Pest Control Advice – Feral Pigs

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Summary

Project and Client

This report contains advice requested by the Hawke's Bay Regional Council on feral pig impacts and control options and funded by the Foundation of Research, Science and Technology Envirolink small advice grant. It is outside the scope of this report to include site-specific recommendations so the information included here is generic with limited information on the site-specific (Te Uri area) pig problem presented in section 8.

Objectives

- Outline the environmental and economic impacts of feral pigs.
- Prepare a comprehensive outline of technical options for initial and maintenance control of feral pigs.
- Outline current issues of impact monitoring and compliance with regard to feral pigs.

Methods

- This report is based on current literature, field experience of the author in pig control methods, and the initial findings of a recent (2006) pig control programme conducted by a North Canterbury Landcare Group. Additional information supplied by Hawke's Bay Regional Council was used where required to add more specific recommendations.

Findings and Discussion

- Increasing pig populations on both conservation and production lands have become more of an issue throughout New Zealand since the late 1990s. This can be attributed to many factors including such things as changes in habitat, reduction in hunting pressure, newly established populations, lack of a commercial market, guided hunting, and perhaps warmer winters increasing pig survival.
- With increasing populations impacts of feral pigs on farmland, forestry, and the conservation estate have become noticeable. While some impacts have, and are likely to always be, present in areas of traditionally high pig populations, newly established populations or populations impacting on intensive production farmland are more often seen as a nuisance that needs to be controlled.
- A wide range of control tools already exist and have been used to successfully control and eradicate pigs in other countries and from local areas within New Zealand. The need then, is not so much for new techniques, but to evaluate and test in New Zealand these existing methods. Control and even local eradication of feral pigs in many areas is achievable provided the strategic options and technical considerations outlined in this document are met. Any spending on control would have to be justified in a strategic management plan that should include an assessment of the problem, a plan of action and implementation, and a method of evaluation and monitoring both the management plan implementation and the reduction in pig impacts.
- There is no established and accepted methodology for valuing conservation benefits, and production losses are poorly defined and quantified. This uncertainty makes any decision on where and how frequently to control pigs, and on how much to spend doing so, difficult. Justifying pig control in many areas is difficult, as pig control may have an opportunity cost by taking funds from control of other pests whose impacts are known. It

is likely that progressive improvement in management of pigs will need to be underpinned by a programme of ongoing research to identify cost-effective tools for pig control and to monitor the outcomes of any control undertaken.

Recommendations

- A site-specific strategic control plan should be prepared as a medium Envirolink Advice project.
- The relationship between pig density and their impacts should be determined to enable target densities to be set.
- Pig control should be initiated once a site-specific strategic plan is approved and all parties involved agree on how best to measure pig impacts against an agreed set of operational and performance measures.

1. Introduction

This report was requested by the Hawke's Bay Regional Council as an Envirolink small advice grant in response to concerns raised by landowners surrounding a 1877-ha area of Ernslaw Forest in the Te Uri area. The landowners' concerns relate to pig impacts on pasture and stock. The feral pigs (*Sus scrofa*) have apparently only been a problem since 1998 and, it being a relatively new invasion, farmers are keen to eradicate pigs from their properties and reduce the chances of reinvasion. The landowners have indicated a boundary to the area they would like to see intensively monitored (Te Uri Rd).

2. Background

The issue of feral pig impacts on farming properties has been an ongoing concern especially where relatively intensive farm operations are bordered by what is seen as a pig 'haven' or corridor that enables pigs to have ready access to adjacent farmland where they can cause significant impacts on pasture. Recently (since the late 1990s) pig numbers appear to have increased and their impacts have been more visible and on a scale not seen since the 1950s when official pig control was carried out. Many rural communities are now facing problems with pig impacts and 'murmurings' of a desire for pig control are becoming more common.

While some property owners have a shared concern that feral pigs have a negative impact on conservation and production values, others see them as a resource to be harvested. These conflicting values can create tension in local farming communities, making it more difficult to develop community-based management plans. Recently the author has been working with one such community (the Coastal Conway Landcare Group – CCLG) to establish and implement a control plan for feral pigs. Some of the advice given to this group and the results of implementation of the plan have been used for this report.

Before pig control is undertaken there needs to be consensus on the measurable impacts caused by feral pigs. Additionally, during and following any control operation the level of control and associated reduction in impacts need to be formally measured to ensure the outcomes of the control programme are achieved.

The manager of Ernslaw Forest has indicated the company is happy with the current control, which is done by a permitted hunting system. However, they will support extra control in their forest as long as they do not incur the costs.

There are many keen pig hunters in the area and the risk of deliberate reintroduction is considered high. In 1995 the discovery of a Tb-infected pig with a strain type from the Wairarapa suggests illegal releases have occurred in the past.

3. Objectives

- Outline the environmental and economic impacts of feral pigs.
- Prepare a comprehensive outline of technical options for initial and maintenance control of feral pigs.
- Outline current issues of impact monitoring and compliance with regard to feral pigs.

4. Methods

Information for this report was obtained from literature, field experience of the author in pig control methods both in New Zealand and overseas, and initial unpublished findings of a recent (2006) pig control programme conducted by the Coastal Conway Landcare Group (North Canterbury). Additional information was supplied by the Hawke's Bay Regional Council on the specific issues related to the Te Uri area.

5. Environmental and Economic Impact of Feral Pigs

5.1 Legal status of feral pigs

Feral pigs are defined as wild animals under the Wild Animal Control Act 1977, and as such they may be hunted or trapped by anyone with the permission of the landowner. It is illegal to liberate feral pigs on any land.

Regional councils can declare pigs as pests of regional significance if they, in consultation with the public, accept that regional intervention is both necessary, efficient, and that the benefits outweigh the costs. Any regional or national pest management strategy as specified in the Biosecurity Act 1993 must be consistent with the provisions of the Wild Animal Control Act. Hawke's Bay Regional Council's current Regional Pest Management Strategy (RPMS) does not include feral pigs, although these could be included if management options are available and the communities want it.

The Department of Conservation (DOC) may kill feral pigs on land it administers and (within the provisions set out in sections 15 and 16 of the Wild Animal Control Act) on Crown lease and private land. Generally, DOC will only control pigs that are adversely affecting conservation values. Feral pigs are generally listed as 'asset led' pests in DOC's Animal Pest Management and Monitoring Strategies. Essentially, this means pigs will be controlled by DOC at places with priority conservation assets that are most vulnerable to pigs.

5.2 History of pig populations – Te Uri area

There are no formal population estimates for feral pigs in this area at present, but it is understood the farming properties north of Te Uri Road did not have feral pigs until 1998. Pig impacts north of the Te Uri Road could be caused by either resident pigs or itinerant pigs that use the forest as a corridor to travel from more pig prone areas south of Te Uri Road

The only control of pigs currently carried out in this area is by recreational hunters (permitted hunting system in Ernslaw Forest) and the farmers themselves who are keen to maintain a zero-pig policy north of Te Uri Road.

5.3 Pig impacts on biodiversity

The impact of feral pigs on New Zealand's native biota is poorly understood. In general, pigs, like other introduced vertebrate pests, have both direct and indirect impacts. Direct impacts include browsing of vegetation, predation of invertebrates (and lambs), and disturbance via rooting of pasture and forest understorey. Potential indirect adverse impacts are changes in soil processes and vegetation successional patterns from rooting (Choquenot et al. 1996).

Feral pigs can root significant areas of forest soils and pasture. In the riparian terraces at Waitutu Forest in Fiordland, c. 5–10% of the soil surface is rooted at any one time (J. Parkes, unpubl. data), and on Ngaroma farm (one of the Coastal Conway Landcare Group (CCLG) farms), c. 2% of the soil surface was rooted when surveyed in 2004 (B. Batema and A. Meddens, unpubl. data). The consequences of this intensity of surface soil rooting on plant regeneration and succession are unknown. We believe that such rooting will in some instances prevent grasslands progressing to scrub vegetation and in others encourage the introduction and establishment of weeds, and may inhibit succession from woody weeds such as broom to native forest.

The effect that pig feeding has on the abundance of fruits and invertebrates is not known, and although diet studies provide information on what pigs eat and what their preferences might be, such studies do not determine what impacts this feeding has on the selected food resources. Three published studies on the diet of feral pigs show that fruit and invertebrates, especially earthworms, are important foods. In podocarp-tawa forest of the Urewera Ranges, feral pig diet consisted of approximately 72% plant material and 28% animal material. Fruits from tawa (*Beilschmiedia tawa*), hīnau (*Elaeocarpus dentatus*), and supplejack (*Ripogonum scandens*) made up to 33% of pigs' diet in this area (Thomson & Challies 1988). On D'Urville Island, fruit made up 24% of the diet by dried weight and pigs were a major predator of giant land snails (*Powelliphanta hochstetteri obscura*) (Parkes et al. 2004). On Auckland Island, earthworms made up 26% of the diet, and megaherbs 38% by dry weight (Chimera et al. 1995).

5.4 Pig impacts on production values

The impact of feral pigs on production values in Australia has been assessed for many agricultural practices, i.e. predation of lambs (Rowley 1970; Pavlov et al. 1981), damage to grain crops (Tisdell 1982; Caley 1993) and competition with livestock and damage to pastures (Hone 1980; Choquenot 1994). However, Choquenot et al. (1996) still consider that in Australia the 'major costs of agricultural damage caused by feral pigs to landholders have never been reliably estimated'. Similarly no attempt has been made in New Zealand to do so.

Although impact on production values may have little direct significance for biodiversity, in the case of the CCLG, production loss due to pig impacts is partly a result of the conservation initiatives implemented by the group (Yockney et al. 2005). That is, by 'retiring' land from grazing and burning to achieve improved biodiversity values, farmers have created an increased area of ideal habitat for feral pigs. Consequently, farmers are paying for increasing the area set aside for biodiversity values by incurring greater areas of pasture loss resulting from pig rooting, and presumably from competitive grazing. This problem is somewhat similar in the Te Uri Road area with the planting of production forestry providing pig habitat adjacent to susceptible farmland.

Loss of production resulting from pigs rooting pasture and grazing on vegetation usually eaten by sheep and cattle can be crudely measured by the resulting reduction in stocking rates. For example, one property in the CCLG reported a reduction of 500 stock units (SU) per annum due to pig impacts. At $65 per SU, this equates to a $32,500 loss of production for this single property. Another property reported the cost of resowing large blocks (>30 ha) after extensive damage by pigs at about $10,000 (per annum). To value the impact on production resulting from the establishment of neighbouring forestry, farmers need information on how much the pig impacts have increased as a direct result of this land use change.

Lamb predation is known to occur although it is poorly quantified. Historical information suggests losses of up to 50% can occur when pig numbers are high. It is likely that sporadic lamb predation still occurs in many areas.

Farmers therefore have two options for reducing the impact of feral pigs on their pasture. The first is to reduce the area of pig habitat by reducing the area of scrub and forest – this is often not viable as it is not owned by the adjacent farmers. The second is to implement a pig management and control programme aimed at reducing pig numbers and maintaining them below a level at which they are causing unacceptable impacts.

5.5 Role of feral pigs in maintaining bovine tuberculosis (Tb)

Feral pig populations in New Zealand often have a high prevalence of Tb infection in areas where other wildlife are infected (Vector Risk Areas or VRAs). In New Zealand prevalence of the disease in pigs from infected areas can range from 50% to 90%. Feral pigs are considered a spillover end host that contract the disease and can spread it to ferrets and possibly possums that scavenge infected pig carcasses. However, they will not maintain the disease in the absence of other wildlife vectors, especially possums (Nugent et al. 2003). In areas of both high pig numbers and high scavenging vector populations (i.e. feral cats, ferrets) a precautionary approach of reducing pig numbers to lower the disease loading in the environment is recommended to break any co-scavenging Tb cycle in wildlife (Nugent et al. 2003).

There is a risk to livestock of natural disease spread from neighbouring properties where Tb has been confirmed in wildlife vectors. While reducing pig numbers to lower the possibilities of a co-scavenging Tb cycle would be recommended (Yockney & Nugent 2003), blanket pig control based on Tb transmission is not currently conducted as part of vector control operations by the Animal Health Board.

5.6 Benefits of pig control

Farmers have mixed motives for pig control. Pigs affect both biodiversity and production values. There are clearly some production losses being incurred by the farmers in an area that prior to 1998 had nil pig impacts. Likewise for the CCLG, significant production losses were recorded and credited to the increased habitat provided for pigs through the farmers' own conservation initiatives (i.e. retiring land as QEII reserves). In the Te Uri area it could be argued that a proactive approach to minimising pig numbers while still at relatively low levels would be prudent, rather than waiting for the problem to persist and potentially become more difficult and expensive to fix. Nevertheless it is important that pig impacts are quantified so an estimate can be made as to how much to spend on the problem.

6. Control Options

6.1 Strategic options for managing feral pigs

In order to reduce or completely stop the impacts of pests, managers generally have five options to select from, listed here in decreasing order of benefit (Parkes 2003):

1. Stop the pest arriving in the first place
2. Eradicate all pests present
3. Apply a single control with a long-term benefit (e.g. biocontrol)
4. Sustain control to keep animals at a lower level
5. Do nothing.

If eradication is desired, the criteria for success identified below must be met. These are (after Parkes 1990):

- All pigs must be put at risk – generally in New Zealand given the terrain, ground cover, financial resources and lack of a suitable toxin this would be difficult to achieve.
- There must be no risk of immigration – unless the pig population considered for control is in a geographic 'island' of habitat, there is usually some form of immigration – including illegal liberations.
- Pigs must be killed at rates faster than they can replace their losses at all densities.

Option three (applying a single control tool, e.g. biocontrol) is also not technically possible at present. The two remaining choices, sustainable control or do nothing, need to be carefully considered. If the cost of control exceeds the benefits then the best option is to do nothing. Sustained control requires that pigs be reduced to some low density in an initial operation and then held there by maintenance control applied at either some set frequency or as the need (i.e. increasing trend in numbers or damage) arises.

6.2 Choice of control methods

No official control of pigs has been carried out for many years, and farmers have been left to deal with any pig problems they may have. Most farmers rely on recreational and/or commercial hunters with dogs. Although pigs can have a high prevalence of Tb they are generally not targeted for control by the AHB. Consequently, there are no established 'best practice' methods for controlling pigs outside the widely used method of hunting with dogs.

The appropriateness of a particular technique will depend on the strategic aim of the control programme and the ecological and social context in which control is to be undertaken.

In the absence of a registered toxin in New Zealand for controlling pigs and the limited research that has been carried out on feral pig control, some current methods of pig control that have worked well in Australia, New Zealand and elsewhere are detailed below.

Habitat modification

Pigs, like other wild animals, need to have areas of safe harbourage (refugia), where young can be raised safely and where all pigs can retreat when pursued by dogs and/or hunters. Removal of refugia such as areas of scrub and or forest remnants will significantly reduce pig numbers, restrict their distribution, and improve farmers' ability to control them. It is believed that the progressive clearance of scrub and forest during European settlement contributed to the gradual reduction in pig populations (Holden 1994).

However, such clearance is less acceptable today and impossible when neighbouring production forests are concerned. Habitat modification as production forests grow will likely see a change in pig numbers within the forest. Young or thinned pines create a refuge, while adult pines with little undergrowth limit pig habitat. Change in the areas of refuge (ground cover) may also increase the difficulties of both ground hunting and aerial shooting.

Exclusion fences

Fences can aid pig control in two ways. Strategically, they prevent immigration and the consequent additions to the population. Tactically, they reduce the effective size of the area in which pigs might need to be controlled, so managers can focus on one area at a time, without having to continually return to previously cleared areas to remove recent immigrants. Fences also permit clear separation of management objectives between adjoining lands of different tenure or use. Even though fences themselves do not actually control pigs, these three features have made fencing the cornerstone of successful and progressive elimination of pigs from large protected natural areas in Hawai'i (Hone & Stone 1989).

The principal drawbacks with fencing are the high initial expense, and the need for ongoing monitoring and maintenance of the fences to ensure their integrity. For New Zealand, fences are likely to be of most value for protecting small areas of high conservation value within a larger area of continuous pig habitat.

Non-electric fences must be of netting or diamond mesh construction with a spacing of vertical wires of about 15 cm (Hone & Atkinson 1983). They must be at least 80 cm tall, with the bottom wire pulled tightly down into dips. In Hawai'i, iron standards are used as posts, with 2-m spacing between posts and with all components triple-dipped galvanised. Fences need to be inspected at regular intervals, and after any major storms.

Poisons

Poison has been widely trialled and used operationally to control pigs in Australia (Hone & Stone 1989; Saunders et al. 1990; Choquenot et al. 1996) and elsewhere overseas (i.e. Santiago Island – Galapagos; Cruz et al. 2005). Both a variety of poisons (e.g. 1080, anticoagulants, phosphorus), bait types (e.g. cereal, fishmeal, meat, carcasses), and bait application methods (e.g. aerial sowing, ground-laying, bait stations) are used. Poison operations have achieved high kills, but poisoning alone has never achieved eradication.

Before poisons can be adopted for general pig control in New Zealand the issues of non-target risks, registration, secondary poisoning, residues and environmental contamination, and public/hunter opposition need to be addressed and baits and toxins registered.

The Australian Invasive Animals CRC (Pest Animal Control CRC 2003–2004), Landcare Research, and Connovation are actively pursuing new poison options for feral pig control. However, at present there are no new poison baits or delivery systems available that can be immediately adopted by landowners. Encapsulated cyanide bait for pigs (similar to Feratox® for possums) is currently being developed and (if successful) is most likely to be suitable for use in New Zealand. The advantages and disadvantages of current vertebrate poisons and our ranking for potential as pig toxins are outlined in Table 1. The long-term solution to cost-effective, large-scale pig control in many areas is most likely to be from the development of a suitable vertebrate poison and a better bait.

Table 1 Advantages and disadvantages of current or potential vertebrate poisons for feral pig control. No vertebrate poison for killing pigs is currently registered for use in New Zealand.

Toxin	Advantages	Disadvantages	Potential for use in NZ
1080	Can be effective against pigs Cheap	Non-target effects (farm and pig dogs special concern from vomitus) Hunter concerns re residues in carcasses Users must be licensed	Low
Cyanide	Pen efficacy established against pigs Fast acting / most humane Feratox formulation available	Preliminary field results (Australia) not successful Possibility of pigs developing bait shyness Users must be licensed	High
Cholecalciferol	Delayed action – may reduce risk of shyness Reduced risks of secondary poisoning	Acute toxicity to pigs not known Humaneness unknown Requires user licence	High
Anticoagulants	Delayed action – reduces risk of shyness Effective against pigs (Australia use)	Humaneness concerns Concerns re residues	Medium
Zinc phosphide	Unknown efficacy against pigs Residues/secondary risk probably relatively low	Humaneness unknown User licensing requirements unknown	Low–medium
Phosphorus	Effective in carcass baits But other bait types unknown	Humaneness unacceptable Secondary risks and residues not well researched Risks to human handlers Licensing	Low

Trapping

Trapping can be an effective technique for controlling pigs providing there is continual and constant effort put into the baiting and trapping programme. Results from Australia suggest capture efficiency of traps, at least for one trial, resulted in 62% of pigs exposed to traps being captured (Saunders et al. 1993), and in another study trapping resulted in about an 81% reduction (based on spotlight counts) in a central tableland environment (Choquenot et al. 1996). In contrast to poisoning, landowners can see the number of pigs trapped, the pigs can also be used either as a resource (as food) or they can be radio-collared and used as Judas pigs. Other advantages of trapping include (Lukins 1989; Choquenot et al. 1996):

- Does not interfere with normal pig behaviour (compared with dogging and shooting)
- Allows for flexibility of use and therefore can be carried out in conjunction with on-farm activities thereby reducing labour costs
- Can be moved and reused in a variety of habitats and seasons. Good trapping makes use of opportunities as they arise
- Humane
- No non-target or residue problems
- Pig numbers can be monitored.

Unfortunately trapping appears to be the least cost-effective control technique (at least in Australian examples) when compared with both poisoning and helicopter shooting. Trapping is time consuming and large numbers of traps are expensive to construct. Nevertheless, with the current lack of a suitable poison for control, and where pig densities make hunting with dogs inefficient, trapping still offers a useful method for controlling pig numbers. The recent control work conducted by the CCLG included a trapping programme with two full-time trappers operating over a period of 4–6 weeks. And although they were reasonably successful (trapping in excess of 100 pigs), when this method was compared with aerial shooting it was considered uneconomical at the initial high pig population level.

Trap types: There are two types of traps commonly used for capturing feral pigs: the portable box trap and the weld-mesh-panel trap. The portable box trap is designed as an efficient and environmentally acceptable method for capturing feral pigs, and the traps are easily relocatable so that seasonal movement and availability of food can be fully exploited. A local engineering shop or welder should be able to build this type of trap at reasonable cost from the plans shown in Fig. 1.

The weld-mesh-panel trap is a little less portable, but nevertheless is reasonably quick to erect (around 45 minutes). This trap requires a one-way swinging door to be welded into one of the weld-mesh panels, and other than that modification it is simply four sides of straight weld-mesh panel (120 cm height, 240 cm width with 5-cm squares). The door is 75 cm wide and 100 cm high. Eight waratah posts and lacing wire are used to hold it together (see Fig. 2). It is important that the weld-mesh panels are spliced together with the waratahs on the outside of the trap. An extra precaution when trapping large pigs is to use a tight wire all the way around the inside top about 25 cm in. The cost for this type of weld-mesh trap is approximately $350 plus the welding costs for each door.

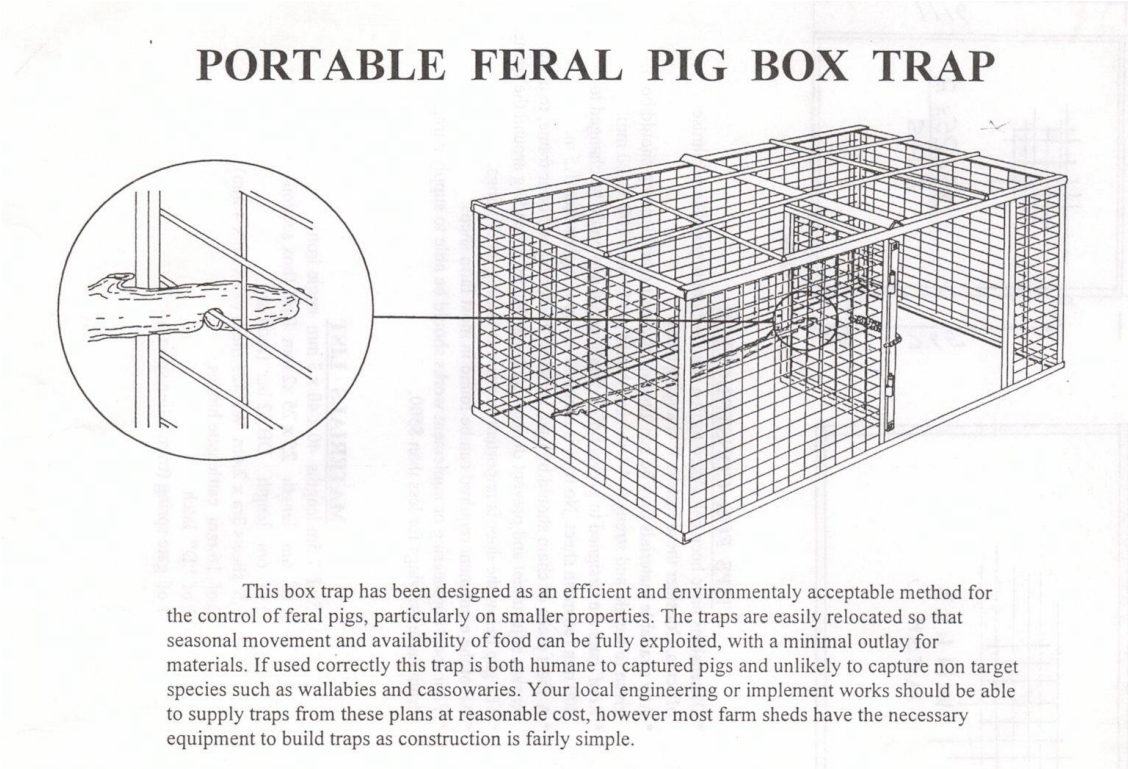

Fig. 1 Portable feral pig box trap as is often used in Australia (source: Department of Natural Resources and Mines 2004).

Fig. 2 Weld-mesh-panel trap set with the door wired open and a trail of fermented barley leading into the trap.

Baiting and trapping techniques: Feral pigs can be extremely wary of new food types or objects in their environment (i.e. they can be neophobic), and it is therefore essential to allow pigs to get confident with the trap and bait type before setting. Thus traps should be set open and baited for at least 10–12 days. There are several different bait types to use, but bait that is easily transported (on ute or motorbike), readily available, and cheap should be selected. For this reason carcasses are often not ideal as prefeed and are therefore less effective as bait. Grains such as maize or barley are more user-friendly. Landcare Research has used fermented barley with good success (I. Yockney, pers. obs.). To ferment this bait type place the barley in a large black container with water added and leave in direct sunlight during summer for 10–12 days or until the barley has a pungent, fermented odour. Maize is another successful bait used by several game estate operations. It can be used dry in automatic feeders or a mini-silo-type operation for pre-feeding. Pre-feeding areas can also be useful for both snaring and returning at night to shoot pigs with the aid of a spotlight (Kessler 2002; Schuyler et. al. 2002).

The trapping routine used successfully by Landcare Research is based on the use of fermented barley as a bait type and is outlined below (after Hone 1984):

- Find areas of significant pig activity to start pre-feeding.
- Pre-feed the area with well-fermented barley in small clumps of approximately 1-kg lots, and try to keep the fermented barley from drying out.
- Once there is continual bait take at a site, construct or place the trap unset (wired open).
- Pre-feed both around and in the trap (unset) until all the bait is taken, for at least 2 consecutive nights.
- Set the trap, rebait and check daily (killing and removing all captured pigs from the trap) until there is no more bait take.
- Start pre-feeding another area and move the trap on once it has stopped catching.

Other points to note when trapping are:

- Try to locate traps or pre-feed sites in a circuit to make for easy daily checking.
- Do not be put off if the pigs will not enter the trap or eat the bait at first as time should overcome this.
- Keep activity in the area to a minimum and cease the use of hunting dogs if you have a large group of pigs that could be trapped.
- Kill the pigs in the trap humanely (shoot in the head with a centrefire rifle) and remove the carcasses from the area.

Aerial shooting

Aerial shooting of feral pigs using a helicopter can be very successful in open country where pigs are easily visible and there is ample opportunity for the shooter. This technique generally results in a quick population knockdown, the success of shooting pigs from helicopters has been well documented (Choquenot et al. 1996), and ranges as high as 80% population reduction in the first year of aerial control (Saunders 1993). No attempt has been made in New Zealand to assess the overall effectiveness of aerial hunting of feral pigs, although a recent trial evaluating the Judas technique with straight aerial hunting has been completed (Yockney & Nugent 2006).

The most cost-effective helicopter for these aerial control operations is the two-seater Robinson R22 at a cost of about $550 + GST per hour exclusive of shooter wages and ammunition used. Additional costs will be incurred for ferrying time. The effectiveness of aerial shooting in the Te Uri area will depend on locating pigs outside high vegetation where

both pilot and shooter can see them. Consequently, effectiveness might be maximised if hunting is restricted to seasons in which pigs favour shorter vegetation and thereby expose themselves to aerial shooting or to aerial shooting while the plantation forestry is still young enough to get good visibility down through the young trees.

An example of the effectiveness of aerial shooting was recently demonstrated in the CCLG control programme. Previous helicopter shooting in this area was generally considered unsuccessful, expensive, and limited in scope due to the very high scrubby vegetation (young pines and extensive broom). However, using an extremely experienced wild animal control pilot and shooter for 2 days of helicopter shooting (approx 10 hours/day) yielded 167 and 155 pigs shot respectively. The pilot commented that although the vegetation was very high, he could generally work the pigs out and into a shootable situation.

Judas pigs

Judas animals can be used in control programmes for locating target species where they are either widely spread or keep predominantly to dense cover. The method involves having one of the target species radio-collared, and then tracking this individual to re-locate it and hopefully others of the same species that it has teamed up with. Judas goats have been highly effective in some habitats, mainly because feral goats are very gregarious. Judas pig work has met with varying success in New Zealand and Australia. In open Otago habitat it was highly effective for locating sparsely distributed pigs over a large area (Knowles 1994). In Molesworth Station, the technique was particularly useful for shooting pigs in areas of dense vegetation that would normally be flown over with no sighting when hunting from a helicopter without the ability to track the pigs (Yockney & Nugent 2006). Best success has been achieved when sows are used that are familiar with the area, therefore trapping and radio-collaring sows from the area intended for control is recommended (J. McIlroy pers. comm.). The Judas pig technique can work in conjunction with trapping operations, as sows caught in traps can be radio-tagged and released (permits will be required under the Wild Animal Control Act). A simple radio-transmitter tag developed by Sirtrack NZ (www.Sirtrack.com) is convenient to use and can be readily used by landowners. The cost per radio-tag is approximately $350 + GST and these can be reused on other pigs if by accident the Judas pig is mistakenly shot or dies naturally. The cost of telemetry equipment (aerial and receiver) would be additional if the helicopter company contracted does not have this equipment.

Some key recommendations for Judas Pig work:

- Radio-tag locally caught sows (from trapping operations) and mark them clearly (spray dazzle or large ear tags).
- Maximise the area the Judas pigs can cover by radio-tagging sows over a large area.
- Ensure the pilot has ample experience with radio-telemetry work *and* aerial shooting techniques.
- Maximise the helicopter effort by having as many Judas pigs to track as practical before hiring the helicopter.
- Before releasing radio-collared pigs, get Department of Conservation approval to do so.

Ground hunting with dogs

Ground hunting with ‘pig dogs’ is the standard method of recreational pig hunting in New Zealand. Pig hunting with dogs (as a control tool) is likely to be the most effective method of pig control when hunters are experienced, using well-trained dogs, and the focus is on *control* (as opposed to recreational hunting). The exception to this is where the habitat becomes more

demanding (steep and overgrown), when the effectiveness of both pig hunters and their dogs declines. There is evidence that the effectiveness of hunting dogs declines as pig group or mob sizes increase (Caley & Ottley 1995), because when dogs encounter a mob of pigs only a small number of those pigs is actually caught and killed, as opposed to a high proportion of single pigs when encountered.

If pig numbers increase dramatically, recreational pig hunting with dogs as the sole control tool can no longer keep the numbers in check and would require additional control. However, it is reasonable to expect that once pig numbers are returned to lower densities, ground hunting with dogs will again be effective at maintaining pig numbers at low densities, providing recreational hunters continue to hunt areas with few pigs.

7. Management Options

As with other species of vertebrate pests, feral pigs are often seen as both a pest and a resource, making management decisions difficult due to both social and biological implications. While some people may want feral pigs eradicated because of unwanted production impacts, others may want to release more pigs in local areas to enhance recreational opportunities.

Before developing any control plan there must be agreement among the parties that there is a problem to address, and that all parties are keen to work together to find a mutually beneficial solution. Development of the plan needs to be a collaborative effort.

Like any control plan for vertebrate pests when control is considered necessary there needs to be a strategic approach to manage feral pigs and minimise the damage they cause to production or conservation values. The four key management components that need considering in this approach are:

(1) Define the problem

Clearly a problem must exist and be measurable; this could be damage to native vegetation, impacts on production values, or stock losses due to predation. The problem will need to be quantified in some measurable way. An example of this is the decreased stock units able to be carried per hectare due to pasture damage caused by pigs, or the percentage of pasture rooted per hectare.

(2) Management plan

A management plan should be prepared with clear objectives established in terms of the desired outcome sought. The management plan should be achievable taking into consideration strategic control options (6.1) and the techniques or tools (6.2) available for control, i.e. there is little point in drawing up an eradication plan if this step is considered technically impossible.

(3) Implementation

How will the plan be implemented on a local and regional level? Will it be a co-ordinated approach by farmers, local or regional government agencies? Who has the experience to deal with the target species? Who will fund it and for how long? Any implementation actions will require the cooperation of landowners and land managers of both public and private lands.

(4) Monitoring and evaluation

There are two components to monitoring (*operational* and *performance*). Operational monitoring assesses the efficiency of the management programme over time, to ensure control is being carried out in the most cost-effective manner. Performance monitoring measures the success of the programme at achieving the goals of the plan, i.e. a measurable decrease in impacts after pig control as spelt out in 'defining the problem' above.

Defining an acceptable level of impact and therefore population density is required to complete a successful control operation. For instance, relative possum abundance can be measured using the Residual Trap Catch Index (RTCI) and a control operation will stipulate the desired RTCI that is considered a success (generally at a level that will not sustain Tb, say <5% RTCI). With the possum example we have a measure of relative abundance (or population density) and a defined measure of impacts (i.e. disease persistence if population >5% RTCI). By having both a measure of abundance (RTCI) and impacts (disease transmission rates) it is easy to quantify outcomes after control and determine success or failure of an operation. Other vertebrate pests have similar population indices that are suitable for enforcement or defining success or failure of control operations (i.e. rabbits, wallabies, etc.).However, feral pig populations and their impacts are both difficult and costly to measure, making any measurable goals and compliance of a control plan extremely difficult if not impossible to achieve or enforce. There is currently no 'official' way of measuring pig populations or their impacts in New Zealand. Abundance estimates and indices robust enough to be used to enforce control on landowners would need to be repeatable and defendable. Given the recent number of regional council, Department of Conservation and farmer concerns over increasing pig populations and impacts, there is a need for the development of a repeatable, relatively simple but scientifically robust method for monitoring pig abundance and impacts.

8. Implications for Te Uri Site

Without additional information and a site visit no specific recommendations can be made for this site. However, based on the information in this report and the background information supplied, some additional site-specific comments can be made.

It is apparent that the 'pig problem' lies with those farmers north of Te Uri Road where pig 'invasion' has only recently occurred (1998). This invasion of pigs seems to have occurred after a significant drought and an increase in pig numbers in areas south of Te Uri Road. Pigs seem to have established following the planting of some 1877 ha of adjacent land in production forest, thereby providing pigs a habitat corridor and refuge. The local farmers are justifiably aggrieved having to deal with a pig problem that (until recently) was non-existent.

In order to address the problem a strategic approach should be followed to define the problem and problem areas, draw up a management (or control plan), implement the plan, and monitor the outcomes. In the Te Uri instance it may be argued that a proactive approach to minimising pig impacts while still at relatively low levels would be prudent, rather than waiting for the problem to persist and therefore become more 'expensive to fix'.

The specific impacts in the area need to be clarified and measured, and then the cost of control compared with the likely cost of impact. A control plan is most likely to be focused

on initial control, then maintenance or sustained control at low levels. Sustained control and possible 'local elimination' of pigs north of Te Uri Road may be possible through the use of pig-proof fencing and ongoing control techniques. One option of measuring success if 'local elimination' of pigs within a particular area of the Te Uri site is attempted is simply the presence or absence of pigs (and their fresh sign) within the eradication area; this will indicate failure or success. To maintain a 'pig free' area, detecting new arrivals is critical, and reporting sightings should be encouraged. Alternatively implementation of a more systematic approach to surveillance could be developed. There is a concern at this site that illegal releases of pigs could jeopardise any local elimination policy. The discovery of a Tb-infected pig in 1995 with a strain type from the Wairarapa suggests illegal release/s have occurred in the past.

9. Findings and Discussion

The issue of increasing pig populations on both conservation and production lands has become more noticeable throughout New Zealand since the late 1990s. This can be attributed to many factors including such things as changes in habitat, reduction in hunting pressure, new established populations, lack of a commercial market, guided hunting, and perhaps warmer winters increasing pig survival.

With increasing populations, impacts of feral pigs on farmland, forestry, and the conservation estate have become noticeable. While some impacts have, and are likely to always be, present in areas of traditionally high pig populations, newly established populations or populations impacting on intensive production farmland are more often seen as a nuisance that needs to be controlled.

A wide range of control tools already exist, and have been used to successfully control and eradicate pigs in other countries and from local areas within New Zealand. The need then is not so much for new techniques, but to evaluate and test in New Zealand these existing methods. Control and even local eradication of feral pigs in many areas is achievable provided the strategic options and technical considerations outlined in section 6 are met. Any spending on control would have to be justified in a strategic management plan (outlined in section 7) which would include an assessment of the problem, a plan of action and implementation, and a method of evaluation and monitoring both the management plan implementation and the reduction in pig impacts.

There is also no established and accepted methodology for valuing conservation benefits, and production losses are poorly defined and quantified. This uncertainty makes any decision on where and how frequently to control pigs, and on how much to spend doing so, difficult. Justifying pig control in many areas is difficult, as pig control may have an opportunity cost by taking funds from control of other pests whose impacts are known. It is likely that progressive improvement in management of pigs will need to be underpinned by a programme of ongoing research to identify cost-effective tools for pig control and to monitor the outcomes of any control undertaken.

10. Recommendations

- A site-specific strategic control plan should be prepared as a medium Envirolink Advice project.
- The relationship between pig density and their impacts should be determined to enable target densities to be set.
- Pig control should be initiated once a site-specific strategic plan is approved and all parties involved agree on how best to measure pig impacts, which will determine if the control programme is a success or failure.

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