

Dealing with invasive alien species in the French overseas territories: results and benefits of a 7-year Initiative

**Yohann Soubeyran, Jean-Yves Meyer,
Marc Lebouvier, Benoit De Thoisy,
Christophe Lavergne, Frank Urtizberea
& Florian Kirchner**

Biological Invasions

ISSN 1387-3547

Volume 17

Number 2

Biol Invasions (2015) 17:545-554

DOI 10.1007/s10530-014-0766-2



Your article is protected by copyright and all rights are held exclusively by Springer International Publishing Switzerland. This e-offprint is for personal use only and shall not be self-archived in electronic repositories. If you wish to self-archive your article, please use the accepted manuscript version for posting on your own website. You may further deposit the accepted manuscript version in any repository, provided it is only made publicly available 12 months after official publication or later and provided acknowledgement is given to the original source of publication and a link is inserted to the published article on Springer's website. The link must be accompanied by the following text: "The final publication is available at link.springer.com".

Dealing with invasive alien species in the French overseas territories: results and benefits of a 7-year Initiative

Yohann Soubeyran · Jean-Yves Meyer · Marc Lebouvier ·
Benoit De Thoisy · Christophe Lavergne · Frank Urtizbera ·
Florian Kirchner

Received: 26 February 2014 / Accepted: 6 August 2014 / Published online: 27 August 2014
© Springer International Publishing Switzerland 2014

Abstract Invasive alien species (IAS) are one of the most serious threats to the rich and unique biodiversity of the 13 French overseas territories (FOTs) scattered across three oceans and two continents. To address this critical issue, a dedicated Initiative has been conducted since 2005, with the support of a large panel of national and local experts and stakeholders. This paper summarizes the main results and benefits of this project after 7 years. As a first phase, an unprecedented overview of IAS and their impacts in all the FOTs was achieved. A total of 630 alien taxa were recorded, among which 258 plants, 52 terrestrial vertebrates and 32 invertebrates were identified as a threat, or a potential threat, to native species and/or natural habitats. Gaps in the knowledge about invasive species were also highlighted and a comprehensive set

of recommendations was developed. Using a range of targeted collaborative actions and promoting the exchange of information and regional cooperation, the Initiative raised awareness of invasive species issues, improved access to information and strengthened local and regional capacities. In this paper, we report on the outcomes of the Initiative and what remains to be done with regards to the prevention of new introductions, early detection, rapid response and public awareness, as well as future challenges.

Keywords French overseas territories · Islands · Network · Capacity building · Regional cooperation

Introduction

The 13 French overseas territories (hereafter FOTs) are distributed across three oceans, at latitudes ranging

This paper is dedicated to the memory of Michel Pascal, alias “Ratator”, an active member of the Initiative.

Y. Soubeyran (✉) · F. Kirchner
Comité français de l’UICN, 26 rue Geoffroy St Hilaire,
75005 Paris, France
e-mail: yohann.soubeyran@uicn.fr

J.-Y. Meyer
Délégation à la Recherche, Gouvernement de la Polynésie
française, BP 20981, 98713 Papeete, Tahiti, French
Polynesia

M. Lebouvier
UMR CNRS 6553 Ecobio, Université de Rennes 1,
Station Biologique de Paimpont, 35380 Paimpont, France

B. De Thoisy
Association Kwata, 16 avenue Pasteur, BP 672,
97335 Cayenne Cedex, French Guiana

C. Lavergne
Conservatoire botanique national de Mascarin, 2 rue du
Père Georges, 97436 Colimaçons Saint-Leu, Reunion
Island

F. Urtizbera
Association SPM Frag’iles, BP 4421, 97500 Saint-Pierre,
Saint-Pierre and Miquelon

from sub-Arctic to sub-Antarctic, including equatorial and tropical regions (Fig. 1). Most of these territories are islands, with the exception of French Guiana in South America. They host a significant part of the world's biodiversity (Kier et al. 2009) and are home to more endemic species than the whole of continental Europe (UICN France 2013). They are also severely affected by the global biodiversity crisis (Vié et al. 2009), with 11 out of these 13 territories present in five global biodiversity hotspots, namely Polynesia–Micronesia, Madagascar and the Indian Ocean Islands, Caribbean Islands, New Caledonia and Mesoamerica (Myers et al. 2000).

Like most regions of the world, the FOTs face the growing threat of invasive alien plant and animal species. Impacts of invasive alien species (IAS) on native species or natural habitats are well documented on several French overseas islands such as the sub-Antarctic islands (Frenot et al. 2001, 2005), Reunion Island (Baret et al. 2006), New Caledonia (Beauvais et al. 2006) and French Polynesia (Meyer 2004). For instance, the tree *Miconia calvescens* in Tahiti (Meyer and Florence 1996) or the little fire ant *Wasmannia auropunctata* in New Caledonia (Jourdan 1997) are well known worldwide. In contrast, little is known about invasive species in some other territories (e.g. French Guiana, Saint-Pierre and Miquelon) despite these being an emerging threat to their biodiversity (Delnatte and Meyer 2012; Sargent et al. 2013).

As FOTs share many IAS and the same management issues, the solutions developed in one territory can be shared with the others. Local stakeholders also face common constraints, such as low public awareness, limited access to information, complex distribution of responsibilities across different relevant administrative services, lack of coordination or inadequate and/or limited proactive policies. Within this context, an “Initiative on invasive alien species in the French overseas territories” (hereafter the Initiative) was launched in 2005 by the IUCN French Committee, with the objectives of improving access to information, increasing management capacity, and strengthening cooperation among the FOTs (i.e. at the national level), and among FOTs and their neighboring countries (i.e. at the regional scale). This paper reviews the main results and benefits brought by the Initiative after 7 years of implementation.

Implementation of the Initiative

The idea to launch a specific action on IAS in the FOTs originated from the work led by the Overseas Territories Working Group of the IUCN French committee, whose aims are to enhance and disseminate knowledge, influence public policies and build the capacities of local stakeholders on the biodiversity of these territories.

The Initiative started in 2005 with the recruitment of a full-time project officer and the appointment of one or two local coordinators in each territory, chosen among recognized IAS experts and/or natural resource managers in their territory. Two action plans were implemented between 2005 and 2011, mobilizing a wide network of national and local experts and stakeholders, mainly from research institutions, NGOs and public agencies. The budget was approximately 140,000 € per year.

The first stage of the action plan (2005–2008) aimed to achieve a complete overview of IAS issues in the FOTs and to develop recommendations on all aspects of their management. Each local coordinator was in charge of mobilizing experts and stakeholders from their territory, in order to collect, compile and validate baseline information on IAS. In addition, a vast review of the literature was conducted and online databases were consulted, including the Global Invasive Species Database (GISD; www.issg.org/database/welcome), the Pacific Island Ecosystems at Risk project (www.hear.org/pier), the botanical databases of the *Conservatoire Botanique National de Mascarin* (flore.cbnm.org) and the *Herbier de la Polynésie française* (www.herbier-tahiti.pf), as well as other relevant information sources.

A workshop held in Paris in 2008 with all the local coordinators validated the conclusions of the overview on IAS in the FOTs and developed a comprehensive set of recommendations, which was then published as a technical report widely distributed at the national level (Soubeyran 2008).

In total, more than 100 experts and stakeholders from the FOTs and Metropolitan France were mobilized over the 3-year first stage. Information on the major IAS in FOTs was integrated into the GISD, both in English and French, in collaboration with the IUCN/ISSG (Invasive Species Specialist Group of IUCN). A dedicated website (www.especes-envahissantes-outremer.fr) was set up to provide access to all the

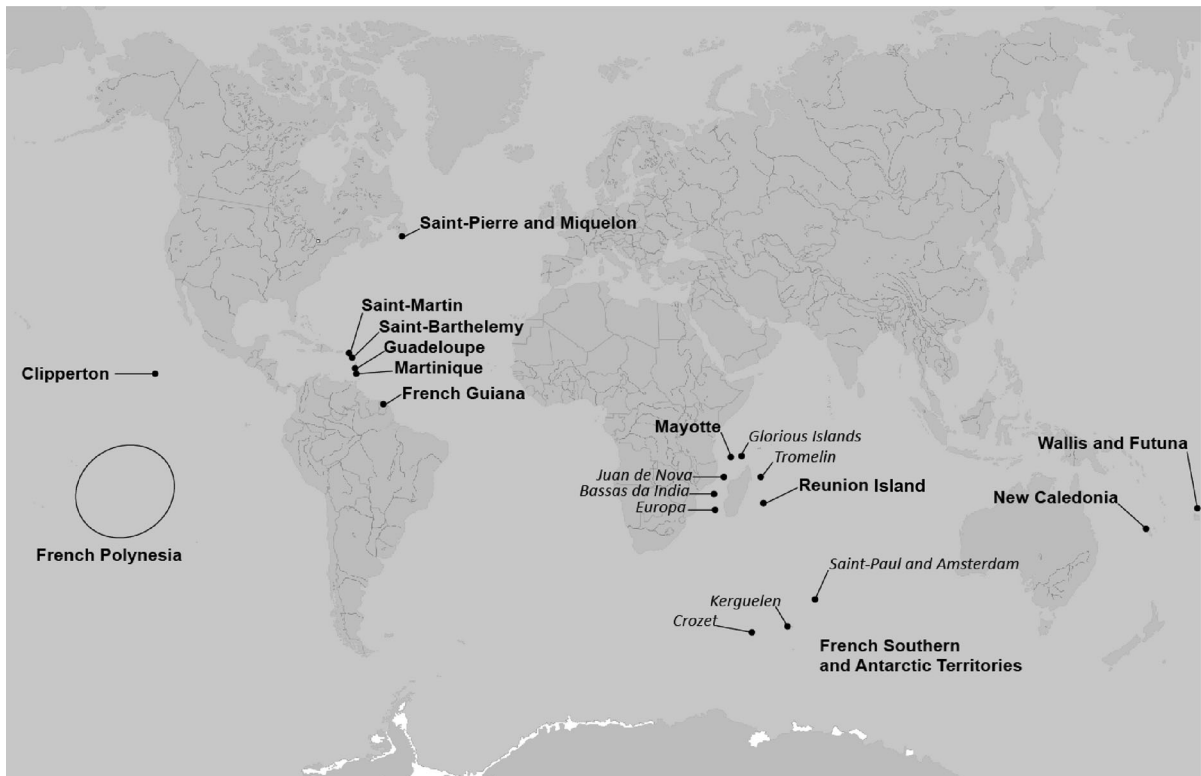


Fig. 1 Location of the 13 French overseas territories (in *bold*). Among these, only the French Southern and Antarctic Territories (made up of the lands in *italics*) and Clipperton have no permanent human population

data gathered in the FOTs, including a species database (630 alien taxa), a bibliographic database (490 references) and numerous documents such as protocols for control, guidelines for preventive action and regulations in force.

The aims of the second stage of the action plan (2009–2011) were to implement the priority recommendations from the first phase, to strengthen the stakeholders' network and to promote regional cooperation. As IAS are a global issue, supporting a regional approach and developing cooperation with neighboring countries was crucial. The highlights of this second phase were the organization of three regional workshops in the Caribbean (Guadeloupe, November 2009), the Pacific (New Caledonia, December 2010) and the Indian Ocean (Mayotte, January 2012). Each workshop gathered about 60 participants from the FOTs and neighboring countries, including researchers, land and resource managers, local authorities' services from the environment, agriculture and forest sectors, members of NGOs, representatives of

the private sector, etc. Each workshop was dedicated to priority IAS issues identified by local stakeholders and concluded in specific recommendations on the topics addressed.

During both action plans, technical guidelines (e.g. UICN France 2010; UICN France and ONCFS 2011) and information leaflets were produced, for practitioners and the general public respectively, and local media were mobilized to raise awareness on IAS issues.

IAS and their ecological impacts in the FOTs

One of the first results of the Initiative was the unprecedented inventory of IAS and their impacts in all the French overseas territories (Table 1). Among the 630 alien taxa recorded in the online Initiative IAS database, 258 plant species, 52 terrestrial vertebrates and 32 invertebrates are listed as causing substantial impacts or as being potential threats to native species

Table 1 Estimated numbers of alien and invasive alien terrestrial plant, vertebrate and invertebrate species in the French overseas territories

Territories	Plants		Mammals		Birds		Reptiles		Amphibians		Freshwater fishes		Terrestrial invertebrates	
	Alien	Invasive*	Alien	Invasive**	Alien	Invasive**	Alien	Invasive**	Alien	Invasive**	Alien	Invasive**	Alien	Invasive**
Saint-Pierre and Miquelon	196	4	6	5	4	?	0	0	1	0	0	0	?	?
Saint-Martin	130	3	7	6	7	2	12	3	3	2	?	?	?	2
Saint-Barthelemy	150	2	3	3	?	?	10	2	4	2	?	?	?	1
Guadeloupe	1260	11	8	6	15	2	11	3	4	3	3	3	?	4
Martinique	1260	4	6	5	20	1	6	3	4	3	5	3	?	5
French Guiana	490	2	4	4	?	?	4	1	?	?	?	1	?	?
Mayotte	585	25	9	6	11	2	6	1	0	0	1	1	?	3
Reunion Island	>2,000	102	14	10	26	5	15	4	2	0	11	4	?	6
New Caledonia	2,008	100	12	11	14	4	4	2	1	1	9	5	>518	6
Wallis and Futuna	338	18	8	8	5	2	1	1	1	1	2	2	?	6
French Polynesia	>1,558	59	12	11	13	4	3	2	0	0	4	2	?	9
Clipperton	?	0	1	1	0	0	1	0	0	0	0	0	?	?
French Southern and Antarctic territories														
Scattered Islands (Europa, Bassas da India, Juan de Nova, Glorious Islands, Tromelin)		2 [£]	5	5	7	1	1	0	0	0	0	0	?	?
French Subantarctic islands (Crozet, Kerguelen, Saint-Paul and Amsterdam)	118	11	8	8	1	0	0	0	0	0	5	1	37 [§]	7

* Main invasive alien plants in natural and undisturbed habitats

** Invasive alien terrestrial vertebrates and invertebrates species with local impacts on native species and/or natural habitats, locally documented or known to be important in other similar ecological contexts

£ and ** According to the online database of the IAS Initiative in the French overseas territories. The main references used appear in “Appendix 1”

£ Data for Europa

§ Data for Crozet and Kerguelen

? indicates unknown data

and natural habitats. The Initiative showed that IAS have largely contributed to the documented loss of native biodiversity in the FOTs and are still a major threat to native species and habitats (Soubeyran 2008). For instance, the plant species *M. calvescens*, *Psidium cattleianum*, *Clidemia hirta* or *Hedychium gardnerianum* invade natural tropical forests in several tropical islands and prevent the germination, growth and reproduction of many native and endemic plants (e.g. Baret et al. 2006; Lavergne et al. 1999; Meyer 2004). Goats (*Capra hircus*), sheep (*Ovis aries*), rabbits (*Oryctolagus cuniculus*), cattle (*Bos taurus*), pigs (*Sus scrofa*), the Javan deer (*Cervus timorensis*) and the white-tailed deer (*Odocoileus virginianus*) cause severe damage to native vegetation, affecting the associated wildlife and accelerating soil erosion (e.g. Chapuis et al. 1994; De Garine-Wichatitsky et al. 2005; Meyer 2007; Micol and Jouventin 1995). Rats (*Rattus rattus*, *Rattus norvegicus*, *Rattus exulans*) and cats (*Felis catus*) are predators of many native seabirds and terrestrial birds, some of them being critically endangered (e.g. Faulquier et al. 2009; Jouventin et al. 2003; Thibault et al. 2002). The rosy wolf snail (*Euglandina rosea*) and the little fire ant (*Wasmannia auropunctata*) disrupt native invertebrate communities (e.g. Coote and Loève 2003; Jourdan 1997). Freshwater native fauna is threatened by introduced tilapias (*Oreochromis mossambicus*, *Tilapia* sp.) and guppies (*Poecilia reticulata*) (e.g. Keith 2002, 2005). Finally, half of the 100 of the world's worst IAS (Lowe et al. 2000) are established in the FOTs.

The Initiative also highlighted gaps in knowledge. For instance, it was impossible to give accurate estimates of alien invertebrates in each territory because of the poor taxonomic knowledge for several invertebrate groups and sometimes because of the lack of species inventories. Similarly, marine alien species are poorly known although they can be a serious threat, as demonstrated by the recent invasion of the lionfish (*Pterois volitans*) in the Caribbean Sea (Arias-González et al. 2011) and the reporting of the invasive tunicate *Cionia intestinalis* in Saint-Pierre and Miquelon (Sargent et al. 2013). More generally, the impacts of the majority of alien species considered as invasive or potentially invasive in FOTs have not been quantified, and the mechanisms underlying these impacts (e.g. competition, alteration of species interactions, hybridization, etc.) are still insufficiently studied.

Benefits of the Initiative

The Initiative resulted in many benefits, including an increase in public and local politics awareness, local capacities, networking among territories and regional cooperation.

First of all, the Initiative has contributed to raise awareness on the ecological and socio-economic issues regarding biological invasions and it has accelerated recognition by stakeholders of IAS being an important threat to tackle. Informal working groups with many different stakeholders were set up in most of the territories at the start of the Initiative to carry out the data collection process. Knowledge gaps were highlighted, which led to the launch of local studies in some territories to address the identified lack of data. For instance, in 2007, the Wallis and Futuna local authorities launched an inventory of alien species on the three archipelago islands with the support of regional experts from New Caledonia and French Polynesia. For territories with more experience on IAS, such as the French sub-Antarctic islands, French Polynesia and Reunion Island, the Initiative focused on consolidating local interest and support for actions already being implemented. Recognition of the importance of IAS issues in the FOTs by the French Government also favorably changed since the beginning of the Initiative. In 2008, guidelines were issued by the French Ministry of Environment for the implementation of local strategies against IAS in the French overseas territories, endorsing a recommendation of the Initiative. Since then, Reunion Island published its strategy in 2010 and French Guiana in 2012. The French West Indies (Guadeloupe, Martinique, Saint-Martin) are expected to publish their strategies in 2014.

As the FOTs share very similar IAS issues, with sometimes different solutions being developed in the different territories, they have a strong interest in an enhanced cooperation. By collecting, synthesizing and providing IAS information to all stakeholders in the FOTs, the Initiative promoted information exchanges and experience sharing among territories through an informal network formed by the local coordinators and all the contributors. Thanks to this network, New Caledonia benefited from the preparatory steps carried out in Reunion Island for the implementation of an "IAS Monitoring Committee"; and the "Cybertracker" software (<http://cybertracker.org/>) used in New

Caledonia for the early detection of invasive plants was subsequently tested in Martinique. The three regional workshops that were organized between 2009 and 2012 contributed to identifying priority actions and enhancing regional cooperation. For instance, the recommendations developed at the Guadeloupe workshop (2009) were used as a basis to draw up the French West Indies strategy on IAS. And among the outcomes of the Mayotte workshop (2012) was the adoption by all participants of a motion to build a regional network on IAS in the Indian Ocean. The idea of this network was subsequently supported by the Indian Ocean Commission, a regional intergovernmental organization, and it should now be developed in the near future. Through collaboration with the GISD team, the French expertise on IAS found a global audience. This collaboration resulted in a lot more new data being added into the GISD and into the development of multi-language capabilities to serve a broader audience. The completed and updated IAS information for FOTs in the GISD will benefit neighboring countries facing similar invasive species.

Overall, the Initiative contributed to reduce the differences on the IAS issue among the FOTs. The longevity of this ongoing project is a good indicator of the positive dynamic it has generated, with important results being achieved and a strong and persistent interest from local stakeholders. Due to the worldwide distribution of the FOTs, the Initiative has enabled the sharing of information and knowledge at large regional scales and provided outcomes of international scope.

Future challenges

The number and impacts of IAS might increase in the near future, due to four main factors: the increasing traffic of passengers and goods, the growing demand for ornamental plants, domestic animals or exotic pets, the accelerated degradation of natural habitats due to growing populations and urbanization, and climate change which could favor the establishment of new alien species, their spread and the magnitude of their negative impacts (Hulme 2009; Hellmann et al. 2008; Kueffer et al. 2010; Lebouvier et al. 2011). Early detection and rapid response to emerging IAS are recognized as critical steps to reduce the high ecological and economic costs of biological invasions. Very

few coordinated systems on this issue are implemented in the FOTs (as well as in continental France), such as those existing in New Zealand or in USA (e.g. Kraus and Duffy 2010), but early detection and rapid response systems are being developed in Reunion Island, New Caledonia and in the French sub-Antarctic islands. In addition, the trade of exotic pets, aquarium fish and ornamental plants (including Internet sales) should be better regulated and controlled. Legal frameworks have evolved to deal with the introduction and management of IAS, but their implementation is often hampered by limited human, technical and financial resources, and they still need to be strengthened. Further efforts are also required to increase awareness, notably towards policy makers and administrations, especially regarding the IAS subject to conflicts of interest among local stakeholders. This is the case, for instance, with *Acacia mangium*, used in Mayotte and in French Guiana for agricultural or mine restoration projects (Delnatte and Meyer 2012), and *P. cattleianum*, which is cultivated in Reunion Island for its edible fruit, but recognized as one of the worst IAS in the world. Community networks also have a key role to play in mobilizing and informing society, for example through citizen science programs developed in partnership with research (Crall et al. 2010). Further research programs are still needed to better quantify the ecological and socio-economic impacts of IAS, to understand local communities perceptions and attitudes to these, and to assess the interactions between climate change and biological invasions. The continuation of the Initiative should help to fill these gaps, in collaboration with the wide range of stakeholders involved and with further involvement of the French government and local authorities.

To date, Europe has paid little attention to IAS issues in the European overseas territories. The last relevant European research projects (DAISIE—“Delivering Alien Invasive Species Inventories for Europe”—and ALARM—“Assessing Large-scale Risks to biodiversity using tested Methods”) aimed at informing the future European Union IAS strategy, have been limited to continental Europe and its very close overseas territories (Madeira, Canary islands, Azores). However, the 34 European overseas territories, composed mainly of oceanic islands scattered around the world and receiving large goods and passenger flows, have an outstanding biodiversity

highly vulnerable to IAS. With these territories, France and Europe have an important role to play, as well as a global responsibility regarding IAS issues. As they have to address the 2020 “Biodiversity Conservation Aichi Targets” (www.cbd.int/sp/targets), especially targets 5, 9 and 12 dedicated respectively to ecosystem restoration, IAS and preventing species extinctions, they will have to act with some urgency in their overseas territories in regard to invasive species.

Conclusion

After 7 years, some lessons of generic value can be drawn from the Initiative, which may be useful to address IAS issues in other countries and situations. Among the points that have contributed to the success of the project, the light and flexible operating mode, without over-formalization, played an important role. The relatively simple model implemented, with a full-time project officer for the overall coordination and local volunteer coordinators involved in each territory, proved to be both easy to manage and efficient. It also resulted in relatively moderate financial requirements, as compared to other large-scale biodiversity projects. However, the annual budget needed may still represent a constraint to overcome in some countries. Another key point was that the Initiative was coordinated by a national “neutral” organization, which allowed to give voice to all stakeholders interested, to identify the blocking points and raise the problems that had to be addressed, and to tackle some picky issues in a frank and objective manner. As a last point, the good results obtained owed much to the fact that a wide range of stakeholders were involved at all stages, with researchers, NGOs, local authorities and national public institutions invited to contribute to all activities undertaken. In the future, the Initiative will have to continue in this way, but also to be opened to other segments of society, especially from the private sector, in order to enhance the scope of the actions and to reach a wider audience.

Acknowledgments The Initiative on IAS in the French overseas territories would not have been a success without the involvement of a wide range of contributors, especially the local coordinators. Some of them are among the authors of the article. We want to thank here warmly all the others for their important role: Anne-Claire Goarant and Julie Goxe (New Caledonia),

Paino Vanai and Atoloto Malau (Wallis and Futuna), Pierre Jouventin (French Southern and Antarctic territories), Fabien Barthelat et Benjamin Espérance (Mayotte), Claudia Pavis and Jean-Marie Flower (Guadeloupe), Vincent Arenales del Campo and Cyrille Barnerias (Martinique), Pauline Malterre (Saint-Martin) and Franciane Le Quellec (Saint-Barthelemy). We also thank all the contributors for sharing their precious knowledge and experience on IAS all along the 7 years. We would like to thank Sébastien Moncorps and Jean-Philippe Palasi, who have initiated the first phase of the Initiative and set up this project in 2005. We are grateful to Souad Boudjelas and Carola Warner for comments and improvement of the clarity of the manuscript, as well as to two anonymous referees who provided valuable comments. We also thank the partner organizations that provided their financial contribution to the Initiative, especially the French Ministry of Environment, the French Ministry of Overseas Territories, the National Forest Office, the Regional Council of Reunion Island and the CIRAD for their strong support.

Appendix 1: Main references used to build Table 1: Estimated numbers of alien and invasive alien terrestrial plant, vertebrate and invertebrate species in the French overseas territories

Atkinson IAE, Atkinson TJ (2000) Land vertebrates as invasive species on islands served by the South Pacific Regional Environment Programme. In *Invasive Species in the Pacific: A Technical Review and Draft Regional Strategy*. South Pacific Regional Environment Programme, Samoa: 19–84.

Breuil M (2002) Histoire naturelle des Amphibiens et des Reptiles terrestres de l'archipel Guadeloupéen. In *Patrimoines Naturels*, MNHN, Paris

Breuil M (2009) The terrestrial herpetofauna of Martinique: Past, present, future. *Appl Herpetol* 6: 123–149.

Breuil M, Guiougou F, Questel K, Ibéné B (2009) Modifications du peuplement herpétologique dans les Antilles françaises—1ère partie. *Le courrier de la nature* n°249

Breuil M, Guiougou F, Questel K, Ibéné B (2009) Modifications du peuplement herpétologique dans les Antilles françaises—2ème partie. *Le courrier de la nature* n°251.

Chapuis JL, Bousès P, Barnaud G (1994) Alien mammals, impact and management in the French Subantarctic Islands. *Biol Conserv* 67: 97–104

Conservatoire botanique national de Mascarin (Boulet V. coord. et auteur principal) (2012) *Index de la flore vasculaire de la Réunion (Trachéophytes)* :

statuts, menaces et protections. Version 2012—Disponible à flore.cbnm.org.

Conservatoire botanique national de Mascarin (Boulet V. coord. (2011) Index de la flore vasculaire de Mayotte (Trachéophytes) : statuts, menaces et protections. Version 2011.1 (mise à jour du 01 août 2011). Conservatoire Botanique National de Mascarin, Antenne de Mayotte - Coconi - Disponible à floremaore.cbnm.org.

Delnatte C, Meyer JY (2012) Plant introduction, naturalization and invasion in French Guiana (South America). *Biol Invasions* 14: 915–927.

Florence J, Chevillotte H, Ollier C, Meyer JY (2007) Base de données botaniques Nadeaud de l'Herbier de la Polynésie française (PAP). www.herbier-tahiti.pf.

Fourdrigniez M, Meyer JY (2008) Liste et caractéristiques des plantes introduites naturalisées et envahissantes en Polynésie française. Contribution à la biodiversité de Polynésie française n°17. Délégation à la Recherche, Papeete.

Fournet J, Sastre C (2002) Progrès récents dans la connaissance de la flore de Guadeloupe et de Martinique. *Acta Bot Gallica* 149: 481–500.

Fournet J (2002) Flore illustrée des phanérogames de Guadeloupe et de Martinique. Gondwana édition.

Frenot Y, Gloaguen J, Massé L, Lebouvier M (2001) Human activities, ecosystem disturbance and plant invasions in subantarctic Crozet, Kerguelen and Amsterdam Islands. *Biol Conserv* 101: 33–50.

Frenot Y, Chown SL, Whinam J, Selkirk P, Convey P, Skotnicki M, Bergstrom D (2005) Biological invasions in the Antarctic: extent, impacts and implications. *Biol Rev* 80: 45–72.

Gargominy O (Ed.) (2003) Biodiversité et conservation dans les collectivités françaises d'outre-mer. Comité français pour l'UICN, Paris.

Hequet V, Le Corre M, Rigault F, Blanfort V (2009) Les espèces exotiques envahissantes de Nouvelle-Calédonie. IRD-AMAP, Province Sud, Province Nord.

Ineich I (1989) Comparaison des herpétofaunes de Polynésie française et des Hawaï : l'homme en tant que facteur biogéographique. *Comptes-Rendus de la Société de Biogéographie*, Paris, 65: 21–38.

Jourdan H, Mille C (2006) Les invertébrés introduits dans l'archipel néo-calédonien : espèces envahissantes et potentiellement envahissantes : première évaluation et recommandations pour leur gestion.

Pages 163–214, in M.-L. Beauvais et al.: Les espèces envahissantes dans l'archipel néo-calédonien, Paris, IRD Éditions.

Keith P (2002) Freshwater fish and decapod crustacean populations on Reunion island, with an assessment of species introductions. *Bull. Fr. Pêche Piscic* 364: 97–107.

Keith P (2002) Revue des introductions de poissons et de crustacés décapodes d'eau douce en Polynésie française. *Bull. Fr. Pêche Piscic* 364: 147–160.

Keith P (2005) Revue des introductions de poissons et de crustacés décapodes d'eau douce en Nouvelle-Calédonie. *Rev Ecol - Terre Vie* 60: 45–55.

Keith P, Vigneux E, Marquet G (2003) Atlas des poissons et crustacés d'eau douce de la Polynésie française. *Patrimoines naturels (MNHN)* 55: 1–175.

Keith P, Marquet G, Valade P, Bosc P, Vigneux E (2006) Atlas des poissons et crustacés d'eau douce des Comores, Mascareignes et Seychelles. MNHN, Patrimoines naturels, vol. 67, Paris.

Levesque A, Villard P, Barré N, Pavis C, Feldmann P (2005) Liste des oiseaux des Antilles françaises. Rapport 29 de l'Association pour l'Etude et la Protection des Vertébrés et Végétaux des Petites Antilles (AEVA). Petit-Bourg, Guadeloupe.

Lim P, Meunier F, Keith P, Noël P (2002) Atlas des poissons et des crustacés d'eau douce de la Martinique (ed Patrimoines Naturels), Vol. 51, MNHN.

Lorvelec O, Pascal M (2006) Les vertébrés de Clipperton soumis à un siècle et demi de bouleversements écologiques. *Rev Ecol—Terre Vie* 61:135–158.

Lorvelec O, Pascal M, Pavis C (2001) Inventaire et statut des Mammifères des Antilles françaises (hors Chiroptères et Cétacés). In Rapport n° 27 de l'Association pour l'Etude et la Protection des Vertébrés et Végétaux des Petites Antilles, Petit-Bourg, Guadeloupe.

Lorvelec O, Pascal M, Delloue X, Chapuis JL (2007) Les mammifères terrestres non volants des Antilles françaises et l'introduction récente d'un écureuil. *Rev Ecol—Terre Vie* 62: 295–314.

Lorvelec O, Pascal M, Pavis C, Feldmann P (2007) Amphibians and reptiles of the French West Indies : Inventory, threats and conservation. *Appl Herpetol* 4: 131–161.

Louette M (1999) La Faune terrestre de Mayotte—Musée Royal de l'Afrique Centrale.

MacKee HS (1994) Catalogue des plantes introduites et cultivées en Nouvelle-Calédonie, 2nd édition. MNHN, Paris.

Malterre P (2009) Espèces invasives de Saint-Martin: Inventaire et préconisations de gestion. Réserve naturelle nationale de Saint-Martin.

Mary N, Dutarte A, Keith P, Marquet G, Sasal P (2006) Biodiversité des eaux douces de Wallis et Futuna, Mission d'octobre 2004. Rapport final, Ministère de l'Outre-Mer.

Meyer JY (2004) Threat of invasive alien plants to native flora and forest vegetation of Eastern Polynesia. *Pac Sci* 58: 357–375.

Meyer JY (2007) Rapport de mission sur l'île d'Uvea (Wallis et Futuna) du 6 au 17 novembre 2007 : inventaire préliminaire de la flore vasculaire secondaire.

Meyer JY, Loope L, Sheppard A, Munzinger J, Jaffre T (2006) Les plantes envahissantes et potentiellement envahissantes dans l'archipel néo-calédonien : première évaluation et recommandations de gestion in M.-L. Beauvais et al. (2006): Les espèces envahissantes dans l'archipel néo-calédonien, Paris, IRD Éditions, 260 p. +cédérom.

Meyer JY, Munzinger J, Pillon Y (2010) Inventaire de la flore secondaire (plantes introduites, cultivées, naturalisées ou envahissantes) de l'archipel de Wallis et Futuna. Délégation à la Recherche, Papeete & IRD, Nouméa.

Pascal M, Barré N, De Garine-Wichatitsky M, Lorvelec O, Frétey T, Brescia F, Jourdan H (2006) Les peuplements néo-calédoniens de vertébrés : invasions, disparitions. Pp 111–162, in M.-L. Beauvais et al. : Les espèces envahissantes dans l'archipel néo-calédonien, Paris, IRD Éditions.

Powell R, Henderson RW (Eds) (2012) Island lists of West Indian amphibians and reptiles. *Bull Fla Mus Nat Hist* 51: 85–166.

Probst JM (1999) Catalogue des Vertébrés de l'île de la Réunion. Amphibiens, Reptiles, Oiseaux et Mammifères se reproduisant sur l'île. Rapport DIREN.

Probst JM, Tezier R, Houchois P, Sourice G, Reynaud L, Villedieu C, Banderier M, Barroil P, Ciccione S, Sauvignet H, Roos D, Bertrand G (2000) Inventaire des Oiseaux, des Reptiles, et des mammifères de l'Archipel des Glorieuses (îles Eparses de l'Océan Indien). *Bull. Phaeton* 11: 31–50.

Russel CJ, Le Corre M (2009) Introduced mammal impacts on seabirds in the Iles Eparses, western Indian Ocean. *Mar Ornithol* 37: 121–128.

Salamolard M (2002) Etat des lieux O.R.G.F.H. - Rapport SEOR/DIREN.

UICN France [coord. Gargominy O, Bocquet A] (2013) Biodiversité d'Outre-mer. UICN France, Paris et éditions Roger LeGuén-PANACOCO, Beaumont-de-Lomagne.

References

- Arias-González JE, González-Gándara C, Cabrera JL, Christensen V (2011) Predicted impact of the invasive lionfish *Pterois volitans* on the food web of a Caribbean coral reef. *Environ Res* 111:917–925
- Baret S, Rouget M, Richardson DM, Lavergne C, Egoh B, Dupont J, Strasberg D (2006) Current distribution and potential extent of the most invasive alien plant species on La Réunion (Indian Ocean, Mascarene islands). *Austral Ecol* 31:747–758
- Beauvais ML, Coléno A, Jourdan H (2006) Les espèces envahissantes dans l'archipel néo-calédonien. IRD éditions, Paris
- Chapuis J-L, Bousset P, Barnaud G (1994) Alien mammals, impact and management in the French Subantarctic Islands. *Biol Conserv* 67:97–104
- Coote T, Loève E (2003) From 61 species to five: endemic tree snail of the Society Islands fall prey to an ill-judged biological control programme. *Oryx* 37:91–96
- Crall AW, Newman CJ, Jarnevich CS, Stohlgren TJ, Waller DM, Graham J (2010) Improving and integrating data on invasive species collected by citizen scientists. *Biol Invasions* 12:3419–3428
- De Garine-Wichatitsky M, Soubeyran Y, Maillard D, Duncan P (2005) The diets of introduced rusa deer (*Cervus timorensis rusa*) in a native sclerophyll forest and a native rainforest of New Caledonia. *New Zeal J Zool* 32:117–126
- Delnatte C, Meyer JY (2012) Plant introduction, naturalization and invasion in French Guiana (South America). *Biol Invasions* 14:915–927
- Faulquier L, Fontaine R, Vidal E, Salamolard M, Le Corre M (2009) Feral cats *Felis catus* threaten the Endangered Endemic Barau's Petrel *Pterodroma baraui* at Reunion Island (Western Indian Ocean). *Waterbirds* 32:330–336
- Frenot Y, Gloaguen JC, Massé L, Lebouvier M (2001) Human activities, ecosystem disturbance and plant invasions in subantarctic Crozet, Kerguelen and Amsterdam Islands. *Biol Conserv* 101:33–50
- Frenot Y, Chown SL, Whinam J, Selkirk P, Convey P, Skotnicki M, Bergstrom D (2005) Biological invasions in the Antarctic: extent, impacts and implications. *Biol Rev* 80:45–72
- Hellmann JJ, Byers JE, Bierwagen BG, Dukes JS (2008) Five potential consequences for invasive species under climate change. *Conserv Biol* 22:534–543
- Hulme PE (2009) Trade, transport and trouble: managing invasive species pathways in an era of globalization. *J Appl Ecol* 46:10–18

- Jourdan H (1997) Threats on Pacific islands: the spread of the tramp ant (*Wasmannia auropunctata*) (Hymenoptera: Formicidae). *Pac Conserv Biol* 3:61–64
- Jouventin P, Bried J, Micol T (2003) Insular bird population can be saved from rats: a long term experimental study of *Procellaria aequinoctialis* on the Crozet archipelago. *Polar Biol* 26:371–378
- Keith P (2002) Revue des introductions de poissons et de crustacés décapodes d'eau douce en Polynésie française. *Bull Fr Pêche Piscic* 364:147–160
- Keith P (2005) Revue des introductions de poissons et de crustacés décapodes d'eau douce en Nouvelle-Calédonie. *Rev Ecol Terre Vie* 60:45–55
- Kier G, Kreft H, Lee TM, Jetz W, Ibisch PL, Nowicki C, Mutke J, Barthlott W (2009) A global assessment of endemism and species richness across island and mainland regions. *PNAS* 106:9322–9327
- Kraus F, Duffy DC (2010) A successful model from Hawaii for rapid response to invasive species. *J Nat Conserv* 18:135–141
- Kueffer C, Daehler CC, Torres-Santana CW, Lavergne C, Meyer JY, Otto R, Silva L (2010) A global comparison of invasive plant species on oceanic islands. *Perspect Plant Ecol Evol Syst* 12:141–165
- Lavergne C, Rameau C, Figier J (1999) The invasive woody weed *Ligustrum robustum* subsp *walkeri* threatens native forest on La Reunion. *Biol Invasions* 1:377–392
- Lebouvier M, Laparie M, Hullé M, Marais A, Cozic Y, Lalouette L, Vernon P, Candresse T, Frenot Y, Renault D (2011) The significance of the sub-Antarctic Kerguelen Islands for the assessment of the vulnerability of native communities to climate change, alien insect invasions and plant viruses. *Biol Invasions* 13:1195–1208
- Lowe S, Browne M, Boudjelas S, De Poorter M (2000) 100 of the World's Worst Invasive Alien Species. A selection from the Global Invasive Species Database. ISSG-IUCN, Auckland, New Zealand
- Meyer JY (2004) Threat of invasive alien plants to native flora and forest vegetation of Eastern Polynesia. *Pac Sci* 58:357–375
- Meyer JY (2007) Conservation des forêts naturelles et gestion des aires protégées en Polynésie française. *Bois For Trop* 291:25–30
- Meyer JY, Florence J (1996) Tahiti's native flora endangered by the invasion of *Miconia calvescens* DC. (Melastomataceae). *J Biogeog* 23:775–781
- Micol T, Jouventin P (1995) Restoration of Amsterdam Island, South Indian Ocean, following control of feral cattle. *Biol Conserv* 72:199–206
- Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB, Kent J (2000) Biodiversity hotspots for conservation priorities. *Nature* 403:853–858
- Sargent PS, Wells T, Matheson K, McKenzie CH, Deibel D (2013) First record of vase tunicate, *Ciona intestinalis* (Linnaeus, 1767) in coastal Newfoundland waters. *BioInvasions Rec* 2:89–98
- Soubeyran Y (2008) Espèces exotiques envahissantes dans les collectivités françaises d'outre-mer: état des lieux et recommandations. Collection Planète Nature. Comité français de l'UICN, Paris, France
- Thibault JC, Martin JL, Penloup A, Meyer JY (2002) Understanding the decline and extinction of monarchs (Aves) in Polynesian islands. *Biol Conserv* 108:161–174
- UICN France (2010) Gestion des espèces exotiques envahissantes. Guide pratique et stratégique pour les collectivités françaises d'outre-mer. Paris, France
- UICN France [coord. Gargominy O, Bocquet A] (2013) Biodiversité d'Outre-mer. UICN France, Paris et éditions Roger Le-Guen—PANACOCO, Beaumont-de-Lomagne
- UICN France and ONCFS (2011) Les vertébrés terrestres introduits en outre-mer et leurs impacts. Guide illustré des principales espèces envahissantes. Paris, France
- Vié JC, Hilton-Taylor C, Stuart SN (eds) (2009) Wildlife in a changing world—an analysis of the 2008 IUCN Red List of threatened species. IUCN, Gland, Switzerland