

Dossier for Verification of Elimination of Lymphatic Filariasis in the Republic of Palau

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Republic of Palau

1. Geography and socioeconomic aspects of Palau

1.1 Location, geography, economy and land use

Location

Palau, sometimes spelled **Belau**, officially the **Republic of Palau** (Palauan: *Beluu er a Belau*), is an island country located in the western Pacific Ocean. It is geographically part of the Western Caroline Islands and stretches from about 2 to 8 degrees north latitude and 131 to 135 degrees east longitude, located about 500 miles east of the Philippines, 500 miles north of Papua New Guinea and 800 miles south of Guam.

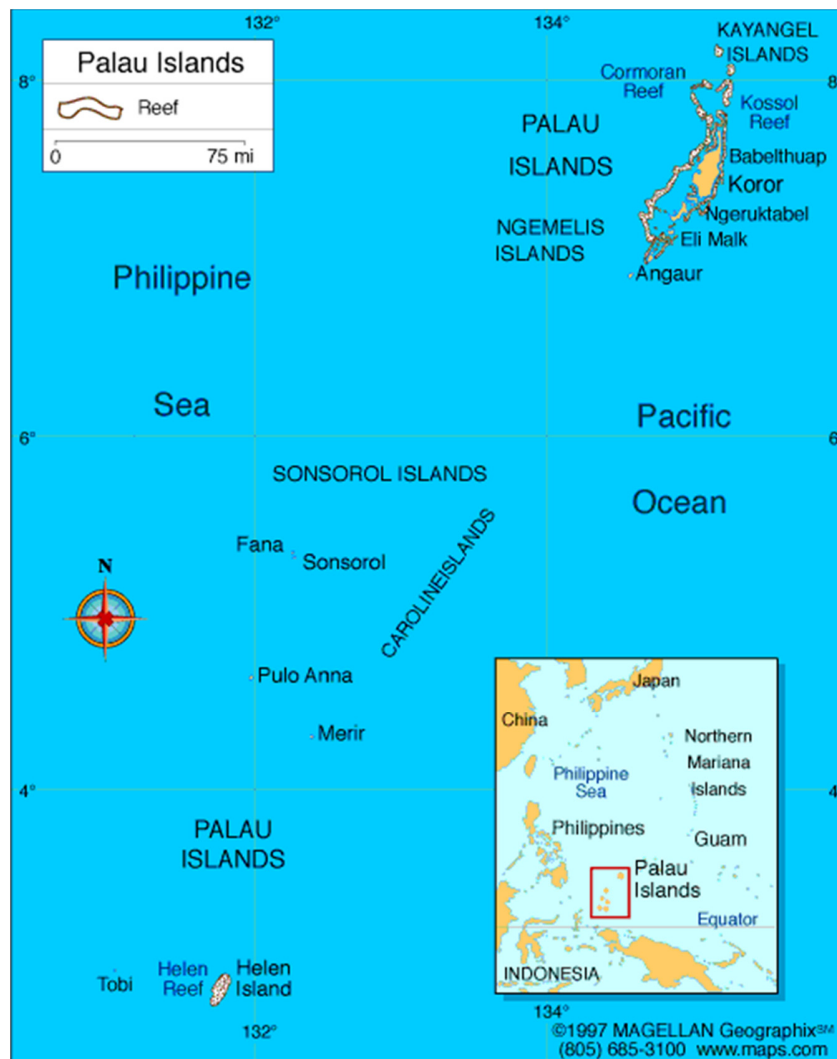


Figure 1 Location of the Republic of Belau (Palau)

Geography

Palau consists of more than 340 islands, 9 of which are inhabited; Kayangel, Babeldaob, Koror, Peleliu, Angaur, Sonsorol, Pulo Anna, Hatohobei, and Helen Reef. Most of the islands are of volcanic origin, and others are atolls. Babeldaob is the largest island, making up 80 percent of the total land area. Ten of Palau's 16 states are on Babeldaob Island, the states of Airai, Aimeliik, Ngeremlengui, Ngerchelong, Ngchesar, Melekeok, Ngiwal, Ngaraard, Ngardmau and Ngatpang. Koror, Kayangel, Peleliu, Angaur, Hatochebei, and Sonsorol are the remaining 6 states.

The Palau land mass covers 188 square miles, including the Rock Islands. Palau maintains its maritime boundary as well an exclusive economic zone extending over 237,850 square miles.

Koror, the most populous state where two thirds of the population resides, has a land area of 7.1 square miles and lies just south of Babeldaob, the largest island, which has 153 square miles of undulating forests, grasslands, rivers, waterfalls, wetlands, mangroves and some of the most beautiful stretches of beaches.¹

Economy

Palau's economy consists primarily of tourism, business, fishing and subsistence agriculture. Business and tourist arrivals numbered more than 118,000 in 2012. Tourist activity focuses on scuba diving and snorkeling in the islands' rich marine environment, including barrier reefs walls and World War II wrecks. Long-term prospects for the key tourist sector have been greatly bolstered by the expansion of air travel in the Pacific, the rising prosperity of leading East Asian countries and the willingness of external programs to finance infrastructure development.

In 2012, 68.1% of the working age population was considered in the workforce, 38% of which were foreign workers. The private sector employs 56% of the workforce and the public sector 34%.²

Palau has one of the highest standards of living among Pacific island countries. Its per capita GDP has increased from US\$159.4 million in 2000 to US \$228.4 million in 2012, making it one of the wealthier Pacific Island States. The living conditions and economy have steadily improved over the years as well. The unemployment rate is 4.1% and the GDP real growth rate, 6.8%.³ The Human Development Index for 2012 was 0.791 and Palau ranks 52 out of 187 countries and territories in the world, placing it in the high human development category. (UNDP Human Development Report 2013).

Because of the improved economic and living standards in Palau, it could be favorably compared to other countries with similar histories, such as China, Japan and South Korea, countries that successfully eliminated LF through public health programs and concurrent environmental and social improvements.

¹ <http://www.palau.gov.net/stats/PalauStats/PhysicalFeatures/phyfeat.htm> Accessed 10/8/2013

² ROP 2012 Census, Ministry of Finance, reported 4/2013

³ Palau Fiscal Year 2012 Economic Review, published 10/1/2013

Land use

Total land area including rock islands is 188 sq. mi (494 sq. km). Arable land is estimated at 10.9% and land with permanent crops approximately 4.35%. The main crops are coconuts, bananas, root crops such as tapioca, taro, vegetables, and tropical fruits. Poultry, pigs, goats and a few dairy cows are the main livestock. In addition, aquaculture ventures produce clams, shellfish and fish. Palau's food supply relies very heavily on imports and food security is a national concern.

Taro, a traditional crop in Palau, can be grown in relatively dry terrain, but most often is grown in swamp gardens.

1.2 Climate

Palau has a maritime tropical climate, warm and humid all year round with a distinct wet season from May to November. The maximum temperatures for Palau range from 85° to 92°F and minimum temperatures are 72° to 79°F. The annual total rainfall ranges from 114 inches to 177 inches, average is 148 inches per year. Average monthly rainfall is 12.4 inches; March is usually the driest month with 8.5 inches and July is usually wettest with more than 17 inches of rain.⁴

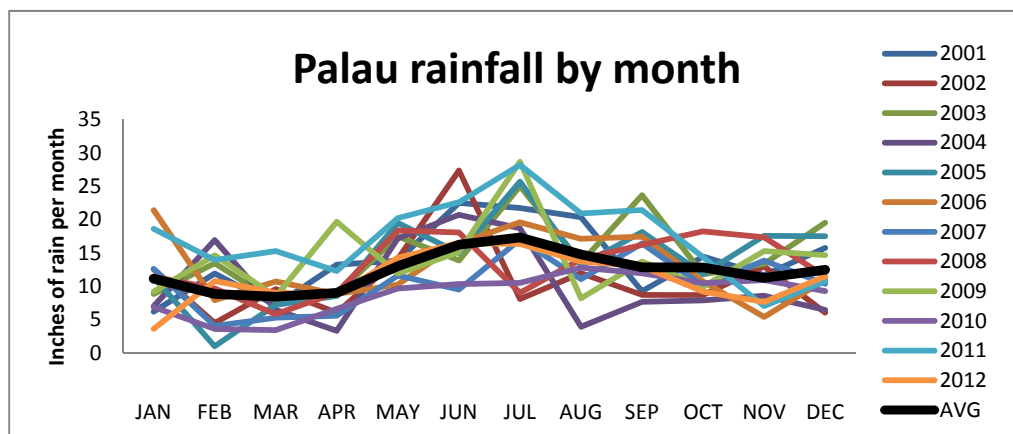


Figure 2 Palau total rainfall by month, 2001-2012)

1.3 History

Palau was originally settled around 4,000 years ago by migrants from the Philippines and sustained a Negrito population until around 900 years ago. The modern population, based on language, may have come from the Sunda Islands (Indonesia and Papua New Guinea). The islands that are now Palau were first visited by Magellan in the 16th century, and were made part of the Spanish East Indies in 1885. Following Spain's defeat in the Spanish-American War in 1898, the islands were sold to Imperial Germany in 1899 under the terms of the German-Spanish Treaty, where they were administered as part of German New Guinea. The Imperial Japanese Navy conquered Palau during World War I, and the islands were later made a part of

⁴ Palau National Weather Service, 10/8/2013

the Japanese-ruled South Pacific Mandate by the League of Nations. During World War II, skirmishes, including the major Battle of Peleliu, were fought between American and Japanese troops as part of the Mariana and Palau Islands campaign. All of these events changed the ecology, flora and fauna of Palau, intentionally by bringing plants for agriculture, changing the face of the land and the use of water for agriculture, and unintentionally by bringing vectors, including mosquitoes.

Along with other Pacific Islands, Palau was made a part of the United Nations Trust Territory of the Pacific Islands in 1947 to be administered by the United States.⁵ As part of its mandate, the US was to improve Palau's infrastructure and educational system in order for it to become a self-sufficient nation. Infrastructure development included improving sanitation and addressing the vector issues, rats and mosquitoes in particular.



Figure 3 Official flag of the Republic of Palau

Palau citizens approved a new constitution and the nation became the Republic of Palau in 1981, signed a Compact of Free Association with the US in 1982, the Compact was ratified in 1993 and Palau gained full sovereignty in 1994.

1.4 Government

Politically, Palau is a Constitutional republic in free association with the United States, which provides defense, funding, and access to social services. Palau is considered a unitary state and non-partisan democracy and the government is comprised of executive, legislative and judiciary branches.

The executive branch consists of the President, Vice-President, and the Council of Chiefs, supported by administrative staff and the Cabinet Ministries. Ministries include State, Justice, Resources and Development, Commerce and Trade, Finance, Health, Education, and Community and Cultural Affairs. The President and Vice-President are elected to a 4-year term.

The Olbiil Era Kelulau (OEK), Belau's National legislative body, is a bi-cameral National Congress made up of the House of Delegates and the Senate. There are twenty-three (23) members of the OEK; sixteen (16) Delegates representing the sixteen states of Belau and nine (9) Senators representing the residential population. Each member is elected to a four (4) year term.

The Judiciary Branch was established in 1981 and consists of the Supreme Court, the Court of Common Pleas and the Land Court. The Supreme Court has trial and appellate divisions and is presided over by the Chief Justice.

⁵Extracted from <http://en.wikipedia.org/wiki/Palau> accessed 10/3/2013

1.5 Demographics

Table 1 Republic of Palau official census statistics

Year	Total population	Male population	Female population
1980	12,116	6,279	5,837
1986	13,873	7,398	6,475
1990	15,122	8,139	6,983
1995	17,225	9,213	8,012
2000	19,129	10,229	9,028
2005	19,907	10,699	9,208
2012	17,501	9,217	8,284

The population of Palau in 2012 was 17,501 and was 73.5% Palauan, 16.0% Filipino and 6.4% other Asian ethnic groups. The decrease in population from 2005 to 2012 is notable; the growth rate from 2005-2012 was negative 1.9%. The decrease between 2005 and 2012 is attributed to a change in the number of foreign workers. Population density is 116/square mile and two thirds (2/3) of the population lives in Koror and Airai States, which are considered urban areas. Average household size is 3.4 persons. Gender distribution is 47% female and 53% male; the number of men is influenced by the number of foreign workers. Twenty percent (20%) of the population are under 15, 73% between 15 and 64 and 7% are 65 and older. The literacy rate for persons 10 and above is 99.5%. (Bureau of Budget and Planning, Office of Planning and Statistics, Government of Palau 2013)

The number of visitors to Palau has expanded during the past 20 years, bringing many more people as tourists, especially from Asia. Since 2004 the number of visitors per year has ranged from about 72,000 in 2009 to more than 118,000 in 2012. The biggest increases have been in visitors from ROC (Taiwan), Japan and Korea. (Palau Visitors Authority, 2013)

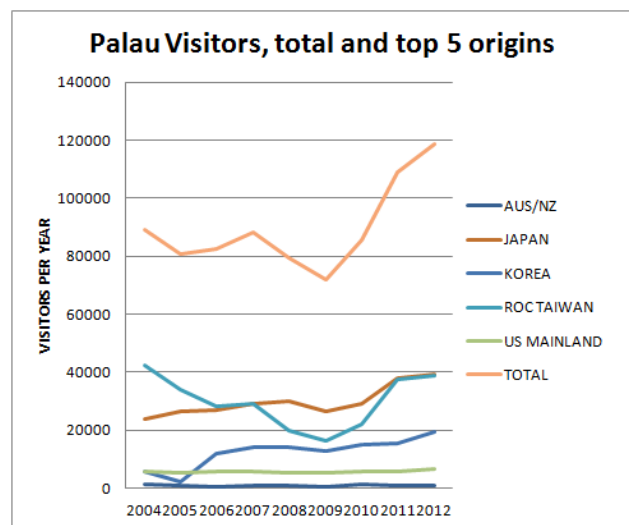


Figure 4 Visitors to Palau 2004-2012, excluding workers (Palau Visitors Authority)

Foreign nationals from working in Palau are not included in the visitor total. Foreign workers from LF endemic areas come primarily from the Philippines, Micronesia and Bangladesh.

1.6 Health indicators

Table 2 Palau Health Indicators

Indicator	Value
Life expectancy at birth (years)	72.1 (2012)
Health index	0.822 (2012)
Crude birth rate/1000 population	15.3 (2012)
Crude death rate/1000 population	9.3 (2012)
Total fertility rate (women age 15-45 years)	2.2 (2012)
Infant Mortality Rate	7.5 (2012)
Probability of dying under 5 (per 1000 live births)	18.6 (2011)
Expenditure on health, public (% of GDP) (%)	7.9 (2012)
Total expenditure on health per capita, US\$	\$ 930 (2011)
Number of General hospitals	1 (2012)
Number of Primary health care centers	5 (2012)

Sources: Palau 2012 census, 2012 UDS Data Report, ROP Fiscal Year 2012 Statistics, MOH HPRD statistics, UNDP 2013 Human Development Report

People in Palau are at risk for various hazards, including uniquely high hydrometeorological and geological risk, e.g., typhoons, tsunamis, earthquakes. Because of its nearness to Asia and the increasing number of tourists, Palau is also vulnerable to infectious hazards emerging in Asia, such as novel influenzas and SARS.

1.7 The health system

Health for all is a top priority for the government of Palau and within the Ministry of Health (MOH) vision of a Healthy Palau in a Healthful Environment, Risk and Disease Prevention are core elements. The Ministry of Health (MOH) has two Bureaus, Hospital and Clinical Services and Public Health. MOH is supported by Palau government funding, grant funds from Japan and the US, and technical assistance from the US, Japan, Australia, WHO and other agencies. In addition Palau has 3 private medical clinics and one private dentist.

Belau National Hospital is the main health care facility in the country and only hospital. Four community health centers, known as super dispensaries, are located strategically throughout the country. In addition, four additional satellite dispensaries serve hard-to-reach outlying localities. According to estimates in 2010, the health worker-to-population ratio in Palau was 1:714 for doctors, 1:179 for nurses, and 1:10 000 for dentists. The Palau Board of Health Professionals licenses health care professionals.

In 2005 the Ministry of Health adopted a Reportable Disease Policy, supported by the Reportable Disease Surveillance System (RDSS), which requires reporting of 29 specific infectious diseases. Lymphatic filariasis is designated a reportable disease in Palau and any case identified clinically or through laboratory results must be reported and investigated.

2. Historical information on lymphatic filariasis (LF) in Palau

2.1 Early evidence of LF in Palau

In the mid 19th century by Queen Isabel II sponsored a young Palauan man, Aulokope, to go Spain. A photograph of Aulokope, the earliest known picture of a Palauan, was taken in Cadiz, Spain in October 1863 (Palau National Museum). While it's not known definitely if he had filariasis, swelling in his right foot in the photograph is suspicious.

2.2 Filariasis vector

Surveys done on the distribution of mosquitoes in the in the early part of the 19th century identified *Culex quinquefasciatus (fatigans)* as present on virtually every island in the Pacific. Kessel and Massal (1961) assert that transmission of bancroftian filariasis in Micronesia is mainly by members of the *Culex pipens* complex, mostly *C. quinquefasciatus (fatigans)*. In other places, particularly in Asia, *Aedes aegypti* and *Aedes albopictus* are the primary vectors.

Recent mosquito identification activities in Palau listed 23 mosquito varieties, four of which affect humans (*Aedes scutellaris*, *Aedes albopictus*, *Aedes aegypti*, and *Culex quinquefasciatus*).

The Palau Division of Environmental Health (DEH) routinely surveys at sentinel sites around Palau, mostly on Koror, and reports the numbers and species of mosquito larva and pupa. In 2012, *Aedes* species accounted for 93% of species identified, of those only 25% were a species affecting humans. *Culex quinquefasciatus* accounted for 7% of the mosquitoes identified. Mosquito density is usually highest during the rainy months, dropping dramatically during the drier months.

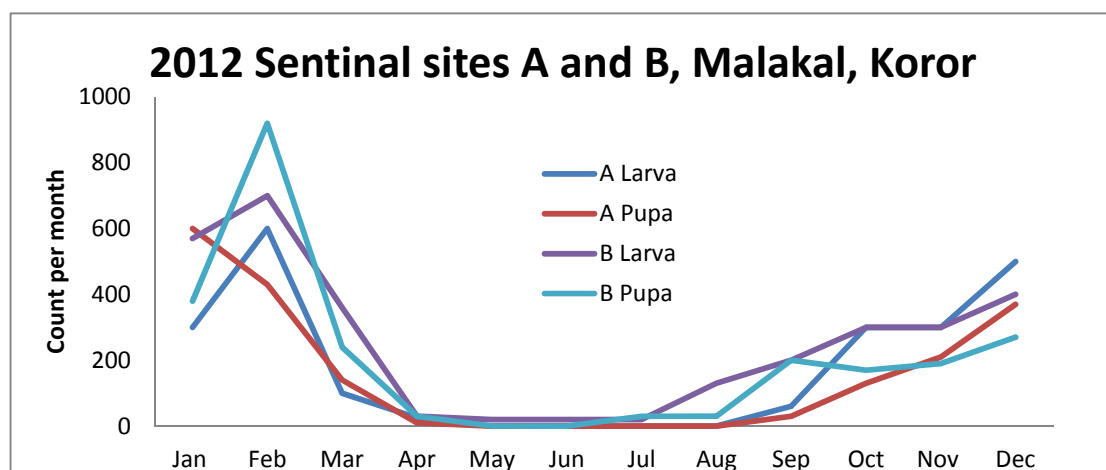


Figure 5 Mosquito larva and pupa count, selected sentinel sites, 2012, Koror, Palau

The Breteau Index, used to calculate risk of transmission of mosquito-borne diseases based on the number of positive containers inspected, in 2012 showed a low level of risk of transmission of disease for *C. quinquefasciatus* (<5 is considered a low risk of transmission).

Table 3 Mosquito species identified in Palau and Breteau Index, 2012

Mosquito Species	Breteau Index
<i>A. aegyptii</i>	1.9
<i>A. albopictus</i>	3.9
Other <i>Aedes</i>	22.0
<i>Anopheles</i>	0.0
<i>C. quinquefasciatus</i>	1.9

Source: DEH Mosquito Larval Summary Report Ngermid/Iyebukel/Ngerkebesang, Koror 2012

In addition to the sentinel site surveys, DEH annually inspects every house in the country as part of the Community Health Program which promotes the control of health risks, focusing on vector and rodent control as well as sanitation, water supply and general safety. Any household can request assistance from DEH for environmental questions or problems and will receive an assessment and aid in addressing the issue. If a household or neighborhood notices an increase in mosquito activity, they are quick to call.

As part of DEH protocol, whenever a case of dengue is reported, DEH teams conduct a house inspection, 200 yard perimeter inspection for vector habitat and a spraying program both inside and outside the dwelling. The program has the added benefit of controlling mosquitoes that could be carrying LF.

2.1 Historical lymphatic filariasis intervention measures in Palau

Wuchereria bancrofti is responsible for 90% of all human lymphatic filarial infection (Vythilingam) and is the form of filariasis in Palau.

According to a survey carried out in 1953, the microfilaremia (Mf) rate in villages ranged from 0.0% to 37.3%, with an average rate of 24.2% (Table 4) (Pipkin, 1953 cited in Sasa, 1976).

Table 4 Mf prevalence observed in different villages in Palau, 1953

Village	Number of people examined	Mf rate (%)
Tobi	81	0.0
Sonsorol	59	0.0
Angaur	102	1.0
Peleliu	108	16.6
Kayangel	74	23.0
Babeldaob	510	37.3
Koror	158	24.1

Retired public health nurses reported that by the mid-1960s, due to bed net use and treatment of patients tested during routine exams for employment, school and travel, the number of cases had declined.¹ The reported MF rate in 1967 was 12.6% (Dazo, 1978).

With technical assistance from WHO, a mass drug administration (MDA) program was conducted from 1970-1971, directed by the Director of Public Health, Dr. Tony Polloi, and administered by each municipality. DEC was administered at the dose of 5 mg/kg body weight at two month intervals for a period of 2 years (WHO/SPC, 1974).

Following the MDA, a post-treatment survey using nocturnal blood sampling demonstrated that the Mf rate was 0.3% (n=1000) (WHO/SPC, 1974). Those who tested positive were treated using the standard DEC protocol. Cases were reported in Ngarchelong, Ngardmau and Koror. Routine

screening continued for travelers and employment and any patients suspected of being infected would have been tested and treated.⁶

3. The Pacific programme to eliminate lymphatic filariasis (PacELF)

The World Health Assembly adopted Resolution WHA 50.29 in 1997, which called on Member States to initiate steps to eliminate lymphatic filariasis as a public health problem. At that time there were 25 countries endemic for LF in the WHO western Pacific region, 23 of which were in Oceania and island countries. In 1999, WHO launched the Pacific Programme to Eliminate Lymphatic Filariasis (PacELF) as the Pacific arm of the Global Programme, which aims to eliminate lymphatic filariasis (LF) as a Public Health problem by 2020. Palau is one of 22 nations participating in PacELF.

3.1 Base-line surveys (2001-03)

Following the guidelines of PacELF, Palau initiated collection of baseline data to determine if MDA was necessary for the country. Surveys to assess the current level of LF in Palau were carried out from 2001 - 2003, shown in Tables 5 and 6. A baseline antigenaemia (Ag) prevalence survey was carried out in the year 2001. A total of 2,031 people from 14 states were assessed and 9 were found to be positive. The overall Ag prevalence rate was 0.4%. Notably, all nine positive persons were detected in one state, Ngardmau. On the basis of this result, the country was classified as partially endemic.

Table 5 Summary of results of Ag surveys in Palau, 2001

Survey Dates	Surveyed location	Diagnostic test used	Sampling method	Number examined	Number positive	Ag prevalence rate (%)
June-September 2001	12 States	ICT card	Convenience	1973	1	0.05
June-September 2001	Ngardmau state	ICT card	Convenience	29	8	27.59
June-September 2001	Ngchesar state	ICT card	Convenience	29	0	0.00
Total				2031	9	0.44

Following the 2001 surveys, two additional Ag surveys were carried out in 2002 and 2003, surveys of Ngardmau, Ngchesar and Sonsorol. The results of all the surveys carried out between 2001 and 2003 are summarized in Table 6. The common features of these surveys were 1) assessing Ag prevalence using ICT cards, 2) using mostly convenience sampling and 3) Ag positive individuals detected only in one state, Ngardmau.

⁶ Interview information from retired public health nurses, 9/25/2013

Table 6 Summary of results of Ag surveys in Palau, 2001-2003

Survey Dates	Surveyed location	Diagnostic test used	Sampling method	Number examined	Number positive	Ag prevalence rate (%)
2001	16 states	ICT card	Convenience	2031	9	0.44
November 2002	Ngardmau state	ICT card	Convenience	131	3	2.29
December 2002	Ngchesar state	ICT card	Convenience	141	0	0.00
June-July 2003	Southwest Islands	ICT card	Convenience	98	0	0.00

3.2 Intervention measures

All individuals who tested Ag positive in the 2001-2003 surveys were followed up by Public Health nurses and given treatment at yearly intervals between 2001 and 2008.

Inasmuch as the baseline survey in 2001 showed a very low prevalence of filariasis antigen (0.4%) and a geographical cluster of positive cases, it was decided to employ a Test and Treat strategy in Palau rather than conduct yearly Mass Drug Administration (MDA) as originally planned through the PacELF program. Because no additional cases have been identified in recent years, the LF program has had no ongoing activity.

4. Palau National Lymphatic Filariasis Prevalence Survey (2012)

In 2011 the Palau Ministry of Health, in consultation with PacELF, decided to carry out a nationwide prevalence survey in order to determine the current LF status. Based on previous prevalence rates and the location of the previous cases, the survey was designed as follows:

- A) Conduct a national prevalence survey in all states, except Ngardmau and Ngchesar, using randomly selected households.
- B) Conduct a stratum of census (referred to here as a 'blanket survey') of all households in the state of Ngardmau and also in the state of Ngchesar. The reasoning for blanket surveys in these two states was that they were similarly surveyed in 2002 and the data could be compared. Also, Ngardmau state was identified as a hot spot based on the 2001 and 2003 surveys and it was important to determine if there were any existing cases as well as check on those who had completed treatment previously. An additional benefit was to be prepared to do focalized interventions if cases were detected.

The Palau Institutional Review Board approved the survey 8 May 2012.

The Palau National Lymphatic Filariasis Prevalence Survey was conducted 1-28 June 2012.

WHO staff provided technical assistance throughout the planning and implementation of the field activities.

4.1 Selection of households

The calculated sample size for the National Prevalence Survey was 1,925, based on Lot Quality Assurance Methods (the design effect is 1.25). The aim was to survey all household members age 5 years and above in randomly selected households in all states except in Ngardmau and Ngchesar (where all houses were included for testing). Average household size was assumed to be 3.5 persons, which would yield 1,925 participants.

Households to be sampled (n=683) were selected from the Palau 2005 census. Of the 16 states in Palau, 15 were represented in the household list. Because of the nature of the random sample, the small state of Hatothobei was not included in the sample.

4.2 Survey teams

Survey teams were formed from staff drawn from the Ministry of Health, particularly the Bureau of Public Health. A total of 12 teams were created with 3 members each. An expert from WHO conducted a training program on 4 June 2012. The training covered a) conducting the ICT card test, and b) completing the household log sheets. The teams were assigned states and hamlets to survey and provided with maps showing location details.

Teams traveled to the states by car (Koror and states on Babeldaob) or boat (Sonsorol, Angaur, and Peleliu).

4.3 Survey implementation

Surveys were carried out throughout the week and during daytime and evenings, weekdays and weekends. The teams visited the households according to a schedule announced by the Ministry of Health through distribution of flyers, newspaper announcements, radio spots and TV spots. Preceding the actual survey, teams visited the areas and located the households and informed the members about the survey. Teams had to make as many as 7 visits to some households to sample all the family members. Details of these visits were recorded on the household log sheets.

4.4 Diagnostic test

The WHO supplied BinaxNOW ICT test cards to use to determine the Ag status of the participants. Teams learned the standard testing procedure provided by the manufacturer, practiced the procedures during the team training and following standard procedures, conducted the tests in the field. The test kit lot number was validated during training.

4.5 Eligibility

Members of the selected households 5 years old and older were eligible for testing.

4.6 Consent

Each household member age 18 and older provided written consent prior to collection of the personal information and the blood sample for ICT card test. Children 5-17 years old provided assent and a parent or guardian provided written consent.

4.7 Survey results

Surveys were carried out in 13 out of the 16 states. No surveys were carried out in 2 of the states that had households selected, Kayangel and Sonsorol. In Sonsorol, an atoll of 4 sq. km, the only selected household was found vacant. The teams could not travel by boat to Kayangel due to bad weather. No households in Hatohebei state were selected during the randomization process.

Interviewers recorded the number of inhabitants in the household (n=2294) and information on each person identified by name (n=2227); no information was collected on 67 inhabitants (3%).

The teams approached all eligible persons in a household about participating in the study. In some households not every person was identified by name or refused to give their name, meaning a person could be counted in the overall household number but not counted in the individual response records.

In the 13 states surveyed, a total of 683 households were identified for the survey. Of those 583 households were sampled (Table 7). The reasons for not being able to sample the remaining 100 households are given in Table 8. Almost 60% of the households not sampled were found vacant, probably because the families migrated to urban areas or abroad since the 2005 census. The number of houses contacted per state ranged from 5 to 313 (Table 9).

In the states Ngardmau and Ngchesar, 51 and 67 houses were identified respectively for inclusion in the blanket survey.

Table 7 Number of houses sampled in Ag surveys in Palau, 2012

Number of households selected	683
Number of households sampled	583
Number of households not sampled	100

Table 8 Reasons for not sampling some households in Palau, 2012

Reason for not sampling	Number of households
Refused to be sampled	7
Houses found vacant	59
Nobody available at the time of visits	12
Houses with selected number do not exist	13
Others	9
Total	100

Table 9 Number of houses contacted and number of household members consented to participate in LF study, 2012

State	Number of households contacted	Total number consented
Aimeliik	13	41
Airai	53	163
Angaur	6	22
Koror	313	1170
Melekeok	23	72
Ngaraard	13	28
Ngarchelong	12	38
Ngardmau	51	149
Ngatpang	5	15
Ngchesar	67	165
Ngeremlengui	11	33
Ngiwal	8	24
Peleliu	15	49
TOTAL ALL	590	1969

The total number of people living in the 683 sample households was 2,294. Of them, 2,124 were present and could be contacted and explained about the surveys. Of the 2,124 contacted, 1,969 gave consent for the survey and blood sampling and 1,963 were actually sampled. Tested participant ages ranged from 5 to 104 and were balanced between male and female.

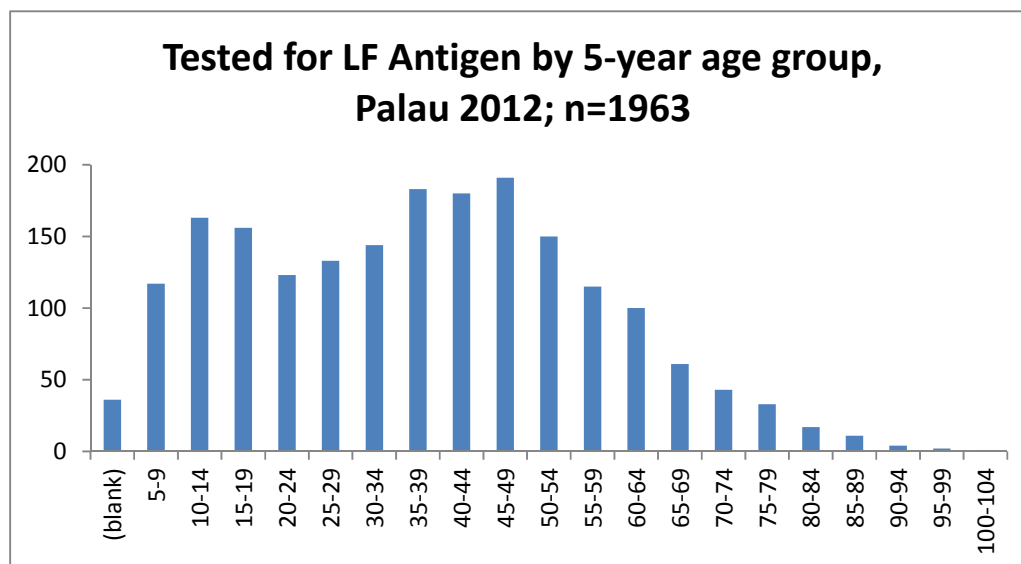


Figure 6 Number tested by 5-year age group

The number of people per state tested ranged from 15 to 1167 (Table 10). Positive cases were found in only one state, Ngardmau.

Table 10 Number tested by state and result with state population age 5 and above, 2012

State	Number examined	Proportion positive (%)	# in state age 5 and over **	Proportion tested
Aimeliik	41	0	262	15.7%
Airai	162	0	2,367	6.8%
Angaur	22	0	120	18.4%
Koror	1167	0	10,918	10.7%
Melekeok	71	0	281	25.2%
Ngaraard	27	0	416	6.5%
Ngarchelong	38	0	262	14.5%
Ngardmau	149	2 (1.34)	180	82.9%
Ngaremlengui	33	0	279	11.8%
Ngatpang	15	0	246	6.1%
Ngchesar	165	0	266	62.0%
Ngiwal	24	0	206	11.7%
Peleliu	49	0	448	10.9%
TOTAL	1963	2 (0.10)	16,251	12.1%

**data from 2012 Palau Census

In Ngardmau State 83% of the population age 5 and over was tested and the Ag prevalence was 1.34% (population, n=180; tested, n=149; positive cases, n = 2).

The two Ag positive persons were men aged 34 and 52, both from the same household in the hamlet of Ngetbong. Following the study protocol, they were tested a second time with the ICT test; no other testing was conducted on them.

The household consists of 5 adults, 4 men and one woman. All other members of the family tested negative. One member of this household that had been found positive in the 2001 survey was treated following WHO guidelines annually for 6 years (2001-2006). That person was not tested in 2012. Of the 13 people who tested positive in the 2001-2003 surveys, 7 were tested again during the 2012 survey; all were negative.

4.8 Treatment

Those who tested positive for filariasis antigen were treated immediately with a single dose of albendazole (400 mg) plus the appropriate number of 50 mg diethylcarbamazine (DEC) tablets indicated by the person's weight (6mg/Kg body weight). The Survey Team enrolled them in the Communicable Disease Unit (CDU) clinic program and they are scheduled for annual treatment of albendazole plus DEC for 5 more years (2013-2017).

4.9 Vector assessment

The Division of Environmental Health (DEH) conducts annual inspections of every home in the country looking for vector breeding sites and assessing mosquito levels. The household was inspected during 2012 as part of the DEH Community Health Program sanitation and vector control activities. Overall the state of Ngardmau received a score of 90% in the 2012 DEH community inspection and review; the average score across all states was 93%.

5. Response

5.1 Treatment

All survey Ag positive persons are enrolled in an ongoing treatment program and treatment will continue for 5 additional years. The patients have already received at least one medication dose reducing, if not eliminating, their infectivity.

5.2 Vector control

DEH will continue regular inspections in Ngardmau as in all states of Palau, including this family home and environs. There is no routine mosquito surveillance in Ngardmau but DEH quickly responds to reports of higher than usual numbers of mosquitoes. In addition, any cases of dengue are immediately investigated and DEH has prescribed protocols for vector determination and spraying.

Palau is home not only to the recognized vector of LF, *C. quinquefasciatis*, but also to *A. aegypti* and *A. albopictus*, both of which are LF vectors in other countries. All efforts to control mosquitoes have a positive effect on reducing the possibility of LF recrudescence in *C. quinquefasciatis* as well as on the possibility of transference to another vector.

5.3 Population mobility

Ngardmau State is on the northwest side of Babeldaob Island and about 20 miles away from the population center in Koror. The state is rural, mostly savannah, and contains Palau's largest rain forest in the shadow of Palau's tallest mountain, Ngerchelchuus. Although seemingly distant from the population center, because of good road access many people travel to and from work in other states each day.

5.5 Immigrant population

There is no routine LF screening of visitor or immigrant workers coming to Palau. The vast majority of tourists (Japan, Taiwan and Korea) are not from LF endemic areas.

Many of the immigrant workers are from endemic countries and it would be possible to bring LF to Palau. Although every worker in the private sector is required to submit a health form within 2 weeks of arrival, the form does not include screening for LF. Employment in the public sector

has no specific health requirement other than whatever is specified as a condition of employment.

In 2012 16% of residents in Palau were from the Philippines and 1% from Bangladesh.

5.6 Effects of climate change

Thai and Anders explored the role of climate change on dengue and concluded that there is little published evidence indicating a direct effect of climate change on the increased distribution and magnitude of dengue transmission. They conclude there is much more evidence that connectedness between areas that already have dengue and the rest of the world, the ease with which vectors have been spread around and population migrations have a stronger effect. (Thai and Anders, 2011) Using the same logic for assessing the effects of climate change on LF is plausible. The factors of human migration and potential transport of vectors are already evident in Palau's history and could readily be the factors that contribute to the possibility of re-introduction of LF into Palau.



Figure 7 Babeldaob Island with states

6. Has interruption of LF transmission and elimination of LF as a public health problem been achieved in Palau?

6.1 Factors favorable to the successful elimination of LF as a public health problem in Palau

- While many states in Palau showed high Mf prevalence in 1953 (up to 37.3%), in 2001 only one state showed high Ag prevalence and all other states showed <0.5% Ag prevalence. The decline since the 1950s can be attributed to the rounds of DEC in the 1970s and environmental interventions during the 60s through the early 2000s.
- An increased standard of living and improved housing conditions that facilitated the reduction of human-vector contact have undoubtedly contributed to this declining trend. Continued improvement in housing conditions and living standard will reduce human-vector contact and negate the chances of LF resurgence.
- With a very low Ag prevalence the chances of microfilaraemia are also very small, making the probability of LF transmission very unlikely.
- The LF Ag survey of 82% of the households in Ngardmau, the only historically endemic state, was concentrated and ample to able to detect the Ag positive individuals.

6.2 Summary of the evidence for interruption of transmission and elimination of LF as a public health problem

- The prevalence of Ag in all tested states except Ngardmau is 0%, below the 2.0% threshold level defined by WHO for *Culex* transmitted LF (WHO, 2012)⁷.
- The prevalence in the only endemic state is only 1.34%, also lower than the 2.0% WHO threshold (WHO, 2012).
- The national prevalence survey was robust in terms of covering nearly the entire nation, using multiple survey approaches and achieving an adequate sample size for each survey modality (blanket and random).
- Annual treatment of the detected Ag positive cases will eliminate them as sources for re-infection.
- Annual environmental inspection of household premises, particularly in Ngardmau, will reduce and/or eliminate any reservoir of vectors.
- Palau has a very low probability of reemergence of filariasis.

⁷ In areas where *W. bancrofti* is endemic and *Anopheles* or *Culex* is the principal vector, the target threshold is <2% antigenaemia prevalence. P47

7. Other anti-helminth activity that supports absence of LF transmission

7.1 Soil-Transmitted Helminths (STH)

Historically the soil-transmitted helminths in Palau were *Ascaris lumbricoides*, *Trichuris trichuria*, and very rarely, *Necator americanus*. During the Trust Territory period travelers going off-island and all government workers and food handlers were routinely screened and treated. With the beginning of the Head Start program in 1968, as part of the enrollment process the children had stool samples tested; if positive, they received treatment. Others were treated if tested and/or symptomatic.

7.1.1 Pediatric de-worming program

In 1978 a program to address the parasite load of children was started through the pediatric clinics at MacDonald Memorial Hospital. Pediatric patients received blood and stool checks and those testing positive were treated with piperazine (Anypar). The program did not have a baseline survey; the clinical presentation of children with failure to thrive and the occasional child with an abdominal mass prompted action. The philosophy was to check only those with symptoms, particularly pre-schoolers.

The treatment philosophy changed to programmed de-worming of all children when it was evident that the children were being re-infected. After that all children age 2 and above were treated every 3-6 months, the treatment interval being based on the life cycle of *Ascaris*.

7.1.2 School-based de-worming program

In 1981 a school-based immunization and health program was started in the schools. Along with immunizations and fluoride treatments, students were treated with antihelminths and given hygiene education that included instruction on hand washing and keeping nails clean, wearing shoes, washing food before preparation and using the benjo (outhouse) rather than the jungle. Based on a zero positivity rate in stool samples from the students, the program concluded in 1987.

7.1.3 Current level of STH infection

All food service workers are tested annually but there is no other regular STH screening program active. According to recent laboratory records at Belau National Hospital, 4-5 patients a year are diagnosed with STH.

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