

# Saving the threatened terrestrial biodiversity in the French Overseas tropical islands

## Which research strategy to improve conservation?

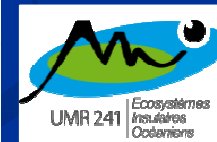


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Quelle stratégie de recherche pour une meilleure conservation de la biodiversité terrestre dans les îles tropicales ultramarines françaises ?

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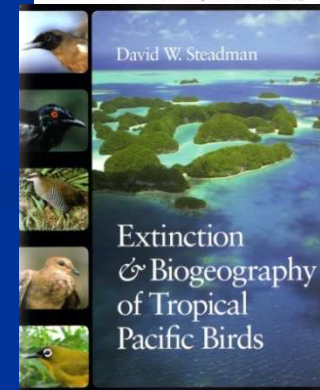
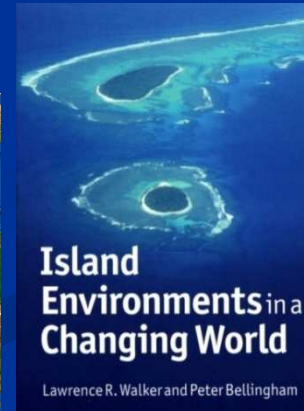
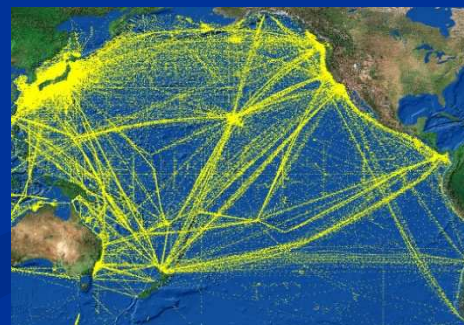
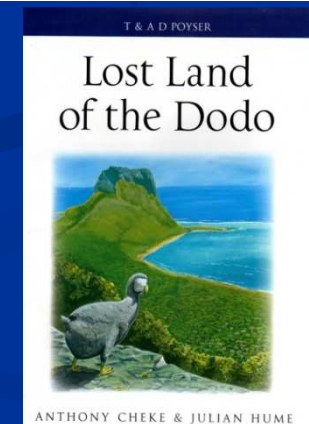
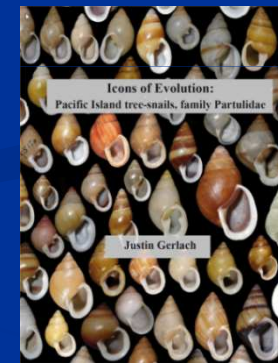
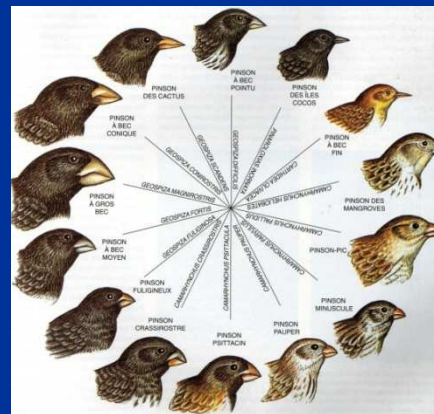
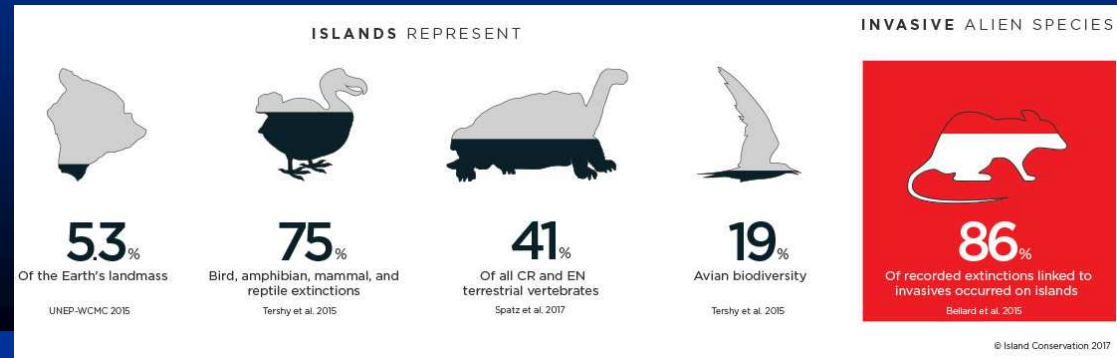
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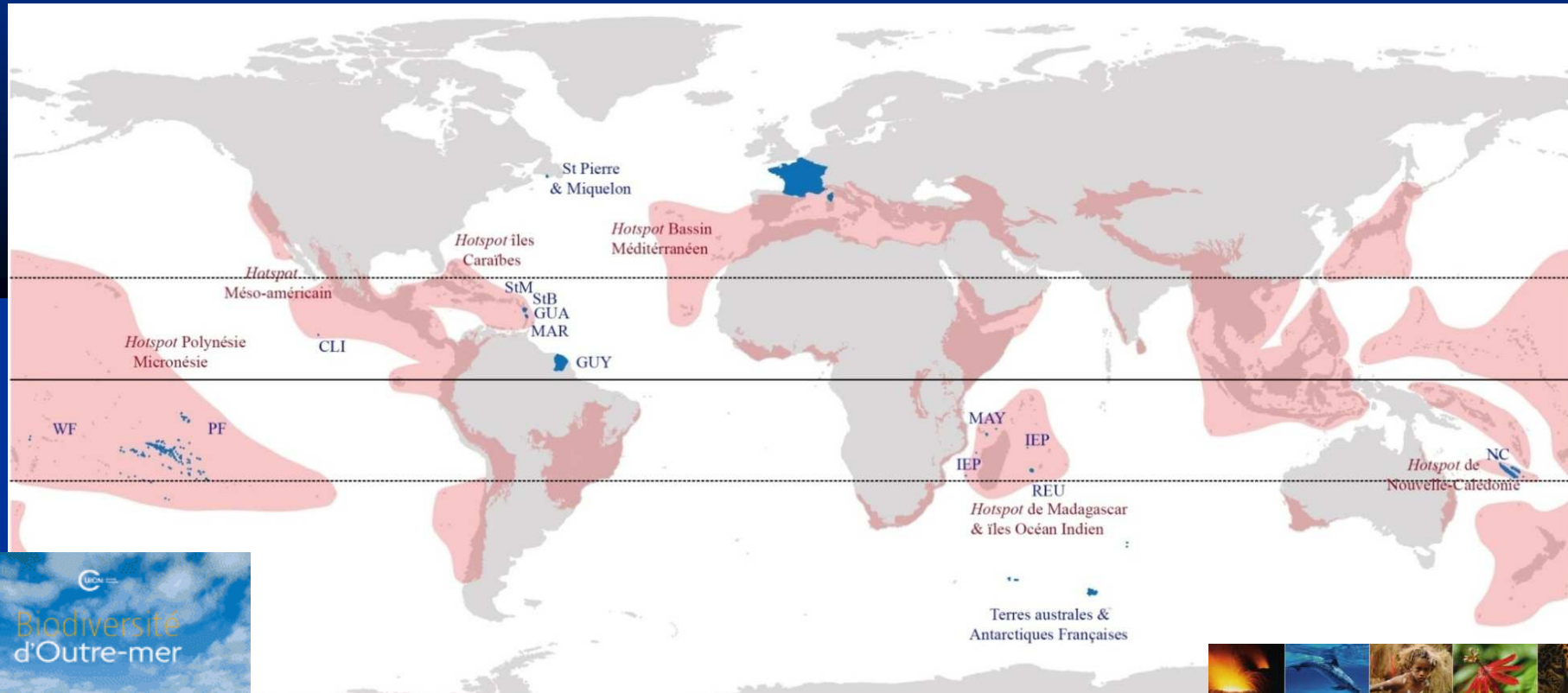


# Islands: unique but highly threatened biota

- **Relative high species richness** (20% of all species on 5% of the world area)
- **Very high endemism** (e.g. 89% flowering plants in Hawaii)
- **Spectacular adaptative radiations** (e.g. Galápagos finches, tree snails)
- **Front line and sentinel of global changes** (sea-level rise, extreme climate events, pollutions, over-exploitation, biological invasions...)
- **Epicenter of the extinction crisis!**

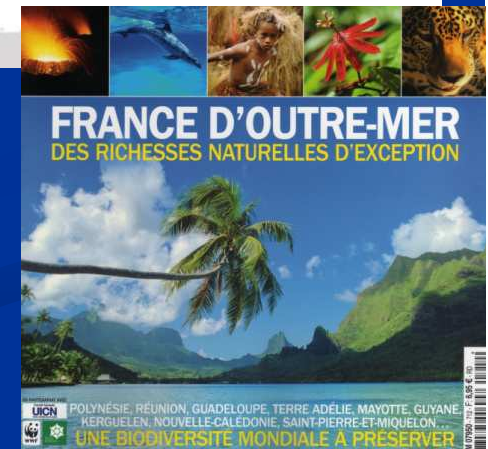


# The French Overseas tropical island territories



(Bocquet & Gargominy, coord. 2013)

- 11 territories (140+ main islands) in 3 oceans
- 5 of the 36 “biodiversity hotspots”
- 70% of the ca. 18,000 French terrestrial endemic plants and animals



# Island endemics

➤ “old relicts” and “new” lineages



*Rhynochetos jubatus* (New Caledonia)  
Photo : H. Jourdan



*Anolis roquet* (Martinique)  
Photo : C. Delnatte



*Lobelia conglobata* (Martinique)  
Photo : C. Delnatte



*Microcystis saintjobni* (Tubuai, Austral Is.,  
French Polynesia) Photo : O. Gargominy



*Lentipes rubrofasciatus* (Marquesas,  
French Polynesia) Photo : P. Keith



*Sclerotheca raiateensis* (Raiatea,  
Society Is., French Polynesia)

# Endemism & « explosive » plant radiations

| Archipelago/Island<br>(area)                             | Native<br>flowering<br>plants | Endemic<br>flowering<br>plants (%) | Endemic<br>species<br>density (per<br>sq. km) |
|--|-------------------------------|------------------------------------|---|
| Fiji<br>(18,270 km <sup>2</sup> )                        | 1,302                         | 799<br>(61%)                       | 0.050   |
| Hawaii<br>(16,880 km <sup>2</sup> )                      | 966                           | 859<br>(89%)                       | 0.051   |
| Galápagos<br>(7,900 km <sup>2</sup> )                    | 233                           | 241<br>(51%)                       | 0.030   |
| <b>New Caledonia</b><br><b>(19,060 km<sup>2</sup>)</b>   | <b>3,063</b>                  | <b>2,448</b><br><b>(80%)</b>       | <b>0.128</b>                                  |
| <b>La Réunion</b><br><b>(2,512 km<sup>2</sup>)</b>       | <b>797</b>                    | <b>309</b><br><b>(39%)</b>         | <b>0.123</b>                                  |
| <b>French Polynesia</b><br><b>(3,520 km<sup>2</sup>)</b> | <b>659</b>                    | <b>478</b><br><b>(72%)</b>         | <b>0.136</b>                                  |

*Psychotria* (Rubiaceae),  
78 endemic species in  
New Caledonia, 27+ in  
French Polynesia

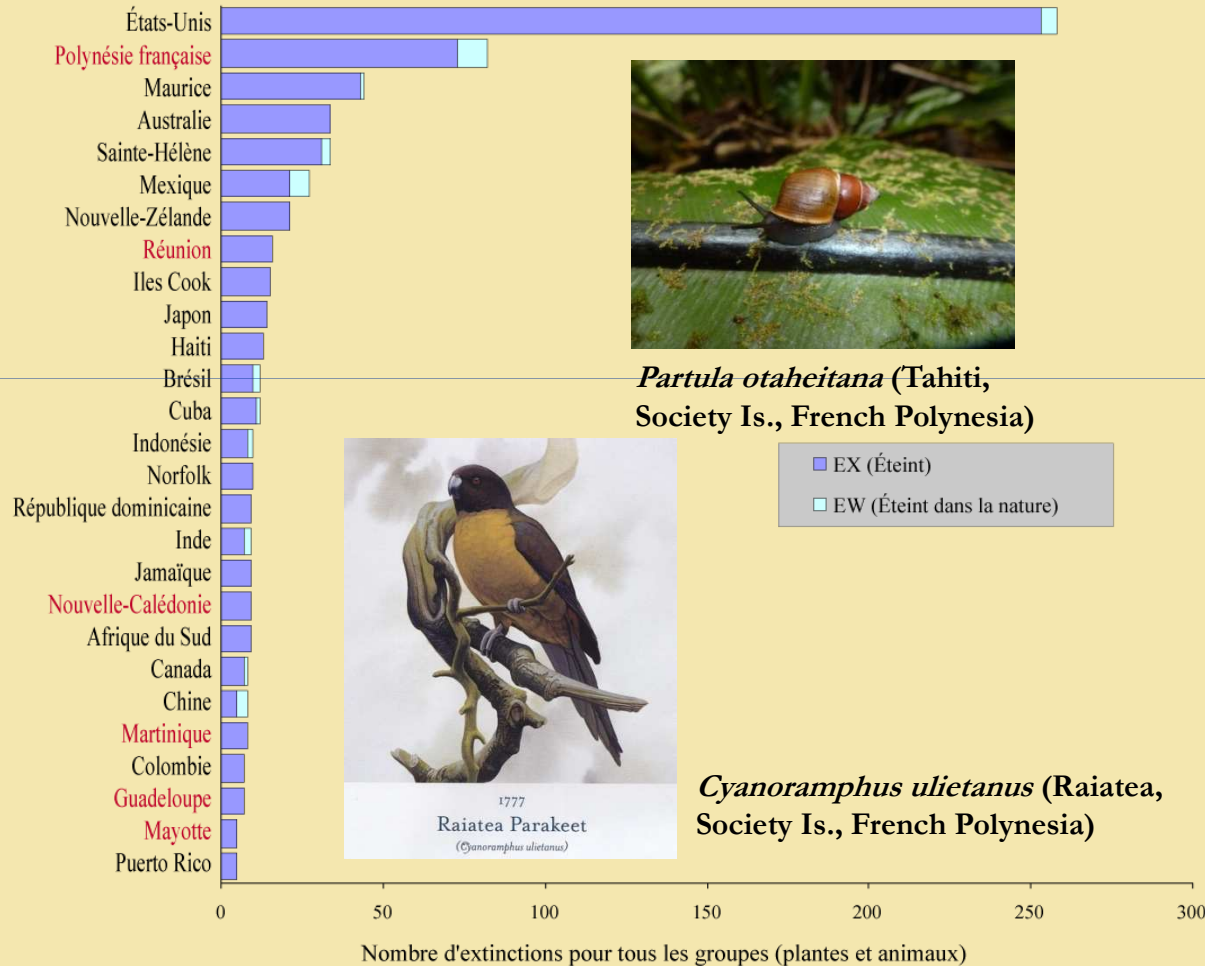


*Cyrtandra* (Gesneriaceae)  
28+ endemic species in  
French Polynesia



# Extinctions & vulnerability

Les 26 pays avec plus de 5 espèces éteintes depuis 1500



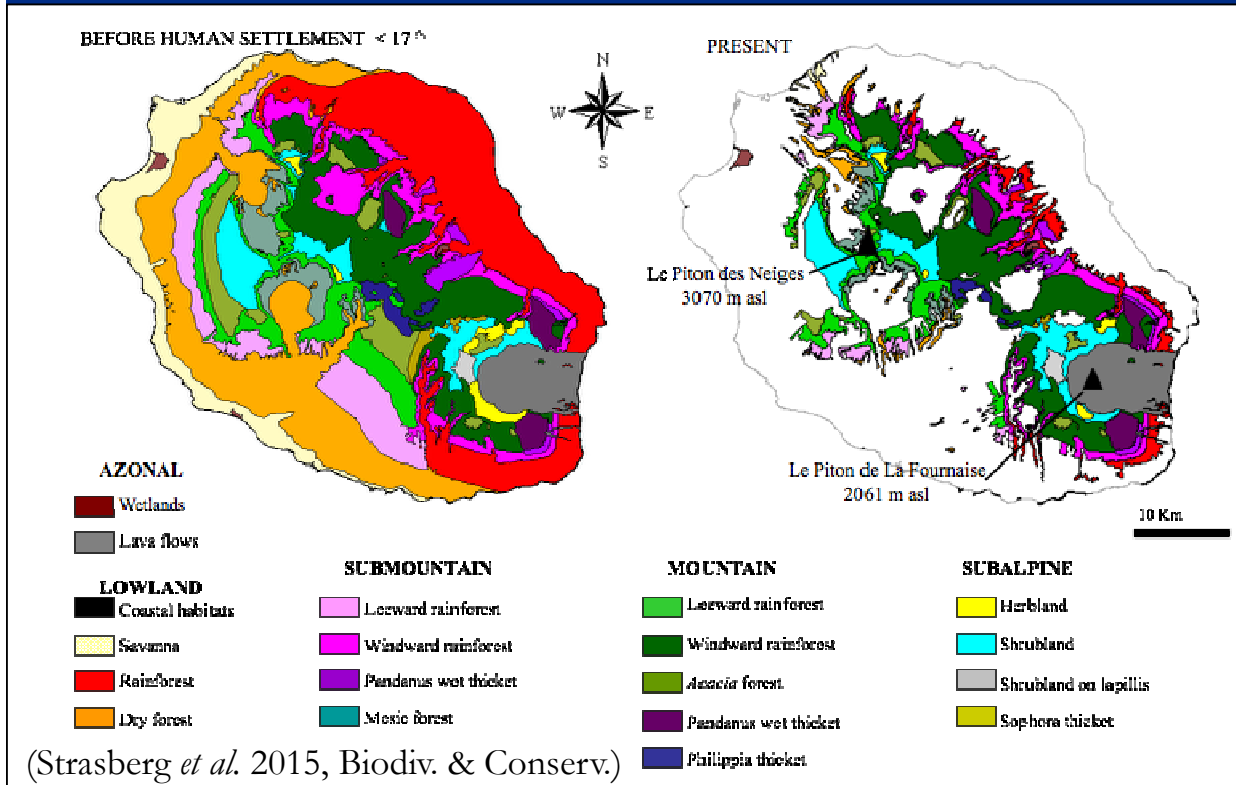
- France = 2<sup>nd</sup> rank for extinct species
- 4<sup>th</sup> for threatened animal species
- 9<sup>th</sup> for threatened plant species



- French Polynesian Endemic Plants : 118 CR, 134 EN, 50 VU

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

# Forest loss & habitat fragmentation



Rivière St-Denis (La Réunion)  
Photo : D. Strasberg

Tahiti (Society Is., French Polynesia)



Makatea (Tuamotu Is., French Polynesia)

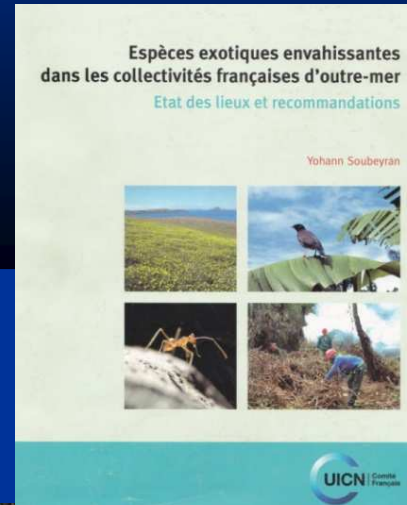
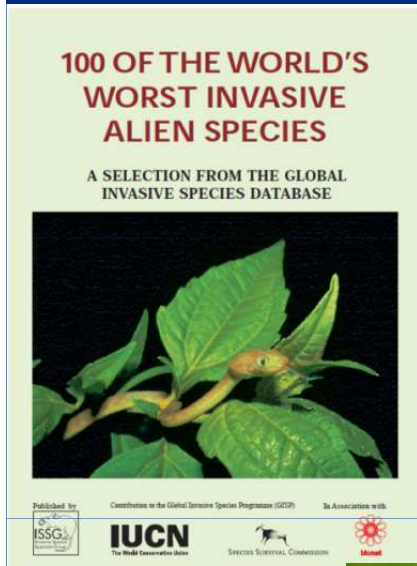


Eiao (Marquesas Is., French Polynesia)





# Invasive alien species

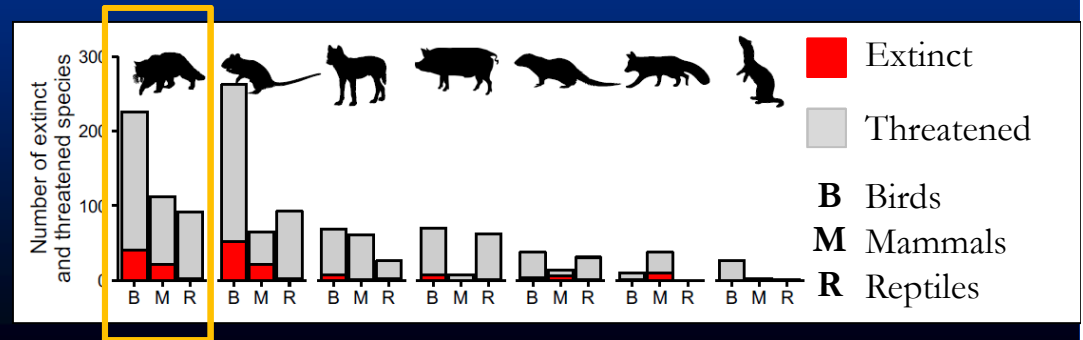


( Photo : H. Jourdan)



# Collaborative Project « FERAL CATS » (2014-on going)

- **Local Governments funding:** New Caledonia & French Polynesia and private companies (Société Le Nickel)
- **Impacts of feral cats on biodiversity** (birds, reptiles, mammals, invertebrates...)
- **Ecological studies** (ecology, density, range, movement, diet...)
- **Transfer to managers:** key-site management areas?



(Doherty et al. 2016, PNAS)



20 IUCN Red-Listed animals as preys! (Palmas et al. 2017, Biol. Cons.)

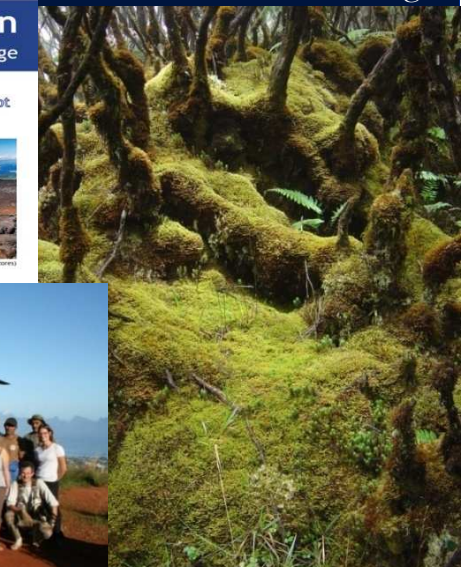
Figure 2 Location of the feral cat diet study sites (n total=9425)

# Collaborative Project « MOVECLIM » (2012-2015)

- **European funded biodiversity research initiative (ERA-NET “NetBiome”):** effects of climate change by studying the spatial variation of sensitive organisms (bryophytes, ferns) along elevational gradients
- **Multi-island research collaboration between** Macaronesia (Canaria, Azores), Caribbean (Guadeloupe), Pacific (Tahiti, French Polynesia) and Western Indian (La Réunion) with local managers and NGO!
- **Permanent plots** for long-term studies and monitoring environmental changes
- **Common sampling methodology and shared data:** global diversity analysis, taxonomy, phylogeny, ecophysiology...

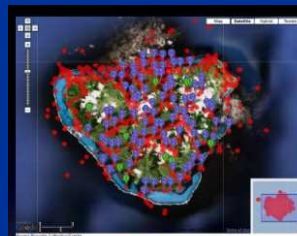
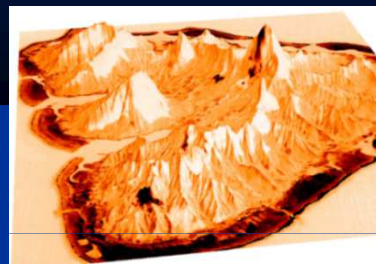


« Mossy » tropical montane cloud forest (La Réunion)  
Photos : D. Strasberg



# Cooperative Project « Moorea BIOCODE »

- **An island model system:** Mo’orea, French Polynesia (140 km<sup>2</sup>)
- **Private funding & Research consortium:** USA, France, French Polynesia
- **Biodiversity inventory:** marine and terrestrial macrobiota (native and alien animal and plant taxa)
- **Barcoding an entire ecosystem!**



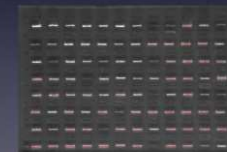
6,707 Collecting Events



44,142 Specimens



18,369 Photos



28,000+ PCRs

<https://mooreabiocode.org/>

## moorea BIOCODE



a multi-national, multi-institutional effort to digitally characterize the entire macrobiota of a tropical ecosystem

**DATA HEAVEN**  
Moorea is one of the most studied ecosystems in the world. Myriad data collected over four decades will be used to build a digital replica of the island that includes its varied geography, its climate and all of its plant and animal life.

**Sediment science**  
Government census data will be combined with tourist numbers, employment status and economic revenues.

**Peaks and valleys**  
Landscape model to 70-centimetre resolution created from satellite images.

**Ocean circulation**  
Time-series measurements of currents, waves and water properties from an oceanographer sensor array around the island.

**Catalogue of life**  
DNA barcodes for every species more than 1 millimetre in length.

**Underwater terrain**  
Sea floor mapped using satellite imagery and sonar data from ships. Will have a resolution ranging from 0.5 metres in the shallows to 20 metres in the deep ocean.

**Wetland secrets**  
Continuous sampling of the wetland's temperature, salinity, pH and microbial diversity at sites around the island, including the Tahanea Marine Protected Area, shows how.

**Coral reefs**  
Long-term trends in coral and fish populations, including numbers and species composition.

## Tropical paradise inspires virtual ecology lab

Digital version of Moorea will provide a way to experiment with an entire ecosystem.

BY DANIEL CRESSEY

A paradise on Earth could soon become the first ecosystem in the world to be replicated in digital form in painstaking detail, from the genes of its plants and animals to the geography of its landscape. An international team is preparing to create a digital avatar of the Pacific island of Moorea, which lies off the coast of Tahiti and is part of French Polynesia. Moorea is already one of the most studied islands in the world, the team plans to turn those data into a virtual lab that would allow scientists to test and generate hypotheses about the impact of human activities. Ecologists have used models for years to tease out the relationships between different facets of nature, such as temperature and population or predators and prey. But much of that modelling is relevant only to specific species or

research questions, and some scientists want a holistic view. As human activity and natural variations combine to alter the environment, researchers need to know how mitigating steps — such as setting protected areas, or attempts to curb fossil fuel use — might affect an entire ecosystem. “We know the world’s changing. Yet the decisions we’re making, we’re making them in the dark,” says Neil Davies, one of the people behind the Moorea IDEA (Island Digital Ecosystem Avatar) project and director of Gump Station, the University of California, Berkeley’s marine-science base on the island. “We’re not going to have precise predictions over, but we need to have a way of modelling different scenarios.” For example, if a hotel is built at a certain location, how does that change the ecosystem? If a species disappears from a bay, what happens downstream?

Moorea is an ideal place to start, says Davies, because the island is about 16 kilometres across and has just 17,000 people living on it, making it easier to model than larger ecosystems and those that are more connected to the rest of the world. In addition, French researchers have been there since the 1970s, and Gump Station has been operating since the 1980s. Both efforts have collected myriad data on the island’s waters, with decades-long studies of coral and fish numbers (see “Data heaven”). These traditional surveys of marine life are now being linked up with the Moorea Biocode Project, which aims to characterize every species larger than a millimetre in length on the island and allocate them a “DNA barcode” — snippets of DNA that can be used as a unique identifier. Species can thus be identified quickly and easily even when they are in places or states that would otherwise be difficult

# Research for conservation... with managers and local communities

- Evolution, endemism
- Extinction process, rarity
- Biotic interactions, multi-invasions, “novel/hybrid habitats”
- Ecological networks
- Tropical forest dynamics
- Resilience of ecosystems



- Protected areas & species
- Invasive species control & management
- Habitat restoration, rehabilitation
- Species re-introduction, translocation, “ecological substitutes”



**SOCIO-ECOLOGICAL SYSTEMS**  
Nature-Human Interactions



Photo: P. Bacchet

## Conclusions : conservation sciences in islands

- Crucial and « grand » challenges!
- **Cooperative science-based programs** are required (e.g. multi-sites and long-term monitoring plots)
- **Collaborative conservation projects** between all stakeholders are essential (e.g. adaptative management)
- Islands are **paradigmatic places, natural laboratories, models** for small socio-ecological systems...but also **incubators** of new ideas, novel strategies and approaches



(Plant Talk©)

« LET'S ISLAND OUR PLANET ! »



16-20 April 2018, Honolulu, HAWAII (USA)



Super Dupont (Gotlieb©)