Population parameters and distribution of the black petrel (*Procellaria parkinsoni*), 2005/06

Elizabeth A. Bell, Joanna L. Sim and Paul Scofield

DOC RESEARCH & DEVELOPMENT SERIES 307

Published by
Publishing Team
Department of Conservation
PO Box 10420, The Terrace
Wellington 6143, New Zealand

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DOC Research & Development Series is a published record of scientific research carried out, or advice given, by Department of Conservation staff or external contractors funded by DOC. It comprises reports and short communications that are peer-reviewed.
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ISSN 1176–8886 (hardcopy)
ISSN 1177–9306 (web PDF)
ISBN 978–0–478–14564–9 (hardcopy)
ISBN 978–0–478–14565–6 (web PDF)

This report was prepared for publication by the Publishing Team; editing by Helen O'Leary and layout by Lynette Clelland. Publication was approved by the General Manager, Research and Development Group, Department of Conservation, Wellington, New Zealand.

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Population parameters and distribution of the black petrel (*Procellaria parkinsoni*), 2005/06

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ABSTRACT

This report is part of a long-term study of the black petrel (*Procellaria parkinsoni*) on Great Barrier Island (Aotea Island). During the 2005/06 breeding season, 366 study burrows within the 35-ha study site near Mount Hobson were checked and intensively monitored. Breeding pairs used 257 burrows, non-breeding adults used 43 burrows, and the remaining 66 burrows were non-occupied. By 5 May 2006, 164 chicks were still present in the study burrows and 8 others were presumed to have already fledged, corresponding to a breeding success of 67%. Nine census grids were monitored within the study site and contained 148 of the inspected burrows, with 93 burrows being used for breeding. One new burrow (not recorded in previous years) was found. Twenty-four chicks from earlier breeding seasons were recaptured within the study site. Twenty-five percent of the random transects established within the study site in 2004/05 were re-surveyed. These results and previous data were analysed to clarify habitat grade characteristics and burrow density within the study site. This clearly identified zones of different burrow density (no burrows, low, medium and high burrow density areas). Based on these density ranges and incorporating habitat characteristics, the study area was stratified, and its black petrel population estimated to be in the range of 3164–4066 birds. Eleven geo-locator data-loggers were also deployed on breeding black petrels. These indicated that the foraging range for the black petrels was highly variable, with no apparent differences between the sexes. Seven birds foraged around the North Island of New Zealand, particularly along the continental shelf edges or seamounts. Four birds travelled near the Chatham Rise, two birds travelled further north towards Fiji, four birds travelled towards the eastern Australian coast and one bird travelled around the southern tip of the South Island of New Zealand. These preliminary results show how important accurate foraging and distribution information is for determining national and international fisheries risk for the black petrel. It is recommended that further tracking work is undertaken for this species.

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Bell, E.A.; Sim, J.L.; Scofield, P. 2009: Population parameters and distribution of the black petrel (*Procellaria parkinsoni*), 2005/06. *DOC Research & Development Series 307*. Department of Conservation, Wellington. 47 p.

1. Introduction

The black petrel, *Procellaria parkinsoni*, is a medium-sized endemic seabird which is only known to breed on Hauturu/Little Barrier Island (36°199´S 175°082´E) and Great Barrier Island (Aotea Island) (36°187´S 175°4125´E), New Zealand (Heather & Robertson 1996). The main breeding area on Great Barrier Island lies around the summit of Mount Hobson. Monitoring work carried out in this area during the 2005/06 breeding season was a continuation of the survey and monitoring study begun in 1995/96 (Bell & Sim 1998a, b, 2000a, b, c, 2002, 2003a, b, 2005; Bell et al. 2007), adding to the baseline data on the Great Barrier Island black petrel population. This study will assist in identifying effects that long-line fishing, rat and cat predation and habitat disturbance may have on the population. The population estimate has been updated, ensuring that any population changes will be detected in time to implement the appropriate management strategies.

2. Objectives

The main objective of this study was to undertake an annual census of the black petrel population on Great Barrier Island via burrow monitoring and the banding of adults and fledglings to establish levels of adult mortality, breeding success and recruitment. Since this study was a continuation of research from previous breeding seasons, we also aimed to provide more data to establish population trends and to determine causes and timing of mortality.

The study objectives were to:

- Monitor a sample of black petrel burrows within the main breeding area on Great Barrier Island and band all adults present in the burrows during December 2005 and January/February 2006 and all remaining fledglings during April 2006
- Determine breeding success in the sample of long-term study burrows and record causes of breeding failure, such as predation or disappearance of parents
- Monitor and re-survey the census grids and study site for new burrows and band and recapture as many breeding and non-breeding birds present as possible
- Determine a population estimate by extrapolating from transect lines and census grids to the main Mount Hobson breeding area.
- Continue the mark/recapture programme and band as many birds as possible at the beginning of the breeding season (November/December) to determine juvenile (pre-breeder) survival, age of first return to the natal colony, age of first breeding attempt, age of first successful breeding attempt and adult (breeder) survival

- Confirm the breeding status of adults during each visit to the colony (i.e. monitor the study burrows at the beginning, middle and end of the breeding season) and, where possible, identify the sex of the resident adult
- Use light geo-locator data-loggers to determine the at-sea distribution of black petrels during the breeding season (incubation and chick rearing)

3. Methods

3.1 STUDY BURROWS

The study site (35 ha at and near the summit of Mount Hobson; Fig. 1) was visited from 1 to 11 December 2005. During this visit the study burrows ($n = 366$, Figs 1–4) were checked for the presence of adults and eggs. The study burrows were either randomly selected from burrows along the track system (i.e. within 10 m of either side), burrows that have returned chicks (pre-breeders) resident, or all burrows within the nine census grids. The study burrows have been selected regularly since the 1995/96 season (Bell & Sim 1998a, b, 2000a, b, c, 2002, 2003 a, b, 2005; Bell et al. 2007). To ensure accurate monitoring, the study burrows were accessible either through the main entrance or via an opening that had been excavated through the burrow roof into the chamber. This opening was covered by a piece of plywood, which was camoflaged with soil and debris. Any occupying adult was removed from the burrow, banded (or the band number recorded if a recapture), sexed by viewing the cloaca (if swollen, the bird is a female—the cloaca is particularly obvious immediately after egg laying), and returned to the burrow. The presence of any egg was noted.

On a second visit to the study area (planned for 14–29 January 2006), the intention was to monitor the study burrows intensively. Because of very bad weather conditions, this trip was cut short and a further visit to the colony was made from 20 to 27 February 2006, when the study burrows were intensively monitored again.

As in the December visit, any adults present were identified or banded, and returned to the burrow. The presence of eggs, eggshell fragments or chicks was noted and the absence of this sign was used to identify non-breeding birds. The study burrows were monitored again (1 to 5 May 2006) to determine breeding success.

The locations of study burrows were mapped by entering GPS co-ordinates into GIS-mapping software (Manifold™).

3.2 CENSUS GRIDS

The three original grids—KDG1, PTG1 and SFG1—were established in 1996 (Bell & Sim 1998a). These grids were located in areas with a known historical presence of black petrels, different strata, vegetation types and topography and were near known petrel-launch sites (Bell & Sim 1998a). These original girds

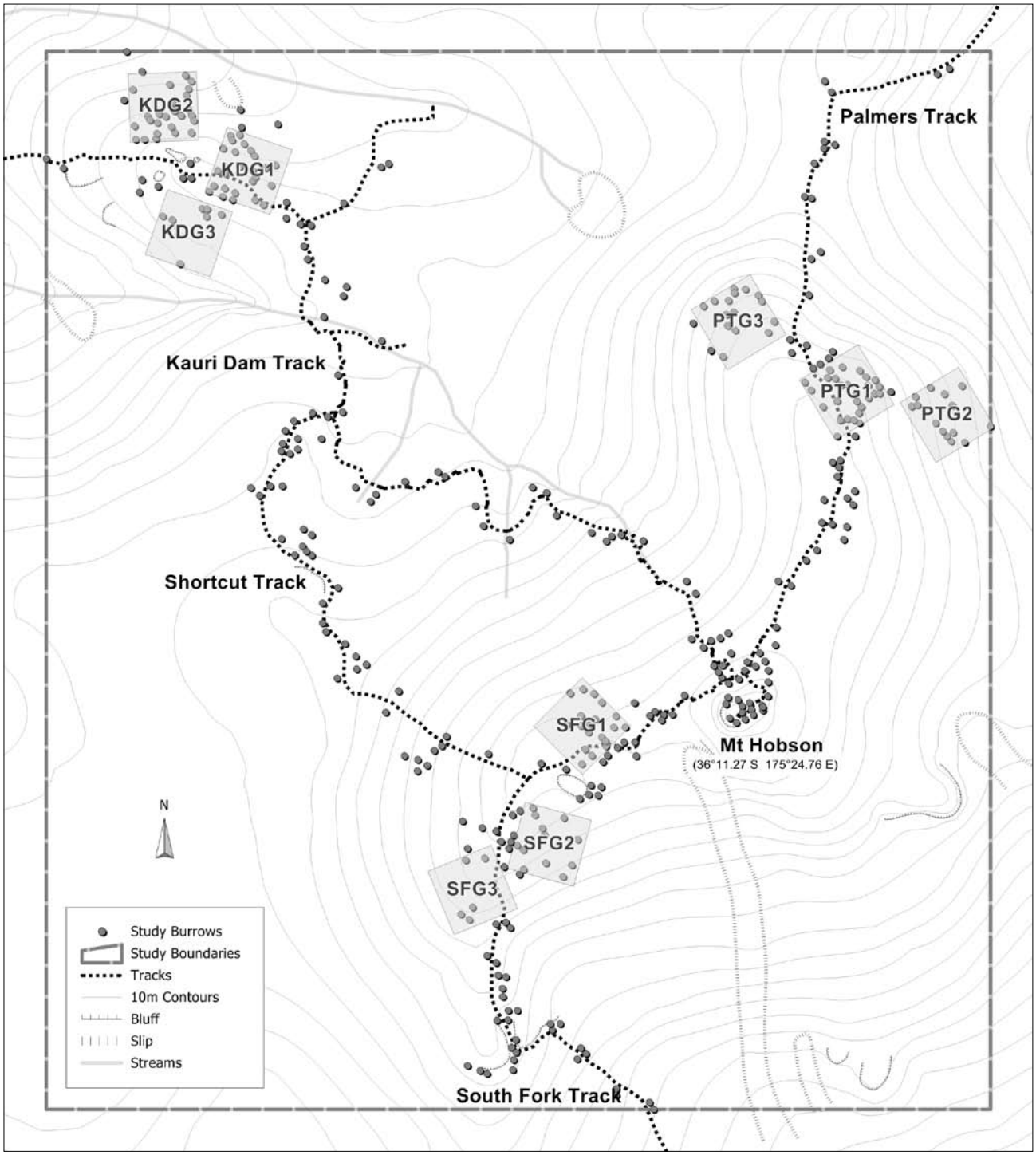
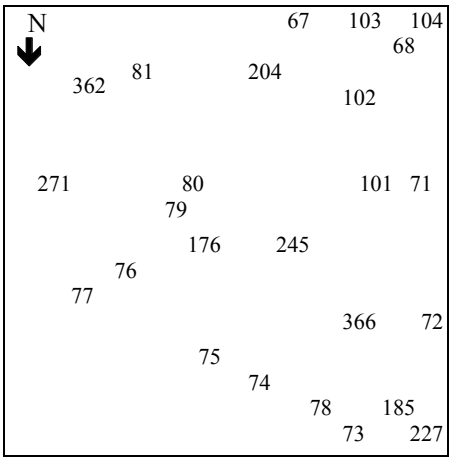
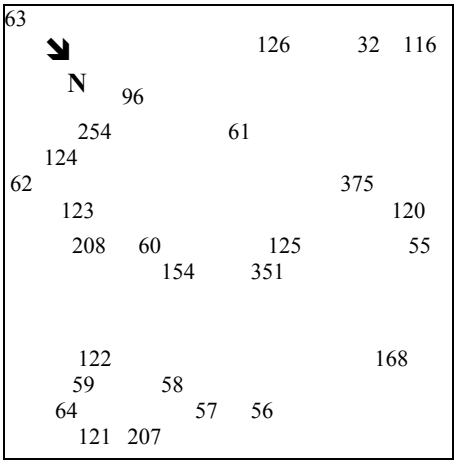


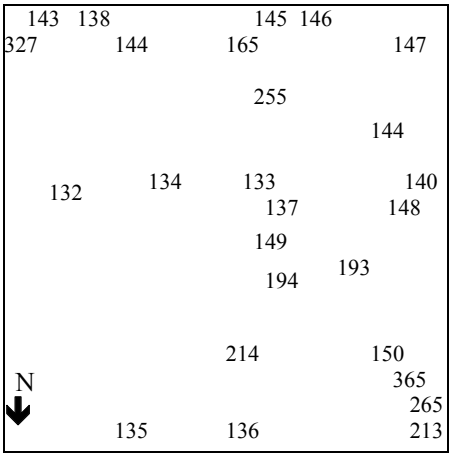
Figure 1. Location of the black petrel (*Procellaria parkinsoni*) study burrows and census grids within the study site on Great Barrier Island (Aotea Island). Altitude (621 m a.s.l.) is shown. Approximate North is shown (N). KDG = Kauri Dam Grid; SFG = South Forks Grid; PTG = Palmers Track Grid.



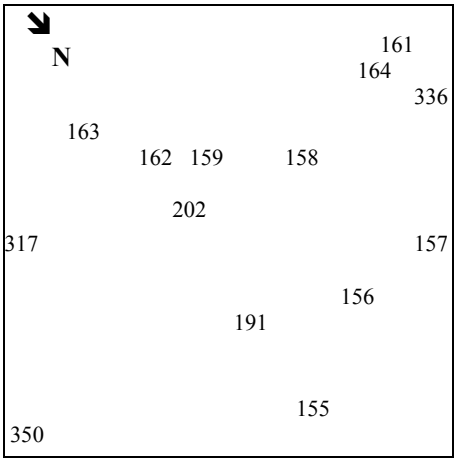
Kauri Dam grid one (KDG1)



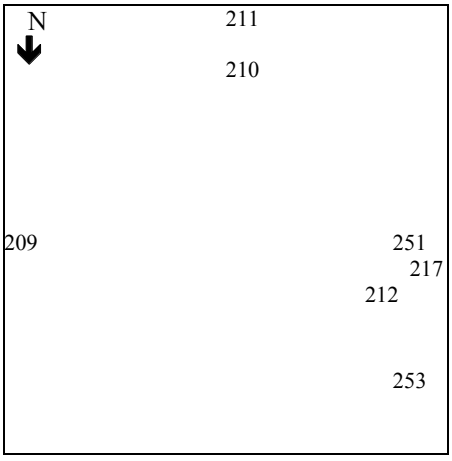
Palmer's Track grid one (PTG1)



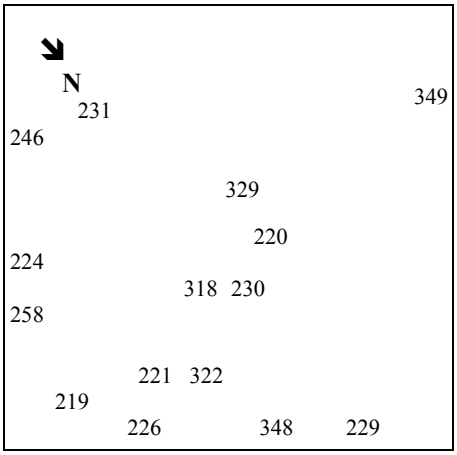
Kauri Dam grid two (KDG2)



Palmer's Track grid two (PTG2)



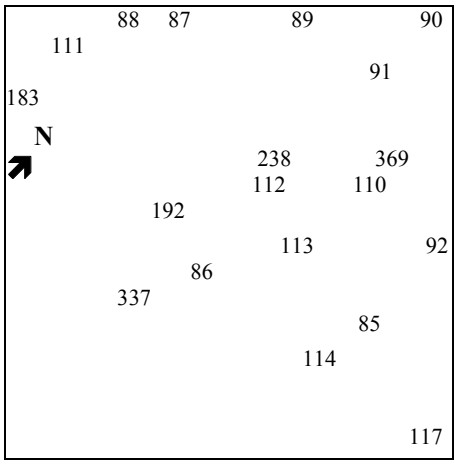
Kauri Dam grid three (KDG3)



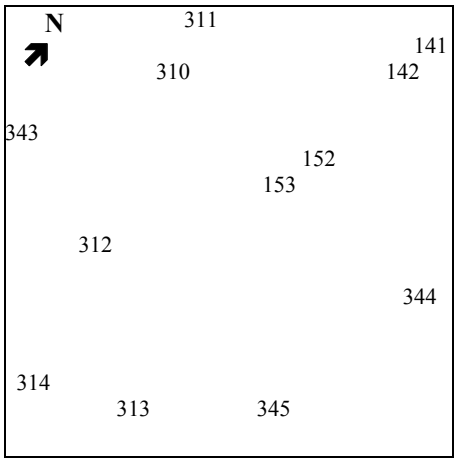
Palmer's Track grid three (PTG3)

Figure 2. Location of black petrel (*Procellaria parkinsoni*) burrows found in the Kauri Dam grid sites (each grid is 40 × 40 m), Great Barrier Island (Aotea Island).

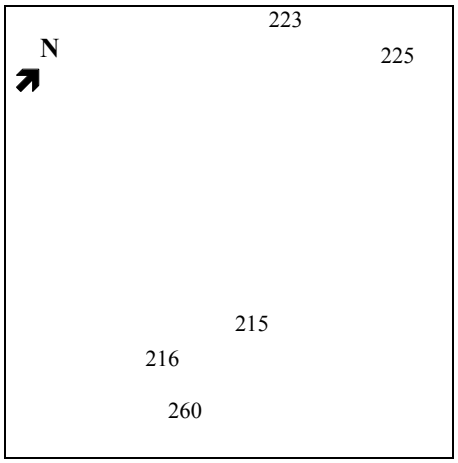
Figure 3. Location of black petrel (*Procellaria parkinsoni*) burrows found in the Palmers Track grid sites (each grid is 40 × 40 m) on Great Barrier Island (Aotea Island).



South Fork Track grid one (SFG1)



South Fork grid two (SFG2)



Kauri Dam grid three (SFG3)

Figure 4. Location of black petrel (*Procellaria parkinsoni*) burrows found in the South Fork grid sites (each grid is 40 × 40 m) on Great Barrier Island (Aotea Island).

were replicated in 1998 (KDG2, PTG2 and SFG2) and in 1999 (KDG3, PGT3 and SFG3) to compare burrow densities between areas and to increase the accuracy of the population estimate (Bell & Sim 2000a, b).

In the present study, these nine census grids (each 40 × 40 m) around Mount Hobson were systematically searched (at 1-m intervals) during the December visit to locate any new burrows and to determine occupancy rates (Figs 1–4). The same procedure as for study burrows (see Section 3.1) was followed for all birds in the burrows in the grids.

3.3 TRANSECTS

Twenty-six random transects were completed during the 2004/05 breeding season to determine burrow density throughout the study site (Bell et al. 2007). Seven of these transects were resurveyed in the same manner during December this season (LT1, 6, 12, 18, 19, 37 and 41). Any burrows located within the search area were treated in the same manner as given in the 2004/05 season report (Bell et al. 2007) and the same procedure as outlined in Section 3.1 was followed for any bird caught in the transect burrows.

In the present (2005/06) study, four grades of petrel habitat were identified, based on the density of petrel burrows and incorporating habitat characteristics such as terrain (slope and aspect), vegetation (emergent tree species, dense or moderate canopy species, scrub species and undergrowth species) and coverage (scrub cover, secondary growth or primary forest). Each transect of the original 19 transects and 7 resurveyed transects were then stratified using these four grades of habitat. The coverage area (two-dimensional only) of the four different grades of petrel habitat (non–petrel habitat, low grade, medium grade and high grade) within the study site was determined using Manifold™.

3.4 NIGHT BANDING

Night work was undertaken during the December 2005 visit to the study area. This involved searching the study area by walking the track system and capturing any adult on the surface. Several nights were also spent at known petrel launch sites, where birds were captured at take off or landing. All birds were banded or had their band numbers recorded. During this visit sex was determined if possible (by cloacal inspection).

3.5 POPULATION AND SURVIVAL ESTIMATES

Bell et al. (2007) noted that previous population estimates determined by direct extrapolation from the nine census grids on Great Barrier Island have overestimated the black petrel population size (Bell & Sim 1998a, b, 2000a, b, c, 2002, 2003a, b, 2005). This is due to the fact that these grids were established in areas of known high petrel density, whereas the study area does not have a uniform distribution of burrows. Extrapolation from transect data might give a fairer estimate, but it still fails to take into account the range of habitat types identified within the study site.

This can be shown by deriving three possible population estimates for the 35-ha study site:

- Extrapolating from the original census grids (multiplying their density values by 35)
- Extrapolating from transects only (multiplying their density values by 35)
- Extrapolating from the transects and census grids after stratification of the study site (by stratifying the 35-ha study site into the four habitat grades based on burrow density, ranking the transects and census grids into those habitat types, and then extrapolating from the ranked transects to the habitat areas which make up the 35-ha study site)

For all estimates, any breeding burrow was treated as having two resident birds present and any non-breeding burrows was treated as having 1.25 birds present (as for any non-breeding burrow there is a 25% chance of capturing more than one bird in the burrow when the resident male attracts a female to that burrow).

Adult survival and the corresponding dispersion coefficient (Chat) value were calculated using the Cormack Jolly Seber model for adult survival over time (Phi(t)

P(t)), where Phi = apparent survival, t = time and *P* = probability of recapture. Juvenile survival and the corresponding Chat value were also calculated, using the Burnham Jolly Seber model. Population trends were measured using multi-state models to determine the probability of changing states from chick to successful or non-successful breeder to non-breeder: S(.) *P*(.) psi(breeder to non-breeder*t), where S = survival rate, *P* = probability of recapture, psi = transition probability and t = time using five states (unknown status, successful breeder, unsuccessful breeder, chick, non-breeder). Adult survival was assumed to be constant and the probability of survival of chicks was set at 0.5 for the first 3 years and then 0.92 thereafter. These parameters were calculated by the Burnham Jolly Seber model, which relaxes the assumption of equal catchability, allows survival to be set for certain age classes, uses the information from both live captures and dead recoveries, and determines the rate of change between each transition state. All parameters were determined using Program MARK (http://welcome.warnercnr.colostate.edu/~gwhite/mark/mark.htm). The goodness of fit of the models (i.e. likelihood value) was measured using Aikakes Modified Information Criterion (AICc). Models with a lower AIC are better that those with higher AIC, i.e. it is more likely that the model fits the population and is likely to be an accurate explanation of, or value for, the parameter (such as survival).

3.6 DATA-LOGGERS

Eleven LOTEK™ LAT2500 geo-locator data-loggers (Lotek Wireless, Ontario, Canada) were attached to known breeding adult black petrels during the December 2005 visit. The birds were chosen from the Kauri Dam area (within the study site) if they had been successful breeders for at least five seasons and had been in the same pair for over eight seasons. These loggers were light (6 g) and small and fitted into a specially designed holder, which was then attached to the bird's leg by a small rubber strap. Six were placed on known males, three were placed on known females and two were placed on birds of unknown sex (one suspected male and one suspected female). All 11 geo-locator data-loggers were retrieved during the January 2006 visit. The data-loggers give data on position, flight time, time spent on the water, surface temperature and dive depth. The loggers record temperature and pressure data every 80 seconds. The data was downloaded in April 2006 and analysed using an algorithm program developed in the USA (Scott Schaffer, University of California Santa Cruz, pers. comm. 2006). A trip was distinguished by the departure from and return to the colony (i.e. Great Barrier Island) by the bird. Any bird could make one or more trips from the colony between deployment and retrieval of the loggers, depending on the stage of incubation and behaviour of the bird. Multiple trips for individual birds were identified separately (i.e. alphabetically). Detailed plots of each trip were then mapped onto New Zealand bathymetry maps (see Section 4.7). Ethical approval for the use of all geo-locator data loggers was given by DOC Ethics Committee (15 Dec 2005, AEC127).

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