Informing Resilience-based Management

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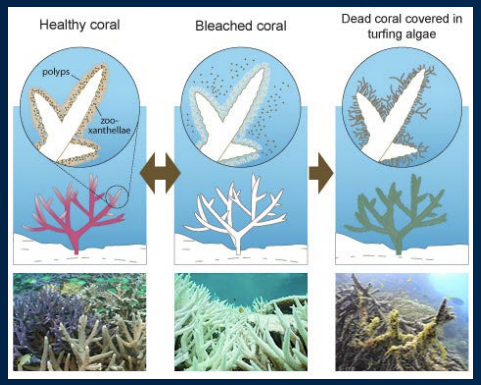
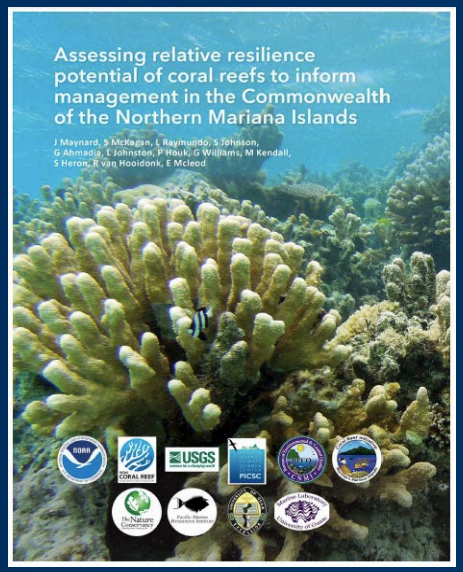
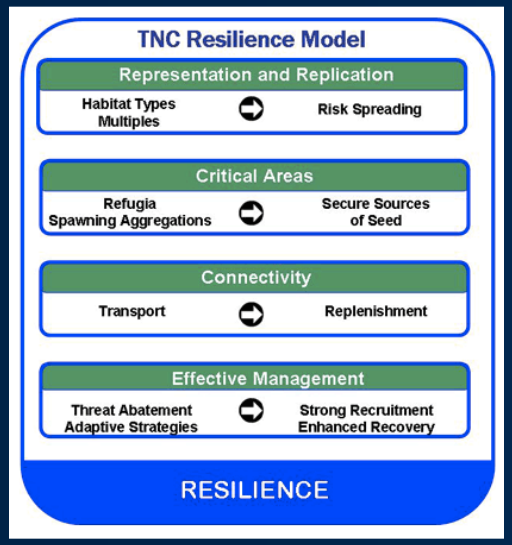
Resilience

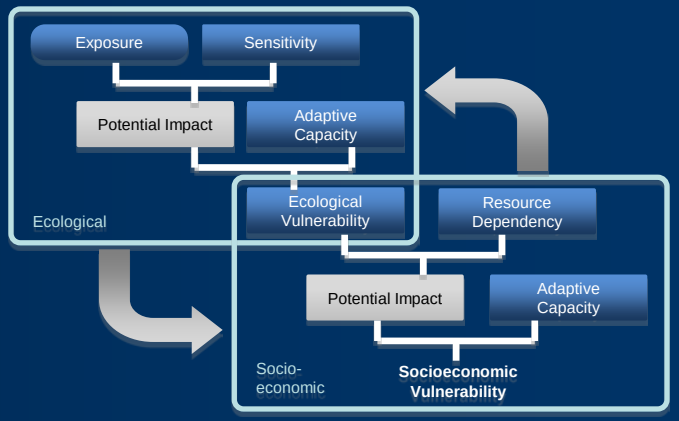
The capacity of a reef to resist and/or recover in the future given its probable exposure regime *and* to maintain provision of ecosystem goods and services. (adapted from Mumby et al 2007)

A Brief Visual History of Resilience









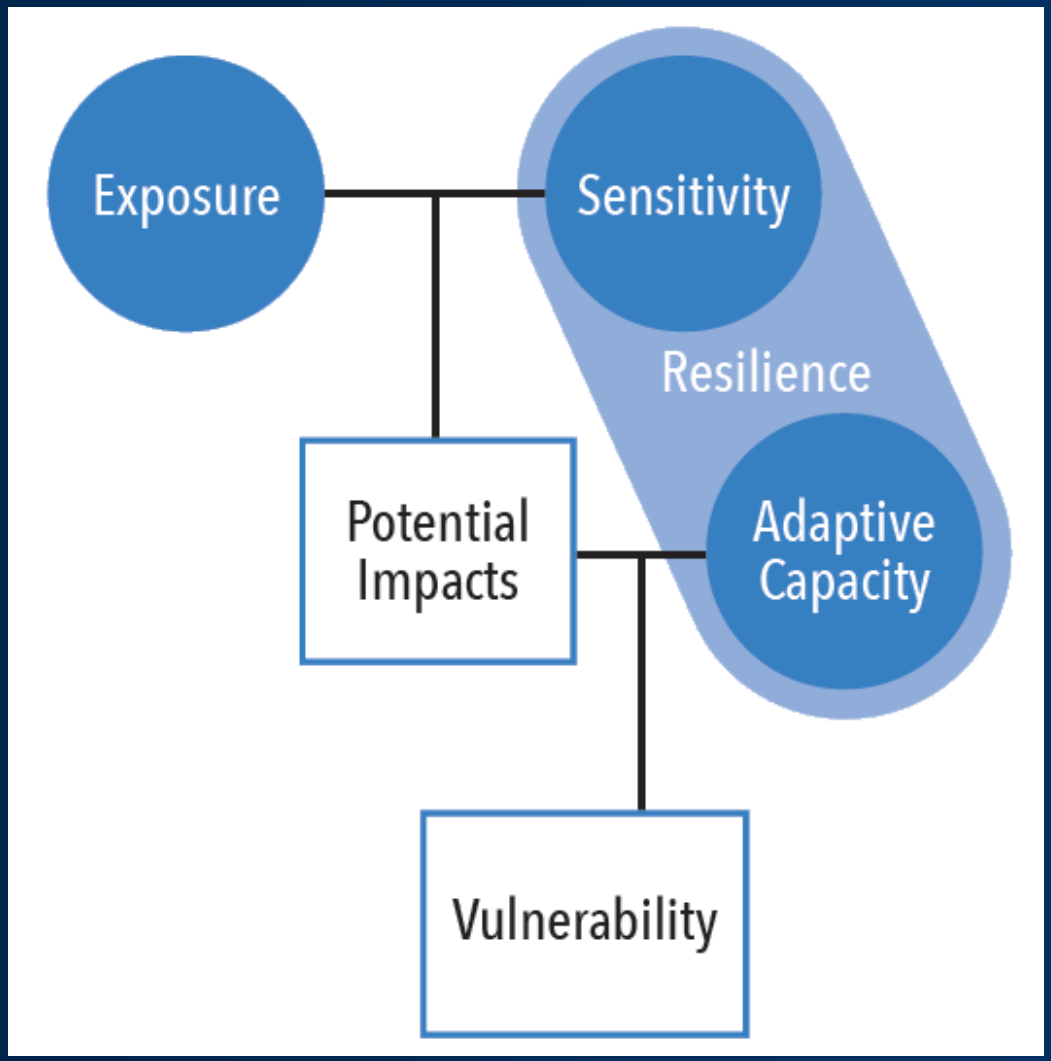
Resilience-based Management

- Addresses climate and non-climate threats
- Addresses both current and future stresses
- Flexible to allow adaptive management
- Can be applied through existing planning & management approaches and frameworks

Why Resilience-based Management?

- Essential in an uncertain future
- Increases effectiveness of management actions by considering climate
- Informs resource allocation (funding, human capacity)
- Empowers local managers

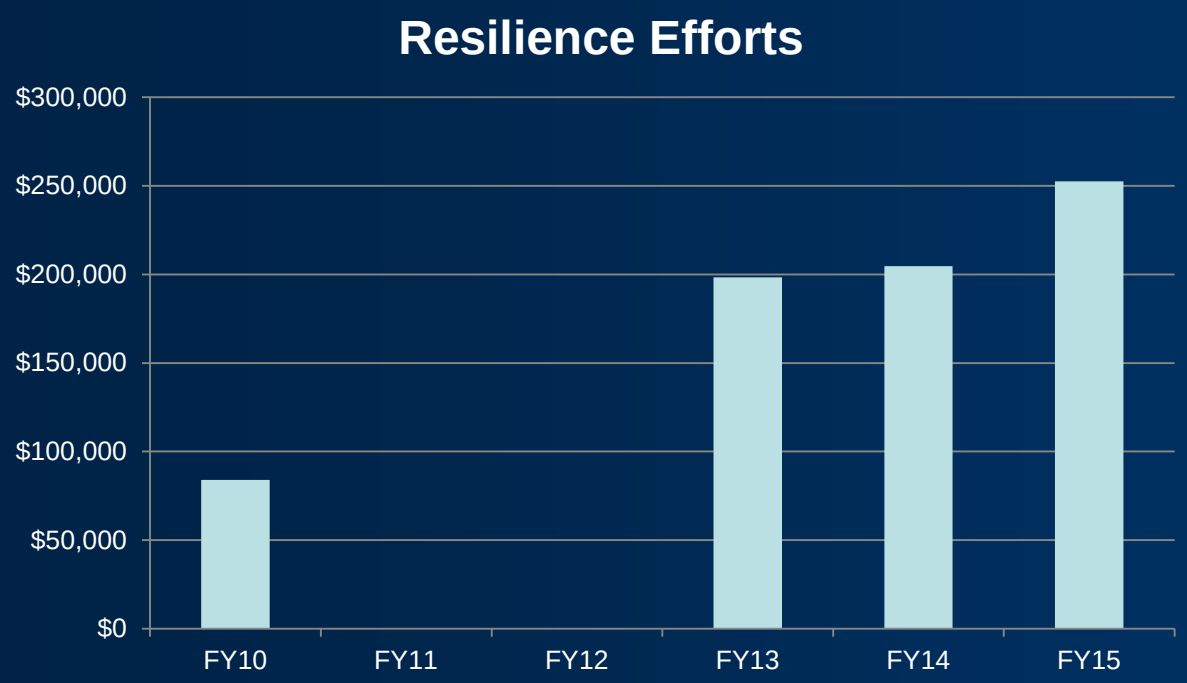
Resilience vs Vulnerability

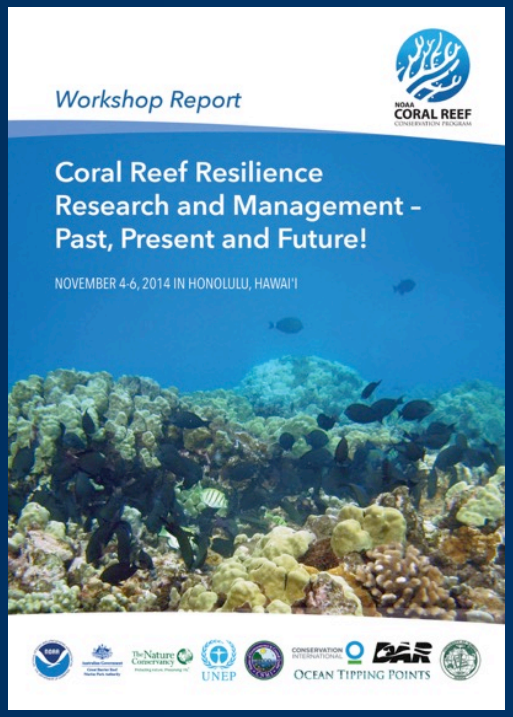


Priority goal of the CRCP Climate Portfolio

Goal 1 - <u>Manage for Resilience</u>

Goal 2 - <u>Address Risk and Vulnerability</u>





CRCP: Informing RBM

- Science – reef response to climate change; resilience assessment science
- **Data and information tools to support resilience-based management**
- **Support resilience assessments and application of other tools**
- Support the incorporation of social and economic information
- Build capacity to apply resilience-based management

Connectivity & Thermal Stress Hx

- Changes in larval import, export, and self-seeding will affect the resilience of coral reefs
  - Use circulation models to determine current larval sources, sinks, and corridors
  - Use climate change models to identify likely future changes in connectivity
  - Could be replicated elsewhere but requires significant data gathering
- Knowledge of thermal history is a lens through which current condition of and anticipation and response to impacts on reefs can be viewed.

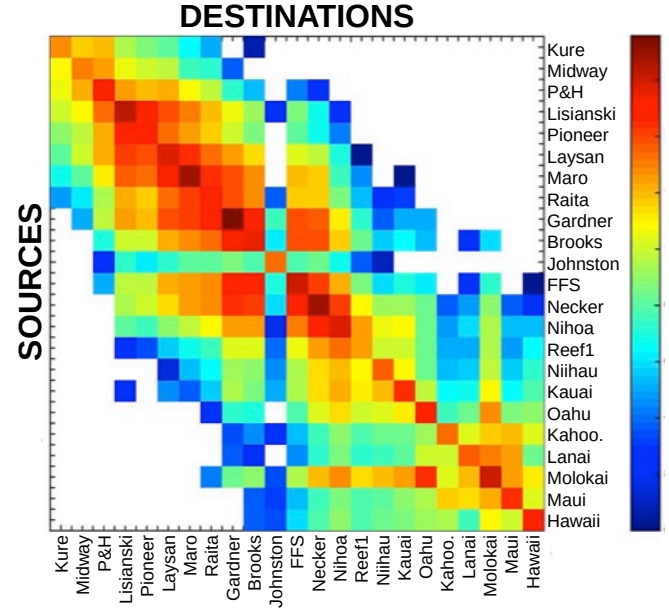
Reef Connectivity for Hawaii

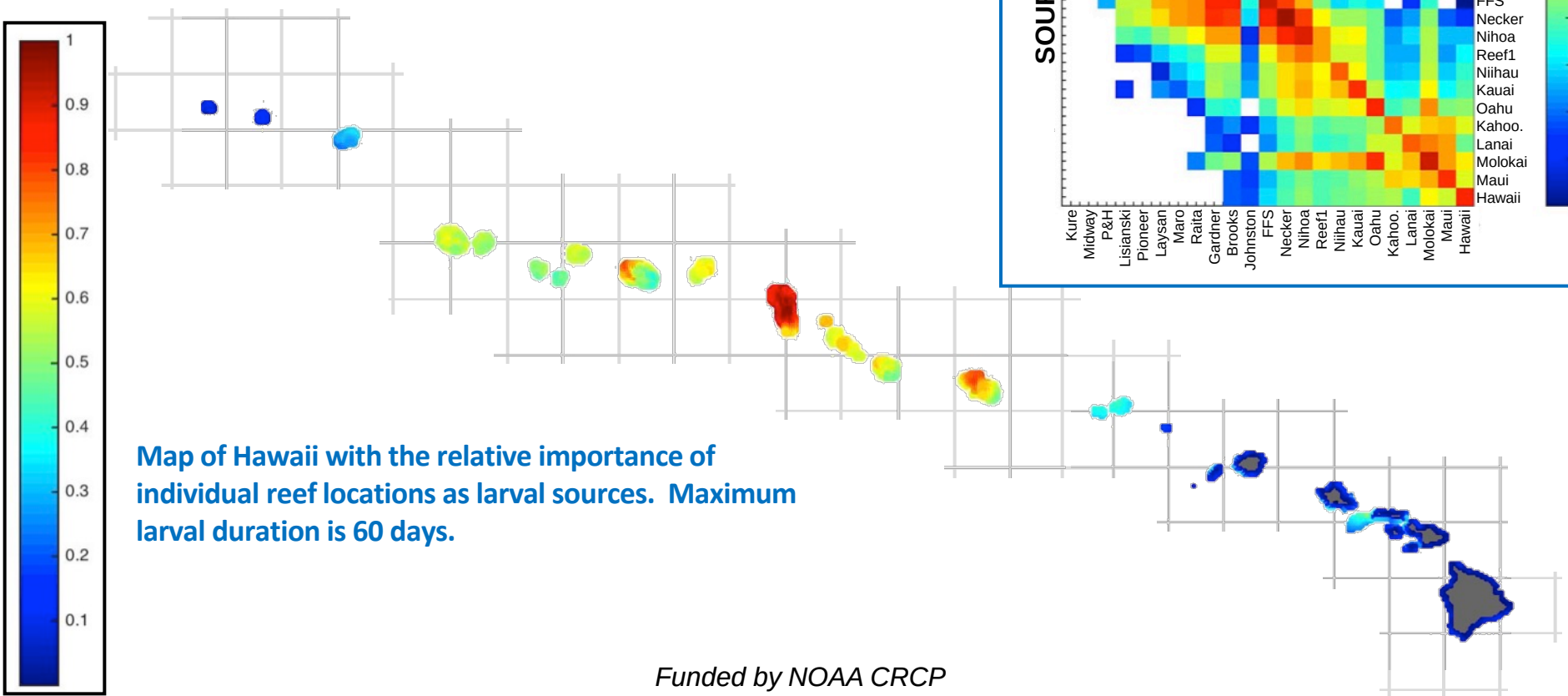
Scott Heron: scott.heron@noaa.gov (NESDIS/STAR/CRW)

Connectivity among coral reefs has been identified as a critically important factor in resilience, specifically in regard to recovery following disturbance. Simulated larval paths determined reef connectivity to determine the relative importance of reefs as larval sources and destinations to inform resilience assessment and spatial planning.

http://coralreefwatch.noaa.gov/satellite/larval_connectivity/

Connectivity matrix for islands/atolls of the Hawaiian archipelago. Red colors along the diagonal indicate strongest connectivity.





Map of Hawaii with the relative importance of individual reef locations as larval sources. Maximum larval duration is 60 days.

Funded by NOAA CRCP

Influence of climate change on larval connectivity in the Marianas

Matt.Kendall@noaa.gov,
NOAA/NOS/NCCOS/CCMA/Biogeography

Products

- Journal Article
- Database Delivered (simulations/results) TBD.
- Training: Oriented potential users to data products, methods, and how to run code for custom simulations

Challenges

- Despite publications, tech memos, in person training, and species-specific recommendations, it has proven difficult to get managers to apply the results

Future directions

- Engage with Micronesia Challenge MPA planning process
- Conduct transport simulations for present day and future climate conditions in other jurisdictions

Climate change and larval transport in the ocean: fractional effects from physical and physiological factors

MATTHEW S. KENDALL[1], MATT POTI[1,2] and KRISTOPHER B. KARNAUSKAS[3]

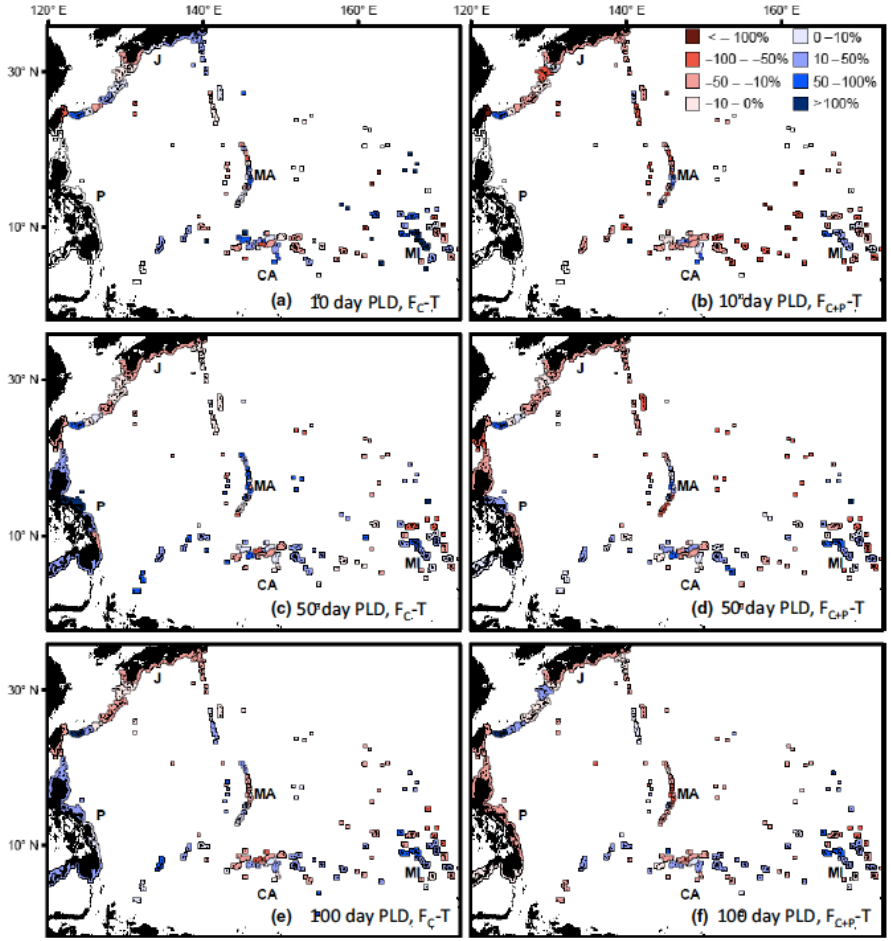


Fig. 5 (a–f) Percentage change in future arrivals for each island by PLD and climate change scenario. Letter definitions are: MA, Mariana Archipelago; CA, Caroline Archipelago; MI, Marshall Islands; J, Japan; P, Philippines.

Manuscript: doi: 10.1111/gcb.13159

Thermal History

Scott Heron, scott.heron@noaa.gov (NESDIS/STAR/CRW)

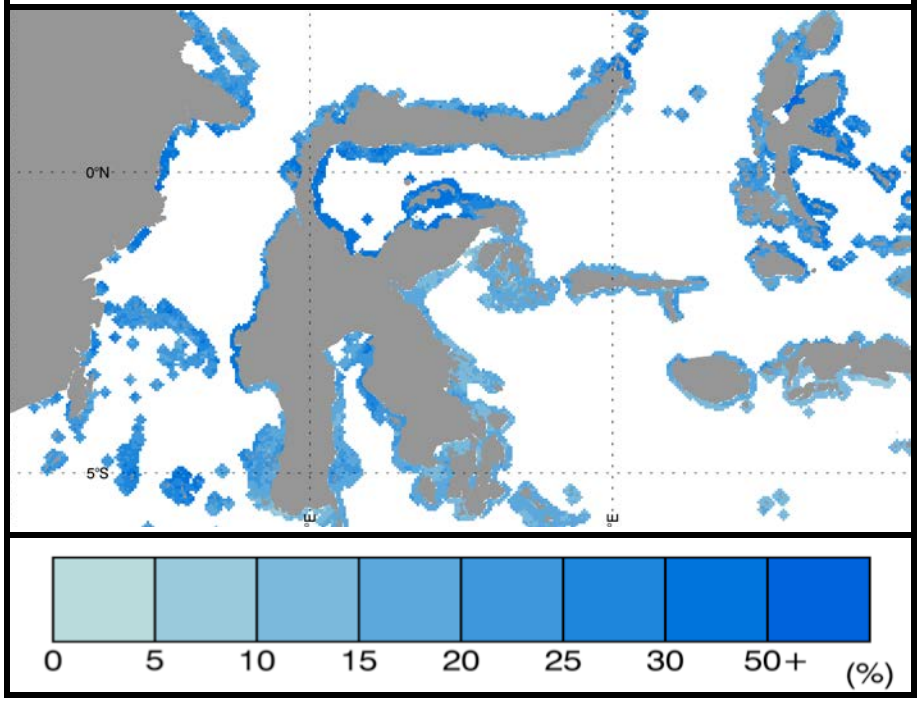
Thermal history has been identified as a critically important factor in reef resilience. Temperature variability and past disturbances influence current reef condition and the capacity to respond to stress. Thermal history characteristics has contributed to several resilience assessments and can inform spatial planning.

http://coralreefwatch.noaa.gov/satellite/thermal_history/

WARM SEASON SST VARIABILITY

Field studies have shown higher temperature variability reduces sensitivity to thermal stress.

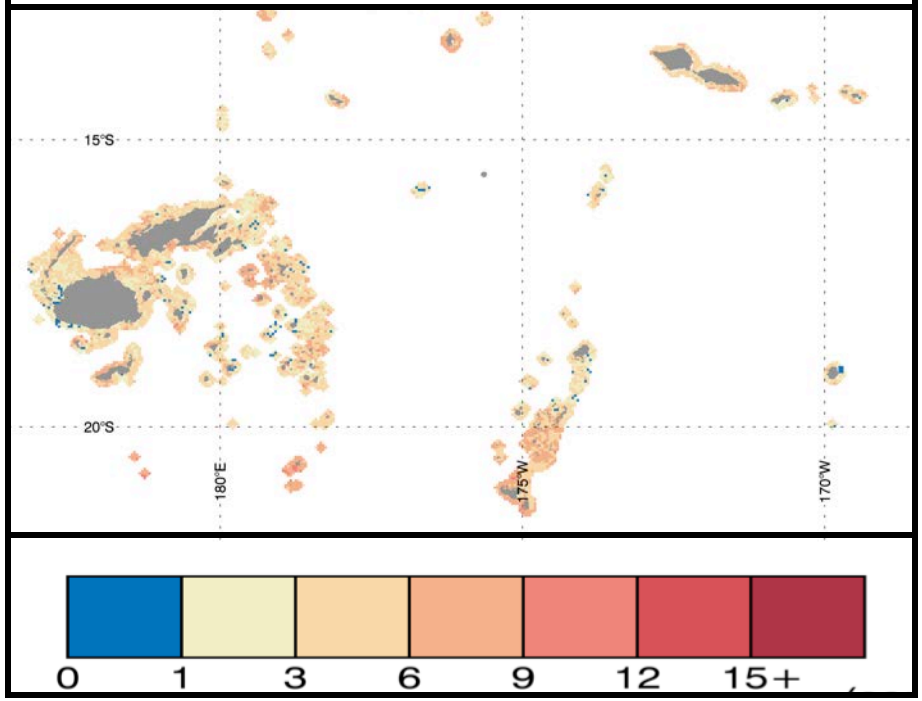
Relative variations within a region may be most useful to determine reefs with reduced susceptibility.



STRESS FREQUENCY

Historically low exposure can indicate localized features that may provide ongoing protection from thermal stress.

Survivors through frequent stress may have acclimated and be best conditioned for future stress.



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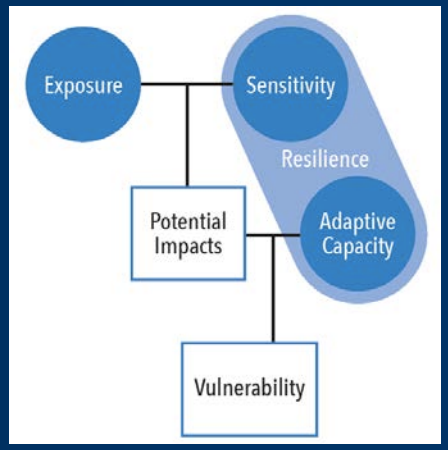
Resilience Assessment

- Layer ecological and anthropogenic stress indicators to give relative resilience potential
- In water, desktop, or combination
- Generate management recommendations
- ID drivers of resilience
- Contribute information to understanding recovery



CNMI Resilience Assessment

Steve McKagan:
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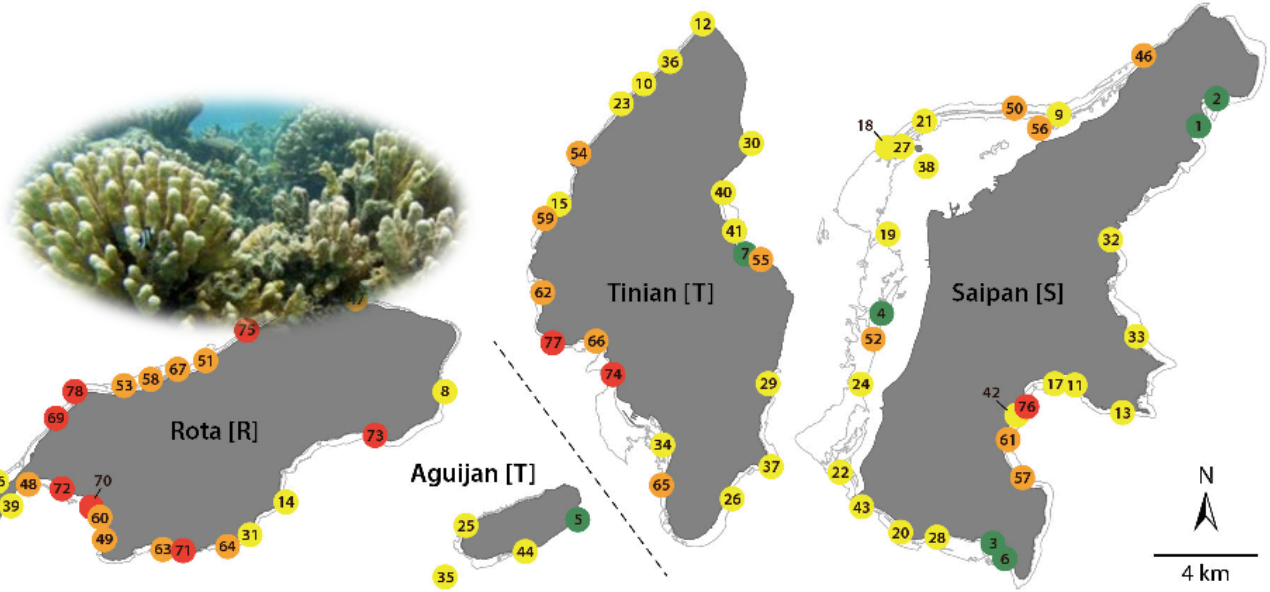
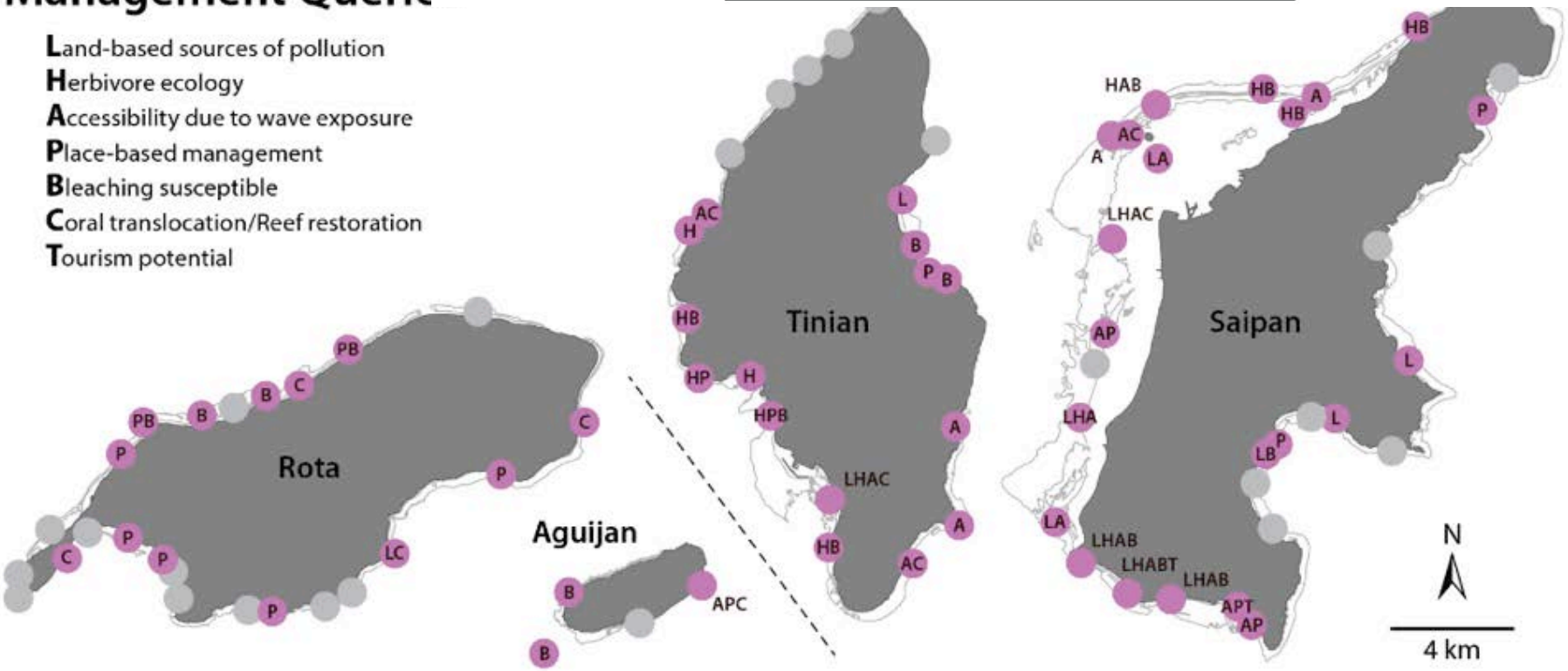
NOAA NMFS PIRO



Relative resilience potential: high med-high med-low low

Management Queries

Land-based sources of pollution
Herbivore ecology
Accessibility due to wave exposure
Place-based management
Bleaching susceptible
Coral translocation/Reef restoration
Tourism potential



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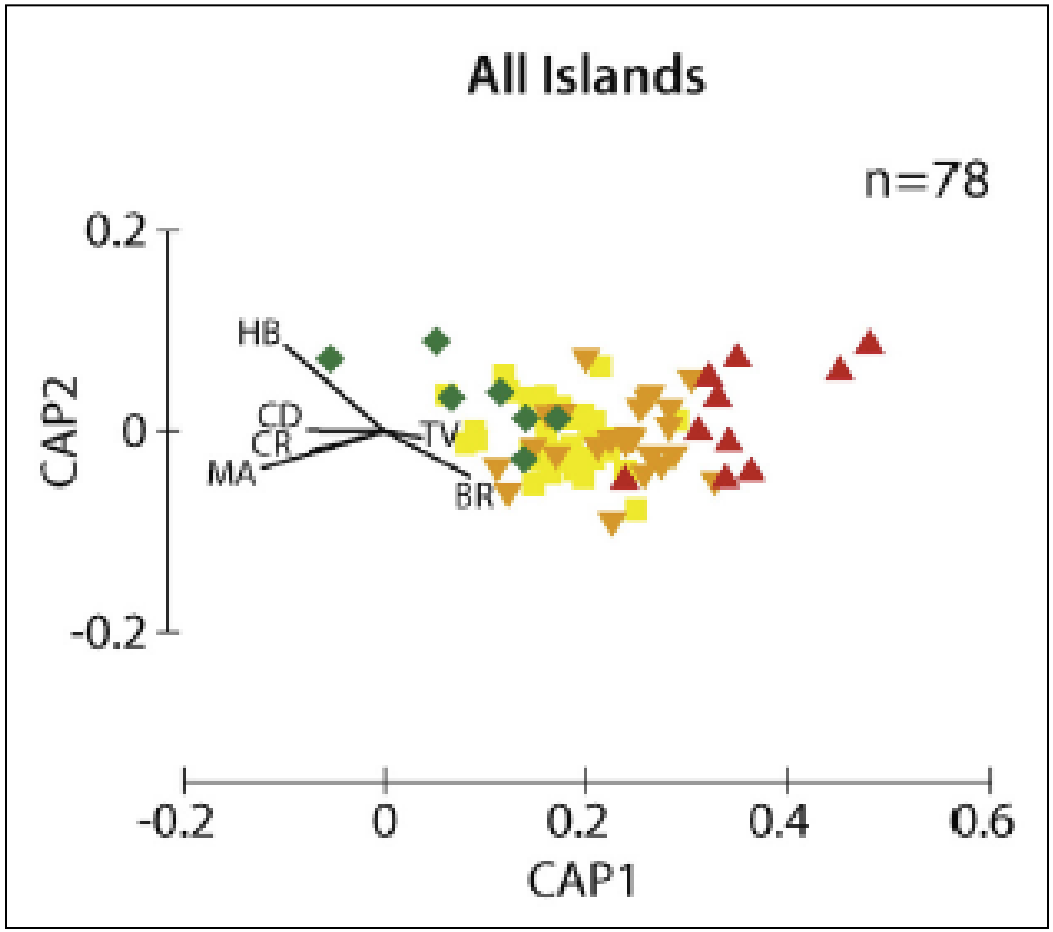
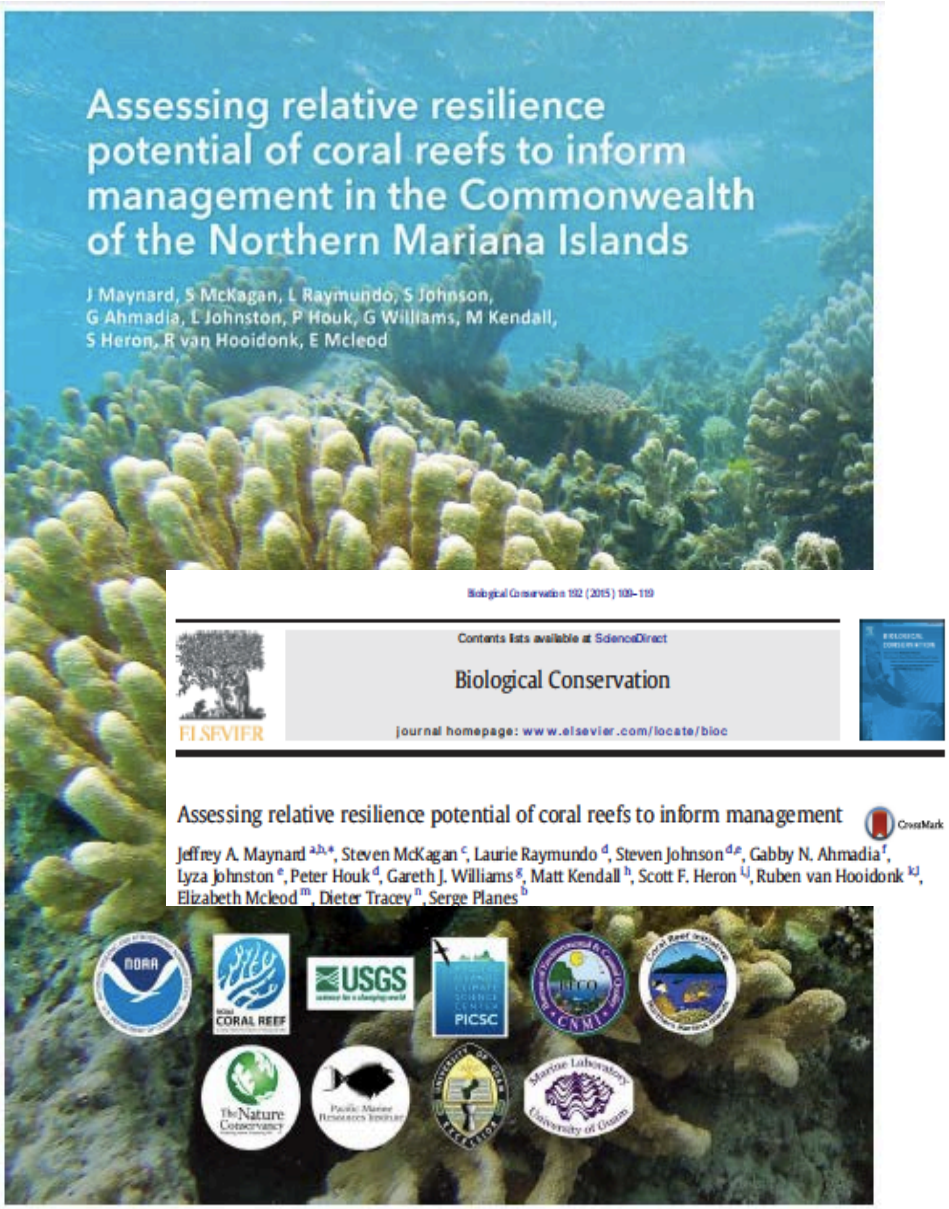
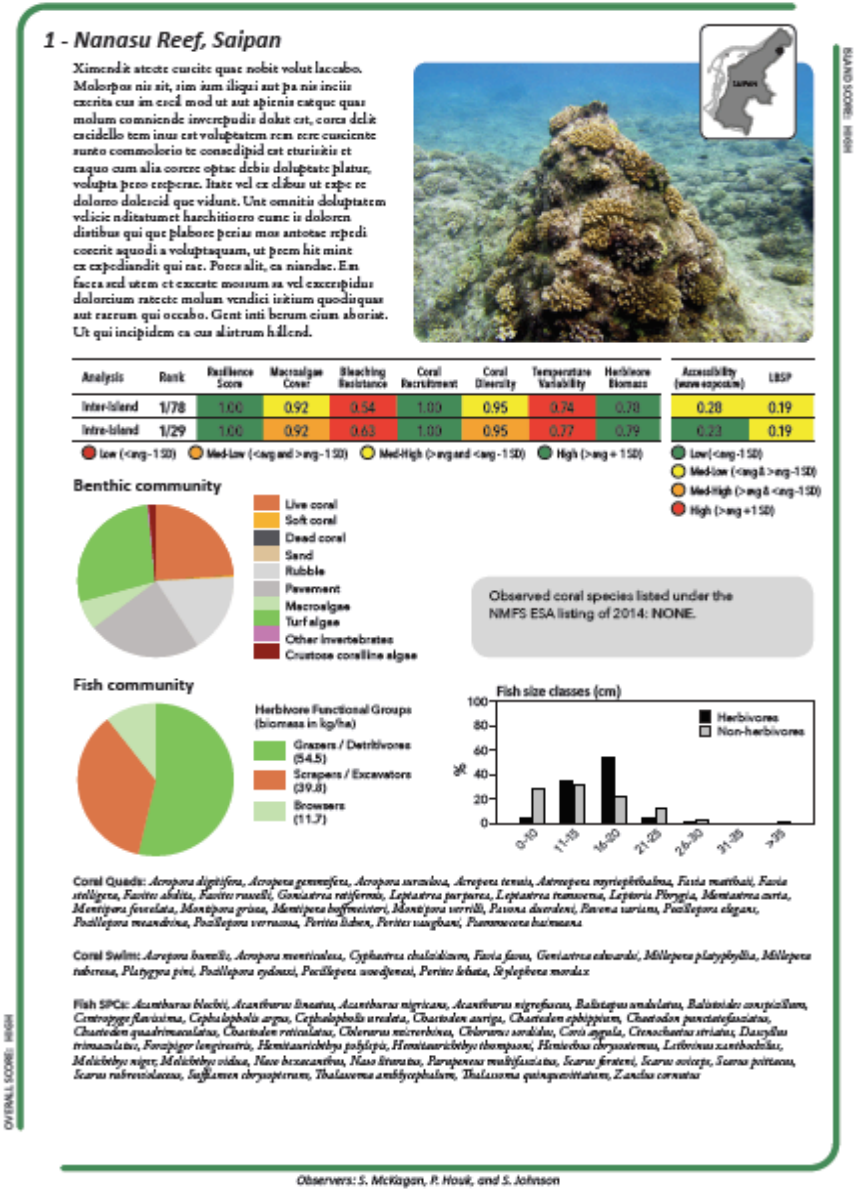


Relative resilience potential: ◆ high ▼ med-low ■ med-high ▲ low

MA = Macroalgae Cover CR = Coral Recruitment TV = Temperature Variability
BR = Bleaching Resistance CD = Coral Diversity HB = Herbivore Biomass

CNMI Resilience Assessment - Dissemination





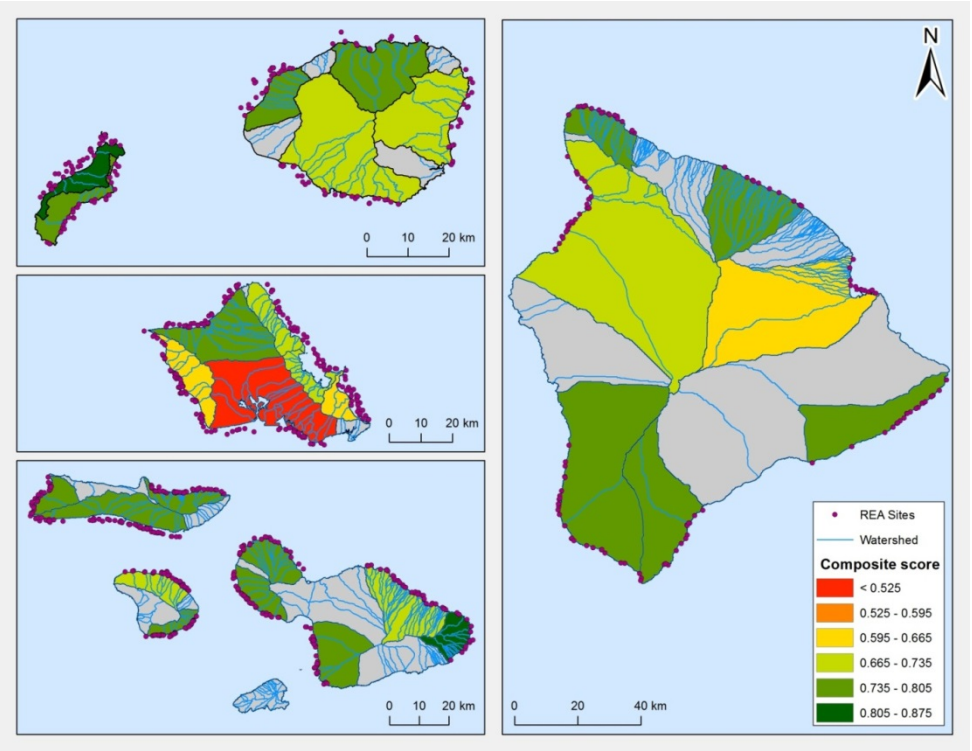
CNMI Resilience Report: http://www.coris.noaa.gov/activities/cnmi_reef_resilience/

Biological Conservation Paper: http://www.sciencedirect.com/science/article/pii/S0006320715300926

Main Hawaiian Islands R2 Assessment

Brett Schumacher; Brett.Schumacher@noaa.gov
NOAA/NMFS/PIFSC/CREP

- Information & products produced
  - 2-page summary (PIFSC-SP 15-001)
  - GIS output: Maps, shapefiles, archived with CoRIS/InPort
- Methods of dissemination
  - PIFSC special publication, blog post
  - ICRS, R2 workshop
- Intended use
  - Increase awareness
  - Spatial guide for resilience-based management
- Challenges
  - Time to advance analysis and create comprehensive report vs.
    - Core (re: RAMP) responsibilities
    - Shrinking pool of coworkers to share these responsibilities

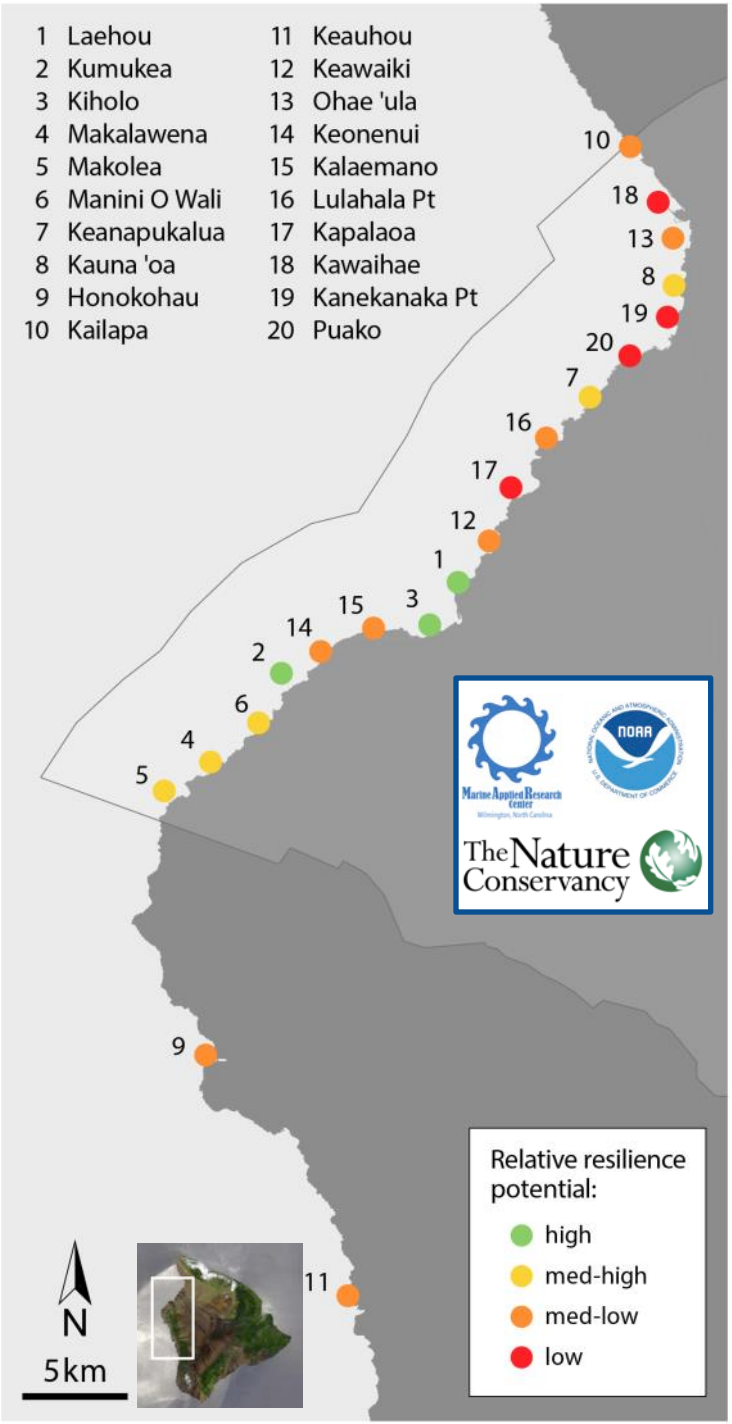


- Potential future directions
  - Compare results vs.
    - Recent bleaching cruise
    - 2016 RAMP

West Hawaii Resilience Assessment

Jon Martinez: jonathan.martinez@noaa.gov
NOAA/NOS/ONMS

- Analyses for 40 locations across 14 variables
- Evaluated 2015 bleaching event
- 2016 Manager Workshop & Public Event & Media
- Identify key stressors and management opportunities
- Manager & land owner buy in
- Monitor recovery post-bleaching and re-evaluate resilience potential



Application: Decision support framework for Prioritizing reefs in the U.S. Virgin Islands

Simon Pittman: Simon.Pittman@noaa.gov NCCOS Biogeography Branch

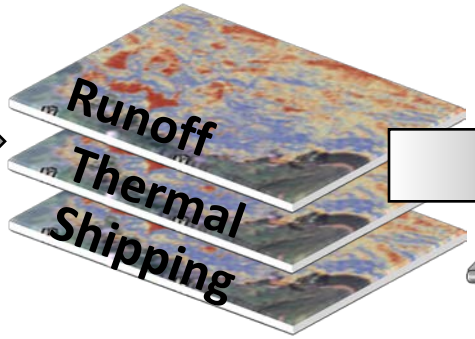
Mapped Ecological Attributes

Mapped Ecosystem Services

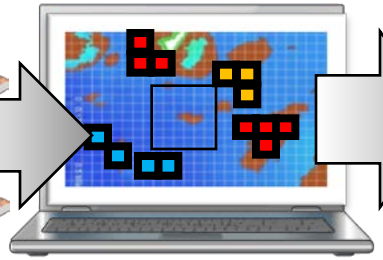
NOAA scientific surveys

Local expert knowledge

Mapped Threats & Stressors



Ranked priority sites



Where are our most diverse reefs ?

Which reefs are most at risk?

ESA corals?

Most valuable?

Most resilient reefs?

Question driven map-based tool

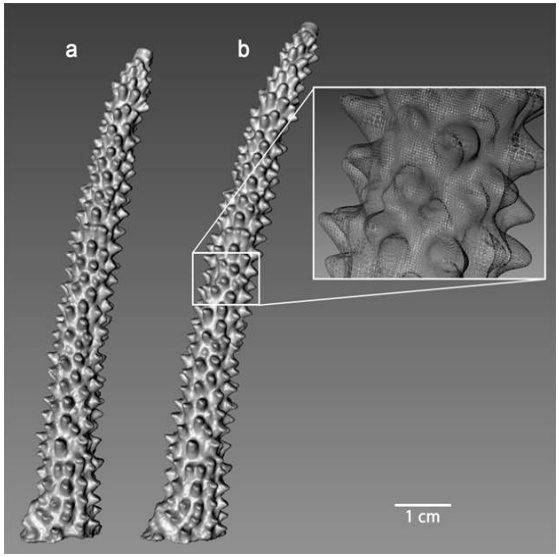
Novel pGIS tool for SCUBA divers

Partners

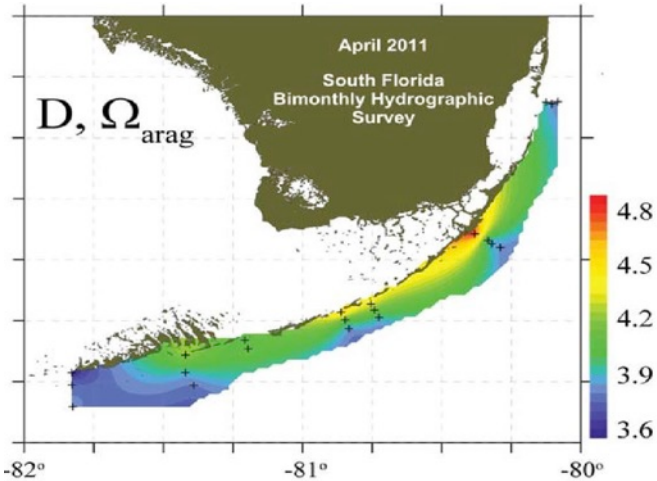
Application: OA (& Resilience) Informed Restoration

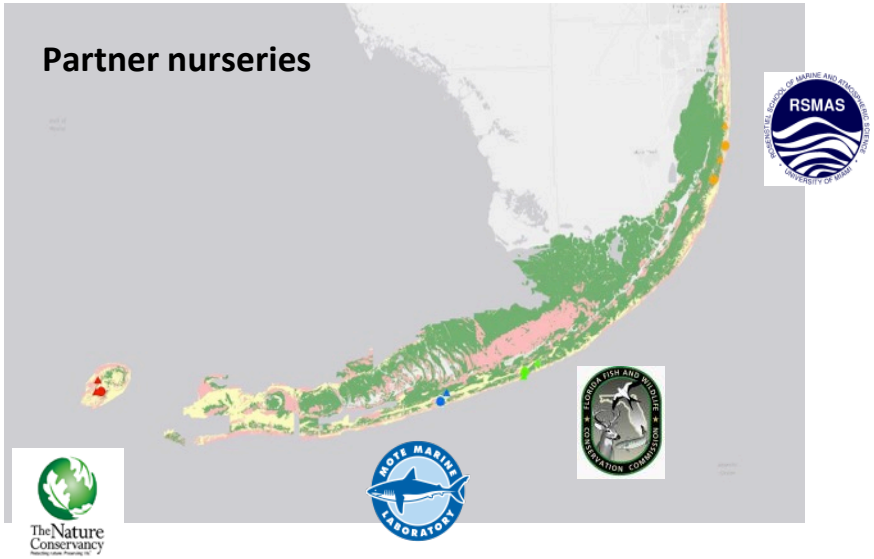
Ian Enochs: ian.enochs@noaa.gov NOAA/OAR/AOML

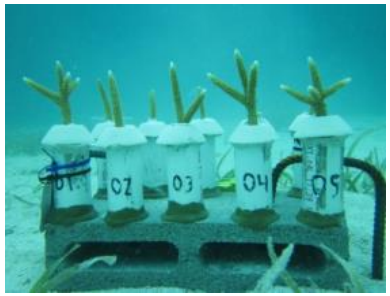
Endangered species respond to acidification



Acidification gradient in Florida Keys







Manzello *et al.*, 2012; Enochs *et al.*, 2014; Enochs *et al.*, in prep

Challenges

- Funding
- Timing
- Management recommendations
- Communication
- Standardization
- Data

Next Steps

- Finish first assessment in all jurisdictions
- Standardized template for outcomes
- Apply RBM & evaluate
- Integrate into ongoing monitoring programs
- Operationalize the approach
  - Integrate information on reef past, present and future to provide a dynamic understanding to inform management

Citations

- CNMI Assessment:

doi:10.1016/j.biocon.2015.09.001

- CNMI Connectivity Work:

doi: 10.1111/gcb.13159

- Ocean Acidification Work:

  doi:10.1371/journal.pone.0041715

  doi: 10.1007/s00338-014-1132-7