Integrated Coral Reef Ecosystem Assessments in the U.S.-affiliated Pacific Islands: a Comparative Approach to Better Understand the Northwestern Hawaiian Islands

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Pacific Islands Fisheries Science Center
national marine fisheries service
Coral Reef Ecosystem Division

Hawaii Conservation Conference, July 30, 2008

Key Threats

- Climate change
  - Ocean warming – coral bleaching and disease
  - Ocean acidification – calcification rates, biodiversity shifts
  - Sea-level rise – drowning reefs and coastal infrastructure?
  - Storm tracks and intensities
  - Ocean circulation – larval transport/recruitment
- Local Threats
  - Overfishing - trophic and ecosystem shifts
  - Pollution and marine debris – habitat degradation
  - Coastal development and sedimentation – habitat degradation
  - Invasive species – ecosystem shifts
  - Recreational overuse – trophic and ecosystem shifts
- Local management requires knowledge of regional and global processes and threats

Background

The mission of CRED is to provide sound scientific information needed to support implementation of ecosystem approaches to management and conservation to address these threats at national, regional, and local (island/atoll) scales.

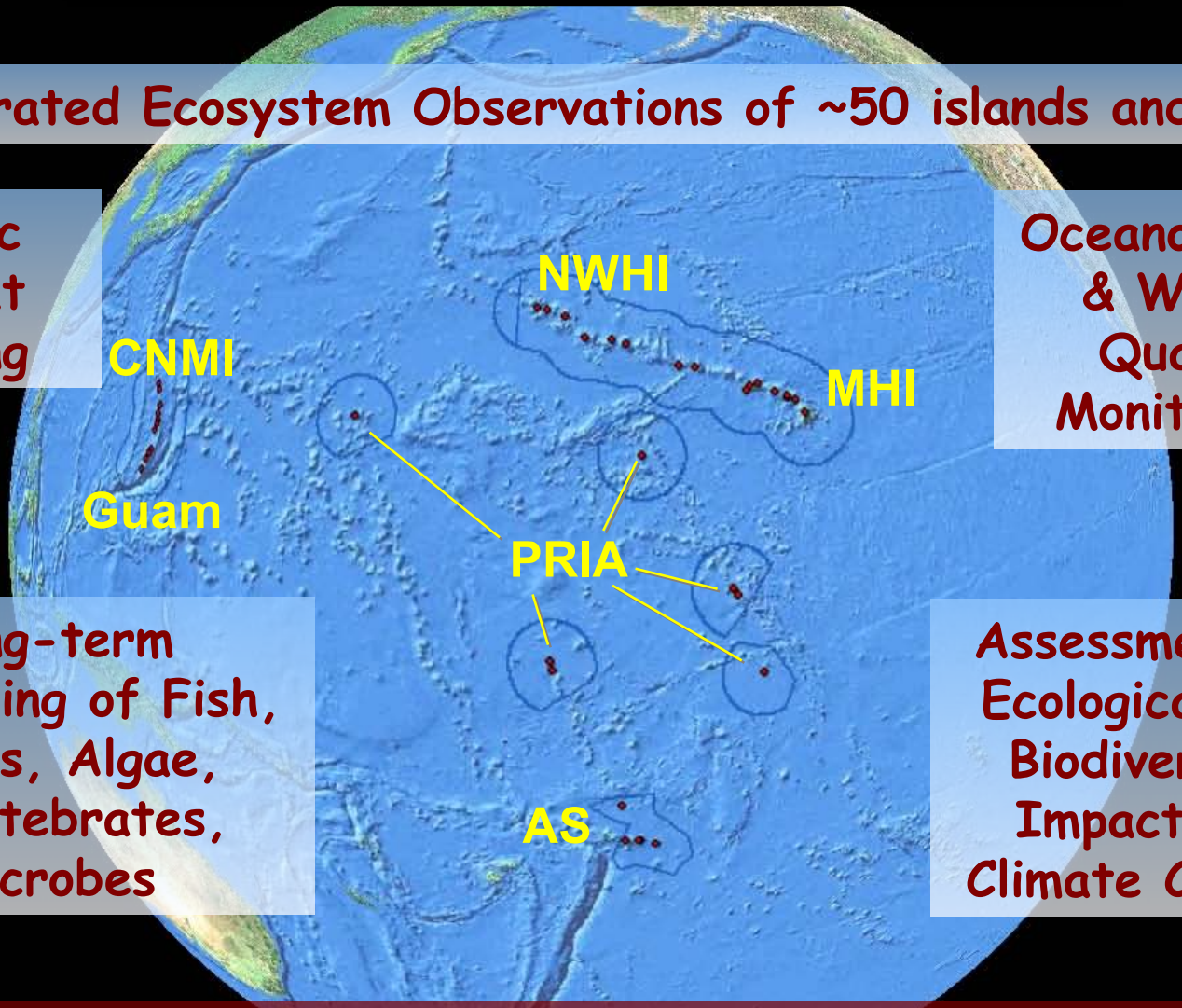
This is accomplished primarily through the Pacific Reef Assessment and Monitoring Program (RAMP), which is an integrated, interdisciplinary, assessment and long-term monitoring program of the coral reef ecosystems of the U.S.-affiliated Pacific Islands.

Pacific RAMP

Integrated Ecosystem Observations of ~50 islands and atolls

Benthic Habitat Mapping

Oceanography & Water Quality Monitoring



Long-term Monitoring of Fish, Corals, Algae, Invertebrates, Microbes

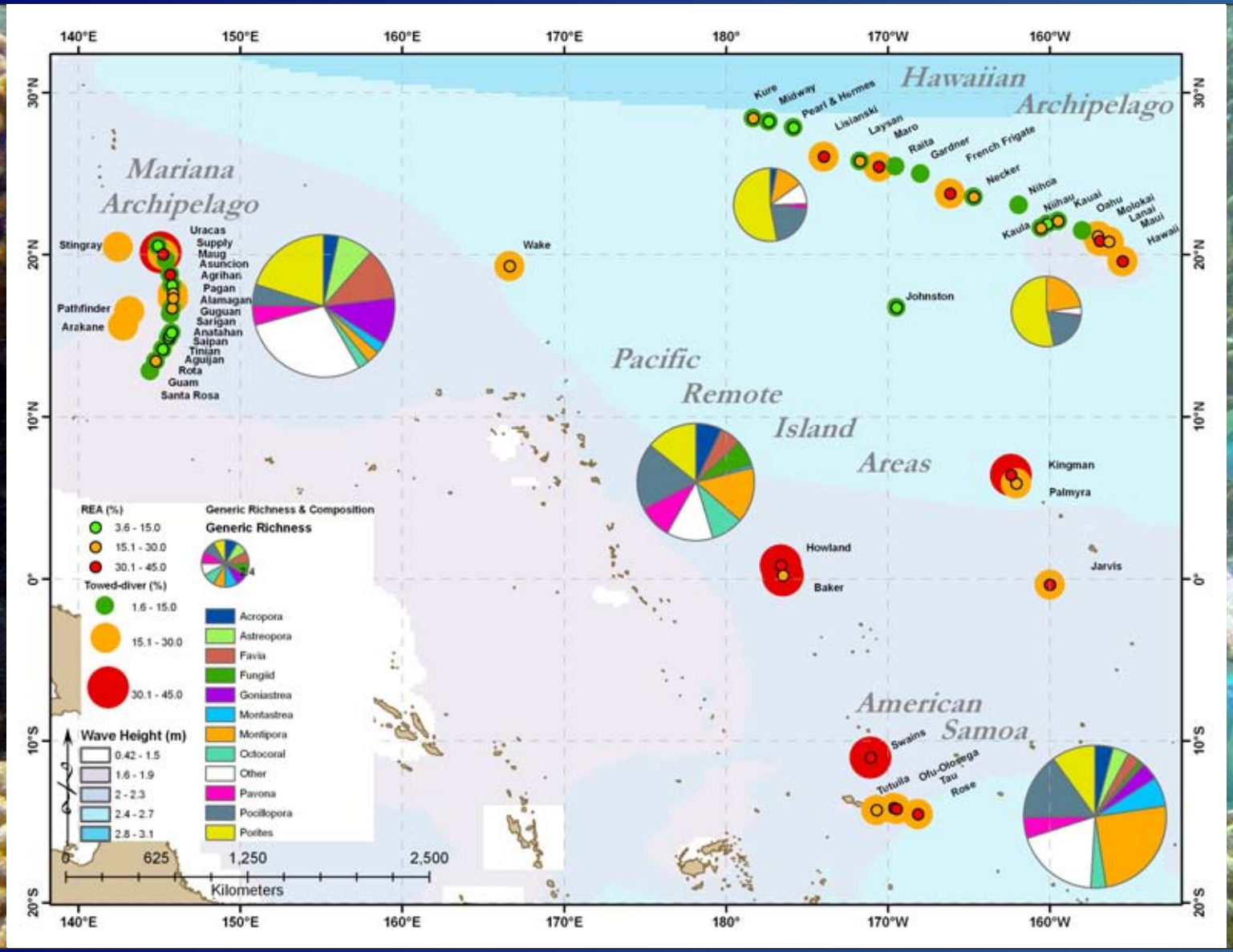
Assessment of Ecological and Biodiversity Impacts of Climate Change

Comparative analyses across diverse biogeographic, environmental, and anthropogenic gradients

Ecological Observations

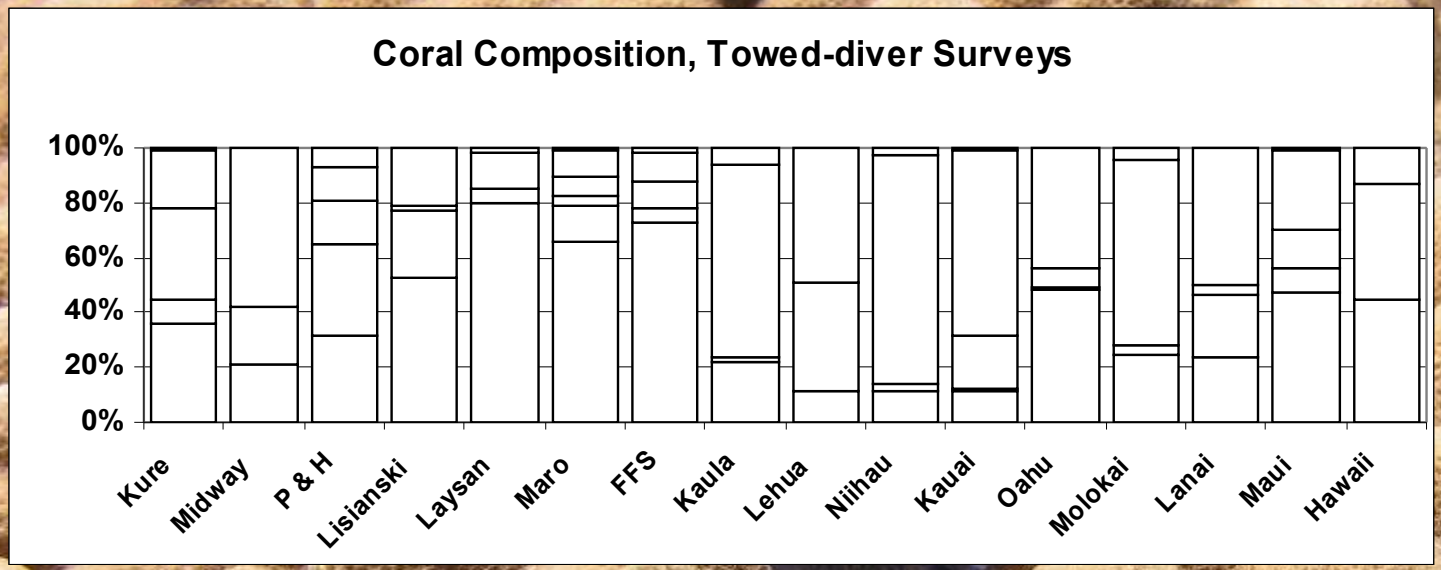
- Rapid Ecological Assessments (REA) - ~200 -1000 m^2
  - Fish, corals, invertebrates, algae, microbes (new)
  - Abundance/density, size, species richness, % benthic cover, disease prevalence
- Towed-diver Surveys (TDS) - ~25,000 m^2
  - Benthic composition/condition
    - % cover of live or stressed coral, macroalgae
    - Habitat complexity
  - Abundance of large fish, macroinvertebrates
    - fish (>50 cm TL), turtles, seals, cetaceans
    - COTS, giant clams, sea cucumbers, urchins
- Autonomous Reef Monitoring Structures (ARMS)
- Ecological Acoustic Recorders (EARs)
- Calcification Plates for Ocean Acidification (new)

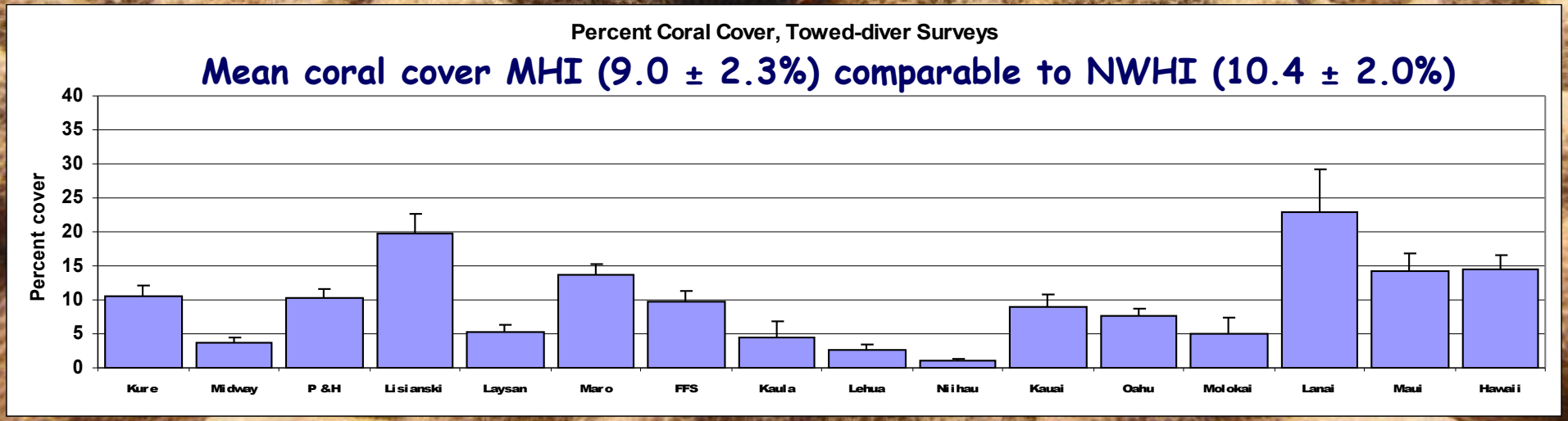
Pacific-wide Corals



Maximum SST Annual Range of SST Annual Mean Significant Wave Height

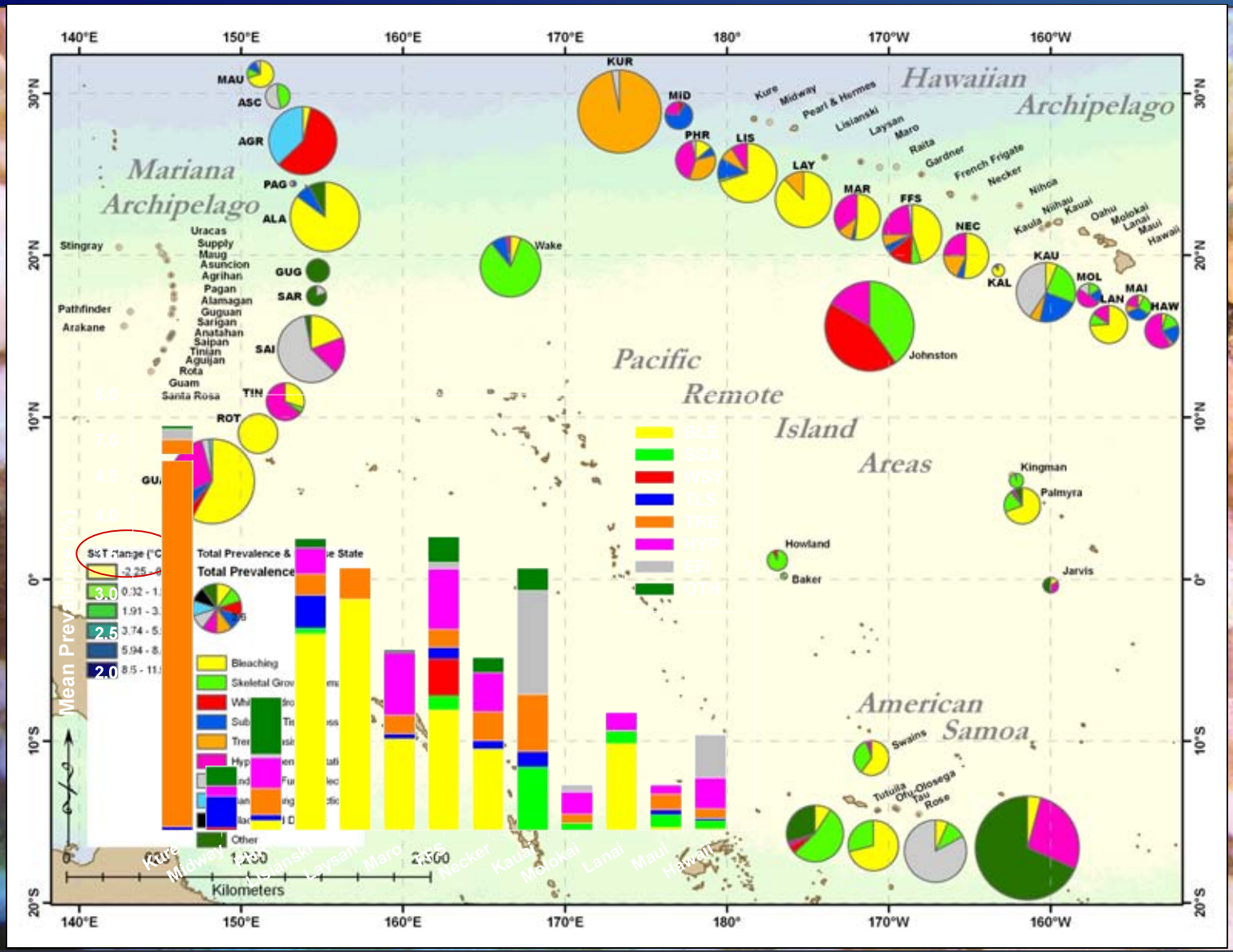
Corals



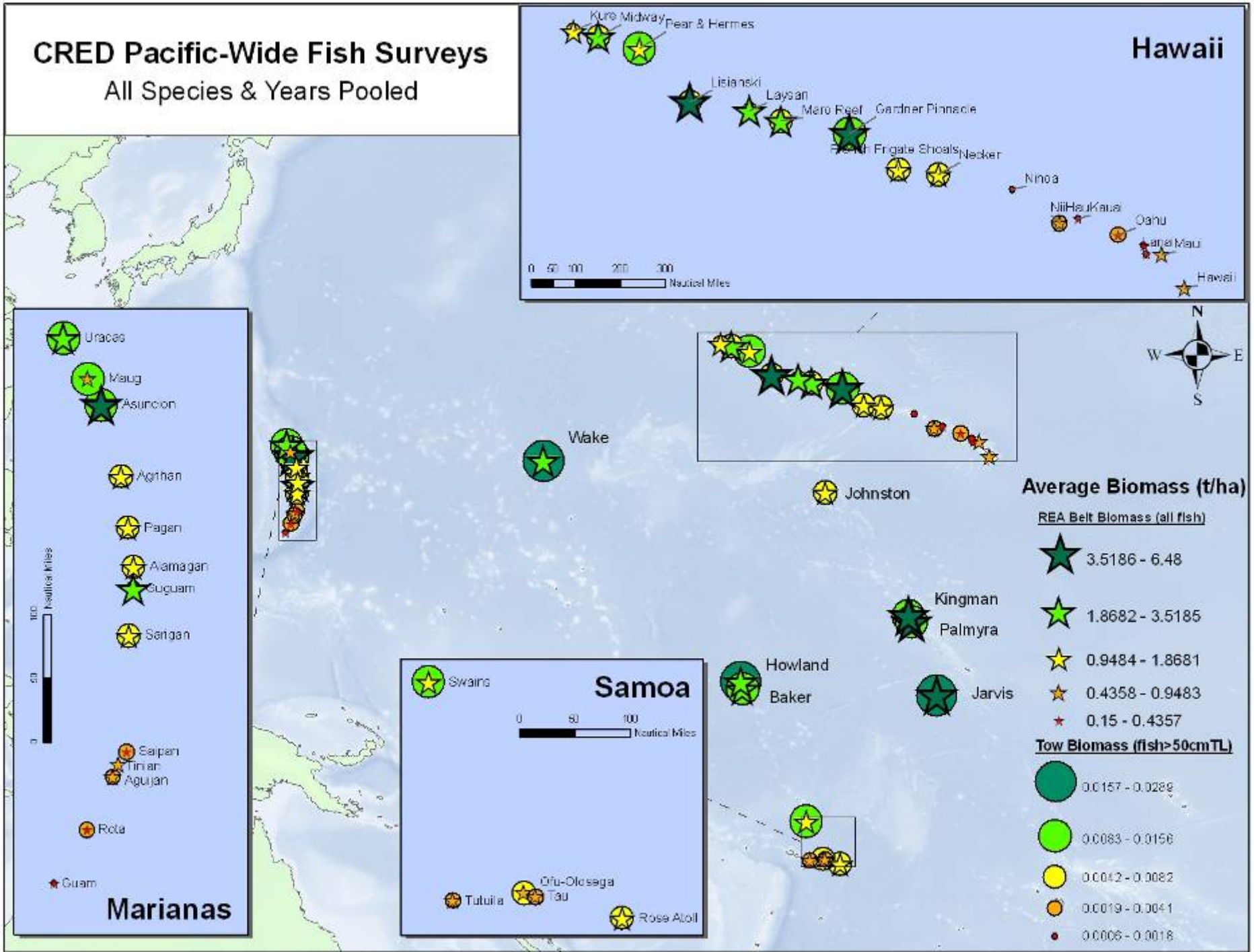


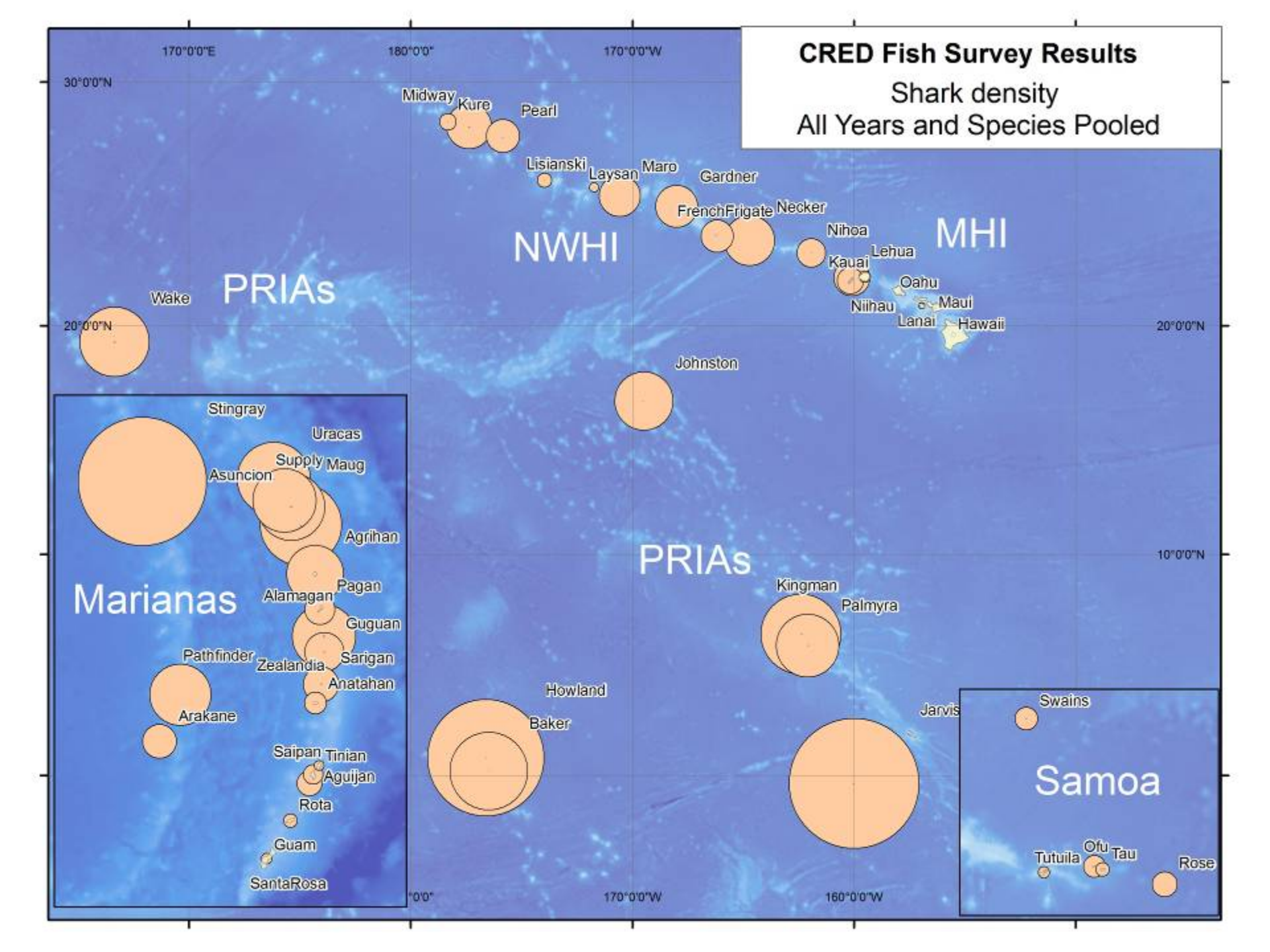
Corals work led by Jean Kenyon

Coral Disease

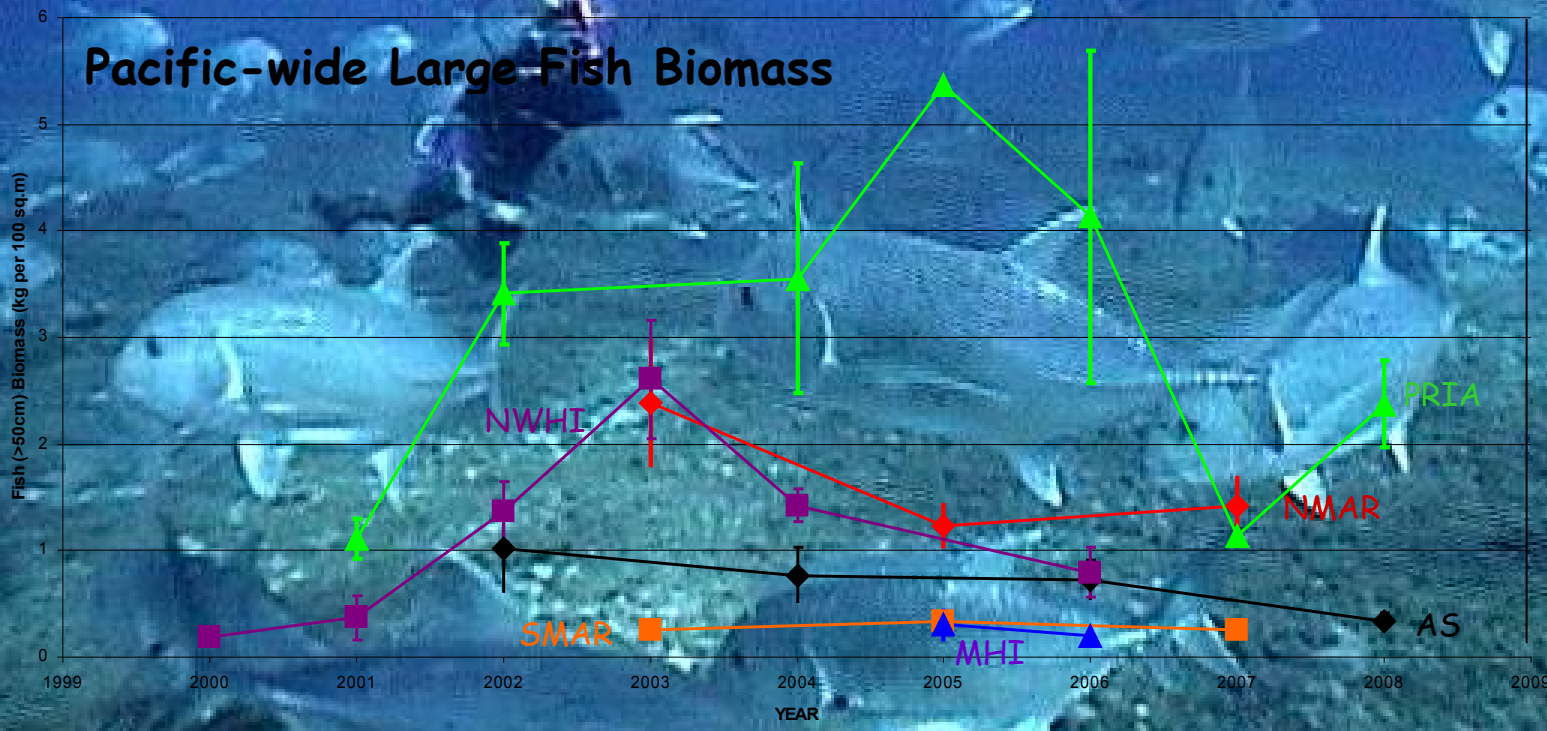


Disease work by Bernardo Vargas-Angel


CRED Pacific-Wide Fish Surveys
All Species & Years Pooled
Hawaii
Kure
Midway
Pear & Hermes
Lisianski
Laysan
Maro Reef
Gardner Pinnacle
French Frigate Shoals
Necker
Nihoa
NiihauKauai
Oahu
Maui
Hawaii
0 50 100 200 300
Nautical Miles
N
W
E
S
Uracas
Maug
Asuncion
Agrihan
Pagan
Alamagan
Guguam
Sarigan
Saipan
Tinian
Aguijan
Rota
Guam
Marianas
0 50 100
Nautical Miles
Wake
Johnston
Kingman
Palmyra
Howland
Baker
Jarvis
Swains
Samoa
0 50 100
Nautical Miles
Tutuila
Ofu-Olosega
Tau
Rose Atoll
Average Biomass (t/ha)
REA Belt Biomass (all fish)
3.5186 - 6.48
1.8682 - 3.5185
0.9484 - 1.8681
0.4358 - 0.9483
0.15 - 0.4357
Tow Biomass (fish>50cmTL)
0.0157 - 0.0289
0.0083 - 0.0156
0.0042 - 0.0082
0.0019 - 0.0041
0.0006 - 0.0018

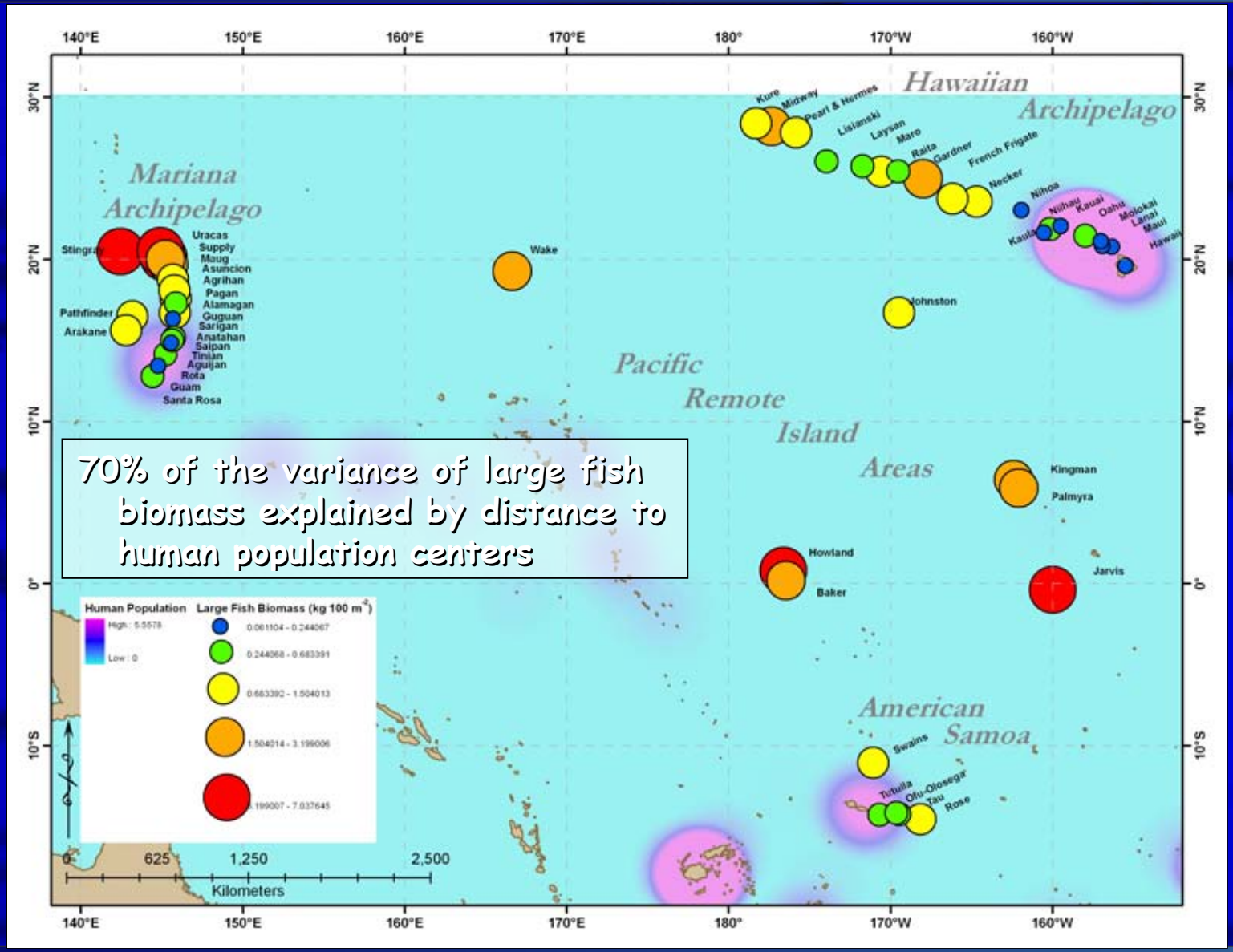

CRED Fish Survey Results
Shark density
All Years and Species Pooled
170°0'0"E
180°0'0"
170°0'0"W
160°0'0"W
30°0'0"N
20°0'0"N
10°0'0"N
NWHI
MHI
PRIAs
Midway
Kure
Pearl
Lisianski
Laysan
Maro
Gardner
FrenchFrigate
Necker
Nihoa
Lehua
Kauai
Oahu
Niihau
Maui
Lanai
Hawaii
Wake
Johnston
Marianas
Stingray
Uracas
Supply
Maug
Asuncion
Agrihan
Pagan
Alamagan
Guguan
Sarigan
Zealandia
Pathfinder
Anatahan
Arakane
Saipan
Tinian
Aguijan
Rota
Guam
SantaRosa
Howland
Baker
Jarvis
Kingman
Palmyra
Samoa
Swains
Tutuila
Ofu
Tau
Rose

Large Fish Over Time



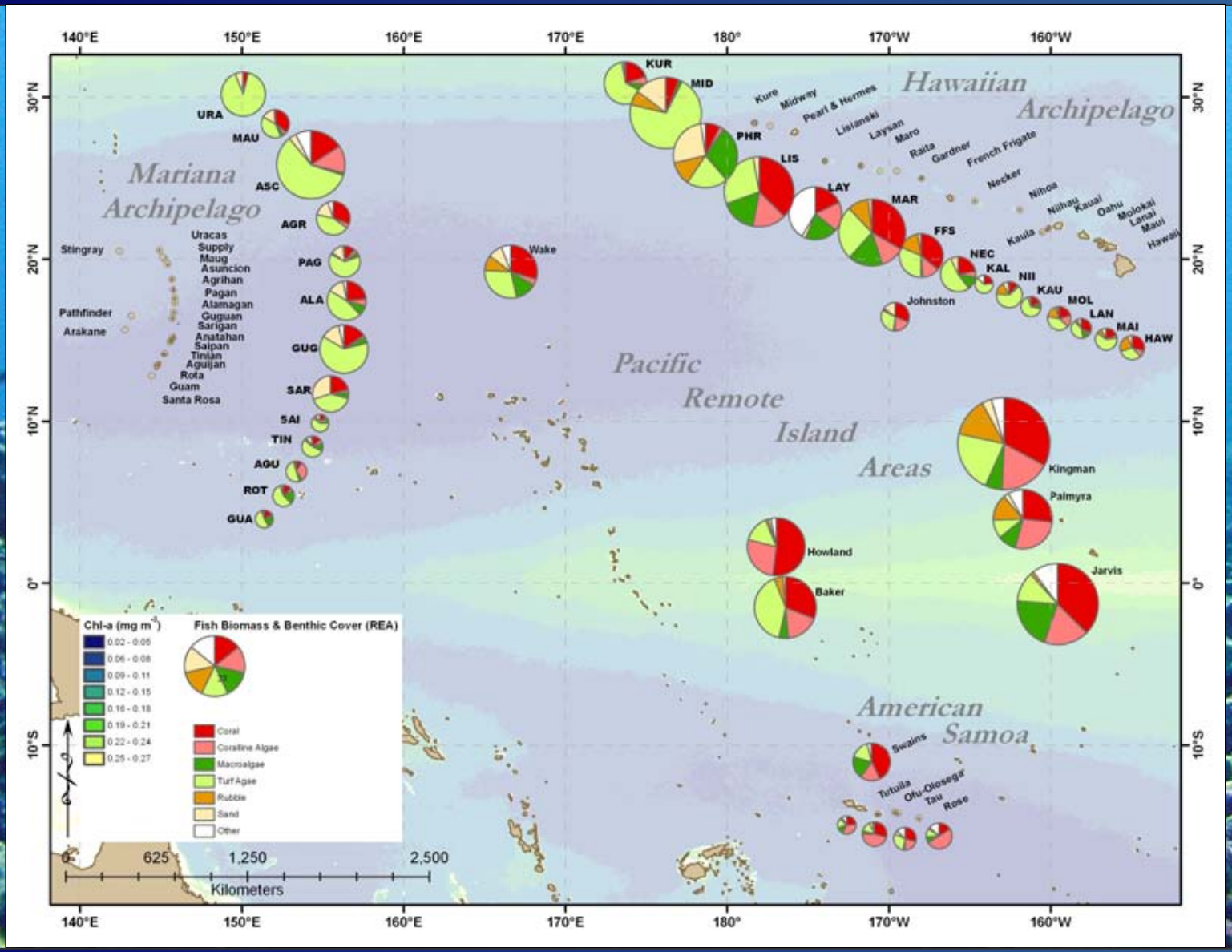
Fish work by Bob Schroeder, Ben Richards, Marc Nadon

Large Fish & People

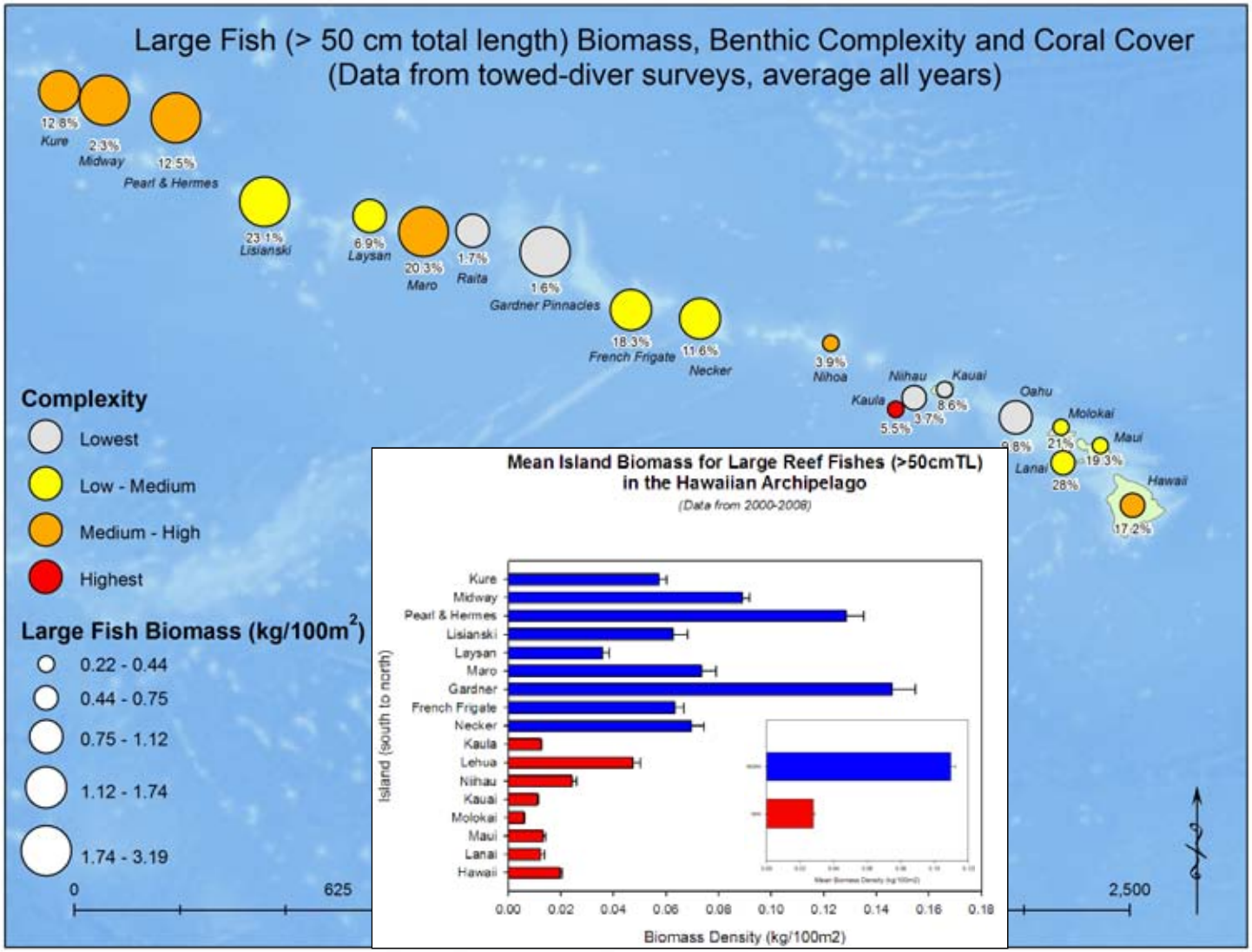


Fish work by Bob Schroeder, Ben Richards, Marc Nadon

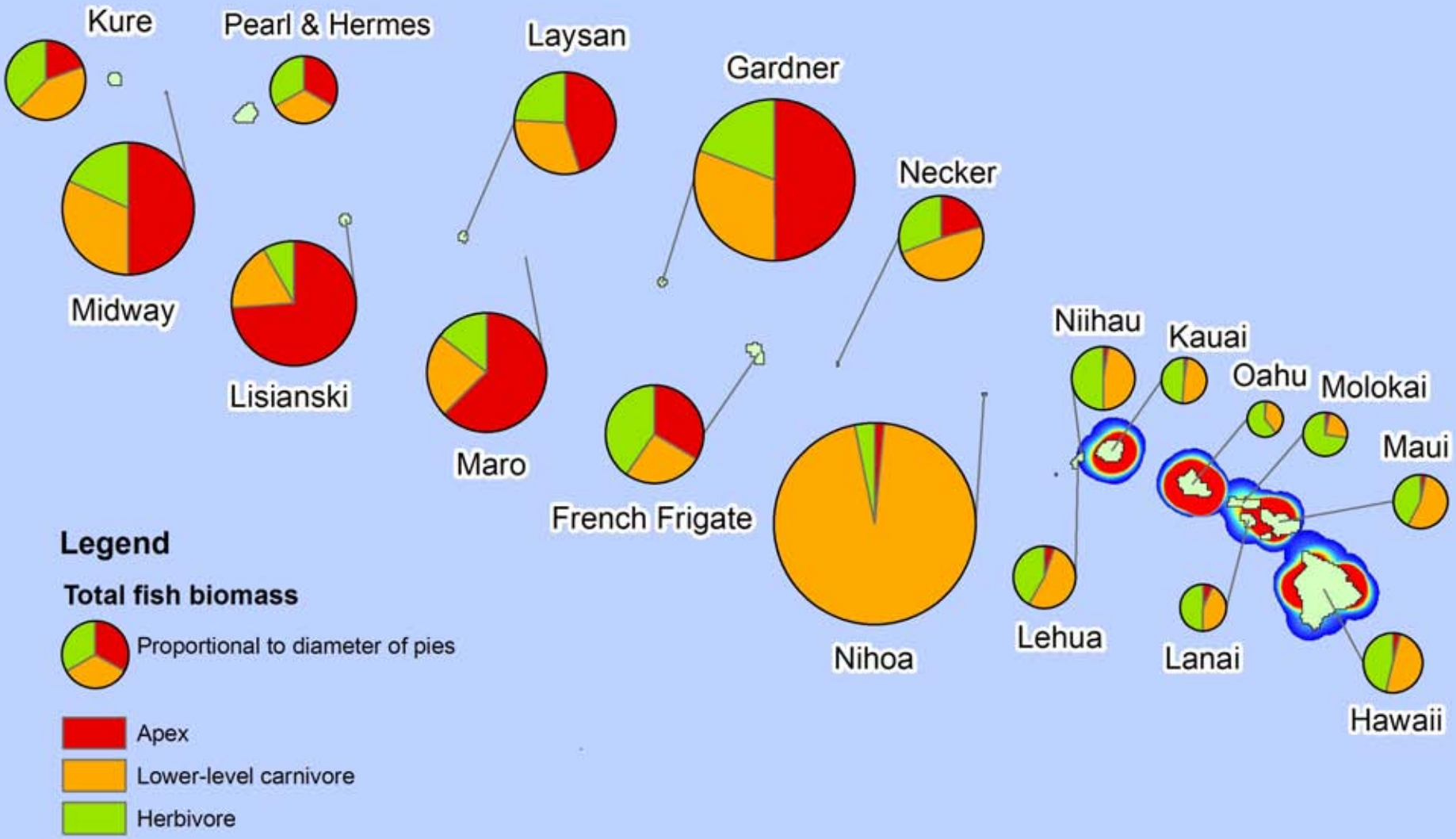
Fish Biomass & Habitat



Large Fish, Coral, & Habitat

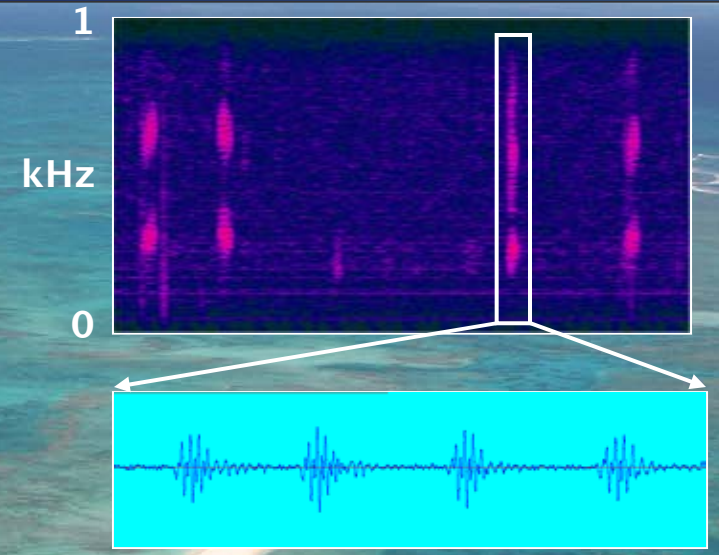


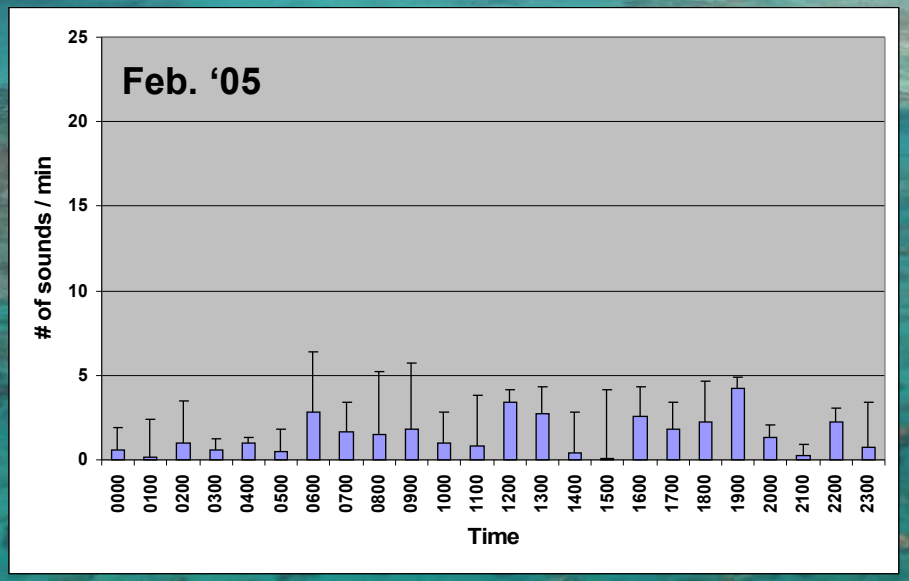
Reef Fish & People

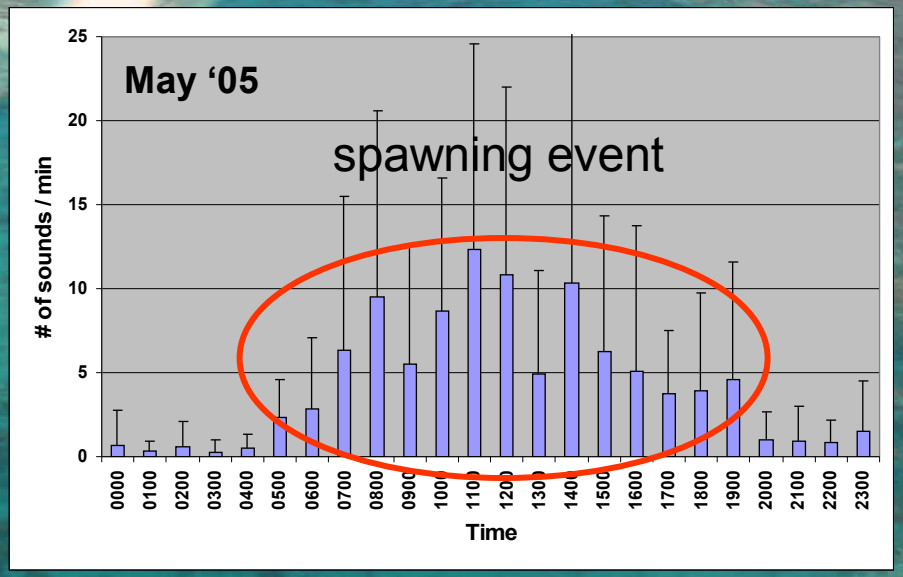


Fish work by Bob Schroeder, Ben Richards, Marc Nadon

Reef Fish



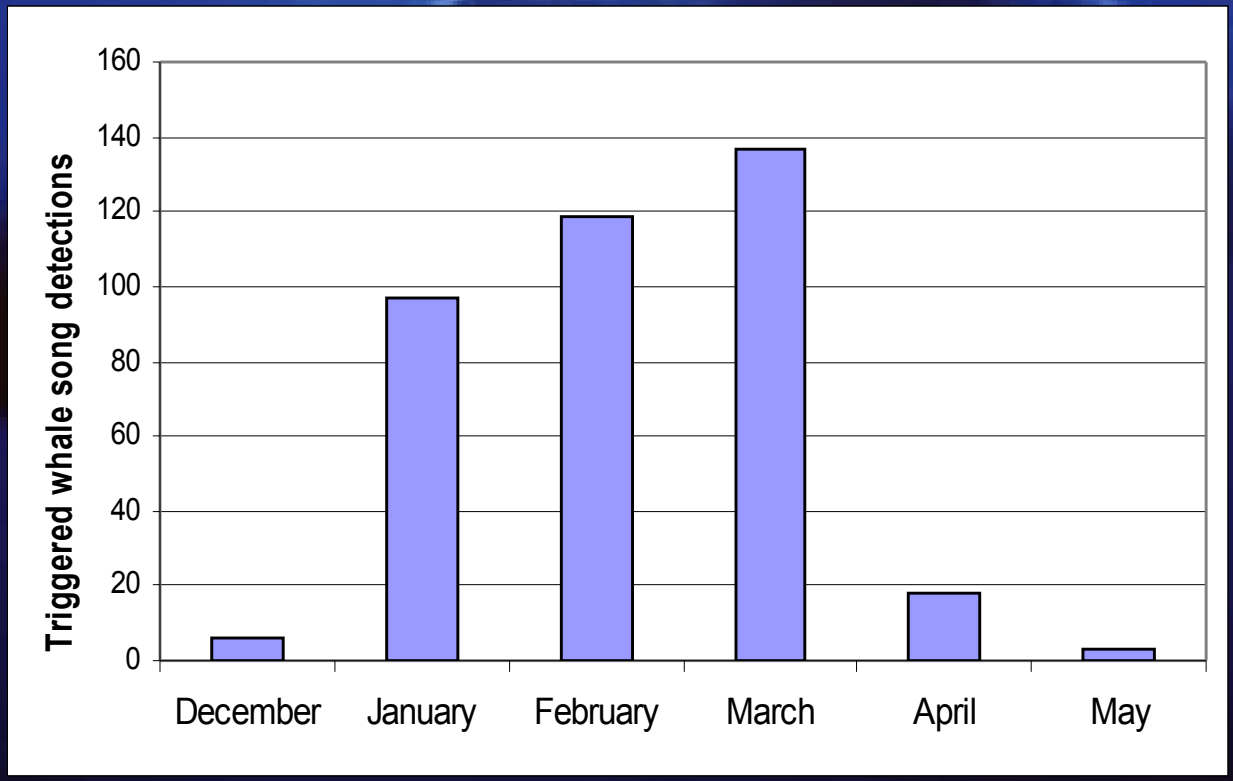




Lammers et al., 2008

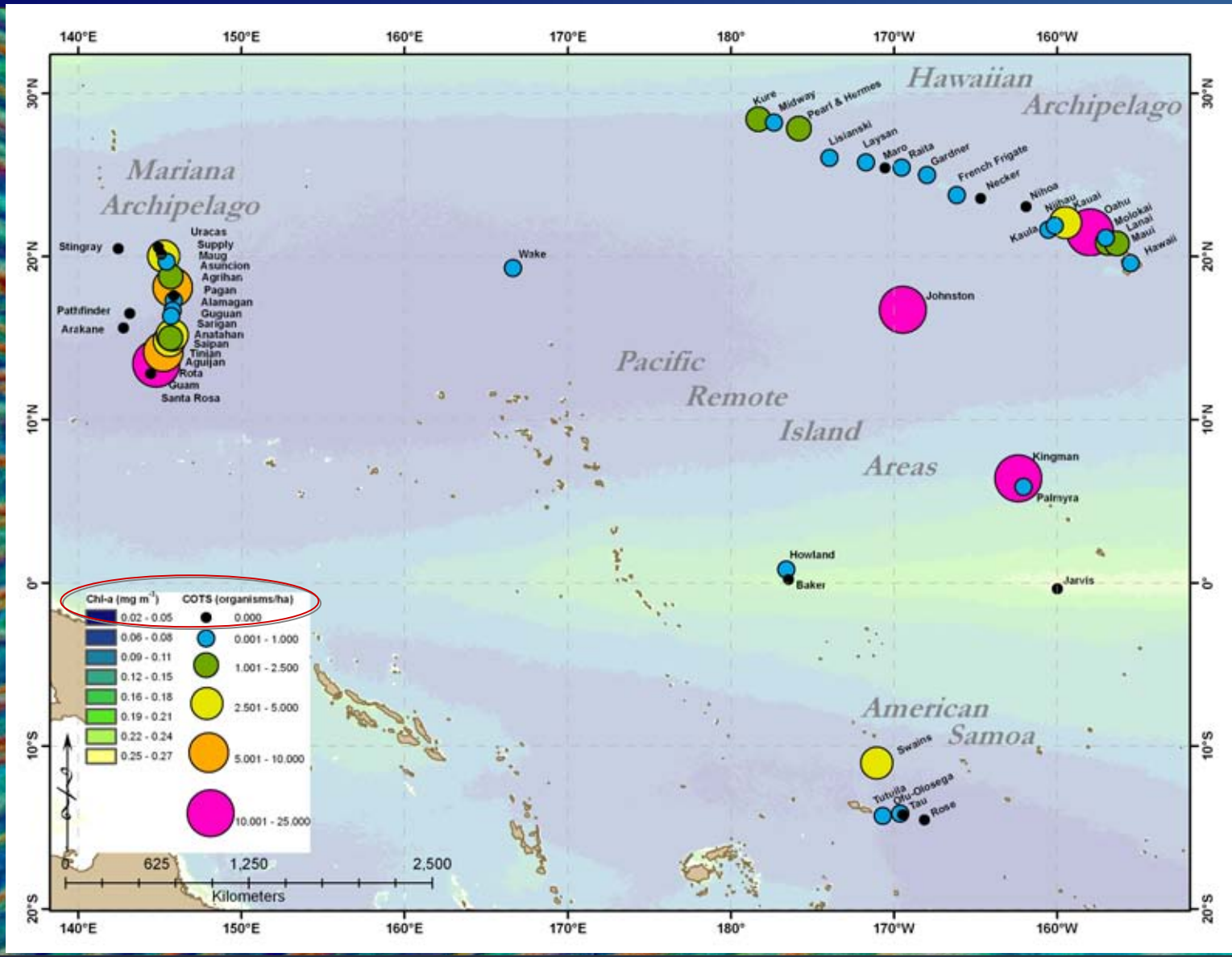
Cetaceans

Humpback whale song at Rapture reef, FFS



Passive acoustics (EARs) work led by Marc Lammers

Invertebrates COTS



Distribution and abundance of Crown-of-thorns seastars

Biodiversity Assessments

Census of Marine Life

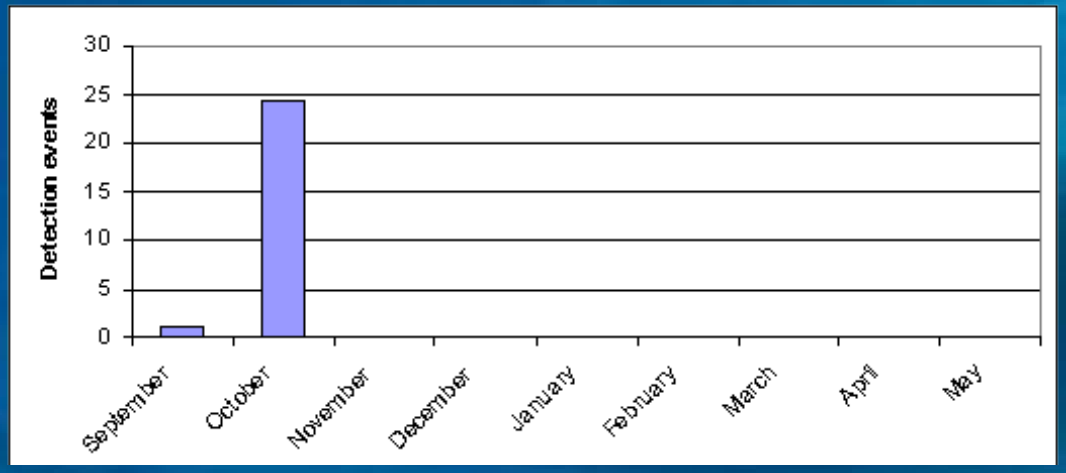
Census of Coral Reef Ecosystems (CReefs)

Assessment and monitoring of coral reef biodiversity with a focus primarily on understudied, lesser known, or cryptic invertebrate, algal, and microbial species.

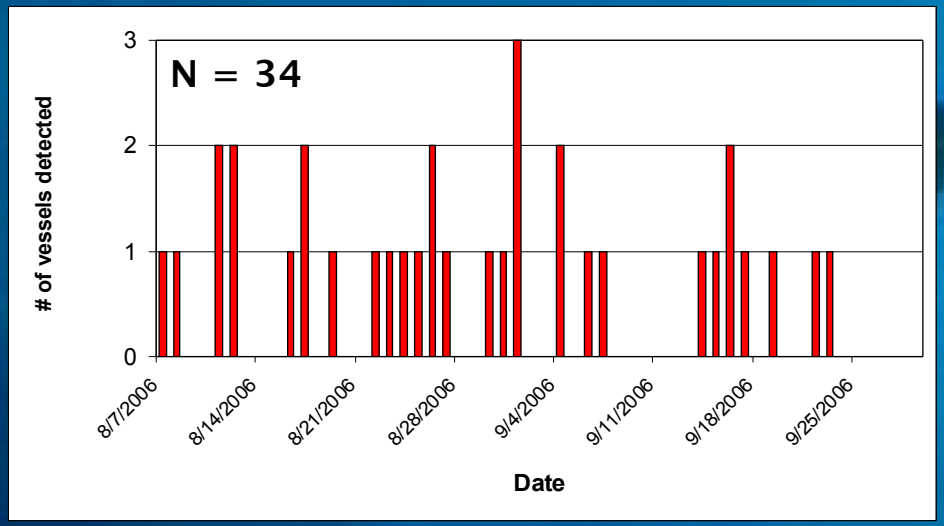
Autonomous Reef Monitoring Structures (ARMS): systematic collectors to monitor indices of invertebrate diversity using molecular techniques.

People

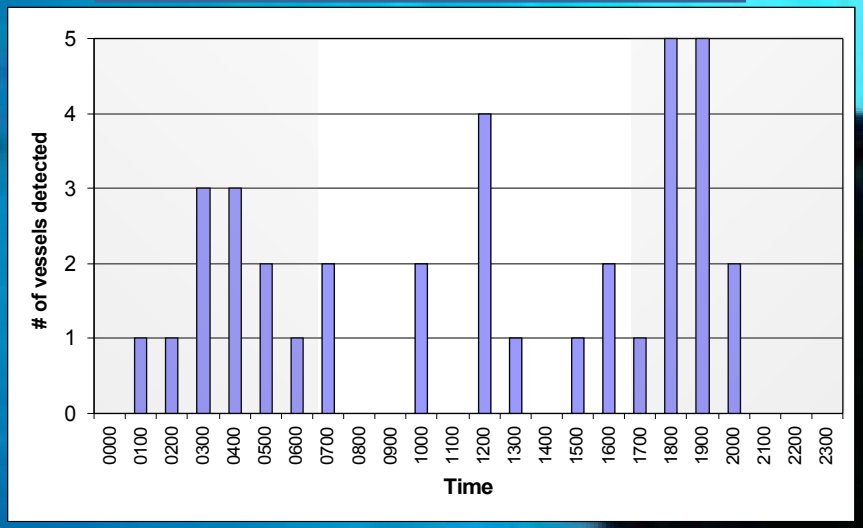
Vessel detections at Rapture reef, FFS



Vessel detections in NPAS



Timing of vessel traffic in NPAS



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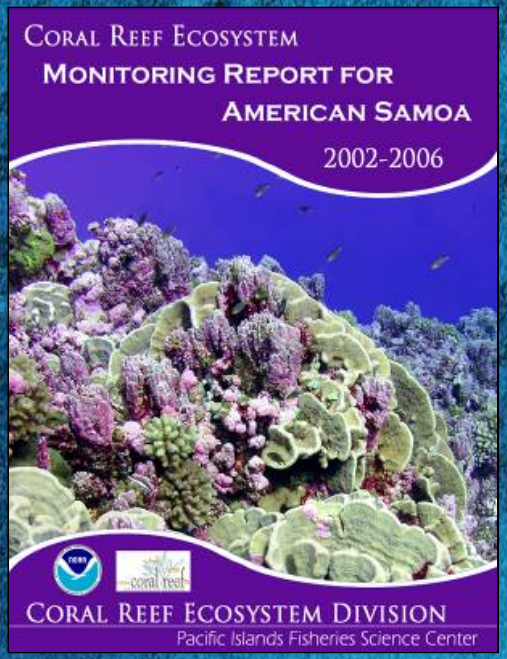
Management Outputs



Coral Reef Ecosystem Monitoring Reports provide comprehensive integrated island and archipelagic ecosystem assessments including:

- Geopolitical Context
- Benthic Habitat Mapping and Characterization
- Oceanography and Water Quality
- Coral and Coral Disease
- Algae and Algal Disease
- Benthic Macroinvertebrates
- Reef Fish
- Island/Archipelagic Summary & Integration

Presently working on Reports for Hawaiian Archipelago and Mariana Archipelago

Pacific RAMP contributed extensively to six chapters of the *State of Coral Reef Ecosystems of the United States and Freely Associated States: 2008*

Pacific RAMP contributed extensively to two chapters of the *Coral Reefs of the World, Vol. 1: Coral Reefs of the USA*

Available for download at: www.pifsc.noaa.gov/cred

Management Outcomes

Some key management outcomes include:

- Documented NWHI as unique predator-dominated ecosystem contributed to establishment of PMNM
- Documented mass coral bleaching in NWHI led to changed understanding of key threats
- Documented baseline levels of coral disease across Pacific
- Discovered many new species of coral, algae, inverts
- Removed ~580 mtons of marine debris
- Proposal to establish additional large-scale MPAs in PRIA and Mariana Archipelago
- Protection of large reef fish in American Samoa
- Scientific foundation for network of MPAs in Am Samoa

Conclusion

Pacific RAMP provides resource managers, policy makers, and other stakeholders essential integrated ecosystem assessments and long-term monitoring information at local, regional, and national levels to support informed decision making for implementing ecosystem approaches to management and conservation to address key threats.

Thank You