*Review*

# Feral Goat Eradications on Islands

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**Abstract:** *Introduced mammals are major drivers of extinction. Feral goats (*Capra hircus*) are particularly devastating to island ecosystems, causing direct and indirect impacts through overgrazing, which often results in ecosystem degradation and biodiversity loss. Removing goat populations from islands is a powerful conservation tool to prevent extinctions and restore ecosystems. Goats have been eradicated successfully from 120 islands worldwide. With newly developed technology and techniques, island size is perhaps no longer a limiting factor in the successful removal of introduced goat populations. Furthermore, the use of global positioning systems, geographic information systems, aerial hunting by helicopter, specialized hunting dogs, and Judas goats has dramatically increased efficiency and significantly reduced the duration of eradication campaigns. Intensive monitoring programs are also critical for successful eradications. Because of the presence of humans with domestic goat populations on large islands, future island conservation actions will require eradication programs that involve local island inhabitants in a collaborative approach with biologists, sociologists, and educators. Given the clear biodiversity benefits, introduced goat populations should be routinely removed from islands.*

**Key Words:** *Capra hircus*, conservation action, eradication techniques, introduced species, invasive species, island restoration, nonnative species

Erradicaciones de Cabras Ferales en Islas

**Resumen:** *Los mamíferos introducidos son los principales causantes de extinción. Las cabras ferales (*Capra hircus*) son particularmente devastadoras de ecosistemas insulares, provocando impactos directos e indirectos por sobrepastoreo, que a menudo resulta en la degradación del ecosistema y la pérdida de biodiversidad. La remoción de poblaciones de cabras de las islas es una poderosa herramienta de conservación para prevenir de extinciones y restaurar ecosistemas. Se han erradicado cabras exitosamente de 120 islas a nivel mundial. Con tecnología y técnicas desarrolladas recientemente, el tamaño de la isla ya no es un factor limitante en la remoción exitosa de poblaciones introducidas de cabras. Más aun, el uso de sistemas de posicionamiento global, sistemas de información geográfica, cacería aérea desde helicóptero, perros de caza especializados y cabras Judas han incrementado la eficiencia dramáticamente y reducido la duración de las campañas de erradicación significativamente. Los programas de monitoreo intensivo también son críticos para las erradicaciones exitosas. Debido a la presencia de humanos con poblaciones de cabras domésticas en las islas grandes, las acciones de conservación en el futuro requerirán de programas de erradicación que involucren a los habitantes locales en un esfuerzo cooperativo con biólogos, sociólogos y educadores. Dados los claros beneficios para la biodiversidad, las poblaciones de cabras introducidas deberán ser removidas de las islas rutinariamente.*

**Palabras Clave:** *Capra hircus*, especies invasoras, especies introducidas, especies no nativas, restauración de islas, técnicas de erradicación

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## Introduction

Extinction over the past six centuries has been largely dominated by insular species, with non-native mammals being responsible for the majority (Diamond 1989; Groombridge et al. 1992; MacPhee & Flemming 1999). Island vertebrates and plants are vulnerable to the impacts of rats (*Rattus* spp.), feral cats (*Felis catus*), and introduced herbivores (Elton 1958; King 1985; Ebenhard 1988; Atkinson 1989; Donlan et al. 2002; Nogales et al. 2004). Feral goats (*Capra hircus*) are particularly destructive to island ecosystems. The introduction of goats to islands worldwide has resulted in widespread primary and secondary impacts via overgrazing, often leading to ecosystem degradation and biodiversity loss (Coblentz 1978; Schofield 1989; Moran 1996; Desender et al. 1999).

In response to these biodiversity threats, techniques have been developed and improved over the past 30 years to remove introduced goat populations from islands (Daly 1989; Parkes 1990*a*; Veitch & Clout 2002). These techniques are powerful tools for preventing extinctions and restoring ecosystems. Unfortunately many insular goat eradications remain unpublished or inaccessible, creating the perception that eradications are rare. This most likely inhibits progress in island conservation and contributes to the low level of importance placed on the eradication of invasive species in many conservation circles (Simberloff 2001; Donlan et al. 2003*b*).

We reviewed feral goat eradication campaigns on islands with the primary intent of assessing the approaches, successes, and challenges of these conservation actions to help facilitate future island conservation programs. Data cover most of the world's insular regions and were compiled using published and gray literature and personal communications with researchers and conservation practitioners. We analyzed key aspects of these eradication campaigns to identify future directions and challenges of island conservation.

## History and Impact of Goat Introductions

Goats were domesticated 10,000 years ago in the highlands of western Iran (Zeder & Hesse 2000). Physiological traits such as a low metabolism, an efficient digestion system, and low water requirements allow goats to persist in conditions unsuitable for many other herbivores (Silanikove 2000). These traits, along with a high reproductive rate and general diet, allow domestic goats to thrive on islands as feral populations (Parkes 1993). Goats have become established on countless islands worldwide, generally having been introduced by humans to serve as a food resource.

The earliest recorded goat introduction occurred shortly after 1458 on Selvagem Grande Island in the Madieras (Zino & Biscoito 1994); medieval (approximately AD 1000–1300) introductions, however, are believed to have occurred on Holy and Lundy islands in Britain (Munton 1975). During European exploration and colonization before and throughout the eighteenth and nineteenth centuries, goats were introduced onto many islands by sailors on long sea voyages. Saint Helena Island, the Juan Fernandez Islands, and Hawaii are but a few well-known examples. Intentional introductions are now relatively rare, although they sometimes still occur on islands used by fishers (e.g., San Benitos, Mexico; Pinta and Marchena Islands, Galápagos).

In most cases, biotas of oceanic islands have evolved in the absence of large herbivores. Although equivocal, some evidence suggests that island floras lack adaptations to mammalian herbivory (Carlquist 1974; Bowen & Van Vuren 1997). Nonetheless, it is clear that introduced goats are responsible for wholesale impacts on island floras, including altering the structure and composition of plant communities, causing extinction, and accelerating soil erosion (Spatz & Mueller-Dombois 1973; Coblentz 1978; Parkes 1984; Brennan 1986; Coblentz & Van Vuren 1987; Cronk 1989; Walker 1991; Moran 1996; Desender et al. 1999). Goats remain a serious threat today. The World Conservation Union (IUCN) identified goats as the primary threat to 26% of threatened insular plant species (Lucas & Synge 1978). Further, more recent data indicate that 31% of extinct plant species and 18% of threatened plant species are from island nations (analysis by authors with data from Walter & Gillett 1998, IUCN classification). Secondary impacts are commonplace, such as habitat degradation via overgrazing leading to extirpation of native fauna (Gibbons 1984; King 1985; Desender et al. 1999). Goats are sometimes the exclusive cause of island extinctions (Moran 1996); in other cases they are a contributing factor along with other anthropogenic forces (Maunder et al. 1995; Shimizu 1995; Tye 2000). Biodiversity and ecosystem impacts from introduced goats have been discussed in detail elsewhere (Coblentz 1978; Ebenhard 1988; Courchamp et al. 2003).

Island recovery after the removal of goat populations is often swift and dramatic, even with long-standing goat populations. On Pinta and Santiago islands (Galápagos), native vegetation recovered rapidly despite it having been heavily affected by goats over many decades (Hamann 1979, 1993; A. Tye, personal communication). Seedbanks or small populations inaccessible to goats appear capable of preventing insular plant extinctions, and insular plant species often recover demographically once goats have been eradicated (Mueller-Dombois & Spatz 1975; Shimizu 1995).

## Island Goat Eradications

Goats have been eradicated from at least 120 islands (Fig. 1; Appendix 1). Areas of islands from which goats have

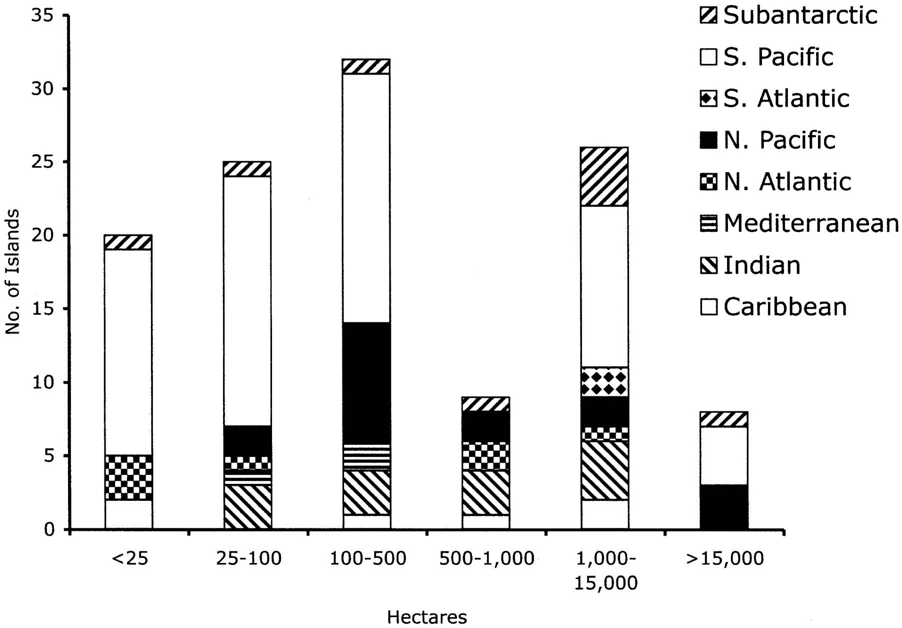


*Figure 1. Size and location of islands (ocean basin) where introduced goat populations have been eradicated.*

been eradicated range from 1 to 132,867 ha (Fig. 1). On the majority of larger islands (>20,000 ha), small numbers of goats have been removed from distinct areas. For example, on Flinders Island, Australia (132,867 ha), only 30 goats were present when they were removed in 1994. Similar situations occurred on Auckland Island (45,975 ha), New Zealand, and King (110,075 ha) and Bruny (36,735 ha) islands, Australia (<150 goats were removed [Appendix 1]). In terms of island size and number of goats removed (Appendix 1), the four largest goat eradications completed to date are from the islands of Lana'i (Hawaii, 36,100 ha), San Clemente (United States 14,800 ha), Pinta (Galápagos 5,940 ha), and Raoul (New Zealand, 2,943 ha). A number of unsuccessful eradications have also been documented (Table 1). These campaigns failed primarily because of a lack of political support, inappropriate methods, lack of effort, or the failure to detect the final goats at low densities.

Invasive mammals can be eradicated by trapping, hunting, poisoning, biocontrol, or some combination of these (Veitch & Clout 2002). The most common method used in goat eradication campaigns is hunting, although

**Table 1. Unsuccessful goat eradication attempts on islands.**

| *Island* | *Country*[a] | *Area (ha)* | *Introduction year* | *Eradication attempt* | *Reason failed* | Ref[b] |
|---|---|---|---|---|---|---|
| Great Barrier | NZ | 28,510 | | 1986–1989 | denied access to private land | 1 |
| St. Helena | UK | 12,100 | ~1513 | 1950s–1970s | failure to remove final goats at low densities | 2 |
| Grande Terre (Aldabra) | SEY | 11,000 | <1906 | 1997 | eradication halted due to politics | 3 |
| Pinta (Galápagos) | ECU | 5,940 | 1959 | 1985, 1990 | failure to detect/remove final goats at low densities[c] | 4 |
| Másatierra (Juan Fernández) | Chile | 4,711 | 1574 | 1686,1996 | inappropriate method and lack of effort | 5 |
| South Percy | AUS | 1,280 | 1880s | 1981–2003 | lack of effort | 6 |
| Lord Howe | AUS | 1,455 | | 1970s, 1999 | lack of support from local inhabitants; insufficient funds | 7 |
| Aguigan | NMI–USA | 715 | | 1990 | political, change in governance | 8 |
| La Plata | ECU | 575 | | 1991 | lack of political support | 9 |
| Holy (Arran) | UK | 250 | ~1000 | 1963 | inappropriate method | 10 |

[a]*Abbreviations: NZ, New Zealand; SEY, Seychelles; ECU, Ecuador; AUS, Australia; NMI-USA, Northern Mariana Islands, United States of America; ECU, Ecuador; UK, United Kingdom.*
[b]*References: 1, Parkes 1990a; 2, Maunder et al. 1995, Melville 1979, Holdgate and Wace 1961, R. Cairns-Wicks, personal communication; 3, Rainbolt & Coblentz 1999, B. Coblentz, personal communication; 4, Campbell et al. 2004; 5, Wester 1991; 6, Brennan 1986, A. Griffiths, personal communication; 7, Recher and Clarke 1974, Parkes et al. 2002, N. MacDonald, personal communication; 8, Rice 1991; 9, F. Cruz, personal communication; 10, Munton 1975.*
[c]*Goats eradicated from island in 1999.*

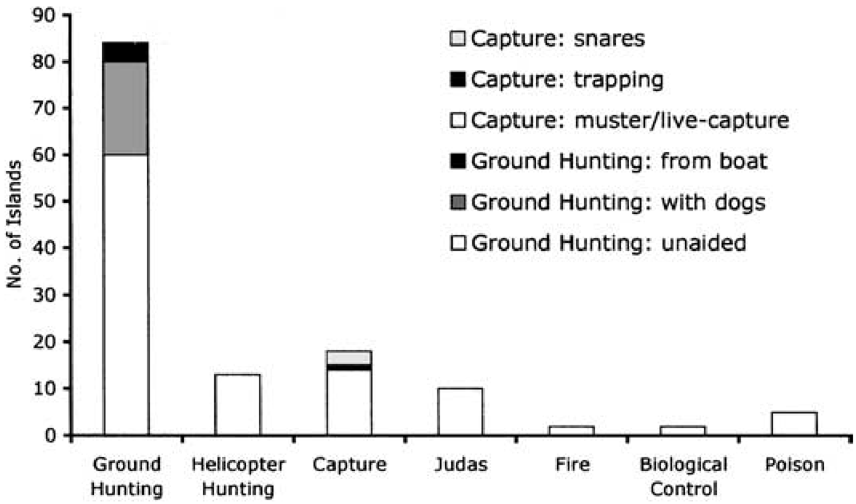


*Figure 2. Methods used in eradication of introduced goats from islands. For many of the 120 documented goat removals the methods were not recorded.*

poisoning, trapping, biocontrol (releasing dogs or dingos [*Canis lupus dingo*]), and habitat alteration via fire have also been used (Fig. 2, Appendix 1). Hunting includes the use of hunting dogs, Judas goats (described below), and shooting from a helicopter. Live removal has been conducted on nine islands. Usually, only one method has been used in eradication attempts (mean number of methods used ± SD: 1.5 ± 0.9, $n = 69$) and the majority of campaigns have not used specialized hunting techniques. Although often not critical for successful eradication on smaller islands, multiple methods—some implemented simultaneously, others sequentially—and specialized eradication methods are requisites for success on larger islands with large populations (Cruz et al. 2005). Workers involved in recent campaigns on larger islands (e.g., Isabela and Santiago islands, Galápagos) have improved and developed specialized eradication techniques, including (1) aerial hunting by helicopter, (2) use of specially trained hunting dogs, (3) the integration of GPS (global positioning system) and GIS (geographic information system) technology with eradication methods, and (4) Judas goat techniques (Taylor & Katahira 1988; Isabela Project 1997; Prohunt New Zealand 1997; Campbell 2002; Campbell et al. 2004; Cruz et al. 2005). These techniques rely heavily on technology and highly skilled staff and allow for goat eradications on larger islands within a shorter time period and with increased cost-effectiveness (Caley & Ottley 1995; Campbell et al. 2004).

Hunting dogs and helicopters were exploited in 20 and 13 eradication campaigns, respectively. The use of specially trained goat-hunting dogs increases the ability to detect and kill goats at low densities and in areas of heavy vegetation (Caley & Ottley 1995; Isabela Project 2001). Aversion training eliminates impacts on native fauna from hunting dogs (Tortora 1982; Prohunt New Zealand 1997; Isabela Project 2001). Although it is expensive and requires specialist personnel, aerial hunting is highly effective when removing goats at high densities where open canopy exists and appears critical for eradications on larger islands with established populations.

A common reason for unsuccessful eradication attempts is the failure to remove the final animals at low densities, because of either the inability to detect them or the selection of inappropriate hunting methods (Table 1). By exploiting the gregarious nature of goats, the Judas goat method is a vital tool for detecting goats at low densities and a monitoring tool to confirm eradication (Taylor & Katahira 1988; Campbell et al. 2004). Radiotelemetry collars are fitted to select goats, which are released and allowed to seek out other goats. Judas goats are then radio tracked, either on foot or by helicopter, and accompanying goats are shot. Judas goats are then allowed to escape to seek out other goats and are then rechecked at a later date. This approach allows the last individuals to be removed (Rainbolt & Coblentz 1999).

Judas goats have been used successfully in a number of eradications: San Clemente and Santa Catalina islands (California, U.S.A.); Kaho'olawe Island (Hawaii, U.S.A.), Ile Malabar and Ile Picard (Republic of Seychelles), Woody Island (Australia), and Pinta Island (Galápagos, Ecuador; Allen 1991; Kaho'olawe Island Conveyance Commission 1993; Keegan et al. 1994; Rainbolt & Coblentz 1999; Schuyler et al. 2002; Campbell et al. 2004). On San Clemente Island, where more than 29,000 goats were removed, trapping and helicopter shooting in combination failed to remove the remnant population. The use of Judas goats finally removed the last 263 individuals (Keegan et al. 1994). Recently developed methods involve hormone therapy and sterilization techniques that should improve the efficacy of Judas goats (Campbell 2002). The use of Judas goats should be standard in most goat eradication campaigns to detect the last individuals and as a cost-effective monitoring tool to confirm eradication.

Of the 120 successful goat eradications, 60% (72) were published, 14% (17) are in the gray literature (unpublished reports), and 26% (31) remain unpublished. Although

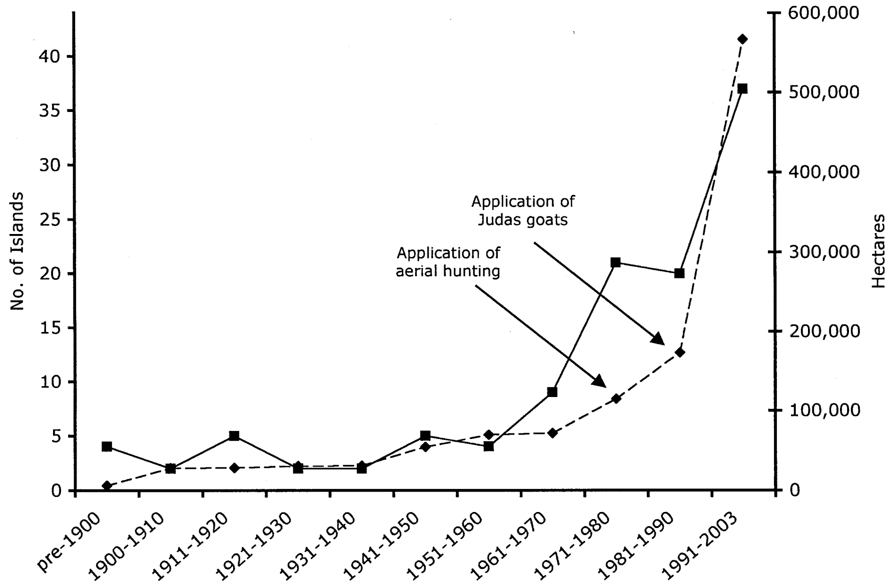


*Figure 3. Frequency of successful introduced goat eradications throughout the twentieth century. Solid line shows the number of islands and dashed line shows the cumulative area of islands where goats were removed.*

it is encouraging that more than half of known goat eradications are published, 84% of both published and gray literature papers lack sufficient detail to assess the eradication (e.g., methods, timing, or number of goats removed). Thus they are of little use in future island conservation efforts. Data on costs of eradication programs are completely absent. Incorporating economics into unpublished reports and publications would prove useful. Publishing detailed accounts of both successful and failed goat eradication attempts will help facilitate future efforts (Simberloff 2001; Donlan et al. 2003*b*).

Approximately 70% of all known goat eradications took place between 1960 and 2003, with the number doubling in the past two decades (Fig. 3). Worldwide, insular goat populations have been eradicated from approximately 567,000 ha (Fig. 3). Because of the relative ease with which goats can be eradicated with recently developed techniques and the clear conservation benefits of eradications, we expect the number of successful eradications to continue to increase in the coming decades.

## Challenges and Recommendations

The successful eradication of introduced mammals from islands is no longer a rare event. This is true not only for goats but also for other introduced species such as cats and rats (Towns & Broome 2003; Nogales et al. 2004). Highly skilled specialists and special equipment should be involved in larger or more complex eradications to provide cost efficiency, whereas smaller eradications can be undertaken effectively without specialized personnel and equipment. Goats can be easily removed from most islands of < 500 ha. Large islands, which generally house more biodiversity, are as feasible but require detailed planning and the use of technology (GPS and GIS systems) and multiple techniques (e.g., aerial hunting, hunting dogs, Judas goats).

Recent island conservation actions demonstrate the feasibility of removing large, established goat populations from large islands. More than 10,000 goats were removed from Raoul Island, New Zealand (2,943 ha, Parkes 1990*a*). On San Clemente Island, United States (14,800 ha), approximately 29,000 goats were removed (Keegan et al. 1994). With both of these campaigns, multiple techniques were used, including ground hunting, aerial hunting, specialty hunting dogs, and Judas goats. Although each eradication campaign will have unique circumstances, these techniques make up the tool chest of any goat eradication campaign on large islands because they allow for successful removals in years rather than decades. For example, on Pinta Island, Galápagos (5,940 ha), it took 30 years to remove 41,000 goats. This was due to lack of continuous effort and limited eradication techniques (Campbell et al. 2004). In contrast, ground hunters removed over 66,000 goats from Santiago Island, Galápagos (58,465 ha), in < 3 years (K.C. and C.J.D., unpublished data) because they were aided by extensive planning, integration of GPS and GIS technology, and multiple eradication techniques (i.e., mustering, ground hunting, hunting dogs). Santiago Island should be free of goats by 2006 (a 5-year campaign). With the application of these new techniques and careful planning, funding rather than island size is now the limiting factor in island goat eradications.

Appropriate methods and their cost-effectiveness will vary with animal density, wariness to certain methods, vegetation, and topography (Rainbolt & Coblentz 1999). In an effort to avoid educating animals, a systematic approach is needed in which each method (or combination of methods) employed removes nearly 100% of the animals that are encountered. Goats rapidly become wary of each method (e.g., finding refuge in caves during aerial shooting), and the use of multiple methods applied sequentially and simultaneously puts educated animals at risk. Switching methods should be based on cost per kill, animal wariness, and timing. For example, it may initially cost more per goat to use helicopter hunting than ground hunting; the use of multiple techniques, however, is likely to significantly shorten the time to eradication.

Once a limiting factor, the problem of failing to detect remnant goats has been solved with Judas goat techniques (Taylor & Katahira 1988). These techniques can be scaled to large islands. On Pinta Island, Galapagos (5,940 ha), 28 Judas goats were used and on Isabela Island, Galapagos (458,812 ha), 600 goats will be deployed (Rainbolt & Coblentz 1999; Campbell 2002; Campbell et al. 2004). Where there is a risk of goat reintroduction (e.g., Galápagos; Appendix 1), a long-term Judas goat program allows for detection and removal of reintroduced goats. The threat of reintroductions highlights the need for a long-term conservation perspective with eradication campaigns and the integration of locally based environmental education programs (Donlan & Keitt 1999; Tershy et al. 2002). Of the islands reviewed, only three goat eradication campaigns mention a community outreach or environmental education component.

Judas goat programs could potentially be used on large continental areas. With helicopter-based hunting, introduced herbivores have been removed from large areas in New Zealand (Nugent et al. 2001*a*, 2001*b*). Nonetheless, preventing immigration from some distant source (e.g., farms) is considered a requisite for eradication to be a solid management strategy (Parkes 1990*b*; Bomford & O'Brien 1992). Extensive, long-term Judas goat programs may be a feasible and cost-effective approach to manage immigration and reintroductions. Although large mainland areas may never be completely free of goats, a single intensive hunting effort followed by a long-term Judas goat program could eradicate goats from an ecological perspective.

Goat eradications should be undertaken with an ecosystem perspective because this facilitates additional introduced mammal eradications, if needed, and prevents unexpected changes to other ecosystem components (Zavaleta et al. 2001). Goat removal can have a dramatic effect on vegetation; thus, recovery of vegetation can interfere with completing the goat eradication itself and the eradication of other introduced species. Therefore, to maximize the efficiency of eradications campaigns, goats should be removed as swiftly as possible (Parkes 1990*a*) and, in many cases, goats should be eradicated after other introduced species. For example, feral pigs (*Sus scrofa*) were removed from Santiago Island, Galápagos, before goats. Simultaneous campaigns, or the reverse order, would have drastically increased the costs of the eradications (Cruz et al. 2005).

Conservation practitioners should take plant and herbivore interactions into account in goat eradication programs (Donlan et al. 2003*a*). Although benefits to native flora from introduced herbivore eradications have been documented widely (Hamann 1979, 1993; North et al. 1994; Donlan et al. 2002), increases in non-native plants because of herbivore release have also been recognized (Eckhardt 1972; Scowcroft & Conrad 1982; Laughrin et al. 1994; Kessler 2002). Vegetation monitoring and assessments before eradication, particularly on islands dominated by non-native plants, can help avoid unexpected negative consequences of introduced herbivore removal. For example, on Guadalupe Island, Mexico, goat exclosures were constructed to assess the non-native plant response from herbivore release before the eradication campaign. Integrating eradication campaigns with a holistic ecosystem restoration framework will help increase the efficiency of eradications and prevent potential adverse secondary effects of introduced mammal removals from islands (Zavaleta et al. 2001; Donlan et al. 2003*a*).

Removing introduced species from islands is one of our most powerful conservation tools. Thanks to improved technologies and techniques, removing feral goats from islands small and large is now feasible. One hundred twenty islands, totaling more than 567,000 ha, have been freed from introduced goats and their detrimental effects; more eradications are being planned or are under way. These include new precedents in island size and number of goats removed: Santiago and Isabela islands, Galápagos (58,465 and 458,812 ha), Guadalupe Island, Mexico (26,500 ha), and Great Barrier Island, New Zealand (28,510 ha) (B. Tershy, personal communication; J. Parkes personal communication). Research challenges revolve around detecting and removing goats at low densities, including improving existing techniques (e.g., Judas goats), applying existing technologies (e.g., FLIR, forward-looking infrared), and developing new technologies and techniques. Island size may no longer be a limiting factor in eradication success; rather, sociological factors and funding will prove important in future island conservation actions. Many large islands with goat populations are also inhabited by people who use goats for economic gain, subsistence, or recreation (e.g., Hawaiian and Australian islands). Designing successful eradication programs for multitenure islands will take collaborative approaches involving biologists, sociologists, educators, and local inhabitants—along with a strong political will. This challenge will require substantial financial backing but will ultimately result in tremendous conservation gains. Given the unequivocal evidence of biodiversity loss and ecosystem degradation caused by introduced goats, they should be routinely eradicated from islands.

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### Literature Cited

Abbott, I., and A. A. Burbidge. 1995. The occurrence of mammal species on the islands of Australia: a summary of existing knowledge. CALM-Science **1:**259–324.

Allen, L., J. Lee, and T. Gonzalez. 1998. The management and eradication of feral goats from Townshend Island. Queensland Department of Natural Resources, Brisbane, Queensland.

Allen, L. R. 1991. The eradication of feral goats from an island national park. Pages 22–26 in Proceedings of Australian vertebrate pest conference. South Australian Animal and Plant Control Commission, Adelaide.

Armstrong, P. H. 1994. Human impact on the Falkland Islands environment. The Environmentalist **14:**215–231.

Ashmole, N. P., M. J. Ashmole, and K. E. L. Simmons. 1994. Seabird conservation and feral cats on Ascension Island, South Atlantic. Pages 94–121 in D. N. Nettleship, J. Burger, and M. Gochfield, editors. Seabirds on islands: threats, case studies and action plans. BirdLife International, Cambridge, United Kingdom.

Atkinson, I. 1989. Introduced animals and extinctions. Pages 54–75 in D. Western and M. C. Pearl, editors. Conservation for the twenty-first century. Oxford University Press, New York.

Atkinson, I. A. E. 1988. Opportunities for ecological restoration. New Zealand Journal of Ecology **11:**1–12.

Atkinson, I. A. E., and R. H. Taylor. 1991. Distribution of alien mammals on New Zealand islands. DSIR Land Resources, Lower Hutt, New Zealand.

Beattie, M. H. 1994. Endangered and threatened wildlife and plants; determination of endangered or threatened status for 24 plants from the island of Kauai, Hawaii. U.S. Fish and Wildlife Service Division of Endangered Species, Honolulu, Hawaii.

Bomford, M., and P. O'Brien. 1992. Feral goat control or eradication? Assessment criteria for decision making. Pages 57–64 in D. Freudenberger, editor. Proceedings of the national workshop on feral goat management: planning for action. Bureau of Resource Sciences, Dubbo, New South Wales.

Bowen, L., and D. Van Vuren. 1997. Insular endemic plants lack defenses against herbivores. Conservation Biology **11:**1249–1254.

Brennan, P. 1986. Anthropogenic modification of vegetation on continental islands: southern section, Great Barrier Reef. Honors thesis. Geographical Sciences, University of Queensland, St. Lucia, Brisbane.

Bullock, D., and S. North. 1985. Round Island in 1982. Oryx **18:**36–41.

Caley, P., and B. Ottley. 1995. The effectiveness of hunting dogs for removal of feral pigs (*Sus scrofa*). Wildlife Research **22:**147–154.

Campbell, K., C. J. Donlan, F. Cruz, and V. Carrion. 2004. Eradication of feral goats *Capra hircus* from Pinta Island, Galápagos, Ecuador. Oryx **38:**328–333.

Campbell, K. J. 2002. Advances in Judas goat methodology in the Galápagos Islands: manipulating the animals. Pages 70–77 in J. Gregory, B. Kyle, and M. Simmons, editors. Judas workshop 2002. New Zealand Department of Conservation, Otago Conservancy, Dunedin.

Carlquist, S. 1974. Island biology. Columbia University Press, New York.

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

Clark, M. R., and P. R. Dingwall. 1985. Conservation of islands in the Southern Ocean: a review of the protected areas of Insulantarctica. World Conservation Union, Gland, Switzerland.

Coblentz, B. E. 1978. The effects of feral goats (*Capra hircus*) on island ecosystems. Biological Conservation **13:**279–285.

Coblentz, B. E., and D. Van Vuren. 1987. Effects of feral goats (*Capra hircus*) on Aldabra Atoll. Atoll Reseach Bulletin **306:**1–6.

Courchamp, F., M. Pascal, and J.-L. Chapuis. 2003. Mammal invaders on islands, impact, control and control impact. Biological Reviews **78:**347–383.

Coyne, P. 1981. An extreme example of the effects of feral animals. Australian Ranger Bulletin **1:**28–29.

Cribb, A. B. 1986. The terrestrial vegetation of Fairfax Islands, Great Barrier Reef. Queensland Naturalist **26:**119–126.

Cronk, Q. C. B. 1989. The past and present vegetation of St. Helena. Journal of Biogeogrpahy **16:**47–64.

Croxall, J. P., S. J. McInnes, and P. A. Prince. 1984. The status and conservation of seabirds at the Falklands Islands. Pages 271–291 in J. P. Croxall, P. G. H. Evans, and R. W. Schreiber, editors. Status and conservation of the world's seabirds. International Council for Bird Preservation, Cambridge, United Kingdom.

Cruz, F., C. J. Donlan, K. Campbell, and V. Carrion. 2005. Conservation action in the Galápagos: feral pig (*Sus scrofa*) eradication from Santiago Island. Biological Conservation **121:**473–478.

Daly, K. 1989. Eradication of feral goats from small islands. Oryx **23:**71–75.

Daly, K., and P. Goriup. 1987. Eradication of feral goats from small islands. International Council for Bird Preservation, Cambridge, United Kingdom.

Daycard, L., and J. C. Thibault. 1990. Gestion de la colonie de Puffin cendré (*Calonectris diomedea)* de l'île Lavezzi (Corse): une expérience de dératisation. Travaux Scientifiques Parc Naturel Régional & Réserves Naturelles de Corse **28:**55–71.

Desender, K., L. Baert, J.-P. Maelfait, and P. Verdyck. 1999. Conservation on Volcan Alcedo (Galapagos): terrestrial invertebrates and the impact of introduced feral goats. Biological Conservation **87:**303–310.

Diamond, J. M. 1989. Overview of recent extinctions. Pages 37–41 in D. Western and M. C. Pearl, editors. Conservation for the twenty-first century. Oxford University Press, New York.

Donlan, C. J., and B. S. Keitt. 1999. Using research and education to prevent extinction. California Coast and Ocean **15:**20–23.

Donlan, C. J., D. A. Croll, and B. R. Tershy. 2003*a*. Islands, exotic herbivores and invasive plants: their roles in coastal California conservation. Restoration Ecology **11:**524–530.

Donlan, C. J., B. R. Tershy, and D. A. Croll. 2002. Islands and introduced herbivores: conservation action as ecosystem experimentation. Journal of Applied Ecology **39:**235–246.

Donlan, C. J., B. R. Tershy, K. Campbell, and F. Cruz. 2003*b*. Research for requiems: the need for more collaborative action in invasive species management and conservation. Conservation Biology **17:**1850–1851.

Ebenhard, T. 1988. Introduced birds and mammals and their ecological effects. Swedish Wildlife Research Viltrevy **13:**1–107.

Eckhardt, R. C. 1972. Introduced plants and animals in the Galapagos Islands. BioScience **22:**585–590.

Elton, C. S. 1958. The ecology of invasions by animals and plants. Methuen, London.

Gibbons, J. 1984. Iguanas of the South Pacific. Oryx **18:**82–91.

Groombridge, B., World Conservation Monitoring Centre, British Natural History Museum, and World Conservation Union. 1992. Global biodiversity: status of the Earth's living resources: a report. Chapman & Hall, London.

Hamann, O. 1979. Regeneration of vegetation on Santa Fe and Pinta islands, Galapagos, after the eradication of goats. Biological Conservation **15:**215–236.

Hamann, O. 1993. On vegetation recovery, goats and giant tortoises on Pinta Island, Galápagos, Ecuador. Biodiversity and Conservation **2:**138–151.

Hobdy, R. 1993. Lana'i—a case study: the loss of biodiversity on a small Hawaiian island. Pacific Science **47:**201–210.

Hoeck, H. N. 1984. Introduced fauna. Pages 233–246 in R. Perry, editor. Key environments: Galápagos. Pergamon Press, Oxford, United Kingdom.

Holdgate, M. W., and N. M. Wace. 1961. The influence of man on the floras and faunas of southern islands. The Polar Record **10:**475–493.

Howell, R., and G. C. Atkinson. 1994. Survey and control of feral goats *Capra hircus* in Tasmania. Parks and Wildlife Service, Department of Environment and Land Management, Hobart, Tasmania.

Isabela Project. 1997. Plan for the protection of northern Isabela Island, Galápagos National Park, Ecuador, from ecosystem damage caused by feral ungulates. Charles Darwin Research Station/Galápagos National Park Service, Puerto Ayora, Santa Cruz, Galápagos Islands.

Isabela Project. 2001. Hunting dog training manual. Charles Darwin Foundation/Galapagos National Park Service, Puerto Ayora, Santa Cruz, Galápagos Islands.

Jouventin, P. 1994. Past, present and future of Amsterdam Island (Indian Ocean) and its avifauna. Pages 122–132 in D. N. Nettleship, J. Burger, and M. Gochfield, editors. Seabirds on islands: threats, case studies and action plans. BirdLife International, Cambridge, United Kingdom.

Kaho'olawe Island Conveyance Commission. 1993. Kaho'olawe Island: restoring a cultural treasure. Kaho'olawe Island Conveyance Commission, Wailuku, Maui, Hawaii.

Keegan, D. R., B. E. Coblentz, and C. S. Winchell. 1994. Feral goat eradication of San Clemente Island, California. Wildlife Society Bulletin **22:**56–61.

Kessler, C. C. 2002. Eradication of feral goats and pigs and consequences for other biota on Sarigan Island, Commonwealth of the Northern Mariana Islands. Pages 132–140 in C. R. Veitch and M. N. Clout, editors. Turning the tide: the eradication of invasive species. World Conservation Union (IUCN), Species Survival Commission, Invasive Species Specialist Group. IUCN, Gland, Switzerland.

King, W. B. 1985. Island birds: will the future repeat the past? Pages 3–15 in P. J. Moors, editor. Conservation of island birds. International Council for Bird Preservation, Cambridge, United Kingdom.

Laughrin, L., M. Carroll, A. Bromfield, and J. Carroll. 1994. Trends in vegetation changes with the removal of feral animal grazing pressures on Santa Catalina Island. Pages 523–530 in W. L. Halvorson and G. J. Maender, editors. The fourth California islands symposium: update on the status of resources. Santa Barbara Museum of Natural History, Santa Barbara, California.

Lucas, G., and H. Synge. 1978. The IUCN plant red data book. World Conservation Union, Morges, Switzerland.

MacPhee, R. D. E., and C. Flemming. 1999. Requim Aeternam: the last five hundred years of mammalian species extinctions. Pages 333–371 in R. D. E. MacPhee, editor. Extinctions in near time: causes, contexts, and consequences. Kluwer Publishing, New York.

Maunder, M., T. Upson, B. Spooner, and T. Kendle. 1995. Saint Helena: sustainable development and conservation of a highly degraded island ecosystem. Pages 205–217 in P. M. Vitousek, L. L. Loope, and H. Adsersen, editors. Islands: biological diversity and ecosystem function. Springer-Verlag, Berlin.

Melville, R. 1979. Endangered island floras. Pages 361–377 in D. Bramwell, editor. Plants and islands. Academic Press, London.

Merlin, M. D., and J. O. Juvik. 1992. Relationships among native and alien plants on Pacific islands with and without significant human disturbance and feral ungulates. Pages 597–624 in C. P. Stone, C. W. Smith, and J. T. Tunison, editors. Alien plant invasions in native ecosystems of Hawai'i: management and research. University of Hawaii Cooperative National Park Resources Studies Unit, Honolulu.

Merton, D. V. 1970. The rehabilitation of Cuvier Island. Wildlife —A Review:5–8.

Merton, D. V., I. A. E. Atkinson, W. Strahm, C. Jones, R. A. Empson, Y. Mungroo, E. Dulloo, and R. Lewis. 1989. A management plan for the restoration of Round Island, Mauritius. Jersey Wildlife Preservation Trust, Port Louis, Mauritius..

Moran, R. 1996. The flora of Guadalupe Island, Mexico. Memoirs of the California Academy of Sciences **19:**1–190.

Morris, K. D. 1989. Feral animal control on western Australian islands. Pages 105–111 in A. Burbidge, editor. Australian and New Zealand islands: nature conservation values and management. Proceedings of a technical workshop, Barrow Island, Western Australia, 1985. Department of Conservation and Land Management, Perth, Western Australia.

Mueller-Dombois, D., and G. Spatz. 1975. The influence of feral goats on the lowland vegetation in Hawaii Volcanoes National Park. Phytocoenologia **3:**1–29.

Munton, P. N. 1975. A description of the social life of the feral goat *Capra hircus hircus*. Ph.D. thesis. University of Bristol, Bristol, United Kindgom.

Nogales, M., A. Martín, B. R. Tershy, C. J. Donlan, D. Veitch, N. Puerta, B. Wood, and J. Alonso. 2004. A review of feral cat eradication on islands. Conservation Biology **18:**310–319.

North, S. G., D. J. Bullock, and M. E. Dulloo. 1994. Changes in the vegetation and reptile populations on Round Island, Mauritius, following eradication of rabbits. Biological Conservation **67:**21–28.

NSW (New South Wales) National Parks and Wildlife Service. 1995. Montague Island Nature Reserve plan of management. NSW National Parks and Wildlife Service, Sydney.

Nugent, G., W. Fraser, and P. Sweetapple. 2001*a*. Top down or bottom up? Comparing the impacts of introduced arboreal possums and "terrestrial" ruminants on native forests in New Zealand. Biological Conservation **99:**65–79.

Nugent, G., K. W. Fraser, G. W. Asher, and K. G. Tustin. 2001*b*. Advances in New Zealand mammalogy 1990–2000: deer. Journal of the Royal Society of New Zealand **31:**263–298.

Ogilvie, P. 1992. Lady Elliot Island. Australian Natural History **24:**16–17.

Parkes, J., R. Henzell, and G. Pickles. 1996. Managing vertebrate pests: feral goats. Australian Government Publishing Service, Canberra.

Parkes, J. P. 1984. Feral goats of Raoul Island. II. Diet and notes on the flora. New Zealand Journal of Ecology **7:**95–101.

Parkes, J. P. 1990*a*. Eradication of feral goats on islands and habitat islands. Journal of the Royal Society of New Zealand **20:**297–304.

Parkes, J. P. 1990*b*. Feral goat control in New Zealand. Biological Conservation **54:**335–348.

Parkes, J. P. 1993. Feral goats: designing solutions for a designer pest. New Zealand Journal of Ecology **17:**71–83.

Parkes, J. P., N. MacDonald, and G. Leaman. 2002. An attempt to eradicate feral goats from Lord Howe Island. Pages 233–239 in C. R. Veitch and M. N. Clout, editors. Turning the tide: the eradication of invasive species. World Conservation Union (IUCN), Species Survival Commission, Invasive Species Specialist Group. IUCN, Gland, Switzerland.

Prohunt New Zealand 1997. Hunting dog policy. Prohunt New Zealand, Paeroa.

Rainbolt, R. E., and B. E. Coblentz. 1999. Restoration of insular ecosystems: control of feral goats on Aldabra Atoll, Republic of Seychelles. Biological Invasions **1:**363–375.

Rauzon, M. J. 1985. Feral cats on Jarvis Island: their effects and their eradication. Atoll Research Bulletin **282:**1–30.

Recher, H. F., and S. S. Clarke. 1974. A biological survey of Lord Howe Island with recommendations for the conservation of the island's wildlife. Biological Conservation **6:**263–273.

Rees, G. J. 1981. Goat management on South Island National Park. Australian Ranger Bulletin **1:**29.

Rice, C. G. 1991. Goat removal from Aguijan Island: lessons for future efforts. Transactions of the Western Section of the Wildlife Society **27:**42–46.

Robinson, T., P. Canty, T. Mooney, and P. Rudduck. 1996. South Australia's offshore islands. Department of Environment and Natural Resources, Adelaide.

Rudge, M. R., and D. J. Campbell. 1977. The history and present status of goats on the Auckland Islands (New Zealand subantarctic) in relation to vegetation changes induced by man. New Zealand Journal of Botany **15:**221–253.

Schofield, E. K. 1989. Effects of introduced plants and animals on island vegetation: examples from the Galapagos Archipelago, Ecuador. Conservation Biology **3:**227–238.

Schuyler, P. T., D. Garcelon, and S. Escover. 2002. Control of feral goats (*Capra hircus*) on Santa Catalina Island, California, USA. Pages 412–413 in C. R. Veitch and M. N. Clout, editors. Turning the tide: the eradication of invasive species. World Conservation Union, Species Survival Commission, Invasive Species Specialist Group, Gland, Switzerland, and Cambridge, United Kingdom.

Scowcroft, P. G., and C. E. Conrad. 1982. Alien and native plant response to release from feral sheep browsing on Mauna Kea. Pages 625–665 in C. P. Stone, C. W. Smith, and J. T. Tunison, editors. Alien plant invasions in native ecosystems of Hawai'i: management and research. University of Hawaii Cooperative National Park Resources Studies Unit, Honolulu.

Selkirk, P. M., R. D. Seppelt, and D. R. Selkirk. 1990. Subantarctic Macquarie Island: environment and biology. Cambridge University Press, Cambridge, United Kingdom.

Sfougaris, A. I., A. S. Nastis, and N. K. Papageorgiou. 1996. Food resources for the introduced Cretan wild goat or agrimi *Capra aegagrus cretica* on Atalandi Island, Greece, and implications for ecosystem management. Biological Conservation **78:**239–245.

Shimizu, Y. 1995. Endangered plant species in the Bonin (Ogasawara) Islands: causal factors and present situation. Regional Views **8:**145–169.

Shimuzu, Y. 2003. The nature of Ogasawara and its conservation. Global Environmental Research **7:**3–14.

Silanikove, N. 2000. The physiological adaptation in goats to harsh environments. Small Ruminant Research **35:**181–193.

Simberloff, D. 2001. Eradication of island invasives: practical actions and results achieved. Trends in Ecology & Evolution **16:**273–274.

Smith, P. J., and M. J. Dodkin. 1989. Reservation and management of seabird islands in New South Wales. Pages 141–156 in A. Burbidge, editor. Australian and New Zealand islands: nature conservation values and management. Proceedings of a technical workshop, Barrow Island, Western Australia, 1985. Department of Conservation and Land Management, Perth, Western Australia,.

Spatz, G., and D. Mueller-Dombois. 1973. The influence of feral goats on koa tree reproduction in Hawaii Volcanoes National Park. Ecology **54:**870–876.

Taylor, D., and L. Katahira. 1988. Radio telemetry as an aid in eradicating remnant feral goats. Wildlife Society Bulletin **16:**297–299.

Tershy, B. R., C. J. Donlan, B. Keitt, D. Croll, J. A. Sanchez, B. Wood, M. A. Hermosillo, and G. Howald. 2002. Island conservation in northwest Mexico: a conservation model integrating research, education and exotic mammal eradication. Pages 293–300 in C. R. Veitch and M. N. Clout, editors. Turning the tide: the eradication of invasive species. World Conservation Union (IUCN), Species Survival Commission, Invasive Species Specialist Group. IUCN, Gland, Switzerland.

Tomich, P. Q. 1986. Mammals in Hawai'i. A synopsis and annotated bibliography. 2nd edition. Bishop Museum Press, Honolulu, Hawaii.

Tortora, D. F. 1982. Understanding electronic dog-training 1. Canine Practice **9:**17–22.

Towns, D. R., and K. G. Broome. 2003. From small Maria to massive Campbell: forty years of rat eradications from New Zealand islands. New Zealand Journal of Ecology **30:**377–398.

Turbott, E. G. 1948. Effects of goats on Great Island, Three Kings, with descriptions of vegetation quadrats. Records of the Auckland Institute and Museum **3:**253–272.

Tye, A. 2000. Galapagos species accounts. Pages 33–430 in R. Valencia, N. Pitman, S. Leon-Yanez, and P. M. Jorgensen, editors. Libro rojo de las plantas endemicas del Ecuador 2000. Herbarium of the Pontifica Universidad Catolica del Ecuador, Quito.

Veitch, C. R., and B. D. Bell. 1990. Eradication of introduced animals from the islands of New Zealand. Pages 137–146 in D. R. Towns, C. H. Daugherty, and I. A. E. Atkinson, editors. Ecological restoration of New Zealand islands. Department of Conservation, Wellington.

Veitch, C. R., and M. N. Clout, editors. 2002. Turning the tide: the eradication of invasive species. World Conservation Union, Gland, Switzerland.

Wace, N. M., and M. W. Holdgate. 1976. Man and nature in the Tristan da Cunha Islands. IUCN monograph no. 6. International Union for Conservation of Nature and Natural Resources, Morges, Switzerland.

Walker, T. A. 1991. Pisonia Islands of the Great Barrier Reef: Part III. Changes in the vascular flora of Lady Musgrave Island. Atoll Research Bulletin **350:**31–41.

Walter, K. S., and H. J. Gillett, editors. 1998. 1997 IUCN red list of threatened plants. Compiled by the World Conservation Monitoring Centre. The World Conservation Union, Gland, Switzerland.

Warman, S., and D. Todd. 1984. A biological survey of Aride Island Nature Reserve, Seychelles. Biological Conservation **28:** 51–71.

Wester, L. 1991. Invasions and extinctions on Másatierra (Juan Fernández Islands): a review of early historical evidence. Journal of Historical Geography **17:**18–34.

Williams, G. R., and M. R. Rudge. 1969. A population study of feral goats (*Capra hircus* L.) from Macauley Island, New Zealand. Proceedings of the New Zealand Ecological Society **16:**17–28.

Wingate, D. B. 1985. The restoration of Nonsuch Island as a living museum of Bermuda's pre-colonial terrestrial biome. Pages 225–238 in P. J. Moors, editor. Conservation of island birds. Technical publication no. 3. International Council for Bird Preservation, Cambridge, United Kingdom.

Zavaleta, E. S., R. J. Hobbs, and H. A. Mooney. 2001. Viewing invasive species removal in a whole-ecosystem context. Trends in Ecology & Evolution **16:**454–459.

Zeder, M. A., and B. Hesse. 2000. The initial domestication of goats (*Capra hircus*) in the Zagros Mountains 10,000 years ago. Science **287:**2254–2257.

Zino, F., and M. Biscoito. 1994. Breeding seabirds of the Madeira archipelago. Pages 172–185 in D. N. Nettleship, J. Burger, and M. Gochfield, editors. Seabirds on islands: threats, case studies and action plans. BirdLife International, Cambridge, United Kingdom.

**Appendix 1. Characteristics of islands where introduced goat populations have been eradicated.**

| Island (group) | Country[a] | Area (ha) | Introduction year | Eradicated year | No. goats removed | Eradication methods | Reference |
|---|---|---|---|---|---|---|---|
| Flinders (Tasmania)[b] | AUS | 132,867 | | 1994 | ~30 | unknown | Howell & Atkinson 1994; G. Atkinson pers. comm.; I. Skira pers. comm. |
| King (Tasmania)[b] | AUS | 110,075 | <1860s | 1997 | 120 (1996–1997) | unknown | G. Atkinson pers. comm.; I. Skira pers. comm. |
| Auckland[c] | NZL | 45,975 | 1865 | 1992 | 105 (1992) | hunting, hunting w/dogs?, helicopter as support, poisoning | Chimera et al. 1995 |
| Bruny (Tasmania)[b] | AUS | 36,735 | | 1996 | 32 (1995–1996) | unknown | G. Atkinson pers. comm.; I. Skira pers. comm. |
| Lana`i (Hawai`i) | USA | 36,100 | early 1800s | 1981 | | hunting, hunting w/helicopter, helicopter as support | Hobdy 1993; R. Bartlett pers. comm. |
| Santa Catalina (Channel) | USA | 19,400 | 1827 | 2002 | 8500 (1990–2002) | hunting, hunting w/helicopter, Judas goats, live capture | Schuyler et al. 2002; P. Schuyler pers. comm. |
| Ni'ihau (Hawai`i) | USA | 18,900 | 1778, 1779 | 1779, 1910[d] | | unknown | Tomich 1986; Beattie 1994; R. Bartlett pers. comm. |
| Saltspring (British Columbia) | CAN | 18,600 | | 1980 | | unknown | D. Shackleton pers. comm. |
| San Clemente (Channel) | USA | 14,800 | <1827 | 1993 | 29,266 (1972–1993) | hunting, hunting w/helicopter, Judas goats, trapping, live capture | Keegan et al. 1994 |
| Marchena (Galápagos) | ECU | 12,996 | c.1967, 1999, 2002, 2003 | 1979[d], 2000, 2002, 2003 | 484 | hunting, hunting w/dogs | Hoeck 1984; K.C. unpublished data |
| Macquarie (Tasmania) | AUS | 12,785 | 1878, 1948 | 1957 | | unknown | Selkirk et al. 1990 |
| Kaho'olawe (Hawai'i) | USA | 11,600 | 1793 | 1990 | ~9000 | hunting?, hunting w/helicopter?, Judas goats | Kaho'olawe Island Conveyance Commission 1993 |
| Ascension | UK | 9,700 | <1700 | 1945 | | unknown | Ashmole et al. 1994 |
| Tristan da Cunha (Tristan-Gough) | UK | 9,500 | <1790, 1942 | 1951 | 12 (1950–1951) | hunting | Holdgate & Wace 1961; Wace & Holdgate 1976; Daly & Goriup 1987 |
| Townshend (Queensland) | AUS | 7,000 | c.1967 | 1997 | 2000-3000 (1993–1997) | hunting w/helicopter, biocontrol | Allen et al. 1998; L. Allen pers. comm. |
| Española (Galápagos) | ECU | 6,048 | <1905 | 1978 | 3344 (1968–1978) | hunting, hunting w/dogs, boat as support? | Hoeck 1984 |
| Pinta (Galápagos) | ECU | 5,940 | c.1957 | 2000 | 41,682 (1971–1999) | hunting, hunting w/dogs, hunting w/boat, boat as support, Judas goats | Campbell et al. 2004 |
| Amsterdam | FRA | 5,500 | 1823 | 1957 | | unknown | Clark & Dingwall 1985; Jouventin 1994 |
| Isla de la Blanquilla | VEN | 5,220 | c.1500 | ? | | unknown | http://www.sibv.org.ve/Aspectos_Comunes/Especies_exoticas/Especies_situacion.asp |
| Faure (Shark Bay)[b] | AUS | 5,148 | c.1900 | 1994 | | unknown | Parkes et al. 1996 |
| Bernier (Shark Bay) | AUS | 4,267 | 1899 | 1984 | >690 (1962–1984) | hunting, hunting w/helicopter, mustering | Morris 1989 |
| Norfolk[b] | AUS | 3,450 | >1774 | 1856 | | hunting | Daly & Goriup 1987; L. Rodgers pers. comm. |
| Grand Jason (Falklands) | UK | 3,000 | 1870 | ? | | unknown | Croxall et al. 1984; Armstrong 1994 |
| Raoul (Kermadec) | NZL | 2,943 | <1836 | 1984 | >10,000 (1956–1984) | hunting, hunting w/dogs, hunting w/helicopter, Judas goats, snares, poisoning, mustering | Parkes 1990*a* |
| Malabar (Seychelles) | ROS | 2,640 | <1967 | 1994 | 80 (1987–1994) | hunting, Judas goats | Rainbolt & Coblentz 1999 |
| Woody (Queensland) | AUS | 2,600 | 1880 | 1991 | 340 (1987–1991) | hunting w/dogs, Judas goats, mustering | Allen 1991 |

*continued*

**Appendix 1. (continued)**

| Island (group) | Country[a] | Area (ha) | Introduction year | Eradicated year | No. goats removed | Eradication methods | Reference |
|---|---|---|---|---|---|---|---|
| Koolan (Western Australia) | AUS | 2,580 | 1920s-30s | 1993 | | unknown | M. Everett pers. comm. |
| Selvagem Grande (Salvagens) | POR | 2,500 | | 1900 | | unknown | Zino & Biscoito 1994 |
| Santa Fé (Galápagos) | ECU | 2,413 | <1905, >1972 | 1972[d], 1974 | 3003 (1964–1972) | hunting, hunting w/dogs | Hoeck 1984 |
| Kapiti[e] | NZL | 1,970 | c.1830 | 1928 | | hunting, hunting w/dogs? | Veitch & Bell 1990 |
| Inaccessible (Tristan-Gough) | UK | 1,800 | 1820s | 1872 | | hunting | Wace & Holdgate 1976 |
| Flinders (Queensland) | AUS | 1,480 | | 1990 | | unknown | K. McDonald pers. comm. |
| Sunday (Victoria) | AUS | 1,034 | 1928 | 1950 | | biocontrol | Abbott & Burbidge 1995 |
| Wedge (Gambier) | AUS | 947 | <1914 | 1963 | ~2000 | hunting | Robinson et al. 1996; R. Henzell pers. comm. |
| Picard (Seychelles) | ROS | 930 | <1878 | 1994 | 21 | hunting, Judas goats | Rainbolt & Coblentz 1999 |
| Shackleford Banks (Outer Banks) | USA | 923 | c.1800 | 1998 | ~150 | unknown | M. Rikard pers. comm. |
| Koufonisi (Lefki) (Crete) | GRE | 900 | | 1976 | | unknown | http://www.crete-today.com/s-koufonisi.htm |
| Natividad (Baja California) | MEX | 720 | | 1999 | | live-capture | Tershy et al. 2002 |
| Sainte-Paul | FRA | 700 | 1800s | 1874 | | unknown | Holdgate & Wace 1961; Clark & Dingwall 1985 |
| Klein Bonaire | NA | 690 | c.1868 | 1990 | <1834 | hunting, live-capture, biocontrol | G. van Hoorn pers. comm. (from E. Domacasse and B. Bowker) |
| Lindeman (Whitsunday) | AUS | 610 | | 1993 | | hunting, hunting w/dogs, helicopter as support | K. McDonald pers. comm.; A. Griffiths pers. comm. |
| Sidney (British Columbia) | CAN | 570 | | ? | | unknown | D. Shackleton pers. comm. |
| Sarigan | NMI-USA | 500 | c.1900, 1999 | 1999 | 908 (1998–1999) | hunting, hunting w/dogs, hunting w/helicopter, fire, boat as support | Kessler 2002 |
| Rábida (Galápagos) | ECU | 499 | c.1971 & >1971 | 1971, 1977[d] | 4 (1971), 10 (1975, 1977) | hunting | Hoeck 1984 |
| North Keppel (Keppel) | AUS | 436 | 1880s | 1975 | >800 | hunting | Brennan 1986; D. Crossman pers. comm. |
| Brampton (Whitsunday) | AUS | 433 | 1920's | 1985 | ~1000 (1962–1985) | hunting | Rees 1981; Brennan 1986 |
| Wild Duck (Northumberland) | AUS | 416 | | 1985 | | unknown | C. Maple pers. comm. |
| Jarvis (Line) | USA | 414 | | 1935 | | unknown | Rauzon 1985 |
| Great (Three Kings) | NZL | 408 | 1889 | 1946 | 393 (1946) | hunting, hunting w/dogs | Turbott 1948 |
| South Molle (Whitsunday) | AUS | 380 | | 1990 | | hunting, helicopter as support, boat as support, fire | K. McDonald pers. comm.; A. Jacobson pers. comm.; Abbott & Burbidge 1995 |
| San Benitos West (Baja California) | MEX | 350 | 1989 | 1998 | 7 (1998) | hunting | Tershy et al. 2002 |
| Macauley (Kermadec) | NZL | 324 | < 1836 | 1970 | 3200 | hunting | Williams & Rudge 1969; Merlin & Juvik 1992 |
| Hayman (Whitsunday) | AUS | 321 | | 2001 | | hunting | K. McDonald pers. comm. (from B. Nolan); A. Griffiths pers. comm. |
| Sloping (Tasmania) | AUS | 312 | | 1997 | 6 (1997) | unknown | G. Atkinson pers. comm.; I. Skira pers. comm. |
| Guana (Virgin) | UK | 297 | 1990 | 1991 | 2 (1991) | hunting w/boat | F. Kraus pers. comm. |
| Dragonera (Balearic) | SPA | 280 | | 1975 | | unknown | M. Pascal pers. comm. (Mayol pers. comm. in data collected by Lorvelec and Pascal) |
| San Francisquito (Gulf of California) | MEX | 261 | | 1999 | | hunting | Tershy et al. 2002 |
| Mukojima (Mukojima-retto) | JAP | 257 | 1945 | 2002 | | unknown | Shimuzu 2003 |
| Philip | AUS | 250 | ~1795 | 1870 | | unknown | Coyne 1981 |
| Nukuwaiata (Chetwodes) | NZL | 242 | | ? | | unknown | Atkinson & Taylor 1991 |

continued

**Appendix 1. (continued)**

| *Island (group)* | *Country*[a] | *Area (ha)* | *Introduction year* | *Eradicated year* | *No. goats removed* | *Eradication methods* | *Reference* |
|---|---|---|---|---|---|---|---|
| Santa Clara (Juan Fernández) | CHI | 223 | 1574 | 2000 | | hunting | CONAF Rangers pers. comm. |
| North Molle (Whitsunday) | AUS | 219 | | 1990 | | hunting, helicopter as support, boat as support | K. McDonald pers. comm.; A. Jacobson pers. comm. |
| Rangatira (Chathams)[e] | NZL | 219 | <1900 | 1916 | | unknown | J. Parkes pers. comm. |
| North East (Percy) | AUS | 217 | late 1880s | 1995 | | hunting, helicopter as support, boat as support | R. Henzell pers. comm.; A. Jacobson pers. comm. |
| Cuvier | NZL | 181 | 1890s | 1961 | 469 (1959–1961) | hunting, hunting w/dogs | Merton 1970 |
| Atalandi (Atalanti) | GRE | 180 | 1953 | 1979 | 350 | unknown | Sfougaris et al. 1996 |
| Coronado South (Baja California) | MEX | 180 | <1950 | 1999 | | hunting | Tershy et al. 2002 |
| Round | MAU | 151 | 1844 | 1979 | 10 | hunting | Bullock & North 1985; Merton et al. 1989; |
| Mokoia (Lake Rotorua) | NZL | 143 | 1987 | 1989 | | hunting, hunting w/dogs | Parkes 1990*a*; Veitch & Bell 1990 |
| Whale (Motuhora) | NZL | 143 | c.1890 | 1977 | >1015 | hunting | Parkes 1990*a*; Veitch & Bell 1990; J. Parkes pers. comm. |
| Nakoudojima (Mukojima-retto) | JAP | 137 | 1945 | 1999 | 417 (1997–1999) | live capture | Shimuzu 2003 |
| Klein Curaçao | NA | 130 | 1915 | 1996 | 20 | live capture | G. van Hoorn pers. comm. (from A. Debrot) |
| Mangere | NZL | 113 | | ? | | unknown | Atkinson 1988 |
| Grassy (Whitsunday) | AUS | 111 | 1930 | 1989 | | hunting | K. McDonald pers. comm.; A. Jacobson pers. comm.; Abbott & Burbidge 1995 |
| Minamijima (Bonin) | JAP | 111 | | 1972 | | hunting | Shimuzu 1995, 2003 |
| South Neptune (Neptune) | AUS | 98 | | 1968 | | unknown | Robinson et al. 1996 |
| Althorpes (York Peninsula)[e] | AUS | 96 | 1880s | 1980 | | hunting | Robinson et al. 1996; R. Henzell pers. comm. |
| Montague (New South Wales) | AUS | 82 | <1967 | 1988 | 60 | unknown | Smith & Dodkin 1989; NSW National Parks and Wildlife Service 1995 |
| Goose (Tasmania) | AUS | 81 | | 1930 | | unknown | I. Skira pers. comm. |
| Yomejima (Mukojima-retto) | JAP | 81 | 1945 | 2000 | | unknown | Shimuzu 2003 |
| Aride | ROS | 72 | | 1920 | | unknown | Warman & Todd 1984 |
| Long (Tasmania) | AUS | 70 | <1977 | 1996 | 109 (1996) | unknown | G. Atkinson pers. comm.; I. Skira pers. comm. |
| East Repulse (Whitsunday) | AUS | 67 | | 1990 | | hunting | K. McDonald pers. comm. (from B. Nolan); Abbott & Burbidge 1995 |
| Lavezzu (Lavezzi) | FRA | 66 | | 1993 | | hunting, live capture | Daycard & Thibault 1990; M. Pascal pers. comm. |
| North Islet (Gambier) | AUS | 64 | 1820s | 1916 | | unknown | Robinson et al. 1996 |
| South Repulse (Whitsunday) | AUS | 61 | | 1990 | | hunting | K. McDonald pers. comm. (from B. Nolan); A. Jacobson pers. comm.; Abbott & Burbidge 1995 |
| Humpy (Keppel) | AUS | 60 | | 1986 | | unknown | Brennan 1986 |
| Motuoruhi | NZL | 57 | | ? | | unknown | Atkinson & Taylor 1991 |
| Saddleback (Whitsunday) | AUS | 53 | | 1988 | | hunting | Abbott & Burbidge 1995; K. McDonald pers. comm.; A. Jacobson pers. comm. |
| Burgess (Mokohinau) | NZL | 52 | | 1973 | | hunting | Veitch & Bell 1990 |
| Pourewa | NZL | 42 | < 1950 | 1993 | 83 | hunting | D. Veitch pers. comm. (from A. Bassett) |
| Middle (Keppel) | AUS | 41 | | 1986 | | unknown | Brennan 1986 |
| Horse (Roaringwater Bay)[e] | IRE | 40 | | 1994 | | unknown | http://homepage.eircom.net/~sherkinmarine/islands.html |
| Henning (Whitsunday) | AUS | 38 | | 1989 | | hunting | Abbott & Burbidge 1995; K. McDonald pers. comm.; A. Jacobson pers. comm. |
| Lady Elliot (Capricorn Bunker) | AUS | 37 | c.1860 | 1969 | | hunting | Olgilvie 1992; D. Crossman pers. comm. |

*continued*

**Appendix 1. (continued)**

| *Island (group)* | *Country*[a] | *Area (ha)* | *Introduction year* | *Eradicated year* | *No. goats removed* | *Eradication methods* | *Reference* |
|---|---|---|---|---|---|---|---|
| Mahurangi | NZL | 32 | 1800s | 1915 | | unknown | J. Parkes pers. comm. |
| Fairfax [eastern] (Capricorn Bunker) | AUS | 28 | 1898 | 1974 | ~100 (1972) | hunting | Cribb 1986; Rees 1981; D. Crossman pers. comm.; D. Arnold pers. comm. |
| Herekopare (Titi)[e] | NZL | 28 | 1973 | 1976 | | hunting | Parkes 1990*a*; Veitch & Bell 1990 |
| Ile aux Aigrettes | MAU | 27 | >1945 | 1987 | | unknown | J. Mauremootoo pers. comm. |
| Ernest (Stewart)[e] | NZL | 25 | <1948 | 1980 | | unknown | Parkes 1990*a* |
| Bono (Septe-Iles) | FRA | 21 | | 1993 | | live capture | M. Pascal pers. comm. |
| Hoskyn [western] (Capricorn Bunker) | AUS | 20 | | ? | | hunting | Rees 1981; D. Arnold pers. comm. |
| Big (Five Islands) | AUS | 19 | 1888 | 1917 | | unknown | Smith & Dodkin 1989; Abbott & Burbidge 1995 |
| Trielen (Molene) | FRA | 17 | | 1998 | | live capture | M. Pascal pers. comm. |
| North Repulse (Whitsunday) | AUS | 16 | | 1990 | ~1200 | hunting | Abbott & Burbidge 1995; K. McDonald pers. comm.; A. Jacobson pers. comm. |
| Allports | NZL | 16 | | ? | | unknown | Atkinson & Taylor 1991 |
| Atihau[e] | NZL | 16 | | 1940 | | unknown | J. Parkes pers. comm. |
| East | NZL | 13 | 1906 | 1960 | | hunting | Parkes 1990*a*; Veitch & Bell 1990 |
| Nukutaunga (Cavalli) | NZL | 13 | | 1972 | | hunting | Parkes 1990*a*; Veitch & Bell 1990 |
| Plaza Sur (Galápagos) | ECU | 12 | | 1961 | 5 (1961) | hunting | Hoeck 1984; O. Chapi pers. comm. |
| Harbour (Tasmania) | AUS | 10 | | 1995 | 34 (1995) | unknown | G. Atkinson pers. comm.; I. Skira pers. comm. |
| Lady Musgrave (Capricorn Bunker) | AUS | 9 | 1898 | 1974 | ~300 | hunting? | Walker 1991; D. Arnold pers. comm. |
| Île aux Moines (Septe-Iles) | FRA | 9 | | 1993 | | live capture | M. Pascal pers. comm. |
| Nonsuch (Castle Harbour) | BER | 6 | c.1953 | 1962 | 9 | hunting, mustering | Wingate 1985 |
| Hoskyn (Queensland) | AUS | 5 | | 1970 | | unknown | Abbott & Burbidge 1995 |
| Ocean (Auckland) | NZL | 5 | 1865 | 1942 | ~14 (1941–1942) | hunting | Rudge & Campbell 1977 |
| Rurima | NZL | 5 | | 1960 | | unknown | Atkinson & Taylor 1991 |
| Fairfax [western] (Capricorn Bunker) | AUS | 4 | | 1971 | ~10 (1972) | hunting | Cribb 1986; D. Arnold pers. comm. |
| Burt's (Hamilton Harbour) | BER | 2 | c.1964 | 1969 | | unknown | D. Wingate pers. comm. |
| Marielas Sur (Galápagos) | ECU | 1 | c.1990 | 1991 | 5 | hunting | F. Cruz pers. comm. |

[a] *Country abbreviations: AUS, Australia; BER; Bermuda; CAN, Canada; CHI, Chile; ECU, Ecuador; FRA, France; GRE, Greece; IRE, Ireland; JAP, Japan; MAU, Mauritius; MEX, Mexico; NA, Netherlands Antilles; NZL, New Zealand; NMI, Northern Mariana Islands; POR, Portugal; ROS, Republic of Seychelles; SPA, Spain; UK, United Kingdom; USA, United States of America; VEN, Venezuela.*
[b] *Domestic goats now present.*
[c] *Occupied only 4000 ha.*
[d] *Largest population eradicated.*
[e] *Semiferal goats eradicated.*