



WADE FAIRLEY

“Many snowy petrels follow in the wake of the ship, but they are silent companions, never uttering a song or a cry of delight or fear, always gliding lightly in the air and dropping easily into the water to seek the pelagic fish, which is their food.”

—FREDERICK COOK (1900)
Through the first Antarctic night 1898-1899.

Predicting snow petrel nesting habitats in East Antarctica

Snow petrels spend their entire life in Antarctica. They forage in the pack ice and breed on islands and rocky, ice-free areas of the Antarctic continent, where nest cavities are available. Sea ice conditions, which are likely to be affected by climate change, influence their survival and reproductive success. But climate change may also affect local continental weather, potentially changing the characteristics of breeding habitats (through altered snow accumulation), which will in turn impact on the breeding success of the birds.

To better understand this potential problem, we need to monitor snow petrel populations and their nesting habitats. However, estimates of local breeding populations are rare as systematic large-scale surveys are labour intensive and logistically difficult.

Some answers may be found in the project I have been undertaking over the past three years. The project analyses regional snow petrel nesting distribution using habitat selection models. Commonly used in temperate areas, habitat selection models are potentially useful for studying the ecological relationships between organisms and their environment in the Antarctic ecosystem. They are based on a variety of spatial statistical models, which determine the probability that an organism is present given certain environmental conditions. When combined with the recent advances in Geographic Information Systems, such models can complement the traditional ground surveys for the production of species distribution maps.

The first phase of the modelling project was the collection of spatial data on the distribution of snow petrel nests. During a summer of scrambling in the Windmill Islands near Casey in 2002-03, I mapped the distribution of snow petrel nests in 200 sites of about four hectares each. The locations of 4036 snow petrel nests were recorded using a Global Positioning System, along with descriptions of the local habitat (topography, orientation, slope and cover of various rocky substrates). The habitat was identified around each nest, providing information from which nesting preferences were interpreted.

Of the environmental predictors that explain snow petrel distribution, nest orientation is the most important. The level of wind exposure of the nests is crucial during incubation time, where successful hatching depends on each parent being

able to live on its energy reserves until their mate returns to relieve them. Paradoxically, I found that nests at Casey were predominantly located on hills exposed to the prevailing winds. However, by doing so, snow petrels avoid areas where snow accumulates (generally located downwind), reducing snow blockage in the nests early in the breeding season and later snow melt which can trap the eggs in ice.

Amongst Antarctic nesting birds, the snow petrel has one of the shortest brooding times. Its chick stays in the nest with only intermittent parental visits from three days onwards until fledging. For this reason snow petrel nests need to be as concealed as possible to minimize exposure of the chick to weather and predators. This determines the choice of specific rock types for nesting. At Casey, snow petrels mostly nest at high concentrations in scree slopes, but in a dispersed manner in flat boulder fields, where habitat availability limited densities. By excluding areas where models predicted snow petrel nests to be absent, I could estimate that the number of snow petrel pairs that reside in the Casey region to be as many as 17 000.

The second but most important phase of the modelling project involved testing the robustness of the habitat selection models by checking if the same environmental factors affect snow petrel distribution elsewhere. Field validation was undertaken at Mawson in 2004-05. Mawson provides two types of nesting environments for snow petrels; coastal nesting habitats relatively similar to the Windmill Islands, although lower in elevation, and inland mountain ranges carved by the ice-sheet (the Framnes Mountains), with a completely different geomorphology. This diversity made it an excellent location to investigate the level of variability in the species' ecological niche, and allowed assessment of the models for the purpose of estimating populations at a large scale in East Antarctica. In two months of endless scrambling, Wade Fairley and I located a total of 1050 snow petrel nests in Holme Bay, around Mawson station, and 6500 in the Framnes Mountains.

Large concentrations (up to a thousand nests) were found over a few hectares in the Framnes Mountains, despite a much harsher climate. The age of nests, which can be estimated from the amount of calcified spit built up at the nest entrance, suggested a much more ancient colonisation than in the



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coastal islands. The shortage of habitat in Holme Bay may explain why snow petrels find refuge inland. General weather and wind conditions also explained differences in habitat selection between Casey and Mawson and were reflected in the model results. But it was with relief that I found overall similar nesting preferences for the snow petrels residing at Mawson. Distribution maps created with the Casey models predicted more than 70% of the nests located in the field. The models worked!

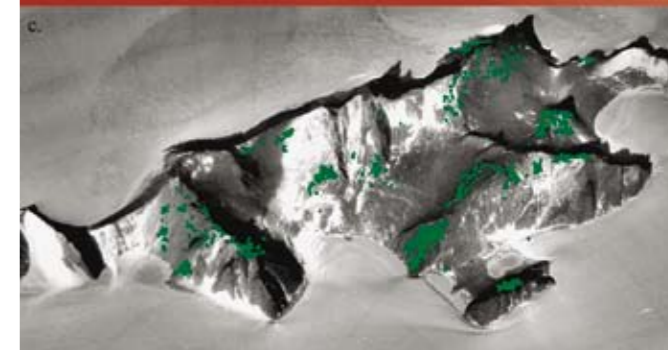
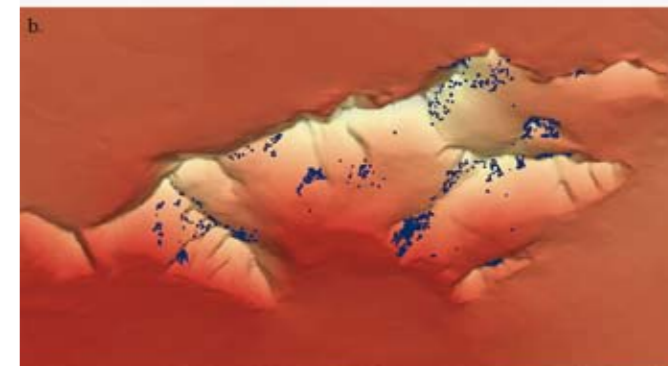
Habitat selection models are likely to be applicable in other unsurveyed areas of East Antarctica and to other species. I am now testing the models with the Wilson's storm petrel. Spatial models have many useful applications in the conservation and management of Antarctic and subantarctic seabird species – in protected areas and areas of human activity, and in flight path maps and the installation of automatic weather stations. Modelling the relationships between species distribution and their environment may also provide valuable monitoring information to predict the effects of habitats altered by climate change.

—FREDERIQUE OLIVIER
IASOS, University of Tasmania



FREDERIQUE OLIVIER

To find the nesting sites of these small, secretive snow petrels, Frederique used her extensive knowledge of their habitat preferences. She recorded nest sites on a Global Positioning System unit (shown below) provided by the Australian Antarctic Data Centre, which allowed her to visualize their location on a digital map of the survey region. This information was used to test models that predict nest sites based on habitat.



Three-dimensional view of the location of snow petrel nests in the Rumdoodle area (Framnes Mountains) of Mawson. From top to bottom: (a) Survey sites (green); (b) GPS observations of snow petrel nests (blue points); (c) nest observations (green points); (d) the predicted location of nests (in blue) generated by the model, based on environmental parameters – probability of nest presence ranking from low (black) to high (white).

Snow petrel nests are well concealed and usually surrounded by snow and an oily spit which accumulates at the top of the nest site and helps to scare predators.