

Biological survey of the Prince Edward Islands, December 2008

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A biological survey of the Prince Edward Islands took place in December 2008. The survey repeated an earlier survey of the populations of surface-nesting seabirds on both islands and of fur seals (*Arctocephalus* spp.) and alien plants on Prince Edward Island in December 2001. Observations on burrowing seabirds, macro-invertebrates and plant communities on Prince Edward Island and an oceanographic survey of surrounding waters were also included. The survey confirmed many of the observations made on the earlier survey and permitted an assessment of trends in the abundance and distribution of biota since 2001.

Key words: Prince Edward Islands, sub-Antarctic, Southern Ocean, population surveys, alien plants, oceanographic research

The Prince Edward Islands (comprising Marion Island and Prince Edward Island) in the southern Indian Ocean are South Africa's only overseas possession and form a Special Nature Reserve with the highest level of national legal protection, equivalent to World Conservation Union (IUCN) Management Category Ia: Strict Nature Reserve (protected area set aside to protect biodiversity and managed mainly for science).¹ In 2007 the islands (including waters to 500 m offshore) were designated a Site of International Importance under the Ramsar Convention on Wetlands (http://www.ramsar.org/profile/profiles_south_africa.htm). South Africa also is party to two international instruments that have specific relevance to the Prince Edward Islands: the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR; www.ccamlr.org) and the Agreement on the Conservation of Albatrosses and Petrels (ACAP; www.acap.aq). South Africa has contributed information on penguins to CCAMLR's Ecosystem Monitoring Program since 1994.^{2,3} Its ratification of ACAP in November 2003 brought this agreement into force on 1 February 2004. In August 2008, South Africa hosted meetings of ACAP's Working Groups and its Advisory Committee. Nine of the 26 species of albatrosses and petrels listed on ACAP's Annex 1 breed regularly on the Prince Edward Islands.

Three major conservation initiatives for the island group are currently under consideration by the South African authorities: the formal adoption of a new environmental management plan

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drafted in 2006 to replace the current plan adopted in 1996; the declaration of a large Marine Protected Area, including all territorial waters out to 12 nautical miles (nm) and extending in several directions to the limit of the islands' 200-nm Exclusive Economic Zone; and the nomination of the islands as a Natural Site to the World Heritage Convention⁴⁻⁸ (see also <http://whc.unesco.org/en/tentativelists/1923>).

In the main, biological research conducted on the Prince Edward Islands has been restricted to the larger Marion Island, which supports a combined weather and research station, relieved annually.⁹ Visits to uninhabited Prince Edward Island occur more rarely and normally only during the annual relief voyages to Marion Island in April/May. Such visits are subject to strict controls on party size, duration and interval.^{4,5} In addition, most physical, chemical and biological oceanographic research conducted in the vicinity of the islands has been carried out during annual relief voyages.

The Prince Edward Islands are internationally-important breeding sites for a diversity of seals and seabirds. Most of these species breed during summer months, when marine productivity peaks. Invertebrate and plant activity and growth are also at their highest at this time.⁹ Although biological research, including surveys and censuses of biota, does take place at Marion Island during summer (conducted by 'overwintering' personnel spending a year at the island), field teams are then small (normally one to two persons per project), and there are no opportunities to visit Prince Edward Island, 21 km distant.

In December 2001 a summer survey of surface-nesting seabirds was undertaken at both islands (and of fur seals (*Arctocephalus* spp.) and alien plants at Prince Edward Island), resulting in a suite of publications that has been used to support South Africa's national and international obligations to manage the islands effectively.^{10,11} In order to assess changes (especially in population sizes) that may have occurred since then, a second summer survey of fur seals and seabirds breeding on the Prince Edward Islands took place in December 2008, with the addition of research on macro-invertebrates and plants at Prince Edward Island and of an oceanographic component. This paper describes the main activities undertaken during the survey and highlights its main findings.

Survey party and itinerary

A 23-person team of biologists and oceanographers under the overall leadership of Robert Crawford, Marine and Coastal Management, formerly of the Department of Environmental Affairs and Tourism, sailed from Cape Town, South Africa aboard the E.R.V. *Africana* on 10 December 2008. Following pre-sailing quarantine procedures and checks, a boot-washing and kit-inspection 'ceremony', in accordance with SANAP (South African National Antarctic Programme) procedures, was undertaken on the southward voyage to ensure that clothing and equipment going ashore would be free of alien propagules.^{1,6} Most equipment and clothing supplied to the Prince Edward Island camping party (see below) was previously unused as an additional quarantine measure.

The islands were reached by dawn on 16 December. A party of 10 persons was landed at Cave Bay, Prince Edward Island, by rigid inflatable boats on that morning, where a tented camp was established. As part of the landing protocol at Prince Edward Island, 11 rodent bait stations (with scented, attractive baits) were set in and around the camp. The ship then proceeded to Marion Island and landed a seven-person party the same day, leaving six persons aboard to undertake oceanographic research in the vicinity of the islands. The two shore parties then divided

into smaller field teams, working from Cave Bay and Hope Stream on Prince Edward Island, and from the weather station and eight coastal field huts on Marion Island. The Marion field teams were joined by several members of the Marion overwintering team.

The Prince Edward Island party transferred to Marion Island on 22 December. Following departure from the island the rodent bait stations were inspected for chew marks. No signs were found, and no field evidence of rodents was recorded at any point during the expedition to the island, thought to have always been rodent-free.¹² All solid, including human, wastes were removed from the island for disposal in South Africa. To avoid genetic exchange of biota between the two islands, protective clothing and footwear used on Prince Edward Island was left aboard the ship, being replaced by clean items for use on Marion Island.

Field work on Marion Island was completed on 23 December and all shore-based survey personnel rejoined the ship the next day. After a period spent in the lee of the island sheltering from rough seas, the *Africana* sailed for home on 25 December, arriving in Cape Town on 31 December.

Preliminary achievements

Seals

Antarctic *Arctocephalus gazella* and sub-Antarctic *A. tropicalis* fur seals were surveyed at Prince Edward Island. For both species, counts were made of territorial males and the numbers of pups present estimated.¹³ One of two inaccessible sections of coastline was surveyed for the first time, with the beaches between McNish Bay and Kent Crater scanned from the cliffs above. A preliminary analysis revealed that the population of Antarctic fur seals has increased since 2001. An extension of breeding colony sites of sub-Antarctic fur seals was observed. Checks of moulting southern elephant seals (*Mirounga leonina*) found very few flipper tags placed on weaned pups at Marion Island in previous years, suggesting limited movement between the two islands.

Birds

Preliminary results suggest that, for most species of surface-nesting seabirds (penguins, albatrosses, giant petrels, cormorants and larids), breeding populations have remained relatively stable since 2001¹⁰ at both islands, although for some species better coverage at Prince Edward Island has led to higher figures. The most marked difference was among cliff-nesting sooty albatrosses (*Phoebastria fusca*), where the 2008 census was almost double that of 2001. This species has recently been uplisted to Endangered (<http://www.birdlife.org/datazone/species/index.html?action=SpcHTMDetails.asp&sid=3967&m=0>), and the larger population on Prince Edward Island further emphasises the importance of this island as a breeding site for albatrosses. A single shy/white-capped albatross (*Thalassarche cauta/steadii*) was found incubating on Prince Edward Island among a small colony of grey-headed albatrosses (*T. chrysostoma*). This is the first time this taxon has been found breeding outside Australasia,¹⁴ bringing the number of species of albatrosses known to have bred on the island to six.

Since 1994, there has been a large decrease (20%) in the mass of southern rockhopper penguins (*Eudyptes chrysocome*) returning to Marion Island from their overwintering feeding grounds to breed.¹⁵ This has been associated with decreased breeding success.¹⁶ The 2008 survey confirmed a large and continued decrease in southern rockhopper penguins at Marion Island, from more than 170 000 pairs in 1994/95¹⁷ to fewer than 60 000

pairs at present. Because Rockhopper Penguins at Marion Island do not feed on commercially-exploited prey, their decrease at this and at other localities within Southern Ocean waters is thought to have resulted from environmental change.¹⁸ For example, recent large displacements of prey items off South Africa have led to mismatches in the distributions of breeding localities and prey, and consequentially to substantial population decreases of some seabirds.¹⁹

The relative abundances of burrowing petrels (families Procellariidae and Oceanitidae) were studied via spot-lighting at night on both islands and by analysing avian remains in sub-Antarctic skua (*Catharacta antarctica*) middens at Prince Edward Island. A preliminary survey of the distribution and density of burrows of the white-chinned petrel (*Procellaria aequinoctialis*) was made at Prince Edward Island, which will enable a first estimate of population size for the entire island. A similar survey is planned for Marion Island.

Time-depth recorders were fitted to nine macaroni penguins (*E. chrysolophus*) brooding small chicks at Funk Bay, Marion Island, of which eight were recovered. Satellite trackers (Platform Transmitter Terminals; PTTs) were fitted to ten (eight brooding) Indian yellow-nosed albatrosses (*T. carteri*) on Prince Edward Island, a species that does not breed at Marion Island. Two PTTs were placed on light-mantled sooty albatrosses (*Phoebastria palpebrata*) on Marion Island, with a further ten left on the island for later placement on this species and on sooty albatrosses.

Ninety-four hours of quantified seabird and marine mammal observations in total were made from the *Africana* during the southern and northern journeys. Almost 2 300 individuals of 45 species of seabirds and 6 species of cetaceans were identified.

Invertebrates

The invertebrate research had four major components. First, invertebrate surveys aimed to assess the density of macro-invertebrates as part of an ongoing study to investigate the influence of introduced house mice (*Mus musculus*), present on nearby Marion Island, but not on Prince Edward Island.¹² Second, individuals of all six weevil species^{20,21} were collected as part of an assessment of body-size change associated with climate change and predation by mice on Marion and Prince Edward Islands.^{12,22} Third, quantitative assessments of springtail densities were made to compare with previous work^{23,24} and to determine which alien species were present. Finally, quantitative sampling of caterpillars, vascular plants, peat, and nest material was undertaken around wandering albatross (*Diomedea exulans*) nests for genetic and isotope analyses. Previous work²⁵ has suggested that wandering albatrosses serve as thermal ecosystem engineers for *Pringleophaga* sp. (Lepidoptera, Tineidae) caterpillars, which are the main bottleneck for nutrient cycling in the terrestrial system. However, mice may also influence the outcome of this interaction, therefore a control on mouse-free Prince Edward Island was essential.

All of the invertebrate research was completed successfully. It is clear that many invasive alien invertebrates common on Marion Island have not yet managed to colonise Prince Edward Island. These include the springtails *Pogonognathellus flavescens* and *Isotomurus* cf. *palustris*, the slug *Deroceras panormitanum*, the wasp *Aphidius matricariae*, the moth *Plutella xylostella*, and the psychodid midge *Psychoda parthenogenetica*.²⁶

Plants

Research on the vascular plants on Prince Edward Island had three main components. First, we examined changes in the

distributions of alien vascular plant species, and documented new arrivals. Second, we provided information for ground-truthing a proposed vegetation map, with over 150 vegetation quadrats sampled in a spatially explicit manner. Third, we collected samples for analysis of genetic variation and relationships among islands of two indigenous species, the prostrate herb *Acaena magellanica* (Rosaceae) and the cushion plant *Azorella selago* (Apiaceae), and the alien annual meadow grass *Poa annua*. This research was successfully completed.

No new alien vascular plant species were found on Prince Edward Island since the last survey in 2001.²⁷ However, procumbent pearlwort *Sagina procumbens* (Caryophyllaceae) has expanded its distribution rapidly since then, and now occurs along virtually all coasts, except for the remote and rather barren High Bluff region. Mouse-eared chickweed *Cerastium fontanum* (Caryophyllaceae) also has extended its range on the north-west side of the island, but was not found above the escarpment and on the eastern side. To record landscape-scale changes, fixed-point photographs were taken at previous points photographed casually by past expeditions to the island and at new points expected to show the most future change.

Oceanography

The Prince Edward Islands are situated in the pathway of the easterly-flowing Antarctic Circumpolar Current. Bordered to the north by the sub-Antarctic Front and to the south by the Antarctic Polar Front, the islands lie within the Polar Frontal Zone which is a transition zone between sub-Antarctic and Antarctic water masses.²⁸ The islands act as obstacles to the Antarctic Circumpolar Current, causing high levels of spatial and temporal mesoscale variability within the region.^{29,30} It has been shown that waters surrounding the islands demonstrate an 'island mass effect' (enhanced phytoplankton production)³¹ whereas an alternative explanation is that food (zooplankton) for the islands' predators (specifically birds) is brought into the vicinity of the islands from upstream regions.³² It has been suggested that the proximity of the islands to the sub-Antarctic Front affects the availability of zooplankton for predators breeding on the islands,³³ such that the high degree of latitudinal variability of the sub-Antarctic Front may have important implications for food availability for breeding predators.

The main objective was to obtain a summer comparison of the zooplankton community upstream and downstream of the Prince Edward Islands with previous studies conducted during the austral autumn/winter months. Secondary objectives included a comparison of zooplankton abundance and biomass upstream, in the vicinity, and downstream of the islands, to investigate the potential influence of the 'island mass effect'.

Conductivity, temperature and depth casts were conducted at 26 stations (six within the area of the islands and 15 downstream of the islands), with water samples collected at selected depths for oxygen, salinity, chlorophyll-*a* and nutrient analyses. In addition, photosynthesis measurements were conducted, using fast repetition rate fluorometry, on water samples from selected depths within the euphotic zone. The biological component of the oceanographic survey consisted of 21 stations where the mesozooplankton community was sampled using a BONGO net with a 200- μm mesh. Unfortunately, due to unfavourable weather conditions, zooplankton was collected from only nine stations for fatty acid and stable isotope analysis for the determination of trophic links between selected components of plankton and nekton. In addition to net tows, surface seawater was collected with a Crawford bucket at each station for the determination of size-fractionated chlorophyll-*a* concentra-

tions. Surface seawater was collected at three stations for POM (particulate organic matter) analysis. Throughout the survey area, the total zooplankton abundance and biomass was dominated by mesoplankton (200–2000 μm), comprising mainly copepods. The macrozooplankton community was dominated by chaetognaths, amphipods, euphausiids and salps.

Full results of the 2008 biological survey of the Prince Edward Islands will be published in specialist scientific journals as detailed analyses and interpretation of findings are completed.

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