



CENTRE FOR BIODIVERSITY AND BIOSECURITY

Island Invasives: Eradication and Management

PROGRAMME

ABSTRACTS AND

LIST OF PARTICIPANTS





CENTRE FOR BIODIVERSITY AND BIOSECURITY

The Centre for Biodiversity and Biosecurity (www.cbb.org.nz) brings together researchers from the University of Auckland and Landcare Research, including many of New Zealand's pre-eminent experts in biosecurity, invasion ecology, conservation biology and biodiversity research. Landcare Research holds a number of nationally and internationally significant

collections at Auckland – including the NZ arthropod and NZ fungi collections, the National Nematode collection and the International Collection of Micro-organisms from Plants. The University has expertise in animal behaviour, invasion ecology, plant ecology, molecular ecology, conservation biology and restoration ecology. At its Tamaki Campus it also hosts the Pacific Invasives Initiative and the Pacific Regional Office of the Invasive Species Specialist Group of SSC/IUCN. Through the CBB, the combined expertise of the University and Landcare Research provides opportunities for joint research, and a strong platform to exploit new opportunities nationally and internationally. Such interactions (including joint supervision of postgraduate students) are leading to novel research to enhance the capacity, efficiency and quality of biodiversity management, conservation and biosecurity in New Zealand and globally. The CBB is proud to be hosting this conference.

The Invasive Species Specialist Group (ISSG) - one of five Disciplinary Groups of the Species Survival Commission (SSC) of the International Union for Conservation of Nature (IUCN) - aims to reduce threats to biological diversity by increasing awareness of invasive alien species, and of ways to prevent, control and manage their spread. ISSG promotes the exchange of invasive species

information across the globe and ensures the linkage between knowledge, practice and policy so that decision making is informed. Founded in 1994, the ISSG Secretariat was based at the University of Auckland in New Zealand until early 2009, when it was moved to Rome, Italy, with the appointment of the new Chair, Dr. Piero Genovesi. A Regional Office for the Pacific has been established in New Zealand, to serve as the Pacific node for ISSG activities and serve as the Invasive Species focal point for the Regional IUCN Oceania office based in Fiji. ISSG is currently a network of 196 invasive species experts from over 40 countries, providing technical and scientific advice to National and Regional agencies and to civil society in developing policy and strategies to manage the risk of biological invasions. The group hosts a website (www.issg.org) and publishes a newsletter "*Aliens*" - biannually. The ISSG also hosts a listserv *Aliens-L* with more than 1000 subscribers and operates a referral service for global stakeholders. ISSG manages and maintains the Global Invasive Species Database (GISD) – recognised as a significant repository of global invasive species information. As of early 2010 the GISD featured 663 species profiles.



Island Invasives:
Eradication and Management

A Conference
At Tamaki Campus
The University of Auckland
8 to 12 February 2010

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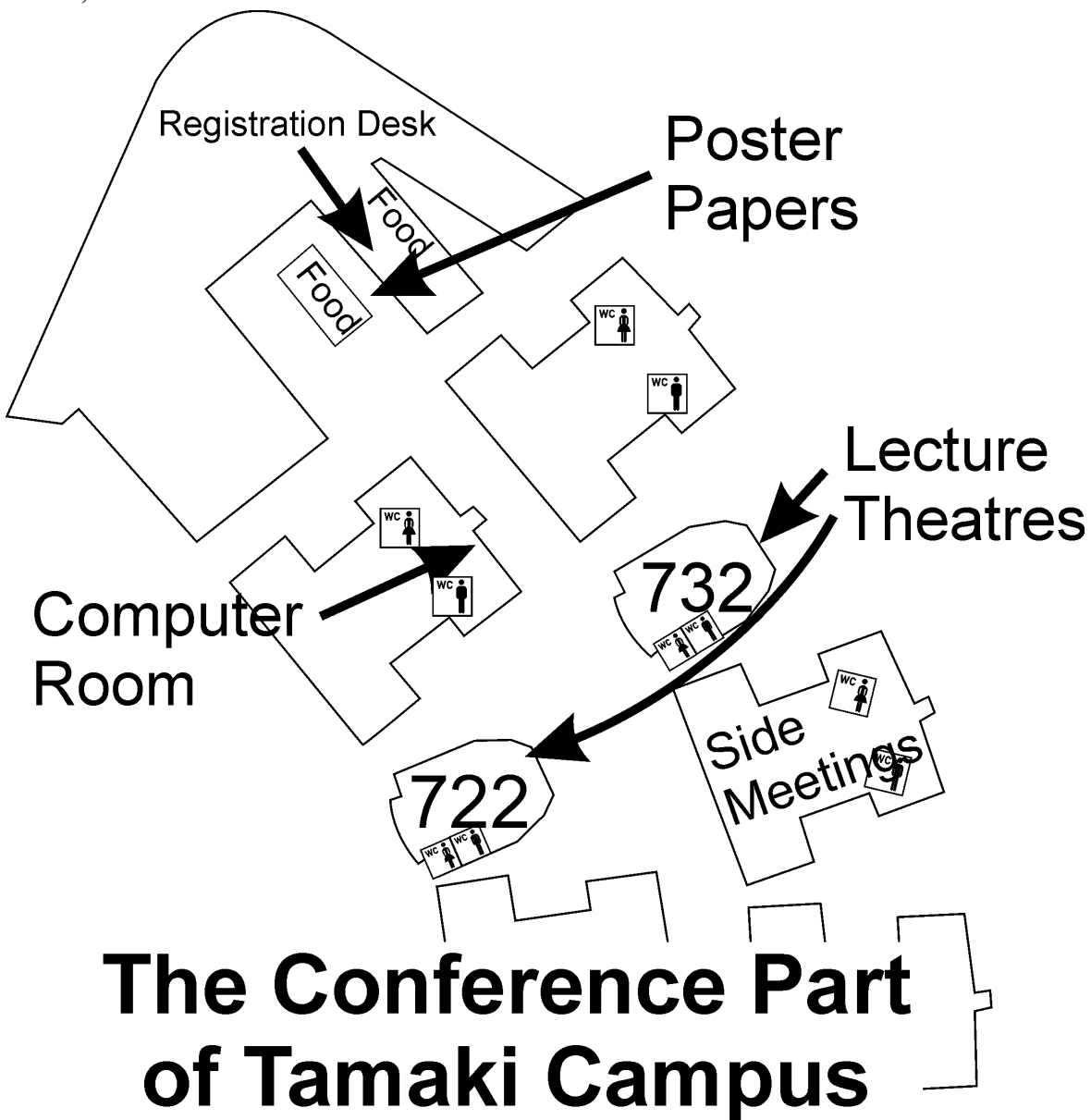
This conference has been organised for you by:

Mick Clout, Centre for Biodiversity and Biosecurity, Auckland, New Zealand
Dick Veitch, Conference Manager, Auckland, New Zealand
Dave Choquenot, Landcare Research, Auckland, New Zealand
Alfonso Aguirre-Muñoz, Grupo de Ecología y Conservación de Islas, A.C., Mexico
Keith Broome, Department of Conservation, Hamilton, New Zealand
Piero Genovesi, IUCN SSC Invasive Species Specialist Group, Italy
John Parkes, Landcare Research, Christchurch, New Zealand
Alan Saunders, Landcare Research, Hamilton, New Zealand
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Carola Warner, Centre for Biodiversity and Biosecurity, Auckland, New Zealand

With onsite logistics by John Walker of Academic and Professional Conferences, Centre for Continuing Education, The University of Auckland.

Conference days assistance is also provided by: Michael Browne, Manpreet Kaur Dhami, Asher Jones, Cheryl Krull, Jacqui Todd, and Andrew Veale

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TIMETABLE

Monday 8 February 2010

8:30 Registration opens
Tea and coffee available
10:30 Welcome and official opening
11:10 Keynote speech
12:00 Lunch

Lecture Theatre 732

1:20 Theme: Eradicating Multiple Pest Species
3:00 Tea and Coffee
3:30 Theme: Eradicating Multiple Pest Species
5:10 Close
Social Hour

Tuesday 9 February 2010

8:30 Theme: Social and Economic Dimensions of Eradications
10:10 Tea and Coffee
10:40 Theme: Social and Economic Dimensions of Eradications
12:20 Lunch
1:20 Theme: Social and Economic Dimensions of Eradications
3:00 Tea and Coffee
3:30 Theme: Social and Economic Dimensions of Eradications
5:10 Close

Wednesday 10 February 2010 Field Trips

Thursday 11 February 2010

8:30 Theme: Ecological Outcomes of Eradications
10:10 Tea and Coffee
10:40 Theme: Ecological Outcomes of Eradications
12:20 Lunch
1:20 Theme: Ecological Outcomes of Eradications
2:10 General Session: Mainly Mustelids
3:00 Tea and Coffee
3:30 General Session: Mainly Mustelids
5:10 Close
Dinner

Friday 12 February 2010

8:30 Theme: Finding the First or Last
10:10 Tea and Coffee
10:40 Theme: Finding the First or Last
12:20 Lunch
1:20 Closing address

Lecture Theatre 722

1:20 General Session: Strategy
2:10 General Session: Amphibia
3:00 Tea and Coffee
3:30 General Session: Invertebrates
5:10 Close
Social Hour

Tuesday 9 February 2010

8:30 General Session: Ecosystems
10:10 Tea and Coffee
10:40 General Session: Ecosystems
12:20 Lunch
1:20 General Session: Plants
3:00 Tea and Coffee
3:30 General Session: Plants
3:55 General Session: Other Species
5:10 Close

Wednesday 10 February 2010 Field Trips

Thursday 11 February 2010

8:30 Theme: New Techniques and Approaches
10:10 Tea and Coffee
10:40 Theme: New Techniques and Approaches
12:20 Lunch
1:20 General Session: Toxins
2:10 General Session: Overviews
3:00 Tea and Coffee
3:30 General Session: Overviews
5:10 Close

Dinner

Friday 12 February 2010

8:30 General Session: Rodents
10:10 Tea and Coffee
10:40 General Session: Rodents
12:20 Lunch
1:20 Closing address

Monday 8 February 2010

8:30 Registration opens

Tea and coffee available

10:30 Welcome

Chair: Mick Clout

Official Opening: Al Morrison, Director-General, Department
of Conservation, New Zealand

11:10 Keynote Speech by Piero Genovesi

*Are we turning the tide? Eradications in times of crisis; how
the global community is responding to biological invasions*

Chair, IUCN SSC Invasive Species Specialist Group and
Institute for Environmental Protection and Research, Rome

Lecture Theatre 732

Monday 8 February

Chair: Alan Saunders

Theme: Eradicating Multiple Pest Species

- 1:20 **Saunders, Alan.** Eradicating multiple pests: an overview.
- 1:45 **West, Carol J.** Plant: animal interactions – considerations prior to rat eradication on Raoul Island, Kermadecs.
- 2:10 **Springer, Keith.** Macquarie Island pest eradication: planning processes for eradication of multiple pest species.
- 2:35 **Edge, Kerri-Anne;** D. Crouchley, P. McMurtrie, M. J. Willans, and A Byrom. Eradicating stoats (*Mustela erminea*) and red deer (*Cervus elaphus*) off islands in Fiordland: the history and rationale behind two of New Zealand's biggest island eradication programmes.
- 3:30 **Luna-Mendoza, Luciana;** J. M. Barredo-Barberena, A. Ortiz-Alcaraz, J. C. Hernández-Montoya, A. Samaniego-Herrera, A. Aguirre-Muñoz, M. Rodríguez-Malagón, M. A. Hermosillo-Bueno, and N. Silva-Estudillo. Planning for feral cat complex eradications on large Mexican islands.
- 3:55 **Griffiths, Richard.** Targeting multiple species – a more efficient approach to island pest eradication.
- 4:20 **Morrison, Scott A.** Trophic considerations in eradicating multiple pests.
- 4:45 **Overton, Jake.** Context matters: assessing the biodiversity benefits of pest eradication.

Throughout this book the name of the presenter
of the paper is shown in **bold type**

A television link will
relay the opening
addresses to this lecture
theatre

Lecture Theatre 722

Monday 8 February

Chair: Dave Choquenot

General Session: Strategy

- 1:20 **Cranwell, S.**; E Seniloli, J Baudat-Franceschi, L Faulquier, and A. L. Isechal. Developing national eradication capacity for the restoration of globally important seabird islands in the Pacific.
- 1:45 **Stringer, Clare**; C. Shine, A. Darlow, and B. Summers. Developing a regional invasive species strategy for the South Atlantic UK Overseas Territories.

General Session: Amphibia

- 2:10 **Beachy, Jane Reppun**; R. Neville, and C. Arnott. *Eleutherodactylus coqui* control on O'ahu: successful eradication of an incipient amphibian.
- 2:35 **Orchard, Stan A.** Innovations in the control and eradication of the American bullfrog (*Rana (Lithobates) catesbeiana*) populations on Vancouver Island, British Columbia, Canada.

General Session: Invertebrates

- 3:30 **Boland, Christopher R. J.** and M. Smith. Use of heli-baiting to control invasive yellow crazy ants (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean.
- 3:55 **Inoue, Maki N.** and K. Goka. The invasion of the Argentine ant across continents and the eradication.
- 4:20 **Randall, John M.**; S. Morrison, K. Faulkner, C. Boser, C. Cory, P. Power, and L. Lozier. Can invasive Argentine ants be eradicated from Santa Cruz Island, California, be managed to minimize or eliminate harmful effects on biodiversity?
- 4:45 **Smith, Michael** and C. Boland. Management of the red crab (*Gecarcoidea natalis*) on Christmas Island, Indian Ocean: the efficacy of a yellow crazy ant (*Anoplolepis gracilipes*) baiting program.

Lecture Theatre 732

Tuesday 9 February

Chair: Alfonso Aguirre-Muñoz

Theme: Social and Economic Dimensions of Eradications

- 8:30 **Burt, Matthew D.** and J. Jokiel. Eradication of feral goats (*Capra hircus*) from Makua Military Reservation, Oahu, Hawaii.
- 8:55 **Alves, Ruy J. V.**; N. G. da Silva, and A. Aguirre-Muñoz. Return of endemic plant populations following feral goat eradication on Trindade Island, Brazil.
- 9:20 **McClelland, Pete**; R. Coote; M. Trow; P. Hutchins; H. Nevins, H. Moller, and J. Newman. Working together – a multi party rat eradication on a private islands: the Taukihepa eradication.
- 9:45 **Lee, Donna J.**; K. Burnett, and M. Chock. Economics of biocontrol for management of *Miconia calvescens*.
- 10:40 **Burt, Matthew D.**; C. Miller, and D. Souza. The use of volunteer hunting as a control method for feral pig populations on Oahu, Hawaii.
- 11:05 **Ogden, John** and J. Gilbert, Running the gauntlet - promoting eradication of rats and feral cats on an inhabited island.
- 11:30 **Varnham, Karen**; T. Glass, and C. Stringer. Involving the community in rodent control on Tristan da Cunha.
- 11:55 **Wilkinson, Ian S.** and D. Priddel. Rodent eradication on Lord Howe Island: challenges posed by people, livestock and threatened endemics.
- 1:20 **Ritchie, Jo.** Bagging them all in one go – the challenges of community based multi species pest eradication programmes.
- 1:45 **Shaw, Vivienne**; J. D. Whitehead, and C. T. Shaw. Creating an island sanctuary: a case study of a community-led conservation initiative.
- 2:10 **Cowan, Phil** and B. Warburton. Ethical issues in island pest eradication.
- 2:35 **Witmer, Gary.** Management of invasive vertebrate species in the United States.
- 3:30 Howald, G.; **Josh Donlan**, P. McClelland, N. Macdonald, and K. J. Campbell. Advantages and disadvantages of government, non profit and for profit approaches to eradications – are there synergies to be leveraged when working together?
- 3:55 **Bonnaud, Elsa**; K. Bourgeois, D. Zarzoso-Lacoste, and Eric Vidal. Cat impact and management on two Mediterranean sister Islands: “the French conservation touch”
- 4:20 **Aguirre-Muñoz, Alfonso**; F. Méndez-Sánchez, A. Ortiz-Alcaraz, A. Samaniego-Herrera, L. Luna-Mendoza, M. Rodríguez-Malagón, M. Félix-Lizárraga, R. González-Gómez, F. Torres-García, M. Latofski-Robles, and J. C. Hernández-Montoya. Eradications at the core of a comprehensive island conservation national approach in Mexico.
- 4:45 **Saunders, Alan**; J. Parkes, A. Aguirre-Muñoz, and S. A. Morrison. Increasing the pace, scale, and effectiveness of island restoration.

Lecture Theatre 722

Tuesday 9 February

Chair: Scott Morrison

General Session: Ecosystems

- 8:30 **Algar, David**; M. Johnston, and S. Hilmer. A pilot study for the proposed eradication of feral cats on Dirk Hartog Island, Western Australia.
- 8:55 **Baudat-Franceschi, J.**; S. Cranwell, P. Cromarty, C. Golding, J. Le Breton, J. P. Butin, and S. Boudjelas. Introduced rodent eradication to restore island ecosystems and protect tropical Pacific seabird breeding grounds: the importance of baseline biological surveys and feasibility studies.
- 9:20 **Kendrot, Stephen.** Restoration through eradication: protecting Chesapeake Bay marshlands from invasive nutria (*Mycastor coypus*).
- 9:45 Carrion V.; **Grant A. Harper.** Introduced rodents in the Galapagos: colonisation, removal and the future.
- 10:40 **Cuthbert, Richard**; H. Louw, P. Visser, K. Rexer-Huber, G. Parker, and P. Ryan. The impact of invasive house mice and plans for their eradication at the UK Overseas Territories of Gough Island, Tristan da Cunha.
- 11:05 **Brodie, Gilianne D.** and G. Barker. Introduced land snails and slugs in Fiji: are there risks involved?
- 11:30 **Yabe, Tatsuo**; T. Hashimoto, M. Takiguchi, M. Aoki, M. Fujita, and K. Kawakami. Damage to plants and seabirds by black rats (*Rattus rattus*) on the Ogasawara (Bonin) Islands before eradication.
- 11:55 **Russell, James C.**; L. Faulquier, and M. A. Tonione. Introduced rat over-invasion of Tetiaroa, French Polynesia

General Session: Plants Chair: Carol West

- 1:20 **Beauchamp, Tony** and E. Ward. Control and eradication of weeds from Motuopao Island, Northland, New Zealand.
- 1:45 **Cooper, John**; R. J. Cuthbert, T. Glass, N. J. M. Gremmen, P. G. Ryan, and J. D. Shaw. Earth, fire and water: applying novel techniques to eradicate the invasive plant, procumbent pearlwort *Sagina procumbens*, on Gough Island, a World Heritage Site in the South Atlantic.
- 2:10 **Meyer, Jean-Yves**; L. Loope, and A. Goarant. Strategy to control the invasive alien tree *Miconia calvescens* in Pacific Islands: eradication or containment?
- 2:35 **Panetta, F. Dane**; O. J. Cacho, S. M. Hester, and N. M. Sims-Chilton. Estimating the duration and cost of weed eradication programs.
- 3:30 **Penniman, Teya**; L. Buchanan, and L. Loope. Recent plant eradications on the islands of Maui County, Hawai'i.

General Session: Other Species Chair: Andrew Burbidge

- 3:55 **Klinger, Rob**; J. Conti, J. K. Gibson, S. M. Ostoja, and E. Aumack. What does it take to eradicate a feral pig population.
- 4:20 Suliman, A. S.; G. G. Meier, and **Peter J. Haverson.** Eradication of house crow (*Corvus splendens*) from the island of Socotra, Yemen Republic – end of a problem or start of a program?
- 4:45 **Nico, Leo G.** and S. J. Walsh. Nonindigenous fishes in freshwater habitats of islands in the Pacific region: their diversity, distribution, management and eradication.

Side Meetings. Tuesday 5:15pm.

In the rooms and lecture theatres shown below.

Lecture Theatre 732

Monitoring and Management in China

Professor Junsheng Li, Assistant Professor Jing Xu, Assistant Professor Xin Lin. Chinese Research Academy of Environmental Sciences

China has a huge territory and is beginning to grapple with the challenges of invasive alien species (IAS). China began surveys in 2001 to determine the current status of invasive species. The first national survey identified 283 IAS (188 plants, 76 animals and 19 microorganisms). The survey found IAS coming mainly from the Americas and Europe reflecting the massive trade and personal exchanges with these countries. The survey also found that 40% of IAS were introduced intentionally. The direct and indirect economical and social costs, has been estimated at approximately \$US17.5 billion per year. This presentation will provide an overview of the extent of the problem of IAS in China, the actions taken to date (including the institutional frameworks established) and future constraints and challenges including strengthening scientific and technical support, monitoring networks, risk assessments and control and eradication techniques.

Lecture Theatre 722

Documentary Video: The Restoration of Isabel Island, Mexico 2009, 26 minutes

Alfonso Agguire, Conservación de Islas, México

Nine breeding seabirds and six reptiles call it home. On Isabel Island, in the Mexican tropical Pacific, a major ecological change occurred during spring 2009. Using high-tech aerial procedures Black Rats were eradicated from this challenging forested environment, which included exotic vegetation and terrestrial crabs presence. The project, along with other recent successful cases on Mexican islands, represents a threshold on biodiversity conservation in America. From preparation to execution, the results documentation will facilitate the application of this island restoration tool in other regions. The video is the chronicle, in voice of the protagonists of how this valuable conservation project unfolded. People interested on details about rodent eradications on islands should attend. The authors of the project will be there welcoming feedback, and open for a general discussion, questions and answers. The documentary just won a Special Mention at the Mexico City Crystal Screen Festival - National Film Archives, and has been reproduced with the support of the Mexican Biodiversity Commission (Conabio). The video has subtitles in English, French and Portuguese.

Side Meetings Room 733-201

Helping Islands Adapt – Improving Coordination to Manage Invasive Species and Associated Climate Change Impacts

Stas Burgiel, Global Invasive Species Programme

From 12-16 April 2010 in Auckland, the government of New Zealand, the Nature Conservancy, the Secretariat of the Convention on Biological Diversity (CBD) and other partners will host a workshop on regional action to combat invasive species on islands to preserve biodiversity and adapt to climate change. This workshop will address institutional coordination and broader capacity building needs with a focus on key island regions (the Caribbean basin, the Coral Triangle, Europe, the Indian Ocean and the Pacific Ocean). The organizers are soliciting input from practitioners attending this meeting on: opportunities for integrating ongoing and future work; collaboration with the broader conservation and climate change communities; and long-term strategic actions to generate political support, funding and awareness for the management of invasive species on islands.

Side Meetings Room 733-221

Management of the spreading population of the mongoose on mainland Europe

Arijana Barun, Dept. of Ecology and Evolutionary Biology, University of Tennessee

The small Indian mongoose (*Herpestes auropunctatus*) has been touted as one of the world's 100 worst invasive species. In the Adriatic Sea, the mongoose was introduced in 1910 to Mljet Island and subsequently to several other islands and the mainland Pelješac Peninsula. It is currently spreading along the coast and has reached the Neretva River in the north and Albania in the south, but the full extent of its spread is still unknown. The mongoose is a generalist predator blamed for the decline and extirpations of many native species on islands worldwide, and its rapid spread on the European mainland has attracted little attention from managers. This workshop will discuss possible management techniques and funding for a multinational effort. We welcome all parties with experience in managing populations of any vertebrate invader to attend.

Side Meetings Room 733-231

Information Needs of Conservation Managers and Practitioners

IUCN SSC Invasive Species Specialist Group jointly with Manaakai Whenua Landcare Research and Island Conservation.

Rapid changes in digital technology and increased global connectivity provide us with an opportunity to streamline and manage invasive species data and information so it is available to conservation managers and practitioners in useful formats to support decision making. The different types of information resources that are providers and repositories of invasive species related data and information include species based databases, Regional and National inventories, thematic databases and local initiatives. While these information sources are useful there is a perceived gap in their ability to provide information in formats that efficiently answer questions that stakeholders ask, information that will assist managers in prioritizing action, selecting methodology and adopting best practice. It is envisaged that the proposed workshop will bring together participants who will clarify the kinds of questions stakeholders ask, will evaluate the ability of current information sources to provide answers in an efficient way and then propose changes that are required to fill this information need gap. If necessary a further discussion/meeting time of an additional two hours may be considered for Friday 12th afternoon after the closing session.

Side Meetings Room 733-234

US Department of Defense (DoD) realignment in the Pacific: Biosecurity Risks and Regional Opportunities

Lisa Fiedler, Environmental Director, ASN (I&E), Joint Guam Program Office, and Phil Andreozzi, US National Invasive Species Council will lead this discussion to solicit input and identify collaborative opportunities.

American military forces are being repositioned throughout the Pacific to better protect US interests and meet international commitments. This effort will result in billions dollars of military construction and private sector development on Guam which will cause dramatic increases in population, shipping volume and trade. Invasive species have already caused tremendous ecological and economic damage to Guam and have negatively impacted both the civilian and military communities. The upcoming increases in cargo and personnel movement pose additional biosecurity threats to the Guam and the entire region of Micronesia. In response to these threats DoD, in partnership with other U.S. Federal Departments and local and regional governments, has funded a \$2.7 million pathway risk analysis and biosecurity plan to minimize biosecurity risks to the entire region.

Lecture Theatre 732

Thursday 11 February

Theme: Ecological Outcomes of Eradications

Chair: David Towns

- 8:30 **Towns, David.** Eradications of vertebrate pests from islands around New Zealand: what have we delivered and what have we learned?
- 8:55 **Cameron, Ewen K.;** P. J. Bellingham, S. K. Wiser, A. E. Wright, and L. J. Forester. Disperser communities and legacies of goat grazing determine forest succession on the remote Three Kings Islands, New Zealand.
- 9:20 **Eijzenga, Heather.** Vegetation change following rabbit eradication on Lehua Island, Hawaiian Islands.
- 9:45 **West, Carol J.** and D. Havell. Plant responses following eradication of goats and rats from Raoul Island, Kermadecs.
- 10:40 **Kessler, Curt.** Mariana Islands and ungulate removal: update on Sarigan's recovery, lessons from Anatahan.
- 11:05 **Courchamp, Franck;** E. Angulo, E. Bonnaud, K. Bourgeois, S. Caut, X. Cerda, and Y. Watari. Surprise effects on Surprise Island: was the rat eradication a success?
- 11:30 **Watari, Yuya;** E. Bonnaud, K. Bourgeois, S. Caut, and F. Courchamp. Recovery of an ecosystem freed from introduced rats.
- 11:55 **Green, Chris J.;** G.W. Gibbs, and P.A. Barrett. Wetapunga (*Deinacrida heteracantha*) population changes following Pacific rat (*Rattus exulans*) eradication on Little Barrier Island.
- 1:20 **Rauzon, Mark J.;** D. J. Forsell, E. N. Flint, and J. Gove. Howland, Baker and Jarvis Islands 25 years after cat eradication: recovery in biogeographical context.
- 1:45 **Aguirre-Muñoz, Alfonso;** L. Luna-Mendoza, A. Samaniego-Herrera, M. Félix-Lizárraga, A. Ortiz-Alcaraz, M. Rodríguez-Malagón, F. Méndez-Sánchez, R. González-Gómez, F. Torres-García, M. Latofski-Robles, J. C. Hernández-Montoya, J. M. Barredo-Barberena, M. A. Hermosillo-Bueno, N. Silva-Estudillo, and E. Soqui-Gómez. Island restoration in Mexico: ecological outcomes after a decade of eradications of invasive mammals.

General Session: Mainly Mustelids Chair: John Randall

- 2:10 **Barun, Arijana;** K. C. Campbell, C. C. Hanson, and D. Simberloff. A review of the small Indian mongoose management and eradications on islands.
- 2:35 **Peters, Darren;** L. Wilson, S. Mosher, J. Rohrer, J. Hanley, A. Nadig, and M. Silbernagle. Small Indian mongoose (*Herpestes auropunctatus*) – eradication and management using DOC 250 kill traps, first lessons from Hawaii.
- 3:30 **Roy, Sugoto.** The eradication of invasive mink *Neovison vison* from the Southern islands of the Hebridean archipelago, and the lessons learned along the way.
- 3:55 **Bowie, Mike;** J. Ross, and M. Kavermann. The eradication of rats and hedgehogs, and maintenance control of mustelids from Quail Island, Canterbury, New Zealand
- 4:20 **Witmer, Gary.** Attempting to eradicate invasive Gambian giant pouched rats (*Cricetomys gambianus*) in the United States: lessons learned.
- 4:45 **Goka, Koichi;** J. Yokoyama, Y. Une, T. Kuroki, K. Suzuki, M. Nakahara, A. Kobayashi, S. Inaba, T. Mizutani, and A. D. Hyatt. The origin of amphibian chytridiomycosis: did it come from Japan?

Lecture Theatre 722

Thursday 11 February

Theme: New Techniques and Approaches

Chair: Keith Broome

- 8:30 **McClelland, Pete.** Campbell Island – taking eradications to new levels.
- 8:55 **Wegmann, Alex;** S. Buckelew, G. Howald, J. Helm, and K. Swinnerton. Rodent eradication campaigns on tropical islands: novel challenges and possible solutions.
- 9:20 **Pernas, Tony** and D. Clark. Mexican red-bellied squirrel eradication from Biscayne National Park in south Florida: there's a first for everything!
- 9:45 **Knapp, J. J.;** P. T. Schuyler, K. N. Walker, N. L. Macdonald, and S. A. Morrison. Comparison of aerial and ground-based eradication methods to meet eradication goals for two taxa on two islands.
- 10:40 **Murphy, Elaine C.;** L. Shapiro, S. Hix, C. T. Eason, and D. MacMorran. A potential new tool to help with the eradication of feral cats on islands.
- 11:05 **Johnston, Michael;** D. Algar, M. O'Donoghue, and J. Morris. Field efficacy of the Curiosity® Feral Cat Bait on three Australian islands.
- 11:30 **Bodey, Thomas W.;** S. Bearhop, S. Roy, J. Newton, and R. A. McDonald. Using stable isotope analysis to inform control – revealing responses of American mink (*Neovison vison*) to an eradication campaign.
- 11:55 **Barr, Stu;** C. Bond, and R. Greig. Potential operational evolution in pest eradication through use of self-resetting trap.

General Session: Toxins

Chair: Charles Eason

- 1:20 **Fisher, Penny;** R. Griffiths, C. Speedy, and K. Broome. Environmental monitoring for brodifacoum residues following aerial application of baits for rodent eradication.
- 1:45 Zabala, J.; V. Carrion, and **Grant A. Harper.** Effects of brodifacoum on a population of Galápagos land iguanas (*Conolophus subcristatus*) during a rat eradication.

General Session: Overviews

Chair: Josh Donlan

- 2:10 **Genovesi, Piero** and L. Carnevali. Invasive alien species in European islands: eradications and priority for future action.
- 2:35 **Waldman, Bill;** J. Beek, S. Buckelew, K. Campbell, A. Carter, C. Hanson, G. Howald, B. Keitt, J. Sheppard, K. Swinnerton, B. Tershy, and A. Wegmann. Island Conservation: 15 years of preventing extinctions by eradicating invasive vertebrates from islands.
- 3:30 **Hess, Steven C.** and J. D. Jacobi. The history of mammal eradications on United States associated islands of the Central Pacific.
- 3:55 **Keitt, Bradford;** K. Campbell, A. Saunders, M. Clout, Y. Wang, and B. Tershy. A global review of vertebrate eradications on islands.
- 4:20 **Priddel, David;** N. Carlile, I. Wilkinson, and R. Wheeler. The eradication of exotic mammals from three coastal islands in New South Wales, Australia.
- 4:45 **Campbell, Karl J.;** C. C. Hanson, D. Algar, B. S. Keitt, S. Robinson, G. A. Harper, and B. Wood. Updated review of feral cat eradications on islands.

Lecture Theatre 732

Friday 12 February

Theme: Finding the last or first

Chair: John Parkes

- 8:30 **McMurtrie, Peter G.**; K-A.Edge, D. Crouchley, D. Gleeson, M. J. Willans, and A. J. Veale. Eradication of feral stoats (*Mustela erminea*) from Secretary Island, New Zealand.
- 8:55 **Clayton, Richard I.**; D. Anderson, A. Byrom, K-A. Edge, P. M. McMurtrie, D. Gleeson, A. J. Veale, and N. Torr. Using genetic analyses and trapping data to model the probability of persistence of feral stoats (*Mustela erminea*) on Resolution Island, New Zealand.
- 9:20 **Crouchley, Dave**; G. Nugent, and K-A. Edge. Eradication of red deer (*Cervus elaphus*) from Anchor and Secretary Islands, Fiordland, New Zealand.
- 9:45 **Parkes, John**; D. Anderson and A. Woolnough. Eradication of European starlings from Western Australia: using the control data to inform eradication success and ongoing surveillance for immigrants
- 10:40 **Innes, John**; C. Watts, N. Fitzgerald, D. Thornburrow, B. Burns, J. Mackay, and C. Speedy. Unexpected behaviour of invader ship rats experimentally released behind a pest-proof fence.
- 11:05 **Maitland, Matt.** Tawharanui Open Sanctuary – detection and removal of pest incursions
- 11:30 **Miller, Steven**; R. Fewster, and J. Ritchie. DNA fingerprinting – a management tool for rat eradication.
- 11:55 **Parkes, John**; D. Anderson, and A. Johnston. Red foxes (*Vulpes vulpes*) in Tasmania: intercepting an incursion on a large island.

Chair: Mick Clout

- 1:20 **Closing address:** 2001 to 2010: Trends and future directions in the eradication of invasive species on islands. **Andrew Burbidge**, Department of Environment and Conservation, Western Australia Wildlife Research Centre.

Lecture Theatre 722

Friday 12 February

General Session: Rodents

Chair: Piero Genovesi

- 8:30 **Bell, Elizabeth**; P. Garner-Richards, K. Floyd, D. Boyle, B. Swann, R. Luxmoore, and A. Patterson. Canna Seabird Recovery Project: the eradication of brown rats (*Rattus norvegicus*) from the Isle of Canna, Inner Hebrides, Scotland.
- 8:55 **Buckelew, Stacey**; V. Byrd, G. Howald, and S. MacLean. Removing rats to restore seabirds in the Aleutian Islands, Alaska.
- 9:20 **Butler, David J.**; A. Tye, M. Wylie, and T. Tipamaa. Eradicating Pacific rats (*Rattus exulans*) from Nu'utele and Nu'ulua Islands, Samoa – the challenges of operating in the South Pacific.
- 9:45 **MacKay, Jamie**; E. Murphy, M. Hauber, J. Russell, D. Wilson, and M. Clout. A successful mouse eradication guided by site specific population data.
- 10:40 **Connor, Rhon A.** and K. Varnham. Of rats and birds: creating a seabirds' paradise on Dog Island, Anguilla.
- 11:05 **Witmer, Gary**. Eradication of invasive rodents on islands of the United States
- 11:30 **Shaw, Vivienne** and N. Torr, Eradicating rodents from Pomona and Rona Islands in Lake Manapouri.
- 11:55 **Samaniego-Herrera, Araceli**; M. Rodríguez Malagón, A. Aguirre Muñoz, R. González Gómez, F. Torres García, M. Latofski Robles, and F. Méndez Sánchez.. Rodent eradications on Mexican islands: advances and challenges.
- 1:20 Closing address relayed to this lecture theatre by closed circuit TV

POSTER PAPERS

- Abe, Shintaro.** Improvement of kill trap for mongoose eradication project on two islands in Japan
- Beachy, Jane R.;** S. Joe, S. Mosher, H. K. Kawelo, J. Rohrer, M. Keir, M. Burt, V. Costello, M. Mansker, and D. Sailer. Multi-threat control strategies for endangered species management on O'ahu army lands in Hawai'i
- Bergman, Carita M.** Island restoration on the Faraday-Ramsay Island group in Gwaii Haanas National Park Reserve and Haida Heritage Site, Haida Gwaii, Canada.
- Bodey, Thomas;** R. Kennerley, S. Bearhop, and R. A. McDonald. Population level impacts of localised ferret control: storing up problems for the future?
- Boudjelas, Souad;** J. Ritchie, B. Hughes, and K. Broome. The Pacific invasives initiative resource kit for planning rodent and cat eradication projects
- Broome, Keith;** P. Cromarty, A. Cox, R. Griffiths, P. McClelland, and C. Golding. The Island Eradication Advisory Group (IEAG) – a model of effective technical support for eradication project planning and management
- Eason, Charles T.;** S. C. Ogilvie, L. Shapiro, S. Hix, D. MacMorran, and E. C. Murphy. Toxins, baits and delivery systems for island use
- Faulkner, Kate R.** and C. C. Kessler. Live removal of feral sheep from Eastern Santa Cruz Island, California
- Fisher, Robert.** Considering Reptiles in Island Eradications in the Tropical Pacific
- Fukasawa, Keita;** S. Abe, and T. Hashimoto. Estimating spatio-temporal change in population size of an invasive species from capture records: application for the mongoose eradication project in Amami Island, Japan
- Ikeda, Tohru;** G. Abe, and K. Ueda. Establishing the raccoon control system and its issues in Hokkaido, Japan
- Ishida, Ken.** Mongoose, rat and acorn - forest dynamics and ecosystem management on Amami Island, Japan
- Johnson, Brent** and K. Morris. Eradication of exotic rodents off six high conservation value Western Australian islands
- Lardner, Bjorn;** J. A. Savidge, G. H. Rodda, R. N. Reed, A. A. Yackel Adams, and C. S. Clark. Effectiveness of bait tubes for brown treesnake control on Guam
- Malmierca, Laura;** M. F. Menvielle, D. Ramadori, B. Saavedra, A. Saunders, A. Schiavini, and N. Soto Volkart. Eradication of an international engineer: a threat to southern South American ecosystems
- Marambe, Buddhi;** J. Gunawardena, S. Wijesundara, P. Silva, S. Ranwala, D. Weerakoon, L. Manawadu, and N. Atapattu. An analysis of the legal and policy environment in Sri Lanka to control invasive alien species
- Masters, P.; N. Markopoulos, B. Florance, and **Elaine Murphy.** Goat eradication on Kangaroo Island, South Australia
- Morrison, Scott A.;** K. R. Faulkner, L. A. Vermeer, L. Lozier, and M. R. Shaw. The essential non-science of eradication on islands: creating conditions for success
- Mosher, S. M.; **Darren Peters,** L. Wilson, J. L. Rohrer, and A. Shiels. Control of the invasive black rat (*Rattus rattus*) and Pacific rat (*Rattus exulans*) using a large scale trapping grid for endangered tree snail and plant conservation in Hawaii.
- Murphy, Stuart** and N. Johnson. Eradicating foxes from Phillip Island, Victoria: techniques used and ecological implications

- Nico, Leo G.;** C. R. Sevilla, J. López, H. L. Jelks, W. F. Loftus, and D. Chapman. Eradication of non-native tilapia from a natural crater lake in the Galapagos Archipelago, Ecuador
- Okamoto, Taku;** T. Kuriyama, M. Hasegawa, T. Hikida, and K. Goka. A newly recorded alien population of a lizard *Plestiodon japonicus* in Hachijojima Island, central Japan
- Pierce, Ray** and T. Teroroko. Enhancing biosecurity at the Phoenix Islands, Kiribati
- Poncet, Sally;** D. Poncet, L. Poncet, D. Christie, and D. Brown. A decade of eradications in the Falkland Islands and South Georgia
- Ritchie, Jo** and R. Stevenson. Aerial baiting for rodent eradication programmes
- Sasaki, Shigeki** and H. Matsuda. Trap allocation strategy for the mongoose eradication project in Amami-Oshima Island, Japan
- Sasaki, Shigeki;** F. Yamada, T. Hashimoto, K. Fukasawa, J. Kobayashi, and S. Abe. An attempt of the surveillance sensitivity comparison in Amami-ohshima Island, Japan
- Savidge, Julie;** R. Reed, J. Stanford, G. Haddock, and A. Y. Adams. Canine detection of free-ranging brown treesnakes on Guam
- Seniloli, Elenoa;** T. Tuamoto, and S. Cranwell. Restoration of globally important seabird islands in Fiji by the removal of rats
- Silva, Pradeepa;** S. Ranwala, D. Weerakoon, B. Marambe, S. Wijesundara, L. Manawadu, N. Atapattu, J. Gunawardena, and M. Kurukulasuriya. Invasive alien fauna in Sri Lanka
- Stringer, Clare;** B. Summers, D. Christie, D. Brown, H. Otley, and N. Rendell. Improving “internal” biosecurity in the Falkland Islands: a pragmatic approach
- Swinnerton, Kirsty;** A. Wegmann, J. Helm, F. Ross, G. Howald, S. Buckelew, and B. Keitt. When failure is not an option: applying new tools to rodent eradication planning
- Tatsuzawa, Shirow;** Y. Suzuki, and K. Kobayashi. The community-based nutria control by traditional irrigation systems
- Thomas, Bruce;** K. Mouritsen, J. Kemp, and P. Dunlevy. Snap-trapping, a viable alternative to ground-based poison operations for eradication and/or control of rats in island and mainland situations
- Tominaga, Atsushi;** K. Goka, K. Suzuki, and K. Tamukai. The infection risk and pathogenicity of chytrid fungus *Batrachochytrium dendrobatidis* carried by the Japanese sword tailed newt
- Tye, Alan.** Coordination mechanisms for invasive species action in the Pacific
- VanderWerf, Eric A.** Rodent control is effective at reducing nest predation on the endangered Oahu elepaio but insufficient scale of management hinders long-term conservation
- Vincent, Karen** and S. Theobald. Dogs working for conservation
- Walsh, S. J. and **Leo G. Nico.** Risk analysis of potential freshwater nuisance fishes and other species associated with increased U.S. military presence in Guam and circum-Pacific islands
- Yamada, Fumio;** Y. Watari, S. Abe, S. Kubo, S. Nagumo, K. Funakoshi, and K. Ishida. Surveillance of mongoose and Amami rabbit by auto cameras during mongoose control programs in Amami-Oshima Island, Japan
- Young, Lindsay C.;** P. Sato, A. Jeffers-Fabro, C. Swenson, R. Kennedy, and D. G. Smith. Lessons learned from gaining political and community support of Hawai'i's first predator-proof fence at Ka'ena Point Natural Area Reserve

ABSTRACTS

The abstracts that follow are for all papers presented, both orally and as posters, at this conference.

They are listed in alphabetical order of the name of the presenter. This name is shown in bold type.

The address of the presenter is in the list of addresses of all conference participants at the back of this book. Addresses or affiliations of all authors will be included in the published papers and abstracts in the Proceedings of this conference.

Improvement of kill trap for mongoose eradication project on two islands in Japan

S. Abe

The small Indian mongoose (*Herpestes javanicus*) was settled in Okinawa Island (1,206km²) in 1910 and in Amami-oshima Island (712km²) in 1979. In 2000, national and prefectural government launched a mongoose control project on both islands. In 2005 the Invasive Alien Species Act was enforced in Japan and a ten year eradication programme launched. Fiscal year 2009 is our 10th year since 2000 and fifth year of this eradication project. Keep adequate trapping pressure is basically important but live trapping techniques are too labour intensive to use over large areas. We introduced kill traps since 2003 in Amami and since 2008 in Okinawa and increasing their numbers gradually. However, a species of endemic bird and two species of rat were captured as non-target species and the traps had been improved again and again. These two native rat species which inhabit both in Amami and Okinawa are also affected by mongoose introduction and their distribution range is reducing in the areas where density of the mongoose is high. Remodeled kill-trap enables us to avoid catching native birds unintentionally, but it is difficult to avoid catching these rats completely. Therefore kill-traps and live traps were separately used depend on the areas and the seasons where these rats inhabit or not. Recently, density of the mongoose is decreasing to a very low level and some of the native animals are recovering. While the native rats recover, the trapping area where we can use kill-traps becomes narrower. We need additional trap-design improvement or good lures for the mongoose and not for rats.

Eradications at the core of a comprehensive island conservation national approach in Mexico

A. Aguirre-Muñoz, F. Méndez-Sánchez, A. Ortiz-Alcaraz, A. Samaniego-Herrera, L. Luna-Mendoza, M. Rodríguez-Malagón, M. Félix-Lizárraga, R. González-Gómez, F. Torres-García, M. Latofski-Robles, J.C. Hernández-Montoya and J.M. Barredo-Barberena.

Invasive mammal eradications have been a key concept to restore Mexican islands during the last ten years. The trajectory to date includes 55 successful eradications on 31 islands. As a core activity, eradications became a critical mass out of which a wide movement to protect and restore Mexican islands with a comprehensive approach developed. The very tangible and concrete eradications' outcomes have been the main motivation and thrust to add partners and institutionally crystallize the various island conservation activities. So, beyond the ecological outcomes, eradications projects created a centrifuge movement that now permeates the most diverse actors and spheres related to islands in Mexico. A variety of federal government agencies, the Mexican Navy, academic institutes and universities, local communities, artisanal fishermen co-operatives, NGOs, and national and international donors have integrated a network that follows a focused collaboration approach. While in-site work gets the emphasis, legal advances to protect all of Mexican islands are taking place simultaneously. Soon all of Mexican islands will be legally protected under hard federal categories. Eradication norms and island conservation management programmes are being developed and implemented. Federal government permanent staffs are being recruited and activities are supported with federal budget. For the field work, a group of 20 specialized scientists and technicians, organized as an NGO, works closely together with government staffs. Matching funds from Mexican government are now available. While the emphasis on a National approach is clear, there are positive cases of international collaboration and exchange. Keeping the pace and consolidating the trajectory will allow the completion of a relevant strategic goal: to eradicate all invasive mammals from the 27 remaining Mexican islands by the year 2025.

Island restoration in Mexico: ecological outcomes after a decade of eradications of invasive mammals

A. Aguirre-Muñoz, L. Luna-Mendoza, A. Samaniego-Herrera, M. Félix-Lizárraga, A. Ortiz-Alcaraz, M. Rodríguez-Malagón, F. Méndez-Sánchez, R. González-Gómez, F. Torres-García, M. Latofski-Robles, J.C. Hernández-Montoya, J.M. Barredo-Barberena, M.A. Hermosillo-Bueno, N. Silva-Estudillo, and E. Soqui-Gómez

Invasive mammals have caused the extinction and extirpation of island-endemics worldwide. In Mexican islands, 20 insular vertebrates have become extinct. To prevent more extinctions, 55 populations of 12 invasive mammals were eradicated from 31 Mexican islands. 147 endemic taxa - 23 mammals, 34 reptiles, 21 birds, and 69 plants - as well as 227 bird breeding colonies were protected. A surface of 51,208 hectares was restored, which represents 10 per cent of Mexico's island territory. Techniques have ranged from the traditional - trapping and ground hunting - to the most sophisticated - aerial hunting, aerial broadcast of bait, DGPS and GIS use. These conservation actions are of high significance for Mexico. Ecological outcomes are extraordinary. Regarding seabirds, recolonization and increase of reproductive success on several islands has been recorded. An ongoing seabird social attraction project at some islands is taking place; results are encouraging. On Guadalupe Island, after the goat eradication, recruitment of arboreal endemics increased from zero to more than 130,000 individuals. Also, six native plants, including one endemic, the Guadalupe mint were rediscovered. Socio-economic outcomes are also present at inhabited islands such as Guadalupe and Isabel, where eradications improved - together with other conservation actions - the quality of life of local communities. As years goes by, ecologic and socio-economic benefits from island restoration through eradications will increase. Following such a trajectory, eradicating all vertebrates from the remaining 27 Mexican islands with 63 populations of invasive mammals is a viable and strategic goal, achievable by 2025, that will set a benchmark.

A pilot study for the proposed eradication of feral cats on Dirk Hartog Island, Western Australia

D. Algar, M. Johnston, and S. Hilmer

A plan for the eradication of the feral cat population on Dirk Hartog Island is currently in preparation. Dirk Hartog Island lies in the Shark Bay World Heritage Property and is the largest island off the Western Australian coast at 62,000 ha. The island formerly supported at least 13 species of native mammal of which only three species still persist. Since the 1860s Dirk Hartog Island has been managed as a pastoral lease. Feral cats became established on the island during the late 19th century and were probably introduced by early pastoralists. The island has recently become available to the Western Australian government as conservation estate. It will provide the opportunity to reconstruct the native mammal fauna of this island, only following successful eradication of feral cats.

A small-scale, 25,000 ha, pilot study was conducted on the island to assess the efficacy of the current aerial baiting strategy, being the primary control technique to be used in an eradication campaign. A trapping program was conducted to enable GPS datalogger radio-collars to be fitted to cats for collecting information on daily movements and home range patterns to determine detection probabilities and to validate the proposed spacing of the monitoring track network for the eradication program. Baiting efficiency was determined from the percentage of radio-collared cats found dead following the baiting program. Data was collected from 15 radio-collared cats of which 12 (80%) consumed a toxic bait. Pre- and post-baiting surveys of cat activity were also conducted to record indices of relative abundance at sand plots and along continuous track transects. Significant reductions, of similar magnitude as radio-collar returns, in these indices occurred post-baiting. Information collected in this pilot study has provided a number of avenues to further improve control effectiveness and also given confidence that eradication can be successfully achieved.

Return of endemic plant populations following feral goat eradication on Trindade Island, Brazil.

Ruy J. Valka Alves, N. G. da Silva, and A. Aguirre-Muñoz

Trindade (Lat. 20° 30' S, Long. 29° 20' W, 10.0 km²) is a Brazilian oceanic archipelago of volcanic origin, roughly 1200km east of Vitória, the coastal capital of the State of Espírito Santo. The main Island bears expressive terrestrial vegetation and many sea birds, among which several are endemic species. Trindade harbors ca. 130 species of vascular plants (ten endemic). Among the arthropods, the ever present land crab *Gecarcinus lagostoma* Milne-Edwards, 1835 (also native to St. Helena) is the most frequent. Since the early 1700s, the forests which used to cover 85% of Trindade gradually dwindled to less than 5%, largely due to devastation by feral goats, pigs, sheep, cats and mice. This meant less nesting opportunities, especially for the two endemic subspecies of frigates. From 1965 to 1995 about 800 goats and a large mouse population remained, preventing the regeneration of vegetation. The eradication of goats (1996–2004) resulted in rapid vegetation recovery of barren areas and revived seed-bank populations of two endemic plant species previously considered extinct. The present conservation status of all endemic plant species and seabirds of Trindade Island is presented in historic perspective, with a discussion of future interventions.

Potential operational evolution in pest eradication through use of self-resetting trap

S. Barr, C. Bond, and R. Greig

Eradication and management of stoats (*Mustela ermina*) and rats (*Rattus rattus* and *norwegicus*) is of vital importance to biosecurity in New Zealand. Kill trap operations have proven the ability to eradicate and control populations sufficient for protection of native species but require intensive and continued maintenance and expense. Goodnature and the Department of Conservation collaborated to develop a self resetting trap for Stoats and rats to exceed the annual performance of current trap schedules with no human intervention, be lightweight, durable and user friendly. Development and testing was completed in June 2009 resulting in a new control tool which kills, clears and resets twelve times before requiring human intervention. This development allows entire control networks to achieve a 'knockdown period' and then remain 100% available to pest predators, dramatically reducing labour required in operation set up and maintenance. It is speculated that this new tool will lead to new operational strategies allowing eradication and management of rats and stoats in significantly larger areas.

A review of the small Indian mongoose management and eradications on islands

A. Barun, K.C. Campbell, C.C. Hanson, and D. Simberloff

The small Indian mongoose (*Herpestes auropunctatus*) has been touted as one of the world's 100 worst invasive species. It is a generalist feeder blamed for the decline and extirpations of many native vertebrate species on islands. It is native to Asia and was introduced to over 75 islands (Pacific and Indian Oceans, Caribbean and Mediterranean Seas) and mainland (Europe and South America). Most introductions were in the late 19th and early 20th century to control rats in sugar cane fields, but also to control poisonous snakes. There are very few recent mongoose introductions but still the risk of either intentional or accidental spread to other islands is enormous and most island taxa are highly susceptible to novel predators such as the mongoose. The mongoose has been eradicated from a couple of very small islands (Fajou and Praslin) using trapping techniques, but in general it has been challenging to eradicate it and attempts to do so have been very few. By contrast, the attempts to manage the mongoose were numerous in the past and many are currently under way using trapping and/or poisoning. New techniques are being developed but with limited success. We have identified several small islands where the mongoose can be eradicated with current approaches with a great benefit to endemic species or with the aim to prevent further introductions. New and more efficient techniques are urgently needed for the successful eradications on larger islands and to prevent further spread on the European and South American mainlands.

Introduced rodent eradication to restore island ecosystems and protect tropical Pacific seabird breeding grounds: the importance of baseline biological surveys and feasibility studies

J. Baudat-Franceschi, S. Cranwell, P. Cromarty, C. Golding, J. Le Breton, J.P. Butin, and S. Boudjelas

Eradication of introduced rodents from islands is an important conservation tool for restoration of island ecosystems and protection of tropical Pacific seabird breeding grounds. Sites are often remote or are used by local communities. In addition many tropical Pacific islands and their biota have not been previously studied nor has pest management to protect native biota been carried out as compared with islands in temperate developed countries. Our two years work in northern New Caledonia provides such an example. This paper emphasises the key roles of initial site assessment (in order to fill gaps in both biological and social data) and carrying out a feasibility study in the eradication planning process. We describe first how biological surveys, gathering information from key stakeholders (including local indigenous (Kanak) communities) and the feasibility study have allowed us to decide if eradication was the appropriate strategy (was it worth doing and what might be involved) and then to develop the method for eradication that fit the local context. It includes confirming the presence of rodents and identification of the rodent species using trapping, non target species assessment and biological surveys. Then we show how social acceptance has been achieved through consultation and information sharing with key stakeholders and the participation of local community members in field work. Finally, we present the method for eradication that has been applied in the field. We will discuss the benefits of using an approach that combines consultation and involvement of local communities and a sound scientific and technical methodology. This work has highlighted the benefits of support to local project managers to build their capacity for planning and carrying pest eradication projects.

***Eleutherodactylus coqui* control on O‘ahu: successful eradication of an incipient amphibian**

J.R. Beachy, R. Neville, and C. Arnott

A much beloved icon of Puerto Rico, native across the Caribbean, the coquí frog (*Eleutherodactylus coqui*) has quickly proliferated across the Hawaiian islands. *E. coqui* was reported in Hawai‘i as early as 1988. Since then it has jumped between islands via intra-state shipping of goods, particularly commercial plant sales. It is now firmly established on the Big Island and is the subject of early detection, eradication and control activities on O‘ahu, Kaua‘i, Maui and Moloka‘i. Hawai‘i provides an ideal home for coquí; all the benefits of its tropical native range and none of its natural predators. Predictably, the coquí thrived. Large populations threaten native arthropods, provide a ready food source for the highly invasive brown tree snake (as yet un-established in Hawaii), and pose serious problems for the tourism and real estate industries. On O‘ahu, coquí distribution is sparse; only one naturalized population was documented, in the town of Wahiawā, between a military base and a residential neighborhood. A multiagency coordinated response resulted in successful eradication. The agencies involved include the O‘ahu Invasive Species Committee, the Hawai‘i State Department of Agriculture, the Department of Land and Natural Resources, and the U.S. Army Garrison Hawai‘i, collectively known as the Coquí Frog Working Group (CWG). Four elements were essential to success: 1) a control method permitted by federal regulatory agencies was known and available; 2) control crews were allowed complete access; 3) adequate funding for the operation remained constant; and 4) the population was relatively small. After close to a decade of work, the Wahiawa population was extirpated using a combination of nighttime citric acid vegetation sprays, daytime citric acid ground drenches, and nighttime monitoring. This is the first such extirpation documented in the State. The CWG is currently focused on early detection/control across O‘ahu to prevent establishment of new coquí populations.

Multi-threat control strategies for endangered species management on O‘ahu army lands in Hawai‘i

J.R. Beachy, S. Joe, S. Mosher, H.K. Kawelo, J. Rohrer, M. Keir, M. Burt, V. Costello, M. Mansker, and D. Sailer

The U.S. Army Garrison Hawai‘i is required to manage 67 endangered taxa, including 51 plants, nine tree snails, one bird species, and potentially six picturewing flies on the island of O‘ahu, Hawai‘i. These species occupy fragmented, disturbed habitat and face multiple threats. The O‘ahu Army Natural Resources Program (OANRP) manages these species across 56 geographically defined Management Units (MUs). Located on the rim of Makua Valley, the Kahanahāiki MU encompasses 90 acres of mixed native/invasive mesic forest and is home to one tree snail species and both wild and reintroduced populations of 10 endangered plant taxa, including *Cyanea superba* ssp. *superba*, which was extirpated from the wild in 2003. Threats include feral pigs, black and Polynesian rats, mice, weeds, snails, slugs, and arthropods. The goal of threat control is to restore habitat in the MU such that endangered taxa thrive and maintain viable, stable populations. Multiple threats must be controlled simultaneously to achieve this goal. Feral ungulates were successfully excluded from the area in 1997 via fencing and snaring. A large snap trap grid, installed in early 2009, maintains low numbers of rodents. Weeds are primarily managed around rare taxa, although more aggressive restoration projects seek to create more continuous native forest. Both incipient and established weeds are controlled. Invasive slugs, predators of native seedlings, are controlled using a natural product containing iron phosphate. Native tree snails are protected from the carnivorous snail *Euglandina rosea* via multiple barrier (salt, electricity, overhang) exclosures. Experiments to detect *E. rosea* using dogs are ongoing. Ant surveys allowed for the detection and eradication of an incipient population of *Solenopsis geminata*. Black twig borer traps are deployed around endangered trees. Rare taxa are responding to these efforts; in 2009, wild seedlings of *C. superba* were documented for the first time in over 30 years.

Control and eradication of weeds from Motuopao Island, Northland, New Zealand

A. Beauchamp and E. Ward

Motuopao Island (30 ha), on the north western tip of the North Island, New Zealand, comprises 118 m basaltic stacks covered in sand. It holds substantial breeding populations of Black-winged petrel (*Pterodroma nigripennis*) and common diving petrel (*Pelecanoides urinatrix*). The island was a manned lighthouse station between 1879 and 1941 and was grazed by cattle and sheep. In 1989 the Department of Conservation eradicated kiore (*Rattus exulans*) and in 1997 it commenced control of Madeira vine (*Anredera cordifolia*), smilax (*Asparagus asparagoides*) and *Watsonia bulbifera*, pulling wallflower (*Cheiranthus cheiri*), and cutting and pulling tree mallow (*Lavatera arborea*). Annual control was not reducing weeds, and since 2005 two visits have been undertaken during April/May and October. Removal rates in the remaining 0.5 ha grided area of Madeira vine have declined from 1.25 kg h⁻¹ in Nov 2006 to 0.66 kg h⁻¹ in April 2009, as the site has been brought under control. Smilax has been recorded within 5.5 ha, and the amount removed has fallen from 5.5 kg per site in Nov 2005 to 0.36 kg per site in April 2009 as older plants and then seedlings have been removed. Tree mallow has been controlled over the accessible regions to prevent seeding, and the two former canopied areas have reverted to grassland. *Watsonia* and wallflower are near eradication.

Canna Seabird Recovery Project: the eradication of brown rats (*Rattus norvegicus*) from the Isle of Canna, Inner Hebrides, Scotland

E. Bell, P. Garner-Richards, K. Floyd, D. Boyle, R. Swann, R. Luxmoore, and A. Patterson.

Monitoring of the seabirds (in particular shags, *Phalacrocorax aristotelis* and manx shearwater, *Puffinus puffinus*) on the Isle of Canna by the Highland Ringing Group had detected declining population levels for several years. In addition to other factors, brown rats (*Rattus norvegicus*) were identified as influencing this decline. The Canna Seabird Recovery Project, which was developed as a result of this information, was a three year project incorporating a brown rat eradication (Phase I) followed by long-term monitoring and quarantine and contingency for rats (Phase II) and long-term monitoring of the seabird populations (Phase III). The National Trust for Scotland contracted Wildlife Management International Limited to direct the first and second phases of the project, with the assistance of NTS volunteers.

This talk outlines the eradication and monitoring phases of the project undertaken between August 2005 and March 2008. All aspects of the operation including techniques, problems, solutions and results will be covered. Over 4200 bait stations were established on a fifty to one hundred metre grid over the island (including rock stacks and steep cliffs). Cereal-based wax blocks (active ingredient diphacinone at 0.005% w/w) were used. Rats consumed over 500 kg of bait throughout the poisoning operation. It appeared that the rat population was lower than suggested by earlier studies, but their distribution on coastal slopes would have been having a significant impact on the seabird populations present on Canna. Some offshore islets harboured rats, although the more sheer stacks did not. Interference of bait stations by non-target species was moderate to high, and bait stations required extra strengthening to exclude cows, ponies, sheep, rabbits and hooded crows.

Canna was declared rat-free in June 2008. The complete removal of rats from the island is major achievement and will provide the opportunity to restore the seabird communities of the island.

Island restoration on the Faraday-Ramsay Island group in Gwaii Haanas National Park Reserve and Haida Heritage Site, Haida Gwaii, Canada

C. M. Bergman

Gwaii Haanas National Park Reserve and Haida Heritage Site is a large protected area jointly managed by the Council of the Haida Nation and Parks Canada Agency. It is located in the southern region of Haida Gwaii, a remote off-shore archipelago of over 150 islands (~1 million hectares) in the Pacific Northwest of Canada. The Gwaii Haanas management plan and State of the Protected Area reports identify introduced species (deer, elk, rats, beavers, muskrats, raccoons, red squirrels, house mice, amphibians, birds and many species of invasive plants) as the biggest threat to the ecological integrity of Gwaii Haanas. Many introduced species in Gwaii Haanas are widespread throughout the archipelago; however, some island groups have been less impacted because of their relative isolation and limited human use history. Under our mandate to protect and present examples of our natural heritage, the priority to restore these islands is high. The island group extending from Faraday Island to Ramsay Island contains only three species of introduced vertebrates (Black and Norway rats, and Sitka black-tailed deer) in addition to an unknown number of introduced plants occurring at low density along island margins; it is thus an excellent candidate for complete eradication of introduced species. Our *Night Birds Returning* project endeavours to eradicate introduced rats from seabird nesting islands in this group, while exploring the long-term ecosystem impacts of rat removal, including both direct and indirect impacts to the terrestrial and intertidal areas surrounding these islands. Building on the work of other successful projects, this work is proposed in two stages, starting with a smaller chain of islands (100 ha) to build capacity and community support. Long term plans are under consideration to target deer removal, but logistical difficulties present many challenges. A small scale experimental project to eradicate one invasive plant species is underway, while a larger framework to guide the control and eradication of all introduced plants is being developed.

Population level impacts of localised ferret control: storing up problems for the future?

T.W. Bodey, R. Kennerley, S. Bearhop, and R. A McDonald

Eradication of introduced mammalian predators is not always an immediately feasible option because of logistical, financial and social constraints. Thus, in many cases, lethal control is carried out only around key sites, often with little study of the population level impacts on the controlled species. We studied the behavioural ecology and population dynamics of feral ferrets *Mustela furo* on Rathlin Island, UK both pre- and post-control, to examine the effects on the entire island population. Prior to control, over-winter ferret densities were relatively low but animals maintained large home range overlaps and were often found in close associations with other individuals. Control was then carried out in limited blocks to mimic protection of important areas for breeding ground-nesting birds. This was highly effective in reducing ferret numbers, with no immigration detected prior to juvenile dispersal. However, the population was found to have substantially increased in the winter following control, remaining high throughout, facilitated by the lack of territoriality. Our study thus suggests limited removal may be counter-productive, and demonstrates how apparently effective control can actually exacerbate the situation in subsequent seasons. This paradox merits further consideration as it may also act for other flexible species, particularly if defining resources such as shelter or food are not limiting.

Using stable isotope analysis to inform control – revealing responses of American mink *Neovison vison* to an eradication campaign

T.W. Bodey, S. Bearhop, S. Roy, J. Newton, and R.A. McDonald

Stable isotope analysis (SIA) is an increasingly widely used technique to help answer a range of ecological questions. While SIA has been utilised to demonstrate the threat posed by invasive species, we show how such information can also be used to evaluate and refine ongoing management actions from even an early stage in an eradication attempt. We utilised SIA of American mink *Neovison vison* carcasses sampled from the first stage of the Hebridean Mink Project eradication effort to describe ecological variation in this exotic predator. Isotope profiles from individual mink demonstrated how behaviour at the population level changed as the eradication campaign progressed, revealing key areas for targeted trapping with an increasing reliance on marine resources and with activity focussed along the coastline. Our results also revealed variation in foraging and ranging behaviour in relation to food availability on the two main island complexes. These findings have contributed to the refinement of the campaign to extend the eradication of mink to the rest of the archipelago. They highlight the potential for stable isotope approaches to rapidly and simply provide detailed information, demonstrating that this technique can be used to facilitate adaptive management of wildlife populations for both eradication and conservation objectives.

Use of heli-baiting to control invasive yellow crazy ants (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean

C.R.J. Boland and M. Smith

Exotic yellow crazy ants (*Anoplolepis gracilipes*) invaded Christmas Island, Indian Ocean, sometime between 1914 and 1935. The species remained in extremely low numbers on the island until the late 1990s when a mosaic of incredibly high-density ‘supercolonies’ began to form across Christmas Island. By 2002, more than 2500 hectares (25%) of the island was covered in supercolonies containing over 20 million ants per hectare. High densities of yellow crazy ants cause the extirpation of keystone red land crabs (*Gecarcoidea natalis*), which in turn dramatically alters the forest ecosystem at three

trophic levels. Supercolonies have the capacity to expand at up to 3 m per day around their entire perimeter, meaning that control is vital. In September-October 2009, a helicopter was used to deliver granular ant bait (active ingredient: Fipronil® at 0.01 g / kg mixed in fishmeal/cornmeal matrix at 4 kg / ha) to over 1000 ha of supercolonies. This paper describes the methodology used throughout the baiting campaign, including monitoring of potential impacts on native species, and provides details of the effectiveness of the program in terms of controlling crazy ant supercolonies.

Cat impact and management on two Mediterranean sister islands: “the French conservation touch”

E. Bonnaud, K. Bourgeois, D. Zarzoso-Lacoste, and E. Vidal

Feral cat, *Felis catus*, is one of the most ubiquitous and damaging introduced species for native island species worldwide. While cat control or eradication is handled with increasing efficiency on uninhabited islands, the strong bond with humans, regardless of ownership, renders such conservation programs especially thorny on inhabited islands. We conducted here a cat-removal program on an island where both the human presence and the threat on the *Puffinus yelkouan*, an endangered Mediterranean endemic species of burrowing petrel, are very important. The two largest French breeding colonies of this procellariid are located on the two studied islands: Port-Cros and Le Levant islands. While the cat-removal program is implemented on Port-Cros, the second, nearby island is used as a comparison. During two consecutive years cat diet was studied through scat analysis according to the shearwater breeding cycle. Cats were shown to be responsible for the extirpation of 162 ± 46 and 21 ± 4 shearwaters per cat and per year on Le Levant and Port-Cros Islands respectively. Bird breeding parameters were monitored during seven consecutive years on Port-Cros Island (four before and three after cat removal) and during three years on Le Levant Island. We evaluated that the strong cat impact on the yelkouan shearwaters was sufficient to threaten the entire population on the long term and justified cat removal. Finally, we designed a conservation management plan on Port-Cros Island taking into account the specificity of human presence: feral cats were live-trapped and a few owned domestic cats were sterilized. Following this two-year campaign, no more sign of cat predation on the shearwaters was observed, followed by an increase in the shearwater breeding population. Thus, protecting seabirds from cat predation is possible, even on islands where inhabitants are notoriously reticent to any sort of cat removal program.

The Pacific Invasives Initiative Resource Kit for planning rodent and cat eradication projects

S. Boudjelas, J. Ritchie, B. Hughes, and K. Broome

Successful removal of invasive species, such as rodents and cats, from islands requires comprehensive planning. Through its extensive capacity building work with project partners in the Pacific, the Pacific Invasives Initiative (PII) has identified the need for information resources to assist Pacific practitioners in carrying out their invasive species eradication projects. Currently, project managers often do not know where to access relevant information and/or gather information from a variety of sources which can be very time consuming. In response to this, PII is currently a Resource Kit for Planning Rodent and Cat Eradication Projects. The resource kit will act as a “one stop shop” and will comprise of the PII Development and Implementation Planning Process and all essential supporting tools. The resource kit will provide access to a range of information sources including current knowledge and best practice. While the focus of the resource kit is the Pacific, many of the tools can be readily adapted to other island projects, making it a global capacity building tool. This paper describes the Planning Process and how the resource kit tools will be used to increase the effectiveness of invasive species eradication projects.

The eradication of rats and hedgehogs, and maintenance control of mustelids from Quail Island, Canterbury, New Zealand

M. Bowie, J. Ross, and M. Kavermann

Quail Island (85 ha) in Lyttelton Harbour, Banks Peninsula, Canterbury is being ecologically restored. Since 1997 eradication of predatory mammalian pests (cats, rabbits, rodents, mustelids and hedgehogs) from Quail Island (Otamahua) has been undertaken to allow the future reintroductions of native species. Cats were shot and rabbits poisoned using pindone. A combination of live trapping, kill trapping using Fenn traps, and night searches were used for hedgehogs, rats and mustelids. In trap boxes on Quail Island, male ship rats (*Rattus rattus*) made up 70% of the rat catch. A ground-based poison operation was also undertaken using Talon (brodifacoum) to eradicate rodents. In August 2002, 555 bait stations (yellow pestoff and black novacoil) were placed at 40 m intervals covering Quail Island in a grid formation. Stations containing Talon (brodifacoum) rodent baits that were regularly monitored for bait take and were topped up when required. Bait-take by rodents was significantly higher from the black novacoil bait stations, and bait stations from scrubland habitats on Quail Island. Rats have been successfully eradicated but mice have increased in numbers in the absence of larger mammalian predators. A total of 59 hedgehogs were captured over three years, with exotic grassland being the dominant habitat. Almost half of the hedgehogs (23) were caught on or near walking tracks. The last hedgehog was trapped on 27th October 2003 and no hedgehog sign have been observed or hedgehogs trapped since then, indicating they have been eradicated. Since the establishment of interception traps on the mainland and King Billy Island only six mustelids have been trapped on Quail Island with Fenn traps, however 50 (89%) have been trapped before getting to the island. Fauna including white-flipped penguins have increased significantly in numbers since the eradications.

Introduced land snails and slugs in Fiji: are there risks involved?

G. D. Brodie and G. Barker

Fiji's land snail fauna is unique, highly diverse and currently not well documented for identification purposes. Over 230 species are present of which, ~ 90% are native, ~78% are endemic to the archipelago, and up to 22 species are introduced aliens. To date information to allow easy identification of these species is lacking at a local level, as is related information about the risks involved with the introduced species particularly in respect to trade, crop production or human and livestock health. To address this information gap, existing and new data on Fiji's introduced land snail and slug fauna is currently being collated. This information is urgently required to; detect and manage introduced and potentially invasive species, and if possible to prevent their spread to non-infected islands. In addition, case studies from other Pacific Island countries show substantial endemic land snail biodiversity loss, particularly from high profile invasive snail species that are not yet present in Fiji. Except for one of these latter species, the Giant African snail *Achatina fulica*, the Fiji government authorities have little information with which to adequately monitor or manage any of the current introduced land snail or slug species. That is they have no baseline reference material that allows them to quickly and accurately identify, and learn the biology of, even the most common introduced snails. If not addressed this lack of information may have major long-term implications for agriculture, quarantine, trade and human health issues because even the alien species already introduced to Fiji are spreading unacknowledged despite the fact that several of them are known disease vectors and agricultural pests in overseas countries. This project is designed to provide direct snail and slug identification assistance to government units, such as the agriculture, quarantine, forestry and environment, and in turn provide a solid platform on which to build a stronger understanding of how introduced snail and slug species may be impacting on trade, agricultural production and human & livestock health in the Fiji Islands.

The Island Eradication Advisory Group (IEAG) – A model of effective technical support for eradication project planning and management.

K. Broome, P. Cromarty, A. Cox, R. Griffiths, P. McClelland, and C. Golding

The IEAG is a small group of New Zealand Department of Conservation (DOC) staff who represent the best island eradication experience available within DOC. Set up in 1997 capture existing knowledge and expertise and provide technical advice to up and coming DOC projects, the role has diversified into six key areas. These are technical support for eradication projects and island biosecurity; evaluation of best practice for pest eradication; building capability within DOC for pest eradication work; advice on national priorities for island eradication projects; and international networking to maintain DOC's knowledge base by participating in the exploration and resolution of island eradication issues worldwide. Key elements to the success of the group are: a strong customer focus to meet the needs of the project manager; clear separation between advice and decision making; a team approach to each project; and effective communication. The group meets three times per year, usually in February, May and October. These meetings involve discussion and problem solving with project managers and are followed up by written advice agreed at the meeting. The IEAG will respond to requests for advice at any time to meet the needs of project managers. Individual members will contribute to group discussion via email or conference call to provide a collective view. Many projects have the IEAG undertake pre-operational 'readiness checks' to identify outstanding issues that need to be addressed before implementation. Examples of projects involving IEAG are presented. Key elements in the success of IEAG advice are: robust debate and review involving the IEAG and the project managers; making the most of collective knowledge; challenging assumptions and growing project managers' experience. We think this approach can be adapted to be useful in other parts of the world.

Removing rats to restore seabirds in the Aleutian Islands, Alaska

S. Buckelew, V. Byrd, G. Howald, and S. MacLean

Increasingly, introduced predators are being removed from islands to aid in the restoration of native ecosystems. Introduced rats are a key species for eradication given their proliferation on islands and their impacts on native flora and fauna, including seabirds. The Aleutian Islands, including many of the islands in Alaska Maritime National Wildlife Refuge, are among the most productive seabird breeding areas in North America, providing habitat for 26 species of seabirds numbering >10 million individuals. Norway rats (*Rattus norvegicus*) have been introduced to several islands in the Aleutians, and are known to affect seabirds. The US Fish and Wildlife Service partnered with The Nature Conservancy and Island Conservation to restore seabird breeding habitat on Rat Island (2,900 ha) by removing introduced rats. In late September 2008, cereal grain pellets containing 25-ppm brodifacoum (Bell Laboratories, Madison, WI) were aerially broadcast in two applications, following standard techniques for rodenticide delivery on large islands. This effort represents the first rat eradication in Alaska, where the remote location and potentially adverse weather present considerable operational challenges. During a reconnaissance visit 9 months post-treatment no signs of rats were detected. Early suggestions of positive ecosystem response were documented, including notable breeding records of shorebirds and seabirds. However, numerous bird carcasses, including Glaucous-winged Gulls and Bald Eagles, were also documented. Most of the gull and eagle mortalities resulted from the bait application. Post-eradication eagle populations were lower as a result. Nevertheless, the local impact is anticipated to have been temporary. Monitoring on the island will continue for 5 years to evaluate ecosystem recovery following rat removal. This project builds upon a long history of successful removal of introduced arctic fox from islands in the Aleutians, including Rat Island. Removal of rats will make the island completely free of introduced predators, facilitating habitat restoration for native species.

Eradication of feral goats *Capra hircus* from Makua Military Reservation, Oahu, Hawaii

M.D. Burt and J. Jokiel

To stem the destruction from and restore the natural habitat in Makua Military Reservation (MMR), the Oahu Army Natural Resource Program (OANRP) conducted a feral goat (*Capra hircus*) eradication project from December 1995 through July 2004. From December 1995 through February 1997, ground hunts were utilized with contract hunters from the U. S. Department of Agriculture Wildlife Services while plans for a fence to enclose MMR were finalized. In 1996-1997, the first stretch of fencing (2 km) separating MMR from a public hunting area was completed by the National Park Service and ~8 km of fencing was erected around the eastern perimeter of the valley. Contract and staff ground hunts continued from 1997-1999 to control the numbers of goats while another 3.5 km of fence was erected connecting the 2 km portion to the ocean. In 1999, OANRP staff began to employ snares as another management tool. In 2000, the last portion of the fence was completed separating the valley from the core populations of goats to the south. At this point, OANRP staff employed aerial shooting and “Judas goats” to remove the remaining individuals from the valley. By July 2004, the last goat was eradicated from MMR with a total of 1, 747 goats eliminated. Several different management methods were employed during the eradication’s effort with varying degrees of success; however, the combination of all techniques, was what made the eradication successful.

The use of volunteer hunting as a control method for feral pig populations on Oahu, Hawaii

M.D. Burt, C. Miller, and D. Souza

Staff with the U.S. Army’s Oahu Natural Resources Program (OANRP) and the State of Hawaii Department of Land and Natural Resources Division Natural Areas Reserve System (NARS) initiated eradication efforts within fenced management units using volunteer hunters with hunting dogs and a staff escort. This method has been successful at removing a large percentage of the animals trapped within the fenced management units. Even more importantly, this control method bridges the gap between the public hunting community and native ecosystem conservation programs by building a rapport and educating the hunting community to the biological resources and restoration work that the agencies are trying to accomplish. This valuable outreach may reduce potential conflict and vandalism in addition can result in new conservation partnerships. Since 1997, about 1,700 acres of endangered species habitat in 17 management units has been fenced on Oahu. These fenced units range in size from 23 to 400 acres, representing a variety of different habitats. Pigs have been eliminated from 3 units (229 acres) and reduced to low densities in two units (596 acres) using this method in combination with trapping. In one of the units with low densities, hunting has ceased and a snaring/trapping program has been initiated to remove the last remaining animals. The last unit with active hunting will eventually move to a snaring/trapping program, once catch has dropped to zero for a period of 3 hunts. Planning for each hunt utilizes information gathered from various aspects of the program to ensure strategic and systematic coverage. Results of scouting, fence inspections, game cameras, and GPS dog collar tracks from previous hunts are considered in planning hunt strategy. Once all the pigs are eliminated from a fenced unit, activity transects and fence inspections are conducted quarterly to insure no further ingress.

Eradicating Pacific rats (*Rattus exulans*) from Nu’utele and Nu’ulua Islands, Samoa – the challenges of operating in the South Pacific.

D.J. Butler, A. Tye, M. Wylie, and T. Tipamaa

The restoration of the small offshore islands of Nu’utele (108ha) and Nu’ulua (25ha) has long been identified as a priority for biodiversity conservation in Samoa. The first stage, an operation to eradicate Pacific rats (*Rattus exulans*) from Samoa by aerial spreading of brodifacoum was carried out in

August 2009. Procedures followed those of similar operations in New Zealand and involved experts from that country. Particular challenges faced included a tight operational time-frame, technical problems magnified by the remote location, variable reliability of weather forecasting, working with the local community, and protecting a threatened bird, the Friendly Ground Dove (*Gallicolumba stairii*). Solutions to these challenges are discussed which may help guide similar projects in remote island locations. Preliminary results of follow-up monitoring of the success of the eradication and of outcomes for native fauna will also be presented, together with a discussion of biosecurity measures. The second and potentially more challenging stage will be the control of yellow crazy ants (*Anoplolepis gracilipes*).

Disperser communities and legacies of goat grazing determine forest succession on the remote Three Kings Islands, New Zealand

E.K. Cameron, P.J. Bellingham, S.K. Wiser, A.E. Wright, and L.J. Forester

Many remote islands are degraded as a result of deforestation and browsing of vegetation by introduced goats. Goat eradication is therefore a focus for island restoration but there are few long-term records of change on islands after eradications. Goats were eradicated from Great Island (Manawa Tawhi), 60 km from the northern tip of New Zealand, in 1946. Three permanent plots were established on the island, across a sequence of forest succession, immediately after goat eradication and provide a 57-year record of change. Over the first 17 years, tree diversity in plots increased because of the recruitment of palatable trees. Over the next 40 years, diversity remained similar and forests have been less dynamic. Unpalatable understorey sedges, present when goats were abundant, have persisted and may be impeding tree seedling establishment. Most woody plant species on the island are bird-dispersed. Non-native *Turdus* species are probably important dispersers of many of the small-seeded species. Large-seeded species were unable to germinate away from parents until the native pigeon *Hemiphaga novaeseelandiae* were present on the island during the last decade. The slow rate of succession after goat eradication and the current low-diversity forests, compared with the available species pool, reflect legacies of past deforestation, communities induced by goat grazing, and the limited capacity of the resident bird species to disperse many of the potential canopy trees. Our results indicate that restoration of remote islands could require manipulation of goat-induced vegetation or may require sufficient time for favourable habitat for keystone dispersers to develop.

Updated review of feral cat eradications on islands

K.J. Campbell, C.C. Hanson, D. Algar, B.S. Keitt, S. Robinson, G.A. Harper, and B. Wood

Feral cats are a substantial threat to the biodiversity of fauna on islands worldwide and increasing are being eradicated. Worldwide 75 operations have been completed, for total area of 101,018 ha. We review past cat eradication campaigns and provide an update on operations with brief case studies of five recent eradications using different techniques. Methods used for eradications and detection or post eradication monitoring are discussed along and their advantages and disadvantages. Recent advances in the use of poisons, traps and dogs are assessed. We outline proposed eradications and note the trend for increasingly larger islands being considered for eradications, but note that although that post-eradication, cat removal generally results in positive outcomes, unexpected negative ecosystem impacts have occurred.

Using genetic analyses and trapping data to model the probability of persistence of feral stoats (*Mustela erminea*) on Resolution Island, New Zealand.

R.I. Clayton, D. Anderson, A. Byrom, K-A. Edge, P.M. McMurtrie, D. Gleeson, and A. Veale

In 2008 the New Zealand Department of Conservation initiated a programme to eradicate feral stoats from 21,000 ha Resolution Island in Fiordland. This operation built on earlier stoat eradication programmes on the Fiordland coast including Secretary Island (8,100ha), which was initiated in 2005 and is ongoing. Added complexity on Resolution Island existed in its size, even closer proximity to the mainland where stoats are present, and the presence of mice. Following the establishment of a 230 km network of tracks and huts, 2,500 trap tunnels were deployed at an average density of 1 tunnel per 9 ha. Each tunnel contained a single-set DOC150™ trap. Coastal trap lines were also in place on the adjacent mainland and stepping-stone islands. Island traps were pre-baited with a fresh hens egg and meat (rabbit, beef, or venison) twice from May to June 2008. Prior to the second pre-bait 230 hair-tube samples were placed at alternate trap tunnels across one quarter of the island. Stoat hair samples were collected over 9 days. DNA extraction of hair samples was conducted and analysed using the spatially explicit mark-recapture software DENSITY, which provided an initial population estimate for the study area of 61 stoats (95%CL 53-73). The first trapping period was conducted from July to August 2008 with two consecutive trap checks. Trapping data from the six trapping sessions conducted so far has also been modelled in Bayesian framework. This analysis has provided an estimated probability of persistence of stoats on Resolution Island of <1% given no detections of stoats in traps. The proportion of trapped animals that had already been detected by hair tubes was about 70%. The application of this research to adaptive management on Resolution Island and other large-scale, complex eradication attempts will be discussed.

Of rats and birds: creating a seabirds' paradise on Dog Island, Anguilla.

R.A. Connor and K. Varnham

Invasive species are known to cause severe impacts on island ecosystems. One such invasive known to have deleterious effects on islands is the black rat (*Rattus rattus*). These rats are a potential threat to seabirds. Live traps were utilized to conduct a feasibility study to ascertain the presence of rats on Dog Island, Anguilla, which hosts eight species of seabirds, including one of the Caribbean's largest nesting populations of sooty terns (*Sterna fuscata*) (170 000 pairs). The results indicate that though the black rat population is relatively high, it should be technically possible to eradicate black rats from the island using brodifacoum bait and ground-based rat eradication techniques, both of which have been successfully used on other islands. It is anticipated the eradication of black rats will be achieved within thirteen (13) weeks of the commencement of the programme. It is also expected that the eradication of rats on Dog Island will enhance the island's seabird populations as well as its biodiversity, in general.

Earth, fire and water: applying novel techniques to eradicate the invasive plant, procumbent pearlwort *Sagina procumbens*, on Gough Island, a World Heritage Site in the South Atlantic

J. Cooper, R.J. Cuthbert, T. Glass, N.J.M. Gremmen, P.G. Ryan, and J.D. Shaw

The European plant, procumbent pearlwort *Sagina procumbens*, was first reported from Gough Island, a cool-temperate island and World Heritage Site in the South Atlantic, in 1998 adjacent to the meteorological station, its assumed point of arrival. Since then it has spread along a few hundred metres of coastal cliff, but has not as yet been found in the sub-Antarctic-like mountainous interior. At South Africa's sub-Antarctic Prince Edward Islands *Sagina* is invasive and is spreading rapidly into many vegetated and unvegetated habitats, and is considered beyond control. It is thought a similar

situation will eventuate on Gough if the plant spreads inland with deleterious ecosystem effects. An eradication programme commenced soon after discovery. To date, eradication has not been achieved, but the plant has been curtailed to its current small distribution. Eradication techniques in use include the mechanical removal and dumping of plants and seed-infested soil at sea well away from the island, herbicides to kill both growing plants and germinating seeds, gas flames to kill seeds and seedlings in rock cracks, near-boiling water to kill seeds in soil, high-pressure water jets to strip infested areas of soil and peat down to bedrock, and spraying with salt water, shown to halt germination in trials. Germination trials have shown a steady decline in seed load in infested areas over a near decade, but the plant's inconspicuous nature, fast growth rate, huge seed load and long-lived seeds, as well as the difficult terrain that requires qualified rope-access technicians to work in safety and the island's remoteness, are all hampering eradication.

Surprise effects on Surprise Island: was the rat eradication a success?

F. Courchamp, E. Angulo, E. Bonnaud, K. Bourgeois, S. Caut, X. Cerda, and Y. Watari

Parallel to the growing number of biological invasions worldwide is an expanding quantity of alien species eradication successes on islands of increasing size, topography and habitat complexity. This irrefutable achievement is, however, to be toned down by the very definition of these successes. Indeed, in the majority of cases, success/failure are measured in terms of absence/presence of the target alien species, while it is increasingly evident that the global response of the invaded ecosystem should be the assessed factor. Most of the remaining eradication failures are related to unexpected populations explosions of hitherto seemingly harmless invasive species, previously controlled to low densities by the target alien species, and brutally released from this pressure following its eradication. These unexpected chain reactions are sometimes referred to as "surprise effects".

Through an eight year ecosystem survey of a simple insular ecosystem invaded by black rats, we assessed the potential of a surprise effect following rat eradication, using complete surveys of the major plant and animal communities, rat diet analyses and community mathematical modelling. We then eradicated the rats following a protocol tailored to the presence of other introduced species. We finally monitored the ecosystem evolution, a step unfortunately too often missing in eradication programmes, in order to assess the success of our control programme, in terms of (1) absence of the eradicated species (2) recovery of the ecosystem and (3) absence of surprise effects.

Ethical issues in island pest eradication

P. Cowan and B. Warburton

Island eradications usually involve the deaths of many animals, mostly the target pest(s) but often other non-target species as inadvertent by-kill. Although the goal to eradicate is often a less complex management challenge than one of having to manage a pest at some defined threshold density, not all eradications are successful. In such cases animals may have died to no good cause and this leaves such wildlife practices open to ethical challenge. Eradications usually involve a variety of lethal methods such as traps, toxins and hunting, which may differ in their animal welfare costs, their risks to non-target species and, for toxins, of environmental contamination and spread through food webs. There are clearly a range of ethical issues that need to be considered when planning and undertaking eradication programmes so that the whole range of costs and benefits are taken into account before proceeding. The various ethical issues will be reviewed and the suggestion made that, given the uncertainty about the outcome of pest eradications in often complex wildlife-resource systems, the only defensible action in such situations is to apply a knowledge-based ethic that ensures future actions will be carried out with increased understanding.

Developing national eradication capacity for the restoration of globally important seabird islands in the Pacific

S Cranwell, E Seniloli, J Baudat-Franceschi, L Faulquier, and A.L. Isechal

The Pacific island archipelagos of French Polynesia, New Caledonia, Palau, and Fiji support a diverse seabird fauna but, many species and breeding colonies are threatened as a result of the introduction of mammalian predators. Several of these island seabird colonies are globally Important Bird Areas (IBAs) and priorities for conservation. As such BirdLife International and national non-government conservation organisations in French Polynesia, New Caledonia, Palau, and Fiji implemented a regional island restoration programme between 2007 and 2009 with the aim of eradicating rats from seabird IBAs. How this programme has led to the development of eradication capacity in four countries resulting in the completion of rat eradication operations for 16 islands of global importance for seabirds is discussed as are the initial results and future restoration priorities and capacity needs.

Eradication of red deer (*Cervus elaphus*) from Anchor and Secretary Islands, Fiordland, New Zealand.

D. Crouchley, G. Nugent, K-A. Edge

Anchor Island (1130 ha), is the first large island in Fiordland to have red deer eradicated. Work to remove the deer commenced in 2002 following the successful eradication of stoats. The final deer was shot in 2007. Team hunting combined with the use of tracking dogs was a key method in the programmes success. Other techniques trialled included capture nets, bailing dogs, helicopter hunting, and self-attaching snare transmitter collars. In 2006 a more ambitious programme to eradicate deer from Secretary Island (8,100 ha) commenced. An earlier deer control programme was carried out on the island in the 1970s and early 1980s but ceased in 1987 due to lack of resources. The current programme has been funded as an eradication operation with two years of population knock-down, two years of mop-up, and ongoing maintenance work to remove any remaining individuals or new immigrants. Knock-down was achieved through ground and helicopter hunting with an estimated 80% of the population shot in the first two years to June 2008 (312 = ground, 130 - helicopter). Now in the mop-up phase, fresh sign on the island is now rare. The intention was to use DNA extracted from hair samples collected from ground shot deer to calculate an initial population size. However, the deer were too closely related to be able to make the required hind/fawn matches through standard DNA analysis. On the positive side, this level of relatedness indicates that very few hinds have ever made it to Secretary Island. Ground and helicopter hunting will continue along with remote-monitored capture pens, snare transmitter collars, and some Judas deer will be trialled (sterilised hinds with hormone implants). The eradication of deer from Resolution Island (21,000ha) will commence in November 2009.

The impact of invasive house mice and plans for their eradication at the UK Overseas Territory of Gough Island, Tristan da Cunha

R. Cuthbert, H. Louw, P. Visser, K. Rexer-Huber, G. Parker, and P. Ryan

The United Kingdom Overseas Territory of Gough Island, Tristan da Cunha, supports globally important seabird colonies, along with many endemic plant, invertebrate and bird taxa, and is recognized as a natural World Heritage Site. The biodiversity of Gough Island is threatened by invasive species, with predation by introduced house mice *Mus musculus* forming the key threat to biodiversity. Recent counts of incubating Tristan albatrosses *Diomedea dabbenena*, which suffers high rates of chick mortality due to mice predation, indicate that since 2001 numbers of incubating pairs have declined at 4.2% a year. This and other conservation impacts mean that eradicating mice from Gough Island is a high priority, however the higher failure rate of mouse versus rat eradications and smaller size of islands that have been successfully cleared of mice means that trials on bait preference, toxicity, and bait-uptake are required prior to an operation. In this study bait-uptake trials were undertaken in around cave systems which are perceived to be potential refuges to mice during an aerial application

of bait. Four trials were undertaken during the winter months, with rhodamine-dyed bait spread by hand at 16 kg/ha over 2.56 ha of ground centred above cave systems in Trials 1-3 and over 20.7 ha and two caves in Trial 4. Totals of 460, 202 and 95 mice were ear-tagged prior to bait spreading in Trials 1, 2 and 3, respectively. 940 mice were caught following bait spreading with 100% of mice positive for bait in three of the four trials, and the single mouse that was negative for rhodamine was a non-ear tagged mouse that was likely to have moved into the core area. All mice that were caught in caves were positive for bait, indicating that cave systems are unlikely to be fundamental obstacle for an eradication attempt on Gough Island. A final large-scale bait-uptake trial covering 5-10% of the islands 6,400 ha area is proposed in order to assess if mice can be eradicated from islands of the size and terrain as encountered at Gough Island.

Advantages and disadvantages of government, non profit and for profit approaches to eradications –are there synergies to be leveraged when working together?

G.R. Howald, **J. Donlan**, P. McClelland, N. Macdonald, and K.J. Campbell

Removal of invasive species to protect and restore island ecosystems is growing, with over 700 eradications documented. The majority of eradications have been conducted by government conservation agencies (GCAs) independently, in partnership with non-governmental organizations (NGOs) and/or for profit companies (FPCs). We compared various models of conducting eradications and identify where synergies have been leveraged. Where GCAs are committed to eradications, there have been highly successful programs such as the ~50 year commitment to fox eradication from the Aleutian Islands, Alaska. However, one disadvantage is that eradications are not the primary business of GCAs. Globally, few GCAs have the technical expertise to implement larger or more complex projects, and projects are infrequent due to lack of funding or political support. There are increasing demands on GCAs to conduct eradications, but do not have the expertise or resources and increasingly, NGOs and FPCs are filling that role. NGOs can be successful at securing funding from sources that are not available to GCAs. FPCs must continually improve eradication techniques or tools to increase their efficacy so they can bid competitively for fixed price contracts. The main advantage to GCAs partnering with FPCs and NGOs is pooling resources such as funds, staff time, equipment and expertise to take on bigger and more complex eradication campaigns. Multi partnership projects can be an effective operating model for eradication projects and should be considered to leverage significant synergies.

Toxins, baits and delivery systems for island use

C.T. Eason, S.C. Ogilvie, L. Shapiro, S. Hix, D. MacMorran, and E.C. Murphy

While there are issues with the repeat use of baits containing brodifacoum in the environment, one-off use for eradication of rodents can result in benefits that significantly outweigh non-target effects. This has been a recommended use pattern for the over 100 islands around the coast of NZ which have been cleared of introduced unwanted rats and mice. Nevertheless difficulties with the existing baits provide a stimulus to search for baits that more effectively target mice as well as rats for island eradication and whilst alternatives to brodifacoum are seen as more important for enabling effective sustained control they may still have potential benefits for pest eradication on islands in some situations. Current product development is focused on extending the utility of existing “low residue” toxins like zinc phosphide, cholecalciferol and a combination of coumatetralyl and cholecalciferol in baits that are particularly palatable to rats and mice. We are also pursuing the registration of products containing substances such as sodium nitrite, para-aminopropiophenone (PAPP) and are working on baits and delivery systems to improve target specificity. Our work with PAPP for stoat and cat control in NZ provides a platform to search for a novel class of rodenticides but this will take a few years to complete. In the short term diphacinone, cholecalciferol and low dose cholecalciferol in combination with coumatetralyl represent low risk acute toxins for control of rats and mice without secondary poisoning. Research focusing on the registration of new solid multispecies baits should yield registered alternative rodenticide baits suitable for aerial application.

Eradicating stoats (*Mustela erminea*) and red deer (*Cervus elaphus*) off islands in Fiordland: the history and rationale behind two of New Zealand's biggest island eradication programmes.

K-A. Edge, D. Crouchley, P.McMurtrie, M.J. Willans, A Byrom

Fiordland, in South West New Zealand, has a long history of island eradications. More than 13 islands totalling over 31,000 ha have been targeted for pest-eradication by the Department of Conservation and community trusts. Many smaller islands have been included as part of ongoing monitoring and control. In 2004 the New Zealand Government announced a 7.1 million dollar funding package for the eradication of feral stoats (*Mustela erminea*) and red deer (*Cervus elaphus*) from Fiordland's two largest islands: Secretary Island (8,100 ha) and Resolution Island (21,000 ha). Mindful of the reputation that New Zealand had developed in pioneering successful rodent eradications, considerable effort went into defining the programmes objectives, project planning, and seeking out the best tools to help achieve the target of eradication. These islands are large, rugged, and inshore - within the swimming range of both stoats and deer. Any eradication attempt is not a one-off operation but requires an ongoing commitment to remove the last individuals of a population as well as immigrants. Key learning points in this programme have included: 1) developing methods on small islands and applying them to larger ones, 2) techniques used in the initial knock-down of pests have often remained in place as part of ongoing monitoring, 3) eradication of these pests from large islands (if possible) takes considerably longer, and 4) reviewing objectives at key times and aligning restoration work with project milestones. Where possible the Department of Conservation has collaborated with Landcare Research to develop technological and statistical methods for defining 'eradication'. Removal of pest species has resulted in whole-ecosystem benefits including increased forest health, and has presented opportunities for the re-introduction of threatened bird species. This work is ongoing with new island initiatives, public education, and a strong focus on island biosecurity to ensure that the islands remain pest-free.

Vegetation change following rabbit eradication on Lehua Island, Hawaiian Islands

H. Eijzenga

Lehua Rock is a 112 hectare tuff crater that lies 1.2 kilometers north of Niihau in the Hawaiian Islands. This island hosts eight species of nesting seabird and is the second largest seabird colony in the main Hawaiian Islands. The first biological survey of the island was conducted in 1936 and European rabbits (*Oryctolagus cuniculus*) were already established on the island. A few years later Polynesian rats (*Rattus exulans*) were detected. There is no historical data to indicate when these species were introduced and their impacts on the island community remain largely unknown. However, fossil pollen and seabird bones indicate that changes on the island have been dramatic. In an attempt to restore the island, rabbits were removed in January 2006. We used a series of transects to monitor vegetation change three years prior to and following rabbit eradication. A significant increase in vegetation cover and species diversity was immediately evident following eradication. There was an increase in vegetation cover for some native plant species, but native cover decreased overall. The majority of this new biomass was largely due to the spectacular spread of the introduced grasses *Setaria parviflora* and *Cenchrus ciliaris* as well as introduced shrubs. Also of concern was the establishment of Golden crown-beard, *Verbesina encelioides*. This invasive plant in the sunflower family has caused devastating changes to native plant communities and seabird habitat elsewhere in Hawaii. The proportion of non-native species will likely continue to increase. As such, active restoration including weed control and the re-introduction of native propagules is necessary to prevent further degradation of the island.

Environmental monitoring for brodifacoum residues following aerial application of baits for rodent eradication

P. Fisher, R. Griffiths, C. Speedy, and K. Broome

Aerial application of baits containing the anticoagulant rodenticide brodifacoum has been responsible for an increasing number of successful eradications of invasive rodents from islands. Such widespread application of a toxin into natural environments inevitably raises concerns about residual contamination in water, soil, vegetation, and non-target animals, birds and invertebrates. While pre-control risk assessments gauge the likelihood of such contamination occurring, post-operational monitoring has a critical role in evaluating these assessments, and in increasing knowledge about the environmental pathways and persistence of residual brodifacoum. We summarise the results of water and other environmental monitoring for brodifacoum residues, undertaken after New Zealand eradication operations including a fenced 'mainland' island at Maungatautari, and on the offshore islands Hauturu (Little Barrier Island), Rangitoto and Motutapu, and Ipipiri (Eastern Bay of Islands). Such monitoring data provide a useful reference for managers undertaking risk assessments for planned eradications, particularly where aerial application of toxic baits is proposed on islands with permanent human habitation and concerns about potential human exposure to residues, such as through drinking water, are likely to be heightened. We encourage managers to recognise the importance of post-operational monitoring for residues, even of environmental media considered at low risk of contamination. Results of such monitoring provide a valuable communication tool that will strengthen demonstrations of eradication success and address social concerns directly.

Considering reptiles in island eradications in the tropical Pacific

R. Fisher

The majority of island restoration projects that consider reptiles as targets of conservation or for monitoring recovery responses have occurred on temperate or xeric islands. There have been decades of research, particularly in New Zealand, on the responses of native reptiles to rodent eradications but very few studies in tropical insular systems. The recent increase in restoration projects involving feral mammal eradications in the tropical Pacific has led to several specific challenges related to native and invasive reptiles. This poster will review these challenges and discuss potential solutions to some of these issues. The first challenge is that the herpetofauna of the tropical Pacific is still being discovered, described and understood. This leads to incomplete knowledge of how eradications may affect these faunas and potential risk to critical populations. The second challenge is that protocols for monitoring the responses of these species are not well documented and are often different from those used in temperate or xeric habitats. A review of techniques being used on Palmyra Atoll, Line Islands, and in the Aleipata Islands, Samoa, for responses to rat eradication projects will be presented. The last challenge is that many invasive reptiles already persist in the tropical Pacific and some could easily spread incidentally through ground based eradication and monitoring programs. The species at greatest risk to continue to spread in the tropical Pacific will be reviewed and recommendations for biosecurity for these taxa will be discussed.

Estimating spatio-temporal change in population size of an invasive species from capture records: application for the mongoose eradication project in Amami Island, Japan

K. Fukasawa, S. Abe, and T. Hashimoto

Estimation of the effect of the control and the spatio-temporal change in the population size of an invasive alien species is very effective to evaluate and improve the strategy for the eradication. It is necessary to establish models to estimate the population dynamics of an invasive alien species from the information obtained in the eradication process.

In Amami Island, Japan, small Asian mongoose (*Herpestes javanicus*) was introduced as a biological control agent for the native poisonous snake, Habu (*Protobothrops flavoviridis*), in 1979. The predation of the non-target endemic animals by the mongoose has been a great threat of the biodiversity conservation. In 2000, the Ministry of Environment began the eradication project of the mongoose. The removal of the mongoose has been done using traps, and the location and capture history of almost all the traps have been recorded.

In this study, we established a hierarchical model to estimate the efficiency of capture and the spatio-temporal change in the population size from the capture history. Our model consists of the population dynamics and the relationship of the population size and the trapping effort to the number of capture. Our model allows the spatio-temporal heterogeneity in the population growth rate. Using Markov Chain Monte Carlo (MCMC) method, the population size and its growth rate in each time and place and the capture probability of the trap were estimated from the data of the number of captured mongoose and the trapping effort. We also suggested the index of the optimal spatial arrangement of traps from the estimated values.

The data used in this study was obtained by Amami Mongoose Eradication Project by Naha Nature Conservation Office, Ministry of the Environment, Japan. The trapping and the recording of capture have been done by Amami Mongoose Busters.

Invasive alien species in European islands: eradications and priority for future action

P. Genovesi and L. Carnevali.

An important portion of the European endemism is found on island ecosystems, and in many cases are highly threatened by invasive alien species. Tackling biological invasions on islands is thus crucial to protect the regional biological diversity and in many cases to protect the well-being of local human communities. Despite Europe is one of the richest regions of the globe, and it has formally committed to halt the regional loss of biodiversity by 2010, the level of action to prevent, eradicate or control invasive alien species on islands has been so far very scarce, if compared to other regions of the world.

In order to provide an update of the eradications carried on in the region and a tool to support decision making, a database on invasive alien species on the islands of all Europe is being implemented by ISSG, with the support of the Bern Convention, that has recently launched a program of work on European islands. The database contains information on the presence of most impacting aliens species, presence of native species directly affected by aliens and eradication programs. The scope of the database extends over biogeographic borders of the region and covers the outermost territories of Europe.

Data have been collected by reviewing scientific literature, unpublished data provided by experts and by reports produced by countries signatories of the Bern convention. Data on islands are being collected through a cooperation with the Global Islands Database (GID).

Preliminary results indicate that over 180 eradications programs have been carried on in over 140 islands and 69% of them have been successful. Most eradications have targeted rats (68%). We also present some preliminary attempts to prioritise future actions by identifying islands/areas where funding and efforts should be concentrated.

The origin of amphibian chytridiomycosis: did it come from Japan?

K. Goka, J. Yokoyama, Y. Une, T. Kuroki, K. Suzuki, M. Nakahara, A. Kobayashi, S. Inaba, T. Mizutani, and A.D. Hyatt

A serious disease of amphibians caused by the chytrid fungus *Batrachochytrium dendrobatidis* was first found in Japan in December 2006 in imported pet frogs. This was the first report of chytridiomycosis in Asia. To inspect the origin and expansion process of the chytrid fungus in Japan, we surveyed the distribution and genetic variation of the fungus among captive and wild frog populations. We established a nested PCR assay that uses two pairs of PCR primers to amplify the internal transcribed spacer (ITS) region of a ribosomal RNA cassette to detect mild fungal infections from as little as 0.001 pg (1 fg) of *B. dendrobatidis* DNA. We collected swab samples from 559 captive amphibians, and 5,565 wild collected at field sites from northern to southwestern Japan. We detected infections in native and exotic species, both in captivity and in the field. Sequencing of PCR products revealed 50 haplotypes of the *B. dendrobatidis* ITS region. Phylogenetic analysis for the haplotypes combined with haplotype sequences already detected in other countries showed that genetic diversity of *Bd* in Japan was higher than that in other countries. Furthermore, it was suggested that 3 of the haplotypes detected in Japan were specific to the Japanese giant salamander (*Andrias japonicus*) and appeared to have established a commensal relationship with this native amphibian. The highest genetic diversity of *B. dendrobatidis* was found in the sword-tail newt (*Cynops ensicauda*) endemic to Okinawa Islands and next in the alien American bullfrog (*Rana catesbeiana*). From these results, combined with no evidence of chytridiomycosis occurrence in the Japanese native species, we led to a new hypothesis for source of the fungus, “Asia or Japan origin hypothesis”. To improve chytridiomycosis risk management in the world, we must restrict the amphibian trade, especially from Japan.

Wetapunga (*Deinacrida heteracantha*) population changes following Pacific rat (*Rattus exulans*) eradication on Little Barrier Island

C.J. Green, G.W. Gibbs, G.W. and P.A. Barrett

Wetapunga (*Deinacrida heteracantha*) (Orthoptera: Anostostomatidae) is the largest of the 11 giant weta species found in New Zealand and is listed as a Nationally Endangered species. Originally distributed throughout Northland and Auckland it is now restricted to Little Barrier Island (3083ha). Largely arboreal, wetapunga feed mostly on the foliage of a range of plants by night and hide in refuges during the day. Following the eradication of Pacific rat, or kiore (*Rattus exulans*) wetapunga population changes were recorded over a five year period. During May each year 121 person hours were spent searching the same areas for the same length of time by the same three-person team to provide a consistent search effort. Search time was split approximately 50:50 between night and day. Wetapunga numbers more than doubled over the five year period with a pattern of approximately a 50% increase in numbers every second year. Each year the size classes of wetapunga found showed a bias towards adults or near adult instars with first to third instar juveniles proving elusive until the fifth year. Approximately 20% of all adults found each year were in male-female pairs, either pre-, or post-mating, or actually in copulation which appears to last for at least 24 hours. The increasing wetapunga numbers over the study period reflect the benefit of Pacific rat eradication and are consistent with other studies on the impacts of exotic rodents on New Zealand indigenous large bodied, flightless, nocturnal invertebrates.

Targeting multiple species – a more efficient approach to island pest eradication

R. Griffiths

The Rangitoto/Motutapu pest eradication aims to remove stoats (*Mustela erminea*), cats (*Felis catus*), hedgehogs (*Erinaceus europaeus occidentalis*), rabbits (*Oryctolagus cuniculus*), mice (*Mus musculus*) and two species of rat (*Rattus rattus*, *R. norvegicus*) from an area of 3842ha and is one of the most challenging and complex operations the Department of Conservation has ever attempted. Most eradication operations to date have targeted a single species or a subset of the suite of pest species present. Preliminary results suggest that the Rangitoto/Motutapu approach, although complex, may present a more efficient approach to island pest eradication. Comparisons made between other eradication programmes provide further evidence of the increased efficiencies that can be made when several pest species are targeted simultaneously or sequentially. Pest eradications that targeted prey species before predator species and ordered the deployment of techniques so that subsequent methods capitalised on the former often achieved a successful result in a shorter period of time than single species operations targeting the same pests. These efficiencies resulted in greater cost savings to the conservation organisations involved.

Introduced rodents in the Galapagos: colonisation, removal and the future

V. Carrion and G.A. Harper

Introduced rodents; black rats, Norway rats and mice, have been present in the Galapagos archipelago for around 300 years. Their presence has resulted in adverse effects on native flora and fauna, including the likely extirpation of native rodents. Control of rodents has mainly been to protect native species like the dark-rumped petrel and to reduce affects on human infrastructure. Eradication of introduced rodents in Galapagos has been conducted since the 1980s on small islands, mainly using poison bait in bait stations. Eradications in the near future are being planned for larger islands using aerial applications of poison, with a view to scaling up to islands as large as 57,000 ha.

Effects of brodifacoum on a population of Galápagos land iguanas (*Conolophus subcristatus*) during a rat eradication.

J. Zabala, V. Carrion, and G.A. Harper

Very little data on the effect on reptiles of 2nd generation anticoagulants like brodifacoum is available. As many islands have both introduced rats and native lizard fauna the expected impacts on native reptile populations when eradication of rats are planned using anticoagulants is largely unknown. The population of Galapagos land iguanas on North Seymour Island, Galapagos, was monitored during a black rat eradication operation. Klerat™ bait containing 50 ppm brodifacoum was applied at approximately 3 kg/ha in two applications in October 2007. Only a few iguanas were found dead after the operation, apparently due to consumption of poison bait and/or poison-killed rats. The overall mortality rate was estimated at approximately 5% of the iguana population. The black rats appear to have been eradicated. The low rate of poison application suggests rats on arid islands may be able to be eradicated with less poison than is current practice.

Eradication of house crow (*Corvus splendens*) from the island of Socotra, Yemen Republic – end of a problem or start of a program ?

A. S. Suliman, G. G. Meier, and **P. J. Haverson**

Invasive alien house crow (*Corvus splendens*) has spread to nearly all countries on the Arabian Peninsula and along the East African coast, affecting agriculture, biodiversity, public hygiene as well as tourism and air traffic. Its considered one of the most invasive birds on earth and no international effort to stem its invasion had been formalised so far.

Following its introduction on Socotra island, Yemen Republic, in 1995 the species established a small breeding population and started to expand in territory over the years.

Different schemes of control or attempted eradication had been deployed by the local authorities and while this kept numbers limited it did not achieve eradication. Due to changes in project priorities no future population control was guaranteed anymore for the time following mid 2009. Therefore a final eradication attempt was undertaken in April 2009 using local knowledge and guiding, foreign professional expertise and international funding. Due to this cooperation eradication of the nearly 15 year old problem was achieved in 15 days. While this success on the UNESCO World Heritage Site of Socotra-island will due to the remote location be likely to remain, the growth of house crow populations in the region continues unrestricted and will increase pressure on free territories. Therefore the eradication of house crow from the island of Socotra island means a local success as well as a starting shot to act region wide.

The history of mammal eradications on United States associated islands of the Central Pacific

S. C. Hess and J. D. Jacobi

Many eradications of mammal taxa have been accomplished on United States associated islands of the central Pacific, beginning as early as 1910. The most commonly eradicated species include rabbits (*Oryctolagus cuniculus*), rats (*Rattus* spp.), feral cats (*Felis catus*), and several species of feral ungulates, primarily from smaller islands and fenced natural areas on larger Hawaiian Islands. Vegetation and avifauna have demonstrated dramatic recovery as a direct result of eradications. Techniques of worldwide significance were refined during these actions, including the Judas goat method. The amount of land area from which ungulates have been eradicated on large islands is now greater than the total land area of some smaller Hawaiian islands. Large multi-tenure islands present the greatest challenge to eradication because of conflicting societal interests regarding introduced mammals, mainly sustained-yield hunting. The difficulty of preventing reinvasion poses a persistent threat after eradication, particularly for feral pigs (*Sus scrofa*) on multi-tenure islands. Progressively larger areas and more challenging species are now under consideration for eradication. These include feral cats on the island of Kaho`olawe, and a wild ungulate species, European mouflon sheep (*Ovis gmelini musimon*), which is currently underway on an area of Hawai`i Island larger than the island of Lāna`i. The recovery of endangered Hawaiian birds may depend on the creation of large predator-proof exclosures on some of the larger Islands. Large scale eradications of small Indian mongooses (*Herpestes auropunctatus*) would be particularly beneficial to ground-nesting birds such as nēnē (*Branta sandvicensis*), but this has not yet been achieved except in relatively small exclosures.

Establishing the raccoon control system and its issues in Hokkaido, Japan

T. Ikeda, G. Abe, and K. Ueda

Abandoned and escaped pet raccoons that have become established in Japan are extending their habitat, damaging agriculture nationwide, and substantially impacting on the native ecosystem. In Hokkaido, scientists and governments have been addressing this issue cooperatively. Initially, raccoons were captured as part of harmful wildlife control; however, this approach lacked evaluation of the capture. Consequently, to contribute to consensus building for the control system, target capture number was determined by predicting population dynamics scientifically with reproduction data analysis of captured individuals. Furthermore, we set model areas and verified the efficacy of the capture by continuing the same capture approach at the model areas. As a result, it was shown that population density can be kept at or below two animals/km² solely by placing cage traps every 500 m in the area and conducting three continuous weeks of capture once a year. In addition, as there was correlation between the population density and the capture per unit effort (CPUE), CPUE was introduced as a relative index of population density. At present, local governments aim to reduce CPUE to one animal/100 trap nights, corresponding approximately to a population density of one animal/km². However, the current capturing method using cage traps is not cost effective in low population density areas. Thus, development of effective capturing approaches in such areas, including training of raccoon detective dogs, is a challenge. Furthermore, although Japan is deeply concerned about the impact of alien species on human living, it remains relatively unaware of their impact on the native ecosystem. Moreover, among Japanese, there is a strong reluctance to killing animals. Therefore, public awareness-raising is also necessary and reinforcement of social education regarding invasive alien species is becoming a social issue in Japan.

Unexpected behaviour of invader ship rats experimentally released behind a pest-proof fence

J. Innes, C. Watts, N. Fitzgerald, D. Thornburrow, B. Burns, J. Mackay, and C. Speedy

Six ship rats were cage-trapped by a pest-proof fence and released with radio transmitters into the adjacent 35 ha pest-free enclosure at Maungatautari, North Island, New Zealand, to mimic reinvasion. Unexpectedly, four of the six rats climbed back out of the enclosure and returned to their original home ranges after periods from a few hours to seven days. All six rats travelled along the fence top, and only three of the six used tracking tunnels. The rats that did move considerably inside the reserve stayed within ca 100m of the release point for about three days, then made increasingly large movements into the reserve. Eventually, these rats moved up to 1100 m from release points, vastly larger than typical mainland rat home ranges. These results suggest that a) some invading ship rats may themselves vacate a fenced sanctuary; b) behaviour of experimentally released ship rats is very similar to that reported for house mice and Norway rats in other studies on islands, and c) detection and killing devices should target rats within 100m of a fence breach for at least three days, and traps should be set on top of the fence.

The invasion of the Argentine ant across continents and the eradication

M.N. Inoue and K. Goka

The Argentine ant, *Linepithema humile*, has successfully spread from its native range in South America across much of the globe. This species is highly polygynous and possesses a social structure, called 'supercolony' whereby individuals mix freely among separated nests. The introduced populations of the Argentine ant are characterized by the formation of very large supercolonies across as much as thousands of kilometers, whereas colony size is generally smaller in the native ranges. Gene flow among supercolonies has been considered to be very limited or even absent. The Argentine ant, first noted in 1993, is now found in several regions of Japan. Early detection as well as rapid control are required to prevent further expansion of the species. A vital component of this prevention is the identification of pathways of introduction into new locations. First, we attempted to demonstrate

the genetic structure of the Argentine ant for understanding its dispersal history. Sequencing of the mitochondrial DNA from the Japanese and overseas populations resulted that one haplotype is shared among different populations distributed in USA, Europe, Australia, and Japan. Three haplotypes were shared among four supercolonies with high levels of aggression in Japan. These results indicate that one massive supercolony is distributed across the continent and that replicated introductions may occur in Japan. Second, we examined whether gene flow can occur among the supercolonies for understanding the mechanism of formation of the massive supercolony. As a result of investigation of reproductive schedule and aggression of workers toward males, gene flow may be limited between adjacent supercolonies. Finally, we will introduce the eradication trails of the Argentine ant in Japan.

Mongoose, rat and acorn - forest dynamics and ecosystem management on Amami Island, Japan

K. Ishida

Small Indian mongoose (SIM) is invaded in Amami Island, for 30 years. The island locates at the north-eastern most corner of the Oriental region, and rich in endemic species of subtropical forest. An intensive control of SIM has been progressed by the Ministry of the Environment in the last decade. The density of SIM is low and the distribution is as wide as 300 square kilometres over the complex forest ecosystem with complicated terrain. There inhabits another invasive alien mammal, black rat (BR), which increases much in the forest after the rich acorn crops of the ever-green oak (*Castanopsis sieboldii*), an extremely dominant tree. BR and a wintering thrush (*Turdus pallidus*) are the two of the important winter foods for SIM. Reproduction, dispersal, and also trapping performance of SIM should depend on the abundance of BR, the thrush and other animals, which are also fluctuating with acorn production. Understanding the patterns and the process of the food web through acorn, BR, other native animals and SIM is important to make an optimal control strategy (smallest cost and highest benefit) and to look for the eradication possibility of SIM. Ecosystem management thinking is indispensable also for invasive species' control on Amami Island.

Eradication of exotic rodents off six high conservation value Western Australian islands.

B. Johnson and K. Morris

Introduced rodents are a major threat to the biodiversity of islands around the world, including Australia. In 2009 a Threat Abatement Plan to reduce the impacts of exotic rodents on biodiversity on Australian offshore islands of less than 100,000 hectares was approved by the Commonwealth Government. Introduced rodents are known from at least 69 islands off the WA coast and since the 1980s successful eradication programs have been implemented on 50% of these. This project will eradicate introduced house mice and rats from another six high conservation value islands over a four year period. House mice will be eradicated from Three Bays and Faure islands in Shark Bay. Black rats from Sunday and Long in the Kimberley and Direction Island in the Cocos-Keeling group. Pacific rats will be eradicated from Adele Island also off the Kimberley coast. In addition, a survey of Dirk Hartog Island in the Shark Bay World Heritage Area will be undertaken to confirm or otherwise, the presence of black rats on this 68,000 ha island. Where bait spreading by helicopter is not practical and where non-target issues are present, appropriate bait stations will be developed and deployed. Where bait stations can not be developed to prevent access to baits by non-target species, some may be removed from the island, eradication undertaken and the non-targets returned once eradication has been confirmed. Eradication will most likely be by baiting with the anticoagulant poison, brodifacoum, however there have been recent developments with other baiting formulations and these will be utilised if appropriate. The eradication programs will be supported by short and longer term monitoring programs, an education program and quarantine protocols will be developed to ensure islands remain free of introduced rodents. Indigenous communities will be engaged to assist with eradication and monitoring activities.

Field efficacy of the Curiosity® feral cat bait on three Australian islands

M. Johnston, D. Algar, M. O'Donoghuen, and J. Morris

Para-aminopropiophenone (“PAPP”) formulations are being developed as new tools for the management of feral cat populations. The toxicant formulations are encapsulated within a degradable polymer. The combination of the toxicant formulation and encapsulation provides a robust pellet which is itself implanted inside a moist meat sausage bait. Pelletised toxicant delivery has been demonstrated to reduce exposure of non-target fauna to bait delivered toxicants. Field evaluations of the bait and pelletised toxicant delivery system have been undertaken at three island sites where the hazard to resident non-target species was minimal.

In the first of these trials (April 2008), eight of ten radio-collared feral cats died following application of bait(s) at 50 baits/km over a 60 km² area within the French Island National Park (Victoria).

In the second trial (April 2009), baits were aerially delivered at 50 baits/km over a 250 km² area on Dirk Hartog Island (Western Australia). Sodium fluoroacetate (1080) was substituted as the toxicant in this trial as engineering issues prevented production of the PAPP doses. Encapsulated pellets of the non-toxic marker Rhodamine were implanted into 22% of baits as an indicator of cats that would have been expected to have died had PAPP pellets been available. Twelve of fifteen radio-collared feral cats died following consumption of bait(s) and of these nine were positive for Rhodamine. Feral cat activity, monitored over 4 x 10 km transects, indicated a twelve-fold decrease following baiting.

For the 3rd trial (August 2009), baits were suspended from 616 devices placed at 100 m intervals along the existing road network across an 85 km² area within Christmas Island National Park (Indian Ocean). Data pertaining to bait take and feral cat activity following baiting will be presented at the conference.

Further trials are planned for Australian mainland sites to collect efficacy data for purposes of obtaining agricultural chemical registration.

A global review of vertebrate eradications on islands

B. Keitt, K. Campbell, A. Saunders, M. Clout, Y. Wang, and B. Tershy

Islands are important for the conservation of biodiversity because they house ~15-20% of terrestrial plant and vertebrate species, have suffered 64% of IUCN-listed extinctions and have 45% of IUCN-listed critically endangered species. Yet islands make up only ~3% of the earth's surface. The main cause of extinction and endangerment on islands is invasive vertebrates. Fortunately, many further extinctions can be prevented by eradicating invasive vertebrates from islands. To assess the current state of this conservation tool, we are compiling a global database of terrestrial vertebrate eradications from islands, including successes and failures. To date, we have documented >775 island eradications of 25 species of vertebrates in 12 families. Most eradications have been of rodents (332) and bovid ungulates (160). Moderate numbers of eradications have been of feral domestic cats (70), suid ungulates (41), and rabbits (~40). Success has been facilitated by significant technical advances in detecting, poisoning, hunting and trapping these taxa. We found few eradications of invasive reptiles (1) and mongoose (3) despite their wide distribution and documented impact on island ecosystems. The majority of projects have been on islands smaller than 500 ha (>60%) and in temperate climates (~80%). Targeting eradications on larger and more tropical islands would lead to protection of more biodiversity. To this end, our vision is to maintain an accurate, web-accessible, regularly updated database that can be used to promote and improve the protection of island ecosystems by eradicating invasive vertebrates.

Restoration through eradication: protecting Chesapeake Bay marshlands from invasive nutria (*Myocaster coypus*).

S. Kendrot

Coastal marshes on the Chesapeake Bay and its tributaries provide valuable ecosystem services including flood prevention, erosion control, filtration, and carbon sequestration. Natural resource-based activities such as commercial and recreational fishing, trapping, hunting, ecotourism generate billions of dollars of economic activity for the region. Nutria (*Myocaster coypus*) were introduced to the eastern shore of the Chesapeake Bay in Dorchester County, Maryland in the late 1930s. Feral populations spread widely across the Delmarva Peninsula and reached peak densities in the late 1990s. During this time, Blackwater National Wildlife Refuge witnessed the conversion of nearly half of its freshwater marshes to saline open water habitat. Vegetation studies conducted in the late 1990s linked nutria herbivory to massive wetland loss throughout Maryland's Lower Eastern Shore. A coalition of state, federal and non-governmental organizations convened to bring attention to the issue and obtained congressional funding to eradicate nutria from the Delmarva Peninsula. In 2002, the U.S. Fish and Wildlife Service contracted the USDA's Wildlife Services program to implement a systematic eradication plan. The eradication team used integrated methods to complete the initial population reduction within 100,000 acres of marsh in five counties across Maryland's lower eastern shore. Reduction to near-zero was accomplished using trapping and shooting applied systematically at the landscape level using GPS and GIS to focus removal efforts. Follow-up removal of residual animals was conducted with dogs and targeted trapping efforts. Adaptive management is being employed to develop, test and refine techniques for detecting nutria at low densities including: dogs, lures and attractants, call surveys, judas nutria, and decoy cages. Recovery of nutria-damaged marsh is being documented through photography and ongoing vegetation studies. The program's goal is to create a nutria-free coastal marsh ecosystem across the Delmarva Peninsula by 2014.

Live removal of feral sheep from Eastern Santa Cruz Island, California

K.R. Faulkner and C.C. Kessler

Channel Islands National Park acquired the eastern 10% of Santa Cruz Island, California including the feral sheep (*Ovis aries*) that lived there. Sheep had been brought to the island ranch in the mid-1800s and were severely impacting the native habitat. The Nature Conservancy eliminated sheep from its 90% of the island in the late 1980s and regularly controlled sheep moving onto their property from the east end. The East Santa Cruz Land Settlement decreed the sheep were privately owned and that the National Park Service was obligated to either move the property or pay fair market value. NPS opted to live capture and move the sheep to the mainland. It was thought there were approximately 2,500 sheep at that time. Capture operations began with park staff in May 1997 using herding and corral traps with bait. Transport of animals from the island utilized a wide array of equipment but primarily relied on sheep trailers and landing craft. As sheep capture became more difficult additional techniques were tested resulting in temporary wire corals and herding being the most efficient. The project was complete in September 1999 with over 9,200 sheep captured; however the last remnant sheep were removed in February 2001. All eight of the Channel Islands had sheep at some time during the peak of the California ranching era. The elimination of sheep from Santa Cruz closed this chapter in Channel Island history

Mariana Islands and ungulate removal: update on Sarigan's recovery, lessons from Anatahan.

C. Kessler

Sarigan Island had a successful eradication of pigs and goats in 1998. Immediately after the removal the native forest was blanketed by the invasive vine *Operculina ventricosa*. Since that time *Operculina* has declined and appears to be limited by competition with two other vines and by drought and storm events. Reforestation of the island has increased greatly as shown by vegetation plots. Most species on the island have increased in population with native snails and skinks showing some of the greatest gains. Now Sarigan Island is a bit of a paradox in having birds introduced from the southern Mariana Islands as a measure to prevent their extinction from the brown tree snake. Due to the success of Sarigan, an eradication of pigs and goats was undertaken on nearby Anatahan Island. Once support of the local inhabitants was gained, a standard operation of helicopter and ground shooting was begun. This progressed until a catastrophic volcanic eruption wiped out most native species from the island, however small numbers of introduced species survived. How these species survived is discussed along with methods and equipment used to remove them.

What does it take to eradicate a feral pig population?

R. Klinger, J. Conti, J.K. Gibson, S.M. Ostoja, and E. Aumack.

Control of feral pigs (*Sus scrofa*) has become a high priority management goal in many island and mainland ecosystems, but few of these programs have used population models to estimate the effect of harvest intensity on population size. We used a nine-year dataset (1991-1999) on density and sex/age structure of feral pigs on Santa Cruz Island, California, to develop a Leslie matrix model for estimation of the likelihood of eradication and number of years to eradication for different combinations of harvest rates and starting densities (N_0). The model included annual harvest rates of 0-95% for all sex and age classes, a management program duration of ten years, and three levels of N_0 : 25% of estimated carrying capacity (low population density), 75% (mean population density), and 150% (high population density). The rate of reduction in population size depended on N_0 at low to moderate harvest rates (5%-60%) but not high harvest rates (>70%). Mortality from harvest was additive at low and mean population densities and compensatory at high density when harvest rates <70%. Harvest rates between 60% and 69% reduced the population to low enough numbers that pigs could be considered ecologically extinct, but there was no likelihood of eradication until 70-75% of the population per year was harvested. Once this threshold was crossed the likelihood of eradication increased rapidly to 1 for all N_0 s. The median number of years to achieve eradication ranged from ten (72% annual harvest rate) to 2.5 (95% annual harvest rate). The model indicates that N_0 will not add appreciable amounts of time to eradication programs when harvest rates are high, and that a strategy of intense harvest for five years will likely achieve eradication of many insular feral pig populations.

Comparison of aerial and ground-based eradication methods to meet eradication goals for two taxa on two islands

J.J. Knapp, P.T. Schuyler, K.N. Walker, N.L. Macdonald, and S.A. Morrison

Certain conditions for success must be met to eradicate invasive alien species from islands. The project must be well-planned and implemented to ensure that all individuals of the invasive population are detected and removed. Land managers must also be able to support the project through to its completion. Failure to meet such conditions of success may fate a project to failure. With large vertebrates and with invasive alien plant species, ground-based eradication methods alone are often elected by land

managers because they appear to be cheaper and safer than methods supported by helicopter. Here, we discuss how helicopter-based methods can help ensure the meeting of eradication success criteria, reducing risk of a project's failure while also increasing efficiency. We evaluate ground-based and aerial-based eradication methods to eradicate feral pigs and control a suite of invasive plants to zero density on two California Channel Islands. Small maneuverable helicopters utilized systematically by pilots with extensive low-altitude flight experience can be a rapid and cost-effective option to successfully eradicate taxa at various trophic levels over large areas.

Effectiveness of bait tubes for brown treesnake control on Guam

B. Lardner, J.A. Savidge, G.H. Rodda, R.N. Reed, A.A. Yackel Adams, C.S. Clark

A bait tube is a device with which a toxicant inserted in a dead mouse can be delivered to invasive Brown Treesnakes (*Boiga irregularis*) with low risk of non-target bait take. We tested two bait tube designs in a 5 ha snake enclosure where the identity of virtually every snake is known. Instead of using toxicants we implanted radio transmitters in small (6.6 ± 1.4 g) and large (21.8 ± 2.9 g) bait mice. Knowing all snakes present in the population allowed us to characterize not only covariates of snakes taking bait, but also those of snakes evading our mock control effort, and if snake covariates interacted with any design variable in determining targeting rate. Tube design had no effect on take rate. Snake snout-vent length was a strong predictor of success: none of the 29 snakes smaller than 843 mm took any bait, while the 126 snakes ≥ 843 mm were responsible for a total of 164 bait takes. The smallest snakes we were able to target ingested both small and large mice, but tended to consume small bait at a higher rate than large bait. The main reason for our failure to target small snakes appears not to be gape limitation, but rather that small snakes prefer other prey (lizards). The time it takes a snake to grow from the size threshold observed to the size of maturation has implications for the interval between discrete efforts using toxic bait. Targeting all snakes before reproduction can occur is highly desirable; otherwise, a new cohort of refractory snakes may enter the population.

Economics of biocontrol for management of *Miconia calvescens*

D.J. Lee, K. Burnett, and M. Chock

Ecological devastation in Tahiti and the threat to biodiversity and watersheds in Hawaii has deemed *Miconia calvescens* a priority invasive plant. Since the early 1990s, millions of dollars have been spent on advanced technologies and best management practices to reduce the prevalence and spread of the tree. On the islands of Hawaii and Maui, aerial reconnaissance and GIS are used to monitor and map populations; manual removal and herbicide treatments are used to destroy the plants. Long term suppression of *Miconia* remains at bay and years of effort is continually threatened by rising costs and uncertain budgets. To this end, scientists in Hawaii have been collecting and testing biological control agents for effectiveness and host specificity. Using information from Hawaii tests of a stem weevil *Cryptorhynchus melastomae* and a nematode *Ditylenchus gallaeformis*, we simulated release scenarios; estimated the total cost of research, development, release, and monitoring; and compared biocontrol costs to projected expenditures under current best management practices. We estimated that net benefits from biocontrol agent release on a *single* Hawaiian island could reach US\$10 million in 50 years. These results strongly indicate that continued research for a safe and effective biocontrol agent in Hawaii is economically warranted.

Planning for complex feral cat eradications on large Mexican islands

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Feral cats have caused the extinction of 20 vertebrates and the extirpation of multiple seabird's populations on Mexican islands. Cats have been eradicated from 17 islands, being Santa Catalina (4,300 ha) the largest. Most of these eradications were done using traditional techniques (trapping, shooting and hunting dogs); only in one, Isabel Island, 1080 was used. For the coming eradications, because of island's size and ecosystem complexity, the use of the most sophisticated techniques and perhaps multiple species eradication programs are required. On Guadalupe Island (24,360 ha), a priority island, feral cats caused the extinction of six birds. In order to develop an eradication plan the following inputs have been considered: (1) relationships with the house mouse; (2) home ranges; (3) bait palatability; and (4) use of 1080, PAPP or Brodifacoum, combined with trapping, hunting and the use of detector dogs. This plan is the first of its kind for Mexico. Its implementation will provide experience for further eradications such as María Madre (14,400 ha), Socorro (13,132 ha), Espíritu Santo (8,000 ha) and María Magdalena (6,980 ha).

A successful mouse eradication guided by site specific population data

J. MacKay, E. Murphy, M. Hauber, J. Russell, D. Wilson, and M. Clout

Invasive rodents have been responsible for the extinction of many species on islands. House mice have proven harder than introduced rat species to eradicate from islands, and we are investigating some of the possible causes. We have studied and successfully eradicated a mouse population on a small island in northern New Zealand in order to identify possible behavioural reasons for eradication failure. We studied mouse movements with radio-tracking and trapping to provide guidance on grid-spacing for bait stations, which are a common tool used in rodent eradication attempts. Mouse densities on the island were estimated during three capture-mark-recapture (CMR) sessions in January, March and May 2008. The island was trapped almost to extinction in August 2008 and remaining mice were poisoned. Removal trapping data provided a final density estimate of mice in the middle of winter, the period when most eradication attempts occur. Densities on the island ranged from 8.8-18.6 mice/ha and home ranges from 0.03-0.33 ha. Eradication success was monitored intensively using tracking tunnels and Wax Tags and was confirmed four months later in December 2008 using a trained rodent monitoring dog. Information gathered during this study will be used to make recommendations to improve the success of future mouse eradication attempts.

Tawharanui Open Sanctuary – detection and removal of pest incursions.

M. Maitland

Tawharanui Regional Park north of Auckland, New Zealand, was developed as an Open Sanctuary integrating conservation, recreation, and farming operations. A council and community partnership saw a 2.7km coast to coast pest proof fence completed in 2004 isolating 550 ha of the peninsula. A multi species mammalian pest eradication was undertaken in spring 2004. Seven of ten target species were eradicated and three species persist. This has allowed the recovery of many species, and the reintroduction of several others, contributing to regional and national biodiversity conservation. Public access remains unrestricted with 160,000 visitors per year. Potential pest incursion pathways include around coastal fence ends, transportation via visitor or park activity, and coastal landing. To date individuals of all but one of the eradicated species have been detected within the sanctuary, including an *in situ* breeding population of *Rattus rattus* in 2008. All incursions have been subsequently removed. Five years operational experience gives a greater understanding of the incursion profile of the site and required management actions. We remain confident that such incursions can be detected and removed without compromising the resident biodiversity values and future restoration potential

of the site. Although the incursion risk profile of Tawharanui Open Sanctuary is greater than most sites, lessons learnt regarding pest incursion detection and removal, particularly buffer zones and surveillance management, are applicable to most 'island' situations.

Eradication of an international engineer: a threat to southern South American ecosystems.

L. Malmierca, M.F. Menvielle, D. Ramadori, B. Saavedra, A. Saunders, A. Schiavini, and N Soto Volkart

Beavers are threatening ecosystems of global significance in southern Patagonia. Introduced from North America, beavers are an invasive species of global importance. After their introduction to Tierra del Fuego 63 years ago, they have spread throughout the whole Fuegian archipelago, in Chile and Argentina, colonizing all types of native ecosystems. Recently beavers reached continental Chile. After 28 years of implementing nationwide control strategies a bi-national assessment was undertaken in 2006. This led to a new approach involving the signing of an Administrative and Scientific Agreement to develop a bi-national eradication program. A management committee will be created to lead the program which has goals to eradicate the beavers and to create opportunities to restore Southern Patagonian ecosystems. With international support and expertise a series of activities have been carried out including assessments of the technical, ecological, economic, social and cultural feasibility of beaver eradication, the signing of a specific bi-national Treaty to work towards the eradication goal; and initial planning of the program. While every eradication program is unique, this one has special challenges associated with collaboration between two countries, and the development of continental and insular ecosystem eradication approaches. These issues will require the application of innovative tools and models. Other challenges and risks which must be addressed include developing appropriate governance procedures and a management structure, addressing the logistics of undertaking an eradication on this scale, issues associated with cross-border field operations, securing funding and developing techniques to monitor progress and to declare success.

An Analysis of the legal and policy environment in Sri Lanka to control invasive alien species

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The threat of invasive alien species (IAS) to the ecosystems of Sri Lanka, a small-island nation in the Indian Ocean, and its biodiversity has become more significant over the past 2-3 decades. Sri Lanka is a signatory to many international and regional agreements related to trade, i.e. WTO, SAPTA, etc. and international conventions such as CBD, IPPC, and MARPOL 73/78 convention, and has enacted large number of ordinances/acts to impose laws governing import of fauna and flora to the country. The main legal enactments that have assisted in controlling the entry and spread of IAS in Sri Lanka are (a) Water Hyacinth Ordinance No 9 of 1909, (b) Fauna and Flora Protection Ordinance No 2 of 1937 (as amended), (c) Plant Protection Act No 35 of 1999, (d) Fisheries and Aquatic Resources Act No 2 of 1996 (as amended), and (e) Marine Pollution Prevention Act No 11 of 2007. Keeping in line with the constitutional directives, several government institutions have developed policies to tackle the issues related to IAS in Sri Lanka. These institutional policies, with direct relevance to IAS control, are (a) National Environment Policy, (b) National Agriculture Policy, and (c) National Wildlife Policy. Despite many sectoral policies, laws and regulations touching on IAS, the regulatory framework remains unclear, piece-meal, overlapping and largely unenforced. This has negatively affected the environmental and economic well being of the ecosystems of the country making it increasingly susceptible to the invasion of alien species. New pathways of entry for IAS have been created as a result of expanding international trade, tourism and transport. This paper discusses the nature of the legislations and policies related to IAS control in Sri Lanka and the causal factors for their weak enforcement, and propose a well-coordinated institutional mechanism for an effective control IAS in the country.

Campbell Island – taking eradications to new levels

P. J. McClelland

In July 2001 New Zealand's Department of Conservation undertook to eradicate Norway rats (*Rattus norvegicus*) from 11,300 ha Campbell Island 700km south of mainland New Zealand. Then the largest, most isolated, and logistically challenging, rodent eradication attempted.

Building on the experience from many smaller eradications over the previous 15 years, the logistics of Campbell required a major re-think of methodology. Reducing from the standard two bait drops of 8 and 4 kg/ha to a single drop of 3kg/ha with a 50% overlap to minimise the risk of gaps (6kg on the ground) reduced both the bait required and flying time to spread it. This required 126 tonnes of bait transported to the island, stored for up to three months and then spread – estimated to take 150 hours of flying time.

Custom built plywood “pods” were used for bait storage as they were cheap, waterproof and could be slung under a helicopter for unloading from the boat and transporting around the island. The island was divided into four blocks and we used five loading sites, with two operating at any one time.

Timing in mid winter coincided with the absence of most non target species but short days, and poor subantarctic weather. To make the most of suitable weather windows, four helicopters were used for the main operation, three Bell Jet Rangers to spread the bait and one Aerospatial B2 Squirrel to move the pods.

Following the project being declared successful the endemic flightless teal were reintroduced, Two other endemic land bird species, plus burrowing petrels have re-established from offshore islets. The benefits of the eradication to the islands flora are hard to differentiate from those of the sheep removal in 1991.

Working together – a multi party rat eradication on a private islands: the Taukihepa eradication

P.J. McClelland, R. Coote, M. Trow, P. Hutchins, H. Nevins, H. Moller, and J. Newman

Taukihepa (Big South Cape Island), 900ha, is best known as the site of a rat (*Rattus rattus*) invasion in the 1960s that lead to the total extinction of two bird and one bat species as well as devastating a range of other flora and fauna, Taukihepa, along with the majority of other islands around Stewart island is a mutton bird or titi island (privately owned tribal lands set aside for the cultural harvest of young sooty shearwater (*Puffinus griseus*) called muttonbirds / titi).

Eradication using aerial techniques had been proposed for over a decade but the required funding was not available. In 2005 an American trust (Oikonos) proposed that some of the restoration money from an oil spill off the Californian coast in 1997 that killed a large number of sooty shearwater, including one bird that had been banded on an island near Taukihepa, be used to remove rats from Taukihepa and three other nearby islands. Oikonos worked with Otago University and the Department of Conservation to put forward the case.

To oversee the project and to provide coordinated input from the muttonbirders a Trust “Ka Mate Nga Kiore” (Death to the Rat, KMNK) representing birders was set up. KMNK provided the vital link between the muttonbirders, Oikonos; the funders (the Command Oil Spill Trust), Otago University who carried out research related to the eradication, and the Department of Conservation who were contracted to carry out the eradication. KMNK also coordinated the on the ground involvement of around 50 muttonbirders to bait in and around the many buildings on the islands.

The eradication was declared successful in 2009 with an increase in many species of flora and fauna being observed. A reintroduction programme for the islands is currently being developed by the muttonbirders.

Eradication of feral stoats (*Mustela erminea*) from Secretary Island, New Zealand.

P.M. McMurtrie, K-A. Edge, D. Crouchley, D. Gleeson, M.J. Willans, and A. J. Veale

Stoats (*Mustelia erminea*) are known to be good swimmers. Following their liberation into New Zealand it took a mere six years for stoats to invade many of the remote coastal islands of Fiordland. Stoats probably reached Secretary Island (8140 ha) in the late 1800s. Red deer (*cervus elaphus*) are the only other animal pest present on Secretary Island; surprisingly rodents have never established. The significant ecological values of Secretary Island have made it an ideal target for restoration. The eradication of stoats from Secretary Island commenced in 2005. Nine-hundred-and-forty-five stoat trap tunnels, each containing two Mark IV Fenn™ traps, were laid out across newly cut tracks at a density of one tunnel per 8.6 ha. Traps were also put in place on the adjacent mainland and stepping stone-islands to reduce immigration. Pre-baiting was undertaken twice in June and July 2005. In late July the traps were baited, set and cleared twice over a 10 day period. Ninety-five stoats were captured: 34 males, 56 females, and 5 unknown. Subsequent trap checks have taken place in November, February and between May-July each year. Forty-four stoats were caught in February 2006, predominantly juveniles. Stoat captures have decreased to between 0 and 8 each trapping period with the majority being caught in summer. Genetic analysis of stoats captured to June 2008 indicates that these stoats were probably a mixture of residents and a few immigrants. A significant stoat plague event during summer 2006-2007 may have increased the likelihood of new stoats arriving on Secretary Island at that time. Island and coastal traps have since been replaced with stainless steel DOC 150™ traps as single-sets. Trap checks will continue at the present level until there are two consecutive checks with zero captures after which time they will be checked twice annually.

Strategy to control the invasive alien tree *Miconia calvescens* in Pacific Islands: eradication or containment?

J.Meyer, L. Loope, and A.Goarant

Miconia calvescens (Melastomataceae) is considered the most aggressive invasive plant in the tropical islands of French Polynesia and Hawaii, and a serious threat to the native rainforests of New Caledonia. A small tree native to Central and South America, it was introduced as an ornamental in private botanic gardens in Tahiti (1937), Honolulu (1961), Nouméa (1970s) where it escaped, became naturalized, and formed dense monospecific stands. More than 80,000 ha are currently invaded in French Polynesia where the species is found from near sea-level to 1400 m elevation, about 10,000 ha in the Hawaiian Islands, and 120 hectares in New Caledonia. Control programs (manual uprooting of seedlings and saplings, chemical treatments of reproductive trees on cut-stumps and/or carefully targeted spraying from helicopter) have been initiated in the Hawaiian Is. (Oahu, Maui, Hawaii, Kauai) and French Polynesia (Raiatea, Tahaa, Nuku Hiva, Fatu Hiva) since the early 1990s, and in New Caledonia (Province Sud) since 2006. Despite more than 15 years of intense control efforts and millions of plants destroyed, complete eradication was not achieved in any of these islands, mainly because of the species invasiveness (e.g. prolific seed production, active dispersal by alien and native frugivorous birds, large and persistent soil seed bank) associated with the difficulty to detect and destroy plants on rough terrain and steep slopes, as well as insufficient control frequency, and limited financial and human capacities. However, because the plant life cycle requires at least four years for growth from seedling to fruiting, eradication in the sense of “no fruiting tree” may be an effective control strategy for populations which size is small enough to be managed over a long-term with sustainable resources. This “juvenilization” process is not a substitute for but a means toward possible eradication of small populations when carefully conducted over a quarter century.

DNA fingerprinting – a management tool for rat eradication

S. Miller, R. Fewster, and J. Ritchie

In winter 2008 an ambitious rodent eradication project was initiated by the Motu Kaikoura Trust on the 530ha Kaikoura Island off the west coast of Great Barrier Island. The project also extended to 25 smaller islands within swimming distance of Motu Kaikoura. Two drops of brodifacoum cereal baits were undertaken two weeks apart in August and September. This was followed up with an intensive ground based detection and response system on Kaikoura and the nearest parts of Great Barrier Island within swimming distance.

Before the eradication, DNA samples from 274 ship rats were collected from 12 locations in the Great Barrier archipelago, including Motu Kaikoura and several other locations within swimming distance. The genetic results aid rodent management in two ways. Firstly, genetic similarity of rats from different locations can be used to estimate the level of ongoing migration between the locations. By considering geographical features associated with high and low migration, such as cliffs or water distances, we gain improved understanding of the swimming tendencies and capabilities of rodents. Secondly, when rats are found in locations after the bait drop has been completed, DNA profiling can be used to determine whether the rats are most likely to be survivors of the bait drop or reinvaders from another source, and to locate that source. This helps to shape the biosecurity system for an island, and leads to a better targeted management response.

This paper examines the results from the DNA work, and its consequences for biosecurity on Motu Kaikoura and other islands.

Trophic considerations in eradicating multiple pests

S. A. Morrison

Invasive species can fundamentally alter island ecosystems, and eradication is often necessary to abate the threats they pose to native species. But just as the introduction of a species to an island can have profound ecological effect so too can its removal. While significant ecological effects are often the desired outcome of an eradication, other unintended and or undesired effects can also manifest. One such undesired effect may be that due to the ecological change following removal of a pest, a different pest may become more of a threat or more difficult to eradicate. Such risks may be reduced by eradicating multiple pests simultaneously, or if sequentially, in a manner that is “trophically strategic”, i.e., in a manner that anticipates trophic cascades and first leverages the ecological impact of one pest to help render another more susceptible to control. To illustrate, I present a case study from Santa Cruz Island, located 40 km offshore of Santa Barbara, California. For nearly two centuries, introduced species caused widespread destruction of natural communities on the 243-km² island, until recent decades when the most damaging non-native species were removed — some sequentially, some simultaneously. I review that history and outline strategic considerations based on the ecological relationships of the managed non-native species, which include sheep, pigs, golden eagles, and wild turkey. This case study highlights how addressing pest management issues comprehensively can not only reduce cost and investment risk in island restoration programs; it can also sooner abate key threats to often unique and often imperiled island biota.

The essential non-science of eradication on islands: creating conditions for success

S.A. Morrison, K.R. Faulkner, L.A. Vermeer, L.Lozier, and M.R. Shaw

Among conservation scientists, eradication of non-native species is widely recognized as an often necessary strategy to protect native biodiversity of islands. Less understood is the great difficulty of actually conducting an eradication program. The biological and technical aspects of eradicating a population represent one category of challenge: how to ensure that every individual of the target species is removed, and how to know when that point has been reached. Here, however, we focus on another less appreciated but nonetheless essential category: how to ensure that the enabling

conditions are set so that the on-island eradication effort can succeed. The planning and preparation required to conduct an eradication program extends far beyond the realm of science and technical planning. Conducting eradication programs is an increasingly multidisciplinary endeavor, requiring comprehensive financial, logistical, political, communications, and legal preparation. Absent such dedicated support, managers of eradication programs introduce risk to what may already be a risky investment of limited conservation resources. Even minor delay or interruption to the program can have significant ramifications. Here, we provide an overview of the depth and breadth of planning to implement the most intensive effort to date to eradicate an insular population of feral pigs.

Eradicating foxes from Phillip Island, Victoria: techniques used and ecological implications.

S. Murphy and N. Johnson

The red fox (*Vulpes vulpes*) is considered to be the greatest land-based threat to little penguins (*Eudyptula minor*) on Phillip Island, in Victoria, Australia. Phillip Island Nature Parks has commissioned a fox eradication strategy to manage this threat and is committed to eradicating foxes from Phillip Island within five years. Island-wide 1080 baiting on private and public land has been employed as the most efficient method for broad-scale control and is supplemented by other methods such as trapping, spotlighting, and den fumigation. The use of scent dogs to detect fox scats is seen to be instrumental in locating and destroying the last few individual foxes on Phillip Island. As foxes are a cryptic species, monitoring fox abundance is difficult. Deriving relative abundance indices from a number of different parameters influenced by fox presence is considered the best way to assess success of the eradication program. The number of penguins killed by foxes has fallen to extremely low levels (2 penguins in 2008/2009 from over 300 penguins in previous years) and other key indicator species such as Cape Barren Geese and Masked Lapwings are showing signs of population increases. Comparing bait take, spotlight transects and efficiency or catch per unit effort (CPUE) of each method over time is another method to gauge the success of the program. Another result of the eradication program has been an increase in mesopredators such as feral cats due to reduced competition and direct predation from foxes. PINP destroyed over 130 feral cats from farmland and reserves on Phillip Island last year and is now undertaking a public education campaign to educate the community on responsible cat ownership and the threat cats pose to native wildlife.

Goat eradication on Kangaroo Island, South Australia

P. Masters, N. Markopoulos, B. Florance and **E. Murphy**

The high conservation value of Kangaroo Island has prompted the KI Natural Resources Management Board, in association with the Invasive Animals Cooperative Research Centre and South Australian Government, to implement a feral animal control program targeting a number of species. Eradication of goats is one of the most successful components of the program. Goats arrived with the first settlers to KI nearly 200 years ago and over the years the western and northern coastal environments have become population strongholds. Goats were controlled by opportunistic ground shooting until a coordinated strategic approach was set in place in 2006. Public meetings and discussions with the community helped identify the area of the island populated by feral goats. That area was divided into seven management units (MUs) using natural barriers as boundaries to help systematic eradication one MU at a time and limit reinfestations. Sterilised goats fitted with radio-telemetry collars (Judas goats) were first released into the first three MUs to join feral populations and determine effectiveness in this environment. Over the past three years, the 27 Judas goats released have provided information on movements, including the location of watering points and shelter locations, group size and behaviour in specific areas. Because of the Judas goats, 997 feral goats have been easily found and destroyed with little extra effort required for the last few. Four management units are now in a monitoring stage with no feral goats spotted for over a year. The remaining three management units are currently being targeted and eradication should be complete by 2012. The success of the program is attributed to the well-planned approach, effective destruction techniques implemented by skilled staff, and support and participation of all stakeholders.

A potential new tool to help with the eradication of feral cats on islands

E.C. Murphy, L. Shapiro, S. Hix, C.T. Eason, and D. MacMorran

Feral cats have caused the extinction and decline of threatened species on islands worldwide. Their eradication or control is an essential part of restoring biodiversity on these islands. In most situations several techniques are required for eradication, including trapping, hunting and poisoning. Para-aminopropiophenone (PAPP) is being developed in New Zealand as a new humane, poison for feral cats. Mammalian carnivore species appear to be much more susceptible than birds, so it potentially has a higher target specificity than other toxins. Pen trials with 20 feral cats were undertaken using meat baits containing a proprietary formulation of PAPP at various doses. A PAPP dose of 80 mg was lethal for feral cats (weight range 2.4 – 3.9 kg; dose 20-34 mg/kg). Onset of first symptoms was 22-55 minutes after consuming a bait and death between 54 to 125 minutes. To evaluate the formulation in the field, 21 cats were live-trapped and radio-collared. The study area was 1500 ha of farmland in the central North Island. Three other cats were monitored using infra red camera traps. Toxic baiting was carried out for five nights by placing five rabbit mince balls containing a bolus of PAPP paste (containing 80mg PAPP) in each of 22 bait stations. Of the 21 radio-collared cats, 16 were alive and in the trial area at the time of the toxic baiting and 13 of these were poisoned with PAPP. All three of the un-collared cats monitored with camera traps also died. Our results confirm that PAPP is potentially a humane and effective toxin which could aid with feral cat eradication on islands. We are collating toxicology data and undertaking further studies towards product registration.

Nonindigenous fishes in freshwater habitats of islands in the Pacific region: their diversity, distribution, management and eradication

L.G. Nico, and S.J. Walsh

Native faunas of freshwater habitats on Pacific islands are relatively depauperate, yet endemism is generally high. Beginning in the 1800s, humans have introduced a wide variety of freshwater fishes to islands in the region and these introductions have resulted in marked changes to inland aquatic faunas of many Pacific islands. On some—for example, Hawaii—the number of nonnative fish species far exceeds those of native species and the former are now common in natural streams and artificial reservoirs. The reason for fish introductions to Pacific islands varies. Some have been introduced as food or sport fish, others for the purpose of controlling nuisance aquatic weeds or insects (e.g., mosquitoes), some via the aquarium trade, and others have escaped from aquaculture facilities. A few of the more common nonindigenous fishes on Pacific islands are members of the families Cichlidae (e.g., tilapias), Poeciliidae, Centrarchidae, Cyprinidae, and Loricariidae. Because of the increased recognition that invasive species pose as substantial ecological as well as economic threats, eradication is an important management option to control or contain the spread of introduced populations. Methods for the management and control of invasive fishes on islands are generally similar to those utilized in mainland areas. Use of fish toxicants, especially rotenone, serves as a primary tool for eradication or control. Examples of other control measures include trapping, netting, electrofishing, use of physical barriers, and even the intentional introduction of biocontrol agents. Because freshwater aquatic systems on small islands are limited, opportunities to eradicate invasive inland fish populations are hypothetically more achievable than in larger mainland systems and habitats. However, because fish toxicants may also harm native fishes and many aquatic invertebrates, a complete knowledge of the chemical effects, species at risk, and targeted habitats is required to develop effective control or management strategies.

Eradication of non-native tilapia from a natural crater lake in the Galapagos Archipelago, Ecuador

L.G. Nico, C.R. Sevilla, J. López, H.L. Jelks, W.F. Loftus, and D. Chapman

In 2006, Nile Tilapia (*Oreochromis niloticus*) were discovered in Laguna El Junco, a natural crater lake on Isla San Cristobal, Galapagos Archipelago, Ecuador. The largest body of freshwater in the Galapagos, El Junco was naturally devoid of fishes. Galapagos National Park, in conjunction with the Charles Darwin Foundation, drafted a plan in 2006 proposing application of rotenone, a commonly used fish poison, to eradicate the tilapia. In August 2007, we visited the lake and surveyed surrounding areas. We verified the identity of the fish, confirmed that the lake population was reproducing, and concluded the tilapia were likely restricted to the lake. Eradication was justified because predation by tilapia was changing the composition and abundance of the lake's native invertebrate community, negatively affecting some species considered endemic to the Galapagos. Moreover, the longer the tilapia persisted, the greater the likelihood of dispersal into other aquatic habitats. We conducted a series of toxicological tests on tilapia and invertebrates from El Junco to determine the optimal concentrations of rotenone to apply. We also sampled aquatic invertebrates from the lake, reserving some in refuge tanks for later restocking. Following months of planning, on 25 January 2008 liquid rotenone was applied and over the next few days approximately 40,000 dead and dying tilapia were removed from the lake. After tilapia removal, and once all residual rotenone in the lake had degraded sufficiently, captive invertebrates were released back into El Junco to speed recovery of invertebrate communities. No live tilapia have been collected or observed since 31 January 2008.

Risk analysis of potential freshwater nuisance fishes and other species associated with increased U.S. military presence in Guam and circum-Pacific islands

S.J. Walsh and L.G. Nico

Islands of Micronesia have low taxonomic richness of strictly freshwater aquatic species, yet endemism on single islands or island groups is often high. In contrast, nonnative aquatic organisms have become increasingly common. Although published reports differ in total numbers, approximately 70-90 species of fishes have been introduced into fresh (and some brackish) waters of the western Pacific and Hawaiian islands. In addition to fishes, nonindigenous freshwater mollusks and crustaceans have also been introduced. Sources of introductions vary from some that were intentional (e.g., for aquaculture, ornamental trade, mosquito control), to those of accidental or unknown pathways. The ecological and economic effects of these introductions are poorly understood and generally have not been quantified. The U.S. Department of Defense (DoD) projects manifold military operations in the western Pacific, centered in Guam and the Commonwealth of Northern Mariana Islands. Increased traffic of cargo and personnel associated with the expansion of military operations poses elevated risk of transport of invasive species throughout the region. Consequently, freshwater systems of Micronesian islands and their vertebrate and invertebrate faunas are in need of greater study to determine extent of threats to the native biota. This project provides a freshwater component to a multi-agency and multi-disciplinary endeavor to evaluate control and management protocols for existing and potential invasive species, as part of a collaborative process to prepare a region-wide environmental impact assessment. The first steps in developing an effective biosecurity program are to conduct risk analyses of pathways of introductions, to identify and characterize those species having the highest potential of becoming invasive, and to document impacts to native communities. Major goals of the DoD biosecurity plan are to prevent new introductions and reduce the risk of spread of potentially invasive marine, terrestrial, and freshwater species. The risk analysis process will require the identification of endpoints, hazards, and the likelihood and consequences of different risks.

Running the gauntlet - promoting eradication of rats and feral cats on an inhabited island.

J. Ogden, and J. Gilbert

Great Barrier is New Zealand's fourth largest island with a population of around 800 people holding a wide variety of environmental and conservation values. The island is nationally ecologically significant with 70% of its 28,000 hectares already held in the Department of Conservation estate. It is the country's largest land mass free of mustelids, possums, hedgehogs, Norway rat, and feral goats having only rats, feral cats, feral pigs, and rabbits representing its small suite of invasive pests. The Great Barrier Island Trust has been promoting its vision of eradicating rats and feral cats, returning those species lost to the island, and helping to build an eco-based economy for the Island since 2002. This presentation profiles the challenges and successes of the Trust, the lessons learnt, relationships held with key stakeholders and the community, and the progress of manifesting the vision to date. It also presents some of the economic, social, and environmental benefits gained from two ecologically restored Sanctuary areas that have been operating for over a decade on private land on Great Barrier. These projects act as working models for the Trusts greater vision and have helped change attitudes and expectations of conservation in the community.

A newly recorded alien population of a lizard *Plestiodon japonicus* in Hachijojima Island, central Japan

T. Okamoto, T. Kuriyama, M. Hasegawa, T. Hikida, and K. Goka

The scincid lizard *Plestiodon japonicus* is naturally distributed in almost part of the Japanese main islands and coastal region of eastern Russia. Since the spring of 2004, an alien population of this species has been recorded in Hachijojima Island, central Japan, where a congeneric population of *P. latiscutatus* is naturally distributed. As native lizard population has faced to be endangered by an alien predator the Japanese weasel *Mustela itatsi*, the alien lizard population will lift up the extinction risk of the native population by competition and introgressive hybridization. Our preliminary study in 2007 and 2008 suggested the followings: the alien species already established a breeding population; the alien population was currently localized in a small part of the island and did not co-occur with the native congener; the alien population had slight genetic variation and therefore seemed originate from a single source; little or no hybridization with the native congener occurred. The invasion of the alien population may be at an early stage and therefore a prompt eradication will suppress the impacts by the alien lizard.

Innovations in the control and eradication of the American bullfrog *Rana (Lithobates) catesbeiana* populations on Vancouver Island, British Columbia, Canada

S.A. Orchard

The American bullfrog is listed as one of the 100 Worst Alien Invasive Species internationally because it is adaptable, prolific, competitively exclusive, loud and predatory. It is also a carrier of the pathogenic chytrid fungus that is lethal to many frog species. By frog standards the American bullfrog is especially large and muscular. In ecological terms this makes it a formidable predator and competitor and from a human perspective it makes it appear to be a potential source of cheaply cultivated edible meat. Potential profits derived from the sale of frog's legs for human consumption is the prime motivation for translocating this species outside of its natural range in the eastern United States. Populations are now well-established on islands in western Canada and the western United States, Hawaii, throughout the Caribbean, Crete, Indonesia, Japan, Singapore, Sri Lanka, and Taiwan. The ecological impact of bullfrogs on islands can be profound especially where ecologically vital freshwater resources are limited. Some endemic-rich and habitat-limited island faunas may suffer more acutely than continental faunas, but the control and eradication of American bullfrog populations on islands is generally a much simpler and more practical proposition. While the problems created by bullfrogs are well-documented and much discussed few technological advances in their effective control and management have been forthcoming. In 2005 a program began on southern Vancouver

Island, British Columbia, on the Pacific coast of Canada. New strategies, tactics and techniques were developed and field tested by one two-person team resulting in three years (2007-2009) of comparative data on the effectiveness of these techniques in driving down bullfrog numbers. To date, over 13,000 bullfrogs have been removed from over 50 sites with numerous examples of 'site control' and 'site eradication'. These new tools are cost-effective, time-efficient, humane, and species-specific.

Context matters: assessing the biodiversity benefits of pest eradication

J. Overton

The biodiversity benefit obtained from the eradication of a particular pest on a particular island depends on both the biodiversity context around the island, as well as the pest context (e.g. suite of pests) on the island. The biodiversity benefits of pest eradication on an island depend on the archipelagic biodiversity context, including the rarity of the native species on the island, whether they are present on other islands, and whether they are being managed on other islands. Well-known concepts from conservation planning, such as complementarity and irreplaceability, can be used to illustrate the importance of archipelagic biodiversity context in choosing what pests to eradicate on which islands. Pest context matters also; the marginal benefits of removing a particular pest depend not only on the effects of that pest on the native species, but also on what other pests are on the island, and their effects on native species. I illustrate both of these contextual effects, using the Vital Sites model, which contains spatially explicit information on the New Zealand distributions of native species and pests, and simple models of the impacts of pests on native species. The removal of a particular pest provides more biodiversity benefit if it is the last pest removed from the island, than if it is the first pest removed from the island. This result is independent from, and exacerbated by, increases in the density of remaining pests due to reduced competition or predation from the removed pest. Furthermore, the marginal operational costs of controlling a particular pest are likely to decrease, as more pests are controlled. Both of these effects argue for multiple (rather than single) pest eradications. These results have important consequences for deciding what pests to eradicate or control on which islands, and whether to do single or multiple eradications.

Estimating the duration and cost of weed eradication programs

F.D. Panetta, O.J. Cacho, S.M. Hester, and N.M. Sims-Chilton

Two of the prerequisites for realistically embarking upon an eradication program are that cost-benefit analysis favours this strategy over other management options and that sufficient resources are available to carry the program through to completion. Clearly, these are not independent criteria, but it is our view that too little attention has been paid to estimating the investment required to complete weed eradication programs. We deal with this problem by using a two-pronged approach: 1) developing a stochastic dynamic model that provides an estimation of program duration and 2) estimating the inputs required to delimit a weed incursion and to prevent weed reproduction over a sufficiently long period to allow extirpation of all infestations. The model is built upon relationships that capture the time-related detection of new infested area, rates of progression of infestations from the active to the monitoring stage, rates of reversion of infestations from monitoring to active stages, and the frequency distribution of time since last detection for all infestations. This approach is applied to the branched broomrape (*Orobanche ramosa*) eradication program currently underway in South Australia. This program commenced in 1999 and currently 7450 ha are known to be infested with the weed. To date none of the infestations have been eradicated. Given recent (2008) levels of investment and current eradication methods, model predictions are that it would take, on average, an additional 73 years to eradicate this weed at an average additional cost (NPV) of \$AU67.9m. When the model was run for circumstances occurring in 2003 and 2006, the average program duration and total cost (NPV) were predicted to be 159 and 94 years, and \$AU91.3m and \$AU72.3m, respectively. The reduction in estimated program length and cost can be considered to represent progress towards the eradication objective, although clearly eradication of this species remains a long term prospect.

Red foxes (*Vulpes vulpes*) in Tasmania: intercepting an incursion on a large island

J. Parkes, D. Anderson, and A. Johnston

Red foxes were reported in Tasmania in 1999 and subsequent evidence suggests a small but widespread population is present. Tasmania is the last refuge of many marsupials that are extinct or rare on the mainland of Australia, partly because of predation by foxes. Thus, governments have been attempting to eradicate the fox from the State since 2002, with an annual budget of up to A\$5.6 million and 60 staff. Managers face several problems in achieving this. (a) The island is large (6.8 million ha), (b) foxes are rare and cryptic which leads to problems in delimiting their range and detecting individuals within that range, (c) there is a limited set of control tools available, basically buried 1080 baits, which may not kill all foxes in the baited area (up to 600,000 ha per year), does not provide direct evidence of success (a dead fox), and may kill non-target animals, and (d) access to land of all tenures – particularly in urban areas where toxic baiting is not possible – constrains actions.

Finding foxes either to direct initial control or to detect survivors of that control relies on public reports of foxes with unknown reliability, infrequent but obvious road kills, or detection of fox scats from reactive or planned searching by trained dogs or people. Fox scats give reliable evidence of the presence of a fox because they can be validated from the presence of fox DNA, the identity and sex of the fox can be determined in some cases, and we have some results on the detection probabilities of both dogs and people. We present a model that enables managers to interpret the key question ‘if we search an area and find no scats what is the probability that no foxes are present, and thus the risk in declaring success and stopping’.

Eradication of European starlings (*Sturnus vulgaris*) from Western Australia: using the control data to validate eradication and inform ongoing surveillance

J.P. Parkes, D. Anderson, and A. Woolnough

Abstract European starlings (*Sturnus vulgaris*) have invaded Western Australia several times since 1971. Intercepting and eradicating these incursions is of high priority to the WA government because of the potential damage the birds may cause to agriculture – estimated at A\$21.2 million per year if they establish – and to biodiversity if they compete with native birds. Small populations have been eradicated in the past and a major campaign has been underway to eradicate an incursion detected in 2001 and eventually covering a coastal area over about 3000 km². Control has been by live trapping and by shooting at nests – the birds seem to restrict nest sites to hollow trees in areas of standing water. Up to 2008, 1394 birds were trapped and 1563 were shot, and only 47 caught by other methods. Live trapping targets juvenile birds (82%) while shooting birds on their nests targets adult birds (82%). Changes in the numbers of these age classes in each operational area can be used to estimate progress towards eradication, eg. the absence of juveniles would indicate all breeding adults in the area had been killed. The program has invested much effort in surveillance and understanding the spatial patterns of the individual starling flocks by employing people to search for birds and their nests (570 ‘swamps’ have been mapped), and by using radio-telemetered birds. The effort expended on surveillance and on the control is recorded in space and time. The programme is reaching the point where few if any birds are found in the surveillance and the kill-rates are declining. The question is how can the data collected to date be used to inform decisions on the success of the campaign and to design an ongoing surveillance project to detect new birds flying in from points unknown?

Recent plant eradications on the islands of Maui County, Hawai‘i

T. Penniman, L. Buchanan, and L. Loope

In the State of Hawai‘i, regulations to limit plant introductions are currently very limited. A network of interagency, island-based invasive species committees have evolved over the past decade to address this vulnerability, with the aim of stopping invasions before they threaten natural areas. Control efforts on Maui, Moloka‘i, and Lāna‘i, which comprise three of the four islands of Maui County, have resulted in single-island eradications of 13 plant species, with an additional 8 species on target

for likely imminent eradication. Species considered eradicated include: (Maui) *Acacia retinoides*, *Enchylaena tomentosa*, *Macaranga mappia*, *Melastoma candidum*, *M. sanguineum*, *Parkinsonia aculeata*, *Rhodomyrtus tomentosa*, and *Rubus ellipticus*; (Moloka'i) *Cortaderia jubata*, *Macaranga tanarius*, *Pennisetum setaceum*, and *Ulex europaeus*; (Lāna'i) *Cryptostegia sp.* and *Macaranga mappia*. Despite a shared political affiliation and geographical proximity, with the average distance between islands at approximately 14 km, the islands vary considerably in size, population, ethnicity, economics, and land ownership. We explore the relative importance of those variables in achieving successful eradications along with the following factors: target species selection, including biological characteristics, feasibility assessment, and legal status; a dynamic and flexible workforce; detection and control strategies for multiple species across multiple islands; and substantial public and political support.

Mexican red-bellied squirrel eradication from Biscayne National Park in South Florida: there's a first for everything!

A. Pernas and D. Clark

In 2008, the US National Park Service (NPS) developed and implemented a precedent setting program to completely eradicate the introduced non-native Mexican red-bellied squirrel (*Sciurus aureogaster*) from several islands within Biscayne National Park (BISC) located off the southeastern coast of Florida near Miami. First introduced in the late 1930s, the *S. aureogaster* population increased unchecked posing a significant threat to the Park's natural resources including several legislatively protected plants and animals. The introduced invasive squirrel also demonstrated the potential to spread to other islands as well as the mainland of Florida and United States by being observed swimming across deep channels between islands. This range expansion outside of BISC would likely lead to competition with native wildlife including native squirrels as well as several other state and federally listed species such as the key largo woodrat. Damage to Florida's agricultural industry, especially vegetables and tropical fruits, is also a major concern since *S. aureogaster* is known to be a significant agricultural pest in its native range.

The eradication project includes development of a management plan including preferred eradication alternatives, monitoring, a resource management weapons training program, and ground and aerial surveys to locate dreys (squirrel nests) for follow-on removal. Aerial survey for dreys includes the use of rotary winged aircraft and a sophisticated digital sketchmapping technique never before used in the US for invasive mammal eradication. Marked dreys are systematically visited after dusk by trained technicians on foot while squirrels are present. Each drey is precisely destroyed by shooting through the use of non-lead shotgun ammunition simultaneously humanely euthanizing its occupants. Project monitoring consists of regularly scheduled drey surveys, camera traps, nest boxes and hair tubes. Authors will present an overview of the program including planning development, operations, methods, and successes and challenges of the eradication.

Small Indian mongoose *Herpestes auropunctatus* - eradication and management using DOC 250 kill traps, first lessons from Hawaii.

D. Peters, L. Wilson, S Mosher, J. Rohrer, J. Hanley, A. Nadig, and M. Silbernagle

Small Indian mongoose *Herpestes auropunctatus* are a catastrophic invasive pest of the West Indies, Hawaiian Islands, South America, Fiji, Mafia Island (Tanzania) and Africa. Small Indian mongoose prey upon and cause extinctions of many bird, mammal, reptile and insect species. Proven and successful tools must be found to manage and eradicate this pest. Direct control of mongoose has been restricted to live cage traps which require daily checks and, in some cases, the added work of providing shelter, food and water to trapped animals. Small Indian mongoose prey upon and contribute to the decline of at least four Hawaiian endemic bird species: Hawaiian moorhen, Hawaiian coot, Hawaiian duck and Hawaiian stilt. Agencies tasked with preventing the decline and extinction of these species put large quantities of resources into their protection mainly into labour intensive live trapping. Humane kill traps have advantages over live traps: they can be checked less often and their

check regimes can be tailored to suit the knock down and control phase of each operation. We trialed DOC 250s at two sites in Hawaii testing the trap's attractiveness and humaneness. At the Hawaii site we caught 10 mongoose in five traps over 2 nights of trapping and at the Oahu site we caught 8 mongoose in 14 traps over 3 nights of trapping. This paper will present the results of two small scale field trials using DOC 250 kill traps (Hawaii Island, Hawaii 2007 and Oahu, Hawaii 2009). These results and their future application will be discussed.

Control of the invasive black rat (*Rattus rattus*) and Pacific rat (*Rattus exulans*) using a large scale trapping grid for endangered tree snail and plant conservation in Hawaii.

S.M. Mosher, D. Peters, L. Wilson, J.L. Rohrer, and A. Shiels

Introduced rats (*Rattus* sp.) in Hawaii are known predators of birds, tree snails, and plants. Since 1997, the Oahu Army Natural Resources Program has been controlling rats through the use of diphacinone rodenticide in bait stations and snap traps on a relatively small scale at multiple sites for the protection of the endangered Oahu Elepaio (*Chasempis sandwichensis ibidis*), five endangered Oahu tree snail species (*Achatinella* sp.), and seven endangered plants species. In May 2009, rat control was initiated over a 26 ha forested management unit with 400 snap traps on the island of Oahu. New Zealand Department of Conservation current best practice rat trap technology is being utilized for the first time in Hawaii with this trap out effort. Rat activity within the management unit will be monitored through the use of tracking tunnels. Forest health, the endangered plant *Cyanea superba* subsp. *superba*, the Oahu tree snail *Achatinella mustelina*, and native invertebrates will be monitored closely to determine the effectiveness of the trap out. Introduced slugs and the predator snail *Euglandia rosea* will also be monitored to determine whether rats are suppressing these two highly invasive species.

Enhancing biosecurity at the Phoenix Islands, Kiribati

R. Pierce and T. Teroroko

All eight of the Phoenix Islands lie in the Phoenix Islands Protected Area (PIPA), Republic of Kiribati. The terrestrial restoration approach of the draft PIPA management plan is to eradicate invasive alien biota (mainly vertebrates) initially from the priority islands, then work towards total eradication of pest vertebrates from the PIPA. Meanwhile improved biosecurity is critical across the entire PIPA and at the Gilbert and Line Groups. Key risks have been identified via workshops and targeted consultation – they include potential invasions stemming from the visits by legal and illegal fishing vessels, tourist vessels and national freighters, all of which can carry a variety of invasive species. Key biosecurity approaches being implemented include the passing of a national Biosecurity Act, setting up of a biosecurity committee, strengthened biosecurity at the borders and internally, and emergency response plans. A novel border approach is to make use of the licensed international fishing vessels visiting Kiribati waters, with vessels having an observer and a geo-fencing radio-beacon on board. It is proposed to require these vessels to be pest-free as part of licensing. Surveillance and apprehension of others will occur via combinations of the complying captains reporting illegal vessels, together with the periodic deployment of aerial and sea surveillance craft. National freighters and other vessels will be inspected at ports of departure where biosecurity is also being strengthened, and also prior to entry at Kanton, PIPA. There are needs for further capacity development as well as international agreements with relevant countries at their departure ports. All of these biosecurity approaches are largely untested but will be continually refined in the future.

A decade of eradications in the Falkland Islands and South Georgia

S. Poncet, D. Poncet, L. Poncet, D. Christie, and D. Brown

Within the past decade Norway rats have been removed from 20 islands in the Falkland Islands and one island in South Georgia. The islands range in size from 1 to 305 hectares. Islands were selected on the basis of accessibility, cost, landowner support, distance offshore and habitat for key rat-vulnerable bird species. The assumption that these islands have a high potential for re-colonisation by these

species has been confirmed by the return of tussacbirds and South Georgia pipits and an apparent increase in white-chinned petrel and sooty shearwater populations.

With no helicopters available, the main method of bait application has been hand broadcasting. Hence, some of the largest islands in the world cleared of rats using this method are in the Falklands. Initially, local operators were supervised by New Zealand experts, thereby gaining the experience required to run their own programmes which now employ local fieldworkers. Operations between 2000 and 2004 used Pestoff (20 ppm brodifacoum) cereal-based pellets. Ditrac wax blocks (50 ppm diphacinone) were used in 2007 - 2009. A GPS-derived grid marked by bamboo canes ensured even bait coverage and the baiting regime was determined by habitat.

Recent developments in the Falklands include the first multispecies eradication attempt: Patagonian foxes were eradicated from Tea Island in 2008 followed by Norway rats in 2009. At South Georgia, plans to eradicate Norway rats and reindeer are in progress.

The eradication of exotic mammals from three coastal islands in New South Wales, Australia

D. Priddel, N. Carlile, I. Wilkinson, and R. Wheeler

In 2005, the only coastal islands in New South Wales, Australia, known to have populations of exotic mammals—black rat (*Rattus rattus*), house mouse (*Mus domesticus*) and European rabbits (*Oryctolagus cuniculus*)—were Brush Island, Montague Island and the Broughton Island Group. Eradication programs to remove these pests have recently been conducted on all these islands. Techniques followed those developed by the New Zealand Department of Conservation, and involved the application of cereal-based bait (Pestoff® 20R) containing the anticoagulant brodifacoum. Brush Island (36 ha) was treated for rats using bait stations in July 2005 and declared pest-free in 2007 after trapping failed to detect any rodents. Montague Island (80 ha) was aerially baited for mice and rabbits in July 2007 and declared to be free of these pests in 2009, following intensive monitoring that included the use of tracking tunnels. The Broughton Island Group (182 ha) was aerially baited for rats and rabbits in August 2009. Detector dogs were used to search for any surviving rabbits in September 2009, and monitoring for the presence of rats is continuing. Recent surveys on Brush Island have revealed increased numbers of frogs and crabs as well as the presence of the white-faced storm-petrel (*Pelagodroma marina*), a species not previously recorded there. It is expected that this species will also recolonise Broughton Island as a large population once bred there, but disappeared soon after rats arrived.

Can invasive Argentine ants be eradicated from Santa Cruz Island, California, or be managed to minimize or eliminate harmful effects on biodiversity?

J. M. Randall, S. Morrison, K. Faulkner, C. Boser, C. Cory, P. Power, and L. Lozier.

Non-native Argentine ants (*Linepithema humile*) are established on California's Santa Cruz Island but appear not yet to be widespread. They were first detected on the island in 1996 but a survey completed in May 2009 found that while they had spread they were still confined to three sites totalling roughly 100 hectares on this 243 km² island. The survey found evidence of the expansion of ants at two sites to nearby riparian corridors at rates of 30 to 60 meters per year, but little or no evidence of expansion into dry upland areas at any of the three sites. Encouragingly, no evidence of Argentine ants was found at 15 other sites on the island with heavy human use. Argentine ants have invaded tropical and temperate areas around the world and have negative effects on the abundance and diversity of native ants and other invertebrates and well as negative impacts on native plants, lizards and birds in protected areas. They invaded mainland California by 1905 and now occupy most coastal areas of the state as well as riparian and irrigated areas in the inland Central Valley. Santa Cruz Island has at least 32 native species of ant and a rich native invertebrate fauna, and earlier work showed that native ant abundance was low near Argentine ant colonies. Santa Cruz Island is highly valued as a conservation area both because it harbors a large number of endemic plant and animal taxa and because several of the most destructive non-native animals once established there have been eradicated, including feral

sheep, pigs, turkeys and honeybees. Argentine ants are now the most harmful invasive animal known remaining on the island. We present findings from a formal assessment to determine whether it is possible and affordable to eradicate them.

Howland, Baker and Jarvis Islands 25 years after cat eradication: recovery in biogeographical context

M.J. Rauzon, D.J. Forsell, E.N. Flint, and J. Gove

For more than a century, three small equatorial islands in the Pacific experienced introduced rodents, cats, and plants, guano mining, military encampment and bombing during WWII toxic contaminants, and biological and chemical weapons testing. In 1973, the islands were protected as U.S. National Wildlife Refuges and mitigation of the stressors began in 1975. The final removal of feral cats in the 1980's has had the greatest benefit to seabirds. Jarvis Island has shown the most dramatic restoration having regained almost all of the 17 seabird species that might be expected to nest there. Howland and Baker Islands have regained enormous populations of seabird species but have not had recolonization by several Procellariiforms that once occurred, perhaps because of the greater distance to healthy source populations. Similarities and differences in the recovery of pre-contact species composition and ecosystem function at the three sites can be partially explained by geography, land use history, climatology and the ecology of each site and its nearest island neighbors and stochastic factors. A surprisingly vigorous rebound of the smallest seabird, the planktivorous Blue Noddy (*Procelsterna cerulea*) at these islands can be attributed to the strong local upwelling at each site caused by the Deep Equatorial Current. Populations of these and other small and vulnerable seabirds that these islands now support were suppressed by introduced mammals before ornithologists ever recorded large numbers and are thus a surprise benefit of the eradication efforts. Continued recovery of these guano islands are assured with the 2009 protection of the regional upwelling system extending out to 50 miles as part of the Pacific Remote Islands Marine National Monument.

Aerial baiting for rodent eradication programmes

J. Ritchie and R Stevenson

Aerial baiting and the use of brodifacoum based cereal baits is the primary technique employed on island based rodent eradication programmes. More recently with the approval of a Code of Practice this techniques has been expanded to pest fenced mainland programmes.

Skywork Helicopters has put a considerable level of investment into the development and refinement of gear and equipment for aerial baiting. This is based on a system of continuous improvement and experience working on mainland sites such as Tawharanui Regional Park (Northland), Rotokare Scenic Reserve (Taranaki) and offshore islands including Little Barrier, McCauley Island, Rangitoto/Motutapu, Great Barrier and the Kaikoura Island chain.

Aerial baiting operations for eradication programmes require exacting standards and the use of experienced pilots and ground crew. These operations are often located in remote environments and require effective logistical support and good problem solving skills.

Planning and operational management of these operations requires good knowledge of the pest species present, the land area the operation is to be undertaken in as well as what factors may influence a successful baiting operation, e.g. weather, steep cliffs, accuracy of helicopter buckets, the use of DGPS navigational systems etc. We will use a number of examples from various operations to demonstrate the effectiveness of this management system.

Bagging them all in one go - the challenges of community based multi species pest eradication programmes

J. Ritchie

Animal pest eradication programmes were once only undertaken by the Department of Conservation on isolated offshore islands. Successful programmes and increasing public concern over the continued decline of New Zealand's native species, has provided the impetus for an increasing number of community groups to take up the challenge of attempting eradications of animal pests on the mainland.

Advances in pest proof fencing led by the Xcluder Pest Proof Fencing Company provided a tool for achieving animal pest eradications on the mainland. A number of community groups rose to the challenge and started down the path of intensive restoration projects with the removal of animal pests as a key task.

Where previously, the removal of animal pests were ticked off one by one, efficiencies in management techniques and increasing experience in pest eradications led to more and more attempts to remove more than one pest at once and up to 12 at the same time. This presentation will illustrate some of the challenges and lessons learned and stimulate some debate on how we can continue to improve our ability to undertake these projects. It will include discussion on the following: getting started – being real about what it takes; plan the work - work the plan; aerial baiting technology – the initial knockdown; the toolbox of techniques for multi species eradications – what works and what doesn't; DNA fingerprinting – finding out where reinvaders come from; the difficulty of detecting pests at low numbers; community perceptions on toxins; the challenges of ongoing funding and sustaining projects; level of support from TLA's and DoC; and, the importance of building and maintaining good relationships.

The eradication of invasive mink *Neovison vison* from the southern islands of the Hebridean archipelago, and the lessons learned along the way

S. Roy

The American mink is listed as one of the world worst invasive species and has had a devastating impact across Europe. From 2001 –2006 a project was undertaken to eradicate the species from the Uists, a group of islands in the south of the Outer Hebridean archipelago off the west coast of Scotland. These islands are important breeding grounds for a number of internationally important populations of ground nesting bird species. The project was successful and 532 mink were removed through a combination of live trapping and capture at breeding den sites. The breeding success of indicator bird species also showed measurable improvements.

Several research projects were carried out alongside the main operational section of the project. Analyses of data from these research projects and from the operational section were used to direct the eradication through a process of adaptive resource management and informed decision-making. Also, due to financial and temporal constraints, a number of important techniques have been developed through necessity in order to improve the effectiveness of the methods used. The main refinements discussed include spatial, seasonal and logistical improvements to the methods used, while some of the techniques developed include modifications in trap design, and the use of scent glands to improve capture success. The lessons learned from the project have since been applied to a number of mink control and eradication projects in the region, and these are discussed.

Introduced rat over-invasion of Tetiaroa, French Polynesia

J.C. Russell, L. Faulquier, and M. A. Tonione

All three species of invasive rats are found throughout the Pacific Ocean: *Rattus rattus*, *R. norvegicus* and *R. exulans*. Over-invasion of the historically introduced *R. exulans* by latter arrival of the European rat species *R. rattus* and *R. norvegicus* has been widespread, although rarely documented as it happened. These over-invasions cause asymmetrical competition, forcing habitat and niche partitioning by all three introduced rat species to permit coexistence. Tetiaroa archipelago (Society Islands) consists of 12 small motu with remnant copra plantations from the early 20th century. *R. exulans* was the only species present on the archipelago until the 1970s when *R. rattus* arrived and over-invaded the seven motu composing the north-west chain. We review the ecological history of Tetiaroa, and document the current extant distributions of *R. rattus*, *R. exulans* and the seabird community. Genetic studies confirm the species of introduced rats with CO1 bar-coding, and preliminary microsatellite analyses support the isolation of *R. exulans* populations on nine motu, and the meta-population of *R. rattus* on seven motu. Seabird colonies were generally associated with rat-free motu; small seabirds such as noddies and terns exclusively breed on rat-free motu, although larger seabirds such as frigates and boobies could breed on rat-invaded motu. With hotel development and mammal eradication now occurring on one motu, the challenge is to manage rat eradication and biosecurity both within and from outside of the archipelago in coordination with preserving the seabird community from rat-invasion and ecotourism disturbance.

Rodent eradications on Mexican islands: advances and challenges

A. Samaniego-Herrera, M. Rodríguez-Malagón, A. Aguirre-Muñoz, R. González-Gómez, F. Torres-García, M. Latofski-Robles, and F. Méndez-Sánchez.

Rats (*Rattus* spp.) and house mice (*Mus musculus*) are among the most noxious invasive species. Their impacts include extinctions and extirpations of insular endemic vertebrates. Eradicating rodents from islands is possible and highly recommended. In Mexico, nine rodent eradication projects have taken place on eight islands, eight of them successfully. Methods evolved from bait stations on small islands to aerial procedures on bigger and more complex ones. Six islands (5 to 82 ha) were treated with bait stations from 1993 to 2002. Three islands (17 to 267 ha) were treated with the high-tech aerial technique, being the first time in Latin America, from 2007 to 2009. Post-eradication monitoring is confirming both, rat absence and ecosystem recovery. Examples include recolonization and reproductive success improvement of seabird populations. The experience and trust gained to date are allowing the planning and funding of future projects. Planning, permitting, logistics, research, and execution have been attended following a focused collaboration approach with multiple partners. There are at least 20 more Mexican islands with one or two invasive rodents. Pending challenges include bigger islands (e.g. Guadalupe; 24,360 ha), tropical islands (e.g. Banco Chinchorro; 580 ha), and islands with endemic mammals including rodents (e.g. María Madre; 14,388 ha). The presentation will describe methods, results, problems, solutions, key partnerships, and future plans.

An attempt of the surveillance sensitivity comparison in Amami-ohshima Island, Japan.

S. Sasaki, F. Yamada, T. Hashimoto, K. Fukasawa, J. Kobayashi, and S. Abe

Many endemic species in Japan, especially in small islands, are now threatened from invasive alien species. In 1979, small Asian mongoose (*Herpestes javanicus*) was introduced into Amami-ohshima Island to control native poisonous habu snake (*Protobothrops flavoviridis*). However, the mongoose has had a predatory impact on the endemic animals.

From 2005, the Ministry of the Environment began a 10 years period full-scale project to eradicate the

mongoose from the whole island. The project has been succeeding about to decrease the population density of the mongoose. Some scientists (e.g. John Parkes and Alan Saunders) gave many advices about this project in the CSIAM2008 (the Symposium of Control Strategy of Invasive Alien Mammals 2008, held in Okinawa Japan). They said that at the next stage, we should have the capture technique in the low density area, and a method to investigate the presence or absence of the mongoose.

Responding to their advice, we are going to develop some methods to investigate the presence or absence of the mongoose. To do this, we have to know the relationship between confirmed frequency and population density. At first, we start a research to know a relationship between photographed frequency by sensor camera and population density. Because, it is thought that the photographed frequency is proportional to population density. We report about the design and the progress of our research.

Trap allocation strategy for the mongoose eradication project in Amami-Ohshima Island, Japan.

S. Sasaki and H. Matsuda

When the establishment of an invasive alien species has once been detected, we should take appropriate steps such as eradication, containment and control. If the eradication is not feasible, the goal of control is to keep a lower population size or to prevent expansion of the distribution of the invasive species. There is a trade-off between high and low population density areas in population control. When the manager allocates many traps in a center of distribution, the population distribution may expand. Eradication is possible if spatial trap allocation is appropriate. In many cases, the manager does not have sufficient information about the distribution of the target species. Therefore, effective trap allocation method based on the capture results of the previous year is probably useful to control the target species. We examined effective trap allocation by using a lattice model in both cases that the eradication is possible and impossible. We suggest effective trap allocation strategy using parameter values of small Indian mongoose in Amami-Ohshima Island where the mongoose eradication project has been carried out by Ministry of the Environment.

Increasing the pace, scale, and effectiveness of island restoration

A. Saunders, J. Parkes, A. Aguirre-Muñoz, and S.A. Morrison

The impact of invasive species on island ecosystems and human livelihoods around the world is severe. Fortunately, advances in eradication offer hope that many threats posed by invasive species on islands can be abated. Most island eradication projects to date, however, have been designed and implemented as “one-off” projects. While that approach has led to important successes, it will be challenging for it to deliver restoration successes at the fast pace and the large scale needed across the world’s islands. Planning and implementing restoration projects in a more programmatic and coordinated manner such that suites of islands and or suites of invaders are addressed systematically would be needed. Here we present a concept for conducting multiple eradication projects using a ship-based platform. This could improve the effectiveness and efficiency of eradication operations and reduce associated risks of failure through reducing start-up costs on different islands and regions, overcoming logistical challenges in working on remote islands, building and retaining specialised national and international capacity, and providing economies of scale. Perhaps the most significant advance, however, is that it would transform implementation via individual projects into a sustained “eradication and restoration programme.” We discuss the potential advantages and disadvantages of this approach and outline the next steps in its due diligence, with the intent of fostering a dialogue for vetting and advancing the concept. Securing societal and conservation returns from this concept will require setting regional eradication priorities, preparing a “pipeline” of appropriately designed projects, and securing the necessary stakeholder, institutional and financial support.

Eradicating multiple pests: an overview

A. Saunders

Most eradications to date have involved the targeting of single invasive mammals from relatively small islands. More typically, however, islands have suites of animal and plant pests present. The cumulative impacts of multiple pests and their dynamic interrelationships often means that a fuller set of the pests present must be removed. Increasingly where multiple pests have been eradicated significant conservation outcomes have been reported. While there is increasing interest in achieving such outcomes multi-pest eradication projects are inherently more complex. There may be significant risks associated with a lack of understanding of key ecological relationships, and an inability to predict management outcomes. Overlapping impacts between pests and compensatory responses by those remaining are examples of issues which must be addressed in the design of multi-pest eradication projects. A lack of precedents in applying particular eradication regimes and specific techniques can also present important challenges. Acknowledging stakeholder perspectives and incorporating social, cultural and economic dimensions in the design of eradication projects is also important – especially as eradications are proposed for inhabited islands. Two general approaches have been used where multiple pests have been targeted for eradication; sequential programmes – where pest species are removed one after the other, or simultaneous programmes – where all targeted pests are removed at the same time. Simultaneous programmes may involve either single or “mixed-tactic” regimes. Important benefits in relation to reduced costs and risks can be expected when multiple pests are eradicated. For example, the marginal benefit per pest eradicated can be expected to increase as more pests are removed. In this session we will consider a number of “cutting edge” projects where multiple pests have been targeted for eradication, and consider the lessons learned.

Canine detection of free-ranging brown treesnakes on Guam

J. Savidge, R. Reed, J. Stanford, G. Haddock, and A.Y. Adams

We investigated canine teams (dogs and their handlers) on Guam as a potential tool for finding exotic Brown Treesnakes (BTS) in the wild. Canine teams searched a defined 40m × 40m forested area with a snake that had consumed a dead mouse containing a radio-transmitter. To avoid tainting the target with human scent, no snake was handled prior to searches. Trials were conducted during the morning, when snakes were usually hidden in refugia. A tracker knew the snake’s location, but dog handlers and data recorders did not. Of 85 trials conducted over 4 months, the two canine teams had an average success rate of 35% of correctly defining a 5-m square area that contained the transmitted snake; the team with the most training had a success rate of 44% compared with 26% for the newer team. Eleven sheds from wild snakes were found, and although dogs alerted outside the location of transmitted snakes, only one wild, non-transmitted snake was found during the trials, possibly reflecting the difficulty humans have in locating BTS in refugia. We evaluated success at finding BTS as a function of canine team, time, canine success at the previous trial (we predicted that dogs that had been recently rewarded might be more successful), environmental conditions (% clouds, average humidity, average temperature, average wind speed, rain during trial, and rain in previous 6 hours), snake perch height, and snake characteristics (snout-vent length and sex). Success rate increased over the course of the trials, perhaps due to increased searching experience. Canine team success also increased with increasing average humidity and decreased with increasing average wind speed. Our results suggest dogs could be useful at detecting BTS in refugia, but techniques are needed to help humans pinpoint a snake’s location once a dog has alerted.

Restoration of globally important seabird islands in Fiji by the removal of rats

E. Seniloli, T. Tuamoto, and S. Cranwell

Seabirds are becoming increasingly scarce among the more than 300 islands of the Fijian archipelago. Several reasons have been attributed to this, but, key amongst these are the introduction of alien mammals to breeding islands (particularly rat spp, feral cats, pigs and dogs) and other anthropogenic influences such as fire and harvesting. In an effort to protect breeding seabird colonies in Fiji, BirdLife International Fiji Programme undertook an assessment of seabird islands identifying sites of national and global importance. Threat assessments confirmed the presence of at least one species of introduced mammalian predator on all islands. In 2006, Vatu-i-ra Island following identification as an IBA was subject to a Pacific rat (*Rattus exulans*) eradication operation removing the invasive predator of seabirds from the island. This operation was a success and in 2008 was followed by rodent eradications from seven of the Ringgold Islands and Mabualau. Community consultation is a vital component to invasive species management in Fiji, as 75% of the land tenure is native owned. The development and implementation of these projects has been conducted using a participatory process where capacity development has been extended to landowning communities. Despite the achievements and local support for the restoration of seabird islands the biggest challenge remains with the long term management and maintenance of pest free islands. The current approach to this is presented.

Creating an island sanctuary: a case study of a community-led conservation initiative

V. Shaw, J D Whitehead and C T Shaw

The Pomona Island Charitable Trust is a community-led initiative with the vision of restoring Pomona Island, Lake Manapouri, New Zealand, to a pest-free state and maintaining it as an island sanctuary. The Trust aims to provide an accessible location for locals and visitors to see, hear and learn about the flora and fauna native to Fiordland.

Since the Trust was formed in 2005, over 163 different volunteers have put in over 4000 hours of work on the island to remove five pest species – stoats, deer, possums, rats and mice. Over NZ\$165,000 of direct funding has been raised, largely from within the local Fiordland Community, with a further NZ\$130,000 of in-kind donations contributing to the work of the Trust. With all animal pests now removed from Pomona Island, volunteers have re-introduced 51 South Island robins – the first of many planned translocations.

Department of Conservation staff have described the Trust's achievements as "a model for community driven conservation". This paper will, therefore, present a case study of the Pomona Island Charitable Trust. It will focus on the managerial initiatives undertaken to plan for the restoration of Pomona Island, how the Trust has worked with key stakeholders including the local community and the Department of Conservation, strategies for successful fund-raising, and how to maintain momentum in a long-term community-led conservation project. Based on the experiences of the Trust a model for successful community-led conservation projects will be presented.

Eradicating rodents from Pomona and Rona Islands in Lake Manapouri

V. Shaw and N. Torr

Pomona and Rona Islands are situated in Lake Manapouri in the Fiordland National Park, New Zealand. Since 2006 a community-led initiative, led by the Pomona Island Charitable Trust, has been removing the introduced pests from the two islands. Rona Island had stoats and mice present, whereas Pomona Island had five pest species to be removed: stoats, deer, possum, rats and mice. Pomona and Rona Islands are 500m and 600m respectively from the mainland. Having removed the stoats from Rona Island and the stoats, deer and over 430 possums from Pomona Island, the Trust undertook an aerial operation to eradicate the rodents from both islands. Following best practice, the aerial operation involved two aerial drops of the pesticide brodifacoum conducted 40 days apart.

The paper will provide an overview of the eradication techniques for each individual pest species on the islands. The main focus will, however, be on the planning for the rodent eradication operation, community consultation, the logistics of the aerial operation itself as well as the post-eradication monitoring to assess the success of the operation. The biosecurity measures put in place post-rodent eradication will also be discussed and their effectiveness assessed.

Invasive alien fauna in Sri Lanka

P. Silva, S. Ranwala, D. Weerakoon, B. Marambe, S. Wijesundara, L. Manawadu, N. Atapattu, J. Gunawardena, and M. Kurukulasuriya

Invasive alien species have a major impact on biodiversity. At least 39 per cent of the species extinction in the world during the past 400 years is due to invasive alien species. Based on a risk assessment procedure, Sri Lanka has identified 30 alien fauna either as invasive or potentially invasive, including 15 vertebrates, 4 mollusks and 11 invertebrates. The freshwater and ornamental fish industries are the major sectors that are responsible for the introduction of freshwater invasive species to Sri Lanka. Of the 13 invasive alien fauna where information on the year of introduction is available, 7 have been introduced before 1978 (the year of introduction of open economic policies) and 6 thereafter.

Direct destruction of native species, being superior competitors, hybridization with native species, and being agricultural pests are the main impacts of invasive alien fauna on the ecosystems. Drafting of relevant policies and legislative frameworks, establishment of institutional framework, implementation of research targeting specific invasive alien fauna, dissemination of knowledge and species target control measures are the main actions adopted to manage the spread of IAF in Sri Lanka.

This paper summarizes the status of invasive alien fauna reported to-date in Sri Lanka. Some of these species have already resulted in a significant impact on the native biodiversity, while others are on the route of destruction of biodiversity of Sri Lanka. Hence, there is an urgent need to adopt proper control measures to prevent further damage to the biodiversity of the country.

Management of the red crab (*Gecarcoidea natalis*) on Christmas Island, Indian Ocean: the efficacy of a yellow crazy ant (*Anoplolepis gracilipes*) baiting program.

M. Smith and C. Boland

Christmas Island is located approximately 360km south of the western head of Java, Indonesia. One major biological feature of the island is the unusually high density of red crabs (*Gecarcoidea natalis*) which are considered a 'keystone species'. *Gecarcoidea natalis* can determine vegetation communities through their herbivory and limit the potential for colonisation by some introduced species. In the late 1990s, *G. natalis* was extirpated from large areas of Christmas Island after the formation of supercolonies by the introduced yellow crazy ant (YCA; *Anoplolepis gracilipes*). In response, Christmas Island National Parks embarked on a YCA supercolony baiting program that has been running continually since 2001. Here, we report on the outcomes of a biannual island wide survey that has now been conducted 5 times to monitor changes in crab burrow densities relative to YCA baiting. On each survey, occupied *G. natalis* burrows are counted along a 50 metre transect at 877 survey points across the island. We used a Bayesian hierarchical spatial model to show that,

despite the death of up to 33% of *G. natalis* in the early phase of YCA supercolony formation, densities of crab burrows have remained stable since 2001. However, significant, but more localised changes in burrow densities occur on a regular basis, suggesting a dynamic system.

Macquarie Island pest eradication: planning processes for eradication of multiple pest species

K. Springer

Macquarie Island presents an ambitious eradication challenge because of the remoteness, large size, terrain, weather and the mix of target species. Long lead times for planning are required, reflecting the scale and complexity of logistics and regulatory aspects. However many of these are contingent on decisions taken early in the feasibility and planning process, and reinforce the importance of selecting the best options for eradicating target species. In planning for eradication of ship rats (*Rattus rattus*), house mice (*Mus musculus*) and European rabbits (*Oryctolagus cuniculus*) from Macquarie Island, many concepts and techniques were applied from previous eradication operations. These identified that both rodent species would take the same baits; that aerial distribution was the only feasible method of applying bait; that mice were likely to be more difficult to eradicate than rats; that while rabbits found the bait palatable some individuals would not take bait and rabbits were thus unlikely to be eradicated by aerial baiting; that comprehensive follow-up hunting would be required to remove surviving rabbits; and that trained detector dogs would be a significant advantage in detecting surviving rabbits. These factors formed the basis for subsequent bait trials, which in turn were used in a permit application to use the toxin (unregistered in Australia for rabbits) and in environmental impact assessments at state and federal level. Approvals are specific to the toxin, techniques and/or bait nominated in applications, so commitment to methods selected increases as planning evolves. Procurement priorities were also determined by early decisions. Dog training was expected to take two years and was the first major procurement item. Bait, shipping and helicopter contracts were also required. Intended eradication techniques also determined staffing levels and the equipment required to support them. Approximately 40% of projected costs are associated with post-baiting rabbit hunting.

Improving “internal” biosecurity in the Falkland Islands: a pragmatic approach

C. Stringer, B. Summers, Derren Christie, D. Brown, H. Otley, and N. Rendell

The Falkland Islands are an archipelago of more than 700 islands, with a wide range of sizes, topography, and ownership arrangements. Many islands are privately owned: some of these are farmed, and some have residences that are occupied for all or part of the year; other islands are uninhabited and treated as reserves or used for grazing livestock. The main transport methods between islands are private boats, ferry, the Falkland Islands Government Air Service (light aircraft) and helicopters. There are three species of rodents present in the Falkland Islands: black rats (*Rattus rattus*), brown rats (*Rattus norvegicus*) and house mice (*Mus musculus*). Some islands have remained rodent-free, but many have one or two of these species present. Since 2001, a successful programme of rodent eradications has been undertaken in the Islands, with more than 20 islands cleared. With increasing numbers of rodent-free islands, reducing the risk of reinvasion (or new invasion) has become a growing priority. The recent emergence of new pest species has also raised the profile of biosecurity issues amongst landowners, the general public and the Falkland Islands Government. A pragmatic, non-regulatory approach has been taken to improving “internal” or inter-island biosecurity in the Falkland Islands in the last three years. Current worldwide best practices were investigated and elements from different programmes were selected to create a system of island biosecurity that should be manageable, cost-effective, and achievable for different landowners and users. This approach has involved improving public awareness and education rather than introducing legal regulations. This approach could be applied in other island groups where reducing the risk of pest invasion is important but legal regulations are lacking. This work was funded by the European Union’s EDF-9 fund and the Falkland Islands Government, with support from island owners and Falklands Conservation.

Developing a regional invasive species strategy for the South Atlantic UK Overseas Territories

C. Stringer, C. Shine, A. Darlow, and B. Summers

The UK has responsibility for five Overseas Territories (UKOTs) in the South Atlantic. Each of these has unique assemblages of endemic plants and animals, for which the greatest recognised threat is invasive species. As well as having significant negative impacts on biodiversity values, invasive species also have significant economic impacts, particularly in those UKOTs with low annual GDP per capita. The human populations of all of the South Atlantic UKOTs are low, ranging between c265 on Tristan da Cunha to c4000 on St Helena (South Georgia is not populated). With such low human and financial resources, it is vital to share experiences and avoid duplicating effort wherever possible. Development of a regional strategy for invasive species was seen as a key step to build links for future cooperation especially to enable collaboration for eradications and control of invasive species in the region, and to prevent new establishments. A workshop involving representatives from all partner organisations including representatives from agriculture, environment, and border security along with scientists, and non-governmental stakeholders was held on Ascension Island in May 2009. This allowed a fully-consultative approach to Strategy development to be taken. Priorities were developed by those attending the workshop, and consulted with other stakeholders remotely. The Strategy will now form a basis for South Atlantic invasive species work in the future. The South Atlantic Invasive Species Strategy could not have been developed without the full support of all of the project partners: the governments of St Helena, Ascension Island, Tristan da Cunha, the Falklands, and South Georgia and the South Sandwich Islands, along with Falklands Conservation and the St Helena National Trust. This work was funded through the European Union's EDF-9 fund.

When failure is not an option: applying new tools to rodent eradication planning

K. Swinnerton, A. Wegmann, J. Helm, F. Ross, G. Howald, S. Buckelew, and B. Keitt.

Rodent eradication is often successfully used to protect native island biota from the negative impact of introduced rodents. However, as this tool is increasingly applied worldwide, standard eradication methodologies are being challenged by increasingly complex systems, e.g. commensal rodents, multi-island atolls and tropical ecosystems. To address these issues, Island Conservation applied three new tools to refine rodent eradication planning: a biomarker bait; hand-broadcast using GIS; and genetic sampling protocols. On Palmyra atoll and Wake Island (tropical Pacific) and Desecheo Island (Caribbean), a placebo bait using the biomarker pyranine, a fluorescent dye, was used to determine bait application rates for high density *Rattus* sp. and commensal rodent populations, and to track bait consumption in land crabs and other invertebrate consumers, which are potential secondary sources of rodenticide for non-target predators. On Wake Island, placebo bait was hand-broadcast across 10 ha study plots using hand-held GPS units uploaded with a GIS layer of predefined points at which bait was broadcast. In the event of a rodent eradication failure, Island Conservation has also developed protocols for genetic sampling of rodent populations to determine if failure was due to re-emergence of a residual population or re-invasion from an outside source. Together, these tools have improved our efficiency of ground-based bait application, enabled a better understanding of non-target bait consumption, and overall have improved our rodent eradication planning, including learning from potential failures.

The community-based nutria control by traditional irrigation systems

S. Tatsuzawa, Y. Suzuki, and K. Kobayashi

Nutria *Myocastor coypus* was once a farmed animal for fur coats, but has been abandoned and naturalized in Honshu island, Japan. Especially in and around of agricultural regions of Hyogo prefecture, this semi-aquatic mammal has rapidly expanded its distribution range in this decade. From some observations in Kasai City which is a typical new range of nutrias, it was discovered that they exhausted some aquatic plants and therefore threatened some invertebrate species including a Japanese endangered dragonfly *Libellula angelina*. Although a nutria has been recognized as a serious invasive species for a wetland ecosystem, it is hard to eliminate them by hunting or trapping because their home ranges are inlaid in villages. To develop an ecological method to control nutria's population, we investigated their dispersing pattern and tried to exclude them from some drainage systems by an indigenous irrigation technique in Kasai City. At first, from analysis of records of first appearance and observations of animals, we clarified that they dispersed through non-manipulated irrigation canal systems and bred in banks of ponds. Next, we contrasted their utilization of canals and banks between manipulated and non-manipulated systems, and it was confirmed that nutrias avoided a fast current and a large fluctuation of water level probably by reason of their difficulties of moving and nesting. Therefore, we tried to operate the water level and volume of un-manipulated irrigation systems mainly in winter season, and observed movements of nutrias. Consequently, they hardly forged ahead from lower to upper reaches, nested female groups abandoned their upriver nests and vegetation started to recover in the next year. In conclusion, reactivation of this old-styled indigenous irrigation system is an effective and receptive (a community-based) method to control the invasive species, nutrias and to restore the specific wetland ecosystem.

Snap-trapping, a viable alternative to ground-based poison operations for eradication and/or control of rats in island and mainland situations

B. Thomas, K. Mouritsen, J. Kemp, and P. Dunlevy

Field-trials during development of the novel, Ka Mate, reverse-bait snap-trap and in particular a large-scale snap-trapping operation targeting rats, involving 450 Ka Mate traps deployed over 75 ha of mature broadleaf/podocarp/kauri forest in Waiaro Sanctuary (Coromandel, New Zealand) in 2009, were designed to replicate with traps classic, ground-based poison campaigns (e.g. the landmark, 1988 eradication of rats from Breaksea Island), to achieve similar successful outcomes without the use of toxins. In Waiaro, rat-catch reduced significantly from 117 *Rattus rattus* killed on night one to less than fifty per check a week later. At six months low catch-takes of 2-10 rats per check occur on the peripheral trap-lines only, with no rat incursion or rat sign found within the core of the trapped area for more than 3 months. All 800+ rats removed from the Sanctuary to date have been clean-kill head-strikes and it is similarly significant that despite the traps being set in open situations without protective stations, a few mice have been the only non-target by-catch. The deployment, effectiveness and problems encountered with various trapping regimes, using a mix of trap types in programmes from wide-ranging localities and habitats worldwide (Seychelle Islands, New Caledonia, Wake Atoll, Hawaii and several New Zealand sites) are also discussed.

The infection risk and pathogenicity of chytrid fungus *Batrachochytrium dendrobatidis* carried by the Japanese sword tailed newt

A. Tominaga, K. Goka, K. Suzuki, and K. Tamukai

Amphibian chytridiomycosis, caused by the chytrid fungus *Batrachochytrium dendrobatidis*, is a highly virulent disease of amphibians and is known to be a major driver of amphibian declines observed in all over the world. In Japan, this fungus was first found in December 2006 from imported pet frogs. The nationwide investigation to assess the risk of pandemic chytridiomycosis to Japanese frogs elucidated that this fungus is distributed in all over Japanese main islands and that the genetic diversity of Japanese chytrid fungus including more than 30 haplotypes is much higher than those of fungus in other countries. Thus, several researchers currently consider that Japanese islands are one of the native localities of this fungus and that amphibian chytridiomycosis observed in all over the world might be caused by the fungus derived from Japanese native one. To verify this “Chytridiomycosis out from Asia hypothesis”, we surveyed the infection risk and pathogenicity of the chytrid fungus carried by the Japanese amphibians. In experimental infection, the chytrid fungus carried by Japanese sword tailed newt *Cynops ensicauda* normally had infected South American horned frog *Ceratophrys ornate* and every frogs infected by Japanese chytrid fungus showed an onset of amphibian chytridiomycosis. Given the fact that Japanese amphibians including sword tailed newt frequently have been exported to foreign countries as a pet, we must consider that the chytrid fungus carried by Japanese amphibians would be also introduced to foreign countries and cause amphibian chytridiomycosis of native species in introduced area.

Eradications of vertebrate pests from islands around New Zealand: what have we delivered and what have we learned?

D.R. Towns

Eradications of invasive mammals have become increasingly complex and expensive. In response to a raised public profile, New Zealand agencies have, through the Resource Management Act 1991, notified many projects that require the spread of toxins. Notification requires the submission and defence of an Assessment of Environmental Effects in which conservation scientists must be prepared to justify the benefits of proposed eradications and defend the science used to measure cause and effect of agents of decline. Here I outline the purported benefits to biodiversity and science for those islands where total mammal eradications have been completed in New Zealand. By 2009, 115 populations of 13 species of vertebrates had been removed from a least 89 islands with a total area of 31 000 ha. Identified benefits to biodiversity were through in situ recovery, translocations or metapopulation management on the 89 islands. These include improved prospects for 16 species of invertebrates, two species of frogs, three taxa of tuatara (*Sphenodon punctatus*), 23 species of lizards, 32 taxa of terrestrial birds and 16 taxa of seabirds. The eradications can also be used to test hypotheses about the impacts of invasive species on native ecosystems. Considerable effort has been applied to understanding the effects of kiore (*Rattus exulans*). There are now published accounts of the effects of these rats on plants, lizards, tuatara and seabirds, often using well designed field experiments. However, the effects of most other invasive vertebrates are poorly documented. Furthermore, impressive accounts of biodiversity achievements obscure potential problems. These include the genetic effects of small relict populations or small founders from translocations. Good reporting systems, agreed performance measures and the frequent communication and defence of benefits are likely to be needed for public acceptance of increasingly ambitious projects.

Coordination mechanisms for invasive species action in the Pacific

A. Tye

Islands are exceptionally vulnerable to invasive species impacts, but small island nations often do not have the human or financial resources to be able to tackle these threats adequately by themselves, especially projects with heavy one-off costs such as eradications. Pacific nations and territories have a long history of cooperation to enable them to overcome such limitations. Mechanisms and tools have been established to promote collaboration and effective action against invasives in the Pacific, which can serve as models for elsewhere, particularly other oceanic regions. The Pacific Invasives Partnership promotes coordinated prioritisation and assistance from regional and international agencies to countries and territories of the region. The Pacific Invasives Learning Network is a professional and information exchange network for invasive species workers in Pacific island countries and territories, with a programme of exchanges for workers to gain experience of new techniques, particularly eradication projects. The Pacific Invasives Initiative locates and provides technical support to demonstration projects, with an emphasis on island eradications. All three of these initiatives assist with building local capacity in different ways. A guiding strategy, the *Guidelines for Invasive Species Management in the Pacific* forms a framework for action by all of them, in which an emphasis is placed on eradication as the preferred management objective for established invasives when feasible. The overall goal of these regional initiatives is to assist Pacific island countries and territories in planning and achieving more effective invasive species management.

Rodent control is effective at reducing nest predation on the endangered Oahu elepaio but insufficient scale of management hinders long-term conservation

E.A. VanderWerf

I investigated importance of threats to the endangered Oahu elepaio (*Chasiempis sandwichensis ibidis*), a forest bird endemic to Hawaii, and evaluated success of rodent control programs from 1995-2008. Rodents were controlled with snap traps and diphacinone bait stations in three sites that were switched from control to treatment over time. I estimated survival of color-banded birds using multi-state mark-recapture models, and I monitored success of 193 nests and determined annual reproduction of each pair. Rodent control resulted in higher nest success (61% vs. 33%) and annual fecundity (0.71 ± 0.05 vs. 0.33 ± 0.07). Survival of females was higher with rodent control (0.80 ± 0.05) than without (0.56 ± 0.12), but survival of males was not affected by rodent control (0.85 ± 0.03 with vs. 0.82 ± 0.04). Survival of elepaio with avian poxvirus lesions was 5-8% lower than survival of healthy elepaio. The estimated population growth rate was stable with rodent control (1.03 ± 0.04) but declining without (0.65 ± 0.06). Rodent control was effective at reducing nest predation, however, elepaio numbers in the study sites declined despite rodent control, probably because some young birds dispersed into unmanaged adjacent areas that acted as sinks. Elepaio likely will continue to decline unless rodent control is implemented on a larger scale.

Involving the community in rodent control on Tristan da Cunha

K. Varnham, T. Glass, and C. Stringer

Tristan da Cunha is the world's remotest inhabited island, with a population of around 270 people. Ship rats (*Rattus rattus*) and house mice (*Mus musculus*) are present on the main island of Tristan and house mice are present on Gough Island, also part of the UK Overseas Territory of Tristan da Cunha. The impacts of invasive rodents on both islands have been well documented and detailed plans to eradicate them were developed in association with island representatives. In March 2008 the island was visited to discuss eradication plans with the island community and get their views on the proposals. Various methods were used to disseminate information about the project, followed with individual meetings with all government departments and other employers. These small meetings proved by far the most effective forum for hearing people's views. Strong concerns were expressed were about the safety of an aerial bait drop on Tristan, in particular the perceived risks to children, livestock and the security of the water supply. The proposed eradication of mice from Gough Island however was fully supported. Although the population on Tristan did not want a full scale rodent eradication carried out on the island, they were keen to have improved rodent control around the settlement and at agricultural sites. Accordingly, advice and training in control techniques were given and baiting grids established. This work underlines the importance of detailed public consultation with small island communities during the planning of rodent eradication projects. This project could not have been successfully completed without the full support of the Tristan community and plans for rodent eradication on the island have been shelved for the time being. This work was funded through the Overseas Territories Environment Programme (OTEP) and the European Union's EDF-9 fund.

Dogs working for conservation

K. Vincent and S. Theobald

Dogs have assisted with mammal eradications in New Zealand for the last 30 years. Since 2002 the Department of Conservation has run a dedicated predator detection dog programme providing dog and handler training and certification, systems development and improvement, a breeding programme and operational support. The dogs are trained to detect the presence of mammalian predators and browsers including rodents, mustelids, cats and rabbits for the purposes of audit, incursion contingency response, surveillance, biosecurity quarantine and optimising trap placement. Dogs have proven to be an extremely effective tool for confirming presence when predator numbers are low and other predator detection methods (tracking tunnels, traps, gnaw sticks) are less efficient. Once detected by dogs the predators are killed using pesticides, traps or shooting. Since the programme started, these dogs have been involved in many successful pest eradication programmes on islands. The NZ dog programme has also provided international advice, training and dogs (practical support) for eradication programmes e.g., Macquarie I., Australia (rabbits) and Amami I., Japan (mongoose). This poster presents the dog programme and illustrates case studies where use of the dog programme has assisted eradications including: Raoul Island (cats), Campbell I. (cats and Norway rats), Secretary I. (stoats), Te Kakahu/Chalky I. (stoats), Tuhua/Mayor I. (cats), and many contingencies including Motuihe I. where the rodent dog detected the rat within 48 hours of tracks being discovered on tracking cards.

Island conservation: 15 years of preventing extinctions by eradicating invasive vertebrates from islands

W. Waldman, J. Beek, S. Buckelew, K. Campbell, A. Carter, C. Hanson, G. Howald, B. Keitt, J. Sheppard, K. Swinnerton, B. Tershy, and A. Wegmann

Islands make up less than 3% of the earth's terrestrial area, yet harbor over 20% of all biodiversity. The vast majority of all extinctions – 95% of all bird species, 90% of all reptile species and 70% of all mammal species – have occurred on islands. These remarkable facts drive Island Conservation's (IC) mission to prevent extinctions by removing invasive species from islands. Since its inception in

1994 IC has removed 47 populations of 6 invasive vertebrates from 33 islands. These actions have protected 249 populations of seabirds comprising 47 species and 190 populations of native terrestrial animals, comprising 91 species. By the end of 2011, IC will remove invasive vertebrates from an additional 20 islands in North and South America, the Caribbean and the tropical Pacific. Building upon the experiences of the past 15 years IC is developing tools and methods that will maximize our impact. Each of our projects is developed by using a set of best practices, including: 1) building strong, mutually beneficial partnerships, 2) developing the most effective and humane eradication techniques, 3) securing independent external review of project plans and outcomes, and 4) monitoring the ecological outcomes on islands to better understand the impacts of our work. To ensure that the islands on which we work return the greatest biodiversity benefit we have developed a site selection tool that incorporates biodiversity and other factors. In order to maximize our impact, IC will implement projects, work to develop local capacity, and serve as an advisor to other projects. IC is committed to sharing our experiences through reports, select peer-reviewed publications, conference presentations and by making staff available for conducting peer review of other projects, or participating in teams conducting eradication planning trips.

Recovery of an ecosystem freed from introduced rats

Y. Watari, E. Bonnaud, K. Bourgeois, S. Caut, and F. Courchamp

In 2005, Surprise Island, a flat, 24 ha wide island 230 km off New Caledonia, was freed from the black rats that had been introduced perhaps up to one century ago. A four years pre-eradication survey of the insect and bird communities indicated that rats probably had a severe impact on several of the species that had survived coexistence with rats for several decades at least. A four years post-eradication survey indicates that some of these species are now recovering, while some others still seem to be unaffected by the major change that should constitute the removal of a central alien invasive predator such as the black rat. The global rearrangement of the local plant and animal communities following the rat eradication is a strong reminder of the necessity to consider alien invasive species removal within an ecosystemic perspective.

Rodent eradication campaigns on tropical islands: novel challenges and possible solutions

A. Wegmann, S. Buckelew, G. Howald, J. Helm, and K. Swinerton

Invasive rodent eradications are a proven, effective method of restoring affected ecosystems and preserving biodiversity on islands. Current rodent eradication practices are inherited from successful temperate or subantarctic campaigns, yet a direct translation of this practice to eradications on tropical islands can be problematic. Tropical island rodent eradications entail novel challenges not seen in temperate climates, such as land crabs and complex three-dimensional habitats. To enhance conservation practitioners' ability to anticipate and respond to such challenges, we have studied the role of land crabs in eradication outcomes, and patterns of habitat use (ground vs. canopy) by rodents on several tropical islands. During rat eradication planning studies at Palmyra Atoll, Line Islands, indigenous land crabs competed with rats (*Rattus rattus*) for broadcast bait pellets, and interfered with bait stations and detection devices. At both Palmyra Atoll and Dekehtik Island, Federated States of Micronesia, rats (*R. rattus* and *R. exulans*) were frequently observed in the forest canopy and most often in the crowns of coconut palms (*Cocos nucifera*). A pyranine-based biomarker study conducted at Palmyra found that over 30% of captured rats were not exposed to bait following sequential hand-broadcast applications of 18kg/ha and 9kg/ha. Extensive use of coconut palm canopy habitat by rats and competition for bait with land crabs may reduce rat exposure to rodenticide applied to the ground. The risk of land crab interference and canopy preference to eradication success can be mitigated through increased broadcast application rates and aerial broadcast techniques. Such practices require close scrutiny for potential adverse impacts to non-target species. A better understanding of the eradication challenges inherent to tropical environments may enhance the conservation community's ability to effectively and safely manage the threat that invasive rodents present to tropical island biodiversity.

Plant: animal interactions – considerations prior to rat eradication on Raoul Island, Kermadecs

C.J. West

In anticipation of the planned rat (two species: *Rattus norvegicus* and *R. exulans*) and cat (*Felis catus*) eradication on Raoul Island in 2002, the exotic flora was evaluated to determine which species might be more invasive following removal of rats. All weed species targeted for eradication in 1996 were not anticipated to increase substantially because they were being controlled effectively. Species such as Norfolk pine (*Araucaria heterophylla*) were expected to produce many more seedlings because seeds and germinating seedlings would no longer be eaten by rats. However, only one stand of Norfolk pine remains on the island and progeny from this historic stand of trees could be managed readily. A group of exotic species that had never fruited in the presence of rats was identified. This group included grape (*Vitis vinifera*), shore hibiscus, fou (*Hibiscus tiliaceus*), rosy periwinkle (*Catharanthus roseus*) and airplant (*Bryophyllum pinnatum*). As a precaution, grape was targeted for eradication as this species would be dispersed effectively by tui (*Prothemadera novae-zelandiae*), a native honey eater, if it began to fruit after rats were eradicated. Grape proved difficult to control but by 2002 all eight known grape infestations were reduced to zero density. In 2008/2009, no grape sprouts were found during searches of all known infestation sites. Since the eradication almost all species that did not fruit when rats were present are now fruiting.

Plant responses following eradication of goats and rats from Raoul Island, Kermadecs

C.J. West and D. Havell

Goats were eradicated from Raoul Island in 1986. Some changes apparent in the vegetation as a consequence were: thickening of the pohutukawa canopy; reduction in the dominance of the invasive aroid lily (*Alocasia brisbanensis*) in the forest understorey; increase in the abundance of a) *Hebe breviracemosa* (from one plant to several discrete natural populations); and *Pseudopanax kermadecensis*. Rats (*Rattus norvegicus* and *R. exulans*) were eradicated in 2002, leaving no introduced mammals to affect vegetation. Some plant responses observed following rat eradications are: 100-fold increase in germination of nikau (*Rhopalostylis baueriana*) seeds; *Homalanthus polyandrus* seedlings visible widely on the island; many orange seedlings (*Citrus sinensis*). Most species that did not fruit in the presence of rats are now fruiting e.g., *Hibiscus tiliaceus*, *Catharanthus roseus*, *Bryophyllum pinnatum* and seedlings of those species are establishing.

Consequences of the removal of all mammalian browsing pressure are two-fold. Potentially vegetation succession can return to natural trajectories. The goals for management of some exotic plant species may need to be revised: ideally, *Catharanthus roseus* and *Bryophyllum pinnatum* should be eradicated.

Rodent eradication on Lord Howe Island: challenges posed by people, livestock and threatened endemics

I.S. Wilkinson and D. Priddel

Like many oceanic islands, World-Heritage-listed Lord Howe Island, 760 km north-east of Sydney, Australia, has populations of invasive rodents. The house mouse (*Mus musculus*) probably arrived around 1860, and the black (ship) rat (*Rattus rattus*) in 1918. Both species have had significant impacts on the island's biodiversity, with rats implicated in the extinction of at least 15 species (or subspecies) and an ongoing threat to many more. Predation by rats on Lord Howe Island is listed as a *Key Threatening Process* under both New South Wales State and Australian Government legislation.

A feasibility study (in 2001) concluded that, given the advances in eradication techniques since the 1980s, eradication of both rats and mice was technically feasible. A subsequent cost-benefit study (in 2003) demonstrated that costs of the eradication would be quickly offset by discontinuation of the current rat control programme and increased yields of commercial palm seed. Technical challenges include the presence of a permanent human population of approximately 350 residents along with their associated pets and livestock, a well-developed tourist industry, and numerous threatened island endemics, several of which would be placed at risk. An eradication plan was prepared in 2009. The presence of a large human settlement necessitated modification to the customary strategy. Bait will be aerially broadcast in uninhabited areas and hand broadcast within the settlement. Livestock will either be removed from the island during the period that the bait is present in the environment or aggregated into small enclosures. Several species of threatened fauna will be housed in captivity for the duration of the operation to mitigate the risk of primary and secondary poisoning. Community support is vital to the success of the operation, and extensive consultation has been, and will continue to be, a major component of the eradication programme.

Eradication of invasive rodents on islands of the United States

G. W. Witmer

Many invasive rodents have become established in the United States (US) and its territories. The species include several species of *Rattus*, house mice, Gambian giant pouched rats, ground squirrels, and marmots. These rodents have caused serious impacts to native flora and fauna. Since the early 1990s, agencies have been eradicating rodents from various islands, primarily for conservation purposes. Of about 30 eradication attempts, only about 6 are known to have failed. For several islands, however, it is too early to determine if the attempted eradication has been successful or not. Numerous additional eradications are planned. I review the eradications, both successful and unsuccessful, that have occurred in the US. Most eradications involved the use of the anticoagulant rodenticides brodifacoum and diphacinone, but other approaches have been used. Rodenticides have been applied by hand-broadcast, bait station deployment, and aerial broadcast. I briefly review the strategies and methods used in eradication projects and the efforts to mitigate potential non-target and environmental impacts. Finally, I consider some of the issues remaining in invasive rodent management and eradication in the US. Some of the challenges faced include the use of toxicants, land access, public attitudes, resource availability, and monitoring difficulties.

Attempting to eradicate invasive Gambian giant pouched rats (*Cricetomys gambianus*) in the United States: lessons learned

G.W. Witmer

Gambian giant pouched rats (*Cricetomys gambianus*) are native to Africa, but they are popular in the pet industry in the United States. They caused a monkeypox outbreak in the Midwestern United States in 2003. A free-ranging population became established on Grassy Key in the Florida Keys, apparently because of a release by a pet breeder. If this rodent species reaches the mainland US, many impacts, especially to the agriculture industry of Florida, can be expected. An interagency effort has conducted an eradication effort for about 3 years now, but complete eradication has been elusive. I discuss the strategy that has been employed, some of the difficulties encountered, and the requirements to assure a successful eradication. I also discuss some of the recent research on rodenticides and attractants with captive Gambian rats that may help with future control and eradication efforts.

Management of invasive vertebrate species in the United States

G. W. Witmer

Many invasive vertebrates have become established in the United States and its territories, including at least 20 mammalian, 97 avian, and 53 reptilian/amphibian species. Members of the “100 of the World’s Worst Invasive Alien Species” are included in each taxonomic group: domestic cat, small Indian mongoose, red fox, goat, pig, rabbit, roof rat, house mouse, grey squirrel, nutria, starling, Indian common myna, red-vented bulbul, brown tree snake, and red-eared slider. I briefly review some of these species and the types of damage they cause. I then review the basic types of methods used for control or eradication of each taxonomic group, including physical, chemical, biological, and cultural methods. I discuss some of the challenges in managing these species, including issues with the use of toxicants, land access, public attitudes, and monitoring difficulties. Finally, I list some ongoing research and future research needs, including fertility control, improved detection methods, improved attractants, improved barriers, improved capture methods, and risk assessment methods.

Damage to plants and seabirds by black rats *Rattus rattus* on the Ogasawara (Bonin) Islands before eradication

T. Yabe, T. Hashimoto, M. Takiguchi, M. Aoki, M. Fujita, and K. Kawakami

Damage by black rats (*Rattus rattus*) to plants and seabirds on the Ogasawara Islands, southern Japan disappeared after eradication campaigns conducted by Dr. T. Hashimoto and his team with diphacinone rodenticides.

1) Black rats cut twigs of endemic trees, *Ochrosia nakaiana* and *Hibiscus glaber*, and fed on all the fruits of *Pandanus boninensis* on Nishijima (27° 07' N, 142° 10' E), a 49 ha uninhabited island. Analyses of their age compositions and food habits suggested that they ate soft tissues of twigs because of food shortage in winter. Age compositions of black rats showed that the season of plant damage corresponded with that of low breeding activities of the rats and scarcity of preferred foods (January – March). We assume a link between low breeding activities of the rats and food shortage, which motivated the rats to consume twig tissues. *Pandanus* fruits were found to be gnawed all year round. However, such damage disappeared after an eradication campaign conducted in March 2007. In April 2008, we found a total of 82 *Pandanus* fruits including mature ones remained undamaged all over the island.

2) Black rats attacked Bulwer’s petrels *Bulweria bulwerii* on Higashijima (27° 05' N, 142° 14' E), a 28-ha uninhabited island. Meat and feathers of the seabirds were found in 16 stomachs (36%) of 44 rats caught in traps in June 2008. The average body mass of bird-eaters (202.1 ± 26.4 g, $n = 16$) was significantly larger than that (144.6 ± 52.5 g, $n = 28$) of non-bird-eaters (202.1 ± 26.4 g, $n = 16$) at the 5% significance level (Mann Whitney U test, $Z = 4.0 > Z_{0.975} = 2.0$). Bird-eaters ranged from 167 to 253 g in their body mass, and they were larger than Bulwer’s petrels (78 – 130 g in general).

Surveillance of mongoose and Amami rabbit by auto cameras during mongoose control programs in Amami-Ohshima Island, Japan

F. Yamada, Y. Watari, S. Abe, S. Kubo, S. Nagumo, K. Funakoshi, and K. Ishida

An invasive small Indian mongoose *Herpestes javanicus* (Family Herpestidae, Order Carnivore, Mammalia) in Amami-Ohshima and Okinawa Islands, and in Kagoshima City in Kyusyu recognized in 2009, is one of big issue of invasive mammals in Japan. Some of control and eradication programs of the mongoose have been operating by Japanese government as a model case for conservation of biodiversity in subtropical islands during 2000-2004 and 2005-2014. For monitoring of mongoose and of its impacts on native species, especially on Amami rabbit *Pentalagus furnessi*, which is an endangered species and one of the most flagship species on Amami-Ohshima Island, we investigated intermittently by 20-40 sets of auto sensor camera. At rabbit nests areas, mongooses were recorded in early stage of the operations, but after capturing of mongooses no mongoose has been recorded yet, and rabbits became to be recorded frequently. At high mongoose and low rabbit areas, mongooses were recorded frequently in the early stage of the operations, but no mongooses were recorded after the operations and rabbit recovered. Those results indicate that if mongooses were eradicated from rabbit habitats, rabbits restore their population. Therefore, it is necessary to eradicate mongooses in the habitats of rabbit and to prevent mongoose from invasion into rabbit habitats.

Lessons learned from gaining political and community support of Hawai`i's first predator-proof fence at Ka`ena Point Natural Area Reserve

L.C Young, P. Sato, A. Jeffers-Fabro, C. Swenson, R. Kennedy, and D.G. Smith

The coastal strand ecosystem of the public access Ka`ena Point Natural Area Reserve on the island of Oahu, Hawai`i hosts one of the largest seabird colonies in the main Hawaiian Islands, and contains up to 11 species of endangered plants. It is also one of the most culturally significant sites in Hawai`i where souls are said to leap into the afterlife. Due to the negative impacts of invasive mammals on native species, construction of a predator-proof fence is planned for late 2009 and the five invasive mammal species present will subsequently be removed. Prior to construction, two and a half years of extensive public outreach was done. These efforts reached over 1800 individuals directly in addition to the thousands that were reached via 11 printed news stories (both local and national) and airing of seven unique television pieces. As a result of these efforts, what was considered a controversial project has achieved broad public support and resulted in the formation of a community and school group dedicated to helping protect the area. During outreach efforts, extensive ecological monitoring was conducted on both native and non-native species to document the effects of predator removal and to determine how best to eradicate the predators present, with the public occasionally participating in this monitoring. The exclusion and removal of these predatory animals is anticipated to result in an increase in the existing population of nesting seabirds, encourage new seabird species to nest at Ka`ena Point, and enhance regeneration and recruitment of native plants and invertebrates. Perhaps just as significant, this project has increased the public awareness of restoration techniques and will provide the people of Hawai`i with a rare opportunity to visit a restored ecosystem.