

Marine Spatial Planning: Washington process status and background

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Why do we need planning?

New uses

Increasing pressures, demands of existing uses

Conflicts among uses

Lots of governments and authorities!

Source: NOAA Olympic Coast National Marine Sanctuary

Hopper Dredge Essayons
Source: US Army Corps of Engineers

State Law Definition

Marine Spatial Planning (MSP) is a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine environments to achieve ecological, economic, and social objectives.

- Coordinating decisions – **NON-regulatory**
- Uses spatial data – often displayed as maps
- Proactive
- Multi-use

State Law: Required plan elements

- **Ecosystem assessment and indicators**
- Management measures
- Series of maps
- State recommendations for federal waters
- Implementation plan
- Framework for renewable energy

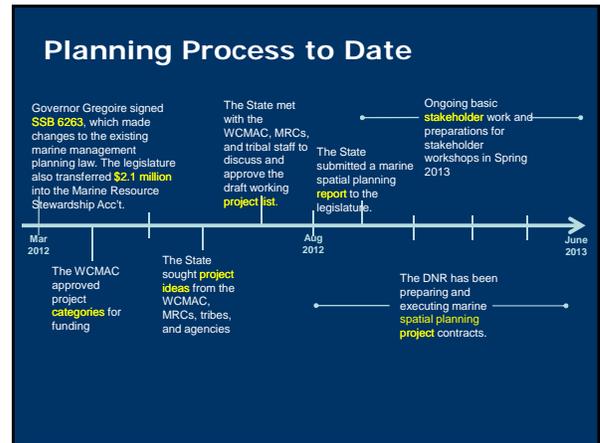
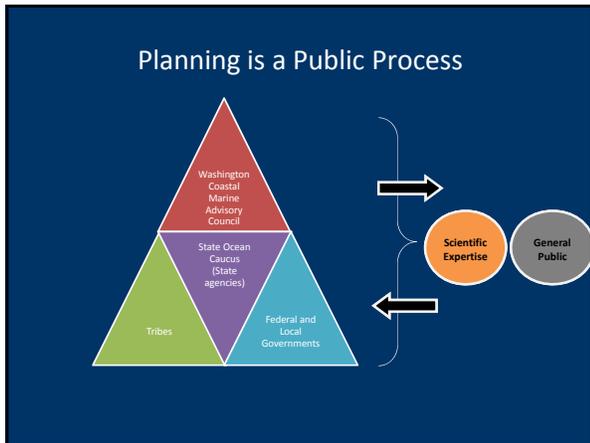
Ecosystem Assessment and Indicators

- Health & status of key ecological, social and economic characteristics
- Identify key threats to goals
- Analyze risk & management scenarios
- **Develop key ecosystem indicators**
- Adaptive management, monitoring and evaluation.

Core planning principles: content and process

Photo: Katie Lassiter

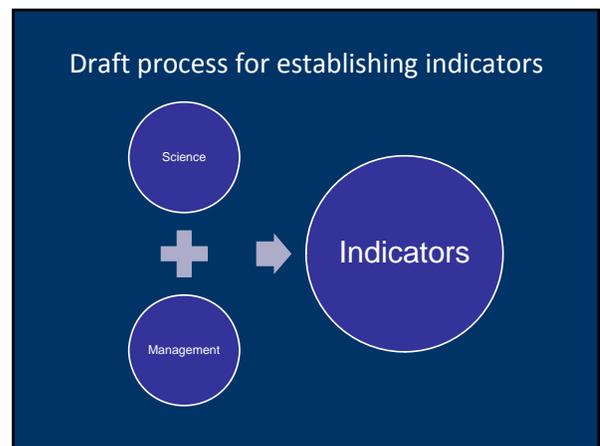
Photo: Katie Lassiter

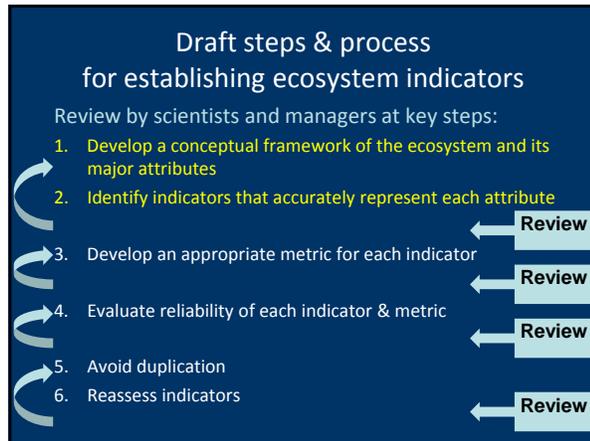


<http://www.msp.wa.gov>

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- ### Draft steps for establishing ecosystem indicators*
1. Develop a conceptual framework of the ecosystem and its major attributes
 2. Identify indicators that accurately represent each attribute
 3. Develop an appropriate metric for each indicator
 4. Evaluate reliability of each indicator & metric
 5. Avoid duplication
 6. Reassess indicators
- *From: Washington Academy of Sciences, August 2012. Sound Indicators: A Review for the Puget Sound Partnership.





Draft process for establishing indicators

- What are the best mechanisms for scientific feedback and review? What is required to achieve that review?
- What level of involvement makes the most sense?
- What timing allows for adequate review, while advancing progress?
- How do we develop a similar process for social and economic indicators?

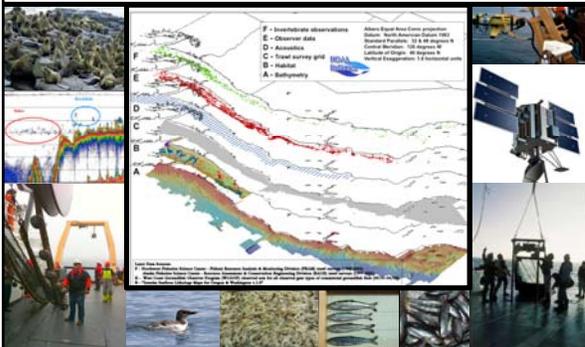
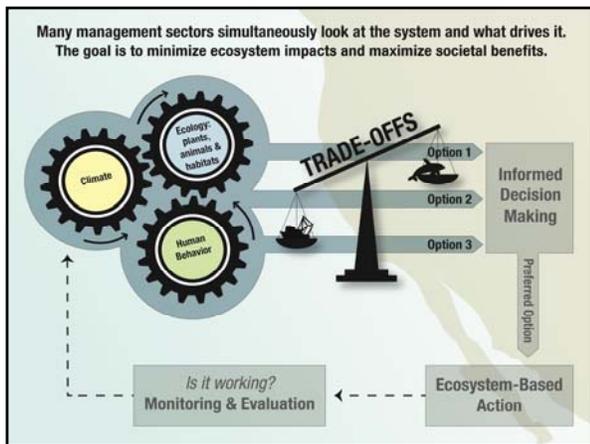
Integrated Ecosystem Assessment: California Current



- Why do we need IEAs?
- What is an IEA?
- How do IEAs advance ocean resource management?
- Current status & next steps

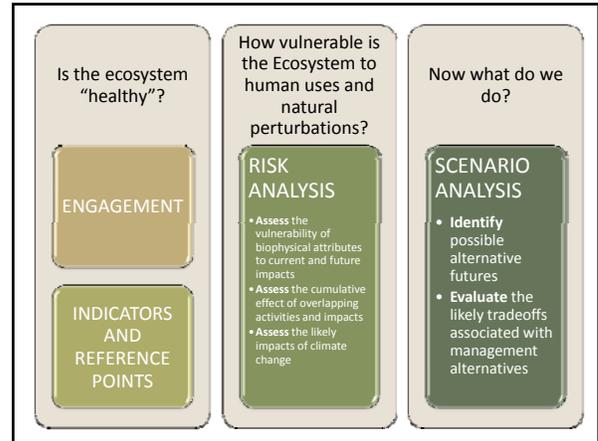
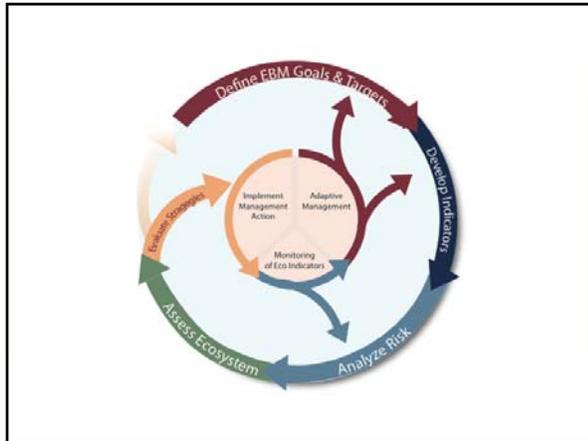
Why do we need IEAs?

We have data

What is an IEA?

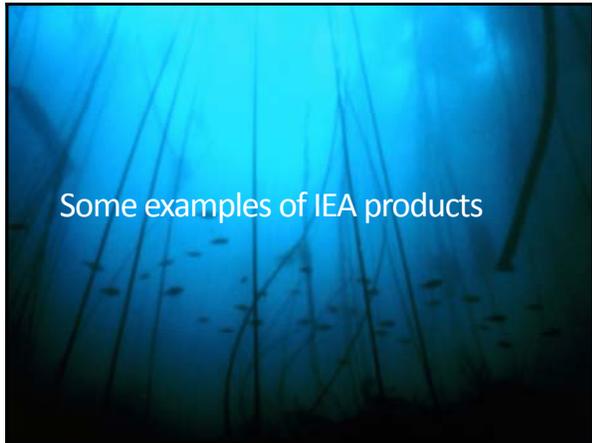
- A next generation tool for ocean coastal management
- A process to inform management decisions



What do IEAs do that is new?

	Today	With IEAs
Status of Ecosystem	Hundreds of Individual Measurements	Comprehensive status and trends
Measuring Ecosystem	Single species stock assessments	Carefully selected indicators; synthesized science
Risk Assessment and Management Strategy	Single species and single threat	Holistic – includes multiple threats and food web

Policy Question	IEA Step
What does a healthy ecosystem look like?	Objectives, indicators / targets
What is the health of the ecosystem?	Current status, risk assessment
What action should be considered?	Generate alternative management options
Where should we start?	Management strategy evaluation



Is the ecosystem "healthy"?

SCOPING

- Random digit phone survey to respondents in King, Kitsap, Mason, Pierce, Skagit, and Whatcom counties
- two waves, between January and February 2012 and July and August 2012.
- Sample size – 1,980 people

INDICATORS AND REFERENCE POINTS

Should We Protect the Environment at the Risk of Curbing Economic Growth or Promote Economic Growth at Risk of the Environment?

■ Protect ■ Growth

26% 74%

Is the ecosystem "healthy"?

SCOPING

- Random digit phone survey to respondents in King, Kitsap, Mason, Pierce, Skagit, and Whatcom counties
- two waves, between January and February 2012 and July and August 2012.
- Sample size – 1,980 people

INDICATORS AND REFERENCE POINTS

Area	Percent
Rural	~55
Suburban	~65
Urban	~75

Is the ecosystem "healthy"?

SCOPING

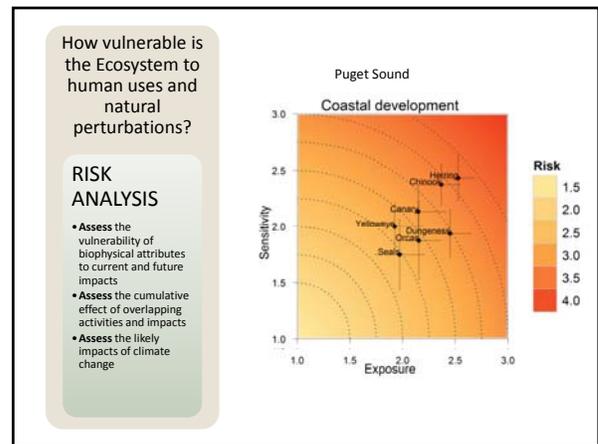
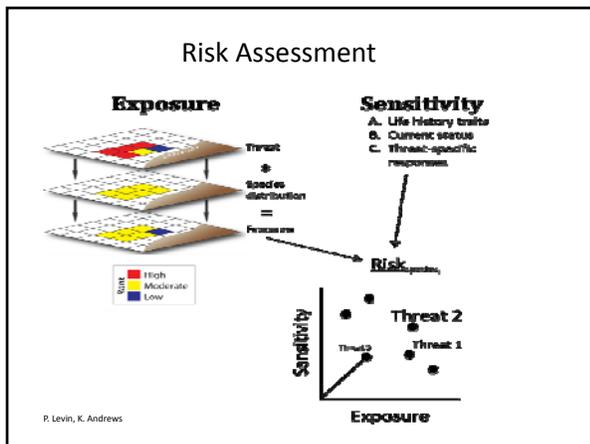
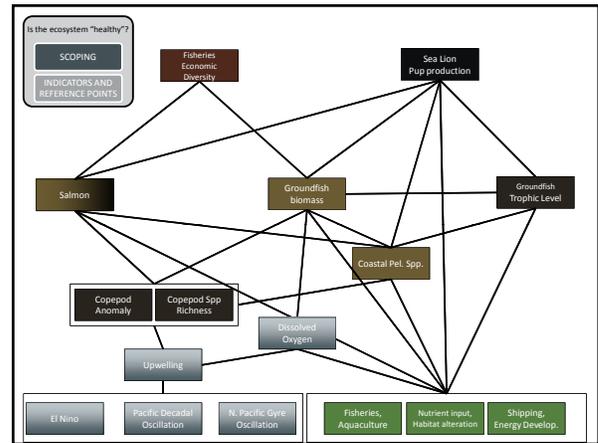
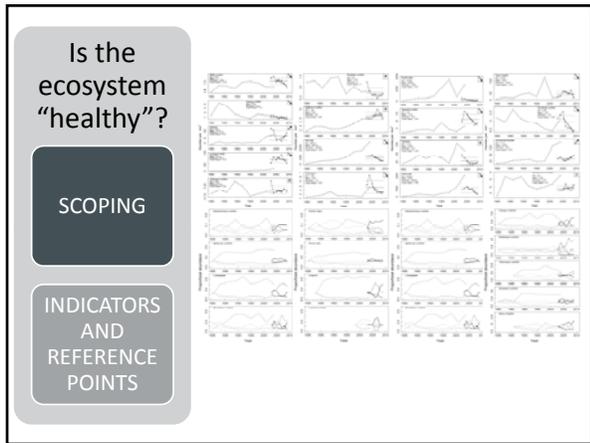
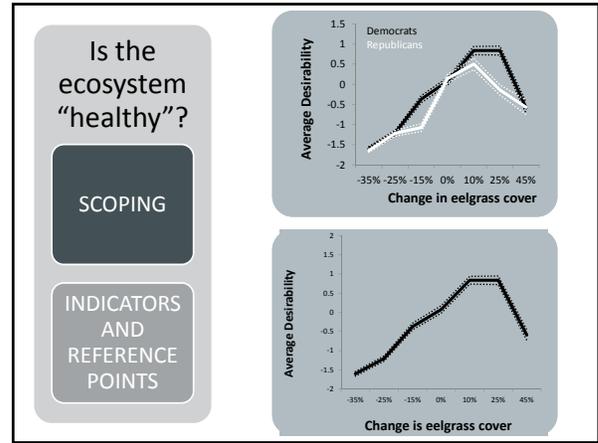
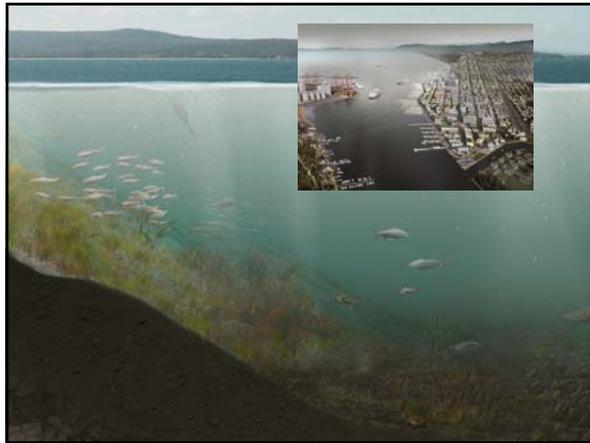
INDICATORS AND REFERENCE POINTS

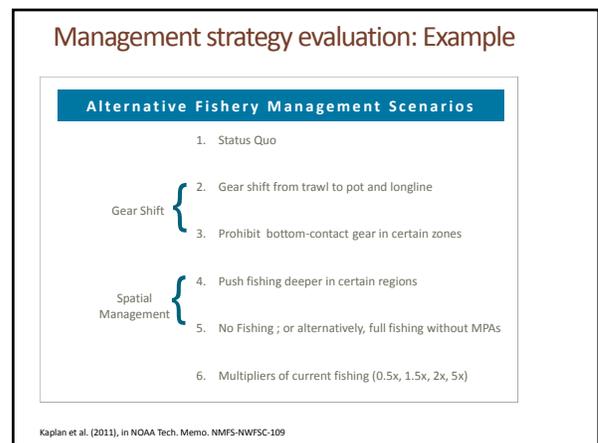
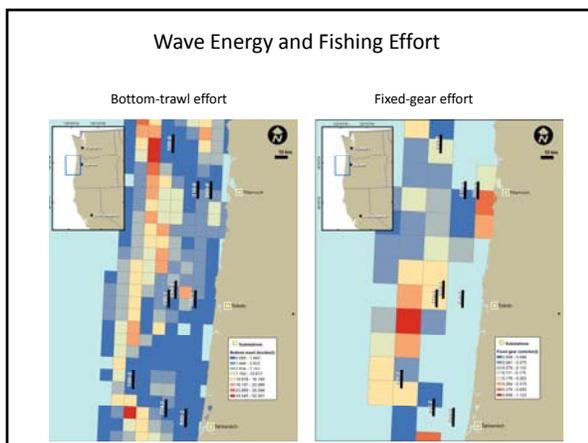
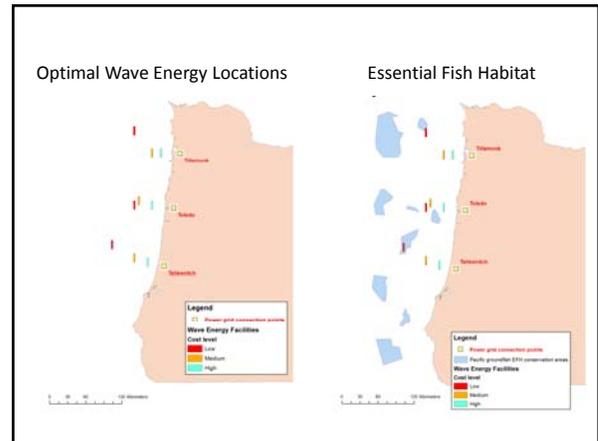
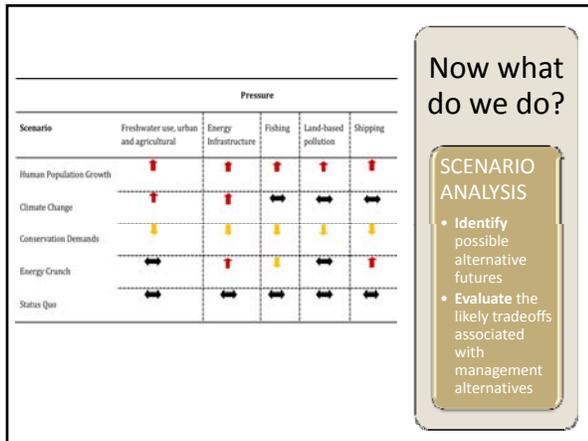
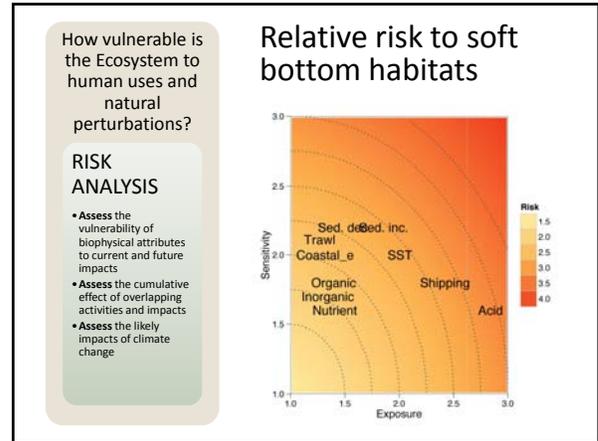
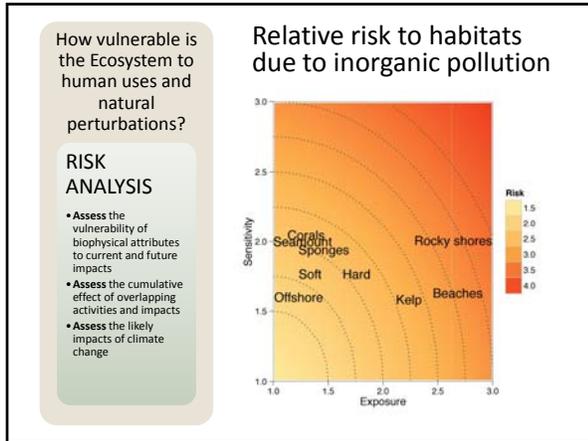
Ecosystem components	Attribute	Indicator
Protected species	Population abundance	?
Fish	Population Condition	?
Human Communities	?	?
Ecosystem Health	Ecosystem Structure	?
	Ecosystem Function	?

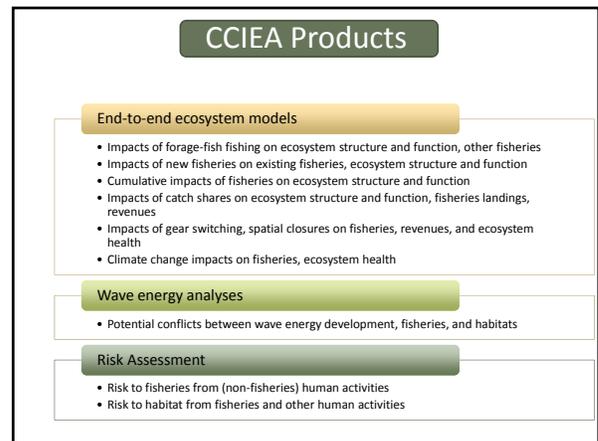
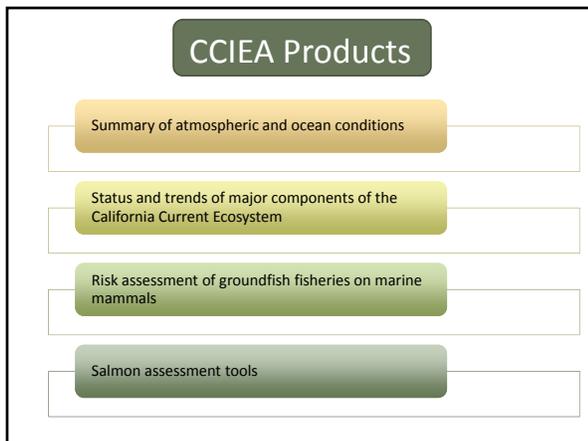
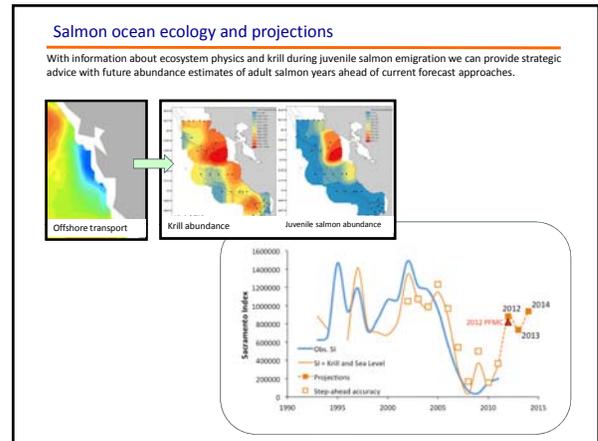
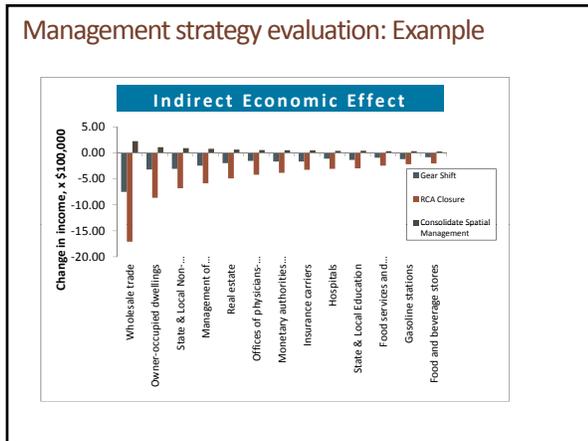
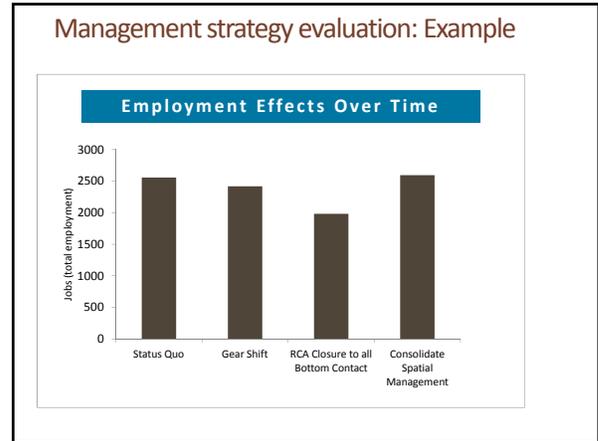
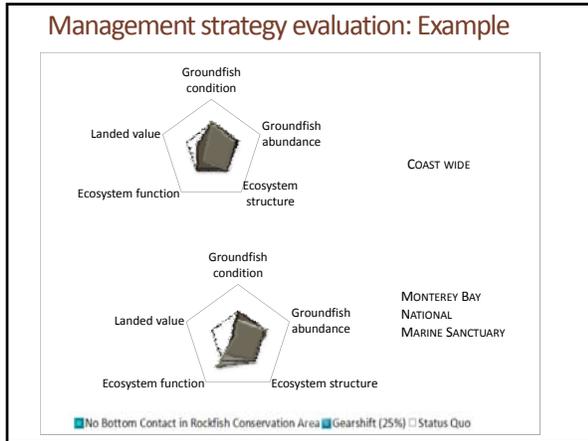
C Ecosystem diversity vs. Habitat degradation

D Mean trophic level vs. Habitat degradation

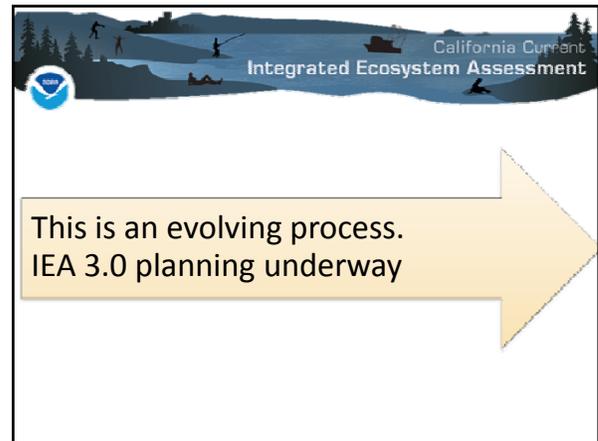
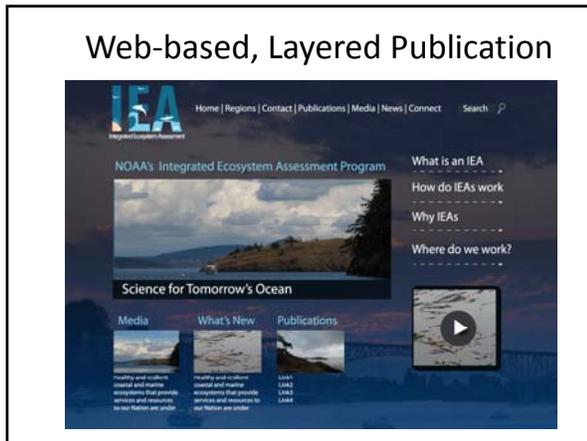








Web-based, Layered Publication



- For more info
- www.noaa.gov/iea
- Phil.Levin@noaa.gov



A draft conceptual model of Washington's coast

Chris Harvey, Kelly Andrews, and Phil Levin

Northwest Fisheries Science Center
National Marine Fisheries Service / NOAA
Seattle, WA

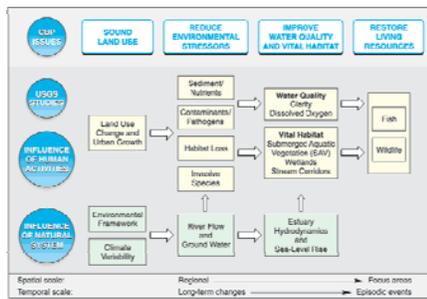
Value and purpose of conceptual models

- Provide framework for synthesizing knowledge (and gaps) of an ecosystem's key components, linkages, and functions
- Provide a means by which societal goals and objectives can be connected to management actions
- Help us to articulate research and monitoring needs that will track ecosystem responses to different drivers, including management actions
- Visually effective; valuable for stakeholder engagement

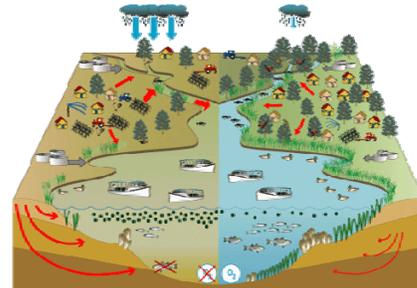
“The Committee considers the use of a conceptual framework representative of the ecosystem to be critical...Selecting restoration actions or indicators without beginning this conceptual step guarantees that key ecosystem attributes will be missed. “

—Washington State Academy of Sciences 2012, “Sound Indicators” report

Examples: conceptual models for Chesapeake Bay ecosystem



(from Phillips, 2007, USGS)



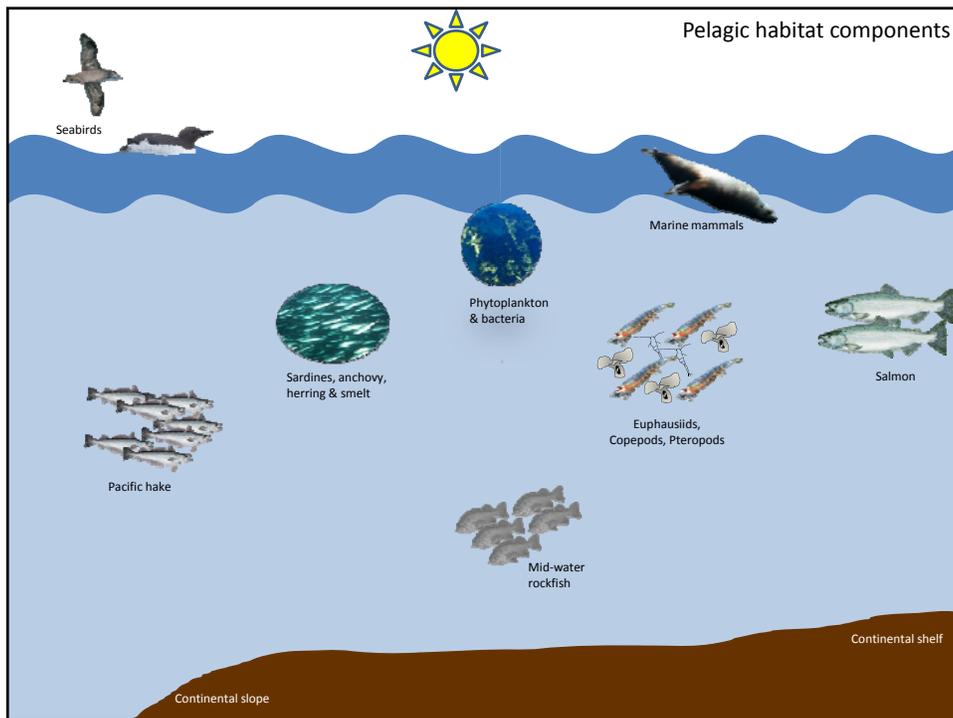
- Future management actions would:**
- Decrease sources and transport of nutrients, sediment, and contaminants
 - Decrease nutrients from atmospheric deposition
 - Decrease concentrations of nutrients from wastewater discharge
 - Increase wetlands and forest habitats
 - Control water withdrawals
 - Promote sustainable harvests of fisheries
- Result in improved ecological conditions:**
- Improved oxygen concentrations
 - Lower algal biomass and improved water clarity
 - Increased submerged aquatic vegetation
 - Sustainable water availability
 - Improved fishery and bird populations

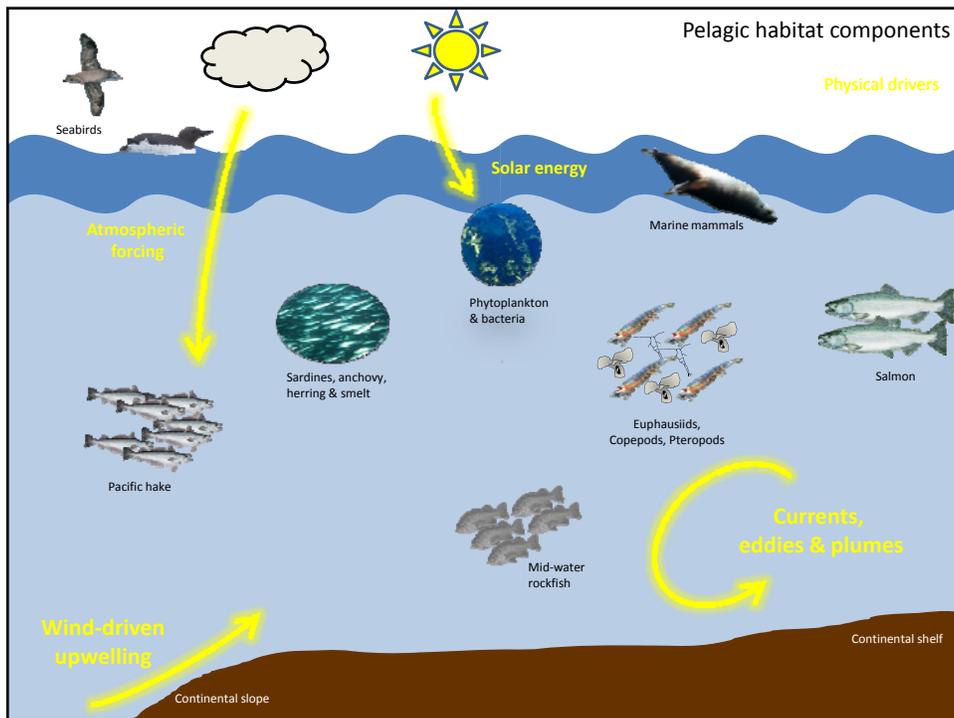
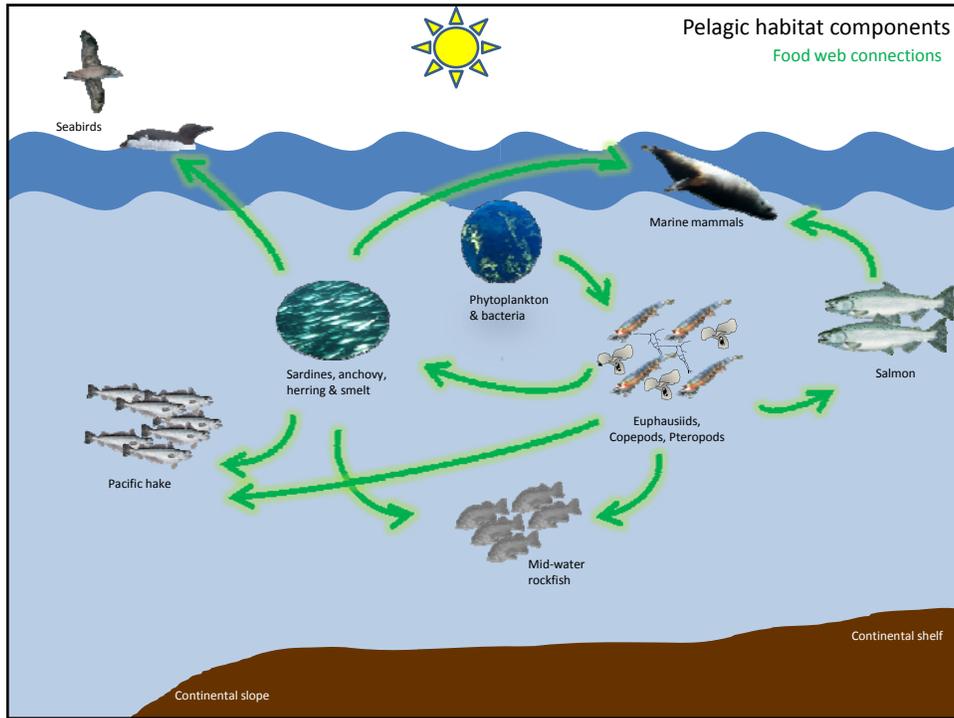
(from Phillips, 2005, USGS)

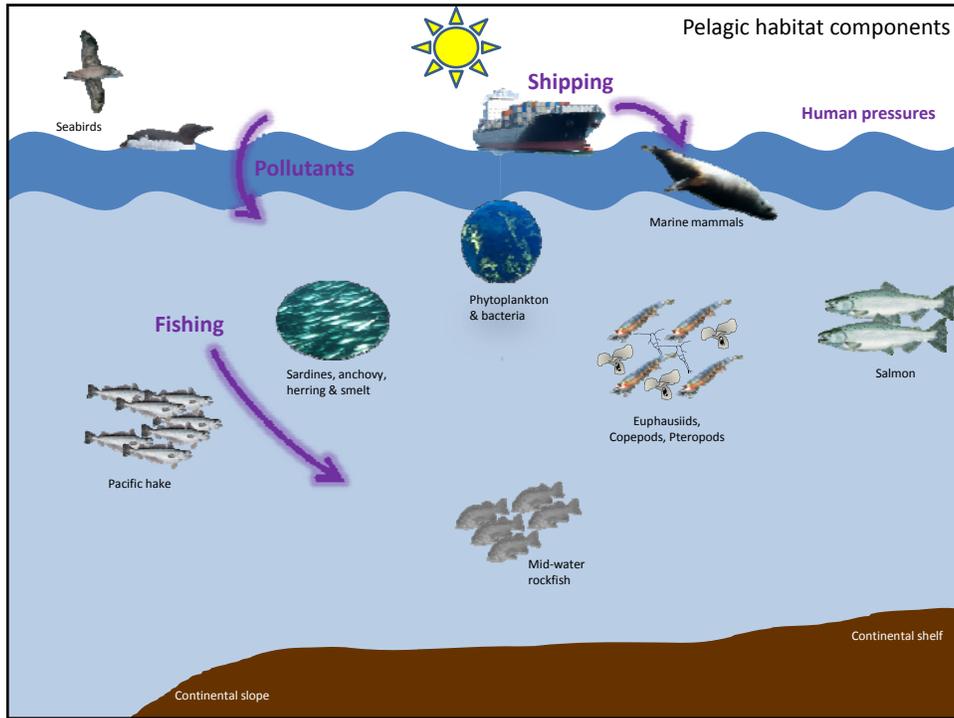
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- Rocky shores
- Sand / gravel beaches

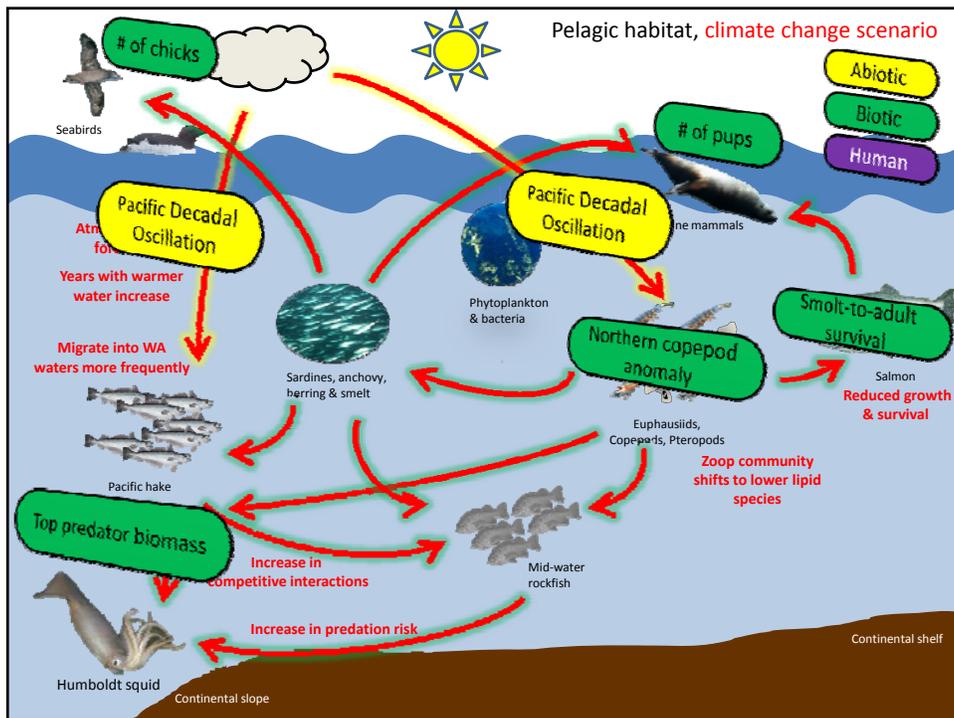
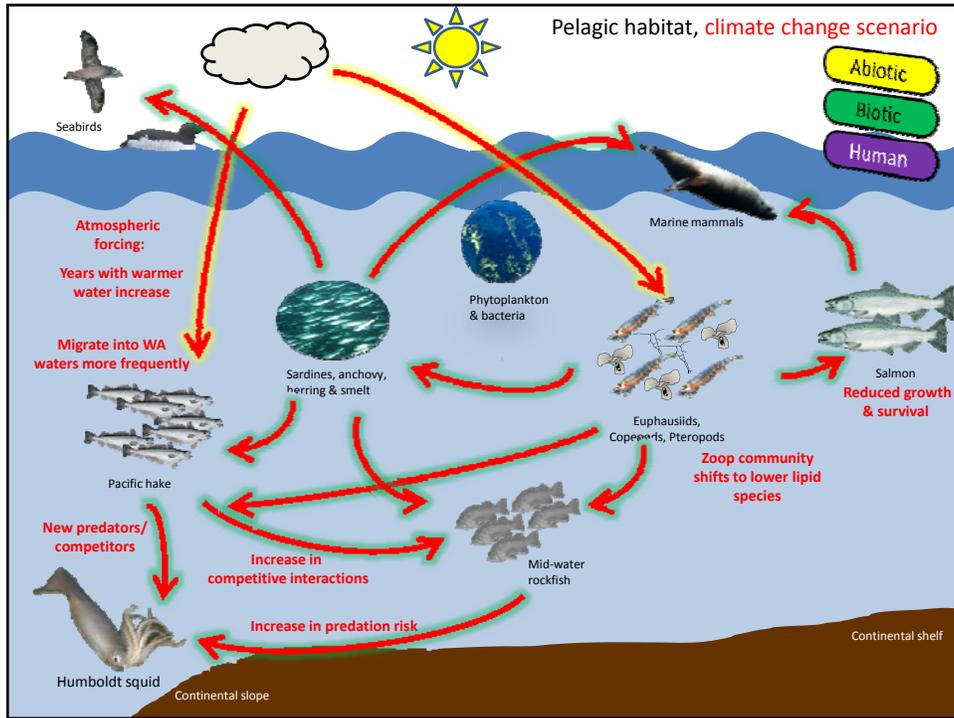
Pelagic habitat



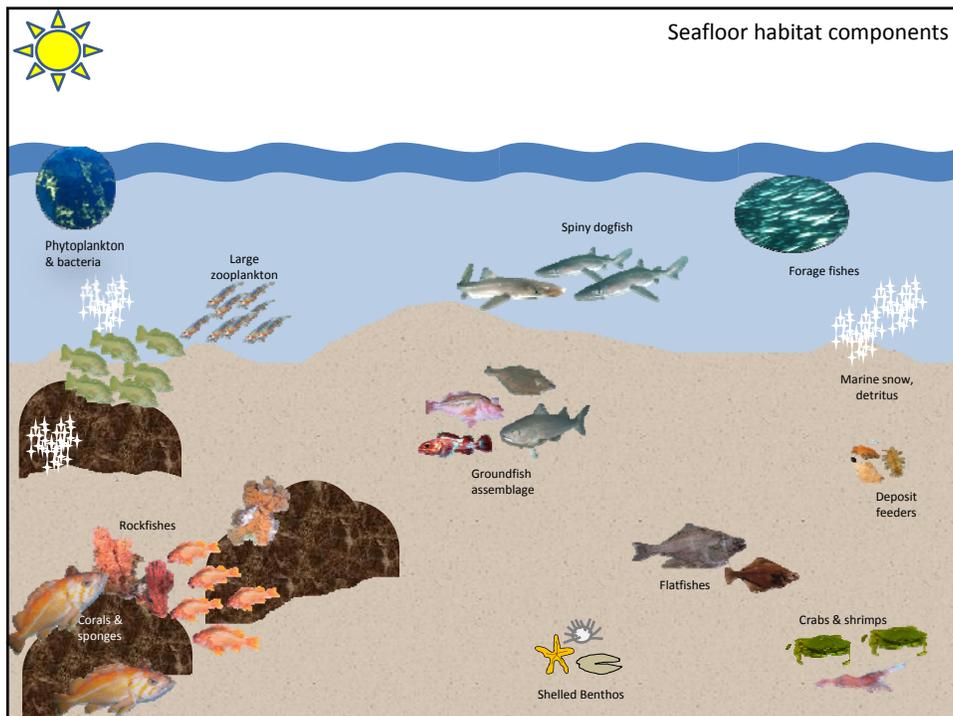


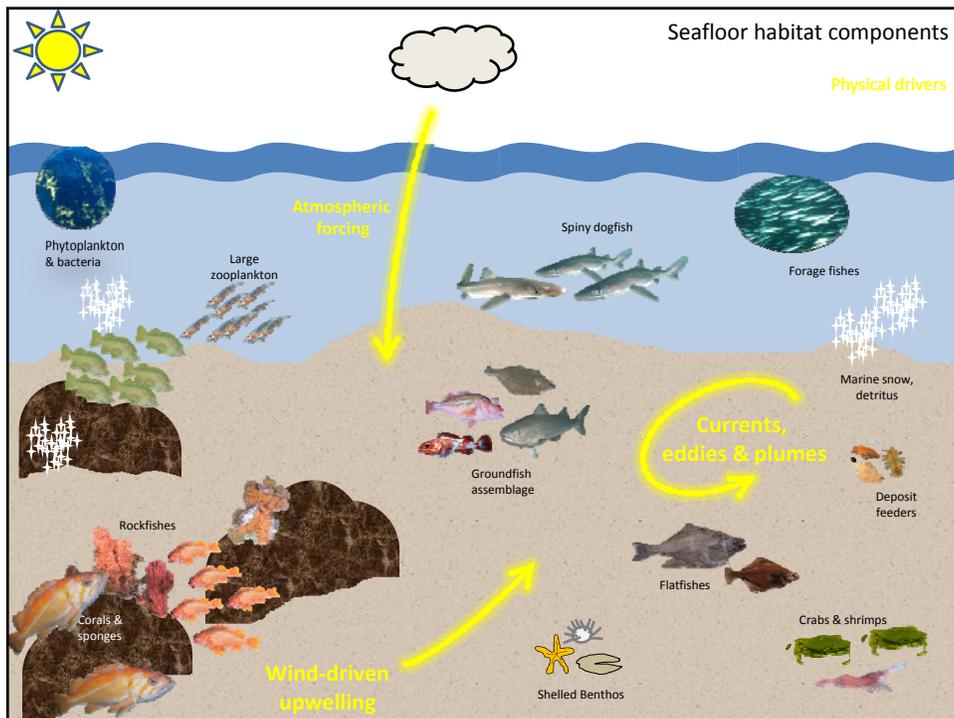
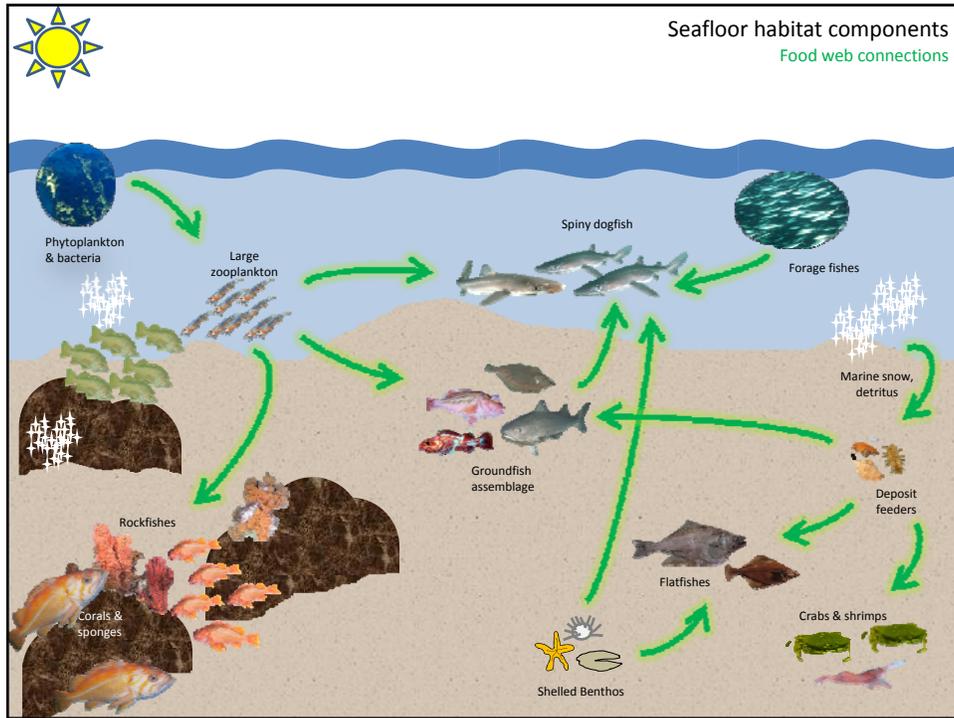


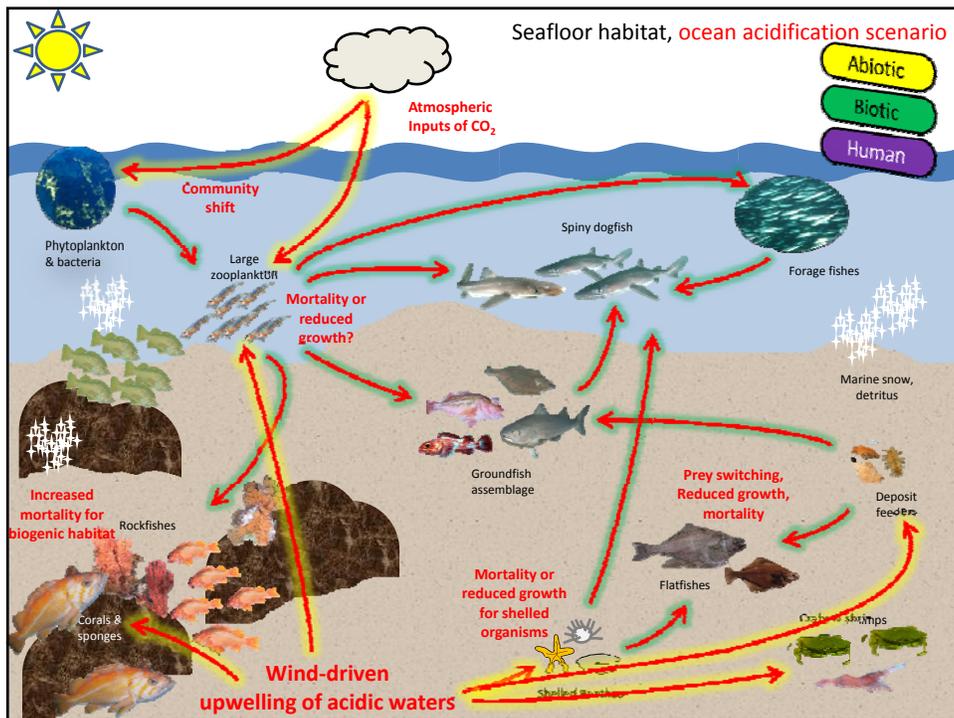
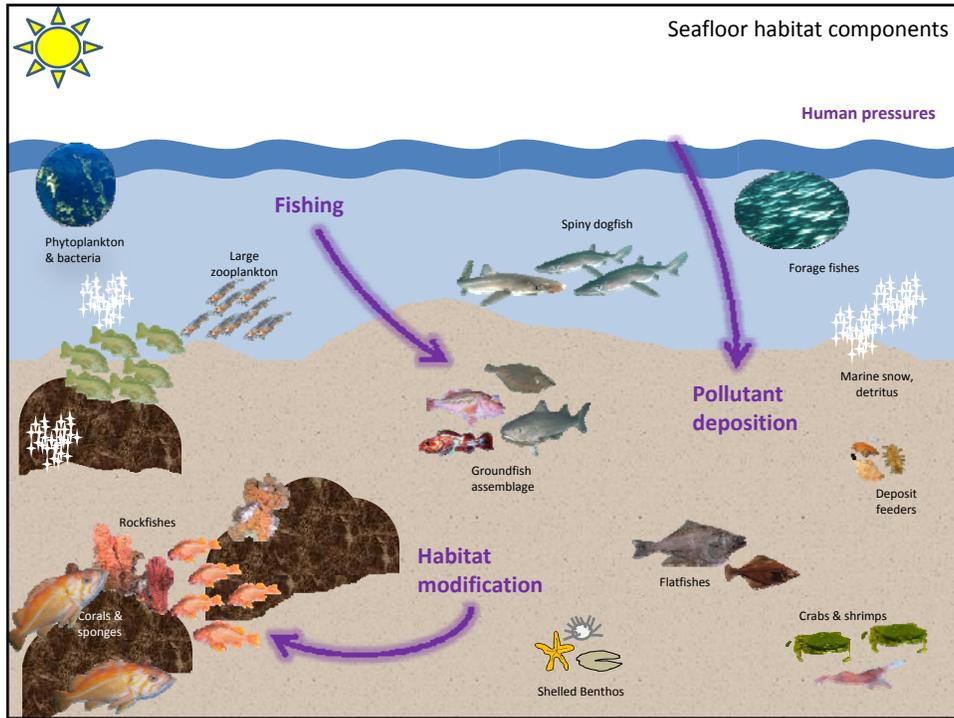
“Mapping” prospective indicators

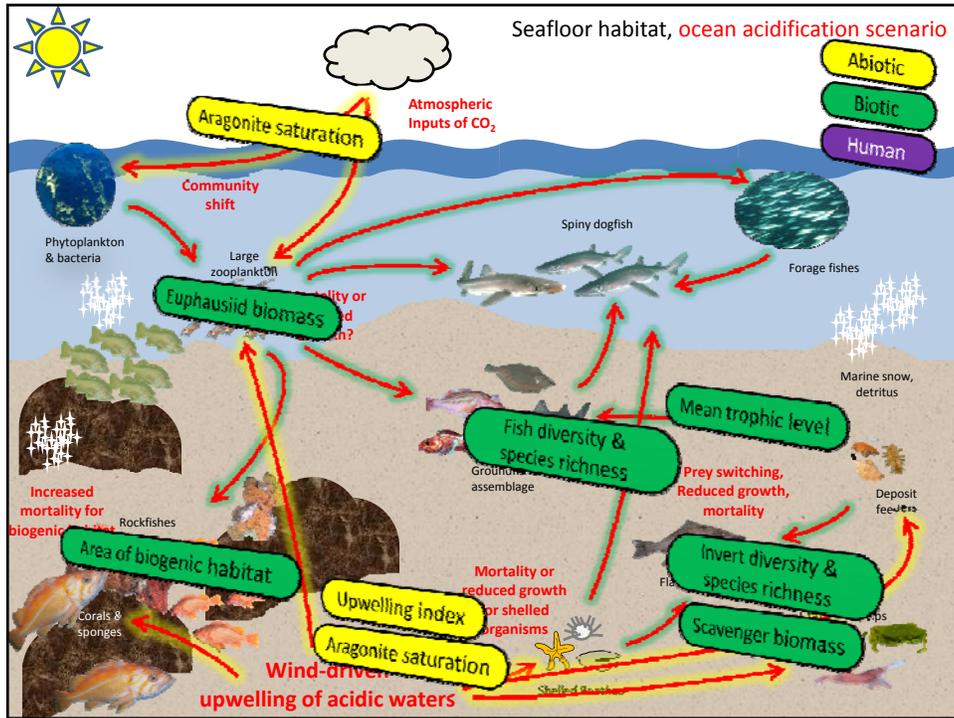


Seafloor habitat

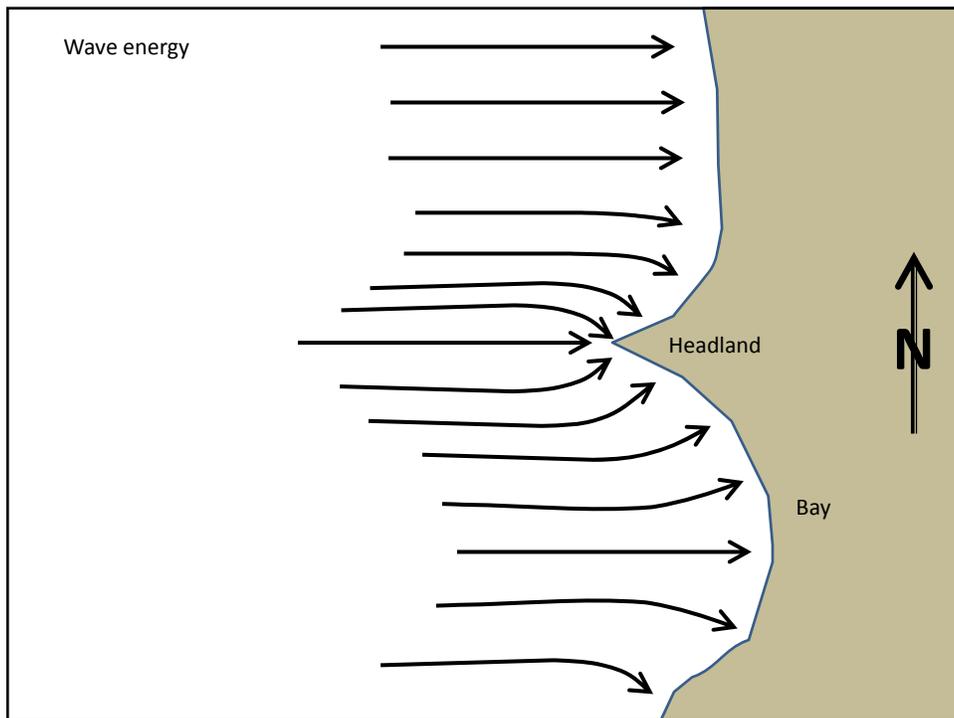
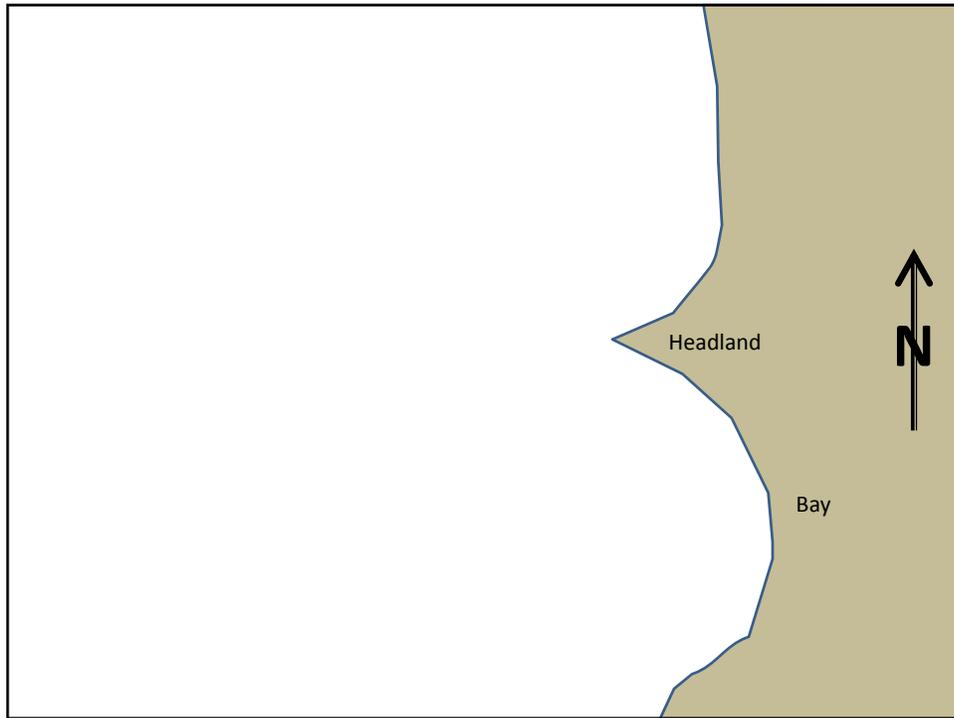


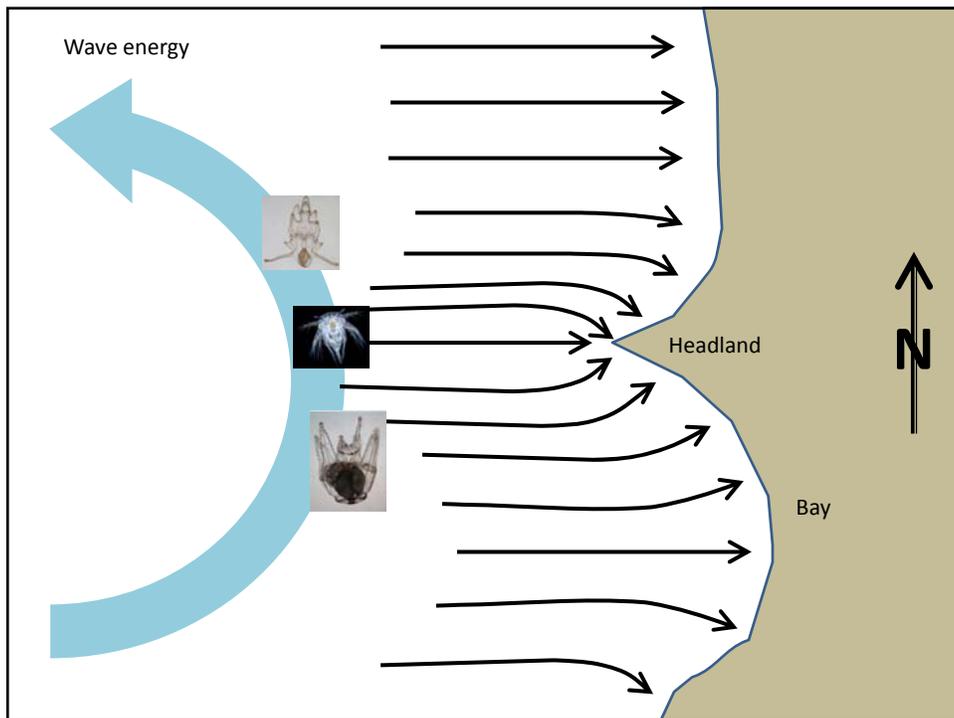
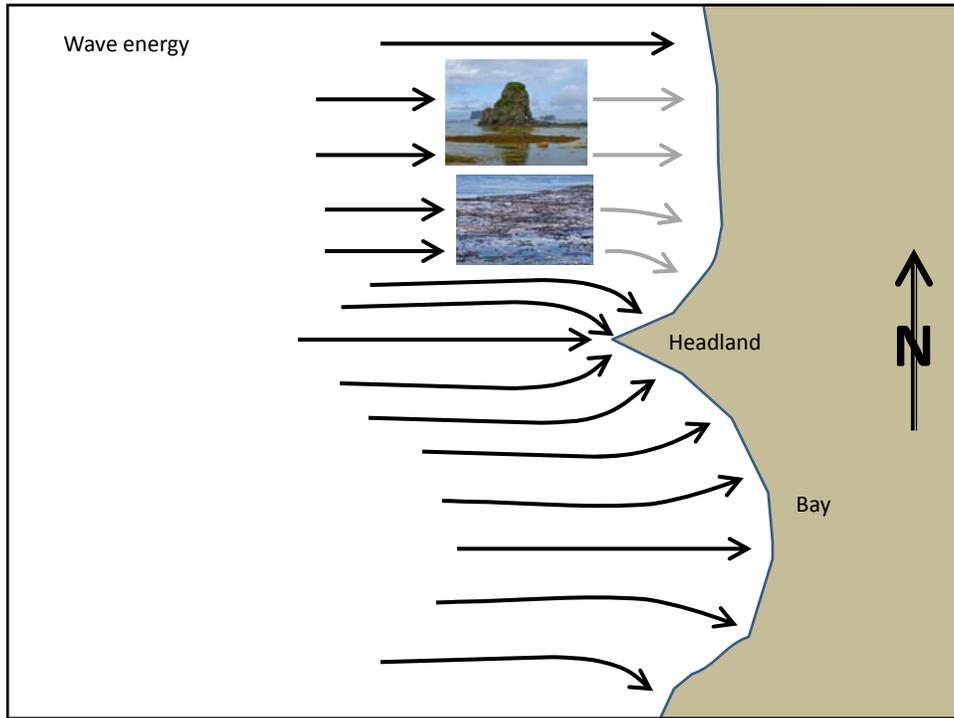


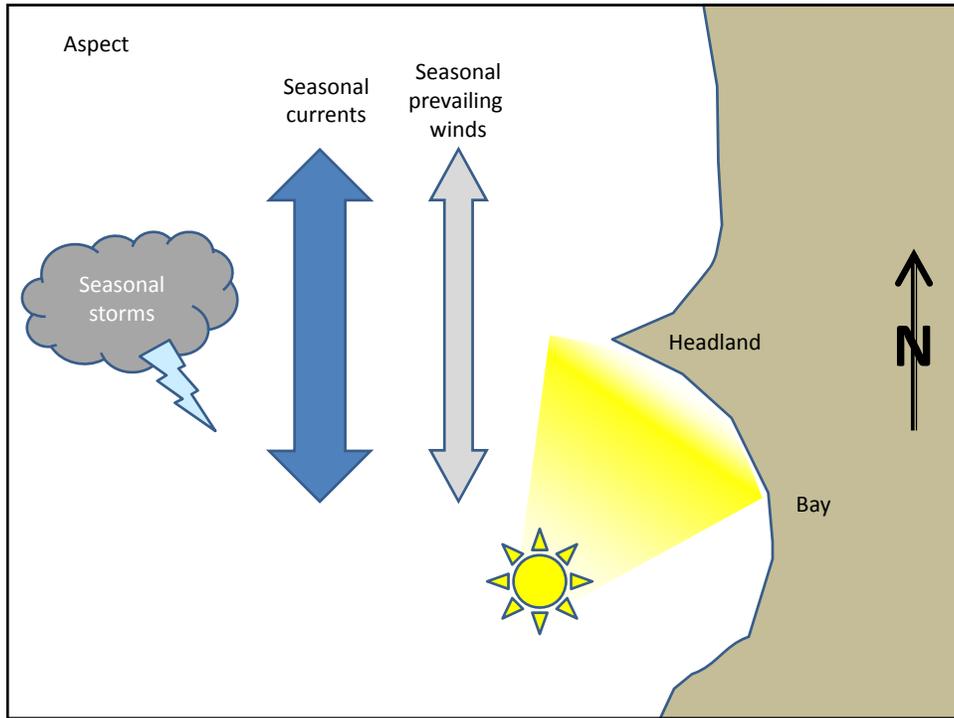




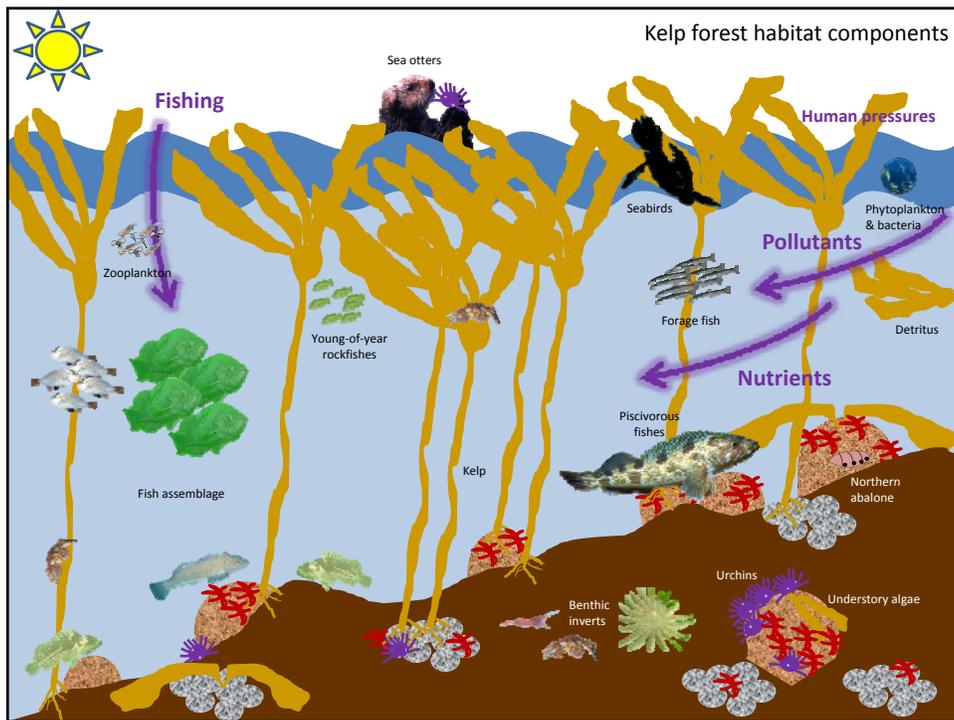
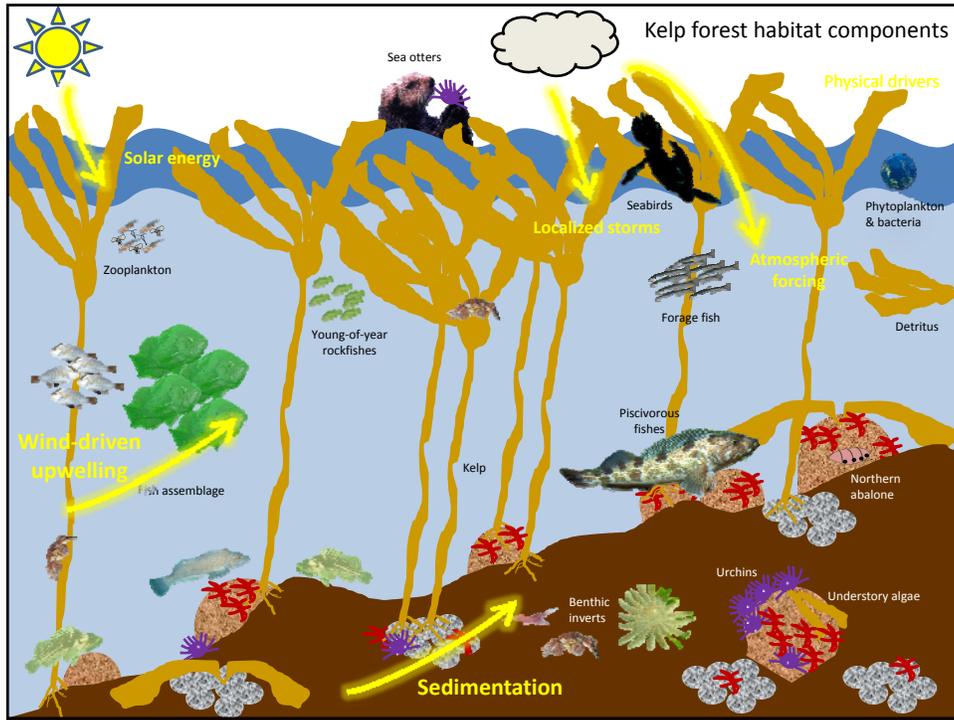
Coastal habitats

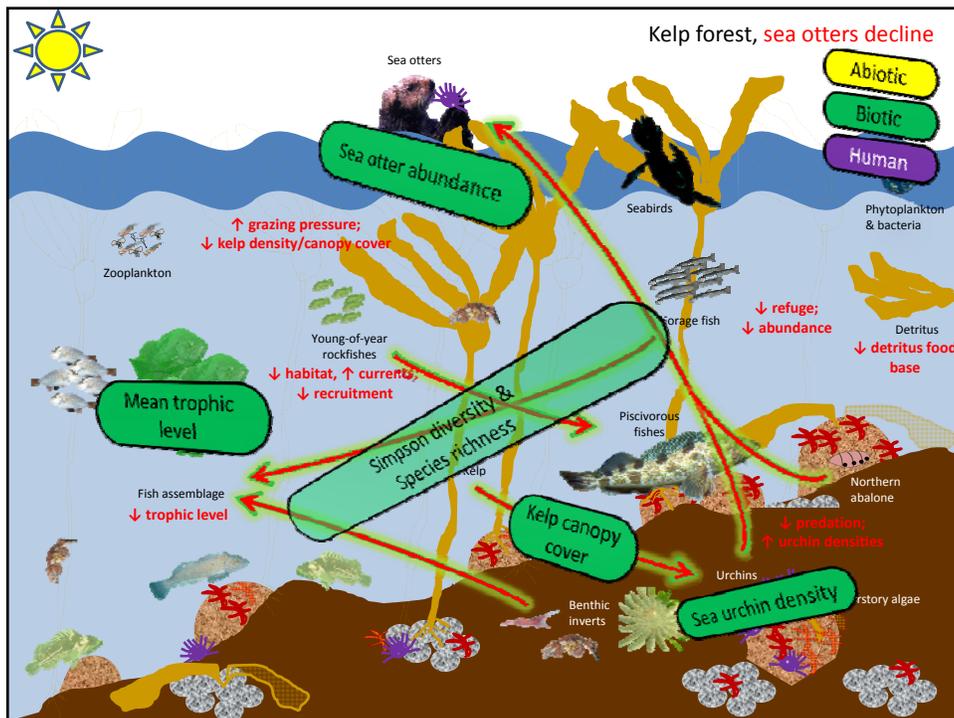
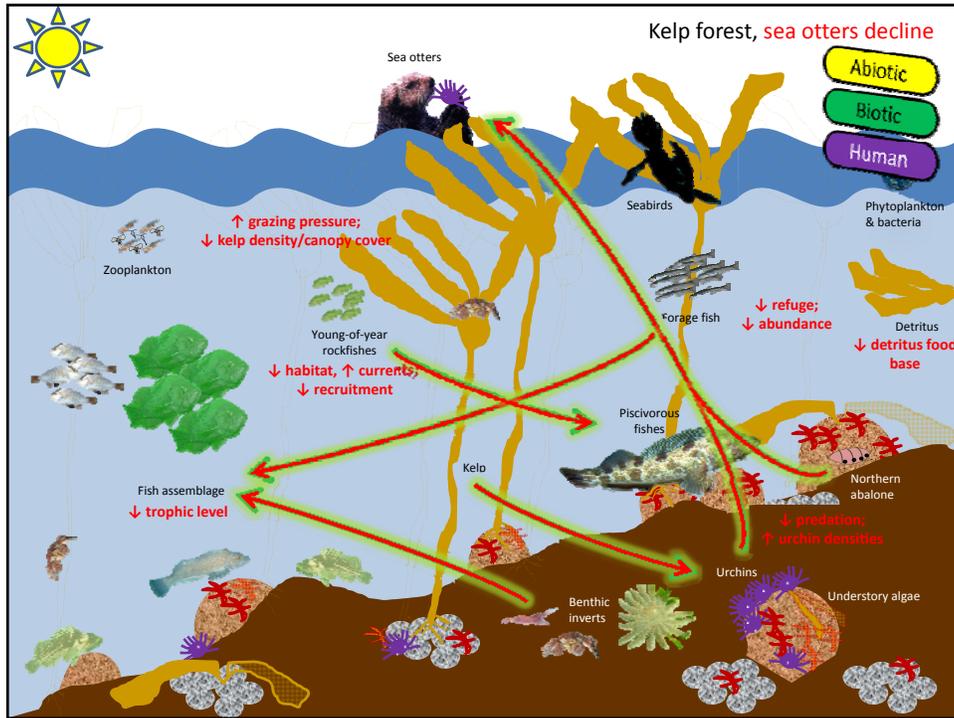




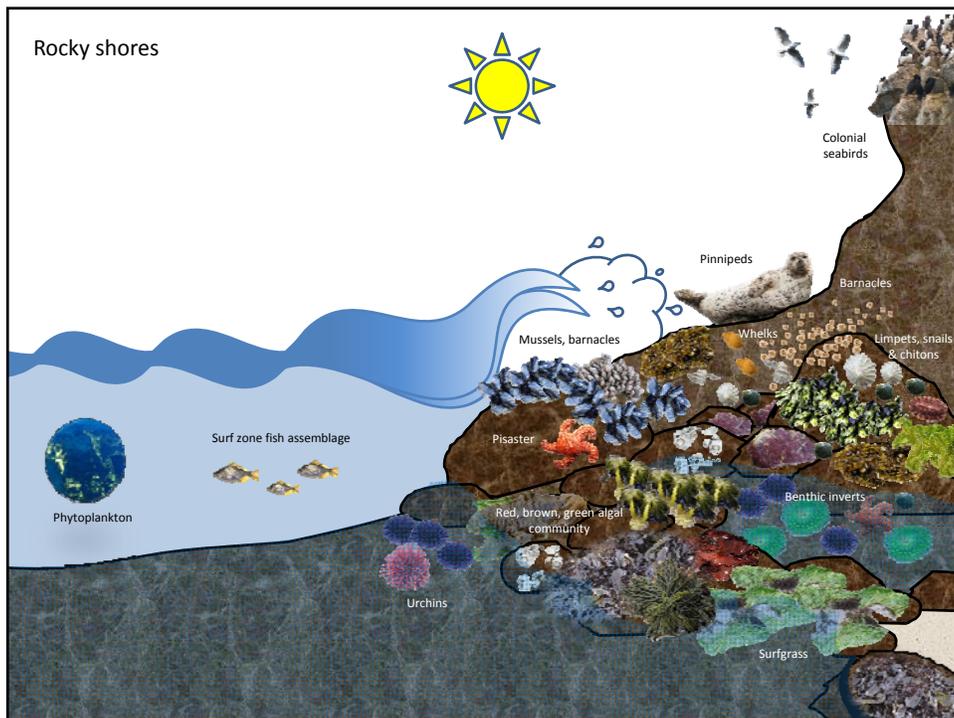


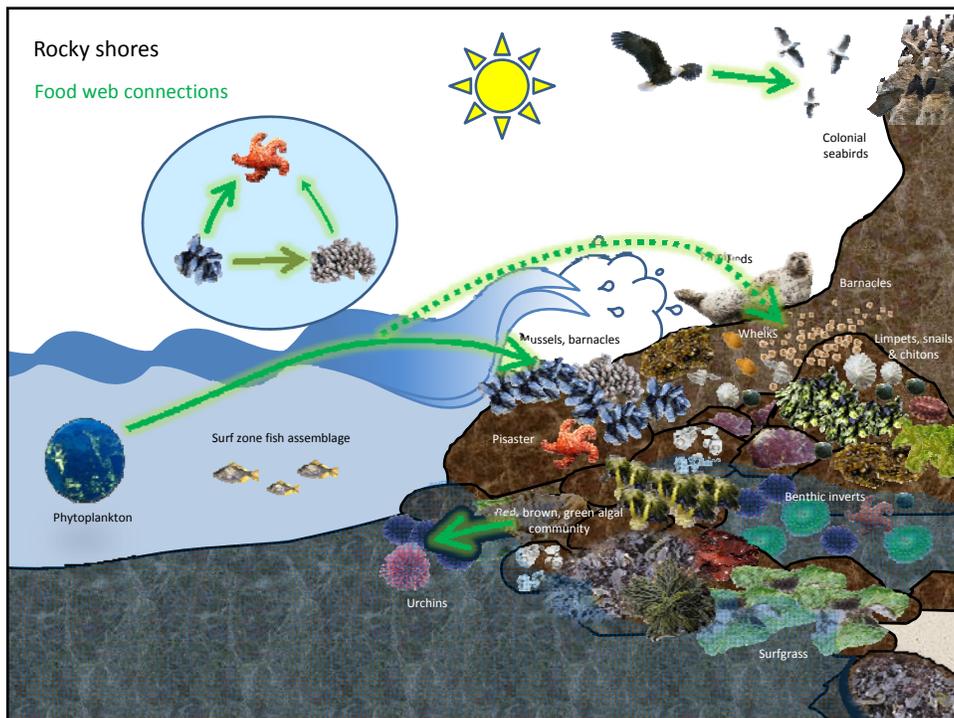
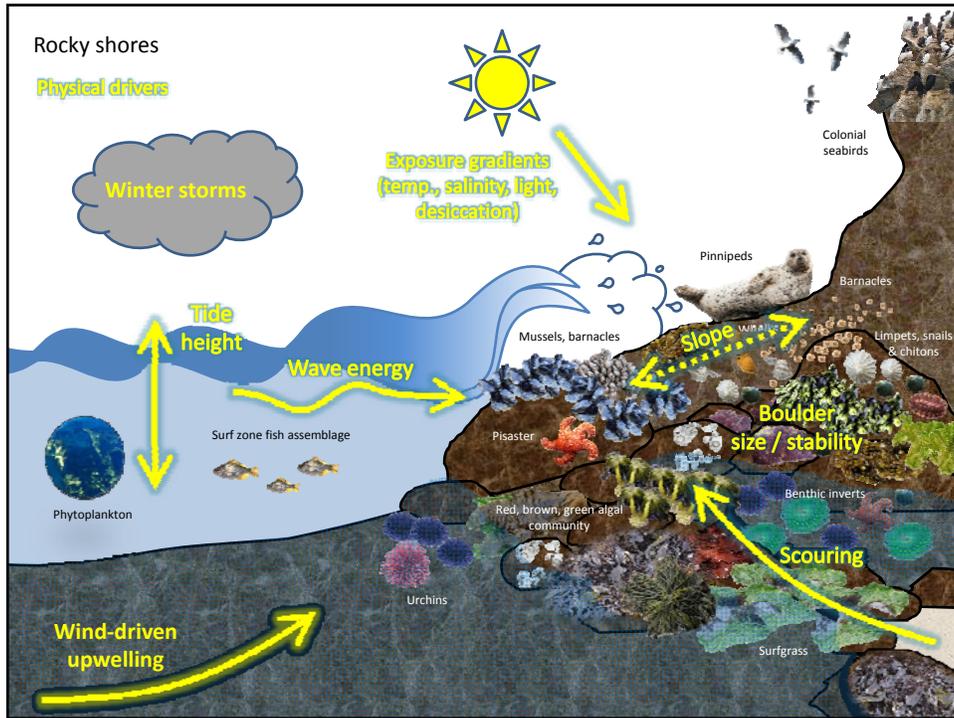
Kelp forest habitat

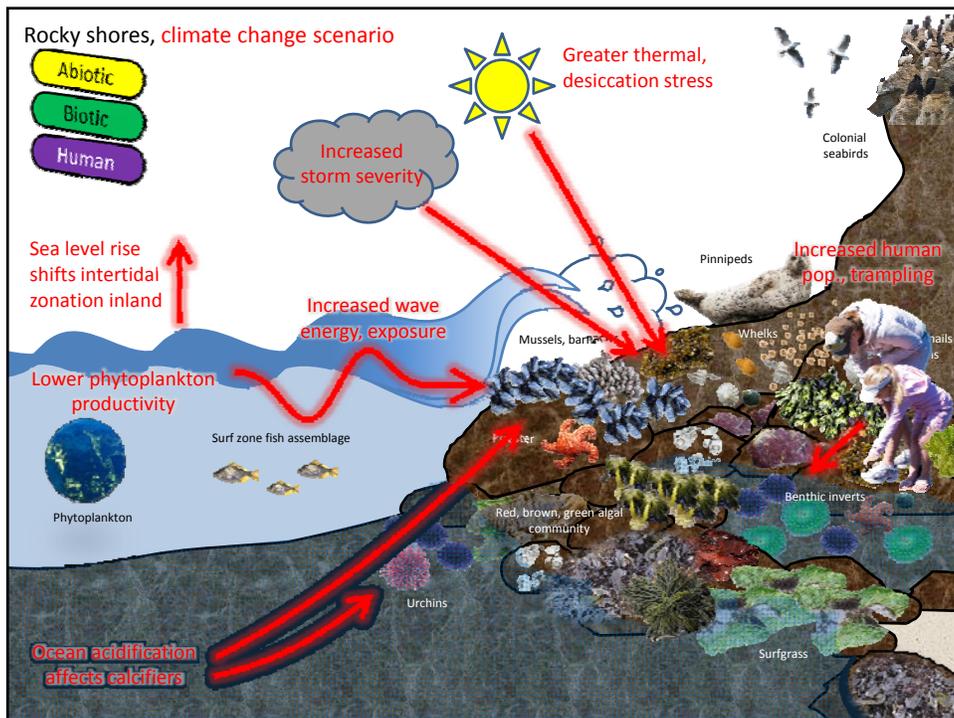
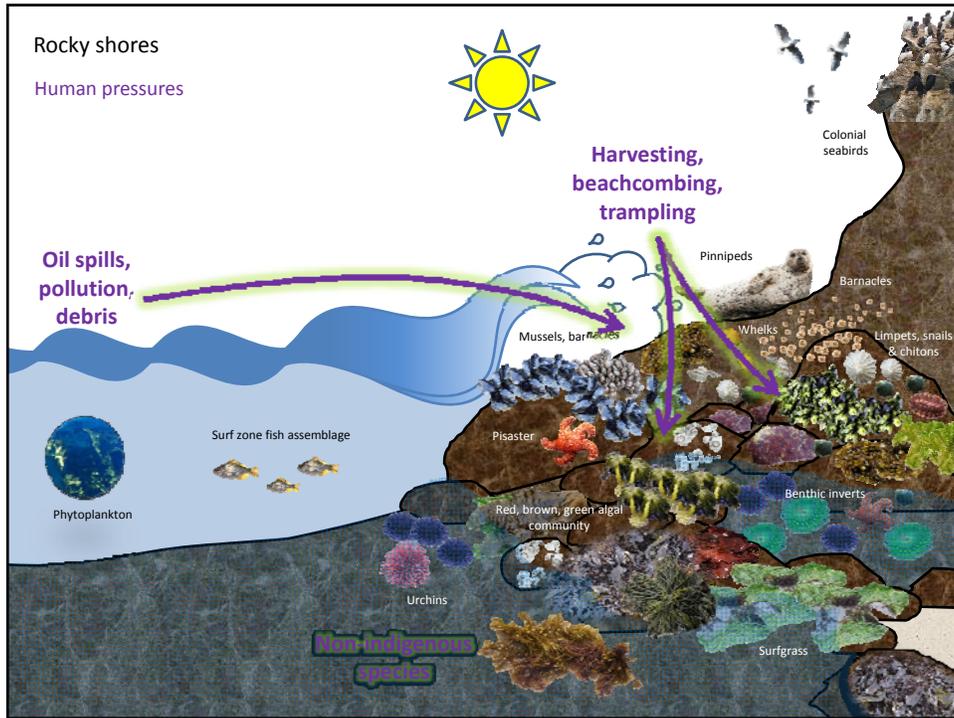


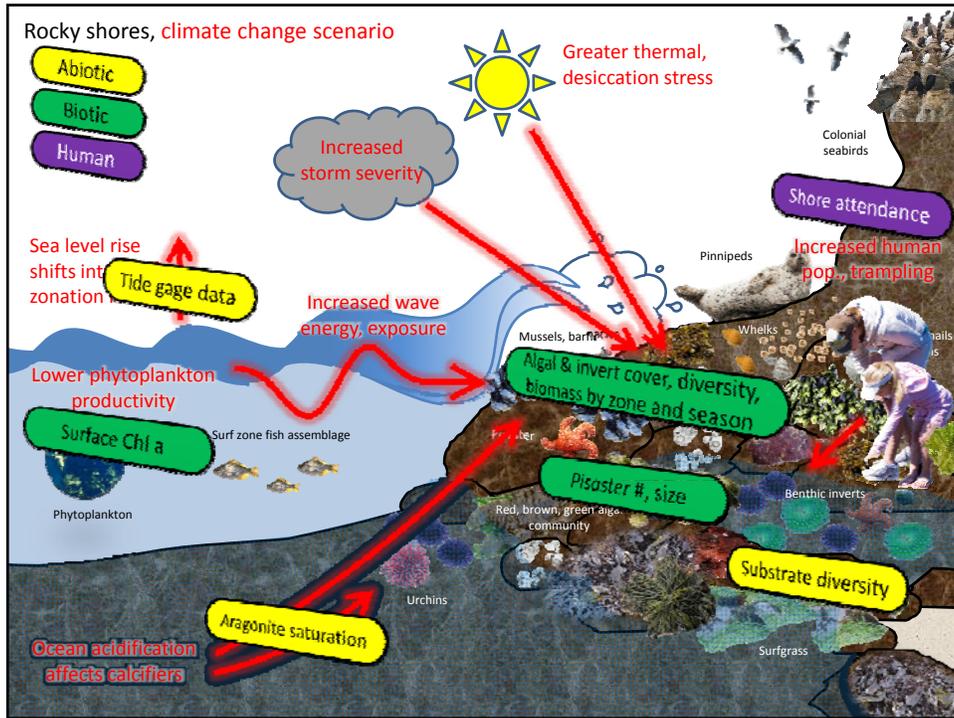


Rocky shore habitats

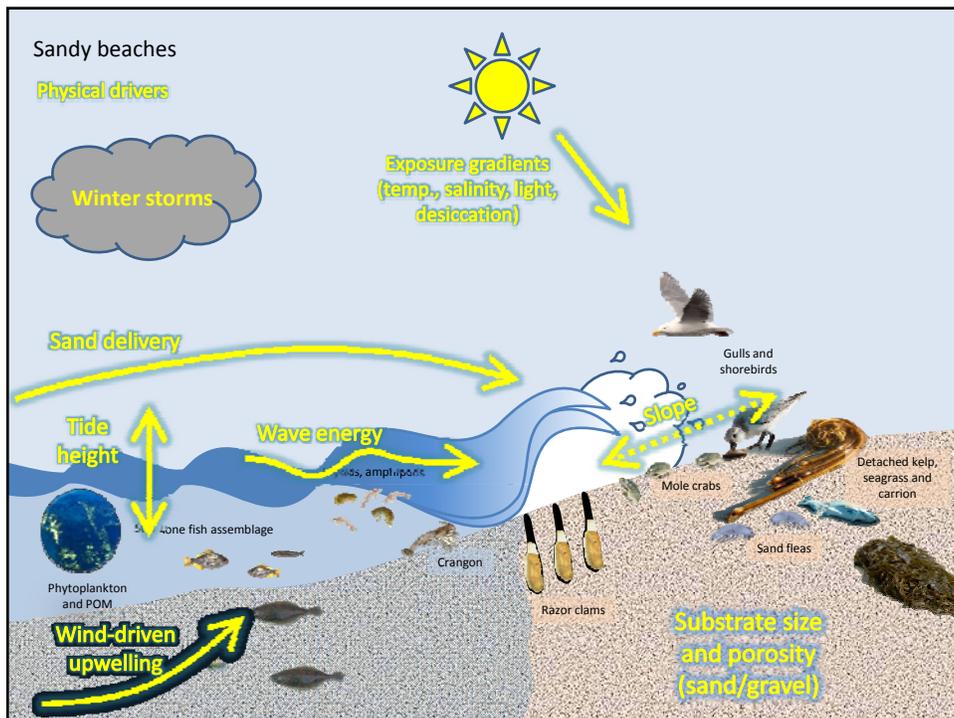
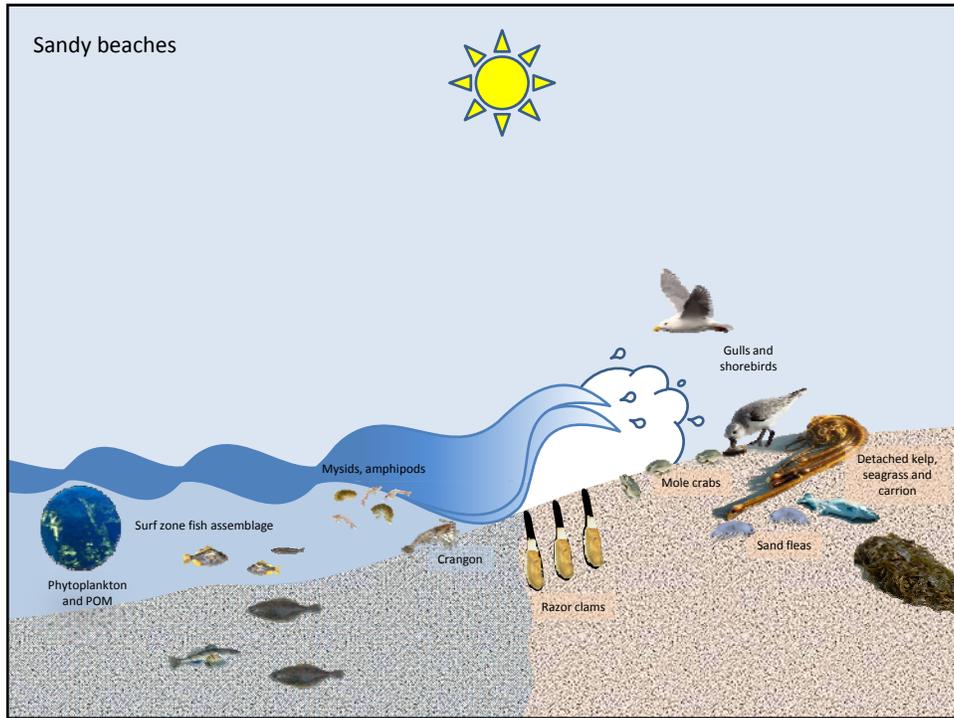


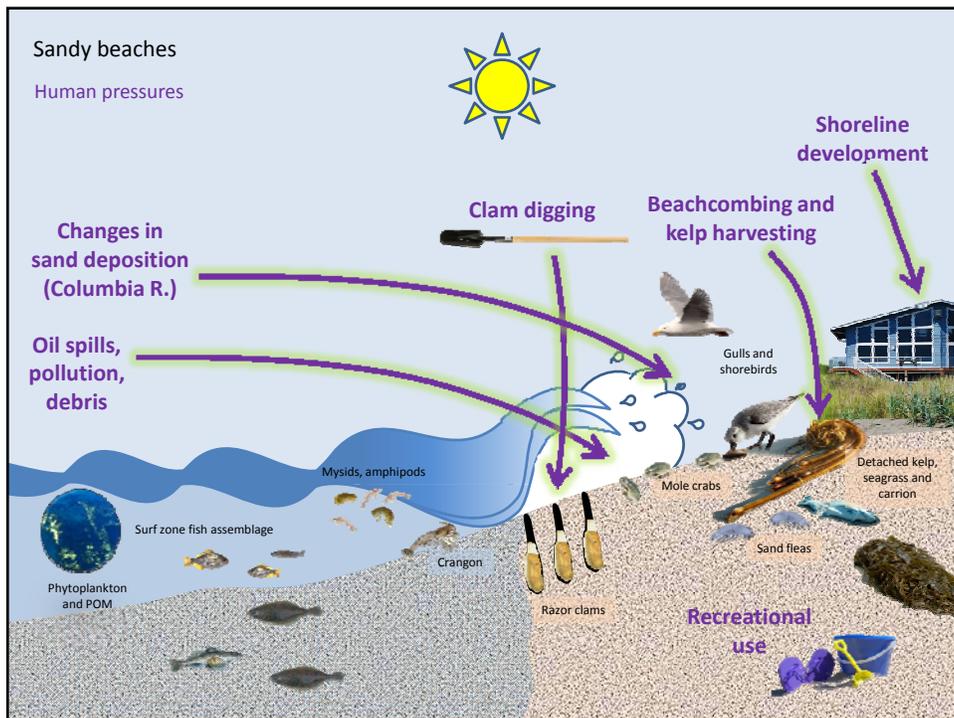
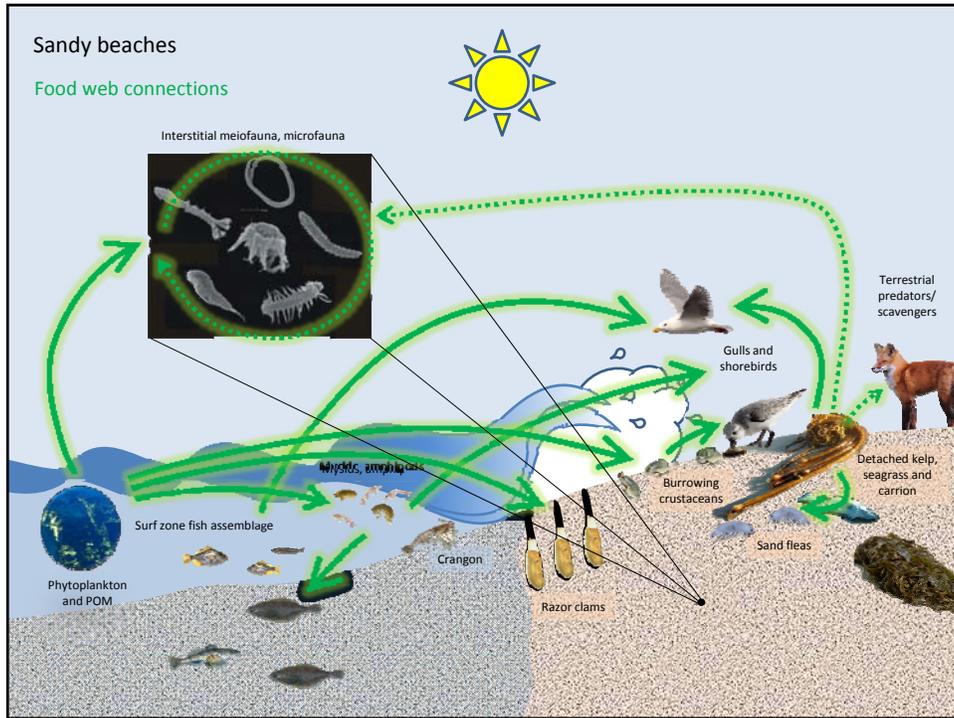


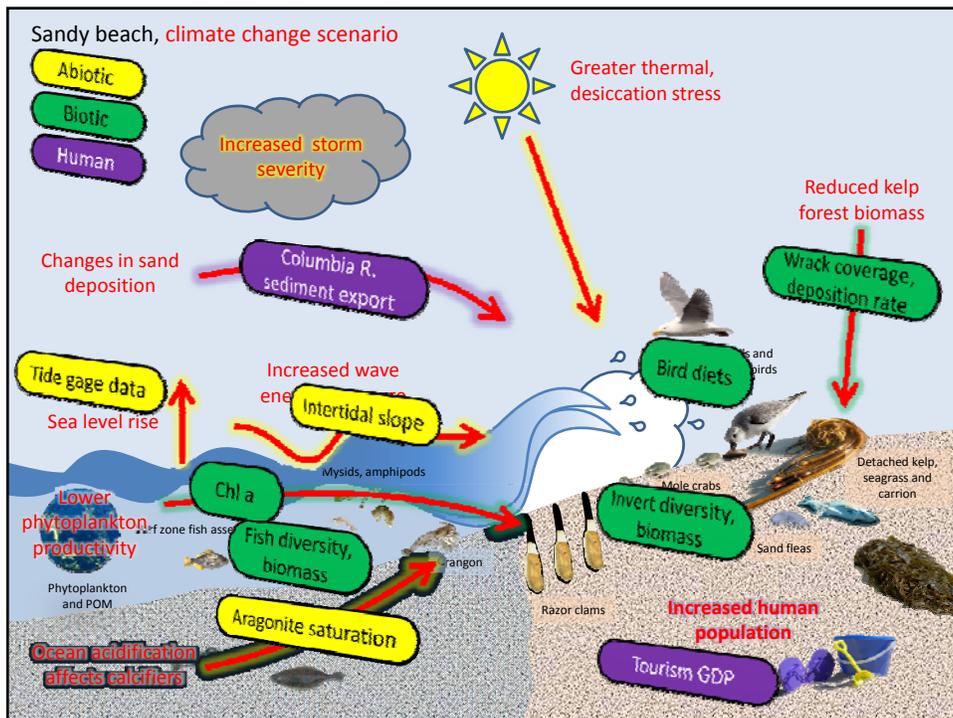
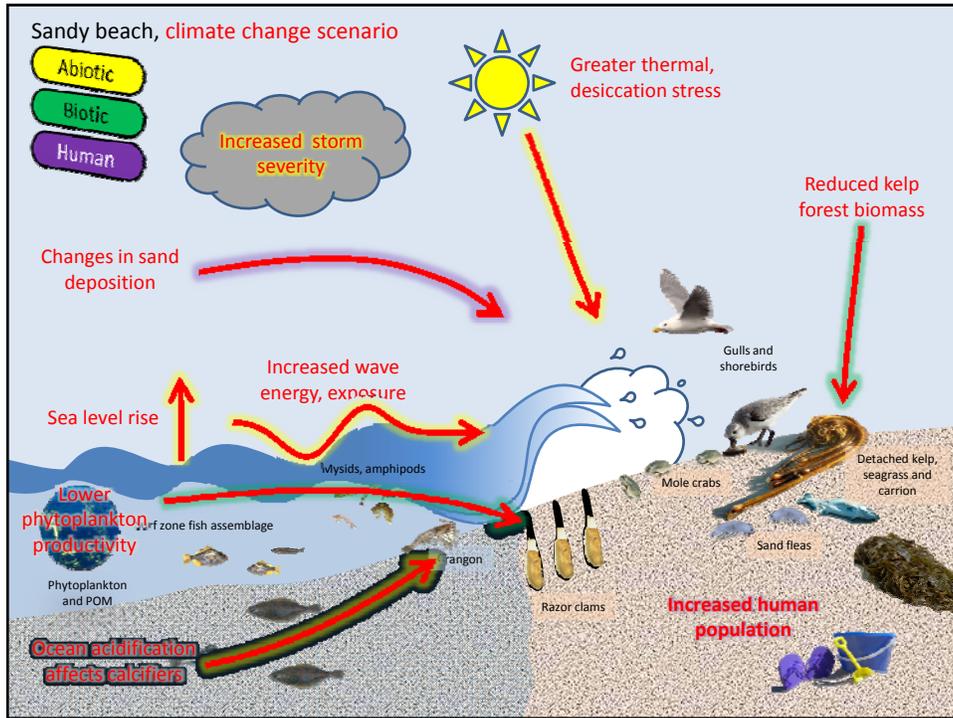




Sand/gravel beach habitats

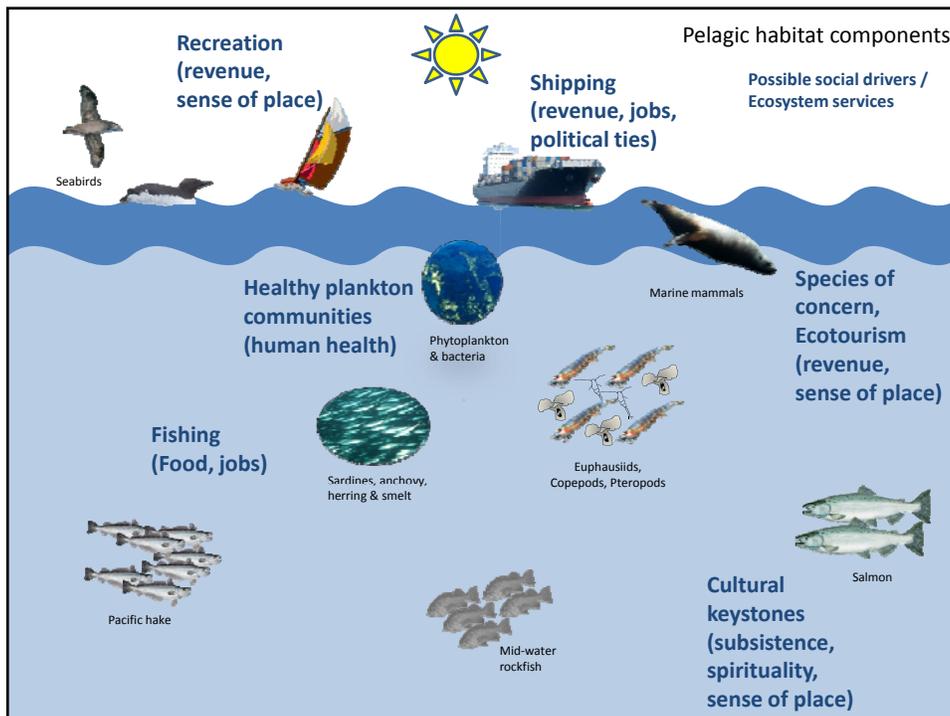






Draft conceptual models for the Washington Outer Coast:

- Pelagic habitat (shelf/slope)
 - Seafloor habitat (shelf/slope)
 - Kelp forests
 - Rocky shores
 - Sand / gravel beaches
-
- Coastal estuaries not done due to time constraints
 - We haven't integrated across habitats to the extent that we probably should have
 - Social/economic drivers and attributes not included



Thanks!

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Potential indicators for pelagic habitats

Structural Element	Key Attribute	Indicator	Potential metrics	
Ecological components	Community composition	Diversity	Simpson diversity & Species richness (coastal pelagics, zooplankton, seabirds)	
		Mean trophic level	Mid-water/surface species	
		Northern copepod anomaly	Anomalies in the relative biomass of copepods with cold-water affinities	
		Top predator biomass	Biomass of individuals with trophic level > 4.0	
		Pinniped and seabird reproductive performance	Annualized # of pups/chicks	
	Energetics & material flows	Productivity	Remotely-sensed Chlorophyll a concentrations	
		Nutrient cycling	Dissolved nitrogen/phosphate concentrations	
		Carbon cycling	Number of cycles	
	Physical drivers	Ocean conditions	Sea surface temperature	Pacific Decadal Oscillation (PDO)
			Upwelling	Spring Transition Index (STI)
Biogeochemistry		Oxygen concentrations	Dissolved oxygen levels	
		Ocean acidification	Aragonite saturation state	
Human pressures	Extractions	Fishery/gathering removals	Commercial/recreational landings	
	Shipping activity	Areas disturbed	Spatial distribution/tracks of vessels.	
	Pollution	Pollutant concentrations	Heavy metals, inorganic/organic pollutants, nutrients	

Potential indicators for seafloor habitats

Structural Element	Key Attribute	Indicator	Potential metrics
Habitat	Extent of habitat	Hard or mixed habitat	Areal coverage of hard or mixed habitat
		Biogenic habitat	Areal coverage of structure-forming invertebrates
Ecological components	Community composition	Diversity	Simpson diversity & Species richness (fish and inverts)
		Mean trophic level	Fish and invertebrates in bottom trawl survey
		Scavenger biomass	Biomass of scavengers (e.g., crabs, deposit feeders)
	Energetics & material flows	Top predator biomass	Biomass of individuals with trophic level > 4.0
		Productivity	Density/biomass of euphausiids
		Nutrient cycling	Dissolved nitrogen/phosphate concentrations
Physical drivers	Ocean conditions	Carbon cycling	Number of cycles
		Sea surface temperature	Pacific Decadal Oscillation (PDO)
	Upwelling	Spring Transition Index (STI)	
	Biogeochemistry	Oxygen concentration	Dissolved oxygen levels
		Ocean acidification	Aragonite saturation state
Human pressures	Biological extractions	Fishery/gathering removals	Commercial/recreational landings
	Habitat modification	Area disturbed	Area/distance disturbed by fishing gear, cable laying, and other benthic structures.
	Pollution	Pollutant concentrations	Heavy metals, inorganic/organic pollutants, nutrient runoff

Potential indicators for kelp forest habitats

Structural Element	Key Attribute	Indicator	Potential metrics
Habitat	Extent of habitat	Kelp forest cover	Areal extent of surface canopy
Ecological components	Community composition	Diversity	Simpson diversity & Species richness (fish and inverts)
		Mean trophic level	Fish and invertebrates in scuba surveys
		Scavenger biomass	Biomass of scavengers (e.g., crabs, deposit feeders)
		Top predator biomass	Biomass of individuals with trophic level > 4.0
	Energetics & material flows	Productivity	Kelp forest cover, Chlorophyll a concentration
		Nutrient cycling	Dissolved nitrogen/phosphate concentrations
		Carbon cycling	Number of cycles
	Focal species	Sea otter size & condition	Abundance and age structure
Sea urchin size & condition		Density and size structure	
Physical drivers	Ocean conditions	Sea surface temperature	Pacific Decadal Oscillation (PDO)
		Upwelling	Upwelling Index (UI)
		El Niño events	Northern Oscillation Index (NOI)
		Localized storms	Maximum wave height
	Biogeochemistry	Oxygen concentrations	Dissolved oxygen levels
		Ocean acidification	Aragonite saturation state
		Sedimentation	Sediment transport
Human pressures	Extractions	Fishery removals	Commercial/recreational landings
	Pollution	Pollutant concentrations	Heavy metals, inorganic/organic pollutants, nutrients

Potential indicators for rocky shore

Structural Element	Key Attribute	Indicator	Potential metrics
Habitat	Extent of habitat	Plant/algal cover	Areal extent of algae and surfgrass
		Habitat-forming inverts	Areal extent of mussels (spring, fall)
	Habitat composition	Substrate type	Diversity of substrate particle size
Ecological components	Community composition	Diversity	Simpson diversity & Species richness (algae, inverts)
		Mean trophic level	Benthic invertebrate density and stable isotope ratios
		Herbivore biomass	Biomass of grazers (spring, fall)
	Energetics & material flows	Suspension feeder biomass	Biomass of filter feeders (spring, fall)
		Productivity	Surface Chlorophyll a
		Nutrient cycling	Dissolved nitrogen/phosphate concentrations
Focal species	<i>Pisaster ochraceus</i>	Carbon cycling	Number of cycles
		Abundance & size structure (spring, fall)	
Physical drivers	Ocean conditions	Sea surface temperature	Pacific Decadal Oscillation (PDO)
		Upwelling	Upwelling Index (UI)
		Sea surface height	Tidal gage data
	Biogeochemistry	Ocean acidification	Aragonite saturation state
	Climate conditions	Exposure stress	Biomass of filter feeders (spring, fall)
Human pressures	Habitat alteration	Trampling	Shore attendance / visitation
	Pollution	Pollutant concentrations	Heavy metals, inorganic/organic pollutants, nutrients

Potential indicators for sandy beaches

Structural Element	Key Attribute	Indicator	Potential metrics
Habitat	Extent of habitat	Plant/algal cover	Areal extent of wrack line
	Habitat composition	Substrate type	Diversity of substrate particle size (sand, gravel)
Ecological components	Community composition	Diversity	Simpson diversity & Species richness (inverts and fish)
		Suspension feeder biomass	Biomass of razor clams
		Scavenger biomass	Biomass of scavengers (e.g., sand fleas, crabs, deposit feeders)
	Seabirds	Seabird and shorebird diet	
Energetics & material flows		Productivity	Surface Chlorophyll a, Wrack deposition rate
		Nutrient cycling	Dissolved nitrogen/phosphate concentrations
		Carbon cycling	Number of cycles
Physical drivers	Ocean conditions	Sea surface temperature	Pacific Decadal Oscillation (PDO)
		Upwelling	Upwelling Index (UI)
		Sea surface height	Tidal gage data
	Wave energy	Slope of intertidal zone	
Biogeochemistry	Ocean acidification	Aragonite saturation state	
Human pressures	Extractions	Fishery/harvest removals	Removals of razor clams, kelp
	Pollution	Pollutant concentrations	Heavy metals, inorganic/organic pollutants, nutrient runoff
	Sedimentation	Sediment (sand) input	Columbia River seasonal sediment export
	Tourism	Tourism revenue	GDP of tourism and recreation

Selection and Evaluation of Potential Ecological Indicators



Kelly S. Andrews, Chris J. Harvey, Phil S. Levin
Northwest Fisheries Science Center, Seattle, WA

You've seen...

- Marine Spatial Planning and Integrated Ecosystem Assessment process
- Conceptual models
 - What are the main components, drivers, and pressures necessary to represent the condition of marine habitats in Washington?
 - Sneak peek at how potential indicators map back onto these conceptual models



In this talk...

- Washington State marine spatial planning process
 - Indicator framework
 - Initial selection of potential indicators
 - Evaluation of potential indicators
- California Current integrated ecosystem assessment
 - Your input wanted

Conceptual framework

Habitats

Structural Elements

Sandy
Beaches

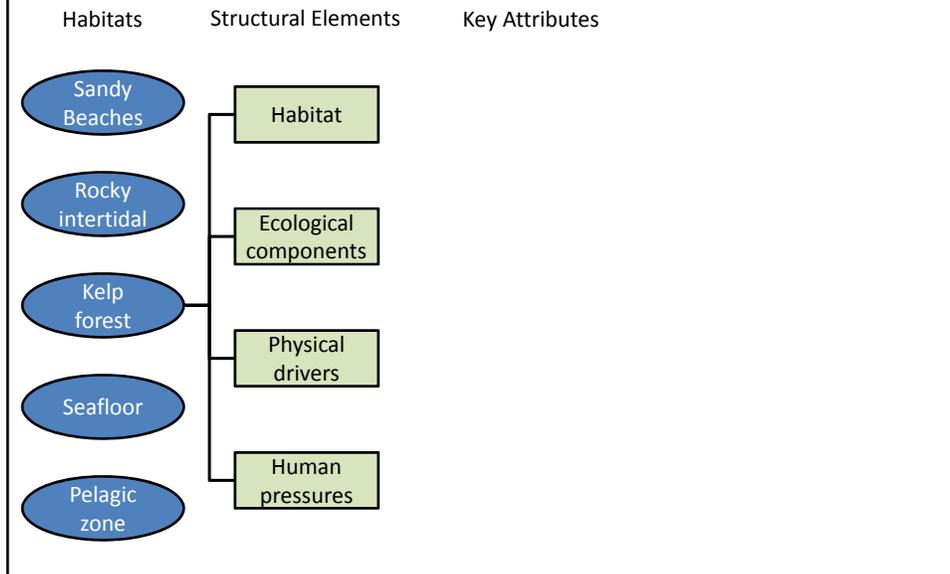
Rocky
intertidal

Kelp
forest

Seafloor

Pelagic
zone

Conceptual framework

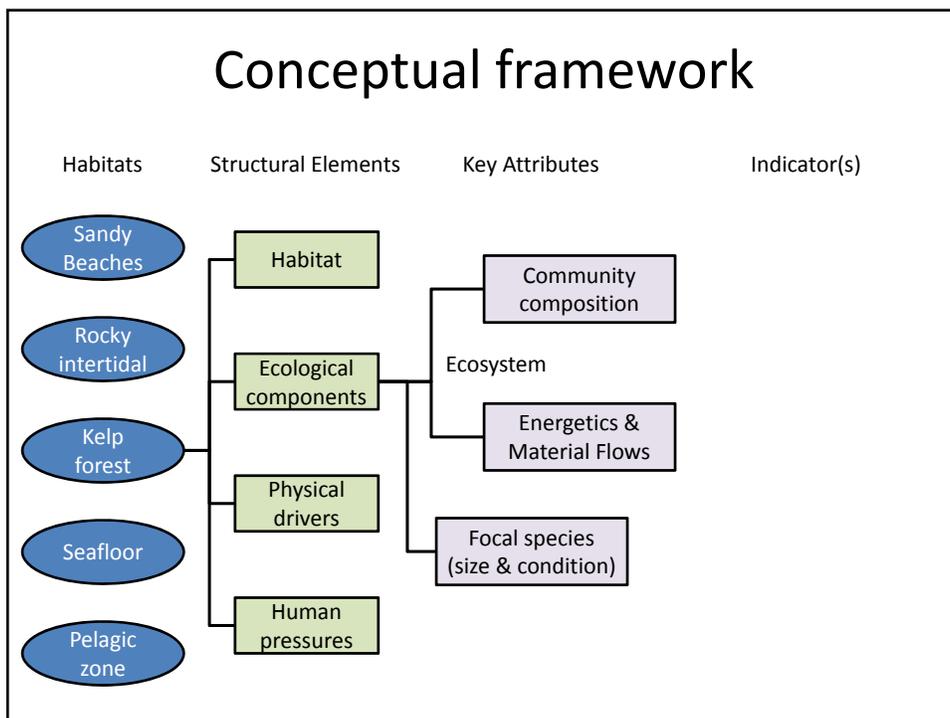
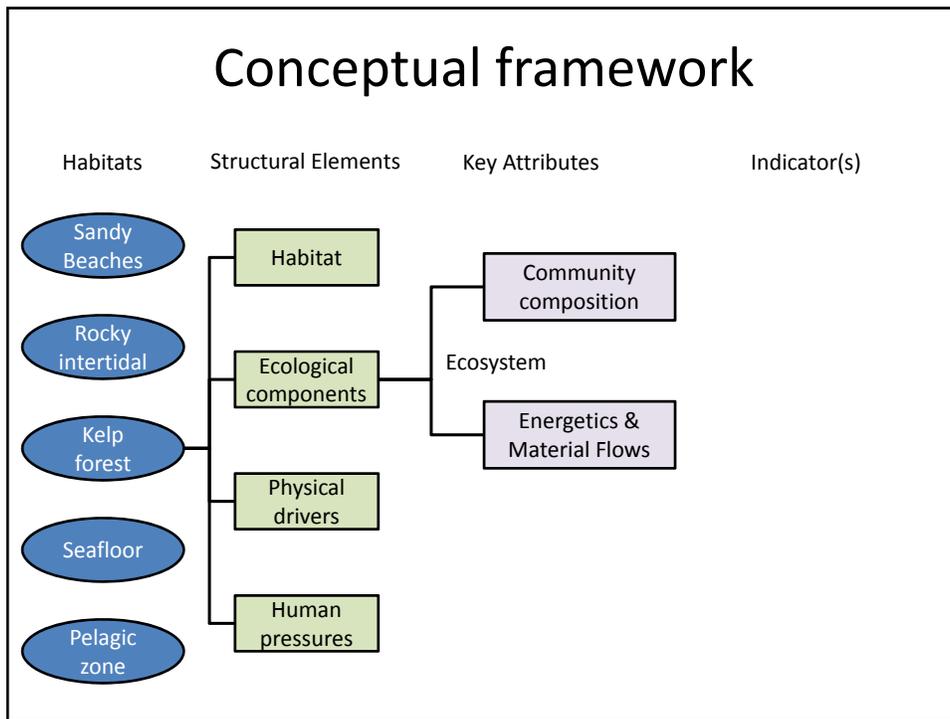


Ecosystem attributes:

- Structural and functional properties of the ecosystem that specifically describe some relevant aspect of a management goal or objective
- *Typically difficult to measure directly*

- Diversity
- Energetics
- Food web structure
- Nutrient cycling
- Resilience





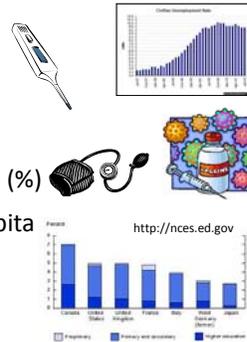
Ecosystem Indicators



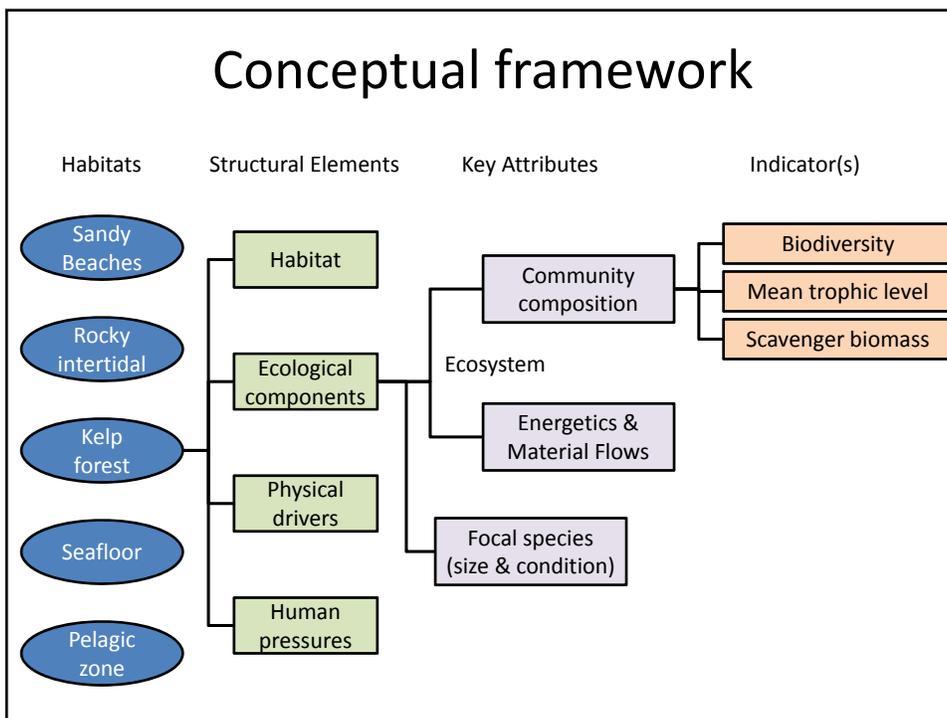
- An empirically tractable metric that serves as a proxy for a **key attribute** of natural and socioeconomic systems.
- Indicators describe where we are now and where we are going?

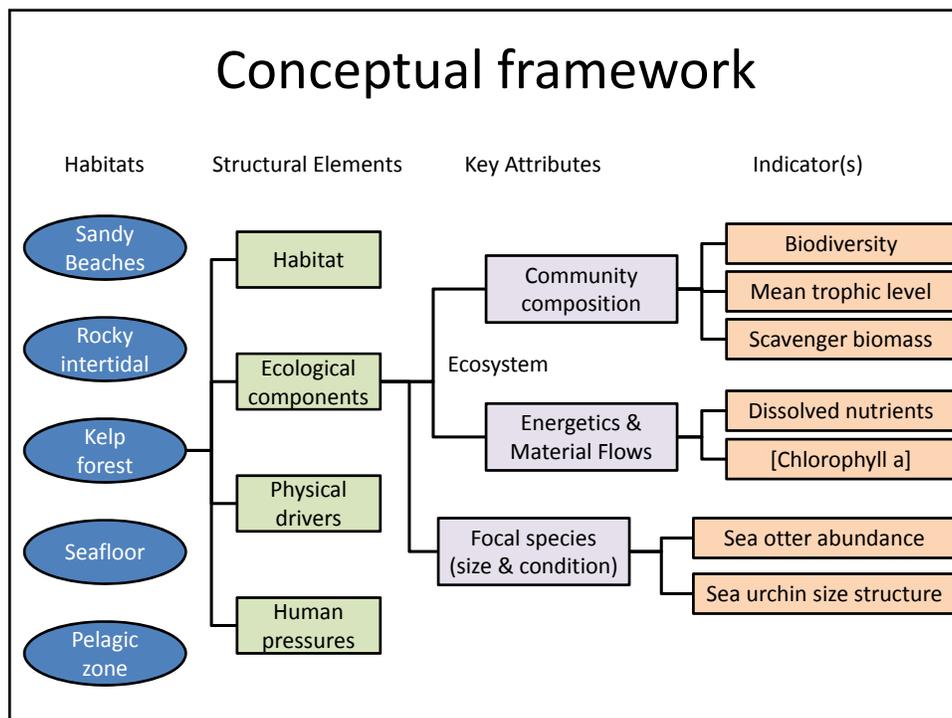
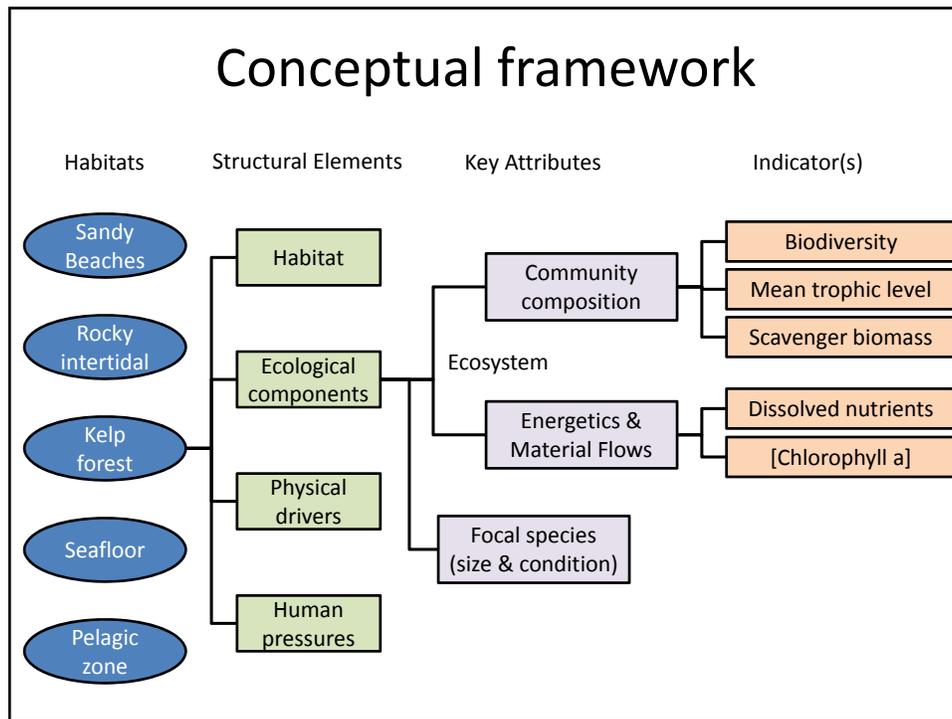
Examples of **Indicators** in other fields:

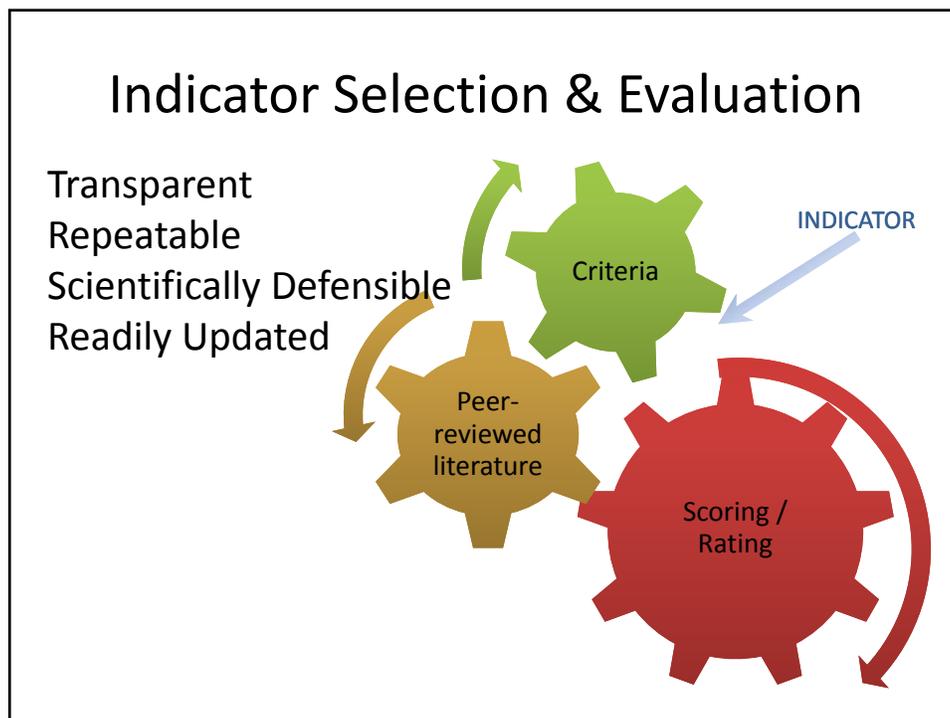
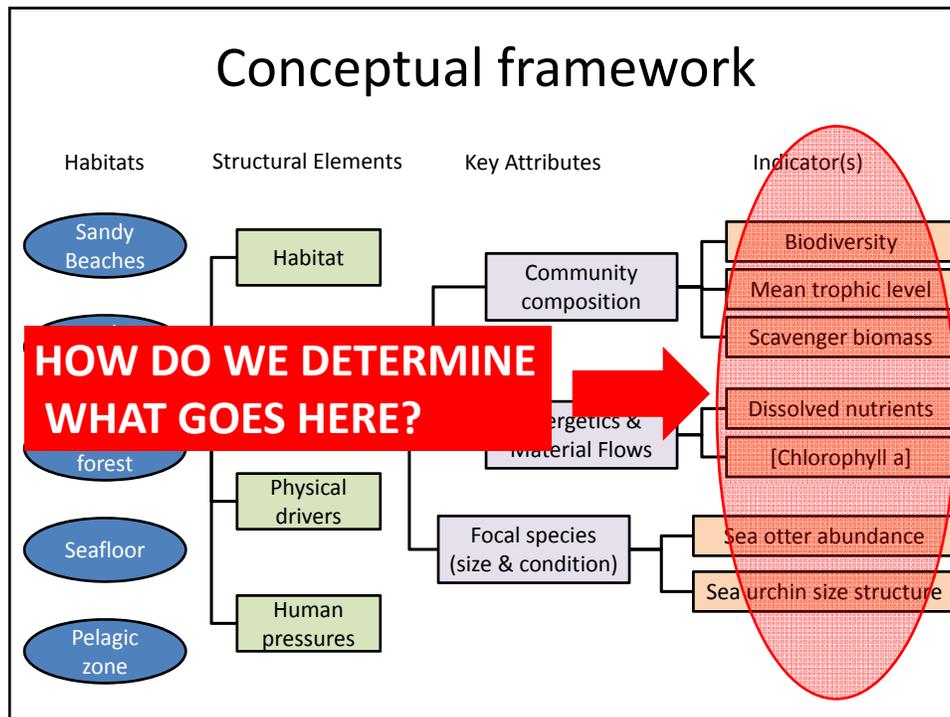
- Economics: Unemployment rate, Housing starts
- World Health: Infant mortality rate, Immuniz coverage (%)
- Public Safety: Homicide rate, Traffic accidents per capita
- Human Health: Blood pressure, Body temperature
- Education: Adult literacy rate, Expenditures as %GDP



Conceptual framework



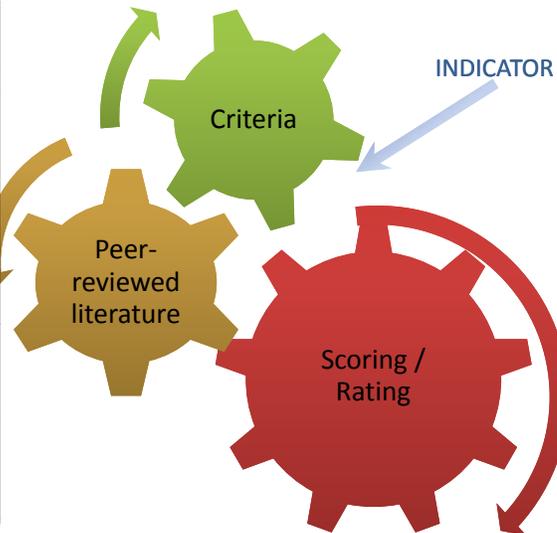




Indicator Selection & Evaluation

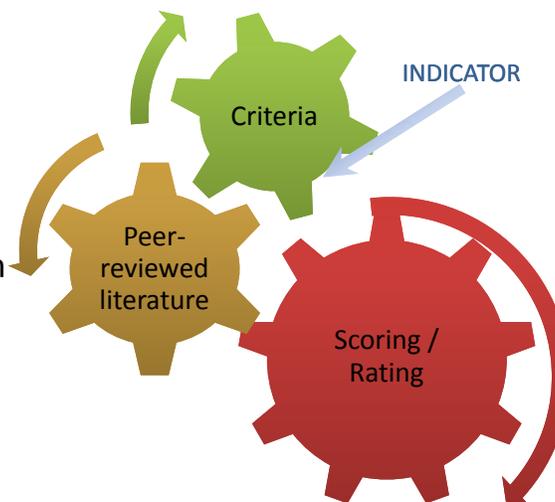
5 Steps:

1. Identify
2. Screen with criteria
3. Literature-based scoring
4. Criteria weighting
5. Final suite selection



Indicator Selection & Evaluation Step 1: Indicator Identification

- Element: Ecological Components
- Attribute: Community Composition
- 67 potential indicators were identified from the literature



Indicator Evaluation Process Step 2: Screen with Criteria

Primary considerations (5)

- Theoretically sound
- Relevant to management concerns
- Responds to changes in attributes
- Responds to changes in management
- Linkable to targets

Indicators were "rated" for each criterion based on information from peer-reviewed literature

Indicator Evaluation Process Step 3: Scoring indicators by our criteria:

Element: Ecological Components

Attribute: Community Composition

Criteria:
Primary considerations

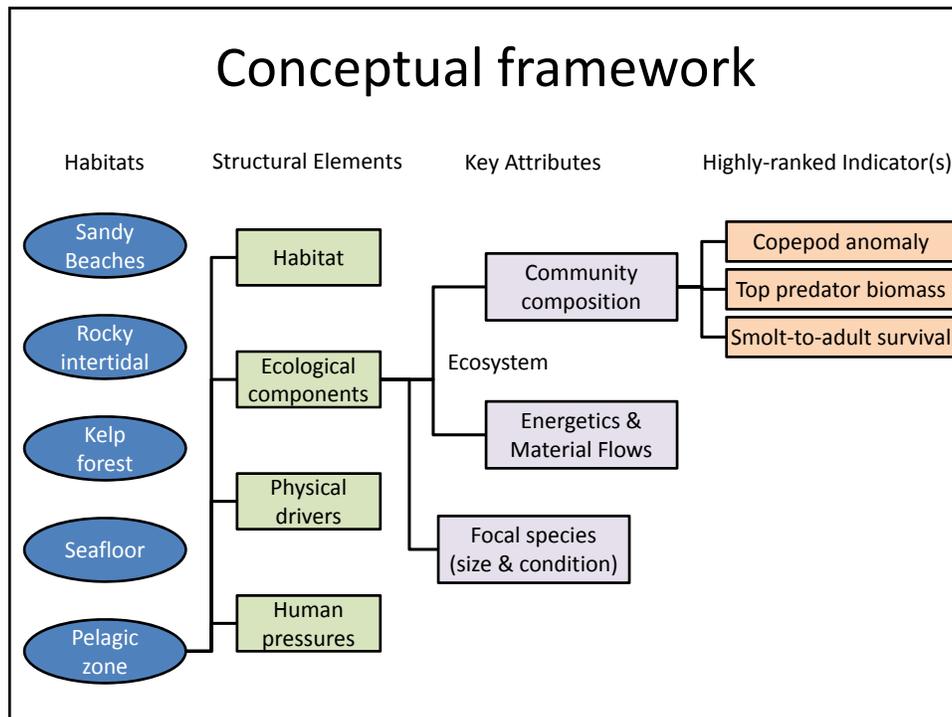


Indicator Evaluation Process Step 3: Sum scores across criteria:

KEY ATTRIBUTE	INDICATOR	Sum of scores (5 is max)
Community composition	Salmon smolt-adult survival rate (SAR)	5
Community composition	Copepod species ratio (Cold vs. warm species)	5
Community composition	Euphausiid biomass / richness	5
Community composition	Top predator B (trophic level > 4)	5
Community composition	Juvenile rockfish index	4
Community composition	Cetacean species status & trends	3
Community composition	Zooplankton/Phytoplankton ratio	3
Community composition	Integrative seabird index (multivariate)	2.5
Community composition	Total fishery removals of all species	2
Community composition	Shellfish (bivalves - mussels, clams, oysters)	0

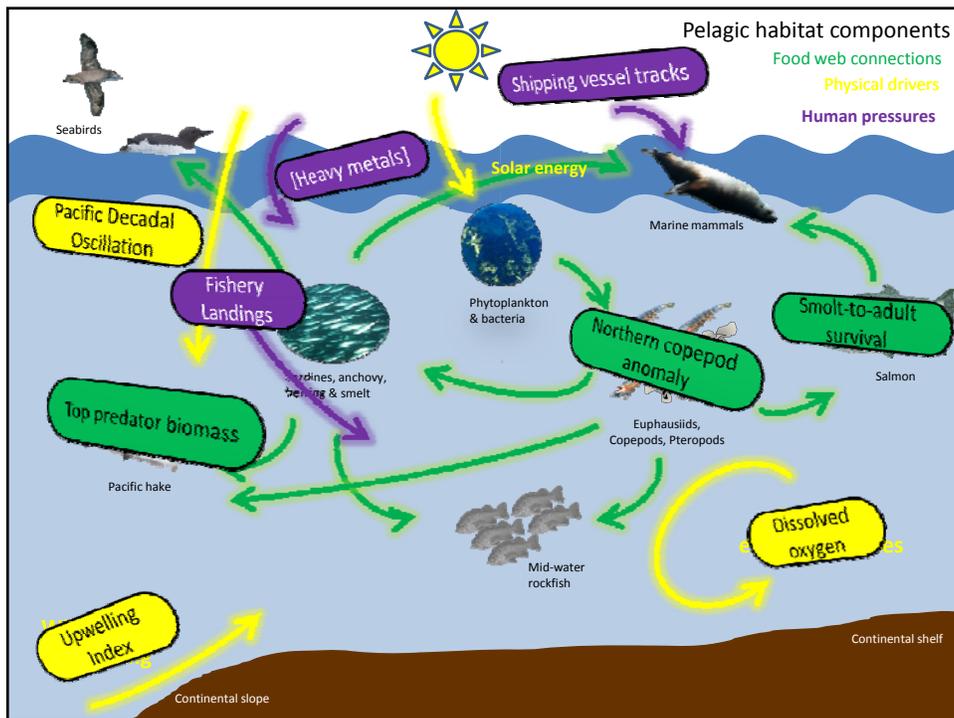
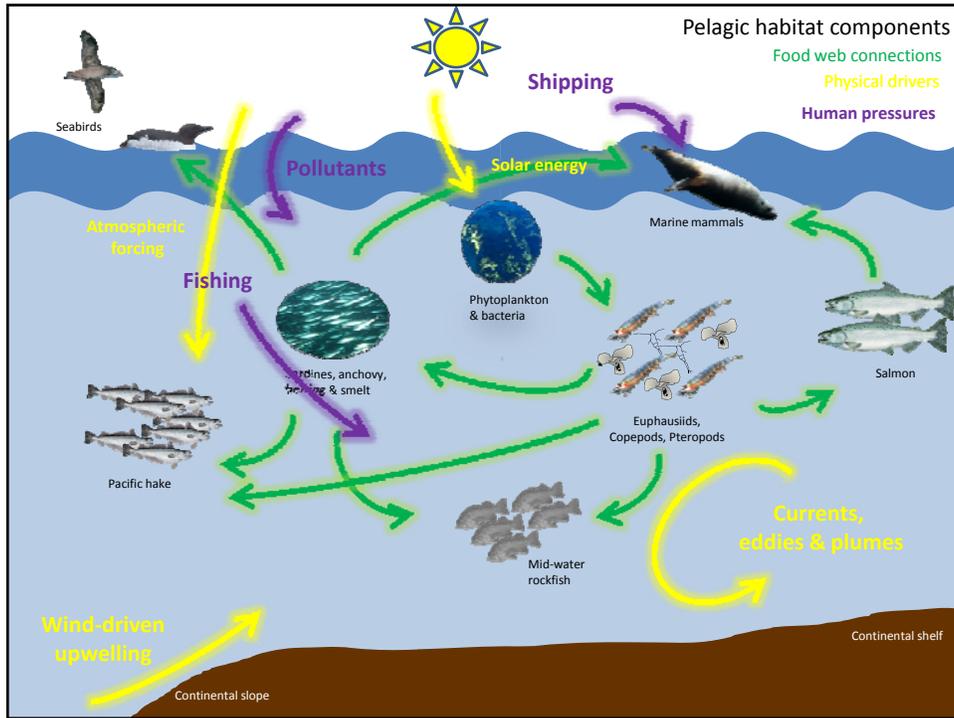
Indicator Evaluation Process Step 3: Identify highly-ranked indicators:

KEY ATTRIBUTE	INDICATOR	Sum of scores (5 is max)
Community composition	Salmon smolt-adult survival rate (SAR)	5
Community composition	Copepod species ratio (Cold vs. warm species)	5
Community composition	Euphausiid biomass / richness	5
Community composition	Top predator B (trophic level > 4)	5
Community composition	Juvenile rockfish index	4
Community composition	Cetacean species status & trends	3
Community composition	Zooplankton/Phytoplankton ratio	3
Community composition	Integrative seabird index (multivariate)	2.5
Community composition	Total fishery removals of all species	2
Community composition	Shellfish (bivalves - mussels, clams, oysters)	0



Potential indicators for pelagic habitats

Structural Element	Key Attribute	Indicator	Potential metrics
Ecological components	Community composition	Diversity	Simpson diversity & Species richness (coastal pelagics, zooplankton, seabirds)
		Mean trophic level	Mid-water/surface species
		Northern copepod anomaly	Anomalies in the relative biomass of copepods with cold-water affinities
		Top predator biomass	Biomass of individuals with trophic level > 4.0
		Pinniped and seabird reproductive performance	Annualized # of pups/chicks
	Salmon smolt-adult survival		
Energetics & material flows		Productivity	Remotely-sensed Chlorophyll a concentrations
		Nutrient cycling	Dissolved nitrogen/phosphate concentrations
		Carbon cycling	Number of cycles
Physical drivers	Ocean conditions	Sea surface temperature	Pacific Decadal Oscillation (PDO)
		Upwelling	Spring Transition Index (STI)
	Biogeochemistry	Oxygen concentrations	Dissolved oxygen levels
		Ocean acidification	Aragonite saturation state
Human pressures	Extractions	Fishery/gathering removals	Commercial/recreational landings
	Shipping activity	Areas disturbed	Spatial distribution/tracks of vessels.
	Pollution	Pollutant concentrations	Heavy metals, inorganic/organic pollutants, nutrients



Now we need your help...

1. You've given input on what's missing from the conceptual models.

Now we need your help...

1. You've given input on what's missing from the conceptual models.
2. Are there other indicator evaluation criteria that should be used?

Indicator Evaluation Process Step 2: Screen with Criteria

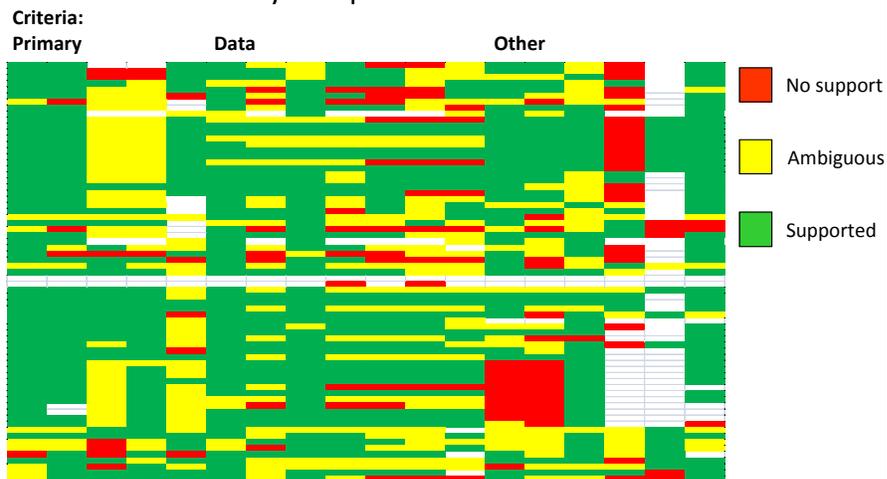
Primary considerations (5)	Data considerations (7)	Other considerations (6)
<ul style="list-style-type: none"> Theoretically sound Relevant to management concerns Responds to changes in attributes Responds to changes in management Linkable to targets 	<ul style="list-style-type: none"> Concrete and Numerical Historical data Simple Broad spatial coverage Continuous time series Spatial & temporal variation understood Signal-to-noise ratio 	<ul style="list-style-type: none"> Understood by the public History of reporting Cost-effective Anticipatory Lagging Compatible (region, national, international)

Indicators were "rated" for each criterion based on information from peer-reviewed literature

Indicator Evaluation Process Step 3: Scoring indicators by our criteria:

Element: Ecological Components

Attribute: Community Composition



A lot of highly-ranked indicators

KEY ATTRIBUTE	INDICATOR	Sum	KEY ATTRIBUTE	INDICATOR	Sum
Community composition	Salmon smolt-adult survival rate (SAR)	5	Community composition	Roundfish biomass	4
Community composition	Copepod species ratio (Cold vs. warm species)	5	Community composition	Demersal fish biomass	4
Community composition	Euphausiid biomass / richness	5	Community composition	Pelagic fish biomass	4
Community composition	Top predator B (trophic level > 4)	5	Community composition	Rockfish biomass	4
Community composition	Proportion noncommercial species (unfished groups)	5	Community composition	Juvenile rockfish index	4
Community composition	Pinniped annual reproductive performance	4.5	Community composition	Juvenile hake abundance	4
Community composition	Crustaceans - Catch/Survey trends; larval surveys	4.5	Community composition	Salmon adult escapement	4
Community composition	Benthic invertebrate B	4.5	Community composition	Seabird annual reproductive performance	4
Community composition	Zooplankton abundance/biomass	4.5	Community composition	Seabird diet (fatty acids, stable isotopes)	4
Community composition	Simpson Diversity	4.5	Community composition	Jellyfish biomass; status and trends	4
Community composition	Shannon Diversity	4.5	Community composition	Biodiversity Index (Hurlbert's Delta)	4
Community composition	Kempton's Q diversity	4.5	Community composition	Taxonomic distinctness (average and variation in)	4
Community composition	Scavenger biomass	4.5	Community composition	Number of Threatened Species (IUCN A1 criteria as modified by Dulvy et al 2006)	4
Community composition	Mean length, all species	4.5	Community composition	Mean Trophic Index / Mean Trophic Level	4
Community composition	Pinniped contaminant load	4	Community composition	Detritivore biomass	4
Community composition	Forage fish biomass; species status & trends	4	Community composition	Herbivore biomass	4
Community composition	Groundfish status & trends	4	Community composition	Forage fish / jellyfish ratio	4
Community composition	Flatfish biomass	4	Community composition	Piscivorous/Zooplanktivorous fish ratio	4
Community composition	Zooplanktivorous fish biomass	4	Community composition	Pelagic / demersal fish ratio	4
Community composition	Piscivorous fish biomass	4	Community composition	Invertivore/Herbivore ratio	4
			Community composition	Finfish / Crustacean Biomass Ratio	4

Fewer highly-ranked indicators

KEY ATTRIBUTE	INDICATOR	Sum
Community composition	Copepod species ratio (Cold vs. warm species)	?
Community composition	Simpson Diversity	?
Community composition	Pinniped annual reproductive performance	?
Community composition	Top predator B (trophic level > 4)	?
Community composition	Proportion noncommercial species (unfished groups)	?
Community composition	Crustaceans - Catch/Survey trends; larval surveys	?
Community composition	Benthic invertebrate B	?
Community composition	Zooplankton abundance/biomass	?
Community composition	Scavenger biomass	?

Now we need your help...

1. You've given input on what's missing from the conceptual models.
2. Are there other indicator evaluation criteria that should be used?
3. How should we weight evaluation criteria?

Indicator Evaluation Process Step 4: Criteria Weighting

- Weight Evaluation Criteria – not all are equally important
- For California Current IEA we polled managers to get weightings
- For Puget Sound IEA, a mixed science-policy group generate weightings in a workshop setting

Understood by public and policy makers	Spatial and temporal variation understood	Broad spatial coverage
1	0.25	0.5

Indicator Evaluation Process Step 4: Criteria Weighting

Element: Ecological integrity for the CCIEA

Attribute: Community Composition

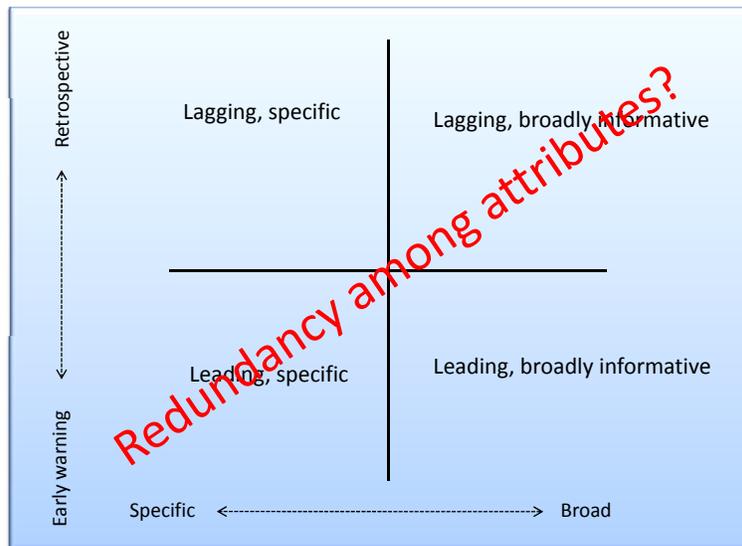
Initial Scoring (Ranked)

After Weighting

- | | | |
|--------------------------------|---|-----------------------------|
| 1. Copepod biomass anomaly | → | Copepod biomass anomaly |
| 2. Pinniped reproductive index | → | Taxonomic distinctness |
| 3. Taxonomic distinctness | → | Scavenger biomass |
| 4. Seabird mortality | → | Pinniped reproductive index |
| 5. Scavenger biomass | → | Finfish:Crustacean biomass |
| 6. Finfish:Crustacean biomass | → | Seabird mortality |

One last thing to think about...

Indicator Evaluation Process Step 5: Complementary Portfolio



Discussion topics

1. Indicator Evaluation Criteria

- What we've used – primary considerations
- What have been used in other IEA processes
 - Data considerations
 - Other considerations

1. Weighting Evaluation Criteria

- Are you willing to participate and rank the relative importance of the final criteria?