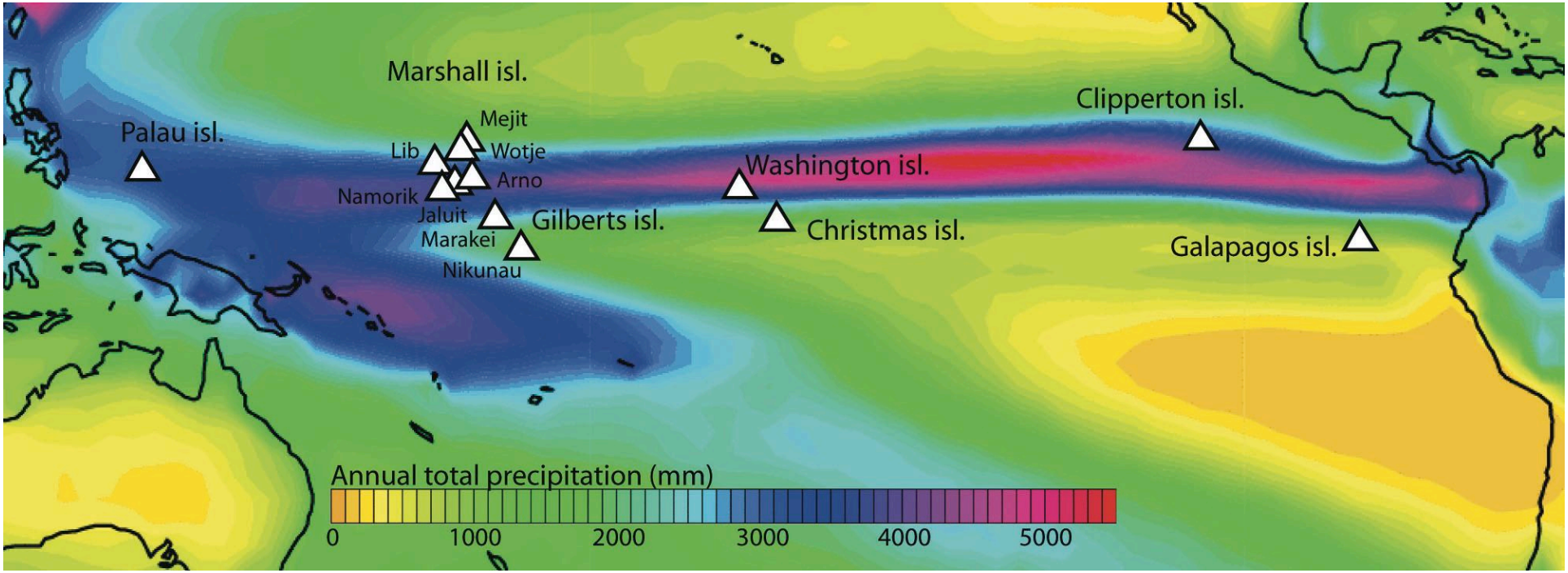
Planning an Expedition to the Marshall (& Gilbert) Islands

PCC 586A

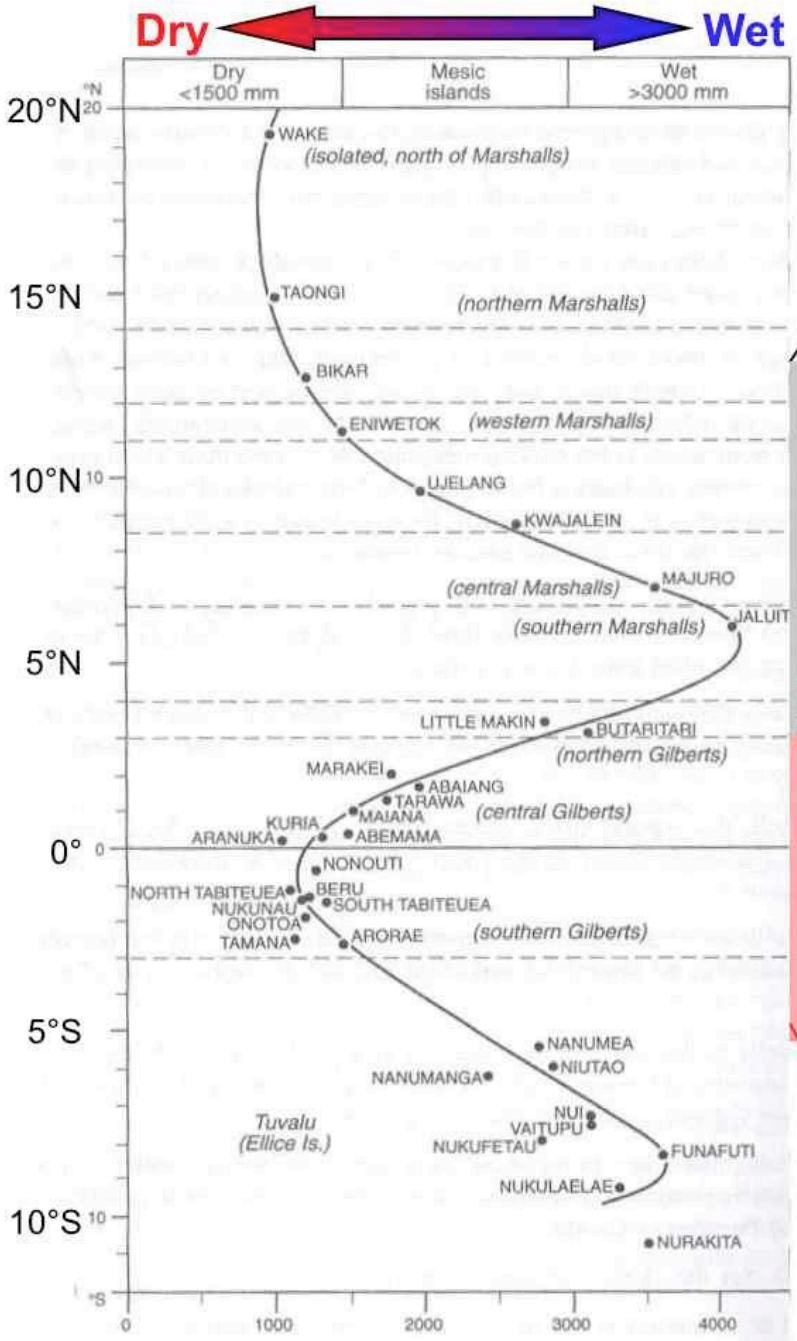
Winter Qtr. 2008

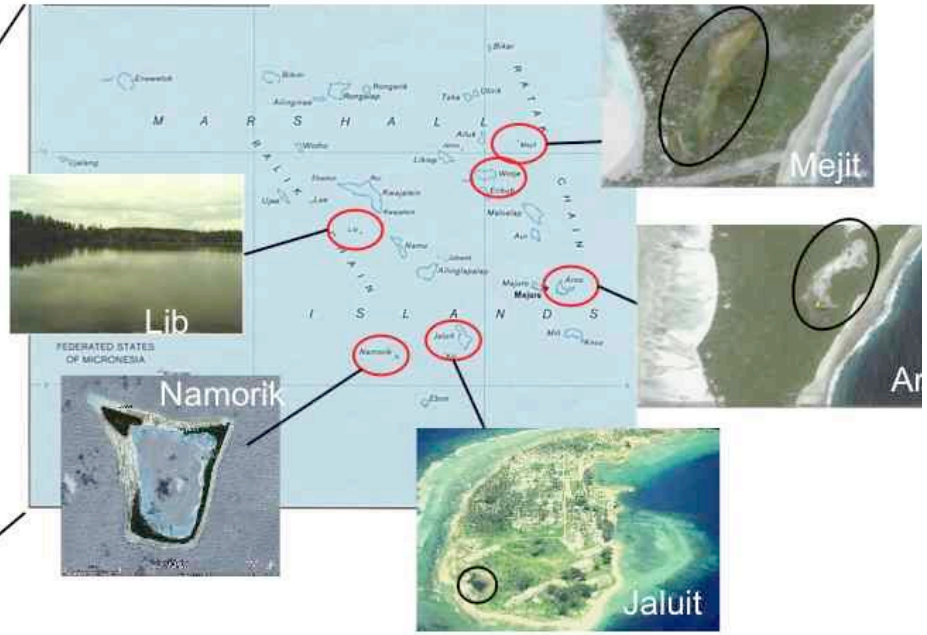
Toward a Prioritized List of Targets

Tracking the ITCZ Through Time

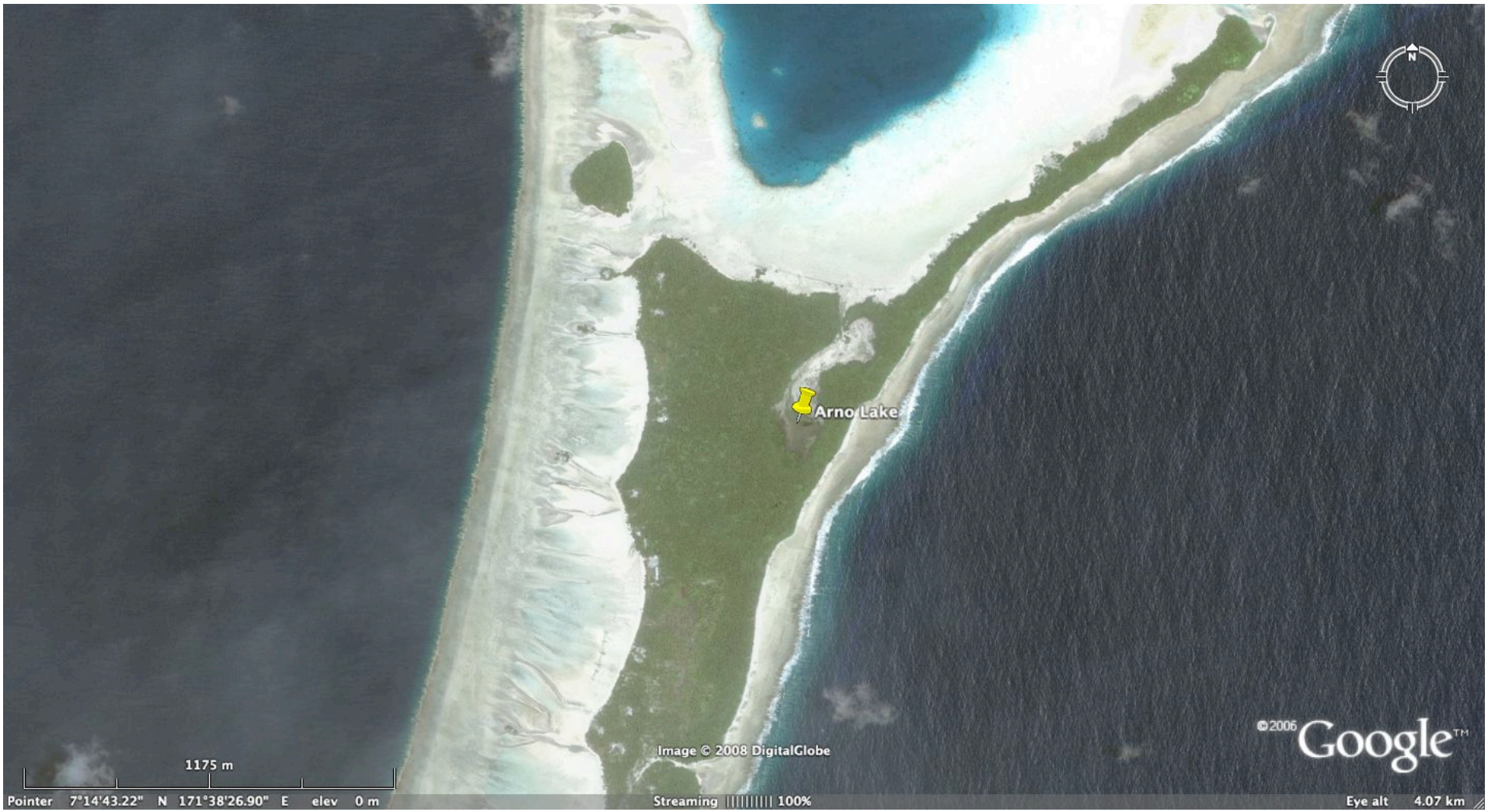


Best Options thus far based on location (annual rainfall) & lake/lagoon



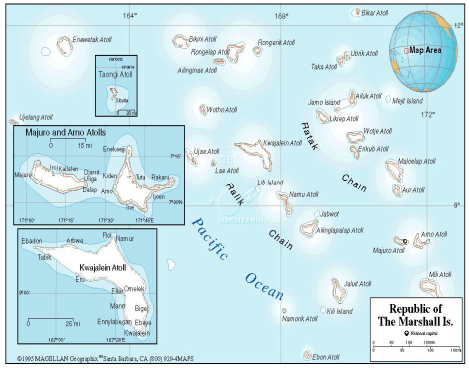


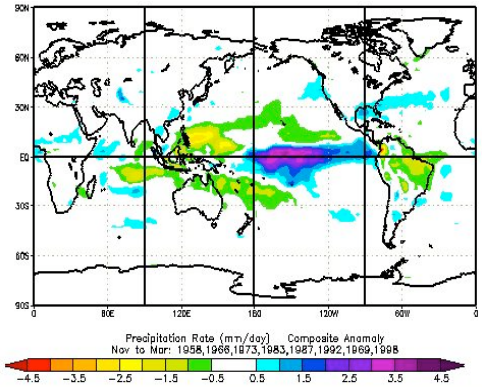
Arno at 7°N fills an important gap: Lake/Swamp?

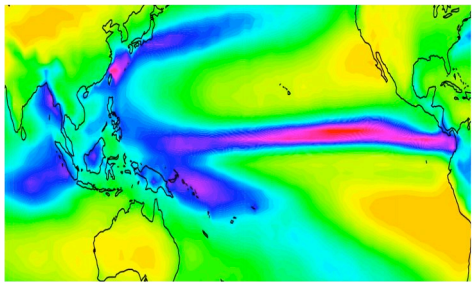


Arno Lake/Swamp - images-2

Winter '08 PCC Seminar: "Planning an Expedition to the Marshall Islands"







Prof. Julian Sachs, OCEAN 586A, 2 Credits

- We will plan an expedition to core lakes, bogs & lagoons in the Marshall Islands for the purpose of reconstructing hydrologic changes during the last 2,000 years, including ENSO & ITCZ.
- Questions & Objectives:
  - What are the best locations to core so that we sample the full range of climate?
  - Identify suitable lakes, bogs &/or lagoons to core
  - Make local contacts to help facilitate the fieldwork
  - Identify & solve logistical hurdles getting our crew & gear around the islands
  - What permits are required? How to obtain?
- 1+ students may be able to participate on the expedition (Spring or Summer 2009)
- Enrollment limited to 12. One 2-hr mtg/wk.
- 1st Meeting: Thurs. 1/10/08, 3:00 PM, OSB 425

Outline for Today

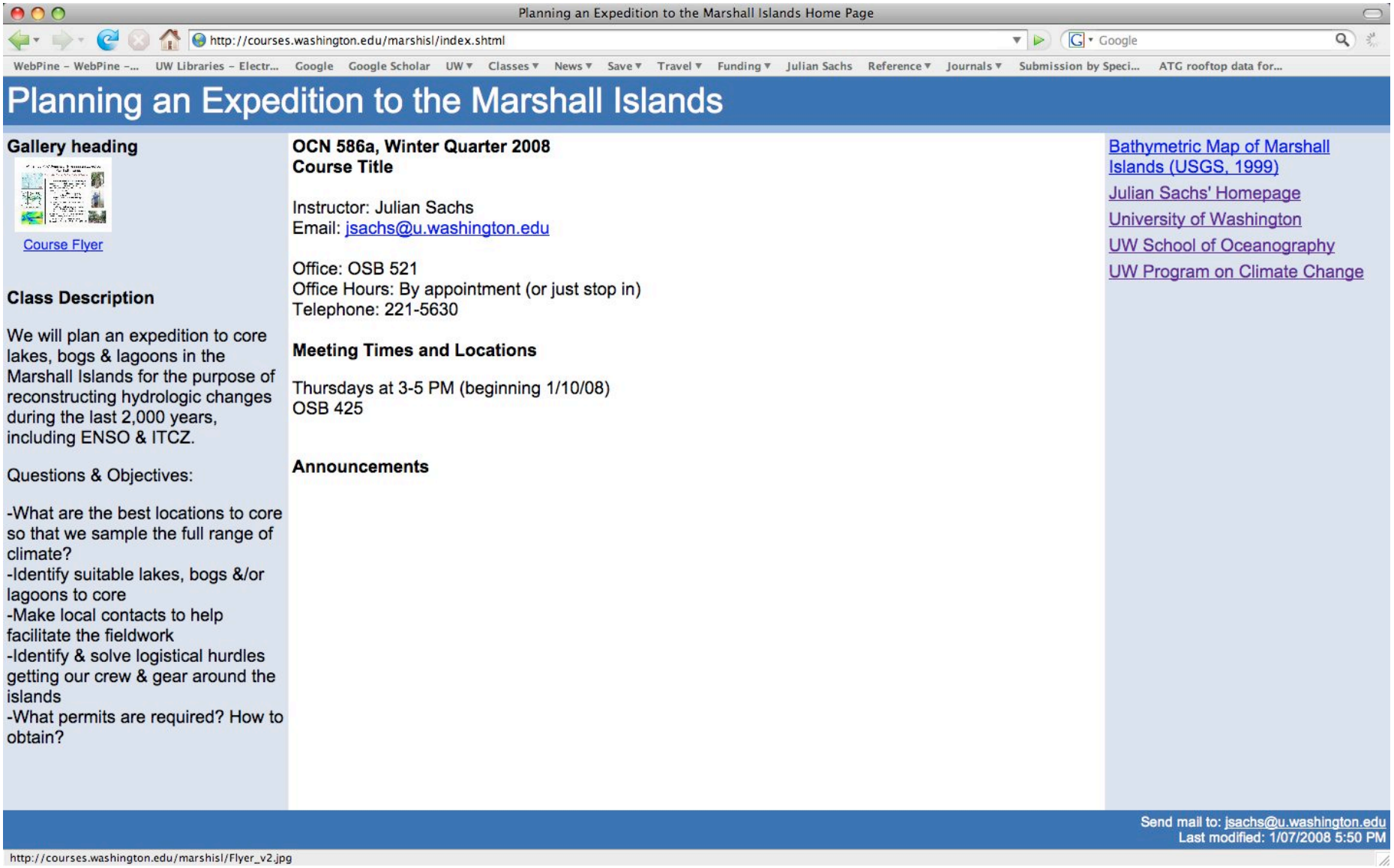
- Introductions
- Course overview & expectations
- 20-min presentation (AGU 12/07 talk)--context & motivation for the expedition & this course
- Overview of the Marshall Islands & where the expedition planning stands now

Introductions

Course Organization & Expectations

- Meet Thursdays 3-5 pm in OSB 425
  - Thursday Feb 21st is last meeting (due to Clipperton expedition)
- Course website: http://courses.washington.edu/marshisl/index.shtml
- Conduct web-based & literature research, plus correspondence, & report back to group each week --> 4 working groups
  - **Weekly report** should be in Powerpoint for editing by others
  - Weekly reports to be uploaded to course website, along w/ articles, maps, correspondence, etc. from each group
- Each working group to write a **final report** with distilled findings
  - Format to be an action plan
  - Length based on nature of the findings, but w/ sufficient detail to move forward with expedition planning (*ca*. Summer '09)
- 1+ particiapnts in seminar expected to go on expedition, pending fiunding ($1,000 already committed by QRC)

Course Website



http://courses.washington.edu/marshisl/index.shtml

Working Groups

1. **Climate & meteorology**
   - Seasonal, annual & inter-annual T, rainfall
   - ENSO & monsoon impacts
   - Modern ITCZ range
   - Historical climate data & Paleo records
2. **Northern RMI Targets**
3. **Southern RMI Targets**
4. **Logistics**
   - Permits (what is needed, how to obtain)
   - Travel within RMI (flights--commercial & charter, airstrips, boat charters, vehicle rentals, etc.)
   - Local involvement (RMI gov't., NGOs, schools, etc)
   - Outfitters, supply shops (e.g., wood, piping, tubing, tools, etc.)

Motivation for this Work

20-Minute Talk from AGU Meeting
in San Francisco

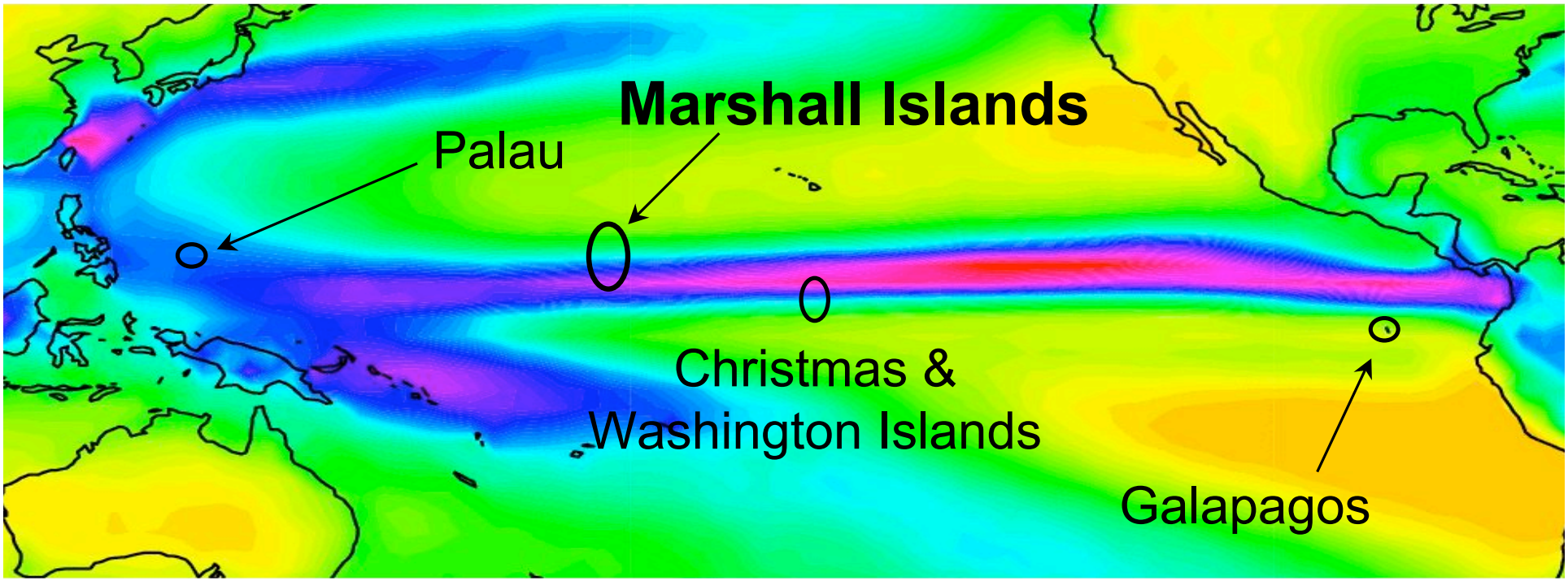
Dec. 12, 2007

Motivation for this course & expedition

Now we want to confirm that:

1. The **ITCZ** was **SOUTH** of its present location during the **LIA** (1400-*1800* A.D.)

2. & **NORTH** of present location during **MWP** (800-1300 A.D.)



Wallace, Mitchell & Lau: Legates/MSU Mean Annual Rainfall '79-'96, http://jisao.washington.edu/legates_msu/

Motivation for this course:

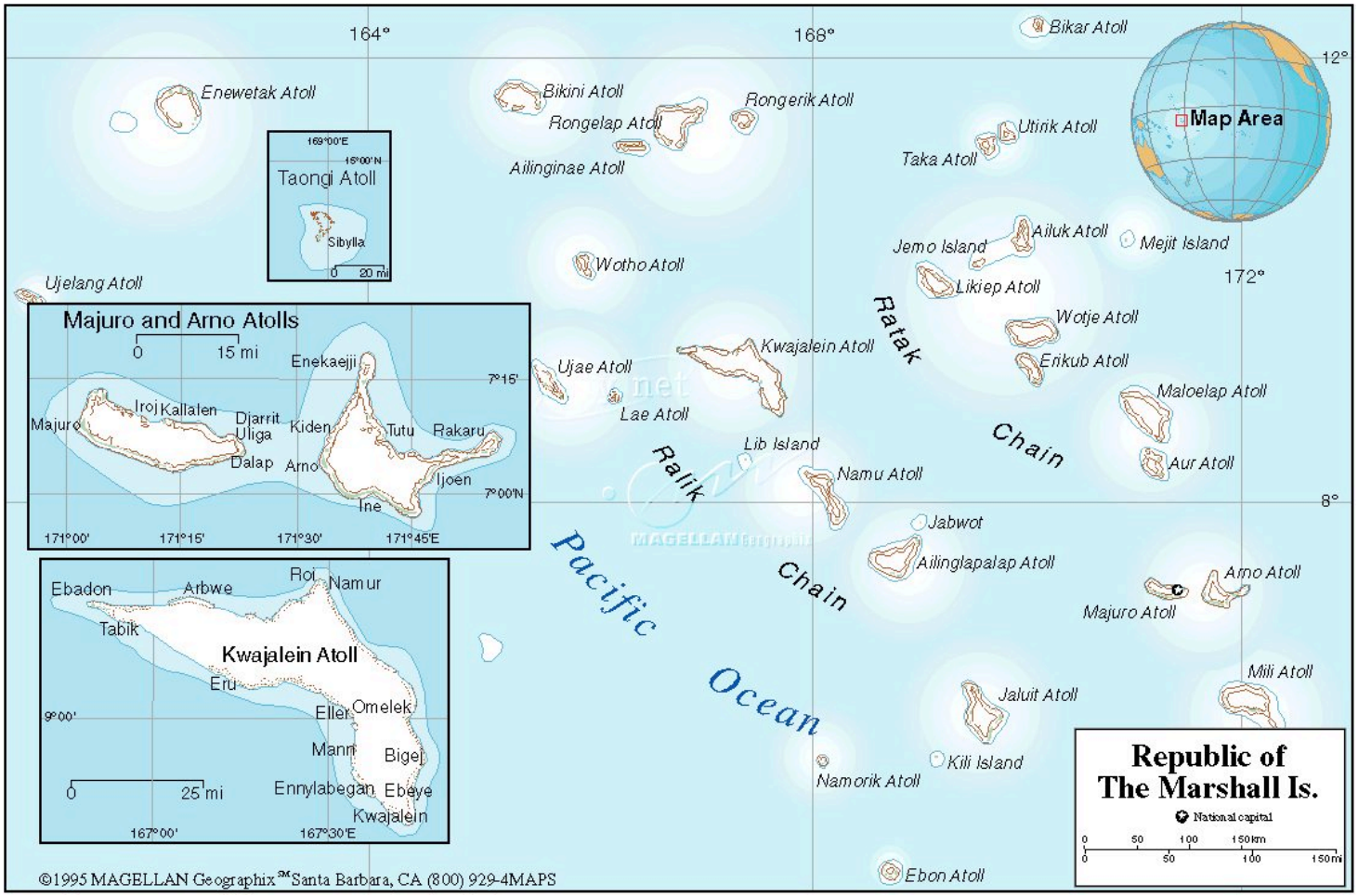
1. Combine our knowledge, creativity & resources to develop a plan to recover the best sediment cores from the most climatically important locations throughout the RMI in order to reconstruct the position of the ITCZ during the last 2,000 yr

2. Develop skills analyzing climate data, understanding paleoclimate proxies, reading & interpreting literature in geology, geography & climate, planning fieldwork in remote locations, etc.

Overview of the Republic of the Marshall Islands (RMI)

- Coring targets, contacts & logistics

Map of Marshall Islands



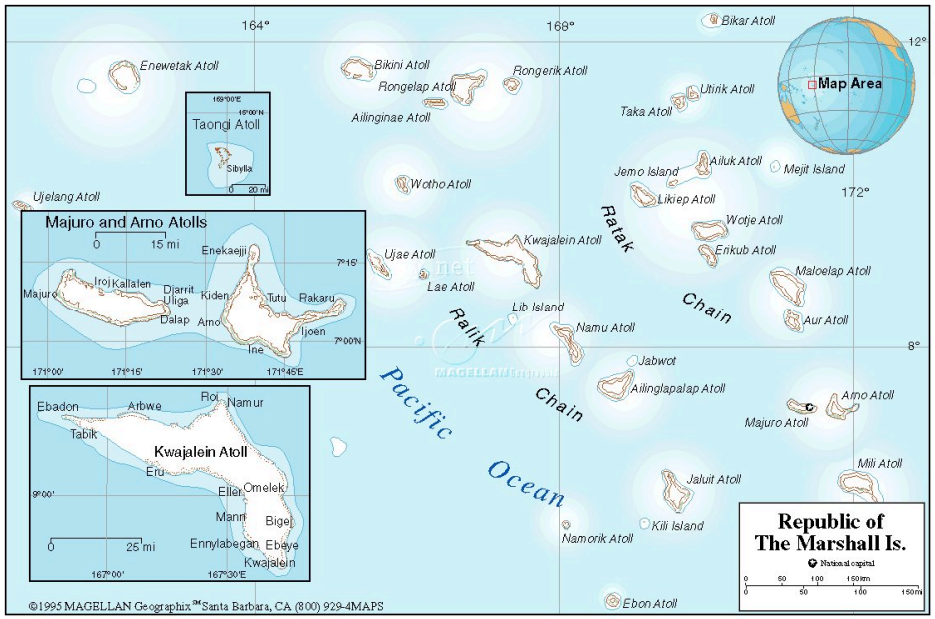
"Included are 29 coral atolls and 5 table reefs, flat coral islands with no lagoons, or at most small ponds of fresh or brackish water."

- Mueller-Dombois & Fosberg (1998) *Vegetation of Tropical Pacific Islands*, Springer, p. 297.

http://www.majurochamber.net/RMI_Map.gif

Climatic Zonation of RMI

Marshall Islands



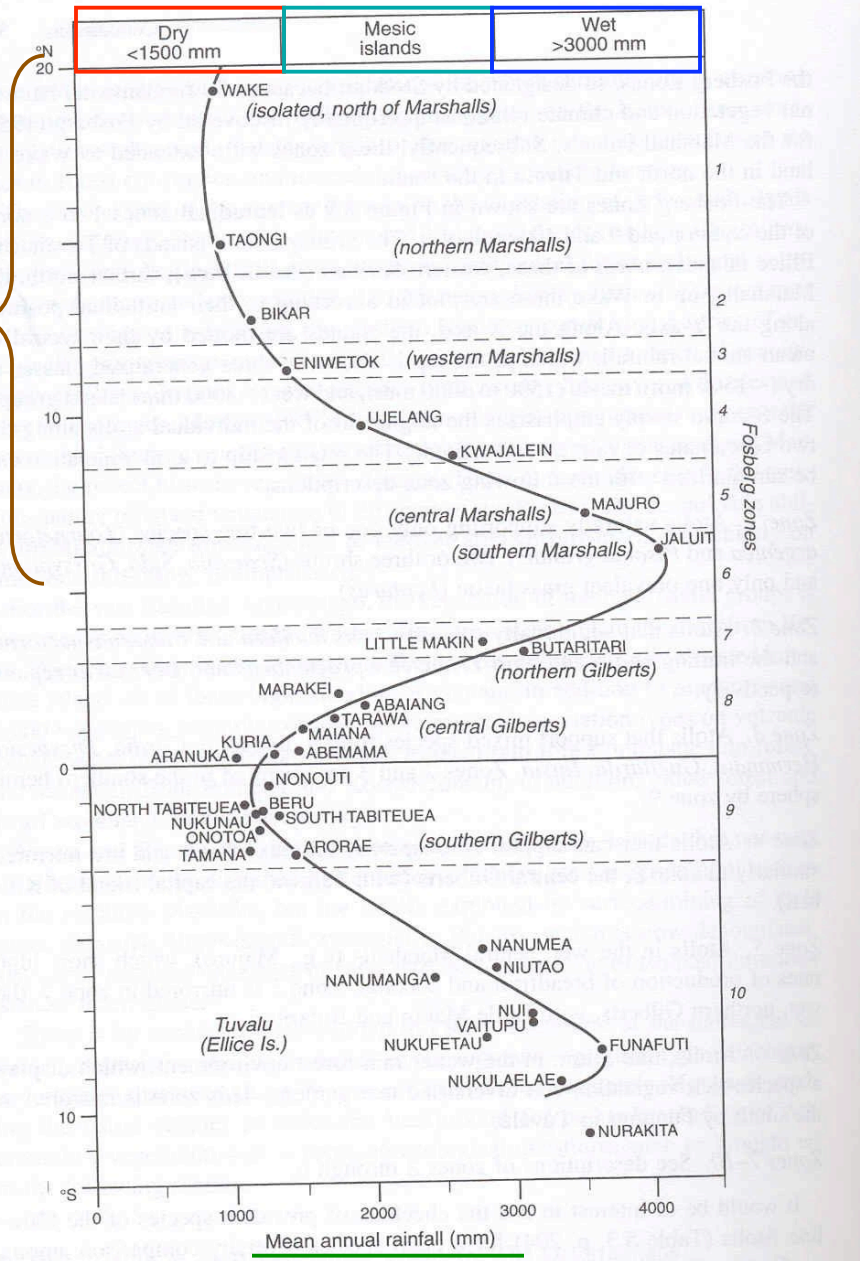
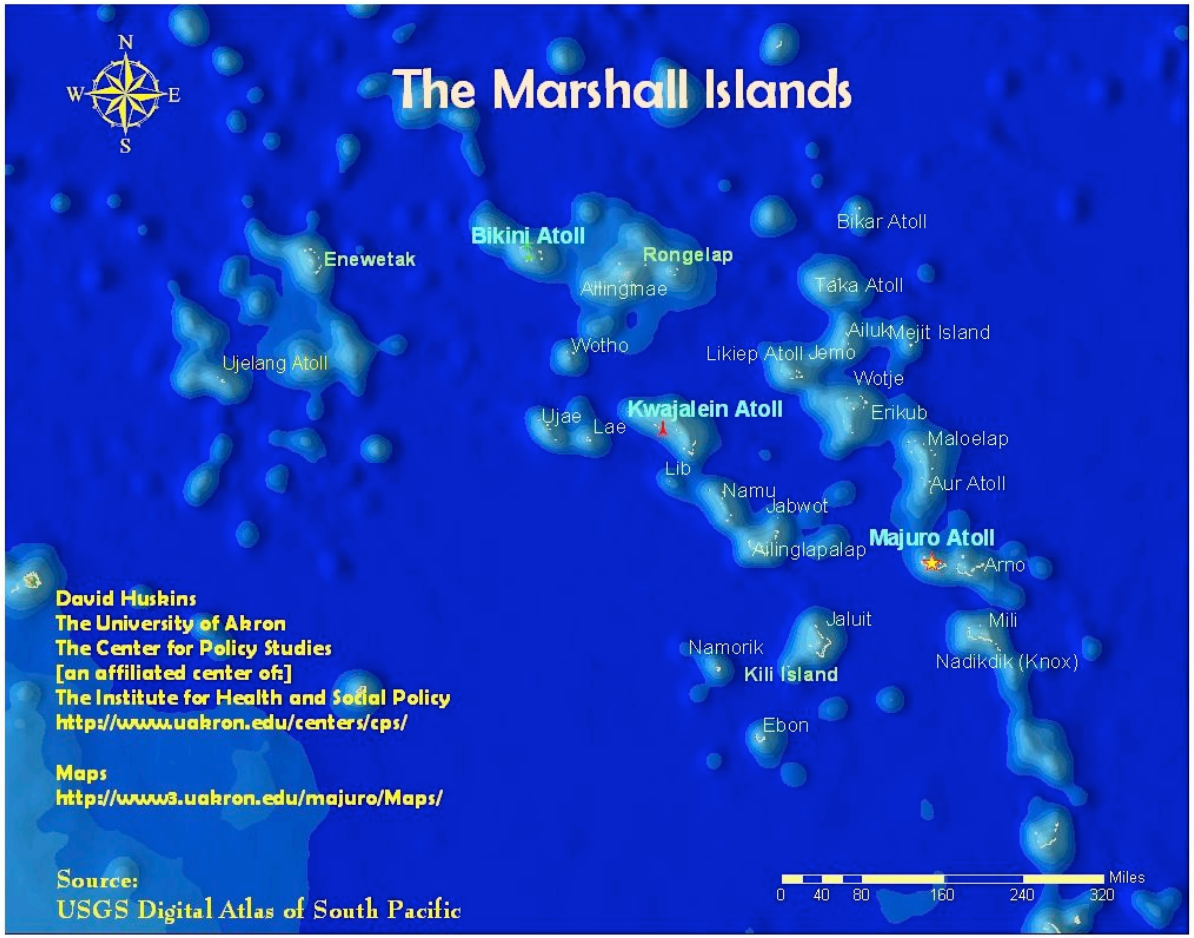


FIGURE 5.9. Latitudinal trend of mean annual rainfall in eastern Micronesia, from the northern Marshalls to the southern Gilberts (Kiribati) and Ellice Islands (Tuvalu), summarized by Fosberg Zones. For seasonality, see climate diagrams of Wake, Ujelang, Tarawa (Fig. 5.2, p. 202), and Funafuti (Tuvalu) (Fig. 3.2, p. 87). (Adapted with modifications from Stoddart 1992.

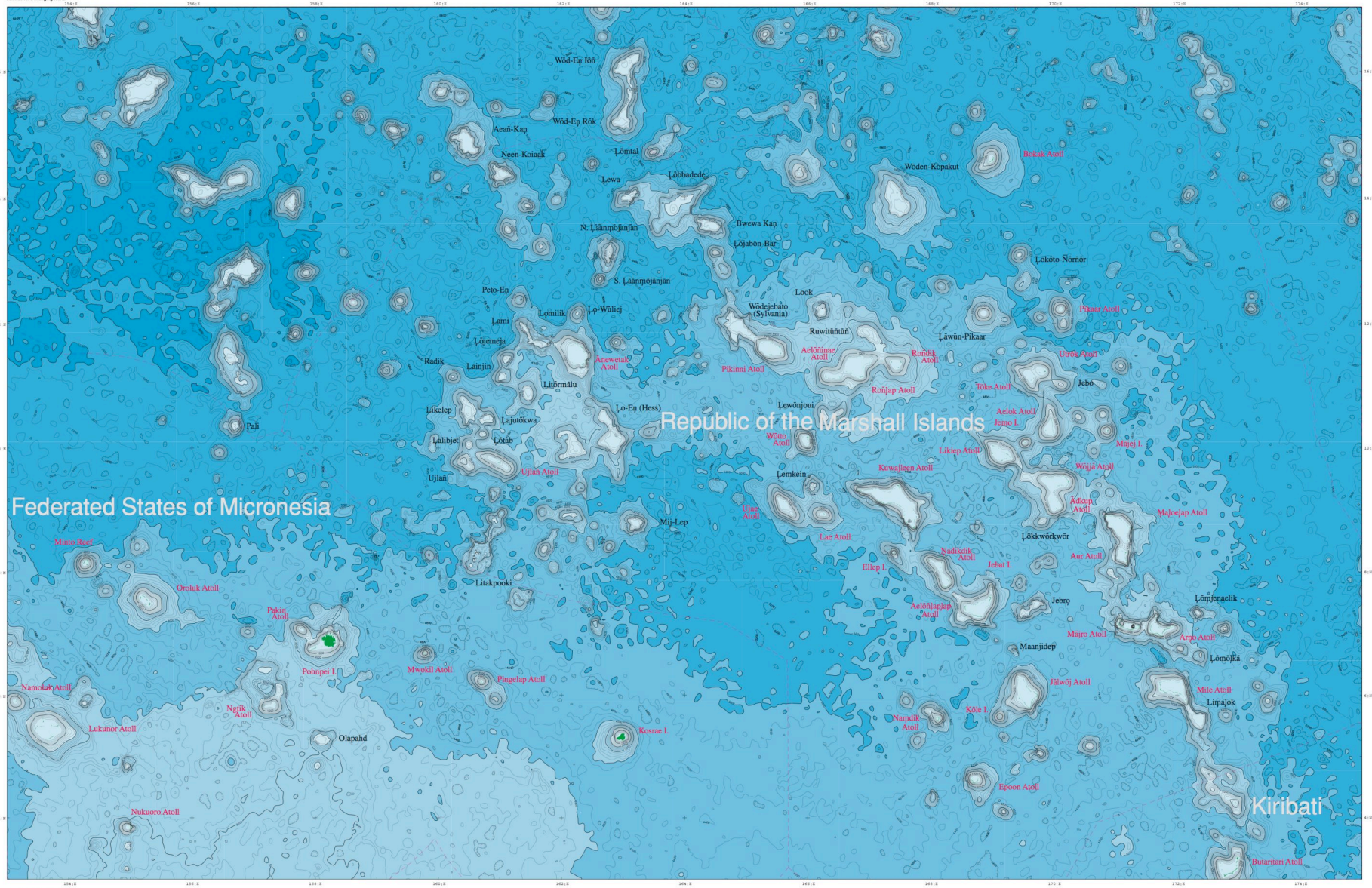
Mueller-Dombois & Fosberg (1998) *Vegetation of Tropical Pacific Islands*, Springer, p. 312.

Labeled relief map of the RMI



http://www3.uakron.edu/majuro/Maps/

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY



Base from Smith and Sandwell, 1997

Mercator Projection, Central Meridian 165°,
Standard Parallel 10°, WGS84

NOTE: THIS MAP IS NOT INTENDED FOR NAVIGATION

SCALE 1:2,000,000
(1 inch represents 31.57 miles)

BATHYMETRIC CONTOUR INTERVAL 200 METERS

BATHYMETRY OF THE REPUBLIC OF THE MARSHALL ISLANDS AND VICINITY

By

James R. Hein, Florence L. Wong, and Dan L. Mosier

Targets

- Individual Islands & associated Lakes, Bogs or Lagoons

Mejit Island (10°17'N 170°53'E) w/ Freshwater Lake

MEJIT ISLAND SOLAR POWER SYSTEM

Mejit Island. (New Year Island)

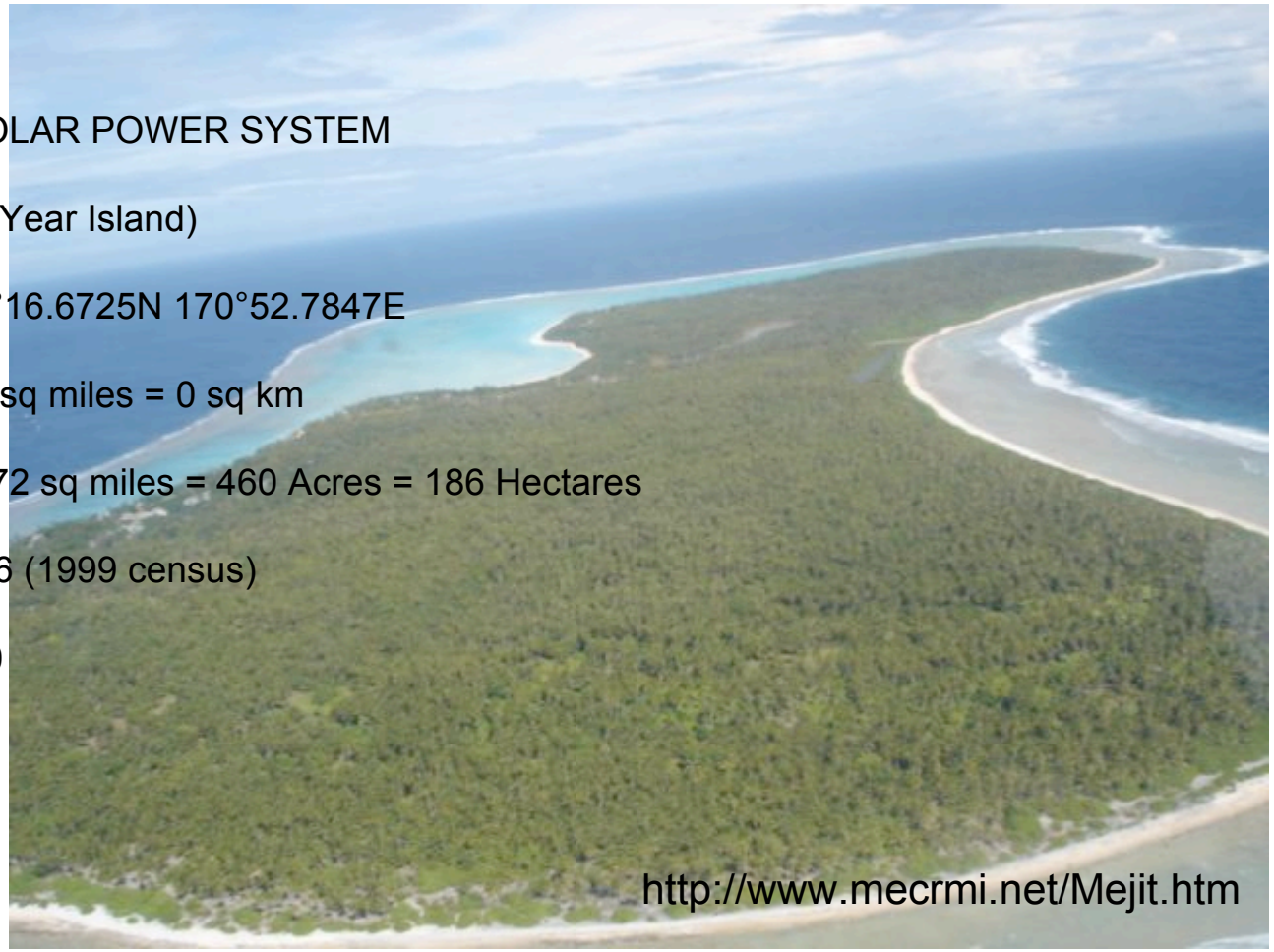
Location 10°16.6725N 170°52.7847E

Lagoon Area 0 sq miles = 0 sq km

Land Area 0.72 sq miles = 460 Acres = 186 Hectares

Population 416 (1999 census)

No. of Homes 80

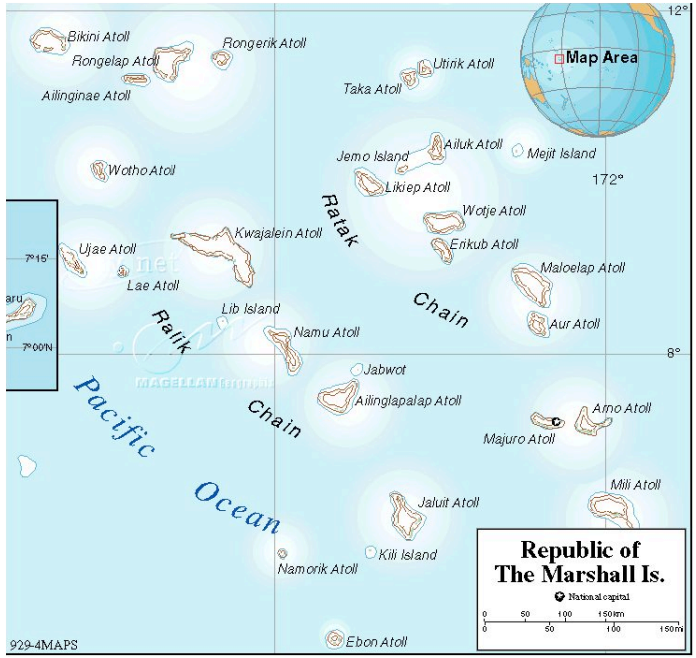


Mejit is one of the few islands (rather than atolls) in the Republic of the Marshall Islands. With an estimated population of 400 people, the island is lush in pandanus, breadfruit and taro. It has a beautiful fresh water lake (rare in the Marshall Islands) with resident ducks. Famous for its pandanus leaf mats. -->Wikipedia

Mejit Island, cont'd

Mejit is a small and beautiful coral island of lush taro patches and an abundance of coconut, breadfruit and pandanus trees. It also has a small freshwater lake that makes for a lovely swim. Since Mejit doesn't have a protective lagoon, fishing and the unloading of boats can be perilous, especially in November and December when the winds kick up.

California Beach on the northwest side of the island is tops for swimming and snorkelling. Best of all, and unlike the other Marshalls, Mejit has no poisonous fish. The island is also known for its pandanus-leaf mats, woven by the Mejit women, and for the quality of its schools.

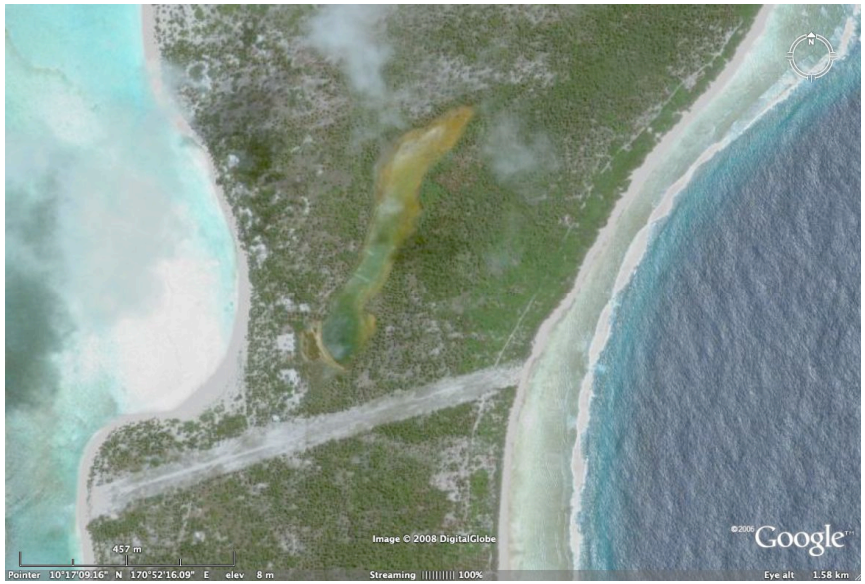


Mejit Island, cont'd

Mejit [1373]
Group: Ratak Chain Archipelago: Marshall Islands
Country: Marshall Islands Region: Oceania 14
Lat: 10.32º N Long : 170.67º E
Area: 1.8 sq. km Altitude: ? m
Land < 5 m elevation: 1.8 sq. km Sea level rise risk: 9
Depth to nearest land: 4000 m
Nearest island: 90 km group: 800 km
Nearest continent: Australia Distance: 3800 km Isolation Index: 99
ISLAND TYPE: low coral island, central pond Natural Protection Indicator: 0
CLIMATE: tropical
CATASTROPHIC THREATS: cyclones
Threat Indicator: 1
ECOSYSTEMS: Number of Ecosystems - Terrestrial: 3 Marine: 2
Mangroves in channel from central pond to sea; fringing reef.
Percent shoreline: Coral Reef: 99% Mangrove: 0% Species Richness Indicator - Terrestrial: 0 Marine: 2
HUMAN OCCUPATION: Inhabited, well cultivated
Population: 329 (1980) Density: 182.8 persons/sq. km
Growth Rate: 3.0%/yr Increasing rapidly
Major Human Activities: coconuts and breadfruit
Percent population in agr/mining/fishing: 80% Human Threat Indicator: 3
Gross Domestic Product: $ 811 per capita Economic Pressure Indicator: 0
DATA RELIABILITY: Data Rel. Indicator: 1
HUMAN IMPACT INDEX HI: 12
CONSERVATION IMPORTANCE INDEX CI-Terrestrial: 2 Low
CI-Marine: 6 Moderate
Last updated: 25/10/88

http://islands.unep.ch/ILL.htm#1373

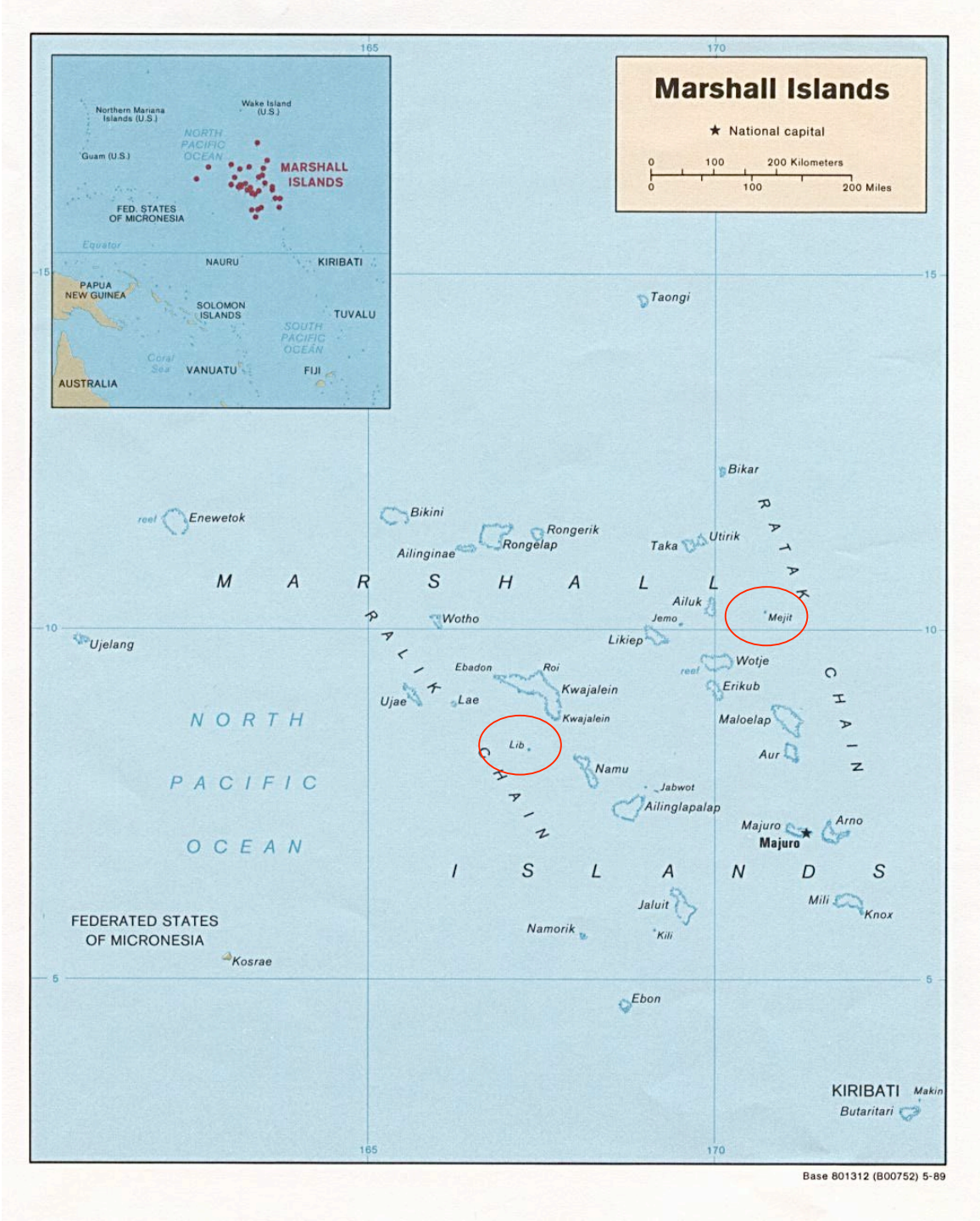
Mejit Island, cont'd



Lib Island Lake: Lib's Pond

From: "RMI Historic Preservation Office" <rmihpo@ntamar.net>
To: <jsachs@u.washington.edu>
Subject: Re: Lakes in the Marshall Islands
Date: Thu, 29 Mar 2007 15:00:03 +1200

Dear Mr. Sachs,
The RMIHPO team has done field surveys in most of the outer islands of the Marshalls. Mejit and Lib Islands both have ponds, I have to check about the one in Wotje. I am more knowledgeable about the one in Lib since I was involved in the survey. It the most unique physical feature on the island. It also possesses traditional significance. While swimming, we dredged large amounts of silt from the bottom, as well as numerous dead bivalves. I might be able to look at the other atoll surveys and find out if they have ponds and lakes, but almost all have lagoons. If you want more info on the Lib pond, I might be able to help you. Josepha Maddison
Lib's pond



Lib Island - Freshwater Pond

Lib Island

This island or table reef lies at 08" 19' N, 167" 25' E, south of Kwajalein. It has a large fresh-water pond in the eastern half, apparently containing some mangroves

(Bruauiera ?) . No scientific information is available, but I examined the island briefly from the air in 1960. It is inhabited and partly planted to coconuts. However, there is considerable native forest remaining on the north side and around the pond. Tournefortia, Scaevola, Calo~hvllum, Pandanus, Hibiscus tiliaceus, Bruauiera, A ~ ~ O C ~ ~anDd U S Cocos, could be identified with some confidence from the air. This island would well repay a visit and careful study. I know of no collections of plants, birds, or other scientific specimens from Lib.

-Fosberg (1990) *Atoll Res. Bull.* No. 330, pp. 84-85
ATOLL RESEARCH BULLETIN
NO. 330
"A REVIEW OF THE NATURAL HISTORY OF THE MARSHALL ISLANDS"
BY F. RAYMOND FOSBERG
ISSUED BY:
NATIONAL MUSEUM OF NATURAL HISTORY
SMITHSONIAN INSTITUTION
WASHINGTON, D.C., U.S.A.
January 1990

Lib Island Pond - photo

MICRONESIAN

JOURNAL OF THE HUMANITIES AND SOCIAL SCIENCES

Vol. 3, n° 1–2 December 2004

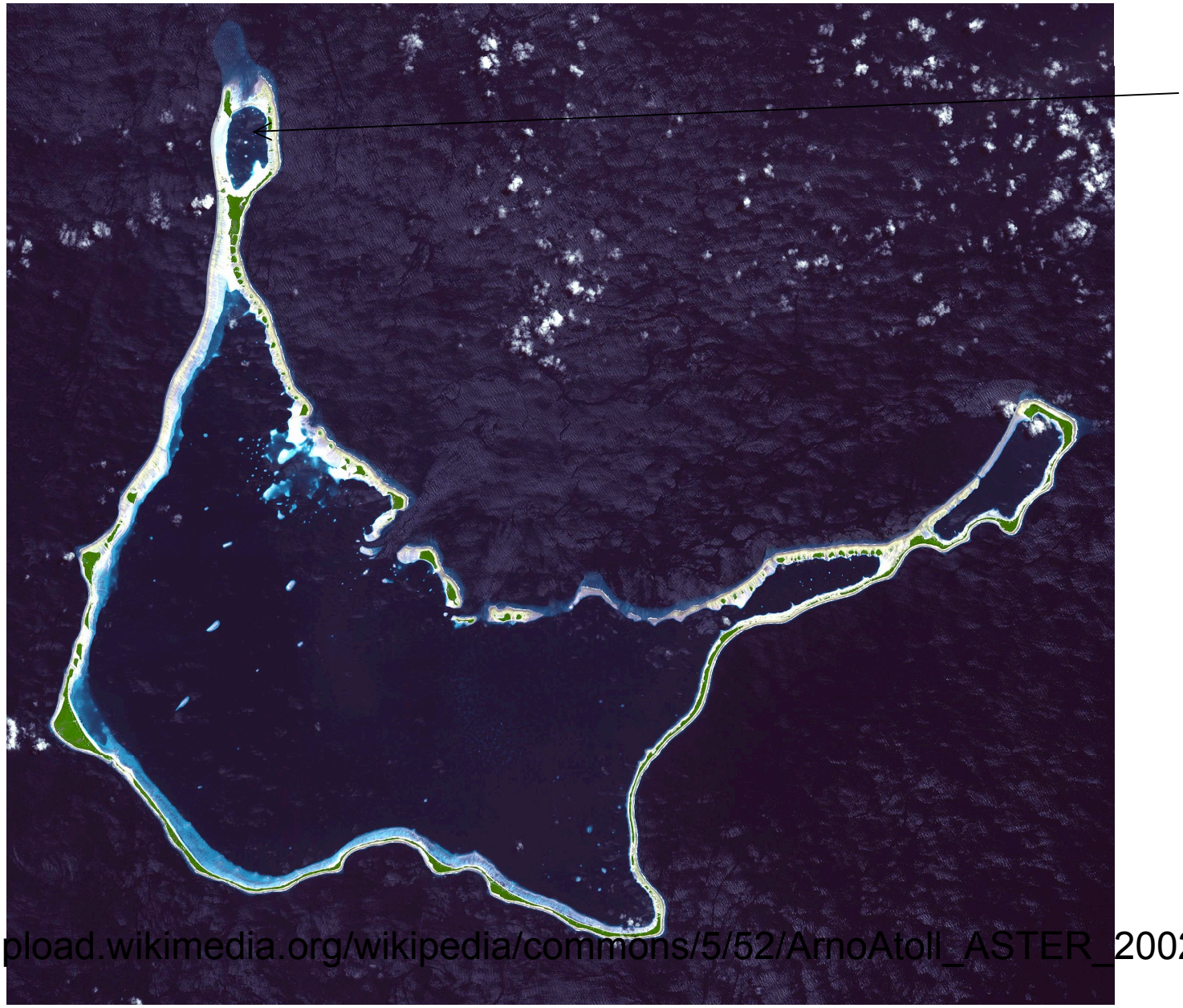
MICRONESIAN ROUND-UP

HISTORIC PRESERVATION IN THE MARSHALL ISLANDS: 2003-2004 RESEARCH

by

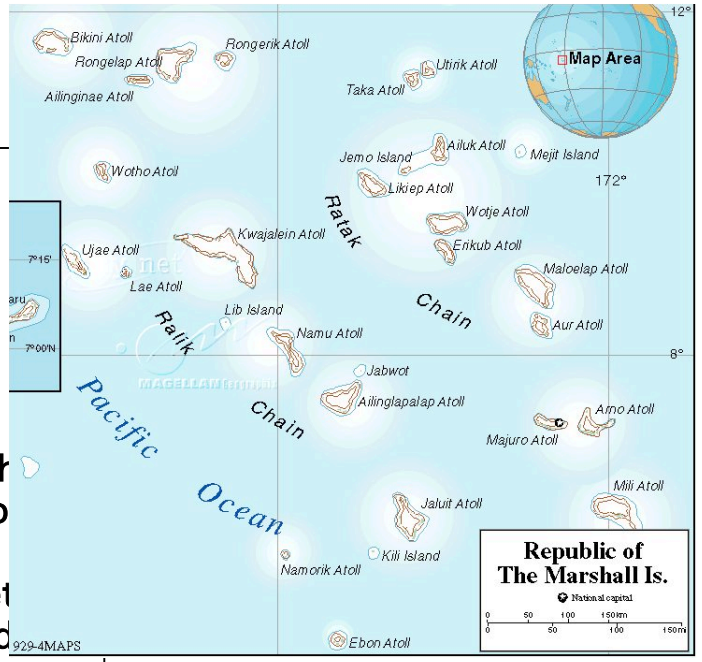
Frank R. Thomas
Historic Preservation Office, Majuro

Arno Atoll: w/ an enclosed lagoon?



http://upload.wikimedia.org/wikipedia/commons/5/52/ArnoAtoll_ASTER_2002jul25.jpg

Arno Atoll: General Info from Fosberg (1990)



ARNO ATOLL

Arno, lying at 07" 05' N, 171' 41' E, is a large, 21 miles long, 6-15 miles wide, irregularly crescent shaped atoll, with many (said to be 133) islets well-distributed around its reef, several of them, Ine, Ijen, and Rakaru quite elongate, occupying much of the southern reef. It contains approximately 5 square miles of land surface. Th site of the 1950-1952 Pacific Science Board study, Arno certainly the best studied of the Marshall Group, though perhaps more time has been devoted to Bikini and Eniwet Outstanding among the published results of the PSB stud

the treatment of the vegetation by Hatheway (1953) . This multifacetted treatment should be consulted by all the members of the Biodiversity Project team. Here will be given some generalizations from Hatheway's work.

-Fosberg (1990) *Atoll Res. Bull.* No. 330, p. 84

Hatheway, W. H. 1953
The land vegetation of Arno Atoll, Marshall Islands.
A.R.B. 16: 1-68.

Arno Atoll - Freshwater Swamps &/or Bogs

Hatheway also described fresh-water swamps or bogs, dominated by the "wild,' or small fruited form of Pandanus tectorius, called "erdwanM or "erwanW by the Marshallese. These are found on Ulien, Tutu and Arno islets. They may have been formed by successive storm ridges cutting off sections of reef flat. They have bottoms of fibrous peat. Other species of trees found occasionally are coconut, Hibiscus tiliaceus, Intsia biiusa, Morinda citrifolia, and Allolshvlus timoriensis. Epiphytes are Polvpodium scolo~endria, Nephrolopis acutifolia and Asplenium nidus. In more open places a herbaceous ground layer of Eleocharis geniculata, Thelv~teris interru~ta, and Polvoodium scolo~endria occurs. Some such fresh-water swamps or marshes may have been taro or yaraj (Cyrtosperma) pits that were abandoned and invaded by the swamp trees and herbs.

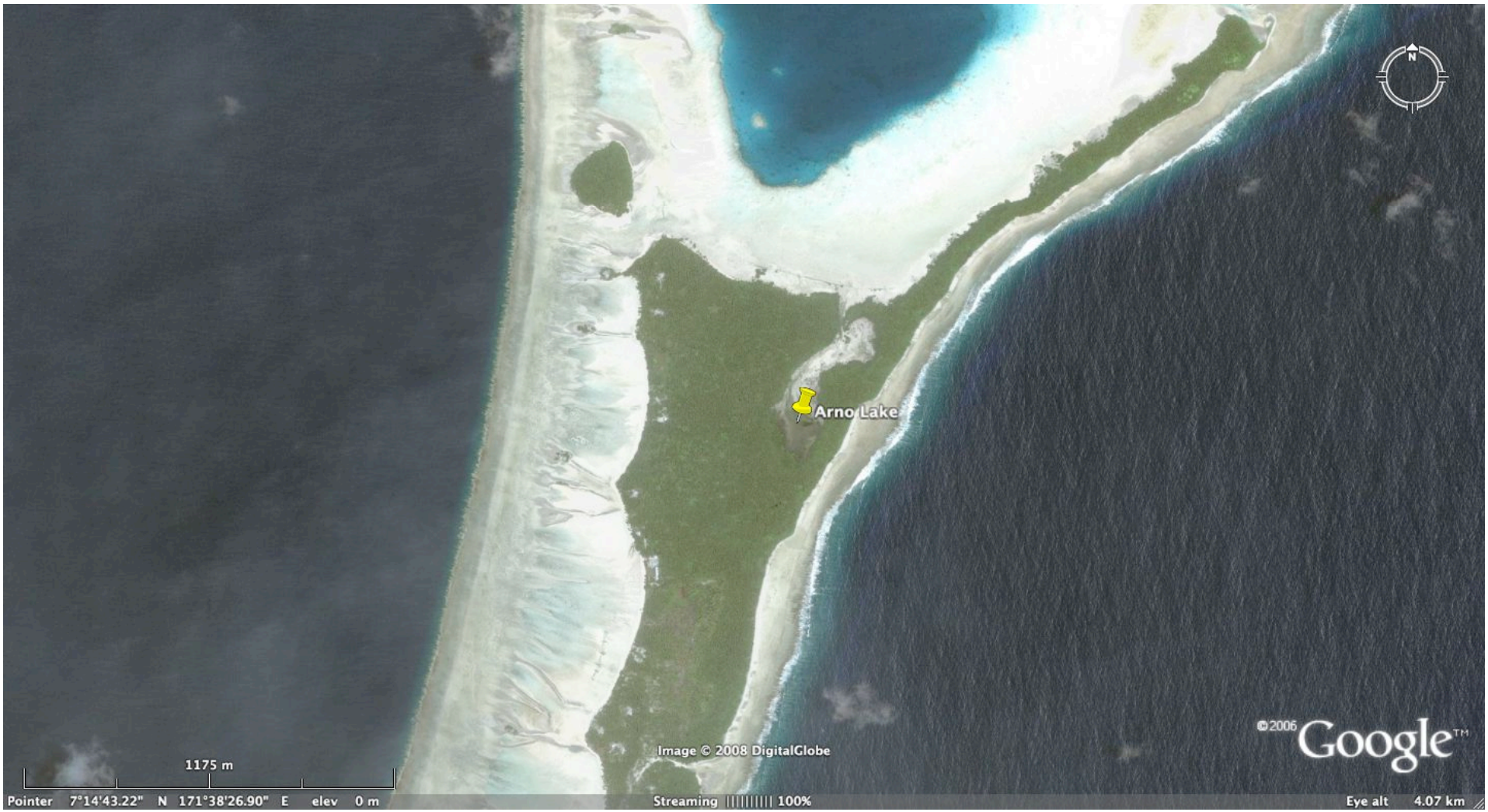
-Fosberg (1990) *Atoll Res. Bull.* No. 330, p. 84

Arno Atoll - Mangrove Depressions

Mangrove swamps and what we now call mangrove depressions, the latter usually rock-bottomed, are fairly frequent on Arno, perhaps more so than in other Marshall atolls. The principal species is Bruuuiera svmnorhiza, with slight to considerable representation of Sonneratia alba, Lumnitzera littorea and Pem~his acidula. Such swamps occur on Tinak, Langau, Bikarej and Manwi islets, the first two completely enclosed by sand or gravel ridges, the latter two connected with the sea. Swamps also occur at Kinajong and Matoleu districts on Ine Islet. Nephrolepis acutifolia and Aslslenium nidus occur epiphytically on the mangrove trees. Elsewhere on the atoll are small local mangrove depressions, usually pure stands of Brusuiera, locally some Lumnitzera. Some of these stands may have resulted from Marshallese introduction of Bruuuiera to wet places.

-Fosberg (1990) *Atoll Res. Bull.* No. 330, p. 84

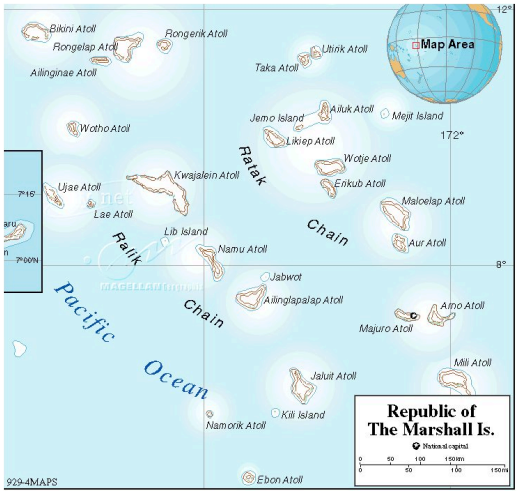
Arno Lake/Swamp - image



Arno Lake/Swamp - images-2

Jaluit Atoll-freshwater lakes

6° 0′ 0″ N, 169° 34′ 0″ E	Decimal	6°, 169.566667°



Date: Sun, 30 Dec 2007 16:32:53 -0800 (PST)
From: Dean Jacobson <atolldino@yahoo.com>
Reply-To: atolldino@yahoo.com
Subject: Re: Muddy and Anoxic basins in the Marshall Islands
To: jsachs@u.washington.edu

Julian:

Most atoll lagoons are quite deep, 100-200 feet, and are flushed by tidal flow, and may not have anoxic basins. I know of a few lakes (freshwater, on small islands), including several near a south western pass in Jaluit (boardering Mejirok pass) but since they are perched on a coral basement they cannot be too deep and may not have much sediment. (Mangroves grow on the interior of a larger islet a bit to the south, called Jaluit Jaluit, but even these mangroves lack sediment; evidently the tannic acids are dissolving the coral bedrock, causing a uneven floor with sharp protuberances; the several species of salt-tolerant trees grow on this rock). Perhaps more promising is a eutrophic lake on the small, isolate northern island of Mejit, near the airstrip. The surface is completely covered with large flocks of algae, (wading in it is unpleasant, with a thick layer of muck)so it must have a high sedimentaton rate (which may not be good for your purposes)
but the bottom is obviously anoxic. I have heard that this was once a tidal inlet that was artificially land locked in historic times.
Returning to saltwater, oa single lagoon, of all the atolls (namely Namrick, west of Jaluit) lacks much tidal flow, as it has no passes (at high tide the lagoon water is "perched"). If one could find an anoxic basin in the RMI, perhaps this would be it.

I will ask around for greater expertise on this and get back to you.

Cheers,
Dean

Jaluit Atoll - Aerial Photo, 1978

http://en.wikipedia.org/wiki/Image:Jaluit_Atoll_1978_.jpg

Jaluit Atoll - Wikipedia Entry

Jaluit Atoll

Coordinates: 06°00′ 00″ N 169°34′ 00″ E / 6, 169.566667

Jaluit Atoll is an atoll of 91 islands in the Pacific Ocean. It is a legislative district of the Marshall Islands. Its total land area is only 4.38 sq mi (11 km²), but that encloses a lagoon of 266.31 sq mi (690 km²).

The population of the islands of Jaluit Atoll is 1,669 as of 1999.

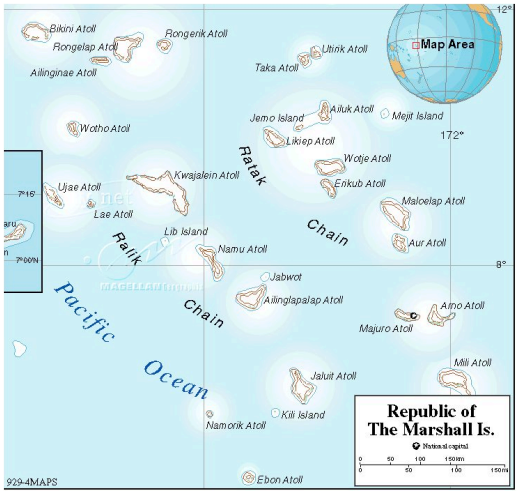
The island of Jabor has the largest population of around 1,200. Jabor is served by two weekly flights (Mondays and Fridays) from Air Marshall Islands. The island features a small hotel with four rooms, air-conditioning, running water, electricity and a communal kitchen and shower, where visitors can stay for $50 a night. There are several small stores that sell staple foods like flower, rice, canned tuna and canned vegetables. Jaluit High School is located at the northern side of the island and serves 350 students from 6 of the southern atolls. About 250 of them live in the dormitories. The rest live with relatives in town. Jabor also has a fish base, where motor boats can be rented and a Mobil station that sells gas for about $6.50 a gallon. Great snorkeling spots are around the sunken dock by the airport and in the northern pass.

The island of Jaluit is connected to Jabor by an 8 mile road. Jaluit, Jaluit has an elementary school and at the southern most tip of the island there are traditionally built huts available for rent on a beautiful beach.

Imej is an island a 45 minute boat ride from Jabor. It used to be the Japanese army headquarters and you can take a tour on foot through the jungle to check out the old power station, military quarters, anti-aircraft guns and the Shinto shrine where the Japanese general committed suicide.

http://en.wikipedia.org/wiki/Jaluit_Atoll

Namorik (or Namdrik Atoll) anoxic(?) Lagoon



5° 37’0″ N, 168° 7’0″ E Decimal 5.616667°, 168.116667°

Date: Sun, 30 Dec 2007 16:32:53 -0800 (PST)
From: Dean Jacobson <atolldino@yahoo.com>
Reply-To: atolldino@yahoo.com
Subject: Re: Muddy and Anoxic basins in the Marshall Islands
To: jsachs@u.washington.edu

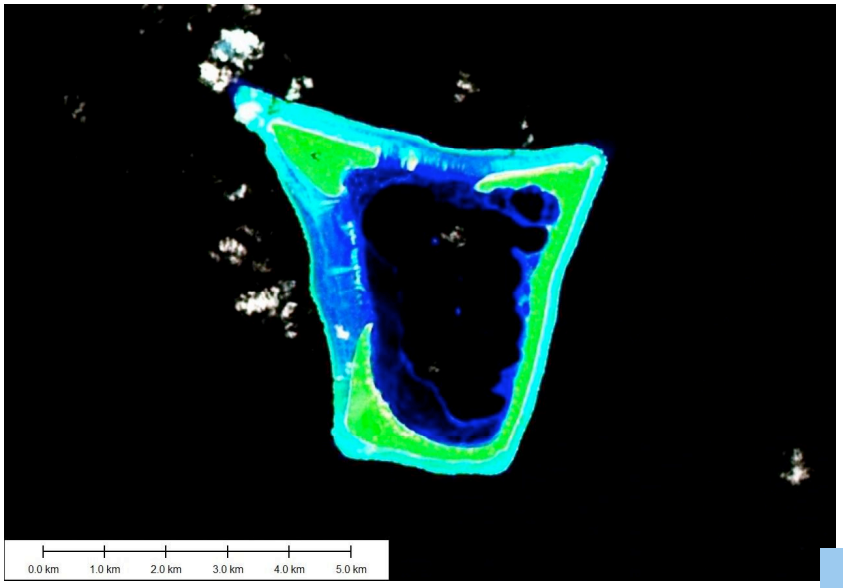
Julian:

Most atoll lagoons are quite deep, 100-200 feet, and are flushed by tidal flow, and may not have anoxic basins. I know of a few lakes (freshwater, on small islands), including several near a south western pass in Jaluit (boardering Mejirok pass) but since they are perched on a coral basement they cannot be too deep and may not have much sediment. (Mangroves grow on the interior of a larger islet a bit to the south, called Jaluit Jaluit, but even these mangroves lack sediment; evidently the tannic acids are dissolving the coral bedrock, causing a uneven floor with sharp protuberances; the several species of salt-tolerant trees grow on this rock). Perhaps more promising is a eutrophic lake on the small, isolate northern island of Mejit, near the airstrip. The surface is completely covered with large flocks of algae, (wading in it is unpleasant, with a thick layer of muck)so it must have a high sedimentaton rate (which may not be good for your purposes)
but the bottom is obviously anoxic. I have heard that this was once a tidal inlet that was artificially land locked in historic times.
Returning to saltwater, oa single lagoon, <u>of all the atolls (namely Namrick, west of Jaluit) lacks much tidal flow, as it has no passes (at high tide the lagoon water is "perched"). If one could find an anoxic basin in the RMI, perhaps this would be it.</u>

I will ask around for greater expertise on this and get back to you.

Cheers,
Dean

Namorik Atoll - Maps: anoxic(?) Lagoon



http://upload.wikimedia.org/wikipedia/commons/d/d5/Namorik_Atoll_-_Image_%28N-59-00_2000%29.jpg

http://www.flickr.com/photo_zoom.gne?id=191460718&size=o

http://upload.wikimedia.org/wikipedia/commons/f/fc/Namorik_Atoll_-_Map.jpg

Namorik Atoll - Wikipedia Entry

Namdrik Atoll (or Namorik Atoll) is an atoll of 2 islands in the Pacific Ocean. It is a legislative district of the Ralik Chain of the Marshall Islands. Its total land area is only 1.07 miles², but that encloses a lagoon of 3.25 miles².

The population of Namdrik Atoll is 814.

Namorik Atoll (5˚35'N., 168˚07'E.), about 63 miles NW of Ebon Atoll, consists of two wooded islands on the reef enclosing the lagoon. A coral islet stands between them on the reef, with numerous black boulders. The very shallow lagoon is cut off from the sea by the drying coral reef. Boats can cross the reef with difficulty, at HW on the W side of the atoll. There is a trade's store on the W side of Namorik Islet, on the S side of the atoll.

Landing near the W side of Namorik Islet can be effected about 90m S of it. There is no shelter during NE winds, and it is dangerous with strong SW winds when there is a heavy sea. There is a fringing reef which extends about 135m in the vicinity of the landing place. There is depth of about 1.2m and there are rocks in places. Two stranded wrecks lie about 90m off the S shore along the reef line. (Sailing Directions Pub-153)

For more information visit EVS-Islands: Namorik Atoll MH

http://en.wikipedia.org/wiki/Namdrik_Atoll

Wotje Atoll - Wikipedia Entry

Wotje Atoll

Coordinates: 09°26′ 30″ N 170°01′ 00″ E / 9.44167, 170.016667

Wotje Atoll is an atoll of 75 islands in the Pacific Ocean. It is a legislative district of the Marshall Islands. Wotje's land area of 3.16 sq mi (8 km²)is large and the main island is one of the widest in Marshall Islands. The islands enclose a lagoon of 241.06 sq mi (624 km²).

The population of the islands in atoll (as of 1999) was 900. As of 2007, the population is nearly 1000, which includes about 200 teenagers who live on the island at the public boarding school, Northern Islands High School. About 125 people live on Wodmej, which is approximately 8 miles from the main island of Wotje. All other islands are uninhabited and are used only for copra production, picnics, and food gathering.

There are four churches on Wotje, Wotje: Catholic (which runs St. Thomas Elementary School), Protestant, Assembly of God, and Full Gospel. There are several stores, but the largest is Mama Store, managed by the Tomeing-Johnny family. This store has a small retail shop, restaurant and coffee window.

The atoll is serviced by field trip ships several times a year which bring supplies like rice, flour, and sugar. In addition, the local government and senator manage a small ship, Northern Star, which makes more frequent trips.

Air Marshall Islands (AMI) flies to the island twice/week on Saturdays and Tuesdays. Round-trip flight from Majuro or Kwajalein is $242USD. Passage by ship is $15-20USD.

Wotje Liberation Day (from the Japanese after WWII) is celebrated annually on June 9 with field day activities, speeches from community leaders, prayers, and a flag raising.

Wotje Atoll has four schools: Wodmej Elementary School, Wotje Elementary School, St. Thomas Elementary School, and Northern Islands High School. The first three are public schools, funded by the national Ministry of Education. St. Thomas is managed by the Maryknoll Sisters of the Catholic Church.

On Wotje, Wotje there are 2 large piers and a pristine white sandy beach. Fishing in the atoll is excellent, especially around the smaller islands. Some of the fish you catch may be poisonous, so check with the locals before you eat any. On the ocean side of the atoll, lobster fishing at night is possible depending on the season, the tides, and location.

Many WWII artifacts remain on the main island of Wotje, Wotje. A large concrete airstrip, bunkers, big guns and more make this island attractive to war history enthusiasts.

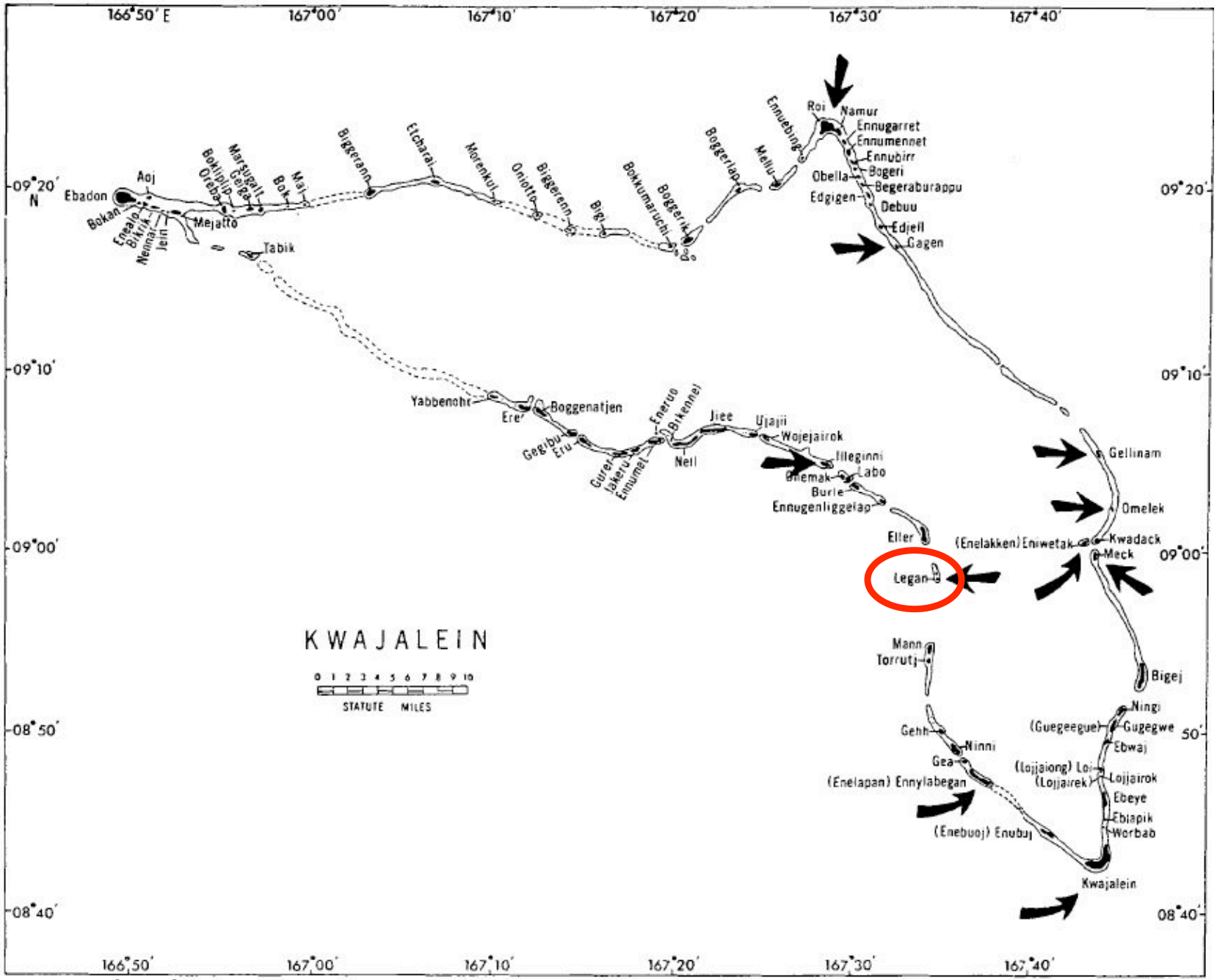
Wotje - confirmation of INLAND (freshwater?) lake(s)

FRESHWATER AND BRACKISH

Ecosystem: **Inland lakes**

Location: non-mangrove areas, Wotje, Wotje; Lekan, Kwajelein
Importance: stopover for migratory waterfowl; soft mud provided protection during World War II when bombs dropped on Wotje did not explode
Threats: drainage for use of freshwater; pollution; waste oil; pesticides; invasive exotics

http://www.biormi.org/index.shtml?en/ecosystems.shtml#FRESHWATER%20AND%20BRACKISH

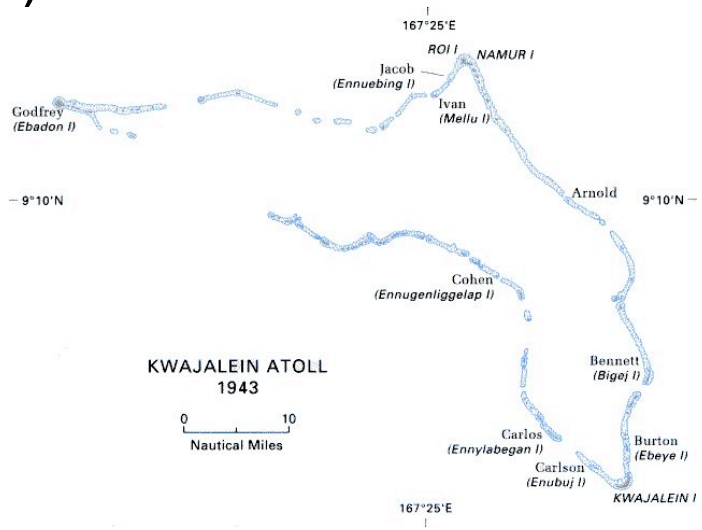


-from Clapp (1990) *AtollResBull*

Legan (Lekan) Islet, Kwajalein Atoll - Confirmed Inland (freshwater?) lake (2 sources)

Legan (Marshallese "Ambo") is uninhabited but does have a few buildings on the southern part of the island. Most of the island is thick jungle like most islands in the Marshall Islands. **Unlike most islands though, Legan has a very small lake in the middle**.

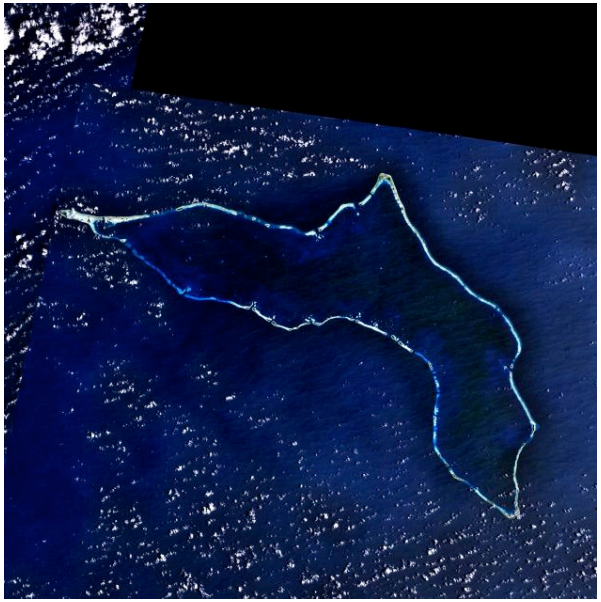
-from http://en.wikipedia.org/wiki/Kwajalein

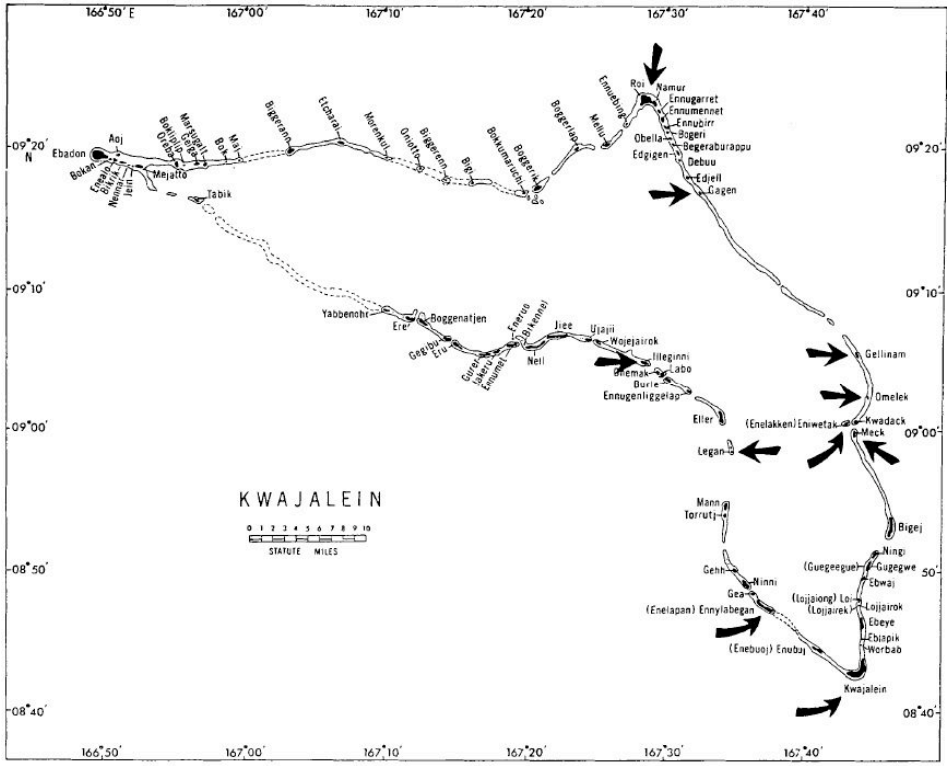


FRESHWATER AND BRACKISH

Ecosystem: **Inland lakes**

Location: non-mangrove areas, Wotje, Wotje; **Lekan, Kwajelein**
Importance: stopover for migratory waterfowl; soft mud provided protection during World War II when bombs dropped on Wotje did not explode
Threats: drainage for use of freshwater; pollution; waste oil; pesticides; invasive exotics
-from
http://www.biormi.org/index.shtml?en/ecosystems.shtml#FRESHWATER%20AND%20BRACKISH





lagoon area of this shore and north of the hook i.s very shallow, and a large, sandy expanse i s exposed at low tide. -p. 8

Legan - Two were seen 11 March, a w h i t e b i r d f o r a g i n g a t t h e north end of the i n t e r i o r lake and a d a r k morph t h a t flushed from the rough c o r a l shore along the southwestern p o r t i o n of the i s l a n d . Four were p r e s e n t 24 March, a mottled b i r d t h a t flushed from t h e north end of the lake t o a l i g h t 20 f e e t up a palm, two white b i r d s t h a t flew over the i n t e r i o r l a k e , and a d a r k b i r d t h a t flushed from the n o r t h e r n shore.
-p.32

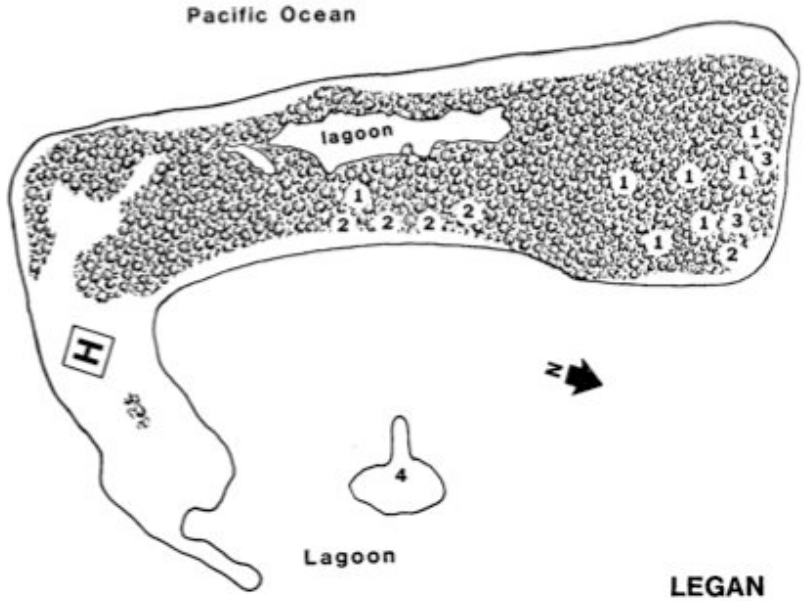
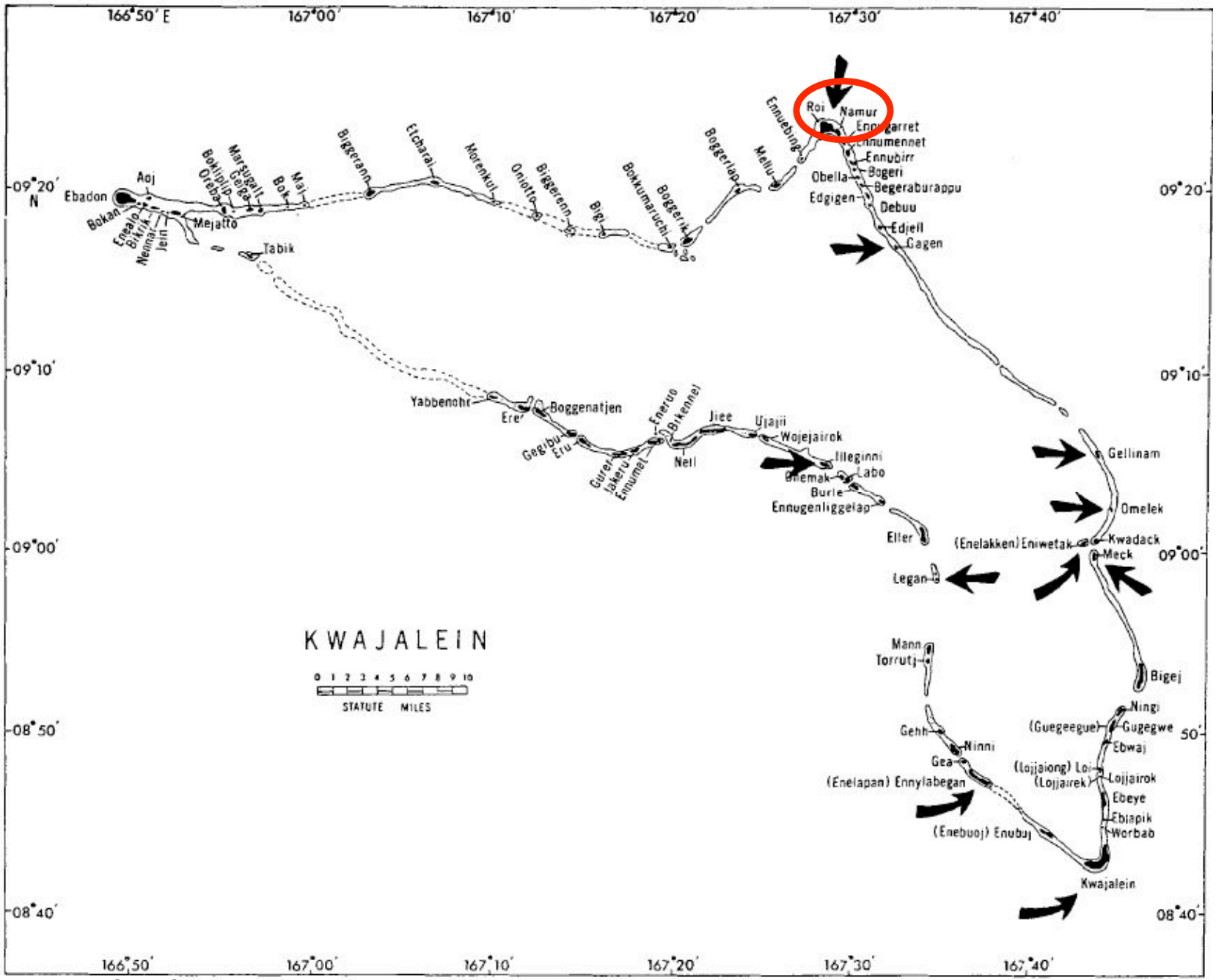


Figure 6. Legan Island. (1) Nesting area of White Terns; (2) nesting area of Brown Noddies; (3) nesting area of Black Noddies; (4) roosting area of Crested and Black-naped Terns.

ATOLL RESEARCH BULLETIN
NO. 342
NOTES ON THE BIRDS OF KWAJALEIN ATOLL, MARSHALL ISLANDS
BY
R. B. CLAPP
ISSUED BY
NATIONAL MUSEUM OF NATURAL HISTORY
SMITHSONIAN INSTITUTION
WASHINGTON, D.C., U.S.A.
SEPTEMBER 1990



-from Clapp (1990) *AtollResBull*

Roi-Namur, islet on Kwajalein

Roi-Namur - As on Legan, t a t t l e r s tend t o c o n c e n t r a t e on the **i n t e r i o r lake**. F i f t e e n were seen t h e r e a t 1439 on 26 March 1988 r e s t i n g on the sand beneath Pemphis bushes on the i n l e t ' s western s h o r e (F i g u r e 3 4) . Others were s c a t t e r e d in small numbers along rocky shores a t low t i d e , p a r t i c u l a r l y on the western s i d e of Roi and on the n o r t h e a s t e r n s i d e of Namur. The t o t a l population of the i s l a n d probably did not exceed 30 b i r d s . I e s t i m a t e d t h a t perhaps 25 b i r d s were here on 4 November 1964 (Arnerson 1969) on a l e s s thorough survey. S c h i p p e r ' s o b s e r v a t i o n s (Table 10) a t Roi-Namur suggest s i m i l a r population l e v e l s and peaks, but data a r e too few t o provide much information on periods of m i g r a t i o n . -p.48

ATOLL RESEARCH BULLETIN
NO. 342
NOTES ON THE BIRDS OF KWAJALEIN ATOLL,
MARSHALL ISLANDS
BY
R. B. CLAPP
ISSUED BY
NATIONAL MUSEUM OF NATURAL HISTORY
SMITHSONIAN INSTITUTION
WASHINGTON, D.C., U.S.A.
SEPTEMBER 1990

Roi-Namur, islet on Kwajalein - Wikipedia

Roi-Namur is an island in the northern part of the Kwajalein atoll in the Marshall Islands.

Occupied by Japanese forces prior to World War II, it was the target of the U.S. 4th Marine Division in the Battle of Kwajalein, in February 1944.

It is home to many Americans who work on the Ronald Reagan Ballistic Missile Defense Test Site. There is one runway for small planes that commute from Kwajalein. The activities on Roi-Namur range from a nine hole golf course, saltwater swimming pool, scuba club, movie theater, volleyball, and basketball court.

The island actually used to be two different islands until they were joined by the Japanese. The Namur side is home to the jungle and the tracking satellites. Roi is the main housing area, with most of the retail facilities there. The housing department, library, gym, barber shop, snack bar, and Outrigger bar share one building. The store carries the same basic necessities as a convenience store, along with a DVD rental facility.

http://en.wikipedia.org/wiki/Roi-Namur

http://www.vmb-613.com/images/roi-namur_today.JPG

Coordinate: 9° 24’ 0″ N, 167° 29′ 0″ E
Decimal: 9.4°, 167.483333°

Kili Atoll (5°37′ N, 169°07′ E)

Kili Island (also known as Kili Atoll) is a 0.93 square kilometer island located in the Pacific Ocean at [show location on an interactive map] 5°37′ N, 169°07′ E. It is a member of the Marshall Islands and is located in the Ralik Chain. The island is one of the smallest islands to form the Marshall Islands. It is a low coral formation of 0.93 km². It is situated southwest of Jaluit.

Kili was uninhabited until November 2, 1948 at which point, the United States Government relocated the Bikini Atoll's indigenous population there while Bikini was used for nuclear tests.

Kili has no lagoon or reef protection. The island cannot be reached by ship four months out of the year because of rough seas. The main agricultural product is copra. Residents are supported through trust agreements between the United States and the Marshall Islands yielding about $15 per person per year.

http://en.wikipedia.org/wiki/Kili_Island

Kili Island (Atoll) , cont'd

K i l i -Islan d
This lagoonless i s l a n d i s surroundedby a r e e f of rather narrow dimensions especially restricted on the leeward side. It is backed on this side by a sand beach i n the southwest sector where small boat landings can be made through a 20-feet-wide channel a-t low tide. A t high t i d e such landings are made with care directly on the rocky tiad bouldery shore. A high bouldery and rocky beach occupies most of the r e s t of the shoreline except a stretch f'ron'cing the north end of the islet vhere sand again occurs. S a l t water enters through coarse boulders in-to a bra,clrish pond on the leeward side surrounded bjr a growth of emp phis acidula which here also grow on the boulder rampart runilin~;in ward from the beach. A fresh water swamp now planted partly i n taro occupies the central p a r t of the i s l e t i n back of the village proper.

Field notes on a t o l l s visited i n the Marshalls, 1956
by
Herold J. Wiens
Issued by
THE PACIFIC SCIENCE BOARD
National Academy of Sciences-National Research Council
Washington, D. C.
Septeruber 15, 1977

Wiens (1957) *Atoll Res. Bull.* No. 54 , p. 10.

Kili Island (Atoll) , cont'd

KILI ISLAND
A small island lying at 05" 34' N, 169" 04' E, about 1 mile long, a third of a mile wide, land area about 1/3 square mile. It has no lagoon, only a brackish pond and a fresh-water marsh or depression. It is totally planted to coconuts and breadfruit, and is the present home of the Bikini people, exiled because of radioactive contamination from nuclear weapons testing on their home atoll of Bikini. The beaches are mostly cobble and boulder, with two stretches of sand. Densely inhabited, there is not likely any remaining native vegetation or native terrestrial animal life, and nothing of interest to a biodiversity field party.

Fosberg (1990) Atoll Res. Bull. No. 330, p. 60

Airok (aka Airik) Island, AILINGLAPALAP ATOLL: 07" 23' N, 168" 46' El

Coordinate	7° 30′ 34″ N, 168° 44′ 10″ E	Decimal	7.509444°, 168.736111°

AILINGLAPALAP ATOLL
This is a large atoll, lying at 07" 23' N, 168" 46' El in the southern portion of the Ralik Chain, roughly W of Majuro and N of Jaluit. It is triangular-crescent shape, convex to the east, about 27 miles by 19 miles, with many islets scattered on all sides, the larger ones mostly around curves and angles in the reef. There is a large resident human population and the larger islands are planted to coconuts.
.....
On Airik, and Ailinglapalap islet also, is one of the very few real mangrove swamps in the Marshalls. This has standing water in the central part, connected by a small channel with the lagoon at high tide. Sonneratia alba and Rhizo~hora mucronata var. stvlosa are the principal trees, with occasional Brusuiera gymnorhiza. The bottom is a gray calcareous mud or marl. Epiphytic Newhroleois acutifolia occurs on some trees.

Fosberg (1990) Atoll Res. Bull. No. 330, p. 65

Airok (cont'd.)

Ailinglaplap Atoll
From Wikipedia, the free encyclopedia
Jump to: navigation, search

Ailinglaplap is an atoll and municipality of 56 islands in the Pacific Ocean. It is a legislative district of the Marshall Islands, located in the Ralik Chain. It is located 152 km northwest of Jaluit Atoll. Its total land area is only 5.67 sq mi (14.7 km²), but it encloses a lagoon of 289.69 sq mi (750 km²). The dominant plant on the atoll are coconut plantations.

"Ailinglaplap" translates as "greatest atoll" ('aelon' (atoll) + 'laplap' (superlative suffix)), because the greatest legends of the Marshallese people were created there. The four major population centers on Ailinglaplap Atoll are the settlements of Woja, at the westernmost end of the atoll, Jeh in the northeast, and **Airok** and Bouj in the south.

The population of the atoll was 1,959 as of 1999. The current president of the Marshall Islands, Kessai Note was born at Ailinglaplap Atoll.

http://en.wikipedia.org/wiki/Ailinglaplap_Atoll

Map of promising Targets-RMI

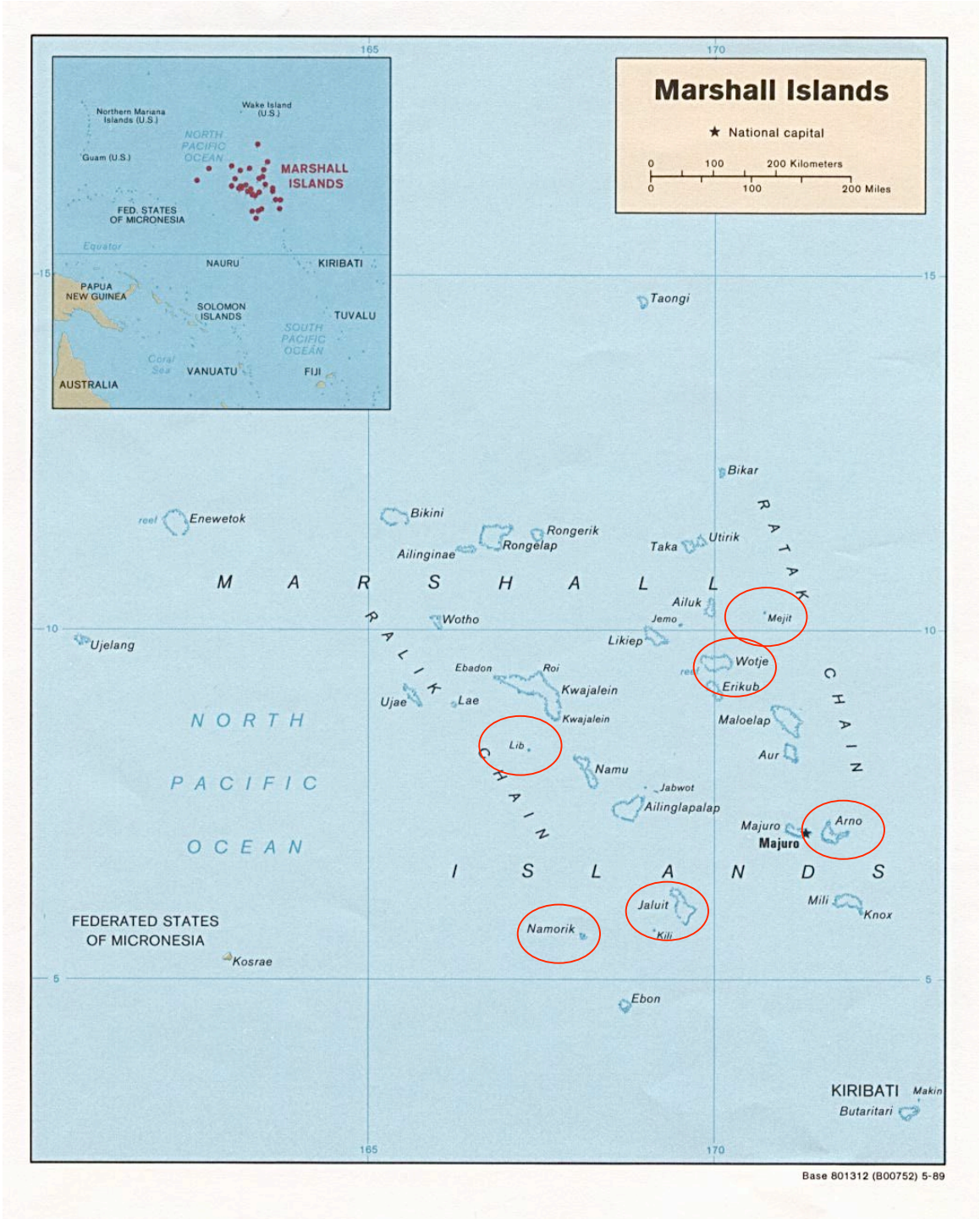


Chart of Potential Targets

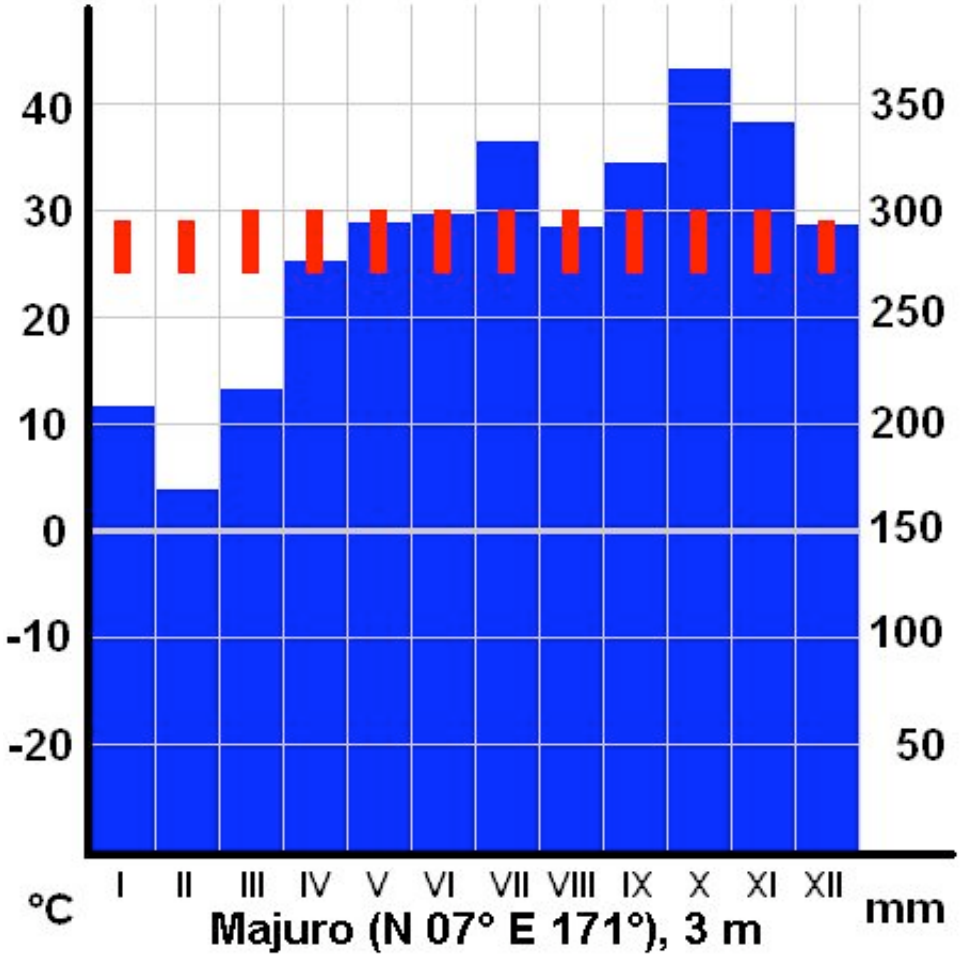
Island	Nlat	N Lat	E Long	Fresh	Lk-unk	Salt	Swamp	Lagoon	Notes	Refs.
				Lake	type	Lake	or Bog	Restr/anox		
Namorik	5	~5°						Y	likely anoxic	Dean Jacobsc
Jaluit	6	~6°		Y					several, may be shallow	Dean Jacobsc
Arno	7	07°05'	171°41'				Y			Fosberg (199
Lib	8	08°19'	167°25'	Y					Lib's Pond	Fosberg (199
Mejit	10	10°17'	170°53'	Y					much literature	Mark & Mabe
Kili				n						Mark & Mabe
Lae										
Madmad					Y				Next to Namorik	Mark & Mabe
Wotje				maybe					ment. by Jos. Maddison	

Chart of Potential Targets

Islands	Fresh Lake	Lake of unk type	Saltwater Lk	Bog	Notes & Refs.
Mejit	Y				Mark & Mabel; much literature
Lae					
Lib					
Kili	n				Mark & Mabel
Namorik					
Madmad		Y			Next to Namorik; Mark & Mabel

Climate & Meteorology

Monthly precip & T, Majuro



http://upload.wikimedia.org/wikipedia/commons/d/dc/ClimateMajuroMarshallIslands.PI

Logistics

Air Mashall Islands provides domestic inter-island air services within Marshall Islands.

http://www.airlineroutemaps.com/Oceania/Air_Marshall_Islands.shtml

Notes from RMI mtg at Arboretum - 3/3/07

•Mark ___: Marshallese citizen; getting MBA @ Gonzaga
•Freshwater lens under most atolls
•RMI just now coming out of months of drought (southern atolls)
•RMI population = 55,000
•10,000 RMI citizens live in USA
•Most freshwater used comes from personal rain catch
•70 km^2 of land in RMI
•~30 atolls; ~1200 islands within atolls
•A weather station funded by US gov't exists on Majuro Island (capital and main population center; 50,000 people--could be used as a base of operations for coring?
•Other major pop ctr is Kwajalein
•College of the Marshall Islands Marine Science Dept has been doing a lot of surveying of the reefs and fish
•S.I. rising 1"/decade

Notes from RMI mtg - 3/3/07, p2

•Science Talks: Sea Level (Ed Harrison)
•S.l. during lg El Ninos is ~40 cm lower than avg
•S.l may be rising 5 mm/yr over last ~10-20 yrs
•S.l sea lvl rise of 3 mm/yr virtually guaranteed; may be as high as 6 mm/yr
•Avg ht above s.l today is 7 ft for RMI

•Ocean Acidification (Dick Feely)
•16% of global coral reefs were bleached & lost in '97-8 El Nino
•Bleaching occurs typically when SST is >1°C above normal summer max SST
•pH dropped 0.1 pH units since 1880 (8.2 --> 8.1), a 30% decrease in H+
•CO_3^{2-} has declined 16% since 1880, consequently
•600-800 ppmV CO2 is the tipping point when coral can no longer ppt CaCO3 (I.e., when saturation state for the coral goes below zero)
•Calcification rate of all corals globally likely to decrease by 30% by 2100 due to acidification (linear rlnshp betw saturation state and calcification rate

•Tropical Rainfall Patterns (**Todd Mitchell**, Nathan Mantua)
•29 coral atolls (19 inhabited)
•5 coral pinnacles (4 inhabited)
•Rain gauge data:
•Majuro rainfall = 340 cm/yr (1954-2004); **16% decline** in annual rainfall over last 50 yr
•Kwajalein = 260 cm/yr (1946-2004); **9% decline** over 50 yr
•Eniwetok = 150 cm/yr (1947-1972); 43% INCREASE over 50 yr
•Jaluit = 400 cm/yr (1896-1968)

Notes from RMI mtg - 3/3/07, p3

•Rainfall (cont'd)
•More tropical storms & hurricanes in northern part of RMI (e.g., Eniwetok)
•"ENSO rainfall changes are notthat strong in Marshall Islands"
•**Large decrease in rainfall at Majuro Isl. DURING El Niño winter (J,F,M,A)**

Notes from RMI mtg - 3/3/07, p4

•Roundtable Discussion
•**Holly Barker** -- US facilitator for the Marshall Islands Embassy in US:
•Offering whatever help we scientists might need to conduct research in the Marshalls

•**Elizabeth Wilmott, Ron Simms** office (King County Executive) representative: believes RMI are poster child for the impact of climate change on island nations and coastal communities globally

•**Clarence Moriwaki, Jay Inslee** -- US Congressman from WA, representative: thinks climate change issue will be growing in prominence

•**Kara Coltiss**, office of insular affairs(?), Dept. of the Interior: $40M/yr goes into Marshall Islands from US for infrastructure

Notes from RMI mtg - 3/3/07, p5

•Other Notables
•Prof. Julie K. Stein, Director of Burke Museum & Professor of Archeology
•Measures d18O in mollusks from Puget Sound; particular research focus is the San Juan Islands
•Trained in Geology, and believes that the environment drives human civilization (an “Environmentalist”)
•Suggests getting in touch with Prof. Peter Lape (Dept. of Anthropology) who studies ENSO variaiotns & human civilization in East Timor, Banda Is., & islands in SE Asia

•Marshall Islands WILL disappear in next century, along with many small island nations
•WA, King County, Seattle, UW take the lead on DEALING with the inevitable loss of the small island nations (refugees, culture preservation, law, economics, science, engineering)
•Invite small island nation / climate refugees to live in WA (fund with EEZ fishing from sunken islands)
•UW Program on Climate Refugees & Small Island Annihilation

•Paleoclimatologists, geologists, archeologists, biologists etc need to get to the island nations before they disappear

Contacts

RMI Contacts

- Dean Jacobson atolldino@yahoo.com, located in RMI, scientist studying reefs and lagoons in RMI

References

Vegetation & Climate Refs.

Williamson, I., Sabath, M., (1982) Island population, land area, and climate: A case study of the Marshall Islands. *Human Ecology*, 10(1), 71-84.

Hatheway, W. H. 1953 "The land vegetation of Arno Atoll, Marshall Islands." A.R.B. 16: 1-68.

http://www.antiquity.ac.uk/projgall/Pre2003/Weisler/weisler.html

Refs, cont'd.

References are composed simply of an abbreviated author name followed by the number and pages in the *Atoll Research Bulletin*. This gives just enough information to make the reference perfectly unique without taking up too much space. These references are even informative in and of themselves. From them researchers know who wrote an article, its length, and, roughly when it was written (knowing that it began in 1951 with number 1 and that this issue is number 347).

-From *Atoll Research Bulletin* Vol. 347, Feb. 1991.

MARSHALL ISLANDS
Anthropology, Cultural Ecology
Doran, Edwin 85:11-16
Neas, Maynard 85:17-24

Botany: Flora and Vegetation
Fosberg, F. Raymond 68:1-9
Fosberg, F. Raymond 330:1-100
Wiens, Herold J. 54:1-23

Slicks of film downwind of reefs
Fosberg, F. Raymond 53:1-4

Zoology and Ecology
Birds
Amerson, A.B. 127:1-348
Fosberg, F. Raymond 330:1-100

Crustaceans, Decapods and Stomatopods
Holthuis, L. B. 24:1-66

MARSHALL ISLANDS, ARNO
Anthropology
Cultural ecology and demography
Hatheway, William H. 16:1-68
Hiatt, Robert W. 4:1-13
Mason, Leonard 10:1-21
Mason and Uyehara 17:116-121
Stone, Earl L. 6:1-46
Tobin, Jack 11:1-36

Botany
Algae
Wells, John W. 9:1-29

Bryophytes
Miller and Doty 25:1-11

Flora
Anderson, Donald 7:1-4

Climate
Cox, Doak C. 8:1-31

Ecology
Terrestrial
Marshall, J. T. 3:1-38
Usinger, R. and I. Rivers 15:1-28

Reefs
Wells, John W. 9:1-29
Hiatt, Robert W. 4:1-13

Economic Development
Coolidge, Harold J. 1:2-5
Hiatt, Robert W. 4:1-13

Geology
Fresh water
Arnow, Ted 30:1-7
Cox, Doak C. 8:1-31

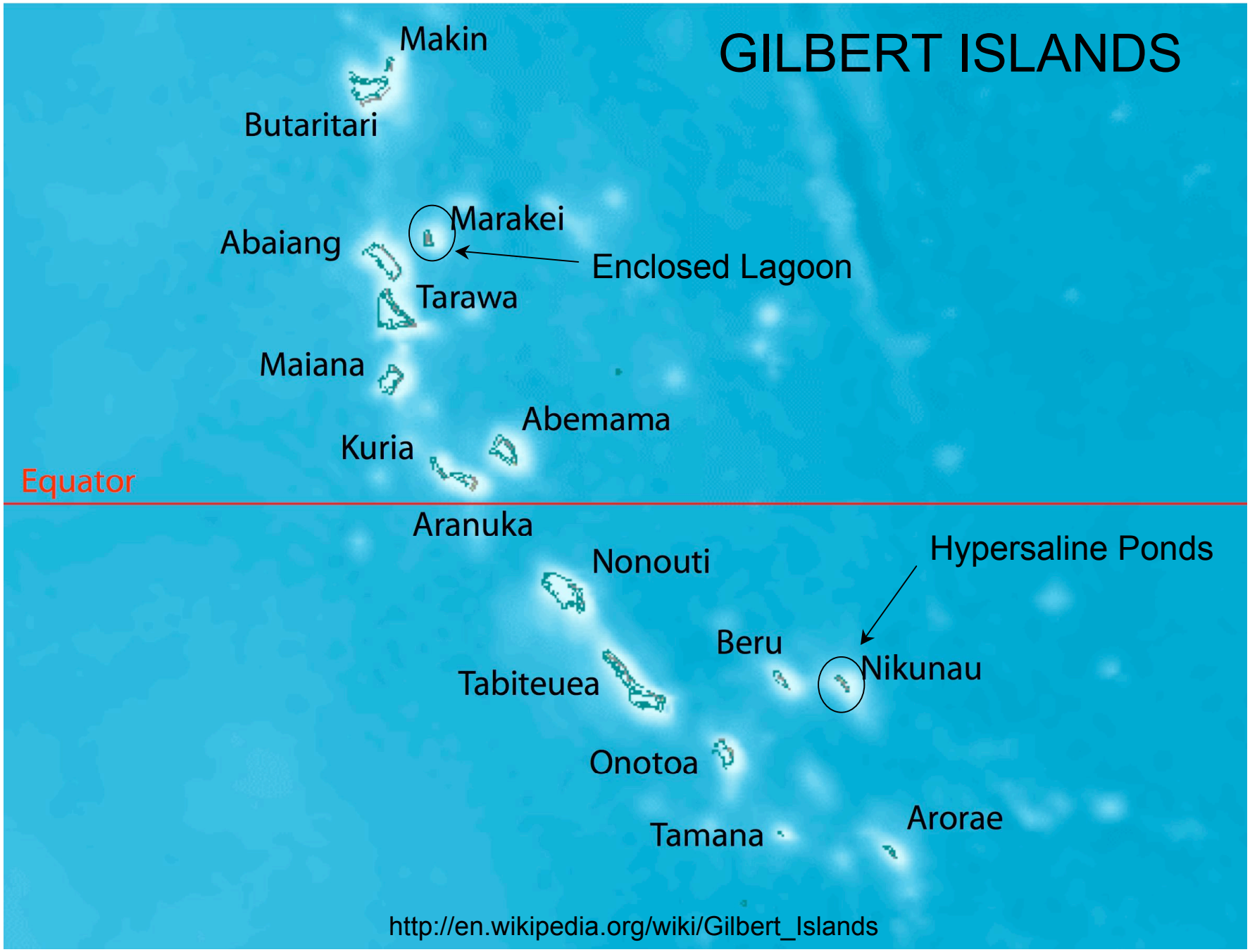
Sediments and soils
Stone, Earl L 5:1-56

Health
Marshall, J. T. 3:1-38
Milhurn, John D. 62:1-7
Usinger, R. and I. Rivers 15:1-28

Research Programs
Coolidge, Harold J. 1:2-5

Refs, cont'd.

Refs, cont'd.


GILBERT ISLANDS
Makin
Butaritari
Marakei
Abaiang
Enclosed Lagoon
Tarawa
Maiana
Abemama
Kuria
Equator
Aranuka
Nonouti
Hypersaline Ponds
Beru
Nikunau
Tabiteuea
Onotoa
Arorae
Tamana
http://en.wikipedia.org/wiki/Gilbert_Islands

Gilbert Islands - Climate Zonation

Marshall Islands

Gilbert Islands

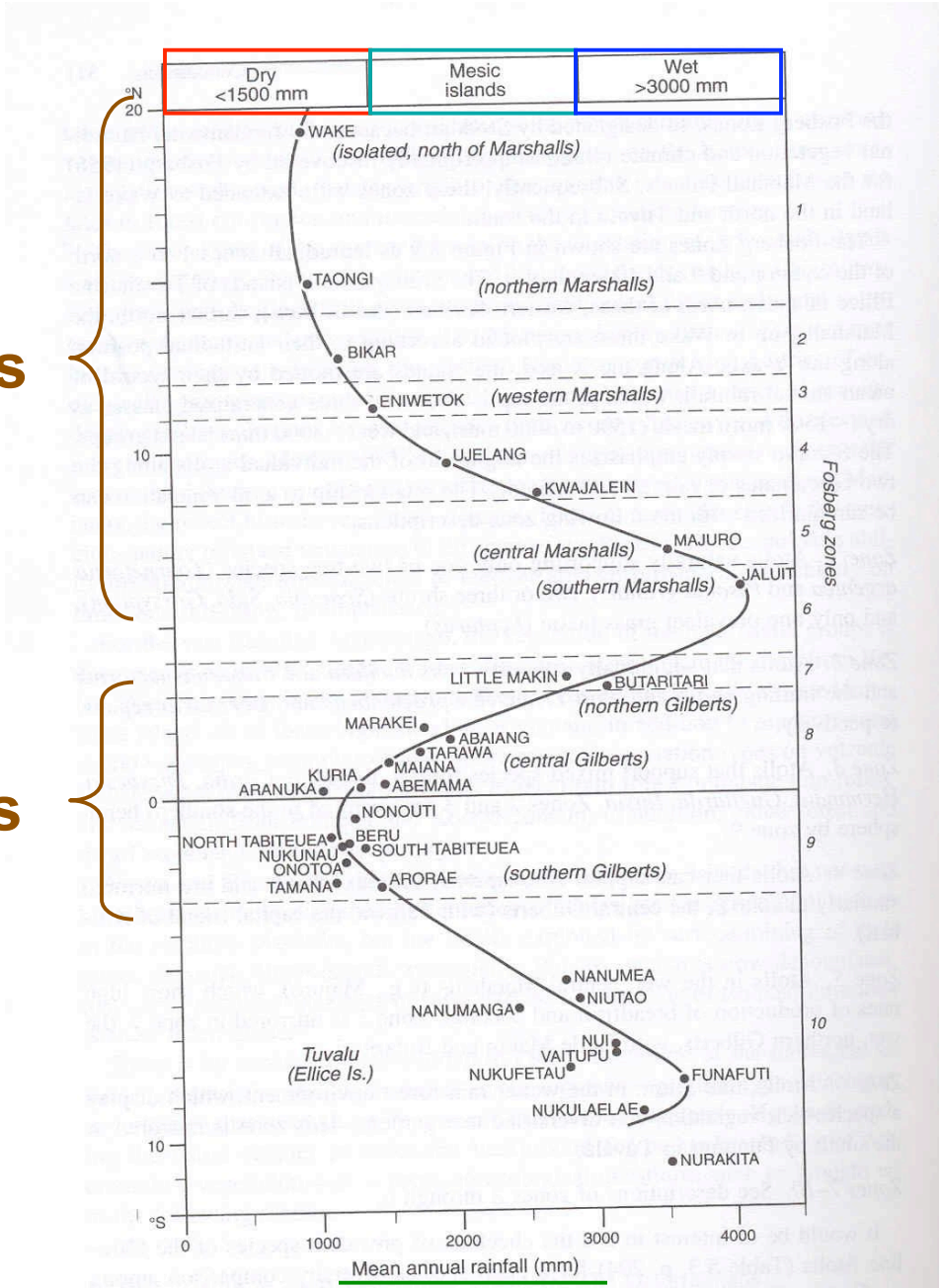


FIGURE 5.9. Latitudinal trend of mean annual rainfall in eastern Micronesia, from the northern Marshalls to the southern Gilberts (Kiribati) and Ellice Islands (Tuvalu), summarized by Fosberg Zones. For seasonality, see climate diagrams of Wake, Ujelang, Tarawa (Fig. 5.2, p. 202), and Funafuti (Tuvalu) (Fig. 3.2, p. 87). (Adapted with modi-

Nikunau Atoll - Hypersaline Ponds, 1°21’ S, 176°27’ E

Nikunau Atoll

Nikunau is a low coral island located in the Gilbert Islands. The island is also a district of Kiribati. The island consists of two parts (the larger one in the northwest) which are joined by an isthmus about 150 m wide.

There are several landlocked, hypersaline lagoons located within the island, measuring about 0.3 km² in area. The island is surrounded by a narrow fringing reef. Vegetation on Nikunau is moderately dense and consists largely of Coconut palms and Pandanus.

The population of the island averages about 3000 I-Kiribati people. Typically, there are also two American Peace Corps Volunteers stationed here.

Nikunau is known throughout Kiribati for their lengthy Botakis and intense fly population. Nikunau Botakis can last anywhere from one evening to months at a time.

Surf on Nikunau ranges depending on location, but averages 2 ft to 8 ft in height. The tip of Nikunau, located near the airstrip, has the largest waves on the island. This is the point where two tides meet, clashing one wave with another, thus creating amazing tides, waves, and currents.

http://en.wikipedia.org/wiki/Nikunau

Tamana Atoll - looks like it may have a pond….

Coordinate	2° 30′ 0″ S, 175° 59′ 0″ E	Decimal	-2.5°, 175.983333°

Tamana, Gilbert Islands

Tamana is the smallest island in the Gilbert Islands. It is accessible by boat and air.

Tamana Airport is in the northern part of the island and is served by Air Kiribati from Tabiteuea North, with the way there stopping twenty minutes at Arorae.

Of course the other way round is also possible: Flying to Arorae, stopping at Tabiteuea North.

http://en.wikipedia.org/wiki/Tamana%2C_Gilbert_Islands

Marakei Atoll, Northern Gilberts, 2°00’N, 173°16’E: Fully-enclosed Lagoon

Marakei

Marakei Atoll

Marakei is a small atoll in the North Gilbert Islands. The central lagoon consists of numerous deep basins and surrounded by two large islands which are separated by two narrow channels. The atoll covers an area of 13.5 km².

The two narrow channels, which are inaccessible at low tide, are called Baretoa Pass and Reweta Pass.

http://en.wikipedia.org/wiki/Marakei