The breeding population of Spotted Shags (*Stictocarbo punctatus punctatus*) on Banks Peninsula: 36 years later

JANET L. DOHERTY[1] & STEFAN BRÄGER[2]
[1] *102 North Hancock Street, Lexington, MA 02173, U.S.A.;* [2] *Department of Marine Science, University of Otago, P.O. Box 56, Dunedin, New Zealand*

ABSTRACT

In 1960, a census of the Spotted Shag (*Stictocarbo punctatus punctatus*) population on Banks Peninsula found 9,787 breeding pairs (Turbott & Bell 1995). Here we report the results of a comparative census conducted on Banks Peninsula during the 1996 breeding season. Thirty-six years after the original census, the number of breeding pairs was found to have more than doubled to 22,123 pairs. We speculate that the population was formerly limited by food availability and that a reduction in fishing effort around Banks Peninsula, especially in the late 1980s, may have contributed to the observed growth in the shag breeding population.

KEYWORDS: population census, Spotted Shag, *Stictocarbo punctatus punctatus*, Banks Peninsula, New Zealand.

INTRODUCTION

The Spotted Shag (*Stictocarbo punctatus punctatus*) is endemic to New Zealand breeding along the coasts mainly of the South Island (Bull *et al.* 1985, Marchant & Higgins 1990). The total population has been estimated to be between 60,000 and 150,000 breeding pairs (Marchant & Higgins 1990). However, a count of occupied nests on Banks Peninsula by Turbott & Bell (1995) in 1960 seems to be the only systematic count of breeding Spotted Shags anywhere to date. Therefore, a repetition of this census after 36 years might give some indication of the general status of this New Zealand species.

Around Banks Peninsula (center at 43° 45'S, 173° E), Spotted Shags nest colonially on the cliffs from Sumner Head south to Birdlings Flat. Egg laying at Whitewash Head, Banks Peninsula began in mid-September and continued over a period of three to four weeks, followed by a month-long incubation period (Fenwick & Browne 1975). Spotted Shags off Kaikoura are reported to feed in deep water, usually within 10 nautical miles (approx. 18.5 km) of land (Stonehouse 1967). Around Banks Peninsula they are often seen foraging close to shore (pers. obs.).

METHODS

Survey techniques and timing were modelled after those used by Turbott & Bell (1995) in 1960. This is crucial to guarantee comparability between the two surveys (Harris & Forbes 1987). The timing of the census in late October to early November was intended to coincide with the incubation stage of the breeding cycle so that a tally of occupied nests should lead to a reasonable estimate of the size of the breeding population.

TABLE 1 - Change in the number of occupied nests in Spotted Shag colonies on Banks Peninsula between 1960 and 1996.

Area	Colony	1960	1996	Difference, no. of nests	Regional change, %
Northwest	Sumner Head	230	729	+499	+116
	Godley Head	1	229	+228	
	Mechanics Bay	43	124	+81	
	Little Port Cooper	110	206	+96	
	E of Beacon Rock	182	285	+103	
	Rock Island	88	102	+14	
	Blind Bay	117	176	+59	
	W of Little Pigeon Bay	214	179	-35	
	Pigeon Bay - W	0	77	+77	
	Pigeon Bay - E	15	54	+39	
Northeast	Wakaroa Point - Whitehead Bay	243	54	-189	-11
	Scrubby Bay	145	353	+208	
	Squally Bay	102	70	-32	
	Decanter Bay	216	232	+16	
	Little Akaloa Bay	0	67	+67	
	W of Long Lookout Point	60	115	+55	
	S of Sail Rocks	388	280	-108	
	Pa Island	306	94	-212	
	Pa Island Bay - S	0	93	+93	
	Ducksfoot Bay	111	0	-111	
	Lavericks Bay - N	269	534	+265	
	Lavericks Bay - S	297	0	-297	
	Le Bons Bay	0	9	+9	
Southeast:	N of Lighthouse	387	1038	+651	+162
	S of Lighthouse	0	454	+454	
	East Head	100	766	+666	
	Hickory Bay - N	234	107	-127	
	Hickory Bay - S	112	282	+170	
	Crown Island	60	92	+32	
	Goughs Bay	0	75	+75	
	Paua Bay	53	297	+244	
	Goats Point	170	161	-9	
	Shell Bay	5	20	+15	
	The Horseshoe	134	22	-112	
	Otanerito Bay - N	7	178	+171	
	Otanerito Bay - S	46	2	-44	
	Reef Nook	3	2	-1	
	E of East Island	3	287	+284	
	East Island	105	81	-24	
	Island Nook	130	169	+39	
	Dyke Head	8	74	+66	
	E of Damons Bay	20	67	+47	
	Damons Bay	0	120	+120	
	The Amphitheatre	101	102	+1	
Akaroa Harbour	Truini Point	20	239	+219	+835
	Dan Rogers Creek	30	209	+179	
	Dan Rogers Caves	25	149	+124	
	N of Dan Rogers	0	19	+19	
	N of Mat White Bay	0	142	+142	
	S of Lucas Bay - Jacobs Ladder	21	140	+119	

TABLE 1 Cont'd

Area	Colony	1960	1996	Difference, no. of nests	Regional change, %
Southwest	Waihuiakina Bay	3	0	-3	+162
	W of Waihuiakina Bay	0	334	+334	
	E of Scenery Nook	35	282	+247	
	Rocky Nook	95	329	+234	
	E of Whakamoa Reef	0	449	+449	
	W of Whakamoa Reef	130	545	+415	
	Island Bay	0	165	+165	
	Island Bay - Long Bay	292	268	-24	
	Long Bay - E	87	547	+460	
	Long Bay - W	125	275	+150	
	Long Bay - Snuffle Nose	389	1050	+661	
	Big Horseshoe Bay - E	0	261	+261	
	Big Horseshoe Bay - W	86	90	+4	
	Little Horseshoe Bay - E	0	141	+141	
	Little Horseshoe Bay - W	64	169	+105	
	Whale Island	538	855	+317	
	Peraki Bay	208	948	+740	
	Robinhood Bay - E	69	393	+324	
	Robinhood Bay - W	76	178	+102	
	W of Robinhood Bay	553	802	+249	
	E of Te Oka Bay - Hells Gate	250	204	-46	
	Te Oka Bay	9	241	+232	
	W of Te Oka Bay	635	604	-31	
	Tumbledown Bay	227	375	+148	
	E of Murrays Mistake	473	976	+503	
	Murrays Mistake	8	157	+149	
	W of Murrays Mistake	10	105	+95	
	E of Magnet Bay	137	1103	+966	
	Magnet Bay	182	122	-60	
	Tokoroa Bay - Ikirangi Bay	26	139	+113	
	Tokoroa Bay - E	143	362	+219	
	Tokoroa Bay - W	4	114	+110	
	E of Ohahoa Bay	6	161	+155	
	Birdlings Flat	16	23	+7	
Total		**9,787**	**22,123**	**+12,336**	**+126**

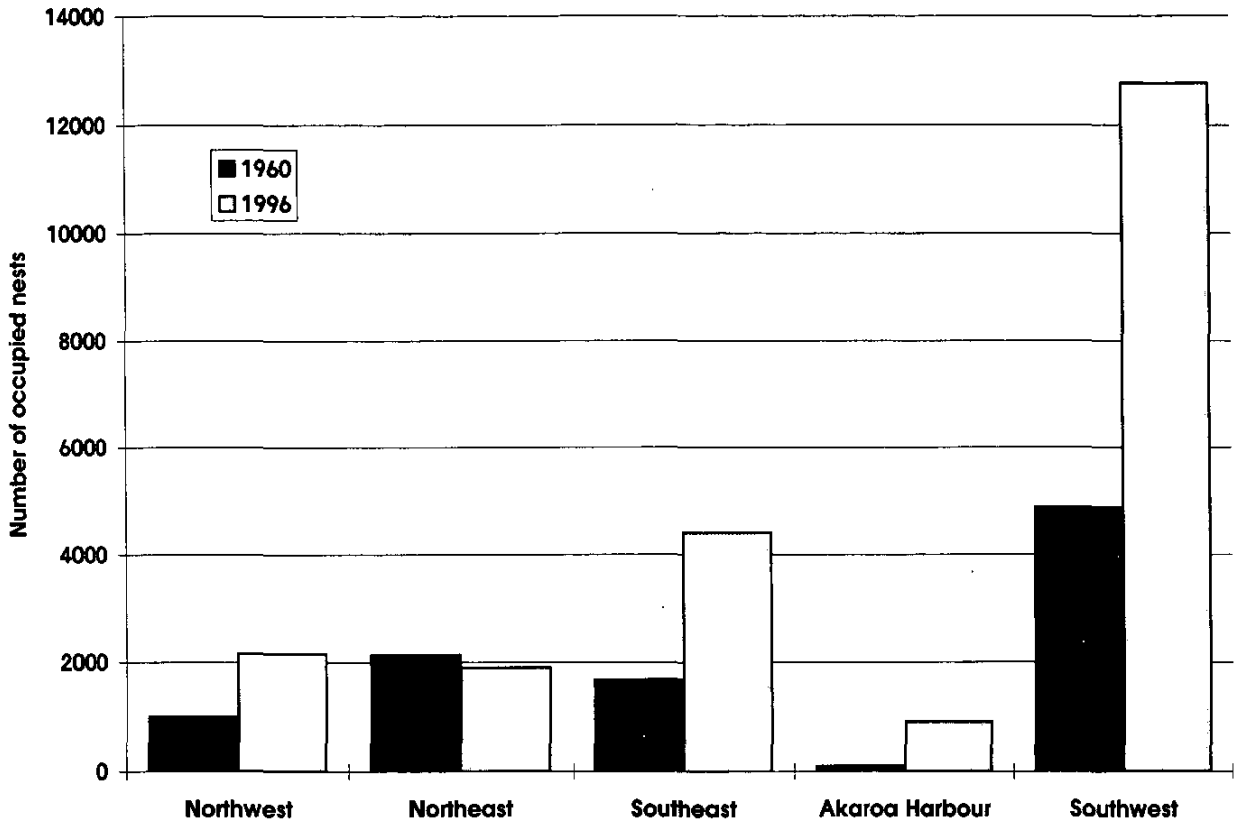

FIGURE 1– Numbers of occupied Spotted Shag nests in the five areas of Banks Peninsula in 1960 and 1996.

The entire coastline of Banks Peninsula from Sumner Head to Birdlings Flat was surveyed in seven days: 24, 25, 26, 29, 30 October and 3, 4 November 1996. In comparison, Turbott & Bell (1995) conducted their survey on 26, 27, 28 October and 26 November 1960. For a detailed map of the study area see Turbott & Bell (1995).

Our observations of numerous Spotted Shags carrying nesting materials one to two weeks prior to the onset of surveys indicated that many birds were still building nests at these times. During the actual survey period no nest initiation or nestlings were observed. Turbott & Bell (1995) reported that most of the shags in their late October surveys appeared to be incubating, or possibly sitting on recently hatched chicks. Therefore, the timing of both censuses appears to coincide with the incubation stage for the majority of the population.

A 4.5 m motorboat served as a platform from which nests were counted using 8x42 and 12x60 binoculars. Nest sites were clearly visible from the water because of the abundance of guano around and below nests. Visual confirmation of a Spotted Shag sitting or standing on a nest was required in order to count it as an occupied nest.

RESULTS

The total number of occupied Spotted Shag nests, and therefore breeding pairs, counted was 22,123, more than twice the size of the breeding population in 1960 (Table 1). On average, the number of nests increased in all areas, except the northeast coast from Wakaroa Point to LeBons Bay where a number of colonies decreased in size (Figure

1). The absolute number of breeding pairs on the northeast coast declined by 236 pairs. However, part of the apparent decline may be accounted for by some of the colonies having shifted their location, rather than being lost altogether. For example, in 1960 there were 297 nests along the south shore of Lavericks Bay. In 1996 there was none, but the size of the colony along the north shore of Lavericks Bay had increased by 265 nests, indicating that the south shore colony may have shifted and been absorbed into the north shore colony.

The number of large colonies (over 300 nests) increased from eight to 21, with most of these concentrated on the southwest coast of the peninsula. The five large colonies located in 1960 between Island Bay and Murray's Mistake were still active and four of them had, on average, nearly doubled in size. The abundance of nests along the southwest coast indicates a preference for this geographical area. In 1960 and 1996, 47% and 49%, respectively, of the total breeding population nested on the southwest coast between Island Bay and Birdlings Flat. Fenwick & Browne (1975) observed that the preferred nest sites in two Spotted Shag colonies were located on shaded, south-facing cliffs. They found that nestlings and adults are very sensitive to high temperatures (> 27° C) and direct sunlight and speculated that shags preferred shaded, south-facing nest sites to avoid heat stress. A preferable microclimate at nest sites on the southwest coast may explain the high concentration of nests located there. However, unoccupied, suitable-looking nest sites were abundant in all areas, even on the densely populated southwest coast.

DISCUSSION

The observed increase in the size of the Spotted Shag breeding population on Banks Peninsula could be explained in three ways. First, because the two nest censuses were conducted by different observers, it is possible that effort and/or coverage were not equal and that the results should not be compared. It is unlikely that this accounts for the significant difference in nest numbers observed. Turbott & Bell (1995) noted how careful they were to count all nests accurately and we believe that our methods were equally accurate. The fact that survey data from both 1960 and 1996 include sites containing only one or two nests is indicative that coverage in both surveys is comparable.

Second, there may be marked interannual variation in the relative number of breeding shags. Under this scenario, 1960 may represent a year when many shags abstained from breeding and 1996 may represent a year when few shags abstained. In a 29-year study of European Shags (*Phalacrocorax aristotelis*) the number of nests in the colony dropped drastically during two periods and subsequently rebounded to higher levels (Aebischer 1986, Harris *et al.* 1994). During the crashes there was no evidence of reduced adult survivorship, indicating extensive non-breeding by experienced adult shags (Aebischer 1986). A significant drop in the available food supply was implicated as the reason behind at least one of the crashes (Aebischer 1986, Aebischer & Wanless 1992). Boekelheide & Ainley (1989) also observed that the number of Brandt's Cormorants (*Phalacrocorax penicillatus*) that abandoned or skipped breeding varied greatly from year to year depending on food availability.

If the same was true for the Spotted Shags on Banks Peninsula, then it is possible that the absolute size of the breeding population has not changed significantly after 36 years. The observed doubling in the number of breeding pairs may simply reflect the choice of two unrepresentative years for nest surveys. Perhaps 1960 was an exceptionally poor year for Spotted Shag prey fish stocks, causing a high proportion of adults to abstain from breeding, while 1996 was a remarkably good year with a much lower proportion abstaining.

However, in European Shags, Aebischer (1986) also found that prey availability and the timing of breeding were highly correlated. During one of the breeding population crashes, egg laying in those shags that did nest was approximately one month later than average (Aebischer 1986). No such delay was observed by Turbott & Bell (1995) nor by us. The timing of the breeding cycle in 1960 and 1996 was, as far as boat-based observations allow, similar. Hence, a shortage of food in 1960 is unlikely to have caused a decrease in the relative number of breeding shags.

The third, and most likely, explanation for the observed change is that the absolute number of breeding shags has increased. Assuming that the relative number of breeding shags is constant from year to year, this would mean that the total population size of Spotted Shags on Banks Peninsula has grown. Immigration of nesting shags to the peninsula from unknown, outlying sites is unlikely based on the high degree of natal philopatry and nest site fidelity observed in the Phalacrocoracidae. The majority of Brandt's Cormorants at Southeast Farallon Island, California nested within 300 m of their natal colony (Boekelheide & Ainley 1989). In European Shags, Potts (1969) found that only 8% of first-time breeders nested outside their natal colony, and that less than 1% changed colonies thereafter. On Banks Peninsula, the average net growth of the breeding population between 1960 and 1996 amounts to 2.29% per annum and is likely to have originated from within the local population. This increase is well within the capacity documented for related species. Potts (1969), Aebischer (1986), and Aebischer & Wanless (1992) report annual rates of increase in European Shag colonies of 11-15.6%.

Possible reasons why the Banks Peninsula population may have grown over the past 36 years include decreased predation and overall increased food availability. However, Fenwick & Browne (1975) did not observe any predation on Spotted Shag eggs or chicks at Whitewash Head and believe it is unlikely that any takes place. Most nests are located on narrow ledges that appear inaccessible to mammalian predators. The only likely avian predator is the Black-backed Gull (*Larus dominicanus*) and very few were observed in the vicinity of the shag colonies.

The most probable reason for the growth in the population is an increase in the available food supply. We speculate that in 1960 the Spotted Shag population on Banks Peninsula was limited by food availability, i.e. productivity was lower and just sufficient to offset adult mortality, thus keeping the population from expanding. In many seabird species, density-dependent competition for food during the breeding season has been implicated in limiting population size through reduced breeding productivity (Duffy 1983, Furness & Birkhead 1984, Aebischer & Wanless 1992, Cairns 1992, Wooller *et al.* 1992, Furness 1996). In addition, a shortage of food outside the breeding season may negatively affect an individual's fitness by reducing its ability to compete for food during breeding (Wooller *et al.* 1992).

Potential impact of reduced fishing effort around Banks Peninsula during the last decade

Two events in the 1980s led to a major reduction in fishing effort around Banks Peninsula and, as a result, may have increased the amount of food available to shags in the past decade. Furthermore, any incidental shag mortality associated with fishing activities would have been reduced at the same time. The first event was the imposition of the Quota Management System (QMS) in 1986 which made set netting uneconomic for many commercial fishermen (Anon. 1994). The second was the establishment of the Banks Peninsula Marine Mammal Sanctuary (BPMMS) in 1988 out to a distance of four nautical miles around the peninsula. Inside the sanctuary, commercial set netting is banned and amateur set netting is subject to numerous restrictions (Dawson & Slooten 1993). After the establishment of the BPMMS approximately 30% of amateur set netters gave up fishing and the average number of fishing trips for the remaining amateur set-netters nearly halved (Anon. 1994). Should the population have increased from 9,787 to 22,123 breeding pairs of Spotted Shag within the last seven years, ie. after creation of the BPMMS, then the average annual growth rate would amount to 12.4%, well within the range of increase (11.0-15.6%) exhibited by colonies of European Shags (Potts 1969, Aebischer 1986, Aebischer & Wanless 1992).

There seems to be little overlap in the fish species targeted by set-netters around Banks Peninsula (Anon. 1994) and the prey of Spotted Shags along the Otago coast (Lalas 1983). No data on the diet of Spotted Shags on Banks Peninsula are available, but its composition is assumed to be similar. Nevertheless, without further data on fish stocks before and after the implementation of the QMS and BPMMS, as well as data on the species and quantity of fish caught as bycatch, fishing cannot be discounted as a possible contributing cause of a shortage of prey available to Spotted Shags prior to the late 1980s. Although bycatch from trawlers can be a major food source for shags in other parts of the world (e.g. Blaber & Wassenberg 1989), it seems to be too little and/or too unpredictable for breeders around Banks Peninsula in recent years and is only used by few opportunistic feeders (Hawke 1994 and pers. obs.).

Assuming that food availability was at least partially responsible for formerly limiting the size of the Spotted Shag population on Banks Peninsula, the prospects for future population growth are promising. If fishing pressure in the area remains low, the number of shags may continue to increase until food availability again limits the size of the population (Cairns 1992). Nest sites do not appear to be limiting to further population growth, although it is difficult to assess what constitutes a suitable nesting site to a shag. Based on the limited information available on nest site selection, it appears that there is scope for existing colonies to grow and for new colonies to become established. Hence, additional Spotted Shag nest censuses on Banks Peninsula will be useful in furthering our understanding of the trends in this population.

ACKNOWLEDGEMENTS

We thank two anonymous reviewers for their helpful comments on the manuscript.

LITERATURE CITED

AEBISCHER, N.J. 1986. Retrospective investigation of an ecological disaster in the Shag, *Phalacrocorax aristotelis*: A general method based on long-term marking. J. Anim. Ecol. 55: 613-629.

AEBISCHER, N.J.; WANLESS, S. 1992. Relationships between colony size, adult non-breeding and environmental conditions for Shags *Phalacrocorax aristotelis* on the Isle of May, Scotland. Bird Study 39: 43-52.

ANON. 1994. Review of the Banks Peninsula Marine Mammal Sanctuary. Department of Conservation; Ministry of Agriculture And Fisheries. Canterbury Conservancy Misc. Rep. Ser. No 3.

BLABER, S.J.M.; WASSENBERG, T.J. 1989. Feeding ecology of the piscivorous birds *Phalacrocorax varius*, *P. melanoleucos* and *Sterna bergii* in Moreton Bay, Australia: diets and dependence on trawler discards. Mar. Biol. 101: 1-10.

BOEKELHEIDE, R.L.; AINLEY, D.G. 1989. Age, resource availability, and breeding effort in Brandt's Cormorant. Auk 106: 389-401.

BULL, P.C.; GAZE, P.D.; ROBERTSON, C.J.R. 1985. The Atlas of Bird Distribution in New Zealand. The Ornithological Society of New Zealand Inc., Wellington.

CAIRNS, D.K. 1992. Population regulation of seabird colonies. Curr. Ornithol. 9: 37-61.

DAWSON, S.M.; SLOOTEN, E. 1993. Conservation of Hector's dolphins: The case and process which led to establishment of the Banks Peninsula Marine Mammal Sanctuary. Aquat. Cons. 3: 207-221.

DUFFY, D.C. 1983. Environmental uncertainty and commercial fishing: effects on Peruvian guano birds. Biol. Cons. 26: 227-238.

FENWICK, G.D.; BROWNE, W.M.M. 1975. Breeding of the Spotted Shag at Whitewash Head, Banks Peninsula. J. Roy. Soc. N.Z. 5: 31-45.

FURNESS, R.W. 1996. A review of seabird responses to natural or fisheries-induced changes in food supply. Pp. 166-173 *in* Greenstreet, S.R. & Tasker, M.L. (eds.) Aquatic Predators and their Prey. Fishing News Books, Oxford.

FURNESS, R.W.; BIRKHEAD, T.R. 1984. Seabird colony distributions suggest competition for food supplies during the breeding season. Nature 311: 655-656.

HARRIS, M.P.; BUCKLAND, S.T.; RUSSEL, S.M.; WANLESS, S. 1994. Year- and age-related variation in the survival of adult European Shags over a 24-year period. Condor 96: 600-605.

HARRIS, M.P.; FORBES, R. 1987. The effect of date on counts of nests of Shags *Phalacrocorax aristotelis*. Bird Study 34: 187-190.

HAWKE, D.J. 1994. Seabird association with Hector's Dolphins and trawlers at Lyttelton Harbour mouth. Notornis 41: 206-209.

LALAS, C. 1983. Comparative feeding ecology of New Zealand marine shags (Phalacrocoracidae). Unpublished PhD Thesis, University of Otago, Dunedin.

MARCHANT, S.; HIGGINS, P.J. (eds.) 1990. Handbook of Australian, New Zealand and Antarctic Birds. Volume 1. Part A. Oxford University Press, Melbourne.

POTTS, G.R. 1969. The influence of eruptive movements, age, population size and other factors on the survival of the Shag (*Phalacrocorax aristotelis* (L.)). J. Anim. Ecol. 38: 53-102.

STONEHOUSE, B. 1967. Feeding behaviour and diving rhythms of some New Zealand shags, Phalacrocoracidae. Ibis 109: 600-605.

TURBOTT, E.G.; BELL, B.D. 1995. A census of Spotted Shags (*Stictocarbo punctatus punctatus*) breeding on Banks Peninsula in 1960. Notornis 42: 197-202.

WOOLLER, R.D.; BRADLEY, J.S.; CROXALL, J.P. 1992. Long-term population studies of seabirds. Trends in Ecology and Evolution 7: 111-114.

Received 29 December 1996, revised and accepted 28 January 1997

SHORT NOTE

"Hard release" of captive-reared New Zealand Pigeons (*Hemiphaga n. novaeseelandiae*)

Some regional populations of the New Zealand Pigeon (*Hemiphaga novaeseelandiae*) were in decline or at very low numbers in 1992 (N.D. Langham unpublished, Pierce *et al.* 1993). Captive-breeding of the New Zealand Pigeon (*H. n. novaeseelandiae*) or Kereru and the Chatham Island subspecies, Parea (*H. n. chathamensis*), and the release of captive-reared progeny might be needed in the near future to bolster or re-establish populations. The release of a wide range of captive-reared animal species into the wild to establish self-sustaining populations has been less successful (38%, N=34 release attempts) than the release of wild-caught animals (75%, N=163; Griffith *et al.* 1989). To improve the chances of success when releasing captive-reared animals, especially of threatened or endangered species, 'soft release' techniques have been used. For example, birds have been placed in aviaries at the release site to allow them to recover from the stress of the translocation and to acclimatise them to the release site. In addition, food is often provided to the birds for a period after their release (Jones *et al.* 1992, Brown *et al.* 1995). The problem is that such a technique requires aviaries and staff to care for the birds, and so is much more expensive than a 'hard release' technique, whereby animals are released into suitable habitat immediately following translocation and without supplementing food. Therefore, it is important to assess first whether a species can cope with this, and under what conditions. This was the aim of a preliminary study of Kereru in 1993.

Two immature Kereru (named 'Green' and 'Pink') at the National Wildlife Centre, Mount Bruce, Wairarapa were available for the trial. They were 14 and 17 months old when radio-tagged in January 1993, and had been raised by the same captive parents, one of which was originally a wild bird. The two Kereru were held in separate aviaries at the National Wildlife Centre that were planted with native species. The birds occasionally fed on these plants. Additionally, during the three months prior to their release, they were offered foods intermittently that were obtained from the intended release site, such as ripe maire (*Nestegis lanceolata*) and pigeonwood (*Hedycarya arborea*) fruit.

A release site was chosen at Rocky Hill Station (41° 12'S, 175° 47'E), eastern Wairarapa, about 60 km from the National Wildlife Centre. This was within a 118 ha block of protected native forest containing a variety of fruiting hardwoods, podocarps and lianas. This forest block was surrounded by pasture and pine (*Pinus radiata*) plantations (containing some native shrubs and trees), and scattered areas of native forest. The covenanted forest had been fenced to exclude stock, and signs of brushtail possums (*Trichosurus vulpecula*) were rare following recent private hunting and trapping efforts. No effort was made to reduce mustelid (*Mustela* spp.) or feral cat (*Felis catus*) numbers before the release.

On 29 January 1993, a metal numbered band, two coloured jesses (strips of 120 x 13 x 0.7 mm plastic-coated cloth spliced around the leg so that a 50 mm length trailed from the back of the leg), and a back-pack two-stage transmitter (20 g, 1-year field life)(Sirtrack Ltd.) were attached to each bird, after which they were returned to their respective aviaries.