



THE PRESENCE OF MAMMALS AND BIRDS ALONG THE NORTHEASTERN COAST OF TIERRA DEL FUEGO

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INTRODUCTION

At the request of Total Austral S.A., which exploits the Hydra and Cañadón Alfa oil/gas fields along the northeastern coasts of Tierra del Fuego, Argentina, we carried out studies to assess the presence of birds and mammals along these coasts during the different seasons of the year. These base-line studies were designed to evaluate the species inhabiting the area, their abundance, seasonality, indexes of mortality on beaches, and to define the areas and species most at risk in the event of an oil spill or other coastal disaster.

The study area, from Cabo Espíritu Santo (CES) to Cabo San Sebastián (CSS), Tierra del Fuego (TF), (52° 40' S, 53° 20' S; 68° 10' W; 68° 40' W), is located in the southwestern South Atlantic off the eastern entrance to the Strait of Magellan, an area with a wide continental shelf, conflicting tidal and ocean currents, undersea banks and mounts. All of these combine to produce mixing of waters, bringing up nutrients for phyto- and zooplankton, the basis of all oceanic life.

This beach area covers a diversity of habitats (high cliffs washed by the sea at each tide; sand, gravel and stone beaches; a long, narrow peninsula formed of uniformly sized stones; extensive mudflats with tidal channels; river mouths; barrier beaches; tidal inlets; wide, gently sloping intertidal areas) which can support a diversity of species. It is an important and unique area because of its special geology and the number of species which live there or use it as a transit zone. Also important are the quantity of shipping and of off-shore wells in the eastern Strait of Magellan. Detailed descriptions of the geology, climate, human occupation, fishing and oil production are given by Goodall, Schiavini and Galussio (1991).

METHODS

The study began with a review of the available literature and of data from our own previous research in the area. We then carried out 16 individual studies during four non-consecutive seasons to document the species and abundance of mammals and birds, their mortality, and the sanitary state of the beach areas. The surveys were from the uppermost part of the beach to an offshore depth of about 20 m. The area was divided into subzones based on types of coastline (Fig. 1).

The studies were carried out by: a) surveying the coastline from shore using a Honda all-terrain-cycle; and b) helicopter, flying at about 200 ft (70 m) altitude and 200 m from the coast. Due to the saturated mud flats, the western part of Bahía San Sebastián (BSS) could be surveyed from shore only from November to February, and then only during times of moderate tides or when it had not rained. The tidal flats are up to nine kms in width and even when fairly dry, one cannot reach the tide line where birds feed. During most of the year, BSS can be surveyed only by

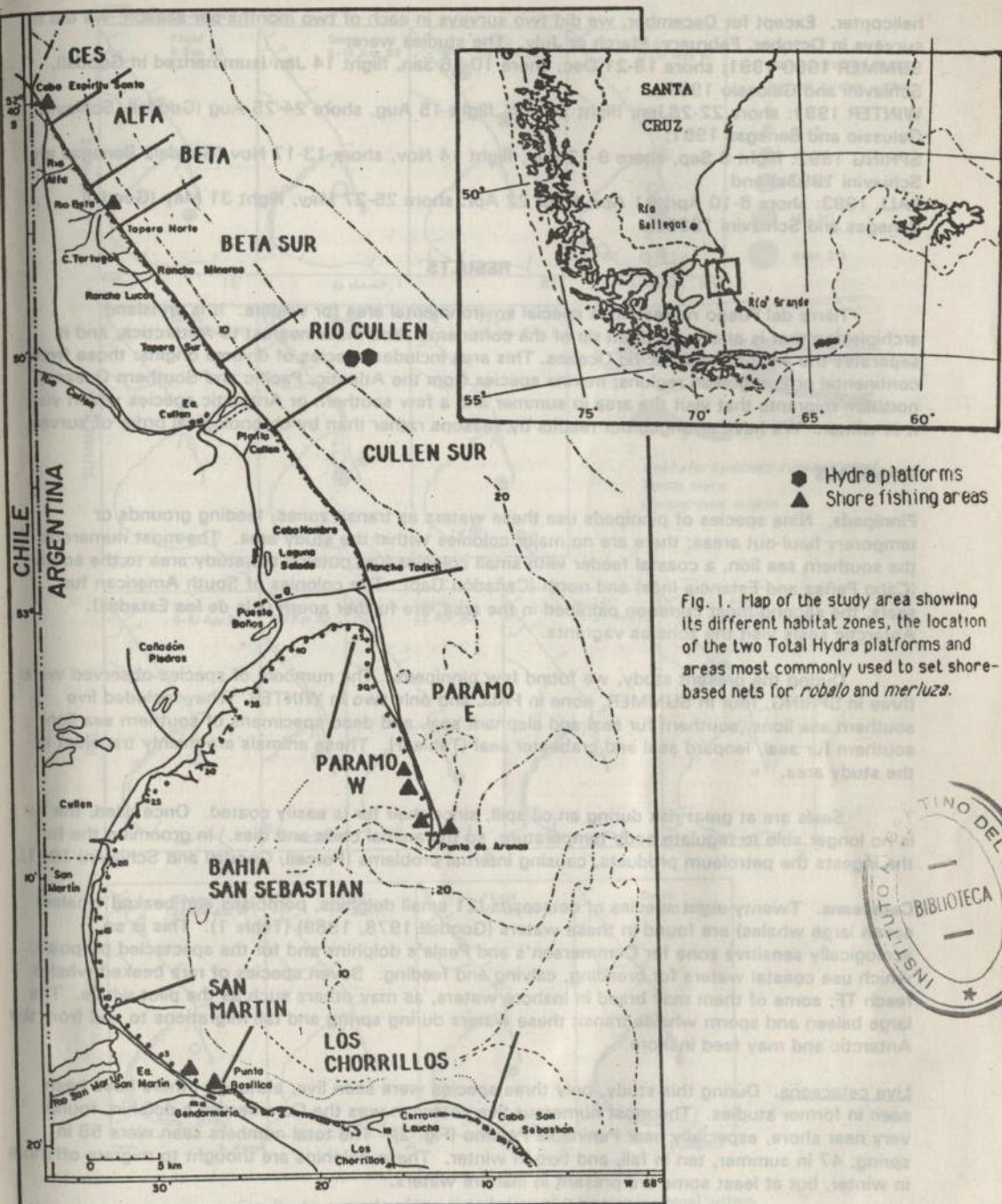


Fig. 1. Map of the study area showing its different habitat zones, the location of the two Total Hydra platforms and areas most commonly used to set shore-based nets for *robalo* and *merluza*.



helicopter. Except for December, we did two surveys in each of two months per season; we did no surveys in October, February, March or July. The studies were:
SUMMER 1990-1991: shore 18-21 Dec, shore 10-16 Jan, flight 14 Jan (summarized in Goodall, Schiavini and Galussio 1991);
WINTER 1991: shore 22-26 Jun, flight 24 Jun, flight 15 Aug, shore 24-25 Aug (Goodall, Schiavini, Galussio and Benegas 1991);
SPRING 1992: flight 9 Sep, shore 9-12 Sep, flight 14 Nov, shore 13-17 Nov (Goodall, Benegas and Schiavini 1993a) and
FALL 1993: shore 8-10 Apr, 21 Apr, flight 22 Apr, shore 25-27 May, flight 31 May (Goodall, Benegas and Schiavini 1993b).

RESULTS

Tierra del Fuego represents a special environmental area for wildlife. It is an island archipelago that is at the southern tip of the continental land mass nearest to Antarctica, and it separates the Atlantic and Pacific Oceans. This area includes species of diverse origins: those from continental or Patagonian regions; marine species from the Atlantic, Pacific and Southern Oceans; northern migrants that visit the area in summer and a few southern or Antarctic species which visit it in winter. We have arranged our results by seasons rather than by chronological order of survey.

MAMMALS

Pinnipeds. Nine species of pinnipeds use these waters as transit zones, feeding grounds or temporary haul-out areas; there are no major colonies within the study area. The most numerous is the southern sea lion, a coastal feeder with small colonies just outside the study area to the south (Cabo Peñas and Estancia Inés) and north (Cañadón Gap). The colonies of South American fur seals, the second most common pinniped in the area, are further south (Isla de los Estados). Antarctic seals visit the zone as vagrants.

During the present study, we found few pinnipeds. The numbers of species observed were: three in SPRING, four in SUMMER, none in FALL and only two in WINTER. They included live southern sea lions, southern fur seal and elephant seal, and dead specimens of southern sea lion, southern fur seal, leopard seal and crabeater seal (Table 1). These animals are mainly transient in the study area.

Seals are at great risk during an oil spill, since their fur is easily coated. Once oiled, the fur is no longer able to regulate body temperature, so the animal chills and dies. In grooming the fur, the ingests the petroleum products, causing internal problems (Purcell, Goodall and Schiavini 1991).

Cetaceans. Twenty-eight species of cetaceans (21 small dolphins, porpoises and beaked whales, seven large whales) are found in these waters (Goodall 1978, 1989) (Table 1). This is an ecologically sensitive zone for Commerson's and Peale's dolphins and for the spectacled porpoise, which use coastal waters for breeding, calving and feeding. Seven species of rare beaked whales reach TF; some of them may breed in inshore waters, as may others such as the pilot whale. The large baleen and sperm whales transit these waters during spring and fall migrations to and from the Antarctic and may feed inshore.

Live cetaceans. During this study, only three species were seen live, although others have been seen in former studies. The most numerous live cetacean was the Commerson's dolphin, found very near shore, especially near Península Páramo (Fig. 2). The total numbers seen were 58 in spring, 47 in summer, ten in fall, and two in winter. These dolphins are thought to migrate offshore in winter, but at least some are present in inshore waters.

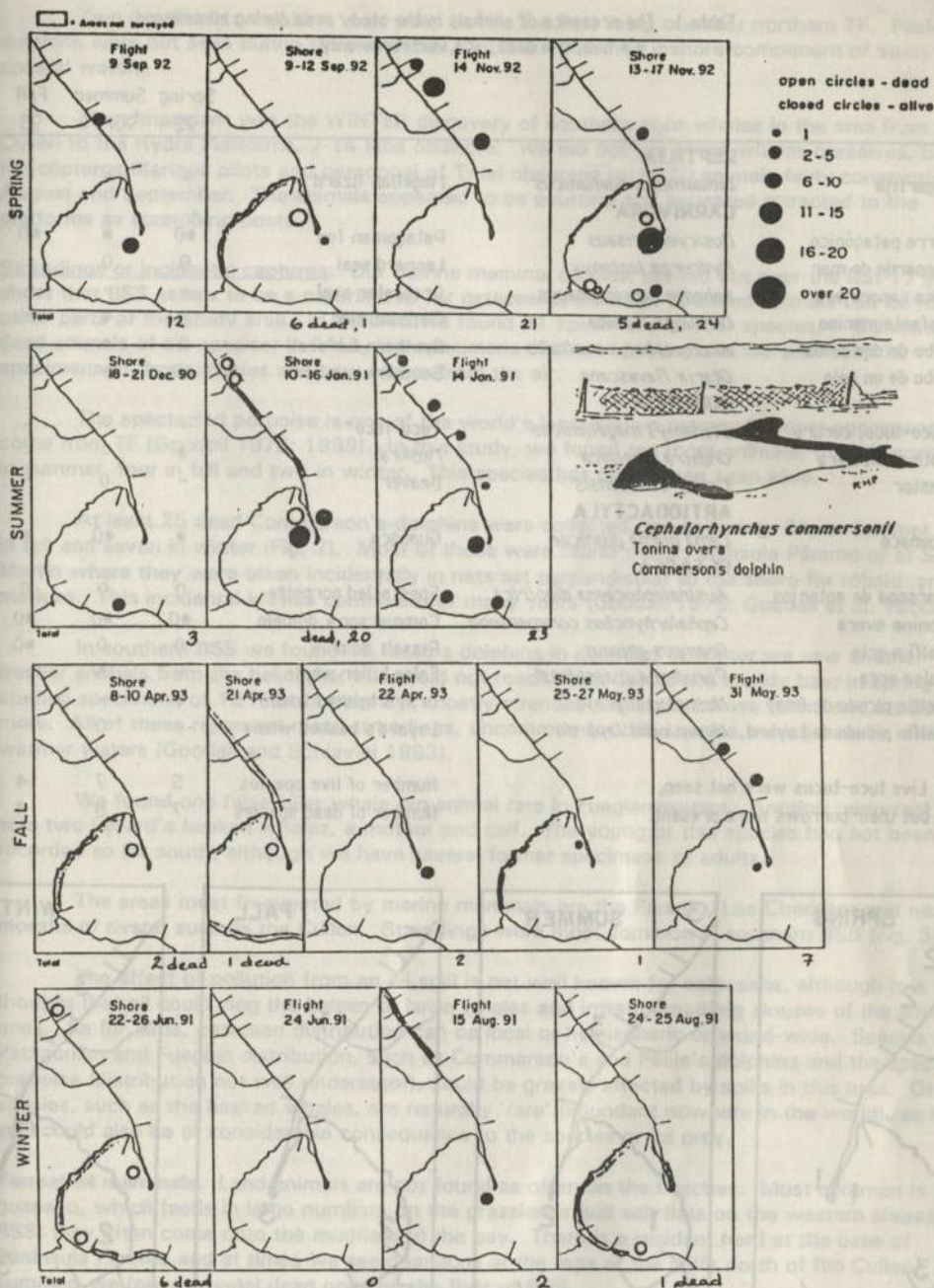


Fig. 2. An example of the distribution of a marine mammal within the study area.

Table 1. The presence of animals in the study area during all seasons

● = live, 0 = dead, v = vertebrae only.

			Spring 92	Summer 90/91	Fall 93	Winter 91
REPTILIA						
Lagartija	<i>Liolaemus magellanicus</i>	Magellan lizard	-	●	-	-
CARNIVORA						
Zorro patagónico	<i>Dusicyon griseus</i>	Patagonian fox	●0	●	●0	●0
Leopardo de mar	<i>Hydrurga leptonyx</i>	Leopard seal	0	0	-	-
Foca cangrejera	<i>Lobodon carcinophagus</i>	Crabeater seal	-	-	-	0
Elefante marino	<i>Mirounga leonina</i>	Elephant seal	-	●	-	-
Lobo de dos pelos	<i>Arctocephalus australis</i>	Southern fur seal	0	●	-	0
Lobo de un pelo	<i>Otaria flavescens</i>	Southern sea lion	●0	●	-	-
RODENTIA						
Tuco-tuco, cururo	<i>Ctenomys magellanicus</i>	Tuco-tuco*	-	-	-	-
Rata almizclera	<i>Onychomys leucogaster</i>	Muskrat	●	-	-	-
Castor	<i>Castor canadensis</i>	Beaver	-	0	-	-
ARTIODACTYLA						
Guanaco	<i>Lama glama guanicoe</i>	Guanaco	●	●0	●	●
CETACEA						
Marsopa de anteojos	<i>Australophocaena dioptrica</i>	Spectacled porpoise	0	0	0	0
Tonina overa	<i>Cephalorhynchus commersonii</i>	Commerson's dolphin	●0	●0	●0	●0
Delfín gris	<i>Grampus griseus</i>	Risso's dolphin	0	0	●0	0
Falsa orca	<i>Pseudorca crassidens</i>	False killer whale	v	0v	-	-
Delfín picudo de Gray	<i>Mesoplodon grayi</i>	Gray's beaked whale	v	-	-	-
Delfín picudo de Layard	<i>Mesoplodon layardii</i>	Layard's beaked whale	-	0	-	-
* Live tuco-tucos were not seen, but their burrows were present.						
Number of live species			5	7	4	3
Number of dead species			7	8	4	5

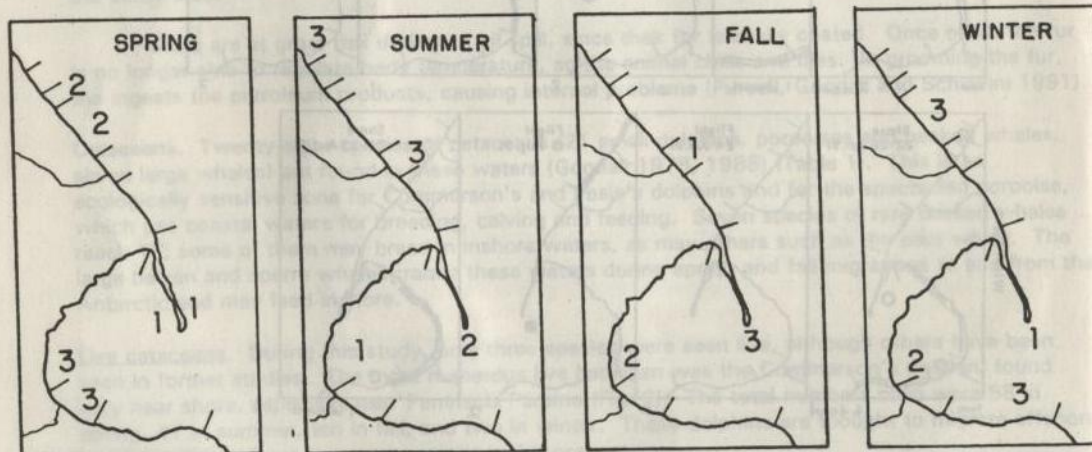


Fig. 3. Zones most frequented by marine mammals (Includes both living and dead).

Two live Risso's dolphins were seen in fall, the first living ones for northern TF. Peale's dolphins were not seen during these surveys, but are a common inshore component of study area coastal waters.

Most important was the WINTER discovery of southern right whales in the area from Planta Cullen to the Hydra Platforms, 7-14 kms offshore. We did not see these whales ourselves, but Helicópteros Marinos pilots and personnel of Total observed up to 20 animals fairly constantly in August and September. The animals appeared to be courting and appeared attracted to the platforms as scratching posts.

Strandings or incidental captures. Our marine mammal studies, carried out over the last 17 years, show that BSS seems to be a natural trap for cetaceans, although stranded animals can be found in other parts of the study area. In SPRING we found 31 specimens of four species; in SUMMER, 28 dead animals of six species; in FALL, ten specimens of three species, and we examined 10 specimens of three species and saw others from the air.

The spectacled porpoise is one of the world's least known mammals; most specimens have come from TF (Goodall 1978; 1989). In this study, we found ten more animals: three in spring, one in summer, four in fall and two in winter. This species has rarely been seen alive.

At least 25 dead Commerson's dolphins were collected, ten in spring, five in summer, three in fall and seven in winter (Fig. 2). Most of these were found along Península Páramo or at San Martín where they were taken incidentally in nets set perpendicular to the shore for róbaló and merluza. This incidental kill has continued for many years (Goodall 1978; Goodall et al. 1986).

In southern BSS we found 16 Risso's dolphins in summer; in winter we saw another 15 fresher animals from the helicopter but could not reach them due to the muddy bay; in spring we studied specimens of 18 Risso's dolphins, mostly stranded earlier; in fall we found and studied three more. All of these represent mass strandings, uncommon for this species, which usually inhabits warmer waters (Goodall and Schiavini 1993).

We found one false killer whale, an animal rare in Fuegian waters. Another important find was two Layard's beaked whales, a mother and calf. The young of this species had not been recorded so far south, although we have several former specimens of adults.

The areas most frequented by marine mammals are the Páramo, Los Chorrillos and near the mouths of rivers, such as the Cullen. Strandings were most common in southern BSS (Fig. 3).

The effect of pollution from an oil spill is not well known for cetaceans, although it is thought that oil could clog the baleen of large whales and irritate breathing sinuses of the smaller ones. As for birds, cetacean distribution can be local or hemispheric or world-wide. Species of only Patagonian and Fuegian distribution, such as Commerson's and Peale's dolphins and the spectacled porpoise (distribution not well understood), could be gravely affected by spills in this area. Other species, such as the beaked whales, are naturally 'rare' (abundant nowhere in the world), so that a spill could also be of considerable consequence to the species or its prey.

Terrestrial mammals. Land animals are not found as often on the beaches. Most common is the guanaco, which feeds in large numbers on the grasslands and salt flats on the western shores of BSS; they often come onto the mudflats of the bay. There is a resident herd at the base of Península Páramo and at times we see guanacos at the tops of the cliffs north of Río Cullen. In summer, we found several dead ones on the flats of BSS.

The introduced Patagonian fox is often found on the beaches, where it feeds on dead marine mammals and birds. We found most foxes, especially young animals, in fall. We found dead foxes in San Martín section in spring and fall; these had been shot.

~~Tucos~~ burrows are common in areas with light, sandy soil such as San Martín and the Páramo base; their burrows are on the upper beach and could be contaminated by a spill. We found one dead beaver in summer and saw a live muskrat in spring; these are not native to TF. Mice are also common, but we saw none on the beaches. In southern Santa Cruz, several other species (puma, skunks, maras, armadillos) occur. In summer we saw two lizards (not mammals) on the beach at Río Cullen.

BIRDS

The Tierra del Fuego bird list (Goodall et al. 1991a) records 210 species; about 95 of these are found in northernmost TF. In our 16 field studies, we encountered 69 species, four of which were found only as dead birds (Table 2). Since these surveys were coastal, we did not include birds of the steppe, lakes and rivers (except where they flow into the sea) and we saw few strictly oceanic species, which do not approach closely to land (Harrison 1983). In several surveys, additional species were found just outside the study area.

The small Passerine birds which occasionally are found on the beach are not of great importance either in biomass or in the event of a disaster such as an oil spill, but we have included them in most of our calculations of diversity and numbers.

Seasonality. Some birds are present in the study area throughout the year. An example of this is the kelp or Dominican gull (Fig. 4). Although always present, it seems to congregate on the beaches even more in fall and winter. Other species are present year round in small numbers. A good example of this is the great grebe (Fig. 5). These birds are almost always on the water, some distance from shore.

In four SPRING surveys we recorded 56 species of birds (52 alive, 4 dead) in the study area (Table 2). This was the largest number encountered in any season and represents both the year-round residents and migrants arriving from other areas. Birds are active at this time, feeding, courting and building nests, hence visible. Nine species (the Coscoroba swan, Chiloe wigeon, southern lapwing, golden plover, Magellan snipe, Antarctic tern, great-horned owl, austral thrush, and Correndera pipit) were seen only in spring.

In our three SUMMER surveys we recorded 38 species (34 alive, 4 dead). Nesting birds may not be as visible during this time. Of great importance in summer are the shorebirds, especially those which nest in Canada during our winter and come to Tierra del Fuego to feed and rest during our summer (northern hemisphere winter) (Hyman, Marchant & Prater 1986). An example of these northern hemisphere migrants is the white-rumped sandpiper (Fig. 6). These birds are often hard to see from shore because they feed mainly near the tide line on the BSS mudflats, where it is impossible for us to go. The willet was the only bird seen exclusively in summer.

In FALL we carried out five surveys, finding 45 species (44 alive, 1 dead). Our surveys were in late April and on some very cold days in late May. Some of the winter visitors had arrived, but in April, not all the summer visitors had left. The snowy sheathbill, red-backed hawk, rufous-chested dotterel and least seed-snipe were seen only in fall.

In four WINTER surveys we found 31 species (29 alive, 2 dead). In winter, bird biomass and species diversity are reduced due to migration. However, some inland birds, such as ducks, move to the shore in winter when lakes and rivers become frozen. Oystercatchers, peregrine and aplomado falcons occurred in the same areas and in about the same numbers in winter as in

Table 2. The presence of birds in study area, all surveys per season combined. 0 = dead birds; • = 1

Species		Spring Summer	
SEABIRDS			
Pinguino rey	<i>Aptenodytes patagonica</i>	King penguin	0 0
Pinguino penacho amarillo	<i>Eudyptes crestatus</i>	Rockhopper penguin	0 0
Pinguino macaroni	<i>Eudyptes chrysolophus</i>	Macaroni penguin	- 0
Pinguino de magallanes	<i>Spheniscus magellanicus</i>	Magellanic penguin	•0 0
Huala, maca grande	<i>Rallandia [Podiceps] major</i>	Great grebe	• •
Albatros ojoso	<i>Diomedea melanophris</i>	Black-browed albatross	0 -
Petrel gigante común	<i>Macronektes giganteus</i>	Southern giant petrel	• •
Fulmar austral	<i>Fulmarus glacialis</i>	Southern fulmar	• -
Petrel negro	<i>Procellaria aequinoctialis</i>	White-chinned petrel	• •
Biguá, yeco	<i>Phalacrocorax olivaceus</i>	Neotropic cormorant	•0 -
Cormorán imperial	<i>Phalacrocorax atriceps</i>	Imperial cormorant	•0 •0
Paloma antártica	<i>Chionis alba</i>	Snowy sheathbill	- -
Salteador grande	<i>Catharacta skua</i>	Great skua	• -
Gaviota cocinera	<i>Larus dominicanus</i>	Dominican, kelp gull	•0 •0
Gaviota capucho café	<i>Larus maculipennis</i>	Brown-hooded gull	• •
Gaviotín sudamericano	<i>Sterna hirundinacea</i>	South American tern	• •
Gaviotín golondrina	<i>Sterna hirundo</i>	Common tern	- •
Gaviotín antártico	<i>Sterna vittata</i>	Antarctic tern	• -
Avutarda de mar	<i>Chloephaga hybrida</i>	Kelp goose	• •
Pato vapor austral	<i>Tachyeres pteneres</i>	Flightless steamer duck	- -
Pato vapor volador	<i>Tachyeres patachonicus</i>	Flying steamer duck	• •0
WILDFOWL			
Coscoroba	<i>Coscoroba coscoroba</i>	Coscoroba swan	• -
Cisne cuello negro	<i>Cygnus melancoryphus</i>	Black-necked swan	• -
Kalken común	<i>Chloephaga picta</i>	Upland goose	• •
Avutarda cabecigrís	<i>Chloephaga poliocephala</i>	Ashy-headed goose	• -
Avutardacolorado	<i>Chloephaga rubidiceps</i>	Ruddy-headed goose	• -
Pato crestón	<i>Lophonetta specularioides</i>	Crested or grey duck	• •
Pato overo	<i>Anas sibilatrix</i>	Chiloe wigeon	• -
Pato maicero	<i>Anas georgica</i>	Yellow-billed pintail	• •
Pato barcino	<i>Anas flavirostris</i>	Speckled teal	•0 -
RAPINES			
Aguila mora	<i>Geranoaetus melanoleucus</i>	Bl-chested buzzard-eagle	- -
Aguilucho común	<i>Buteo polyosoma</i>	Red-backed hawk	- -
Carancho común	<i>Polyborus plancus</i>	Crested caracara	• •
Chimango, Liuque	<i>Milvago chimango</i>	Chimango caracara	0 -
Halcón peregrino (pat.)	<i>Falco peregrinus [kreyenborgi]</i>	Peregrine (pallid) falcon	• •
Halcón plumizo	<i>Falco femoralis</i>	Aplomado falcon	- •

SHOREBIRDS

Ostrero austral	<i>Haematopus leucopodus</i>	Magellanic oystercatcher	•	•	•	•
Ostrero negro	<i>Haematopus ater</i>	Blackish oystercatcher	-	•	•	•
Tero-tero	<i>Vanellus chilensis</i>	Southern lapwing	•0	-	-	-
Chorlo dorado	<i>Pluvialis dominica</i>	Golden plover	•	-	-	-
Chorlito doble collar	<i>Charadrius falklandicus</i>	Two-banded plover	•	•	•	•
Chorlito pecho canelo	<i>Charadrius modestus</i>	Rufous-chested dotterel	-	-	•	-
Chorlo de magallanes	<i>Pluvianellus socialis</i>	Magellanic plover	-	-	•	•
Becasa de mar	<i>Limosa haemastica</i>	Hudsonian godwit	•	•	•	-
Playero trlnador	<i>Numenius phaeopus</i>	Whimbrel	•	•	•	•
Playero ala blanca	<i>Calotrophorus semipalmatus</i>	Willet	-	•	-	-
Playero, vuelvepiedras	<i>Arenaria interpres</i>	Ruddy turnstone	•	•	•	-
Becasina de magallanes	<i>Gallinago paraguayae mag.</i>	Magellan snipe	•	-	-	-
Playero rojizo	<i>Calidris canutus</i>	Red knot	•	•	•	-
Playerito blanco	<i>Calidris alba</i>	Sanderling	•	•	•	-
Playerito rabad, blanca	<i>Calidris fuscicollis</i>	White-rumped sandpiper	•	•	•	-
Playerito rabad, parda	<i>Calidris bairdii</i>	Baird's sandpiper	•	•	•	-
Agachona chica	<i>Thinocorus rumicivorus</i>	Least seedsnipe	-	-	•	-

PASSERINES

Caminera patagónica	<i>Geositta antarctica</i>	Short-billed miner	•	-	•	-
Remolinera araucana	<i>Cinclodes patagonicus</i>	Dark-bellied cinclodes	•	•	•	•
Remolinera común	<i>Cinclodes fuscus</i>	Bar-winged cinclodes	•	-	•	•
Dormilona cara negra	<i>Muscisaxicola macloviana</i>	Dark-faced ground tyrant	•	•	•	-
Sobrepuesto, colegial	<i>Lessonia rufa</i>	Rufous-backed negrito	•	•	-	-
Golondrina patagónica	<i>Tachycineta leucopyga</i>	Chilean swallow	•	-	•	-
Zorzal patagónico	<i>Turdus falcklandii</i>	Austral thrush	•	-	-	-
Cachirla común	<i>Anthus correndera</i>	Correndera pipit	•	-	-	-
Jilguero austral	<i>Sicalis lebruni</i>	Patagonian yellow-finch	•	-	•	-
Comesebo andino	<i>Phrygilus gayi</i>	Gay's, gray-hooded finch	-	•	•	-
Chingolo común	<i>Junco [Zonotrichia] capensis</i>	Rufous-collared sparrow	•	-	-	-
Loica común	<i>Sturnella loyca</i>	Long-tailed meadowlark	•	•	-	-

OTHER BIRDS

Garza bruja	<i>Nycticorax nycticorax</i>	Black-crowned n-heron	•0	-	•	•
Bandurria baya	<i>Theristicus caudatus</i>	Buff-necked ibis	•	•	•0	•
Flamenco austral	<i>Phoenicopterus chilensis</i>	Chilean flamingo	•0	•	•	•
Nacurutú, buho orejón	<i>Bubo virginianus</i>	Great horned owl	•	-	-	-

Total species, live	•	52	34	45	29
Additional species, dead	0	4	4	1	2

Note: Although the black-necked swan and some seaducks (Anatidae) are considered SEABIRDS, we have included them with wildfowl because they occupy both fresh and salt water habitats.

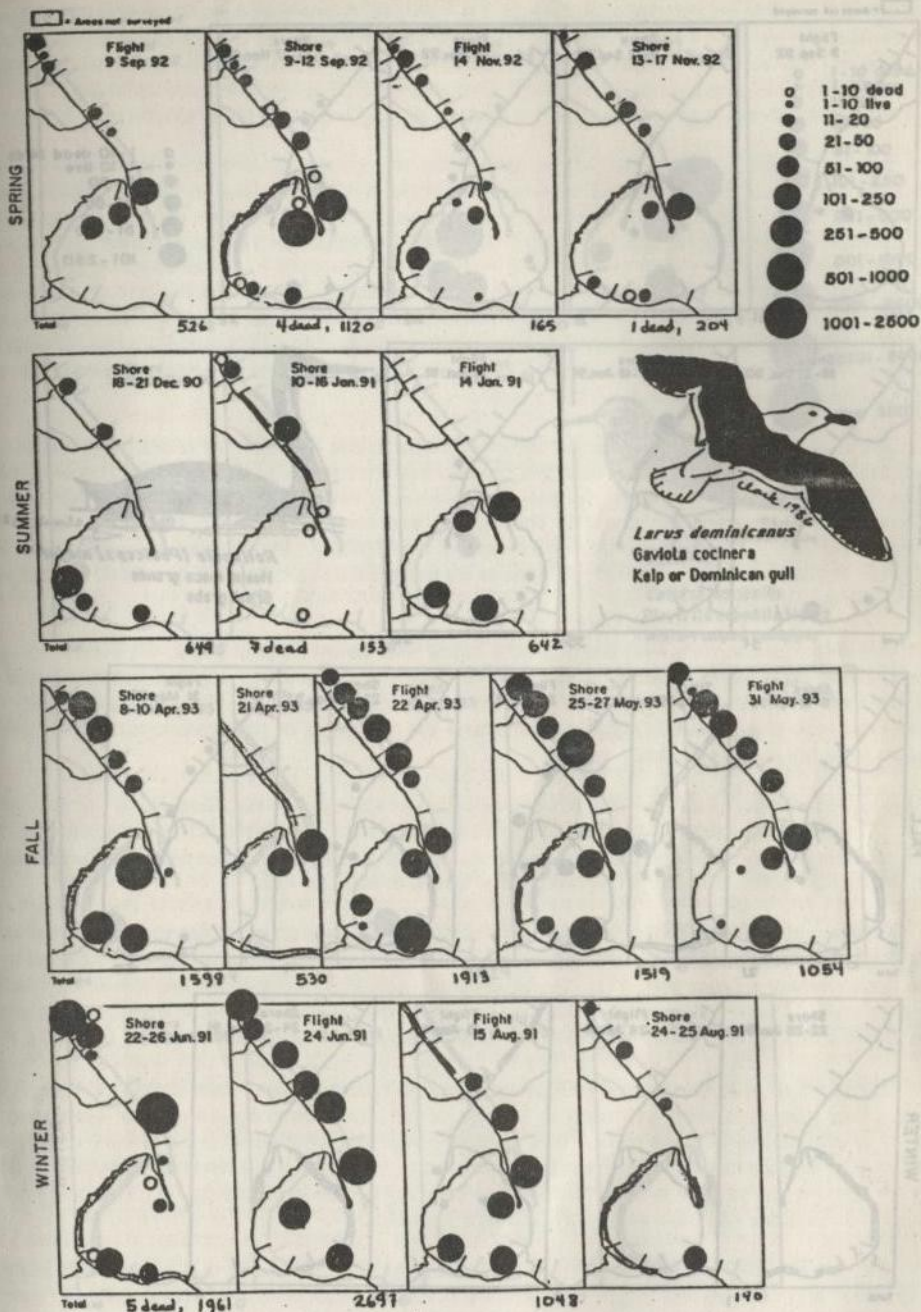


Fig. 4. An example of a bird species which is abundantly present in the study area year round.

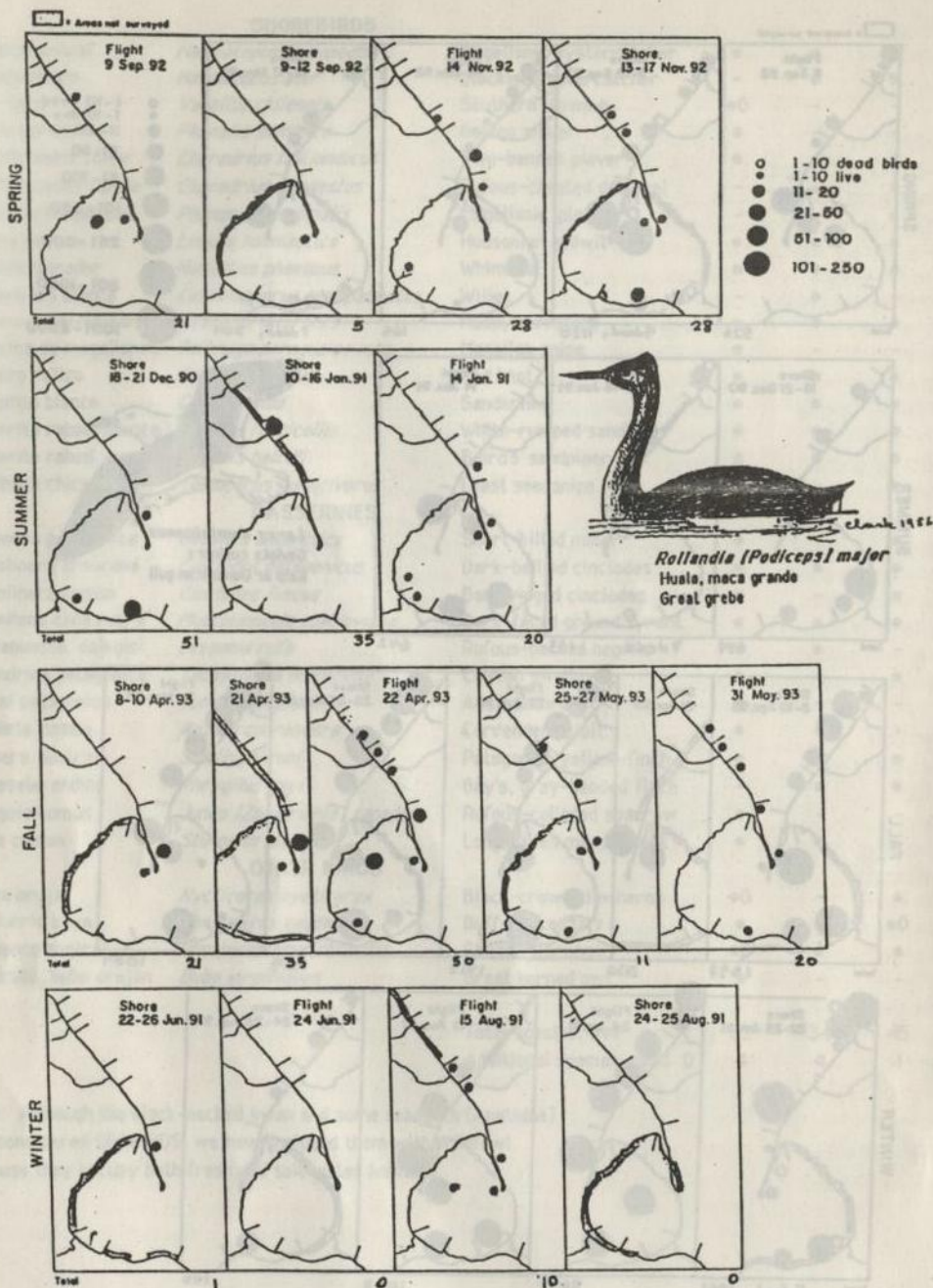


Fig. 5. An example of a bird species which is present in all seasons in low abundance.

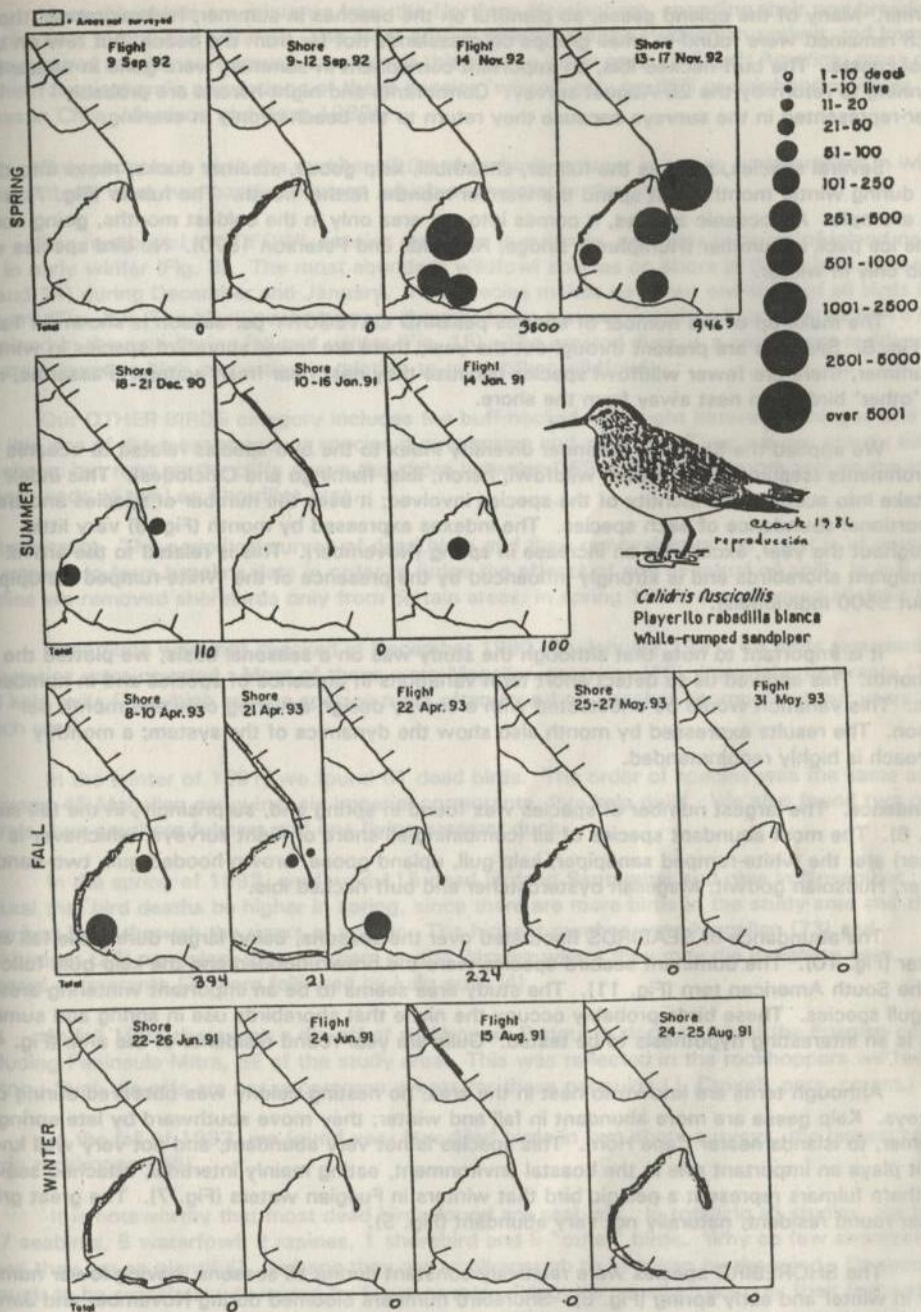


Fig. 6. An example of a shore bird which is present in the area during the warmer months. This is a species which migrates to and from northern Canada each year, spending its resting season in TF during our summer. The bird was not seen from shore in January because it feeds far out on the mudflats.

summer. Many of the upland geese, so plentiful on the beaches in summer, had migrated; those which remained were found in small groups on grasslands not far from the beach, but few on the actual coasts. The buff-necked ibis, an important component in summer, were gone in winter but beginning to return by the 25 August survey. Cormorants and night-herons are probably under-represented in the surveys because they return to the beaches only in evening.

Several species, such as the fulmar, sheathbill, kelp goose, steamer ducks, move into this area during winter months, but spend the warmer months farther south. The fulmar (Fig. 7) is the best example. An oceanic species, it comes into our area only in the coldest months, going south to the ice pack in summer (Humphrey, Bridge, Reynolds and Peterson 1970). No bird species was found only in winter.

The make-up of the number of species per BIRD CATEGORY per season is shown in Table 2 and Fig. 8. Seabirds are present throughout the year; there are fewer shorebird species in winter. In summer, there are fewer wildfowl species because they nest near fresh waters. Passerine, rapine and 'other' birds also nest away from the shore.

We applied the Shannon Weanier diversity index to the bird species related to oceanic environments (seabirds, shorebirds, wildfowl, heron, ibis, flamingo and Cincloides). This index does not take into account the identity of the species involved; it uses the number of species and the proportional abundance of each species. The indexes expressed by month (Fig. 9) vary little throughout the year, except for an increase in spring (November). This is related to the arrival of the migrant shorebirds and is strongly influenced by the presence of the White-rumped sandpiper (about 9500 individuals).

It is important to note that although the study was on a seasonal basis, we plotted the data by month. This allowed us to detect short term variations in presence of species and in number of birds. This variation would be undetected with a survey design covering only one month per season. The results expressed by month also show the dynamics of the system; a monthly approach is highly recommended.

Abundance. The largest number of species was found in spring and, surprisingly, in the fall surveys (Fig. 8). The most abundant species of all (combining all shore or flight surveys, whichever is higher) are: the white-rumped sandpiper, kelp gull, upland goose, brown-hooded gull, two-banded plover, Hudsonian godwit, Magellan oystercatcher and buff-necked ibis.

The abundance of SEABIRDS fluctuated over the seasons, being larger during the fall and winter (Fig. 10). The dominant seabird species were the brown-hooded and the kelp gull, followed by the South American tern (Fig. 11). The study area seems to be an important wintering area for the gull species. These birds probably occupy the niche that shorebirds use in spring and summer. This is an interesting hypothesis to be tested. Gulls are year-round residents of the area (Fig. 4).

Although terns are known to nest in the area, no nesting colony was observed during our surveys. Kelp geese are more abundant in fall and winter; they move southward by late spring and summer, to islands nearer Cape Horn. This species is not very abundant, and not very well known, but it plays an important role in the coastal environment, eating mainly intertidal, attached seaweed. Southern fulmars represent a pelagic bird that winters in Fuegian waters (Fig. 7). The great grebe is a year-round resident, naturally not very abundant (Fig. 5).

The SHOREBIRD species were relatively constant during all seasons, having lower numbers only in winter and early spring (Fig. 8). Shorebird numbers bloomed during November and January (Fig. 12). The lower numbers in December relate to our shore surveys, when we could observe the birds on the outer mud flats (there was no helicopter flight in December). The most numerous shorebird is the white-rumped sandpiper, with about 10,000 individuals in November (Fig. 6).

Most shorebirds are migrants from the Northern Hemisphere, spending their non-breeding 'winter' here during our summer. The most critical species are the Hudsonian godwit, red knot and white-rumped sandpiper, because they prefer this area to other parts of South America; most of the northern hemisphere's populations of these species 'winter' only on BSS or neighboring Bahía Lomas in Chile (Morrison and Ross 1989).

Only about one sixth the number of the shorebirds present in spring were present in winter. Most of these were two-banded plovers, which overwinter in the area.

The number of WILDFOWL species decrease in summer, probably because of inland nesting, and in early winter (Fig. 8). The most abundant wildfowl species on shore is the upland goose (Figs 13 and 14) during December and January. This species makes up about one-third of all birds in January (Fig. 10). The black-necked swan, thought to be a summer visitor (Humphrey et al. 1970) remained in the area during fall and winter (Fig. 15). The crested duck is a permanent resident of the area, found in high proportion in relation to most other wildfowl.

Our OTHER BIRDS category includes the buff-necked ibis, night herons, flamingos and owls. The ibis one of the most abundant species during spring and summer. They are not strictly birds of the shore, but nest on the cliffs above the shore between CES and Cabo Nombro and on the cliffs of both ends of the Los Chorrillos area.

Bird mortality. The periodical survey of dead birds and their removal from the coast is of prime importance to form baseline data in order to judge the effects of any eventual oil spill. In our early studies we removed shorebirds only from certain areas; in spring 1992, we removed all dead birds.

Dead birds were not checked in December 1990. In January 1991, 48 birds representing 12 species were counted. Most of these were Magellan penguins (18), imperial cormorants (12) and kelp gulls (7), which are the species most often found on beaches throughout our years of beach work.

In the winter of 1991, we found 61 dead birds. The order of species was the same as summer: 45 Magellan penguins, six imperial cormorants, five kelp gulls. We also found two giant petrels, two southern fulmars and one flying steamer duck.

In the spring of 1992, we found 115 dead birds in September and nine in November. It is natural that bird deaths be higher in spring, since there are more birds in the study area and they have just been through the rigors of winter. The highest number were Magellan (73) and rockhopper (26) penguins, most of them on the Páramo where they may die in fishing nets. Imperial cormorants (7) were followed by kelp gulls (4).

In fall 1992 there was a die-off of rockhopper Penguins along much of the Fuegian coast, including Península Mitre, SE of the study area. This was reflected in the rockhoppers we found in spring. Such die-offs are not uncommon events for these penguins (J. Croxall, pers. comm.)

In the fall of 1993, we found very few dead birds in two shore surveys, the largest number being rockhoppers (5).

It is noteworthy that most dead birds found are seabirds. In totalling all studies, we have 227 seabirds, 6 waterfowl, 2 rapines, 1 shorebird and 6 "other" birds. Why so few shorebirds, when they are so plentiful? Perhaps they are small enough to be taken by the wind. Or succulent enough to be completely devoured by foxes or rats. Penguins usually have only their feet eaten.

The northern part of the study area is very close to Cabo Vírgenes, Santa Cruz, location of the continent's second-largest Magellanic penguin colony, with some 320,000 birds (193,000



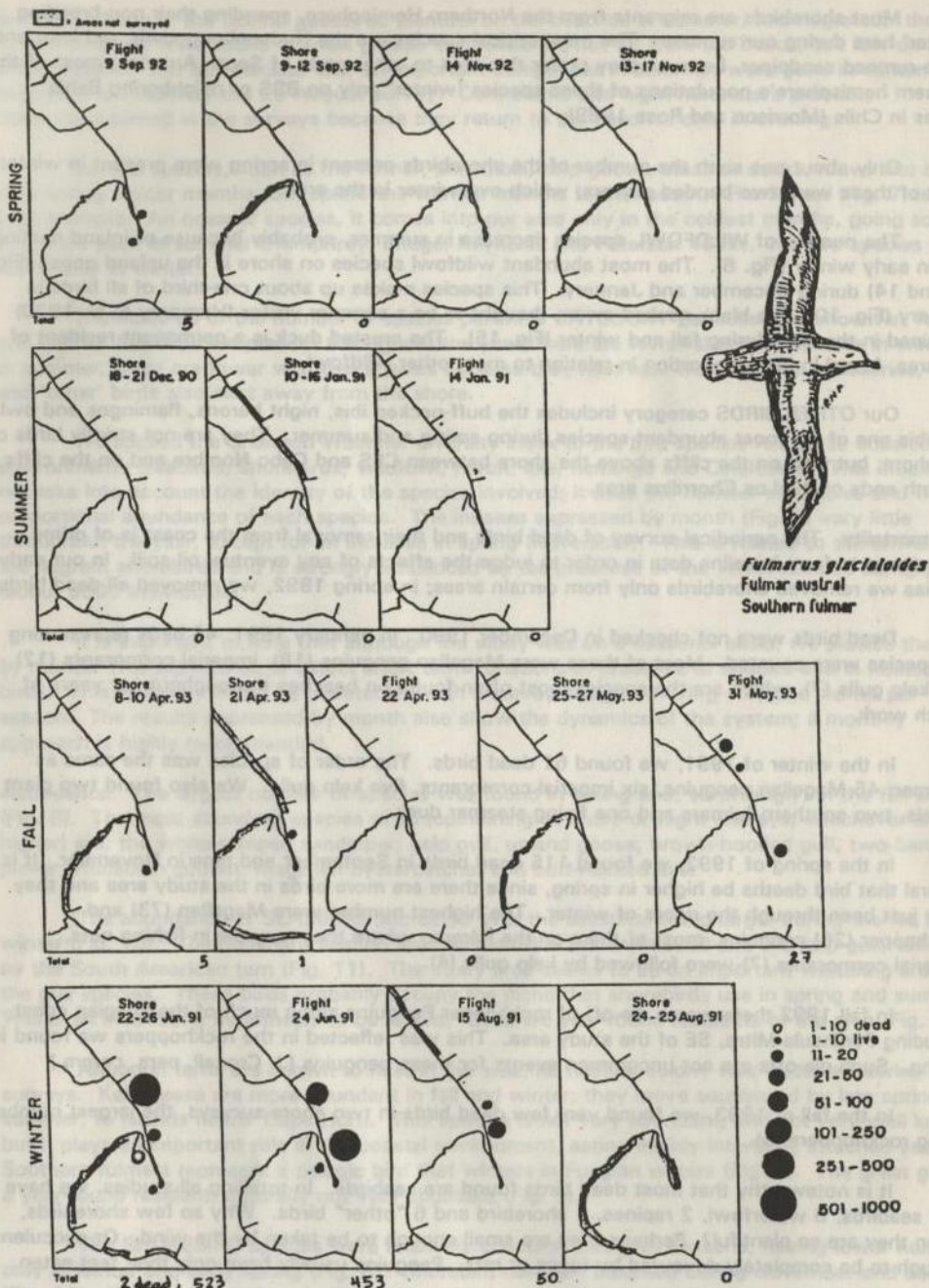


Fig. 7. An example of a bird which visits the study area during cold months, going south to the Ice pack in summer.

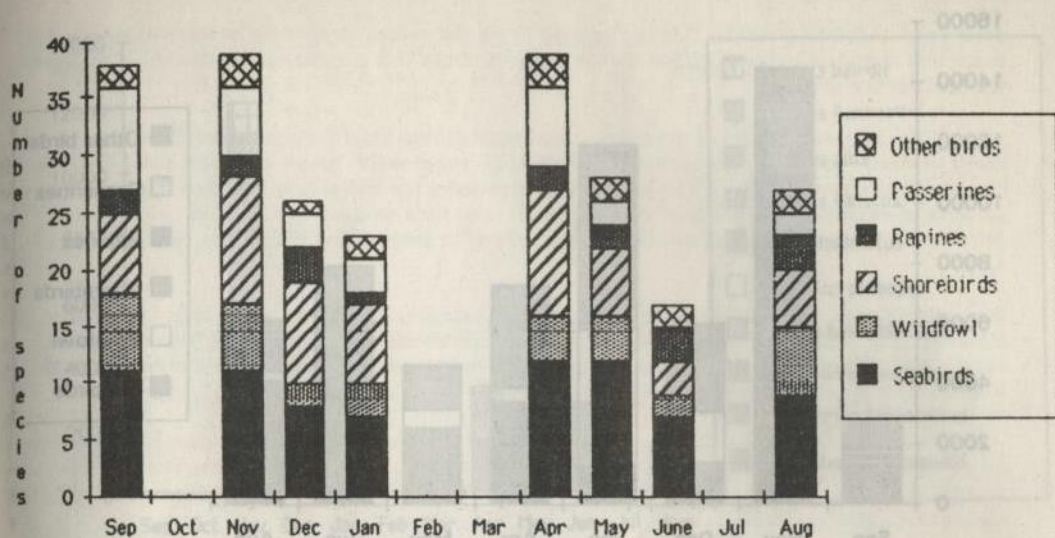


Fig. 8. The number of species in the different bird categories seen on the northern coasts of Tierra del Fuego throughout the year.

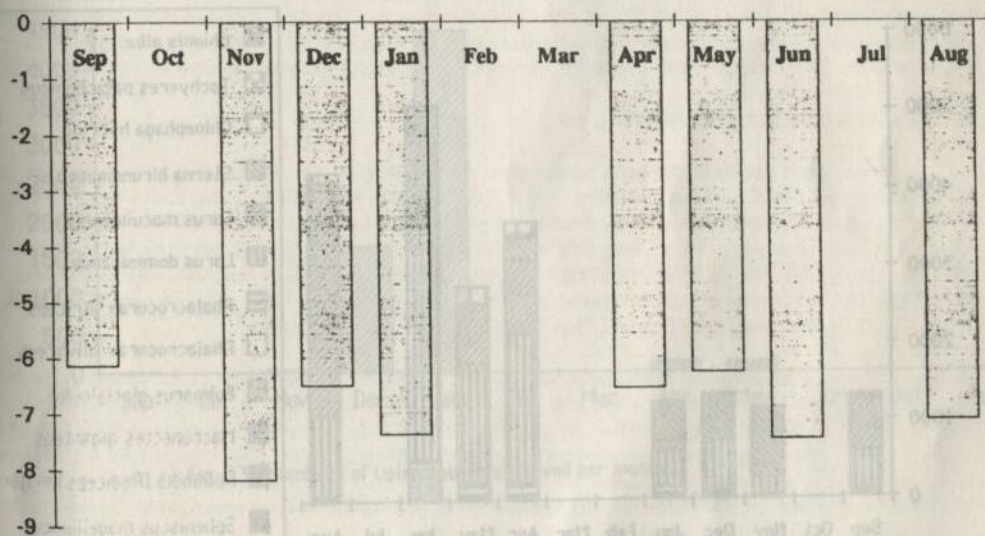


Fig. 9. The Shannon Weaner diversity index of the number of individuals and number of species of birds related to the sea. When more than one survey was made per month, the higher number was used.

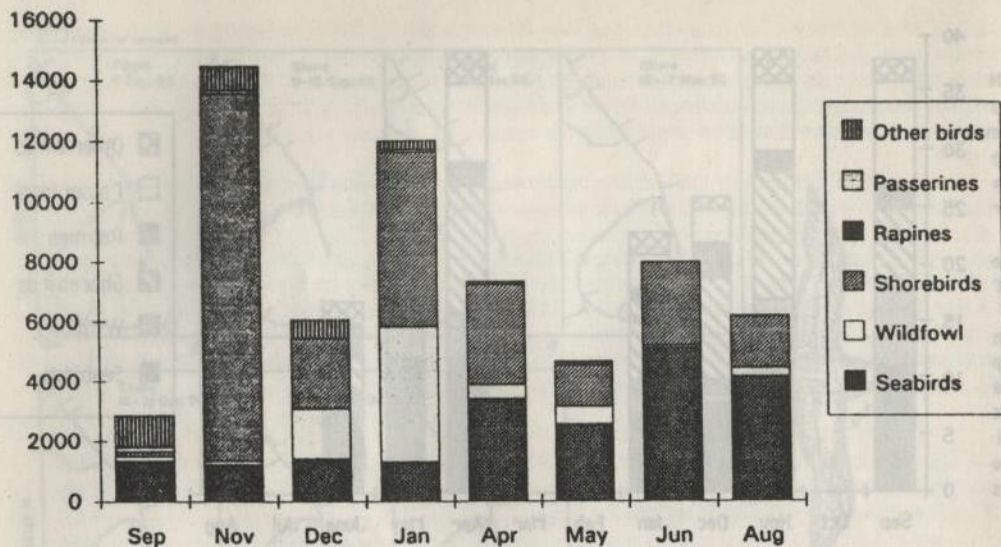


Fig. 10. Number of individuals for the different categories of birds found per month.

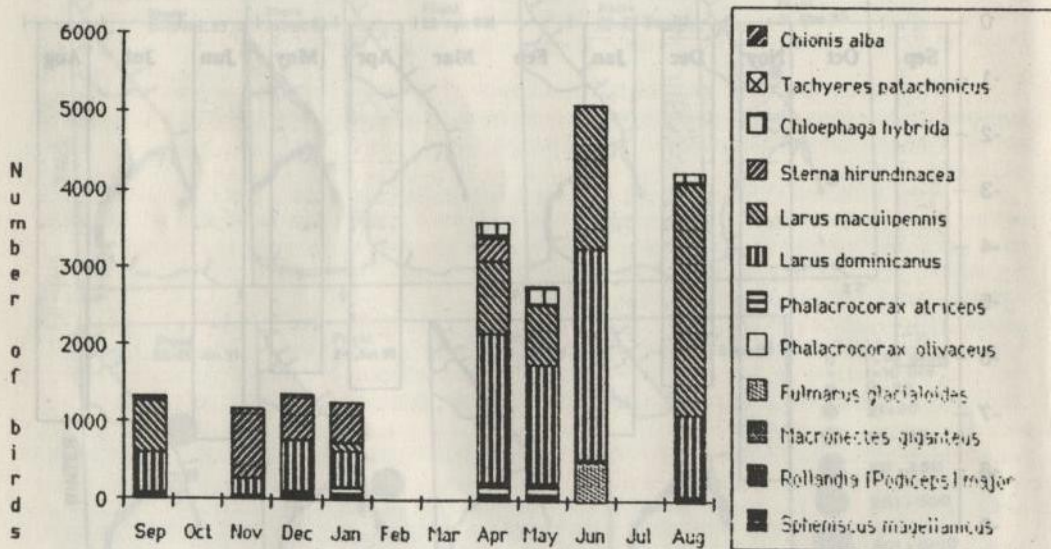


Fig. 11. Number of individuals per species of SEABIRDS per month.

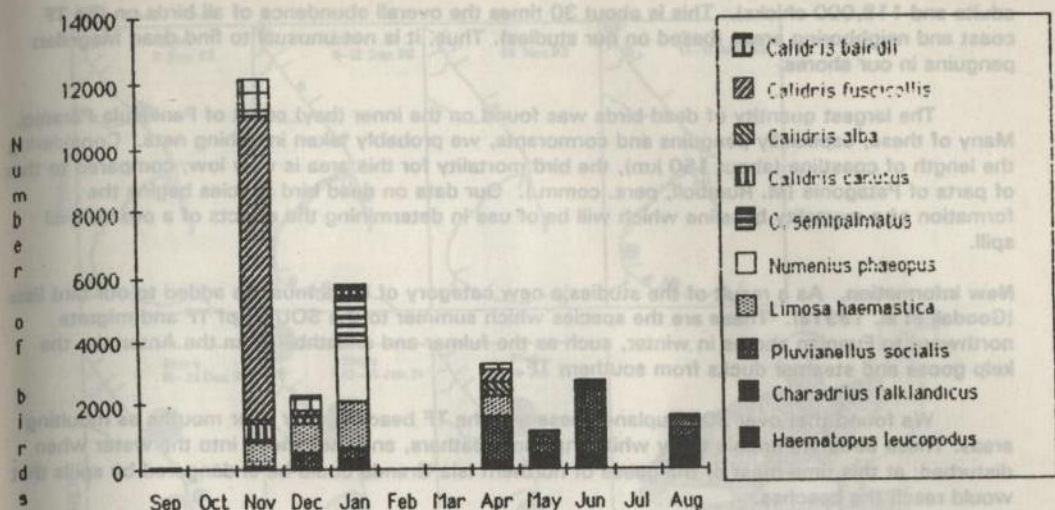


Fig. 12. Number of individuals per species of SHOREBIRD per month. Only those with more than 100 individuals are included.



Fig. 13. Numbers of Upland geese observed per month.

adults and 118,000 chicks). This is about 30 times the overall abundance of all birds on the TF coast and neighboring areas (based on our studies). Thus, it is not unusual to find dead Magellan penguins in our shores.

The largest quantity of dead birds was found on the inner (bay) coast of Península Páramo. Many of these, especially penguins and cormorants, were probably taken in fishing nets. Considering the length of coastline (about 150 km), the bird mortality for this area is very low, compared to that of parts of Patagonia (M. Rumboll, pers. comm.). Our data on dead bird species begins the formation of a mortality baseline which will be of use in determining the effects of a possible oil spill.

New information. As a result of the studies, a new category of birds must be added to our bird lists (Goodall et al. 1991a). These are the species which summer to the SOUTH of TF and migrate northward to Fuegian shores in winter, such as the fulmar and sheathbill from the Antarctic, the kelp goose and steamer ducks from southern TF.

We found that over 3000 upland geese use the TF beaches near river mouths as moulting areas. These birds are unable to fly while changing feathers, and they move into the water when disturbed; at this time most of the geese of northern Isla Grande could be endangered by spills that would reach the beaches.

The buff-necked ibis nest in large numbers on the tops of the sea cliffs in the study area. They usually feed on grassland, but we found that in summer, their fledging young drop to the beach and feed there until able to fly, making the susceptible to any beach pollution.

The two-banded plover was found in large numbers even in winter. As a result of the winter surveys, the status of this species and of the Magellanic plover must be changed from 'summer breeding visitor' to 'resident' throughout the year. The Magellanic plover was considered 'not abundant' by several former authors (Humphrey et al. 1970; Clark 1986) and thought to migrate from TF in winter. We found these birds on the beach only in fall and winter (Fig. 16).

MOST SENSITIVE AREAS AND SPECIES

Areas with greatest diversity of species. The area with the largest number of species during all seasons was Los Chorrillos (LC) (Fig. 17). This area has high cliffs to the E and W; those to the W have abundant vegetation at their bases, providing a perfect niche for small Passerine birds. There are both sandy and rocky beaches with both restinga and mudflat being exposed at low tide. The area second in line in diversity of species was the Páramo and, in summer, Río Cullen and BSS. This reflects the number of upland geese on the shore at Río Cullen and the summer shorebirds at BSS. Third in rank was, in all cases, San Martín, and also BSS in winter.

Areas with most abundance. The areas with largest numbers of individual birds varied more than those for the number of species (Fig. 18). The Páramo and BSS had the most birds in spring, followed by LC, San Martín and Alfa. In summer, bird numbers were fairly even at BSS, LC and Río Cullen, again reflecting the numbers of geese and shorebirds. In fall, San Martín had the greatest numbers, mostly shore birds, followed by Los Chorrillos, BSS, Páramo and Río Cullen. In winter, LC and BSS had most birds, mostly brown-hooded gulls, the outer coastal areas (kelp, brown-hooded gulls and fulmars) and San Martín.

Critical areas. The San Sebastián complex (Páramo, BSS, San Martín and Los Chorrillos) is the most environmentally sensitive area in terms of both greatest number of bird species and greatest number of individual birds. The most vulnerable of these are the Páramo and the BSS mud flats. Thousands of shorebirds feed in this habitat. The vulnerability of the area is based on the geomorphology of the bay, with its distinct habitats and wide mudflats exposed by the tide. The

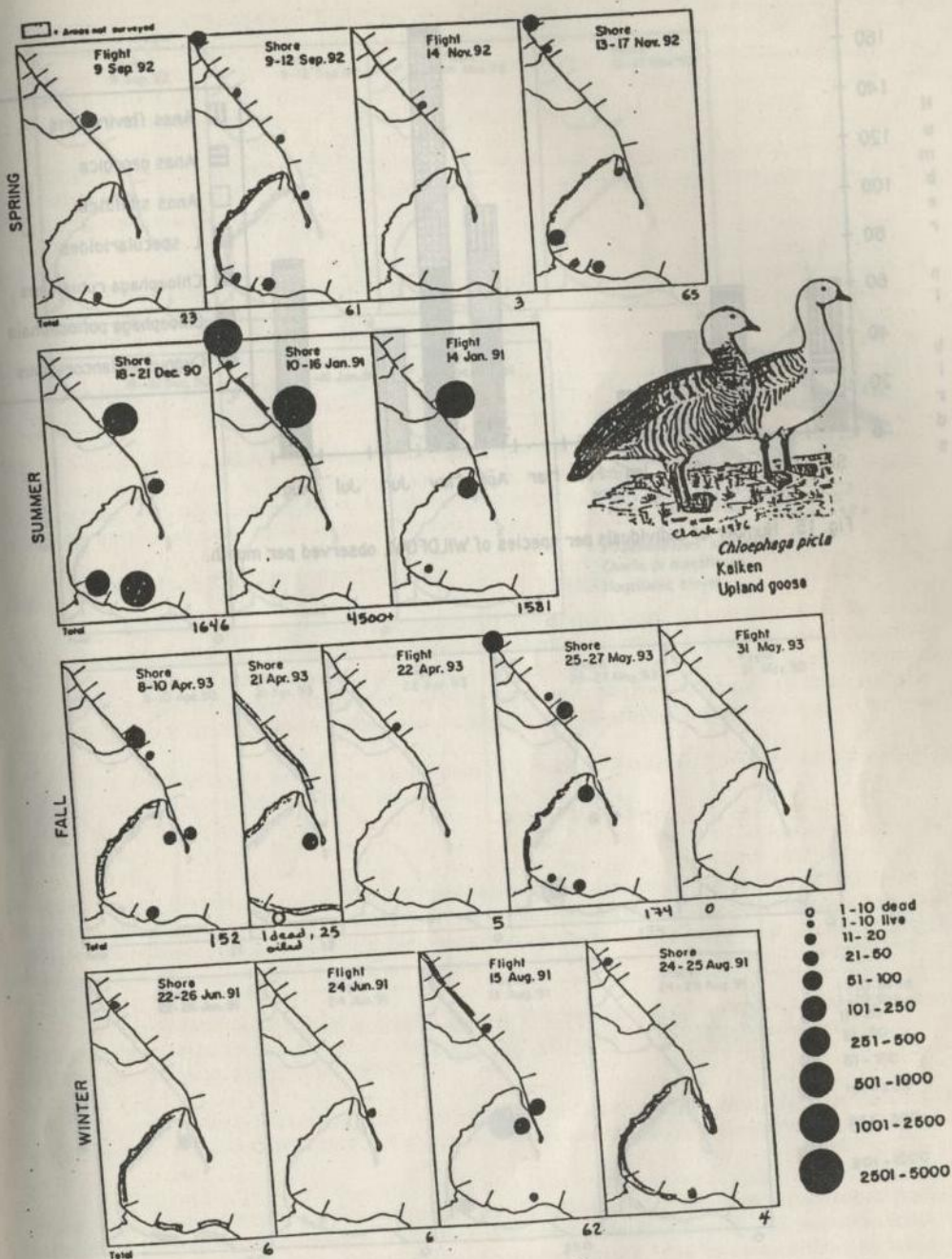


Fig. 14. Most upland geese migrate in winter, but some stay year round. Great numbers move to the coasts in summer to moult their feathers. When disturbed, they cannot fly, but take to the water.

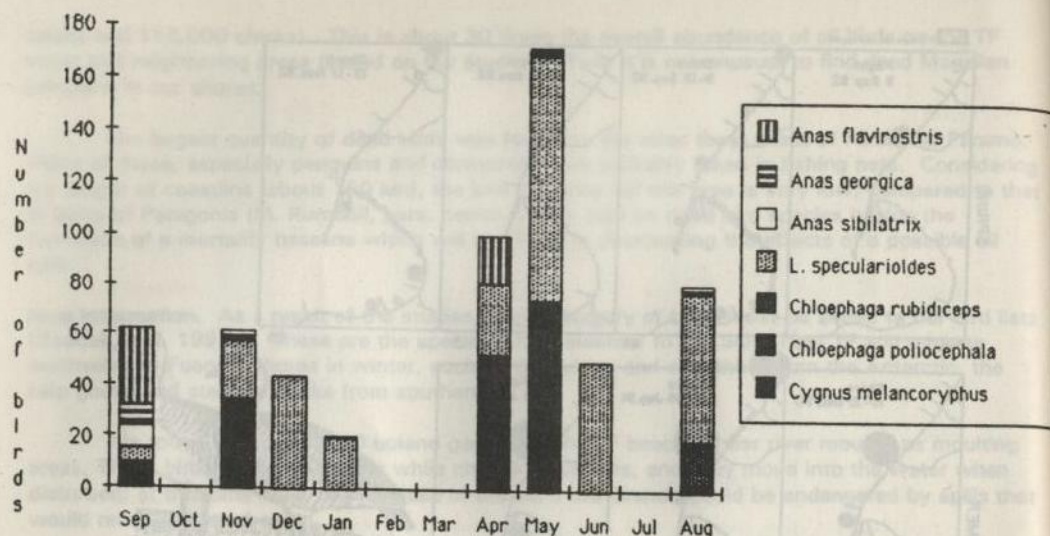


Fig. 15. Number of individuals per species of WILDFOWL observed per month.

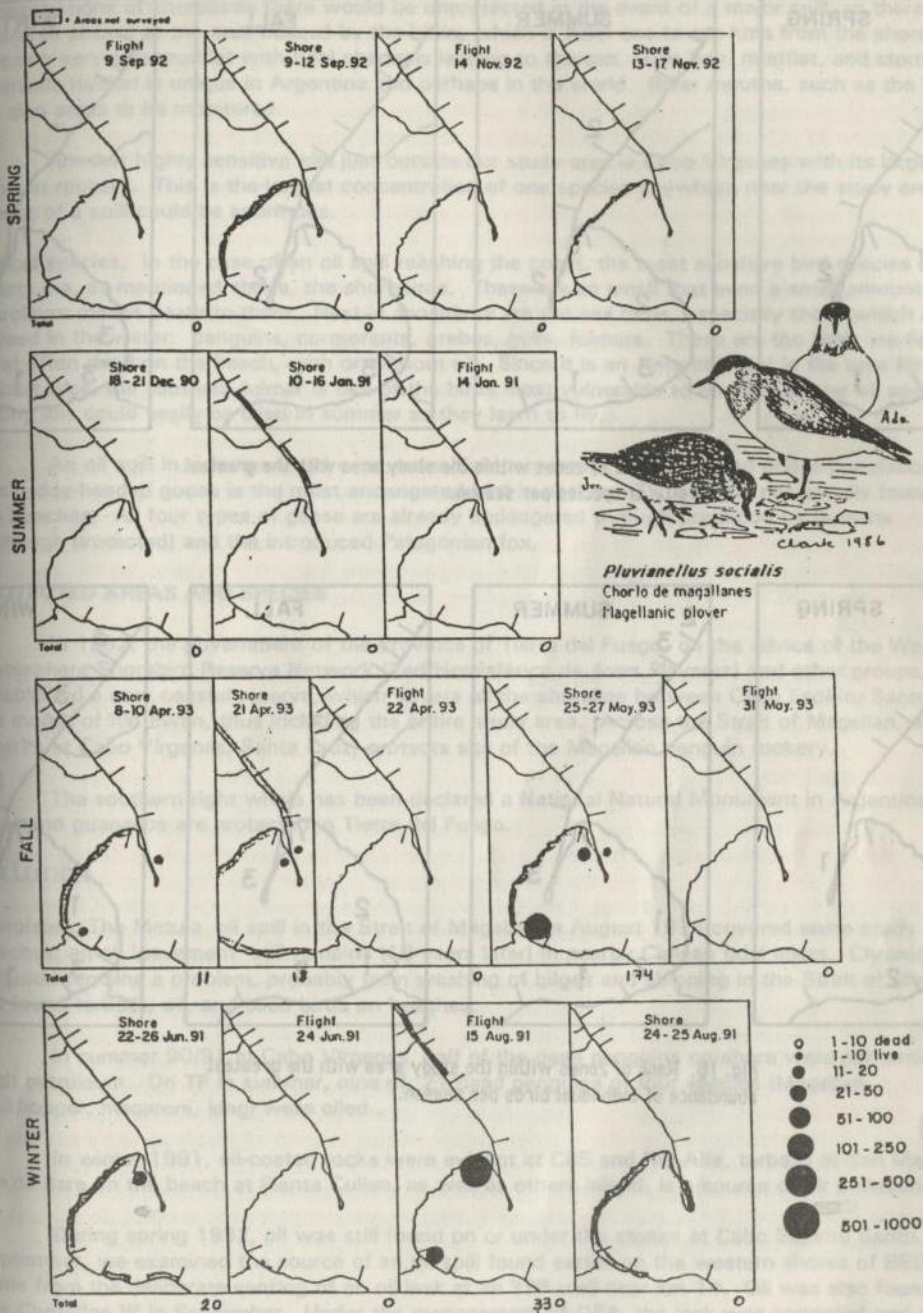


Fig. 16. The Magellanic plover was considered 'not abundant' and thought to migrate in winter. We found them more prevalent in fall and winter.

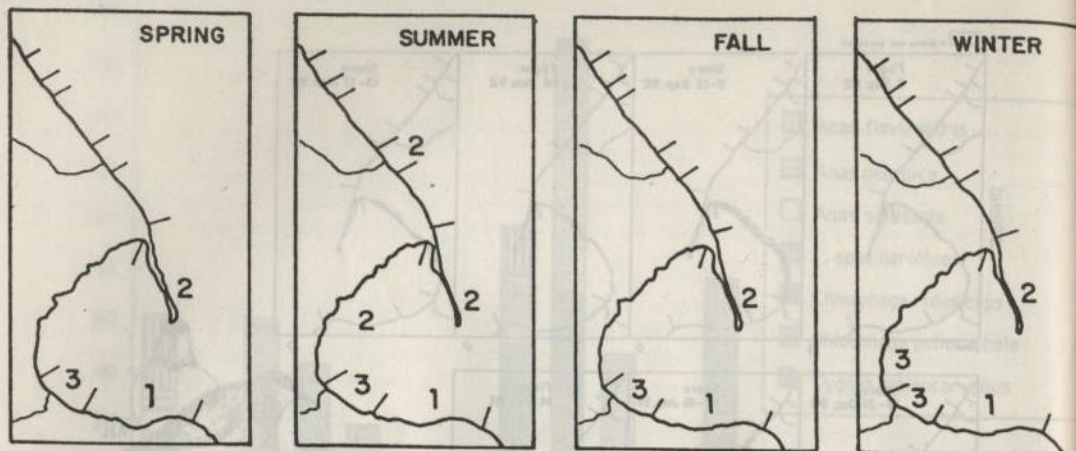


Fig. 17. Rank of zones within the study area with the greatest diversity of species per season.

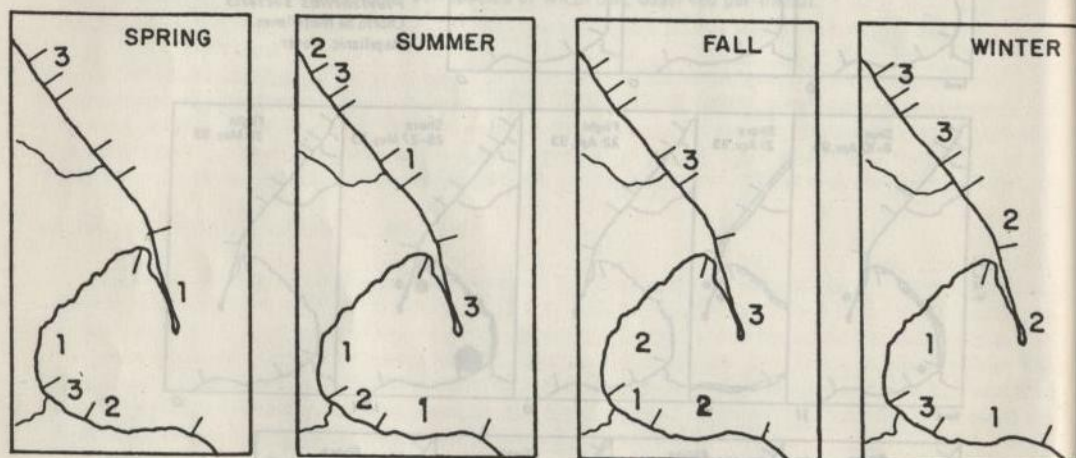


Fig. 18. Rank of zones within the study area with the greatest abundance of individual birds per season.

concentrations of shorebirds there would be unprotected in the event of a major spill, as there is no means of access to the area utilized by the birds, which is from one to ten kms from the shore across a very soft mudflat with tidal channels leading to the sea. This bay, mudflat, and stony peninsula habitat is unique in Argentina and perhaps in the world. River mouths, such as the Cullen, are also areas to be monitored.

Another highly sensitive site just outside our study area is Cabo Vírgenes with its large penguin rookery. This is the largest concentration of one species anywhere near the study area; the impact of a spill could be enormous.

Critical species. In the case of an oil spill reaching the coast, the most sensitive bird species on the coasts are, as mentioned above, the shorebirds. These are so small that even a small amount of petroleum means death to them. Next in sensitivity are the sea birds, especially those which sit on or feed in the water: penguins, cormorants, grebes, gulls, fulmars. These are the birds we find most often dead on the beach, with or without oil. Since it is an Antarctic bird in the area for such a short time, the southern fulmar is one of the birds most vulnerable to an early winter oil spill. Young ibis could easily be oiled in summer as they learn to fly.

An oil spill in summer could wipe out a high percentage of the upland goose population. The ruddy-headed goose is the most endangered bird in northern TF, but it is not usually found on the beaches. All four types of geese are already endangered through predation by humans (although protected) and the introduced Patagonian fox.

PROTECTED AREAS AND SPECIES

In 1992, the government of the Province of Tierra del Fuego, on the advice of the Western Hemisphere Shorebird Reserve Network (Red Hemisférica de Aves Playeras) and other groups, established a new coastal reserve, which covers all the shoreline between Cabo Espritu Santo and the mouth of Río Ewan, thus including the entire study area. Across the Strait of Magellan, a reserve at Cabo Vírgenes, Santa Cruz, protects site of the Magellan penguin rookery.

The southern right whale has been declared a National Natural Monument in Argentina; all birds and guanacos are protected in Tierra del Fuego.

POLLUTION

Petroleum. The Metula oil spill in the Strait of Magellan in August 1974 covered some study area beaches; an oil 'pavement' still remains (18 years later) in nearby Chilean tidal inlets. Chronic oil pollution remains a problem, probably from washing of bilges and shipping in the Strait of Magellan; we found tarballs, oil, and oiled birds on beaches.

In summer 90/91 at Cabo Vírgenes, half of the dead penguins on shore were contaminated with petroleum. On TF in summer, nine of 21 dead penguins of four species (Magellan, rockhopper, macaroni, king) were oiled..

In winter 1991, oil-coated rocks were evident at CES and Río Alfa, tarballs at San Martín: the oil flare on the beach at Planta Cullen, as well as others inland, is a source of air pollution.

During spring 1992, oil was still found on or under the stones at Cabo Espritu Santo. In September, we examined the source of an oil spill found earlier on the western shores of BSS. It came from the deliberate venting of an oil leak at an YPF well near km 14. Oil was also found at Los Chorrillos W in September. Under the management of OEA, the leak was corrected and only dry oil was seen in November. Most of this had disappeared by January 1993.

Apart from the damage to animals such as fur seals and sea lions and birds such as penguins, shorebirds, geese, cormorants, grebes and ibis, oil floating offshore can damage plankton, krill, surface feeding whales and bottom organisms (Purcell, Goodall and Schiavini 1991).

Debris. The presence of man-made debris, such as plastics, leather, glass, cloth, metal, has been studied for TF (Goodall 1990). Beach garbage was highly increased when there was a drilling platform offshore. In our present surveys, debris was found at Cabo Espíritu Santo, Río Alfa, Páramo and San Martín. Most heavily contaminated beaches are the inner tip of the Páramo (during the spring survey, from shore-based fishing operations) and northern San Martín section. In other areas the debris was fairly well scattered.

Man-made debris is extremely harmful to wildlife. We found a false killer whale with a ball of fishing net in the stomach, and in our fall survey found a Risso's dolphin which probably died of stomach blockage from five plastic bags (Goodall and Schiavini 1993).

Noise, vehicle and other disturbances. Some birds and animals can stand a certain amount of disturbance, while others are vulnerable. Shorebirds will move away with any disturbance. People on the coast will cause moulting geese to take to the water, which would be disastrous during a spill. Terns are especially vulnerable to disturbances such as vehicles during their nesting periods. If disturbed, they may not return to the same area for many years. This is most important on the Páramo Peninsula, where they sometimes nest in thousands, even on the road. Although we saw terns on the Páramo, we did not see any nesting there in 1992. YPF and fishermen continually used the Páramo road with four-wheel drive vehicles during 1991-92. Seismographic work in northwestern BSS greatly disturbed the mudflats; the tracks are still visible. All such activity should be carefully monitored.

On the other hand, Commerson's dolphins have been known to follow seismographic boats during surveys (Goodall et al. 1986) and southern right whales used oil platforms for scratching stations and became tolerant to the noise of helicopters (J.M. Fraguero Frías, pers. comm.)

CONSIDERATIONS

These studies, carried out during several days during two months per season, give an IDEA of what is in the study area, but obviously do not represent all the animals or birds that might be present. In a study such as this, there are a great many variables that cannot be controlled (the state of the tides, the time of day of the survey, the amount of wind, recent rainfall, prolonged dryness) all these can affect the presence or absence of birds or mammals in an area. We try to do our flights as the tide starts to recede, but this is not always possible; we must fly when a helicopter is available. Some birds appear on the flats as soon as the tide starts to go down. Others rest during highest and lowest tides, then feed during the first three hours of a rising tide. Most birds are active in the morning, but others only in the evening. We can pass along the shores under the long cliff areas only during low tide. The mud flats of Bahía San Sebastián are enormously wide; we can see only a small portion on flights. On shore surveys, we have more time to observe the small birds (hence more species are recorded), but we cannot see far out to sea. Strong winds or cold can keep birds under shelter and be so uncomfortable as to hinder our own powers of observation. In sponsoring these studies, Total Austral S.A. has furthered our understanding of the ecology of mammals and birds in an area which has been little studied scientifically, especially in the colder months. We recommend that such surveys be continued and be extended to other coastal areas.

ACKNOWLEDGEMENTS

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