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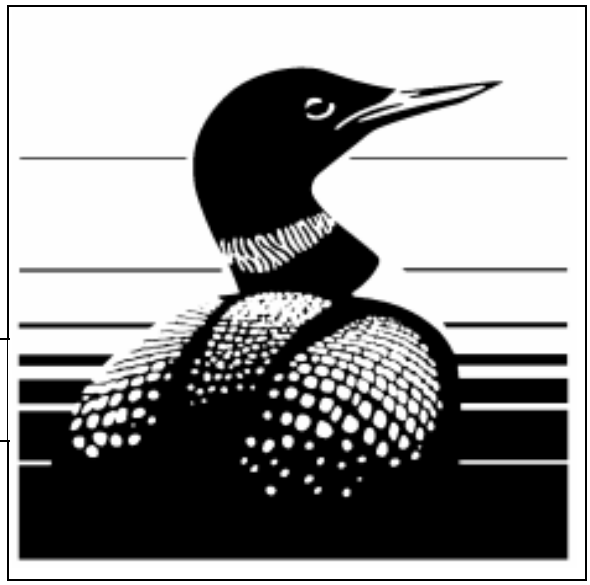

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SEASONAL USE OF THE SCOTT ISLAND MARINE AREA BY BREEDING AND NON-BREEDING SEABIRDS, 1981-2001

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ABSTRACT

Seabirds were counted opportunistically from Department of Fisheries and Oceans (DFO) vessels conducting research in the vicinity of the Scott Islands off the northern end of Vancouver Island, between 1981 and 2001. Seabird densities are mapped and patterns of spatial and temporal distribution are identified in order to assess the seasonal extent to which the waters around the Scott Islands are used by marine birds. These analyses revealed extensive use of the region throughout the year by year-round residents (six species), by breeders (eleven species) and by non-breeding species (fourteen species). Pooling of the data records over all years confirmed that the marine area around the Scott Islands is of particular importance for Cassin's and Rhinoceros auklets, Tufted Puffin, Marbled Murrelet, Red-necked Phalarope, Sooty Shearwater, Black-footed Albatross, and Fork-tailed Storm Petrel. The annual and interannual pooled seasonal patterns of seabird use presented in this report confirm that the marine area around the Scott Islands provides consistent forage food organisms for a diverse array of seabird species. Application of this information will greatly assist the Canadian Wildlife Service in meeting its regional, national, and international commitments to the conservation and management of Pacific Canada's marine bird populations.

RÉSUMÉ

Des dénombrements d'oiseaux de mer ont été effectués au gré des observations à partir de navires de Pêches et Océans lors de campagnes de recherche menées dans les environs des îles Scott, au large de l'extrémité nord de l'île de Vancouver, entre 1981 et 2001. On a produit des cartes de la densité des populations et des profils de distribution spatiale et temporelle des oiseaux de mer afin d'évaluer le degré d'utilisation des eaux voisines des îles Scott par les oiseaux de mer. Les analyses ont montré que la région était très fréquentée toute l'année par des nicheurs résidents (six espèces), des nicheurs (onze espèces) et des non-nicheurs (quatorze espèces). Le regroupement des fichiers de données pour toutes les années a permis de confirmer que la zone marine des environs des îles Scott revêt une importance particulière pour le Starique de Cassin, le Macareux rhinocéros, le Macareux huppé, le Guillemot marbré, le Phalarope à bec étroit, le Puffin fuligineux, l'Albatros à pieds noirs et l'Océanite à queue fourchue. Les profils saisonniers annuels et interannuels regroupés de la fréquentation de la région par les oiseaux de mer présentés dans ce rapport confirment que la zone marine des environs des îles Scott constitue une source constante d'organismes pour l'alimentation d'une gamme variée d'espèces d'oiseaux de mer. Ces informations aideront énormément le Service canadien de la faune à donner suite à ses engagements régionaux, nationaux et internationaux en matière de conservation et de gestion des populations d'oiseaux de mer du Pacifique canadien.

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Financial support was provided by Environmental Damages Fund, Environmental Protection Branch of Environment Canada and the Canadian Wildlife Service. Further funding was provided by the Nestucca Trust Fund to D. F. Bertram and D. Mackas, which was used to employ shipboard observers, as well as pay for the Triangle Island telemetry project. We gratefully acknowledge the support of World Wildlife Fund Canada for funding the fourth year of Triangle Island telemetry work.

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1. GOAL OF THIS REPORT

Since 1981, observers have conducted marine bird surveys, on an opportunistic basis, aboard Department of Fisheries and Oceans (DFO)/ Canadian Coast Guard (CCG) vessels performing oceanographic studies off the coast of British Columbia. These survey data have been used to generate estimates of marine bird densities and to examine patterns of temporal and spatial distribution of marine birds. Here, a subset of these survey data were analyzed to document the extent to which marine birds use the waters in the vicinity of the Scott Islands. The goal of this report is to provide information on the distributions of the marine birds using these waters, and by extension, also their principal zooplankton and fish prey bases.

2. INTRODUCTION

2.1. Scott Islands location and Marine Vicinity

The Scott Islands extend in a northwesterly direction from Cape Scott, at the northern tip of Vancouver Island, British Columbia. Scott Islands Provincial Park, established in 1995, is composed of five main islands (Triangle, Sartine, Beresford, Lanz and Cox), totalling an area of 7,967 ha (land area is 2,230 ha; marine area, 5,736.6 ha) (Figure 2). Triangle, Sartine, and Beresford Islands have been established Ecological Reserves since 1971. Cox and Lanz islands became part of the provincial park in 1995.

Generally, off the coast of British Columbia, the outer edge of the continental slope begins at the 1,800-m bathymetric contour (Thomson, 1981). In the Scott Islands area, this slope gradually rises to 1,000 meters depth, then steepens to the 200-m depth mark. This represents the continental shelf break which in turn gives rise to the continental shelf (Figure 1). Currents over the continental shelf are driven primarily by prevailing winds, which are controlled by the annual and interannual juxtapositions of the Aleutian Low and the North Pacific High pressure systems (Thomson, 1981). As such, winter winds are primarily from the southeast and southwest, in response to the dominance of the Aleutian Low. In the summer, the North Pacific High exerts its dominance causing the winds to generally reverse from the northwest between June and October. These northwest winds cause deeper, cold water to rise to the surface thus creating regions of upwelling along the continental shelf break (Thomson, 1981). Areas of upwelling, because they are highly productive and concentrate food organisms, are

important feeding areas for many species including seabirds and marine mammals. Mackas and Galbraith (1992) suggest that British Columbia's seabird colonies may be related to closeness to the shelf break and, therefore, their food sources. A region of upwelling exists just north of the Scott Islands (Figure 1), which could help explain the large numbers of breeding seabirds found foraging in the region. It may also explain the high propensity for non-breeding seabirds to be transient visitors.

2.2. Scott Islands – Internationally Important Bird Area

As a group, these islands have been recognized as a globally significant Important Bird Area (IBA) under an international program led by BirdLife International. In Canada, the program is headed by the Canadian Nature Federation (CNF) and Bird Studies Canada (BSC). Twelve species nesting on the Scott Islands fall under Category 4[1] of the Canadian IBA Criteria (Table 1) (Drever, 2001 and references therein). Three species occur in globally significant numbers (i.e., greater than 1% of the world's population, Table 1): Cassin's Auklet (*Ptychoramphus aleuticus*), Rhinoceros Auklet (*Cerorhinca monocerata*) and Tufted Puffin (*Fratercula cirrhata*). Other seabirds present in nationally significant numbers (i.e., greater than 1% of the national population) include: Common Murre (*Uria aalge*), Brandt's Cormorant (*Phalacrocorax penicillatus*), Pelagic Cormorant (*P. pelagicus*), Pigeon Guillemot (*Cepphus columba*), Glaucous-winged Gull (*Larus glaucescens*), Leach's Storm-Petrel (*Oceanodroma leucorhoa*), and Fork-tailed Storm-Petrel (*O. furcata*).

2.3. Research Activities

Due to their international significance to seabirds, the Canadian Wildlife Service (CWS) has supported applied research studies on the Scott Islands since the mid-1970s. Since 1994, Triangle Island has been the site of a research station operated by Simon Fraser University's (SFU) Centre for Wildlife Ecology (CWE). Currently, the research program at Triangle Island involves both directed graduate studies and monitoring of breeding seabirds. Studies include the breeding chronology, breeding performance, nestling development, and adult survival of Cassin's auklets, Rhinoceros auklets and Tufted Puffins; the breeding chronology and breeding performance of Common Murres; and, on an opportunistic basis, the breeding chronology and breeding

[1] Congregatory Species; species that concentrate in significant numbers (> 1% of their global, biogeographical, or national population) at an IBA site

Table 1: IBA species in the Scott Islands and their occurrence at the global or national level (Drever, 2001)

Common Name	IBA Category	Numbers breeding (pairs)[1]	Percent of Global Population[2]	Percent of National Population[2]
Fork-tailed Storm-Petrel	4	3,000	-	1.5
Leach's Storm-Petrel	4	12,700	-	2.3[w]
Brandt's Cormorant	4	39	-	40
Pelagic Cormorant	4	741	-	17.5
Glaucous-winged Gull	4	1,077	-	4
Common Murre	4	4,100	-	95[w]
Thick-billed Murre	4	7	-	100[w]
Pigeon Guillemot	4	310	-	6
Cassin's Auklet	4	990,000	55	73
Rhinoceros Auklet	4	41,700	7	12
Horned Puffin	4	11[t]	-	~30[w]
Tufted Puffin	4	34,900	2	90

[1] Numbers from Rodway *et al*. (1990,1992), break-down by island in Appendix 1.
[2] Percentages from the Canadian IBA database (1998)
[w] from western Canada only
[t] based on total counts of birds

performance of Pelagic Cormorants, Pigeon guillemots, and Storm-Petrel spp. In 1998 the Nestucca Trust Fund supported a 3-year telemetry study to examine the relationship between the at-sea foraging distribution of the planktivorous Cassin's Auklet population breeding at Triangle Island and its prey distribution and abundance. In 2002, World Wildlife Fund Canada supported a fourth year of telemetry work to examine the foraging distributions of the piscivorous Rhinoceros Auklet breeding on Triangle Island (M. Hipfner, pers. comm.). In addition to this annual research program, the CWS conducts a burrow census at permanent monitoring plots on Triangle Island to determine nesting density and to gauge the breeding population size of Cassin's Auklet, Rhinoceros Auklet and Tufted Puffin. These censuses are conducted using permanent 10m x 10m plots stationed at various locations on Triangle Island and neighbouring Puffin Rock. The censuses are repeated every five years as recommended by the regional Seabird Management Plan. (M. Lemon, pers. comm.).

As part of a collaborative effort funded by the Nestucca Trust Fund, DFO has been working since 1998 in the marine area of the Scott Islands to investigate interannual distribution and abundance of zooplankton, juvenile salmon and water

properties (D.F. Bertram, pers. comm.). These investigations were in collaboration with the at-sea telemetry surveys.

1. METHODS

3.1. Ship Transects and Data Collection

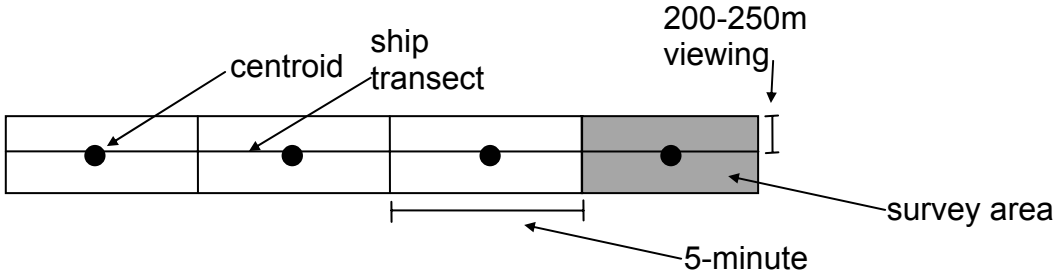
Pelagic seabird surveys have been conducted along the coast of British Columbia since 1981, with increased effort around the Scott Islands between 1996–2001 (Figure 2). The majority of these surveys were carried out opportunistically aboard DFO/CG vessels undertaking oceanographic investigations. Seabird surveys were conducted using methodologies similar to those described by Brown (1986).

Ship-based observations were conducted while underway from above the ship's bridge approximately 10-15 m above the water (depending on the vessel) and only during daylight hours. Observations were discontinued during heavy rain, fog, or rough seas. The sea was scanned with binoculars in a forward field of 180º, centered on the bow of the ship. Standard seabird offshore sampling technique involves scanning with binoculars in a band of a predetermined width, on either side of the bow. In the present study, this band was 200-250 m on either side of the vessel. Bird species within the 400-500m band were recorded as well as whether they were in flight or on the water. In most cases, all birds encountered could be identified to species, where this was not possible birds were tallied under general categories (e.g. unidentified gull). Ship followers, such as gulls and albatrosses, were counted only once (Morgan *et al*., 1991). It should be noted that this method could result in under-estimations of the standing stock of species that avoid the ship and do not, or rarely, enter the band.

When the ship was headed directly into sunlight, the field was scanned either at right angles to the sun or on only one side of the vessel (Morgan *et al*., 1991). Transects consisted of a running series of timed surveys. Most of the surveys were of 5-minute duration and were carried out for as long as the ship maintained a constant course. The position of the vessel, using either a Global Positioning System (GPS) or Loran (1980s only), and the time of the start and end of each transect were recorded (K. Morgan, pers. comm.).

3.2. Data Processing, GIS Preparation and Spatial Representation of Bird Data

Survey data were originally inputted and stored in MS Excel spreadsheets. Field names and records were standardized for all spreadsheets to facilitate the harmonization of the data. Subsequently, all spreadsheets were converted into a relational database. The original database design was assessed and converted to conform to current Geographic Information System (GIS) standards. A single key identifier uniquely distinguished all features. The key identifier was a concatenation of the date, original transect identifier, and the original survey identifier. These features linked to the pelagic shipboard survey tabular data (one-to-many data relationship), based on the single key identifier in that database. It was necessary to transpose species information that was stored in many fields into a single species field to simplify querying and processing of the data. A GIS automation script was created to automate the process that would otherwise need to be conducted manually. The area, in square kilometers (km^2), of each survey transect was generated, which represents the viewing distance, i.e. 200-250m (depending on the vessel used), off each side of the vessel. Densities were calculated by dividing the count for each species by the survey area of each survey transect. The centroids of the survey transects were used to represent the densities.



Geographic coordinates recorded on the vessel were spatially geo-referenced using two methodologies. The first method was applied to pre-1990 records which pre-dated the use of GPS units. This method involved a single set of start/stop coordinates for a set of survey transects. Time intervals were logged for each survey transect. A computer automation script was used to interpolate the start/stop coordinate of each survey transect based on a series of formulas that calculated velocity and bearing of the ship's track. The second method was applied to the post -1990 records that were collected with a GPS and as such start/stop coordinates were already recorded for each survey transect, eliminating the need for coordinate interpolation. Longitude and latitude

for the years 1981 and 1983 were collected using Loran-C navigational equipment. It was assumed that these were collected using Geographic North American Datum of 1927 (NAD 27) reference coordinates. As a result, the 1981 and 1983 transect coordinates were converted to NAD 83, thus providing a higher spatial accuracy. Coordinate information from 1990 onwards was assumed to have been collected using NAD 83 and therefore did not require datum conversions.

Seabird spatial distributions were queried and analyzed using a modification of the classification scheme of seasons developed by Wahl *et al*. (1993). This was necessary to better reflect patterns of marine distributions. For the purposes of this analysis: Spring is the period during which time many seabirds are migrating (1 March - 31 May); Summer is the period during which time birds remain in the area to breed or spend their non-breeding season (1 June - 31 July); Fall is another period of migration (1 August - 31 October); and, Winter is the period during which time birds remain in the area to over-winter (1 November - 28 February).

It is recognized that the marine environment is a highly dynamic system. Since we wished to examine the overall use of the Scott Islands marine area by seabirds, it was decided to use a cumulative year method. This dataset spans a 20-year period, and as such, the pooling of all years appeared to be the best way to capture the dynamic nature of the marine system.

All mapped bird density information in this report is presented at a 1:1,250,000 scale and is superimposed on baseline and bathymetric data. The mapped bathymetric data are based on interpolation of data obtained from an interactive version of the Smith and Sandwell (1997) global ocean bathymetry map of sea floor topography.

Two methods of data classification were used to aid in the interpretation and analysis of the spatial relationships. It was determined that the natural breaks, or Jenks optimization, method would best represent the bird species densities by identifying the natural groupings that exist within the data (Minami, *et al*., 1999). Where there were insufficient data to perform a natural break method, each species was depicted by using unique symbols to plot the locations of observations.

3.3. The Study Area

The Scott Island marine area, covered in this report, is a 225 km x 330 km area around the Scott Islands (an arbitrarily chosen area that was large enough for adequate assessment) representing approximately 12% of Canada's Pacific waters (i.e. the marine area within Canada's EEZ). Our approach was to record the number of

observations of a species within the Scott marine area relative to the total data set for that species within the EEZ. This method consisted of dividing the number of surveys in the Scott Islands marine area having at least one observation of that species, by the number of surveys within Canada's EEZ that had at least one observation of that species. This figure was then multiplied by 100%. If the resulting percentage was greater than 25% (a conservative value used for this report) then the marine area in the vicinity of the Scott Islands was deemed of particular importance to that species since it occurred at a higher proportion than would be expected.

2. RESULTS AND DISCUSSION

4.1. Sampling Effort and Coverage

A total of 2,805 surveys were conducted in the marine area around the Scott Islands (Figure 3). Of these, 809 transects were surveyed in the spring (28.8% of total), 1,465 in the summer (52.2%), 322 in the fall (11.5%) and 209 (7.5%) in the winter. These transects covered a total area of 2,218.45 km^2, approximately 4% of the total Scott Islands marine area.

4.2. Seabird Seasonal Occurrence

The proportion of the surveys in the Scott Islands marine area, which yielded at least one avian record, was 1,325 of 2,805 (47%). From these, 3,065 observations of birds were recorded from the sampling points along these transects. A total of 19,596 individual birds were counted during the surveys, representing 46 avian species. Of these 46 species, 6 are listed internationally by the International Union for Conservation of Nature and Natural Resources (IUCN) or nationally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Table 2).

Table 2. Species of marine birds which occur in the Scott Group marine area and are Internationally or Nationally at risk.

IUCN* CATEGORY	COSEWIC** CATEGORY	Species
	Marine birds	
Vulnerable		Black-footed Albatross
Vulnerable	Threatened	Short-tailed Albatross
Vulnerable		Buller's Shearwater
Vulnerable		Pink-footed Shearwater
	Special Concern	Ancient Murrelet
Vulnerable	Threatened	Marbled Murrelet
	Marine mammals	
Vulnerable		Northern Fur Seal
Endangered		Steller's Sea Lion
Lower Risk/Conservation Dependent		Baird's Beaked Whale
Lower Risk/Conservation Dependent		Dall's Porpoise
Vulnerable	Data deficient – Pacific Ocean	Harbour Porpoise
Vulnerable	Threatened – North Pacific Population	Humpback Whale
Lower Risk/Conservation Dependent	Endangered – NE Pacific Southern Resident Population Threatened – NE Pacific Northern Resident Population Threatened – N Pacific Transient Populations Special Concern – NE Pacific Offshore Population	Killer Whale
Lower Risk/Conservation		Minke Whale
Dependent Vulnerable		Sperm Whale

* Hilton-Taylor, 2000

** COSEWIC, 2001

For the purpose of this report, birds were classified by their seasonal use of the marine area. To determine which class to place an individual species, its seasonal occurrence within this data set, as well as, other published and unpublished sources, were used. The result provided the following classifications: Year-round Resident – a species which both breeds in, or adjacent to, the area and uses the marine habitat throughout the year; Summer - Breeder – a species which breeds in, or adjacent to, the area and uses the marine habitat to forage for their young. Not present during the non-breeding season; Summer - Non-Breeder – a species which breeds elsewhere in the

world (i.e. in the southern hemisphere or Japan) and uses the Scott marine area during the summer; Spring and Fall Migrant – a species which moves through and uses the region during migration between its Arctic breeding grounds and its wintering areas from southern California to coastal South America; Winter Resident – a species which breeds elsewhere in the northern hemisphere but moves into the marine area for the non-breeding season; and, Visitor – species that did not clearly fit into the preceding groupings.

4.2.1. Year-round Residents

Six species were found to use the marine area around the Scott Islands on a year-round basis. Northern Fulmar (*Fulmarus glacialis*), Common Murre, California Gull (*Larus californicus*), Glaucous-winged Gull, Herring Gull (*Larus argentatus*), and Tufted

Puffin were observed in all four seasons (Figures 3 - 8). California and Herring gulls breed in inland regions of British Columbia but use the Scott Islands marine area whilst breeding; the other four year-round residents are nesters on the Scott Islands.

4.2.2. Summer - Breeders

Eleven species breeding in the area (i.e. on the Scott Islands, at other coastal colonies, or inland) (Rodway and Lemon, 1991; Rodway and Lemon, 1990; Rodway, *et al*., 1990a; Rodway, *et al*., 1990b) were found to use the Scott marine area. Fork-tailed and Leach's storm-petrels, Cassin's and Rhinoceros auklets, Pelagic Cormorant, Pigeon Guillemot, Ancient (*Synthliboramphus antiquus*) and Marbled murrelets (*Brachyramphus marmoratus*), and Mew Gull (*Larus canus*) were observed frequently (Figures 9 - 17). Horned Puffins (*Fratercula corniculata*) were also observed but on fewer occasions (Figure 33).

4.2.2.1. Scott Island Breeders

Species that breed on the Scott Islands were observed regularly and frequently in large numbers. Fork-tailed and Leach's storm-petrels, Cassin's and Rhinoceros auklets breed on the Scott Islands in high numbers (Table 1) and use the marine area extensively, especially in spring and summer. Both species of storm-petrel occurred in high densities with some overlap in their distributions. However, Fork-tailed Storm-Petrels had a higher tendency to occur in the waters over the continental shelf, whereas Leach's Storm-Petrels had a greater association with the waters beyond the shelf break (Figures 9 and 10, respectively). In the spring, Cassin's Auklets are associated with waters less than 200m in depth, but move beyond the shelf break during the summer

(Figure 11). Rhinoceros Auklets occurred at highest densities in waters less than 200m (Figure 12).

There were however, a couple of species known to breed on the Scott Islands, but were not observed in large numbers. This can be attributed to either the behaviour of the species (i.e. foraging behaviour, ship avoidance behaviour), to low breeding numbers or to the survey methods. Pelagic Cormorants and Pigeon Guillemots breed on the Scott Islands (approximately 740 and 310 pairs, respectively, Table 1) and at other locations in the area. Their foraging habitats are close to shore and, as such, individuals would not be detected regularly in pelagic surveys such as those of the current study (Figures 13 and 14, respectively). Horned Puffins are suspected to breed on several of the Scott Islands (approximately 11 pairs, Table 1), as well as Solander Island (roughly 100 km southeast of the Scott Group; Figure 35), in low numbers (Rodway and Lemon, 1990). Although Horned Puffins are suspected to feed within two kilometres of the nest site (Wehle, 1980), they are frequently encountered hundreds of kilometers from land during the nesting season (K. Morgan, pers. obs.). Tufted Puffins use these waters year round, but are more concentrated around the colonies during the breeding season and more dispersed and farther offshore during the fall and winter (Figure 8).

4.2.2.1.1. Confirmed at-sea distributions of seabirds breeding on Triangle Island

A four-year telemetry study was conducted at Triangle Island, 1999 to 2001, the purpose of which was to determine the at-sea foraging distributions of breeding Cassin's Auklets (1999-2001) (Boyd *et al.*, 2000; Ryder *et al*., 2001) and Rhinoceros Auklets (2002). Each year for the first three years of the study, approximately 40 breeding adult Cassin's Auklets were marked with transmitters; 40 Rhinoceros Auklets in the fourth year. In 1999 and 2000, the majority of radio-marked Cassin's were found in an area 30-60 km southwest of Triangle Island (Ryder *et al.*, 2001). However, in 2001, Cassin's were located northwest of Triangle Island (J. Ryder *et al.*, in prep.), approximately 80 km north of the core area of the previous two years with a maximum detection distance of approximately 110 km from the island (Figure 34). This indicated that the foraging area of Cassin's auklet from Triangle Island is more extensive and variable than originally estimated. Figure 11 suggests that the majority of birds encountered were within 90 km of Triangle Island, consistent with the results of the telemetry study.

The results of the shipboard surveys provide significant evidence supporting the extensive use of the marine area around the Scott Islands. It was assumed in this study

that the majority of the individual seabirds observed are local breeders. However, the Triangle Island telemetry study provides sufficient evidence that the seabirds that breed in the region use these waters extensively.

4.2.2.2 Seabirds Breeding at Other Colonies

In addition to the birds that breed on the Scott Islands, seabirds from other colonies forage in the Scott Islands marine area. There are 35 known seabird colonies, within a 150 km radius of Triangle Island (Figure 35). Ancient Murrelets historically bred in the Buckle Group (north end of Queen Charlotte Strait; Rodway and Lemon, 1991, Figure 42) but were observed along or west of the shelf break in the study area (Figure 15); Marbled Murrelets nest in old growth forests adjacent to the heads of inlets along the mainland coast and along the west coast of Vancouver Island. Some of these inlets fall within the marine area considered for this report (Moses and Smith inlets, Drever and Kaiser, 1998) and Marbled Murrelets were observed in or near these inlets in the current study (Figure 16). Further, in 2002, radio tagged juvenile Marbled Murrelets dispersing from Clayoquot Sound, moved north to the waters of northern Vancouver Island, off Cape Scott remaining there for some time prior to loss of contact. It is believed they headed for Alaska (D. Lank, pers. comm.). Mew Gulls were observed in the inshore waters in all seasons but fall (Figure 17).

There exists a strong likelihood that seabirds breeding at other colonies in the region use the marine area around the Scott Islands for foraging. Several studies have been conducted on the foraging ranges of seabirds during the breeding season. In addition to the aforementioned results of the Triangle Island telemetry study, similar investigations carried out in California on Cassin's Auklet yielded foraging distances of 10-25 km from San Miguel Island (J. Adams USGS-BRD, unpubl. data). Common and Thick-billed murres have been reported to travel up to 50 km from the colony in Greenland and 50-80 km from colonies in the Chukchi Sea, Alaska (Falk *et al.*, 2000 and Hatch *et al.*, 2000, respectively). Hull *et al.* (2000), in their 1998 study in British Columbia, found that Marbled Murrelets traveled 12-102 km from their nests to foraging sites. Whitworth *et al*. (2000) reported Alaskan radio-tagged Marbled Murrelets traveled a mean distance of 78 $\pm$ 42 km and up to 124 km to foraging locations. The foraging ranges of storm-petrels have not been well documented; however, reported trip durations may imply that they travel great distances while foraging for their young. Ricklefs *et al*. (1985) reported trip durations ranging from 1-4 days for Leach's Storm-Petrels and Simons (1981) found Fork-tailed Storm-Petrel provisioned their young

anywhere from 2 times per night up to once every 4-days. Other seabirds closely related to storm-petrels, such as Northern Fulmars may forage 122-245 km from their nesting colonies (Hamer *et al*., 1997).

4.2.3. Summer - Non-Breeders

Eight species, which breed either in Hawaii, Japan or in the southern hemisphere during the boreal winter and spend their non-breeding season foraging in the North Pacific during the boreal summer, were observed in the Scott area. These species are Black-footed Albatross (*Diomedea nigripes*), Laysan Albatross (*D. immutabilis*), Short-tailed Albatross (*D. albatrus*), Buller's Shearwater (*Puffinus bulleri*), Pink-footed Shearwater (*P. creatopus*), Sooty Shearwater (*P. griseus*), Short-tailed Shearwater (*P. tenuirostris*), and South Polar Skua (*Catharacta maccormicki*), (Figures 18 - 25).

The Black-footed Albatross, globally listed as vulnerable, breeds in Hawaii as well as Japan during the boreal winter. This species foraging flights have been tracked using satellite-telemetry from their nest sites in Hawaii to waters off the British Columbia and Washington coasts, which may account for their occurrence in the Scott Islands marine area during spring and fall (an estimated distance of over 3500 km) (Anderson, 1999). The data presented in Figure 18, shows how Black-footed Albatross tend to prefer waters along the edge of and seaward of the shelf break, consistent with the findings of Anderson (1999). Laysan Albatross travel regularly from their Hawaiian nesting colonies to the Gulf of Alaska in search of food for their young (Anderson, 1999). Figure 19 depicts Laysan Albatross densities from the current study and shows that there are far fewer observed in the Scott Islands marine area as compared to the Black-footed Albatross, and that they were encountered seaward of the shelf break. The globally vulnerable (threatened in Canada) Short-tailed Albatross breeds almost entirely on Torishima Island, Japan. However, post-breeding Short-tailed Albatross disperse to the Aleutian Islands, the Bering Sea, and the Gulf of Alaska. Two individuals were observed in the Scott Islands marine area during this study (Figure 20). More recently, a juvenile Short-tailed Albatross captured in the Aleutian Islands in August 2003 and fitted with a satellite transmitter, was recorded within the study area near the Scott Islands in November 2003 (Balogh and Suryan, unpublished data). One detection indicated the albatross was within 4 km of Cape Scott.

Buller's Shearwaters, another globally vulnerable species, breed on Poor Knight's Island off New Zealand, and migrate northward in May to waters off of Japan, eastern Russia and western Canada. The species returns to its breeding colonies in

early September (Wilson, 2000). The higher concentrations and distributions of Buller's Shearwaters in fall, as shown in Figure 21, suggest that this species uses the Scott Islands marine area on its return trip to its breeding grounds.

Pink-footed Shearwaters (also globally vulnerable) are present off the Scott Islands primarily during fall (Figure 22). They breed in the Juan Fernandez Archipelago and on Isla Mocha both off the coast of central Chile (Wilson, 2000). Sooty Shearwaters are one of the most numerous and prevalent seabirds in the Scott Islands area, reaching densities of over 400 birds per square kilometre. As implied by the distributions of Sooty Shearwaters in Figure 23, they are rather strongly associated with waters of depths less than 200 m. Short-tailed Shearwaters spend the non-breeding season in the north Pacific and Bering Sea. Post breeding adults take approximately 6 weeks to reach the Bering Sea from Australia. The first individuals reach the Bering Sea at the end of April with the majority arriving in May and June. Some adult Short-tailed Shearwaters begin to turn south in late August. Although most birds leave the Bering Sea during September and October, a few individuals stay as late as mid-November (Wilson, 2000). Most of the Short-tailed Shearwaters observed in the Scott area were seen in July and October suggesting summer, and fall migration usage. They were generally associated with the waters of the continental shelf (Figure 24).

South Polar Skuas breed on South Shetland Island and in Antarctica from late October to April. During their non-breeding season, they migrate as far north as the Gulf of Alaska (Woehler and Clippingdale, 2001). Consequently, South Polar Skuas would be expected in the marine area of the Scott Islands in summer and early fall, as seen in Figure 25.

4.2.4. Spring and Fall Migrants

Three species found to use the waters primarily during migration were Red Phalarope (*Phalaropus fulicaria*) (Spring), Red-necked Phalarope (*Phalaropus lobatus*) (Spring and Fall) (Figures 26 - 27), and Sabine's Gull (*Xema sabini*) (Fall) (Figure 33). Red Phalaropes traverse the Scott marine area in the spring while migrating north to their breeding sites in the Arctic. As seen in Figure 26, Red Phalaropes were associated with the waters beyond the shelf break. Phalaropes are well known for their concentrations at fronts associated with the California, Peru and Canary boundary currents, as these fronts are highly productive resulting in higher concentrations of plankton, the principal diet of phalaropes (Spear *et al.*, 2001, and references therein). Although Red-necked Phalaropes are also often associated with oceanic fronts in the

same manner as Red Phalaropes (Spear *et al.*, 2001), generally, in the present study, they occurred in the shallower waters of the continental shelf and in summer occurred predominantly at the mouth of Queen Charlotte Sound (Figure 27). Red-necked Phalaropes appear to use these waters during spring and fall migration.

Sabine's Gull nest in the Arctic, and following the breeding season, migrate to Baja, Mexico, and central Chile along the continental shelf, between 10 and 100 km from land (Wilson, 2000). The few observations of Sabine's Gull in the Scott marine area were consistent with other studies, occurring at a distance greater than 10 km but less than 100 km from land (Figure 33).

4.2.5. Winter Residents

Three species used the marine area predominantly between fall and spring. They were Black-legged Kittiwake (*Rissa tridactyla*) (Figure 28), Thayer's Gull (*Larus thayeri*) and Xantus's Murrelet (*Synthliboramphus hypoleucus*) (Figure 33). In this study, species considered to be winter residents were those that breed elsewhere and observations within the Scott marine area were confined to late fall, winter and early spring. Black-legged Kittiwakes breed in Alaska from May to August and thus would be expected in the Scott Islands marine area from late August through to April. Other than three sightings on May 31, 2001, most kittiwakes were encountered during fall through spring (Figure 28). Thayer's Gulls breed in the Arctic and are known to winter in coastal British Columbia (Campbell *et al.,* 1990). In the Scott marine area, Thayer's Gulls were observed only during the winter and at distances no greater than 10 km from land. The globally vulnerable Xantus' Murrelet was only observed once (2 birds) in the Scott marine area (Figure 33); they were encountered approximately 115 km west of Triangle Island.

4.2.6. Visitors

Several species were observed regularly but with no evident seasonal pattern; they were Common Loon (*Gavia immer*), Pacific Loon (*G. pacifica*), Double-crested Cormorant (*Phalacrocorax auritus*), and Pomarine Jaeger (*Stercorarius pomarinus*) (Figures 29 - 32); other species observed less regularly were Red-throated Loon (*Gavia stellata*), Long-tailed Jaeger (*Stercorarius longicaudus*), Parasitic Jaeger (*S. parasiticus*), Western Gull (*Larus occidentalis*), and Arctic Tern (*Sterna paradisaea*) (Figure 33).

Three species of loon were observed in the Scott Islands marine area during the study period. Common Loons breed on inland freshwater lakes throughout British Columbia and winter in the waters along the Pacific coast from the Aleutians south to Baja California and Sonora (American Ornithologists' Union, 1983). In the current study, Common Loons were observed in late spring and early summer only (Figure 29). Pacific Loons breed throughout much of the boreal forest and tundra regions of North America and winter off the west coast of North America, from the Gulf of Alaska to Baja California. As shown in Figure 30, Pacific Loons commonly occurred throughout the Scott Islands marine area. Red-throated Loons breed on freshwater lakes of the sub arctic and boreal zones. In the Scott Islands area, Red-throated Loons were observed on three occasions in late May, possibly as they were heading north to breed.

Three species of jaeger were observed in the Scott Islands marine region at various times of the year during the study period. Long-tailed Jaegers breed in the high Arctic during the summer months and spend the remainder of the year on the open ocean (Wiley and Lee, 1998). In the area around the Scott Islands, Long-tailed Jaegers were observed on three occasions in the late spring and early summer and all beyond the continental shelf break (Figure 33). Parasitic Jaegers were sighted on two occasions, once in early summer and once in early fall, and all observations occurred at distances greater than 40 km from land (Figure 33). Pomarine Jaegers, like the other two species, breed in the Arctic and when not breeding, individuals spend their lives at sea, often far from land, in tropical and subtropical oceans (Wiley and Lee, 2000). Pomarine Jaegers were observed in the Scott Islands marine area during spring through fall with highest densities beyond the shelf break (Figure 32).

Western Gulls breed from Washington, south to California. In the Scott Islands marine area, Western Gulls were observed on only two occasions, once in the summer and once in the winter (Figure 33). On the west coast of North America, Arctic Terns breed in Alaska and northern British Columbia, and their migration route is such that they would be expected to pass through the Scott Islands marine area in the spring on their way north. Arctic Terns would not be expected to occur in the Scott Islands marine area during their fall migration because they cross North America and join the Atlantic Canadian populations before crossing the Atlantic Ocean and heading south along the coast of Africa to winter in the Antarctic. Arctic Terns were observed during the spring, but also into September; the highest densities were found in association with waters less than 200 m in depth (Figure 33).

4.3. Scott Islands Marine Area - In Context

Thirteen species of seabird used the marine area surveyed around the Scott Islands at a rate of occurrence greater than 25% relative to the waters surveyed within Canada's EEZ (Table 3). These species were Black-footed Albatross, Short-tailed Albatross, Short-tailed Shearwater, Fork-tailed Storm-Petrel, Double-crested Cormorant, Pelagic Cormorant, Cassin's Auklet, Pigeon Guillemot, Marbled Murrelet, Rhinoceros Auklet, Tufted Puffin, South Polar Skua, and Red-necked Phalarope. The Scott Islands marine area represents only approximately 12% of the marine area that is inside Canada's EEZ and since these species occurred in a higher than expected proportion, the Scott Islands marine area is considered of particular importance to these species.

Table 3. Species of marine bird, which occurred in the marine area around the Scott Islands at a rate of occurrence greater than or equal to 25%, relative to the portion of the data set that falls within the western limits of Canada's EEZ.

Species	**Number of Occurrences* (Total)**	**Number of Occurrences (Scott Island Area)**	**Rate of Occurrences in Scott Island Area (%)**
Black-footed Albatross	1014	284	**28**
Short-tailed Albatross	3	2	**67**
Short-tailed Shearwater	69	17	**25**
Fork-tailed Storm-Petrel	1076	268	**25**
Double-crested Cormorant	10	8	**80**
Pelagic Cormorant	19	8	**42**
Cassin's Auklet	668	315	**47**
Pigeon Guillemot	48	22	**46**
Marbled Murrelet	125	38	**30**
Rhinoceros Auklet	877	359	**41**
Tufted Puffin	326	200	**61**
South Polar Skua	25	8	**32**
Red-necked Phalarope	77	22	**29**

* Please note that "Occurrence" ≠ Individual and that one "Occurrence" could be one or many individuals.

1. CONCLUSIONS

5.1. Summary

Thirty-nine species of seabirds were observed in the Scott Islands marine area during the period of this study. Of these species, six were Year Round Residents of the marine area. Three of these species breed on the Scott Islands and three breed away from the coast but nevertheless use the marine waters.

Eleven species were classified as Summer - Breeders, four of which breed in large numbers on the Scott Islands and hence use the surrounding marine area extensively. Four species breed on the Scott Islands and on neighbouring islands in lower numbers. These species tend to use the waters generally within two kilometres of their colonies and as such were only occasionally observed. Another three species do not nest on the Scott Islands but breed nearby. Within the Summer - Breeders, there are two listed species, Ancient Murrelet (COSEWIC – Special Concern) and Marbled Murrelet (COSEWIC – Threatened; IUCN – Vulnerable) (Table 2).

Eight species were classified as Summer - Non-Breeders. These are species which breed elsewhere during boreal winter months and use the waters in the vicinity of the Scott Islands during boreal summer. Two of these species, Black-footed Albatross and Sooty Shearwater, were found to extensively use the waters in the vicinity of the Scott Islands, Black-footed Albatrosses tended to be found more often at or beyond the shelf break, whereas Sooty Shearwaters were more associated with the waters over the continental shelf. Four of these eight species are listed globally as at risk; Black-footed Albatross, Short-tailed Albatross, Buller's Shearwater and Pink-footed Shearwater (IUCN – Vulnerable).

Three species were classified as Spring and Fall Migrants and three species used the marine area almost exclusively during the winter (late fall through to early spring). The numbers are low but this is likely attributable to a paucity of surveys during these seasons. One of the wintering species, Xantus' Murrelet, is globally Vulnerable. All of the species that were classified as Visitors were observed in low numbers or not in a detectable seasonal pattern.

Although we have categorized the species based on seasonal use, many factors influence the abundance and distribution of marine birds. Factors including variability in meteorological conditions, physical and chemical oceanographic parameters, and the

abundance, distribution and availability of zooplankton and forage fish, all impact the seasonal distribution of seabirds, and hence contribute to the highly dynamic and complex nature of the marine environment. Decidedly, the best way to capture the dynamic nature of the marine system and the way the birds respond to those changes was to examine the data with all years pooled. Consequently, it was determined that the marine area around the Scott Islands is of particular importance for Cassin's and Rhinoceros auklets, Tufted Puffin, Marbled Murrelet, Red-necked Phalarope, Sooty Shearwater, Black-footed Albatross, and Fork-tailed Storm-Petrel.

5.2. Recommendations

The importance of the Scott Islands marine area is most clearly demonstrated during the summer (1 June – 31 July). However, even with the lower sampling effort during spring, fall and winter, consistent forage food abundance appears to exist. The area supports a large local and international seabird community including those species listed as nationally or globally at risk (Ancient Murrelet, Marbled Murrelet, Black-footed Albatross, Short-tailed Albatross, Buller's Shearwater, and Pink-footed Shearwater). It is suggested that pelagic shipboard surveys continue in the marine area in the vicinity of the Scott Islands in order to refine the extent of marine use by marine birds.
It is recommended that the results from the shipboard surveys and the Triangle Island telemetry study (Boyd *et al*., 2000; Ryder *et al*., 2001) form the basis for defining the marine area around the Scott Islands that would encompass the marine areas that marine birds consistently utilize to forage for food.

The purpose of this report was to answer such questions as: What birds use this area? Where are the birds in relation to the Scott Islands? And, when are the birds there? An attempt to explain the why and how these birds are distributed the way that they are, require investigations which go beyond the scope of this report. For example, geostatistical techniques, such as universal kriging, may be employed, which take into consideration other parameters that may explain why seabirds occur in the patterns observed. These parameters can be physical or biological, and include sea-surface temperature, salinity, productivity (chlorophyll-level), nutrient concentrations, currents, major and minor oceanographic perturbations, and zooplankton and forage fish distribution. As well, more specific questions, may be answered such as, how does climate variability influence seabird distribution and density? There is also a high international research interest in this region using marine birds as indicators of oceanic shifts related to climate change.

The annual and interannual pooled seasonal patterns of seabird use presented in this report confirm that the marine area around the Scott Islands provides consistent forage food organisms for a diverse array of seabird species. Application of this information will greatly assist the Canadian Wildlife Service in meeting its regional, national, and international commitments to the conservation and management of Pacific Canada's marine bird populations.

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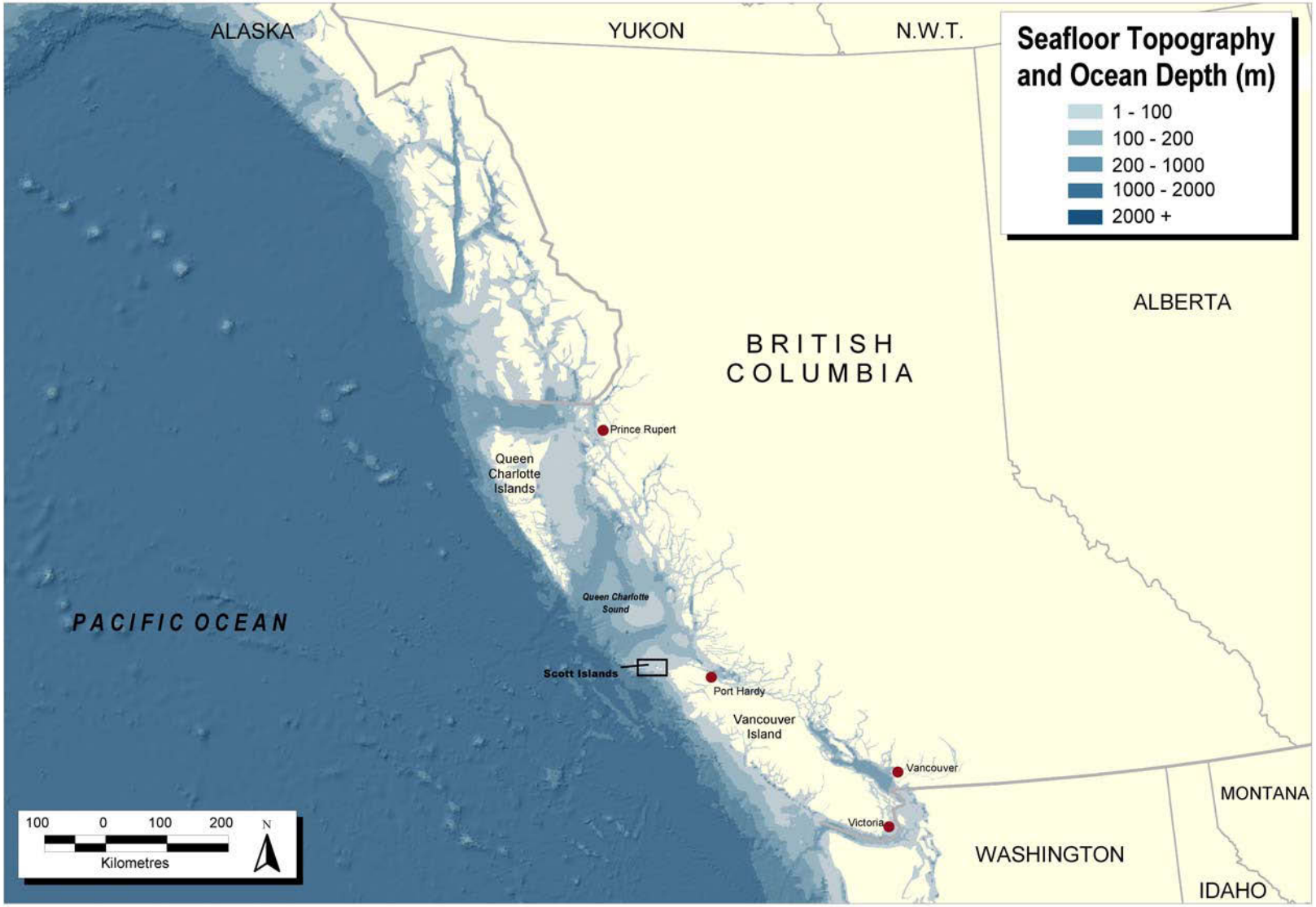

Figure 1. Map of British Columbia showing bathymetry.

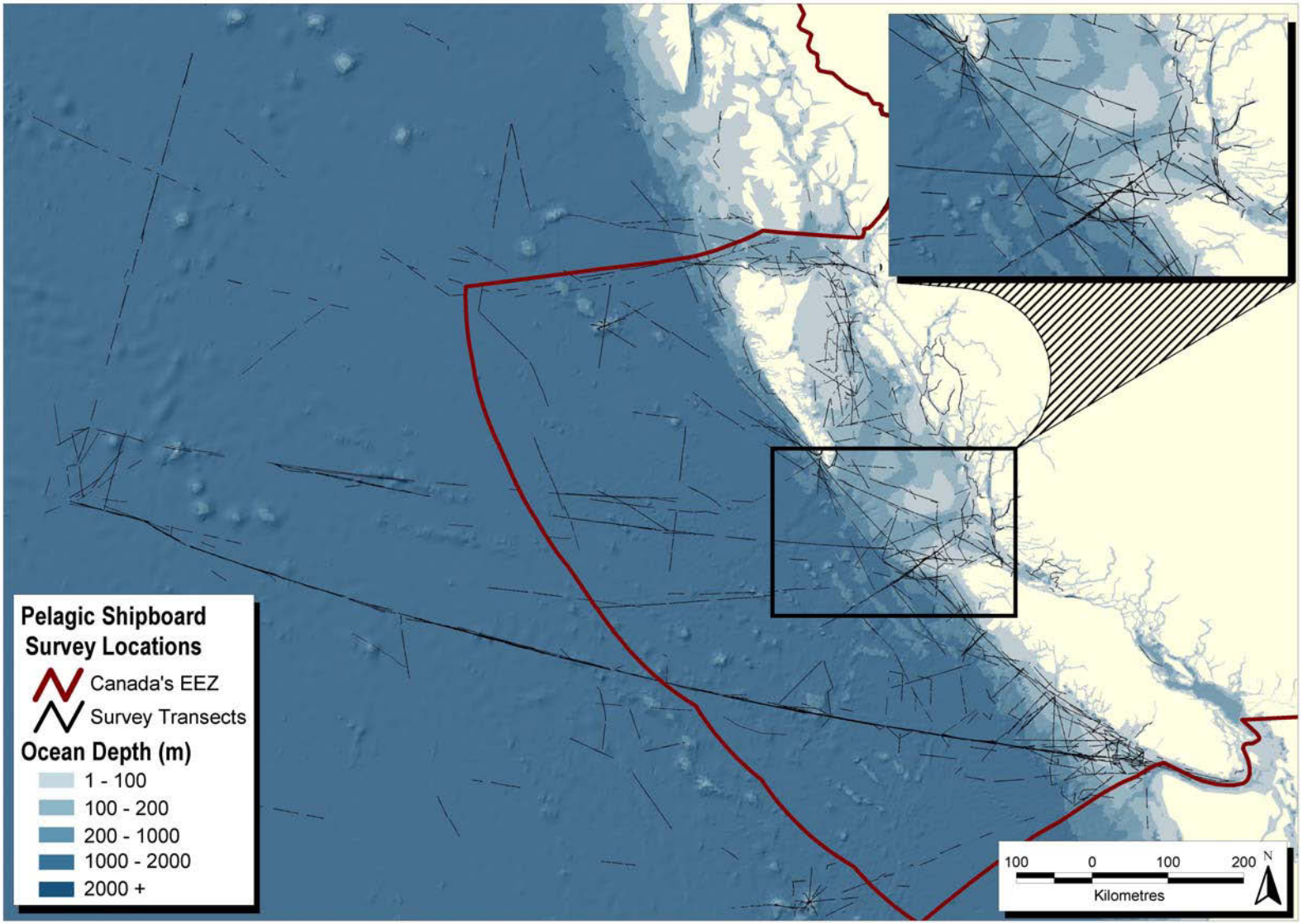

Figure 2. Map depicting all survey transects conducted off of British Columbia, 1981 - 2001, and the boundary of Canada's Exclusive Economic Zone . The inset map is of the Scott Islands marine area.

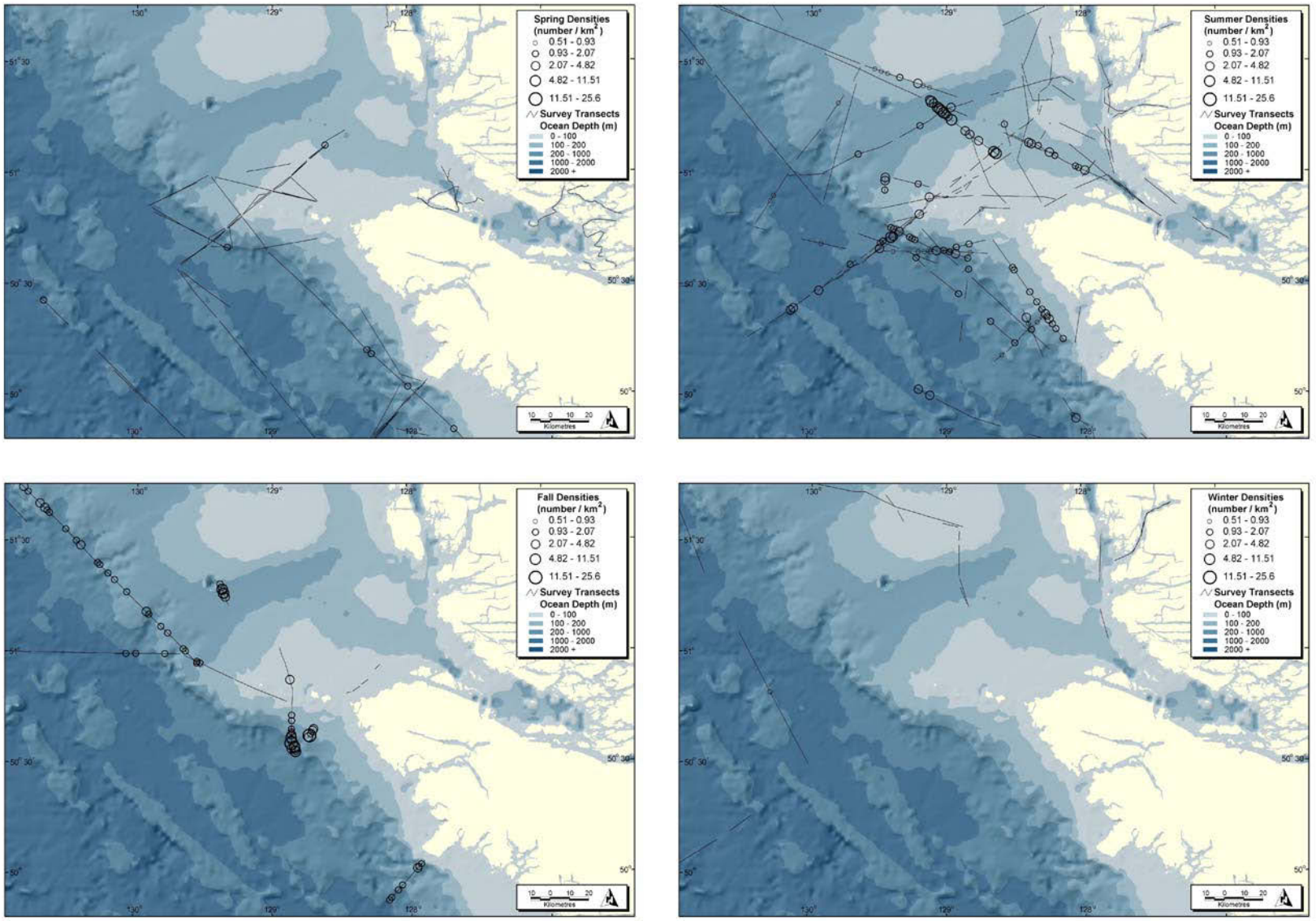

Figure 3. Northern Fulmar seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

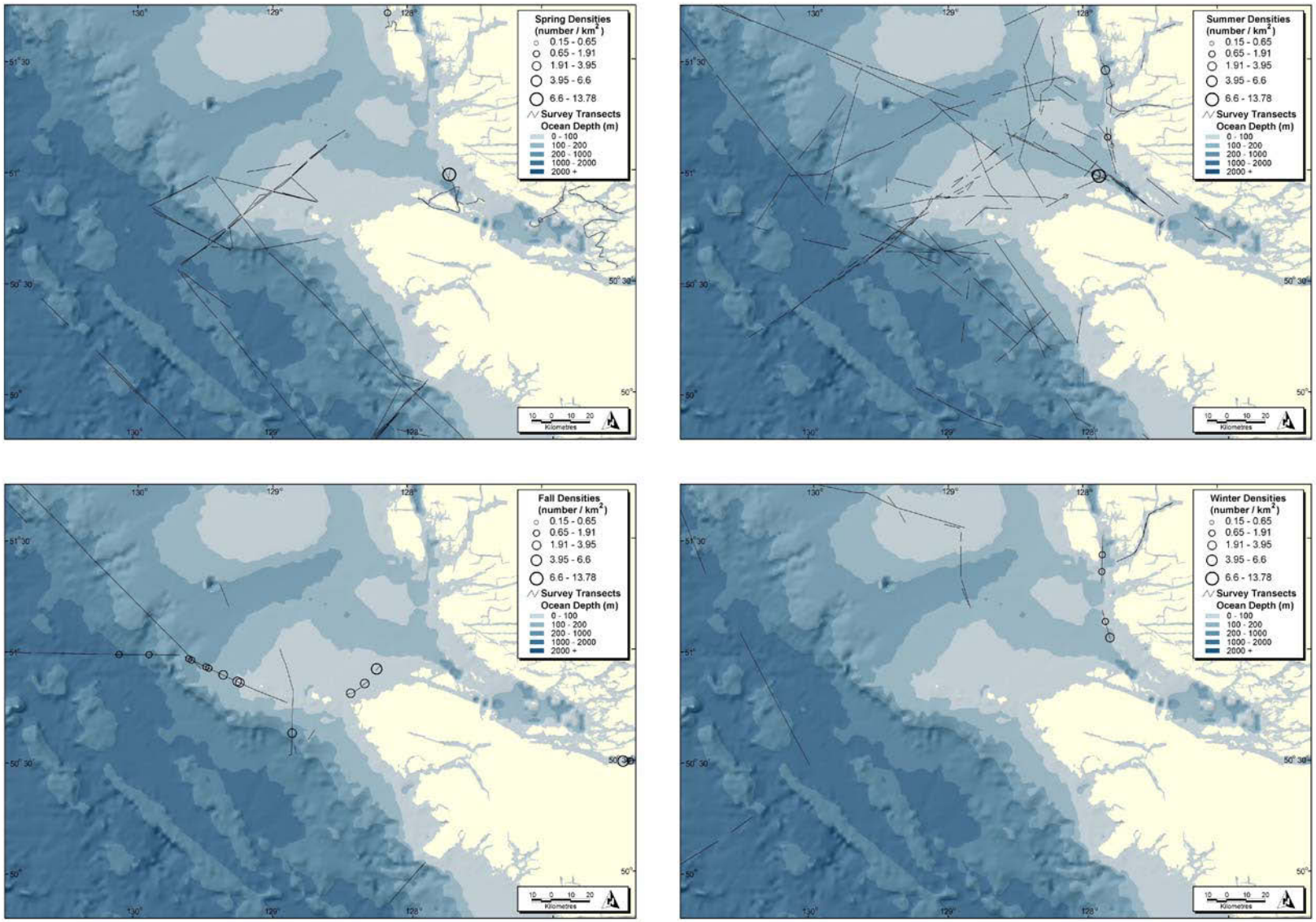

Figure 4. California Gull seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

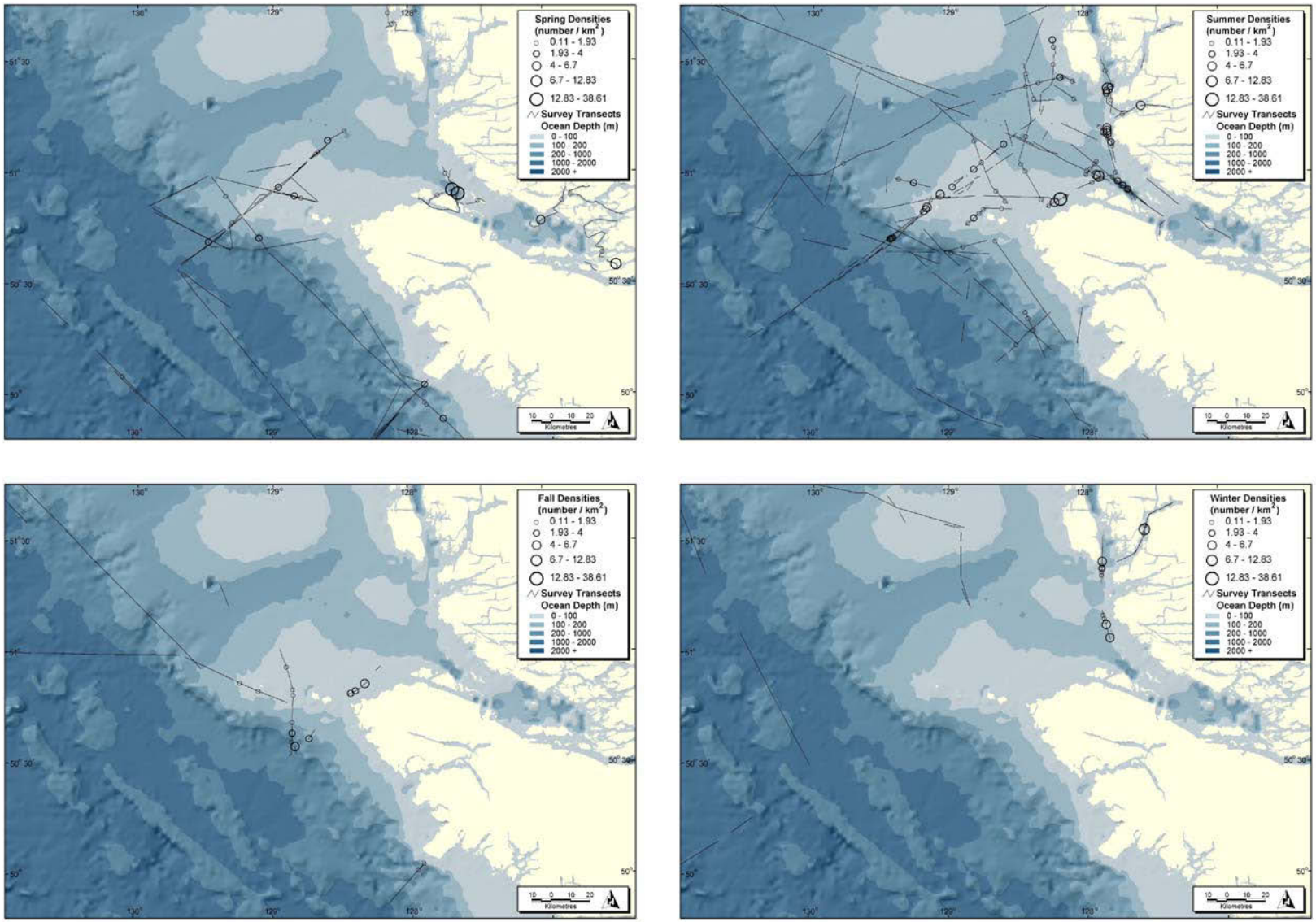

Figure 5. Glaucous-winged Gull seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

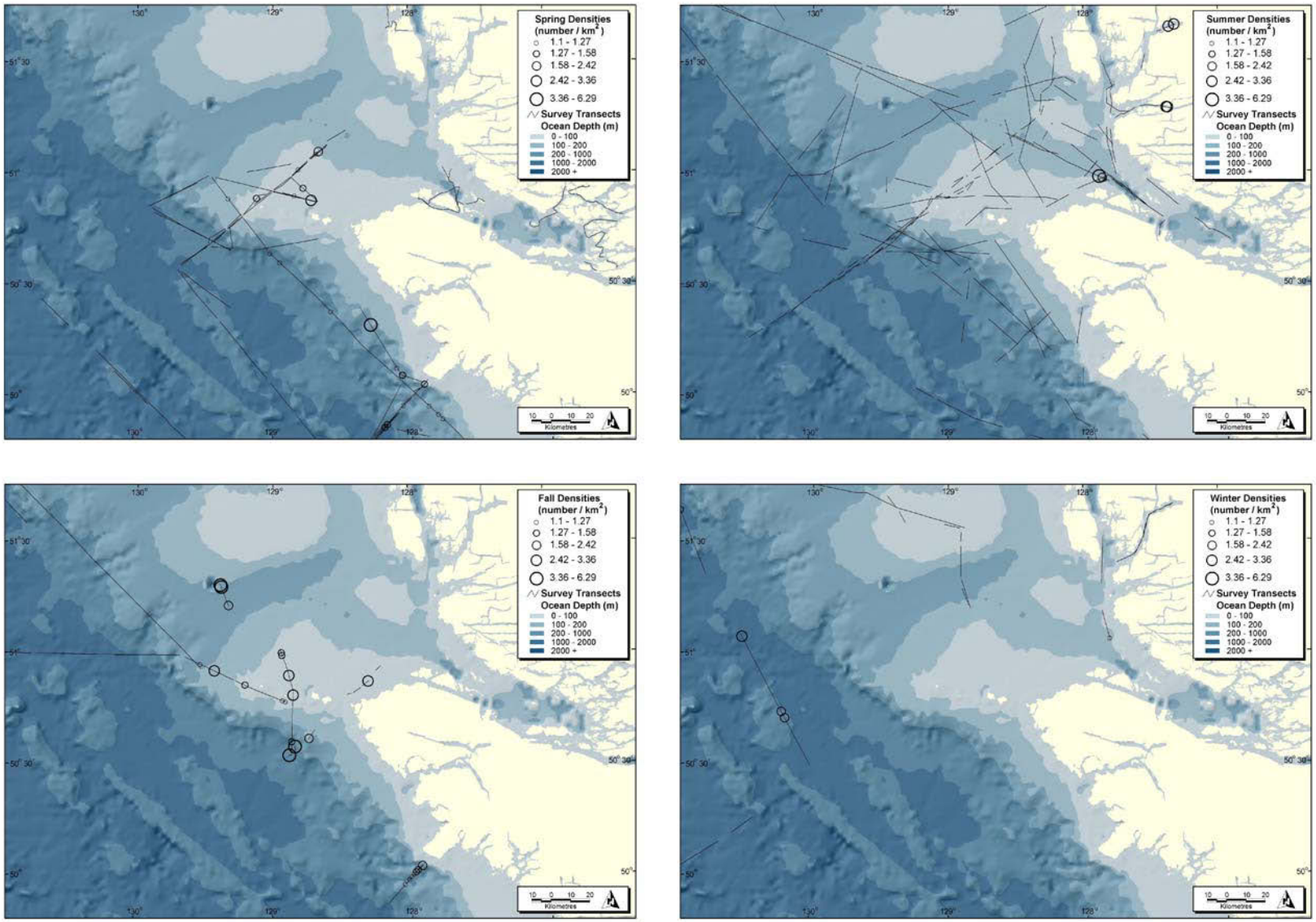

Figure 6. Herring Gull seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

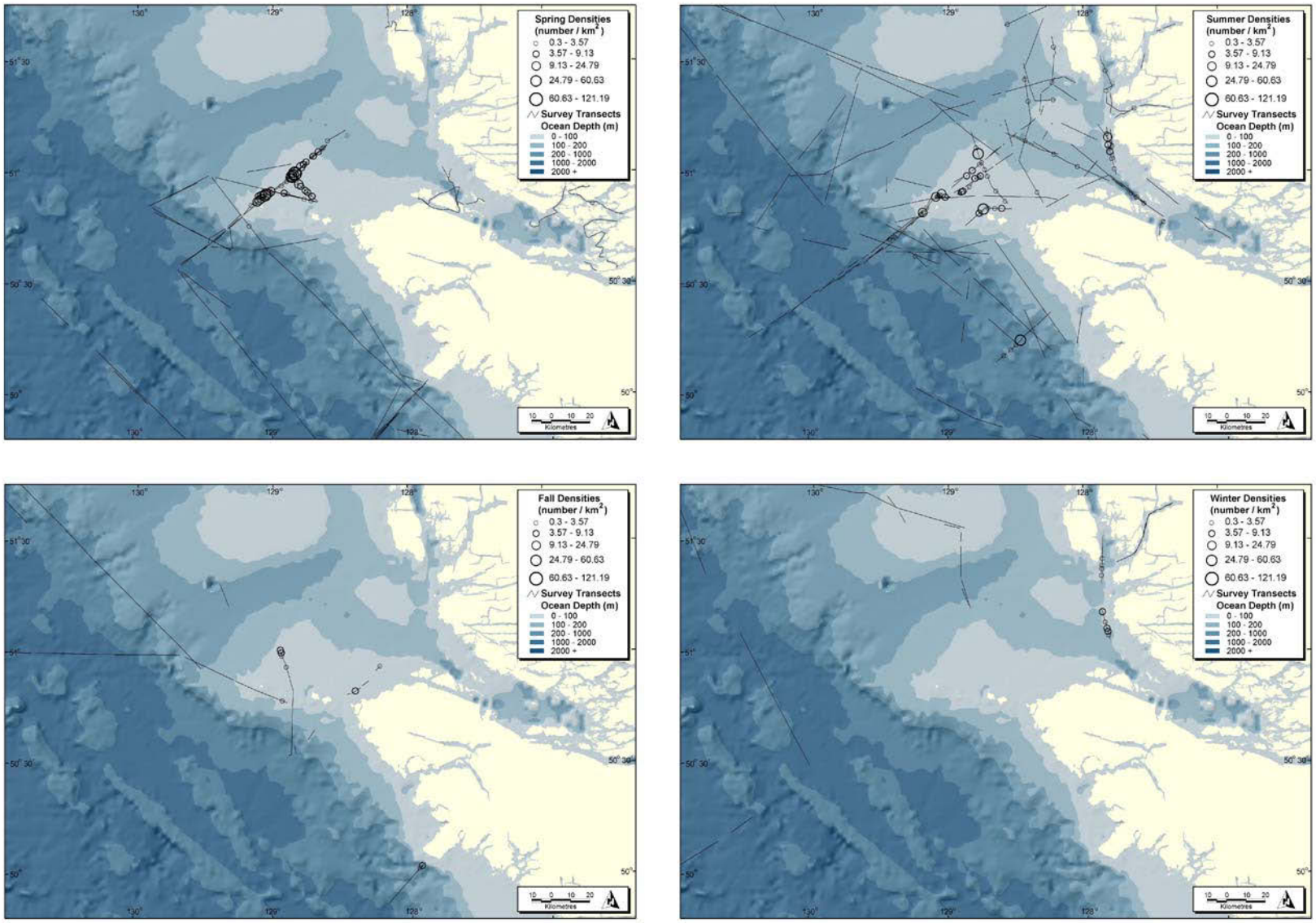

Figure 7. Common Murre seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001

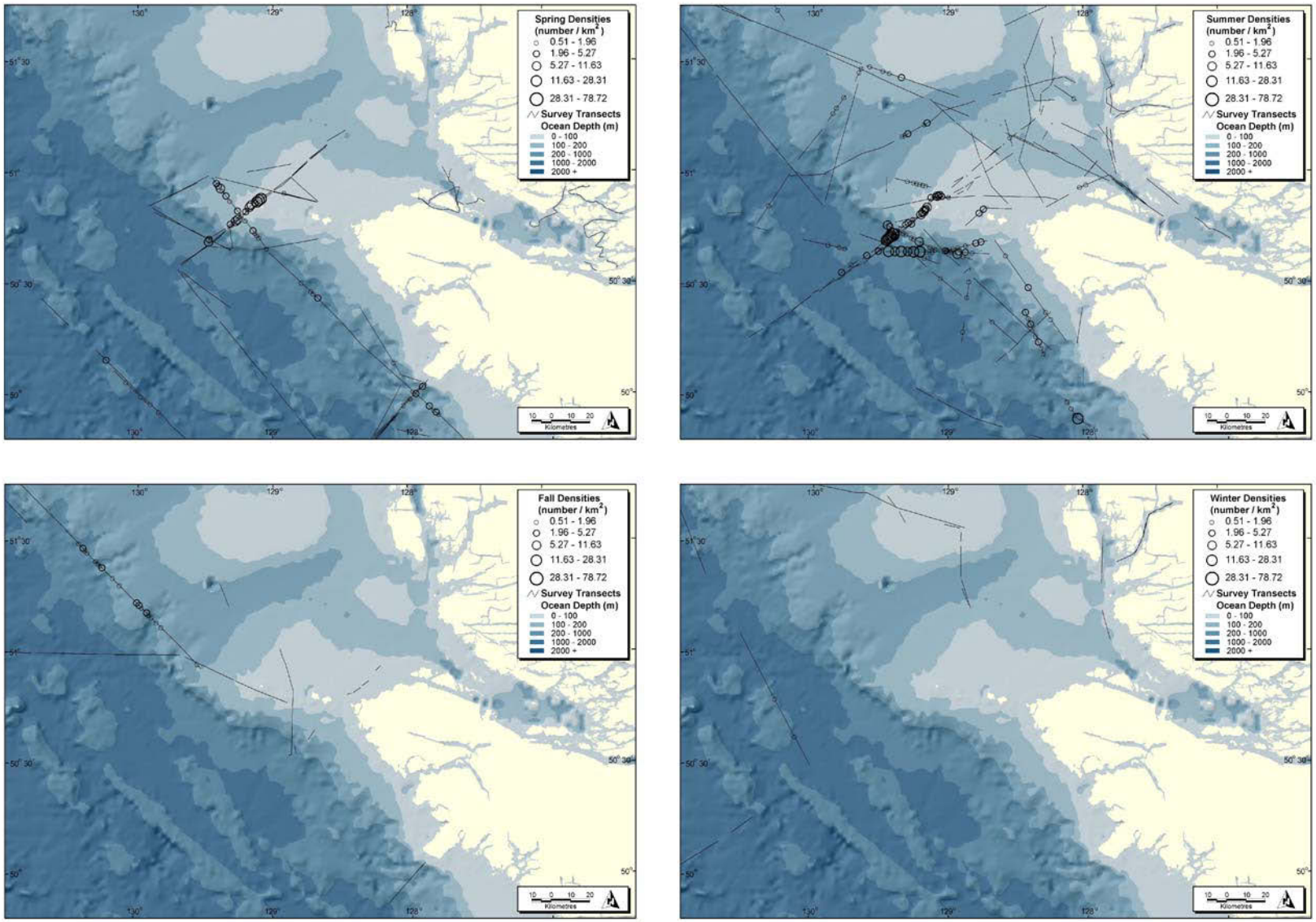

Figure 8. Tufted Puffin seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

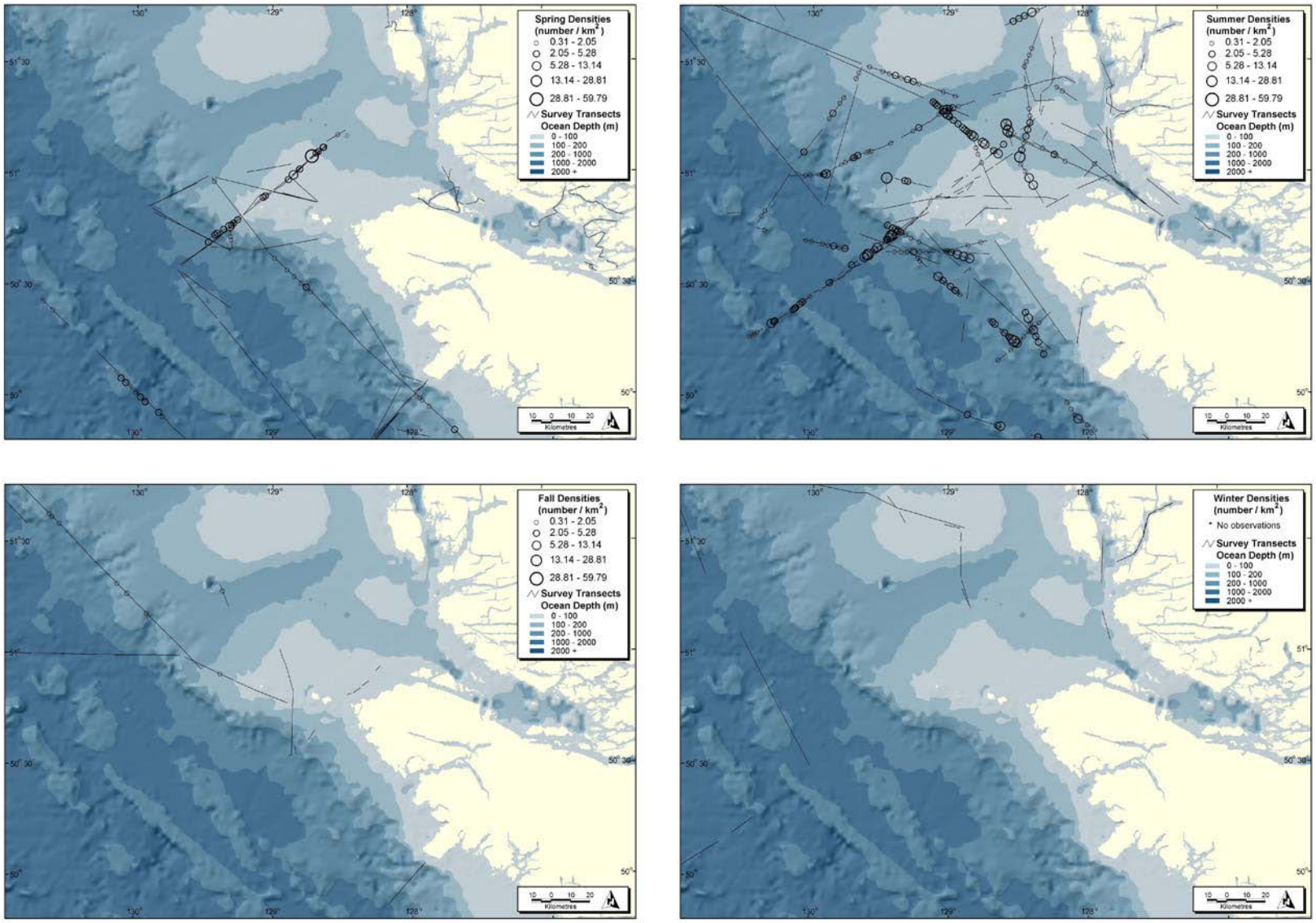

Figure 9. Fork-tailed Storm-Petrel seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

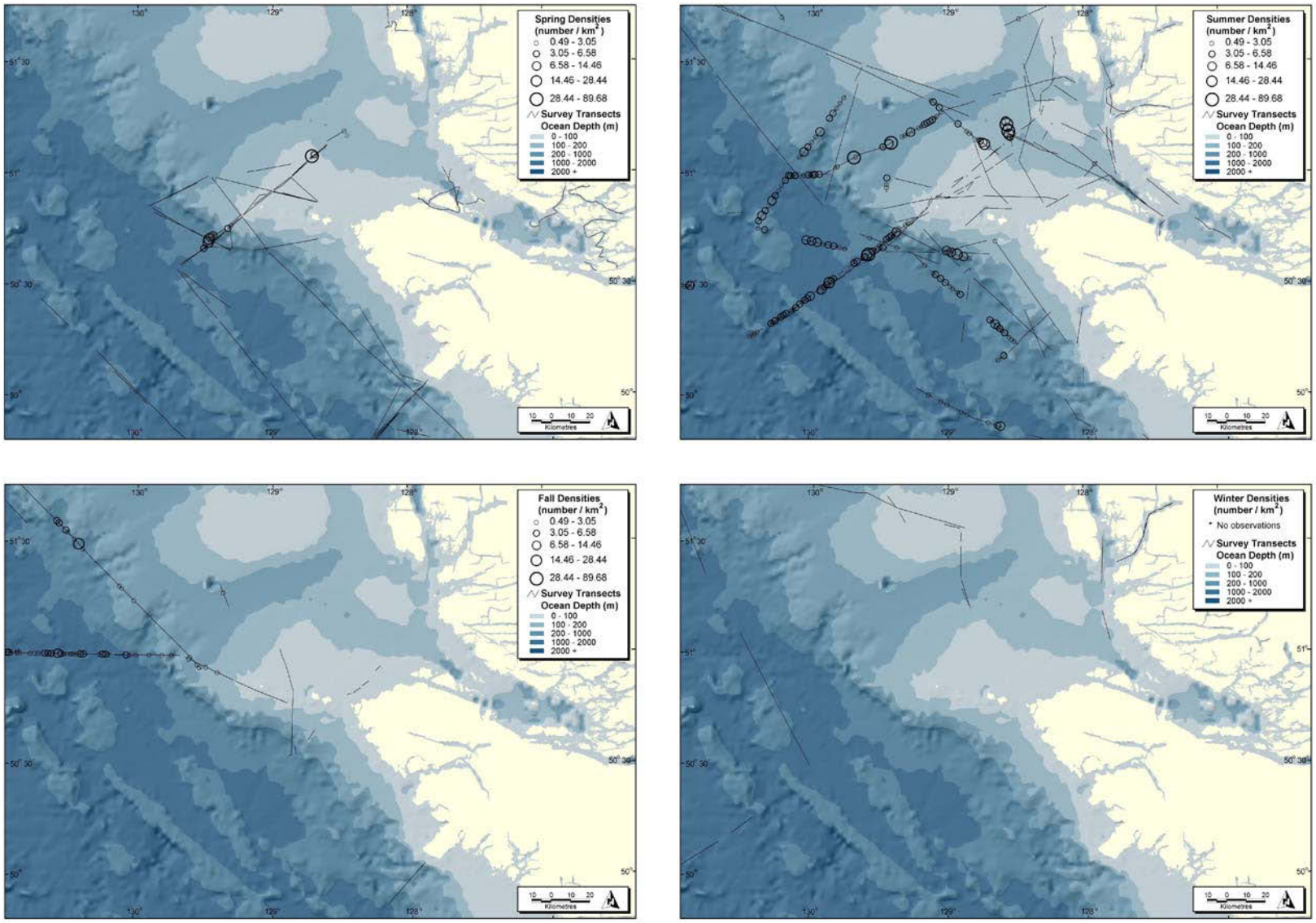

Figure 10. Leach's Storm-Petrel seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

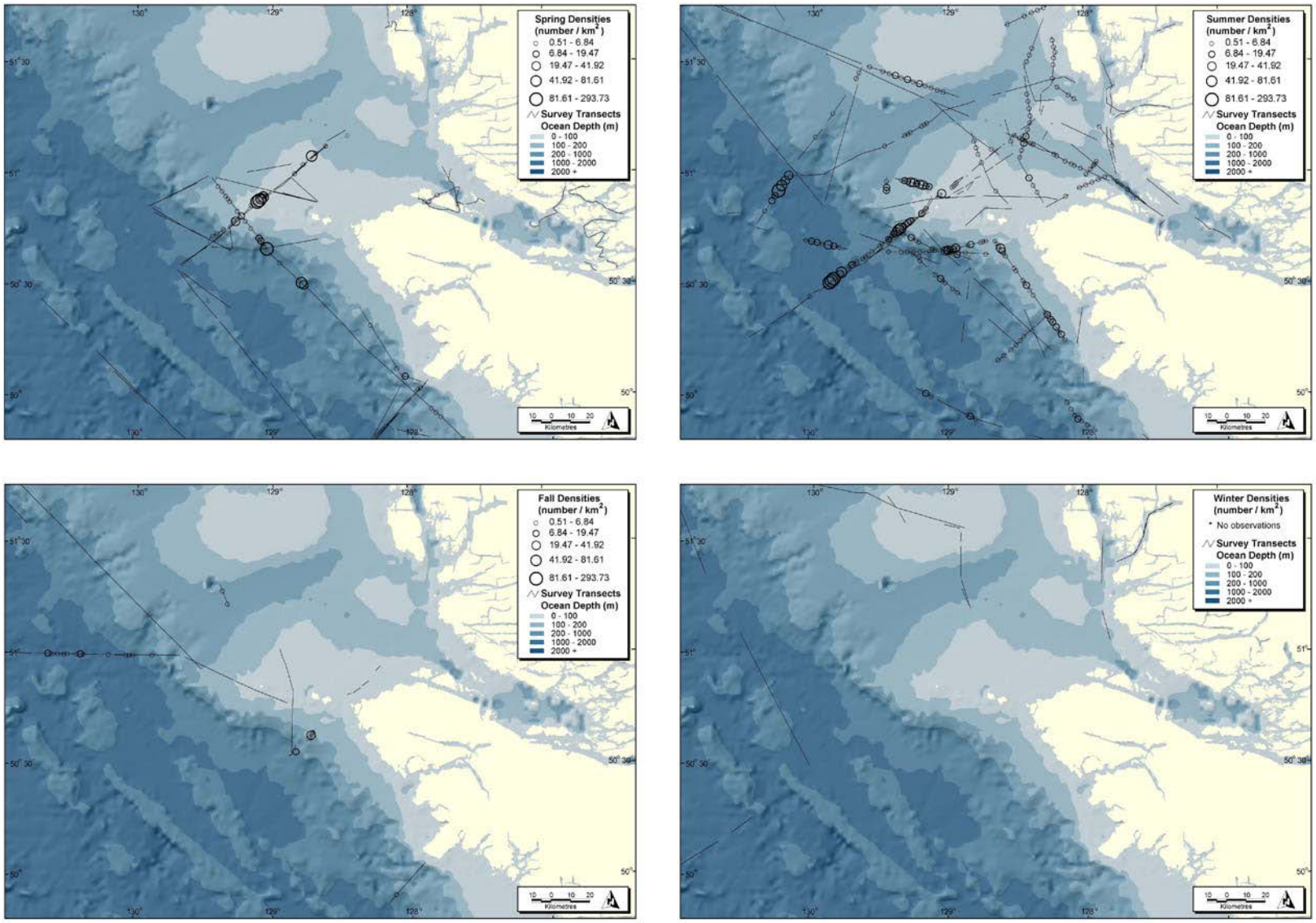

Figure 11. Cassin's Auklet seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

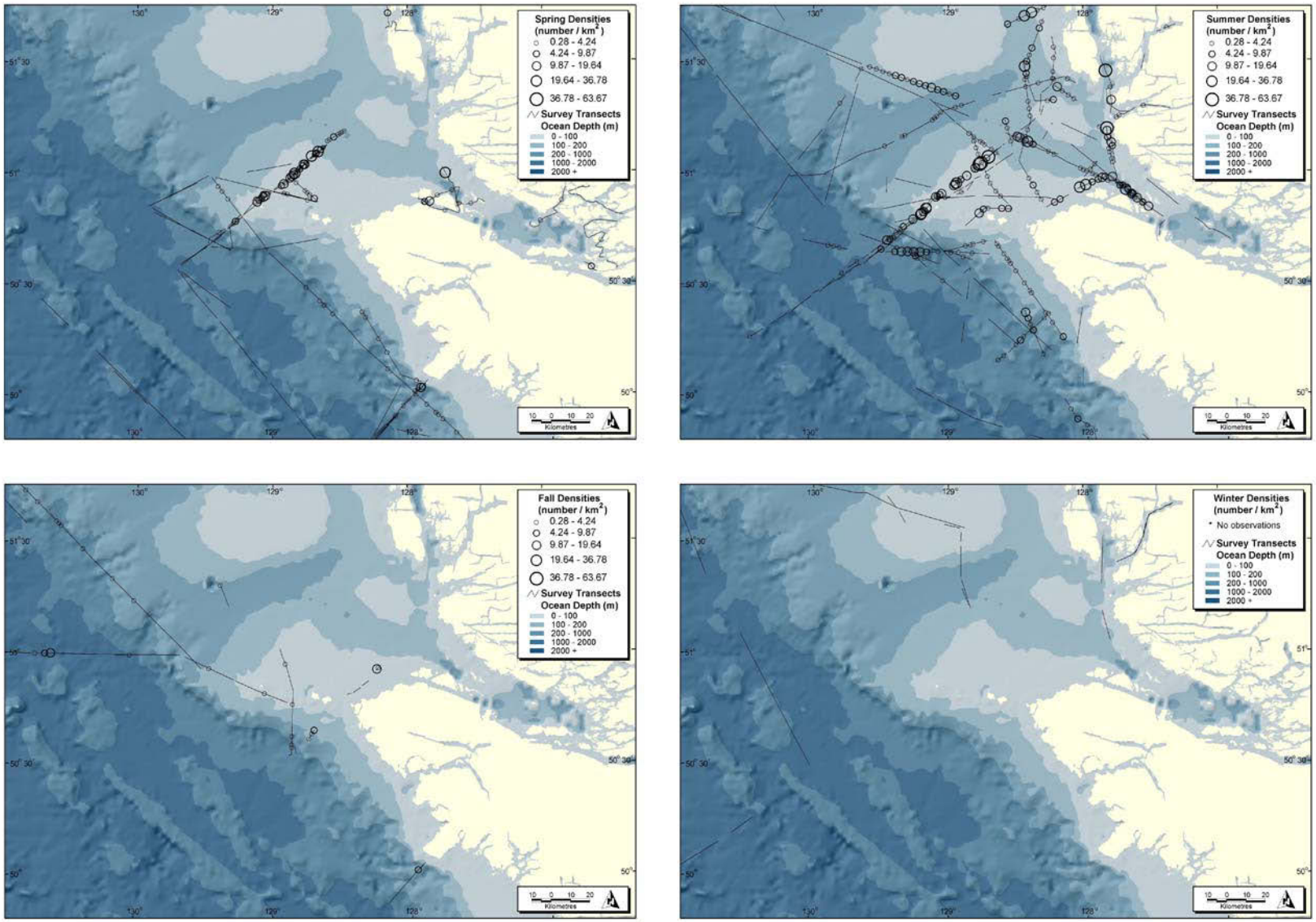

Figure 12. Rhinoceros Auklet seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

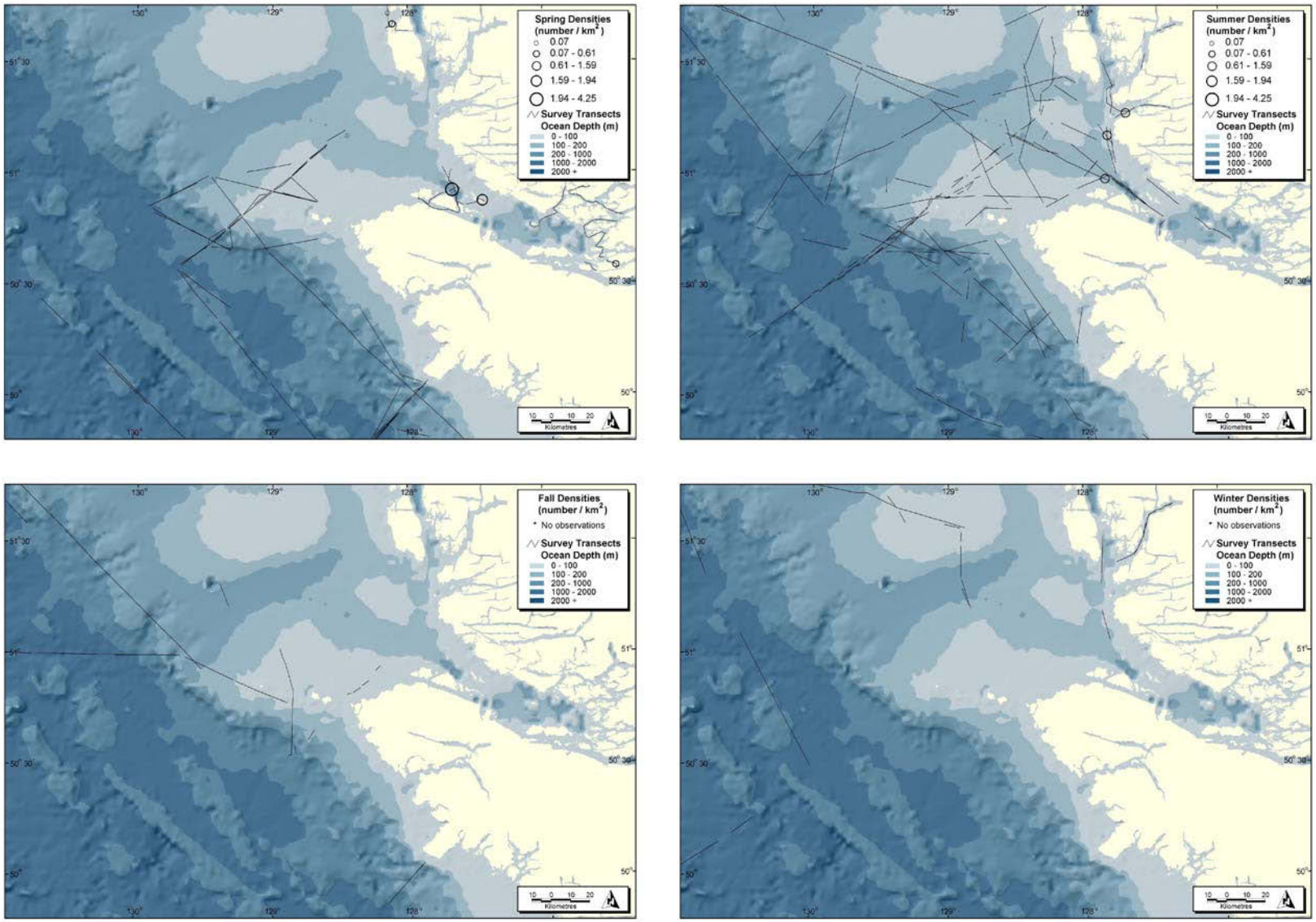

Figure 13. Pelagic Cormorant seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

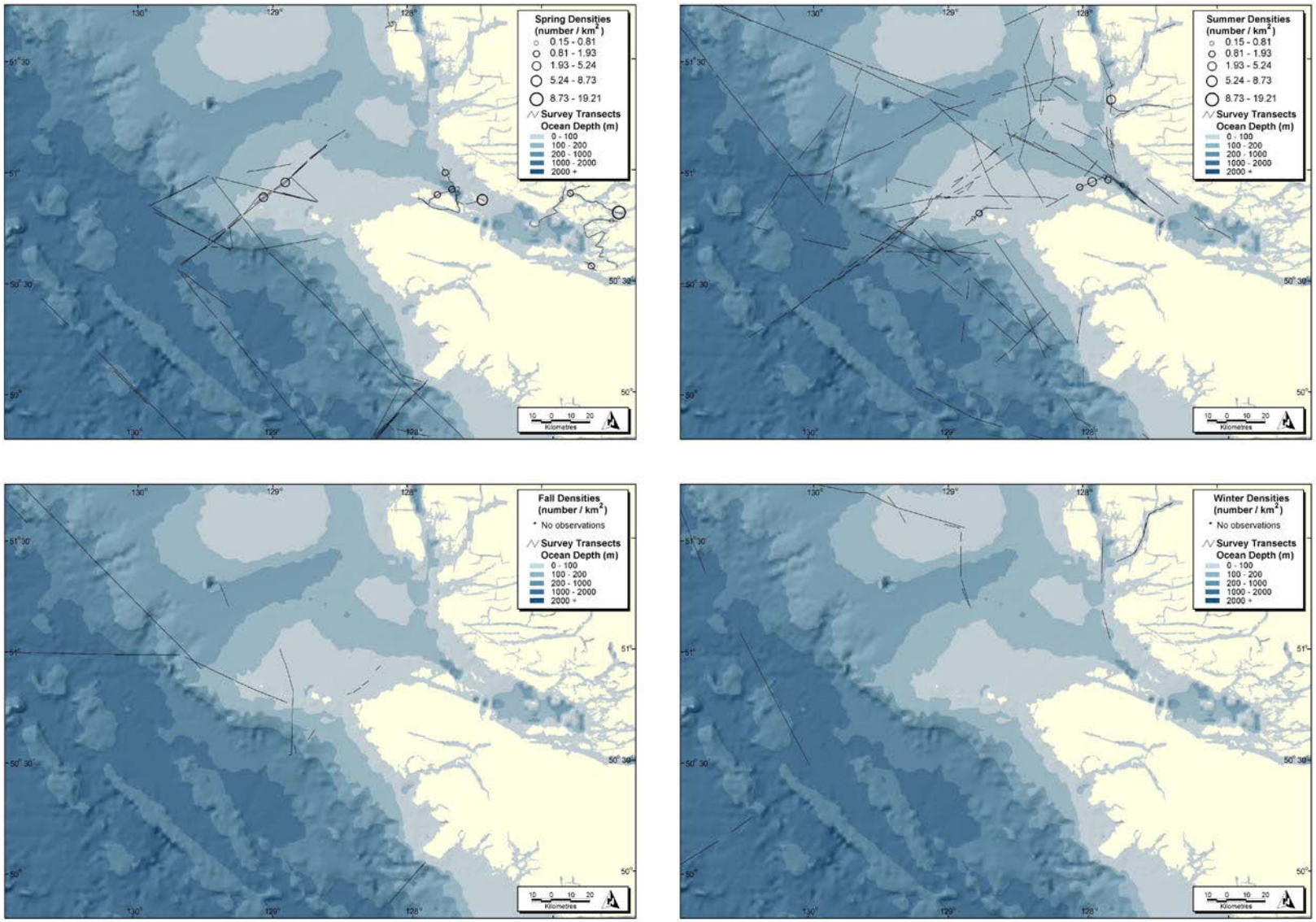

Figure 14. Pigeon Guillemot seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

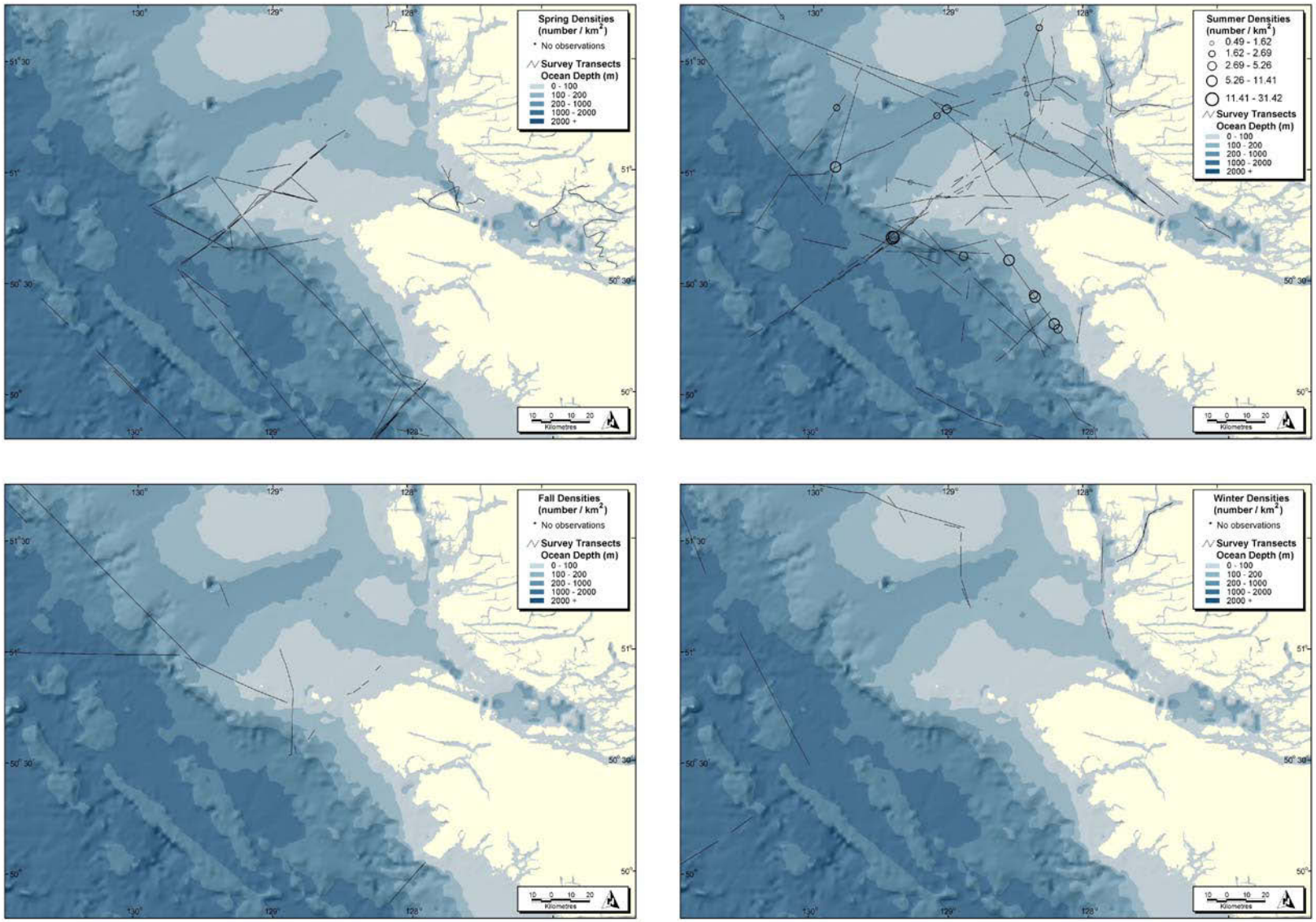

Figure 15. Ancient Murrelet seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

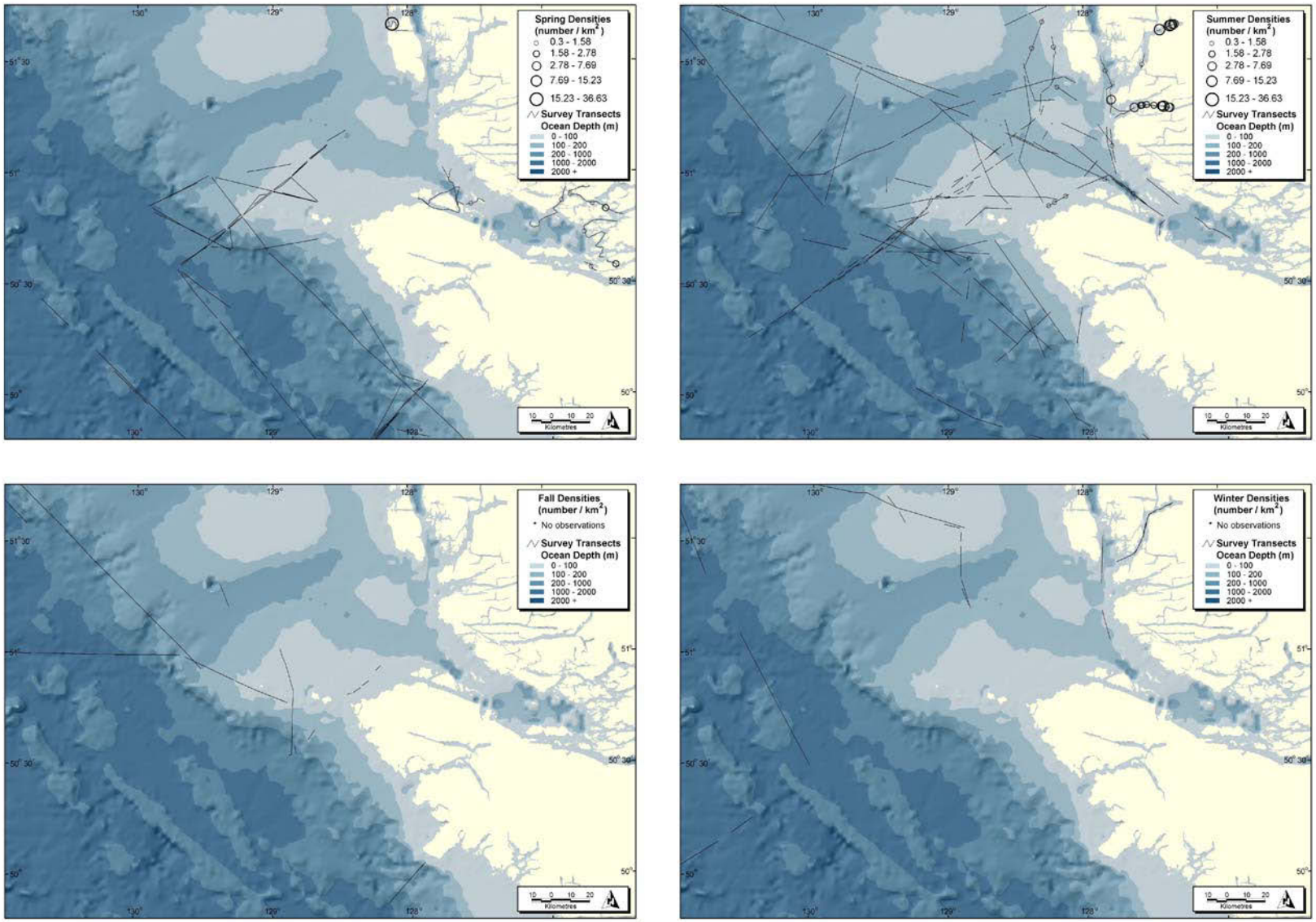

Figure 16. Marbled Murrelet seasonal distribution and densities in the Scott Islands marine area, 1981-2001.

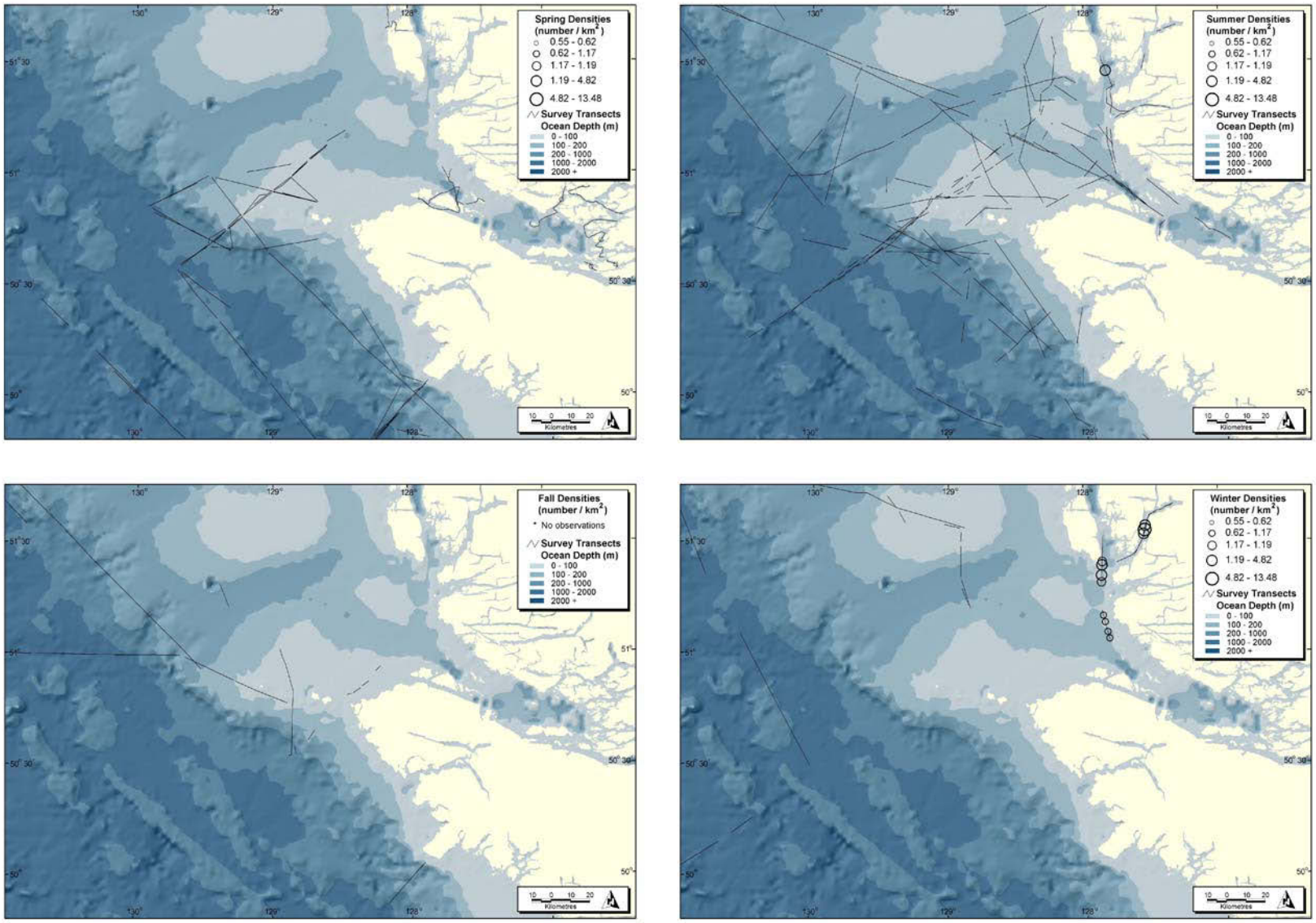

Figure 17. Mew Gull seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

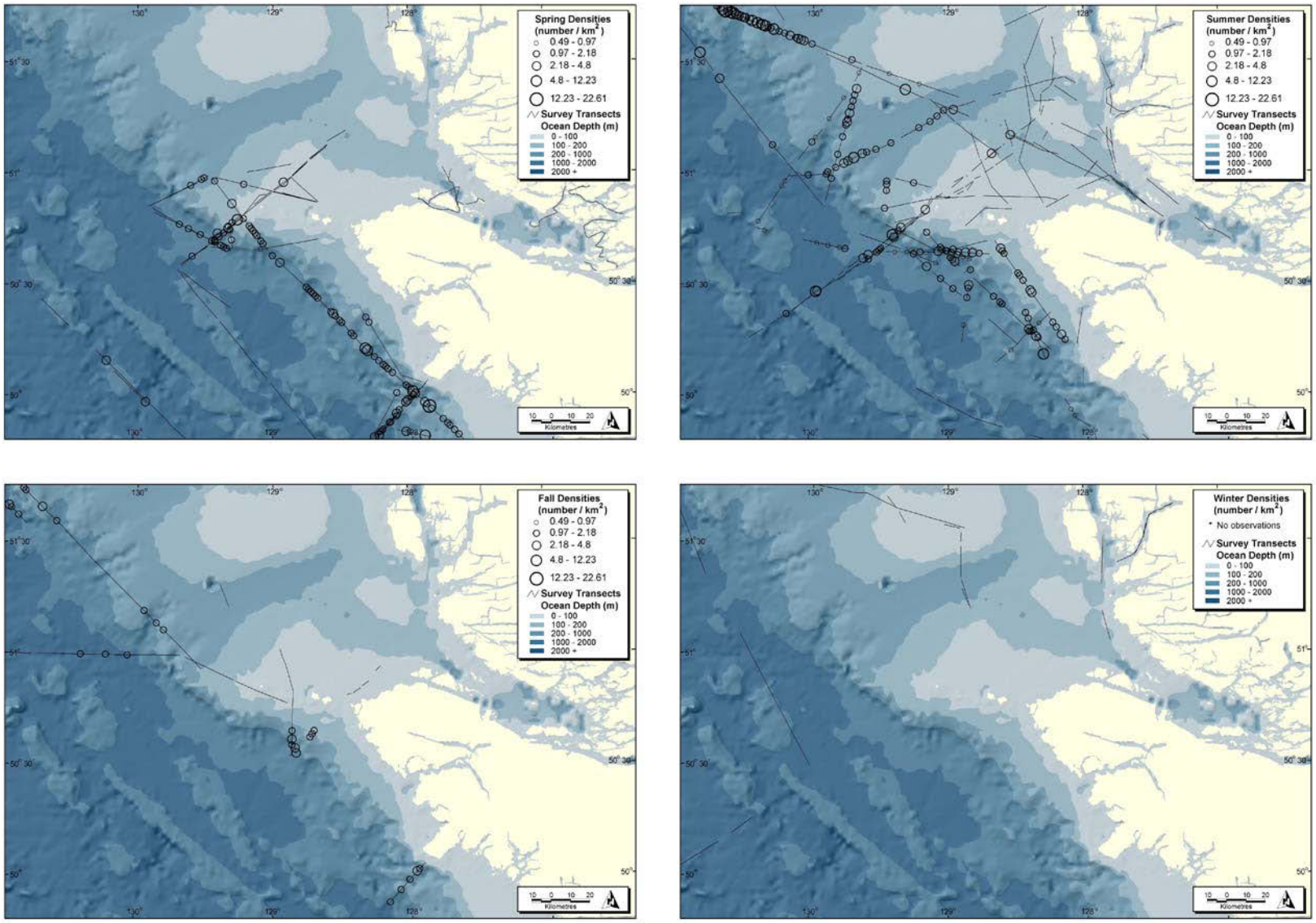

Figure 18. Black-footed Albatross seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

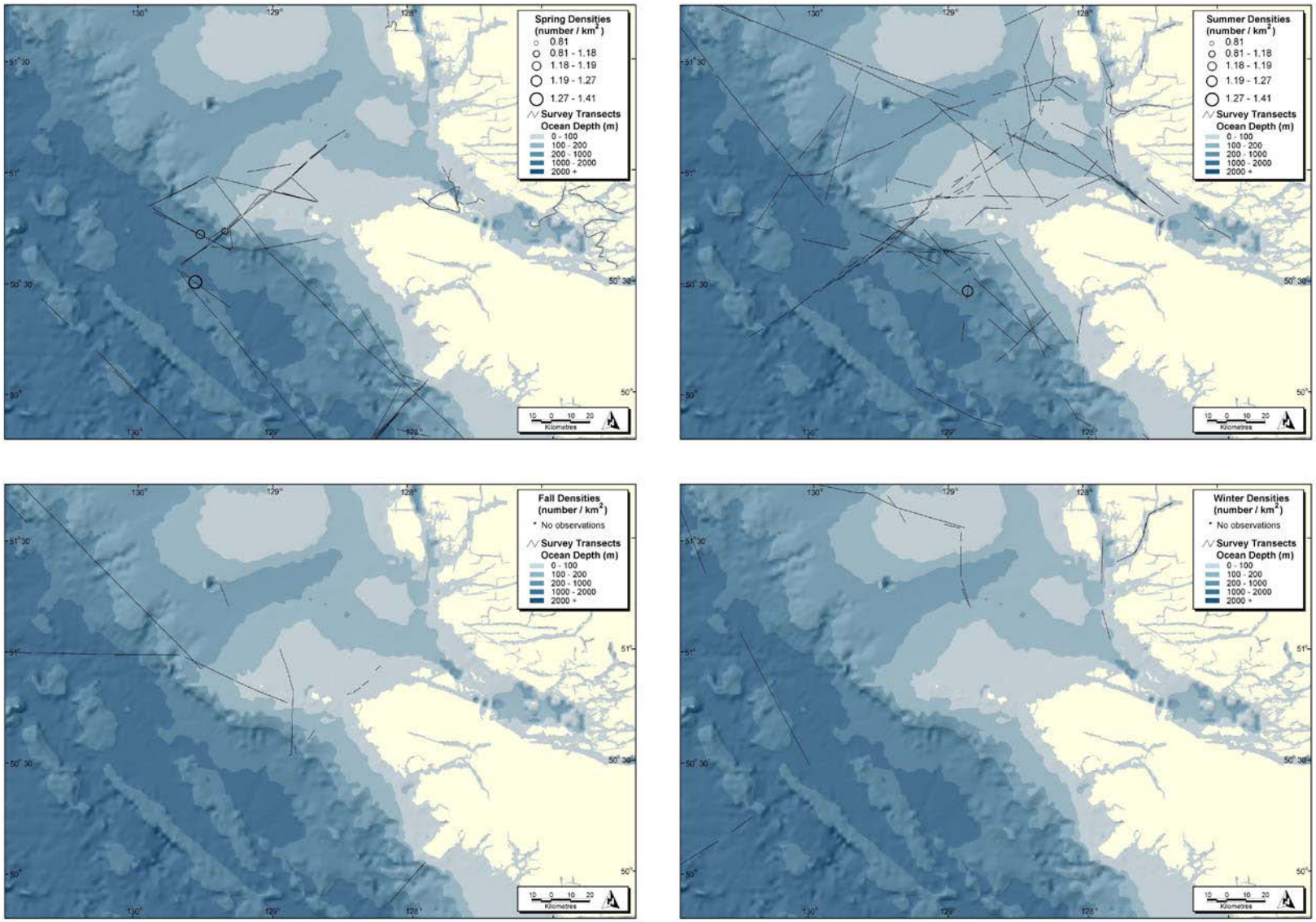

Figure 19. Laysan Albatross seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

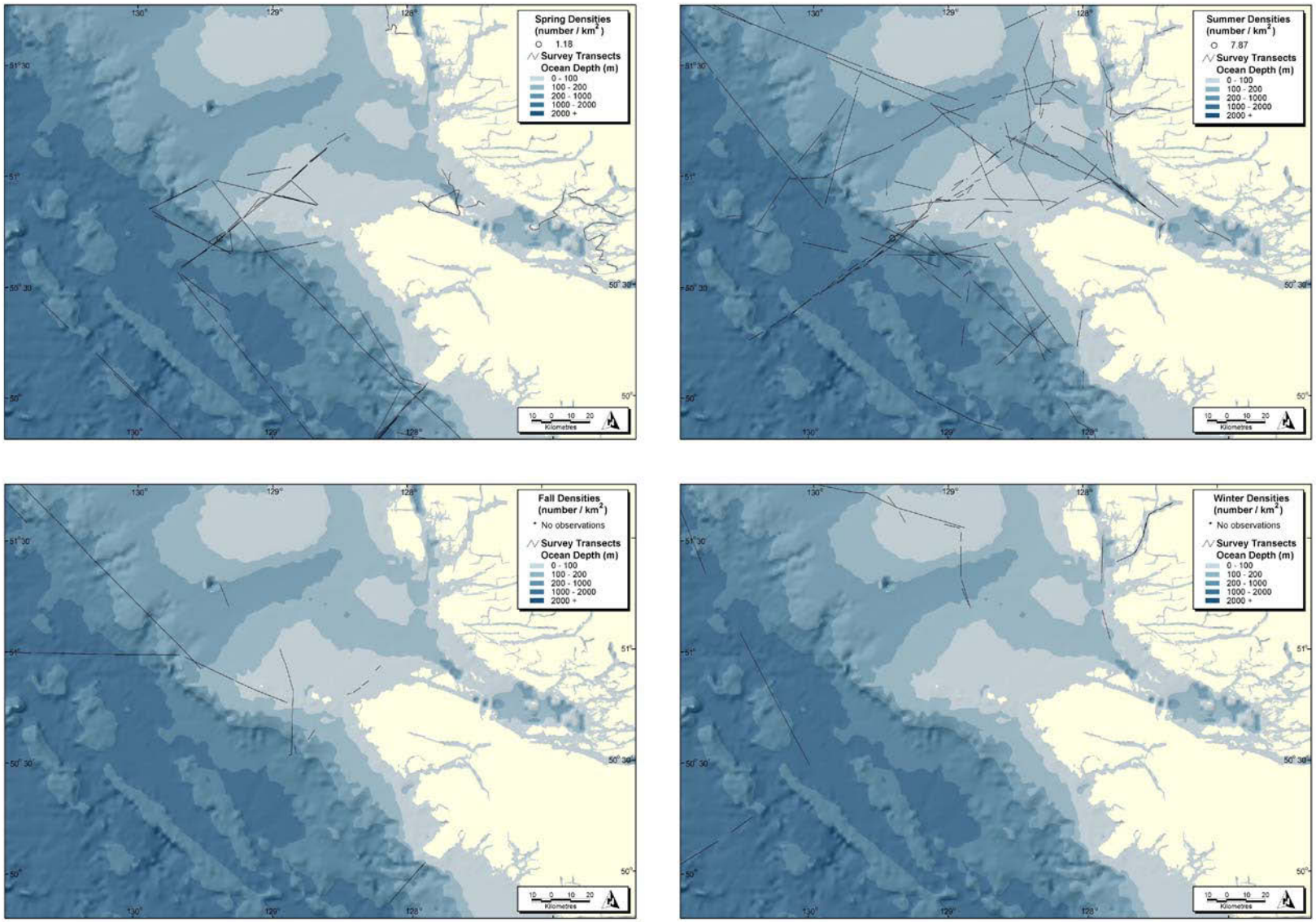

Figure 20. Short-tailed Albatross seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

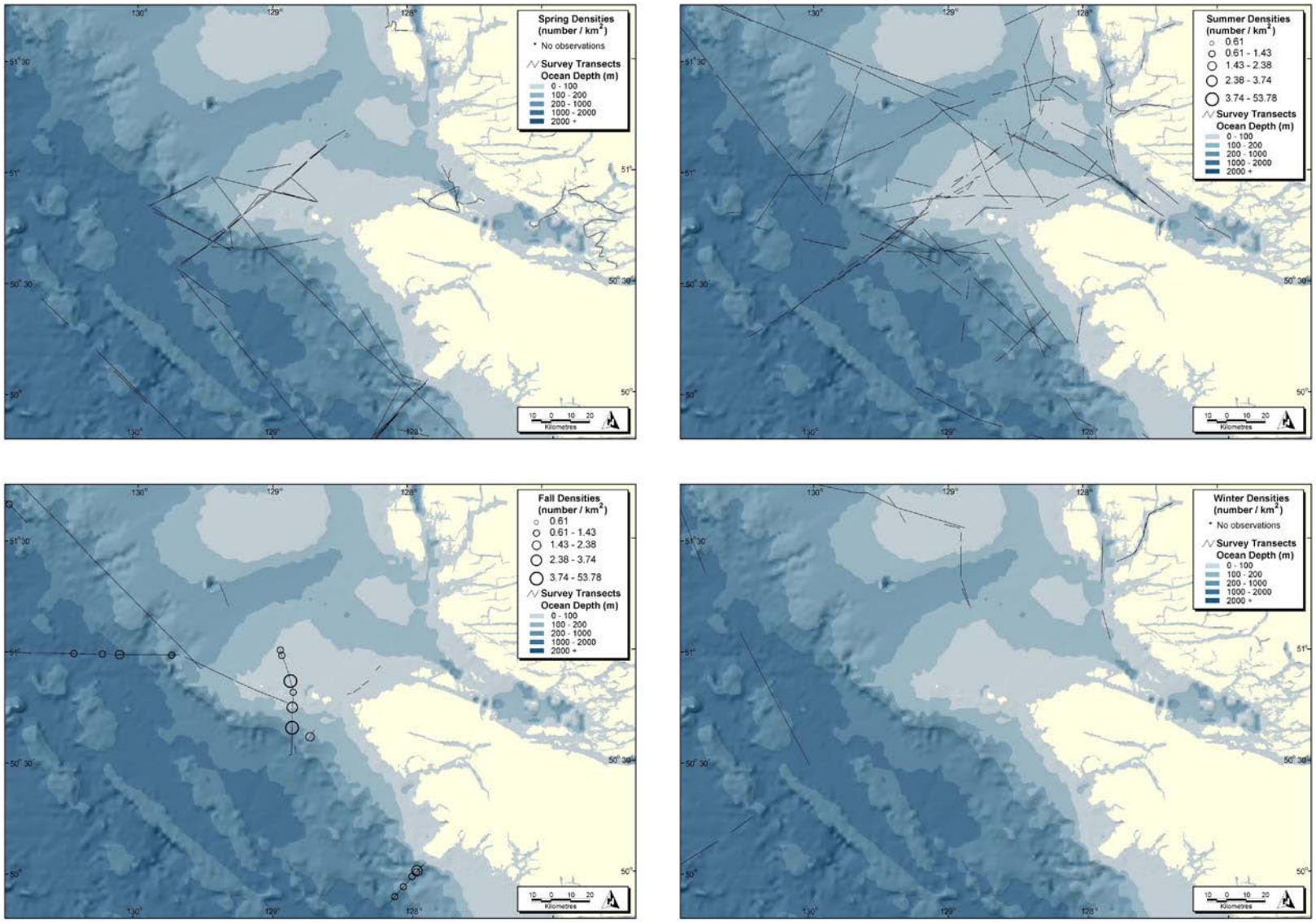

Figure 21. Buller's Shearwater seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

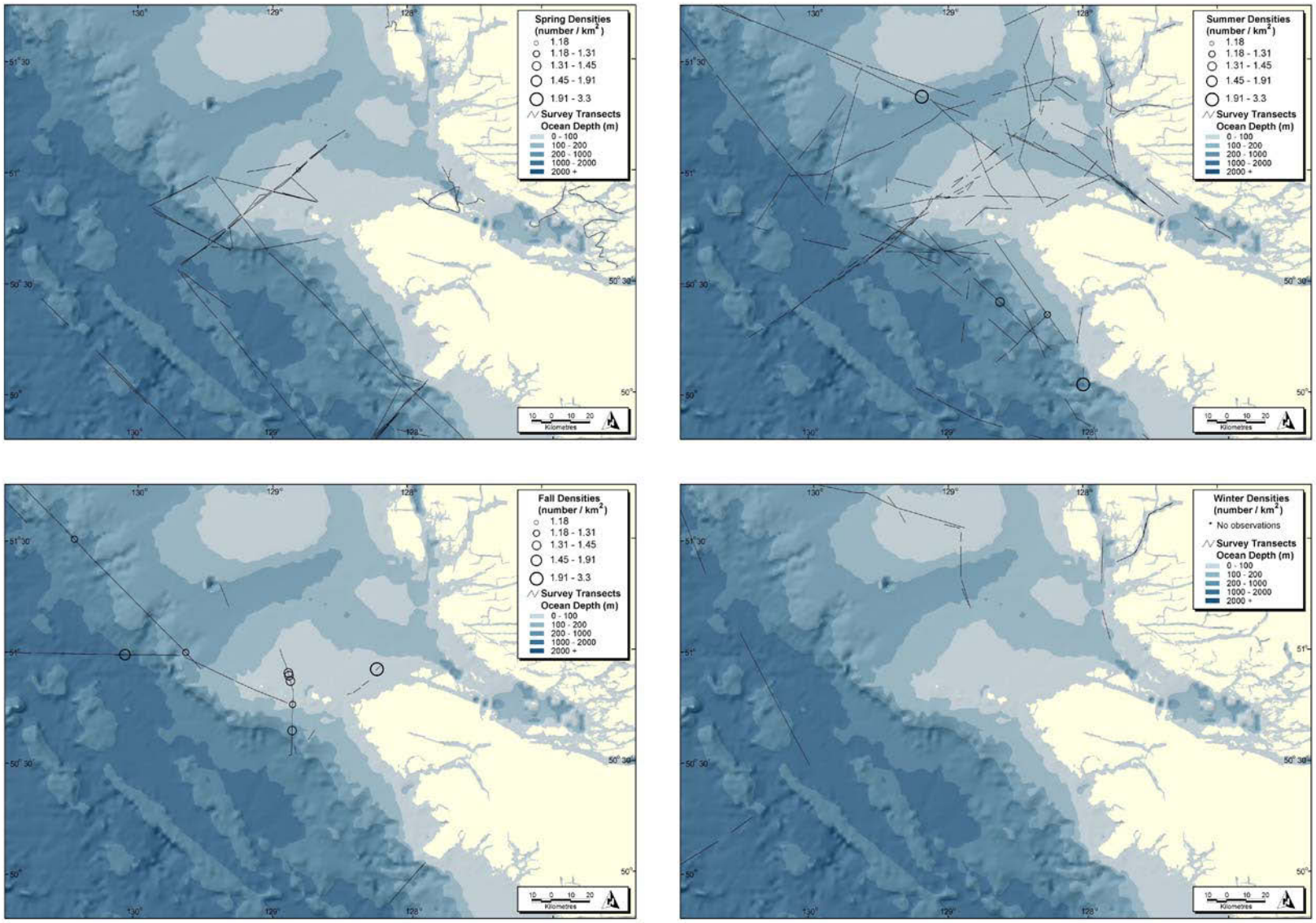

Figure 22. Pink-footed Shearwater seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

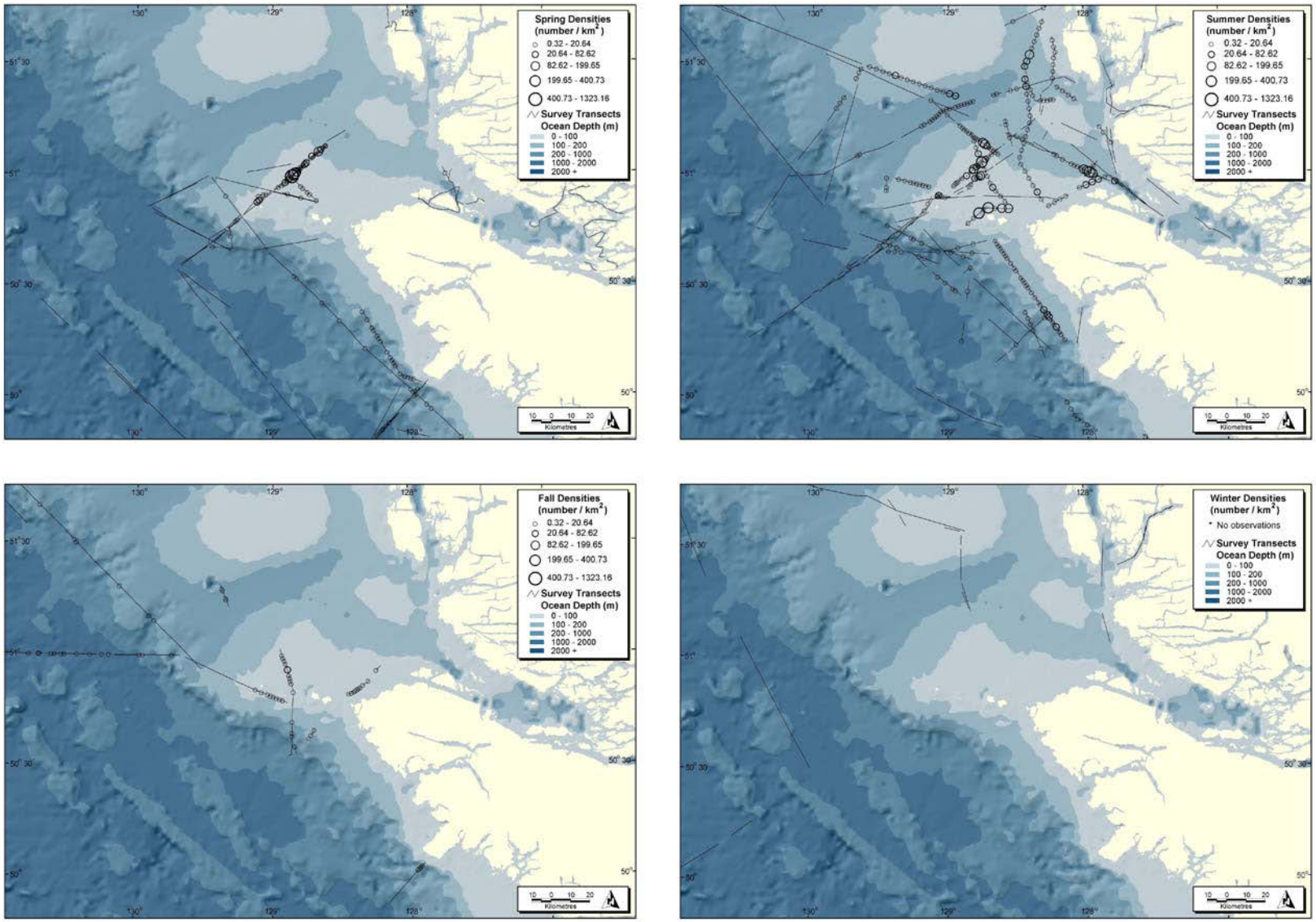

Figure 23. Sooty Shearwater seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

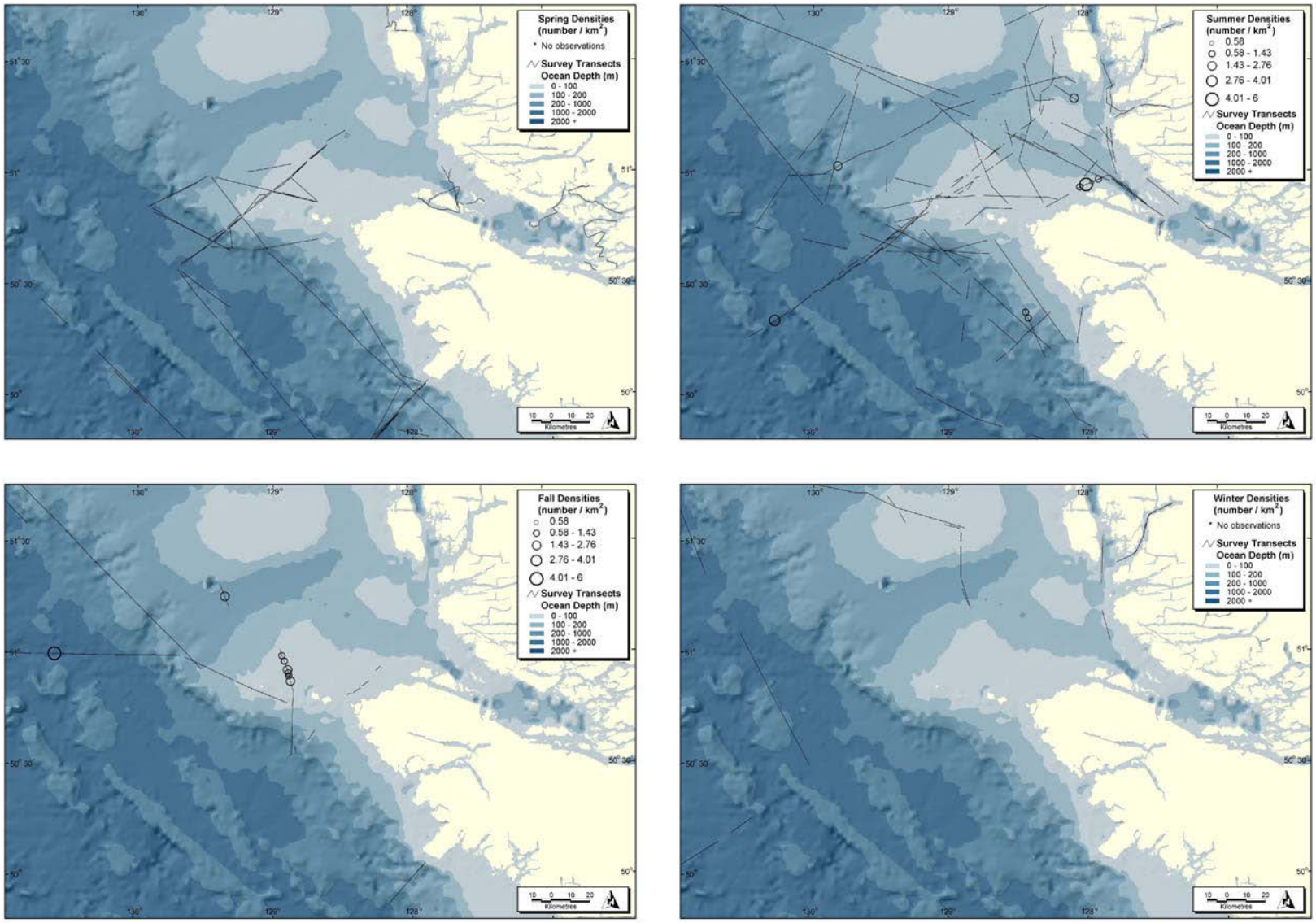

Figure 24. Short-tailed Shearwater seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

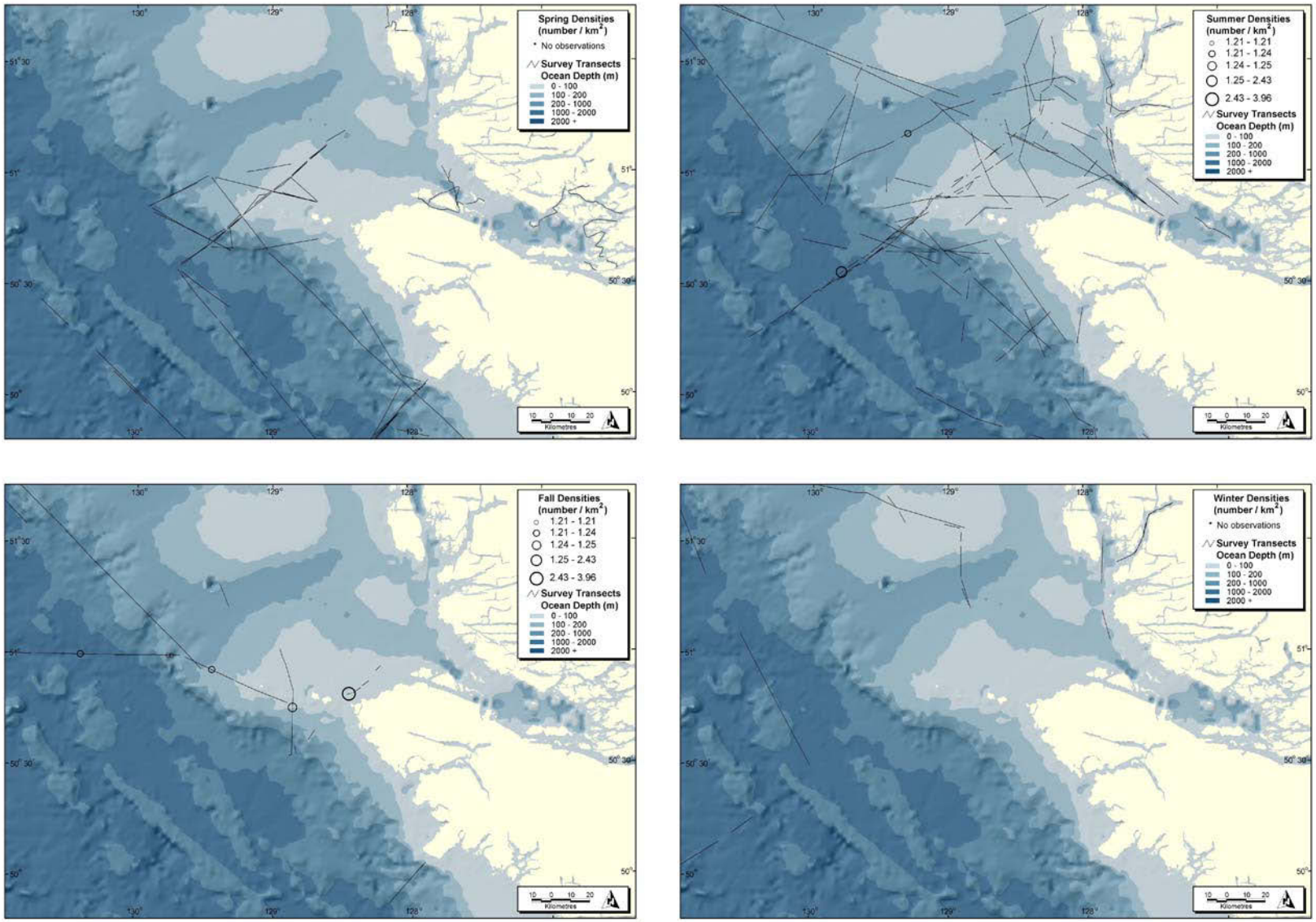

Figure 25. South Polar Skua seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

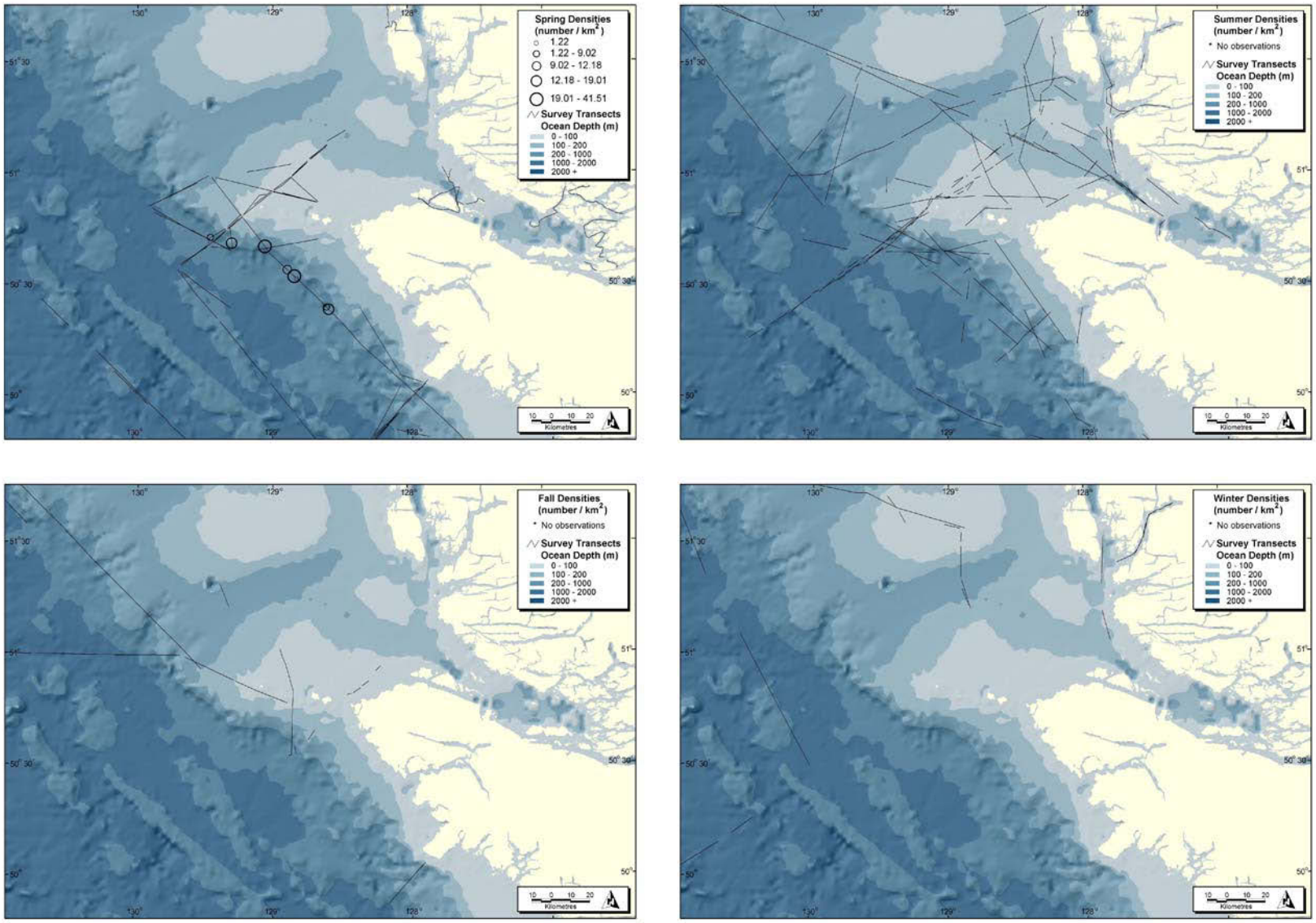

Figure 26. Red Phalarope seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

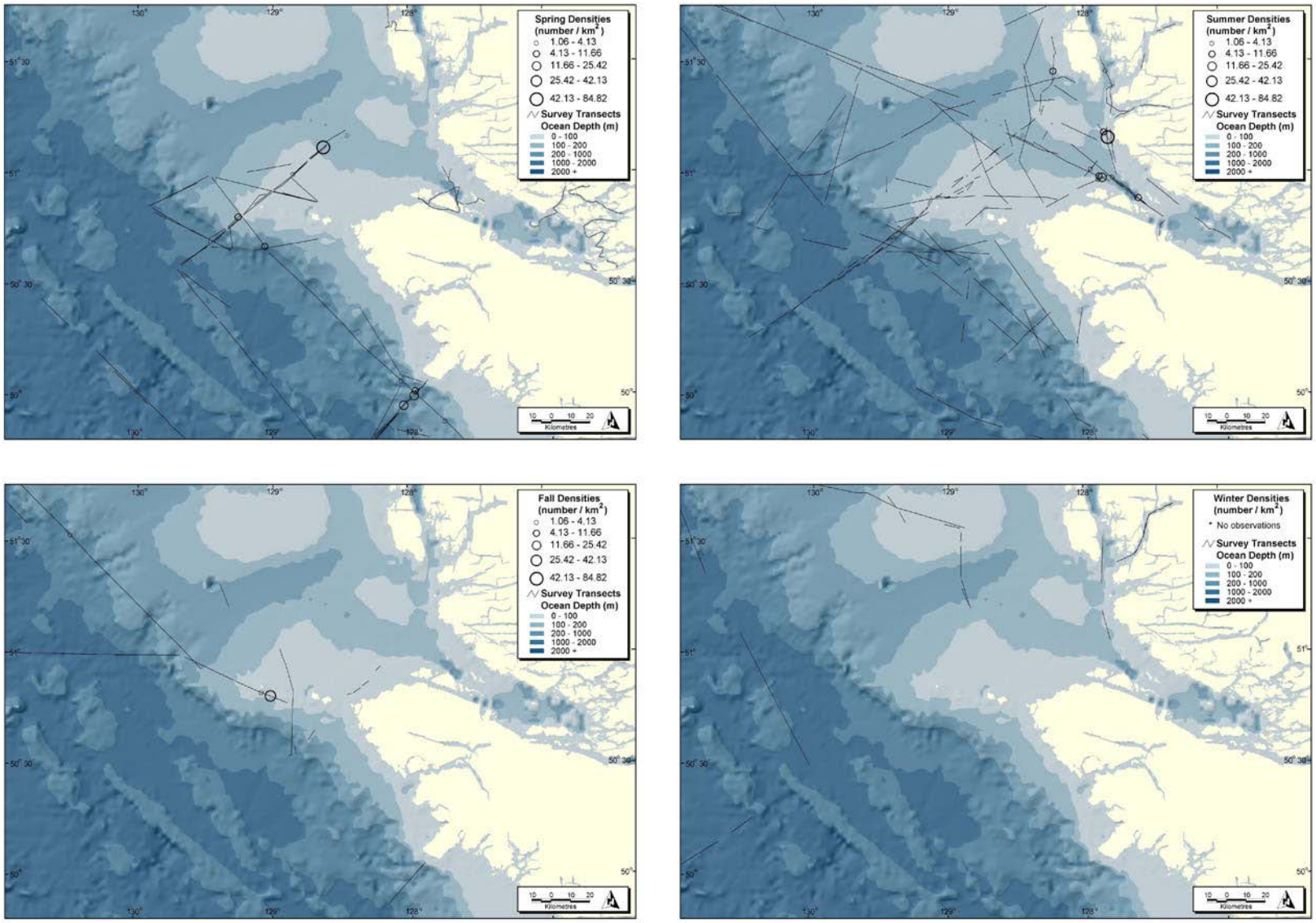

Figure 27. Red-necked Phalarope seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

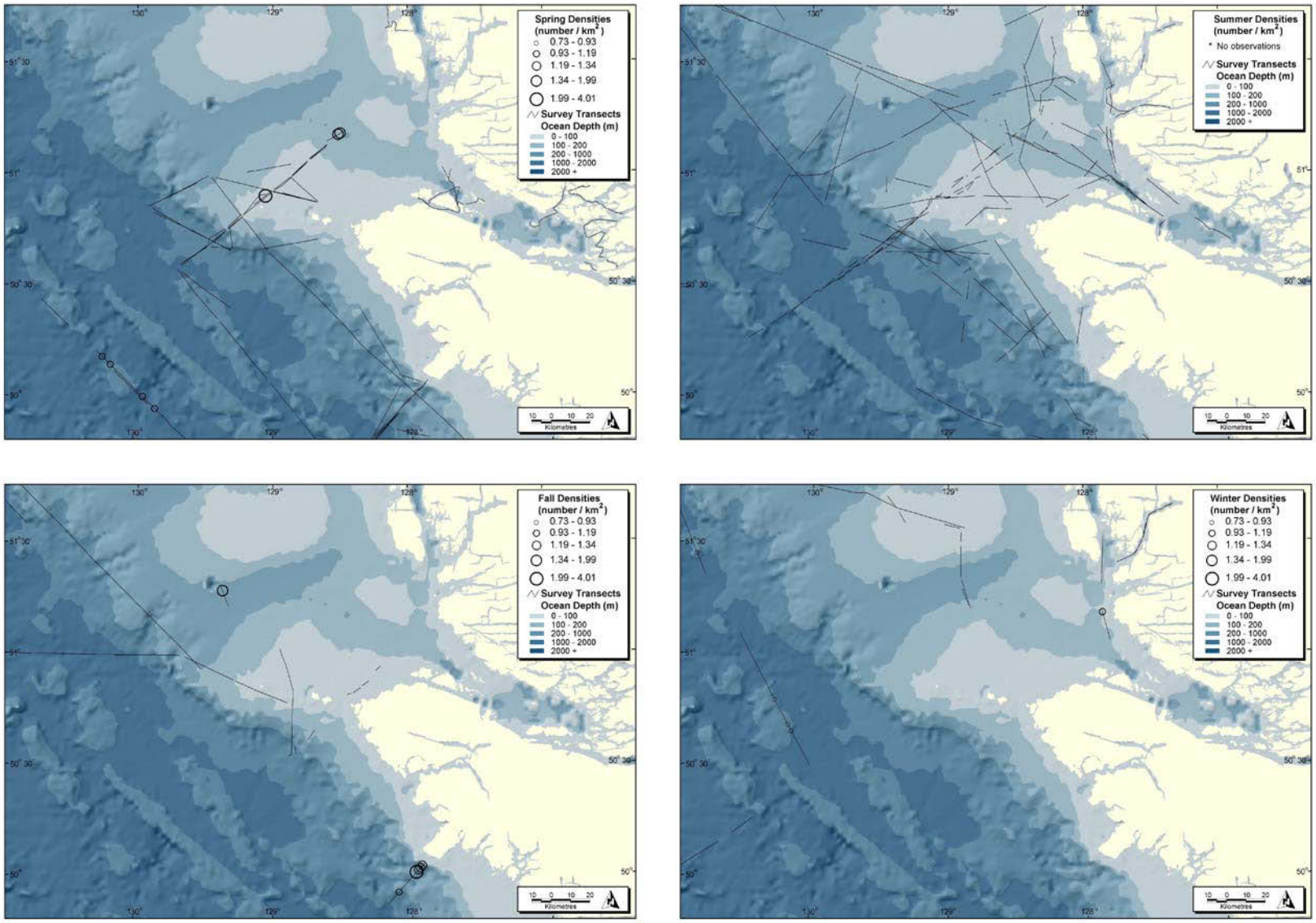

Figure 28. Black-legged Kittiwake seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

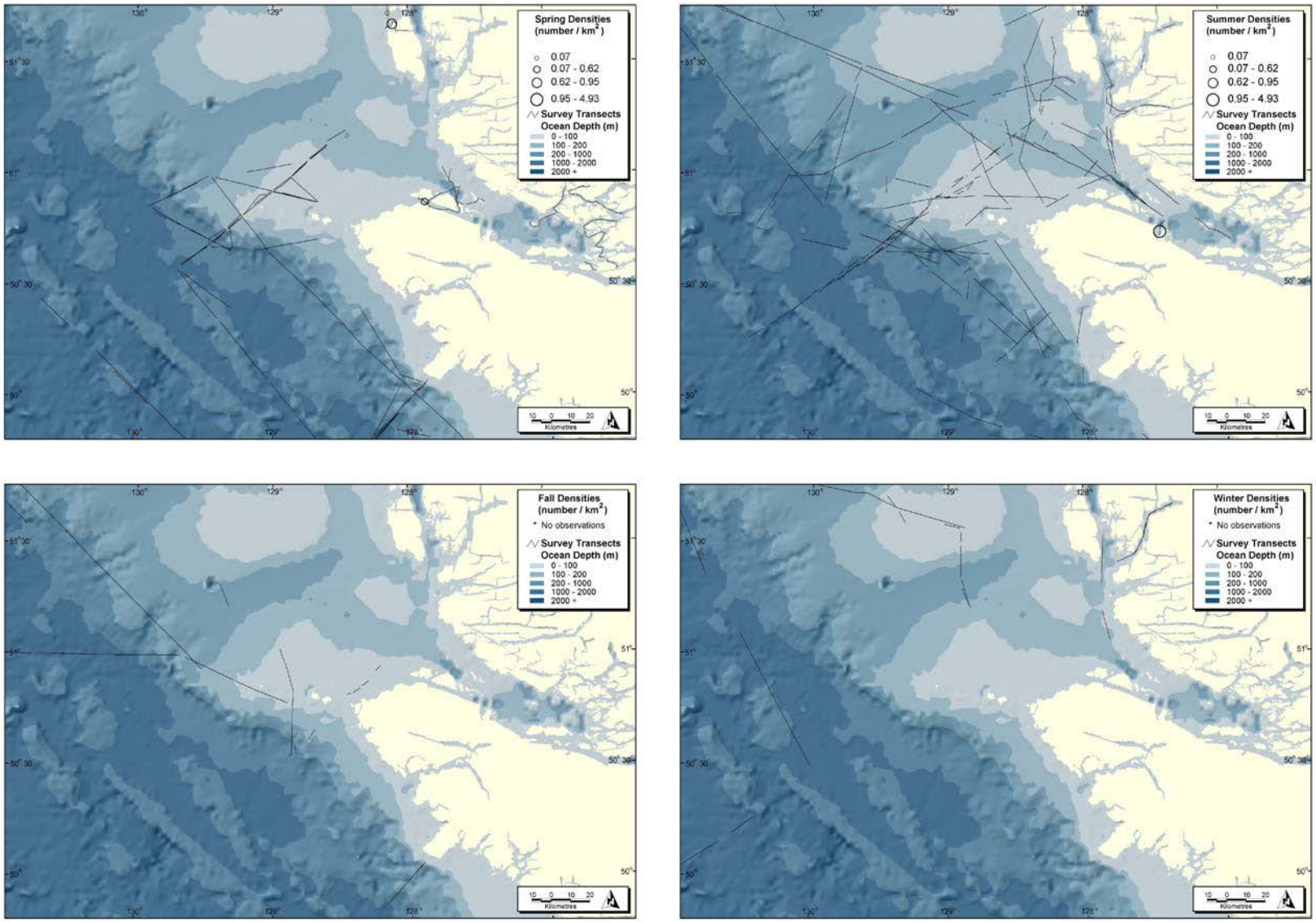

Figure 29. Common Loon seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

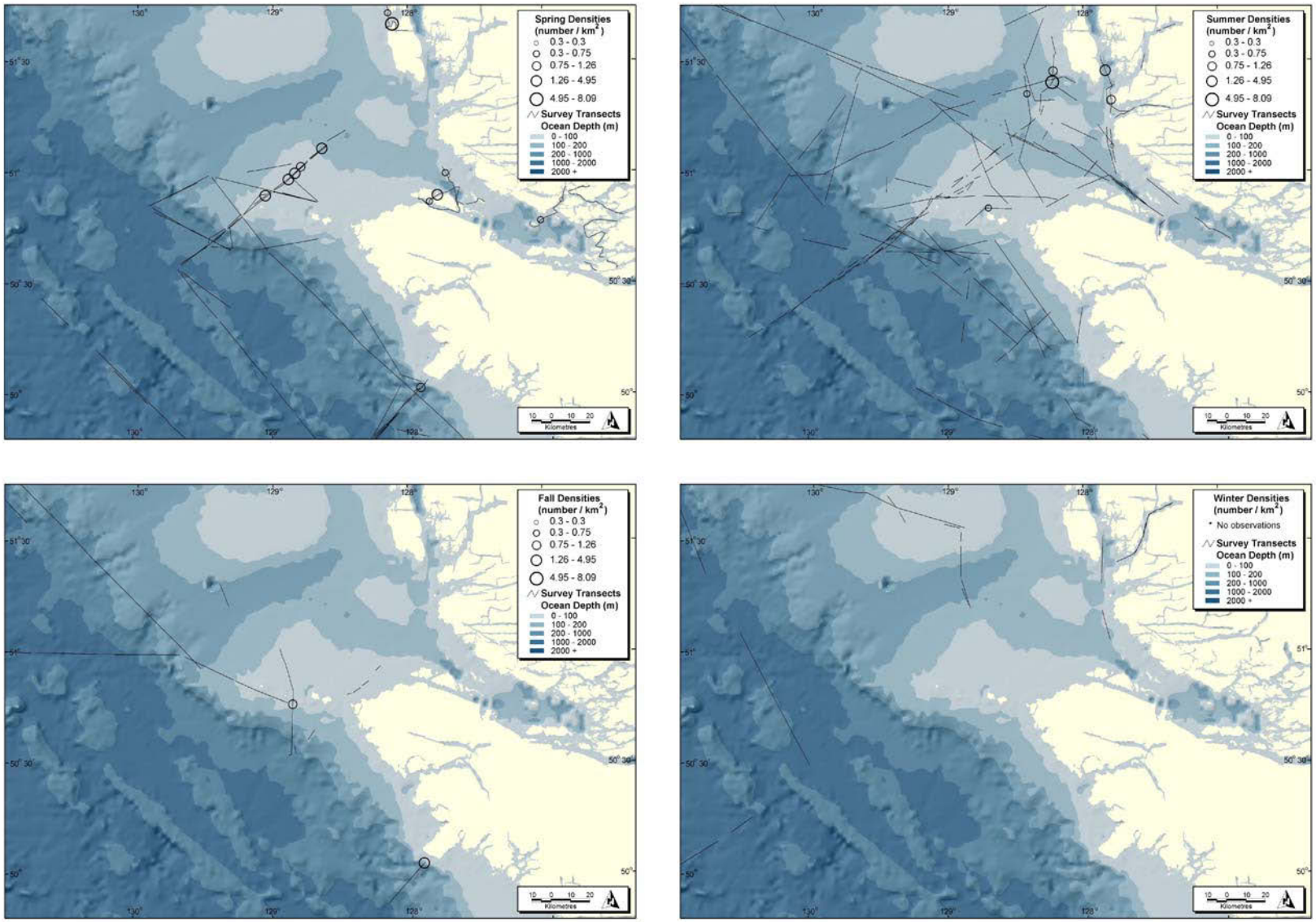

Figure 30. Pacific Loon seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

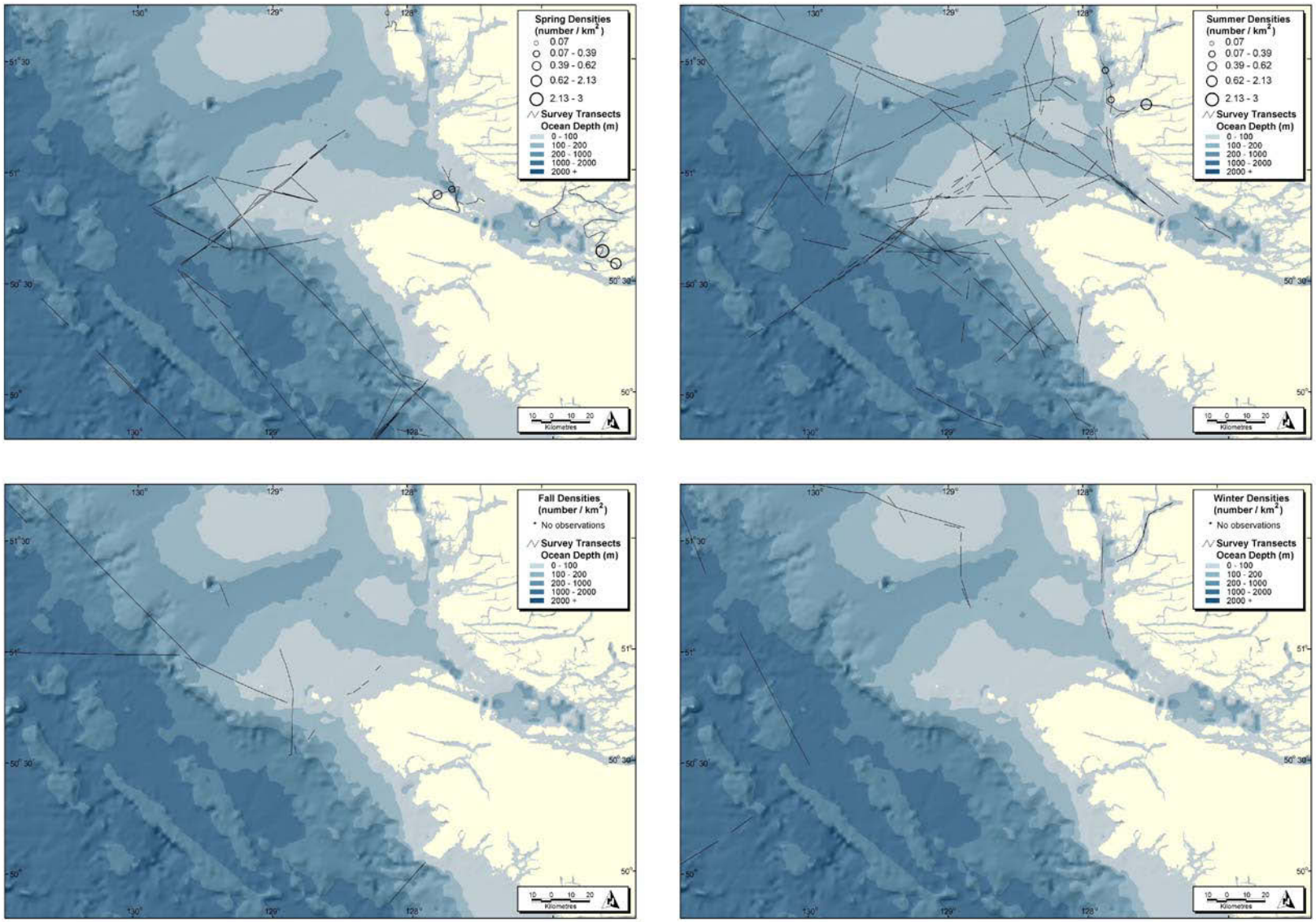

Figure 31. Double-crested Cormorant seasonal distribution and densities in the Scott Island marine area, 1981 – 2001.

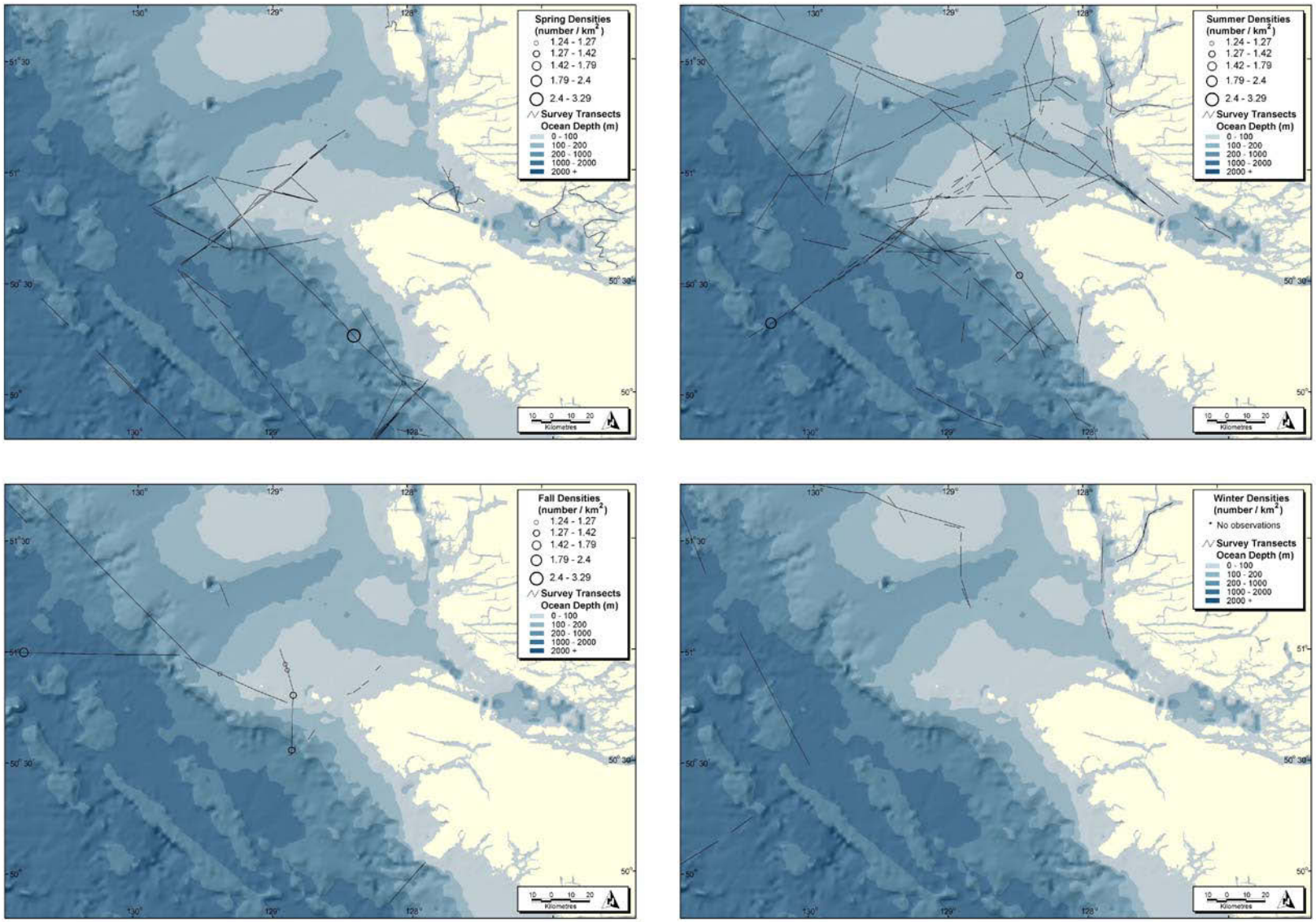

Figure 32. Pomarine Jaeger seasonal distribution and densities in the Scott Islands marine area, 1981 – 2001.

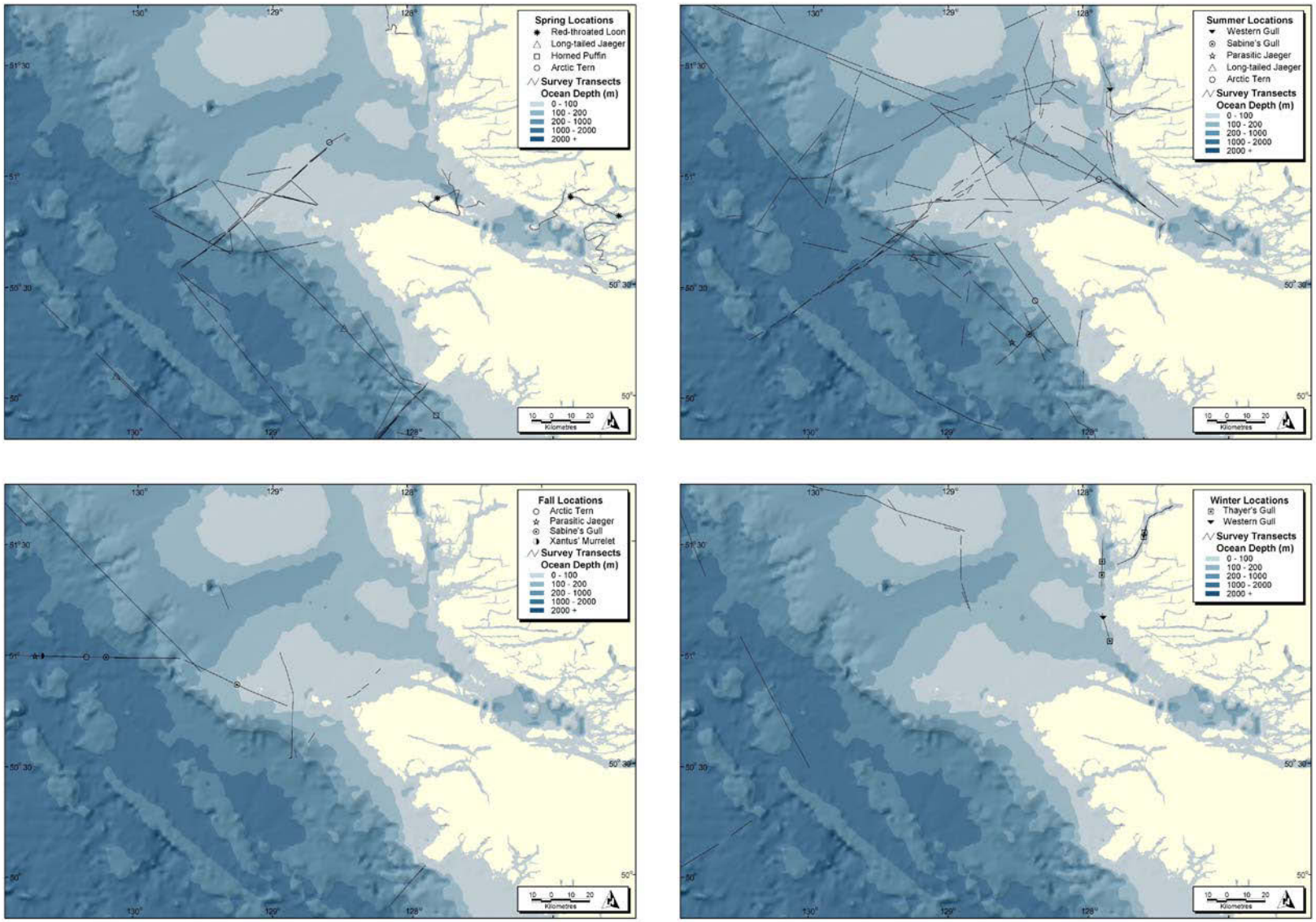

Figure 33. Locations of Red-throated Loon, Sabine's Gull, Thayer's Gull, Western Gull, Arctic Tern, Long-tailed Jaeger, Parasitic Jaeger, Xantus' Murrelet and Horned Puffin observed in the Scott Islands marine area, 1981 – 2001.

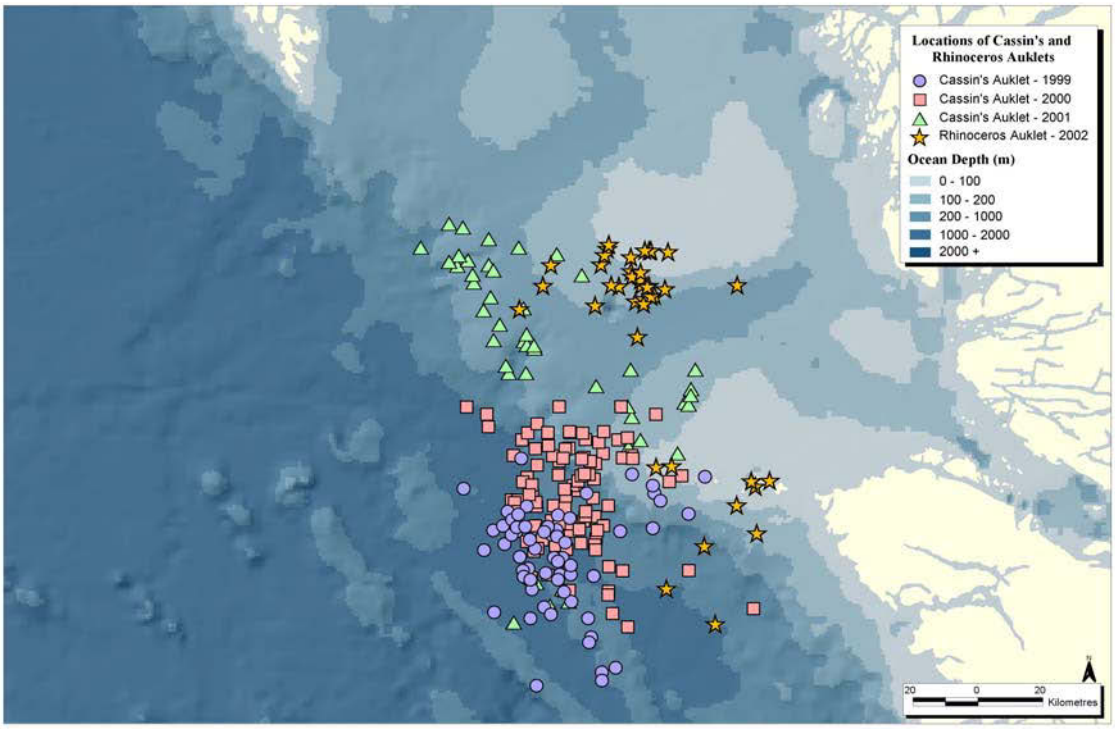

Figure 34. Cassin's and Rhinoceros Auklet locations from Triangle Island telemetry study, 1999-2002 (J. Ryder and M. Hipfner, pers. comm.)

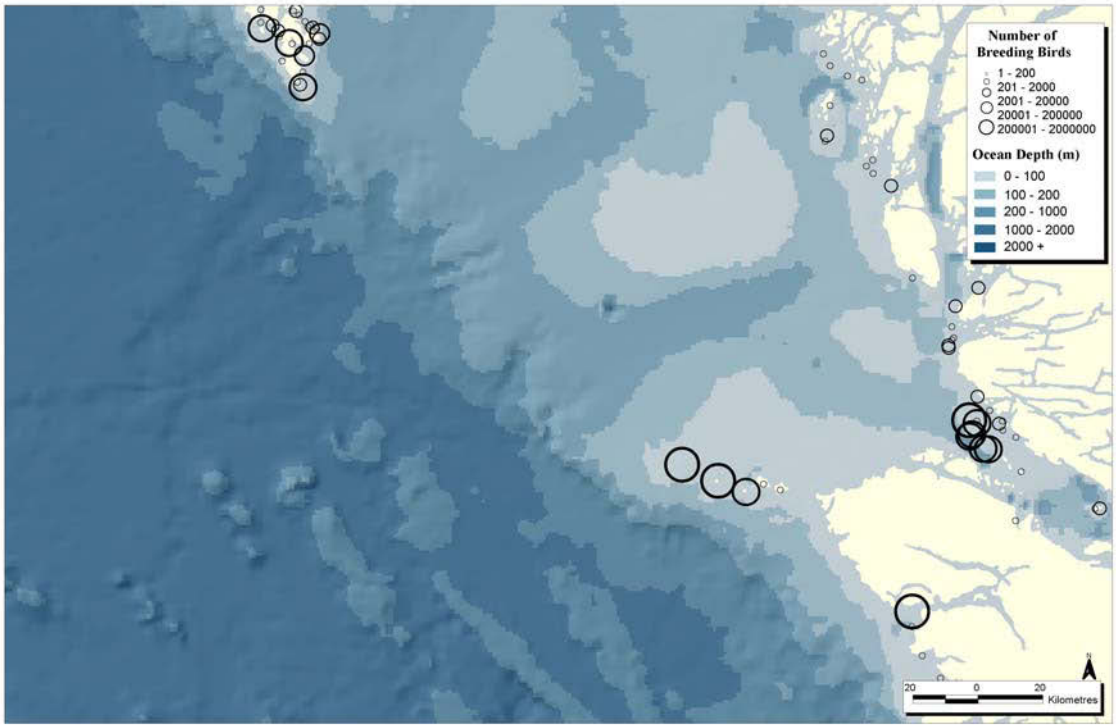

Figure 35. Locations of seabird colonies whose breeders potentially use the Scott Island marine area (CWS, 2001, and references therein). Please note that only those colonies, which have a breeding population of >101 are labelled with the colony name.

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