Invasive Species Specialist Group of the IUCN Species Survival Commission

ALIENS

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SPECIAL ISSUE ON INVASIVE ALIEN SPECIES AND PROTECTED AREAS

INVASIVE ALIEN SPECIES AND BIODIVERSITY CONSERVATION – THE ANOMALY

Kruger National Park (South Africa)

Introduction

Many protected areas worldwide are more know for their management focussed on protecting endangered species and other aspects which attract emotional and sympathetic reaction from supporters. However, invasive alien species (IAS) are regarded as the second greatest threat to global biodiversity by scientists worldwide (IUCN, 1997). This, second to habitat degradation and fragmentation (i.e. deforestation). As conservation areas are often protected and not subjected to any or large scale fragmentation and degradation, it stands to reason that the number one threat facing the core business of biodiversity conservation is that of Invasive Alien Species. These sentiments are exactly those expressed by the Kruger National Park (KNP), which during a workshop on Biodiversity conservation (1997) rated IAS as the greatest threat to the KNP. Surely a turning point from the past where anti-poaching, fire control, water provision and other aspects were considered the most important duties of a ranger or protected area manager. These are still indisputably important and necessary (and I do not attempt to portray it in any other way). However, if the integrity of the natural system is degraded through the introduction of IAS to such an extent that it creates a significant negative impact on native biodiversity, we should become concerned, as the core business of protected area management will certainly be eroded away.

The problem with invasive species is that they are not intrinsically interesting to most people, often including protected area managers and officers. They do not conjure up stories of excitement or the thrill and reward of catching an armed poacher with ivory in his hands. They do not have long flashing fangs that can shred you and sharp claws to rip. The invasion by alien species is often quite slow, unnoticeable and the impacts most frequently irreversible and immense.

The problems in Kruger National Park

Currently, the KNP has recorded approximately 363 alien plant species, Indian myna's have been recorded in the park on occasion, three fish species have been recorded as well as other insect pests etc. All of the major rivers, as well as the larger tributaries have been invaded to some extent. Combined clearing efforts between the *Working for Water* programme and the SANParks funding have totalled approximately R35 million since 1997, in the KNP alone. In spite of the amount of funding and the efforts being put in, we are only just managing to keep the levels of invasive plants down to a minimum level; in

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MESSAGE FROM THE CHAIR (ON SABBATICAL LEAVE IN EUROPE)

In July I visited Uist in the Outer Hebrides (Scotland) and learned about progress with the Scottish Natural Heritage (SNH) project to protect native wildlife from invading hedgehogs. These animals were introduced to South Uist several years ago and have since spread north to Benbecula. Without preventative measures they are now poised to colonise North Uist. The hedgehogs threaten ground-nesting waders such as dunlin by preying on their eggs. A sustained eradication campaign is planned, concentrating initially at preventing further spread and reducing hedgehog densities in core habitats. This campaign has been controversial, but (to their credit) SNH commenced it as planned this year and have had a successful first season. I hope that we will have a fuller report in a later issue of Aliens.

Mick Clout

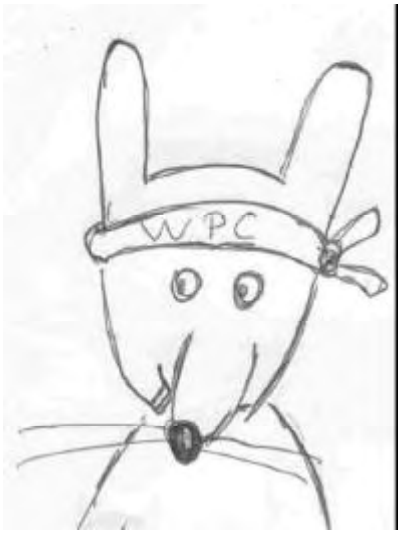

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Figure 1: Sunset Dam, 5th August 2002

Figure 2: Sunset Dam, 29th January 2003

Photographs: Llewellyn C Foxcroft

some areas. Other areas are reporting rapid increases in abundance and distribution. The recent invasion of *Chromolaena odorata* (Chromolaena or triffid weed) into the KNP, which is now found in most rivers in the park, was one of the most rapid plant invasions experienced in the KNP and poses a serious threat to the rivers in the future if follow-up control efforts are not maintained.

Control efforts make use of mechanical / chemical means, biological control and integrated control. Each technique appropriately determined by the particular invasive species and situation. Aquatic weeds are generally well controlled biologically, which further reduces the potential danger posed by working in and on water bodies (see figure 1 & 2. *Pistia stratiotes* invasion on Sunset dam, Lower Sabie, KNP. Under biological control by the weevil, *Neohydronomus affinis*).

Summary
If parks are to succeed into the future, more emphasis and effort will need to be spent on issues relating to biological invasions. The long-term success or failure of any programme will require long-term sustainability, both ecological and economical. Careful integration of the most appropriate methods of control will be needed to ensure that management of invasive species is integrated into protected area management as one of the key issues.

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MESSAGE FROM THE EDITOR

This issue of Aliens has a focus on Invasive Alien Species (IAS) and Protected Areas - at the occasion of the World Parks Congress (see page 3). The aim is to illustrate the many ways that IAS are impacting on protected areas, as well as the many methods and processes that can be used to successfully fight back. Coverage extends from World Heritage sites, National Parks or National Refuges to conservation areas in traditional ownership, and locations range from the Subantarctic and Arctic to the temperates and tropics. IAS problem species range from the usual suspects (rats, *Mimosa pigra*) to the more unusual (feral elephants). Solutions range from large scale strategies and programmes to local communities and champions. Case studies include quarantine, surveillance and rapid action, control, eradication, education and awareness building - and, of course, vision and committment! The next issue of Aliens will focus on Europe as well as neighbouring areas (so it can include Mediterranean or circum-Arctic initiatives etc.). We hope for many contributions: contact *m.depoorter@auckland.ac.nz.*

Maj De Poorter

Erratum for hard copy of IUCN Guidelines, published as insert in Aliens 11

It has been brought to our attention that on the hard copy of the "IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species", published as an insert in *Aliens 11*, 2000, there is a mistake. The last bullet, regarding Criteria to be satisfied to achieve eradication (p.14) is missing.

An additional paragraph should be included

- The socio-political environment must be supportive throughout the eradication effort. Objections should be discussed and resolved, as far as practicable, before the eradication is begun.

If you would like an amended copy, please let us know, at *ISSG@auckland.ac.nz* and we will send it out to you.

KEEP THEM OUT OF PARADISE: INVASIVES AT THE WORLD PARKS CONGRESS

The IUCN World Congress on Protected Areas, or the World Parks Congress as it has become known, is a 10-year event that provides the major global forum for setting the agenda for protected areas (PAs). The Congress is a major international event offering a unique opportunity to take stock of protected areas and biodiversity management; provide an honest appraisal of progress and setbacks; and chart the course for protected areas for the next decade and beyond.

The 5th IUCN World Parks Congress will be held in Durban, South Africa from 8th to 17th September 2003. The theme of the Congress responds to the challenge to show how protected areas are relevant to the broader economic, social and environmental agenda for humankind in the 21st Century and the importance of such areas in adapting to global change: **"Benefits Beyond Boundaries"**. It should also pose the challenge to society as to how it will sustain this investment over time. The WPC is an event not only for PA professionals but for the broader conservation and develop-ment community.

Seven workshop Streams will be conducted over three days during the Congress. One of them, ***"Maintaining protected areas for now and the future: management effectiveness",*** will be addressing threats to protected areas with the necessary adaptive management. This will include a special day-long session on **Invasive Alien Species (IAS)** in relation to PA management.

It is acknowledged that invasive species are one of the major threats to biological diversity worldwide and many strategies for biodiversity management stress prevention, monitoring and controlling alien species - especially in and near high-risk entry points and in high value biodiversity areas like Protected Areas.

Examples of invasive species causing damage in PAs are numerous in the terrestrial, freshwater and marine environments and invasive alien species have been a major concern for PA managers.The 1989 South Pacific Parks and Reserves Conference resolved that the region needed an invasive species programme that would be best administered by the South Pacific Regional Environment Programme (SPREP). Other organizations and agencies are now undertaking and integrating IAS surveys as part of environmental management. For example, next year (2004), NOAA has requested an increase of $1.0 million to develop alternative technologies for the treatment of ships' ballast water to eliminate the potential for invasions of non-indigenous marine species in U.S. and other waters and to set up a nationally a nationally coordinated monitoring system for aquatic nuisance species focusing on Marine Protected Areas.

The IUCN World Commission on Protected Areas (WCPA) marine group, WWF and NOAA have developed a "Guidebook of Natural and Social Indicators for Evaluating Marine Protected Area Management Effectiveness". This guidebook includes indicators to management effectiveness specific to marine protected areas, the marine environment in general and for coastal communities. It is important to note the biophysical indicators recommended for the prevention and removal of alien and invasive species and genotypes as a specific objective associated with the following MPA goals: protection of biological diversity, protection of individual species, protection of habitat and restoration of degraded areas.

Addressing invasive alien species in the borderless marine environment is a very challenging issue. Eradication may be possible when an introduced species is identified at an early stage of colonization and has limited spatial distribution. For this reason alone it is essential to have effective surveys, monitoring and early warning systems linked to any management plan for the marine environment.

Very few attempts to control invasions of alien species in aquatic and marine ecosystems have been successful - once the AIS have become established. We will never repeat enough that PREVENTION is the key. Where intentional introductions of useful species to the marine and coastal environments are concerned, only extreme caution can prevent the spread of noxious invasions and screening of potential introductions for "invasibility" is essential.

Marine Protected Areas are not isolated and immune from the threats to the marine environment in general, as they have no barriers or distinct boundaries to invasion. Harbours and shipping are widespread and not limited by MPA boundaries, and even if it is hard to find a big commercial port within a national park or the MPA itself, it is very often easy to find it nearby. MPAs, especially those with multipurposes, offer a set of socio-economic activities such as fisheries and tourism. The small craft that visit MPAs are often vectors of secondary introductions of alien species which were first introduced by larger (often ocean-going) vessels in the vicinity.

The invasive species workshop in Durban will cover three major topics:
1) Sooner or later IAS will be a management issue regardless of where you are and what type of protected area you manage, as few PAs are completely free from this threat to biodiversity and livelihoods.
2)IAS issues **are** manageable; there are many ways to prevent and/or fight back.

3) Managing IAS in an ecosystem context is the most effective way to ensure PA management objectives are addressed

A special presentation will be made on Marine invasive species and will focus on the specific challenges posed by the marine environment. But the integration of ideas on IAS management in all types of PA situations and ecosystems will assist this WPC workshop to come up with recommendations on collaboration and integration for monitoring and controlling IAS whatever the context.

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Previously published: *Global Ballast Water (Ballast Water News) Issue 13, April - June 2003, p.11.*

TAKITIMU CONSERVATION AREA (COOK ISLANDS) – LANDOWNING CLANS IN CHARGE OF THE KAKERORI RECOVERY PROGRAMME

In 1989, the Rarotonga Flycatcher was fighting for its life, its numbers reduced to a mere 29. It was one of the world's ten rarest birds, and listed as 'critically endangered'. The cause: an introduced predator, the ship rat (*Rattus rattus*), which first made its appearance in the Cook Islands in the mid-1800s.

The community-owned reserve protects the kakerori habitat, and the kakerori provides a flagship for income-generating activities...

In 2002, more than 250 birds were alive and well in Takitumu Conservation Area on Rarotonga, the largest of the Cook Islands. Three landowning clans — the Kainuku, Karika, and Manavaroa families — are working together, and are in charge of the recovery programme. The community-owned reserve protects the kakerori habitat, and the kakerori provides a flagship for growing income-generating activities.

1987 the Kakerori Recovery Project started a Cook Island government program led by the Environment Service. In 1996**, t**he Takitumu Conservation Area, 155 hectares of forested ridges and valleys was established. Project management was transferred to the clans that own the land. It was the first time the government had ever turned a project over to landowners. The area was adopted by the South Pacific Regional Environment Programme (SPREP) as a Conservation area within the South Pacific Biodiversity Programme (SPBCP). .

The most important task in the conservation area is saving the birds. Staff and volunteers band new birds and conduct a bird census every August. Then, rat stations are stocked with bait on a weekly basis during the bird's breeding from September through December. (Intensive rat baiting began in 1989, spearheaded and maintained by Ed Saul, a New Zealander who is so devoted to kakerori he has come to Rarotonga to lay rat bait for 13 years in a row). Because the growing bird population is fragile – one severe cyclone could take out the entire species – the conservation area committee decided to start a relocation programme. In 2001 and 2002, the clans moved a small number of birds to Atiu, a small island of less than 1,000 people located 200 kilometers northeast of Rarotonga. The species has recently been downgraded from "Critically Endangered" to "Endangered" by the World Conservation Union (IUCN), one rank down from its 'critically endangered' status of a decade ago.

The other main activity in the conservation area is a nature walk and bird-watching venture. Rarotonga is an ideal place to start an ecotourism operation, because the island is already a popular tourist destination. Tested in 1997, the nature tours got into full swing in 1998. Income from the nature walks and souvenir shop is helping the community and the kakerori conservation efforts- but it is not able at this stage to provide financial self-sufficiency.

Takitumu Conservation Area's success has prompted active interest from other places in the Cook Islands. Residents of both Mangaia and Mitiaro Islands have visited Takitumu to get ideas for protecting their own endemic species, and the Cook Islands Tourism Department frequently uses Takitumu's nature walk and bird-watching business as a case study in its ecotourism workshops.

Shortened from *"Warrior bird, warrior people – three clans cooperate and save a species in the cook islands" in "navigating a new course – stories in community-based conservation in the pacific islands"* by Tory Read (2002). Published by UNDP. Pdf of the full article can be downloaded:
www.undp.org.ws/PDF/Stories%20Cook%20Islands%20.pdf

For more on kakerori conservation status:
http://www.birdlife.net/datazone/search/species_search.html?action=SpcHTMDetails.asp&sid=6076&m=0

Editor's Note:*We hope to provide a more detailed update in a future issue.*

PARKS IN PERIL IN THE ISLANDS OF FRENCH POLYNESIA
(SOUTH PACIFIC OCEAN)

The current situation of parks and nature reserves in the tropical oceanic islands of French Polynesia (South Pacific Ocean) is critical. Natural protected areas are found in only nine islands of the 118 that formed this French overseas territory. Seven of them are uninhabited high volcanic islets (including Eiao, Hatutu, and Mohotani in the Marquesas Is.) or uninhabited small atolls (including Motu One in the Marquesas, Scilly and Bellinghausen in the Society Is., and Taiaro in the Tuamotu Is.). The total protected area is ca. 7,000 ha, i.e. only 2% of the total land surface of French Polynesia (ca. 3520 km²). All of these protected zones, except Taiaro which has been recently included (1998) in the Tuamotu Biosphere Reserve (along with 5 other atolls), are characterized by a lack of active management, with no monitoring, caretaking or park guards. In the absence of human activities, the main threat to these protected areas remains the invasion by alien plant and animal species. Feral sheep are thriving on the islets of Mohotani (1,300 ha) and Eiao (4,000 ha) where less than 25% of the native vegetation is left. The understory of the native *Pisonia grandis* coastal forest is "cleaned up" by overgrazing and the mesic vegetation has turned into eroded bare land in some places. The native lowland rainforest of Te Faaiti Natural Park (750 ha), established in 1989 and located in the largest valley of Tahiti (Papenoo valley), is heavily invaded by the introduced tree *Miconia calvescens* (Melastomataceae) which forms dense monospecific stands and threatens rare endemic plants, such as the protected shrub *Polyscias tahitensis* (Araliaceae) or the orchids *Phaius tahitensis* and *Bulbophyllum tahitensis*. Wild horses, cattle and goats make frequent incursions into the Natural Park and Nature Reserve of Vaikivi (240 ha) recently established in 1997 in the island of Ua Huka (Marquesas). Mohotani and Vaikivi have still good populations of the critically endangered Marquesan flycatchers (*Pomarea mendozae* and *Pomarea iphis* respectively) because of the absence of black rats (*Rattus rattus*). Ua Huka is also one of the few French Polynesian islands without the carnivorous snail *Euglandina rosea* and has still good populations of endemic tree snails of the genus *Samoana* (Partulidae). Hatutu (750 ha), another rat-free island, is the only place (along with Fatu Huku, another inhabited but unprotected Marquesan islet) where the endangered Marquesan ground-dove *Gallicolumba rubescens* is found. Fencing projects were proposed on Mohotani and Vaikivi, as well as sheep eradication on Mohotani and Eiao, but these have not yet been achieved due to lack of strong political support and/or of available funds.

Other natural areas of high conservation value in French Polynesia that were proposed to be protected, are also under the immediate threat of invasive species. For instance, the Temehani plateaus in the island of Raiatea (Society Is.) where the endangered endemic lobeliad *Apetahia raiateensis* (Campanulaceae) is growing, is currently threatened by the spread of two invasive alien shrubs (*Rhodomyrtus tomentos*a, Myrtaceae, and *Chrysobalanus icaco*, Chrysobalanaceae). The endemic tree snails are vanishing on the remote island of Fatu Iva (Marquesas) due to the introduction of *Euglandina rosea*, as well as the Fatu Iva flycatcher (*Pomarea whitneyi*) and the Ultramarine lorikeet *Vini ultramarina* due to the recent arrival of black rats in 2000. It is clear that if no active management of invasive plant and animal species is conducted promptly in the natural protected areas of French Polynesia, these areas will rapidly lose their most vulnerable and ecologically interesting taxa !

ACKNOWLEDGEMENTS
I am grateful Dr. to David Lorence (National Tropical Botanical Garden, Kauai, Hawaii, USA) for revising the English on this paper.

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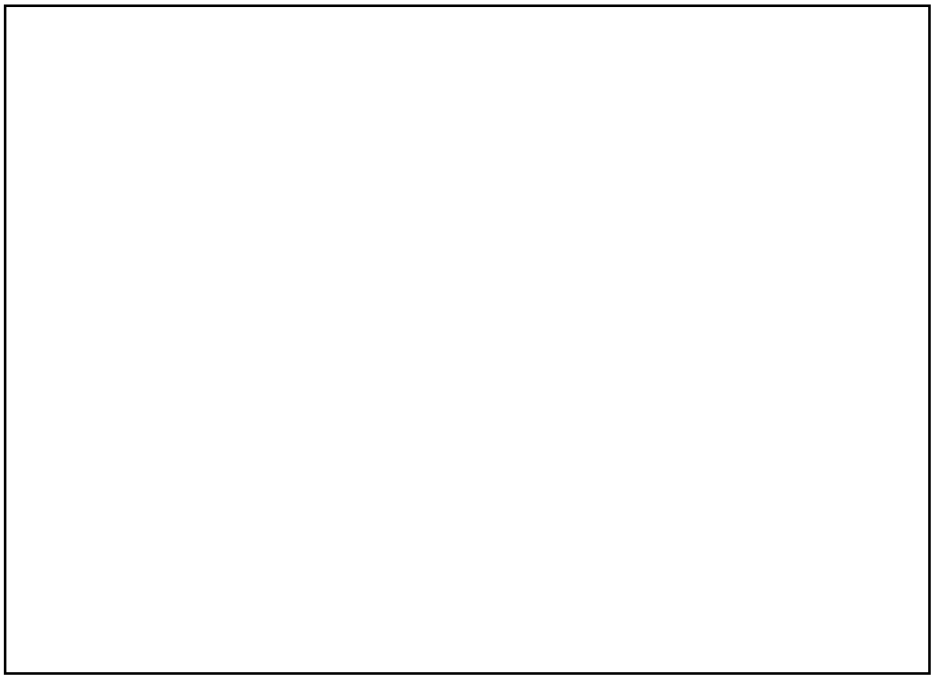
The "cleaned" understory of a native *Pisonia grandis* (Nyctaginaceae) coastal forest caused by overgrazing by feral sheep on the Nature Reserve of Mohotani. Photo: J.-Y. Meyer, Délégation à la Recherche.

National Park Service Exotic Plant Management Teams; An Innovative Response to Harmful Invasive Species (USA)

The national parks of the United States are home to complex communities of native plants and animals that have developed over millions of years. The natural heritage protected in parks is threatened by the invasion of exotic plants. These exotic plants are able to reproduce rapidly because the animals and diseases that keep them in check in their home ranges are missing. For example, *melaleuca* trees from Australia threaten to replace the wet prairies of the Everglades. Leafy spurge (*Euphorbia esula)*, an import from Eurasia, easily replaces the grasslands of the Northern Great Plains. When the populations of native plants are reduced, the animals that depend upon them lack the food and shelter needed for survival.



Today, exotic plants infest approximately 2.6 million acres in the national park system, reducing the natural diversity of these places. Drawing funds from the Natural Resource Challenge, the National Park Service is establishing rapid response Exotic Plant Management Teams (EPMT) to control exotic plants. Modeled after the approach used in wildland fire fighting, EPMTs provide highly trained, mobile strike forces of plant management specialists who assist parks in the control of exotic plants.

In 2003, seven new tactical EPMTs joined the nine existing EPMTs. These nine EPMTs have been lauded for their work in controlling nuisance exotic plants. These field- or park-based teams are illustrated in the map accompanying this article.

Each EPMT serves multiple parks within a broad geographic area. They work through steering committees to identify, develop, conduct, and evaluate exotic species removal projects and undertake appropriate native species restoration efforts. Each of the 17 established teams has developed site-specific strategies for combating exotic plants that reflect the needs and resources of the more than 145 parks they serve.

The success of the EPMT derives from its ability to adapt to local conditions and needs. Each team employs the expertise of local experts and the capabilities of local agencies. Each sets its own work priorities based on the following factors: severity of threat to high-quality natural areas and rare species; extent of targeted infestation; probability of successful control and potential for restoration; opportunities for public involvement; and park commitment to follow-up monitoring and treatment.

Since the specialized team's inception in 2000, they have controlled, inventoried, or restored over 73,000 acres. Over 12 species have been controlled to a maintenance level in park units. Over $1.8 million dollars have been leveraged with NPS partners.

This is a golden time for managing invasive species in national parks. There is broad recognition from our partners, visitors, and political institutions that invasive species are a major threat to natural heritage. Increased funding for invasive species management reflects this recognition as well as commitment. Control of invasive species in national parks is within our grasp if we stay the course

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Editor's note: of related interest (wider than Parks) are the following publications and download sites:
- *Pulling Together -The National Strategy for Invasive Plant Management* has been developed by the Federal Interagency Committee for the management of Noxious and Exotic Weeds (FICMNEW). *http://ficmnew.fws.gov/page11.html*
- *National Early Warning and Rapid Response System For Invasive Plants in the United States* at *http://www.nawma.org/documents/Early%20Warning%20and%20Rapid%20Response/EarlyWarningActionPlan031502.doc*

NEW ZEALAND "MAINLAND ISLANDS": ECOLOGICAL RESTORATION THROUGH INTENSIVE MULTI-PEST CONTROL

The generic term "Mainland Islands" refers to biodiversity conservation projects which are undertaken at "mainland" sites (i.e. terrestrial sites adjacent to other land rather than surrounded by water). The goal is ecological restoration and intensive, multi-pest control is involved. Unlike "real" islands which are discrete land masses surrounded by sea, Mainland Islands are subjected to continual re-invasion pressure from pests in surrounding areas. Mainland Island projects are also distinctive in that they involve more extensive result and outcome monitoring than more traditional pest control projects. Some of them also employ an adaptive management ("Learning-by-doing") approach whereby hypotheses about pest impacts and anticipated changes resulting from management are tested as part of on-going management programmes. As such they are places where Best Practice can be developed and disseminated.

Why do we need Mainland Islands?

While eradicating pests from offshore islands will continue to be important, more effective control is urgently required on the New Zealand "mainland" if further losses and extinctions are to be averted. After only a few years of operation significant conservation outcomes, including species recovery and habitat restoration have been demonstrated. Because they are more accessible than offshore islands many Mainland Islands also have value as "Showcases" where people can visit and see for themselves what is involved in achieving important conservation goals.

In 1994 and 1995 the NZ Department of Conservation initiated six Mainland Island projects. Now, Mainland Island-type projects are also increasingly being initiated by agencies other than the Department of Conservation, including by private entities (see box).

Example: Northern Te Urewera Ecosystem Restoration Project

The Northern Te Urewera Ecosystem Restoration Project (a Department of Conservation initiative in partnership with Ngati Tuhoe – the indigenous people of the area) covers 50,000 hectares of the Te Urewera National Park (total Park area of 213,000 hectares, North Island, New Zealand). The goal is to restore the Mauri (life force) of the forest. An adaptive management approach is being employed to determine whether a network of "core management areas" within a matrix of less-intensively managed forest will be sufficient to restore the entire 50,000-hectare project area. Pests targeted for control include possums over the entire area and various combinations of stoats, cats, rats, deer and pigs within the smaller core management areas.

One important feature of this project is that while the anticoagulant toxin Brodifacoum was used initially, trials are now underway to establish whether trapping alone is sufficient to control predators to the very low prescribed target densities in the core areas. Initial results are encouraging. Innovative techniques have been developed here including the use of freeze-dried rats as bait to attract stoats to traps, and rat traps suspended on tree trunks to catch rats while posing minimal risk to non-target species. Important outcomes have included a significant increase in the number of kokako (*Callaeas cinerea*) in core management areas compared to nearby less-intensively managed areas and the re-appearance of spectacular scarlet mistletoe blooms in the forest canopy as a result of effective possum control.

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Karori Wildlife Sanctuary

While the Northern Te Urewera Ecosystem Restoration Project, covering 50,000 hectares is the largest Mainland Island project in New Zealand (so far), almost at the opposite end of the spectrum is the initiative to restore and manage 252 hectares of regenerating native hardwood in Wellington city as a mainland island. For a start, it is a community initiative rather than a government project, and rather than be in a majestic vast wilderness area, it focuses on an area in the capital city, a few kilometres from Parliament and the Central Business District. This is an ideal location for education and awareness raising. The project has a high level of support from the public, local and regional authorities and the Department of Conservation. It is unique in that the entire area is protected by a predator-proof fence, which encircles the 8.6km perimeter and which is specifically designed to exclude 14 species of non-native mammals ranging from possums and feral cats to rodents.

Source: *www.sanctuary.org.nz*

CORAL REEF INVASIONS

In the past three decades anthropogenic movements of marine shallow water organisms has become more frequent and increasingly important. Since the 1970s a significant increase in non-indigenous species have been identified in harbors, ports, and other man-made areas along the temperate coasts. These studies and others have focused on areas of substantial maritime activity most likely to receive introductions through ballast water discharge or by hull fouling. Information on introductions into subtropical/topical waters has been mainly based on reviews of the literature, primarily focused on species intentionally introduced for aquaculture purposes in the Pacific. Introductions on coral reefs in the tropical Pacific have also reported. Current numbers for marine and brackish water species in the Hawaiian Islands is 343: 287 invertebrates, 24 algae, 20 fish, and 12 flowering plants. In addition to the Hawaiian Island studies, surveys have been conducted in Guam and Australia. The greatest number of introductions have arrived through hull fouling with solid ballast and ballast water following.

Intensive biological inventories have been carried out in the Pacific region at several locations in the Hawaiian Islands (Pearl Harbor, Oahu south and west shore harbors, Kaho'olawe, Midway Atoll, French Frigate Shoals, Johnston Atoll, Kaneohe Bay, and Waikiki), Guam, American Samoa, and Australia (Queensland ports, Hay Point Port, Mourilyan Harbour, Lucinda Port). Percentages of non-indigenous species in the Hawaiian Islands vary from 23% and 17% in Pearl Harbor and Honolulu Harbor, respectively, although percentages are misleading, since a single species can be the major invader.

In the Hawaiian Islands five species of algae are causing major problems. Three species—*Hypnea musciformis, Gracilaria salicornia, Kappaphycus* spp.—were intentionally introduced to investigate the feasibility of developing an aquaculture industry. One—*Acanthophora spicifera*—was accidentally introduced on a barge from the western Pacific in 1950, and the origin of one—*Avrainvillea amadelphia*—is unknown. *Hypnea musciformis* has spread to several of the main Hawaiian Islands. On Maui 20,000 pounds of algae wash up on Kihei beaches per week, costing more than US$100,000 per year to clean. In an economic study, algal biomass costs north Kihei more than US$20 million per year in lost of rental income, decrease in property value, and clean up. Added impacts include smothering and overgrowth of the native biota. In Kaneohe Bay, Oahu, experimental removal of *Kappaphycus* has demonstrated that it regrows at a rate of more than seven times within a five month-period.

Some invertebrates are also causing serious impacts. The Caribbean snowflake soft coral—*Carijoa riisei*—first observed in the early 1970s, is rapidly spreading along the shores of all the main Hawaiian Islands. In 2001 the species was observed at depths of 100 meters carpeting 90% of the substrate, threatening the black coral industry, valued at US$30 million per year. A western Atlantic barnacle—*Chthamalus proteus*—was first observed in the mid 1995, having arrived sometime after 1970. The small species is very abundant on docks and pilings, covering 100% of a sea wall in Hilo Harbor on the island of Hawaii. Its impact is not known. Several sponge species the Philippine Islands and the Caribbean are proliferating in the bays, growing over and covering upright branching corals.

Several species of fish were intentionally introduced in the mid1950s to enhance the fishery potential. One—*Lutjanus kasmira*—has spread to all the Hawaiian Islands as far north as Midway Atoll. The species forms large schools that feed of the bottom and probably compete with several species of native fish. A number of tilapia species have been introduced over a long period of time. Individuals have been observed nibbling on coral polyps at a boat harbor.

For the attempted removal of the algae, alien algal clean-up events have been held at Waikiki and Kaneohe Bay. These are community and volunteer training events organized in conjunction with multi-agency partnerships with the goal of reducing the impact of alien algae in Hawaii. An "early warning system" is being developed with the assistance of the U.S. National Oceanographic and Atmospheric Administration. This will include a web-site checklist of the marine biota of the Hawaiian Islands with search capabilities to identify various organisms. When used at island-entry points, a species not listed, would be considered as a possible non-indigenous species. The web site would include information on known non-indigenous species, including origin, local distribution, potential impacts, and identification notes.

Some recommendations for action include the raising of awareness of the problem at all levels from government to individuals; the building of stronger capacity for the identification of marine biota and the establishment of a pool of specialists willing to identify specimens as expeditiously as possible; the establishing of scientifically based risk assessment programs; and the reducing of vulnerability by minimizing pollution, sedimentation, and physical degradation.

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(see also note page 3)

DEALING WITH INVASIVES IN THE NATIONAL PARK OF AMERICAN SAMOA

IAS IN AN ECOLOGICAL AND CULTURAL CONTEXT

The National Park of American Samoa was officially established in 1993. Its mission includes: protection of the only old-world tropical rainforest in the U.S National Park System, protection of the only Indo-Pacific coral reef in the U.S Park System and helping the preservation of the 3000-year-old Samoan culture. Invasive Alien Species (IAS) problems in the park include Kerosene tree (*Paraserianthes falcataria*), Mafoa (*Canarium harveyi*), Lopa (*Adenanthera pavonia*) Fuelautetele (*Merremia peltata*), Laau fulu (*Clidemia hirta*) and other.

School children assist Tavita Togia with awareness raising and media work.
Photo Leua Aiono Frost, Samoa Post

IAS Management is carried out in an ecological and cultural context and the project goals include:

- To reduce the rate of invasion and impact of invasive alien plants in the Park and American Samoa
- To revive traditional cultural practices and language as they relate to native heritage plants and their uses
- To involve students and the community in solving the problem of invasive plants
- To preserve and protect rare endangered species
- To provide food and habitats for native wildlife

In practice this includes a wide range of activities, like the girdling of 700+ tamarind which covered 20 acres of the park, invasive species control, coupled with reforestation (e.g. tree planting in the village of Fagasa in partnership with Fagasa's leaders), weed surveillance in village gardens followed by the opportunity for garden owners to exchange "bad" plants for "good" plants, community outreach, partnership with community leaders to identify important invasive plants on the one hand and native heritage trees on the other hand, field trips for students and community, student involvement in IAS awareness and weed surveys, restoration and maintenance of five acres of disturbed land with 1,400+ heritage trees and medicinal plants, re-introduction of rare and endangered native plants, as well as revival of traditional practices (e.g. carving). More recently a greenhouse has been built at Le'atele school, and a Native Botanical Garden has been established, with support ranging from Village Matai to students and the wider community.

Goals for the future include:

- Develop a children's guide to the National Park and its native flora
- Develop a Native Plant/Invasive Species unit plan to be used throughout the school system which will assist teachers in classroom instruction
- Involve high school students in volunteer service to the Park
- Develop a 'plant giveaway' program which will encourage members of the community to assist in protecting culturally significant plants
- Utilise all media resources for educational purposes
- Eradicate the tamarind tree within the Park boundaries by December, 2004

A brochure of the Top Ten Invasive Plants in American Samoa will be published shortly, in cooperation with the principal of Le'atele Elementary school, Evelyn Weileman.

The top ten invasives are:

1. Kerosene tree (*Paraserianthes falcataria, Fabaceae*)
2. Fuelautetele (*Merremia peltata, Convolvulaceae*)
3. Pulu mamoe (*Castilla elastica, Moraceae*)
4. Mafoa *(Canarium harveyi, Burseraceae*)
5. Tinamoni (*Cinnamomum vernum, Lauraceae)*
6. Laau fulu (*Clidemia hirta, Melastomaceae)*
7. Strawberry guava *(Psidium cattleianum, Myrtaceae)*
8. Ivy gourd *(Coccinia grandis, Cucurbitaceae)*
9. Faapasi *(Spathodea campanulata, Bignoniaceae)*
10. Fee *(Scheflera actinophylla, Araliaceae)*

Source: shortened from a presentation by Tavita Togia, presented at the University of Auckland, April 2003, by permission.

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INTRODUCED MAMMALS IN ANDAMAN & NICOBAR ISLANDS (INDIA): A CONSERVATION PERSPECTIVE

The Andaman and Nicobar islands in the Bay of Bengal are peaks of a submerged mountain range, arching from Myanmar to Sumatra, between latitudes 6°45' and 13°41'N and longitudes 92°12' and 93°57'E. The group comprises over 560 islands and rocks, with a total coastline of about 1962 km. The Andaman group with over 300 islands and the Nicobar group with 23 islands. The forest type of the Andaman and Nicobar islands can be broadly classified as tropical evergreen, with inland areas being either forest or grasslands and significant proportion of the coast being mangroves. These islands are home to 5357 species of fauna and 1454 taxa of angiosperm. Of the total species of fauna, 487 are endemic and in flora a total of 221 species are reported to endemic to these islands.

For recreational purposes three species of deer chital *Axis axis*, barking deer *Muntiacus muntjak* and sambar *Cervus unicolor* were introduced into the Andaman Islands around 1915. Because of good vegetation the population of the chital increased rapidly and became menace to the agriculture. Two male leopards were introduced for controlling the deer population in 1952 but those two leopards were not sighted thereafter. In 1891 domestic goats were initially introduced in Barren Island and then in Narcondam Island, which now number in the hundreds. Elephants were introduced into these islands for timber works somewhere around 1960. After closing most of the timber factories, elephants were released into the virgin forests of respective islands and now they have become feral with around 75 individuals in 71 km^2 area. Later, Striped Palm Squirrel (*Funambulus palmarumi*), common palm civet (*Paradoxurus* hermaphroditus), domestic cat, dog, goat (feral in Narcondam and Barren Islands) and cattle were introduced to these islands by mainlanders for various domestic purposes.

Impacts on Insular ecosystem:

Chital (Axis deer, *Axis axis*) is considered to be the worst invasive species in Andaman. This species has been documented to eat over 70 species of plants. Great adaptability and high variability in foraging pattern of chital contribute to their highly destructive nature in Andaman. Fast maturity, high annual pregnancy rate, low fawn mortality and good vegetation enabled its population to explode in Andaman. A current geographical distribution pattern of the chital in Andaman has not yet been studied. I observed in Andaman that deer have no predators and hunting deer is prohibited by the Forest Department of Andaman and Nicobar Islands.

Elephants, which are gregarious browsers, have been damaging native tree species by debarking and uprooting and may also affect the native fauna. A study shows that in the Interview Island Sanctuary, elephants were responsible for the creation of 82% of gaps in evergreen forest by their uprooting of large trees.

Impacts of dog, cat, goat, cattle, palm squirrel, common palm civet and various species of introduced rats and birds are not yet studied, but they are all harmful to the native fauna and flora in respect of space, competition, food and predation. Unfortunately, in 1997 an outbreak of epidemic avian cholera in domestic fowls (which were kept by Nicobarese in the Great Nicobar Biosphere Reserve) was transmitted to the highly threatened endemic bird species, Nicobar Megapode (*Megapodius nicobariensis*).

Conservation perspectives

1. There are two thoughts about the chital in Andaman. Whether this species needs to be eliminated totally from islands by culling (or relocation) or maintaining the population at certain levels by sterilisation of males. I personally feel that we have to get back the chital free Andaman Islands.
2. Elephants in India have a lot of attachment with the Hindu religion and it may not be advisable to cull this species in Andaman, however, the 80, or so, individuals could be captured and relocated from the Protected Areas. It would be a very difficult task but we have to do it before entire Interview Island Sanctuary gets destroyed.
3. Removing chital and elephants from Andaman requires a change in the wildlife policy of India, as India does not have a separate policy on Introduced Terrestrial Species. The State Government of Andaman and Nicobar Islands must be given the legal security to do this task successfully.
4. Introduced species like feral dog, cat, squirrel, goat etc. need to be eliminated from the Protected Areas. Local people need to be aware of invasive species, which must be either through the forest department or local NGOs.
5. Since there has been no detail study and documentation on invasive species in these islands this needs to be initiated quickly.

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VISION, ENERGY, AND COMMITMENT: KEY TO CONTROLLING INVASIVE VEGETATION

What do we need to control nonnative vegetation? We need vision, energy, and commitment. That's easily said, but where do we get them? Let's start with vision. How many times have you heard something like, "You've got to have a plan to do the job right"? I couldn't agree more whole-heartedly. A plan is like a cookbook. It shows the way to put essential ingredients together to get what you want. But the truth is we all have cookbooks and plans that sit on shelves gathering dust, never quite used to their potential. What's the deal? Why don't they motivate us into action?

The simple truth is that *a plan does not a program make*. Many plans tell us which way to go, and what, where, and when to do things, but they can't motivate us. Maybe that should be said of poor plans. Good plans, on the other hand, entice us with a vision of our destiny if we follow them. That's important. The poet said, "Without vision a people perish." We need help to leap the chasm between inaction to action. We need encouragement for the sustained energy that worthwhile programs require.

What is *your* vision for a protected forest, field, and waterway? Do you see native species in tact? Do you see functioning ecosystems where all creatures thrive? Do you see beauty … balance?

What gives you energy and what robs you of it? Perhaps the biggest energy robber is the tyranny of the day. Those normal daily tasks can loom heavy. How can we do *one more thing*? In the case of fighting invasive vegetation, an energy robber is the idea that nonnatives are everywhere and *we can't possibly make a difference*. It's the overwhelming notion that hundreds of years of colonization and settlement have opened the doors too widely to protect even a single acre. Though some of the data might agree, it's not over.

Shenandoah National Park, Virginia, has a total of 1,363 plant species listed to date. Included are 318 nonnatives. That's 23%! It's easy to feel hopeless with such a view. But let's look again. Are they covering every meter? The Park's invasive vegetation inventory indicates that most invasives are within 75 meters of Skyline Drive and other access roads. Since the vast majority of invasives are sun worshippers, our forests are relatively free of nonnatives. We can take courage, then, in knowing we may focus on minimizing new disturbances and keeping infestations from spreading.

Another energy robber is wondering whether we're accomplishing anything in the long run. Some might ask, "In an age of world travel and trade, isn't it just a matter of time until all species are everywhere?" If *all* species could prevail everywhere we might take comfort in the fact that no species would die out from our lack of action (That still leaves the problem of damaged native ecosystem functioning. What species interactions and biotic/abiotic actions can no longer take place because of the introduction of nonnatives?). But there is overwhelming evidence that thousands of species are being squeezed out. "Everything thriving everywhere" is a myth. Through time, the separation of continents and other geographic limitations have afforded tremendous species diversity. What we face with the free movement of species across these barriers is an implosion of species back to an age of virtual Pangaea (Pangaea describes a time when the current continents were once one (). The loss of species to science, to human need, to world biological functioning could be fantastic beyond understanding. It behooves us to protect what we can. Perhaps each of us needs to get to know our native resource a little better – to count our forests, fields, and waterways as friends. Friends don't let friends fall into the abyss.

Fighting exotics takes the long view. Indeed, invasive species management does require the long view. You're never quite done. That shouldn't surprise us. Farmers and gardeners understand that it's not just a matter of having an end goal, planting seeds, and taking a vacation until harvest time. Farming and gardening requires sustained effort – year in and year out. If you want pretty flowers along your walkway, you need to keep after the weeds that will invade. Invaders haven't been taught to share. When they come in, your flowers do poorly and don't last for long. That doesn't stop us from gardening – our vision of a pretty landscape keeps us going.

What we need is *vision* and hope. Do you feel like the legendary Dutch boy with his finger in the leaking dike? Do you ask, "What's the use?" Life isn't easy is it? We could curl up in the fetal position and wish for better days. Or, like the Dutch boy, we can stick it out until help arrives. Help and hope seemed awfully far away on a night when no one was near. And yet his heroics saved a village and a way of life. Our situation is very much the same. Our work of stemming the tide of invasive exotics will lead to the salvation of thousands of native species and the healthy functioning of whole ecosystems. There's a lot riding on it.

Where does our practical hope lie? What will the help we're waiting for look like? Though controversial, our hope may lie with the judicious introduction of biological controls. A prime example of successful alien vegetation biological control in America is with control of the invasive tansy ragwort (*Senecio jacobaea*) with cinnabar moth (*Tyria jacobaeae*) and flea beetle (*Longitarsus jacobaeae*). Biological control is not without risk. We can all name past bio-control efforts gone awry. But carefully done, the risks are less than with merely allowing invasive species to dominate native landscapes – a green pollution that never goes away. The casualties will be far greater without intervention.

When using mechanical, manual, and herbicide control methods, working smart and strategically tackling invasives is another way of engendering hope. Don't dive into the middle of huge problem species/areas as your first step. Take on new

invasions, eradicate outliers, and make a difference in discrete areas. Prove to yourself and your supporters that you can cleanse specific areas, making them fit for native species and ecosystem restoration. Brick by brick, as the Russians would say, gets the job done, and with it comes a sense of accomplishment.

Part of our vision comes from the hope that making people aware of the *silent green invasion* creates willingness to resist and reverse the trend. A big part of our problem today is lack of awareness and ignorant abetting of the problem by the public. We're in love with exotica, the sense of new as better. Yet when confronted by the facts, most gardeners are aghast by what they've done. People genuinely want to protect their native forests, fields, and waterways.

***Momentum* requires commitment**. As with marriage and faith, it's only with commitment that anything survives. When things get tough, it's our commitment to keep at it that brings anything but chaos and failure. It gets down to individuals, you and me. Are we strong enough to keep working at it when the hope robbers tell us to give up? The measure of our lives is all about what we do when things get tough. Fighting invasive vegetation, then, can be our extended existential moment and our opportunity to show who we really are. One day, years from now, will we be able to say we saw a problem and did our best to make a difference?

Let's take action. Let's be wise and strategic about fighting invasives. Let's build programs that protect the tremendous variety of species and habitats entrusted to us. By all means, let's keep moving. Our plant and animal friends depend on us.

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PUBLICATIONS

BUSHLAND WEEDS: A PRACTICAL GUIDE TO THEIR MANAGEMENT

Bushland Weeds, by K Brown and K Brooks is a practical guide to bushland weed management, with case studies from the Swan Coastal Plain and beyond. *Bushland Weeds* encompasses four years of work, resulting in a 108 page, full colour publication including numerous tables of weeds with biological features and control
Methods. The book will be of particular interest to those who live in Mediterranean climates, and those doing on-ground weed control in remnant vegetation.

The book will be available from the Wildflower Society of Western Australia at a cost of A$38.50 (GST inc.) plus postage.
http://members.ozemail.com.au/~wildflowers/index2.html

Source: publisher

EXPERIMENTING WITH INVASIVES IN CONSERVATION AREAS

Invasive species are largely seen as a problem by virtue of their devastating effects in high conservation value areas. However, studies of invasive species are for the most part limited to observational (or eradicational) within these areas. Experimental manipulation of invasive species is generally left to areas of reduced conservation value.

Combining our high technological ability of rodent eradication on New Zealand islands, with the requirement for accurate data on the processes and effects of invasion on New Zealand islands, has led the New Zealand Department of Conservation to fund a research project investigating the invasion of small islands by introduced rodents. The crux of this project being the ability to eradicate the population and replicate the entire experiment. The valuable data will provide much needed information on:

- Rodent detectability at low densities
- The rate of rodent invasion (population growth)
- Habitat preference during invasion
- Island carrying capacity (and time to reach it)
- Calibration of detection techniques
- Island 'risk-profiles' for invasion
- An idea of the 'stochasticity' of rodent invasion

Although the intentional release of an invasive species on conservation estate (islands no less) can be seen as a step-backwards in conservation, the benefits from the project will be outweighed by the leaps forward made with regard to invasion dynamics. The results will hopefully lead to an appreciation of the use of 'inshore' islands (where reinvasion can occur) as high-value conservation estate, provided the reinvasions can be detected early and eradicated. The islands selected for the study will be small, so that ground-based eradication is feasible, and will already have an established rodent population, or recently eradicated one, so that effects on the ecosystem will be minimal. Overall the project will hopefully provide scientific information to assist managers in utilising many more islands as high-conservation areas.

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WETLANDS: RUDDY DUCK CONTROL IN SPAIN

In the last three years, the Spanish Ministry of Environment has established a new invasive species control program with the objective of to cull all Ruddy Duck, *Oxyura jamaicensis*, and recognisable hybrids between Ruddy and White-Headed Duck, *Oxyura leucocephala*. Environment and species management in Spain is under the exclusive jurisdiction of the Autonomous Regions of Spain.

Methods

Systematic surveys are developed three times a year on suitable wetlands for *Oxyura* species, including most of the wetlands where White-Headed Duck reproduction was found in the last 30 years, and the wetlands where Ruddy Ducks or hybrids have been located in the past (in all, 140-160 wetlands were searched per survey). The first annual survey was undertaken in March-April, just before the *Oxyura* mating season. The second in July, when broods are swimming and are visible, and the third in December, in the middle of the *Oxyura* migratory season. Outside those surveys, rangers and wildlife managers of the Autonomous Regions of Spain with suitable wetlands for *Oxyura* species are collaborating on the project notifying the arrival of any suspicious birds at any time of the year, and in some cases they directly cull the birds. When a target bird has been located, a team of several beaters (depending on wetland size), a professional shooter and a supervisor move to the wetland and start a control operation that doesn't end until the bird is eliminated or the bird disappears from the wetland.

Results

From June 2000 to June 2003, 41 Ruddy Ducks and 3 hybrids have been located and eliminated in 16 wetlands located on 7 different Autonomous Regions of Spain. Most of the birds (86.4%) appeared in five wetlands: Parque Natural de El Hondo (Alicante), Embalse de Ullibarri (Álava), Albufera de Adra (Almería), Veta la Palma (Sevilla), Laguna del Tarelo (Cádiz). A total of 24 females and 18 males were eliminated (in two occasions the determination of the sex was not possible). The age of the bird was known just for 20 birds (11 adults and 9 juveniles). From the data obtained, 68.2% of the invasive birds were located by the wildlife managers of the wetlands of the Autonomous Regions where the birds appeared (and 21 of the birds were directly culled by them). During the systematic censuses, 22.7% of the birds were located, and the rest of the birds were located by voluntary birdwatchers. The control operations begun within the 24 hours after the location of the bird in 62.2% of the occasions, and in just 8 occasions the start of the control operation were delayed by more than 3 days (up to a maximum of 11 days). The time between the start of the control operation and the bird elimination was less than 24 hours in 70.3% of the occasions. In five occasions the control operation lasted more than 5 days, up to a maximum of 44 days, due to the weather conditions that made it difficult to shoot the birds. On a few occasions, the control operation ended with the bird disappearing from the wetland after several days trying to shoot it. On all of these occasions a new bird with the physical characteristics of the bird that had disappeared was located in another wetland and a new control operation was started. We believe that all of the birds were eliminated.

Photo:Javier Calzada

Discussion

A high number of Ruddy Ducks are arriving every year to Spain, but the number of hybrids between Ruddy and White-Headed Duck is now smaller than in previous times. Control of the arrival and reproduction of Ruddy Ducks in Spain is possible if the actual control programme is maintained, but White-Headed Duck conservation in Spain, and by extension in the Western Palearctic, needs the establishment of similar control programmes in all the countries where alien Ruddy Ducks occur or reproduce.

Acknowledgements

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COOPERATION IN THE WAR ON INVASIVES (MID ATLANTIC PARKS ,USA)

The scope of the nonnative species invasion in this country is too big for any single agency to handle alone. In the case of nonnative vegetation, it's not merely a task of "weeding the garden." It also requires the cooperation of neighbors and other agencies to ensure long-lasting results. Nonnative invasives know no boundaries. No sooner might one rid their property of a pest plant than the very species finds its way back by hopping aboard the wind, birds or mammals. The most invasive plants have re-colonizing mechanisms including enduring seed banks in the soil, stored underground energy reserves, or tremendous stump sprouting potential. What's a gardener or landowner to do?

Cooperation

For many, the challenge of controlling invasives seems overwhelming. Indeed, no agency can hope to rid their lands of hundreds of years of nonnative introductions. The planning process, however, helped us clarify the picture for the Virginia parks in the fledgling invasive species control cooperative by focusing on the opportunities for appropriate action. There is great potential in strategically protecting specific areas and eradicating early infestations. That's the aim of the Mid-Atlantic cooperative.

In our early program development, the cooperative treated over 700 forested acres in 18 months. It was through the sharing of staff and expertise that the parks were able to move forward beyond the tyranny of normal maintenance and protection demands. They targeted specific infestations of kudzu *(Pueraria Montana)*, Oriental bittersweet, *(Celastrus orbiculata)* tree of heaven, *(Ailanthus altissima)* princess tree, *(Paulownia tomentosa)* white poplar, *(Populus alba)* privet, *(Ligustrum spp.)* multiflora rose, *(Rosa multiflora)* Japanese knotweed, *(Polygonum cuspidatum)* autumn olive, *(Elaeagnus cuneata)* Johnsongrass, *(Sorghum halepense)* and Japanese stiltgrass, *(Microstegium vimineum)* among others. Each plant exhibits its ability to dominate native sites and reduce species richness.

Collaboration

Within the cooperative, one park found a neighboring ally to address a common problem. Colonial National Historical Park linked with Colonial Williamsburg Foundation (CFW) in a collaborative effort to tackle a three-acre patch of kudzu (*Pueraria montana*) and tree of heaven (*Ailanthus altissima*) that straddled both ownerships. They worked together in planning and conducting on-the-ground controls. Each contributed time, funding, and in-kind resources. The tract is along the federal Colonial Parkway that links Jamestown Island, Colonial Williamsburg, and Yorktown Battlefield. Public recognition of an exotic plant helped the effort. Kudzu is well known as a "bad boy" throughout the South. CWF became interested in the project because of negative public reaction to the patch, situated very close to their world famous historic district of restored and reconstructed colonial buildings. The park wanted to rehabilitate the tract that contains a small perennial stream, several springs, and a pond. The site's capacity for species richness is great. Yet without treatment, kudzu vine covered virtually the entire area and smothered herbs, shrubs and trees alike. Native richness was being smothered to death.

Initial control began in July 2001 using staff from both organizations. Kudzu in the tree canopy was severed and pulled down as possible. Herbicide was applied to the cut vines and ground-level plants. Large tree of heaven were cut down and stump-sprayed. Tree seedlings/saplings were sprayed as well. Alien plants along the stream, springs, and pond were treated with herbicide that is approved (labeled) for use around waters. Follow-up control work was conducted in July and August by CWF staff to catch the plants initially missed. Subsequent controls, monitoring, and site restoration was done jointly by the park and CWF to make sure that neither the targeted species nor any other invasives re-colonize the area.

No Resource Impairment

The cooperative has given all eleven parks a shot in the arm to make substantive steps in controlling their targeted invasives. They plan to continue working together beyond the project period. Their hope is that the infusion of expertise and tactical supplies from the project can help them form a sustainable program that protects native species and natural ecosystem functioning. The need for invasive management funding will not go away, however, and each park is working to increase their operational capacity through budget base appropriations and special project funding.

The 1916 NPS Organic Act commissions parks to "*conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations*." Shenandoah Superintendent, Douglas Morris, believes, "Invasive species are impairing the natural resources and historical scenery of our parks. The challenge is before us to protect them." Though that's a tall order, cooperation and collaboration with others is helping broaden our effectiveness. Morris adds, "Protecting our parks is worth the fight."

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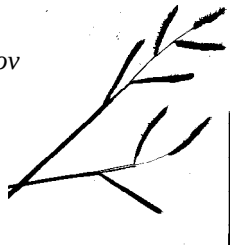

CONTROL OF INVASIVE ALIEN SPECIES IN NATURE RESERVES IN CHINA

China is a "megadiversity country". The most effective and economic way of conserving biodiversity is by maintaining self-sustaining populations of native species *in situ* in their natural habitats. China has already made important progress in *in* situ conservation by establishing over 1550 Nature Reserves (NRs) and 690 Scenic Spots, which cover around 14% of total terrestrial land of China.

Invasive Alien Species (IAS) occur in almost every watershed and ecosystem, and represent many taxonomic groups, including mammals, birds, reptiles, amphibians, fishes; arthropods and crustaceans; algae, ferns and seed plants; and fungi, viruses, bacteria, and other micro-organisms. IAS has been considered as the second important threat to biodiversity in China. Under the situation, it becomes important to reduce their impact on local biodiversity by ensuring security for precious and endemic species at key sites. Such sites include the national system of protected areas and other geographically critical areas such as areas of local endemism, isolated lakes, mountains, mangroves, islands etc.

Invasive Alien Species problem in nature reserves in China

IAS problems in the Nature Reserves of China have become a big concern. IASs have been reported everywhere, except in a few remote reserves in Qinghai-Tibet Plateau, Hengduan Mountain, Xinjiang and Inner Mongolia. Many NRs in China have been heavily threatened by IASs. However, no efforts have been made to remove them. On the contrary, a lot of activities in NRs are encouraging IAS spreading.

Fig 1: *Spartina* in Dafeng Milu NR. Photo: Xie Yan

Many Nature Reserves in China have plans to restore vegetation with alien species. In the master plan of Dafeng Milu NR, which was established for reintroduction of Pere David's Deer (Milu) in Jiangsu Province and is severely threatened by *Spartina* (Fig. 1), most of the suggested tree species for restoration are alien to the region (such as Italian *Populus*, Japan cedar, conifer trees, gingko, *Metasequoia)*. It is planned to increase 20% ~ 30% of forest coverage by planting these trees. It is also planned to introduce alien pasture species to provide forage for Milu. In Ruoergai NR, which was established to protect an important grassland marsh that provides water to the two main rivers of China (Yangzte River and Yellow River), there are plans to plant high productive alien grass and even trees for reducing grazing pressure or abating desertification.

Dafeng NR has a plan to establish a garden that will introduce magnolia, cherry blossom, rose, peony, lilac, redbud, trees, climbers and aquatic plants. In the plant species list in its master plan, there are 13 species listed in the booklet of *Invasive Alien Species in China* and many more are alien species to this region.

Fig 2: Photo: XieYan

Establishing wildlife rescue centers to breed water deer, pheasants, cranes, swans and other endangered species has been recognized as a key conservation action in most NRs in China. For example, research in Yancheng NR has focused on the red crowned crane. The research is to breed the species to enlarge wild population and establish a non-migrating population. The NR is a wintering area for red crowned crane and it doesn't naturally breed there. The researchers are attempting to change the behavior of the species but this may pose a threat to the wild population. If the artificially bred population is mixed with the wild population it may bring diseases from the human area to the wild population. Red-crowned cranes, ostriches, peacocks and other birds are also kept in pens at the edge of the core area (Fig. 2).

The problem of invasive species in lakes (such as Louisiana crayfish in Dongting Lake and Poyang Lake) affect every corner of lakes and actions within NRs can do little to reduce the threat. Even duck farming causes disease risks of transferring new diseases to wild duck populations. Reduction of invasive alien species introductions requires new legislation and coordination between several agencies.

Recommendations to IAS control for NRs

The following recommendations provided for combating IAS in NRs by the Ecosecurity Task Force of China Council for International Cooperation on Environment and Development;

• Information on alien species, and their effects on natural ecosystems and local economies to be made available to all staff

• Introduction of alien species anywhere inside the protected area, including any animal and plant collections and staff residential areas to be prohibited, except for approved biological control purposes

• Sensible and adequate precautions to be taken in the import of any supplies including foods and building materials

• Inventories of alien species and hybrids with local species in the protected area to be made and the risks to the protected area values to be assessed

• Assessment of threats to protected area values from alien species and appropriate actions to be included in all management plans

• Monitoring and research programmes to include work on trends in range and population sizes for alien species

• Sound ecological principles to be followed during restoration and eradication programmes

• The practice of releasing confiscated and "rescued" wildlife into protected areas without proper assessment to be stopped. Only healthy local species should be released into protected areas.

• Captive breeding and keeping animal and plant collections within protected areas to be discouraged to reduce chances of bringing in new alien species (such as diseases)

• Local people and visitors to be aware of regulations and the dangers of introductions (including for example discarding fruit seeds) through outreach programmes

• All information displays for the general public to cover alien species and dangers they pose to natural ecosystems

• IAS issue to be included into national policies to ensure operation funding

• To make links with and work together with other relevant organizations, governmental and non-governmental

• Careful planning of surrounding land-use adjacent to be made to NRs

• Aggressive control and eradication programmes for alien species to be found in NRs or surrounding areas.

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PUBLICATIONS

CORAL REEF NON-INDIGENOUS AND INVASIVE SPECIES

Non-indigenous and invasive species are just recently being identified and there has been little work done on these species in relation to coral reefs.

The Mini-Symposium E8 "*Coral Reef non-indigenous and invasive species*" was convened at the 9th International Coral Reef Symposium held at Bali, Indonesia, on 27 October 2000. Eight of the papers presented there, all published in the journal Pacific Science, are available as pdf files from *http://www.bishopmuseum.org/research/pbs/coralreefsymp.html*
By permission from the University of Hawai'i Press.

THE MARSHALL ISLANDS: LIVING ATOLLS AMIDST THE LIVING SEA

The Marshall Islands: Living Atolls Amidst the Living Sea (Republic of the Marshall Islands biodiversity report) The first and only school textbook on botany, zoology and ecology of the Marshall Islands, their relation to its people and their culture. This book is exceptionally accurate, authoritative and readable; it is richly illustrated with over 300 biological illustrations. Following the main text of the report is discussion on numerous threats to the Marshalls' biodiversity, including nuclear weapons testing. The conclusion is that invasive species pose a worse threat than anything else.

Available now: US$45 for individual copies, $30 each in quantities of 10 up to 1,000, ($28 each in quantities of more than 1,000) Shipping and handling for individual copies, U.S. domestic priority mail, additional $8.50. The RMI Biodiversity Strategy and Action plan (32 page booklet) can be included upon request at no extra cost.

For orders, please contact:
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Source: *Nancy Vander Velde*

DYNAMICS AND CONSEQUENCES OF THE INVASION OF RURAL LANDSCAPES OF RÉUNION ISLAND BY *ACACIA MEARNSII*

Invasion patches of woody plants are a main part of rural landscapes inside of insular biomes, but knowledge is poor concerning these patch dynamics and their environmental effects. Providing large ecological gradients and very changeable landscapes, Réunion Island is an appropriate model to set up a diagnostic of such invasions. On the island, *Acacia mearnsii* has a large range and can be considered as an opportune plant model. The main objective of my thesis (undertaken last year) was to provide a diagnostic based on transposable methods usable on other sites and plants.

This way, we have analysed the biological attributes of *A. mearnsii* and the landscape turnover, which favours colonisation. Spatial variability of breeding patterns and main germination traits have been also observed. Then, the spatio-temporal dynamics of the plant invasion have been studied from aerial photographs covering about fifty years. On another occasion we studied the impact on biodiversity, referring to three different organisation levels (landscapes, patch aggregates, woodlots) and using birds and flowering plants as indicators. Multivariate analysis has been used on the data sets collected at the three levels of organisation, which have been retained.

This work shows that breeding strategy of *A. mearnsii* is based on a strong allocation of resources to fructification, a variability of phenologic patterns with elevation and a fast outbreak of seed dormancy. The analysis of spatio-temporal dynamics reveals contrasts between western and southern regions, linked to the decline of *pelargonium* cultivation and the development of animal production. These contrasts are enforced with the confrontation of the dynamics and the structures of landscape units. *At the landscape level, the effects of this plant invasion on biodiversity are hidden by the effects of a strong elevational gradient and an important dichotomy in the spatial distribution of native and exotic plants.* At lower levels, the composition of the biotic communities is partially determined by *A. mearnsii*. These points are discussed as tools for evaluating the impact of plant invasions in rural landscapes and setting up strategies for limiting the invasions.

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TEN YEARS OF PREVENTING RAT INTRODUCTIONS TO THE PRIBILOF ISLANDS ALASKA, USA

The year 2003 marks the 10th anniversary of the rat prevention program in the Pribilof Islands. The Pribilof Islands are located in the Bering Sea, Alaska. They have about three million nesting seabirds, a million northern fur seals, an endemic shrew, and other wildlife. Rat introduction would greatly reduce bird and shrew populations and might transfer diseases to other mammals. The islands have been inhabited since 1786, and although the lack of harbors impeded rodent introduction, house mice became established on St. Paul in 1872.

In the early 1990's harbors were constructed on both St. George and St. Paul Islands. A boom of commercial fisheries soon followed and eventual rat introduction seemed a certainty. A prevention program was initiated by the U.S. Fish and Wildlife Service in 1993. It is maintained primarily by the local communities, and industry. The program consists of maintaining trap and poison stations, community education, outreach to vessels to make them rat free, and regulations. Over 600,000 trap nights have passed and six rats have been killed on the St. Paul docks, and there is no evidence of rats becoming established. Improved design of preventive stations has decreased maintenance needs. The U.S. Fish and Wildlife Service also maintain shipwreck response capabilities to stop "rat spills".

Snap traps have been more effective than poisons at killing rats, but have caused more non-target species loss. About five winter wrens *(Troglodytes troglodytes)* per year have been killed in snap traps. Six brown lemming *(Lemmus sibricus)*, native on St. George Island, have been killed, five in a snap trap and one by eating poison. While snap traps have been the major cause of non-target loss they are highly recommended. The rat carcass in hand (only six times in 10 years) has been a powerful message that prevention measures are needed and must be maintained. It appears fewer ships using the Pribilof Islands carry rats. Unless there is a major advancement in rodent removal technology, the prevention program will have to be continued forever. It is too early to be certain that the program is adequate to protect the Pribilof Islands. Technical advice from Rowley Taylor, Joe Brooks, and Paul O'Neil was instrumental in the initiation of this program.

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ERADICATION FOR RESTORATION IN SOUTHERN OCEAN WORLD HERITAGE SITE: CAMPBELL ISLAND RAT ERADICATION

In May 2003 Sub-Antarctic Campbell Island was officially declared rat-free after the largest eradication programme of its kind. About 120 tonnes of poison were used killing an estimated 200,000 rats on the 11,331ha (110 km2) island at a cost of around $2.6 million (NZ). The Minister for Conservation, Mr Carter was quoted as saying that the rat had been on the island for 200 years and that now the island's millions of seabirds would be free from the predator, calling it "a proud day for New Zealand conservation". The Department of Conservation (DOC)'s mission is to protect and restore the natural heritage. It set out to protect the special terrestrial and inter-tidal ecosystems so that the fields of giant leafed flowering mega herbs and colonies of seabirds like grey petrels, sooty shearwaters and the magnificent Campbell albatross once again would become abundant on the island. In addition it wants to re-establish endemic species such as Campbell Island teal and Campbell Island snipe that were once found on this island, but are now restricted to a few offshore islets. Campbell Island had the world's highest density of Norway rats and it was vital that these be eradicated to achieve these restoration goals.
The announcement has coincided with the release of a report led by the Department of the Prime Minister and Cabinet that examines innovative practice in the New Zealand public service. In it, the Campbell Island rat eradication project is cited as an example of good innovative practice.

Campbell Island is part of the New Zealand Sub-Antarctic Islands World Heritage Site (Inscribed 1998). The site consists of five island groups: the Snares, Bounty Islands, Antipodes Islands, Auckland Islands and Campbell Island in the Southern Ocean south-east of New Zealand.

More on the New Zealand Sub-Antarctic Islands World Heritage Site:
http://whc.unesco.org/nwhc/pages/doc/mainf3.htm

More on the eradication and restoration programme:
http://www.doc.govt.nz/Conservation/Offshore-Islands/Campbell-Island-Rat-Eradication.asp

Editor's Note:
There is an excellent article on the rat eradication on Campbell Island, which appears in the New Zealand Geographic magazine for July/August 2003, Number 58. Written by Pete McClelland (the project leader) and Pete Tyree (logistics adviser/photographer) it outlines in detail the complexities of the project. For overseas readers, New Zealand Geographic magazine can be obtained via the publishers. View their website on *www.nzgeographic.co.nz*. Their e-mail address is: *subs@nzgeographic.co.nz* and the phone number is: +64 (9) 303 0126

SEARCH AND DESTROY PROGRAMME FOR MIMOSA PIGRA (KAKADU NATIONAL PARK, AUSTRALIA): SAVING THE ENVIRONMENT AND SAVING MONEY BY EARLY DETECTION/RAPID ACTION

The following two approaches illustrate the crucial difference that early detection and rapid action provide, both in terms of environmental and financial costs.

In Kakadu National Park (KNP). Due to an awareness of mimosa's potential threat and also a capacity to act, a 'search and destroy' control program was instituted in 1983. Since that time people have been employed full-time to undertake surveillance operations and intervene rapidly when mimosa is discovered. Consequently, although there have been about 200 outbreaks of mimosa, there are no large stands of mimosa in KNP. This program costs in the vicinity of $2 $ha^{-1}yr^{-1}$.

In contrast, in 1983 an incursion of around 200 ha was discovered on the Oenpelli floodplain in Western Arnhem Land. The infestation had grown to 1 200 ha in 1985. Short-term intermittent chemical control projects were undertaken but in spite of this by 1990 it was estimated that the infestation had increased to about 8 200 ha. The Oenpelli Mimosa Control Program (1991-1996) involved the largest aerial herbicide application to mimosa in the World with over 60 tonnes of chemical applied to the wetland over five years. The spray program to control the large mimosa infestation at Oenpelli cost $220 $ha^{-1}yr^{-1}$ for five years and, like KNP, will require approximately $2 $ha^{-1}yr^{-1}$ to carry out follow-up work in the broader region.

Source: Storrs M, Ashley M & Brown M 1999. *Aboriginal community involvement in the management of mimosa (Mimosa pigra) on the wetlands of the Northern Territory's 'Top End'*. In *12th Australian Weeds Conference: Papers and Proceedings*, eds Bishop AC, Boersma M & Barnes CD, Weed Society of Tasmania, Hobart. Pp 562-565.

Editor's note : of related interest (wider than Protected Areas) Australia wide weed strategies:
- *The Determination of Weeds of National Significance* by John R Thorp, National Weeds Strategy & Rod Lynch, Agriculture, Fisheries and Forestry – Australia. It can be downloaded from: *http://www.weeds.org.au/docs/WONS/*
- A summary of the *Australian National Weed Strategy* can be downloaded from: *http://www.weeds.org.au/nws-doc.htm*

PACIFIC OYSTERS IN THE EUROPEAN WADDEN SEA: AN IRREVERSIBLE IMPACT IN A HIGHLY PROTECTED ECOSYSTEM

The Wadden Sea is the largest European wetland area and its tidal flats form the largest unbroken stretch of mudflats worldwide. Biophysically it represents an interconnected morphological system with the adjacent North Sea, significant in terms of unique ecological, socio-economic, scientific and cultural characteristics. At the beginning of the 1970s, a process began which resulted in the protection and conservation of the entire Wadden Sea with nature reserves and national parks and the establishment and extension of the trilateral Wadden Sea cooperation between The Netherlands, Germany and Denmark. In parallel, parts of the area were designated as Wetlands of International Importance (Ramsar Areas), Bird and Habitat Directives areas and as Man and Biosphere (MAB) Reserves.

Potential nomination as a natural World Heritage Site
An important topic of the 9th Trilateral Governmental Conference in Esbjerg (30 October 2001) was the potential nomination of the Wadden Sea national parks and nature reserves or parts of them as a natural World Heritage Site. This is a follow-up of decisions of previous conferences and a recent feasibility study has concluded that an inscription in the World Heritage List under the current conservation and management arrangements is feasible.

Historical status of oyster beds
Until the beginning of the 20th century the native European oyster *Ostrea edulis* was widely spread in the Wadden Sea and formed extensive oyster beds from low tide level down to about -6 m. These reefs were regarded to belong to the most characteristic biotope types of the Wadden Sea and provided secondary habitats to numerous species. The last living reef of the European oyster was found in 1940. After that *O. edulis* was declared to be extinct in the region. There has been some debate about the actual cause of the decline but more recent accounts on the subject seem to prove that overexploitation by oyster fishery since the 18th century exterminated these populations. Through the destruction of the oyster reefs, many associated invertebrate populations severely declined or disappeared completely.

Pacific oysters invasion
More than once in the past, attempts have been made to revive exploited stocks of the European oyster with imported American *Crassostrea virginica* and Portuguese *C. angulata* at several sites on the North Sea coasts. These attempts largely failed. In the 1960s, Dutch oyster farmers began to cultivate the Pacific oyster (*Crassostrea gigas*) in the Oosterschelde estuary. One assumed that the introduction of the Pacific oyster as seed stock had to be accepted because these oysters, native to Japan, were not able to reproduce at the latitude of the Netherlands. However, in 1975 a spatfall occurred during a very warm summer and resulted in millions of so-called weed oysters in the estuary. Within several years the Pacific oyster has expanded enormously and they nowadays interfere with the recreational use of the estuary because of their razor-sharp shells. Since the 1980's this alien was frequently observed in the Dutch Wadden Sea. In 1996 a first settlement of the Pacific oyster occurred in the western Wadden Sea area of Germany as well, which may have been dispersed from the Netherlands by natural means (Fig. 1).

Spat and larvae of *C. gigas* were repeatedly introduced into the German Wadden Sea since 1971, mostly for aquacultural experiments and studies. Since 1985 commercial farming activities started up in the northern area of the Wadden Sea near the island of Sylt (Fig. 2). These oysters reproduced successfully, too and in 1991 the first oysters were found outside the culture plot. Spat settel on any hard substrate in the intertidal zone but preferentially upon wild banks of the blue mussel *Mytilus edulis*. In the following years, significant dispersal with increasing abundances took place. It was estimated that the wild Pacific oyster population at Sylt was in the region of 1 million oysters in 1995, with a mean oyster density of 8 individuals / m² in a mussel bed. In 2002, the mean oyster density came up to 83 individuals / m² and the blue mussel beds are currently about to transform into oyster reefs (Reise pers. comm.).

Oysters as vectors
Over the last 100 years, the Wadden Sea and its estuaries have been invaded by numerous alien species. In the past oyster transports certainly served as an important vector for associated parasites and exotic species. Some of the aliens became massively abundant, such as the American slipper limpet *Crepidula fornicata*, the Japanese brown algae *Sargassum muticum* and several phytoplankton species. Nowadays, the worldwide scale of oyster imports has become less important for Europe. However, since the regular culturing of the Pacific oyster began in 1986 at Sylt, five benthic species are suspected to have been inadvertently transferred with imported spat to the Wadden Sea of Sylt.

Most of the introductions by transfers occurred before the ICES Code of Practice on the Introductions and Transfers of Marine organisms was worked out in 1994. The code is based on quarantine measures and provides a practical set of rules to prevent introductions through the import of oysters and other non-indigenous organisms. However, such a measure can slow down introductions of new aliens but not prevent them completely. Aquaculture is the fastest growing sector within fisheries due to increasing demand for aquatic products. Therefore, the threats of intensified aquaculture and increasing international transfer of exotic species for stocking and culture posed to natural communities, needs to be pushed up to political agenda.

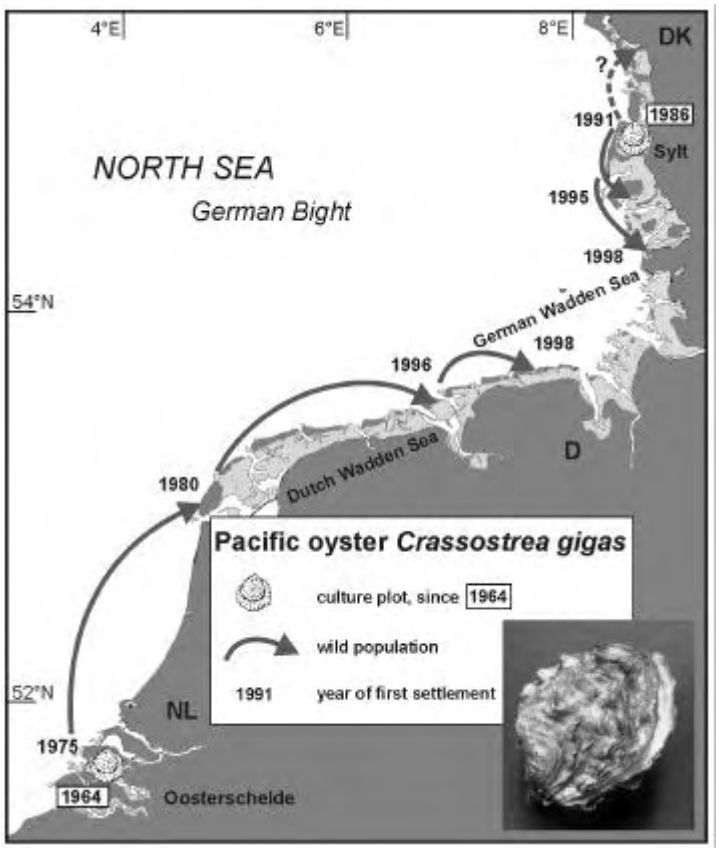

Fig. 1. The invasion of the Pacific oyster in the Wadden Sea.

Ecological consequences

Among the introduction of alien species by the oyster vector with all its consequences for the native biocoenoses, the most important aspect of competition is the ability of exotic oyster species to reproduce successfully in new environments. The Pacific oyster appears to be more ecologically potent, *i.e*. more adaptive, than the European oyster *O. edulis*, although it requires warmer water for spawning. The recently expanding occurrence of *C. gigas* in the Wadden Sea makes it likely that oyster reefs, together with their associated community of organisms, will "re-establish", at least in the intertidal zone. If these irreversible changes in the biota of the North Sea can be classified as a positive example of population 'enrichment' is still under discussion. Due to the higher growth rate and the larger size of oysters, blue mussels are eventually overgrown and killed. In North America Pacific oysters has been known to settle in dense aggregations, excluding other intertidal species. In Dutch waters, at the same time as *C. gigas* increased in the Oosterschelde estuary, the stocks of blue mussels and cockels decreased, the same goes for an important shellfish-feeding bird, the oystercatcher *Haematopus ostralegus*. However, it is not yet clear if this is a causal relationship. Much remains unknown in terms of the patterns and processes of the invasion of the Pacific oyster in the European Wadden Sea.

Outlook

Alien invasions in aquatic systems are irreversible and should be avoided wherever possible. These species pose a serious impact to native biodiversity because they have the potential to alter the natural state of an ecosystem into which they were introduced. Such changes, and especially the example of the Pacific oyster in the highly protected Wadden Sea, may consequently affect nature conservation interests. At the present time, most analyses that evaluate patterns of aquatic invasion or test specific hypotheses derive data from existing literature, which is extremely uneven in space and time. In order to establish effective management plans, much more information is needed on the principles of successful establishments of aquatic alien species. For the Pacific oyster, a coordinated environmental program in order to document the spreading and effects on the native biocoenoses in detail, should be designed and realized on the level of the Trilateral Cooperation on the Protection of the Wadden Sea.

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Fig. 2. Pacific oyster farming near the German island of Sylt. Oysters are cultivated in plastic mesh bags, called 'poches', fastened onto steel trestles with rubber bands. Photo: Stefan Nehring

INVADING MUSSELS THREATEN AMAZON: GLOBALLAST - BRAZIL TAKE ACTION

In the late 1980's the Golden Mussel Limnoperna fortunei, a native of East Asia, was found in the Rio de la Plata between Uruguay and Argentina. A freshwater bivalve that normally lives attached to natural and artificial hard substrates in its native range, L. fortunei is most likely to have been carried to South America by ships trading between riverine/estuarine ports in Asia and the ports of Buenos Aires and/or Montevideo.

Having been carried across the oceans in ships' ballast water (it would have been killed by oceanic salinity if carried attached to the hulls of ocean-going vessels), the Golden Mussel is now being translocated throughout South American freshwater systems as fouling on river vessels.

Spreading rapidly into adjacent watersheds, within 10 years the mussel had established 1,100 km upstream throughout the Plata, Parana and adjacent river systems. It is spreading northwards in South America at the rate of 240 km per year (Darrigran 2001), potentially threatening the entire Amazon basin and linked river systems within the next decade.

The rapid spread of this aggressive invader is cause for major ecological and economic concerns. The aggressive rate of invasion by the Golden Mussel is exemplified by the following: In 1991, the density of Golden Mussels in Bagliardi, Argentina was five individuals per m^2. By 1992, this had increased to 36,000 per m^2. In 1993, 80,000 per m^2 and in 1998, the density was 150,000 mussels per m^2. In Brazil, it was first found in 1998, at the mouth of the Jacui River, near the port of Porto Alegre. One month later, it was found 70 km southward, in Guaiba River, Itapua, near Patos Lagoon. In 2000, it was also found in Arambare. After 18 months of invasion in Brazil, it was observed in a density of 27,275 individuals per m^2, mainly on the roots of aquatic plants.

The potential economic impacts of *L. fortunei* in South America are very similar to those described for *Dreissena polymorpha*, the European Zebra Mussel, in the North American Great Lakes and adjacent waterways (biofouling and blockage of pipes and water systems of cities, industries, power plants and other infrastructure). Zebra Mussel control measures in North America are estimated to have cost between US$750 million to US$1 billion from 1989 and 2000 alone (O'Neil 2000). The cost of similar control measures in remote parts of South America is likely to be even higher.

Since 1998, the mussel has already reached the city of Corumba, in Mato Grosso do Sul State, brought by boats through the Paraguay River. In April of 2001, it was first found at the massive Itaipu Hydroelectric Plant, attached to the pipes, filters and pumping systems. The biologists of this hydroelectric company are frantically searching for alternatives to control the infestation to avoid the consequences experienced at the Yacyreta hydroelectric plant (Argentina/Paraguay), which has to be stopped for periodic cleaning, with significant economic losses.

Ecologically, harmful effects of the golden mussel on native molluscs and benthic communities of Brazil, Argentina and Uruguay have also been significant. Before the Golden Mussel invasion, the macrofouling communities in the neotropical region were restricted to salt or estuarine waters. Today, due to its high fecundity and the absence of natural enemies, it is possible to find *L. fortunei* and associated bio-encrustations throughout the entire Parana watershed.

The potential repeat of a Great Lakes-type Zebra Mussel invasion in the sensitive Amazon system is unthinkable, and demands immediate action. Brazil was first alerted to the problems this species was causing in Argentina and Uruguay by Calixto (2000), and in 2002 the GEF/UNDP/IMO GloBallast Programme launched the Golden Mussel Project in Brazil.

Supervised by the Brazilian Ministry of Environment (MMA), co-ordinated by the Admiral Paulo Moreira Marine Research Institute (IEAPM) of the Brazilian Navy, and supported by the GloBallast Programme Coordination Unit at IMO in London, the most important aim of this project is to offer the Brazilian Government and industry procedures for controlling the spread of the mussel.

Of particular concern are potential irreversible impacts on the aquatic ecology of the Pantanal Conservation Complex, declared a World Heritage Area by UNESCO. The GloBallast Golden Mussel Project therefore links with the 'sister' GEF project *Integrated Watershed Management Program for the Pantanal and Upper Paraguay River Basin*, thereby effecting synergies and cooperative deployment of GEF resources for the protection of the Pantanal.

The study started in October 2002 and aims to be completed in January 2004, and is being developed in 9 phases:

1) Literature review on *L. fortunei* (completed).
2) Project planning workshop in Porto Alegre, Brazil (December 2002).
3) Technical site visits to impacted areas to obtain information on the impacts caused by the mussel, including institutions, universities, water treatment companies, ports, hydroelectric powerplants and other industries that depend on river water.
4) Field sampling at 30 sites in rivers and lakes of south, southeast and Midwest Brazil. The field sampling will assess current distribution and densities of *L. fortunei* in the plankton (larval stages) and in the benthos (settled spat and adults). The following environmental data will

be recorded: air and water temperature, conductivity, salinity, pH, dissolved oxygen and water transparency.
5) Genetic analysis of molecular markers (aloenzymes) to confirm the mussel's origin.
6) Data analysis and mapping of the current distribution and density of the Golden Mussel and the speed of its dispersion, including modelling to forecast its potential arrival at ecologically and economically strategic sites. Procedures of control will be proposed by this work.
7) Assessment of present and future environmental and economic impacts of the mussel, using information from phases 1to 6 plus additional research.
8) Preparation of reports in Portuguese, Spanish and English.
9) Seminar to present results and recommended control measures to Brazilian, Argentinean, Paraguayan and Uruguayan authorities, industries and academics.

To undertake such a project in so large an area, and given the mussel's wide distribution across political boundaries, a multi-national team involving researchers from different Brazilian States and also Argentina, Uruguay and Paraguay, has been assembled. The project marks the practical beginning of regional co-operation in South America on ballast water and aquatic bio-invasion issues, a key objective of the GloBallast Programme.

The incursion of the Golden Mussel so deep into the internal waterways of the world's fourth largest continent, impacting the Pantanal and Iguacu World Heritage Areas, and threatening even the globally significant Amazon basin, clearly demonstrates the far reaching environmental impacts of international shipping.

While it is hoped that the GloBallast Golden Mussel Project will help develop management actions to control the further spread of this highly invasive species, such measures can only be effective if the original source of introductions is also effectively addressed, through the proper management and treatment of ships' ballast water.

The fact that the Golden Mussel invasion has occurred, despite obvious lessons from the Zebra Mussel in North America, highlights the urgent need for industry and governments to take immediate action to reduce the spread of harmful aquatic species by shipping activities.

Fig: Main Brazilian waterways and connections. Red = current extent of L. fortunei (Source: Darrigran 2000)

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http://globallast.imo.org/BallastWaterNews12.pdf

Designing representative and adequate Marine Protected Areas in a structured environment – implications for Marine Invasive Alien Species management

Setting aside a portion of the environment for conservation purposes has a long history. For centuries, land has been set aside for game parks and, more recently, natural parks, a wide variety of conservation areas and smaller areas including streamside buffer zones. The values and functions of land set aside in this manner have been clearly identified. Underwater, there is less of an exclusive relationship between habitat and species compared with on land. Compared to terrestrial vertebrates, most species of fish are carnivorous with highly flexible diets and more flexible growth rates, suggesting that a variety of areas can provide suitable habitat (Larkin 1978). In addition, the diverse life histories of marine organisms means that there is not as clear a link between habitat and organisms. Consequently, it is harder to identify areas of the seabed that have high biological conservation value.

A perceived solution to this lack of clearly identified conservation values is to set aside representative areas. Australia is implementing a National Representative System of Marine Protected Areas (NRSMPA). The primary goal of the NRSMPA is to commit jurisdictions to establish and manage a comprehensive, adequate and representative system of MPAs (ANZECC TFMPA 1999a). Comprehensive implies recognising the full range of ecosystems; adequate implies developing MPAs of sufficient size and appropriate spatial distribution to ensure the ecological viability and integrity of populations, species and communities; representative implies that selected areas should reasonably reflect the biotic diversity of the marine ecosystems they are part of.

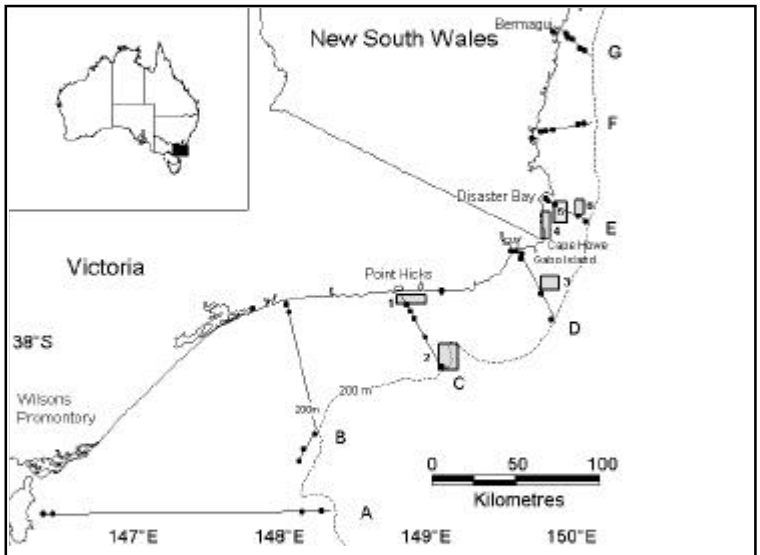

Fig. 1. Map of study area on the Twofold Shelf bioregion on the south-eastern Australian continental shelf, showing transects (lines), positions of depth-stratified stations (dots) and sites of intensive sampling (boxes) for the surveys from 1993-1996.

A hierarchy of scaled ecological units has been proposed for the NRSMPA. These scaled ecological units are: bioregion, ecosystem, habitat, community/population and species/individual (ANZECC TFMPA 1999b). Twofold Shelf, a 32,198km^2 bioregion, is one of 60 bioregions identified in the NRSMPA. Only a small percentage of the Twofold Shelf Bioregion has been protected to date. A series of surveys of the Twofold Shelf Bioregion area provide the information from which to determine what will be needed if MPAs in this area are to meet the goals of the NRSMPA (Fig. 1).

Importance of alien invasive marine species in the Twofold Shelf Bioregion

Marine communities are not fixed in time and space – even sessile invertebrates frequently have a pelagic life history stage that can lead to a wide dispersal of reproductive products and early life history stages. While representative MPAs can be defined through understanding the spatial structure of the bioregion, adequacy can only be achieved by understanding the processes that produce that spatial structure over the short and long term.

Invasive alien marine species threaten Australia's coastline and a few threaten the continental shelf. Recent port surveys have identified over 250 alien marine species in Australian waters and based on their arrival over the last century and a half, the rate of arrivals is increasing exponentially. Two invasive alien marine species are of particular concern to the biodiversity of the Twofold Shelf bioregion – the New Zealand screwshell *Maoricolpus roseus* and the North Pacific seastar *Asterias amurensis* – because they are already here and have the capacity to invade much of the continental shelf in this bioregion.

Maoricolpus roseus inhabits depths from the shoreline to at least 80 m in the Twofold Shelf bioregion (Bax and Williams 2000). In its native New Zealand it occurs down to 130 m and reaches densities in excess of 1,000 individuals per square metre. It is the only known alien marine species, anywhere in the world, that has successfully invaded the continental shelf from a port environment. Very little is known about the biology of *M. roseus*, its impacts on sediment structure or its competition with other invertebrates. Even the empty shells may have substantial impact as homes for hermit crabs, as indicated by the crabs' frequent occurrence in areas where *M. roseus* is abundant. From its densities, it is likely that *M. roseus* may well be the environmentally most damaging of the invasive alien marine species present in Australia, though largely out-of sight and hence unknown to the general public or conservation managers.

The Northern Pacific seastar, *Asterias amurensis*, arrived in the Derwent estuary, Tasmania, in the 1980s but it was not recognized until the 1990s when the population was

estimated to number in the 10s of thousands. Nothing was done to reduce the risk of the seastar spreading, and in 1996 the first few specimens were collected from Port Phillip Bay, Victoria, presumably transported there by a commercial or recreational vessel. Numbers in Port Phillip Bay increased from a few occasionally collected specimens in 1996 to over 115 million individuals in 2001 (Fig 2); it now covers 1500 km^2 and its biomass equals the total biomass of fished species in the Bay. Prevailing currents can now spread it northwards along Australia's east coast at least as far as Bermagui. *A. amurensis* is a dominant invertebrate predator that occupies habitats from the subtidal to 200m depth in its native habitat. In its presence, the abundance of shellfish is greatly reduced.

Implications for adequate MPAs

Marine protected areas can be delineated by fixed lines drawn on a two dimensional representation of a four dimensional habitat. One of the missing dimensions – time – is critical to the adequacy of a MPA for achieving management objectives. The other – the water column

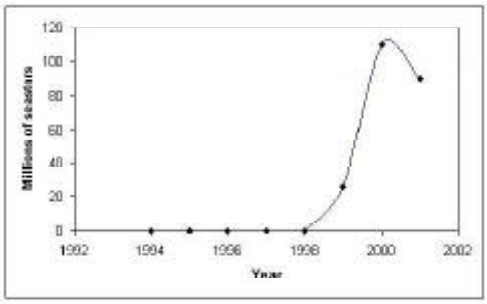

Fig. 2. Numbers of seastars *(Asterias amurensis)* estimated to be in Port Phillip Bay (Victoria, Australia). Early data are numbers caught by scallop dredgers (Don Hough, Victorian DNRE, pers. comm.)

and substratum interface provides the medium for time-varying processes to operate. For an MPA to be adequate it must address the four dimensions of habitat.

Over time, nearly all marine organisms will cross the lines drawn on a map. Once outside the MPA, organisms will be susceptible to deleterious events, such as fishing or loss of habitat. All an MPA can protect, by itself, is the physical habitat and the limited number of self-recruiting populations within it. Even this protection may be limited over the long-term, as fishing effort continues to increase and alien marine species continue to spread through Australian waters – lines drawn on a map will provide no deterrent.

For an MPA to be adequate in protecting marine life, it must be part of a larger process of management that controls external events including invasive alien marine species, fishing effort, marine pollution and climate change.

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Pond apple - an increasing problem in the Wet Tropics World Heritage area of north Queensland, Australia

Pond apple, or cherimoya (*Annona glabra*), was imported into north Queensland, Australia, in 1912 from Florida, USA, as root stock for custard apple trees and became naturalised and starting spreading at some unknown date after that. It is a semi-deciduous tree 12 to 15 m tall, with shiny leaves 7 to 12 cm long, and the trees start fruiting at two or three years old. The flowers are small and yellow-cream, and the fruit are green, spherical, 5 to 15 cm diameter, and contain up to 100 fat black seeds about 1 cm long. Both fruit and seed float and can remain viable for months in fresh or salt water. Seedlings and adult trees tolerate high salinity but also do well in fresh water situations. Seedlings need light for rapid growth, and in rainforest environments a dense mat of seedlings can remain in arrested growth until the forest canopy is damaged, usually by the cyclones and tropical storms common in the area. Once established, pond apple forms a dense understorey that suppresses other growth and prevents regeneration of the native rainforest or melaleuca trees. Native understorey vegetation, and rare endemic orchids and other plants that grow as epiphytes on the melaleuca trees, are all threatened by this invader.

Pond apple is rapidly invading creeks and riverbanks, wetlands, melaleuca swamps, mangrove communities and litter zones on beaches at the edges of the World Heritage-listed Wet Tropics National Parks in north Queensland. It already infests more than 2000 ha from north of Townsville to the tip of Cape York (a distance of about 1000 km), and now the seed is being spread into the rainforest by wild animals that eat the abundant fruit and disperse the seeds in their dung. Feral pigs, another invasive species, and the cassowary, a large native bird, have both been shown to be efficient dispersers of the seed, taking them several kilometres from the parent tree into the rainforest. It is ironic that pond apple, now rare in its native range in the Florida Everglades where it is threatened by the invasion of the very same melaleucas which are under attack by the pond apple invasion in north Queensland, is being spread by another endangered species the cassowary!

Attempts to manage this invasion have focussed on the location and eradication of isolated patches, and the reduction of seed spread from larger areas. Pond apple was identified as one of the 20 worst Weeds of National Significance (WONS) in Australia under the National Weeds Strategy. The WONS Pond Apple Strategic Plan, formulated in 2001 (see *www.weeds.org.au/docs/ponstrat.pdf*), calls for its eradication over a 20 year period, but the resources allocated to its control and management are not nearly adequate even to prevent further spread into the rainforest or along the Queensland coast, where seed are carried north by the predominant sea currents. Chemical control is particularly difficult because no effective chemicals are registered for use close to water. Stem injection methods are not economic because the simultaneous germination of numerous seeds from one fruit results in dense mats of small thin stems. In some seasonal swamps, fire can be used to kill the plants and seeds so long as sufficient grass is present to carry the fire. However, dense infestations cannot usually be burnt. At present, therefore, there is no prospect of successful control or even containment of this rapidly increasing invasive in the World Heritage area of northern Australia.

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Pond apple fruits. Photo: Qld Department of Natural resources & Mines

PUBLICATIONS

Alien weeds and invasive plants – A complete guide to declared weeds and invaders in South Africa by Lesley Henderson. Descriptions, distributions and beautiful line drawings of 234 species, colour photographs of 100 species. $88 plus $10 p&p.

AusGrass: Grasses of Australia By Donovan Sharp and Bryan K. Simon. CD-ROM - The largest and most comprehensive identification guide to a plant group ever published. It enables quick and accurate identification of any of the 1323 species of grass, native or naturalized, in Australia. $99 plus $4 p&p.

Weed Manager 2002 - Software for planning, managing and controlling weeds in natural bush areas from Viperware *Environmental Software solutions*. $500.00 per site plus installation costs.
Please note prices are in Australian dollars and postage rates apply to Australia only. For further information please visit *www.weedinfo.com.au.*

Issues in the management of alien species in the Galápagos National Park, Ecuador

Alien invasive species have been identified as the principal threat to the conservation of the unique biodiversity of the Galápagos Islands, a province of Ecuador 1000 kms off the South America coast in the Pacific Ocean. The Galápagos is an archipelago consisting of thirteen larger islands and 115 smaller ones, with a total land area of 8,000 km^2; The Galápagos National Park was created in 1959, comprising 95% of the archipelago. The Galápagos Marine Reserve was created in 1998, consisting of nearly 138,000 km^2 of near and offshore waters, the third largest marine reserve in the world. Management of the Galápagos National Park and Marine Reserve is the responsibility of the Galápagos National Park Service, a government body that works closely with the Charles Darwin Foundation, an international NGO dedicated to carrying out research to ensure the conservation of biodiversity in the Galápagos.

The identification of the importance of alien invasive species is one of the corner stones of the law which governs the development of the Galápagos Islands, the Special Regime Law for the Conservation and Sustainable Development of Galápagos Province, made effective in March 1998. Recognition of the need to establish a special regime for what is, after all, a province of a developing country in Latin America, was an exceptional step to take for the government of the time, and a clear statement of the governments commitment to biodiversity conservation. Core funding of management activities in the National Park were secured under the same law, by designating 40% of the National Park entry fee paid by tourists ($100 for non-national visitors) to the National Park itself. The marine reserve receives 5%, and the Galápagos Quarantine Inspection Service, responsible for protecting the Province from new incursions, also receives 5%. Note that this implies that levels of core funding depend entirely on tourist figures, making tourism critical for the effective conservation of the archipelago.

The National Park and Marine reserve are divided into zones, depending on their biodiversity value, and dictating their use. In the terrestrial areas, there are three zones:

- Zone of absolute protection, pristine islands with no known invasive species and flora and fauna in a natural state.
- Primitive zone, near-pristine islands with few invasive species or disturbances to the natural state.
- Special use zones. Visitor sites, themselves graded in terms of numbers of visitors allowed per day and type of use.

The Marine Reserve also has three zones;

- Multiple use zone, primarily deep waters, permitting fishing of specified methods
- Limited use zone, primarily coastal areas and including dive sites
- Ports.

Management activities are concentrated mainly on the islands or sites in the primitive zone, where invasive species have become an issue. Eradication programmes for pigs, goats, feral cats, and fire ants are being undertaken on five islands, for example. The largest scale goat eradication yet to be attempted worldwide is scheduled to begin later in 2003, clearing 250,000ha of northern Isabela Island of an estimated 100,000 feral goats in an ambitious operation that has taken several years to plan and organize. Restoration programmes follow in the track of successful eradications and mitigation exercises, and captive breeding programmes for several races of the Galápagos giant tortoise *Geochelone elephantopus*, land iguana *Conolophus* spp. and the Opuntia cactus *O. megasperma orientalis* go back more than 30 years in some cases (Bensted-Smith, 2000; Fritts et al, 2000).

Knowledge of the endemic, native and introduced flora and fauna of the terrestrial ecosystems is advancing, and the gaps are slowly filling. Big increases in the list of known introductions of invertebrate and plant species in recent years can be related more to the increase in research effort than to actual new introductions. However, in the marine environment research is very young, and the first base line report, for rocky shore ecosystems down to 20m depth, was published in 2002 (Danulat & Edgar 2002). Identification of marine species as native or introduced, and recognition of potential or actual invasives is still in the future.

Conservation of the Galápagos National Park is complicated by the fact that four of the islands are inhabited, with a total human population of around 16,100 people. Three further zones in the archipelago are therefore recognised:

- Urban zones, four coastal towns
- Agricultural zones, in the highlands of the four inhabited islands
- Military base, Baltra Island, site of the original airport.

Agricultural production is limited by poor soils, lack of water, and introduced pests and diseases. The main income in the islands is from fishing and tourism, with around 80,000 visitors arriving each year (Anon. 2002).

Clearly, invasive species do not recognize barriers and zoning, and many species impact both National Park and non-park areas. This is illustrated in *Figure 1*. One example is the blackberry, *Rubus* spp. Five species are present in the Galápagos, and massive invasion in the highlands of the main inhabited island, Santa Cruz, by two species has caused abandonment of agricultural land rapid and severe degradation of natural highland habitat, where it forms dense, impenetrable thickets up to 4 m high and totally replaces native vegetation. Control of *Rubus* is complicated by the high cost of labour in the

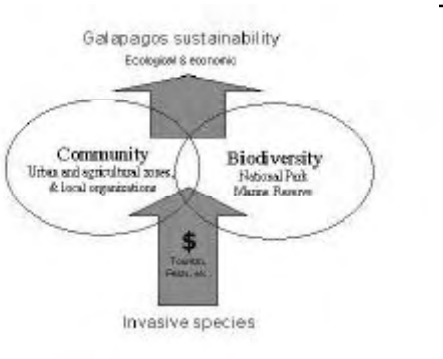

Figure 1. Economic impact of invasive species in the Galapagos islands. The community suffers directly, from pests and diseases, while the National Park and Marine Reserve suffer from the cost of research and management actions.

Islands, the fast life cycle of the plant and its ability to reproduce vegetatively, the spread of seeds by birds and other animals, and the ability of the seed bank to survive for many years in the soil (A. Tye, pers. Com.).

Participation of the community in conservation activities is also seen as crucial for success; one example, the inter-institutional committees (CIMEIs) outlined in a previous *Aliens* article (No. 16, page 21-22) address invasive species issues in urban areas. The interconnected nature of the different zones are recognized in the Special Regime Law of 1998, which states that conservation and sustainable development depend on the integrated environmental management of the three components, National Park, non-Park and marine. As alien invasive species affect the whole archipelago they need to be tackled as a coherent whole, recognizing the different zones as a mosaic of bio-diversity values and threats of varying intensities and urgencies. This is an approach increasingly being developed by the various actors working within Galápagos on conservation and development programs.

Acknowledgements
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SILENT INVASION IN NATIONAL WILDLIFE REFUGES (USA)

The release in the USA, of *Silent Invasion* (October 2002) marked the beginning of National Wildlife Refuge Week and of the National Wildlife Refuge Association's campaign to stop the advancement of invasive species before the problem spirals out of control and spoils some of America's most important natural treasures. Utilizing volunteers and mobile strike teams is a practical and affordable use of taxpayer funds to solve a problem that could effect 37 million refuge visitors annually. Recognizing the problem early on and responding rapidly are a crucial elements to this campaign - before they swell to uncontrollable proportions. To stop the Refuge invaders, a three-part strategy was identified - educating and mobilizing volunteers, deploying rapid response strike teams across the nation and implementing the strategic management plan of the National Invasive Species Council (USA). *Silent Invasion* profiles a "Dirty Dozen" invasive species and shows how 12 diverse refuges in as many states are working to address this ecological crisis.

Download: *http://www.refugenet.org/New%20invasives/index-silent%20invasion.htm?eCode=ikt*
Further information: *Heather Dalsimer, Program Assistant,* National Wildlife Refuge Association, *E-mail hdalsimer@refugenet.org*
Source: Press release 10 October 2002, National Wildlife Refuge Association

Invasive Alien Flora in Sri Lanka and their management

The spread and dominance of invasive alien plants in ecosystems has become an issue of national importance in Sri Lanka, an Indian Ocean island. The introduction and spread of majority of invasives are linked either directly or indirectly to human activity with an economic or aesthetic objective. Majority of these species have entered Sri Lanka through germplasm exchange programs between botanic gardens. This report describes the present status of some of the invasive alien flora identified in Sri Lanka.

(a) *Salvinia molesta* has been introduced to Sri Lanka in late 1930's for scientific interests, but currently has become a major aquatic weed in Sri Lanka choking the irrigation canals and water bodies, and also invading rice fields in the north western province of the island nation. Although there is no accurate information on its degree of infestation, in 1988, about 8000 ha of rice fields have been reported to infest with the weed (Amarasinghe and Ekneligoda, 1997). Although the biological control with *Cyrtobagus salviniae* has been successful in several areas in Sri Lanka, the attempt has failed in cooler climates and areas with low water levels and high environmental temperature.

(b) *Eichhornia crassipes* has been introduced to Sri Lanka due to its horticultural value. However, two years after its deliberate introduction to the country, a Water Hyacinth Ordinance was enacted in 1907, which indicated the understanding of the long-term detrimental effects alien invasive plants by the policy makers of Sri Lanka even more than 90 years ago. However, *E. crassipes* is still a major aquatic weed in Sri Lanka choking water bodies, and affecting the maintenance of irrigation schemes. Biological control with *Neochetina eichhorniae* and *N. bruchi*, introduced in 1980s, has not performed to the expected levels. Thus, mechanical removal has been practiced to clean water bodies infested with this aquatic weed, resulting in high costs and its spread due to contamination of the machinery used (Marambe *et al.* 2001a).

(c) *Mimosa pigra* was identified in Sri Lanka in mid 1990s growing luxuriantly in the riverbanks of Mahaweli, which is a major source of irrigation water that supports the agricultural crops in Sri Lanka, and in other areas in the central province spreading at an alarming rate (Amarasinghe and Marambe, 1997; Marambe *et al*. 2001b). Although the pathway of entry of this plant into the country is not well understood, it is widely believed that this invasive alien was intentionally introduced to protect the riverbanks. *M. pigra* has spread into other parts of the country via irrigation water, machinery, river sand used for construction purposes, and lopping with mature pods as a result of the use of stem of the plant as a firewood by people.

(d) *Parthenium hysterophorus* is the latest recorded invasive alien plant in Sri Lanka. The weed has occupied about 150 ha of fallow and agricultural land in the upcountry area and some parts of the central province, and northern province (Jayasuriya 2001). The weed was first believed to have entered the country in late 1980's through the goats imported from India by the Indian Peace-Keeping Force (IPKF). However, available information indicates that seeds of *P. hysterophorus* have been introduced to Sri Lanka together with onion and chilli seeds imported from India. This is a classic example of the impact of open trade policies and poor quarantine measures on the spread of alien species. The Ministry of Agriculture declared the species a noxious weed by an extraordinary gazette notification issued on 20th December 2000 (No. 1163/23) under the Plant protection Act No. 35 of 1999.

(e) *Lantana camara* (Lantana) was introduced to Sri Lanka in 1826 due its horticultural value and attraction of butterflies, and planted in sugarcane growing areas in the southern province of Sri Lanka to protect the cane plants from elephant damage. However, the weed has now invaded one of the major elephant sanctuaries in Sri Lanka at Uda Walawe, significantly reducing the grazing fields of the elephants. The plant is widespread island-wide and commonly found in dense stands along the roadsides and abandoned lands (Marambe *et al*. 2001b).

(f) *Ulex europaeus* (Gorse weed) is presently confined to the Horton plains, located in the upcountry region of Sri Lanka, and is found to change the habitat of this nature reserve. Although efforts have been taken by many organizations comprising environmentalists and school children to eradicate this weed, the attempts were aborted due to the fact that endemic lizard species and amphibians seeking protection form this thorny plant, from its natural enemies (Bambaradeniya *et al*. 2001).

(g) *Prosopis juliflora* (Mesquite) is a species introduced to Hambantota district in the southern province of Sri Lanka in early 1950's to improve the salt affected soils and as a ground cover (Algama and Seneviratne, 2000). The species has now become invasive and a serious threat in the Bundala National Park (southern province of Sri Lanka), a wetland in Sri Lanka listed under the Ramsa Convention. The weed has caused major habitat change in the national park and deprived large mammals such as the elephants of important habitats. The species is also spreading in the shore areas of Bundala thereby reducing the area for wading birds (Bambaradeniya *et al*. 2001).

(h) *Alternanthera philoxeroides* has been an accidental introduction to Sri Lanka, which has spread rapidly due to human intervention. The weed, easily misidentified to a commonly cultivated leafy vegetable *Alternanthera sessilis*, has been reported have spread in several parts of Sri Lanka. The state Department of Agriculture has now taken measures to eradicate the plant from cultivated land

with the assistance of the farming community.

In many cases, frequent use of chemical or mechanical methods to control the invasive alien flora has resulted in a significant economic burden to the country. Failure to develop an integrated management plan for the alien invasive plants in Sri Lanka has become a major obstacle to overcome this environmental threat. Thus, development and implementation of a national action plan with the active involvement of all stake holders is necessary to overcome the threats of these invasive plant species to the ecosystems of Sri Lanka.

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TROPICAL ADAPTATION OF THE RAINBOW TROUT (*ONCORHYNCHUS MYKISS)*

Rainbow trout (*Oncorhynchus mykiss*, Walbaum, 1792), has its native range from Kuskokwim river, Alaska to Santo Domingo river, Baja California, Mexico and British Columbia (Page L.M. & B.M. Burr, 1991). Being one of the most valuable aquaculture and sport fishing species, rainbow trout has been introduced in more than 80 countries. In many of these it has caused a decline of native fishes, eating their eggs as well as juvenile fish. For this reason, Rainbow trout has been classified as one of the 100 worst invasive species by the ISSG (Invasive Species Specialist Group). In tropical regions it has been introduced in countries such as Bolivia, Brazil, Costa Rica, Guyana, Hawai'i, Mexico, Panama and Venezuela. It has also been introduced in the Dominican Republic in 1985 for aquaculture in the National Park of Valle Nuevo at the Cordillera Central.

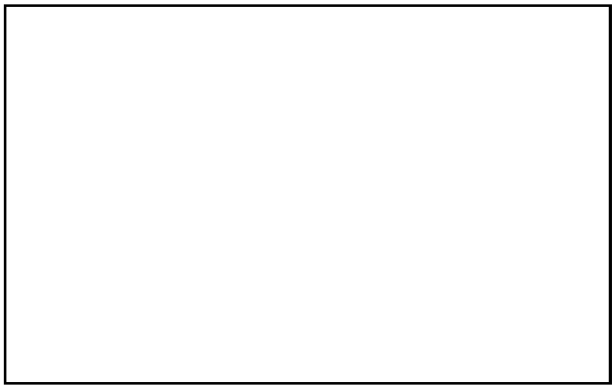
Preliminary research was carried out from September to December 2002 and was sponsored by the Sub-Secretary of Coastal and Marine Resources (Secretary for Environment and Natural Resources), Grupo Jaragua Inc, The Nature Conservancy (by Foundacion Moscoso Puello) and Universidad Autonoma de Santo Domingo. The research focused on tropical adaptation of rainbow trout to try to understand its potential impact on native and endemic fauna into the aquatic ecosystem.

Preliminary studies were carried out regarding: morphology, reproduction and feeding habits. Specimen fish were caught by net and lines, thus permitting us to collect enough fish for a statistical analysis. 88 trout were collected, at 2.600m above sea level; 48 females and 40 males. These fish had a standard length of 12.7 – 28.8cm, a mean of 18cm and a standard deviation of 4cm. This sample shows that at high density (1 trout/m^2) is a great influence in the trout's size, which is smaller (length and weight) than European trout.

No others documented re-stocking of rainbow trout were made after 1985 and the presence of mature females and males demonstrated that this species is naturalized in that particular tropical aquatic ecosystem. After having analyzed rainbow trout we observed that 25% were mature and 25% of these had recently spawned. From literature, eggs, with a size of 4.72 – 5.43mm, found in mature females are considered the upper dimension before spawning. Ovary seems to be non-synchronic: eggs had 3-4 different sizes (from ready for spawning to just visible) and it isn't a re-absorption process that could present this situation. This doesn't happen in temperate countries (Rounsefell G.A., 1957) but could be acceptable after 17 years of adaptation in a sub-tropical country without marked seasons. More than one reproduction is possible in the Dominican water but must be confirmed by new research in that area. This is an example of the adaptation level that could be reached by an invasive species in a country outside its native range.

The stomach contents showed drift feeding habits, classical for trout (Ivlev V.S.,1961) which have no preference for a specific category. Diptera is the best represented in the stomachs and in the environment. Percentages of taxa found in the stomachs are exactly the same as of the environment along the river. Lizards long more than 50% of fishes' total length were also found during this study.

For this reason we can affirm that no significant impact should exist for insects and invertebrate but a great impact has been demonstrated for fish. *Poecilia Dominicensis* , an endemic Dominican fish, collected in 1996 has now disappeared (in that area, but still present in other regions). Not one fish was found during the study and even if we are not sure of the role of the trout in this decline, no other reason could have the same importance in changing the trophic chain in this isolated place. This area has, in fact, a low-density population and there are no farms or factories able to create pollution in the river. No ecological changes were found during past studies to suppose a risk for this endemic fish. So the only reason could be the positive trend in trout population numbers. However, without evidence we are not able to confirm the trout's invasiveness role in this case, but it is strongly likely.



In the European Countries rainbow trout eat invertebrates, eggs and juvenile fish but mature fishes are normally too big to be considered as prey for the trout; in the Dominican Republic 70% of species of fish are small, which converted them into potential prey for all their life cycle. We only know about 10% of the Dominican reptiles, but by introducing predators we are abusing the ecosystem before knowing it completely. Even if sometimes we can't be sure about the negative effects of an introduction, having too many variables for a sure risk assessment, in the Dominican Republic the potential risk was evident before the introduction. An aggressive fish, such as rainbow trout, which is larger than any other Dominican freshwater species, and without a natural predator is a great threat to the aquatic ecosystem.

Introducing fish must be undertaken only if really necessary and under strict supervision during and after the introduction. There should be no introductions on islands and where every trophic relation and every niche is the result of thousands of years of adaptation. Also the Convention on Biological Diversity (CBD) recognises the very urgent need to deal with invasive alien species issues in isolated and vulnerable ecosystems as islands.

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NOTES

Hawai'i

Until now, it has been difficult to obtain copies of the July 1992 report entitled "*The Alien Pest Species Invasion in Hawaii: Background Study and Recommendations for Interagency Planning*." Now a text-searchable (PDF) version of this report is available online at: *http://www.hear.org/articles/tnchnrpp1992/*

This report was originally jointly prepared by Susan Miller of the National Resources Defense Council (NRDC) and Alan Holt of The Nature Conservancy of Hawaii (TNCH). It is still widely considered to be the best document of its kind about interagency planning regarding the alien pest species invasion in Hawaii.

Source: Aliens-l message from

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Invasive Aliens Species Management in the Fiordland National Park – World Heritage Area (New Zealand)

Fiordland National Park is the largest of New Zealand's national parks, covering an area of 1,260,200 ha. The park stretches from Martins Bay, north of Milford Sound, to the South Coast and across to the eastern shores of lakes Te Anau and Manapouri. All of the islands off the coast and in the fiords are part of the National Park, including the Solander Islands, but not the waterways of the fiords.

In 1986 Fiordland National Park became a World Heritage Area. Then in 1990 an expanded area was listed which included most of the Southwest corner of the South Island south of Aoraki/Mount Cook. This area is known as Te Waahi Pounamu South West New Zealand World Heritage Area. This classification acknowledges the international importance of Fiordland National Park as an outstanding area of uninterrupted natural wilderness with high biodiversity values. The wilderness value of this corner of New Zealand is unsurpassed with its spectacular mountain ranges, wild, indented and relatively unmodified coastline, uninterrupted tracts of beech (*Nothofagus spp*) and podocarp forests and the network of lakes and fiords.

Some of the wildlife values that Fiordland is renowned for are the takahe (*Porphyrio mantelli*), kakapo (*Strigops habroptilus*), blue duck/ whio (*hymenolaimus malaco-rhynchos*), tokoeka/kiwi (*Apteryx australis*) yellowhead/mohua (*Mohua ochrocephala*) South Island Saddleback/tieke (*Philesturnus carunculatus carunculatus*), South Island kaka (*Nestor meridionalis meridionalis*), kea (*Nestor notabilis*), short tailed bats/pekapeka (*Mystacina tuberculata*) and the sandfly (*Simuliidae*).

Fiordland has not been excluded from the invasion of introduced plant and animal species that have colonised the rest of New Zealand. Some species, such as moose (*Alces alces andersoni*) and wapiti (*Cerphus elephus nelsoni*), were initially released into very remote areas of Fiordland. The moose is now considered extinct. The lakes, rivers and fiords combined with the rugged alpine terrain have resulted in a slower rate of invasion by animal pests to some of the more remote areas of the national park

The suite of introduced animal pests is now considered to have colonised most areas of suitable habitat apart from islands that are too far off the coast. One exception is that possums (*Trichosurus vulpecula*) have yet to invade a few of the more remote western areas.

Predator control has traditionally been focussed around protected species programmes such as takahe and yellowhead but has more recently shifted towards an ecosystem protection approach. Small Islands outside the swimming range of animal pests have been another priority for the New Zealand Department of Conservation (DOC), where eradication of resident animals is possible. In the early 1980s the New Zealand Forest Service removed red deer (*Cervus elaphus scoticus*) from many of the small islands in Doubtful, Breaksea, Dusky, Chalky Sounds and Preservation inlet. DOC has maintained the deer free status of these islands through regular monitoring.

On Breaksea Island (170ha), off the Fiordland Coast, Norway rats (*Rattus norvegicus*) were removed through an intensive ground based poison operation (1988-1991). Breaksea Island is now providing a life raft for a number of threatened species that have subsequently been transferred to it, such as yellowhead, South Island saddleback and two weevil species from the nearby Gilbert Islands (*Hadramphus stilbocarpae* and *Anagotus fairburni*).

Richard Henry's early conservation efforts on Resolution Island during the 1890s are also being mirrored on several other islands off the Fiordland Coast. Te Kakahu/Chalky Island (475ha) has been cleared of stoats (*Mustela erminea*) and kakapo have since been transferred. Stoats have been eradicated on Anchor Island, (1525ha) in Dusky Sound, and red deer are now reduced to extremely low numbers. Yellowhead and saddleback have been transferred to Anchor recently (with plans for another kakapo population in the future). Secretary Island (8140ha), at the entrance to Doubtful Sound, is the next island under consideration to receive the same treatment. These are all islands that are within the swimming range of stoats and deer. These programmes represent a management by research approach where the ongoing control of animal pests, as they arrive, results in the maintenance of a pest free status. If this style of island management is effective, it will increase the number of islands within New Zealand that have the potential to be used as island refuges. This approach could eventually be applied to Resolution Island (20860ha).

Since the discovery of the takahe population in the Murchison Mountains in the early 1950s, the control of stoats and red deer has been integral to the protection programme. Deer compete with the takahe for the food resource and stoats are capable of killing adults and chicks.

Before kakapo were discovered on Southern Stewart Island in 1977, the only known birds to exist were male kakapo which were still surviving in several glacial valleys around Milford Sound and in a single location in Doubtful Sound. The ruggedness of the terrain had slowed the advance of predators to these valleys.

The Eglinton Valley, en route from Te Anau to Milford Sound, was recognised early by conservation managers as being one of the species-rich areas of the National Park. This, combined with its accessibility, has resulted in the valley receiving stoat, rat and possum control in an effort to

protect the yellowhead, kaka, and bat populations. Recent work has shown that even with the current level of effort, yellowheads are still vulnerable to ship rats and stoats during plague years.

The work initiated in the Eglinton Valley has been built on over the last few years to expand the area receiving protection from animal pests. The objective is to provide integrated pest management to a large area of the land to the north of Lake Te Anau. Feral goats have been eradicated from the Clinton Valley and stoats are controlled. Sustained possum control occurs in the Pembroke Wilderness Area, the Eglinton Valley and is planned for the Arthur, Clinton and Cleddau Valleys. Whio/blue duck monitoring in the Clinton Valley recently recorded a stoat killing a female on the nest, the first irrefutable evidence of stoats predating this species.

Fiordland's cloak of native forest makes it less susceptible to plant pests than modified habitats, but it is still plagued by a number of species. The Department of Conservation has a number of weed control programmes aimed at minimising the impact of plant pests on the ecosystem.

Marram (*Ammophila arenaria*), gorse (*Ulex europeaus*) and broom (*Cytisus scoparius*) are controlled along the entire Fiordland coastline to maintain the natural character of the coast and dunes. Blackberry (*Rubus fruiticosis*) is controlled in the Clinton Valley and crack willow (*Salix fragilis*) is controlled whenever it gets established around the shore of Lake Te Anau.

Some plants intentionally brought to Fiordland by early settlers are now threatening to spread into the national park. Mature pine trees at Big Bay and both macrocarpa and eucalyptus at Martins Bay have required control of seedlings where they have spread onto conservation land.

Above the tree line, alpine grasslands are susceptible to invasion by introduced grasses. These invasions are less noticeable to the untrained eye, but are just as capable of altering the landscape and the ecosystems it supports.

Map Coutesy Department of Conservation

Managing invasive pest species on an area of land the size of Fiordland National Park requires careful prioritising and planning. There are some ambitious conservation projects currently being undertaken within the national park in an effort to restore and protect this unique area of New Zealand for the appreciation and enjoyment of generations to come.

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NOTES

Invasive Species Symposium,Sacramento, California, October 14-16, 2003

The United States will examine intended (purposeful) and unintended (accidental) animal introductions in terrestrial and aquatic ecosystems with introduced vertebrate species and their interactions with native animal and plant species as the central theme. This symposium may address ecological, sociological, political, economic, cultural, conservation, and policy perspectives, with views encouraged from areas throughout the world. Call for papers, preliminary program, and registration information may be found at *www.tws-west.org, g*o to the Meetings/Workshop page and select the select the workshop for October 2003.

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New weed education website

Landcare Research New Zealand has developed a new Weed Education Website *http://www.landcareresearch.co.nz/education/weeds/*

The website aims to encourage teachers to use weeds as a learning context in their teaching and to encourage students to learn how weeds impact on the environment. The website includes information, resources and learning activities on weed ecology and control.

Any feedback or questions about the website can be directed to:

Margaret Stanley
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SURVEILLANCE FOR ECOLOGICAL WEEDS – PROTECTING THE NEW ZEALAND CONSERVATION AREAS BY EARLY DETECTION/RAPID ACTION

Early detection and control of new incursions of environmental weeds is considered highly desirable because it minimises both the control costs and ecological impacts of invasive weeds. In New Zealand, the Department of Conservation (DOC) developed a weed surveillance system. Surveillance is about finding new weed infestations when effective action is still possible and before the cost of control becomes too high. This involves both systematic searching and fortuitous surveillance (the latter a by product of other activities of DOC personnel).

Where to search: Surveillance efforts focus on Valuable sites (sites of high conservation value) as well as on sites vulnerable to weed invasion; road ends, rubbish dumps or "waste areas" near towns may be of low conservation value, but often this is where weeds first appear, and subsequently spread to the areas of high conservation value. Taking action in these sites outside the conservation area is a crucial part of protecting the conservation areas themselves.

What weeds to look out for: Likely species (for example an invasive species that may be newly established in a nearby area) as well as "nasty" species (known to be of conservation concern). In addition it is also important to be watchful for species that have not been a concern before (e.g. they may have recently turned invasive, they may not have been detected in New Zealand before, etc) and to check out any plant which is new to a site or "looks out of place".

Role of the public: Weed surveillance involves DOC staff actively hunting for weeds. But as many eyes as possible are needed for surveillance to really work. Members of the public have been the first to spot many major pest invasions in New Zealand in recent years, so public education is crucial. In the Wellington Region alone, over 300 new weed sightings have been recorded in less than three years. These sightings have not just come from DOC weed staff. Other DOC staff, members of the public, and staff from the regional council, have all helped. Publications and public information have been central to surveillance success stories involving members of the public: (an example is the Wellington Conservancy fact sheet *"Have you seen these plants in Wellington Conservancy?")* – whether walking in a reserve, motoring on a lake, or driving through the neighbourhood, the public can make a huge contribution to conservation by keeping a look out for weeds and notifying

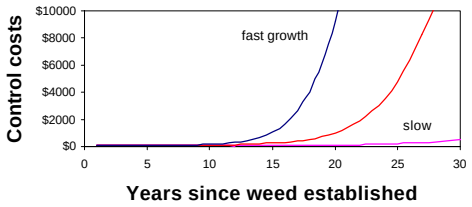
Follow up action. After a reported sighting (as part of surveillance, fortuitous, or reported by member of public), details are verified and then requirements for action can be determined. Detailed procedures for all surveillance activities within DOC are contained in a Standard Operating Procedure document.

How often to search?: Early detection of weeds minimises both control costs and ecological impact. But how often and where to search for maximum benefit? DOC developed a model to recommend appropriate search frequencies for different habitat types. Based on a standard search intensity of 2 hrs per 10 ha, and on field experience, the growth, spread and visibility of different weeds in different habitats were estimated. The weed growth for most likely to be of concern in each habitat was also determined. Results included the following outcomes: Searches every two years are needed in short vegetation to find and control short weed early, but could be 5 years if a whole week of control work can be scheduled. Wetland surveillance for shrubs and trees can be as infrequent as every ten years, but for short terrestrial weeds it would be required to search every three years to be 80% certain to find them. If 90% certainty of finding them is required, searches would have to be every year for short weeds. (Note that the model did not include aquatic weeds – surveillance would likely have to be even more frequent for them).

Management costs: The faster spreading a weed is, the quicker management costs rise. All environmental weeds have moderate to fast growth and spread. The cost of environmental weed management increases exponentially over time (*see figure*).

Source:
- Braithwaite H: *Weed surveillance plan for the Department of Conservation* 24.pp (DOC science Publications)
- Timmins S (2002) Weed Surveillance: when to search for new weeds. Science Poster 55 (DOC science Publications)
- DOC News: *http://www.doc.govt.nz/Conservation/003~Weeds/001~Weedy-Reads-(Weed-Stories-From-Around-the-Country)/Surveillance-Saves-Lake-from-Purple-Peril.asp*

Editor's note: of related interest (wider) *Space-Invaders* (Summary of the Department of Conservation's Strategic Plan for Managing Invasive Weeds) which can be downloaded from: *http://www.doc.govt.nz/Conservation/003~Weeds/004~Space-Invaders-(Summary-of-DOCs-Strategic-Plan-for-Managing-Invasive-Weeds).pdf*



Weed control costs increase as a weedy shrub invades short vegetation. The faster growing the weed, the faster the costs rise.

Figure courtesy Susan Timmins (DOC)

Tongariro National Park – Biocontrol to Manage invasive heather in New Zealand

Heather, *Calluna vulgaris*, is a European plant deliberately introduced into New Zealand by an early park warden in 1912 in an attempt to reproduce Scottish moors. Grouse were later released but thankfully did not survive; however, the heather has gone on to heavily infest an estimated 50,000 ha of the North Island's Central Plateau, including a third of a World Heritage

Fig 1. Photo Landcare

Area, Tongariro National Park (TNP) (fig 1) Heather is now the most widespread and invasive weed in the park and has also established and is spreading in other areas around New Zealand.

Within the park and in surrounding areas, heather impedes recreational activities, disturbs natural plant regeneration and succession in tussock and shrublands, and threatens rare plants and insects. It also interferes with New Zealand Army training activities in areas adjacent to TNP. Within TNP, chemical control methods are not used because, as well as being quite impractical at this scale, non-target impacts are not well understood and non-chemical control methods are ineffectual and no longer being attempted. On Army land, chemical control methods are currently used while non-target impacts are more thoroughly investigated.

Landcare Research initiated an investigation into potential biological agents in 1986. The heather beetle, *Lochmaea suturalis*, was selected as the insect with greatest potential because of its reputed specificity to *Calluna* and the levels of damage it inflicts on heather in Europe (fig 2). In fact, the heather beetle is regarded as a pest species in its native range. After extensive host-range testing in the UK and NZ, which confirmed host specificity, and the completion of an Environmental Impact Assessment, the heather beetle was cleared for field release into New Zealand.

Beetles were mass-reared using line rearing techniques to eliminate a microsporidian (protozoan) disease identified while in quarantine. During 1996 and 1997 5,000 adults were released at 15 sites throughout TNP and adjacent areas representing a range of environmental factors including rainfall, altitude, substrate as well as heather age and density. None of the releases apparently established successfully, and in late summer 1999 (January-February), we began a second phase of releases that would also tell us something about the effect of release size and life stage on establishment success. This involved releasing a further 4,500 adults, 7,000 larvae and 1,200 eggs at a further 35 sites between March 1999 and January 2003. We plan to complete this work in 2005.

Shortly after starting this second phase of releases we found 5 adults and 20 larvae at one of the original 15 release sites. No damage was visible but we were confident that nearly 4 years after being released, and having withstood a series of volcanic eruptions that left the release site covered in a thick layer of ash, this heather beetle population had established. In the following year our excitement turned to amazement. Within 1 year a patch of healthy heather measuring roughly 20 by 15 metres appeared to be either dead or dying and heather beetles were easy to find. Ironically, while we were excited by the prospect that heather

Fig 2. Photo: Landcare

beetle may at last live up to our expectations in New Zealand, UK newspapers were lamenting that plagues of hungry heather beetles had been decimating heather there; up to 271,350 ha of moorlands being affected.

Since large numbers of heather beetles were now building up at the successful release site only 2 years after detection, we began to follow subsequent beetle dispersal. All heather within a 200m radius of the release point was located, tagged, and described, and GPS references were taken during the spring of 2001 (September) and again in late summer 2002 (February). Sticky traps to capture flying adults were also erected around the original release point. Results from this work clearly indicate that heather beetles can disperse through areas of native tussock/shrubland, locating and damaging, and in some cases even killing, individual heather plants. Again, this good news suggests the heather beetle may be effective even in mixed heather/tussock/shrubland. Outbreaks and subsequent damage in the UK are often only associated with large homogeneous areas of heather.

Heather beetle outbreaks in Europe are usually sporadic and collapse fairly quickly. Between 6–100% of larvae can be killed by a parasitic wasp (*Asecodes mento)*, and up to 88% of adults can be parasitised by a tachinid fly (*Degeeria collaris*). We also know from earlier work that a microsporidian disease is prevalent in heather beetle populations overseas and we now believe a combination of parasitism and disease limits these beetles in Europe, not shortage of food. So far in New Zealand we have seen no sign of any egg, larval or adult parasitism after rearing field collected samples in the laboratory. A native bug (*Cermatulus nasalis*) feeds on larvae, and carabid beetle larvae may prey on eggs, but it seems unlikely that either of these predators, or anything else we have collected during regular pitfall, intercept or sweep net sampling at the site, will pose much threat. Also, beetles

collected and deliberately reared in crowded conditions showed no signs of the microsporidian. So we predict beetle outbreaks may persist longer in New Zealand and perhaps be limited by other factors like food supply or climate.

Returning to the successful release site 3 years after establishment was a much anticipated trip. We were predicting a very large increase in numbers and further dispersal. Again we were surprised, but unfortunately this time we weren't so pleased. The population had declined below numbers seen in the second year after detection. Given that we are able to discard predation, parasitism and disease as likely causes, we checked meteorological records to see if there was anything unusual about the weather during spring and early summer. Both October and November 2002 (spring) provided the coldest mean minimum temperatures on record. In fact 2002 was the only year during the past 2 decades when the mean minimum temperature for October was below zero. In addition, unseasonably late snowfalls in November are likely to have been important. Snow this late in the beetle's native range is virtually unheard of and may be something heather beetles can't cope with. Eggs and larvae especially would be vulnerable to freezing. We now believe this unusual weather caused the beetle's setback.

Fortunately, we recently found a site in the north eastern New Zealand (Bay of Plenty) where beetles were doing well only 1 year after release, and possibly two more sites where they are establishing adjacent to TNP. We plan to continue the second phase of our release programme until 2005 and will continue to monitor and document the progress of newly established sites.

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World zoos and aquariums oppose transfer and release of lions and other species into the wild

In response to media reports on the planned transfer of Iraqi lions to game parks in South Africa, the World Association of Zoos and Aquariums (WAZA) and the Pan-African Association of Zoological Gardens, Aquaria and Botanic Gardens (PAAZAB) state their opposition in principle to the indiscriminate transfer and release to the wild of animals kept in human care. The two organisations emphasize that such actions must always be in keeping with the provisions of the relevant Guidelines issued by the Survival Specialist Group of the World Conservation Union (IUCN).

From June 3 to 6, the Annual Meeting of the Pan-African Association of Zoological Gardens, Aquaria and Botanic Gardens (PAAZAB) took place in Oudtshoorn, South Africa. The meeting was also attended by the Executive Director of the World Association of Zoos and Aquariums (WAZA) and included a discussion on the uncontrolled importation of African wildlife species for the purpose of keeping the animals under semi-wild conditions or releasing them to the wild.

Concerns were expressed of the disease risk implications to local populations of wildlife. In addition, to this, a "genetic pollution" of the original populations by animals of unknown or different genetic lineage would be possible if uncontrolled breeding with such individuals is allowed to occur. According to the respective Codes of Ethics applied by both organisations no release-to-the-wild programme shall be undertaken without the animals having undergone a thorough veterinary examination to assess their fitness for such release and that their welfare post release is reasonably safeguarded. Such assessment must be made in accordance with the quarantine and health screening protocols for wildlife prior to translocation and release to the wild issued by the Veterinary Specialist Group of IUCN. Following release, a thorough monitoring programme should be established and maintained. In addition, the IUCN/SSC/ *Reintroduction Specialist Group Guidelines for reintroduction* must always be followed. This implies inter alia that only animals of known and demonstrable genetic status are returned to and released in a range state of the species.

As a general rule the release to the wild of animals bred by member zoos are the result of a coordinated and intensively controlled *ex situ* breeding programme. They are undertaken in compliance with the applicable legislation and guidelines, and in close cooperation with the local authorities and other stakeholders. If animals do not qualify for being included into such release-to-the wild programmes WAZA and PAAZAB stress that other options must be vigorously investigated.

Source: (Press Release) Oudtshoorn, S. Africa, 5th June 2003

For further information
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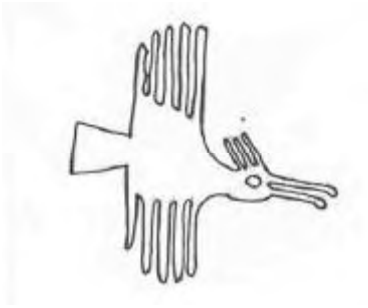
Tel: ++27-(0) 82-8934199



Quarantine measures to halt alien invasions of Southern Ocean islands: the South African experience (Prince Edward Islands special Nature Reserve)

Southern Ocean islands are no stranger to alien species invasions. Even the most remote of these have experienced rates of new species introductions two to three orders of magnitude greater than background levels (Gaston *et al*. 2003). For example, conservative estimates for winged insects only are of one successful establishment every three to four landings. Across Southern Ocean islands as a whole the total number of introduced species (of all taxa) is strongly related to the number of human occupants (Chown *et al*. 1998), and concerns have thus been raised about tourism to these islands (Heydenrych & Jackson 2000; Chown & Gaston 2000).

South Africa's Prince Edward Islands (Marion, which supports a research station and programme and Prince Edward, uninhabited and near-pristine) in the southern Indian Ocean also have their share of introduced species (Watkins & Cooper 1986,; Gremmen & Smith 1999;, Chown *et al*. 2002). Since the 1970s, South Africa has undertaken measures to eradicate established alien species from these islands. Brown Trout *Salmo trutta* were removed from Marion Island in 1984 (Cooper *et al*. 1992). Feral cats *Felis catus* were eradicated on Marion in 1991 following a long and sustained effort with full governmental support and funding (Bester *et al*. 2002). Efforts are underway to eradicate small populations of the alien grass *Agrostis gigantea* (first recorded in 1994) and the isopod *Porcellio scaber* (first recorded in 2001) before they spread from founder sites (Gremmen & van der Meijden 1995, Gremmen & Smith 1999, Slabber & Chown 2002). For other alien species, eradication has either not as yet been attempted (e.g. for the house mouse *Mus musculus* on Marion Island; Chown & Cooper 1995, Cooper 1995) or is not considered feasible (e.g. for the well-established grass *A. stolonifera* and slug *Deroceras caruanae* on Marion Island and the pearlwort *Sagina procumbens* on both Marion and Prince Edward Islands; Smith 1992, Gremmen *et al.* 1998, Ryan *et al.* 2003).

Despite some quarantine measures, new alien invertebrates and plants haves been discovered at Marion Island in recent years, mainly in the vicinity of the research station (Hänel *et al.* 1998, Gremmen & Smith 1999). Each new incident identifies loopholes in existing quarantine procedures, and suggests additional strategies for employment. The development of effective quarantine procedures is thus an ongoing process, and increased vigilance by the islands' management committee, biologists and annual conservation officers has helped raise awareness In most years on Marion Island at the time of the annual relief alien moths are noticed in and around the research station, when immediate efforts are made to kill the usually singletons observed (pers. obs.). These unwelcome visitors have undoubtedly arrived on the relief vessel: it is usual for the ship to leave its port, Cape Town, with a few flying insects still aboard. Although efforts are made to kill these on the four-day southward journey, it is clear that these are not always successful. Occasionally, the ship has inadvertently carried larger invertebrate populations to the islands, as described below.

During the April 2002 relief it became apparent the day after sailing that the ship was infested with house crickets, *Gryllus bimaculatus*. It is believed that these had flown aboard one or two nights before sailing, perhaps attracted by lights. At the time Cape Town and environs were experiencing a plague of these crickets. Using their characteristic chirping as a clue to their presence, 46 specimens were caught and killed by repeated searches of interior spaces during the southward voyage. In addition the ship's exterior was washed down with seawater to flush out survivors and a glutaraldehyde solution was sprayed into channels and scuppers prior to the ship arriving at Marion Island. Despite these on-the-spot efforts, a few live crickets were observed aboard after the ship had spent several days at the island off-loading personnel and cargo (Cooper 2002).

During the following year's relief voyage cardboard trays holding canned drinks that were being removed from sealed metal containers on the island, shortly after their offloading from the relief ship were found to be infested with the cockroach, *Blatella germanica*. The containers were immediately resealed and flown back to the ship, where they were inspected, all discovered cockroaches killed, the cardboard removed for incineration aboard ship, and the containers sprayed with a pyrethroid-based insecticide, repacked and resealed. Several days later the containers were returned to the island where all plastic-wrapped "six packs" of canned drinks were once more inspected before immersion in a bleach (sodium hypochlorite) solution. Fortunately no more cockroaches were found. In all, *c*. 40 live cockroaches were collected (Cooper & de Villiers 2003).

At the time of writing (July 2003), no further observations of crickets or cockroaches have been made at Marion Island (where neither species previously occurred). It would appear that the eradication procedures devised on the spot succeeded.

However, such "finger in the dyke" reactions are not the best way to stop new alien species reaching the islands. Infestations should be halted at source, and for this to work successfully a comprehensive set of quarantine measures must be in place and rigorously and continuously applied by all involved. Over the period 2003 to 2006, South Africa will be constructing a new research station at Marion Island that will require the transport of very large amounts of materials and large contingents of construction workers to the island. Two dedicated construction voyages each year will triple the number of annual visits. It is probable that without concerted

quarantine efforts, all this new activity will result in further alien species arriving and some becoming established, at Marion Island.

In terms of the islands' management plan (PEIMPWG 1996) and the environmental study for the new research station (Environomics 2002), strict quarantine procedures to prevent alien invasions must be adopted during the whole construction period. To implement and manage these procedures the senior author has been appointed as the Environmental Project Officer. Responsibilities include inspecting manufacturing and storage facilities on the mainland and accompanying all eight planned construction voyages to the island over the next three years. A full set of operational procedures is still being finalized but they are to be wide-ranging, to cover activities in Cape Town, aboard the ship and on the island (Tab. 1).

With the expected full commitment of all involved with the construction of the new research station, it is hoped that come its inauguration in 2006, Marion and Prince Edward Islands will welcome new suites of researchers without the unwelcome presence of new aliens.

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TABLE 1

Quarantine measures currently in force and recommended for implementation in 2003 (in italics) for visits to the sub-Antarctic Prince Edward Islands

A. Mainland South Africa

- Regular inspections of storage facilities
- Cleaning of reusable metal transport containers
- No exchange of containers between Marion and Gough Islands
- Fumigation, and *provision of electronic fly traps*, and rodent bait stations at storage, packing, *manufacturing* and *supply* facilities
- Packing of foodstuffs and most other supplies into sealed containers
- *No paper or cardboard-based packaging materials to be used*
- Cleaning of issued and personal clothing and field equipment (packs, tents, etc.)
- *Phasing out of use of Velcro on issued protective clothing*
- Transport of materials in covered vehicles
- Education of personnel

B. Aboard ship

- Rodent bait stations, de-ratting exemption certification, and hawser rat guards prior to sailing
- Compulsory "boot-washing ceremony" (scrubbing footwear in bleach solution; inspection and cleaning of protective clothing, back packs, day packs and camera and video bags, especially pockets and Velcro strips, for

plant and animal propagules),
• Inspection and cleaning of helicopter interiors, landing skids and wheels
• Compulsory education and information session presented by relief voyage Conservation Officer lecture to shore-going personnel
• *Provision of electronic fly traps, insecticides,, fumigants and rat traps for emergency use*.

C. Ashore at Marion Island
• Inspection of all off-loaded materials and supplies on arrival and during unpacking
• Banning of all fresh vegetables and fruits
• Supply of irradiated eggs and deboned poultry
• Freezing and return to mainland of all poultry wastes, including eggshells
• On-going inspections of base buildings and environs for alien plants and invertebrates
• *Provision of pesticides, fumigants, rodent bait stations and rat traps for emergency use*.

D. Special provisions for Prince Edward Island
• Limitation on number and size of visits (maximum of six persons for four days per year)
• No fresh food or foods containing whole seeds allowed ashore
• Provision of new or cleaned, dedicated protective clothing, footwear and camping equipment
• All packing under supervision of a Conservation Officer
• Landings from ship only and not via Marion Island
• No interchange of protective clothing, footwear, back packs, camping equipment and biotic materials between the two islands
• *Freezing of selected items aboard ship*

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The Global Invasive Species Database is freely available on online at *www.issg.org/database*. The development of the database, and the provision of content for it, is ongoing. Priorities range from a focus on the some of the world's worst invasive species to a focus on areas where information and resources are comparatively scarce, including small-island developing states and other islands. The database has images and descriptions for a wide variety of invasive species. Records for these species include information on the ecology, impacts, distribution and pathways of the species, and most importantly, information on management methods as well as contact details of experts that can offer further advice. The database also provides links to numerous other sources of information.

IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species *http://iucn.org/themes/ssc/pubs/policy/invasivesEng.htm*

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