



Bathymetric and 3-D Maps of the U.S. Pacific Remote Islands: Collaborative Mapping in the Pacific

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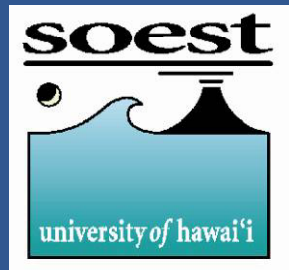
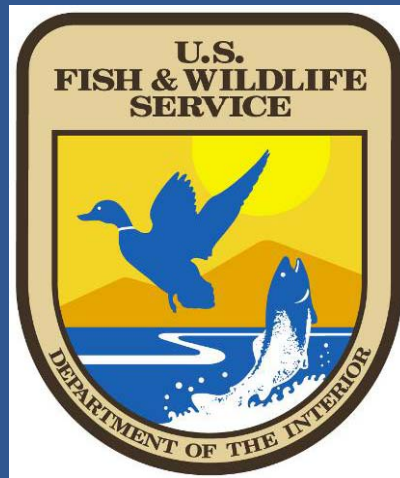
U.S. Coral Reef Task Force Goal



Produce comprehensive digital maps of all shallow (<30m) coral reef ecosystems in the United States and characterize priority moderate-depth reef systems by 2009.



Collaborative Mapping In the Pacific



NOAA Partners:

- PIFSC
- NMSP
- NWHI MNM
- Biogeo
- OCS
- NGDC
- IOCM
- PSC

University Partners:

- Oregon State
- New Hampshire
- Guam
- Florida
- Scripps IO



Commonwealth of the Northern Mariana Islands, Territories of Guam and American Samoa



Pacific Moderate Depth Mapping



R/V *AHI*

NOAA Ship *Hi'ialakai*



240 kHz
Reson 8101ER
250 m range
101 beams



300 kHz
EM3002D
150 m range
250-500 "soundings"

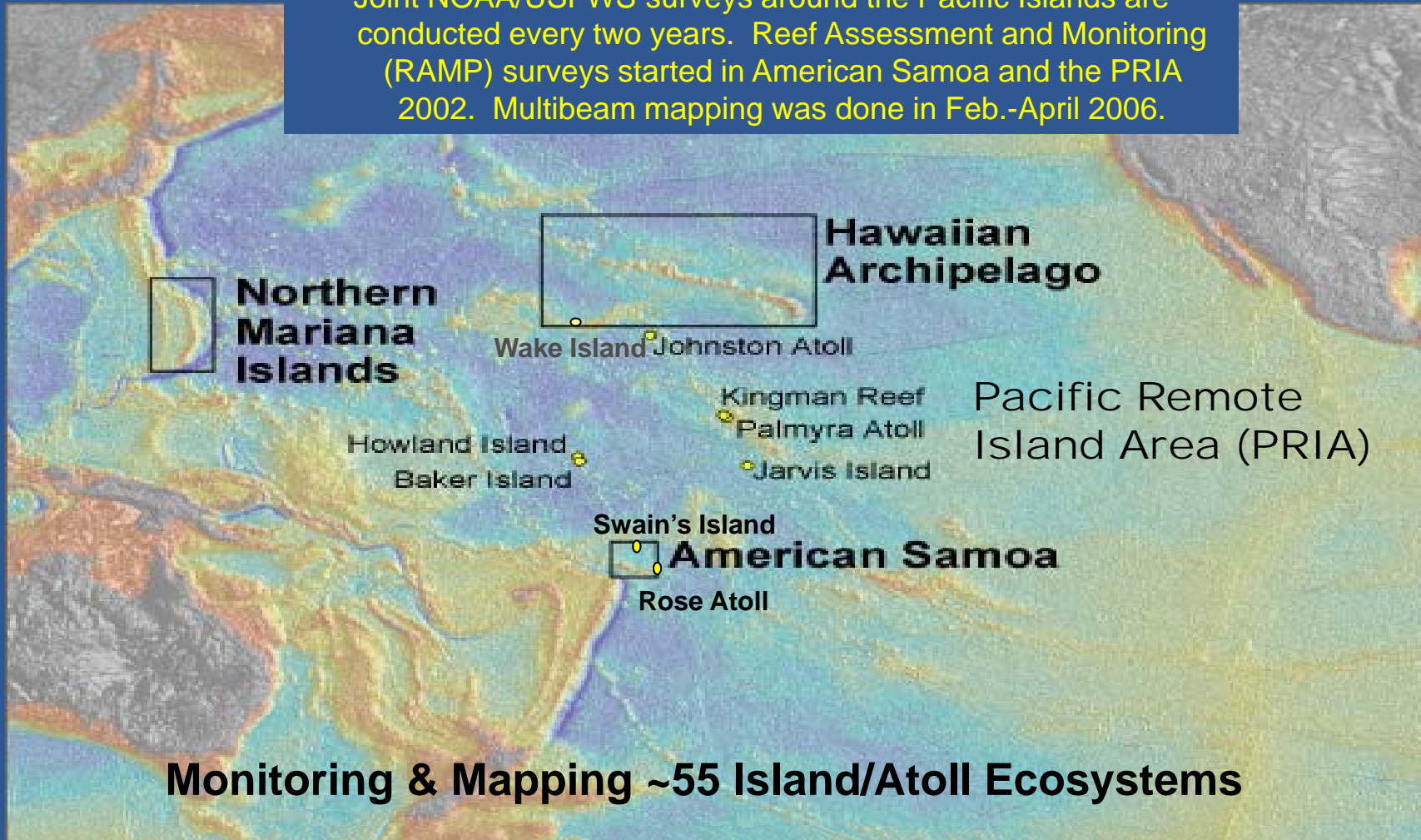
30 kHz
EM300
5000 m range
135 beams



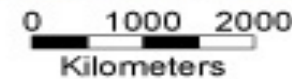
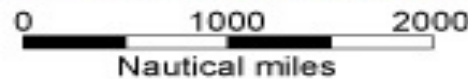
U.S. Pacific Islands: Vast and Remote



Joint NOAA/USFWS surveys around the Pacific Islands are conducted every two years. Reef Assessment and Monitoring (RAMP) surveys started in American Samoa and the PRIA 2002. Multibeam mapping was done in Feb.-April 2006.



Pacific Islands





Multibeam Coverage Since 2001

NWHI (2002/KM)	38,367 km ²
NWHI (2003-2006)	2,821 km ²
MHI (2005-2006)	2,505 km ²
CNMI/Guam (2003)	244 km ²
Am. Samoa (2004-2006)	1,385 km ²
<u>PRIA</u> (2006)	<u>3,793 km²</u>
Total	49,115 km² (14,319 nm²)



PRIA Under U.S. Jurisdiction



Size – Land Mass – Total Managed Area

- Baker Island – 1.64 km² – 123.45 km²
- Howland Island – 1.84 km² – 129.8 km²
- Jarvis Island – 4.4 km²
- Johnston Island – 2.6 km² – 130 km²
- Kingman Reef – 0 km² (reef)
- Palmyra Atoll – 2.75 km² – 62.7 km²
- Rose Atoll – 0.06 km² – 159.1 km²
- Swains Island – 1.5 km²

(For comparison, Rabbit Island 0.25 km², Mokapu 12 km²)

USFWS National Refuges

- Baker Island
- Howland Island
- Jarvis Island
- Johnston Island
- Kingman Reef
- Palmyra Atoll
- Rose Atoll

Habitation/Usage History

- Baker (1935-1942) – Kamehameha Schools
- Howland (1935-1942) – Kamehameha Schools
- Jarvis (1935-1942) – Kamehameha Schools
- Johnston (1858-2003) – Various groups
- Kingman (1937-1938) – Pan Am Airlines
- Palmyra (1862-2006) – Private ownership
- Swains (1856-2006) – Private ownership

Guano Mining

- Baker Island
- Howland Island
- Jarvis Island
- Johnston Island



Geography and Geology



Line Islands

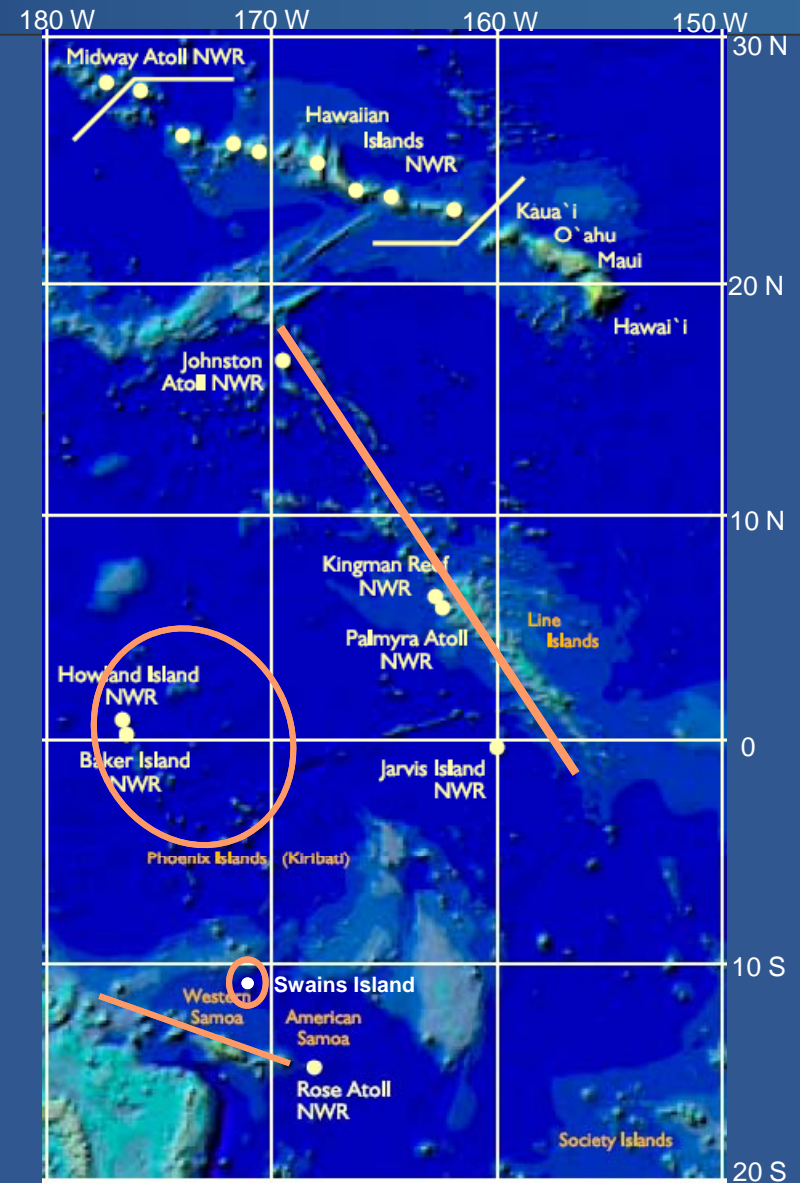
- Johnston and Jarvis Isl., Kingman Reef, Palmyra Atoll
- Originally thought to be a single “hot spot” trace
- General age trend 93 my in north 44 my in south
- But recurrent volcanic activity in both north and south
- Line Islands has been dated as Late Cretaceous (65-89 my) to Eocene (34-56 my)
- Crossed by three fracture zones
- Ridge crest model, fracture zone model, multiple hot spot model, and lithospheric architecture/stress model proposed as formation mechanisms

Phoenix Islands (now Rawaki Islands, Kiribati)

- Seven other islands part of Kiribati
- Howland and Baker (U.S.) have no strong linear or geologic association with other islands

American Samoa

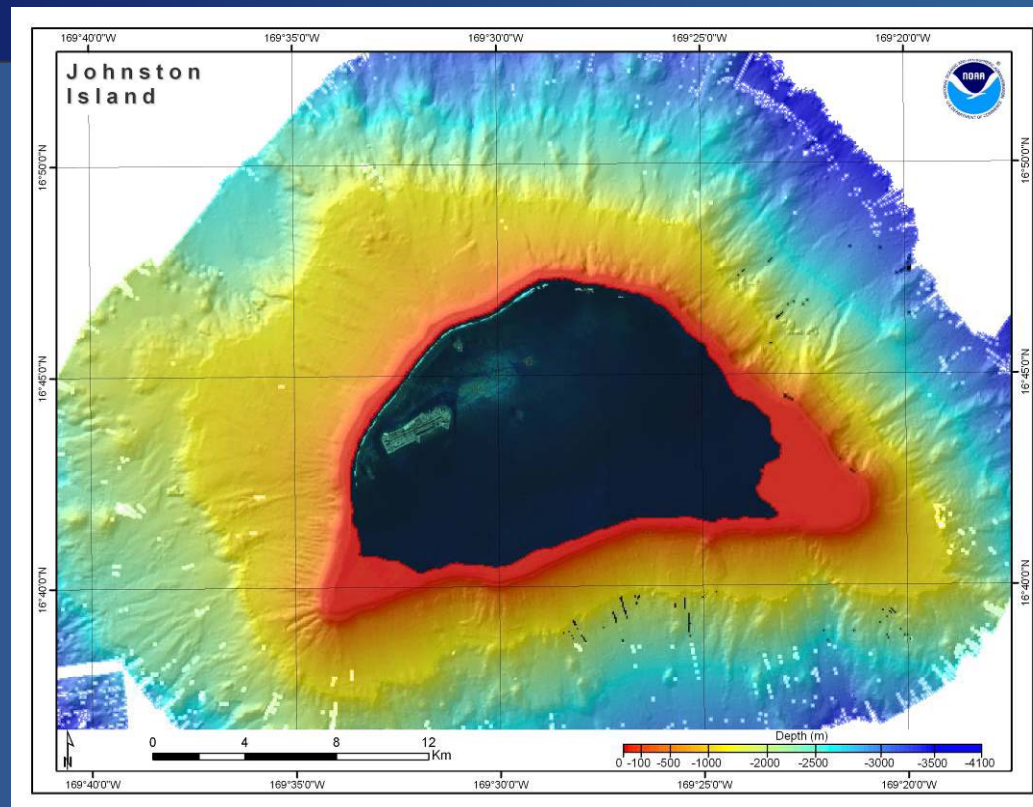
- The Samoan chain is a probable hotspot trail, with an active seamount (Vailul'u) between Ta'u and Rose.
- This is complicated by recent volcanism at western end of chain caused by intersection with the Tonga Trench
- Rose is an atoll with no surface volcanic rocks and is an anomaly in the hotspot hypothesis
- Swains Island lies 200 miles to north and is not in hotspot trail, more similar to Rawaki Islands



Map from USFWS – Howland Island, Baker Island, Jarvis Island National Wildlife Refuges – Planning Update 2005



Johnston Island/Atoll



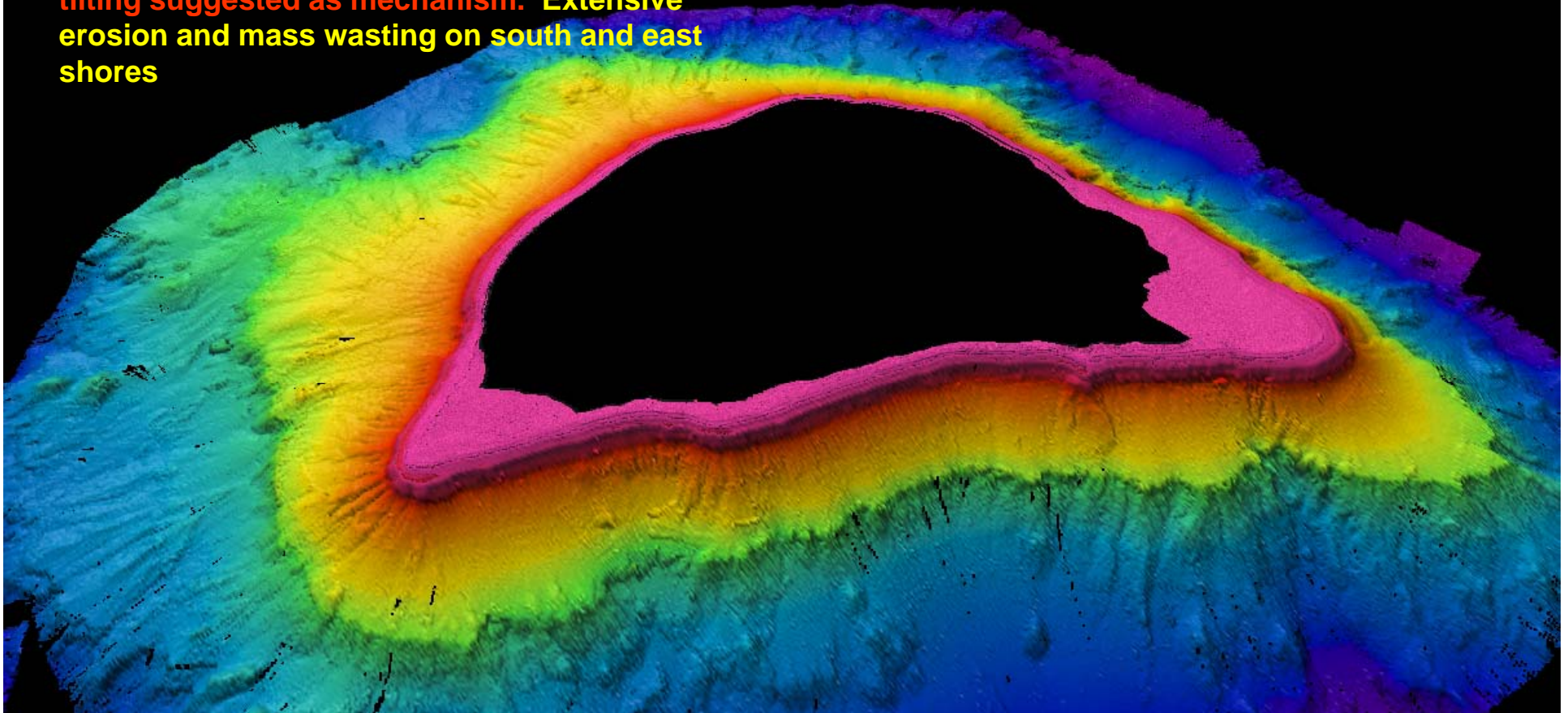
- Discovered in 1796 – Brig *Sally* ran aground.
- 1807 – Named for Capt. Johnson, HMS *Cornwallis*
- 1858 – Claimed by both U.S. and G.B., guano mining
- 1909-1924 – Privately owned under Terr. of Hawai'i
- 1923 – Mapped by *Tanager* expedition
- 1926 – Federal Bird Refuge, DOI (Roosevelt)
- 1934 – U.S. Navy control, jointly with DOI
- 1941-1945 – WWII – attacked by Japanese
- 1945-2003 – Variety of military usage, 1100 pop., toxic waste disposed there
- 2003 – USFWS National Wildlife Refuge
- July 2006 – Listed for sale on GSA Office of Property Disposal website!



Johnston Island/Atoll

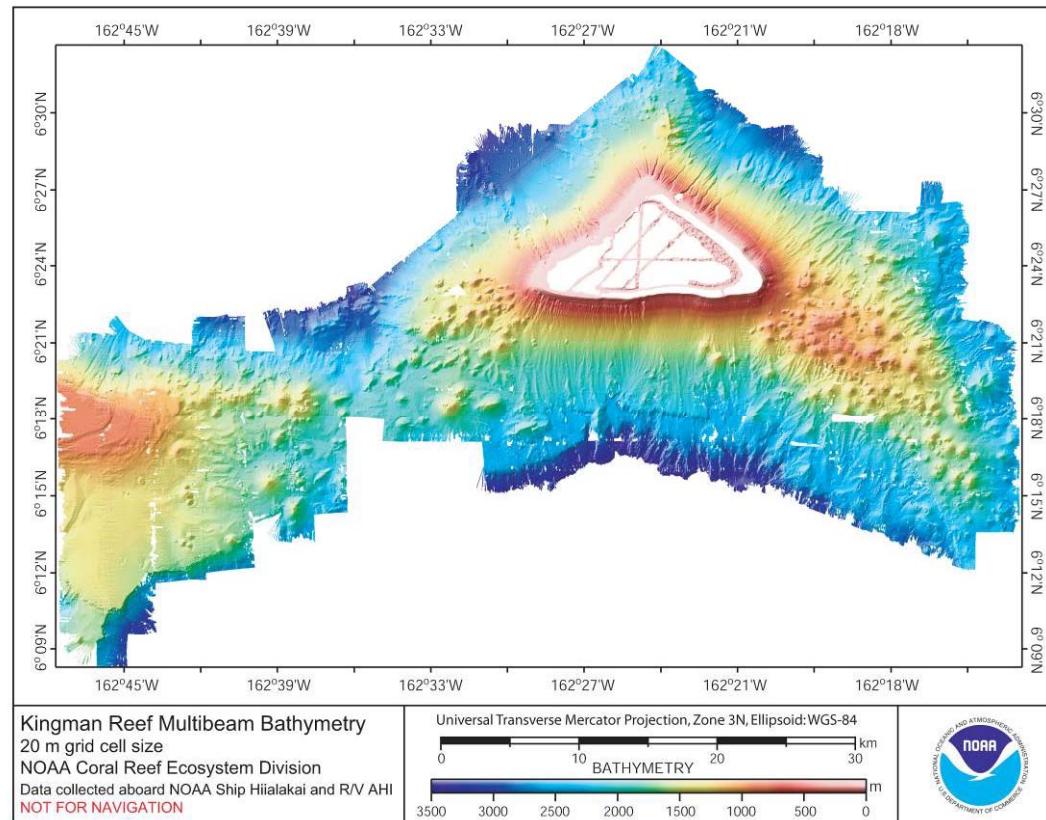


- North end of Line Island chain
- Volcanism at 86 and 45 mya
- 4 small islands, enlarged or built by Navy, **not** a classic atoll structure with surrounding reef
- Best developed reef is on northwest side, recent tilting suggested as mechanism. Extensive erosion and mass wasting on south and east shores
- Thought to be a genetic “gateway” to parts of NWHI, most likely French Frigate Shoals, very isolated island
- Most northeastern Pacific outpost for several types of corals
- 14 species of seabirds and 5 of shorebirds





Kingman Reef



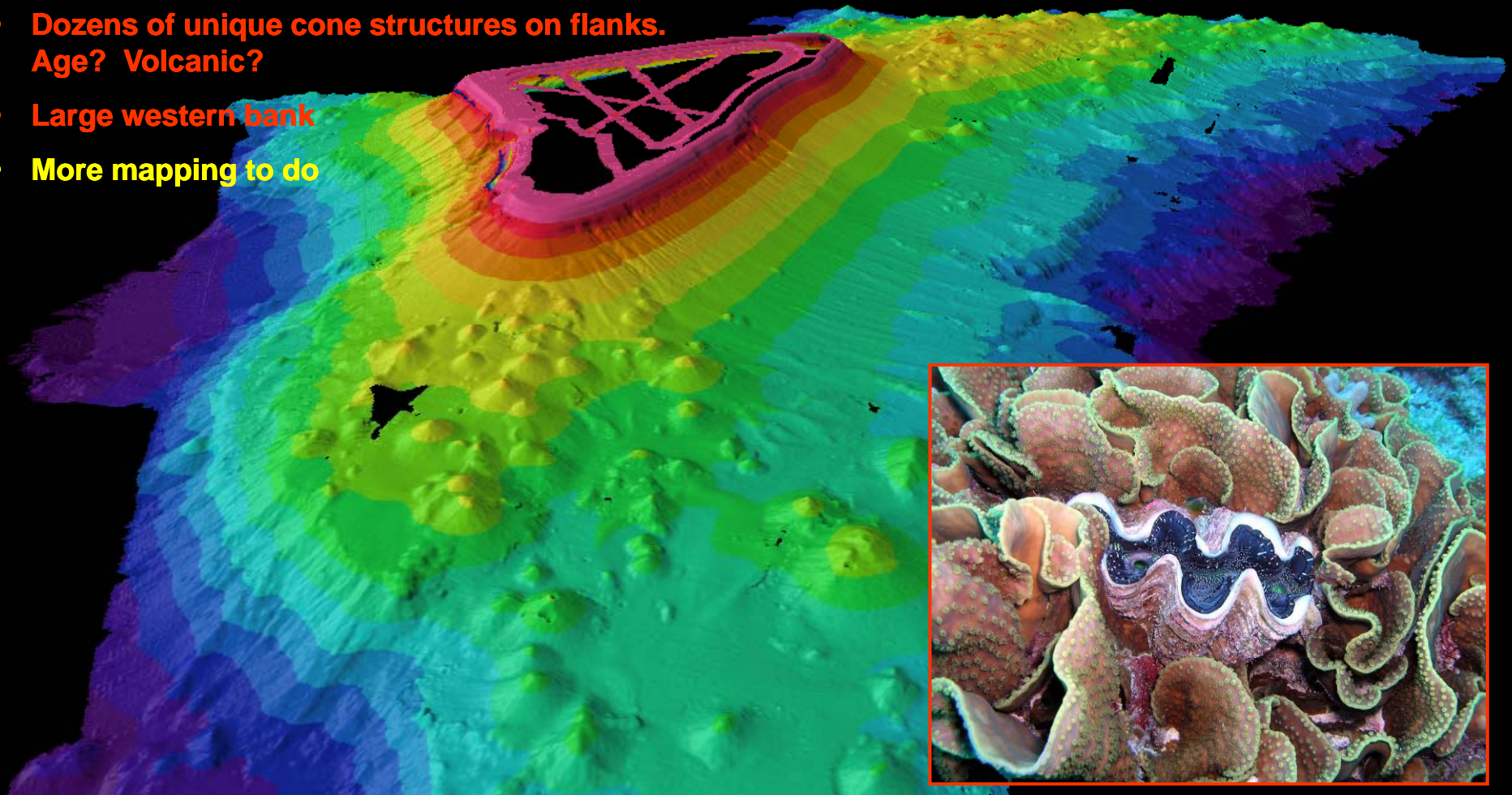
- 1798 – Discovered by Capt. Fanning of *Betsy* and was called “Danger Reef”
- 1853 – Described by Capt. W. E. Kingman
- 1856 – Claimed by U.S. under Guano Act
- 1922 – Annexed to U.S. by Palmyra Copra Co.
- 1926 – Surveyed by U.S.S. *Wippoorwill*
- 1937 – U.S. Navy Reservation
- 1937-1938 – Pan American seaplane stop
- 2001 – USFWS National Wildlife Refuge



Kingman Reef

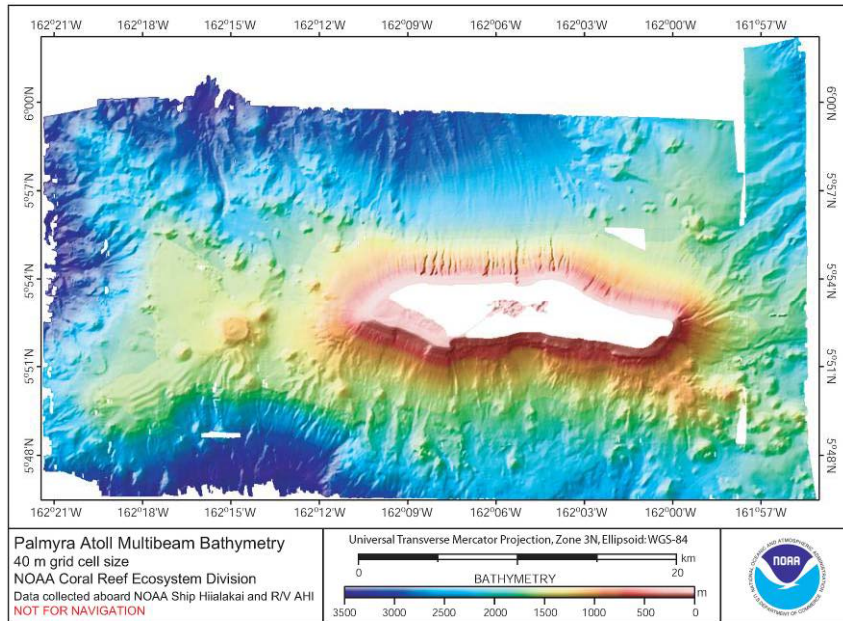


- **V-shaped reef, mostly submerged.**
- **Middle of Line Island Chain, 35 nm from Palmyra**
- **Geological ages in this area in 45-95 my range**
- **Dozens of unique cone structures on flanks. Age? Volcanic?**
- **Large western bank**
- **More mapping to do**
- **In path of east flowing Equatorial Countercurrent, which brings larval reef species from diverse corals of W. Pacific, very high biodiversity**





Palmyra Atoll



- Palmyra Atoll has three interior lagoons, 2 of which were surveyed. Other is inaccessible. There are 55 islets and sand bars around atoll.
- There is a small shelf on west end of island.
- Evidence of erosion, particularly on s. flank.

- 1798 – Discovered by Capt. Fanning
- 1802 – Vessel *Palmyra* ran aground
- 1816 – Spanish pirate ship wrecked
- 1859 – Claimed by U.S. under guano act, but is too rainy for guano to accumulate
- 1862 – Claimed by Kingdom of Hawaii and Bent and Wilkinson granted property rights
- 1898 & 1911 – Claimed by US
- 1862-1922 – Numerous private owners
- 1922 – Sold to Fullard-Leo family
- 1941-1947 – U.S. Navy air facility
- 1947 – Supreme Court returned island to Fullard-Leo family
- 1961 – Kennedy assigns management to DOI
- 1974 – Two murders at Palmyra Atoll
- 2000 – Sold to The Nature Conservancy
- 2001 – USFWS National Wildlife Refuge
- 2005 – TNC scientific research center built



Palmyra Atoll

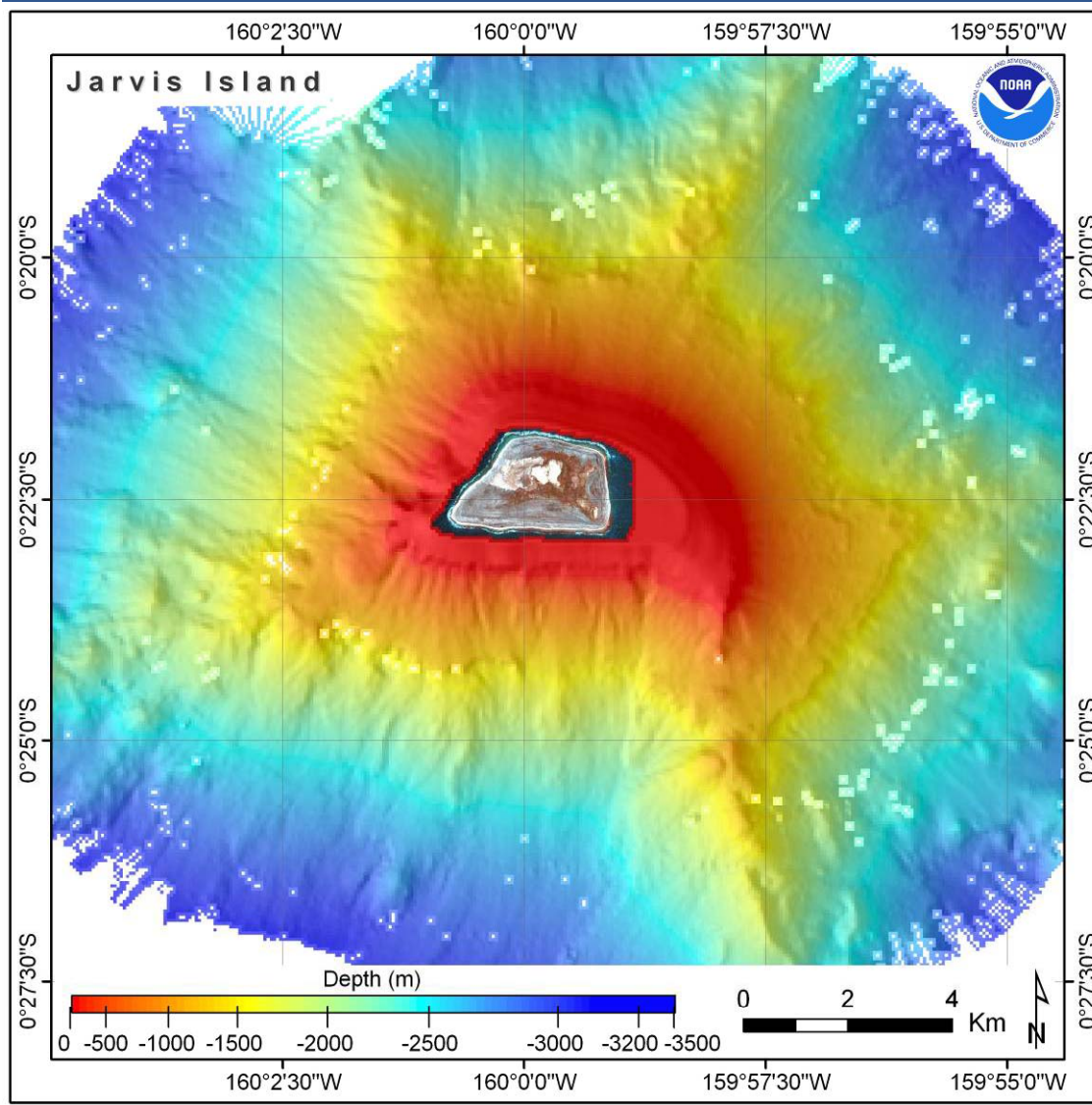


- Middle of Line Island Chain, 35 nm from Kingman
- Geological ages in this area in 45-95 my range
- Very steep slope on north shore of island
- Small rise found 11 km west of atoll
- Lush, tropical climate, 175" rain/year
- Also, in Equatorial Countercurrent with high biodiversity, 125 coral species.





Jarvis Island

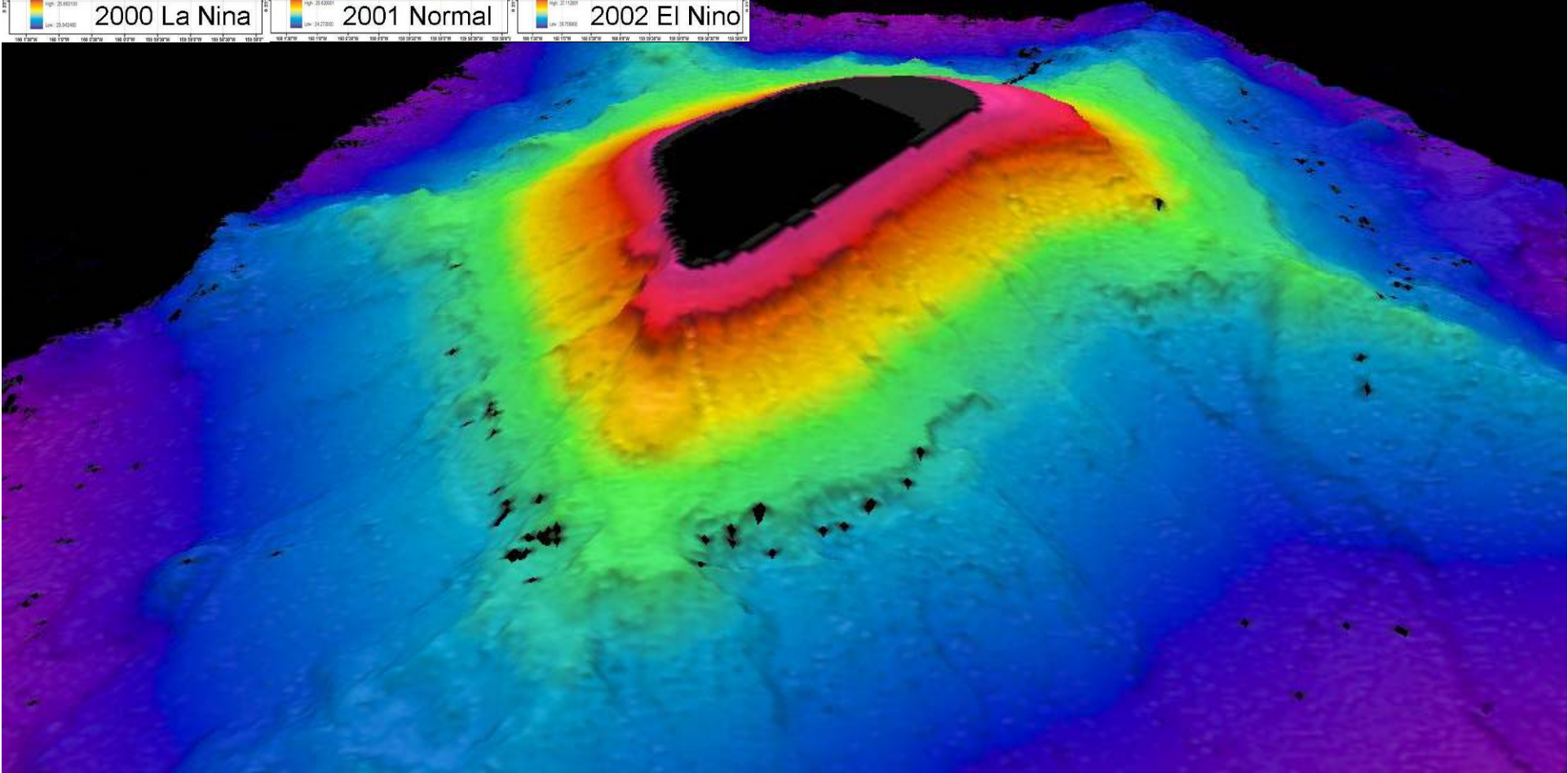
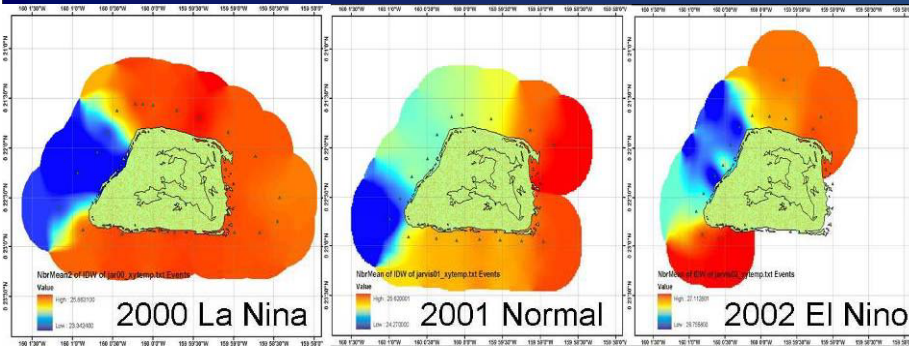


- 1821 – Discovered by British ship *Eliza Frances* and named for owner
- 1856 – Claimed by US under Guano Act
- 1886-1934 – British Overseas Territory, but guano mining conducted by U.S.
- 1935-1942 – Colonization by students and faculty of Kamehameha Schools
- 1942 – After Howland & Jarvis Islands were attacked by Japanese, Jarvis was evacuated by U.S. Coast Guard aboard *Roger B. Taney*, and all buildings on island were burned
- 1957-1958 – occupied as part of International Geophysical Year
- 1974 – Established as USFWS National Wildlife Reserve
- 1983 – Successful project to eradicate feral cats



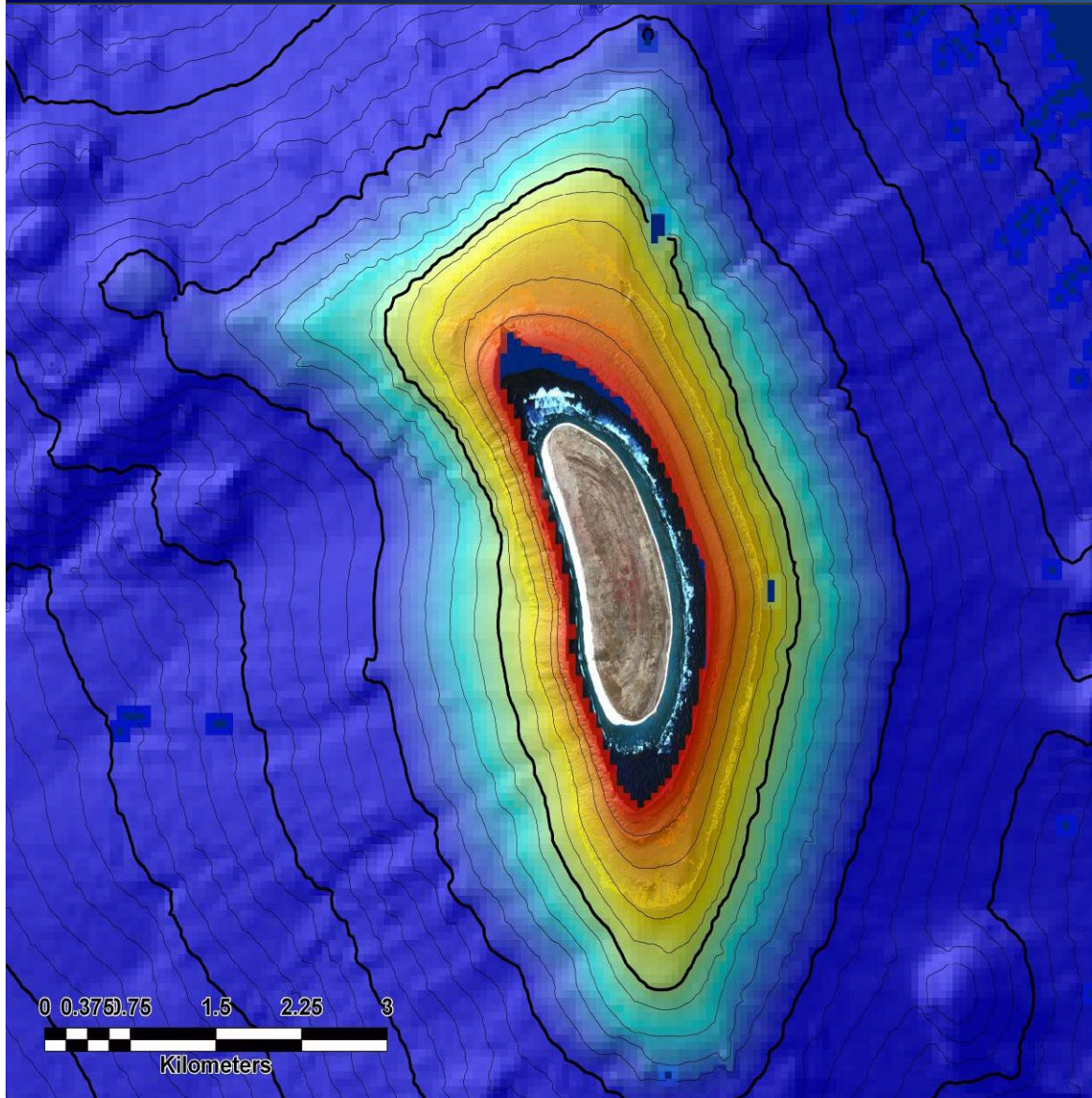
Jarvis Island

- Southern end of Line Island chain
- Geologic age in area is 38-72 mya
- Upwelling from Equatorial Undercurrent at Jarvis, Howland & Baker enriches west side of islands. Deep (200-400 m) corals found at Jarvis in 2005.





Howland Island



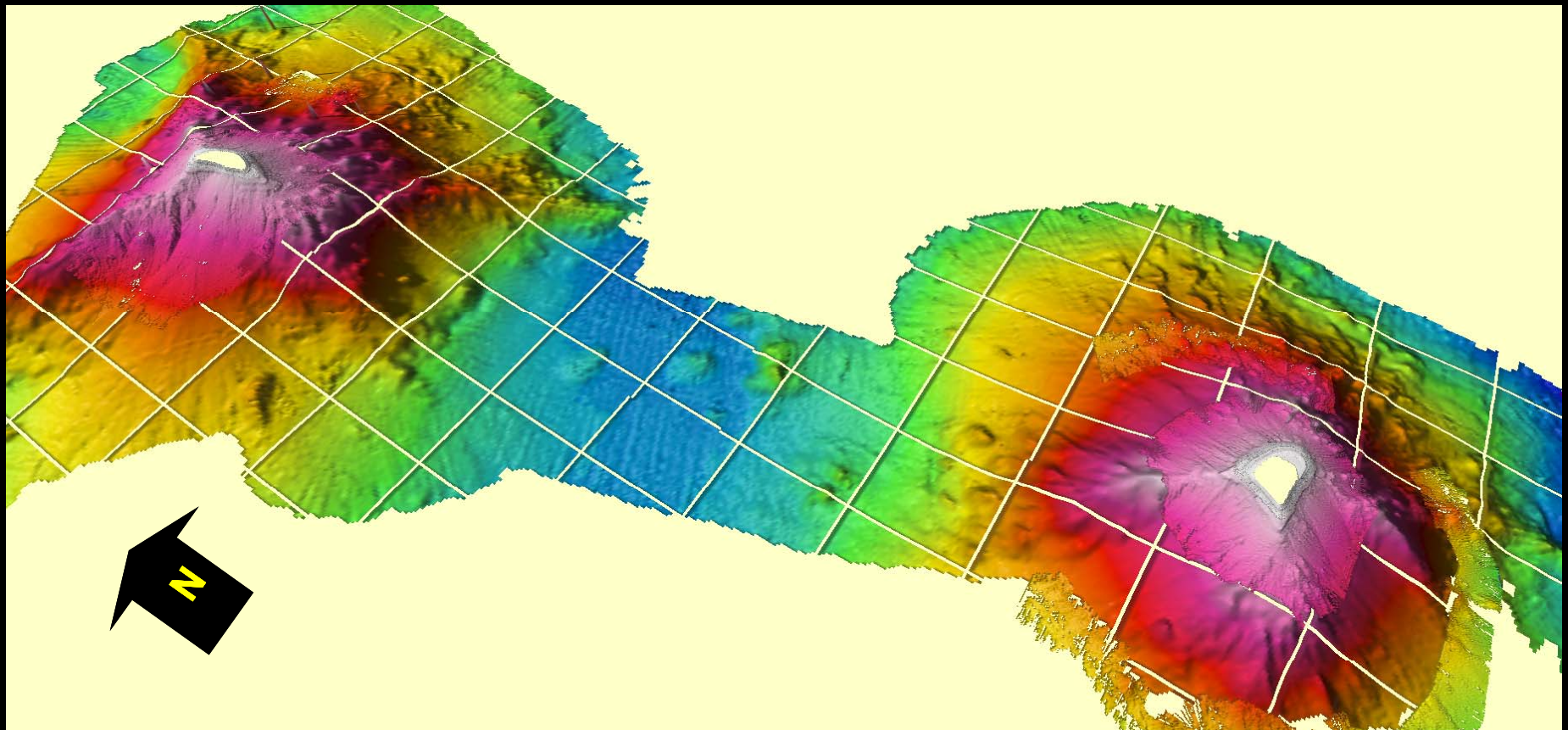
- 1821 – Discovered by U.S. whaler *Oeno* and named *Worth Isl.* for Capt.
- 1842 – Named for lookout on U.S. whaler *Isabella*
- 1856 – Claimed by US under Guano Act, mined until ~1900
- 1886-1934 – British Overseas Territory
- 1935-1942 – Colonization by students and faculty of Kamehameha Schools. Three runways and a beacon were constructed to be used by A. Earhart.
- Dec 8-10, 1941 – attacked by Japanese and two colonists were killed. Evacuated Jan. 31, 1942.
- 1942-1945 – used as airbase by U.S. military, much debris left behind
- 1974 – Established as USFWS National Wildlife Reserve
- 1980s – Ham radio operations
- 1991-1992 – listed as possible Superfund site by EPA



Howland and Baker Islands

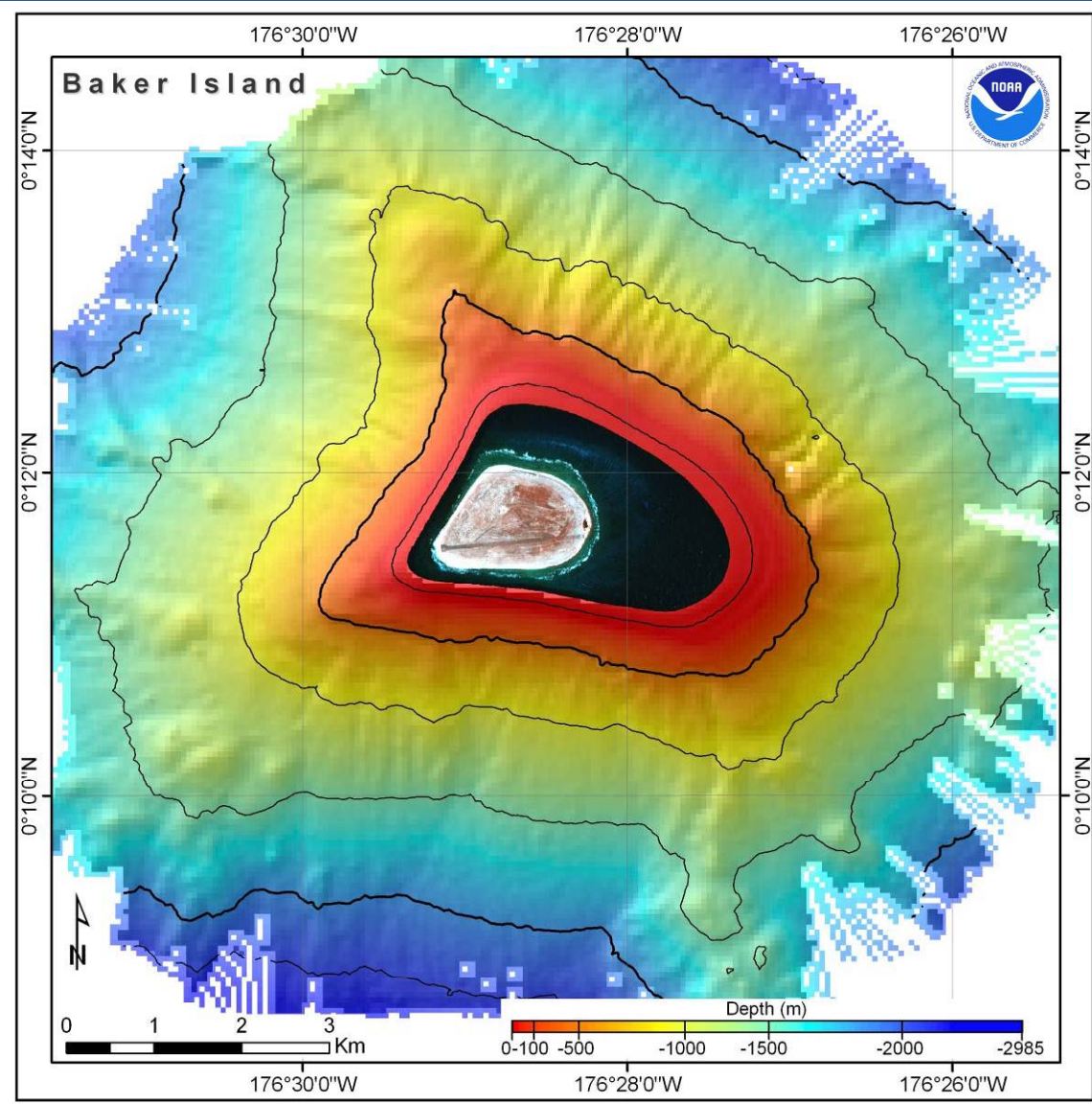


- Part of Phoenix/Rawaki Islands, little known about geology of area
- Deeper data from Seamount Catalog, SIO
- Howland N-S alignment, Baker E-W
- Both islands show erosional features on deeper flanks to east, steep upper slopes
- Both in Equatorial Undercurrent with upwelling and high biodiversity





Baker Island



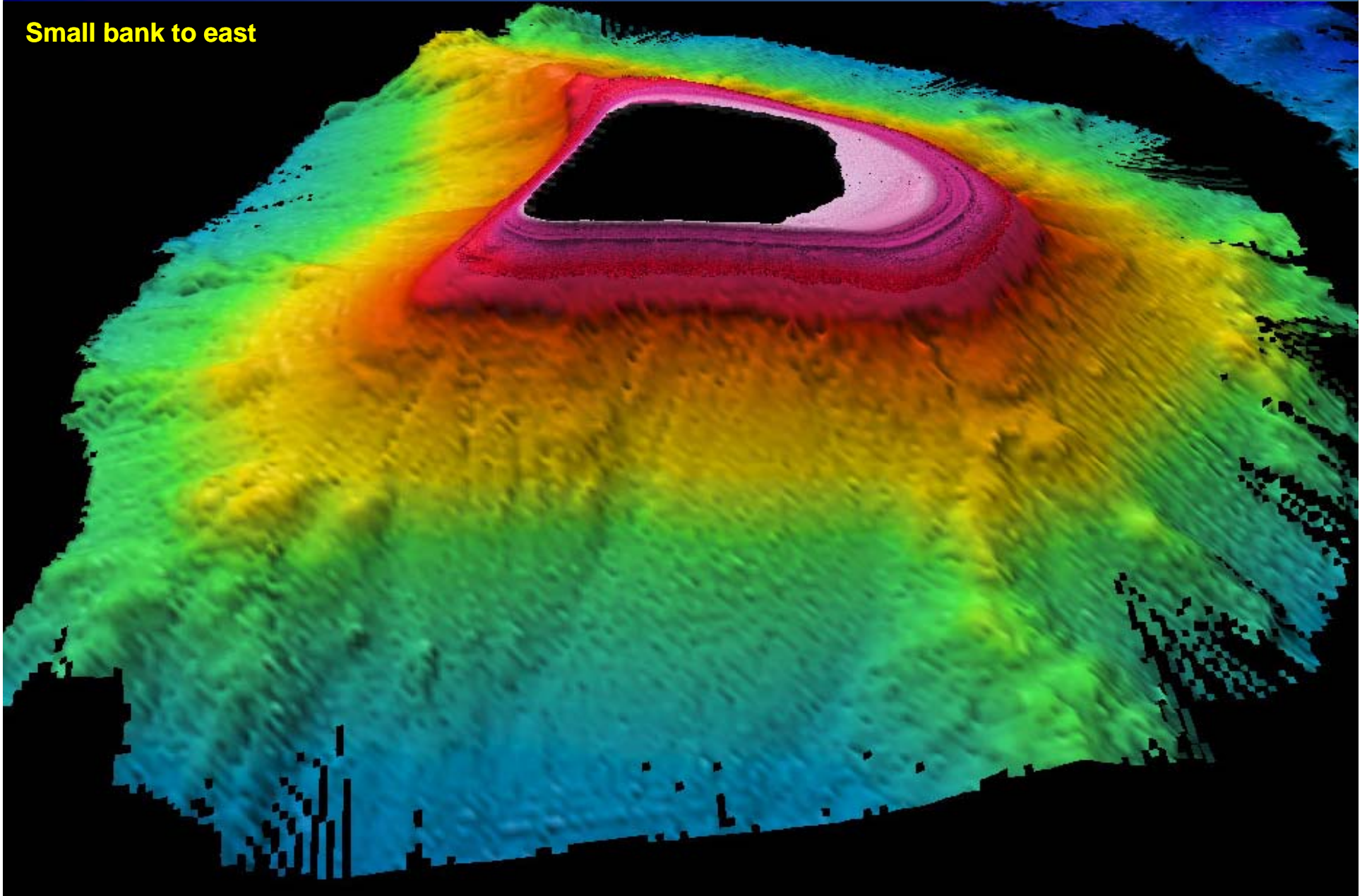
- **1856 – Claimed by US under Guano Act, mined until ~1900 when guano stocks were depleted**
- **1886-1934 – British Overseas Territory**
- **1935-1942 – Colonization by students and faculty of Kamehameha Schools.**
- **Dec 8-10, 1941 – attacked by Japanese. Evacuated Jan. 1942.**
- **1942-1945 – used as airbase by U.S. military.**
- **1964 – Feral cats eradicated.**
- **1974 – Established as USFWS National Wildlife Reserve**



Baker Island



Small bank to east



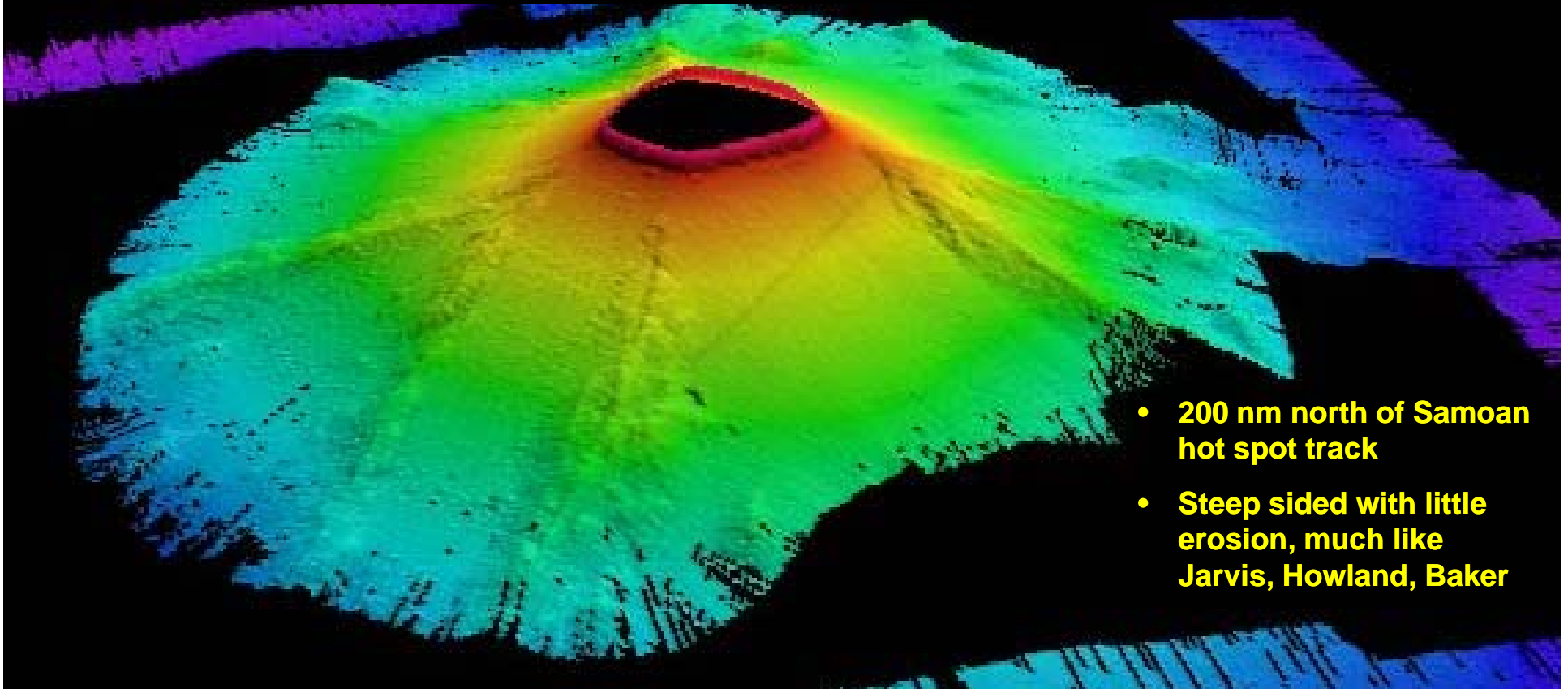
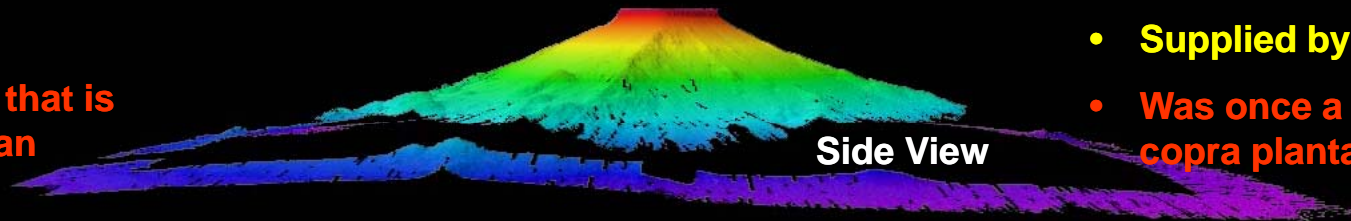


Swains Island



- Part of American Samoa
- Privately owned
- Has central lake that is cut off from ocean

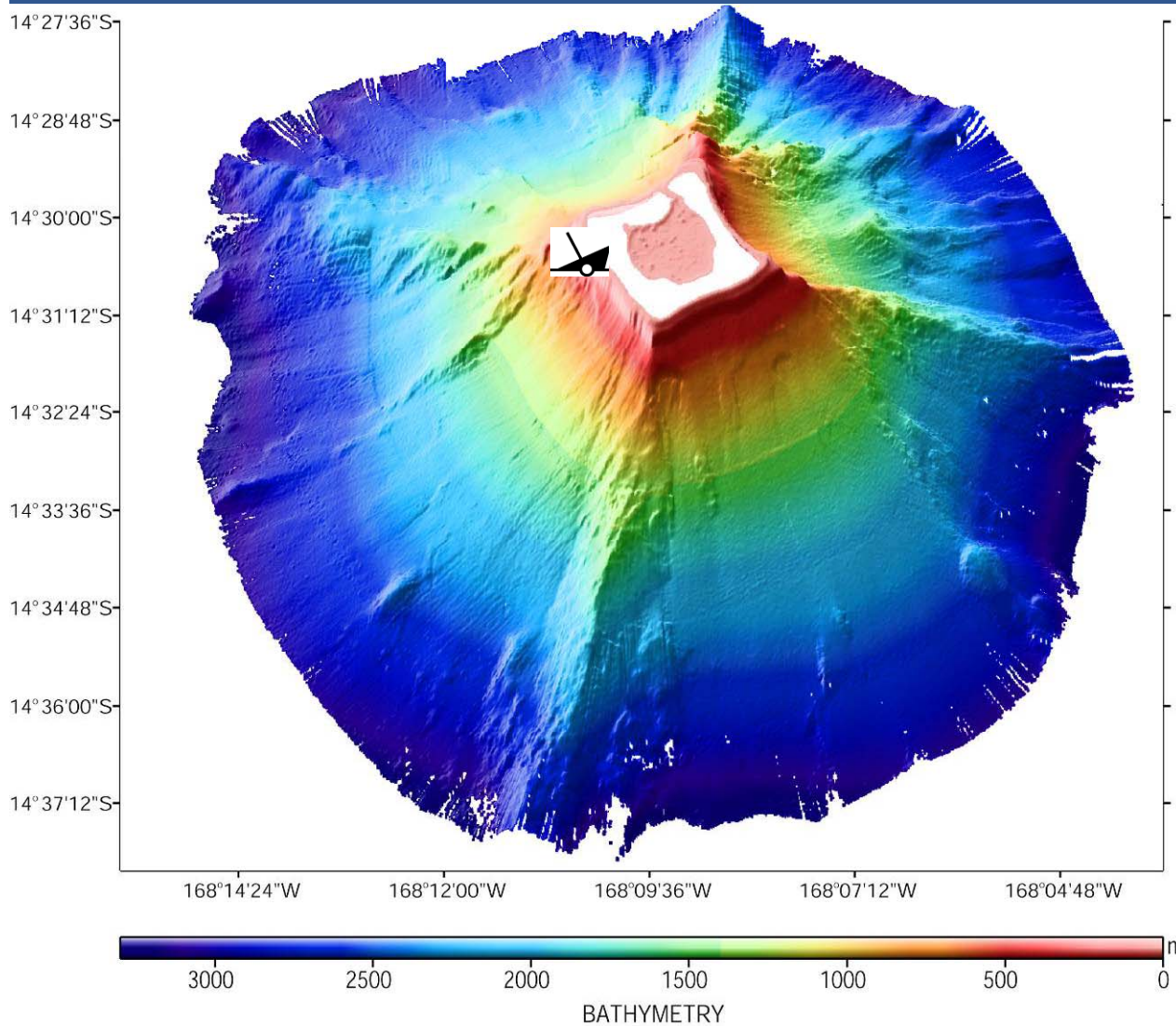
- Population varies 4-30
- Supplied by sea only
- Was once a thriving copra plantation



- 200 nm north of Samoan hot spot track
- Steep sided with little erosion, much like Jarvis, Howland, Baker

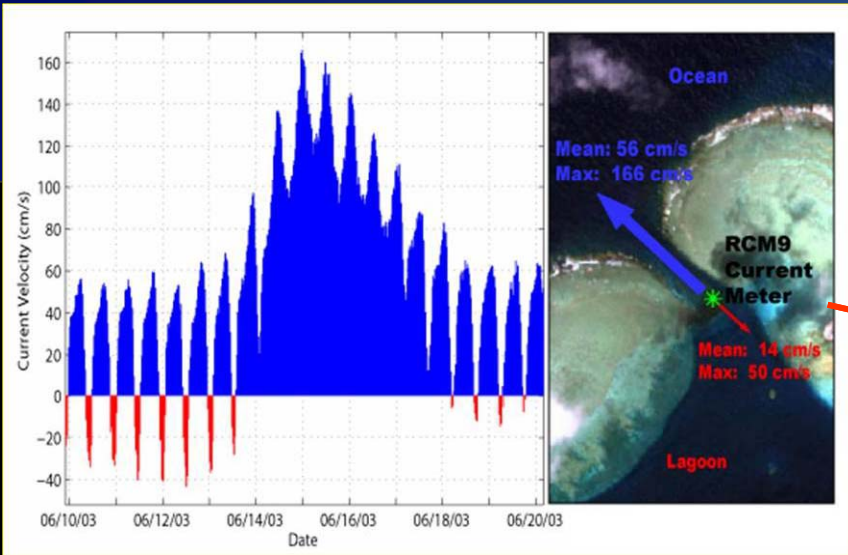


Rose Atoll

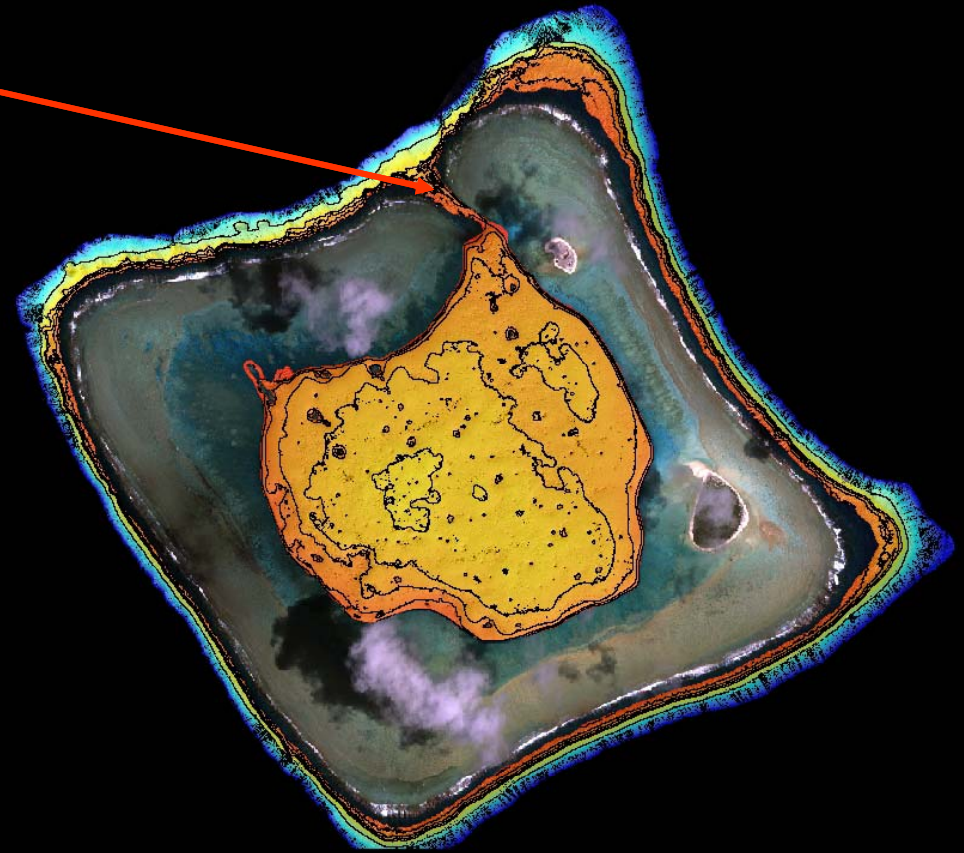


- Part of American Samoa
- USFWS National Wildlife Refuge
- Rare populations of humphead wrasse and bumphead parrotfish
- Shipwreck of Taiwanese longline vessel on SW side of atoll in 1993 caused extensive damage to reef and on-going change in ecosystem with very high percentage of cyanobacteria, turf algae and herbivorous fish near shipwreck. USFWS has removed almost all of the wreckage and biennial NOAA/USFWS RAMP cruises monitor the atoll. The reef is recovering.

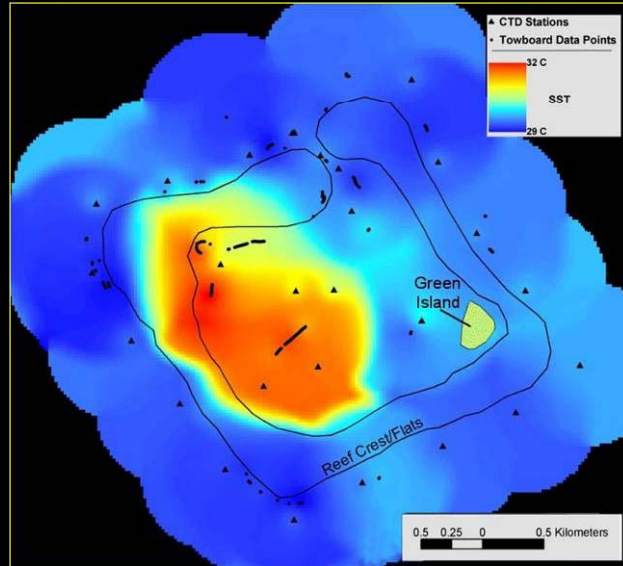
Rose Atoll Lagoon



Current studies show very strong tidal currents in pass into lagoon



Rose Atoll Lagoon Multibeam Bathymetry and IKONOS Imagery



Extremes of temperature in lagoon affect coral richness and location



Data Set Availability



PRIA Data

- Bathymetry grids on web at <http://www.soest.hawaii.edu/pibhmc>
- Swath data will be submitted to National Geophysical Data Center (NGDC) by April 2007 (1 year data submission required by NOAA)

American Samoa Data

- 2004 bathymetry and backscatter grids at <http://www.pifsc.noaa.gov/cred> and swath data are available through NGDC data download facility
- 2006 bathymetry grids & 2004 updates now ready for posting at pibhmc ~ November 2006

Commonwealth of Northern Mariana Islands and Guam

- 2004 bathymetry and backscatter grids at pifsc web site and swath data are available through NGDC data download facility
- Additional surveys planned in early 2007

NWHI Synthesis

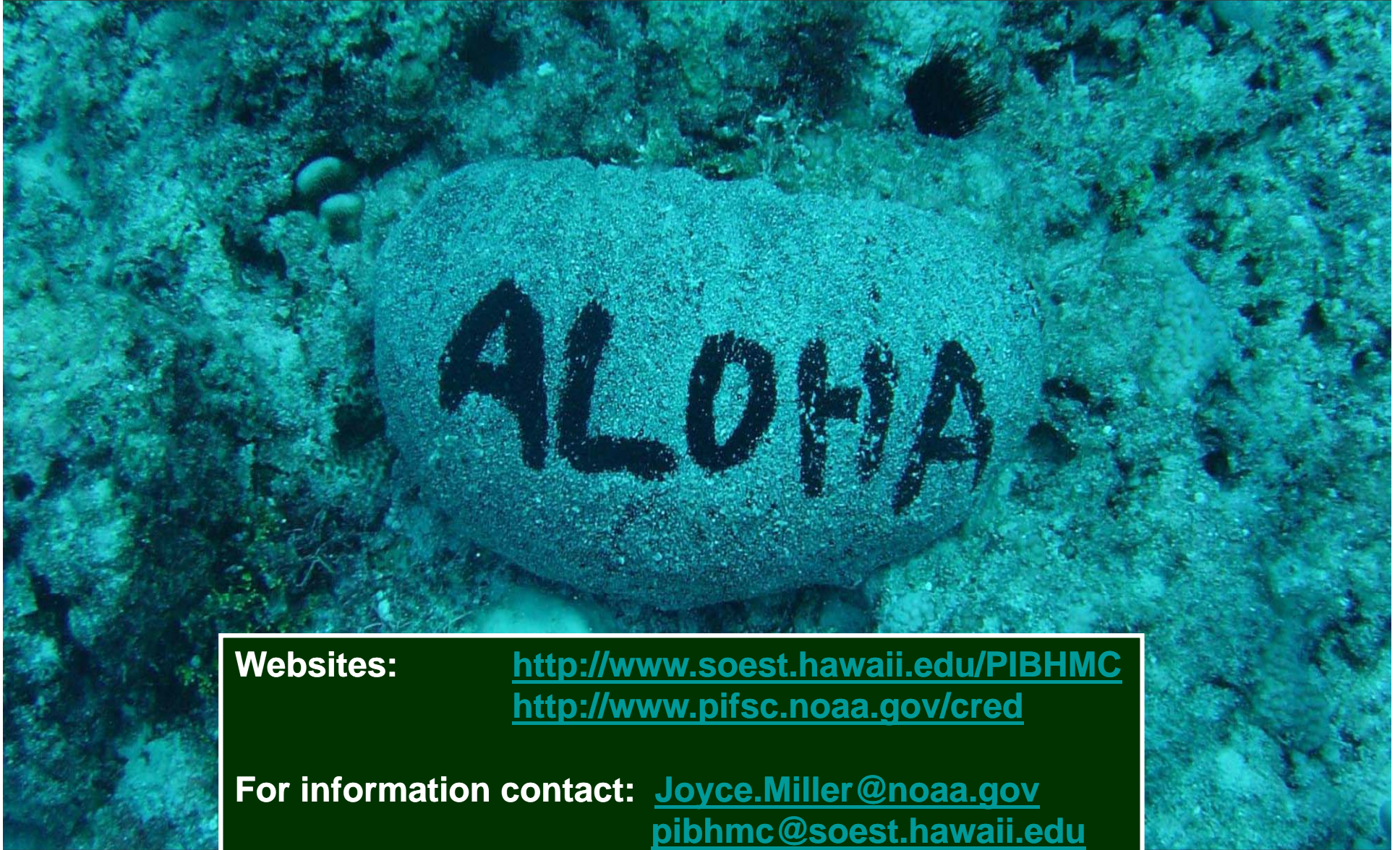
- Bathymetry grids through 2005 on pibhmc web site
- Swath data through 2005 submitted to NGDC
- Yearly updates to pibhmc website and NGDC
- Backscatter data from French Frigate Shoals available on pibhmc web site

MHI Synthesis

- In collaboration with UH SOEST MHI data being compiled, but there is a State of Hawaii request to hold NOAA data from public release until bottom fishing issues are resolved.



For Information



Websites: <http://www.soest.hawaii.edu/PIBHMC>
<http://www.pifsc.noaa.gov/cred>

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