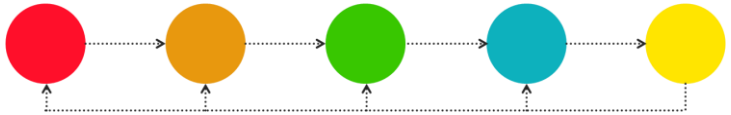
SystemSketch

Making Systems Thinking Intuitive

Making Ecosystem Services Explicit



heilke.ingrid@epa.gov
tenbrink.marilyn@epa.gov

Ingrid Heilke[1,2],
Marilyn Buchholtz ten Brink[1,]
Tom Stockton[3],
Brian Dyson[1],
Claudette Ojo[1,2]

[1]US Environmental Protection Agency, Office of Research and Development
[2] Oak Ridge Institute for Science and Education
[3] Neptune and Company

ACES: Day 4…

Once we have defined, valued, and otherwise poked and prodded ecosystem services…

How can they be made **explicit** in **decisions** related to environmental management and public policy?

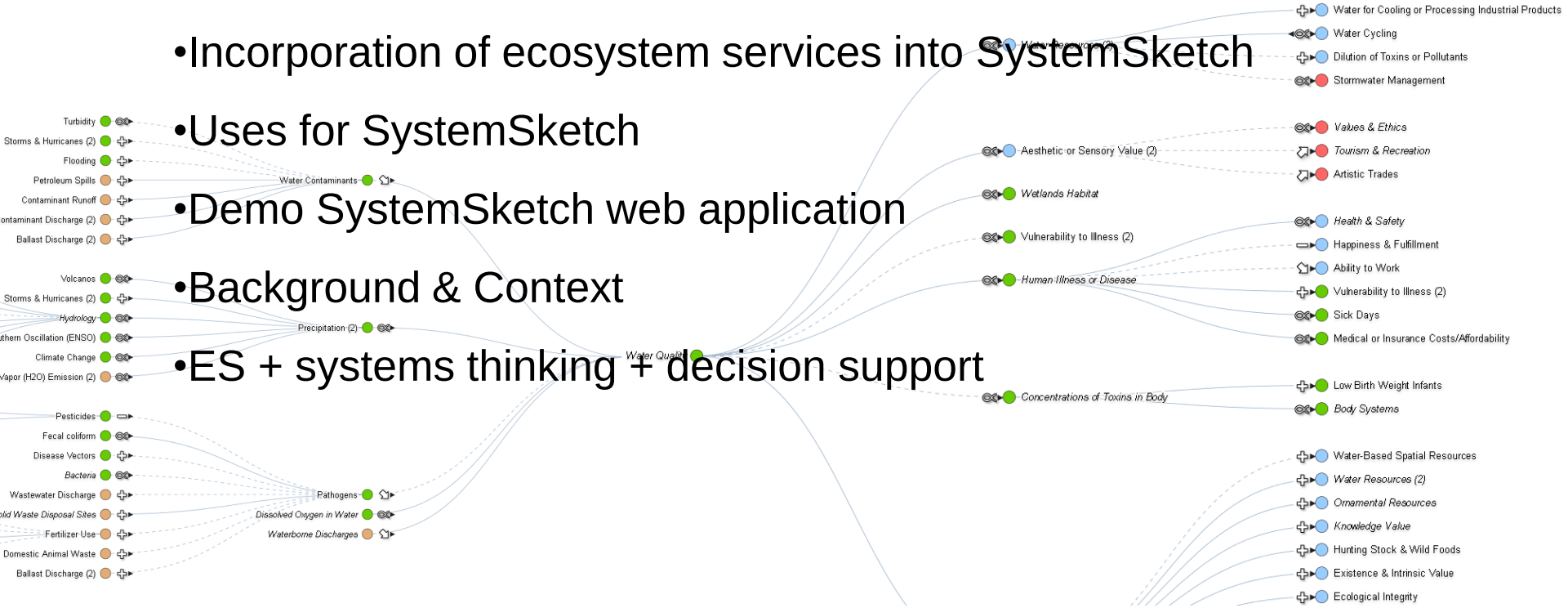
- Decision makers must be able to understand the **linkages** between abstract ecosystem functions and the benefits to people in the form of **social, economic, or cultural values**.

- This understanding must be **intuitive and accessible**

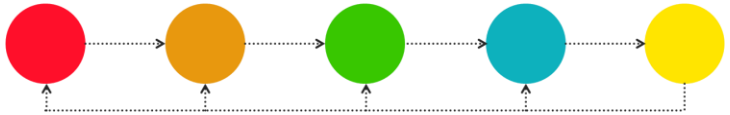
SystemSketch

Know the System to Improve the System

- Underlying DPSIR framework
- Incorporation of ecosystem services into SystemSketch
- Uses for SystemSketch
- Demo SystemSketch web application
- Background & Context
- ES + systems thinking + decision support



SystemSketch uses the DPSIR Framework



SystemSketch uses the DPSIR Framework

Drivers are the social, demographic, and economic forces that affect production patters, consumption, and lifestyles.

SystemSketch uses the DPSIR Framework

Drivers exert ***Pressures***: human activities that create stress on environmental or human systems

SystemSketch uses the DPSIR Framework

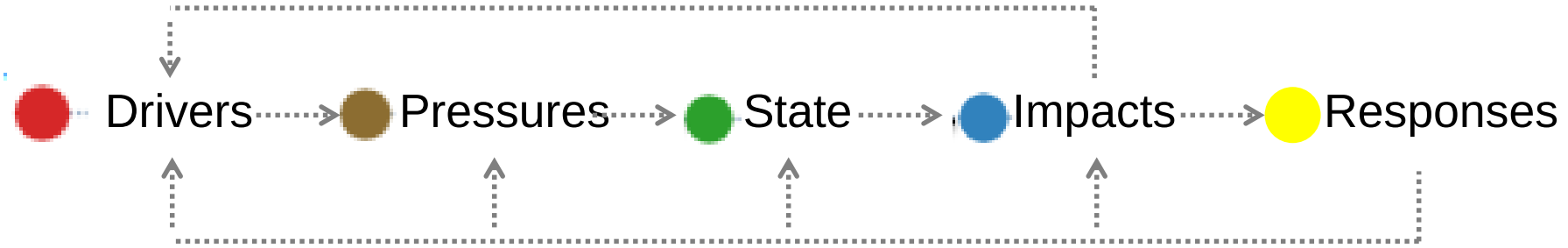
Pressures affect the ***State***, which describes the condition of both environmental and human systems at any given point in time.

SystemSketch uses the DPSIR Framework

Changes in the State ***Impact*** human well being, either directly, or vis-a-vis changes in ecosystem services.

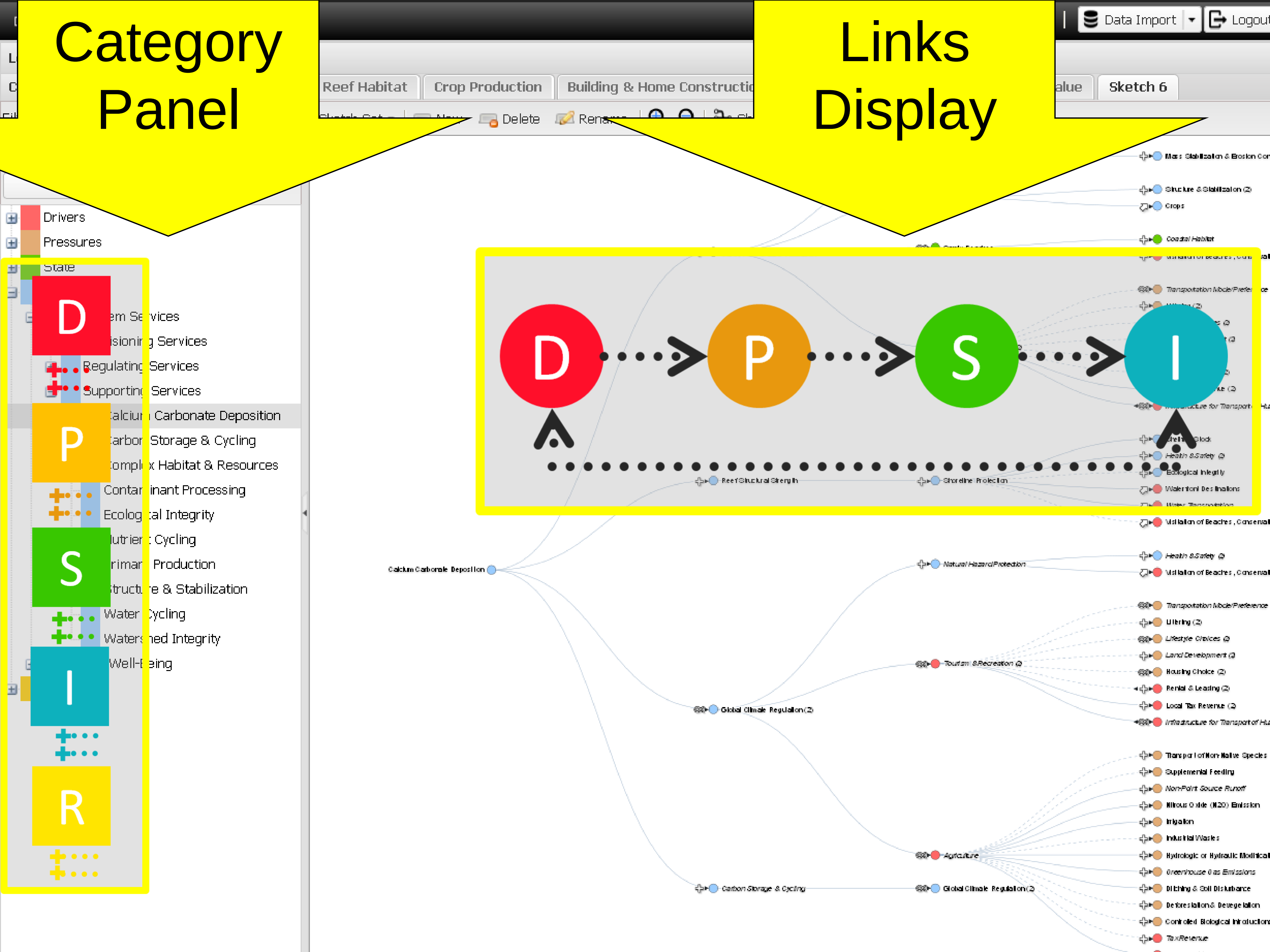
SystemSketch uses the DPSIR Framework

Ecosystem services and human well-being both affect socio-economic drivers



Humans ***Respond*** to impacts in a variety of manners. Response can be targeted at any area of the system.

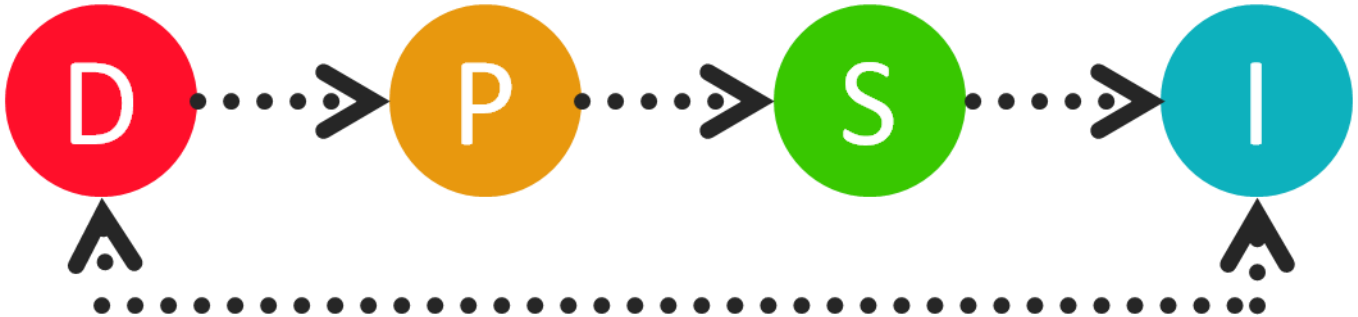
e.g. Environmental management
Planning
Public policy and regulation
Education & outreach
Behavioral Change
Etc.


Category Panel
Links Display
Data Import
Logout
Reef Habitat
Crop Production
Sketch 6
Delete
Drivers
Pressures
Regulating Services
Supporting Services
Water Cycling
D
P
S
I
R
Calcium Carbonate Deposition
Global Climate Regulation (2)
Carbon Storage & Cycling
Global Climate Regulation (2)
Tourism & Recreation (2)
Agriculture
Natural Hazard Protection
Reef Structural Strength
Shoreline Protection
Health & Safety (2)
Transportation Mode/Preference
Lifestyle Choices (2)
Land Development (2)
Housing Choice (2)
Rental & Leasing (2)
Local Tax Revenue (2)
Supplemental Feeding
Non-Point Source Runoff
Nitrous Oxide (N2O) Emission
Irrigation
Industrial Wastes
Greenhouse Gas Emissions
Ditching & Soil Disturbance
Deforestation & Devegetation
Tax Revenue
Crops
Coastal Habitat
Ecological Integrity
Waterfront Destinations

Category Panel

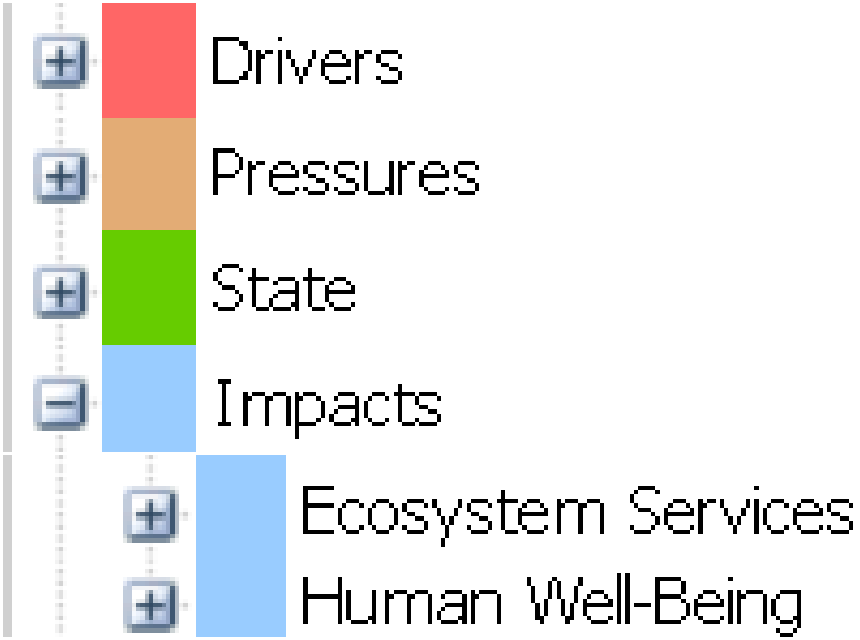
- Content organized categorically
- Over 800 distinct nodes
- Can be searched or filtered
- Good for browsing or searching content

Links Display

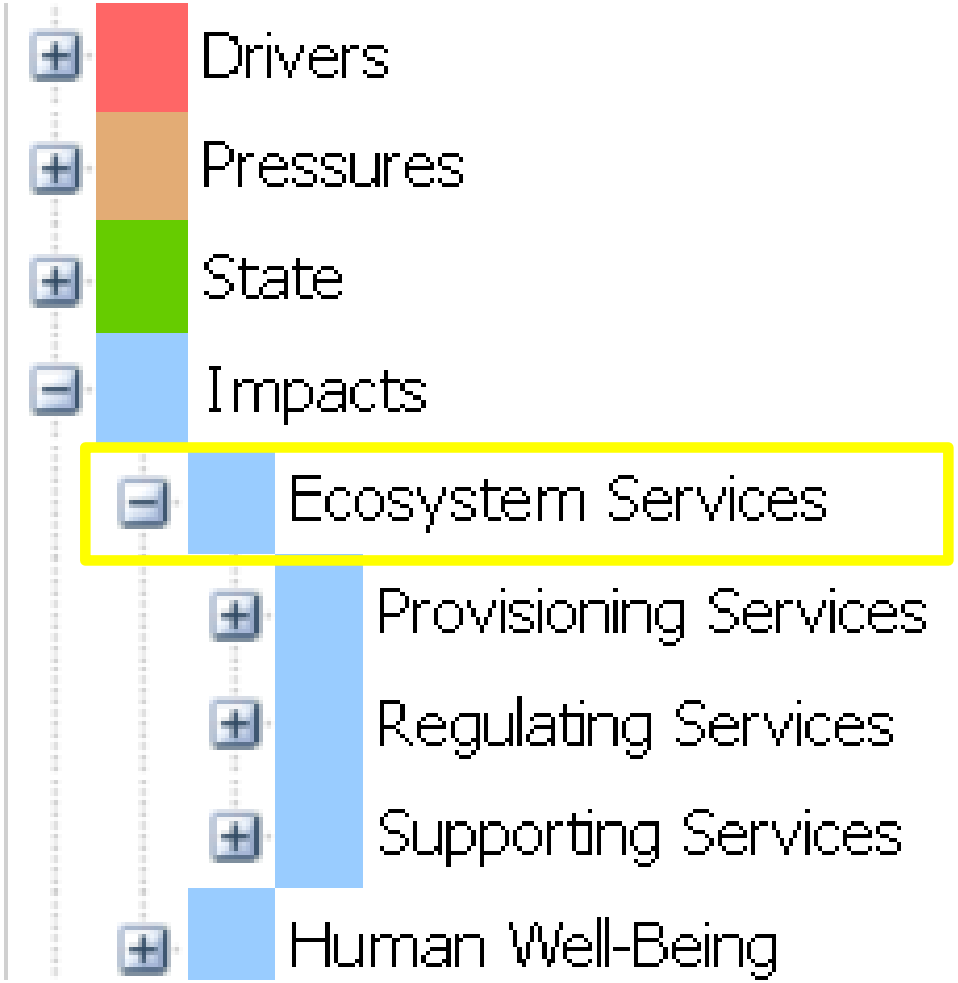


- Represents causal relationships
- ~7,000 “seeded” linkages
- Where user defines system parameters for their decision process

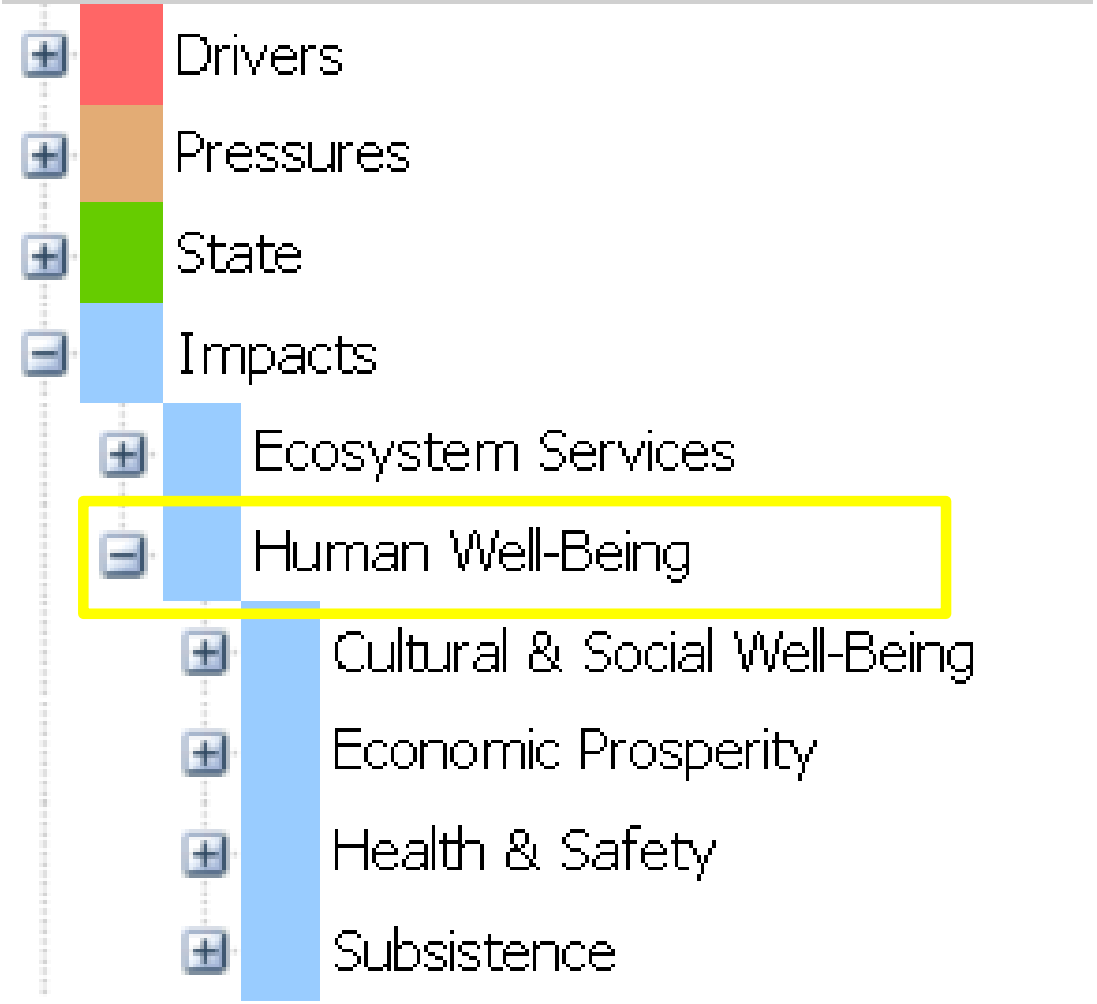
Ecosystem Services within SystemSketch DPSIR Framework



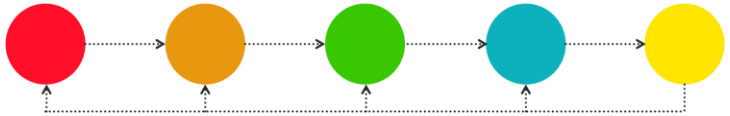
Ecosystem Services within SystemSketch DPSIR Framework



Ecosystem Services within SystemSketch DPSIR Framework



How Can SystemSketch be Used
+
Example Demonstration



How can SystemSketch be Used?

SystemSketch is a Scoping Tool

How can SystemSketch be Used?

Practice-based Applications

- **Understand decision context**
  - **Areas not previously considered**
  - **Unintended consequences**
  - **Long term challenges**
- **Collaborate or build consensus**
- **Write or update comprehensive plans or management plans**
- **Decide what/how to measure**
- **Explore options for management or action**

How can SystemSketch be Used?

Research-based Applications

- **Construct research design or system model**
- **Framework for analysis or synchronization of research or decision support tools to maintain a systems perspective**

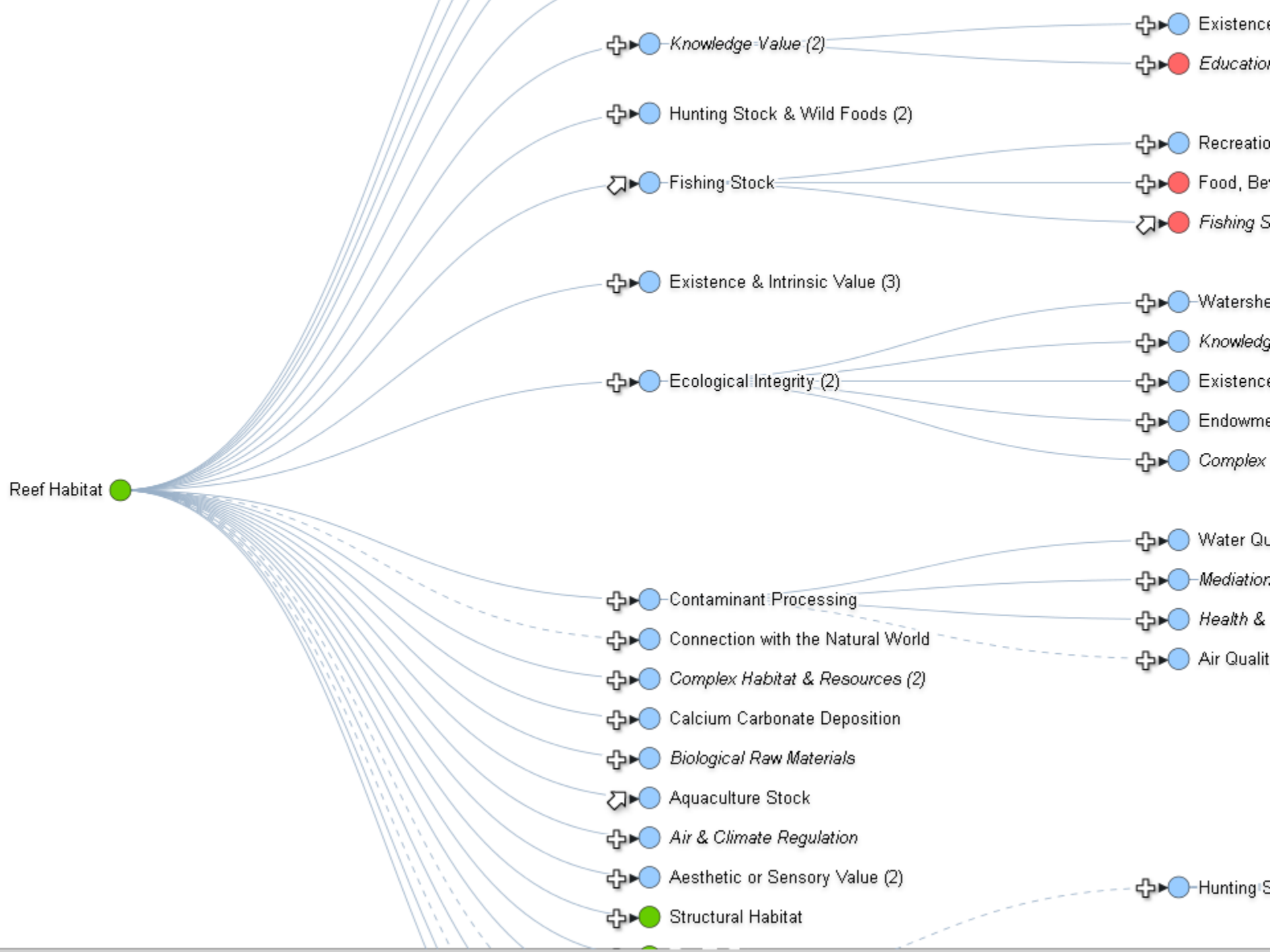
- **Synchronize/crosswalk….**
- **Index…**
- **Query…**
- **Analyze…**

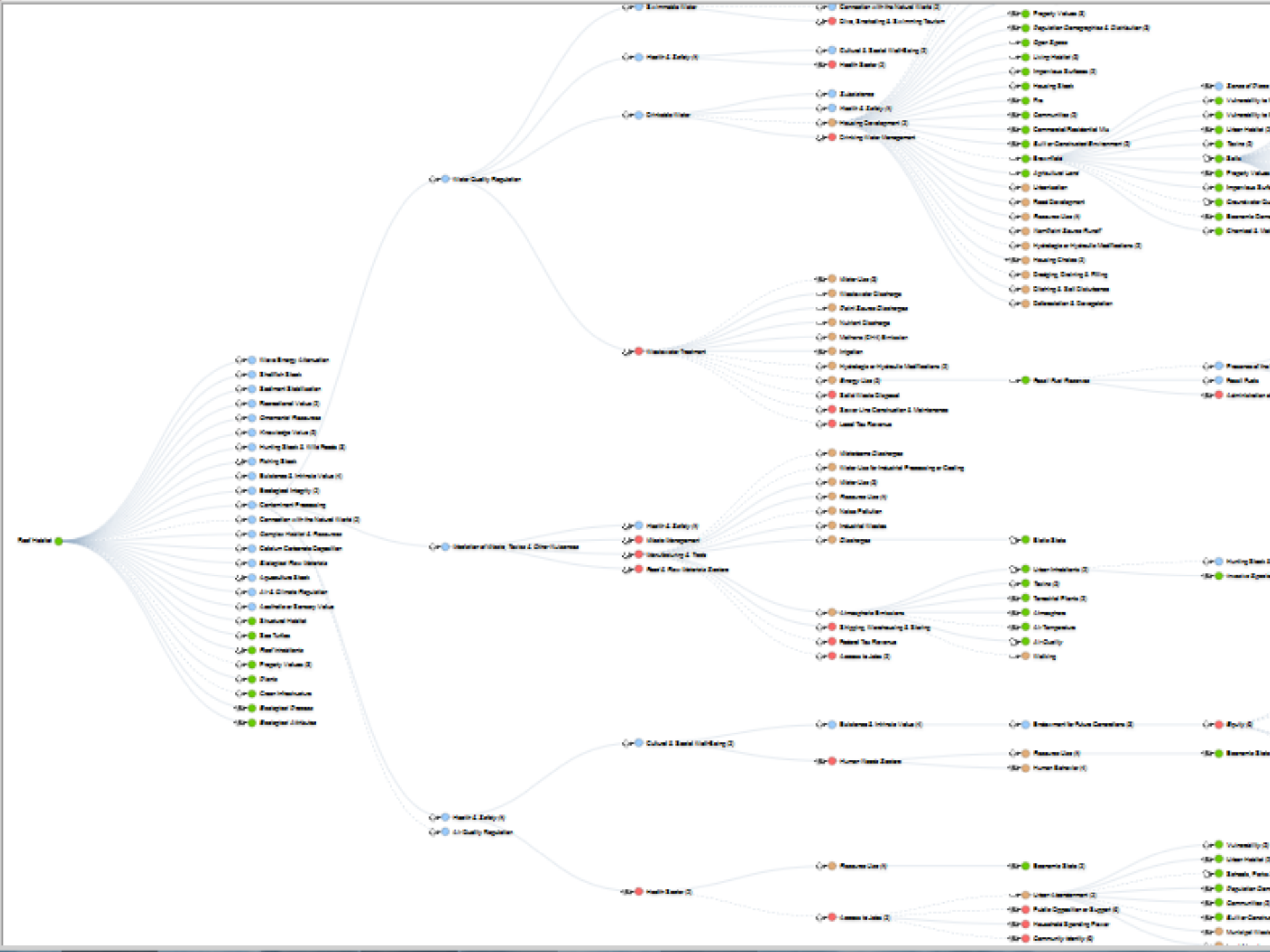
- **Multiple models**
- **Qualitative datasets**
- **Quantitative datasets**
- **Compilations of information**
- **Compilations of resources**
- **Etc.**

Example Demonstration

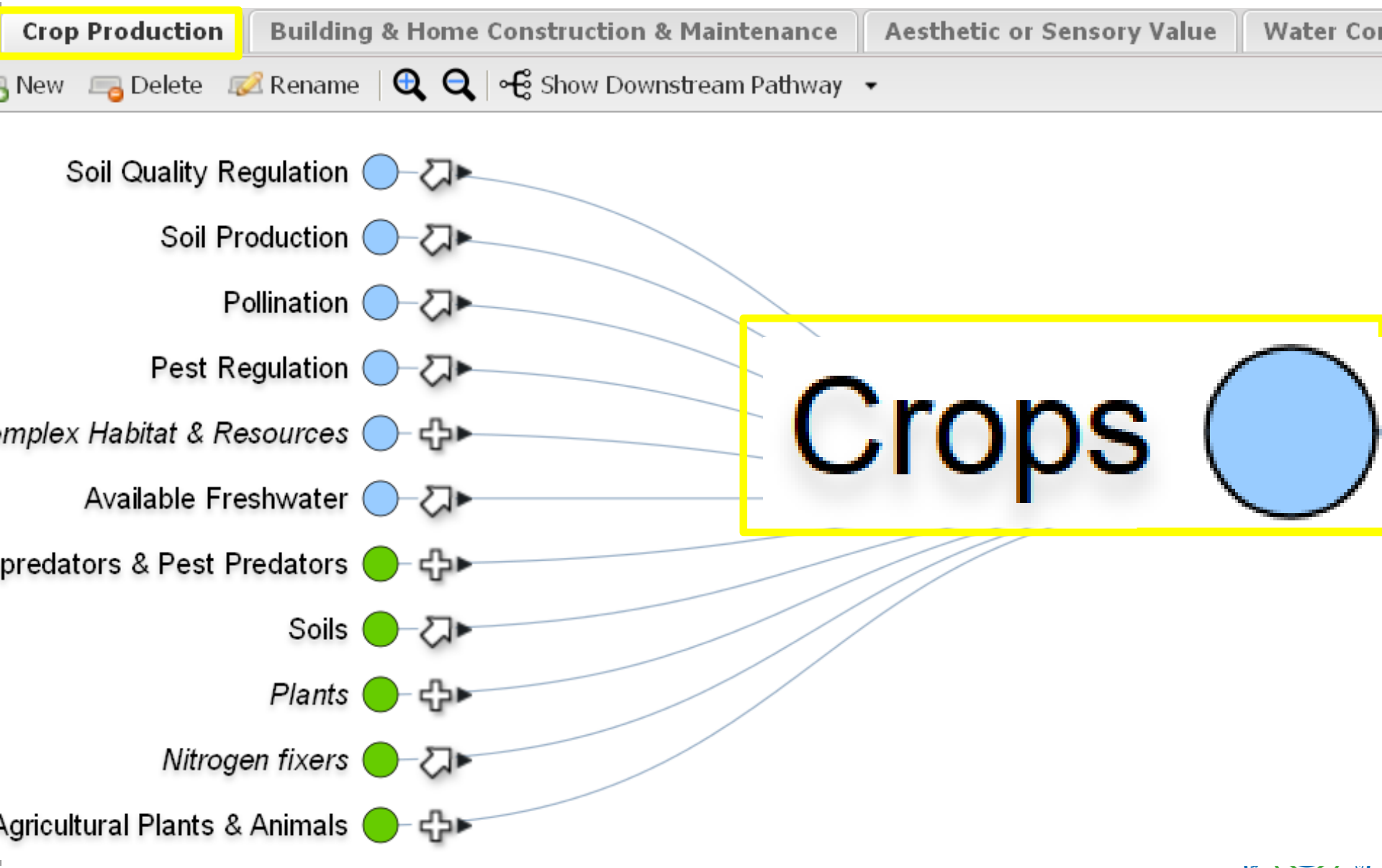
Decision Process for Management of Reef Ecosystem Health and Coastal Land Use

Group Objectives	Stakeholders	...Individual Objectives
1) Watershed Management Plan	• Fishermen	…..Fishing stock
	• Farmers	…..Crop yields
	• Developers	…..Development rights
2) Water Quality Criteria	• Env. Managers	……Water quality
	• Scientists	……Ecosystem integrity
	• Tourism businesses	……Aesthetics

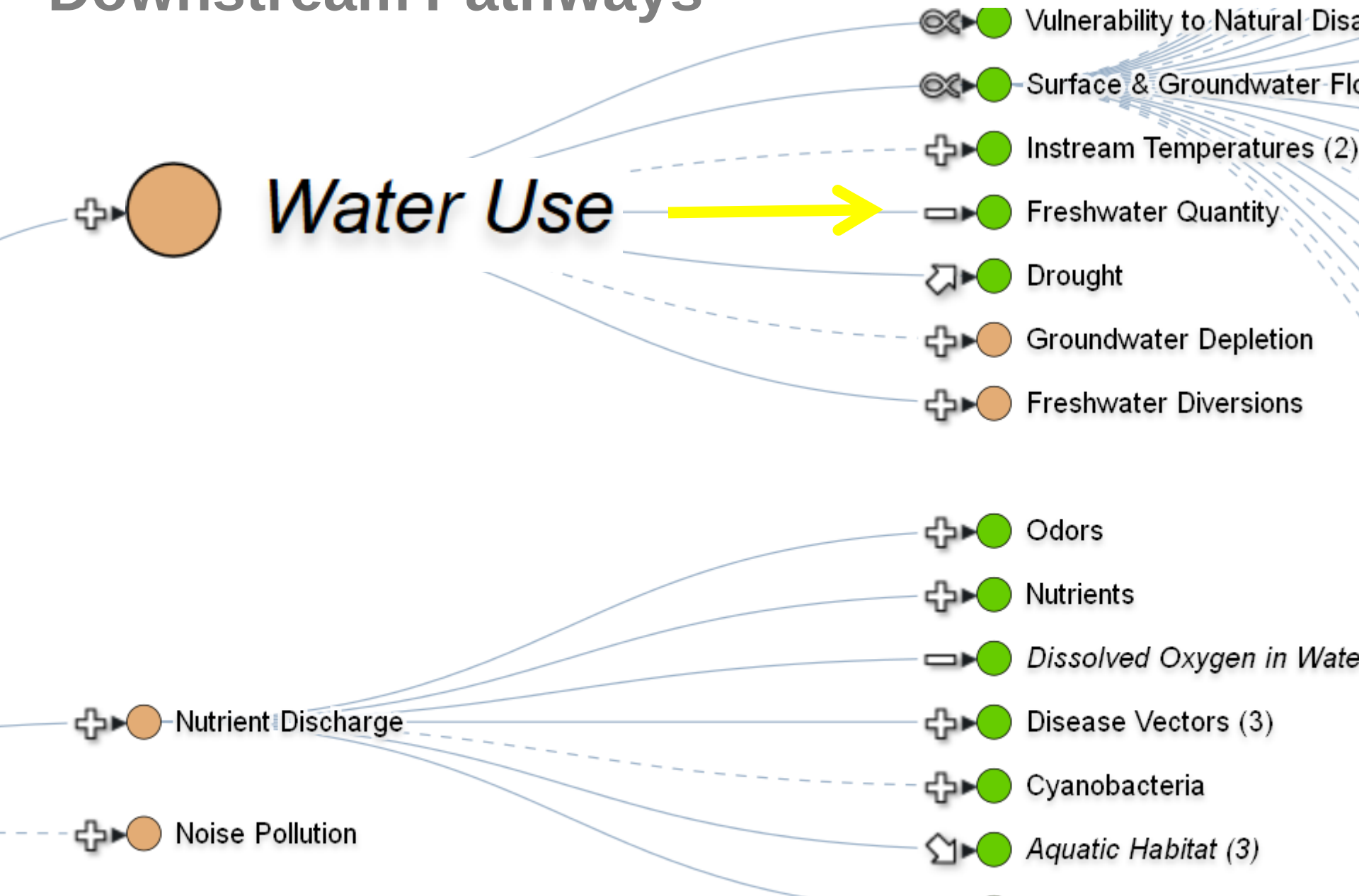

Reef Habitat
Knowledge Value (2)
Existence
Education
Hunting Stock & Wild Foods (2)
Fishing Stock
Recreatio
Food, Be
Fishing S
Existence & Intrinsic Value (3)
Ecological Integrity (2)
Watershe
Knowledg
Existence
Endowme
Complex
Contaminant Processing
Water Qu
Mediation
Health &
Air Qualit
Connection with the Natural World
Complex Habitat & Resources (2)
Calcium Carbonate Deposition
Biological Raw Materials
Aquaculture Stock
Air & Climate Regulation
Aesthetic or Sensory Value (2)
Hunting S
Structural Habitat


Reef Habitat
Wave Energy Attenuation
Shellfish Beds
Sediment Stabilization
Recreational Value (+)
Ornamental Resources
Knowledge Value (+)
Hunting Beds & Wild Fauna (+)
Fishing Beds
Existence & Intrinsic Value (+)
Biological Integrity (+)
Contaminant Processing
Connection with the Natural World (+)
Complex Habitat & Resources
Calcium Carbonate Deposition
Biological Raw Materials
Aquaculture Beds
Air & Climate Regulation
Aesthetics or Sensory Value
Structural Habitat
Sea Turtles
Reef Invasions
Property Values (+)
Plants
Green Infrastructure
Biological Diseases
Biological Attributes
Water Quality Regulation
Stormwater Water
Connection with the Natural World (+)
Dive, Snorkeling & Swimming Tourism
Health & Safety (+)
Cultural & Social Well-Being (+)
Health Easter (+)
Drinkable Water
Substances
Health & Safety (+)
Housing Development (+)
Drinking Water Management
Property Values (+)
Population Demographics & Distribution (+)
Open Space
Living Habitat (+)
Impervious Surfaces (+)
Housing Stock
Fire
Communities (+)
Commercial Residential Mix
Built or Constructed Environment (+)
Beach/Sand
Agriculture Land
Urbanization
Mass Development
Resource Use (+)
Non-Point Source Runoff
Hydrologic or Hydraulic Modifications (+)
Housing Choices (+)
Dredging, Draining & Filling
Draining & Soil Disturbance
Deforestation & Deregulation
Wastewater Treatment
Water Use (+)
Wastewater Discharge
Point Source Discharges
Nutrient Discharge
Methane (CH4) Emission
Irrigation
Hydrologic or Hydraulic Modifications (+)
Energy Use (+)
Solid Waste Disposal
Sewer Line Construction & Maintenance
Lease Tax Revenue
Reef Fish Resource
Presence of Invasive Species
Reef Fish
Commercial Fishing
Violation of Waste, Toxics & Other Nuisances
Health & Safety (+)
Waste Management
Manufacturing & Trade
Reef & Raw Materials Access
Wastewater Discharges
Water Use for Industrial Processing or Cooling
Water Use (+)
Resource Use (+)
Noise Pollution
Industrial Wastes
Discharges
State Data
Atmospheric Emissions
Shipping, Warehousing & Storing
Federal Tax Revenue
Losses in Jobs (+)
Urban Inhabitants (+)
Toxins (+)
Terrestrial Plants (+)
Atmosphere
Air Temperature
Air Quality
Walking
Hunting Beds & Wild Fauna
Invasive Species
Cultural & Social Well-Being (+)
Existence & Intrinsic Value (+)
Human Waste Access
Enjoyment for Future Generations (+)
Resource Use (+)
Human Behavior (+)
Equity (+)
Economic Data
Health & Safety (+)
Air Quality Regulation
Health Easter (+)
Resource Use (+)
Losses in Jobs (+)
Economic Data (+)
Urban Development (+)
Public Opposition or Support (+)
Household Spending Power
Community Identity (+)
Vulnerability (+)
Urban Habitat (+)
Schools, Parks
Population Dem
Communities (+)
Built or Constru
Municipal Wast
Zones of Disco
Vulnerability to
Vulnerability to
Urban Habitat (+)
Toxins (+)
Soils
Property Values
Impervious Surfa
Groundwater Qu
Economic Dam
Chemical & Wat

Stakeholders:Farmers

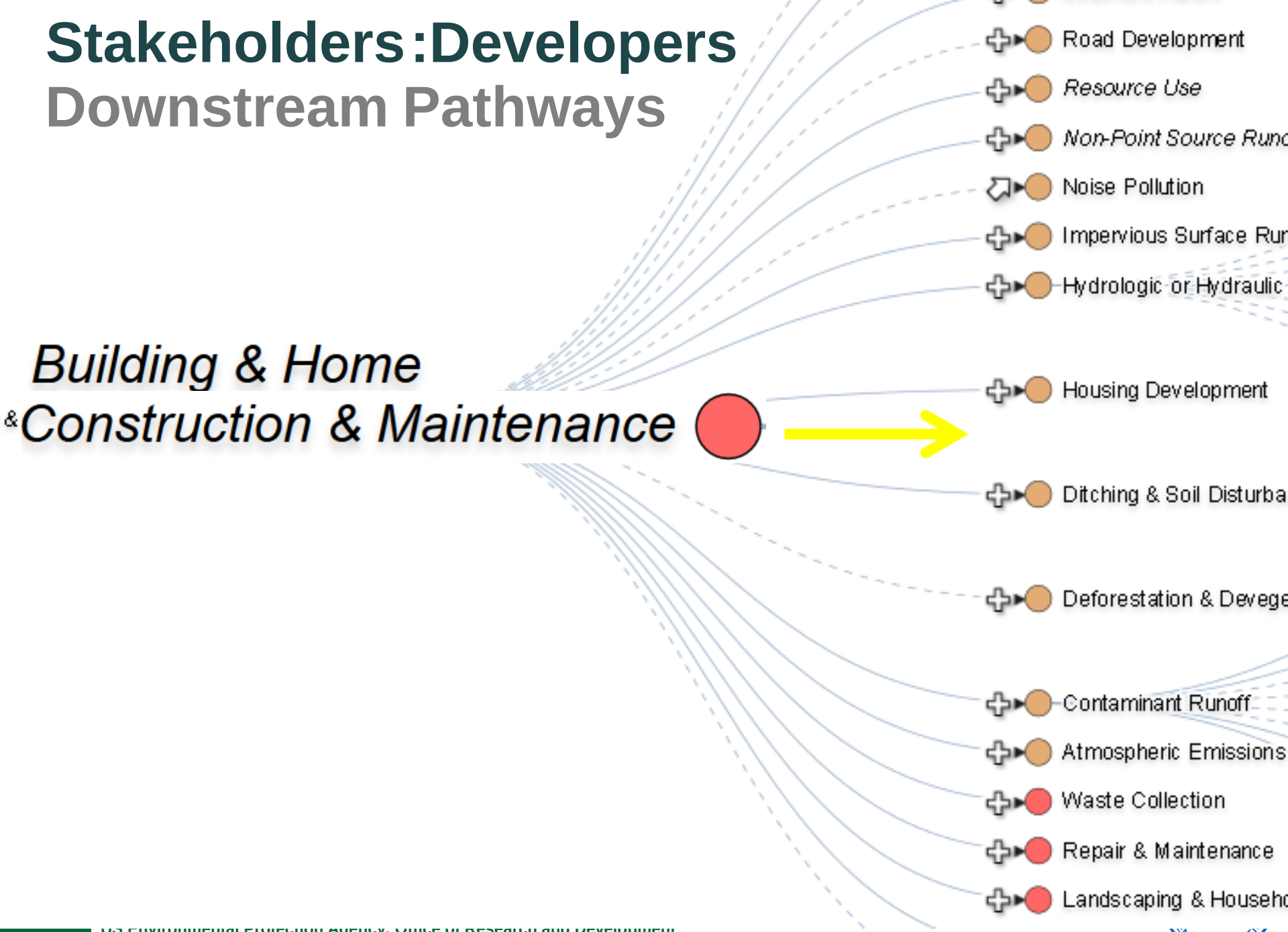


Crop Production
Downstream Pathways

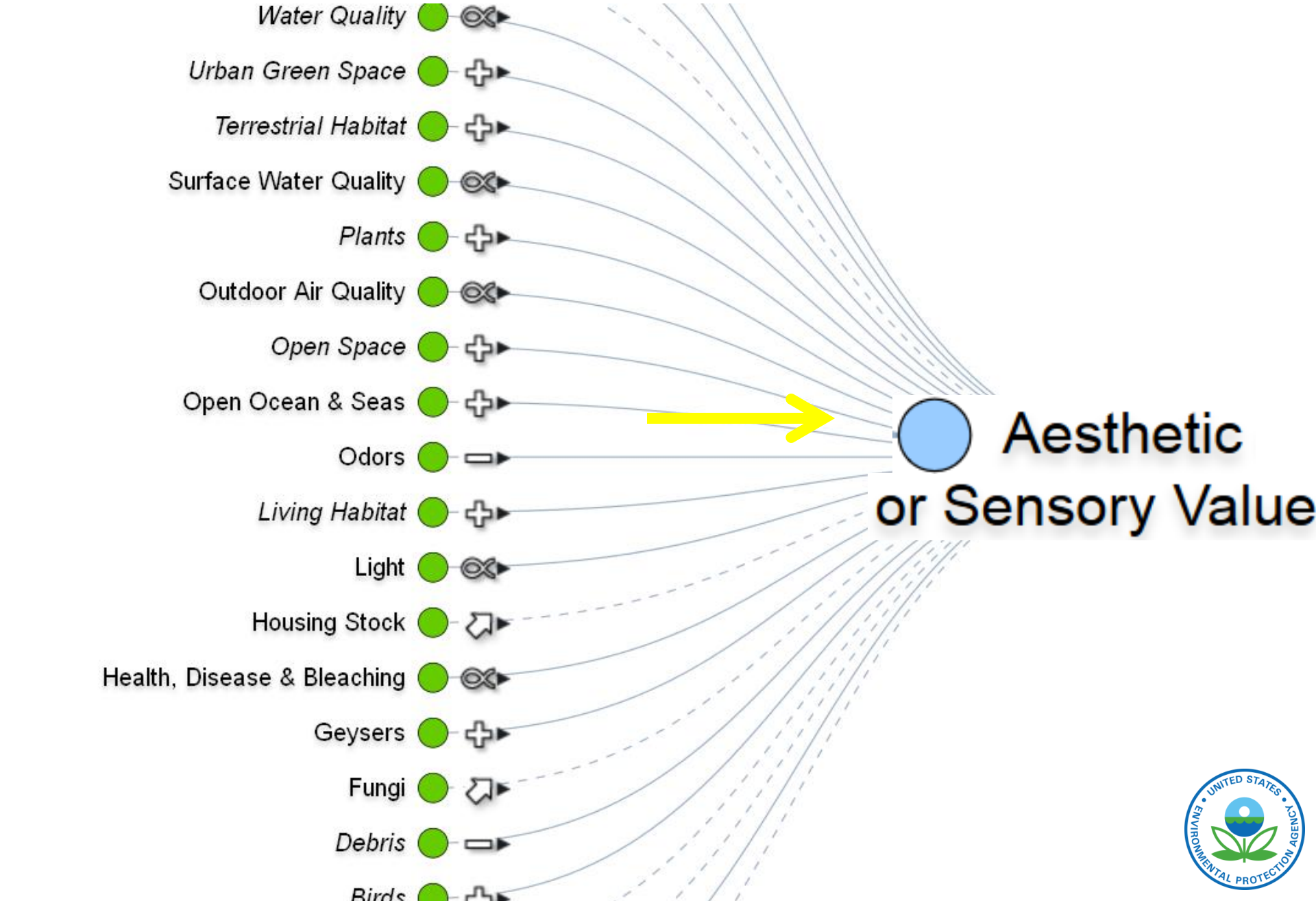


Stakeholders:Developers
Upstream Pathways

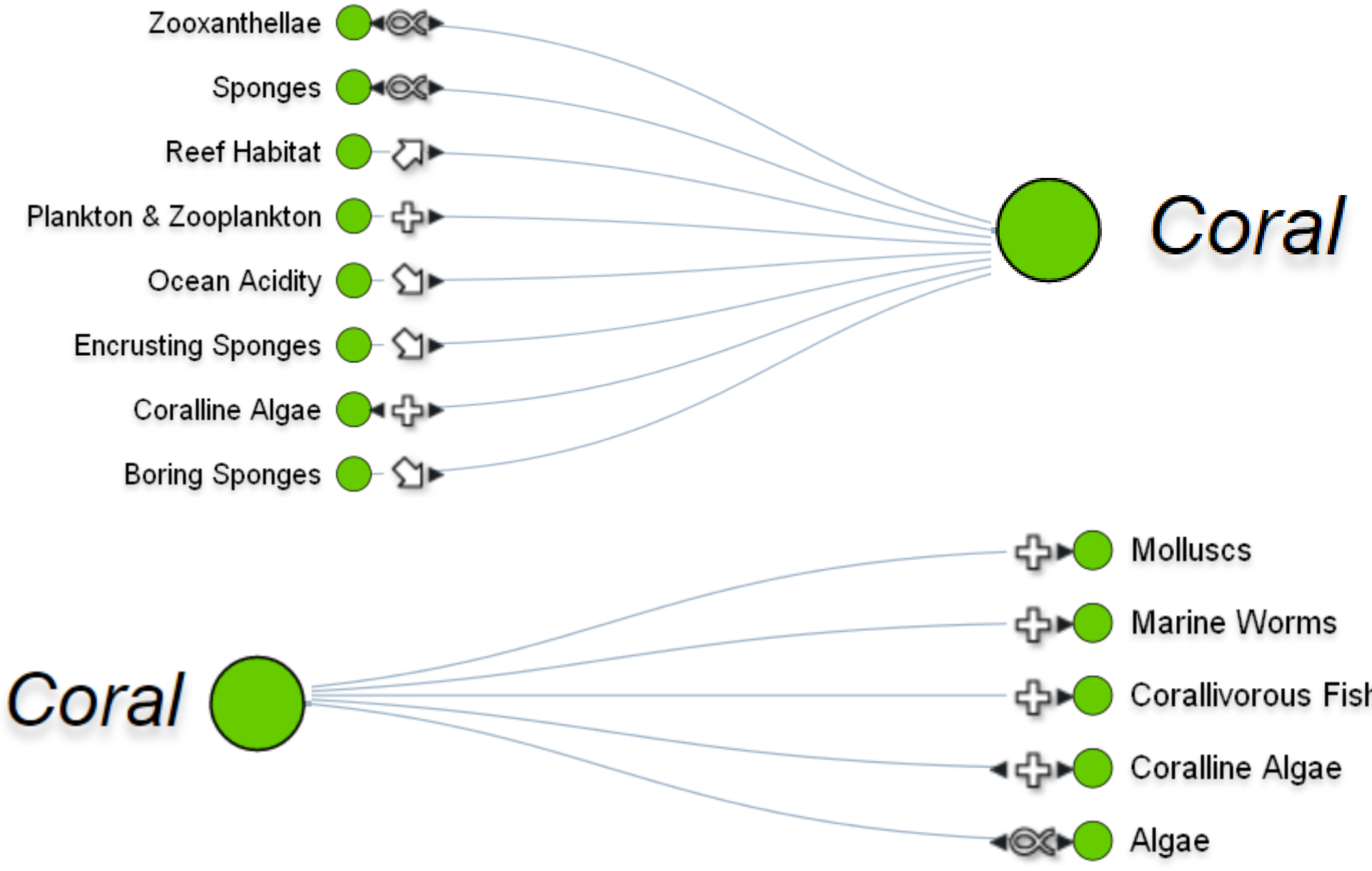
Stakeholders:Developers
Downstream Pathways



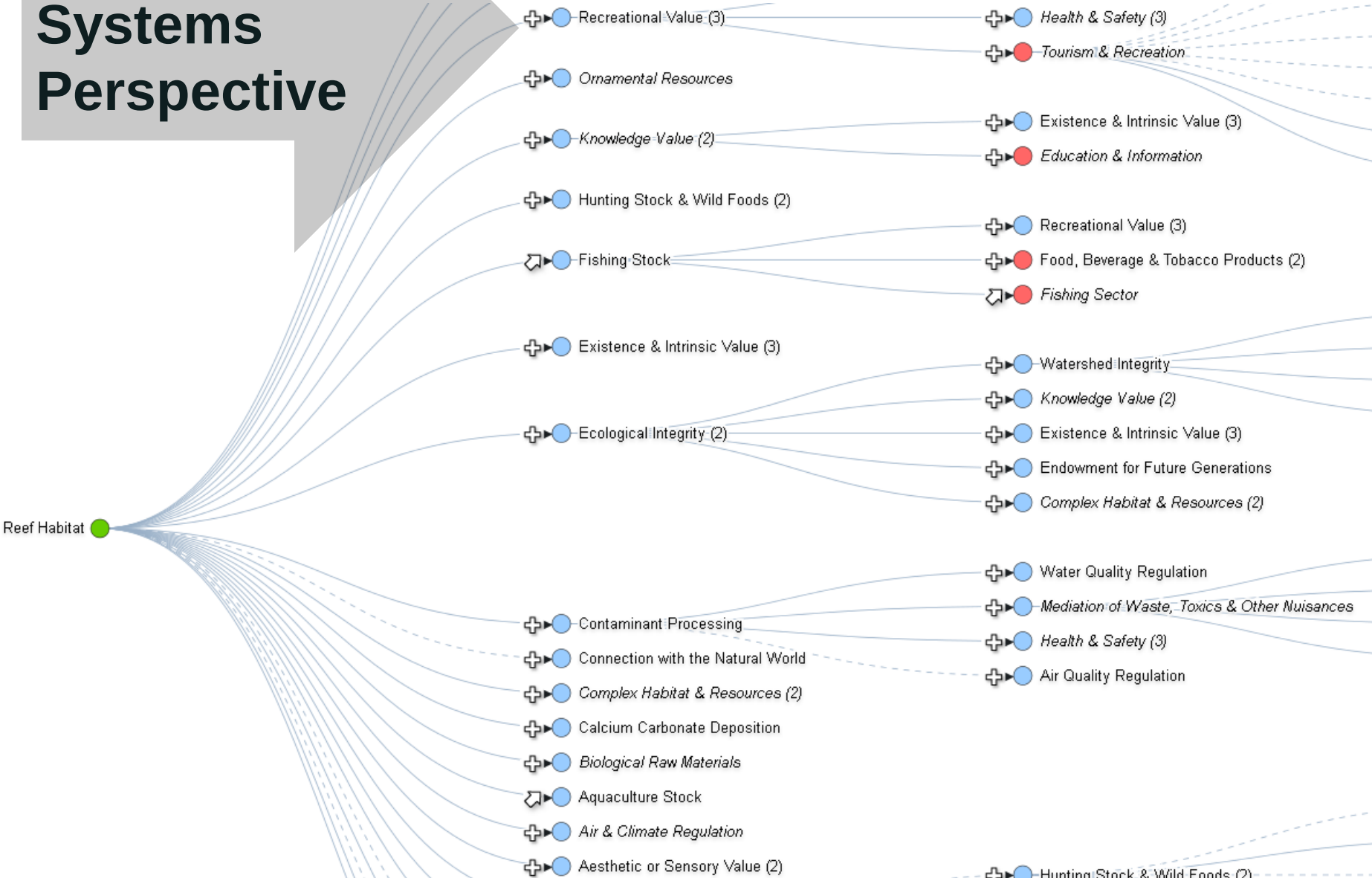
Stakeholders :Tourist-dependent Businesses



Stakeholders :Marine Scientists



Whole Systems Perspective



Whole Systems Perspective

Path Forward R

Users can access tables of information based on the system that they sketch out, including management options (the “R” in DPSIR), objectives, indicators, or any other compilations of information that are mapped to SystemSketch content.

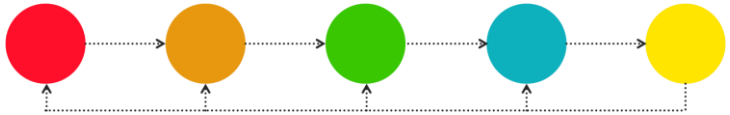
Management Options	Target Node
Hydrologic & Hydraulic Analysis	Waterborne Discharges
Biotope-based Plant Arrangement Along...	Urban Habitat
Buffer Strips	Plants
Constructed Wetlands	Green Infrastructure
Cisterns	Impervious Surfaces
Construction Phase Plan Review	Surface & Groundwater Flow
Conservation Easements	Open Space
Landscape Design	Aesthetic Value
Integrated Water Resources Management	Water Regulation
Biotope-based Plant Arrangement Along...	Ecological Integrity
Conservation Easements	Complex Habitat & Resources
Conservation Easements	Watershed Integrity
Cisterns	Water Resources
Biotope-based Plant Arrangement Along...	Mass Stabilization & Erosion Control
Catch Basin Inserts (aka Storm Drain Inl...	Water Quality Regulation

Indicators

Objectives

.....???

Background & Context



System Sketch is part of ongoing collaborative work across EPA., building on multiple ES related research efforts

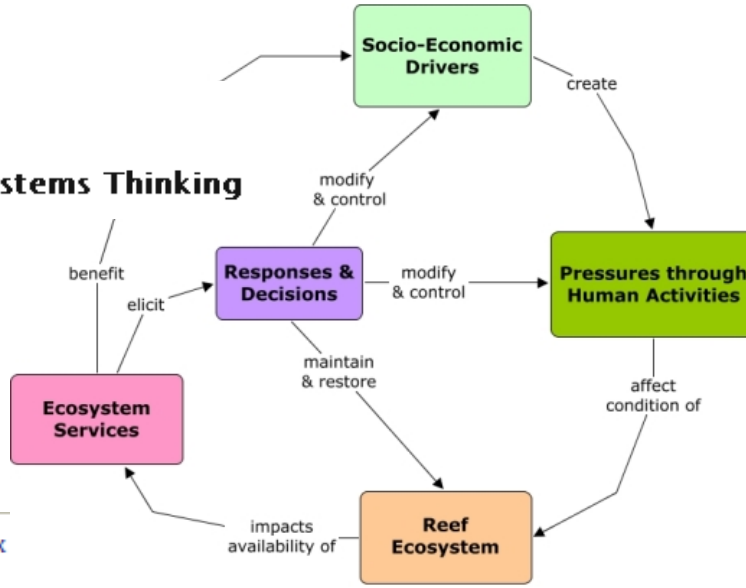
Some examples…

Building on EPA Work…

ReefLink Database

A Decision Support Tool for Linking Coral Reefs and Society through Systems Thinking

ACES Session 3G on Wednesday Linking Decisions to Stakeholder Values in the Guánica Bay Watershed



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Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Developing scientific information to support decisions for sustainable coral reef ecosystem services

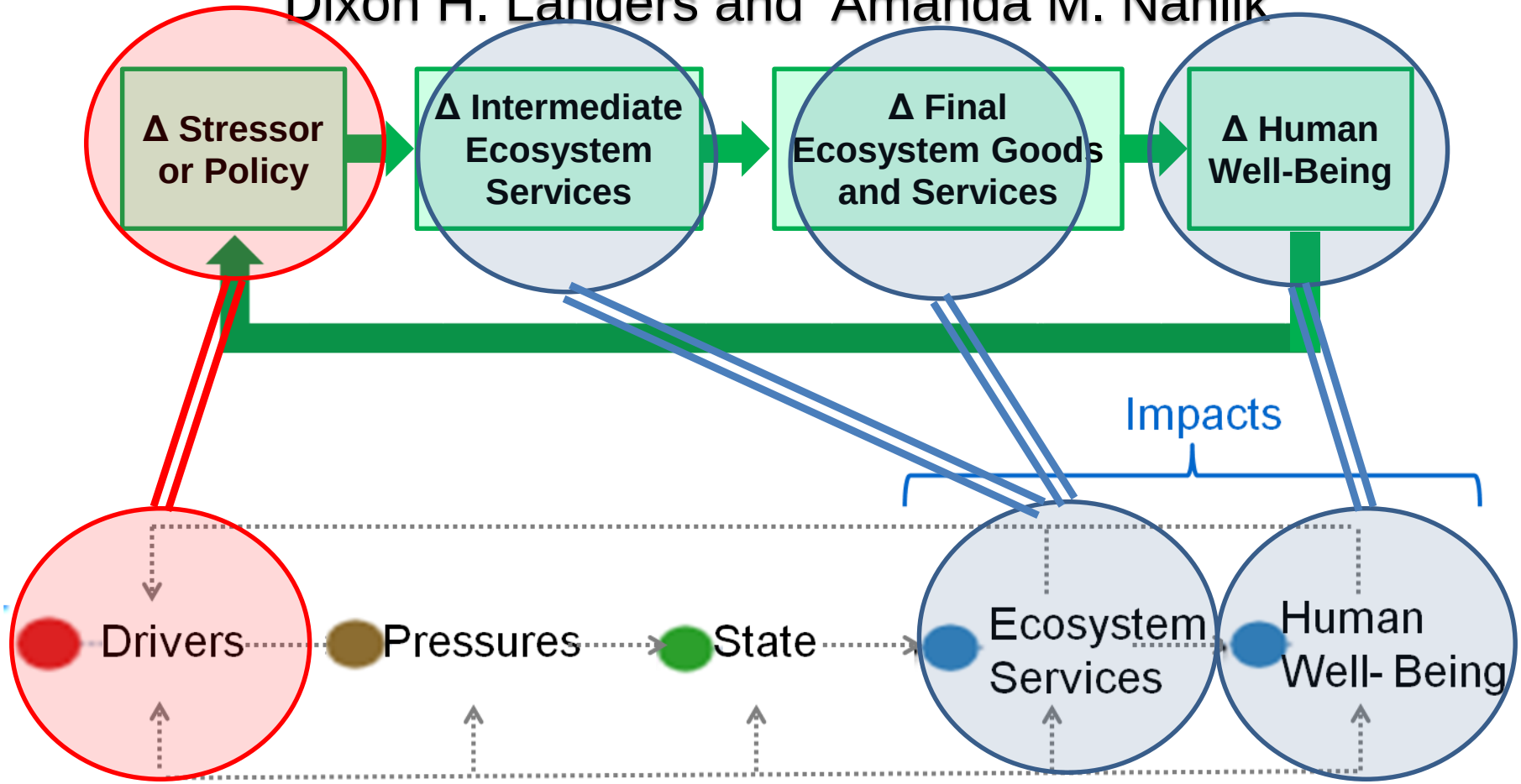
Susan Harrell Yee [a,*], John F. Carriger [a], Patricia Bradley [b], William S. Fisher [a], Brian Dyson [c]

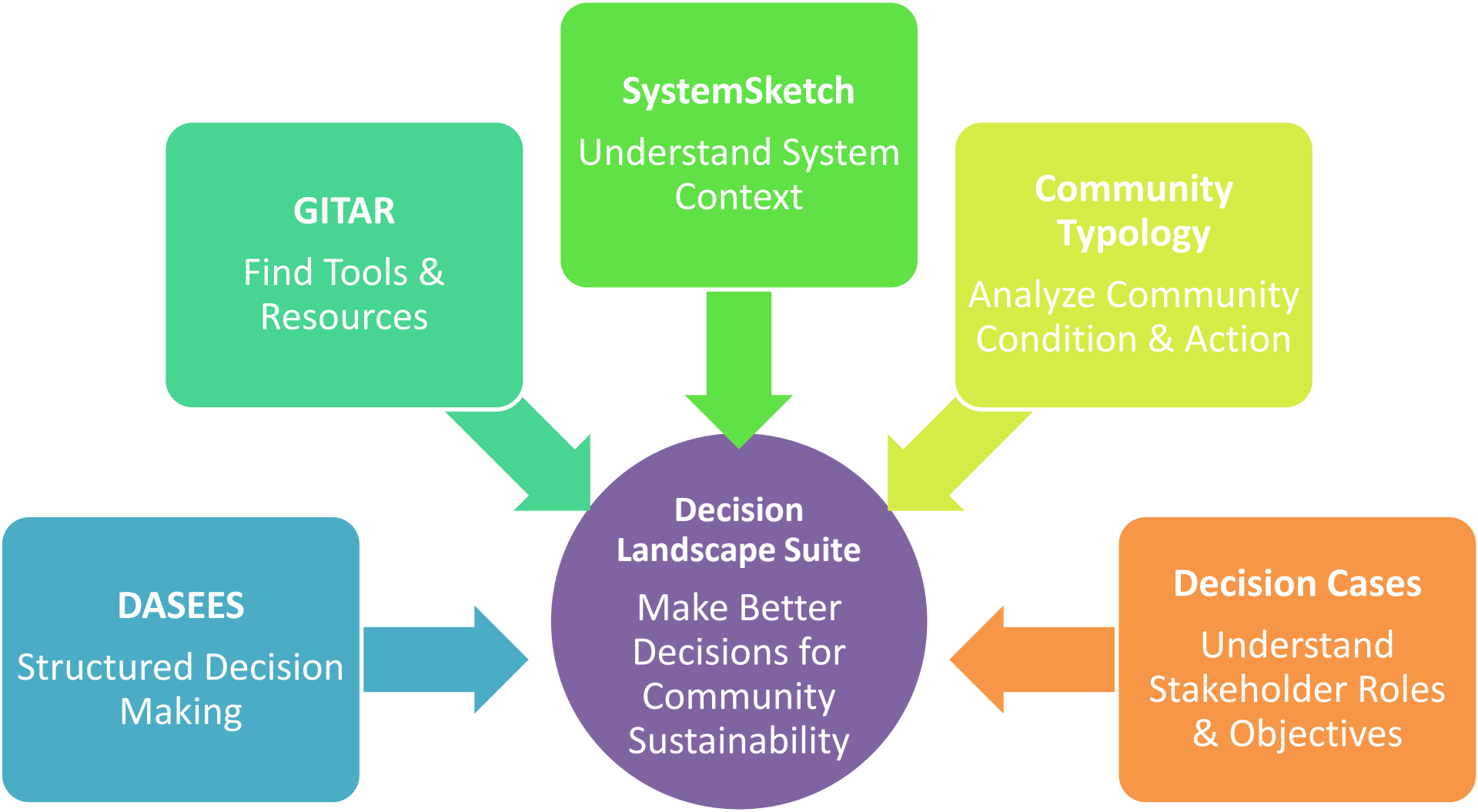
[a] US Environmental Protection Agency, Office of Research and Development, Gulf Ecology Division, Gulf Breeze, FL 32561, USA
[b] US Environmental Protection Agency, Office of Research and Development, Atlantic Ecology Division, Narragansett, RI 02882, USA
[c] US Environmental Protection Agency, Office of Research and Development, Land Remediation and Pollution Control Division, Cincinnati, OH 45268, USA

United States Environmental Protection Agency
Office of Research and Development
Health And Ecological Effects Research Laboratory, Western Ecology Division, Corvallis, Oregon

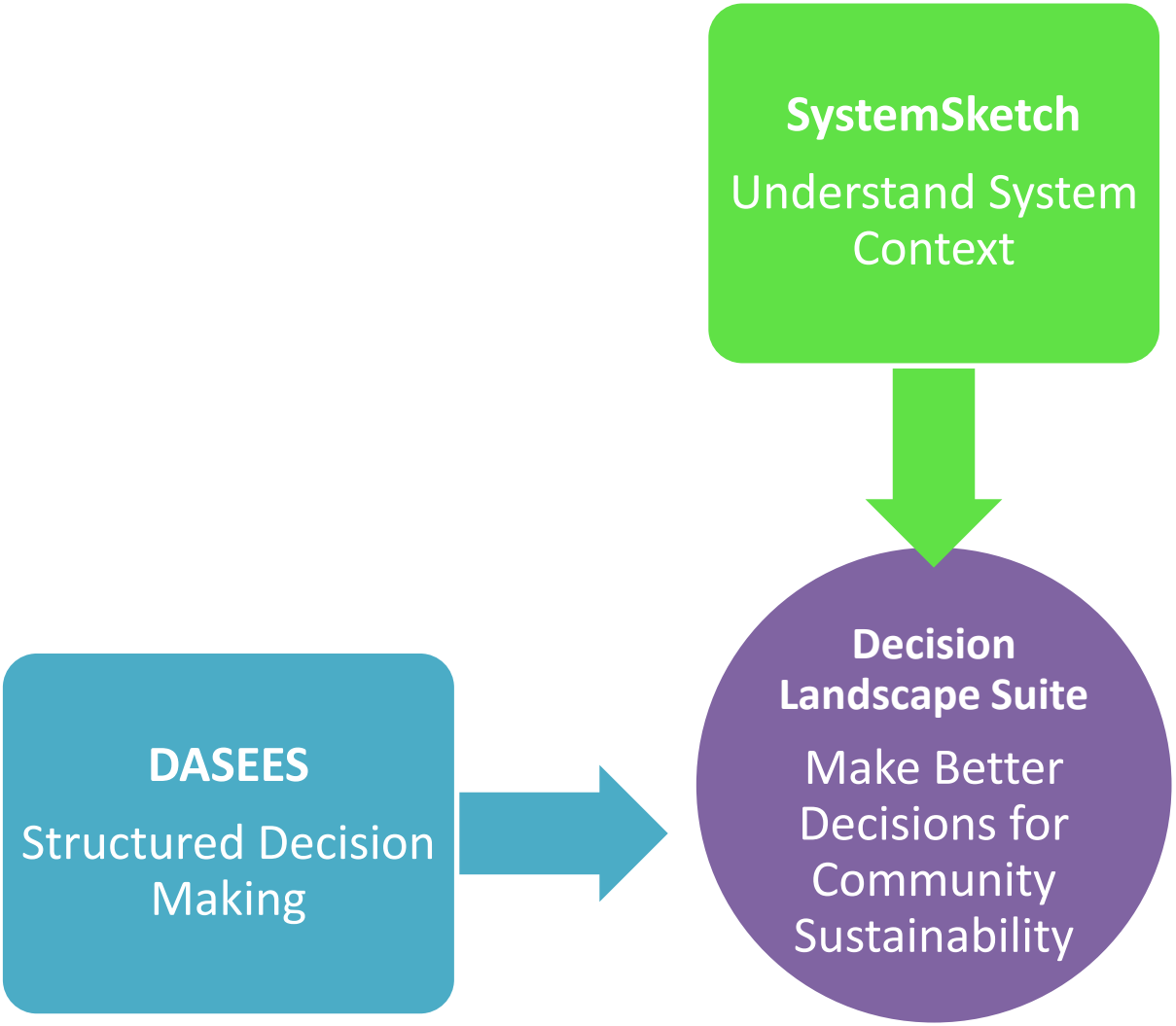
A Final Ecosystem Goods and Services Classification System (FEGS-CS)

Dixon H. Landers and Amanda M. Nahlik





- Interoperable
- Expandable
- Open Source


SystemSketch
Understand System Context
DASEES
Structured Decision Making
Decision Landscape Suite
Make Better Decisions for Community Sustainability

DASEES is a Framework and Tool for Structured Decision Making (SDM)

DASEES
(Decision Analysis for a Sustainable Environment Economy & Society)

1. Understand Context — **SystemSketch**
2. Define Objectives
3. Develop Options
4. Evaluate Options
5. Take Action

US Environmental Protection Agency, Office of Research and Development
National Health & Environmental Effects Research Laboratory, Atlantic Ecology Division, Narragansett RI

DASEES contains a set of component sub-tools for each step in the SDM process

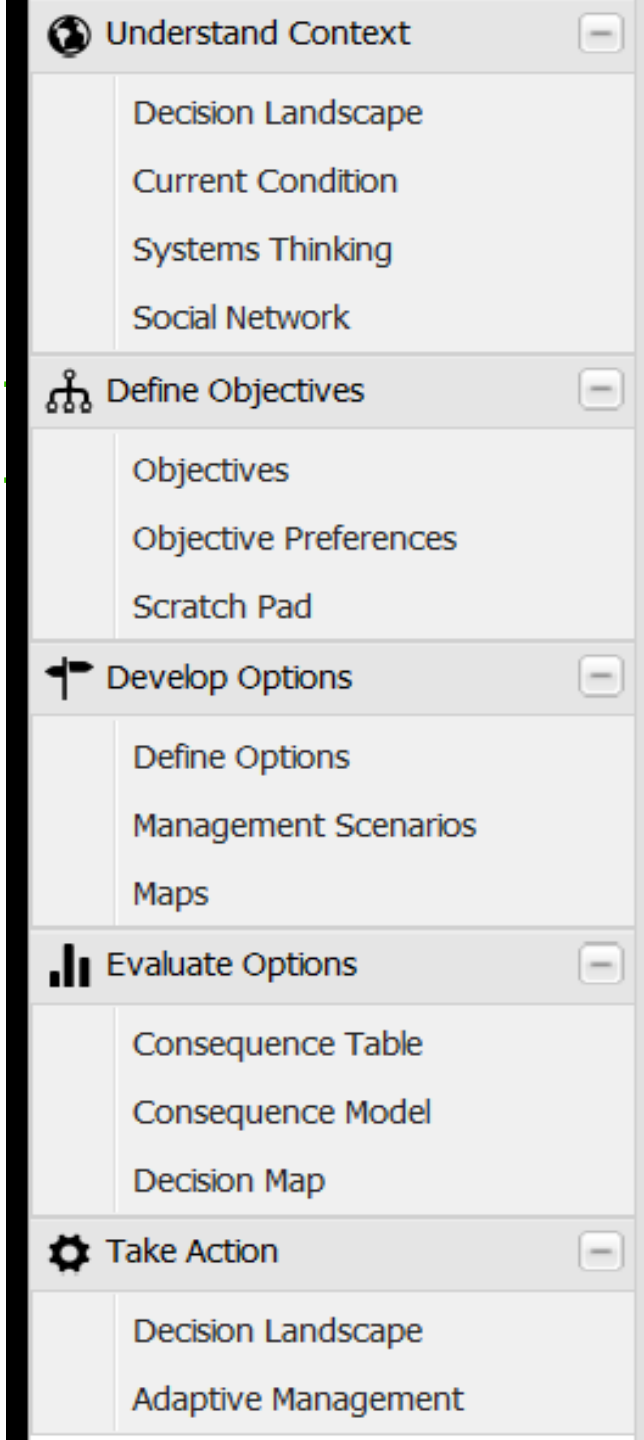
1. Understand Context

2. Define Objectives

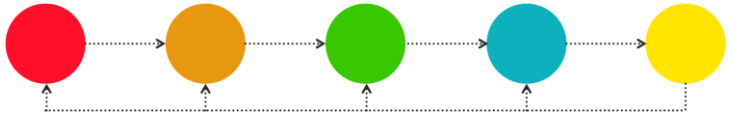
3. Develop Options

4. Evaluate Options

5. Take Action



Last Words



Systems Thinking is Necessary for Integration of Ecosystem Services in Environmental Management and Public Policy Decision Making

Human values are integral to environmental management & policy decisions

∴

Integration of ecosystem processes and attributes into decision making requires
intuitive/accessible understanding of linkages
between ecological and human systems

Systems Thinking is Necessary for Integration of Ecosystem Services in Environmental Management and Public Policy Decision Making

SystemSketch provides a way for decision makers to **visualize** system linkages, **record stakeholder values**, and **access relevant resources**, which has potential to…

- Increase **cooperation** amongst stakeholders
- Increase chances that responses will be **integrative** rather than piecemeal
- Increase consideration of **non-monetary values** in decision-making
- Avoid **unintended consequences**
- Increase integration of **scientific information** into decision making

Beta Test SystemSketch

Ingrid Heilke
heilke.ingrid@epa.gov

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Oak Ridge Institute for Science and Education.