Aliens: The Invasive Species Bulletin

Newsletter of the IUCN/SSC Invasive Species Specialist Group

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IUCN

SSC Species Survival Commission

ISPRA Institute for Environmental Protection and Research

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Front Cover Photo
The California Kingsnake (*Lampropeltis californiane*): striped albino pattern
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Editorial

The Rio+20 Conference was held in June of this year in Rio de Janeiro; the city that in 1992 hosted the United Nations Conference on Environment and Development (UNCED). The conference was focused on 'the green economy' in the context of sustainable development and clearly reflects the main concerns of society in this moment of deep financial crisis. The ISSG had an in-depth discussion on this issue, which involved its Members, as well as many subscribers of the Aliens-L list-server. The conclusions were summarised in a policy briefing that was endorsed by the IUCN, and included in the official documentation of the Rio+20 Conference.

In our briefing we underlined to world leaders that addressing the problem of invasive alien species is not only crucial to preserve biological diversity, but can also contribute to protecting world food security, human health and global economy. We also highlighted that, as invasion biologists, we have developed effective measures for preventing and mitigating the negative effects of invasive species, but that to enforce these measures it is crucial that there is a need for greater support from the general public, as well as a stronger commitment from decision makers.

From our side, we committed to continue and strengthen our efforts for informing on the impacts of invasions and on the responses that need to be undertaken. ISSG also considers it a priority to continue working with the international standard setting organisations, with the aim of improving the trade regulatory processes necessary to minimise the spread of invasive species. Another key area of our work is the on-going cooperation with the IUCN Red List to enhance links between the Global Invasive Species Database and the IUCN Red List. Collaboration with the Convention of Biological Diversity (CBD) in an initiative that aims to improve the inter-operability between invasive species and other relevant information systems so that the CBD parties are better informed on this issue is another important area of work. In fact, we believe that a better synergy between the providers of invasive species knowledge can indeed provide valuable support for enabling the prevention of new invasions as well as more timely response to new incursions when prevention fails.

The key message that the community of invasion biologists and practitioners send to the world leaders is that it is imperative that the recommendations so far agreed upon be taken beyond 'good advice' and 'guiding principles' and turned into enforced policies; and, that the challenge for the next few years is the implementation and progress towards the achievement of the Strategic Plan 2011-2020 of the CBD.

Piero Genovesi, ISSG Chair

News from the ISSG

The ISSG has had a very busy and productive half year. Below is a brief synopsis.

ISSG represented by the Chair Piero Genovesi and Manager Information Services participated in the GBIF convened **'Informatics Expert Meeting on Invasive Alien Species'** in Copenhagen from 5 to 6 September 2011. It was attended by a group of 10 experts involved in various initiatives on invasive alien species and experienced in the interface between informatics and environmental science.

The Fifteenth Meeting of the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA15) took place in Montreal, Canada, from 7-11 November 2011 (*http://www.cbd.int/doc/?meeting=sbstta-15*). SBSTTA15 was the first meeting of the subsidiary body after the successful COP10 that took place in Nagoya, Japan, in October 2010 and the first of two SBSTTA meetings that were to be held before the next COP in Hyderabad, India in October 2012. Its agenda covered a number of issues of relevance to the scientific and technical work of the Convention and the advancement of the Nagoya decisions including invasive alien species (Agenda item 4.1). ISSG represented by the Chair and Manager Information Services participated in the meeting as part of the IUCN Delegation which also included the IUCN Global Coordinator for Invasive Species Geoffrey Howard. The IUCN - the ISSG and the IUCN Invasive Species Initiative (ISI) - **signed a supplementary agreement and Memorandum of Cooperation** with the Secretariat of the CBD (SCBD) on the side lines of SBSTTA15, agreeing to a) collaborate in the activities and initiative that contribute to the implementation of Aichi Target 9, b) continue to provide the SCBD with technical and scientific support on invasive alien species and c) identify additional sources of funding to implement these activities.

A side event was convened by the Secretariat of the CBD (SCBD), GBIF and the IUCN/ISSG, on the sidelines of SBSTTA15 aimed to present the '**joint work programme to strengthen information services on invasive alien species (IAS) as a contribution towards Aichi Biodiversity Target 9**' as an outcome of the informatics expert meeting on invasive alien species convened by the GBIF Secretariat in Copenhagen, Denmark. The side event was attended by more than 50 delegates. The presentations from the GBIF (Samy Gaiji), ISSG (Piero Genovesi) and CAB International (Gareth Richard) were very well received. Patricia Koleff (CONABIO Mexico) provided an excellent country perspective recalling the need for global/regional information systems. Some delegates strongly recommended the development of a business plan for donors.

ISSG represented by the Manager Information Services participated in **the Sixteenth Meeting of the CBD SBSTTA 16** (*http://www.cbd.int/sbstta16/*) that took place in Montreal, Canada from the 30 April to 5 May 2012 as part of the IUCN delegation. ISSG participated in the Global Taxonomic Initiative (GTI) meeting representing the IUCN; contributed to the in-depth review of the implementation of the programme of work on Island Biodiversity; participated in the first informal meeting of the newly established Invasive Species Working Group of the Global Island Partnership (GLISPA); committed to contribute to the proposed Island Summit during COP 11 in Hyderabad, India during October 2012 and participated in side events.

ISSG (Regional Pacific office) participated in the **Inaugural Pacific Islands Species Forum** in Honiara, Solomon Islands from April 25th-27th 2012, organized by IUCN Oceania, the IUCN Species Survival Commission (SSC), BirdLife International, the Pacific Islands Roundtable for Nature Conservation (PIRT), the Secretariat of the Pacific Region Environment Programme (SPREP), and the Government of the Solomon Islands. ISSG- Pacific with the Pacific Invasives Initiative presented the results of an in-depth study on the impacts of invasive species on threatened species in the Pacific Region and a review of the management of invasive species related to the conservation of endangered birds in the Pacific Region over the past decade and more.

The Chair and Programme Officer of the ISSG continued to support the European Commission on its work for the development of a **EC legislative instrument on invasive alien species**, by providing qualitative and quantitative information on issues such as pathways, impact and management of invasives. In this regard, the Chair of the ISSG attended a meeting of the Nature Directors General of the EU member states, presenting the possible options for developing a EU legislation on the issue (EU Nature Directors Meeting, 29th September 2011, Ryin, Poland).

ISSG is also working with the **European Environmental Agency** at different on other issues, including

the development of indicators of biological invasions, and the production of an awareness raising report titled *Communicating on environmental and socio-economic impacts of invasive alien species in Europe*.

The ISSG is continuing with the long tradition of cooperation with the **Bern Convention**. and The two organizations co-organised a meeting in Rome, held last on the 15th-16th March, to discuss the ongoing lines areas of cooperation. These that include the development of several **codes of conduct and guidelines**: including on zoos and aquaria (in cooperation with the European Association of Zoos and Aquaria); and, on invasives and hunting (in cooperation with the European Federation of Hunting Association). ISSG is also working at on developing guidelines for the management of invasive species in Europe, in cooperation with several organizations, including the IUCN World Commission on Protected Areas.

Rio+20

Planet Under Pressure 2012 was the largest gathering of global change scientists leading up to the United Nations Conference on Sustainable Development (Rio+20) with a total of 3,018 delegates at the conference venue and over 3,500 that attended virtually via live web-streaming. The first State Of The Planet Declaration was issued at the conference. Following the conference and declaration several ISSG members were concerned with the limited attention being paid to the issue of biological invasions and invasive alien species in the Rio+20 processes. Members proposed the development and submission of a policy paper highlighting the growing threat of biological invasions on biodiversity, human health and food security for the Rio+20 process. After extensive consultation with the membership, the ISSG with the IUCN's ISI developed and submitted a policy brief related to biological invasions and invasive alien species to the IUCN. This brief will be included in the IUCN documentation for Rio+20 and text be reflected in the umbrella position paper (which will form the basis of IUCN's statement to the Rio+20 conference). *http://cmsdata.iucn.org/downloads/policy_brief_in_invasive_and_alien_species_final.pdf*

ISSG Information Services

The restructure and revision of the **Global Invasive Species Database** is well under way and will conclude in the third quarter of 2012. The revised GISD includes a revised and comprehensive framework for recording information on species expansion and pathways of spread and impact mechanisms and outcomes; a framework for developing a Global Register of Introduced and Invasive Species (GRIIS); better search functionality and user-friendly and interactive interface.

The **Island Biodiversity and Invasive Species Database (IBIS)** is in its final iteration of revisions and version 2012.3 will be online by the end of July 2012.

Improved links between the IUCN Red List of Threatened Species and the GISD - Work is ongoing to develop reciprocal links between the GISD and the IUCN Red List including enhancing information on the impacts of invasive species on threatened species.

The IUCN recently published **'IUCN Knowledge Products- The basis for a partnership to support the functions and work programme of IPBES'** (*http://data.iucn.org/dbtw-wpd/edocs/2012-015.pdf*). It was prepared for the second session of the plenary meeting on the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES), on 16-21 April 2012, in Panamá City, Panamá. IUCN offered these knowledge products to IPBES as a contribution to establishing a firm strategic partnership support the developing of the IPBES work-plan and thereby deliver crucial information for decision-makers. Knowledge products included the IUCN Red List of Threatened Species, Protected Planet (including the World Database on Protected Areas WDPA, the IUCN Red List of Ecosystems among others. The GISD was featured in this publication as well as the IBIS database as an emerging knowledge product. For more information: The ISSG now hosts the **Database of Island Invasive Species Eradications (DIISE)** a centralized database covering all of the recorded invasive vertebrate eradications on islands and an important tool in helping improve the quality of eradications. The DIISE (*http://eradicationsdb.fos.auckland.ac.nz/*) was developed by Island Conservation, the Coastal Conservation Lab, University of California Santa Cruz, in partnership with the ISSG, Manaaki Whenua Landcare Research New Zealand and the University of Auckland.

The ISSG was awarded a consultancy by the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) to '**Undertake a review of the nature and extent of the impact of invasive species on migratory species, with particular emphasis on those listed on the CMS Appendices**' during 2012.

Upcoming events in which the Secretariat will be

participating- lookout for updates in the next issue of the Aliens Bulletin!

- The Organizational Workshop for the 'Global Invasive Alien Species Information Partnership' to be held under the auspices of the CBD at the Natural History Museum, London, United Kingdom on the 9-10 July 2012.

- World Trade Organization (WTO) STDF Workshop on International Trade and Invasive Alien Species for some Selected Countries to be held in Geneva, Switzerland, from 12 to 13 July 2012 &

- Inter-agency Liaison Group on Invasive Alien Species (the Liaison Group) on 13 July 2012, at the WTO headquarters

- IUCN World Conservation Congress 6-15 September 2012. Jeju, Korea. The ISSG will be holding two events 1) A Knowledge Cafe- Ensuring Ecosystem Resilience & Services: Developing Global Guidelines on the Management of Invasive Alien Species in Protected Areas incl. World heritage Sites and 2) A poster Session on Information Services. The ISSG is also presenting the results of the work on enhancing links between the GISD and the IUCN Red List of Threatened Species in a session at the Species Pavilion.

- Eleventh meeting of the Conference of the Parties to the Convention on Biological Diversity (COP11) 8- 19 October 2012, Hyderabad, India.

...And other news

ESENIAS: a regional network on invasive alien species

A new regional network on Invasive Alien Species (IAS), the East and South European Network on Invasive Alien Species (ESENIAS) has been recently established under the auspices of the ISSG at the meeting "EEA/EIONET Workshop on Networking on IAS in West Balkan Countries and Their Neighbours", organized by European Environment Agency (EEA) in cooperation with the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, University of Forestry and Ministry of Environment and Water of Bulgaria in Sofia on 17-18 October 2011 (see presentations here: http://forum.eionet.europa.eu/nrc-nature-and-biodiversity-interest-group/library/workshop-networking-ias-west-balkan-countries-and-its-neighbours-17-18-october/

The goal of the network is to develop a regional web-based data portal, which will provide a forum for information exchange related to the identification of new invasive species, risk assessment and management, as well as monitoring and control of already established IAS in South-East Europe.

In particular, the regional web-based data portal on IAS [www.esenias.org] will serve as a forum for sharing information and knowledge on:
• IAS in East and South Europe – scientific names, biology, ecology, habitat, invasiveness, pathways of introductions, and impact (species lists, species factsheets; basic or more detailed information)
• First sightings, distribution and spread of IAS in East and South Europe (species alerts; interactive distribution maps)
• Risk assessment and management information on IAS (risk assessment protocols, management option and practices, IAS action plans)
• Regulations, guidance, scientific references related to IAS in the region.
The objective is to establish regional cooperation in the West Balkan Countries, to aid in early detection, eradication, control and mitigation; develop a common database on IAS for the region and raise awareness of the problem among decision makers and the general public.
ESENIAS brings together experts on biodiversity, environmental management and pest control from national and regional environmental and agriculture departments, the scientific community and organizations working with IAS. Current members of network are Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Kosovo (under UNSC Resolution 1244/99), FYR Macedonia, Montenegro, Serbia and Turkey. Countries are represented by two members: one from ministry or public institution and the other from academia. It is expected that in the future the network will include members from the wider region, such as the south European countries and countries in Mediterranean and Black Sea area.

The network is hosted by the Bulgarian Academy of Sciences in partnership with the Ministry of Environment and Water, Bulgaria. It will be chaired by Ms Teodora Trichkova from IBER-BAS, Bulgaria, and co-chaired by Ms Milica Rat from University of Novi Sad, Serbia.

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NatureWatch to explore Europe-wide citizen science reporting

European Union (EU) Member States have a variety of systems for reporting on invasive alien species (IAS). Many include observations made by citizen scientists. Some citizen scientists act independently. Others are members of networks or communities with an interest in a topic relating to the environment, such as birds, hunting or local endangered species.

The European Environment Agency (EEA) has recognised the important contribution that can be made by citizen science in filling important gaps in our knowledge and understanding of Europe's environment. In response, NatureWatch, which is managed by EEA biodiversity and IT experts, is EEA's first project to explore its use for reporting purposes.

This pilot initiative – the first of its kind at the European level – has significant potential to help implement a European early warning and information system for IAS. It is designed to help EU Member States fulfil obligations they may have in the EU's future legal instrument on IAS. NatureWatch can also bring together existing reporting systems and stimulate the development of new ones.

The NatureWatch system will be used by citizen scientists to identify and submit observations of IAS. Observations can be: photos of species, droppings and footprints, sound bites, and written remarks. They can be reported to an online portal, either through a mobile application or PC. Citizen scientists and their communities can also learn more about IAS through links to species Fact Sheets and identification keys. In this way, NatureWatch has significant potential to raise public awareness about the threats of IAS and demonstrate how civil society can get involved in helping to stop their spread.

A recent report produced by the EEA's European Topic Centre on Biological Diversity identified key factors required for the success of an initiative such as NatureWatch. These include linking with local citizen science organisations already in place that care about their sites, data and results. Also important is feedback to citizen scientists, public transparency, and the verification of data by specialists.

NatureWatch can host sub-sites for specific citizen science communities. Here they can organise their observation data and share additional information such as trends, reports and maps. One community can view results from other communities or other geographical areas and compare or learn.

IAS data from NatureWatch can be shared with Eye on Earth, a global public information service developed by EEA and its partners Esri and Microsoft. Eye on Earth aims to expand and improve the environmental knowledge base. It enables the online collection of vast amounts of data and information from diverse sources. Web applications then allow for the information to be used for multiple purposes such as the creation of new knowledge, without the need of technical expertise. IAS data from NatureWatch can therefore be combined ('mashed up') with other datasets, such as those related to protected areas, temperature change or transport routes.

A survey among experts from within EEA and beyond resulted in the selection of 15 priority IAS of European concern for the pilot phase: (four mammals) American mink, raccoon dog, grey squirrel and coypu (river rat); (three birds) Canada goose, ruddy duck and ring-necked parakeet; (six plants) tree of heaven, common ragweed, water hyacinth, hogweed, Freeway iceplant and Japanese knotweed; (one freshwater species) red-eared slider; and (one insect) Asian hornet. Additional species may be added in the future. Country communities can also select their own priority species.

The project's pilot phase entails EEA working with a few European countries to implement NatureWatch nationally. Countries currently include Denmark, Hungary and Slovenia. Some other European countries already have their own applications for citizen science observations of IAS, or are now in the process of developing systems. Some have agreed to export their IAS data to NatureWatch. User testing of the system is projected to begin this summer.

Echoes from the BIOLIEF 2011 meeting in Argentina

BIOLIEF 2011 - 2nd World Conference on Biological Invasions and Ecosystem Functioning was held in Mar del Plata, Argentina, on November 21-24, 2011. The meeting was organized by Drs. Jorge Gutiérrez, Gabriela Palomo, and Pablo Ribeiro – on behalf of the environmental non-profit organization GrIETA (Grupo de Investigación y Educación en Temas Ambientales) – and received financial and logistic support from the Argentinean research council (CONICET) and ISSG-IUCN, respectively. Nearly 250 participants from 31 countries in five continents attended the meeting, including representatives from academia, governments and businesses. As in the first BIOLIEF – held at Porto, Portugal in 2009 – the emphasis of the meeting on the ecosystem-level impacts of invasive species did not preclude the presentation and discussion of research on other aspects of biological invasions such as the development and evaluation of theory and models in invasion biology, the biogeography and macroecology of biological invasions, habitat requirements and distribution of invasive species, the impacts of invasive species on native species and communities, and the prevention and management of biological invasions.

The Conference Opening Lecture was given by of Dr. David Strayer (Cary Institute of Ecosystem Studies, USA), who discussed whether the general questions that are the foundation of most research on the impacts of invasions on ecosystem functioning have been fully or partially answered, or are unanswerable in their present form. In addition, insightful Keynote Addresses were also offered by Drs. Sally Hacker (Oregon State University, USA), Jonathan Jeschke (Technische Universität München, Germany), Hugh MacIsaac (University of Windsor, Canada), and Ronaldo Sousa (Universidade do Minho, Portugal). During the meeting closure ceremony, both participants and organizers agreed in envisioning BIOLIEF as a continuing conference series as well as an emerging global forum for the communication and discussion of scientific findings in the field of biological invasions. In order to further enhance global participation, it was proposed to organize future BIOLIEF meetings in continents other than those of the 2009 and 2011 editions (i.e., Europe and South America, respectively)*. A Special Volume of Acta Oecologica entitled "Ecosystem Impacts of Biological Invasions" will feature selected papers presented at this exciting conference.

* The place, dates and organizers of the next BIOLIEF are yet to be decided. If interested in organizing BIOLIEF contact Dr. Ronaldo Sousa, *ronaldo.sousa@ciimar.up.pt*

Wild Hippos in Colombia

Carlos Andres Valderrama Vásquez

*Alien species are the second largest cause of biological diversity loss. Since 1981 in Colombia, Puerto Triunfo municipality, there has been a wild hippo (*Hippopotamus amphibius*) population. This population is composed of at least 28 individuals residing in Hacienda Nápoles, and probably two more migrating along the Magdalena Medio region, making use of the swampy habitats of the municipality of Puerto Berrio (Antioquia). Hippos are difficult to contain and manage, due to their size. They are extremely aggressive and therefore dangerous and should always be considered as animals that may cause fatal injuries (Figure 1). In Colombia, there have been complaints that hippos have attacked fishermen and that they do not allow access to rivers and lagoons for fishing, and have destroyed crops and cattle fences, creating panic amongst the local communities that are fearful of attack. To prevent people getting killed or injured by the hippos that leave Hacienda Nápoles, one male hippo was culled and another was successfully captured, castrated and relocated back to the Hacienda Nápoles, which, to this author's knowledge, was the first castration of a hippo in the wild. Colombia is an ideal habitat for hippos to graze and seek refuge in water and it would support huge numbers of the species if allowed to roam freely. Even though further analysis is required in order to assess the risk of establishment, impact, management capacity and control, all efforts should be focused on finding the resources needed to contain the hippo population in Hacienda Nápoles and to stop the breeding, by means of a fence strong enough to prevent hippos from escaping, as well as by proper management of the population in order to control its reproduction.*

Fig. 1. Hippo (*Hippopotamus amphibius*) that attacked the fishermen and killed 6 calves in Puerto Berrio (Antioquia), Colombia. Photo: Carlos Valderrama

Introduction

Alien species are the second largest cause of biological diversity loss (McNeely et al. 2001; MEA 2005). Exotic species may result in the modification of a habitat, as the species and the habitat have not evolved together (Mellink 1991; Schlaepfer et al. 2005). The invasive species may even affect the distribution, abundance and reproduction of many native species (Strauss et al. 2006). Invasive alien species also exacerbate poverty and threaten sustainable development through their impact on agriculture, forestry, fisheries, human health and on biodiversity, which is often a basis of livelihoods of the people in developing countries (CDB 2009).

Fig. 2. Wild hippo (*Hippopotamus amphibius*) population in Hacienda Nápoles at Puerto Triunfo (Antioquia), Colombia. Photo: Carlos Valderrama

In Colombia, since 1981 there is a wild hippo (*Hippopotamus amphibius*) population (Figure 2) in Puerto Triunfo municipality that has its origins from three pairs of hippos that were brought from the United States of America to Hacienda Nápoles. Suitable environmental conditions, the absence of natural predators and the excellent adaptation of these individuals have favoured their reproduction and migration. (FVSN 2009; Valderrama Vásquez 2009). There are at least 28 individuals in Hacienda Nápoles and probably two migrating in the Magdalena Medio, using the swampy habitats of the municipality of Puerto Berrio (Antioquia). Since the population is not contained and is reproducing without restrictions, the young males are pushed out by the dominant male and the young males then start migrating to new territories. Hippos have attacked fishermen and do not allow them to fish the rivers and lagoons and have destroyed crops and cattle fences, creating panic amongst the local communities who are fearful of being attacked (FVSN 2009; Guzman Amado 2007; Knight and Morkel 2009; Valderrama Vásquez 2009).

The current situation

Hippos are mega-herbivores, native to Africa and are classified in Colombia as an established introduced species as they have successfully reproduced and have a viable population (Baptiste et al. 2010). Hippos can weigh up to 3200 kg (Fowler and Miller 2003), are extremely aggressive and dangerous, and are considered as the species that causes most human deaths in Africa (Burroughs et al. 2006).

Fig. 3. Hippo (*Hippopotamus amphibius*) at Parque Zoológico Santa Fe in Medellín (Antioquia), Colombia. Photo: Carlos Valderrama

Deaths occur mainly when people are fishing in the rivers or when they locate themselves between the grazing areas and hippo shelters in the rivers. Hippos become especially aggressive at night as this is the time they usually graze. It is known that they attack anything that may seem strange to them (Knight and Morkel 2009).

Hippos are difficult to contain and manage due to their size and should always be considered as dangerous animals that may cause fatal injuries. Their elongated teeth are their primary weapons (figure 3) (Fowler and Miller 2003). The use of drugs to immobilize hippos has not been properly researched, and as a result, effective doses have not been defined. Hippos that have been immobilized can easily suffer from severe cardiac and respiratory failure, resulting in high rates of mortality (Burroughs et al. 2006). Also, when hippos are injected with immobilizing darts, they naturally run to water, so every effort should be made to avoid this in order to prevent accidental drowning (Burroughs et al. 2006; Fowler and Miller 2003). On the other hand,

due to the high volumes of drugs required, the thick skin and fat tissue can limit the quantity of drugs administered. Staff should also be aware of sudden arousals (Fowler and Miller 2003). Even though castrations in mammals are relatively easy, hippos have internal testicles and a thick layer of fat and skin which make access difficult. This is why surgery can take a long time, leading to further complications of anesthesia and surgery viability (Eltringham 1999).

Fig. 4. One of the calves killed by the hippo (*Hippopotamus amphibius*) (FVSN 2009). Photo: Carlos Valderrama

Since 2007, to prevent people getting killed or injured by the hippos that leave Hacienda Nápoles, a plan was set up to relocate them. Unfortunately it was impossible to find a place for relocation and after 2 years of effort one of the hippos was culled because it attacked the fishermen and killed 6 calves (figure 4) in Puerto Berrio (Antioquia), putting the local community at risk (FVSN 2009).

In 2010 another hippo was sighted outside Hacienda Nápoles and again a plan was set up to relocate it, as part of the Program designed by the Local Environmental Authority CORNARE and the Ministry of Environment for the Management of the Hippo population. Fortunately, this time the Hacienda Nápoles accepted the return of the hippo and by March 2011 it was successfully captured (Figure 5a), castrated (figure 5b) and relocated back to the Hacienda Nápoles using a Russian helicopter MI 17 provided by the Colombian Army (figure 5c) (Valderrama Vásquez 2011). To this author's knowledge, this is the first castration of a hippo in the wild and it was carried out to stop its reproduction; to reduce its territorial behavior and to prevent fighting with the dominant male of the herd when returned to Hacienda Nápoles (Valderrama Vásquez 2011).

Fig. 5. Pictures taken during the capture, castration and relocation back to Hacienda Nápoles of a hippo (*Hippopotamus amphibious*). The procedure was recorded for the documentary "Drug Kingpin Hippos" that was produced by Explora Films for Animal Planet. a) Capture of a wild hippo. b) Castration of a wild hippo. c) Backhoe and Russian helicopter MI 17 used for the transportation. The helicopter was provided by the Colombian Army. Photo: Explora Films

Recommendations for Management

It is important to emphasize that hippos are an alien species in Colombia and even though further analysis is required to assess the risk of establishment, impact, management capacity and control (Baptiste and Munera 2010; Valderrama Vásquez 2011), they should be treated as such and be removed or contained in captive conditions (Baptiste and Munera 2010; Valderrama Vásquez 2009). Furthermore, the Convention on International Trade in Endangered Species (CITES) recommends to the parties, in the exotic species section, to make synergy with the Convention on Biological Diversity (CBD) that declares that each party will "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species" (CITES 2002, 2004; Valderrama Vásquez 2009).

The complete eradication of invasive alien species populations in a controlled area is often the most desirable outcome and is also considered as ecologically healthier and more ethical in the long term. It has been proven to be feasible as the longer it takes for eradication to be achieved, the more costs increase and the species may become more invasive. It is important for the eradication to start as soon as the potential invasive species is detected. Even though eradication can be initially costly, if it is done efficiently it will definitely be cheaper than any other measure that requires a continuous cost during a long period of time (CDB 2009).

Hippos are an important ecological driver having a major impact on biodiversity by opening rivers, controlling reed beds, opening side channels, creating new river courses, nitrifying inland water supplies, creating grazing lawns in habitats adjacent to rivers (Knight and Morkel 2009; McCarthy et al. 1998). In Africa they can have a major positive influence on local biodiversity but they can also have a negative impact on biodiversity through facilitating the spread of water borne alien vegetation. In Colombia, there is no ecological equivalent and major ecological damage could result, including a loss of biodiversity (Knight and Morkel 2009).

Hippos are susceptible to various infectious diseases which pose a threat to humans, domestic animals, and indigenous wildlife. Diseases like tuberculosis, brucellosis, leptospirosis, anthrax, and salmonellosis. Anthrax is the most important infectious disease in wild hippo. Antibodies to infectious bovine rhinotracheitis (IBR), rinderpest, and contagious bovine pleuropneumonia (CBPP) have also been found in hippos (Eltringham 1999; Knight and Morkel 2009; Miller 2003). They are probably also susceptible to foot-and-mouth disease (FMD). Additionally they get various internal and external parasites. Some of these parasites are specific to hippos while others affect a broad range of species. Additionally hippos defecate and urinate in water and this contaminates water sources and can facilitate the transmission of diseases Therefore, hippos must be considered a potential threat to public health (Knight and Morkel 2009).

Colombia is an ideal habitat for hippos to graze and seek refuge and it would support huge numbers of the species if allowed to roam free, therefore, they should be eradicated or held under strict control (Knight and Morkel 2009). All handling and management procedures should be carefully planned to guarantee staff and animal safety (Burroughs et al. 2006; Fowler and Miller 2003; Hofmeyr 2007; Lewison 2007).

Fig. 6. Orphan hippo (*Hippopotamus amphibius*) born at Hacienda Nápoles in Puerto Triunfo (Antioquia), Colombia. Photo: Explora Films

Currently the situation is manageable, but even though the options are expensive, dangerous and difficult to implement, all efforts should be focused on finding the resources needed to contain the hippo population in Hacienda Nápoles and to stop the breeding, by means of a fence resistant enough to prevent them from escaping, as well as by proper management of the population in order to control its reproduction (Figure 6) (Knight and Morkel 2009; Valderrama Vásquez 2011).

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Identification and distribution of non-indigenous species in the Mediterranean Sea: the Italian challenge

Franco Andaloro, Manuela Falautano, Patrizia Perzia, Claudio Maricchiolo, Luca Castriota

Non-indigenous species (NIS) represent one of the main threats for world biodiversity, both in the terrestrial and in the marine environment, to such an extent that they are an important subject of several international conventions and directives aiming at safeguarding the environment. Since 2002, the Institute of Environmental Protection and Research (ISPRA), in cooperation with the Italian Ministry of the Environment, conceived a research project to comply with Article 8h of the Convention on Biological Diversity – aiming at preventing the introduction of, controlling or eradicating those alien species which threaten ecosystems, habitats or species - and with Article 13 of the Specially Protected Areas and Biological Diversity Protocol of the Barcelona Convention – focusing on regulating intentional or accidental introduction of non-indigenous or genetically modified species in nature. This project had the purpose of monitoring marine NIS in Italian seas and, more generally, in the whole Mediterranean Sea which is estimated to be the most invaded sea in the world, counting to date 955 NIS (Zenetos et al. 2010).

The Mediterranean Sea is a basin of relatively recent origin (about 5 million years), which derives from the closure of ancient Tethys and which, in geological times, experienced many colonization events, favored by climatic changes, allowing the settlement of now arctic-boreal now temperate now tropical-subtropical species. The Mediterranean assumed therefore a certain biogeographical identity, mainly characterized by a predominant Atlantic component and by low endemism; this justifies our preferential use of the term non-indigenous instead of allochthonous for those species which were introduced/penetrated in this basin since the last century. NIS introductions in the Mediterranean take place through several pathways, the most important being maritime traffic (ballast water, keel fouling), aquaculture and aquarium trade, live bait imports, penetration through artificial (Suez Canal) and natural (Strait of Gibraltar, the Dardanelles) channels. Considering the scanty information on NIS in Italian seas, this project represents the first attempt to create an organized structure for the knowledge and monitoring of NIS phenomenon. Investigations within the project were carried out for:

- definition of the present state of knowledge of the immigration phenomenon through acquisition and analysis of literature on eight selected *taxa* (algae, ascidians, bryozoans, cnidarians, decapods crustaceans, fishes, mollusks, polychaetes);
- realization of a network of expert researchers for recording new sightings;
- promotion of a campaign to raise public awareness, involving sea operators;
- realization and continuous update of NIS database and geo-referenced cartography (GIS) aimed at visualizing temporal and spatial distribution of NIS;
- creation of a taxonomic atlas of NIS to be consulted online;
- collection of NIS tissue samples for the establishment of an archive available to scientists;
- identification of hybrids, genetically modified organisms (GMOs) and NIS used for aquaculture and aquarium trade;
- experimentation of a monitoring network to identify NIS from ballast waters;
- survey of harbor structures;
- realization of a network to promote an early warning system.

NIS database, GIS and taxonomic atlas

The huge collection of data through continuous and attentive analysis of literature and prompt notification of new sightings by researchers and sea operators, allowed to define NIS phenomenon in the Mediterranean, which was the first step for the construction of the taxonomic atlas.
A total of 5308 records since 1900, (including 693 NIS belonging to eight selected *taxa*) have been recorded in the Mediterranean. Of these, 1262 records belonging to 242 species refer to Italian waters. Obviously, such records have to be continuous-

ly updated due to new findings of NIS and to correct inaccuracies. All data was entered into a database created to be easily updated and managed. The situation of the 8 examined taxonomic groups in the Mediterranean and in Italian seas, updated to December 2011, is reported in Table 1.

Taxonomic groups	Mediterranean		Italy	
	Number of NIS	Number of records	Number of NIS	Number of records
Algae	133	707	81	460
Ascidians	14	81	6	47
Bryozoans	18	81	6	51
Cnidarians	30	280	17	83
Decapods crustaceans	78	685	18	67
Fishes	159	2262	48	198
Mollusks	172	917	37	236
Polychaetes	89	295	29	120

Table 1 Number of non-indigenous species and records for 8 taxonomic groups in the Mediterranean and Italian seas, updated to December 2011.

Supporting this project through geographic information systems allowed the archiving and analysis of this massive quantity of data, and produced spatio-temporal distribution maps for each taxonomic group and species. The maps showed in Figure 1 represent an example of the various GIS elaborations feasible by using the database.

For each NIS within the eight considered *taxa*, a species card (Fig. 2) has been realized considering both the biological aspects of NIS (white part of the card) and those concerning their invasive state and eventual impacts (blue part of the card) in the perspective of risk analyses.

Each NIS card reports the following items:
a) species systematic and synonyms
b) picture of the species and/or of its anatomical details
c) distribution map reporting all the records in the Mediterranean
d) descriptive, taxonomical, biological and ecological data of the species and their distinctive characters from other similar species
e) data on geographical distribution and invasive characteristics and sample availability (tissue bank)
f) consulted literature.

The atlas has been first published online by the Ministry of the Environment (*http://www.sidimar.tutelamare.it/distribuzione_alieni.jsp*), and then transferred to the ISPRA web site (*www.medalien.isprambiente.it*) where it is continuously updated as part of the National Environmental Information System (SINA).

Collection of NIS tissue samples for the establishment of an archive available to scientists

Thanks to fishermen which actively cooperate to retrieve samples of NIS, and the researchers involved in the project, a tissue bank has been prepared for preservation of muscle pieces of non-indigenous organisms as well as thermophilic ones in expansion in Italian seas. Such samples are useful, for instance, for comparing organisms through DNA extraction and isolation of nuclear/mitochondrial markers.
At present, the tissue bank includes NIS (i.e. *Seriola fasciata*, *Seriola rivoliana*, *Sphoeroides pachygaster*, *Fistularia commersonii*) and thermophilic species (i.e. *Acanthocybium solandri*, *Balistes capriscus*, *Caranx crysos*, *Caranx ronchus*, *Lagocephalus lagocephalus*, *Pomadasys incisus*, *Sphyraena viridensis*, *Xyrichtys novacula*, *Zu cristatus*) but will be soon enriched by current research projects, in particular those concerning the Marine Strategy Framework Directive (2008/56/EC) of the European Parliament and of the Council.

Identification of hybrids, genetically modified organisms (GMOs) and NIS used for aquaculture and aquarium trade

The investigation on hybrids, GMOs and NIS used for aquaculture and aquarium trade purposes was carried out through information retrieval from national farmers, fish feed producers, aquaculture associations, research institutes and on the base of available literature.
In the Italian territory nine pisciculture companies handle the following NIS: red seabream *Pagrus ma-*

jor, Senegalese sole *Solea senegalensis,* bastard halibut *Paralichthys olivaceus* and Nile tilapia *Oreochromis niloticus niloticus.*

Two other companies use GMOs (i.e. triploids of *Dicentrarchus labrax* and *Umbrina cirrosa*). Several mollusk farmers operate with the non-indigenous bivalves *Tapes philippinarum* and *Crassostea gigas*.

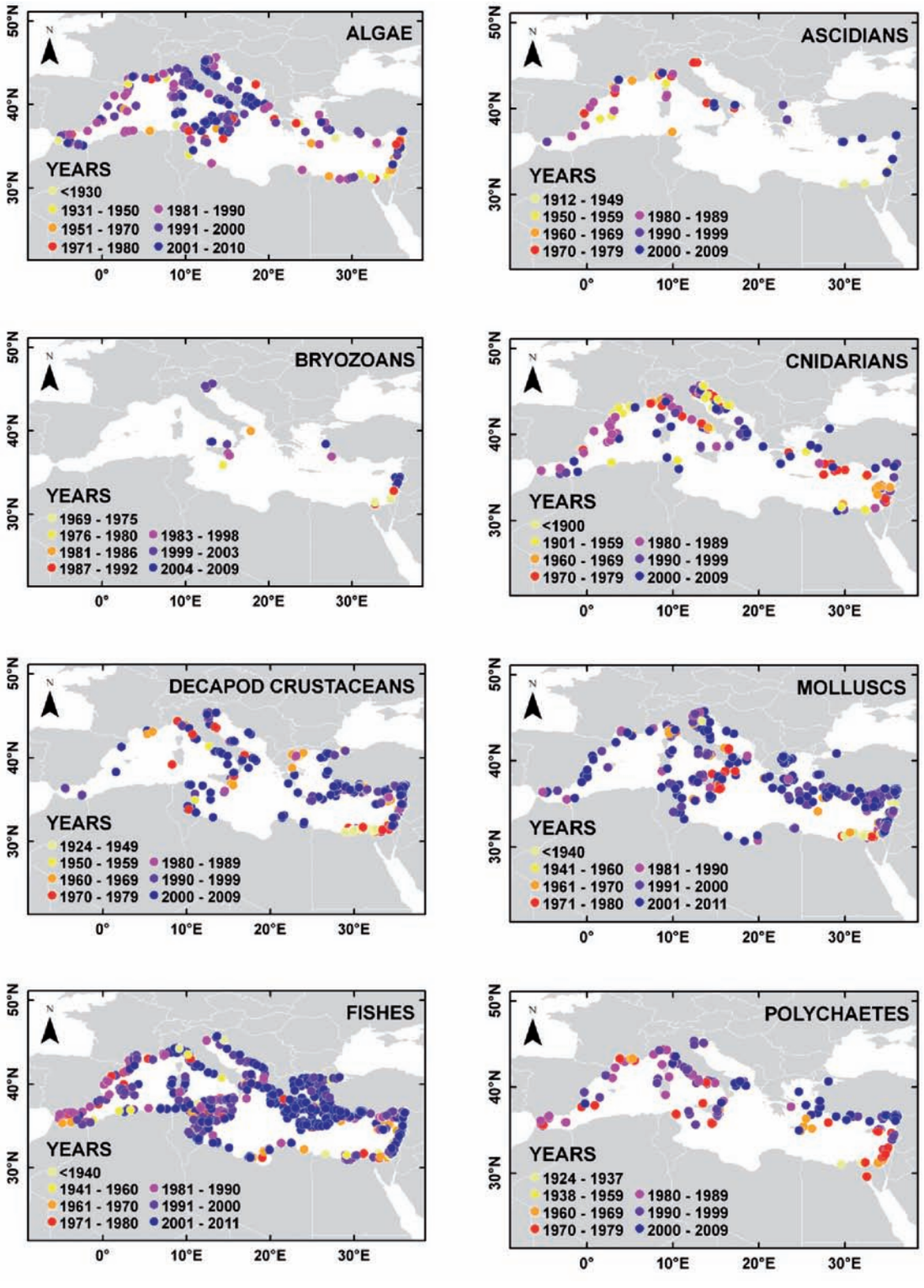

Fig. 1 - Spatio-temporal distribution maps for 8 taxonomic groups in the Mediterranean

Experimentation of a monitoring network to identify NIS from ballast waters and survey of harbor structures

One of the aims of the project is the implementation of a sampling protocol to detect non-indigenous microorganisms in ballast water and the sediment of commercial ships entering Italian harbors, which are among the principal pathways for NIS. With this purpose in mind, a Ballast Water Reporting Form (BWRF) was considered to collect ship details, transported water volumes, and all data dealing with ballast water charge and discharge. The experimentation of BWRF was carried out in the Port of Trieste (north-eastern Italy) for its importance in terms of maritime traffic, in different surveys lasting three months each. The results allowed to identify a ship route from the starting harbor as well as identifying the harbors where waters were charged/discharged along the national territory. Further, the study of plankton from ballast water and sediment collected in the Gulf of Trieste and Naples allowed the identification of species never recorded before in our seas as well as potentially toxic and thermophilic species.

Similarly, monitoring organisms living on harbor structures and the surrounding environment may help at identifying NIS before they spread elsewhere. Such an action has been experimented in different national harbors (Trieste, Milazzo, Augusta), through sampling of organisms on pier pillars and surrounding sediment, with the aim of searching for hard-bottom and soft-bottom NIS which have escaped from maritime operations and settled in a harbor environment. Results allowed the identification of, among others, some species of non-indigenous mollusks and polychaetes never recorded before in our seas.

All these actions are useful to prepare prevention plans and intervention operations for control and eradication of NIS.

Risks of NIS in Italian seas

Biological invasions, in addition to their negative impacts on biodiversity and ecosystems, may cause economical damage and threaten human health. The analysis of literature and the database of NIS records, currently allow, through analysis of NIS spatio-temporal migration, the identification of those species which represent a potential danger to human health and which are close to or have colonized Italian seas. For instance, among immigrant species, some tetraodontid fishes are expanding their distribution areas. Tetraodontids are known for their toxicity due to the neurotoxin tetrodotoxin (TTX) contained in the liver, gonads and skin, which, at high concentrations, may produce paralysis of the diaphragm and death due to respiratory failure. Since 1984 pufferfish *Sphoeroides pachygaster* have been colonizing Italian waters (Vacchi and Cau 1986) where they are now frequently fished; this species is toxic but not lethal to humans. According to the migration pattern of Lessepsian species in the Mediterranean, another tetraodontid species, *Lagocephalus sceleratus*, is supposed to be close to colonizing Italian waters: this invasive Eritrean species is distributed in all the Levant Basin and the Aegean Sea, and it recently appeared in Tunisian waters (Jribi and Bradai 2012). This species deserves particular attention as, unlike *S. pachygaster*, it contains high concentrations of TTX in its flesh (Sabrah et al. 2006; Kasapidis et al. 2007; Bentur et al. 2008; Katikou et al. 2009) and its consumption causes many cases of deadly poisoning in Egypt (Zaki and Mossa 2005) and Israel (Bentur et al. 2008).

Another dangerous species deserving attention is the stinging siphonophoran *Physalia physalis*, which was recorded along Italian coasts in the last few years. Although the specimens found in Italian waters were small and therefore non lethal for humans (only one case of death recorded in Sardinia, possibly imputable to contact with a specimen of *P. physalis*), this species has not to be underestimated, both for its danger to human health and for a consequent economic collapse that it may cause in the tourism sector.

Early warning system

The phenomenon of NIS invasion imposes continuous attention, constant surveillance, methodic updating in order to follow in time and space the evolution of threatening organisms for the environment and public health. For this purpose, during the project, a series of informative alerting bulletins were produced by experts and sent to the Ministry of the Environment for their eventual diffusion. Further, harbor offices and fishery associations were involved in an awareness campaign through personnel training and production of posters and other informative material, and an early warning system which focused at preventing the risk of environmental and sanitary emergency triggered by NIS. Focal, for this purpose, is the role of fishermen who act as sentries for researchers. Such a bottom up system – from fisherman to researcher – gave positive results in terms of NIS records and allowed the registration of species not previously recorded in Italian seas, like the fishes *Seriola carpenteri* (Pizzicori et al. 2000), *Seriola fasciata* (Andaloro et al. 2005), *Seriola rivoliana* (Castriota et al. 2002; 2004), *Etrumeus teres* (Falautano et al. 2006), *Siganus luridus* (Castriota and Andaloro 2008), *Fistularia commersonii* (Falautano et al. 2011) and other organisms.

Fig. 2 – Example of species card from the taxonomical atlas

NIS and climatic changes

Data collection of NIS records since 1900 confirmed a certain correlation between the bioinvasion phenomenon and climatic changes which currently affect the Mediterranean Sea. In particular, analyzing non-indigenous fish species introductions in the eastern and western Mediterranean basins, from Red Sea and Atlantic Ocean respectively, revealed increasing number of records over time in both areas; such increases were found to have accelerated in the last decade, alongside the increase of superficial seawater temperatures (Andaloro *et al*. 2011). Although the study of NIS and climatic changes in the Mediterranean is still in its early stages, the data recorded during the Project seem to support the hypothesis of the influence of climatic changes on bioinvasion.

NIS monitoring 2.0

Based on previous experience and success stories, the project will strengthen the participation of active communities and citizens in the data gathering process, thus implementing the "environmental monitoring 2.0" concept to the NIS observation; engaging the public will make the observation system more effective, by filling the gap in information on NIS states and trends. The necessary Information and Communication Technology (ICT) platform - including web and portable device applications - will be developed and made available to the public to facilitate the collection and management of relevant NIS observation data, at the same time ensuring the necessary data validation by the researchers.

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The management and control of the California kingsnake in Gran Canaria (Canary Islands): Project LIFE+ Lampropeltis.

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The California kingsnake was introduced to Gran Canaria by the accidental or deliberate release of individuals bred in captivity. In 2007, its naturalization was confirmed in the east of the island. California kingsnake has become an important environmental problem due to the enormous social alarm and the damage caused to many endemic reptile species. Until 2011, this snake has settled in two areas in the Northwest and East of Gran Canaria (55 km^2) and some sightings and captures have been reported out of these areas. From 2007 to 2011, 1064 snakes were caught in Gran Canaria, mainly by visual searching and hand capture. The traps tested have failed and only artificial covers (e.g. wooden board used as artificial shelter) have had some success in catching snakes. The data obtained shows that the California kingsnake has a high ability to adapt and its spread to all of the island is more than likely. This snake will quite possibly impact the local reptilian population to the point where we see their total disappearance, especially in the areas with a higher density of snakes. The Life+ Lampropeltis and the new regulation of exotic invasive species could be the main devices to reduce the California kingsnake population and its gradual eradication in Gran Canaria.

The Islands are isolated ecosystems which are particularly vulnerable to the impacts caused by exotic species. In fact, invasive exotic species are one of the main causes of the loss of biodiversity on islands, and their control and eradication is one of the priorities of the programme of work on biological diversity of the Islands included in the decision VI-II/1 of the Convention on Biological Diversity (COP 8 Decisions 2006). Unfortunately, a very large number of exotic species are part of the flora and fauna of the Islands. In the Canary Islands, 1.567 introduced species have been reported (almost 11% of terrestrial fauna and flora), 183 being considered invasive (Arechavaleta *et al.* 2010).

Ophidia are poorly represented or absent in the native fauna of islands (López-Jurado *et al.* 2005), and the naturalization of exotic snakes can have a dramatic impact on endemic species. Examples such as the brown tree snake (*Boiga irregularis*) in the island of Guam, considered one of the 100 worst invasive species in the world (Lowe *et al.* 2000), the wolf snake (*Lycodon aulicus*) in Mauritius or the introduction of the viperous snake in Majorca and Minorca (*Natrix maura*), show the serious environmental and economic consequences of the introduction of these specialized predators on islands (Rodda *et al.* 2002; Rodda and Savidge 2007; Mateo *et al.* 2011).

Snakes are not part of the native fauna of the Canary Islands and there are no records of ancient introductions as in other archipelagos (Álvarez *et al.* 2010; Lever 2003). The references to the presence of snakes in the Canary Islands are very recent. In the last two decades there has been a significant increase in the number of snake sightings; mainly those species bred in captivity as pets.

In 2004, the Brahminy blind snake (*Ramphotyphlops braminus*) was detected in the South of Gran Canaria (López-Jurado *et al.* 2006). Only six years later, it was found on 5 islands in the archipelago. The rapid spread of this species is closely related to the production and trade of ornamental plants (De Urioste and Mateo 2011).

The naturalization of the California kingsnake (*Lampropeltis californiae*) was confirmed in 2007 in the east of Gran Canaria (Pether and Mateo 2007). This snake, originally from the south-west of the United States and the northwest of Mexico, has biological characteristics and environmental requirements that have favoured its trade as a pet-snake (Cabrera-Pérez 2009; Mateo *et al.* 2011). The introduction and spread of the species in Gran Canaria has been caused by the release or mass escape of individuals bred in captivity (Pether and Mateo 2007; Cabrera-Pérez 2009; Mateo *et al.* 2011).

The growing number of sightings caused social alarm among the population, not accustomed to the presence of snakes. Furthermore, once it was confirmed that endemic species had been affected, the California kingsnake became a serious environmental problem and the main risk of loss of biodiversity attributed to alien species of reptiles or amphibians in Spain (Mateo *et al.* 2011).

In 2008, the Government of the Canary Islands and the Cabildo of Gran Canaria launched a program to control the California kingsnake. Their main aim being to limit its distribution area; optimize the methods of capture; improve knowledge of its biology and behaviour as an alien invasive species; and promote awareness and citizen participation. From September 2011, this program has the support of the European Union, which is co-financing the Project LIFE10 NAT/ES/000565 LAMPROPELTIS- Control of the invasive species *Lampropeltis getula californiae* on the island of Gran Canaria.

Monitoring the invasion. Cartography.

The California kingsnake was first found in 1998 in El Barranco Real de Telde (La Solana) in the east of Gran Canaria (Pether and Mateo 2007). From 2005 to 2007, twenty individuals were caught, some of them in the north of the island (Cabrera-Pérez 2009). In 2006, this species became common in El Barranco de Telde (Mateo *et al.* 2011) and in the spring and summer of 2007, hundreds of sightings were recorded in La Solana. The first measures to control this species were taken by the Cabildo de Gran Canaria, who caught 47 individuals in an area of 25 km^2 (Pether and Mateo 2007) (Fig. 1).

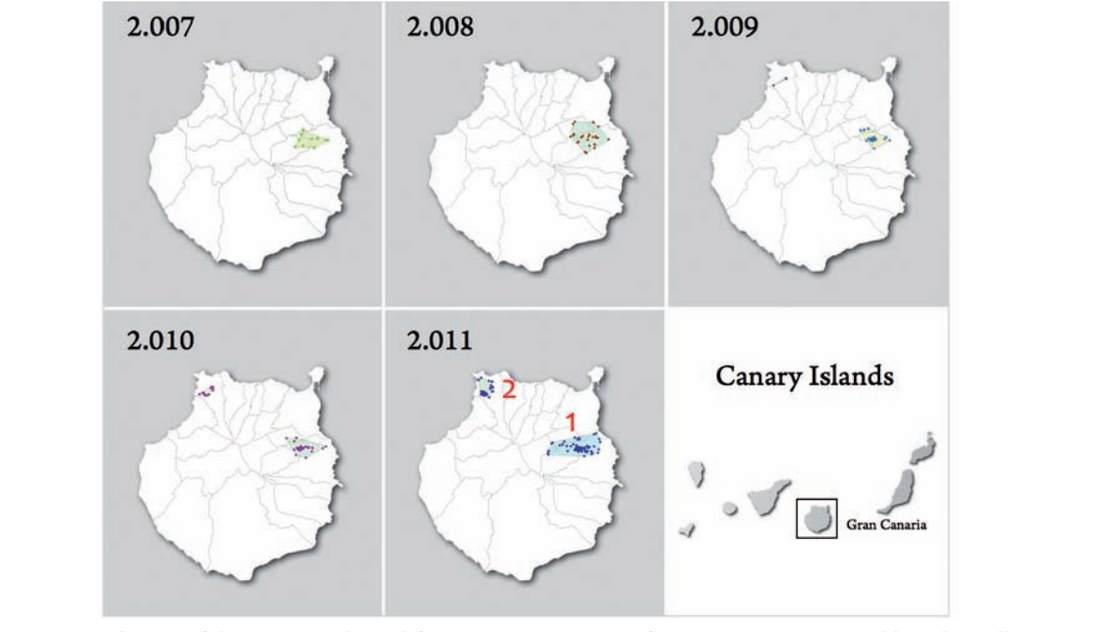

Fig. 1. Distribution of the *Lampropeltis californiae* in Gran Canaria from 2007 to 2011. 1) Telde-Valsequillo (primary fieldwork area); 2) Gáldar (secondary fieldwork area).

In 2008, the distribution area was defined by considering the location of the captures (92) and the 925 surveys conducted to the population. The results showed that the area occupied by the species could cover 38 km^2 in the east of Gran Canaria. Since 2009, the spread of this species has been estimated by the location of the caught snakes, rejecting those which are not related to their natural spread. In 2010, another snake population was found in the northwest of the island (Gáldar). The different color pattern in these snakes suggests a second introduction (Mateo *et al.* 2011).

Since 2007, the California kingsnake range has increased to around 55 km^2 (3,52% of Gran Canaria) in two well defined areas: Telde-Valsequillo, in the east of the island (45 km^2), and Gáldar in the northwest (10 km^2)(Fig. 2). In addition, some sightings and captures have been reported out of these areas, mainly in the south east of the island, increasing the risk of new introductions.

Captures

Since 2007, work teams for the visual searching and hand capture of snakes (Fig. 3) have been set up in Telde-Valsequillo (primary fieldwork area, Fig. 4), whereas in Gáldar (secondary fieldwork area, Fig. 5) the work started in 2010. Taking into account Hubbs (2009), these teams worked in the environmental conditions that made searching most efficient, mainly temperature and humidity.

Different kinds of traps for the passive capture of these individuals were tested: traps used in Guam to control *Boiga irregularis*, funnel traps and pitfall traps (Fig. 6). All of them were baited with mice. In some cases artificial barriers were also used. Since 2010, artificial cover objects consisting of 60 x 120 x 14 cm wooden board have been used (Fig. 6c). Until 2011, 104 wooden boards were put in an area of 0.25 km^2 in Telde- Valsequillo.

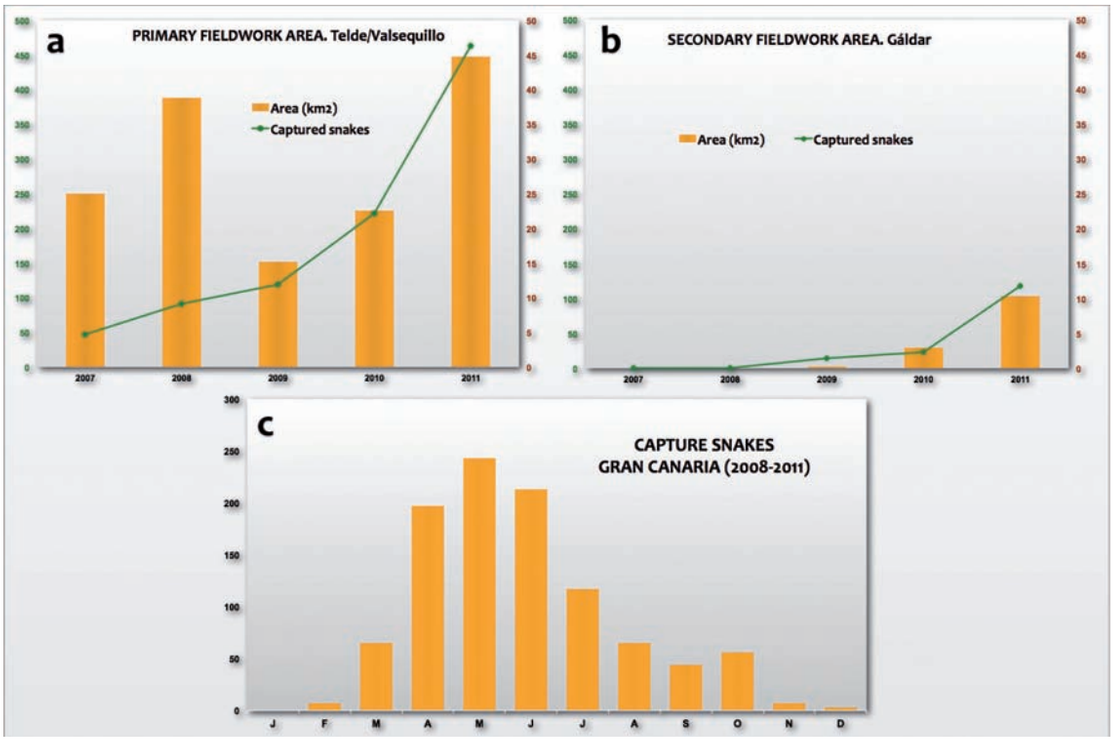

Fig. 2. Relationship between the captures in the fieldwork areas and the range evolution of California kingsnake from 2007 to 2011 (a. Telde-Valsequillo, b. Gáldar). c. Monthly variation of captures. Data of Gran Canaria from 2008 to 2011.

Fig. 3. Member of the fieldwork team in Gáldar. The location, size, weight, sex and color pattern of each snake is recorded in the field. Photo: Jorge Saavedra Bolaños.

From 2007 to 2011, 1064 snakes have been caught in Gran Canaria (Fig. 2). 86% of the snakes have been found in the primary fieldwork area, whereas only the 14% have been caught in Gáldar. Most snakes have been caught by hand after visual searching. The different kinds of traps tested have been unsuccessful, catching only two snakes. The failure of the traps may be the limited number of traps and the low snake density, the size selectivity of the traps or the seasonal cessation of feeding activity (Rodda *et al.* 2002), but the low interest of the snakes for the food in the traps and the high prey abundance in the area seem to be the main causes for the lack of success.

Fig. 4. Photograph showing La Solana (primary fieldwork area, Telde-Valsequillo). Photo: Francisco Alarcón Quintana

However, artificial cover objects proved successful for catching snakes. In 2011, 33 snakes (7.12%) were caught in the primary fieldwork area by using this method; 27 in less than two weeks and 8 in just one day. All of them were captured after very rainy days and with increasing cloudiness, as described by other authors (Joppa *et al.* 2009).

The captures have been achieved mainly from April to June (Fig. 2), and they decreased in summer and in the rainy months. The capture success is closely related to the snakes' activity and mating. Most captured individuals were adult and up until May the rate of male snakes was higher than female. From March onwards, pregnant snakes were found and in May the rate changed; catching more female snakes.

Fig. 5. Montaña de Amagro (secondary fieldwork area, Gáldar). Photo: Jorge Saavedra Bolaños

Furthermore, the juvenile rate in this period was very low, increasing after the breeding period, when the average size of the snakes decreased. All this data coincided with their habitual behaviour in their original habitat (Hubbs 2009).

Biology and Behaviour.

The California kingsnake (*Lampropeltis californiae)* has a mean adult size range of 76-122 cm, and a maximum size of 200 cm. Natural populations exhibit a white or light yellow banded pattern or a striped pattern on a black or dark brown ground color. However, there are other individuals that are jet black, with almost no trace of pattern (Pyron and Burbrink 2009). It is a fossorial and habitat generalist species, not limited to a specific habitat. It can be found anywhere in their distribution range, from 0 to 1800 metres altitude, being more prevalent under 900 metres. The optimum temperature for their activity is from 15.1ºC to 31.3 ºC and the critical maximum and minimum is 2 ºC and 42 ºC (Hubbs 2009). The diet of the California kingsnake is varied, including rodents, small mammals, birds, reptiles, amphibians and eggs. Sexual maturity is reached at age 3 or 5 years. The size of the egg clutch usually ranges from 3-24 (an average of 10) after a gestation period of 45 to 65 days post-mating.

All of the snakes captured in Gran Canaria have been killed and the size, weight, sex and color pattern of each individual has been recorded. From 2009 to 2011, the necropsy of more than 400 individuals was done to determine their sex and study their folidosis, their reproductive parameters, their diet and nutrition conditions. The gastrointestinal content and the mass fat percentage was analysed and the number of gravid females and eggs was fixed. In a sample of 27 individuals found in Telde-Valsequillo, the age of the individuals was established by analyzing the growing rings in different bones.

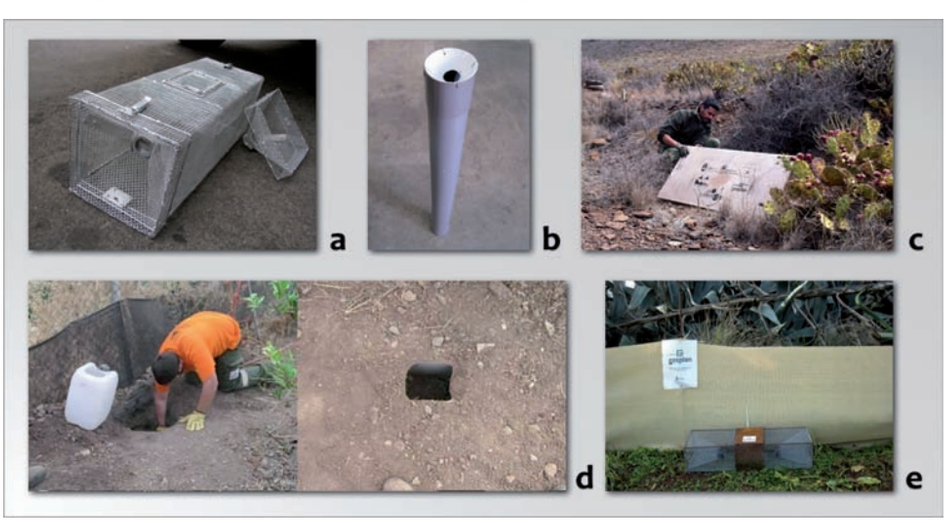

Fig. 6. Kinds of traps tested (a. funnel trap; b. PVC funnel trap; c. artificial covers; d. pitfall trap; e. artificial barriers with funnel trap). The artificial covers consist of 60 x 120 x 14 cm wooden boards. Photos a, b, d y e: José Miguel Sánchez Rivero. Photo c: Alejandro Ramírez Reyes.

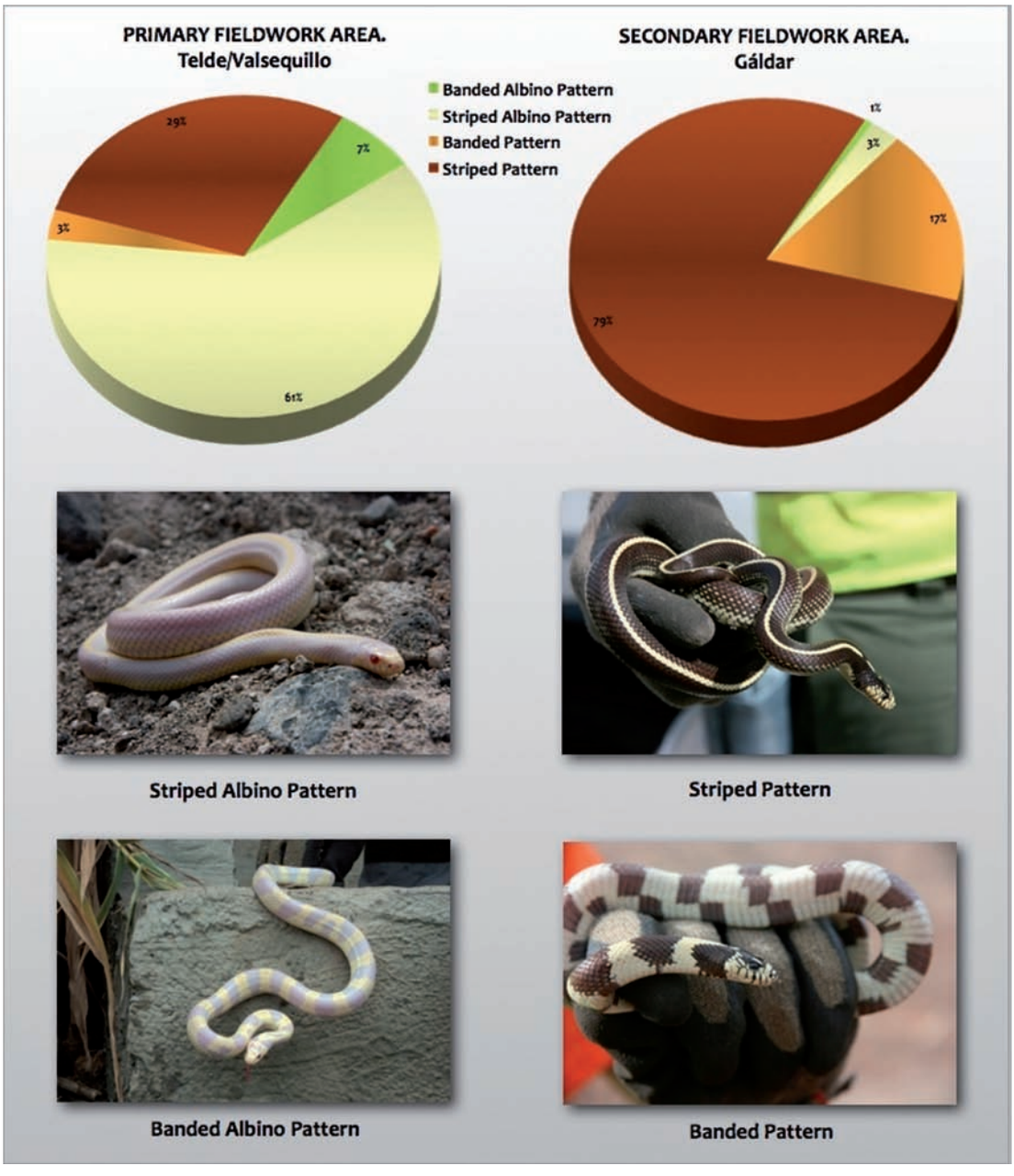

Fig. 7. Color patterns of California kingsnake: striped albino pattern, banded albino pattern, striped pattern and banded pattern (some aberrant color patterns have also been found in a lower percentage). In Telde-Valsequillo, the albino snakes prevail (68%), whereas in Gáldar most snakes show striped and banded patterns (96%). The number of albinos is aroiund 4% in Gáldar. Photos: Ramón Gallo Barneto (striped patterns and banded pattern) and José Miguel Sánchez Rivero (banded albino pattern).

The biometric data and the folidosis show that all the individuals caught in Gran Canaria belong to the Californian kingsnake (Table 1). These snakes showed four different color patterns: banded, striped, banded albino and striped albino. Some aberrant color patterns have also been found in a lower percentage. Both populations show significant differences in the color pattern (Fig. 8). In Telde-Valsequillo, the albino snakes prevail (68%), whereas in Galdar most snakes are striped (79%) and the number of albinos is around 4%. This data suggests that the population in Gáldar comes from a new introduction (Mateo *et al.* 2011).

	L. californiae (Pyron and Burbik 2009)	Gáldar	Telde-Valsequillo
Maximum length	200 cm	121 cm	130,3 cm
Minimum length		51,2 cm	10,5 cm
Average length	76-122 cm	94,9 cm	90,97 cm
Ventral	213-255	230-239	225-242
Dorsal	23-25	23-24	23-25
Minimum weight		393 gr	628 gr
Minimum weight		27 gr	11 gr
Average weight		187 gr	205,5 gr

Biometric data of 2010

Table 1. Biometric data of snakes captured in Gáldar and Telde-Valsequillo (2010). All the individuals caught in Gran Canaria belong to the California kingsnake (*Lampropelis californiae*).

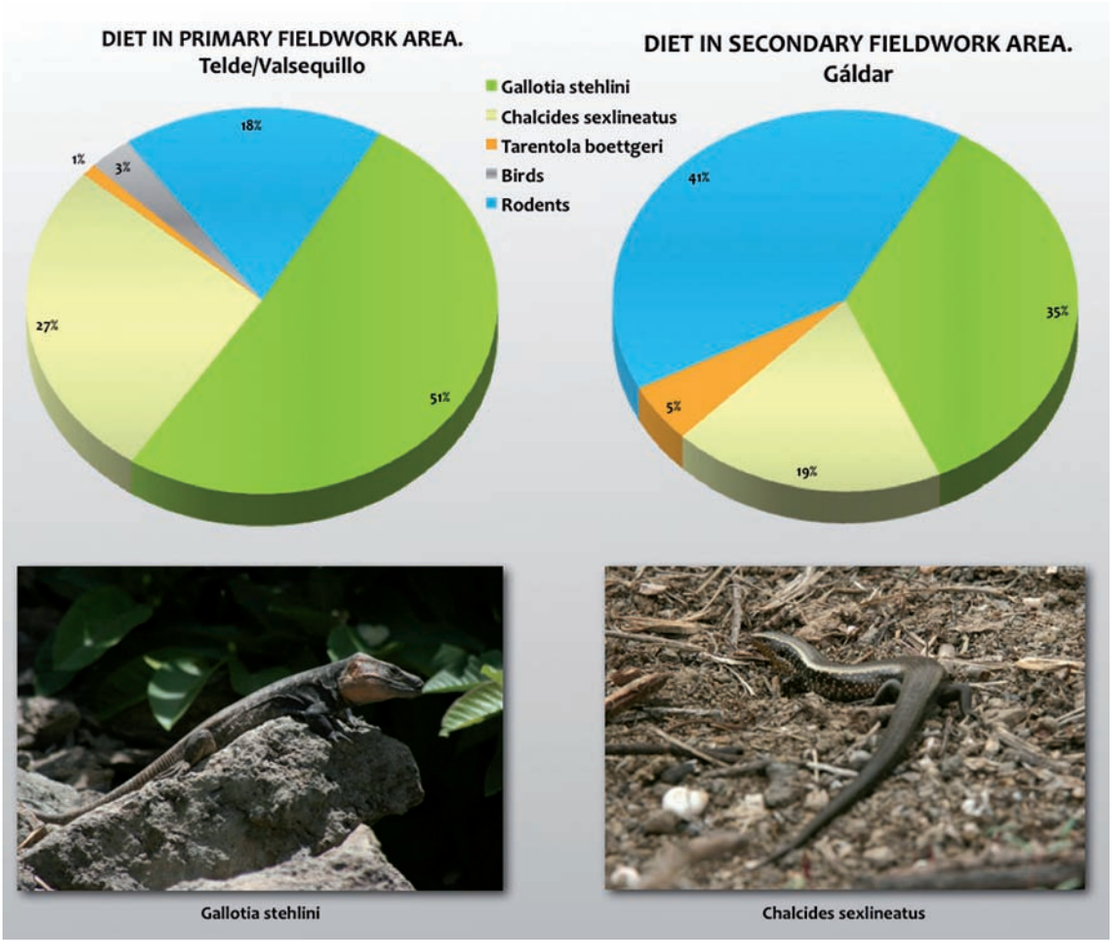

Fig. 8. Prey of California kingsnake. In Telde-Valsequillo (primary fieldwork area), most prey was reptiles, mainly the Gran Canaria giant lizard (Gallotia stehlini). In the secondary fieldwork area (Gáldar), the most important prey was rodents. Data of necropsies done in 2009 and 2010. Photos: Ramón Gallo Barneto.

Only 5% juveniles were found, also, there are significant differences in the size of the snakes in both populations. In 2011, the average length of the snakes in Gáldar was 110.66 cm, whereas in Telde-

Valsequillo the average was 89.53 cms. The average age of the analyzed individuals was 8.9 years.

The necropsys performed indicated that the diet was made up of 69% reptiles, 29.5% small mammals and 1.5% small birds. In the case of reptiles, the *Gallotia stehlini*, Gran Canaria giant lizard appeared in 43% of the cases studied; *Chalcides sexlineatus*, Gran Canaria skink, in 23% and *Tarentola boettgeri*, Canary Island wall gecko, in 3%. There are also differences between both populations. (Fig 9). In Telde-Valsequillo, most prey was reptiles, mainly the Gran Canaria giant lizard (51%), however, in the secondary fieldwork area, the most significant prey was rodents (41%). The data obtained shows that the specimens maintain a similar body fat percentage throughout the year (average rate of 7.12% of total body weight), with no significant differences between sexes. This demonstrates the good physiological state of the snakes, and shows they have no problem in finding food throughout the year.

The sex rate is balanced (females, 51.1%; 48.9% males), but in Gáldar the rate of females is slightly more than males (54% female/46% male). In 2009 and 2010, we found a high percentage of females with eggs (25% in 2009 and 85% in 2010). A high number of eggs were recorded in each female (16.8 on average) (Fig. 9).

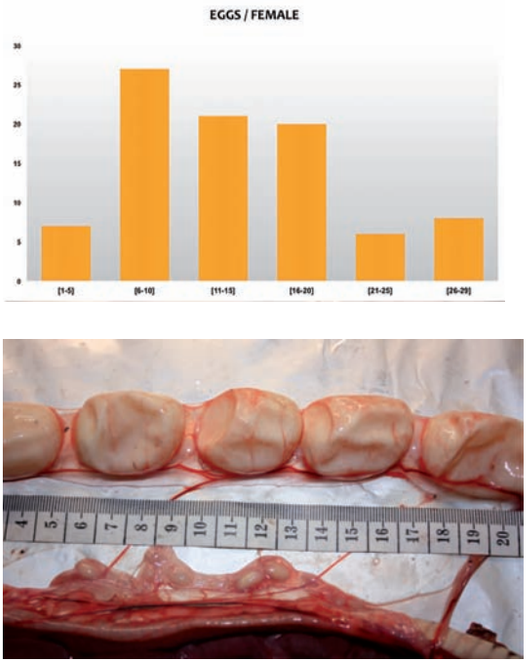

Fig. 9. a) Relationship between females snakes and number of eggs. The average number of eggs/female was 16,8. Data of necropsies done in 2009 and 2010. b) Female snake with well-developed eggs and oviductal eggs. Photo: Clara Patiño Martínez.

Regulatory Aspects

Up to 2011, no regulation against the importation and sale of the California kingsnake in the Canary Islands existed. This species was very popular among people fond of reptiles and it was very often found for sale in pet shops. Selling online contributed to the spread on the islands.

In November 2011, The Spanish Catalogue of Exotic Invasive Species (Real Decreto 1628/2011, de 14 de Noviembre) forbidding the ownership, transport and sale of living or dead individuals of all the species of the Colubridae in the Canary Islands, Ibiza and Formentera was passed. It also included not allowing the introduction of these species to the Islands.

This regulation is not only an important tool to avoid the introduction of potentially invasive snakes to the Canary Islands, but also to control the ones which are already on the islands. It binds people to legalize all the specimens bought before 2011 and provides the owners' voluntary handing over to the environmental authorities. This way, the introduction of new individuals in other areas should be avoided.

The LIFE+ Lampropeltis project

The Life+ Lampropeltis project began in September 2011, having a budget of 1.025.863 Euros and a length of four years. This project will develop new actions in order to improve the results obtained to control the California kingsnake, minimizing its impact on native biodiversity.

The environmental characterization range of California kingsnake and the information on the spatial ecology of populations recorded by radio-tracking will provide a deeper understanding of their biological activity (daily and seasonal activity, sites selected for hibernation, reproduction and egg laying, etc). Its correlation with environmental parameters may improve direct control actions, lowering the cost involved in implementing the programme.

The use of trained dogs for the detection of the California kingsnake in the wild may be a reinforcement to the activity of search and capture method. They may comb larger areas in a quicker and more effective way and they can also detect snakes in refugia, as suggested by other authors (Savidge *et al.* 2011). The first experiences with a canine team consisting of a dog (Belgian Shepherd Malinois) and its handler in a controlled environment have been successful.

As has been demonstrated in our previous experiences, the active role of the community to help control the spread of an invasion is important. For this reason, Detection and Early Warning Systems have been provided for citizens to voluntarily cooperate in the capture of snakes and contribute to the overall success of the eradication process. This mechanism is in place for prevention and early action, based on information provided by community members on a voluntary basis through the website: *http://www.lifelampropeltis.es/index.php/colabora* or by directly contacting local government authorities.

Finally, it is necessary to provide the tools for the prompt and continuous evaluation of the effectiveness and viability of control actions. In our case, such evaluation is very difficult due to the behaviour and biological characteristics of the California kingsnake. The Life+ Project has proposed molecular genetics techniques, specifically those based on the use of microsatellite markers, as an effective research tool to establish the effective size of natural populations and their genetic variability. Periodic analysis would be conducted in order to check if the populations have decreased and if the control measures have been successful.

Conclusions

Introduced into the wild by the accidental or deliberate release of individuals bred in captivity, the California kingsnake has settled in two areas in the Northwest and east of Gran Canaria. Both areas present different environmental characteristics and differences on diet, size, color pattern and sex rate of snakes, depending on their location.

The data obtained until 2001 showed that the California kingsnake has a high ability to adapt and acclimatize, so the spread over the island is likely, which could pose a serious risk to critically endangered species. Also, the increased numbers will quite possibly impact the local reptilian population to the point where we see their total disappearance, especially in the areas with a higher population density of snakes.

It is possible to reduce the density and the abundance of the California kingsnake by visual searching and hand capture. However, if the most favourable environmental conditions are determined, the task of capturing will be better. Other measures, such as the improvement of the traps and the use of trained dogs to detect snakes may increase the number of captures. In addition, the new regulation on exotic invasive species might reduce the risk of new introductions to the wild.

We expect to reduce the populations of California kingsnake and its gradual eradication throughout the Life+ Lampropeltis project. It is expected that we reduce the distribution area up to 50% in the northwest of the island and the containment of the population in the east of the island, stopping further migration of the species.

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Additional information

The LIFE+ Lampropeltis project *http://www.lifelampropeltis.com*

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Aerial broadcast of rodenticide on the island of Sa Dragonera (Balearic Islands, Spain). A promising rodent eradication experience on a Mediterranean island

Joan Mayol, Martí Mayol, Oriol Domenech, Joan Oliver, Miguel McMinn, Ana Rodríguez

The Natural Park of Sa Dragonera is a small group of non-habited islands just off the coast of the summer holiday destination island of Mallorca. Sa Dragonera, which gives its name to the Natural Park, is a massive limestone island of 362 ha that protrudes out of the sea as the northwestern extension of the Tramuntana mountain range of Mallorca. The island is over 4 km long with a maximum peak altitude of 360 m. The north coast of sa Dragonera is dominated by abrupt cliffs that plunge vertically in the turquoise blue Mediterranean. Along the southern coast, much less abrupt, the visitor can find beautifully preserved natural coves and the only harbor and landing place to access the Park. Outstanding natural values of Sa Dragonera are the important breeding colonies of six Mediterranean seabirds: shag, yellow-legged gull, Audouin's gull, Scopoli's shearwater, European storm petrel and Balearic shearwater (a critically endangered shearwater that only breeds in the Balearic Islands).

The island is also an important breeding site in the Mediterranean for the rare Eleonora's falcon. Other important bird species that breed on the island are the Peregrine falcon and the Balearic warbler. The osprey doesn't breed on sa Dragonera, but they do regularly fish in the sea strait that separates the island from Mallorca. The non-avian fauna is no less important, among which is the Balearic wall lizard, a survivor of the pre-human fauna of the Balearic islands, and 25 endemic invertebrates (mostly land snails and beetles). The flora of sa Dragonera includes 372 species, of which 12 are endemic to the Balearic islands.

In the 1970's a devastating development plan was

Fig. 1 - The complet team involved in the project: the flags were used as signal to the helicopter for precise flyways (See also map in fig. 3). Photo: Martí Mayol.

stopped by the mobilization of people of Mallorca that favored the conservation of the natural values of sa Dragonera instead of a large tourist villa. The island was bought by the local council of Mallorca in 1987 and in 1995 the Natural Park of Sa Dragonera was created with the inclusion of two small neighboring islands (Pantaleu and Mitjana).
After legal protection, the main environmental problem of Sa Dragonera was the large population of ship rats. Rabbits and house mice were also present on the island. These species are not native to the Balearic Islands, and even in the 70's, the private owner of the island tried to control the rat population by using massive amounts of a first generation rodenticide. Previous experiences in other Balearic Islets has been applied by our team, but never using aerial management techniques (Aguilar and Cózar 1989, Orueta 2003).

Fig. 2 - A young black rat (*Rattus rattus*) the most important target for this project. Photo: Joan Mayol.

The Balearic shearwater action plan and the management plan of the Park of Sa Dragonera including rodent eradication has a high priority conservation objective. The negative effect of rats in the Balearic Islands has been documented (Traveset et al. 2008) on endemic invertebrates guilds and the productivity of nesting seabirds, such as the European storm petrel and the Balearic shearwater. Rodents also have a devastating effect on the flora, predating seeds, seedlings and even the bark of bushes and tress. Rat density on Sa Dragonera has reached up to 50 individuals/ha, but has fluctuated in response to yearly control campaigns with rodenticide. Baits with rodenticide were laid out in baiting stations designed to protect lizards and land birds. Between 2001 and 2008, several control campaigns were carried out on the island, covering the most accessible areas, but leaving a large surface of rugged terrain untreated.
The positive results of these control campaigns lasted only a few months, and the rat population quickly recovered high densities, probably due to a recolonization from non treated areas. The cost and effort of these campaigns was very high, and with very poor results, and a complete eradication using an air drop of rodenticide was considered as probably the best solution, due to the extreme orography. The initial plan was to rely on the experience and technology used in New Zealand, and in 2009 one of the authors visited New Zealand hosted by Landcare Research. In 2010 an airdrop eradication was done on the Mediterranean island of Molara, Sardinia, Italy. M. Mayol, director of the Natural Park of Sa Dragonera, contacted the team that did the Tavolara (Anonymous 2009) eradication, and proposed a cooperation to do a similar airdrop on sa Dragonera. Finally the Dragonera airdrop was organized with the aid and cooperation of the Italian team, which also kindly supplied the bucket for the operation.

Preparation of the air drop was laborious, due to the fact that the helicopter had to follow the flight paths using a reference grid marked with flags displayed by a coordinated ground team. Unfortunatly, no GPS aided control system for the airdrop was available.

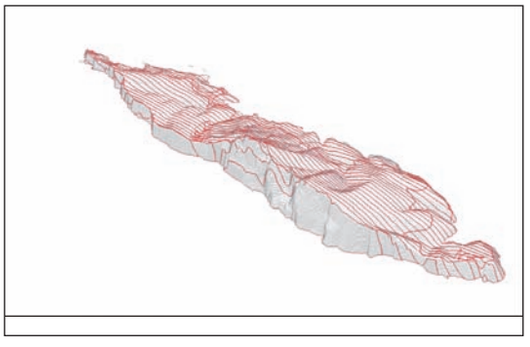

Fig. 3 - 3D model of Dragonera, with the flyways in read, every 40 m. Five perpendicular transects were marked in advance, and flags were located successively at each intersection by 3/5 men oving on the transect.

Two air drops with brodifacoum were done in January and February of 2011. The weather conditions were suitable for the dispersion of bait, and all minor incidents were promptly resolved. Although the dispersion of bait was controlled from the helicopter, a small amount of bait did fall into the sea during the flight paths of the northern cliffs. No mortality of sea life during the following weeks was detected. Additional bait was manually broadcast in buildings, caves, and other areas that could be a potential refuge for rodents.

The only negative side effect of the eradication was the death of yellow-legged gulls. Over 5000 gulls breed on Sa Dragonera, and the bait dispersion was carried out when the birds start to defend their territories, just before the laying period. During the weeks after the dispersion of rodenticide, an average of 13 gulls per day died of primary intoxication. This negative side effect was not considered of concern as the large populations of yellow-legged gulls has a negative impact on the biota of sa Dragonera, and the gulls are systematically culled on the main landfills of the large islands. No other mortality of birds or marine or terrestrial fauna was detected at all.

Post eradication monitoring using tracking tunnels and photographic trapping, has been carried out since the day after the last bait drop. The park staff have also been trained to identify any sign of the presence of rodents. After fifteen months of monitoring, no signs of rats or mice has been detected. Only a few rabbits have survived the bait drop, probably due to a winter baiting when the animals had more palatable food resources. We are still evaluating the results as a preliminary success, and the problem of the rabbits has to be correctly addressed in the near future.

Fig. 4 - This project is a very important victory for island biorestauration in the Mediterranean. Photo: Oriol Domenech.

It is very important to stop rodents colonizing again at Sa Dragonera, and a biosecurity protocol is a very important tool against a new infestation. The protocol has been implemented in the Park management, and all commercial boats visiting the island have been supplied with baiting stations. The local council of the nearest village on Mallorca has improved rodent control of the main harbors where supplies and visitors are ferried to sa Dragonera. Visitors are also informed of the project.

Fig. 5 - The bucked and the helicopter used in Dragonera, and Miguel Mcminn, one of the tecnical consultants in the operation. Photo: Joan Mayol.

Last spring (2011) Balearic shearwaters success-

fully fledged young birds near the main pier of sa Dragonera. During previous years with rats, all eggs were depredated very early during the breeding season. Other good news is the improved fruiting of bushes of the garrigue of Sa Dragonera, improving the amount of available food for terrestrial birds. In the near future we plan to continue monitoring the recuperation of the biota of sa Dragonera.

Sa Dragonera is now probably the largest island in the Mediterranean with no rats (Howald et al. 2007). We do hope that this project will serve as an example of what a restoration project can do for many other islands of the Mare Nostrum.

Technical aspects of the campaign

Product and dose used
Product: Brodifacoum pellets (0'005%)
Dose used: 14'02 kilos/ha
Timing of the operation: January-February. During the winter the public doesn't visit the park and coastal areas. The activity of endemic lizards is reduced and the Elonora's falcon are still in their wintering grounds in Africa. A summer drop would have compromised the breeding season of the falcon.
Dates: 13 de January and 8 de February 2011 (with a period of 26 days between treatments).
Duration of the flights: Two hours

Team involved
Marking of the flight grid on the ground: 17 people
Loading bucket: 6 people
Technical coordination: 6 people
Air team: Two pilots and a flight mechanic.
Control of island access during the operations: 3 people

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Rodent eradication on Molara Island and surrounding islets (NE Sardinia): from success to the riddle of reinvasion

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The eradication of rodents on islands, aimed at the conservation of seabird populations and other components of insular ecosystems, is becoming a common management practice. To restore island ecosystems, rodents (mainly rats Rattus spp. *and house mouse* Mus musculus*) are removed according to standardized methods, including the helicopter delivery of poisoned baits, which has allowed access to larger islands (up to more than 12,000 ha) or difficult to access islands (Howald et al 2007, Veitch et al., 2011). In recent years eradication projects have been carried out in the Mediterranean Sea (Genovesi & Carnevali, 2011), on small to medium sized islands: the largest of these where success has been confirmed are Lavezzi (73 ha, Pascal et al. 2008), Zannone (103 ha, Francescato et al. 2010) and Giannutri (240 ha, Sposimo et al. 2008), all treated by networks of bait stations placed on the ground.*
High predation rates by black rats Rattus rattus *on the largest population of Yelkouan shearwater* Puffinus yelkouan *(Baccetti et al. 2009; Zenatello et al. in press.) (Fig. 1), suggested the urgent adoption of conservation measures in the Tavolara archipelago (NE Sardinia), within the Tavolara – Punta Coda Cavallo Marine Protected Area. An action plan for an overall decrease of the rat impact was produced and operational strategies were evaluated for all different islands and islets of this area.*

Fig. 1. Yelkouan shearwater *Puffinus yelkouan.* Photo: Massimo Putzu

Here we report on the first actions that were put into practice, namely: black rat eradication from Molara island (360 ha), achieved by aerial distribution (cf. Veitch 2002) in October 2008, and ground-based black rat eradication on three islets.

Study area, materials and methods

Study area

Tavolara's group (Fig. 2) is composed of 2 main islands, Tavolara and Molara (600 e 340 ha respectively, 1900 and 1600 m from the nearest point of the Sardinia's coast; Fig. 3-4) and 4 islets, with a surface area between 2.2 and 13.6 ha, set in an intermediate position between the coast and the main islands.

The only wild mammals inhabiting these islands were the black rat *Rattus rattus* (absent only from two islets,) and *Mus musculus* (absent only from Molara). Feral cats are present on Tavolara, cows on Molara and goats are present on both.

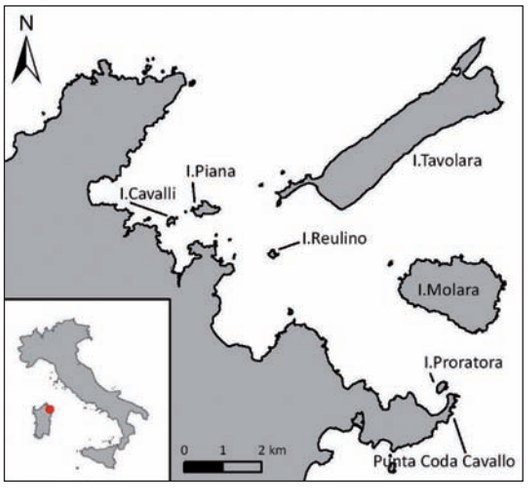

Fig. 2.Study area

Fig. 3. Molara Island from the top of Tavolara. Photo: Massimo Putzu

Trappings

In March and September 2008 we performed two four night trapping sessions (March: 19-22; September: 2-5) on Molara, in order to estimate the relative abundance of rats.

Fig. 4. Tavolara from Molara. Photo: Massimo Putzu

Materials and methods

A spreader bucket for the aerial broadcast of pellet baits has been purchased from HeliOtago, New Zealand and helicopters (Eurocopter Ecureuil AS 350 - B2) have been hired for the operation (Fig. 5). The pilot had no previous experiences of similar works.

Bait was chosen according to the results of palatability and longevity tests. The selected product was Brocum® (with 0.005% brodifacoum as the active ingredient). The formulation was 2-gram cereal pellets. Distribution trials for instrumental calibration and pilot training have been conducted using non-toxic baits. Trials showed that, from a height of 50 m, in absence of wind, pellets were distributed on a radius of 45 m, i.e. on 90 m-wide transects.

Livestock protection

To avoid poisoning of free-ranging livestock, two enclosures were built and c. 50% of the goats and 80% of cattle were herded in (total enclosures area: 1 ha).

Rat eradication on Molara

A transect map was made with GIS software and transferred on the helicopter's GPS. Distribution transects were spaced 50 m from each other, for a total transects length of 53 km (Figure 2).

In October 2008 two aerial distributions of bait were performed, spreading 12.3 kg of bait/ha on 1st October and 11.6 kg/ha on 21st October. The pilot's assistant manually switched the spread on and off. The two enclosures were excluded from aerial delivery. In these areas bait was placed inside tamper-resistant bait stations, and so was a buffer area surrounding the enclosures.

A 20 m wide belt running all along the sea coast, larger in two areas (Fig. 6), was baited by hand.

Post-eradication monitoring

To assess the success of the rat eradication we placed and monitored 29 monitoring stations, containing gnawing sticks, toxic and non-toxic wax blocks; six of them being located at most likely landing places.

Rat and mouse eradication/control on other islands.

Ground-based rodent eradication was performed on the three islets in winter 2009-2010. To determine eradication units for future operations (also on Tavolara) and evaluate the risk of rat reinvasion of Molara, rat specimens were trapped and collected for genetic analyses, in order to test possible genetic flow between rat populations in the archipelago and on the adjacent Sardinian coast. Genetic analysis was performed by genotyping 8 microsatellite loci (see Abdelkrim et al., 2005b; 2009) in four black rat populations (Tavolara Is., N = 30; Molara Is., N = 30; Piana Is., N = 30, Sardinian mainland - Capo Coda Cavallo, N = 24). DNA was isolated from rat tail tissues using the Puregene Kit (Gentra System), re-suspended in TE buffer and then preserved at -20°C. Each individual was genotyped for 8 microsatellite loci already used on *Rattus rattus* (see Abdelkrim et al., 2005b; 2009).

Results

Molara rat eradication

The relative abundance of rats on Molara was higher in late winter (0.75 ind/trap/night in March) and much lower in late summer (0.38 ind/trap/night in September), suggesting that summer was a critical period for rat survival. This evidence allowed us to identify the latter season as the best period to carry out the rat eradication on Molara.

A total of 7.4 tons of rodenticide bait was delivered on the island. Several technical problems occurred during the operation. The most serious of which was the malfunctioning of the spinner engine on both delivery sessions, so most transects were covered by vertical dropping (see Micol e Juventin 2002 for a similar episode). Pellet distribution on the ground was found to be in 10 m (wide stripes, alternating to c.40 m) wide empty stripes.
The comparison of the helicopter tracks recorded by GPS and the original planned transects showed marked discrepancies (up to 35 m in some cases). Nevertheless, in the first delivery only six areas, all smaller than 1 ha, were at distances greater than 40 m from the nearest treated point.
Considering both deliveries together, no areas existed with a distance of more than 30 m from the nearest treated point.
Starting two days after the first delivery, several rain showers were recorded, which steadily degraded most fallen pellets; after 21 days, on the date of the second delivery, most previous pellets already seemed considerably degraded.
On the day following the second delivery, a heavy and un-forecast rainfall (33 mm recorded by the nearest weather station) almost completely degraded the newest pellets. If any rat had survived the first delivery, therefore, pellets from the second one were available to them in adequate conditions only for a single night.
Carried out in a season when very few gulls (Laridae) are locally present, poisoning affected few non target species. Corpses of two barn owls (*Tyto alba*) and two ravens (*Corvus corax*) were found, both presumably dead after secondary poisoning.
Livestock that could not be herded into the enclosures was affected for an estimated one third of the goats; while none of the 6-7 free ranging cows died nor showed any problems.
Yelkouan shearwater reproductive success greatly increased after rat eradication on Molara, from total failure at the previous rat eradication reaching values of 0.6-0.8 fledglings per pair in 2009 and 2010.
After 21 months of an apparent absence of rats, signs of their presence were discovered in July 2010 along 1 km of the Molara coast, facing the Sardinian mainland, 1600 m far.

These signs of rats followed the appearance of several domestic rabbits (quickly captured and removed) in the previous winter. The responsibles of the introduction of rabbits to Molara are unknown.

Rats eradication from islets

From all three islets black rats were easily eradicated, but success was short lived.
After 6 months they were found again on the islet nearest to the mainland (Proratora, 4.6 ha, 170 m offshore), and also after two years at Cavalli (2,2 ha, 300 m offshore), although not yet on adjacent Piana (13,6 ha, 660 m far from land and 530 m from Cavalli).

Genetic analyses

All the analyzed loci are polymorphic, with a mean number of alleles equal to 10.
The highest values of genetic variability have been recorded for the Capo Coda Cavallo population, while the lowest one is for the population of Piana (Tab. 1). Molara and Tavolara populations have similar value of allelic richness, number of alleles and heterozygosity values (Tab. 1). Piana and Tavolara populations show evidence of heterozygosity excess.

Table 1. Mean allelic richness per locus (Na), observed heterozygosity (Ho), expected unbiased heterozygosity (He) and the P- value of departure from the Hardy-Weinberg equilibrium (P).

Population	Na	Ho	He	P
Piana	2.36	0.352	0.355	P < 0.001
Tavolara	4.22	0.510	0.554	P < 0.001
Molara	4.42	0.488	0.545	P = 0.28
Capo Coda Cavallo	6.67	0.715	0.724	P = 0.03

Fig. 5. Helicopter and bucket. Photo: Nicola Baccetti

All four populations are characterized by a high number of private alleles, a clear evidence of inter-population differentiation. Statistically, this is confirmed by AMOVA that shows low levels of gene flow among our populations (Fst = 0.33, P < 0.001), as well as by SAMOVA showing that the number of population groups that maximised the distribution of genetic variation was k = 4. Moreover, the cluster analysis conducted with the program STRUCTURE recorded the presence of four groups of populations (K = 4), each corresponding to one of the four analysed populations.
Finally, STRUCTURE indicates that the genotypes of two specimens of *R. rattus* collected on Molara during the post-eradication monitoring cluster within the mainland population (Fig. 7).

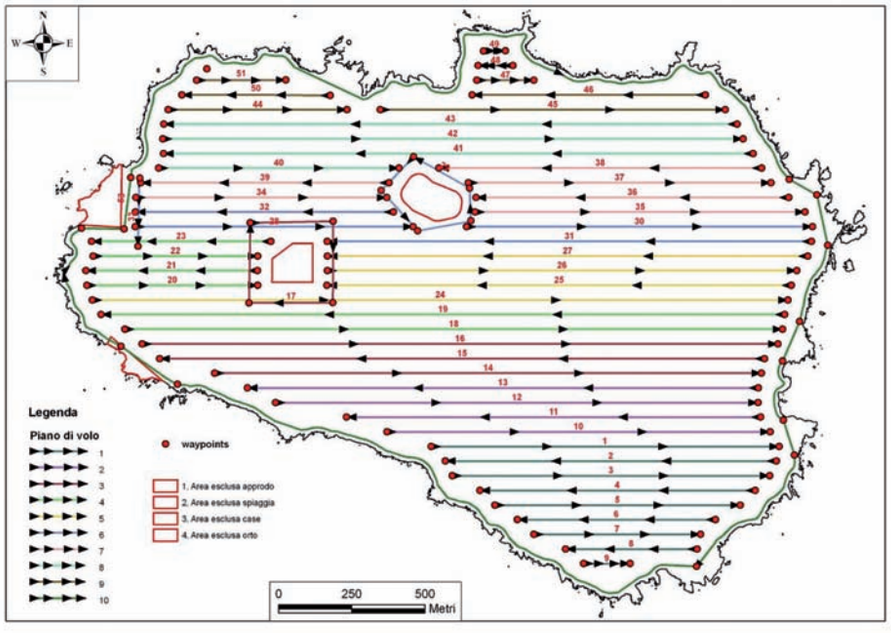

Fig. 6. Flight plan

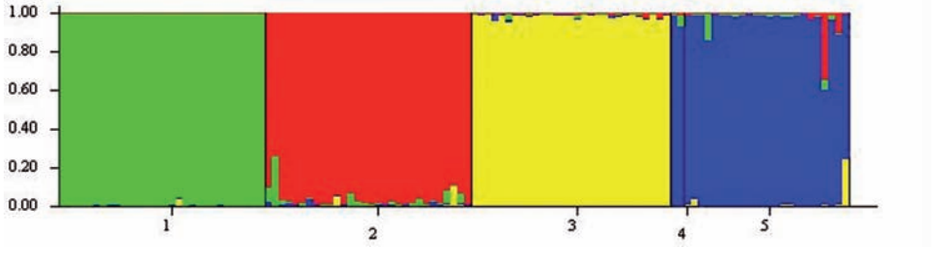

Fig. 7. Cluster analysis: the run with the highest posterior probability corresponds to K = 4. Black vertical bars delineate predefined populations: Group 1, Piana in green; Group 2, Tavolara, in red; Group 3 Molara pre-eradication, in yellow; Group 4, two Molara individuals collected after the eradication, in blue; Group 5, Capo Coda Cavallo, also in blue.

Conclusions

Aerial bait delivery proved an effective way to eradicate rats on Mediterranean mid-sized islands, where a ground-based action would not be possible for technical and/or economic reasons. The Molara operation represented the first case in the Mediterranean and Europe of using a helicopter and bucket. Problems with instruments and the lack of a trained pilot made sticking to strict protocol (Cromartry et al. 2002, McClelland 2011) impossible. The problems with instruments were at least partially due to inexperienced staff in their utilization (experiences gained on Molara have helped two eradications realized after with the same bucket, on Sa Dragonera, J. Mayol *et al.* this volume., and Montecristo, P. Sposimo *et al.* unpublished., where all instruments worked without noticeable problems). On the other hand, the failure of the spinner engine had also happened during the (succesful) eradication of an island larger than Molara (Saint-Paul Island, 800 ha, Micol e Juventin 2002), and prompted us not to suspend the flight.

The four populations of *R. rattus* collected in the Marine Protected Area Tavolara Punta Coda Cavallo resulted to be genetically differentiated based on summary statistics, as well as on cluster analysis. Thus, four independent eradication units with extremely reduced or absent gene flows existed within the Marine Protected Area. The two specimens collected during post-eradication monitoring on Molara Island clearly clustered with the Sardinian mainland population and not with the pre-eradication Molara population. The extinction of the private alleles that were present in all rats previously examined strongly suggests that: 1) a new population is present; 2) the combined effects of inexperienced staff, heavy rains and engine malfunctioning had not affected the success of the eradication efforts; 3) the potential source for rat recolonization is the Sardinia mainland population. Assessing whether recolonization occurred spontaneously (which would entail the largest sea crossing recorded for the species, 500 m being the maximum known, e.g. Russell et al., 2005; Russell and Clout, 2005) or following intentional introduction is unfortunately impossible to know. Unintentional transportation is also possible, but we judge this as the most unlikely option. The concurrent – and definitely intentional - introduction of rabbits represents an additional evidence of the intentional introduction option. However, the rapid reinvasion of the islet nearest to the mainland (130 m), followed by that

of the second nearest, shows that rat recolonization by swimming is a frequent phenomenon and confirms that a careful evaluation of the risks of recolonization is a fundamental measure before a rat eradication project is carried out (see Capizzi et al., 2010).

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13th MEDMARAVIS Pan-Mediterranean Symposium, Alghero (Sardinia), 14 - 17 October 2011

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Pl@ntInvasion: collaborative identification and information platform on invasive plants in French Overseas Territories

Thomas Le Bourgeois, Yohann Soubeyran

Invasive alien plants are a major threat to the biodiversity of French Overseas Territories, but information on these species is often incomplete or not easily accessible to many stakeholders. Better management of these species therefore hinges on sharing experiences with, and knowledge of, these pests. The Pl@ntInvasion project aims to build a specialised technical network by providing a set of tools (collaborative platform, database and plant identification applications) to help people in plant identification, obtain pertinent information and share experiences and problems.

Invasive alien plants are a major threat to the biodiversity of French Overseas Territories. These are mainly islands and constitute 4 of the 34 world biodiversity "hotspots".
Information on these invasive alien plant species is often incomplete or may be unavailable or difficult to access for many stakeholders. Better management of these species hinges on sharing experience and knowledge of these invasive alien plants and requires global collaboration between researchers, agronomists, ecologists, rangers, land managers, citizens, etc.
To this end, the Pl@ntInvasion[1] project - one of the case studies of the Pl@ntNet[2] project (Barthélémy et al. 2009; Barthélémy et al. 2011) - proposes to set up a specialised network that can be used by all those concerned with invasive alien plants in French Overseas Territories. The project was supported by the IUCN French Committee through the second phase of its initiative[3] (2009-2012) which was devoted to promoting the means and coordination necessary to prevent, survey and control invasive species in French Overseas Territories.
The Pl@ntInvasion platform can be used by members to share knowledge, data and discussions, but it also makes its species information and identification tools available to the wider public. It currently contains information on approximately 300 alien plant species that have already been documented and are considered as invasive in at least one of the territories.

IT tools

The project operates through a combination of four main IT tools interacting with each other:

- The Pl@ntInvasion collaborative platform (Fig.1) is part of the Pl@ntNet-community main platform developed with Elgg[7] V.1.7.15, a leading open source social networking engine. It is the hub of communications between project members, allowing them to work in a common space and share documents, wikis, bookmarks, discussions, photo albums, questions and all information on invasive plants and their management. Members may comment on all documents, texts and photos available on the platform, and discuss a whole range of issues. Discussions on, or additional information about, a document are structured and can be used to update the document regularly. This means the community can be challenged or called upon for any purpose, for example, the identification of an unknown species from an uploaded photo, or improvements in the content of a recommendation sheet for species control. Each document, album or discussion can be restricted to members only, or can be opened up to public access. Direct links are provided to species information sheets and identification systems.

Fig. 1: First page of the Pl@ntInvasion platform providing an introduction to the project, direct access to resources, tools and recently uploaded documents (discussions, photo albums, documents, bookmarks, etc.)

- The plant identification system offers two different approaches. “Identify” is an image recognition process (Boujemaa et al. 2001; Yahiaoui et al. 2006). The user can submit one or several photos corresponding to different parts of the plant (e.g. seedling, stem, leaf, flower, fruit, etc.). The system will compare these photos to those in a referenced image base and sort the species by probability (Fig.2). Process efficiency partly depends on the quality and diversity of the reference base which is currently being finalized. “IDAO”[5] is an identikit system (Grard et al. 2009; Grard et al. 2008; Le Bourgeois et al. 2004) that guides users through a series of step-wise choices and simple schematics to identify a plant based on its morphological and habitat characteristics. Final identification is expressed as the similarity (ranked percentage probability) between the unknown specimen and information on the type of specimen in the database. This IDAO tool for invasive plants is not yet available on the platform but several applications for weeds, trees and pollens have already been published and are available.

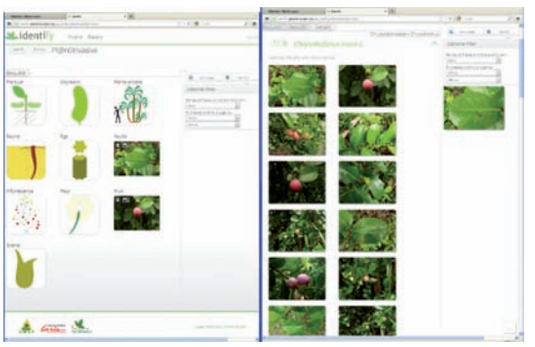

Fig. 2: “Identify” screen for submitting photos of different parts of a species, and the result obtained (example of the identification of *Chrysobalanus icaco* L. from photos of a leaf and fruit)

Both identification systems provide access to supporting text and images of candidate species, helping the user confirm identification.
These applications are compatible with a range of mobile electronic devices (Smartphones, PDAs and Tablets), allowing on-site identification and immediate action.

- All field observations and species-related information is managed in the database. Species datasheets (Fig.3) are automatically generated from this database and are available to all on the collaborative platform, as well as identification systems. The database was initially operated as an offline single-user tool but now uses a new system (“DataManager”[6]) that supports multi-user access, online or offline use from a local or network base and syncing with other bases. This facilitates the installation and use of local databases in each territory, all temporarily or permanently linked to a central database.

Species datasheets are linked with local, national or international databases such as EPPO (European Plant Protection Organisation) or GISD (Global Invasive Species Database) to provide invasive plant descriptions, invasive risk assessments, and information on control measures.

Uses

There are two main ways of using the Pl@ntInvasion collaborative platform:
- As a member of the public you can consult the main page and access species datasheets, identification tools and all documents and discussions open to the public.
- If you wish to become a project member, you need to log in and provide a password on the Pl@ntNet-Community platform then apply for membership of the Pl@ntInvasion project. Once you are a member you can access all discussions restricted to project members.

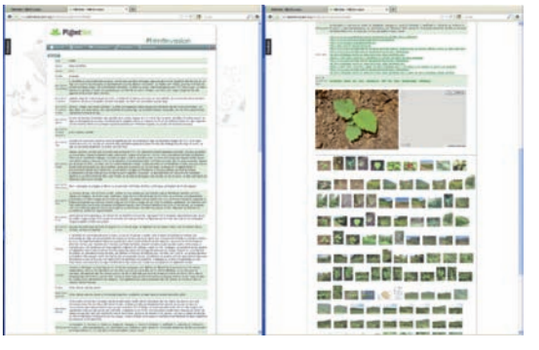

Fig.3: Datasheet for *Rubus alceifolius* Poir.

The platform currently uses only the French language as it is used by mainly French-speaking stakeholders. It has 28 members in France, New Caledonia, French Polynesia, La Reunion Island, French Guiana, Saint Pierre and Miquelon, Guadeloupe, Mauritius, Comoros Islands and Seychelles where French is spoken.

Conclusion

This collaborative platform and the tools it provides, primarily address the needs of those involved in the border control of plant imports, in plant import regulations, plant protection services, decision makers, land managers, scientists and citizens who are not familiar with botany and need information to prevent the introduction of invasive plants or the management of invasive plants. It should facilitate relations between players who can interact, discuss

and exchange information through the platform and gradually build up a network on alien invasive plants. It is particularly suited to researchers, developers, suppliers, producers and policy makers and will provide a better understanding and better management of invasive plants in French Overseas Territories.

The Pl@ntInvasion sub-project is funded by Agropolis Foundation as part of the Pl@ntNet project.

(1) *http://community.plantnet-project.org/pg/groups/516/plntinvasion/*
(2) *http://www.plantnet-project.org/papyrus.php?langue=en*
(3) *http://www.especes-envahissantes-outremer.fr/*
(4) *http://community.plantnet-project.org/*
(5) *http://idao.cirad.fr/*
6) *http://community.plantnet-project.org/pg/groups/5320/plntnetdatamanager/*
(7) *http://www.elgg.org/index.php*

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Occurrence of major Invasives in Nilgiri Biosphere Reserve, India: Perspective and Prospective

Sasi Ramasamy, Arumugam Rajendran

Invasions of alien species have a major focus in biogeography, ecology and conservation (Stadler et al., 2000). Biological invasions by alien species are now considered one of the main factors in biodiversity loss and endangered species listings worldwide (Ota, 1993). An alien species which becomes established in natural or semi-natural ecosystems or habitat is an agent of change and threatens native biological diversity (IUCN, 2000).
About 40% of the species in the Indian flora are alien, of which 25% are invasive. Human activities are supposed to be one of the main triggers of invasions (Williamson, 1996). IAS (Invasive Alien Species) may cause changes in environmental services such as flood control, water supply, water assimilation, nutrient recycling, conservation and regeneration of soils (GISP, 2004).
It is worth noting that such IAS have not only disturbed the environment and ecosystem but have also threatened the indigenous flora of the state (Khanna, 2009). Even though the Nilgiri Biosphere Reserve in South India has been extensively explored ecologically, in recent years much attention has been given to invasion of this area by weeds.

Nilgiri Biosphere Reserve is one of the eight hottest hotspots in the world, situated at the confluence of the Western and Eastern Ghats of India. It lies between 110˚ 36' to 120˚ 00' N Latitude and 760˚ 00' to 770˚ 15' E Longitude. The region generally receives 2000 - 7000 mm of rainfall and is rich in natural resources. Apart from the biological richness of the Nilgiri Biosphere another most important character of the Nilgiris area is its cultural polyvalence.

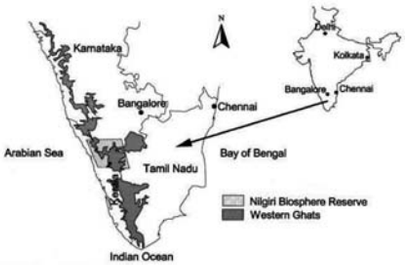

Fig. 1 Location map of Nilgiri Biosphere Reserve (India)

The comprehensive field survey was conducted during 2010 – 2011 and the plant species collected and identified with the help of local floras. The specimens were deposited in the Herbarium (BUH), Department of Botany, Bharathiar University, Coimbatore, Tamil Nadu.

Helichrysum bracteatum (Vent.) Andrews - **(Ever Lasting Flower).** A native to Australia, *Helichrysum bracteatum* is grown for their leaves and used in beddings and borders. Also, the whole plant is made into a paste and applied to stop bleeding (Paulsamy *et al*., 2007). The present study designated that the species is growing in, and on the margins of evergreen forests of the Nilgiris. The plant is associated with *Brachylepis nervosa* and is exclusively endemic to the Nilgiris. The increased spread of *H. bracteatum* is affecting the endemic species *Brachylepis nervosa*.

Ulex europaeus L. **(Gorse)**. A native of Western Europe, *Ulex europaeus* was first introduced as an ornamental plant and became naturalized. It is an ideal plant to learn how a nitrogen-fixing invasive plant can affect the soil ecosystem temporally. According to the present survey, this species is intermingled with economically important species like *Berberis tinctoria*, *Disporum leschenaultianum* and also the endemic species *Viburnum hebanthum*. The growth of *Ulex europaeus* is very fast and its spines very sharp. It also suppresses the growth of indigenous species.

Lantana camara L. **(Spanish Flag).** A native of tropical America, *Lantana camara* was first introduced as an ornamental plant. The ripened berries are consumed by wild birds and animals. Leaf extracts exhibit antimicrobial, fungicidal, insecticidal and nematicidal properties. The present survey determined that the species grows well in any ecological condition and withstands heavy pollution and high temperatures. As a result, it occupies the indigenous locality, disturbs the growth of native species and replaces indigenous species such as *Bacopa monnieri* and *Bidens biternata* from the native environment.

Cytisus scoparius (L.) Link **(Scotch broom or broom).** A native to Europe, *Cytisus scoparius* appears to be dominating vast areas of the grasslands in the Nilgiris (Zarri *et al*., 2004). It can be used as a fuel wood. Our present survey observed that the species grows well in, as well as the margins of evergreen forests of Nilgiris. Sometimes it grows alongside *Eucalpyptus globulus* and *Rhododendron arboreum* subsp. *nilagirica* (an endemic plant which grows in the high altitudes of Nilgiris). The multiplication of this endemic species is decreased when compared to the invasive *Cytisus scoparius*, hence it occupies more area.

Acacia mearnsii De Wild. - **(Black wattle tree).** A native of southeastern Australia, *Acacia mearnsii* is one of the fastest-growing trees of the highland tropics, widely used as a source of tannin, fuel wood, charcoal, poles and green manure (Anon., 1980). The present survey observed that the species is growing well in the margins of evergreen forest and also along roadsides. It can withstand heavy pollution and biotic disturbances. Due to its demands on water supply, there is less possibility of native plants growing under or near this species.

Eupatorium glandulosum Michx. (**Forest killer)** is a Mexican species, first introduced as an ornamental plant. The species creates a serious environmental problem as it is decreasing the number of native species as well as a reduction in fodder and medicinal species, thereby affecting the biodiversity and the economy based on the grasslands. (Tiwari and Rajwar, 2010). It multiplies easily through dispersal of seeds and occupies its new locality in a very short time.

Eucalyptus globulus Labill.- **(Southern blue gum).** A native to Australia, the timber is quite heavy and oil is distilled from its leaves. *Eucalyptus globulus* may deplete the soil of nutrients and break down the soil structure, which will affect the water-holding capacity of the soil and the long-term sustainability of the plantations, particularly where site preparation is intensive (Jonesa *et al*., 1999). The present study noted that the species can be planted as a monoculture in disturbed areas, especially near roadsides. The growing of *Eucalyptus globulus* not only affects the native environment but also suppresses the growth of other invasives which are growing near or under this species.

Discussion and Conclusion

The list of alien species is increasing every year due to the large number of pathways for species to enter and become established in the country. Sharma *et al.* (1977) enumerated 221- species of exotics from Nilgiris, Tamilnadu. Among this 221- invasive alien species, 7- species are considered serious invasives in the extensive list. Raghu banshi *et al*. (2005) highlighted the outcome of the workshop to discuss various aspects relating to alien species and biodiversity in India. Negi and Hajra (2007) advised that the occurrence of invasive alien species cannot be considered harmless to native and endemic flora.

Human invention is the major cause for invasive alien species, especially in cleared habitats. The invasive alien species are able to modify the original native environment. It is often associated with the decline in species diversity and the biomass of herbaceous nature flora and are often implicated in modifying soil properties that might affect the success of native plants.

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New publications

Identifying Invasive Freshwater Shrimps and Isopods

The surface fresh waters of the UK support 10 native species of amphipods (true shrimps), mysids (opossum shrimps) and isopods (hog louse). To these have now been added a further 7 introduced species. Evidence from the European mainland suggests that a further 15 species, native to the Ponto-Caspian region of south east Europe, are expanding their distributions across the continent. Many are taking advantage of inland shipping and the extensive canal system that now links most of Europe's main river basins. Others were early deliberate introductions to lakes in the Baltic states that, due to their tolerance of a range of water salinities, appear to be spreading along coastal regions.

While its island status makes the UK relatively difficult for fresh- and brackish-water species to colonise, it is believed that all of these Ponto-Caspian species have the potential to reach the UK in due course, where they may become invasive and threaten the native fauna. This was illustrated in 2010 by the first record in Britain of the amphipod *Dikerogammarus villosus*, which is now confirmed in four widely scattered localities.

This guide produced by the Freshwater Biological Association (FBA) on behalf of the Department for Environment, Food and Rural Affairs (DEFRA), has been written in response to this recent arrival and the recognition that other species are likely to turn up in the UK in due course. It is designed to enable the identification of invasive non-native freshwater amphipods, mysids and isopods, including those species that are not currently recorded from the UK, in order to facilitate their detection should they manage to reach this country, and to draw attention to this possibility. It shows how to identify both currently present introductions and these potential invaders and how to distinguish them from the native fauna. It is fully illustrated with line drawings showing whole animals and specific identification features, and is designed for use by those without specific knowledge of crustacean identification. It covers invasive Ponto-Caspian species in the families Janiridae (*Jaera*, 1 species), Mysidae (*Hemimysis*, 1 species; *Limnomysis*, 1 species; *Paramysis*, 3 species), Corophiidae (*Chelicorophium*, 3 species) and Gammaridae (*Dikerogammarus*, 3 species; *Echinogammarus*, 3 species; *Obesogammarus*, 2 species; *Pontogammarus*, 1 species), along with established invasive species in the families Crangonyctidae and Talitridae. Identification is by means of pictorial guides and associated text, with a dichotomous key for separating genera of Gammaridae, Crangonyctidae and Talitridae.

The guide, which is designed to be printed as an A5 booklet, is available as a free download from *www.fba.org.uk/downloads*. The booklet will be available from the FBA as a printed booklet in a few months' time, once feedback has been received and incorporated on any errors that need correcting. Therefore, if you do have any comments, please email these to the author: *mdobson@fba.org.uk*.

Detecting and preventing new incursions of exotic animals in Australia

The Invasive Animals Cooperative Research Cen-

tre has just released a report on 'Detecting and preventing new incursions of exotic animals in Australia', by Wendy Henderson and Mary Bomford. It contains Australian data collected on incursions at large, smuggling and stowaway interceptions, and thefts and seizures from private keeping. Each identified species has been assessed for its risk of establishing in the wild in Australia.

This report presents data on incursions and interceptions of exotic vertebrates in Australia that have occurred within the country and at the national border, over the past 10 years. It includes data on species (that are not widely established) found 'at large' in the environment, and seizures, surrenders and thefts from private keeping within Australia. It also includes data on animals intercepted entering the country as stowaways or in attempted smuggling incidents. Information on animal numbers and species and incident locations (at state/territory level) is presented, providing a national picture of which exotic vertebrates have been sighted at or within Australian borders. High-risk species are identified for future priority biosecurity actions, to prevent new pests establishing.

Data sources included state, territory and federal government agencies, the Zoo and Aquarium Association and online publications. Information varied in quantity and quality from the different sources, with some agencies having far more detailed information than others. The reporting of animal sightings and interceptions depends on (a) the general awareness of threats posed by exotic species and (b) the effectiveness of pest-related legislation and its implementation (which in turn is dependent on government resources).

The report is available online at *http://www.feral.org.au/?p=49089*

BioInvasions Records

BioInvasions Records is a new open access, rapid peer-reviewed international journal focusing on applied research on alien species and biological invasions in aquatic and terrestrial ecosystems from around the world. BioInvasions Records is a continuation of the former Aquatic Invasions Records, an electronic supplement of the open-access international journal Aquatic Invasions. BioInvasions Records is devoted to bridging the gap between scientific research and the use of science in decision-making, regulation and management in the area of introduction of invasive alien species (IAS) and biodiversity conservation. The journal provides a forum for professionals involved in research and management of IAS. BioInvasions Records contributes to rapid information dissemination, risk assessment procedures and early warning systems on IAS.

The journal provides the opportunity of timely publication of first records of aquatic and terrestrial invaders and other relevant information needed for risk assessments and early warning systems. Also, relevant technical reports and conference proceedings can be considered for publication in this journal. In contrast with "Aquatic Invasions", "BioInvasions Records" will have more applied focus and cover all *taxa* and ecosystems. The very first edition of BioInvasions Records is available here: *http://www.reabic.net/journals/bir/2012/Issue1.aspx*

Proceedings of 2nd International Workshop Invasive Plants in the Mediterranean Type Regions of the World (2010-08-02/06, TR, Trabzon)

The Workshop, co-organized by the University of Igdir and The Turkish Ministry of Agriculture was held in Trabzon (Turkey), from 2 to 6 August 2010. It was attended by more than 90 participants from 29 countries (Australia, Armenia, Azerbaijan, Bulgaria, Chile, Croatia, Czech Republic, France, Greece, Hungary, India, Iran, Israel, Italy, Lithuania, Malaysia, Morocco, Portugal, Saudi Arabia, Serbia, Slovakia, Slovenia, South Africa, Sudan, Syria, Switzerland, Tunisia, Turkey, UK, USA). Experts from the other Mediterranean Type Regions of the World (Northern Chile, California, the Cape Region of South Africa, and Western Australia) presented their experience with invasive species. The workshop consisted in plenary sessions and small working groups, allowing participants to network and to discuss current and future projects.

The electronic version of the Trabzon proceedings is now available on the EPPO website at: *http://archives.eppo.org/MEETINGS/2010_conferences/mediterranean_ias.htm*

Events

NEOBIOTA 2012 - Halting Biological Invasions in Europe: from Data to Decisions

11-14 September 2012 – Pontevedra, Spain

The progressing and escalating threats posed by invasive alien species in Europe suggest that immediate cooperative, specific planning is necessary if we are to have any chance to halt biodiversity loss. Scientific, technical, political and legal actions need to be put in place urgently in order to diminish the ecological and economic impacts of biological invasions.

In this framework, NEOBIOTA 2012 – the 7th European Conference on Biological Invasions - will provide an international high-level forum to incorporate research into decision making processes and management of invasive alien species. NEOBIOTA will constitute an important opportunity to advance the dialogue and strengthen cooperation between the scientific community, conservation agencies, stakeholders, and policy and decision makers.

Researchers, representatives from governmental entities, non-profit organizations, and any person or party involved in biodiversity conservation and natural resource management are invited to participate and share ideas, new results and opinions in the field of biological invasions.

CONFERENCE TOPICS

- Impacts of biological invasions
- Management of biological invasions
- Ecology of biological invasions
- Evolution of biological invasions

Background information, a draft programme, and registration information will be sent out shortly at the conference website *http://eei2012-neobiota2012.blogspot.com*

For questions you can contact the NEOBIOTA 2012 Conference Secretariat
neobiota2012@gmail.com

18th Australasian Weeds Conference 2012

8-11 October 2012 - Melbourne, Victoria, Australia

The conference will showcase recent advances in weed science, extension and policy across Australian and international communities and landscapes.

The program will provide valuable information and networking opportunities for anyone with an interest in aspects of weed legislation and development of practical solutions to evolving weed problems.

The Conference will focus on: ‘Developing solutions to evolving weed problems’ and will address the following sub-themes:

- Introduction of new weeds
- Weed management in aquatic systems
- Weed management for biodiversity conservation
- Evaluation of weed management outcomes
- New technology
- Understanding weed distributions
- Weed management in cropping systems
- Policy and legislation
- Weed management in grazing systems
- The future of weed R&D
- The role of Landcare
- Eradication theory and practice
- Local government’s role in weed management
- Weed control and food security

Learn more about the conference at the website:
http://www.18awc.com/

International Symposium on Current Trends in Plant Protection with ESENIAS Workshop - Managing Invasive Alien Species in SE countries: the way ahead

25-28 September 2012 – Belgrade, Serbia

The ESENIAS Workshop – Managing Invasive Alien Species in SEE countries: the way ahead, is a continuation of series of workshops on invasive species in the Western Balkan countries and as of

this year, in wider area of the South Eastern Europe. The workshop will focus on discussion about further steps in creation of the regional list of invasive species (availability and sharing of information, project activities), current practices in management of invasive species (elimination, control measures, characterization of invasiveness) and monitoring of invasive species.

The workshop is organised by the Institute for Plant Protection and Environment from Belgrade in co-operation with:
-Faculty of Agriculture of the Novi Sad University, Department for Environmental and Plant Protection
-Faculty of Science of the Novi Sad University, Department of Biology and Ecology, and
-European Environmental Agency
as co-organizers, and upon public invitation of the Ministry of Education and Science for 2012.

The Symposium and featured workshop will take place in the Hotel Prestige, in the vicinity of the Belgrade Racetrack. The program of the Symposium includes topics related to current issues and trends in plant protection, with emphasis on novel research methods.

Learn more about the symposium and featured workshop at the website:
http://www.izbis.com/aktuelno-e.html

IUCN World Conservation Congress 2012

6–15 September 2012, Jeju, Republic of Korea

The IUCN World Conservation Congress is the world's largest and most important conservation event. Held every four years, the Congress aims to improve how we manage our natural environment for human, social and economic development.

The 2012 World Conservation Congress will be held from 6 to 15 September 2012 in Jeju, Republic of Korea. Leaders from government, the public sector, non-governmental organizations, business, UN agencies and social organizations will discuss, debate and decide solutions for the world's most pressing environment and development issues.

The Congress starts with a Forum where IUCN members and partners discuss cutting edge ideas, thinking and practice. The Forum leads into the IUCN Members' Assembly, a unique global environmental parliament of governments and NGOs.

Effective conservation action cannot be achieved by conservationists alone. The 2012 IUCN World Conservation Congress is the place to put aside differences and work together to provide the means and mechanisms for good environmental governance, engaging all parts of society to share both responsibilities and the benefits of conservation.

Learn more about the congress at the website:
http://www.iucnworldconservationcongress.org/

Symposium: Rapid evolution during biological invasions

6-7 September 2012 - Fribourg, Switzerland

The 2012 Fribourg Days of Ecology & Evolution will explore the facilitating role of evolution in invasions, particularly of rapid adaptive evolution, which has recently become a major subject of research. We want to bring together researchers studying various aspects of rapid evolution in the context of biological invasions and across *taxa*, involving:
(i) rapid evolutionary change in the invader,
(ii) in the environment of the invader in the introduced range, and, as a special case,
(iii) in the context of biological control introductions.
The underlying process is the genetics of adaptation.

Special emphasis will be given to the role of hybridization and polyploidization. Ecological and evolutionary functional genomics provide exciting insights into the dynamics of invasion of genomes when previously diverged species are brought into contact, and these new developments will be highlighted.

Learn more about the symposium at the website:
http://www.unifr.ch/biol/ecology/CUSO/EE-day2012/index.html

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