

Photo: Bob Jones

WORLD BANK FUNDS STUDY ON ECONOMIC IMPACTS

Despite widespread acknowledgement of the substantial and growing impacts of invasive species on economies and people's livelihoods, there have been relatively few comprehensive assessments of these aspects. Probably the most widely quoted figures are those published by David Pimental and colleagues, comprising estimates of the more direct costs of invasive pests and pathogens. One of these studies¹ compared economic and environmental losses due to invasive species in six countries from around the world, and concluded that these losses amount to some US\$314 billion per year.

Perrings² considered these costs in relation to the countries' agricultural GDP in 1999, and showed that the impact of invasive species is considerably more severe in developing than developed countries. While the damage caused by invasive species was equal to 53% of agricultural GDP in the USA, 31% in the UK and 48% in Australia, the same figures in

the developing countries of South Africa, India and Brazil were 96%, 78% and 112% respectively.

Of course, most people in developing countries are also heavily dependent on agriculture for their food security and livelihood, so their experience of the impacts of invasive species can be particularly harsh. In Africa, for example, agriculture supports 80% of the population in rural areas, and invasive pests such as the cassava mealybug and larger grain borer have had devastating effects on staple food supplies.

In an effort to deepen our understanding of the socio-economic impacts of invasive species, GISP – with support from the World Bank – recently commissioned in-depth case studies on seven key invasive species in Africa. Psi-Delta – a consultancy in Australia – was tasked with assessing the impact of *Salvinia molesta* and *Mimosa pigra* in Senegal and Zambia respectively, while the CSIR in South Africa will study

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FROM THE DESK OF THE DIRECTOR

Over the past few years there has been a substantial increase in the number of individuals, as well as national, regional, and global organisations, that have approached GISP and its partners for assistance in responding to invasive species.

This, we believe, is a clear reflection of a deepening understanding of the massive and growing threat posed by invasive species, not only to biodiversity in the aesthetic sense, but to the natural resources and ecosystem services which underpin our very existence. It is also a heart-warming acknowledgement of the central role that GISP has played – and we trust will continue to play – in the response to invasive species.

The assistance we have been able to provide has taken a variety of forms, but with a strong emphasis on building the capacity required to deal with invasives. For example, the exposure given to a community-based management project in a previous GISP newsletter has recently enabled the author to secure a place on a postgraduate course at an academic institution in the UK, where he will hopefully acquire additional skills to take back to his community. Similarly, we have been able to provide financial support to a PhD candidate working on aquatic invasives in Senegal. In collaboration with the UNEP Regional Seas Programme, we have been able to develop and deliver a training course on

the management of marine and coastal invasives. To date, the course has been presented in Tanzania (Nairobi Convention); Turkey (Black and Caspian Sea countries); and Panama (Northeast Pacific and Spanish-speaking Caribbean countries), and there are plans to roll it out in other regions in the future. These efforts are expected to culminate in a GEF-funded project aimed at building capacity in five pilot countries across five different regions.

At the global level, there has been growing collaboration between the CBD and GISP Secretariats, with GISP playing a leading role in the development of a Joint Global Work Programme on Invasive Species; the implementation of Target 10 of the GSPC; and the development of a global indicator on invasive species as one of the suite of indicators designed to measure progress towards the 2010 Biodiversity Target.

In light of these achievements, and the recent decision of the GISP Board to relocate the Secretariat to Nairobi, it is with considerable sadness that most of the current staff of the Secretariat will be saying goodbye – or at least *au revoir* – to GISP in the near future. As Director, I would like to acknowledge and thank all staff – past and present – of the Cape Town office for their hard work and dedication to our mission, not always under the easiest of circumstances.

Dr Lynn Jackson
Director: GISP Secretariat

SWEDEN PLEDGES SUPPORT TO GISP



With the prospect of the World Bank grant – which provided, amongst other things, core funding for the GISP Secretariat – coming to an end in December 2006, GISP launched the Ten Nations Initiative with a view to securing ongoing core support from a group of countries committed to addressing the threat posed by invasive species.

Brazil became the first country to join this initiative with an announcement at the CBD COP in Curitiba in March. More recently, Sweden – through SwedBio – has confirmed that they will be providing a substantial contribution for 2007–2008. This is based on the shared priorities and aims of the two programmes, in particular the links between biodiversity and livelihoods, and marine issues.



A Sida-funded programme at the Swedish Biodiversity Centre

Photo: Mississippi Department of Marine Resources



the larger grain borer (*Prostephanus truncates*), Nile tilapia (*Oreochromis niloticus*), water hyacinth (*Eichhornia crassipes*), parthenium weed (*Parthenium hysterophorus*) and chromolaena or Siam weed (*Chromolaena odorata*).

Each case study will cover:

- The biology of the species;
- Its current distribution and density in the selected geographic area, and the likelihood of it spreading to adjacent areas;
- The full range of impacts of the invasive species on the quality and quantity of goods and services normally provided by the land or water body concerned – for example, crop or fisheries yields, fuelwood, grazing etc;
- The cost and expected impact of available management strategies.

From the outset, it was acknowledged that there was unlikely to be adequate basic research on the economic impacts of these species in Africa. The approach, therefore, was to gather information on the same, or similar species, from locations where data were available, and then to extrapolate this to the study areas.

The case studies are now nearing completion and have already yielded some interesting insights into the potential impacts of the species concerned. For example, *Salvinia molesta*, which first appeared in the Senegal River delta in September 1999 and has since spread to many bodies of water and water basins in the vicinity, could be expected to have impacts on:

- **Tourism:** The lower reaches of the Senegal River flow through the Djoudj National Bird Park in Senegal and the Diawling National Park in Mauritania, on the opposite bank. As important sanctuaries for migratory water birds, both parks have been designated wetlands of international importance under the Ramsar Convention, and Djoudj National Bird Park is also a World Heritage Site.
- **Rice production:** Irrigation channels have allowed

salvinia to invade rice paddies adjacent to the Senegal River. The weed impedes production by competing with rice for space and nutrients and interfering with drainage. It also incurs costs to farmers, as it requires ongoing clearing.

- **Fishing:** Although fishing in the Senegal Delta is primarily subsistence-based – with fish being the primary source of protein in the diet of the local population – the area has become the main supplier to the major cities in the lower Senegal valley.

In dollar terms, the study indicates that the greatest impact on the local economy would be in the tourism sector – on the assumption that tourists would be less inclined to visit should migratory water birds be displaced by dense infestations of salvinia or other waterweeds. The cost – through direct loss of income to wildlife sanctuaries – was estimated at US\$268 per hectare per year. In contrast, subsistence rice farmers or fishermen could be expected to lose US\$19 and US\$12 per hectare respectively. However, the latter impacts are probably far more significant in terms of their implications for food security at the household level.

The detailed reports on these case studies will be available from GISP in early 2007.

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www.pdphoto.com

DNA Barcoding – a breakthrough for invasive species detection?

Picture this. An official from your country's border inspection agency finds a tiny egg mass on a carton of imported fruit. Aware that this is the second shipment from the same origin in a week, he considers the possibility that a potentially invasive insect pest has slipped into the country undetected. Before raising the alarm, however, he pops a few of the eggs into a handheld scanner with Internet connectivity – and is relieved to learn that the eggs belong to an innocuous species already found throughout the country.

Surprisingly, this scenario is not all that far-fetched. The development of portable DNA sequencing devices is considered a real possibility in the not too distant future. And combined with a comprehensive online database of DNA 'barcodes' from expert-identified voucher specimens to serve as a reference library, instant identification of species could soon be at anybody's fingertips.

Using DNA to identify species is nothing new, but DNA barcoding is making it faster, cheaper and more widely available to users. Indeed, it is already possible for border inspectors to send intercepted material to a lab by overnight mail, and have an identification back the next day.

The beauty of DNA barcoding is that it is based on a short, standardised gene region that can serve as an identification marker for nearly all animal groups. The region being used as the standard for higher animals is the mitochondrial cytochrome c oxidase subunit 1, known as *cox1* or COI. In most groups it is 648 nucleotide base pairs long – a very short sequence considering there are 3 billion base pairs in the human genome. COI doesn't evolve at a rate that makes it useful as a barcode region in certain animal groups and most plants, so alternative gene regions are being tested.

The technique's application for species identification hinges on the ability to match DNA barcodes of unidentified specimens to those of known species identified through traditional taxonomy, based on morphological characteristics. A public archive of barcode records is therefore being

The Consortium for the Barcode of Life, or CBOL, is an international initiative with a Secretariat Office at the Smithsonian Institution in Washington. Supported by the Alfred P. Sloan Foundation, CBOL has 130 Member Organisations from 40 countries on six continents, comprising natural history museums, herbaria, conservation and biodiversity organisations, NGOs, government agencies, and private companies. Its mission is to promote the development of barcoding as a tool for taxonomic research and as a global standard for species identification, and to catalyse barcoding activities that benefit science and society.

www.barcoding.si.edu

established in two main repositories of gene sequence data. The first is a global collaboration of three international sequence databases – GenBank in the United States, the European Molecular Biological Laboratory, and the DNA Data Bank of Japan. The other, based at the University of Guelph in Canada, is BOLD – the Barcode of Life Database¹ – which serves as an online workbench facilitating the collection, management, analysis and use of DNA

barcode data. A number of global campaigns have been initiated to populate these databases with barcode data. The All-Leps campaign, for example, is gathering barcodes for 25 000 species of Lepidoptera, focusing on the faunas of Australia, Canada, Costa Rica and the United States, and has already passed the 7 500 mark.

Access to barcode data of species from around the world has particular advantages for those involved in the detection and management of invasive species, which may have travelled from distant origins and – in the case of invertebrates – are often discovered as eggs or larvae that lack distinguishing morphological characters. A number of studies have already demonstrated the potential of DNA barcoding in identifying invasives.

■ In New Zealand, Armstrong and Ball² used the barcoding approach to reanalyse the DNA of tussock moth and fruit fly specimens intercepted at the country's border over the previous decade. Several species of these insect groups are major pests in other parts of the world, and although they have so far not established in New Zealand, they are considered high risk to its forestry and horticultural industries respectively.

The researchers compared species identifications using COI sequencing to those in the historical dataset based on other molecular identification methods, such as RFLP – or restriction fragment length polymorphisms, which uses diagnostic sets of "bands" on electrophoretic gels. They found that some of the tussock moth specimens – typically intercepted as egg masses on imported used vehicles – had

been diagnosed as the particularly destructive Asian gypsy moth, but were in fact other, less dangerous species. In the case of fruit flies, the COI method could not confidently discriminate between taxa within species complexes, such as the *Bactrocera dorsalis* complex, but was no less accurate than the RFLP method. The researchers concluded that DNA barcoding using COI offers “the best opportunity to date to form the foundation of a flexible and accurate identification system for invasive insect species”.

■ Scheffer et al.³ applied a DNA barcoding approach to identify species involved in outbreaks of invasive leafmining flies in the Philippines. These pests cause millions of dollars of damage to vegetable and flowers crops around the world, but identifying the culprit is difficult as the species are hard to tell apart. The research team analysed 258 specimens from 26 plant hosts, and compared the resulting COI sequences to those previously obtained from samples of the most destructive leafminers *Liriomyza huidobrensis*, *L. sativae* and *L. trifolii*, collected from around the world. Recent research has shown, however, that these species actually belong to species complexes containing morphologically cryptic lineages, and the team confirmed that in these instances DNA barcoding is likely to either overestimate or underestimate the number of species present. Nevertheless, they recognised the value of the technique, noting that it offers a powerful means of rapid identification for economically and medically important species that require an immediate response when discovered beyond their natural range.

■ American Museum of Natural History zoologists Siddall and Budinoff⁴ used DNA barcoding to show that leeches collected from Australia, New Zealand, South Africa and Hawaii were an invasive species from South America. All the leeches were found to have similar COI sequences and belong to the inappropriately named *Helobdella europaea*, probably introduced with common aquatic plant invaders such as water lettuce and salvinia. These leeches prey on aquatic invertebrates, rather than being bloodsuckers, and it is possible that their penchant for oligochaetes and molluscs could disrupt trophic interactions in invaded habitats.

■ DNA barcode data and their many potential uses are also adding impetus to the development of new technologies, for example DNA micro- and macro-arrays for identification of species in mixed samples such as ballast water. Researchers at the EPA's Molecular Ecology Research in Cincinnati are creating a reference library of DNA barcodes for both native and exotic species in the Great Lakes, so that they can screen ballast water samples for potential invaders.



Photo: Robb Fair

The use of DNA barcoding in recognising potential invaders is now being promoted by INBIPS – the International Network for the Barcoding of Invasive and Pest Species – an informal CBOL-initiated network of researchers, research institutes and government agencies working in the invasive species field.

The DNA barcoding technique is not without its critics, however. Traditional taxonomists, who use a variety of morphological traits to delineate species, quite rightly assert that relying on a single mitochondrial gene for species identification can be misleading^{3,5}. It is important, therefore, that all the available biological and non-biological information associated with a specimen is still considered alongside a DNA barcode in making an identification. Certainly, given the potential problems of using mitochondrial genes at the species boundaries in some groups, the idea of supplementing the mitochondrial DNA-based barcode with nuclear barcodes is being widely advocated^{5,6}.

Even so, the barcoding technique is likely to gain increasing acceptance as a frontline tool in the invasive species detection kit. As such, it can play a valuable role in preventing and controlling the spread of invasive species, which are a threat to economic, environmental and human health.

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The GISP Partnership Network in Action

Removing the 'Bush of Evil'



Photo: Mandy Noffke

SANBI's Urban Conservation Programme is implementing an unusual alien-clearing project on behalf of the City of Cape Town. While invasive acacias in the Cape Floristic Region are typically targeted for control in order to protect the region's rich biodiversity, conserve its scarce water resources, limit encroachment onto agricultural land or reduce the risk of fire, in this case the main motivation is to destroy a hotbed of crime.

Acacia saligna, commonly called Port Jackson, was introduced from Australia during the 1840s to stabilise the drift sands of the Cape Flats, to the east of central Cape Town. Today the plant covers vast areas of these windswept lowlands, forming dense thickets that serve as a hiding place for evil-doers.



Sickened by regular incidents of abduction, rape and murder on their doorstep, residents of the impoverished community of Delft called for the removal of the adjacent thickets, dubbed the 'Bush of Evil' by local media. The City of Cape Town responded to their cry for help, and asked SANBI to implement an alien-clearing project as part of the national government's Expanded Public Works Programme. As with all EPWP initiatives, the project provides direly needed job opportunities for members of the local community. Labour-intensive methods are being used to remove the invasive vegetation and encourage its replacement by indigenous fynbos, which in this area has a low profile, offering criminals little place to hide.

For more information, contact George Davis of SANBI's Urban Conservation Programme at davis@sanbi.org.



Photo: Mandy Noffke



Invasive plants take hold in tsunami's wake



In August 2006 – almost 20 months after the tsunami – the Sri Lankan chapter of IUCN-The World Conservation Union conducted a rapid assessment in the administrative district of Hambanthota, in the south-east of the country, to document environmental changes following the catastrophic event. The survey found that several invasive alien plant species have expanded their distribution in the coastal zone of this district. Their spread seems to have been facilitated by disturbances to natural coastal ecosystems created both by the tsunami as well as by the subsequent reconstruction and rehabilitation activities.

Prickly pear cactus (*Opuntia dillenii*), mesquite (*Prosopis juliflora*), lantana (*Lantana camara*) and Siam, or trifid, weed (*Chromolaena odorata*) were shown to be spreading in coastal scrublands, mangrove and seashore vegetation. The spread of the cactus has increased significantly, resulting in the loss and/or deterioration of nesting habitats of five species of globally threatened marine turtles that visit this area. It has also hindered the regeneration of coastal vegetation destroyed by the tsunami, such as *Pandanus odoratissimus*, *Scaevola*

takkada and *Spinifex littoreus*. In the case of mesquite, thick and impenetrable stands have established in tidal flats and salt marshes associated with coastal lagoons, depriving seasonally abundant migratory waders of feeding habitat.

Invasive water hyacinth (*Eichhornia crassipes*) and cattail (*Typha angustifolia*) were largely destroyed immediately after the tsunami – probably due to a rise in salinity levels – but have re-established in lagoons and estuaries, covering a much greater extent in some of the affected wetlands.

IUCN has initiated a management and control programme targeting prickly pear cactus and mesquite on a pilot scale, in a 2 ha area, where the synthetic hormone 2-4 D and the herbicide glyphosate were injected into plants after drilling holes in the stems. This method was shown to be successful in the eradication of mesquite, while the cactus has been controlled to a lesser extent. Plans are underway to expand this management programme to other seriously affected areas in the Hambanthota district.

Article and photo contributed by Channa Bambaradeniya, Coordinator of IUCN's Asia Regional Species Conservation Programme, e-mail cnb@iucnsl.org.



Unraveling the mysteries of mesquite in Kenya

CABI and a number of collaborators have launched a project in Kenya that seeks to improve understanding of the country's invasion by mesquite (*Prosopis* spp.) in order to enhance its management.



Native to arid and semi-arid regions of western Asia, Africa and the Americas, mesquite species have been widely introduced to other regions of the world due to their ability to survive in inhospitable locations and provide a source of fuel, timber, fodder and edible seedpods.

In Kenya, mesquite species were introduced – without any comprehensive risk assessment – to stop desertification and to provide fodder, charcoal and fuelwood in the dry zones of the country. The major introduction efforts in the 1980s were supported by local communities. However, mesquite species soon began spreading from their initial places of introduction and are now advancing rapidly, eliminating other species and threatening ecosystems, livestock and the livelihoods of thousands of people. For example, about 30 000 people are affected in Marigat Division in the Baringo District of the Rift Valley, where mesquite has been blamed for encroaching onto grazing land, blocking roads and watering points, drying up rivers and changing their courses, and causing the loss of teeth – and even death – in goats. This has led to a high-profile debate in the country, resulting in the Minister of Environment declaring mesquite a national disaster.

About half a dozen different mesquite species are reported to have been introduced to Kenya, but details on

the materials brought in – including their sources – have been poorly documented. The project will therefore attempt to unravel the links between mesquite species composition and invasiveness. This will help to ensure that taxonomic considerations are given due prominence in any mesquite management efforts, such as the introduction of biological control agents.

The spatial distribution of mesquite will be mapped, allowing the identification of areas that are susceptible to invasion but not yet infested. Management measures such as prevention of and early warning and rapid response to new infestations can then be implemented in these areas.

Surveys of arthropods and microorganisms associated with mesquite in Kenya will also be undertaken, to quantify how mesquite invasion impacts upon key biodiversity components. This work will also help in the identification of empty niches that could be filled by introduced biological control agents.

The project is a collaborative initiative between CABI, the University of Fribourg, Swiss Federal Institute of Technology (ETH) and the World Agroforestry Centre (ICRAF), with funding support from the Swiss Agency for Development and Cooperation (SDC) through the Swiss Centre for International Agriculture (ZIL). It is hoped that the knowledge generated from this project can help to reduce the rate of spread of this controversial tree in Kenya as well as other affected countries.

Information contributed by Walter Okello Ogutu
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Invasive Species Learning Networks – coming of age



Participants at the Eastern Invasives Learning Network meeting in Saratoga Springs, New York, enjoy a field trip on a fine fall day.

The Nature Conservancy is increasingly using learning networks as a tool for gathering and motivating staff, government partners and scientific experts to facilitate peer learning and develop lasting professional relationships. Based on experiences with freshwater and landscape conservation networks, the Conservancy initially developed two U.S. invasive species learning networks as a forum to discuss invasive species management plans for priority conservation areas.

The Eastern (U.S.) Invasives Learning Network – inaugurated in 2001 – held its sixth meeting in Saratoga Springs, New York, in October, on how to set measurable objectives and assess invasive species threats. The organizers benefited from a special focus on their region and the chance to solicit feedback and free labour on management issues during local field trips. This network is increasingly addressing policy-related issues as participants seek to expand the scale of their work beyond specific sites to broader political geographies.

Building on a history of aridlands grazing workshops, the Conservancy's Western (U.S.) Invasives Learning Network has met three times. While many of the planning and assessment methodologies apply to both U.S. networks, differences in the types of invasives, landscapes and geographic scales make division of the U.S. into Eastern and Western networks more manageable and effective. Given the predominant focus of these networks on terrestrial invasives, the Conservancy is developing a freshwater aquatics invasives learning network to address threats to North America's lakes, waterways and riparian areas.

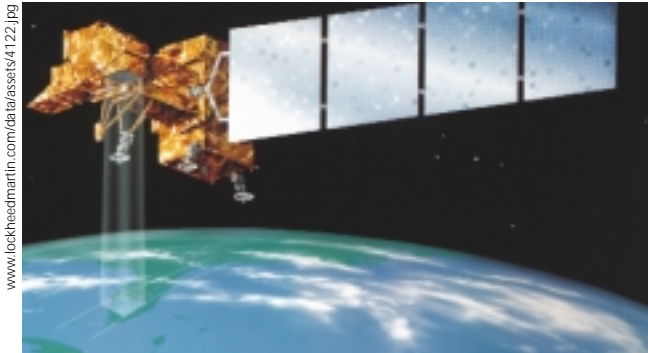
With annual or bi-annual meetings, participants can provide updates and receive feedback on implementation, gain insights from others' progress, and truly integrate adaptive management into their work. Learning networks are designed to facilitate:

- Networking, exchange of experiences and better understanding of shared challenges;
- Support for field and strategic projects by exploring similar models, developing cooperation and learning new techniques;
- Involvement of other regional invasive species programmes and partnerships;
- Identification of critical issues and expert exchange needs; and
- Development of action plans for priority issues.

Looking internationally, learning networks can be a cost-effective mechanism for building capacity and enhancing regional coordination from the ground up. The Pacific Invasives Learning Network, supported by a consortium of NGOs, governmental and intergovernmental agencies and universities, has generated so much interest that it doubled its intended size to include twelve island states and territories. The first set of six island teams met in May 2006, and the second team of six will meet in February 2007. Efforts are also underway to assess interest in and support for learning networks in the Caribbean, Central America and South America.

For more information, please contact Stas Burgiel at sburgiel@tnc.org.

An eye-in-the-sky approach to detecting invaders



Remote sensing technology, coupled with geographic information systems (GIS), is increasingly being used to detect invasive species and map their distribution. It is especially practical in areas that are inaccessible due to their remote location or harsh terrain, but is also a quick and cost-effective method for collecting information for management purposes.

At the 12th congress of the International Society for Photogrammetry and Remote Sensing in Istanbul, Turkey, in July 2004, Joshi et al¹ presented a comprehensive overview of the application of remote sensing and GIS technologies in mapping biological invasions. Reading their paper, it soon becomes clear how important it is to choose the right tool for the job. For example, data from multispectral imagers such as LANDSAT and SPOT, with ground resolution of 30 and 20 metres respectively, would generally only be useful for mapping invasive plants that form large stands². Recently, however, CSIRO scientists have been using images provided by the IKONOS satellite to map the spread of prickly acacia across Australia's northern grasslands³. These satellite images have a much higher resolution, allowing anything larger than one square meter to be detected, and since acacia trees have a canopy of up to 5 m, individual trees can be easily seen.

Going the high-tech, space-age route isn't always the best option though. In a study in South Africa, researchers compared the cost and accuracy of aerial photography, aerial videography and satellite imagery in identifying invasive

riparian in a small catchment, and found that 1:10 000 black and white aerial photographs came out tops⁴. The least cost-effective data sources were 1:10 000 colour aerial photographs and digital aerial photographs, while aerial videography and LANDSAT TM satellite imagery were the least accurate. By the same token, it might be overkill to use high spectral resolution imagery to map species that dominate entire ecosystems and form a monotypic dense canopy over massive areas¹, such as tamarisk and prosopis.

Choosing the appropriate spatial scale is essential, but timing is equally important, and to get this right, some knowledge of the life stages of the species under study is required. In New Zealand, for example, a LANDSAT image taken of the Wellington region in spring showed flowering gorse clearly enough for this invasive plant to be mapped as a separate scrub type⁵. Likewise, autumn colours have proved useful in mapping invasive Chinese tallow in the south-eastern United States with both aerial photography and hyperspectral image data from the Earth Observing 1 satellite's Hyperion sensor⁶.

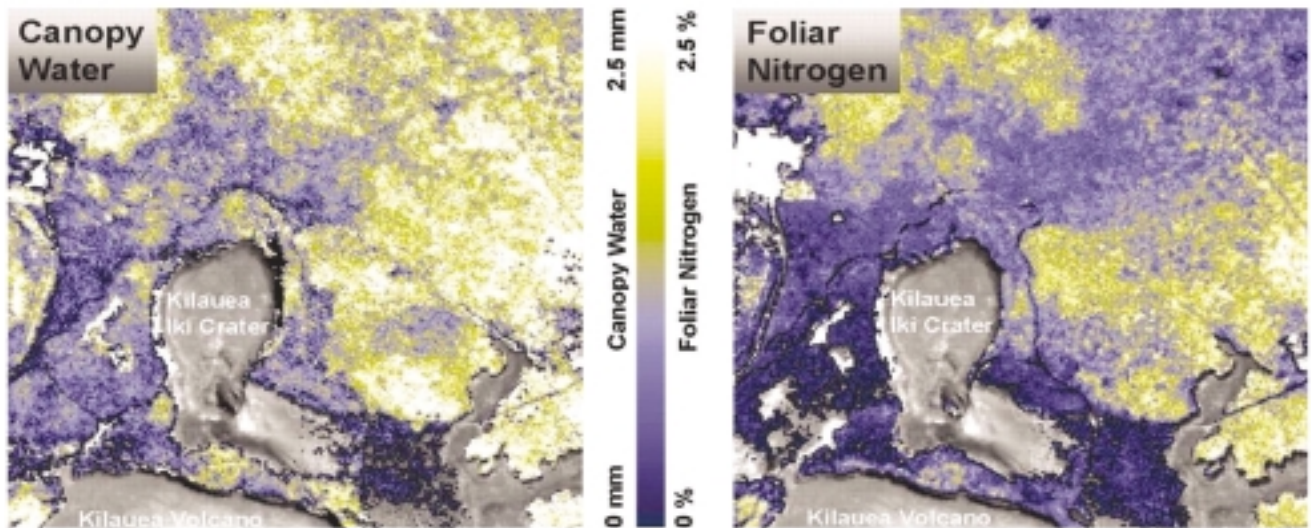
Remote sensing has even been used to detect and map invasive pests and pathogens affecting canopy plants, where the reflective properties of unhealthy plants could be differentiated from healthy specimens.

But as Joshi et al¹ pointed out, while most remote sensing studies on invasive species have focussed on canopy plants, some of the world's worst invasive plants are understorey species, such as chromolaena, lantana, giant mimosa and blackberry, for which straightforward application of remote sensing is almost impossible.

The authors concluded their paper on a positive note, however, suggesting that this limitation could potentially be overcome with a bit of expert knowledge and integration with other techniques. Their optimism proved well founded, as an innovative study in Hawaii has since succeeded in detecting an understorey invader lurking beneath the dense canopy of the rainforest (see opposite).

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Canopy water content and leaf nitrogen concentrations estimated at 9 x 9m spatial resolution in a 1 360-hectare area of Hawaii Volcanoes National Park, using airborne high-fidelity imaging spectroscopy and photon transport modelling.¹

Novel technique exposes understory invader

Conventional remote sensing techniques are only able to detect invasive plants that make up a substantial part of the vegetation canopy. A novel study in Hawaii, however, used airborne imaging spectroscopy to measure changes in canopy chemistry caused by invading plants – and revealed an understory species that was invading the rainforest of the Hawaii Volcanoes National Park.

Gregory Asner and Peter Vitousek¹, from California's Carnegie Institution and Stanford University respectively, used NASA's recently upgraded Airborne Visible and Infrared Imaging Spectrometer (AVIRIS) from a high-altitude aircraft to measure canopy water content and leaf nitrogen concentrations in a 1 360-hectare area near the summit of Kilauea Volcano, and complemented these remote measurements with extensive analyses in the field.

The rainforest canopy in this area is dominated by the native tree *Metrosideros polymorpha* – known locally as *oohi'a* – but is rapidly being invaded by the Canary Islands' firetree *Myrica faya*. The invader is a symbiotic nitrogen fixer and its leaves are much richer in nitrogen than its native neighbours, yielding a chemical 'fingerprint' that could be identified through imaging spectroscopy. Areas with high canopy water content and leaf nitrogen concentrations were found to be associated with well-established stands of firetree, while those with low water and nitrogen levels corresponded with native *oohi'a* distribution.

The scientists were in for a surprise, though, when the airborne measurements also identified large areas with low

foliar nitrogen content but relatively high canopy water content. When they visited these areas, they found that their understories were often dominated by Kahili ginger, *Hedychium gardnerianum*, an invasive herb which is widespread in Hawaii forests. The plant's leaves in fact have relatively high nitrogen levels, but airborne imaging spectroscopy is only sensitive to foliar nitrogen in the upper canopy. The *oohi'a* canopy above Kahili ginger actually appeared to have lower foliar nitrogen than uninvaded stands, which the scientists attributed to nitrogen uptake by the nutrient-demanding understory invader.

Apart from reducing the nitrogen available to the *oohi'a* trees sheltering it, and significantly increasing aboveground water content, Kahili ginger also inhibits the establishment of native plant species by creating dense shade and a tangled network of tubers and roots. Its partner-in-crime, the firetree, has increased canopy nitrogen more than four-fold in some places, and approximately doubled canopy nitrogen content over the 1 360-hectare area as a whole. By changing the rainforest's biogeochemistry in this way, these two invaders are likely to have a host of secondary impacts on the ecosystem, such as altered nutrient cycling rates.

This innovative remote sensing approach proved valuable not only in determining the distribution of two invasive species, but also the ecosystem-level effects of their invasion. Its wider application could enhance the role of remote sensing in ecosystem analysis and management.

Reference:

- Asner, GP & Vitousek, PM, 2005. Remote analysis of biological invasion and biogeochemical change. *Proceedings of the National Academy of Sciences of the United States of America*. Vol. 102 (12):4383-4386. Available for download from the online edition of 22 March 2005: www.pnas.org/content/vol102/issue12

The Galapagos gets mapped!

The Nature Conservancy has recently been involved in an interesting remote sensing and mapping project in the Galapagos Archipelago. Cartographers had last mapped the islands during the World War II era, and the old maps were inaccurate by more than 600 yards in some locations. Reliable base maps are important tools for conservation planning, and the TNC – having supported conservation in the Galapagos since 1984 – was eager to assist various stakeholders in their efforts to protect the islands' unique biodiversity.

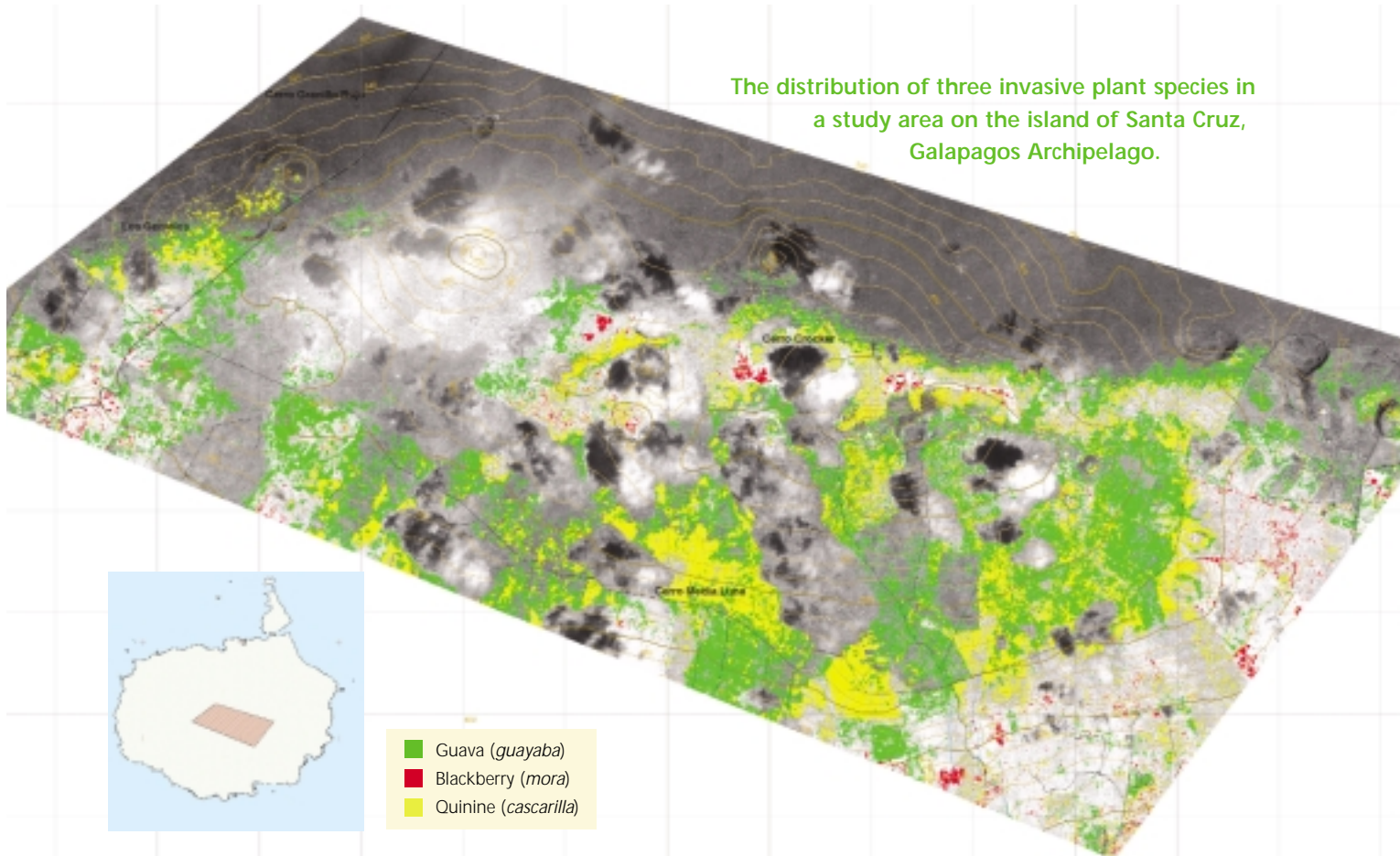
The Galapagos Cartography Project was therefore undertaken by TNC and Ecuador's Center for Integrated Surveying of Natural Resources by Remote Sensors (CLIRSEN), in collaboration with the Galapagos National Park, the University of North Carolina, the Navy's Oceanographic Institute (INOCAR), and the Military Geographic Institute of Ecuador. The project relied on a combination of remote sensing and ground-truthing – features that could be clearly identified in satellite images were georeferenced in the field using GPS – to produce a 1:50 000 topographical model as well as maps of

vegetation cover and land use for the entire archipelago.

With that done, the team honed in on invasive plants on five of the main islands – Santa Cruz, Santa Maria (Floreana), Isabela, San Cristobal and Santiago. High resolution satellite images from the QUICKBIRD and SPOT systems, multi-spectral aerial images from the CLIRSEN system, and radiometric measurements taken in the field were used to obtain the spectral characteristics of quinine (locally known as *cascarilla*), guava (*guayaba*), blackberry (*mora*) and rose apple (*pomarosa*).

These four plant species are some of the worst invaders on the islands, and all form large stands that are easy to see on satellite images. The study focussed in on areas that have been targeted for control efforts, with each of the resulting images showing a bird's-eye view of the plants' distribution. This methodology will undoubtedly be useful in monitoring invasions on the Galapagos islands, and providing a 'before and after' record of control efforts.

Information and images provided by Marcelo Guevara and Juan Carlos Gonzalez of The Nature Conservancy.



Counting the cost of an unwanted invader in Uganda



As our cover story suggests, good estimates of the economic impacts of invasive species are thin on the ground, particularly from the developing world. A recent study in Uganda is helping to address this gap.

The citronella grass *Cymbopogon nardus* was introduced to Uganda during the colonial era for erosion control. It has since become widespread in the south-west of the country, and appears to be spreading rapidly. The grass – known locally as *omuteete* – is a tussock-forming species that establishes naturally from seed. The leaves have a rough texture and contain aromatic oils that impart a bitter taste, making the grass unpalatable to grazers. The foliage grows rapidly and quickly builds into such thick, coarse vegetation that both humans and cattle find it difficult to walk in areas dominated by the grass.

Uganda is one of the four countries participating in the UNEP/GEF project *Removing Barriers to Invasive Plant Management in Africa*. The project contracted Casson Trenor of the Conservation Strategy Fund to lead a study on the impact of the grass in Kikatsi subcounty in western Uganda – part of an area known as the ‘cattle corridor’. The study consisted of interviews with a range of individuals from the affected community.

The investigation indicated that *Cymbopogon* has widespread and substantial negative financial impacts. The infestation has resulted in reductions in the average size of cattle herds of 30 - 50%. Meat quality is also affected, with cattle from *Cymbopogon*-infested areas fetching prices of 33 - 50% less than cattle from uninfested areas. Cattle feeding on *Cym-*

bopogon produce milk of lower quality and quantity (50 - 75% less milk per day) than healthy cattle of the same breed. Furthermore, cattle are more affected by ticks in *Cymbopogon*-infested areas, necessitating more frequent spraying.

Clearing *Cymbopogon* is a substantial undertaking. Initial removal of the grass costs between \$180 and \$230 per hectare, with ongoing expenses for follow-up clearing. This represents a major expenditure for cattle keepers, who as a result may be forced to sell cattle or land – and land prices in *Cymbopogon*-infested areas are on average 20% lower than in uninfested areas.

Other negative effects of *Cymbopogon* include increased cover for predators – threatening the existence of the nascent poultry industry – and the displacement of wild game from infested parklands to cleared pasturelands.

The individuals interviewed did identify some positive attributes of *Cymbopogon*. The grass can serve as thatching, bedding and traditional medicine, and is used in churning milk, weaving mats, making toothpaste and processing alcohol. However, when asked whether such uses were enough to warrant the presence of the grass in local pasturelands, every interviewee questioned responded in the negative. The data suggest that all services provided by the grass can be performed by a substitute resource.

The National Agricultural Research Organisation – the National Executing Agency for the African Barriers project in Uganda – is conducting trials on cost-effective measures to control *Cymbopogon* on a site and landscape level. Preliminary results indicate that the methods being investigated are cheaper and more effective than current practice, and if widely applied can result in substantial net savings for the farmer and hence the local and national economy.

The study described here provides the foundation for more extensive work to be undertaken during the African Barriers project to produce aggregate cost-benefit data for affected areas. Nevertheless, simple extrapolation of the current findings indicates that *Cymbopogon nardus* is costing the Ugandan economy millions of dollars. This information is now being used to alert decision-makers at the highest level of the threat posed by invasive species.

Article contributed by John Mauremootoo of CABI, e-mail J.MAUREMOOTOO@CABI.ORG.

Global Invasive News

UNITED STATES

Court tells EPA to control ballast water

In September a federal court in California ordered the US Environmental Protection Agency to start regulating ballast water discharges from ships within two years. The order follows the court's 2005 finding that the EPA had illegally exempted ballast water discharges from Clean Water Act permit requirements. The shipping industry – represented by a group called the Shipping Coalition – sided with the EPA and asked the federal court to postpone any new ballast water regulations until it could appeal the earlier ruling in a higher court. However, the judge refused this, and directed the EPA to take specific action by 30 September 2008, to ensure that shipping companies comply with the Clean Water Act and restrict the discharge of invasive species in ballast water. The ruling has national implications because it was handed down in federal court and involves a federal agency.

Six Great Lake states – New York, Michigan, Pennsylvania, Illinois, Minnesota and Wisconsin – joined the lawsuit brought by three environmental groups to persuade the court to require a federal permitting programme. The lack of effective federal action, combined with the negative impacts of invasive species, has led a number of states to develop their own ballast water regulations. The Michigan Legislature, for example, recently passed a law requiring shipping companies to obtain discharge permits before emptying ballast tanks in Michigan's portion of the Great Lakes.



The Great Lakes have become home to more than 180 exotic species, many of which were introduced in the ballast water of ocean freighters. The most notorious is the zebra mussel, which causes massive fouling problems at huge cost to industry.

Adapted from an article by Jeff Alexander in the Muskegon Chronicle, 20 September 2006.

SOUTH ATLANTIC ISLANDS

Oil rig on walkabout introduces aliens

An oil rig that went astray in the South Atlantic may have introduced potentially invasive species into the waters surrounding the island of Tristan da Cunha. The decommissioned rig was being towed from Brazil to Singapore via Cape Town, when bad weather necessitated that it be released on 30 April to avoid risk to both it and the tug. Ten days later the crew of the tug lost sight of the rig, and then briefly spotted it again a fortnight afterwards, almost 100 miles to the north-west of Tristan. Despite another tug joining the search, subsequently it could not be found – until Tristan islanders discovered it stranded in a remote bay on their south-east coast on 7 June.

Two weeks later a salvage tug arrived from Cape Town, but despite repeated attempts over the next month, the rig could not be refloated and was increasingly damaged by rough seas. When divers were sent down to make an inventory of marine life on the rig in mid-September, they recognised more than 30 non-native species, which might pose a threat to Tristan's biodiversity if they become established and spread.

At the time of writing at the end of November, island authorities had issued a permit for the platform to be scuttled in deep water, and plans were being made for a more powerful tug to remove it from the bay. According to the UK Foreign and Commonwealth Office, regular inspections will be carried out to determine whether any invasive species have been introduced to Tristan waters.

For more information, refer to www.tristandc.com/news/PXXI.php.



Photo: Paula Neill

CHILE

Codium compromises seaweed farming

The green alga *Codium fragile* ssp. *tomentosoides* is a recognised invader in marine ecosystems around the world, but a recent study in Chile showed that the species has dire implications for the future of seaweed farms there.

During 2005 codium was recorded at 34 of 123 sites sampled along the Chilean coast, with over half the invaded sites occurring at latitudes of 26-30°S. At 12 sites codium was present only on artificial structures, suggesting that these may act as corridors for the alga's dispersal into subtidal or intertidal habitats where it could not otherwise survive. The species is particularly abundant in mariculture farms cultivating the red agar-producing seaweed *Gracilaria chilensis* in Calderilla Bay, in northern Chile. In fact, during four months in which algae wet weights were measured at the site, the biomass of codium exceeded that of gracilaria. The invader's abundance peaks in summer and autumn, when sea temperatures rise, suggesting that it is likely to spread faster in the north of the country than in the cold waters down south.

Seaweed farmers must invest time and money in removing codium, which becomes entangled in gracilaria and then pulls it off the bottom before it can be harvested by divers. The authors of the study speculate that these costs threaten the future survival of gracilaria farms in northern Chile, unless steps are taken to control invading codium and prevent its spread.

For more information, refer to Neill et al. 2006. *Aquaculture* 259 (1-4): 202-210.



Photo: Geoffrey Hodgkin

SOUTH ATLANTIC ISLANDS

Fighting invasives in the far south

The European Commission has allocated £1.3 million for a three-year project to reduce the threat of invasive species in the South Atlantic. The project, which will be managed by the Royal Society for the Protection of Birds (RSPB), involves the islands of St Helena, the Falklands, Ascension, Tristan da Cunha and South Georgia.

The islands' rich wildlife attracts tourists from around the world, but invasive animals such as rats and mice are known to have caused significant reductions in the populations of some species, such as Cobb's wren, which is endemic to the Falklands. On Tristan da Cunha there is an annual "Ratting Day" to help keep rat numbers down.

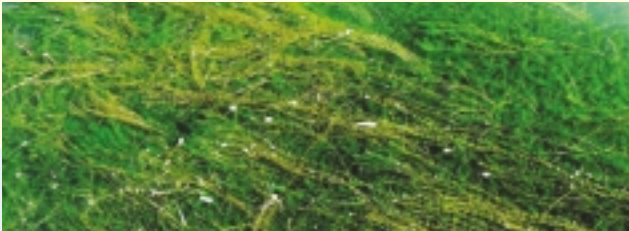
Invasive plants are also a concern – in the Falklands, particularly, more than a third of plant species growing there have been introduced since humans first came to the islands. Most have been beneficial for agriculture and public amenity, but some are invasive and alter the structure of natural vegetation, such as the spear thistle *Cirsium vulgare*, which forms dense, prickly thickets. The thistle is also considered a pest by farmers as it reduces the grazing value of pastures and impairs fleece quality.

For more information on the project, contact Clare Miller, RSPB South Atlantic Project Manager, at clare.miller@rspb.org.uk.



www.kuleuven-kortrijk.be

Photo: Julie Costree



SOUTH AFRICA

Uniting against hydrilla

While aquatic weeds such as water hyacinth, parrot's feather and red water fern continue to plague South Africa's waterbodies, a new threat lurks in Pongolopoort Dam, at Jozini in the far north of KwaZulu-Natal province.

The submersed weed *Hydrilla verticillata* was first discovered in the dam in 2002, but in the last year has spread so rapidly that it now covers some 680 ha of the 16 000 ha surface area. The dam is an important tourism destination because it offers the only tiger-fishing in South Africa, but areas with severe hydrilla infestations have now been designated no-entry zones to limit the weed's spread. An awareness campaign has also been initiated, and all vessels leaving the dam must be cleaned with a high-pressure hose to remove any plant pieces.

However, experience in the south-eastern United States, where hydrilla management and control costs millions of dollars each year, has shown that biological control offers the only sustainable solution in the long term. South Africa's Plant Protection Research Institute is now investigating the suitability of biocontrol agents released there – the most widely established of which is the leaf-mining fly *Hydrellia pakistanae* – for local use.

At the same time, two labs in Florida, USA, are conducting surveys aimed at finding new biocontrol agents to tackle the state's No. 1 aquatic weed. Since the native range of hydrilla is thought to include much of Asia, parts of northern Australia, and a few lakes in East/Central Africa, the University of Florida is collaborating with Kenya-based ICIPE to identify the weed's natural enemies in eastern Africa. The USDA-ARS Invasive Plant Research Lab in Fort Lauderdale, meanwhile, is working with the CSIRO in Australia on host-range testing of an aquatic moth from Sumatra, and with the Chinese Academy of Sciences on field specificity of an aquatic leaf beetle of the family Donaciinae.

For more information on hydrilla in South Africa, see *Plant Protection News* Nos. 67 & 68 on www.arc.agric.za. For a report on biocontrol research in Florida, refer to *Biocontrol News and Information* 27 (3), at www.pestscience.com.

CANARY ISLANDS

Soft borders pave way for invaders

The unique plant and animal life of the Canary Islands is being steadily overtaken by invasive species, which have been arriving in increasing numbers since border checkpoints within the European Union were abolished under the Schengen agreement a decade ago.

Government officials on these islands – about 115 km off Morocco's south-western coast – say that an invasive species enters their borders at the rate of once every 17 days, and that one turns into a plague capable of altering natural habitats and seriously threatening native species an average of once every six months. There are concerns that the invading plants and animals might seriously endanger the islands' endemic species, which occur naturally nowhere else on earth. About 4 000 endemics have been recorded on the Canary Islands, but it is estimated that invasive species have already cut the percentage of endemic plant species on the islands in half over the past 50 years.

Among the most notorious invasive species here is the Barbary ground squirrel, which has decimated plants on the island of Fuerteventura, and the highly aggressive Argentine ant, whose fast-growing colonies have expelled native ants and other insects from their natural habitats. The most recent threat comes from the red palm weevil, known locally as *picudo rojo*, which has been ravaging many of the islands' signature Canary palm trees for the past several months. The beetle appears to have spread from exotic palm trees that were recently brought into the islands.

Extracted from an article by Renwick McLean of The New York Times, 29 August 2006: www.nytimes.com



Photo: Javier de la Cruz

Global Invasive News

UNITED KINGDOM

Top 10 most unwanted

The UK's Environment Agency issued a list of the ten most unwanted invasive species in the country in August. Top of the list was the Japanese knotweed *Fallopia japonica*, originally introduced as an ornamental garden plant but now running amok along riverbanks and roadsides. The plant is causing such problems – damaging buildings and roads and choking native species – that it is illegal to plant it and there are strict rules on its removal. The agency recently released guidelines for land developers on how to get rid of the plant. The new approach is expected to halve the cost of clearing the weed, which can amount to £50 000 per acre.



www.kuleuven-kortrijk.be

American signal crayfish came second on the list of unwanted invaders. Introduced

in the 1970s for commercial farming, it brought with it the fungus that causes crayfish plague, which has decimated the native white-clawed crayfish. The invading crayfish also digs extensive burrow complexes in riverbanks, causing them to collapse.

Mink, which was introduced half a century ago for fur-farming, also made it onto the winners' podium. The animal now thrives in the wild, and has devastated the numbers of some native birds and small mammals.

The other species on the Top 10 list are the plants giant hogweed, floating pennywort, Himalayan balsam, Australian swamp stonecrop, parrot's feather, as well as the Chinese mitten crab and the topmouth gudgeon, a small freshwater fish from Asia.

Extracted from an article by Lewis Smith in The Times, 4 August 2006. www.timesonline.co.uk

CHINA

Golden apple snail linked to meningitis outbreak

An outbreak of meningitis in Beijing last summer was attributed to the golden apple snail – known in China as the Amazonian snail or *fushouluo*. The Beijing Friendship Hospital found the first case of meningitis on 24 June 2006, when a 34-year-old man presented with a violent headache and nausea after eating a dish of cold snail meat at the Shuguo Yanyi Restaurant. By mid September, 130 other cases had been reported in the city.

The snail is generally considered safe and nutritious to eat, and is served as a gourmet offering in many Chinese restaurants. If eaten raw or undercooked, however, the lungworm parasite *Angiostrongylus cantonensis*, which is hosted by the snail, can be transmitted to humans, causing eosinophilic meningitis. The disease has an average latency period of 10 days, during which time people may suffer from headache, fever, vomiting and a stiff neck.

The golden apple snail was first introduced into China's Guangdong Province as a food source in 1981, and by 1988 had infested 1 700 ha of rice. Today it is widespread throughout southern China, causing significant economic losses by damaging rice and other aquatic crops.

For more information, see www.worldwatch.org/node/4517.



www.freewebs.com/galassnie/afelschnecke.jpg

AUSTRALIA

Lorikeets labelled pests in Perth

The rainbow lorikeet's status as a pest species was recently extended by the government of Western Australia to include the city of Perth. The birds were previously declared pests in regional areas of the state, but are now *persona non grata* in Perth too following an increase in complaints from the general public. The birds are not only very noisy – continuously screeching while in flight or at a food source – but also damage backyard fruit crops, foul outdoor areas and vehicles with their droppings, and compete with other garden birds.

More seriously, though, the large flock that roosts at Perth Airport may pose a bird-strike risk to aircraft, while grape farmers in the Swan Valley have reported that the birds cause damage of up to 30% of table-grape crops. The birds also have a negative environmental impact as their aggressive behaviour in protecting their feeding and nesting resources could exclude native species, plus they have the potential to spread Psittacine beak and feather disease to wild and captive parrots.

Although it is unlikely that the rainbow lorikeet could be eradicated from Perth, efforts will be made to reduce its numbers at key locations. The population is thought to have originated from less than 10 captive birds kept near the University of Western Australia, and now numbers well over 10 000 birds.

For more information, refer to www.agric.wa.gov.au.

Photo: Pierre Pouliquin





NEW ZEALAND

Didymo down under

BioSecurity New Zealand is reinforcing its awareness campaign this summer in an effort to limit the spread of didymo on South Island and try to prevent it from reaching North Island. *Didymosphenia germinata* is a freshwater alga native to northern Europe and North America, but was discovered in Southland's Lower Waiau River in October 2004. It has since been found in numerous other streams and rivers on South Island, but as of the end of November 2006 it had not been detected on North Island.

Didymo is a diatom that cannot be seen with the naked eye until it forms large colonies. It attaches itself to stones, plants and other materials in flowing water, and can bloom to form thick brown mats that reduce habitat for freshwater fish, plants and invertebrates. The mats appear slimy – with the result that didymo has been dubbed 'rocksnott' by the local Kiwis – but feel like wet cotton wool to the touch.

BioSecurity New Zealand's 2006 budget for didymo response was NZ\$6.5 million, \$2 million of which was allocated for research. Six scientific studies were undertaken on didymo monitoring, detection, ecology, survival, control and the effects of didymo on trout. The awareness campaign is focusing on changing the behaviour of the public to minimise further spread of the invader. The 'Check, Clean, Dry' catchphrase is being promoted to encourage freshwater users to check for clumps of algae before leaving a waterway, clean all items with one of a number of recommended solutions, or dry them for 48 hours before entering another waterway.

For more information, refer to www.biosecurity.govt.nz/publications/biosecurity-magazine/issue-71/didymo.

AUSTRALIA

Conflict over coconut palms

Swaying coconut trees may symbolise the laid-back lifestyle of the tropics, but in northern Queensland they are the focus of an acrimonious public debate which has left locals anything but relaxed. Tourism operators say *Cocos nucifera* palms are essential to the state's tropical ambience, offering the promise of long lazy days spent swinging in hammocks, sipping cool drinks, and gazing out at the azure waters of the Coral Sea.

But conservation groups loathe the coconut palm, saying it is an invasive alien species that is encroaching on native vegetation and crowding out a narrow band of littoral rain forest – one of the rarest types of forest in the world. Some of its most vehement opponents have taken it upon themselves to conduct a covert campaign of sabotage, killing large trees by injecting poison into them, cutting down smaller trees and ripping out germinating nuts. Their guerrilla tactics have made them enemies in the local community, but are not strictly illegal, as the trees have no protected status.

Coconut palms were first planted in Australia by 19th-century pioneers and later spread along the remote coastline of northern Queensland by postwar settlers and, in the 1970s, bands of hippies.

Extracted from an article by Nick Squires of The Christian Science Monitor, 14 September 2006: www.csmonitor.com

FRENCH POLYNESIA

Sharpshooter comes under enemy attack

The glassy-winged sharpshooter (GWSS) was introduced to Tahiti in 1999 and now occurs in almost all neighbouring islands in the Society Island group, as well as some other islands in French Polynesia. Its extremely rapid spread was probably due to unregulated movement of plants bearing egg masses or nymphs between islands by plane and boat.

In Tahiti the insect reached densities far exceeding those in its native range in the southeastern USA or in invasive populations in California. At high densities this xylem-feeding cicadellid is a major nuisance because copious quantities of its watery excreta rain down from heavily infested trees, earning it the local name *mouche pisseuse* ('pissing fly'). Such high and continuous removal of xylem fluids by thousands of feeding nymphs and adults is thought to have had a detrimental impact on many plant species in French Polynesia. GWSS is suspected of retarding plant growth and causing declines in fruit production, especially in mangoes and other fruit trees. But the major concern for French Polynesia is the possibility that this pest could transmit the pathogenic bacterium *Xylella fastidiosa*, which potentially would have a disastrous impact on the agriculture and biodiversity of these isolated islands.

A biological control programme using the mymarid wasp *Gonatocerus ashmeadi*, which lays its eggs in GWSS eggs, was therefore approved in 2004. The first releases took place in Tahiti in May 2005, and by October the parasitoid had colonised the entire island, including high-elevation mountainous areas. Survey results indicate that it has had a catastrophic impact on GWSS populations, resulting in a decrease in the pest's abundance of more than 95%. Due to its success, the biological control programme will now be extended to all GWSS-infested islands in French Polynesia.

For more information, refer to *Biocontrol News and Information* 27 (3), at www.pestscience.com, or the biological control programme's website: <http://moorea.berkeley.edu/research/health/>.



Photo: 1999 The Regents of the University of California



www.esu.edu/~jlewett/cocos_nucifera.jpg



Seychelles turns spotlight on marine invaders

A high-profile campaign was held in the Seychelles during August 2006 to raise public awareness about the threats posed by marine invasive species, and to identify possible management solutions.

The campaign was the final component of a project initiated in 2004 by the IUCN, in partnership with the Seychelles Centre for Marine Research and Technology (SCMRT-MPA) and the Ministry of Environment and Natural Resources.

The Marine Introduced Species Project – funded by the Total Foundation – aimed to identify non-indigenous species in the Seychelles, enhance the capacity of staff and institutions involved in monitoring, and improve public knowledge about the impacts that introduced organisms may have on the country's ecology and economy.

A pilot survey was undertaken in April 2004, soon after the project began, to prepare for a large-scale assessment. In early 2005 a capacity-building workshop was held to train a team of local specialists in detection and monitoring procedures for introduced species in ports and coral reef environments.

A full baseline survey was then undertaken in May 2005 to identify native and introduced species in Port Victoria and Sainte Anne Marine Park. Eleven sites were sampled and species were sent to international taxonomic experts for identification. Of a total of 330 species, three were found to be introduced: the amphipods *Erichthonius braziliensis* and *Stenothoe valida* and the sponge *Mycale cf. cecilia*.

Although these species are not known to have caused any damage in the Seychelles to date, their presence indicates that the threat of invasive species is real and must be addressed.

The results of the baseline survey were disseminated during the August 2006 awareness campaign, which included presentations, exhibitions, radio shows, school competitions and the distribution of educational material. A stakeholder workshop was also held to discuss strategies for managing introduced species in the Seychelles.

Shortly afterwards, the Seychelles government designated an area within its territorial waters where visiting ships should exchange their ballast water before calling at Port Victoria. The site is about 80 miles from the port, and located in an area where currents should wash any discharged organisms out to sea. Clearly, the Marine Introduced Species Project has succeeded in raising awareness about invasive species, and the issue is being taken seriously by this idyllic island nation.



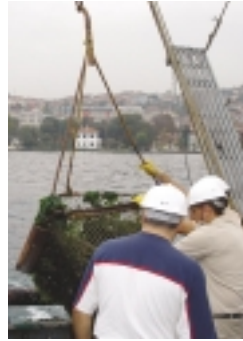
For more information, refer to www.iucn.org/themes/marine/invasives/coral-reefs/seychelles/campaign.htm

Training course targets marine invasives of the Black and Caspian Seas

The GISP/UNEP Regional Seas training course on the management of invasive species in marine and coastal environments was presented in October 2006 in Istanbul, Turkey. A total of 23 participants representing 10 countries from the regions of the Black and Caspian Seas attended the course, designed to help countries plan for and take action towards preventing and minimising the impacts of invasive marine species.

The training course was hosted by the Black Sea Commission with funding from UNEP Regional Seas Programme and the World Bank. International experts delivered the 8 modules of the course, which cover all aspects of managing invasive species in marine and coastal habitats, focussing on prevention but also including detection and incursion response strategies. Experts from within the region were invited to present case studies highlighting the issues around the significant invasions that have already taken place in the Black and Caspian Seas.

Amongst other serious introductions, both seas have suffered dramatically from the invasion of the comb jelly *Mnemiopsis leidyi*. Hundreds of millions of dollars in annual losses have been reported as a result of collapsing fisheries due to the proliferation of this plankton feeder. However, some recovery has been seen recently in the fisheries of the Black Sea due to the subsequent introduction of *Beroe ovata*, which preys on *Mnemiopsis*. Though accidental, this example of biocontrol has been highly effective in reducing *Mnemiopsis* populations, and no adverse effects on other species have been recorded. It is predicted that *Beroe* will eventually make its way to the Caspian Sea, where debate continues as to whether it will be as effective in reducing *Mnemiopsis* densities. Some authorities are advocating the intentional introduction of *Beroe* into the Caspian in order to facilitate this process.



LEFT: Benthic trawling revealed high densities of the invasive rapa whelk.

RIGHT: Istanbul's exotic skyline set the scene for the training course.

BELOW: A field trip on a research vessel allowed course participants to investigate invaded areas of the Bosphorus Straight first hand.

The participants of the training course had ample opportunity to debate this issue as a practical example of the strategies being presented. A field trip on a research vessel provided by the University of Istanbul allowed the participants the opportunity to investigate invaded areas of the Bosphorus Straight first hand. Bottom trawling revealed high densities of the predatory rapa whelk *Rapana venosa*, which has been an ecological pest in the Black Sea for many years due to its impact on benthic communities. The whelk has been kept in check to some degree by ongoing harvesting for export to foreign markets, and is considered an important resource for the area.

The course was generally well received by the participants, and has already led to interest in follow-up activities within some of the countries. Given the enclosed nature of the Black and Caspian Seas, regional cooperation must be an explicit goal of any further initiatives. The UNEP Regional Seas structure provides a functional vehicle through which such initiatives may be channelled, helping to overcome some of the contentious political issues that have stifled relations between certain countries. The training course was a successful first step in progressing towards regional agreement on strategies and actions that will ultimately protect these important sea areas.

Article and photos contributed by Adnan Awad, facilitator of the training course.

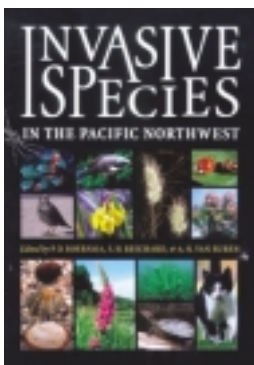


New Releases

NEW FROM NORTH AMERICA

Invasive Species in the Pacific Northwest

Edited by P. D. Boersma, S. H. Reichard, and A. N. Van Buren



Although this book focuses on the Pacific Northwest – covering 108 species of greatest concern in the region – it is sure to have broader appeal as a useful reference. It offers comprehensive profiles of both aquatic and terrestrial plant and animal invaders, not all of which are currently present in the Pacific Northwest.

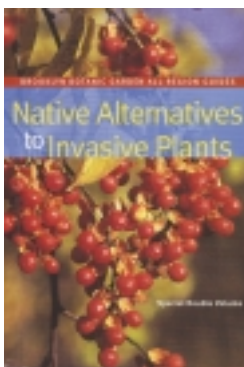
Each species is reviewed in a two-page spread that includes a physical description, colour photograph and range map, as well as summaries of its impact on native communities,

the main control and management methods, its life history and invading record.

The book also provides suggestions on individual action to help reduce the spread of invasive species; habitat preferences of Pacific Northwest invasive species; the World Conservation Union (IUCN) list of the world's 100 most invasive alien species; and a questionnaire designed to evaluate ecological impact and invasive potential.

The 276 page paperback is published by the University of Washington Press and can be ordered through the website www.washington.edu/uwpress, or from a number of online book stores. It sells for approximately \$30/£20. ISBN 0-295-98596-8

Native Alternatives to Invasive Plants



This colourful handbook provides a wealth of information on how ecologically sound approaches to gardening can help mitigate the impact of invasive plant species on local environments.

The latest in the All Region Guide series published by New York's Brooklyn Botanic Garden, the handbook is a follow-up to an earlier edition, *Invasive Plants: Weeds of the Global Garden*. Published in 1996, it showed that almost half the invasive plants degrading natural habitats in the

United States were intentionally introduced for horticultural use. During the intervening decade, the Garden has received many requests for a companion volume featuring ecologically safe alternatives to these invasive plants in a comprehensive format for easy use by gardeners.

The resulting handbook includes introductory sections on preventing plant invasions and the role of roadside managers, followed by an encyclopedia of trees, shrubs, vines, herbaceous plants and grasses. Each profile contains an "Attributes at a glance" box highlighting the plant's most attractive features, as well as hands-on growing tips.

The book can be ordered from a number of online book stores at a cost of \$9.95. ISBN 978-1-889538-74-7

GUIDE TO GOLDEN APPLE SNAILS

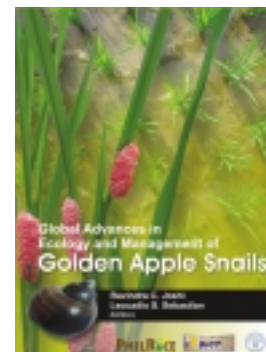
Global advances in the ecology and management of golden apple snails

Edited by Ravindra C. Joshi and Leocadio S. Sebastian

This book, published by the Philippine Rice Research Institute (PhilRice), represents the most complete reference to date on the Golden Apple Snail, considered one of the world's worst invasive alien species. Commonly known as GAS, it is a serious pest of rice in south-east Asia, and has also invaded Hawaii and the southern parts of the United States.

The book comprises some 500 pages organised into 24 chapters. These cover various aspects of snail taxonomy, impacts of GAS on aquatic ecosystems and farmers' health, and pesticide abuse and misuse, as well as country reports from GAS-invaded nations. There are also chapters dedicated to the utilisation of GAS for food and for controlling weeds in rice paddies, and practical information on management and control options.

The book costs US\$102 for developed countries and US\$52 for developing countries, and can be ordered direct from PhilRice: www.philrice.gov.ph. ISBN 978-971-9081-31-9



BIOCONTROL PROVES ITS WORTH

Economic impact assessment of Australian weed biological control

By AR Page and KL Lacey, AECgroup

The Cooperative Research Centre for Australian Weed Management – popularly known as Weeds CRC – has published a report from a recent study by AECgroup Ltd that reviewed all biocontrol programmes conducted in Australia since 1903 – and confirmed that this method of controlling invasive species provides a remarkably high return on investment.

Over the 103-year review period and across the 29 programmes assessed, the 14 successful biocontrol programmes delivered a total average annual benefit of \$95.3 million for an annual average investment of \$4.3 million – a benefit:cost ratio of 23:1. In the case of the top-ranked programme, however, involving 35 years of research on the biocontrol of prickly pear, the benefit:cost ratio soared to an outstanding 312:1. The total loss from unsuccessful programmes over 103 years was a comparatively low \$15 million.

Social and environmental benefits of the programmes were seldom able to be quantified in the economic study, although substantial value has been delivered by many of them in one of both of these areas.

The overall conclusion of the study was that although each individual programme may be regarded as high-risk, biocontrol has repeatedly delivered valuable and lasting solutions for an impressively low initial outlay, underlining the wisdom of investing in this kind of research.

The report is the 10th in the Technical Series published by Weeds CRC. The full 164-page report, or a reader-friendly summary, can be downloaded from the website: www.weeds.crc.org.au.



FOCUS ON FRUIT FLIES

Field Guide to the management of economically important Tephritid fruit flies in Africa

Edited by S Ekesi and MK Billah



The International Centre of Insect Physiology and Ecology (ICIPE) has published a comprehensive manual on the fruit flies of Africa. It provides information on the life cycle, damage symptoms, species composition, distribution and host plants of all the major fruit flies attacking the continent's fruits and vegetables. The purpose, tools and methodology for fruit fly monitoring and suppression, as well as host fruit processing and handling, are also comprehensively covered, with brief sections on safety precautions that should be taken.

The seven-chapter manual costs US\$30, and can be ordered via e-mail to affi@icipe.org.

GUIDELINES ON IAS IN AQUACULTURE

Alien Species in Aquaculture: considerations for responsible use

By Chad L Hewitt, Marnie L Campbell and Stephan Gollasch



This publication originated from the project, "Addressing alien species in aquaculture systems", jointly implemented by IUCN and the Chilean Government's fisheries division. The project aimed to reduce threats posed by alien species use in aquaculture systems by providing methodologies to assess the risks of invasions, and to control and manage escapes and invasions when they occur.

Aquaculture is one of the most important and fastest growing sectors within fisheries, but most facilities in the marine environment – particularly in developing countries – rely on alien species,

mainly to reduce costs by using readily available R&D outputs, and exploit existing markets.

In order to share the findings of the Chilean project, and also make other relevant information available to decision-makers, this guideline document was commissioned, with the authors requested to pay special attention to the needs of developing countries. The final product includes applicable international and regional agreements, three examples of national responses to this issue, and considerations to be taken into account when deciding whether to use alien species for aquaculture purposes.

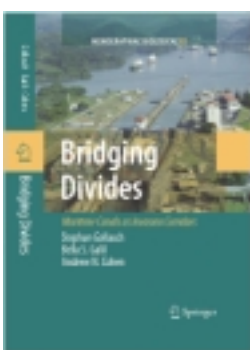
The document is available at www.iucn.org/dbtw-wpd/edocs/2006-036.pdf.

CANALS AS CORRIDORS

Bridging Divides: Maritime Canals as Invasion Corridors

By Stephan Gollasch, Bella S. Gallil & Andrew N. Cohen

Maritime canals remove natural barriers to the dispersal of marine organisms, providing novel opportunities for natural dispersal, as well as for shipping-mediated transport. This book is the first to assess the impacts of the world's three principal maritime canals – the Kiel, Panama and Suez – as invasion corridors for alien biota.



The three canals differ in their hydrological regimes, the types of biota they connect, and in their permeability to invasions.

The 315-page, hardcover book comprises Volume 83 of the *Monographiae Biologicae* series, published by Springer. It sells for approximately 120€ / \$160 and can be ordered direct from www.springer.com.

ISBN-10: 1-4020-5046-1 / ISBN-13: 978-1-4020-5046-6

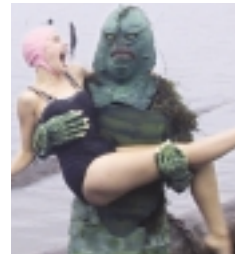
SWAMP THINGS AND WEED MONSTERS

Black Dog Productions have created three short public service announcements that raise awareness about invasive species in a fun and quirky way.

The first 'Knotweed', was originally created for the public outreach efforts of the Whatcom County Noxious Weed Board and the City of Bellingham, Washington, in the USA. The last frame of the 30-second video shows contact information for the Whatcom County initiative in controlling knotweed (*Polygonum* spp), but this can be personalised at a cost of \$125. Included in this price is a copy of the video in one of a number of formats (such as a quicktime file, dvd, mini-dv tape) that would be the highest quality and fully broadcast/cable ready for broadcasting stations or theatres, as well as a VHS review copy.

The second video 'Gillman', focuses on aquatic invasives, and was created for the Florida Fish & Wildlife Conservation Commission. Most recently, the team followed up with 'Rush skeletonweed', on the menacing *Chondrilla juncea*.

All three productions can be downloaded from the website of The Nature Conservancy's Global Invasive Species Initiative as 3-4 MB mp4 files, and viewed in Quicktime version 6 or later. See <http://tncweeds.ucdavis.edu/outreach.html#knotweed>.



LATEST GISP BROCHURES

In order to gain a better understanding on the true socio-economic impact of invasive species, GISP recently commissioned research into the effects of invasive species infestations on the livelihoods of poor, rural communities. Most studies on economic impacts of invasives have been undertaken at the macro-economic level, but within countries it is generally rural communities that are most at risk, as their livelihoods are almost solely based on agriculture, forestry and fisheries. This is particularly so in developing countries, where the majority of rural people are poor and heavily dependent on biodiversity-based products for food, fuel and construction material.

A 16-page brochure *Invasive Species and Poverty: exploring the links* summarises the main findings of this research, as well as other supporting information.

GISP is also engaged in a joint work programme with the UNEP Regional Seas Programme, for which it is conducting various needs analyses and running training courses on marine and coastal invasive species. The brochure *Invasive Alien Species – a growing threat in Regional Seas* aims to raise awareness about the issue through Regional Seas programmes around the world, and outlines initiatives already being taken in some of the programmes to address this threat.

Both brochures can be downloaded as PDF files from the GISP webpage: www.gisp.org/publications/brochures.index.asp



People against invasives



Geoffrey Howard

As Regional Programme Co-ordinator for IUCN in Eastern Africa for more than a decade, Geoffrey Howard is one of the stalwarts of the global conservation movement. In recent years – with the worldwide recognition that biological invasions pose one of the greatest threats to bio-

diversity – his efforts have increasingly been directed at invasive species prevention and management. Today Geoffrey is the IUCN Secretariat's focal point for invasive species issues, and its alternate representative on the GISP Board.

Geoffrey was born and brought up in Adelaide, Australia, where he obtained his PhD in veterinary parasitology and ecology related to sheep. In 1973 – wanting to expand his horizons “beyond kangaroos and sheep” – he relocated to Africa to take up a zoology lecturing position at the University of Zambia in Lusaka. He remained at the university until 1989, working his way up the ranks of academia, and then spent a year as an international consultant specialising in wetland research and training. He joined the IUCN in Nairobi in 1991, serving as Regional Wetlands Coordinator for Eastern Africa for many years, all the while maintaining his links to academia as an honorary lecturer, thesis supervisor and external examiner.

Geoffrey has an impressive list of publications to his name, amongst them the booklet, *Alien invasive species in Africa's wetlands: some threats and solutions*, which he co-authored with Susan Matindi. In his current position he has overall responsibility for the production of a variety of work plans and progress reports for IUCN's Eastern Africa programme, which encompasses activities in 10 countries in East Africa, the Horn of Africa and the Western Indian Ocean – all of them affected by invasive species in either terrestrial, freshwater or marine systems.

When he manages to find a break in his busy schedule, Geoffrey takes to the skies in any available small aircraft, which affords him a bird's-eye view of the insidious spread of invasive species across the African landscape. Luckily, it also gets him close enough to the clouds to remind him that most have a silver lining, and he remains optimistic that the battle against invasive species can be won.



Moses Kairo

Moses Kairo has years of experience in invasive species work, and the GISP partnership is fortunate to be able to draw on his wealth of expertise, having appointed him a member of its Technical Advisory Committee.

Although his roots are in Africa, Moses is currently based

in Tallahassee, Florida, where he is Director of the Center for Biological Control – a joint partnership between the Florida Agricultural and Mechanical University (FAMU) and the USDA Agricultural Research Service (ARS) and Animal and Plant Health Inspection Service (APHIS). He is also an Associate Professor of Entomology in FAMU's College of Engineering Sciences, Technology and Agriculture, so as well as being responsible for the administration and scientific leadership of the Center, he has research and teaching duties.

His own student days – back in the early 1980s – were spent at the University of Nairobi. After graduating he was employed as an entomologist at the Kenya Agricultural Research Institute, where his work focussed on coffee IPM. He subsequently completed an MSc in this field at Imperial College, London, and then returned to Kenya to conduct research on corn pests. During this time he was also involved in the first-ever efforts to release biological control agents against salvinia on Lake Naivasha.

In 1991 he joined CAB International in the UK, working on biological control projects on invasive aphid pests in Africa and the Middle East while also doing a PhD through the University of London. He transferred to CABI's Caribbean and Latin America Regional Center (CLARC) in 1996 to lead a 15 nation regional project against the invasive pink hibiscus mealybug, which was rapidly spreading through the Caribbean and causing widespread devastation. As Director of CLARC, Trinidad remained his base of operations for nearly a decade, during which time he provided leadership to CABI's development activities in the Caribbean and Latin America region, including several projects on invasives. He continues to be actively involved in the region as a member of the inter-agency Caribbean Invasive Species Working Group.

Moses is married to Maryann, and they have two children – Margaret, 18, and Johann, 12. When time allows, Moses enjoys walking and playing table tennis, but perhaps most of all, just spending time with his family.

IAS event highlights:

RATS, HUMANS & THEIR IMPACTS ON ISLANDS

The University of Hawaii will host the interdisciplinary conference "Rats, Humans and their Impacts on Islands: Integrating Historical and Contemporary Ecology", from 27 to 31 March 2007. The human colonisation of islands has dramatically transformed island environments through forest clearing, use of fire, and the introduction of exotic species. Invasive rats have had particularly severe impacts on native flora and fauna of some islands, and an understanding of their role in environmental transformations can be better served by bringing together ecologists, paleoecologists and archaeologists.

14TH EUROPEAN WEED RESEARCH SOCIETY SYMPOSIUM

The European Weed Research Society (EWRS) is an international organisation that promotes and coordinates scientific research into all aspects of weed science. Its 14th symposium will be held in Hamar, Norway between 18 and 21 June 2007, and will include sessions on:

- Invasive plants and biological weed control
- Chemical weed management and intelligent technologies
- Crop-weed interactions and non-chemical methods
- Weed temporal and spatial dynamics
- Herbicide resistance in weeds and crops
- Weed biology
- Biodiversity and weed communities.

Overview of upcoming IAS events

DATE	EVENT	WHERE	CONTACT DETAILS
2007			
30-31 January	Wildlife & Invasive Plants: Finding Common Ground to Protect Ecological Diversity	Monterey, California, USA	http://www.weedcenter.org/calendar/wildlifeinvasive%20plant%20flyer.pdf
5-8 February	Weed Science Society of America Annual Meeting	San Antonio, Texas, USA	http://www.wssa.net/society/2007brochure.pdf
26-28 February	CBD Third Coordination Meeting for Governments and Organisations implementing and/or funding Biosafety Capacity-building Activities	Lusaka, Zambia	http://www.biodiv.org/default.shtml
26 Feb – 2 Mar	World Aquaculture Society: Aquaculture 2007	San Antonio, Texas, USA	http://www.was.org/meetings/WasMeetings.asp
13-15 March	Western Society of Weed Science Annual Meeting	Portland, Oregon, USA	http://www.wsweedscience.org/
20-22 March	9th Annual Southeast Exotic Pest Plant Conference - Pulling Together: Cooperation to Combat Invasive Plants	Athens, Georgia, USA	http://www.gaeppc.org/meeting07.html
26-30 March	IPPC Commission on Phytosanitary Measures – 2nd Session	Rome, Italy	http://www.ippc.int/IPPC/En/default.htm
27-31 March	Rats, Humans, & Their Impacts on Islands: Integrating Historical and Contemporary Ecology – An Interdisciplinary Conference	Hawaii, USA	http://www.botany.hawaii.edu/faculty/drake/Rodents2007.htm
15-20 April	3rd Global Botanic Gardens Congress	Wunan, China	http://www.3gbgc.com/index.asp
17-20 April	Brown Treesnake Technical Meeting	Tumon Bay, Guam	http://www.hear.org/announcements/pdfs/2007btstechmeeting.pdf
23-27 April	12th International Symposium of Biological Control of Weeds	Montpellier, France	http://www.cilba.agropolis.fr/symposium2007.html
20-25 May	13th International Colloquium on Amphipoda	Tihany, Hungary	http://www.blki.hu/13thICA
21-24 May	5th International Conference on Marine Bioinvasions	Cambridge, Massachusetts	http://web.mit.edu/seagrant/bioinvasion2007/index.html
23-25 May	International Pacific Invasive Ant Conference	Hawaii, USA	http://www.invasivespeciesinfo.gov/news/calendar.php
18-21 June	14th European Weed Research Society Symposium	Hamar, Norway	http://www.ewrs.org
1-5 July	21st Annual Conference of the Society for Conservation Biology	Port Elizabeth, South Africa	http://www.conbio.org/2007

DATE	EVENT	WHERE	CONTACT DETAILS
2-6 July	CBD 12th meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-12)	Paris, France	http://www.biodiv.org/default.shtml
23-27 July	Non-Native Fishes: Integrated Biology of Establishment Success and Dispersal – Fisheries Society of the British Isles International Symposium	University of Exeter, United Kingdom	http://www.fsbi.org.uk
August, 2007	Pacific Invasive Learning Network Annual Meeting (SPREP)	American Samoa	http://www.sprep.org.ws/
7-9 August	Managing Vertebrate Invasive Species – An International Symposium	Fort Collins, Colorado, USA	http://www.invasivespeciesinfo.gov/news/calendar.php
17-21 Sept	9th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPI9)	Perth, Australia	http://www.congresswest.com.au/emapi9/
20-22 Sept	2007 California Invasive Plant Council Symposium	San Diego, California, USA	http://www.cal-ipc.org/symposia/nextyear.php
23-27 Sept	15th international Conference on Aquatic Invasive Species	Nijmegen, Netherlands	http://www.icaais.org
1-4 October	2nd International Invasive Sea Squirt Conference	Prince Edward Island, Canada	http://www.who.edu/institutes/OLI/activities/seasquirt-2007.html
2-6 October	21st Asian Pacific Weed Science Society (APWSS) Conference	Colombo, Sri Lanka	http://www.apwss21.lk/
15-18 October	16th International Plant Protection Congress	Glasgow, UK	http://www.bcp.org/iapps2007/
28-October – 2 November	12th World Lakes Conference	Jaipur, India	http://www.taal2007.org
29-October – 2 November	IPPC Standards Committee Working Group meeting	Rome, Italy	http://www.ippc.int/IPP/En/default.htm
5-9 November	IPPC Standards Committee meeting	Rome, Italy	http://www.ippc.int/IPP/En/default.htm
26 October – 4 November	North Pacific Marine Science Organisation (PICES) Annual Meeting	Victoria, BC, Canada	http://www.pices.int
2008			
18-22 February	CBD 13th meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-13)	Rome, Italy	http://www.biodiv.org/default.shtml
May	9th meeting of the Conference of the Parties to the Convention on Biological Diversity (COP-9)	Germany	http://www.biodiv.org/default.shtml
6-10 May	3rd European Whitefly Symposium	Aguadulce, Spain	http://www.whitefly.org/EWSIII_2007/EWSIII.asp
19-23 May	World Aquaculture 2008	Busan, Korea	http://www.was.org/meetings/WasMeetings.asp
16-26 October	North Pacific Marine Science Organisation (PICES) Annual Meeting	Dalian, China	http://www.pices.int

This list is compiled largely from a monthly update provided by Dr Richard Orr, Assistant Director for International Policy and Prevention of the National Invasive Species Council, Washington, DC. Please send an e-mail to Richard_orr@ios.doi.gov to join the mailing list or have your IAS event included.

The Secretariat of the Global Invasive Species Programme has been sponsored primarily through the generous contributions of the World Bank via the Bank Netherlands Partnership Programme and Development Grant Facility. We thank these and other contributing organizations warmly for their support, partnership and commitment.

We are grateful to those who have kindly made their photographs available for awareness-raising purposes.



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