Invasive Species Specialist Group of the IUCN Species Survival Commission

ALIENS

Issue Number 27, 2008

FROM THE NEW CHAIR OF ISSG – PIERO GENOVESI

As you know, Mick Clout has recently decided to step back from the Chair of ISSG, and Simon Stuart – elected Chair of IUCN SSC at last WCC in Barcelona - has invited me to take this role.

I cannot say how challenging it is to take this role after Mick, who is the "father" of ISSG and - as Chair of the group - has been incredibly active globally in conservation in the last decades. Mick was in fact the founder of ISSG in 1993, and since then he has been the main actor of the success of the group - one of the most active and influential within the Species Survival Commission. In particular by making the GISD portal the most widely used tool on alien species, by organising keystone meetings, by providing scientific and policy advice to global programs such as GISP, by creating synergies with programs – among others - on protected areas and islands. But beyond the important results gathered within the IUCN world, Mick's constant work and commitment have contributed substantially to the advances we have seen in the last decade in the knowledge and awareness on biological invasions. Mick's role was acknowledged by the recent attribution of the Peter Scott Award , which was awarded in the WCC meeting at Barcelona in October 2008.

So, I believe it is clear to you all that taking Mick's role is for me a tremendous challenge, and I hope with your advice and support to be a good Chair of the group. I am sure that Mick and the other ISSG people in New Zealand will assist me not only in the transition phase, but also in the coming future.

I have worked for about 15 years in species' management, but in the last years my work has focused more on policies than on field activities. My activities have been mostly based in Europe, and I will definitely need to increase my understanding of the key topics and problems in other areas of the world in order to keep on strengthening and expanding the geographical scope of ISSG, improving our ability to assist the areas more at risk, or with less capacity to address invasions.

Despite the great successes so far gathered, ISSG has many challenges to face in the near future. It is my opinion that there is still much to do to raise the profile of the impacts posed by biological invasions, that are still largely underestimated – if not unknown - to many decision makers, NGOs, governments and the public. In a recent survey carried out in Europe on biodiversity, only 2% of respondents considered alien invasive species as a major threat. In this regard we cannot miss the opportunity of this year CBD Biodiversity Day, that will be on invasive species, launching a global campaign with all the means we have.

I also believe that we need to ensure a constant updating of the Global Invasive Species Database, making this tool more and more integrated with other international databases, and taking the challenge offered by new information technologies to improve our ability to provide prompt and authoritative information to scientists, practitioners and decision makers. I take this chance to thank Michael Browne for his commitment and passion in managing the GISD; Michael's contribution has been crucial for making the database the valuable tool it is now.

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Apart from the GISD, I am convinced that other ISSG tools, such as the Aliens newsletter and the Aliens listserver, have been crucial for improving circulation of information at the global scale, contributing to making key data and expertise readily accessible to key people in the world. In this regard I will do my best to keep both these products as successful as they are now, and possibly to improve their circulation and utilization.

We also need to concentrate on the transectoral spirit of the group, strengthening the links with other specialist groups for addressing more effectively raising threats such as climate change or new threats posed by introduced species to different taxonomic groups.
These are some of the main challenges that I see for our near future, but I need your opinions and suggestions to get a more comprehensive picture of what are the priorities for ISSG. In this regard I am planning an online survey in the coming months of your opinions on these and other topics.

Lastly, I hope you understand that moving the Chair of the group from New Zealand to Europe, and organising staff to assist me in my work, will take some time. The newly established Regional Office for the Pacific (based at the University of Auckland) will help handle the transition (contact person is Shyama Pagad). I hope I can count on your patience in this transition phase that I and the ISSG staff will try to make as smooth and as rapid as possible.

With warm regards,

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CONTENTS

CLIMATE CHANGE AND INVASIVE SPECIES: AN EXAMPLE FROM NEW ZEALAND

This condensation is reprinted from Melting Point: New Zealand and the Climate Crisis (2008, Penguin New Zealand). The book is a no-nonsense overview of the climate change issue as it effects New Zealanders (and, by extension, Australasia and the Pacific). This chapter, about environmental impacts, includes details of the relationship between climate change and the spread of feral species in New Zealand. Introduced species have been responsible for the country's worst environmental degradation. Climate change adds to the problem, both by enabling feral species to spread, and by making climate-adapted species more vulnerable.

There isn't a square centimetre of this planet that the hand of *Homo sapiens* has not altered in some way. No desert is too remote, no ocean trench too deep. Even the snows of Antarctica show traces of pollution from our cities and the rate at which we impose these changes is phenomenal. In the fifteen seconds it took you to read the opening lines of this chapter, six hectares of the world's forests have been chopped down, the world's deserts have increased by three hectares, and 12,000 tons of CO_2 have been pumped into the atmosphere. These figures are the inevitable result of the skyrocketing human population which has, during the last fifteen seconds, increased by thirty five.

Every day, scattered around the world, about a hundred species have been sent extinct. Most of these are insects in tropical rainforests, gone before they were even described by science. Perhaps one would have provided a cure for cancer. Or perhaps it was simply beautiful. The world's wildlife is over-hunted and forced to compete with foreign invasive species. Entire ecosystems are polluted or removed completely.

The world's climate has changed many times in its past. Sea level has risen, glaciers have advanced and deserts have formed, creating new opportunities and closing off old ones. Over millions of years animals and plants have had two options in response: adapt or die. Mass extinctions in the Earth's history give spectacular evidence of what can happen with ecosystems fail to adapt to changing climate. The most famous extinction event is the Jurassic catastrophe (65 million years ago). At that time the global ecosystem was rocked by a meteor that carved out what is now the Gulf of Mexico. The dinosaurs and other giant reptiles that dominated the planet were unable to cope and died. Geologically speaking, it was the work of an instant. This incredible event, however, pales by comparison to the great Permian extinction 251 million years ago, in which 96 percent of all marine species and 70 percent of terrestrial vertebrate species became extinct, possibly due to a meteor. Whatever the cause, it seems that the world's ecosystems took between 5 and 30 million years to recover.

In the modern world, species have evolved to respond to seasonality in temperature and rainfall, the primary drivers of resource abundance. The most vivid examples of these are the seasonal migrations of large herbivores like zebra and antelope across southern Africa, and the annual shift of countless millions of ocean-going birds from winter feeding grounds to polar nesting sites in summer. There are, however, many more subtle examples, no less important. Most species, from whales to parasitic wasps, time their reproduction to coincide with resource cycles, often in quite intricate ways. A great many organisms from the tropics like coral, or the poles, like penguins and seals also have narrow ranges of temperature and in which physiologically they are capable of living.

Although modern species have been coping with the Earth's climatic fluctuations for millennia, anthropogenic climate change offers them a new challenge. This is principally because human activity has reduced the options for species by carving up the landscape, confining populations to increasingly tiny fragments, hemmed in by agricultural land urban settlement. This affords animals nowhere to move when conditions change. We are racing full-pelt into another age of mass extinctions.

Examples already exist of species changing their distribution, or failing to respond to changing conditions. The ranges of many non-migratory butterflies in Europe have shifted to the north by 35–240km during this century[1]. In Antarctica, the northern-most populations of the ice-adapted Adélie Penguin have been declining, while the Chinstrap Penguin, which is often found in ice-free waters, is increasing and extending its range southwards along the western coast of the Antarctic Peninsula[2]. Coral in Australia's Great Barrier Reef is bleaching, a process which is directly related to rising sea temperatures[3].

New Zealand

New Zealand's situation as an isolated island in the southern Pacific has led to the evolution of a unique community of plants and animals. Before the arrival of humans, New Zealand was a very different place from today. No terrestrial mammals travelled here as the New Zealand land mass broke away from its parent super-continent Gondwana (or if they did, they died out early), and the only mammals to live here in the recent pre-human era were bats. Instead, the forests that covered most of the New Zealand land mass were filled with birds and insects, free of the pressure from mammals common on larger continents. "Use it or lose it" is a phenomenon of evolution, and in the absence of ground-based predation pressure, flightlessness became a way of life. Moa diversified into at least nine species and ducks left the water to roam permanently over the forest floor. Many arboreal birds developed ground-nesting habits and even two of the bat species (the short-tailed bats, of which one species still survives) left off feeding in the skies to forage through the leaf litter like shrews.

Like so many island communities, the species that lived here were completely naïve to predation. When humans arrived about 1100 years ago they began hunting and brought with them predators and competitors: rats, dogs, pigs, and later cats, possums, and mustelids (weasels and their relatives). The result was devastating. Fifty percent of New Zealand's birds and a fair percentage of other animals were sent extinct. Many species

Tuatara

The tuatara is, contrary to popular belief, neither a lizard nor a dinosaur, but the last-surviving member of the Order Sphenodontia, a group of medium-sized reptiles that had their heyday coexisting with the dinosaurs around 200 million years ago. The largest species known, *Priosphenodon* from South America, reached a metre in length (about a third larger than the tuatara) and form an important part of Cretaceous terrestrial ecosystems.[4] All the species except for the tuatara eventually became extinct about 60 million years ago, replaced by the modern lizards. New Zealand's isolation, however, provided a reprieve for our species, which has lived on to the present day.

Tuatara are restricted to New Zealand and, like most of our endemic fauna, were abundant on much the mainland before the arrival of humans. Today they are rare, restricted to a handful of islands and nature reserves. Their most important threat, in place for more than a thousand years, is from rats, which prey on eggs and young and compete for their invertebrate food. The islands on which tuatara survive have usually been made rat-free and still attract breeding seabirds (gone now from the mainland) which provide guano to foster a rich invertebrate community.

Climate change has the potential to impact tuatara in a couple of ways. The islands that form the principal refuges for tuatara are in the Bay of Plenty, Marlborough Sounds, and Cook Straight. One might speculate that these sanctuaries could become less habitable with increasing westerly winds, more intense storms and rising sea level (Chapter Two). If this becomes the case, the small mainland refuges, like Wellington's Karori Sanctuary, could become more important in the future.

There is, however, a potentially more pressing concern stemming from climate change. Tuatara, like crocodiles and some lizards and turtles, have temperature-dependent sex determination, meaning that the temperature at which their eggs are incubated dictates the gender of the offspring. For tuatara, eggs incubated at warmer temperatures produce males, and the cut-off appears to be extremely precise, lying somewhere between 21ºC and 22ºC[5]. In natural circumstances tuatara can incubate their eggs in a wide range of temperatures, at least between 5ºC and 34ºC[6], however rising temperatures could slowly skew the sex ratio of populations towards males. Over time, this could prove disastrous for their long-term survival, potentially making them dependent on inputs of females from artificial incubation.

Alpine regions

New Zealand's alpine region is populated by over 600 species of low-growing flowering plants, of which over 90% are endemic to the region in which they live. Often entire species or species complexes are confined to single mountain tops, their fragmented distribution the result of climate fluctuation in eons past. Many of these species are threatened, and the whole alpine ecosystem is under continual pressure from competing weeds, feral goats and deer, as well as high-country grazing.

Climate change is a particular threat to alpine regions because rising temperatures will tend to push biological communities higher in altitude and rising treeline is a phenomenon that has been recognised in New Zealand for at least twenty years[7]. For lower and mid-altitude plants, this simply means a gradual shift in position. However, mountain peaks are like islands and the rising tide of mid-altitude communities will reduce the range of alpine plants. On lower mountains, treeline will probably rise above their peaks, allowing trees to colonise everywhere, completely smothering the alpine meadows. Modelling has shown that if the current average temperature of ~0.6°C higher than in 1900 were combined with a large pool of exotic species, 40–70 species of native plants could be at risk. A 3°C rise by 2100 could lead to the extinction of 200–300 indigenous alpine species (about 80%), unless intensive management is undertaken to maintain alpine habitat[8]. In those alpine areas that are left, heat waves, drought and wildfires are expected to be more intense, putting further pressure on the flora.

Alpine animals are also vulnerable to altitudinal shifts in biological communities. Competitors and predators that have so far been kept out by low winter temperatures are predicted to spread upwards. For example, the tiny alpine rock wren, 10 cm, 16–20g and virtually tailless, lives amongst the low scrub in boulder-strewn places like Arthur's Pass. This is a relative of the now famously extinct Stephens Island wren, apocryphally sent extinct by a single cat. The rock wren is a poor flier and totally naïve to predators. The Department of Conservation now fears that that increased temperatures will allow cats and rats access to the wrens, requiring the development of trapping programmes previously unnecessary.

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"LIFE" RESOURCES AGAINST ALIEN SPECIES IN EUROPE ARE GROWING!

A new report on "EU funding for management and research of invasive alien species in Europe" shows that over the last 15 years, despite the lack of a specific strategy or a dedicated financial instrument to deal with invasive alien species (IAS), the European Commission has contributed to financing 187 LIFE projects which address this issue. In fact, the total budget devoted to IAS has exceeded 44 million EUR. The wide range of measures funded through LIFE included activities aimed at preventing, controlling or eradicating unwanted populations (American mink, ruddy duck, *Caulerpa taxifolia*, Rhododendron, etc.), and were often connected with either the restoration of habitats or recovery of species of EU interest.

The report has been prepared by the European Environment Agency (EEA) as a part of its work on SEBI 2010 to assess progress toward the target of halting the loss of biodiversity by 2010. To this regard the EEA report shows that the contribution of the LIFE programme has been characterised by an overall positive trend over the years, in terms of both the number of projects and the budget spent. On average each year over the period 1992-1006, the EC financed 12 IAS related LIFE projects, for an average cost of 230 000 EUR each, corresponding to a budget of almost 3 million EUR. The increasing trend to fund IAS reflects an overall increase in both the awareness of the problem among wildlife managers and scientific institutions, and the willingness of the European Commission institutions and the EU citizens to provide financial support.

The report also analyses the contribution of the Framework Programmes for Research and Technological Development (RTD) to funding IAS. In this case the EC financed 90 RTD projects dealing with IAS for a total budget of more than 80 million EUR. The number of RTD projects is therefore lower in comparison to LIFE projects, but the budget is higher and the overall trend over the years is positive in both financial programmes.

Download the full report "EU funding for management and research of invasive alien species in Europe" here: *http://biodiversity-chm.eea.europa.eu/stories/eu-funding-management-and-research-invasive-alien*

THE ROLE OF INFORMATION EXCHANGE AND RESEARCH FOR EFFECTIVE RESPONSES TO BIOLOGICAL INVASIONS

M Browne, S Pagad & M De Poorter

This recently published paper uses a number of case studies of good management practice, including prevention, ecosystem approaches, adaptive management and stakeholder involvement, to illustrate an increasing ability to combat invasive alien species (IAS). It identifies some of the challenges inherent in managing IAS in complex situations and identifies areas where weed scientists and other researchers can increase their contributions. Crucially, communities, conservation groups, NGOs and agencies undertaking prevention and management activities need ready access to science-based biological and ecological information about target species, prevention strategies and management techniques, as well as case studies from other regions facing similar problems. Information exchange is a key component of effective responses to biological invasions. A number of global-scale information exchange mechanisms are described.

An abstract is available at:
http://www3.interscience.wiley.com/journal/121633902/abstract

TOWARD AN EC STRATEGY ON IAS

At the very end of 2008, the European Commission has taken a major step forward to face the problem of biological invasions. In fact, on 3 December 2008 the EC has adopted a Communication presenting policy options for an EU Strategy on Invasive Species. In particular the Communication examines the evidence regarding the ecological, economical and social impact of invasive species in Europe, analyses the effectiveness of the current legal situation for tackling this problem and describes 4 possible options for a future EU strategy. In addition the Commission highlights measures that can be put in place immediately, including a Europe-wide early warning system to report on new and emerging species. Feedback from stakeholders and other EU Institutions will be taken into account by the Commission in selecting amongst those options and developing the EU Strategy on Invasive Species, planned for 2010.

SUCCESSFUL MAINLAND ECOSYSTEM RESTORATION THROUGH ONGOING PREDATOR CONTROL AT ARK IN THE PARK, WAITAKERE RANGES (NEW ZEALAND)

The Ark in the Park Restoration project is a community volunteer based project in existence since January 2003, situated in the Cascades Kauri Park, Waitakere Ranges Regional Parkland, close to Auckland City (New Zealand). The project is a partnership between Forest and Bird and the Auckland Regional Council. There is an initial focus on native bird species, but the project is not limited to them – the aim is to restore functioning native ecosystems through pest control and reintroduction of native animals and plants lost from the Waitakere Ranges. Possum control conducted by Auckland Regional Council has allowed the forest vegetation to recover, but restoration of many of the "lost" species cannot happen unless they are further protected through ongoing pest control (especially for rodents and mustelids).

Unlike many other "mainland island" projects, Ark in the Park does not rely on a predator proof fence – instead, ongoing control, supported by many thousands of volunteer hours each year, continuously keeps predator numbers low enough to allow survival and breeding of re-introduced as well as original native birds and other biodiversity. The *Ark in the Park* area, as at 31 March 2007, is 1100 ha, but expansion is planned. In addition, there is a buffer zone outside it where pest control is carried out on neighbouring private property.

Some examples of success:

- Fifty-nine hihi (stitchbird, *Notiomystis cincta*) were reintroduced into the park in 2007 and another 51 in May 2008. The reintroduction is experimental as it is the first transfer to an area with low numbers of predators (as opposed to an area that is predator free). The hihi is one of New Zealand's rarest birds but was once found throughout the North Island. Introduced predators, habitat destruction and possibly disease reduced them to a small population on Hauturu/Little Barrier Island in the Hauraki Gulf. The Hihi Recovery Group is interested in the survival and breeding success of hihi in the *Ark in the Park* area. If successful, this may increase the opportunities for potential populations in other suitable areas with pest management. Post release monitoring and breeding-season monitoring has been carried out to determine dispersal, survival, territories and breeding success. Successful breeding took place in the first and second season since the first release.

- Fifty-three North Island Robin (toutouwai, *Petroica longipes*) were re-introduced into the park in April 2005. Volunteers monitored them in the first year. Five to six breeding pairs have been monitored over subsequent breeding seasons with an average of 4.5 chicks per female successfully fledged. Chicks have been colour-banded for future identification.

- Fifty-five whitehead (popokatea *Mohoua albicilla*) were introduced in August 2004. The post-release monitoring of this species has proved difficult, as they dispersed widely and are relatively inconspicuous canopy dwellers. Small groups of whiteheads, including unbanded individuals, have been seen in the Waitakere Ranges. Whiteheads are still seen and heard in the Ark in the Park area. As numbers increase, these birds should hopefully become more conspicuous.

Kokako (Callaeas *cinerea*) reintroduction is planned for 2009.

The Auckland Regional Council (ARC) supports the project in many ways, including the provision of bait for the project's 1100 hectares. ARC also provides logistical support, technical advice, and their rangers are a much appreciated source of on-the-ground support. A Technical Advisory Group with specialists from the Department of Conservation, universities and Auckland Zoo meets regularly to advise on a range of issues. Significant funding for the project comes from major sponsors: ASB Community Trust and the Portage and Waitakere Licensing Trusts. Funding has also come from the Birdlife International Community Fund, Auckland Zoo Conservation Fund, and the Department of Conservation Biodiversity and Advice Fund. However, the project's success lies in the huge volunteer commitment with many thousands of hours provided on an annual basis. We would gratefully welcome any further financial support or volunteer contributions (several overseas volunteers have participated in the monitoring programmes in the past).

Adult Male hihi (stitchbird , Notiomystis cincta)
Photo - Eric Wilson

For more information please see:
http://www.arkinthepark.org.nz/ or contact me.

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WILD ROSE *ROSA SOULIEANA* CREP: A NEW INVASIVE SPECIES IN THE RHINO LANDSCAPE OF INDIA

Introduction

Kaziranga National Park (KNP), a World Heritage Site, is located between latitudes 26˚30 N and 26˚45 N, and longitudes 93˚08 E to 93˚36 E in the state of Assam, India. Kaziranga National Park is the home of world's largest population of one horned Rhinoceros with its history of successful conservation efforts. It also provides a natural habitat for number of rare and charismatic species such as Elephant, Wild buffalo, Swamp deer, fresh water Dolphins etc. The habitat of Kaziranga is part of the Brahmaputra floodplain ecosystem with tall grasslands and reeds comprising the one third of its area. The water bodies (*beels*) of Kaziranga get recharged every year with the water from floods. These annual floods not only bring water to the park but also deposit silts and other materials carried with them including seeds, plants or other propagules. These propagules germinate in the park and sometimes result in the unintentional spreading of the invasive species.

Invasive species of Kaziranga National Park:

The major plant invasive species that have been posing a threat to the habitats on a large scale at Kaziranga National Park are *Eichhornia crassipes, Mimosa spp., Mikania micrantha, Cannabis sativa, Eupatorium odoratum, Ageratum conyzoides, Lantana camara, Litsea polyantha, Glochydion spp.* and wild rose. Among, these invaders, the wild rose, was found mainly in and around the beel (wetland) area, occupying the short grasslands preferably used for the grazing by most of the herbivores of the National Park.

The invasive wild rose present in the KNP has been identified as *Rosa soulieana* Crep. It is native to China, where it normally grows in temperate regions, but tolerant of a wide range of soil and environmental conditions. It invades low lying areas, pastures, degraded areas and reduces grazing area. It was observed encroaching the most crucial habitat of beel grasslands of KNP. This species might have brought down to India by the river Brahmaputra that passes through China.

Current status and distribution of wild rose in KNP

It was found that the distribution of wild rose was not uniform in the Kaziranga National Park. Generally, the distribution was significantly higher in the western parts but it is very rare in the eastern part of the Park. Total beel area comprises less than 5% of the total area of the Park and it was estimated nearly, 1-4% area of the sampled *beels* was infested with wild rose, i.e. approximately 24 to 96 ha of wild rose thickets present in the sampled area. The wild rose is usually present in and around the *beel* area, which is the most critical habitat for all major flagship species of the Park. Direct sightings and indirect evidence such as pellets, dung piles of rhinoceros, wild buffalo, elephant, swamp deer, etc were observed in the wild rose infected areas.

It has been observed that the wild rose distribution is more in the western parts of the KNP. The possible reason behind this may be the slope and terrain aspects of the Kazirnga landscape, which is elevated in the eastern parts and has a depression towards the western side. This depression may allow the flood water to settle for more time in the western part during and after the floods.

Management of wild rose in the Kaziranga National Park

Presently, there is no management mechanism in place to control the wild rose by the Park Authority. Since the wild rose (*Rosa soulieana*) is a new invasive species to the world, no information about the phenology and ecology of this species is available. Therefore, it is important to carry out a detailed study on the pheonology of this species in KNP before taking up any major management programme. However, based on experiences with other invasive rose viz., *Rosa multiflora*, manual control measures for the wild rose (i.e. repeated cutting or mowing [three to six times per growing season] for two to three years, or uprooting and burning) is expected to give better results (IUCN 2000). Various herbicides have been used for controlling the wild rose elsewhere in the world which may not be an option for KNP as it may adversely affect other native plants. However, application of the systematic herbicides (e.g. Glyphosate) to freshly cut stumps or to re-growth may be an effective method, especially if conducted late in the growing season, which may also be tried outside the wildlife Protected Areas especially in the agricultural landscape.

Figure 1: Map of the Study Area (Source:

A rhino in the middle of invasive wild rose bushes in the Kaziranga National Park.

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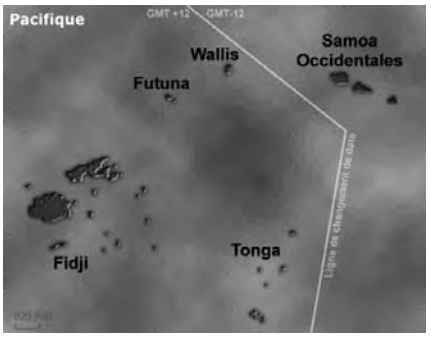
RECENT INCURSIONS OF INVASIVE ANIMAL AND PLANT SPECIES IN THE SMALL AND REMOTE ARCHIPELAGO OF WALLIS AND FUTUNA (SOUTH PACIFIC): *"LA MAISON BRÛLE MAIS NOUS REGARDONS AILLEURS".*

An inventory of all alien terrestrial plant and animal species recently carried out in the French Overseas Territory of Wallis & Futuna, reveals that incursions of some of the worst invasive alien species still occur in this small and remote archipelago of the South Pacific.

Wallis & Futuna, also known as the Horne Islands, is formed by the three small high volcanic islands of 'Uvea (78 km², 151 m asl, surrounded by ca. 19 offshore islets), Futuna (47 km², 524 m asl) and Alofi (17 km², 417 m asl), located between 280-400 km from Fiji, Samoa and Tonga. The archipelago is connected by an international flight to New Caledonia only twice (up to three) per week with a stop-over in Suva (Fiji), and there is are two daily flights between 'Uvea and Futuna (230 km apart) with a small Twin-Otter plane. The population comprises 13,450 inhabitants (2008 census), with 68% living on the main island of 'Uvea. People on Futuna have kept their traditional socio-political (ruled by two kingdoms), and agricultural, and pig rearing systems intact. Futunians cross the 1.8 km sea channel to Alofi (with no permanent settlement) daily to cultivate taro, kava, paper mulberry and tobacco, and to hunt flying foxes, Pacific pigeons and coconut crabs found in the dense primary rainforest.



Wallis & Futuna islands

Two three-week field-expeditions, funded by Wallis & Futuna Department of Environment and lead by the Centre IRD de Nouméa, were conducted in November 2007 and November 2008. In addition to the two first authors, the field team was comprised of malacologist Ira Richling (Kiehl University, Germany), zoologist Jörn Theuerkauf (Museum and Zoological Institute, Poland), botanists Jérôme Munzinger and Yohann Pillon (IRD-Nouméa), and entomologists Bruno Gatimel, Emilie Baby (IRD-Nouméa) and Fabien Condamine (INRA-Montpellier, France). The main objectives were to list, identify and locate all the introduced, naturalized (or established) and invasive plants and animals, and to assess the conservation status of the native and endemic species, as well as the native habitats (coastal vegetation, wetlands and mangroves, littoral forests, uplifted limestone forest, lowland and upland rainforests). Obtaining current data on the native and alien biota of Wallis & Futuna is crucial, as the last study on the ant fauna was conducted in 1965 and on the vascular flora in the early 1980's.

Among the recently introduced invasive animals, the black rat, Rattus rattus, commonly found on 'Uvea has now reached Futuna, where it is restricted to the main village and wharf of Leava, and it is still absent on Alofi. The little fire ant, *Wasmannia auropunctata*, abundant in 'Uvea and Futuna, has gained a foothold on Alofi as well as the rosy-wolf snail, *Euglandina rosea*, which is now threatening the last populations of the endemic tree snail, Partula subgonochila. The aggressive myna bird, *Acridotheres tristis*, on 'Uvea and *A. fuscus* on Futuna were intentionally introduced during the last 5-10 years. Feral dogs were observed on Alofi and might have caused the extirpation of the native ground-dove, *Gallicolumba stairii*. Among the dominant weeds, the liana, *Merremia peltata* is thriving in abandoned cultivated areas on 'Uvea and covers entire lowland slopes on Futuna. The shrub *Clidemia hirta* is aggressively colonizing the

View of Futuna - Credit Jean-Yves Meyer

work team at Alofi - credit Ira Richling

understory of *Falcataria moluccana* and pine plantations of *Pinus caribaea* as well as open native shrublands and disturbed dense forest on the three islands. The invasive vine *Mikania micrantha* in 'Uvea is still absent from Futuna and Alofi, and the African tulip tree, *Spathodea campanulata* which is spreading on 'Uvea is only planted as an ornamental on Futuna. The invasive grasses *Melinis minutiflora* and *Pennisetum clandestinum* were intentionally introduced to 'Uvea in the 80's as fodder plants, and are now naturalized. The thorny shrub *Mimosa diplotricha* was discovered in 2003 in a few localities on 'Uvea and more recently on Futuna. We estimated that the number of non-native vascular plants in Wallis & Futuna increased from ca. 175 in the early 80's to more than 300 species today, including 120 naturalized plants. Many newly established species were introduced as garden ornamentals, with some of them now showing signs of invasion, such as the small tree *Tecoma stans* (Bignoniaceae) and the vine *Thunbergia laurifolia* (Acanthaceae) in Futuna, and the palm *Livistona chinensis* in 'Uvea.

The conservation of the unique terrestrial biodiversity of this small and remote Pacific archipelago, especially on the islands of Futuna and Alofi where many native and endemic birds (e.g. the lorikeet *Vini australis*, the Polynesian triller *Lalage maculosa futunae*, the shrikebill *Clytorhynchus vitiensis fortunae*, the kingfisher *Halcyon chloris regina*), animal (e.g. the Pacific boa *Enygrus (Candoia) bibroni* on Alofi) and plant species (e.g. the endemic shrub *Cyrtandra futunae*, Gesneriaceae) still survive is a challenge. Native forests are vanishing rapidly and are being transformed into fernland (called "toafa"), with less than 5-10% left on 'Uvea, mainly because of deforestation for agriculture and housing development, and repeated fires.

Wallis & Futuna adopted its first nature protection legislation in July 2007 ("Code de l'Environnement"), and the newly created Service de l'Environnement is in charge of biodiversity conservation and invasive species management. However, without strong funding support and rapid action (e.g. black rat eradication), new incursions and dispersal of alien species are inevitable in this French Overseas Territory isolated in the Pacific Ocean. As quoted by a former French president during an international conference on biodiversity in 2005 (Paris), *"la maison brûle et nous regardons ailleurs"* (the house is burning and we look elsewhere)…

This paper is dedicated to our colleague and friend Paino Vanal, former (and first) chief of the Service de l'Environnement, for his dedication and perseverance towards the conservation of Wallis & Futuna's natural heritage. We also thank Bradley Balukjian (UC Berkeley, R. B. Gump South Pacific Research Station, Moorea) for revising the English.

Village of Leava wharf - Credit Jean-Yves Meyer

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ALIEN SPECIES IN THE MEDITERRANEAN SEA – SIGNALS OF CHANGE

Abstract

More than 600 alien marine metazoan species have been recorded in the Mediterranean Sea. Though no extinction of a native species is known, sudden decline in abundance, and even local extirpations, concurrent with proliferation of aliens, had been recorded. The majority of aliens are thermophilic species originating from the Indo-Pacific or Indian Oceans, which have entered the Mediterranean through the Suez Canal. Data, gleaned from a recently assembled database tracing the spread of alien species in the Mediterranean, allow examination of the possible impacts of climate change. Thermophilic species have been introduced for much of the 20th century, yet few spread outside the Levantine Basin until the 1980s. Multiple anthropogenic stressors – pollution, eutrophication, destruction and fragmentation of habitats, fisheries overexploitation, climate change – are implicated in the decline in the richness and diversity of the native Mediterranean littoral ecosystem. Yet, it is proposed that the rising sea water surface temperature in the past two decades has favoured the thermophilic aliens reproduction, growth, and survival, and provided them with a distinct advantage over native temperate Mediterranean taxa. The influx of thermophilic aliens impacts tourism and the already teetering fisheries through proliferation of noxious and poisonous species, displacement of commercially-important native species, and the alteration of the food web.

Introduction

Among the dozen alien species recorded in the Mediterranean before 1900, half - the molluscs *Pinctada radiata*, *Cerithium scabridum*, *Mactra olorina*, the alga *Hypnea valentiae*, the seagrass *Halophila stipulacea* and the swimming crab *Portunus pelagicus* - have entered the Mediterranean through the Suez Canal, heralding the Erythrean invasion of the Mediterranean Sea. Of the others, three were fouling serpulid polychaetes - *Hydroides dianthus, H. diramphus, H. elegans* - collected in the harbours of Izmir and Naples; the silver pomfret, *Pampus argenteus*, collected near Rijeka in 1896, was likely ship-transported as well; and the pearl oyster, *Pinctada maragritifera*, was an early mariculture introduction. The influx of alien species into the Mediterranean has continued unabated ever since.

The opening of the Suez Canal engendered debates on its possible impact on the Erythrean and Mediterranean biotas. Malacologists who studied the Mediterranean and the Red Sea faunas determined that there is no species common to both seas, and that the opening of a maritime canal will result in modification of the faunas at both ends of the Suez Canal. Early researchers of the phenomenon considered the canal as a "caravan route" between the Mediterranean and the Red Sea with species proceeding from both ends of the canal. Yet, fifty years after the opening of the Canal, no scientific institute had undertaken a comprehensive study of biotic transfer so as to answer whether *"… an exchange of fauna take place between the two oceans by means of this canal? Do the immigrants from the other side flourish on this or die? Has such an immigration caused important changes in the fauna of the eastern basin of the Mediterranean?"* (W. Steinitz, 1919). Steinitz studied the marine biota of Palestine in 1924 and 1925 and noted 15 species of Indo-Pacific origin. In 1924 'The Cambridge Expedition to the Suez Canal' embarked on an investigation of the "intermingling of the Mediterranean and Red Sea organisms in the Suez Canal" (Gardiner, 1924:520). The results of the studies on the material collected during the three months long expedition are to this day the only comprehensive study on the biota of the Suez Canal.

The progression of Erythrean biota in the Levant in the early 20th century was noted in the inventories of the Levantine biota. The investigations of the continental shelf biota off Israel by the Sea Fisheries Research Station in 1946-1956 resulted in a series of publications that highlighted the extent the Erythrean taxa have been established along the coast. In 1967, a joint program by the Smithsonian Institution, the Hebrew University of Jerusalem, and the Sea Fisheries Research Station, Haifa, was established to investigate the spread of the Erythrean biota in the Levant (Israel, Cyprus, Rhodes) and its impact on the native biota. At the end of the 3rd year of the program, with some 5300 samples collected and partially sorted and identified, H. Steinitz, who co-led the research with W. Aron, published "A critical list of immigrants via the Suez Canal" of 140 Erythrean and Indo-Pacific species known to have crossed the Suez Canal into the Mediterranean (H. Steinitz 1970). By now, it was widely perceived that the littoral and infralittoral biota of the Levantine basin has been undergoing a rapid and profound change (Por 1978), and that the shallow benthic communities along the Levantine Basin have no known parallel in the Mediterranean because of the great number of Erythrean aliens.

Cultural attitudes towards the natural environment permeate the study, representation and reception of alien species. When once unintentionally introduced alien species have been viewed as a potentially exploitable marine resource: "… *les passages définitifs de ces espèces à traverse la totalité du [Suez] Canal présentent un résultat économique également très important"* (Gruvel 1936:228), they are now denounced as "biological pollution" (Boudouresque and Verlaque, 2002). The much invaded Levantine Sea that had been formerly viewed as "biologically enriched" by the Erythrean aliens, "… a sort of ecological vacuum where many ecological niches are available" for "marine colonization", and termed a "Godot basin" (Oliverio and Taviani, 2003: 313, 314) – a label the authors dared not attach to the equally invaded northern Adriatic or French lagoons – is reckoned victim of unchecked propagule pressure from the Suez Canal.

Growing awareness worldwide that bioinvasions constitute one of the most significant components of global change, with often harmful effects on biodiversity, economy and human health, coupled with the opportune misfortune of a handful of invasive aliens noted for their conspicuous impacts on the native Mediterranean biota, has drawn the attention of scientists, management and media. It was widely perceived that the littoral and infralittoral biota of the sea has been undergoing a rapid and profound change. A series of Atlases

(fishes, decapod and stomatopod crustaceans, mollusks) summarized the extant knowledge of the scale and impact of 'Exotic species in the Mediterranean' (*www.ciesm.org/atlas/*). Recently, as part of a EC-sponsored comprehensive inventory of alien species in Europe, a voluminous body of literature, including research papers, surveys, and conference abstracts, was assembled and critically examined in order to construct an authoritative dataset tracing the origin, date and mode of introduction, current distribution, rate of spread, and actual and potential impacts of the alien species in the Mediterranean Sea.

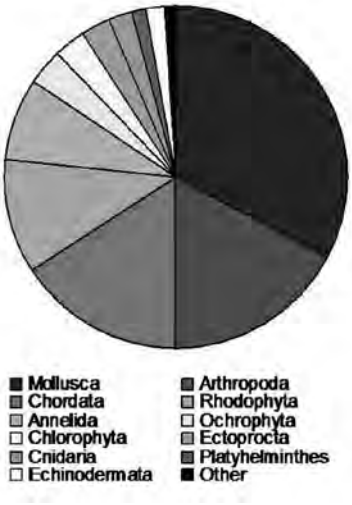
Figure 1. Alien decapod crabs in the Mediterranean. Clockwise from top left: Atergatis roseus (Rüppell, 1830), Myra subgranulata Kossmann, 1877, Macrophthalmus graeffei A. Milne Edwards, 1873, Eucrate crenata de Haan, 1835.

What have we here?

More than 600 metazoan species have been recorded as alien in the Mediterranean. All are littoral and sublittoral benthic or demersal species (or their parasites). Since the shallow coastal zone, and especially the benthos, has been extensively studied, and is more accessible, the chances that new arrivals will be encountered and identified are higher. Also, the species most likely to be introduced by the predominant means of introduction (Suez Canal, vessels, mariculture) are shallow water species.

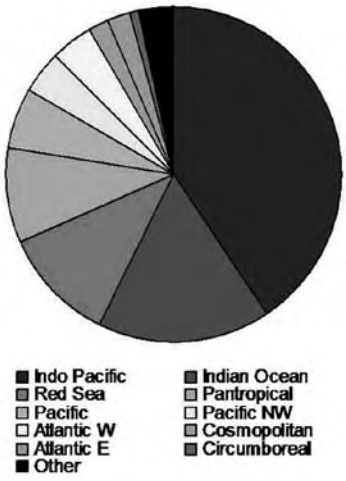
A taxonomic classification of the alien species (Figure 2) shows that the alien phyla most frequently recorded are Mollusca (33%), Arthropoda (17%), Chordata (16%), Rhodophyta (11%) and Annelida (8%). The data is presumably most accurate for large and conspicuous species which are easily distinguished from the native biota, and those occurring along a frequently sampled or fished coast and for which taxonomic expertise is readily available. Data is entirely absent for many of the small-sized invertebrate phyla like the little studied Porifera, Nemertea, Priapula, Nematoda, Entoprocta, Pogonophora, Sipuncula, Echiura, Brachiopoda and Phoronida (Galil, 2008).

Figure 2. Number of alien species in the Mediterranean Sea, presented by phylum.



The native range of the alien species in the Mediterranean (Figure 3) is most commonly the Indo-Pacific Ocean (40%), the Indian Ocean (17%), the Red Sea (11%), and pantropical (9%). Caution should be taken when using these data, as the actual origin of the Mediterranean populations of a species widely distributed in the Indo-Pacific Ocean may be its populations in the Red Sea, wheresoever in the Indian or Pacific Oceans, or secondary introduction from already established populations in the Mediterranean itself. With few notable exceptions, the source populations of alien species in the Mediterranean have not be ascertained by molecular means. Even taking into account these caveats, it is quite clear that most of the alien species in the Mediterranean are thermophilic, originating in tropical seas.

Figure 3. Number of alien species in the Mediterranean Sea, presented by their native range.



As far as can be deduced the majority of aliens in the Mediterranean entered through the Suez Canal (53%), followed by vessels (22%), and aquaculture (10%) (Figure 4). The means of introduction differ greatly among the phyla: whereas of the 102 alien macrophytes, 39% and 26% were introduced respectively with mariculture and vessels, the majority of alien crustaceans, mollusks and fish are Erythrean aliens (58%, 64% and 87%, respectively), and mariculture introductions are few (4%, 6% and 4%, respectively) (Figure 5a-d).

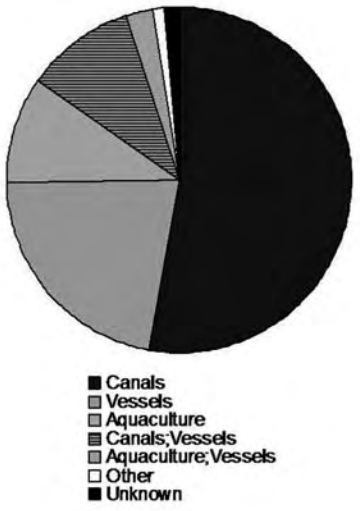


Figure 4. Number of alien species in the Mediterranean Sea, presented by their means of introduction.

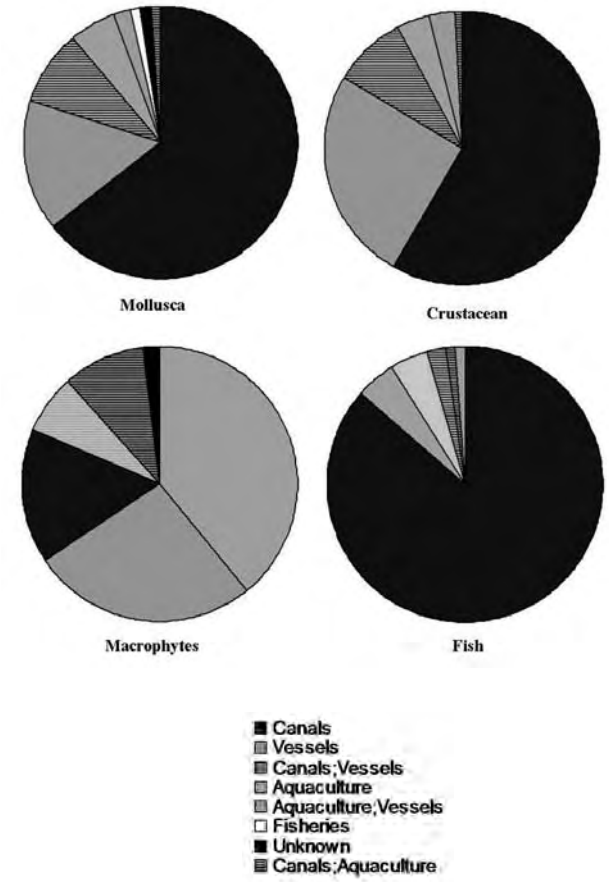


Figure 5. Number of alien macrophytes, crustaceans, molluscs and fish recorded in the Mediterranean Sea, presented by their means of introduction.

The numbers of alien species which have been recorded in the Mediterranean each decade over the past century have increased in recent decades (Figure 6). The figure reflects political crises, economic development and scientific interest in recording marine alien species. The few alien species recorded prior to the 20th century reflect most probably ignorance of the phenomenon coupled with lack of detailed marine biological surveys. The gap in the 1910s indicates the First World War, whereas the dip in the 1930s and 1940s may be ascribed to the economic recession and devastation of the Second World War.

The rather sharp decline in the number of records in the 1980s may be due to the closure of the Suez Canal and the impact of the Arab Oil Embargo on oil shipping and international trade that limited the number of vessels transiting the Mediterranean. The increase in vessel-transported aliens since may be attributed to the increase in shipping volume throughout the region due to the development of the Middle Eastern oil fields and later, the increasing trade with south-eastern Asian nations.

The increasing role of the Mediterranean as a hub of international commercial shipping, a surge in development of marine of shellfish farming over the last twenty five years, and the continuous enlargement of the Suez Canal, contribute to the resurgence of introductions since the 1950s. A spate of records in the 1920s and 1970s reflect the publication of the results of 'The Cambridge Expedition to the Suez Canal', and the joint program by the Smithsonian Institution, the Hebrew University of Jerusalem, and the Sea Fisheries Research Station, Haifa, respectively. There seem to be slightly more introductions recorded in the first years of the 21thC (104 species) than in the 1990s (111 species). Many have established durable populations and extended their range: 197 alien species have been recorded from three or more peri-Mediterranean countries, and 125 have been recorded from four or more countries.

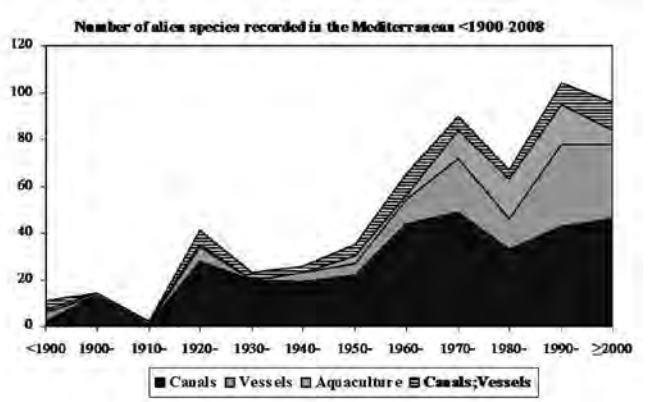


Figure 6. Number of alien species recorded in the Mediterranean Sea, 1900-2008, and their means of introduction.

A comparison of the alien species recorded along the Mediterranean coasts of Spain and France, and an equivalent length of coast in the Levant (Port Said, Egypt to Marmaris, Turkey), shows marked differences in their numbers, origin and means of introduction (Figure 7). There are nearly four times as many alien species along the Levantine coast (449) as in the westernmost Mediterranean (113). The majority of aliens in the easternmost Mediterranean entered through the Suez Canal (68%, 15% vessel-transported, 2% mariculture), whereas mariculture (43%) and vessels (37%) are the main means of introduction in the western Mediterranean.

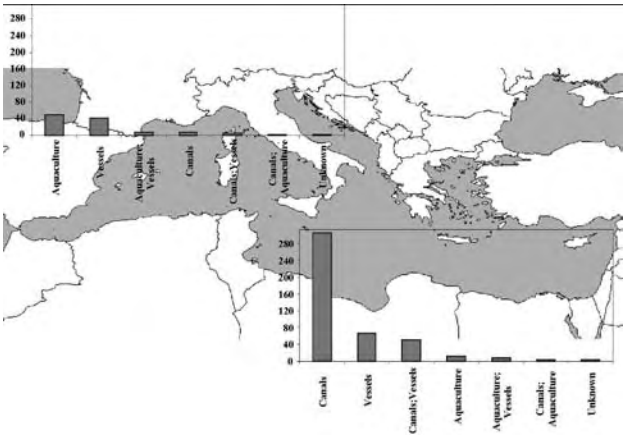


Figure 7.
Number of alien species in the easternmost (Egypt to Turkey) and westernmost (Spain and France) Mediterranean Sea, presented by their means of introduction.

Economic Impacts of Erythrean Aliens

Some Erythrean aliens have been exploited commercially almost as soon as they entered the Levant and their economic importance had been acknowledged early: "... les passages définitifs de ces espèces à travers la totalité du Canal présentent un résultat *économique* [sic] également très important..... pour les marchés palestiniens et syriens, un appoint non négligeable et particulièrement intéressant, par consequent, pour l'ensemble des populations de ces deux Pays" (Gruvel 1936: 228, 229).

An early Erythrean invader, the swimming crab *Portunus pelagicus* was on sale already by the early 1900s in the fish markets of the Levant. By mid-century the Erythrean fishes were an important part of the Levantine fisheries. Insofar as the Israeli fishing grounds were concerned, the bulk of the trawler catch from 1950 to 1955, was comprised of three species – the native red bream, *Pagellus erythrinus*, and hake, *Merluccius merluccius*, and the Erythrean yellow striped mullet, *Upeneus moluccensis*. In 1955 Israeli fishermen noticed greater numbers of the yellow striped mullet, and data assembled by the Sea Fisheries Research Station, Haifa, indicated that their percentage in the mullid catch rose to 20%, and to over 83% in early 1956, and was considered the most important commercial fish in the Israel trawl catches. Since the total mullid catch had remained constant, the yellow striped mullet had in the early 1950s almost completely replaced the Mediterranean species, the red mullet, *Mullus barbatus* in the trawl catch. In 1955, another Erythrean alien, the lizardfish, *Saurida undosquamis* became an important part of the trawl catch. The sudden increase in the populations of the lizardfish, the yellow striped mullet, the red soldierfish, and Erythrean penaeids was attributed to a rise of 1-1.5ºC in sea temperature during the winter months of 1955.

Examination of the Israeli fisheries statistics since the mid 1980s underscores the growing prominence of the Erythrean aliens. The Erythrean conch, *Conomurex persicus*, and on occasion the Erythrean spiny oyster, are served in seafood restaurants in Israel. Erythrean penaeid prawns make up most of the shrimp catches along the SE Levantine coasts. The Erythrean prawns, in particular *Marsupenaeus japonicus, Metapenaeus monoceros* and *Penaeus semisulcatus*, are highly prized. In the 1970s a shrimp fishery was developed in the Levant where a small fleet of coastal "mini" trawlers has specialized in shrimping. Nearly half of the trawl catches along the Levantine coast consist of Erythrean fish. The dominant fishes in the inshore fisheries (trammel-netting and hook-and-lining) are the siganids S. rivulatus and *S. luridus*, the obtuse barracuda *Sphyraena chrysotaenia*, and the Erythrean jack, *Alepes djedaba*. The above species, together with Sillago sihama and S. commerson, two species that underwent population explosion in the early 1980s, are common in purse-seine landings. In addition, two of the four species of Erythrean clupeids that established populations in the Levant – *Dussumieria elopsoides* and *Herklotsichthys punctatus*– are of importance in the inshore-pelagic fishery. The increasing exploitation of Erythrean aliens meant the shifting of the trawling grounds nearshore since their densest populations occur at depths up to 50m. The shoreward displacement of the fishing grounds coupled with the inexorable gain of Erythrean aliens raise the ratio of alien to native taxa in the Levantine trawl landings.

But together with the commercially exploitable species, the Erythrean invasion swept ashore the scyphozoan jellyfish, *Rhopilema nomadica*. Each summer since the mid 1980s huge swarms of the Erythrean jellyfish have appeared along the Levantine coast. These planktotrophic swarms, some stretching 100 km long, must play havoc with the limited resources of this oligotrophic sea, and when the shoals draw nearer shore, they adversely affect tourism, fisheries and coastal installations. As early as the summer of 1987 severe jellyfish envenomations requiring hospitalization had been reported in the medical literature: patients, mainly children, suffering various degrees of painful injuries to different parts of their bodies are treated each summer in the emergency wards in Israel. The annual swarming brings each year reports of envenomation victims suffering burning sensation, eurythema, papulovesicular and urticaria-like eruptions that may last weeks and even months after the event. Local municipalities report a decrease in holiday makers frequenting the beaches because of the public's concern over the painful stings inflicted by the jellyfish. The local newspapers and TV news report during the summer months the presence of jellyfish along the beaches. Coastal trawling and purse-seine fishing are disrupted for the duration of the swarming due to net clogging and inability to sort yield. Fishermen, especially purse seines, discard entire hauls due to the overwhelming presence of jellyfish in their nets. Jellyfish-blocked water intake pipes pose a threat to cooling systems of port-bound vessels and coastal power plants: in the summer of 2001 Israel Electric removed tons of jellyfish from its seawater intake pipes at its two largest power plants, at estimated costs of 50,000 US$.

The recent spread of the silver stripe blaasop, *Lagocephalus sceleratus*, and the striped catfish, *Plotosus lineatus*, pose severe health hazards. The blaasop's internal organs, and in particular the gonads during the spawning season, contain a strong paralytic neurotoxin. In the Suez City, on the Red Sea, eight fatalities from tetrodoxin poisoning associated with eating the fish have been described recently. Several cases of poisoning had been reported from Israel, but none proved fatal. However, recently, seven foreign seamen

who dined on the pufferfish were hospitalized. Injuries caused by the barbed and venomous first dorsal spine and pectoral spines of the striped catfish may produce pain levels requiring hospitalization – injuries have been reported by local professional and amateur fishermen (Galil, 2007).

Figure 8. Rhopilema nomadica. From top: a single specimen, Haifa Bay; by-catch of a trawler, Haifa Bay; welts caused by stings of R. nomadica; a shoal, Haifa Bay.

Ecological Impacts

Several cases of sudden decline in abundance concurrent with proliferation of aliens had been recorded off the Israeli coast and a single local extirpation of a native species. But even when populations of native Mediterranean species appear to have been wholly outcompeted or partially displaced from their habitat space by an alien, the causes cannot be disentangled from other potential factors such as the profound anthropogenic alteration of the marine ecosystem through habitat destruction, pollution and rising Mediterranean sea-water temperature.

Figure 9. top. Lagocephalus sceleratus (Gmelin, 1789), south coast of Turkey, photo. M. Bilecenoğu. Bottom. Plotosus lineatus (Thunberg, 1787), central coast of Israel, photo. S. Gayer.

The first Erythrean alien killifish, *Aphanius dispar*, was collected off Tel Aviv, Israel, in the winter of 1943/44. The last specimens of the native killifish, *A. fasciatus*, along the Israeli Mediterranean coast were collected in 1976. Naturally occurring hybrids of the two killifish species were described as common, and in some localities the populations comprise mostly hybrids. Within a generation an endemic genotype appears to be locally lost through hybridization, and A. *dispar* and its hybrids replaced *A. fasciatus* along the Mediterranean coast of Israel.

The two species of siganid fish, *Siganus rivulatus* and *S. luridus*, that entered the Mediterranean from the Red Sea through the Suez Canal, comprise one third of the fish biomass in rocky habitats along the Israeli coast. The siganids have altered the community structure and the native food web along the Levantine rocky infralittoral. They replaced native herbivorous fish, such as *Sarpa salpa* that had been abundant in trawl catches early in the 20th century. Prior to the invasion of the siganids, there were few native herbivorous fish and invertebrates and their role in the food web off the Levantine rocky habitats had been negligible. The siganids' grazing pressure on the intertidal rocky algae may have benefited the proliferation of an alien Erytrean mussel by providing suitable substrate for its settlement (see below). An analysis of the siganids' gut contents, in conjunction with the spatial and seasonal composition of the local algal community, showed that their diet has a significant impact on the structure of the local algal community: it seems that by feeding selectively they have nearly eradicated some of their preferred algae locally.

A small Erythrean mytilid mussel, *Brachidontes pharaonis*, was considered in the early 1970s 250 times rarer than the native mytilid *Mytilaster minimus* that formed dense '*Mytilaster* beds' on intertidal rocky ledges along the Israeli coastline. However, in the late 1990s a survey showed a rapid shift in dominance, with some dense populations of up to 300 specimens per 100 cm² on rocky platforms while *M. minimus* is only rarely encountered. The establishment of massive

beds of *Brachidontes* has had significant effects on the biota of the rocky intertidal. As the presence of algae is negatively correlated with the presence of the Erythrean mytilid, and is considered to impede the settlement of its postlarvae, a shift in habitat conditions that reduces algal cover might have benefited *Brachidontes*. As it happens, few herbivores occurred in the rocky shores of the south-eastern Levant prior to the arrival of the Erythrean siganid fish (see above). During high tide schools of (mostly young) siganids feed on the intertidal platforms. It is suggested that the siganids may have triggered the population increase by clearing the intertidal platform of algae. The displacement of the native mussel by the larger, thicker-shelled Erythrean mytilid may have changed predation patterns so that the population of the native whelk, *Stramonita haemastoma*, that were found to preferentially prey on *Brachidontes*, increased greatly.

An Erythrean limpet, *Cellana rota*, was first collected in the Mediterranean in 1961. A recent survey along the Mediterranean coast of Israel found that the alien limpet dominates the upper rocky littoral and along the southern coast of Israel it has already completely replaced the native limpet. Similarly, the Erythrean jewel box oyster, *Chama pacifica*, outnumbered its native congener, *C. gryphoides*. The native Mediterranean *cerithiid* gastropods, *Cerithium vulgatum* and *C. lividulum* ,common in shallow water along the coast of Israel until the 1970s, were supplanted by the Erythrean cerithiids *Cerithium scabridum* and *Rhinoclavis kochi*. The Erythrean dragonet, *Callionymus filamentosus* replaced the native callionymids *C. pusillus* and *C. risso* along the Levantine upper shelf. The Erythrean snapping shrimps *Alpheus inopinatus* and *A. audouini* are more common in the south-eastern Levantine rocky littoral than the native *A. dentipes.* The native penaeid prawn, *Melicertus kerathurus* was commonly caught by trawlers along the Levantine coastal shelf on sandy or sandy mud bottoms and supported a commercial fishery throughout the 1950s. It has since nearly disappeared and its habitat overrun by the Erythrean penaeid prawns.

Rising Temperatures and Thermophilic Aliens

The last decades of the 20th century saw pronounced thermal fluctuations and "a significant increase in the average temperature of the waters" in the Mediterranean (Francour *et al.,* 1994: 523), and a growing concern over the "tropicalization" of its fauna (Bianchi & Morri, 2003). The biological indicators comprised of temporal changes in seasonal migration patterns, a simultaneous increase in the numbers of native warm-water "vagrants" extending their range into the northern Tyrrhenian and Adriatic, some apparently forming self-sustaining populations, and the spread of thermophilic alien biota beyond the SE Levantine Basin. In point of fact, the appearance of six Erythrean fish species in the Adriatic was concurrent with a rise in the sea surface temperatures. Similarly, the timing of the initiation of a significant increase in the number of Erythrean aliens along the south-western Anatolian and the southern Aegean coasts was positively correlated with a more extensive inflow of the warm-water Asia Minor Current. Continuation of the warming trend would likely have a significant influence on the establishment and distribution of thermophilic species. Rising seawater temperature may change the pool of species which could establish themselves in the Mediterranean, enable the warm stenothermal species (native and alien) to expand beyond their present distributions, and may impact on a suite of population characteristics (reproduction, survival) that determines interspecific interactions, and, therefore, the dominance and prevalence patterns of both native and alien species, and provide the thermophilic aliens with a distinct advantage over the native Mediterranean biota.

Multiple stressors – pollution, eutrophication, destruction and fragmentation of habitats, fisheries overexploitation – are implicated in a web of linkages that caused the decline in the richness and diversity of native Mediterranean littoral ecosystem, but it is probably climate change that is causing its domination by thermophilic aliens.

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INVASIVE SPECIES INTERNATIONAL – A NEW VENTURE

Invasive species are a major factor in the decline of indigenous biodiversity worldwide. Their impacts are immense, insidious and increasing. On many islands invasive species have become the main agent of environmental change. Species declines and even extinctions have been attributed to the effects of invasions by alien species. New Zealand practitioners are widely acknowledged internationally as being at the "cutting edge" of invasive species management.

Landcare Research, New Zealand's leading terrestrial environmental research agency, has provided much of the research underpinning New Zealand's international reputation as a successful manager of invasive species. Our scientists work alongside staff from the Department of Conservation, regional government, territorial authorities, landowners and others, providing advice on improving invasive species management approaches and techniques and conducting research to underpin policies, strategies and new approaches.

Landcare Research specialists are providing support to a growing number of agencies managing invasive species internationally. The growing demand for technical advice and scientific support services for invasive species' eradications and management has led us to establish Invasive Species International – an international invasive species management programme focused on providing such services (www.isinz.org). ISI's current focus is on the Pacific, the Americas (North, Central & South), Japan, Australia and the southern ocean; on insular habitats; on terrestrial invasive species; and on prevention, eradication and control. ISI will continue to focus, backed by Landcare Research's experience, on facilitating advice (strategic planning, feasibility studies and project design), leveraging research (sound science to underpin invasive species management decisions) and reviewing projects (monitoring and evaluation for risk minimisation).

On behalf of The Nature Conservancy (TNC) and the Channel Islands National Park, ISI has recently helped determine the success of eradication of feral pigs on Santa Cruz Island, California, USA. Santa Cruz Island, a 25,000-ha reserve off the coast of Santa Barbara, is being restored by first removing a large population of non-native feral pigs. Between March 2005 and May 2006 just over 5 000 pigs were removed from the island and the hunting contractor could find no more despite extensive aerial and ground searching. The helicopters used for aerial hunting, the ground hunters and their dogs, and some feral pigs carried GPS devices so that search patterns and hunting or monitoring intensities could be plotted against the known numbers of pigs remaining in any area, and the home ranges of pigs estimated. ISI then developed and applied a Bayesian modelling framework using these data to answer four questions:

- What was the probability that no pigs remained given none were detected at the end of the hunting programme?
- How much additional monitoring would be needed to increase this probability to a level at which TNC was comfortable with the residual risk of being wrong?
- Where on the island should this additional monitoring be conducted?
- What monitoring method would be most effective for this additional effort?

Pig trap Photo Landcare Research

The analysis suggested eradication success was likely given the lack of detection of any pigs soon after May 2006, and also provided TNC with a spatially explicit prescription of how much extra monitoring was required to achieve their desired level of certainty before ending the hunting contract. Essentially, the level of comfort has to be determined by the managers, and in this case a high probability of success was required partly because of the high costs of reinstating the control and partly by the 'political' costs of falsely declaring success. This approach ISI developed for the Santa Cruz project has wider applications for both eradication projects and for some sustained control projects where eradication is not possible, e.g. where immigration is certain, but where the project objective is to reduce the pest population to zero and manage the immigration risks.

Increasingly whole islands are being considered as management units, and the management of pests is but a first step in the restoration of island ecosystems. ISI has been helping the New Caledonia Province Sud government decide whether the biota on Île Leprédour, ravage by fires and a suite of introduced animal and plant pests, could be restored by eradicating or managing all or some of these pests and weeds. ISI advice is that removal of deer, rabbits and rodents is the key to protecting and restoring the forest habitats, that such removals are feasible, and that the order in which eradications are attempted is critical – deer first, and then rabbits and rodents. Small scale removal trials are also recommended to check for possible exacerbation of weed and giant snail impacts once mammal pests are removed. If the eradications proceed, the Province Sud government will need to consider long term goals - while the proposed strategy would allow remnant forest patches to recover quickly, habitats now reduced to bare soil or rock will likely require active restoration by planting.

ISI is engaged in a number of other regional initiatives aimed at achieving invasive species management goals through cooperative activities with strategic partners. A growing number of organisations are promoting invasive species management as a core activity in resource management programmes. Robust project management using the most appropriate procedures coupled with for management-driven research to underpin decision making has been shown to improve the effectiveness and minimise the risks of invasive species management.

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ALIEN SNAILS AND SLUGS IMPORTED INTO HAWAII

Hawaii's ongoing problem with invasive species includes the import of snails and slugs. A recent publication (Cowie *et al*. 2008) documents the results of a survey of snails and slugs in the horticultural industry in Hawaii. It is the first documented baseline compilation of the distributions of all snail and slug species associated with the horticultural industry throughout the Hawaiian Islands. Many of the species found are widespread globally as a result of commerce, and include some of the common greenhouse species of more temperate regions.

The survey covered 40 nurseries on the six largest of the Hawaiian Islands. Alien snails and slugs were found in all 40 nurseries. In total, the survey discovered 29 alien species, including five that had never been reported in Hawaii before, as well as many species that were also found on particular islands on which they had never before been reported (Hayes *et al*., 2007). Most of the unwanted species were probably first imported to the island of Oahu, where the main port of entry (Honolulu) into the Hawaiian Islands is located, and then spread to the other islands.

Some of these species cause damage in the nurseries themselves. Some may cause shipments of nursery products to be rejected when they are inadvertently exported with them. Such an instance occurred when a species, previously unknown in Hawaii, was discovered on cut plants exported to the U.S. mainland where they were inspected (Cowie 1999). One species (identified as *Succinea tenella*), new to Hawaii, was even found infesting plants due to be sent to the small, uninhabited island of Kahoolawe as part of the restoration effort on that island. When these species are transported to and become established in new areas they may cause agricultural, horticultural and environmental problems. But, with notable exceptions including the giant African snail (*Achatina fulica*) and veronicellid slugs, for the most part, the nurseries are unaware of these other alien species in their midst.

The publication garnered significant local media interest, coincidentally with the discovery of numerous species of slugs (notably European species of *Arion* as yet not present in Hawaii) among the huge shipments of Christmas trees imported annually into Hawaii from the Pacific Northwest of the U.S., especially Oregon. In the past, all manner of alien species have been found among the trees, some of which have escaped into the wild, including wasps, lizards, frogs and beetles. While some suggest that such temperate

Succinea tenella on a horticultural nursery plant pot.

Chuong Tran searching for snails and slugs in a nursery.

climate species would not survive Hawaii's tropical climate, we have shown (Meyer and Cowie, in prep.) that temperate species of snails and slugs such as these can survive well at higher elevations in Hawaii, notably in places where many vegetables are grown, as well as in relatively intact native forest where the remnants of Hawaii's once highly diverse native snail fauna (Cowie 1995) are hanging on. Such forests are under threat from other species of alien, temperate climate slugs (Joe and Daehler 2008).

There is a clear need for greater awareness of these snails and slugs in the nursery industry, and among plant quarantine officials and monitoring agencies, such as the Hawaii and U.S. Departments of Agriculture, as well as a willingness to reject or destroy shipments that are found to be infested, in order to prevent further agricultural, horticultural and environmental impacts.

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EUROPEAN COMMISSION PRESENTS POLICY OPTIONS FOR FUTURE EU STRATEGY ON INVASIVE SPECIES

On 3 December 2008, the European Commission published its first ever Communication on invasive species. This Communication presents a series of policy options for developing a strategy to deal with invasive species that threaten European biodiversity. Feedback from stakeholders and other EU institutions will be taken into account by the Commission when finalising its proposal for an EU strategy in 2010.

Existing EU legislation and policies, such as those covering nature, plant and animal health, aquaculture, water and trade regulations, contain some provisions that contribute to invasive species prevention and control. However, at present there are no mechanisms to support harmonisation or consistency of approaches between neighbouring countries or countries in the same sub-region. There is no systematic formal requirement for risk analysis in connection with intentional introduction of non-native species that may affect biodiversity, and accidental or negligent introductions remain largely unregulated at both Member State and Community level. No unified system exists to monitor and control invasive species and their effects on European biodiversity. The fragmented measures in place are unlikely to make a substantial contribution to lowering the risks posed to European ecosystems.

Implementing effective policies at the scale of the EU raises unique challenges. The EU comprises 27 countries, mostly sharing land boundaries, and includes many isolated biodiversity-rich islands amongst its outermost regions and overseas territories. Few species are likely to be invasive throughout the EU but many can have impacts across borders and in shared river basins or regional seas.

Trade is an exclusive Community competence and once goods are placed on the Community market they are able to circulate freely. Addressing trade-related issues can only be done effectively at the EC's external frontier. The existence of the single market means that once an invasive species is brought into the territory of one Member State, either as a traded commodity or carried on a traded commodity, it can be dispersed rapidly throughout the EU. Given the way that these species become established and spread, measures taken by one Member State can be totally negated if neighbouring countries fail to take action or respond in an uncoordinated manner.

The EU institutions have expressed support for coordinated action at the highest political level and a commitment to an EU strategy is included in the EU's Action Plan (2006) to halt biodiversity loss by 2010 and beyond. The DAISIE[1] project, supported under the EU's Sixth Research Framework Programme, has identified 10,822 non-native species present in Europe. 10-15% of these are expected to have a negative economic or ecological impact.

In 2008, the Commission supported a preliminary impact assessment which assessed annual invasive species-related costs in Europe at between EUR 9 600 million and EUR 12 700 million per year[2]. This figure is undoubtedly an underestimate, as it is based on current expenditure to eradicate and control invasive species plus the documented cost of the economic impact. Given that many countries are only now starting to document and record costs and effects, the real figures for the financial costs involved will be considerably higher. The European Environment Commissioner Stavros Dimas noted at the launch of the Communication that "the ecological, economic and social consequences of the spread of invasive species for EU countries are serious and need a harmonised response."

The Commission also conducted an online public survey in March-May 2008, the results of which were used to inform the development of the Communication. The consultation attracted 880 replies (three quarters of them from individuals) and revealed widespread backing for action at EU level on invasive species:

- some 91% of respondents agreed on the urgent need to bring in new measures to prevent the spread of such organisms, with 85% agreeing on the importance of preventing the introduction of invasive species in the wild;
- an EU-wide early warning system would be welcomed by 90% of respondents, and 86% thought that Member States should be legally obliged to take action against the most harmful invasive species;
- most respondents (90%) considered that the lack of public awareness would constitute a barrier to launching more stringent policies, and that it was therefore important to raise the profile of the issue (77%).

The Communication of 3 December, "Towards an EU Strategy on Invasive Species" (COM(2008)789 final) proposes four options in order of increasing intensity and sets out their possible advantages and disadvantages. These options are not mutually exclusive and elements from the different options could be combined. The choice for one option or combined options will depend on the results of a prior financial impact analysis. They include:

- business as usual;
- maximising the use of existing legislation together with voluntary measures;

This would imply carrying out risk assessments using existing institutions and procedures such as the European Food Safety Authority. Member States would voluntarily make invasive species issues part of their border control function. A Europe-wide Early Warning and Information System based on existing activities[3] could also be set up [4]. The DAISIE inventory could be maintained and updated regularly. Species eradication plans would be developed and supported by national funds. Cross-sectoral stakeholder groups could be set up at appropriate levels to foster exchange of best practice, to develop targeted guidance and to help resolve conflicts of interest. Voluntary codes of conduct could be drawn up to encourage responsible behaviour by retailers, users and consumers.

This option would not require new legislation: assessment procedures and Member States' control and inspection procedures already exist. However, even with a proactive approach the coverage would not be complete, considerable legal uncertainty would remain, and the level of response to the threat of IS would be likely to vary considerably between Member States. A system which is built on voluntary undertakings by Member States and voluntary codes of conduct would only be as effective as the weakest link in a chain.

- Adaptation of existing legislation;

This option is similar to the preceding option in most respects, but would include amendments to existing legislation on plant/animal health to cover a broader range of potentially invasive organisms and extension of the list of 'ecological threat species' for which import and internal

movement are prohibited under the EU Wildlife Trade Regulation. Additional resources would need to be dedicated to invasive species in the assessment process and in the border control activities carried out by Member States.

The advantage of this approach is that while some legal uncertainties and gaps would be addressed, no new piece of legislation would be required. However, coverage of the invasive species problem would still not be comprehensive or complete and co-ordination would be a significant challenge.

- Comprehensive, dedicated EU legal instrument

This option would involve the setting up of a comprehensive, dedicated legal framework for tackling invasive species with independent procedures for assessment and intervention taking into account existing legislation. If it were considered desirable and cost effective, the technical aspects of the implementation could be centralized by a dedicated agency. Member States including the European Outermost Regions would be obliged to carry out controls at borders for invasive species and to exchange information. Mandatory monitoring and reporting procedures and efficient rapid response mechanisms might also be established. While it is possible to envisage some EU funding being dedicated to support eradication and control actions, Member States could also fund these actions directly.

This option would be the most effective in terms of control of invasive species. It would provide the greatest legal clarity whilst respecting the principle of proportionality. However, there would be administrative costs for the Member States and for the Commission as well as direct costs for economic operators.

The Communication also addresses key horizontal issues such as public awareness, research, funding and the EU's responsibility as a source of potentially invasive species towards third countries.

For background information, see:
http://ec.europa.eu/environment/nature/invasivealien/.

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[3] The IAS Inventory for Europe delivered by DAISIE see http://www.europe-aliens.org/index.jsp; NOBANIS (North European and Baltic Network on IAS); scientific online journals including "Aquatic Invasions" and "Biorisk".

[4] A feasibility study is currently being carried out by the European Environment Agency.

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SINCERE APOLOGIES

The image of an albatross chick used on page 20 of Aliens 26 was not credited.

The credit should have read *"Wounded albatross chick on Gough Island. Copyright Angel/Wanless"*. We wish to sincerely apologise to Ross Wanless and his wife that the caption was omitted from the image.

THE ROLE OF EUROPEAN RURAL DEVELOPMENT PLANS IN MANAGING INVASIVE ALIEN SPECIES

Rural Development Plans and Invasive Alien Species

It is well known that Invasive Alien Species (IAS) represent the greatest biological threats to biodiversity, second only to habitat destruction, due to their active contribution to the extinction of native species (Scalera & Zanghi, 2004).

Forestry and agriculture have always triggered biotic invasions, not only by actively contributing to their spread, but also (and above all) by easing their diffusion (Wittenberg and Cock, 2001). A correct land management can in fact lead to a flourishing countryside, suitable to a variety species, but, on the other hand, an heavy-exploitation of rural regions could lead to species depletion and spread of invasive organisms.

Soon after the UN "earth summit" held in Rio de Janeiro in 1992, the European Community developed its own biodiversity conservation strategy, where, for the first time IAS were addressed as a major threat to biodiversity and prevention or control measures are encouraged. Since then, the IAS problem has been dealt with by an increasing number of legal instruments, ranging from trade regulations to the "Habitat" and "Bird" directives. Nevertheless, before the new programme for the round 2007 – 2013, rural development plans have never been considered as active parts in solving the problem.

The European community biodiversity strategy (1998) deals with IAS, presenting them as a potential cause of irreversible impacts on ecosystems balance, forcing EU member states to: *"take measures pursuing to prevent that alien species cause detrimental effects on ecosystems, priority species or the habitats they depend on and establish measures to control, manage and, wherever possible remove the risks that they pose"*.

Despite this clear stance, in the communication IAS problems are never mentioned in relation to agricultural practices, even if a farmer's role in environment preservation is clearly stated, in fact, the strategy focuses on agriculture polluting potential and fails to remember its role as a reservoir of Invasive Species.

It is quite symptomatic that previous legislation on Rural Development (Council Regulation (EC) No 1257/1999) mentions the role of rural management in preserving biodiversity, encouraging instead *"....farming methods which are compatible with the protection of the environment, environmental planning in farming practice, intensification, the conservation of farmed environments of high Natural value and the upkeep of the landscape..."*.

With the new rural development policies for the period 2007 to 2013 the European Union recognizes the role of farmers and agricultural producers as custodians of rural biodiversity and commits them to the management of species richness in agricultural landscapes. The Council Regulation (EC) No. 1698/2005, setting up the essential rules governing rural development policy, clearly defines the issues that European agriculture should address. Among them, biodiversity conservation occupies a relevant role.

According to regulations, Regional and National Rural Development Plans (RDPs) are obliged to spend a part of their funding in measures aimed to improve the environment and the countryside by supporting land management, in order to achieve biodiversity conservation and promote other environmental services. The regulation put a very specific focus on forest biodiversity, which is seen as a means to reinforce the protective value of forests with respect to soil erosion, maintenance of water resources and water quality and to natural hazards.

Despite legislation, elusiveness in regarding the topic, RDPs have a specific role in European Strategy against IAS. They implement management actions at a very local level, tailoring them on the needs of a specific territorial portion. According to the *Drivers-Pressure-States-Impacts-Responses* (DPSIR) scheme applied to biological invasions; local management is in fact the last step in a chain of responses that summarize the institutional answer to various phases of invasive spread at different scales, from international to local (Hulme, 2007).

According to the European Strategy on Invasive Alien Species (Genovesi & Shine, 2003), the involvement of landowners and occupiers in carrying out mitigation procedures on their land is fundamental in order to achieve significant results. RDPs absolve this task and go even further, supporting habitat restoration by mean of agri-environment measures designed to support relief from invasions and supporting the use of native species in degraded ecosystems.

This paper reviews Rural Development Plans from some European countries, in order to understand where and how the IAS problem is addressed. Every measure or action directly aimed to alien species is taken in consideration. The purpose is to identify the weaknesses and the strengths of the measures adopted by the analysed countries in dealing with the nuisance and then to become a definition of the role of Rural Development programme in the European strategy against IAS.

The Survey

We analysed the RDPs from England, France, Finland, Italy and Spain: in all 38 out of 46 RDPs have specific measures aimed to IAS management, but the greater part of them are solely aimed to contrast the spread of invasive trees in productive forests. The 2007 – 2013 programme also provides financing for a series of interventions aimed to the removal of noxious alien weeds and shrubs, essentially in the framework of the agri-environment payments. Almost all of the RDPs somehow address the IAS problem; even those who don't provide specific measures dedicate at least few rows in the ex-ante valuation to presenting the problem. The only exception is constituted by the Finnish RDP, that never mentions the topic. The alien nuisance in non – forest habitat is addressed specifically anywhere it is considered a serious menace to biodiversity conservations: Islands, above all (Corsica, Reunion, Balears Islands) but also zones where it causes great economic losses (Emila Romagna) or threaten

an outstanding biodiversity (Friuli Venezia Gulia).
Here below a brief description of the actions undertaken against IAS in the analysed RDPs is provided.

England

In England, the Rural development plan is essentially devoted to the correction of wrong silvicultural choices made in the past , when large plantations with exotic trees have been made. Afforestation with non-native species is expressly forbidden and the substitution with native trees is financed with *ad hoc* measures. In order to control alien species, farmers are therefore encouraged, where requested, to set up additional planting with native broadleaved species.

Moreover, a significant portion of the resources belonging to the agri-environment payments are dedicated to the most valuable habitats and features which require complex management, and in particular, Natura 2000 sites. The programme in fact presents a list of measures to restore or recreate habitat by means of good agricultural practices. Some of these prescribe the removal of non-native plant species, especially in buffer strips, pond margins and field corners, i.e. all those areas that, although part of the agricultural landscape, are a valuable feature to biodiversity conservation. The control of invasive plant species is rewarded with €88 per ha.

Spain

Spanish RDPs are actually an exception compared to the European trend, which give a strong priority to forest biodiversity conservation: the greater part present measures specifically aimed to contrast the spread of invasive species in pastures and permanent meadows, in the framework of agri-environment payments. 8 regions out of 17 have a specific payment for that.

The financial aid for the removal varies greatly from region to region, ranging from the 30 €/ha granted to the manual removal of the invasive shrubs in Catalunya to €96,50 per ha in Castilla La Mancha. In La Roja the financial aid for the mechanical removal goes from €70 per ha to €336 per ha, depending on the type of the intervention.

Nevertheless, some regions connect invasive management to a specific habitat.

Castilla - La Mancha dedicates two measures to biodiversity conservation in wetlands and river banks, where invasive management is a recommended practice; in Murcia plantations with non–native tree species are forbidden in productive woodlands, while in Cantabria this prohibition concerns Natura 2000 forests; on the other hand, in Navarra the prohibition is extended to the entire regional farmland. Asturias and Communidad Valenciana extend IAS control to all the weak and endangered areas of the region. It is worth to note that the Asturias are the only region (among those analysed) whose RDP has a specific voice dedicated to the IAS management in the overall RDP balance sheet: €50115. The single intervention is remunerated 105 €/ha in non Natura 2000 areas and €235 per ha in Natura 2000 areas. Comunidad Valenciana's RDP, instead, sets the target of 700 ha of restored area in 5 years; invasive species removals are contemplated among restoration interventions. Balears Islands plan provides for an action specifically aimed to the removal of *carpobrotus edulis* in endangered or highly valuable sites (Natura 2000 areas and Sites of Communitarian Interest). The action belongs to the agro-environment payments. Andalucia and Castilla – La Mancha plans have a specific measure aimed to the sustainable management of olive growings which prescribe the removal of invasive species in order to preserve the intra-row grassy spaces.

France

The invasive nuisance is addressed in the framework of the environmental payments; a particular attention is paid to the Natura 2000 zones. Only Corsica and Reunion have a specific measure for the removal of IAS, which remunerates the commitment: in Corsica the removal of invasive species is ruled by Measure 225-1; it pays the monitoring activities and the costs of the removal (302,32 €/ha/year) for both animal and plants. Payments are eligible in Natura 2000 zones and in endangered areas (spotted by a dedicated cartography). In Reunion, Measure 214, Action 2 is dedicated to the control of invasive species, but it is especially aimed to the fight against alien vegetation in woodlands. The eradication is rewarded with €270,08 per ha per year. Corsica and reunion RDPS provide a list of invasive plant species. Four out of six plans have a specific measure for restoring marshes and river banks: they contemplate a special commitment which includes the removal of invasive plant species.

Italy

In Italy 14 Regions out of 21 have considered the IAS problem in stressing of their RDPs. The topic is essentially treated in relation to biodiversity conservation in productive forests. The main goal is the economic restoration of the old plantations by mean of their substitution with new ones composed exclusively by native species.

Lazio, Emilia Romagna and Friuli Venezia Giulia provide for invasive management in wetlands, ponds and marshes. Friuli RDP forbids the use of exotic species in the maintenance of hedges and small woods. It also disposes the removal of IAS, both animals and plants, in lakes and ponds. Sardegna is the only Italian region whose RDP recommends the removal of invasive alien plants in pastures, even if the RDP itself doesn't provide for a specific action in order to contrast their spread.

As a general rule, Italian programmes do not remunerate the removal of invasive species, unless it is not functional to a broader commitment, as the creation of hedges or the restoration of degraded woodlands. Veneto RDP, for instance, pays clearing operation in degraded forest €65 per 100 mq. Friuli Venezia Giulia, on the other hand, rewards the complete removal of invasive alien plants €200 per/ha.

It is worthy to note that Emilia Romagna is the only region, among those taken in consideration, where the removal (plants and animals) is completely refunded in protected areas, no matter how much the expenditure is. It should be noted that in Emilia biodiversity management in protected areas is ruled by a specific regional law.

Discussion and concluding remarks

It clearly appears, from the review of the RDPs, how strong is the tribute paid by the 2007-2013 programmes to the guidelines proposed by the European legislation: the management of forest biodiversity through the removal of the IAS is the most common action among the RDPs that deal with this nuisance. Fast growing alien trees are in fact powerful competitors and their spread could result in the strained development of valuable indigenous species, with the subsequent loss in the value of harvested timbers.

So, the removal of invasive trees is essentially motivated by economic causes, nevertheless, the removal of the nuisance brings plenty of ecological benefits: it reduces the danger of wildfire, provides a suitable habitat for indigenous animals and helps the forest to reach a stable climax status.

There's a general scarcity of measure specifically aimed to invasive management, as RDPs seem to privilege their inclusion in wider commitments, such as habitat restoration or good agricultural practices. It would be advisable, with the future checks of the rural development policy, to supply invasive management with an *ad-hoc* measure, in order to make IAS control economically desirable to the farmers. At present, considering IAS management as a commitment within other measure results in a lack of a rational assessment of the costs related to the removal itself and the subsequent miscalculation of the payment, as besides shown by the prize variability observed from region to region. The creation of a specific measure could moreover bring to a pan-European standardization of the control methods and to a comparability of the results.

The analysis of the rural programmes coming from various European countries has shown that regional RDPs are more likely to propose more effective actions in the fight against IAS than national ones. They in fact tailor the measure on a smaller portion of national territory, and, moreover, they are drawn on the basis of specific needs. For example: France has a single plan for the entire continental territory (the so called "Hexagone") which stretches between the north European oceanic climate and the mild tempered one of the Mediterranean sea. This results in neglecting Mediterranean pasture and permanent meadows, which instead occupy a relevant place in conservation strategy of Spanish regions and Sardegna.

Mediterranean grazing lands are essentially constituted by steppes that are facing a fast degradation process due to the progressive abandonment of farming activities. The preservation of these habitats is a priority for the EU (Beaufoy & Cooper, 2008), which classify them among the High Nature Value (HNV) areas. Their management is therefore entrusted to Rural Development Plans, it follows that a lack of prompt responses could results in a further habitat loss. Also olive groves provide a plenty of semi-Natural features essential in biodiversity preservation (Kabourakis, 1999) and are therefore included in the HNV inventory. Nevertheless, only two RDPs, both of them belonging to Spanish regions, contemplate an action aimed to the control of invasive plants in the olive orchards.

Given their nature of low-intensive farmland suitable in supporting a high level of biodiversity, HNV areas management is likely to involve trans-boundary actions. They could be therefore a good test-bench for link between local needs and the pan-European biodiversity preservation that RDPs will be called on to occupy.

It is not surprising, therefore, that the brand new document *"Towards an EU strategy on invasive species" (2008), arranged by the European commission complains the lack of a "... mechanism to support harmonisation or consistency of approaches between neighbouring countries or countries in the same sub-region".* RDPs could have a major role in correcting this tendency, as however evidenced by the measures concerning the fight against IA trees in European forests, characterized by an almost perfect identity of desired result and applied methods from English coniferous forests to degraded *Eucalyptus sp*. woodlands in Sicily. The principle applied to European forests could be extended to other trans-national habitats: Alpine grasslands, Mediterranean steppes and olive groves, for instance. Unfortunately, the plethora of measures detected with the review of the European RDPs reveals a lack of a coordinated response to the nuisance which goes beyond the Natural variety of management and ecological needs from region to region. A standardization of the measure addressed to trans-boundary habitats could be therefore advisable. In the perspective framework of a cooperative strategy against IAS, a more effective interaction between RDPs and the other European initiatives aimed to biodiversity conservation could be definitely desirable. Balears Island offers a positive example speaking of this (DG ENV 2008): here, in order to become to the eradication of *Carpobrotus edulis* from the island surface, the eradication of the weed in non agricultural land is demanded to the LIFE program, while RDP covers the removal in the farmlands.

The review revealed that only few RDPs set a goal for the measures against invasive species. It is surely a good practice to have a precise target to be achieved at the end of the 5-year programme, it doesn't matter whether it is expressed in maximum expenditure or in cleared hectares. It in fact avoids the waste of public resources and constitutes a reliable basis on which to define perspective impact and result indicators for the measure itself.

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DISPERSAL OF THE EUROPEAN HARE IN SOUTH AMERICA

Below is an updated distribution and dispersal rate of the European hare (Lepus europaeus Pallas, 1778) introduced in South America, with geo-referenced record localities. According to our results, the current geographic distribution of the European hare would cover practically all of Argentina and Chile, southeastern Peru, southwestern Bolivia, southeastern Paraguay, central part of southern Brazil, and all of Uruguay. During the process of invading new areas, the hare has occupied very dissimilar environments, from the bushy steppes and Andean deserts of Bolivia and Peru to the dry and humid forests and wooded savannahs of Paraguay and Brazil. This would explain the variation observed in the dispersal rates that varied between 10 and 37 km/year.

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Current distribution of the European hare in South America (the dotted area corresponds to the distribution until 1982)

6TH INTERNATIONAL MARINE BIOINVASIONS CONFERENCE

The Sixth International Conference on Marine Bioinvasions will be held at Portland State University (Oregon, USA) on 24-27 August 2009.

The conference will address the following:

- Ecological and evolutionary impacts, including potential shifts with global change
- Predicting the scale and diversity of invasions in the face of global change
- Measuring and predicting spread on regional and global scales
- Invasion patterns over time and space: does the past predict the future?
- Advances in detection, identification and tracking-to-origin capabilities
- Management, rapid response, eradication and restoration

Conference web site: www.clr.pdx.edu/mbic/

THE IUCN WORLD CONSERVATION CONGRESS, BARCELONA

The IUCN World Conservation Congress, held in Barcelona, between the 5th and 14th October 2008, brought together in one place around 8000 decision makers from Governments, NGOs, UN and academia from all over the world. The purpose of the congress was to debate, share and network, learn, commit, vote and decide ideas, action and solutions for a diverse and sustainable world.

The IUCN SSC Invasive Species Specialist Group (ISSG) hosted 4 events at the World Conservation Congress (WCC) and ISSG staff and members participated in many other events.
Several other invasive species related events were held: Stop Biodiversity Being Invaded: make the world aware of the threat of invasive species (hosted by the Invasives Initiative IUCN); CleanTrade: Threading the Needle of Invasive Species and Trade (hosted by the Global Invasive Species programme (GISP)).

Other highlights included the launch of a very impressive (in terms of functionality), updated World Database on Protected Areas (http://www.wdpa.org/). The WDPA is a joint venture of UNEP and IUCN.

Results of the most comprehensive assessment of the world's mammals were released. The results confirm an extinction crisis of the world's mammals, with almost one in four at risk of disappearing forever. A detailed review of the 2008 Red List of Threatened Species (http://www.iucn.org/about/work/programmes/species/red_list/review/) provides information on the state of the world's species including information on species susceptibility to climate change and development of biodiversity indicators.

Mick Clout, Professor of Conservation Ecology at the University of Auckland, SSC Steering Committee and outgoing Chair of the IUCN/SSC Invasive Species Specialist Group, was awarded the Sir Peter Scott Award for Conservation Merit, "in recognition of his unflagging and successful efforts to bring invasive alien species issues to the forefront of IUCN's work and his dedicated leadership of the Invasive Species Specialist Group for 15 years". Mick is the founding Chair of the IUCN SSC Invasive Species Specialist Group.

Mick Clout's primary research specialty is the ecology and behavior of vertebrates. Mick, after gaining a PhD from the University of Auckland in 1977, worked as a research scientist with the DSIR Ecology Division at Nelson. He joined DOC as Manager (Research) in 1989 and started working at the University of Auckland in 1993, where he extended his research interests into areas of biosecurity and invasive species management.

Mick has authored or co-authored about 150 publications, including 96 research papers. He is also the Chair of the New Zealand Biosecurity Ministerial Advisory Committee, and Director of the UOA Centre for Biodiversity and Biosecurity.

Mick was recently honoured with the New Zealand Charles Fleming Award and the Te Tohu Taiao Award for Ecological Excellence. The Charles Fleming Award recognizes those who have achieved distinction in the protection, maintenance, management, improvement or understanding of the environment, in particular the sustainable management of the New Zealand environment.

IUCN SSC Invasive Species Specialist Group

A TOOLKIT FOR THE ECONOMIC ANALYSIS OF INVASIVE SPECIES

L. Emerton and G. Howard

A Toolkit for the Economic Analysis of Invasive Species has been produced by the IUCN Global Invasive Species Programme and IUCN Global Economics & the Environment Programme.

The first part of the toolkit (Module 1) provides an introduction to invasive species as biological entities. It describes how and why they are important, as well as defining key terms and concepts in the science of invasion biology. Subsequent modules deal with the steps in economic analysis of invasive species: to understand the economic reasons why alien species are introduced, and become invasive (Module 2); establish the scope and level of the impacts of invasives and their management (Module 3); understand and define the economic costs and benefits of invasives (Module 4); value the economic effects of invasives on ecosystems and human wellbeing (Module 5); and support and inform decision-making and identify economic and financial instruments which can be used to address invasives (Module 6). The toolkit also contains a glossary of key scientific and economic terms, as well as a list of key readings on the economics of invasives.

English and French versions are available for download from:
http://www.gisp.org/publications/toolkit/index.asp
(Warning: large file: 22 Mb)

A TOOLKIT FOR DEVELOPING LEGAL AND INSTITUTIONAL FRAMEWORKS FOR INVASIVE ALIEN SPECIES

C. Shine

A toolkit for developing legal and institutional frameworks for invasive alien species, is published by the Global Invasive Species Programme.

Module 1 gives decision-makers an overview of what invasive alien species are and why they matter for economic as well as environmental reasons. It outlines how the international community approaches the issue and the implications for national governments, specifically as regards the collection of baseline information. Module 2 looks at the overall design of your legal and institutional framework, pointing up the need to mainstream invasive alien species across all concerned sectors and walking you through the process of conducting a legal review and choosing between different options for the design of national policies, coordination arrangements and laws. The next two modules address concrete legal requirements for implementing prevention (Module 3) and responding to biological invasions (Module 4). Module 5 focuses on getting results, in terms of effective oversight, enforcement and compliance mechanisms. It identifies the limitations of conventional approaches to liability in this area and provides an overview of the way in which economic and financial instruments can be used to tackle biological invasions. Lastly, Module 6 brings together the different components of international and regional cooperation and provides specific guidance on the interface between national regulations and the international trade regime. The toolkit also contains a list of key readings on policy and legal aspects of invasive alien species.

Available for download from:
http://www.gisp.org/publications/toolkit/index.asp
(Warning: large file: 13 Mb)

PIAKEY: IDENTIFICATION GUIDE TO INVASIVE ANTS OF THE PACIFIC ISLANDS (EDITION 2.0)

A new Lucid® interactive identification resource to Pacific invasive ants

CPHST is pleased to announce the release of its newest identification resource, *PIAkey: Identification Guide to Invasive Ants of the Pacific Islands.* The Pacific Invasive Ant Key (*PIAkey*) was developed through a collaboration among USDA/APHIS/PPQ – CPHST, University of California — Davis, New Zealand Ministry of Agriculture and Forestry, and the Quadrilateral Scientific Collaboration in Plant Biosecurity in response to the growing threat invasive ants pose to the environment, agriculture, public health and economy of the United States and Pacific Island nations. *PIAkey* has particular relevance to tropical and subtropical states such as Hawaii, Florida, and Texas which are currently under siege from a number of invasive ant species. Additionally, many of the ants included in *PIAkey* have been intercepted at ports across the country.

Although early detection strategies are the best hope for preventing future incursions, identification of ant species is a difficult undertaking for non-specialists. The interactive, media-rich and user-friendly features within *PIAkey* facilitate accurate determination of invasive ant species by quarantine staff, ecologists and conservationists. *PIAkey* includes an illustrated interactive key to 44 ant species in 20 genera, illustrated factsheets, video clips, an illustrated glossary, and links to additional resources for ant identification and biology. All illustrations are original artwork and include hundreds of high-resolution photographs of specimens and informative line-drawings of characters.

PIAkey was developed and released in Lucid version 3.4 software and uploaded to the Internet on December 11th, 2008 to support easy access by PPQ and our cooperators. *PIAkey* can be accessed at:

PIAkey is cross-platform and can be viewed and used on PCs or Macs. The key requires that your computer has Java Runtime Environment version 1.4.2 or greater installed; Lucid software is not necessary.

The primary tool offered by *PIAkey* is an interactive matrix-type key designed using Lucid3 software. Lucid matrix keys are more flexible than traditional paper-based dichotomous keys. For example, users can begin at multiple entry points, skip unknown characters, and find the most efficient path for identifying their specimens. *PIAkey* fully exploits Lucid multimedia capabilities with drawings, photographs and Html pages to aid the identification process. Each species is linked to its own factsheet.

The species factsheets consist of six tabbed sections: (1) A species synopsis, (2) a diagnostic chart illustrating identification characters, (3) comparison charts illustrating differences among similar species, (4) video clips of species behavior at food baits (where available), (5) an image gallery of specimen images and live images (where available), (5) a nomenclature section detailing the taxonomic history, and (6) links and references to additional literature and online resources.

The author of *PIAkey*: *Identification Guide to Invasive Ants of the Pacific Islands,* Eli Sarnat (UC Davis Entomology), would appreciate receiving any comments, suggestions or questions regarding *PIAkey*.

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PATHWAYS OF INVASION IN PROTECTED AREAS – INSIGHTS FROM THE KRUGER NATIONAL PARK, SOUTH AFRICA

Plant invasions affect virtually all ecosystems on earth, even those parcels of land set aside as protected areas and mandated with the conservation of biological diversity. Unfortunately, designating an area as protected does not mean that it is immune to the invasion of alien species. Protected areas are islands in a sea of different types and sources of propagules, including those of many non-native species. These propagules can enter into the protected areas in many ways, continuously bombarding what are often the last bastions of natural habitats.

Researchers from the Centre for Invasion Biology at Stellenbosch University and South African National Parks have been studying the dynamics of plant invasions of the largest protected area in South Africa, namely the Kruger National Park (KNP). Their efforts focus on determining the pathways of invasion and exploring the implications for long-term management of plant invasions in the park.

The most highly invaded area in the KNP is the riparian vegetation along the banks of most of the major rivers. Two main pathways appear to have contributed significantly to the current levels of invasion in the park, namely dispersal along rivers from the upper catchments of the main rivers (Fig. 1) and the use of alien species in ornamental gardens in the tourist camps and personnel villages (Fig. 2).

To determine the role of alien plant infestations in the upper catchments of the parks' rivers serving as a source of invasions, a framework was developed to evaluate the risk of spread of alien plants from different parts of the catchments into the KNP. The framework combines species- and landscape-level approaches and has five key components: (1) definition of the geographical area of interest (domain), (2) delineation of the domain into ecologically meaningful zones, (3) identification of the appropriate landscape units, (4) categorization of alien species and mapping of their distribution and abundance, and (5) definition of management options. The framework guides the determination of species distribution and abundance through successive, easily followed steps, providing the means for the assessment of areas of concern.

A total of 231 invasive alien plant species (of which 79 have potential to transform the character and form of the environment) were recorded in the study area. The KNP is facing increasing pressure from alien species in the upper regions of the drainage areas of neighbouring watersheds. On the basis of the climatic modelling, we showed that a large number of the most invasive riparian species have the ability to spread across the KNP should they be transported down the rivers. With this information, KNP managers can identify areas for proactive intervention, monitoring, and resource allocation. Even for a very large protected area such as the KNP, sustainable management of biodiversity will depend heavily on the response of land managers upstream managing alien plants.

Read more at:
http://www.blackwell-synergy.com/doi/abs/10.1111/j.1523-1739.2007.00673.x?prevSearch=allfield%3A%28Foxcroft%29]

Within the park, a detailed survey was done of alien plants in the 36 tourist camps, staff villages and other infrastructure over a four year period. 257 alien plant species were recorded, of which at least 85 taxa are well know invasive aliens in South Africa or elsewhere in the world. The most widespread and common species include: *Alpinia zerumbet* (shell ginger), *Bryophyllum daigremontianum* (good luck plant), *Bryophyllum delagoense* (chandelier plant/mother of millions), *Callisia repens* (striped creeping inch plant), *Nephrolepis exaltata* (sword fern/Boston fern), *Sphagneticola trilobata* (Singapore daisy), *Syngonium podophyllum* (goose-foot plant/ arrowhead-vine), *Tradescantia pallida* (purple wandering Jew/purpleheart), and *Tradescantia spathacea* (boat plant/ oyster plant). Introductions of ornamental plants were also responsible for what have become some of the most prominent alien plant problems in the park, including *Opuntia stricta* (sour prickly pear) and *Pistia stratiotes* (water lettuce).

Read more at :
http://www.springerlink.com/content/4t141834077205r7/?p=aa4d29827d55465d8be1304973940061&pi=0]

The identification of these two important conduits of invasion into the park has assisted in developing more holistic long-term strategies for the management of alien plants. In the case of the riparian invasions, the national Working for Water programme, which also has a number of projects in South African National Parks, carries out control measures along the most invaded rivers in the park. Using the information gained through the risk assessment process, this enabled the project to assess areas of increased importance, both in terms of alien species of priority and areas of priority, and then prioritise these for clearing operations. Internally, policy has been adopted that prohibits the use of alien plants as ornamental species, and regulates the phased removal of existing species. Currently all tourist camps and personnel villages have been cleared of alien plants at least once, with follow-up operations ongoing.

1a

Figure 1a. The Sabie River, which originates in the high lying areas to the west of the Kruger National Park, and flows through the southern region of the park and into Mozambique. 1b. Lantana camara, 1c. Chromolaena odorata and 1d. Senna occidentalis along the Sabie River.

Figure 2. Five commonly used alien ornamental plants, also found in the Kruger National park. (a) Bryophyllum delagoense (Eckl. & Zeyh.) Schinz. (= Kalanchoe delagoense, K. tubiflora) chandelier plant/mother of millions, (b) Zingiber zerumbet (L.) Sm. Zingiberaceae wild ginger/pinecone ginger, (c) Stachytarpheta mutabilis (Jacq.) Vahl Verbenaceae pink porterweed, (d) Pontederia cordata L. Pontederiaceae pontederia/pickerel weed, (e) Thevetia peruviana (Pers.) K. Schum. Apocynaceae yellow oleander.

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PUBLICATIONS

ALIEN SPECIES IN EUROPE BOOK AVAILABLE

The publication ***"Handbook of Alien Species in Europe"*** has been published under the auspices of the DAISIE (Delivering Alien Invasive Species Inventories for Europe) project and is the culmination of three years work by almost 200 scientists. It presents for the first time an up-to-date cross taxonomic assessment of the history, extent and impact of alien species in Europe.

Details can be found at:
http://www.springer.com/life+sci/ecology/book/978-1-4020-8279-5

The book will be available soon but individual chapters can now be purchased from:
http://www.springerlink.com/content/978-1-4020-8279-5

An example chapter, setting the scene of the DAISIE project and outlining the scope of the book is free to download from:
http://www.springer.com/life+sci/ecology/book/978-1-4020-8279-5?detailsPage=samplePages

We hope this work will be influential, not only in Europe but worldwide and perhaps sets a benchmark for the form regional assessments of alien species might take. Access to the data underlying the Handbook is available free from:
http://www.europe-aliens.org/

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NOTES

TOWARD AN EC STRATEGY ON IAS

At the very end of 2008, the European Commission has taken a major step forward to face the problem of biological invasions. In fact, on 3 December 2008 the EC has adopted a Communication presenting policy options for an EU Strategy on Invasive Species. In particular the Communication examines the evidence regarding the ecological, economical and social impact of invasive species in Europe, analyses the effectiveness of the current legal situation for tackling this problem and describes 4 possible options for a future EU strategy. In addition the Commission highlights measures that can be put in place immediately, including a Europe-wide early warning system to report on new and emerging species. Feedback from stakeholders and other EU Institutions will be taken into account by the Commission in selecting amongst those options and developing the EU Strategy on Invasive Species, planned for 2010.

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University of Auckland, Centre for Biodiversity and Biosecurity
The New Zealand Department of Conservation
National Biological Information Infrastructure (NBII), USA
Biosecurity New Zealand

IUCN SPECIES SURVIVAL COMMISSION ISSG Invasive Species Specialist Group