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# INTERNATIONAL PERSPECTIVE ON PROGRAMS OF INVASIVE VERTEBRATE SPECIES

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***Abstract:*** An account of global initiatives in invasive alien species, including vertebrates, was presented based on the author's experience and that of colleagues, mainly in the developing world. The account focused on those programmes which highlight typical problems or best practice for design and which promised improvements in the future. Some of the characteristics of these programmes were described and discussed. Techniques used in vertebrate control programmes, especially in developing island states, were also described with a commentary on their efficacy and suitability for use. Finally, some future directions were recommended in terms of the design of in-country and regional programmes and the methodology best suited for these programmes.

***Key Words:*** international programmes, international projects, invasive species, lessons, techniques.

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## INTRODUCTION

The response to the invasive alien species (IAS) problem has been increasing markedly over the last 10 years or so. An example of the increased profile is the classification of IAS as a "cross-cutting" issue in the implementation of the Convention of Biological Diversity, meaning that IAS will be considered in all other aspects of implementing the Convention and kept on the agenda for a protracted period. The raised awareness of the IAS problem has triggered a number of national, regional, and larger international projects and programmes. These have been instigated by various organisations and run by many different people from various backgrounds. These projects and programmes have been underway long enough to be able to conclude lessons about what works best and some of the technical needs that exist. In this paper, I have drawn on my own and colleagues' knowledge (obtained by interview and noted in the acknowledgements) and attempted to describe only projects or programmes that illustrate positive characteristics and lessons for the future. The great majority of this experience I have drawn on originates from work done in developing countries. Hence, this paper is not a comprehensive account of past and present IAS projects or programmes and it is entirely subjective. While there is a significant amount of other's information in this account, I take full responsibility for all that has been written. Most projects and programmes involve a number of different IAS, with vertebrate species just one amongst many, although I have not included information drawn from projects which specifically involve invasive plant species. However, this account is more about IAS generally, rather than specialising in invasive vertebrate species specifically.

## INTERNATIONAL INITIATIVES

The purpose of this section is to summarise some of what has been done at programmatic and institutional levels and include examples of some lessons have been learnt.

### The Secretariat for the Pacific Regional Environment Programme

The Secretariat for the Pacific Regional Environment Programme (SPREP) has had one of the longest running programmes on Invasive Alien Species in the developing world, having started in 1998. Originally the Programme Officer ran the IAS programme along with the Regional Avifauna Programme, which was logical because IAS are a significant threat to birds throughout the Pacific. The Programme has been funded by the New Zealand government (salary and some operating) and supported for project funding by the Australian and United States (US) governments. In recognition of the size of the IAS issue the SPREP created a full-time position for IAS and another for handling terrestrial species conservation on islands.

One of the main achievements of the SPREP IAS programme includes commissioning a review of the status of IAS (including vertebrates) throughout the Pacific. This formed the information basis to create a Regional IAS Strategy which was signed off by the SPREP Meeting at the formal meeting of the signatories to the SPREP and Apia Conventions (Sherley 2000). Other work included designing and writing a training programme for professionals involved in IAS as conservation officers or border protection officers, which has been carried out in five countries (Samoa, Vanuatu, Palau, Papua New Guinea and Niue) and two territories (American Samoa and Tokelau) in the Pacific. This programme formed the template for a similar training programme run by the Global Invasive Species Programme in parts of Africa and Asia. The SPREP IAS and Avifauna programmes also ran a number of threatened species programmes involving predator control or eradication. The idea was that the high profile threatened species (all birds) would help to profile invasive alien species. One of the programmes also developed a new "tropical formula" for a rat bait and experimentally determined minimum application rates to allow the recovery of the passerine kakerori, *Pomarea dimidiata* (Robertson et al. 1998, Robertson and Saul 2006). Finally, a programme called the Pacific Invasive Species Management Programme was designed and tendered to the Global Environment Facility (GEF). This programme reached the "PDF B" stage when it was "re-pipelined" for a second consideration. In effect, the programme is designed to start the implementation of the Regional IAS Strategy.

The structure of the proposed GEF programme could form the basis in part, or in full, for other funding proposals. The main components in the design of the bid are:

- Set up sub-regional centres of excellence for best practice, knowledge and training sites.
- Centres become "one stop shops" for sub-regional projects – supplying training in wildlife management including pest eradication and control. At least in the early stages they should be focussed on flagship species recovery programmes (including their habitat). Ultimately, these centres are run by islanders or locals for islanders/locals. Because these centres are sub-regionally based there is reasonable insurance of cultural compatibility.
- Centres supported by external expertise (such as the Global Invasive Species Database which receives some financial support for its services) whose objective is to pass on knowledge and skills (biological information on IAS, their control or eradication, expert lists, etc.) so that these can in turn be passed on by islanders/locals. Thus, technical information services ares not duplicated in the region.
- Identify sub-regional in-country projects supported by the regional centres; these projects capture an endangered species/habitat recovery programme (usually threatened, at least partly, by an invasive species) which serve as advocacy foci for the countries for the endangered species and invasive species prevention and other conservation messages ("flagship" species concept).
- The sub-regional centres are coordinated centrally by an inter-governmental organisation programme officer who coordinates external expert support (first stage training, etc.) and technical support such as technical information on the net (e.g., the Global Invasive Species Database).

Since the beginning of the SPREP-based Pacific region invasive alien species programme, others have been established, including the Pacific Invasives Learning Network (motivated by The Nature Conservancy) and the Pacific Invasives Initiative (funded by New Zealand AID). The Secretariat for the Pacific Community has also progressively worked more closely with the SPREP programme with its biosecurity programme. The Cooperative Islands Initiative has also started with its first phase, which is in fact the Pacific Invasive Initiative (NZAID-funded), which includes the above as partners and others (see below). This situation is ideal to allow cooperation and collaboration, probably best facilitated by the Programme Officer IAS (SPREP) serving to coordinate overall the implementation of the Regional IAS Strategy, which in turn, can do its part to implement the Action Strategy for Nature Conservation in the Pacific Islands Region (SPREP 2004). The latter could be seen as implementing the Island Biodiversity Programme of Work (motivated by decisions of the Conference of Parties to the Convention on Biological Diversity, see www.cbd.int/island).

Despite the apparent logic in this relationship, there are additional initiatives which need to be aligned with others. These include the National Biodiversity Strategy and Action Plans (NBSAPs). There needs to be some agreement between countries and major funding bodies regarding the relative roles of these strategies and plans and how these relate to funding agency and country priorities. The number of initiatives in the Pacific Region is causing confusion and diluting effort (and dollars) of the relatively few committed to conservation. One wonders how often this scenario of multiple "instruments," all doing similar things, has repeated itself around the world.

One of the roles of the SPREP has been to facilitate the creation and monitoring of the Action Strategy for Nature Conservation in the Pacific Islands Region (SPREP 2004) whose purpose is to serve as an over-arching document to guide conservation work in the Pacific. The most significant feature of the Action Strategy for Nature Conservation in the Pacific Islands Region is that the process for its creation was consultative over a wide range of representatives from all over the Pacific, representing government (including donor countries such as New Zealand and Australia) and non-government organisations (NGO) and other local representatives which met without political influence. The Action Strategy is now in its fourth iteration since 1977. The Strategy has been signed off by the SPREP, so it can be viewed as an official policy document. Monitoring the implementation (including designing indicators) is done by the Pacific Round Table which has a number of Working Groups, one of which is an invasive species working group. The Action Strategy pre-dates the CBD's Island Biodiversity Programme of Work, so their relationship is unclear. The Round Table reports every four to five years to a meeting of countries and non-government organisations which review the Action Strategy and make improvements to the strategy.

The latest report of the Round Table has shown that, although significant achievements have been made implementing the Action Strategy, it seems the original objectives were too ambitious and effort spread too thinly, leading to meagre progress against most declared objectives (including IAS). The operation of the Round Table has relied on voluntary contribution from members and has only formally a committed and funded part of a work programme for a few programme officers who have never been certain of long-term funding. On the other hand, there has been a wide variety of membership organisations and contributions have been without prejudice such as one might see in politically-motivated organisations. To date, the main benefits of the Round Table have been the opportunities for networking and planning collaborative projects. These benefits are difficult to quantify but, nonetheless, they are significant. To expect the Round Table to monitor the implementation of the Action Strategy for Nature Conservation in the Pacific Islands Region (SPREP 2004), including Invasive Alien Species, is probably unreasonable unless some major funding initiative arises to support it. The problems of the Pacific Round Table, in this respect, have been compounded (at least with respect to IAS) with objectives set in the Strategy which are far too ambitious and not designed with the technique of measuring performance in mind.

Over the last 10 years, the SPREP has allowed a number of key programmes which have been funded externally to be located in their buildings at Apia, Samoa. Physically locating these programmes, and often assuming the task of administering them, has allowed for a high degree of collaboration and cooperation between these programmes and those funded by SPREP such as the Regional Invasive Alien Species Programme.

**Pacific Invasives Learning Network**

One programme which has been co-located within SPREP in Apia is the Pacific Invasives Learning Network (PILN). The purpose of this programme is to create skills and knowledge bases and use these to seed further skills in others working on the same type of projects. There are eight partners in the Network: The Nature Conservancy, Secretariat of the Pacific Regional Environment Programme, IUCN Invasive Species Specialist Group, Conservation International, Secretariat of the Pacific Community, University of the South Pacific, National Palau Office of Environmental Response and Coordination, and the US Department of Agriculture's Forest Service. These partners, with help from the National Park of American Samoa, helped design and set up the PILN. In its early stages, funding has been from various sources, including The Nature Conservancy. There are six formed country teams (America Samoa, Guam, Niue, Palau, Pohnpei and Samoa) and six planned teams (Fiji, Hawaii, Kiribati, Kosrae, Marshall Islands and New Caledonia). Team members have various skills and all have commitments to conservation and invasive species management and prevention in their

countries. Country teams initiate in-country projects (such as developing a national invasive species strategy, public awareness programmes, eradication and restoration projects) and they are assisted by the PILN coordinator based at SPREP, who runs annual face-to-face and regular telephone conferences to enable sharing.

So far there are four distinguishing features that have materialised running the PILN: (1) the Network has generated further requests to join without any marketing, (2) six in-country teams were set up in May 2006 and a performance evaluation of all PILN individuals involved was conducted in November 2006, with 70% expressing high performance, 30% medium, and none low, (3) technical support for in-country projects has been done in such a way as to wean themselves from dependency from "outside" expertise so countries with a similar culture and technical issues support each other, and (4) the PILN has moved into marine invasive species as a direct consequence of demand from countries, starting with awareness raising. Thus, the PILN concept has accelerated faster than expected and seems to be a model which works and is popular. To date, the programme has been acutely short of funds, which may have been a blessing in disguise because it has forced the country members of the programme to include the projects and the necessary support into their existing work programmes (i.e., self-fund or find the funds themselves); this has forced countries to value and maximise ownership of the project. The concept should work in other regions and attract other investors because the start up funding leverages other sources of funds, including in-country sources. A future additional development is extending the concept into the agricultural and quarantine sectors, where need has been declared by the programme manager and countries.

**Pacific Invasives Initiative**

Another programme closely linked to the SPREP (as a partner) is the Pacific Invasives Initiative (PII). To date, the main *modus operandi* of the PII has been planning and implementing demonstration projects. These projects model best practice in planning and delivery, including community involvement. The programme has exacting standards for successful planning and implementation of invasive vertebrate species projects, including monitoring, project management, and community involvement. The concept for eradications includes placing all individuals of the target species at risk, ensuring that the method of removing the target individuals is faster than their intrinsic rate of increase, and ensuring that biosecurity of the island prevents further introductions. The success of the programme has been dependant on accessing technical support from New Zealand and networking in-country in the Pacific. It is often hard to determine, whether programmes should be situated in the Pacific where the eradication is needed or in a country like New Zealand near to the sources of expertise. The solution is to have the right partnerships of expertise with Pacific-based programmes and collaboration through all phases of a project (which the PII has been doing well). Funding bodies do not necessarily see having programmes based in New Zealand or "developing" countries as an ideal model, nor do programmes based in the Pacific necessarily identify with a programme situated "outside" the Pacific. The Pacific-based programmes can never (or at least not yet) have the immediacy of contact with expertise as those situated in centres of excellence, while the programmes outside need to have the experience of seeing a programme through to completion (in the sense of eradicating the pest species and securing biosecurity) to fully understand the range of needs in planning an in-country project.

**Critical Ecosystem Partnership Fund**

Another programme that uses "demonstration projects" is the Critical Ecosystem Partnership Fund (CEPF). This programme has been sponsored by Conservation International, the Global Environment Facility, the Government of Japan, the John D. and Catherine T. MacArthur Foundation, and the World Bank, who have created a fund which will fund projects focussed on biodiversity hotspots in developing countries. There are 33 hot spots identified around the world of which about 10 are already funded: Atlantic Forest (Brazil), Cape Floristic Region (South Africa), Choco-Darien-Western Ecuador (Columbia and Ecuador), Guinean Forests of West Africa (Cote d'Ivoire, Ghana, Guinea, Liberia, Sierra Leone and Togo), Madagascar and Indian Ocean Islands (Madagascar), Mesoamerica (Costa Rica, Nicaragua, Panama), Mountains of Southwest China, The Philippines, Sundaland (Indonesian island of Sumatra), and Tropical Andes (Bolivia and Peru). The CEPF supports projects run by non-government organisations and community groups but, apparently, not government agencies (including inter-governmental organisations). However, CEPF does make every effort to

coordinate its efforts with existing strategies and frameworks created by local, national, and regional government organisations (e.g., the Cooperative Islands Initiative in the case of the Polynesia-Melanesia Hotspot programmes).

Typically, the CEPF funds small- to medium-sized projects between 20,000-100,000 US dollars. In 2005, the CEPF received 1 million US dollars from the Australian Government's Regional Natural Heritage Programme for an IAS management programme. In one year, this programme funded 17 projects dealing with nine invasive species in the Polynesia-Micronesia Hotspot. Most of these budgets were under $20,000 but one, rat eradication on Aleipata Island offshore of Upolu, Samoa, received $140,000.

Later in 2007, the CEPF will launch a new 7 million US dollar fund for conservation in the Hot Spot, over a five year period, with about three million dollars being assigned to invasive alien species management. This programme is significant because the Ecosystem Profile (an investment strategy researched and negotiated for the hotspot) showed that IAS affected about 75% of the globally threatened terrestrial species. Habitat loss was the other cited cause of decline (Conservation International 2007). These causes of decline are probably aggravated by climate change and sea level rise. The hotspot spans 11 countries, 8 territories, and 1 US state (Hawaii) and covers a total sea and land area about 2.6 times the area of the continental US. Its land area is small, being 46,488 square kilometres (about the size of Switzerland) and includes about 4,500 islands (although 5 countries and territories are ineligible for receiving funding as they are not members of the World Bank and signatories to the Convention on Biological Diversity, Atherton 2004). Hence, in the 14 countries which are eligible, there are 161 sites with terrestrial threatened species (including turtles because they breed on land). Many of the globally threatened species at these sites are threatened by vertebrate invasive species such as rats (*Rattus* spp.).

**Global Invasive Species Programme**

The Global Invasive Species Programme (GISP) is a partnership between non-government organisations (The Nature Conservancy, TNC), government organisations (Government of the Republic of South Africa, Department of Internal Affairs; South African National Biodiversity Institute, SANBI), IGOs (CABI), the World Bank, and The World Conservation Union (IUCN). The latter is in itself actually a mixture of government and non-government organisations. From a business point of view, the last few years have involved contractual financial arrangements between the World Bank and the SANBI, with the former contributing dollars and the latter some dollars and considerable in-kind institutional support. The GISP also has a number of "Memoranda of Understanding" such as with Bionet International and national government agencies. Over the duration of its existence, the GISP has evolved, yet its prime purpose has been to facilitate the creation and implementation of IAS programmes around the world. In so doing, GISP put effect to Article 8(h) of the Convention on Biological Diversity which deals with IAS.

The GISP has: published advocacy and expert publications (including case-studies), run a sophisticated website which supplies and shares quality and up-to-date technical information, run regional workshops designed to produce IAS strategies, run specialist workshops (such as quantifying the economic cost of IAS to countries – especially with regard to poverty), published guidelines and best practice manuals for IAS management, designed and ran training workshops (initially in English and now in French and Spanish) for professionals in developing countries involved with terrestrial border biosecurity and post-border IAS management (including a course in prevention), run courses in the management of marine and coastal IAS (including ballast water), contributed to the Global Strategy on Plant Conservation (Target 10 Invasive Species) in particular identifying IAS indicators, and run special side-events at the CBD meetings and advised the Secretariat on implementing the COP decisions relating to IAS. IAS is considered a "cross-cutting" issue and, therefore, always on the agenda because it affects most other programmes.

The GISP has used a different approach to the SPREP in running its courses. Whereas SPREP has taken a country by country approach, the GISP has run courses for regions. These regions include southern and eastern Africa (2004 and 2005 introductory courses held in Kenya and Mozambique, 2005 marine and coastal course in Tanzania, and a 2006 course in prevention strategies in Tanzania), Black and Caspian Sea (2006 Istanbul marine and coastal course), North east Pacific and Caribbean Spanish-speaking countries (2006 Panama marine and coastal course in Spanish), and Francophone West Africa (2007 course on Marine and Coastal areas in French). It

is expected that a general/introductory course in IAS will continue to be run through the Global Environment Facility-funded African Barriers Project and is anticipated to include Ghana, Zambia, Uganda and Ethiopia. More training in legal aspects of IAS biosecurity is anticipated with World Bank funding for courses in Western and Eastern Africa and the South Pacific.

The GISP has also been involved in running the IAS sector of the Global Environment Facility's Biodiversity Indicators Programme. This work involves developing indicators for IAS and, amongst other things, reviewing relevant databases which might provide information on IAS indicators. Other GISP work includes: developing standards for the prevention of IAS via aircraft, planning contributions to the CBD COP 9 in-depth review of IAS, up-grading the GISP website (www.gisp.org) including developing a contacts database and electronic newsletter, a marine and coastal IAS brochure, and a booklet on IAS and poverty.

**Galapagos Islands Invasive Species Programme**

The Galapagos Islands Invasive Species Programme (GIISP) has already achieved some world firsts in invasive species eradications, such as eradicating goats (*Capra hircus*) off Isla Santiago (approximately 58,000 ha) and most of Isla Isabella (458,000 ha) as well as donkeys (*Equus asinus*) and pigs (*Sus scrofa*). The GIISP has also eradicated the little fire ant (*Wasmannia auropunctata*) from 58 ha Marchena (Causton et al. 2005). The scale of the operations involved in the IAS programmes in the Galapagos are extraordinary. For example, on Isla Santiago 66,329 goats were killed during 37 hours flying time and 59 forays. On Isla Isabella, 69,579 goats were killed in the 2004-05 season during 1,180 flying hours and 92,000 flying kilometres (F. Cruz, personal communication). Man-dog teams and Judas goats were used, especially when goat numbers were at their lowest. While these basic techniques have been known for years, the Galapagos team modified these to suit the extreme conditions on the archipelago. The pest animal programme is continuing to expand with the instigation of planning for the eradication of introduced rodents (there are still native rodents extant), starting with developing and ground testing techniques on relatively small islands with a view to moving to progressively larger islands as the skills (and funding) grow.

The concept behind the Galapagos Archipelago that is also extraordinary is that it attempts a "whole system" approach to managing IAS, including threatened terrestrial species and marine protection. This is based on a special law written for the protection of the Galapagos Archipelago, whose land area is approximately 97% in National Park status. The special legislation sets the framework for integrating all aspects of the administration of the islands, including land-use outside of the National Park, protected natural area and species management inside the Park (including National Park staff supported by a technical service provided by the Charles Darwin Foundation), quarantine, tourist management, etc. This concept of integrating all aspects of administering land (most especially integrating wildlife management with a technical support service) exemplifies a system that could be applied throughout the world.

**State of Hawaii**

Some in-country programmes are showing initiative with preventing and managing IAS. In Hawaii (US), the Invasive Species Early Detection Reporting Network aims to receive and act on information of new invasions in a timely manner to reduce the chances of a new IAS establishing. Early detection and eradication of a new invasion would minimise the ecological impacts of the species and the cost of eradicating it. Often, early intervention means the difference between being able to eradicate and IAS and having it become permanently established. The Network involves early detection, rapid assessment, and rapid response – all mediated through multi-agency (government) and private organisations or individuals. The Maui system includes a designated list of high priority species to watch for, outreach to train members of the public and professionals and semi-professionals working in natural resource management, user-friendly reporting and assessment system (e.g. by email, web-based system, walk-in drop off of specimens, see http://pbin.nbii.gov/invasives_report/online.asp), a searchable database to store early detection sightings, and reporting and action systems (also web-based and with 24 hour turn-around). Awareness raising is achieved with web-based identification fact sheets, a printed field guide, and workshops to provide a "search image" for the targeted IAS (e.g., www.reportapest.org), and simple methods for recording technical information. The fact that there is an easy to use system available encourages professionals, semi-professionals, and members of the public to actively search for invasive pests. So the existence

of the system itself encourages active searching by many people in various situations (termed by the authors of the system as the "eyes and ears network") which is more than can be achieved by agencies alone.

**Island Conservation**

Island Conservation (IC), like the Pacific Invasives Initiative, advocates technical and scientific excellence in their programmes. Programmes include island eradications from the Aleutians, British Columbia coast (Canada), Baja California, and Mexican islands off the Gulf of California. The projects all include systematic planning with set standards, which if they cannot be met, involve designing scientific research to support the planning objectives. Experts engage and consult with appropriate land owners, build ownership of the programme, plan, fund-raise, implement and set up monitoring of results. Implementation includes using the most modern methods and empowering local agencies. Pre- and post-operation monitoring of pest and beneficiary species is always done and written up for post-operation debriefing. Apparently, the IC has a policy of getting as many operations done as possible and, by iteration, improving techniques. IC exemplifies a business model for implementing its projects which, along with its pro-active pursuit of best practice and scientific basis of carrying out island eradications, functions as a target of excellence and standards for others in the international community to aspire to. Given this fact, it is important that the IC projects (how they were conducted, lessons learnt, etc.) are written up and disseminated to the wider conservation community. Technical transfer to local communities and agencies has been facilitated by forming sister organisations located in the areas where much of the historical work has taken place. These are the Conservacion de Islas in Mexico and Island Conservation Northwest in Canada.

An example of the type of project the IC runs has been on Santa Cruz Island (18,624 ha) in the Baja group of islands belonging to Mexico (one of about 23 eradication operations in the Baja Island Group). Other partners in the Santa Cruz operation included The Nature Conservancy and professional pest control companies (Pro Hunt and White Buffalo were hired to eradicate the pigs). Standard pre- and post-operation monitoring of target and non-target species was carried out. After the pig eradication, the feral turkey (*Meleagris gallopava*) population increased markedly and prompted an eradication programme for them. This eradication exemplifies how there can be unexpected outcomes from an eradication programme with the removal of the initial target species resulting in flow-on effects on other species. It also shows the importance of thorough and comprehensive monitoring, including non-target species.

**IAS Databases**

There have been a number of initiatives designed to provide technical support to operational programmes. One of the earliest of these is the Global Invasive Species Database (GISD). The purpose of the GISD is to provide high quality accurate information on alien invasive species, which is essential to running any IAS programme. In response to this need, the GISD was established in 1998 (www.issg.org/database). The GISD is run by two people out of Auckland University, New Zealand, as one of the programmes of the Invasive Species Specialist Group (ISSG). The ISSG is part of the Species Survival Commission, which in turn, is one of the commissions (like a programme) run by the IUCN. The GISD provides free information to conservation practitioners, decision makers and the general public. The basic unit of information in the GISD is a "species profile" (over 440 species) which provides information on how to identify the species (including diagnostic images), behavioural and ecological facts, and impacts and management methods including early incursion best practices. The GISD is also "networked" to other sources of information. These include experts who can advise on the species and links to other databases such as the IUCN Red List of threatened species, Ramsar sites where IAS are identified as threats, and the US Geological Survey's National Biological Information Infrastructure. The information is also available on CD ROM which is distributed to developing countries where internet access can be prohibitively expensive.

Testimony to the success of the GISD is in the frequency of it use – 1,100 unique visitors per day and a total of 75,000 hits per day. Feed back from users shows the database is being used for practical invasive species management, awareness raising activities (including education at schools), training, and assessments. Yet, despite the obvious demand for such a facility, the GISD has struggled for funding. The number of IAS databases as grown (two years ago I had found over sixty on the internet), resulting in duplication of effort in the area of IAS management. I have long advocated that IAS programmes include a component for

supporting the GISD as a sort of "tithe" so that it can add species profiles to its database. Over time, its size could increase and it could become the most comprehensive and authoritative source of technical information on IAS. With the diversity of information it contains, the GISD could become a "one stop shop" for practical programmes involving IAS.

The same principle applies to a new initiative called the Global Register of Invasive Species (GRIS). The ISSG in Auckland has developed a prototype database of the annotated names of known alien invasive species (meaning actually known to be invasive, potentially invasive, or posing disease risks somewhere in the world) which could be a standard tool to screen for and identify potentially risky organisms (e.g., pre-import screening of proposed imported species). The GRIS compiles and integrates invasive species names, which are linked to their threat status, location and data source annotations. The GRIS compiles and integrates lists of taxon names and associated information from multiple sources. All taxon names are linked to records of occurrence, native/alien status and invasiveness in specific geographic areas, along with associated information such as impact, spread or abundance. The GRIS will be able to capture (and donate to them) data from other sources of information such as the Global Biological Information Forum (GBIF) and the Global Invasive Species Information Network (GISIN). The GRIS database already contains 38,606 geographic records for 16,051 taxa, of which 1,453 species have records of invasiveness and 14,121 taxa are considered potentially invasive (where risk assessments have been done).

The GISD and the GRIS demonstrate the tremendous potential for data sharing on IAS provided by the World Wide Web. However, this full potential has not yet been realised because of the lack of commitment by an international agency to maintain a universal database. Thus, the leveraging and incremental benefits over time of having a centralised system are not yet realised.

## TECHNOLOGY AND METHODS

In this section, I am only going to give commentary on methods of pest eradication and control based on what I have observed with IAS programmes in the developing world and which exemplify improvements or best practice. Thus, it is not meant to be a comprehensive account. When it comes down to it, there are few generic methods available for pest animal control or eradication. Leaving aside biocontrol the same basic four methods are available today that have been available for thousands of years: trapping, poisoning, shooting, and hunting dogs (*Canis familiaris*, or other hunting animals). This makes us vulnerable to not meeting objectives when one of these tools is removed either through public objections or a tool becomes ineffective or unsuitable for technical reasons (such as large-scale operations). Hence, there is an imperative to start research into new methods now to remove this dependency on so few methods. Despite the small range of tools, we have not made as much of some as we could have.

For example, dogs can be trained to be efficient team-mates for hunters tracking down pest species, especially at low densities. Dogs have been used to great effect in this way in New Zealand and the Galapagos Islands. The latter programmes have used dogs in combination with Judas goats in the eradication of goats from Isla Santiago. Dogs (different individuals than those used for hunting pest species) have been used for searching for endangered species in New Zealand including such unlikely taxa as lizards, exemplifying the flexibility of dogs as tools. In New Zealand, the use of dogs has been structured so that there are systems for certifying dogs for a particular function, certifying the dog operators, and creating standards for the training programmes for the dogs and operators. These standards are necessary to avoid non-target species being killed and to ensure the most efficient use of man-dog teams is achieved. The necessity for standards of practice was exemplified in one reserve I visited where feral pigs were being eradicated using a mixture of techniques (e.g., man-dog hunting teams and trapping). In that situation, new dogs who had never hunted pigs before were being trained (without even the company of experienced dogs) on the target population of pigs. This meant that individual pigs that had escaped a hunt were in danger of becoming much more human-dog shy, and consequently, potentially very much harder to kill. Instead, the appropriate practice should have been to train the dogs on a non-target population of pigs until they were up to standard for use on the target population destined for eradication.

Some of the issues with using domestic dogs include quarantine if dogs are used between sites (especially between islands and countries), working out if particular breeds are more suitable than others, how to best maintain the dog's sensitivity to

detect the target species, how to best use dogs in combination with other methods such as aerial hunting, and continuing to develop better training methods.

In some situations, it may not be appropriate to aim for eradication using aerial broadcast of toxins or shooting from the air as parts of the tool box. This situation can result from inadequate biosecurity after the operation which may allow re-introduction. In developing countries with long traditions of customary use of land, land tenure disputes, and the inability to enforce biosecurity or quarantine standards, the biosecurity issue can often remove the option of eradication. The use of toxins may also be culturally unacceptable, or at least their protracted use. Despite this, pest animal control may still be required to retain threatened species or traditional horticultural practices. In New Zealand, improvements in trap and bait station technology, and aerial bait use separately or in combination, have greatly increased the possibilities for long-term control (not eradication) of pests over large areas. "Knock-down" operations using aerial 1080 (sodium monofluoroacetate) over areas as large as 40,000 ha have been achieved with tracking tunnel and residual trap catch indices of target pest species (possums [*Trichosurus vulpecula*] and stoats [*Mustela erminea*]) at or next to zero. Once large areas such as these have had the "knock-down" operation, "hold down" management can be implemented. This includes trapping, using custom-made kill traps which are designed to kill target mammals. Because the target species are at such low densities after the "knock-down" operation and the traps themselves are so efficient and target only one species, the time and effort to service them is minimal. Further, because the area is so large, the periphery to internal area is relatively small, the rate of reinvasion is reduced. Immigration of the target species back into the core protected area can be further reduced with more intensive control methods (perhaps including poison bait stations or man-dog hunting teams) focussed on the periphery. Further refinements on design can include focussing the "central" protected area on known distributions of key species threatened by the pest species under control. The benefits of the above scenario of protected natural area management include, using more acceptable methods to land owners (who, in developing countries, often occupy and harvest from the protected natural area) and employing the traditional land owners. Some of the research and management concepts which may be considered in planning such projects are discussed in Parkes et al. (2006) and Parkes and Murphy (2003).

Other technological developments suit themselves to low maintenance, minimum effort control programmes. Working versions of "control tunnels" have been developed in New Zealand which can sense which invasive pest species is entering the tunnel (e.g., rat or mustelid [*Mustela* spp.]) and deliver a dose of poison bait (e.g., cholecalciferol) to the animal as it passes into the tunnel or another machine made by another firm may apply toxin via an aerosol. Further modifications include small electronic cameras which can transmit an image of the animal which has passed through the tunnel, thus allowing a monitoring and research function (e.g., developing lures, baits and toxins) using this technology (see www.scentinel.co.nz, King et al. 2005). One of the great advantages of this technology is that the tunnels need not be serviced for very long periods of time (many months), depending on what functions they perform. Also, they necessarily mean that preset standards can be better met in field work. Their "per unit" cost is relatively high, but this may well be off-set if the alternative is another manual method which involves expensive man-power to service traps or poison bait stations. Of course, if these tunnels become widely used, their per unit cost should diminish.

Toxins are widely used and are often the only method available for invasive pest management or eradication. However, the widespread and prolonged use of toxins (especially via aerial methods) has its downsides. These include environmental risks, human health risks and animal welfare issues. Here, I relate from my personal experience as the leader of the applicants to New Zealand's Environmental Risk Management Agency requesting the assessment of sodium monofluoroacetate (commonly known as "1080") in order to validate the use of 1080 in terms of acceptable risks under New Zealand law (e.g., Hazardous Substances and New Organisms Act 1996). Over the last six years, the three main public bodies in New Zealand that use 1080 applied to the Environment Risk Management Authority (Department of Conservation 2006) to have it formally assessed for its public health and environmental safety under relevant statute criteria. The process was long and drawn out and included a thorough technical and scientific assessment of its safety, along with a public submission and hearing phase. The process was extremely exacting,

exposing the use of 1080 to the closest scrutiny imaginable. It drew on all facets of technical information (scientifically defensible and otherwise) and the public's views of the use of a broad spectrum toxin and its aerial application.

In New Zealand, 1080 is used on the mainland as a toxin to control introduced pest animals which threaten native biodiversity, one of which is also a vector for bovine tuberculosis (TB) whose prevalence threatens exports of cattle products. The species targeted for the latter is the Australian brush-tail possum (*Trichosurus vulpecula*). During these control programmes other species which threaten native biodiversity are killed incidentally, but effectively, including rat species and mustelids. The toxin, 1080, is one of only a few "toxin tools" available to conservation and TB managers for effective management of pest species. Other methods are being investigated (such as biocontrol and technological methods), but these are likely to be years, even decades away from being available for widespread use (see below). The use of 1080 in conjunction with other toxins (principally brodifacoum, cholecalciferol and cyanide), involves bait stations or aerial methods (mainly using helicopters with under-slung buckets with mechanical "spreaders" with spinning blades to throw out the baits as the machine flies over a pre-set course using differential geospatial positioning systems). In the early 1970s, 1080 carrot baits used to be used aerially broadcast at up to 30 kg/ha in native forests to control possums, resulting in reductions of only about 65%, based on residual trap catch indice, RTCI, figures, whereas today application rates are down to less than 3 kg/ha with RTCI's of over 95% (Department of Conservation 2006). The successful "by-kill" of other invasive species such as mustelids and rats can also be now relied upon using 1080 (Brown and Urlich 2005).

The benefits to native species of using 1080 has been supported by extensive scientific literature (New Zealand Environmental Risk Management Agency 2007). However, the assessment brought to light technical and "social" short-comings in the use of broad-spectrum toxins in wild-lands and the attitudes of communities. The volume of scientific literature on the effects of 1080 on target and non-target species and social aspects is very large (New Zealand Environmental Risk Management Agency 2007), and the checks and balances on the handling and use of the toxin are exhaustive and continually being improved. Over the forty plus years of using 1080 in New Zealand, the publicity (mainly bad) has meant that there has been unparalleled public debate over its safety and efficacy. Despite the history of research and debate, there were some clear gaps in knowledge and lessons about public perceptions on the use of toxins, especially using aerial application methods. The public distrusted expert scientific evidence, even if it was based on extensive peer reviewed research and literature. Scientific evidence was insufficient to answer cultural and spiritual objections to the use of a toxin in natural environments and there was an obsessive concern about toxin getting into water and flow-on effects to the ecosystem, generally or risks to non-target species including humans. Despite evidence to the contrary, there was a reluctance to believe that there were benefits to native biota. Rather, people clung to believing the opposite, citing as evidence their (qualitative) observations of declining number of animals after the use of the toxin, the effects of long-term use of the toxin (and the by-products of its breakdown) on the ecosystem and people even at extremely low concentrations, and the humaneness of the manner of death of target and non-target species was questioned.

Given the few tools for invasive vertebrate pest control and eradication, there is a premium on finding new methods. One group of possibilities that are being investigated in New Zealand have been termed "biotechnological" which includes some aspects of classic biocontrol. These methods are aimed at possum control and have potential for other mammals, although there are some fundamental differences in physiology between marsupials and eutherian mammals. There are three basic avenues of enquiry: Zona Pellucida (ZP) protein-based vaccines (including using virus and a host-specific nematode vectors) which prevent fertilisation, hormone toxin conjugates (inducing permanent sterility with one dose or hit by targeting the pituitary gland and GnRH), and possum gut ion transporter system toxins (see www.possumbiocontrol.agresearch.co.nz). The three million New Zealand dollars per year programme is multi-disciplinary and involves New Zealand and offshore institutions working in a complicated, integrated manner. The programmes will be funded for four years by which time proof-of-concept for at least one of the techniques must be reached. After this time, a further eight years research will be triggered to continue the successful option towards the point where it can be tried in the field.

Some of the issues which have emerged so far include the concern that any vaccine delivery (of hormonal toxins) involving a bait will still attract

the same objections currently aimed at baits used for delivering poisons; the practicality and desirability of distributing baits with vaccines over the vast areas which will be required for widespread control; public mistrust of biotechnologically originated methods; the depth of research needed (including "basic"/first principles physiological research) and, hence, time required to bring the methods being pursued to proof of concept stage. The latter is perhaps the most significant if indeed it is indicative of this general area of research because of the sheer volume of research that has to be done to develop the new methods to proof of concept stage, and the concurrent cost and time to bring the method to a field delivery standard. Current reckoning is that the time yet to develop a field deliverable method is possibly decades away.

## REQUIRED IMPROVEMENTS

### Technical

Many of the gaps in methods and techniques have been described. The needs for development are driven by societal and target and non-target species considerations. There is also at least one "commercial" one as well. The problem is that the size of the "market" for using new technology is often too small in any one country to justify the research and development investment required to create the new technology. Thus, it is time that international programmes or agencies pool their resources (possibly along with the private sector) to create the economies of scale required to afford the investment needed to create new methods for controlling, eradicating, and monitoring pest species. This cooperative approach should win favour with funding organisations which typically look for integrated, "leveraged," and cooperative projects. Funding agencies will have to be educated into the long-term nature of research and development of new techniques. A multi-disciplinary team approach is needed with focussed teams of sufficient number to get past that critical mass required to achieve results in a reasonable time frame.

New techniques that are needed include:

- Improved methods of using existing toxins such as 1080 by developing new bait formulations (including attractants for target species and repellants for non-target species) and applying these toxins at strategic periods during the annual cycle of the target species such as when food supply or other environmental stresses (e.g., drought) are at their maximum. Improvements have been demonstrated in the past with the use of 1080 in New Zealand with the application rate in forested areas in the 1970s at about 30 kg per hectare and achieving about 70% kill of the target species (brush-tailed possum) compared with the current application of less than 3 kg per hectare and reductions of at least 90%.
- New toxins which are as species specific as possible in terms of their target species toxicity or in the way they are deployed (bait stations or bait design).
- Methods for using toxins in combination with each other using different methods of application and trapping in different habitats.
- Monitoring methods for target species, especially at extremely low densities.
- Research which demonstrates the benefits (e.g., to threatened native species) of long-term periodic (pulsed) pest control, especially over large areas and efficient temporal and spatial designs of establishing large areas in which pests are initially reduced with a broad scale application method (such as aerial application), then "protected" by minimising immigration of target species (by setting up barricades surrounding the protected area using traps and/or poison bait stations) and reducing recovery of surviving target species within the controlled area, all balanced against the requirements for beneficiary species to recover as viable populations or to re-establish them. Such management of large protected areas surrounded by a "barricade of protection" also requires new technological tools such as monitoring pest and beneficiary species at low densities.
- Data which will assist showing the benefits of removing pest species need to be collected over long periods of time. Short-term benefits are relatively well documented. The recent experience of the 1080 reassessment in New Zealand has been that conclusions based on long-term monitoring research are required to mollify the critics of using toxins and these studies are almost non-existent. It needs to be kept in mind that the developing countries deserve the same standards and considerations as the developed countries for using toxins. This is particularly relevant for many of the island programmes now

underway which will in the future involve, more and more, inhabited islands. Public education on the use of invasive pest control benefits (especially toxins and their aerial application) need to be done in the context of explaining the benefits to indigenous biodiversity, agriculture or human health so that any perceived down-sides are considered in the context of benefits.

- New technology such as biocontrol and biotechnological methods that will, in the long-term, remove our dependence on the few "traditional" methods (poisons, trapping, shooting, and hunting dogs) need to be researched. However, we need to recognise that the time frame for these avenues of research to generate methods available for use in the field are many years (perhaps decades) away, judging from our experience with possum biocontrol and biotechnological control in New Zealand. This is because the research required is quite fundamental biological research before it can be progressed to the "applied" stage and there are major checks and balances relating to human and environmental safety which must be overcome. Also, the scientists involved in this research are at pains to point out that no method being developed is likely to ever be a "silver bullet" which will singularly reduce invasive pest numbers down to target levels. Therefore, in the short to medium term (possibly even long-term if you consider that it is unlikely that a given new technology is ever likely to be the complete "silver bullet" for pest control or eradication) we need innovative methods of delivering toxins and trapping so that only selected species are targeted in the most efficient, cost-effective manner possible. Again, the best approach is to take a collective, cooperative approach in developing these methods to achieve economies of scale and complete development of new methods in an acceptable time frame.

In the long-term, the need to deliver a control technique over a large scale will always be the limiting factor requiring redress because much of the land which must be worked is rough and inaccessible or the available man-power is too limited or costly to enable using manual methods such as poison bait stations, hunting dogs, or trapping. Therefore, long-term we need to develop more species specific toxins and bio-control and biotechnological methods, especially as the size of areas requiring eradication or control get progressively larger.

**Programmes**

Many of the international programmes (such as the GISP) have promoted and facilitated the creation of various "strategies" or plans. While this may appear laudable, it is not without its downsides. Many of the "strategies" have been developed in large and expensive workshops which have taken a lot of preparatory work and follow-up with publication of the proceedings. These workshops have been run without any planned funding in place for their implementation. Thus, the worst outcome has happened in the past, that of raising expectations in-country and not meeting them. This has developed cynicism and mistrust of "outside" developing nations and their initiatives. Funding agencies supporting these types of workshops must be signed up for follow-up funding arrangements to implement work-plans arising out of the workshop. On the other hand these workshops do act as advocacy for work which might attract funding agencies (especially if there is formal endorsement by countries or other "official" bodies) and, thus, serve as leverage or initiate programmes.

One of the fundamental functions of programmes such as the GISP has been to coordinate effort around the world or regions to avoid duplication of effort and to combine effort or facilitate the creation of complimentary programmes. Despite this, much duplication is occurring such as the creation of databases on IAS, including various aspects. Part of the problem is that the GISP and other regional programmes (such as the SPREP) are not formally able to direct agencies or programmes towards any particular activity and agencies or programmes are not formally required to engage the GISP or other programmes and to seek and take advice. Further, over-arching organisations such as the CBD have harboured the rather naive view that programmes such as the GISP can somehow effect the required coordination. This inability is especially acute if those same agencies trying to achieve coordination are strapped for cash. Without cash to fund the coordinated type of projects required, they have very little influence. Further, these high-level programmes are struggling to find sufficient funds to keep solvent themselves. Thus, they are spending a lot of time "surviving" (acting like

consultants undertaking projects) rather than working in a role as coordinators and facilitators.

The issue of "working to role" of programmes with large mandates such as the GISP (but also the SPREP IAS programme) is in itself often a point of contention between colleagues. Many think that these programmes should not be actually doing project work, but rather this should be the left to countries, NGO's, and the like ("smaller" players). Instead, it is perceived that the programmes such as the GISP should be focussed on generic international-level work such as policy, coordinating and facilitating projects and finance, etc. While this may be the ideal, funding is very difficult to find for "secretariats" doing this generic-level work. The reality is that funds can be far more easily won by bidding for project support.

Some programmes have as one of their maxims technical excellence and using the highest technical standards to establish projects involving eradication. These standards involve well known practices which include placing all individuals of the target species at risk, killing target individuals at a rate that exceeds the rate of reproduction and immigration, and ensuring the future biosecurity of the site or island after the eradication. These and other "rules" are absolutes if true eradication is to be achieved and the failure to guarantee them (especially the latter on biosecurity) has caused debate amongst colleagues and the postponement of operations. This desire to exact such high standards has been sharpened because these projects (mainly in developing countries) may be "demonstration projects" one of whose objectives is to showcase best management practices without compromise. Thus, in effect, the implementation of at least one project has been stalled because, ostensibly, the necessary standards for an eradication operation have not been met. However, could this risk-averse approach be preventing progress? If one reflects on the lessons learnt from the developed countries, much of the "know-how" has been generated by making mistakes (or undertaking some operations "the hard way") and iteratively building up knowledge. While it is obviously beneficial to learn from other's experience, in order to embed knowledge securely in a new culture, I think there is also a need to make provision for "learning by experience" in the developing world which might mean not doing things in the best possible way every time. Thus, there needs to be some risks taken, where some of the accepted prerequisites (or standards) for eradication (or control operations) may not be met so that there are provisions for learning and adapting as the programme progresses. The project might be allowed to start without all the exactitudes of every standard met *apriori*. This recognition of the requirement to learn while implementing demonstration projects is further justified by the fact that, almost certainly, not all practices learnt from the developed world will apply the same way in the developing world. For example, many monitoring and bait deployment practices have been developed in temperate countries and will not work as well in tropical countries because of new types of non-target species such as land crabs which interfere with equipment and consume large amounts of baits.

Demonstration projects are commonly proposed in funding bids for programmes such as the Pacific Invasives Initiative and the Critical Protected Ecosystems Fund. As discussed, the concept is to provide a learning model for local implementing agencies to acquire the skills necessary to carry out further projects. Most demonstration projects are selected on the basis of biological characteristics such as the presence of threatened fauna and flora. Yet, if capacity building is in fact the main objective then more time needs to be spent on selecting local implementing agencies which can be involved in a series of projects. These projects should gradually place progressively more responsibility on the local implementing agency for instigating, planning and implementing the project. In this scenario, the "external" support would shift from one of being planner, designer and teacher to one of finally providing peer review and advice only. Thus, it may be more important to place emphasis on selecting the right implementing agency rather than putting so much emphasis on the biological qualities of the projects.

Another feature of the CEPF is its policy to support local civil organisations such at the village or NGO level and with relatively small grants. Thus, the demonstration projects which seem to be feasible under this regime would appear to be one-off projects. This policy might be improved if the Fund followed the principle of empowering such agencies with a series of projects which progressively built the capability required to finally independently design and run projects. Thus, multiple projects involving single agencies responsible for fewer locations funded by larger grants maybe a better model to follow. It would also be advisable to involve relevant government (and possibly IGOs) in the process of running the projects to maximise the leveraging of support and

skills (e.g., networking with Secretariat of the Pacific Regional Environment Programme [an IGO] and the Pacific Invasives Learning Network [a NGO]). The CEPF funded projects may also be a prime opportunity to integrate with the Cooperative Islands Initiative (CII) launched at the Convention on Biological Diversity's 6th Conference of Parties at The Hague, 2002, which is a global partnership concept involving NGO and IGO agencies cooperating on a collective work programme. Indeed, the Pacific Invasives Initiative (itself the first initiative under the CII) has been suggested as assisting the establishment of the demonstration projects described in the Micronesian Polynesian Hotspot, CEPF programme (thus incidentally, involving IGO's in the CEPF programme after all because the SPREP, an IGO, is a partner of the PII).

In a similar vein, there is further networking possible for the CEPF and its partners with the Global Island Partnership (GLISPA) which was launched at the CBD COP8 in Curitiba in March 2006 by the President of Palau and Indonesia, and others. The GLISPA was launched with the "Micronesian Challenge" which includes committing 30% of marine and 20% of remaining forests to becoming protected natural areas. The "challenge" has been to other countries and territories to match it. The purpose of the GLISPA is much wider though because it hopes to implement the Convention on Biological Diversity's Island Biodiversity Programme of Work. Hence, there are plenty of initiatives all with the mandate to promote IAS programmes. The challenge will be for countries to settle on one to provide leadership (and hence, coordination and collaboration) which will require significant investment.

While early detection and intervention is not, strictly speaking, preventing the introduction of new species, systems as established on Maui in the Hawaiian Islands are ideal, provided the community has the technology, because the system potentially mobilises the whole community to keep watch and provides unity of purpose and shares the risk posed by IAS. The concept of the IAS Early Detection Reporting Network as set up in Maui, Hawaii, may not be as workable in some developing countries. However, the principle is excellent and, indeed, will serve a number of functions including the obvious of early intervention and eradicating potentially invasive alien species before they establish, and raising the profile of IAS in the minds of the public and transferring some of the responsibility for their management on to the public. As with many IAS initiatives, the real benefits of programmes such as these will only be realised with long-term funding. The point being, it is essential that a reasonable time period is included in planning because the input of the community (which is so critical) is essentially about changing behaviour which takes a long time.

Of all the options available for IAS work, prevention still must rank highest priority. The problem with prevention work is that zero occurrence is the measure of success. Thus, by definition, there are no tangible outcomes for a successful prevention programme – not an attractive scenario for a funding agency which wants to see material outputs and outcomes. The international conservation community needs to make as much as possible out of the consequences of the break-down of biosecurity measures when they happen (such as occurs with invasive rat invasions) and drive this point home to funding agencies so that the value of prevention programmes can be placed in perspective.

## SYNTHESIS AND RECOMMENDATIONS

Based on my experience and the commentary from colleagues, I offer the following analysis. Considering all the money and effort that is being spent on IAS programmes in the developing world (and this would be true of at least others addressing threatened species conservation), the ratio of planning for, advising and investigating the problem to actually doing something about it on the ground is too much weighted towards the former. Too often, analyses of problems (like IAS issues), planning and "advising" is done without the follow through of completing the projects on the ground. Thus, the expectations of in-country people are raised without these being met and cynicism sets in.

In considering what projects should be attempted, more attention should be given to empowering selected institutions aimed towards them acquiring progressively more and more capacity to be able to plan and run projects themselves. This scenario is more preferable than trying to address a wider range of biological topics. Thus, weighting projects this way should better address the issue of permanently empowering local institutions with the capacity to meet their conservation and IAS needs.

In this paper, I have mentioned only a small number of the international programmes involved

in invasive alien (vertebrate and other) species. Programmes relating to island conservation alone include the Pacific Invasives Initiative, Cooperative Islands Initiative, Island Biodiversity Programme of Work (under the Convention on Biological Diversity), Global Islands Partnership (partly set up to implement the IBPOW), the Critical Ecosystems Partnership Fund, Island Conservation, and so on. There are also numerous database-style programmes involving invasive alien species (e.g., the Global Invasive Species Database, Global Invasive Species International Network) and other programmes or projects which support on the ground work. These programmes include many sub-programmes and projects which multiply the complexity of the situation. With so many programmes and projects working on invasive alien vertebrate (and other) species, there must be a lot of duplication of effort. A lot of work needs to be done between programme leaders to network and share expertise. Programmes such as the Global Invasive Species Programme are mandated to do this yet they struggle to win funds to play this role in the global community. The task is huge yet, after about 10 years in existence the GISP is still tiny and cannot cope with the task at hand. The role of networking and sharing expertise and knowledge seems unattractive in itself to funding agencies. Most want to see more tangible output based projects in their portfolios. For their part, programmes such as the GISP need to work on methods to quantify how much added value they bring to other programmes and projects. Thus, there needs to be a turn-around in attitude of funding agencies which will mean funding "secretariat" style programmes such as the GISP and recognise their "added-value" benefits to other "on the ground" projects. One solution could be to follow Island Conservation's model of creating "sister organisations" in the regions they work in and programme the costs of establishing these into the project costs of the island eradications in the region. In this way, locals are being empowered to carry out their own conservation work and the model of the implementing agency (like IC) moves progressively from demonstration projects to being advisors to local agencies carrying out the conservation project.

Funding agencies and planners need to consider how many similar projects there are in existence today and whether new ones are really necessary, or whether it would be better to invest more in existing projects and programmes. There is certainly duplication in purpose with various IAS projects and in the "service" programmes such as the information databases. Thus, I think it is time to seriously think about a consolidation phase in funding new work under existing programmes umbrellas rather than starting new ones. Related to this issue is the need for projects and programmes to more efficiently trade information for obvious reasons. This improvement may be achieved by funding bodies insisting on making this networking happen in the planning and implementing phases of projects and programmes. Some of this trading of knowledge and skills can (and should) be the responsibility of some key organisations such as the Global Invasive Species Programme and other secretariat-style programmes. In turn, these should be valued by funding bodies as necessary for helping to ensure "operational" programmes are as cost-effective as possible, receiving as much benefit from other projects as possible. This "added value" capacity of "secretariat" like programmes should be seen as sufficient justification for "secretariats" being funded.

Non-government organisations need to retain their link with the government sector because, in the long term, the government agencies need to be up-skilled if some continuity of improvements is to be achieved. Non-government organisations can and do provide much of the practical, on-the-ground work at least in the Pacific and, in so doing, provide a stark reminder to government agencies of what they should be themselves doing. While this is important, nevertheless, NGO's should make every effort to work in with government agencies.

One of the most difficult problems to overcome is long-term funding (meaning decades) to ensure that a project will continue. Funding time-frames are typically one to five years – too short to ensure that local capacity has been improved sufficiently to ensure the continuity of the programme. This is particularly significant as a problem because the biological and ecological nature of the issues coupled with the changes in human behaviour required mean that significant periods of time are required to effect long-term changes. One aspect of this need for long-term planning is for on-going biosecurity after an eradication has been done. The question of continuing biosecurity to prevent re-invasion has been the stumbling block for deciding whether a number of projects should go ahead. The basic problem is the time frame for the eradication operation itself and ensuring ongoing biosecurity are completely different (the latter being much longer) and are also different in the nature of the work required. While some funding and

implementing agencies are aware of the biosecurity issue, others apparently are not. The above also needs to be considered in the context of not making project and programme objectives over-ambitious.

The future for making rapid enough progress in technical improvements lies with international cooperation. Individual agencies cannot cope with improving trapping, monitoring, and toxin-based methods by themselves because the economies of scale will not allow it. For conservation purposes, it is unlikely that commercial corporations will be attracted to researching and developing new methods because the market is too small. Conservation agencies and funding organisations need to consider pooling resources on common technical problems. I think there are enough similarities of issues between countries to make this feasible such as the need to eradicate rodents off large islands. Labour saving technical advances are possible in such labour intensive activities as tracking tunnels, species specific traps, automated traps, and monitoring devices which traditionally take up huge components of the total budget of the project. These labour-saving improvements will allow (1) staff to be redirected to other conservation work such as threatened species management or biosecurity, and (2) much larger areas to be managed (control or eradication) than possible at present.

The rigorous exercise of registering 1080 in New Zealand as a "safe" toxin from environmental and human health points of view highlighted to me the biggest weaknesses of using broad-spectrum toxins that can kill a number of different species apart from the target species. These include the increasing opposition (especially from traditional cultures) of killing non-target species and the objection to "spiritually corrupting" the ecosystem by applying toxins, especially using aerial techniques which, of course, are the very methods we need to use for larger areas. Another problem with acute and chronic toxins (such as 1080 and brodifacoum, respectively) is the manner of death of the target and non-target species (especially where the latter are large-bodied animals which may only get exposed to sub-lethal doses) because of animal welfare issues. For 1080 and brodifacoum, there is insufficient known about the manner of death of target pest species and what is known of the manner of death of wild animals seems to be inferred from research based on captive or laboratory animals. Thus, there is little known about the pathology of toxins in wild animals (see review papers such as Mason and Littin 2003, Littin and Mellor 2005). Research is needed on the pathology of these and other toxins commonly used on target and non-target species known to take toxins to off-set the inevitable opposition likely to increase from the animal rights movement.

## CONCLUSION

In conclusion, I think there are some well known lessons about how best to design invasive alien species programmes or projects in "developed" and "developing" countries alike and the real challenge is to heed these lessons in planning and implementing them. There is an obligation on funding organisations and those proposing programmes or projects to jointly avoid duplication of effort, and plan and commit to long-term support to maximise the chances of transferring capacity to local organisations. Local capacity building, the focus of much NGO work, needs to be coupled with "national" (often government agencies) agencies to help ensure longevity of the transfer of capacity. Our dependency on the few control and eradication methods we have available needs to be reduced. Hence, new methods of killing (such as p-aminopropiophenone – PAPP) and monitoring pest, and some particular taxa of non-target, species are needed which are species specific. This research and development is urgent and needs to be tackled cooperatively between international organisations. Finally, as has been repeated elsewhere many times, prevention must be the priority and new methods (such being developed in Maui, Hawaii) for ensuring biosecurity are essential.

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