

Review and compile a Vanuatu Invasive Alien Species (IAS) bibliography, a database for IAS information, and add data to PESTLIST database

Draft Report for the Department of Environmental Protection and Conservation,
Republic of Vanuatu

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September 2013



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Glossary and Definitions

ALIEN SPECIES- IUCN

Alien species (non-native, non-indigenous, foreign, exotic) means a species, subspecies, or lower taxon occurring outside of its natural range (past or present) and dispersal potential (i.e. outside the range it occupies naturally or could not occupy without direct or indirect introduction or care by humans) and includes any part, gametes or propagule of such species that might survive and subsequently reproduce

ALIEN SPECIES- CBD

A species, subspecies or lower taxon, introduced outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce

INVASIVE ALIEN SPECIES- IUCN

The International Union for Conservation of Nature, (IUCN) describes invasive species as “animals, plants or other organisms introduced by man into places out of their natural range of distribution, where they become established and disperse, generating a negative impact on the local ecosystem and species.” Invasive species can negatively impact human health, the economy (i.e. tourism, agriculture), and native ecosystems. These impacts may disrupt the ecosystem processes, introduce diseases to humans or flora and fauna, and reduce biodiversity.

INVASIVE ALIEN SPECIES- CBD

An alien species whose introduction and/or spread threaten biological diversity (For the purposes of the present guiding principles, the term "invasive alien species" shall be deemed the same as "alien invasive species" in decision V/8 of the Conference of the Parties to the Convention on Biological Diversity).

IUCN RED LIST OF THREATENED SPECIES CATEGORIES

The IUCN Red List of Threatened Species classifies species in terms of the risk of extinction. It provides taxonomic, conservation status and distribution information on plants and animals that have been globally evaluated using the IUCN Red List Categories and Criteria. The assessment is designed to determine the relative risk of extinction and highlight and classify those plants and animals that are facing a higher risk of extinction. Categories include 'Critically Endangered (CR)', 'Endangered (EN)', 'Vulnerable (VU)', 'Lower Risk/ Conservation dependent (LR)', 'Near Threatened (NT)', 'Least Concern (LC)'. Also included are plants and animals declared 'Extinct (EX)' or 'Extinct in the Wild (EW)'. Those species that cannot be assessed due to lack of information are listed as 'Data Deficient (DD)'. Those species that face the highest risk of extinction belong to the top three classifications of CR, EN and VU.

Review and compile a Vanuatu Invasive Alien Species (IAS) bibliography, a database for IAS information, and add data to PESTLIST database

Introduction

Lying about three-quarters of the way from Hawaii to Australia, Vanuatu represents the main bulk of an island chain which continues into the eastern Solomon Islands. The islands are volcanic rock or uplifted carbonate structures and there is ongoing volcanic activity in a number of locations. Fringing reefs predominate. Crown-of-thorns sea star (*Acanthaster planci*) outbreaks have been reported. Up to the present time the larger islands have remained forested, however, increased logging threatens to destroy Vanuatu's rainforests. Rising pollution from sewage inputs and sediment run off and overharvesting of some non-motile reef species are also concerns.

Most land species came from Indo-Australia, for example the Australian Goshawk (*Accipiter fasciatus*), the sooty rail, cuckoos, the speckled ground skink and the silver eared honeyeater (*Lichmera incana*). When compared with the lands from which they originated Vanuatu has a very limited number of species. However, it is particularly rich in marine molluscs. Reefs are dominated by coralline algae and robust plate and branching corals. Coconuts may have evolved in Vanuatu since the number of insect species dependent on the nut is greater in these islands than anywhere else.

Threats to biodiversity include biological resource use, land use change, agriculture & aquaculture, logging, natural system modification, climate change and severe weather impacts and the **impacts of invasive alien species (IAS)**

A Global Environment Facility (GEF) funded project is currently being implemented in the Republic of Vanuatu titled the "Prevention, Control and Management of Invasive Alien Species in the Pacific Islands". This is a multicountry project and includes the Cook Islands, Federated States of Micronesia, Kiribati, Marshall Islands, Niue, Papua New Guinea, Palau, Tonga, and Samoa. Activities within the framework of this project include the conservation of priority species and ecosystems and the management of IAS.

Key activities identified by Vanuatu include a) Raise awareness and carry out outreach on the impacts of IAS on biodiversity, economy, health, cultural values etc. b) Develop a National Invasive Species Strategy (NISS); c) Surveys of invasive species including fire ants (*Wasmannia auropunctatus*), Indian mynas (*Acridotheres tristis*), Merremia (*Merremia peltata*), marine invasives, and others identified under the NISS. d) Host testing of six promising new agents to control African Tulip tree (*Spathodea companulata*); e) Merremia control at Vatthe Conservation Area

Before any biodiversity conservation planning and action is undertaken, sufficient biological and related information must be gathered in order to make informed decisions and establish appropriate priorities for the formulation of an effective and practical strategy and action plan. Biodiversity information management including data and information on the threats to biodiversity are critical to the success of these projects. Access to, and availability of current and credible biodiversity data and information are a

must for setting conservation action priorities, managing pathways of introduction, spread and control of IAS and other threats to biological diversity. Pertinent socio-economic information such as population demographics, land use, trade and economics are necessary and useful to take informed decisions.

This review and compilation of data and information on the impacts of IAS and other key threats on the biodiversity of Vanuatu (focused on endemic and native species that have been assessed using the IUCN Red List criteria and listed in the National Biodiversity Strategy and Action Plan), and natural areas (focused on those that have been designated as areas of high biodiversity value), aims to provide a resource that can aid in decision making on the management of this threat.

The following areas were identified for this Desk-top review

- IAS known to be present in Vanuatu, developing an annotated inventory
- Priority Pathways of introduction and spread of IAS
- Native species that are assessed as threatened and threats to these species with a focus on IAS but including other threats such as biological resource use, pollution, climate change, human disturbance
- Priority conservation areas, biodiversity they contain and threats to these areas with a focus on IAS and
- Biodiversity and IAS projects undertaken and on-going in Vanuatu and relevant socio-economic data

A comprehensive desk-top review was undertaken. Journal articles, reports, project documents and data and information from all significant databases was surveyed for relevant information. All the data and information collated was structured into annotated inventories. The draft of these datasets and report was presented to members of the National Invasive Species Technical Advisory Committee (NISTAC) in Vanuatu for a review. A meeting of the NISTAC discussed the report and information in a meeting with the consultant. The data was reviewed and additional information was provided and any inaccuracies corrected. Below is the revised report.

All data and information collated were to be compiled in sortable annotated lists in Excel format that facilitate analysis and allow users to store, filter, manipulate and graph data. These inventories are annexed to this report (see **Vanuatu Inf 1- Inf 9**). All source information collated has been stored and will be presented.

A concise discussion is presented based on a synthesis of the data and information collated highlighting key endemic and threatened species, threatened ecosystems, conservation issues and key IAS already occurring in the country or at the verge of potential invasion.

Vanuatu and the Convention on Biological Diversity and other relevant Multilateral Environmental Agreements

Vanuatu is a Party to the Convention on Biological Diversity (CBD). Vanuatu's commitments to the CBD are the basis of all priorities related to the conservation of biological diversity.

The Convention on Biological Diversity (CBD) entered into force in 1993. The three main objectives of the CBD are: 1) The conservation of biological diversity; 2) The sustainable use of the components of biological diversity; and 3) The fair and equitable sharing of the benefits arising out of the utilization of genetic resources. 193 countries including Vanuatu are Parties to the Convention.

The Government of Vanuatu acceded to the CBD in 1993, and ratified the Cartagena Protocol on Biosafety¹ to the CBD in 2003.

The principle instrument for implementing the CBD at the national level is the National Biodiversity Strategy and Action Plan (NBSAP). Vanuatu developed a NBSAP in 1999 formulating a strategy and planned actions for the conservation of biodiversity and its sustainable use.

Measures taken for the implementation of the Convention and their effectiveness have to be reported to the Convention in National Reports. Vanuatu has submitted the First, Second and Third National report in 1998, 2002 and 2007 respectively.

Island biodiversity, mountain biodiversity, forest biodiversity, Inland water ecosystems etc. are thematic programmes under the CBD. Protected Areas is a cross-cutting issue within the CBD². Each of these themes has a programme of work, in the case of protected areas known as the Programme of Work on Protected Areas (PoWPA). Countries are also required to submit action plans related to the PoWPA.

In 2010 at the tenth Conference of the Parties in 2010 the CBD adopted a revised and updated Strategic Plan for Biodiversity 2011-2020 that included twenty targets called the Aichi targets³ to serve as a framework for the establishment of regional and national targets. Countries are encouraged to establish national targets in the framework of the Aichi Biodiversity Targets and in revising and updating national biodiversity strategies and action plans in line with the Strategic Plan for Biodiversity 2011-2020.

Vanuatu signed the Nagoya Protocol on Access and Benefit-sharing in 2011

Vanuatu is a signatory of the Nagoya Protocol, it has acceded to the Convention on International Trade in Endangered Species (CITES), the Kyoto Protocol, and, ratified the World Heritage Convention (WHC) and the United Nations Convention to Combat Desertification (UNCCD). Vanuatu has also signed the Memorandum of Understanding for the Conservation of Cetaceans and their Habitats in the Pacific Islands Region⁴

¹ The Cartagena Protocol on Biosafety to the CBD is an international agreement which 'aims to ensure the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biological diversity, taking also into account risks to human health'. It was adopted in 2000 and came into force in 2003.

² A "protected area" is defined in Article 2 of the CBD as "a geographically defined area, which is designated or regulated and managed to achieve specific conservation objectives"

³ Aichi Biodiversity Targets < <http://www.cbd.int/sp/targets/>>

⁴ SPREP Multilateral Environment Agreements (MEA) Database <http://www.sprep.org/attachments/MEA_database.pdf>

Threatened Species of Vanuatu

The IUCN Red List of Threatened Species⁵ and the Vanuatu National Biodiversity Strategy and Action Plan NBSAP (1999) have been used as the primary reference sources for the lists of native threatened species of Vanuatu. Additional fish species have been included as a result of personal communication⁶.

IUCN Red List of Threatened Species

The IUCN Red List provides taxonomic, conservation status and distribution information on plants and animals that have been globally evaluated using the IUCN Red List Categories and Criteria. Species are classified as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) are threatened with the risk of extinction. Other categories include Near Threatened (NT), Lower Risk (Conservation dependant) (LR/cd), Least Concern (LC) and Data Deficient (DD). Species that are Extinct (EX) are also included (See Definitions above). The IUCN Red List also provides information on the major threats driving the decline of these species populations.

1159 of the 3720⁷ known species native to Vanuatu have been conservation assessed using IUCN Red List criteria and categories. A majority of the assessed species belong to Animalia (1093) - and 66 to Plantae. A majority of these species occur in the marine biome (1013) followed by Terrestrial (184) and Freshwater (139) (see Table 1 for a breakdown of species and biomes). In the marine biome most of the species are found in the marine neritic⁸ and marine intertidal zones. The neritic zone together with the estuarine habitat, cause the most productivity in the sea. This is the zone where corals occur and provide the major food source to fish. In the terrestrial biome the majority of the species are found in inland wetlands followed by forests.

Of a total of 3720 described native species close to 31% (1159) have been assessed for their conservation status. Of these less than 12% (137) are classed into an IUCN threatened category (3 Critically Endangered, 18 Endangered and 116 Vulnerable). Of these 40 species are listed as Endemic to Vanuatu, this includes the Extinct- Tanna ground dove (*Gallicolumba ferruginea*). The majority of the endemic species are palms and birds. Three species an endemic palm (*Carpoxydon macrospermum*), an endemic partulid snail (*Partula milleri*) and the Hawksbill turtle (*Eretmochelys imbricata*) are classified as CR; 18 species including two endemic palms (*Veitchia montgomeryana*, *Cyphosperma voutmelensis*), the endemic Aneityum skink (*Emoia aneityumensis*) and the endemic Banks Flying fox (*Pteropus fundatus*) are classified as EN; and, 116 species are classified as VU (predominantly corals).

The complete list of native Vanuatu species that are listed in the IUCN Red List is provided with annotations that include higher taxonomy, synonyms, endemic/native status, IUCN Red List status,

⁵ IUCN Red List of Threatened Species < <http://www.iucnredlist.org/>> It must be noted that the IUCN Red List is a global assessment

⁶ These names have been provided by Ms. Donna Kafilatak from the Dept of Environment and Conservation protection

⁷ Pippard, H., 2008. The Pacific islands: An analysis of the status of species as listed on the 2008 IUCN Red List of Threatened Species <http://cmsdata.iucn.org/downloads/the_pacific_islands_an_analysis_of_the_status_of_species_as_listed_on_the_2008_iucn_r.pdf>

⁸ Shallow marine environment extending from mean low water down to 200-metre (660-foot) depths, (generally corresponding to the continental shelf) - Neritic waters are penetrated by varying amounts of sunlight, which permits photosynthesis by both planktonic and bottom-dwelling organisms. The zone is characterized by relatively abundant nutrients and biologic activity because of its proximity to land.

common names, biome or system in which the species occurs, year assessed and population trend (see **Vanuatu-IUCN RedList-Inf-1**)

See Table 2 below for the breakdown of classifications.

Table 1: Species and Biomes

Species	Biome
101	Terrestrial
24	Freshwater
882	Marine
21	Terrestrial/Freshwater
37	Terrestrial/Marine
68	Freshwater/Marine
26	Terrestrial/Freshwater/Marine

Table 2: Native species of Vanuatu that are conservation assessed in the IUCN Red List of Threatened Species

IUCN Red List Category	Numbers of species
Extinct (EX)	1
Critically Endangered (CR)	3
Endangered (EN)	18
Vulnerable (VU)	116
Lower risk/Conservation dependent (LR/nt)	4
Near Threatened (NT)	142
Data Deficient (DD)	84
Least Concern (LC)	791

Vanuatu National Biodiversity Strategy and Action Plan

Vanuatu National Biodiversity Strategy and Action Plan (NBSAP) (1999) identifies priority lists of native species, these include:

- endemic animal and plant species
- animal and plant species of cultural and economic value
- animal and plant species that are rare and vulnerable
- animal species that are totally vulnerable to over-exploitation.

The lists have been compiled as described in the NBSAP including additional annotations such as higher taxonomy, common names, biome or system in which the species occur (see **Vanuatu-NBSAP-Inf-2**).

A number of species listed as endemic, vulnerable and rare in the NBSAP have been assessed and are listed in the IUCN Red List. While there is agreement on the biostatus for most of the species there are some discrepancies which have been marked the respective lists. These involve the 'endemic' status and species names.

*Note: The Critically Endangered palm species *Pelagodoxa henryana* is not listed as present in Vanuatu in the IUCN Red List, as a result it is not included in the native species inventory from the IUCN Red List*

Endemic species

65 endemic species of Vanuatu listed in the IUCN Red List and the NBSAP have been compiled in a matrix with additional annotations (see **Vanuatu-Endemic-Inf-3**)⁹.

All endemic and native species from the IUCN Red List and NBSAP have been recorded in the matrix **Vanuatu-All-Inf-4**). Location notes have been made at island and site level including protected and other designated areas of high biodiversity value where information is available.

Pressures on and threats of endemic and native species

A review was undertaken to assess all pressures (with a focus on the threat of IAS) on all endemic and native Vanuatu species that are threatened with extinction (CR, EN and VU). For the purpose of this assessment species from the IUCN Red List as well as those listed in the NBSAP have been considered. The results of this review have been recorded in the matrix (see **Vanuatu- Threats-Inf-5.1 & 5.2**).

The following pressures/threats were considered Agriculture & Aquaculture, Biological Resource Use, Climate Change and Severe weather, Energy production and mining, Human Intrusions and disturbance, Invasive Alien Species, Natural system modifications, Pollution and Transportation and service corridors

Biological resource use followed by Agriculture and Aquaculture are the two top threats to native species and natural areas. Following these threats are Climate change and severe weather events Invasive Alien Species and Natural system modifications

⁹ Please note this includes an addition of species names in two instances where only genus was identified. This rows have been highlighted

Species in the marine biome are most endangered. Some of the threats to coral reefs are eutrophication, physical disturbance, over-fishing, loss of habitat, sedimentation and predation by crown-of-thorns starfish, leading to coral mortality and collapse of fisheries. A warming climate where temperature extremes can lead to bleaching and increased susceptibility to disease, increased severity of El Nino Southern Oscillation (ENSO) events and storms, ocean acidification and the spread of coral diseases have been identified as a threat to coral species globally. Coral harvesting for the aquarium trade is another potential threat. Both hard and soft corals that can be used in aquariums are traded (IUCN Red List of Threatened Species).

A report by the Vanuatu Environment Unit (2007), lists the country's endangered marine species. "These include all turtle species (*Cheloniidae*), dugong (*Dugong dugong*), coconut crab (*Birgus latro*), giant clams (*Tridacna spp.*), triton shell (*Charonia tritonis*), and the marine crocodile (*Crocodylis porosus*). The green snail (*Turbo marmoratus*) is currently considered critically endangered with stocks severely depleted or totally wiped out in most parts of the archipelago where they were once found in abundance".

Overfishing (both commercial and recreational fishing) including the live reef fish trade, and habitat degradation of coral reefs are some of the threats to threatened marine fish species. Finfish from shallow water reefs are a major source for subsistence as well as artisanal fisheries. Offshore bottom-fish fishery, commercial fishery of tuna species is prevalent.

Habitat loss due to logging, deforestation, change in land-use- agriculture and aquaculture and natural system modifications are the primary threat to terrestrial threatened species. The native and endemic palm species are especially vulnerable to both biological resource use and habitat loss. The native kauri *Agathis macrophylla* is vulnerable to logging and deforestation. Of the 21 indigenous palm species, 14 are endemic to Vanuatu. Endemic palms include *Heterospathe uniformis* (Fakul) whose seeds are used as a remedy against impotence; and, *Caryota ophiopellis* used to make sago.

The impact of invasive species on native and endemic native biota is discussed in the Alien and Invasive Species of Vanuatu Section below

Priority Conservation Areas of Vanuatu

The World Database on Protected Areas (WDPA)¹⁰ provides the most comprehensive dataset on protected areas worldwide. The WDPA lists 35 'protected areas' for Vanuatu, 12 Terrestrial and 22 Marine. These include one Conservation Area, 19 Forest Conservation Areas, eight Marine Protected Areas, three Marine Reserves, three Recreational Reserve and one Reserve. Only five of the sites have an IUCN Category. Other sites that have been recognised in Vanuatu as areas of high biodiversity value include Endemic Bird Areas and Important Bird Areas (see **Vanuatu-Designated Areas Inf-6.1**). These areas are described below.

Three other categories of areas have been listed in the Vanuatu NBSAP – Important places, Vulnerable places and Places that are damaged or degraded due to human impacts (see **Vanuatu-Areas- NBSAP-Inf-**

¹⁰ World Database on Protected Areas –Protected Planet < <http://www.protectedplanet.net/>>

6.2). These include specific species habitat and ecosystem types – coconut crab areas, bat caves, flying fox habitat, mangrove areas, seagrass beds, seabird rookeries, coastline, lakes, rivers and forests.

Ownership of land in Vanuatu is in the hands of traditional owners. The land owners of ecologically important areas have been reluctant to lease these traditional lands to the Government to create and manage protected areas. The Government of Vanuatu has therefore established Community Conservation Areas (CCA) that are managed in a participatory manner. The Vatthe Community Conservation Area home to endemic birds and an endemic bat is one such terrestrial protected area. The Nguna-Pele Marine Protected Area Network is a successful example of a community managed ecologically important area. Nguna and Pele's managed reefs, sea grass beds, mangrove forests and intertidal lagoons now exceed 3,000 hectares.

Vanuatu has one identified Alliance for Zero Extinction Site the islands of Vanua Lava and Mota- the range of the Banks Flying Fox (*Pteropus fundatus*). The restricted habitat of this species is threatened by habitat loss and the impact of stochastic events.

One Endemic Bird Area (EBA) Vanuatu and Temotu has been identified. Four Important Bird Areas (IBAs) have been listed for Vanuatu - Vanua Lava and Mota, Gaua, Santo Mountain Range, Duviara and Environs and Ambrym North Coast. However these are yet to be confirmed. The Endemic Bird Area of Vanuatu and Temotu is home to 30 species of birds including endemic birds of Vanuatu - Buff-bellied Monarch (*Neolalage banksiana*), Chestnut-bellied Kingfisher (*Todiramphus farquhari*), Santo Starling (*Aplonis santovestris*), Vanuatu Imperial-pigeon (*Ducula bakeri*) and the Vanuatu Megapode (*Megapodius layardi*)

This EBA includes the Santa Cruz Islands of Temotu province of the Solomon Islands, and the more southerly Torres, Banks and Islands of Vanuatu. The area is predominated by lowland and montane rain forests; conifer forests dominated by *Agathis* spp. occur on Espiritu Santo, Erromango and the Santa Cruz Islands, cloud forests, mangroves, freshwater lakes and seawater lagoons. Major threats to this area includes logging and deforestation, land-use change- agriculture. Major threats to species include hunting and habitat loss.

The impact of invasive species on high biodiversity value areas is discussed below.

Alien and Invasive Species in Vanuatu

The International Union for Conservation of Nature, (IUCN) describes invasive species as “*animals, plants or other organisms introduced by man into places out of their natural range of distribution, where they become established and disperse, generating a negative impact on the local ecosystem and species.*” Invasive species can negatively impact native ecosystems and the species they contain. These impacts may disrupt the ecosystem processes, degrade habitats, reduce biodiversity and introduce diseases to flora and fauna

Island ecosystems appear to be more vulnerable to invasions. Island ecosystems tend to have fewer species present and are less complex with distance from the continent; simpler systems are less resilient to new arrivals. Introduced mammal predators (rats, feral cats, mongooses, stoats and pigs) and

herbivores (rabbits, deer, goats and sheep), alien invasive plants and introduced diseases have had devastating effects on native and endemic island species and their habitats.

A comprehensive desk-top review was undertaken to compile an annotated inventory of introduced and invasive species recorded in Vanuatu that have impacts on native biodiversity and natural areas (see **Vanuatu-IAS-Inf-7**).

Four main online resources were used they are the IUCN ISSG Global Invasive Species Database (GISD)¹¹, Pacific Island Ecosystems at Risk (PIER)¹², CAB International Invasive Species Compendium (ISC)¹³, FishBase¹⁴. Information on alien species from the expedition to the island of Santo (Bouchet *et al* 2011) as well as Tapisuwe (2001) a report on the Invasive Pest species of Vanuatu were also referred. Additional searches were conducted on Biological Abstracts Database, Google Scholar and other reports. There is a paucity of information on alien species in Vanuatu in peer-reviewed journal articles. Further details of distribution and management action to control the spread of these species was collated through contributions by members of the National Invasive Species Technical Advisory Committee (NISTAC). A dataset from the Live and Learn project in Vanuatu was received for inclusion. It is anticipated that other unpublished information will be made available when a visit to Vanuatu is made facilitating inclusion of this information.

The GISD focuses on alien species known to have negative impacts on native biodiversity and ecosystems. It features over 850 species profiles of some of the most harmful species. While there are taxon and geographical biases on selection of species (due to funding sources and priority themes) that are featured on the GISD, the Oceania region is well represented with a large number of harmful species listed. Other information extracted from the GISD included information on taxonomy, species organism type, common names, habitat type, biome, biostatus information and information on pathways of introduction and spread of these species.

The PIER database is focused on plant species that are known to have been introduced to the Pacific region including the Pacific Rim. Information extracted from PIER included biostatus of alien species at island level, common names in Pacific languages, habitat information and most importantly links to risk assessments conducted for the Pacific region.

CABI ISC is an encyclopedic type of database on invasive alien species that impact biodiversity and livelihoods. CABI maintain compendia on Crop Protection, Forestry, Aquaculture and Animal Health and Production. The CABI ISC lists invasive species that impact biodiversity as well as pests of crops and pathogens. The focus for this project was on species that are known to impact biodiversity and ecosystems.

¹¹ Global Invasive Species Database < <http://www.issg.org/database/welcome/>>

¹² Pacific Islands Ecosystems at Risk < <http://www.hear.org/pier> >

¹³ CAB International Invasive Species Compendium < <http://www.cabi.org/isc/default.aspx?site=144&page=4066>>

¹⁴ Fishbase < <http://www.fishbase.org/>>

FishBase is a database focused on all fish species known to science. Data and information included in FishBase includes ecological information, information on traits and distribution at country and ecosystem level including in the introduced range.

Bouchet et al 2011 is a comprehensive report on a French led expedition to the island of Santo. It includes a section of biological invasions and notes made of the invasive species recorded during the survey. All this information has been included in the matrix.

Tapisuwe (2001) includes inventories of pest species in Vanuatu- the results of a literature review and consultation with stakeholders. The document focuses on species that are harmful to the environment as well as to agriculture. The information gathered is from 17 islands- Buninga, Efate, Erromango, Gaua, Hiu, Loh, Malakula, Maewo, Mataso, Merelava, Mota, Santo, Tanna, Toga, Tongariki, Tongoa and Ureparapara. 54 pests have been reported with 37 classified as being 'invasive' and 'dominant'. Notes from this document related to the dominant invasive species including distribution and impact information have been included in the matrix in a separate column. Information on species where the species name is unclear have not been included.

260 alien/introduced species have been recorded in natural areas in Vanuatu as a result of the desktop review and consultation with in-country partners (194 plant species, one fungi and 65 animal species)¹⁵. Of the 260 33% (89 species) have been recorded as showing invasive traits- evidenced impacts on the environment or record of aggressive spread. These include 65 plant species, one fungi and 23 animal species. A majority of these species occur in the terrestrial habitat. The remaining 171 species are introduced species that can be considered to be 'potentially invasive'. Many of these species are known to be invasive elsewhere in their native range.

Annotations that have been recorded for each of the species include higher taxonomy, common names, organism types, species preferred habitats, pathways of introduction and spread, risk assessment scores with links, limited distribution information in Vanuatu and limited management information.

Of the seven introduced bird species two are recorded as invasive, these are the Indian myna (*Acridotheres tristis*) and jungle fowl (*Gallus gallus*). (Bouchet et al 2011) includes a description of introduced birds. It reports that the Indian myna was first recorded in 1935 on Tanna and is said to have been introduced as a result of a ship wreck – the ship traveling from Fiji is supposed to have been carrying caged myna birds. The myna which occurs in suburban habitats is a pest and could potentially compete with the collared kingfisher (*Todiramphus chloris*). The red jungle fowl in Vanuatu is described in it is reported to occur in mature rainforests as well as 'secondary forests, scrubs, clearings and boundaries of cultivated patches'. It was found to be abundant in Vathe Conservation Area forests, common in Saraoutou primary forests but rare in Butmas secondary forests. The omnivorous and ground feeding red jungle fowl occurs in forests where the endemic and threatened Vanuatu megapode occurs and could be a potential competitor.

¹⁵ Please note that species that are pests and diseases of agriculture have not been included in this study

Of the six introduced fish species that occur in the wild, three are reported to be invasive- these include Mozambique tilapia (*Oerochromis mossambicus*) [that occurs in the marine/freshwater biome], and the two freshwater poeciliids that had been intentionally introduced for biological control of mosquitoes the western mosquito fish 'Fish Blong Government' (*Gambusia affinis*) and guppy (*Poecilia reticulata*). Tapisuwe (2001) reports that guppies were introduced to Lake Wailetbutaka on East Ambae in the 1940's, by the 1960s it was the most dominant fish in the lake. It is also known to be abundant in Leah Nimoho). Its impact on native fish species has not been studied.

Alien invasive mammals include both predators (rats, cats, pigs), and herbivores (cattle and ungulates (goats and sheep). Bouchet et al (2011) describes the impacts of feral cattle in the Vatthe conservation area. Domestic stock held by Australian farmers appear to have been released into the area giving rise to a feral herd. Permission to hunt the cattle needs to be given by the village Chief, cattle are mostly slaughtered during festivals. Feral cattle trample on vegetation and degrade forest habitats. They browse native as well as alien and invasive species in the area.

Two alien reptiles have been recorded in Vanuatu, these are the Asian house gecko (*Hemidactylus frenatus*) and the blind snake (*Rhynchotyphlops braminus*). No evidence of impacts or aggressive spread have been reported. The cane toad (*Rhinella marina*), the reptiles *Gehyra mutilata* and *Hemidactylus garnotti* have been reported in the past and not known to have naturalised or established. These species have not been included in the matrix.

Alien and invasive insect species include the little fire ant (*Wasmannia auropunctata*) (see below for summary of the spread of little fire ant), and crazy ant (*Anoplolepis gracilipes*). Other alien ant species recorded include the big-headed ant (*Pheidole megacephala*), tropical fire ant (*Solenopsis geminata*), ghost ant (*Tapinoma melanocephalum*), slender crazy ant (*Paratrechina longicornis*) and the bicoloured trailing ant (*Monomorium floricola*), no impacts on the environment in Vanuatu have been recorded. The Erythrina gall wasp (*Quadrastichus erythrinae*) and the Macau paper wasp (*Polistes olivaceus*) are also reported to be present in Vanuatu. The yellow-fever mosquito (*Aedes aegypti*) and the Southern house mosquito (*Culex quinquefasciatus*) have been recorded in Vanuatu

Two introduced snail species the Giant African snail (*Lissachatina fulica* (= *Achatina fulica*) and the Rosy wolf-snail (*Euglandina rosea*) are recorded as invasive the latter having caused severe decline in populations of endemic and native partulid snails.

The majority of the alien plant species are terrestrial. Grasses followed by herbs predominate the list. The two major invasive plant species that are known to compete with and impact populations of native species are Big lif (*Merremia peltata*) and wan dei rop (*Mikania micrantha*). These two species are subject to several focused management and control projects, this has been discussed below. In addition to these species over 20 other plant species are described as 'dominant' in Tapisuwe (2001), they include buffalo grass (*Stenotaphrum secundatum*), big leaf wild tobacco (*Elephantopus mollis*), indigofera (*Indigofera suffruticosa*), guava (*Psidium guajava*), kasis (*Leucaena leucocephala*), korosol (*Annona muricata*), corda (*Cordia alliodora*), rain tree (*Koelreuteria elegans* or *Samanea sama*), brum grass (*Sida rhombifolia*), Pico (*Solanum torvum*), hibiscus ber (*Urena lobata*), Waet knil krass (*Mimosa*

diplotricha (= *Mimosa invisa*), lantana (*Lantana camara*), wael pinut (*Cassia tora*), nutgrass (*Cyperus rotundus*), small leaf wild tobacco (*Pseudelephantopus spicatus*), blue rat tail (*Stachytarpheta cayennensis*), broom small leaf (*Sida acuta*), grasnel (*Mimosa invisa* and *M. diplotricha*), needle amaranth (*Amaranthus spinosus*), Koronivia grass (*Brachiaria humidicola*), signal grass (*Brachiaria decumbens*). Some of these plant species are the subject of biological control programmes (see section below on biological control).

Freshwater invasive plant species include - water hyacinth (*Eichhornia crassipes*), and the water lettuce (*Pistia stratiotes*); goose grass (*Eleusine indica*) that grows in coastal, wetland as well as drier habitats is also recorded.

In the marine habitat the species of concern is the crown-of-thorns starfish (COTS). COTS is native to the Indo-Pacific region, so its provenance in Vanuatu is 'uncertain'. The species is reported to be spreading aggressively and is the main threat to coral reefs. Coral species are the most threatened native species of Vanuatu according to the IUCN Red List of Threatened Species. Five bryozoans (*Amathia distans*, *Bugula neritina*, *Schizoporella errata*, *Watersipora subtorquata*, *Zoobotryon verticillatum*) were identified during a marine survey undertaken by the National Institute Of Water & Atmospheric Research (NIWA) at Port Vila, these species are known to be invasive in their introduced range elsewhere. These records await formal identification by specialist taxonomists.

Information has been recorded on the impacts of IAS on fourteen threatened species. A description of the threat, the threat mechanism and outcome of this impact is included. IAS are identified. Location of occurrence of these species is recorded where information was available (see **Vanuatu-Threats-Inf-5.2**). Species threatened by IAS include seven bird species (four endemic), three snails (two endemic), three reptiles and one ray-finned fish. Predation, habitat loss and degradation and disease transmission are the principle impacts leading to decline in populations and habitat loss. Impacts on the three native reptiles need to be confirmed.

Introduced mammals predators (Rats (*Rattus* spp.), feral cats (*Felis catus*) and feral dogs (*Canis lupus*) are a major threat to the endemic VU Mountain starling (*Aplonis santovestris*). Predation by feral dogs is a threat to the endemic VU Vanuatu Megapode (*Megapodius layardi*). Being an understorey species the endemic NT Vanuatu Kingfisher (*Todiramphus farquhari* [= *Halycon farquhari*]) is likely to be affected by habitat degradation due to trampling by feral cattle (*Bos taurus*) and rooting by pigs. Threats to the VU Santa Cruz Ground-dove (*Gallicolumba sanctaecrucis*) include introduced rats, Feral cats, dogs and pigs (*Sus scrofa*). Reduction of habitat through forest clearing and degradation (invasion by *Merremia peltata*) may also contribute to the decline of this species population. Threats to the VU Palm lorikeet (*Charmosyna palmarum*) include avian malaria (*Plasmodium relictum*), cyclones and loss of habitat.

The two endemic partulids- the CR *Partula milleri* and the EN *P. auraniana* and *Ouagapia perryi* are under threat by predation by the Giant African snail and the Rosy wolf-snail. The Rosy wolf-snail was an intentional introduction to Vanuatu as a biological control agent to control the Giant African snail. This

introduction turned out to be a failure with the Rosy wolf-snail predated on endemic and native snails instead of the Giant African snail.

Impacts of Invasive species on areas of high biodiversity value

Threats to terrestrial protected areas include logging and converting land to plantations and for use in agriculture and the impacts of the spread of alien invasive species. Below is a description of the threat of IAS to the ecological integrity of the Vatthe Community Conservation Area.

Threats to marine areas of high biodiversity value has been over-fishing and exploitation of the resources of these areas. Increased infestations by COTS is reported. It is uncertain if these infestations occur in marine protected areas and the locally managed marine areas.

There is limited information available on the threats to individual sites.

Vatthe Community Conservation Area

Bouchet et al (2011) includes a description of the impacts of invasive species on the species and ecological integrity of this conservation forest area

PestList Database maintained by the Secretariat of the Pacific Community

The Pestlist database managed by the Secretariat of the Pacific Community (SPC) was consulted for a list of species (pests and pathogens) recorded for Vanuatu. This list was provided (see **Appendix 1**) by SPC on the request by the Vanuatu Department of Environmental Protection and Conservation. The list consists of three main organism types arthropods, fungi and nematodes- these are largely pests of the production area and agriculture. A decision needs to be taken on whether to merge the Invasive species of Vanuatu list with the SPC list soon.

Pathways of introduction and spread

The agricultural, forestry and fisheries sector play a vital role in the economy of Vanuatu. Latest trade figures show that Vanuatu's major trading partners are Australia, Japan, New Caledonia, New Zealand, other Melanesian countries and all other countries¹⁶. These main trading partner countries are the origin of much of the air and sea movement/links to Vanuatu.

A sortable list of species and corresponding pathways has been compiled for nearly 900 global alien and invasive species. Both long distance pathway methods and short distance pathways (annotated as 'local') have been listed (see **Pathways-Vanuatu-Inf-8**). This dataset has been compiled from the GISD. Included in the list are known invasive species that are featured in the GISD and their corresponding pathways.

Additionally please also refer to **Vanuatu-Inf-7** for pathway and spread information for all the alien and invasive species listed in Vanuatu

Pathways of concern noted during the discussion with the NISTAC were species accidentally introduced during the importation of second hand heavy machinery such as bull dozers. Lack of scanning machines

¹⁶ Vanuatu National Statistics Office < <http://www.vnso.gov.vu/index.php/econ/23-trade-news/39-trade-news>>

and other protocols were recognised as lacking. Accidental introductions through inter-island movement was noted as another concern.

Risk Assessments

Risk assessments have been undertaken for several hundred plant species in most cases by the Hawai'i Pacific Weed Risk Assessment group and listed on the PIER database. Information on these assessments including scores achieved and links to the assessments have been provided in the matrix. The risk assessment documents are a good source of credible information on the species. 110 of the 193 plant species have had risk assessment conducted for this region, close to 90% of the species have achieved a 'high risk' score or a 'reject score'.

Biodiversity Conservation and Invasive Alien Species Management Projects in Vanuatu

A review was undertaken to compile a list of biodiversity conservation and IAS management projects active in Vanuatu and undertaken in the recent past (see **Vanuatu-Biodiversity-IAS-Projects-Inf-9**). The search involved contact with key persons as well as a Desk-top review.

Over 20 individual activities have been recorded, most of them being related to biodiversity conservation. These include four activities related to the development of the NBSAP, the first, second and fourth National Report to the CBD.

Five specific activities have been recorded related to IAS management. This includes the GEF- PAS Pacific Invasive Project, and two related to the testing and developing management options for the management of invasive species including 'Invasive vine control to protect bio-cultural and economic values in lowland forest in Vatthe Conservation Area'. A project related to the management of COTS was discussed but has not been included for lack of information. A brief description of these projects has been provided below

GEF- PAS Pacific Invasive Project

Five key activities identified by Vanuatu for implementation as part of the GEF-PAS invasive species project, several of which are underway. These include

- Raising awareness and implementing outreach programmes on the impacts of invasive species on biodiversity, economy, health, cultural values etc.
- Developing a National Invasive Species Strategy (NISS);
- Surveys of invasive species including fire ants (*Wasmannia auropunctatus*), Indian mynas (*Acridotheres tristis*), Merremia (*Merremia peltata*), marine invasives, and others identified under the NISS.
- Host testing of six promising new agents to control African Tulip tree (*Spathodea companulata*);
- Merremia control at Vatthe Conservation Area

***Merremia peltata* control**

The Live & Learn Invasive species project which runs between 2011 and 2016 is titled 'Testing and modelling preventative measures to limit the spread and ecological impact of invasive species in Small

Islands Developing States (SIDS)¹. The main activities of the project have been phased into four stages: research and assessment, generating support for management of invasive species, Legislation and policies and control and eradication of invasive species. More detail on these phases can be read by following this link (<http://www.livelearn.org/projects/invasive-species-vanuatu>).

A management plan for *Merremia* has been developed which has been approved by NISTAC. Assessing various non-chemical options for *Merremia* control is a key activity. Project sites are located on Santo, Tanna, Erromango. Trials being carried out include removal of *Merremia* through manual methods and planting native species such as white-wood and sandalwood and other crops.

The project also seeks to contribute to the development of legislation and policies focused on preventing the introduction and spread of invasive species and is working closely with relevant Government departments. The *Merremia* control project

The second project focused on the management of *Merremia* in Vanuatu is one which is being implemented in partnership with the Royal Forest and Bird Society from New Zealand, the project runs from 2010 to 2013. The project site is the Vathe Conservation Forest Area on the island of Santo. The aims of the project as described on the project page: *The project intends to trial low cost methods through develop local capacity to control Merremia, complete initial control by cutting, complete herbicide trials, develop an efficient herbicide application method, control approximately approximately 600ha by injecting herbicides into vine stems, spread awareness of the bio-cultural threats of invasive vines and will lead to the development of a long-term sustainable management regime, able to be undertaken by the Vathe and other Pacific Island landowners to control Merremia to a level that the forest can withstand*¹⁷.

Monitoring and management of the spread of the little fire ant *Wasmannia auropunctatus*

The little fire ant was reported to the Vanuatu Quarantine & Inspection Service (VQIS) in December 1998. Populations were found occupying an area of 10 square kms on the islands of Vanua Lava, Mota and Gaua. It is suspected that the ant may have been present in Vanua Lava since 1994. The spread of this ant has implications for agriculture as well as human welfare. Jourdan 2002 reported infestations covering as many as 1200 hectares on Vanua Lava. Eradication was declared as an option that was not feasible.

The little fire ant has since spread to the islands of Santo and Efate where active management is ongoing. Infested sites have been identified. It is suspected that the ants may have been introduced from Vanua Lava on kava roots. Facilitated by funding from AusAid, the French Government and SPC delimiting surveys, survey and mapping of infected areas and bait application have been used to control and spread of this ant.

¹⁷ The following link provides more details on the project < <http://www.forestandbird.org.nz/files/file/F&BFeb09VatheStory2.pdf> >

Biological Control projects

Several biological control projects are under operation in Vanuatu by the Quarantine Department. Releases of biocontrol agents and monitoring is on-going. The alien and invasive plant species that are the subject to biological control include water hyacinth (*Eicchornia crassipes*), knobweed (*Hyptis capitata*), Lantana (*Lantana camara*), grasnel (*Mimosa diplotricha*), Wan dei rop (*Mikania micrantha*), Big lif (*Merremia peltata*), Parthenium (*Parthenium hysterophorus*), Cats-claw creeper (*Macfadyena unguis-cati*), wota letus (*Pistia stratiotes*), broom small leaf (*Sida acuta*), pispis tree (*Spathodea companulata*).

Conclusion

Biodiversity data and information are crucial to well-informed decision making in the implementation of biodiversity conservation action, yet these data and information are not readily available. One of the problems is the complexity of biodiversity data and information in terms of bio-status and distribution. Also, these data and information are dispersed, sometimes outdated and are not available in ready to use and compatible formats.

Baseline information on the status and distribution of biodiversity and natural resources serve as a benchmark for monitoring and the development of biodiversity indicators and trends. Data and information on the distribution of endemic and native species, their conservation status; the extent and distribution of IAS and other threat information are all critical for the prioritization of conservation action. These data and information are necessary for reporting and planning future action. It is recommended to keep this resource updated by providing all 'new' information to information providers.

The results of this comprehensive review provide a baseline for biodiversity data and information for Vanuatu. Based on the information collated we can conclude that species most under threat occur in the marine biome. Biological resource use (overfishing and overharvesting) is the primary threat type. Invasive alien species including invasive fish, snails, predatory mammals, herbivores and invasive plants including vines, grasses, shrubs and trees are the predominant biological invaders. Coral reefs and allied ecosystems in the marine biome and forests in the terrestrial biome are most under threat.

It is observed that many of the most harmful of the alien species have been introduced intentionally for the purpose of biological control or for planting (forestry and other purposes). This makes it imperative to have better knowledge of alien species that have the potential to become invasive, the need for assessing risk before introduction of any alien species and better border control to prevent introductions. It is also important to understand which the pathways of spread are so as to prevent the spread of these species across islands. Documentation of distribution of these species are critical. There is also limited information on evidence of impacts

An End Note Library has been compiled of various peer reviewed journal articles related to biodiversity of Vanuatu including newly discovered species.

References

- BirdLife International Data Zone < <http://www.birdlife.org/datazone/home>>
- BirdLife International, 2013. Endemic Bird Area factsheet: Vanuatu and Temotu. <http://www.birdlife.org/datazone/ebafactsheet.php?id=200>
- Bouchet, P., H Leguyader, O Pascal, 2011. The Natural History of Santo, Patrimoines Naturels #70. Museum National d`Histoire Naturelle
- CAB International 2013. Invasive Species Compendium <<http://www.cabi.org/isc/>>
- Convention on Biological Diversity (CBD) Strategic Plan for Biodiversity and Aichi Targets 2011-2020 < <http://www.cbd.int/doc/strategic-plan/2011-2020/aichi-targets-en.pdf>>
- Department of Vanuatu Quarantine and Inspection Services, 2005. National Biosafety Framework. Developed as part of the National Biosafety Framework Project by Vanuatu Quarantine and Inspection Services with financial support provided through UNEP-GEF. < <http://www.unep.org/biosafety/files/VUNBFrep.pdf>>
- Dupuyoo, Jean-Michel, 2005 Ethnobotanical Notes on *Caryota ophiopellis* in Vanuatu. Palms Vol. 49(2) 2005
- Dupuyoo, Jean-Michel, 2006 Two Palms with Surprising Qualities Palms Vol. 50(4) 2006
- IUCN 2013. The IUCN Red List of Threatened Species. Version 2012.2. <http://www.iucnredlist.org/>
- FAO, 2001. FAO 2000 Forest Resource Assessment Vanuatu Country Report. Department of Forests March 2001
- Froese, R. and D. Pauly. Editors. 2013. FishBase. < <http://www.fishbase.org/>>
- Invasive Species Specialist Group 2013. Global Invasive Species Database (GISD). Version 2012.2 <http://www.issg.org/database/welcome/>
- Invasive Species Specialist Group 2013. Island Biodiversity and Invasive Species Database (IBIS). Version 2012.1 <http://ibis.fos.auckland.ac.nz/>
- Jourdan, H. 1997. Threats on Pacific islands: the spread of the tramp ant *Wasmannia auropunctata* (Hymenoptera: Formicidae). Pac. Conserv. Biol.3:61-64.
- Jourdan, H., L. Bonnet de Larbogne & J. Chazeau 2002. The recent introduction of the neotropical tramp ant *Wasmannia auropunctata* (Roger) into the Vanuatu archipelago (Southwest Pacific). Sociobiology 40:483-509.
- Live & Learn Project, Invasive Alien Species Database
- Nguna-Pele Marine Protected Area < <http://www.marineprotectedarea.com.vu/>>

NIWA Managing marine pest threats at Port Vila, Vanuatu < <http://www.niwa.co.nz/pacific-rim/update/asia-pacific-update-02-july-2010/managing-marine-pest-threats-at-port-vila-vanuatu> >

Pacific Island Ecosystems at Risk (PIER) 2013. <<http://www.hear.org/pier/>>

Pearson, M. N. and M. Grisoni. 2002. Records of plant viruses for the Pacific Islands. Australasian Plant Pathology **31**:15-26.

Pippard, H., 2008. The Pacific islands: An analysis of the status of species as listed on the 2008 IUCN Red List of Threatened Species
<http://cmsdata.iucn.org/downloads/the_pacific_islands_an_analysis_of_the_status_of_species_as_listed_on_the_2008_iucn_r.pdf>

Protected Planet- World Database of Protected Areas - Vanuatu
<<http://www.protectedplanet.net/search?utf8=%E2%9C%93&q=Vanuatu&commit=Search#>>

Raubani, J. J, 2007. The Status of Coral Reefs in Vanuatu. Fisheries Department Ministry of Agriculture, Quarantine, Forestry & Fisheries

Republic of Vanuatu, Vanuatu Statistics Office < <http://www.vnso.gov.vu/>>

Republic of Vanuatu First National Report to the Convention on Biological Diversity 1998 <
<http://www.cbd.int/doc/world/vu/vu-nr-01-en.pdf>>

Republic of Vanuatu National Biodiversity Strategy and Action Plan (NBSAP) 1999. <
<http://www.cbd.int/doc/world/vu/vu-nbsap-01-en.pdf>>

Republic of Vanuatu, National Advisory Committee on Climate Change- National Adaptation Programme for Action

Republic of Vanuatu Second National Report to the Convention on Biological Diversity 2010. Review of the National Biodiversity Strategy and Action Plan. <<http://www.cbd.int/doc/world/to/to-nr-04-en.pdf>>

Republic of Vanuatu Third National Report to the Convention on Biological Diversity 2010. Review of the National Biodiversity Strategy and Action Plan. < <http://www.cbd.int/doc/world/vu/vu-nr-03-en.pdf>>

Ruben Bakeo & Francis Quarani, 2003. Country report on the forestry invasive species situation in Vanuatu. The unwelcome guests. Proceedings of the Asia-Pacific forest invasive species conference <
<ftp://ftp.fao.org/docrep/fao/008/ae944e/ae944e02.pdf>>

SPC Aquaculture Portal 2013 <
http://www.spc.int/aquaculture/index.php?option=com_countries&view=country&id=20&Itemid=51>

SPREP Multilateral Environment Agreements (MEA) Database
<http://www.sprep.org/attachments/MEA_database.pdf>

Tapisuwe A. 2001. Invasive Pest Species in Vanuatu. Unpublished report

Wetterer, J.K. & S.D. Porter - Little Fire Ants. Sociobiology Vol. 41, No. 3, 2003

World Database on Protected Areas (WDPA) <<http://www.wdpa.org/>>