

# Integrated Ecosystem Assessments and indicators: Washington State



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# OVERVIEW

- What is an Integrated Ecosystem Assessment?
- How are we applying this to the Washington State Marine Spatial Planning process?
- Development of indicators
  - Ecological components
  - Social components



# Challenge of Ecosystem-based Management

- Ecosystems provide a large number of goods and services
- These services interact, often in ways we don't understand
- People place different values on different services

**What do we do?**

**Where?**

**How much?**



# WHAT IS AN IEA?



IEAs provide ‘a *synthesis and integration of information on relevant physical, chemical, ecological, and human processes in relation to specified management objectives*’

IEAs draw on both the natural and human-dimension sciences

IEAs determine the status of **coupled Socio-Ecological Systems** and Evaluate management options

IEAs are both a process and products



# INTEGRATED SOCIO-ECOLOGICAL SYSTEM OF THE CALIFORNIA CURRENT ECOSYSTEM

## FOCAL ECOSYSTEM COMPONENTS

### Ecological Integrity

Diversity, Seabirds, Marine mammals, Salmon, Forage species, Groundfish



### Human Well-being

Conditions, Connections, Capabilities (e.g., safety, community, livelihood)



## MEDIATING COMPONENTS

### Habitat

Marine  
Estuarine  
Freshwater



### Human Activities

(e.g., fishing, farming, mining, recreation, research, education, activism, restoration, management)



### Local Social Systems

(e.g., laws, policies, economies, institutions, social networks, hierarchies, cultural values, built environment)

## DRIVERS AND PRESSURES

### Climate & Ocean Drivers

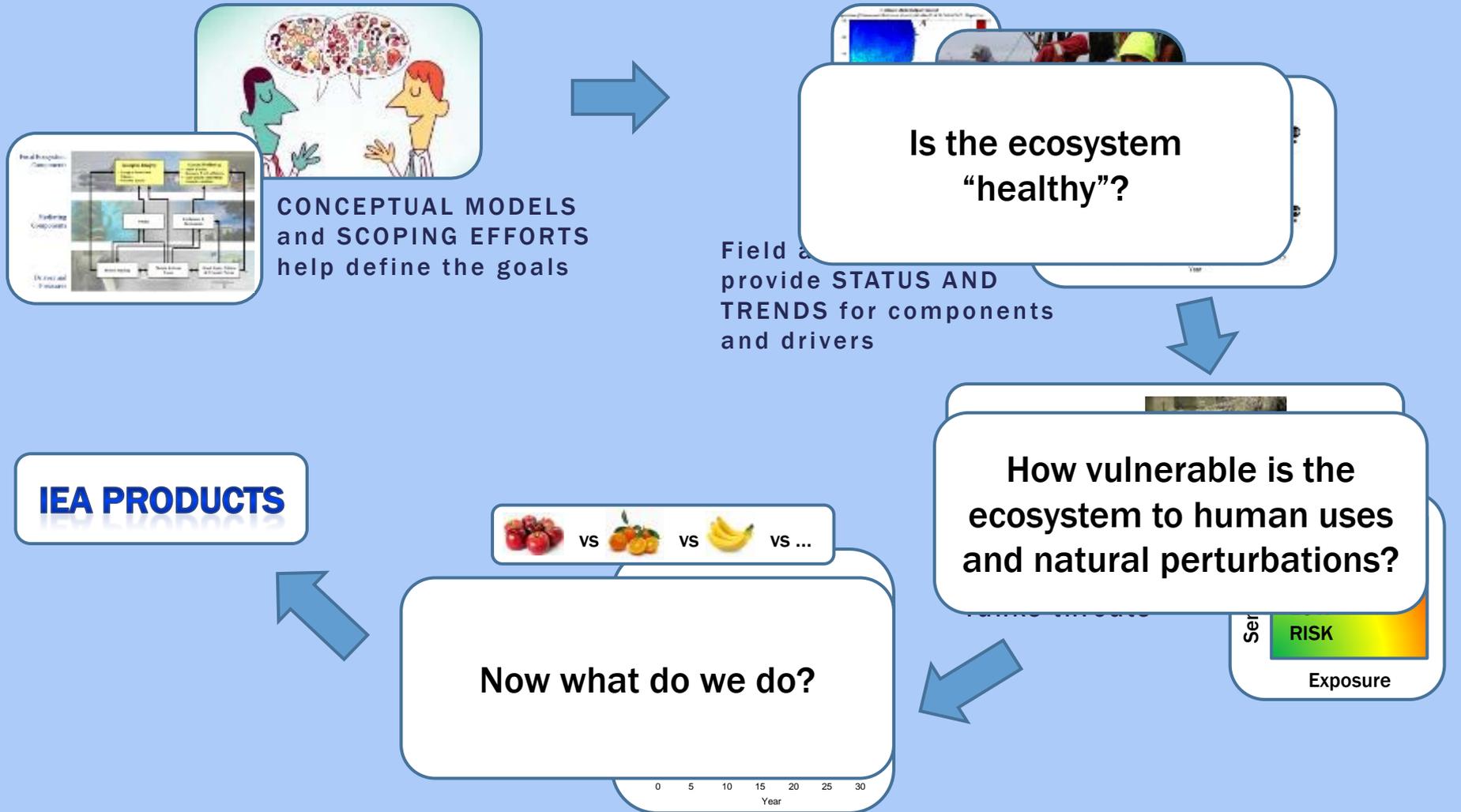
(e.g., climate, ocean upwelling)



### Social Drivers

(e.g., population growth and settlement patterns, national and global economic and political systems, historical legacies, dominant cultural values, and class systems)

# THE CCIEA IN ACTION



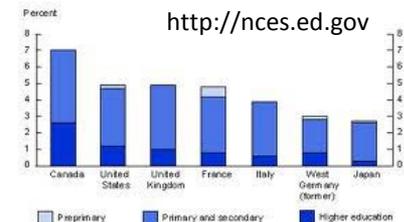
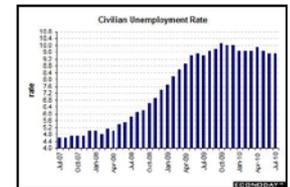
# Ecosystem Indicators



- Empirically tractable metrics that reflect the status or trend in ecosystem attributes
- Where are we now? Where are we going?

## Examples of **Indicators** in other fields:

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

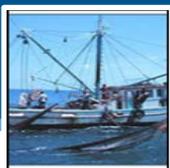


# Indicator Portfolio for the California Current IEA - 2013



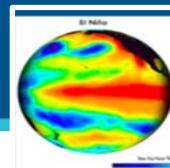
## Ecological Components

- **Ecological Integrity** - Mean trophic level, species diversity, scavenger biomass, Northern copepod biomass anomaly, gelatinous zooplankton biomass
- **Fisheries** -
  - **Salmon** - Age structure diversity, population growth rate, % natural spawners, spawning escapement;
  - **Groundfish** - # groups under management thresholds, age at length;
  - **Forage species** - Survey CPUE (biomass) by species, sardine age distribution
- **Protected species** -
  - **Seabirds** - At-sea abundance, annual reproductive performance, diet, mortality;
  - **Marine Mammals** – baleen and toothed whale survey abundance, CA sea lion pup annual count



## Human Activities

- **Fishery removals** – landings, total est. mortality
- **Habitat destruction** – distance trawled
- **Nutrient input** – land-based N and P fertilizer input
- **Invasive species** – tons shipping cargo
- **Coastal engineering** – human coastal population
- **Light pollution** – ave. nighttime visible light
- **Sediment input** – impoundment area



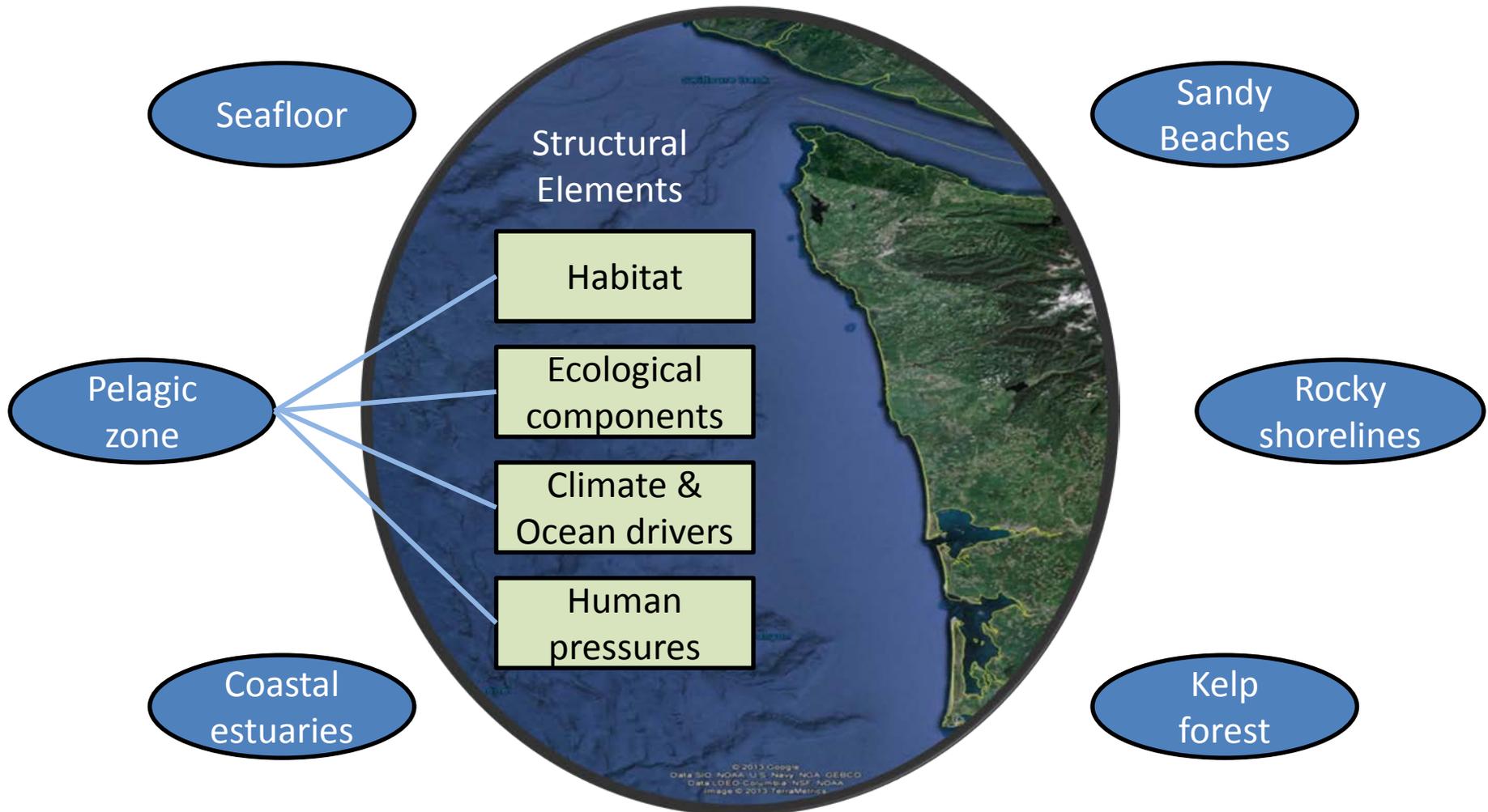
## Climate and Ocean Drivers

- **Timing/frequency of ENSO events** – MEI, NOI
- **Temperature change** – PDO, sea surface buoy temperatures
- **Sea level rise** – coastal sea level
- **Ocean acidification** – DO
- **Water column structure** – pycnocline depth
- **Timing and strength of upwelling** – winds, UI, STI

# APPLICATION TO WASHINGTON STATE

- **Washington Marine Spatial Planning**
  - **Requires the development of key indicators and an assessment of “the health and trends of the ocean ecosystem.”**
    - **Develop conceptual models of Washington’s ocean ecosystem**
    - **Evaluate indicators for components of the conceptual models**
    - **Develop time series of indicators to help determine status and trends**

# Conceptual framework for ecological indicators



# Pelagic habitat components



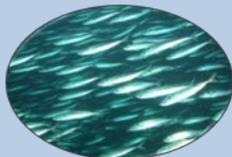
Seabirds



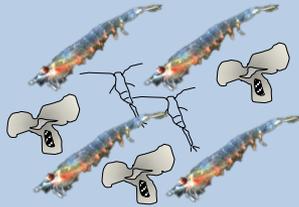
Marine mammals



Phytoplankton & bacteria



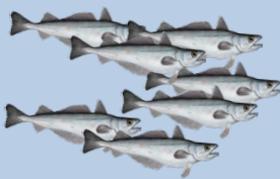
Sardines, anchovy, herring & smelt



Euphausiids, Copepods, Pteropods



Salmon



Pacific hake



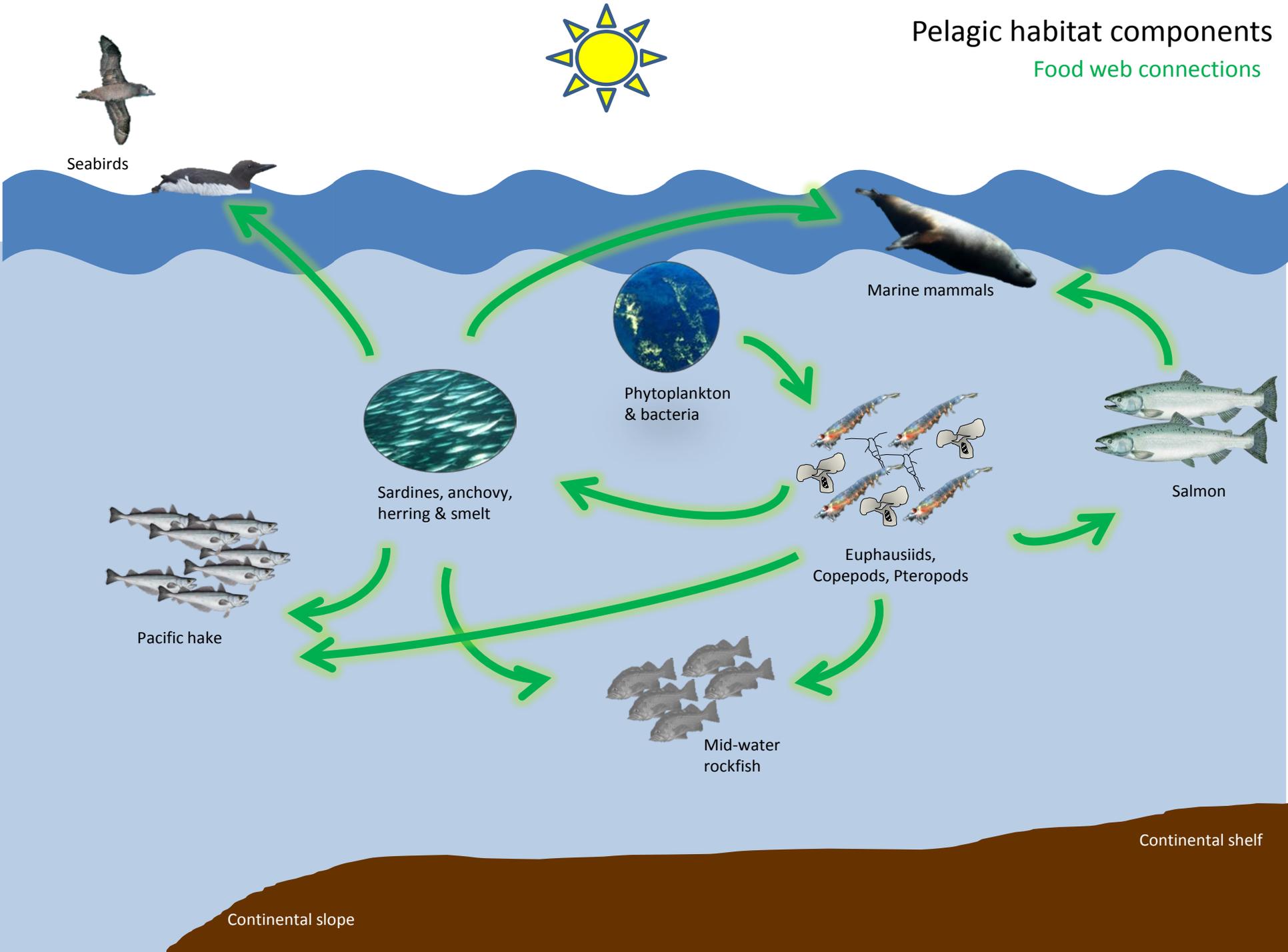
Mid-water rockfish

Continental slope

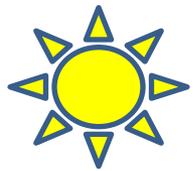
Continental shelf

# Pelagic habitat components

Food web connections



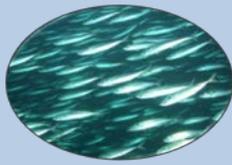
Seabirds



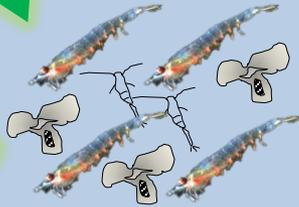
Phytoplankton & bacteria



Marine mammals



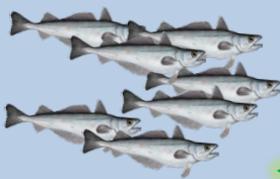
Sardines, anchovy, herring & smelt



Euphausiids, Copepods, Pteropods



Salmon



Pacific hake



Mid-water rockfish

Continental slope

Continental shelf

# Pelagic habitat components

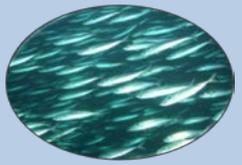
Physical drivers



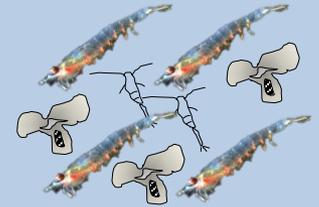
Solar energy



Phytoplankton & bacteria



Sardines, anchovy, herring & smelt



Euphausiids, Copepods, Pteropods



Salmon

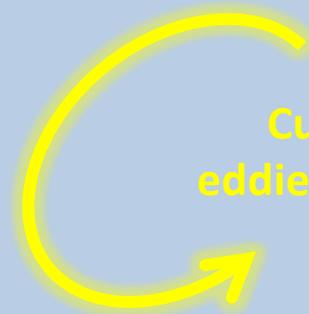


Marine mammals



Mid-water rockfish

Currents, eddies & plumes



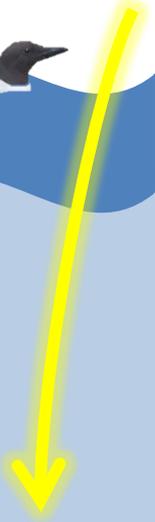
Continental shelf



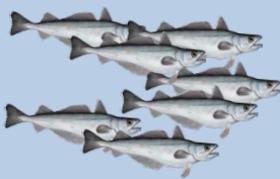
Wind-driven upwelling

Continental slope

Climate change

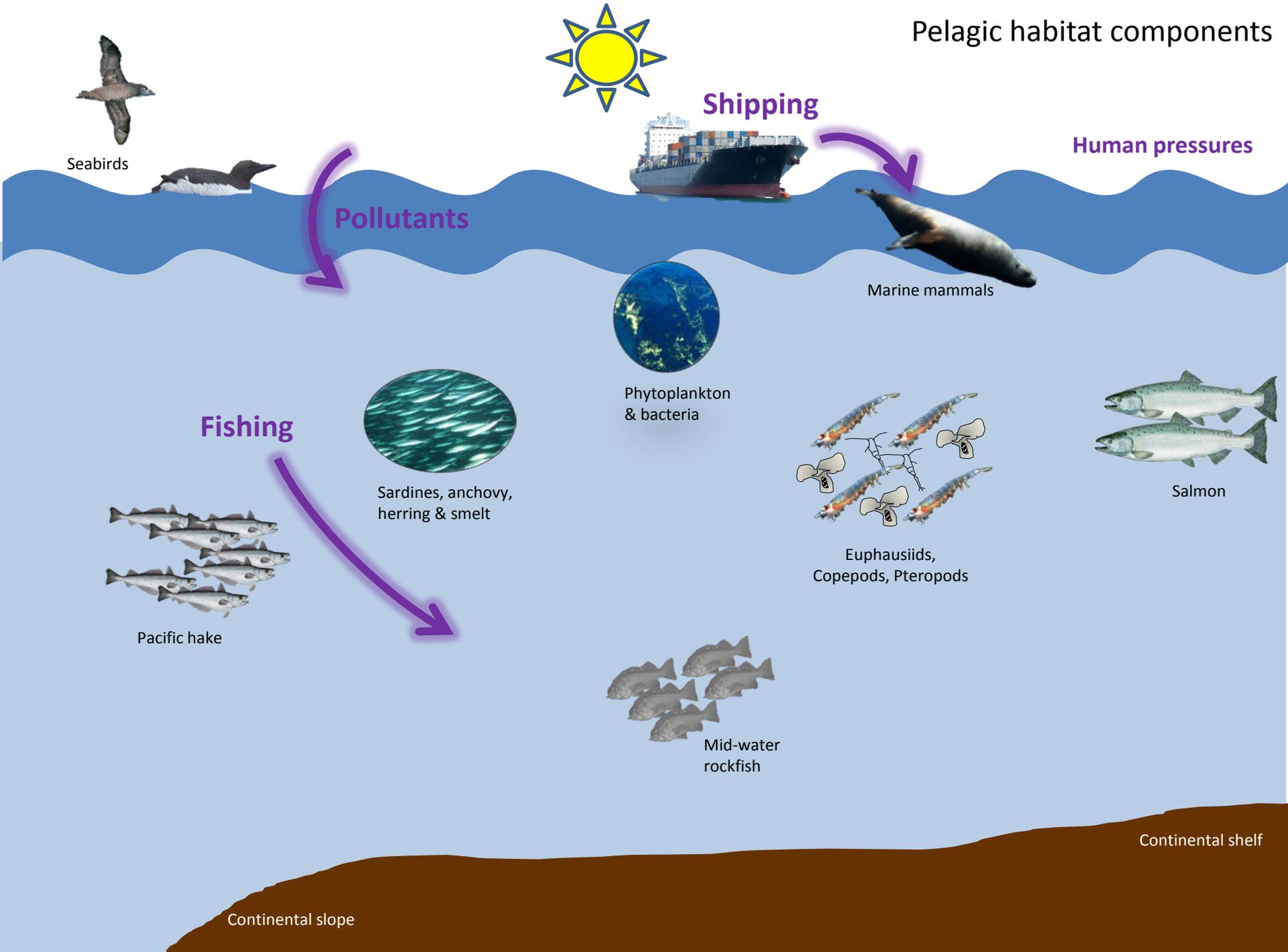


Seabirds



Pacific hake

Pelagic habitat components



Seabirds

Shipping

Human pressures

Pollutants

Marine mammals

Phytoplankton & bacteria

Fishing

Sardines, anchovy, herring & smelt

Euphausiids, Copepods, Pteropods

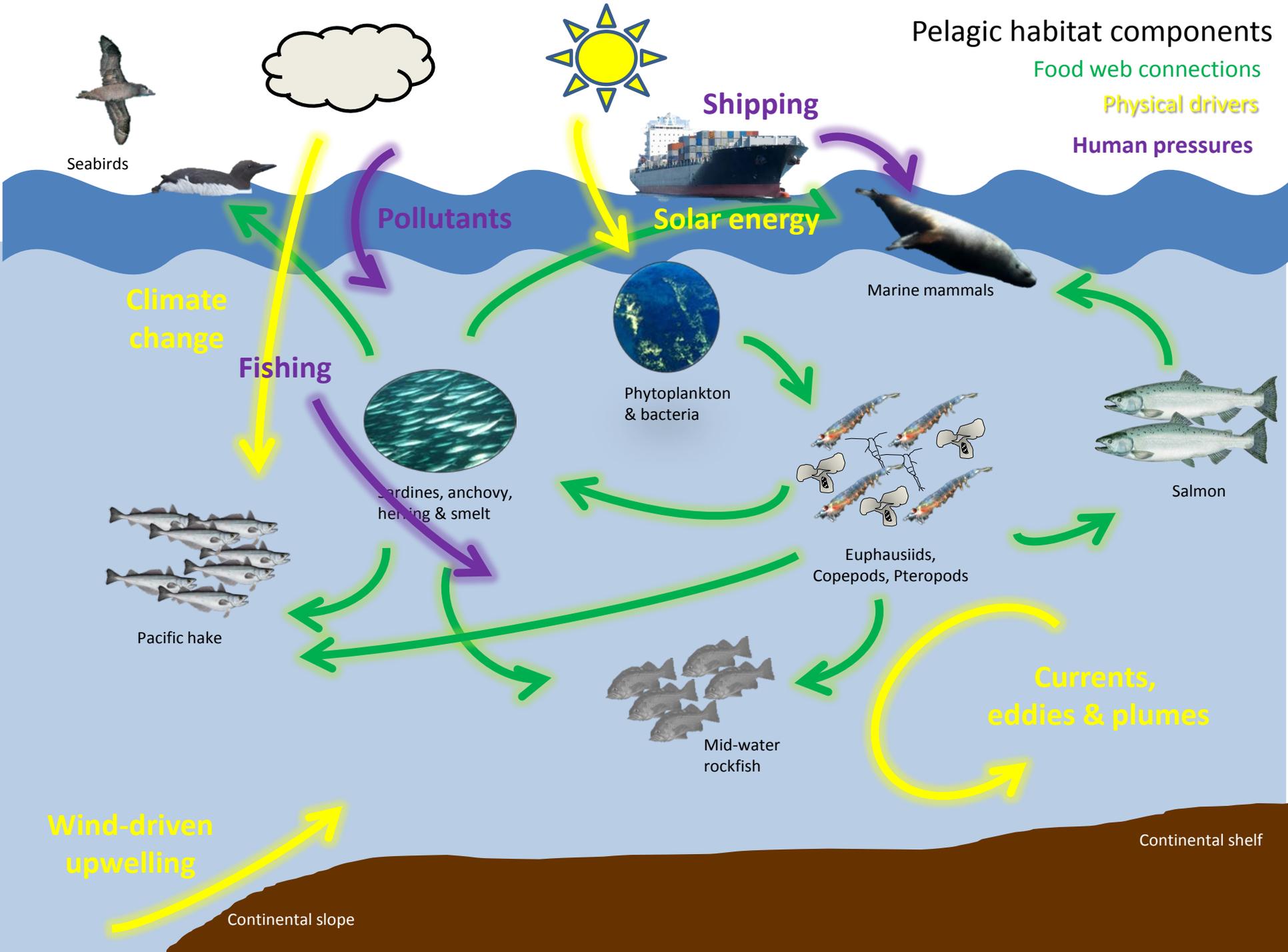
Salmon

Pacific hake

Mid-water rockfish

Continental slope

Continental shelf



# SELECTION OF INDICATORS



**For each habitat, compile a list of potential indicators**

**Sources of potential indicators:**

- **CCIEA-developed indicators**
- **Puget Sound Vital Signs**
- **OCNMS condition report**
- **Other West Coast indicator portfolios & indicator development efforts**

# Potential indicators for pelagic habitats

| Structural Element      | Key Attribute          | Indicator                                     | Potential metrics                                                              |
|-------------------------|------------------------|-----------------------------------------------|--------------------------------------------------------------------------------|
| Habitat                 | Quality                | Water quality index                           |                                                                                |
| Ecological components   | Ecological Integrity   | 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                                |
|                         |                        | Productivity                                  | Remotely-sensed Chlorophyll a concentrations                                   |
|                         | Protected Species      | Pinniped and seabird reproductive performance | Annualized # of pups/chicks                                                    |
|                         |                        | Salmon smolt-adult survival                   |                                                                                |
| Fisheries               | Population growth rate |                                               |                                                                                |
| Climate & Ocean drivers | Ocean conditions       | Sea surface temperature                       | Pacific Decadal Oscillation (PDO), Contour maps                                |
|                         |                        | Upwelling                                     | Spring Transition Index (STI), Upwelling Index (UI)                            |
|                         | 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                          |

# EVALUATE INDICATORS



## Evaluate potential indicators based on:

- Relevance to Marine Spatial Planning process
- Standardized indicator evaluation process
- Complementary indicator portfolios

# Indicator Evaluation Process

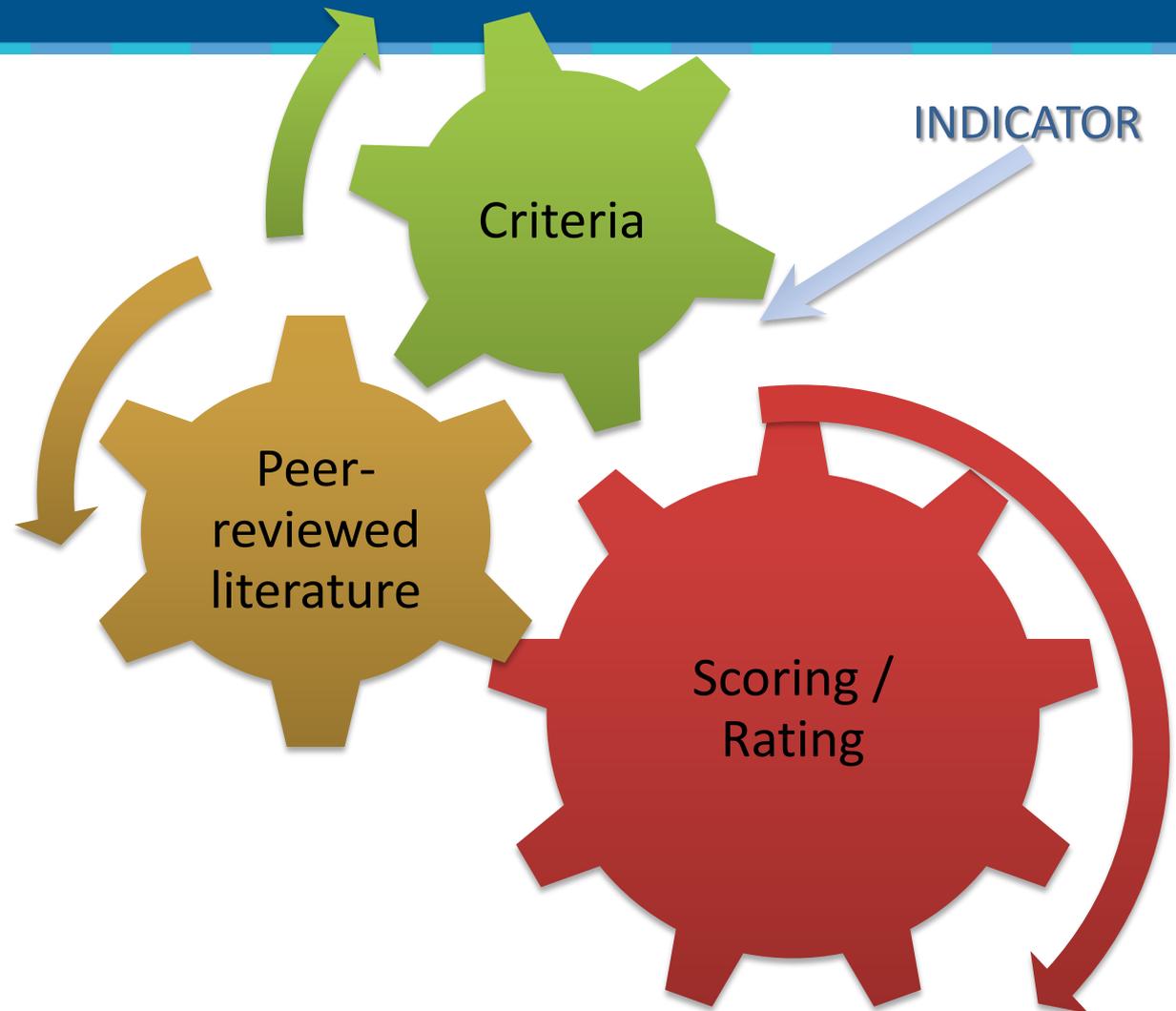
- Transparent
- Repeatable
- Scientifically Defensible
- Readily Updated



# Indicator Evaluation Process

## 5 Steps:

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



# Step 2: Screen with criteria

## Indicator Evaluation Criteria (Kershner et al. 2011)

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

Indicators “rated” for each criterion based on information in peer-reviewed literature

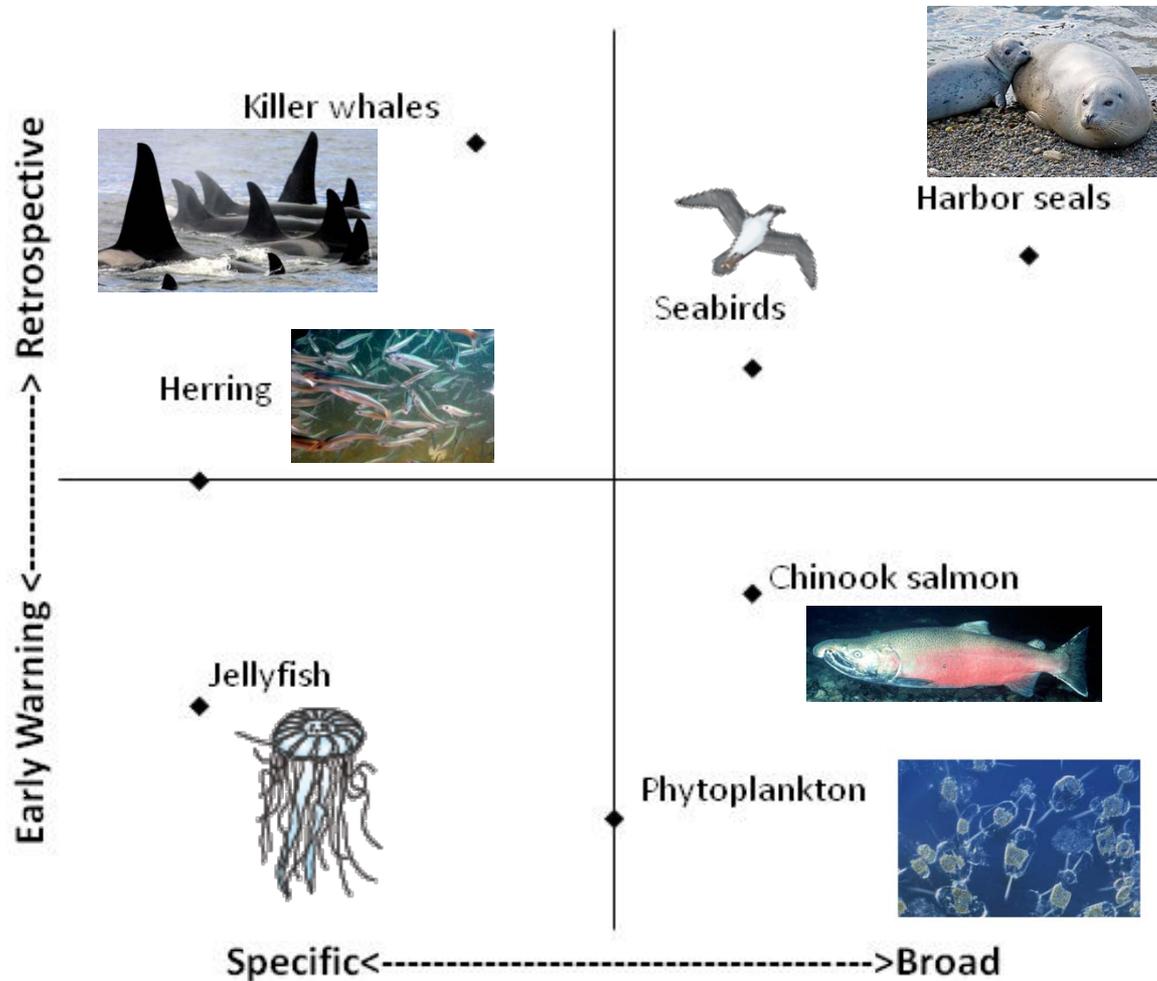


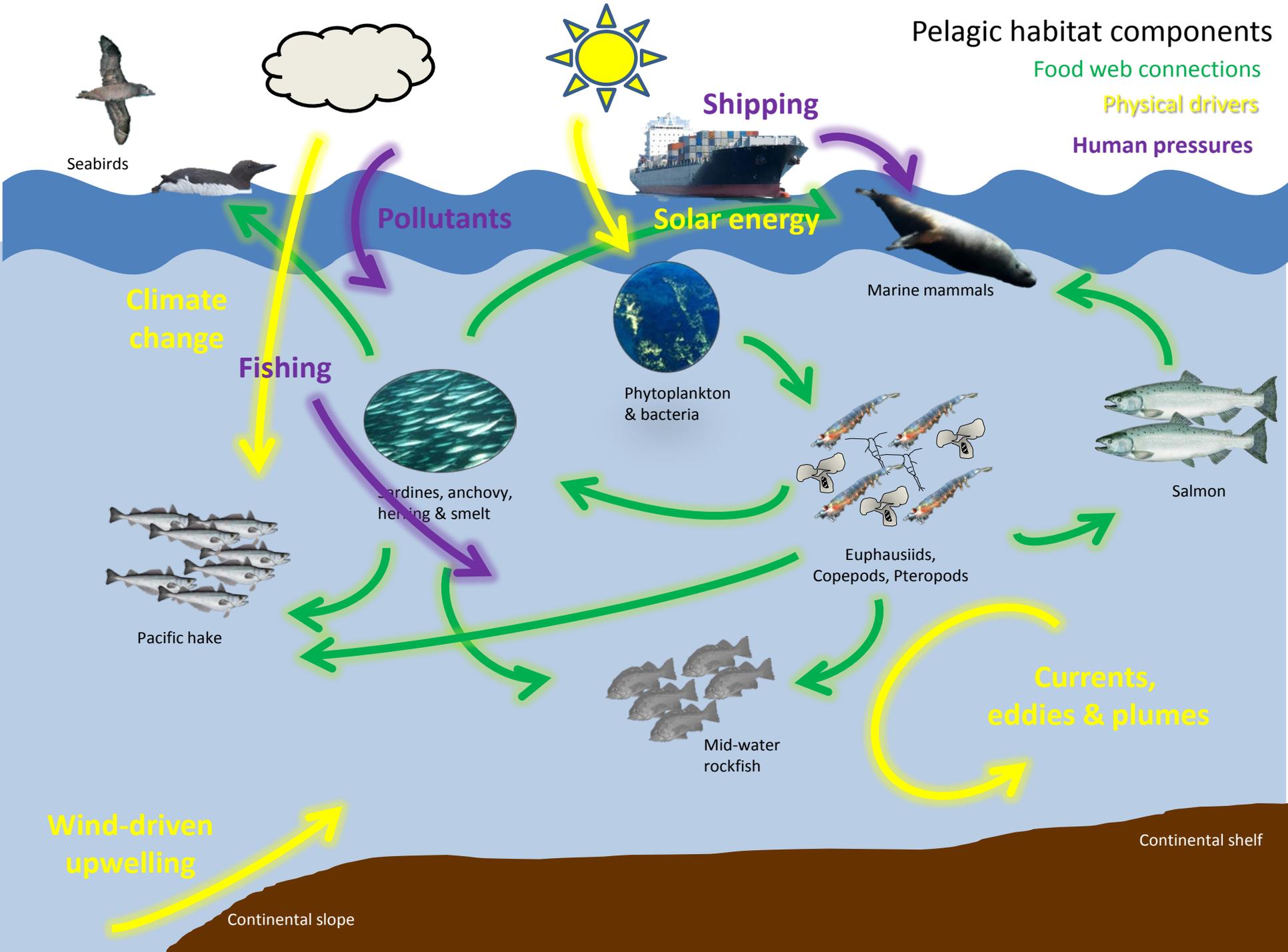
# Step 4: Criteria weighting

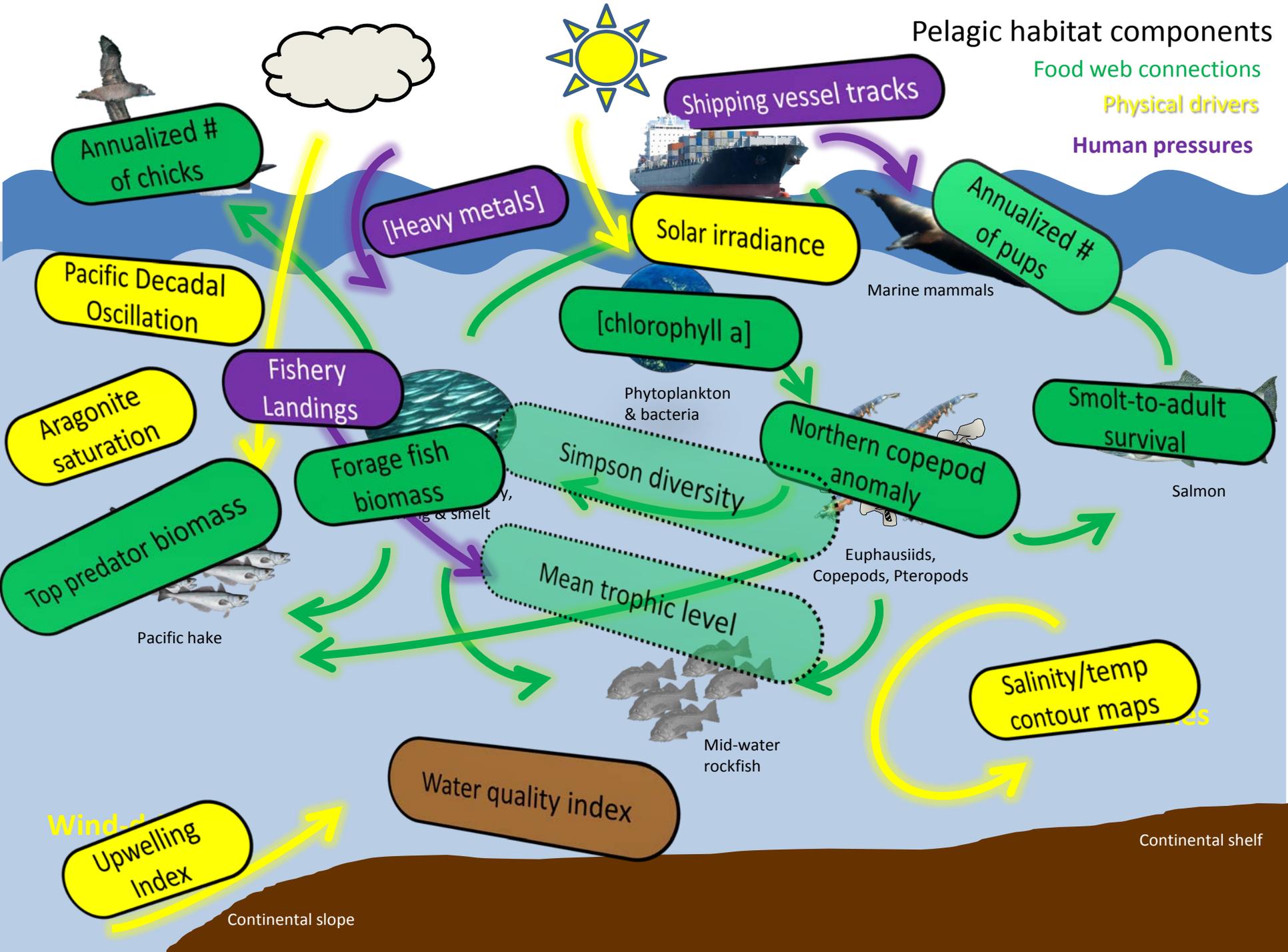
- Weight Evaluation Criteria – not all are equally important
- For California Current IEA we polled managers to get weightings
- For Puget Sound IEA, a mixed science-policy group generate weightings in a workshop setting

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

# Step 5: Complementary Portfolio







# USE SELECTED INDICATORS TO ASSESS ECOSYSTEM



# COMPLETED AND ON THE BURNER



## ■ 2013

- Conceptual models for each habitat type except estuaries were completed
- Initial indicator selection and evaluation based on primary evaluation criteria
- Document available at [msp.wa.gov/explore/MSP-projects/](http://msp.wa.gov/explore/MSP-projects/)

## ■ 2014 – 2015

- Estuaries
  - Conceptual models for Willapa Bay and Grays Harbor completed
  - Indicator selection and evaluation process beginning
  - Webinar on estuary conceptual models and indicators July 25
- Weighting of indicator evaluation criteria.
- Status and trends for final suite of selected indicators.

# THIS IS ONLY ONE-HALF OF THE COUPLED ECOSYSTEM...



- Human well-being indicators
  - Melissa Poe and Sara Breslow
  
- Time to discuss ecological and sociological aspects at the end of Melissa's presentation.



## ***IEA-based Social Indicators for Washington Marine Spatial Planning***

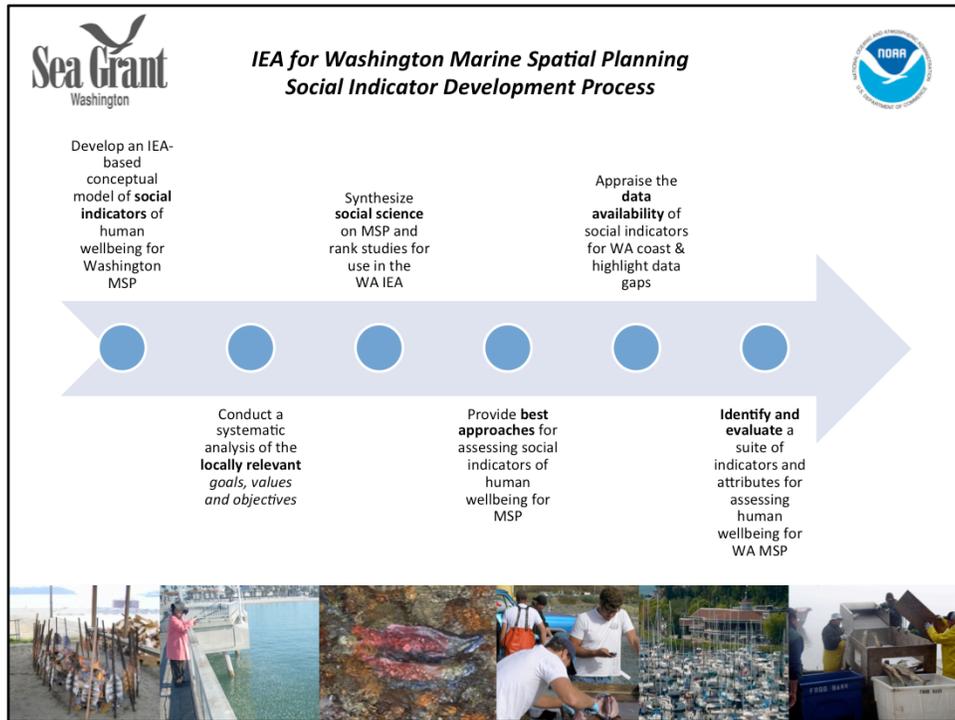
Dr. Melissa Poe, *Environmental Social Scientist & Liaison*  
Washington Sea Grant (UW)  
Northwest Fisheries Science Center (NOAA)

*Presentation to the Washington Coastal Marine Advisory Council  
Aberdeen, WA; July 9, 2014*



Overview: Good afternoon. In the next 15 minutes, I'd like to walk you through Washington Sea Grant's (WSG) effort to develop social indicators for the Integrated Ecosystem Assessment (IEA) for Marine Spatial Planning (MSP) and describe the ways that we are integrating this work with locally-defined objectives. I'll talk about our progress to date and our time frame for delivering results, and I will conclude with a discussion to get your comments and feedback ...

First a little about me, I'm an environmental social scientist at WSG, and I'm also a social science liaison working with NOAA's NWFS. I earned a PhD in Environmental Anthropology with a focus on CBNRM. I've been working as an applied social scientist in the PNW region for over 10 years. Including contributing to a social values mapping project on the Olympic Peninsula and a socioeconomic monitoring assessment of the NWFP. I started working with NOAA's NWFS and WSG on cultural ecosystem connections and the ongoing IEA efforts of the CA Current in 2012. I continue this collaborative work and adopt some of the important frameworks for WA IEA.

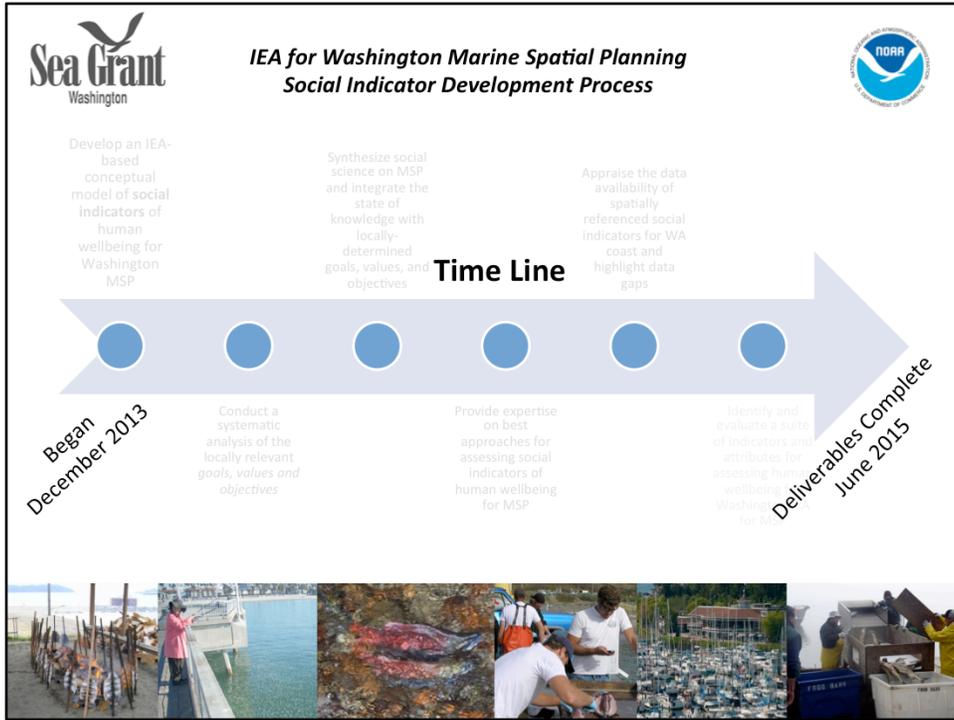


On the screen you can see a road map of the process we are taking to develop Social Indicators for the WA IEA for MSP.

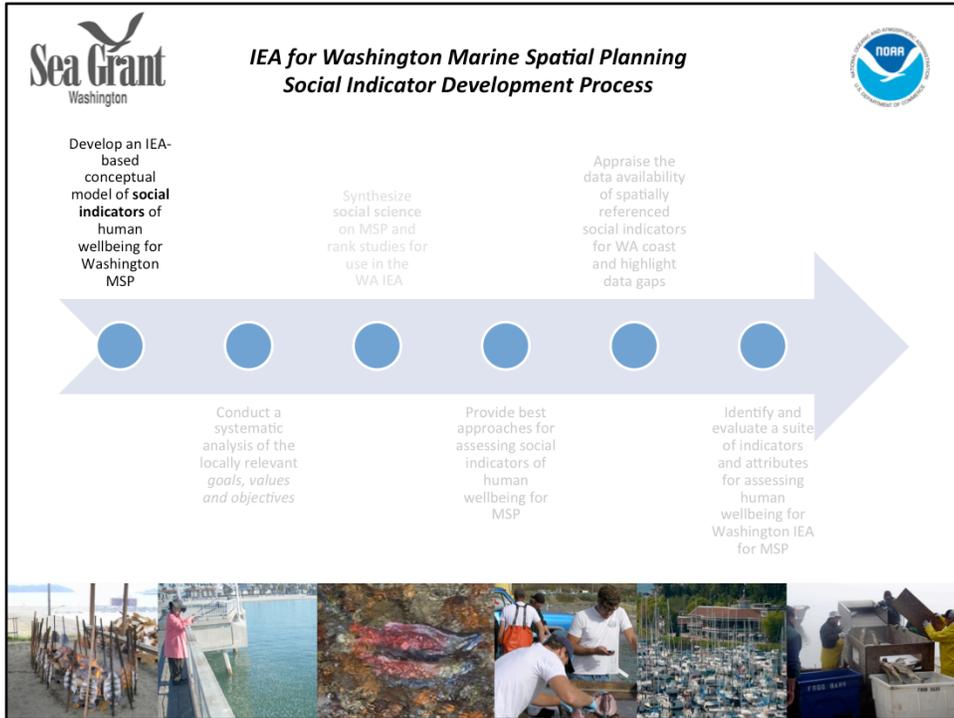
In today's brief presentation, I'd like to walk you through the first four steps of our process. The final two are listed here for you to see our full process, but I won't be discussing these today. However, I'd like to make an open invitation to you to send me any references that you know of with social indicators data beyond basic census info to help with our effort in step 5.

#### Social Indicator Development Process:

1. Collaborate with NWFSC to develop an IEA-based conceptual model of social indicators of human wellbeing for Washington MSP
2. Conduct a systematic document analysis of the socially relevant *goals, values and objectives* articulated during the 2012-2013 multi-stakeholder objective-setting workshops and community outreach meetings on MSP. Summarize the range of human values, activities, and concerns voiced by local stakeholders
3. Synthesize and review human dimensions and social indicators mapping approaches for marine spatial planning from the social sciences literature and integrate the state of social science knowledge with locally-determined goals, values, and objectives
4. Provide expertise on best approaches for assessing social indicators of human wellbeing for MSP



We're about 1/3 of the way into the project at this point, and our timeline to completion is the end of next June.



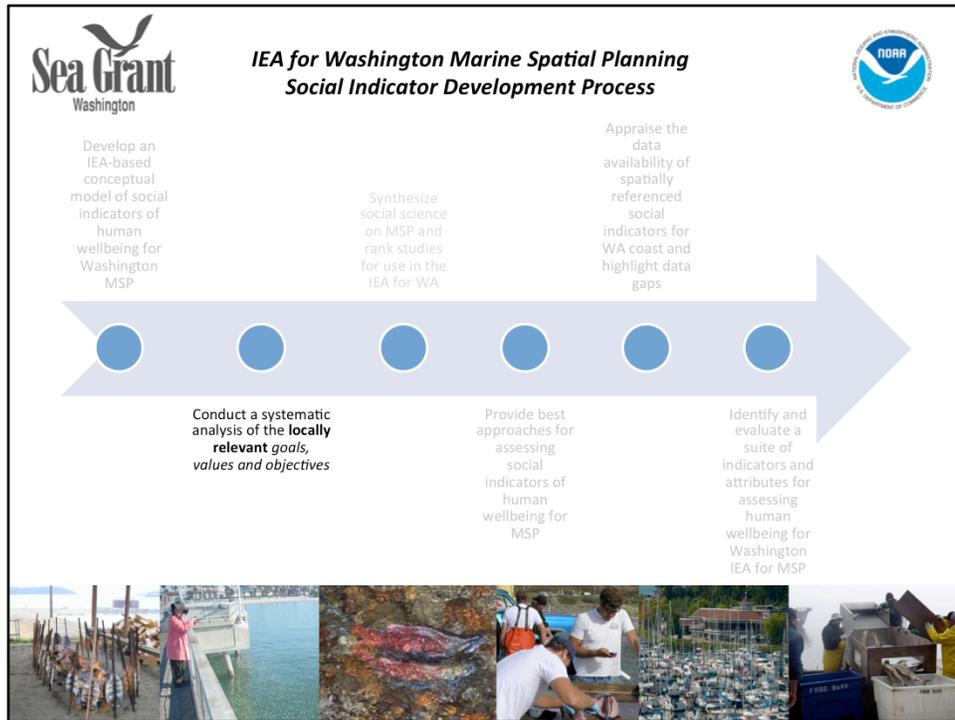
We began the process by scoping and conceptualizing a framework of Social Indicators in an EBM-based IEA. To get here, we've collaborated with the NWFSC and other institutions.



The Social Indicator development process follows the same logic flow as other components of the ecosystem for an IEA as outlined by NOAA. An IEA is also: theoretically sound, linkable to conceptual models of the ecosystem, relevant to management concerns, and sufficiently sensitive to reflect dynamic socio-ecological systems.

In our model for social indicator development, we also add that an IEA should be linkable to **locally-defined goals**.

In a few slides from now, I will show a PROVISIONAL conceptual model for HWB produced for the CCIEA, which we are adopting to inform the WA IEA; but before I do, I want to discuss a little more about our process for defining EBM Goals and Targets as it relates to Social Indicators.



Part of the effort to define Goals and Targets for the social system **draws directly from LOCAL input on what matters most!**

Initial scoping of locally-defined goals come from 3 primary sources:

- (a) values, goals and objectives voiced and documented through extensive notes during the 2013 multi-stakeholder objective-setting workshops hosted by WSG held in Aberdeen, which many of you participated in;
- (b) coastal MRC-hosted workshop results published in the *Coastal Voices* report on local priorities, interests and expectations for MSP; and
- (c) upcoming scoping interviews with ~30 individuals representing a broad range of local coastal interest groups on the WA outer coast – part of the CCIEA human wellbeing indicator process, led by Sara Breslow – to be used as relevant for WA IEA... (TBD)



In this slide, for example, we show key topics to emerge from our *preliminary* analysis of the workshop notes and summaries produced at the 2013 WSG-hosted Values, Goals And Objectives Setting Workshops, together with the results of the COASTAL VOICES MRC workshops. These themes are the initial results from the analysis conducted by Bridget Trosin. They are not in any ranked order. Each theme can be further broken down to identify related indicators.



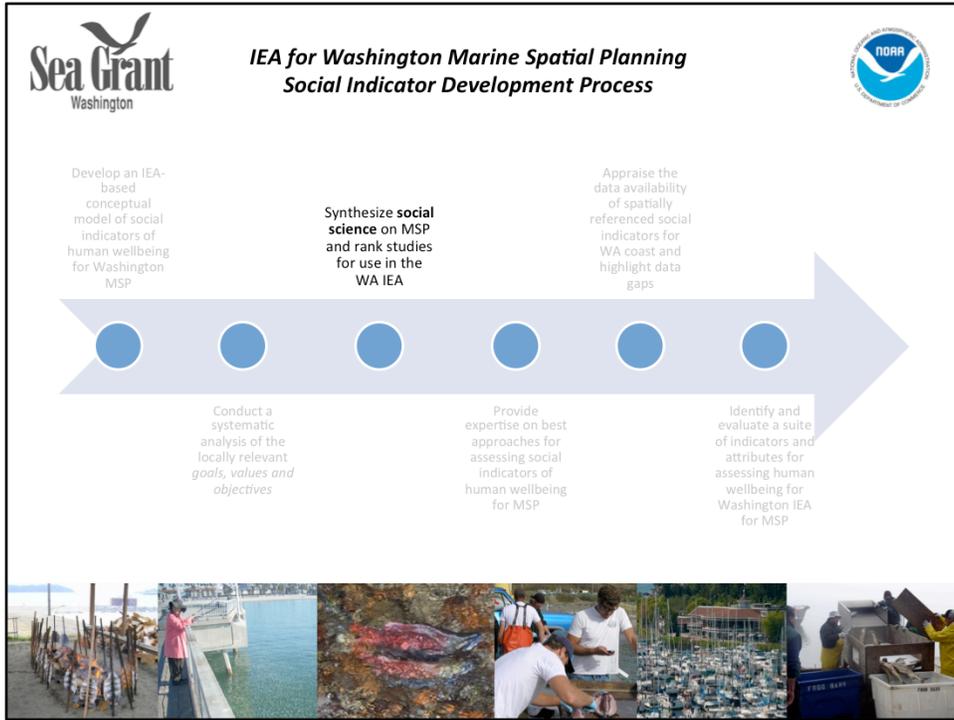
Then, we are cross-walking these goals with the PROVISIONAL conceptual framework of HWB developed for the CCIEA.

Here using our *work-in-progress* (“4-C’s”) **conceptual framework**, you can see that a comprehensive effort to evaluate social indicators of HWB expands beyond uses and livelihood activities, to include a whole host of additional considerations regarding socioeconomic wellbeing and quality of life that are interrelated and cross-cutting.

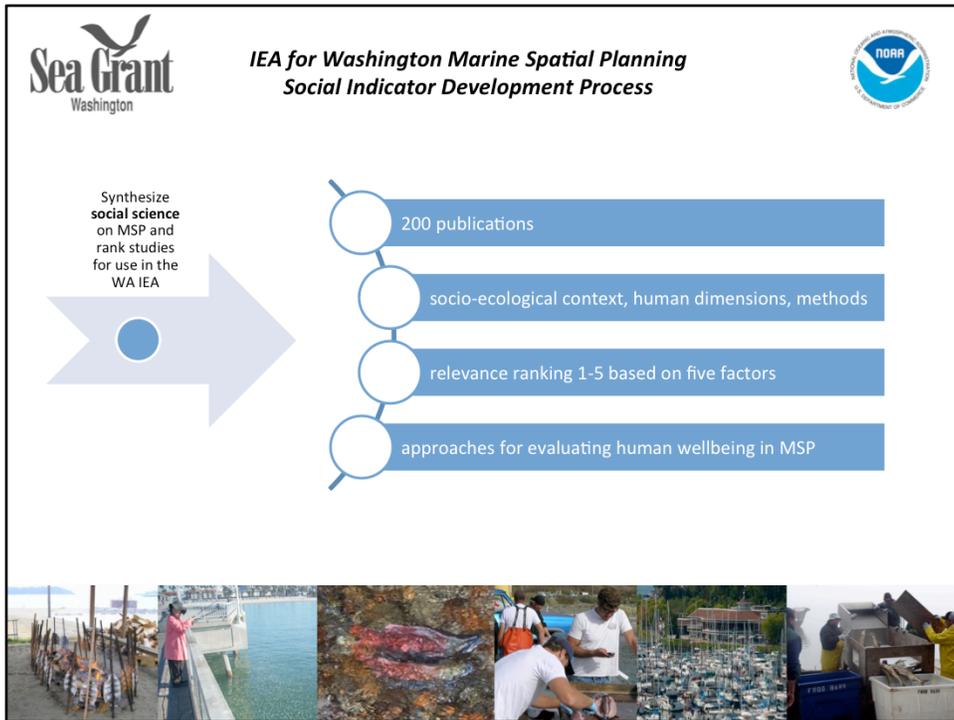
The domains in this framework are rooted in 4 key sources:

- US Legislation and Policy
- Existing HWB projects
- Social science recommendations
- **Local communities** – this final source is the most important factor in order to (a) tailor the framework to local contexts and priorities; (b) ensure usefulness and relevance; (c) engage local citizens in the development process and its applications

Local goals will be used to identify priority indicator areas.



In addition to defining goals and linking these to a HWB conceptual framework and local input, we are also underway with an extensive effort to synthesize the social science literature on human dimensions and social indicators mapping approaches for marine spatial planning from the social sciences literature and integrate the state of social science knowledge with locally-determined goals, values, and objectives

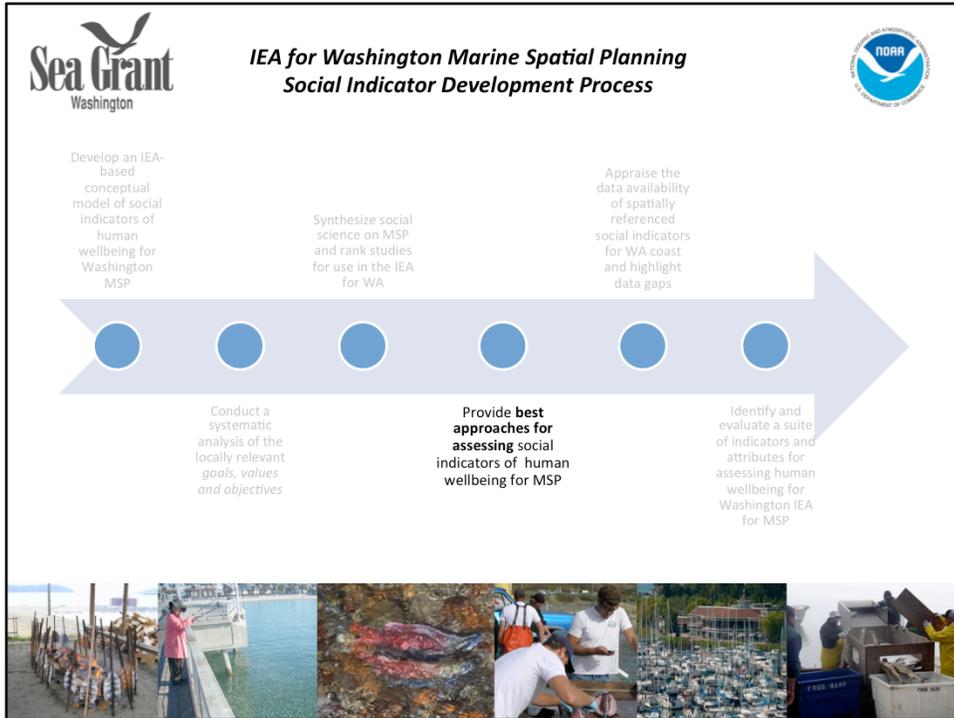


We aim to synthesize 200 publications from case studies around the world. WSG is working with UW SMEA RA, Samantha Macks, to help with this effort.

These studies were selected for their use of MSP in a variety of socio-ecological contexts to evaluate and map some set of human dimensions.

We scrutinize the case studies through a “relevance ranking” exercise and score each one on a 1-5 scale, depending on whether or not any of the following factors are met: meaningful social indicator; methodologically feasible; coastal ecosystem; geopolitical context; EBM-based.

Finally, we will select from this synthesis some potential approaches for mapping and evaluating social indicators of HWB in marine contexts like WA.



In addition to the MSP case study ranking from the social science literature synthesis, we are also working with CC IEA social science program to develop a social indicator selection criteria based on best available social science.



In this slide, I provide a draft of the some of the considerations for selecting indicators in consideration for the CCIEA; this is to give you a snap-shot of what this step might entail, and how the WA IEA could adopt similar evaluation standards. This is very much a work-in-progress.

Additionally, WSG has assembled a Science Panel for MSP science products, and the social scientist on the panel will be invited to review of our Social Indicator for WA IEA.



**IEA for Washington Marine Spatial Planning  
Social Indicator Development Process**



**Collaborators**

**Washington Sea Grant Staff**

- Penny Dalton
- Bridget Trosin
- Samantha Macks
- Kevin Decker

**Social Wellbeing Indicators (SWIMM)  
Team for CCIEA**

- Penny Dalton, WA Sea Grant
- Phil Levin, NOAA
- Sara Breslow, NRC/NOAA
- Nives Dolsak, UW
- Karma Norman, NOAA
- Raz Barnea, UW-SMEA
- Brit Sojka, UW-SMEA

**SWIMM Social Science Working Group**

- Arun Agrawal, U Michigan
- Xavier Basurto, Duke U
- Courtney Carothers, U Alaska
- Susan Charnley, USFS, Portland
- Sarah Coulthard, Northumbria U
- Jamie Donatuto, Swinomish Tribe
- Carlos Garcia-Quijano, U Rhode Isl.
- Christina Hicks, Ctr Ocean Solutions
- Arielle Levine, San Diego State U
- Michael Mascia, WWF (recent)
- Terre Satterfield, U British Columbia
- Kevin St. Martin, Rutgers U



Before concluding, I'd like to acknowledge a few important collaborators who have been involved in the MSP and IEA work (for both WA and CC):

**Washington Sea Grant Staff involved in MSP Social Indicators for WA IEA**

- Penny Dalton, WA Sea Grant
- Bridget Trosin, WA Sea Grant
- Samantha Macks, UW-SMEA
- Kevin Decker, WA Sea Grant

**Social Wellbeing Indicators for Marine Management for CCIEA (SWIMM)**

**Local Team**

- Phil Levin, NOAA
- Sara Breslow, NRC/NOAA
- Nives Dolsak, UW
- Karma Norman, NOAA
- Melissa Poe, WSG/NOAA
- Raz Barnea, UW-SMEA
- Brit Sojka, UW-SMEA

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- Michael Mascia, WWF (recent)
- Terre Satterfield, U British Columbia
- Kevin St. Martin, Rutgers U



Thank you!

Questions/Comments?

email: [mpoe@uw.edu](mailto:mpoe@uw.edu)



Please contact me with questions or feedback.