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RESEARCH

Use of automatic feeders to attract feral pigs on Auckland Island

Finlay S. Cox[1*] and Norm L. Macdonald[2]

[1]Department of Conservation, PO Box 743, Invercargill 9840, New Zealand
[2]Department of Conservation, PO Box 29, Te Anau 9640, New Zealand
*Author for Correspondence (Email: fcox@doc.govt.nz)

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Abstract: A feasibility study for removing feral pigs (*Sus scrofa*) from Auckland Island trialled feeders monitored by trail cameras to determine their effectiveness for detecting and attracting feral pigs. Ten automatic feeders were installed during January–February 2019 (summer) and again in August–September 2019 (winter) on Auckland Island. They delivered kibbled maize daily for a period ranging from 25 to 37 days. Sites selected for feeder installation needed to be of appropriate relief and area to allow feeder and trap installation, as would occur during an eradication operation. Feeder success varied across sites during the trial. Site selection where there was evidence of fresh pig presence improved the rate of visitation. Feeders offer significant efficiencies to lethal techniques such as trapping by automatically dispensing feed to allow constant supply over a long period. This automation reduces operator effort, but is also advantageous as consistent feed times train pigs to condition their visits so they can be more effectively targeted. In this trial, most visiting pigs returned to the feeder daily from around 15 days after installation. Automated feeders will be an integral component of the proposed methodology for Auckland Island pig eradication to target nocturnal individuals and family groups, and, importantly, reduce the risk of education through non-lethal engagement.

Keywords: Auckland Island, control, eradication, maize, *Sus scrofa*, trapping

Introduction

Feral pigs (*Sus scrofa*) are omnivores and opportunistic feeders, as such they have a wide range of impacts on agricultural, biodiversity and environmental resources (Parkes 2006; Bengsen et al. 2017). Islands are biodiversity hotspots and eradication of invasive species, such as feral pigs, is often necessary to prevent extinctions of native species (Hutton et al. 2007; Buxton et al. 2016; Holmes et al. 2019). Internationally, management of pig populations commonly uses poison baiting, trapping, aerial and ground shooting (Reddiex et al. 2006; West & Saunders 2007). Strategic eradication programmes utilising multiple techniques have made feral pig eradications possible on islands as large as Santiago Island, Galápagos Islands, Ecuador (58 465 ha; Cruz et al. 2005).

Trapping can be an effective technique for controlling feral pigs (Saunders et al. 1993; Wright & Boughton 2018). Traps were critical during the Santa Cruz Island (California, USA; 25 064 ha) eradication to reduce risk of educating survivors and keep remaining individuals naive to subsequent, more aggressive techniques (Parkes et al. 2010; Cox et al. 2022). They were also necessary to target nocturnal individuals and importantly family groups, as piglets are more difficult to detect with other tools. Trapping can require significant resources as sustained effort is needed particularly in relation to feeding or baiting; trapping efficacy can be improved if pigs condition to a site and/or trap (Saunders et al. 1993; Wright & Boughton 2018).

Feeders are regularly used recreationally by hunters and for ungulate management (A. DeNicola, pers. comms.; Metcalf et al. 2014) with developments often focused on investigating ways of delivering poison baits while limiting access to non-targets (Long et al. 2010; Lapidge et al. 2012). Developments of commercially available feeders to automatically dispense bait at programmed times have improved trapping regimes by decreasing the number of field staff visits compared to single feed feeders and by encouraging habitual visitation of pigs with consistent feed timing. Trail cameras allow 24-hour surveillance of a site which provides a high resolution understanding of pig activity and behaviour at sites.

The ecological and biodiversity impacts of feral pigs on Auckland Island have been well documented and include extensive rooting and widespread consumption of flora and fauna (Challies 1975; Rudge 1976; Chimera et al. 1995; Russell et al. 2020). The eradication of feral pigs from Auckland Island has been discussed since 1968 (Challies 1975) and there has been multiple studies on Auckland Island investigating the palatability of different baits to pigs that could be used as a poison matrix or an attractant for trapping (Harper 2007; Russell et al. 2018). Saunders et al. (1993) suggests feral pigs seek out high-protein foods. Bait trials by Harper (2007) were consistent with this suggestion as the preferred baits by Auckland Island feral pigs had a substantial protein component. In contrast during the cafeteria trial in 2015 on Auckland Island, of the baits trialled, kibbled maize (low in protein and high in

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carbohydrate) was the most effective (Russell et al. 2018). The use of maize as a highly palatable bait is also supported by other eradications and control programmes such as the Santa Cruz Island eradication (Parkes et al. 2010). Practitioners often argue soured maize is more attractive than dry maize given its distinct odoriferousness. However, Williams et al. (2011) found that soured maize when compared to dry maize did not attract pigs to a site any quicker or hold them at a site any longer. Dry maize is also advantageous as it is readily available, relatively inexpensive, has a long shelf life, comes pre-packaged in 25 kg bags for ease of transport, and, importantly, it flows well from the automatic feeders. Kibbling maize reduces the risk of germination.

As part of work to assess the feasibility of removing feral pigs from Auckland Island (Cox et al. 2022; Horn et al. 2022), automatic feeders, monitored by trail cameras, targeting pigs were trialled on Auckland Island. This trial was to investigate their efficacy on Auckland Island pigs in situ and to understand seasonal and site selection influence on their performance.

Methods

Ten free-standing custom-built automatic feeders with a 125-litre capacity were installed across Auckland Island (Fig. 1) during January–February 2019 (summer) and again in August–September 2019 (winter). Feeder sites needed to be accessible by helicopter or vessel given the bulk of the feeder, accessories and feed. Sites also needed to be of appropriate relief and area to allow feeder and trap installation (area c. 16 m^2). Locations were spaced c. 1.5 km apart to ensure independence and were pre-selected using satellite imagery and digital elevation models (DEM). Field-staff had freedom to locate feeders within close vicinity (c. 100 m) of the pre-determined point to select for sites that may improve detection of pigs e.g. well-defined game trails, habitat boundaries or pig sightings or disturbance.

The feeders trialled during the summer were installed adjacent to Falla Peninsula (Fig. 1) while a helicopter was present and other feasibility investigations were being

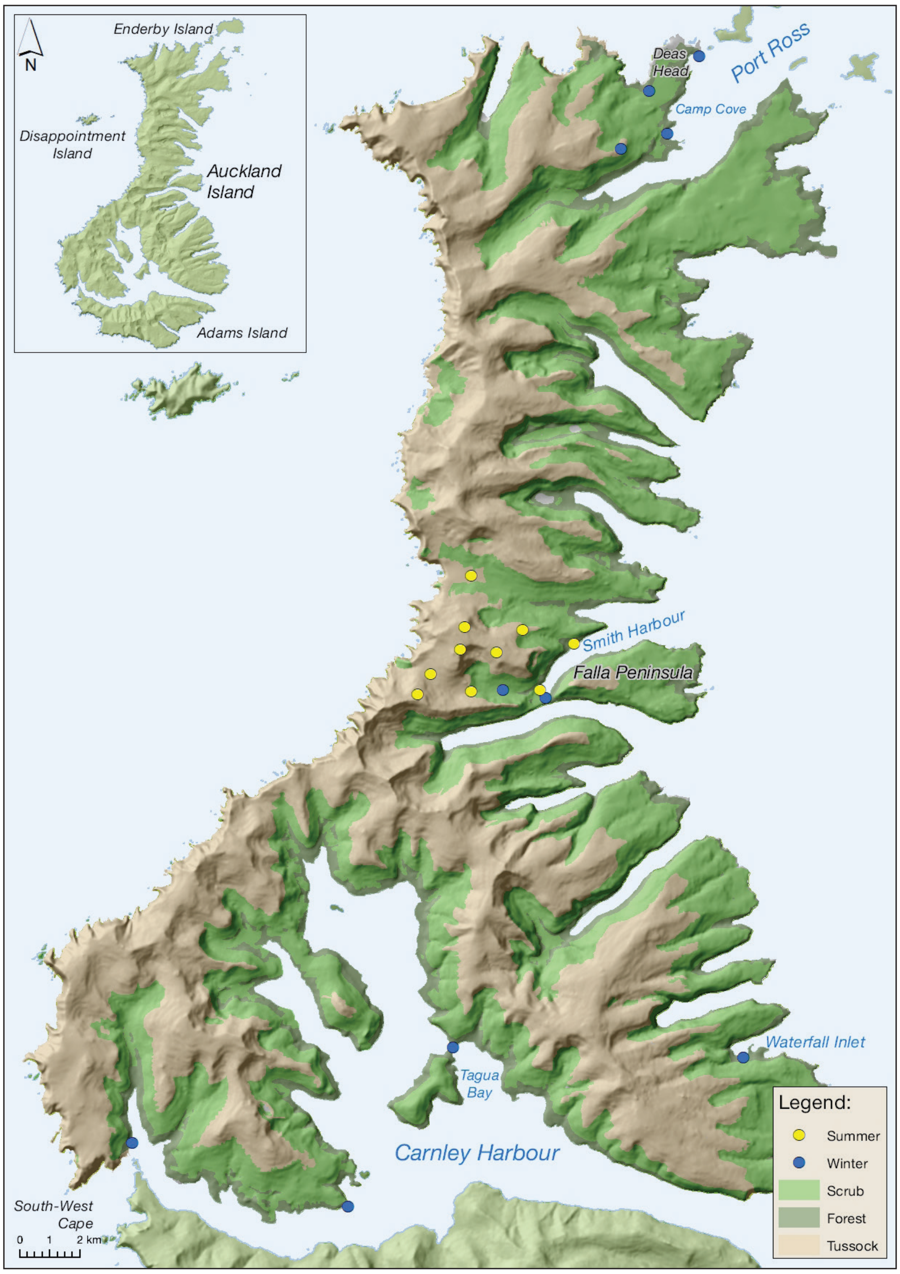

Figure 1. Map showing summer and winter feeder locations relative to vegetation type on Auckland Island.

undertaken (Cox et al. 2022). All feeders were positioned and removed as underslung helicopter loads with most being installed on the tussock tops (except two which were installed in coastal forest). In contrast, winter feeders were installed extensively across Auckland Island (Deas Head, Smith Harbour, Waterfall Inlet, Tagua Bay, Camp Cove and South-West Cape; Fig. 1). During the winter programme sites were chosen to sample a range of perceived pig densities. Age and extent of field sign such as ground disturbance was assessed and sites were noted as fresh or old, and low, moderate or high pig levels. Sites were accessed from the coast via a support vessel's tender. Feeders were only transported a short distance from the coast and as such most were installed in coastal rātā forest with only two being installed in scrub and none in tussock habitat. In contrast to summer, feeders were constructed and filled with feed on site.

Improving on commercially available feeder design, custom feeders were constructed for this research to improve usability and durability (Fig. 2). Components were watertight plastic 125 L drums with lids, three removable steel legs with lifting points, All-in-one Deer Feeder Timer Kit™ (Moultrie, Moultrie Feeders, Alabama, USA), and a malleable bucket to direct feed below the feeder. Feeders were secured to the ground with Waratahs (Summit Steel & Wire, Auckland, NZ) fixed to each leg and angled in different directions. The feeders were set to feed c. 2 kg of kibbled maize each day. In the summer, feed was dispensed once per day at 17:00 h (c. 5 h before sunset); in winter c. 1 kg was applied twice per day, once at 07:00 h and again at 18:00 h (c. 1 h after dawn and c. 1 h before dusk respectively). The feeders were set by timer rather than feed weight. Flow rates were tested before installation to find the appropriate length of time to dispense bait to achieve the target weight (in the winter this rate was 13 s for 1 kg of feed). The feeders had ample capacity for the trial period.

Bushnell Trophy-Cam Aggressor No-Glow infrared trail cameras (Bushnell Corporation, Kansas, USA) were installed at each feeder to record pig activity. Some sites were sporadically visited by field staff to check feeder function and retrieve data; however, most were only revisited at removal. Feeders were installed for a period ranging from 25 to 37 days. Game camera footage was analysed to measure pig presence and behaviour.

Results

Figure 3 summarises pig activity at feeders for both the summer 2018 and winter 2019 study periods. During the summer trial, only three of the ten feeders (30%) were visited by pigs and only solitary pigs were observed. For two of the sites with pig visitation, pigs eventually conditioned to the site and were returning almost every day. During the winter programme, five of the ten sites (50%) were visited by pigs across the island. The five visited feeders were at sites that generally had fresh sign at high to moderate levels. Four of the five feeders that were not visited were at sites that had old sign at moderate to low levels. The sites visited during the winter programme were visited by between one and six pigs. Pigs returned daily once they were conditioned to a site. The time taken before pigs exhibited this habitual behaviour varied but was around 15 days for most sites and at most 21 days.

Discussion

The low visitation rate observed in the summer operation compared to mainland use of feeders (FSC, pers. obs. 2015) motivated the winter operation to investigate spatial, temporal

Figure 2. Pig feeder installed on open tops above Smiths Harbour, Auckland Island during summer 2019. Note the wind-blown maize underneath demonstrating the exposed nature of the site (Photo: FSC).

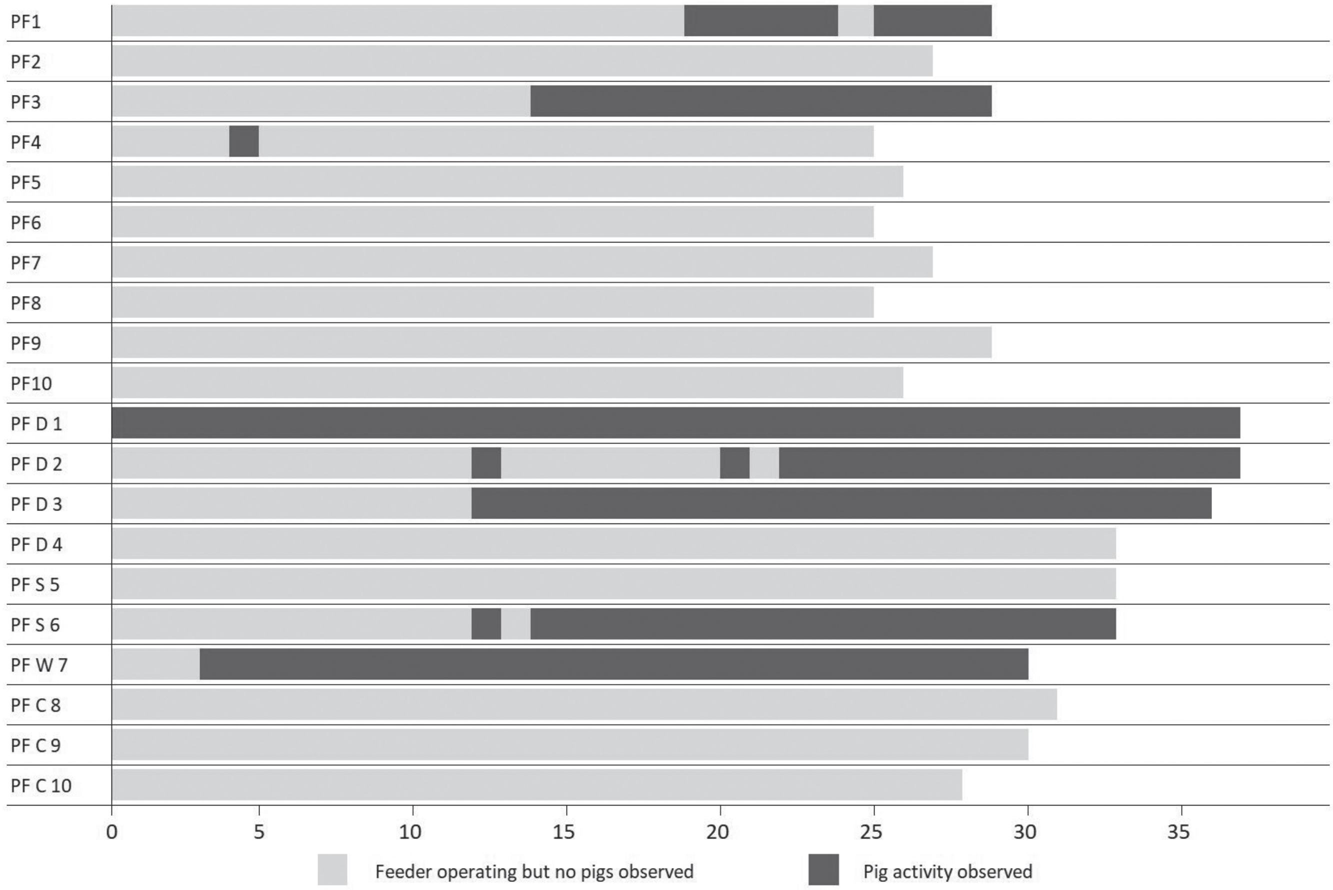

Figure 3. Timeline showing the length of time each pig feeder was operating and the days of pig visitation.

and vegetation influence on feeder efficacy. Bait-take and hence feeder success is directly related to the leverage of the applied bait over alternative food. Control operations using baits to attract pigs on the mainland are timed for winter as it is theorised that this is the period when there is less alternative food available and hence pigs are most resource limited. Although there was more visitation to feeders during the winter programme of this trial, given the limited sample size feeder use should not be discounted outside winter. Seasonal variation of the climate on Auckland Island is not as significant as mainland New Zealand (Fraser 2020) and pigs may in fact be resource-limited all year round.

Feeder visitation is affected by pig density. It was perceived that there was a higher density of pigs in the Port Ross area compared to southern locations (Cox et al. 2019). Three of the four feeders installed in the Port Ross area (the three coastal ones) had pig visitation. Anderson et al. (2022) found pig density is likely affected by habitat with pigs selecting coastal, tussock, hills with north-facing aspects, rivers and stream habitats, while avoiding scrub and swamp habitats. The two feeders installed in the scrub had no visitation, however, there were also feeders located in coastal and tussock habitats that had no visitation. The results during the winter programme strongly support site selection within a habitat, where evidence of fresh pig presence is more critical than simply selecting pig-favoured habitats. If the results for sites of moderate to high and fresh sign are isolated, then the feeders had 80 percent success rate. This result gives confidence feeders will attract pigs across Auckland Island, regardless of habitat or timing, if their location is targeted to areas with sign of fresh pig presence.

Efficiency is important given the scale of Auckland Island. During the Santa Cruz Island eradication all traps were installed and serviced by helicopter (Macdonald & Walker 2008). During the summer investigations of this study, Waratahs were wired to the side of the pre-constructed and filled feeders before they were transported as an underslung load by the helicopter, which allowed swift installation. This method is recommended for transportation and installation, however, it is then important exact sites are selected prior to installation. Even in the soft peat soil the Waratahs installed on different angles were adequate to prevent pigs from tipping the feeders. On two exposed sites moisture was blown into the Moultrie feeder mechanism and mixed with the residual maize powder, which clogged the mechanism. Installing feeders in less exposed sites or checking and cleaning the feeder mechanism frequently will prevent this blockage occurring.

The behaviour of the pigs at the feeders was consistent with mainland feral pig control operations that have used feeders (FSC, pers. obs. 2015). Following first discovery, pigs usually become conditioned and return to the feeder daily around the time the feed is being released. One feeder was installed on a significant game trail on the coast that was regularly used by team members for access during other work programmes. In this area they frequently ‘spooked’ pigs in close vicinity to the feeder. The feeder at Waterfall Inlet during the winter programme had a family group interacting with it. Once keyed onto the food source, they frequented the site almost continuously for the rest of the feeder period (27 days) and were often observed sleeping directly below the feeder waiting for more maize to appear. The pig feeder at Smith Harbour during the winter programme had three pigs visiting the site. One was a large boar that dominated the site and when present excluded other individuals (altercations were observed on the trail camera). Within the trial period the two sub-dominant individuals continued to visit, suggesting they were compelled to return to the site even with the deterrent of a large boar. If a lethal technique was applied to this site, there is confidence that once the dominant individual was removed the sub-dominant individuals would continue to visit the feeder and could subsequently be exposed to a lethal technique.

Morrison et al. (2007) outlined the importance of a systematic application of a range of eradication techniques, each applied at the appropriate pig population density, to reduce the inherent risk of eradication failure. As part of the proposed methodology for the Auckland Island pig eradication (Cox et al. 2022), feeders will be critical to support trapping and aerial shooting to reduce pigs in the initial phase of the programme to lower densities while maintaining population naivety. Following the use of feeders and their associated lethal techniques, remaining individuals will need to be targeted with subsequent tools that will be more aggressive. Feeders will be installed at the commencement of each block and once redundant they will be repositioned within the active block or to a subsequent block. The number of feeders and their density across the island requires a balance of benefit and cost. Although pig densities were relativity low during the time of these trials, they are known to fluctuate (McIlroy 2005). If pig densities are high at the time of an eradication attempt there would be significant risk to eradication success if there is not enough investment into passive tools as there would have to be a higher reliance on the subsequent aggressive tools. The consequence of using feeders and getting a low visitation rate because of low population density is the cost / effort in delivery without a significant population reduction. However, in this scenario feeders will still provide lessons around population density and build confidence in the success of the eradication. As such, an eradication strategy on Auckland Island should incorporate the use of feeders.

Given the importance of installing feeders at locations where there is evidence of pig presence, feeders will likely be better applied more flexibly than a prescribed grid to target perceived pig occupied areas and in response to pig observations. It is proposed that feeder locations will not be selected by vegetation type, given the extensive distribution of pigs (Anderson et al. 2022) and will be installed in most habitats. Coastal vegetated sites will need to be identified and selected by ground personnel, but installation could be by helicopter if more efficient. A multi-catch trap (e.g. corral style trap with a one-way gate or Pig Brig Trap Systems; Connecticut, USA) installed and pre-fed to allow pigs to condition to the trap is proposed for feeders visited by several pigs. Sites with individual pig visitation (as commonly observed in this trial) will be targeted with aerial or ground shooting. The canopy above the feeder will need to be open to allow swift aerial shooting in response to visiting pigs. Timing will be dictated by pig behaviour interpreted from trail camera footage. Given the behavioural responses observed in this trial, targeting of pigs will likely be at the same time feed is applied. Feeders will be checked 15 days after installation but may be opportunistically checked more frequently. They will again be checked at 20 days, and if a site has not had visitation, the feeder will be removed. It is intended that some feeders (c. 20%) will be left monitored by trail cameras in strategic locations in each block as an extended sentinel detection tool (4–5 months) to build confidence in the absence of pigs after eradication is completed.

Author contributions

FSC and NLM designed the study; FSC undertook fieldwork; and FSC wrote the manuscript with input from NLM.

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References

Anderson DP, Latham MC, McClelland P, Latham ADM 2022. Analysis of spatiotemporal patterns of home range use and habitat selection to inform management of feral pigs on Auckland Island. New Zealand Journal of Ecology 46: 3489.

Bengsen AJ, West P, Krull CR 2017. Feral pigs in Australia and New Zealand: range, trend, management, and impacts of an invasive species. In: Meijaard E, Melletti M eds. Ecology conservation management wild pigs peccaries. Cambridge, United Kingdom, Cambridge University Press. Pp. 325–338.

Buxton RT, Jones CJ, Lyver PO, Towns DR, Borrelle SB 2016. Deciding when to lend a helping hand: a decision-making framework for seabird island restoration. Biodiversity Conservation 25: 467–484.

Challies CN 1975. Feral pigs (*Sus scrofa*) on Auckland Island: status, and effects on vegetation and nesting sea birds. New Zealand Journal of Zoology 2: 479–490.

Chimera C, Coleman MC, Parkes JP 1995. Diet of feral goats and feral pigs on Auckland Island, New Zealand. New Zealand Journal of Ecology 19: 203–207.

Cox FS, Jacques P, Kirby-Crowe M, Ware J 2019. Maukahuka Pestfree Auckland Island - 2019 winter trials operational report. Internal Report - Department of Conservation. Wellington, Department of Conservation Te Papa Atawhai. 81 p.

Cox FS, Horn SR, Bannister WM, Macdonald NL 2022. A local eradication pilot study of methods for feral pig eradication on Auckland Island. New Zealand Journal of Ecology 46: 3490.

Cruz F, Donlan CJ, Campbell K, Carrion V 2005. Conservation

action in the Galàpagos: feral pig (*Sus scrofa*) eradication from Santiago Island. Biological Conservation 121: 473–478.
Fraser A 2020. The climate and weather of the Auckland Islands. Unpublished Report – prepared for the Department of Conservation Te Papa Atawhai. Invercargill, New Zealand, 45˚S Weather Service Ltd. 40 p.
Harper GA 2007. Introduced mammal eradication research expedition Auckland Island NZ subantarctic June – July 2007. Internal Report – Department of Conservation. Wellington, Department of Conservation Te Papa Atawhai. 15 p.
Holmes ND, Spatz DR, Oppel S, Tershy B, Croll DA, Keitt B, Genovesi P, Burfield IJ, Will DJ, Bond AL, Wegmann A, Aguiree-Muñoz A, Raine AF, Knapp CR, Hung CH, Wingate D, Hagen E, Méndez-Sánchez F, Rocamora G, Yuan HW, Fric J, Millett J, Russell JC, Liske-Clark J, Vidal E, Jourdan H, Campbell K, Springer K, Swinnerton K, Gibbons-Decherong L, Langrand O, de Brooke ML, McMinn M, Bunbury N, Oliveira N, Sposimo P, Geraldes P, McClelland P, Hodum P, Ryan PG, Borroto-Páez R, Pierce R, Griffiths R, Fisher RN, Wanless R, Pasachnik SA, Cranwell S, Micol T, Butchart SHM 2019. Globally important islands where eradicating invasive mammals will benefit highly threatened vertebrates. PLoS One 14: e0212128.
Horn SR, Sagar RL, Frank VK, Cox FS, Jacques PM, Ware J, Hanley-Nickolls R, Leask EP, MacDonald NL, Kirby-Crowe MS, Le Lievre ME, Broome KG 2022. The next frontier: assessing the feasibility of eradicating mammalian pests from Auckland Island. New Zealand Journal of Ecology 46: 3500.
Hutton I, Parkes JP, Sinclair ARE 2007. Reassembling island ecosystems: the case of Lord Howe Island. Animal Conservation 10: 22–29.
Lapidge S, Wishart J, Staples L, Fagerstone K, Campbell T, Eisemann J 2012. Development of a feral swine toxic bait (HOG-GONE) and bait hopper (HOGHOPPER) in Australia and the USA. Proceedings 14th Wildlife Damage Management Conference. Pp. 19–24.
Long DB, Campbell TA, Long BDB, Campbell TA, Massei G 2010. Evaluation of feral swine-specific feeder systems. Rangelands 32: 8–13.
Macdonald N, Walker K 2008. A new approach for ungulate eradication: a case study for success. Internal Report – Prohunt Inc., Ventura, California, USA.
McIlroy JC 2005. Feral pig. In: King CM ed. The handbook of New Zealand mammals. 2nd ed. Melbourne, Oxford University Press. Pp. 334–345.
Metcalf EM, Parker ID, Lopez RR, Higginbotham B, Davis DS, Gersbach JR 2014. Impact of gate width of corral traps in potential wild pig trapping success. Wildlife Society Bulletin 38: 892–895.
Morrison SA, Macdonald N, Walker K, Lozier L, Shaw RM 2007. Facing uncertainty, the dilemma of absence at eradication's end: uncertainty and the Lazarus effect. Frontiers in Ecology and the Environment 5: 271–276.
Parkes J 2006. Eradication of vertebrate pests: are there any general lessons? In: Cowan DP, Feare CJ eds. Advances in vertebrate pest management IV. Filander Verlag, Furth, Germany. Pp. 91–110.
Parkes JP, Ramsey DSL, Macdonald N, Walker K, McKnight S, Cohen BS, Morrison SA 2010. Rapid eradication of feral pigs (*Sus scrofa*) from Santa Cruz Island, California. Biological Conservation 143: 634–641.
Reddiex B, Forsyth DM, McDonald-Madden E, Einoder LD, Griffioen PA, Chick RR, Robley AJ 2006. Control of pest mammals for biodiversity protection in Australia. I. Patterns of control and monitoring. Wildlife Research 33: 691–709.
Rudge MR 1976. A note on the food of feral pigs (*Sus scrofa*) of Auckland Island. In: Proceedings of the New Zealand Ecological Society 23: 83–84.
Russell JC, Horn SR, Harper GA, McCelland P 2018. Survey of introduced mammals and invertebrates on Auckland Island, March–April 2015. DOC Research and Development Series 352. Wellington, Department of Conservation. 17 p
Russell JC, Horn SR, Miskelly CM, Sagar RL, Taylor RH 2020. Introduced land mammals and their impacts on the birds: of the subantarctic Auckland Islands. Notornis 67: 247–268.
Saunders G, Kay B, Nicol H 1993. Factors affecting bait uptake and trapping success for feral pigs (*Sus scrofa*) in Kosciusko National Park. Wildlife Research 20: 653–665.
West P, Saunders G 2007. Pest animal survey 2004–2006: a review of the distribution, impacts and control of invasive animals throughout NSW and the ACT. Orange: NSW Department of Primary Industries.
Wight B, Boughton RK 2018. Feral swine trapping: techniques and designs. WEC395, Ona, Florida: Wildlife Ecology and Conservation Department, UF/IFAS Extension.
Williams BL, Holtfreter RW, Ditchkoff SS, Grand JB 2011. Efficiency of time-lapse intervals and simple baits for camera surveys of wild pigs. The Journal of Wildlife Management 75: 655–659.

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