Decision support framework for prioritizing reefs in the U.S. Virgin Islands

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80% of USVI economy linked to tourism

*van Beukering et al. 2011*

Valuing USVI's coral reefs

50% visit for coral reef

50% won’t return if reef quality declines
Structural Decline of Caribbean Coral Reefs

- Declining Water Quality
- Lack of Herbivory & Algal domination
- Hurricanes 6% pa
- Bleaching & Diseases
- Shift in coral dominance: From reef-building to weedy corals
- Stressors acting simultaneously
- Declining Water Quality
- Lack of Herbivory & Algal domination
Decline of live corals in the U.S. Virgin Islands

Why prioritize?

Coral reefs are not made equal

Limited resources result in tough decisions

Legal framework can dictate priorities (e.g. ESA, CWA)

Quantitative spatial framework supports transparent and rigorous evidence-based decision support

Biology & Ecology
Ecosystem Services & Value
Stressors
Connectivity
Resilience
Development of a decision support framework

Step 1: Determine decision support needs in coral reef conservation

Step 2: Develop conceptual framework & acquire data

Step 3: Prioritize ecologically & economically important coral reefs

Step 4: Map exposure to stressors

Step 5: Identify priority reefs from most to least at risk

Step 6: Identify reefs for priority action
Integrated social-ecological data

Mapped Ecological Attributes
- Terrain complexity
- Fish richness
- Connectivity
- Acropora presence
- Fish spawning sites

Scientific surveys

Priority reefs

Local Expert Knowledge

Mapped Ecosystem Services
- Coastal defence
- Fisheries potential
- SCUBA diving sites
- Reef monitoring sites

Scientific surveys

Local Expert Knowledge

Mapped Threats & Stressors
- Runoff
- Thermal stress
- Shipping
- Wave action
- Cumulative stress

User-defined questions

Reefs of concern & reefs of hope
Biodiversity & habitat complexity

- New 20 m res bathymetry product
- High complexity = good predictor of high biodiversity
Mapping fish richness hotspots

Top 25% fish species richness
Boosted Regression Trees
AUC = >.93
Special and vulnerable places

Sites with known Acropora locations & Models of ESA coral distributions

Fish spawning aggregations

Reefs with permanent monitoring sites
Accounting for seascape connectivity

Connectivity maintains productivity, biodiversity & resilience

Strong connections = High score
Weaker connections = Intermediate score
Isolated reef = Lowest score

Source: Pittman & Olds 2015 Seascape Ecology of Fishes on Coral Reefs. In Mora C. Ecology of Fishes on Coral Reefs
Proximity of reefs to seagrasses & mangroves

Distance to seagrasses

Distance to mangroves

Meters
- 0 - 100
- 100.1 - 300
- 300.1 - 500
- 500.1 - 1,000
- >1,000
Harnessing local SCUBA diver knowledge
Participatory GIS via online mapping tool using Google Earth

U.S. Virgin Islands Coral Reef Study

Latitude:
18.31507100483745
Longitude:
-64.93057250976562
SCUBA Divers – our eyes in the ocean

87 occupational SCUBA divers (~ 8 yrs experience)
7,993 pins placed on reefs (92 avg. per person)
Exposure to stressors: land-based sources of pollution

Reef exposure mapping 1 km buffer

Coral Reef and colonized hardbottom

Exposure to runoff
- Highest
- Lowest

Major pour points
- <200
- >200

Summit to Sea Revisited
Thermal Stress History (1985-2012)

SST ~4 km

http://coralreefwatch.noaa.gov/satellite/thermal_history/
Tracking ship movements over coral reefs:
Threat from pollution & re-suspended sediments
Ecosystem Services: Coastal Protection Value of Coral Reefs


Annual CPV = USD 1.2 M$
Ecosystem services: Mapping Fisheries Value of Coral Reefs

Annual value of USVI fishery = USD 3.3 Million
How are reefs ranked and risk evaluated?

**Physical Complexity**
- (High = 1; other = 0)

**Physical Connectivity**
- (Close proximity = )

**Biodiversity**
- (High = 1; other = 0)

**Protected Biota**
- (Presence = 1; other = 0)

**Diver Priority Sites**
- (Class A = 1; Class B = 0)

**Monitoring Sites**
- (Presence = 1)

**Default settings**
- Equal weight
- Sum of all scores
- 100 m grid resolution

**User defined**
- Adjustable weightings
- & metric selection
- Variable grid resolution

**Spatial scenarios**

Evaluate Possible Actions

High Value + High Threat = Management Priority Level 1?

High Value + Low Threat = Management Priority Level 1?

Or Mixed Portfolio to spread risk?
Question driven prioritization to meet specific needs

Sites of Concern

Acropora presence + Poor water quality =

High biodiversity sites + High, medium & low cumulative threats =

Important tourism dive sites + High cumulative threats

High priority sites in proximity to proposed development

High priority reefs outside of existing MPA network

Reefs with highest exposure to historical thermal stress

Support for:
Coral Reef Conservation Act
EPA Clean Water Act
Endangered Species Act
Local Action Strategies
Management Applications

• Support permit evaluation & risk assessments
• Marine Spatial Planning
• Prioritize coral reef conservation actions
• Evaluate design of MPA network
• Assess and value ecosystem services
• Optimize monitoring strategies (multi-agency)
Next steps: Operationalization (2016/7)

Operationalization = Challenge of creating a tool that will be used by people!

Build test version

Review & revise

Decision Support Tool

Complete by Oct 2016

Happy evidence-based decision makers
Thanks to the project team

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