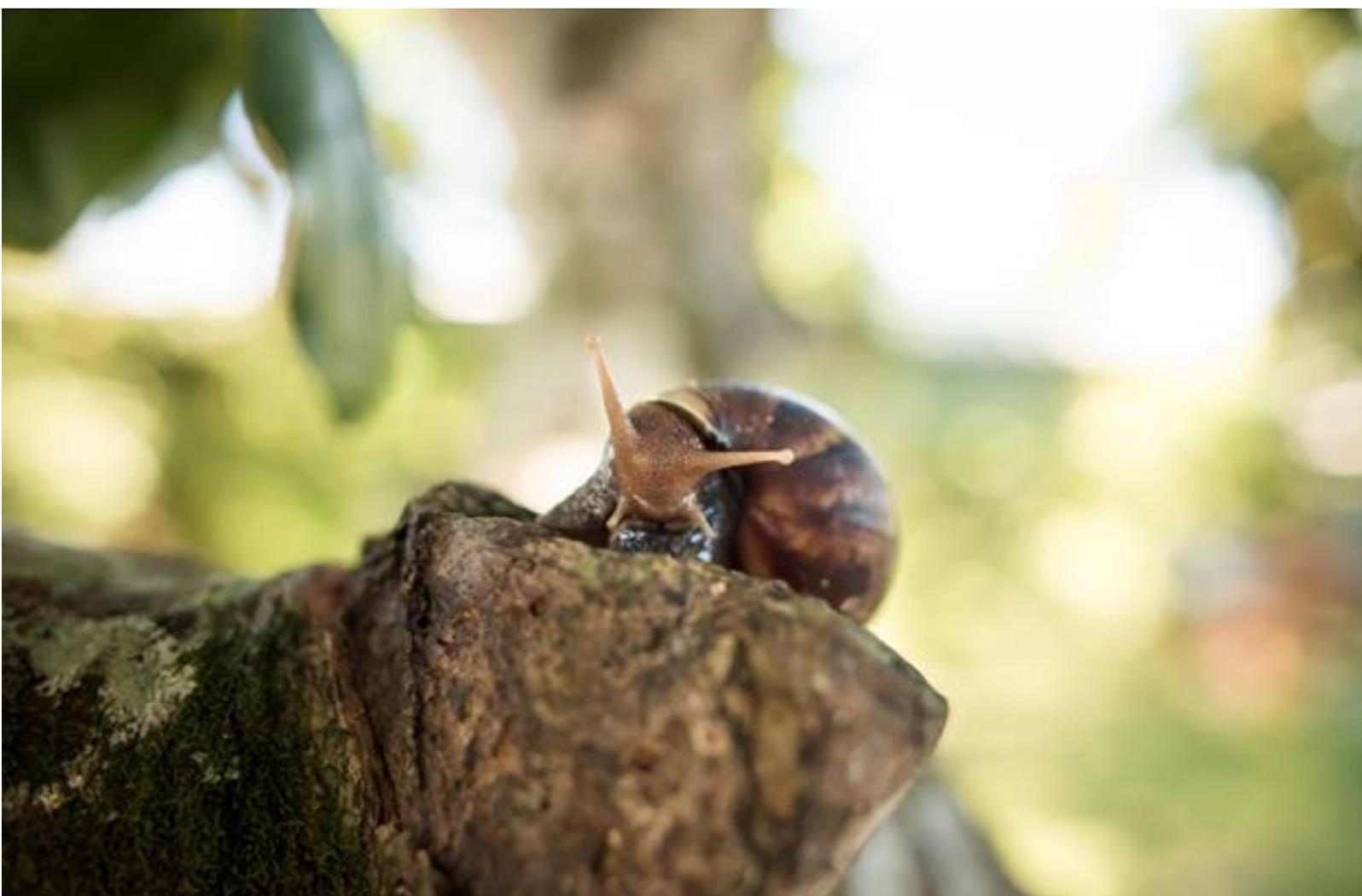




Pacific  
Community  
Communauté  
du Pacifique

RESCCUE

# **INVASIVE SPECIES AND ECOLOGICAL RESTORATION DIAGNOSIS AND ACTION PLAN NORTH EFATE, VANUATU**



The operator in charge of the implementation of the RESCCUE project in Vanuatu under the supervision of both SPC and the Government of Vanuatu is: Opus International Consultants with Development Services, OceansWatch, Landcare Research, Live and Learn Vanuatu, C<sub>2</sub>O consulting and individual consultants.

**Opus International Consultants**

Adam Fraser, Project Coordinator  
Ph: +64 21834653  
Email: [adam.fraser@opus.co.nz](mailto:adam.fraser@opus.co.nz)



**Development Services**

Kylie Mullins  
Ph: +678 7727356  
Email: [kmullins@devservices.net](mailto:kmullins@devservices.net)

**Live and Learn**

Glarinda Andre  
Ph: +678 27455  
Email: [glarinda.andre@livelearn.org](mailto:glarinda.andre@livelearn.org)



**OceansWatch**

Chris Bone  
Ph: +64 94344066  
Email: [chris@oceanswatch.org](mailto:chris@oceanswatch.org)



**Landcare Research**

Sue Greenhalgh  
Ph: +64 33219809  
Email: [greenhalghs@landcareresearch.co.nz](mailto:greenhalghs@landcareresearch.co.nz)



**C<sub>2</sub>O Consulting**

Johanna Johnson,  
Ph: +61 418760225  
Email: [jjohnson@c2o.net.au](mailto:jjohnson@c2o.net.au)



Main redactor(s)/Contributor(s)	Date of publication
Roger MacGibbon and Adam Fraser	April 2017

## **Overview of the objectives and components of RESCCUE Project:**

The RESCCUE (Restoration of Ecosystem Services and Adaptation to Climate Change) project is a regional project implemented by the Pacific Community (SPC).

The overall goal of RESCCUE is to contribute to increasing the resilience of Pacific Island Countries and Territories (PICTs) in the context of global changes. To this end RESCCUE aims at supporting adaptation to climate change (ACC) through integrated coastal management (ICM), resorting especially to economic analysis and economic and financial mechanisms.

The RESCCUE project operates both at the regional level and in one to two pilot sites in four countries and territories: New Caledonia, Vanuatu, Fiji and French Polynesia.

RESCCUE is funded primarily by the *French Development Agency* (AFD) and the *French Global Environment Facility* (FFEM) for a duration of five years (01/01/2014 to 31/12/2018). The total project budget is 13 million Euros, including 6.5 million Euros from AFD/FFEM and about the same in co-funding.

## **Summary of RESCCUE Project in Vanuatu**

The Vanuatu RESCCUE Project covers the northern side of the island of Efate beginning at the village Mangaliliu and ending with the village of Epao (inclusive). The islands of Nguna, Pele, Lelepa, Emao and Moso are also included in the project site. In total, the site covers around 50 km<sup>2</sup> of marine ecosystems (coral reefs, seagrass beds, lagoons, mangroves and beaches), 180 km<sup>2</sup> of terrestrial ecosystems (including forests) with a total population of approximately 8,000 (VNSO 2009). The project area also includes an established network of marine protected areas at Nguna-Pele, as well as multiple community-managed marine protected areas.

The RESCCUE Project is structured around five components:

**Component 1: Integrated coastal management.** This component aims at supporting ICM implementation “from ridge to reef” through ICM plans, ICM committees, coastal management activities concerning both terrestrial and marine ecosystems, capacity building and income generating activities.

**Component 2: Economic analysis.** This component aims at using the economic analysis toolbox to (i) demonstrate the added-value of ICM activities, and (ii) inform coastal management and policy decisions.

**Component 3: Economic and financial mechanisms.** This component aims at setting up economic and financial mechanisms to generate additional and sustainable funding for ICM: review of options (payment for ecosystem services, taxes, user fees, trust funds, quota markets, biodiversity offsets, carbon finance, labels...); feasibility studies; implementation; monitoring.

**Component 4: Capitalization, communication, dissemination of project outcomes in the Pacific.** This component aims at going beyond pilot sites activities to make RESCCUE a truly regional project, having impacts at the national and regional levels. This is done through fostering experience sharing between sites, providing cross-sectoral expertise, and communicating / disseminating the project outcomes.

**Component 5: Project management.** This component aims at implementing and coordinating the project, by providing technical assistance, organizing local and regional steering committees, conducting audits and evaluations (mi-term and ex-post), etc.

# Table of Contents

<b>EXECUTIVE SUMMARY .....</b>	<b>6</b>
<b>1 ASSESSMENT OF CURRENT ECOLOGICAL STATE .....</b>	<b>8</b>
1.1 INVASIVE SPECIES.....	8
1.2 NORTH EFATE ECOLOGY.....	11
<b>2 DIAGNOSIS: PRIORITY REQUIREMENTS.....</b>	<b>15</b>
2.1 OVERVIEW.....	15
2.2 INVASIVE SPECIES KNOWLEDGE GAPS .....	16
2.3 ECOLOGY / ECOLOGICAL RESTORATION KNOWLEDGE GAPS .....	16
<b>3 PROPOSED INVASIVE SPECIES AND ECOLOGICAL RESTORATION ACTION PLAN .....</b>	<b>17</b>
3.1 OVERVIEW.....	17
3.2 PROPOSED ACTIVITIES .....	18
<b>4 REFERENCES .....</b>	<b>25</b>

## **Abbreviations and Definitions**

BIORAP	Rapid Biodiversity Assessments
DEPC	Department of Environmental Protection and Conservation
ELMA	Efate Land Management Area
IUCN	International Union for Conservation of Nature
LLV	Live and Learn Vanuatu
NAB	National Advisory Board on Climate Change and Disaster Risk Reduction
NGO	Non-Governmental Organisation
NISSAP	National Invasive Species Strategy and Action Plan
RESCCUE	restoration of ecosystem services and adaptation to climate change
SPREP	Secretariat of the Pacific Regional Environment Programme

## EXECUTIVE SUMMARY

Vanuatu's volcanic origins and relative geologic youth have resulted in a flora which is generally less diverse and with lower levels of endemism than neighbouring countries such as the Solomon Islands and Fiji. There is however, little data on the ecology and landscape of Vanuatu.

The terrestrial landscape of Efate is shaped by frequent and historical disturbance. In the steeper, forested areas it is observed there is substantial forest tree crown dieback/defoliation. Much of which was apparently caused by Tropical Cyclone Pam in 2015. The canopy over large areas of the forested interior of Efate appears to comprise of patches of tree/shrub canopy of different sizes and ages which implies a history of disturbance. Closer to the coast, areas cleared for agriculture are increasingly obvious, interspersed by regenerating scrub areas that, presumably, had been cleared, farmed and left to be recolonised by pioneer and early successional plant species, many of them invasive.

Invasive plant and animal species have had, and continue to have, a major negative impact on the ecology and economy of Vanuatu. The isolation of the islands, the favourable terrestrial growing conditions, and a flora and fauna that has evolved in the absence of a diversity of vertebrate predators and intense competition means the indigenous biota of Vanuatu is highly vulnerable to competition and predation from introduced exotic species.

While it appears that there have been few if any studies in Vanuatu to quantify the level of impact of the major invasive species, the sheer observable biomass of species such as big leaf vine and giant African snail, accompanied by research undertaken in other countries (Master et al. 2013; Raut and Barker 2002), leaves little doubt that their impact is considerable. This applies equally to North Efate and Nguna and Pele Islands, where most of the major invasive species occur.

The Vanuatu Department of Environmental Protection and Conservation (DEPC) has produced a "National Invasive Species Strategy and Action Plan 2014-2020" (NISSAP). This detailed action plan sets nine key target outcomes and recommended actions and activities. Activities generated by the RESCCUE programme align with the NISSAP.

The challenges associated with invasive species management and ecological restoration are completely entwined. Efforts to undertake successful ecological restoration require a strategy to understand and manage the impacts of invasive species as a priority.

Invasive species are having a fundamental effect on Vanuatu and North Efate communities in two ways:

- Impact of food production and village life;
- Impact on the ecosystem function and the natural ecology of indigenous flora and fauna.

For this reason, it is proposed that activities should be split between two types of site: typical community food production gardens, and more natural areas that remain predominantly in natural vegetation. It may be that both sites can be found on the same patch of land.

RESCCUE proposes a number of actions to improve ecological management in North Efate. This plan builds upon the work being done by the Vanuatu Government, Shefa Provincial Government and non-governmental organisations (NGOs). The Action Plan has been formulated to be consistent with and to complement the National Invasive Species Strategy and Action Plan.

Preparatory work for the Action Plan is programmed to take place through the second half of 2016 with most of the project activity at village level in the latter two years of the project (2017-2018). The proposed activities are summarised in Table 1.

**Table 1: Proposed Activity Summary**

<b>Activity</b>		<b>Action</b>	<b>When</b>
<b>1</b>	Introduce Invasive Species and Ecological Restoration Diagnosis and Action Plan to stakeholders, Tasivanua and Nguna Pele community groups and obtain Steering Committee endorsement	Meet with government departments (DEPC, Bio-Security, and Forestry) to align activity with government priorities and existing infrastructure	First quarter 2017
		Present Plan to chairman of the Nguna Pele and Tasivanua community networks	First quarter 2017
<b>2</b>	Identify members of Tasivanua and Nguna Pele community networks to lead and promote this Action Plan	Identify 1-2 members of the Tasivanua and 1-2 members of Nguna Pele community networks to advocate for the objectives of this Action Plan	First – second quarter 2017
		Appointment of community champions to work closely with RESCCUE Terrestrial Team	First – second quarter 2017
<b>3</b>	Identify suitable land for trial plots		Second quarter 2017
<b>4</b>	Production of biodiversity identification resources	Development of existing Vanuatu Live and Learn Invasive Species Identification Booklet	Second quarter 2017
<b>5</b>	Community Technical Training Workshops	Develop and deliver workshops	Second – third quarter 2017
<b>6</b>	Rapid Biodiversity Survey (bioblitz)	In partnership with Shefa Provincial Council and Efate Land Management Area (ELMA)	Second – fourth quarter 2017
<b>7</b>	Socio-economic survey and quantitative evaluation of the costs and benefits of invasive species management	In conjunction with RESCCUE economic activities	Second quarter 2017
<b>8</b>	Garden African Snail and Rodent Control Trial	With Vanuatu Bio-Security Department	Second quarter 2017 – third quarter 2018

# 1 ASSESSMENT OF CURRENT ECOLOGICAL STATE

## 1.1 INVASIVE SPECIES

### 1.1.1 Species Present in Vanuatu

Invasive plant and animal species have had, and continue to have, a major negative impact on the ecology and economy of Vanuatu, as they do in many island archipelagos around the globe. The isolation of the islands from the continental areas, the favourable terrestrial growing conditions, and a flora and fauna that has evolved in the absence of a diversity of vertebrate predators and intense competition means the indigenous biota of Vanuatu is highly vulnerable to competition and predation from introduced exotic species, especially those from continental areas.

At least 27 species listed in the IUCN 2004 “100 of the World’s Worst Invasive Species” publication (Lowe et al. 2004) are known to occur in Vanuatu. Several other species yet to arrive in the country have been identified as major threats because they occur in neighbouring countries with whom Vanuatu trades. Some of these, including the Queensland fruit fly (*Bactrocera tryoni*) and the cane toad (*Rhinella marina*), have been intercepted at the border but the risk remains high (Department of Environmental Protection and Conservation [DEPC] 2014).

Vanuatu has many of the vertebrate pests that have been spread around the rest of the Pacific by early European explorers. Black/ship rats (*Rattus rattus*), brown/Norway rats (*Rattus norvegicus*) and Pacific/Polynesian rats (*Rattus exulans*) are common on all Vanuatu islands, and feral pigs (*Sus scrofa*), feral goats (*Capra hircus*), rabbits (*Oryctolagus cuniculus*), feral cats (*Felis catus*) and mice (*Mus musculus*) also occur on some islands. Indian mynah birds (*Acridotheres tristis*) are common and increasing on Tanna, Efate, Santo, Malakula and Epi.

Many of the world’s worst invertebrate pests also exist in Vanuatu, including the giant African snail (*Achatina fulica*) and the rosy wolf snail (*Euglandina rosea*), which was introduced to control the giant African snail but instead turned on indigenous snail species; several species of ant including the little fire ant (*Wasmannia auropunctata*), the big-headed ant (*Pheidole megacephala*), and the yellow crazy ant (*Anoplolepis gracilipes*); and several species of fruit fly that attack cultivated fruit and vegetable crops.

Many invasive plant species are well established in Vanuatu. Amongst the worst of these are a selection of climbing vines that smother trees and forest including ‘big lif’ (big leaf vine - *Merremia peltata*) and ‘wan dei rop’ (mile-a-minute - *Mikania micrantha*).

### 1.1.2 Impact

The worst of the invasive species are having a substantial impact on Vanuatu’s indigenous biota, food production, human health and the economy generally, including tourism which Vanuatu relies on for export earnings. While it appears that there have been few if any studies in Vanuatu to quantify the level of impact of the major invasive species, the sheer observable biomass of species such as big leaf vine and giant African snail, accompanied by research undertaken in other countries (Master et al. 2013; Raut and Barker 2002), leaves little doubt that their impact is considerable. This applies equally to our study area, North Efate and Nguna and Pele Islands, where most of the major invasive species occur.

Big leaf vine completely smothers large areas of forest canopy in some locations in North Efate (see figure 1) and is a constant invader in village garden areas. It establishes and grows rapidly in areas of forest canopy disturbance, especially where light can reach the ground, and its smothering nature is so substantial that locals refer to it literally tearing the branches of forest trees. While unquestionably invasive in nature, the origins of this species are less than clear. Locals, and some references, refer to big leaf having been introduced by the American military during World War II, however, others are now questioning whether it may in fact be a native species to Vanuatu or have been introduced by the early occupants of Vanuatu (2000 years or more ago). The fact that the species is described as native to Fiji in the east, to the Solomon Islands in the west, and possibly native to New Caledonia to the south suggests that if it is not a native species to Vanuatu then it has quite likely been present for centuries. Irrespective of its status, big leaf is a species that responds aggressively to

disturbance, both human-induced (forest clearance, subsistence agricultural practices) and naturally caused (cyclones and droughts).



**Figure 1: View of big leaf vine smothering the forest canopy in north-east Efate.**

The little fire ant has a very painful bite that causes distress to villagers, agricultural workers and tourists. In addition, this species of ant has been reported to cause blindness in domestic and native animals in the Solomon Islands as a result of its sting (Wetterer and Porter 2003), and they have wiped out entire native ant faunas in some countries where they have been introduced. In some cases this has resulted in the enhancement of populations of Homoptera (aphids, scale insects, cicadas, leafhoppers) which have then caused increased damage to agricultural crops.

The giant African snail, which arrived in the Pacific during World War II and in Vanuatu in the 1970's, eats a wide range of plant material (reportedly, more than 500 different plant species) in natural, rural and urban areas, including most agricultural crops and vegetables grown in community gardens, and many native forest species (MPI, 2013). It is also suspected of spreading plant diseases and has been known to transmit human parasites and pathogens, such as a lungworm that causes eosinophilic meningoencephalitis, in slime trails or when infested snails are eaten undercooked.

Black, water and Polynesian rats are present in Efate and on all or most of the islands of Vanuatu. They cause significant damage to agricultural crops and are recognised as the main pest of cocoa but their impact on native biodiversity, particularly birds, lizards and plant species, while likely to be substantial, is largely unknown. Their direct impact on Vanuatu communities has been reported as greatest following significant natural disasters. The locals on Pele reported that rats came down off the island slopes and into the villages in large numbers in search of food immediately following Cyclone Pam in 2015.

All of the invasive plant and animal species referred to above, and most of the many other species that are causing problems in Vanuatu, are genetically programmed to respond to and take advantage of any form of environmental disturbance. They have been successful across the globe because of the speed and aggressiveness of their ability to occupy disturbed sites and to out-compete indigenous species. Vanuatu is a collection of oceanic islands with a history of natural disturbance events (cyclones and El Nino droughts). With climate change predictions, the severity of these extreme weather events is likely to increase which in turn is likely to create conditions that further favour invasive species. Furthermore, the subsistence food production systems adopted by Vanuatu communities, where the vegetation in small plots is cleared and burned to create an area for growing crops and vegetables, provides a further degree of localised disturbance that also greatly favours invasive species. The vulnerability of these farming practices to failure during extreme weather and climate events further increases the magnitude of weed and animal pest opportunities.

### 1.1.3 Invasive Species Control

Methods have been developed in some parts of the world that have been moderately successful in controlling at least some of the problematic invasive species found in Vanuatu, however many of these methods are expensive

and require repeated treatment to keep weed and pest numbers at low levels. Vanuatu communities generally do not have the resources to apply these methods (which are often chemical based) on a consistent and on-going basis.

Vanuatu communities have had some success in developing control methods for a number of invasive species. The owners of the Vatthe Conservation Area on Santo have developed a technique that has been effective at killing big leaf in the forest canopy. Their method, which involves drilling holes into the main stems of big leaf vines and then injecting glyphosate chemical into the holes, has resulted in medium scale removal of the vine from areas of forest canopy, the recovery of many previously unhealthy forest trees, and the regeneration of large numbers of forest species seedlings on the forest floor. Research led by NGO Live and Learn Vanuatu (LLV) has shown that big leaf regeneration can be prevented provided vegetation is established to prevent sunlight reaching the forest floor. Big leaf seedlings cannot grow without light.

A variety of chemical control methods (molluscicides), physical barriers (copper stripping, salt, bare earth and tin fences) and biological control (microbes, predatory flatworms, predatory snails, rats and lizards) have been tried globally to reduce the impact of giant African snails, with varying degrees of success. In some cases, the results have been devastating, for example, the introduction of the predatory rosy wolf snail (*Euglandina rosea*) into Vanuatu to control the giant African snail failed with the wolf snail turning on native species instead. One study undertaken in the Andaman Islands in the Bay of Bengal established a barrier hedge of alligator apple plants (*Annona glabra*) around a nursery bed that effectively excluded all giant African snails (Master et al. 2013). Alligator apple is not eaten by the snails and when planted at close spacings the snails apparently chose not to move through the plant barrier. Alligator apple is an invasive species itself and so would not be appropriate for use in Vanuatu but there may be merit in seeking indigenous plant species that are not consumed by African snails and trialling these as barrier hedges.

Chemicals, hot water and sticky oil based barriers (e.g. TangleFoot®) have been used with some success in the control of little fire ants, but the cost of these methods is generally prohibitive for Vanuatu communities.

In all cases the control methods used with some success are generally resource hungry, either in terms of cost to purchase the materials or time and persistence required. Most of the control methods currently used in North Efate, Nguna and Pele are manual (i.e. physical removal by hand), reactive (after damage has reached critical levels), and sporadic. Effort also tends to be single species focussed rather than part of an integrated weed and pest management programme. Periodic, reactive control will, at best, generate short term benefits only. In some situations, the methods being used may even create a greater problem; for example, the villagers on Pele referred to their periodic hunting of feral pigs on the island but acknowledged that this often resulted in even more coming down the slopes to feed in their gardens. The same can often happen with rodents, with removal of the adults with established territories leading to many more dispersing sub-adults arriving and competing with each other to create their own territories.

To achieve some meaningful medium to long term benefit from pest and weed control, measured by increased food crop yields and recovering indigenous flora and fauna, techniques are needed that will enable communities either to successfully prevent substantial reinvasion from the surrounding landscape or to substantially reduce the size and invasiveness of the pest and weed populations that occupy the land that surrounds them.

International invasive species management has shown that effective localised exclusion of animal pests requires either the construction of a physical barrier (e.g. a pest exclusion fence) or the establishment of a substantial buffer of intensive trapping or poisoning devices to minimise reinvasion. In areas where there is no right of access to adjacent land the construction of physical barriers is frequently the only effective option to achieve control of animal pest reinvasion.

Invasive plant species are invasive because they have very effective dispersal strategies. Seeds are readily carried by wind, water or wildlife and/or they can regenerate from small twigs or root sections. Consequently they are not generally able to be excluded by barriers or the establishment of control buffers. Localised control of invasive plants therefore requires persistent control of regenerating seedlings and/or minimisation of conditions suitable for germination.

Control of invasive plant and animal species in the wider landscape, even if undertaken only periodically, can reduce the potential for reinvasion of a particular plot of land. Reduction of invasive animal populations will reduce the pressure on remaining individuals to disperse and find new habitat, and control of invasive plant species will reduce the likelihood and volume of seed dispersing across the landscape. Lack of resources and mixed, non-public landownership makes the option of wide scale pest and weed control unlikely in Vanuatu, consequently effective invasive species management solutions probably need to be focused on localised exclusion.

#### 1.1.4 Community Awareness and Knowledge of Invasive Species

The Tasivanua and Nguna Pele working groups are both well aware of the main invasive species present and that they cause considerable damage to food crops and gardens. Knowledge of the type and extent of damage caused by animal pests was greater amongst the Nguna Pele group than the Tasivanua group and as a consequence they had a clearer perspective of those invasive species most needing attention.

The Nguna Pele group identified feral pigs, rats and African snails as the animal pests causing greatest damage to food crops. They noted that African snails seemed to be worst immediately following significant rain events and pigs and rats were most apparent and damaging immediately after Cyclone Pam. Pigs were controlled by periodic hunting (but still cause lots of problems), the impact of rats was lessened by trapping and by keeping their gardens clean, and African snails were controlled by manual collect and destroy excursions through their gardens. This group also referred to damage caused to nut crops by the animal they call the “flying rat” soon after Cyclone Pam. Fire ants were considered annoying because of their bite but they did not damage their food crops. The locals were controlling the ants by spraying them with boiling water. Pele does not have big leaf vine but they control other invasive plant species by digging out germinating seedlings roots and all and burning them.

Tasivanua workshop attendees expressed little detail about the nature of the damage being caused by invasive species (e.g. seasonal timing of damage; crops most damaged; conditions when damage is worst, etc.). This may have been because of communication issues and/or because we asked the wrong questions, but the general impression was that there was only limited knowledge of the nature and extent of damage caused by invasive species. African snails and wandering cattle (from neighbouring cattle ranches) were highlighted as major problems and big leaf vine was identified as the major weed problem amongst many others.

Neither group expressed a good knowledge of the impact of pests on the natural terrestrial ecology of their landscapes. Understandably, their focus and knowledge was greater about the impacts of invasive species on their gardens and villages. Their knowledge of the impact of coastal marine invasive species, especially crown-of-thorns starfish, seemed to be more comprehensive, reflecting the historical reliance of communities on the marine fishery. Communities have a good knowledge of the plants and animals that exist on their land based on traditional knowledge. However, extraction and conversion of that knowledge into more robust scientific ecological concepts will probably be best achieved by initiating collaborative practical trials on their patches of land.

Live and Learn have produced a series of high quality guides to assist villagers to identify problematic invasive plant and animal species and to provide some ideas as to how they might be controlled. Intended to be a teaching tool for community groups they provide a good introduction about invasive species however it is uncertain how widely they have been distributed and used.

## 1.2 North Efate Ecology

### 1.2.1 Overview

No detailed physical study of the ecology of North Efate was undertaken as part of the RESCCUE terrestrial teams visit however aspects of land, water and vegetation management were observed while meeting with Tasivanua at Tanoliu, staying the night at Emua, and driving around the full circuit of Efate on the ring road. Aspects of the ecology were also viewed while on Pele Island. In addition, substantial video aerial footage of the North Efate

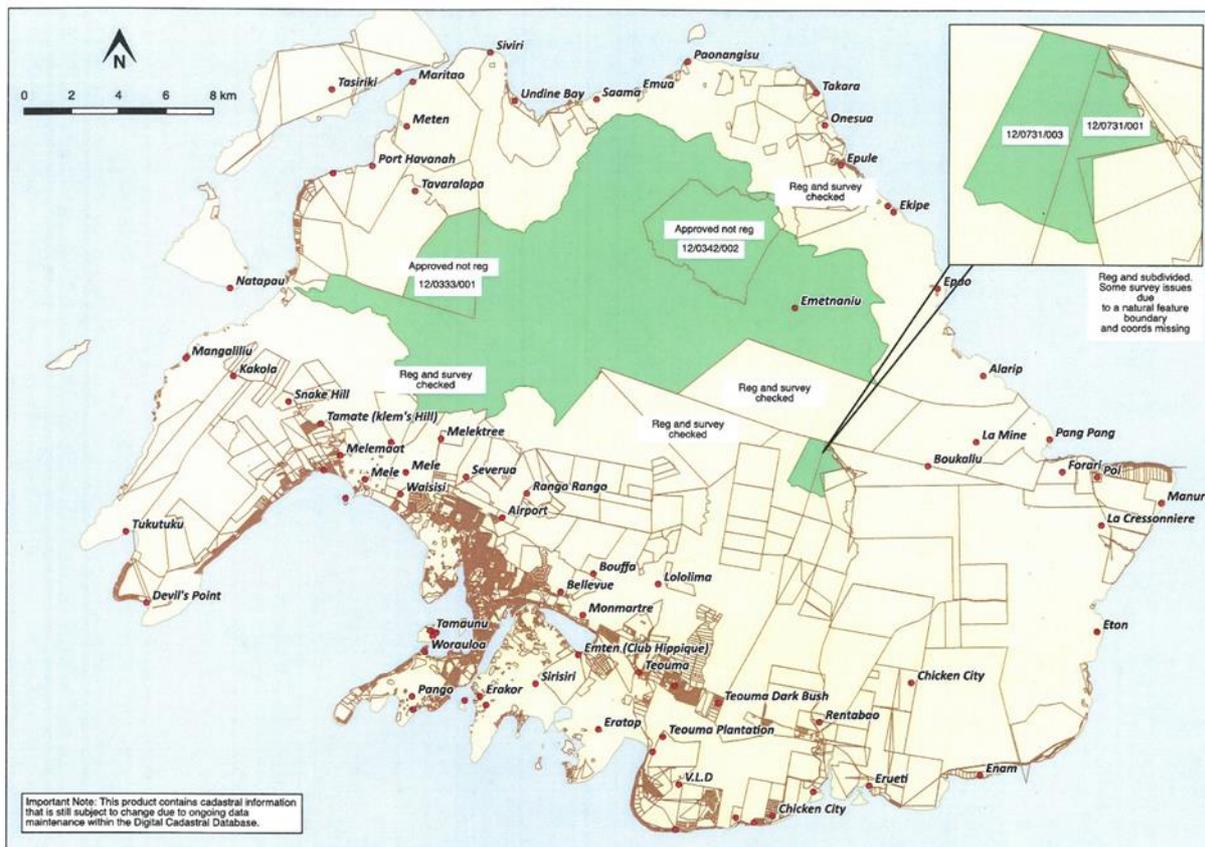
forest land and coastal areas was provided by Vanessa Organo from the Shefa Provincial Government. This footage, taken from a fixed wing plane in October 2015, provided a comprehensive picture of the state of the interior forest areas of Efate, the extent of forest damage caused by Cyclone Pam and the nature of land disturbance caused by the subsistence nature of farming practices along the northern coast.

The terrestrial landscape of Efate wears the scars of frequent and historical disturbance. In the steeper, forested areas there is substantial forest tree crown dieback/defoliation, especially of the large emergent trees (which are understood to be whitewood (*Endospermum medullosum*) [V. Organo pers comm] that sit above the forest canopy. Much of this damage was apparently caused by Cyclone Pam. The canopy over large areas of the forested interior of Efate appeared to be comprised of patches of tree/shrub canopy of different sizes and ages which implies a history of disturbance. Closer to the coast, areas cleared for agriculture were increasingly obvious, interspersed by regenerating scrub areas that, presumably, had been cleared, farmed and left to be recolonised by pioneer and early successional plant species, many of them invasive.

There are no formally protected national parks in Vanuatu, and no protected conservation or biodiversity areas on Efate. The lack of protected areas has a lot to do with the fact that there is very little public land in Vanuatu; most land is under village or tribal ownership. However, areas protected for terrestrial biodiversity and conservation do exist in some areas of the country. The Vatthe Conservation Area is the largest example. It covers 2,276 hectares of lowland alluvial forest at the southern end of Big Bay on the island of Espiritu Santo. The project to establish this protected area was initiated in 1994 as a partnership between the local community, NGOs, and the provincial and national governments. The basic idea to establish a protected area began in 1993 during a biodiversity survey of the area by the Vanuatu Environment Unit in collaboration with the *Royal Forest and Bird Protection Society of New Zealand*. During the study there was some discussion with the community about the idea of setting up a protected area.

The Efate Land Management Area (ELMA), a forested area in the hinterland of northern Efate (see figure 2) has been proposed as a possible protected natural area but this will require the collective collaboration of all of the tribal landowners before any formal status can be applied. Recently discussions have begun to create an ELMA Network and executive committee to raise community awareness of environmental conservation concepts and with the aim of establishing a Civil Society Organisation through which external funding can be sought.

Little information exists about the state of health of the forested areas of Efate.



**Figure 2: Map of Efate showing the location of the Efate Land Management Area (ELMA)**

### 1.2.2 Flora

The flora of Vanuatu has not been fully described due to limited resources and expertise. The 2015 publication “Remarkable plants of Vanuatu” illustrated and written by Laurence Ramon and Chanel Sam, is an excellent guide to the indigenous plants of Vanuatu for the general public, and the Vanuatu national herbarium has grown from its 1986 beginnings to house 1400 species. However, it is likely that there are more plant species yet to be discovered and described in a scientific sense.

Because of the islands volcanic origins and relative geologic youth, the flora of Vanuatu is generally less diverse than neighbouring countries such as the Solomon Islands and Fiji. For the same reason, the level of endemism is lower as well. Currently 13% of the species in the national herbarium are described as endemic (compared to 23% of Fiji’s flora), although this figure is regularly being updated downwards (Ramon and Sam 2015).

The forests and native flora of Vanuatu have evolved to withstand regular natural disturbance. Cyclones are not new to the islands, although the intensity of these severe weather events may be getting worse, and Vanuatu sits in a location that can suffer from drought in El Nino years (as 2015/16 has been). The nature of the environmental disturbance is not confined to weather events. Timber extraction, especially of sandalwood in the 1800’s, altered the forest composition of forested areas in the 8 main islands where this species occurs naturally. The introduction of invasive plant and animal species from many parts of the world will also have caused considerable disturbance to native flora and fauna, and the slash and burn approach to clearing land for food production is in itself a perpetual form of disturbance that can stifle natural ecosystem function and encourage the dominance of invasive species.

Little information exists about the impact of invasive weed species on the indigenous flora within the forested areas of Vanuatu. Big leaf vine is visually obvious smothering large areas of forest canopy especially around the forest – farmland margins in North Efate but little quantitative data is available that describes the effect of this invasive vine and other invasive weed species on the subcanopy and forest floor species and their regeneration.

### 1.2.3 Fauna

The indigenous terrestrial fauna of Vanuatu also lacks great diversity. With the possible exception of the Polynesian rat, all other native mammals are bat species (11 species, 3 of which are endemic). The Polynesian rat is considered by some to be a native in Vanuatu.

Tim Flannery, well known environmental scientist and author, recently completed a book called “Among the Islands” which includes information from his surveys of Melanesia. No reference is made in the book to Vanuatu and when questioned as to why he responded “I had not surveyed Vanuatu because its mammal fauna is so poor, having no endemic genera, relative to the rest of Melanesia” (Vanessa Organo pers comm). The IUCN view, however, is that there is still not enough data on Vanuatu biodiversity to have a full appreciation of the relative diversity of the islands.

171 bird species have been recorded in Vanuatu, including coastal and seabird species. Eleven of these have been introduced, 9 are endemic and 12 are considered to be globally threatened. 19 species of native reptile exist on the islands (9 endemic). Vanuatu is also home to a reasonably rich terrestrial mollusca fauna.

As is the case for the flora of Vanuatu, the status of the indigenous fauna is not well studied and the impact of invasive species and climate induced natural disturbances is not well known.

### 1.2.4 Community Awareness of Indigenous Ecology

Local village people appear to have a reasonable knowledge of the plant and animal life that resides in their areas, especially those that have an impact on their lives and food production, however, identification of species is often challenging because they have unique Bislamic names for these species (e.g. the Pele villagers refer to a bat which they call a “bat rat”: by their description a flying rat and not a fruit bat).

Local understanding of the interaction between the species of indigenous flora and fauna (i.e. the ecology) and the impact of invasive species on indigenous species is less apparent. This may be because of a lack of opportunity to discuss and extract this knowledge during the visit by the RESCCUE Terrestrial team than a lack of understanding per se. The establishment of a series of field based invasive species and ecological assessment trials, as is proposed in sections below, should enable the traditional knowledge held by North Efate villagers to be revealed and applied.

### 1.2.5 Ecological Restoration

Ecological restoration in the holistic western science sense is about the re-establishment of predominantly indigenous plant and animal communities and the re-ignition of key ecological processes sufficient to accelerate the recovery of an ecosystem with respect to its health, integrity and sustainability (source: Society for Ecological Restoration). Effective ecological restoration requires a good knowledge of the indigenous flora and fauna of an area and an equally good knowledge of the non-indigenous, invasive and human-induced influences on the indigenous components. With this knowledge the target of ecological restoration is usually to minimise the exotic influences and to reintroduce sufficient natural or indigenous components to “kick start” natural processes.

No examples of ecosystem or habitat level terrestrial ecological restoration were seen while in Efate nor were any examples of such restoration discussed. This is not surprising considering the lack of resources to undertake such restoration and the limited knowledge of the ecology of Efate’s forest ecosystems. However, we did see and discuss several examples where native trees and shrubs were being planted for more applied reasons including replacement of vegetation felled during Cyclone Pam, tree plantings to reduce soil erosion (e.g. Norfolk pine planting on the upper slopes of Nguna), small tree and shrub plantings to provide shelter and shade to food crops, and coastal plantings to reduce the impact of storm surges (e.g. shore edge plantings on Pele). Sandalwood seedlings are being planted on a number of islands including Efate for timber and sandalwood aromatic oil production, and as forest enrichment planting.

The Tasivanua and Nguna-Pele workshop attendees all spoke of several government and NGO initiatives that produce tree and food crop nursery seedlings for communities to use to plant on their land. Delegates from Nguna, who met the RESCCUE Terrestrial team on Pele, described their attempts to establish tree species above the existing upper tree line on their island. Reference was made to several species having been tried with limited or no success. The introduced Norfolk Pine has proven to be the most successful survivor to date. It is understood that this work has been supported by the Department of Forestry.

## 2 DIAGNOSIS: PRIORITY REQUIREMENTS

### 2.1 OVERVIEW

The DEPC has produced a “National Invasive Species Strategy and Action Plan 2014-2020” (NISSAP). This plan contains a detailed action plan that sets nine key target outcomes and a series of recommended actions/activities to achieve those outcomes. The outcomes are:

- 1.1: The impacts of priority invasive species on biodiversity, economies, livelihoods and health, are widely understood and actions to manage and reduce them are supported.
- 1.2: The institutions, skills, infrastructure, technical support, information management, networks and exchanges required to manage invasive species effectively are developed.
- 1.3: Appropriate legislation, policies, protocols and procedures are in place and operating to underpin the effective management of invasive species.
- 2.1: Systems are in place to generate baseline information on the status and distribution of invasive species, detect changes, including range changes and emerging impacts.
- 2.2: Effective systems are established and implemented to assess risk and prioritise invasive species for management.
- 2.3: Knowledge is updated for priority invasives, including species biology and impacts, and development of effective management techniques.
- 3.1: Mechanisms are established to prevent the spread of invasive species across international borders and between the provinces and main islands, quickly detect and respond to those that arrive.
- 3.2: The impacts of priority established invasive species are eliminated or reduced by eradicating or controlling the target species.
- 3.3: Restore sites and biodiversity after invasive species management occurs.

It is important that any activities generated by the RESCCUE programme align with the NISSAP and are integrated into and consistent with any activities currently being planned or undertaken, and are approved by the agencies identified as being responsible for the delivery of each action and activity.

Outcome 1.1, “the impacts of priority invasive species on biodiversity, economies, livelihoods and health, are widely understood and actions to manage and reduce them are supported”, and Outcome 3.2, “the impacts of priority established invasive species are eliminated or reduced by eradicating or controlling the target species”, have been chosen as the focus area for the invasive species activities component of the RESCCUE programme, for reasons that are discussed below. A derivative of these Outcomes has also been used for the ecological restoration activities proposed for our programme.

## 2.2 INVASIVE SPECIES KNOWLEDGE GAPS

The major plant and animal pests in Vanuatu are well established in Efate and pervasive, and in reality the opportunity to eradicate most of them from Efate has largely gone. With this being the case, the major challenge for most North Efate communities is how to reduce the impacts of those species that are well established on their land. With most of the surrounding landscape occupied by invasive plant and animal species this task seems unachievable to many in the Tasivanua group and assistance is needed.

The impact of each invasive species on biodiversity and/or agricultural yields will vary from site to site depending on a variety of environmental factors, including time of year, nature of climatic conditions (e.g. drought), vegetation cover and type, animal life present, cultivation techniques used, and even the interaction between invasive species. Resources and community energy are finite and insufficient to control all invasive species all of the time. Ideally, local communities would benefit from having the ability to assess the risk of each invasive species to the crop they are growing (or intending to grow) or the natural biodiversity present (flora and fauna) so that they can prioritise the timing and nature of effort and resources. This requires knowledge of the lifecycle and dispersal biology of each species (including lifecycle vulnerabilities), an understanding of the habitat preferences of each species, and skills to undertake before and after control surveys to assess the effectiveness of control measures undertaken. North Efate communities currently do not have these skills.

Local communities with the skills to assess, understand and prioritise the major risks to their land and vegetation and devise a management plan to most effectively minimise the effects of invasive species and increase food crop production or natural area species survival will be in the best position to learn and adapt to conditions on their land and increase their resilience to additional disturbances, whether from climate change or other causes.

In association with learning more about when and where invasive species have the greatest impact, the encouragement of communities to undertake surveys and observations to note the presence of indigenous plants and animals and their interaction with invasive species will increase the likelihood of new and better methods of reducing the impact of invasive species and increasing plant survival and growth being discovered. A healthy and more complete ecology is often more resilient to the impact of invasive species (e.g. indigenous natural predators; browsing resistant plants etc.) but Efate communities need to observe and experiment to discover what works and what does not. This can only be achieved by teaching villagers to undertake their own ecological assessments.

## 2.3 ECOLOGY / ECOLOGICAL RESTORATION KNOWLEDGE GAPS

Successful and sustainable ecological restoration requires a thorough knowledge of the past and present state of the indigenous ecology of an area (i.e. climax species, plant and animal communities, natural successional processes, responses to natural disturbances, etc.) and a sound knowledge of the impact of exotic influences (especially invasive plants and animals including humans). Only when this information is known can restoration strategies be developed that have a good chance of reactivating natural processes.

The process of restoring a natural site usually consists of two phases:

- i) Remove or control the invasive and non-indigenous influences;
- ii) Reintroduce those indigenous elements that cannot reintroduce themselves.

The second phase can only be undertaken when Phase 1 has been effective and also only when all or most of the indigenous elements of that ecosystem are known. While there would appear to be an increasing number of studies being undertaken on aspects of Vanuatu's ecology and biodiversity, the level of knowledge is not comprehensive and has focused on islands other than Efate. Knowledge of what a full and flourishing North Efate forest ecosystem looks like probably doesn't exist.

When starting from a point of limited knowledge, as is the case currently with regard to North Efate forest ecology, trials that eliminate all or most of the non-indigenous and invasive influences can often reveal the full extent and diversity of the indigenous biodiversity and, as a result, help define the level of expectation for future

efforts. In New Zealand, for example, it was only upon the removal of all animal pests from some offshore islands that the full diversity of the indigenous flora and fauna was revealed. Many of the more vulnerable and less visible aspects of New Zealand's flora and fauna that had been reduced to very low numbers by pests flourished or reappeared when pests were removed.

To advance the state of knowledge of the ecology of North Efate it is suggested that effort should be focused at two levels (note: it is acknowledged that the first recommendation below is probably beyond the scope of the RESCCUE programme but it is considered important):

1. Seek to obtain the resources to have professional ecologists undertake a large scale assessment of the flora and fauna of all or part of the Efate Land Management Area. An assessment of this kind will enable a more substantial knowledge of the diversity, complexity, uniqueness and vulnerability of the North Efate ecology to be developed, and in turn will provide important information as to the key elements that need to be incorporated into restoration efforts at a community level. SPREP and others have undertaken "Rapid Biodiversity Assessments" (BIORAP) in a number of Pacific islands including Nauru and parts of Samoa and Tonga; assessments of this nature would greatly benefit Vanuatu.
2. Assist local North Efate communities to establish small scale forest restoration sites where invasive plants and animals are excluded or heavily controlled and observe and record the extent and nature of the recovery of the indigenous flora and fauna.

### **3 PROPOSED INVASIVE SPECIES AND ECOLOGICAL RESTORATION ACTION PLAN**

#### **3.1 OVERVIEW**

The challenges associated with invasive species management and ecological restoration are completely entwined. Efforts to undertake successful ecological restoration require a strategy to understand and manage the impacts of invasive species as a priority.

Invasive species are thought to be having a fundamental effect on Vanuatu and North Efate communities in two ways:

1. Impact of food production and village life;
2. Impact on the ecosystem function and the natural ecology of indigenous flora and fauna.

For this reason, it is proposed that activities should be split between two types of site:

1. Typical community food production gardens; and
2. More natural areas that remain predominantly in natural vegetation.

It may be that both sites can be found on the same patch of land.

##### **3.1.1 Requirements for Success**

There are five key ingredients/requirements for this proposed programme to be a success:

1. Availability of suitable land. Guaranteed access to the same plots of land for several years is necessary for this programme to generate the best results. Ideally 4 plots of land will be required : two food producing plots (possibly one in North Efate and one on Nguna or Pele), and two natural areas with at least one a more mature forest stand with a relatively intact forest canopy (again, one could be in North Efate and one on Nguna or Pele).
2. Motivated local community members to lead the programme at each site.
3. Local technical support for each site team to assist with methodology, data interpretation and motivation.

4. Experts in Vanuatu plant and animal identification, and plant and animal survey methodology to provide the initial training to the local work groups.
5. Involvement of government and NGO staff who are participating in related invasive species and ecological restoration projects.

### 3.1.2 Measures of Success

The primary objective of this proposed programme of work is to develop knowledge and awareness of terrestrial plant and animal ecology and the effects of invasive species on biodiversity and food production sufficient to enable local communities to prioritise invasive species control efforts and ecological restoration focus to achieve best success.

The specific measures of success will be:

- Community groups, and individuals within each group, competent in plant and animal identification and with a knowledge of which species are indigenous to Vanuatu.
- Community groups, and individuals within each group, competent in plant and animal survey methods.
- Awareness of the most effective invasive species control methods available with an understanding of cost and effort required.
- Ability of community groups in North Efate, Nguna and Pele to determine invasive species management priorities and develop management programmes that generate the best results for effort.
- Community groups motivated and interested in the state and composition of their terrestrial biodiversity.

### 3.1.3 Site Requirements

Four trial sites are sought. Two that are community food production garden areas, and two that are natural forest sites. The food production areas can be at two separate locations in North Efate or one could be on Pele or Nguna. Because of the advanced state of knowledge of the Nguna – Pele communities on matters related to sustainable food production and invasive species management there would be some advantage having one site in their area. In this way they can provide some expertise to assist the North Efate project teams.

The two forest sites could be split between North Efate and Nguna or Pele but there would be some scientific benefit in having both sites in North Efate so that more direct comparisons of biodiversity and response can be made. Ideally, one forest site would be mature forest edge habitat or a clearing in mature forest created by some natural or human-induced disturbance (with or without big leaf vine present) and the other would be a degraded and/or regenerating area of forest that is close to a patch of mature canopy forest but significantly younger than mature forest. Two such sites will enable comparison of the recuperative powers of forest in different states of regeneration and/or health.

An option for one of the forest sites, especially if other suitable sites are not found, is to find an erosion prone site just above the current tree line (especially on Nguna or Pele) and focus the restoration efforts on continuing the work started by local communities and the Department of Forestry to find species that will survive in that environment.

## 3.2 PROPOSED ACTIVITIES

### 3.2.1 Activity Objectives

### 3.2.1.1 Food/Garden Sites

It is proposed that the trial work at the food garden sites should focus on development of techniques to control the populations and monitor the effects of giant African snails and rats on food crops. In addition, because one of the proposed control techniques is to investigate the cost effectiveness of barrier fences, evaluation of the impact of feral pigs on food production and techniques to reduce this impact will also be studied.

The giant African snail is nominated as a key species to investigate as it seems to be amongst the most widespread invasive species in Vanuatu with a very wide range of food sources and habitat preferences that span from native forest to wetlands and food gardens. On the basis of its observable biomass alone, it would appear to be a significant consumer of food crops and indigenous plant material, but villagers seem not to have a great deal of knowledge of the extent and nature of the damage snails cause. For this reason, control or eradication of this species from food production areas should result in improved productivity, and monitoring of when and where snails cause most damage should increase knowledge about how best to control them.

The major challenge for effective snail control is to find and develop an affordable control method. Chemical control and manual search and destroy efforts are the most practiced approaches but neither have proven to be very affordable or effective on small plots where snails are abundant on surrounding land. For this reason, it is proposed that RESCCUE activities assess the potential of barrier fences, including snail resistant plant hedges, as a snail control tool.

Knowledge of rat control techniques is considerably more substantial than it is for African snails, including low cost control methods suitable for Vanuatu communities. What is less well known is what the impact of rats is on food production in Vanuatu and what level of control, if any, generates a return (increased yield) that justifies the effort. This trial will be designed to find this out.

The objectives for the food garden site trials are to:

1. Tap into the local knowledge of villagers to determine plant species that may not be consumed by snails, and to use that information to trial the selected species as barrier hedges to prevent snails accessing garden areas (as recounted in Prasad et al. 2004).
2. Assess the impact of the giant African snail on a variety of food crops, trial a selection of snail control techniques and develop the skills and knowledge of the community workgroups to where they can determine their own snail management strategy. The control techniques to be tested will depend on resources available but will consist of one or more of the following:
  - Snail barrier fencing (area up to 1 hectare in size proposed)
  - Manual collect and destroy sorties
  - Traps or alternative barriers

Manual walk-through collection surveys, tracking tunnels or snail traps will be used to monitor before and after snail populations to evaluate the success of control methods trialled.

3. Assess the impact of rodents (rats and mice) on a variety of food crops and develop the skills and knowledge of villagers to apply one of more control techniques, including:
  - Barrier fencing
  - Mechanical trapping
4. Assess the effectiveness (including cost-effectiveness) of rodent and snail barrier fences as barriers to feral pigs (and cattle).
5. Quantify the costs and benefits of each control technique and compare to the actual and perceived costs and benefits of current approaches/practices.

Members of the RESCCUE team have considerable expertise in the construction of barrier fences as well as multi-species pest control without the use of fences. The value of a barrier fence is that it can be used to exclude several

pest species. The relatively small scale of the food production areas in Vanuatu (and the consequent high edge to core ratio) places the option of barrier fencing in the realm of being a cost effective invasive species management tool.

### 3.2.1.2 Natural Forest Sites

The objectives for the forest site trials are to:

1. Learn of the traditional knowledge of Vanuatu communities and individuals with regard to the indigenous plants and animals of Vanuatu and invasive species control techniques that have succeeded in the past.
2. Teach community groups about plant and animal identification, invasive species control and monitoring methods, and forest recovery monitoring techniques.
3. Using the skills acquired through objective 2, assist community workgroups to develop an understanding of the indigenous plant and animal diversity present with and without invasive plants and animals. This will be achieved by:
  - i) Undertaking a localised rapid biodiversity survey (bioblitz) through the forested land including and adjacent to each forest site in advance of any targeted invasive species control to assist local communities to identify and build awareness of the diversity of plant and animal life present in the area. The biodiversity survey will focus on identifying key bat, bird, lizard, amphibian, and notable invertebrate animal taxa, and key indigenous plant taxa. It will also include an assessment of the relative abundance of target invasive animal pests (snails, rodents, ants) and invasive plant species using low cost techniques including tracking tunnels, pitfall traps, and vegetation sample plots.
  - ii) Developing plant and animal identification resources (printed material) of the species found during the bioblitz to enable communities to retain knowledge of the species present and undertake future such surveys.
  - iii) Repeating the bioblitz on each trial site after a period of sustained invasive species control to determine any changes in diversity and abundance.
4. Develop and implement an invasive species management programme for each forest site utilising the best and most appropriate practices drawn from traditional knowledge, successful methods tested elsewhere in Vanuatu, and conventional techniques used in other countries. The programme will:
  - occur with the direct participation of each community group to build their skills in matching available resources to the project size and complexity;
  - use the information gained in the bioblitz to determine which invasive species to focus control effort at; and
  - test the effectiveness, timing and effort required for a small range of control techniques for each of the key plant and animal pest species targeted for control.
5. Undertake trial restoration plantings, post pest and weed control, using appropriate successional plant species.
6. Quantify, in terms of cost, effort and benefit, the outcomes of the forest restoration activities. This assessment should be undertaken at two levels:

- i) at a local community /village level, with the results of the RESCCUE activity programme to be compared to practices previously undertaken by community groups as measured by the communities themselves; and
- ii) at a provincial or country level to be used to provide information to guide policy, focus and information dissemination.

### 3.2.2 Proposed Activity Programme

#### 3.2.2.1 Knowledge Building Workshops and Information Generation Activities

##### ***Activity 1: Introduce Invasive Species and Ecological Restoration Diagnosis and Action Plan to Tasivanua and Nguna Pele and Government stakeholders***

The RESCCUE team will introduce the Invasive Species and Ecological Restoration Diagnosis and Action Plan (this plan) to key stakeholders.

It is important to gain stakeholder support for the plan and the actions contained within it for the plan to successfully assist communities to adapt to changing terrestrial conditions. Their backing is also important to gain endorsement from the National Advisory Board on Climate Change and Disaster Risk Reduction (NAB). The NAB is the supreme policy making and advisory body on climate change and disaster risk reduction (CC and DRR) programmes and projects in Vanuatu.

Purpose: Gain support for actions from Tasivanua and Nguna Pele community groups, Government Stakeholders, and finally NAB endorsement.

Output/outcomes: Acceptance of Plan by stakeholders and NAB endorsement.

Contributors: Opus and LLV will present the Plan to stakeholders gathered during the October steering committee meeting. LLV and Emil will introduce the Plan to Tasivanua and Nguna Pele community groups as soon as possible after the steering committee meeting. Following acceptance by Tasivanua and Nguna Pele community groups, the Plan will be submitted to NAB for formal endorsement.

Resources required: Time for meetings, especially for LLV and Emil Samuel to present plan to community groups.

When: First quarter 2017

##### ***Activity 2: Identify members of Tasivanua and Nguna Pele community groups to lead and promote Plan and its actions***

The key to the successful implementation of this Plan is ownership of its actions by the Tasivanua and Nguna Pele community groups.

Purpose: Identify 1-2 members of the Tasivanua and 1-2 of the Nguna Pele community groups to advocate for the objectives of this Plan, and lead actions contained within.

Output/outcomes: Appointment of community champions to work closely with the RESCCUE Terrestrial team.

Contributors: The RESCCUE team will work with the Tasivanua and Nguna Pele community executives to identify appropriate community members.

Resources required: Time for meetings, especially for LLV and RESCCUE Field Officer (Emil Samuel) to present plan to community groups.

When: First – second quarter 2017.

### ***Activity 3: Identify suitable land for trial plots***

The key on-ground actions will require the identification of suitable land for trial plots.

Purpose: To gain guaranteed access to the several plots of land for several years, which is necessary for this programme to generate the best results.

Output/outcomes: Ideally 4 plots of land will be required: two food producing plots (possibly one in North Efate and one on Nguna or Pele), and two natural areas with at least one a mature forest stand with a relatively intact forest canopy (again, one could be in North Efate and one on Nguna or Pele).

Contributors: RESCCUE Field Officer (Emil Samuel) with Tasivanua and Nguna Pele. Provide a shortlist with map and photos to RESCCUE ecologist for finalising plot locations.

Resources required: Time and resources for local site visits for RESCCUE Field Officer and community leads, plus agreement over access to plots.

When: Second quarter 2017.

### ***Activity 4: Production of Biodiversity Identification Resources.***

With the assistance of the community groups and LLV produce printed plant and animal identification material (photos and physical descriptions) that can be used by others to identify key plant and animal species (these are to build on those already produced for by LLV for invasive species and contained in the publication “Remarkable plants of Vanuatu”).

Purpose: The objective of this activity is to build up a printed inventory of plant and animal species for villagers to use to identify indigenous plants and animals on their patch of land and for professional taxonomists to use for scientific identification. This information will be added to constantly throughout the duration of the activity programme.

Output: printed plant and animal identification posters and/or leaflets.

Contributors: Live and Learn, community members, ID input from experts

Resources required: camera, computer, graphics expertise and printers

When: Second quarter 2017

### ***Activity 5: Community Technical Training Workshops***

Run a series of practical community workshops in North Efate and Nguna or Pele on plant and animal identification (indigenous and invasive species), the lifecycle and dispersal biology of significant invasive species, the damage caused by invasive species (as much as is known), invasive species control techniques and plant and animal monitoring techniques.

Purpose: The main objectives of these workshops will be to build the knowledge (and interest) of community participants so that they:

- i) can identify key plant and animal species (indigenous and invasive), including bats, birds, lizards and invertebrates that inhabit their patch of land;
- ii) can differentiate between indigenous and introduced/invasive species;
- iii) develop knowledge of the lifecycles and dispersal biology of invasive species and how to use this knowledge to assist in more effective control;

- iv) learn about some of the control techniques for invasive plants and animals and how to use them most effectively;
- v) have knowledge of standard plant and animal monitoring techniques and how to undertake field surveys.

Output/outcomes: series of training workshops, and development of community participant knowledge and skills.

Contributors: RESCCUE terrestrial team technical experts; LLV; Tasivanua and Nguna Pele community members.

Resources required: training venue(s) including classroom and suitable field sites; traps, equipment and monitoring devices (most likely to be provided by the RESCCUE project team).

When: Second – third quarter 2017.

#### ***Activity 6: Rapid Biodiversity Survey (bioblitz)***

Undertake a rapid biodiversity survey (bioblitz) of the two proposed forest trial sites and their surrounds to establish an inventory of plant and animal species present (indigenous and invasive). The focus will be on bats, birds, lizards, amphibians, notable invertebrates and plants. The bioblitz will be led by RESCCUE terrestrial team and local biodiversity experts and will involve as many community members as can be encouraged to participate. Biodiversity monitoring techniques and devices (e.g. tracking tunnels, acoustic bat detectors, pitfall traps etc.) will be used and demonstrated. The biodiversity experts will identify plants and animals found down to species level where possible.

Purpose: to build increased knowledge amongst communities of the biodiversity that exists on their land.

Contributors: RESCCUE terrestrial team technical experts; LLV; Vanuatu indigenous plant and animal experts; community members.

Resources required: monitoring equipment (to be supplied by RESCCUE team), workshop area to undertake plant and invertebrate ID.

When: Second – fourth quarter 2017

#### ***Activity 7: Socio-economic survey and quantitative evaluation of the costs and benefits of invasive species management***

Undertake a socio-economic survey of North Efate and Nguna and Pele communities to extract their knowledge of invasive species and their impacts on food production and biodiversity and the effort and practices currently directed at invasive species control.

Assess and compare the costs and benefits of invasive species management as part of the garden / food production impact assessment and reduction activities.

Purpose:

- i) To tap into current community knowledge of invasive species and indigenous biodiversity, quantify the effort expended on invasive species management and restoration, and develop an understanding of community perceptions of the impact of invasive species and the effectiveness of their current management practices. The information gathered will serve as a baseline for comparison with the results of the RESCCUE programme of activities.
- ii) Account for both the costs and benefits of managing invasive species from the garden invasive species control activities outlined below, and use this information to help government officials prioritise investment in managing these species.

**Output/outcomes:** Production of a detailed report, suitable for circulation to government officials and NGO's, that evaluates the costs, benefits, effort and perceived value of a selection of invasive species control techniques when applied to community food production.

**Contributors:** The survey will be led by the RESCCUE economic analysis team and will involve as many North Efate, Pele and/or Nguna communities as the budget can afford. The RESCCUE local coordination team will organise the logistics and attendees.

**Resources required:** Village venues in which to undertake the survey.

**When:** Second quarter 2017.

**NOTE: the details of this major activity will be provided by our RESCCUE economic analysis team.**

### 3.2.2.2 Garden / Food Production Invasive Species Impact Assessment and Reduction Activities

#### ***Activity 8: Garden African Snail and Rodent Control Trial***

At two pre-determined food production sites/gardens:

- i) Select an area suitable for management of African snails with room to establish 3 plots: one where intensive control methods will be applied (plot 1), one where a barrier fence will be constructed (plot 2), and one with no control or current control methods adopted by the landowners (plot 3).
- ii) Design, test and then build a barrier fence around one plot to exclude giant African snails and rodents (this fence will also be designed to exclude cattle and feral pigs).
- iii) Design and undertake a repeatable survey of the number and location of giant African snails within the 3 plots, and from this survey evaluate snail habitat, environmental conditions and vegetation preferences.
- iv) From the findings of iii) design and undertake a survey to assess the damage caused by giant African snails to one or more food crops or types of vegetation.
- v) Eradicate all snails and rodents from the fenced enclosure (plot 2), and activate the snail and rodent control programme in a second plot (plot 1). Continue to manage plot 3 as previously managed.
- vi) Repeat activities iii) and iv) at 3 monthly intervals to assess the effectiveness of the barrier and changes in food crop productivity.

**Purpose:** to compare the effectiveness of exclusion fencing, focused control techniques and the status quo in terms of reduction of damage to crops and effort required to undertake the management.

**Outcomes/output:** Development of knowledge of giant African snail and rodent control techniques and requirements to successfully design and implement a control programme; increased understanding of the impact of snails on food production.

**Contributors:** RESCCUE pest control and barrier fence experts; Live and Learn, government and NGO invasive species and agriculture field officers; community workgroups.

**Resources:** long term access to the garden plots; motivated community leaders to drive the programme; barrier fencing equipment (chainlink, 6mm x 6mm wire mesh, corrugated or sheet iron or aluminium, fence posts, fence staples and nails), traps (for rodents and snails).

**When:** Second quarter 2017 – third quarter 2018

### 3.2.2.3 Natural Area Monitoring and Impact Assessment Activities

## 4 REFERENCES

- Bianchessi, P. 2012. Vanilla Handbook. Australian AID.
- Copsey, J.A., Shelbourne, G., Grice, R., Goder, M., Buckland, S., Jhumka, Z., Nundlall, V., Jones, C. and Cole, N. 2011. Possible control of the introduced giant African land snails (*Achatina* Spp.) by the reintroduced endemic skink *Leiopisma telfairii*, Ile aux Aigrettes, Mauritius. Management of Biological Invasions, 2011, 2.
- da Silva, E.C. and Omena, E.P. 2014. Population dynamics and reproductive biology of *Achatina fulica* Bowdich 1822 (Mollusca, Gastropoda) in Salvador – Bahia. Biota Neotropica 14(3): e20140004, 2014.
- Davis, C.J. and Butler, G.D. 1964. Introduced Enemies of the Giant African Snail, *Achatina fulica* Bowdich, in Hawaii (Pulmonata: Achatinidae). Proceedings of the Hawaiian Entomological Society: Vol. XVIII, No. 3, June 1964.
- Department of Environmental Protection and Conservation. 2014. National Invasive Species Strategy and Action Plan 2014-2020.
- Hollema, S., Miller, D., and Chong, A. 2015. Vanuatu. The impact of Cyclone Pam. Cyclone Pam impact maps and analysis. World Food Programme.
- Live and Learn Environmental Education. 2015. Invasive Species in Vanuatu. A Community Learning Guide.
- Live and Learn Environmental Education. 2014. Invasive Species in Vanuatu. Media Guide.
- Live and Learn Environmental Education. 2015. Invasive Species in Vanuatu. Pocket Guide.
- Ministry of Primary Industries (NZ). 2013. Giant African Snail. Information brochure.
- Mael, H.S. 2013. Climate Change and Agriculture in Vanuatu: a study of crops and farming system. Food and Agriculture Organisation of the United Nations.
- Master, J., Tjitrosoedirdjo, S.S, Qayim, I., and Tjitrosoedirdjo, S. 2013. Ecological impact of *Merremia peltata* (L.) Merrill invasion on plant diversity at Bukit Barisan Selatan National Park. Biotropia 20 (1): 29-37
- Page, T., Tate, H., Bunt, C., Potrawiak, A. and Berry, A. 2012. Opportunities for the smallholder sandalwood industry in Vanuatu. Australian Centre for International Agricultural Research: ACIAR Technical Report 79.
- Paynter, Q., Harman, H., Waipara, N. 2006. Prospects for biological control of *Merremia peltata*. Landcare Research Contract Report: LC0506/177
- Prasad, G. S., Singh, D. R., Senani, S and R.P. Medhi. 2004. Ecofriendly way to keep away pestiferous Giant African Snail, *Achatina fulica* Bowdich from nursery. Current Science 87: 1657-1659.
- Ramon, L and Sam, C. 2015. Remarkable plants of Vanuatu. New York Botanical Garden Press.
- Raut, S. K. and Barker, G.M. 2002. *Achatina fulica* Bowdich and other Achatinidae as Pests in Tropical Agriculture. In: Barker G.M (eds.), Mollusc as Crop pests. CABI Publishing, Wallingford: 55-114.
- Secretariat of the Pacific Regional Environment Programme. 2014. Managing the impacts of the Little Fire Ant (*Wasmannia auropunctata*) in French Polynesia.
- Secretariat of the Pacific Regional Environment Programme. 2013. Rapid Biodiversity Assessment (BIORAP) Nauru June 2013. Synthesis Report Key Findings and Recommendations.
- Society for Ecological Restoration: [www.ser.org/resources/resources.../ser-international-primer-on-ecological-restoration](http://www.ser.org/resources/resources.../ser-international-primer-on-ecological-restoration)

Tatayah, R.V.V, Malham, J. and Haverson, P. 2007. The use of copper strips to exclude invasive African giant land-snails *Achatina* spp. From echo parakeet *Psittacula eques* nest cavities, Black River Gorges National Park, Mauritius. Conservation Evidence (2007) 4, 6-8.

Taylor, S. and Kumar, L. 2016. Will climate change impact the potential distribution of a native vine (*Merremia peltata*) which is behaving invasively in the Pacific region? Ecology and Evolution 2016 6(3): 742-754

Wetterer, J.K. and Porter, S.D. 2003. The Little Fire Ant, *Wasmannia auropunctata*: Distribution, Impact and Control. Sociobiology 41/3.