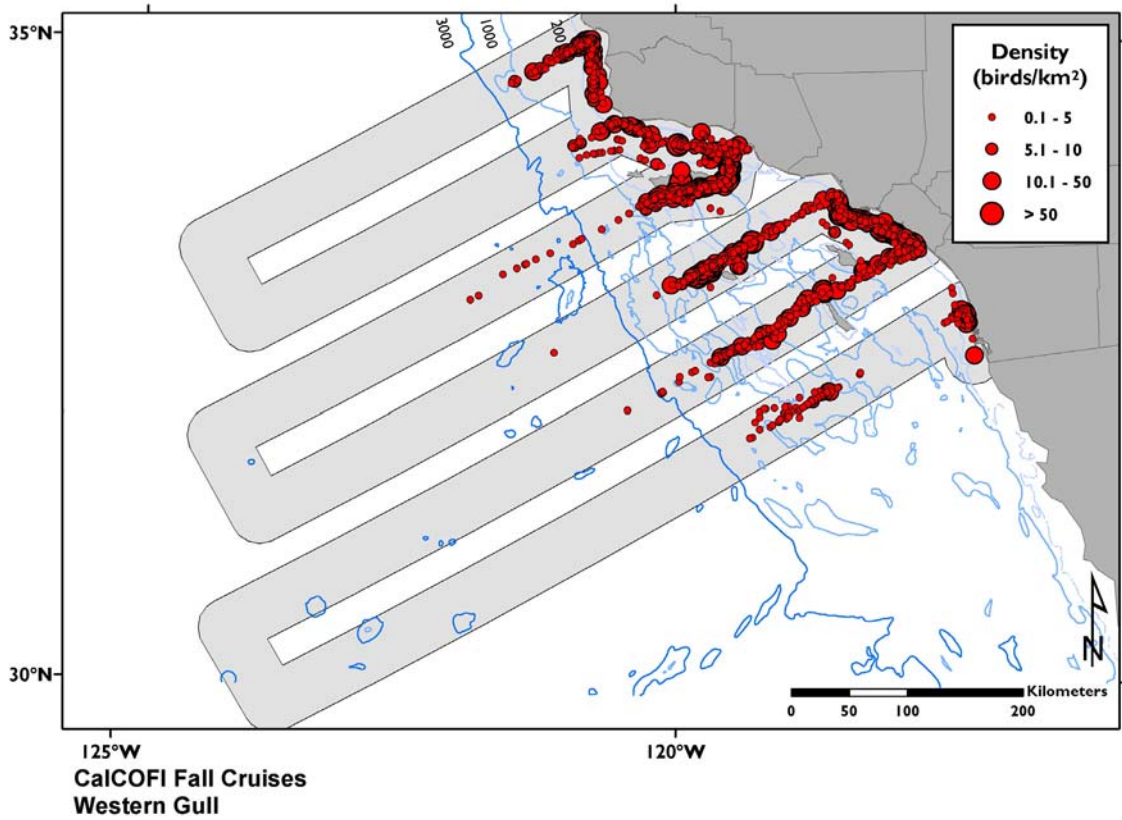
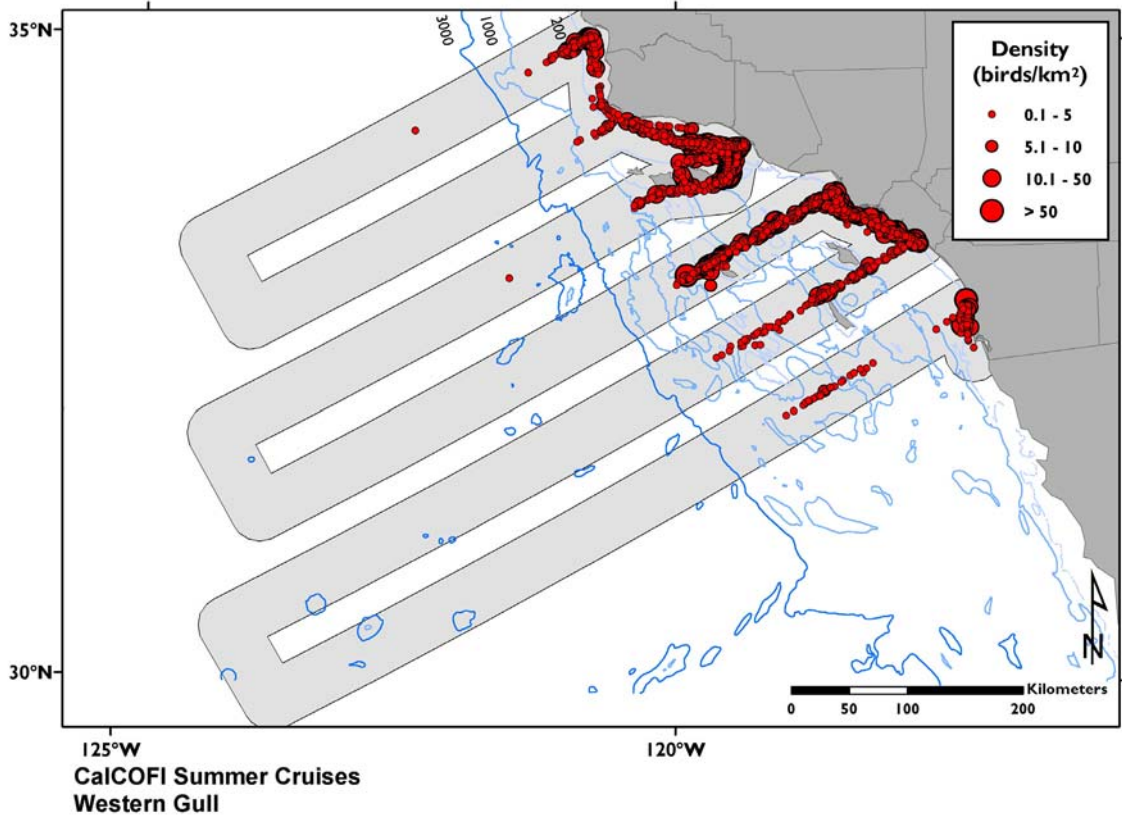
*Larus occidentalis*

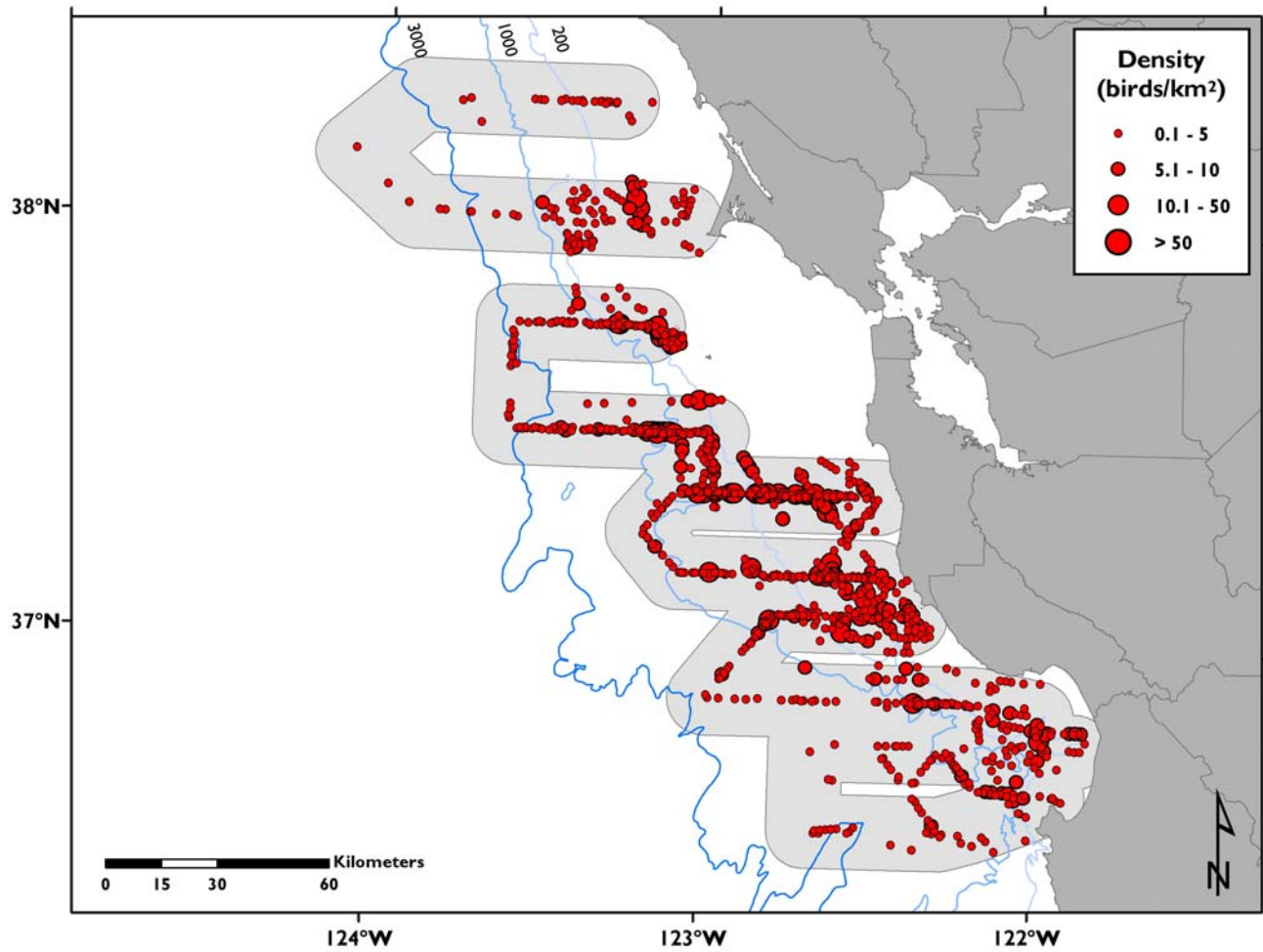


Western Gulls (WEGU) are endemic to the California Current System with the majority of the population concentrated in California (Kushlan 2002), and the largest single colony is located on Southeast Farallon Island. At sea, WEGU primarily feed on fish and marine invertebrates (Pierotti and Annett 1995). Highest densities of WEGU were concentrated over the continental shelf in both the NMFS and CalCOFI study areas; few were encountered over pelagic waters. Distribution of WEGU in the CalCOFI study area appeared to be coastal in summer with dispersal to deeper waters in winter. Notably, the average density of WEGU on the shelf in this area remained relatively constant throughout all seasons.

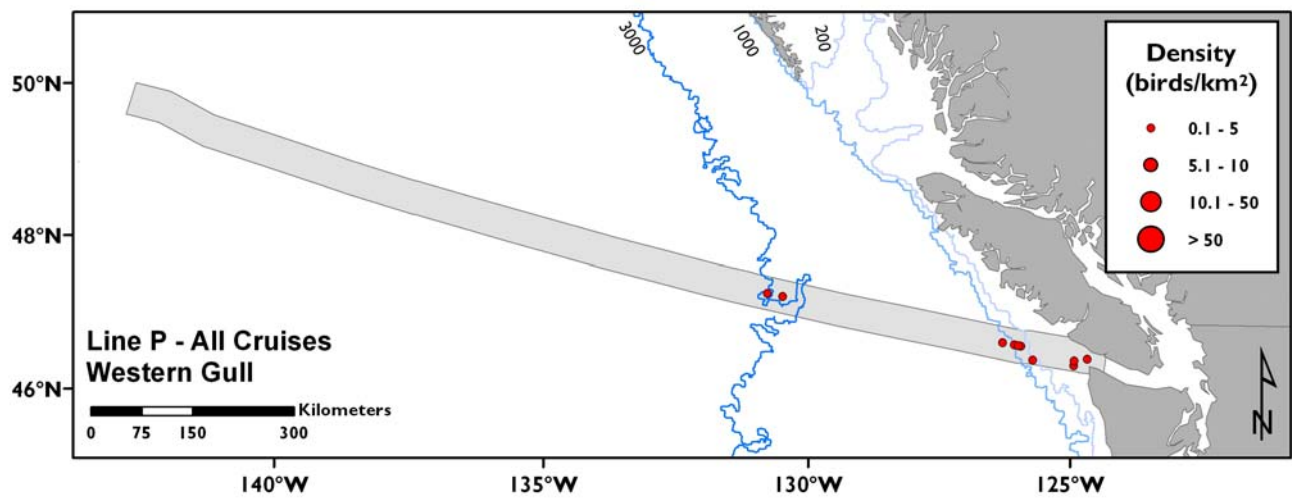




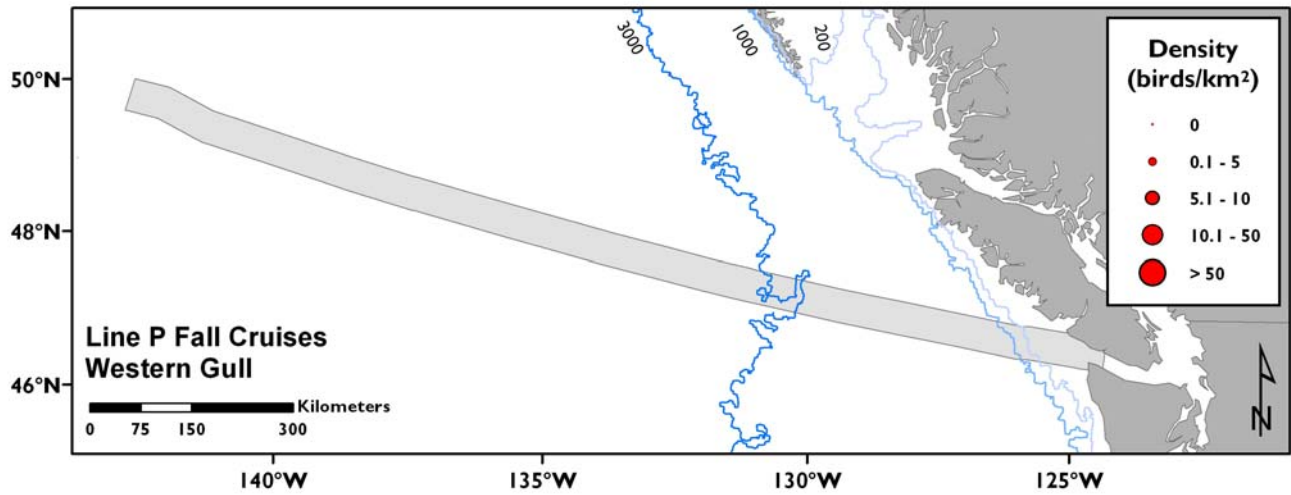
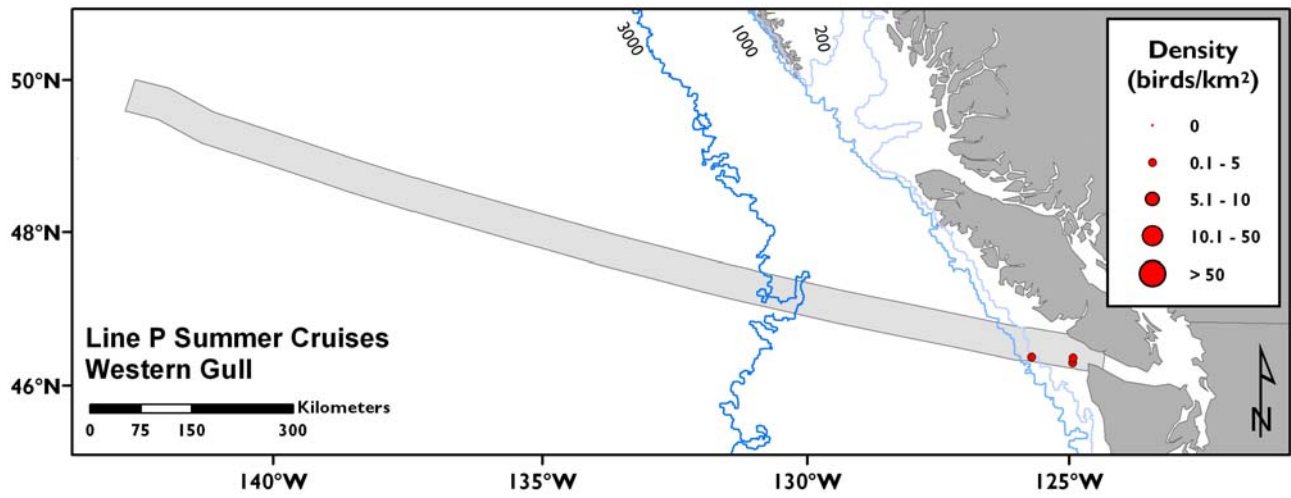
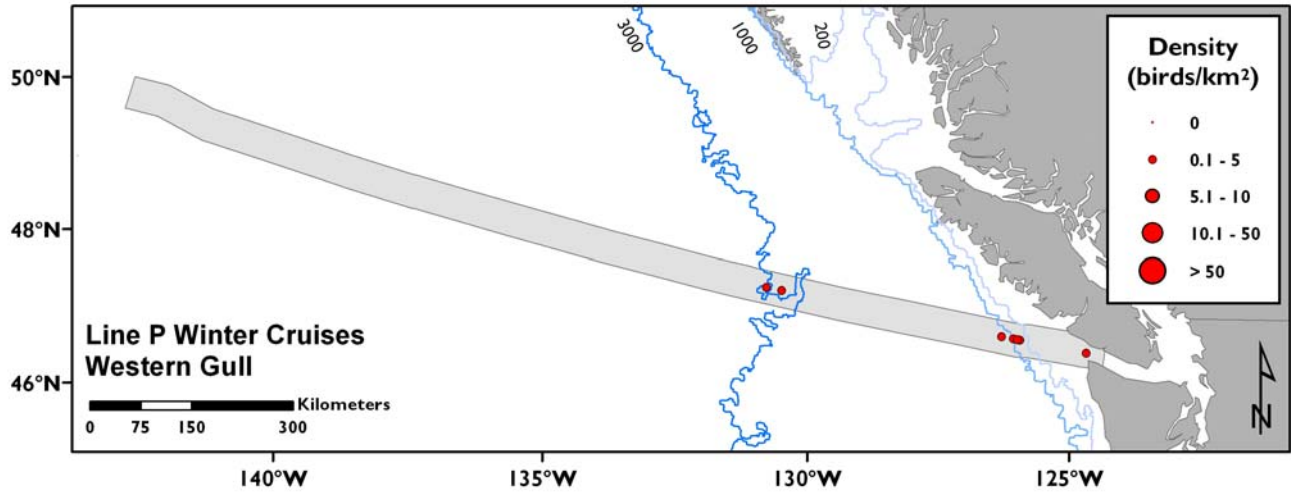




NMFS - All Cruises  
Western Gull



Line P - All Cruises  
Western Gull



# Migratory/Non-breeding Seabirds of the California Current System

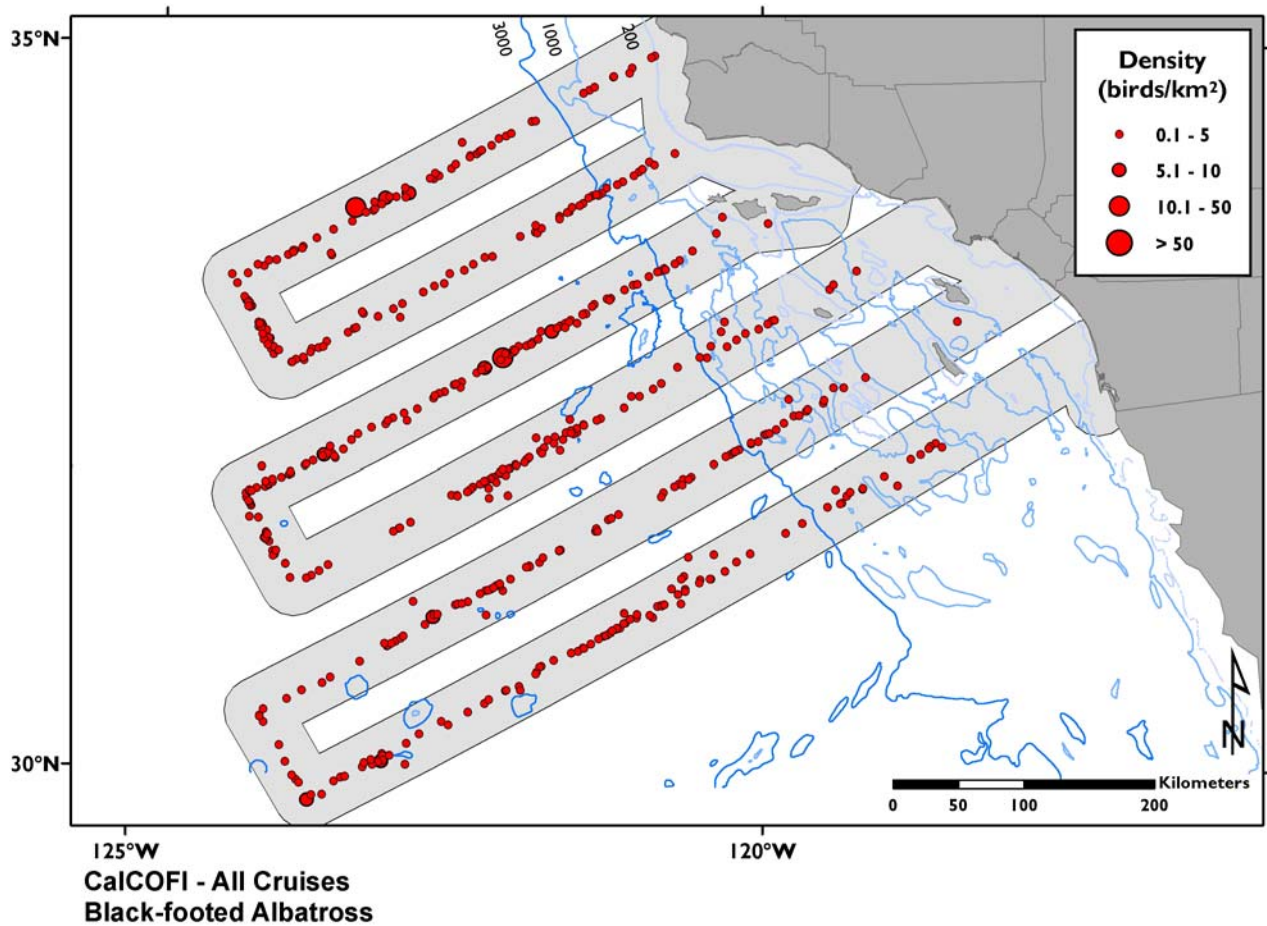


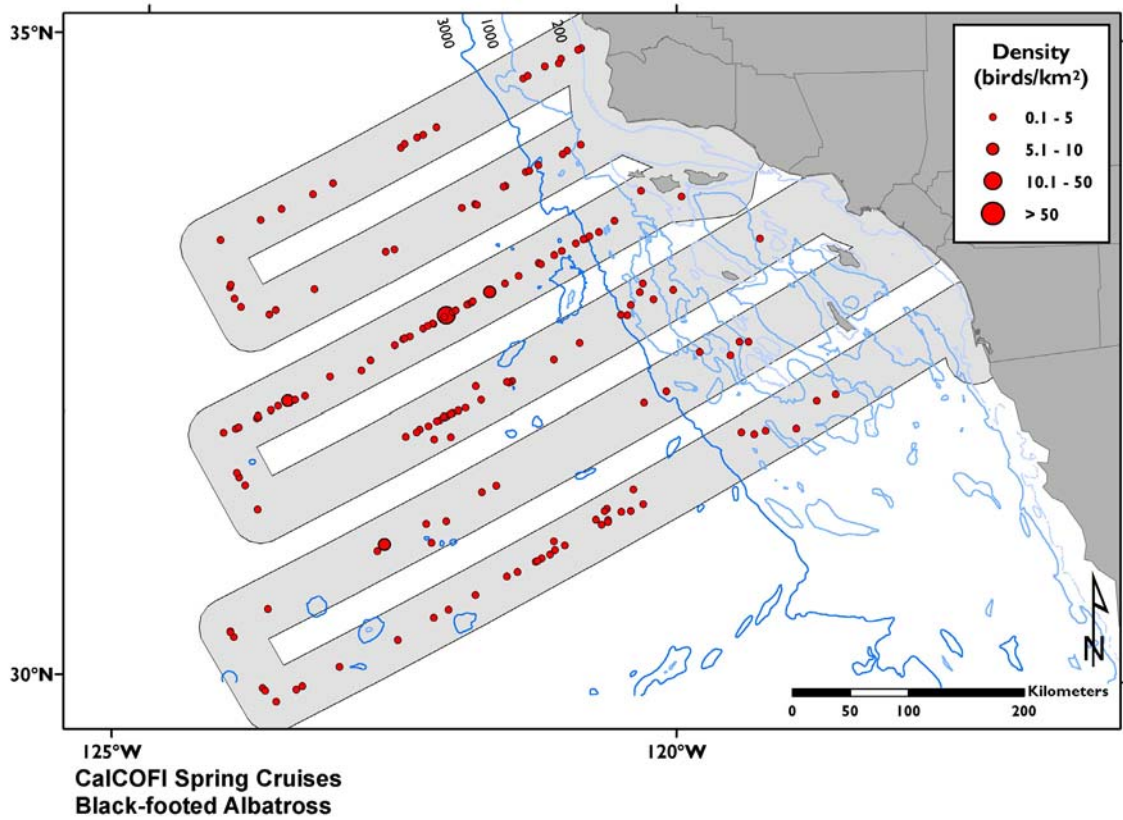
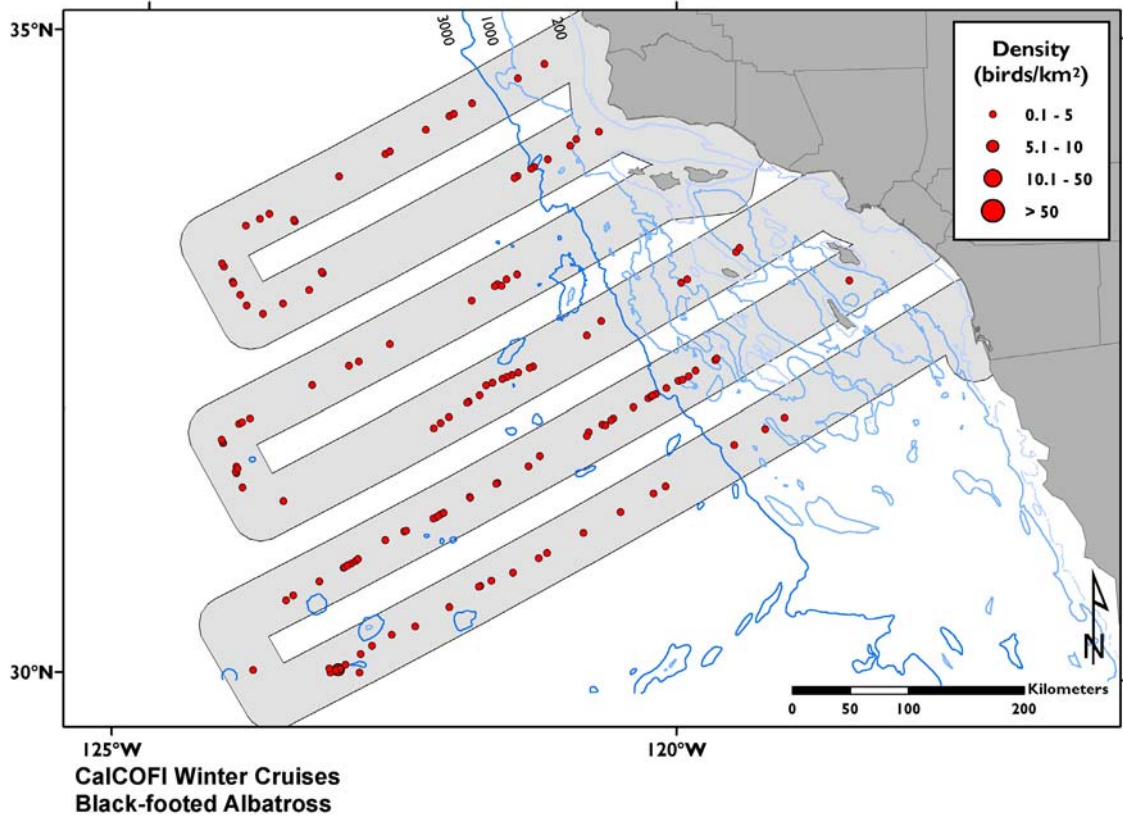
# Black-footed Albatross

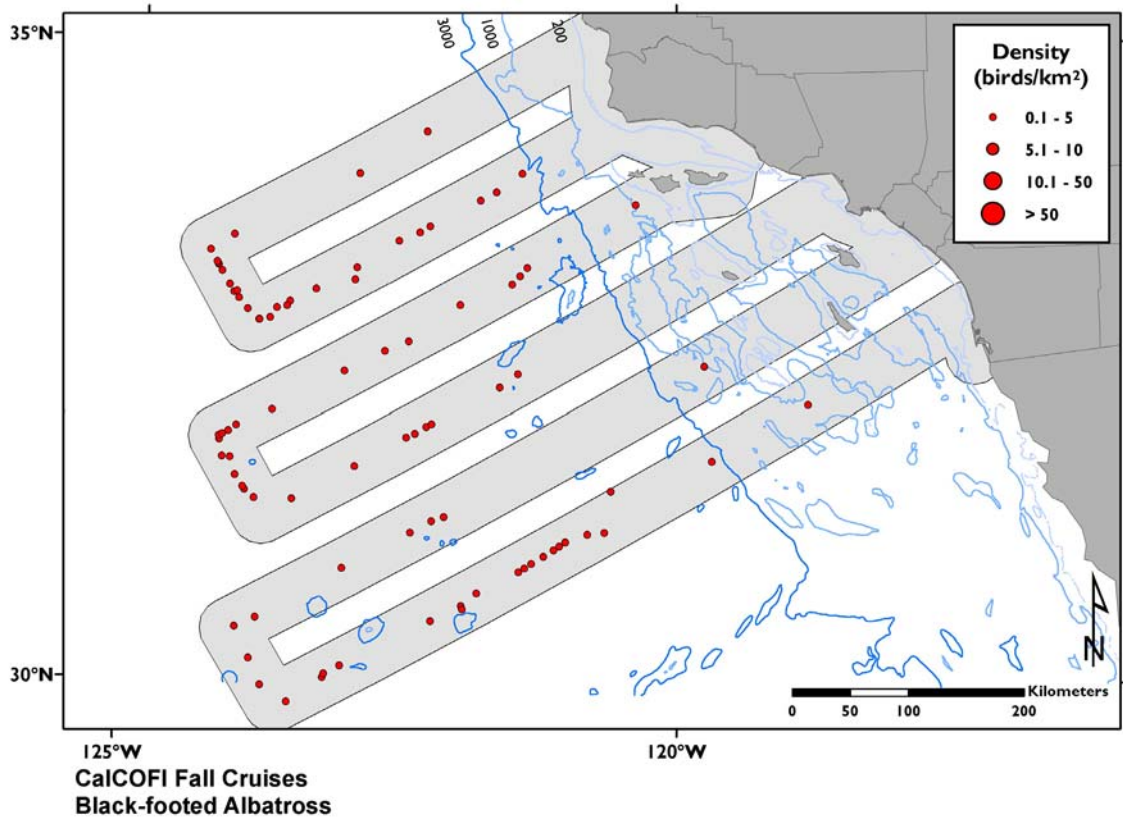
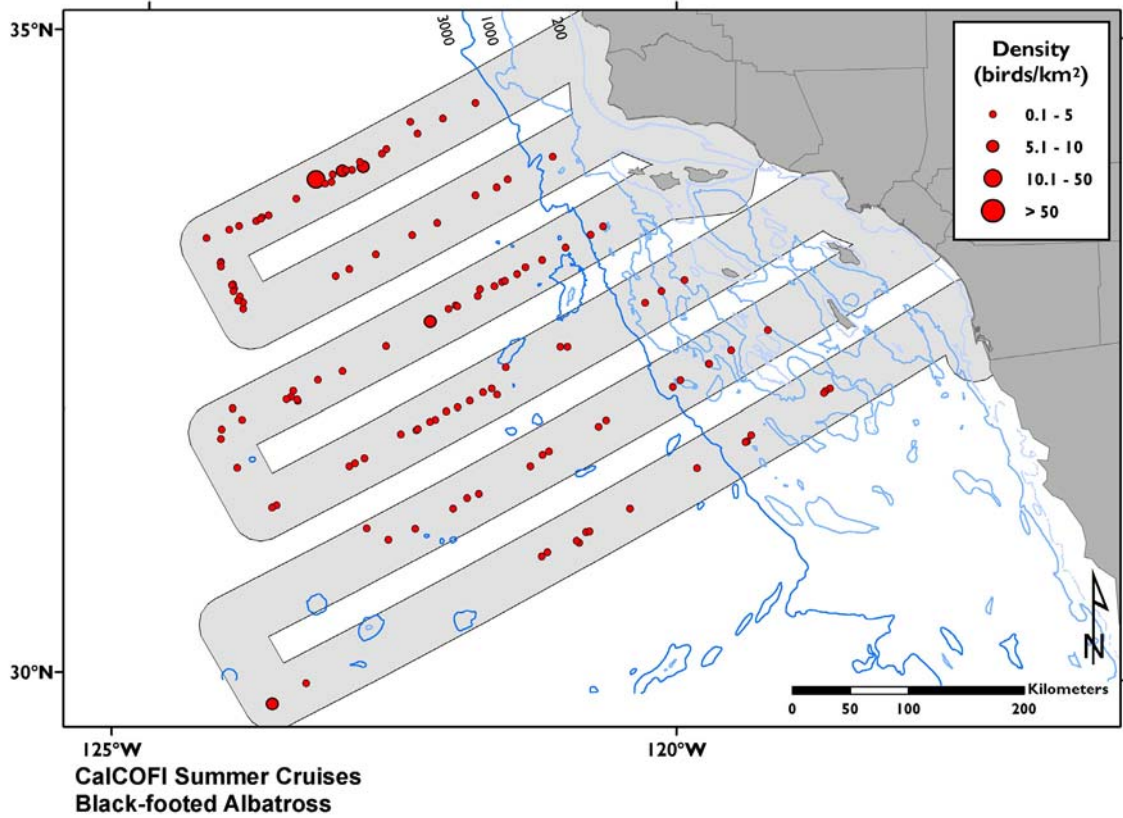
*Phoebastria nigripes*

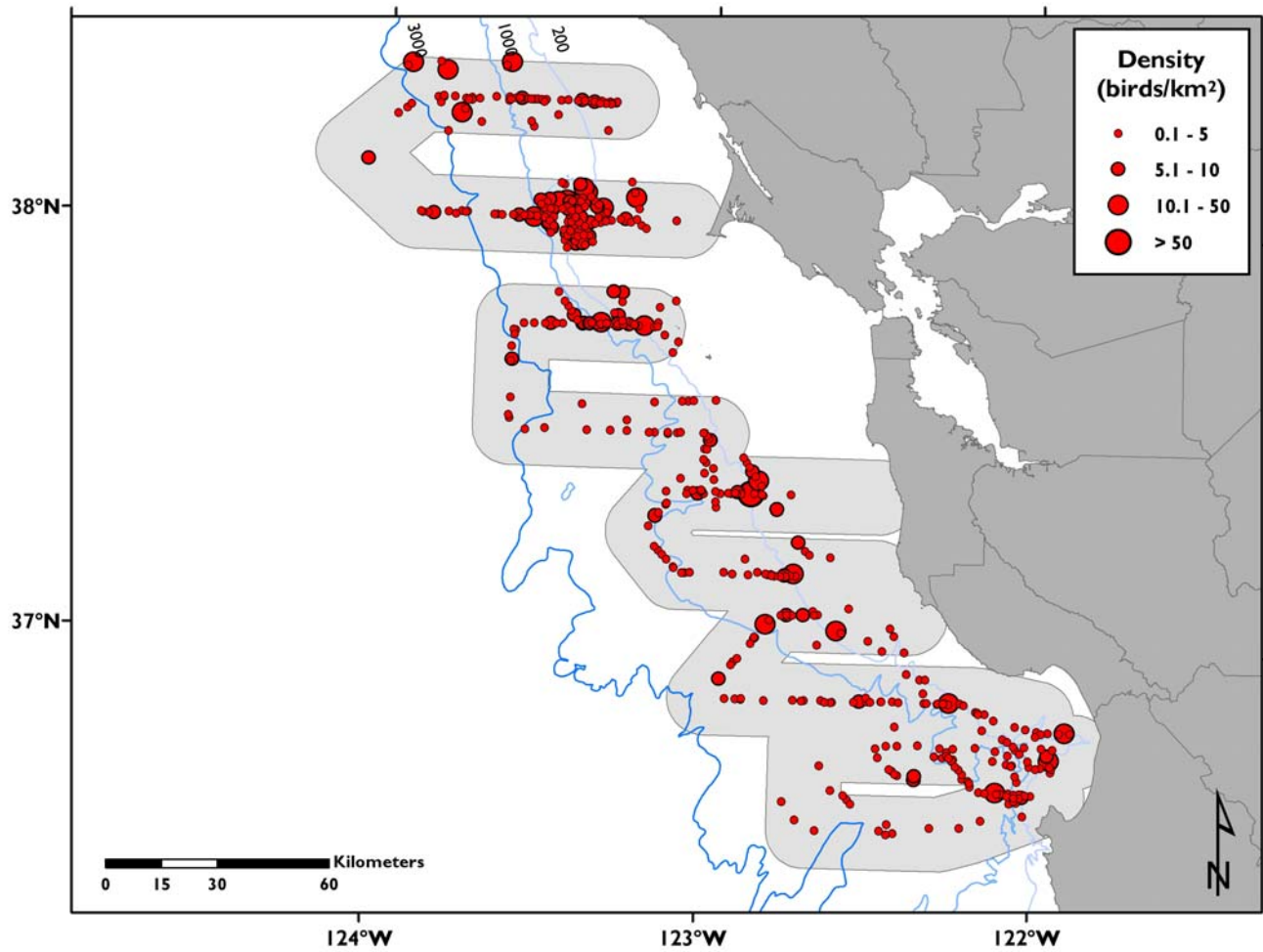


In the CalCOFI study, Black-footed Albatross (BFAL) occur in greater abundances at distances greater than 100 km from the mainland (Sanger 1974). Across survey areas, there were higher densities north of Point Conception in the NMFS and Line P areas. Line P and NMFS surveys showed the highest BFAL densities over the shelf-break and slope. During the breeding season, BFAL feed primarily on flying-fish eggs, squid, and crustaceans. This species attends fishing boats and feeds on bait and discards (Whittow 1993).

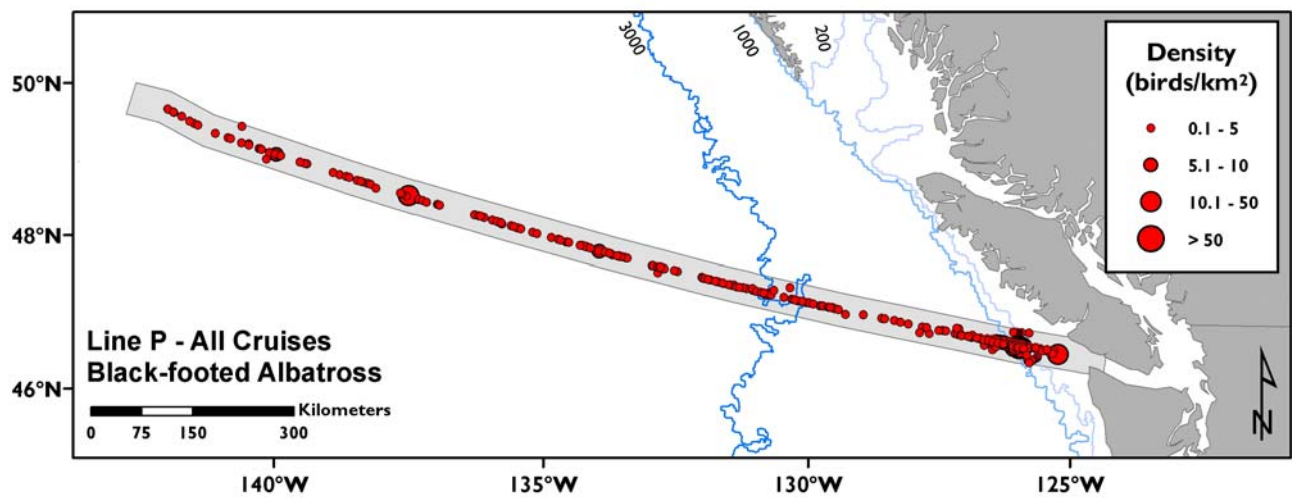




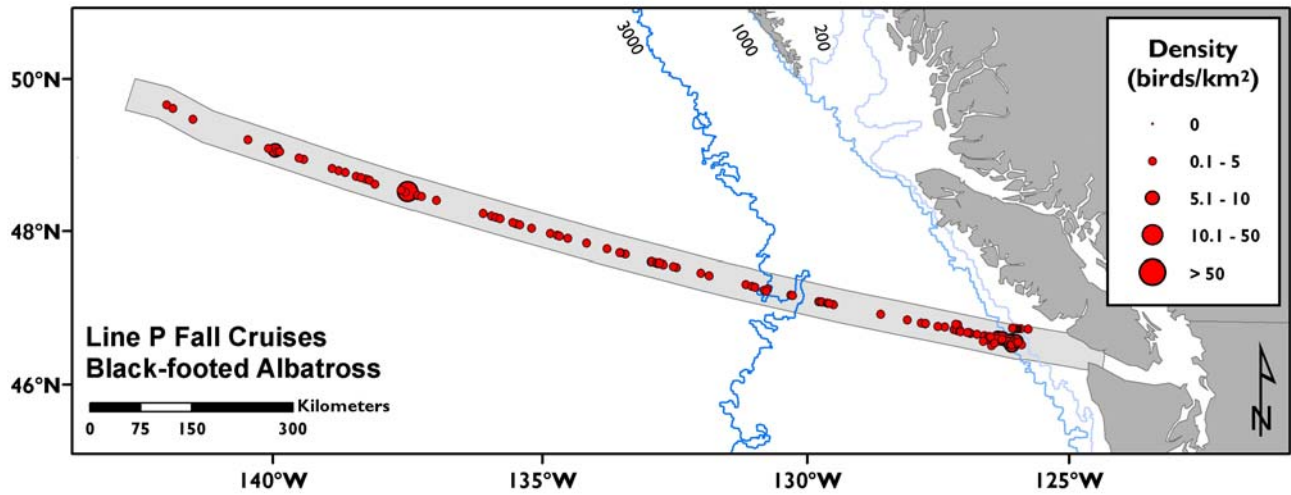
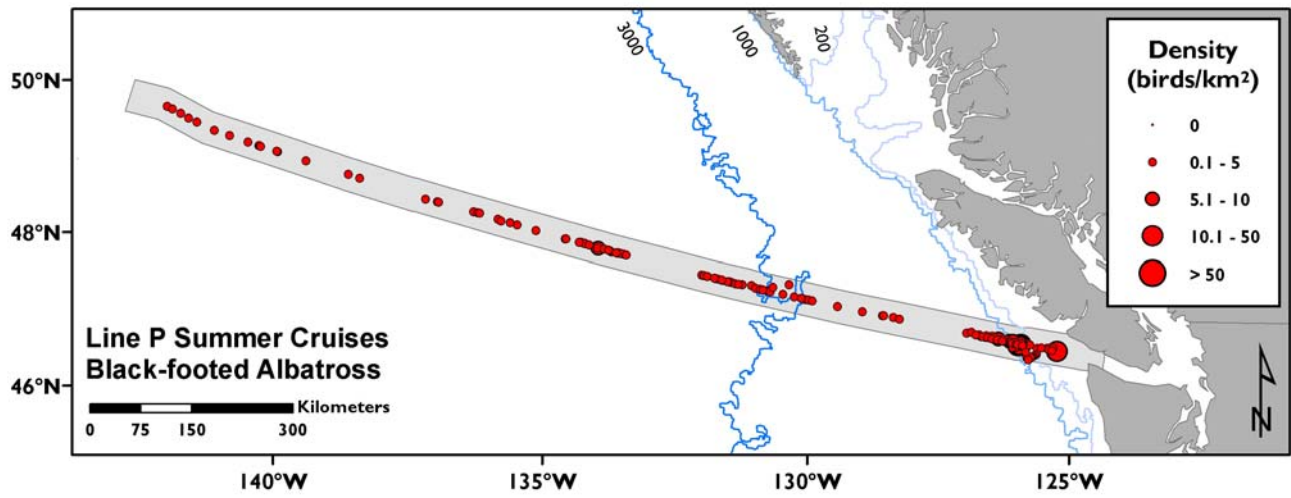
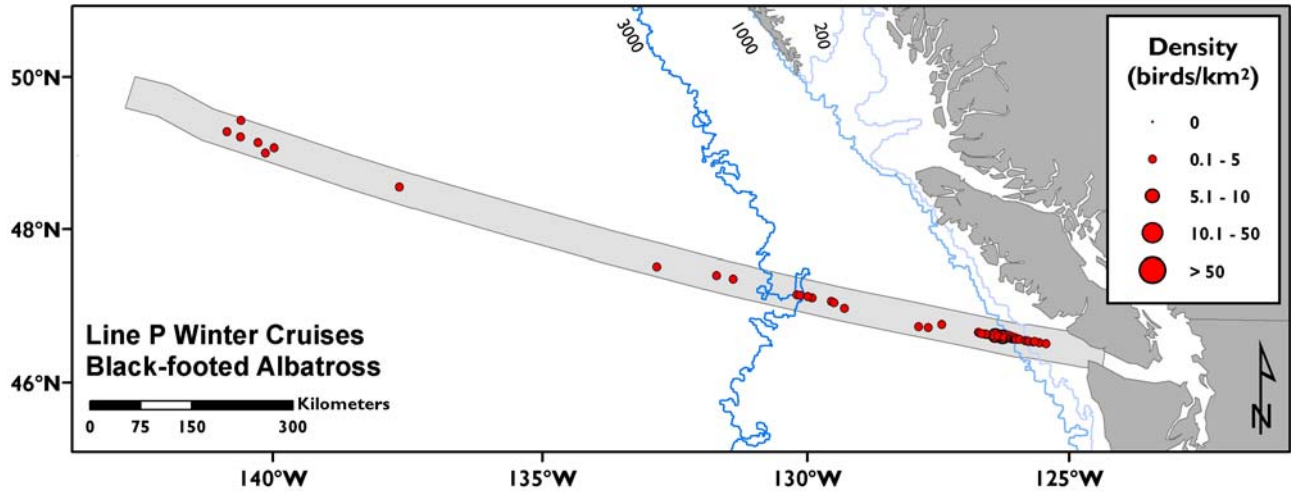




NMFS - All Cruises  
Black-footed Albatross



Line P - All Cruises  
Black-footed Albatross





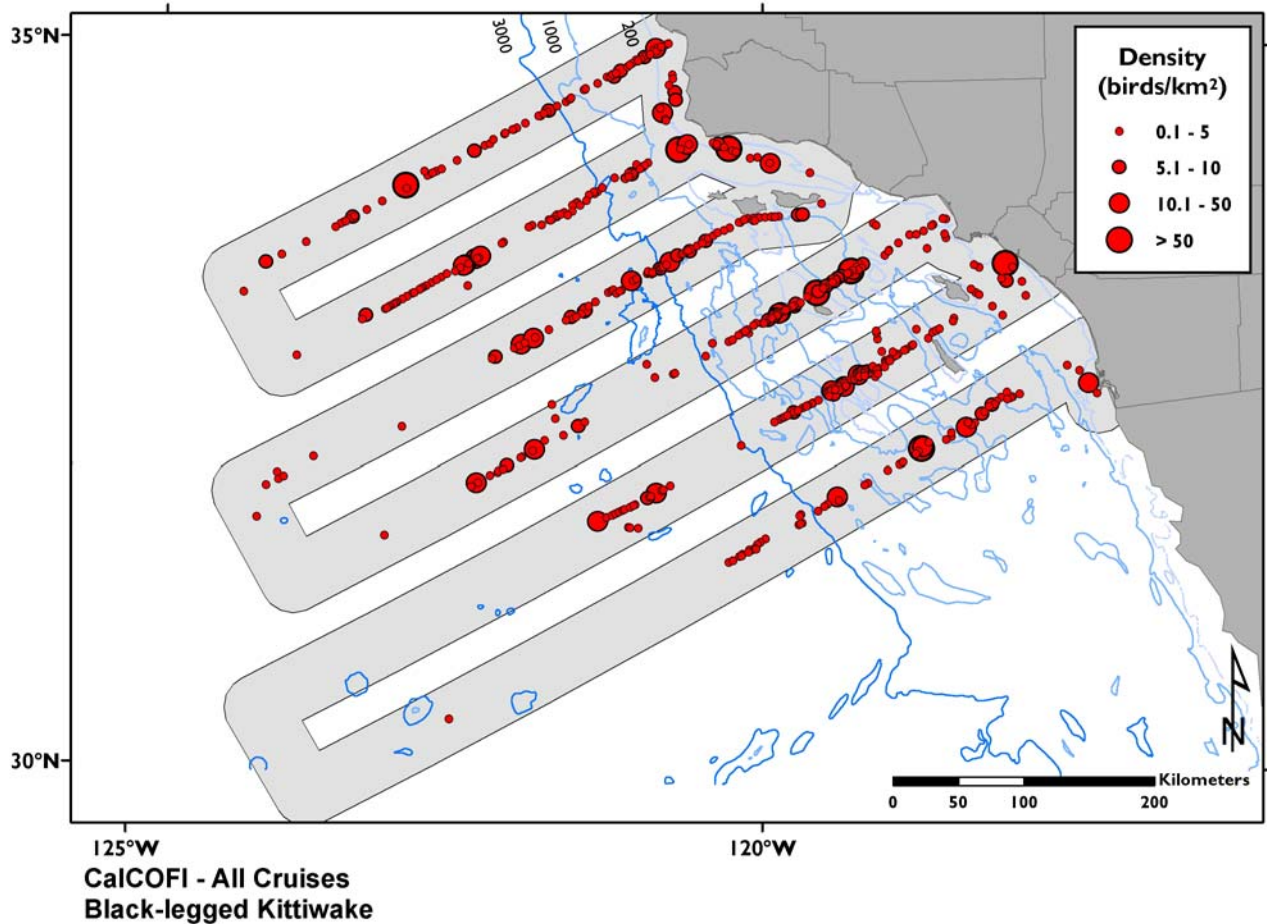
# Black-legged Kittiwake

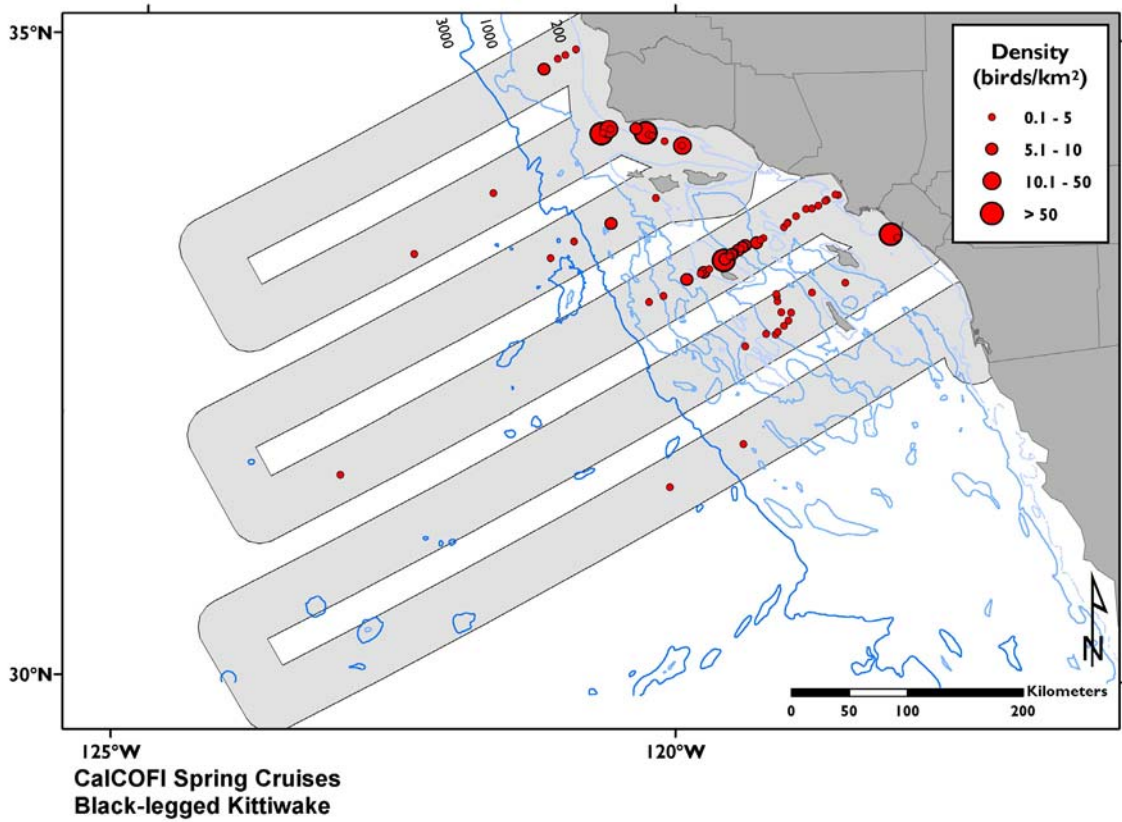
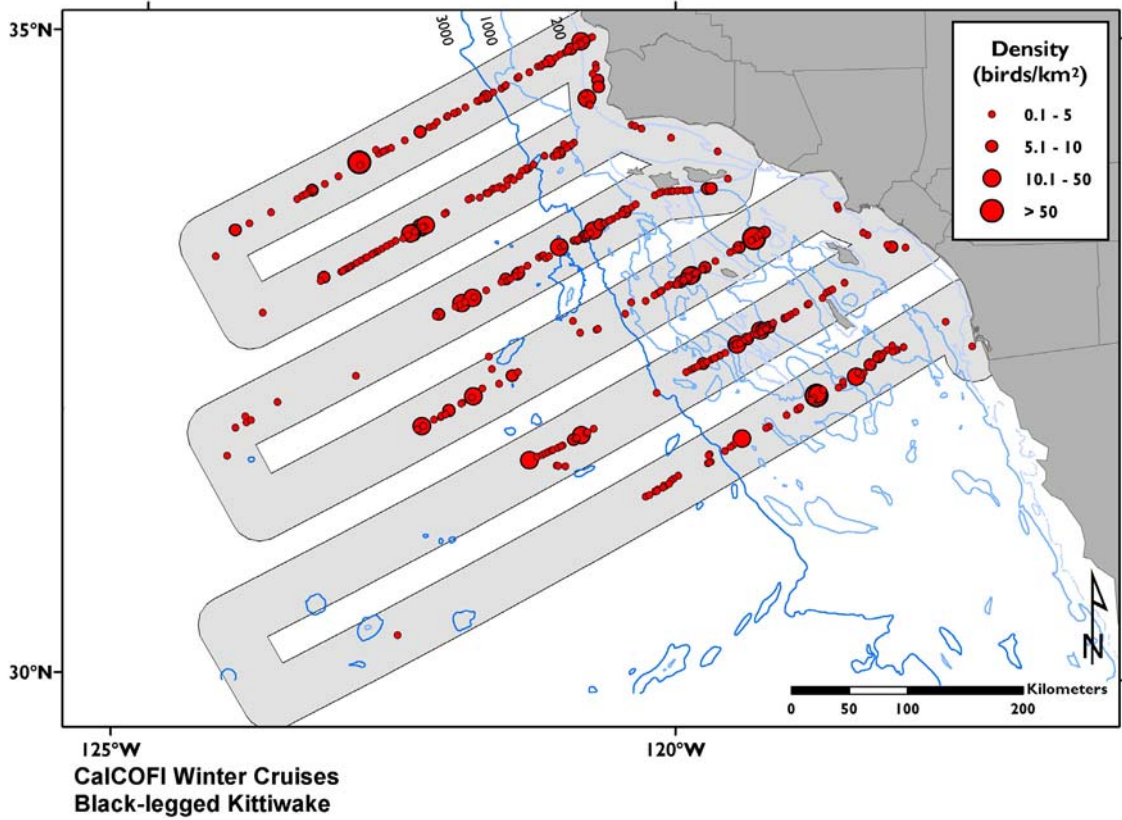
*Rissa tridactyla*



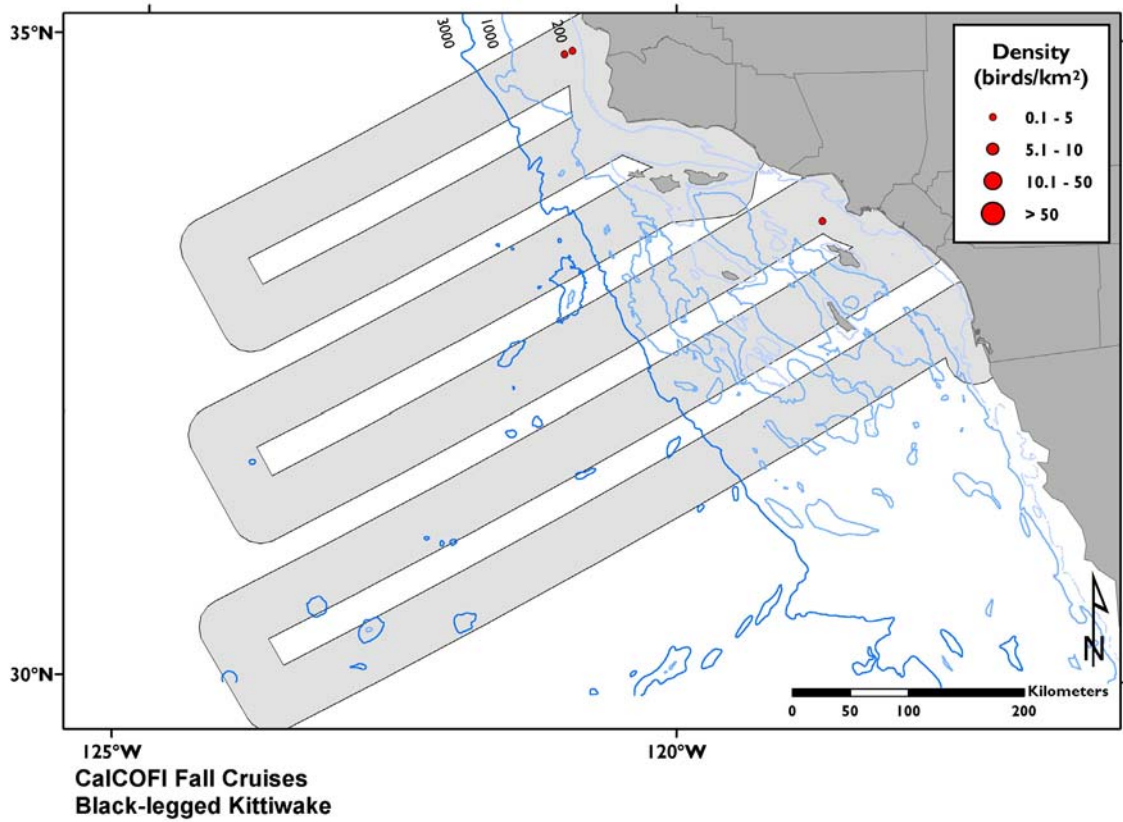
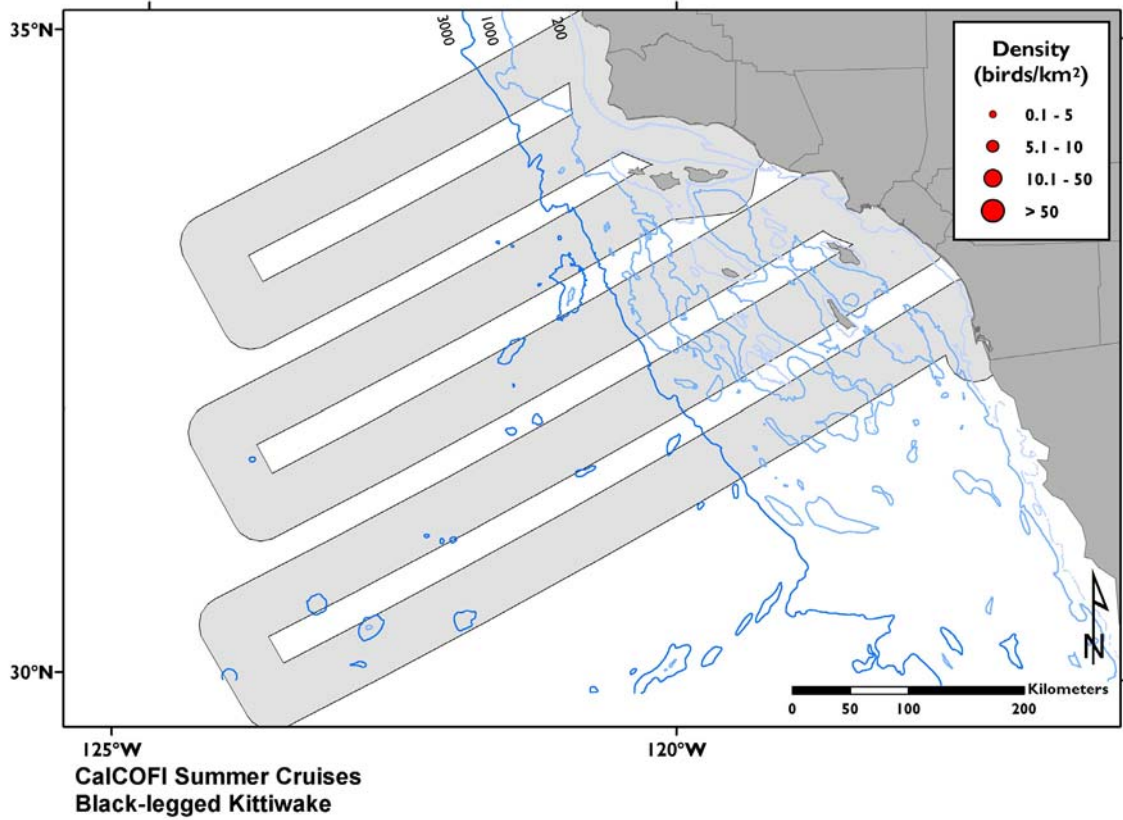
Glen Tepke (pbase.com/gtepke)

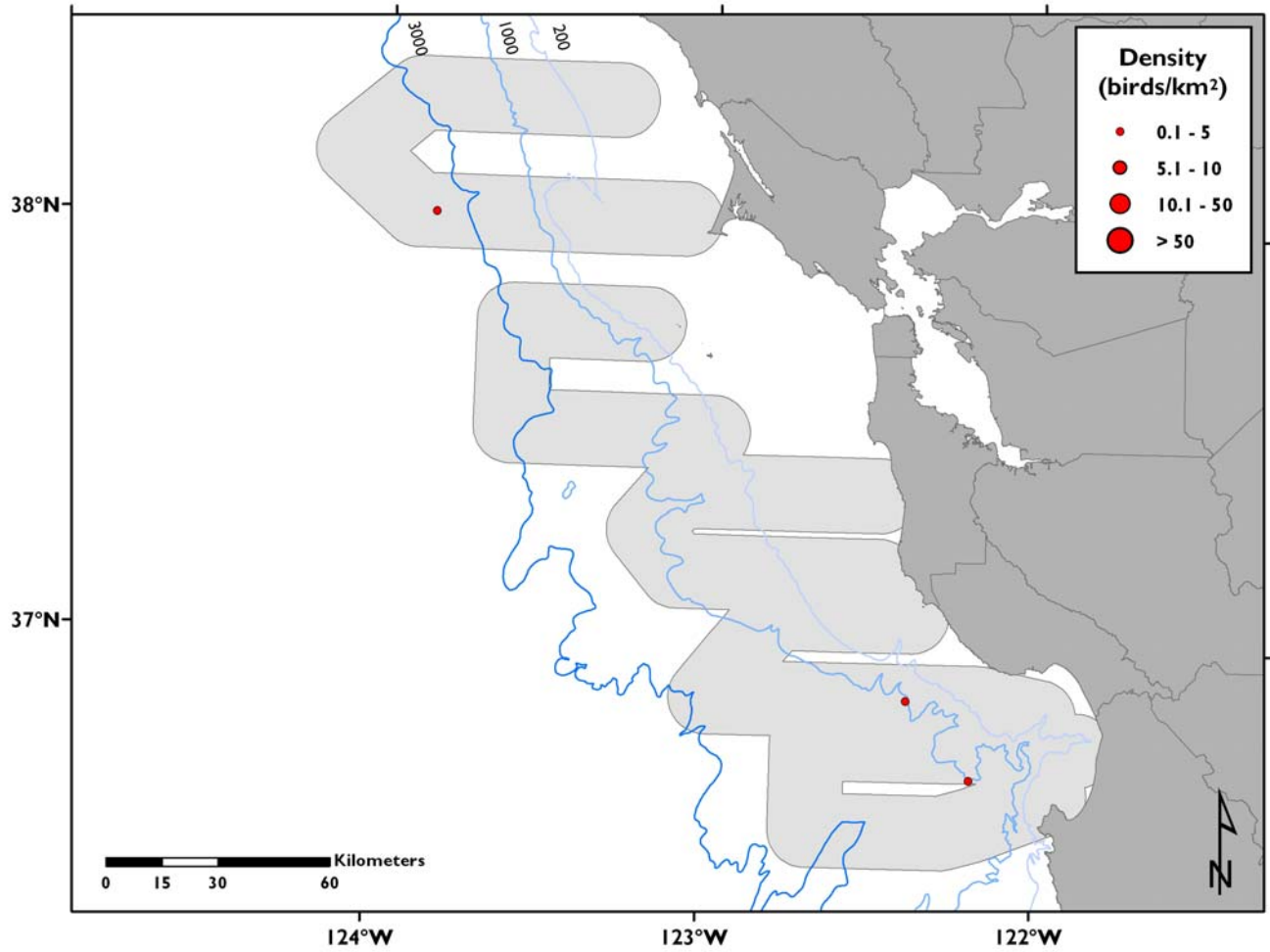
Highest densities of Black-legged Kittiwake (BLKI) occurred over the slope and shelf-break of the CalCOFI and Line P study areas during winter, respectively. BLKI were largely absent from the CalCOFI and Line P areas in summer and fall; coinciding with the breeding season. BLKI feed on fish at the oceans surface, and sometimes on offal from ships (Baird 1994).



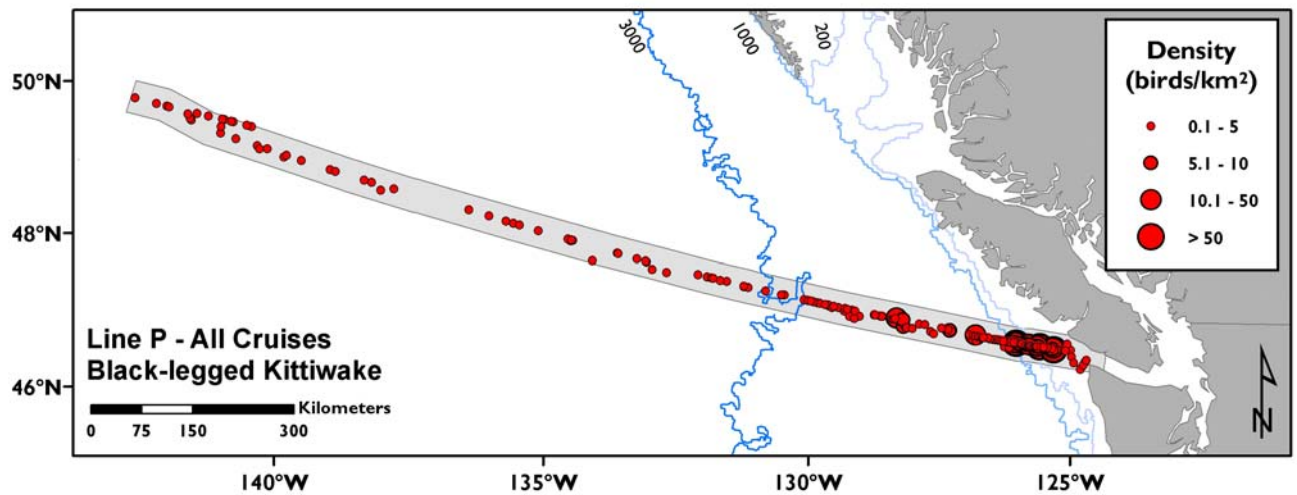




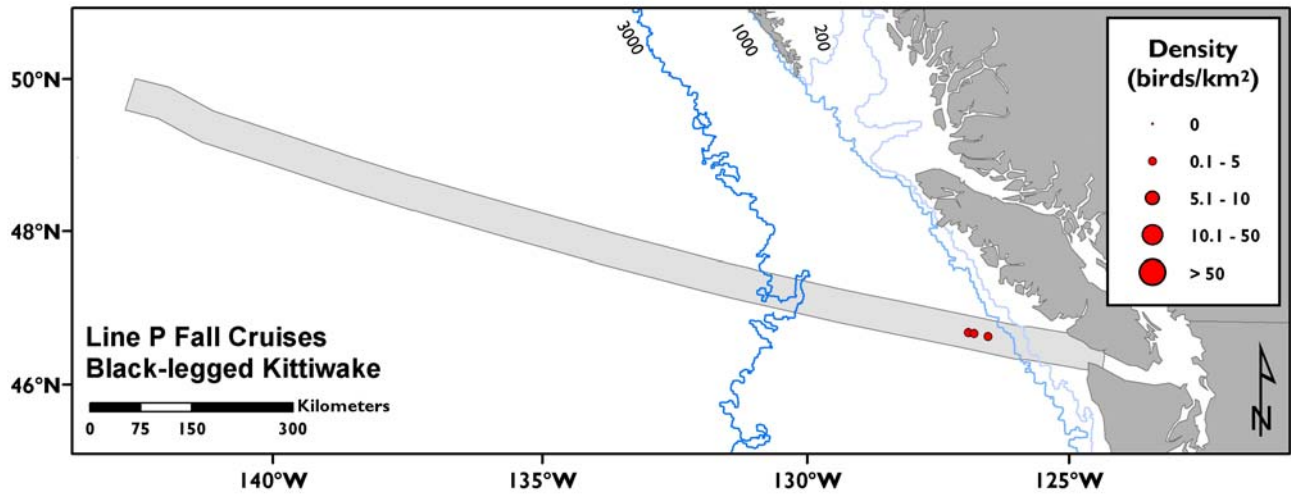
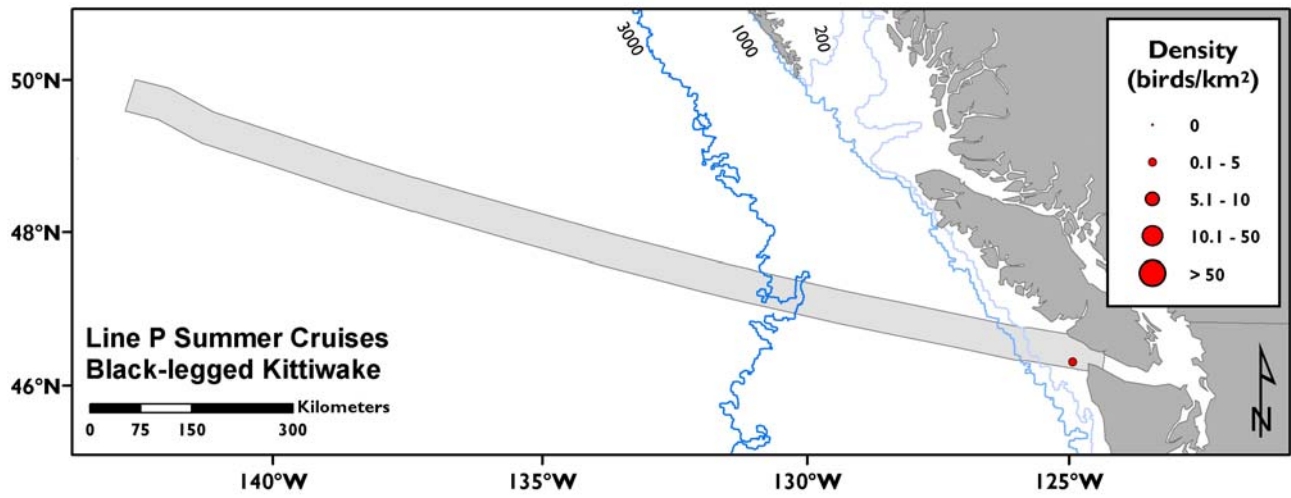
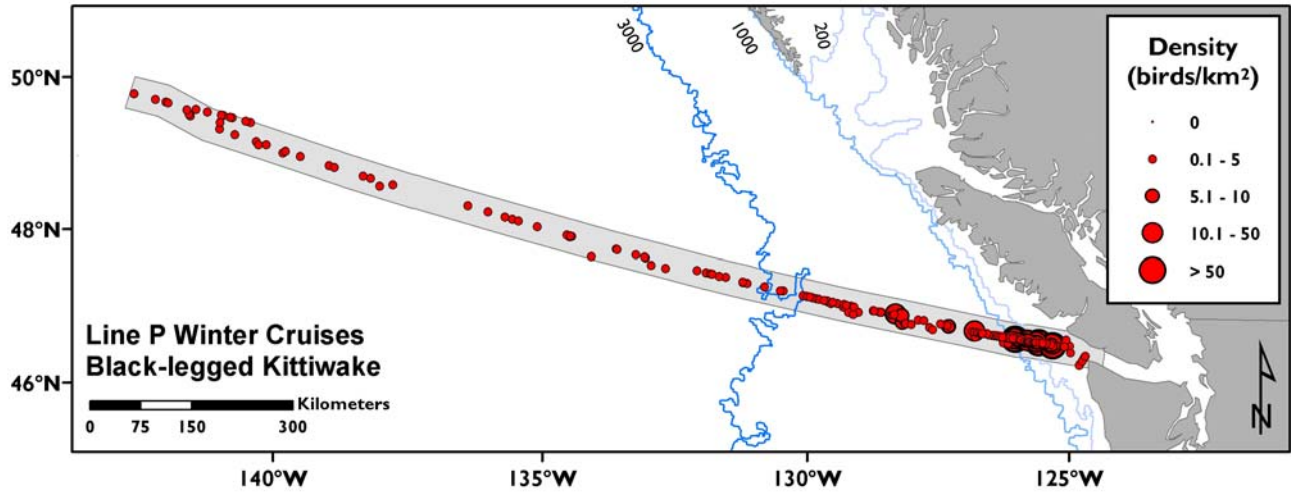




NMFS - All Cruises  
Black-legged Kittiwake



Line P - All Cruises  
Black-legged Kittiwake



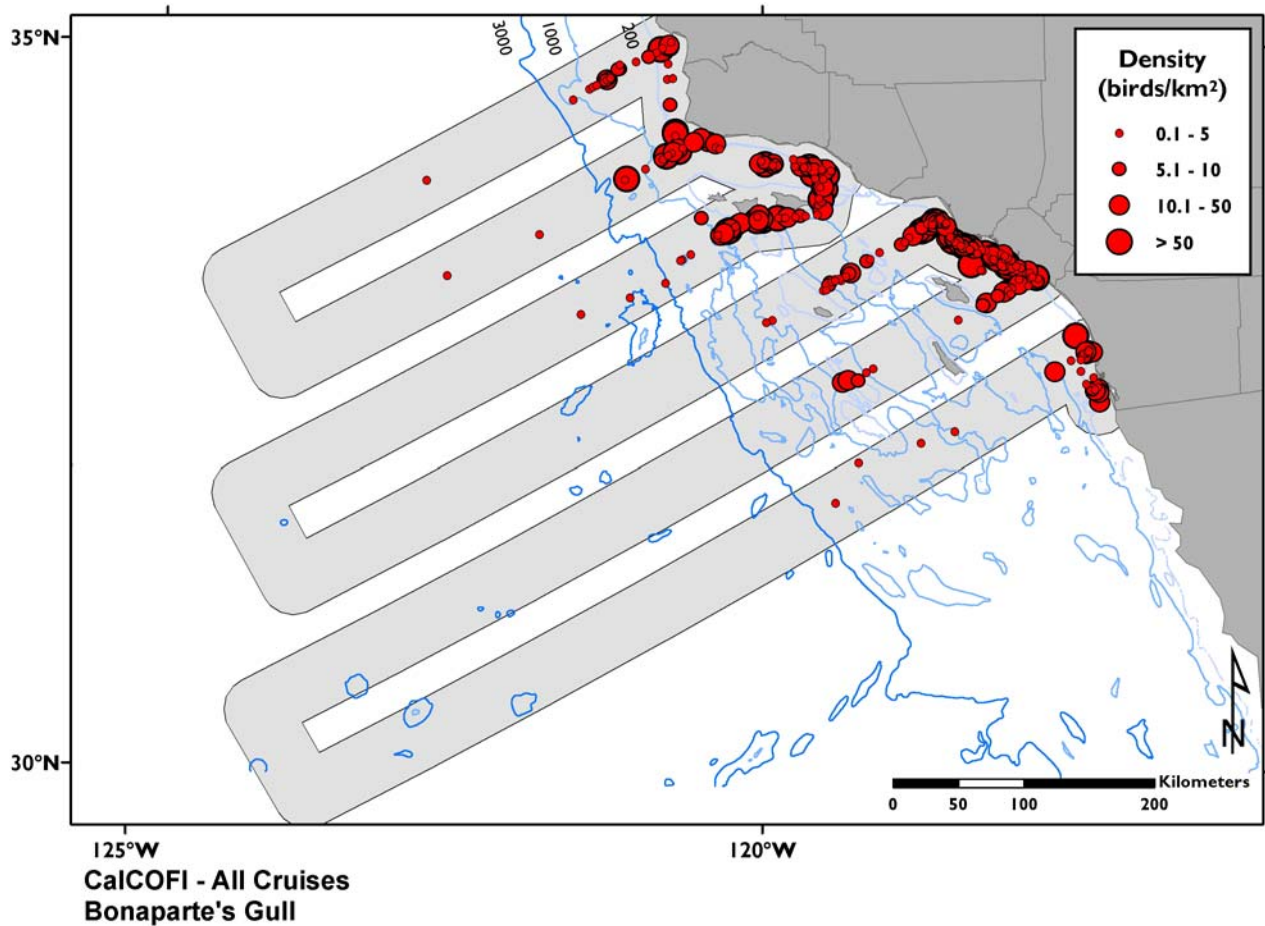


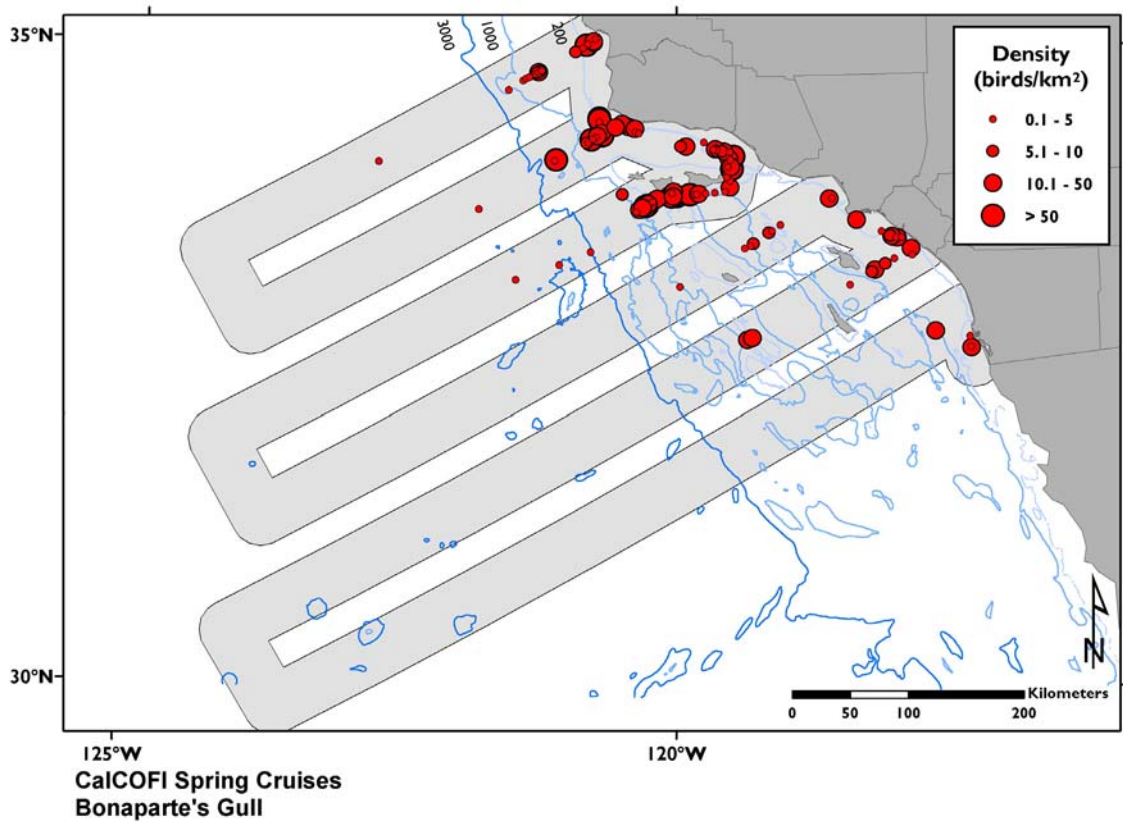
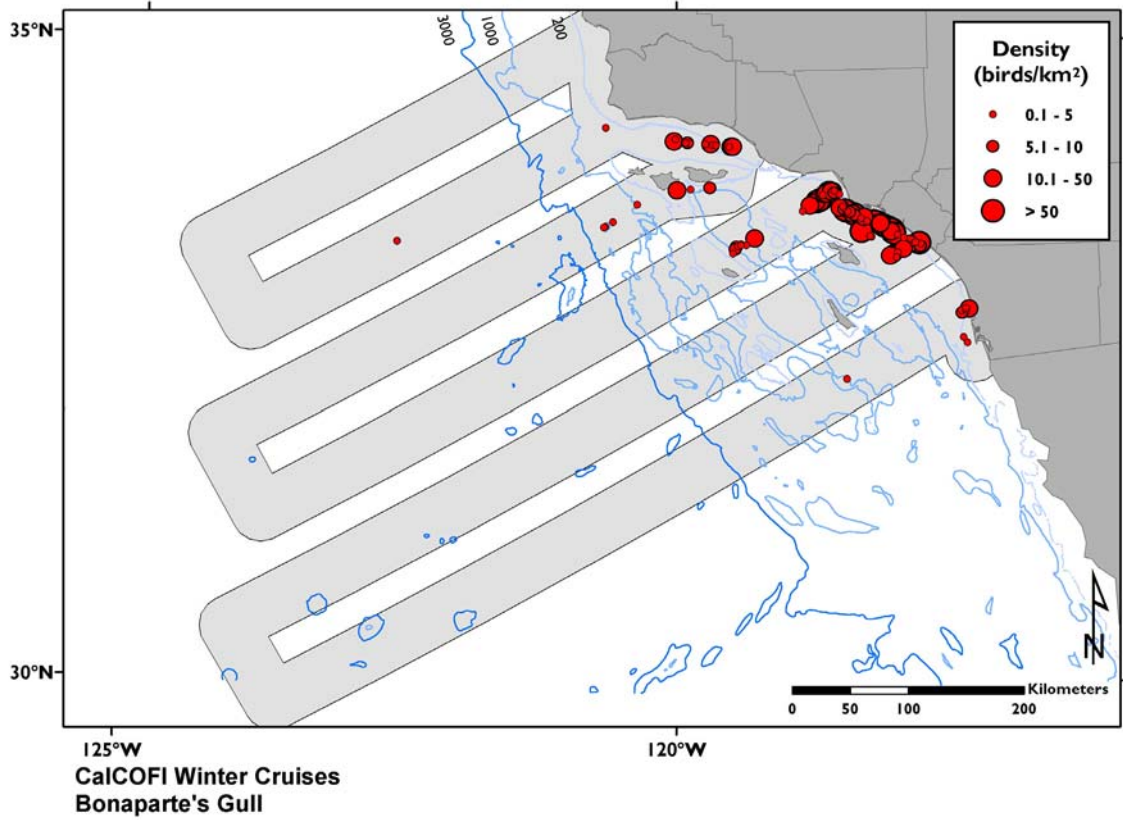
## Bonaparte's Gull

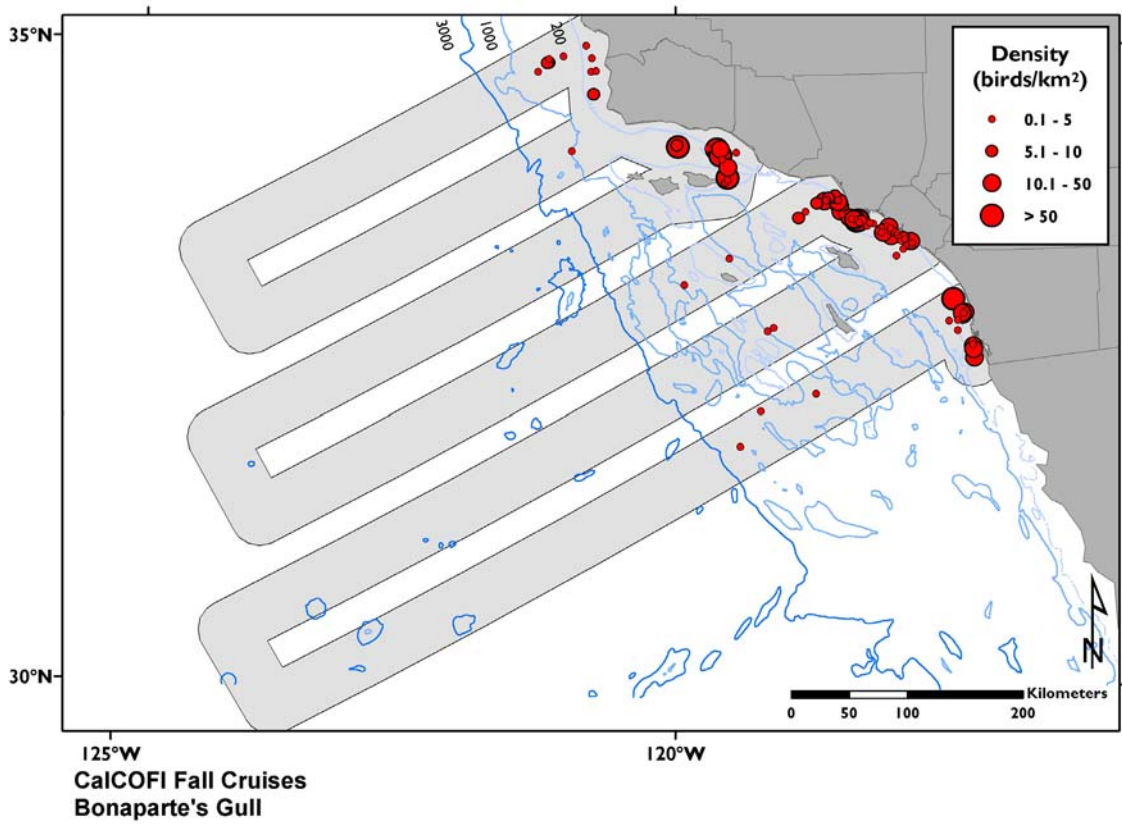
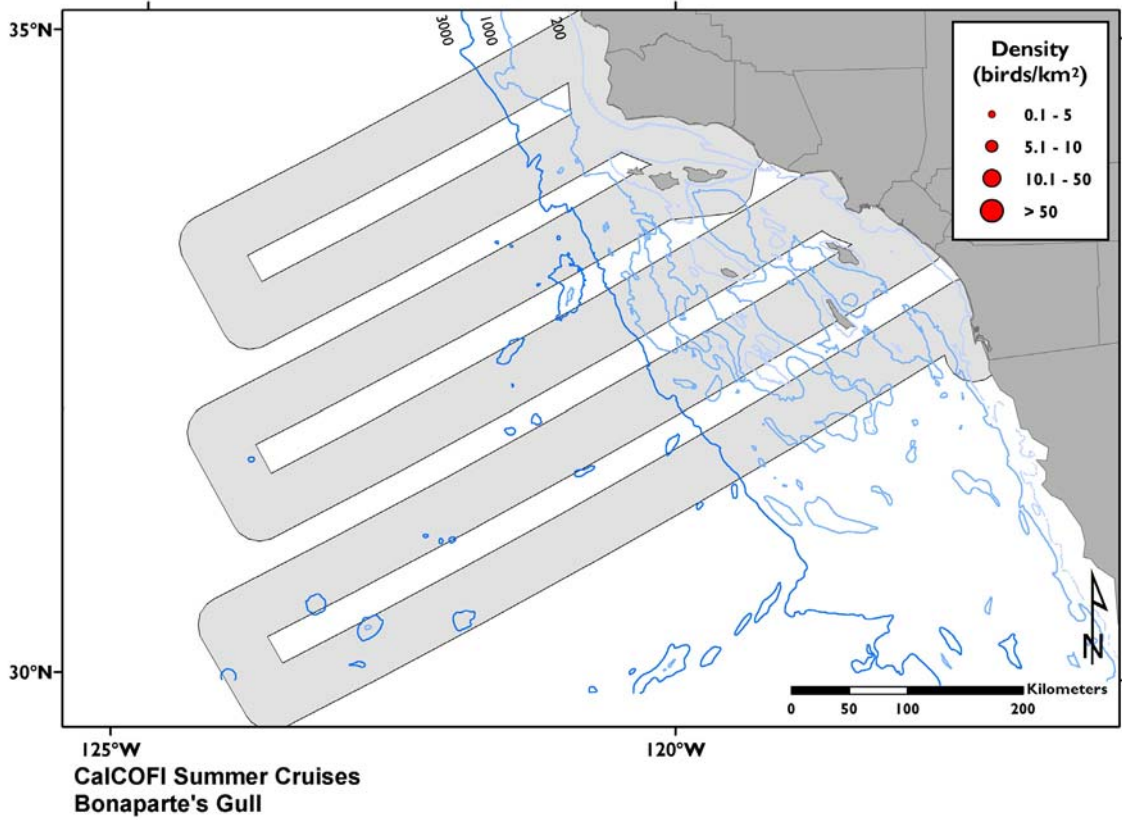
*Larus philadelphia*



Bonaparte's Gulls (BOGU) were absent from the CalCOFI study area during the summer. They occurred over shallow waters < 1000 m, with highest densities over the continental shelf. In the marine environment, BOGU feed on small fish and invertebrates (Burger and Gochfeld 2002).









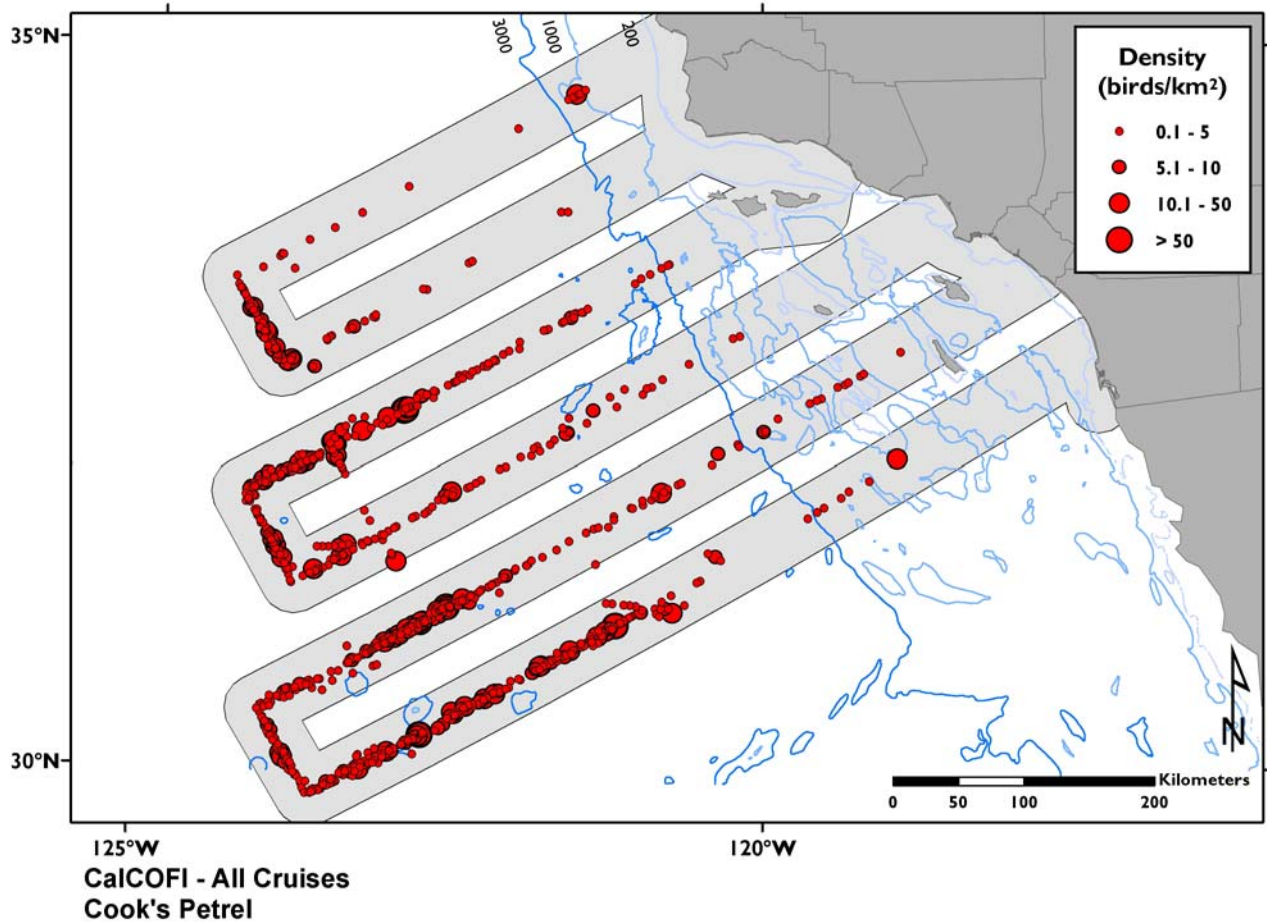


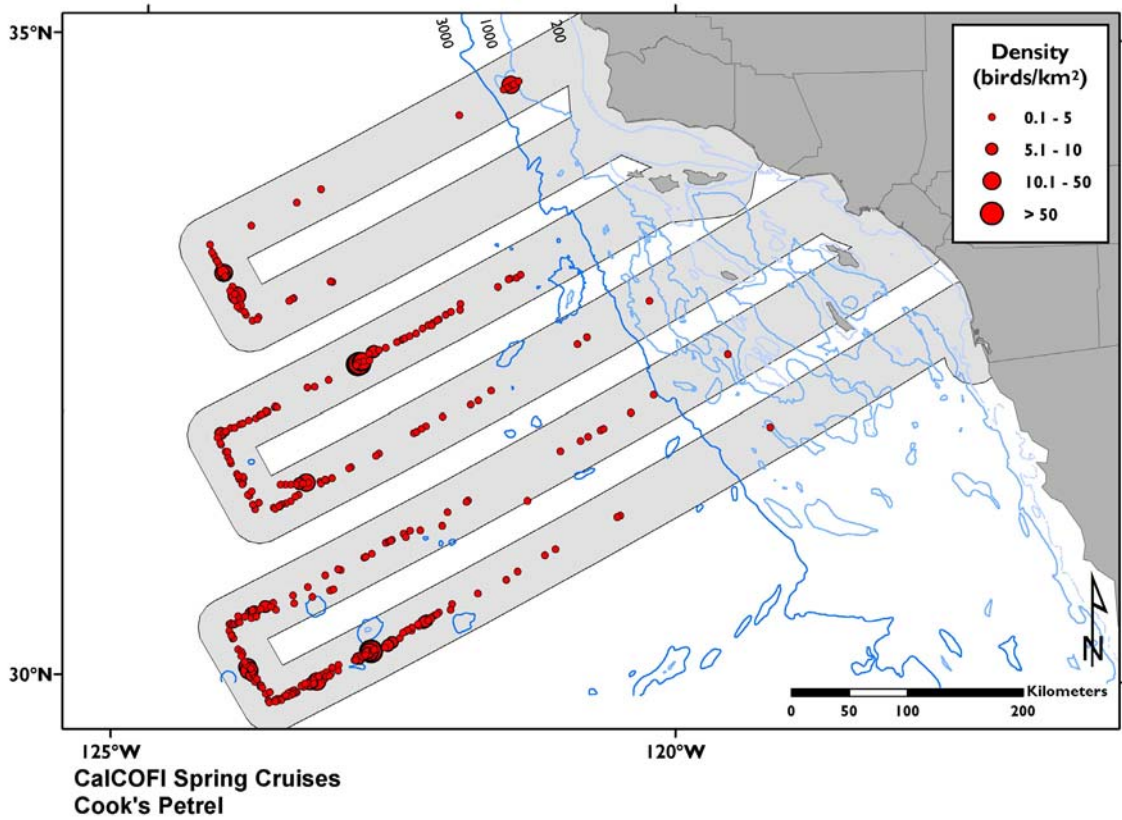
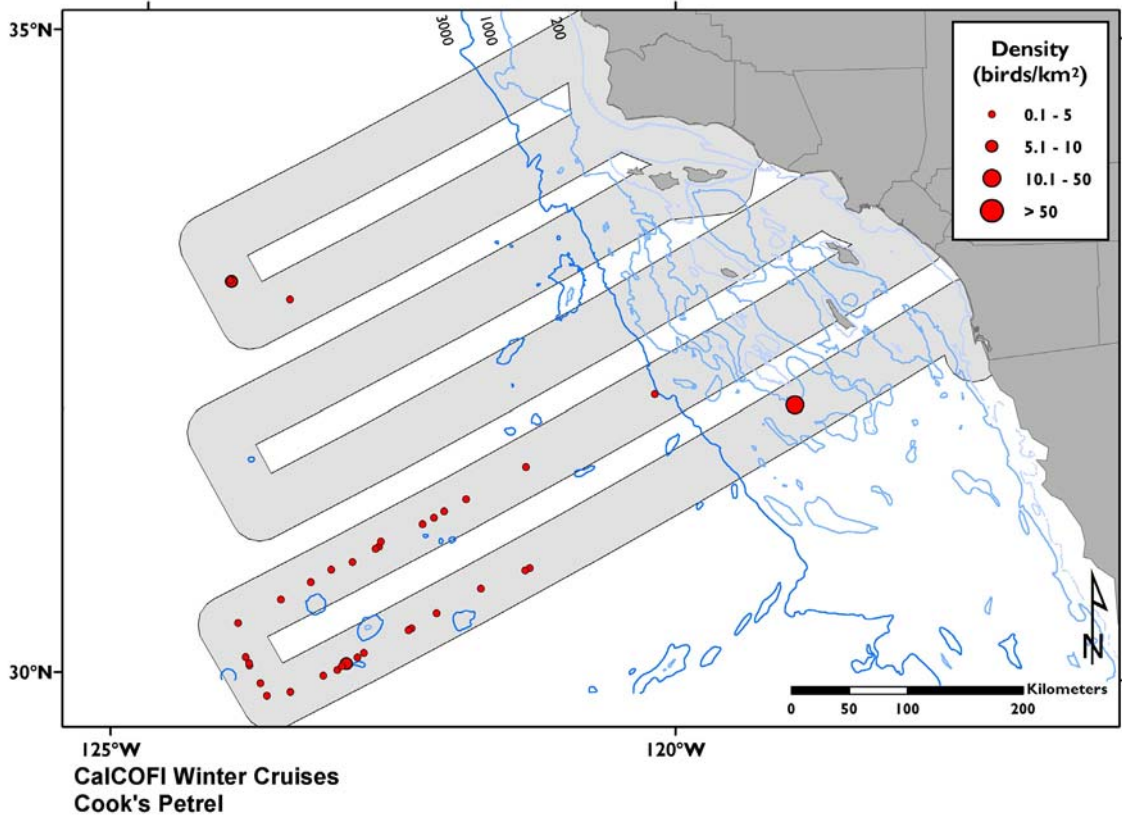
# Cook's Petrel

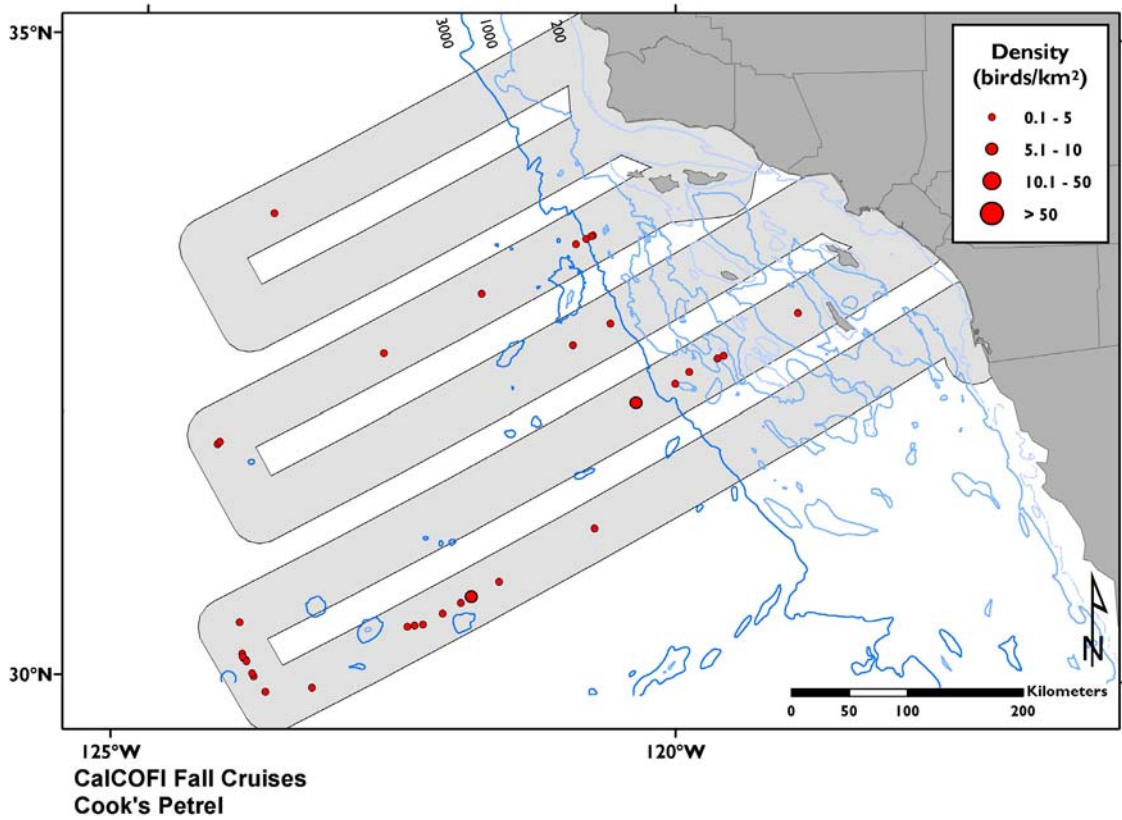
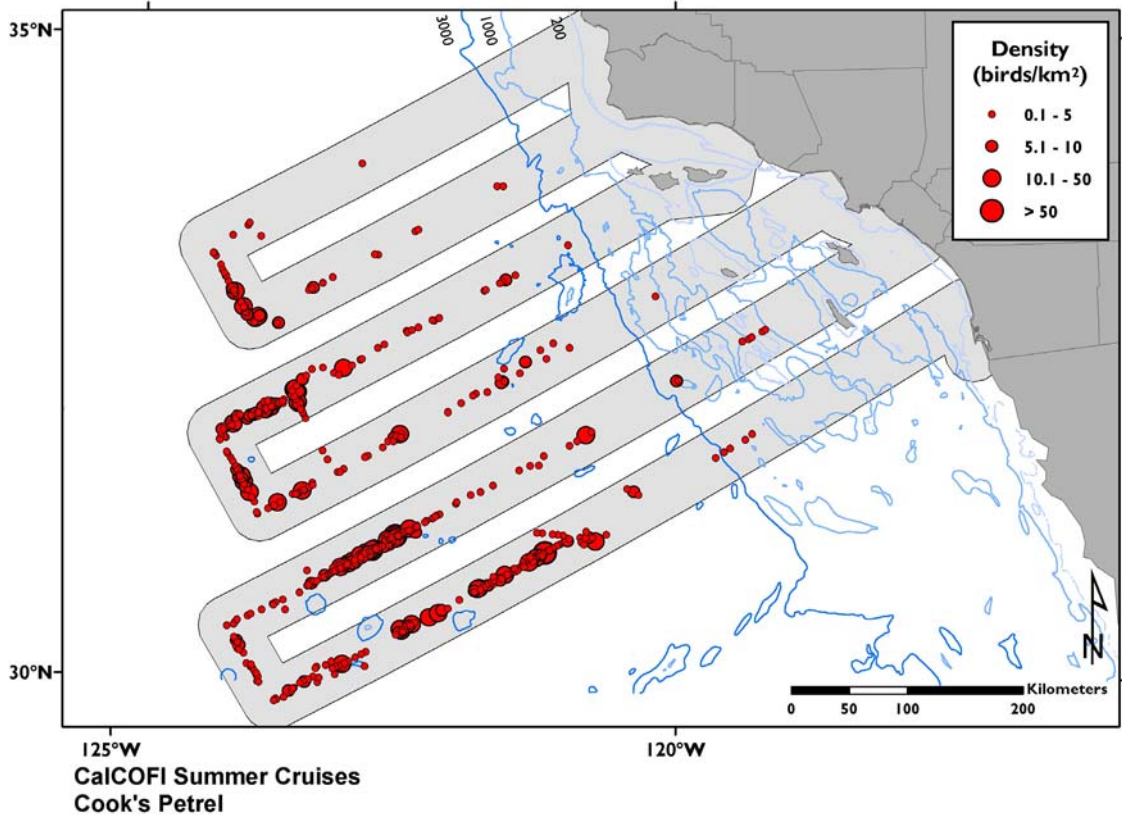
*Pterodroma cookii*



Little information exists for Cook's Petrel (COPE) in the California Current System. Generally, this species is found far offshore, preferring pelagic waters (>3000m), especially at the southern extent of the CalCOFI study area. COPE occurs most abundantly during the spring/summer seasons.







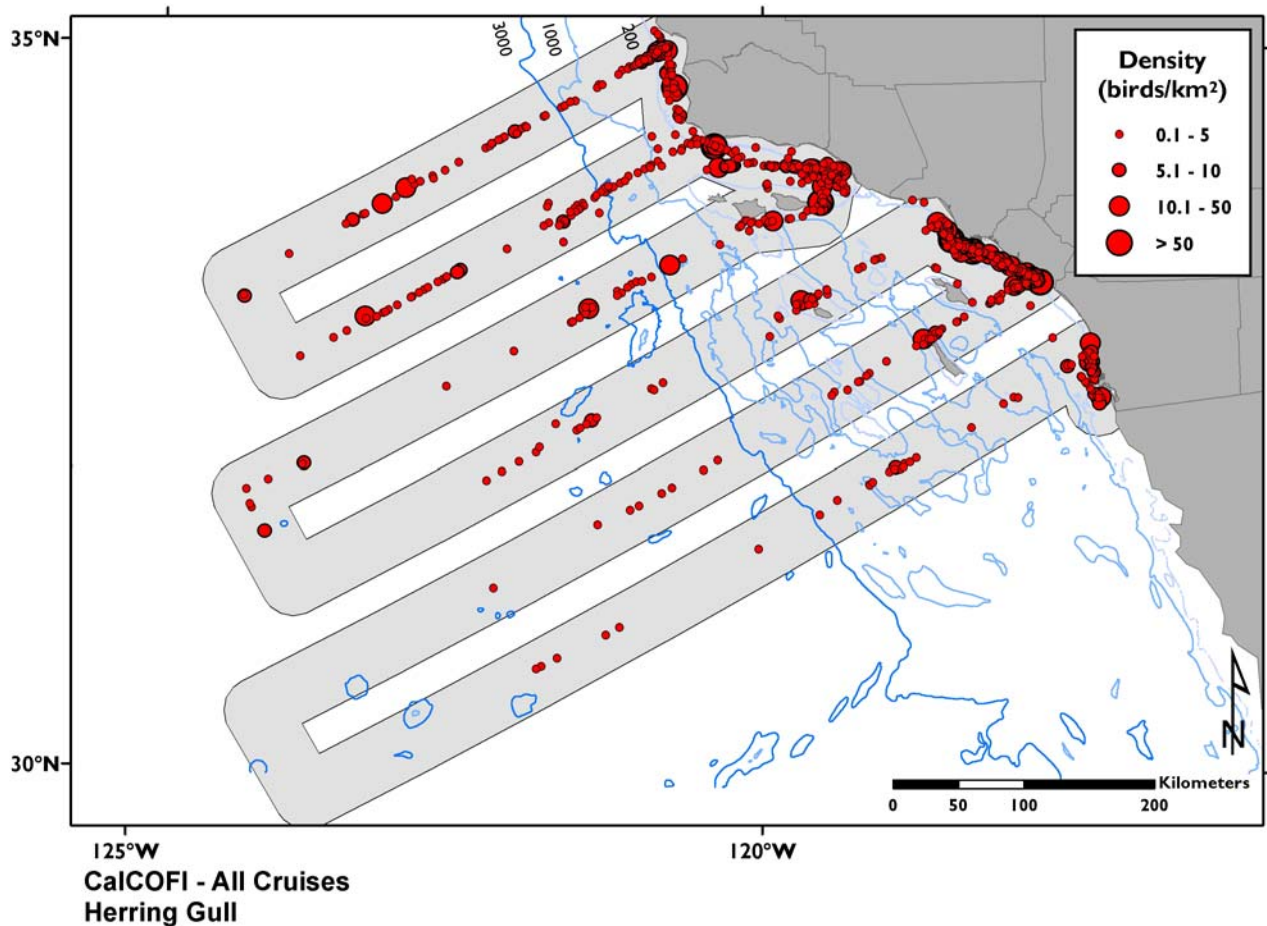


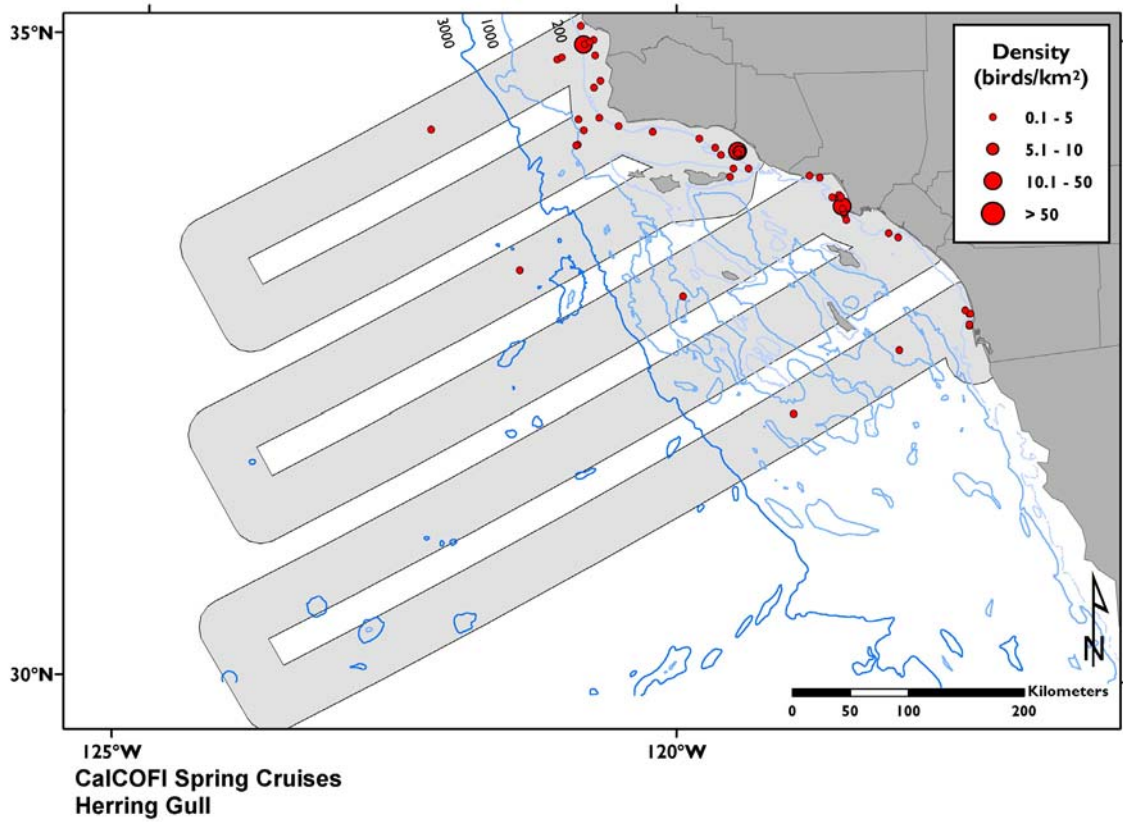
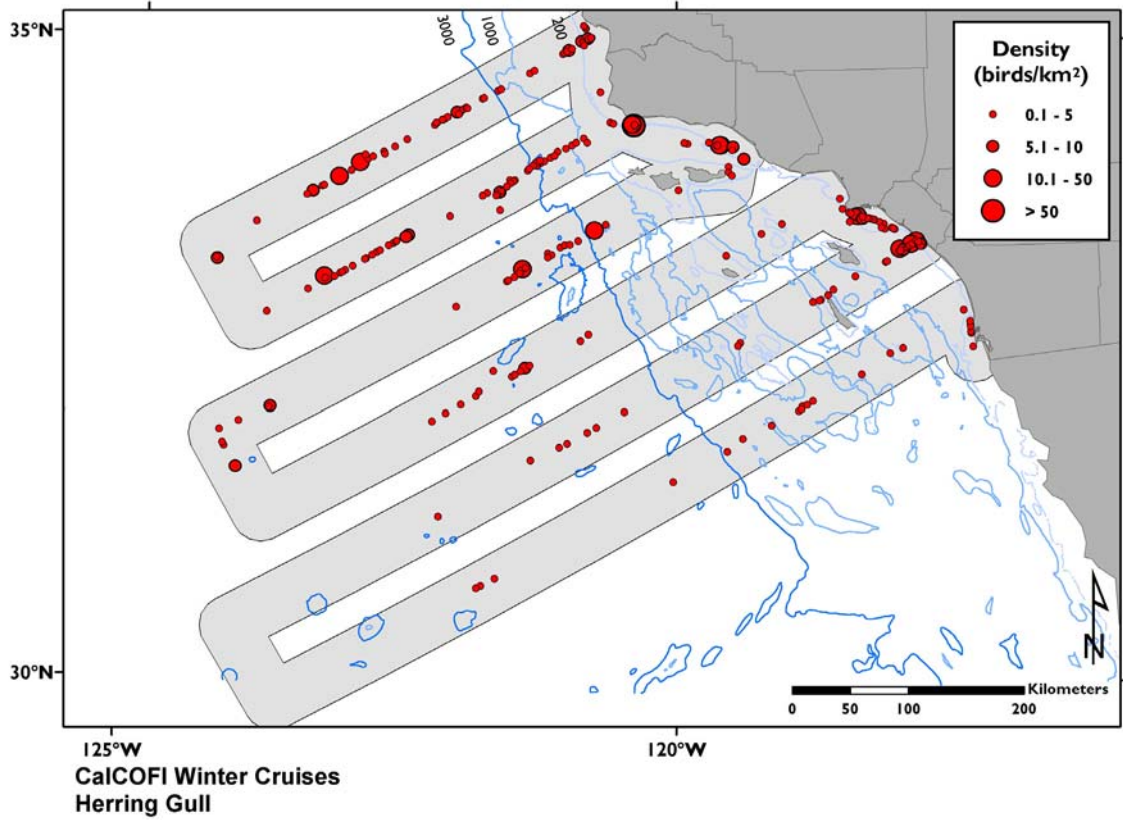
# Herring Gull

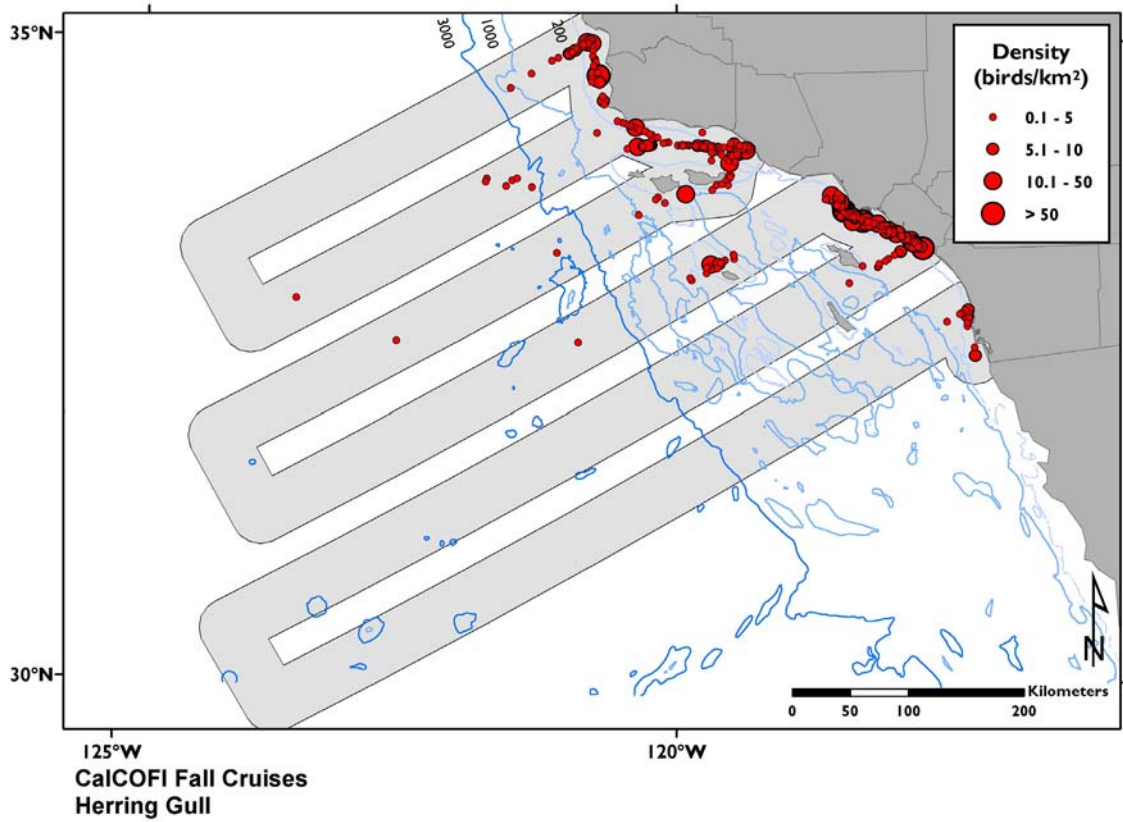
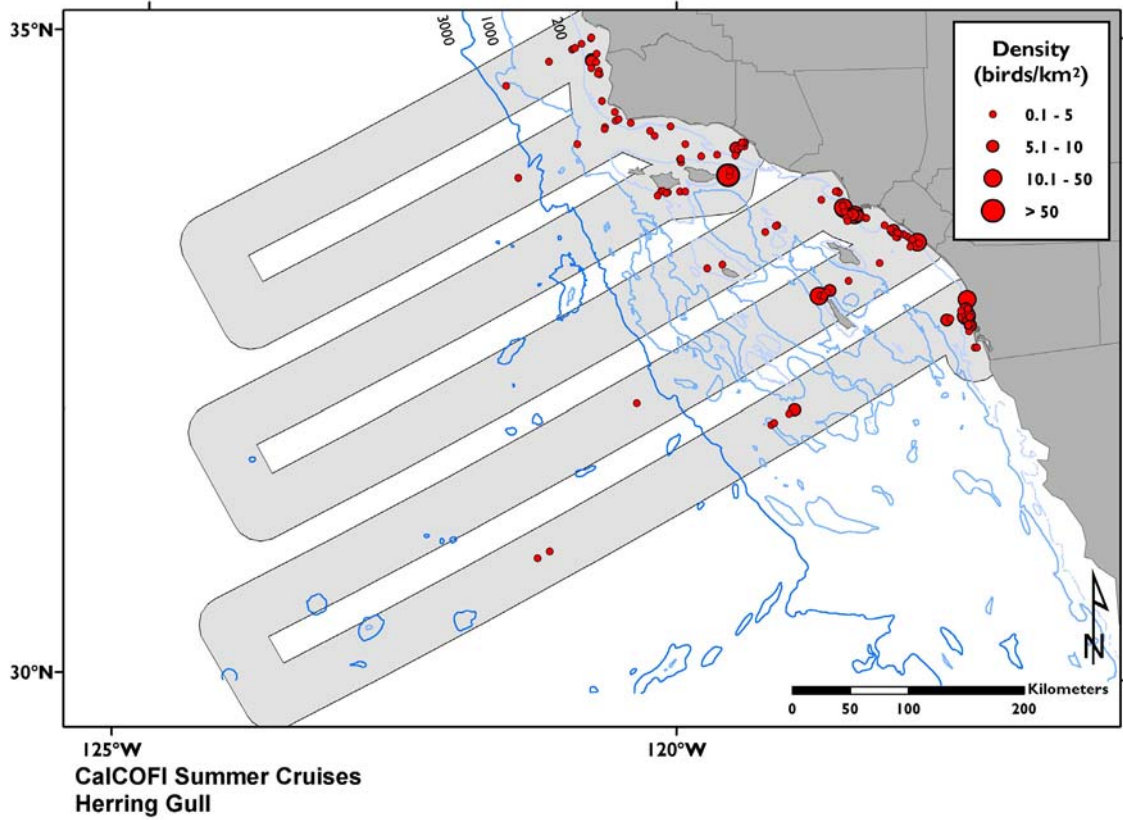
*Larus argentatus*



Marine fishes and invertebrates constitute a large part of the Herring Gull's (HERG) diet, although they exhibit opportunistic foraging behaviors (Pierotti and Good 1994). The species was most frequently observed and at highest densities in the CalCOFI area over the continental shelf - from spring through fall. During winter, HERG were encountered over the shelf and over pelagic waters. The greatest abundance of HERG was found in fall.









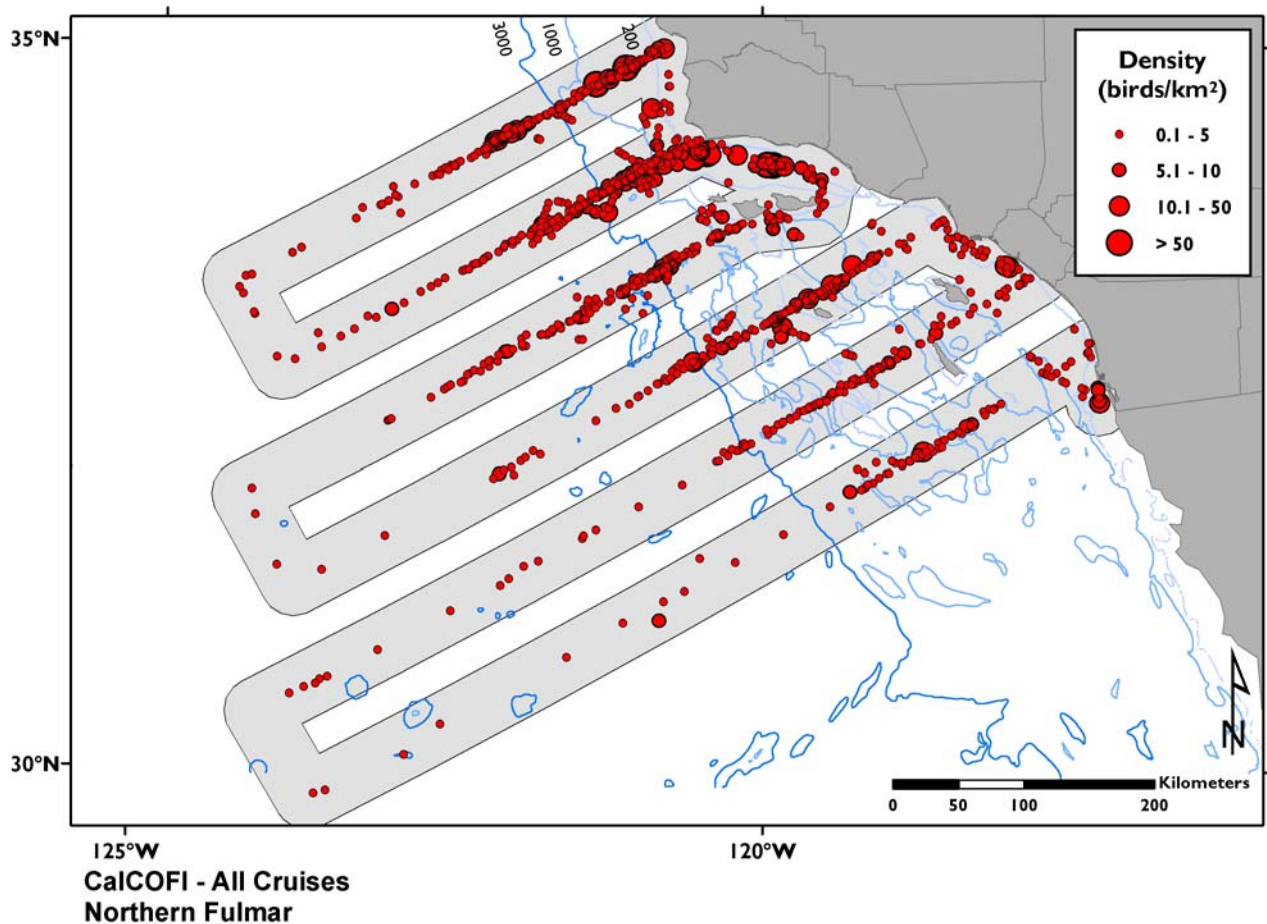


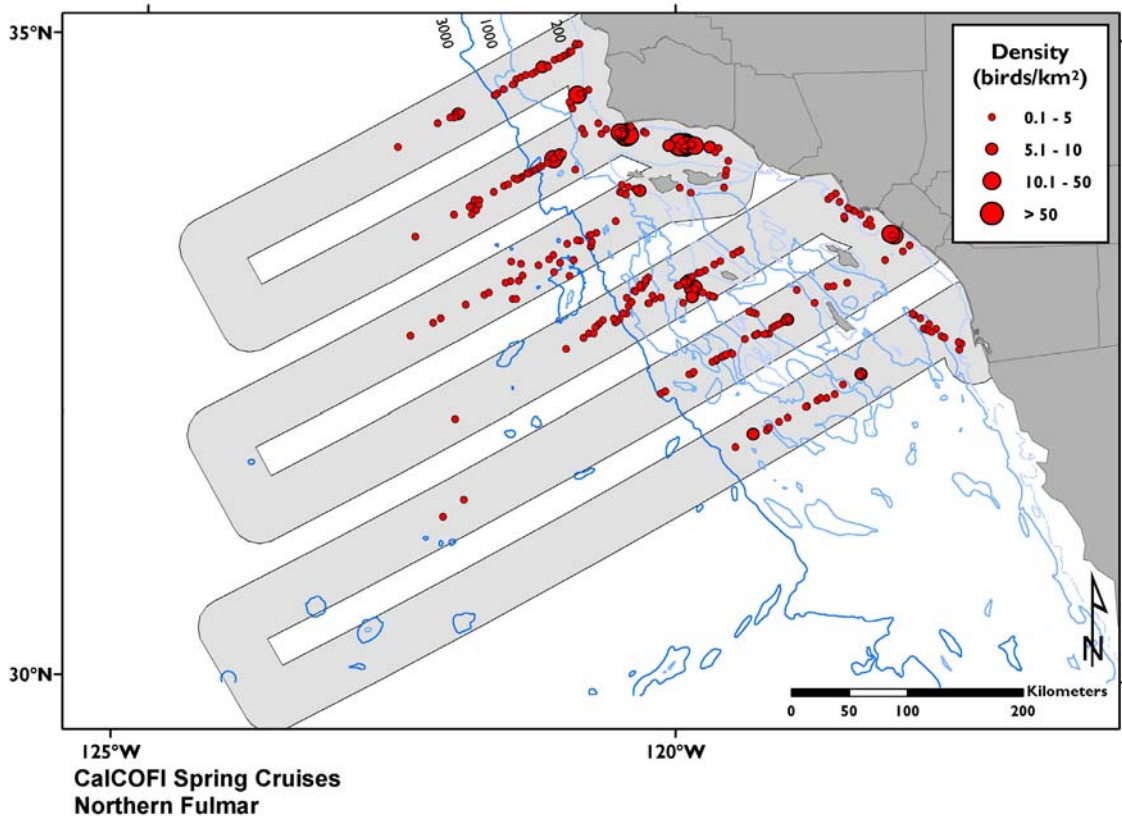
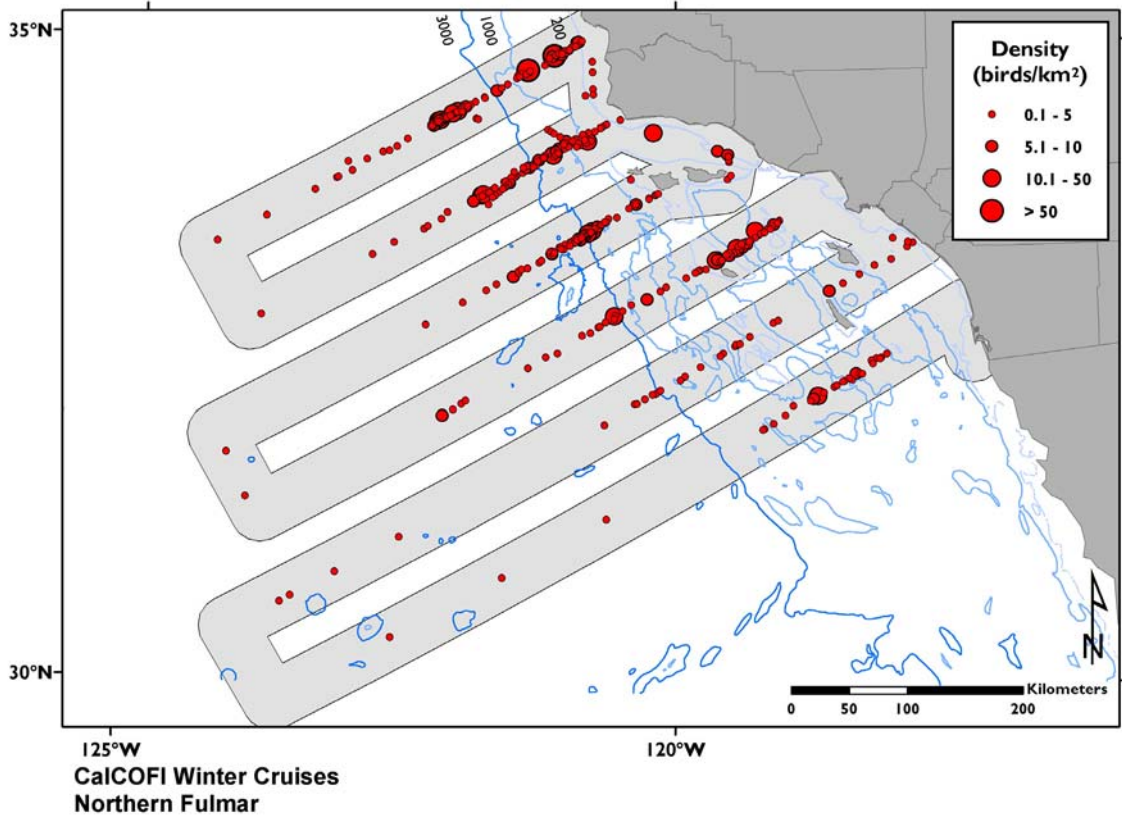
# Northern Fulmar

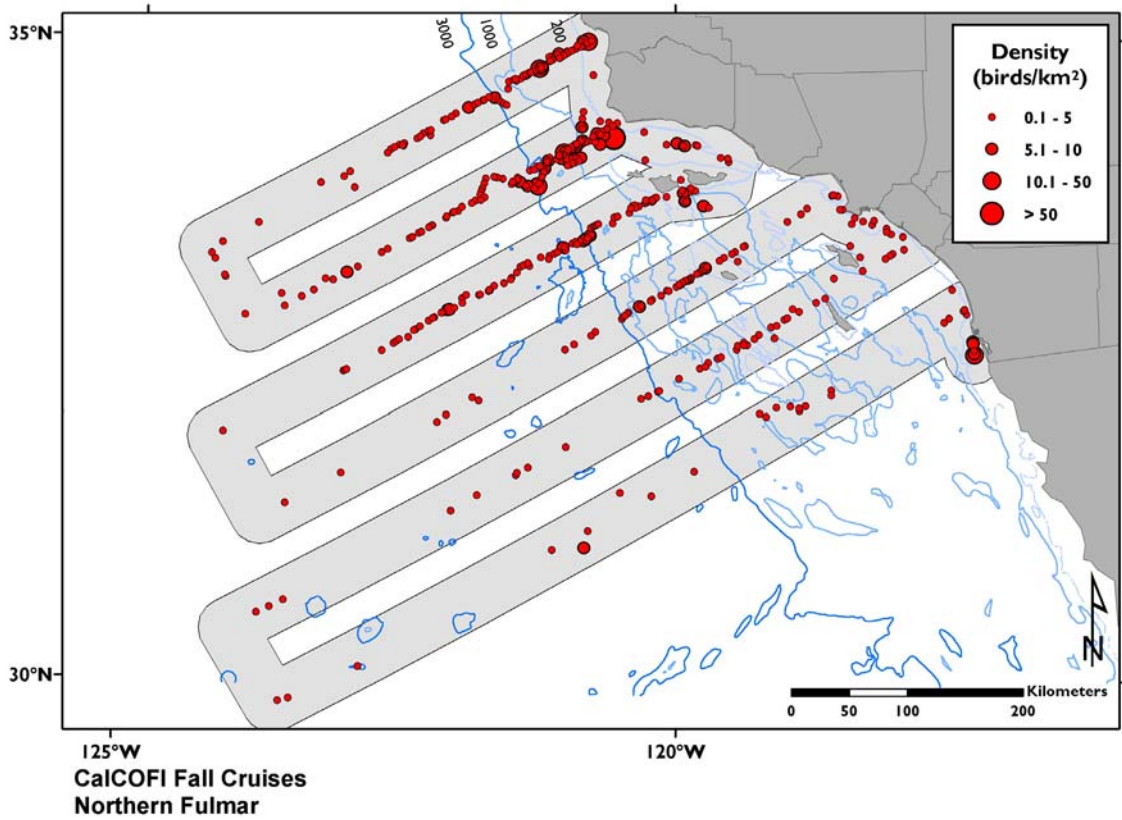
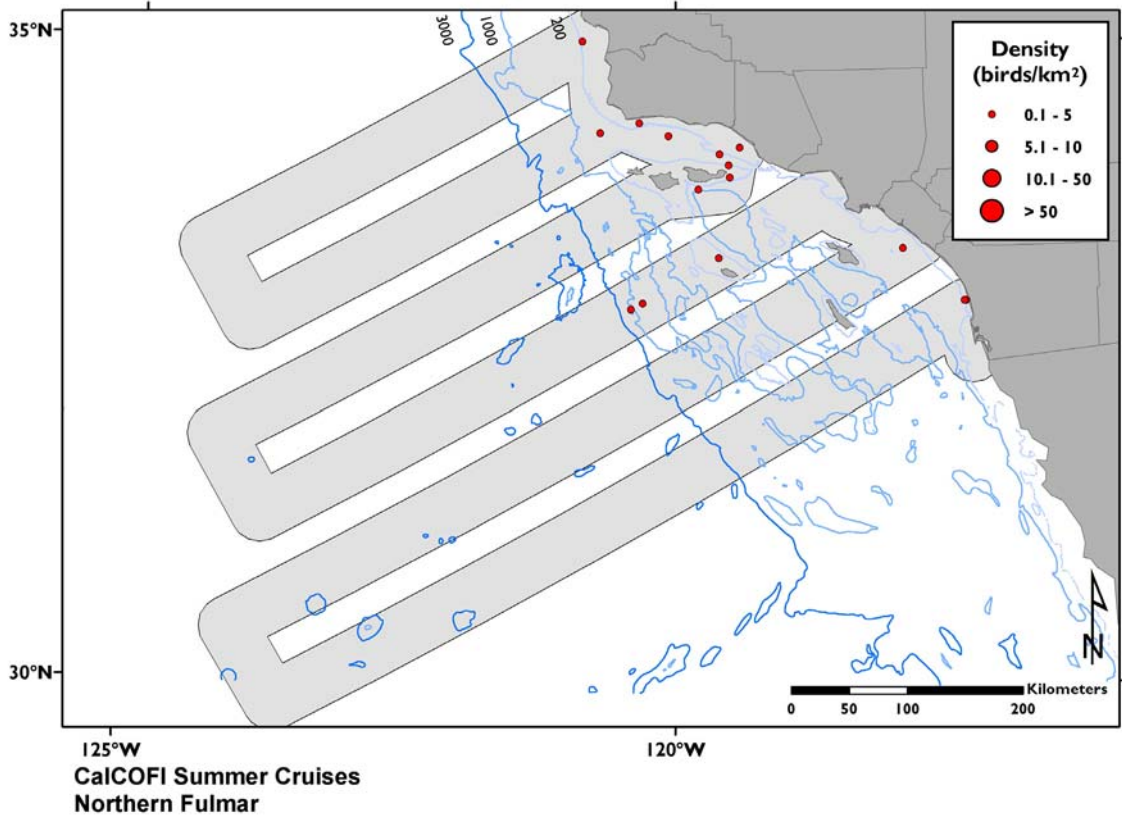
*Fulmarus glacialis*

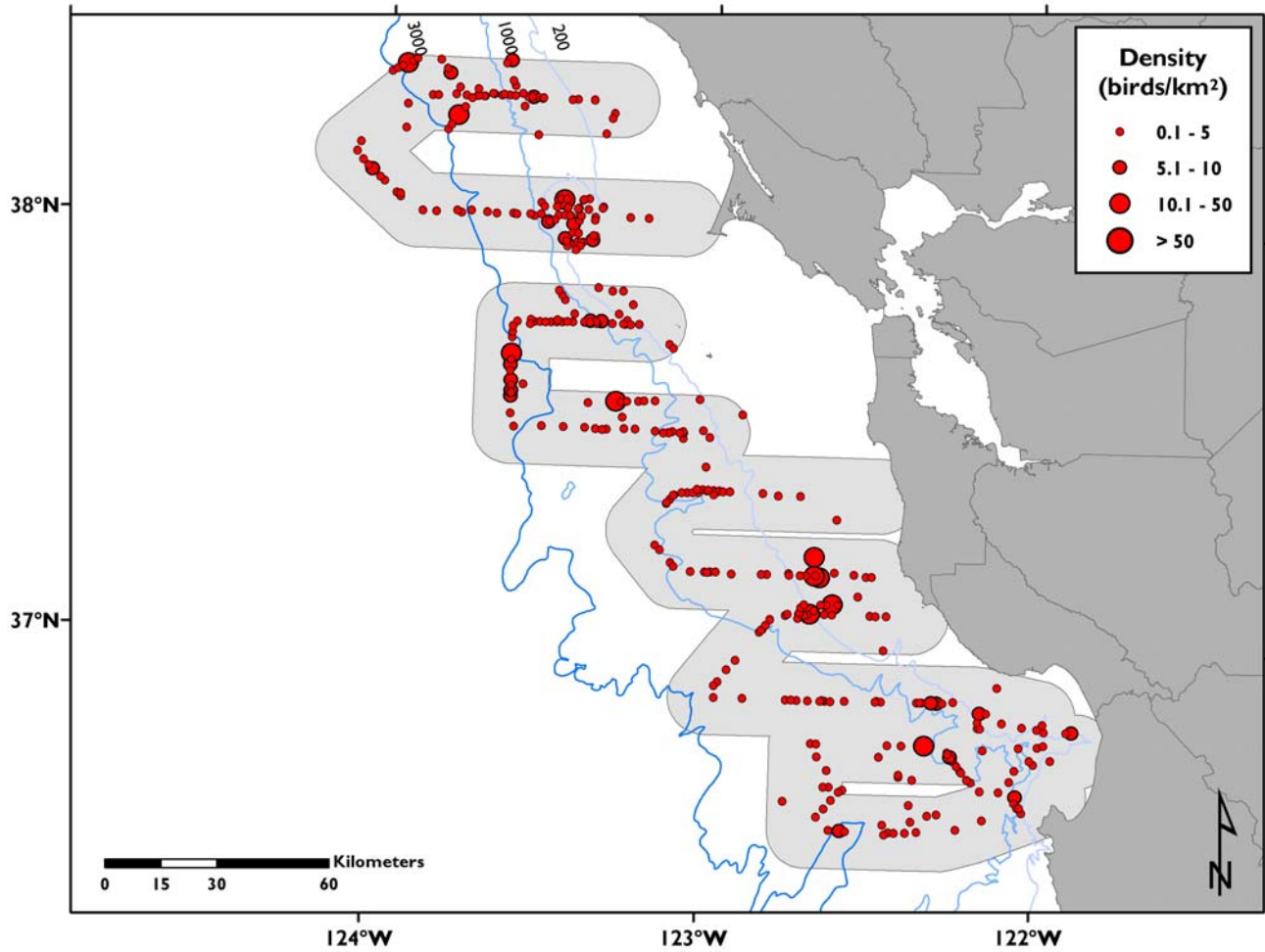


Northern Fulmars (NOFU) forage on fish, zooplankton, squid, offal, and carrion, often nocturnally (Hatch and Nettleship 1998). NOFU made far greater use of pelagic waters in the Line P study area during winter, and in the CalCOFI area during fall and winter. NOFU were nearly absent from the CalCOFI study area during summer months; whereas, they were regularly encountered over the shelf and shelf-break of Line P at that time. Waters over the shelf-break appeared to have been the preferred habitat of NOFU in the NMFS and CalCOFI areas.

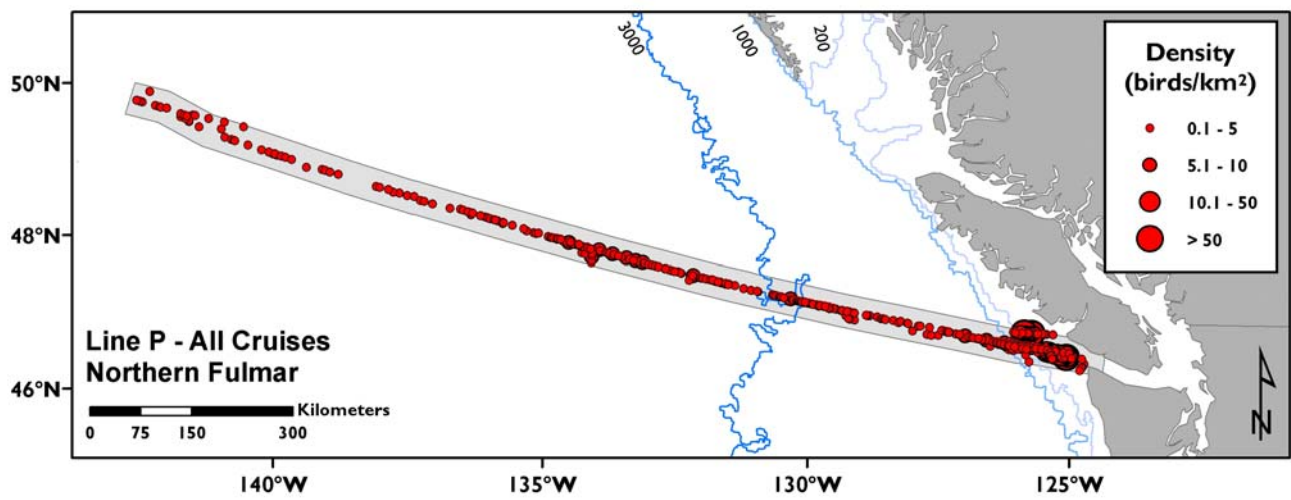




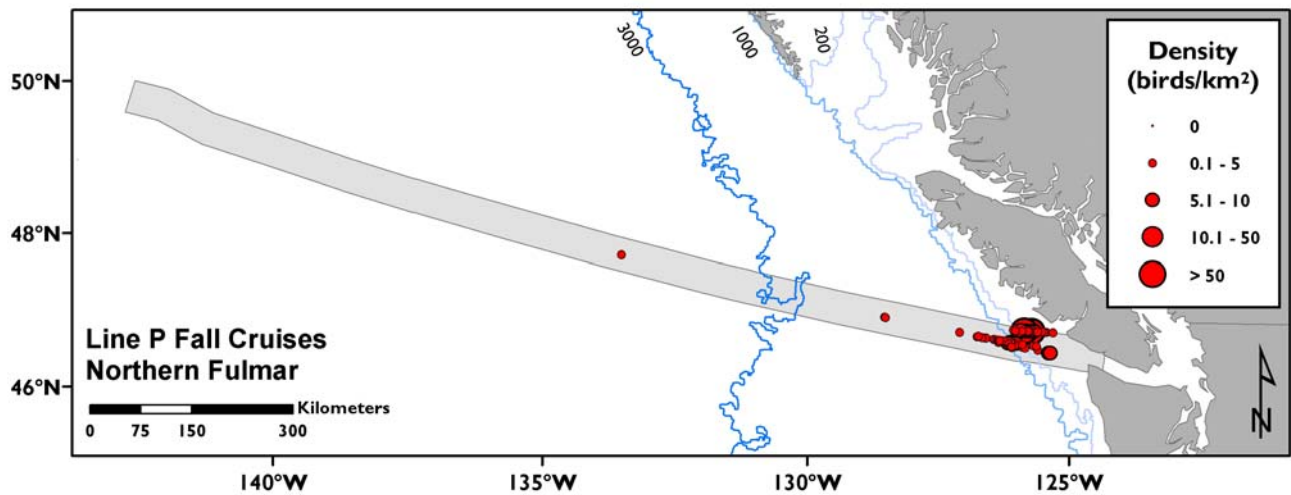
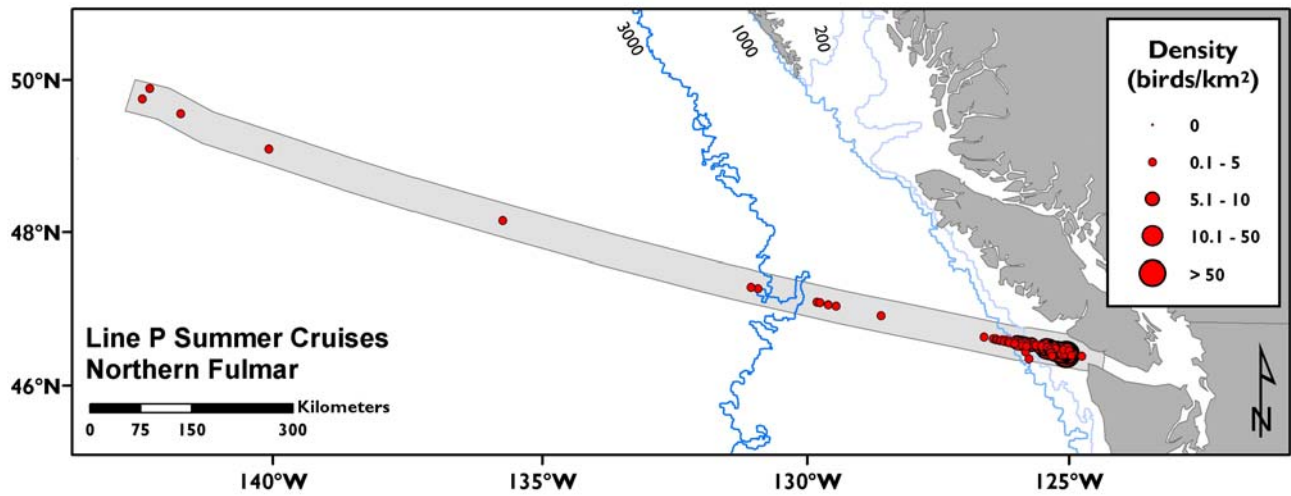
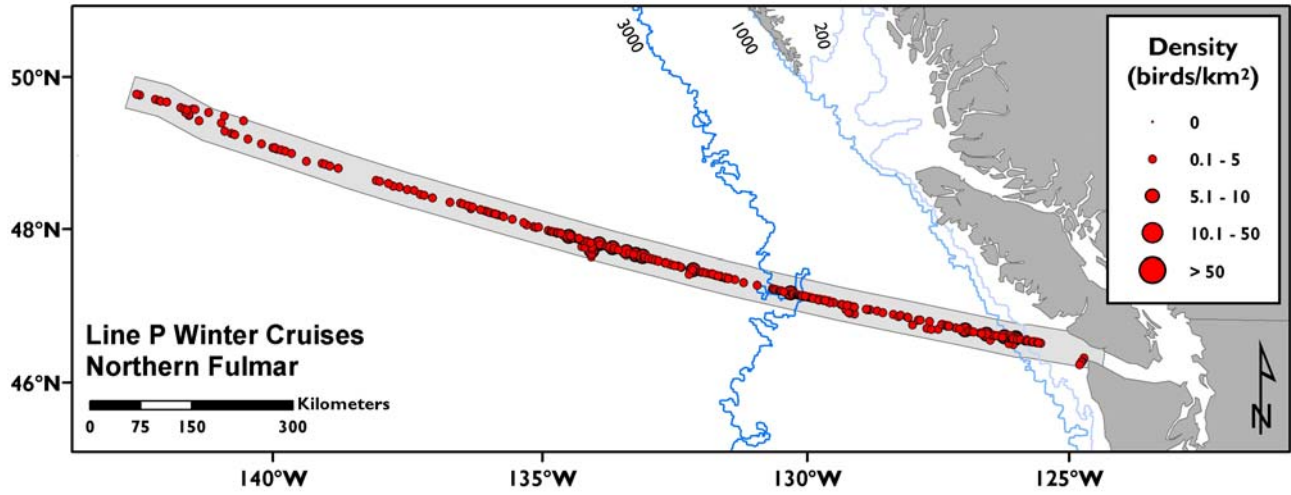




NMFS - All Cruises  
Northern Fulmar



Line P - All Cruises  
Northern Fulmar



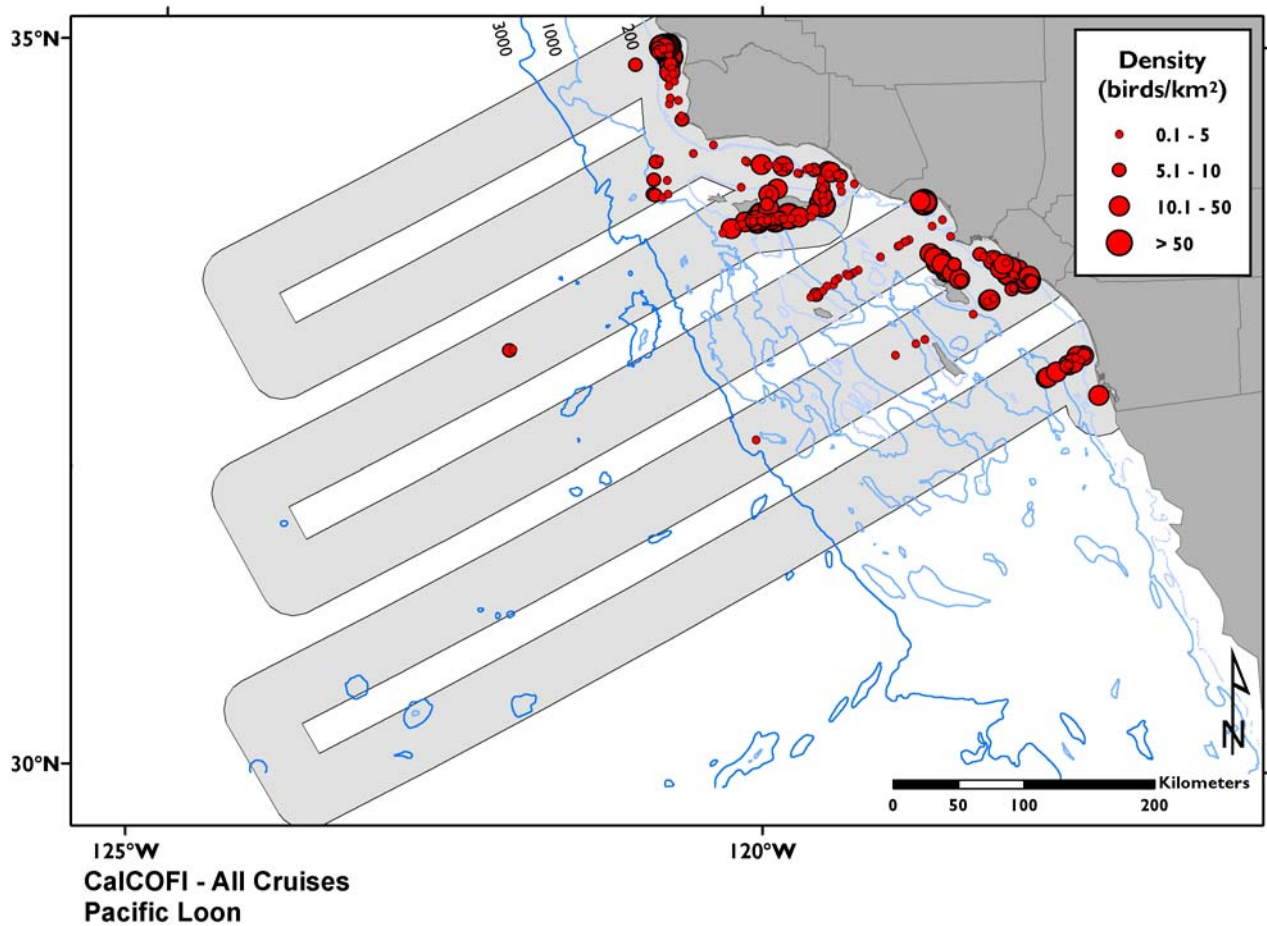


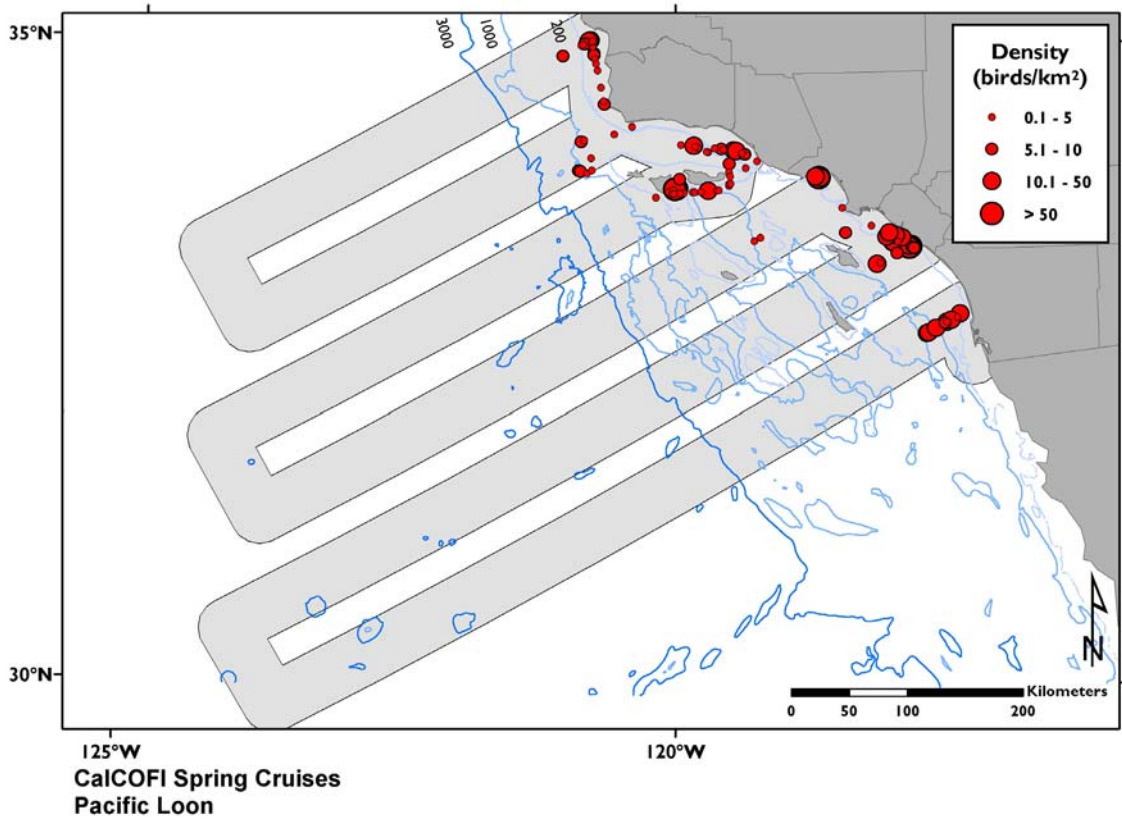
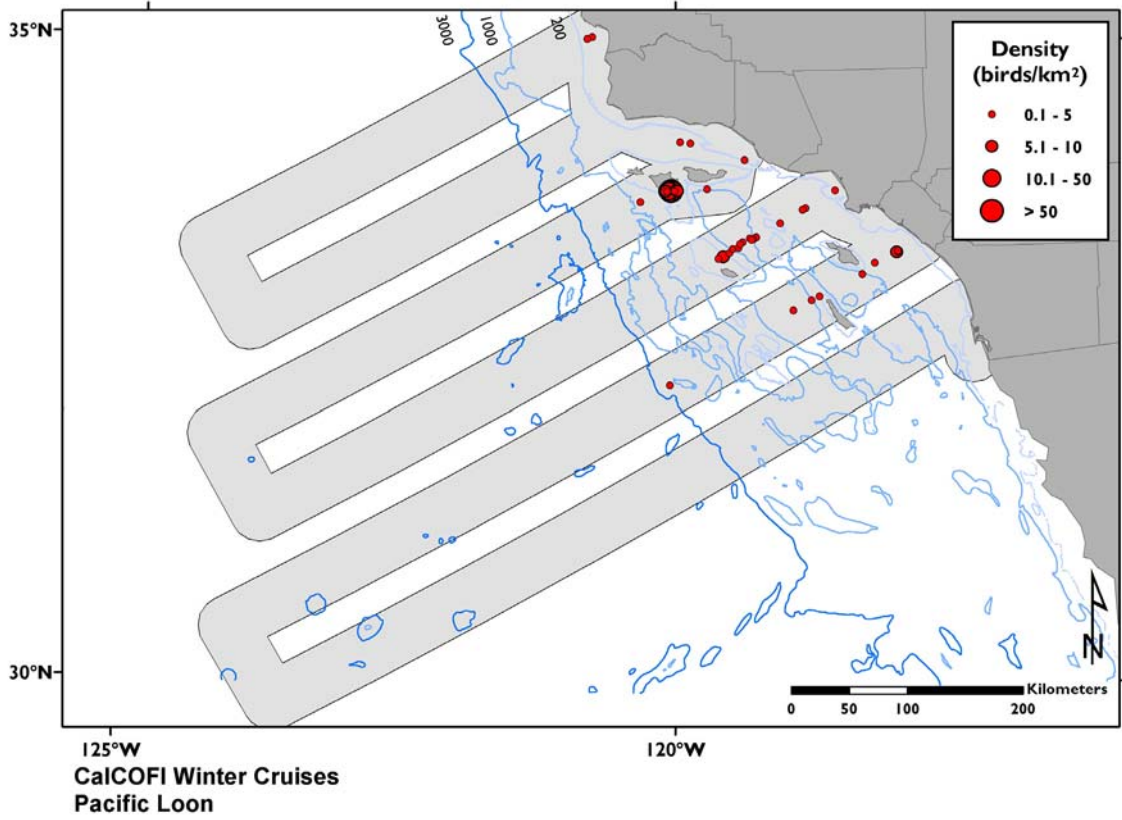
# Pacific Loon

*Gavia pacifica*

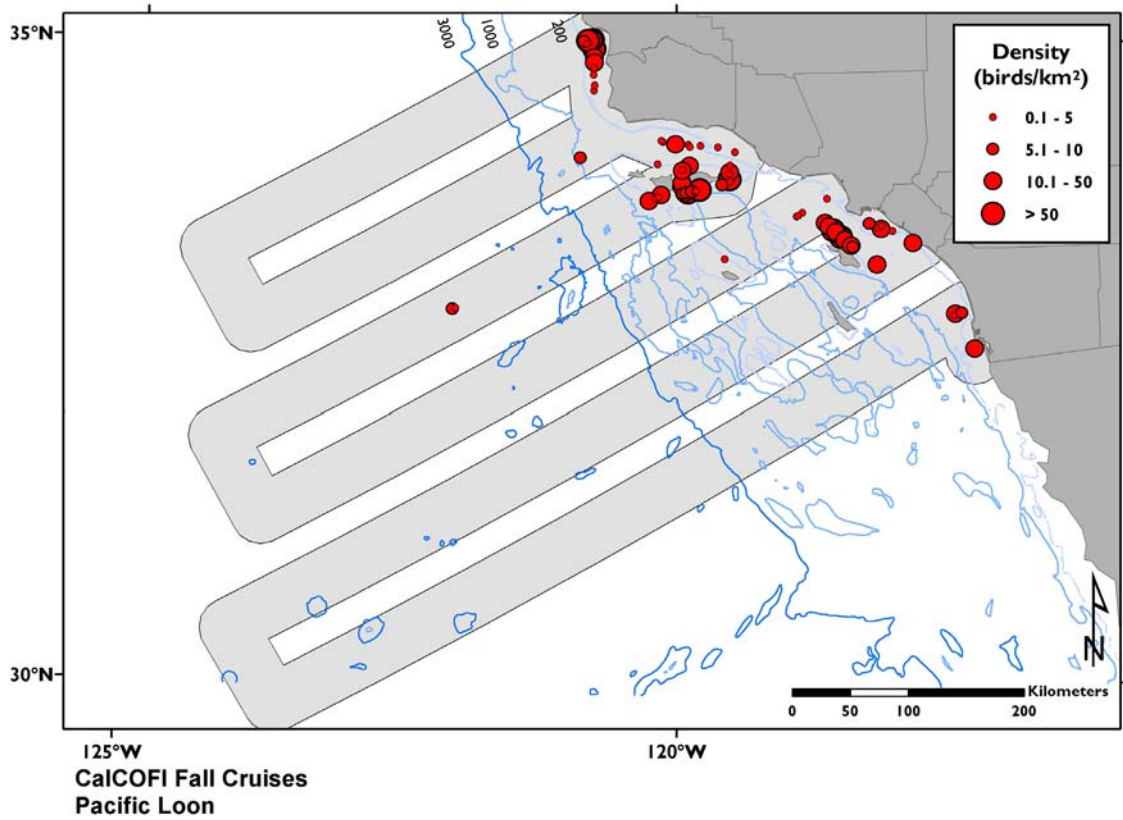
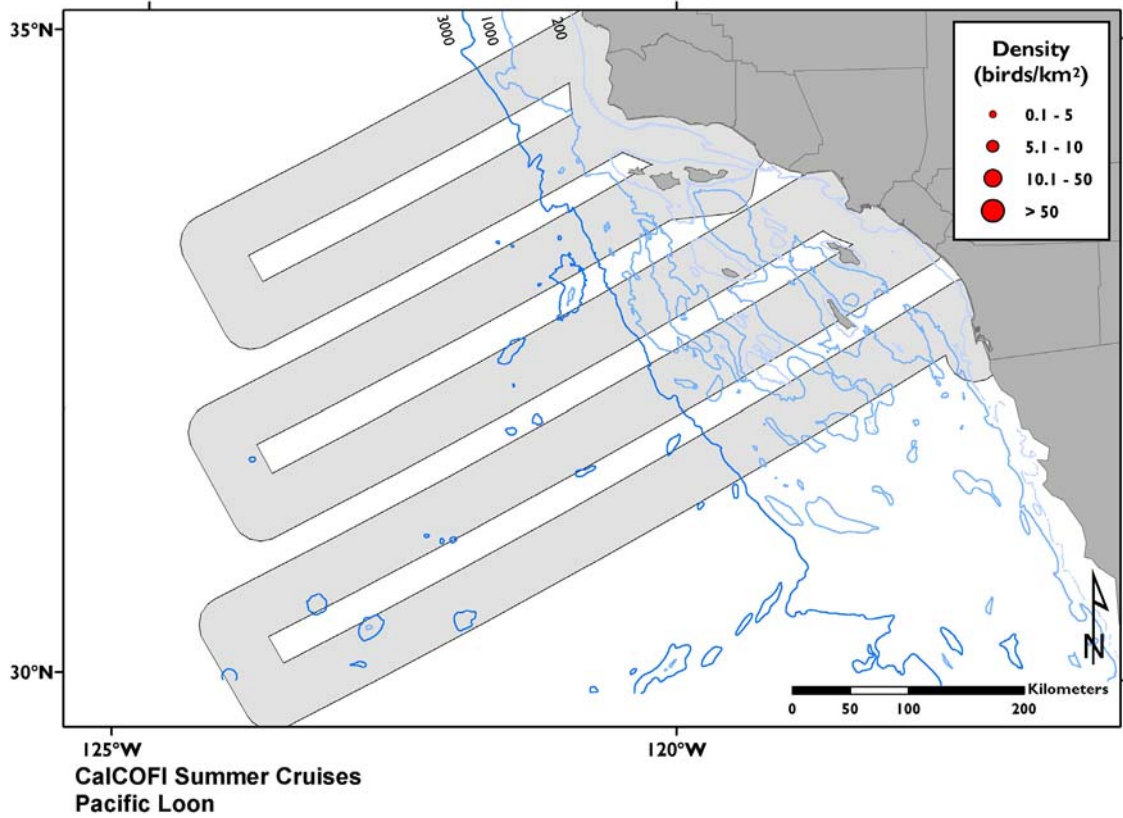


Pacific Loons (PALO) breed on Artic lakes during summer and are absent from the California Current System during this period. PALO generally occurred over the continental shelf and shelf-break, especially near the northern Channel Islands. Highest densities occurred in fall. Aggregations of PALO appeared to be highly variable between years. Marine foods consumed include fish and aquatic invertebrates (Russell 2002).









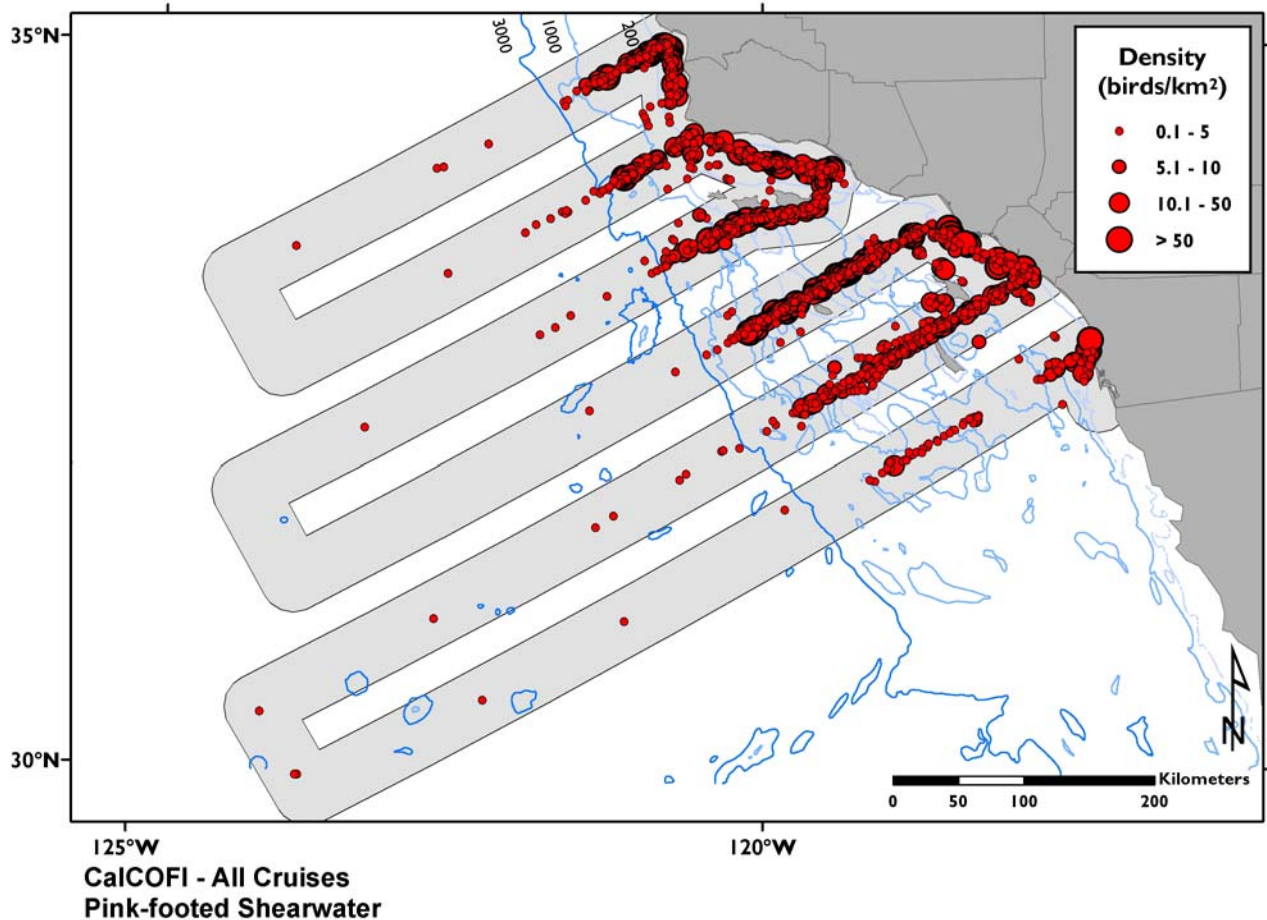


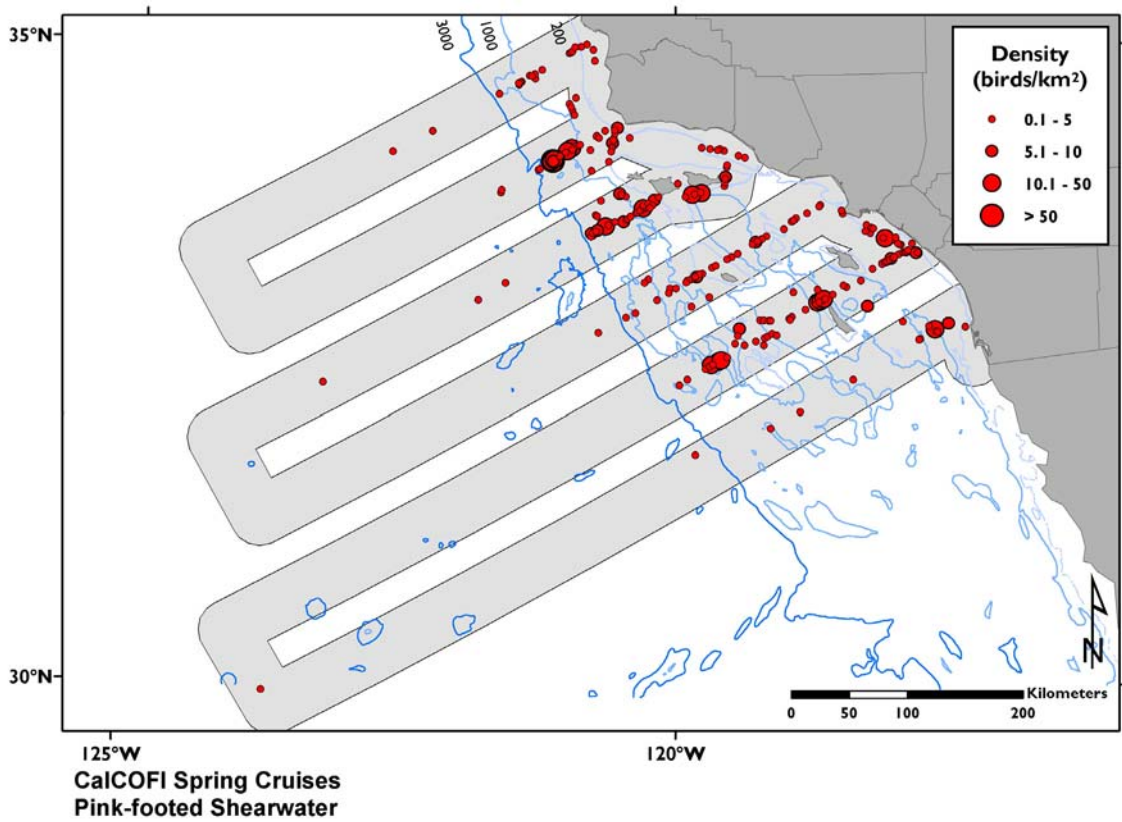
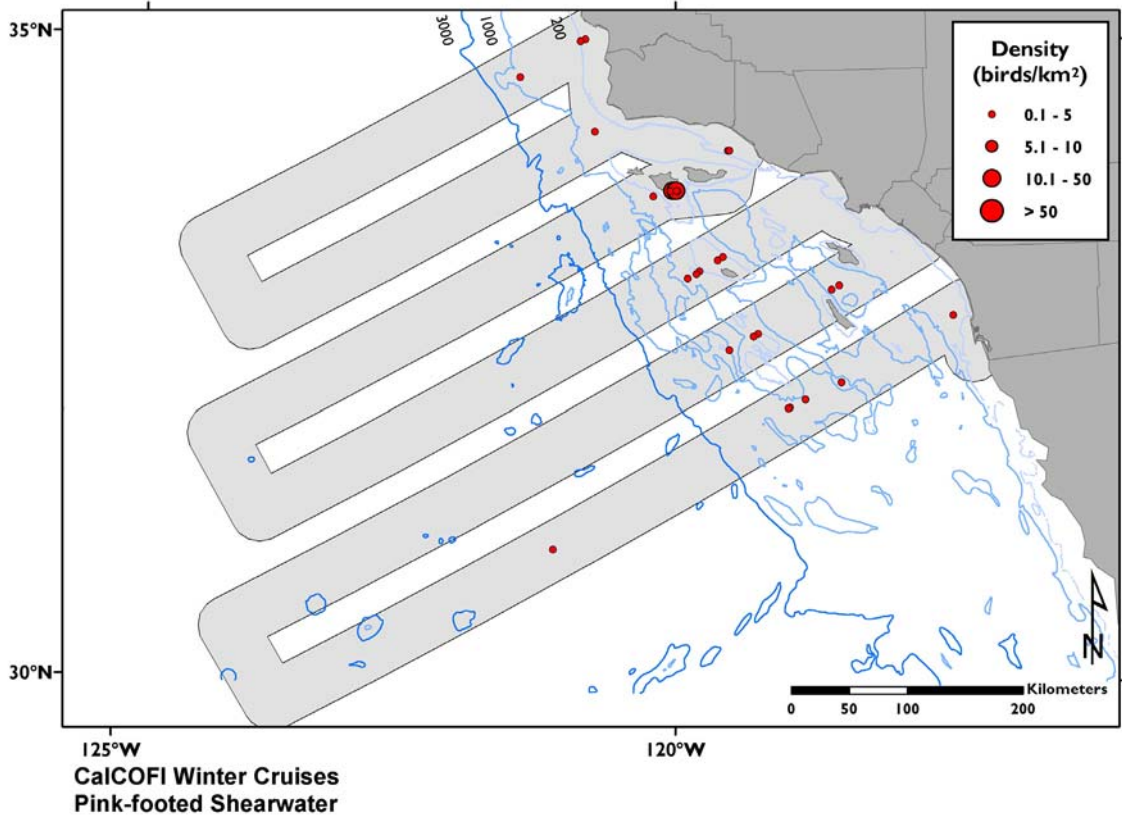
# *Pink-footed Shearwater*

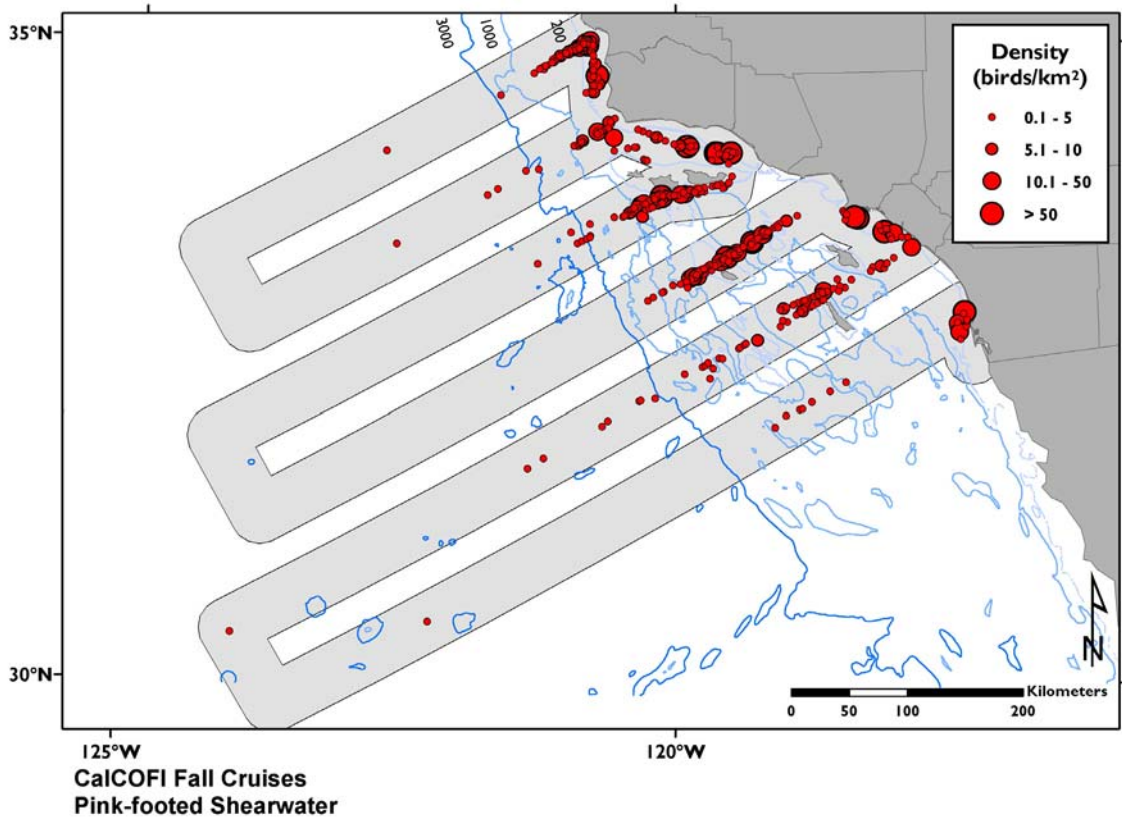
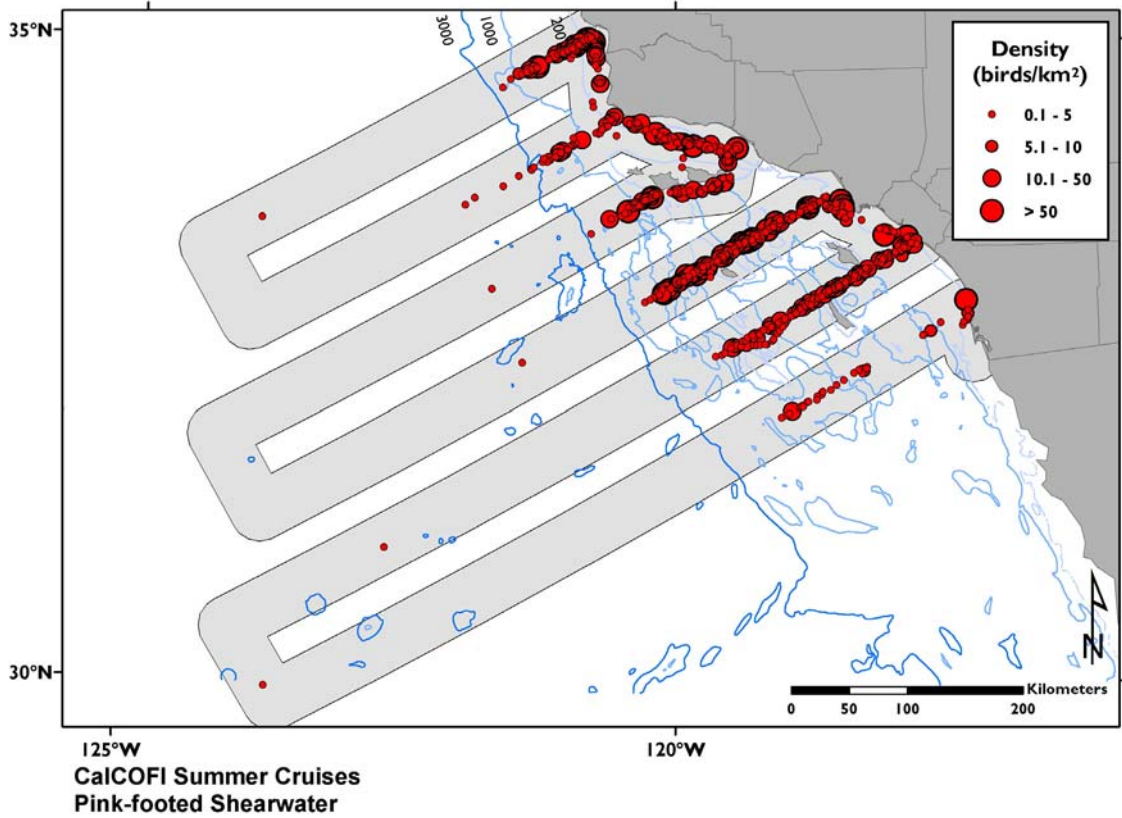
*Puffinus creatopus*

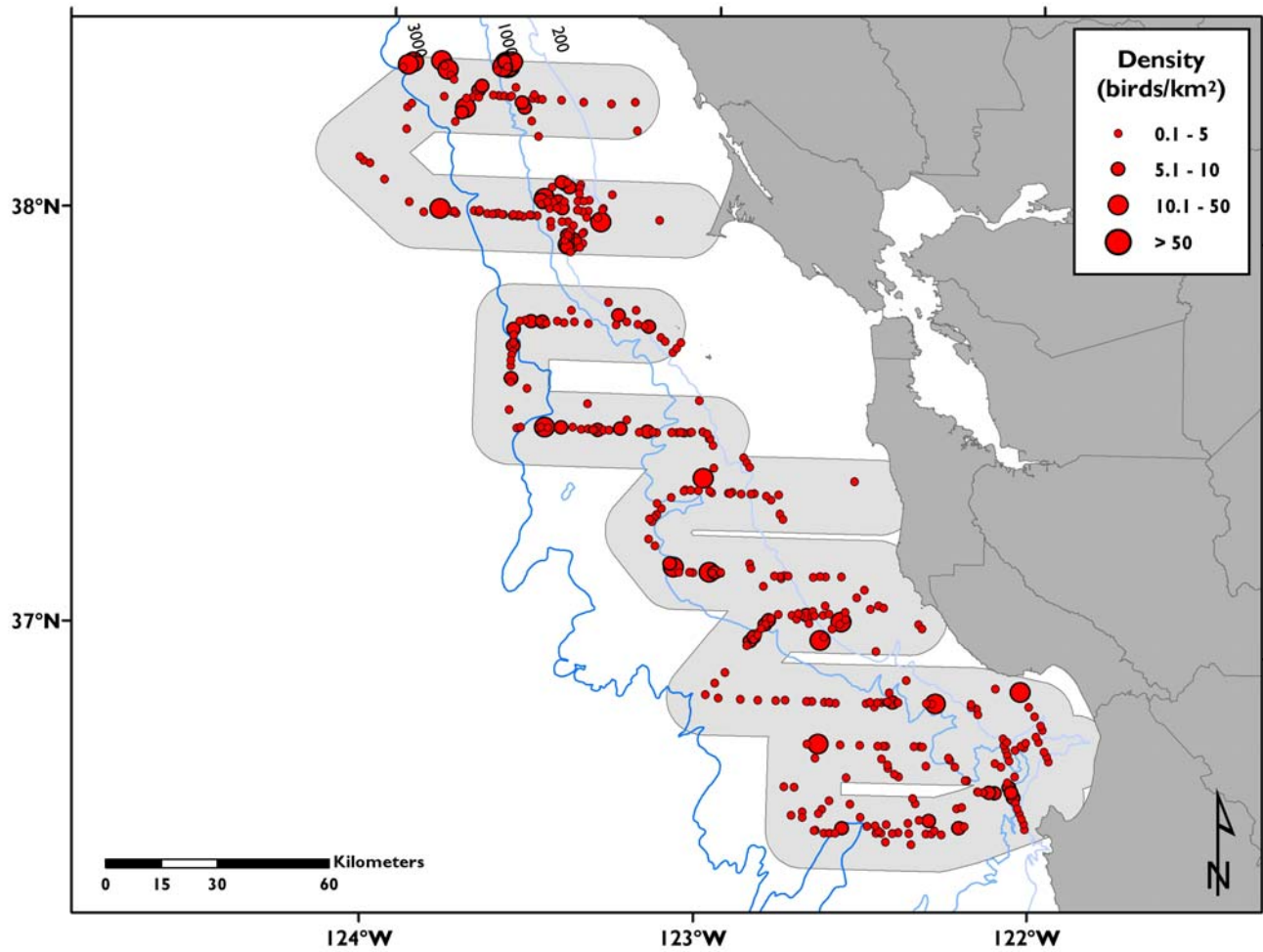


Pink-footed Shearwaters (PFSH) breed on islands off Chile in the austral spring. Numbers in the CalCOFI area increased in spring, peaked in summer, and dropped off in fall. PFSH appeared to show a preference for shelf and shelf-break habitats in all three CCS areas (Briggs et al. 1987; Morgan et al. 1991).

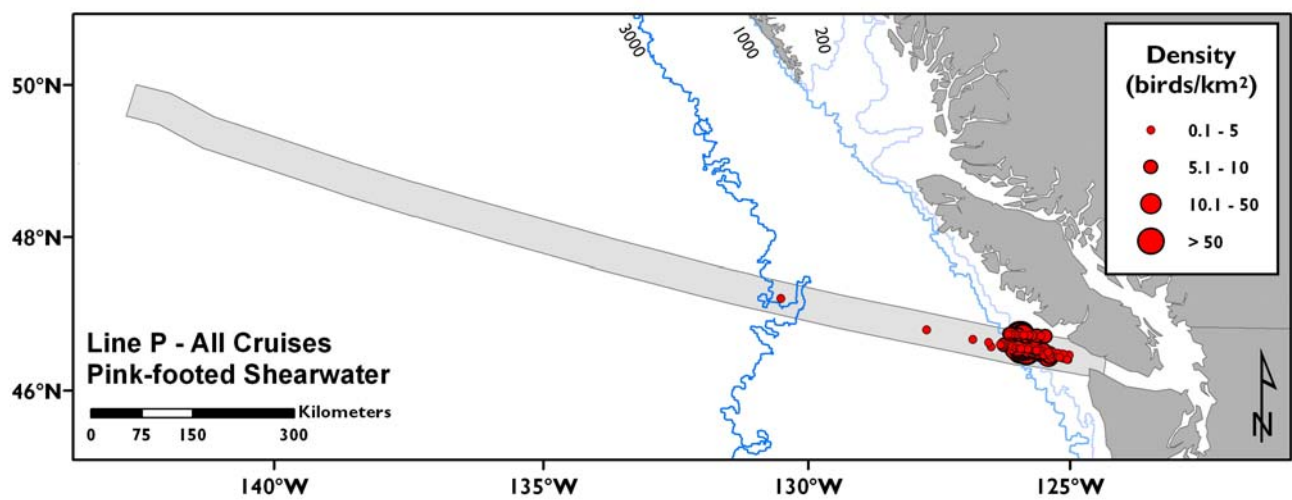




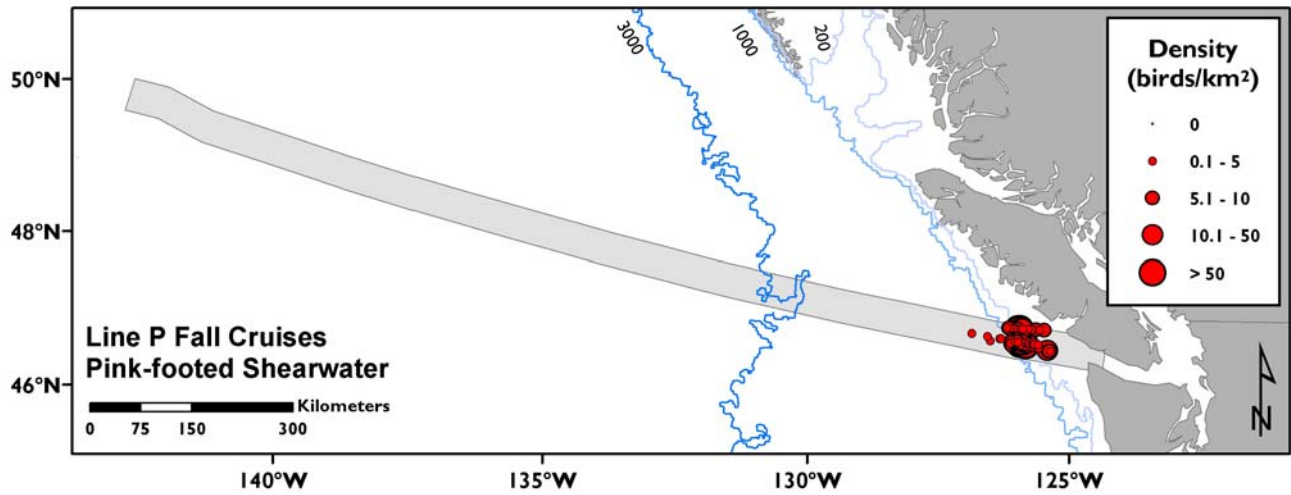
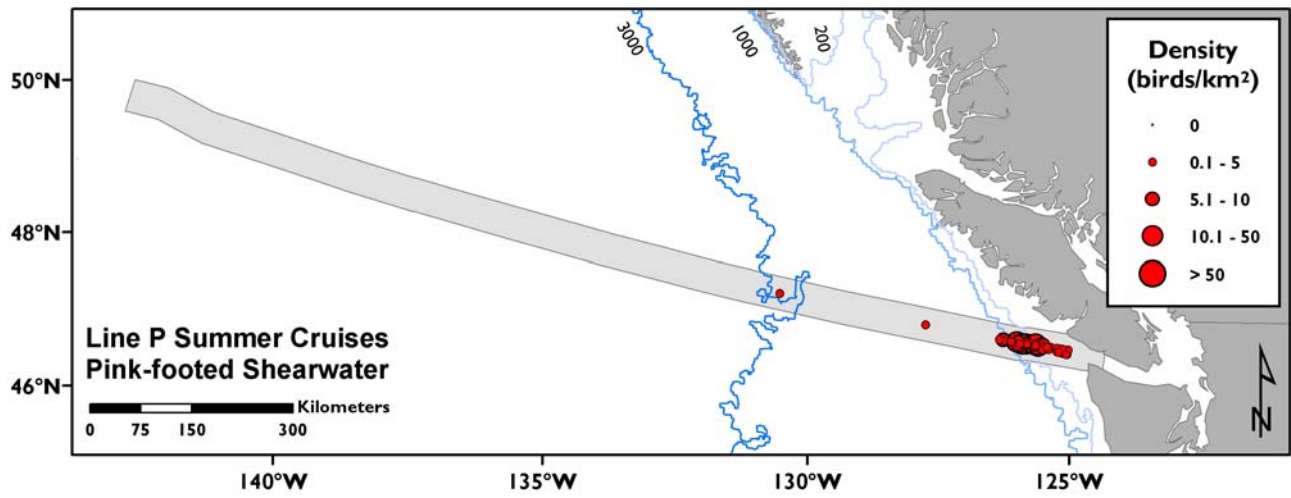
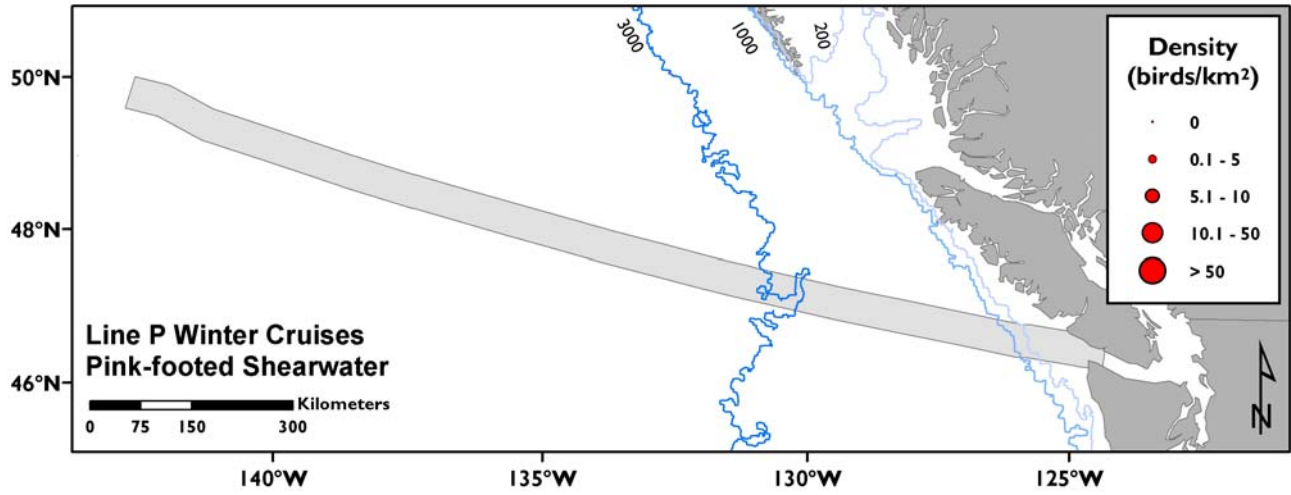




NMFS - All Cruises  
Pink-footed Shearwater



Line P - All Cruises  
Pink-footed Shearwater





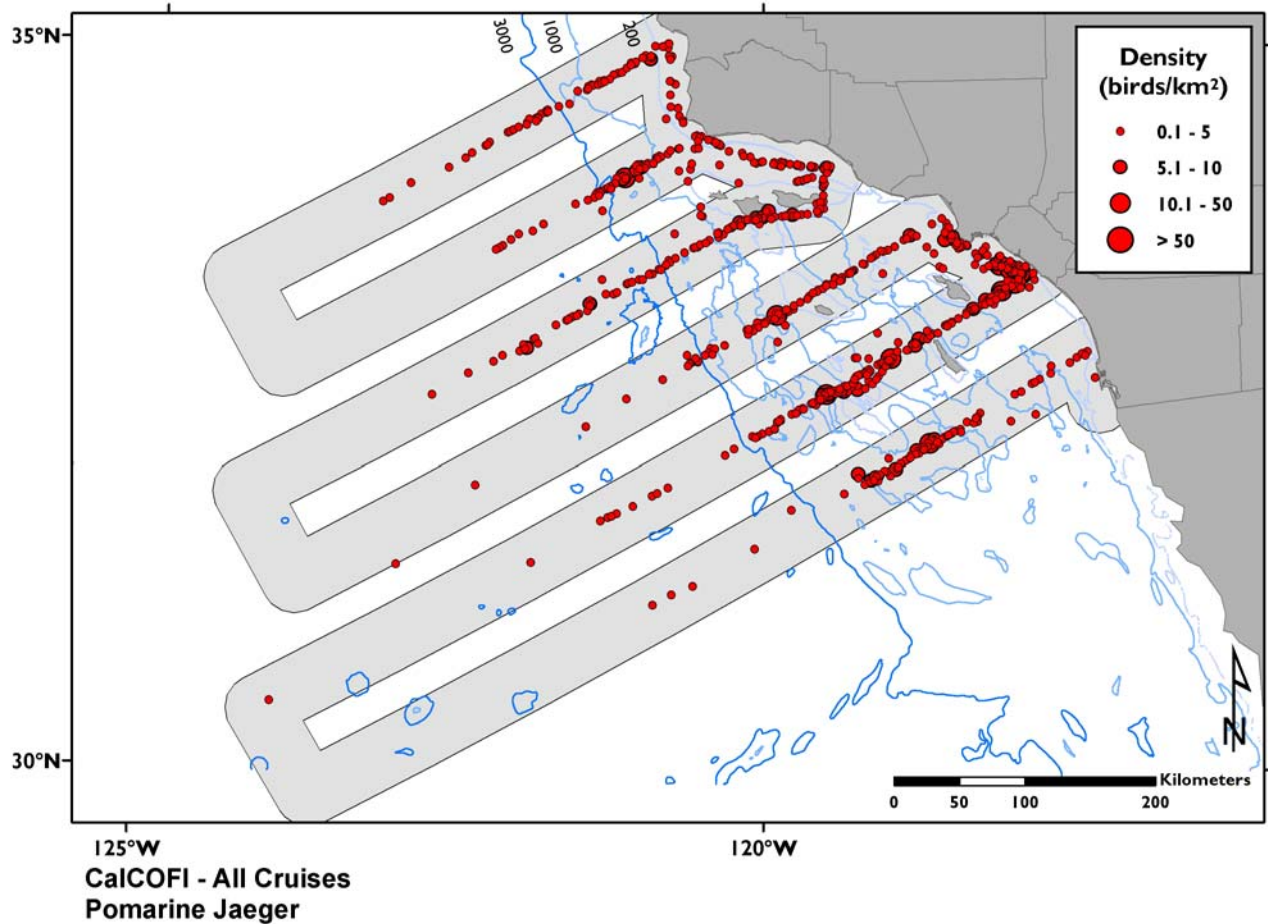


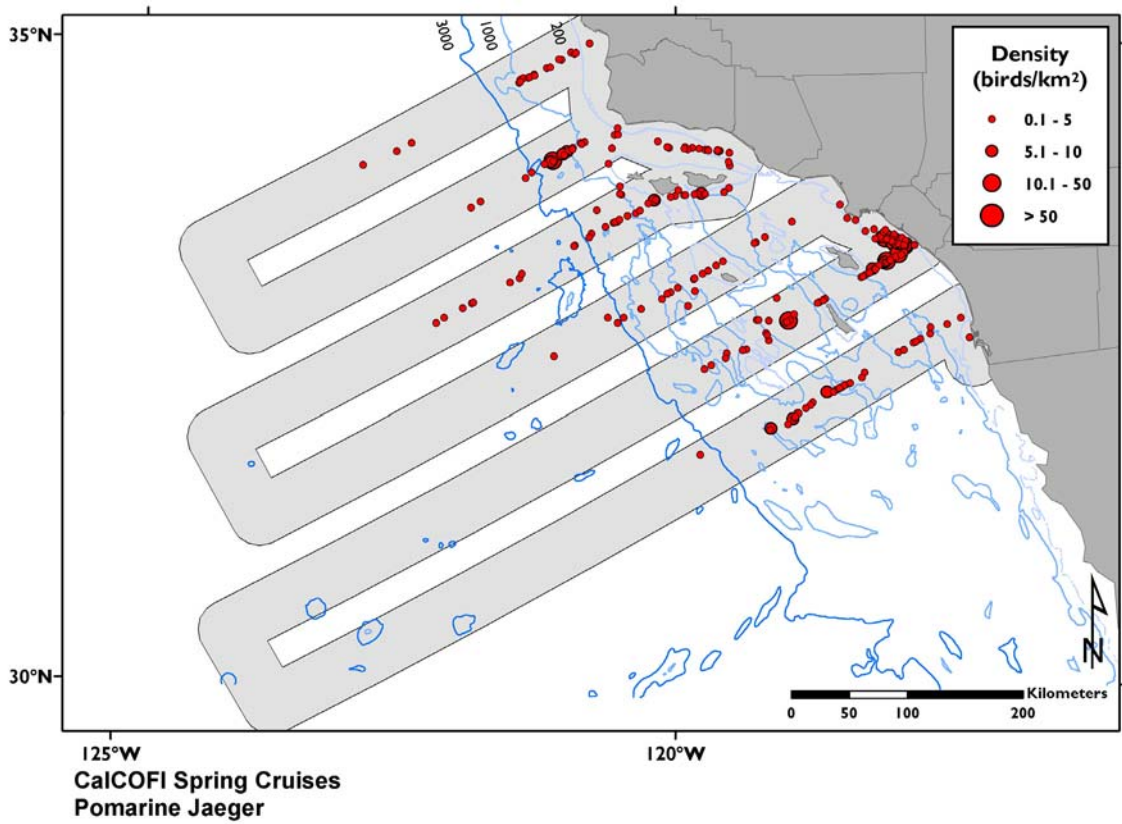
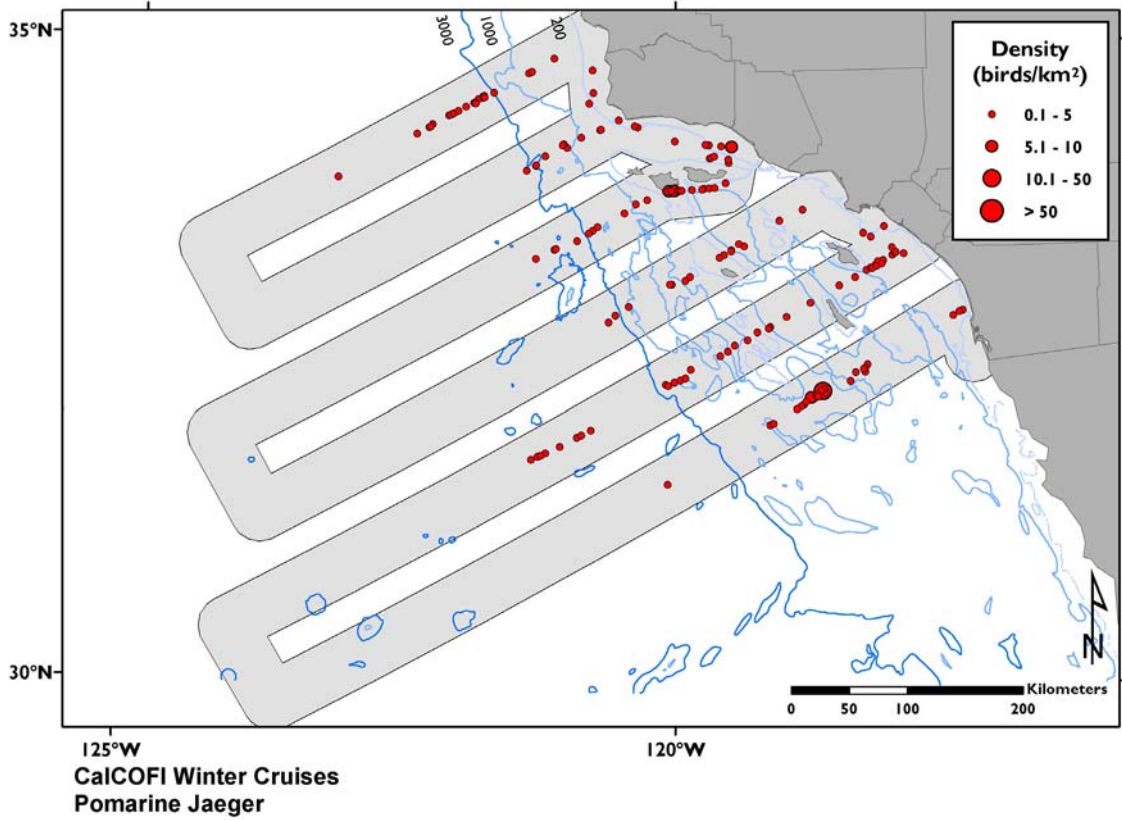
# Pomarine Jaeger

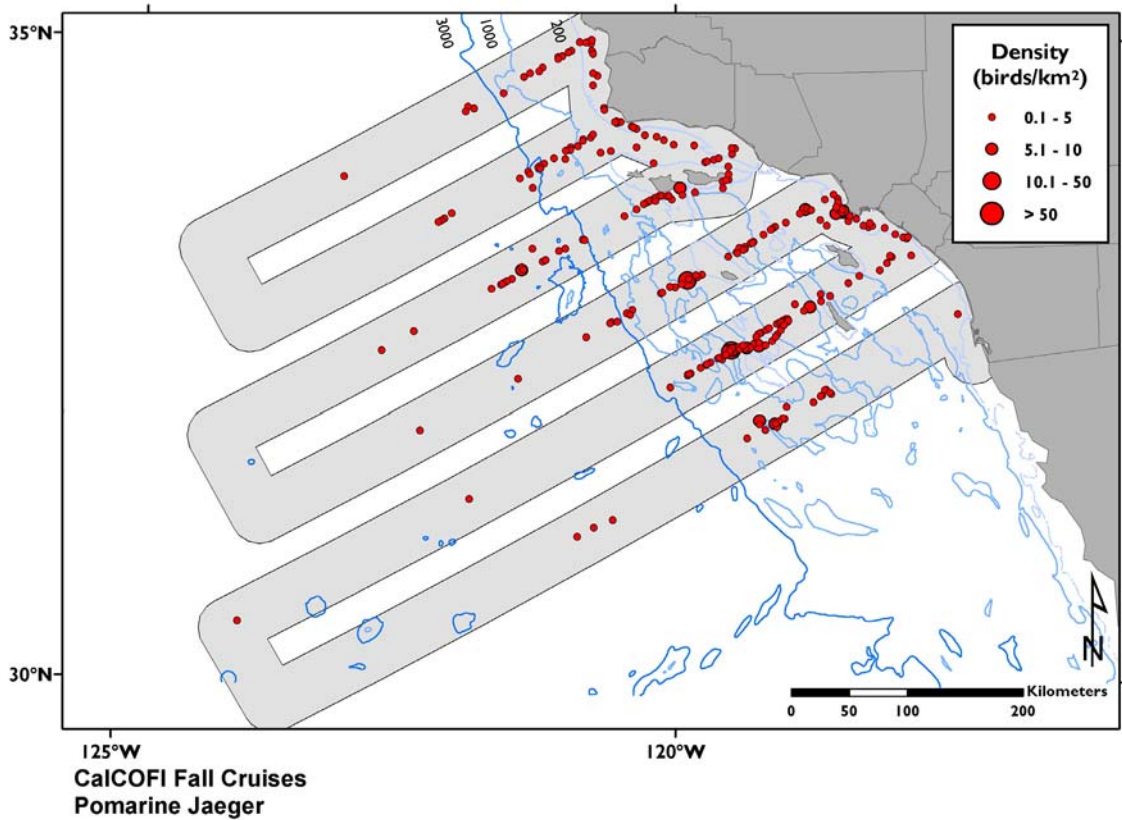
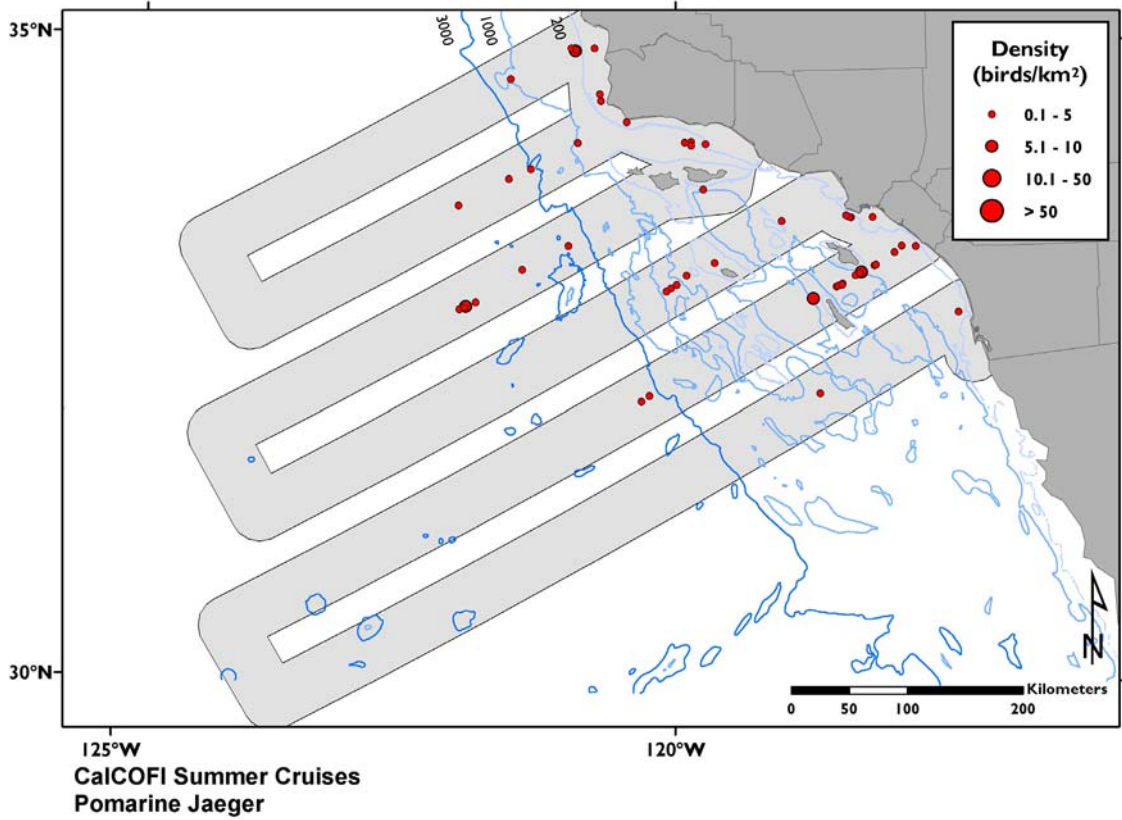
*Stercorarius pomarinus*



The main foraging habits of Pomarine Jaegers (POJA) include scavenging, kleptoparasitism, and predation of small seabirds. In the CalCOFI study area, POJA are most often observed over depths < 3000 m (Wiley and Lee 2000). POJA abundance varied seasonally, with fewer birds occurring in summer when the majority of POJA have already migrated to their Arctic nesting grounds..







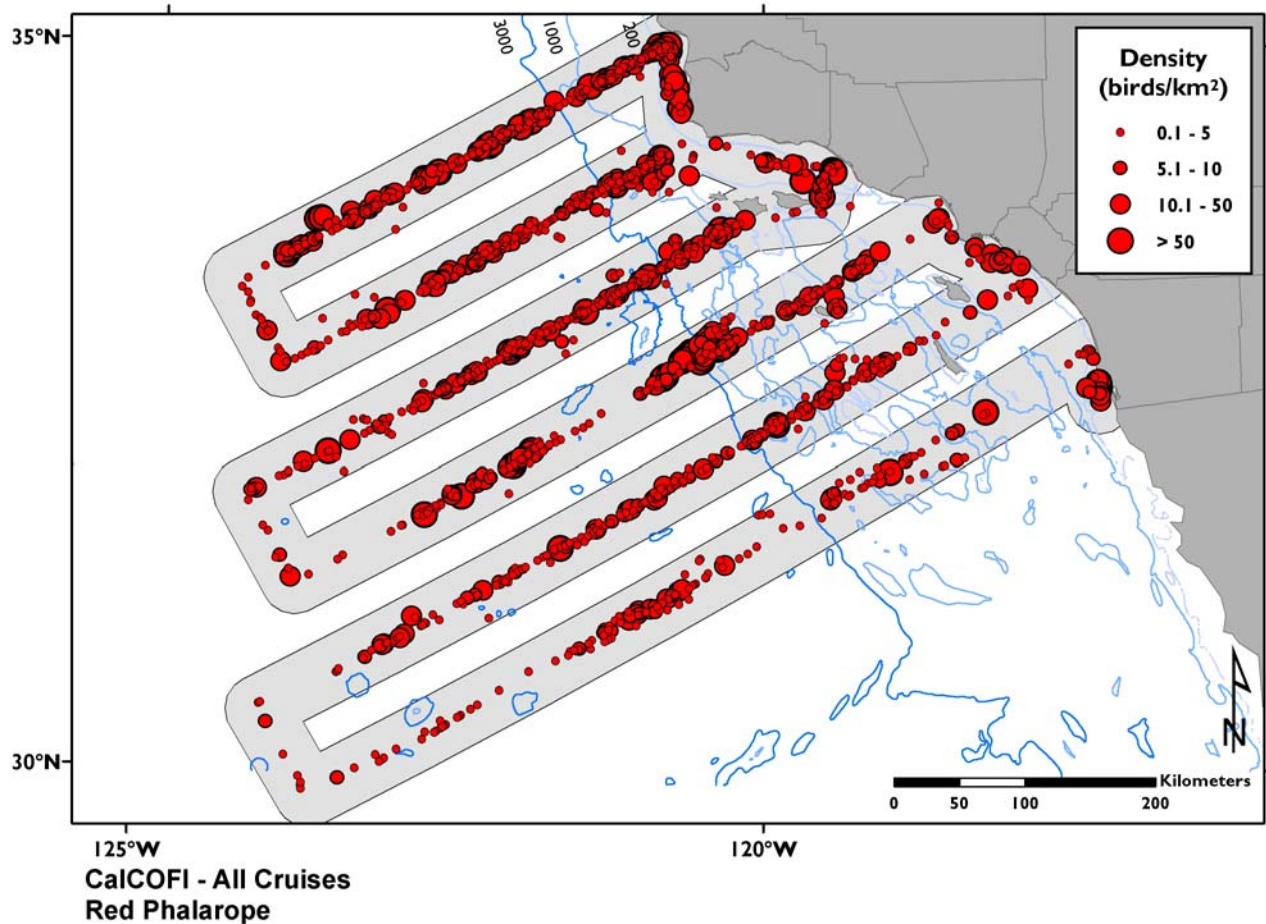


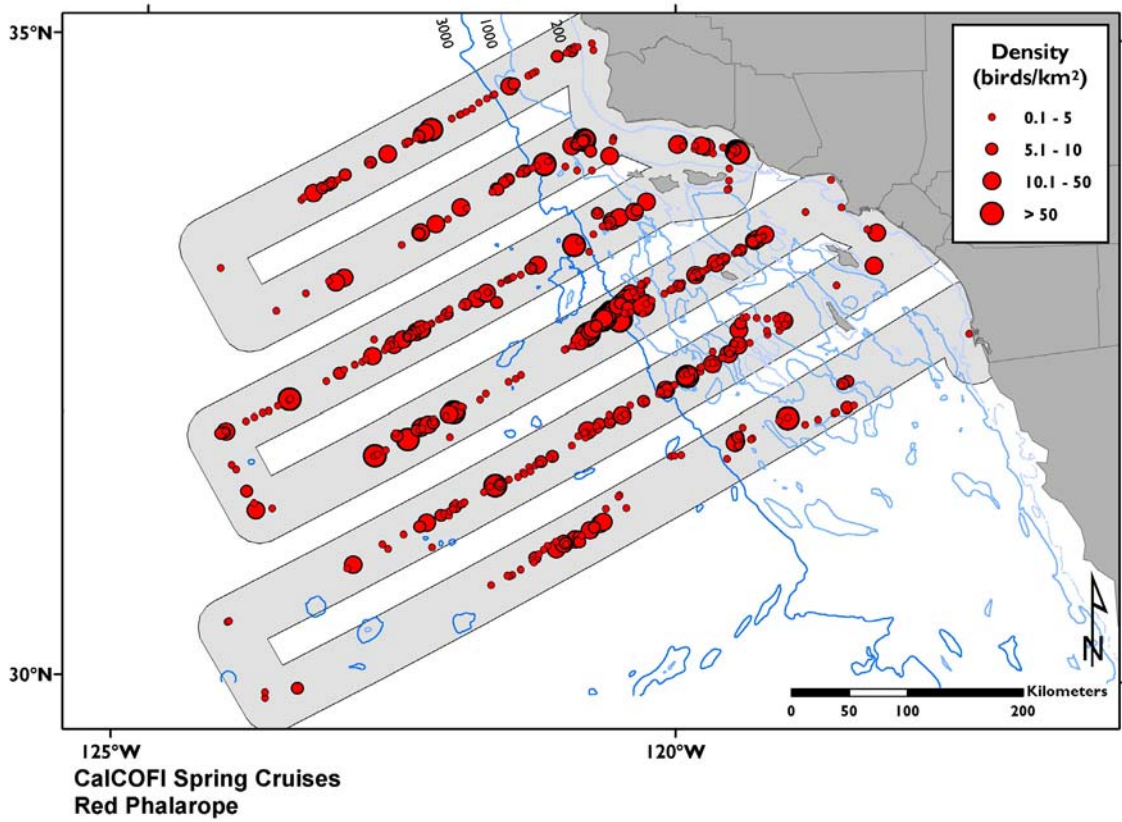
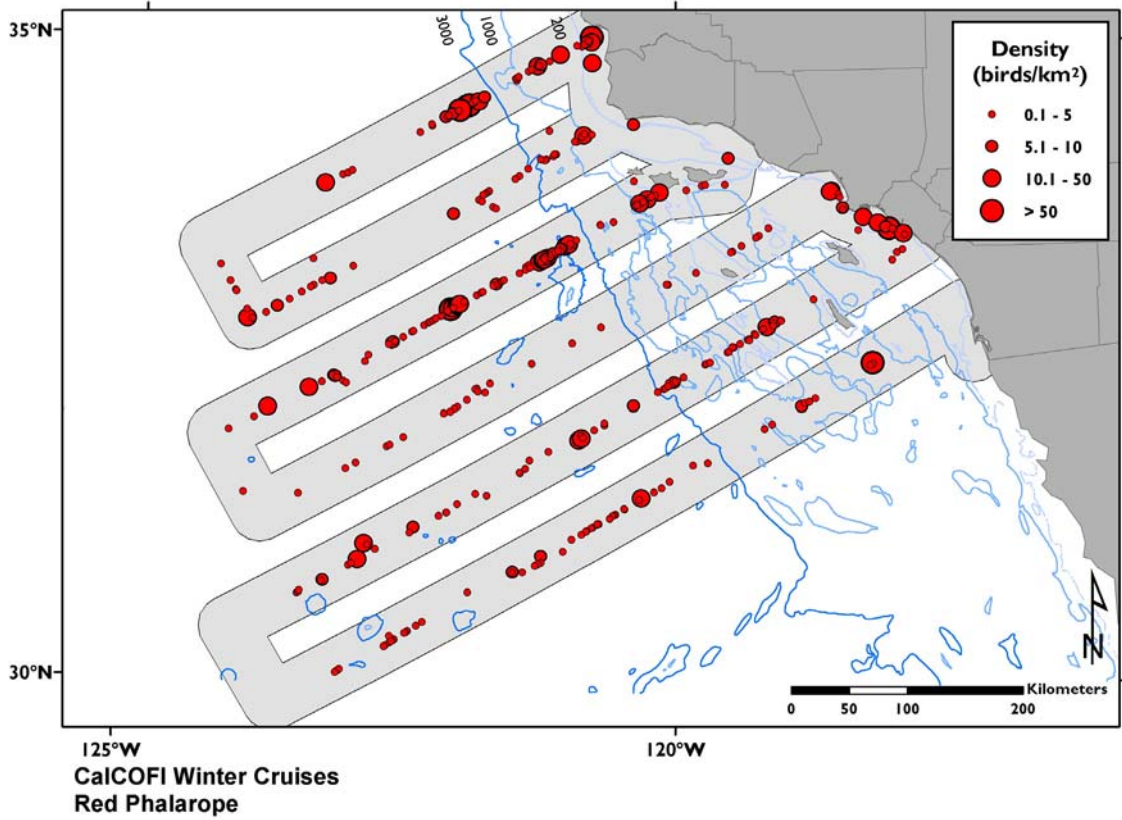
## Red Phalarope

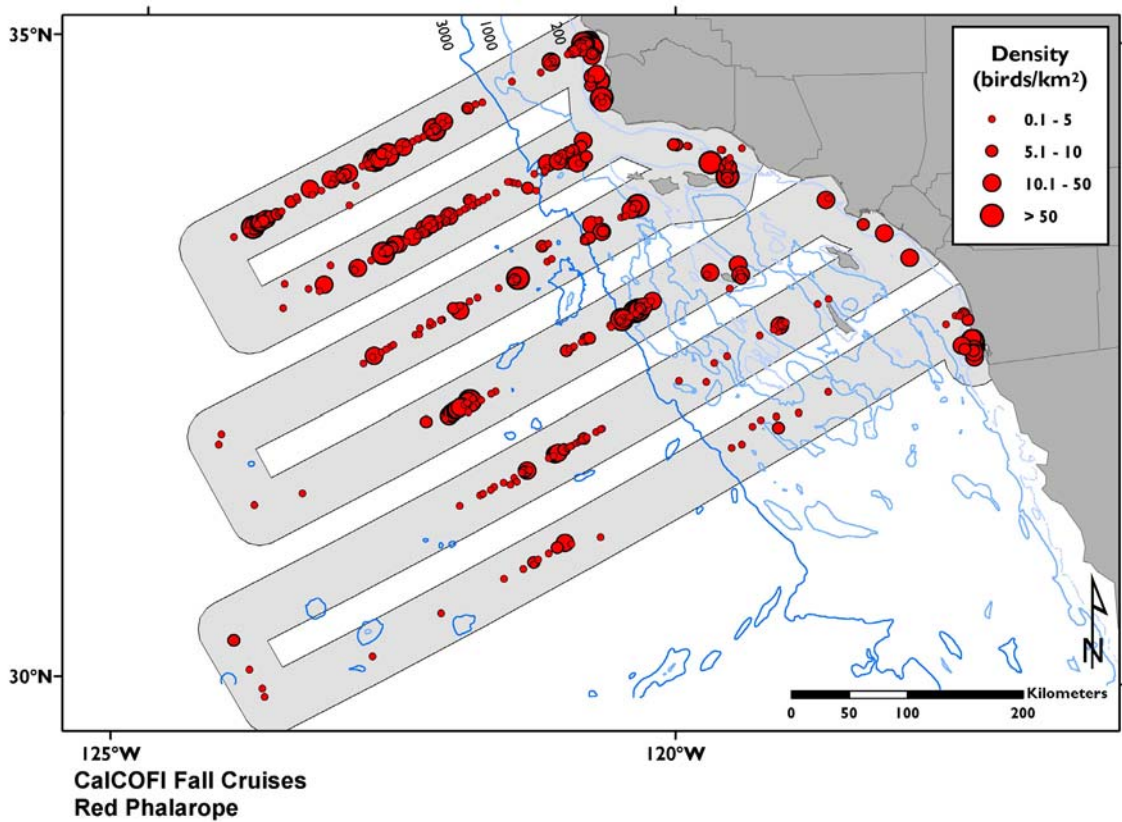
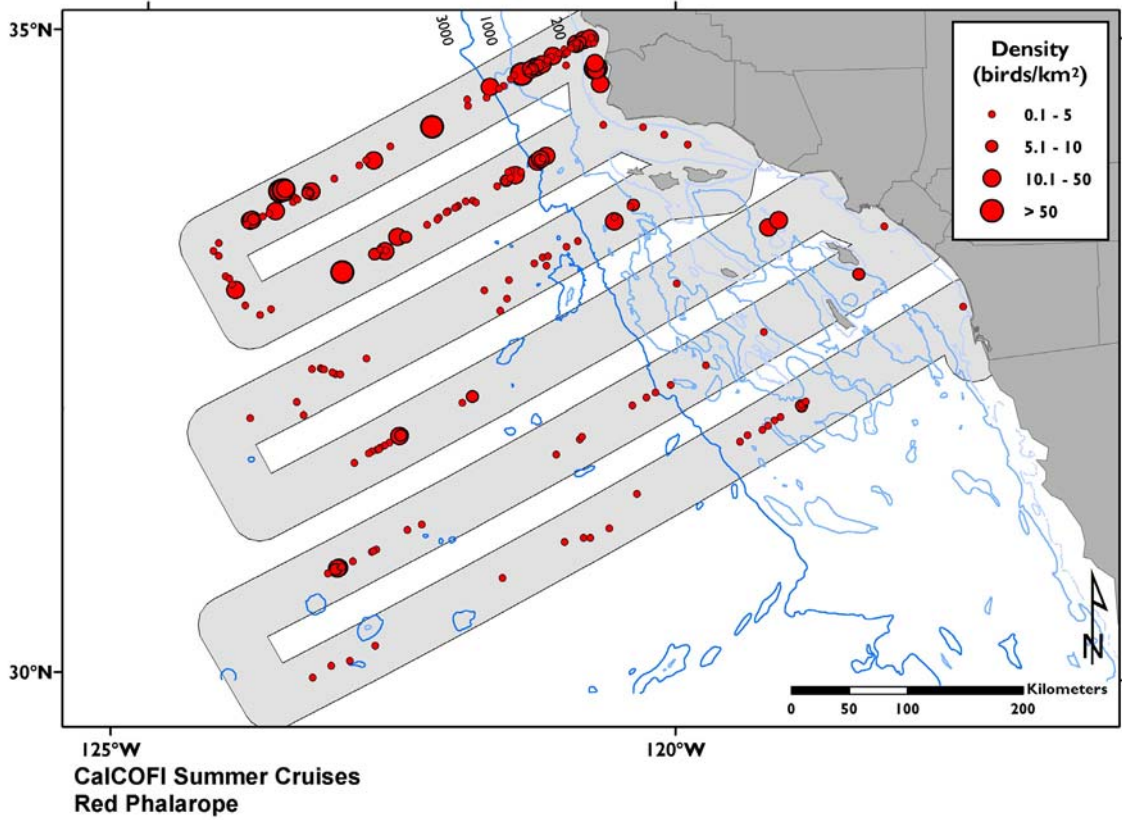
*Phalaropus fulicarius*



Red Phalaropes (REPH) are the most pelagic of the three phalarope species. REPH were present in the study area during all seasons though their abundances vary across years. The highest densities of REPH occurred over the slope.









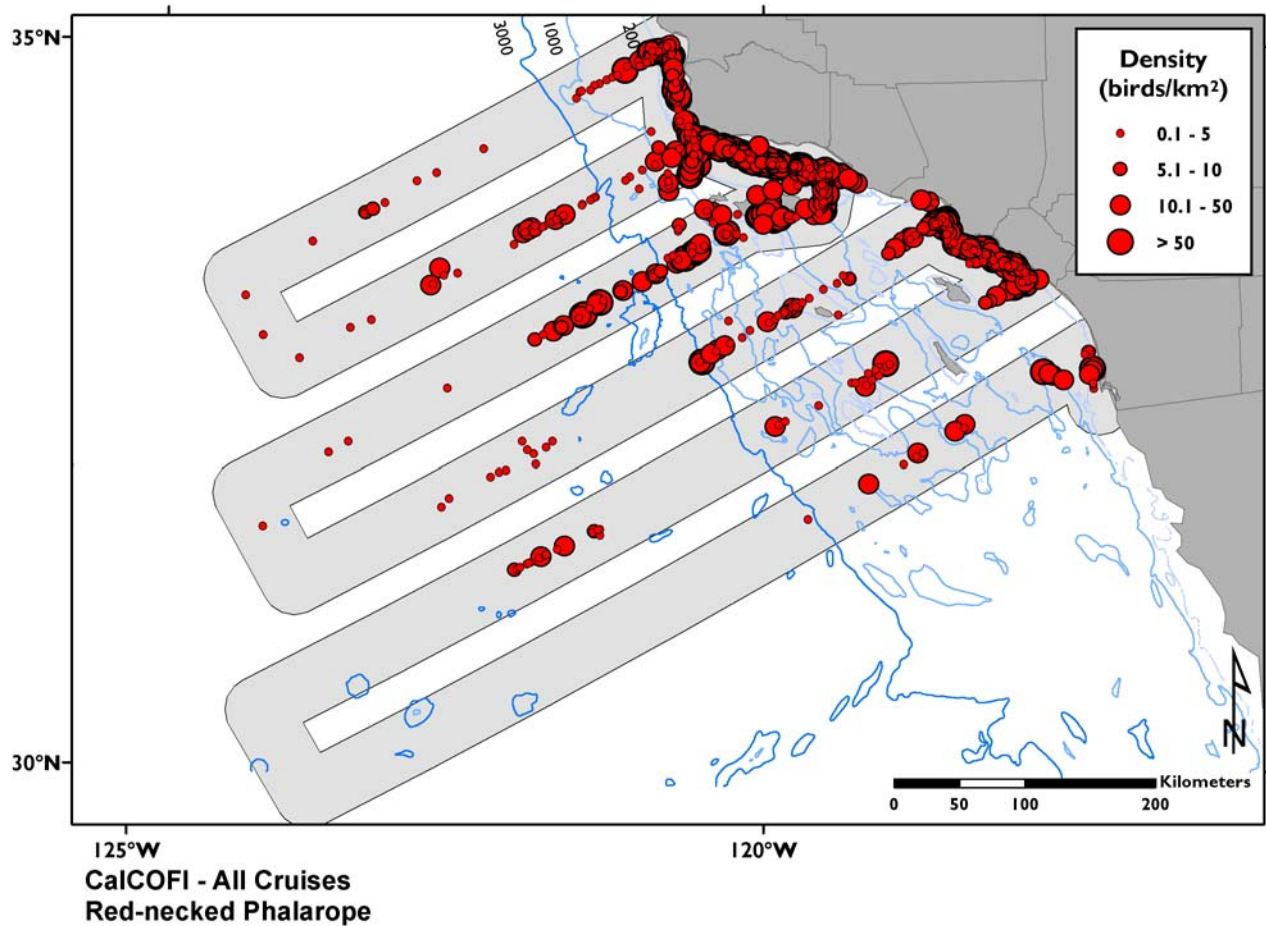


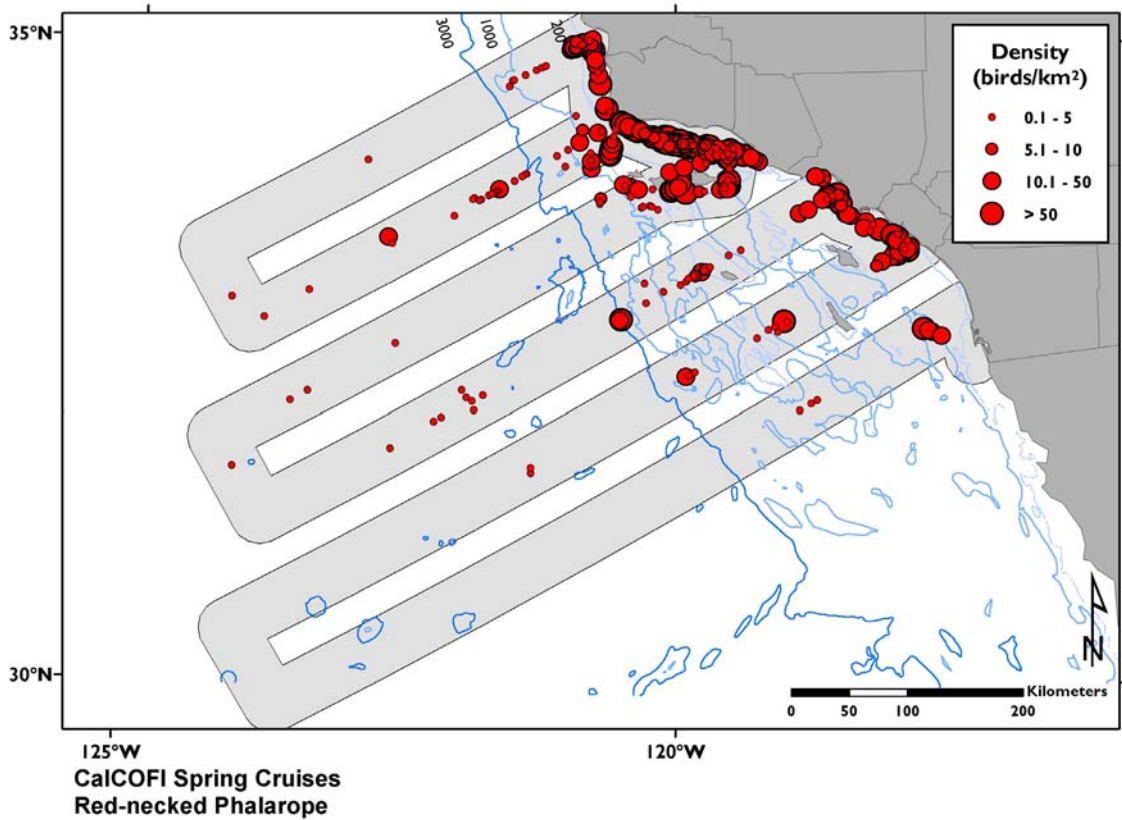
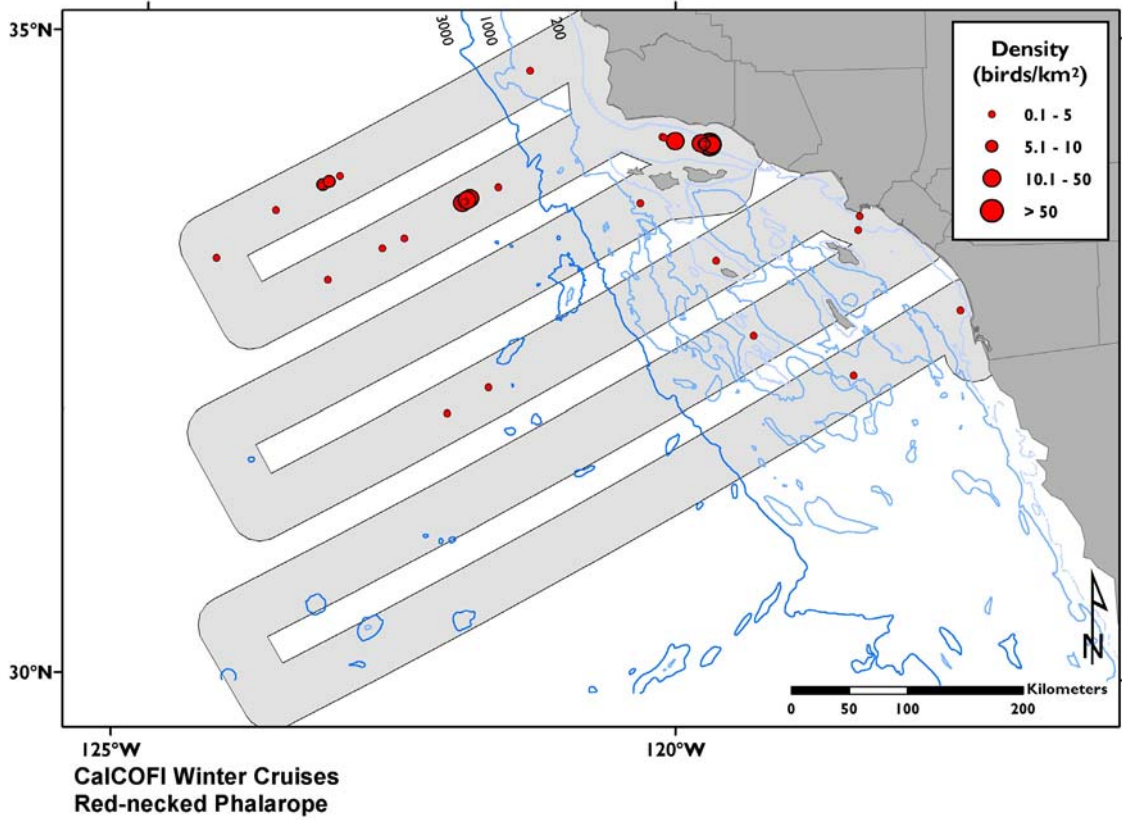
# Red-necked Phalarope

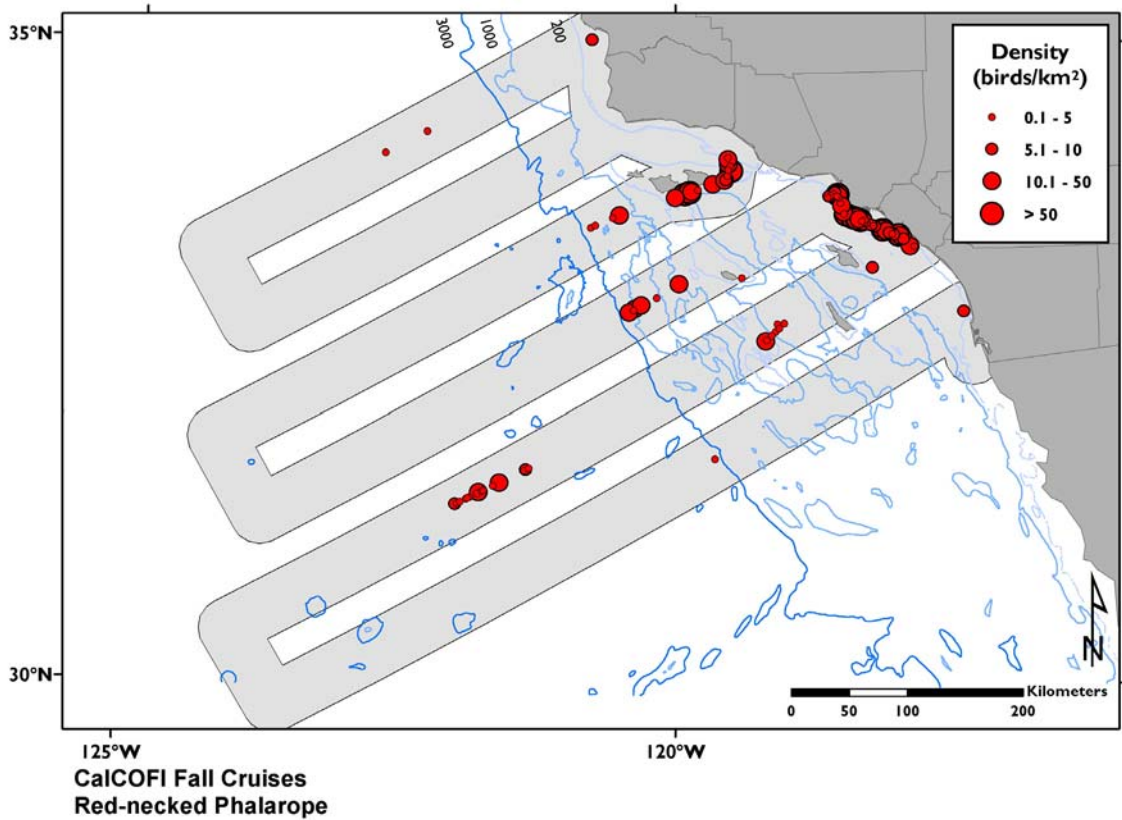
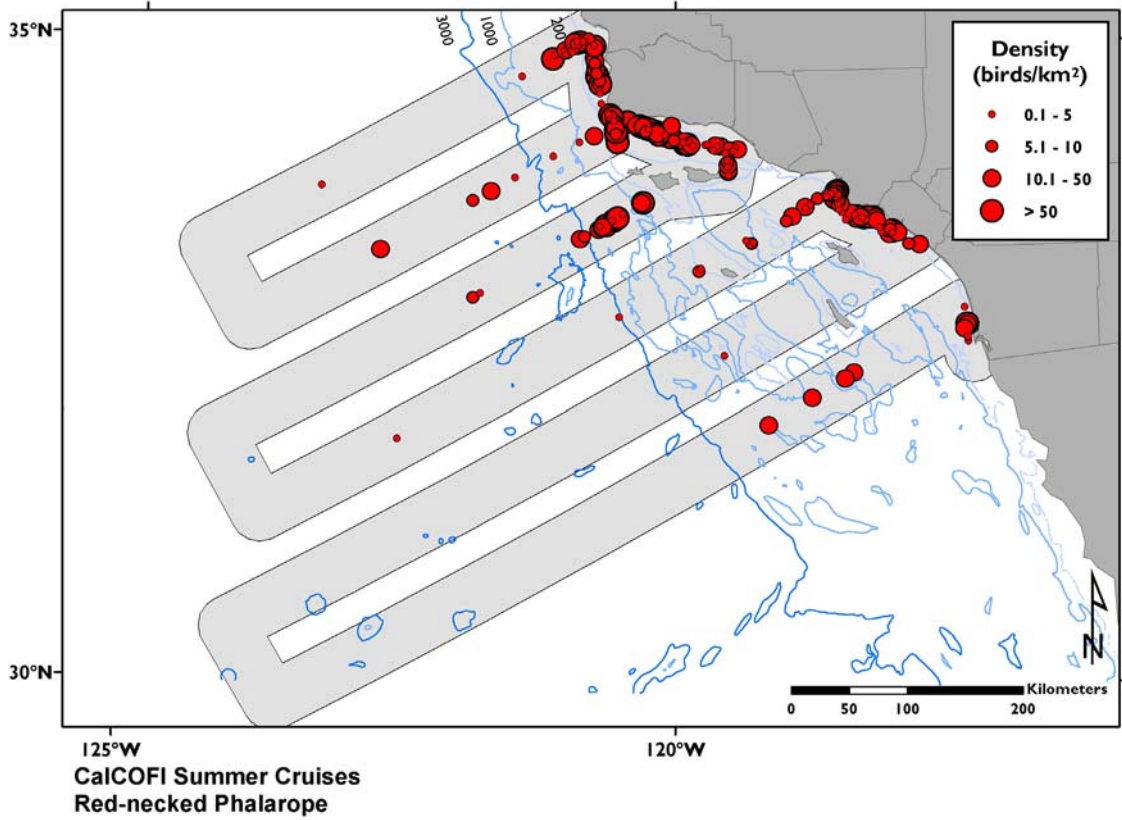
*Phalaropus lobatus*

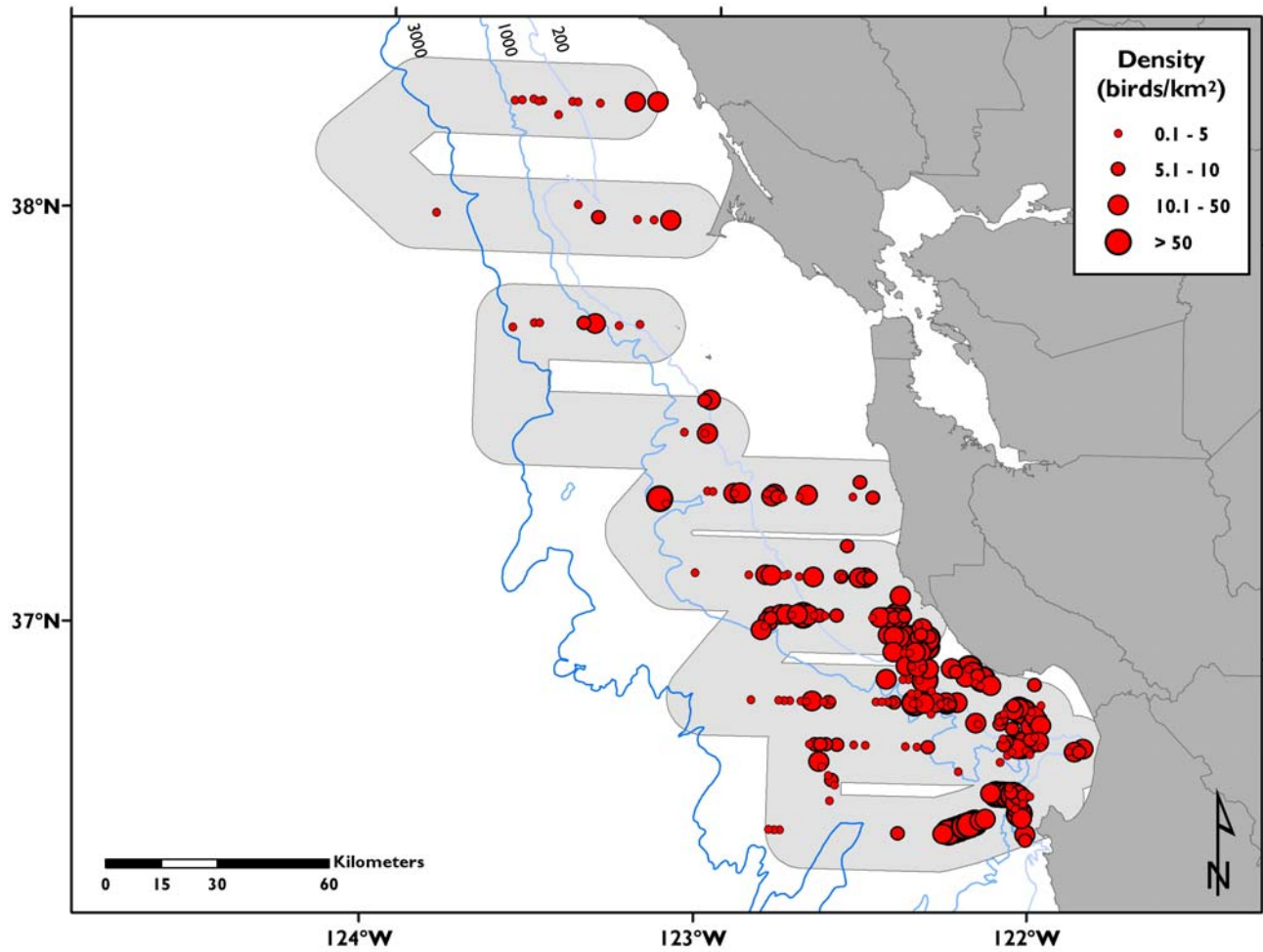


Red-necked Phalaropes (RNPH) were most abundant in the CalCOFI study area in spring. Winter surveys documented the lowest densities. The highest seasonal densities occurred over the continental shelf, although RNPH were also observed in deep offshore waters. In the NMFS study area, RNPH were found south of Point Bonita, especially in the vicinity of Monterey Bay. The diet of RNPH consists primarily of small marine invertebrates including euphausiids and copepods (Rubega et al. 2000).

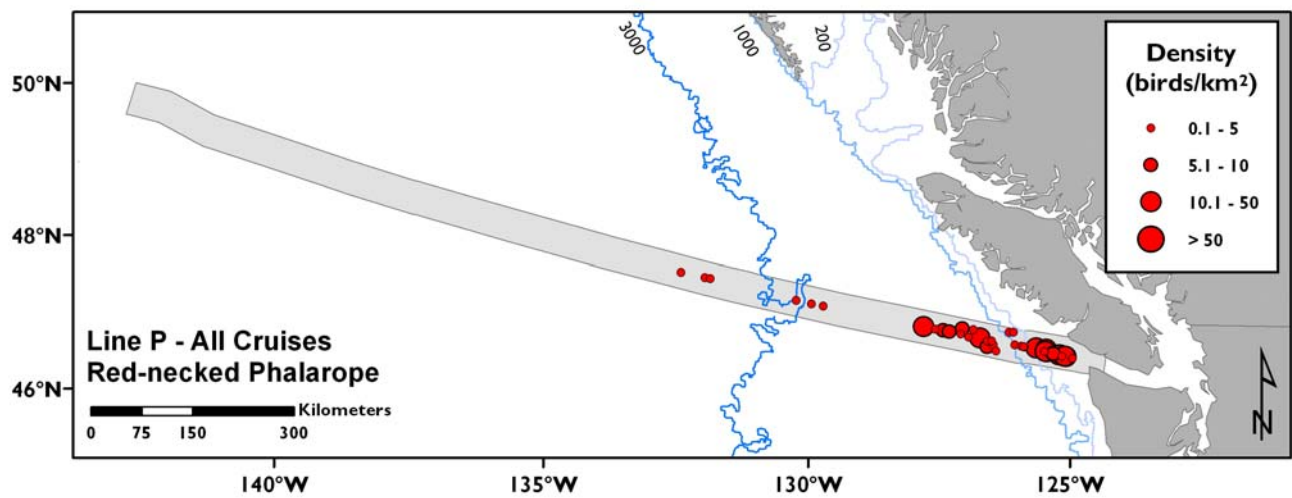




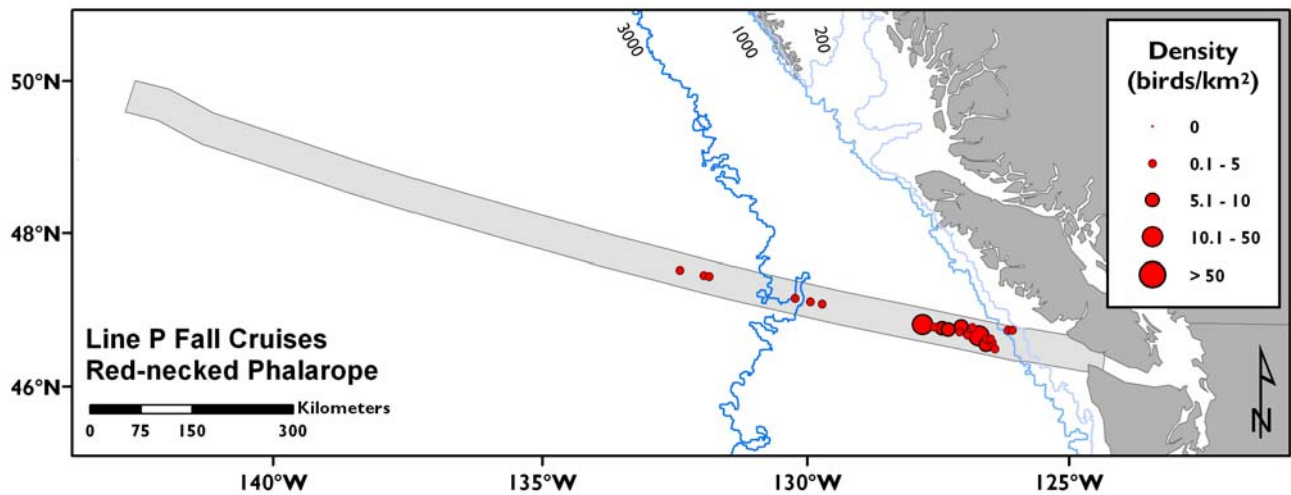
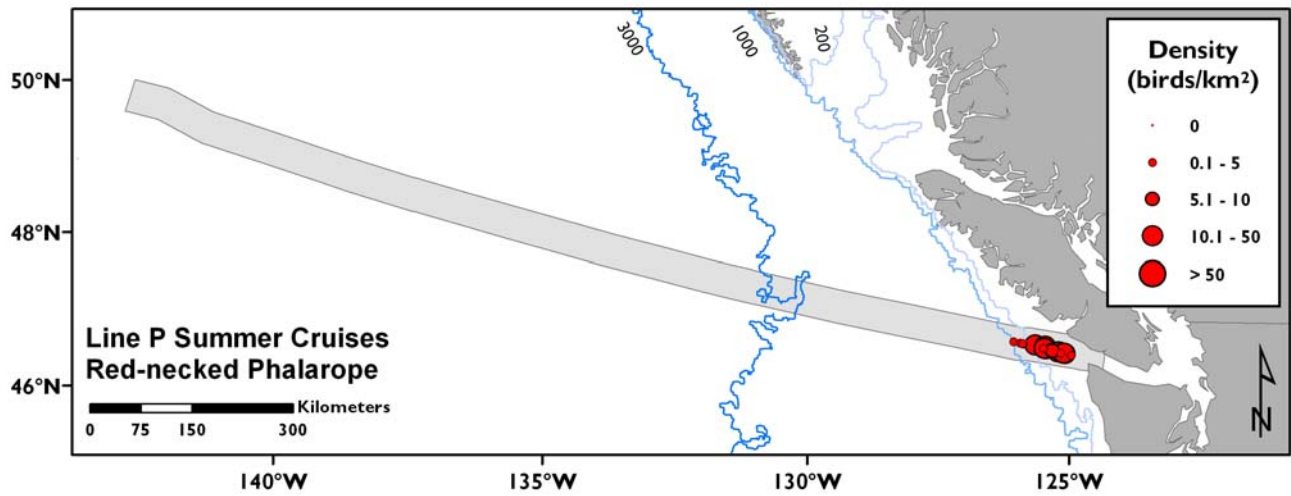
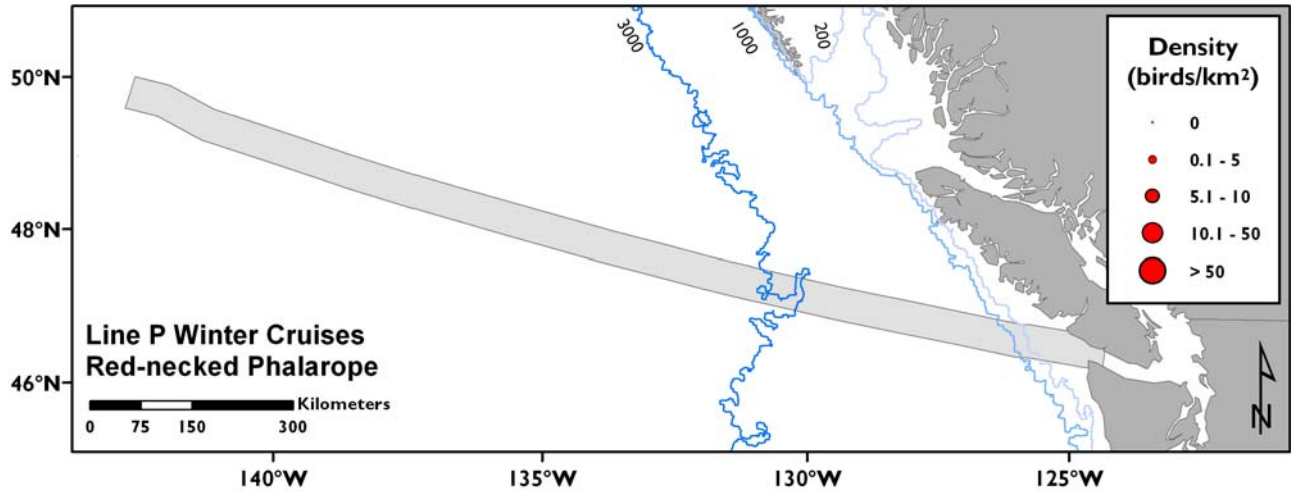




NMFS - All Cruises  
Red-necked Phalarope



Line P - All Cruises  
Red-necked Phalarope



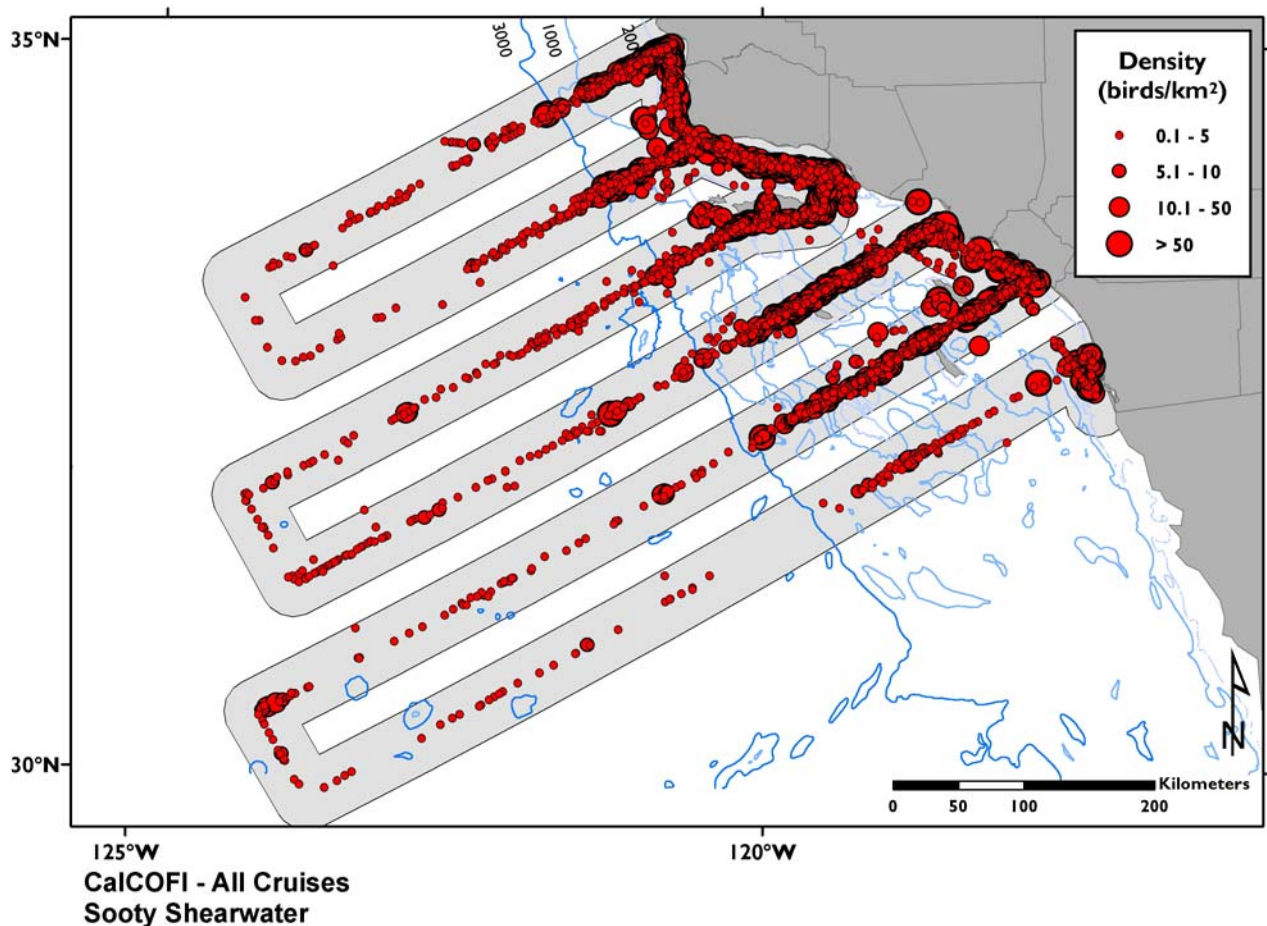


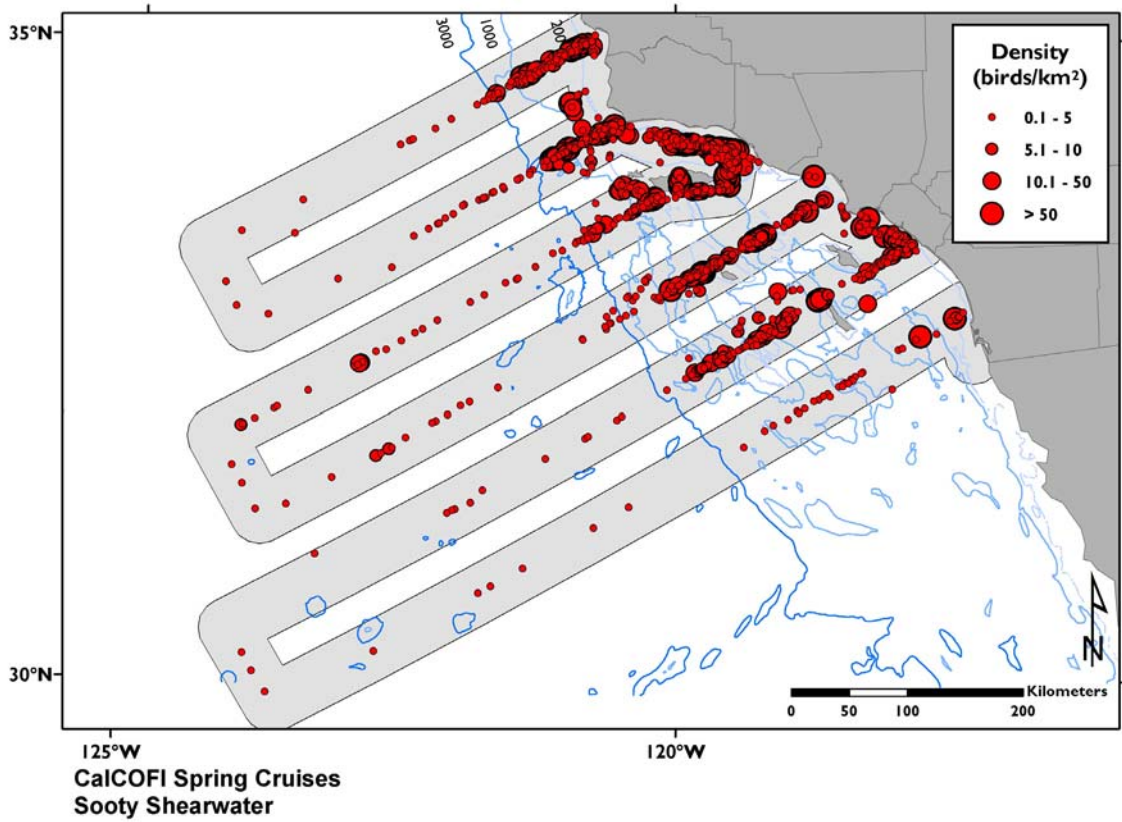
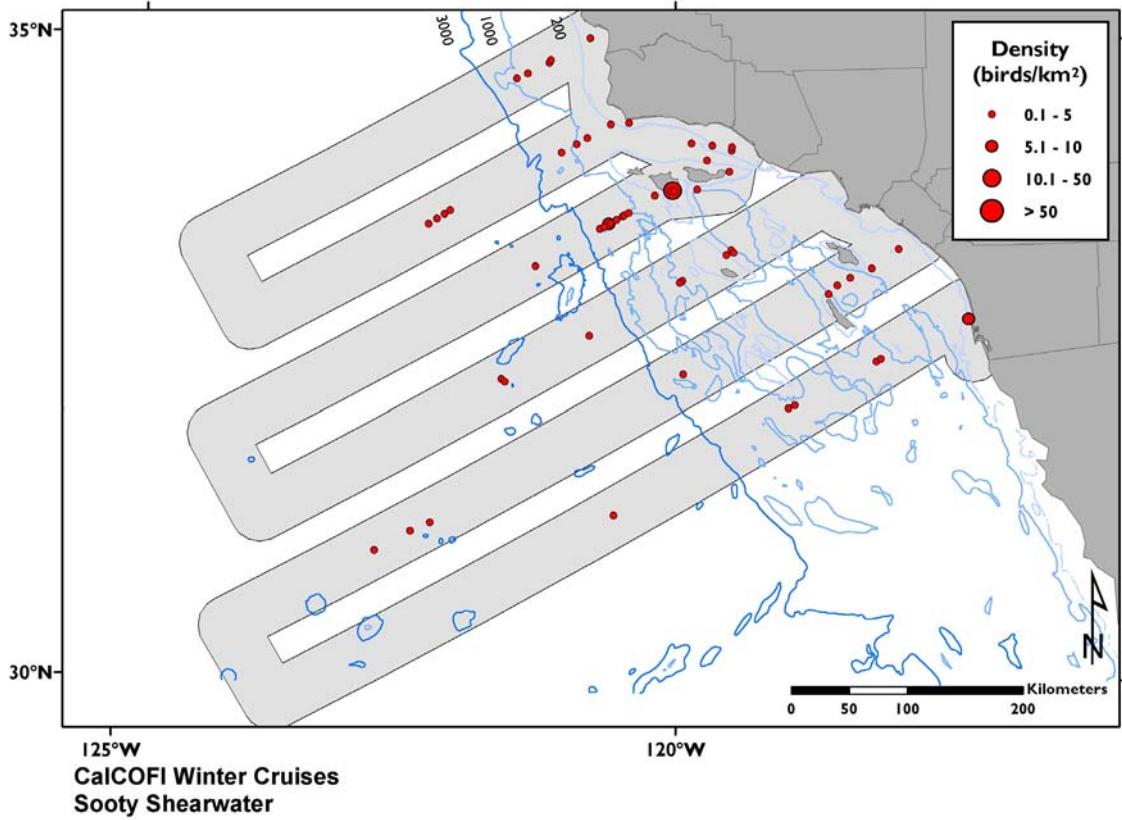
## Sooty Shearwater

*Puffinus griseus*

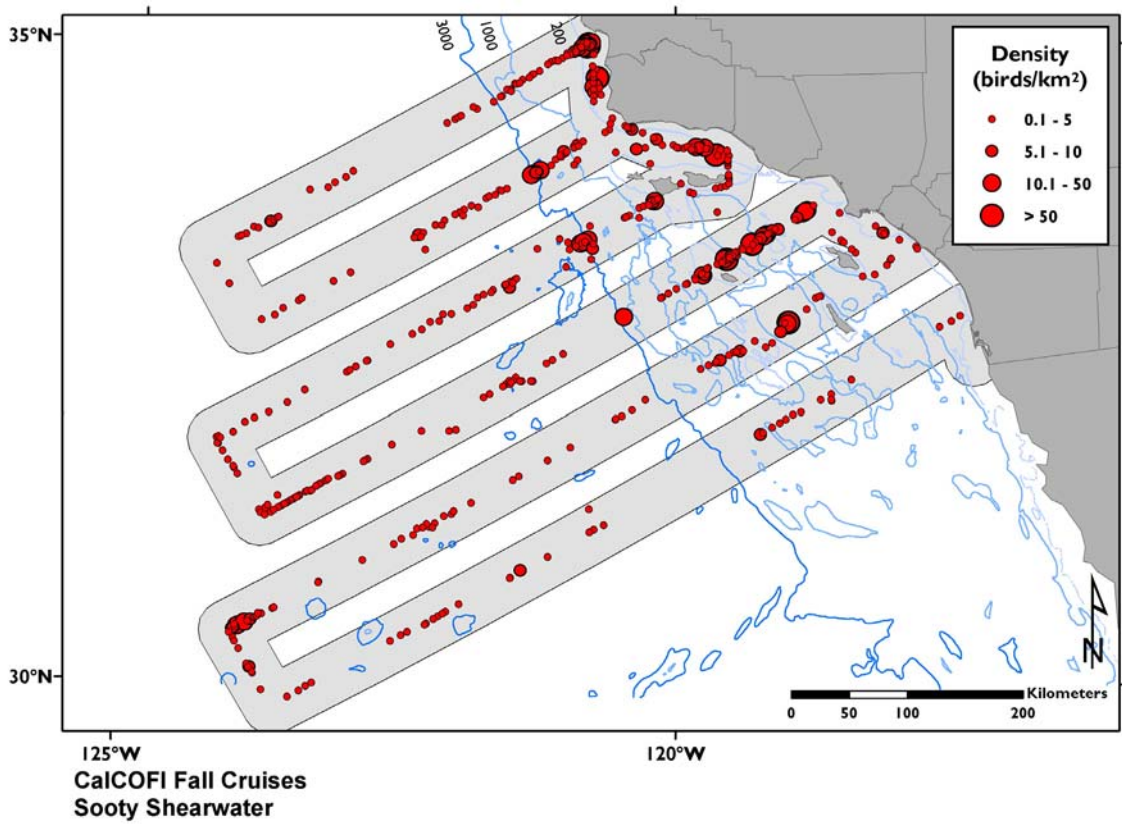
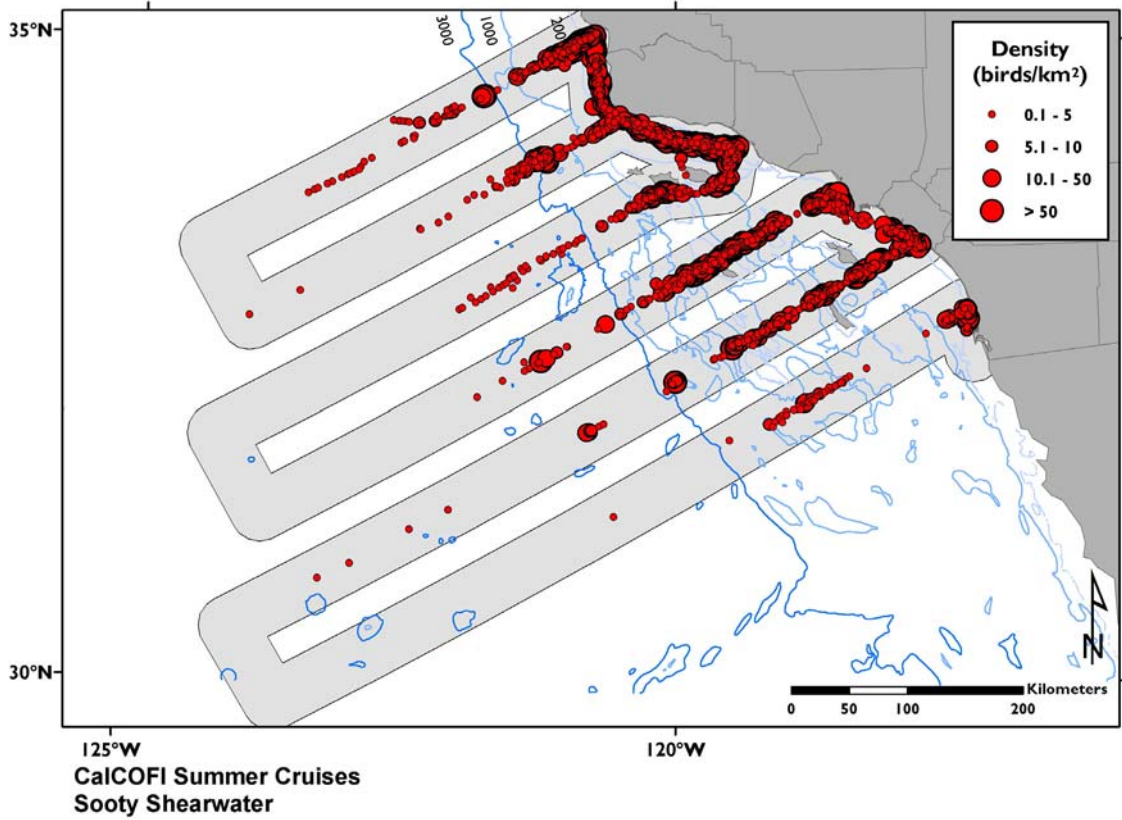


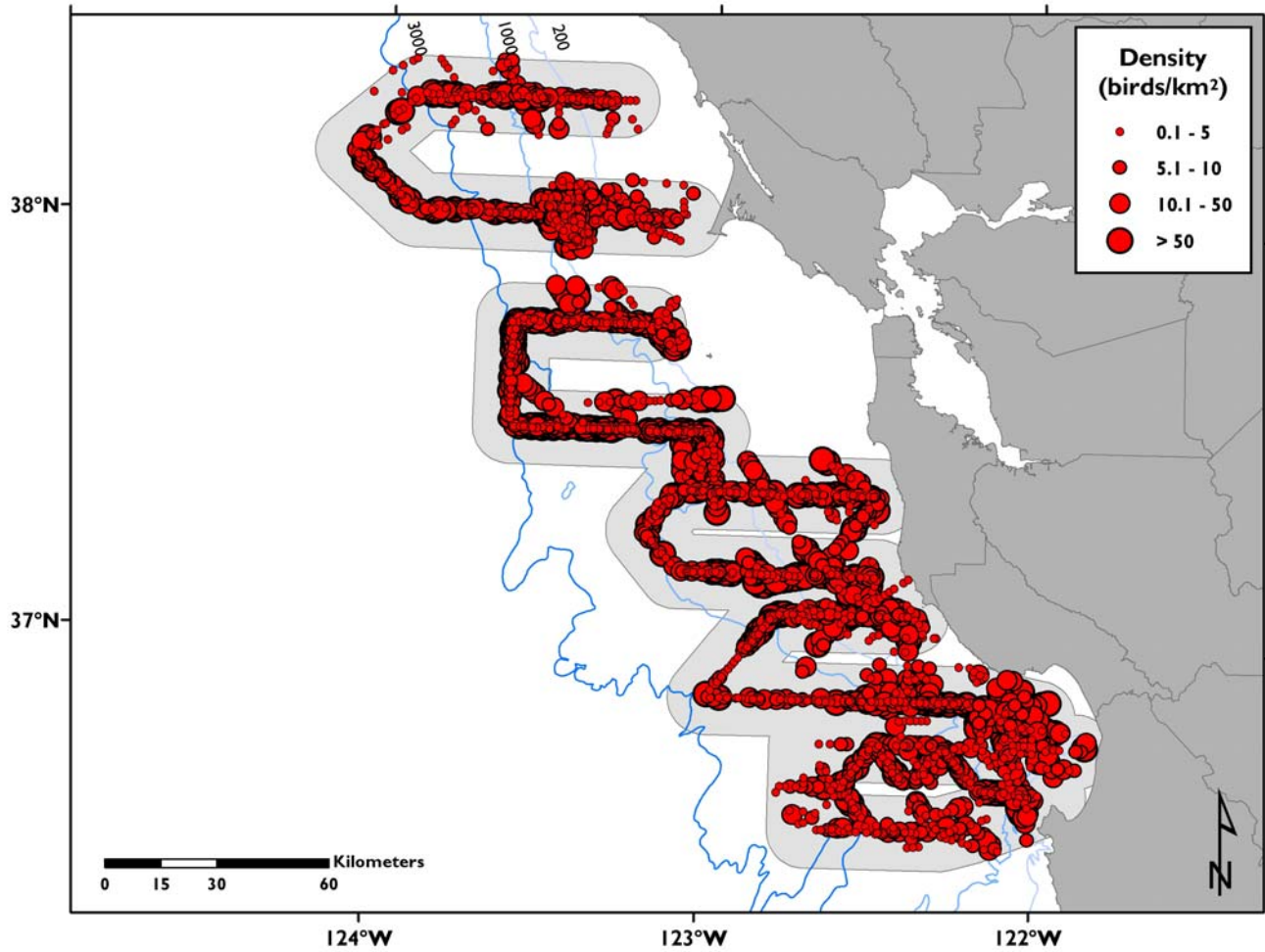
Sooty Shearwaters (SOSH) are seasonally abundant throughout all three study areas, peaking in abundance during spring/summer. The near absence of the species during winter reflects migration to breeding grounds in the southern hemisphere. Distributions in the CalCOFI area showed greater use of offshore habitat in spring and especially fall, and inshore habitats during summer. High densities of SOSH generally occurred over the continental shelf, as well as further offshore during summer and fall. Populations in the NMFS area were widely distributed, with high densities occurring over all habitats. SOSH feed primarily on fish, squid, and macrozooplankton.



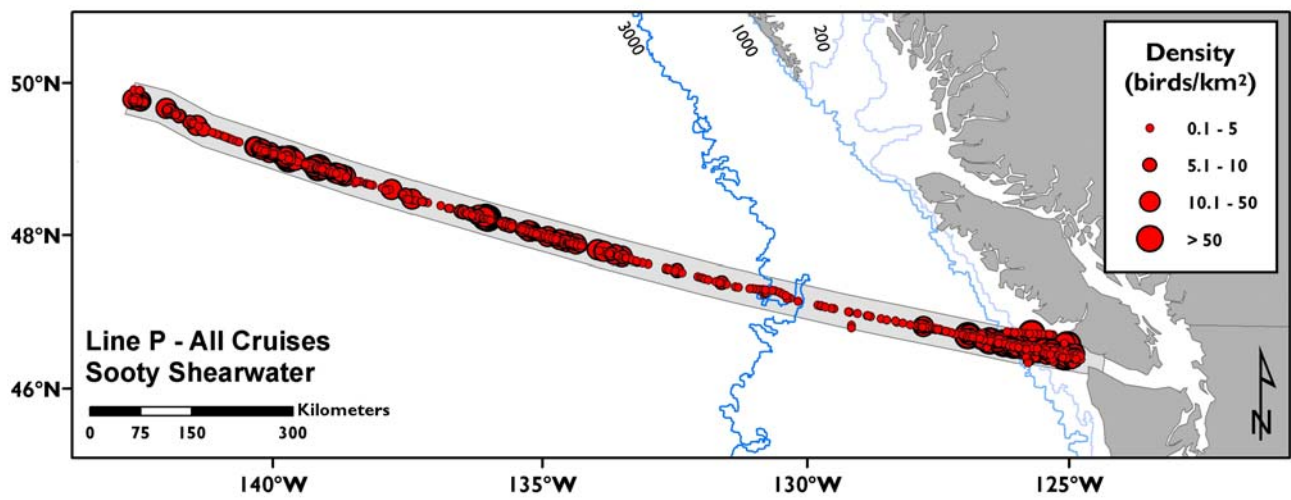




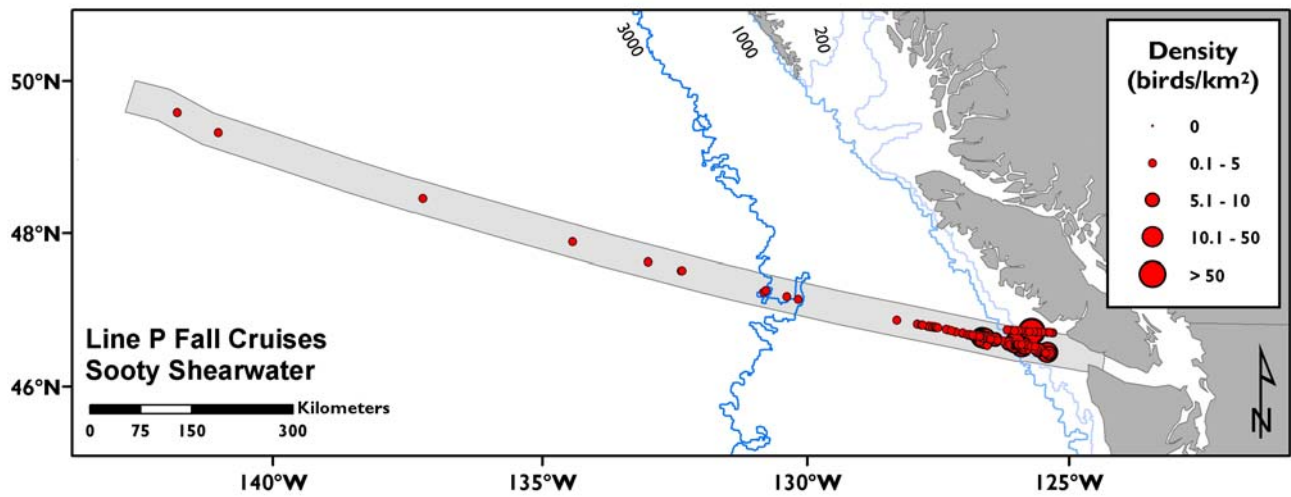
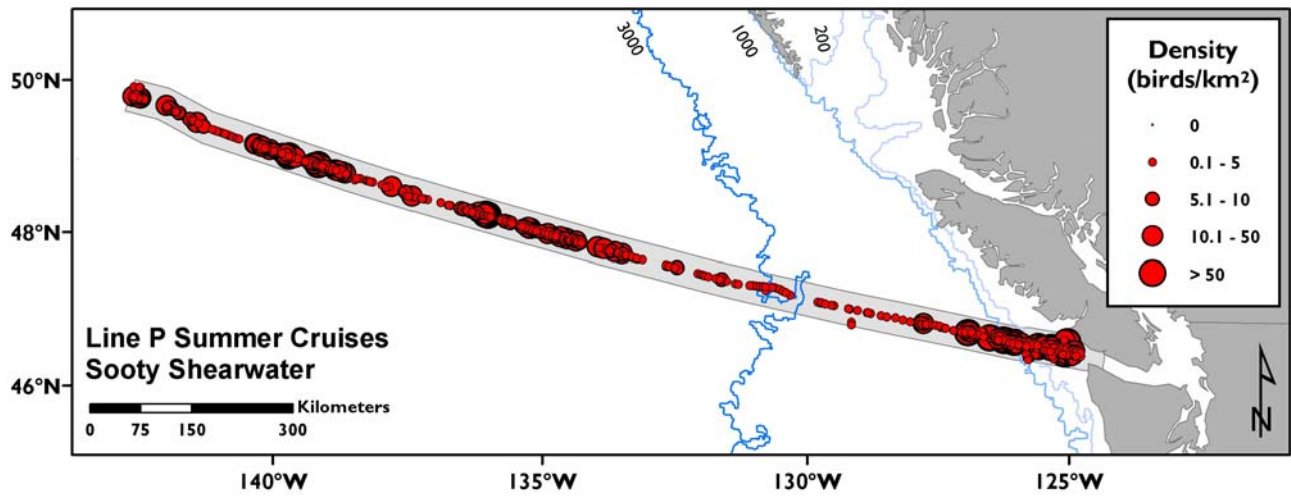
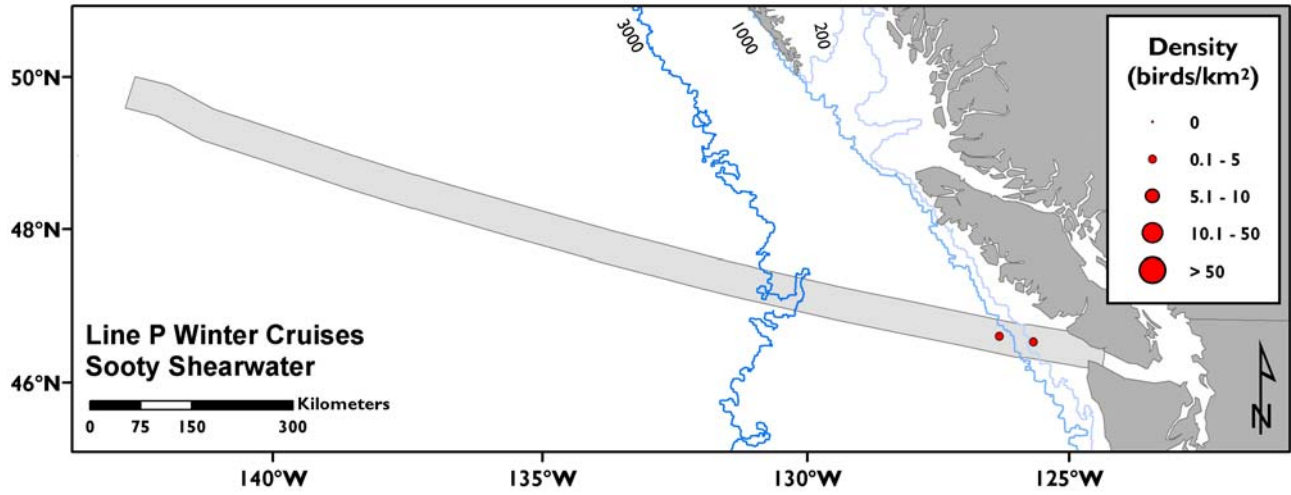




NMFS - All Cruises  
Sooty Shearwater



Line P - All Cruises  
Sooty Shearwater



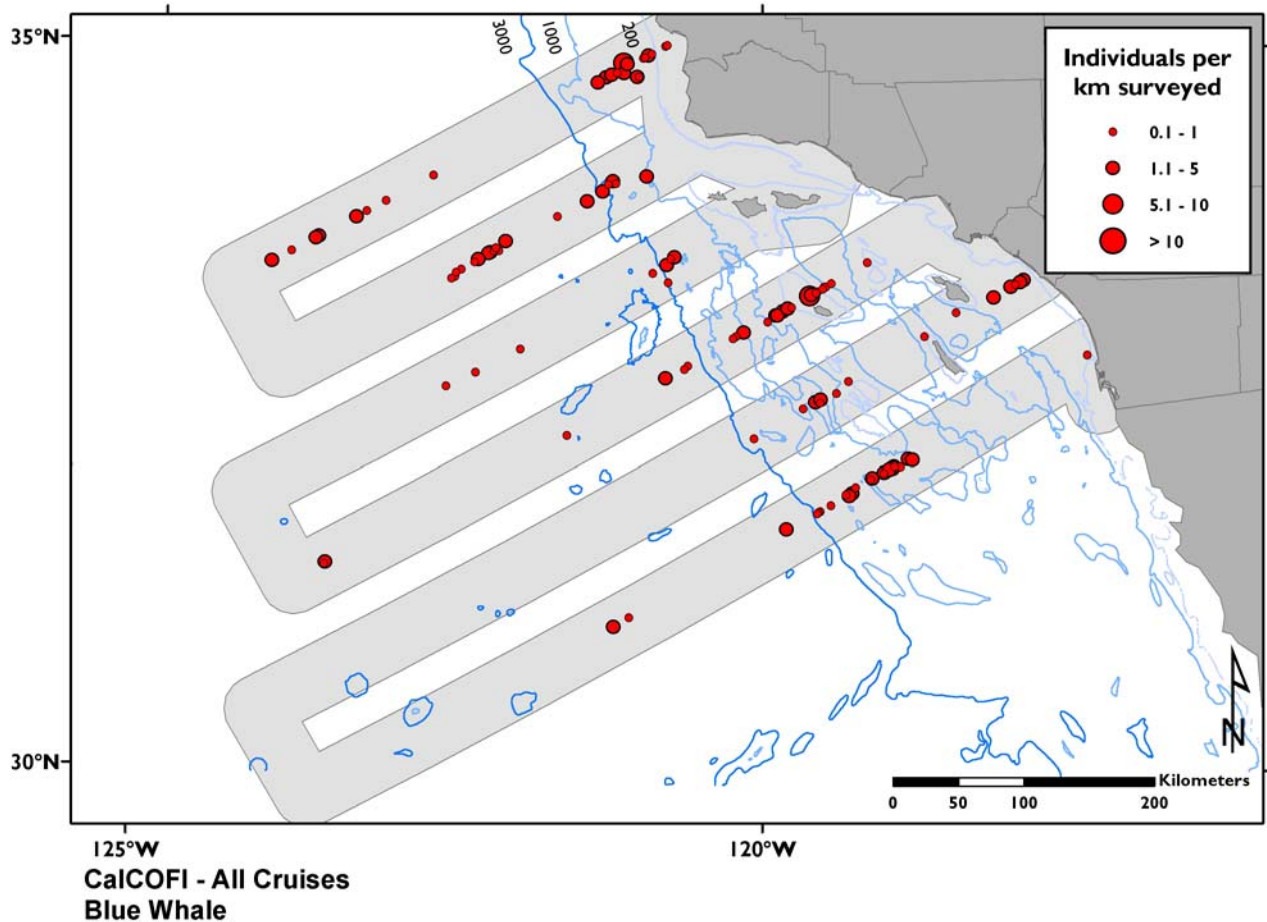
# Selected Marine Mammals Of the California Current System

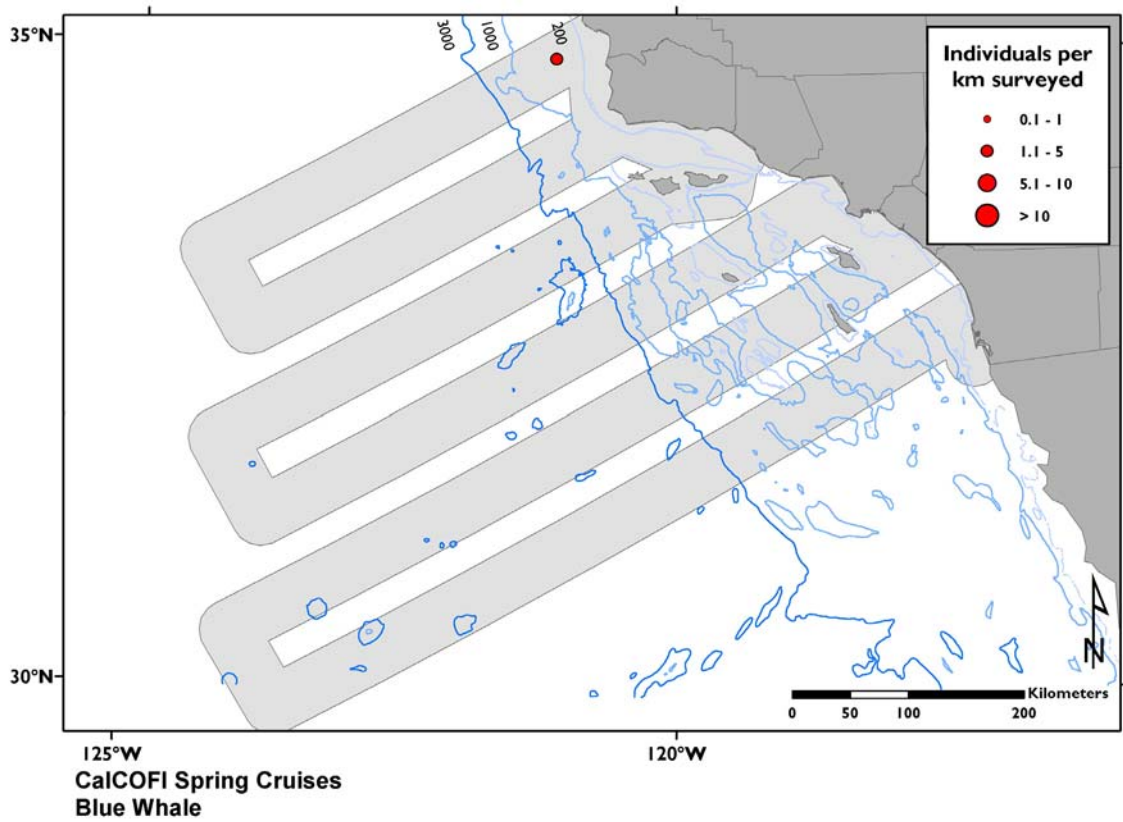
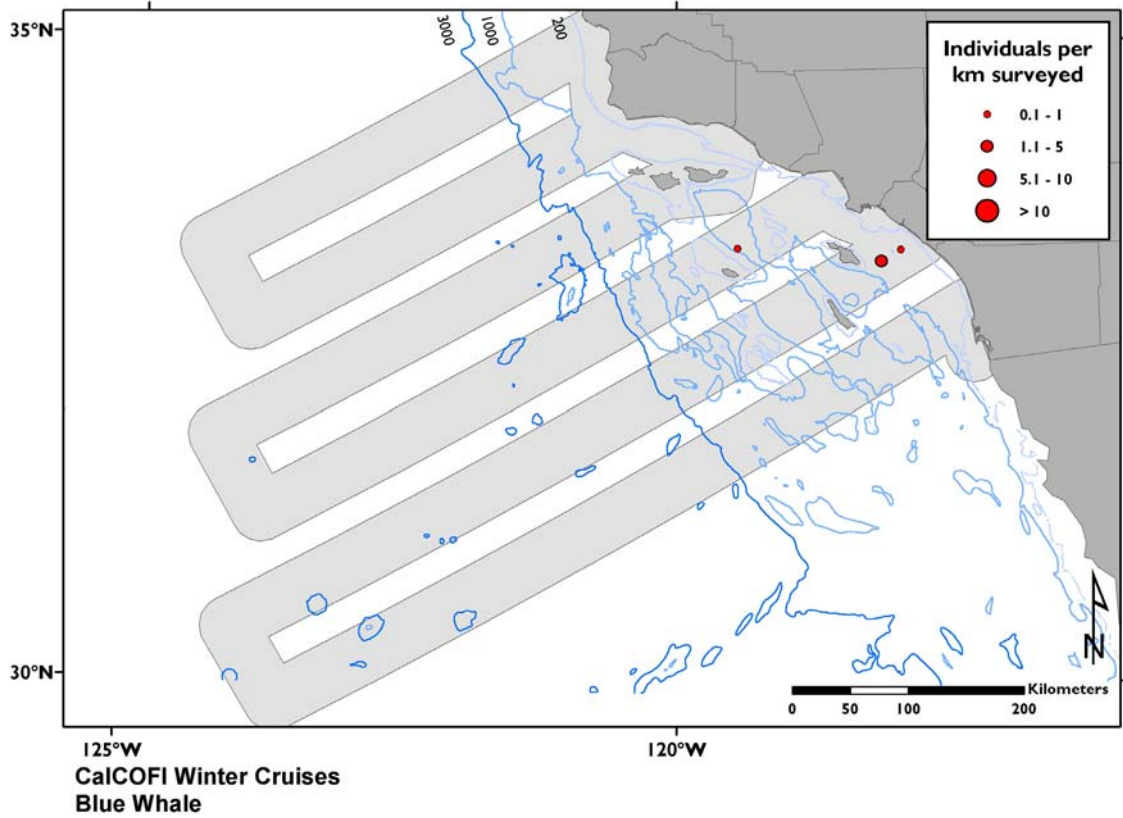
# Blue Whale

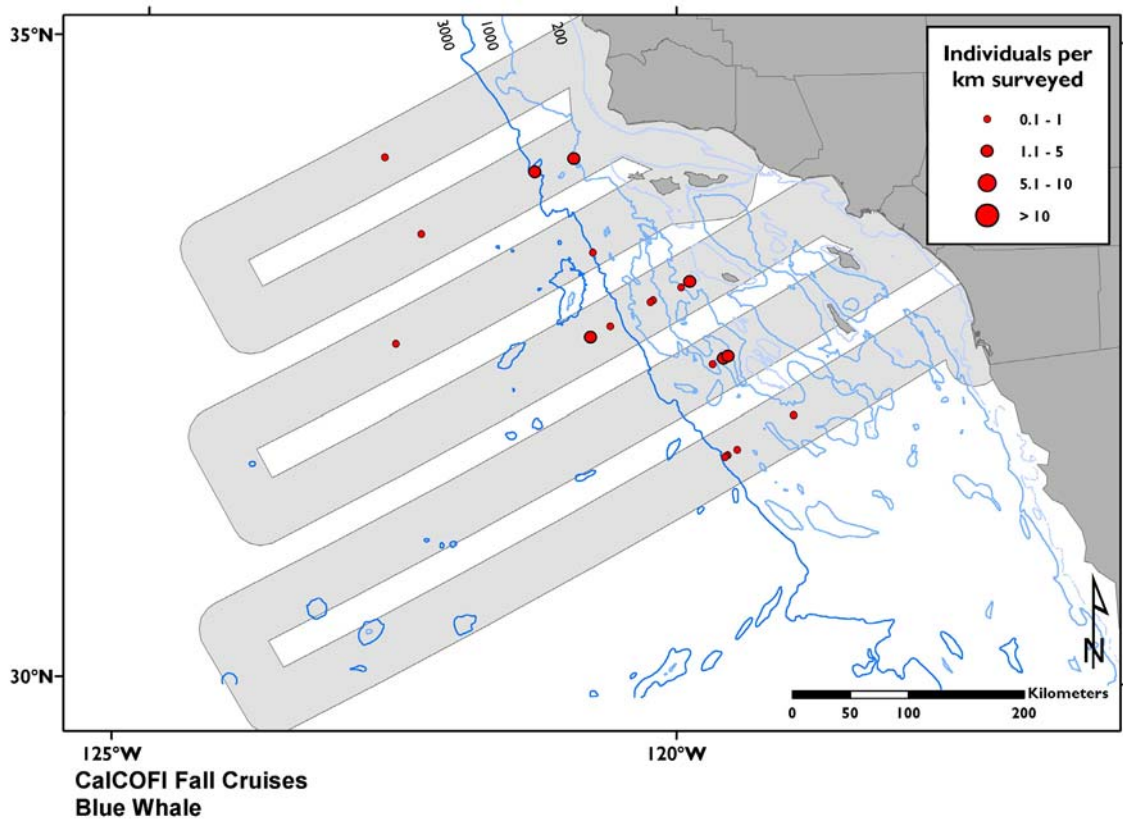
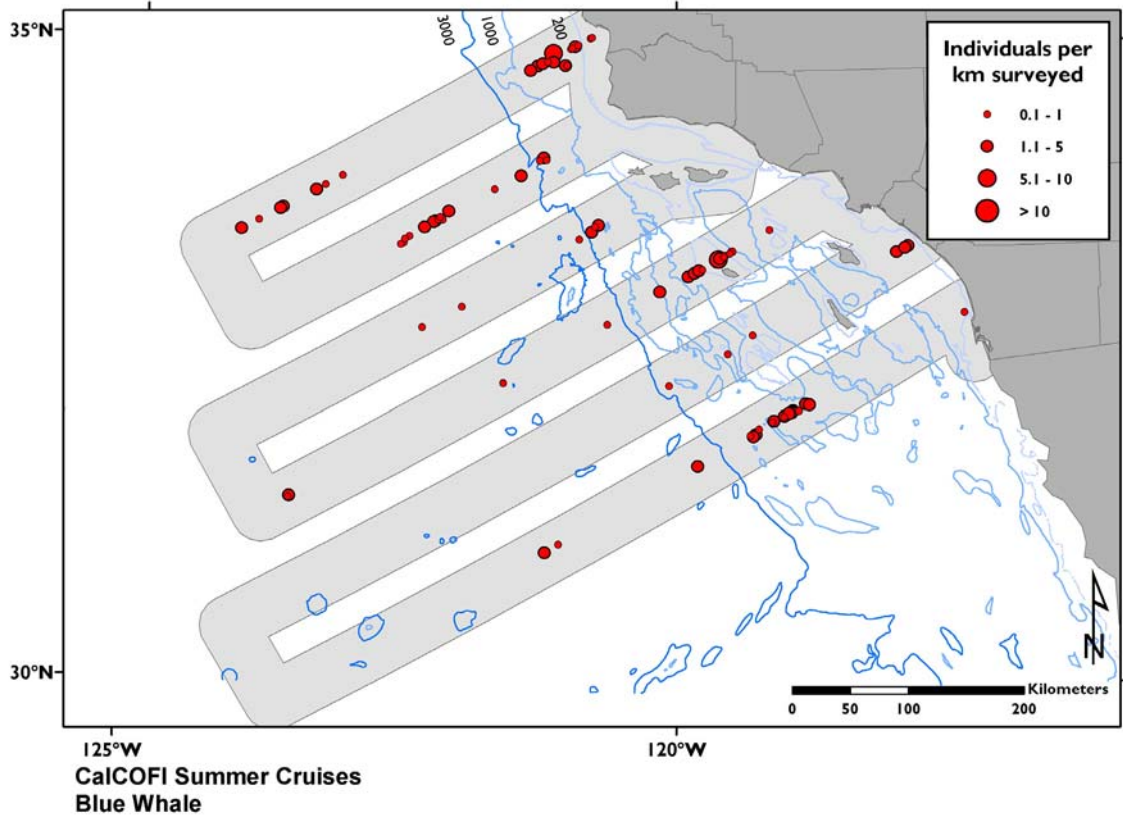
*Balaenoptera musculus*

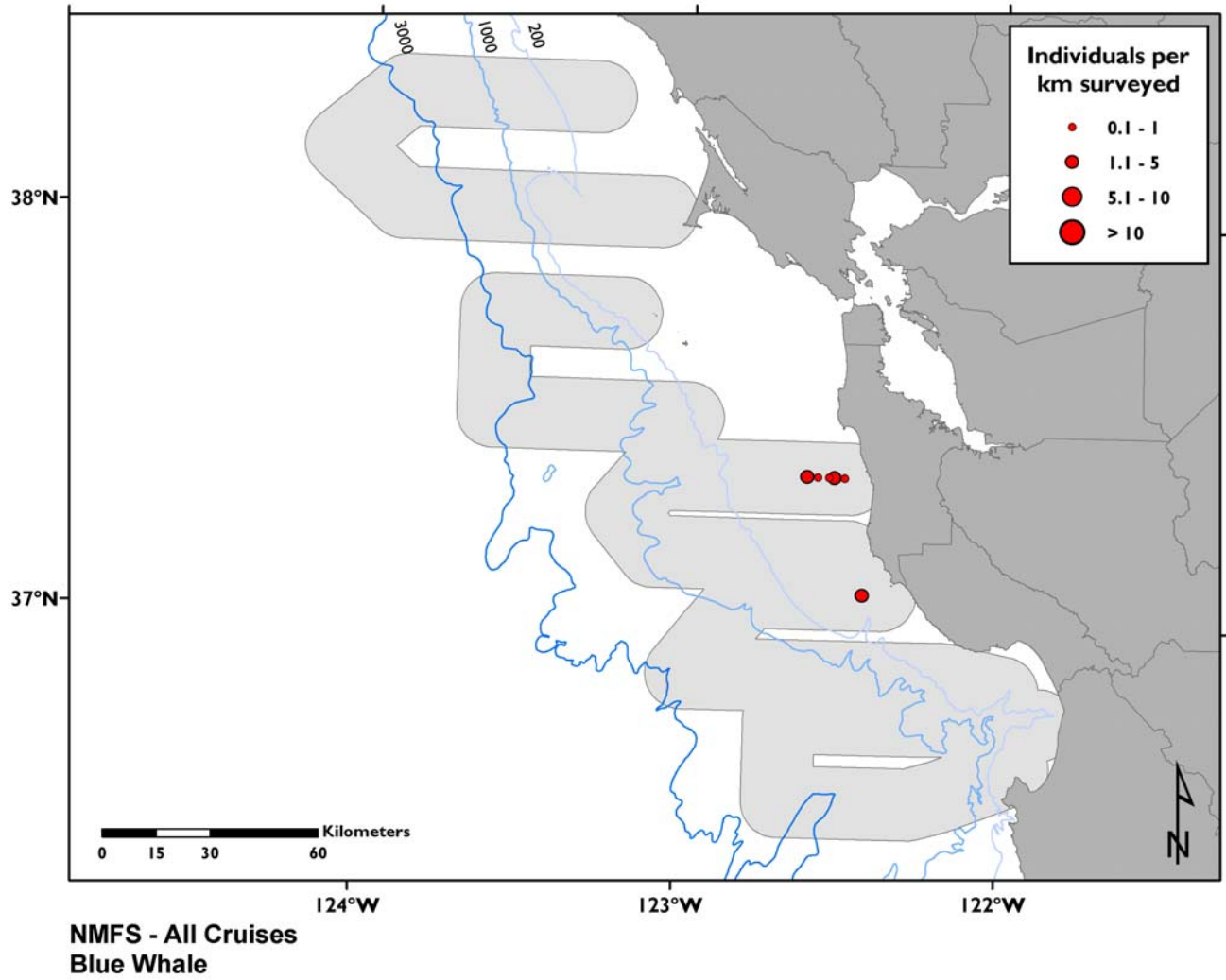


Blue whales inhabit a wide variety of ocean depths and occurs in all oceans throughout the globe. Identified as the largest animal ever known to live on the Earth, the diet of blue whales consists almost entirely of euphausiids (krill). Blue whales were observed most frequently during summer in the CalCOFI study area.









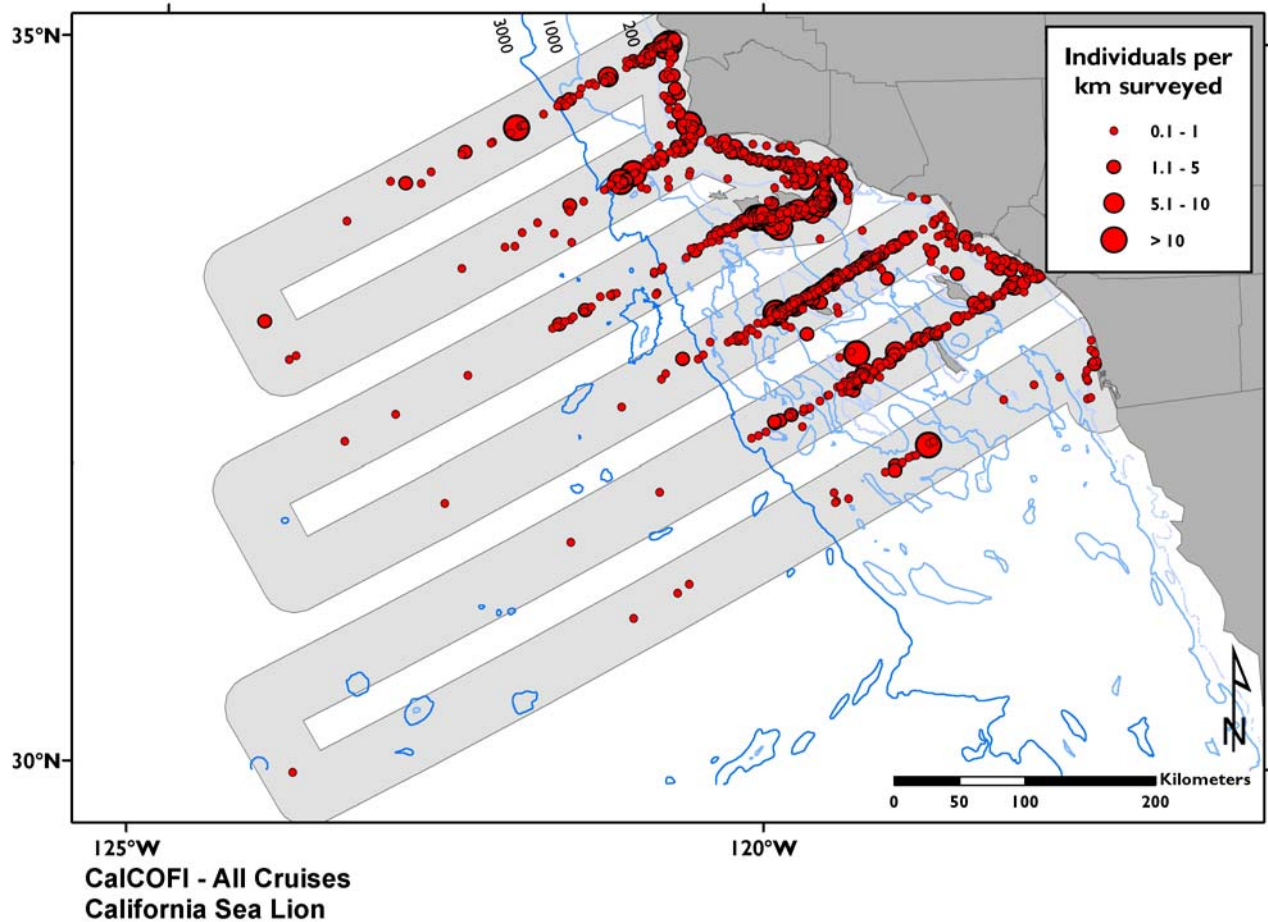


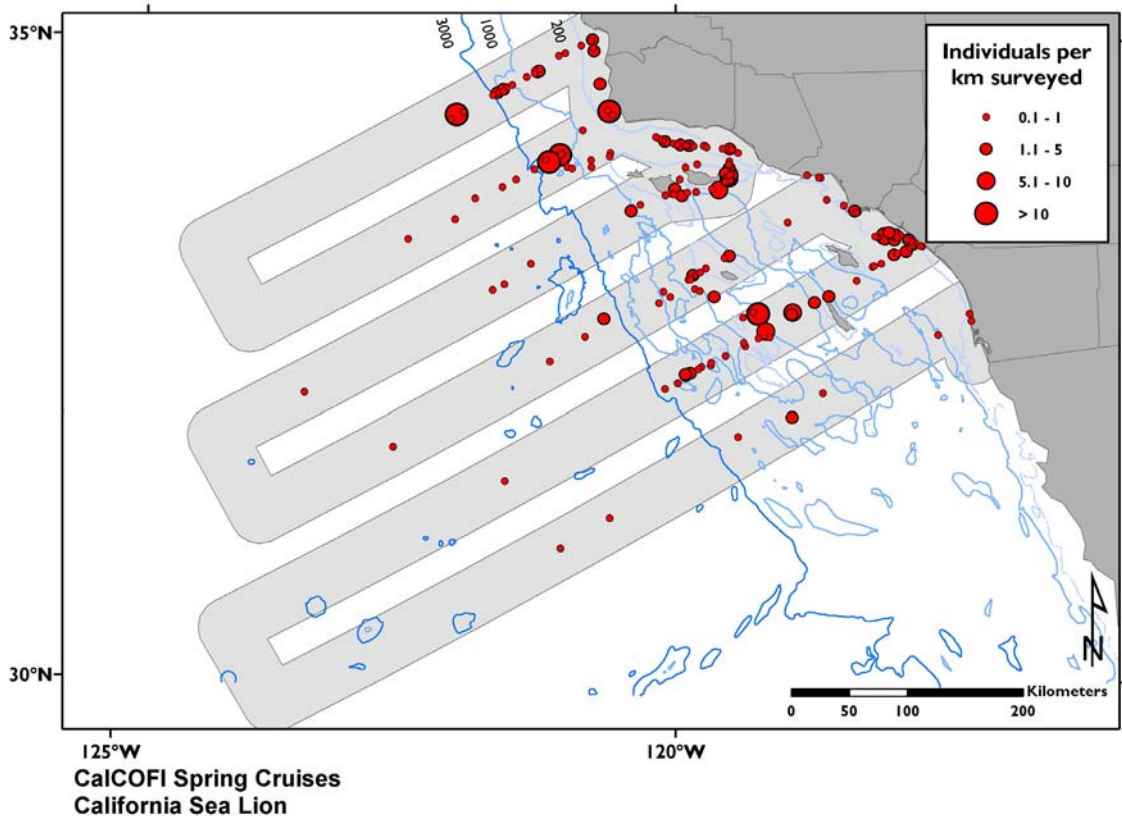
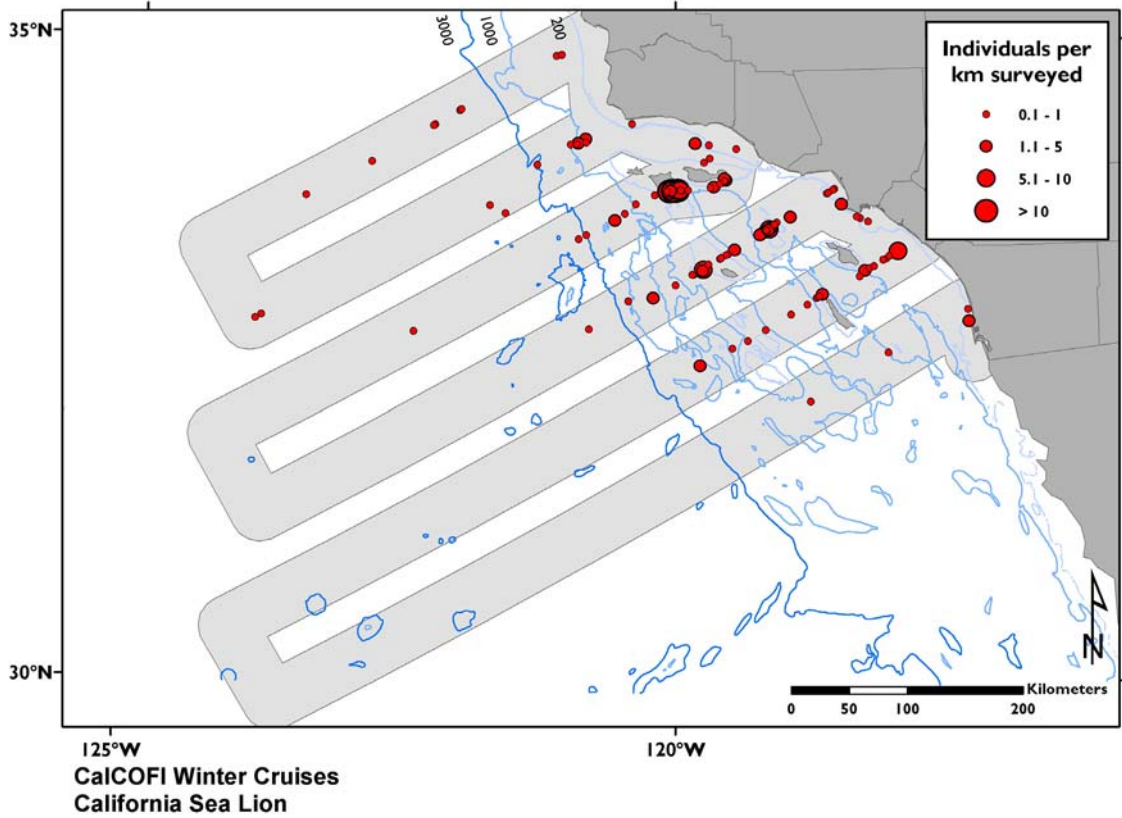
# California Sea Lion

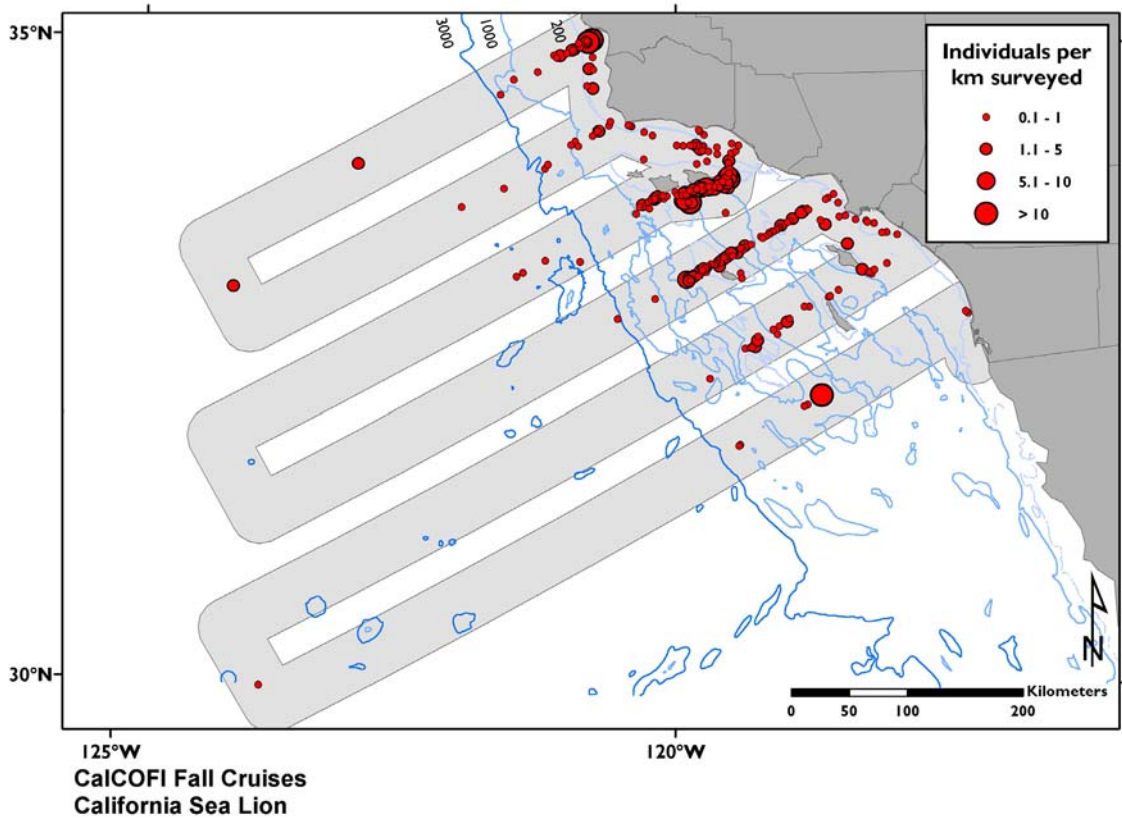
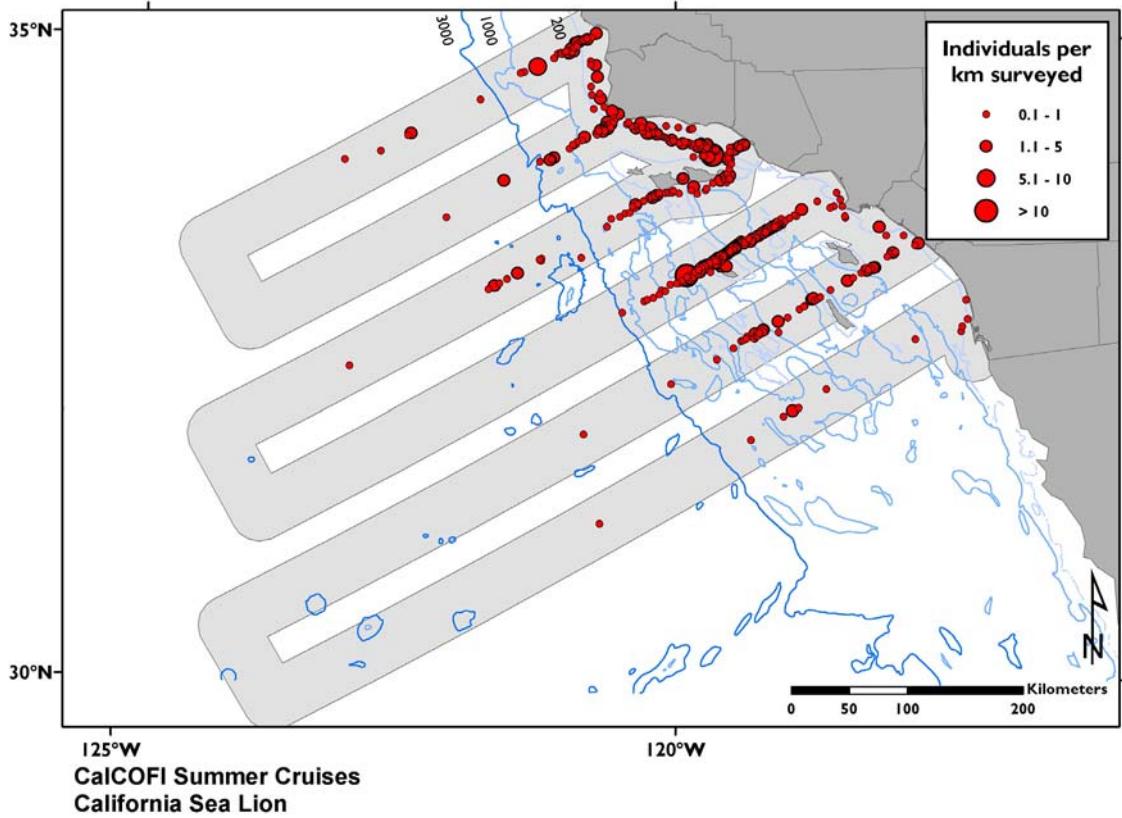
*Zalophus californianus*

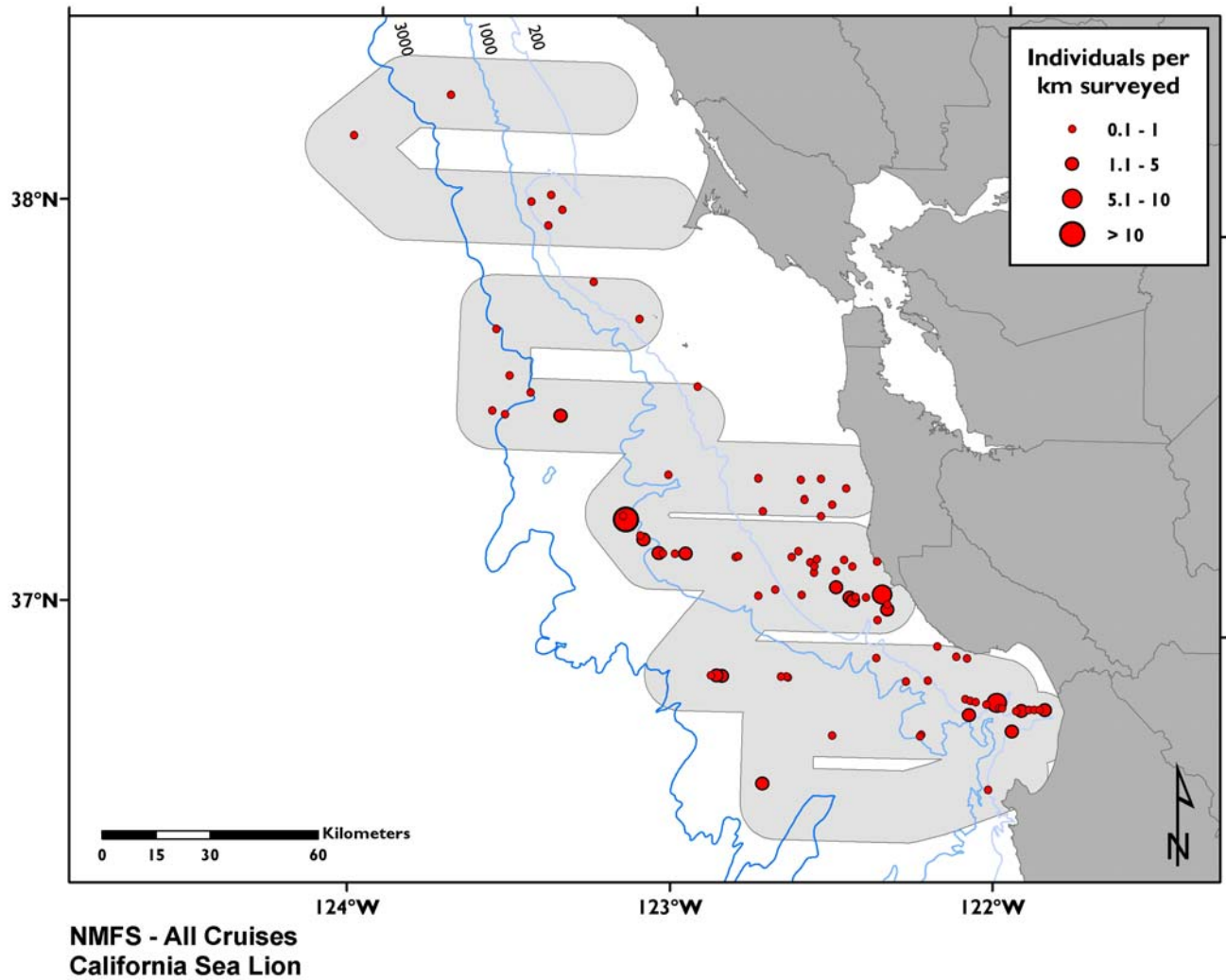


California sea lions in the CalCOFI study area were generally found in waters < 3000 m in winter. In the NMFS study area, the species was more likely to occur south of Point Bonita - roughly the northern edge of its breeding range. The diet of California sea lions consists of squid, octopus, and many species of fish (Jefferson et al. 1993).







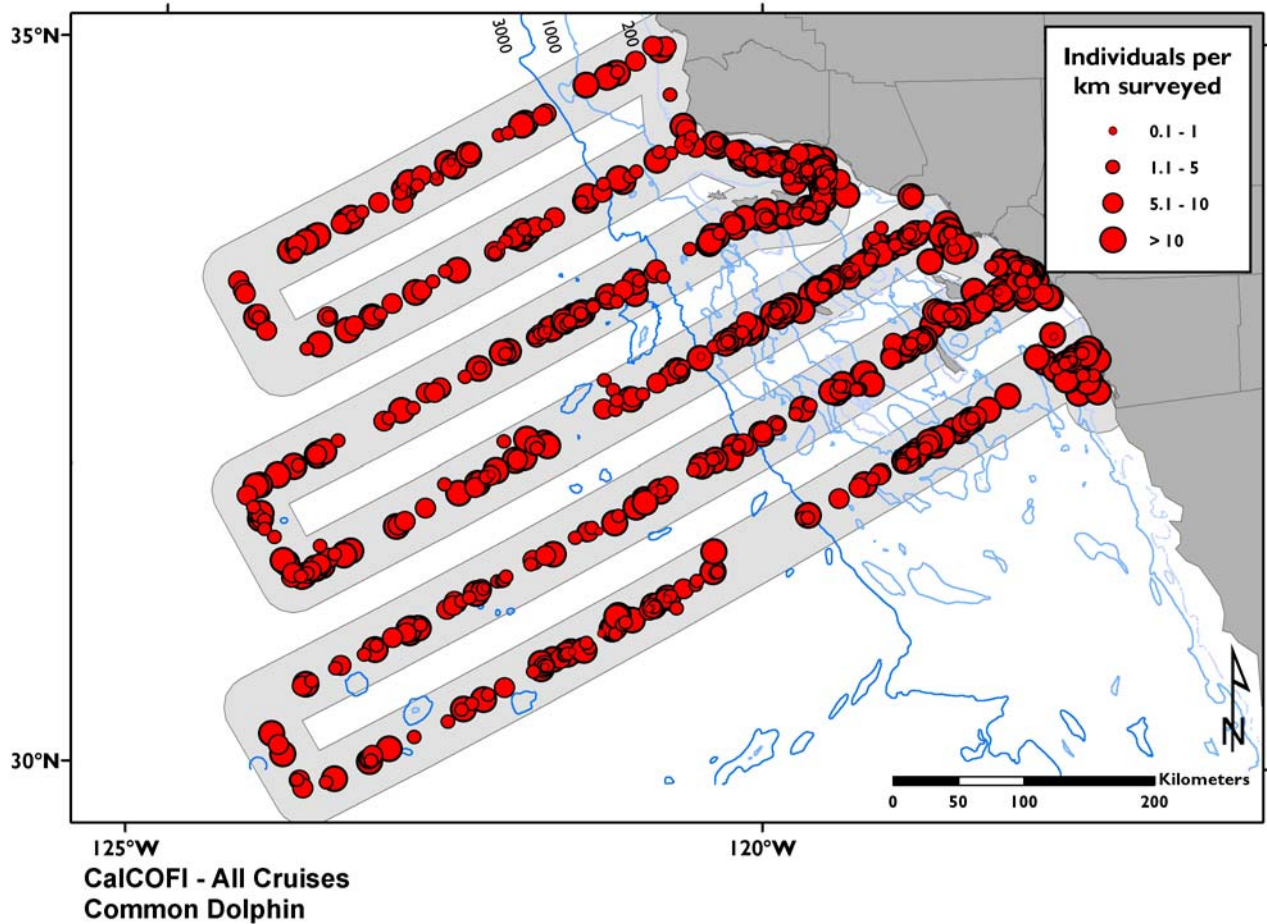


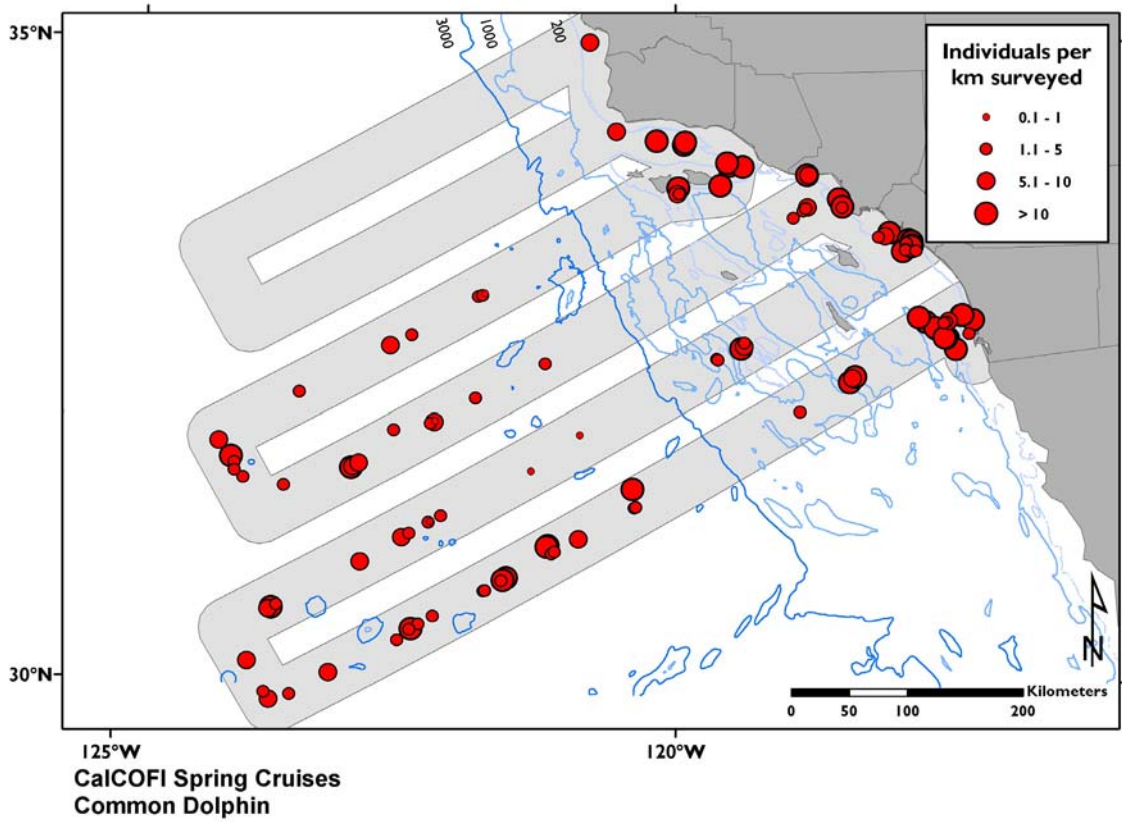
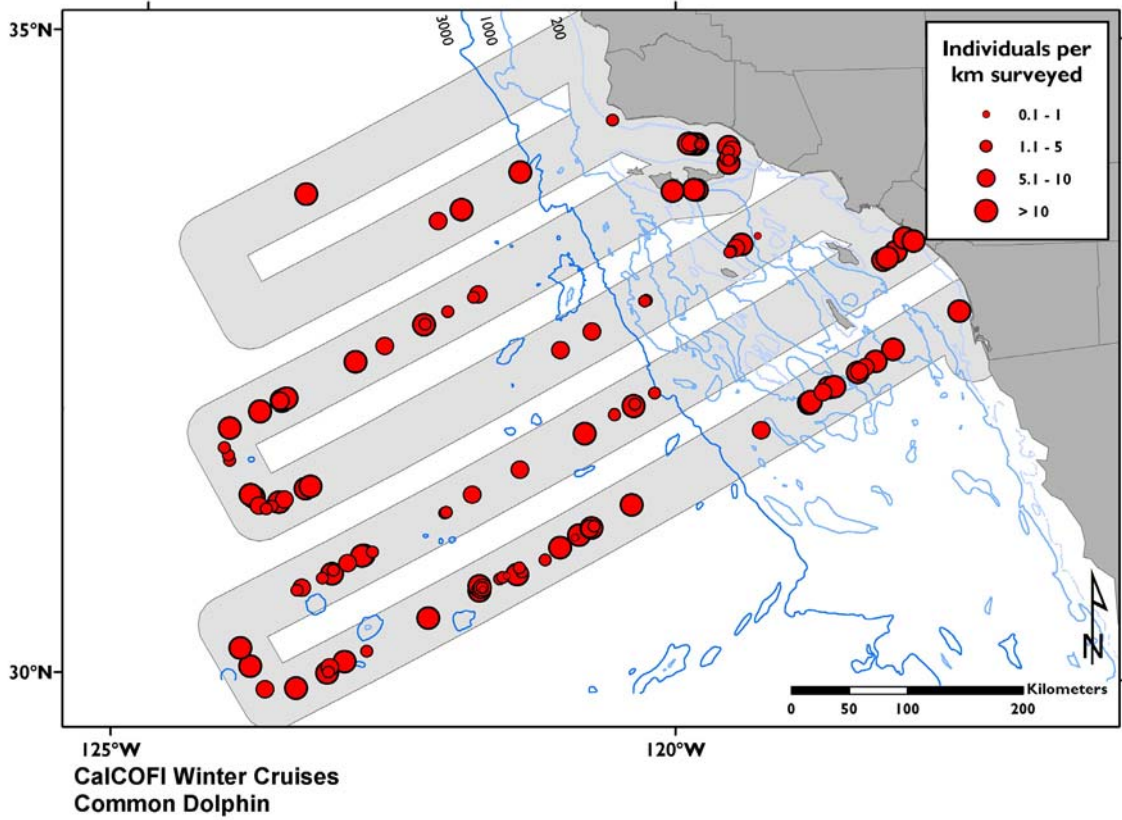
# Common Dolphin

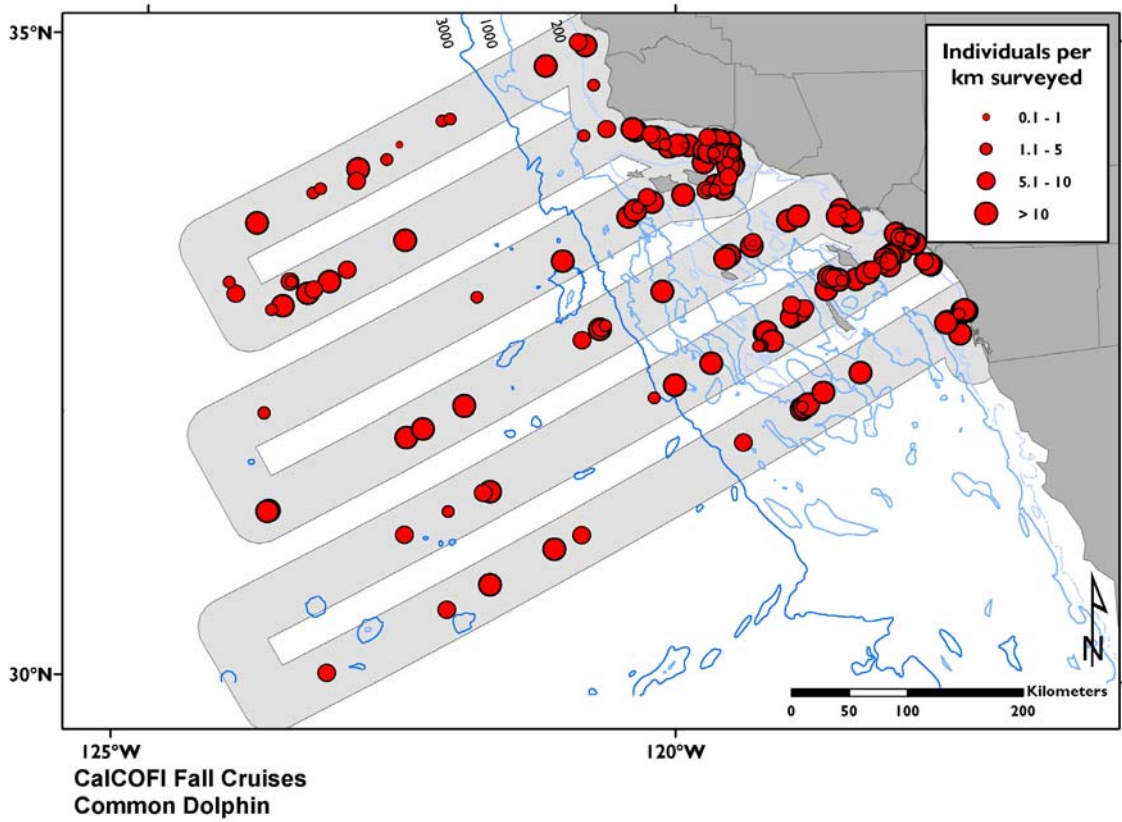
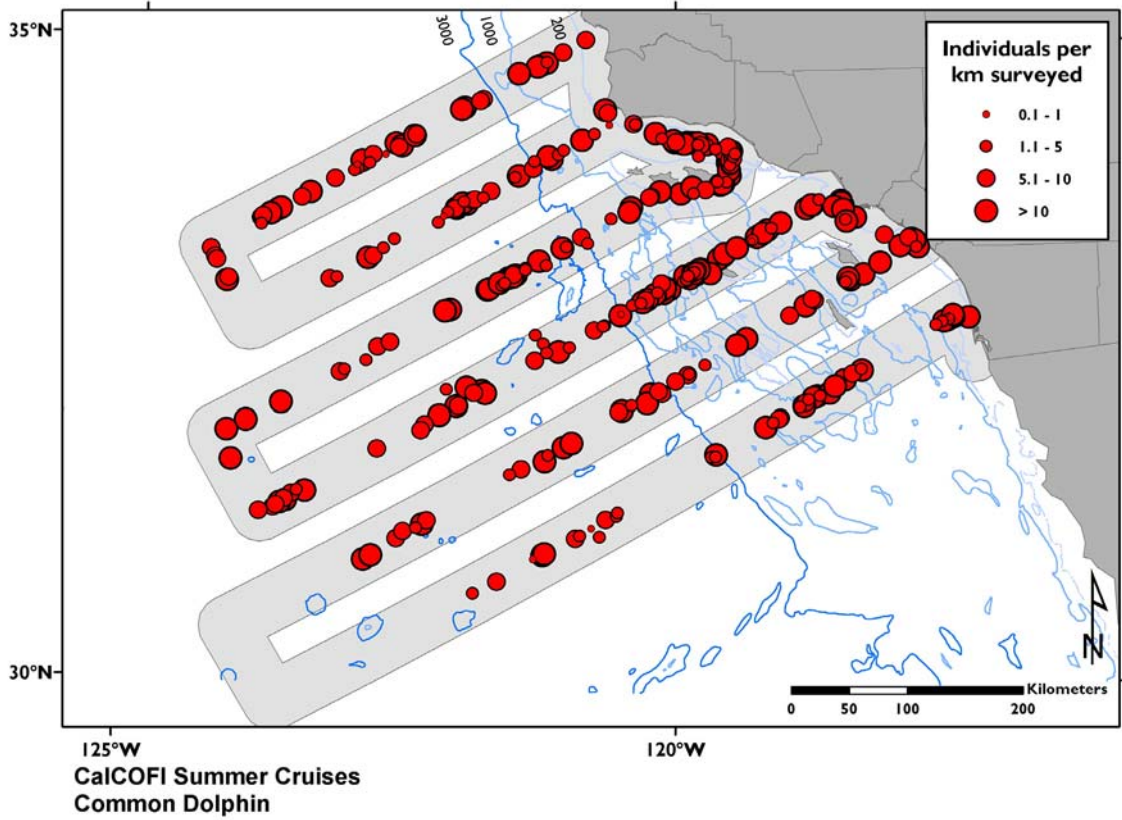
*Delphinus delphi*  
*Delphinus capensis*



Due to the difficulty of differentiating these species in the field, observations of Long-beaked and Short-beaked Common Dolphins were combined. Aside from one sighting in the NMFS study area, this species was only encountered in the CalCOFI area. Highest densities were observed during fall surveys. Main prey taken by both species includes squid and small schooling fish (Reeves et al. 2002).









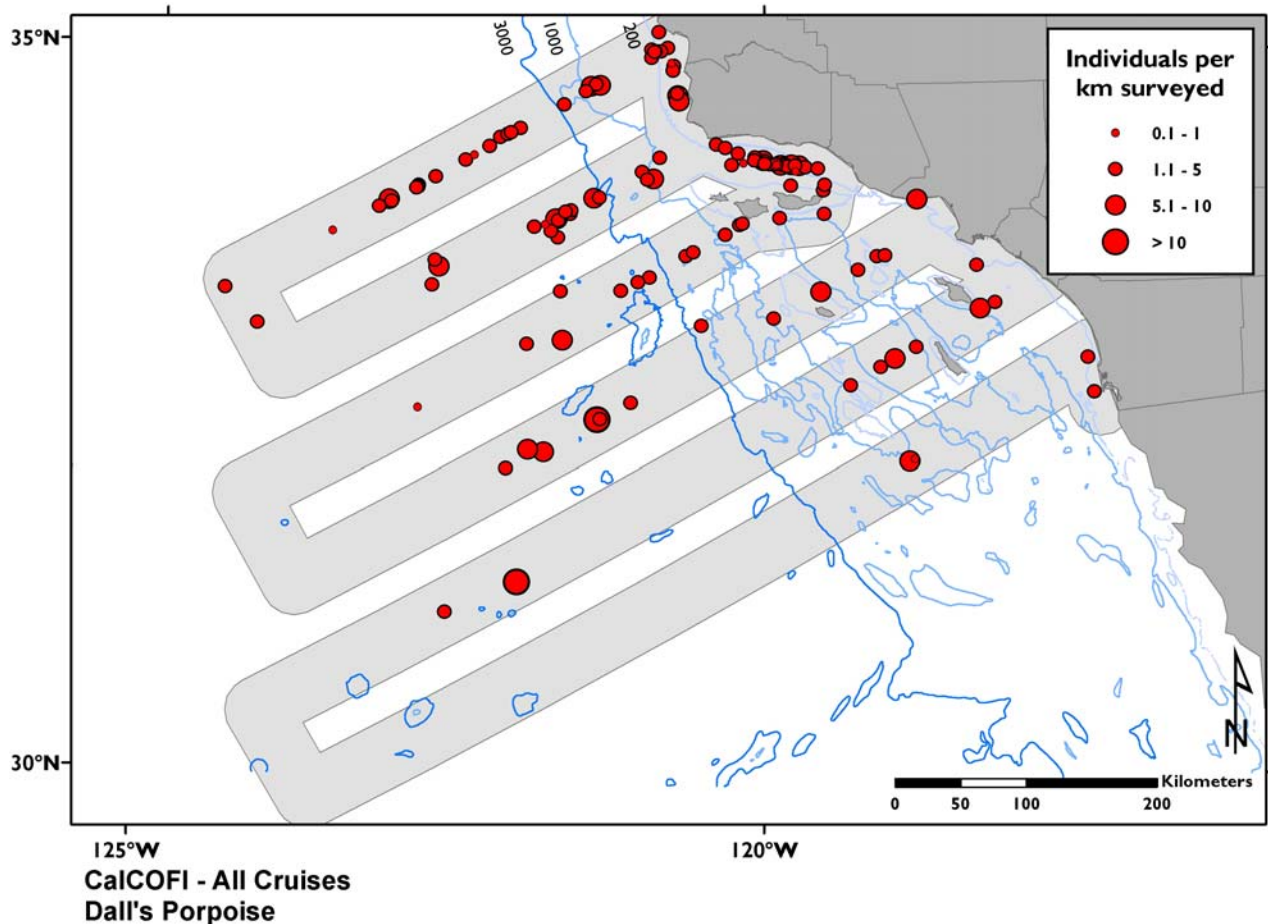


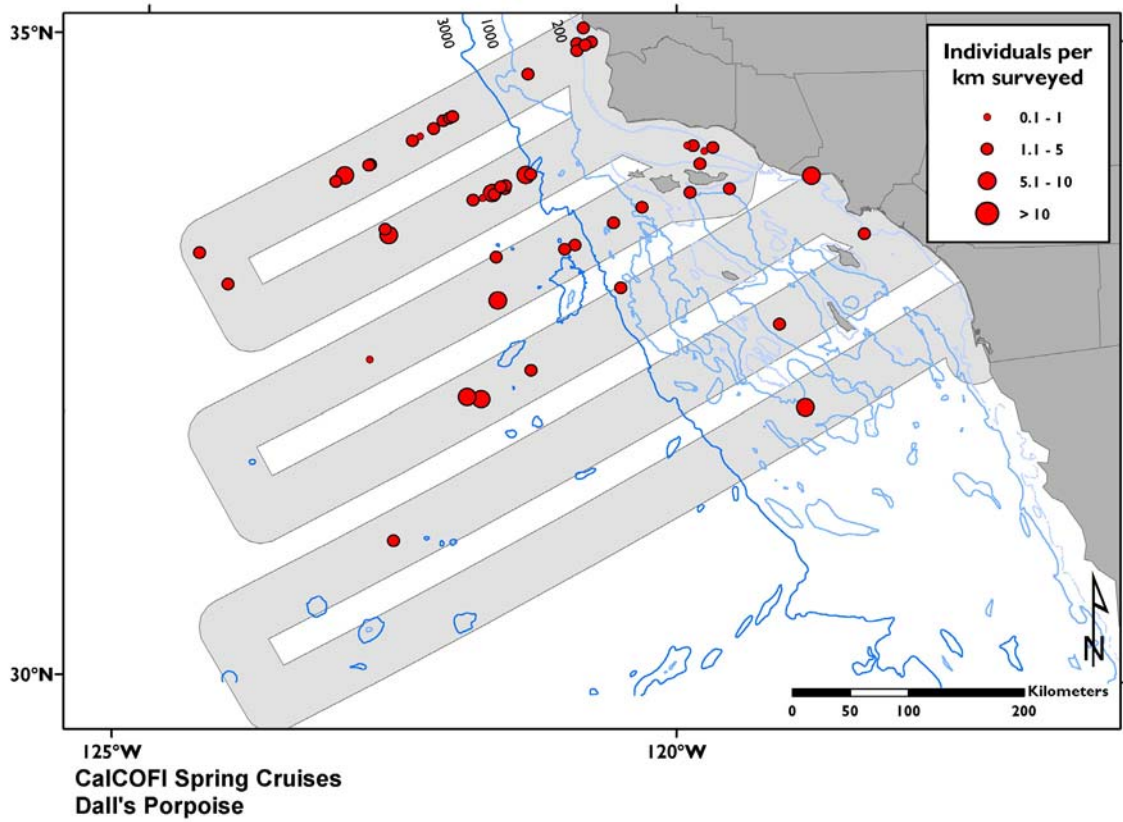
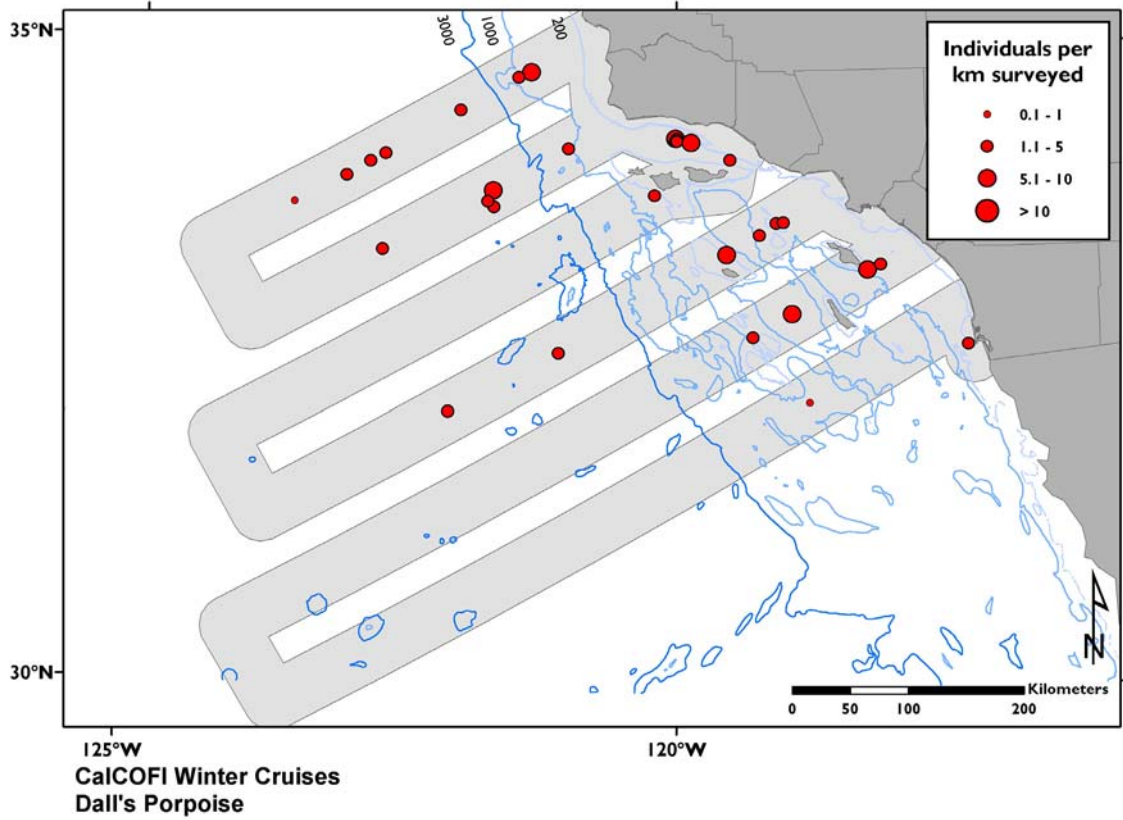
## Dall's Porpoise

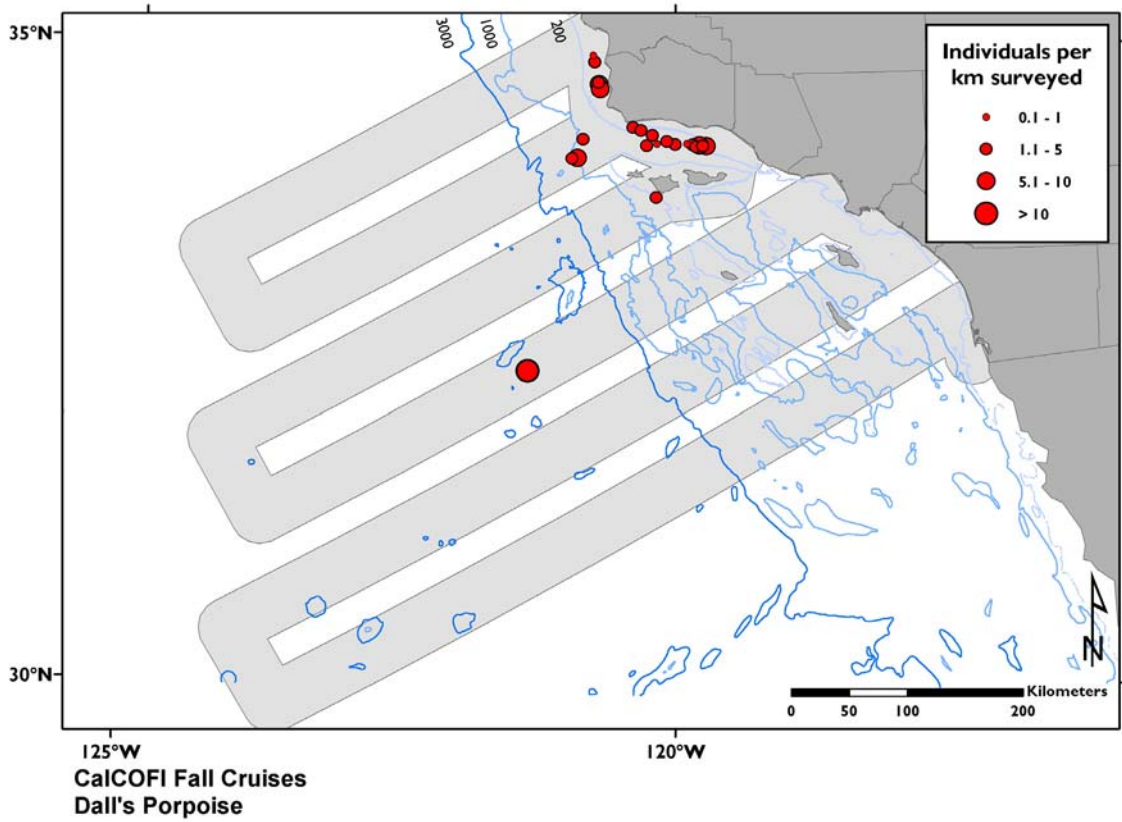
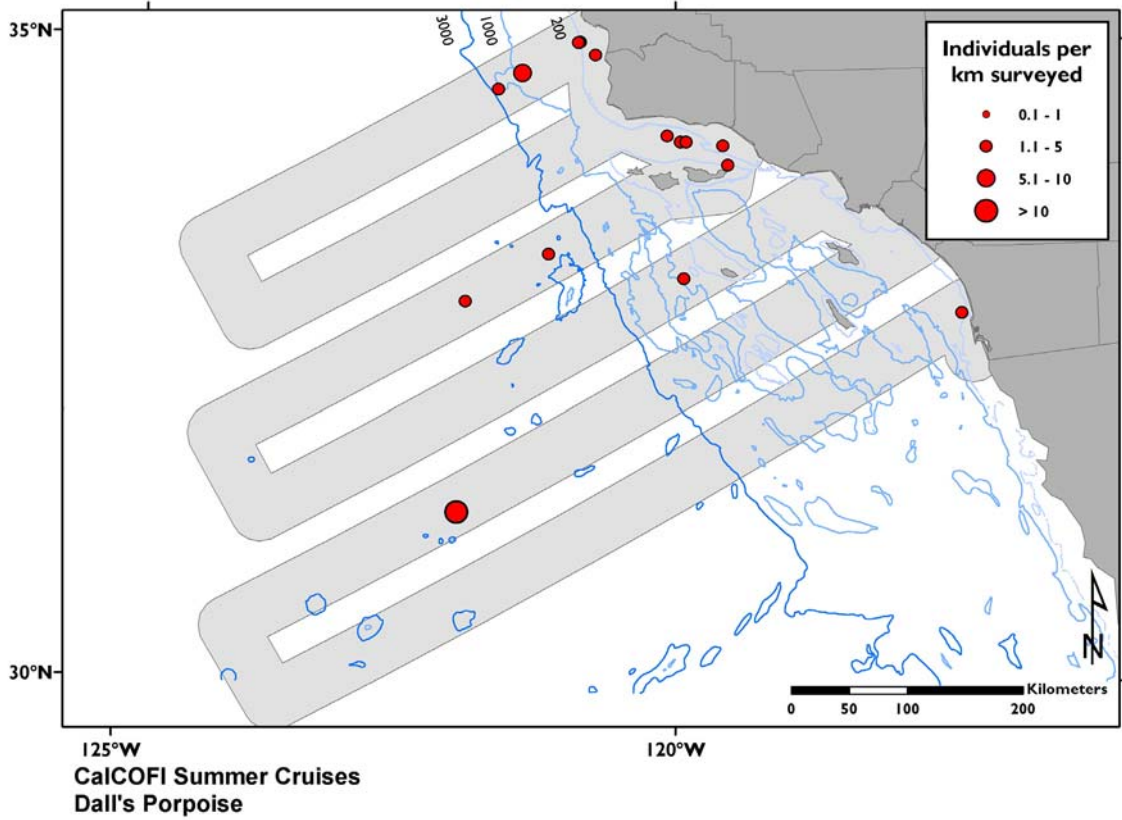
*Phocoenoides dalli*

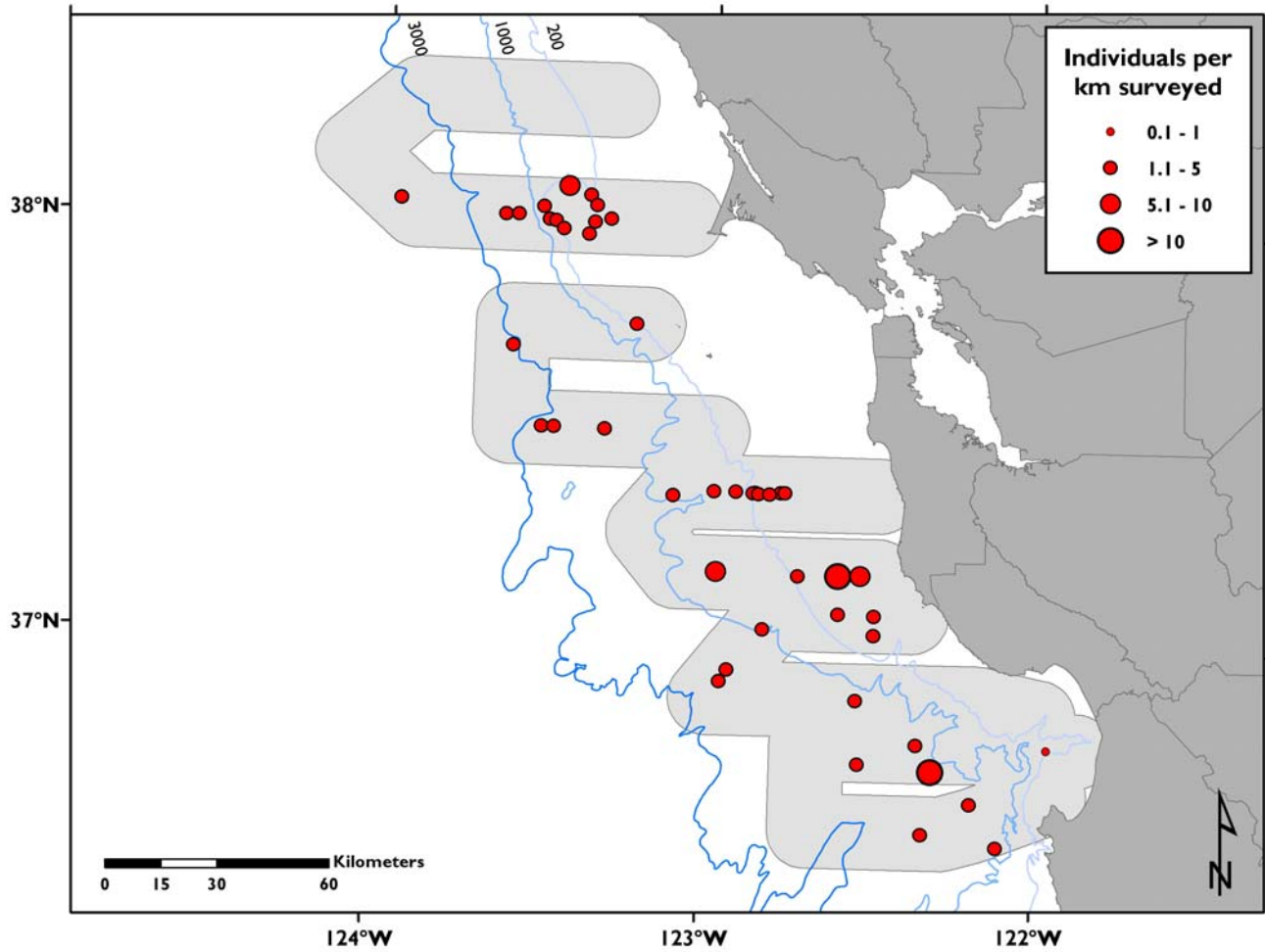


Dall's porpoise occurs in all of the study areas. Within the CCS, Dall's porpoises were widespread, and found in waters of varying depths. Lowest numbers occurred in the CalCOFI area in summer and in the Line P area during winter. The diet of Dall's porpoise consists of small fish and squid (Reeves et al. 2002).

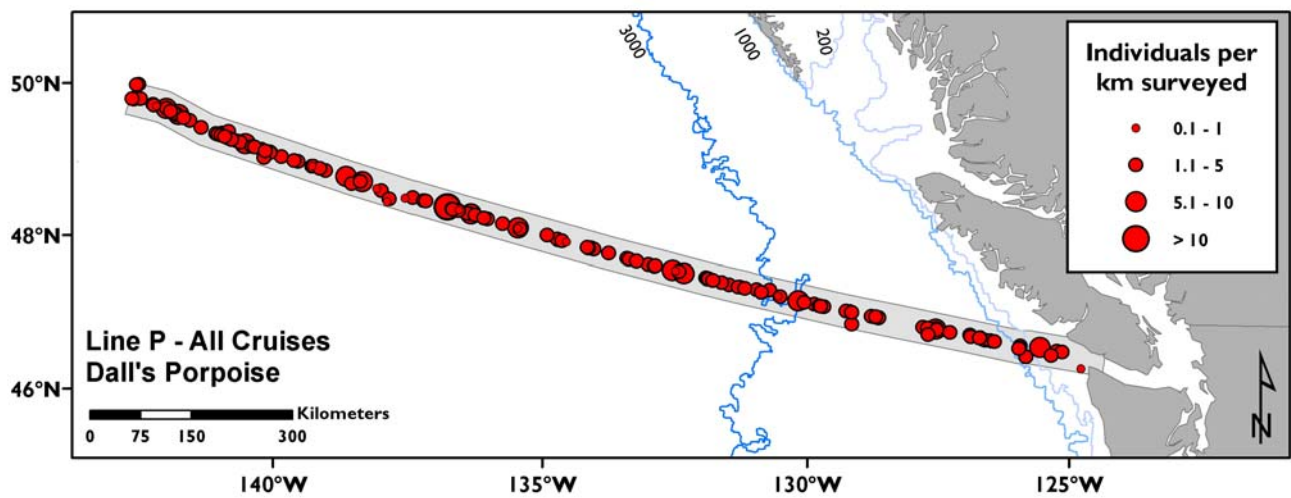




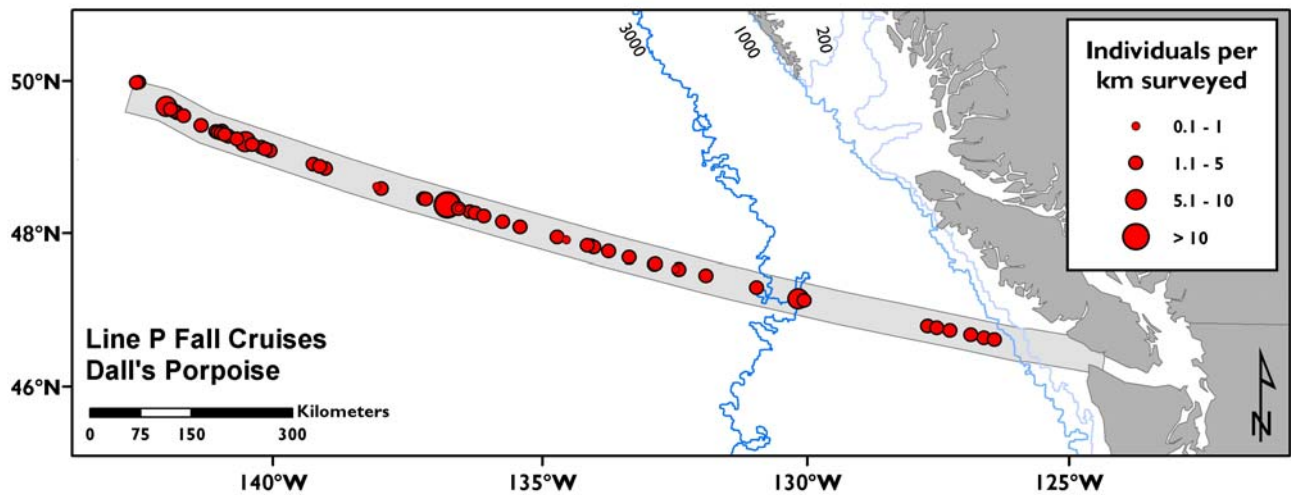
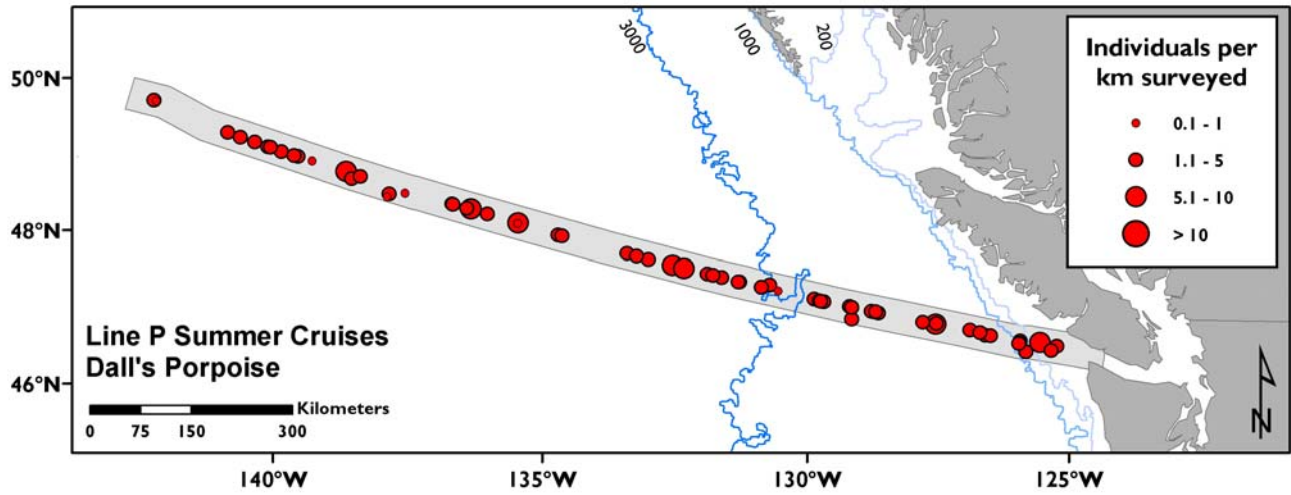
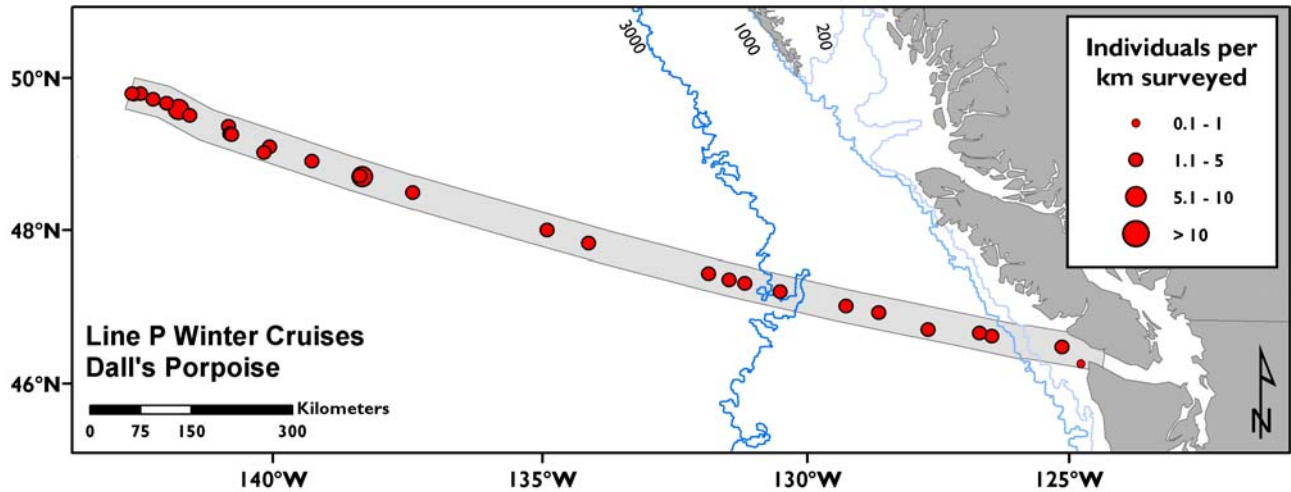




NMFS - All Cruises  
Dall's Porpoise



Line P - All Cruises  
Dall's Porpoise



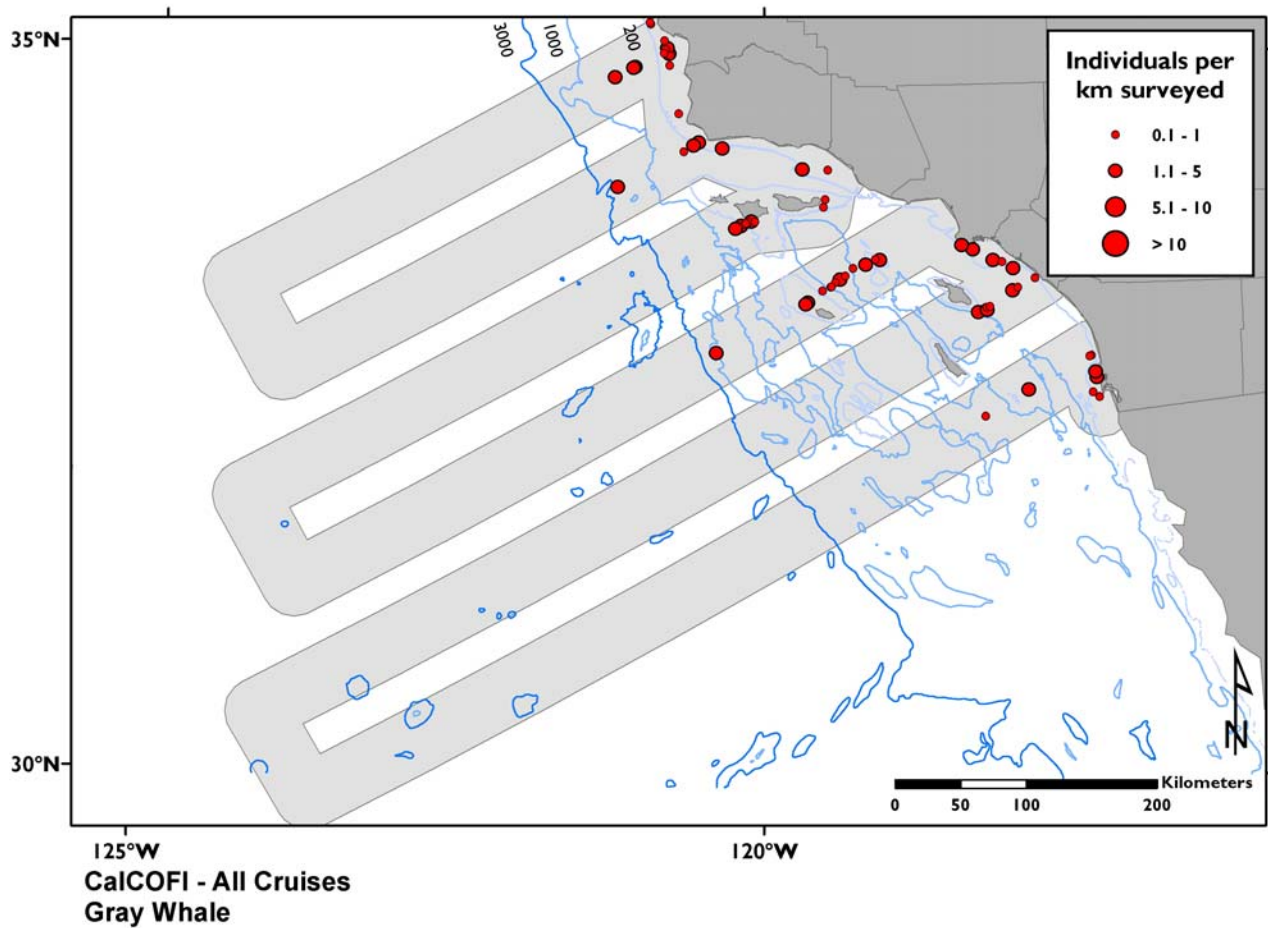


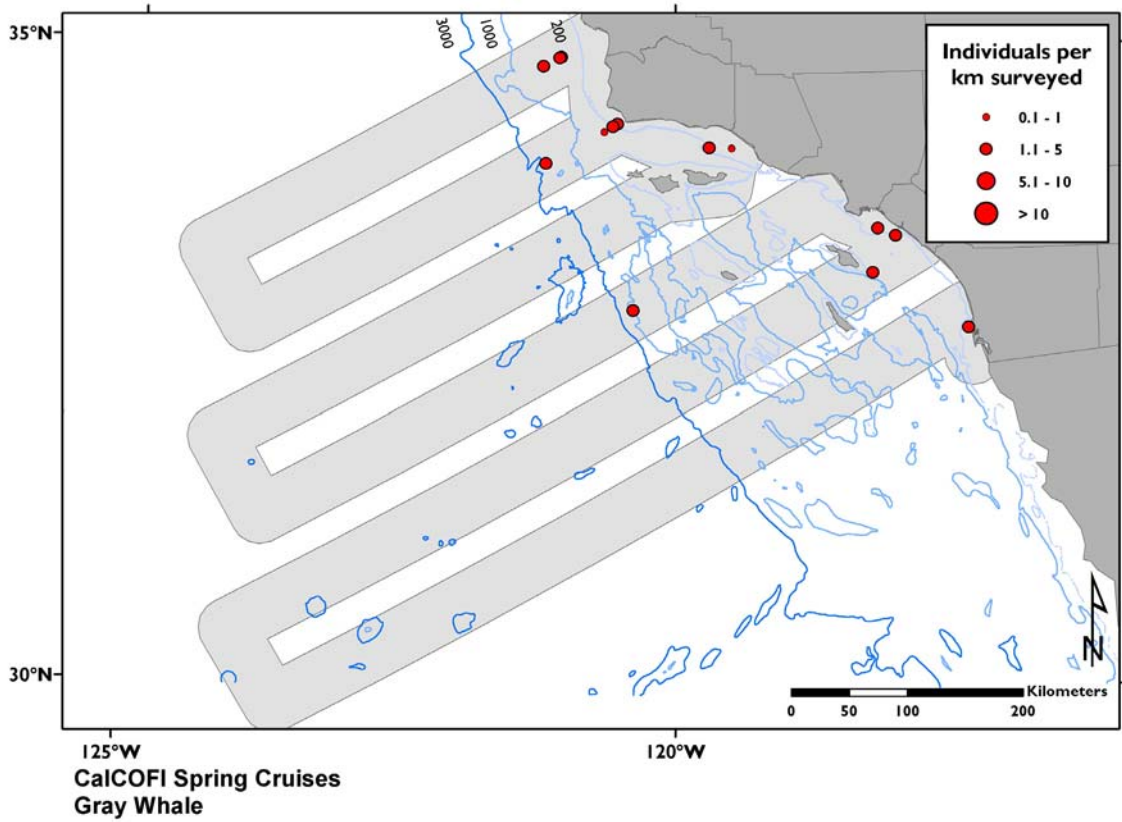
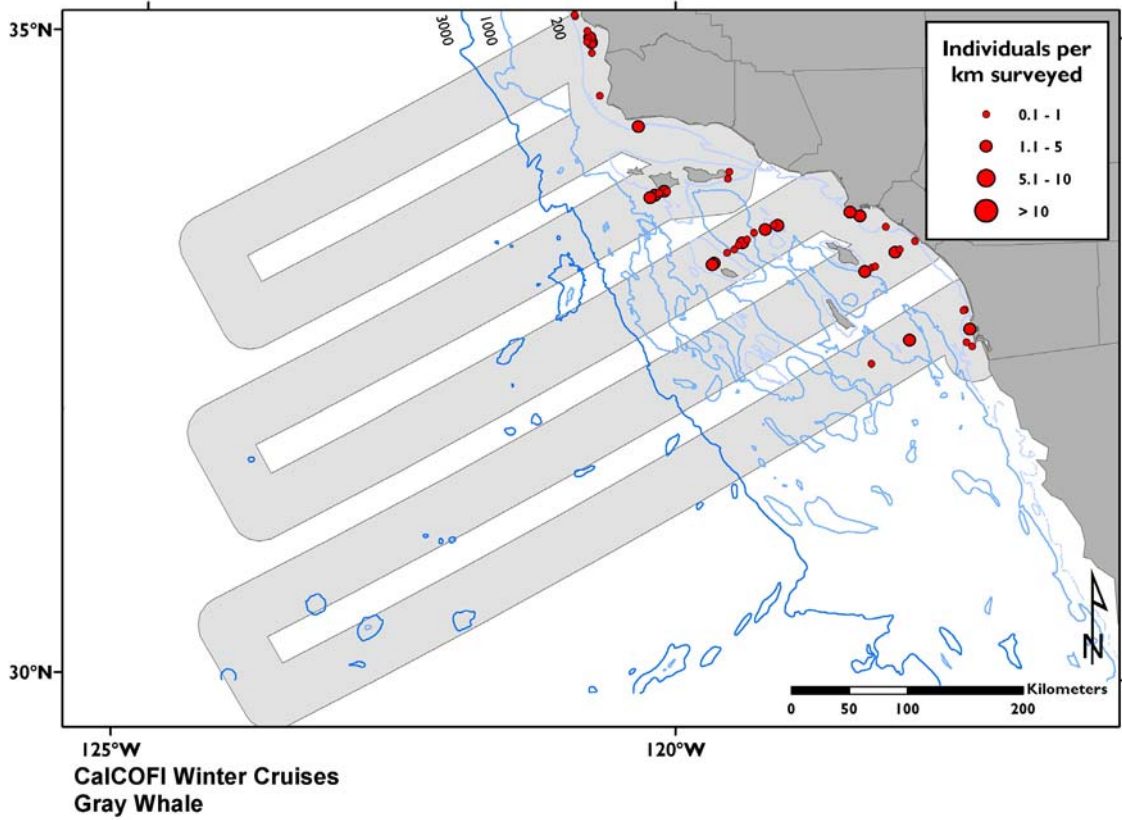
# Gray Whale

*Eschrichtius robustus*

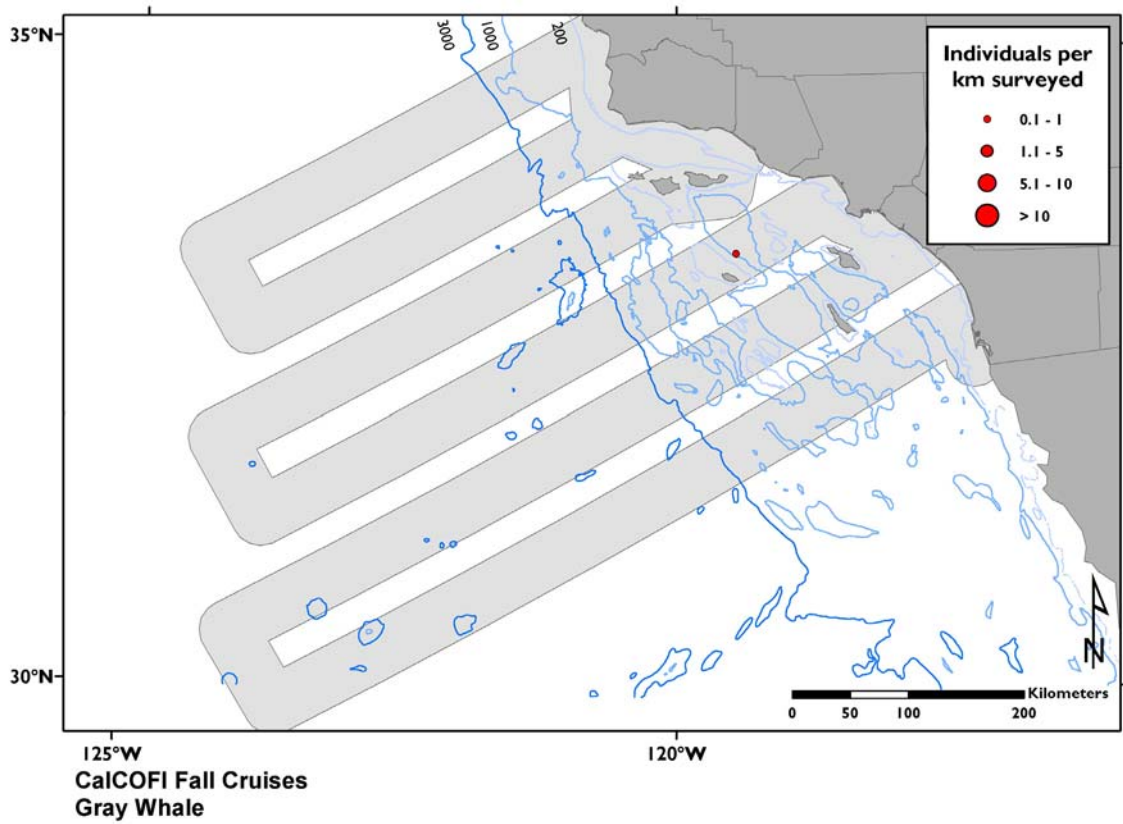
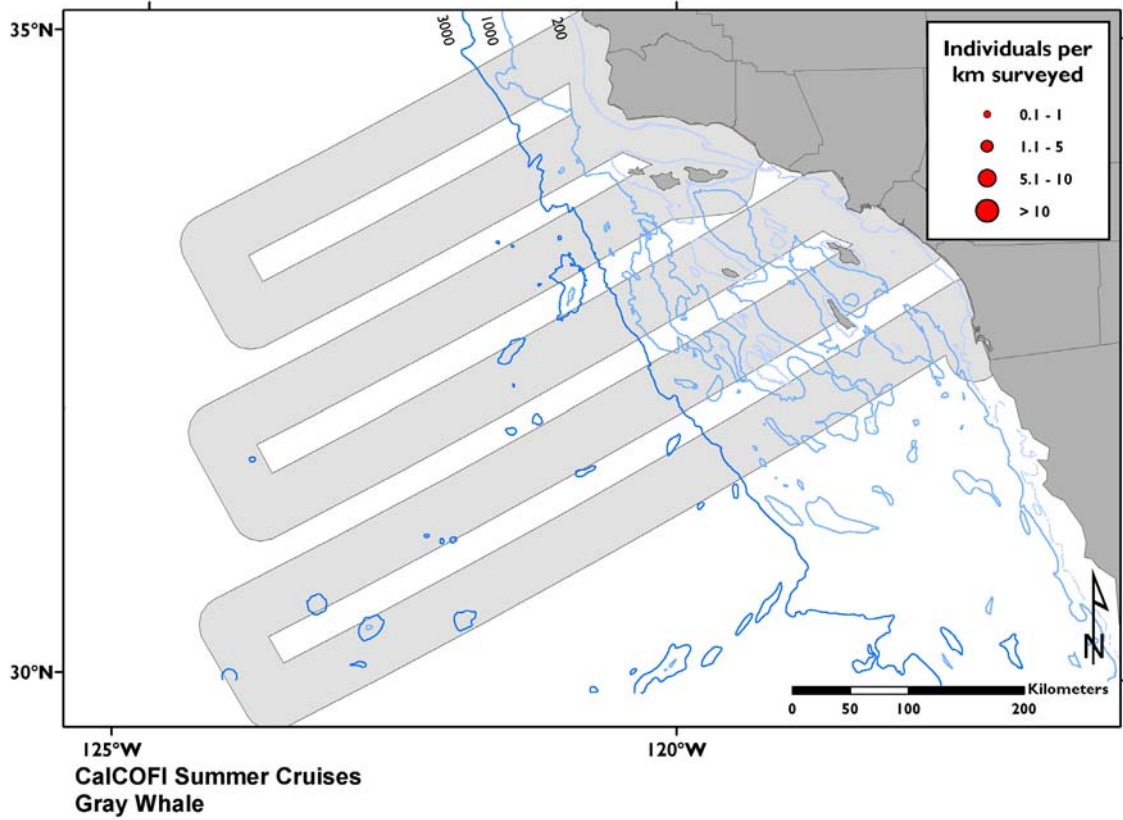


Because gray whales feed on benthic prey, they occur mostly in shallow coastal waters. The occurrence of gray whales in the CalCOFI study area was limited to winter and spring migration periods.









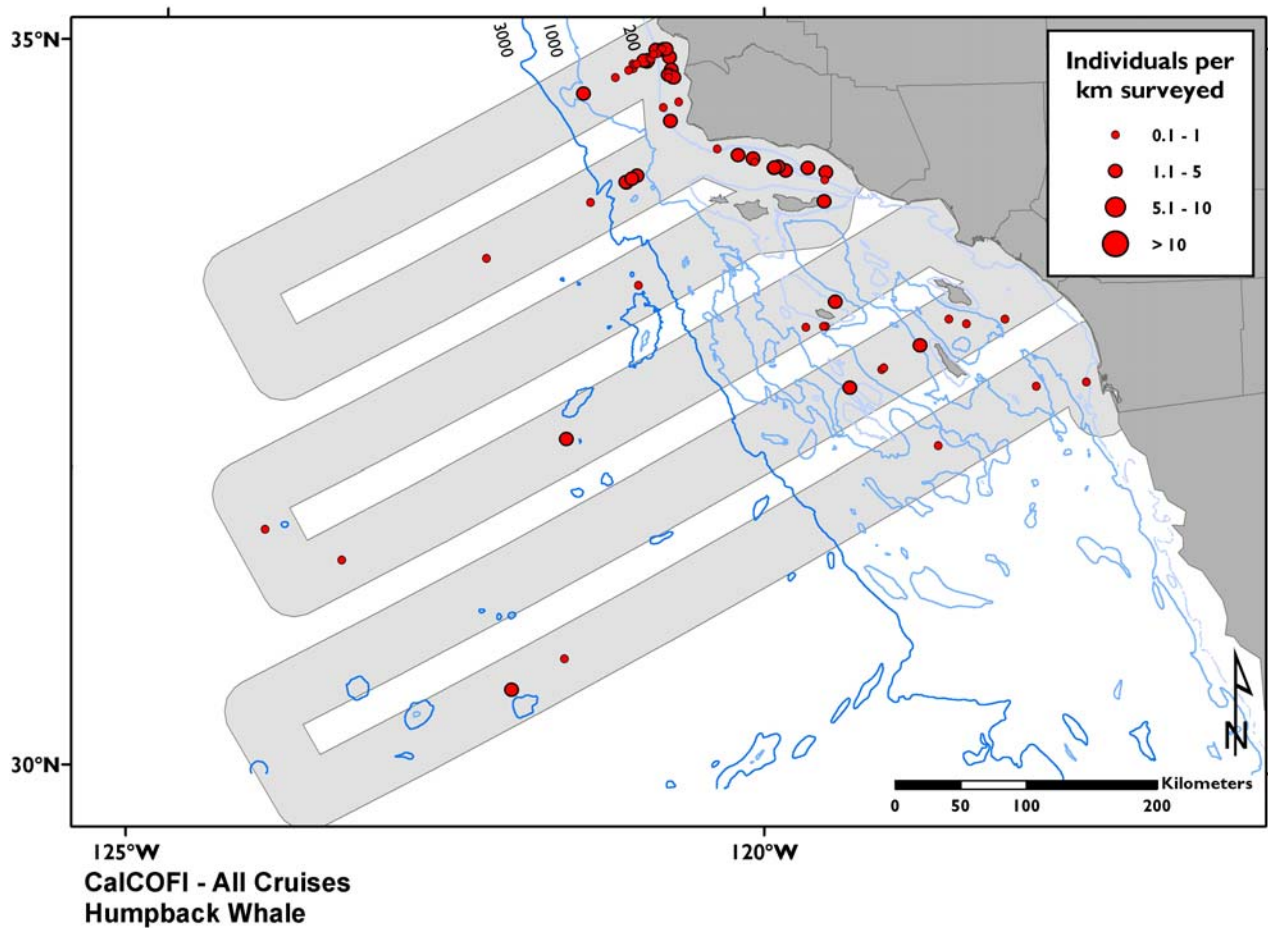


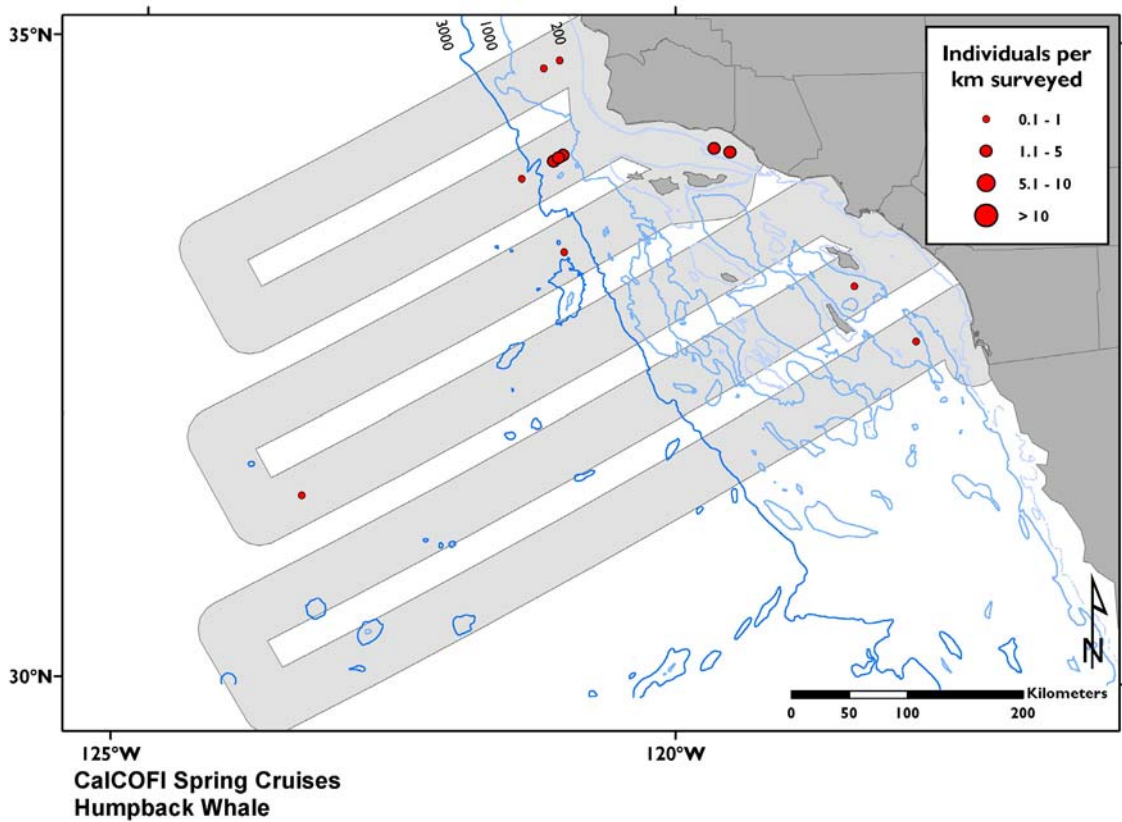
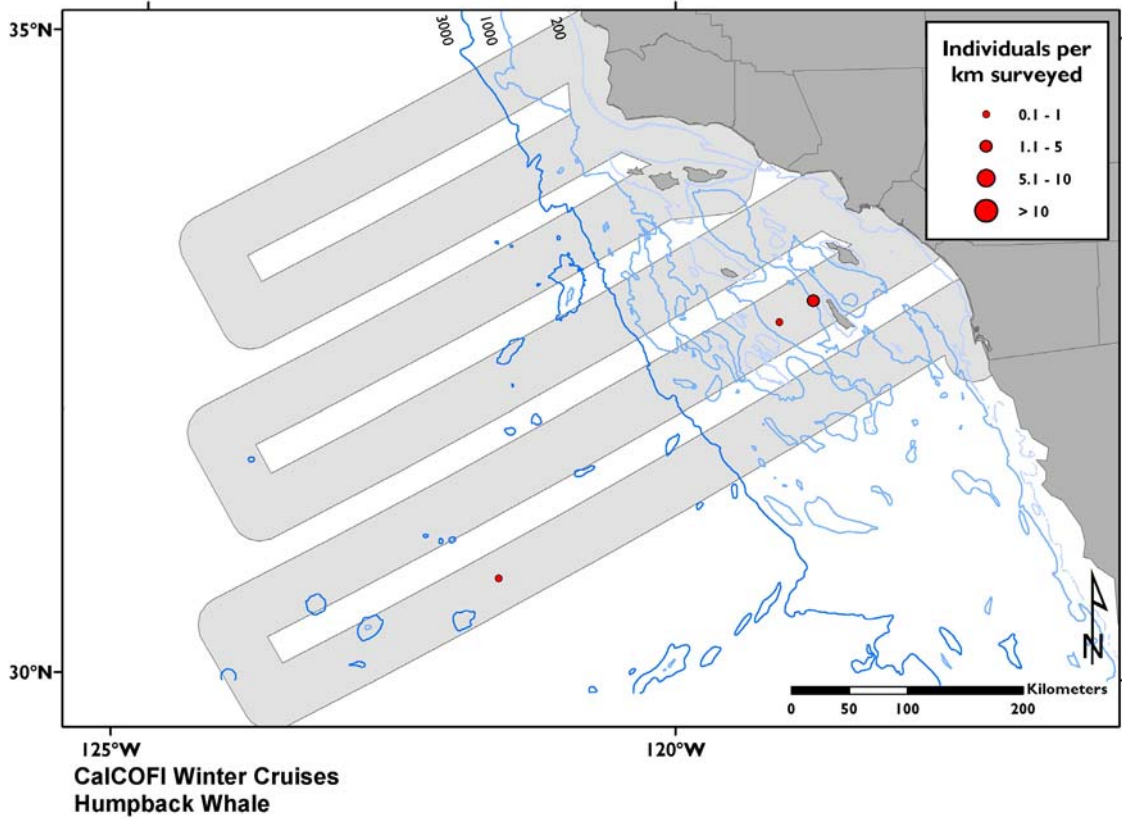
# Humpback Whale

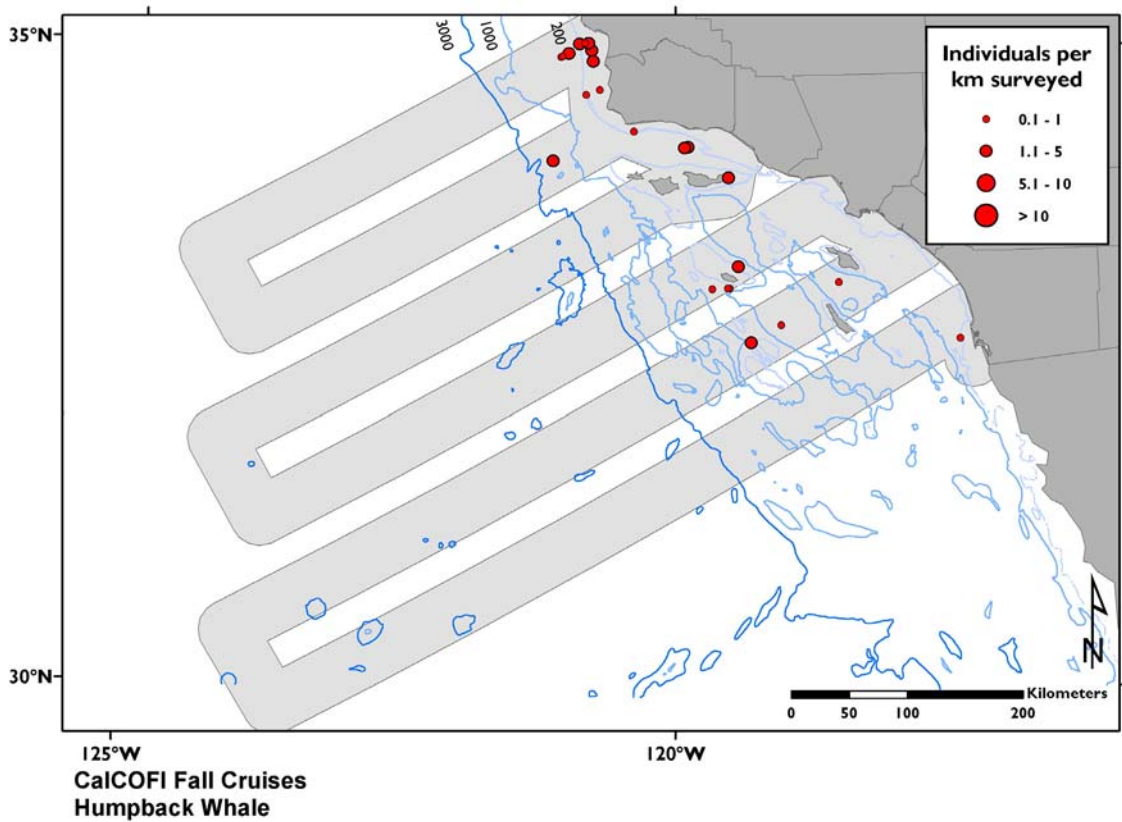
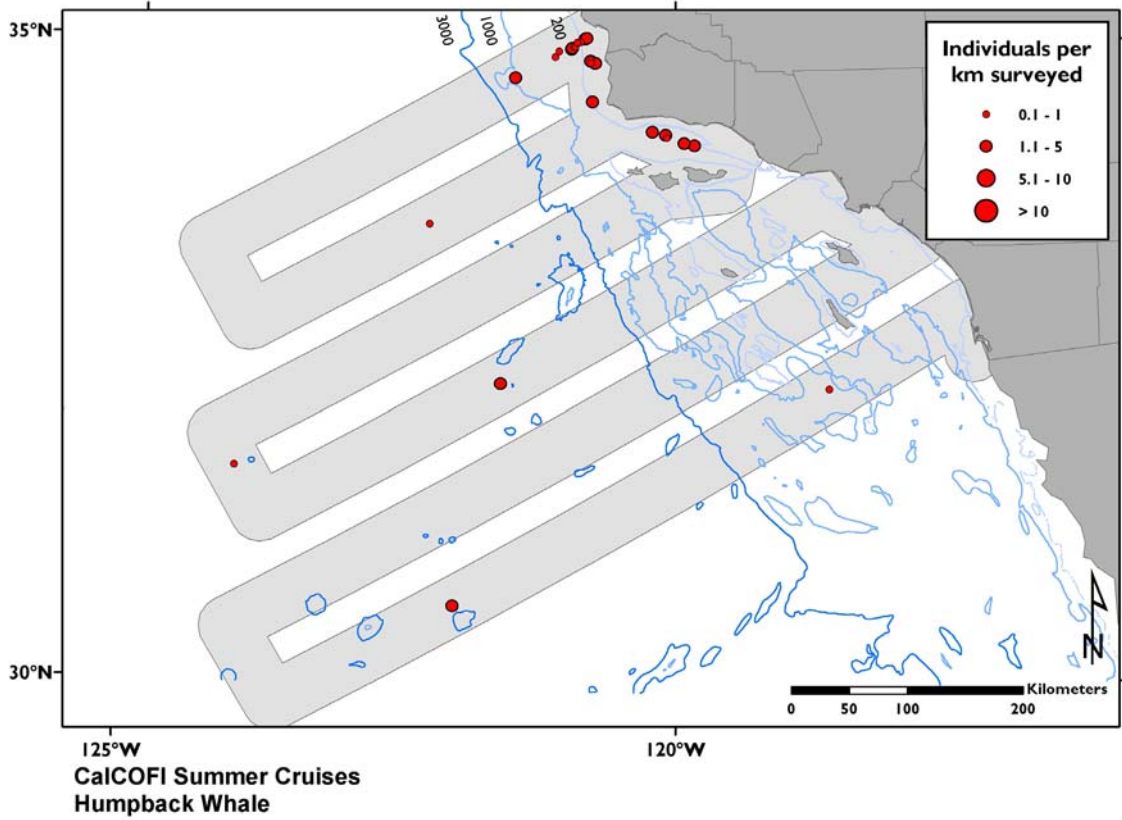
*Megaptera novaeangliae*

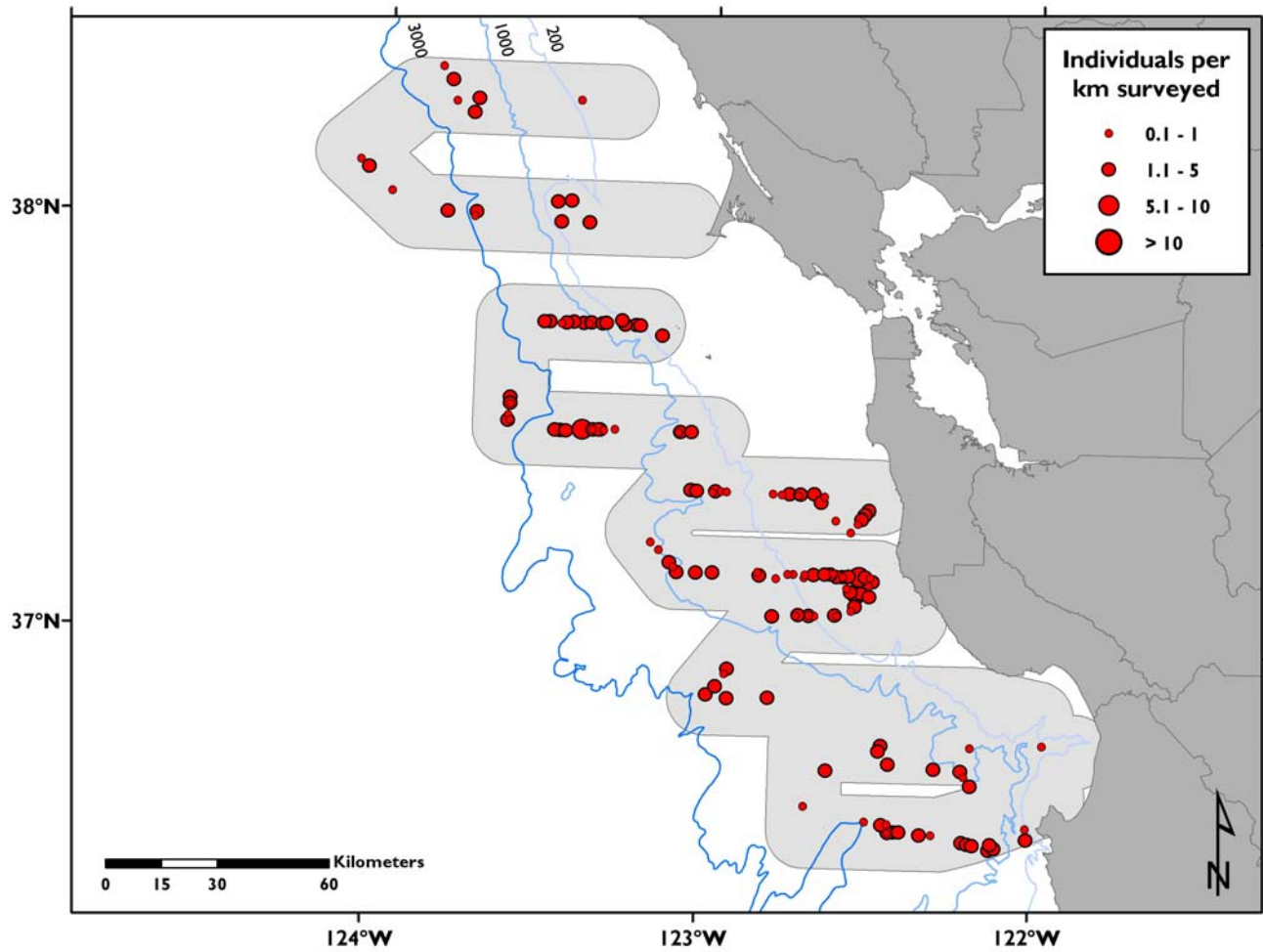


Humpback whales make the longest migration of any mammal, breeding in tropical waters in the winter and feeding at northern latitudes in the summer. Humpbacks were nearly absent from the study areas in winter. Within the CalCOFI area, they were most frequently encountered near Point Conception and the Santa Barbara Channel. Of all three study areas, the greatest number of humpback whales were observed in the NMFS study area during the spring. Their diet consists of small schooling fish and krill.

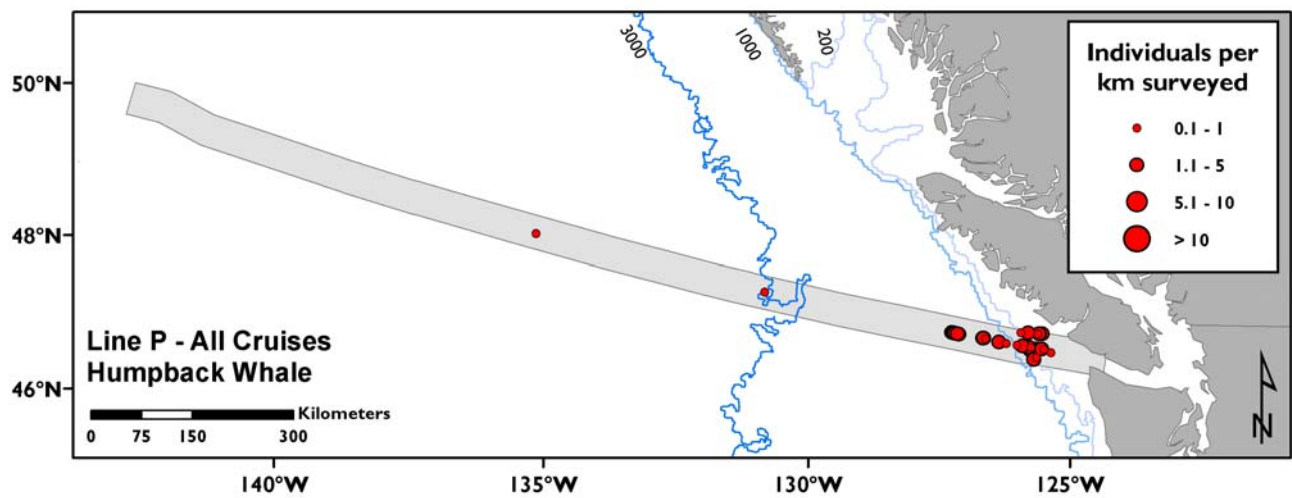




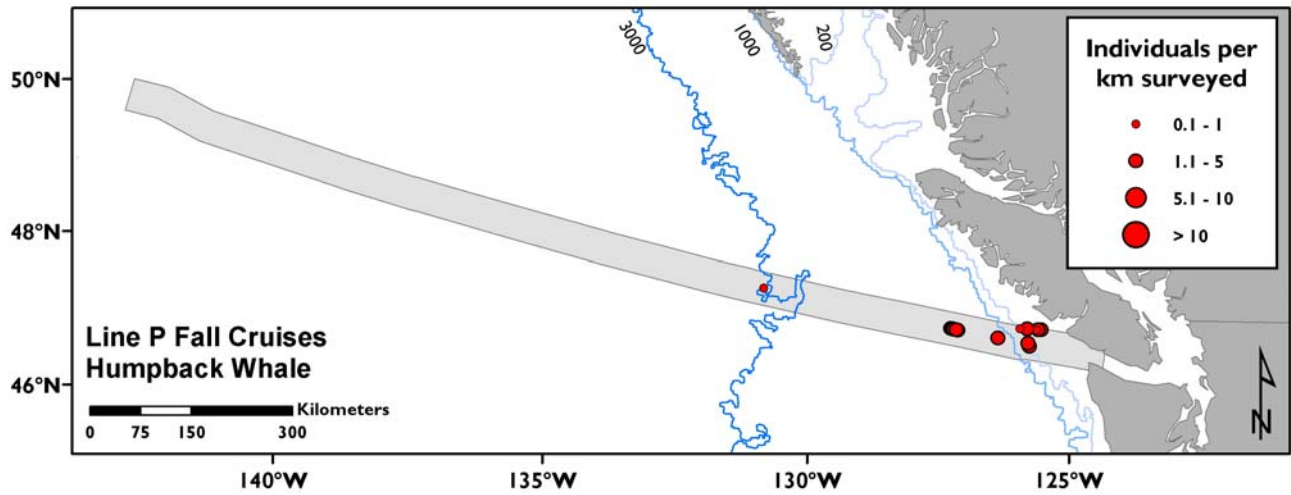
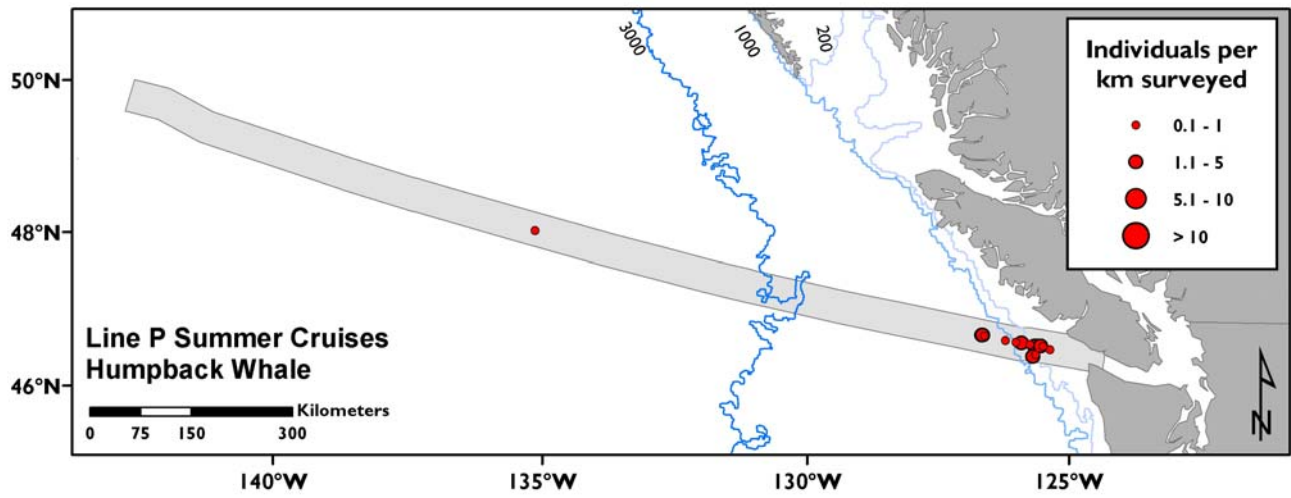
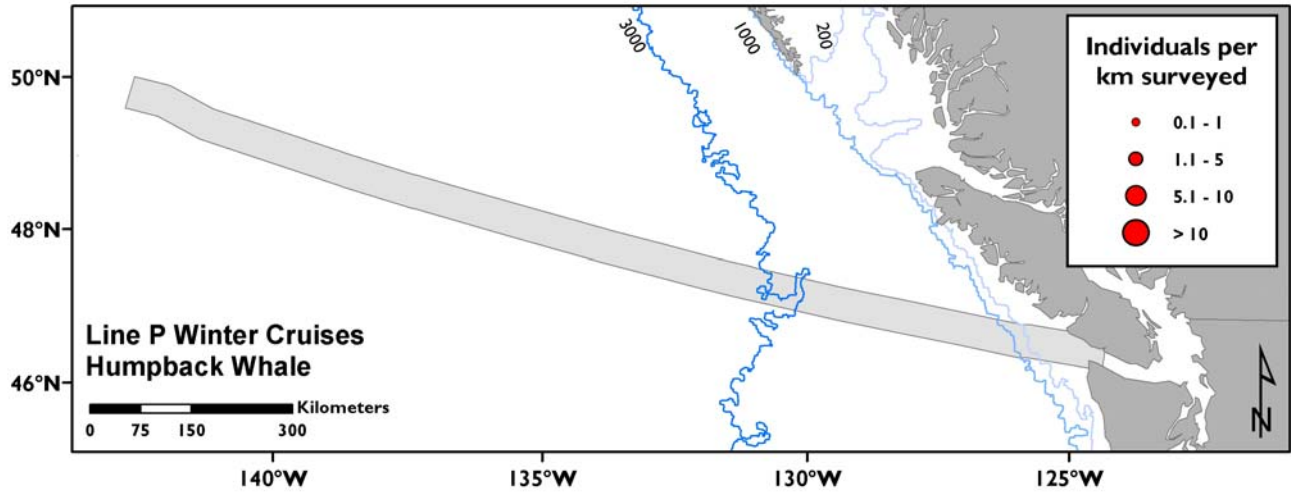




**NMFS - All Cruises  
Humpback Whale**



**Line P - All Cruises  
Humpback Whale**

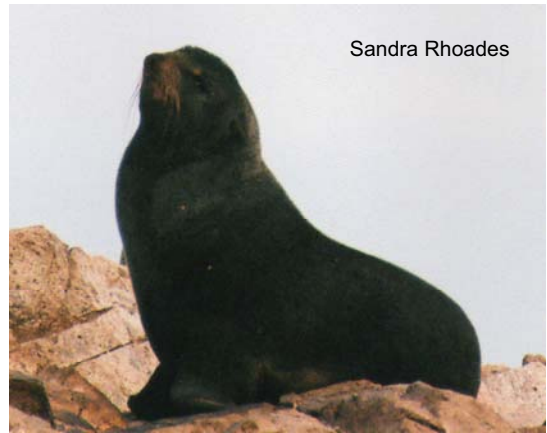




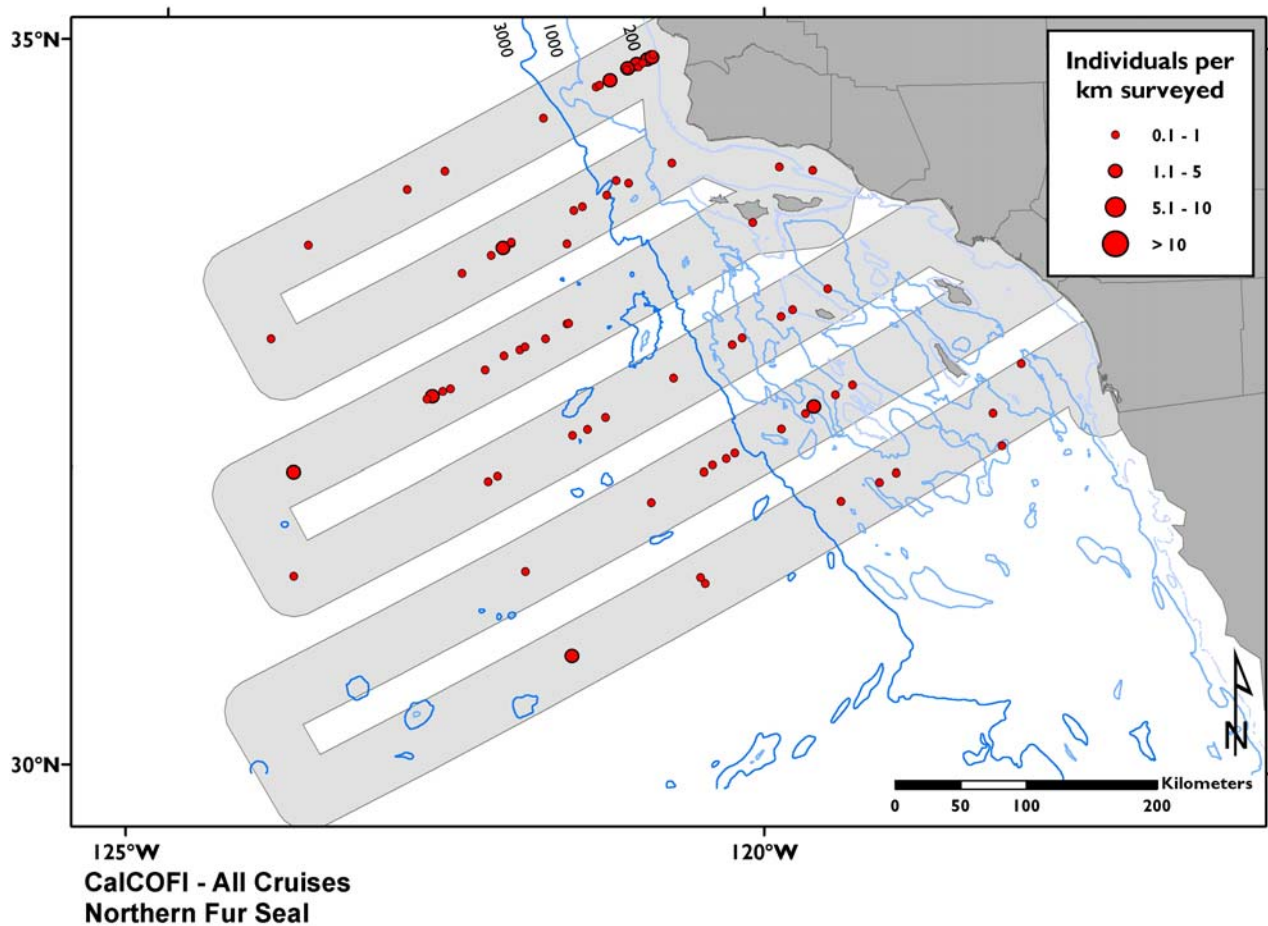


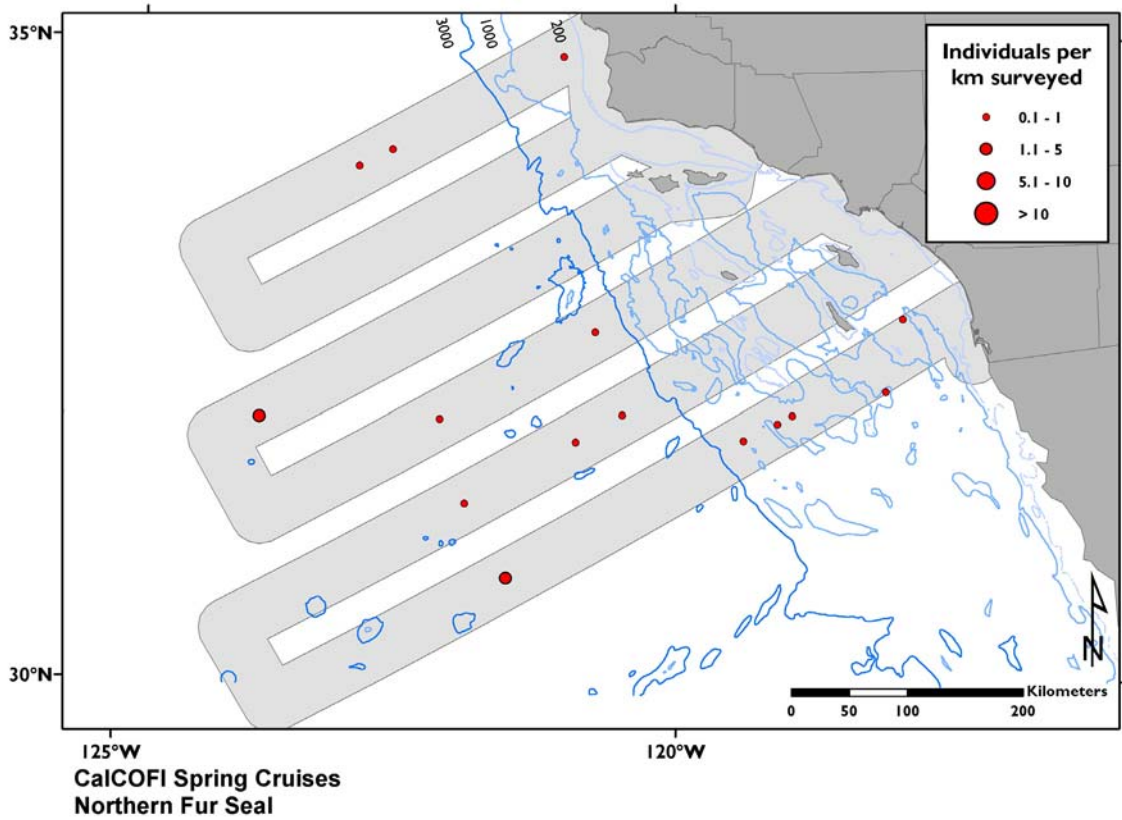
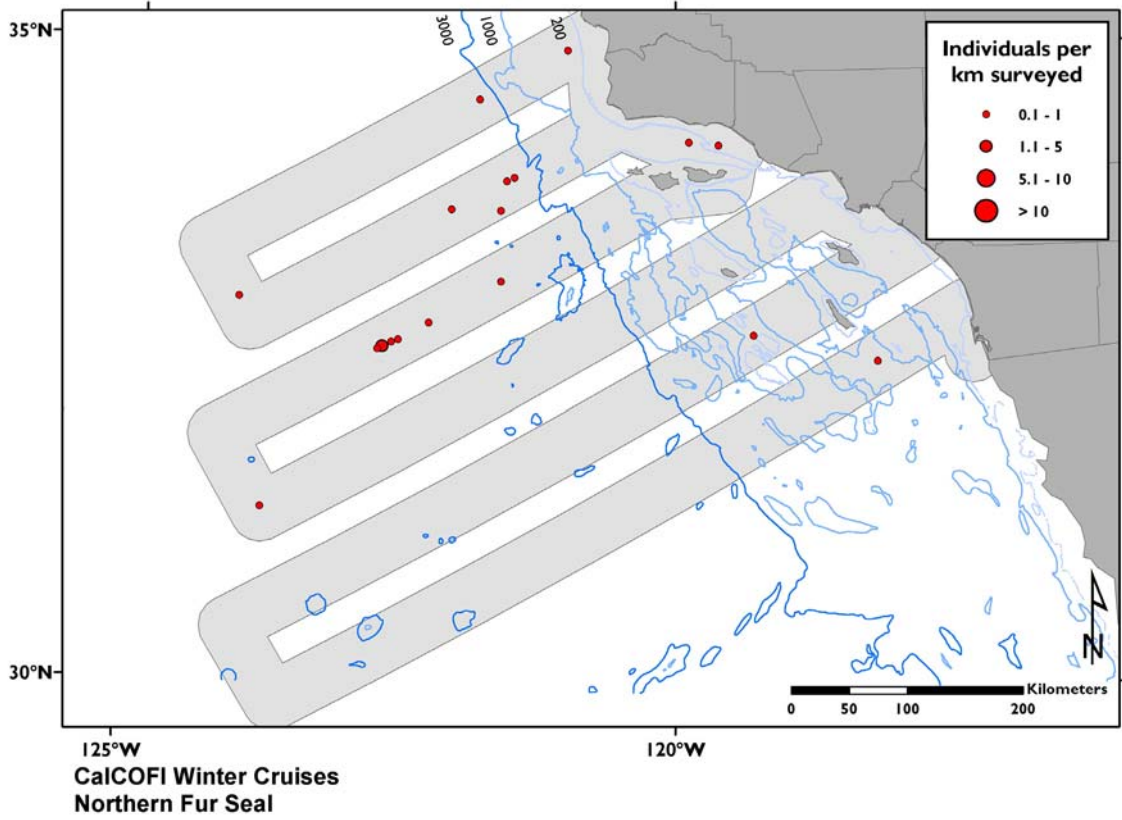
# Northern Fur Seal

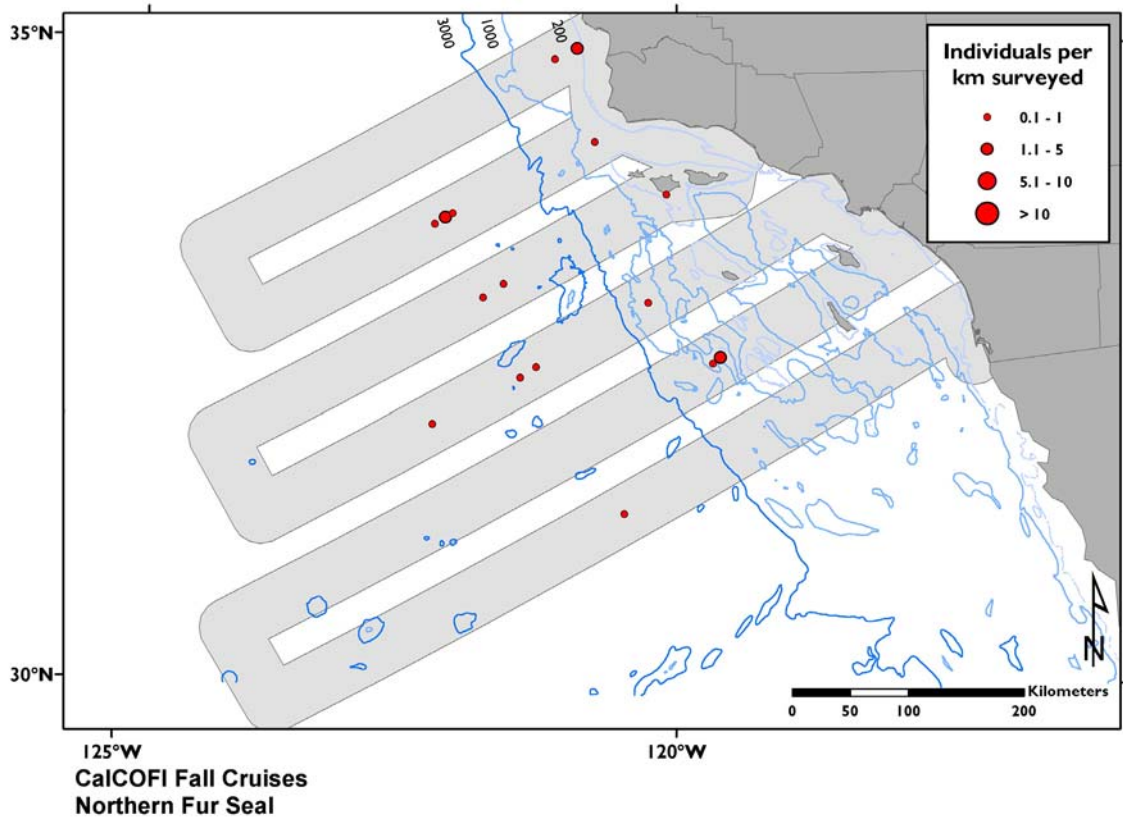
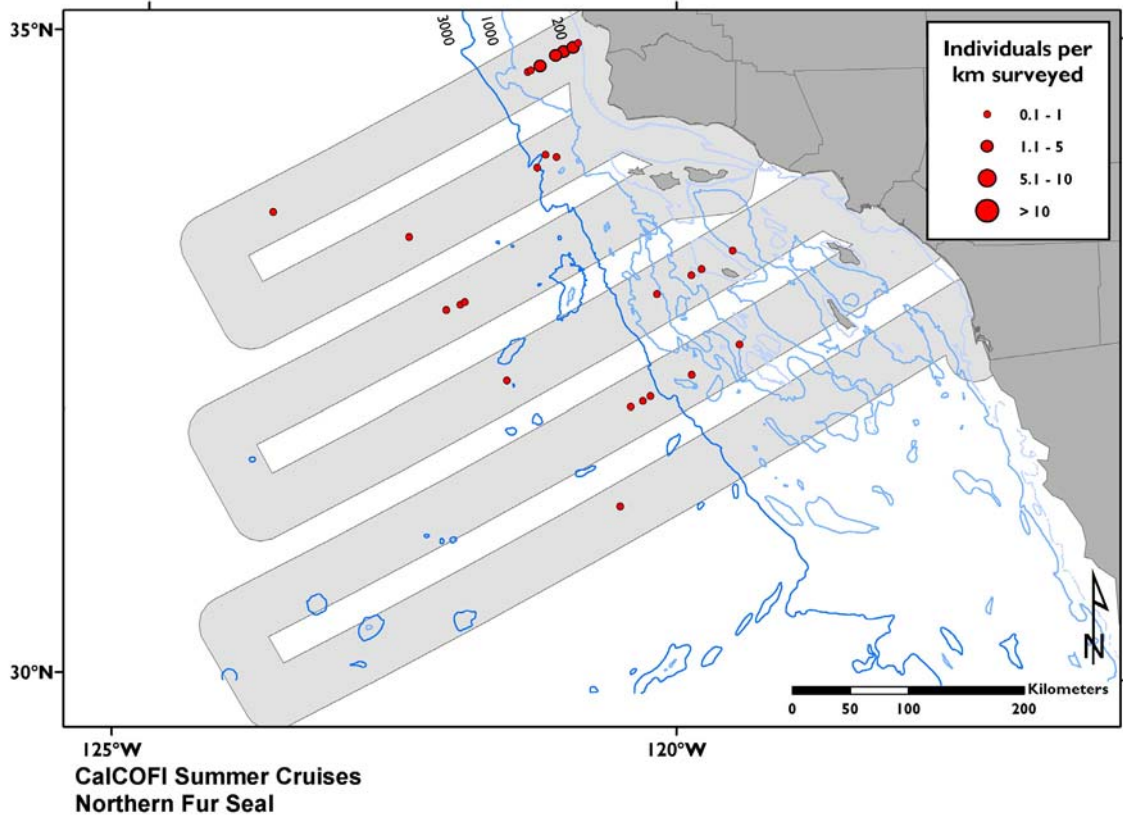
*Callorhinus ursinus*

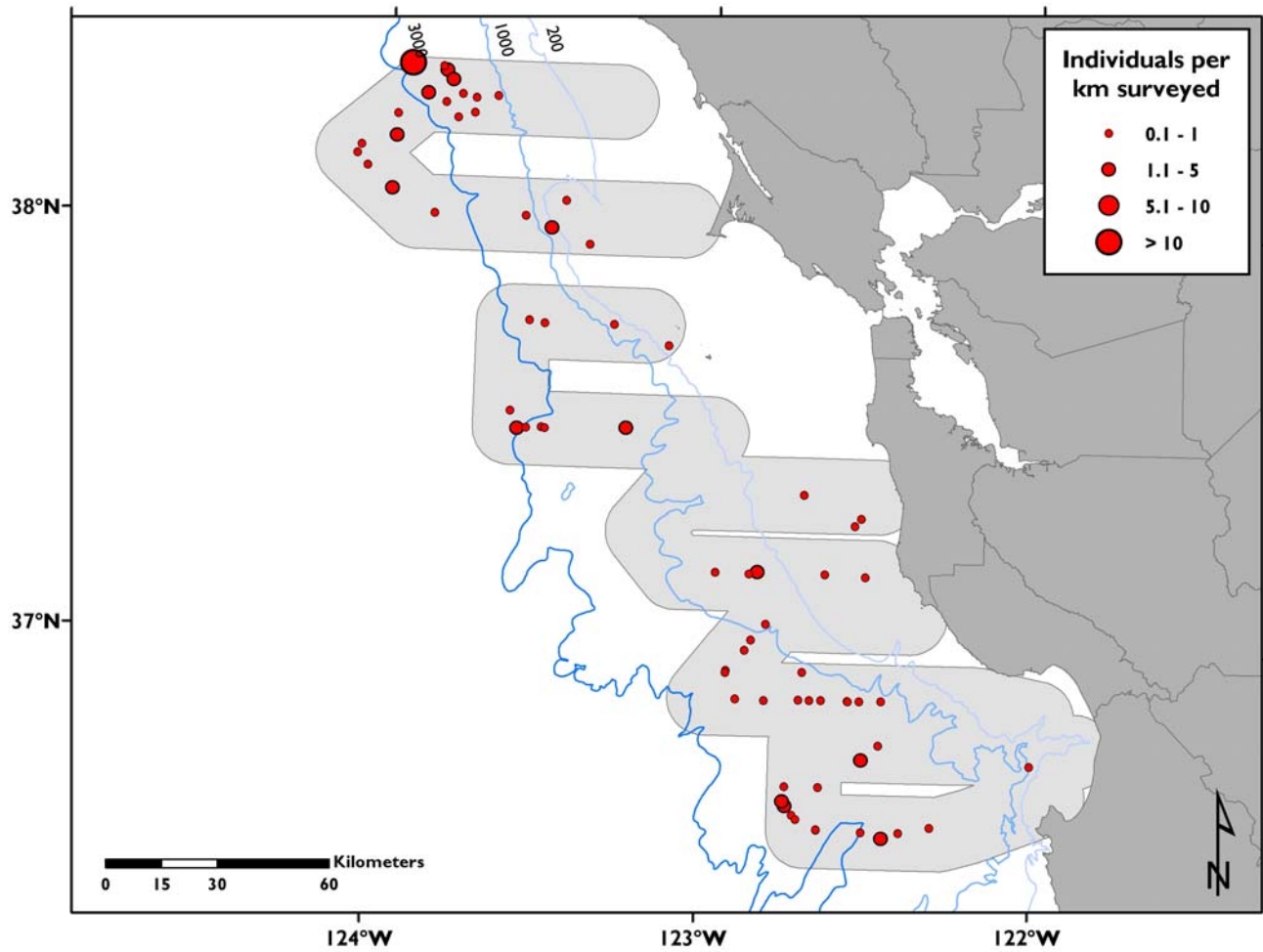


Northern Fur Seals are endemic to the North Pacific and the Bering and Okhotsk Seas. In the NMFS study area, Northern Fur Seals occurred most frequently over the continental slope. Distribution in the CalCOFI study area was sparse, wide, and without a clear pattern. Although they were regularly seen along Line P in winter and summer, they were detected only once during the fall. Northern Fur Seals feed on an assortment of fish and squid species.

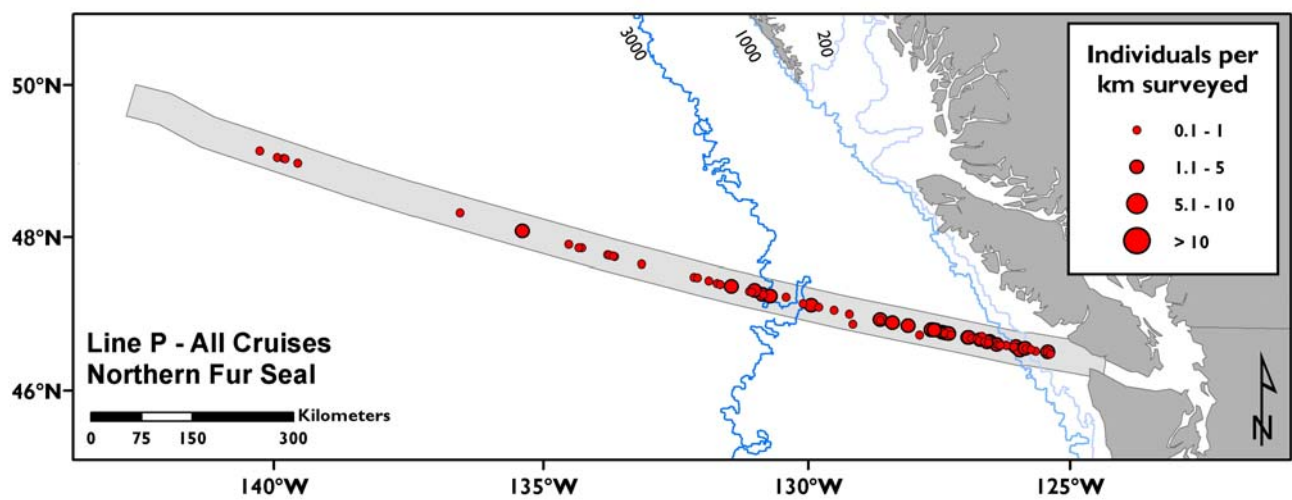




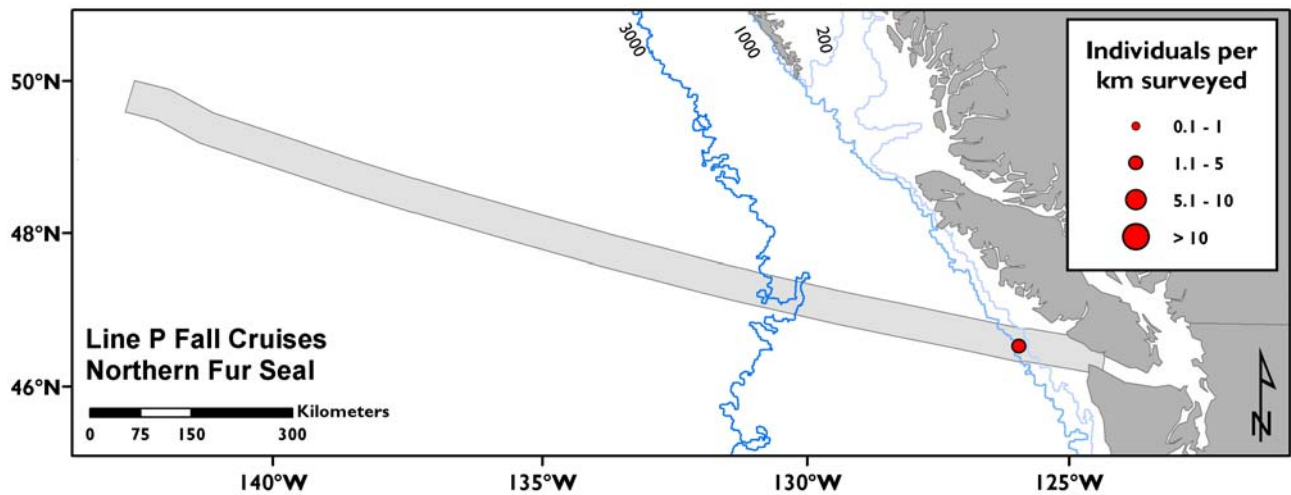
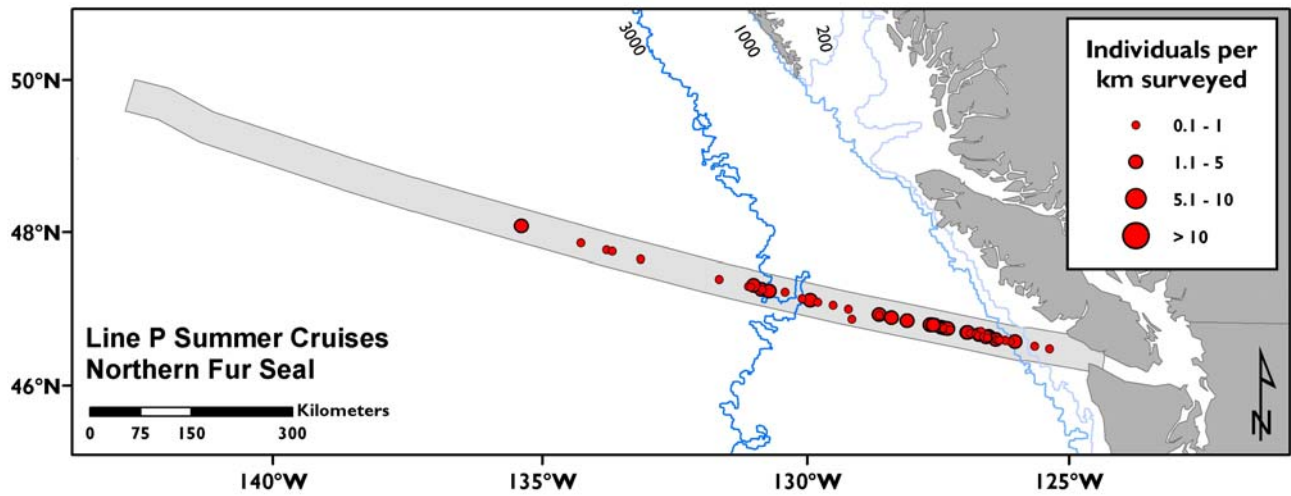
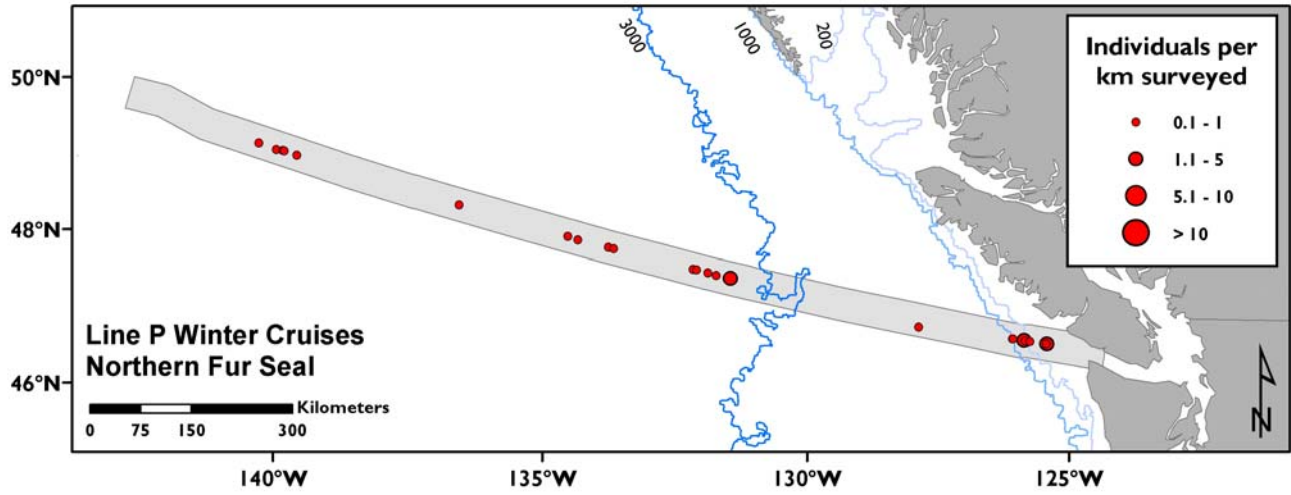




NMFS - All Cruises  
Northern Fur Seal



Line P - All Cruises  
Northern Fur Seal



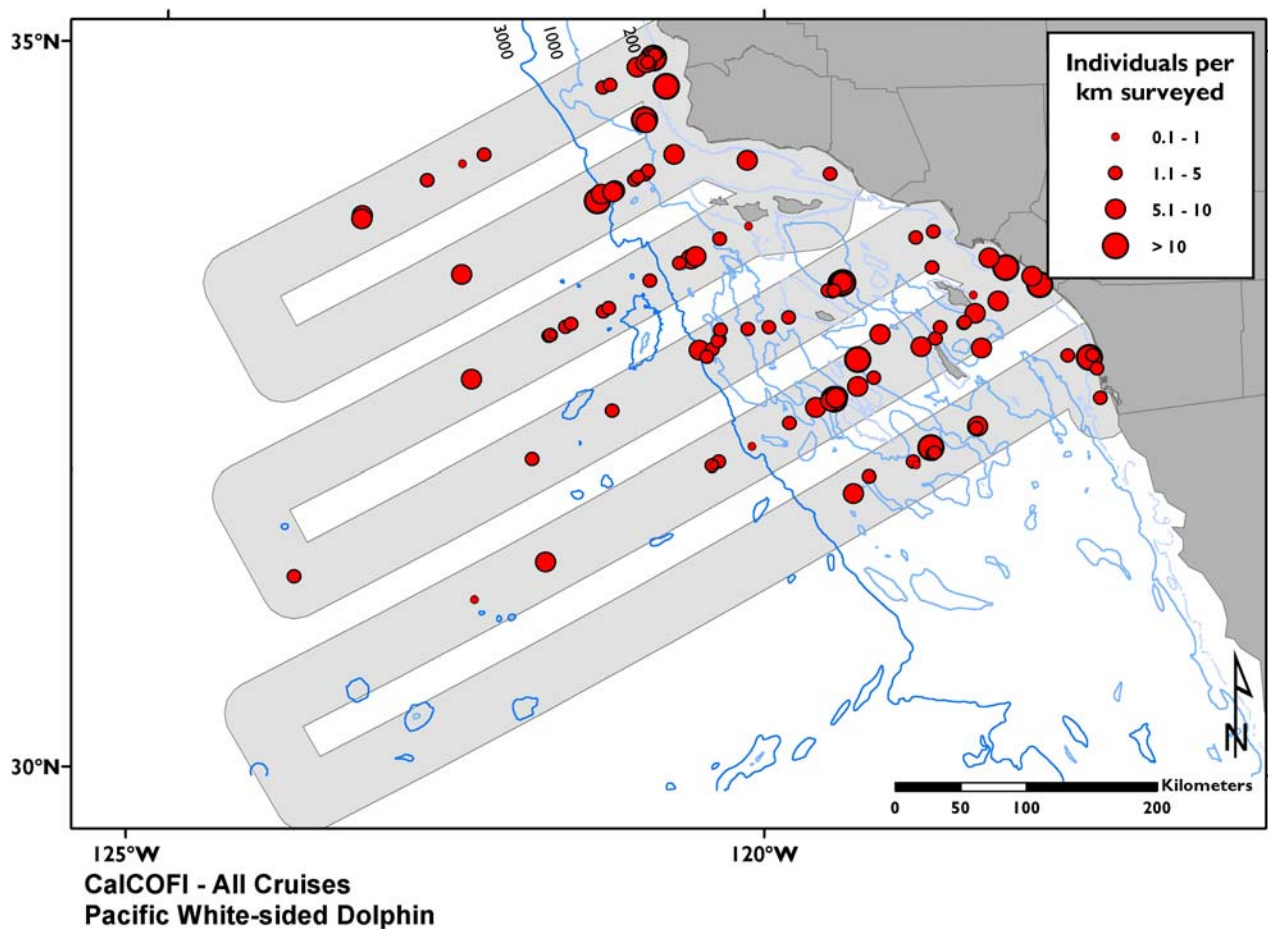


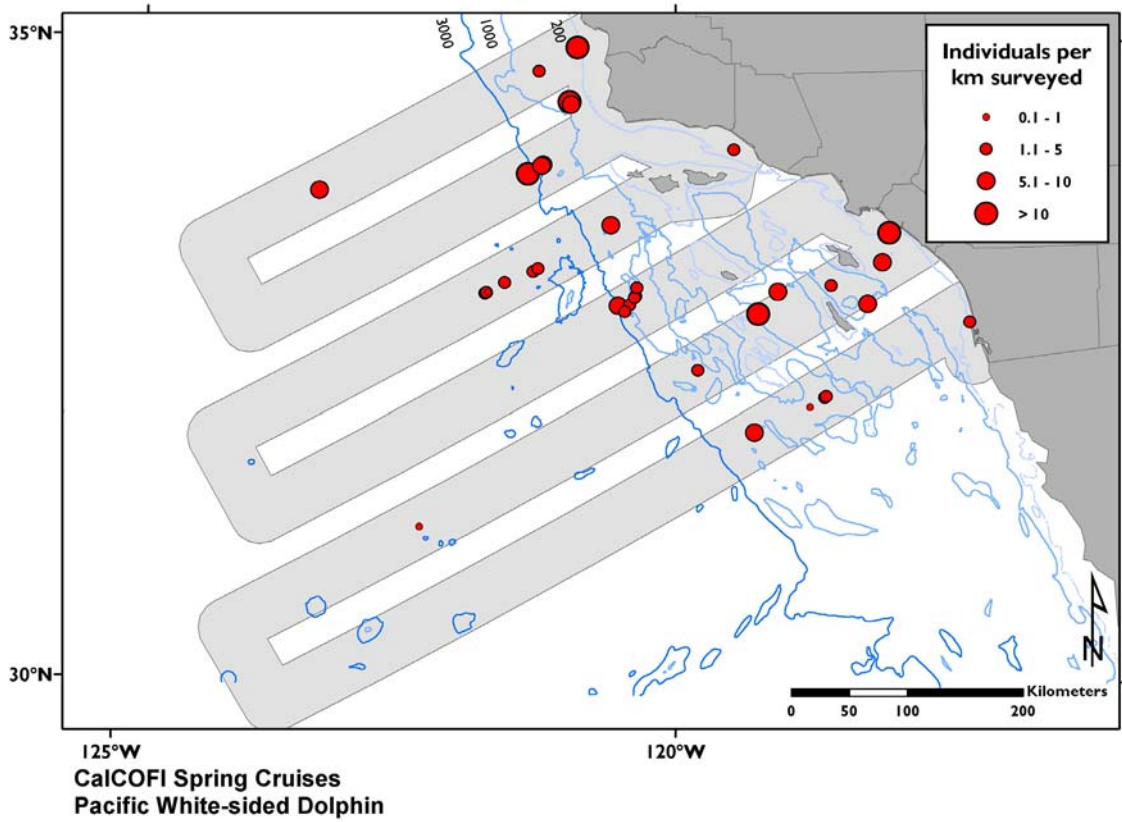
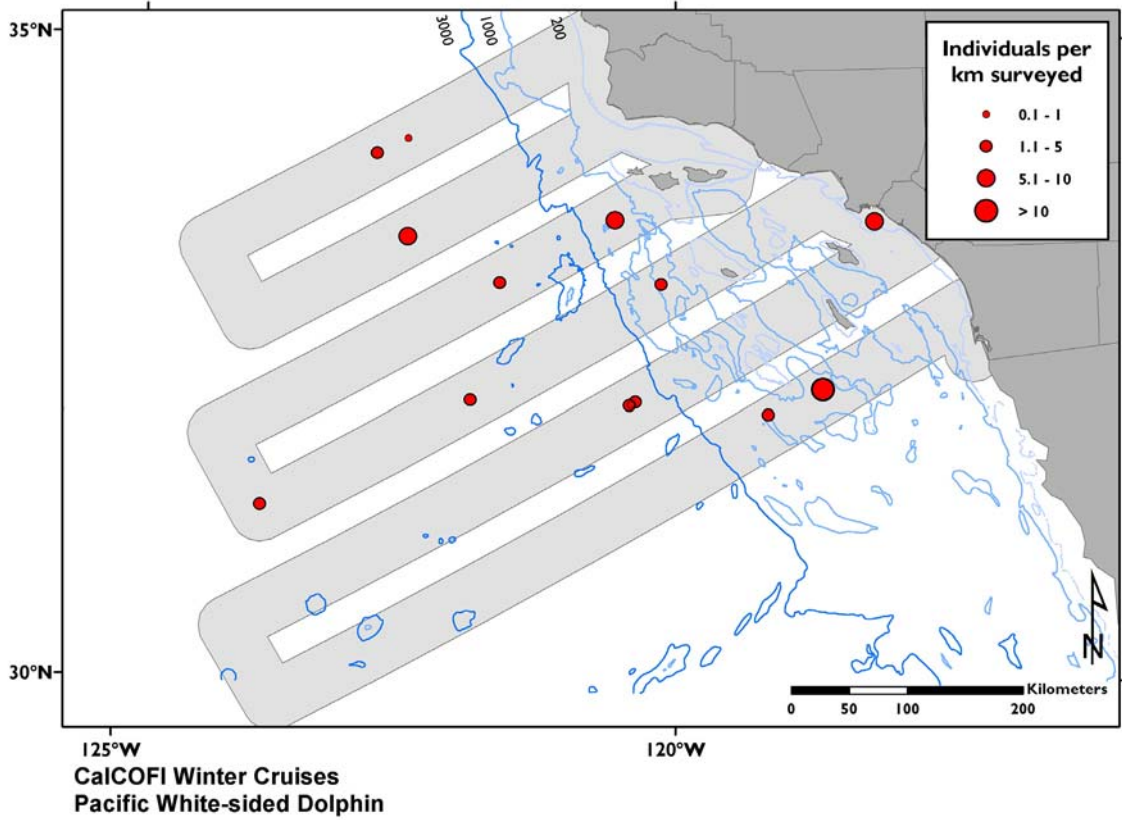
# Pacific White-sided Dolphin

*Lagenorhynchus obliquidens*

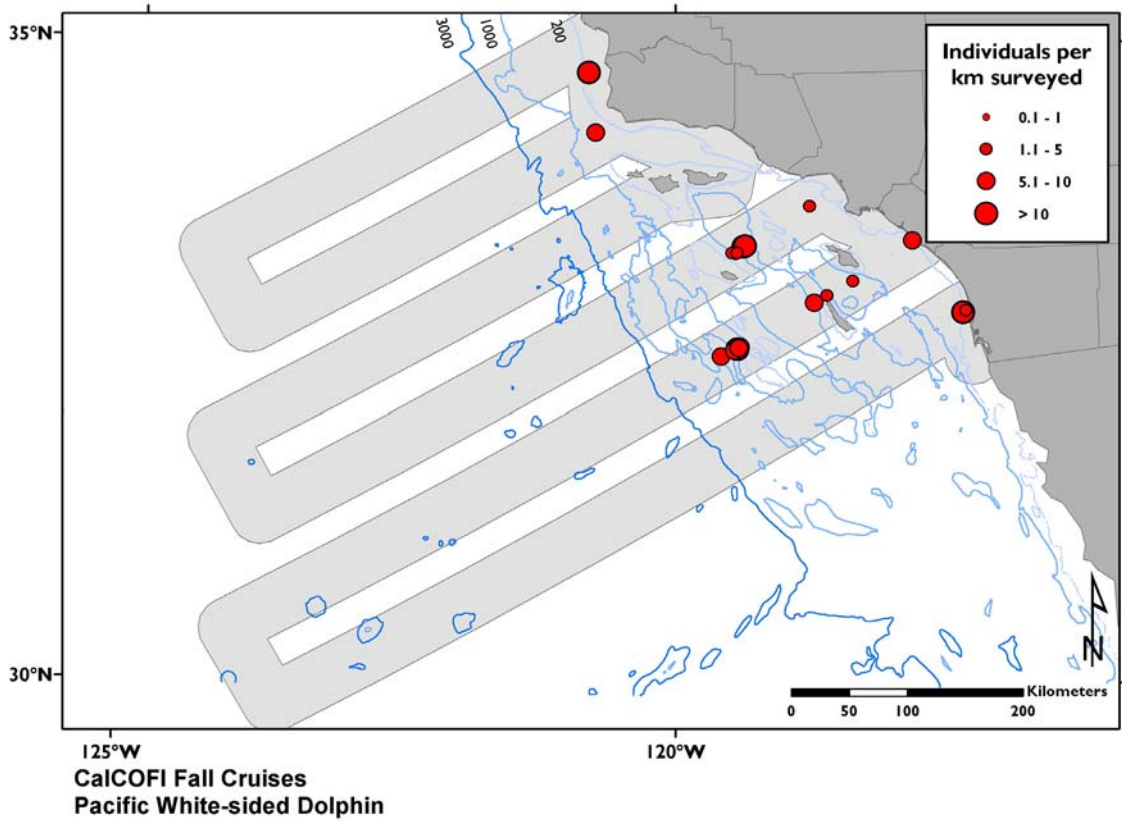
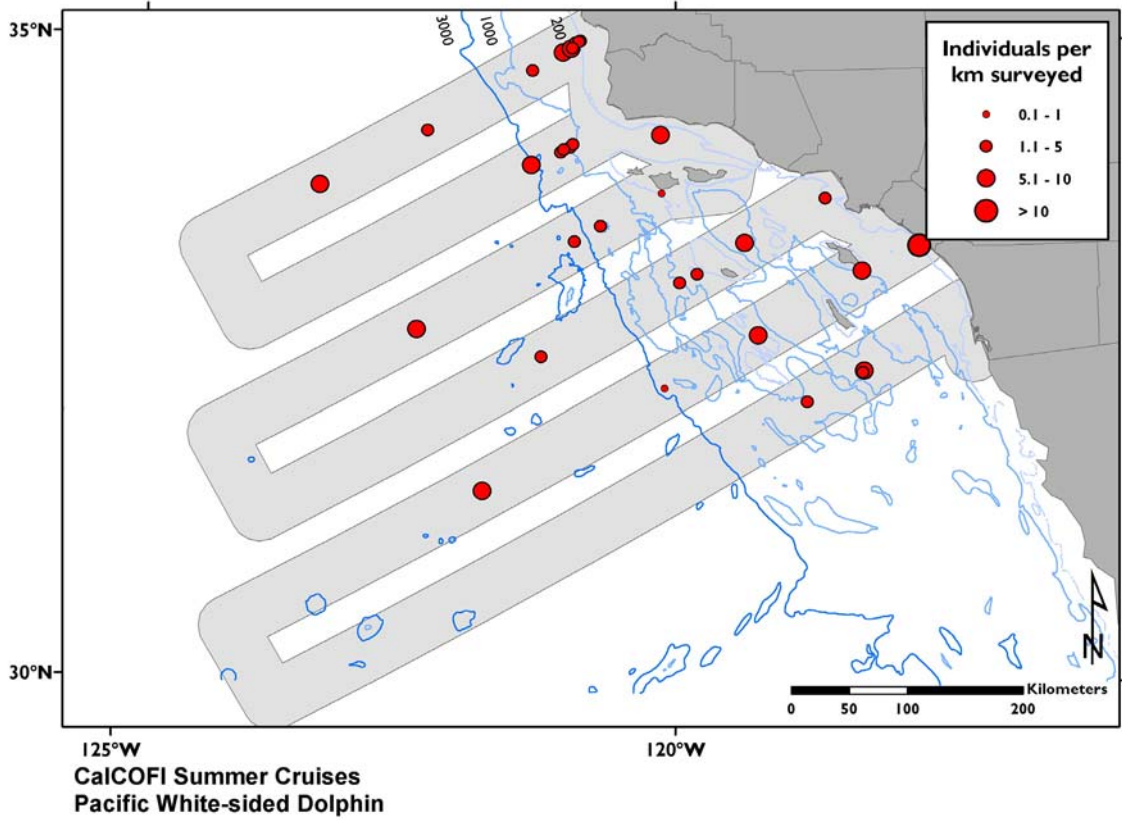


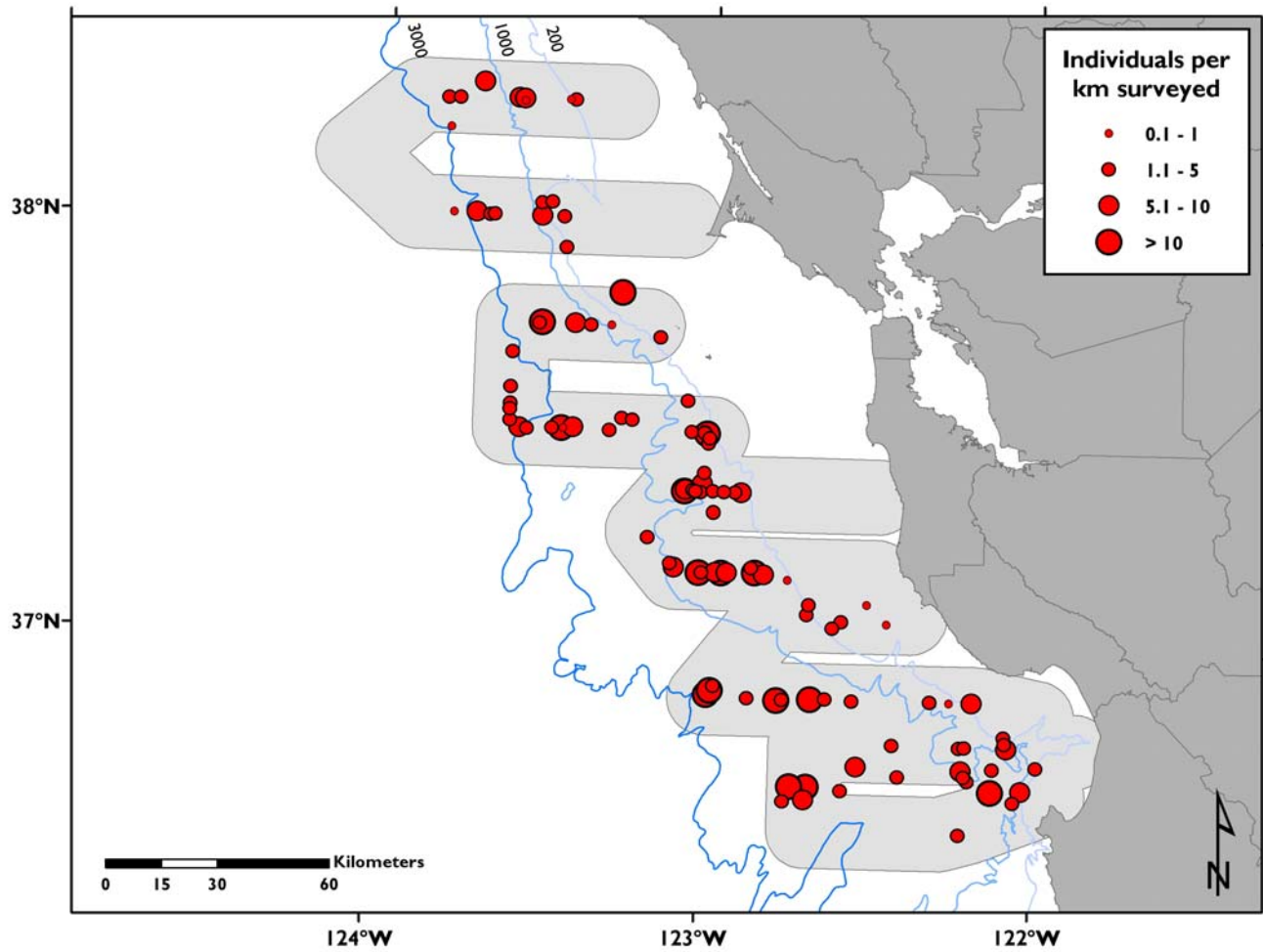
Pacific White-sided Dolphins are a common species in the North Pacific and were encountered in all three study areas. The species was absent from Line P cruises in winter and was restricted to the shelf and slope area during the summer. However, they were far more widespread in the Line P area in the fall. In both the CalCOFI and NMFS study areas, highest numbers were found over the continental slope. Pacific White-sided Dolphins mainly feed on small schooling fish and squid.



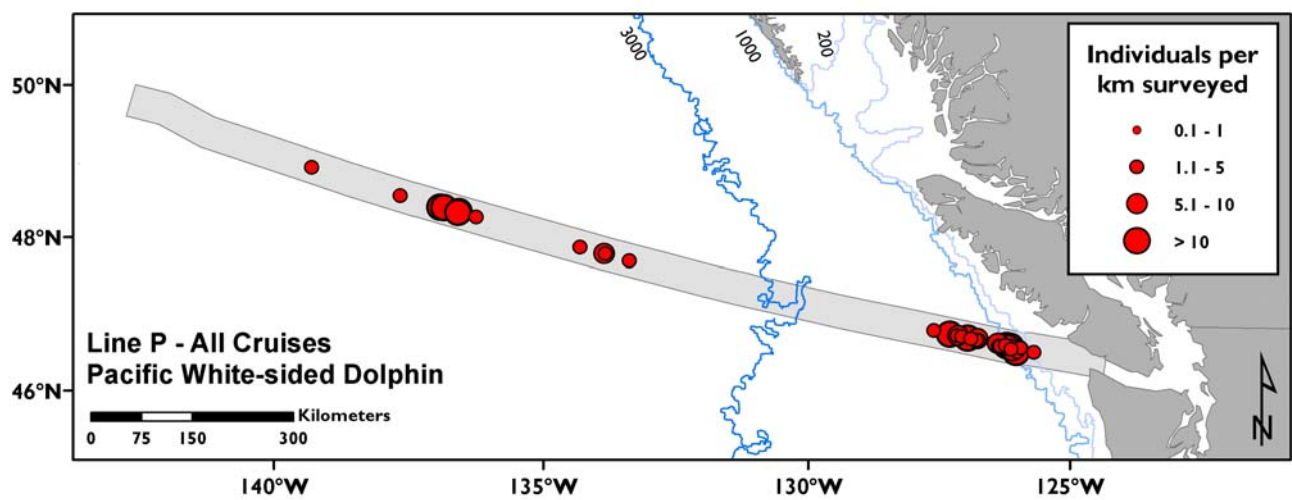




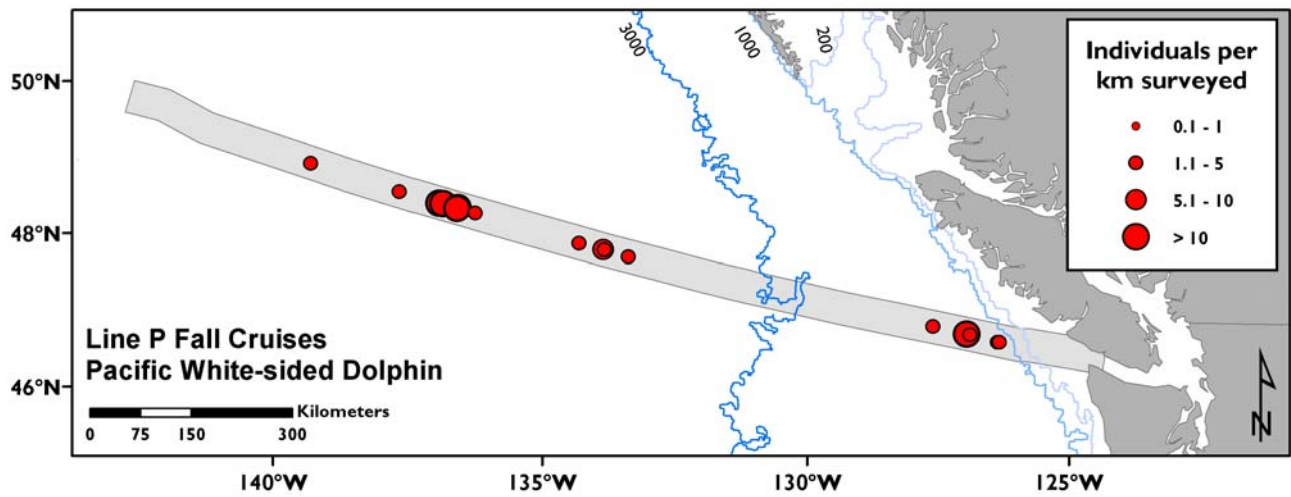
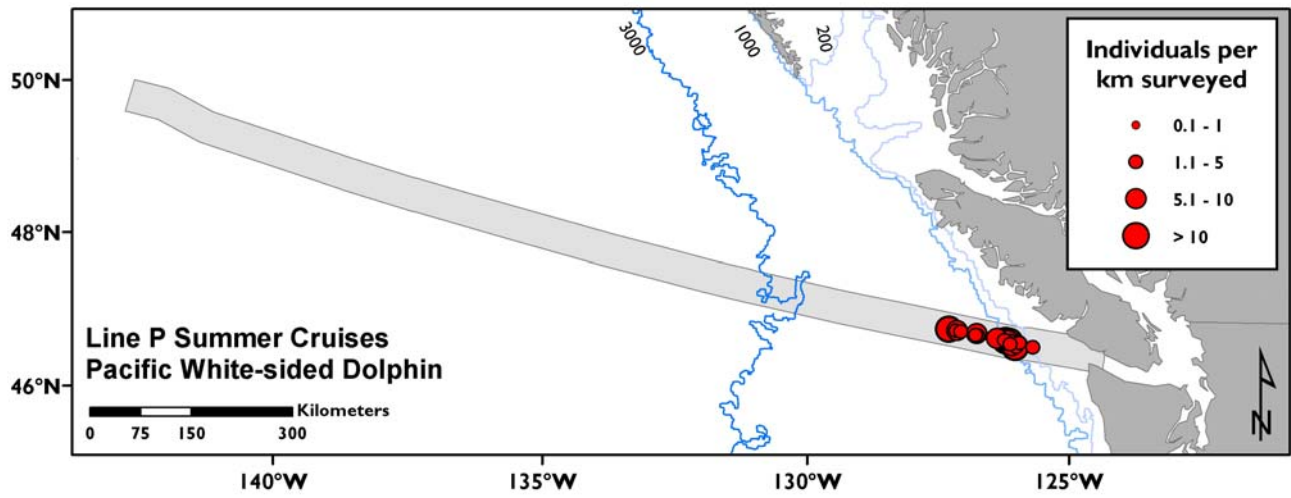
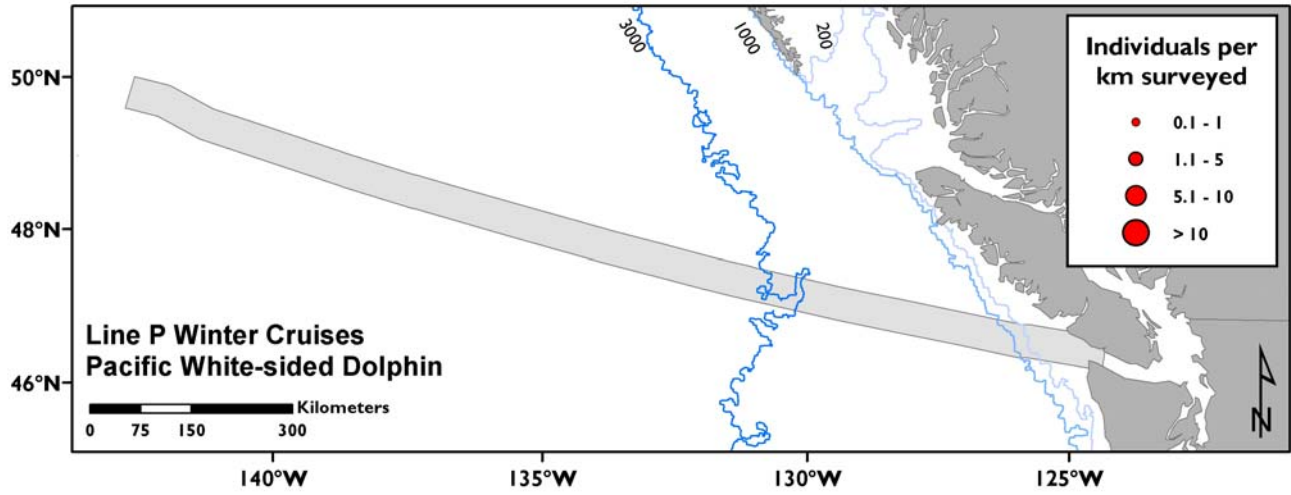




**NMFS - All Cruises  
Pacific White-sided Dolphin**



**Line P - All Cruises  
Pacific White-sided Dolphin**



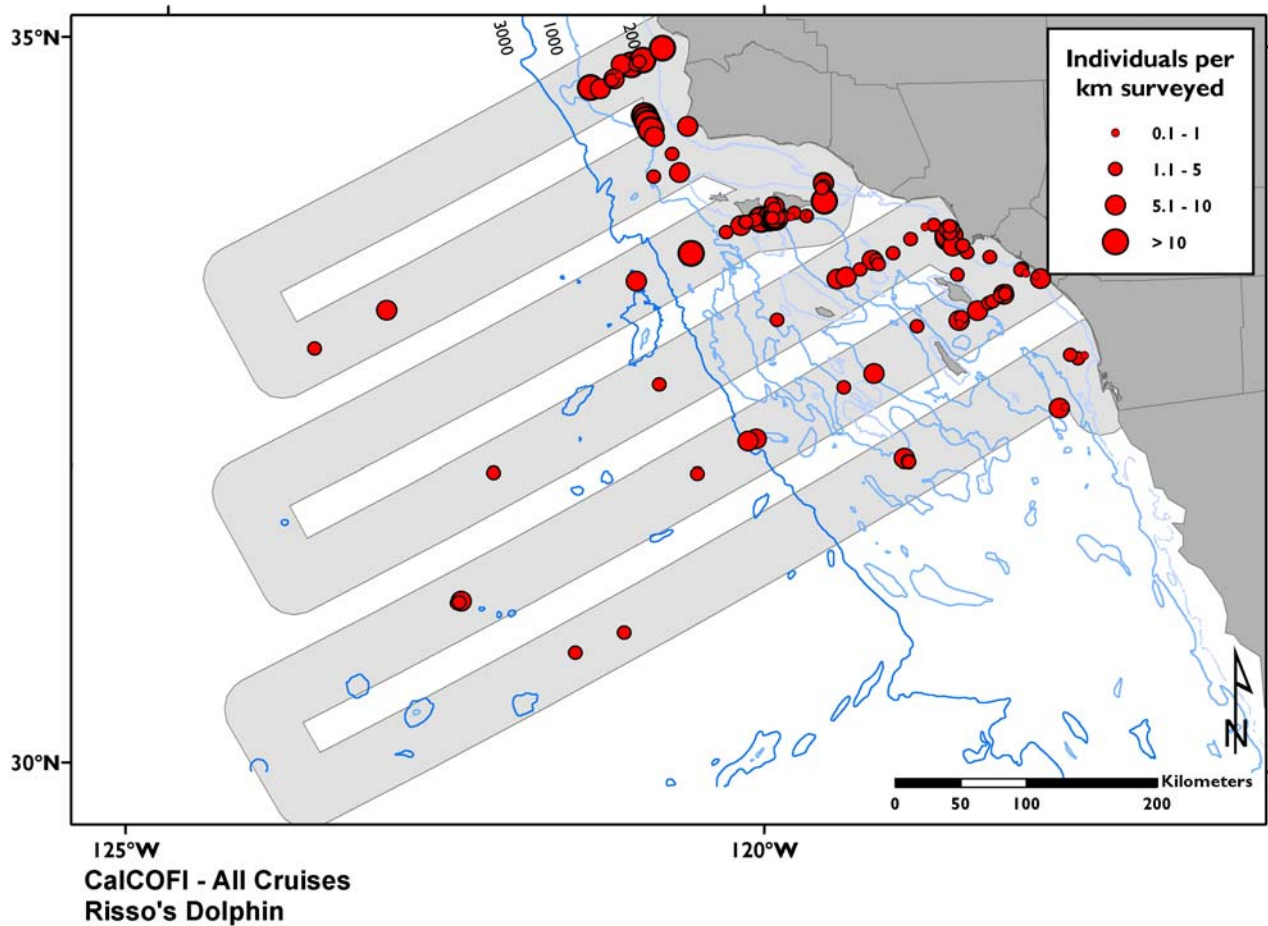


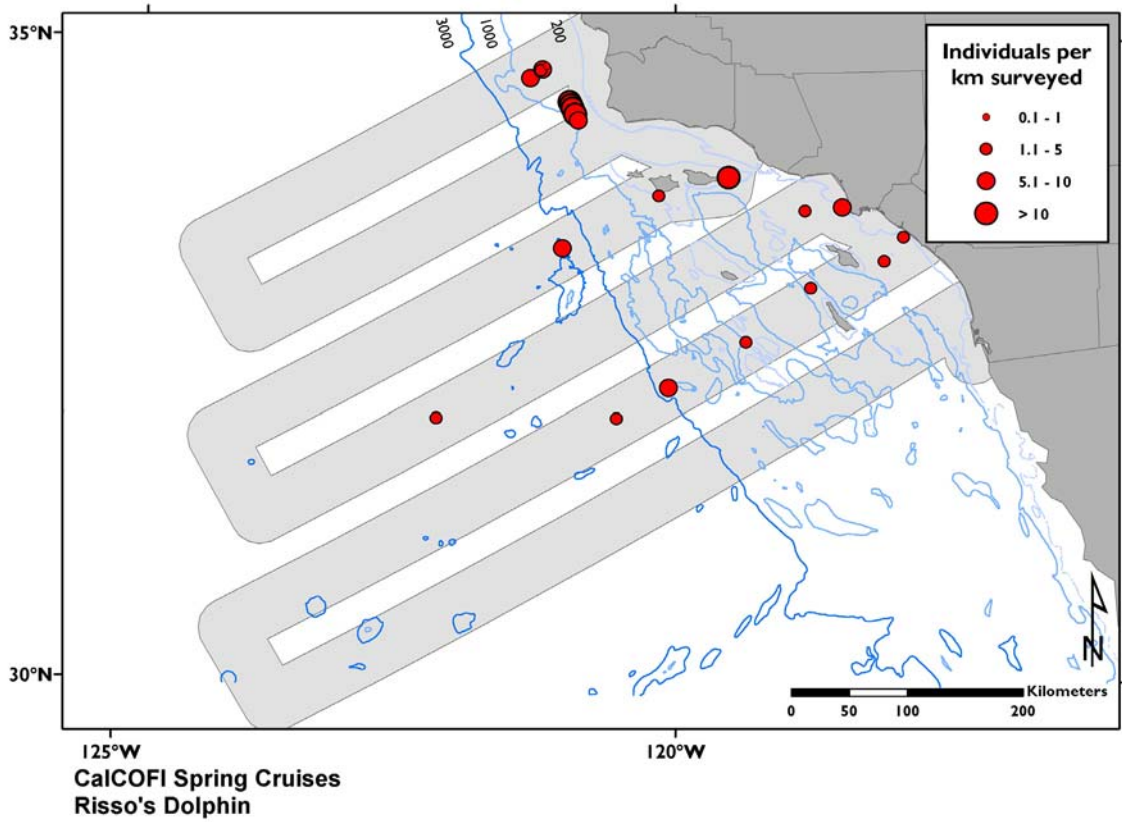
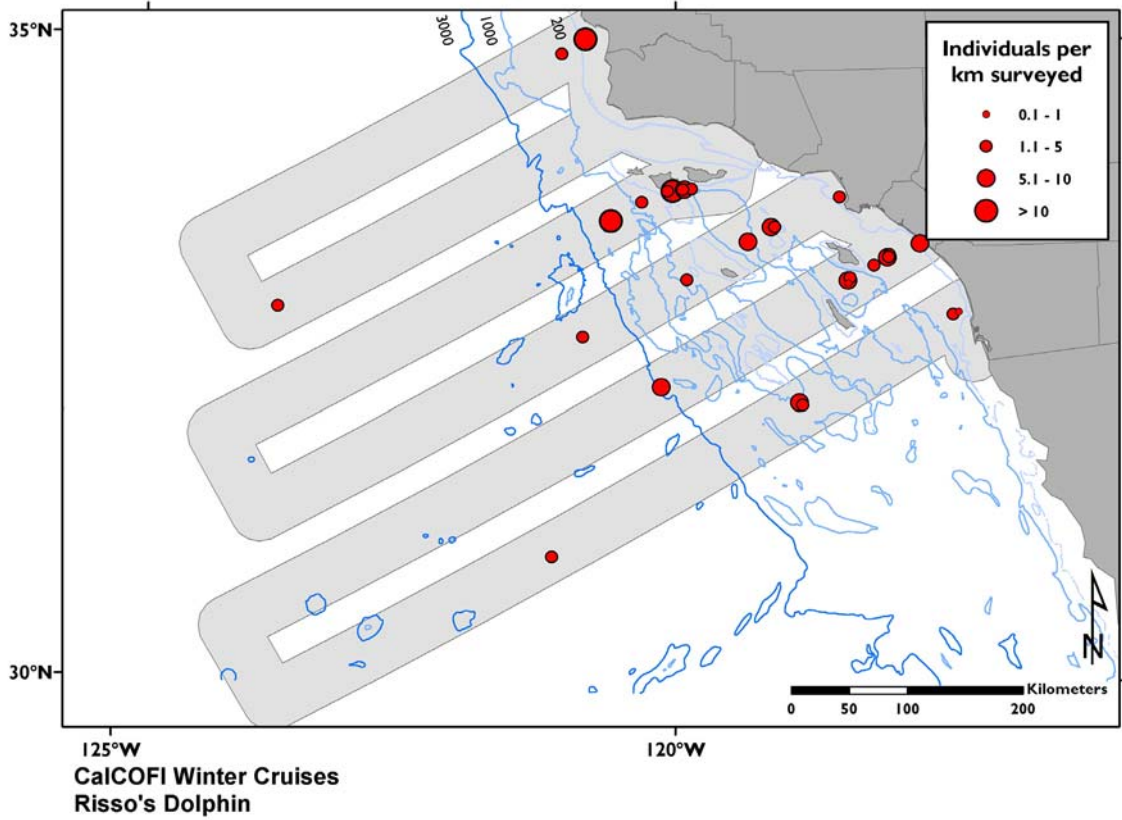
# Risso's Dolphin

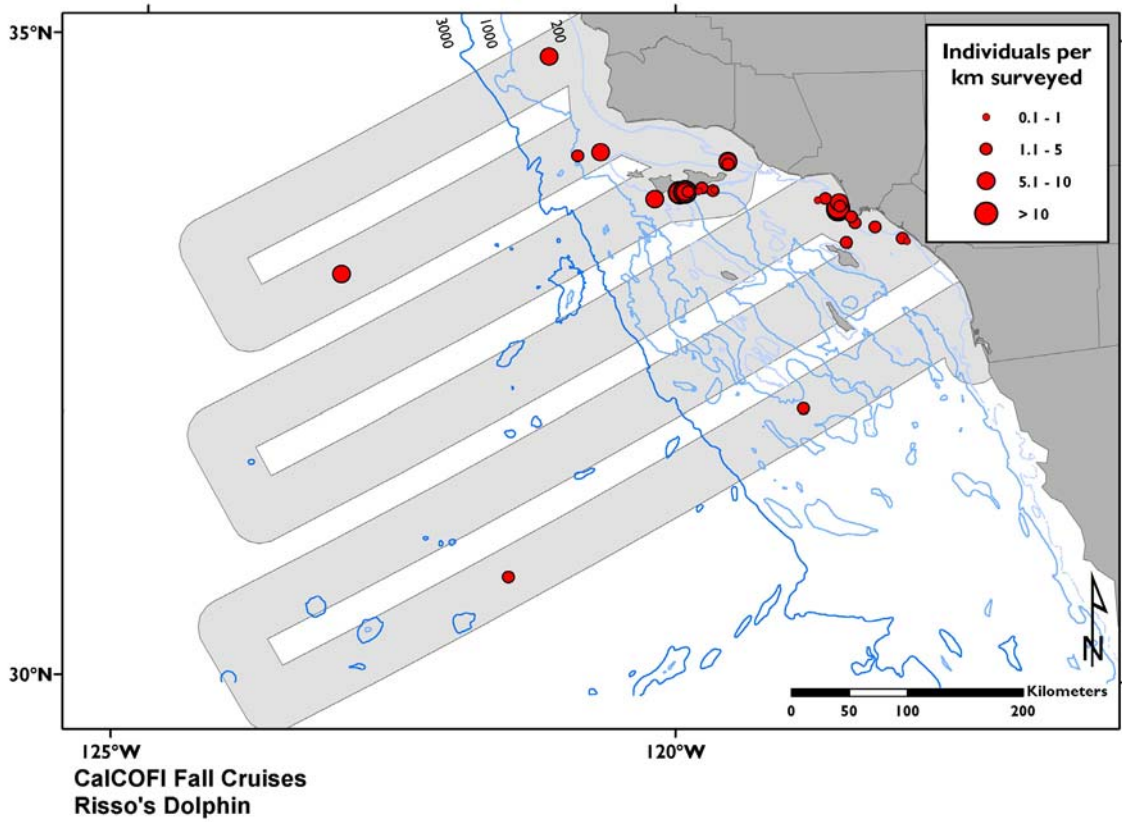
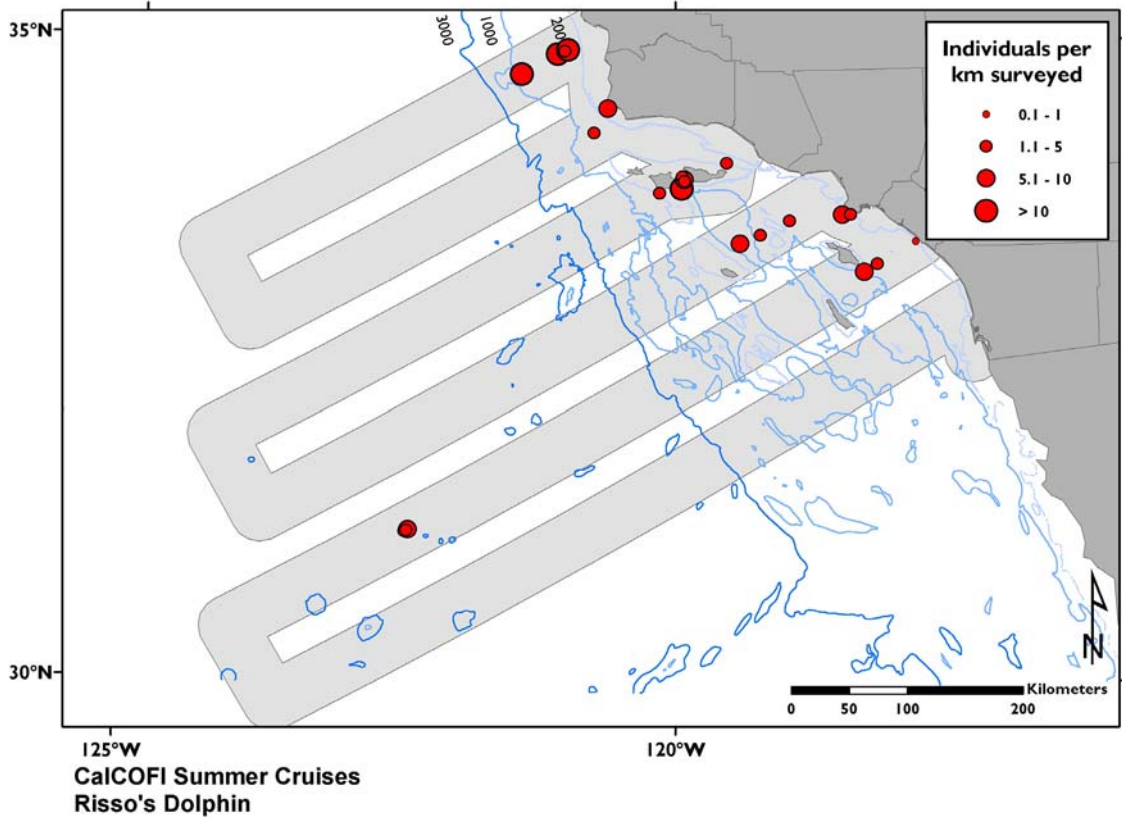
*Grampus griseus*

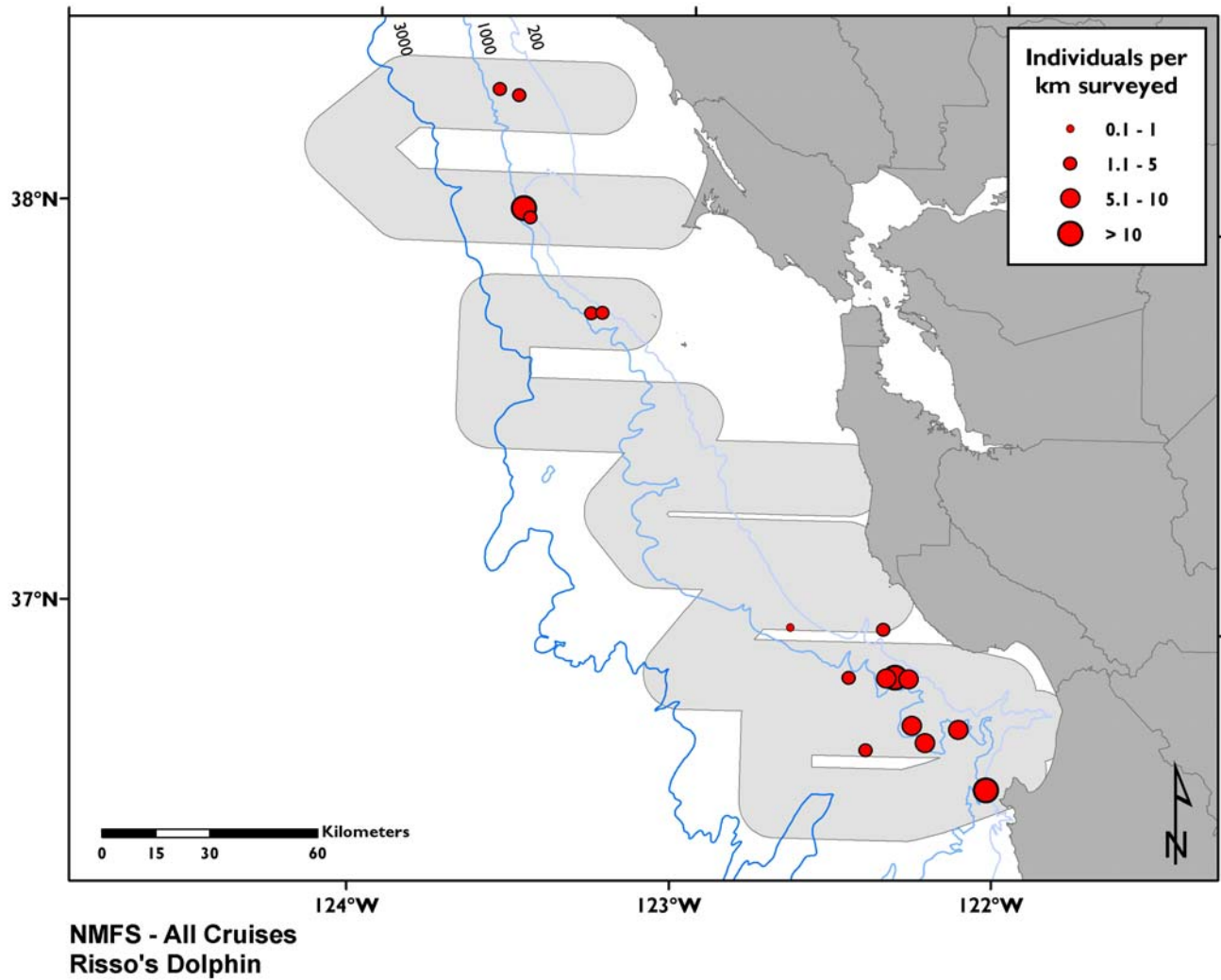


Risso's dolphins are widely distributed throughout tropical and warm temperate ocean waters of the world (Reeves et al. 2002). Although they do occur off the B.C. coast, they were not encountered during any Line P cruises. Within the CalCOFI and NMFS study areas, they were most numerous over the shelf-break in most seasons. Risso's dolphins are believed to mainly forage on squid, though some fish may be taken as well (Reeves et al. 2002).











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**Appendix A. Seabird species observed in the CalCOFI study area**

|                          |                          |                           |
|--------------------------|--------------------------|---------------------------|
| American Coot            | Elegant Tern             | Pigeon Guillemot          |
| Ancient Murrelet         | Flesh-footed Shearwater  | Pomarine Jaeger           |
| Arctic Loon              | Forster's Tern           | Ring-billed Gull          |
| Arctic Tern              | Franklin's Gull          | Red-breasted Merganser    |
| Ashy Storm-Petrel        | Fork-tailed Storm-Petrel | Red-billed Tropicbird     |
| American White Pelican   | Great Blue Heron         | Red Phalarope             |
| Black-footed Albatross   | Glaucous Gull            | Red-footed Booby          |
| Black Brant              | Green Heron              | Rhinoceros Auklet         |
| Black-legged Kittiwake   | Glaucous-winged Gull     | Red-necked Grebe          |
| Black Scoter             | Heermann's Gull          | Red-necked Phalarope      |
| Black Skimmer            | Herring Gull             | Royal Tern                |
| Black Storm-Petrel       | Horned Puffin            | Red-throated Loon         |
| Black Tern               | Juan Fernandez Petrel    | Red-tailed Tropicbird     |
| Bonaparte's Gull         | Kelp Gull                | Ruddy Duck                |
| Brandt's Cormorant       | Kermadec Petrel          | Sabine's Gull             |
| Brown Booby              | Laysan Albatross         | Snow Goose                |
| Brown Noddy              | Laughing Gull            | Solander's Petrel         |
| Brown Pelican            | Least Tern               | Sooty Shearwater          |
| Bufflehead               | Leach's Storm-Petrel     | South Polar Skua          |
| Buller's Shearwater      | Long-tailed Jaeger       | Short-tailed Albatross    |
| Black-vented Shearwater  | Least Storm-Petrel       | Stejneger's Petrel        |
| Cassin's Auklet          | Mallard                  | Short-tailed Shearwater   |
| California Gull          | Marbled Murrelet         | Surf Scoter               |
| Caspian Tern             | Mew Gull                 | Thayer's Gull             |
| Clark's Grebe            | Mottled Petrel           | Tufted Puffin             |
| Common Loon              | Murphy's Petrel          | Western Grebe             |
| Common Murre             | Northern Fulmar          | Western Gull              |
| Cook's Petrel            | Parakeet Auklet          | Wilson's Storm-Petrel     |
| Common Tern              | Parasitic Jaeger         | Wedge-rumped Storm-Petrel |
| Craveri's Murrelet       | Pacific Loon             | Wedge-tailed Shearwater   |
| Double-crested Cormorant | Parkinson's Petrel       | White-winged Scoter       |
| Dark-rumped Petrel       | Pelagic Cormorant        | Xantus's Murrelet         |
| Eared Grebe              | Pink-footed Shearwater   |                           |



**Appendix B. Mammal species observed in the CALCOFI study area**

Baird's Beaked Whale  
Blue Whale  
Bottlenose Dolphin  
California Sea Lion  
Cuvier's Beaked Whale  
Common Dolphin  
Dall's Porpoise  
Fin Whale  
False Killer Whale  
Guadalupe Fur Seal  
Gray Whale  
Harbor Porpoise  
Harbor Seal  
Humpback Whale  
Killer Whale  
Minke Whale  
Northern Elephant Seal  
Northern Fur Seal  
Northern Right Whale  
Dolphin  
Pilot Whale  
Pygmy Sperm Whale  
Pacific White-sided Dolphin  
Risso's Dolphin  
Short-beaked Common  
Dolphin  
Sea Otter  
Sei Whale  
Short-finned Pilot Whale  
Sperm Whale  
Striped Dolphin  
Steller Sea Lion

**Appendix C. Seabird and mammal species observed in the NMFS study area**

|                          |                         |                     |
|--------------------------|-------------------------|---------------------|
| Arctic Tern              | Horned Puffin           | White-winged Petrel |
| Ashy Storm-Petrel        | Laysan Albatross        | Xantus's Murrelet   |
| Black-footed Albatross   | Least Tern              |                     |
| Black Brant              | Leach's Storm-Petrel    |                     |
| Black-legged Kittiwake   | Long-tailed Jaeger      |                     |
| Black Storm-Petrel       | Mew Gull                |                     |
| Bonaparte's Gull         | Murphy's Petrel         |                     |
| Brandt's Cormorant       | Northern Fulmar         |                     |
| Brown Pelican            | Parasitic Jaeger        |                     |
| Buller's Shearwater      | Pacific Loon            |                     |
| Black-vented Shearwater  | Pelagic Cormorant       |                     |
| Cassin's Auklet          | Pink-footed Shearwater  |                     |
| California Gull          | Pigeon Guillemot        |                     |
| Caspian Tern             | Pomarine Jaeger         |                     |
| Common Loon              | Ring-billed Gull        |                     |
| Common Murre             | Red-billed Tropicbird   |                     |
| Cook's Petrel            | Red Phalarope           |                     |
| Common Tern              | Rhinoceros Auklet       |                     |
| Double-crested Cormorant | Red-necked Phalarope    |                     |
| Dark-rumped Petrel       | Red-throated Loon       |                     |
| Eared Grebe              | Sabine's Gull           |                     |
| Elegant Tern             | Sooty Shearwater        |                     |
| Flesh-footed Shearwater  | South Polar Skua        |                     |
| Forster's Tern           | Surf Scoter             |                     |
| Franklin's Gull          | Tufted Puffin           |                     |
| Fork-tailed Storm-Petrel | Western Grebe           |                     |
| Glaucous-winged Gull     | Western Gull            |                     |
| Heermann's Gull          | Wilson's Storm-Petrel   |                     |
| Herring Gull             | Wedge-tailed Shearwater |                     |

**Appendix D. Mammal species observed in the NMFS study area**

Blue Whale  
Bottlenose Dolphin  
California Sea Lion  
Common Dolphin  
Dall's Porpoise  
Fin Whale  
Guadalupe Fur Seal  
Gray Whale  
Harbor Porpoise  
Harbor Seal  
Humpback Whale  
Killer Whale  
Minke Whale  
Northern Elephant Seal  
Northern Fur Seal  
Northern Right Whale  
Dolphin  
Pacific White-sided Dolphin  
Risso's Dolphin  
Sea Otter  
Sperm Whale  
Steller Sea Lion

**Appendix E. Seabird species observed in the Line P study area**

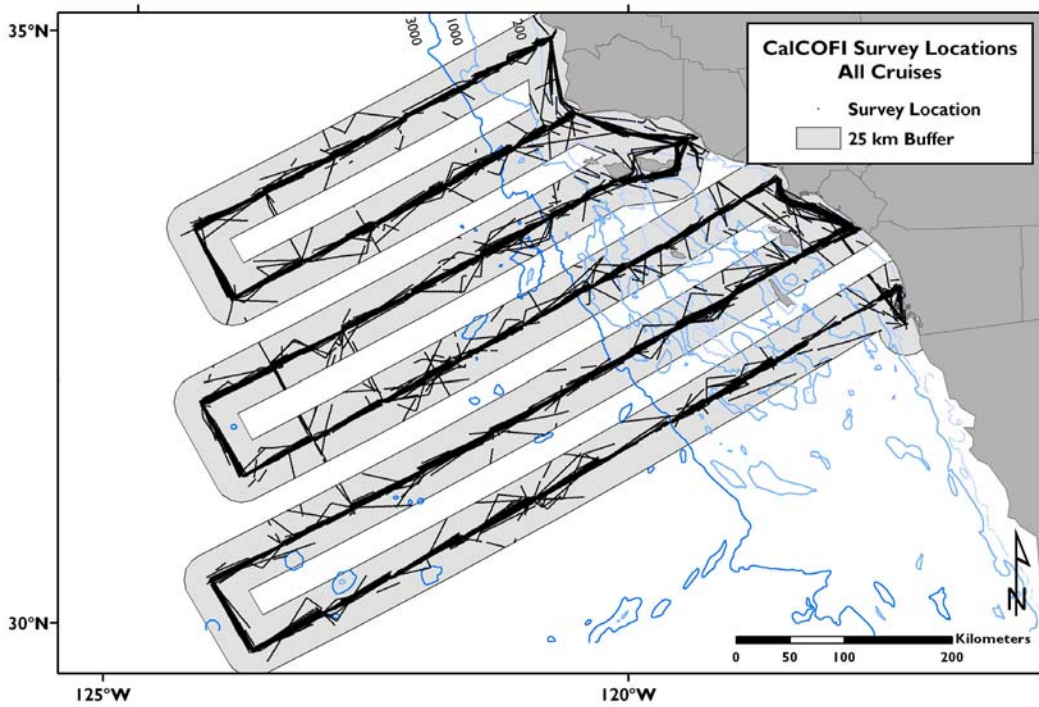
|                          |                         |                                     |
|--------------------------|-------------------------|-------------------------------------|
| Aleutian Tern            | Leach's Storm-Petrel    | Tufted Puffin                       |
| American Wigeon          | Long-tailed Jaeger      | Western Gull                        |
| Ancient Murrelet         | Marbled Murrelet        | Western/Glaucous-winged Gull Hybrid |
| Arctic Tern              | Mew Gull                | White-winged Scoter                 |
| Black Brant              | Mottled Petrel          | Xantus's Murrelet                   |
| Black-footed Albatross   | Murphy's Petrel         | Yellow-billed Loon                  |
| Black-legged Kittiwake   | Northern Fulmar         |                                     |
| Black-vented Shearwater  | Pacific Loon            |                                     |
| Bonaparte's Gull         | Parakeet Auklet         |                                     |
| Brandt's Cormorant       | Parasitic Jaeger        |                                     |
| Buller's Shearwater      | Pelagic Cormorant       |                                     |
| California Gull          | Pigeon Guillemot        |                                     |
| Cassin's Auklet          | Pink-footed Shearwater  |                                     |
| Common Loon              | Pomarine Jaeger         |                                     |
| Common Murre             | Red Phalarope           |                                     |
| Common Tern              | Red-breasted Merganser  |                                     |
| Cook's Petrel            | Red-necked Grebe        |                                     |
| Dark-rumped Petrel       | Red-necked Phalarope    |                                     |
| Double-crested Cormorant | Red-throated Loon       |                                     |
| Flesh-footed Shearwater  | Rhinoceros Auklet       |                                     |
| Fork-tailed Storm-Petrel | Ring-billed Gull        |                                     |
| Glaucous Gull            | Sabine's Gull           |                                     |
| Glaucous-winged Gull     | Short-tailed Shearwater |                                     |
| Harlequin Duck           | Solander's Petrel       |                                     |
| Heermann's Gull          | Sooty Shearwater        |                                     |
| Herring Gull             | South Polar Skua        |                                     |
| Horned Puffin            | Surf Scoter             |                                     |
| Kittlitz's Murrelet      | Thayer's Gull           |                                     |
| Laysan Albatross         | Thick-billed Murre      |                                     |

**Appendix F. Mammal species observed in the Line P study area**

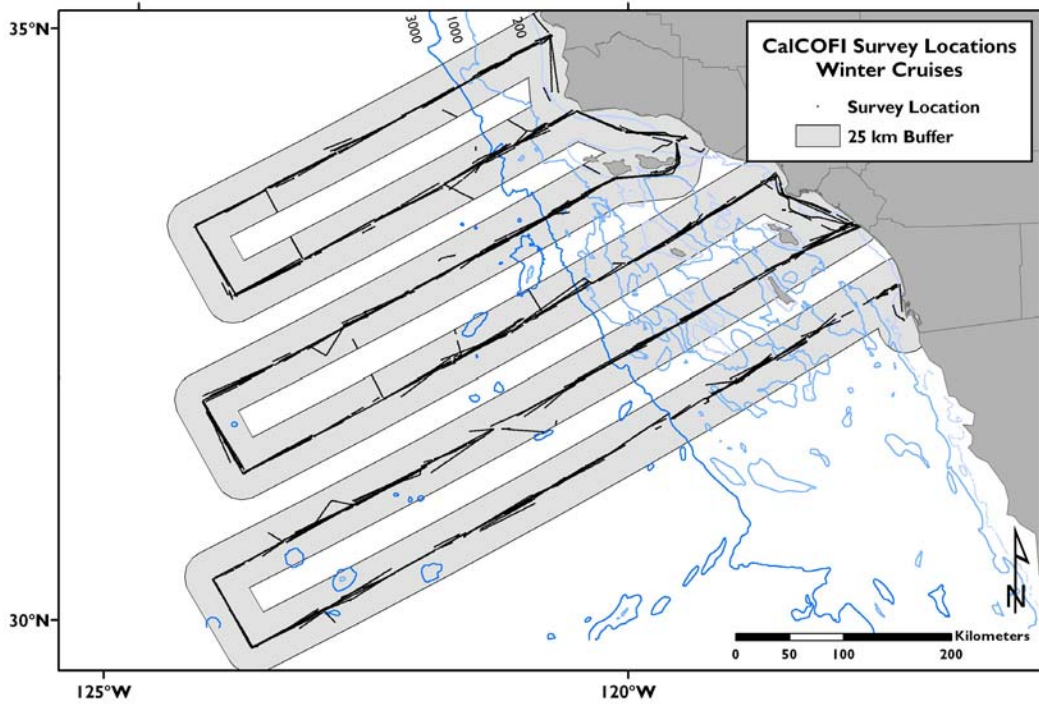
Baird's Beaked Whale  
Blue Whale  
California Sea Lion  
Dall's Porpoise  
Fin Whale  
Gray Whale  
Harbor Porpoise  
Harbor Seal  
Humpback Whale  
Killer Whale  
Minke Whale  
Northern Elephant Seal  
Northern Fur Seal  
Northern Right Whale Dolphin  
Pacific White-sided Dolphin  
Sea Otter  
Sei Whale  
Short-finned Pilot Whale  
Sperm Whale  
Striped Dolphin  
Steller Sea Lion

**Appendix G. Cumulative and seasonal maps of survey effort by study area.**

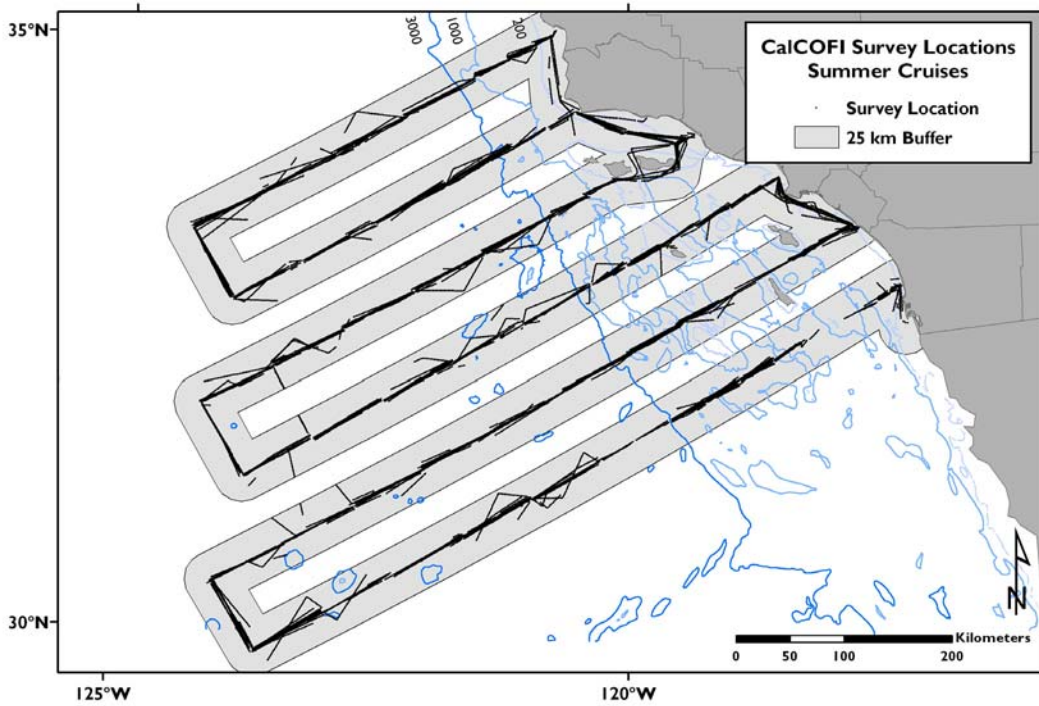
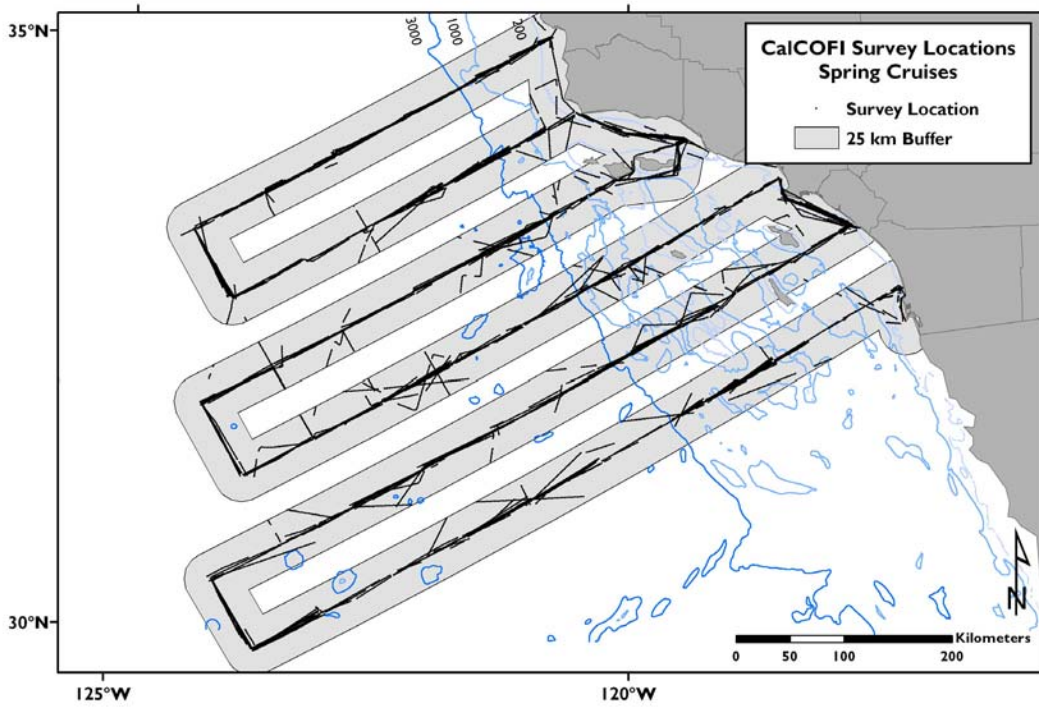
**CalCOFI Cumulative Survey Effort**



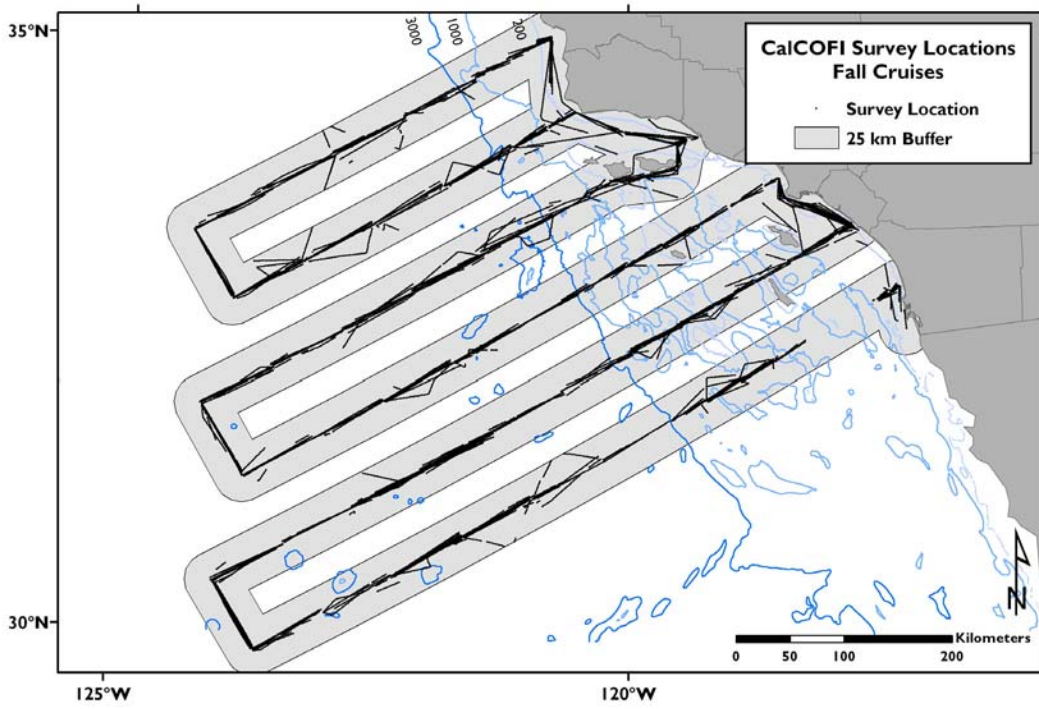
**CalCOFI Seasonal Survey Effort**



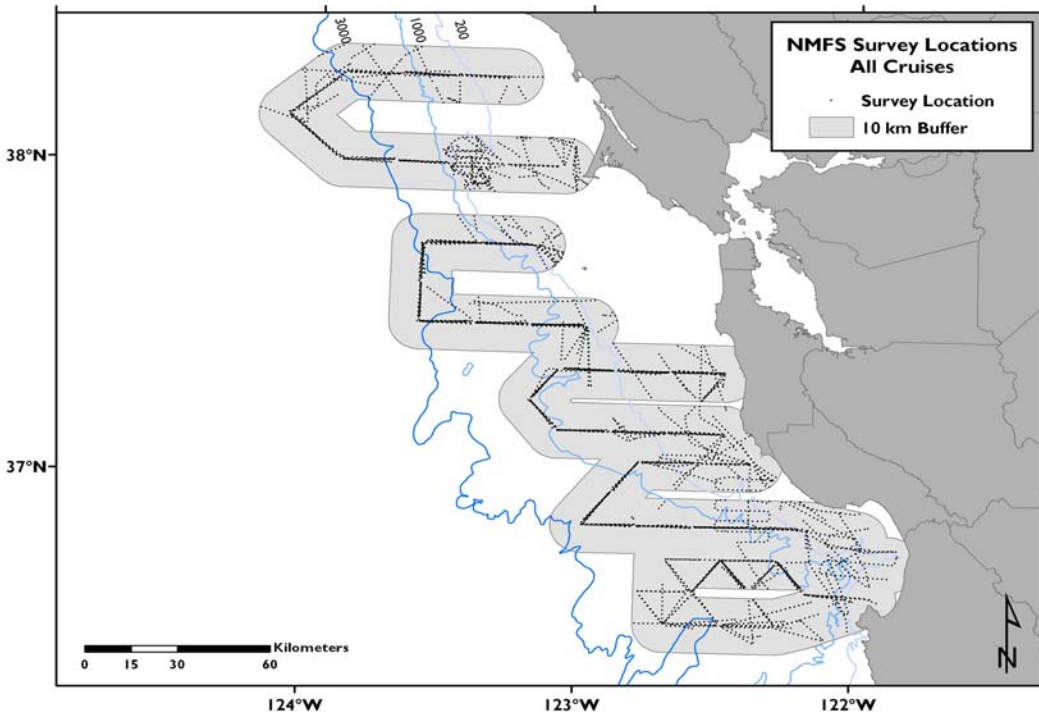
**CalCOFI Seasonal Survey Effort (continued)**



CalCOFI Seasonal Survey Effort (continued)



NMFS Cumulative Survey Effort





### Line P Cumulative and Seasonal Survey Effort

