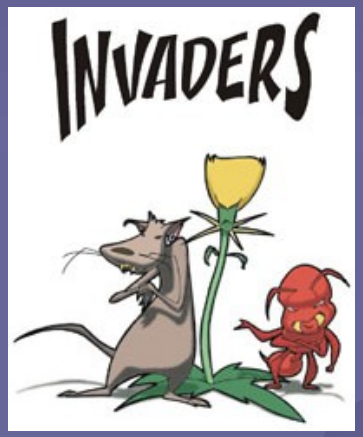
UE “Sciences de la conservation & Invasions biologiques”, Master 2 EIO, UPF, 25 nov. 2019

Biological Invasions on Islands: an –Illustrated- Introduction



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www.jymeyer.com

Délégation à la Recherche, B.P. 20981 Papeete, Tahiti

Gouvernement de la Polynésie française

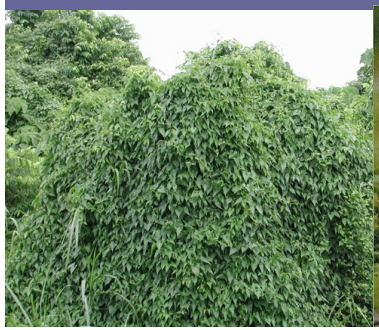
Definition(s)

- Invasive Alien Species (IAS)

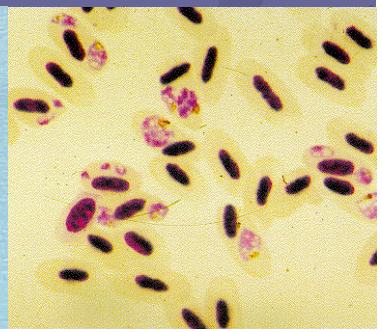
= an alien species which becomes established in natural or semi-naturel ecosystems or habitats, is an agent of change, and threatens native biological diversity (IUCN, 2000)

= alien species which threatens ecosystems, habitats or species (Article 8h of the Convention on Biological Diversity, CBD, 2012)

= alien species whose introduction or spread has been found to threaten or adversely impact upon biodiversity and related ecosystem services (European Union, 2014)



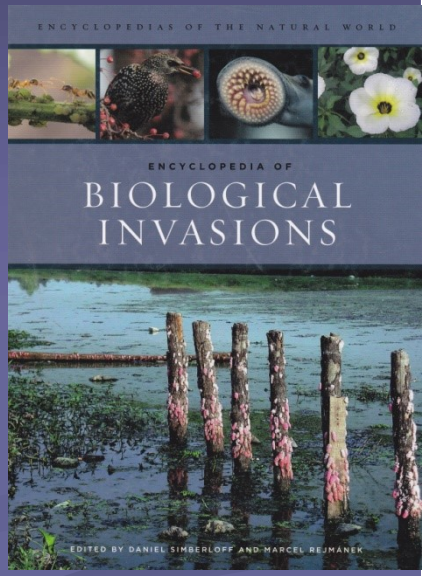




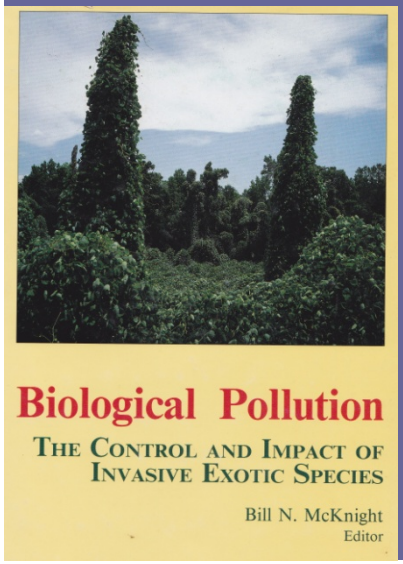
Why Biological Invasions?

- Island ecosystems & "insular syndrome"
- Biodiversity crisis (conservation)
- Global changes (incl. climate change)
- Sustainable development (management of natural resources)

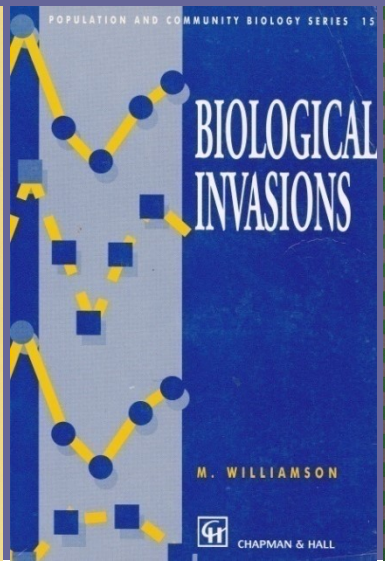
2011



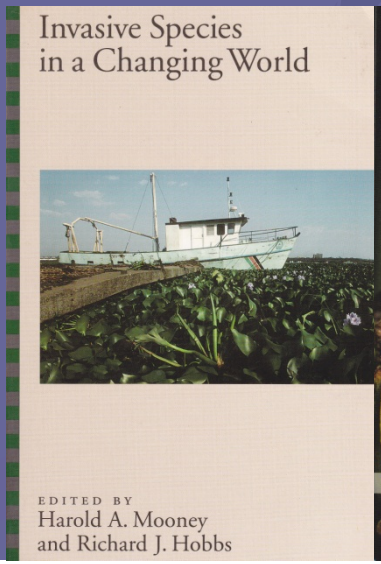
1993



1996

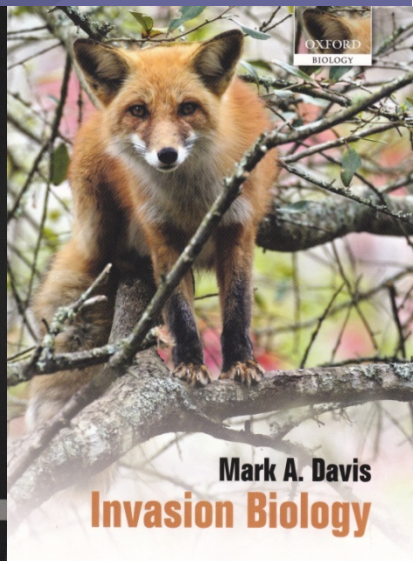


2000



2007

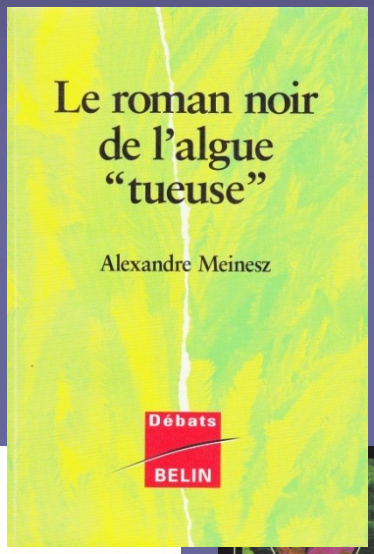
2009



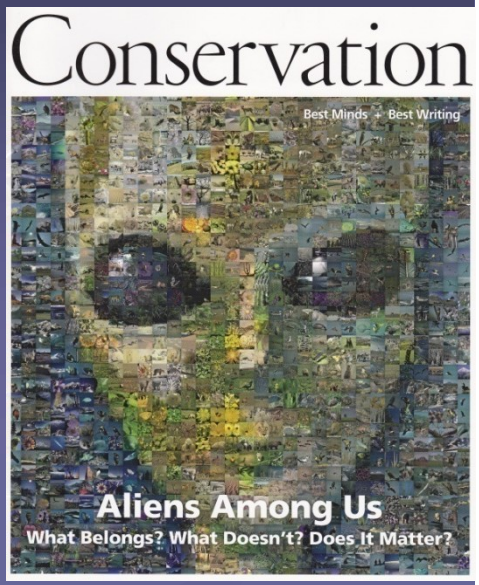
A new fashion?

- Popular
- Controversial
- Anthropocentric
- “Sexy / Hot Topic”

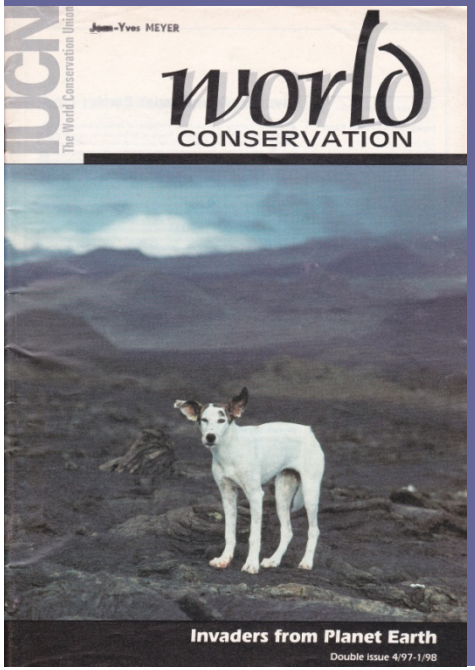
1997



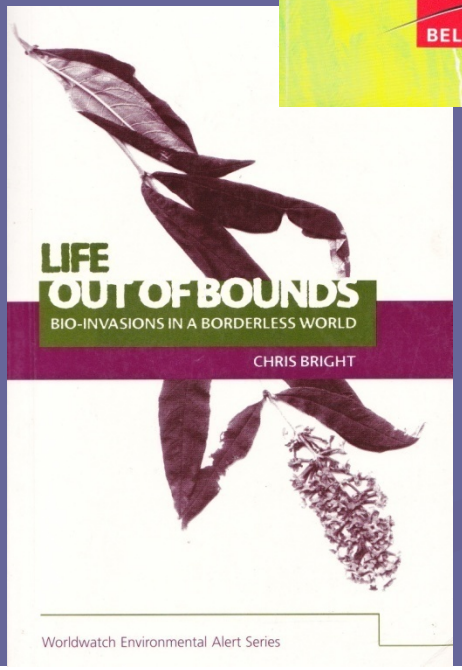
2008



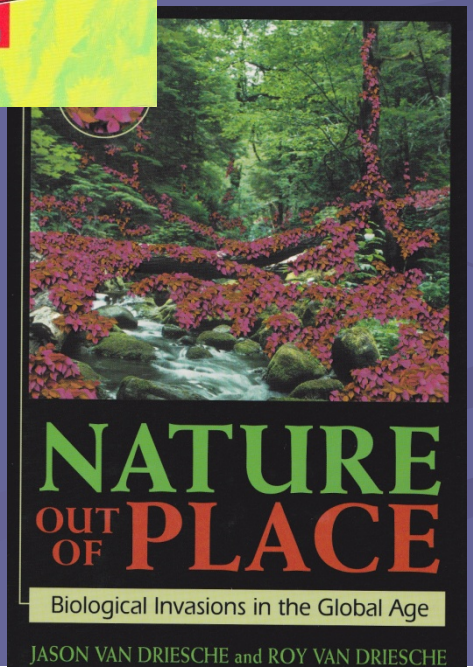
1998



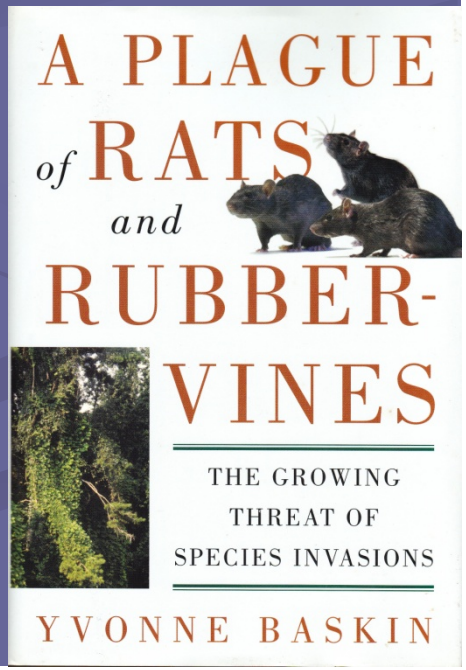
1999



2000



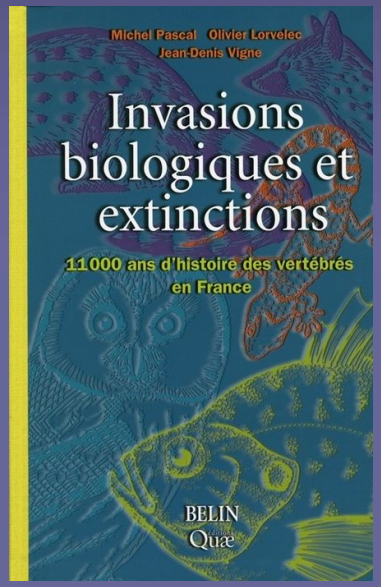
2002



The (late) French Connection

2003

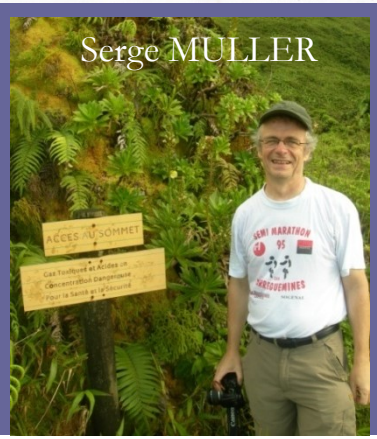
2006



2013

2016

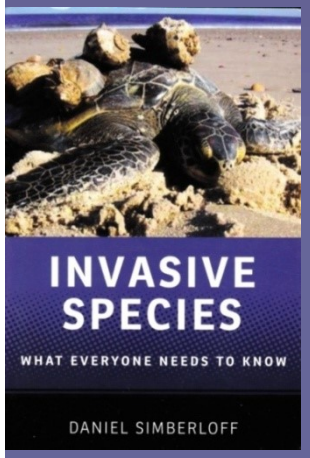
2004



2008

Latest news

2013

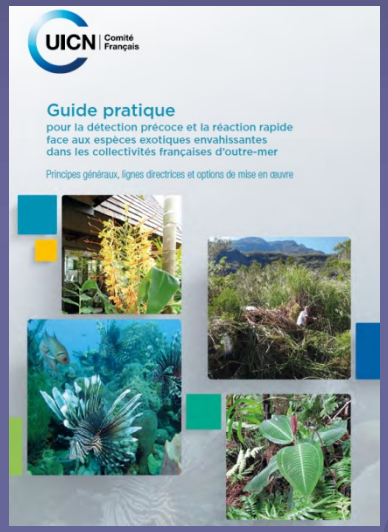


Dan SIMBERLOFF
(Orléans, 2014)

2014

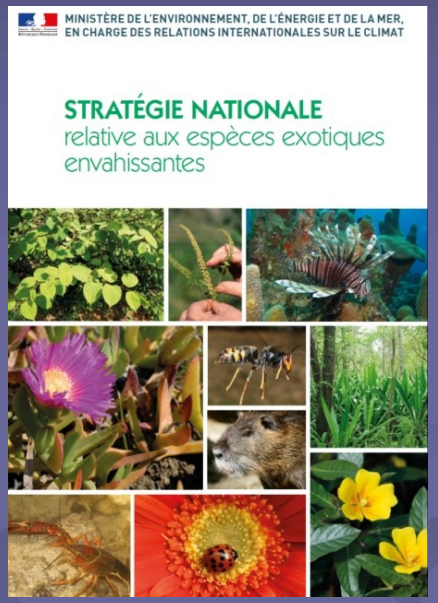
2015

2015



2018

2017



2017

Dave RICHARDSON
(Rennes, 2018)

2018

Ecological impacts

Invasive predators and global biodiversity loss

Tim S. Doherty[a,b,1], Alistair S. Glen[c], Dale G. Nimmo[d], Euan G. Ritchie[a], and Chris R. Dickman[e]

[a]Centre for Integrative Ecology, School of Life and Environmental Sciences, Deakin University, Geelong, VIC 3216, Australia; [b]Centre for Ecosystem Management, School of Natural Sciences, Edith Cowan University, Joondalup, WA 6027, Australia; [c]Landcare Research, Auckland 1072, New Zealand; [d]Institute for Land, Water and Society, School of Environmental Science, Charles Sturt University, Albury, NSW 2640, Australia; and [e]Desert Ecology Research Group, School of Life and Environmental Sciences, University of Sydney, Sydney, NSW 2006, Australia

2016

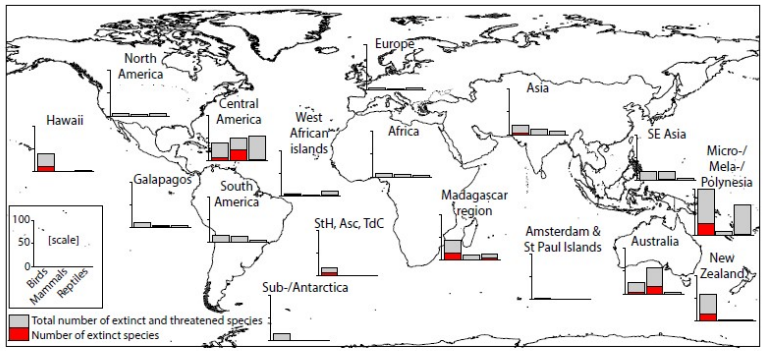


Fig. 4. Numbers of threatened and extinct bird, mammal, and reptile species impacted by invasive predators in 17 regions (Fig. S3 and Table S2). Gray bars represent the total number of extinct and threatened species, and red bars represent the number of extinct species (including those classed as extinct in the wild). StH, Asc, and TdC indicate the islands of St. Helena, Ascension, and Tristan da Cunha, respectively.

2017

SCIENCE ADVANCES | RESEARCH ARTICLE

CONSERVATION BIOLOGY

Globally threatened vertebrates on islands with invasive species

Dena R. Spatz,[1,2]* Kelly M. Zilliacus,[1] Nick D. Holmes,[2,3] Stuart H. M. Butchart,[4,5] Piero Genovesi,[6] Gerardo Ceballos,[7] Bernie R. Tershy,[1,8] Donald A. Croll[1]

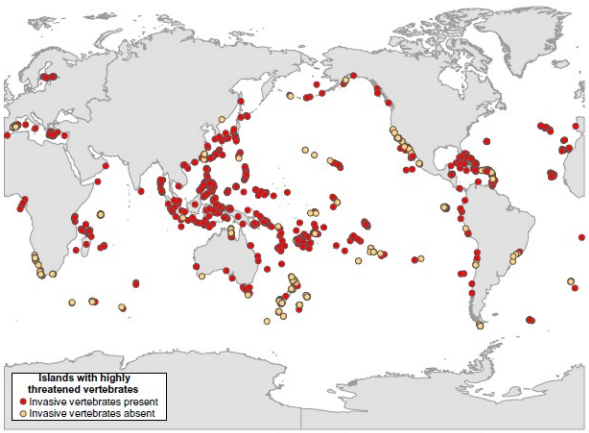
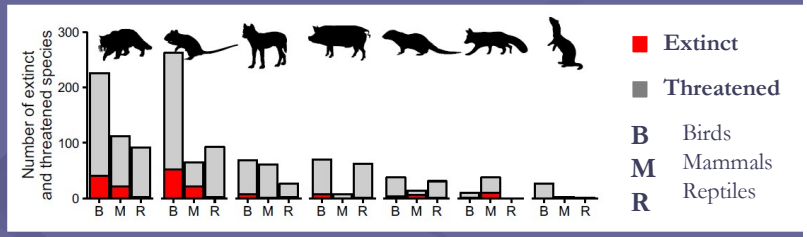
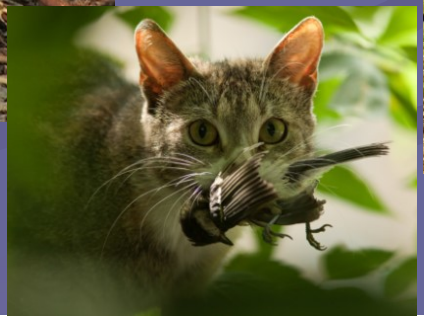


Fig. 5. The 1030 islands with highly threatened native vertebrates and information on the presence or absence of invasive vertebrates. Of these, 779 (76%) had at least one invasive vertebrate species present. Mammals were the most common invader on these islands (753 islands; 97% of islands with highly threatened vertebrates).





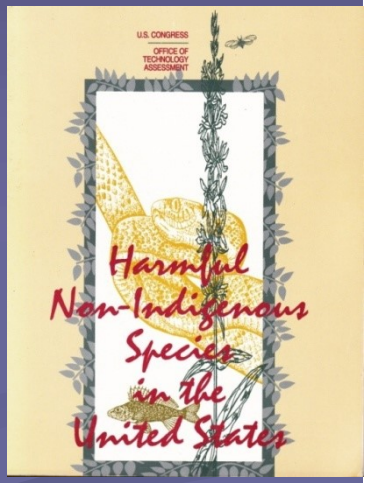
Economic impacts

BOX 5

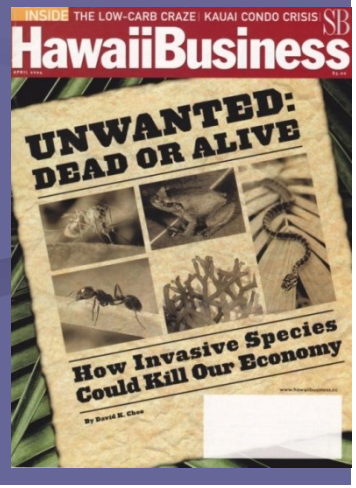
INDICATIVE COSTS OF SOME INVASIVE ALIEN SPECIES (COSTS IN US$)

SPECIES	ECONOMIC VARIABLE	ECONOMIC IMPACT	REFERENCE
Introduced disease organisms	Annual cost to human, plant, animal health in USA	$41 billion per year	Daszak et al., 2000
A sample of alien species of plants and animals	Economic costs of damage in USA	$137 billion per year	Pimentel et al., 2000
Salt Cedar	Value of ecosystem services l ost in western USA	$7-16 billion over 55 years	Zavaleta, 2000
Knapweed and Leafy spurge	Impact on economy in three US states	$40.5 million per year direct costs $89 million indirect	Bangsund, 1999; Hirsch and Leitch, 1996
Zebra mussel	Damages to US and European industrial plants	Cumulative costs 1988-2000 =$750 million to 1 billion	National Aquatic Nuisances Species Clearinghouse, 2000
Most serious invasive alien plant species	Costs 1983-92 of herbicide control in Britain	344 million/year for 12 species	Williamson, 1998
Six weed species	Costs in Australia agroecosystems	$105 million/year	CSIRO, 1997 cited in Watkinson, Freckleton and Dowling 2000
Pinus, *Hakeas*, and *Acacia*	Costs on South African Floral Kingdom to restore to pristine state	$2 billion	Turpie and Heydenrych, 2000
Water hyacinth	Costs in 7 African countries	$20-50 million/year	Joffe-Cooke, cited in Kasulo, 2000
Rabbits	Costs in Australia	$373 million/year (agricultural losses)	Wilson, 1995 cited in White and Newton-Cross, 2000
Varroa mite	Economic cost to beekeeping in New Zealand	$267-602 million	Wittenberg et al,, 2001

1993



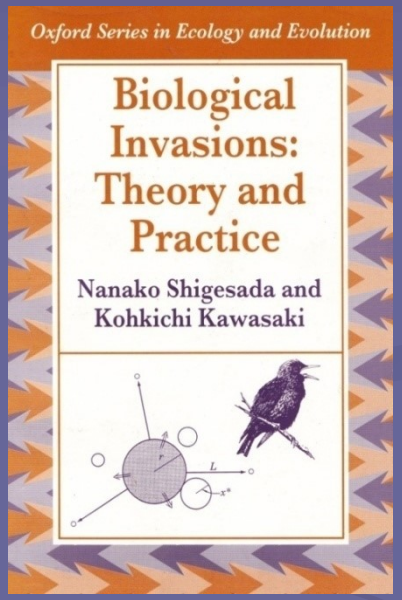
2004



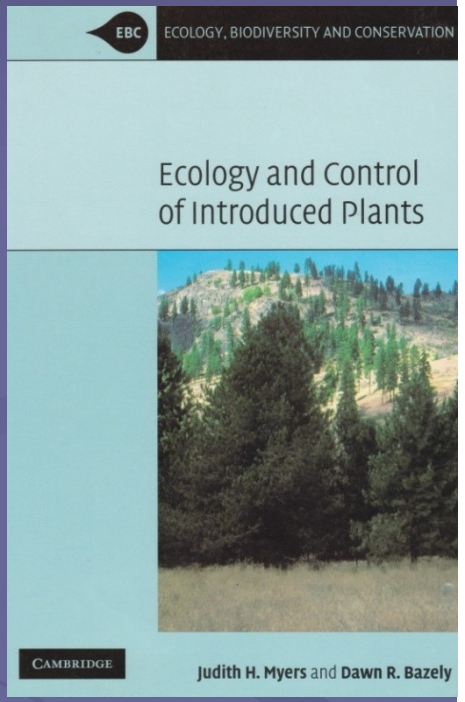
A new scientific discipline?

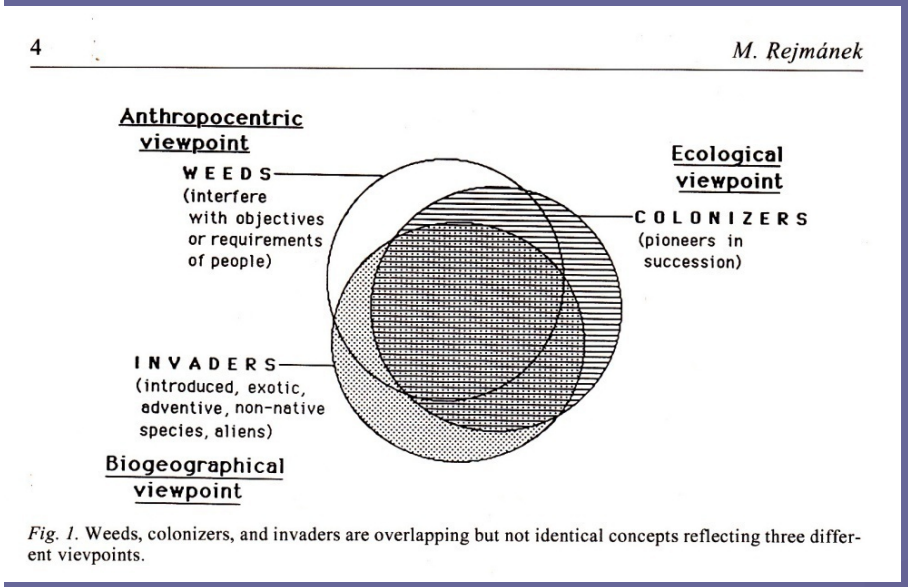
- New theories in science
- Ecology & Evolution
- Biogeography
- Conservation & Restoration

1997



2003





4 M. Rejmánek

Anthropocentric viewpoint

WEEDS (interfere with objectives or requirements of people)

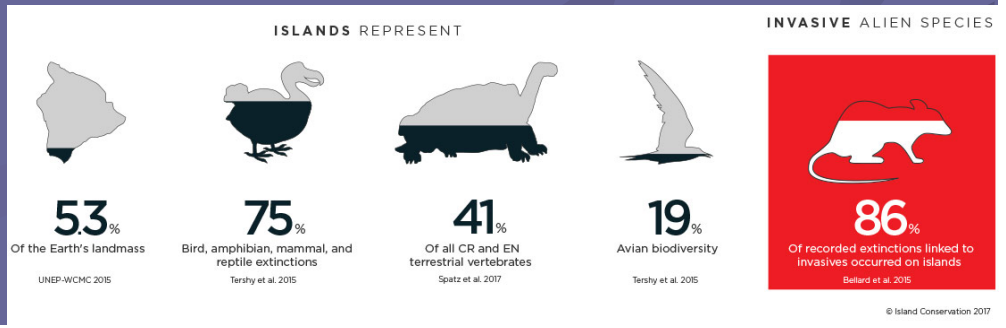
Ecological viewpoint

COLONIZERS (pioneers in succession)

INVADERS (introduced, exotic, adventive, non-native species, aliens)

Biogeographical viewpoint

Fig. 1. Weeds, colonizers, and invaders are overlapping but not identical concepts reflecting three different viewpoints.



Scientific journals

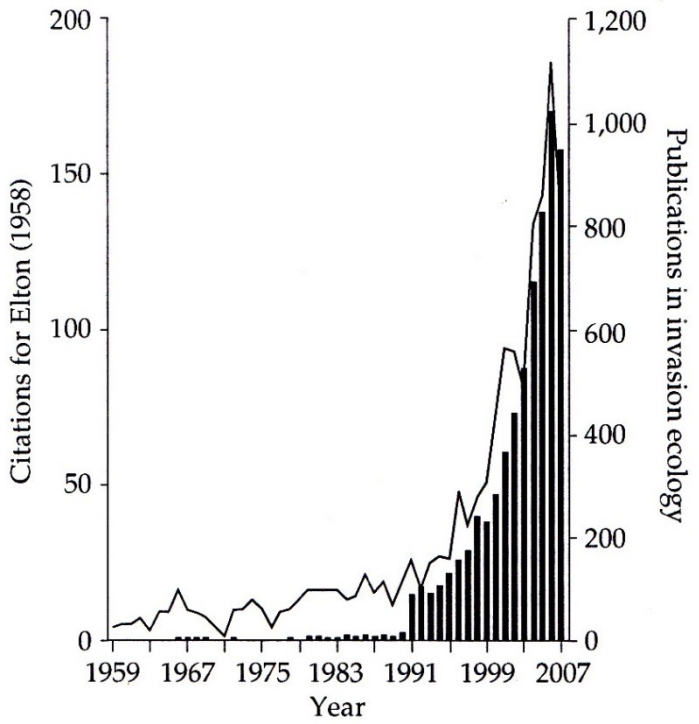
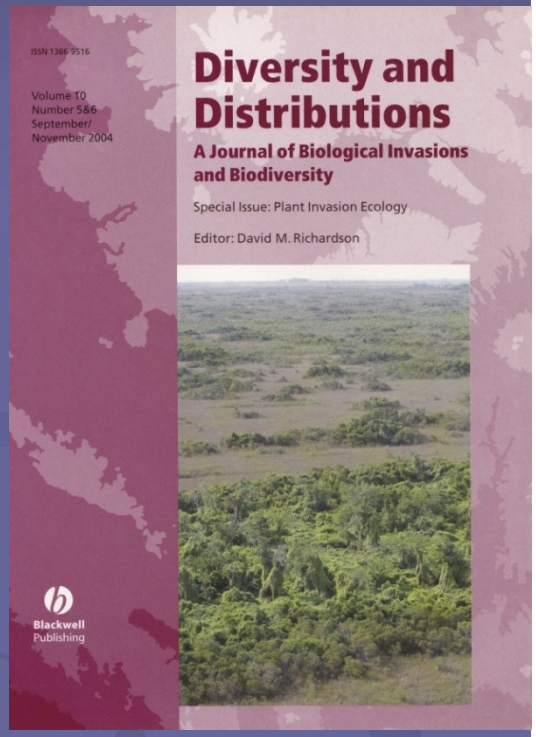


Fig. 1.1 The number of biological invasion publications since Elton published *The ecology of invasions by animals and plants* in 1958 (columns). Also shown are the number of publications that cited Elton's 1958 book during this time period (linegraph). Redrawn and printed, with permission, from Ricciardi and MacIsaac (2008), copyright Nature Publishing Group.

1999

2010

1998



A peer-reviewed open-access journal

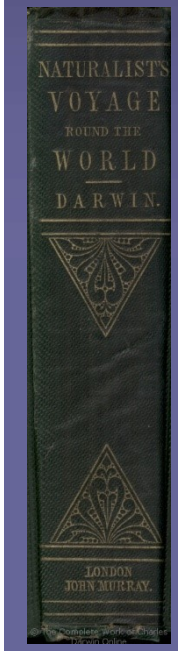
NeoBiota

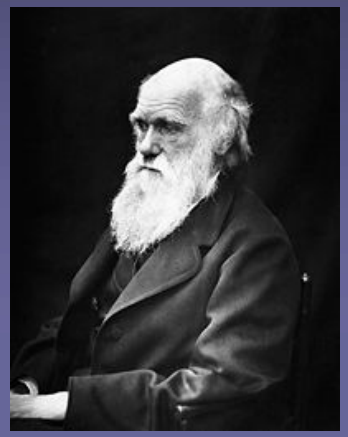
Launched to accelerate research on alien species and biological invasions

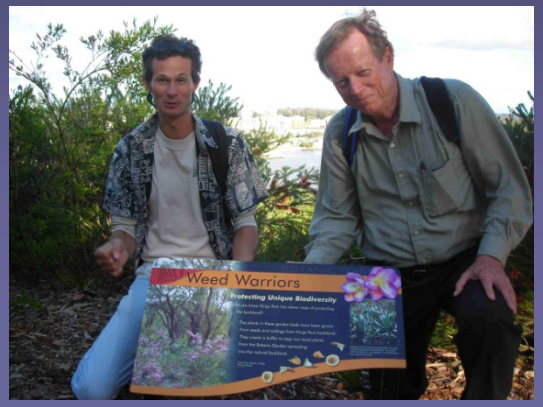
2002

History: from research…

1839

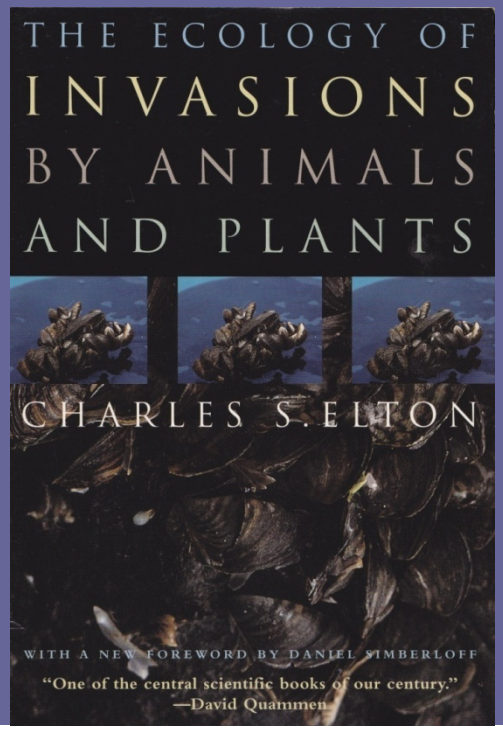




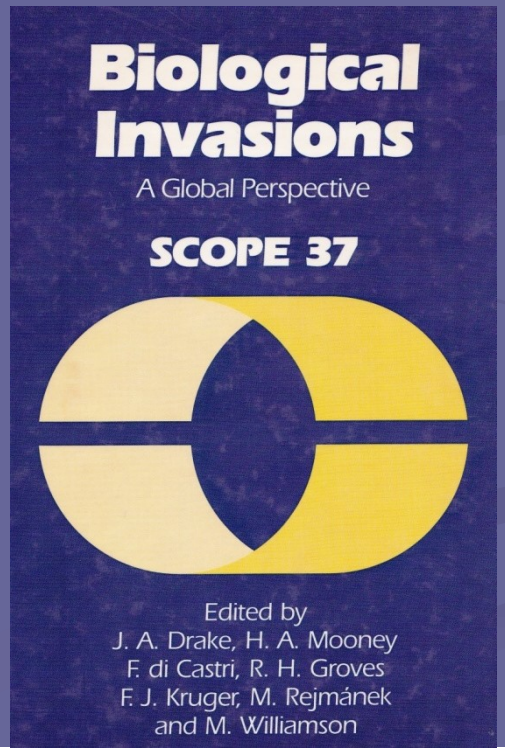


Lloyd L. LOOPE
(USGS, Hawaii)

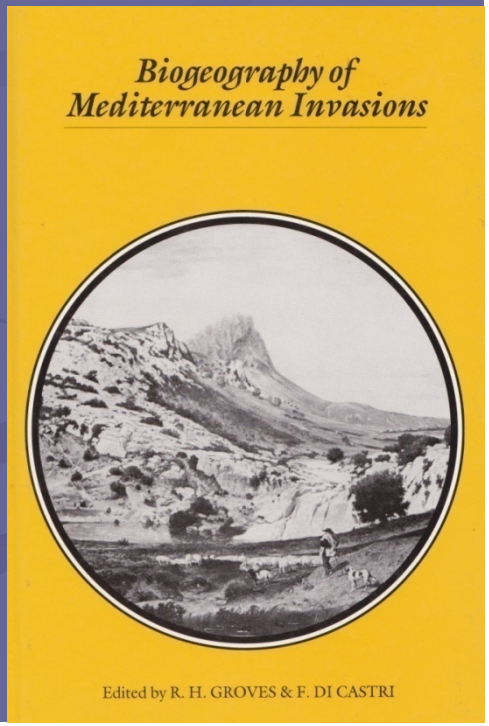
1958



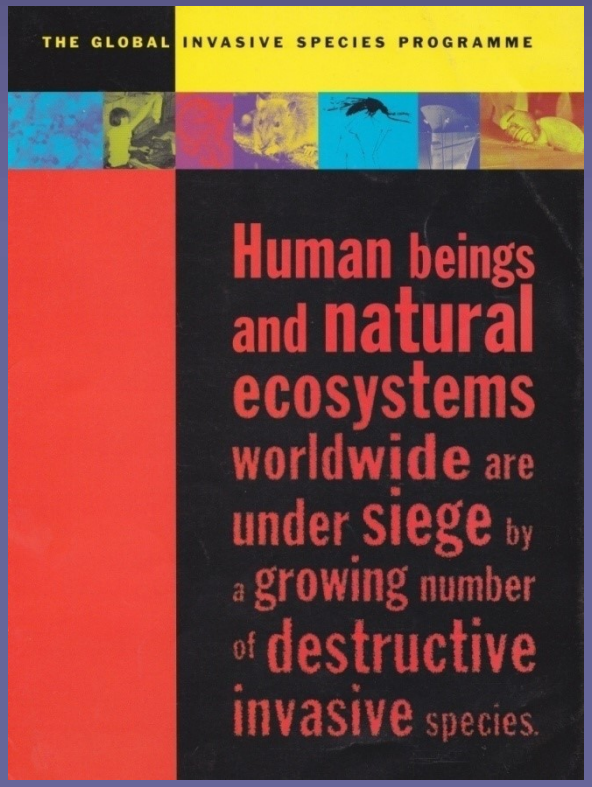
1989



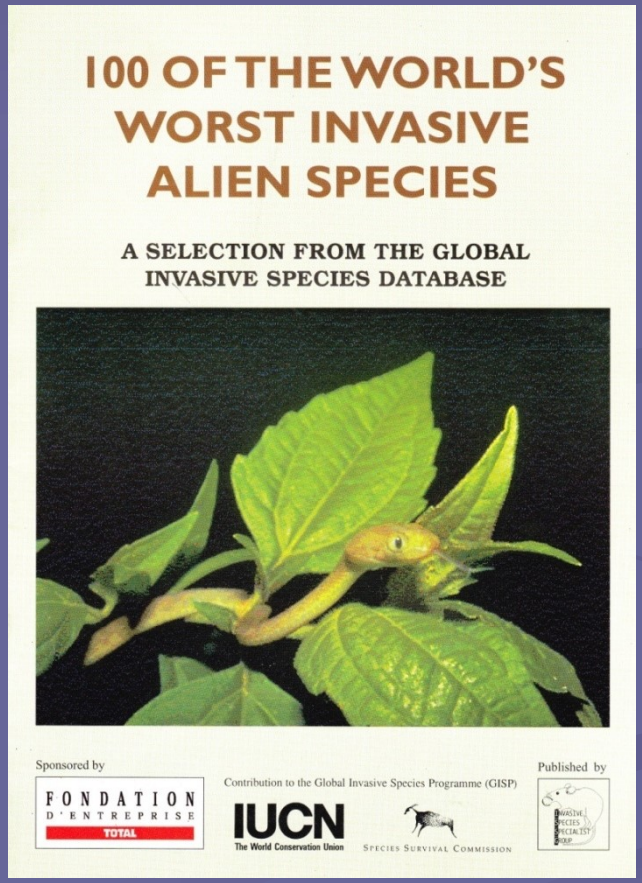
2003



…to management and communication

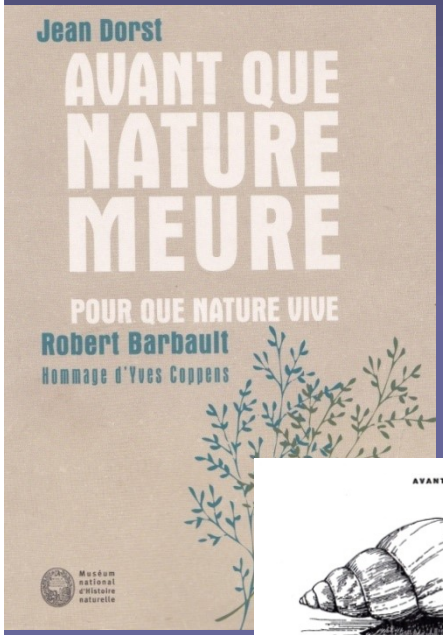


2000



French (His)story

1965



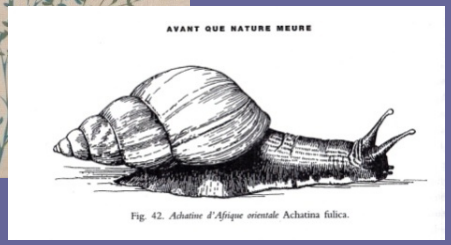


Fig. 42. *Achatine d'Afrique orientale* Achatina fulica.

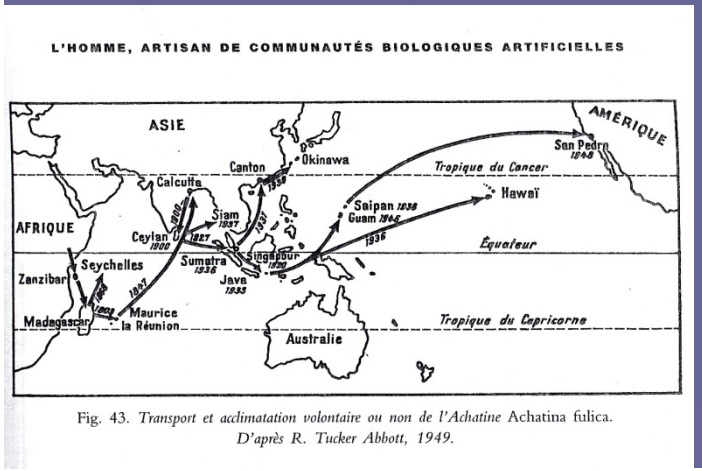
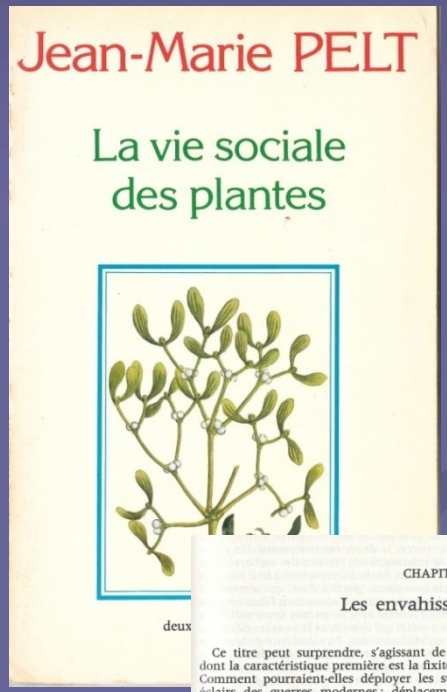
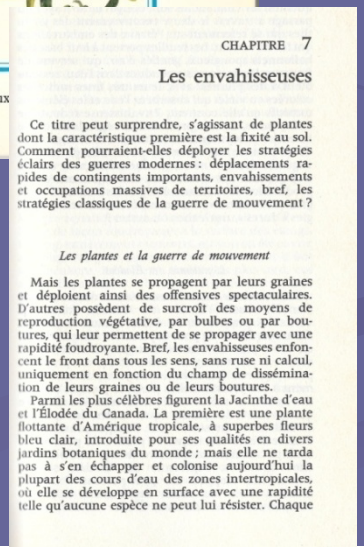


Fig. 43. *Transport et acclimatation volontaire ou non de l'Achatine* Achatina fulica. *D'après R. Tucker Abbott, 1949.*

1984





CHAPITRE 7

Les envahisseuses

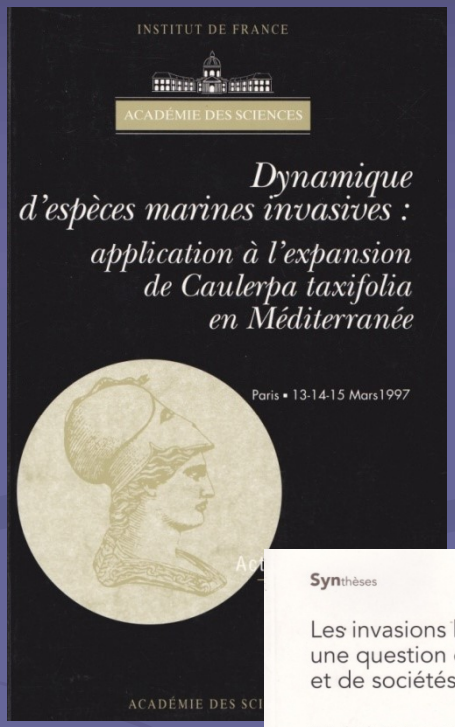
Ce titre peut surprendre, s'agissant de plantes dont la caractéristique première est la fixité au sol. Comment pourraient-elles déployer les stratégies éclairs des guerres modernes : déplacements rapides de contingents importants, envahissements et occupations massives de territoires, bref, les stratégies classiques de la guerre de mouvement ?

Les plantes et la guerre de mouvement

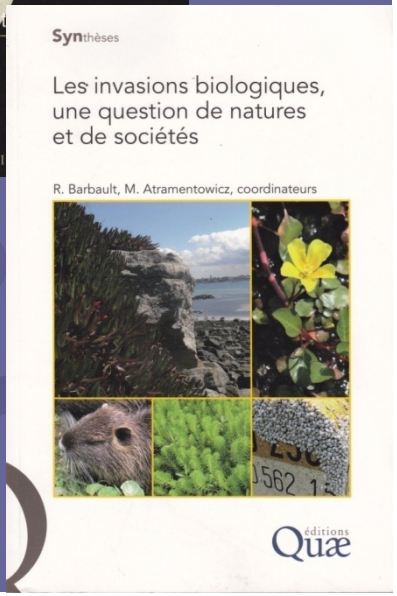
Mais les plantes se propagent par leurs graines et déploient ainsi des offensives spectaculaires. D'autres possèdent de surcroît des moyens de reproduction végétative, par bulbes ou par boutures, qui leur permettent de se propager avec une rapidité foudroyante. Bref, les envahisseuses enfoncent le front dans tous les sens, sans ruse ni calcul, uniquement en fonction du champ de dissémination de leurs graines ou de leurs boutures.

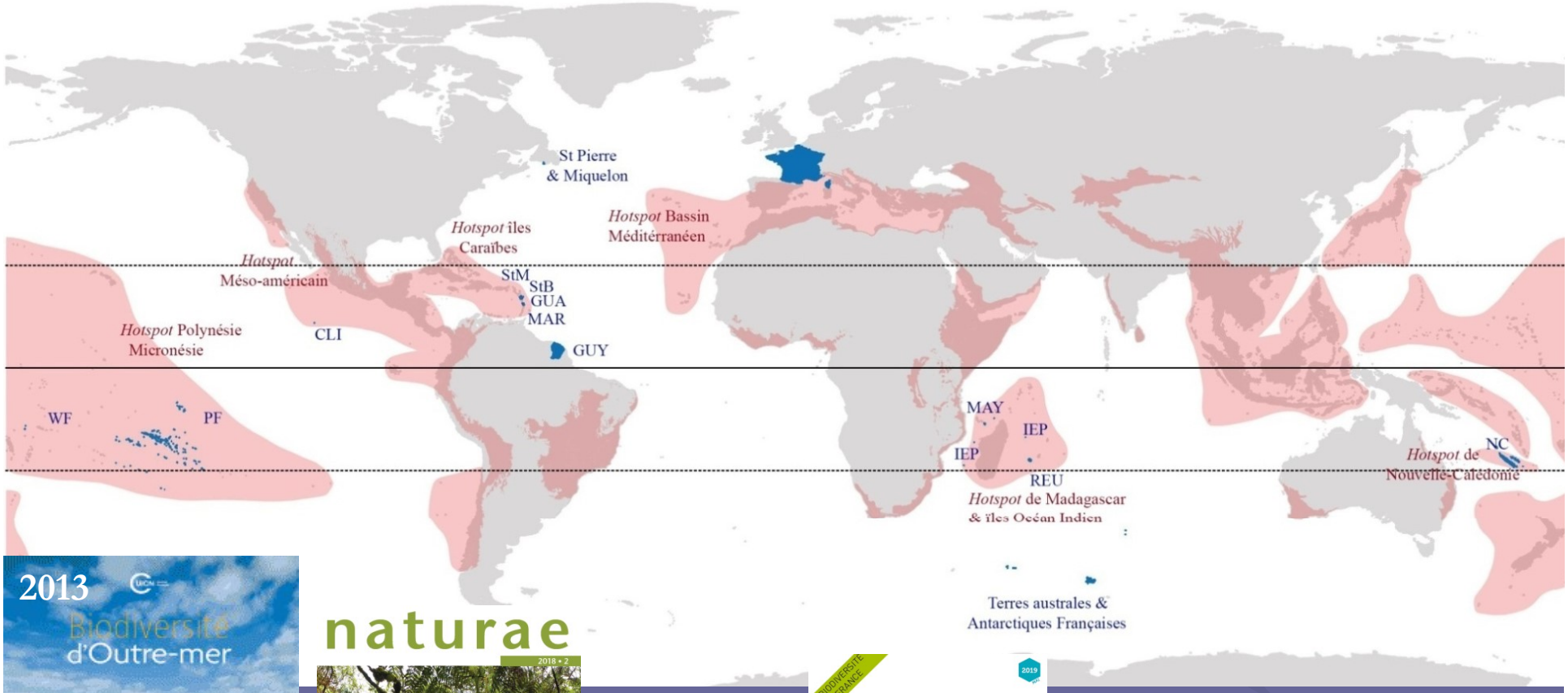
Parmi les plus célèbres figurent la Jacinthe d'eau et l'Élodée du Canada. La première est une plante flottante d'Amérique tropicale, à superbes fleurs bleu clair, introduite pour ses qualités en divers jardins botaniques du monde ; mais elle ne tarda pas à s'en échapper et colonise aujourd'hui la plupart des cours d'eau des zones intertropicales, où elle se développe en surface avec une rapidité telle qu'aucune espèce ne peut lui résister. Chaque

1997



2009





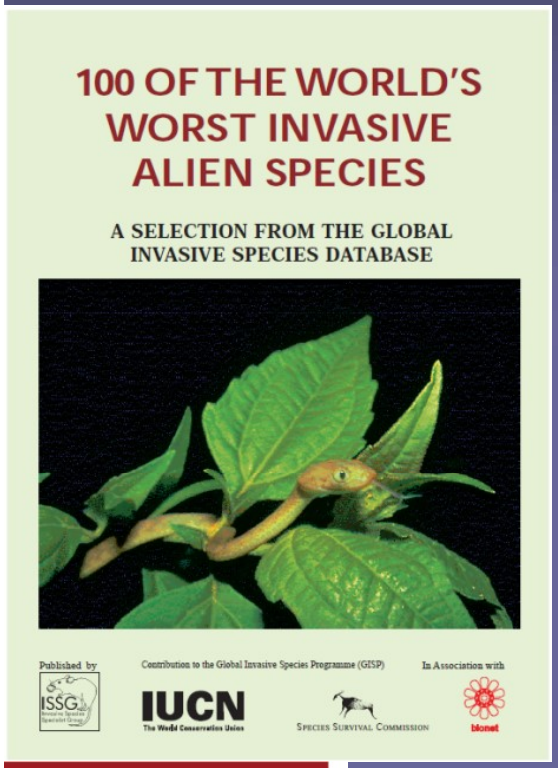
2018

2019

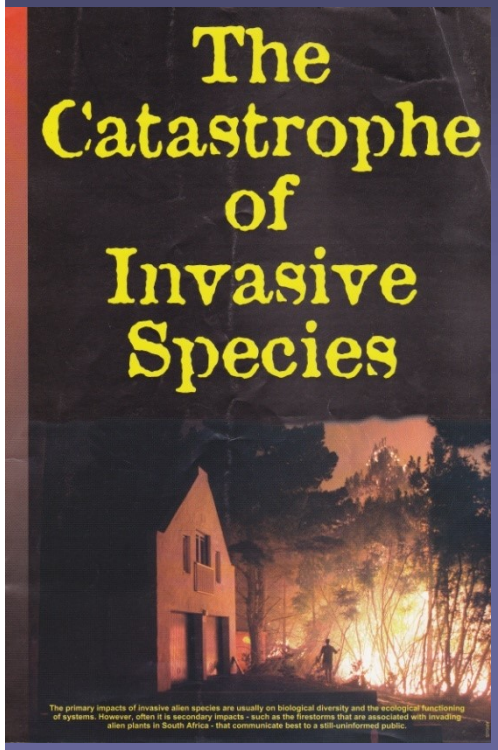
12 FOTs (Collectivités d’Outre-Mer) found in three Oceans…

… and 5 of the 36 « biodiversity hot-spots »

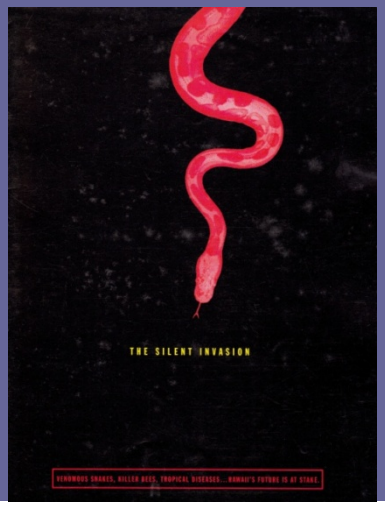
50% of the 100 IAS are found in the FOTs !



Debates

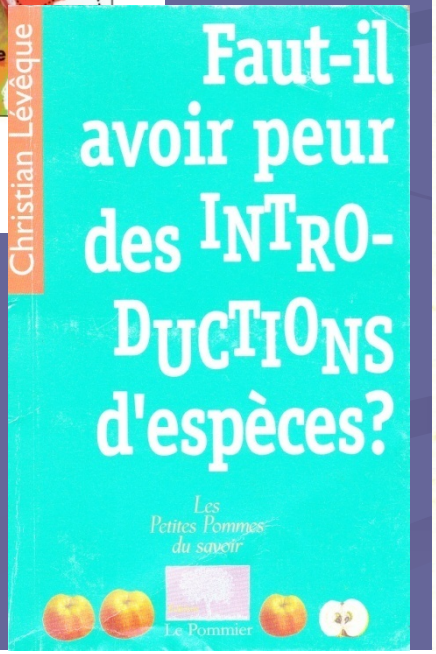


2010



Learn how to become a Weed Warrior!

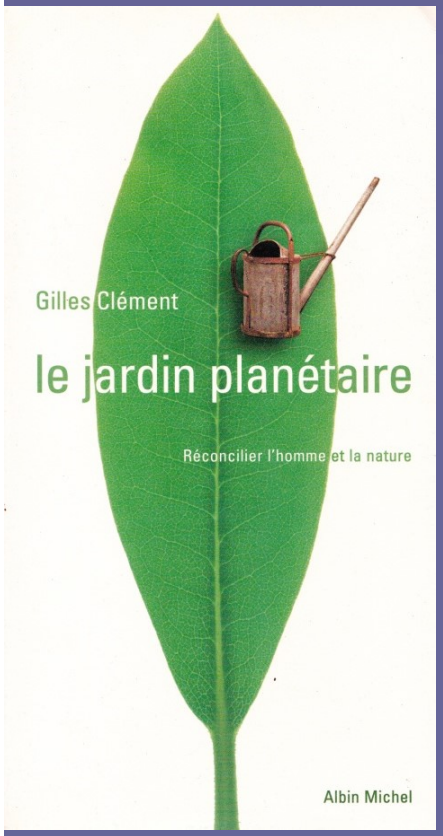
2008



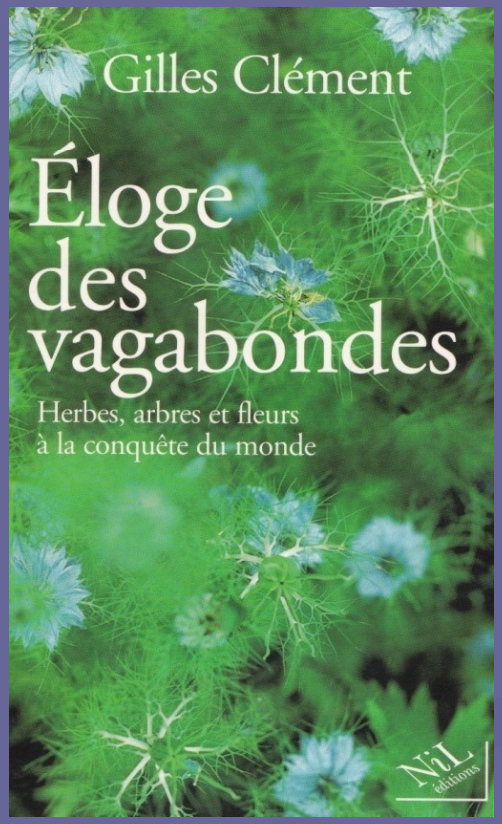
On ne peut s'empêcher de penser également, compte tenu du vocabulaire utilisé, qu'il existe une certaine analogie entre la « peur de l'étranger », lorsqu'il s'agit des hommes, et la peur de l'envahisseur, lorsqu'il s'agit des espèces végétales et animales. Que leur reproche-t-on ? De prendre la place des espèces autochtones ? De ne pas pouvoir se prévaloir du droit du sol ? Reconnaissons qu'il y a une forme de xénophobie dans notre attitude par rapport aux introductions d'espèces. Une xénophobie latente qui tient à la crainte de l'inconnu ou du changement. D'ailleurs, le thème des invasions est souvent marqué d'une forte charge émotionnelle. La preuve en est l'usage de mots à connotation négative (« envahisseurs », « pestes », « aliens ») ou d'un langage très martial (« bombardement d'exotiques », « lutte », « combat », « bataille », etc.), y compris par des scientifiques. Ainsi, la

Biotic homogenization

1999

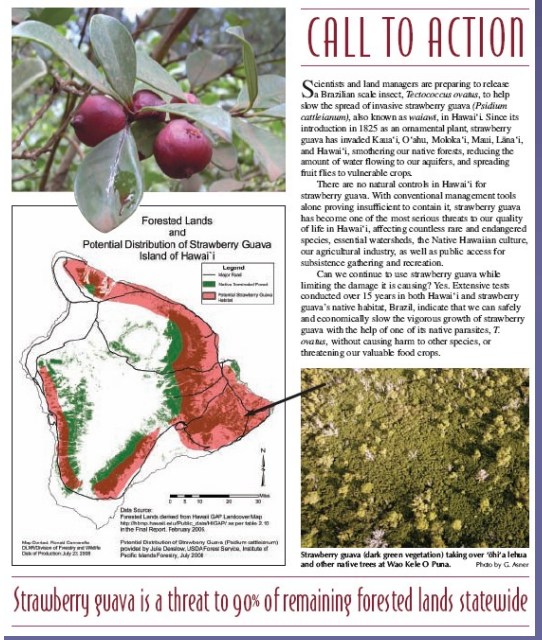


2002



– En voilà un, tenez, cette île, la Réunion, un résumé du monde. Du battant des lames au sommet des montagnes, comme on dit là-bas, les flores s'empilent comme des assiettes de 0 à 2 500 m. On commence avec les filaos d'Australie, on termine avec les ajoncs d'Europe. Entre les deux la flore indigène, une couronne de sylve relictuelle vers 1 500 m, succède aux étages américains, sud-africains, tandis que la ronce malaise s'installe partout. Il ne reste plus grand-chose des bois de couleur et des landes à philippies mais cette flore indigène, ajoutée à celle des autres continents, augmente le nombre absolu d'espèces en présence et anticipe sur le scénario du brassage en voie d'équilibre. Pour l'instant, nous sommes au début d'une mécanique de contacts dont l'homme accélère chaque jour le processus. Le bilan à terme devrait se solder par un déficit d'espèces. Mais, dans cette grande aventure, l'animal sapiens, vous et moi, ne faisons que prendre le relais des éléments. Regardez ces graines anémochores faites pour voyager avec le vent, ce ballon de foot, une noix de coco – la plus grosse graine du monde –, destinée à flotter comme le fruit des badamiers sur les mers salées pour s'enraciner au premier rivage tropical atteint. Le cocotier n'a pas attendu l'homme pour envahir le monde. Dans les limites de ses possibilités de vie – ce que l'on nomme un biome –, une espèce peut devenir cosmopolite. Aucune contre-indication.

Conflicts of interest



CALL TO ACTION

Scientists and land managers are preparing to release a Brazilian scale insect, *Teotococcus ovatus*, to help slow the spread of invasive strawberry guava (*Psidium cattleianum*), also known as *waiawī*, in Hawai'i. Since its introduction in 1825 as an ornamental plant, strawberry guava has invaded Kaua'i, O'ahu, Moloka'i, Maui, Lāna'i, and Hawai'i, smothering our native forests, reducing the amount of water flowing to our aquifers, and spreading fruit flies to vulnerable crops.

There are no natural controls in Hawai'i for strawberry guava. With conventional management tools alone proving insufficient to contain it, strawberry guava has become one of the most serious threats to our quality of life in Hawai'i, affecting countless rare and endangered species, essential watersheds, the Native Hawaiian culture, our agricultural industry, as well as public access for subsistence gathering and recreation.

Can we continue to use strawberry guava while limiting the damage it is causing? Yes. Extensive tests conducted over 15 years in both Hawai'i and strawberry guava's native habitat, Brazil, indicate that we can safely and economically slow the vigorous growth of strawberry guava with the help of one of its native parasites, *T. ovatus*, without causing harm to other species, or threatening our valuable food crops.

Forested Lands and Potential Distribution of Strawberry Guava Island of Hawai'i

Legend
Major Road
Native Forested Forest
Potential Strawberry Guava habitat

Data Source:
Forested Lands derived from Hawaii GAP Landcover Map
http://hilmp.hawaii.edu/Public_data/HIGAPI as per table 3-10 in the Final Report, February 2004.

Potential Distribution of Strawberry Guava (Psidium cattleianum) provided by Julia Denslow, USDA Forest Service, Institute of Pacific Islands Forestry, July 2004

Strawberry guava (dark green vegetation) taking over 'ōhi'a lehua and other native trees at Wao Kele O Puna. Photo by C. Anzer

Strawberry guava is a threat to 90% of remaining forested lands statewide

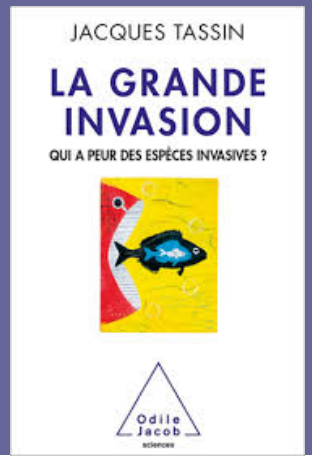
LA PLAINE-DES-PALMISTES FILIÈRE D'AVENIR

Le goyavier prend son envol

La filière goyaviers s'organise et l'association « Le goyavier, culture et tradition » rassemble des adhérents de toute l'île. Avec la création d'une organisation de producteurs (OP), producteurs et transformateurs ont réussi à obtenir des aides substantielles du Poseidom.

2018

« La clé du problème semble bien être dans la redéfinition d'une nature figée, idéalisée sur des bases erronées, au profit d'une nature en perpétuel renouvellement, sainement gérée et maîtrisée. Toutes les espèces « invasives » ne sont pas néfastes, et il importe, pour le bien de tous, d'accompagner les changements de l'environnement plutôt que de les combattre. La guerre des espèces n'aura pas lieu… »



2014

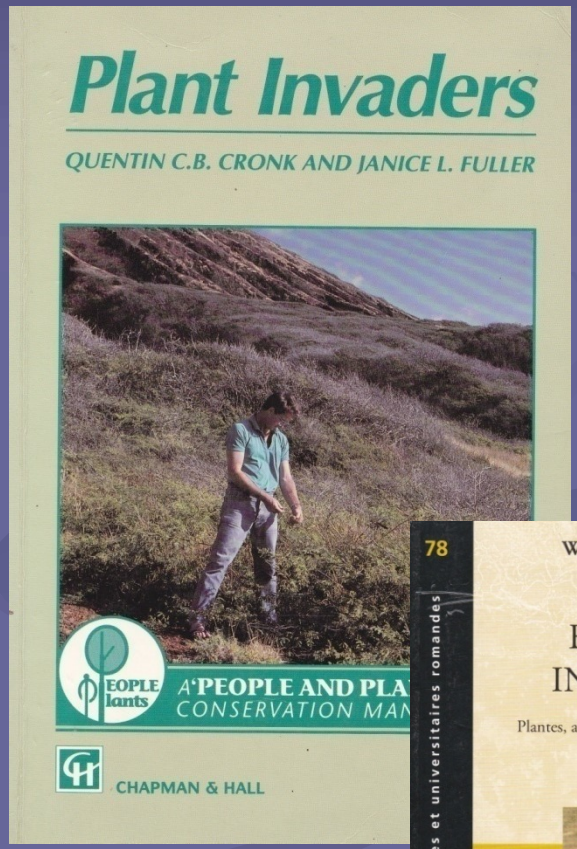
Terminology

Table 1.1 **Terminology commonly used for non-native species in the English language.**

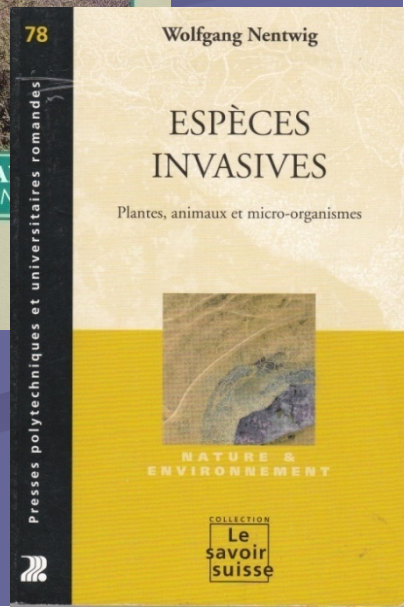
	Native	Non-native	Transported	Established	Spread	Impact	Invasive
Adventive	✸	✸		✸	✸		
Alien		✸	✸	✸	✸	✸	✸
Casual		✸	✸				
Colonizing		✸	✸	✸	✸		
Cryptogenic		✸	✸	✸			
Escaped	✸	✸	✸	✸	✸		
Established		✸		✸	✸		
Exotic		✸	✸	✸	✸	✸	✸
Foreign		✸	✸	✸			
Immigrant		✸	✸	✸	✸		
Imported		✸	✸	✸	✸		
Introduced	✸	✸	✸	✸	✸		
Invasive	✸	✸	✸	✸	✸	✸	✸
Naturalized		✸	✸	✸	✸		✸
Non-indigenous		✸	✸	✸	✸	✸	✸
Noxious	✸	✸				✸	✸
Nuisance	✸	✸				✸	✸
Pest	✸	✸				✸	✸
Ruderal	✸	✸		✸	✸		✸
Tramp		✸	✸	✸	✸		
Transformer		✸				✸	✸
Transient		✸	✸				
Translocated	✸	✸	✸	✸			
Transplanted	✸	✸	✸	✸			
Transported	✸	✸	✸				
Waif		✸	✸	✸			
Weed	✸	✸	✸	✸	✸	✸	✸

Notes: The list was compiled from the authors' readings of the invasion ecology literature. Other scientists may categorize the terms differently. This inconsistency of usage creates problems for synthesis and management. The columns indicate types of species and invasion stages to which the words apply. See Figure 1.2.

1995



2012



Novel ecosystems

2006

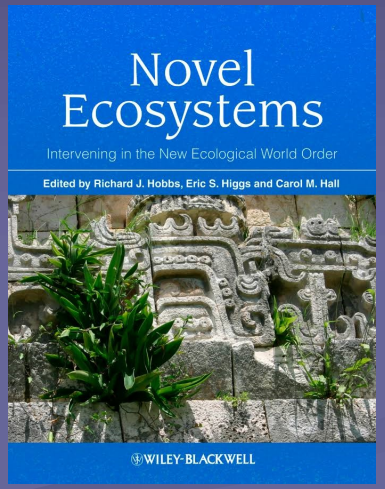
Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2006) **15**, 1–7

ECOLOGICAL SOUNDING

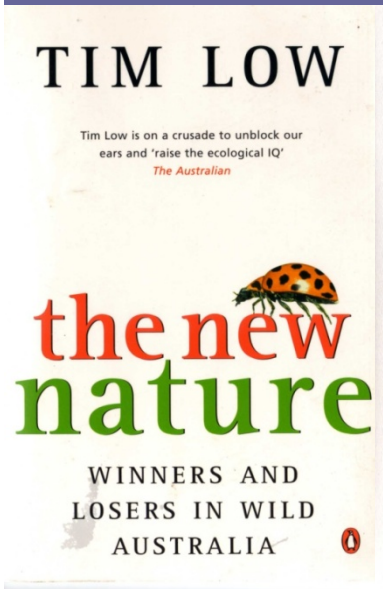
Novel ecosystems: theoretical and management aspects of the new ecological world order

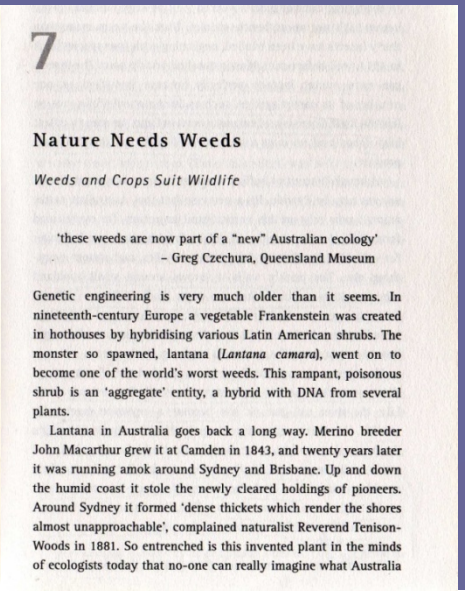
Richard J. Hobbs[1]*, Salvatore Arico[2], James Aronson[3], Jill S. Baron[4], Peter Bridgewater[5], Viki A. Cramer[1], Paul R. Epstein[6], John J. Ewel[7], Carlos A. Klink[8], Ariel E. Lugo[9], David Norton[10], Dennis Ojima[4], David M. Richardson[11], Eric W. Sanderson[12], Fernando Valladares[13], Montserrat Vilà[14], Regino Zamora[15] and Martin Zobel[16]

2013



2002





7

Nature Needs Weeds

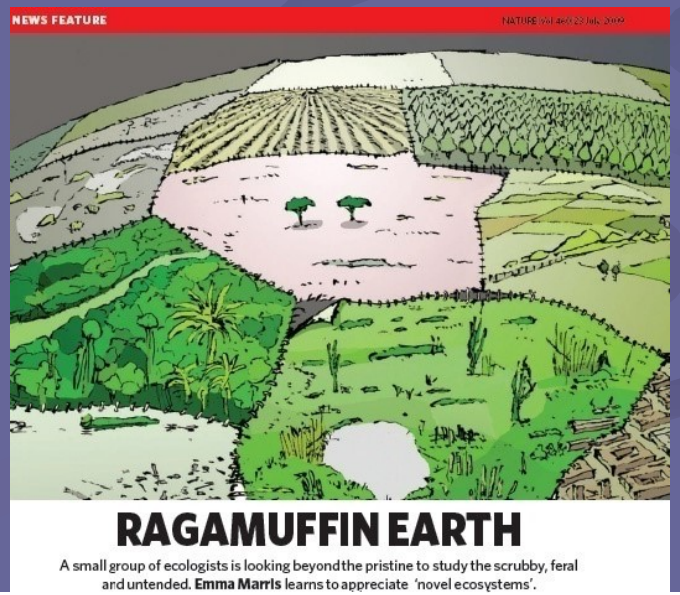
Weeds and Crops Suit Wildlife

'these weeds are now part of a "new" Australian ecology'
– Greg Czechura, Queensland Museum

Genetic engineering is very much older than it seems. In nineteenth-century Europe a vegetable Frankenstein was created in hothouses by hybridising various Latin American shrubs. The monster so spawned, lantana (*Lantana camara*), went on to become one of the world's worst weeds. This rampant, poisonous shrub is an 'aggregate' entity, a hybrid with DNA from several plants.

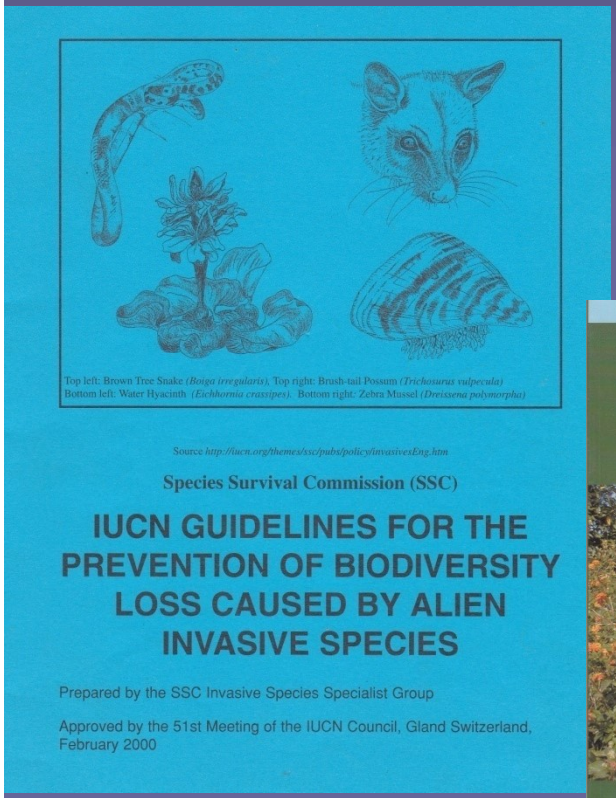
Lantana in Australia goes back a long way. Merino breeder John Macarthur grew it at Camden in 1843, and twenty years later it was running amok around Sydney and Brisbane. Up and down the humid coast it stole the newly cleared holdings of pioneers. Around Sydney it formed 'dense thickets which render the shores almost unapproachable', complained naturalist Reverend Tenison-Woods in 1881. So entrenched is this invented plant in the minds of ecologists today that no-one can really imagine what Australia

2009

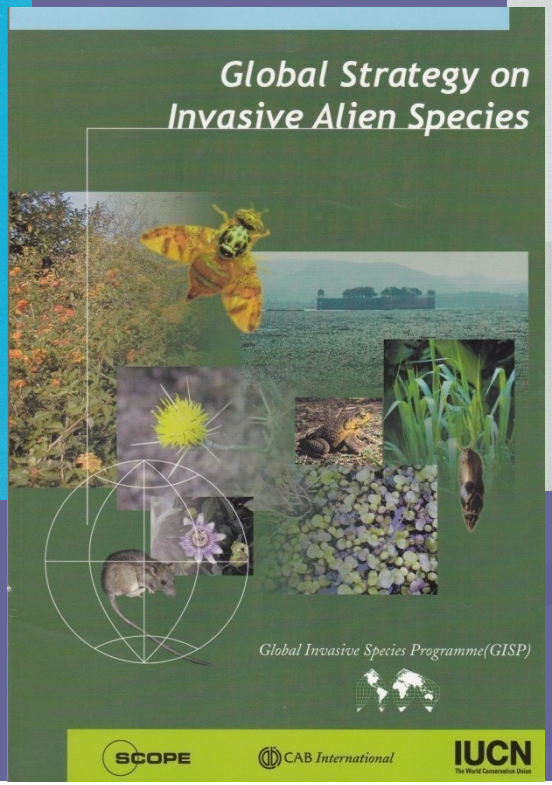


Strategies: global to regional and local

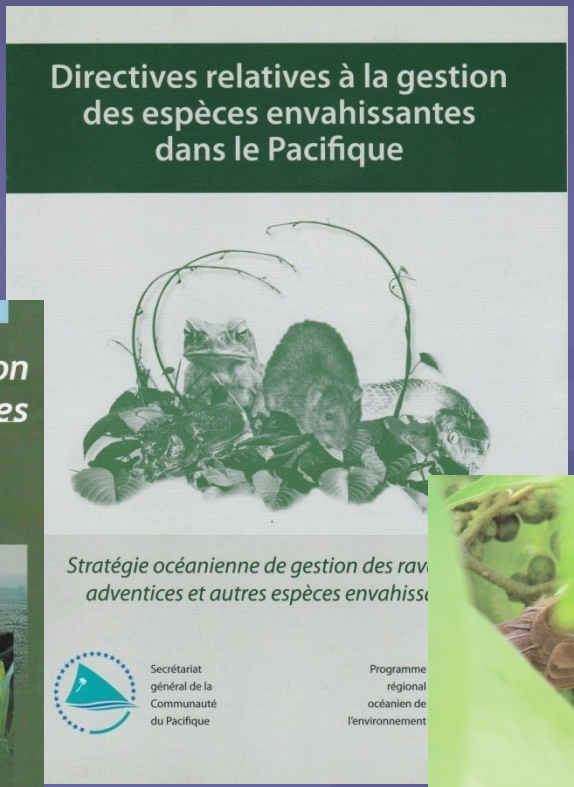
2000



2001



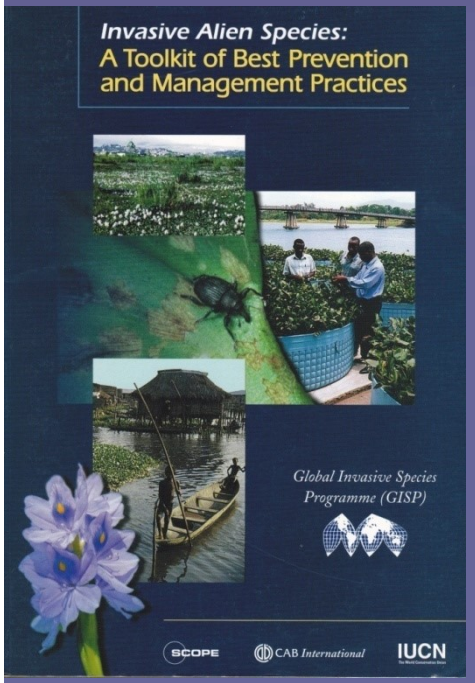
2010



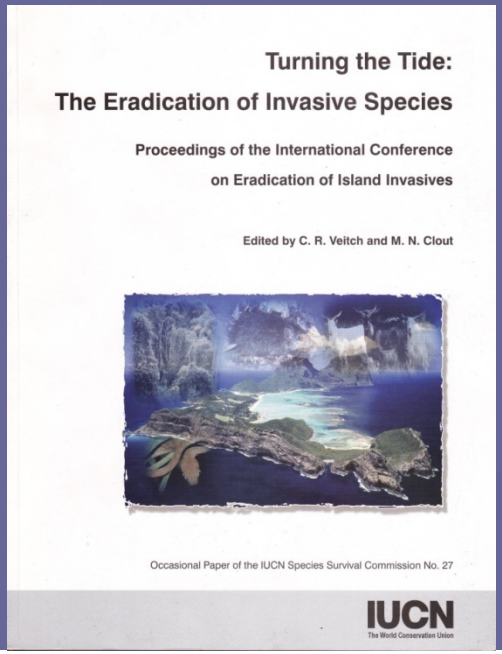
2008

Management: from prevention, to control & eradication

2001



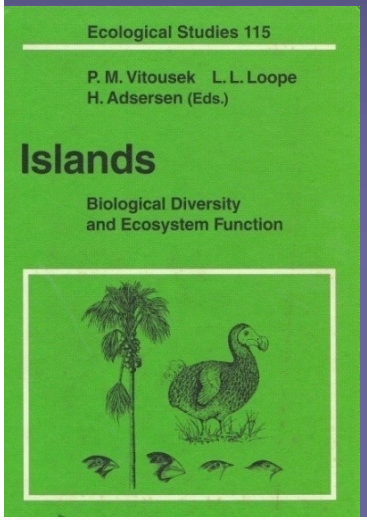
2004



2011

Invasions & Islands

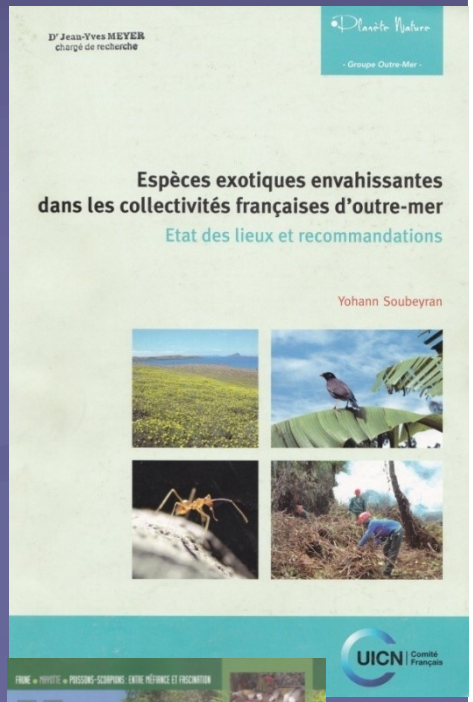
1995



2000

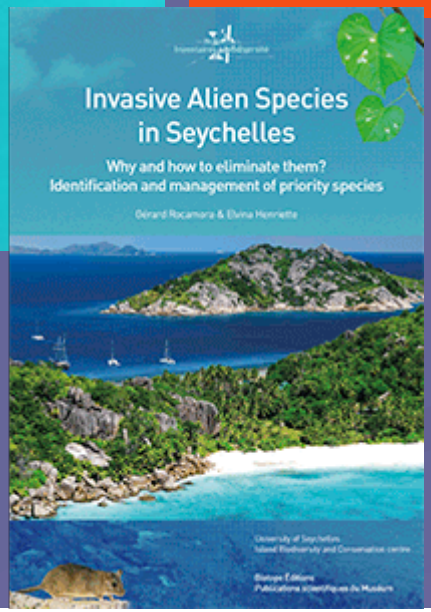
2006

2008



2011

2011

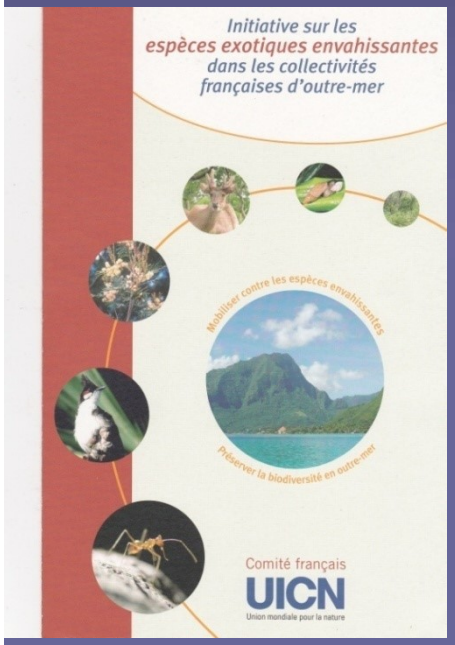


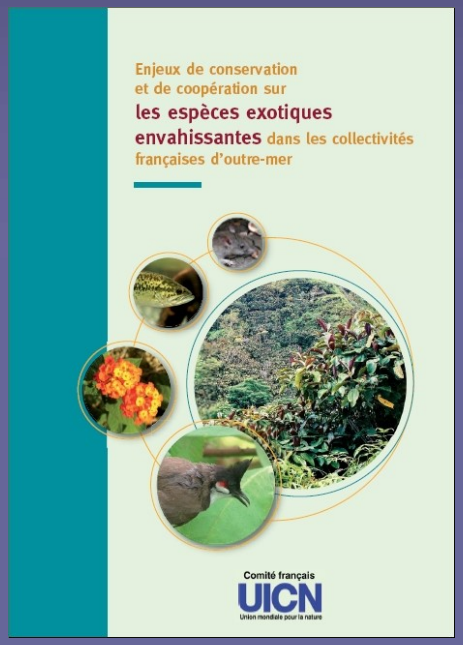
2011

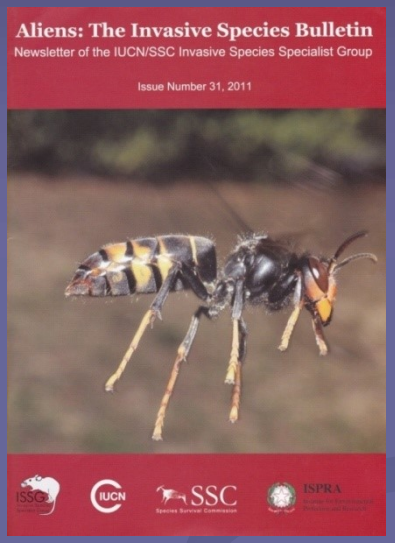
2015

Networks

2005







IUCN

ISSG
Invasive Species
Specialist Group

SPREP

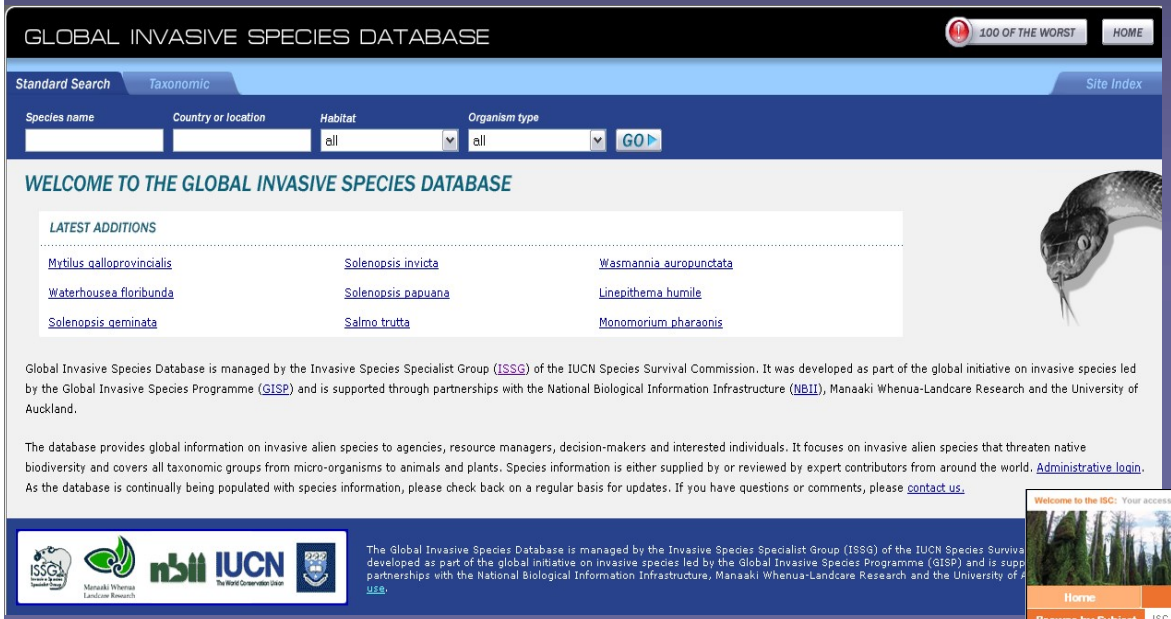
PACIFIC INVASIVES LEARNING NETWORK
PILN

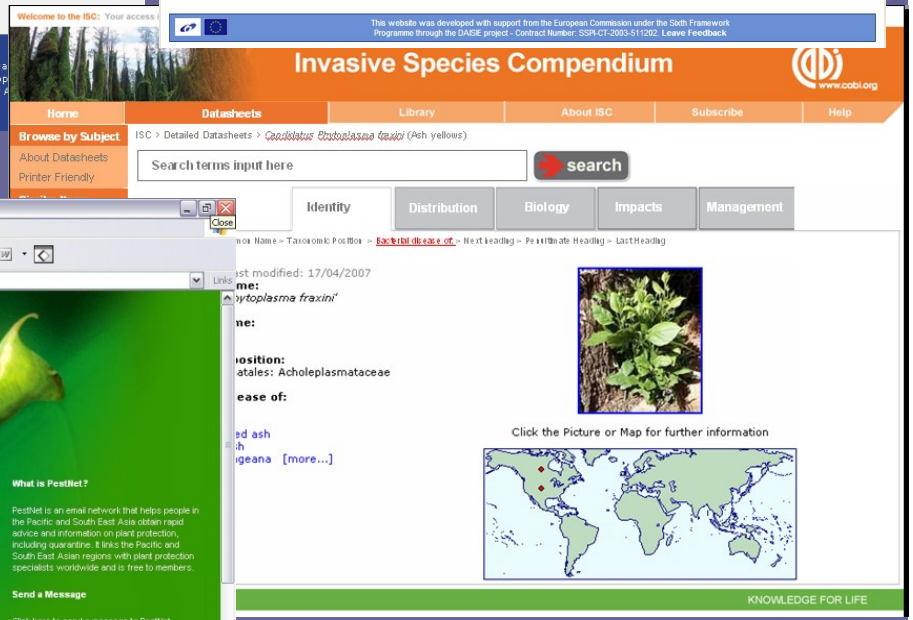
UICN | Comité Français

JOIN THE FIGHT
Protect our islands
from Invasive Species

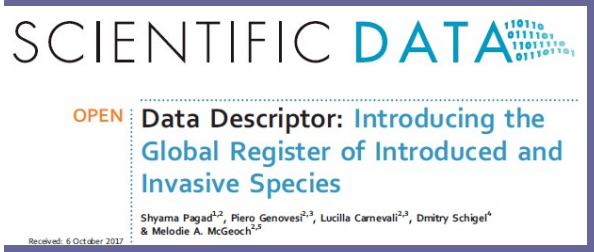
Pacific
INVASIVES
INITIATIVE

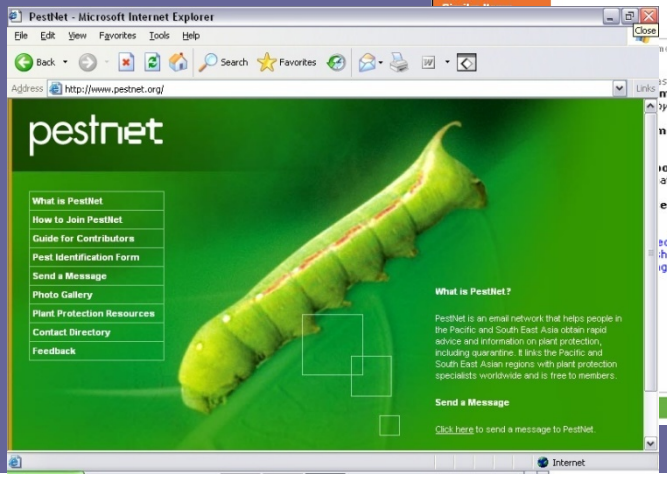
Databases





2017





2010

2019

ESPÈCES EXOTIQUES ENVAHISSANTES DANS LES COLLECTIVITÉS FRANÇAISES D'OUTRE-MER

Les espèces exotiques envahissantes sont l'une des principales menaces pour la biodiversité d'outre-mer et constituent un défi croissant pour ces territoires aux richesses naturelles exceptionnelles.

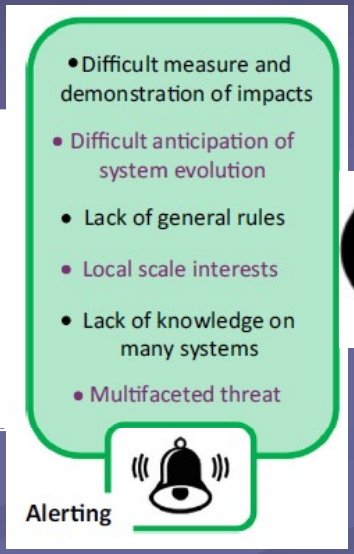
Face à cet enjeu, le Comité français de l'UICN conduit une initiative spécifique basée sur la mobilisation de tous les acteurs.

Développé dans le cadre de cette initiative, ce site Internet permet l'accès à de nombreuses informations scientifiques, techniques et juridiques sur les espèces invasives qui menacent les écosystèmes et les espèces indigènes en outre-mer et sur les stratégies pour mieux les gérer.

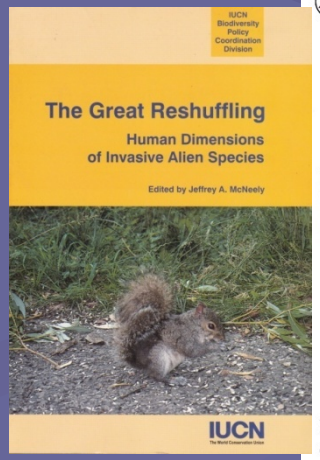
Conclusions

- Crucial challenges: biodiversity crisis, climate change…
- Strong human dimension
- Multidisciplinary field (« Invasion Science »): research, management, legislation, education, communication…

2017



2001



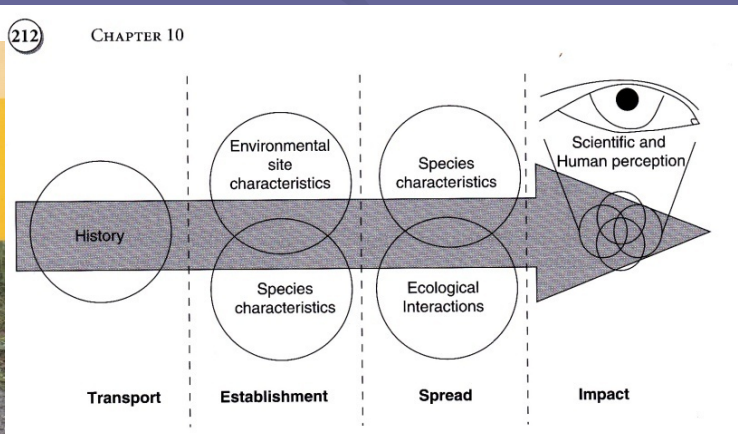


Figure 10.4 **Success at each stage may depend on several types of factors, may affect subsequent stages, and will affect impact. Final impact is also dependent on our perception. This figure combines the Venn diagram of Figure 10.1 and the concepts from Equation 7.3.**