WETLANDS OF WALLIS AND FUTUNA

2017

WALLIS et FUTUNA
SERVICE DE L'ENVIRONNEMENT

25 SPREP
Secretariat of the Pacific Regional Environment Programme

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FONDS PACIFIQUE

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2017

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CONTENTS

Wetland Site Accounts

Figures

Tables

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LIST OF ABBREVIATIONS

CBD	Convention on Biological Diversity
CIA	Central Intelligence Agency
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
ICPE	Infrastructure Classified for Protection of the Environment
IPPC	International Plant Protection Convention
IUCN	International Union for Conservation of Nature
OCT	Overseas Countries and Territories
OFP	Oceanic Fisheries Programme
OGAF	Operation Grouped Land Development
PIRT	Pacific Island Roundtable for Nature Conservation
PMI	Pacific Mangrove Initiative
PROCFish	Coastal Fisheries Development Programme
SADP	Sustainable Agriculture Development Program
SNB	Stratégie Nationale de Biodiversité (National Biodiversity Strategy)
SPC	Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme

FOREWORD

Wetlands are among the world's most productive environments. They are very important for the way they maintain ecological processes, as well as for the diverse flora and fauna they shelter and support. Wetlands continue to provide tremendous economic benefits to humans, through fisheries production, maintenance of hydrological systems and flood control, shoreline stabilisation, water purification and recreational opportunities. Unfortunately, wetlands are also amongst the world's most threatened habitats, the Pacific Islands region being no exception.

The people of the Oceania region share common aspirations for ecologically sustainable development, to use our resources wisely and in a sustainable way. Pacific Island governments seek to ensure that human use of wetlands yield the greatest continuous benefit to present generations while maintaining their potential to meet the needs and aspirations of future generations as defined by the Ramsar Convention on Wetlands of International Importance.

However, a number of unique circumstances in the region combine to limit the opportunities for both development and the conservation of wetlands and other ecosystems. These include the small landmasses of islands and their dispersal over large ocean areas. In some countries, the pressures of population density and increased per capita consumption also threaten ecologically sustainable development.

Effective wetland conservation strategies rely very much on good baseline data, especially for the most important wetlands of a country. This data plays a pivotal role in informing national and regional priorities for conservation and management of wetlands and the subsequent formulation and implementation of related projects, programmes and initiatives.

This updated inventory of wetlands for Wallis and Futuna contributes to the four strategic core priorities of the Secretariat of the Pacific Regional Environment Programme (SPREP) Strategic Plan for 2017–2026:

- Climate Change Resilience
- Ecosystem and Biodiversity Protection
- Waste Management and Pollution Control
- Environmental Governance

Only by effectively conserving and managing wetlands can we hope to conserve and sustainably use our wetland resources in perpetuity.

Kosi Latu
Director General
Secretariat of the Pacific Regional Environment Programme

Agricultural wetlands. Photo: Pascale Salaun

EXECUTIVE SUMMARY

In 2014, with support from the French Government, Wallis and Futuna informed SPREP of its intention to identify nationally significant wetlands for future designation as wetlands of international importance (Ramsar Sites) under the Convention on Wetlands (Ramsar, Iran, 1971). This Wetlands of Wallis and Futuna 2017 inventory update builds upon the original *Directory of Wetlands in Oceania* (Scott 1993). With financial support from the Fonds Pacifique, new available data and information have been gathered to provide a detailed and updated baseline inventory of the wetlands of Wallis and Futuna.

This update provides a comprehensive overview of Wallis and Futuna's biodiversity, conservation framework and wetland fauna and flora.

Wetlands are amongst the world's most productive ecosystems and they provide multiple and significant services to humanity. In Wallis and Futuna, coastal wetlands such as reefs, mangroves and seagrasses act as frontline defences from waves and storms by slowing the speed and reducing the height and force of floodwater. Other services include, but are not limited to, provision of habitat for key biodiversity, sources of clean water and food, erosion control, sediment and nutrient assimilation, plus education, cultural and aesthetic values.

Yet even on remote Pacific Islands, wetlands are becoming vulnerable and threatened ecosystem types. In the Pacific Islands, climate change related events, including frequent cyclones, sea-level rise, and increased and prolonged droughts, increase the vulnerability of wetlands. They are also vulnerable to increasing anthropogenic pressures such as introduced species, habitat loss and impacts from upstream activities, which include pollution and exploitation of habitats for subsistence and commercial economies.

Under the Convention's criteria for their international significance, there are several sites that can be listed as Ramsar sites, including crater lakes and a lagoon on the island of Uvea, along with a river on Futuna. These include several brackish crater lakes, the Lakes Lalolalo, Lano, Lanutavake, Kikila and Lanutuli on Uvea. These permanent inland wetlands are unique and rare in the Central Polynesia Marine Ecoregion, being some of the few volcanic wetlands in the Pacific and the only lakes in Wallis and Futuna. The Uvea Crater Lakes are the centre-piece of the cultural creation of Uvea Island and the surrounding forested catchment holds sacred values. The Uvea Lagoon and the barrier reef that protects it are also wetlands of significant importance, as the majority of the population of Uvea lives close to the lagoon and depends on its resources. The lagoon also holds strong cultural and social ties for Uveans. Lastly, the river Vainifao and its catchments on Futuna is one of the of the richest biodiversity areas in Wallis and Futuna.

Together with other sites, they constitute 14 different types of wetlands. They provide habitat for hundreds of different species, 35 of which are threatened. Twelve of these threatened species are endemic to these wetlands in Wallis and Futuna.

Other than biodiversity, they also hold strong cultural value and provide multiple ecosystem services, which are two major themes in the most recent Ramsar Strategic Plan. These vulnerable sites are recommended for the Ramsar List for recognition of their international importance and for encouraging effective conservation and management of Wallis and Futuna's biodiversity and the viability of its ecosystems.

Tidal mudflats. Photo: Pascale Salaun

1

INTRODUCTION

The Secretariat of the Pacific Regional Environment Programme is an intergovernmental organisation charged with promoting cooperation among Pacific Island countries and territories to protect and improve their environment and to ensure sustainable development for present and future generations.

Wetlands are among the most productive ecosystems on Pacific Islands and the services that they provide to humanity are significant. In order to effectively conserve and manage wetlands, a first step is to document and understand their distribution and status by conducting detailed baseline wetland inventories. In 1993, the *Directory of Wetlands in Oceania* documented available information on the distribution, status and values of wetlands in Pacific Island countries and territories. However, this information was far from complete and needed updating. In 2014, SPREP with financial support from the Australian Government carried out work to update the directories of wetlands for Kiribati, Palau and Vanuatu, with the intention of updating the wetland directories for all of SPREP's Pacific Island Members.

Six Pacific Island countries are Contracting Parties to the Ramsar Convention on Wetlands and as such are obligated to formulate and implement national planning to promote the conservation and wise use of their Ramsar Sites and other wetlands within their jurisdiction. The Pacific territories are similarly committed through their signatory country. This planning and management for wetlands relies very much on the availability of comprehensive data on their wetland resources.

With support from the French Government, Wallis and Futuna advised SPREP of its intention to identify nationally significant wetlands for future designation as wetlands of international importance under the Ramsar Convention. This project updates the wetland inventory for Wallis and Futuna as a means of strengthening the baseline state of knowledge of wetlands in this territory and to enable informed planning for future Ramsar Sites.

The project is part of an ongoing effort by SPREP and the Ramsar Convention Secretariat, under their partnership MOU, to update wetland inventories across the Pacific Islands region, a priority action under the SPREP Regional Wetlands Action Plan 2011–2013. This baseline information is valuable for informing conservation decisions, raising awareness of the importance of wetlands, influencing public perception of wetlands, establishing ongoing monitoring, revealing trends over time and identifying priority sites for conservation management (eg. for designating Ramsar Sites or other types of protected areas). It also provides a tool for planning and implementing effective wetland conservation interventions, especially in light of the impacts of climate change on these sensitive ecosystems.

This project also builds national capacity to conduct future wetland inventory updates in Wallis and Futuna, as well as help to inform national biodiversity planning and decision-making. This inventory is a consolidated report of updated information and data for Wallis and Futuna to meet its commitments to the Ramsar Convention and should be used to nominate a site for consideration. The data and literature used for the inventory is centralised at SPREP as a regional depository point for environmental planning and management. Such information should be reviewed in the near future by the Ramsar officer for Oceania through SPREP's mandate to support future wetland conservation efforts in the Wallis and Futuna.

An overview of wetlands in Wallis and Futuna was first published in Scott (1993), *A Directory of Wetlands in Oceania,* supported by the Ramsar Convention Bureau. This updated inventory has been prepared by the Coastal and Marine Team at the Secretariat for the Pacific Regional Environment Programme, with in-country assistance by Chef de service, Atoloto Malau from the Service de l'Environnement, Wallis and Futuna.


UVEA (WALLIS)
FUTUNA
ALOFI
0
km
100
0
km
10

2

WALLIS AND FUTUNA OVERVIEW

2.1 Scope of update

The Convention on Wetlands (Ramsar, Iran, 1971) is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. It has been ratified by 169 countries (Ramsar 2017). The inclusion of wetlands in the list of Wetlands of International Importance as 'Ramsar Sites' under the Convention is an international designation that rewards and enhances sustainable management of these areas (Haouet and Lefeuvre 2016).

The Wallis and Futuna 2017 Wetland Inventory Update builds upon the original wetland directory for Oceania (Scott 1993) with new available data and information. Additionally, the updated inventory includes new categories relevant to the Ramsar Convention, including the ecosystem service value of each wetland listed in the inventory. Each inventory update also includes geospatial information data and maps of the listed sites. Currently, the data and metadata for each site is stored at the Secretariat of the Pacific Regional Environmental Programme, Apia, Samoa. References are cited for each wetland account and are available at the end of the document.

2.2 Geographical summary of Wallis and Futuna

AREA

Wallis and Futuna is a French Overseas Territory in western Polynesia comprising of two island groups, 230 km apart, Uvea and islets with a terrestrial surface area of 78 km² and a lagoon surface area of 220 km² (Meyer 2017) and the Hoorn Islands (also now spelt "Horne") with a terrestrial surface area of 64 km² (Futuna Island, 46 km² and Alofi Island, 18 km²), with a total of 22 islands (Ellison 2009) comprised of 3 main islands and 19 islets (Meyer 2017). The Wallis Islands are at the latitude 13°S and Hoorn Islands at 14°S (Meisch et al. 2007). The total terrestrial surface area for Wallis and Futuna is 142 km² with an exclusive economic zone of 300,000 km². The territory is approximately 600 km north of the Republic of Fiji and 300 km west of Samoa (Fig. 1).

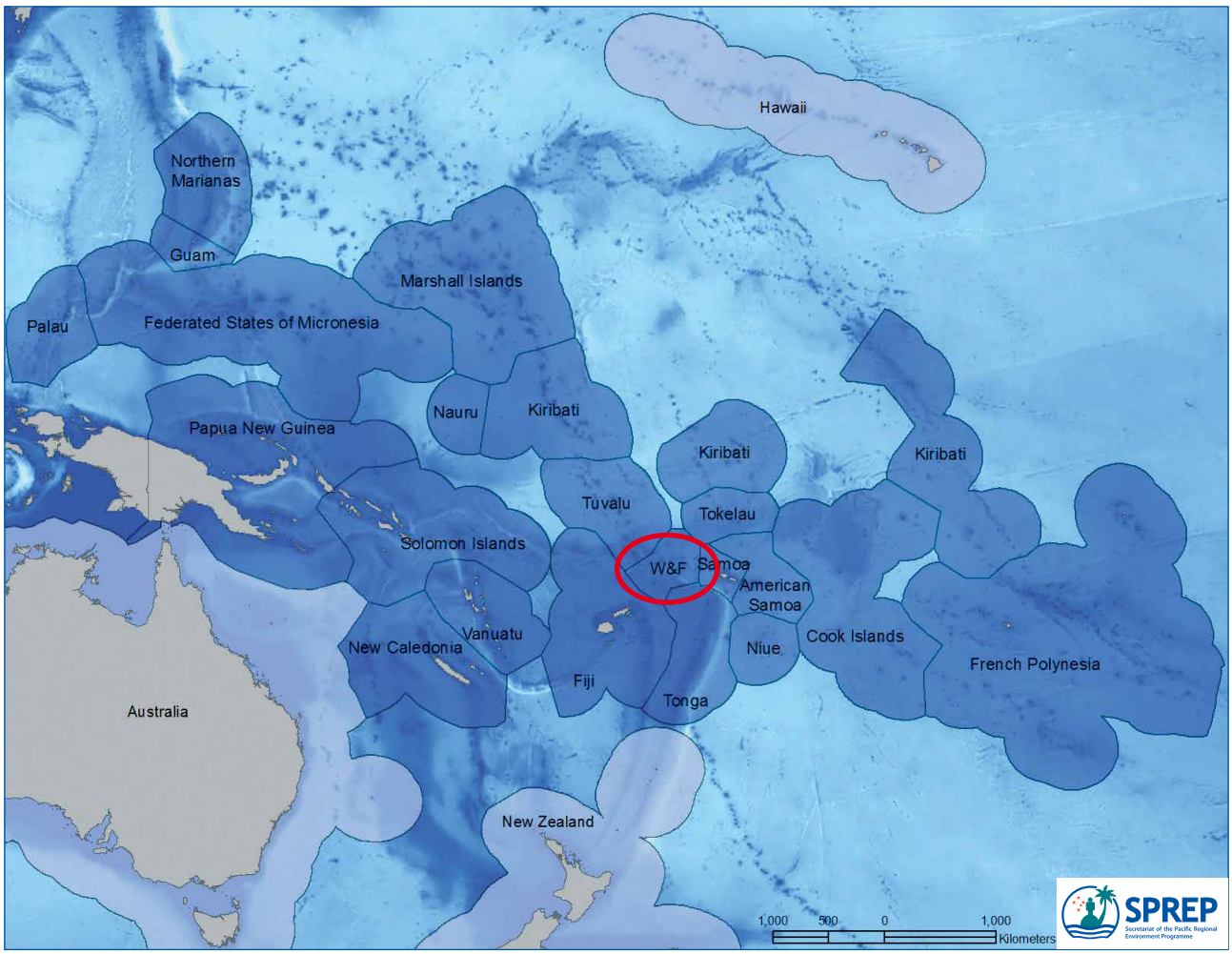

FIGURE 1 The exclusive economic zones of SPREP Member countries and territories in the Pacific Islands. W&F = Wallis and Futuna is circled in red.

The main island is Uvea/Wallis Island (78 km²), which is a low volcanic island with a maximum elevation of 151 m (Fig. 2). Uvea Island is surrounded by a barrier reef approximately 4 km offshore, with 19 sandy and rocky islets (Scott 1993). The Hoorn group comprises mountainous islands, including Futuna (46 km²) and Alofi (18 km²) with maximum elevations of 524 m and 417 m, respectively. Futuna is surrounded by a 100 m wide fringing reef and Alofi has a fringing reef on the northwest coast of the island.

FIGURE 2 Wallis and Futuna overview map: Geological and geomorphic setting (The Institut d'émission d'Outre-Mer 2008).

2.3 Geological and geomorphic setting

Wallis and Futuna is located on the convergence zone between the Australia and Pacific tectonic plates, which is one of most active tectonic areas in the world (Konn et al. 2016). Uvea Island rose from the sea during the Tertiary period (Sichrowsky et al. 2014) and is comprised of basaltic flows and pyroclastics younger than 0.5 million years ago (mya) (Price et al. 1991). Phreatomagmatic explosions during the Holocene epoch created Lalolalo, Lanutavake and Lano lakes (Stearns 1945). The basins of other lakes and depressions on Uvea were created by volcanic activity in the mid-Pleistocene epoch (Sichrowsky et al. 2014). The Futuna Islands are the result of much older Tertiary volcanic activity (Scott 1993).

2.4 Climate and natural disasters

The islands of Wallis and Futuna have a warm tropical climate with an average surface temperature of 27°C on Uvea and 26°C in Futuna, with only a 1° change annually (Meisch et al. 2007). The territory has significant seasonal variation with no defined dry period but a strong rainy season occurs between October and May (Meisch et al. 2007). During the rainy period, Uvea receives approximately 3 m and Futuna 4 m of rain annually (Meisch et al. 2007). The wettest month is December, with three times as many rain events than August (Angleviel et al. 1994).

The islands' location in the Pacific Ocean makes them susceptible to both cyclones and tsunamis (Leleivai 2012). The territory has been subject to five serious cyclones in 1973, 1984, 2002 (Diamond et al. 2012), 2010 (Donguy and Le Lay 2010) and more recently in 2012 with cyclone "Evan". There is historical evidence of a tsunami occurring in 1452 AD (Goff et al. 2011), one in 1993 and the most recent South Pacific Tsunami on 29 September 2009 (Lamarche et al. 2010). The maximum water reached a height of 4.5 m in 2009, with inundation reaching 95 m inland (Lamarche et al. 2010).

2.5 Biogeographic regions

Wallis and Futuna is a small French territory with a very small land mass surrounded by the Pacific Ocean in western Polynesia. Therefore, the marine ecological regions of the world are used to describe the bioregion where the territory is located (Spalding et al. 2007). Wallis and Futuna is located in central Polynesia, Marine Eco Region 157 Province (refer to Appendix 1 under Fig. 7–9), which is under the Samoa Islands (Spalding et al. 2007; SPREP 2017).

2.6 Vegetation characteristics

In the mid-1980s, the forest covered 15% of Uvea, 30% of Futuna and 70% of Alofi (Scott 1993). Currently, the forests in Uvea are highly fragmented and are reduced to a few patches covering approximately 5 to 10% of the island (Haouet and Lefeuvre 2016; Meyer 2007). On Futuna, the forests communities are still relatively dense, covering approximately 20 to 25 % of the island, which are most notably away from the coast (Haouet and Lefeuvre 2016).

The terrestrial vegetation on Wallis and Futuna is comprised of coastal vegetation, littoral and supralittoral forest, lowland rainforest, low to mid-elevation mesic forest, montane rainforest (above 400 m on Futuna), secondary forest, grasslands, scrub and fernlands (Dahl 1986; Scott 1993, Meyer 2017), *toafa* (fern desert) and cultivated habitats (Haouet and Lefeuvre 2016). Across the islands, group surveys in the 1980s identified 400 vascular plant species, with 250 being indigenous and 5 endemic (Dahl 1986). In the most recent survey conducted in 2017, 370 native vascular plant species including 297 flowering plants and 72 ferns were identified (Meyer 2017). There could however be discrepancies in these numbers as new surveys are currently being undertaken.

The lowland and montane forests differ on every island depending on the soil substrate, the island's age and geographic isolation (Haouet and Lefeuvre 2016). The montane forests areas have the highest biodiversity and have at least three endemic species (Haouet and Lefeuvre 2016). The secondary forests are generally highly modified and are dominated by coconut trees, with dense undergrowth of thickets and fallow vegetation (Haouet and Lefeuvre 2016).

The *toafa* vegetation is present on all three main islands in Wallis and Futuna. *Toafas* have relatively low biodiversity but are dominated by the ferns *Dicranopteris linearis*. Sometimes these vegetation communities are comprised by the tree and shrub species *Pandanus tectorius, Scaevola sericea* and *Decaspermum fructicosum* at low densities. When disturbance is reduced, natural plant succession continues and the undergrowth will contain native species (Haouet and Lefeuvre 2016).

Cultivated vegetation communities include agricultural crops, gardens and plantations (Haouet and Lefeuvre 2016). The understory of the plantations has been gradually colonised by tree species, such as *Calophyllum inophyllum, Parinari* spp., *Syzygium* spp., *Cordia subcordata* and *Adenanthera pavonina* (Haouet and Lefeuvre 2016).

There are two types of coastal vegetation on Wallis and Futuna, mangroves and coastal foreshore vegetation. Mangroves are not present on the islands of Futuna and Alofi. In western Uvea, mangroves only occupy a few beaches and muddy areas (Marchand 2006; Haouet and Lefeuvre 2016). There are a total of 20 coastal areas where mangroves are developing, which comprise 26 individual zones (Marchand 2006) (Fig. 3) with a total area of approximately 32.66 ha (Bluecham 2017). These mangrove patches are comprised of two species, *Bruguiera gymnorrhiza* and *Rhizophora samoensis* (Marchand 2006; Haouet and Lefeuvre 2016) (Fig. 4). The other types of coastal vegetation normally form on beaches or behind beaches, which are comprised of species endemic to the territory (Haouet and Lefeuvre 2016).

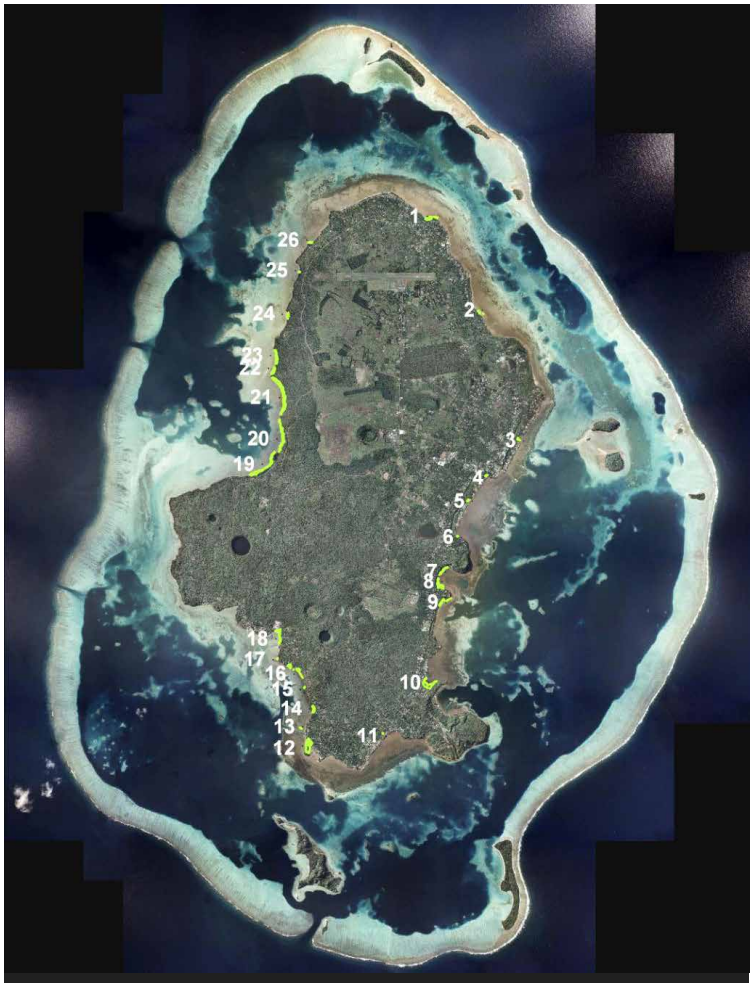

FIGURE 3 The 26 areas of established mangrove habitat on Wallis/Uvea Island in Wallis and Futuna (Cyril Marchand 2006).

FIGURE 4

Map of location of mangroves for *Bruguiera gymnorrhiza* and *Rhizophora sameonsis* on Uvea Island (Bluecham 2017).

2.7 Wetlands of Wallis and Futuna

There are very few wetlands in Wallis and Futuna. On Uvea Island (Wallis), there are seven crater lakes formed by volcanic activity (Sichrowsky et al. 2014), but no running surface streams due to the high surface permeability (Meisch et al. 2007). No lakes or swamps are present on Futuna, but there are several rivers, streams and springs with significant biodiversity value (Scott 1993) and a montane marsh on Futuna at 375 m elevation (Meyer 2017). Alofi does not have any surface water (Meisch et al. 2007). In northern Uvea, there are three islands atolls, Nukufotu, Nukulaelae and Nukuloa, which hold significant wetlands, including a lagoon and coral reefs.

Uvea Island has a barrier reef surrounding the entire island, approximately 4 km offshore (Juncker et al. 2006; Scott 1993). In Hoorn Island group, Futuna is surrounded by a 100 m wide fringing reef and Alofi has a fringing reef on the northwest coast (Scott 1993).

2.8 Wetland fauna

The fauna present at each wetland is listed in the subsequent wetland account, with a brief overview written in this report. The terrestrial wetland areas (rivers, estuaries, lakes and supporting forested catchment areas) and the marine wetlands (beach, flats, mangroves, rocky intertidal zones and the corals reefs) in Wallis and Futuna support important terrestrial and aquatic fauna. The wetlands, lagoons and forest catchment areas support a total of 47 bird species, including migratory, vagrants and endemic species (Thibault et al. 2015).

Notably, the lagoon to the north of Uvea Island including the nearby atolls and islands are important habitat for 15 species of the 24 seabirds in the area. These marine wetlands support large colonies of frigates, noddies and terns. Similarly, these wetland areas support 127 crustacean species (Poupin and Juncker 2008).

The benthic zone for these marine wetlands and the lagoon support a rich biodiversity (Haouet and Lefeuvre 2016). The reefs and closely associated mangroves here provide plankton and important fisheries for reef species that spawn in the pelagic and benthic zones. Some of these species include the pelagic spawners *Pareupeneus barberinum*, *Acanthurus triostegus* and the benthic spawners *Abudefduf sexfasciatus* and *Dascyllus aruanus* (Juncker et al. 2006). These reef habitats also support a number of corals, including *Isopora crateriformis,* which is rare and has a unique morphology on the barrier reef compared to populations on other Pacific reefs (Haouet and Lefeuvre 2016). Likewise *Leptoseris gardineri,* which is typically uncommon on Indo-Pacific coral reefs, can be found on the Uvea barrier reef in high abundance.

The Uvea lakes support a diversity of aquatic and terrestrial biodiversity. The aquatic species in these lakes include invertebrates such as several crustacean and molluscs species (Scott 1993). The only native fish species present in Lake Lalolalo is the Pacific short-finned eel, *Anguilla obscura* (Sichrowsky et al. 2014). The eel is only present in Lake Lalolalo and is hypothesised to have come from the ocean when the lake was once connected to the sea (Mary et al. 2006; Sichrowsky et al. 2014). The invasive fish species *Oreochromis mossambicus* was likely introduced to Lake Lalolalo in 1966 and it is believed to have been introduced as a source of protein and population control of mosquitoes (Mary et al. 2006). Today the invasive fish species is present in all three large crater lakes Lalolalo, Lano and Lanutavake (Mary et al. 2006; Sichrowsky et al. 2014).

These lakes also support a diversity of micro-invertebrates (Meisch et al. 2007; Sichrowsky et al. 2014), including 10 ostracod species, four of which had not been previously collected in the Pacific (Meisch et al. 2007). Similarly, 32 phytoplankton species have been recorded in these lakes, including 23 ciliate taxa, 18 rotiferan, one cladoceran, one copepod and one gastrotrich species (Sichrowsky et al. 2014). There are 18 freshwater species of crustaceans and 18 freshwater species of fish species, four of which are endemic (Appendix 2, Table 6).

The forests surrounding the lakes area described as a refuge for fauna, including birds and bats (Haouet and Lefeuvre 2016; Scott 1993). This area is especially important for the Pacific flying fox *Pteropus tonganus* (Haouet and Lefeuvre 2016; Scott 1993). These forests also support the endemic subspecies of the collared kingfisher *Halcyon chloris,* Polynesian triller *Lalage maculosa futunae* and the Fiji shrikebill *Clytorbynchus vitiensis futunae* (Hay 1985).

2.9 Human population

The population demographic of Wallis and Futuna is almost entirely comprised of Polynesians, with Wallisians mostly descendants of Tongans and Futunans mostly descendants from Samoa (Scott 1993). In the 2013 census, the population of Wallis and Futuna was 12,197 people (Sourd 2014). The population was estimated to be 15,714 people in July 2017 (CIA 2017). However, there are more expatriates from Wallis and Futuna currently living in New Caledonia. The island of Alofi, 2 km east of Futuna is not inhabited due to lack of potable drinking water, but is visited daily by Futunan fishermen and farmers (Scott 1993).

2.10 Land tenure system

The land tenure system in Wallis and Futuna is dynamic and is based on family descent (Worliczek and Allenbach 2011). Land parcels belong to families and the land tenure is defined as ‘who is part’ of that land parcel (Worliczek and Allenbach 2011). Wallis and Futuna currently do not have a land registry and the boundaries of most land parcels are regulated through oral tradition (Worliczek and Allenbach 2011). Currently, every Wallisian has access to more than one land parcel through decent (Worliczek and Allenbach 2011).

The customary system manages land tenure issues with status and social hierarchy. The social hierarchy is as follows: the *Lavelua* (King of Wallis) holds the greatest power, followed by the six *fa'u* ministers, the three district chiefs and then the village chiefs. Within individual families the hierarchy is based on principles around seniority and age, with each family having a male representative. Tenure disputes generally between family members are first brought to the attention of the village chief and if not resolved, they go through the social hierarchy until a resolution has been reached. After a resolution has been achieved, the land tenure issue can be questioned again and repeated through the same process. Whilst there is a French administration system, it does not have the right to interfere with any land tenure regulations held by the traditional system (Worliczek and Allenbach 2011).

2.11 Governance and economy

Wallis and Futuna became an overseas territory of the French Republic in 1961 (Law No. 61–814 of 29 July 1961) and has three customary institutions, one in Uvea and two in Futuna in addition to the French Republic Institution. The territory is not part of the European Union; it is under a different French government system as 'Countries and Overseas Territories' (OCT).

Wallis and Futuna's gross domestic product (GDP) is ranked 224th in the world, with an annual GDP of approximately US$60 million. Per capita, the GDP is ranked at 179th, with estimations of approximately US$3,800 (10,100 euros in 2014 according to IEOM 2015) (CIA 2017). The economy is limited to subsistence agriculture, mainly of coconuts, vegetables, livestock and fish. Employment in subsistence agriculture constitutes 80% of the workforce (CIA 2017). In addition, approximately 70% of the workforce is employed in the public sector, but only 20% of the population has full-time salaried employment with 12.2% of the population unemployed (CIA 2017).

As a French Overseas Territory, the French government finances the public sector, education and health services. The French government also funds development, including infrastructure, economic stimulus, natural resource management and healthcare facilities. Revenue from French government subsidies comes from Japanese and South Korean fishing rights in Wallis and Futuna's EEZ (CIA 2017).

2.12 Pressures and threats to wetlands

Pacific Islands' wetlands are vulnerable to the pressures of climate change in the region (Ellison 2009). The main reason the wetlands are vulnerable to climate change is due to their small size, lack of protection from legislation and agreements, minimal information, data availability and lack of capacity in local governments (Wright et al. 2006). Climate change related events, including more intense cyclones, sea-level rise, increased and prolonged droughts increase the vulnerability of wetlands in the region (Ellison 2009; Wright et al. 2006).

Many wetlands in the Pacific region, including the wetlands in Uvea, are subject to anthropogenic pressures (Ellison 2009; Scott 1993). Generally, the threats to wetlands in the Pacific include introduced species (refer to Table 1), habitat loss and impacts from upstream industries, which include pollution and exploitation of habitats for subsistent economies (Ellison 2009). Whilst the current human population in Uvea is relatively constant, during the last two decades, population growth resulted in clearing for subsistence agriculture (Scott 1993). Similarly, hunting of wetland fauna, especially birds, is currently an issue despite the practice decreasing in recent decades (Thibault et al. 2015).

TABLE 1 Total number of threatened endemic and indigenous species in contrast to the number of introduced and invasive species (SPREP, 2016).

	Total	Endemic	Indigenous	Introduced	Invasive or threatening
Vascular plants	690	7	345	338	65
Terrestrial birds	24	4[1]	17	3	2
Molluscs	51	20	15	16	13
Mammals	14	0	1	13	6
Reptiles	15	1?	10	4	0
Amphibians	1	0	0	1	0
Fish crustaceans	39	4	33	2	2
Insects	211	6	80	125	74[2]

1 Under endemic species

2 70 crop pests and 4 invasive ant species

Like many ecosystems in the Pacific Islands, wetlands in Wallis and Futuna are threatened by invasive flora and fauna. Invasive flora threatens the ecosystem function of wetlands and their surrounding catchment (Moverley pers.comm 2017). An invasive species survey was conducted in 2007 to 2008, where 338 plants were classified as introduced and 65 as invasive. The field visits confirmed the dominant presence of invasive trees (*Falcataria moluccana, Leucaena leucocephala*), vines (*Merremia peltata, Mikania micrantha*) and shrubs (*Mimosa diplotricha, Clidemia hirta*). Only *Mimosa diplotricha* (giant sensitive weed) is being managed by manual labour (Meyer 2007).

The invasive fauna present on Wallis and Futuna includes dogs, cats, rats, birds, pigs, fish, amphibians and several invertebrates (Meyer 2000). The invasive fish species *Oreochromis macrochir, Oreochromis mossambicus* and *Tilapia rendalli*, all commonly known as Tilapia, are present in the Uvea crater lakes (Mongabay 1995) and are now dominant in mangrove areas. These species were introduced to Wallis and Futuna in 1969 for aquaculture purposes and development (SPC Aquaculture for Wallis and Futuna). Likewise, the invasive common myna, *Acridotheres tristis* is present on Uvea Island, and is potentially threatening native bird species (Meyer 2000). The introduction of black rats, *Rattus rattus* on Futuna will likely have negative impacts for several native birds (Thibault et al. 2015), including wetland species. This is especially the case for the blue-crowned lorikeet, *Vini australis* which became extinct on Uvea from direct impacts caused by the *Rattus rattus* (Thibault et al. 2015).

Pigs on Wallis and Futuna are considered common and have the potential to alter entire ecosystems by stopping the regeneration of vegetation and causing erosion (Meyer 2000). Streams and rivers of Uvea are also impacted by effluent from pig farms, which could cause an increase in nitrogen and phosphorus (Gunkel-Grillon et al. 2015). The introduced green and golden bell frog *Litoria aurea,* listed as vulnerable in Australia, is considered invasive in Wallis and Futuna (Pyke et al. 2002), where it has likely colonised the islands via transoceanic transportation (Nicolas et al. 2015).

Destructive ants (*Wasmannia auropunctata* little fire ants, *Anoplolepis gracilipes* yellow crazy ants and *Pheidole megacephala* bigheaded ants) are common, as is the giant African snail *Lissachatina fulica* and the rosy wolf snail *Euglandina rosea*. Managing invasive species, including invertebrates is particularly challenging in Wallis and Futuna because of land-tenure system and lack of clear management boundaries.

For these wetlands to survive and maintain their ecosystem function there needs to be direct action, including engagement of local communities to promote sustainable management practices, access to technical support for capacity building from the scientific community especially for baseline assessments for the wetlands and lastly, monitoring and rehabilitation to improve the wetlands resilience (Ellison 2009).

2.13 Threatened wetland species

The IUCN Red List (2017) identifies the following globally threatened species found in Wallis and Futuna: one shark species (Whale Shark, *Rhincodon typus*), 16 coral species, 11 bird species and six fish species. There are at least 15 endemic species found on Wallis and Futuna (Table 2).

TABLE 2 Endemic Species of Wallis and Futuna.
Compiled by A. Hamada-Ano, IUCN Redlist 2017, WoRMS 2017 and ITIS 2017.

Order	Genus	Species	Red List Status	Reference
Perciformes	*Stiphodon*	*rubromaculatus*	CR	iucnredlist.org
Perciformes	*Smilosicyopus*	*sasali*	CR	iucnredlist.org
Perciformes	*Akihito*	*futuna*	CR	iucnredlist.org
Perciformes	*Stenogobius*	*keletaona*	CR	iucnredlist.org
Perciformes	*Callionymus*	*futuna*	DD	marinespecies.org (WoRMS)
Perciformes	*Callionymus*	*sereti*	DD	marinespecies.org (WoRMS)
Araneae	*Schizocosa*	*vulpecula*	DD	marinespecies.org (WoRMS)
Coleoptera	*Ropica*	*wallisi*	DD	marinespecies.org (WoRMS)
Stylommatophora	*Partula*	*subgonochila*	DD	marinespecies.org (WoRMS)
Decapoda	*Microgoneplax*	*cope*	DD	marinespecies.org (WoRMS)
Perciformes	*Coralliocaris*	*junckeri*	DD	marinespecies.org (WoRMS)
Sepioloida	*Sepia*	*subplana*	DD	iucnredlist.org
Piperales	*Peperomia*	*futunaensis*	DD	catalogueoflife.org
Myrtales	*Medinilla*	*racemosa*	DD	catalogueoflife.org
Rosales	*Elatostema*	*yenii*	DD	catalogueoflife.org

2.14 Conservation measures

In recent years, the Wallis and Futuna government and subsequent environment ministries have taken action to improve conservation outcomes for wetlands. These actions include increased engagement with international conventions and involvement in regional initiatives. For some of the conventions, Wallis and Futuna is a member indirectly as a territory of France.

INTERNATIONAL CONVENTIONS

- Ramsar Convention (1971)
- Convention on Biological Diversity (CBD)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- National Biodiversity Strategy (SNB, Stratégie nationale de biodiversité)
- Territorial Biodiversity Strategy
- International Plant Protection Convention (IPPC).

MEMBER TERRITORY OF THE PACIFIC COMMUNITY (SPC)

- Sustainable Agriculture Development Program (SADP – Financing Europeans)
- Coastal Fisheries Development Programme (PROCFISH – SciCoFish) or
- The Oceanic Fisheries Programme (OFP)
- INTEGRE project (SAGE: General Planning Scheme of Futuna).

MEMBER TERRITORY OF THE SECRETARIAT OF THE PACIFIC REGIONAL ENVIRONMENT PROGRAMME (SPREP)

- Pacific Regional Framework for Nature Conservation and Protected Area (Pacific Regional Framework for Nature Conservation and Protected Areas)
- Pacific Invasive Learning Network.

REGIONAL INITIATIVES THAT SUPPORT NATURE CONSERVATION

- Pacific Mangrove Initiative (PMI)
- Pacific Wetlands Initiative
- Pacific Invasives Learning Network
- Invasive Alien Species Eradication and Control Programme
- Pacific Invasives Initiative.

MANAGEMENT PLANS

- Grenelle de l'Environnement and the National Waste Policy 2011–2016
- Territorial Biodiversity Strategy 2015–2020
- Management of the Marine Areas
- RITA Innovation and Agricultural Transfer Networks (Réseaux d'Innovation et de Transfert Agricole)
- Environmental Code
- Infrastructure Classified for Protection of the Environment (ICPE).

2.15 Wetland area legislation

In the first wetland inventory published in 1993 there was no formal legislation protecting the wetlands in Wallis and Futuna (Scott 1993). Several of the wetlands and the subsequent surrounding areas are protected by cultural law (Scott 1993). France is a signatory of the Ramsar Convention. It applies to a variety of wetlands including, "rivers, lakes, coastal lagoons, mangroves, coral reefs, reservoirs, canals, marshes, ponds...". Wetlands added to the List of Wetlands of International Importance 'Ramsar Sites' receive increased support for sustainable management. France has designated 47 wetlands as Ramsar Sites, 11 of which are in overseas territories. As of this report (2017), there are no wetlands in Wallis and Futuna listed under the Convention, however, previous studies have included descriptions of potential sites for Ramsar nomination and recommendations for conservation. The Territorial Environmental Service has since decided to undergo the process to list several of the wetlands in Uvea under the Convention.

Currently, neither an established nature reserve nor the official listings to protect the wetlands under the Ramsar Convention have been formalised. The only formality for wetlands is for the groundwater table, which is regarded as a protected area (Scott 1993). Dahl (1986) recommended that reserves be established to conserve forests, lake and reefs of significant conservation value and Hay (1985) suggested Alofi be protected to conserve avian fauna. Recently, Conservation International (New Caledonia) with the Territorial Environmental Service, proposed a nature reserve of 400 ha on Alofi Island in the Hoorn Group (Haouet and Lefeuvre 2016). The proposal of the nature reserve includes the watershed of Vainifao River from Mount Puke to the shoreline and includes lowland rainforest, montane forests and valleys (Haouet and Lefeuvre 2016). Likewise, the coastal forests and the fringing reefs on Alofi Islands have been recommended for the proposal of a UNESCO Biosphere Reserve (Haouet and Lefeuvre 2016).

2.16 Organisations responsible for or otherwise involved in wetlands

DEPARTMENT OF ENVIRONMENT OF WALLIS AND FUTUNA

- It ensures the management of the natural or artificial physical environment and the improvement of the living environment.
- It defines and proposes the elements necessary for the elaboration of a coherent policy of the environment.
- It coordinates studies, works, researches and conferences in the field of protection of the natural resources, as well as treatment of pollution, risks and nuisances.

DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES (SEAFP) AND THE TERRITORIAL SERVICE FOR RURAL AFFAIRS AND FISHERIES (STARP)

They are responsible for:

- the implementation of agricultural, forestry, development and agricultural policy as well as rural development;
- the sustainable development of agricultural production by accompanying farmers, breeders and fishermen, professional agricultural organisations, for the allocation of aid to agriculture, the management of OGAF (Operation Grouped Land Development), the organisation of agricultural sectors and technical support and training;
  - the preservation of natural forests by accompanying professionals in the development of the wood industry;
  - the development of the training for which the SEAFP is the academic authority of agricultural education;
  - food safety, animal health and protection and phytosanitary control at borders.

2.17 Wetland research

There have been a number of geological and biological scientific studies undertaken on the wetlands in Wallis and Futuna. These studies have focused on both the crater lakes and the coral reefs surrounding the island groups. There is no formal research institution in Wallis and Futuna and hence these studies have mostly been conducted by academics and researchers at/or associated with the University of the South Pacific, Université de la Nouvelle Calédonie and Université de la Polynésie Française. Recently, the Université de la Nouvelle Calédonie established a research station in Wallis and Futuna. Moreover research is conducted through a number of partnerships and organisations outside of the Pacific, including The National Museum of Natural History (France), Ecole Pratique des Hautes Etudes and the Policy Academy of Sciences. Lists of reference studies are available here and throughout the wetland inventory.

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Lake Kikila. Photo: Vainuupo Jungblut

3

WETLAND SITE ACCOUNTS

3.1 Uvea Crater Lakes

LAKES LALOLALO, LANO, LANUTAVAKE, KIKILA AND LANUTULI

A. Overview

There are at least seven freshwater lakes in dormant volcanic craters on Uvea: Kikila (17.9 ha), Lalolalo (15.2 ha), Lanutavake (4.6 ha), Lanutuli (2.2 ha), Alofivai (1.3 ha), Lano (1.1 ha) and Lanomaha (0.8 ha) (Scott 1993). Lake Lalolalo or Lac Lalolalo (15.2 ha), west side of Uvea, is a volcanic crater lake of about 80 m in depth with sheer inner rocky cliffs falling 30m to the lake waters below. There is not sufficient amount of data for Lake Lano, Lake Lanutavake, Lake Kikila and Lake Lanutuli.

B. Area, boundary and dimensions

Area and depth

Lake Lalolalo (15.2 ha, 88.5 m), Lake Lano (1.1 ha, 3.5 m)

Lake Lanutavake (4.5 ha, 23.6 m) Lake Kikila (17.2 ha)

Lake Lanutuli (2.2 ha)

C. Location

Coordinates

Lake Lalolalo	13°18’00.0”S, 176°14’01.8”W
Lake Lano	13° 17.650”S, 176° 14.429”W
Lake Lanutavake	13° 19.287”S, 176° 12.846”W
Lake Kikila	13° 29.669”S, 176° 18.888”W
Lake Lanutuli	13° 31.527”S, 176° 21.694”W

D. Site maps

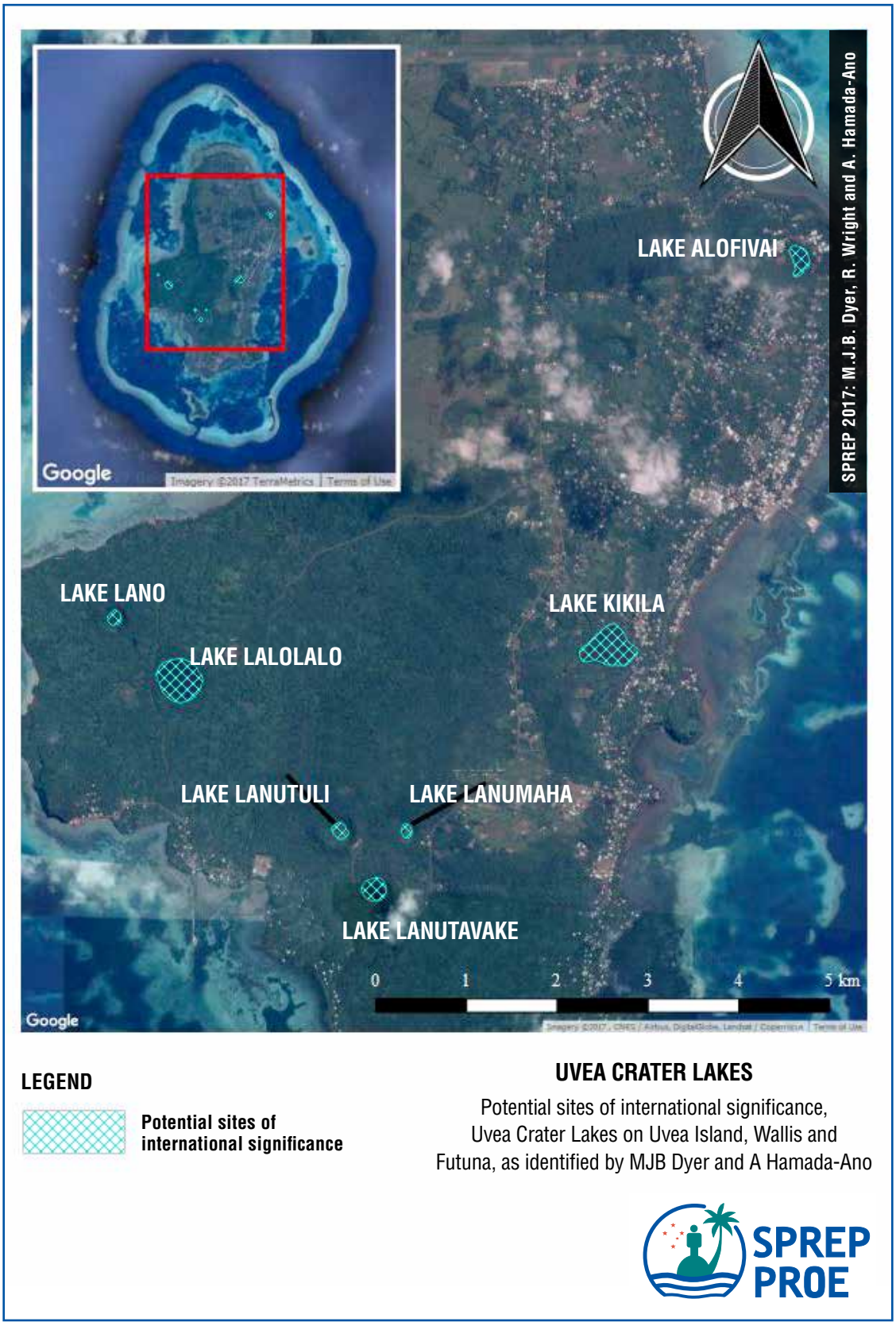

FIGURE 5 Uvea Crater Lakes, Uvea Island, Wallis and Futuna. Map created by: M J.B. Dyer, R. Wright and A. Hamada-Ano.

For detailed imagery of each lake, refer to Appendix 2, Figures 10–13.

E. Ramsar Wetland Types

Dominant types

O, permanent inland lakes with an area greater than 8 ha

Tp, permanent inland lakes with an area less than 8 ha

Types also present

Q, permanent inlands lakes with brackish water characteristics

F. Geomorphic setting

Uvea Island is located on the convergence zone between the Australia and Pacific tectonic plates, which is one of most active tectonic areas in the world (Konn et al. 2016). Uvea Island rose from the sea during the Tertiary Period (Sichrowsky et al. 2014) and is comprised of basaltic flows and pyroclastics that are younger than 0.5 mya (Price et al. 1991). Phreatomagmatic explosions during the Holocene created the lakes: Lalolalo, Lanutavake and Lano (Stearns 1945). Volcanic activity in the mid-Pleistocene created the other four lakes and basins (Sichrowsky et al. 2014).

G. Biogeographical region

Wallis and Futuna is located in the Central Polynesia Marine Ecoregion 157 (refer to Appendix 1, Figures 7–9) (Spalding et al. 2007).

H. Climate

Wallis and Futuna has a warm tropical climate with an average surface temperature of 27°C on Uvea and 26°C in Futuna, with only a 1° change annually (Meisch et al. 2007). The territory has significant seasonal variation with no defined dry period but a strong rainy season occurs between October and May (Meisch et al. 2007). During the rainy period Wallis receives approximately 3 m and Futuna 4 m of rain annually (Meisch et al. 2007). The wettest month is December, with three times as many rain events than August (Angleviel et al. 1994).

I. Soils N/A

J. Water regime The lakes hold water permanently.

K. Water chemistry

The following information describing the water chemistry of the lakes was authored by Sichrowsky et al. (2014):

- Lake Lalolalo has step physio-chemical gradient, with the chemocline gradient found at 10 metres, where the dissolved oxygen concentration changes from 6.4 mgL-1 at the surface to 1.2 mgL-1 at 9. 5 metres, with anoxic conditions below 10.5 metres. The surface temperature is 31.7° C with 30.6° C at 9.5 m and 27.1° C at 20 m. At the lake's surface the water is at the threshold of fresh to brackish conditions, with nearly reaching the salinity of sea water at 50 m. The water pH is slightly acidic at the surface and drops slightly acidic to in the monimolimnion.
- Lake Lanutavake has a similar chemical profile to Lake Lalolalo. Lake Lanutavake has a similar chemocline at 10 m depth. The temperature profile is the same as Lake Lalolalo but at 22.5 m depth Lanutake is 2°C warmer. Salinity remained below 200 μS cm-1 at the deepest point. The pH goes from slightly alkaline (8.4) to neutral (7.0) between the surface and 9 m and reach an acidity level of 6.3 at the lake's maximum depth.
- Lake Lano has a temperature shift of 1.8°C from 32.0°C the surface to the bottom. Oxygen shifts from saturated at the surface to nearly anoxic conditions are the sediment and water interface. Salinity has a weak gradient in the water column. The pH dropped from neutral to slightly acidic at the bottom, from 7.3 to 5.8 respectively.

L. Biota

The crater lakes have a rich biodiversity and early inventories suggest that these lakes are the only sites in Wallis and Futuna that are recommended to be listed under Ramsar Convention (Haouet and Lefeuvre 2016; Meisch et al. 2007; Meyer 2007; Sichrowsky et al. 2014). Additionally, the lakes have a rich planktonic diversity but most are cosmopolitan species (Sichrowsky et al. 2014), with only the tropical species being restricted to lakes in the South Pacific (Schabetsberger et al. 2009). In total there is 32 phytoplankton species, 23 ciliate taxa, 18 rotiferan, one caldoceran, one copepod and one gastrotrich species in the pelagic zone of the lakes. For an in-depth description of the plankton species present in the Uvea crater lakes see Sichrowsky et al. (2014).

M. Land use

The areas surrounding the lakes are used for subsistence agriculture, typically for taro production.

N. Pressures and trends

Lake Lalolalo is relatively undisturbed because of its isolation and the cultural taboo to enter the surrounding forest (Sichrowsky et al. 2014).

O. Land tenure and administrative authority Customary ownership

P. Ramsar listed? No

Q. Ramsar Criteria met

The Uvea Crater lakes meet the criteria of Group A, Criterion 1 of the Ramsar site criteria: the wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near natural wetland type within the appropriate biogeographic region.

R. Justification for Ramsar Criteria met

Under Group A, Criterion 1: The crater wetlands are unique and rare in the Central Polynesia Marine Ecoregion, being some of the few volcanic wetlands in the Pacific and the only lakes in Wallis and Futuna.

S. Conservation and management status of the wetland N/A

T. Ecosystem services

Lake Lalolalo	**Provisioning**: ++	**Regulation**: ++	**Cultural**: ++	**Supporting**: ++
Lake Lano	**Provisioning**: +	**Regulation**: +	**Cultural**: +	**Supporting**: +
Lake Lanutavake	**Provisioning**: ++	**Regulation**: ++	**Cultural**: ++	**Supporting**: ++
Lake Kikila	**Provisioning**: ++	**Regulation**: +	**Cultural**: ++	**Supporting**: ++
Lake Lanutuli	**Provisioning**: +	**Regulation**: 0	**Cultural**: +	**Supporting**: +

The Uvea lakes provide two types of ecosystem services under the services listed in the Ramsar field assessment of ecosystem services. The two major service types are cultural services and supporting services.

The crater lakes have strong cultural heritage, spiritual and inspirational value. The forested area around Lake Lalolalo is called *Vao tapu*, the forbidden forest. The forest represents the source of life, vitality and energy of Wallis and Futuna. In cultural representations, the trees in the forest and lake together distribute all the water to the island. *Vao tapu* is the origin of all the tree species in Wallis, which are believed to have been distributed by birds. This sacred forest is the domain of the gods and visitors have to be respectful to their place of residence. In cultural law, the forest is refuge for animals and villagers who have broken social order and are placed in exile until they are able to return to their village (Haouet and Lefeuvre 2016; Sichrowsky et al. 2014).

Additionally, these lakes hold recent historical value. Uvea Island was an important U.S. military base during the Second World War. At the end of the war, the American military dumped its vehicles, ammunition and supplies into the lakes. Whilst these ruins are a threat to the lake, breakdown of metal residuals and degradation of containment of the motor oils, they also hold historic value and possibly a potential for recreation and tourism (Scott 1993).

The crater lakes also hold cultural value for education and research. The lakes, whilst visited rarely, are places of long-term research by academics and researchers from leading universities in the region.

The lakes provide supporting services, such as the provision of habitat. The lakes and the surrounding catchments support a diversity of local biodiversity that is under threat. The lakes support both terrestrial species that are of conservation interest to people in Wallis and Futuna, including the Pacific flying fox, *Pteropus tonganus.* Lake Lalolalo is the only lake on Uvea to support populations of the Pacific shortfinned eel *Anguilla obscura* (Haouet and Lefeuvre 2016).

U. Current recreation and tourism

Lake Lalolalo is occasionally visited by tourists and locals for swimming. Lake Lanutavake is utilised for leisure activities on a regular basis by the local population (Sichrowsky et al. 2014).

V. Existing scientific research (with references)

Numerous research programmes have been conducted in the crater lakes. Conservation International, New Caledonia, has published a wetlands inventory report on the Eco Regions of Wallis and Futuna, including the wetlands and Uvea crater lakes (Haouet and Lefeuvre 2016). Recent research has focused on the limnology of the lakes, given them characteristics (Sichrowsky et al. 2014). Additionally, other surveys have identified freshwater copepod *Ostracada* in the lakes, which is important for understanding entire ecosystem connectivity between trophic levels (Meisch et al. 2007). More encompassing surveys have studied the bird life in the wetlands and other habitats, however ornithologists rarely visit Wallis and Futuna (Meyer 2007). There has been an emphasis on geological research in the crater lakes, describing the volcanic formation of the lakes and the Uvea Island (Stearns 1945). Hydrological surveys have recently assessed freshwater resources on Uvea Island with Conservation International and academics from the University of Belfast (Sichrowsky et al. 2014).

W. Management plans and monitoring programmess N/A

X. Current communication and public education programmes N/A

Y. References cited

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Z. Compilers

Michael Dyer and Akiko Hamada-Ano, Secretariat of the Pacific Regional Environment Programme.

3.2 Other Freshwater wetlands meeting Ramsar Criteria

Other wetlands in Wallis and Futuna may meet one or more of the Ramsar criteria and could be noted for future consideration for designation as Ramsar Sites, including: Lake Lanumaha, and Lake Alofivai.

LAKE LANUMAHA

A. Overview N/A

B. Area, boundary and dimensions

Area: 1.42 ha

C. Location

Coordinates: 13°31'52.4"S 176°21'03.7"W

D. Site Maps N/A

E. Ramsar Wetland Types

Dominant types

Tp, permanent inland lakes with an area less than 8 ha

F. Geomorphic setting

Uvea Island is located on the convergence zone between the Australia and Pacific tectonic plates, which is one of most active tectonic areas in the world (Konn et al. 2016). Uvea Island rose from the sea during the Tertiary Period (Sichrowsky et al. 2014) and are comprised of basaltic flows and pyroclastics younger than 0.5 million years ago (Price et al. 1991). Volcanic activity in the mid-Pleistocene created the Lake Alofivai, Lake Kikila, Lake Lanumaha and Lake Lanutuli and basins (Sichrowsky et al. 2014).

G. Biogeographical region

Wallis and Futuna is located in the Central Polynesia Marine Ecoregion 157 (refer to Appendix 1, Figures 7–9) (Spalding et al. 2007).

H. Climate

Wallis and Futuna has a warm tropical climate with an average surface temperature of 27°C on Uvea and 26°C in Futuna, with only a 1° change annually (Meisch et al. 2007). The territory has significant seasonal variation with no defined dry period but a strong rainy season occurs between October and May (Meisch et al. 2007). During the rainy period Wallis receives approximately 3 m and Futuna 4 m of rain annually (Meisch et al. 2007). The wettest month is December, with three times as many rain events than August (Angleviel et al. 1994).

I. Soil N/A

J. Water regime N/A

K. Water chemistry N/A

L. Biota N/A

M. Land use N/A

N. Pressures and trends N/A

O. Land tenure and administrative authority N/A

P. Ramsar listed? No

Q. Ramsar Criteria met N/A

R. Justification for Ramsar Criteria met N/A

S. Ecosystem Services

Provisioning: +, **Regulation**: 0, **Cultural**: +, **Supporting**: +

T. Conservation and management status of the wetland N/A

U. Current recreation and tourism N/A

V. Existing scientific research (with references) N/A

W. Management plans and monitoring programmes N/A

X. Current communication and public education programmes N/A

Y. References cited N/A

Z. Compiler

Michael Dyer and Akiko Hamada-Ano, Secretariat of the Pacific Regional Environment Programme.

LAKE ALOFIVAI

A. Overview N/A

B. Area, boundary and dimensions

Area: 4.35 ha

C. Location

Coordinates: 13°26'17.0"S 176°17'15.4"W

D. Site Maps Refer to Fig. 5

E. Ramsar Wetland Types

Dominant types

Tp, permanent inland lakes with an area less than 8 ha

F. Geomorphic setting

Uvea Island is located on the convergence zone between the Australia and Pacific tectonic plates, which is one of most active tectonic areas in the world (Konn et al. 2016). Uvea Island rose from the sea during the Tertiary Period (Sichrowsky et al. 2014) and are comprised of basaltic flows and pyroclastics younger than 0.5 million years ago (Price et al. 1991). Volcanic activity in the mid-Pleistocene created the Lake Alofivai, Lake Kikila, Lake Lanumaha and Lake Lanutuli and basins (Sichrowsky et al. 2014).

G. Biogeographical region

Wallis and Futuna is located in the Central Polynesia Marine Ecoregion 157 (refer to Appendix 1, Figures 7–9) (Spalding et al. 2007).

H. Climate

Wallis and Futuna has a warm tropical climate with an average surface temperature of 27°C on Uvea and 26°C in Futuna, with only a 1° change annually (Meisch et al. 2007). The territory has significant seasonal variation with no defined dry period but a strong rainy season occurs between October and May (Meisch et al. 2007). During the rainy period Wallis receives approximately 3 m and Futuna 4 m of rain annually (Meisch et al. 2007). The wettest month is December, with three times as many rain events than August (Angleviel et al. 1994).

I. Soil N/A

J. Water regime N/A

K. Water chemistry N/A

L. Biota N/A

M. Land use N/A

N. Pressures and trends N/A

O. Land tenure and administrative authority N/A

P. Ramsar listed? No

Q. Ramsar Criteria met N/A

R. Justification for Ramsar Criteria met N/A

S. Conservation and management status of the wetland N/A

T. Ecosystem Services

Provisioning: +, **Regulation**: +, **Cultural**: 0, **Supporting**: 0

U. Current recreation and tourism N/A

V. Existing scientific research (with references) N/A

W. Management plans and monitoring programmes N/A

X. Current communication and public education programmes N/A

Y. References cited N/A

Z. Compiler Michael Dyer and Akiko Hamada-Ano, Secretariat of the Pacific Regional Environment Programme.

3.3 Uvea Lagoon

A. Overview

The lagoon surrounding Uvea Island is a marine wetland with several islets and mangrove patches, mudflats and sandy beaches surrounded by a barrier reef with three passes. The lagoon supports a rich biodiversity, as well as environmental and socio-economic ecosystem services. The lagoon zoned into four areas, but for the purpose of this inventory the information for each area is compiled together.

B. Area, boundary and dimensions

Area: Lagoon North (2900 ha)

Lagoon East (1700 ha)

Lagoon South (3600 ha)

Lagoon West (1806 ha)

Total lagoon area is 10,006 ha, 100 km^2

C. Location

Wallis/Uvea Island and the lagoon are located approximately 235 km east of Futuna Island. Uvea is 249 km southwest of Niuafo'ou (Tonga) and 352 km east of Savaii (Samoa) (Wantiez and Chauvet 2003).

Coordinates: Uvea Island and the lagoon are located between latitudes 13°10' and 13°23'S and longitudes 176°06' and 176°17'W.

D. Site maps

FIGURE 6 Uvea Lagoon, Uvea Island, Wallis and Futuna.
Map created by: M J.B. Dyer, R. Wright and A. Hamada-Ano.

E. Ramsar Wetland Types

Dominant types

J, Coastal brackish/saline lagoons

A, Permanent shallow marine waters

C, Coral reefs

Types also present

E, Sand, shingle or pebble shores

G, Intertidal mud, sand or salt flats

H, Intertidal marshes

I, Intertidal forest wetlands

B, Marine subtidal, aquatic beds

F. Geomorphic setting

Uvea Island is located on the edge of the Pacific tectonic plate and the Australian plate. The geomorphology of the lagoon is dynamic, with many basaltic ridges that separate shallow areas less than 10 m deep from deep hollow areas with depths greater than 50 m (Wantiez and Chauvet 2003). The entire lagoon is surrounded by a barrier reef.

G. Biogeographical region

Wallis and Futuna is located in the Central Polynesia Marine Ecoregion 157 (refer to Appendix 1, Figures 7–9) (Spalding et al. 2007).

H. Climate

Wallis and Futuna has a warm tropical climate with an average surface temperature of 27°C on Uvea and 26°C in Futuna, with only a 1° change annually (Meisch et al. 2007). The territory has significant seasonal variation with no defined dry period but a strong rainy season occurs between October and May (Meisch et al. 2007). During the rainy period, Wallis receives approximately 3 m and Futuna 4 m of rain annually (Meisch et al. 2007). The wettest month is December, with three times as many rain events than August (Angleviel et al. 1994). The surface currents in this region head west and south-west, even during El Niño scenarios (Reverdin et al. 1994).

I. Soils N/A

J. Water regime

The water regime of the lagoon is altered by both terrestrial and oceanic processes (Haouet and Lefeuvre 2016). The hydrology of the lagoon is mostly controlled by the daily tidal regime (Haouet and Lefeuvre 2016). The lagoon has a tidal range of 2 m and approximately one third of the water is exchanged during each tide event (Williams et al. 2006). Due to complex nature of hydrology, the lagoon can be divided into three independent basins (Haouet and Lefeuvre 2016).

K. Water chemistry N/A

L. Biota

At the turn of the millennium 648 reef and lagoon fish species were inventoried in the Uvea Lagoon (Williams et al. 2006), however the number of species could be higher because the external reef slopes were not surveyed. Of the 648 species inventoried, 15 were new to science (Haouet and Lefeuvre 2016). The lagoon surface has a relatively high biodiversity (Williams et al. 2006), however coastal fishes are in greater concentrations on the coral bottoms, and outer slope sand lagoon passes (Richard and Bagnis 1982). The coastal fishes include surgeons, parrots, etc., however there is minimal endemism. In the lagoon, there are 19 species of sea cucumber but none of them are endemic to the island (Haouet and Lefeuvre 2016). The sea snake, *Hydrophis platurus* is also found in the lagoon and territories.

There are possible breeding sites in the Uvea Lagoon for green turtles (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*), with nesting grounds observed in the south of the lagoon on the islets surrounding Wallis (Haouet and Lefeuvre 2016).

The lagoon supports 10 known species of avifauna, including noddies, frigates, terns and brown fowls. The main area for these birds is in northern islets of the lagoon (Thibault et al. 2015). The birds present in the lagoon and the islets are:

TABLE 3 Birds of the Uvea Lagoon (Thibault et al. 2015).

Common name	Species
Crimson-crowned fruit dove	*Ptilonopus porphyraceus*
Lesser frigate bird	*Fregata ariel*
Great frigate bird	*Fregata minor*
Red-footed booby	*Sula sula*
Brown booby	*Sula leucogaster*
Black noddy	*Anous minutus*
White tern	*Gygis alba*
Bridled tern	*Onychoprion aneathetus*
Black-naped tern	*Sterna sumatrana*
Brown noddy	*Anous stolidus*

There are 135 species of coral, 50 genera and 12 families in the reefs in Wallis and Futuna. In general, the coral species surrounding Uvea Island are dominated by the *Favia* genus. The most notable species is *Acropora crateriformis* which is extremely rare but found in high abundance in the outer slope of northern barrier reef surrounding the lagoon (Haouet and Lefeuvre 2016). On the outerslopes of the barrier reefs below depths of 25 m, there are large colonies of *Halomitra pileus, Mycedium elephantotus, Turbinaria sp., Lobophyllia hemprichii* (Haouet and Lefeuvre 2016).

The flora of the lagoon is well developed, with three different sea grass beds alternating from the beaches to the reefs. The species include *Halodule pinifolia, Halophila ovalis* and *Syringodium iseotifolium*. The remaining flora is represented by 197 species of macrophytes, including 14 cyanobacteria, 11 heterochondes, 41 green algae and 128 red algae (N'Yeurt and Payri 2004). Due to the high species richness of red algae and corals, with high abundance of *Halimeda opuntia* and *Halimeda minima*, the flora of Uvea Lagoon is considered unique (N'Yeurt and Payri 2004).

Along the brackish and muddy areas of the lagoon there are numerous native plant species, including *Acrostichum aureum* (golden leather fern), *Barringtonia asiatica* (fish poison tree), *Bruguiera gymnorhiza* (mangrove tree), *Paspalum vaginatum* (grass) and *Rhizophora mangle* (mangrove tree).

M. Land use

One third of the households in Uvea fish in the lagoon for personal consumption (Haouet and Lefeuvre 2016). There are some professional fishing activities, but in low numbers and with relatively small vessels (6 to 10 m) (Haouet and Lefeuvre 2016).

N. Pressures and trends

The lagoon and the islets within are subject to increased degradation and more frequent disturbance by visitors, especially in the north. Despite the establishment of a landfill centre in the early 1990s, toxic waste and substances, household waste and batteries are commonly dumped on the beach and lagoon (Haouet and Lefeuvre 2016).

The coastal areas of Uvea are especially susceptible to pollution caused from piggeries and after large rainfall events, pathogens, heavy metals and nitrates can be found within the lagoon. Fine particle pollution is also present in the lagoon, which is mostly from the erosion of degraded soils (Haouet and Lefeuvre 2016). Alarmingly, increased urbanisation along the coastline of Uvea will only increase the pressures on these habitats (Haouet and Lefeuvre 2016).

Research conducted by the University of New Caledonia and the Pacific Community Forum indicated that there is a relatively low fishing pressure on the lagoon and reefs surrounding Uvea, given the low population on the island (Haouet and Lefeuvre 2016). However reef fishes that are more accessible to fishermen are indicating early warning signs of overfishing, including decrease in abundance, biomass and species sizes (Haouet and Lefeuvre 2016). Overall the northern part of the lagoon is less impacted than the south of the lagoon. However, there are some fishing practices that are likely to cause more damage than the regular pressure exerted from subsistence fishing. These include the continuation of explosives, poisons and mine bars (Chancerelle 2008).

Invasive species are also increasing pressure on ecosystem function and biodiversity in the lagoon, particularly rats and pigs, which are known to destroy the eggs and habitat of the sea birds (Haouet and Lefeuvre 2016).

O. Land tenure and administrative authority

Currently the Service de l'Environnement (Department of Environment) managers are responsible for all natural resources in Wallis and Futuna. There are two cultural conservation zones established in the lagoon. The Department of Environment is also responsible for the zoning and protected areas in the lagoon, and monitoring pollution levels.

P. Ramsar listed? No

Q. Ramsar Criteria met

The Lagoon surrounding Uvea Island in Wallis and Futuna meets the following Ramsar site criteria:

- Group B, sites of international importance for conserving biological diversity.
- Criterion 2: A wetland should be considered internationally important if it supports vulnerable endangered or critically endangered species or threatened ecological communities.
- Criterion 4: A wetland should be considered internationally importance if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
- Criterion 8: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path of which fish stocks, either within the wetland or elsewhere, depend.

R. Justification for Ramsar Criteria met

- Criterion 2: The lagoon provides habitat for several endangered sea cucumber species, *Holothuria nobilis, Holothuria scabra* and *Thelenota ananas* listed as endangered on the IUCN Red List. Additionally *Holothuria fuscgoliva* and *S. hermanii* are considered vulnerable. Additionally sea turtles, *Chelonia mydas* (EN) and *Eretmochelys imbricata* (CR) have been observed around the lagoon. In total, the lagoon supports 3 critically endangered, 5 endangered and 5 vulnerable species.

TABLE 4 Species listed as threatened in the Uvea Lagoon (Haouet and Lefeuvre 2016).

Location	Taxonomy	Genus	Species	IUCN Redlist
North lagoon	Cnidaria	*Galaxia*	*acstreata*	VU
		Acropora	*crateriormis*	VU
	Echinodermata	*Holothuria*	*scabra*	EN
		Thelenota	*ananas*	EN
		Holothuria	*nobilis*	EN
		Holothuria	*fuscogilva*	VU
		Stichopus	*hermanii*	VU
	Reptilia	*Chelonia*	*mydas*	EN
		Eretmochelys	*imbricata*	CR
East lagoon	Pisces	*Cheillinus*	*undulatus*	EN
	Cnidaria	*Acropora*	*crateriormis*	VU
	Echinodermata	*Holothuria*	*nobilis*	EN
	Reptilia	*Chelonia*	*mydas*	EN
		Eretmochelys	*imbricata*	CR
South lagoon	Pisces	*Cheillinus*	*undulatus*	EN
	Echinodermata	*Stichopus*	*hermanii*	VU
		Holothuria	*nobilis*	EN
	Cnidaria	*Acropora*	*aspera*	VU
		Acropora	*crateriormis*	VU
		Galaxia	*acstreata*	VU
	Reptilia	*Chelonia*	*mydas*	EN
		Eretmochelys	*imbricata*	CR
West lagoon	Echinodermata	*Holothuria*	*nobilis*	EN
		Holothuria	*scabra*	EN

- Criterion 4: The benthic zone of the lagoon has a high biodiversity of flora and fauna (Haouet and Lefeuvre 2016).The lagoon supports many coral species but supports significant populations of *Isopora crateriformis*, which is typically rare in the Indo-Pacific and in the Wallis Lagoon it has a unique morphology. Likewise, *Leptoseris garidneri* is uncommon on most Indo-Pacific reefs, has a high abundance in Wallis (Haouet and Lefeuvre 2016). Specifically the northern area of the barrier reef supports a high abundance of the significantly rare coral *Acropora crateriformis*.
- Criterion 8: The lagoon, including the reefs and the mangroves within supports a large abundance of fish species. The lagoon is particularly important habitat for the pelagic spawners *Pareupeneus barberinum* and *Acanthurus triostegus* (Juncker et al. 2006). Additionally the reef and lagoon is important habitat for the benthic spawners *Adudefduf sexfacciatus* and *Dascyllus aruanus* (Juncker et al. 2006).

S. Conservation and management status of the wetland

Biodiversity Conservation Zones have been established in the Uvea Lagoon. Although they only cover a small portion of the marine space, they protect 50% of the lagoon and 50 % of all flora, algae and coral reefs (Haouet and Lefeuvre 2016). The Uvea Lagoon has a sustainable management policy and in 2007 marine spatial planning management plan included the lagoon in an effort to resolve conflicts from the dynamic nature of the customary context of Wallis and Futuna (Haouet and Lefeuvre 2016).

Two areas in the Uvea Lagoon are protected by customary law, which are the Turtle and Lano Hole, encompassing a total of 65 ha (Haouet and Lefeuvre 2016). However, the biodiversity value contained in these customary conservation zones has little importance (Andréfouët and Dirberg 2006). In addition to the cultural areas, the Environment Department defined areas of conservation priority in the Lagoon and aimed to protect 20% of the surface area, however these areas are yet to be formally protected (Haouet and Lefeuvre 2016).

T. Ecosystem services

Provisioning: ++, **Regulation**: ++, **Cultural**: ++, **Supporting**: ++

The Uvea Lagoon (all areas) provides all four of the encompassing types of ecosystem services as defined by Ramsar, including provisioning, regulating, cultural and supporting services. The reef and lagoon are an important food source for the population of Wallis and Futuna. This includes both fish and sea cucumber species that are eaten and sold in Wallis and Futuna (Haouet and Lefeuvre 2016). The mangroves provide the highest amount of plankton in the area, which is the food supply for both reef species and pelagic spawners

The lagoon provides at least two regulating ecosystem services. The first ecosystem service is climate regulation. The lagoon, mudflats, mangroves and coral reefs store and sequester carbon. Likewise, the same habitat types in the lagoon provide storm hazard/disaster regulation by reducing the impact of storms, waves and impacts from cyclones and tsunamis. The presence of the barrier reef around Uvea is particularly important for storm mitigation because of Uvea's susceptibility to tsunamis and cyclones due to its geomorphological setting (Goff et al. 2011; Lamarche et al. 2010).

The lagoon has cultural importance due to its natural character, being utilised by Wallisians for many reasons. The lagoon is utilised for recreation and tourism, in the south of the lagoon, aquatic sports, such as wind surfing and paddling is common (Haouet and Lefeuvre 2016). The lagoon provides both aesthetic value and is important for maintaining social relations; with majority of Wallisians living on the east coast of the island, living off the resources the lagoon provides (Worliczek and Allenbach 2011). Another cultural service the lagoon provides is education and research, being a place of regular biodiversity and geological surveys from researchers from NGOs, universities in the OCTs and Europe.

Finally, the lagoon provides habitat, supporting a diversity of local flora and fauna. The species in the lagoon are described above in biota and several are of conservation concern, especially the coral reefs. The lagoon is also important for soil formation, with the coral reefs contributing to the sand cycle.

U. Current recreation and tourism

On the eastern side of the lagoon, there is a customary fishing area for villages, where recreational water sports are also conducted, such as windsurfing and kayaking. In this region there are 5 islets frequented on the weekends and during parties (Haouet and Lefeuvre 2016).

V. Existing scientific research (with references)

To date, there are no national research institutions in Wallis and Futuna, however University of New Caledonia has established a research base on Uvea to host researchers, post graduate students and trainees (Haouet and Lefeuvre 2016). The research is conducted through partnerships with organisations and institutes, including, The Institute of Research and Development, University of New Caledonia, The National Museum of Natural History (France) and the Ecole Pratique des Hautes Etudes and the Policy Academy of Sciences. Additionally, other research partners including the New Caledonian Institute of Agronomy and the French Research for the Exploitation of the Sea have conducted research in Uvea.

The reefs surrounding and within the Uvea lagoon have been part of global coral reef surveys conducted by the University of South Florida, with support from NASA. Site-specific research in the Uvea Lagoon has focused mainly on the biodiversity present in the lagoon and surrounding reefs. Research on the following have been conducted: comparing fish species occurrences, sizes, the variations in species migrations with populations in Fiji (Juncker et al. 2006); an inventory of crustaceans present in the lagoon (Poupin and Juncker 2008); and a survey investigating which avifauna species utilise the reef (Thibault et al. 2015).

W. Management plans and monitoring programmes N/A

X. Current communication and public education programmes N/A

Y. References cited

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Z. Compilers

Michael Dyer (Coastal and Marine Assistant at the Secretariat of the Pacific Regional Environment Programme).

3.4 Vanifao River

A. Overview

The Vainifao River and the surrounding catchment run from Mt. Puke to the coast on south of Futuna. The catchment area is recommended to be a nature reserve and is one of the richest biodiversity areas in Wallis and Futuna, supporting 30% of the forest on Futuna.

B. Area, boundary and dimensions

Area: 400 ha

Length: 4 km

C. Location

Futuna Island, from Mt. Puke to the coast.

D. Site maps

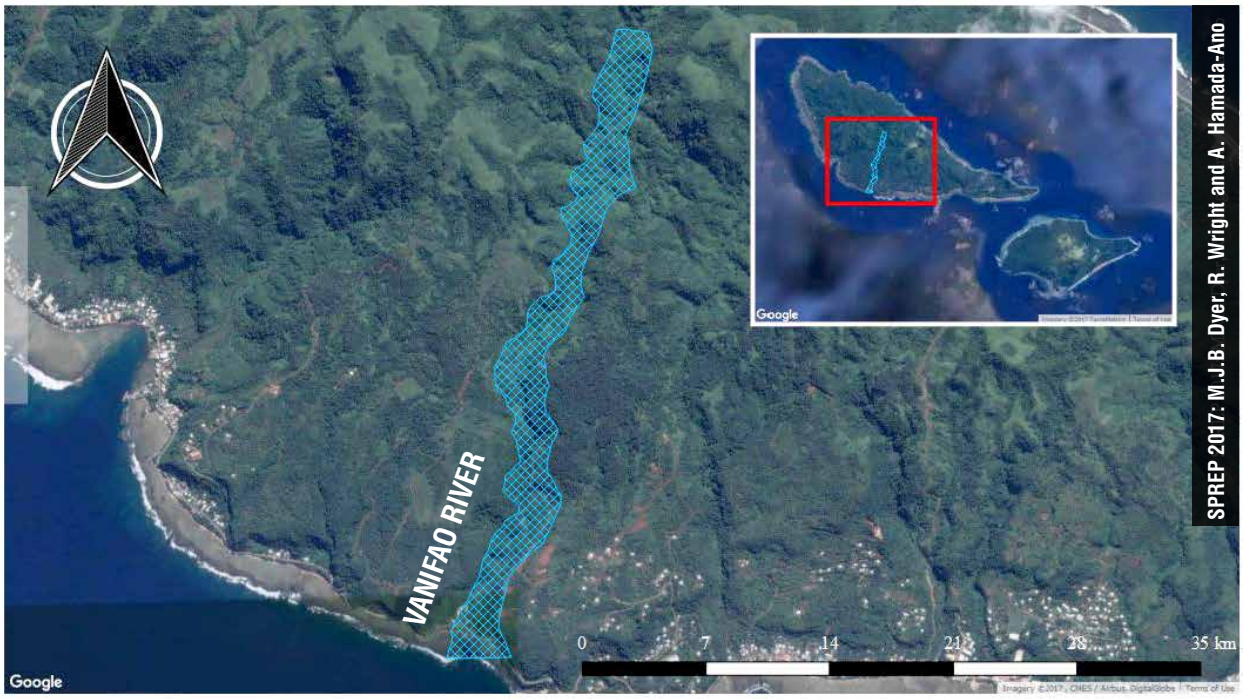

FIGURE 7 Vainifao River, Futuna Island, Wallis and Futuna. Map created by: M J.B. Dyer, R. Wright and A. Hamada-Ano.

E. Ramsar Wetland Types

Dominant types:

M, permanent rivers/streams/creeks

Types also present:

F, estuarine waters

Y, springs, oases

F. Geomorphic setting

Futuna Island is the result of volcanic Tertiary activity originating from the Pacific and Australian tectonic plates.

G. Biogeographical region

Wallis and Futuna is located in the Central Polynesia Marine Ecoregion 157 (Appendix 1, Figures 7–9) (Spalding et al. 2007).

H. Climate

Wallis and Futuna has a warm tropical climate with an average surface temperature of 27°C on Uvea and 26°C in Futuna, with only a 1° change annually (Meisch et al. 2007). The territory has significant seasonal variation with no defined dry period but a strong rainy season occurs between October and May (Meisch et al. 2007). During the rainy period Wallis receives approximately 3 m and Futuna 4 m of rain annually (Meisch et al. 2007). The wettest month is December, with three times as many rain events than August (Angleviel et al. 1994).

I. Soils N/A

J. Water regime The Vainifao River is a permanent water source.

K. Water chemistry N/A

L. Biota

The Vainifao River and its catchment area have some of the greatest biodiversity in Wallis and Futuna (Haouet and Lefeuvre 2016). The area supports a range of biodiversity, including avifauna, reptiles fish, and crustaceans (Haouet and Lefeuvre 2016). In 2006, there were no aquatic invasive species reported (Haouet and Lefeuvre 2016). The benthic zone of the Vainifao River supports more water invertebrates and molluscs than other rivers in Wallis and Futuna (Haouet and Lefeuvre 2016). One third of all the fish species are endemic to Vainifao and endemic fish parasites have also been discovered (Haouet and Lefeuvre 2016).

Specifically, the river has 18 fish species, which were unknown until the first freshwater survey in 2004 (Keith and Marquet 2005; Keith and Marquet 2007). Of the 18 species present, 4 were new species to science from the Gobioidei family, including *Stenogobius keletanoa*, *Sicyopus (Smilosicypus) sasali, Akihito futuna* and *Stiphodon rubromaculatus* (Keith and Marquet 2005; Keith and Marquet 2007; Keith et al. 2007). *Akihito futuna* is found in swift and clear streams with rocky bottoms at about 147 m in altitude (Keith et al. 2007). Observations have shown it can swim in open waters (Keith et al. 2007). *Sicypus sasalia* and *Stiphodon rubromaculatus* are found in the rivers on Futuna Island and are typically found in high gradient and rocky areas (Keith and Marquet 2007). Typically this goby is found between 90 to 200 m in altitude and is sometimes seen swimming in open waters and large pools (Keith and Marquet 2007). For morphological descriptions of three newly identified species, see Keith and Marquet (2005; 2007) and Keith et al. (2007). Additionally, a parasitic fish, *Cucullanus oceaniensis* was discovered inside the intestine of the giant mottled eel *Anguilla marmorata*, in the river system on the 12th of October 2004, (Moravec et al. 2006).

There are 16 crustaceans in the Vainifao River (Haouet and Lefeuvre 2016). Surveys at the mouth and dam of the river have sampled a number of species, including two large prawn species, *Macrobrachium latimanus* and *Macrobrachium lar*, which are also found in French Polynesia but in smaller numbers (Poupin and Juncker 2008). Other species collected include *Macrobrachium australe* and a shrimp species, *Cardina typus,* both of which are abundant in the river dam (Poupin and Juncker 2008). In the mouth of the river, two species can be found. The most abundant is *Ptychognathus hachijyoensis* and can be found amongst and beneath pebbles in the mouth and supra-tidal zone of the river (Poupin and Juncker 2008). Similar to previous species, *Ptychonathus barbatus* is present but has a distribution across the Indo-west Pacific, from Madagascar to Japan and Samoa (Poupin and Juncker 2008). Additional species include *Atyoida pilipes, Atoypsis spinipes, Caridina serratiostris, Caridina weberi, Macrobrachium aemulum, Macrobrachium gracilirostre, Macrobrachium grandimanus, Macrhobrachium placidulum, Paleamon concinnus* and *Paleamon debilis* (Mary et al. 2006).

M. Land use

The Vainifao River catchment is mostly surrounded by natural rainforest habitat. However, the lower area of the river is used for taro production by flooding the fields. The river is also resource for drinking water and hydro-electricity production.

N. Pressures and trends

Currently, the waterways on Futuna are threatened by over exploitation, pollution from inadequate litter and human waste management and erosion (SPC). Projects have been established to rehabilitate the waterways and protect these important water assets by Wallis and Futuna's environmental governing body and several regional agencies.

O. Land tenure and administrative authority

Service de l'Environnement is the authoritative body for the management and protection of environmental resources.

P. Ramsar listed? No

Q. Ramsar Criteria met

Group B

- Criterion 2: A wetland should be considered internationally important if it supports vulnerable endangered or critically endangered species or threatened ecological communities
- Criterion 3: A wetland should be considered internationally important if it supports populations of plant and/or animals species important for maintaining the biological diversity of a particular biogeographic region
- Criterion 7: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.

R. Justification for Ramsar Criteria met

Criterion 2, the four newly identified goby species are threatened, *Stenogobius keletanoa* and *Sicyopus (Smilosicyopus) sasali* are endangered and *Akihito futuna* and *Stiphodon rubromaculatus* are critically endangered on the IUCN Red List 2014 (Haouet and Lefeuvre 2016).

Criterion 3, The rivers on Futuna Island, especially, the Vainifao catchment supports populations of flora and fauna that are important for maintaining the biological diversity for Marine Ecoregion 157. Ninety percent of the Vainifao River is primary forest lowland and montane forests (339 ha) which are some of the most

threatened habitats in the biogeographic region. These forests including the river, streams and wetlands within support 7 endemic plants, 4 endemic fish and numerous other species.

Criterion 7, The Vainifao River and supporting tributaries support a significant portion of fish indigenous to Wallis and Futuna. There are 18 fish species present in the waterway, all of them native to the territory (Mary et al. 2006). The river also supports large populations of the giant mottled eel, *Anguilla marmorata* (Moravec et al. 2006*)*. Additionally the waterway has no invasive fish species present (Mary et al. 2006).

S. Conservation and management status of the wetland

Currently, the Vainifao River and other water resources on Futuna Island are managed under the INTEGRE Project, administered by the Pacific Community (SPC). The plan was submitted to CTEDD (Territorial Environment and Sustainable Development Council) on the 20 June 2014 (SPC). The project aims to improve waste management, preserve and manage water resources and reduce erosion. Tangible outcomes from the project so far include an integrated coastal zone management plan, awareness campaigns and communications. The project has also established infrastructure elsewhere on Futuna and identified vegetation areas that require rehabilitation to reduce erosion.

Several species in the Vainifao wetland are protected under the Wallis and Futuna Environment Code (in total 81 species are protected under the code in Wallis and Futuna).

T. Ecosystem services

Provisioning: ++, **Regulation**: ++, **Cultural**: ++, **Supporting**: +

The Vainifao River provides a wide range of ecosystem services. The Vainifao River is a source of fresh water for local communities. The mouth and terraces of the river also support the provision of food, with subsistence farming of taro grown in marshy areas of the lower river. Electricity is also harvested from the river from hydroelectric dam.

The river vegetation and surrounding forest habitats reduce erosion of the riverbanks and agricultural soil in the mouth of the river. The forest habitats also regulate the amount of run-off and effluent that is deposited on the fringing reefs around Futuna Island.

The river provides two types of cultural ecosystem services, including social relations and education/research. Communities use the lower area of the wetland for subsistence agriculture and cropping. Additionally, the wetlands have research value and in the last 15 years, several new fish and parasite species have been identified in the Vainifao River and supporting tributaries.

The river provides habitat for biodiversity. The river catchment supports diverse, local and regional representative flora, fauna and ecological communities. Included in this flora and fauna are several species of conservation concern for the public and research community in Wallis and Futuna and Polynesia abroad. (Discussed above in the Biota Section).

U. Current recreation and tourism N/A

V. Existing scientific research (with references)

Recently, there have been numerous surveys on the aquatic biota of the Vainifao River. However, the fish species were unknown to science until the first freshwater survey conducted by the University of Perpignan and the Museum of National Natural History (Paris) in 2004 (Keith and Marquet 2005). More recently biodiversity assessments and inventories for crustaceans have been conducted by Conservation International and other parties including the Pacific Community (Mary et al. 2006; Poupin and Juncker 2008).

W. Management plans and monitoring programmes N/A

X. Current communication and public education programmes N/A

Y. References cited

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Z. Compilers

Michael Dyer (Coastal and Marine Assistant at the Secretariat of the Pacific Regional Environment Programme).

3.5 Other wetlands of interest

There are other wetlands in Wallis and Futuna that should be of conservation interest and should be listed under the Ramsar Convention in the future but are not described in high detail here in this report—information about these wetlands is difficult to acquire due to gaps of information and lack of centralised database of resources.

There are several rivers and streams on Futuna Island that are not mentioned in great detail. They include the Leava and SauSau River, which flows into the Leava Harbor. There is also the Gutuvai River and Lake Nuku. Likewise, taro marshes can be considered independent wetlands, with their own biota and ecosystem services. Prawns aquaculture was considered, but due to lack of funding for the aquaculture project, it is no longer viable. These wetlands support numerous species, similar to that of the Vainifao River and likewise, have similar ecosystem services. However, information on these species and services are not documented to the extent of the Vainifao River.

The Leava River supports several ostracod species, including the *Stenocrypis major, S. malayica, Strandeisa vidua* and *Cypretta seurati and C. vidua*. Alternatively, SauSau River and associated taro farms support only *S. malayica* and *C. seurati* (Meisch et al. 2007). Lake Nuku supports *Candonopsis* sp. and *C. vidua*.

It is known that the endemic fish species *Stenogobius keletanoa*, *Sicyopus (Smilosicypus) sasali, Akihito futuna* and *Stiphodon rubromaculatus* are found in abundance in the Vainifao River (Keith and Marquet 2005; Keith and Marquet 2007; Keith et al. 2007) and they have been recorded in the Leava River and SauSau River but to how abundant is unknown. On this assumption, these rivers could be listed at the Ramsar Convention, however, it is recommended that information about the abundance and population status is published first. Currently academic papers only state that the fish are present in Futuna rivers (Keith and Marquet 2005; Keith and Marquet 2007; Keith et al. 2007). There is little to no information regarding the rest of the biota of these wetlands and they should be an area of future research for information dissemination.

These rivers certainly provide many ecosystem services, across all four encompassing areas described by the Ramsar guidelines for a rapid ecosystem service assessment. The most documented services that are provided are the supply of fresh water, food production through taro fields, taro marshes and electricity, specifically for the Leava River. There is also potential for the Leava River and its associated taro farms to be used for aquaculture (Barbier et al. 2010).

In future wetland inventories and ecosystem profile descriptions, there should be a greater emphasis on these wetlands, including anthropogenic-modified wetlands (taro marshes and aquaculture ponds). Especially because there could more endemic species yet to be discovered and like most wetlands in the Pacific these ecosystems are likely threatened and exploited. Alternatively, there may be sound information about these wetlands in Futuna, however they are not accessible and hence, the ecosystems may not be as well protected. Ultimately, future projects should investigate all of the wetlands and information sources.

Lake Lanutavake. Photo: Flora Artzner

4

SUMMARY

The wetlands in Wallis and Futuna are important representatives of wetlands of conservation significance in the Oceanic region. Currently these wetlands are not listed under the Ramsar Convention but as a result of this inventory it is now known that several sites meet the one or more of Ramsar sites criteria and direct action can take place to list these areas under the Convention. Wallis and Futuna host a few wetlands but four sites can currently be listed under the Convention, including several brackish crater lakes, one permanent river and a lagoon encompassed by a barrier reef. These four sites constitute 14 different types of wetland. The wetlands provide habitat for hundreds of different species, 35 of which are threatened and 12 of these threatened species are endemic to the wetlands.

Other than biodiversity, the wetlands also hold strong cultural value and provide ecosystem services, which are two major themes in the most up to date Ramsar Strategic Plan. Specifically the Uvea Crater Lakes are the centre-piece of the cultural creation of Uvea Island and the surrounding forested catchment holds sacred values. The lagoon also has strong cultural ties for Wallisians and most of the population is dependent on its resources. The four sites collectively provide the population of Wallis and Futuna all four encompassing types of ecosystem services. Notably, the main services provided are cyclone and tsunami protection, which is of high importance for the population. Other services include but are not limited to, provision of habitat, sources of water and food, erosion control, education, cultural and aesthetic values. Ultimately, several wetlands in Wallis and Futuna meet the requirements to be listed under the Ramsar Convention, of which France is a signatory, and their conservation and sustainable use align with Ramsar's Strategy in the Oceanic region.

Mangrove seedling. Photo: Pascale Salaun

APPENDICES

APPENDIX 1

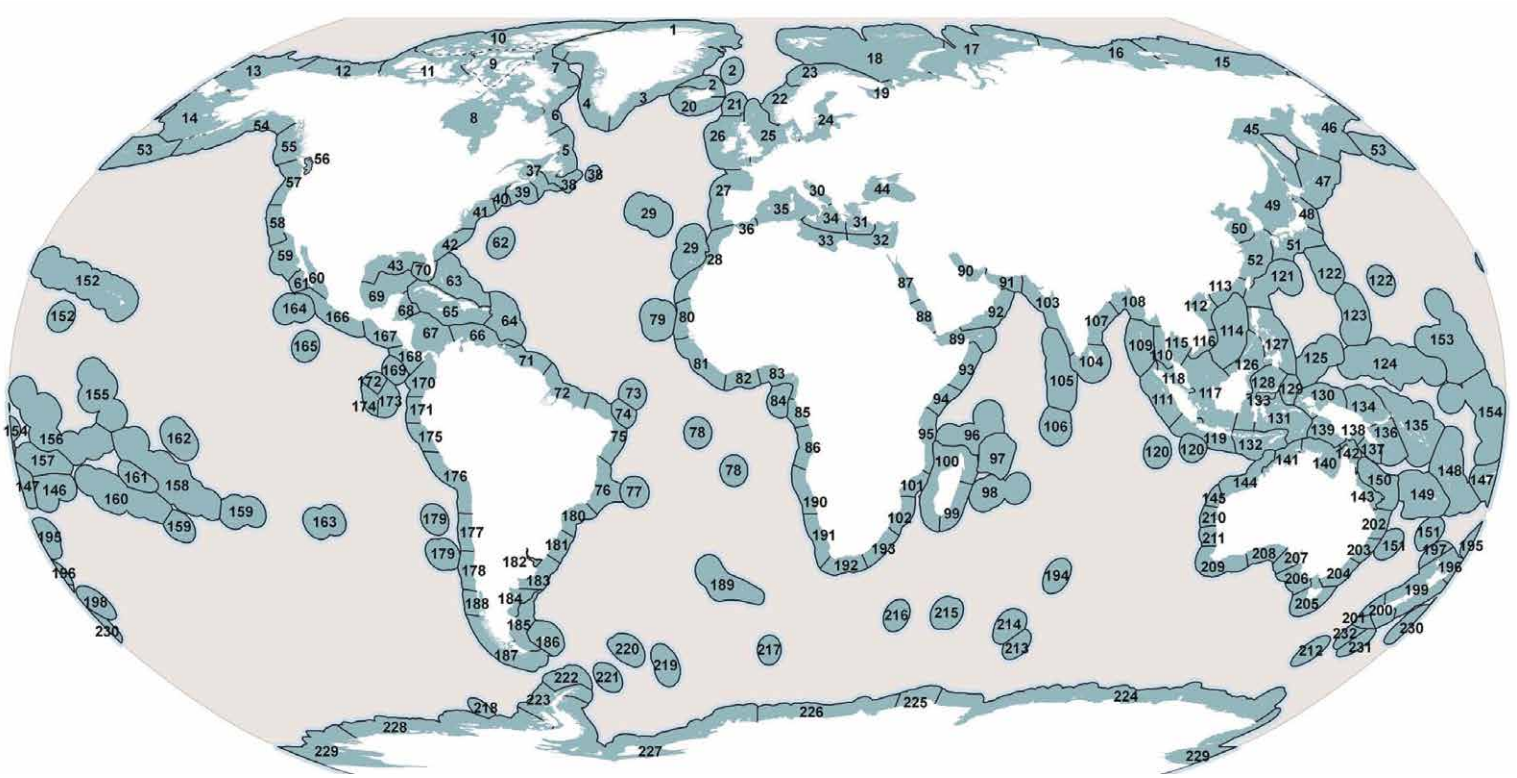

FIGURE 8 Image of marine ecoregions of the world, Wallis and Futuna is highlighted under bioregion 157 (Spalding et al. 2007)

Marine Ecoregions of the World

Numbers for the provinces and ecoregions match those shown on the maps in figures 2b and 3.
Realms are indicated in **bold**, provinces (1–62) in ***bold italics***, and ecoregions (1–232) in roman type.

Arctic

1. Arctic (no provinces identified)

1. North Greenland
2. North and East Iceland
3. East Greenland Shelf
4. West Greenland Shelf
5. Northern Grand Banks–Southern Labrador
6. Northern Labrador
7. Baffin Bay–Davis Strait
8. Hudson Complex
9. Lancaster Sound
10. High Arctic Archipelago
11. Beaufort–Amundsen–Viscount Melville Queen Maud
12. Beaufort Sea—continental coast and shelf
13. Chukchi Sea
14. Eastern Bering Sea
15. East Siberian Sea
16. Laptev Sea
17. Kara Sea
18. North and East Barents Sea
19. White Sea

Temperate Northern Atlantic

2. Northern European Seas

20. South and West Iceland
21. Faroe Plateau
22. Southern Norway
23. Northern Norway and Finnmark
24. Baltic Sea
25. North Sea
26. Celtic Seas

3. Lusitanian

27. South European Atlantic Shelf
28. Saharan Upwelling
29. Azores Canaries Madeira

4. Mediterranean Sea

30. Adriatic Sea
31. Aegean Sea
32. Levantine Sea
33. Tunisian Plateau/Gulf of Sidra
34. Ionian Sea
35. Western Mediterranean
36. Alboran Sea

5. Cold Temperate Northwest Atlantic

37. Gulf of St. Lawrence–Eastern Scotian Shelf
38. Southern Grand Banks–South Newfoundland
39. Scotian Shelf
40. Gulf of Maine/Bay of Fundy
41. Virginian

6. Warm Temperate Northwest Atlantic

42. Carolinian
43. Northern Gulf of Mexico

7. Black Sea

44. Black Sea

Temperate Northern Pacific

8. Cold Temperate Northwest Pacific

45. Sea of Okhotsk
46. Kamchatka Shelf and Coast
47. Oyashio Current
48. Northeastern Honshu
49. Sea of Japan
50. Yellow Sea

9. Warm Temperate Northwest Pacific

51. Central Kuroshio Current
52. East China Sea

10. Cold Temperate Northeast Pacific

53. Aleutian Islands
54. Gulf of Alaska
55. North American Pacific Fjordland
56. Puget Trough/Georgia Basin
57. Oregon, Washington, Vancouver Coast and Shelf
58. Northern California

11. Warm Temperate Northeast Pacific

59. Southern California Bight
60. Cortezian
61. Magdalena Transition

Tropical Atlantic

12. Tropical Northwestern Atlantic

62. Bermuda
63. Bahamian

64. Eastern Caribbean
65. Greater Antilles
66. Southern Caribbean
67. Southwestern Caribbean
68. Western Caribbean
69. Southern Gulf of Mexico
70. Floridian

13. North Brazil Shelf
71. Guianan
72. Amazonia

14. Tropical Southwestern Atlantic
73. Sao Pedro and Sao Paulo Islands
74. Fernando de Naronha and Atoll das Rocas
75. Northeastern Brazil
76. Eastern Brazil
77. Trindade and Martin Vaz Islands

15. St. Helena and Ascension Islands
78. St. Helena and Ascension Islands

16. West African Transition
79. Cape Verde
80. Sahelian Upwelling

17. Gulf of Guinea
81. Gulf of Guinea West
82. Gulf of Guinea Upwelling
83. Gulf of Guinea Central
84. Gulf of Guinea Islands
85. Gulf of Guinea South
86. Angolan

Western Indo-Pacific

18. Red Sea and Gulf of Aden
87. Northern and Central Red Sea
88. Southern Red Sea
89. Gulf of Aden

19. Somali/Arabian
90. Arabian (Persian) Gulf
91. Gulf of Oman
92. Western Arabian Sea
93. Central Somali Coast

20. Western Indian Ocean
94. Northern Monsoon Current Coast
95. East African Coral Coast
96. Seychelles
97. Cargados Carajos/Tromelin Island
98. Mascarene Islands
99. Southeast Madagascar
100. Western and Northern Madagascar
101. Bight of Sofala/Swamp Coast
102. Delagoa

21. West and South Indian Shelf
103. Western India
104. South India and Sri Lanka

22. Central Indian Ocean Islands
105. Maldives
106. Chagos

23. Bay of Bengal
107. Eastern India
108. Northern Bay of Bengal

24. Andaman
109. Andaman and Nicobar Islands
110. Andaman Sea Coral Coast
111. Western Sumatra

Central Indo-Pacific

25. South China Sea
112. Gulf of Tonkin
113. Southern China
114. South China Sea Oceanic Islands

26. Sunda Shelf
115. Gulf of Thailand
116. Southern Vietnam
117. Sunda Shelf/Java Sea
118. Malacca Strait

27. Java Transitional
119. Southern Java
120. Cocos-Keeling/Christmas Island

28. South Kuroshio
121. South Kuroshio

29. Tropical Northwestern Pacific
122. Ogasawara Islands
123. Mariana Islands
124. East Caroline Islands
125. West Caroline Islands

30. Western Coral Triangle
126. Palawan/North Borneo
127. Eastern Philippines
128. Sulawesi Sea/Makassar Strait
129. Halmahera
130. Papua
131. Banda Sea
132. Lesser Sunda
133. Northeast Sulawesi

31. Eastern Coral Triangle
134. Bismarck Sea
135. Solomon Archipelago
136. Solomon Sea
137. Southeast Papua New Guinea

32. Sahul Shelf
138. Gulf of Papua
139. Arafura Sea
140. Arnhem Coast to Gulf of Carpenteria
141. Bonaparte Coast

33. Northeast Australian Shelf
142. Torres Strait Northern Great Barrier Reef
143. Central and Southern Great Barrier Reef

34. Northwest Australian Shelf
144. Exmouth to Broome
145. Ningaloo

35. Tropical Southwestern Pacific
146. Tonga Islands
147. Fiji Islands
148. Vanuatu
149. New Caledonia
150. Coral Sea

36. Lord Howe and Norfolk Islands
151. Lord Howe and Norfolk Islands

Eastern Indo-Pacific

37. Hawaii
152. Hawaii

38. Marshall, Gilbert, and Ellis Islands
153. Marshall Islands
154. Gilbert/Ellis Island

39. Central Polynesia
155. Line Islands
156. Phoenix/Tokelau/Northern Cook Islands
157. Samoa Islands

40. Southeast Polynesia
158. Tuamotus
159. Rapa-Pitcairn
160. Southern Cook/Austral Islands
161. Society Islands

41. Marquesas
162. Marquesas

42. Easter Island
163. Easter Island

Tropical Eastern Pacific

43. Tropical East Pacific
164. Revillagigedos
165. Clipperton
166. Mexican Tropical Pacific
167. Chiapas–Nicaragua
168. Nicoya
169. Cocos Islands
170. Panama Bight
171. Guayaquil

44. Galapagos
172. Northern Galapagos Islands
173. Eastern Galapagos Islands
174. Western Galapagos Islands

Temperate South America

45. Warm Temperate Southeastern Pacific
175. Central Peru
176. Humboldtian
177. Central Chile
178. Araucanian

46. Juan Fernández and Desventuradas
179. Juan Fernández and Desventuradas

47. Warm Temperate Southwestern Atlantic
180. Southeastern Brazil
181. Rio Grande
182. Rio de la Plata
183. Uruguay–Buenos Aires Shelf

48. Magellanic
184. North Patagonian Gulfs
185. Patagonian Shelf
186. Malvinas/Falklands
187. Channels and Fjords of Southern Chile
188. Chiloense

49. Tristan Gough
189. Tristan Gough

Temperate Southern Africa

50. Benguela
190. Namib
191. Namaqua

51. Agulhas
192. Agulhas Bank
193. Natal

52. Amsterdam–St Paul
194. Amsterdam–St Paul

Temperate Australasia

53. Northern New Zealand
195. Kermadec Island
196. Northeastern New Zealand
197. Three Kings–North Cape

54. Southern New Zealand
198. Chatham Island
199. Central New Zealand
200. South New Zealand
201. Snares Island

55. East Central Australian Shelf
202. Tweed-Moreton
203. Manning-Hawkesbury
56. Southeast Australian Shelf
204. Cape Howe
205. Bassian
206. Western Bassian

57. Southwest Australian Shelf
207. South Australian Gulfs
208. Great Australian Bight
209. Leeuwin

58. West Central Australian Shelf
210. Shark Bay
211. Houtman

Southern Ocean

59. Subantarctic Islands
212. Macquarie Island
213. Heard and Macdonald Islands
214. Kerguelen Islands
215. Crozet Islands
216. Prince Edward Islands
217. Bouvet Island
218. Peter the First Island

60. Scotia Sea
219. South Sandwich Islands
220. South Georgia
221. South Orkney Islands
222. South Shetland Islands
223. Antarctic Peninsula

61. Continental High Antarctic
224. East Antarctic Wilkes Land
225. East Antarctic Enderby Land
226. East Antarctic Dronning Maud Land
227. Weddell Sea
228. Amundsen/Bellingshausen Sea
229. Ross Sea

62. Subantarctic New Zealand
230. Bounty and Antipodes Islands
231. Campbell Island
232. Auckland Island

FIGURE 9 Marine ecoregions of the world. Wallis and Futuna is under bioregion 157. Samoa Islands.

APPENDIX 2

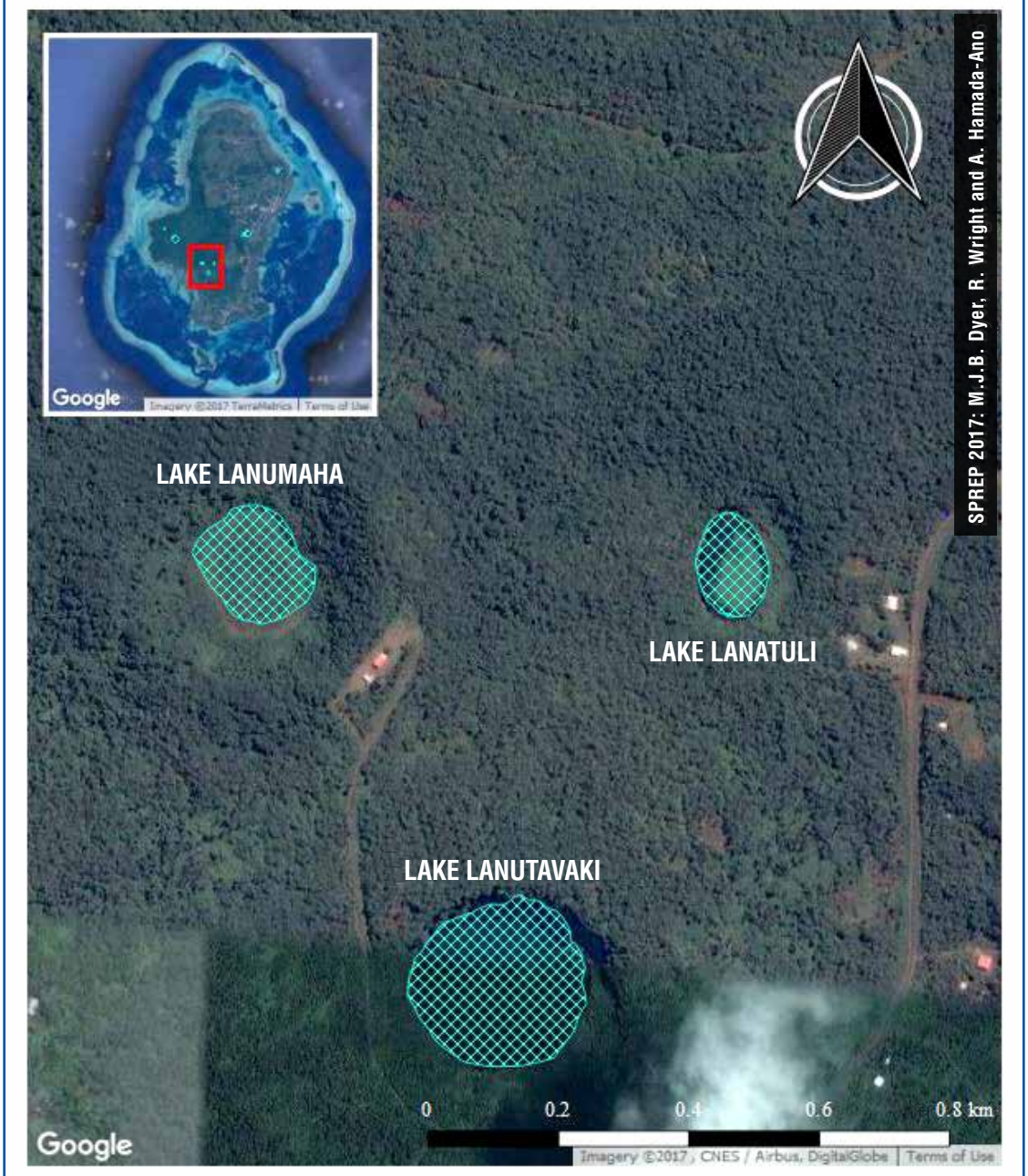

FIGURE 10 Southern Uvea crater lakes, Uvea Island, Wallis and Futuna. Map created by: M J.B. Dyer, R. Wright and A. Hamada-Ano.

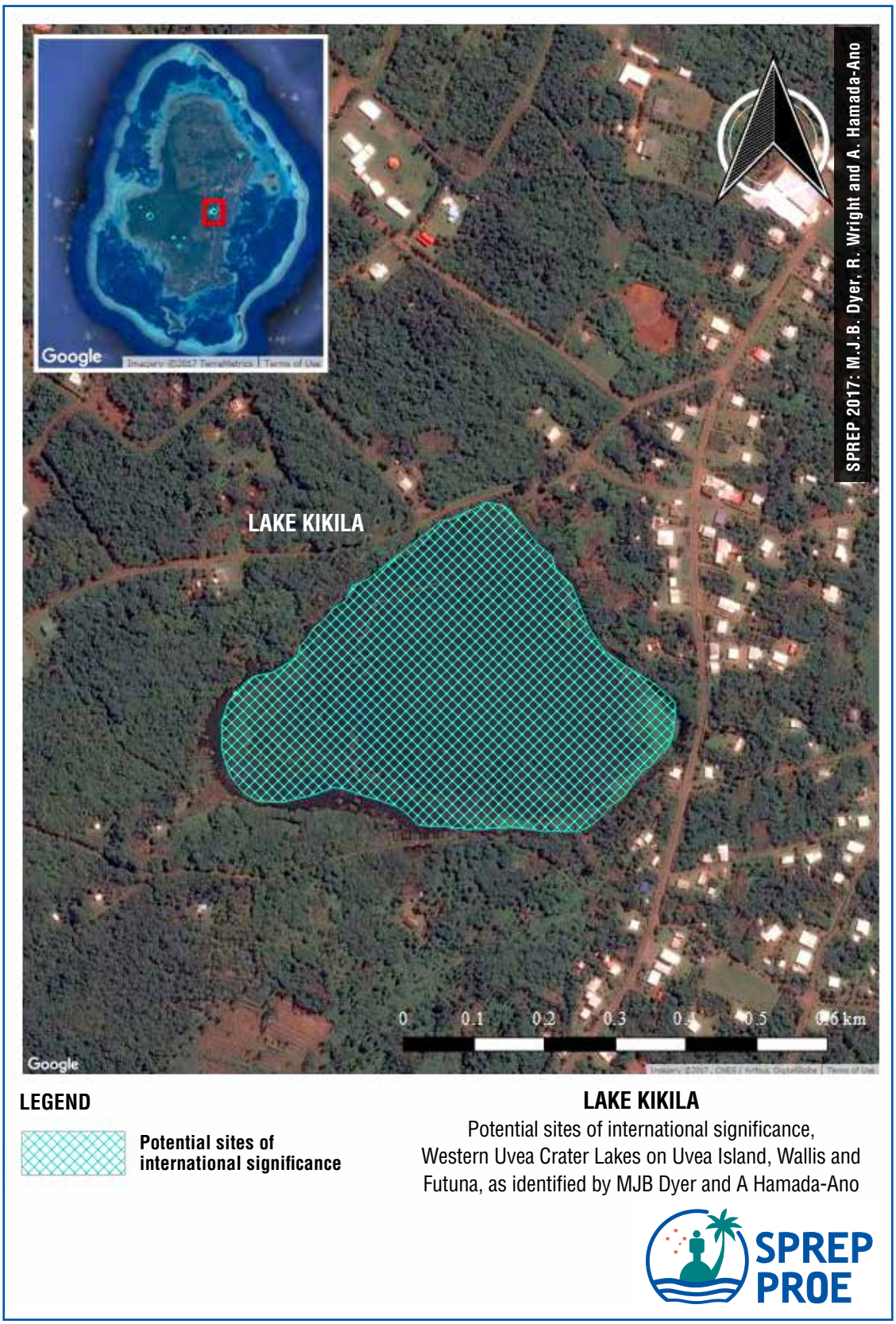

FIGURE 11 Eastern Uvea crater lake, Uvea Island, Wallis and Futuna. Map created by: M J.B. Dyer, R. Wright and A.Hamada-Ano.

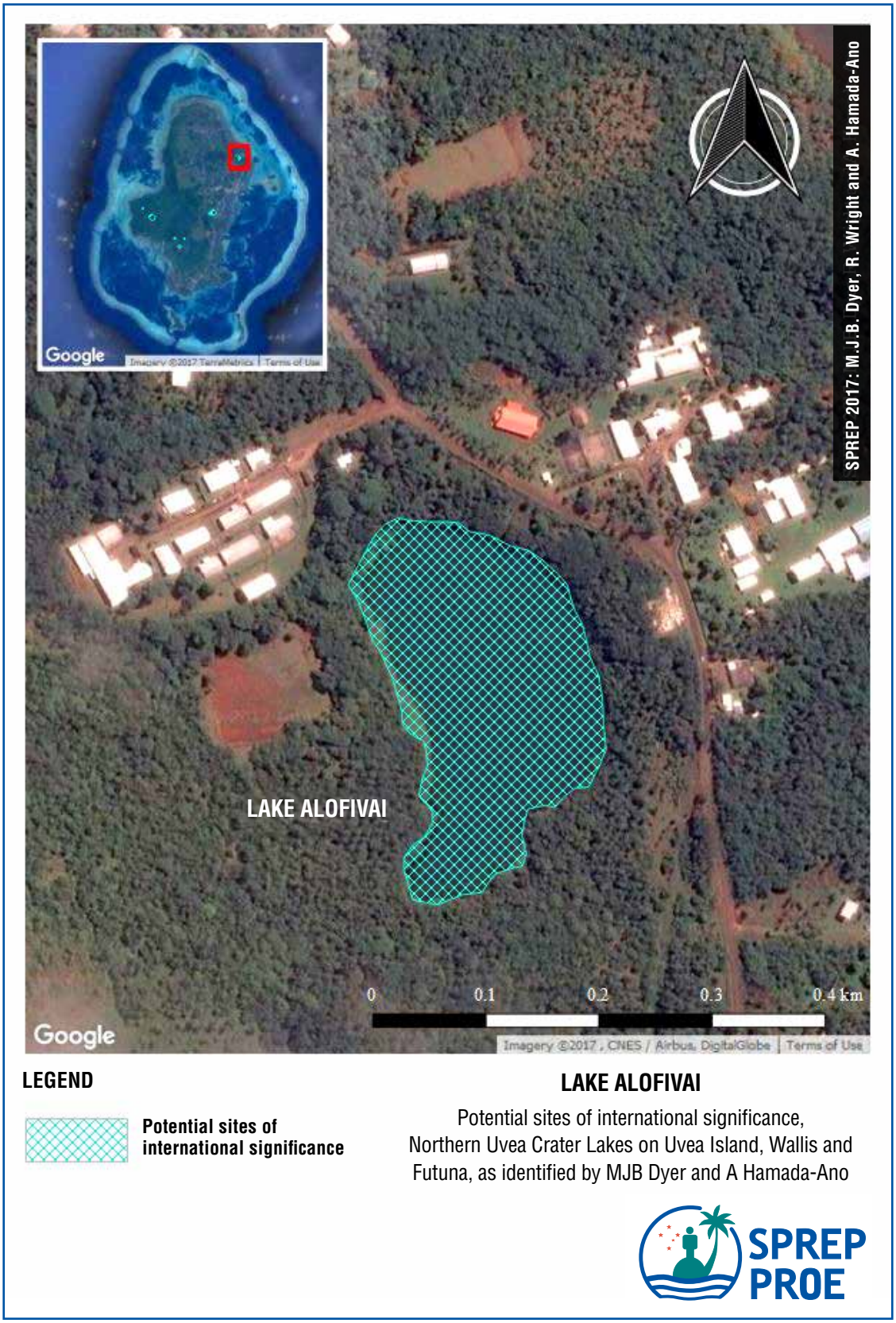

FIGURE 12 North Eastern Uvea crater lakes, Uvea Island, Wallis and Futuna. Map created by: M J.B. Dyer, R. Wright and A. Hamada-Ano.

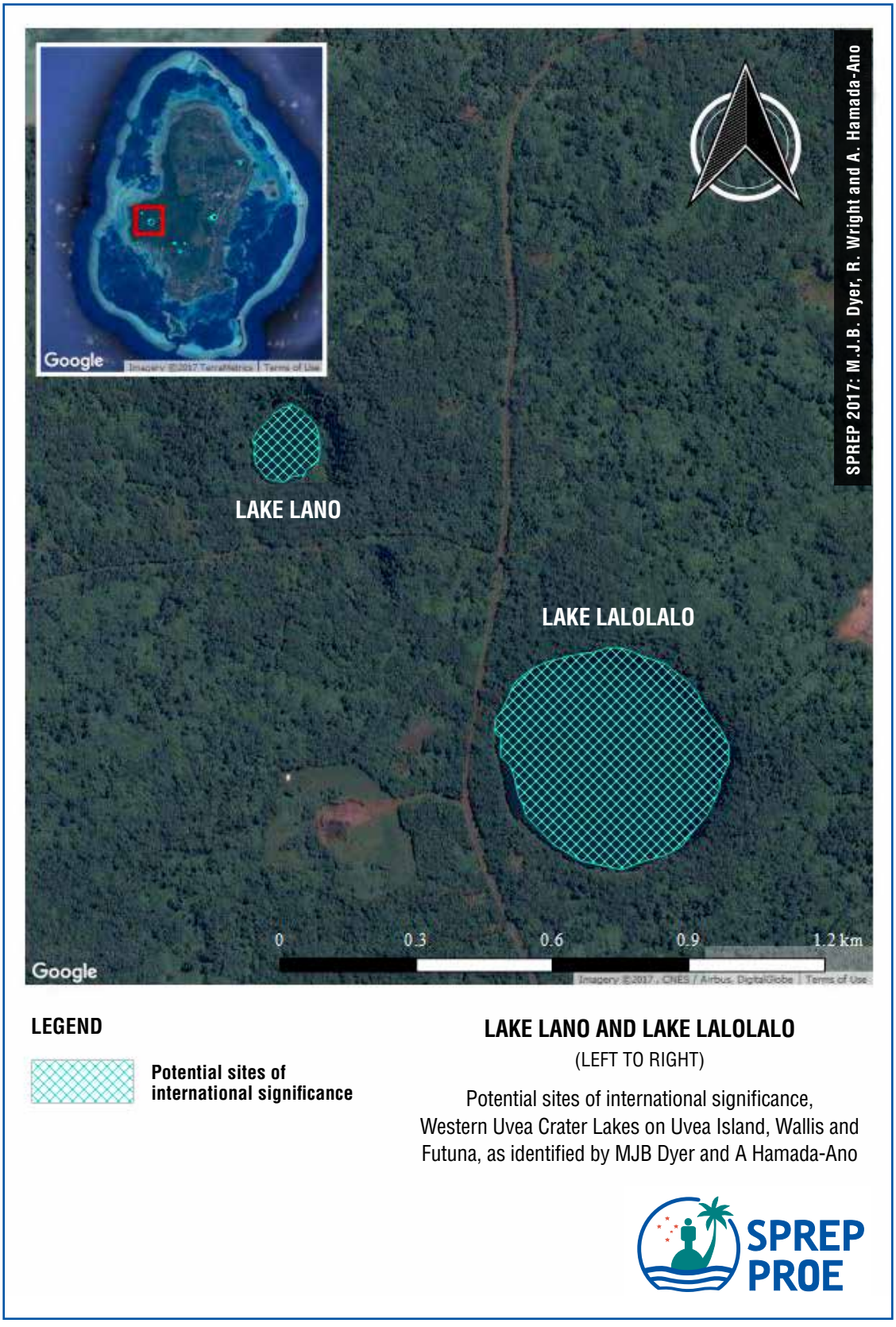

FIGURE 13 Western Uvea crater lakes, Uvea Island, Wallis and Futuna. Map created by: M J.B. Dyer, R. Wright and A.Hamada-Ano.

APPENDIX 3

TABLE 5 Freshwater species present in Wallis and Futuna Islands

Black: Futuna **Blue: Wallis and Futuna** **Green: Wallis**

* endemic ** introduced

(Keith and Marquet, 2011) Complied by Akiko Hamada-Ano.

				Habitat Types (Ramsar Wetland Code)							
Family	**Species**	**Local Common Name**	**English Common Name**	**Permanent shallow marine waters (A)**	**Estuarine waters (F)**	**Intertidal forested wetlands (I)**	**Coastal brackish/ saline lagoons (J)**	**Rivers/ streams/ creeks (M/N)**	**Lakes (O/P)**	**Marshes/ pools (Tp/Ts)**	**Irrigated land (3)**
Crustacean Species											
Atyidae	*Atyoida pilipes*		Green lace shrimp					x			
	Atyopsis spinipes	Ula-ula	Bamboo shrimp					x			
	Caridina serratirostris		Ninja shrimp		x			x			
	Caridina typus		Type shrimp					x			
	Caridina weberi		Weber's shrimp					x			
Palaemonidae	*Macrobrachium aemulum*	Ula-ula	Noumea river prawn					x			
	Macrobrachium australe	Ula-ula	Koua river prawn	x	x		x	x			
	Macrobrachium gracilirostre		Lollipop prawn	x				x			
	Macrobrachium grandimanus		Hawaiian river prawn	x	x						
	Macrobrachium lar	Ula-ula	Giant jungle prawn	x	x			x			
	Macrobrachium latimanus	Ula-ula	Mountain river prawn	x				x			
	Macrobrachium placidulum		Peaceful prawn	x				x			
	Palaemon concinnus		Mangrove prawn		x			x			
	Palaemon debilis		Feeble prawn	x	x	x	x	x			
Varunidae	*Ptychognathus barbatus*				x			x			
	Ptychognathus hachijyoensis				x			x			
	Ptychognathus pusillus							x			
Sesarmidae	*Geosesarma angustifrons*							x			

				Habitat Types (Ramsar Wetland Code)							
Family	**Species**	**Local Common Name**	**English Common Name**	**Permanent shallow marine waters (A)**	**Estuarine waters (F)**	**Intertidal forested wetlands (I)**	**Coastal brackish/ saline lagoons (J)**	**Rivers/ streams/ creeks (M/N)**	**Lakes (O/P)**	**Marshes/ pools (Tp/Ts)**	**Irrigated land (3)**
Fish Species											
Anguillidae	*Anguilla marmorata*	Tuna mea	Giant mottled eel		x			x			
	Anguilla megastoma	Tuna mea	Polynesian longfinned-eel		x			x			
	Anguilla obscura	Tuna uli, Pokofu	Pacific shortfinned-eel					x	x		x
Poeciliidae	*Poecilia reticulata***		Guppy						x	x	x
Syngnathidae	*Microphis retzii*	Tia'l pape	Ragged-tail pipefish		x			x			
Kuhliidae	*Kuhlia marginata*	Loka loka	Dark-margined flagtail		x			x			
	Kuhlia rupestris	Loka loka	Rock flagtail	x	x			x			
Cichlidae	*Oreochromis mossambicus***	Tilapia, Lapia	Mozambique tilapia		x			x	x		
Eleotridae	*Eleotris fusca*	Tolo	Dusky sleeper	x	x			x			
Gobiidae	*Akihito funtuna**		Futuna's emperor	x				x			
	Awaous ocellaris	Tolo		x				x			
	Lentipes kaaea		Caledonian red-nose	x				x			
	Sicyopterus lagocephalus	Tolo	Red-tailed goby	x			x	x			
	*Smilosicyopus sasali**		Sasal's sicyopus	x				x			
	*Stenogobius keletaona**		Keletaona's Goby	x				x			
	Stiphodon elegans	Tolo		x			x	x			
	Stiphodon hydrorebatus			x			x	x			
	*Stiphodon rubromaculatus**							x		x	

APPENDIX 4

TABLE 6 Crustacean species present in the wetland areas in Wallis and Futuna (Poupin, 2005).

Order	Group	Family	Genus	Species
Stomatopoda		Gonodactylidae	*Gonodactylus*	*chiragra*
Decapoda		Lysioquilloidea	*Lysioquillina*	*maculata*
	Crevetes	Stenopodidae	*Stenopus*	*hispidus*
		Atyidae	*Atyoida*	*pilipes*
				sninipes
			Cardina	*typus*
				serratirostris
				weberi
		Rhynchocinetidae	*Cinetorhynchus*	*striatus*
		Palaemonidae	*Coralliocaris*	*sp.*
		Hippolytidae	*Marcobrachium*	*aemulum*
				australe
				gracilirostre
				grandimanus
				lar
				latimanus
				placidulum
			Paleamon	*concinnus*
				debilis
			Saron	*marmoratus*
		Callianassidae	*Corallianassa*	*coutierei*
	Langoustes	Scyllaridae	*Parribacus*	*caledonicus*
		Pallinuridae	*Panulirus*	*femoristriga*
				penicillatus
				versicolor
	Anormoures	Galatheidae	*Galathea*	*mauritiana*
		Porcellanidae	*Petrolisthes*	*fimbriatus*
				hastatus
				haswelli
				lamarckii
		Coenobitidae	*Birgus*	*latro*
			Coenobita	*brevimanus*
				perlatus
				rugosus
				spinosus
		Diogenidae	*Aniculus*	*retipes*
				ursus
			Calcinus	*elegans*
				laevimanus
				latens
				minutus
				morgani
				seurati

Order	Group	Family	Genus	Species
			Clibanarius	*strigatus*
				corallinus
				merguiensis
				eurysternus
				humilis
				ransoni
				striolatus
			Dardanus	*guttatus*
				lagopodes
				megistos
				scutellatus
	Crabes	Calappidae	*Calappa*	*calappa*
				hepatica
		Leucosiidae	*Nucia*	*speciosa*
		Majoidea	*Camposcia*	*retusa*
		Epialtidae	*Menathius*	*monoceros*
		Parthenopidae	*Rhinolambrus*	*pelagicus*
		Portunidae	*Scylla*	*serrata*
			Thalamita	*ademete*
				gloriensis
				chaptalii
				crenata
				danae
				picta
				prymna
		Carpiliidae	*Carpilius*	*convexus*
				maculatus
		Menippidae	*Eriphia*	*scabricula*
				sebana
				annulipes
			Pseudozius	*caystrus*
		Pilumnidae	*Pilumnus*	*verspertilio*
		Tetriliidae	*Tetralia*	*glaberrima*
				rubridactylya
				nigrifrons
		Trapeziidae	*Trapezia*	*bidentata*
				rufopunctata
				septata
		Xanithidae	*Actaeodes*	*tomentosus*
			Atergatis	*floridus*
				subdentatus
			Chlorodiella	*laevissima*
				nigra

Order	Group	Family	Genus	Species
			Cymo	*melanodactylus*
				demani
				splendidus
			Leptodius	*gracilis*
				nudipes
				sanguineus
			Liomera	*rugata*
				bella
			Pilodius	*arealatus*
			Pseudoliomera	*speciosa*
			Xanthias	*lamarcki*
				tetraodon
			Zozimus	*aeneus*
		Ocypodidae	*Marophthalmus*	*boscii*
				convexus
			Ocypode	*ceratophthalma*
				cordimana
				pallidula
			Uca	*crassipes*
				neocultrimana
				perplexa
				tetragonon
		Gecaricinidae	*Cardisoma*	*carnifex*
			Discoplax	*rotunda*
		Grapsidae	*Geograpsus*	*crinipes*
				grayi
				stormi
				intermedius
				tenuicrustatus
			Metopograpsus	*thukuhar*
			Pachygrapsus	*minutus*
				planifrons
				plicatus
			Pseudograpsus	*allbus*
			Thalassograpsus	*harpax*
		Plagusiidae	*Percnon*	*guinotae*
				planissimum
		Sesarmidae	*Parasesarma*	*picatum*
		Varunidae	*Ptychognathus*	*barbatus*
				hachijyoensis

APPENDIX 5

TABLE 7 The planktonic species present in the Uvea crater lakes (Sichrowsky et al. 2014).
LL = Lalolalo LV=Lanutavake LN=Lano

Group	Genus	Species	Wetland	Distribution
Cyanoprokaryota	*Aphanocapsa*	sp.	LV, LN	
	Aphanothece	sp.	LV	
Pyrrhophyta	*Gymnodinium*	sp.	LL	
	Peridinium	*africanum*	LM	Cosmopolitan
	Peridinium	*striolatum*	LN	
	Peridinium	spp.	LL, LV, LN	Australia
Cryptophyta	*Cryptomonas*	*obovata*	LL	Europe
	Cryptomanos	sp.	LL, LN	
Chlorphyta	*Actinastrum*	*hantzchii*	LN	
	Chlamydomonas	sp.	LL	
	Chlorella	sp.	LL	
	Coelastrum	*pulchrum*	LV	Cosmopolitan
	Coelastrum	*reticulatum* var. *cubanum*	LV	Tropical
	Coelastrum	*sphaericum*	LN	Cosmopolitan
	Didymocystis	*fina*	LN	Cuba, probably cosmopolitan
	Lagerheimia	*ciliata*	LN	
	Monoraphidium	*arcuatum*	LL, LN	
	Monoraphidium	*komarkovae*	LN	
	Nephrochlamys	*rotunda*	LN	Africa, cosmopolitan
	Pediastrum	*tetras*	LN	
	Pediastrum	*tetras* var. *tetradon*	LN	
	Scenedesmus	*communis*	LN	Cosmopolitan
	Scenedesmus	*magnus*	LN	Cosmopolitan
	Scenedesmus	*octocauda*	LN	
	Tetrastrum	*heteracanthum* var. *homoiacanthum*	LN	Cosmopolitan
	Tetraedron	*triangulare*	LL	Cosmopolitan
Euglenophyta	*Trachelomonas*	*hispida*	LL	Cosmopolitan
Streptophyta	*Cosmarium*	sp.	LV, LN	
Ochrophyta	*Tetraplektron*	*laevis*	LN	
	Pseudostaurastrum	*limneticum*	LN	Cosmopolitan
	Tetraedriella	*acuta*	LN	Cosmopolitan

Group	Genus	Species	Wetland	Distribution
Ciliophora	*Armophea*		LL	
	Cyrtophosis	sp.	LV, LN	
	Mesodinium	sp.	LL, LN	
	Monodinium	sp.	LN	
	Pseudocohnilembus	sp.		
	Cinetochilum	sp.	LL	
	Paraecium	sp.	LV	
	Coplidium	sp.	LV	
	Vorticella	sp.	LL	
	Coleps	sp.		
	Coleps	sp. *holophrya*	LV	
	Urotricha	sp.	LV	
	Halteria	sp.		
	Halteria	*bifurcata*	LN	
	Spirotrichia		LL	
	Karyorelictea		LL	
Rotifera	*Anuraeopsis*	*fissa*	LV, LN	
	Ascomorpha	*saltans saltans*	LV, LN	
	Asplanchna	*brightwelli*	LN	
	Brachionus	*quadridentatus*	LN	
	Colurella	*obtusa*	LN	
	Epiphanse	*brachionus* var. *spinosa*	LL	Cosmopolitan
	Filinia	*longiseta*	LN	Cosmpolitan
	Hexarthra	*brandorffi*	LL	Western hemisphere
	Keratella	*quadrata*	LL,LN, LV	
	Lecane	sp.	LN, LV	
	Lecane	*closterocera*	LV	
	Lepadella	sp.	LV	
	Polyarthra	*indica*	LL, LV, LN	Africa
	Synchaeta	sp.	LL	
	Trichocerca	*chattonia*	LN	Comspoloitan
	Trichocera	*pusilla*	LN	Comspoloitan
	Trichocera	*tenuior*	LV, LL	Comspoloitan
Copepoda	*Mesocyclops*	*aspericornis*	LL, LV, LN	Tropical
Cladocera	*Ceriodaphinia*	*cornuta*	LV	Tropical
Gastrotricha	*Polymerurus*	sp.	LV	

APPENDIX 6

TABLE 8 The marine species in the Uvea Lagoon, Wallis and Futuna. (https://www.alr-journal.org/articles/alr/olm/2004/02/alr23/online_mat_alr23.pdf). Compiled by Akiko Hamada-Ano.

Common name	Family (Scientific)	Family (Common)	Genus	Species
Blackstreak surgeonfish	Acanthuridae	Surgeonfishes, Tangs, Unicornfishes	*Acanthurus*	*nigricauda*
Brown surgeonfish		Surgeonfishes, Tangs, Unicornfishes	*Acanthurus*	*nigrofuscus*
Elongate surgeonfish		Surgeonfishes, Tangs, Unicornfishes	*Acanthurus*	*mata*
Eyestripe surgeonfish		Surgeonfishes, Tangs, Unicornfishes	*Acanthurus*	*dussumieri*
Humpnose unicornfish		Surgeonfishes, Tangs, Unicornfishes	*Naso*	*tuberosus*
Orangeband surgeonfish		Surgeonfishes, Tangs, Unicornfishes	*Acanthurus*	*olivaceus*
Orangespine unicornfish		Surgeonfishes, Tangs, Unicornfishes	*Naso*	*lituratus*
Ringtail surgeonfish		Surgeonfishes, Tangs, Unicornfishes	*Acanthurus*	*blochii*
Spotted unicornfish		Surgeonfishes, Tangs, Unicornfishes	*Naso*	*brevirostris*
Striated surgeonfish		Surgeonfishes, Tangs, Unicornfishes	*Ctenochaetus*	*striatus*
Whitemargin unicornfish		Surgeonfishes, Tangs, Unicornfishes	*Naso*	*annulatus*
Yellowfin surgeonfish		Surgeonfishes, Tangs, Unicornfishes	*Acanthurus*	*xanthopterus*
Arrowtooth cardinalfish	Apogonidae	Cardinalfishes	*Cheilodipterus*	*lachneri*
Bridled cardinalfish		Cardinalfishes	*Apogon*	*fraenatus*
Doederlein's cardinalfish		Cardinalfishes	*Apogon*	*deoederleini*
Five-lined cardinalfish		Cardinalfishes	*Cheilodipterus*	*quinquelineatus*
Goldbelly cardinalfish		Cardinalfishes	*Apogon*	*apogonides*
Iridescent cardinalfish		Cardinalfishes	*Apogon*	*kallopterus*
Narrowstripe cardinalfish		Cardinalfishes	*Apogon*	*exostigma*
Ringtailed cardinalfish		Cardinalfishes	*Apogon*	*aureus*
Sevenstriped cardinalfish		Cardinalfishes	*Apogon*	*novemfasciatus*
Three-spot cardinalfish		Cardinalfishes	*Apogon*	*trimaculatus*
Yellowstriped cardinalfish		Cardinalfishes	*Apogon*	*cyanosoma*
Clown triggerfish	Balistidae	Triggerfishes	*Balistoides*	*conspicillum*
Halfmoon triggerfish		Triggerfishes	*Sufflamen*	
Masked triggerfish		Triggerfishes	*Sufflamen*	
Orange-lined triggerfish		Triggerfishes	*Balistapus*	

Common name	Family (Scientific)	Family (Common)	Genus	Species
Titan triggerfish		Triggerfishes	*Balistoides*	
Bluestriped fangblenny		Combtooth blennies	*Plagiotremus*	
Floral blenny		Combtooth blennies	*Petroscirtes*	
Piano fangblenny		Combtooth blennies	*Plagiotremus*	
Dark-banded fusilier	Caesionidae	Fusiliers	*Pterocaesio*	
Double-lined fusilier		Fusiliers	*Pterocaesio*	
Banana fusilier		Fusiliers	*Pterocaesio*	
Three-striped fusilier		Fusiliers	*Pterocaesio*	
Bluefin trevally	Carangidae	Jacks and Pompanos	*Caranx*	
Indian scad		Jacks and Pompanos	*Decapterus*	
Yellowspotted trevally		Jacks and Pompanos	*Carangoides*	
Blacklip butterflyfish	Chaetodontidae	Butterflyfish	*Chaetodon*	
Blue-spot butterflyfish		Butterflyfish	*Chaetodon*	
Dot & Dash butterflyfish		Butterflyfish	*Chaetodon*	
Indian Redfin butterflyfish		Butterflyfish	*Chaetodon*	
Lined butterflyfish		Butterflyfish	*Chaetodon*	
Longfin bannerfish		Butterflyfish	*Heniochus*	
Saddled butterflyfish		Butterflyfish	*Chaetodon*	
Speckled butterflyfish		Butterflyfish	*Chaetodon*	
Threadfin butterflyfish		Butterflyfish	*Chaetodon*	
Vagabond butterflyfish		Butterflyfish	*Chaetodon*	
Yellowback butterflyfish		Butterflyfish	*Chaetodon*	
Yellow-crowned butterflyfish		Butterflyfish	*Chaetodon*	
Blackside hawkfish	Cirrhitidae	Hawfishes	*Paracirrhites*	
Dwarf hawkfish		Hawkfishes	*Cirrhitichthys*	*falco*
Blue-spotted stingray	Dasyatidae	Stingrays	*Dasyatis*	*kuhlii*
Blueband goby	Gobiidae	Gobies	*Valenciennea*	*strigata*
Maiden goby		Gobies	*Valenciennea*	*puellaris*
Steinitz' prawn-goby		Gobies	*Amblyeleotris*	*steinitzi*
Whitebarred goby		Gobies	*Amblygobius*	*phalaena*
Dotted sweetlips	Haemulidae	Sweetlips	*Plectorhinchus*	*picus*
Giant sweetlips		Sweetlips	*Plectorhinchus*	*obscurus*
Many-spotted sweetlips		Sweetlips	*Plectorhinchus*	*chaetodonoides*
Painted sweetlips		Grunts	*Diagramma*	*picturn*
Yellowbanded sweetlips		Sweetlips	*Plectorhinchus*	*goldmanni*
Crown squirrelfish	Holocentridae	Squirrelfishes and Soldierfishes	*Sargocentron*	*diadema*

Common name	Family (Scientific)	Family (Common)	Genus	Species
Sabre squirrelfish		Squirrelfishes and Soldierfishes	*Sargocentron*	*spiniferum*
Bluestreak cleaner wrasse	Labridae	Wrasses	*Labroides*	*dimidiatus*
Bluntheaded wrasse		Wrasses	*Thalassoma*	*amblycephalum*
Canary wrasse		Wrasses	*Halichoeres*	*chrysus*
Cigar wrasse		Wrasses	*Cheilio*	*intermis*
Cutribbon wrasse		Wrasses	*Stethojulis*	*interrupta*
Floral wrasse		Wrasses	*Cheilinus*	*chlorourus*
Golden-spot hogfish		Wrasses	*Bodianus*	*perditio*
Hartzfeld's wrasse		Wrasses	*Halichoeres*	*hartzfeldii*
Humphead wrasse		Wrasses	*Cheilinus*	*undulatus*
Jansen's wrasse		Wrasses	*Thalassoma*	*jansenii*
Moon wrasse		Wrasses	*Thalassoma*	*lunare*
Pale-barred coris		Wrasses	*Coris*	*dorsomacula*
Peacock wrasse		Wrasses	*Xyrichtys*	*pavo*
Red shoulder wrasse		Wrasses	*Stethojulis*	*bandanensis*
Slender wrasse		Wrasses	*Suezichthys*	*gracilis*
Three-ribbon wrasse		Wrasses	*Stethojulis*	*strigiventer*
Threespot wrasse		Wrasses	*Halichoeres*	*trimaculatus*
Two-spot wrasse		Wrasses	*Oxycheilinus*	*bimaculatus*
Yellow-brown wrasse		Wrasses	*Thalassoma*	*lutescens*
Yellowspotted wrasse		Wrasses	*Macropharyngodon*	*negrosensis*
Yellowtail coris		Wrasses	*Coris*	*gaimard*
Humpnose bigeye bream	Lethrinidae	Emperors or Scavengers	*Monotaxis*	*grandoculis*
Longface emperor		Emperors or Scavengers	*Lethrinus*	*olivaceus*
Longspine emperor		Emperors or Scavengers	*Lethrinus*	*genivittatus*
Spangled emperor		Emperors or Scavengers	*Lethrinus*	*nebulosus*
Spotcheek emperor		Emperors or Scavengers	*Lethrinus*	*rubrioperculatus*
Striped large-eye bream		Emperors or Scavengers	*Gnathodentex*	*aureolineatus*
Bluestripe snapper	Lutjanidae	Snappers	*Lutjanus*	*kasmira*
Five-lined snapper		Snappers	*Lutjanus*	*quinquelineatus*
Humpback snapper		Snappers	*Lutjanus*	*gibbus*
Green jobfish		Snappers	*Aprion*	*virescens*
Black and white snapper		Snappers	*Macolor*	*niger*
Brownstripe red snapper		Snappers	*Lutjanus*	*vitta*
Two-spot red snapper		Snappers	*Lutjanus*	*bohar*
Blue blanquillo	Malacanthidae	Tilefishes	*Malacanthus*	*latovittatus*
Quakerfish		Tilefishes	*Malacanthus*	*breviorstris*

Common name	Family (Scientific)	Family (Common)	Genus	Species
Blackfin dartfish	Microdesmidae	Wormfishes	*Ptereleotris*	*evides*
Bicolor goatfish	Mullidae	Goatfishes	*Parupeneus*	*barberinoides*
Cinnabar goatfish		Goatfishes	*Parupeneus*	*heptacanthus*
Dash-and-dot goatfish		Goatfishes	*Parupeneus*	*barberinus*
Freckled goatfish		Goatfishes	*Upeneus*	*tragula*
Gold-saddled goatfish		Goatfishes	*Parupeneus*	*cyclostomus*
Indian goatfish		Goatfishes	*Parupeneus*	*indicus*
Yellowstripe goatfish		Goatfishes	*Mullodichthys*	*flavolineatus*
Greyface moray	Muraenidae	Moray eels	*Siderea*	*thysoidea*
Bridled monocle bream	Nemipteridae	Coral Breams	*Scolopsis*	*bilineata*
Black dotted sand perch	Pinguipedidae	Sandperch	*Parapercis*	*millepunctata*
Cylindrical sandperch		Sandperch	*Parapercis*	*cylindrica*
Latticed sandperch		Sandperch	*Parapercis*	*clathrata*
Speckled sandperch		Sandperch	*Parapercis*	*hexophtalma*
Emperor angelfish	Pomacanthidae	Angelfishes	*Pomacanthus*	*imperator*
Keyhole angelfish		Angelfishes	*Centropyge*	*tibicen*
Two-spined angelfish		Angelfishes	*Centropyge*	*bispinosus*
Bicolor angelfish		Angelfishes	*Centropyge*	*bicolor*
Ambon damsel		Damselfishes	*Pomacentrus*	*amboinensis*
Barrier reef anemonefish		Damselfishes	*Amphiprion*	*akindynos*
Barrier reef chromis		Damselfishes	*Chromis*	*nitida*
Black-tailed dascyllus		Damselfishes	*Dascyllus*	*melanurus*
Blue damsel		Damselfishes	*Pomacentrus*	*pavo*
Blue-green chromis		Damselfishes	*Chromis*	*viridis*
Clark's anemonefish		Damselfishes	*Amphiprion*	*clarkii*
Humbug dascyllus		Damselfishes	*Dascyllus*	*aruanus*
Lemon damsel		Damselfishes	*Pomacentrus*	*moluccensis*
Neon damsel		Damselfishes	*Pomacentrus*	*coelestis*
Pacific half-half chromis		Damselfishes	*Chromis*	*iomelas*
Philippine damsel		Damselfishes	*Pomacentrus*	*philippinus*
Princess damsel		Damselfishes	*Pomacentrus*	*vaiuli*
Reticulated dascyllus		Damselfishes	*Dascyllus*	*reticulatus*
Smoky chromis		Damselfishes	*Chromis*	*fumea*
Starck's demoiselle		Damselfishes	*Chrysiptera*	*starcki*
Stout-body chromis		Damselfishes	*Chromis*	*chrysura*
Ternate chromis		Damselfishes	*Chromis*	*ternatensis*
Threeband anemonefish		Damselfishes	*Amphiprion*	*tricinctus*
Three-spot dascyllus		Damselfishes	*Dascyllus*	*trimaculatus*

Common name	Family (Scientific)	Family (Common)	Genus	Species
Vanderbilt's chromis		Damselfishes	*Chromis*	*vanderbilti*
Weber's chromis		Damselfishes	*Chromis*	*weberi*
Yellow-axil chromis		Damselfishes	*Chromis*	*xanthura*
Moontail bullseye	Priacanthidae	Bigeyes or Catalufas	*Priacanthus*	*hamrur*
Bicolour parrotfish	Scaridae	Parrotfishes	*Cetoscarus*	*bicolor*
Blue-barred parrotfish		Parrotfishes	*Scarus*	*ghobban*
Daisy parrotfish		Parrotfishes	*Chlorurus*	*sordidus*
Filament-fin parrotfish		Parrotfishes	*Scarus*	*altipinnis*
Highfin parrotfish		Parrotfishes	*Scarus*	*longipinnis*
Pacific longnose parrotfish		Parrotfishes	*Hipposcarus*	*longiceps*
Palenose parrotfish		Parrotfishes	*Scarus*	*psittacus*
Steephead parrotfish		Parrotfishes	*Scarus*	*microrhinos*
Swarthy parrotfish		Parrotfishes	*Scarus*	*niger*
Yellowbar parrotfish		Parrotfishes	*Scarus*	*schlegeli*
Kawakawa	Scombridae	Mackerels, Tunas, Bonitos	*Euthynnus*	*affinis*
Shortfin turkeyfish	Scorpaenidae	Scorpionfishes or Rockfishes	*Dendrochirus*	*brachypterus*
Blacksaddled coralgrouper	Serranidae	Seabasses: Groupers and Fairy Basselets	*Plectropomus*	*laevis*
Blacktip grouper		Groupers	*Epinephelus*	*fasciatus*
Coral grouper		Seabasses: Groupers and Fairy Basselets	*Cephalopholis*	*miniata*
Flagtail grouper		Seabasses: Groupers and Fairy Basselets	*Cephalopholis*	*urodeta*
Goldenstriped soapfish		Seabasses: Groupers and Fairy Basselets	*Grammistes*	*sexlineatus*
Highfin grouper		Groupers	*Epinephelus*	*maculatus*
Honeycomb grouper		Groupers	*Epinephelus*	*merra*
Leopard coralgrouper		Seabasses: Groupers and Fairy Basselets	*Plectropomus*	*leopardus*
Peacock grouper		Seabasses: Groupers and Fairy Basselets	*Cephalopholis*	*argus*
Snubnose grouper		Groupers	*Epinephelus*	*macrospilos*
Speckled Blue grouper		Seabasses: Groupers and Fairy Basselets	*Epinephelus*	*cyanopodus*
Starspotted grouper		Seabasses: Groupers and Fairy Basselets	*Epinephelus*	*hexagonatus*
Tomato grouper		Seabasses: Groupers and Fairy Basselets	*Cephalopholis*	*sonnerati*
Yellow-edged lyretail		Seabasses: Groupers and Fairy Basselets	*Variola*	*louti*
Scalefin anthias	Serranidae/ Anthiinae	Anthias	*Pseudanthias*	*squamipinnis*

Common name	Family (Scientific)	Family (Common)	Genus	Species
Stocky anthias	Serranidae/ Anthiinae	Anthias	*Pseudanthias*	*hypselosoma*
Gold-spotted rabbitfish	Siganidae	Rabbitfishes	*Siganus*	*punctatus*
Blackear lizardfish	Synodontidae	Lizardfishes	*Synodus*	*hoshinonis*
Sand lizardfish		Lizardfishes	*Synodus*	*dermatogenys*
Variegated lizardfish		Lizardfishes	*Synodus*	*variegatus*
Humpback turretfish	Tetraodontidae	Puffers and filefishes	*Tetrosomus*	*gibbosus*
Spot-fin porcupinefish		Puffers and filefish	*Diodon*	*hystrix*
Valentin's sharpnose puffer		Puffers and Filefishes	*Canthigaster*	*valentini*
White-spotted puffer		Puffers	*Arothron*	*hispidus*
Yellow boxfish		Pufferfish and Filefishes	*Ostracion*	*cubicus*
Yellow-spotted triggerfish		Puffers and filefishes	*Pseudobalistes*	*fuscus*
Moorish idol	Zanclidae	Moorish idols	*Zanclus*	*cornutus*

Mangrove seedling. Photo: Pascale Salaun

APPENDIX 7

TABLE 9 Field Assessment of Ecosystem Services according to RAMSAR Guidelines. Data provided by Atoloto Malau Service de l'Environnement, Administration of Wallis and Futuna. Compiled by M J.B. Dyer.

Ecosystem Service	Provisioning	Regulation	Cultural	Supporting
Description	Fresh water, food, fuel, fibre, genetic resources, natural medicines or pharmaceuticals, ornamental resources, clay, mineral aggregate harvesting, waste disposal, energy harvesting from natural air and water flows	Air quality, local climate, global climate, water, diseases, flood hazard, storm hazard, pest, disease – human/livestock, erosion, water purification, pollination, salinity, fire and noise/visual buffering	Cultural heritage, recreation tourism, aesthetic value, spiritual/ religious, inspirational value, social relations and educational/research	Soil formation, primary production, nutrient cycling, water recycling and provision of habitat
Gutuvai River	++	+	+	+
Leava River	++	++	+	++
Sausau River	++	++	+	+
Vanifao River	++	++	++	+
Lake Alofivai	+	+	0	0
Lake Kikila	++	+	++	++
Lake Lalolalo	++	++	++	++
Lake Lano	+	+	+	+
Lake Lanumaha	+	0	+	+
Lake Lanutavake	++	++	++	++
Lake Lanutuli	+	0	+	+
Lake Nuku	+	+	++	++
Uvea Lagoon	++	++	++	++
Taro Plantation	–	–	–	–

Score	Assessment of ecosystem service
++	Significant positive benefit provided
+	Positive benefit
0	Negligible benefit or dis-benefit
–	Negative benefit
––	Significant negative benefit provided
?	Gaps in evidence

6

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7

GLOSSARY[1]

appropriate (Criterion 1) – when applied to the term «biogeographic region» as here, this means the regionalisation which is determined by the Contracting Party to provide the most scientifically rigorous approach possible at the time.

biogeographic region (Criteria 1 & 3) – a scientifically rigorous determination of regions as established using biological and physical parameters such as climate, soil type, vegetation cover, etc. Note that for non-island Contracting Parties, in many cases biogeographic regions will be transboundary in nature and will require collaboration between countries to establish representative, unique, etc., wetland types. In some cases, the term bioregion is used synonymously with biogeographic region. In some circumstances, the nature of biogeographic regionalization may differ between wetland types according to the nature of the parameters determining natural variation.

biological diversity (Criteria 3 & 7) – the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species (genetic diversity), between species (species diversity), of ecosystems (ecosystem diversity), and of ecological processes. (This definition is largely based on the one contained in Article 2 of the Convention on Biological Diversity.)

critically endangered (Criterion 2) – as used by the Species Survival Commission of IUCN. A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined [for both animals and plants by the criteria layed out in the *IUCN Red List Categories and Criteria*] See also 'globally threatened species' below.

ecological communities (Criterion 2) – any naturally occurring group of species inhabiting a common environment, interacting with each other especially through food relationships and relatively independent of other groups. Ecological communities may be of varying sizes, and larger ones may contain smaller ones.

endangered (Criterion 2) – as used by the Species Survival Commission of IUCN. A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined [for both animals and plants by the criteria layed out in the *IUCN Red List Categories and Criteria:* Version 3.1.(IUCN 2001)]. See also ‹globally threatened species› below.

endemic species (Guidelines for Criterion 7) – a species that is unique to one biogeographical region, i.e., it is found nowhere else in the world. A group of fishes may be indigenous to a subcontinent with some species endemic to a part of that subcontinent.

endorheic (or endorrheic) – a water body which loses water only by evaporation, i.e. no stream or river flows from it.

family (Criterion 7) – an assemblage of genera and species that have a common phylogenetic origin, e.g., pilchards, sardines and herrings in the family Clupeidae

fish (Criterion 7) – any finfish, including jawless fishes (hagfishes and lampreys), cartilaginous fishes (sharks, rays, skates and their allies, Chondrichthyes) and bony fishes (Osteichthyes) as well as certain shellfish or other aquatic invertebrates.

fish stock (Criterion 8) – the potentially exploitable component of a fish population.

globally threatened species (Criteria 2, 5 & 6) – species or subspecies which are listed by IUCN Species Survival Commission›s Specialist Groups or Red Data Books as either Critically Endangered, Endangered or Vulnerable. Note that, especially for invertebrate taxa, IUCN›s Red Data listings may be both incomplete and dynamic, reflecting poor knowledge of the global status of many taxa. Interpretation of the terms ‹vulnerable›, ‹endangered› or ‹critically endangered› species should thus always be undertaken at a national level in the light of the best available scientific knowledge of the status of the relevant taxa.

importance (long-term target for Criterion 2) – sites, the protection of which will enhance the local and thus global long-term viability of species or ecological communities.

1 Definitions of the glossary are based on the official Ramsar Glossaries, available at: http://archive.ramsar.org/cda/en/ramsar-about-glossary-terms/main/ramsar/1-36-56-157_4000_0__ Consulted on 21.02.2018

indigenous species (Criterion 7) – a species that originates and occurs naturally in a particular country.

introduced (non-native) species – a species that does not originate or occur naturally in a particular country.

keystone species – species whose loss from an ecosystem would cause a greater than average change in other species populations or ecosystem processes; whose continued well-being is vital for the functioning of a whole community, such as the herring in the North Atlantic or krill in Antarctica.

life-history stage (Criterion 7) – a stage in the development of a finfish or shellfish, e.g., egg, embryo, larva, leptocephalus, zoea, zooplankton stage, juvenile, adult, or post-adult.

migration path (Criterion 8) – the route along which fishes, such as salmon and eels, swim when moving to or from a spawning or feeding ground or nursery. Migration paths often cross international boundaries or boundaries between management zones within a country.

near natural (Criterion 1) – when used in Criterion 1 this means those wetlands which continue to function in what is considered an almost natural way. This clarification is provided in the Criteria to allow for the listing of sites which are not pristine, yet retain values making them internationally important.

nursery (Criterion 8) – that part of a wetland used by fishes for providing shelter, oxygen and food for the early developmental stages of their young. In some fishes, e.g., nest-guarding tilapias, the parent/s remain at the nursery to protect the young whereas in others the young are not protected by the parent/s except by virtue of the shelter provided by the habitat in which they are deposited, e.g., non-guarding catfishes. The ability of wetlands to act as nurseries depends on the extent to which their natural cycles of inundation, tidal exchange, water temperature fluctuation and/or nutrient pulses are retained. Welcomme (1979) showed that 92% of the variation in catch from a wetland-recruited fishery could be explained by the recent flood history of the wetland.

plants (Criteria 3 & 4) – meaning vascular plants, bryophytes, algae and fungi (including lichens).

population (Criterion 7) – in this case meaning a group of fishes comprising members of the same species.

populations (Criterion 3) – in this case meaning the population of a species within the specified biogeographical region.

provides refuge (Criterion 4) – refer also to definition for «critical stage» which is related. Critical stages are defined as being those activities (breeding, non-breeding, migration stopovers, etc.) which if interrupted or prevented from occurring may threaten long-term conservation of the species. Refuges should be interpreted to mean those locations where such critical stages gain some degree of protection during adverse condition such as drought.

representative (Criterion 1) – a wetland that is a typical example of a particular wetland type found in a region.

significant proportion (Criterion 7) – for the fish Criteria – in polar biogeographical regions a «significant proportion» may be 3–8 subspecies, species, families, life-history stages or species interactions; in temperate zones 15–20 subspecies, species, families, etc.; and in tropical areas 40 or more subspecies, species, families, etc., but these figures will vary among regions. A «significant proportion» of species includes all species and is not limited to those of economic interest. Some wetlands with a «significant proportion» of species may be marginal habitats for fish and may only contain a few fish species, even in tropical areas, e.g. the backwaters of mangrove swamps, cave lakes, the highly saline marginal pools of the Dead Sea. The potential of a degraded wetland to support a «significant proportion» of species if it were to be restored also needs to be taken into account. In areas where fish diversity is naturally low, e.g., at high latitudes, in recently glaciated areas or in marginal fish habitats, genetically distinct infraspecific groups of fishes could also be counted.

spawning ground (Criterion 8) – that part of a wetland used by fishes for courting, mating, gamete release, gamete fertilization and/or the release of the fertilized eggs, e.g. herring, shad, flounder, cockles, and many fishes in freshwater wetlands. The spawning ground may be part of a river course, a stream bed, inshore or deep water zone of a lake, floodplain, mangrove, saltmarsh, reed bed, estuary or the shallow edge of the sea. The freshwater outflow from a river may provide suitable spawning conditions on the adjacent marine coast.

species (Criteria 2 & 4) – naturally occurring populations that interbreed, or are capable of interbreeding, in the wild. Under these (and other) Criteria, subspecies are also included.

species interaction (Criterion 7) – exchanges of information or energy between species that are of particular interest or significance, e.g., symbiosis, commensalism, mutual resource defence, communal brooding, cuckoo behaviour, advanced parental care, social hunting, unusual predator-prey relationships, parasitism and hyperparasitism. Species interactions occur in all ecosystems but are particularly developed in species-rich climax communities, such as coral reefs and ancient lakes, where they are an important component of biological diversity.

supports (Criteria 4, 5, 6 & 7) – provides habitat for; areas which can be shown to be important to a species or an assemblage of species for any period of time are said to support that species. Occupation of an area need not be continuous, but may be dependent on natural phenomena such as flooding or (local) drought conditions.

survival (long-term target for Criterion 2) – sites which contribute most to the survival of species or ecological communities locally and as a whole are those which enable its geographic range to be maintained on a long-term basis. The long-term persistence of species is most likely to occur where:

i. population dynamics data on the species concerned indicate that it is self-sustaining on a long-term basis as a viable component of its natural habitats, and

ii. the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and

iii. there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

unique (Criterion 1) – the only one of its type within a specified biogeographic region.

vulnerable (Criterion 2) – as used by the Species Survival Commission of IUCN. A taxon is Vulnerable when it is not either Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined for both animals and plants by the criteria layed out in the *IUCN Red List Categories and Criteria: Version 3.1*.(IUCN 2001). See also 'globally threatened species' above.

wetland benefits (Criterion 7) – the services that wetlands provide to people, e.g., flood control, surface water purification, supplies of potable water, fishes, plants, building materials and water for livestock, outdoor recreation and education.

wetland types (Criterion 1) – as defined by the Ramsar Convention classification system.

wetland values (Criterion 7) – the roles that wetlands play in natural ecosystem functioning, e.g. flood attenuation and control, maintenance of underground and surface water supplies, sediment trapping, erosion control, pollution abatement and provision of habitat.

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