

**Preliminary Analysis of Vector Routes
and Selected Invasive Species for Pacific
Island Countries and Territories**

**Prepared for the South Pacific Regional
Environment Programme as part of the following
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**South Pacific Invasive Alien Species Management:
Restoration of Small Island Ecosystems
Harbouring Critically Endangered Endemic
Species.**

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Table of Contents

EXECUTIVE SUMMARY.....	3
1. INTRODUCTION.....	4
2. COUNTRY-BY-COUNTRY ANALYSIS.....	6
2.1 AMERICAN SAMOA.....	7
2.2 COOK ISLANDS.....	11
2.3 FEDERATED STATES OF MICRONESIA.....	15
2.4 FIJI.....	22
2.5 FRENCH POLYNESIA/TAHITI.....	29
2.6 GUAM.....	34
2.7 KIRIBATI.....	39
2.8 MARSHALL ISLANDS.....	43
2.9 NAURU.....	48
2.10 NEW CALEDONIA.....	52
2.11 NIUE.....	57
2.12 NORTHERN MARIANA ISLANDS.....	61
2.13 PALAU.....	65
2.14 PAPUA NEW GUINEA.....	69
2.15 SAMOA.....	76
2.16 SOLOMON ISLANDS.....	80
2.17 TOKELAU.....	85
2.18 TONGA.....	86
2.19 TUVALU.....	91
2.20 VANUATU.....	95
2.21 WALLIS AND FUTUNA.....	101
3.SUMMARY OF VECTOR ROUTES.....	105
TABLE 1. MAJOR INTERNATIONAL SHIPPING ACTIVITY – YEARLY VISITS.....	105
TABLE 2. INTERNATIONAL FLIGHTS– WEEKLY TOTALS BY REGION.....	106
4. INVASIVE SPECIES THREATS – AN OVERVIEW.....	109
4.1 INVASIVE PLANTS.....	111
4.2 INVASIVE MAMMALS AND REPTILES.....	119
4.3 INVASIVE BIRDS.....	123
4.4 INVASIVE FRESHWATER FISH.....	124
4.5 INVASIVE AMPHIBIANS AND FRESHWATER CRUSTACEANS.....	126
4.6 INVASIVE ARTHROPODS.....	127
4.7 INVASIVE LAND AND FRESHWATER MOLLUSCS.....	130
5. SUMMARY OF INVASIVE SPECIES INFORMATION.....	133
6. REFERENCES.....	134

Executive Summary

Understanding vector routes for invasive species (i.e. the routes by which pest plants and animals move from place to place via human assistance) is a key element in global and national efforts to reduce risks and limit the further spread of invasive species. This report is divided into two main sections. The first section provides a quantitative analysis of air and sea movements between the countries and territories of the Pacific. The second section summarises information on eighty existing or potential invasive plants and animals to Pacific islands. While the GEF project with which this report is linked is limited to SPREP countries, the analysis also includes the territories of the region (with the exception of Pitcairn Island). This is essential since some territories are pivotal to understanding vector routes and transport ‘hubs’ in the region. For the same reason, flights from Pacific islands to Hawaii are included, as well as including Hawaii in the analysis of the selected invasive species.

There is significant variability in the volume and patterns of ship movements and aircraft flights between the countries and territories of the Pacific, which is consistent with their diverse sizes, economies, exports, and political linkages. A few countries emerged as significant ‘hubs’ for sea and air transport within the region. (Refer to Tables 1 and 2 for summaries.) In the northern Pacific, Guam emerges as the “high risk” country, given its high levels of total merchant ship and oceanic fishing vessels as well as the largest number of weekly flights to other Pacific island countries (139) and to Asian destinations (148). In the central southern Pacific, Fiji is the major transport centre with a large volume of merchant shipping, cruise liners and itinerant yachts (585 yearly visits) and relatively high numbers of weekly flights both within and outside the region.

To the east, French Polynesia has a smaller annual number of merchant ship visits, but when other shipping activity is included, as well as 26 weekly flights to the USA (including Hawaii) and more within the region, it emerges as an important vector route. (It already has a significant number of invasive species). Papua New Guinea and New Caledonia are important countries in the western Pacific for shipping volumes; New Caledonia also for visits by yachts (500/yr). Papua New Guinea has extensive air links with Australia, another source of tropical invasives, but very few within the Pacific. New Caledonia has a larger number of weekly flights than Papua New Guinea spread within the region, as well as to Asian, Australian and New Zealand destinations.

The information in the second section on eighty invasive species provides evidence for the links between trade, travel and the distribution of invasives. Vector routes and methods of spread are identified. It also highlights the importance of early detection and eradication if Pacific countries are to be more effective at limiting the arrival and spread of invasive species.

1. Introduction

The current and potential threats that invasive alien species pose to the endemic biodiversity of Pacific island countries are well documented. The technical review by SPREP (Sherley 2000) and the accompanying regional invasive species strategy for the South Pacific detailed the threats. This work and other initiatives have led to ambitious efforts for a regional response to invasive species, whether current or potential, particularly as they threaten the indigenous avifauna of the Pacific islands.

This report is part of the background work of the PDF-A agreement to assist the development of a GEF (Global Environment Facility) Project, titled “Pacific Invasive Species Management”. The development objective for that project is:

“An effective biosecurity system (including invasion prevention and ecosystem restoration), is established in the Pacific, with a particular strategic focus on the region’s most critical biodiversity needs, and builds capacity to sustain initiatives into the future.”

One of the problem areas that the GEF Project seeks to address is the lack of sufficient information on key issues, one of which is the need to have a much better understanding of the pathways by which known, and potentially invasive species, are arriving in Pacific islands. Preventing invasive species from arriving is a much cheaper and more effective way of combating the problem than trying to eradicate or manage them after their arrival. Part of that effort is to develop a broad overview of the major movements of goods and people between countries. These are the vector pathways by which invasive species are likely to arrive. From such an overview a more detailed analysis of country-specific patterns can be established, including within country movements, especially between the islands of countries that are made up of extensive archipelagos, such as the Solomon Islands, Federated States of Micronesia, Fiji and French Polynesia.

This first part of this report provides a preliminary, quantitative analysis of trade routes and aircraft flights between the countries and territories of the Pacific. It documents the wide disparities in the volume of ship movements and aircraft flights throughout the region and thereby draws attention to those countries that are most at risk from the arrival of invasive alien species, referred to in the report as ‘invasives’ or ‘pests’. The vector analysis is presented on a country-by-country basis to make it easier for subsequent work to elaborate on the information specific to particular countries.

It should be noted that although the GEF Project excludes territorial countries (essentially those associated with France and the USA) they have been included in this analysis. The reason for that is quite simple. Understanding the overall pattern of vector routes in the Pacific requires that *all* countries and territories be included, particularly as some of those territories, such as Guam, French Polynesia and New Caledonia, are regionally significant transport hubs for northern, eastern and western parts of the region

respectively. (Along with Papua New Guinea and Fiji, they constitute the major transport hubs.) Their exclusion would provide an incomplete and misleading picture of major routes and risks. It could well be argued that the Hawaii should be included for the same reason, given its extensive trade and tourist links into the Pacific and its potential to export invasive species to southern parts of the Pacific. Separate data on flights to (but not from) Hawaii are therefore included.

At another level of analysis, trade and people movements *from*, as well as to, Pacific territories may significantly affect countries that are part of the GEF Project. Consider Samoa as a case in point. There is considerable flow of people, goods and cargo between Samoa and its nearby neighbour, American Samoa, a territory of the USA. The port of Pago Pago in American Samoa is 'home' to the second largest international fishing fleet in the Pacific and therefore there is a high risk that marine invasives might arrive either in ballast water or as fouling organisms on the hulls of fishing vessels. Given that small coastal traders and ferries travel between the two countries at least weekly, there is a good chance that should any marine invasives establish in Pago Pago they could, quite quickly, be transferred to Samoa, not to mention their possible natural arrival via ocean currents.

The second part of this report summarises information on eighty important species either established, or threatening Pacific islands. These range from plants to vertebrates and molluscs, but exclude marine species given the paucity of data for the region. This remains an important, but poorly researched area that urgently requires work. A logical place to start to understand the degree to which marine invasives are already established would be to survey the most heavily used harbours of the region. Sampling of hull fouling species and analysis of the composition of ballast water in a selection of merchant ships, fishing vessels, cruise liners and inter-island traders would be a useful extension of harbour surveys.

The actual number of invasive species identified from Pacific islands is much more extensive, of course. The ones that are chosen are certainly some of the most significant ones and information is provided on their ecological effects, mode of spread, the countries where they are known to be present and the countries they are likely to invade, based on the vector data of the first section.

2. Country-by-country Analysis

The following sub-sections detail the results for each of the 21 countries or territories that were analysed. For each country, a brief ‘national profile’ is given first to help locate the country in its physical and developmental context. Most of the information for this profile is taken from the recent major work on the South Pacific by Ron Crocombe (2001). The information on major trading partners, income levels, primary exports and nearest neighbours is an important contextual consideration for further analysis of vector patterns.

The information on shipping patterns and quantitative details of vessel movements are summarised from the major SPREP study on ship movements undertaken as part of the SPREP Pacific Ocean Pollution Prevention Programme (Nawadra et al, 2002). I took their data on the average number of persons on board each of the vessel types to derive a “Average person visits/annum” figure. This is intended to give a rough approximation of the potential for ‘people visitors’ to add another vector route to those of the vessels and cargoes they carry *per se*.

I am indebted to staff at the Parag and Otte, House of Travel, Wellington, for working with me and providing the raw data on flight details for the island countries. These numbers are, of course, only as current as the airlines determine. Some flight details will have changed since these numbers were first provided. However, I believe they provide an important and accurate insight into the relative volumes of air travel as well as useful information on between-country linkages. The difference between ‘non-stop’ (direct) and non-direct services are not commented on in the text, but indicates the possibility for passengers to ‘hop’ between destinations. Information on non-scheduled flights was not available. The information provided on the number of runways in each country is from the CIA website.

2.1 American Samoa

National profile

Population (2000 estimate)	66,000
Population growth rate	3% (variable , given free access to USA)
Density (people per km²)	335
Urban population (% of total)	48 +
Land area (km²)	197
Land area per person	0.003 km ²
GDP per person (US\$)	\$3,833
Aid per person (US\$)	\$4,615
Political system	United States territory
Major economic base	Tuna fishing and canning, US aid, garment manufacturing
Major trading partners	USA, Japan, Australia
Nearest country neighbours	Samoa (west), Niue/Tonga (south), Cook Islands/French Polynesia (east)

Summary of vector issues

(using attached transport data)

Main vector routes

With one of the best, natural deep-water harbours in the South Pacific, American Samoa is able to provide wharf facilities for large vessels, from warships to cruise liners, which is a relatively uncommon situation for the smaller Pacific nations. Consequently, when the extensive fishing fleet is added in, the marine traffic is extensive and heavy. This provides a major route for marine invasive species, either on ship hulls or via ballast water, and opportunities for ship crews and tourists to bring in exotic terrestrial species. Cruise ships tie up at the wharf, which is not common for the smaller Pacific countries with less generous harbours. Again, the large harbour and its status as a United States territory, means that there are a relatively high number of large warships visiting Pago Pago harbour on an annual basis (over 1 per month). Then there is a high number of small local fishing boats that could potentially spread exotic organisms from Pago Pago to other coastal locations.

There is a considerable volume of inter-island ferry traffic, moving both goods and people, between Pago Pago and Apia, capital of neighbouring Samoa. The smaller, more distant islands of American Samoa have less shipping traffic, but are well connected by air links to Pago Pago with an average of two flights a day to the islands of Ofu and Ta'u. With a relatively affluent population, by Pacific standards of income (see above

summary), there is more potential for people to move by air between destinations both within and outside the country.

Flights between Pago Pago and Apia, Samoa are very frequent (about 46 per week) and provide another major vector pathway for organisms that can be transported by air. There are daily flights to Savai'i, in Samoa as well. There is also considerable movement of American Samoan citizens to the USA and return, providing another vector route.

Transport modes and threats

As a major Pacific port for tuna fishing boats, with about 450 vessel-visits per year, Pago Pago is significantly exposed to exotic marine species from distant fishing nations. It is also important to note that as a maintenance base for tuna boats, many of them can remain in port for up to 14 days at a time. This is an unusually long time for such vessels to remain in port and obviously significantly increases the opportunities for exotic marine organisms to be transferred to the harbour environs. There can also be up to 50 large purse-seiners in port at the same time. A more detailed analysis of the ports of origin of these fishing vessels would give a better indication of which marine invader species are likely to arrive inadvertently on ships hulls or via ballast water. Cargo ships are bringing in containerised cargoes and these are important vector pathways for invertebrates, seeds and other hitchhiker organisms.

It is also on the Pacific circuit for cruise liners and, together with large warships, these vessels tie up at the wharf. While such visits are for short periods, they do provide a threat to the marine environment and a pathway for exotic organisms between island countries. The high volume of activity by inter-island ferries and traders, especially to Samoa, provide a major transport route for a variety of invasive species to move between countries. These range from agricultural pests coming in via food supplies, to accidental transport of insects, seeds and weeds that might be threats to the natural environment.

Pago Pago is also host to about 100 itinerant yachts per year. Many of these yachts are cruising other Pacific Island waters as well and are a potential source of mainly marine invaders via hull transport. The major within-Pacific connections, both for marine and air traffic, are clearly with Samoa. These connections are the routes where exotic vectors are most likely to move, both with respect to marine and terrestrial threats.

Given this high level of exposure to exotic marine organisms, Pago Pago harbour may be a potential important source of marine invasives for subsequent distribution to other Pacific Island countries. This possibility would become clearer if information on the marine species in the harbour was available. Whether such a harbour survey has been done already is not known.

Country: American Samoa

Airport infrastructure

Airports with paved runways	2
Airports with unpaved runways	2
Total number of airports	4

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Apia, Samoa	46	Yes
Maota, Savai'i, Samoa	7	Yes
Vava'u, Tonga	1	Yes
Honolulu	1	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Nil	-	

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Ofu	13	Yes
Ta'u	13	Yes

Country: American Samoa

Seaport infrastructure

Main ports	Major trading activities
Pago Pago	Main activity: support for tuna fishing fleets, large purse-seiners. Small marina and moorings for yachts, local fishing boats. <i>Major tuna fishing port in the South Pacific. Provides maintenance base – tuna boats in port for up to 14 days/visit.</i> Link port for inter-island passenger and cargo services within American Samoa and to Apia, Samoa.
Other ports/harbours are: Aunu'u, Auasi, Faleosao, Ofu, Ta'u	Inter-island passenger and cargo services to the outer islands.

Domestic shipping activity: Pago Pago

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimated)
Inter-island traders (15)	50	750
Inter-island ferries (220)	60	13,200
Tourist charter boats (15)	10	150
Fishing – local (2)	6,000	12,000
Local work boats (3)	400	1,200
Local craft (day trips) (2)	-	

International shipping activity: Pago Pago

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum
Merchantmen (18)	190	3,420
Cruise liners (1500)	10	15,000
Warships – large (200)	15	3,000
Warships – small (20)	-	
Fishing – oceanic (18)	450	8,100
Yachts - itinerant (3)	100	300

2.2 Cook Islands

National profile

Population (2000 estimate)	15,500
Population growth rate	Declining slightly through emigration
Density (people per km²)	65
Urban population (% of total)	60%
Land area (km²)	240
Land area per person	0.015 km ²
GDP per person (US\$)	\$4,727
Aid per person (US\$)	\$364
Political system	Self-governing state, free association with New Zealand
Major economic base	Tourism, pearls, fishing, agriculture (copra, citrus fruits)
Major trading partners	New Zealand, Japan, Hong Kong, Australia, Italy,
Nearest country neighbours	Tonga (west), American Samoa (northwest), French Polynesia (northeast)

Summary of vector issues

(using attached transport data)

Main vector routes

Of the two main vector routes into the Cook Islands, air travel is probably more significant than marine vessels. This reflects its reliance on tourism for much of its foreign earnings, aside from aid and remittances from residents living abroad. Air New Zealand is the only international airline serving the Cook Islands, but has a frequent service with about 19 flights per week. There are also almost daily flights to Los Angeles and to Papeete, in French Polynesia. Flights to other Pacific Island countries are less frequent, and therefore provide fewer opportunities for exotic species to arrive.

The far-flung islands of the Northern Group are much more isolated from potential new exotic species with only a few monthly visits by inter-island trading vessels and very limited air travel (see attached domestic flight details.) There are more frequent flights linking the Southern Group islands, especially to Aitutaki, which receives almost three flights a day from Rarotonga, mainly for the tourist trade.

The Cook Islands main port of Avarua on Rarotonga does not receive a large number of international vessels. They tend to be smaller cargo vessels bringing in the usual container cargo oil products and LPG supplies. Some local fishing vessels operate from

here but are less likely to be bringing in new marine species. The largest number of vessels from other destinations is itinerant yachts. The Cook Islands are a popular destination for yachts from New Zealand and Fiji and these vessels can provide an important pathway for new marine species.

Transport modes and threats

Given its strong links to New Zealand, with respect to trade, migration flows, aid and tourism, the Cook Islands have their main vector routes for any airborne exotic species with Auckland and, to a much lesser extent, with Los Angeles, USA. These threats would cover the range of organisms that can be carried deliberately, or accidentally, by airline passengers. The spread of invasive ant species, particularly the Red Imported Fire Ant (RIFA), up the western coast of the United States may be a future concern for the Cook Islands. There is considerable interchange of Cook Islanders between New Zealand and the Islands. This creates an important route for exotic species to be carried between the two countries, although many of the temperate species of New Zealand would find conditions unsuitable in the tropics.

Domestic air traffic, mainly for tourists, provides an opportunity to move exotic species to other islands, mostly within the Southern Group of the Cook Islands. The island of Aitutaki is the main tourist destination outside Rarotonga, followed by Atiu.

The main vector route for marine exotics is via the small number of cargo vessels that bring in container cargo and oil supplies to Rarotonga. Containers are important vector pathways for invertebrates, seeds, soil organisms and other hitchhikers.

There is a significant annual traffic of itinerant yachts to the Cook Islands that pose a threat to the marine environment through hull fouling and a lesser extent through exotic species that may be carried on board and accidentally released on shore. Much of this yacht traffic comes from Fiji and New Zealand.

Country: Cook Islands

Airport infrastructure

Airports with paved runways	1
Airports with unpaved runways	6
Total number of airports	7

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Nandi	1	Yes
Suva	<1	Yes
Papeete	5	Yes
Niue	<1	Yes
Port Vila	<1	No
Honolulu	2	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Auckland	19	Yes
Christchurch	1	No
Los Angeles	6	Yes

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Aitutaki	19	Yes
Atiu Island	5	Yes
Mangaia Island	4	Yes
Mitiaro Island	5	Yes
Mauke Island	3	Yes
Penrhyn Island	1	Yes

Country: Cook Islands

Seaport infrastructure

Main ports	Major trading activities
Avarua, Rarotonga	Most visiting vessels are recreational yachts sailing the South Pacific. Otherwise, cargo vessels, container ships, oil and LPG tankers. A dozen long-line small fishing boats operate from here.
Avatiu	Small boat/yacht anchorage.
Aitutaki Island	A very small harbour supporting roadstead operations.

Domestic shipping activity: Avarua

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimated)
Inter-island traders (8)	35	280
Inter-island ferries	-	
Tourist charter boats	-	
Fishing – local (3)	500	1,500
Local work boats (3)	600	1,800
Local craft (day trips) (3)	300	900

International shipping activity: Avarua

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimated)
Merchantmen (10)	44	440
Cruise liners (1500)	Occasional	-
Warships – large (150)	1.5	225
Warships – small (20)	18	360
Fishing – oceanic (18)	-	
Yachts - itinerant (3)	150	450

2.3 Federated States of Micronesia

National profile

Population (2000 estimate)	118,000
Population growth rate	2.0%, variable, with USA emigration
Density (people per km²)	168
Urban population (% of total)	27%
Land area (km²)	701
Land area per person	25 km ²
GDP per person (US\$)	\$1,822
Aid per person (US\$)	\$1,060
Political system	Independent republic with compact of free association with USA. Confederation of four sovereign states – Yap, Chuuk, Pohnpei, Kosrae.
Major economic base	Agriculture (copra), tuna fisheries (international and domestic), tourism
Major trading partners	USA, Japan
Nearest country neighbours	PNG/Solomon Islands/Naru (south), Palau (west), Guam/Northern Marianas (north), Marshall Islands (east)

Summary of vector issues

(using attached transport data)

Main vector routes

Spread over a vast expanse of the Pacific Ocean from east to west, the Federated States of Micronesia (FSM) rely primarily on shipping for the major movements of goods and people between the four separate states. Kolonia, the port for Pohnpei, receives the most visits by cargo ships (60 per year) carrying mostly containerised cargo. The other three ports each receive around 40 such visits per year. With its strong trading orientation towards the USA, the main shipping route is from the USA to the Marshall Islands, onto Kosrae, Pohnpei, Chuuk, then to Guam before returning to the USA. Pohnpei, Yap and Chuuk receive bulk petroleum from Guam, while Kosrae receives its supplies by tanker from Brisbane.

International shipping activity is dominated by the number of tuna and purse-seine fishing fleets operating within the EEZ of the FSM. The main destinations for these vessels are Chuuk's port of Weno, with about 420 international fishing vessels visiting each year, and Kolonia with about 330 visits. Each of these ports also has 30-40 fishing 'motherships' staying for 6-8 weeks in the two harbours. These motherships remain at

anchor in the harbours while the smaller vessels unload their catches. As for American Samoa (see separate country report) these vessels and the fishing fleets provide a major potential vector route for marine exotic species into FSM.

Cruise liners are infrequent or absent and therefore are not likely to be an important vector route. Itinerant yacht traffic is a minor component of vessel visits. Tourism is growing, but is not a major component of economic activity.

Inter-island traders are major transport modes for moving people between the separate island States, and also between islands within the States, although there is a limited amount of air travel between them as well. The international air travel is of modest volume. The flights from Guam feed in passengers from Asia (Taipei, Manila, Japan) as well as from the USA. Honolulu and the Marshall Islands provide the other international air links.

Transport modes and threats

The main threat to the FSM States is likely to come from the marine traffic of foreign fishing vessels and their motherships and from merchantmen vessels carrying containers and other cargo. The threat is primarily from exotic marine organisms via hull fouling and ballast water exchanges and stowaway species on cargo, machinery or vehicles. As for American Samoa, further analysis of the ports of origin and movement patterns of these fishing vessels would be interesting to pursue.

There is also considerable marine traffic between the main islands carrying people and cargo. These provide additional opportunities to spread marine invaders as well as species that threaten agricultural crops along with more general pests such as rodents.

International tourist traffic arriving by air is frequent enough to warrant consideration as a potentially important vector route via luggage and air containers to the different arrival points. Since this traffic is primarily from the USA and Asia, there is a wide range of potentially damaging species that could be arriving this way, especially ant species as they spread up the US west coast.

Country: Federated States of Micronesia

Airport infrastructure

Airports with paved runways	6
Airports with unpaved runways	1
Total number of airports	7

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Honolulu	3	No
Guam	4	No
Kwajalein	3	No
Majuro	3	No

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Nil	-	

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Kosrae	3	Yes
Chuuk	4	Yes

Country: Federated States of Micronesia

Seaport infrastructure for Yap

Main ports	Major trading activities
Colonia	Used by commercial tuna fleet. International traffic is mostly containerised cargo, mostly from Guam or Asia. Bulk petroleum from Guam, monthly. Visits from US Coast Guard cutters; six purse-seine vessels per month. Yachts anchor in the harbour. A slip-way services the domestic long-line fleet.
Yap	Several small docks located around the island, mainly for local use.

Domestic shipping activity: Yap

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (130)	150	19,500
Inter-island ferries	See above	-
Tourist charter boats (30)	10	300
Fishing – local (6)	500	3,000
Local work boats (13)	30	390
Local craft (day trips)	-	

International shipping activity: Yap

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (12)	40	480
Cruise liners (1200)	0.5	600
Warships – large (200)	2	400
Warships – small (20)	5	100
Fishing – oceanic (25)	72	1,800
Fishing – mothership (18)	5	90
Yachts - itinerant (3)	20	60

Country: Federated States of Micronesia

Seaport infrastructure for Pohnpei

Main ports	Major trading activities
Kolonia	International traffic is mostly containerised cargo. Bulk petroleum products from Guam on a twice-monthly cycle. The FSM national patrol boat fleet (3 vessels) is based here. Island trading/passenger vessels moored here for long periods. Occasional visits from small Australian warships. Yearly visit by Japanese research vessel. Yachts anchor in the harbour.
Pohnpei	Several other mooring sites and private docks around the island.

Domestic shipping activity: Pohnpei

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (150)	150	22,500
Inter-island ferries	See above	-
Tourist charter boats	-	
Fishing – local (10)	1,500	15,000
Local work boats (2)	200	400
Local craft (day trips) (2)	12,500	25,000

International shipping activity: Pohnpei

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (20)	60	1,200
Cruise liners (700)	1	700
Warships – large (200)	2	400
Warships – small (20)	30	600
Fishing – oceanic (25)	330	8,250
Fishing – mothership (18)	30	540
Yachts - itinerant (3)	10	30

Country: Federated States of Micronesia

Seaport infrastructure for Kosrae

Main ports	Major trading activities
Okat	International traffic is predominantly containerised cargo with some bulk items (construction materials). <i>Usual route for trips originating in the USA is the Marshall Islands, Kosrae, Pohnpei, Chuuk, Guam, then direct return to USA.</i> Bulk petroleum from Brisbane, 6 week cycle. Fish transfer to 'mothership' occurs while at the dock or at anchor within the lagoon.
Lelu Harbour	Minimal use by inter-island cargo and passenger vessels.

Domestic shipping activity: Okat

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders	-	
Inter-island ferries (120)	6	720
Tourist charter boats (10)	600	6,000
Fishing – local (9)	2,000	18,000
Local work boats	-	
Local craft (day trips)	-	

International shipping activity: Okat

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (20)	42	840
Cruise liners	-	
Warships – large	-	
Warships – small (20)	3	60
Fishing – oceanic (20)	30	600
Fishing – mothership (18)	3	54
Yachts - itinerant (3)	15	45

Country: Federated States of Micronesia

Seaport infrastructure for Chuuk

Main ports	Major trading activities
Weno	International traffic is predominantly containerised cargo, with minor bulk items. Chuuk is on same general routes and services as Kosrae. Bulk petroleum items from Guam, coming monthly. Annual visit from international research vessel, stays up to 5 days. Long-line and purse-seiners use Weno port and lagoon. <i>Motherships often stay 6-8 weeks and most transfers occur while at anchor in the lagoon. Ideal location for mothership activities and also central within EEZ of FSM.</i> Long-line tuna vessels use the port. Over 500 small water craft within Chuuk.

Domestic shipping activity: Weno

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (100)	100	10,000
Inter-island ferries	See above	-
Tourist charter boats (30)	120	3,600
Fishing – local (9)	200	1,800
Local work boats	-	
Local craft (day trips) (2)	25,000	50,000

International shipping activity: Weno

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (12)	36	432
Cruise liners (1200)	0.3	360
Warships – large (200)	3	600
Warships – small (20)	3	60
Fishing – oceanic (20)	420	8,420
Fishing – mothership (18)	40	720
Yachts - itinerant (3)	10	30

2.4 Fiji

National profile

Population (2000 estimate)	810,000
Population growth rate	1.1%
Density (people per km²)	44
Urban population (% of total)	46%
Land area (km²)	18,272
Land area per person	0.02 km ²
GDP per person (US\$)	\$2,652
Aid per person (US\$)	\$56
Political system	Independent republic
Major economic base	Sugar, tourism, gold, fishing, timber, clothing manufacture, industry, copra. Major exports are sugar (declining), molasses, gold, fish, timber and garments.
Major trading partners	Australia, Japan and New Zealand
Nearest country neighbours	Vanuatu (west), Wallis & Futuna (north), Tonga (east), New Zealand (south)

Summary of vector issues

(using attached transport data)

Main vector routes

As the following summaries of the volume of air and marine travel to and from Fiji make clear, Fiji, along with Hawaii, is one of the main hubs for the Pacific. This applies not only to the movement of people into the region, but also movements of containerised cargo and bulk cargoes to many of the Pacific Island countries. It should therefore be a particular focus for subsequent more detailed studies of vector routes in the region.

Weekly flights originate from Fiji's two main airports to more Pacific Island countries (12) than from any other Pacific Island country. Note, however, that there is no direct air connection with the region's largest country, Papua New Guinea, which connects by air only to the Solomon Islands. There are also over 60 weekly flights direct to five New Zealand and Australian destinations. Two flights per day also connect with Los Angeles and others connect weekly with Tokyo and Seoul.

In addition, there is an extensive network of airports within the group of Fiji islands with 360 weekly commercial flights connecting them. Many of these are oriented towards the tourist sector and there will be additional charter flights that are more difficult to monitor.

This volume of international and domestic air travel provides major vector routes into and within Fiji for a wide variety of potential pest species.

Fiji's designated ports of entry are Suva and Lautoka (both on Viti Levu) Savusavu (on Vanua Levu) and Levuka in the Lomaiviti Group. Of these, Suva and Lautoka, along with Vuda Point (near Suva), are the most important ports for international cargo and trade. While Suva is a principal hub port for import/export containerised cargoes, the Vuda Point petroleum terminal is one of the largest fuel storage facilities in the Melanesian/Polynesian region of the Pacific. Tankers arrive from Australia and Singapore at Vuda Point and from here smaller tankers supply other Pacific Island countries. The port at Lautoka is the bulk loading port for exports of sugar and timber and imports of fertilisers and chemicals. Lautoka also acts as hub port for container vessels servicing the western end of Viti Levu. These vessels come from Australia, New Zealand and the USA.

In total, these three ports handle about 680 merchantship visits per year, more even than Guam, which is the major hub for the northern region servicing Micronesia. Papua New Guinea is the major marine hub for the Melanesian region.

Given its strong focus on tourism, Fiji also has considerable vessel movements associated with transfers to island resorts, with much of this traffic based at the Point Denaru Marina near Nadi. There is also major movement to and around Fiji by itinerant yachts. Each year, about 200 yachts visit the Point Denaru Marina, while the national annual total is close to 600. Many of these yachts are sailing from Australia and New Zealand, but others come from the USA and the UK.

Fiji ports on Viti Levu also have a relatively high number of annual visits by large and small warships from visiting navies. A large number of oceanic fishing vessels also operate out of Fiji. The other main island of Vanua Levu has two ports, with a much smaller volume of traffic, mainly for inter-island freight and passengers, and sugar exports.

Transport modes and threats

As the above summary of vector routes and volumes of air and sea movements suggests, Fiji is vulnerable to pest arrivals from a wide variety of countries both by sea and by air. The volume of shipping exposes Fiji to marine invasives and a wide range of risks associated with the container trade and bulk commodities. Air travel, especially from Australia, New Zealand, and Los Angeles, is another major vector pathway for tourists and air cargoes.

Fiji should also be seen as a significant potential *source* of invasive species, along with Guam and Papua New Guinea, for other Pacific Island countries, given these role all three play as the significant hub points from which much of the Pacific marine traffic originates. Fiji has a rich invasive species flora and fauna 'available' for export.

Country: Fiji

Airport infrastructure

Airports with paved runways	3
Airports with unpaved runways	24
Total number of airports	27

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Honolulu	4	Yes
Noumea	<1	Yes
Tongatapu, Tonga	6	Yes
Apia, Samoa	1	Yes
Rarotonga	1	Yes
Papeete	<1	No
Honiara	2	No
Nauru	2	No
Tarawa	2	Yes
Port Vila	3	Yes
Wallis Island	1	Yes
Tuvalu	1	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Sydney	18	Yes
Melbourne	7	Yes
Brisbane	8	Yes
Auckland	30	Yes
Christchurch	<1	Yes
Los Angeles	14	Yes
Vancouver	1	No
Tokyo	3	Yes
Seoul	2	Yes

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil		

Domestic Flights: Fiji

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Nandi – Suva link	62	Yes
Kadavu	14	Yes
Labasa	78	Yes
Mana	35	Yes
Malololailai	37	Yes
Savusavu	41	Yes
Taveuni	51	Yes
Bureta	25	Yes
Cicia	1	Yes
Koro	1	Yes
Kadavu Group	7	Yes
Lakeba	2	Yes
Moala	1	Yes
Ngau	2	Yes
Rotuma -dependency of Fiji	2	Yes
Vanau Balavu	2	Yes

In addition to the these listed airline flights there are unlisted transfers from the Nadi and Suva airports to many island resorts as well as air charter flights to a number of domestic locations.

Country: Fiji

Seaport infrastructure: Viti Levu

Main ports	Major trading activities
Suva	<i>Principal hub port for Pacific for import/export cargoes.</i> Container vessels are the principal arrivals from Asia, Australia, N.Z. and the USA. Cargo is transhipped in smaller vessels to other islands. Significant tanker traffic – 80 tankers per year. About 16 cruising yachts /year.
Lautoka	Not far from main international airport at Nadi, <i>this is the bulk port for sugar, timber, fertilisers and chemicals.</i> Also container vessels, tankers, passenger/cargo for outer islands travel.
Vuda Point, near Suva	<i>Vuda petroleum terminal is one of the largest fuel storage facilities in the Melanesian/Polynesian region.</i> Large supply tankers call monthly, from Australia & Singapore. Inter-island tankers travel fortnightly to other islands. Vuda Marina has 300 yachts/pleasure craft using the facility per year, with 90% from other countries.
Point Denarau Marina	Significant passenger traffic, over 150,000 tourists/year, with resort transfers, fishing and charter craft. About 200 yachts from Australia, N.Z., U.K. and USA visit each year.

Domestic shipping activity: Viti Levu (in total)

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (10)	40	400
Inter-island traders (100)	700	70,000
Inter-island ferries (100)	1,500	150,000
Inter-island ferries (50)	1,500	75,000
Tourist charter boats	Incl. in 'large ferries '	
Fishing – local	Unknown	
Local work boats (4)	750	3,000
Local craft (day trips) (2)	2,200	4,400

International shipping activity: Viti Levu (in total)

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	680	12,240
Cruise liners (1500)	26	39,000
Warships – large (200)	5	1,000
Warships – small (20)	245	4,900
Fishing – oceanic (18)	220	3,960
Yachts - itinerant (3)	585	1,755

Country: Fiji

Seaport infrastructure: Vanua Levu

Main ports	Major trading activities
Labasa /Malau	Inter-island freight, passengers, and small fishing vessels at Labasa wharf. The deepwater major port at Malau is used for loading sugar and molasses, for a total of 12 ships/year. Malu is also used for loading timber and woodchip for export to India and Japan. About one such vessel calls each month on average.

Domestic shipping activity: Labasa/Malau

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders	-	
Inter-island ferries (20)	100	2,000
Tourist charter boats	-	
Fishing – local (3)	8,000	24,000
Local work boats (3)	12	36
Local craft (day trips)	-	

International shipping activity: Labasa/Malau

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	36	648
Cruise liners	-	
Warships – large	-	
Warships – small	-	
Fishing – oceanic	-	
Yachts - itinerant	-	

2.5 French Polynesia/Tahiti

National profile

Population (2000 estimate)	236,000
Population growth rate	1.8%
Density (people per km²)	67
Urban population (% of total)	56%
Land area (km²)	3,521
Land area per person	21 km ²
GDP per person (US\$)	\$17,398
Aid per person (US\$)	\$10,888
Political system	Overseas territory of France
Major economic base	Tourism, aid from France, fishing, pearls, timber, agriculture and coconut products
Major trading partners	France, USA, Japan and New Zealand
Nearest country neighbours	Cook Islands (west), Pitcairn Is. (southeast)

Summary of vector issues

(using attached transport data)

Main vector routes

In the widely dispersed, 118 islands of the French Polynesia archipelago, Papeete remains a magnet for tourists from all over the world. There are more flights connecting it to Pacific Rim countries than there are to the rest of the Pacific. Over three flights a day arrive from Los Angeles and two per day from Auckland. It is the only Pacific Island country with specific flights originating in Paris (9/week). There are also direct flights from Japan and Sydney, while flights from Santiago arrive via Easter Island. Its links are therefore stronger with countries outside the Pacific Islands region than within.

The number of airports in French Polynesia (45) also indicates the intensity of domestic air travel within the archipelago. Over 300 domestic flights per week take tourists to many resort destinations as well as linking distant islands to the commercial activities of Papeete. This includes an impressive total of 130 flights weekly to Moorea, a major tourist destination. Major airport re-development in the Marquesas island of Nuku Hiva is likely to increase flights, and vector routes, to this more distant part of French Polynesia. With a high per capita income, and strong links to France, citizens probably have more opportunity to travel than many other Pacific residents.

Papeete serves as the main port for the eastern Pacific. There are large numbers of merchant vessels visiting each year, around 320 port visits on average, with a major volume arriving as containerised cargo. This merchant traffic arrives primarily from

Australia, New Zealand, the USA and France. From Papeete, there is then considerable trade with other Pacific Island countries, especially with New Caledonia, Fiji, Samoa and American Samoa.

An average of two large cruise liners visit each month, making it as popular a destination for cruises as Fiji, but behind New Caledonia. It is also an important destination and port of call for international yachts, with many yachts cruising between the many islands of the archipelago. With over 300 such visits recorded per year, this is an important vector route for marine organisms travelling on hulls and in bilge water. The source of most of these yachts is Australia, New Zealand and the west coast of the USA.

Another significant international shipping activity is the annual visits by relatively large numbers of naval vessels, mainly from France. There is also a permanent presence of four patrol vessels that may travel to other island countries in the Pacific.

French Polynesia has an extensive system of inter-island domestic ferries and traders operating. There are a large number of annual visits and significant numbers of people moved between islands by these ferries (estimated at about 265,000 per year). The details of the routes and frequency of vessels per route would be worth closer study to more accurately assess pathway details and threats.

Transport modes and threats

Both air and sea routes are important transport modes for potential invasive species into French Polynesia, which already has significant animal pest and weed problems. Merchant ships are mainly travelling from more temperate waters, but given the volume of vessel traffic, and that they are likely to be travelling to other Pacific ports as well, means they can provide opportunities for hitchhiker marine and terrestrial species during these voyages. The large volume of containers arriving into Papeete is also a threat, given the potential for a wide range of species and organisms, particularly invertebrates, to travel inside and outside containers.

Once landed in Papeete, there are numerous domestic trading vessels capable of dispersing unwanted species to other island ports within French Polynesia that remain on containers. The high number of passenger movements between the various island groups adds further potential to move species to many internal locations that may have arrived first in Papeete.

The high volume of tourists and yachties visiting annually, from a wide variety of countries, is a potentially important source of intentional and unintentional introductions. These could range from imported seeds to plants, aquaria fish and discarded pets.

Country: French Polynesia

Airport infrastructure

Airports with paved runways	32
Airports with unpaved runways	13
Total number of airports	45

Airline flight information

International flights: Papeete

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Rarotonga	8	Yes
Nadi	<1	No
Suva	<1	No
Honolulu	<1	Yes
Easter Island	2	Yes
Noumea	<1	Yes
Port Vila	<1	No
Wallis Island	1	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Los Angeles	25	Yes
Auckland	13	Yes
Christchurch	<1	No
Sydney	2	No
Tokyo	2	Yes
Osaka	1	Yes
Santiago	2	No

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Paris	9	No

Frankfurt	<1	No
Chicago	<1	No
New York	<1	No

Domestic Flights: French Polynesia

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Moorea	130	Yes
Bora Bora	50	Yes
Huahine	35	Yes
Raiatea	35	Yes
Rangiroa	22	Yes
Tikehau	12	Yes
Manihi	6	Yes
Ahe	3	Yes
Apataki	1	Yes
Atuona	4	Yes
Aruta	2	Yes
Fakarava	5	Yes
Gambier	1	Yes
Hao Island	4	Yes
Maupiti	4	Yes
Makemo	2	Yes
Motu Lava	1	Yes
Rurutu Island	3	Yes
Roirua	2	Yes
Takapoto	3	No
Takatoa	3	Yes
Anaa	1	Yes
Tubuai Island	4	Yes

Country: French Polynesia

Seaport infrastructure

Main ports	Major trading activities
Papeete	Main port for eastern Pacific Islands region, especially for container ships and cruise liners. The major port for cruise liners travelling Pacific routes or transiting the Pacific region. International merchant traffic principally operates between Australia, N.Z., the USA and France. Regional merchant trade is considerable, especially with Samoa, Fiji, American Samoa and New Caledonia. About 40 inter-island trading vessels are based here. Very large number of yachts (over 300) arrives annually.

Domestic shipping activity: Papeete

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (10)	4,000	40,000
Inter-island ferries (600)	110	66,000
Inter-island ferries (100)	2,000	200,000
Tourist charter boats (10)	2,500	25,000
Fishing – local (5)	1,500	7,500
Local work boats (4)	1,100	4,400
Local craft (day trips) (2)	1,400	2,800

International shipping activity: Papeete

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (14)	320	4,480
Cruise liners (1,800)	25	45,000
Warships – large (200)	30	6,000
Warships – small (30)	90	2,700
Fishing – oceanic (18)	10	180
Yachts - itinerant (3)	325	975

2.6 Guam

National profile

Population (2000 estimate)	152,000
Population growth rate	1.3%, variable with mobility with USA
Density (people per km²)	281
Urban population (% of total)	40-100%
Land area (km²)	541
Land area per person	0.004 km ²
GDP per person (US\$)	\$20,164
Aid per person (US\$)	\$22,851 (US government expenditure)
Political system	Unincorporated territory of the USA
Major economic base	Tourism, petroleum products, construction materials, fish, professional services for East Asia.
Major trading partners	USA, Japan
Nearest country neighbours	Northern Marianas (north), Palau/FSM (south), Philippines (west)

Summary of vector issues

(using attached transport data)

Main vector routes

Regarded as the metropolis of Micronesia, Guam is also the region's largest island. As the following volumes of both air traffic and shipping activity indicate, it is the most significant northern transport hub for the Pacific Island countries. With the highest per capita income of any Pacific Island country or territory, its economy is also boosted by a significant US military presence.

Described in guidebooks as a 'little Hawaii' it has about 17 flights a week to Honolulu and a larger number originating from Houston and Miami (27 in total). Significant as they are, these numbers are much smaller than the weekly flights from several Japanese cities (over 110) and from other Asian cities such as Hong Kong, Seoul and Pusan in the Philippines. There is also heavy weekly air traffic from Guam heading north to the Northern Marianas. Most of the flights, about 70, are to Saipan, which is only 200km distant and is another rapidly growing tourist destination for Japanese visitors. Rota, which is the southernmost island of the Marianas and less than 100km from Guam, also has 35 flights a week from Guam.

The only other significant flights within the Pacific are south to Palau (11/week), and destinations in the Federated States of Micronesia (11/week in total) and to the Marshall

Islands. In summary, the international flights to and from Guam are overwhelmingly oriented to the northern Pacific; from Hawaii and the continental USA in the east, to Asian cities in the west and north. Links further south than FSM are limited to only two direct flights to Cairns, Australia.

As the busiest port in Micronesia, and for the north-western Pacific island countries, Apra harbour is the only entry point for shipping into Guam. It is the major receiving point from which goods are shipped onwards to other ports in the region. Despite its small size, Guam receives almost as much merchant vessel traffic (about 560 annual visits) as Fiji, and a very large number of visits from the US navy (about 2 vessels/week). Most of these naval vessels are frigates, cruisers, destroyers and submarines. Much of the merchant traffic is containerised cargo. Ship movements in and out of Guam cover a wider range of routes than do the airline flights. Hence, the cargo runs originate in Asian countries as well as from Papua New Guinea, Australia, Honolulu, the US west coast and, to a lesser extent, other Pacific Island countries. Singapore supplies most of the bulk petroleum products, which is then shipped onto other islands in Micronesia.

There is considerable use of Guam by international fishing fleets (long-line and purse-seine), to the extent of about 260 port visits per year. On average, there is one large mothership per month in Apra, spending about 4-6 weeks in port at a time. There is heavy sea traffic with neighbouring Saipan, both by merchant vessels and inter-island ferries. Cruise ships are mostly from Japan, about one per month. The number of visiting yachts is relatively small, about 25 per year.

Transport modes and threats

Guam, which has already suffered from the infamous arrival of the brown tree snake from PNG in the 1940s, is exposed to significant contemporary threats from both sea and air routes. The very high volumes of passengers, mostly tourists, that arrive daily from the USA and numerous Asian airports could deliberately, or accidentally, bring a host of invasive species into the country. Given their large annual income and easy access to the US, citizens of Guam could also bring home a number of problem 'pets' and invasive ornamental plants. There are daily flights from two US States (Texas and Florida) with long-standing fire ant infestations and therefore there is a potential risk of stowaway fire ants arriving via aircraft containers as has already happened in New Zealand.

The sea routes travelled by large numbers of merchant ships, foreign fishing vessels and naval vessels to and from Guam provide major opportunities for marine invasives travelling via hulls and ballast water, as well as the opportunity for alien species to arrive via cargo, especially sea containers and vehicles. In turn, the large movements of people, cargo and supplies from Guam to Saipan on a daily basis makes this an important route for the rapid transfer of unwanted species from Guam to its near neighbour, the Northern Marianas.

Country: Guam

Airport infrastructure

Airports with paved runways	4
Airports with unpaved runways	1
Total number of airports	5

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Honolulu	17	Yes
Saipan, Marianas	71	Yes
Tinian, Marianas	2	Yes
Rota, Marianas	35	Yes
Kwajalien	3	No
Majuro	3	No
Kosrae	3	No
Pohnpei	4	No
Koror	11	Yes
Chuuk, FSM	4	Yes
Yap, FSM	3	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Hong Kong	4	Yes
Tokyo	47	Yes
Nagoya	16	Yes
Fukuoka	9	Yes
Osaka	24	Yes
Seoul	13	Yes
Manila	13	Yes
Niigata	2	Yes
Komatsu	<1	Yes
Matsuyama	<1	Yes
Okayama	2	Yes
Sapporo	3	Yes
Tatamatsu	<1	Yes

Sendai	6	Yes
Okinawa	<1	Yes
Hiroshima	<1	Yes
Taipei	4	Yes
Pusan, Philippines	5	Yes
Cairns, Australia	2	Yes

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Denpasar, Bali	5	Yes
Houston, USA	20	No
Miami, USA	7	No

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Not applicable	-	

Country: Guam

Seaport infrastructure

Main ports	Major trading activities
Apra	Apra is the largest and busiest port in Micronesia. Goods are transhipped from here to other ports within the region. International traffic is mainly containerised cargo. Vessels originate from Asia (Japan, Taiwan, Korea, Indonesia, Singapore, Philippines, Thailand), Australia, the Pacific islands and US west coast. Extensive visits by US navy vessels; courtesy visits by navies of Australia, N.Z and Asian countries. Most cruise ships are from Japan. Weekly commuter trips to Saipan. Extensive use by long-line fishing vessels and motherships.

Domestic shipping activity: Apra

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders	-	
Inter-island ferries (250)	55	13,750
Tourist charter boats (15)	6,000	90,000
Fishing – local	-	
Local work boats (3)	600	1,800
Local craft (day trips)	-	

International shipping activity: Apra

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (22)	560	12,320
Cruise liners (700)	12	8,400
Warships – large (200)	60	12,000
Warships – small (20)	50	1,000
Fishing – oceanic (25)	260	6,500
Fishing – mothership (18)	15	270
Yachts - itinerant (3)	25	75

2.7 Kiribati

National profile

Population (2000 estimate)	90,000
Population growth rate	3.7%
Density (people per km²)	111
Urban population (% of total)	37%
Land area (km²)	811
Land area per person	0.01 km ²
GDP per person (US\$)	\$625
Aid per person (US\$)	\$187
Political system	Independent republic
Major economic base	Tuna fishery, remittances, copra
Major trading partners	Australia, Japan, Fiji, N.Z., USA
Nearest country neighbours	Nauru (west), Marshall Islands (north), Tuvalu/Samoa (south), Tahiti (east)

Summary of vector issues

(using attached transport data)

Main vector routes

Spread across a huge expanse of the Pacific Ocean along the Equator, the 33 atoll islands of Kiribati are well off the tourist route. The main island of Tarawa, with the majority of the population, has the only international flights. These are infrequent flights (2/week) to Nadi and a similar number to Nauru. Less frequent flights also link up with Majuro in the Marshall Islands. These cater mostly to Pacific travellers and to the movement of air cargo.

There are runways on many of the other islands in the chain and these would be available for occasional, unscheduled visits by air. Christmas (Kiritimati) Island, famous for its huge seabird colonies (and with invasive mammal problems) is over 3200km to the east of Tarawa and is linked only to Honolulu by regular flights.

In contrast to the low level of air contact with other countries, Kiribati, with its huge Exclusive Economic Zone (EEZ) derives significant income from licensing a major tuna fishery. This means that some 350 foreign fishing vessels 'visit' Kiribati waters each year, but don't necessarily tie up at Betio, the main port. Even the motherships that support the fishing fleets anchor off Betio and are provisioned at sea by support vessels that come from Guam.

The other major shipping activity is about 60 annual visits by merchant vessels principally bringing in containers. These ships arrive from Japan and other Pacific ports, including the Fijian ports of Lae and Suva as well as Majuro in the Marshall Islands. Kiribati receives its refined petroleum products from Vuda Point, Fiji. Cargo for the other island groups within Kiribati is then transferred to small inter-island traders that provide the main transport within each of the three island groups.

Christmas (Kiritimati) Island is popular with cruise ships, but the 15 or so that visit each year anchor well offshore and passengers (tourists wanting to see the bird colonies) are taken ashore in the ship's boats. Fanning and Christmas Island are visited by yachties, but the numbers per year are hard to record. Only a dozen or so visiting yachts are recorded at Tarawa each year and are not likely to be an important vector route.

Transport modes and threats

Its isolation, coupled with a lack of commercial exploitation of terrestrial resources, reduces the pathways for potential invasives into the island groups of Kiribati. Air travel is very limited and most flights are only to Tarawa. There is some potential threat, via air passengers and air cargo for the arrival of risk species, but it is probably not high.

The major threat is likely to come from marine vessels. Given that the traffic in sea containers is not large, and is mostly to Tarawa, this is not likely to be a major route in itself, although it is certainly possible for unwanted organisms to arrive this way. The large tuna fishing fleet, with its motherships anchoring off Tarawa, is an obvious route for marine invasives to arrive via ballast water and hull fouling. The regular visits by a tanker from Fiji to Tarawa could also be bringing marine invasives from southern waters.

The most likely route for transporting pests between islands is via the small number of inter-island traders that collect cargo from Tarawa or operate just within the island groups. The long time taken for these journeys (7 days to Christmas Island from Tarawa for example), reduces the likelihood that major pests would arrive unnoticed. These traders would also be the main transport mode for marine species to hitchhike a ride on hulls or superstructure from Tarawa to other islands, unless the hulls were subjected to regular inspection and cleaning.

Country: Kiribati

Airport infrastructure

Airports with paved runways	4
Airports with unpaved runways	17
Total number of airports	21

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Nadi	2	Yes
Naru	2	Yes
Majuro	<1	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Nil	-	

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Details unknown	-	

Flights to Christmas Island are about once a week from Honolulu.

Flights from Tarawa go to Tabiteuea, Butaritari, and Abemama, but none are geared for tourism.

Country: Kiribati

Seaport infrastructure

Main ports	Major trading activities
Betio Island, linked to Tarawa	Main base for inter-island cargo and passenger services. Trips to Christmas Island take 7 days from Tarawa. Six small inter-island traders are the principal transport mode within each group of islands, operating cargo/ferry services. The <i>large fishing fleet operates in the Kiribati EEZ</i> , with 350 vessels transferring to a 'mothership' anchored off Betio. Itinerant yachts may visit other islands. Tanker from Fiji supplies petroleum products.
Christmas Island (Kritimati)	Around 15 cruise ships visit Kritimati each year out of Papeete. They <i>anchor well offshore</i> and use the ship's boats to transport passengers to the shore.

Domestic shipping activity: Betio

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (30)	150	4,500
Inter-island ferries	-	
Tourist charter boats	-	
Fishing – local	-	
Local work boats (3)	400	1,200
Local craft (day trips)	-	

International shipping activity: Betio

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	60	1,080
Cruise liners	-	
Warships – large (200)	2	400
Warships – small (20)	16	320
Fishing – oceanic (18)	350	6,300
Yachts - itinerant (3)	12	36

2.8 Marshall Islands

National profile

Population (2000 estimate)	52,000
Population growth rate	1.5%
Density (people per km²)	289
Urban population (% of total)	65%
Land area (km²)	180
Land area per person	0.003 km ²
GNP per person (US\$)	\$1,961
Aid per person (US\$)	\$890
Political system	Republic, in compact of free association with the USA
Major economic base	US aid, fishing, tourism, copra
Major trading partners	USA, Japan
Nearest country neighbours	Kiribati (south), FSM (west), Hawaii (east)

Summary of vector issues

(using attached transport data)

Main vector routes

Like Kiribati, the Marshall Islands are a collection of small flat atolls, totalling only 180km², but covering a vast oceanic EEZ. Most of the 1225 islands are very small and uninhabited. There are, however, unpaved airstrips on a dozen of the main atolls with an average of one flight per week that links them to each other and the international airport on Majuro Atoll. The most frequent domestic flights are 9/week direct from Majuro to Kwajalein atoll, a missile testing range operated by the US Department of Defence.

Air connections beyond the Marshall Islands also reflect the ties to the USA, both militarily and with respect to imports. There are almost daily flights to Honolulu, 2 per week to the American-controlled Johnston Atoll to the north, and 3 per week to Guam. The other international air connections are primarily to airports in the Federated States of Micronesia, with 3 flights per week calling in at Pohnpei, Chuuk and Kosrae.

The Marshall Islands only have two atolls with port facilities capable of receiving large international cargo vessels – Majuro and Kwajalein. The latter port is under the control of the US military and the frequency of visits by cargo and military vessels is not made available. It is probably reasonable to assume that the bulk of these vessel movements are with the mainland USA and probably with Guam and Honolulu.

As with the air routes, international shipping routes also reflect the dominant links to the USA and associated countries. One or two merchant vessels, mostly carrying containers, arrive in the port at Majuro each week, usually from the US west coast, Guam or Australia. They then travel on to FSM and Guam, before returning directly to the USA. Bulk petroleum products also come from the USA or Guam on a monthly basis.

The Marshall Islands, also in common with Kiribati, have a large international fleet of tuna boats (purse-seine and long-line) fishing the waters of its EEZ. There is also a sizeable domestic tuna fleet and all these vessels use the port at Majuro. There are 15 purse-seiners in port, on average, per month where they stay for up to 5 days. This means there is a large number of ship personnel that are coming ashore on an annual basis. The large motherships tend to anchor in the lagoon (40 visits per year), where they stay for 6-8 weeks while filling up with fish.

Other atolls have small concrete docks for domestic inter-island traders to transfer passengers and cargo. These carry an average of 120 people and call into Majuro about six times a week. There is therefore potential for considerable movement of people between the islands by domestic vessels. Few itinerant yachts call into the Marshall Islands.

Transport modes and threats

As the main transport hub for the external world into the Marshall Islands, Majuro has about two flights a day arriving from US and Guam. This is not a particularly high number of flights, and from limited destinations, although it does provide a potential pathway for small pests to arrive with passengers and air cargo. The 3 weekly flights from Guam could provide another travel route for the brown tree snake, which has been intercepted several times at Honolulu airport. The number of domestic flights is very limited, not likely to involve many tourists, and would operate with smaller, locally-based planes. Hence air transport is likely to be a less important threat to other islands within the Marshall Islands than the extensive number of people moving by inter-island trading vessels. There is a high volume of such travel in and out of Majuro, providing an important route for the spread of pests associated with domestic cargoes, passengers and marine species travelling on the hulls of trading vessels.

As a port with a high visitation by foreign fishing vessels, including motherships staying up to 8 weeks, Majuro faces a more significant threat of marine invasives arriving via hull fouling and ballast water. Since the vessels are tied up at the wharf there could also be a transfer of terrestrial pests, possibly arriving via crew. The volume of cargo vessels arriving is typical of many of the other smaller Pacific Island countries and with over 1/week in Majuro is another route of significance via sea containers, hulls and ballast water. There are also invasive threats via the military vessels visiting Kwajalein Atoll, although the non-release of data makes it difficult to assess the level of this threat.

Country: Marshall Islands

Airport infrastructure

Airports with paved runways	4
Airports with unpaved runways	12
Total number of airports	16

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Honolulu	5	Yes
Johnston Island	2	Yes
Kosrae	3	No
Pohnpei	3	No
Chuuk	3	No
Tarawa	<1	Yes
Guam	3	No

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Nil	-	

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Kwajalein	9	Yes
Airok	<1	Yes
Ailuk Island	1	Yes
Bikini	<1	No
Aur Atoll	1	Yes

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Ebon	1	Yes
Enewetak Island	1	No
Jabat	<1	Yes
Jeh	<1	Yes
Kaben	1	Yes
Kili	1	Yes
Likiep	1	No
Lae	1	No
Loen	1	No
Maloelap	1	No
Mili	1	No
Mejit island	1	No
Majkin	<1	No
Namorik	1	Yes
Rongelap	1	No
Jaluit	2	Yes
Ujae	1	No
Utirik	1	Yes
Wota	<1	No
Wotje	1	Yes
Wotho	1	No

Country: Marshall Islands

Seaport infrastructure

Main ports	Major trading activities
Majuro	Most international traffic is containerised cargo. Typical cargo runs originate from the US west coast, Guam or Australia and visit other Pacific ports. Usual route for US vessels is Majuro, Kwajalein, Kosrae, Pohnpei, Chuuk, Guam, then direct to US. Petroleum products from the US or Guam, monthly. Only port in RMI with support facilities for tuna fleets. <i>Motherboats remain in lagoon for 6-8 weeks.</i> Itinerant yachts rarely use the ports. Slipway is for all vessels up to 800 tons – only one in Marshall Islands.
Kwajalein Atoll	Only other island with a large port facility capable of receiving large international cargo vessels. Controlled by the US military.

Domestic shipping activity: Majuro

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (120)	300	36,000
Inter-island ferries	-	
Tourist charter boats (10)	400	4,000
Fishing – local (18)	200	3,600
Local work boats (2)	250	500
Local craft (day trips) (2)	15,000	30,000

International shipping activity: Majuro

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	84	1,512
Cruise liners	-	
Warships – large (200)	1	200
Warships – small (20)	18	360
Fishing – oceanic (25)	360	9,000
Fishing – motherships (18)	40	720
Yachts - itinerant (3)	20	60

2.9 Nauru

National profile

Population (2000 estimate)	11,000
Population growth rate	1.3%
Density (people per km²)	524
Urban population (% of total)	100%
Land area (km²)	21
Land area per person	0.002 km ²
GNP per person (US\$)	\$7,292
Aid per person (US\$)	\$200
Political system	Independent republic
Major economic base	Phosphate (nearly exhausted), investments
Major trading partners	Australia, New Zealand
Nearest country neighbours	Kosrae, FSM (north), PNG (southwest), Solomon Islands (south), Kiribati (east)

Summary of vector issues

(using attached transport data)

Main vector routes

A small isolated country, Nauru has few air links both within and outside the Pacific. Australia is the only regular connection outside the island countries (3/week to Brisbane and Melbourne), while within the Pacific, flights link Nauru with Fiji and Kiribati only (two flights to each per week).

The large number of merchant vessels visiting Nauru (2/week on average) are mostly bulk carriers removing the diminishing reserves of phosphate from the island. This is done via a buoy mooring system rather than by tying up to a wharf. Container vessels have to offload containers onto a combination of barge and raft to reach land. The bulk carriers trade from Nauru to Australia, New Zealand, India, Korea and the Philippines. Container vessels are less frequent (1/fortnight) and arrive from Brisbane and Melbourne.

There are no foreign fishing vessels or itinerant yachts calling on Nauru.

Transport modes and threats

Sea routes are the most likely entry pathways for invasives into Nauru, given the limited number of air links to other countries. As relatively affluent citizens in the Pacific context, however, there may be a need to consider the amount of air travel undertaken by Nauruan nationals as a potential route for alien species getting into the country. The flights from Fiji, in particular, are potential routes for exotic species, given that Fiji is a major hub for the South Pacific.

The highly disturbed landscapes of Nauru, a legacy of the phosphate mining, means that invasive plant species that are suited to disturbed sites and colonising environments are likely to thrive if they arrive, accidentally or are brought in deliberately.

The large international vessels arriving in Nauru are a potential threat and provide a transport mode for marine invasives via ballast water and hull fouling, given the relatively high frequency of such vessels arriving in Nauru, and the fact that a number are coming from Asian ports. They are less likely to bring in terrestrial species since they anchor offshore. The bulk phosphate carriers are also less likely to provide hospitable places for invertebrate and vertebrate stowaways than the fortnightly sea containers that arrive by barge and raft from Australia. Winged insects could probably overcome both of these barriers and make it to shore from time to time.

Country: Nauru

Airport infrastructure

Airports with paved runways	1
Airports with unpaved runways	0
Total number of airports	1

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Nandi	2	No
Tarawa	2	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Melbourne	1	No
Brisbane	2	Yes

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Not applicable	-	

Country: Nauru

Seaport infrastructure

Main ports	Major trading activities
Aiwo	<i>Marine traffic is mostly bulk carriers, trading between N.Z., Australia, India, Korea and the Philippines that all use a buoy mooring system for loading phosphate or discharging oil products. Container vessels off-load containers onto a barge/raft combination. Petroleum products come from Australia and Fiji, usually one vessel/month. No cruise ships visit and foreign fishing vessels do not use the facilities. Patrol craft from China pay courtesy visits of about 5 days length. There are no inter-island ferries, most travel to other islands is by air.</i>

Domestic shipping activity: Aiwo

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders	-	
Inter-island ferries	-	
Tourist charter boats	-	
Fishing – local (2)	300	600
Local work boats (3)	300	900
Local craft (day trips)	-	

International shipping activity: Aiwo

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	100	1,800
Cruise liners	-	
Warships – large	-	
Warships – small (20)	1	20
Fishing – oceanic	-	
Yachts - itinerant (3)	-	

2.10 New Caledonia

National profile

Population (2000 estimate)	212,800
Population growth rate	2.5%
Density (people per km²)	11
Urban population (% of total)	71%
Land area (km²)	18,576
Land area per person	0.09 km ²
GDP per person (US\$)	\$15,910
Aid per person (US\$)	\$\$1,790
Political system	Overseas territory of France
Major economic base	Nickel, tourism, French aid, fishing, aquaculture, agriculture
Major trading partners	Australia, New Zealand
Nearest country neighbours	Vanuatu (northeast), Fiji (east), Australia (west), New Zealand (southeast)

Summary of vector issues

(using attached transport data)

Main vector routes

The largest Pacific Island country after Papua New Guinea, New Caledonia has a diversified economy based around nickel exports and tourism, and is a major regional point of call for maritime trade. Almost 30 airstrips are spread around the country including its offshore islands. Despite its regional importance, flights to Pacific Island countries are relatively limited. Daily connections to Port Vila in Vanuatu are the most frequent flights and there are only weekly flights to more distant airports in Fiji, Papeete, Samoa and Wallis Island.

The strongest airlinks outside the island countries are with Australia (20 flights/week), Auckland (7 flights/week) and Japan (12 flights/week). Tourists probably dominate these passenger lists, as New Caledonia has long been a popular holiday destination, especially for Australians.

From Noumea, smaller airlines provide an extensive network of flights to offshore islands. To the south, there are 25 weekly flights to Ile des Pins. There are a total of 69 weekly flights to the islands of Lifou, Mare and Ouvea in the Loyalty Islands Province, lying about 100 km east off the main island of Grande Terre. About 14 flights per week fly to the airports of Kone and Touho on Grande Terre from Noumea.

The main port of Noumea is used for a wide range of activities. Containerised cargo, bulk ore carriers and oil/LPG tankers dominate international shipping. These merchant vessels total about 570 port visits per year, or over 10 each week. The large container ships and bulk ore carriers sail mainly between Noumea and Australia, New Zealand, Singapore and France. As a French administered territory, New Caledonia also receives annual visits from large (2/month) and small (8/month) warships, including patrol and support vessels. Since these visits are for 2-5 days, there is a large number of crew and naval personnel visiting each year (about 7,000).

A much larger number of passengers arrive via cruise ships – about 66,000 each year – but stay for shorter periods. As a major call-in point for these ships, Noumea averages one cruise ship per week, usually overnight or for a few hours. They also drop anchor around New Caledonia's coasts so passengers can spend a day on the beach. Noumea is also a major attraction (and the only official entry point) for visiting yachts from a range of countries, but dominated by Australia and New Zealand.

New Caledonia has a considerable amount of trade with Vanuatu and the French territory of Wallis and Futuna. Over 20 port visits a month to Noumea are made by inter-island traders and a much larger number of people are moved between the islands of New Caledonia (almost 2,000 per month) by inter-island ferries.

Transport modes and threats

The large volume of diversified vessels visiting New Caledonia annually exposes it marine and terrestrial invasives from a variety of sources – Australia, south-east Asia and Europe, as well as from other Pacific Island countries. Inter-island ferries travelling frequently between nearby islands provide opportunities for hull fouling organisms and ballast water species to arrive. The large number of itinerant yachts that visit New Caledonia are also a potentially significant threat as a transport mode for hull and ballast water hitchhikers. Containers are a threat, providing a transport mode for a wide variety of invasives, from fungi and soil organisms to invertebrates and, possibly, vertebrates.

The cruise ships that bring many thousands to New Caledonia are a potential pathway for marine invasives all along the “Pacific cruise circuit”. While these cruise ships follow strict procedures regarding disposal of wastes, it is not known if they have similarly demanding standards with respect to managing risks of spreading invasive species. Since they anchor offshore for a day at many points around the coasts of New Caledonia (and on other countries) there are clearly opportunities for exotic organisms to be spread this way.

Air links to New Caledonia also provide opportunities for invasives to arrive, via passengers and goods. The high frequency of flights from Australia and Japan identifies the routes that are the most obvious threats. The recent arrival of the fire ant (*Wasmannia auropunctata*) into New Caledonia makes it a threat to other countries that are linked to it by trade routes and visitors. Brisbane flights could also bring the Red Imported Fire Ant.

Country: New Caledonia

Airport infrastructure

Airports with paved runways	6
Airports with unpaved runways	23
Total number of airports	29

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Port Vila	7	Yes
Wallis Island	2	Yes
Nadi	1	Yes
Suva	<1	No
Apia	<1	Yes
Rarotonga	<1	No
Papeete	1	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Sydney	14	Yes
Brisbane	6	Yes
Norfolk Island	1	Yes
Tokyo	9	Yes
Osaka	3	Yes
Auckland	7	Yes

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Ile des Pins	25	Yes
Lifou	31	Yes
Mare	19	Yes
Ouvea	19	Yes
Kone	8	Yes
Touho	6	Yes
Belep Island	2	No
Tiga	3	Yes

Country: New Caledonia

Seaport infrastructure

Main ports	Major trading activities
Noumea	<i>A major regional port which is also a centre for maritime support and ship repair. Containerised cargo dominates traffic, mainly with Australia (nickel), N.Z., Singapore and France. Considerable trade also with island states, especially Vanuatu and Wallis & Futuna. French Navy presence – 3 patrol and 2 support vessels. Major port for cruise ships, which also drop anchor at points around the coast for shore visits by passengers. Around 10 major warships visit annually, staying for 2-5 days. Very large nos. of itinerant yachts (from Aust., N.Z., Pacific Islands, USA, Europe), with Noumea the only official entry port. Tourist vessels, incl. cruising services.</i>

Domestic shipping activity:

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (12)	270	3,240
Inter-island ferries (200)	110	22,000
Tourist charter boats	-	
Fishing – local (8)	400	3,200
Local work boats (4)	2,200	8,800
Local craft (day trips) (2)	40,000	80,000

International shipping activity:

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	570	10,260
Cruise liners (1,200)	55	66,000
Warships – large (200)	25	5,000
Warships – small (25)	100	2,500
Fishing – oceanic (18)	60	1,080
Yachts - itinerant (3)	500	1,500

2.11 Niue

National profile

Population (2000 estimate)	1,600
Population growth rate	Slow decline, due to emigration to N.Z.
Density (people per km²)	6
Urban population (% of total)	32%
Land area (km²)	259
Land area per person	0.16 km ²
GDP per person (US\$)	\$4,375
Aid per person (US\$)	\$4,375
Political system	Self-governing, free association with New Zealand
Major economic base	Aid, remittances, agriculture, tourism
Major trading partners	New Zealand
Nearest country neighbours	Tonga (west), American Samoa/Samoa (north), Cook Islands (east)

Summary of vector issues

(using attached transport data)

Main vector routes

As an isolated coral outcrop, with few links to the outside world and limited on-island economic activity, Niue has a correspondingly limited number of vector routes. Its close economic, aid and social links to New Zealand define the main potential routes whereby invasives species are most likely to arrive.

Niue's single airstrip is directly linked only to its closest Polynesian neighbours of Tonga and Samoa and also to Auckland, which now has more Niuean residents than the island itself. There is about 1 flight a week to Auckland. Samoa and Tonga are also air-linked with Niue on a weekly basis. Given the low level of tourism activity on Niue, most of the passengers will be Niueans travelling within the Pacific, including trips to and from New Zealand.

The lack of a harbour facility works in Niue's favour as far as excluding invasive species is concerned. All of the containers and other cargo has to be off-loaded onto barges and then transported to shore, which reduces the likelihood of hitchhiker species getting ashore as can happen more easily from vessels tied up at wharves. A container ship arrives about once every two weeks. They start in New Zealand, call at the Chatham Islands, Tonga and Niue before continuing to the Cook Islands. Tankers from Fiji deliver petroleum products.

The number of yachts that visit annually is growing, but is still relatively small at 150 per year. Most of the 60 local fishing boats operate out of the only port of Alofi, but do not constitute an important vector route, given their local activities.

There are no foreign fishing vessels operating in Niuean waters.

Transport modes and threats

Niue's isolation and small population base, currently about 1,600 and shrinking, means that it faces only limited threats from external invasive species. This applies both to air and sea routes.

Returning residents flying in from Auckland, Tonga or Samoa should be regarded as potential vector routes, given their relative wealth in Pacific terms (national profile), and practices of taking food as gifts when visiting. Many insect species can hitchhike on food items, particularly in fruit. The low number of weekly flights does not make this a major threat, but rather it is a pathway that could bring in a wide range of organisms, both intentionally and accidentally.

The extensive damage to forests from the recent hurricane could open up forest gaps to invasive plants that would otherwise struggled to establish.

The low frequency of merchant vessels visiting Niue provides a pathway for marine pests, most likely arriving via hull fouling, although ballast water is also a risk. The ubiquitous containers also provide the other obvious route for invasives to get ashore. None of these modes could be regarded as 'high risk' when compared with other Pacific countries that have substantially greater flows of vessels and goods. The limited sea routes travelled by cargo vessels that visit Niue also cuts down the likelihood that a wide range of exotic marine species is threatening Niuean waters.

Country: Niue

Airport infrastructure

Airports with paved runways	1
Airports with unpaved runways	0
Total number of airports	1

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Tongatapu, Tonga	1	Yes
Vava'u, Tonga	1	Yes
Apia	1	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Auckland	1	Yes

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Not applicable	-	

Country: Niue

Seaport infrastructure

Main ports	Major trading activities
Alofi	The island's only port and base for most of the 61 small local fishing boats. <i>Container and limited bulk cargo comes fortnightly, from N.Z. with calls at the Chatham Islands, Tonga, Niue and then Rarotonga (or reverse).</i> Cargo vessels anchor off the wharf and discharge via a barge and launch operation. Petroleum products come from Fiji via Tonga, then the tanker generally returns to Fiji. One naval vessel visits each year, staying 2-3 days. <i>The number of itinerant yachts visiting (currently 150/year) is growing.</i>

Domestic shipping activity: Alofi

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders	-	
Inter-island ferries	-	
Tourist charter boats (5)	240	1,200
Fishing – local (2)	15,000	30,000
Local work boats (2)	200	400
Local craft (day trips)	-	

International shipping activity: Alofi

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	26	468
Cruise liners (1000)	3	3,000
Naval vessel (120)	1	120
Warships – small	-	
Fishing – oceanic (8)	1	8
Yachts - itinerant (3)	150	450

2.12 Northern Mariana Islands

National profile

Population (2000 estimate)	70,000
Population growth rate	Fluctuates due to immigration, mostly from East Asia
Density (people per km²)	149
Urban population (% of total)	Nearly 100%
Land area (km²)	471
Land area per person	0.007 km ²
GDP per person (US\$)	\$10,401
Aid per person (US\$)	\$160
Political system	Self-governing commonwealth in union with the United States
Major economic base	Tourism (Asians), garments (mainly to US markets), copra
Major trading partners	USA, Japan
Nearest country neighbours	Guam/Palau/FSM (south), Philippines (west), Japan (north), Hawaii (east)

Summary of vector issues

(using attached transport data)

Main vector routes

The Northern Mariana Islands (“Northern Marianas”) are an island chain much favoured by Asian visitors, especially from Japan. Consequently, the main island of Saipan has 65 flights a week arriving at the capital of Garapan from nearby Guam and another 23 direct from Japanese airports. (It is only 80 km from Guam to Rota, the southernmost of the Marianas island chain.) Ten flights a week arrive in Saipan from Seoul, four from Hong Kong and three from Pusan in the Philippines. There are none from any other Pacific or Pacific rim countries, which merely emphasises the dominance of the Asian connection to the Northern Marianas.

Also favoured by the package tourist tours are the southern islands of Tinian and Rota, which receive about 90 and 35 flights a week respectively. Tinian is within several kilometres of Saipan, close enough for large inter-island ferries to take tourists daily to the Tinian casino. Rota is about 100km from Saipan and is therefore closer to Guam.

The international marine traffic is dominated by containerised cargo travelling to the one commercial dock on Saipan. As with the air routes, cargo runs are mostly of Asian origin – Japan, Taiwan, Korea, Philippines, Indonesia, Singapore and Thailand. Merchantships

also arrive from Australia, Guam, the US west coast and other Pacific islands. Barges arrive from Guam twice a week carrying containers. There are 330 container ship visits into Saipan annually – almost one every day – a high level of activity for the region. There are almost weekly visits by USA navy vessels.

The volume of cruise ships visiting is relatively small at only eight visiting per year on average. There is much more local activity of tourist charter boats making about 100 trips a week from Saipan to local destinations. Unlike Guam, there is very little use of the port made by international fishing fleets. Where Guam has 260 fishing vessel visits each year, the Saipan port has only ten, on average. The domestic fishing fleet is small and focuses on bottom fishing. Few itinerant yachts visit the islands.

Transport modes and threats

Assessing the threats to the Northern Mariana Islands needs to be done in the context of its major links, both sea and air, with nearby Guam. Since Guam is Micronesia's most significant transport hub, and is only 200km away, the frequent flow of people and goods between the two countries also provides a number of opportunities for invasives to travel the same routes. Hence new arrivals of exotics in Guam may have a fairly high probability of making it across to the Northern Marianas as well. The reader is therefore referred to the synopsis for Guam as well as the following comments.

The heavy air traffic to Saipan from a number of Asian locations puts it at risk from hitchhiker species that may arrive with passengers, their luggage, or air cargo containers. Once they arrive in Saipan there are major movements of visitors to the southern Marianas islands of Tinian and Rota, which are already 'home' to introduced sambar deer. Islands that are important to protect from invasive species are the Marianas islands north of Saipan which are part of the Northern Islands Sanctuary, with few people and protected flora and fauna.

Given the large number of US travellers to Guam, the risks of fire ants arriving there and being transferred to the Northern Marianas needs to be evaluated and appropriate precautionary steps taken.

The relatively frequent visits by container vessels are another potential pathway for both terrestrial and marine invasives into the country. Again, the frequent trips with containers from Guam are an important transport mode to evaluate further, particularly for terrestrial hitchhiker species. The large number of vessels from Asian ports is a threat with respect to marine invasives, both via ballast water and hull fouling. The frequent visits by US navy ships that are covering large areas of the Pacific would also be another potential source for marine invasives.

Country: Northern Mariana Islands

Airport infrastructure

Airports with paved runways	3
Airports with unpaved runways	3
Total number of airports	6

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Guam	65	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Tokyo	14	Yes
Nagoya	9	Yes
Osaka	6	Yes
Seoul	10	Yes
Hong Kong	4	No
Pusan, Philippines	3	No

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Tinian	93	Yes
Rota	35	Yes

Country: Northern Mariana Islands

Seaport infrastructure

Main ports	Major trading activities
Saipan	International traffic is mostly containerised cargo into this, the one commercial dock. <i>Cargo runs usually start in Asia</i> (Japan, Taiwan, Korea, Indonesia, Singapore, Philippines, Thailand), Australia, Guam, Pacific islands, US west coast. <i>Twice-weekly barges with containers from Guam</i> , 200km away. Main containerised export is garments to US (mostly). Petroleum products direct from Singapore, or via Guam, monthly. <i>Regular visits from US navy ships</i> . Cruise ships mostly from Japan. Absence of tuna fishing fleets, with small local fishing fleet, concentrating on bottom fishing. Research vessels (usually Japanese), twice/year and stay about 5 days.
Rota, Tinian	Ports are located on both islands of Rota and Tinian and handle an <i>extensive volume of daily passenger ferry traffic</i> . (Tinian casino attracts many passengers.) Rota port receives small cargo vessels.

Domestic shipping activity: Saipan

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders	-	
Inter-island ferries (300)	750	225,000
Tourist charter boats (20)	5,000	100,000
Fishing – local (5)	1,000	5,000
Local work boats (4)	600	2,400
Local craft (day trips) (2)	4,000	8,000

International shipping activity: Saipan

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	460	8,280
Cruise liners (1000)	8	8,000
Warships – large (200)	8	1,600
Warships – small (20)	50	1,000
Fishing – oceanic (18)	10	180
Yachts - itinerant (3)	25	75

2.13 Palau

National profile

Population (2000 estimate)	19,200
Population growth rate	2.6%
Density (people per km²)	40
Urban population (% of total)	75%
Land area (km²)	494
Land area per person	0.025 km ²
GDP per person (US\$)	\$8,000
Aid per person (US\$)	\$1,550
Political system	Republic, compact of free association with the United States
Major economic base	Tourism (marine-based), aid, fisheries and agriculture
Major trading partners	USA, Japan
Nearest country neighbours	PNG/Solomon Islands (south), Philippines (west), Japan/Guam (north), FSM (east)

Summary of vector issues

(using attached transport data)

Main vector routes

With its mix of high volcanic islands, low coral atolls and the limestone Rock Islands (famous among scuba divers), Palau has extremely rich marine biodiversity to protect. The airline connections link Palau only with Micronesia and Asia. The main airline connections are the nine weekly flights from Guam. Next in frequency are the three weekly flights from Yap and another three from Taipei. There are no flights to other Pacific island destinations. There are few airstrips on Palau's eight permanently inhabited islands.

Few merchant vessels visit Palau, even compared to Pacific countries generally. About 36 vessel trips annually bring mostly containerised cargo that originates from Guam and, sometimes, from Yap. Guam also supplies petroleum products to Palau.

A much larger number of international and domestic tuna long-line vessels use the wharf at Koror, Palau's most populated island and the main port. About 15 vessels use the port monthly with stays of up to five days. The number of long-liners visiting Palau has declined in recent years, as has the activities of the international purse-seine fishing fleets. Purse-seiners bunker and re-provision in Palau and some transfer their catch to

motherships while at anchor in the lagoon. Mothership vessels average 20 visits each year.

Only one or two cruise ships visit Palau annually, from Guam or Asia, and the number of visiting yachts is also small (about 25/year).

In addition to domestic fishing activities there is considerable movement of people and goods between the islands of Palau via inter-island trading/ferry vessels. There are almost daily (300/year) trips out of Koror by these traders. There are numerous small docks located throughout Palau that are used by these trader/ferries as well as by government and private vessels.

Transport modes and threats

Although Palau does not have a large number of flights arriving from other countries, the daily flights from Guam should be seen as posing a potentially significant risk with respect to invasive species. This needs to be seen in the context of the high number of flights into Guam from the USA and a wide variety of Asian destinations, many of which could be the source of invasives, particularly invertebrates. Ant species could arrive via this pathway.

Some of Palau's rich marine biodiversity is protected through legislation which has set aside the uninhabited Rock Islands as a marine reserve with limits on public access. This biodiversity could be threatened by the arrival of marine invasives, through hull fouling and ballast water. The distance from Koror to the Rock Islands is about 30 km, not a great distance for exotic marine species to spread naturally, or via the tourist vessels that visit the area from Koror. Many tourists travel to Palau to dive around its waters. A few come via yachts, and while the number of itinerant yachts visiting Palau is low, they could be a threat if they have been cruising the Pacific and picking up exotic species on their hulls.

The main port at Koror is the arrival point for vessels, many of which arrive from Guam which has been identified earlier in this report as a potentially major point for the arrival of marine invasives and other species that could arrive via containers. The large number of fishing vessels are a likely route for hull fouling species to arrive. From Koror, the local trader/ferry vessels could spread invasives to other islands. Hull fouling is probably the most likely mode of spread, although cargo should not be overlooked as a mode for hitchhiker species.

The government of Palau has proposed relocating most government functions to the larger island of Babelthuap, along with building a new government port. Implications for vector routes will need to be re-assessed in light of these developments.

Country: Palau

Airport infrastructure

Airports with paved runways	1
Airports with unpaved runways	2
Total number of airports	3

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Guam	9	Yes
Yap	3	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Taipei	3	Yes
Manila	1	Yes

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Nil	-	

Country: Palau

Seaport infrastructure

Main ports	Major trading activities
Koror	Main port for the eight inhabited islands (out of 340). Most international traffic is containerised cargo, usually originating from Guam, sometimes via Yap (FSM). All petroleum products come via Guam, monthly. <i>International/domestic tuna long-line vessels (15/month) and stay 5 days.</i> Catch transfers from purse-seine fleet to motherships occur in the lagoon. Cruise ships come from Guam or Asian ports. A single slipway takes all vessels up to 100 tons.
Other docks	Numerous smaller docks are located throughout Palau for domestic passenger and cargo vessels, yachts and private craft. The majority of these docks are on the island of Koror.

Domestic shipping activity: Koror

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (30)	300	9,000
Inter-island ferries	-	
Tourist charter boats (20)	100	2,000
Fishing – local (8)	500	4,000
Local work boats	-	
Local craft (day trips)	-	

International shipping activity: Koror

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	36	648
Cruise liners (800)	2	1,600
Warships – large (200)	1	200
Warships – small (20)	12	240
Fishing – oceanic (10)	185	1,850
Fishing – motherships (18)	20	360
Yachts - itinerant (3)	20	60

2.14 Papua New Guinea

National profile

Population (2000 estimate)	4,810,000
Population growth rate	2.5%
Density (people per km²)	10
Urban population (% of total)	15%
Land area (km²)	462,243
Land area per person	0.1 km ²
GNP per person (US\$)	\$900
Aid per person (US\$)	\$82
Political system	Independent state
Major economic base	Minerals (copper, gold, oil), agriculture (coffee, copra, palm oil), forestry, fishing
Major trading partners	Australia, Japan, USA
Nearest country neighbours	Australia (south), Irian Jaya (west), FSM (north), Solomon Islands (east)

Summary of vector issues

(using attached transport data)

Main vector routes

As the largest and most populated country of the Pacific Island region, Papua New Guinea (PNG) has easily the largest and most diverse economy of the Pacific island countries. As well as the eastern half of the island of New Guinea there are 600 other islands; some of those in the east are very close to the Solomon Islands.

The international airline links with PNG are surprisingly limited, given its size and regional importance, and are heavily skewed towards Australian destinations. Of the almost 40 weekly connections with Australia, 23 are direct from Cairns, 11 from Brisbane and four from Sydney. There is only one flight per week to Tokyo, one to Manila and two from Singapore. Flights to other Pacific countries are limited to only two per week to Honiara in the Solomons.

As the following summary pages of domestic flights demonstrates, there is an extensive network of scheduled flights to PNG's hundreds of 'airports' (472 are unpaved runways; 20 only are paved). In addition, there are many flights by private and business planes linking the communities throughout the mountainous interior. Getting information on these flights was not possible, but they are also potential routes for invasives into communities and places such as logging sites and mining areas.

Papua New Guinea has two major ports and it is through these that the most significant transport links are made to other Pacific island countries. Lae handles the most traffic and is the significant trans-shipment link for trade into the Pacific for containers and petroleum products. Port Moresby is the second busiest port, but handles a wider variety of vessels, ranging from general cargo, to container, log and bulk ore carriers, tankers, navy and fishing vessels.

Almost one third of the 340 annual merchant vessels arriving in Lae are container ships from Australia, Singapore and the United States, that are then routed onto other Pacific islands. The weekly tankers arrive from Australia and Singapore before heading onto other Pacific islands. New and used vehicles arrive here from Japan and Korea for sale in PNG and shipment onto other Pacific islands. Lae is also the base for a small amount of international fishing (21 vessel visits per year) and a large amount of traffic by inter-island traders (400/year) and ferries (about 1.5/week).

Port Moresby receives fewer container vessels than Lae, but over 150 log ships visit annually and take logs mostly to Australia, Japan and India. Most of the trade out of Port Moresby is with Australia, Japan, New Zealand and the United States. Barges bring copper concentrate (about weekly) from Ok Tedi mine and it is then transferred to ore carriers for export. Only a few cruise ships visit Port Moresby (6/year) as part of the Noumea/Suva/Port Vila (Vanuatu) circuit. Cruising yachts largely bypass PNG.

Transport modes and threats

Given its size and diversity of species, Papua New Guinea needs to be considered not only as potentially receiving unwanted species, but also as a source of species that may become invasive in other countries. The brown tree was a harmless species native to PNG before hitchhiking a ride in a barge to Guam after World War II (see section 2.6 Guam).

The most likely route for invasive species to arrive in PNG is via its extensive shipping links with the outside world. These may be a variety of terrestrial species arriving on and in containers, or on vehicles (e.g. moth eggs) or as marine invasives on hulls and in ballast water. Given the diverse range of cargo items shipped to PNG, it needs to be seen as a potentially major arrival point for invasives that travel by sea. The ongoing links to other Pacific island countries then provide the opportunity for further spread. Inter-island traders from both Lae and Port Moresby are an important mode for carrying exotic species, via cargo, hulls and passengers, to other ports around PNG including its off-shore islands. (See the list of other ports administered under ‘Seaport infrastructure’.)

In comparison with its sea links, Papua New Guinea does not face the same level of threat from international air travel. Links are mostly with Australia and virtually none with the Pacific countries. This does not exclude the possibility of species getting into PNG via this route – fire ants from Brisbane’s port or airport being a possible case in point. The extensive network of domestic flights then provides important internal routes for invasives to spread within the country, via cargo and passengers.

Country: Papua New Guinea

Airport infrastructure

Airports with paved runways	20
Airports with unpaved runways	472
Total number of airports	492

Airline flight information

International flights : Port Moresby

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Honiara	2	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Cairns	23	Yes
Brisbane	11	Yes
Sydney	4	Yes
Tokyo	1	Yes
Manila	1	Yes
Singapore	2	Yes

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights: Port Moresby

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Lae	46	Yes
Rabaul	26	Yes
Mount Hagen	26	Yes
Goroka	17	Yes
Madang	13	Yes
Popondetta	12	Yes

Talasea	12	Yes
Daru	12	Yes
Alotau	11	Yes
Wewak	10	Yes
Tabubil	10	Yes
Kavieng	8	Yes
Kiunga	6	No
Kerema	7	Yes
Hobkins	6	Yes
Bialla	5	No
Lihir Island	5	Yes
Kikori	4	No
Mendi	4	Yes
Wau	4	Yes
Bulolo	4	No
Manus Island	4	Yes
Buka	3	No
Balimo	3	Yes
Vanimo	3	No
Itokama	2	No
Kokada	2	Yes
Chimbu	2	Yes
Amazon Bay	1	Yes
Kawito	2	Yes
Lake Murray	1	No
Losuia	2	Yes
Misima	2	No
Manihiki Island	2	Yes
Wanigela	1	Yes
Aragip	<1	No
Agaun	<1	No
Mougulu	<1	No
Kamusi	<1	No
Nomad River	<1	No
Obo	1	No
Rabaraba	<1	No
Tetabedi	2	No
Tufi	2	No
Baimuru	1	No
Wedau	<1	No

Domestic Flights: Alotau

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Port Moresby	12	Yes
Amazon Bay	2	Yes
Losuia	2	Yes
Misima	2	Yes
Wanigela	<1	No
Aragip	<1	No
Agaun	<1	No
Cape Vogel	<1	Yes
Popondetta	<1	No
Rabaraba	1	Yes
Salamo	1	Yes
Sehulea	1	Yes
Tufi	<1	No
Vivigani	<1	No
Wedau	<1	Yes
Biniguni	1	No

Country: Papua New Guinea

Seaport infrastructure

Main ports	Major trading activities
Port Moresby	<i>Second largest PNG port</i> in marine traffic. Vessels in 1999 were: 82 container, 153 general cargo, 43 tankers, 14 ro-ro, 6 cruise and 157 log ships. Coastal shipping movements (1999): 238 general cargo, 5 tankers, 87 barges (bringing copper concentrate from Ok Tedi for transfer for export), 5 passenger, 354 fishing vessel. <i>The majority of international traffic is between Australia, Japan, N.Z. and the US.</i> Log ships mainly trade to Australia, India and Japan. Cruise vessels anchor in the harbour as part of the Noumea/Suva/Port Vila circuit. Fishing is primarily by local vessels.

Domestic shipping activity: Port Moresby

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (10)	330	3,300
Inter-island ferries (50)	250	12,500
Tourist charter boats	-	
Fishing – local (3)	11,000 ¹	33,000
Local work boats (3)	2,000	6,000
Local craft (day trips) (2)	3,000	6,000

International shipping activity: Port Moresby

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	455	8,190
Cruise liners (1500)	6	9,000
Warships – large	-	
Warships – small (20)	100	2,000
Fishing – oceanic (18)	3	54
Yachts - itinerant	-	

¹ Short voyages by the local fishing fleet of 16 vessels.

Country: Papua New Guinea

Seaport infrastructure

Main ports	Major trading activities
Lae (on the northern coast of eastern PNG)	Busiest port in PNG. Port is a <i>significant trans-shipment link for Pacific island trade in containers and petroleum products</i> . Inbound container ships are from Australia, Singapore and the U.S. and out-bound is mainly to Pacific Islands. Tanker traffic arrives from Australia and Singapore, then heads to the Pacific Islands. <i>Ro-ro car carriers come from Japan and Korea with new and used vehicles for sale in PNG and other island countries</i> . In 1999, intern. vessel movements were: 126 containers, 96 general cargo, 53 tanker, 14 ro-ro, 41 log carriers, 21 fishing vessels. Inter-island ferries are short duration voyages, up to nine vessels a month.
Other ports	Thirteen other ports are administered in PNG. These are: Aitape, Alotau, Biella, Buka, Daru, Kimbe, Kaviena, Kieta, Lorengau, Madang, Oro Bay, Rabaul, Samarai, Vanimo and Wewak.

Domestic shipping activity: Lae

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (10)	400	4,000
Inter-island ferries (50)	75	3,750
Tourist charter boats	-	
Fishing – local	-	
Local work boats (4)	1,000	4,000
Local craft (day trips)	-	

International shipping activity: Lae

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	340	6,120
Cruise liners	-	
Warships – large	-	
Warships – small	-	
Fishing – oceanic (18)	21	378
Yachts - itinerant	-	

2.15 Samoa

National profile

Population (2000 estimate)	173,000
Population growth rate	0.5%
Density (people per km²)	59
Urban population (% of total)	21%
Land area (km²)	2,934
Land area per person	0.017 km ²
GNP per person (US\$)	\$983
Aid per person (US\$)	\$288
Political system	Independent state
Major economic base	Agriculture (coconut products), remittances, fisheries (tuna), manufacturing
Major trading partners	New Zealand, Australia, American Samoa, Germany, Japan, China
Nearest country neighbours	American Samoa (east), Tokelau (north), Fiji (west), Tonga (south)

Summary of vector issues

(using attached transport data)

Main vector routes

Airline links with Samoa are dominated by its connections with the neighbouring territory of American Samoa and with New Zealand. Fourteen flights a week from Auckland highlight the strong connections to Samoan communities in New Zealand, compared with two weekly flights to Los Angeles, one to Honolulu, and three from Sydney. In contrast, there are about seven flights each day to Pago Pago in American Samoa, making this the dominant link to other island countries, significantly ahead of the four flights per week to Fiji and six to Tonga. Weekly flights connect Samoa with Niue, Tonga, Vanuatu, the Cook Islands, and French Polynesia. Small domestic aircraft take passengers to the other main island of Savai'i about three times a day.

Samoa has one main commercial port in the capital, Apia. Marine traffic is dominated by merchant ships that make about 240 trips per year, most of them carrying containerised cargo from Australia, New Zealand or American Samoa. These vessels have generally called into other Pacific ports prior to arriving in Samoa. Tankers from Fiji provide the bulk petroleum products, with about four vessels arriving each month. The fuel tankers do not come alongside the wharf, which is used by all other ships.

Large naval vessels from New Zealand or Australia visit about every 3 months, while smaller naval vessels visit monthly, with visits usually lasting for up to three days.

There is considerable movement of people and goods by inter-island ferries and traders to American Samoa and daily to Savai'i. Unlike American Samoa, there is not a big international fishing fleet using the port at Apia, although there is a large amount of domestic subsistence fishing by villages throughout the Samoan islands. Cruise liners and itinerant yachts are infrequent visitors to Apia.

Transport modes and threats

The strong air and sea links from Samoa to New Zealand and American Samoa define the major pathways and likely sources of new invasive species. Many of the air passengers are Samoans visiting relatives, while a minority are tourists. There is considerable movement of goods, including food, by these passengers and this provides a pathway for a variety of insect pests, including pests of agricultural crops. There are interceptions of food items when passengers arrive from Samoa in New Zealand, but the inspections of passengers arriving in Samoa are less stringent, a common situation in Pacific island countries.

The frequent ferry services between Apia and Pago Pago are another threat as the goods and luggage provide a major pathway for a range of hitchhiker species. The vessels making the journeys at least weekly to and from Pago Pago are also a threat to the marine environment, depending on the number of marine invasives that have already settled in the Pago Pago harbour. At the time of writing, it is not known if the Pago Pago harbour has been surveyed for invasive species. Arrival of invasives via the hulls of these traders and ferries would seem to be a high possibility if they establish in Pago Pago, a harbour used extensively by both international fishing fleets and the US navy (see section on American Samoa).

Other ships arriving in Apia, mainly those bringing containers, should also be regarded as a threat, both for invasives carried on containers and marine invasives on hulls and in ballast water, given their frequent visits and calls into other islands en route to Samoa.

The domestic ferry connections from the island of Upolu to Savai'i are frequent and carry many passengers as well as vehicles, timber, produce and other goods. They are an important internal quarantine barrier at present to prevent the Giant African snail from infecting Savai'i, and ongoing diligence will be required to make sure this is maintained as an effective barrier for a range of pest species.

Country: Samoa

Airport infrastructure

Airports with paved runways	1
Airports with unpaved runways	2
Total number of airports	3

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Pago Pago	46	Yes
Nadi	4	Yes
Tongatapu, Tonga	6	Yes
Suva	< 1	No
Honolulu	1	Yes
Rarotonga	< 1	No
Papeete	< 1	Yes
Niue	1	Yes
Port Vila	< 1	No

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Auckland	14	Yes
Wellington	1	No
Los Angeles	2	Yes
Sydney	3	Yes

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Savai'i	22	Yes

Country: Samoa

Seaport infrastructure

Main ports	Major trading activities
Apia	Only international port in Samoa. International traffic is mainly containerised cargo, plus minor items such as vehicles, usually originating from Australia, N.Z. or American Samoa. All these vessels call into other Pacific ports. All bulk petroleum products originate from Vuda Point terminal, Fiji, four vessels visiting per month. LPG tankers, nine/year, come from Australia or N.Z., via other Pacific islands. Quarterly visits by naval vessels from N.Z. or Australia, usually for less than 3 days. About 80 small domestic fishing vessels operate from here out of the national total of 200. No commercial slipway in Samoa. Tuna purse-seine vessels do not use Samoan ports, operating from Pago Pago instead.

Domestic shipping activity: Apia

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (10)	100	1,000
Inter-island ferries (230)	80	18,400
Tourist charter boats (6)	400	2,400
Fishing – local (2)	32,000	64,000
Local work boats	-	
Local craft (day trips)	-	

International shipping activity: Apia

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	240	4,320
Cruise liners (1000)	4	4,000
Warships – large (200)	4	800
Warships – small (20)	24	480
Fishing – oceanic (18)	6	108
Yachts - itinerant (3)	50	150

2.16 Solomon Islands

National profile

Population (2000 estimate)	446,000
Population growth rate	3.4%
Density (people per km²)	16
Urban population (% of total)	13%
Land area (km²)	28,530
Land area per person	0.06 km ²
GDP per person (US\$)	\$771
Aid per person (US\$)	Variable
Political system	Independent state
Major economic base	Forestry, fishing, agriculture (copra, etc), phosphate, gold
Major trading partners	Malaysia, Japan, South Korea, Taiwan
Nearest country neighbours	Papua New Guinea (west), Vanuatu (south-east), Australia (south-west), FSM (north).

Summary of vector issues

(using attached transport data)

Main vector routes

Caveat: The following information on the Solomon Islands needs to be considered in the light of current political difficulties and uncertainties. This may be affecting flights to the Solomons and shipping patterns, as well as adversely affecting the capacity of the government to manage its functions relating to invasive species.

The Solomon Islands is the third largest archipelago in the region, with 992 islands, many quite mountainous, with a large population that is dependant on subsistence livelihoods. The area is particularly rich in marine and terrestrial biodiversity.

There are only a small number of flights linking the Solomon Islands to other countries. There are two flights a week to each of the following destinations – Nadi (Fiji), Port Moresby (PNG) and Port Vila (Vanuatu). The only flight beyond Pacific Island countries is a weekly flight to Brisbane. Within the country, there is an extensive network of 29 unpaved runways with flights to many different island locations in the various provinces. Most frequent are flights to Auki (12/week), Gizo (11/week) and Munda (8/week), with less frequent scheduled flights to 16 other destinations. The Solomon Islands has little in the way of a tourist industry, so most flights are for nationals, government and business-related matters.

There is considerable export of natural resources from the Solomon Islands and the main shipping links are with Australia, Japan, Malaysia, Hong Kong, New Zealand, Europe and other Pacific Island countries. These will be carrying exports that include timber, phosphate, agricultural products and fish. A major fishing fleet operates from the Solomons, out of the main port of Honiara. The motherships anchor offshore for long periods while filling their quota of fish catch. Detailed quantitative data on the volume of shipping is not available at present. Much of the export of logs and copra, as well as the base for fishing activities, is the port of Yandina in the Russell Islands, which is about 100km from the capital of Honiara.

The Solomon Islanders rely primarily on ferries and traders for moving between the many inhabited islands. The fleet is probably old and mostly small vessels, but capable of carrying a large number of passengers and volume of goods each year. These vessels are likely to be an important pathway for the movement of unwanted organisms between islands, including via hull fouling.

Transport modes and threats

Marine pathways are the most significant routes for the likely arrival of invasive species into the Solomon Islands. By comparison with the large volume of ships exporting timber and other resources, the number of airline flights from overseas is small and effectively limited to neighbouring Pacific island countries. With logs being loaded from numerous ports throughout the archipelago there is a high likelihood that invasives species could transfer from these ships at places far removed from the main port of Honiara.

There is considerable sea trade with Asian counties, and with Australia, in addition to the international fishing fleet. The latter are a likely source of marine invasives from ballast water and uncleaned hulls of fishing ships and the motherships that anchor offshore for long periods. The container ships provide a pathway for terrestrial invasives, via cargo, and the bulk carriers for logs and other exports may potentially be bringing in exotic species if cargo areas are not cleaned between journeys.

The numerous small inter-island traders and ferry vessels are an important route for the accidental and deliberate dispersal of invasives between the many islands of the Solomon archipelago.

Given the current economic and social difficulties faced by the people of the Solomon Islands, there is likely to be limited capacity for quarantine services. As a consequence, significant breeches of border security, with respect to invasives species, are more likely to occur.

Country: Solomon Islands

Airport infrastructure

Airports with paved runways	2
Airports with unpaved runways	29
Total number of airports	31

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Nadi	2	No
Port Moresby	2	Yes
Port Vila	2	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Brisbane	1	Yes

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Auki	12	Yes
Gizo	11	Yes
Munda	8	Yes
Sege	5	Yes
Kirakira	3	Yes
Fera Island	3	Yes
Afutara	1	Yes
Atoifi	3	Yes
D. Flights within the country		

Destination	Average flights /week	Non-stop services
Balalae	2	No
Yandina	2	Yes
Bellonia	1	Yes
Choiseul Bay	2	No
Kagau	1	Yes
Santa Ana	1	Yes
Parasi	1	Yes
Rennell Island	1	No
Santa Cruz	1	Yes
Suvavanao	1	Yes

Country: Solomon Islands²

Seaport infrastructure

Main ports	Major trading activities
Honiara	Main port of entry. <i>Major shipping links are with Australia, N.Z., Hong Kong, Japan, Europe and Pacific island countries.</i> Receives oil products, mostly from New Guinea or Fiji, occasionally from Singapore. LPG carriers come from Australia. <i>Major fishing fleet</i> operating with motherships that anchor offshore for long periods. <i>Substantial domestic trading and inter-island passenger fleet.</i> These are probably old and small vessels.
Yandina	Second main port, focused on copra exports, located in the Russell Islands. <i>Also the major port for fishery activities and for log exports.</i>
Other ports	Numerous ports for log/timber exports and local trading.

Domestic shipping activity:

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders	Major fleet	
Inter-island ferries	Major fleet	
Tourist charter boats	Likely none	
Fishing – local	Probably considerable	
Local work boats	Unknown	
Local craft (day trips)	Unknown	

International shipping activity:

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen	Extensive	
Cruise liners	Currently none	
Warships – large	Variable	
Warships – small	Variable	
Fishing – oceanic	Major fleet	
Fishing – motherships	Large number	
Yachts - itinerant	Probably few	

² Quantitative data on the marine activity of the Solomon Islands was not available for this study.

2.17 Tokelau

National profile

Population (2000 estimate)	1,450
Population growth rate	Slow decline
Density (people per km²)	121
Urban population (% of total)	0%
Land area (km²)	12
Land area per person	0.008 km ²
GNP per person (US\$)	\$1,034
Aid per person (US\$)	\$2,759
Political system	Non-self governing territory under New Zealand administration
Major economic base	Aid & remittances, licence fees for US tuna boats, stamps
Major trading partners	New Zealand
Nearest country neighbours	Samoa (south), Cook Islands (south-east),

Summary of vector issues

Main vector routes

Tokelau has no airport and hence the only vector routes are by sea.

The three atolls that make up Tokelau (Atafu, Nukunonu, and Fakaofu) are serviced by a cargo vessel from Apia, Samoa, which makes only monthly trips bringing all outside supplies. Since there is no harbour on any of the atolls, supplies are unloaded by small craft from the shore. Inter-atoll travel is by a small vessel that travels fortnightly between the atolls. Any visiting yachts also need to anchor offshore and need a visitor's permit obtained in Apia prior to sailing to Tokelau. There are very few yachts visiting Tokelau and this is not an important vector route.

Transport modes and threats

The transport modes to Tokelau are very restrictive and limited to small trading vessels that come only from Samoa and then only once a month. They could potentially bring marine invasives that attached to ship's hulls while the vessels were in port at Apia or were pumped out in bilge water while transferring cargo into the small local craft. Pests, including rodents, could conceivably stow away in cargo items that are offloaded at the atolls. Plant diseases could be introduced in food items that are brought to Tokelau by visitors or returning residents.

2.18 Tonga

National profile

Population (2000 estimate)	99,000
Population growth rate	0.6%
Density (people per km²)	142
Urban population (% of total)	36%
Land area (km²)	699
Land area per person	0.007 km ²
GNP per person (US\$)	\$1,263
Aid per person (US\$)	\$357
Political system	Independent kingdom
Major economic base	Remittances, agriculture (squash, copra), tourism, aid
Major trading partners	Japan, Australia, New Zealand
Nearest country neighbours	Fiji (west), Samoa/ American Samoa/ Wallis & Futuna (north), Niue (east)

Summary of vector issues

(using attached transport data)

Main vector routes

The Kingdom of Tonga is a widely dispersed archipelago of 171 islands in four main island groups; 36 of the islands are inhabited. The capital of Nuku'alofa on the island of Tongatapu has six flights a week to Fiji, five flights a week to Samoa, and averages one a week to a few other Pacific island destinations. The most frequent flights are 15 each week to Auckland where there is a large population of Tongans. Flights to other destinations are less frequent – 2/week to Sydney and 1/week to Los Angeles.

Within Tonga, there are frequent flights to other island destinations. Most visited by the small domestic planes are the islands of the Vava'u group with 26 flights per week, a destination where tourists watch passing humpback whales and numerous cruising yachts take advantage of ideal anchorages. There are also nine weekly flights to the Ha'apia group and five to the island of Eua, location of Tonga's national park.

Two vessel types dominate the shipping activity to Tonga. These are the 160 annual visits by merchant ships, carrying containers and general cargo and exporting fresh squash to Japan from the two ports in the Vava'u and Ha'apia groups, and the 900 itinerant yachts that cruise Tongan waters each year. The merchant ships are mostly from Tonga's main trading partners – New Zealand, Australia and Japan – or from other Pacific island countries (American Samoa, Fiji, Cook Islands and French Polynesia). It is only one

day's sailing from Fiji for the supply of petroleum products to the main port of Nuku'alofa, with the tankers carrying on to Vava'u and Ha'apia. There is a small international fishing fleet operating in Tonga's EEZ that exports whole tuna to markets in Hawaii and Japan.

The number of visiting yachts is high and is probably influenced by Tonga's relative proximity to Fiji and New Zealand. About 500 of these yachts visit Vava'u where there is no provision for collection for their sewage and limited facilities for garbage collection. With sewage discharge into the lagoon and the inevitable exchange of ballast/bilge water this provides a clear route for the arrival of marine invasives.

Cruise liners visit Tonga's capital Nuku'alofa about once a month and half of these vessels sail on to the ports of Neiafu (Vava'u) and Pangai (Ha'apia). There is also a relatively high number of visits by various naval vessels to Nuku'alofa, of 1-2 per week on average. There is considerable movement of cargo and people between the various islands by cargo/passenger vessels that make around 135 round-trip voyages between the islands annually.

Transport modes and threats

The most likely route that presents risks to Tonga from invasive species is the merchant ships and itinerant cruising yachts. Risks posed by yachts have been mentioned above, to which the potential to bring in unwanted organisms on hulls or terrestrial pests in food and goods should be added. With Fiji only one day's sailing away for merchant ships, there are opportunities for species to arrive from one of the region's main transport hubs, as marine invasives, or as terrestrial species via cargo and sea containers.

Like Samoa, Tonga has strong social and economic connections with New Zealand, primarily to Auckland. The regular flow of people and goods between the two provides another route for pests, via personal luggage and air cargo. Auckland is a warm temperate zone and while specifically tropical pests are less likely to establish there it is a major entry point for many plant and animal pests into New Zealand and therefore a potential export point for them as well. For example, infestations of the Argentine ant have been discovered throughout the environs of Auckland Airport and a nest of the major pest ant, Red Imported Fire Ant was discovered there in 2002 and destroyed.

Once invasives arrive in Tonga, the frequent trips by inter-island cargo/passenger vessels provide the most likely route for them to be transported from one island group to the next. Some pests may well first appear in places like Vava'u, where the high visitation by yachts and tourists (arriving by air) make it a potentially important entry point with dispersal from there to other places in the archipelago.

Country: Tonga

Airport infrastructure

Airports with paved runways	1
Airports with unpaved runways	5
Total number of airports	6

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Apia	5	Yes
Nadi	3	Yes
Suva	3	Yes
Niue	1	Yes
Honolulu	1	Yes
Noumea	<1	Yes
Rarotonga	<1	No
Port Vila	<1	No
Papeete	<1	No

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Auckland	15	Yes
Sydney	2	Yes
Los Angeles	1	No

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Brunei	<1	No

Domestic Flights: Tonga

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Vava'u	26	Yes
Ha'apai	9	Yes
Eua	5	Yes
Niutoputapu	1	No
Niuafo'ou	1	No

Country: Tonga

Seaport infrastructure

Main ports	Major trading activities
Nuku'alofa	As the major port, it supports container, general cargo, tanker traffic and cruise trips. Vessels come from Australia, N.Z., Fiji, Cook Islands, American Samoa. Inter-island cargo/passenger vessels make 135 round trips per year to the Vava'u and Ha'apia groups of islands.
Neiafu (Vava'u group) Pangai (Ha'apia gp.)	Import general cargo, oil and LPG. Load fresh squash for Japan onto vessels from Kobe.

Domestic shipping activity: Nuku'alofa

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders	-	
Inter-island ferries (100)	135	13,500
Tourist charter boats	-	
Fishing – local (2)	7,000	14,000
Local work boats (3)	700	2,100
Local craft (day trips) (2)	750	1,500

International shipping activity:

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	162	2,916
Cruise liners (1500)	14	21,000
Warships – large (200)	10	2,000
Warships – small (20)	80	1,600
Fishing – oceanic (18)	14	252
Yachts - itinerant (3)	900	2,700

2.19 Tuvalu

National profile

Population (2000 estimate)	10,500
Population growth rate	0.8%
Density (people per km²)	403
Urban population (% of total)	42%
Land area (km²)	26
Land area per person	0.003 km ²
GDP per person (US\$)	\$571
Aid per person (US\$)	\$700
Political system	Independent state
Major economic base	Fishing vessel licences, remittances, copra, data transmission, stamps
Major trading partners	Fiji, Australia, New Zealand
Nearest country neighbours	Fiji (south), Samoa (south-east), Kiribati (north)

Summary of vector issues

(using attached transport data)

Main vector routes

Tuvalu has a small population and only 26 km² of land area in nine tiny atolls spread over a declared EEZ covering 900,000 km², and only marine natural resources. It is well removed from both tourist and transport routes as the following air and shipping data demonstrate.

Its very limited air connections are a weekly flight from Suva, Fiji, to the capital of Funafuti. None of the other atolls are linked with regular air services and none have airstrips.

There is a similar amount of contact with Tuvalu by sea, with an average of one merchant ship arriving at the main port of Funafuti every week. The traffic is mostly containerised cargo and a small amount of building material. Shipping links are mainly with Tuvalu's main trading partners – Fiji, Australia and New Zealand. Ships arriving from these places are likely to also visit Samoa and the Wallis and Futuna Islands. Tankers bring oil products from Vuda Point in Fiji, and call in on Vanuatu and Tonga en route.

While there are dozens of foreign tuna fishing vessels operating under licence in the EEZ, very few actually come into port during each year, thus effectively reducing the likelihood of transferring pest species. A more likely source of unwanted marine species

is the fishing motherships that anchor off the port of Funafuti for 2-3 days annually so that fish can be transferred off the foreign fishing vessels. Naval and cruise ships are very occasional visitors and therefore not a likely source of invasive species.

A passenger ferry/cargo vessel is based at Funafuti and makes about 40 trips within the widely separated inhabited atolls of Tuvalu each year as well as occasional visits to Fiji.

Transport modes and threats

Like its northern neighbour of Kiribati, the low level of outside contact with Tuvalu reduces the number of pathways for potential invasives. The one weekly flight from Fiji means pest species could arrive via passengers or air cargo, but the likelihood is low.

The greater volume of cargo and containers arriving by sea poses a larger threat, but even then there is less than one merchant ship arriving each week. The off-shore, international fishing fleet is a source of marine invasives in ballast water and on hulls, but usually this will be limited to the few occasions when fishing boats or motherships come into the Funafuti port. Since all major shipping is into Funafuti, the threats of invasives getting to other islands within Tuvalu are low. The threats to outer islands will be influenced by the nature of the cargo carried by the one ferry/cargo vessel and the operating procedures for exchanging ballast water and frequency with which its hull is cleaned.

Country: Tuvalu

Airport infrastructure

Airports with paved runways	0
Airports with unpaved runways	1
Total number of airports	1

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Suva	1	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Nil	-	

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Nil	-	

Country: Tuvalu

Seaport infrastructure

Main ports	Major trading activities
Funafuti	Tuvalu's main, but small port, where <i>most international traffic is containerised cargo</i> plus minor amount of building material. Most cargo runs start from Australia or N.Z., call into Noumea, Suva, Wallis & Futuna Islands and Apia before Funafuti. The reverse run also takes place. Oil products come from Vuda Point, Fiji, via Port Vila and Tonga. <i>Of the dozens of foreign tuna fishing vessels operating in the EEZ, only a few come in annually for brief stays.</i> Motherships may anchor off Funafuti for 2-3 days annually. A local ferry/cargo vessel trades within Tuvalu with occasional visits to Fiji. A small slipway can take only small local craft. Warship visits are usually for 2-3 days; cruise ships only for 6 hours or so.

Domestic shipping activity: Funafuti

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (200)	40	8,000
Inter-island ferries	-	
Tourist charter boats	-	
Fishing – local	-	
Local work boats	-	
Local craft (day trips) (2)	10,000	20,000

International shipping activity: Funafuti

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	50	900
Cruise liners (600)	0.5	300
Warships – large (200)	1	200
Warships – small (20)	20	400
Fishing – oceanic (18)	4	72
Yachts - itinerant (3)	12	36

2.20 Vanuatu

National profile

Population (2000 estimate)	192,000
Population growth rate	2.8%
Density (people per km²)	16
Urban population (% of total)	18%
Land area (km²)	12,190
Land area per person	0.06 km ²
GNP per person (US\$)	\$1,286
Aid per person (US\$)	\$253
Political system	Independent republic
Major economic base	Agriculture (copra, cocoa, squash), beef, timber, fishing, tourism
Major trading partners	Australia, New Zealand, Japan, France, Netherlands, New Caledonia
Nearest country neighbours	New Caledonia (south), Solomon Islands (north-west), Fiji (east)

Summary of vector issues

(using attached transport data)

Main vector routes

About 300km north of New Caledonia, the 80 or so islands of the Vanuatu chain stretch further northwards, home to over 190,000 people and a diverse terrestrial and marine biodiversity. Port Vila, the capital, is located on the island of Efate, while the other most inhabited island is Espiritu Santo to the north. Vanuatu's second official entry point for all shipping is the port of Luganville on Espiritu Santo. About 300km separates these two main ports.

Given its size, Vanuatu has a relatively modest number of flights linking it with other countries in the region. There are daily flights to Noumea, New Caledonia, three per week to Fiji, and one to Honiara in the Solomon Islands. The most frequent flights are the 10 per week from Sydney. Another five flights arrive weekly from Brisbane and one from Auckland, New Zealand, completes the scheduled flights. Within Vanuatu, there are about 30 unpaved runways on different islands and almost 50 scheduled flights per week linking the varied locations. Most frequent are the 18 weekly flights into Espiritu Santo, followed by nine weekly flights to Tanna Island, a popular destination for tourists.

International shipping is dominated by merchantships, with 70% of the 215 annual visits to Port Vila, the balance going to Luganville, which actually handles the larger volume of

international freight. Traffic into Luganville is mainly containerised goods, LNG and refined oil products, while exports are mainly wood products and meat. Bulk carriers take copra, with smaller volumes exported from Port Vila. International traffic into Port Vila is similar to that arriving in Luganville – containerised goods, oil products, LPG and motor vehicles. Most of the trade is with Australia, New Zealand, Japan and Europe.

The extensive trading and sea-passenger movements within Vanuatu are split between Port Vila from where 40 vessels trade in the south of the country, while about 30 traders similarly operate hundreds of trips out of Luganville for the northern islands. These traders typically carry copra, drummed oil, other commodities and occasional livestock.

Cruise liners visit Port Vila at the rate of one/week, usually for 12 hours only, while Luganville gets a cruise liner visiting about once a month. Vanuatu is a popular destination for yachties; over 350 yachts visit each year.

Transport modes and threats

The dominant transport mode for Vanuatu that provides routes for invasives is the almost daily arrivals of merchant ships or cruise liners into the two main ports. There is a wide variety of vessel types arriving, from container ships, to bulk carriers and cruise ships doing the South Pacific circuit. The bulk-loading copra ships are in port for up to a week, ample time for transfer of pest species travelling in the ship or attached to the hull. If the cargo spaces in these bulk carriers are not cleaned between voyages, agricultural and other pests could be transported between the island countries they visit. The same risk applies to ‘dirty’ vessels transporting timber and agricultural products.

Container ships are another important potential route for pest arrivals and are frequent enough into Vanuatu to be a significant route for further analysis. Ballast water and hull fouling are, as usual, possible sources of marine invasives as well. If pest species arrive in Vanuatu there is an extensive network of inter-island trading vessels, making about 2,700 trips to different islands per year, that provides the main mode for the further dispersal of unwanted species.

The itinerant yachts that visit Vanuatu are also present in significant numbers to warrant mention as a potentially important vector for pests. International yacht races start or finish in Port Villa, one of the attractions for over 300 yachts to visit annually.

Perhaps of lesser importance, although a route that also needs to be considered as available to pests, are the flight connections to other countries. Noumea is the most well connected Pacific island country to Vanuatu that should be considered as a potential source of pests, via cargo or as hitchhikers.

Country: Vanuatu

Airport infrastructure

Airports with paved runways	2
Airports with unpaved runways	30
Total number of airports	32

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Noumea	8	Yes
Nadi	3	Yes
Honiara	1	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Sydney	10	Yes
Brisbane	5	Yes
Auckland	1	Yes

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Espiritu Santo	18	Yes
Tanna Island	9	Yes
Norsup	5	Yes
Craig Cove	1	Yes
Emae	1	Yes
Futuna Island	1	No
D. Flights within the		

country		
Destination	Average flights /week	Non-stop services
Lonprore	1	Yes
Longana	1	Yes
Lamap	2	Yes
Paama	1	No
Sara	1	No
Tongoa	2	Yes
Ulei	1	No
Valesdir	2	Yes

Country: Vanuatu

Seaport infrastructure

Main ports	Major trading activities
Luganville	On the large island of Espiritu Santo, <i>one of two official entry points</i> and focal points for inter-island trading within Vanuatu. In cargo is mainly delivering refined oil products, LNG and container goods. Exports are mainly meat and wood products. Bulk carriers take copra, taking 3-7 days to load. Annual visits from 50 cargo ships (40 container, 10 copra), 12 oil product tankers, 2-3 LPG carriers. <i>Thirty ships operate inter-island trading from here</i> – people and mixed cargo, with occasional livestock. Cruise ships visit for 8-10 hours and more frequently stop off Champagne Beach and transfer passengers ashore by boat. Day charters do diving, fishing and cruise trips.

Domestic shipping activity: Luganville

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (15)	1,800	27,000
Inter-island ferries (100)	50	5,000
Tourist charter boats (10)	2,000	20,000
Fishing – local	-	
Local work boats (2)	150	300
Local craft (day trips)	-	

International shipping activity: Luganville

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	65	1,170
Cruise liners (1500)	12	18,000
Warships – large	-	
Warships – small (20)	6	120
Fishing – oceanic	-	
Yachts - itinerant (3)	50	150

Country: Vanuatu

Seaport infrastructure

Main ports	Major trading activities
Port Villa	<i>Main cruise ship destination</i> and second official entry port. Second in international freight volumes. Most international traffic is delivering refined oil products, LPG, container goods and vehicles. Limited exports including copra. About 150 cargo ships/year. Centre of operations for inter-island domestic trading fleet for southern regions of Vanuatu. Hand loading means port visits of up to a week. <i>Port Vila is a major sailing destination in the South Pacific and is the starting or finishing point for international yacht races.</i> Live cattle (about 10 trips/year) are sent to Port Vila from outlying islands. Day charter vessels and ferries sail to resorts.

Domestic shipping activity: Port Villa

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders (15)	750	11,250
Inter-island ferries (100)	100	10,000
Tourist charter boats (15)	3,000	45,000
Fishing – local (6)	300	1,800
Local work boats (3)	400	1,200
Local craft (day trips)	-	

International shipping activity: Port Villa

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	150	2,700
Cruise liners (1500)	50	75,000
Warships – large (200)	3	600
Warships – small (20)	30	600
Fishing – oceanic	-	
Yachts - itinerant (3)	300	900

2.21 Wallis And Futuna

National profile

Population (2000 estimate)	15,000
Population growth rate	0.5%
Density (people per km²)	59
Urban population (% of total)	Officially 'nil', but urban-like.
Land area (km²)	255
Land area per person	0.015 km ²
GDP per person (US\$)	\$1,666
Aid per person (US\$)	Not known
Political system	Overseas territory of France
Major economic base	Remittances, aid, stamps, fishing licence leases, copra, agriculture, lumber,
Major trading partners	France, Australia, New Zealand
Nearest country neighbours	Fiji (south), Samoa (east), Tokelau (north-east), Tuvalu (west)

Summary of vector issues

(using attached transport data)

Main vector routes

Although Samoa and Fiji are closer neighbours, the French territory of Wallis and Futuna has its very modest air connections with Noumea (2 flights/week), Papeete in French Polynesia (1flight/week) and less frequently with Fiji. The two main volcanic islands, home to 15,000 people and separated by 230 km, are linked by daily flights.

Mata-Uta is the territorial capital on Wallis (Uvea) Island and has one of the two ports. The other port is Leava on the smaller island of Futuna, 10-12 hours sailing away. Small cargo ships make about 2-3 trips each month to Wallis and Futuna, mostly carrying containers. The usual shipping route is from Suva in Fiji, to Noumea, Tuvalu and occasionally from Wallis and Futuna to Luganville in Vanuatu.

Other shipping is thought to be light, with no regular visits by cruise ships, few yachts call in, and visits by French navy vessels are thought to be irregular. There are minimal exports from the islands, which rely on traditional subsistence agriculture and fishing.

Transport modes and threats

The territory of Wallis and Futuna has limited contact with the outside world and therefore limited opportunities for pest species to arrive. Although there are only 2-3 ship visits per month by small cargo ships there is the possibility that accidental pest arrivals may occur via containers or other cargo. Ship stays are usually only overnight at both of the two ports, which further reduces the likelihood that pest species will transfer to the islands.

These cargo vessels are limited to a circuit of relatively close Pacific countries and are therefore less likely to be picking up hitchhiker species during their voyages than ships coming from more distant destinations that are sources of a wider range of invasive species. There are few other visiting vessels that are likely to be putting Wallis and Futuna at risk from invasive species.

Airline flights are more frequent than ship visits to the islands, but provide more limited pathways for invasive species. These pathways are the usual ones of air cargo containers and freight and passenger luggage.

Country: Wallis and Futuna

Airport infrastructure

Airports with paved runways	1
Airports with unpaved runways	1
Total number of airports	2

Airline flight information

International flights

A. Flights to other Pacific Island countries		
Destination	Average flights /week	Non-stop services
Noumea	2	Yes
Papeete	1	Yes
Nadi	<1	Yes

B. Flights to Pacific Rim countries		
Destination	Average flights /week	Non-stop services
Nil	-	

C. Flights beyond Pacific countries		
Destination	Average flights /week	Non-stop services
Nil	-	

Domestic Flights

D. Flights within the country		
Destination	Average flights /week	Non-stop services
Futuna	7	Yes

Country: Wallis & Futuna

Seaport infrastructure³

Main ports	Major trading activities
Mata-Uta	Services the territorial capital on Wallis (Uvea) Island. Serviced by small cargo ships , mainly carrying containers. Typical routes are from, or to, Suva, Funafuti (Tuvalu), and Noumea. Occasional direct links to Luganville in Vanuatu. <i>Cargo ships stay only overnight.</i> Petroleum products come from Vuda Point (Fiji) in light tankers. No regular cruise ships or passenger ships and irregular visits by French naval vessels.
Leava	Port for the smaller island of Futuna, 230 km from Wallis. Receives inter-island trade and the cargo ships to the two main islands.

Domestic shipping activity

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Inter-island traders	Regular – take people	
Inter-island ferries	Nil	
Tourist charter boats	Nil	
Fishing – local (2)	Probably many	
Local work boats	Probably few	
Local craft (day trips)	Unlikely	

International shipping activity

Vessel type (average persons on board)	Average port visits/annum	Average person visits /annum (estimate)
Merchantmen (18)	25-35	450-630
Cruise liners	Nil	
Warships – large	Nil	
Warships – small (20)	Few	
Fishing – oceanic (18)	Few – moderate nos.	
Yachts - itinerant (3)	Few	

³ Detailed statistics of shipping movements were not available at the time of this study.

3. Summary of Vector Routes

The preceding analyses document the great variability in the volume and patterns of air and sea trading between the island countries of the Pacific, as would be expected, given their diverse sizes, economies and different political orientations. This variability points to wide differences in vector routes into and out of the countries and, by implication, different degrees of exposure to the possible arrival of invasive alien species. The following two tables summarise major international shipping and flight activities.

Table 1. Major international shipping activity – yearly visits

Country	Merchant ships	Oceanic fishing	‘Mother’ fishing ships	Cruise liners	Itinerant yachts
American Samoa	190	450	-	10	100
Cook Islands	44	0	0	<5	150
Federated States of Micronesia ⁴	178	852	78	2	55
Fiji ⁵	716	220	0	26	585
French Polynesia	320	10	0	25	325
Guam	560	260	15	12	25
Kiribati	60	350	0	0	12
Marshall Islands	84	360	40	0	20
Nauru	100	0	0	0	0
New Caledonia	570	60	0	55	500
Niue	26	1	0	3	150
Northern Marianas	460	10	0	8	25
Palau	36	185	20	2	20
Papua New Guinea ⁶	795	24	0	6	-
Samoa	240	6	0	4	50
Solomon Islands ⁷	Many	Many	Many	0	Few
Tokelau	12	0	0	0	Few
Tonga	162	14	0	14	900
Tuvalu	50	4	0	<1	12
Vanuatu	150	0	0	50	300
Wallis and Futuna ⁷	25-35	Few	0	0	Few

⁴ Figures are the totals for the four ports of Pohnpei, Weno, Yap and Okat. This might involve some “double-counting” if vessels were included in more than one port’s total.

⁵ Figures are the totals for the ports on Viti Levu and Vanua Levu.

⁶ Figures are the totals for Port Moresby and Lae.

⁷ Detailed data are not currently available.

Table 2. International flights– weekly totals by region

Country	Pacific island countries	Australia & New Zealand	Asian destinations	USA incl. Hawaii
American Samoa ⁸	98	0	0	1
Cook Islands	9	20	0	8
Federated States of Micronesia	10	0	0	3
Fiji	21	64	5	18
French Polynesia	15	16	3	25
Guam	139	2	148	44
Kiribati	5	0	0	0
Marshall Islands	15	0	0	5
Nauru	4	3	0	0
New Caledonia	14	28	12	0
Niue	3	1	0	0
Northern Marianas ⁹	65	0	46	0
Palau	12	0	4	0
Papua New Guinea	2	38	4	0
Samoa ⁸	61	18	0	2
Solomon Islands	6	1	0	0
Tokelau	0	0	0	0
Tonga	16	17	1	2
Tuvalu	1	0	0	0
Vanuatu	12	16	0	0
Wallis and Futuna	4	0	0	0

The shipping table compares the average yearly visits of five classes of vessels that are potentially important vector pathways – merchant ships, international fishing vessels, fishing ‘motherships’, cruise liners and itinerant yachts. The table of flights arriving each week groups destinations into four distinct regions, each with a different level of threat as to the type of alien species that may be a risk to Pacific island countries.

Comparisons of the level of sea and air activity with each country reveal that only four countries rank highly for both shipping and airflights. **Guam** in the northern Pacific ranks fourth for merchant ship activity, has a high volume of international fishing activity, and easily ranks highest with respect to flights within the Pacific, to Asian and also to USA destinations. It should therefore be considered as a “high risk”, in the Pacific context, for the arrival of potential invasive species both by sea and air routes. It is then important to look in more detail at other Pacific island countries and assess how they might be at risk in turn, given their particular links with shipping or airline travel from Guam.

⁸ About 90% of the Pacific island flights are between Samoa and American Samoa.

⁹ The Pacific island flights are all to Guam

Fiji is the major transport hub in the southern Pacific as shown by the figures. It is second only to Papua New Guinea with respect to merchant ship activity (716 visits/year), has a large fishing fleet operating in its waters, the second highest number of itinerant yachts visiting (585/year), and ranks highly with the number of flights to most regions in and around the Pacific but has few flights to Asia.

Two territories, **New Caledonia** and **French Polynesia**, also have fairly high visitation by different classes of shipping as well as significant numbers of linkages with other countries through airline flights. French Polynesia has the second highest number of flights originating from the USA. New Caledonia receives a high numbers of visits from merchant ships (570), the largest number of cruise liners (55), large numbers of yachts and a moderate number of international fishing vessels. Like Guam, fishing vessels might also prove to be a source of invasive species that could be carried further into the Pacific once they establish in New Caledonia.

Papua New Guinea has the highest number of visits by merchant ships, which reflects its geographic size and large population (4.8 million), but in other categories of shipping (fishing, cruise liners and yachts) it ranks well down the list. Air links from Papua New Guinea are skewed and relatively few given its population, with a high number of flights linking it with Australia, very few to South-east Asia, and only two weekly connections by air to the Solomon Islands within the Pacific.

The **Federated States of Micronesia** dominate the region for the number of visits by oceanic fishing vessels (852/yr) and ‘mother’ fishing ships (78/yr). This is almost double the numbers of fishing vessels that visit American Samoa (450), which is second in the list. Without information on the marine invasives these fishing vessels carry, and some understanding of their role in transporting terrestrial alien species, it is difficult to assign risks to these numbers.

This report provides an overview of the routes and modes of transport that are most likely to provide the ways and means for invasive alien species to be carried, accidentally or deliberately, into 21 Pacific island countries. Within the different modes of transport more detailed assessments can be made of the aspects that are important threats. For example, evidence from other countries and studies shows that terrestrial invasives, such as insects and other invertebrates, are often carried in or on sea containers. Since these are an important and dominant component of all the merchantship traffic into the Pacific, with its high level of dependence on imported goods, they represent a potentially major pathway that warrants more detailed examination. Second-hand vehicles and equipment that is not cleaned before shipping are another threat as dirt can contain seeds, micro-organisms, invertebrates and other potential pests.

Marine invasives are more difficult to detect than terrestrial ones, and much more difficult to eradicate if they are not detected very quickly. While all vessels can potentially carry marine invasives in ballast water or on their hulls, some vessel types can be more of a risk than others. More detailed studies are needed in the Pacific context.

How clean are the hulls of the large international fishing fleets that operate across the north Pacific? Are the fishing motherships that spend long periods inside lagoons a greater risk? What risks are associated with the 900 yachts (the region's highest number) that cruise around the many islands of **Tonga** during each sailing season? Are they carrying marine pests in their bilge water or on their hulls, or do some have ship cats that might 'jump ship' onto a cat-free island?

It is also important to explore the behaviour of people travelling on yachts and cruise ships once they are on shore in remote localities. How many of them collect "pretty flowers", or seeds on their shoes, which are then transferred to their next port of call? Risks are greater when yachts travel to uninhabited islands within countries that may have high biodiversity values and an absence of invasive species. Perhaps yachts and their crews pose a bigger risk of in-country spread than fishers?

These and other questions, including analysis of between-islands-within-country movements and behaviour of specific groups of people, will require further study to develop more detailed information on the risks that particular countries face from unwanted species.

4. Invasive Species Threats – an Overview

The purpose of the first section analysing vector routes was to assist Pacific countries to assess the routes and likelihoods they face that a variety of alien species, especially those that are known or potential invasive species, will actually arrive. The second section of this report details about forty plant plus forty vertebrate and invertebrate species that are known invasives or threats (such as the red imported fire ant) to Pacific countries and territories. This is not an exhaustive list. It excludes marine invasives because of the very limited regional information that is presently available, not because of their insignificance in the region. It is a representative list designed to show the range of species that are present, how they have an impact and their most likely way of arriving or spreading. In the case of plant invasives, specific vector routes are too variable to provide realistic estimates. Instead, the reproductive methods are usually given to indicate the common characteristics by which invasive plants gain their advantage. Deliberate introductions are still an important route for plant arrivals and therefore hard to predict by country.

The value of this selective listing of about eighty main pests to the region is to raise awareness of the variety of species, the ways in which they are likely to arrive and spread, and the countries that are most at risk. For many species this section of the report also indicates which vector routes to watch out for. However, in the case of many invasives, especially plants, deliberate introductions by people were the cause of their arrival and establishment. While some of these introductions were historical, when the impacts were not understood, others are recent. Human ignorance is still a significant factor in the continuing, deliberate spread of invasive alien species.

There are specific caveats to the information that follows. Even for the groups that are covered, the baseline information varies considerably in quality, both between groups of animals and between countries. Some countries still lack comprehensive baseline surveys of indigenous groups of animals, let alone having information on the alien species that are now resident. What is also missing for many islands is information on the actual impact of alien species on native species and ecosystems. Is a ‘tramp ant’ species, for example, merely an urban irritant, or is it having impacts on other important invertebrates and plants in local ecosystems?

There is a final important ‘warning’ for the following information relating to countries listed as having particular species present. For single island countries, such as Niue or Nauru, the information regarding ‘presence’ or ‘absence’ is clear. For other countries with many islands, such as Papua New Guinea, French Polynesia, Fiji or the Solomon Islands, the invasive species might be present on some islands while still absent on others that have high biodiversity values.

This information gap highlights an aspect of understanding vector routes and prevention efforts that is particularly relevant in the Pacific. By comparison, large, continental countries often pay little consideration to in-country movements of invasive species. This is because it is often very difficult or impossible to control species once they are

established. With the benefit of the sea as a major barrier between different islands within a single Pacific country, in-country (between island) movements become a significant issue. In New Zealand, small offshore islands have been developed as important refugia for species that are threatened by predators and competitors on the mainland. This especially applies to threatened bird species. It has also proven possible to eradicate pest species, including rodents and predators, from many of these islands to improve their usefulness as refugia for endangered species. *For Pacific islands, a challenge is to keep invasives from spreading between islands, within a country.*

For this reason the vector pathways within countries and territories are particularly important and will require more detailed analysis at the country level. There should be a focus on examining the movement patterns and volumes of island trading vessels and passenger ferries. As the vector analysis in chapter 2 documents, there are significant movements of both inter-island traders and inter-island ferries in many island countries.

Just as the vector data was preceded by a caveat that airline and shipping routes change and flight frequencies will also be altered from year to year, so too will the presence or absence of invasive species change with time. Both the human and natural systems are dynamic. New trading arrangements between distant countries can open up new opportunities for invasive species. Not only is the following information reliant on accurate observation, it is also only as current at the time it was recorded. For these reasons, some of the listed invasives may now be present in more countries than those identified in the following tables.

4.1 Invasive plants

Species	Likely modes of spread	Known presence	Countries at risk
Plants (excluding agricultural weeds)			
<p>Summary information</p> <p>The list of actual and potential invasive plant species for Pacific island countries is, unfortunately, a long one. The list of invasive plants that follows concentrates on those that are having a negative impact on native habitats in Pacific islands. It excludes weeds that are primarily urban or agricultural. It is drawn from a list of the “most significant invasive taxa” (Meyer 2000) to give an idea of the range of plant types that are invasive in the Pacific – from creeping grasses and vines to tall canopy trees. Meyer gives further useful lists for many of the SPREP countries covered here. Other details of the characteristics of these species and their distribution (as of 2000) was taken from the Pacific Island Ecosystem at Risk (PIER) project. This major web site for invasive plants in the Pacific can be found at: www.hear.org/pier/</p> <p>Most of these plants were deliberately introduced, often as ornamentals, sometimes for fodder crops, nitrogen fixation or to prevent erosion. These pressures remain today, highlighting the importance of sharing good information, not only about existing invasive plants, but also reducing the likelihood that agencies, including development, forestry and agricultural organisations, do not introduce new species that are known invasives in other countries. In this regard, the list by Meyer (2000) of potential invaders for 16 SPREP countries and territories is a useful reference. The determination of which countries to include in the “Countries at risk” was based on the major trading patterns for each country and an assessment of potential movements. Its function is to serve as a warning, and <i>not</i> as a predictor of likely future occurrences. In an ideal world, few of these countries would move into the “Known presence” listings.</p>			
<p><i>Acacia confusa</i></p> <p>Small tree</p>	<p>Spread through forestry and ornamental plantings. Can be reproduced from cuttings. Is being planted in Micronesia, but is invasive elsewhere. Seeds present in the ground can germinate profusely after fire. Should not be introduced, given its potential as an invasive.</p>	<p>Hawaii, Guam, FSM, Northern Marianas, Palau.</p>	<p>Fiji, French Polynesia, Cooks, Samoa, New Caledonia, Vanuatu, PNG, Solomons.</p>
<p><i>Acacia farnesiana</i></p> <p>Ellington curse, klu, sweet acacia</p> <p>Thorny shrub.</p>	<p>Seeds are dispersed by ungulates which eat the pods. Survives fires, was introduced to Hawaii and other places for perfume production, Likes dry tropical habitats.</p>	<p>Hawaii, Guam, Palau, Northern Marianas, New Caledonia, Fiji, French Polynesia, Nauru, Solomons, Kiribati, Vanuatu, Cooks.</p>	<p>FSM, Tuvalu, Tonga, Samoa.</p>
<p><i>Acacia mearnsii</i></p> <p>Black wattle</p> <p>Tree</p>	<p>Produces copious numbers of seeds, resprouts by basal shoots following fire. Generates numerous suckers resulting in monotypic thickets.</p>	<p>Hawaii, Cooks.</p> <p>(Native of Australia)</p>	<p>Countries that are likely to introduce it deliberately.</p>
<p><i>Acacia melanoxylon</i></p> <p>Australian blackwood, blackwood acacia</p>	<p>It is best adapted to cooler, moist sites. Seed, sprouts profusely from roots. Reproduces prolifically after fire.</p>	<p>Hawaii.</p> <p>Used for forestry in New Zealand and South Africa.</p>	<p>Any country that introduces it for forestry, but could then risk it becoming invasive.</p>

Species	Likely modes of spread	Known presence	Countries at risk
Plants (excluding agricultural weeds)			
Tree			
<i>Adenanthera pavonina</i> Coral bean tree, red sandalwood tree Tree	Trees produce large quantities of seed. It will grow on a variety of soils in moist and seasonally moist tropical climates. Found in dry and occasionally dense forest. Used to be introd. as a landscape tree but less so now given its potential as an invasive.	Hawaii, Guam, FSM, Northern Marianas, Marshalls, Palau, PNG, Solomons, American Samoa, Samoa, Fiji, Tonga, Niue, Cooks, French Polynesia.	New Caledonia, Vanuatu.
<i>Albisia lebeck</i> Siris-tree, rain tree, East Indian walnut Related invasives: <i>Albizia chinensis</i> <i>Albizia saman</i> Tree	Often planted as a fast-growing shade tree and to fix nitrogen. Naturalises along roadsides, lower elevations. Grows from seeds and extensive root suckers.	Hawaii, Guam, FSM, Palau, Northern Marianas, Fiji, PNG, Solomons, French Polynesia, New Caledonia, Tonga.	Risk from deliberate introductions with main trading partners. Could be to Vanuatu, Samoa, Cooks, Wallis & Futuna.
<i>Clerodendrum chinense</i> Related invasives: <i>C. japonicum</i> <i>C. paniculatum</i> Shrub	<i>C. paniculatum</i> (pagoda plant) is a shrub, propagated by seed.	Guam, FSM, Palau, Marshalls, Fiji, French Polynesia, PNG, Samoa, American Samoa.	Hawaii, Northern Marianas (high), Tonga, Cooks, New Caledonia, Vanuatu, Wallis & Futuna.
<i>Eichhornia crassipes</i> Water hyacinth Aquatic herb	Freshwater lakes, ponds, marshes, ditches, canals, slow-moving streams. Salinity can limit or modify its distribution. Widely introduced as an ornamental and now the world's worst aquatic weed. Reproduces vegetatively by means of stolons which are readily distributed by water currents, wind, boats and rafts.	Hawaii, Guam, FSM, Marshalls, Palau, PNG, Solomons, American Samoa, Samoa, Fiji, Tonga, Niue, Cooks, French Polynesia, New Caledonia, Vanuatu.	Northern Marianas and would need to be deliberately introduced. Atolls are probably low risks, given the water hyacinth's inability to cope with brackish water.
<i>Hedychium coronarium</i> White ginger, ginger lily Herb	Favours wet habitats. Rainforest, moist forest, roadsides, open areas, and streamsides. Can overwhelm low growing plants in pastures and forests. Grows via stolons and, to some degree, seeds.	Hawaii, Guam, FSM, Marshalls, Palau, Fiji, American Samoa, Samoa, Tonga, Nauru, Cooks, French Polynesia	New Caledonia, Vanuatu, Northern Marianas, PNG, Solomons. Deliberate cultivation of ginger species needs to be monitored.
<i>Hedychium gardnerianum</i> Kahili ginger Herb	Grows in wet habitats between sea level and 1,700 m. Forms vast, dense colonies, displacing other plant species. Spreads by stolons and fleshy, red seeds are dispersed by frugivorous	Hawaii, FSM, French Polynesia, Cooks.	Guam, Northern Marianas, Marshalls, Fiji, American Samoa, Samoa.

Species	Likely modes of spread	Known presence	Countries at risk
Plants (excluding agricultural weeds)			
	birds as well as people.		
<i>Hedychium flavescens</i> Yellow ginger, cream ginger Herb	Found in rainforest, moist forest, roadsides, open areas, streamsides. Similar to <i>H. coronarium</i> and <i>H. gardnerianum</i> . Spreads via stolons and escaping from cultivation. Even small root fragments will regrow. Often spread by people dumping garden waste.	Hawaii, Guam, FSM, American Samoa, Samoa, Tonga, Cooks, French Polynesia, Niue.	Fiji, New Caledonia, Vanuatu, Northern Marianas, PNG, Solomons.
<i>Lantana camara</i> Lantana, shrub verbena Thorny shrub	Widely cultivated as an ornamental, then escaped as a weed. Forms dense understory vegetation that crowds out and inhibits establishment of other species. Sea level to 1500 m in French Polynesia. Major weed in the Pacific. The fleshy fruit is dispersed by frugivorous birds pigs and rodents. It is capable of surviving all but the hottest fires, regenerating from basal shoots.	Reported from all of the countries in this report with the exception of the Tokelaus.	Tokelaus and other islands within archipelagos where it is currently absent.
<i>Leucaena leucocephala</i> Leucaena, wild tamarind, lead tree Shrub or small tree	Originally grown for fodder, but unless severely grazed or controlled, it spreads rampantly throughout adjacent areas. Prolific seed producer which are dispersed by rodents and granivorous birds. Seeds can also be spread in cattle manure. It regrows from cut stumps and from cuttings. It regenerates from basal shoots after fire.	Reported from all of the countries in this report with the exception of the Tokelaus.	Tokelaus and other islands within archipelagos where it is currently absent.
<i>Melinis minutiflora</i> Melinis, molasses grass Grass	Introduced as a forage grass. A spreading, perennial mat grass that smothers everything around it. Once established, it forms monotypic stands from rooted runners. Fire adapted, seeds are wind dispersed. Because of its oil content, it can be a serious fire hazard.	Hawaii, Guam, Palau, Fiji, Tonga, French Polynesia, New Caledonia, PNG, Solomons, Vanuatu, American Samoa, Wallis & Futuna.	FSM, Samoa, Cooks, Northern Marianas.
<i>Merremia peltata</i> Merremia Vine	Status as a native or an aboriginal introduction to many Pacific islands is open to question. Still spreading. Grows in forests and thickets, crawling up and over shrubs and trees, especially in disturbed areas. Grows from seed and by adventitious rooting from	FSM, Guam, Palau, Marshalls, French Polynesia, New Caledonia, Vanuatu, American Samoa, Samoa, Fiji, Tonga, PNG, Solomons, Wallis & Futuna.	Hawaii, Cooks, Kiribati, Tuvalu, Nauru, Northern Marianas.

Species	Likely modes of spread	Known presence	Countries at risk
Plants (excluding agricultural weeds)			
	stems.		
<i>Miconia calvescens</i> Miconia, velvet leaf, purple plague, bush currant Tree	Moist and wet forests from sea level to 1300 m in French Polynesia. Reproduces even in dense shade and eventually shades out all other plants except mature tall trees. Produces thousands of tiny bird and rat-dispersed fruits at maturity. Most long-range spread is by frugivorous birds. People also spread seeds carried on shoes, equipment, etc. Seeds are also long-lived in soil. Major threat to many Pacific countries. First introduced as an ornamental.	Hawaii, French Polynesia (devastating impacts), New Caledonia.	FSM, Guam, Fiji, Cooks, Vanuatu, PNG, Samoa, American Samoa, Solomons, Palau, Tonga, Vanuatu. Vigilance to identify and remove any small saplings by hand is required. Awareness of the risks to prevent importation is essential.
<i>Mikania micrantha</i> Climbing vine	Vine that can cover plants and crowd out native vegetation. Does best in disturbed habitats and openings, but can also invade forest gaps and margins. Numerous wind-dispersed seeds.	Guam, Fiji, American Samoa, Samoa, Cooks, Niue, Solomons (?), Tonga, Vanuatu, Wallis & Futuna.	Hawaii, FSM, Northern Marianas, French Polynesia, New Caledonia, Palau.
<i>Mimosa invisa</i> Thorny shrub	A pioneer or early successional plant with rapid growth rates and prolific reproduction which aids its establishment. Fruits stick to animals or on people's clothing and are also moved via vehicles.	Guam, FSM, Northern Marianas, Fiji, American Samoa, Samoa, Palau, Niue, Solomons (?), Tonga, French Polynesia, New Caledonia	Hawaii, Vanuatu, Cooks, Wallis & Futuna.
<i>Panicum maximum</i> Guinea grass, green panic, buffalo grass Grass	Coarse, perennial grass reaches heights of more than 2 m. It grows in dry areas between sea level and 1,200 m. Shade tolerant and seeds profusely. The seeds are dispersed by wind, birds, flowing water or as a contaminant. Survive long periods of drought. Regenerates rapidly after fire from underground rhizomes. Seeds likely to be carried by people, vehicles and machinery.	Hawaii, Guam, FSM, Palau, PNG, Northern Marianas, Kiribati, Solomons, American Samoa, Samoa, Fiji, Tonga, Niue, Cooks, French Polynesia, New Caledonia, Vanuatu, Wallis & Futuna.	Marshalls, Tuvalu, Nauru, Tokelau
<i>Panicum repens</i> Torpedo grass, couch panicum, creeping panic Grass	Primary a weed of moist, coastal, sandy soils, but grows to 2000m in Indonesia. Rhizomes can stand prolonged dry periods, only occasionally produces seeds. Main spread is via long rhizomes, therefore soil is a likely route of spread.	Hawaii, Northern Marianas, Palau. (Native to Australia)	First spread is most likely to: Guam, FSM, Cooks, Fiji, PNG, Solomons via trade.
<i>Paspalum</i>	A perennial grass that rapidly	Found in all countries	Kiribati, Nauru.

Species	Likely modes of spread	Known presence	Countries at risk
Plants (excluding agricultural weeds)			
<p><i>conjugatum</i></p> <p>Ti grass, sour grass; sour palpalum, buffalo grass</p> <p>Grass</p>	<p>invades wet habitats from sea level to 2,000 m. Found along roadsides and in cultivation, in pastures, villages, plantations, and along beaches and river banks. Can form dense floating mats. The small seeds are probably distributed by people and animals on clothing and fur. Also spreads by stolons.</p>	<p>listed in this report with the exception of Kiribati and Nauru.</p>	
<p><i>Paspalum dilatatum</i></p> <p>Paspalum, dallis grass, water grass</p> <p>Grass</p>	<p>Widely introduced as a forage species. Prefers wet situations. Produces large quantities of seed that are probably distributed by people and animals.</p>	<p>Hawaii, Guam, French Polynesia, New Caledonia, Vanuatu, Fiji, American Samoa, Samoa, Cooks, Niue, PNG, Solomons, Tonga.</p>	<p>FSM, Marshalls, Northern Marianas, Palau, Tuvalu.</p>
<p><i>Passiflora edulis</i></p> <p>Passion fruit, yellow passion fruit, purple passion fruit, qarandila</p> <p>Vine</p> <p>Related species that are also invasive in the Pacific are: <i>P. foetida</i>, <i>P. laurifolia</i>, <i>P. ligularis</i>, <i>P. mollissima</i>, <i>P. quadrangularis</i>, <i>P. rubra</i>.</p>	<p>Cultivated for fruit, from which it may escape. Smothers trees and shrubs. While it is often planted by humans, the seeds spread by animals; in Hawai'i, especially by feral pigs. Birds may also spread the seeds.</p>	<p>Hawaii, Guam, FSM, Palau, Marshalls, French Polynesia, Fiji, Cooks, Niue, Kiribati, Tonga.</p>	<p>American Samoa, Samoa, New Caledonia, Vanuatu, Niue, PNG, Northern Marianas, Solomons.</p>
<p><i>Pennisetum clandestinum</i></p> <p>Kikuyu grass</p> <p>Grass</p>	<p>A low, mat-forming, perennial grass. A favoured, but overrated, rangeland grass. It is a serious pest in forests because, apart from shading out shrubs and herbs, it releases allelopathic substances which kill almost all other species in the vicinity. It can also invade wet environments when the forest is disturbed. Spreads mostly via rhizomes and stolons; wind-dispersed seeds (rarely).</p>	<p>Hawaii, French Polynesia, PNG.</p> <p>Also a problem in New Zealand and Australia.</p>	<p>Guam, FSM, Fiji, Palau, Northern Marianas, Solomons, Samoa, American Samoa, New Caledonia, Vanuatu, Niue, Cooks, Tonga.</p>

Species	Likely modes of spread	Known presence	Countries at risk
Plants (excluding agricultural weeds)			
<p><i>Pennisetum polystachyon</i></p> <p>Mission grass, feathery pennisetum</p> <p>Grass</p>	<p>An aggressive weed species. Tufted annual grass that establishes in disturbed areas. In Fiji, grows in very dense stands and is the dominant plant on open hills in certain areas. Seeds dispersed by wind, flowing water, or sticking to clothing.</p>	<p>Hawaii, Guam, FSM, Northern Marianas, Palau, Marshalls, Fiji, French Polynesia, Kiribati, Solomons, Vanuatu.</p>	<p>Samoa, American Samoa, Cooks, New Caledonia, Tuvalu, PNG, Tonga.</p>
<p><i>Pennisetum purpureum</i></p> <p>Elephant grass, napier grass, merker grass</p> <p>Grass</p> <p>Related invasive is: <i>P. setaceum</i></p>	<p>Forms dense perennial stands, difficult to penetrate, which inhibits establishment of other vegetation. Seed are wind-dispersed; also spreads by tillers and cuttings. One of the most invasive weeds in Papua New Guinea.</p>	<p>Hawaii, Guam, FSM, Northern Marianas, Marshalls, Palau, Kiribati, French Polynesia, New Caledonia, Vanuatu, Fiji, American Samoa, Samoa, Cooks, Niue, PNG, Solomons, Tokelau, Wallis and Futuna</p>	<p>Tonga, Tuvalu, Nauru.</p>
<p><i>Psidium cattleianum</i></p> <p>Strawberry guava, cherry guava, Cattley guava, Chinese guava</p> <p>Tree</p>	<p>Favours moist or wet slopes. Produces dense thickets of small-stemmed plants. Density of stands and allelopathic characteristics inhibit other species. Seeds and suckers. Birds and pigs disperse fruits. Might also be spread by cattle. One of the worst invasive species in forests of Hawai'i, Tahiti, La Réunion and Mauritius.</p>	<p>Hawaii, FSM, Palau, French Polynesia, Fiji, Samoa.</p>	<p>Guam, New Caledonia, Vanuatu, American Samoa (high), Tonga, Niue, PNG, Solomons, Kiribati.</p>
<p><i>Psidium guajava</i></p> <p>Guava</p> <p>Shrub, small tree</p>	<p>Can reach heights of 8 m. It invades disturbed sites and forms dense thickets. Cultivated in gardens but often escaped and naturalised where introduced. Common on abandoned fields</p>	<p>Hawaii, Guam, FSM, Northern Marianas, Marshalls, Palau, Kiribati, Tuvalu, French Polynesia, New Caledonia, Vanuatu, Fiji, American Samoa, Samoa, Cooks, Niue, PNG, Solomons, Tonga, Wallis and Futuna.</p>	<p>Tokelau, Nauru.</p>
<p><i>Rubus spp.</i></p> <p>Main problems are from two species: <i>R. moluccanus</i>, <i>R. rosifolius</i> among the <i>Rubus</i> genus.</p> <p>Thorny shrubs</p>	<p>These are the wild raspberry species that can grow into impenetrable thickets. Seed are often spread by frugivorous birds making control difficult.</p>	<p>Hawaii, FSM, French Polynesia, New Caledonia, Fiji, PNG (probably)</p>	<p>Guam, Northern Marianas, Vanuatu, Tonga, Solomons.</p>

Species	Likely modes of spread	Known presence	Countries at risk
Plants (excluding agricultural weeds)			
<p><i>Sorghum halepense</i></p> <p>Johnson grass, Aleppo grass, Aleppo milletgrass</p> <p>Grass</p>	<p>Perennial grass with strong rhizomes bearing buds which germinate readily. Reproduction is by seed and rhizome production. Seed production is variable. The seeds can remain viable in soil for periods of up to 6 years. A problem species in Hawaii. Old plants contain hydrocyanic acid and are dangerous to livestock.</p>	<p>Hawaii, Guam, FSM, Northern Marianas, Marshalls, Palau, French Polynesia, New Caledonia, Vanuatu, Fiji, American Samoa, Tonga, PNG, Solomons, Wallis and Futuna.</p> <p>A noxious weed in New Zealand.</p>	<p>Samoa, Cooks, Niue, Nauru, Kiribati, Tuvalu.</p>
<p><i>Spathodea campanulata</i></p> <p>African tulip tree, fireball, fountain tree</p> <p>Tree</p>	<p>This showy, shade-tolerant, evergreen tree reaches heights of 25 m. It invades both abandoned agricultural land and closed forest. Favors moist and wet areas from sea level to 1,000 m in Hawai'i. Has very showy scarlet flower clusters. Commonly planted throughout the Pacific, naturalized locally. Wind-dispersed seeds. Also propagates from root suckers and cuttings. A problem species in Hawai'i, Fiji, French Polynesia and Samoa.</p>	<p>Hawaii, Guam, FSM, Northern Marianas, Marshalls, Palau, French Polynesia, Vanuatu, Fiji, American Samoa, Samoa, Cooks, Niue, Nauru, Tonga, Wallis and Futuna.</p>	<p>New Caledonia, Kiribati, Tuvalu, PNG, Solomons, Tokelau.</p>
<p><i>Stachytarpheta cayennensis</i></p> <p>Also known as: <i>S. urticifolia</i></p> <p>Blue rat's tail, dark blue snakeweed, false verbena, nettleleaf velvetberry</p> <p>Herb</p>	<p>An erect, sparsely-branched shrub. A common and important weed of crops, pastures, plantations, roadsides and wasteland, and also occurs as a minor weed in most other places. From low altitude to about 2,000 m in Papua New Guinea. Spreads by seed. Very prevalent in the Cook Islands, American Samoa and Samoa.</p> <p>Similar weed species is <i>S. jamaicensis</i> (blue porterweed) which is more a weed of openings and roadsides.</p>	<p>Hawaii, Guam, FSM, Northern Marianas, Marshalls, Palau, French Polynesia, New Caledonia, Vanuatu, Fiji, American Samoa, Samoa, Tokelau, Tuvalu, Cooks, Niue, Nauru, Tonga, PNG, Solomons, Wallis and Futuna.</p>	<p>Kiribati</p>
<p><i>Tecoma stans</i></p> <p>Yellow bells, yellow-elder, yellow trumpetbush</p> <p>Shrub or small tree</p>	<p>Ecological features not available at time of writing. The seeds are wind-dispersed.</p>	<p>Hawaii, Guam, FSM, Northern Marianas, Marshalls, Palau, French Polynesia, New Caledonia, Kiribati, Fiji, American Samoa, Samoa, Cooks, Niue,</p>	<p>Vanuatu, Tuvalu, PNG, Tokelau, Wallis and Futuna.</p>

Species	Likely modes of spread	Known presence	Countries at risk
Plants (excluding agricultural weeds)			
		Nauru, Tonga, Solomons.	
<p><i>Wedelia trilobata</i></p> <p>Note: <i>Sphagneticola trilobata</i> is the accepted name for this species, but not widely used, yet, in the Pacific.</p> <p>Wedelia, trailing daisy, Singapore daisy, creeping ox-eye</p> <p>Herb</p>	<p>Creeping, mat-forming and perennial herb. Cultivated as an ornamental. A noxious weed in agricultural areas, along roadsides and trails, in open lots, waste places and rubbish dumps and other disturbed sites. Also naturalized and invasive along streams, canals, along the borders of mangroves and in coastal strand vegetation. Forms a dense ground cover, crowding out or preventing regeneration of other species. Usually spreads vegetatively and via dumping of garden waste.</p>	<p>Hawaii, Guam, FSM, Northern Marianas, Marshalls, Palau, Kiribati, French Polynesia, Vanuatu, Fiji, American Samoa, Samoa, Cooks, Niue, Nauru, Tonga, PNG.</p>	<p>New Caledonia, Nauru, Solomons, Tuvalu, Tokelau, Wallis and Futuna.</p>

4.2 Invasive mammals and reptiles

Species	Likely transport modes	Known presence	Countries at risk
Mammals and reptiles			
<p>Summary information</p> <p>Mammals are generally the most obvious invasive species in any country. Some are also important, useful domestic species that become invasive when they establish feral populations. Good examples are goats, pigs, cats, dogs and cattle. Given their relatively large size and relative ease of control (when compared to marine species or invertebrates, such as ants) eradication of many invasive mammal populations is feasible and can yield major gains for local species and ecosystem restoration. Technological advances continue to improve the chances of eradication and better control of mammal pests, providing expertise and resources are available. Pathways for mammal invasives include deliberate introductions, which is especially a problem when species are moved between islands within countries, e.g. goats, cats as well as accidental introductions, such as the spread of rodents via ships, yachts and cargo. Effective quarantine systems are essential to detect potential arrivals via both of these routes and greater awareness of the consequences of these introductions amongst the public and officials. Like other groups of invasive plants and animals included in this survey, there is still a lack of important information on the status of many invasive species within countries, especially details for archipelago groups.</p>			
<p><i>Rattus exulans</i></p> <p>Pacific or Polynesian rat</p>	<p>Spread throughout the Pacific by first immigrants and were used for food. Predominantly plant diet in the Pacific as well as insects and an agricultural pest. Spread via aircraft and vessels and still likely to be introduced via yachts, fishing boats, coastal traders and in a range of cargoes, food supplies and building materials. For all rodents, the time at wharves, slipways, or when anchored close inshore is the time of greatest risk.</p>	<p>Present in all Pacific island countries considered in this report.</p>	<p>There may be islands within countries where <i>R. exulans</i> is absent that have high conservation values. Such islands will be at risk from accidental introductions.</p>
<p><i>Rattus rattus</i></p> <p>Ship rat</p>	<p>Skilful tree climbers and are omnivorous generalists. Favour arthropods but also prey on birds eggs. As the name indicates, main transport for centuries was via ships and other vessels and is still an important pathway. See details for Pacific rat.</p>	<p>Most likely present in all Pacific island countries considered in this report. Might be absent from the Tokelaus.</p>	<p>Some islands within countries where <i>R. rattus</i> is absent may have high conservation values. Such islands will be at risk from accidental introductions.</p>
<p><i>Rattus norvegicus</i></p> <p>Norway rat</p>	<p>Omnivores and opportunistic feeders. Can include invertebrates and eggs, birds and lizards. Also serious urban and agricultural pests. Like other rodents, invade via ships and other vessels, food, vehicles, cargoes, building supplies and, less likely, via aircraft.</p>	<p>Hawaii, American Samoa, FSM, Fiji, French Polynesia, Guam, Marshalls, New Caledonia, Niue, Northern Marianas, Palau, Samoa, Tonga, Tuvalu, Vanuatu, Wallis & Futuna (?).</p>	<p>Those few countries where the Norway rat is absent are at risk, especially PNG, Solomons, Kiribati and large islands within archipelagos that are presently rodent free.</p>

Species	Likely transport modes	Known presence	Countries at risk
Mammals and reptiles			
<i>Mus musculus</i> Mouse	Feed on plant and invertebrate material in urban and natural habitats. Impacts on biodiversity less clear than for rats. Like the rat species, mice arrived as stowaways on sailing ships. Ships, yachts and fishing boats are still the most likely way mice will locate in new places, although travel via cargo, vehicles is still likely to be an important route, especially within countries.	Hawaii, FSM, Fiji, French Polynesia, Kiribati, Guam, Marshalls, Naru, New Caledonia, Northern Marianas, Palau, Solomons, Tonga, Tuvalu, Vanuatu,	PNG, Niue, American Samoa, Samoa. Less likely on the Tokelaus unless mice establish in Samoa.
<i>Felis catus</i> House cat	Feral cat populations cause significant losses, especially to Pacific seabird colonies and other ground-nesting birds. Distribution is largely by deliberate human introduction. Pets escaping from yachts are a risk and education, coupled with quarantine measures, are needed. Between-island transfers are most likely via ferries and traders.	Likely to be present in all Pacific countries, but not necessarily on all islands within countries. Protecting these islands should be a high priority.	Uninhabited islands with large seabird colonies are at risk from accidental or intentional introductions. Yachts and fishing vessels are likely risk pathways.
<i>Canis familiaris</i> European dog	Introductions are mostly deliberate, hence the importance of checking and good quarantine. Feral dogs, and even domestic “free-ranging” dogs, can kill wildlife, often birds. Wildlife impacts in the Pacific are not known. Deliberate introductions via vessels or aircraft are the most likely routes of spread.	Already taken to most inhabited islands in the Pacific. Extent of feral dog populations in forested islands is not clear.	Islands within groups with high conservation values.
<i>Sus scrofa</i> Pig	Domestic pigs often go wild. Pigs damage soils, spread seeds of invasive plants and can have big impacts on large native invertebrates, such as snails and earthworms. Pacific studies are rare, but pigs probably eat eggs and young of ground-nesting birds. Between-island movements will be deliberate, via trading vessels and ferries in most cases.	Introduced to most island groups in the Pacific.	Islands within groups with high conservation values.
<i>Capra hircus</i> Feral goat	Destructive herbivores, goats can eliminate local populations of their preferred plants. Most likely to be moved deliberately between islands, usually via trading vessels and ferries.	Hawaii, French Polynesia, FSM, Cooks, Fiji, New Caledonia, PNG, Palau, Northern Marianas, Kiribati.	Countries where goats may be seen as a useful additional species for domestic use. These may include Guam, Solomons, Vanuatau.

Species	Likely transport modes	Known presence	Countries at risk
Mammals and reptiles			
<i>Bos taurus</i> Cattle	Feral cattle have damaged forests and woodlands in Hawaii and New Caledonia. Transport modes between islands are usually via vessels and are only likely to be deliberate introductions. Good fencing is usually sufficient to prevent escapes and reduce the risk of feral populations becoming established.	Hawaii, French Polynesia, New Caledonia, FSM, Fiji, PNG, Northern Marianas. Cattle are present, but contained in other countries, such as Samoa.	
<i>Oryctolagus cuniculus cuniculus</i> European rabbit	Damage vegetation, especially on islands with low rainfall (less than 1000mm). Introductions are deliberate and can be detected in cargo or baggage with strict surveillance and entry ports. Movements within island groups is more difficult to prevent.	Hawaii, French Polynesia, Fiji, Kiribati (?), Tonga.	Difficult to predict, since introductions will need to be deliberate. Larger countries such as PNG, New Caledonia, Solomons, Samoa and Vanuatu might be targeted.
<i>Herpestes javanicus</i> Small Indian mongoose	Attack rodents, chickens, birds and native animals, including many invertebrates. Deliberately introduced to Fiji and would most likely need to be deliberately taken to other countries. Capacity to act as a 'stowaway' is not known. Lack of spread suggests this might be small.	Hawaii, Fiji.	Ill-informed and illegal introductions may be attempted to control rodents in other countries.
<i>Suncus murinus</i> Musk shrew (house shrew)	Omnivorous, mostly insect prey. Spread over Guam in 3 years. Impacts on native flora and fauna are not known. Probably arrived as stowaways in cargo goods. Spread between the main islands of the Northern Marianas, so is capable of spreading between islands, probably as a stowaway in ship goods or on trading vessels.	Guam, Palau, Northern Marianas.	Hawaii, - given its strong trade and tourist links to Guam. Other trading countries such as FSM, PNG, may also be at risk given the successful spread of this shrew so far.
<i>Boiga irregularis</i> Brown tree snake	The snake that is feared after it exterminated seven bird species in Guam. A hitchhiker stowaway species that can travel in aircraft or ships with cargo goods or independently. A major potential threat to many Pacific island countries, especially if it were to establish in Hawaii. The importance of good inspection practices at airports, container and cargo facilities is essential to keeping brown tree snakes from establishing in vulnerable Pacific island countries.	Native to Australia, Indonesia, PNG and the Solomons. Introduced to Guam, has been sighted in Northern Marianas (Saipan) and Pohnpei.	Hawaii (already detected in arriving aircraft), FSM, Palau, Northern Marianas (high), American Samoa, Fiji, Vanuatu, French Polynesia, New Caledonia, Tonga. Other countries would be added to this list if the species establishes beyond its current range.

4.3 Invasive birds

Species	Likely transport modes	Known presence	Countries at risk
Birds			
<p>Summary information</p> <p>This is a minor group of invasive vertebrates when compared with the impacts of rodents and predators, such as cats, on island biodiversity. The impacts of pest bird species on indigenous species, either directly or via competition for food or nesting sites, and as disease vectors, has been little studied to date. The following are three of the better known introduced bird species that may be adversely affecting indigenous biodiversity</p>			
<p><i>Acridotheres tristis</i></p> <p>Common myna (from India)</p>	<p>A problem for commercial crops; its impact on native species is less clear. Myna have been introduced deliberately, usually as pet birds. Wild populations can probably disperse between adjacent islands themselves. Presumably they can 'hitchhike' on inter-island trading vessels and larger container ships.</p>	<p>Hawaii, Fiji, Cooks, Kiribati (?), French Polynesia, Samoa, American Samoa (?), New Caledonia, Solomons, Vanuatu, Wallis & Futuna</p>	<p>Guam, FSM, Tonga, Marshalls, Northern Marianas, Palau, PNG (could spread naturally via the Solomons).</p>
<p><i>Acridotheres fuscus</i></p> <p>Jungle myna</p>	<p>A problem for commercial crops; its impact on native species is less clear. Myna have been introduced deliberately, usually as pet birds. Apparently reached Tonga without human assistance. Presumably they can 'hitchhike' on inter-island trading vessels and larger container ships.</p>	<p>Fiji, Samoa, American Samoa (?), Tonga</p>	<p>Possibly Hawaii, New Caledonia, Vanuatu. Pet traffic could add other countries.</p>
<p><i>Pycnonotus cafer</i></p> <p>Red-vented bulbul (from India)</p>	<p>Regarded as a potential problem for some native birds, but impacts not studied. Current distribution closely reflects that of the myna species and pathways are likely to be similar.</p>	<p>Fiji, Tonga, French Polynesia (possibly), American Samoa, Samoa.</p>	<p>Possibly Hawaii, New Caledonia, Vanuatu. Pet traffic could add other countries.</p>

4.4 Invasive freshwater fish

Species	Likely transport modes	Known presence	Countries at risk
Freshwater fish			
<p>Summary information</p> <p>Freshwater fish have been introduced to Pacific island countries – 86 species in total. Many of these are aquarium species and those that escape have negative impacts on native species and ecosystems. Other species were introduced for sport, improvement of wild stock, food or for biological control. Ecological impacts include removal of aquatic vegetation and degradation of water quality, introduction of parasites, pathogens and diseases, disruption of trophic levels, hybridisation with native stocks, socio-economic effects. Greater awareness of the dangers posed by these species is needed to reduce human introductions – both deliberate and accidental. Clearly it is more difficult for freshwater fish to be transported accidentally between countries than many other potential invasives, hence the importance of public education and control of movements of these fish by people.</p>			
<p><i>Tilapia mossambica</i></p> <p>Mozambique tilapia (Family Cichlidae)</p>	<p>The most widely distributed tilapia species in the Pacific, introduced for mosquito and aquatic weed control. Has reduced native fish stock, introduced parasites and caused the decline of birds by competing of aquatic foods. Likely transport is by people between locations. As with following species – awareness of negative impacts is key to controlling spread.</p>	<p>Hawaii, American Samoa, FSM, Fiji, French Polynesia, Guam, Kiribati, Nauru, Palau, New Caledonia, Northern Marianas, PNG, Samoa, Solomons, Tonga, Tuvalu, Vanuatu, Wallis & Futuna</p>	<p>Marshalls - from deliberate introductions – hence the importance of education and border inspection.</p>
<p>Other tilapia species</p>	<p>Eight other tilapia species have been introduced , but have much more limited distribution. Introductions were deliberate.</p> <p>The redbreast tilapia (<i>Tilapia rendalli</i>) is in Fiji, Wallis, Hawaii PNG, New Caledonia, Guam.</p>	<p>Hawaii (3 spp) and Fiji (4) have the most tilapia species.</p>	<p>Larger islands and high trade routes where deliberate introductions might still occur – e.g. New Caledonia, PNG, Guam, French Polynesia, Fiji, Hawaii.</p>
<p><i>Poecilia reticulata</i></p> <p>Guppy</p>	<p>Introduced into 10 island countries, probably through the aquarium trade and for mosquito control. Prolific breeders, guppies eat fish eggs and reduce native fish stocks, shrimps and can introduce parasites. Transport between islands must be by people; established populations spread rapidly through ditches, ponds, and swamps.</p>	<p>Hawaii, French Polynesia, Cooks, Samoa, Fiji, New Caledonia, Vanuatu, PNG, Palau, Guam.</p> <p>5 of these countries also have the Mexican molly (<i>Poecilia mexicana</i>) – Hawaii, French Polynesia, American Samoa, Samoa, Fiji.</p>	<p>Trade and people-linked countries at risk probably include: American Samoa, FSM, New Caledonia, Northern Marianas, Marshalls, Solomons, Tonga, with a lower risk for Wallis & Futuna.</p>
<p><i>Gambusia affinis</i></p> <p>Mosquitofish</p>	<p>Described as “probably the most widely distributed fresh-water fish in the world” primarily</p>	<p>Hawaii, Kiribati, French Polynesia, Cooks, Samoa,</p>	<p>New Caledonia (high), Tonga, Northern Marianas, Palau.</p>

Species	Likely transport modes	Known presence	Countries at risk
Freshwater fish			
	spread for mosquito control. An aggressive fish that hosts helminth parasites and can wipe out smaller, native fish that also eat mosquitoes. Still introduced to kill mosquitoes, but other impacts are more severe. People are the main deliberate dispersers.	American Samoa, Fiji, Vanuatu, Solomons, PNG, Marshalls, FSM, Guam, Northern Marianas.	

4.5 Invasive amphibians and freshwater crustaceans

Species	Likely transport modes	Known presence	Countries at risk
Amphibians and freshwater crustaceans			
<p>Summary information</p> <p>This group of invasives is dominated by one species – the cane toad. Like many of the freshwater fish introductions, cane toads were deliberately introduced into Pacific countries for insect control. Later introductions were made despite strong objections, given their known damaging impacts on native species. These later introductions demonstrate that conservation considerations are often overruled by agricultural and development interests, an issue that still applies to less obvious, but still potentially damaging invasive alien species such as grasses. Threats from other amphibians and freshwater crustaceans are relatively minor compared with other groups (such as mammals and invertebrates) but are worth noting as potential invasives, despite limited studies, so far, of their biodiversity impacts.</p>			
<p><i>Bufo marinus</i></p> <p>Cane toad, marine toad</p>	<p>First introduced to Hawaii (1932) for insect and garden slug control. These toads eat beneficial insects, freshwater fishes and the poison from their parotid glands has killed cats, dogs and even humans. Can travel as hitchhikers on aeroplanes, road vehicles, and in containers. (Some arrived in Tahiti in a container with logs from Fiji.) Once established, cane toads spread naturally and the free-swimming tadpole stage can be dispersed in flash floods.</p>	<p>Hawaii, Guam, FSM, Northern Marianas, Palau, Fiji, PNG, Tuvalu, Solomons, American Samoa</p>	<p>Tonga, Samoa (high risk of arrival from American Samoa), Marshalls, French Polynesia, Cooks, New Caledonia</p>
<p>Frog species – various</p>	<p>Some species were deliberately introduced to Hawaii to control insects. Threats can be to native insects and snails and competing with birds for insects. These included <i>Rana catesbiana</i>, <i>Rana rugosa</i>, <i>Dendrobates auratus</i>. Pathways for accidental introductions include airlines (accidental release of pets), plant shipments and soil from plant nurseries.</p>	<p>Introduced frogs have been recorded from Hawaii, Guam, New Caledonia, Vanuatu, Wallis,</p>	<p>Major transport hubs – Guam, Fiji, French Polynesia, PNG, New Caledonia, Hawaii, and other neighbouring countries to a lesser extent.</p>
<p><i>Cherax quadricarinatus</i></p> <p>Australian redclaw crayfish</p>	<p>Illegally introduced, possibly for aquaculture. A generalist species able to tolerate a range of conditions, eats almost anything and has high fecundity. Introduced nematode worm to New Caledonia. Potential pathways are illegal introductions. Biodiversity impacts not clear.</p>	<p>New Caledonia, Fiji, Samoa (possible introduction)</p>	<p>Countries with potential interests in aquaculture.</p>

4.6 Invasive arthropods

Species	Likely transport modes	Known presence	Countries at risk
Invasive arthropods			
<p>Summary information</p> <p>Most numerous invasive animals of islands, but their conservation impacts are poorly documented except for Hawaii. Ants are probably the biggest arthropod threat throughout the Pacific and one of the most significant invasive animal threats to island countries that justify intensive border quarantine services. The impact of ants as invasive species and threats to biodiversity are becoming more widely appreciated but are grossly under-studied in the Pacific. ‘Countries at risk’ are based on pathway connections only and are likely to be underestimates. Ants will arrive by air (in cargo) or by sea – in containers, on vehicles, in soil.</p>			
<p><i>Xylosandrus compactus</i></p> <p>Black twig borer; Ambrosia beetle</p>	<p>A serious pest of forest trees, both healthy and unhealthy plants. A known risk pathway is via the nursery trade. Sea containers are a likely pathway.</p>	<p>Hawaii, American Samoa, Fiji, PNG, Solomons</p>	<p>FSM, French Polynesia, Guam, New Caledonia, Niue, Northern Marianas, Palau, Samoa, Tonga, Vanuatu, Wallis & Futuna</p>
<p><i>Oryctes rhinoceros</i></p> <p>Coconut rhinoceros beetle</p>	<p>Serious pest of the coconut palm, also damages native palm trees and native <i>Pandanus</i>. Initially spread through sea traffic in World War II and is still most likely to be moved by sea in agricultural products.</p>	<p>Cooks, Fiji, Guam, Palau, PNG, Samoa, Tokelau, Tonga, Wallis & Futuna.</p>	<p>American Samoa (high?), FSM, French Polynesia, Kiribati, Marshalls, Nauru, New Caledonia, Niue, Marianas, Solomons (high?) Tuvalu, Vanuatu,</p>
<p><i>Culex quinquefasciatus</i></p> <p>Avian malaria mosquito; southern house mosquito</p>	<p>Although the malarial parasite has only been found in Hawaii so far, there is a high potential for spread to other Pacific countries. High potential for fatality of native species.</p> <p>Air or shipping pathways are both possible. Major risk of spread is by import of infected non-native birds.</p>	<p>The mosquito occurs in all the Pacific islands included in this study.</p> <p>Avian malaria only found so far in Hawaii, but many countries have not been surveyed for the <i>Plasmodium</i> parasite.</p>	<p>Countries with high sea and air trade with Hawaii are probably at most risk – Guam, Marshalls, Northern Marianas (via Guam).</p>
<p><i>Vespula pensylvanica</i></p> <p>Yellowjacket wasp</p>	<p>Potential threat to many native arthropod species by predation. Sea freight is the most likely pathway, but air travel is also likely. Accidental stowaways in human goods. Once established, queen wasps can fly 30-70km per year.</p>	<p>Hawaii.</p> <p>(Common and a pest in North America and New Zealand)</p>	<p>Countries with high sea and air trade with Hawaii are probably at most risk – Guam, Marshalls, Northern Marianas (via Guam) as well as those with strong links to NZ, such as Fiji, Samoa, Cooks.</p>
<p><i>Solenopsis invicta</i></p> <p>Red Imported</p>	<p>Major potential threat to native biodiversity, agriculture and has serious social impacts. Untreated soil (on used machinery, vehicles,</p>	<p>Not yet in the Pacific island countries. Dispersing up the western coast of USA</p>	<p>All Pacific countries. Most at risk are island countries with high trade & flight</p>

Species	Likely transport modes	Known presence	Countries at risk
Invasive arthropods			
fire ant (RIFA)	nursery plants) is very high risk. Sea containers, vehicles, used machinery & car parts, used electrical equipment are high risk. Sea vessels, personal effects, treated wooden building materials are moderate risk while aircraft, accompanied baggage and international mail is probably low risk.	and established around Brisbane, Australia, where an eradication effort is underway. Refer to the “Pacific Ant Prevention Plan” (March 2004) by the Pacific Invasive Ant Group (PIAG) in the References.	connections with USA and Brisbane – Hawaii, Guam, Marshalls, FSM, American Samoa, New Caledonia, Fiji, PNG, Cooks, French Polynesia
<i>Pheidole megacephala</i> Bigheaded ant	Serious biodiversity threat by aggressively displacing most native invertebrate faunas. Affects plants and horticultural crops and chews cabling. Unintentional spread through garden waste, potted plants and household movements from infested areas. Sea containers and sea freight, including machinery and road vehicles are high risk pathways between countries.	Hawaii, Line, Society Islands, Cooks, French Polynesia, Fiji, Marshalls, Guam are known locations, but this species is probably more widely located.	FSM, Palau, Marianas, New Caledonia, Tonga, Samoa
<i>Anoplolepis longipes</i> Long-legged ant, crazy ant	Depletes native arthropod fauna and can kill newly hatched birds. Can prey on agricultural pests. Major pathways not well documented, but likely to be accidental introduction as a ‘tramp species’ with a wide range of human activities.	Hawaii, Guam, FSM, Marshalls, Kiribati, Tuvalu, Wallis & Futuna, Fiji, Samoa, Cooks, Solomons, Tokelau, French Polynesia,	May well be present on other island countries not already listed such as American Samoa, Palau, New Caledonia, PNG, Vanuatu.
<i>Linepithema humile</i> Argentine ant	Can eliminate other ant species and affect ground nesting native invertebrates. Mostly found in the 30-60 degree latitudes, but a classic ‘tramp’ species, moving by air and sea containers in a variety of cargoes. Can be moved via agriculture, food items and garbage, in potted plants or through military equipment.	Hawaii (so far the only reports from the Pacific). Also present in New Zealand.	Capacity to survive in hot tropics may be limited, but mountainous island countries might be at risk – such as PNG, New Caledonia and French Polynesia. The volume of airflights with NZ may put Fiji at risk.
<i>Wasmannia auropunctata</i> Little fire ant	Major negative impacts on ants, native invertebrates and agriculture. Painful sting. Can severely affect vertebrates, as on the Galapagos and in the Solomons. Spreads easily via sea freight (containers, bulk carriers), logs and lumber products, coconuts, food products, equipment and locally via agricultural products such as cattle feed, plant material.	Hawaii (likely), New Caledonia, Wallis & Futuna, Solomons, Fiji, Vanuatu. Has been spreading rapidly recently in the Pacific and is a major ‘tramp species’ threat. Like other ‘tramp species’ these ants hitchhike on machinery and plants from disturbed	Countries with good air and sea links with known infested countries – FSM, Guam, PNG, French Polynesia (high risk), Samoa, American Samoa, Cooks. Perhaps less threatened are the Marshalls, Northern Marianas and Palau.

Species	Likely transport modes	Known presence	Countries at risk
Invasive arthropods			
	This species is regarded as perhaps one of the greatest threats to Pacific conservation and is now spreading rapidly between countries. Effective quarantine measures and rapid response capacities are going to be critical in limiting the spread of this and other invasive ant species.	habitats.	
<i>Anoplolepis gracilipes</i> Yellow crazy ant	Major pest for agriculture as well as biodiversity. Affects reptiles, birds, mammals as well as invertebrates. Used to be deliberately used for biological control in coconut, coffee and cacao plantations. Moves in packing material, timber, plants, produce, pallets in containers, soil. Spreads locally by budding of colonies.	Pacific distribution not clear but could be widespread, including known presence on the Tokelaus, Guam, Marshalls, French Polynesia. Severe damage on Christmas Island in the Indian Ocean.	Linked countries on high volume trade routes that are likely to be at risk include: Hawaii, FSM, Marianas,

4.7 Invasive land and freshwater molluscs

Species	Likely transport modes	Known presence	Countries at risk
Land and freshwater molluscs			
<p>Summary information</p> <p>Although some snail species are still introduced deliberately for food or for the aquarium trade (e.g. <i>Pomacea bridgesii</i>), most introductions are accidental. Juveniles and eggs are the stages likely to avoid detection. Transport modes include containers, dirty used vehicles and machinery, agricultural products, food (e.g. among bananas, in food packing material), in soil on shoes, flowerpots and inadvertently via the horticultural trade. Eradication is very difficult; strict quarantine is the most effective action. High island archipelagos are most at risk, especially larger ones with extensive snail fauna. Focus should probably be on French Polynesia, American Samoa, Fiji, New Caledonia, PNG and the Solomon Islands.</p>			
<p><i>Achatina fulica</i></p> <p>Giant African snail</p>	<p>Can travel in sea containers – either outside or inside. (A number of live snails and eggs were found and destroyed in a container in Auckland in early 2004.) Could also be moved (eggs or small snails) via air cargo or on personal belongings. Other possible routes include association with agricultural products, on vehicles (local or imported). It has been smuggled in as a food resource or novelty pet. Inter-island ferries and traders are potentially important transport modes to moving snails within island archipelagos. Once in a country it can quickly spread via vehicles, agricultural produce, nursery trade (on plants or soil).</p>	<p>Hawaii, FSM, French Polynesia, Guam, Marshalls, New Caledonia, Northern Marianas, Palau, PNG, Samoa (Upolu only), Solomons, Tuvalu, Vanuatu, Wallis & Futuna</p>	<p>Cooks (5 flights/week from Tahiti), Ofu in Amer. Samoa (very high risk from in-country travel and from Upolu), Fiji (trades extensively with several infected countries), Kiribati, Nauru, Niue, Tokelau, Tonga (5 weekly flights from Samoa)</p> <p>Prevention by applying good inspection practices is essential.</p>
<p><i>Euglandina rosea</i></p> <p>Cannibal snail, rosy wolf snail</p>	<p>A predatory snail that has been deliberately spread by agricultural officials to control the Giant African snail. Sometimes deliberately spread by other people. Once established, natural spread is the main means of further spread. Ease of accidental transfer by sea or air routes is not known. Is ground and tree living. Very serious threat to native species.</p>	<p>Hawaii, French Polynesia, Guam, American Samoa, Kiribati, New Caledonia, PNG, Solomons, Vanuatu</p>	<p>Cooks, FSM, Fiji, Marshalls, Nauru (low), Niue (low), Northern Marianas, Palau, American Samoa (high for Ofu), Samoa, Tokelau (low), Tonga, Tuvalu, Wallis & Futuna. Seven countries listed here already have the African snail and hence may be at risk of deliberate introductions of <i>E. rosea</i>.</p>
<p><i>Gonaxis kibweziensis</i></p>	<p>A predatory snail that is ground dwelling. Potential impacts on native snails are less well known</p>	<p>Hawaii, American Samoa, FSM, Guam, New Caledonia,</p>	<p>Cooks, Fiji, French Polynesia (high via New Caledonia trade),</p>

Species	Likely transport modes	Known presence	Countries at risk
Land and freshwater molluscs			
	than for <i>E. rosea</i> . There also the potential for deliberate introduction by agricultural officials to control the Giant African snail, which should be resisted. Small in size, therefore accidental introduction is the biggest risk. This is most likely via sea containers, used vehicles and agricultural produce that is moved by trading vessels.	Northern Marianas, Palau, PNG.	Kiribati, Marshalls (potentially high), Nauru, Niue, Samoa (high from American Samoa), Solomons, Tokelau (low), Tuvalu, Vanuatu & Wallis & Futuna (high via New Caledonia trade).
<i>Gonaxis quadrilateralis</i>	Similar to, but larger than <i>G. kibweziensis</i> , a widely spread predatory snail. Primarily a potential threat, rather than a proven risk to native snails at this time. Transport is most likely accidental, via the same routes as for <i>G. kibweziensis</i> – containers, used vehicles and inter-island trading vessels.	Hawaii, Guam, Kiribati, Northern Marianas, Palau, PNG, Vanuatu.	American Samoa (high, from Hawaii, Guam links), Cooks, FSM (high), Fiji, French Polynesia, Marshalls, Nauru, New Caledonia (high, via Vanuatu trade), Niue, Samoa, Solomons, Tokelau (low), Tonga, Tuvalu, Wallis & Futuna.
<i>Subulina octona</i>	Probably compete with native litter-dwelling snails, from sea-level to mountain tops. Readily transported, accidentally, often in association with horticultural and agricultural products. Within- and between-island spread is therefore likely to occur via movement of people and goods in containers, island ferries and trading vessels.	Hawaii, American Samoa, Cooks, FSM, Fiji, French Polynesia, Guam, Marshalls, New Caledonia, Northern Marianas, Palau, Samoa, Solomons, Tonga, Vanuatu.	Surveys have most likely under-estimated its spread, hence this list is tentative. Kiribati, Nauru, Niue, PNG (high), Tokelau, Tuvalu, Wallis & Futuna.
<i>Helix aspersa</i> Brown snail, the garden snail, l'escrgot petit gris	Common western European species, not suited to the tropics or extremely wet habitats. Common garden pest in Hawaii and does well in drier habitats. Is more of a potential pest. Given its potential for culturing, deliberate introductions are likely. Transport routes are speculative. Sea containers are likely accidental routes as well as smuggling by (air) passengers.	Hawaii, French Polynesia, New Caledonia.	Most are low risk. American Samoa, FSM, Fiji, Guam, Kiribati, Marshalls, Nauru, Niue, Northern Marianas, Palau, PNG, Samoa, Solomons, Tonga, Tuvalu, Vanuatu (possibly high, given trading connections) Wallis & Futuna
<i>Ovachlamys fulgens</i>	Tentative and limited identifications so far. Very much a potential risk at this time. Frequently transported via the orchid trade, from Japan. Has become a dominant species in American Samoa forests. Suggested transport modes are likely to include	Hawaii, American Samoa	Uncertain risk level for most of these countries. FSM, Fiji, French Polynesia, Guam (high via Asian/USA links), Marshalls, Nauru, New Caledonia, Northern Marianas, Palau, PNG,

Species	Likely transport modes	Known presence	Countries at risk
Land and freshwater molluscs			
			Samoa (high, given links to Amer. Samoa), Solomons, Tokelau, Tonga, Vanuatu, Wallis & Futuna
<i>Laevicaulis alte</i> Veronicellid slug	Probably from Africa, now widely spread throughout Asia. Potential impacts on plant communities and as competitor with native snails – yet to be demonstrated. Distribution pattern suggests movements via human activities. These are likely to be via dirt and debris on the outside of containers and on used, imported vehicles and machinery. Also can move with agricultural products.	Hawaii, American Samoa, New Caledonia, Samoa, Vanuatu.	FSM, Fiji, French Polynesia, Guam (high), Kiribati, Marshalls, Nauru, Northern Marianas, Palau, PNG, Solomons, Tokelau, Tonga, Tuvalu, Wallis & Futuna
<i>Pomacea canaliculata</i> Golden apple snail 3 related species in Hawaii – less threatening, but hard to distinguish, incl. <i>Pomacea bridgesii</i> for aquaria use.	Introduced as potential food item, from south-east Asia, where it is a major pest of rice. Rapid breeder, threat in wetlands and freshwater systems – competitor and even predator of native snails. Current limited distribution; but likely to be spread by people deliberately as a food species. Importance of quarantine and public education. Possible transportation (eggs, adults) on containers, used vehicles & machinery. Inter-island transport with agricultural produce or deliberate movement.	Hawaii, Guam, PNG.	American Samoa, FSM (high, based on trade), Fiji, French Polynesia, Kiribati, Marshalls, New Caledonia, Northern Marianas, Palau, Samoa, Solomons, Tonga, Tuvalu, Vanuatu, Wallis & Futuna
<i>Corbicula fluminea</i> Asian freshwater clam – no common name.	Fouls rivers, canals and outcompetes native unionid clams. Potential for major damage in island freshwater ecosystems. Pathways not well described, but has been included as a reminder that some clams can be a significant threat to biodiversity.	Only known from Hawaii – so far. Any Asian clams should be viewed with caution by Pacific island nations.	Countries with strongest trade links to Hawaii – Guam, FSM, Marshalls, American Samoa – are probably most at risk.

5. Summary of Invasive Species Information

Some of the invasive species listed above arrived with the intrepid human settlers who first colonised the vast Pacific. The majority are much more recent arrivals, however, and still others are serious threats that will require considerable vigilance if they are to be prevented from arriving or establishing. The species that are listed vary greatly in their impacts and mode of spread. Many can take advantage of ships, aircraft or vehicles to extend their range and impacts with no further deliberate assistance from people. Many plants and insect species, especially ants, fall into this category. Other species, such as large mammals or freshwater fish, need more deliberate human assistance to invade new territory.

In all cases, human awareness of the risks and potential damage particular species can cause, as well as the capacity to identify, intercept and eradicate or control them, is essential to increase the chances of effective and co-ordinated action. Quarantine, border control and surveillance systems all need to be capable of identifying invasive species that threaten natural ecosystems, as well as the more traditional sectoral pests of agriculture, horticulture and forestry.

What the preceding tables also suggest is that the occurrence of invasives is linked to patterns of main vector routes that were described in the first section of this report. For example, Guam and the Northern Mariana Islands are close geographically and have strong transport links. It is not surprising, therefore, that 50% of the invasive plants found in Guam are also present in the Northern Mariana Islands. Less predictable on the basis of geography is the higher percentage of plant invasives (59%) in the list that are found on Guam, the Federated States of Micronesia as well as the much more distant Hawaii. The strong influence of political, trade and economic links between these three countries is a better predictor of shared invasives than geographical distances.

Other examples can be identified by comparing the preceding tables with the vector analysis information. Hence the importance of analysing vector pathways as an integral part of developing national and regional approaches to building effective biosecurity systems in the Pacific.

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