Incorporating Ecosystem Services into Coastal and Watershed Management

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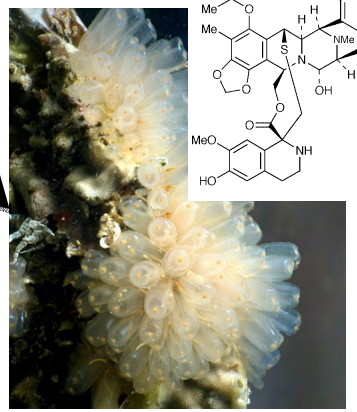
Ecosystem Services: the benefits people obtain from ecosystems

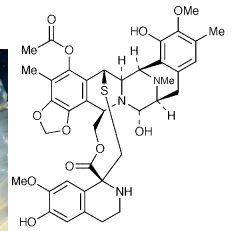
Tourism & Recreation

Fishing

Ecosystem Integrity

Shoreline Protection





Natural Products

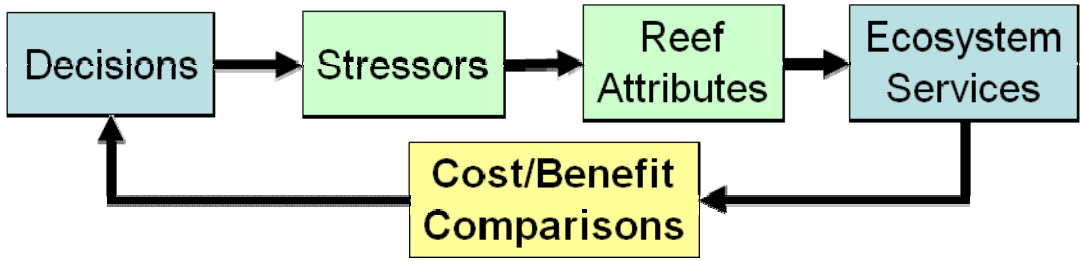
Ecology will Replace Physics as the Master Science

(Thomas Homer-Dixon 2009)

- The dominant scientific discipline of a historical epoch.
- Generates and orders the concepts through which society understands itself and its relation to its surroundings.

Research Areas

1) Understanding human land- and water-use decisions
2) Links between human activity (stressors) and coral reef condition (reef attributes)
3) Links between coral reef condition and delivery of ecosystem services
4) Understanding consequences of decisions on delivery of coral reef ecosystem services
5) Methods to communicate and incorporate information and analyses into future decisions



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Decision Workshops

- Characterize the biophysical landscape
  - Overviews on state of the ecosystem, primary stressors and proposed management plans
  - Plotting in a DPSIR framework
- Identify priority environmental issues
- Characterize the decision landscape
  - Social Network Analysis: who interacts with whom on what matters
  - Legislation
  - Scientific information
- Elaborate potential management options

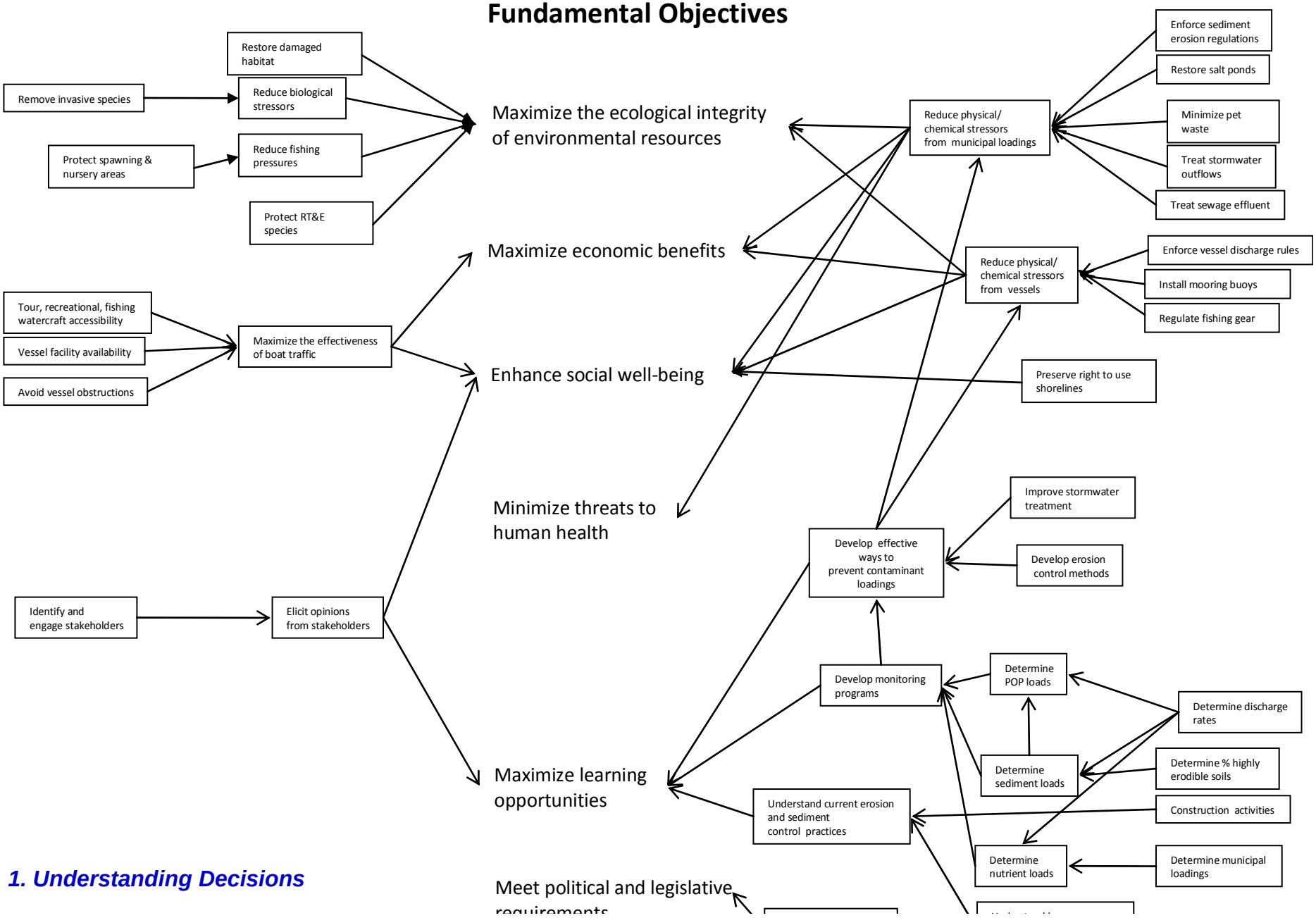
Objectives Hierarchy

Manage coastal resources to improve quality of life in USVI

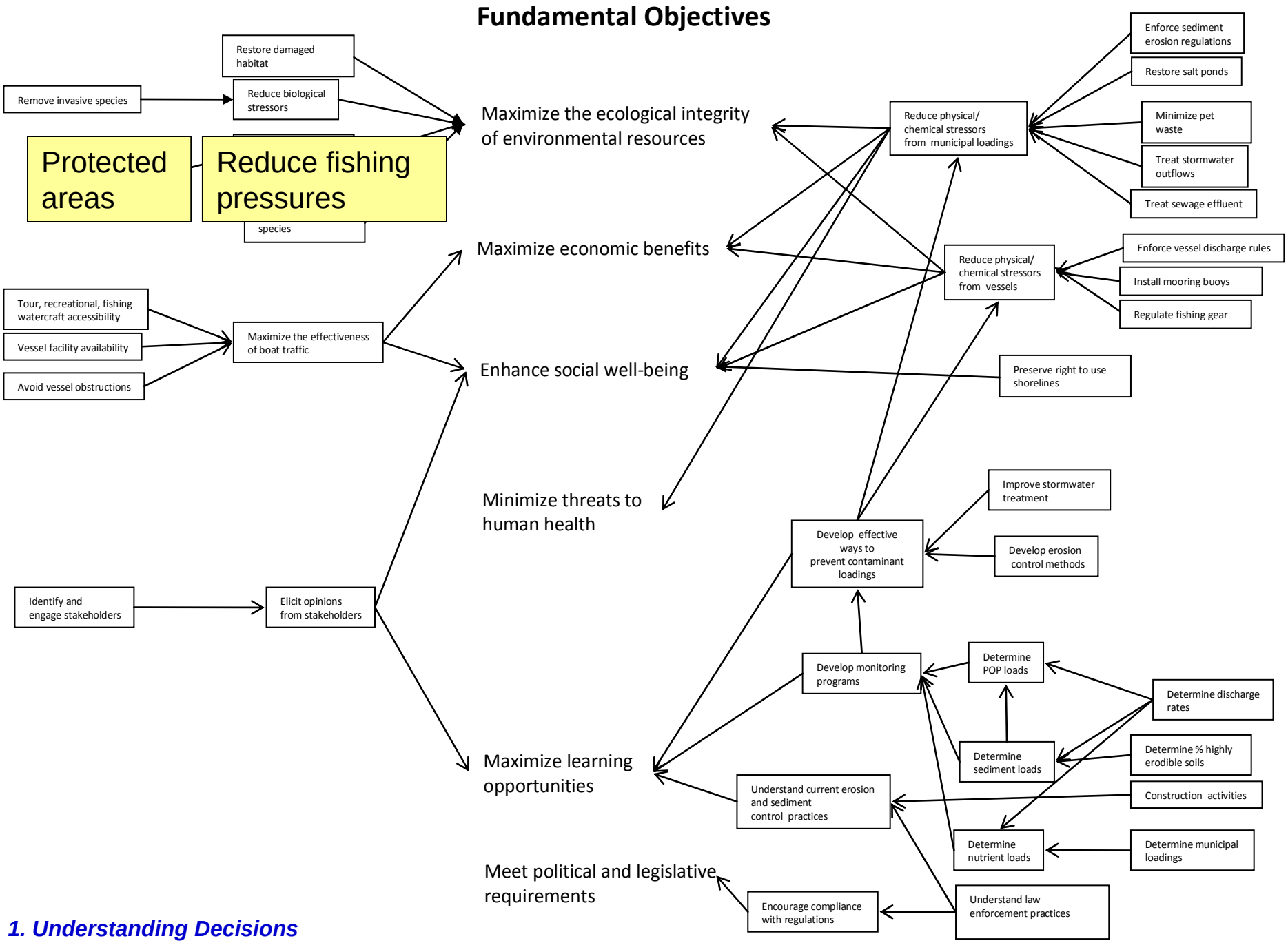
1. Maximize **ecological integrity** of reefs
    a. maximize diversity & abundance of reef species
2. Maximize economic benefits
    a. maximize economic benefit from **tourism**
    b. maximize **sustainable fisheries** (quantity & quality)
    c. minimize **shoreline erosion** and **storm damage**
3. Enhance social well-being of residents
    a. maximize **aesthetic value** of resources
    b. maximize **recreational opportunities**
4. Minimize threats to human health from floods, pathogens, and poor **water quality**
5. Maximize learning opportunities
    a. maximize **educational opportunities** and communicate risks
    b. maximize use of information in decisions
6. Meet political and legislative requirements in decision-making

Means-Ends Network

Fundamental Objectives



1. Understanding Decisions



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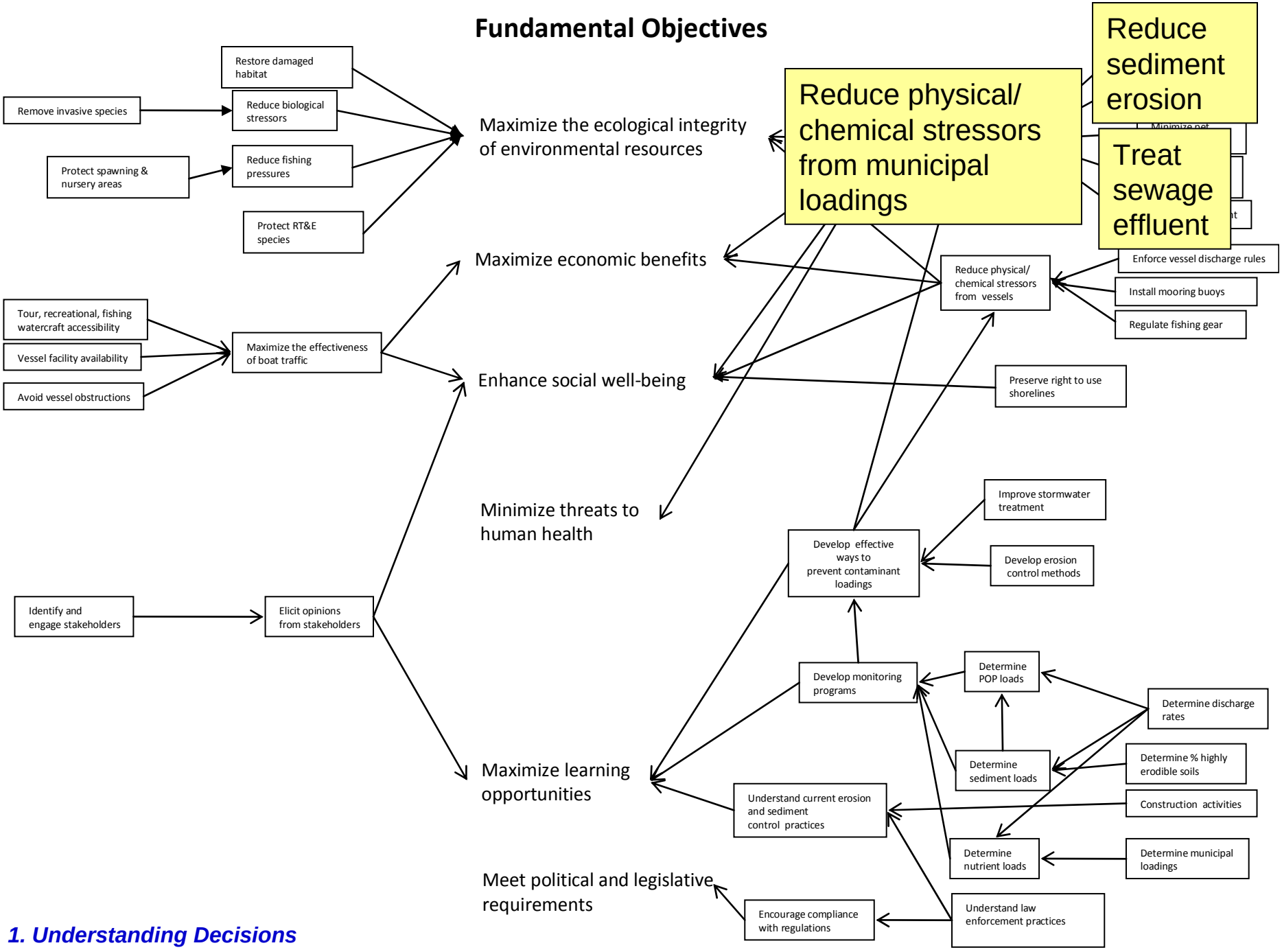

1. Understanding Decisions

Knowledge Base

Literature Database

- **Identifies the published literature relevant to coral reef ecosystems**

Legislative Atlas

- **Identifies the laws, regulations, and policies that are currently in place (at vastly different scales - from global to national to state levels) related to coral reef ecosystems**

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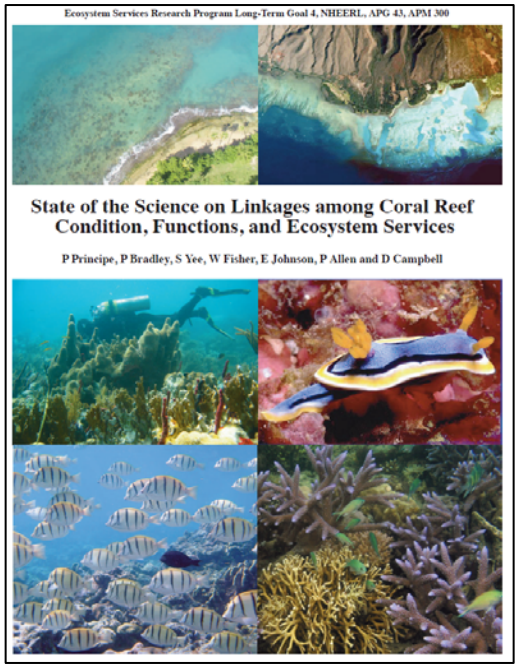
Connecting Reef Attributes to Ecosystem Services

Literature Review

- What services have been identified?
- How were services measured?
- How were services valued?
- How can reef attributes be translated into services?
- What indicators estimate delivery of services?



Reef Attributes relevant to Ecosystem Services

	Shoreline Protection	Fishing	Natural Products	Tourism and Recreation				
Attributes				**Diving, Snorkeling & Underwater Photography**	**Sport Fishing**	**Surfing**	**Beach Activities**	**Viewing Nature**
Overall Marine Diversity & Abundance								
Fish Diversity & Abundance								
Coral Diversity & Abundance								
Water Clarity								
3D Reef Structure								
Wildlife Diversity								
White coralline Sands								
Invertebrate Diversity								
Shallow Water								

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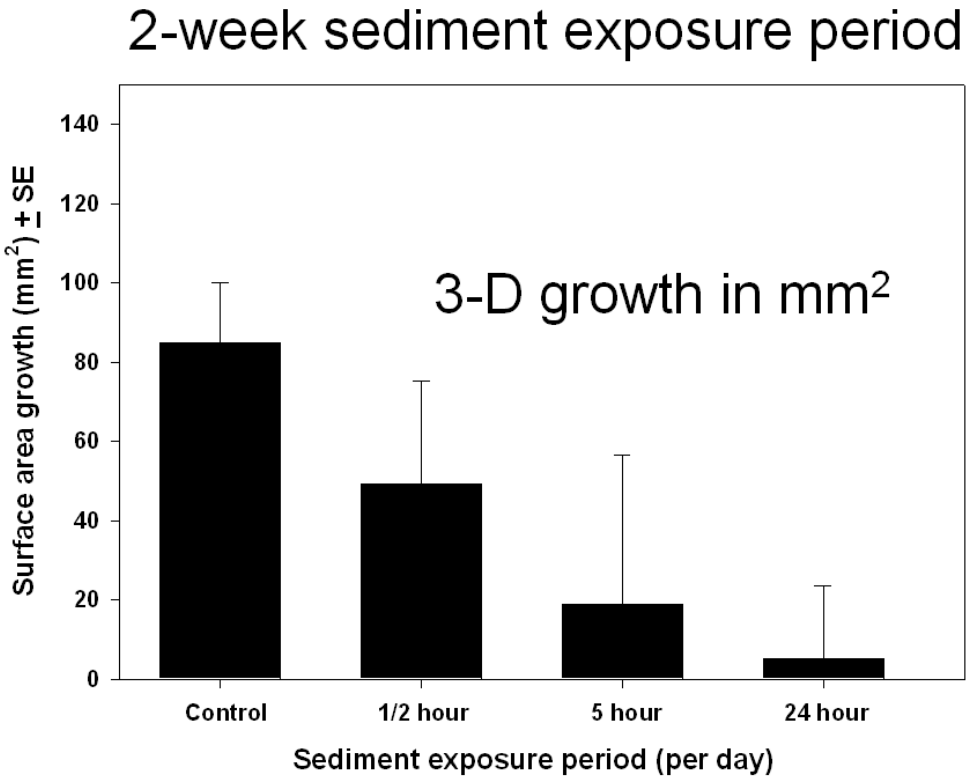
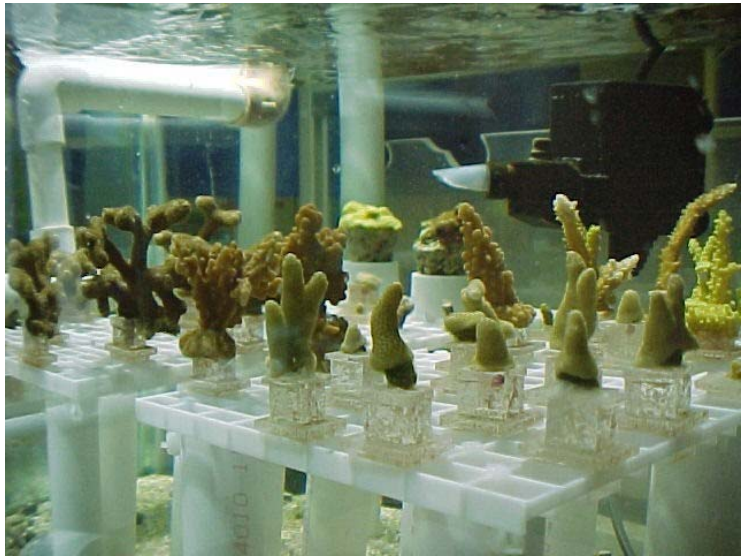
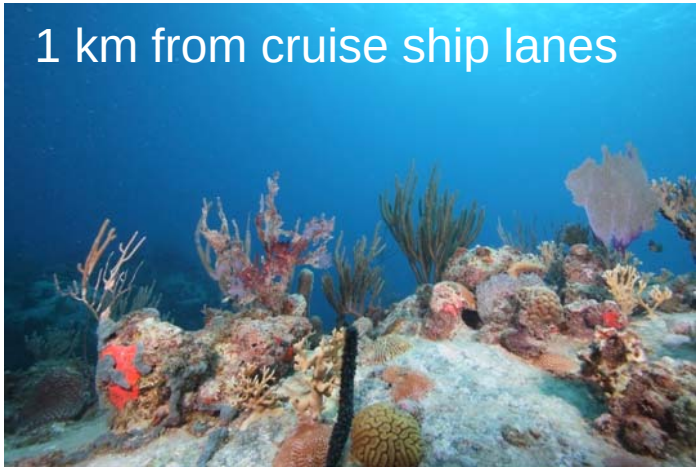
Dose-response Relationships



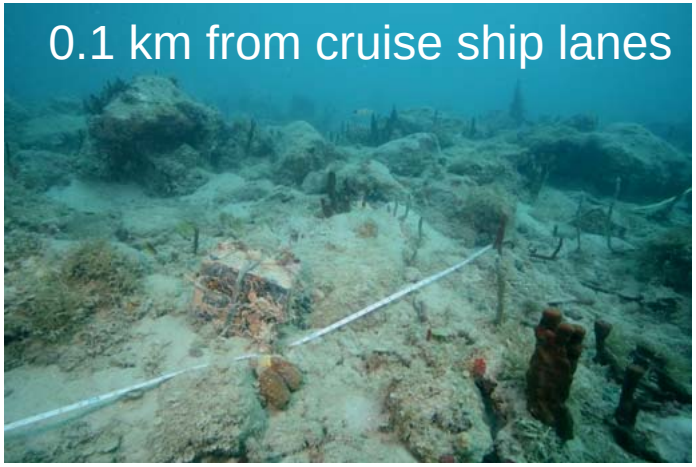


Human-disturbance Gradient

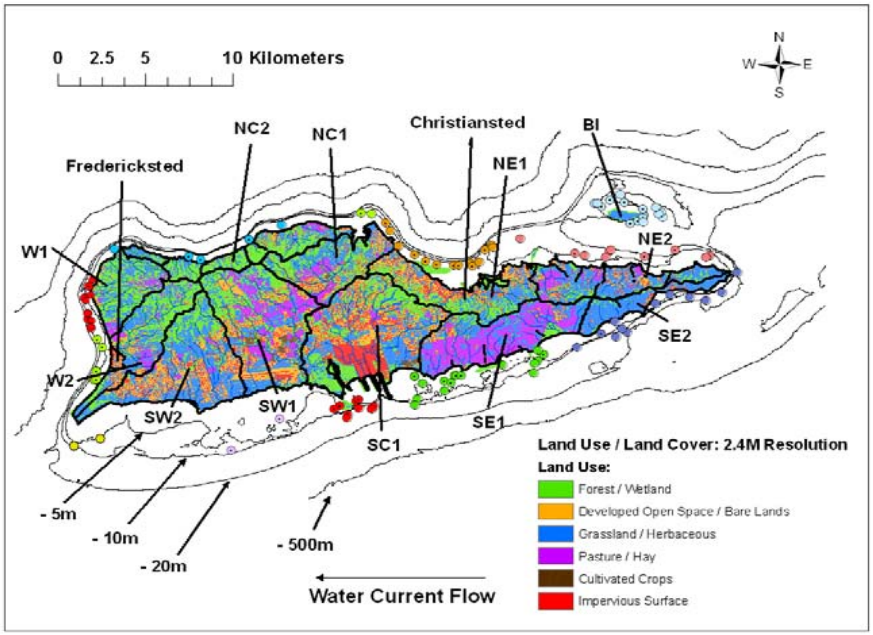
Including:
- Sediment
- Nutrient
- Contaminants
- Physical damage

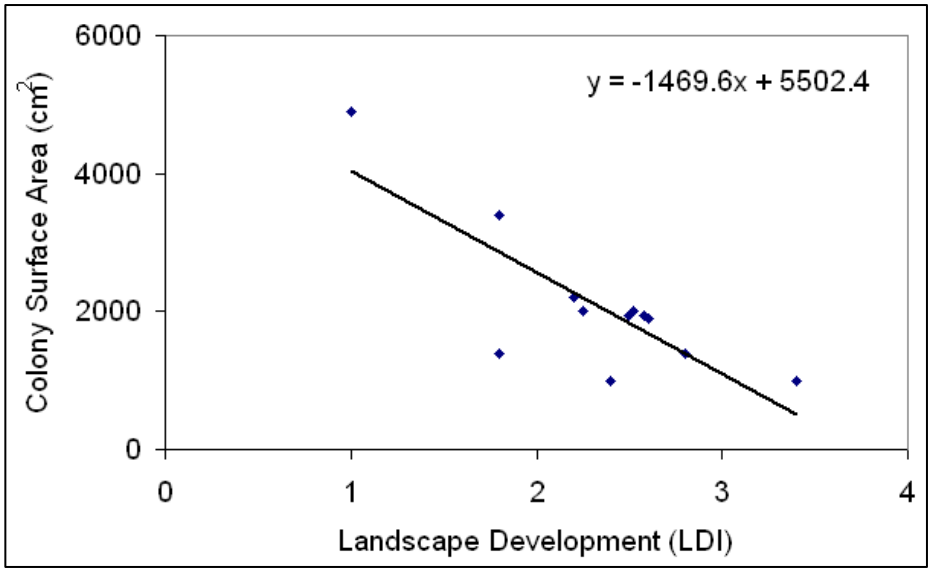


St. Thomas, USVI



Linking Landscape Activity to Reefs





Landscape Development Intensity (LDI) Index: Quantifies human impact in the watershed

Significant correlations between LDI & coral attributes

- Coral density
- Taxa richness
- Average colony surface area
- 3D Total cover

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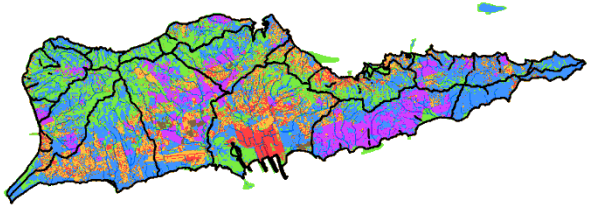
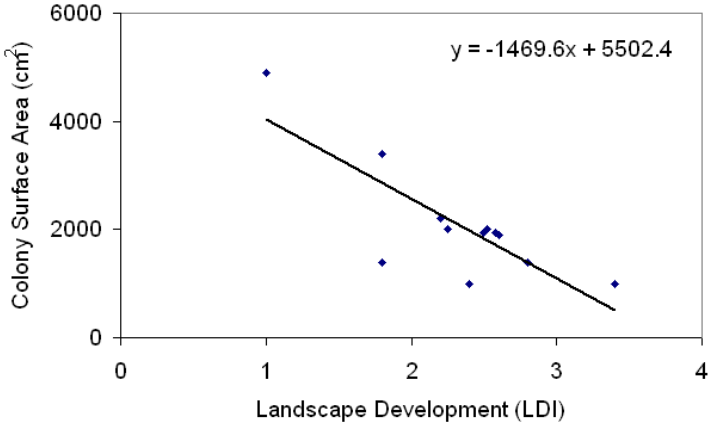
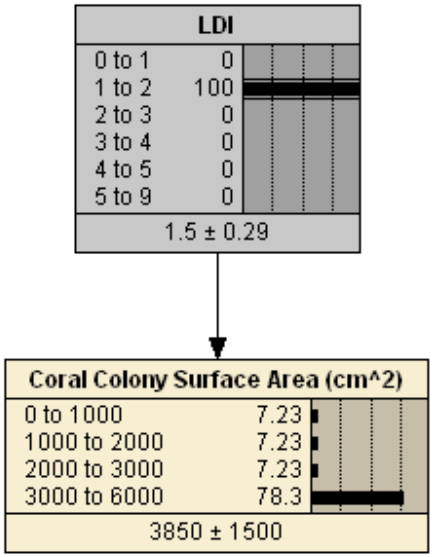
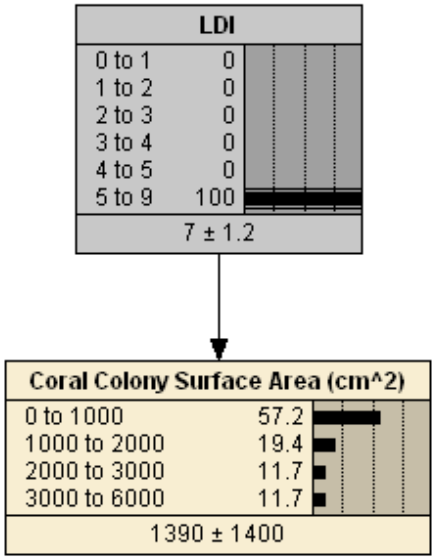
Building a Bayesian Network







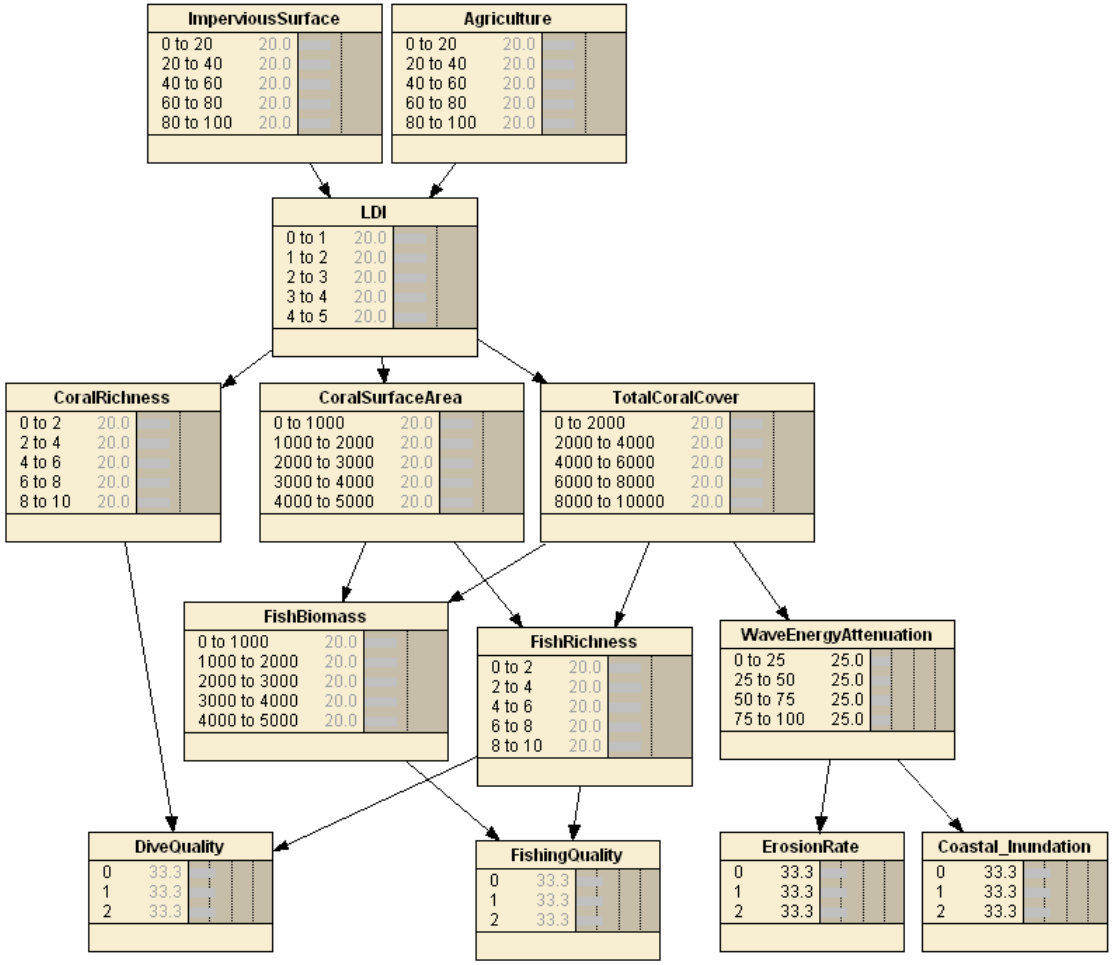
- LDI from 1 to 2
- 78% chance coral surface area >3000

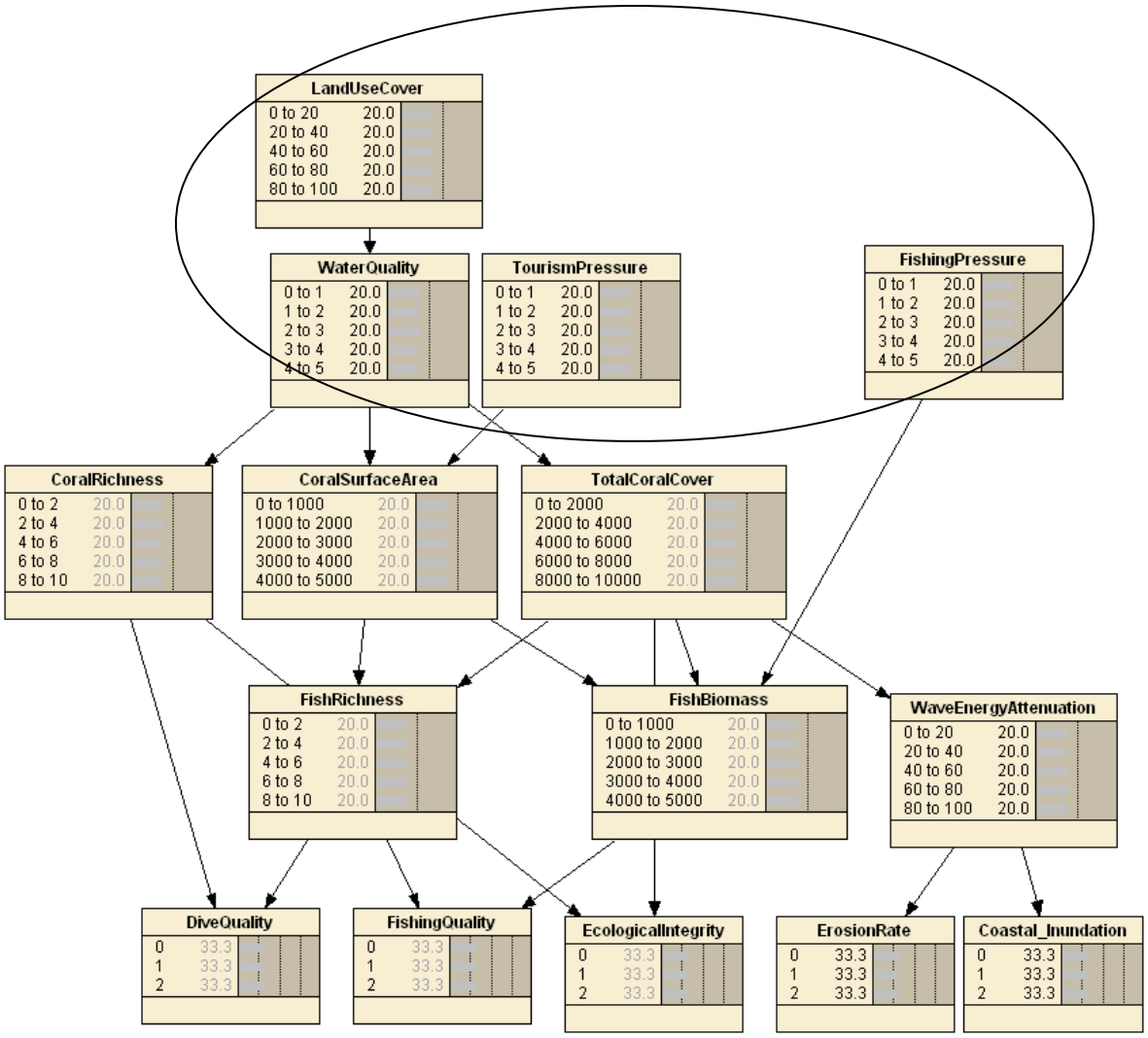


- LDI from 5 to 9
- 57% chance coral surface area <1000

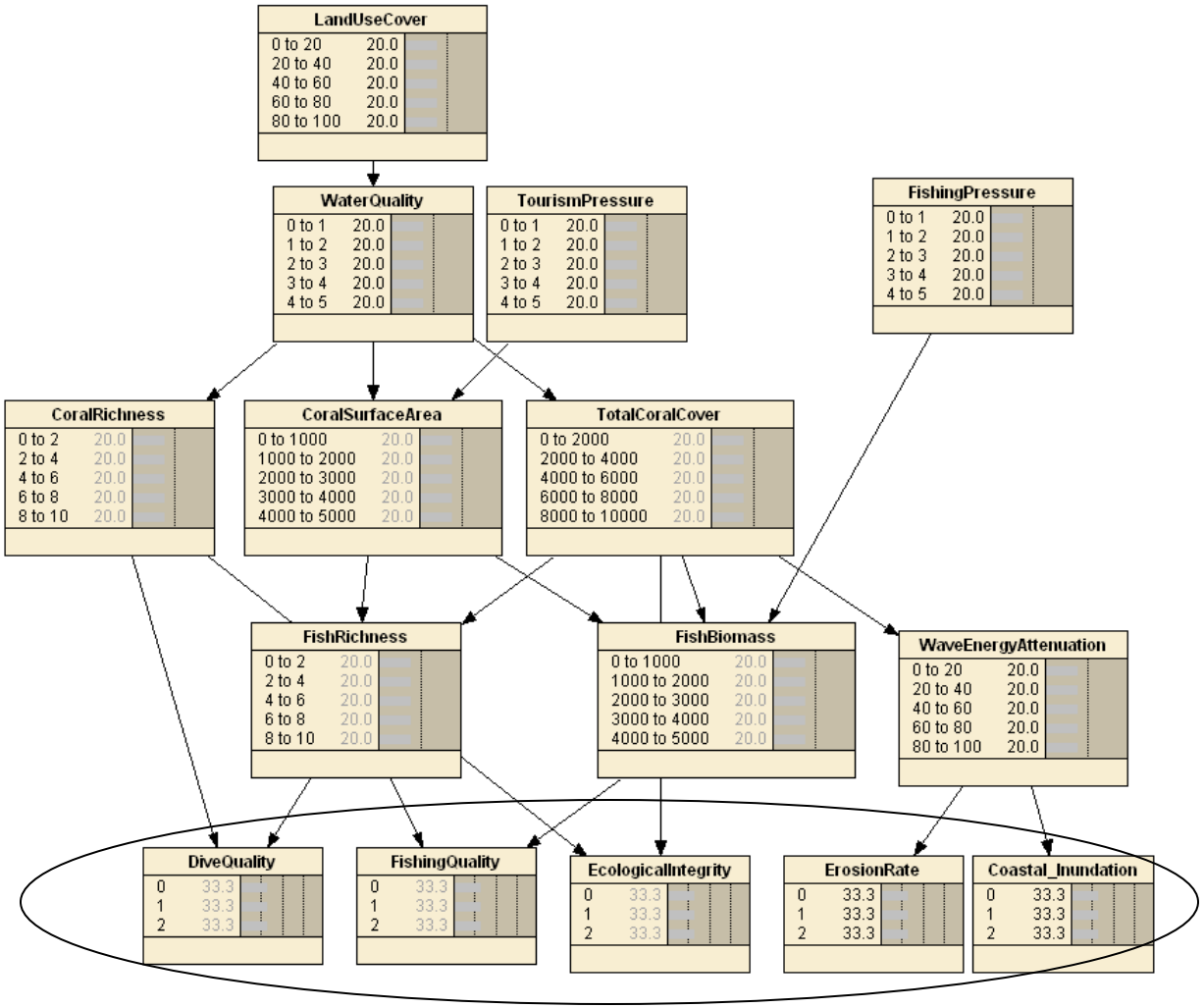
Netica

Link condition to ecosystem services



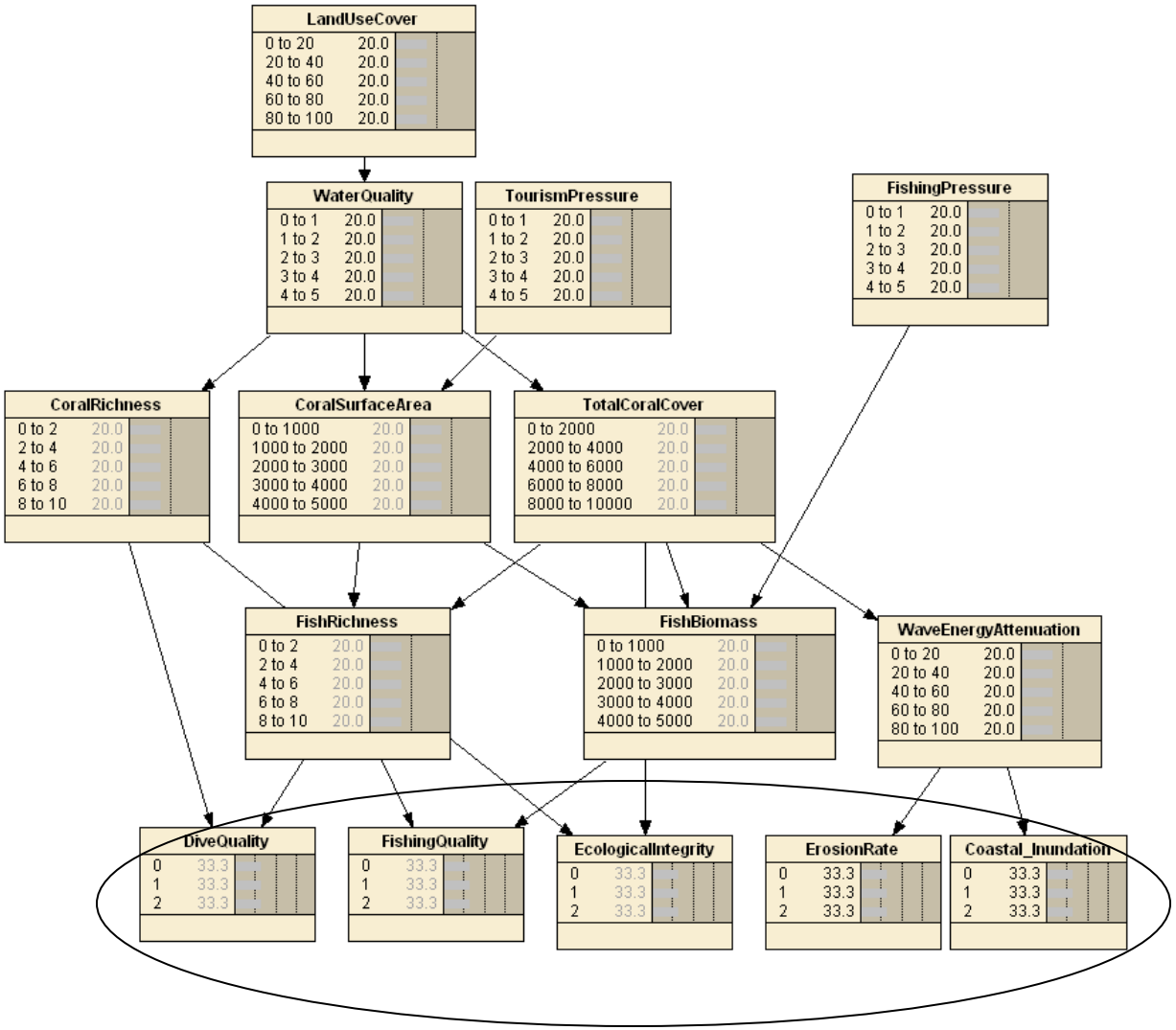


If we change this pressure…

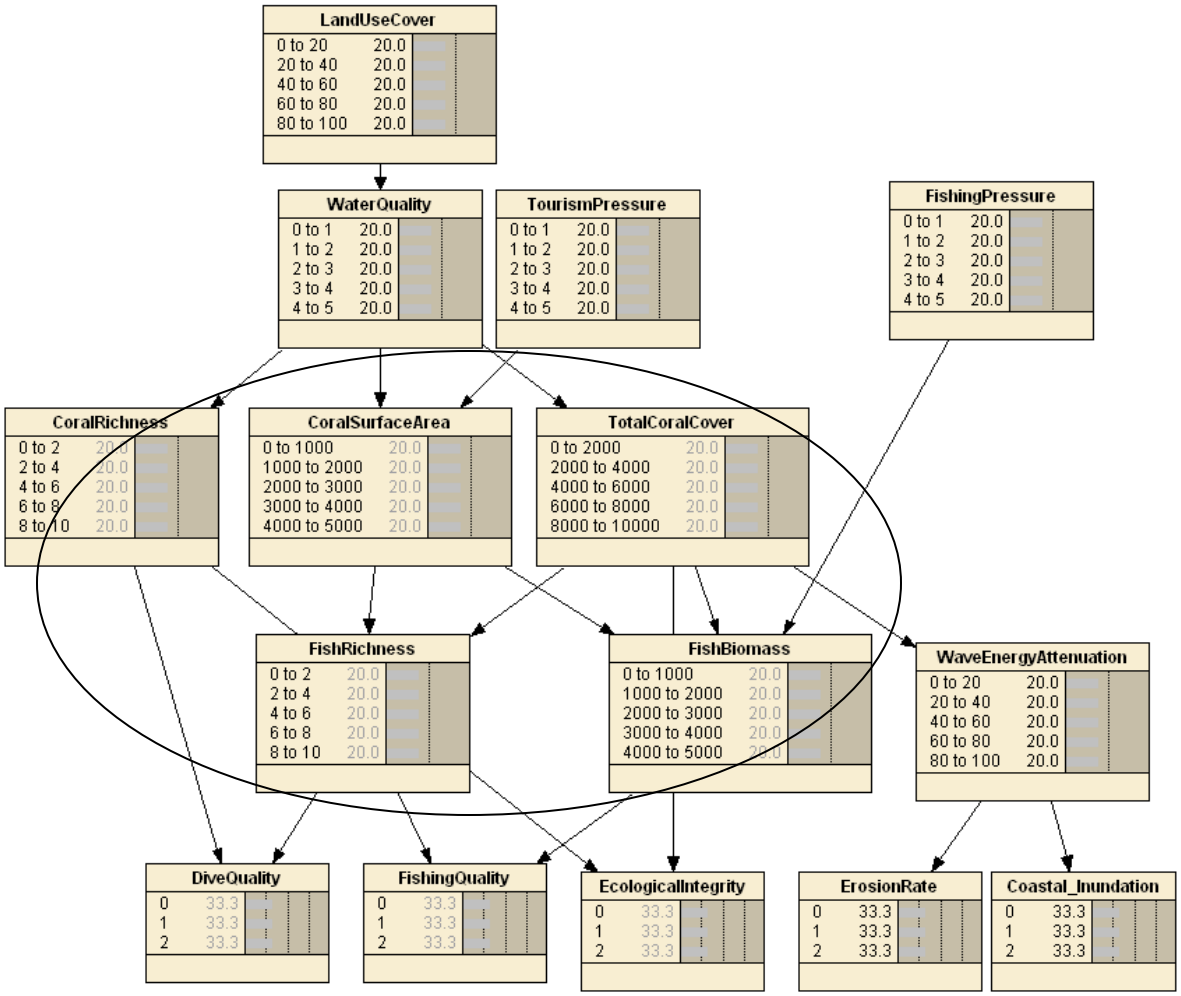


If we change this pressure…

…what is the effect on ecosystem services?

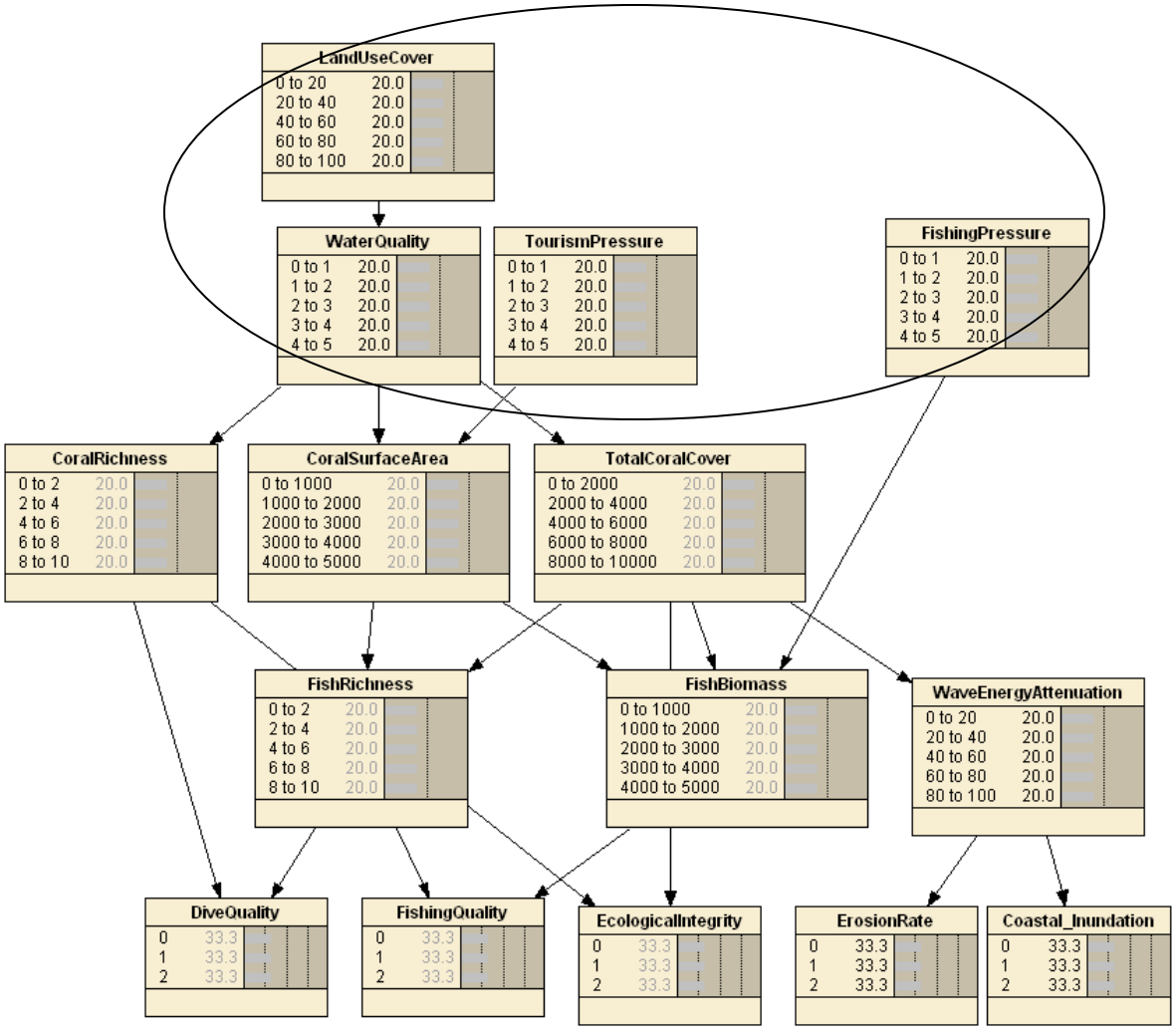


If we want to achieve this level of ecosystem services…



What level of reef condition do we need?

If we want to achieve this level of ecosystem services…

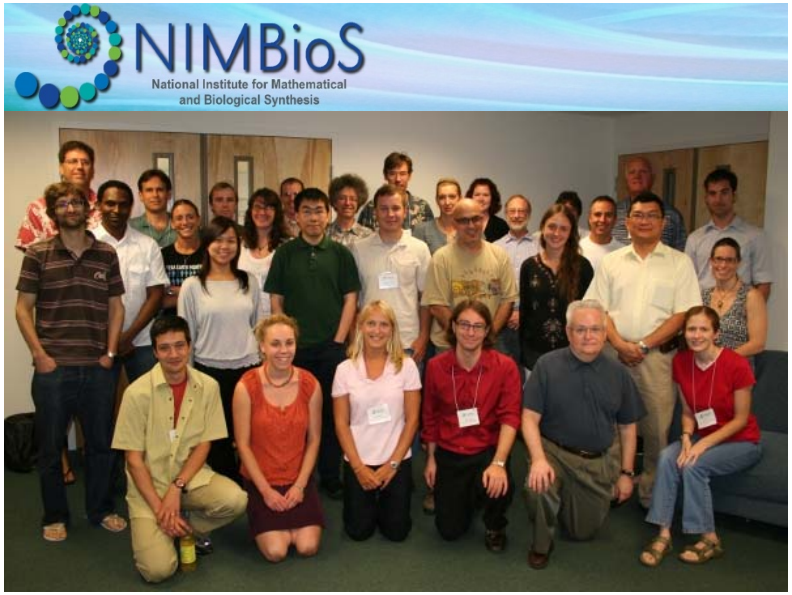


And to what level must we reduce pressures?

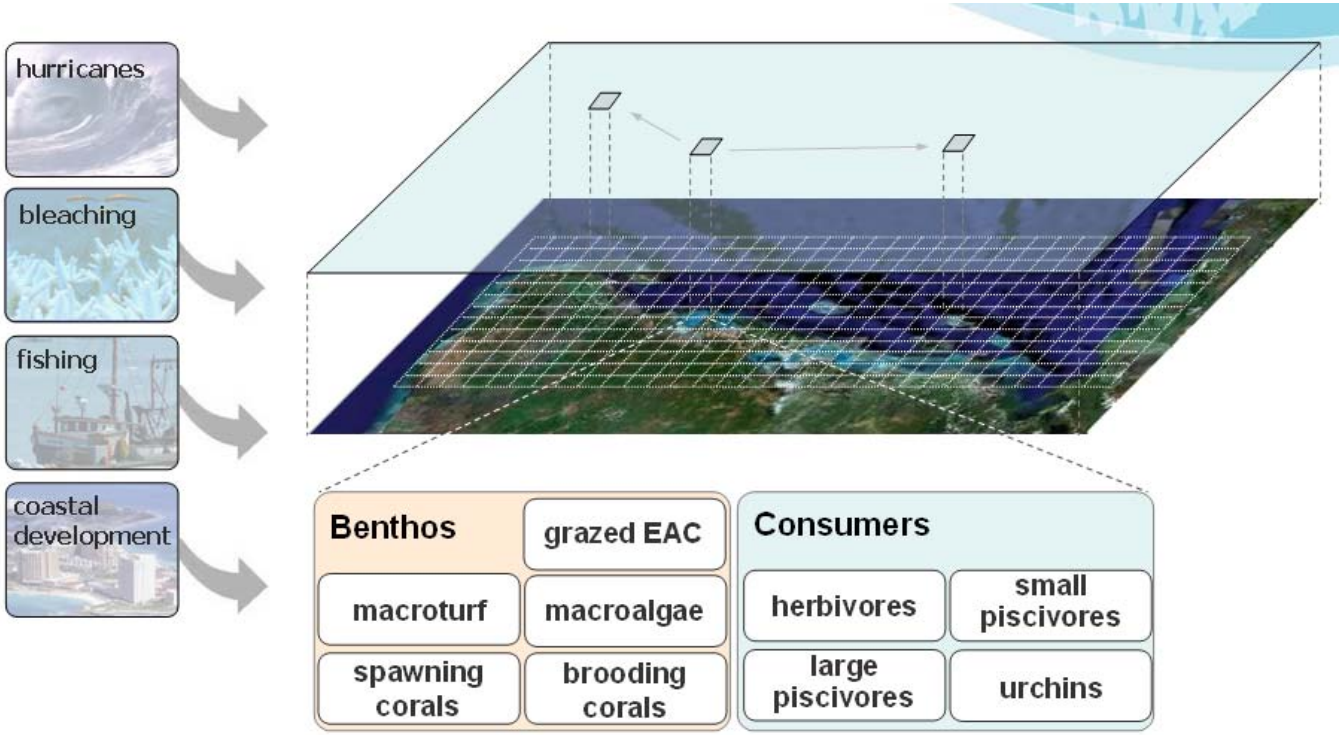
What level of reef condition do we need?

If we want to achieve this level of ecosystem services…

Modeling Sustainable Delivery of Reef Ecosystem Services



- **A systems dynamic approach for Spatial Dynamic, Modeling and Valuation of Ecosystem Services.**
  - **Simulate Ecosystems and Human Systems in Space**
  - **Simulate Ecosystems and Human Systems over Time**
  - **Simulate the interactions between the eco and human systems through coupling**



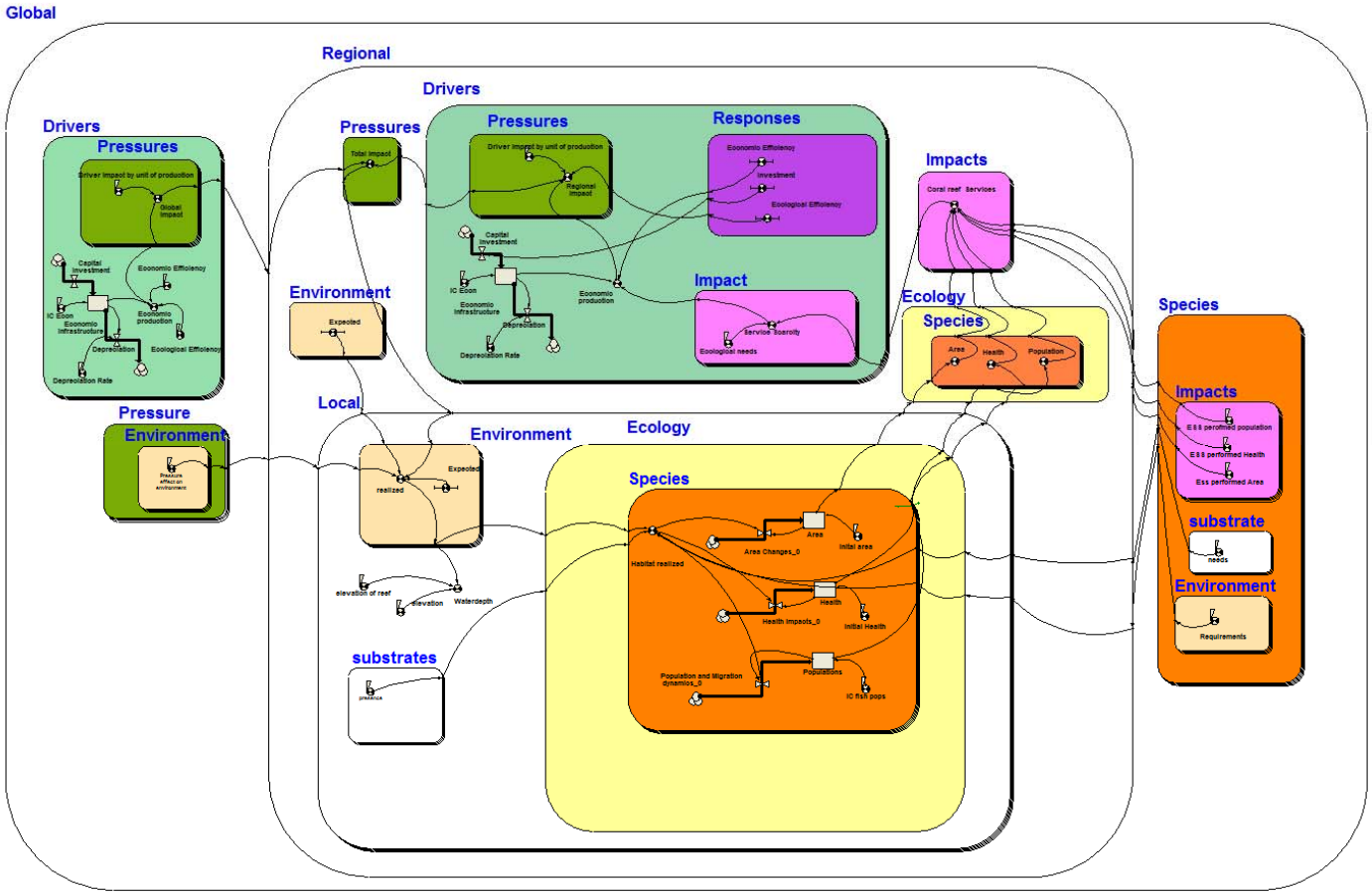
CORSET
C. Johnson
U. Tasmania

Connect land-based stressors to water quality

Additional reef attributes

Link to ecosystem services

Decision-support whole-systems models



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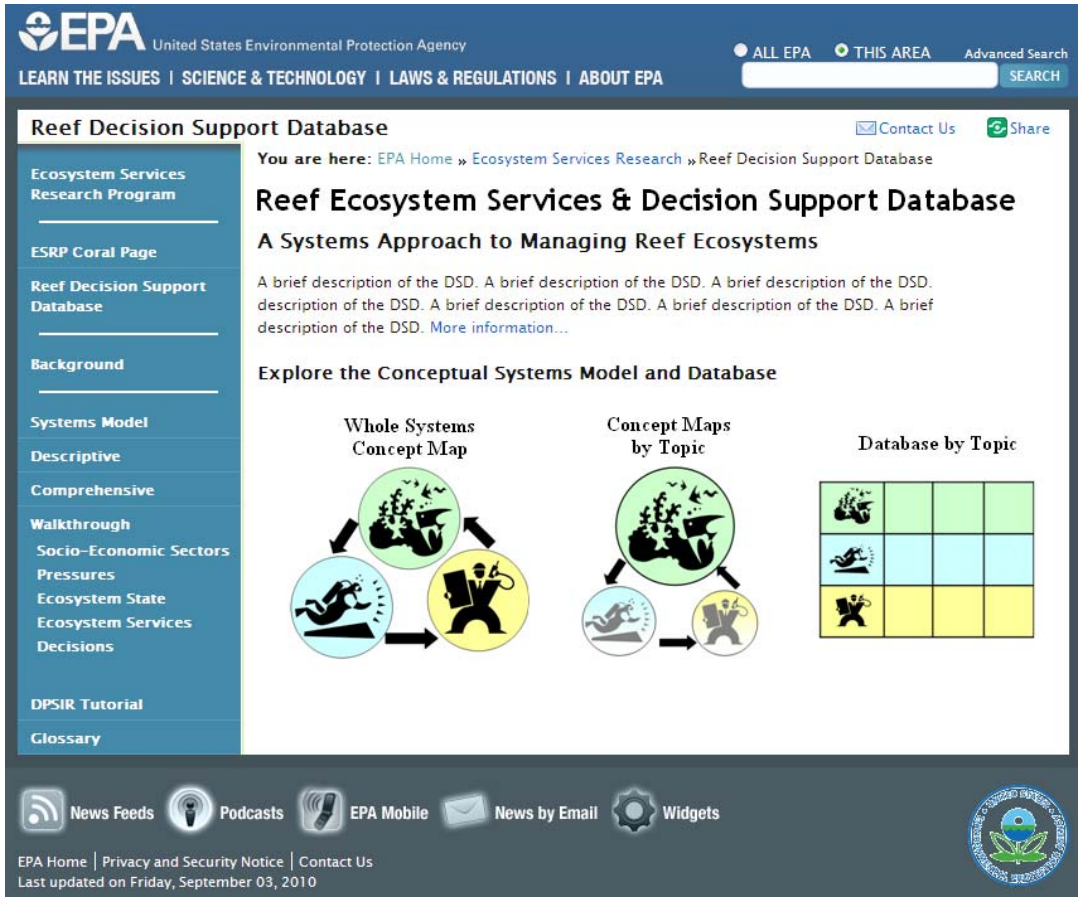
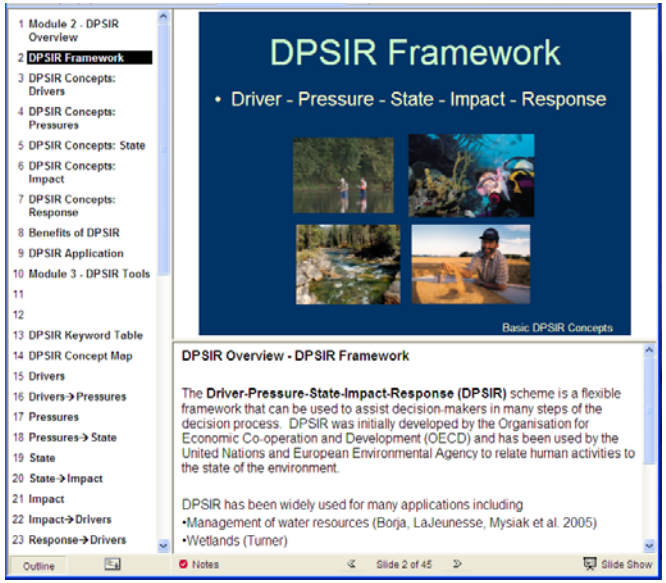
ECOSYSTEM SERVICES RESEARCH PROGRAM





5. Methods to communicate and incorporate information and analyses into future decisions