BLACKWOOD BAY
AERIAL DEER CONTROL TRIAL

PREPARED BY | TRAP AND TRIGGER LTD

01 | INTRODUCTION

The red deer population in the Marlborough Sounds has increased rapidly in recent years, due to limited hunting pressure and changing habitats, to an extent where deer numbers are very high.

This is causing rapid damage to what was previously a diverse and healthy forest understory, threatening native forest succession processes, and causing major amenity problems for bach owners throughout the Sounds, as their gardens and properties are damaged by deer.

As a result, Trap and Trigger were engaged by Andrew Macalister, of R&D Environmental Ltd, to undertake a deer control trial to determine the feasibility of carrying out cost effective landscape-scale deer management in the Marlborough Sounds.

FIGURE ONE | Deer Damaged Forests

02 | WHY ARE DEER A PROBLEM?

The negative impacts associated by feral deer either stalling or reversing the native forest regeneration process has been well-documented in New Zealand. The following summary is from Macalister & Butler (2015).

One report (Smale et al, 1995), from Kaipara Heads in Northland, concluded that two markedly different succession pathways are evident in a kanuka forest, inside and outside a deer-proof fenced enclosure. "Within the exclosure (i.e., in the absence of deer), kanuka and its associated subcanopy species are being replaced by mahoe and another generation of houpara, and outside by another generation of both kanuka and houpara - an example of a partially "stalled succession" (Connell and Slatyer, 1977). Mapou seems likely to be but a minor component of any future canopy. Successions similarly stalled by red deer have been reported in secondary kanuka forest in the northern Urewera country by Payton, Allen and Knowlton (1984)." The authors note that the current and immediate future canopy species (ie: primarily kanuka) are all relatively short-lived, implying frequent canopy turnover and hence susceptibility to invasion by weeds.

Similarly, a longitudinal study of native forest succession in a kanuka forest at Te Urewera, in the North Island, concluded that, in the presence of browsing mammals: "the minimal compositional change over 30 years in these communities and paucity of recruitment of trees of canopy species point to arrested succession. Without management intervention to increase tree recruitment rates of canopy species, forest successions in this region will be characterised by high tree fern abundance, low biomass at local scales, and limited transitions to tall forest communities". (Richardson et al, 2014). The authors subsequently note that such future forest successions will be "vulnerable to exotic tree invasion".

While no such formal studies have been done in the Sounds, a 2012 survey of the Momorangi Bay Scenic Reserve by the Department of Conservation found that, following repeated burning:

"natural recruitment is either very slow or not evident … due to the paucity of seed sources and by suppression of forest succession due to browsing impacts by ungulates and possums." (Shannel Courtney, pers. comm).

Species that were identified as "very rare or locally extinct" under the intact kanuka canopy of the reserve, and which would be expected to be present, included kahikatea, matai, miro, black beech, hard beech, hinau, nikau, pukatea, swamp maire, tawa, titoki and tree fuchsia.

In summary, there is abundant evidence that, following burning, a pioneer forest of manuka and kanuka may not necessarily give way to the diverse podocarp forests that previously cloaked the Sounds, if feral ungulates are allowed to subvert the natural succession process. In time they may only be succeeded by more pioneer species, species unpalatable to ungulates, and opportunistic weeds. In the Marlborough Sounds, the most likely adventive weeds are wilding pines, old man's beard and banana passionfruit.

Feral deer also have a negative impact on otherwise intact native forest remnants. This process has also been well-documented in New Zealand.

Deer and goats, in particular, have extensively modified native forest understories (Wardle 1984, McKelvey 1995), favouring certain plant species over others as food and therefore considerably modifying the composition of the vegetation. One recent report, using a 'seedling ratio index' across multiple sites, including the Marlborough Sounds, found that the following were highly-preferred species:

- Asplenium bulbiferum (Hen & Chicken Fern Mother Spleenwort)
- Astelia Spp.
- Freycinetia Baueriana (Kiekie)
- Coprosma Grandifolia (Kanono)
- Coprosma Lucida (Karamu)
- Griselinia Littoralis (Kapuka/ NZ broadleaf)
- Melicytus Ramiflorus (Mahoe)
- Myrsine Australis (Red Matipo)
- Olearia Rani (Heketara)
- Schefflera Digitata (Pate/Seven-finger)
- Weinmannia Racemosa (Kamahi)

SOURCE | Sweetapple & Nugent, 2004

In 1978, three ungulate exclosures, approximately 30m x 20m in size, were constructed within the forest in Arapawa Island Scenic Reserve, to gauge the impact of ungulates, the effectiveness of controlling them and the forest undergrowth recovery process in the absence of ungulates. Within a few years, a deep layer of leaf litter had accumulated within the exclosures, soil was beginning to be rebuilt from the litter and the ground was covered in masses of ferns and tree seedlings. Many of the trees had produced new shoots from their bases. Now, what was completely devoid of undergrowth has become a dense thicket, with canopy species well on the way to taking their place alongside the old trees.

Prolonged impacts can be devastating, leaving the forest with a "hollowed out" structure, lacking undergrowth and ultimately threatening canopy regeneration.

In the Sounds, this phenomenon can be readily observed in many native forest remnants, such as those within the D'Urville Island Scenic Reserve, which has high deer numbers.

"It should not be possible to see far or walk easily within a healthy temperate rain forest. In the forests of the reserve though, the lower tiers of ferns, shrubs, seedlings and saplings are depleted or missing. From the outside they look great - healthy canopies and diverse vegetation on the edges - but the hollow interior tells a different story. Many of the smaller trees have their bark stripped by deer and are dead or wounded. And in the upland forests, where the giant land snails are, the ground is extensively bared and ploughed up. It's not just the direct damage that ungulates do that is the problem; once the damage is done, it only takes a few animals to prevent recovery." (Geoff Walls, pers. comm).

FIGURE TWO & THREE | Deer Damaged Forests

03 | OBJECTIVES

Although conventional methods such as aerial shooting and ground hunting have been proven methods of control in particular environments, these methods in the Marlborough environment are limited by vegetation, topography and scale. Through other ungulate management projects and trials delivered by Trap and Trigger, TADS is proven as an effective method for single layer canopy vegetation types, with no limitation to topography or scale.

Due to the vegetation type and scale of the Marlborough sounds, in addition to its inclusion of many communities and private land holdings, TADS has been identified as a potential silver bullet method to retain control of the troublesome deer population these communities are seeking to manage.

The objective of this trail is to demonstrate the ability of TADS as a cost efficient alternative for landscape deer control across the wider Marlborough sounds. This trial was run in conjunction with two similar successful Department of Conservation projects using TADS to detect and remove deer at low densities from Maud and Blumine Islands.

FIGURE FOUR | Ground Shooting with Indicator Dog.

04 | ALTERNATIVE METHODS CONSIDERED

1 GROUND HUNTING Ground and aerial hunting have been the two primary control methods that managers of ungulate programs had in their "tool box" to control deer, pigs and goats in New Zealand forests since controlling ungulates started with the NZ Department of Internal Affairs.

Ground hunting with dogs (indicating or chasing) have the highest detection probability of all the current tools for ungulates. While improvements have been made in the way these techniques are applied, hunting with dogs is proven to be most effective at very low-animal densities and although the detection probability is high, the probability of dispatch is significantly lower.

The limitations are that although effective this tool relies on having "skilled" hunters, and well-trained target specific dogs. The method of deployment, the initial population density and the target animal's wariness can also affect the speed and outcome of a control program. Ground hunting at scale will require a large supporting infrastructure and operational timeframe and also require foot access/permission to properties to put all deer at risk. A major limiting factor to ground hunting in such environments is the vegetation type. In the sounds, the dense hardwood understorey found in regenerating coastal forest means stalking deer is difficult. More often than not, the deer will detect the hunter and move off before the he/she can get within visual range. Even though detection probability of a hunter and dog is high, kill success is only moderate, and this success rate decreases based on the number of animals present per encounter.

2 CONVENTIONAL AERIAL SHOOTING Aerial shooting works the best in open country where animals are visible to the pilot and shooter. However the detection probability and effectiveness of aerial shooting reduces as forest cover increases. In the Sounds, while it is possible to detect deer on slips and other cleared areas, due to the extensive forest and scrub cover, aerial shooting would only put a small percentage of the population at risk.

05 | THERMAL AERIAL DETECTION SYSTEM (TADS)

FIGURE FIVE | Thermal Image of a Deer.

OVERVIEW

While TADS has not been developed to surpass the detection probability of a skilled hunter and dog, it is a tool that significantly increases the speed and effectiveness of aerial shooting in all terrain while increasing the probability of dispatch on encounter. The added sensitivity of a high definition thermal camera also makes detection and dispatching ungulates possible even under forest canopy.

Although it is still in the development phase and is not being used at its full potential, it has already proven to be the largest step forward in ungulate control in the last 50 years and already fills that critical niche that has been previously lacking to managers of animal populations. Primarily it is a tool to quickly reduce moderate to high ungulate populations to the level where the ground hunters using dogs are most effective, it also excels in several other applications where speed and efficiency matter.

TADS SYSTEMS There is a significant difference between applying a bespoke high-resolution thermal camera system designed for ungulate detection and using thermal cameras commonly used by recreational hunters as a supplementary detection tool.

Trap and Trigger's Thermal Animal Detection Systems (TADS) is an innovative technique that has been optimised to detect wildlife for population surveys or improve effectiveness of aerial search and destroy operations. The wide field of view in conjunction with a hi power laser aligned with the camera lens points the pilot and shooter into the exact location of the heat signature being viewed by the camera operator. The operator follows the target until there is an opportunity for the shooter (who's rifle is also equipped with a thermal scope) to clearly identify and dispatch the target.

The effectiveness of high resolution cameras is heavily reliant on the way it is applied. Distance above the ground, speed and look angle are optimised so the camera operator has the highest detection probability based on the canopy density and slope of the terrain beneath them. The general rule being, the slower the speed and closer the distance, the higher the detection rate

FIGURE SIX | TADS Set Up

THERMAL CAMERA SETUP The 1084x 760HD infrared camera is stabilised by a cinematic strong arm camera mount which is aligned with a military-grade 2.5w laser and a Sony ADX-55 4K video camera. The video feed is transferred via HDMI to a 12-inch HD screen presented with a custom fit viewfinder in front of the operator. The camera is fitted with a 30mm Wide FOV lens. The operator sits comfortably in the helicopter's front passenger seat and holds the camera in a position where the pilot and shooter can both see the camera's position and direction.

The process is likened to having a person on the ground at night shining a torch up through the canopy and another person flying above looking down. While the canopy looks dense from above there are still enough gaps to see light shining through.

TADS VS OTHER CONTROL OPTIONS Prior to the Blackwood Bay proof of concept trial, TADS was also used on both Maud and Blumine Islands in conjunction with a ground hunting component to detect and remove deer at low densities. The ground hunting team consisted of three hunters using both indicating and chasing dogs.

Because of the proximity to high deer densities on the mainland and the potential for deer to swim to these islands the goal is to maintain deer on these Islands to as low as possible by pulsed hunting effort. In 2018 both of these islands were hunted using a mix of hunters with chasing and bailing dogs over a period of six weeks. Thirty one deer were taken off Blumine Island and two more off Maud Island. It is thought that some deer could have remined on the islands after the hunt was completed. Deer numbers were though to be two to three on Maud and 12-15 on Blumine immediately prior to Trap and Trigger arriving. With in 20mins of the first flight using TADS, two of the three deer thought to be on Maud Island were found and despatched. Three subsequent intensive systematic sweeps of Maud Island by the ground hunting and two aerial shooting sweeps using TADS were unable to find the last deer suspected to be on Maud.

Blumine Island had similar results, in approximately two and half hours flying using TADS to detect deer, 20 deer were despatched. Two more deer were despatched in two days over the same period with the ground hunting team.

While the ground hunting team in hindsight were disadvantage using indicator dogs and chasing dogs at the same time which affected the effectiveness of the hunters with the indicator dogs. What stand out is the advantage TADS offered over conventional hunting methods. In this application the cost effectiveness and speed which TADS could achieve the project goals was significantly better than a ground only approach. Also was not as apparent was the lack of support infrastructure necessary in comparison to a ground hunting campaign. In the Blumine Island example, which could have been done successfully without any help from DOC staff, boats and without setting foot on the Island.

ESCAPEES TADS increases the efficacy of aerial shooting when a mob is detected. The helicopter and shooter concentrate on one individual at a time and as they are dispatched, the team moves on to the next or the pilot herds the remaining animals back into the open. This applies to goats, deer and pigs. In most situations, once you take your eyes off the other animals in the group it is easy for them to slip away.

In all mob encounters during this operation, after an individual in a group was dispatched, the thermal camera was able to relocate the survivors and direct the pilot and shooter to them, minimizing the opportunity for any animals to escape.

Survivors of lethal encounters can overtime create a residual population that becomes wary and becomes increasingly skilled at avoiding helicopters, hunters and dogs, hence why encounter/dispatch rates are considered important.

06 | SUMMARY OF EVENTS

22 ARPIL — 7:40am - 8:55am
1 hour 25min - 20 deer removed .

22 ARPIL — 5:30pm - 6:00pm
30min - 10 deer removed

In total 1 hour 55minutes of survey were conducted, a total of 30 deer were removed and 300 hectares area treated.

07 | TIMING AND CONDITIONS

This proof of concept trial was conducted over 115 minutes flying, comprising 90 minutes of productive flying, 25 minutes of ferry over two flights on the 22nd of April 2021. Low cloud delayed the start time of the initial aerial hunting, so it was approximately 7:30 am before cloud lifted to around mid-slope to give enough room for the trial to begin. It also meant that about 40% of the control area was in cloud.

The second sortie was flown later that afternoon starting at 5:30pm. Once the low cloud had broken up, the rest of the day was bright and sunny so even though there was no direct sunlight there was a lot of latent heat in rocks and branches so again there was not ideal thermal conditions.

08 | RESULTS

30 DEER

90 MINS

The first sortie lasted 65 mins and resulted in 20 deer kills. Although conditions were not ideal for the second sortie, another eight deer were dispatched in 25 mins.

We estimated a resident deer population of between 40-50 deer on the 300ha Blackwood Bay Peninsula at the start of the trial (pers. comm., Andrew Macalister) or a population density of 12 to 16 deer per sq km. The total number of deer dispatched during the trial was 30, estimation between 60% and 80% of the resident population.

The TADS proved to be very effective at detecting deer under tall Kanuka/ Manuka and coastal broadleaf forest that covered much of the Blackwood Bay peninsula. Except for five deer from the morning run that were detected and immediately disappeared into the cloud layer on the first morning, all other deer detected using TADS were dispatched.

09 | SAFETY

The operation was undertaken with no near misses or incidents. A hazard briefing was held with the Helicopter company and a further Site Specific Work Plan was undertaken by Trap and Trigger with Jordan, Norm and Twiz (Pilot).

Andrew Macalister, as a local resident, kept all other people present in the bay informed and communicated with the wider landowner group via email and text.

IDENTIFICATION All detected heat signatures were quickly identified as deer or other non-target animals. The thermal camera used by the camera operator and the thermal scope on the aerial shooter's weapon have the resolution and magnification not only identify the species but parts of an animal such as the ears, nose or tail.

Before any lethal engagement of an animal both the shooter and the camera operator have to verbally confirm to each other that they both clearly identify that what they are looking at is the target species. They also identify a specific part of the animal (head, neck, vital organs) as a point of impact for an ethical lethal dispatch.

10 | TADS ADVANTAGES

While TADS has not been developed to surpass the detection probability of a skilled hunter and dog, it is a tool that significantly increases the speed and effectiveness of aerial shooting in all terrain while increasing the probability of dispatch on encounter. The added sensitivity of a high definition thermal camera also makes detection and dispatching ungulates possible in forested areas.

Although TADS is still in the development phase and is not being used at its full potential, it has already proven to be the largest step forward in ungulate control in the last 50 years and fills that critical niche that has been previously lacking to managers of animal populations.

Primarily it is a tool to quickly reduce moderate to high ungulate populations to a low level, it also excels in several other applications where speed and efficiency matter.

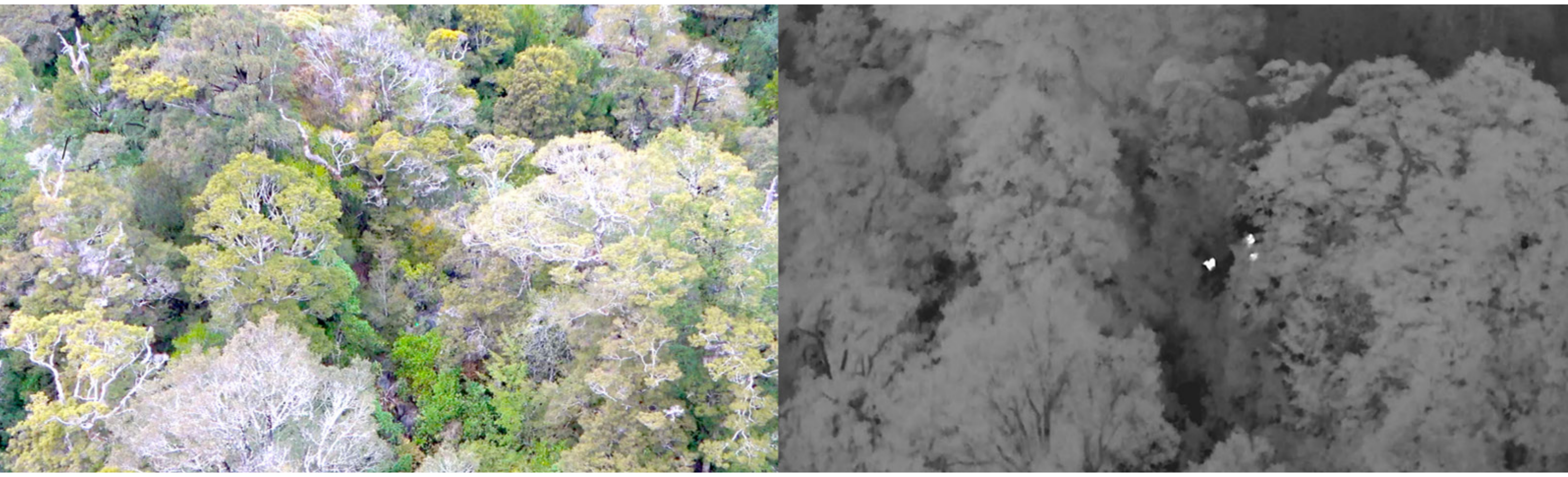


FIGURE SEVEN | Goats detected, invisible to the naked eye.

10 | RECOMMENDATION FOR CONTROLLING DEER

The highest deer population densities in New Zealand have been recorded at around 20 deer per sq km. Based on anecdotal evidence of deer sightings and the absence of palatables in the browse tier, much of the Sounds will be at similar densities.

If the goal in the future was to restore palatables in the understorey, the deer population would have to be reduced to around 1 deer per square km or >90% population reduction. This is unlikely to be achieved cost effectively by the use of TADS assisted aerial shooting alone, and would require additional ground hunting effort with experienced contract hunters with indicator dogs. However, aerial shooting using TADS should reduce current deer populations by >75% by or reduce the deer population to less than 4 deer per sq km, which would improve amenity values for bach owners and have some benefit in terms of native forest succession.

In considering how wider-scale deer control could be implemented in the Sounds, to meet the objectives described above, we would recommend the following:

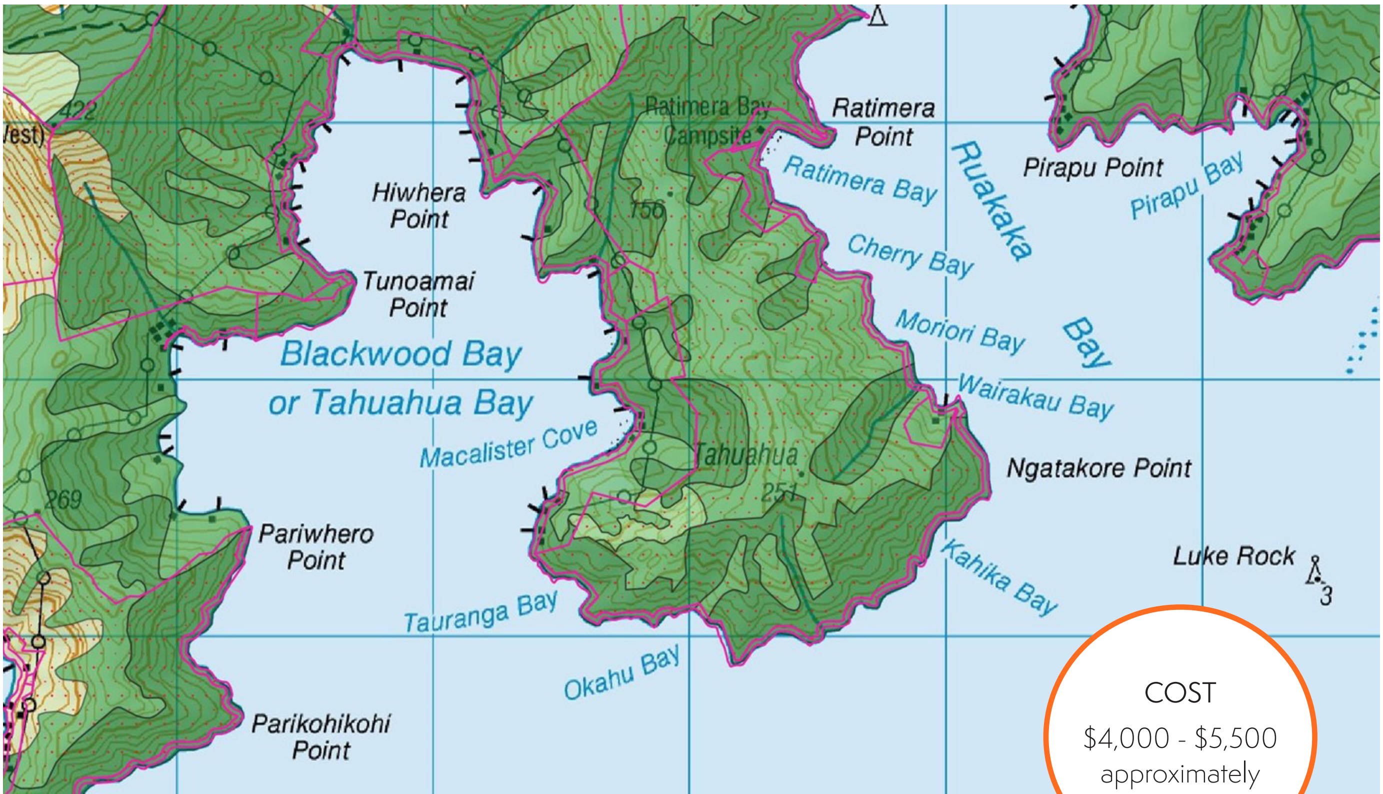
- Control area need to be of sufficient scale, so that the site can sustain some level of incursion, which is inevitable given the high population pressure throughout the Sounds.
- Control needs to be focussed on areas that are dominated by the correct habitat for this method, which in this case will be kanuka/manuka and broadleaf coastal forests. It will be less effective in stands of mature or intact native beech or podocarp forest.
- The control area should be have small reinvasion fronts, either by virtue of being surrounded by sea or being connected to uncontrolled areas by narrow necks of land
- The control area should be of lower public use

In addition, land tenure needs to be considered. The control area will require mostly supportive landowners, such access permission is given by landowners or land managers for at least 90% of the control area.

Finally, cost is a key consideration. Based on the learnings from the pilot project at Blackwood Bay, we believe one hour's flying time should be allowed for every 100ha, equating to a cost of around $1500 – $2000 per 100ha dependant on the helicopter type used, this includes the TADS operator withing the hourly rates. As the scale of the project increases, efficiency in helicopter time and rates can be made. Each layer will achieve an approximately 60 – 80% reduction. Additional costs/time around project management, particularly consulting and notifying landowners should be factored in.

To illustrate the complexities of selecting a site, the following illustrative examples show different control scenarios (Shaded green areas indicate areas of kanuka/manuka or broadleaf forest which are suitable for TADS, pink dotted areas indicate public conservation land, for which access should be assured):

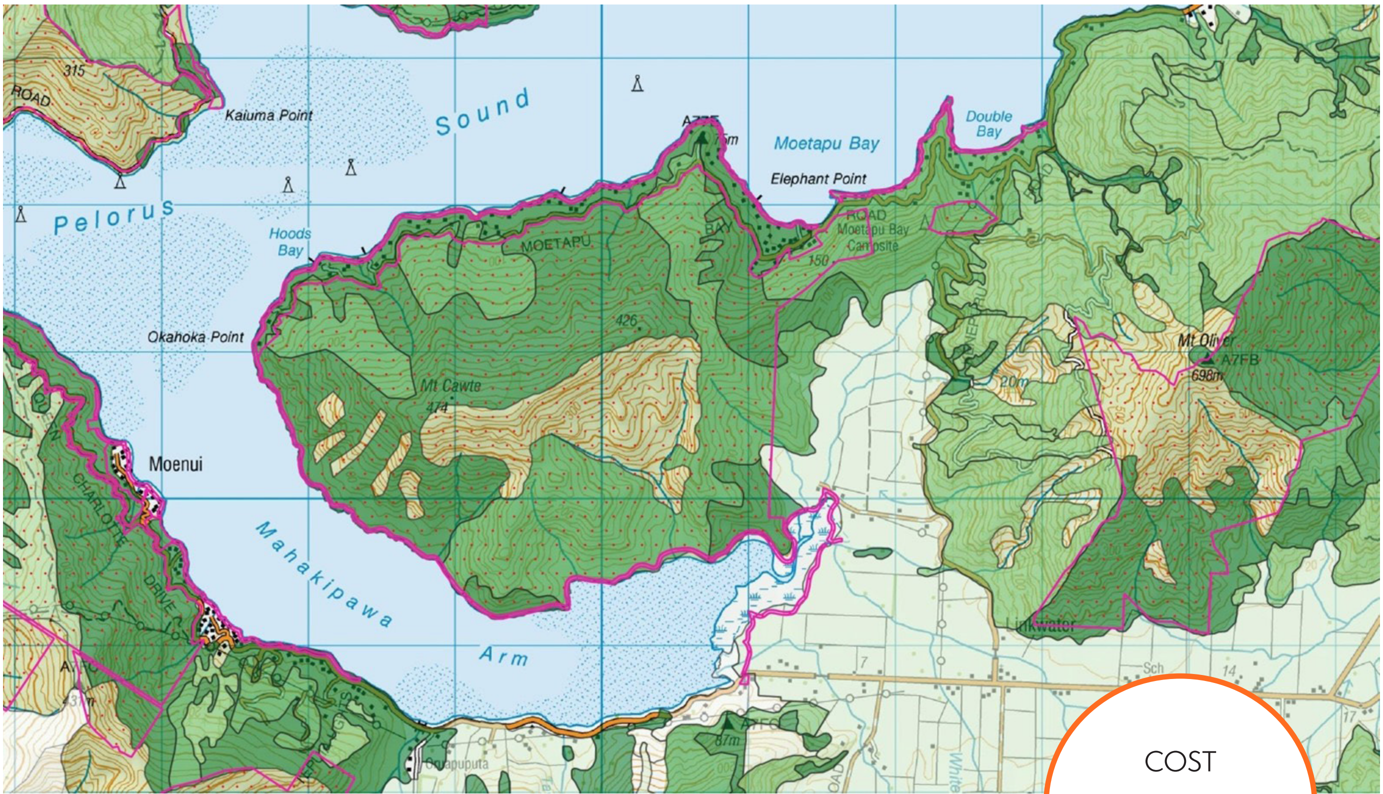
BLACKWOOD BAY HEADLAND



COST
$4,000 - $5,500 approximately

SCALE	Small scale (~250ha)
CONTROL FREQUENCY	A control frequency of 1 per year to manage the reinvasion
GOOD HABITAT	The site is almost entirely dominated by kanuka/manuka and broadleaf forest, which has high detectability
REINVASION	A small reinvasion front, of less than 1km at the base of the peninsula
PUBLIC USE	Low, with no public tracks
LAND TENURE	The site is dominated by public conservation land, for which access should be assured, along with supportive bach owners

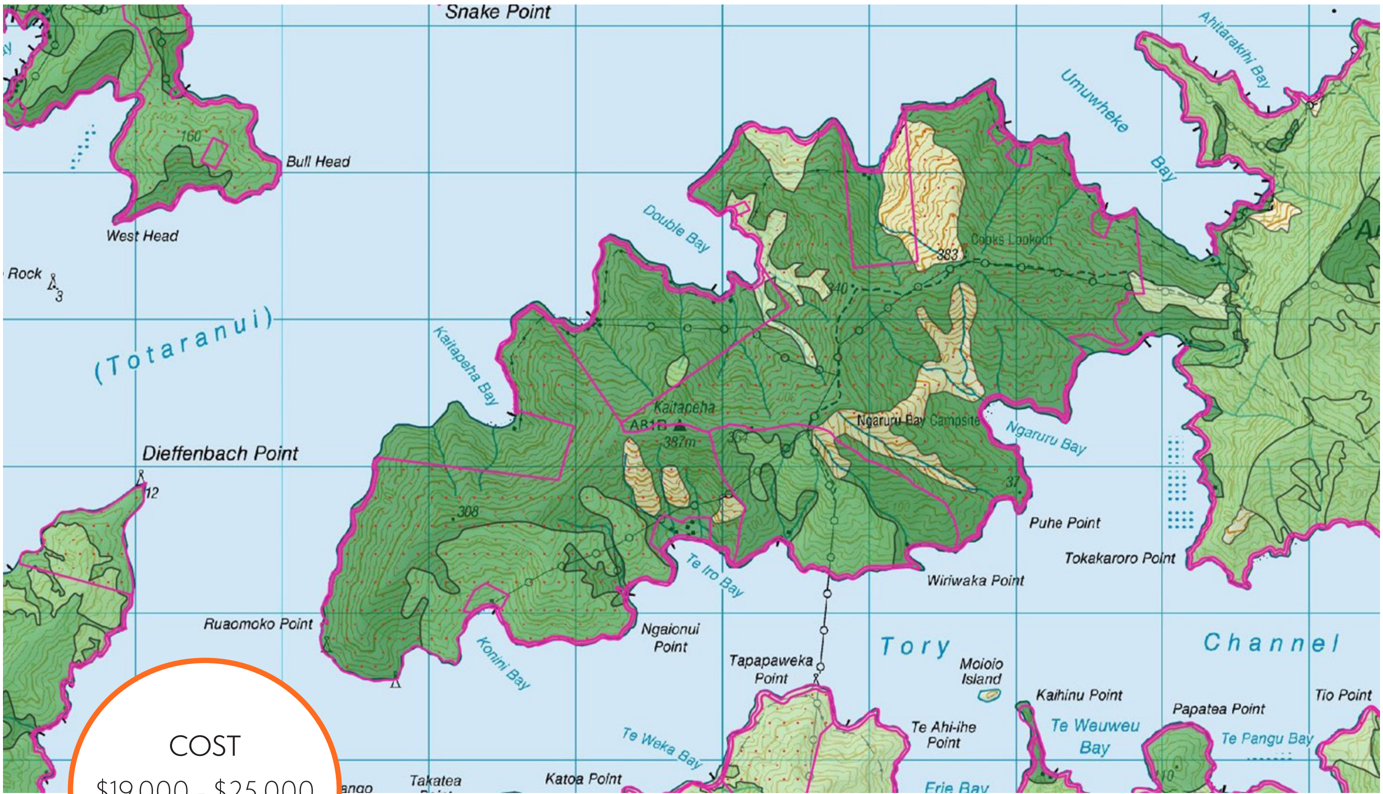
MT CAWTE/MOETAPU HEADLAND



COST
$13,000 - $18,000 approximately

SCALE	Moderate scale (~850ha).
CONTROL FREQUENCY	Frequency of control being 2 yearly to manage reinvasion
GOOD HABITAT	The site is largely dominated by kanuka/manuka and broadleaf forest, which has high detectability, but has an area of intact forest on the southern side of Mt Cawte where detectability will be lower. This area may need some ground control.
REINVASION	A moderate reinvasion front, of almost 2km at the base of the peninsula
PUBLIC USE	Low, with no public tracks
LAND TENURE	The site is dominated by public conservation land, for which access should be assured, along with supportive bach owners

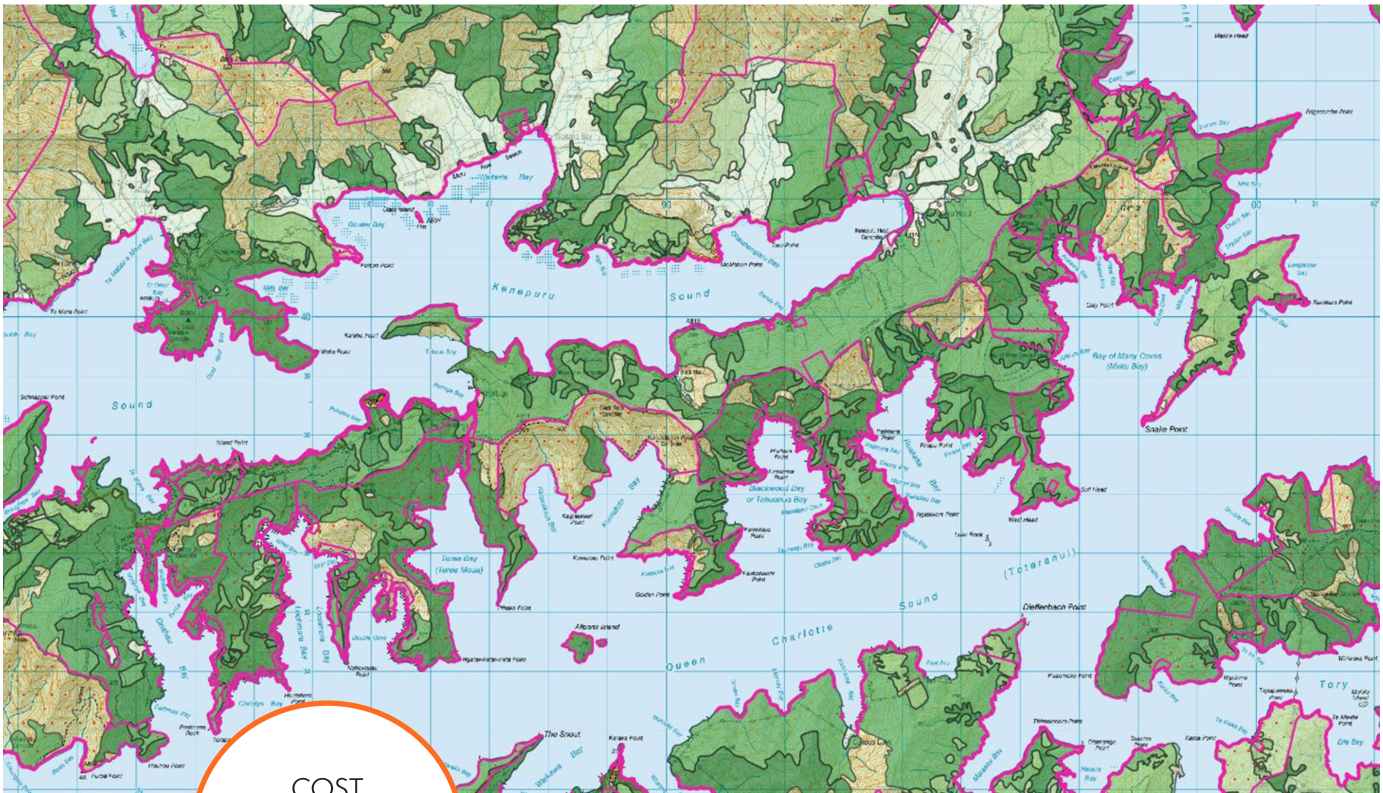
SOUTHERN ARAPAWA ISLAND



COST
$19,000 - $25,000
approximately

SCALE	Moderate-large scale (~1200ha), meaning control would not need to repeated frequently as the site will hold up to reinvasion
CONTROL FREQUENCY	Frequency of control being 3 yearly to manage reinvasion
GOOD HABITAT	The site is almost entirely dominated by kanuka/manuka and broadleaf forest, which has high detectability
REINVASION	A small reinvasion front, of less than 1km at the base of the peninsula
PUBLIC USE	Low, with no public tracks
LAND TENURE	The site is dominated by public conservation land, for which access should be assured, but it is unknown whether landowners would be supportive.

NORTHERN QUEEN CHARLOTTE SOUND (FROM ONAHAU SADDLE TO KENEPURU HEADS)



COST
$110,000 - $150,000
approximately*

SCALE	Large scale (~7000ha), meaning control would hold up well to reinvasion
CONTROL FREQUENCY	Frequency of control being 4-5 yearly cycle to manage reinvasion
GOOD HABITAT	The site is almost entirely dominated by kanuka/manuka and broadleaf forest, which has high detectability, although there are some areas of intact forest on the southern side of the main ridgeline where detectability will be lower. This area may need some ground control
REINVASION	A small reinvasion front, of less than 1km at each end of the block
PUBLIC USE	Moderate, as the Queen Charlotte Track runs through the block, meaning some areas may be excluded from TADS
LAND TENURE	The site is a mix by public conservation land, for which access should be assured, and landowners. It is unknown whether all landowners would be supportive, which would require an extensive consultation exercise.is unknown whether landowners would be supportive.
COST	* At this scale, stakeholder buy-in from parties such and Doc and Council is likely.

11 | CONCLUSION

Based on this trial, deer control at scale in the Marlborough sounds is achievable. The communities should now consider if the impacts of feral deer and the costs associated to manage those impacts.

In conclusion, if communities on a small or large scale are willing to fund feral deer management, then:

1. Sites should be selected for control, based on either demand from landowners and/or the sites values.
2. Any site selected should strive to meet the criteria outlined above in order to be effective.
3. A control objective of 75% - 90% should be sought to meet forest regeneration outcomes.

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