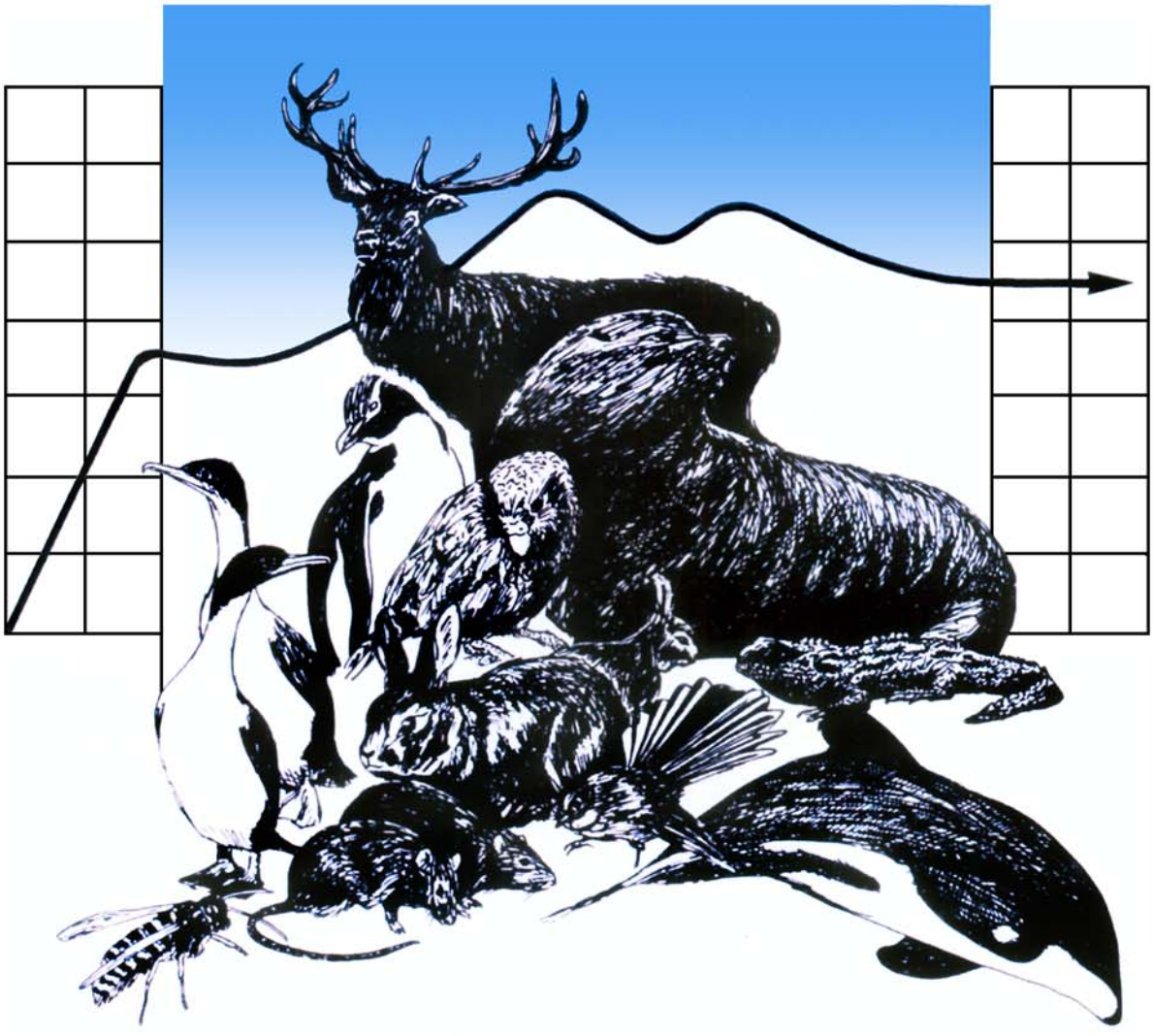
UNIVERSITY of OTAGO

Te Whare Wānanga o Otāgo

NEW ZEALAND

DEPARTMENT OF ZOOLOGY



WILDLIFE MANAGEMENT

Black-backed gull (*Larus dominicanus*) control on Tihaka and Rarotoka Islands -Review of the 2005 control operation and recommendations for future control-

Jo Ledington

A report submitted in partial fulfilment of the
Post-graduate Diploma in Wildlife Management

University of Otago

2006

University of Otago
Department of Zoology
P.O. Box 56, Dunedin
New Zealand

WLM Report Number: 198

Executive Summary

In November 2005 an operation to control black-backed gulls (*Larus dominicanus*) on Tihaka and Rarotoka Islands in Foveaux Strait, New Zealand was carried out as part of the islands restoration plans. The aim of these three to five year control operations is to significantly reduce black-backed gull densities on Tihaka and Rarotoka aiming for zero density (Cole, 2004). A secondary objective of the 2005 operation on Tihaka was to implement a mark recapture study on the endangered herekopare weta (*Deinacrida carinata*) in order to gain a preliminary indication of the species population status on the island.

The black-backed gull control operation targeted both adult breeding gulls and non-breeding juveniles using the toxin alpha-chloralose, mixed with margarine and spread on bread. It resulted in a kill rate of 11% on Tihaka and 12% on Rarotoka. Ground shooting was also used on Tihaka taking the total percentage of black-backed gulls killed to 37%. The take rate of both pre-feed and toxic baits was extremely low on both islands, resulting in lower than expected kill rates. In order to increase the kill rate of black-backed gulls in future control operations a number of recommendations have been made, including:

- Carrying out pre-feeds on the three nights prior to laying the toxic bait in order to increase the take rate of both pre-feed and toxic baits;
- Undertaking control on both islands once 80% of occupied nests contain eggs in order to ensure maximum gull occupancy and to minimise the number of chicks escaping control;
- Considering using ground shooting and destroying all nests on Tihaka as a more cost effective method to target the last 100 gulls;
- Destroying any eggs that have been laid by birds that survived the poisoning operation and have re-nested in the months following control.

In conclusion the overall kill rate of 37% on Tihaka was a successful total kill however the low kill rate from alpha-chloralose poisoning on both islands is concerning and the above changes are necessary to increase future kill rates.

The herekopare weta study found a total of seven (±3) weta, six of which were marked. This population estimate is much lower than those determined in previous studies and more research should be conducted in the near future to determine the age classes present in the population in order to ensure that a viable population still exists on Tihaka. In order to determine age classes future mark recapture studies should take measurements of the length of the rear tibia and the thoracic shield as well as weight measurements.

General Introduction

In November 2005 an operation to control black-backed gulls (*Larus dominicanus*) on islands in Foveaux Strait, Southland, New Zealand was carried out as part of ongoing control of the species. This operation begun on Pig (Tihaka) Island in October 2003, and on Centre (Rarotoka) Island in November 2005. This is year three of the Tihaka operation due to end by July 2008 (Cole, 2004), and year one of the Rarotoka operation due to end by July 2010 (Ledington, 2005). The aim of this operation is to significantly reduce black-backed gull densities on Tihaka and Rarotoka Islands aiming for zero density (Cole, 2004). A secondary objective of the 2005 operation on Tihaka was to implement a mark recapture study on the endangered herekopare weta (*Deinacrida carinata*) in order to gain a preliminary indication of the species population size on the island.

The Islands

Tihaka (Pig) Island

Treatment area one is the Pig Island Scenic Reserve. The island lies in Foveaux Strait approximately 3km south of the South Island and 6km SSW of Riverton/Aparima (NZMS 260-D46: GR 2124900, 5410700). Tihaka Island has a total area of 12.1406 hectares with a vegetation type composed of flax (*Phormium tenax*) and low growing herbaceous plants including *Carex trifida* and club rush (*Isolepis nodosa*) (Cole, 2003). Several endemic species inhabit the island, some of which are nationally endangered or threatened. These include the herekopare weta (*Deinacrida carinata*), Stewart Island shag (*Leucocarbo chalconotus*), Cook's scurvy grass (*Lepidium* oleraceum) and sand tussock (*Austrofestuca littoralis*) (Cole, 2003). Tihaka Island is open to the public, experiencing low level summer use by recreational boaties for purposes such as picnicking.

Rarotoka (Centre) Island

Treatment area two is Centre Island. Rarotoka also lies in Foveaux Strait, approximately 16km SW of Riverton/Aparima (NZMS 260-D47: GR 2112400, 5402000). The total area of Rarotoka is 96.8780 hectares. Rarotoka was historically farmed and as a result has a variety of vegetation types including bracken, flax (*P. tenax*), hebe (*Hebe elliptical*), gorse (*Ulex europeaus*) and grasslands composed of both native and exotic species (DoC, 2001). Revegetation projects are an integral part

of the restoration of Rarotoka. Unlike Tihaka, Rarotoka is owned by Te Runanga o Ngai Tahu, and local iwi manage the island. Although permission must be gained to visit the island, Rarotoka does experience low level use by recreational boaties for purposes such as picnicking (DoC, 2001). Rarotoka also supports a range of threatened and endangered native species, including yellow-eyed penguin (*Megadyptes antipodes*), blue penguin (*Eudyptula minor*), Stewart Island shag (*L. chalconotus*), takahe (*Porphyrio hochstetteri*), shore cress (*Lepidium tenuicaule*), sand tussock (*A. littoralis*), and pingao (*Demoschoenus spiralis*) (DoC, 2001). While this is the first year of black-backed gull control on Rarotoka previous pest management has been carried out on the island. Kiore (*Rattus exulans*) were successfully eradicated from Rarotoka in a poison and trapping operation carried out between 1997 and 1999 (IUCN/SSC, 2005). Since then, invertebrate numbers appear to be increasing. The recovery of vegetation however is slow due to the many years of grazing by cattle and sheep (IUCN/SSC, 2005). Monitoring for the presence of kiore is still being conducted.

1. Black-backed Gull Control

Introduction

The Species

Black-backed gulls (*L. dominicanus*, Southern black-backed gulls, karoro) are native to New Zealand and are the largest of our three gull species (DoC, 2002). Due to their adaptability to different habitats and to human habitation, black-backed gulls are now a widespread and abundant species (DoC, 2002). Black-backed gulls are commonly found throughout coastal New Zealand on harbours and estuaries, but may also be found inland and at high altitudes (Moon, 2001). Their diet consists of fish, shellfish, crustaceans, molluscs, invertebrates, worms, small animals and carrion and they can often be found scavenging at rubbish dumps (Moon, 2001; DoC, 2002). Previous studies have found that black-backed gulls predate on many native species including gannet eggs (*Sula bassana serrator*), white-fronted tern chicks and adults (*Sterna striata*), New Zealand dotterel eggs (*Charadrius obsurus aquilonius*) and black stilt chicks (*Himantopus novaezelandiae*) (Robertson, 1964; Williams, 1963; Wills *et al.*, 2003; Brown and Keedwell, 1998). Black-backed gulls usually breed in large colonies and may nest in a variety of habitats including on coastal dunes, rocky headlands or

islets, near inland lakes or riverbeds and on mountainsides at high altitudes (Moon, 2001; DoC, 2002). Clutches of two or three eggs are laid between October and December with incubation being carried out by both sexes and taking between 24 and 26 days (Moon, 2001). Juvenile black-backed gulls are distinct from adults as they are brown in colour until their third year when they mature and become white with a black back (Moon, 2001).

Why are black-backed gulls being controlled?

Control of black-backed gulls on Rarotoka and Tihaka is being carried out in order to enhance the ability of DoC to restore both islands to their original conditions, as the gulls are currently negatively impacting the ecological values of both islands (Cole, 2004). Black-backed gulls are decreasing vegetation values on the islands by introducing pest plants, and are known to behave aggressively towards other bird species (Cole, 2004; Robertson, 1964; Williams, 1963; Wills *et al*., 2003; Brown and Keedwell, 1998). If the gull population is left uncontrolled, this aggressive behaviour is expected to reduce the success of endangered species translocations to Rarotoka (Cole, 2004). Thus gull control will ultimately help to increase the number of *taoka* (treasure) species translocated to the island as outlaid in the Rarotoka Restoration Plan (DoC, 2001).

One of the species translocated to the island is the New Zealand shore plover (*Thinornis novaeseelandiae*), which was released in February 2006 (S. Chesterfield pers. comm., 2006). The New Zealand shore plover is endangered with the population currently numbering around 200 individuals (DoC, 2002). Their natural range is now restricted to South East Island and the Western Reef in the Chathams (DoC, 2002). Previous translocations have established populations on Motuora, Portland and Mangere Islands (DoC, 2002) and ground assessments have found that Rarotoka is the next best island in New Zealand to support a population (O'Conner, 2003). It is expected that shore plover introduced to Rarotoka may also self-establish on Tihaka, meaning gull control is also required there (Cole, 2004). The translocation of species such as New Zealand shore plover to Rarotoka will help to achieve the Oraka Aparima Runaka vision for the island, which is

> 'to have restored Rarotoka to a state where it is recognised and valued as a *motu wananga*. It is in continuous use by members of Kai Tahu who are

attracted by the *wairua* of the island and the desire to participate in many of the *wananga* available' (DoC, 2001).

Methods

Bait Preparation

The toxin, alpha-chloralose (Chloralose 97.5% Technical) was used in this operation. Alpha-chloralose is an oral stupefacient which is often used for sedating and capturing wildlife (Gregory and Wilkins, 1997), however due to its increased toxic effects on avian species it is now a commonly used method of control in New Zealand. The toxin was applied by mixing it with margarine at a 10% mixing rate and spreading it on bread. Each slice of bread was then cut into eight pieces and frozen until required. Pre-feed was also prepared prior to the trip, consisting of untreated bread cut into eight pieces and frozen.

Poisoning Operation

Approximate numbers of black-backed gulls present on the island were recorded, including both nesting adults and non-breeding juveniles. These counts were taken in order to provide an indication of the effectiveness of the operation. The first pre-feed of non-toxic bait was carried out by hand on both islands between 10.30am and 11.30am, taking approximately 30 minutes. On Tihaka two to three baits were spread at black-backed gull nest sites and widespread application occurred in three locations where juveniles were situated; the western end, southern side and north-eastern point of the island. On Rarotoka two to three baits were laid in black-backed nest sites while widespread application occurred at the northern and southern ends of the island, where non-breeding gull densities were highest. A second pre-feed was carried out later in the same day, between 1pm and 2pm in the same manner as the earlier pre-feed. At 6pm the toxic bait was laid using the same methods as that of the pre-feeds. The take rate of bait by black-backed gulls was monitored on both islands for a few hours after the toxic bait was laid. At 6.30am the next morning all dead birds and uneaten bait was collected to be disposed of on the mainland. All black-backed gull nests with eggs were destroyed.

Analysis

The efficacy of the operation was calculated simply by counting the number of black-backed gulls killed during the operation. This was worked out as a percentage of the population present on the islands before the operation to give a kill rate. This was then compared with previous years kill rates on Tihaka in order to give an indication of the overall success of the operation.

Results

The percentage of adult and juvenile black-backed gulls poisoned on Tihaka was 11%, compared to 12% on Rarotoka (Table 1). On Tihaka another 26 birds were killed by ground shooting. Therefore the total percentage of black-backed gulls killed on Tihaka was 37% (Table 1). On Tihaka a high bycatch was recorded, with nine red billed gulls being killed from eating the toxic bait (Table 1). Bycatch on Rarotoka was slightly lower with five red billed gulls being killed during the operation (Table 1). The total number of eggs destroyed was not recorded in the operation, however 70 nests were destroyed on Tihaka and 95 were destroyed on Rarotoka (Table 1). On Rarotoka and Tihaka all eggs destroyed were in the early stages of incubation, except for one nest on Tihaka that had two eggs very close to hatching.

Table 1: Kill rates of black-backed gulls, number of black-backed gull nests destroyed, and bycatch recorded on Tihaka and Rarotoka Islands during the control operation.

Island	% kill	Nests destroyed	Bycatch (redbill gulls)
Tihaka	37% 11% (poisoned), 26% (shot) (37/100)	70	9
Rarotoka	12% (15/130)	95	5

The percentage of black-backed gulls poisoned was highest in 2004 when 49% of the black-backed gulls present on Tihaka were killed (Figure 1). This was a much higher kill rate than both the 2003 and 2005 operations where 30% and 11% of birds present on the island were poisoned (Figure 1).The overall number of black-backed gulls present on the island has been steadily decreasing since control began in 2003 when 1000 breeding pairs were on the island. In 2004 this was down to approximately 300 individuals on Tihaka, and by 2005 this had been reduced to 100 individuals (Figure 1).

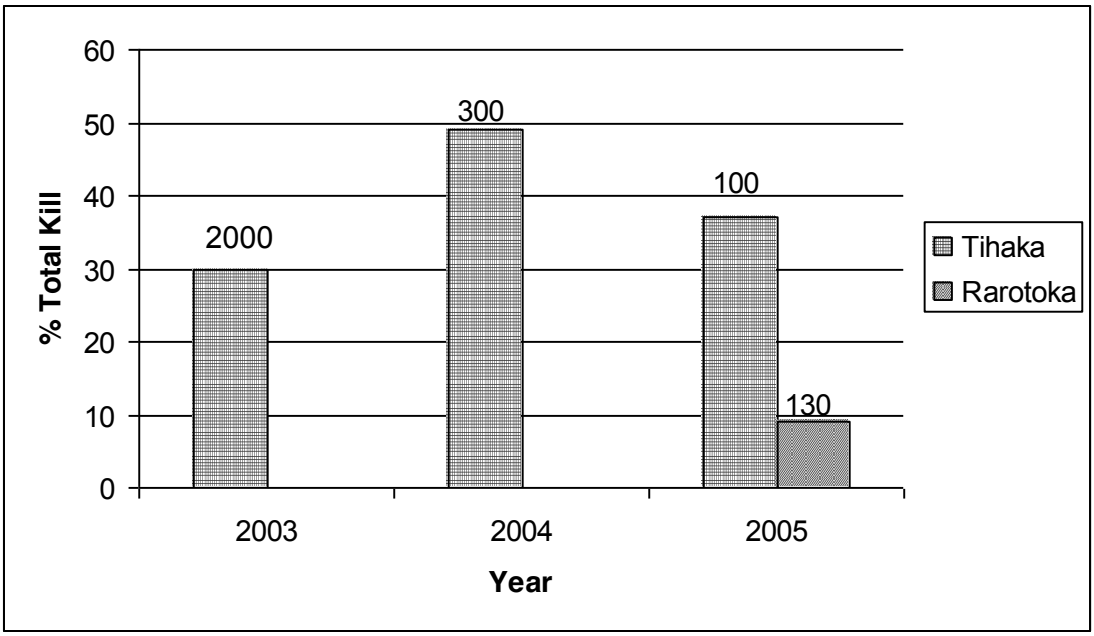


Figure 1: Percentage of black-backed gulls killed on Tihaka and Rarotoka 2003-05. Note no data for Rarotoka 2003-04 as control only began in 2005; Tihaka 2005 total kill is composed of 11% from alpha-chloralose poisoning and 26% from ground shooting. N for each bar is the number of gulls at each island prior to poisoning.

Discussion

Previous black-backed gull control operations have been carried out on Tihaka in 2003 and 2004 as part of a 3-5 year operation. These operations were successful in reducing the gull populations and objectives for each year were met with a 30% kill rate in 2003 and a 49% kill rate in 2004. In 2005 the kill rate from alpha-chloralose poisoning dropped significantly to 11%, however with the use of ground shooting the overall kill rate remained relatively high at 37%. In the first year of control on Rarotoka a slightly higher kill rate from poisoning occurred (12%), however a much higher kill rate was expected due to the birds having reduced bait shyness as they had never before experienced control. Although the 2005 kill rate from poisoning on both islands was much lower than expected the objective of the control operation is to significantly reduce black-backed gulls on Tihaka and Rarotoka, aiming for zero density. Whilst zero density of black-backed gulls on Tihaka has not yet been reached the numbers of gulls present on Tihaka has fallen from 1000 breeding pairs in 2003 (R. Cole, pers. comm., 2006) to just 100 birds in 2005 meaning that the three year operation has so far been successful in significantly reducing the numbers of birds

present and breeding on Tihaka. In order to reach the goal of zero black-backed gull density on Tihaka however, at least one more year of control is necessary. The objectives for Rarotoka were clearly not met in this first year of control. It is therefore clear that in order to reduce the gull numbers on Tihaka and Rarotoka to the zero density being aimed for problems with the control operation must be addressed.

The main problem found in the 2005 operation was the extremely low rate of bait take by both breeding and non-breeding birds. In order to achieve a higher kill rate it is therefore necessary to increase the bait take amongst the birds. In a control operation conducted in the Ahuriri and Tekapo Valleys pre-feeding was carried out on one or two mornings prior to dawn poisoning in order to accustom the gulls to the food source (Brown and Keedwell, 1998). This method resulted in more than 95% of pre-feed and toxic baits being consumed (Brown and Keedwell, 1998). Another study conducted by Caithness (1968) pre-baited a black-backed gull colony at similar times for four days prior to spreading toxic baits. They found that the black-backed gulls only began reacting to the pre-bait on the third day, when gulls were seen moving from other parts of the colony to the pre-feed area (Caithness, 1968). It was not until the fourth day of pre-feeding however that incubating gulls were observed leaving their nests to feed on non-toxic baits (Caithness, 1968). In our operation two pre-feeds were carried out, however they were laid out at 10.30am and 1pm, while the toxic feed was laid at 6pm. It is therefore recommended that in order to increase the take rate of both pre-feed and toxic baits, at least three pre-feeds should be carried out at similar times to when the toxic bait will be laid. For example, in the 2005 operation pre-feed should have been laid at 6pm for three nights prior to the toxic bait being laid. This does have logistical problems as it increases the length of the operation to four nights thereby increasing the cost of the project, however if the operation is more successful it would save a lot of time and resources that would be used going back to the island over the following months to continue control. Another problem that may have arisen in the 2005 operation is overfeeding. Due to the short period of time between bait drops (10.30am, 1pm and 6pm) gulls may have had a decreased response to the toxic bait simply because they were not hungry. By increasing the length of time between the bait drops to every 24 hours as described above and by reducing the amount of bait dropped on the last day of pre-feeding (Caithness, 1968), the threat of overfeeding would be reduced and the take-rate of toxic bait increased.

In order to further increase the success of black-backed gull control, the timing of the operation could have been later, when more eggs were present in nests and eggs were in a later stage of development. This would ensure maximum gull occupancy in the colony, and would ensure that few eggs have hatched therefore reduceing the need to kill live chicks (Caithness, 1968). The 2005 operation was delayed as breeding occurred later than usual, however at the time of control many nests still did not have eggs in them, for example at the eastern colony on Rarotoka only five out of 27 (19%) nests contained eggs. In the study by Caithness (1968) it was found that the best time to attempt black-backed gull control was when at least 80% of nests contained eggs. The optimum timing for control has been found to be mid to late November (Caithness, 1968; Brown and Keedwell, 1998). As the control of black-backed gulls on Tihaka has always been undertaken in late October it may increase the success of the operation to carry out poisoning later when gull occupancy is highest. This would also minimise the number of chicks escaping control (Brown and Keedwell, 1998). Visits to the islands around breeding time would be useful to get more accurate information on the best timing for the operation. To get this information for the colonies on Rarotoka and Tihaka it would mean that a number of trips would have to be made to the island prior to the operation, increasing the cost of the whole project. However as frequent trips are made to Rarotoka by DoC staff and local iwi it would be possible to conduct nest surveys on Rarotoka throughout October and November and time both islands operations on when nest occupancy is highest on Rarotoka. Due to the close proximity of both islands and their similar environmental conditions it can be assumed that breeding cycles for gulls on both islands is the same. The problem with this method is that it could cause the operation to occur at short notice and thus staff would have to be on standby for the operation possibly causing problems with staff availability.

During the 2005 operation on Tihaka ground shooting was carried out on the last day of the operation after the toxic bait had been picked up. In two hours this resulted in 26 black-backed gulls being killed by one shooter. This was a highly effective and target specific method of control and should therefore be considered as another method that can be used to control black-backed gulls on both islands. Ground shooting would be especially effective on Tihaka where the numbers of gulls are

already significantly reduced making control difficult and less cost-effective. Ground shooting has previously been used successfully on Mana Island to control black-backed gulls that had become poison shy to alpha-chloralose (Cole, 2004). Shooters hid in the scrub, shooting birds as they flew into the colony and leaving dead birds lying where they fell to attract other individuals. Shooting was carried out until nightfall as it was found that the gulls became gun shy the next day. Using these methods one shooter was able to kill 500 black-backed gulls in a week, though in successive years of control this was reduced to 50+ a day (Cole, 2004). As the black-backed gull population on Tihaka is currently relatively low combining ground shooting with destroying nests may prove to be a more successful and cost effective method of reducing the gull densities to zero.

Recommendations

In order to increase the kill rates of black-backed gulls on Tihaka and Rarotoka Islands a number of recommendations have been made. These include:

- Carrying out pre-feeds on the three nights prior to laying the toxic bait in order to increase the take rate of both pre-feed and toxic baits. The pre-feeds should be carried out at similar times to when the toxic bait will be laid so that the birds become accustomed to this food source. While this will increase the length of the operation to four nights thereby increasing the cost of the project, the operation will be more successful and therefore save time and resources that would be spent going back to the islands over the following months to continue control.
- Undertaking control on both islands when 80% of occupied nests contain eggs in order to ensure maximum gull occupancy, to minimise the number of chicks escaping control and to reduce the chance of having to kill live chicks. This would mean making more visits to the islands during October and November to determine when most nests have eggs, increasing the cost of the project. As frequent trips are made to Rarotoka by DoC staff and local iwi it would be possible to conduct nest surveys on Rarotoka throughout October and November and time both islands operations on when 80% of nests on Rarotoka contain eggs.
- Ground shooting should be used on Tihaka in an attempt to reduce the black-backed gulls to zero density. This combined with destroying all nests on the

island may prove to be a more cost effective method of control for the last 100 birds than alpha-chloralose poisoning. This may also prove to be an effective measure to target juvenile birds that are not nesting on the island and therefore have less attachment to returning to the islands after feeding offshore.

- At least one trip should be made to each island after the control operation has taken place in order to destroy any eggs that may have been laid by birds that survived the poisoning operation and have re-nested.

2. Herekopare weta mark-recapture study

Introduction

The herekopare weta (*Deinacrida carinata*) (Figure 2) is the smallest species of giant weta and is currently listed as a category C species and is therefore nationally endangered (Sherley, 1998). *D. carinata* is present on Herekopare Island, off Halfmoon Bay, Stewart Island; Tihaka (Pig) Island, Foveaux Strait and Kundy Island, southwest of Stewart Island (Sherley, 1998). Numbers of *D. carinata* present on Herekopare Island are unknown as the island is a muttonbird island, making access difficult for non-Rakiura Maori (Sherley, 1998). The Tihaka Island population was discovered in 1990 and has been recorded as being a large, viable population (Meads and Notman, 1995). Searches carried out by Meads and Notman (1995) concentrated on areas similar to the environment where the first specimen was found, including driftwood in the upper wrack zone. The search then spread to other areas that were assumed to provide quality refuges including in and around sedgeland vegetation, composed of flax (*P. tenax*), *C. trifida* and club rush (*I. nodosa*). Three age classes of *D. carinata* were present on Tihaka Island, including juvenile, intermediate and adult. Juveniles are characteristically just over 1cm long while females weigh approximately 6g and males approximately 2g (Meads and Notman, 1995; Sherley, 1998). The main threat to *D. carinata* appeared to be predation from weka, (Sherley 1998) however weka numbers on Tihaka have since declined, with one possible individual now remaining (G. Miller, pers. comm., 2005). In December 2004 ten weta boxes were placed in flax vegetation around the island in areas where *D. carinata* were found to be present. Subsequent checks of the boxes have found that *D. carinata* are using the boxes.

Figure 2: Herekopare weta (Individuals 2 and 3), Tihaka Island, Foveaux Strait.

Methods

In order to gain a current estimate of the *D. carinata* population on Tihaka Island a mark-recapture study was designed. This was to be a long term population study and the search carried out in November 2005 was the first to be conducted, with individuals being marked and one recapture occurring. Each subsequent trip to the island will involve the weta boxes being searched with any unmarked weta being marked and recorded and marked weta sightings being recorded.

Each of the ten weta boxes on Tihaka Island were located and marked with a permanent pole marker and their location recorded with a GPS. Weta boxes were then searched and any weta found were marked using one digit waterproof tags adhered onto the pronotum using super glue as in Leisnham *et al.* (2003) (Figure 2). Individuals were then weighed using a 10g Pesola spring balance and all data recorded. The next morning all weta boxes were searched again and all weta seen recorded. Unmarked individuals were not marked or weighed due to time constraints. The population estimate was calculated using the Lincoln-Peterson estimator (Henderson, 2003):

$$N = n_1 n_2 / m_2$$

Where n_1 = the number of weta first marked and released

n_2 = the number of weta caught in the second sample

m_2 = the number of marked weta in the second sample

Once the abundance of *D. carinata* was calculated using the Lincoln-Peterson model, Chapman's equation was used to eliminate statistical bias found in the Lincoln-Peterson index:

$$N = [(n_1 + 1)(n_2 + 1)/m_2 + 1] - 1$$

The variance was then calculated using Seber's method:

$$\text{Var} = [(n_1 + 1)(n_2 + 1)(n_1 - m_2)(n_2 - m_2)]/(m_2 + 1)^2(m_2 + 2)]$$

This then allowed the confidence intervals of the estimate to be calculated:

$$95\%\ \text{CI} = \pm 1.965\ \sqrt{\text{Var}}$$

Results

A total of six herekopare weta were marked during the study carried out on Tihaka Island in November 2005. Five of those weta were caught and marked in the first marking session. Three weta were caught in the recapture session, two of which were already marked (Table 2). The weights of the individuals caught ranged between 1.5g and 4.5g (Table 2).

Table 2: Weta ID, date of capture, site at which weta was captured, weight of weta (g), and recaptures of Herekopare Weta on Tihaka Island, 9-10 November 2005.

Weta ID	Date	Site	Weight (g)	Recapture 10/11/05
Y1	09/11/05	1	3	*x*
Y2	09/11/05	7	1.5	*x*
Y3	09/11/05	10	4.5	✓
Y5	09/11/05	10	3.5	✓
Y6	09/11/05	10	4.5	*x*
Unmarked	10/11/05	10	-	n/a

Using the Lincoln-Peterson estimator it was found that the present herekopare weta population on Tihaka Island was seven (±3) individuals.

Discussion and Recommendations

The numbers of herekopare weta found in the mark-recapture study conducted on Tihaka on 9 and 10 November 2005 were much lower than those found in a search of the island in 1993. In 1993 twenty person-hours were spent searching all areas of Tihaka Island in both daylight and at night. A total of 34 *D. carinata* were found during the study (Meads and Notman, 1995). In this study three hours were spent finding the weta boxes and marking individuals and thirty minutes were spent recapturing weta the next day. Areas searched in the 1993 study included all vegetation types present on the island, whereas this study only looked at weta found in the weta boxes during the day, all of which are located in flax. The location of these boxes is not representative of all the habitat types that *D. carinata* are found in. The lower count of *D. carinata* in this study therefore reflects the reduced effort and single vegetation type searched as compared to the exhaustive 1993 search. Previous visits to the island by DoC staff have found that weta are using the boxes year round and although the boxes are located in a single vegetation type they are spread randomly around the island and are available to all weta, making them a useful and non biased way of catching weta for mark recapture studies. The method used in this study is an accurate means of estimating species abundance and therefore the population estimate of seven (±3) herekopare weta on Tihaka can be considered accurate.

The decline in the population since 1993 is concerning and because this study did not take measurements of the length of individuals it is impossible to determine whether the population present on Tihaka is viable. As the average weight for a female *D. carinata* is 6g and the average male weighs 2g it is difficult without the length measurements to determine if for example, individual Y3 (4.5g) is a large male or a small female. The lack of length measurements also makes it impossible to distinguish between juveniles and adults, for example Y2 (1.5g) may be a juvenile or a small male. Studies need to be undertaken in the near future to determine the age classes present in the population in order to ensure that a viable population still exists on Tihaka. Future mark recapture studies should therefore take more measurements of the weta including the length of the rear tibia and the thoracic shield as well as weight measurements in order to increase the understanding of age classes present on the island. The main threat to the Tihaka population of *D. carinata* in 1993 was weka

(Meads and Notman, 1995). It was thought that predation by weka occurred seasonally, when food was limited in winter, meaning weka may have had a significant impact on weta numbers (Meads and Notman, 1995). It is thought that one weka may remain on Tihaka (G, Miller, pers. comm., 2005) and action should be taken to remove this individual. This is important especially since black-backed gull control on the island has reduced an important food source for weka which may have increased their reliance on *D. carinata* as a food source.

The Lincoln-Peterson index was used for this study as only one recapture session was required and all assumptions of the method were satisfied. These assumptions include (Henderson, 2003)

1. The population is closed (satisfied as the population is on an island and recapture occurred soon after the marking session);
2. The probability of capture is constant and the probability of capturing each individual in the population is equal;
3. Marked animals are not affected in behaviour or life expectancy by being marked and marks will not be lost (other studies on endangered weta have found this to be a suitable method, for example Leisnham *et al.*, 2003)
4. Marked animals completely mix back into the population once released;
5. Sampling is at discrete time intervals and the actual time involved in taking samples is small in relation to the total time.

In order to get a long term indication of the Tihaka herekopare weta population future recaptures should be analysed using the Schnabel method (Henderson, 2003). This method is based on the same assumptions of the Lincoln-Peterson method outlined above but enables several recapture sessions, where each new animal caught is marked before release (Henderson, 2003). Recaptures should be carried out relatively frequently over the next two years in order to gain an accurate estimation of population size including determining age classes present on Tihaka.

3. Conclusions

The 2005 black-backed gull operation carried out on Tihaka and Rarotoka Islands was less successful than previous control. While the kill rate from alpha-chloralose poisoning on Tihaka was relatively low, the overall kill rate of 37% made the

operation successful. Black-backed gull numbers are now relatively low on Tihaka making control difficult and less cost-effective. It is therefore recommended that a combination of ground shooting and nest destruction is used to further lower the Tihaka population and to prevent reinvasion. The low kill rate from alpha-chloralose poisoning on Rarotoka is concerning as this was the first year of control, so birds should not have been bait shy. In order to increase kill rates in future years it is recommended that the operation is carried out later in the breeding season when at least 80% of nests contain eggs. Pre-feeding should be carried out for at least two nights prior to the toxin being laid and at a similar time each night. This will increase the take rate of bait and result in a much higher kill rate. Both islands should be visited after the operation to destroy any eggs that are laid by surviving gulls. These changes to the operation should result in the objectives for each island being met.

The secondary objective of the trip to Tihaka was to set up a long term mark-recapture study to determine the population status and trends of the herekopare weta. This objective was met with six weta being marked, and a total of seven weta being seen. As each of the weta boxes are now clearly marked it enables any DoC staff visiting the island to easily search the boxes, recording any individuals seen and marking new individuals. It is important that measurements of the length of the thoracic shield and the rear tibia are taken as well as weight in order to determine the age classes present on Tihaka. This will enable the population status of the herekopare weta on Tihaka to be more accurately defined.

Acknowledgements

A big thank you to Ros Cole for her help in the early stages of this project and to Sally Chesterfield for her ongoing help. Thank you also to everyone who answered questions and helped me along the way, including Jessyca Bernard , Alan Christie, Pete McClelland, and David Agnew.

References

Brown, K.; Keedwell, R. 1998. *Alphachloralose control operations at southern black-backed gull colonies in the Tekapo and Ahuriri Valleys.* Canterbury Conservancy Technical Report Series Number 7, Department of Conservation, Twizel.

Caithness, T.A. 1968. Poisoning gulls with alpha-chloralose near a New Zealand airfield. *Journal of Wildlife Management* 32: 279-286.

Cole, R. 2003. *Tihaka (Pig Island) Restoration Plan*. Department of Conservation, Invercargill.

Cole, R. 2004. *Assessment of Environmental Effects for Black-Backed Gull Control in the Pig Island Scenic Reserve*. Department of Conservation, Invercargill.

Department of Conservation (DoC). 2001. *Rarotoka Restoration Plan*. Murihiku Area Office, Invercargill.

Department of Conservation (DoC). 2002. *The Penguin Guide to New Zealand Wildlife: native and introduced birds, mammals, reptiles and amphibians.* Penguin Books (NZ) Ltd., Auckland.

Gregory, N.G.; Wilkins, L.J. 1997. Stupefying and lethal effects of alpha chloralose in chickens. *New Zealand Journal of Agricultural Research* 40: 361-364.

Henderson, P.A. 2003. *Practical methods in ecology.* Blackwell Publishing, Oxford.

IUCN/SSC. 2005. Global Invasive Species Database Management and Information Links for Rattus exulans. www.issg.org/database/species/management_info .asp?si =170&fr=1&sts=. Accessed 20 July 2005.

Ledington, J. 2005. *Assessment of Environmental Effects for Black-Backed Gull (Larus dominicanus) Control on Pig Island (Tihaka) Scenic Reserve and Centre Island (Rarotoka)*. Department of Conservation, Invercargill.

Leisnham, P.T.; Cameron, C.; Jamieson, I.G. 2003. Life cycle, survival rates, and longevity of an alpine weta *Hemideina maori* (Orthoptera: Anostostomatidae) determined using mark-recapture analysis. *New Zealand Journal of Ecology* 27: 191-200.

Meads, M.J.; Notman, P. 1995. *Giant weta (Deinacrida carinata) on Pig Island, Foveaux Strait.* In *Surveys of giant weta*. Science for Conservation no. 16, Department of Conservation, Wellington.

Moon, G. 2001. *The Reed Field Guide to New Zealand Birds.* Reed Publishing (NZ), Auckland.

O'Conner, S. 2003. *Ground Assessment of Rarotoka for shore plover reintroduction.* Department of Conservation, Wellington.

Robertson, C.J.R. 1964. Observations on black-backed gull predation at the Cape Kidnappers gannetries 1959-1963. *Notornis* 10: 393-403.

Sherley, G.H. 1998. *Threatened Weta Recovery Plan. Threatened Species Recovery Plan no. 25*. Department of Conservation, Wellington.

Williams, M.J. 1963. Predatory habits of the black-backed gull. *Notornis* 10: 239-240.

Wills, D.E.; Murray, J.; Powlesland, R.G. 2003. Impact of management on the breeding success of the northern New Zealand dotterel (*Charadrius obscurus aquilonius*) on Matakana Island, Bay of Plenty. *Notornis* 50: 1-10.