Putting the Pieces Together

Alternatives Analysis and Decision Support

Kevin Halsey and Paul Manson

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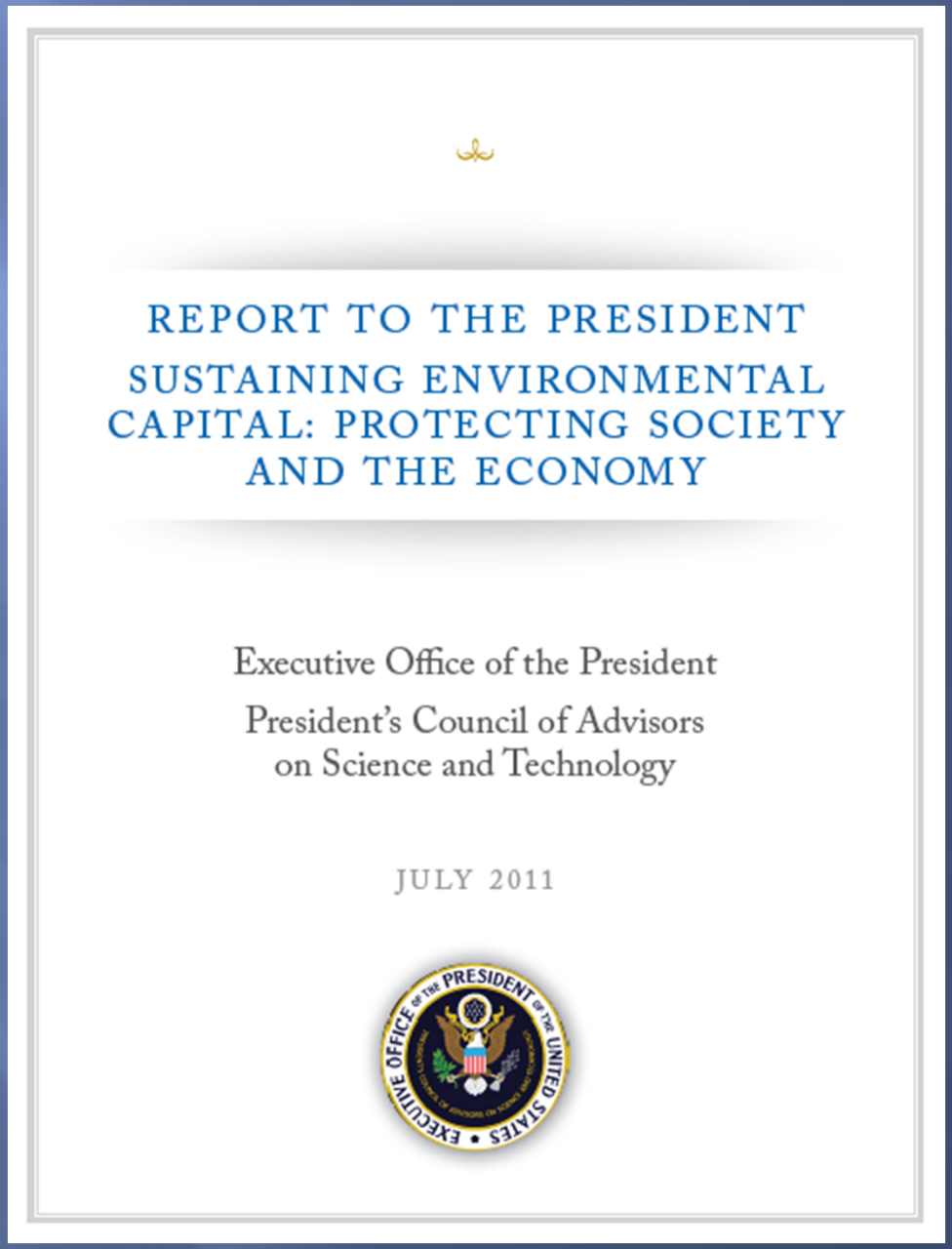

http://www.whitehouse.gov/administration/eop/ostp/pcast/docsreports

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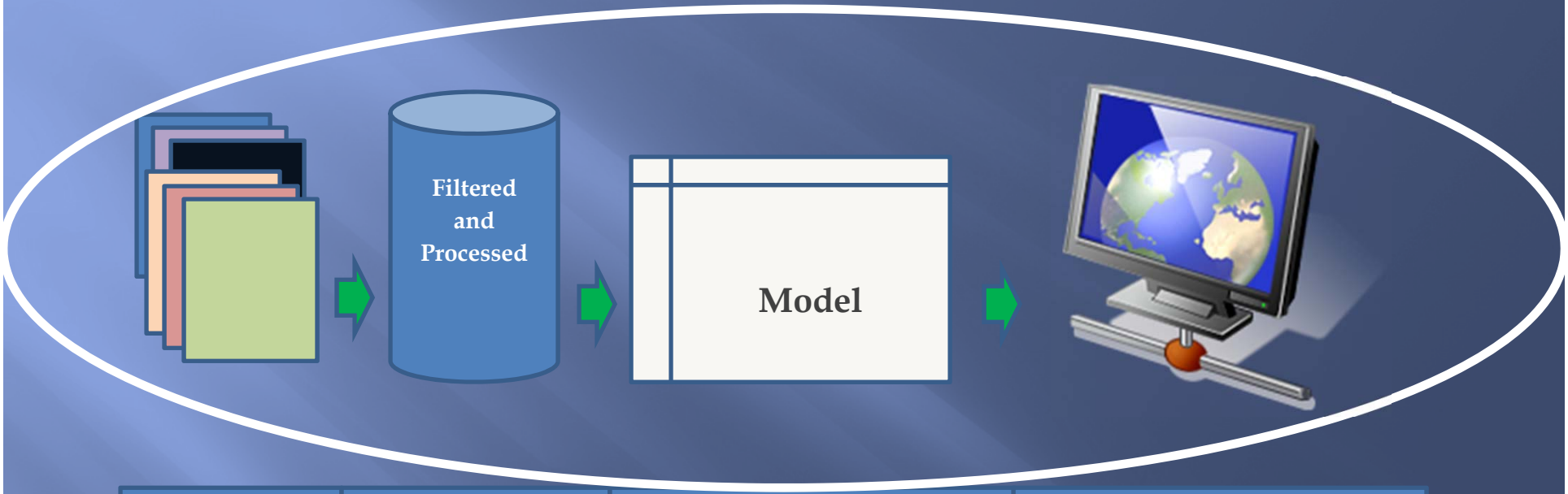
Conclusions

- Focus on ecosystem services based analysis
- Target specific data needs
- Improve use of existing knowledge
- Increase focus on refining and developing decision support tools

Ecosystem Services Framework



Raw Data	Data Library	Decision Engine	User Interface

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Ecosystem Services

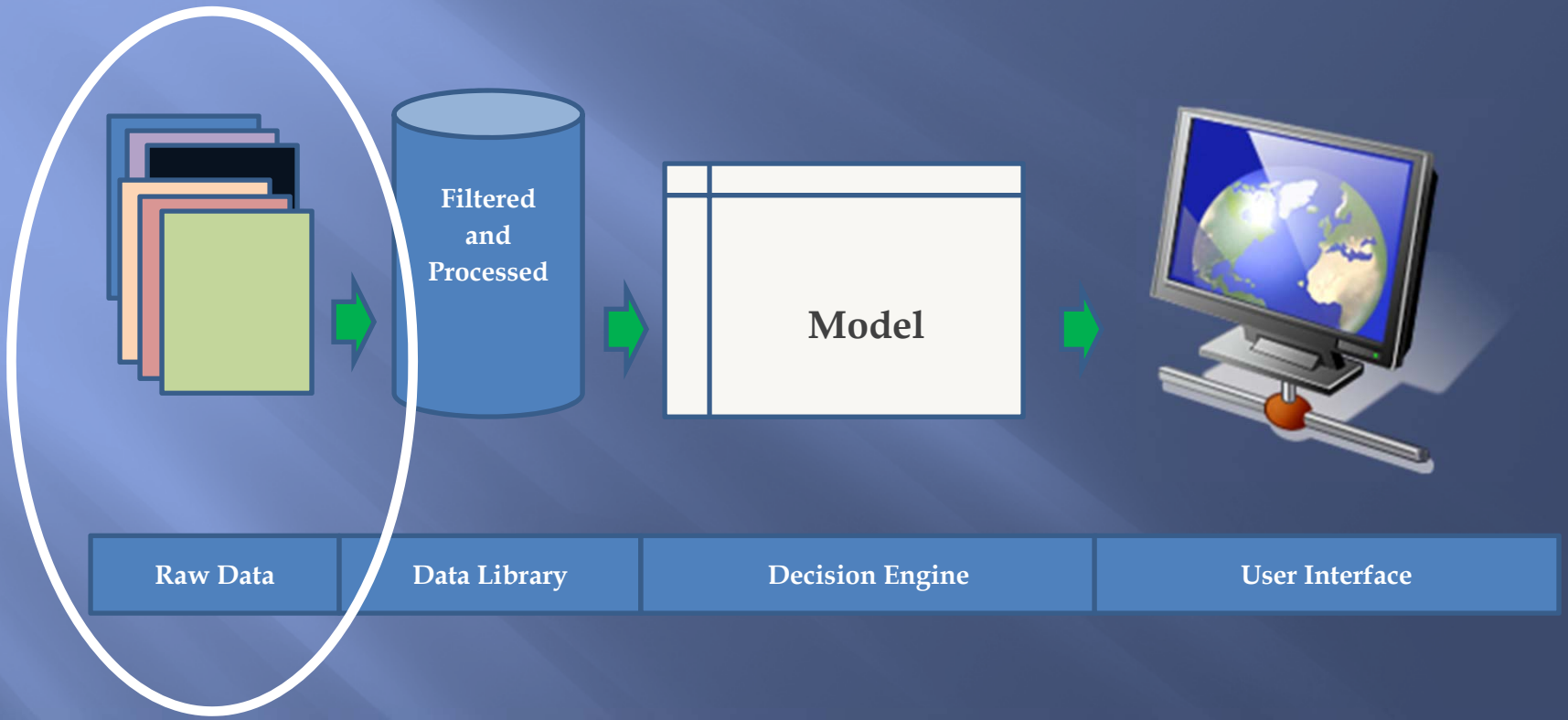
"[PCAST has addressed the needs and opportunities] . . . of governments—and especially the U.S. Federal government—to fulfill more effectively their responsibility in relation to the **protection of environmental capital and ecosystem services**."

-President's Council of Advisors on Science and Technology.
Sustaining Environmental Capital: Protecting Society and the Economy"
July 2011

Ecosystem Services

- Sustainability
- "Much of the world's environmental capital, moreover, consists of common-property resources rather than privately held assets . . ."
- OMB/OSTP FY 2012 budget guidance

Gathering Data



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Understanding Ecological Condition and Ecosystem Service Relationships

" . . . the information actually available on these topics is far from complete. But it is also far, far more than none at all."

-President's Council of Advisors on Science and Technology. *Sustaining Environmental Capital: Protecting Society and the Economy"* July 2011

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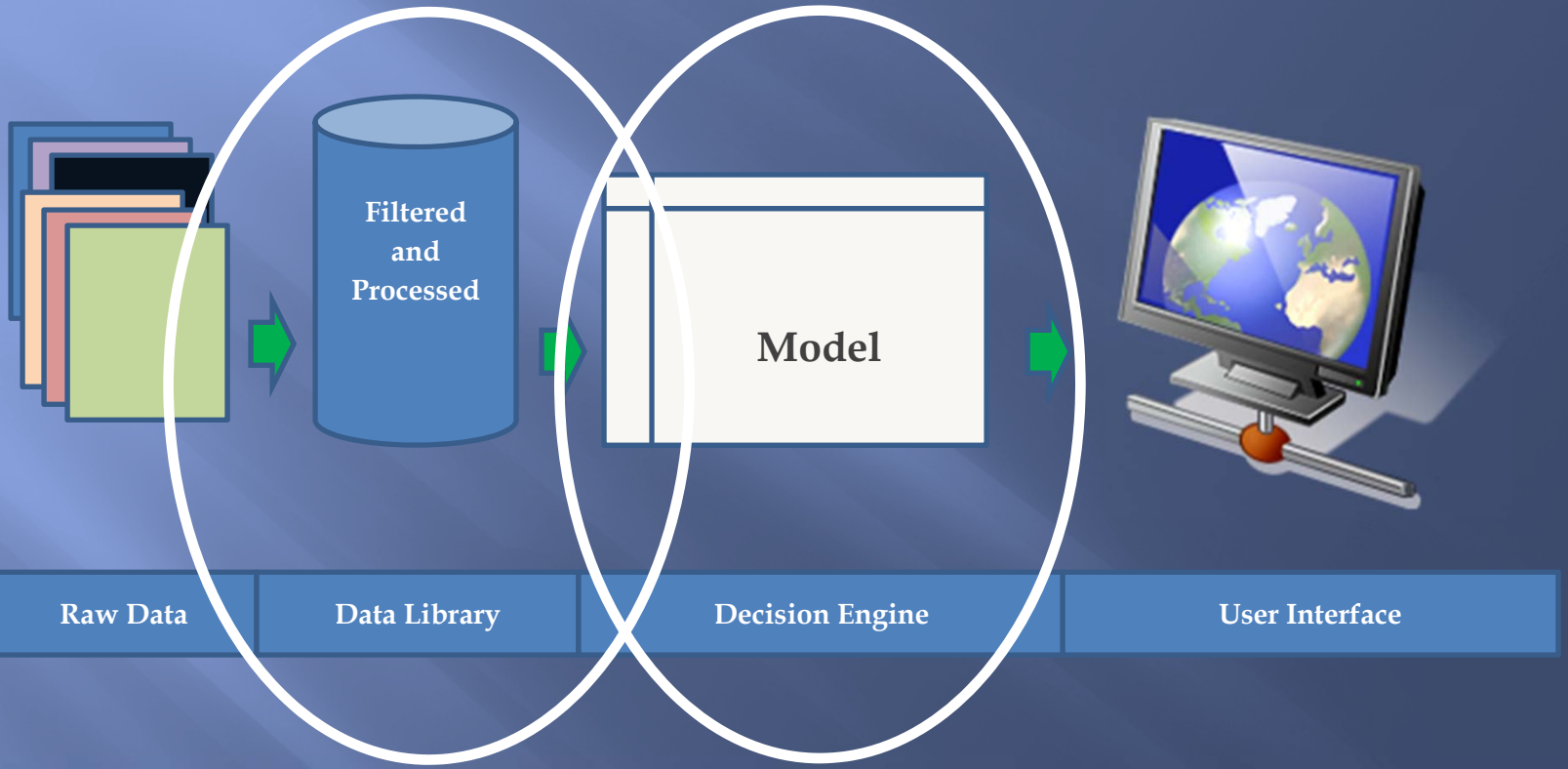
- Ecotrust Fishing study
- Surfriders non-consumptive recreation study
- Near shore high resolution bathymetry
- Integrated Ocean Observatory System (IOOS)
- BOEMRE space use conflicts study

Decision Support Elements



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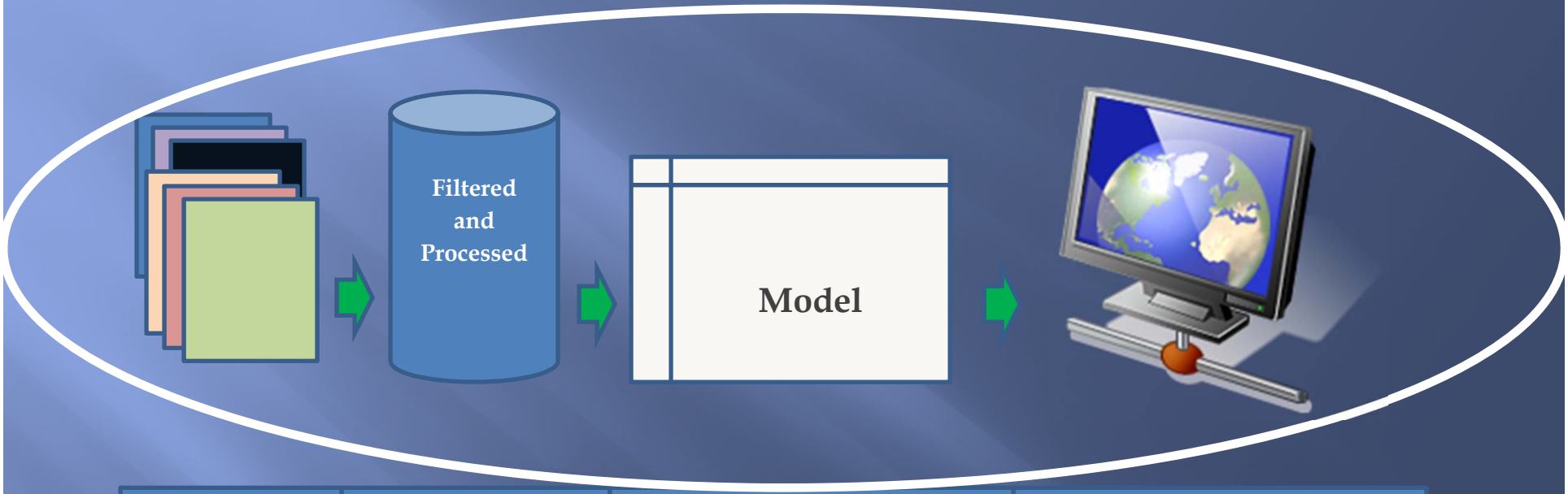
"EcoINFORMA is needed to ensure that Federal agency data relevant to biodiversity and ecosystems, as well as the socio-economic and geophysical data required in support of ecosystem valuation and decision-support, are **published in machine-readable, interoperable format to facilitate research** engagement by public, private, academic, and other stakeholders, and to support policy- and decision-making at Federal, state, and local levels."

-President's Council of Advisors on Science and Technology.
Sustaining Environmental Capital: Protecting Society and the Economy"
July 2011

Data and Studies

- Managing Data Sets
  - Marine Cadastre
  - Coastal Atlas
  - Marine Map (Oregon)
- Studying Ecological Processes
  - OWET Studies
  - NOPP studies (BOEMRE/NOAA/DOE)
  - BOEMRE environmental studies

Supporting Decision Support



Raw Data	Data Library	Decision Engine	User Interface

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Need for Decision Support

"Despite the abundance of data that come from existing monitoring programs, decision makers at every level lack sufficient information—that is, the results of analysis and interpretation of data."

-President's Council of Advisors on Science and Technology. *Sustaining Environmental Capital: Protecting Society and the Economy"* July 2011

On-going Efforts

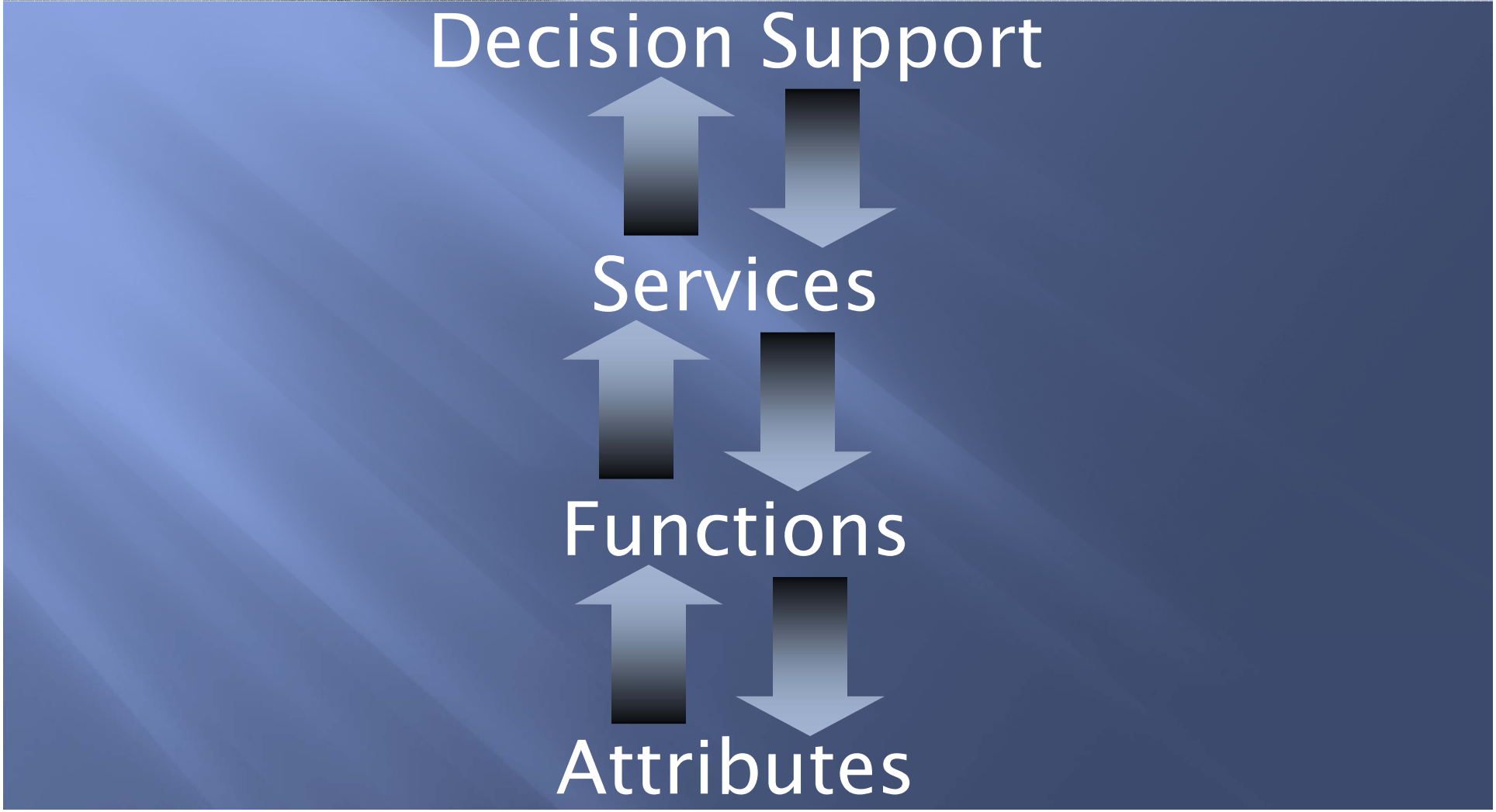
- Marine Map
- Marine InVEST
- ARIES
- TNC Ecoregional Assessment

Ecosystem Services Examples

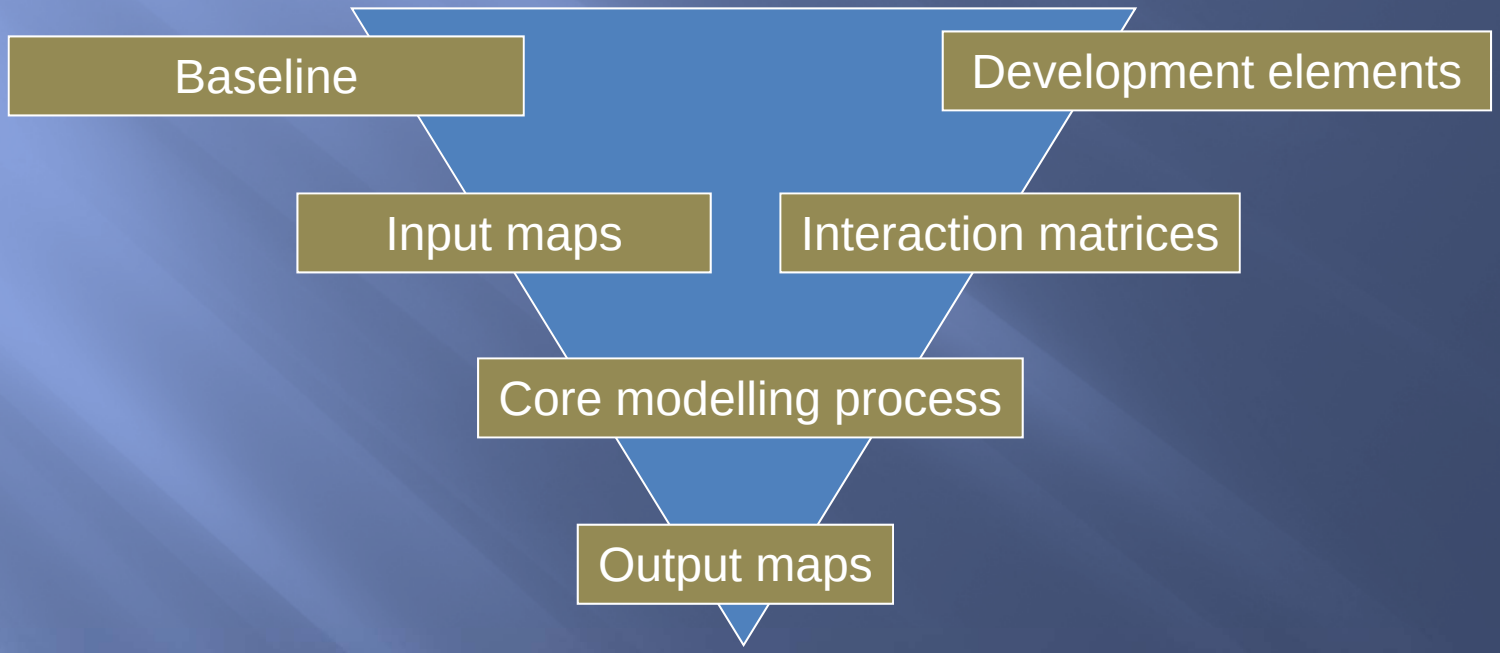
- Oregon Wave Energy Trust:
  Cumulative Effects Analysis Framework

- Bureau of Ocean Energy Management:
  Bayesian Analysis for Spatial Siting (BASS)

Linking Data to Decisions



Analytical framework structure



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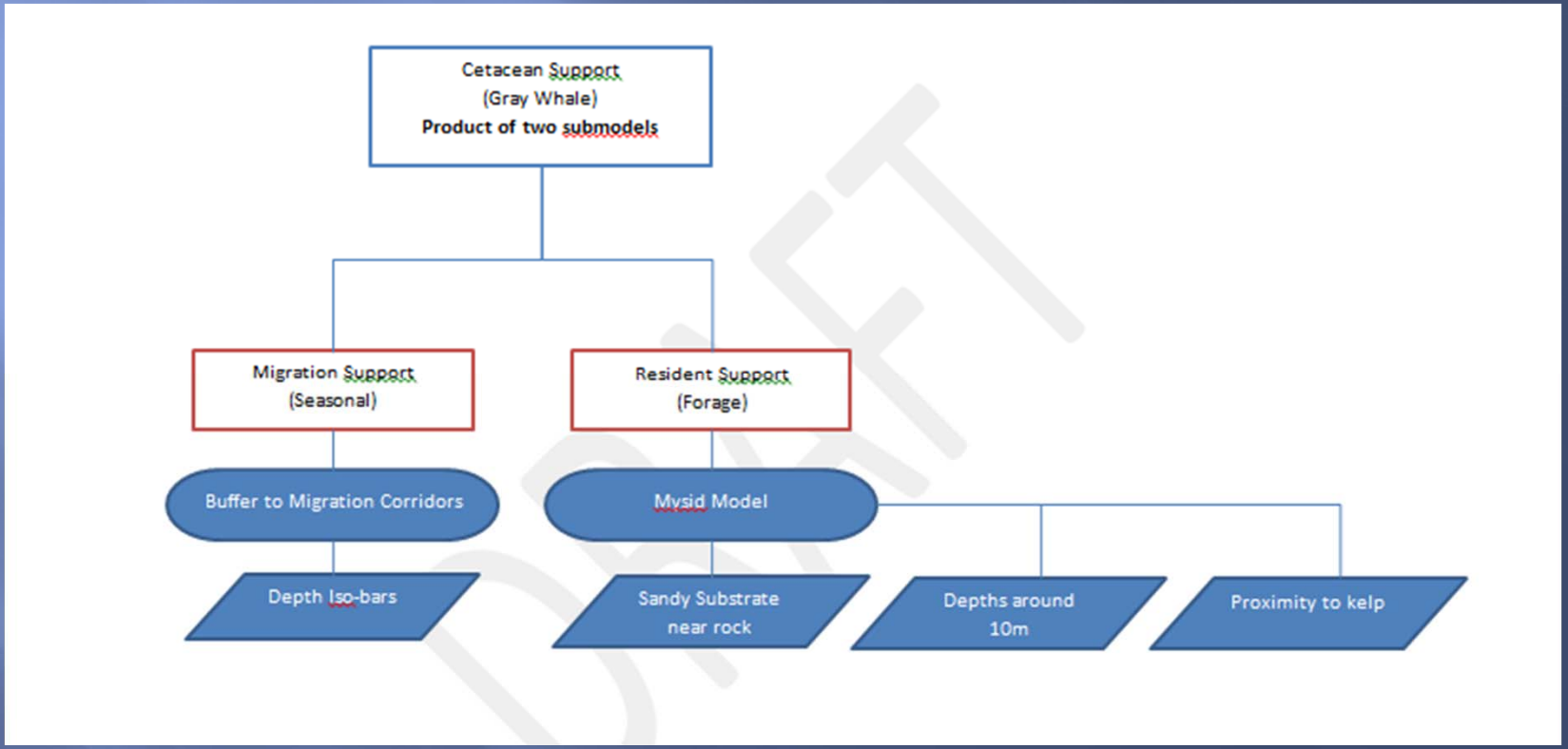
Cumulative Effects Method

Function-Based Product Model



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Scoring

Model Specifications

The cetacean support model includes two parts, migration support and foraging support. The model is Gray Whale specific (*Eschrichtius robustus*) and is a synthesis of both spatial and non-spatial data. The migration sub-function models corridors of importance based on observed point data and the correlation with physical environmental parameters, primarily depth contours. The forage sub-function is primarily for resident species and is also based on available observed data from the Oregon coast.

The impact models are the interaction of the function with known existing sea uses, conditions and activities. These are anthropogenic and include fishing effort, vessel navigation and water quality.

References:

Angliss, R. P. and B. M. Allen. 2007. Marine Mammal Stock Assessment Report: Gray Whale: Eastern North Pacific Stock. NOAA-TM-AFSC-193. http://www.nmfs.noaa.gov/pr/sars/species.htm Retrieved March 12, 2011.

Newell, Carrie 2010. Ecological Interrelationships Between Summer Resident Gray Whales (Eschrichtius robustus) and Their Prey, Mysid Shrimp (Holmesimysis sculpta and Neomysis rayi) along the Central Oregon Coast. MS Thesis. Oregon State University.

Ortega-Ortiz, Joel, Bruce Mate. 2008. Distribution and movement patterns of gray whales off central Oregon: Shore-based observations from Yaquina Head during the 2007/2008 migration. Report to Oregon Wave Energy Trust.

:

Attribute: Depth Iso-bars for Migration

Ref.	Classification	Score
1	< 10m	0.5
2	10m < 27.5m	3
3	27.5m < 32.5m	5
4	37.5m < 47.5m	10
5	47.5m < 60m	5
6	60m < 75m	3
7	> 75m	1

Source: 100m DEM Bathymetry

Attribute: Substrate

Ref.	Classification	Score
1	Sand dominant	1.5
2	Sand adjacent to rock	5
3	Rock with sand secondary	3
4	All other	1

Source: DOGAMI

Attribute: Depths for Foraging

Ref.	Classification	Score
1	8m < 12m	5
2	Other	1

Source: 100m DEM Bathymetry

Attribute: Proximity to Kelp

Ref.	Classification	Score
1	Within 100m of Survey	5
2	Other areas	1

Source: ODFW Survey Data processed

Attribute: Fishing Effort

Ref.	Classification	Score
1	<4m	10
2	4m < 5m	3.5
3	> 5m	0.01

Source: Interpolated NOAA Tidal Station Data

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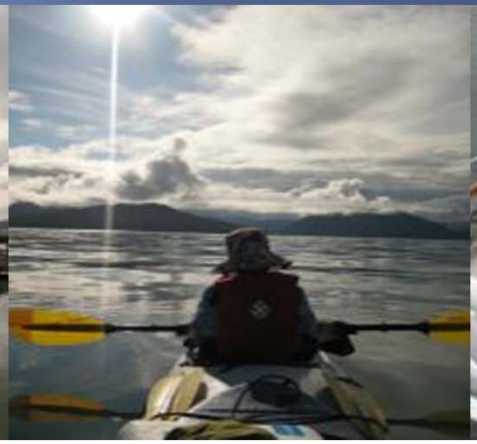
Function Mapping

- Representing How Well the Water Supports…
  - Ecology: e.g. Cetaceans, Pinnipeds, Kelp, Fish Species
  - Physical: e.g. Coastal Resilience/Erosion, Sediment
  - Social/Use: e.g. Fishing Effort, Navigation, Recreation, Visual



Cumulative Effects Structure

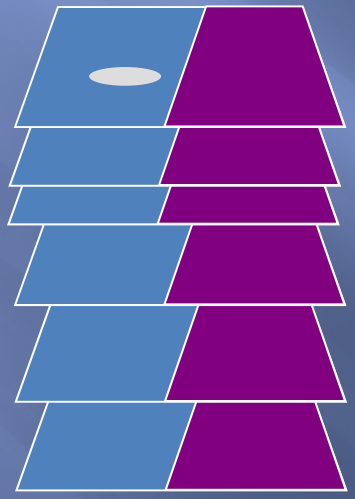
Services/Functions

- Physical
- Biological
- Existing Use
- Social
- Economic

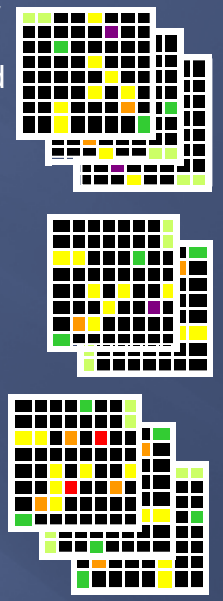
Environmental receptors & functions

Possible areas of cumulative effects

Sensitivity normalized in relation to level of impact, risk or ecosystem & society services



Impact levels for the relevant activity, specific to the sensitivities in the defined area are collated



Environmental sensitivities & functions

Activities

- Devices
- Supporting technology
- Associated operations

A series of Weighted Product Models (WPM) – Combined in Scenarios

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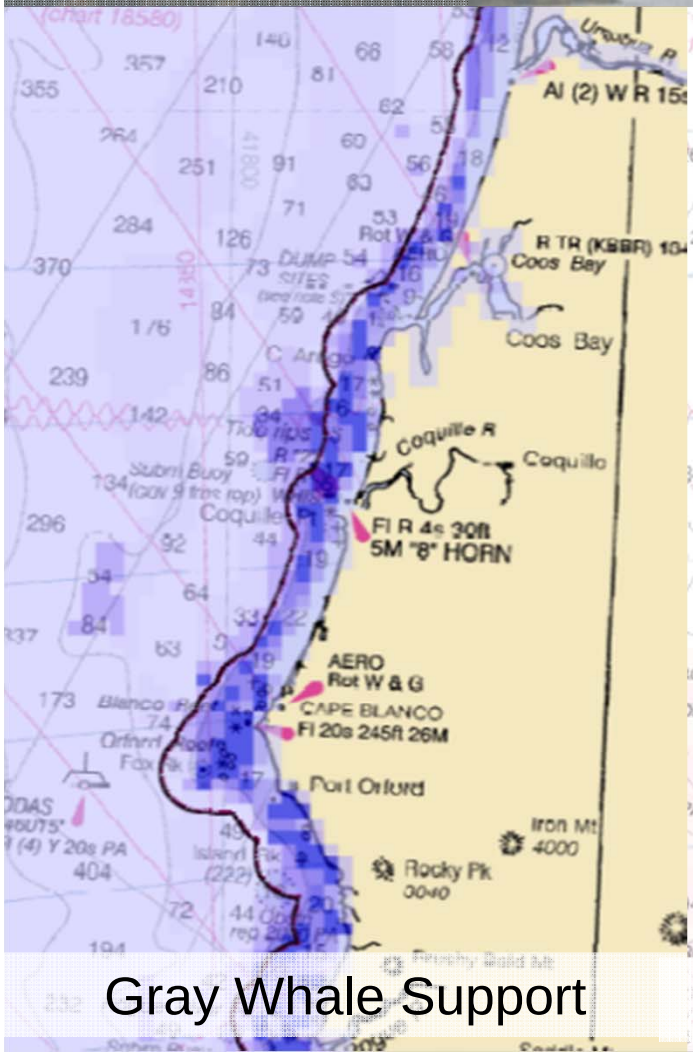
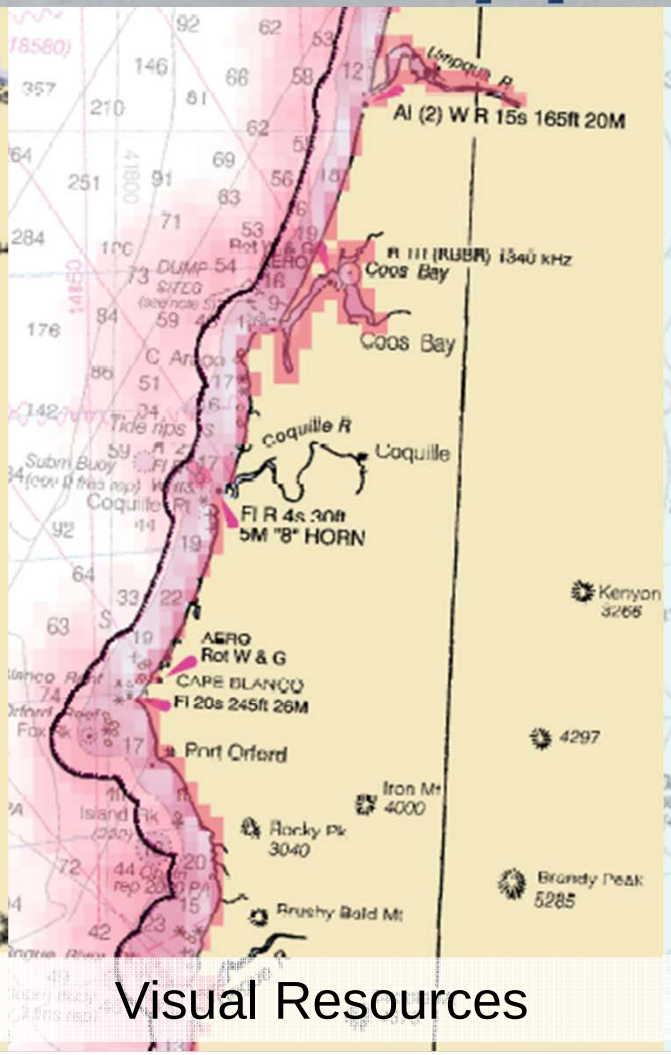
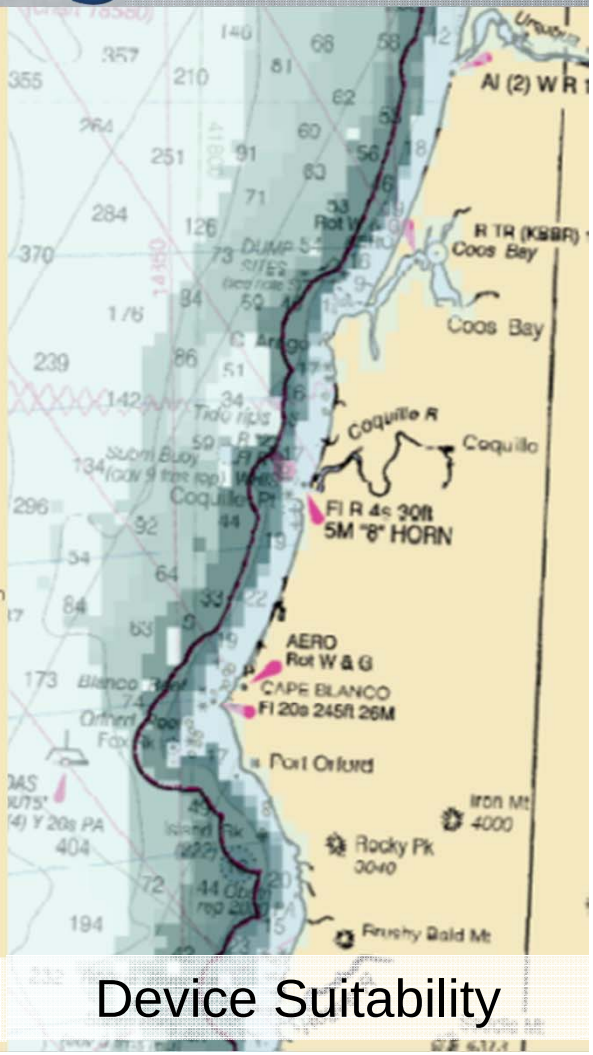
Function Mapping



Gray Whale Support



Visual Resources



Device Suitability

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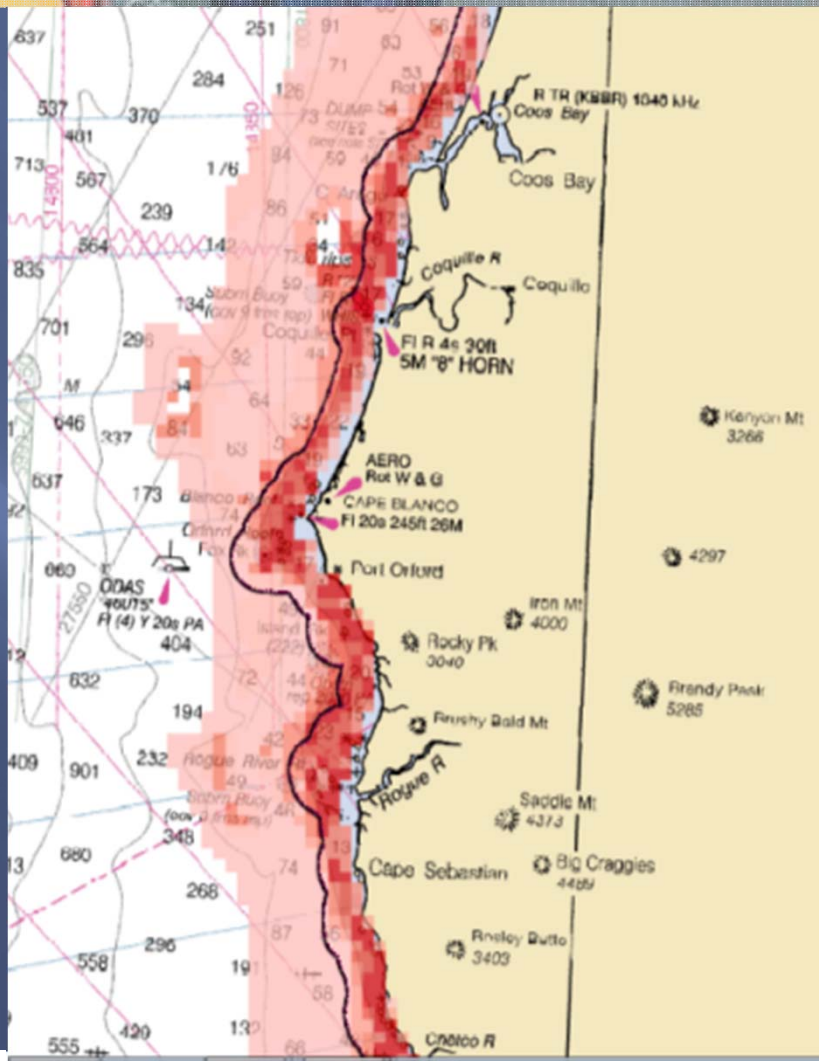
Combined Functions

- Scenario Based Analysis
  - Functions are related to other uses
  - Proposed Development Scenario related to functions
  - Combined impact delta from natural baseline for cumulative impact



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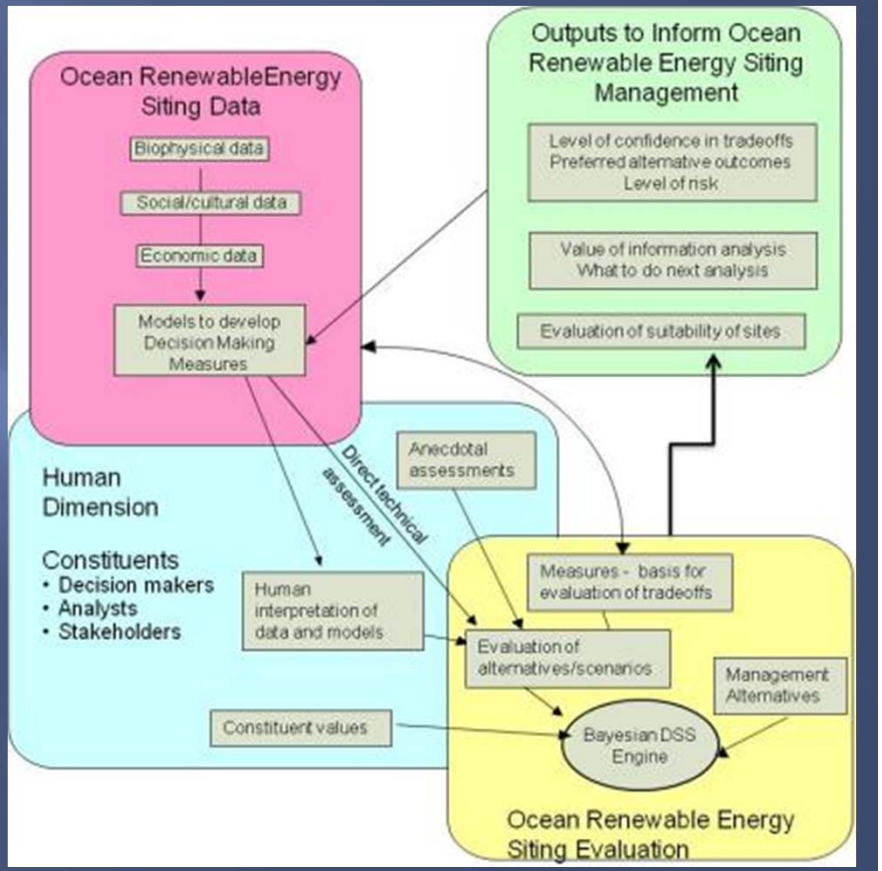
Some Challenges…

- Managing Data Variability and Gaps
- Managing Differing Opinions
  - Scientific
  - Development
  - Public
- Managing Uncertainty

Bayesian Analysis

- Probability Driven
  - Conditional probabilities to capture complex uncertainty
- Partners
  - Oregon State University
  - Robust Decisions
  - The Nature Conservancy



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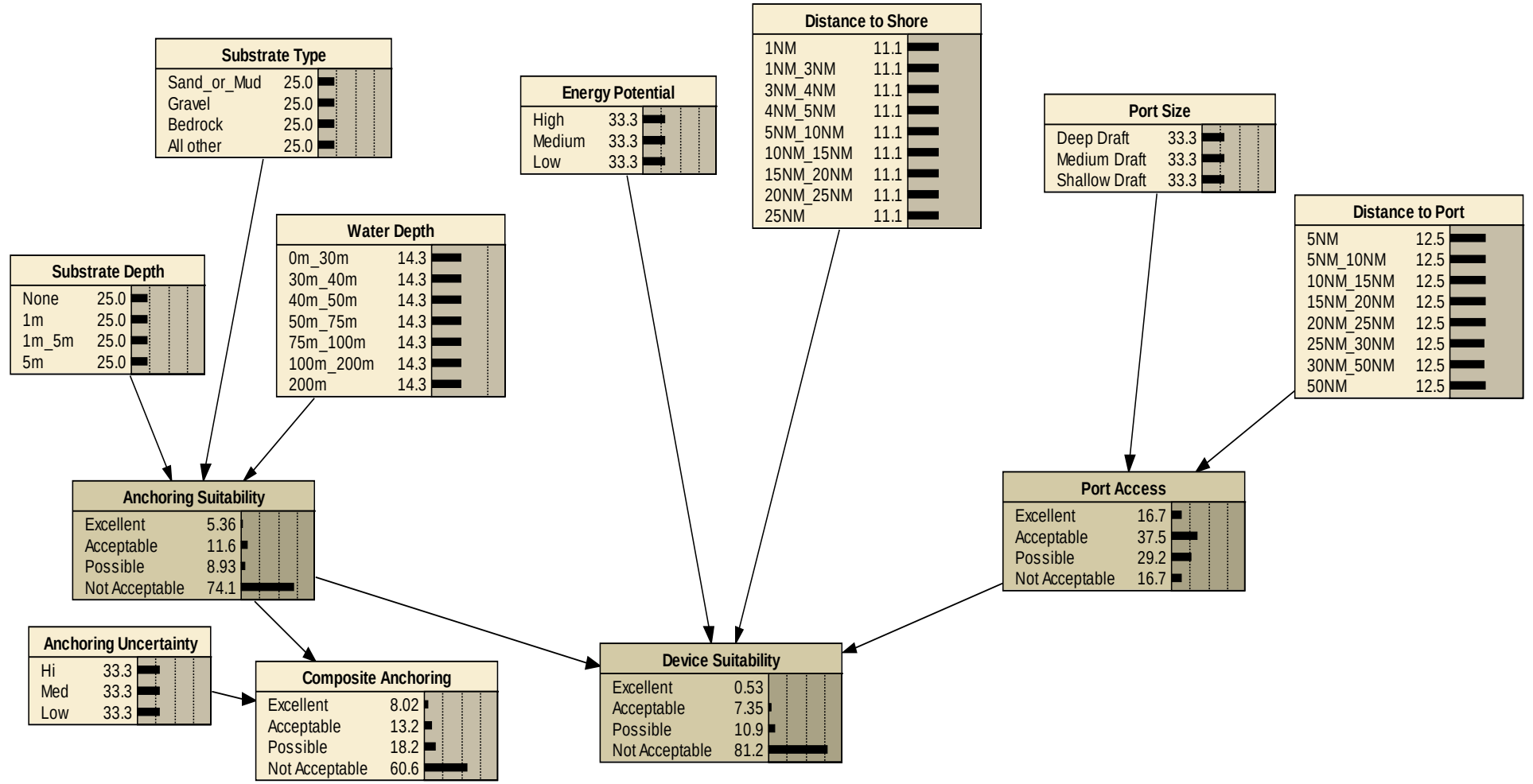
Bayesian Belief Networks



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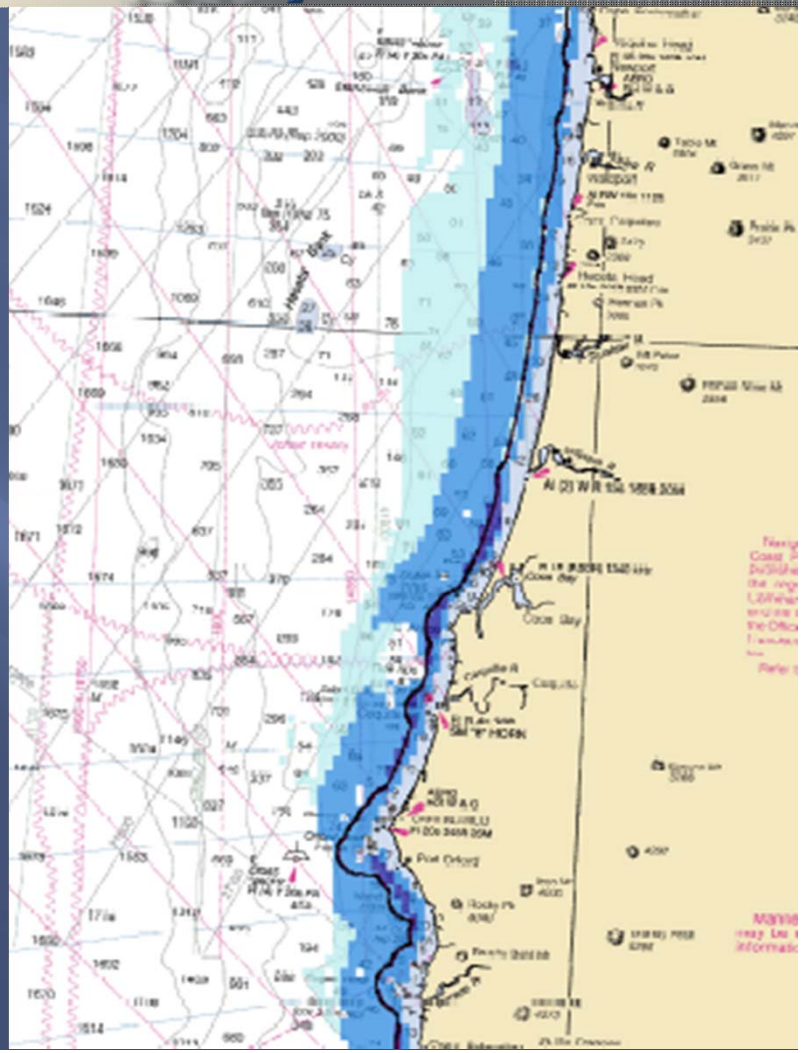
Guided Spatial Analysis

- Multiple Models and Inputs
- Various Reviewers
- Allows for Non-Existent Data



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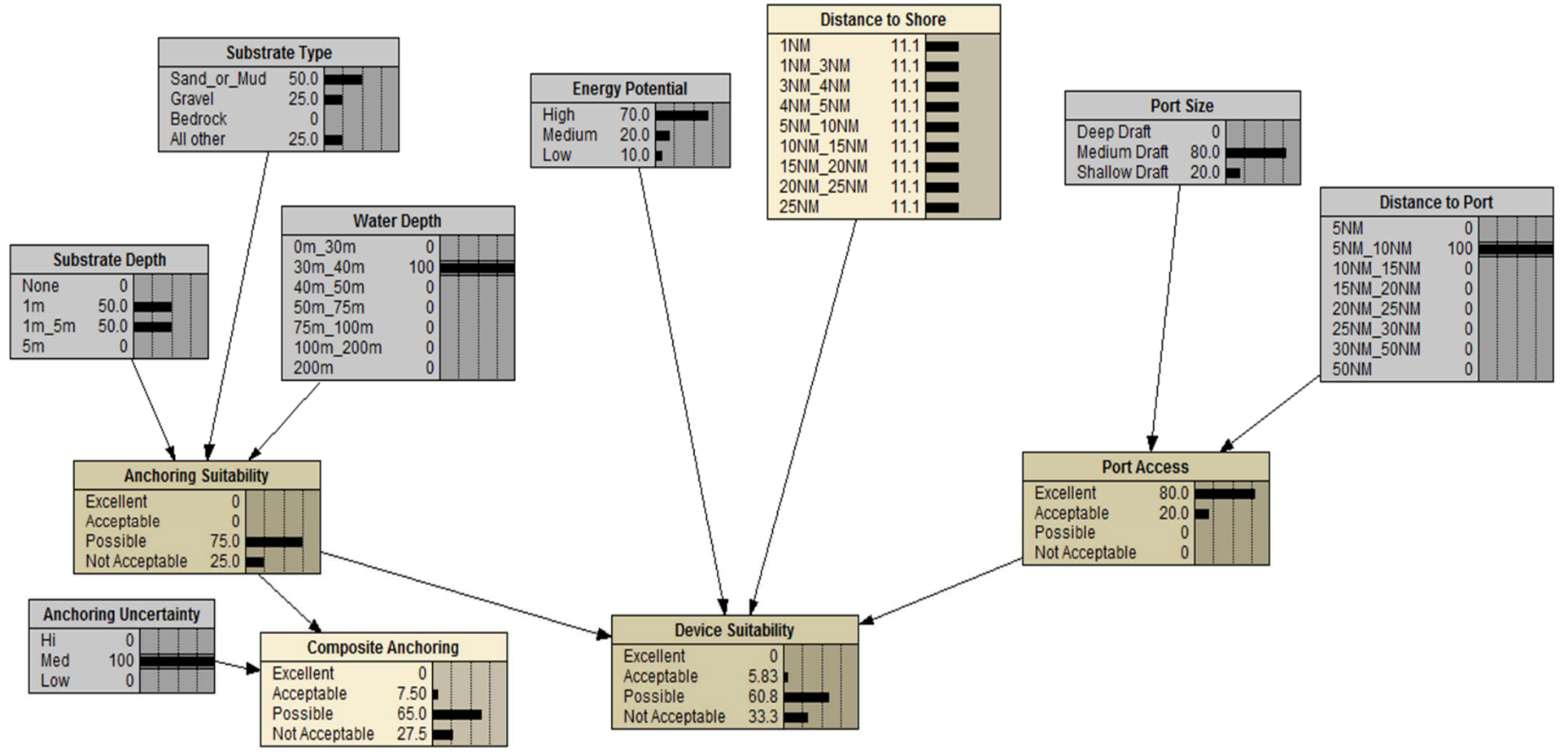
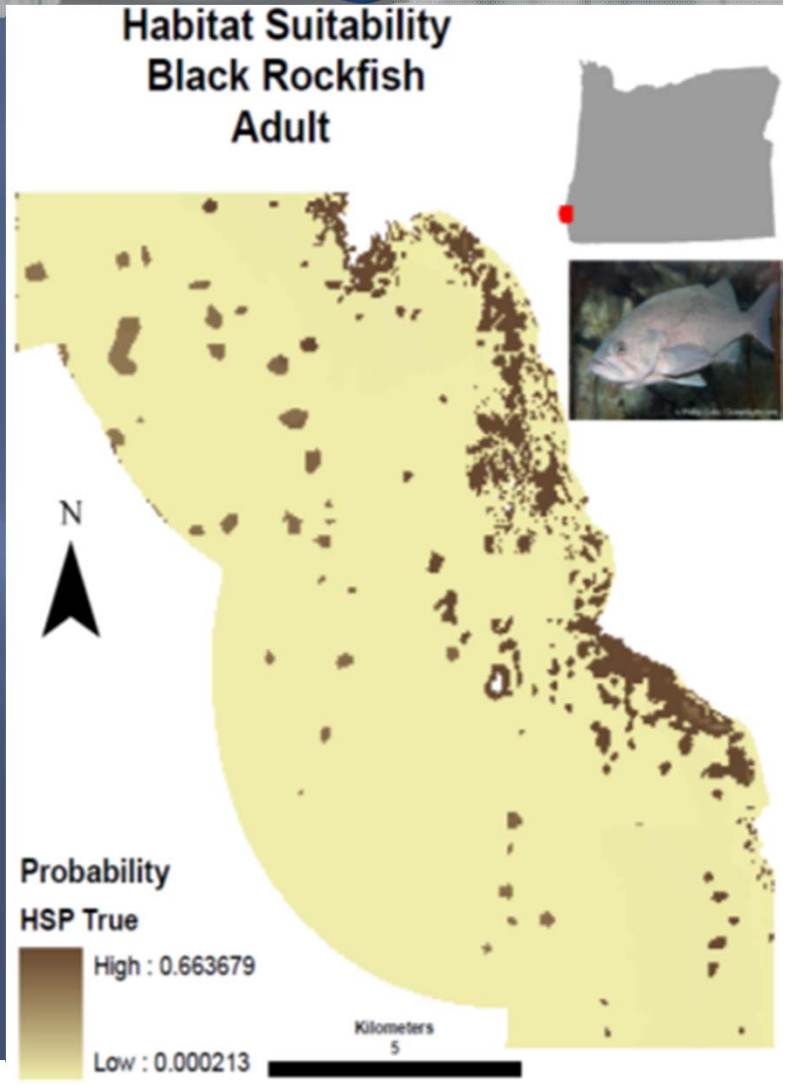
Partial Information Management



Ecological Modelling

- Black Rockfish Example
  - Two different bathymetry data sets (50M and 4M)
  - Different assumptions about habitat "believe-ability"
- Manages uncertainty and varying data quality



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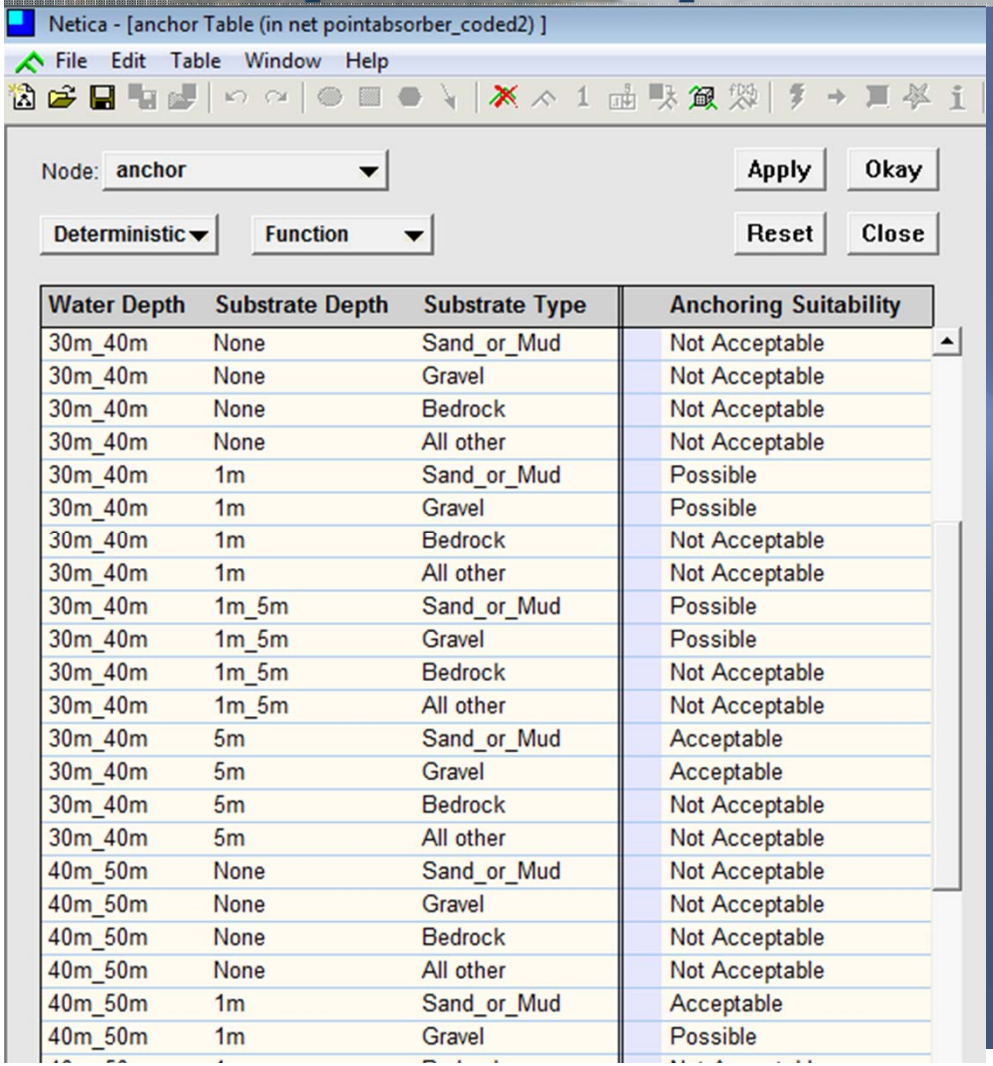
Expert Input Drives Analysis

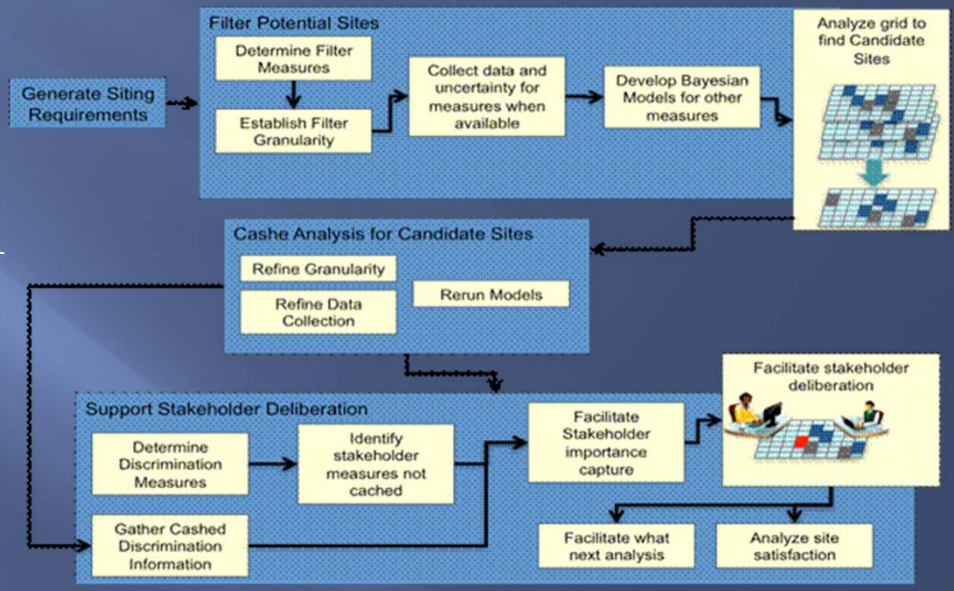


Water Depth	Substrate Depth	Substrate Type	Anchoring Suitability
30m_40m	None	Sand_or_Mud	Not Acceptable
30m_40m	None	Gravel	Not Acceptable
30m_40m	None	Bedrock	Not Acceptable
30m_40m	None	All other	Not Acceptable
30m_40m	1m	Sand_or_Mud	Possible
30m_40m	1m	Gravel	Possible
30m_40m	1m	Bedrock	Not Acceptable
30m_40m	1m	All other	Not Acceptable
30m_40m	1m_5m	Sand_or_Mud	Possible
30m_40m	1m_5m	Gravel	Possible
30m_40m	1m_5m	Bedrock	Not Acceptable
30m_40m	1m_5m	All other	Not Acceptable
30m_40m	5m	Sand_or_Mud	Acceptable
30m_40m	5m	Gravel	Acceptable
30m_40m	5m	Bedrock	Not Acceptable
30m_40m	5m	All other	Not Acceptable
40m_50m	None	Sand_or_Mud	Not Acceptable
40m_50m	None	Gravel	Not Acceptable
40m_50m	None	Bedrock	Not Acceptable
40m_50m	None	All other	Not Acceptable
40m_50m	1m	Sand_or_Mud	Acceptable
40m_50m	1m	Gravel	Possible

- Conditional Probability Tables
  - Engine for decisions
  - Creates probabilities
  - Allows for analysis of value of information

Final Tool

- Web-Enabled Tool for Decision Support
  - Collects preferences from reviewers
  - Presents spatial results from preferences
  - Supports informed alternatives analysis
  - 2012 Roll-out



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