

“Conservation of Biodiversity in French Polynesia”, UC Berkeley, Tetiaroa, 29 Jan. 2022

# Conservation of biodiversity in French Polynesia: from research to management and education



with a focus on Tetiaroa atoll (Society Is.)



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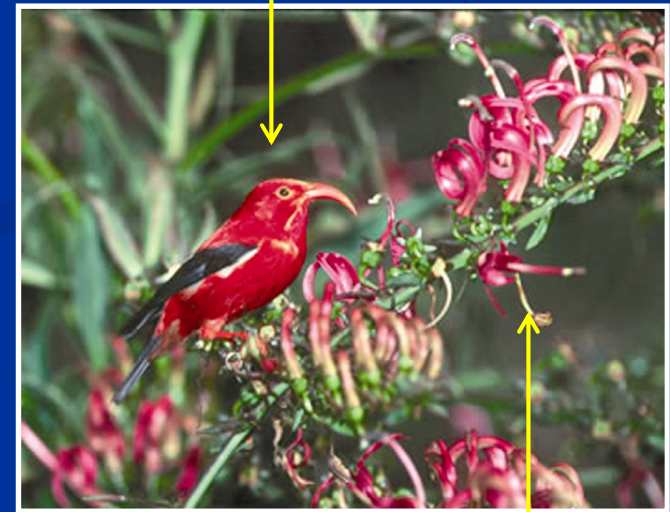


## Unique island biota...

- **Relatively high species richness** (ca. 20% of all species on less than 7% of the world area)
- **Very high endemism** (89% flowering plants in Hawaii, 80% in New Caledonia, 72% in French Polynesia)
- **Spectacular adaptative radiations** (e.g. Galápagos finches, Hawaiian honeycreepers & lobeliads)

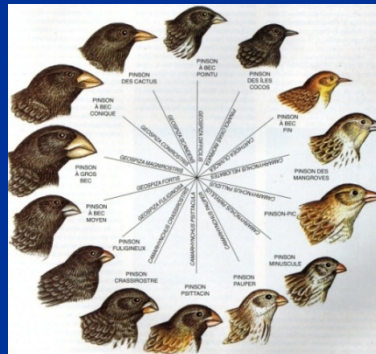
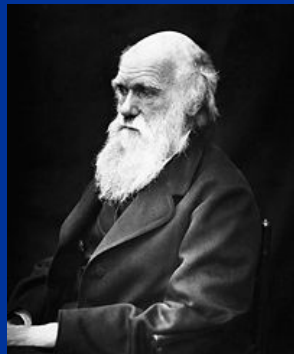
60 endemic honeycreepers in the endemic subfamily Drepanidinae

*'Tiwi Vestiaria coccinea*



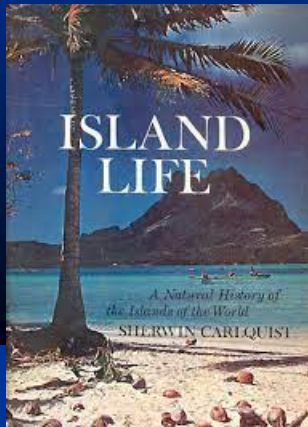
*Trematolobelia* sp.

126 endemic lobeliads within 6 endemic genera (Campanulaceae, Lobelioidae)

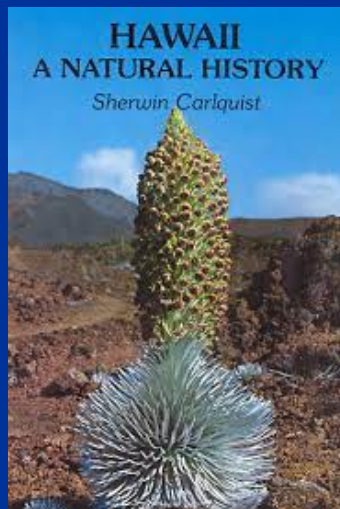


# The « Island syndrome »

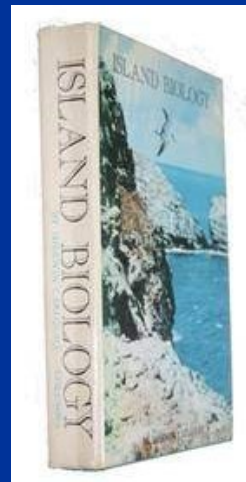
(2021)



(1965)



(1980)



(1974)

(In memory of Sherwin CARLQUIST, 1930-2021†)



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Scientists' warning – The outstanding biodiversity of islands is in peril

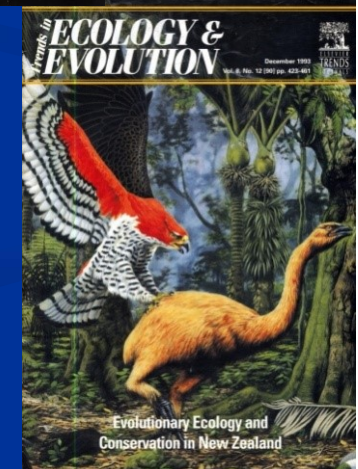
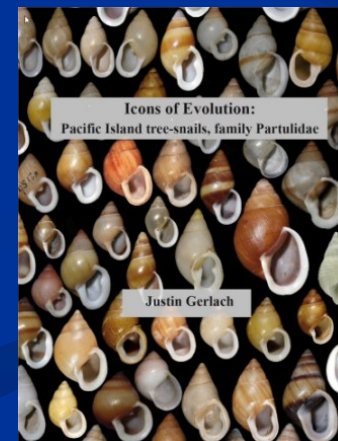
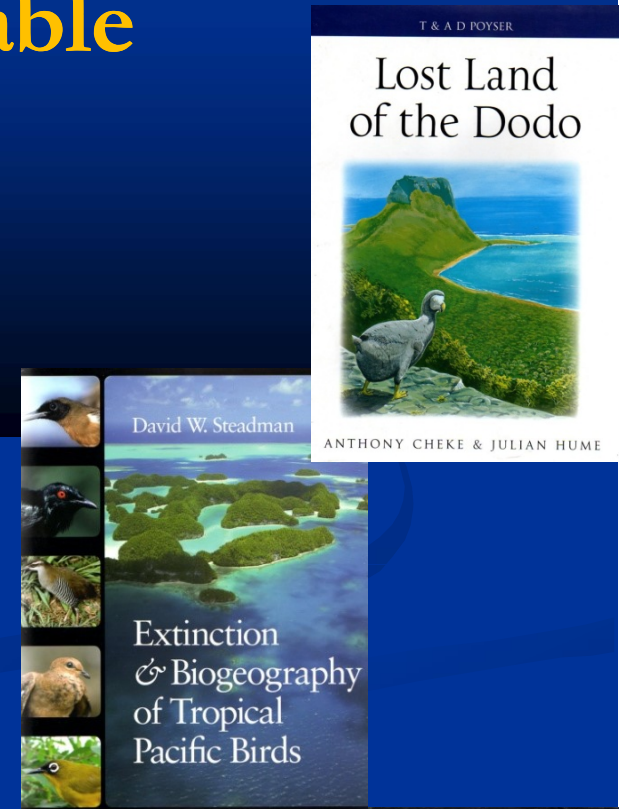
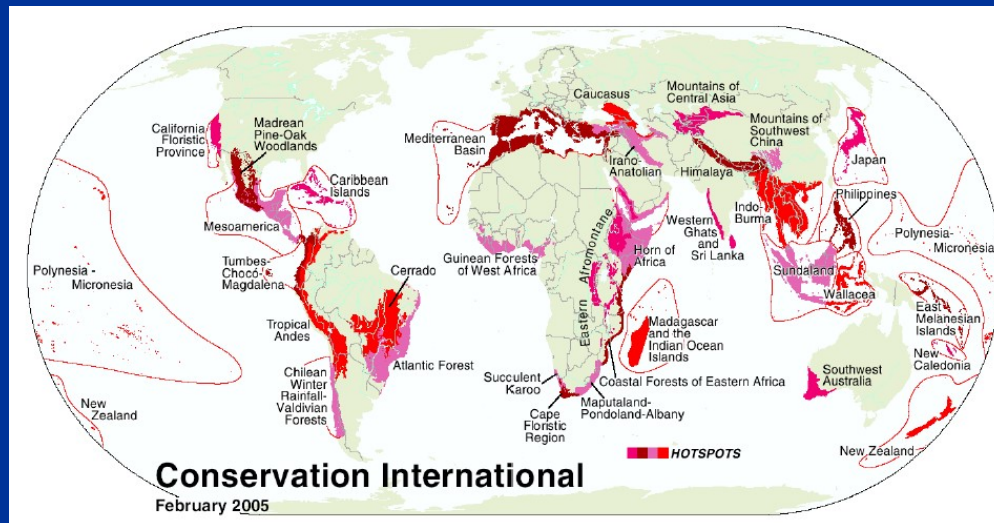
José María Fernández-Palacios<sup>a,1</sup>, Holger Kreft<sup>b,1</sup>, Severin D.H. Irl<sup>c,\*,1</sup>, Sietze Norder<sup>d,1</sup>, Claudine Ah-Peng<sup>e,1</sup>, Paulo A.V. Borges<sup>f,1</sup>, Kevin C. Burns<sup>g,1</sup>, Lea de Nascimento<sup>a,1</sup>, Jean-Yves Meyer<sup>h,1</sup>, Elba Montes<sup>i,1</sup>, Donald R. Drake<sup>j,1</sup>

	island	continent	
low species richness			community level
disharmonic biota			
high endemcity			
few interactions			
demographic release			species level
ecological release			
flightlessness			
dwarfism			
gigantism			
secondary woodiness			
loss of defenses			
tameness			
slow reproduction			
loss of dispersal ability			

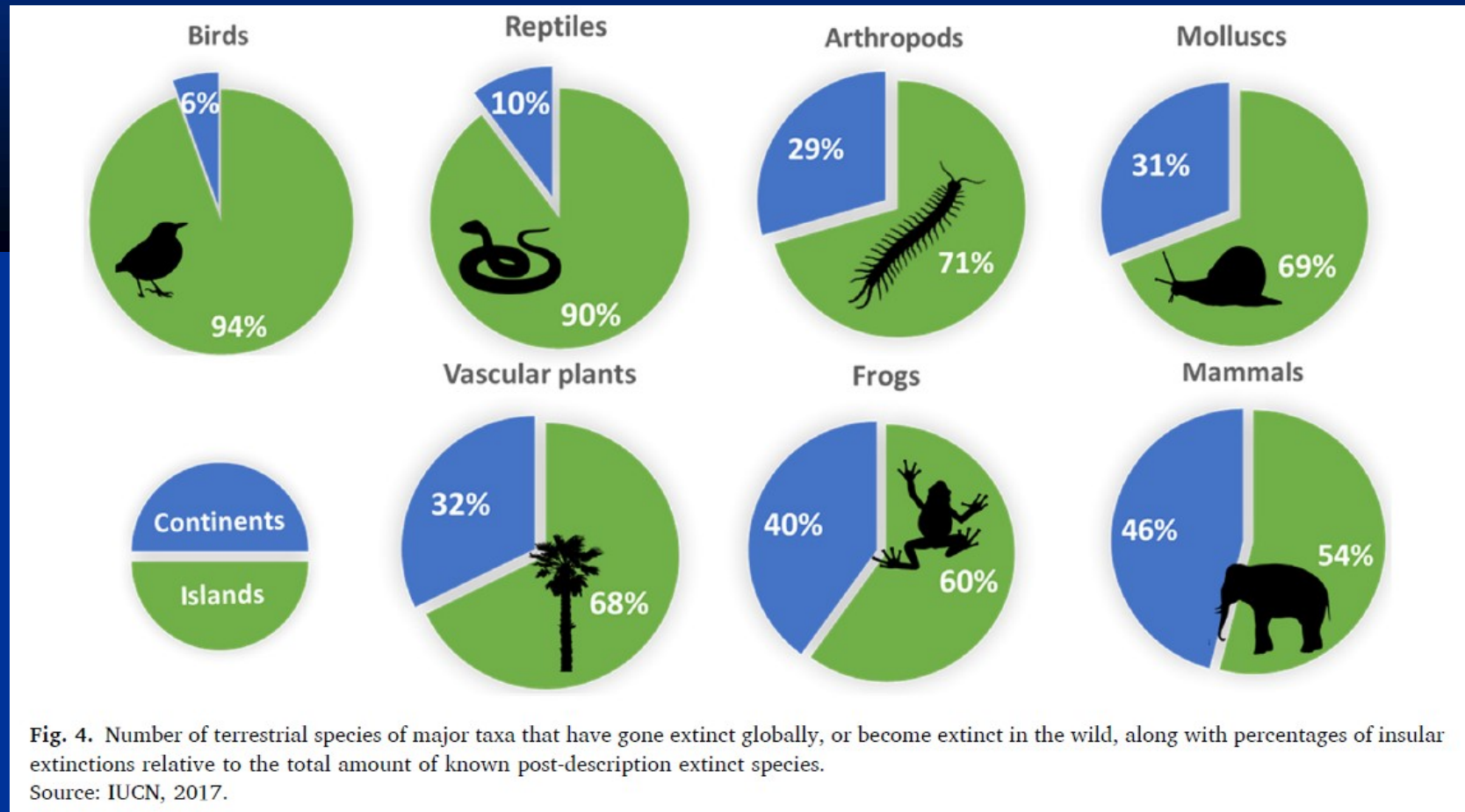
Fig. 3. Some typical characteristics of island species and communities that make them different from continental ones.

## ...but highly vulnerable

- **Massive extinction events** (75% of all extinct species, 90% of all extinct birds and reptiles)
- **Endangered biota** (90% of all the threatened birds, 2.5 x more threatened plants on islands)
- **10 of the 36 “Biodiversity Hotspots”** (areas with high endemism and high level of threat)

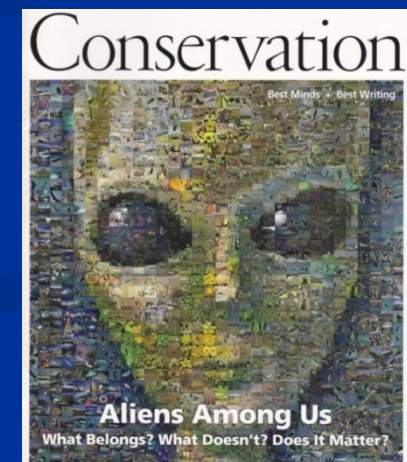
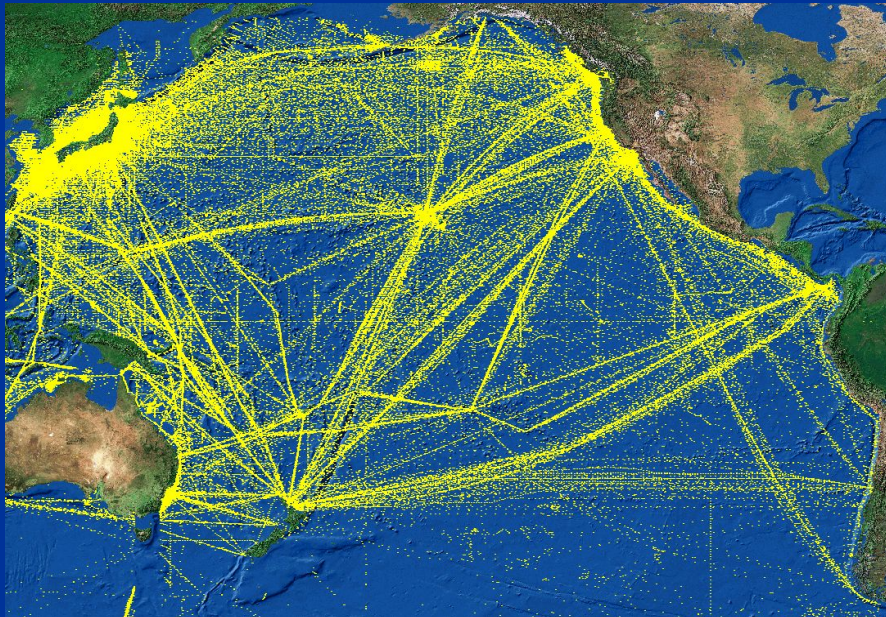


## Extinction crisis on islands



# The Anthropocene

- Globalization & Biotic Mixing
- Global Changes
- Extinction crisis

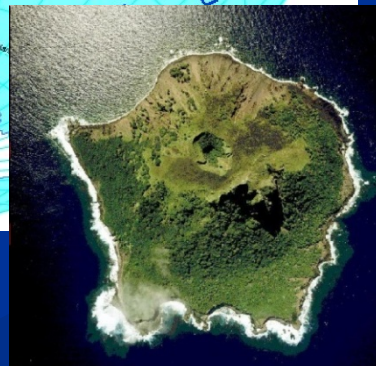


# French Polynesia as a case study: Ecosystem diversity

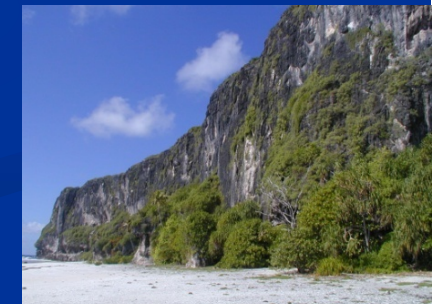


- 120+ oceanic islands, 3,520 km<sup>2</sup>, 30,000 yrs to 60 MY (atolls)
- Tropical to subtropical climate
- 34 high volcanic islands (e.g. Tahiti, Mo’orea) to almost atolls (e.g. Mai’ao) and « composite » islands (e.g. Rimatara, Rurutu)
- 83 atolls (e.g. Rangiroa) including 6 uplifted atolls (e.g. Makatea, Niau, Ana’a)

Me’etia (Society)



Ua Pou (Marquesas)



Makatea (Tuamotu)

# Isolation and Insularity

## POLYNESIE FRANCAISE



Maupiti

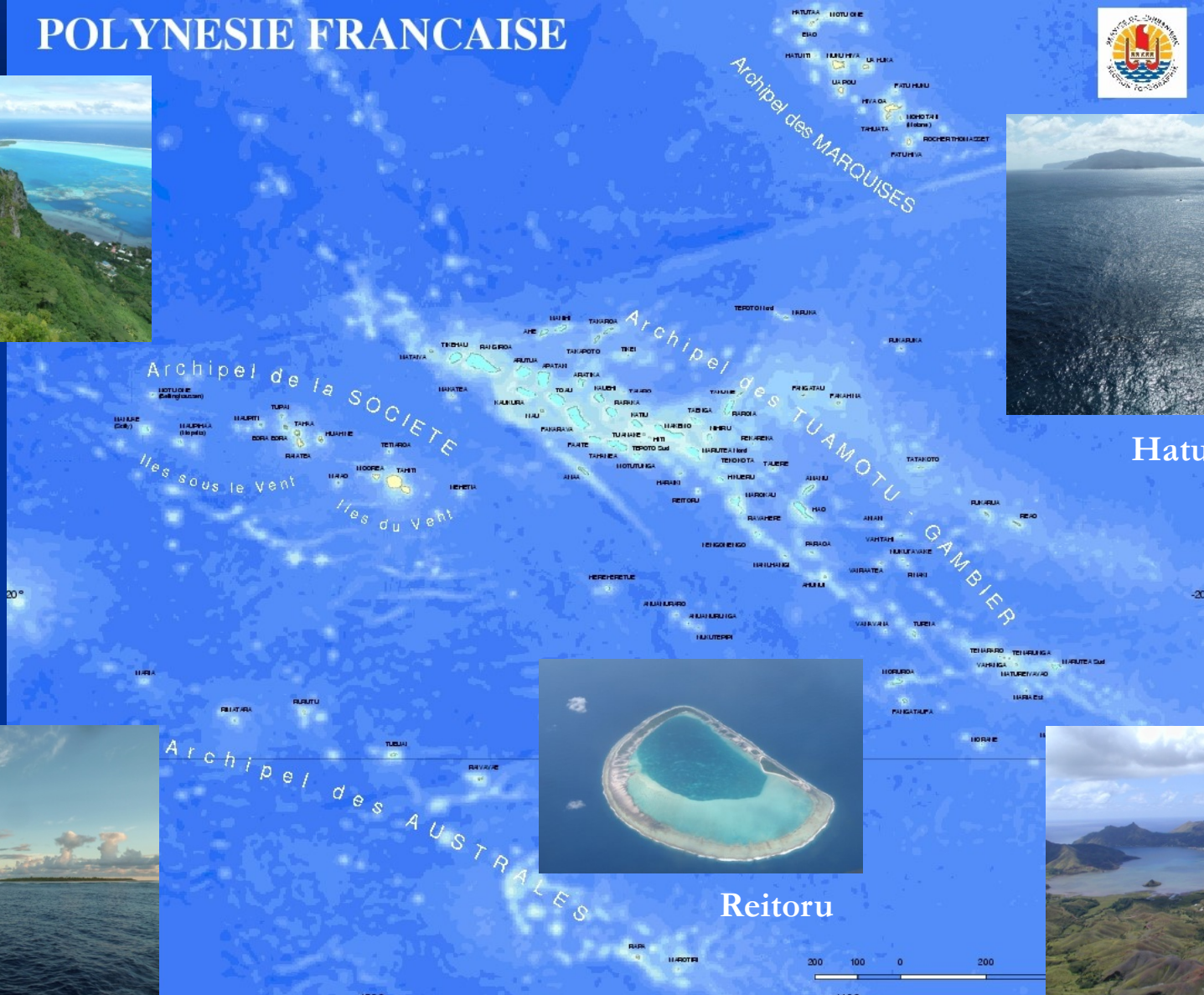


Hatutaa & Eiao

Maria



Rapa



Reitoru



## Habitat diversity & vegetation types

- Coastal/littoral vegetation & forests
- Para/supra-littoral forests
- Semi-Dry forests
- Mesic forests
- Lowland and valley wet/rainforests
- High elevation/montane rainforests (« cloud forests »)
- Sub-alpine vegetation (« summit shrublands »)
- Wetland vegetation (from sea-level to mountains)



Niau (Tuamotu)



Te Pari, Tahiti Iti  
(Society)



Mt Orohena (2241 m  
elev.), Tahiti Nui (Society)



Roto Rahi & Roto Iti lakes, Maiao (Society)



Pariati valley & slope, Rapa (Austral)



Mt Aorai (ca. 1700 m elev.), Tahiti

# Species diversity

- **Arthropods > 3000 native species** incl. 1570 endemics (1406 endemic insects\*)
- **Plants > 900 native taxa** incl. 570 endemics, 62% endemism
- **Land molluscs > 525 native taxa**, 95% endemism
- **Freshwater fishes = 37 native species** incl. 15 endemics
- **Land birds = 36 native land birds** incl. 27 endemic species
- **Reptiles = 9 native geckos & skinks**



*Rhyncogonus planatus* (Ua Huka)



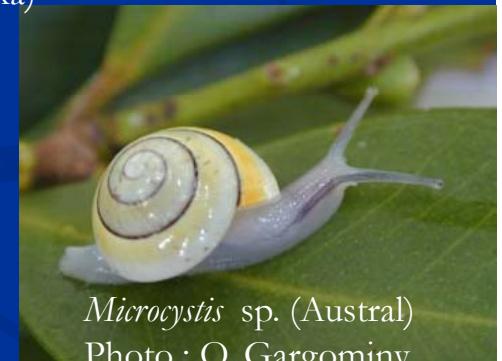
*Nacaduba tabitiensis* (Tahiti)



*Sclerotheca (Apetabia) raiateensis* (Raiatea)



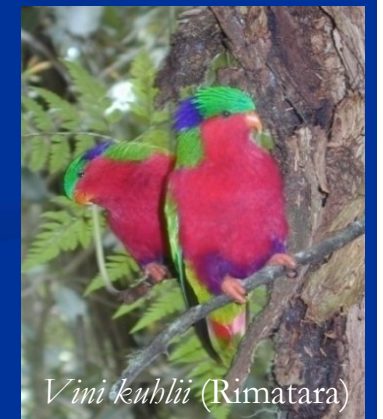
*Lentipes rubrofasciatus*  
(Marquesas) Photo : P. Keith



*Microcystis* sp. (Austral)  
Photo : O. Gargominy



*Ducula galeata* (Nuku Hiva)



*Vini kublii* (Rimatara)

## Endemism (Angiosperms)

Archipelago/Island (area)	Native flowering plants	Endemic flowering plants (%)	Endemic species density (per sq. km)
New Caledonia (19,060 km <sup>2</sup> )	3,063	2,448 (80%)	0.128
Fiji (18,270 km <sup>2</sup> )	1,302	799 (61%)	0.050
Hawaii (16,880 km <sup>2</sup> )	966	859 (89%)	0.051
La Réunion (2,512 km <sup>2</sup> )	797	309 (39%)	0.123
<b>French Polynesia (3,520 km<sup>2</sup>)</b>	<b>659</b>	<b>478 (72%)</b>	<b>0.136</b>

# Speciation & evolutive radiation

Archipelago	<i>Cyrtandra</i> (Gesneriaceae)	<i>Psychotria</i> (Rubiaceae)
Hawai'i	60	11
Fiji	37	76
<b>French Polynesia</b>	<b>28</b>	<b>27+</b>



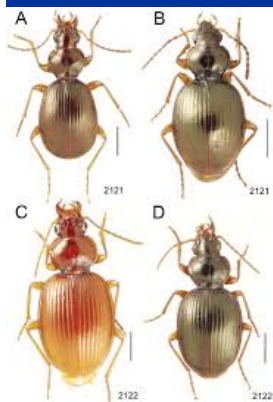
*Cyrtandra*



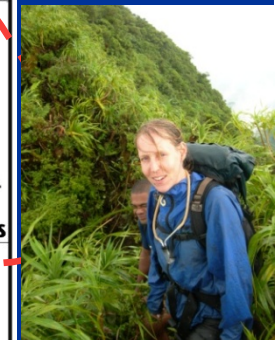
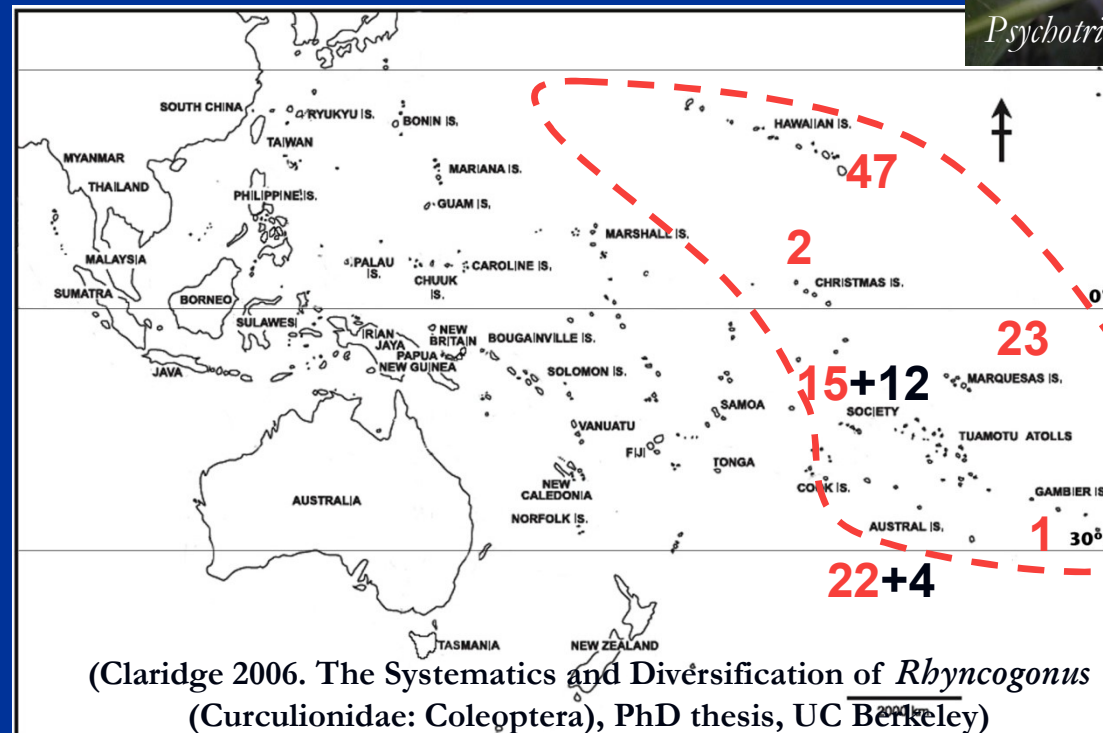
*Psychotria*



*Rhyncogonus adamsonii* (Hiva Oa)



*Mecyclothorax* spp.  
(101 species)



(Raiatea, 2006)

## Main threats to biodiversity

- Population growth (x2 in the past 30 yrs)
- Urbanization pressure
- Deforestation & fragmentation (agriculture, forestry, fires, mining, etc.) + Pollutions + Overexploitation + Introductions of alien species + Climate change

The Earth's Evil Destroyer  
of Biodiversity:

Habitat Destruction

Invasive Species

Pollution

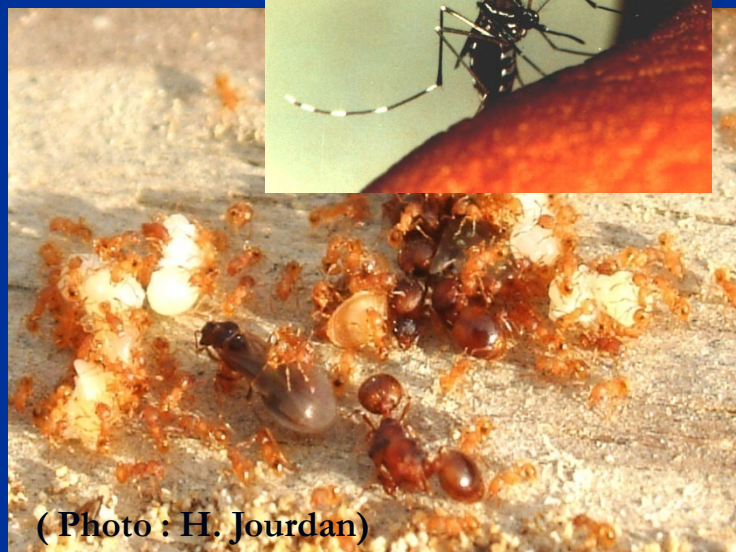
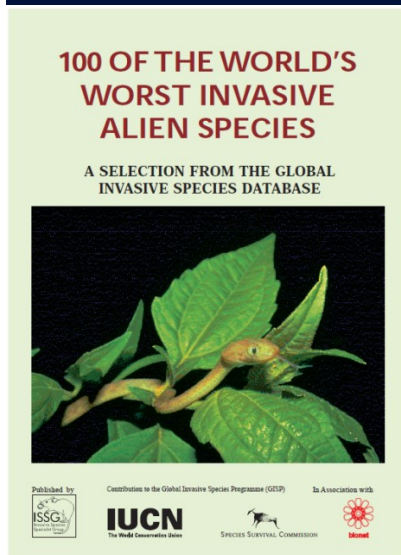
Population

Overharvesting



# Invasive alien species

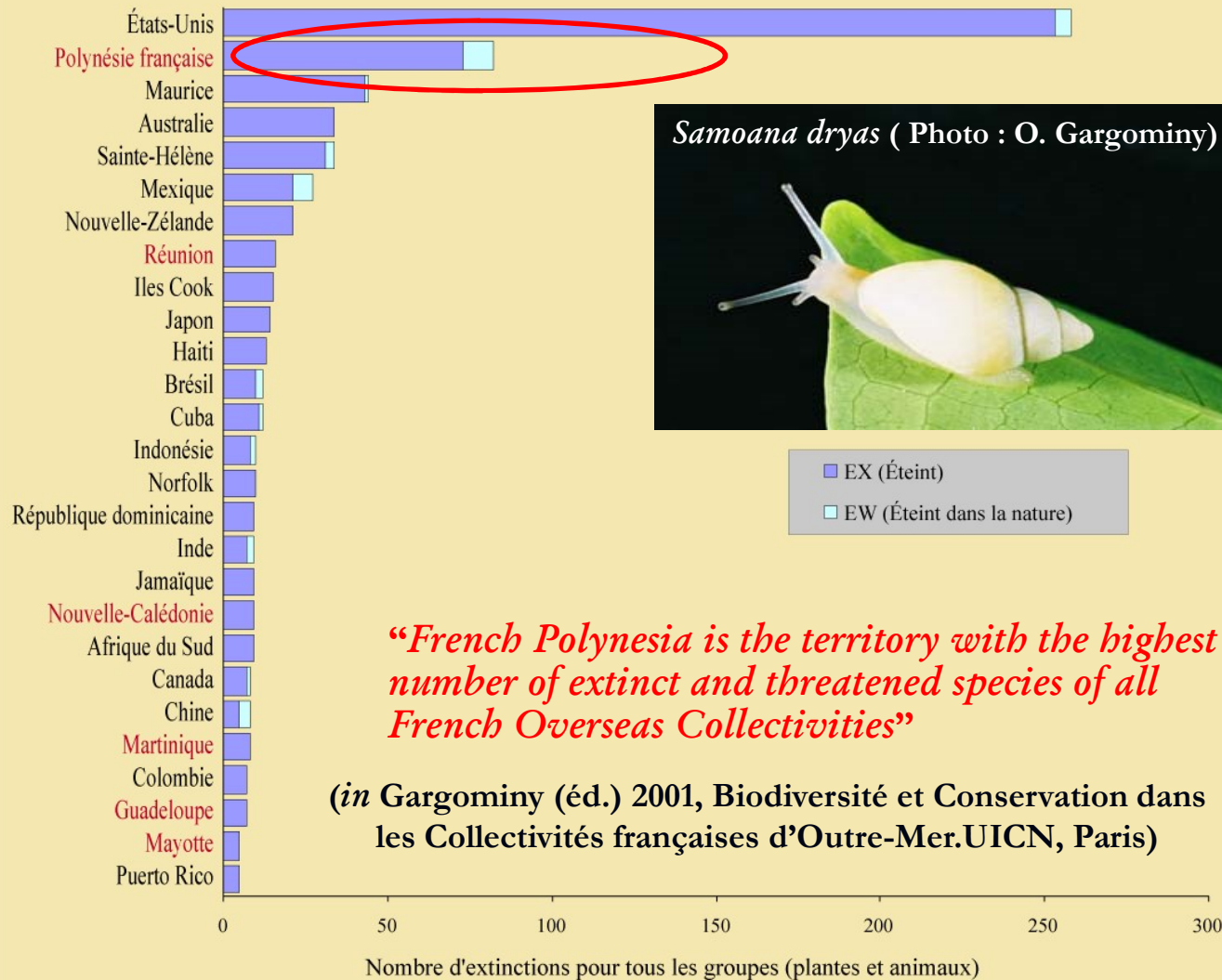
- Increasing transportation of goods and people
- Huge ecological, socio-economical and human health impacts



( Photo : H. Jourdan)

# Species extinctions

Les 26 pays avec plus de 5 espèces éteintes depuis 1500



*Samoana dryas* ( Photo : O. Gargominy)

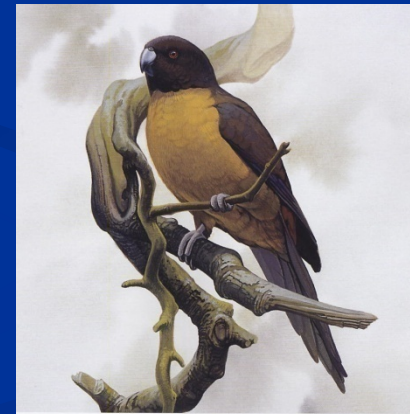
■ EX (Éteint)  
■ EW (Éteint dans la nature)

**“French Polynesia is the territory with the highest number of extinct and threatened species of all French Overseas Collectivities”**

(in Gargominy (éd.) 2001, Biodiversité et Conservation dans les Collectivités françaises d’Outre-Mer. UICN, Paris)



*Sesbania coccinea subsp. atollensis var. parkinsonii*  
(Sydney Parkinson, 1773)



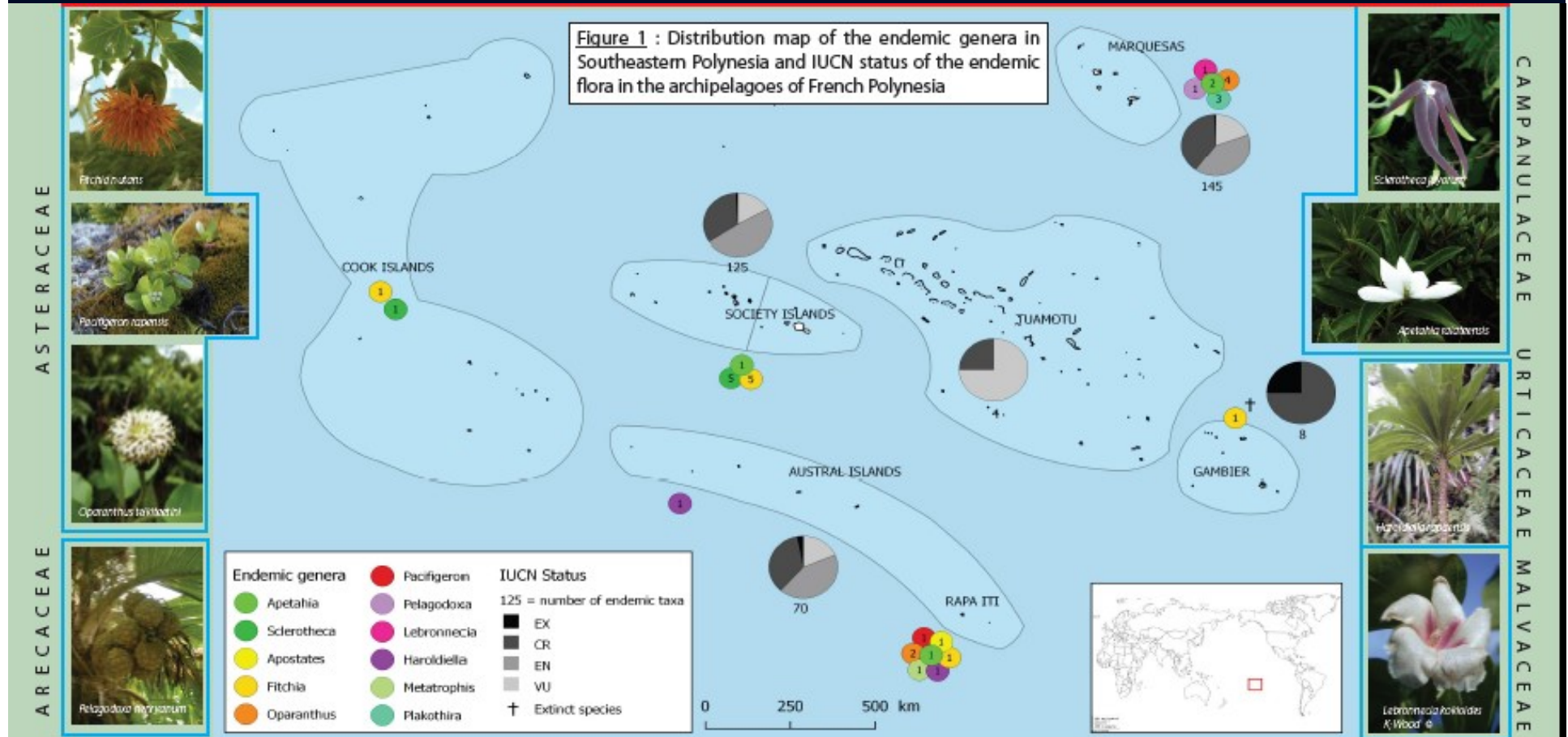
1777  
Raiatea Parakeet  
(*Cyanoramphus ulietanus*)  
*Cyanoramphus ulietanus*

# Threatened flora & fauna



- Birds : 11 CR, 17 EN, 13 VU
- Plants : 118 CR, 134 EN, 50 VU

(Meyer, 2016. Island Biology Conference, Azores)





# Contemporary extinction or decline of monarchs (flycatchers) *Pomarea* spp. in Eastern Polynesia

**Rarotonga**

*P. dimidiata* ★

**Tahiti**

*P. nigra* ★

*P. fluxa* † 1977

*P. nukuhivae* † 1930s

*P. iphis* ☆

*P. mira* † 1985

† Extinct  
★ Critical  
★ Endangered  
☆ Vulnerable

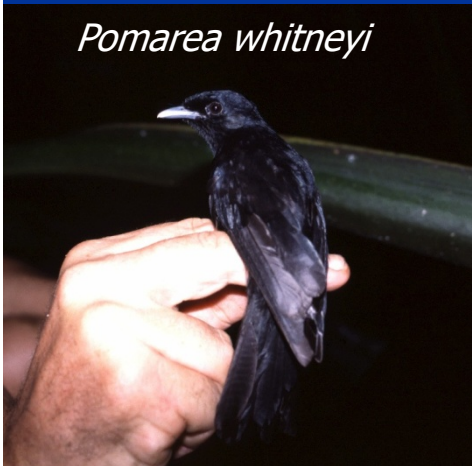
**MARQUESAS**

*P. mendozae* † 1975

*P. motanensis* ★

*P. mendozae* † 1922

*P. whitneyi* ★



(Thibault & Meyer 2001)

# The impacts of the Carnivorous snail *Euglandina rosea*



*Achatina fulica*  
1967



*Microcystis saintjohni* (Tubuai)



*Euglandina rosea*  
1975



*Partula otabeitana* (Tahiti)



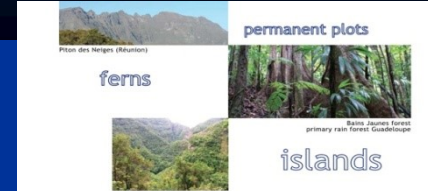
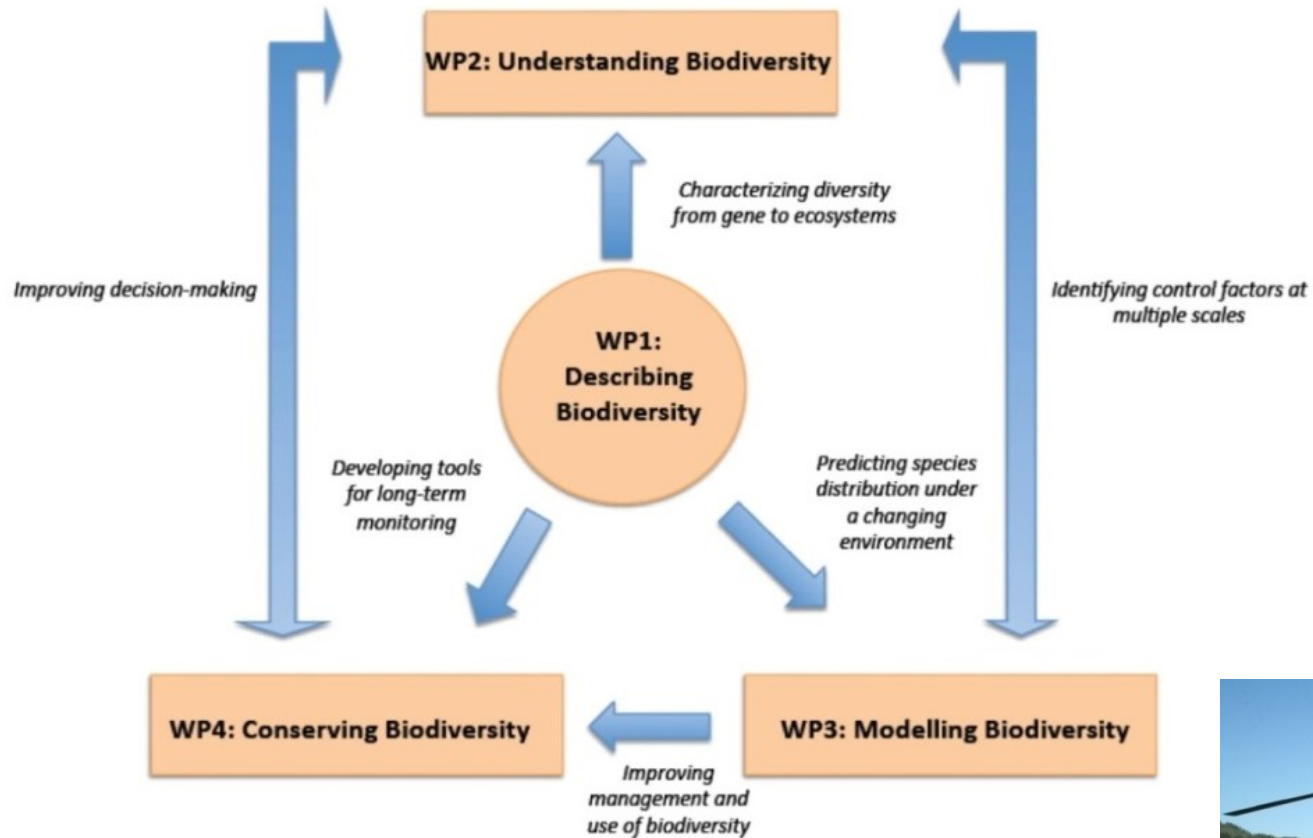
*Partula taeniata* (Moorea)



*Samoana ganymedes* (Tahuata)

- Extinction of 56 of the 61 endemic *Partula* species in the Society Islands

# From research to management

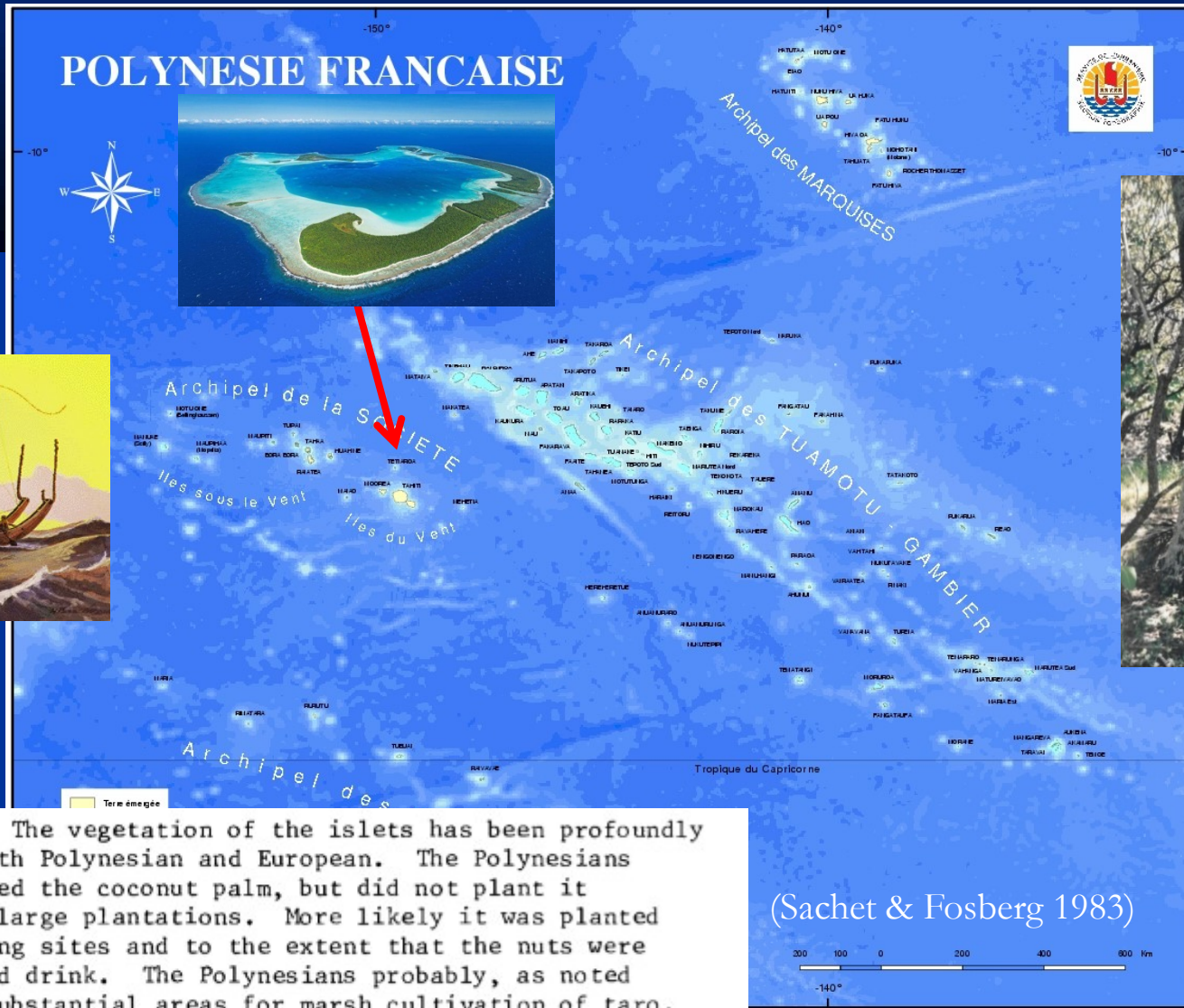


**Montane vegetation**  
as listening posts for climate change



(after « MOVECLIM » project)

# Tetiaroa as a model system

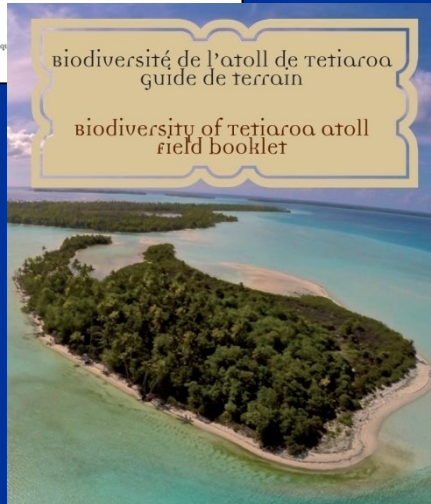
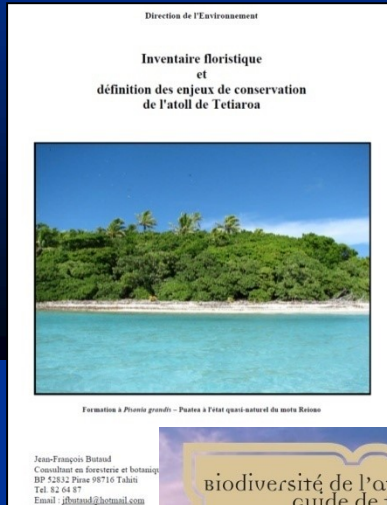


(1993)

Vegetation: The vegetation of the islets has been profoundly altered by man, both Polynesian and European. The Polynesians certainly introduced the coconut palm, but did not plant it generally to form large plantations. More likely it was planted only around dwelling sites and to the extent that the nuts were needed for food and drink. The Polynesians probably, as noted above, excavated substantial areas for marsh cultivation of taro.

(Sachet & Fosberg 1983)

# Flora of atolls in French Polynesia

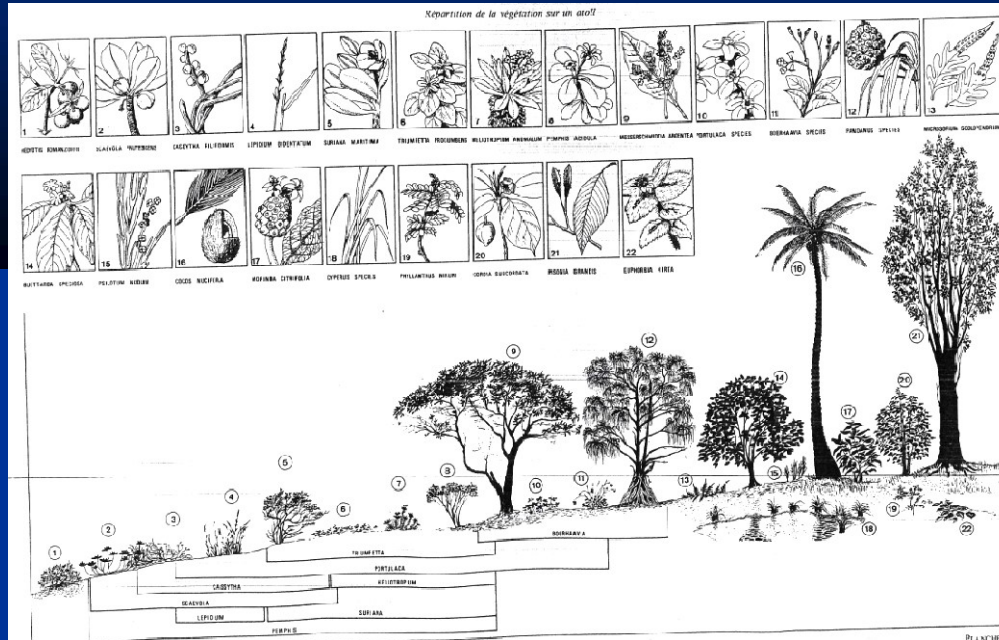


Atoll	Area (km <sup>2</sup> )	Native plants	Alien plants	Source
Toau (Tuamotu)	12	33(+)	74	Taputuarai & Niva, 2015
Tupai (Society)	11	40(-)	95	Butaud, Taputuarai <i>et al.</i> , 2011
Raraka (Tuamotu)	7	30(+)	105	Taputuarai & Niva, 2015
<b>Tetiaroa (Society)</b>	<b>5</b>	<b>39(-)</b>	<b>180</b>	Butaud, 2006, 2013
Taiaro (Tuamotu)	4	25	21	Niva & Taputuarai, 2013
Moruroa (Tuamotu)	3	29(-)	55	Meyer, 2007
Morane (Gambier)	2.2	21	1	Meyer, 2020
Maria (Australs)	1.5	24	10	Meyer, 2013

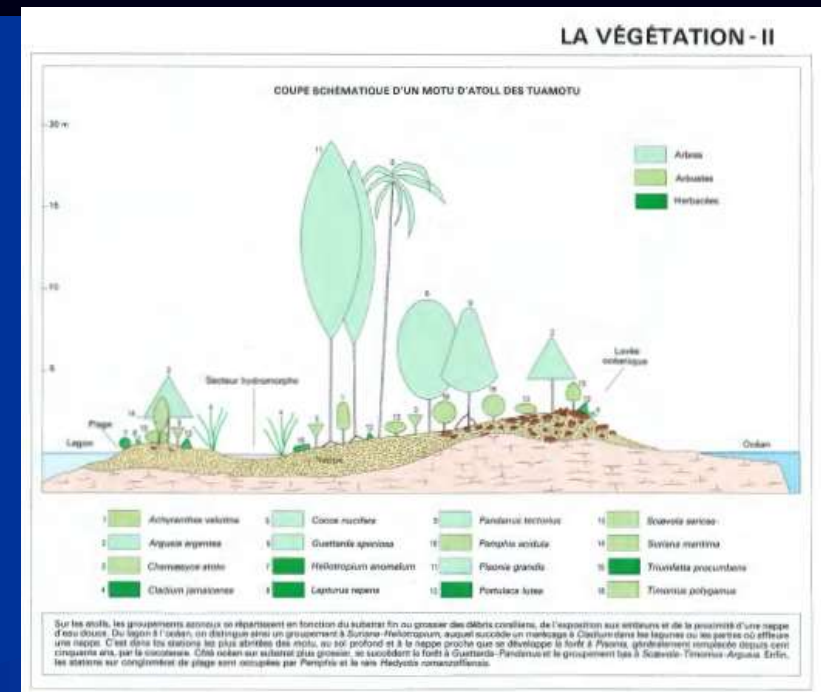


(Morane, 2019)

# Botany & plant ecology

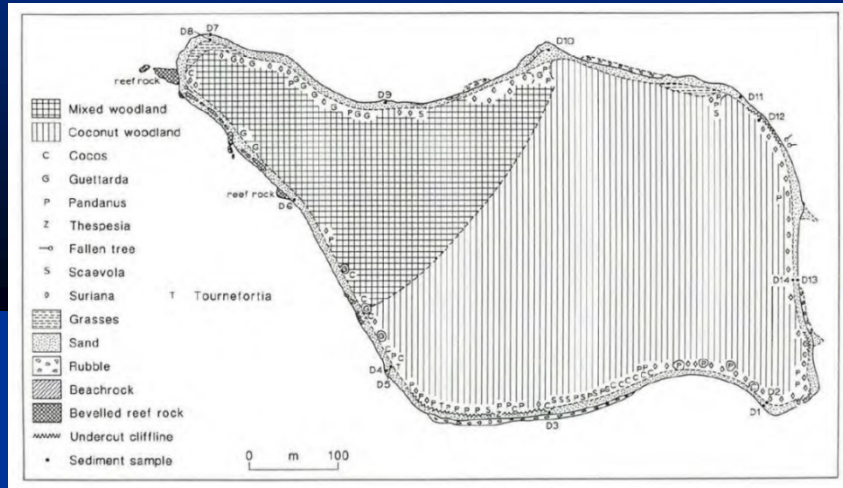


(in Cayet, O. 1973. Le Monde Vivant des Atolls. Polynésie française)



(in Florence 1993. La végétation de quelques îles. Atlas de la Polynésie française)

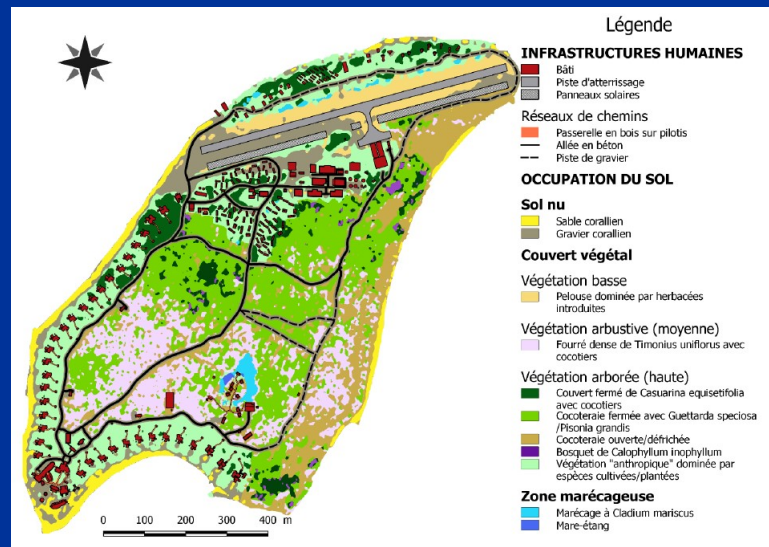
# GIS & Vegetation map



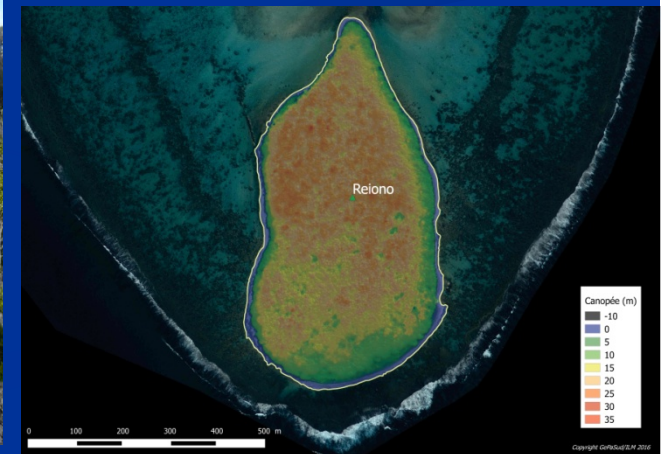
(Stoddart, unpub. data)



(Google Earth©)



(Jost, 2016)



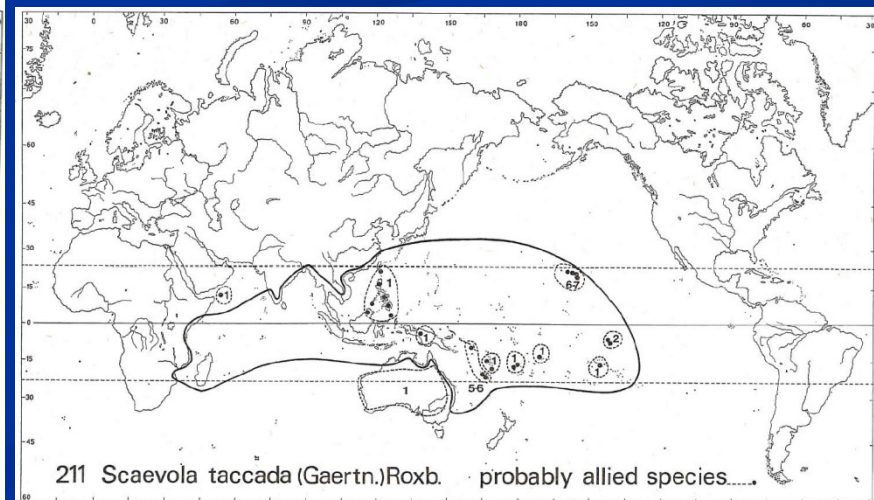
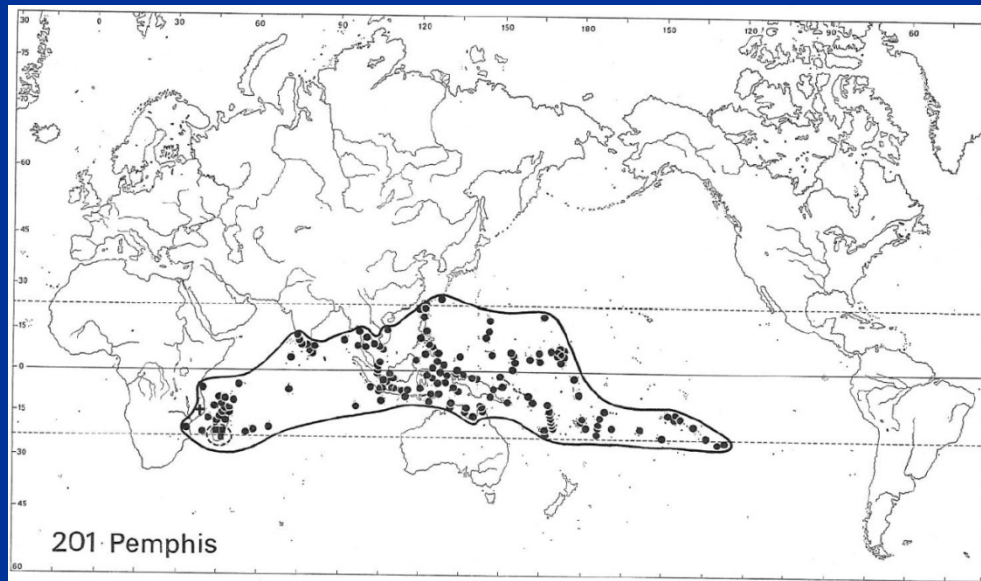
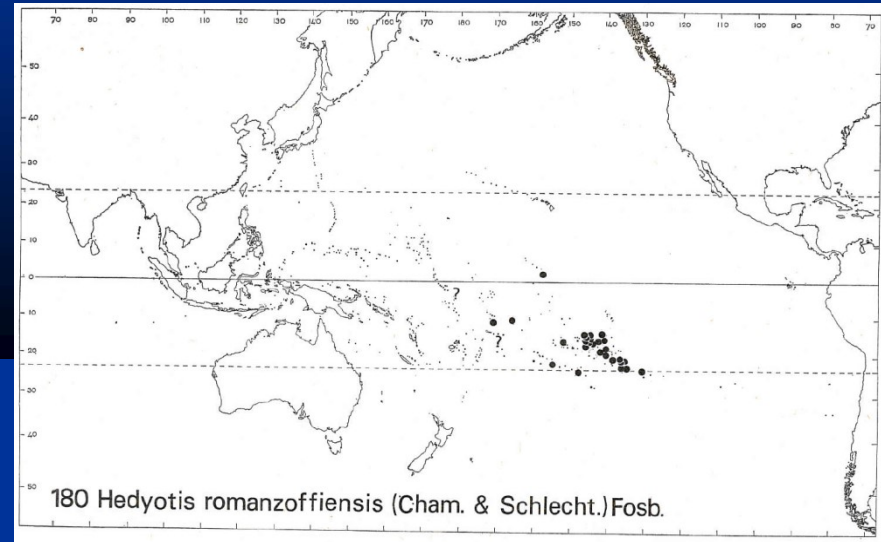
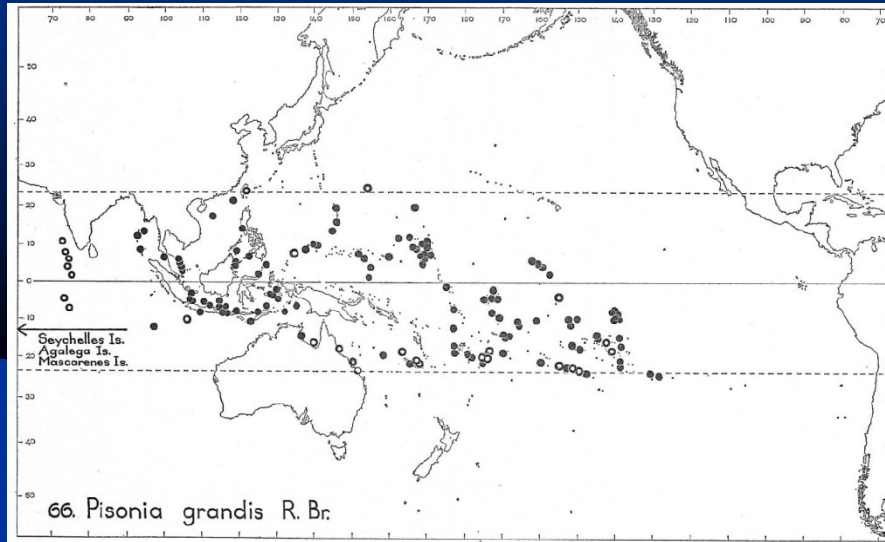
(Stoll, GePaSud, UPF/ILM 2016)

# Habitat types & plant formations





# Phytogeography



(in Van Steenis & Van Balgooy. 1966 & 1975. Pacific Plant Areas Vol. 2 & Vol. 3

## Common native species in atolls

*Scaevola taccada* var. *taccada* & var. *tuamotensis* (syn.  
*Scaevola sericea*, Goodeniaceae)  
SOC = « naupata », HAW = « naupaka »



*Heliotropium foertherianum* (Boraginaceae, syn.  
*Tournefortia argentea*), SOC = « tāhinu », TUAM =  
« tōhinu », « geogeo », « piupiu », MANG =  
« to'unu », COOK = « tau'unu' »

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*Suriana maritima* (Surianaceae) SOC = « ouru », « 'o'uru » ; TUAM = « kokuru », « kuku », « 'u'u », COOK = « kuru », MANG = « giegie » ?, TONG = « ngingie » ?



*Pemphis acidula* (Lythraceae) SOC = « 'ā'ie », COOK = « ngangie », TUAM = « mikimiki », « gagie », « giegie », MANG = « ngangie », TONG = « ngingie », 'UVEA = « giegie »

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*Sophora tomentosa* (Fabaceae), SOC = « pofatu 'ao'ao », TUAM = « pofatukao », AUST = « pohuta'ata », « pohuturata », COOK = « po'utukava »



*Pisonia grandis* (Nyctaginaceae), SOC = « pu'atea », MARQ = « pukatea », TUAM = « ngatae », « puka » (forêt)



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*Hernandia nymphaeifolia* (syn. *H. peltata*,  
Hernandiaceae), SOC = « ti'anina »,  
« tōnina », « tūnina », MANG =  
pukamaga, 'UVEA = « puko »,  
FUTUNA = « puka »



*Guettarda speciosa* (Rubiaceae) SOC =  
« tāfano », TUAM = « kahāia », MANG =  
« ano », MARQ = « hano », « fano »

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*Cordia subcordata*,  
 (Boraginaceae), SOC,  
 MARQ = « tou », MRQ =  
 « kou », HAW = « kou »,  
 SAM = « tauanave »,  
 TONG = « taukanave »,  
 ‘UVEA = « kanava »

*Thespesia populnea*,  
 (Malvaceae), SOC =  
 « miro », « 'āmae »,  
 « rau 'ava » (feuilles),  
 MARQ « mi'o », HAW  
 = « milo », SAM =  
 « milo », ‘UVEA =  
 « milo », FIJI =  
 « mulomulo »



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(*Lepidium bidentatum*,  
Brassicaceae) SOC = « nau »,  
« horahora », MANG =  
« naunau », COOK =  
« naunau », HAW =  
« ‘anaunau »

*Laportea ruderalis* (Urticaceae), SOC = «  
'iriā'eo » (ortie ?), TUAM = « ogaoga »



## Rare native species



*Terminalia littoralis* (syn. *T. samoensis* ?), SOC = « taraire », SAM = « talie »



*Acrostichum aureum* (motu Oroatera, Rimatuu), SOC = « 'āoa », « hā'ato », « pīhā'ato »

*Digitaria stenotaphrodes* (motu Rimatuu, Tiaraunu)



*Kadua romanzoffiensis* (Rubiaceae), TUAM = « poroporo » (motu Honoea)



*Cyclosorus interruptus* (motu Rimatuu, Tiaraunu)





# Extinct native species?

➤ Not found since the 1920's (motu Rimatuu)



*Heliotropium anomalum* (Boraginaceae), HAW  
= « hinahina »

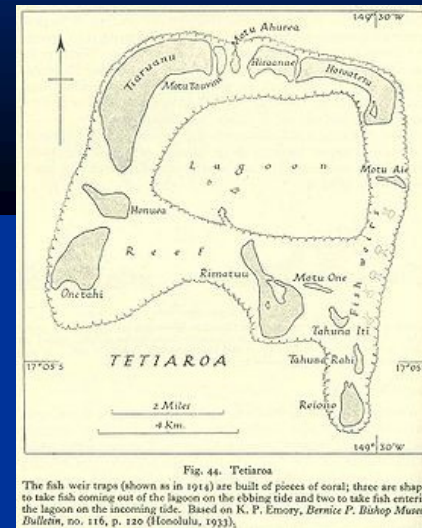


Fig. 44. Tetiaroa  
The fish weir traps (shown as in 1914) are built of pieces of coral; three are shaped to take fish coming out of the lagoon on the ebbing tide and two to take fish entering the lagoon on the incoming tide. Based on K. P. Emory, *Bernice P. Bishop Museum Bulletin*, no. 116, p. 120 (Honolulu, 1933).

➤ Not found since the 1970-80's

*Sesbania coccinea* subsp. *atollensis* var.  
*parkinsonii* (motu Rimatuu, Tiarauu ?),  
(SOC = « 'ōhai », TUAM = « kofai »,  
MARQ = « kohai »)



*Achyranthes aspera* var. *velutina* (motu  
Aie ?), SOC = « 'aerofai »

## Polynesian introductions



*Gardenia taitensis* (SOC  
= « tiare tahiti »)



*Tacca leontopetaloides* (SOC, MARQ = « pia »)



*Ficus tinctoria* (SOC = « mati »)

# Native species introduced by Polynesian in the atoll of Tetiaroa



*Barringtonia asiatica* (Lecythidaceae), SOC = « hotu », « hutu »

*Calophyllum inophyllum*  
(Calophyllaceae), SOC =  
« tamanu », « 'ati » (fruits :  
« pōro 'ati »), HAW =  
« kamani »



# « Cryptic species »: native or introduced by Polynesians?



*Sida fallax* (Malvaceae),  
HAW = « 'ilima », TUAM  
= « kurima »



*Pipturus argenteus* var. *tuamotuense* (Urticaceae), SOC = « rō'ā »



*Colubrina asiatica* var. *asiatica*  
(Rhamnaceae), SOC, COOK = « tutu »,  
SAM = « fisoa »



*Nervilia aragoana* (Orchidaceae),  
COOK = « rautahi »

## Atolls as « Cool Spots »

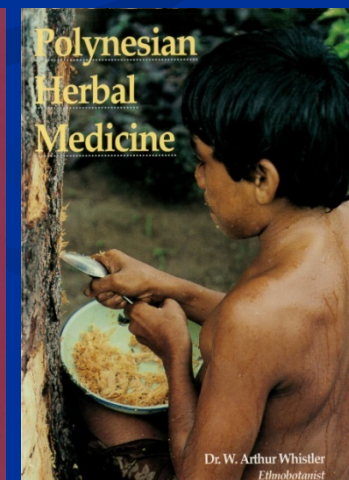
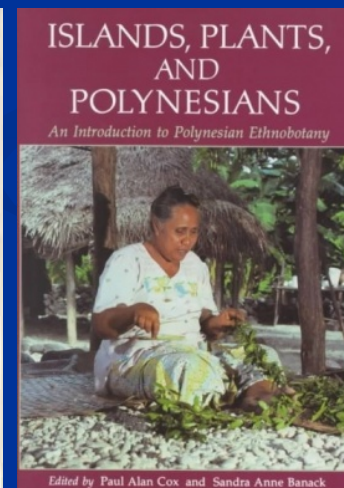
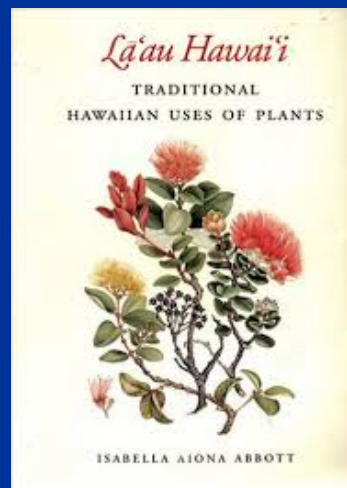
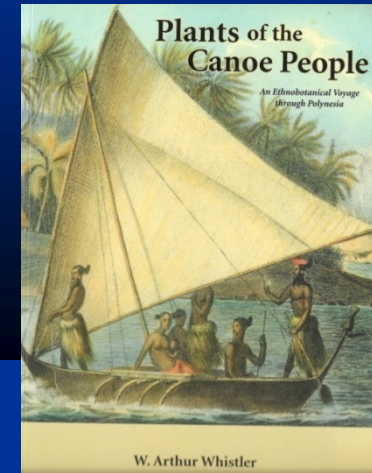
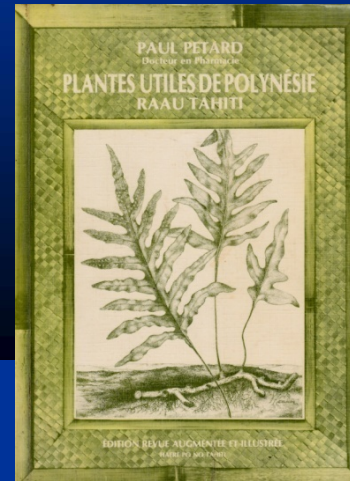
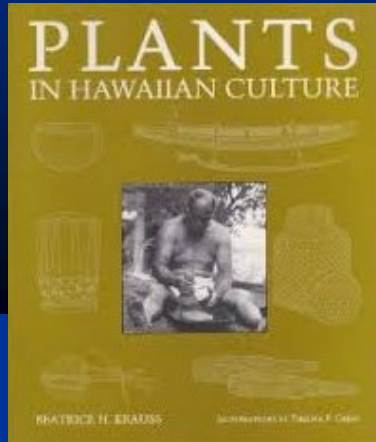


- 75 different purpose/use categories for 140 common Pacific Island coastal plants, almost all of which are found on atolls
- Frequency of usage for the 140 plants was 1024, an average of 7.3 purpose/use categories per plant (up to 125 for the coconut!)
- 17 species have 20 or more reported uses

(Thaman 1992, *Atoll Research Bulletin* 361)

## Ethnobotany and « TEK »

- food
- clothing
- medicine
- boat or canoe making
- house construction
- fuelwood
- fishing equipment
- cordage and fibre
- weapons or traps
- dyes or pigments
- body ornamentation (tattoos)
- ceremony and ritual
- magic and sorcery
- games or toys
- perfumes and scenting coconut oil
- fertiliser and mulching
- woodcarving
- food wrapping, domesticated and wild animal feed, handicrafts, cooking equipment, fish poisons, adhesives or caulking, musical instruments
- subjects of legends, mythology, songs, riddles, and proverbs...



(In memory of W.  
Arthur WHISTLER,  
1944-2020†)

# Ethnobiodiversity



(Heiva i Tahiti, 2013)



(Kiritimati, 2012)



(Alofi, 2008)



(Hiva Oa, 2012)

*« The knowledge, uses, beliefs, resource-use systems and conservation practices, taxonomies and language that island societies have for their ecosystems, species, and genetic diversity » (Thaman 2008)*



(‘Uvea, 2007)

# Ecological restoration & biotic interactions

Motu Reiono (22 ha)



*Birgus latro*



*Pandanus tectorius*



*Cocos nucifera*



*Pisonia grandis*

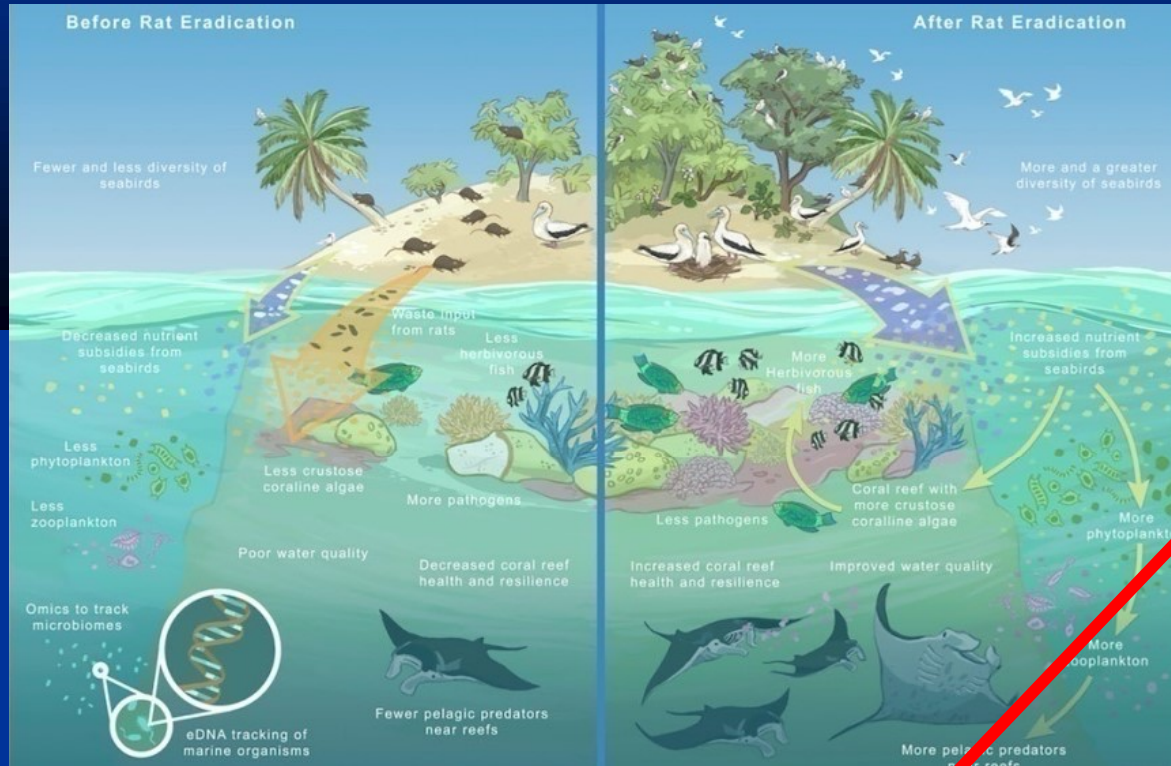


*Rattus exulans*





# Ecosystem trajectories & ecological scenarii



(VEGA-THURBER *et al.*)



*Pisonia grandis* forest



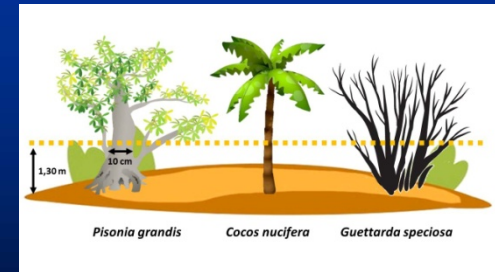
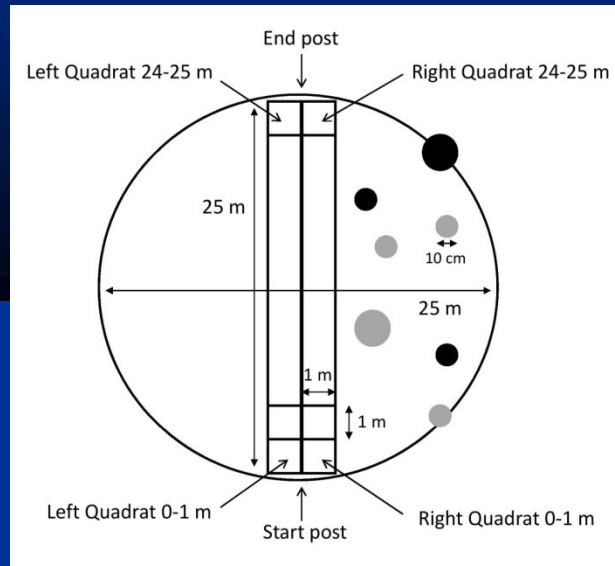
Rat-free Motu 'A'ie (Tetiaroa)



Rat-free atoll of Morane  
(Tuamotu-Gambier)



# Protocol



(2018)



(2019)



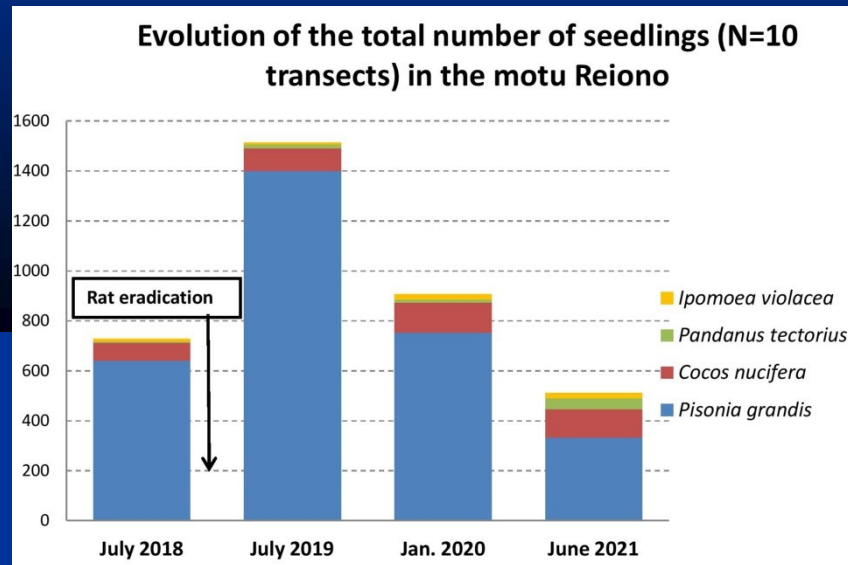
(2020)



(2021)



# Preliminary results



(Meyer 2021)

(2018)



(2021)



*Pisonia grandis*



*Pandanus tectorius*



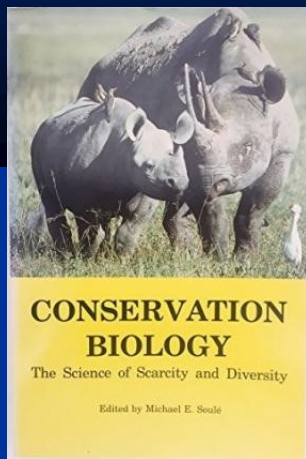
*Ipomoea violacea*



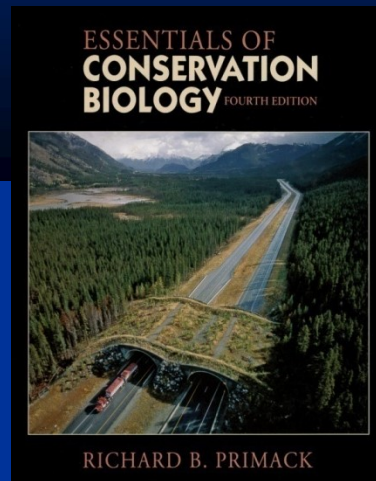
*Cocos nucifera*

# Conservation Biology & Science

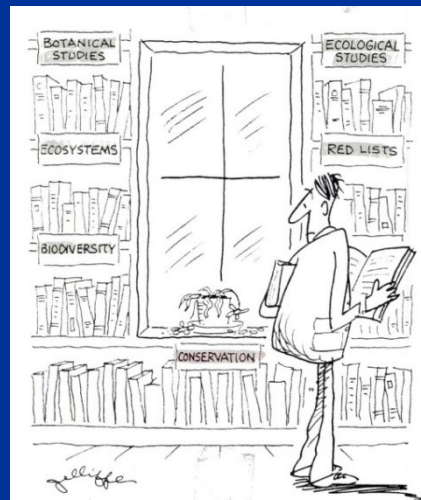
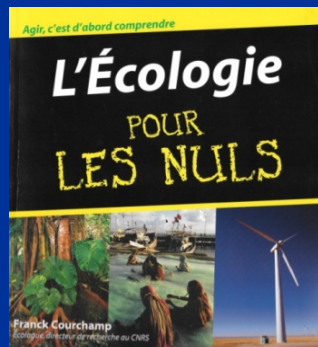
« *The Science of Scarcity and Diversity* »  
(Soulé 1986)



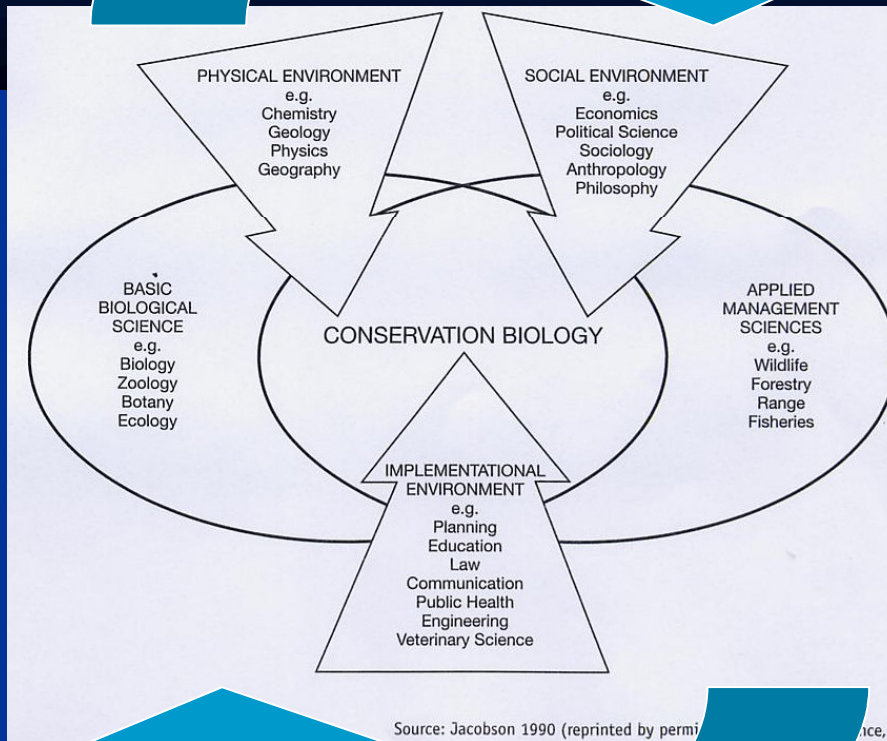
« *A crisis discipline* »  
(Primack 2006)



« *A science of dilemmas and doubts* »  
(Courchamp 2009)



New ideas, principles and approaches

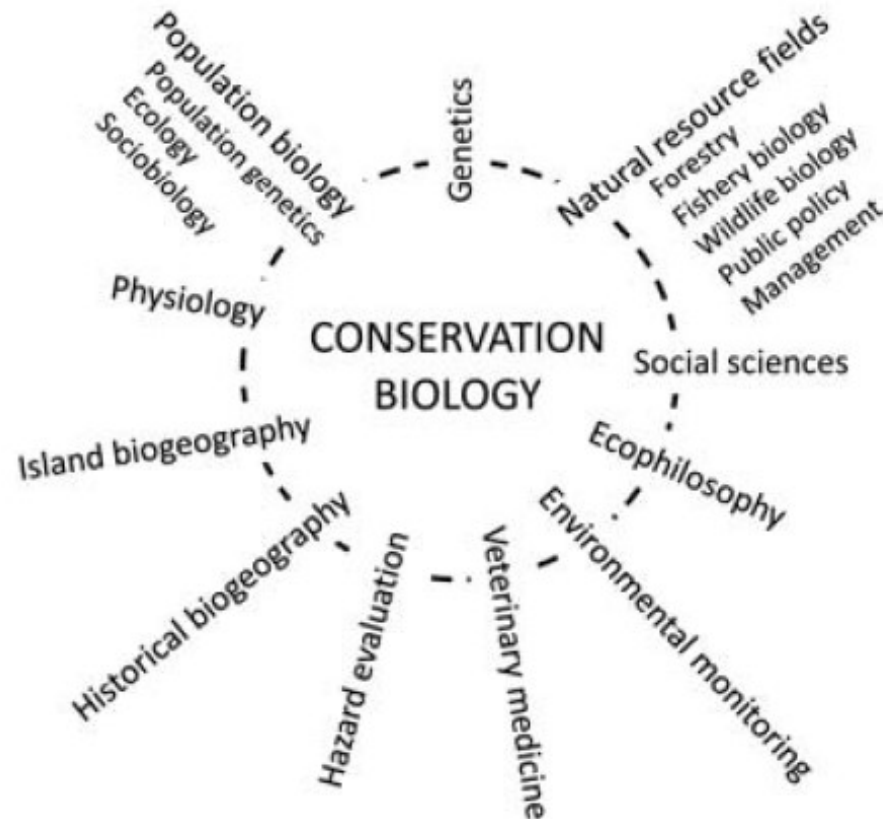


Field experiments and research needs

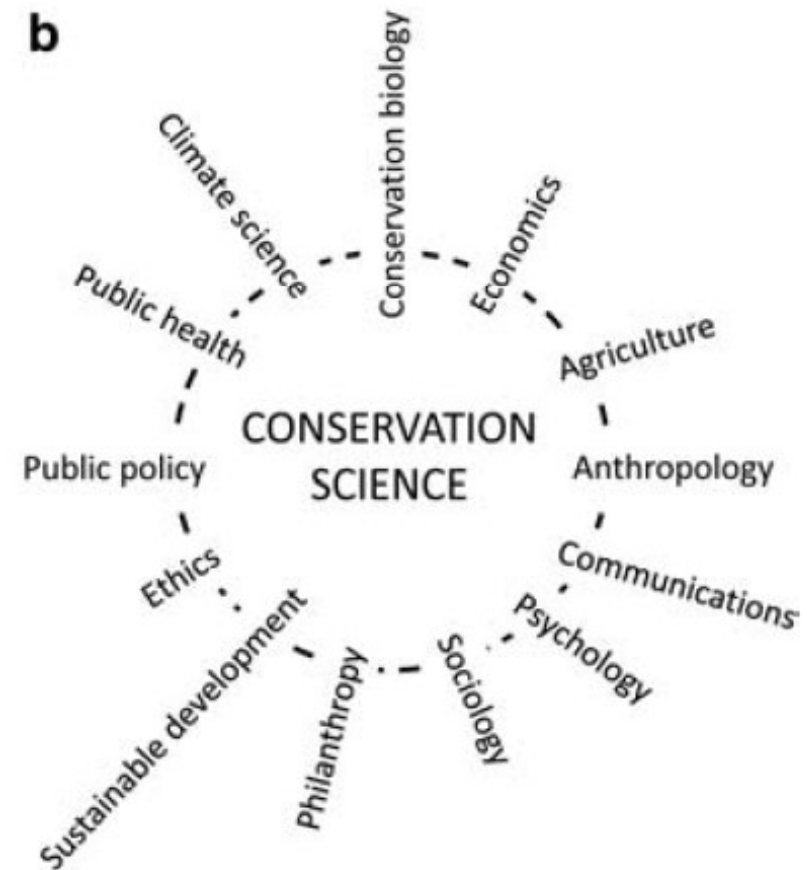
# What Is Conservation Science?

PETER KAREIVA AND MICHELLE MARVIER

**a**

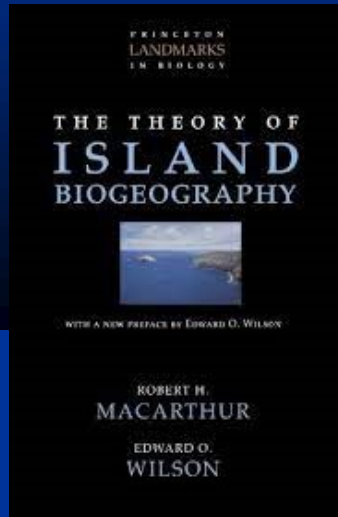


**b**

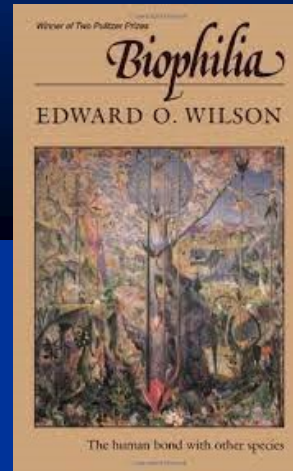


# In memory of Edward O. WILSON (1929-2021†)

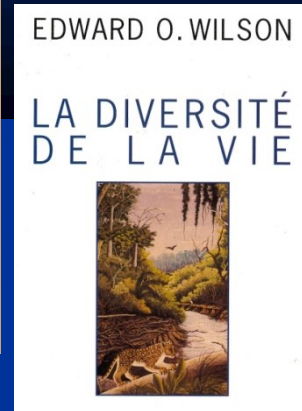
*“The next century will, I believe, be the era of restoration in ecology” (Wilson 1992)*



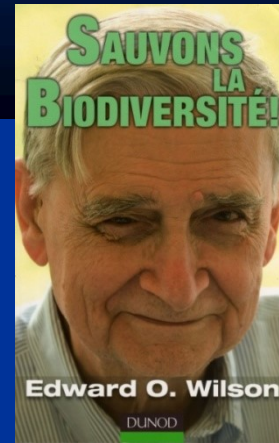
(1967)



(1984)



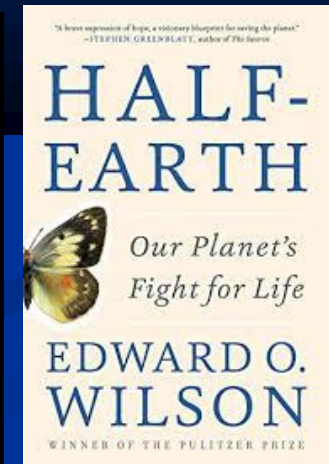
(1993)



(2002)



(2007)



(2016)



(1988)

*“For a minority of conservation projects, some amount of restoration, meaning human intervention, is necessary. Each project is special unto itself. Each requires knowledge and love of the local environment shared by partnerships of scientists, activists, and political and economical leaders. To succeed, it needs every bit of their entrepreneurship, courage, and persistence” (Wilson 2016)*

Mauruuru roa, merci beaucoup, thanks for your  
attention (and patience !)



« Super Dupont »  
(*Gotlieb*©)