Reefs for the future:

Resilience of coral reefs in the main Hawaiian Islands

Herbivorous fish such as *uhu* (parrotfish) support resilient reefs by reducing macroalgae abundance. *Uhu* species shown are Bullethead Parrotfish (*Chlorurus spilurus*) above and Palenose Parrotfish (*Scarus psittacus)* below.

Declining health of coral reef ecosystems led scientists to search for factors that support reef resilience: the ability of reefs to resist and recover from environmental disturbance. Scientists recently identified 11 measurable factors that affect the resilience of coral reefs (Table 1) (McClanahan et al. 2012). Reef resilience factors include characteristics of the coral assemblage, populations of fish that live on the reef, land use practices, and water temperature variability. These factors were used to conduct a quantitative assessment of the resilience potential of reefs across the main Hawaiian Islands (MHI).

Locations of Rapid Ecological Assessment (REA) surveys conducted by the NOAA Pacific Islands Fisheries Science Center's Coral Reef Ecosystem Division (CRED) from 2010 to 2013 were used to designate study units called "georegions" (Figure 1). Watersheds upstream of georegions were then grouped to delineate the area that could affect adjacent reefs through pollution, runoff, and sedimentation. REA surveys provided data to evaluate biological/ecological resilience factors, and external data sources were used to inform physical and environmental factors not directly measured by CRED (Table 1). Data for each factor was compiled, normalized, and averaged to produce a composite resilience score for each georegion.

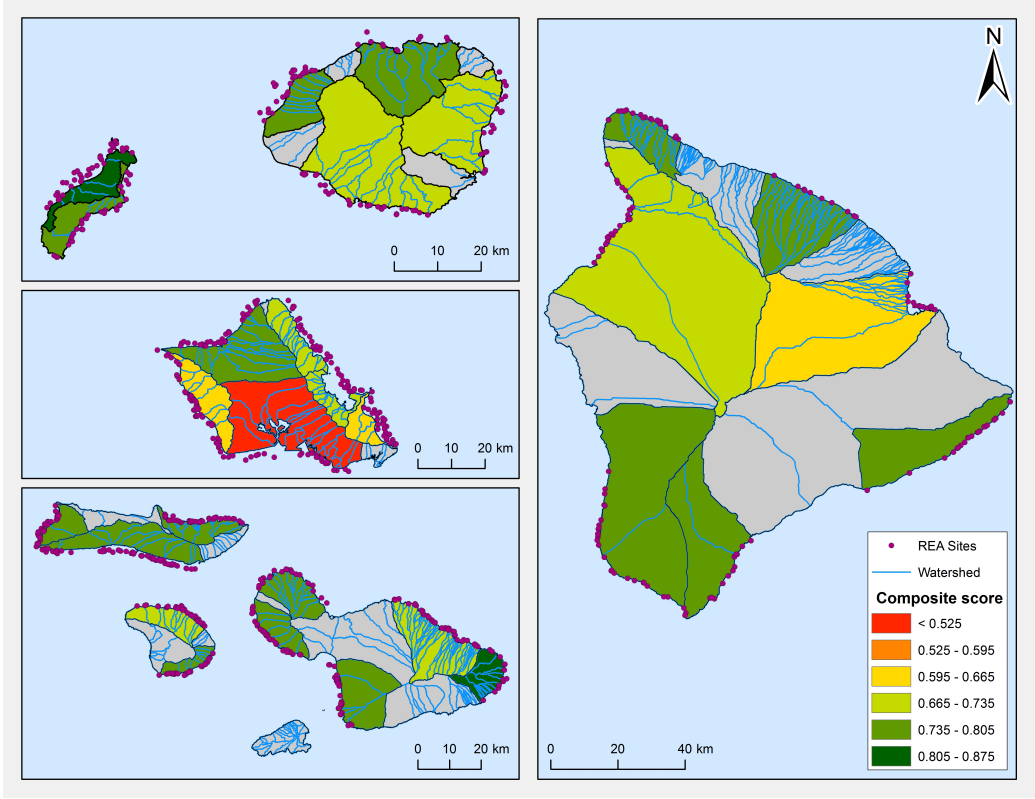


Figure 1. Composite resilience scores: Colors indicate the score for each georegion and encompass watersheds which drain onto the reef. Dots indicate locations of NOAA CRED in-water rapid ecological assessment surveys.

KEY POINTS:

- 29 coral reef "georegions" assessed to compare reef resilience across the main Hawaiian Islands
- 10 metrics used for Resilience Assessment
- Top scores earned by Northwest Niʻihau and East Maui reefs
- Lowest score earned by south Oʻahu reefs
- Analysis highlights georegions where local management may be used to preserve or improve resilience

Resilience of coral reefs in the main Hawaiian Islands

Results & Discussion

Twenty-nine georegions were analyzed across the MHI. Lowest composite resilience scores were earned by reefs near densely populated areas on O'ahu, while highest scores were earned near relatively sparsely populated areas of other islands (Figure 1).

A key aspect of the reef resilience framework is that it can empower local action to improve resilience of coral reefs because some drivers of resilience are heavily influenced by large-scale climatic forces, while others can be directly affected by local management (Table 1). For example, land use practices and marine resource stewardship will affect watershed health and herbivorous fish biomass, respectively.

Figure 2 compares the mean score of locally manageable factors to other factors for each georegion. If a region falls below the comparison line, locally managed scores are low relative to other scores, and resilience could be improved through targeted management action. Factors influenced by local management often scored relatively low, so most georegions in the MHI are below this line. However, each island has areas which fall near the comparison line.

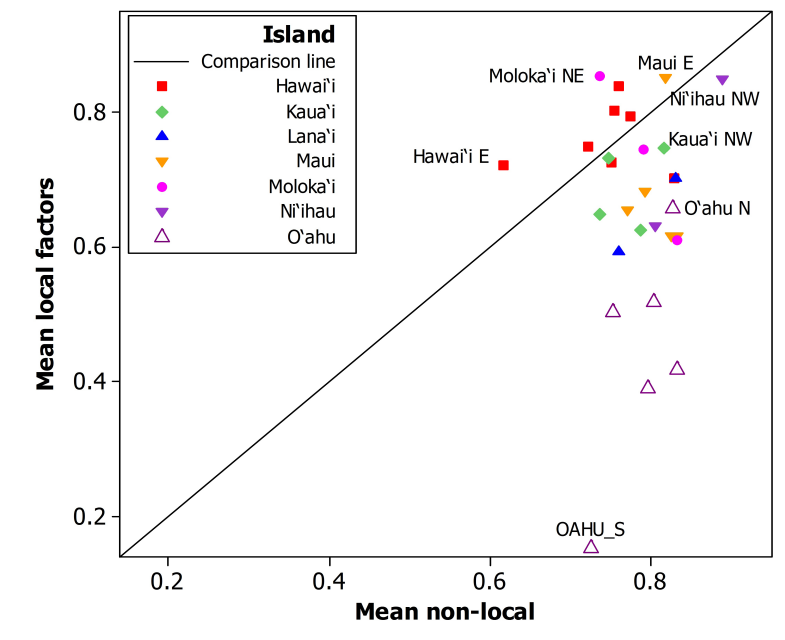
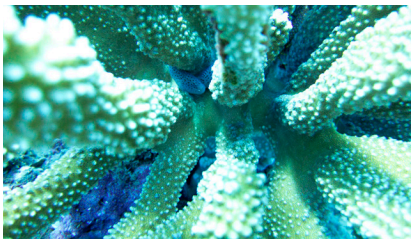


Figure 2. Comparison of resilience factors that can be influenced by local action vs. those that cannot.



Antler Coral (*Pocillopora eydouxi*) provides habitat for a number of fish, crabs and other animals but is susceptible to bleaching.

The range in scores affords local management different avenues to address reef resilience. For example, georegions near or above the line could be prioritized to maintain reef resilience, or efforts could be focused on georegions below the line to improve their resilience.

Table 1. List of resilience factors, measures used for evaluation, and sources of data. Boldface indicates factors that can be directly influenced by local management.

FACTOR	INPUT	SOURCE
Pollution	Watershed Health Index	Kido 2006
Sedimentation	Rainfall, coastline	Giambelluca et al. 2013
Herbivore biomass	Grams/m^2 of herbivorous fish	CRED RAMP
Macroalgae cover	Percent cover of macroalgae	CRED RAMP
Coral diversity	Taxonomic distinctness	CRED RAMP
Coral recruitment	Recruits/m^2	CRED RAMP
Disease prevalence	Percent diseased corals	CRED RAMP
Bleaching resistance	Percent susceptible corals	CRED RAMP
Physical impacts*	Percent damaged corals	CRED RAMP
Fishing pressure	Population within 10 km, Percent households fishing, Percent MPA	U.S. Census, Allen & Bartlett 2008
Sea surface temperature variability	Warmest month variability, number of thermal events (DHW ≥ 4)	S. Heron - 786 (CRCP project)

* Data on physical impacts were not available for all georegions, so it was not incorporated in composite resilience scores.

Diseases such as the Black Band Disease afflicting this Rice Coral (*Montipora capitata*) undermine the resilience of coral reefs.

Acknowledgement: This work was funded through a grant from the NOAA Coral Reef Conservation Program.

For additional information on resilience scores or citations, please contact: nmfs.pic.credinfo@noaa.gov

This document may be referenced as: PIFSC. 2014. Reefs for the future: Resilience of coral reefs in the main Hawaiian Islands. NOAA Fisheries Pacific Science Center, PIFSC Special Publication, SP-15-001, 2p.