



The California Current IEA: Avenues of Growing Collaboration

Greg Williams

NOAA - Northwest Fisheries Science Center

NWFSC – P. Levin, C. Harvey, K. Andrews, N. Tolimieri, B. Peterson, R. Brodeur, et al.
SWFSC – B. Wells, J. Field, A. Thompson, E. Hazen, S. McClatchie, J. Redfern, et al.
Monterey Bay National Marine Sanctuary - Jenn Brown, et al.

Presentation Overview

- The California Current Integrated Ecosystem Assessment (IEA)
 - Background, Indicator Selection, Status and Trends
- IEA products for the Sanctuaries and Partners
 - Indicators and data: Monterey Bay NMS
 - Regional time-series analyses: Olympic Coast NMS
- Sanctuary products being used for the IEA
 - Ocean data used to validate climate and sardine forecast models

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 Social-Ecological Systems** and to 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

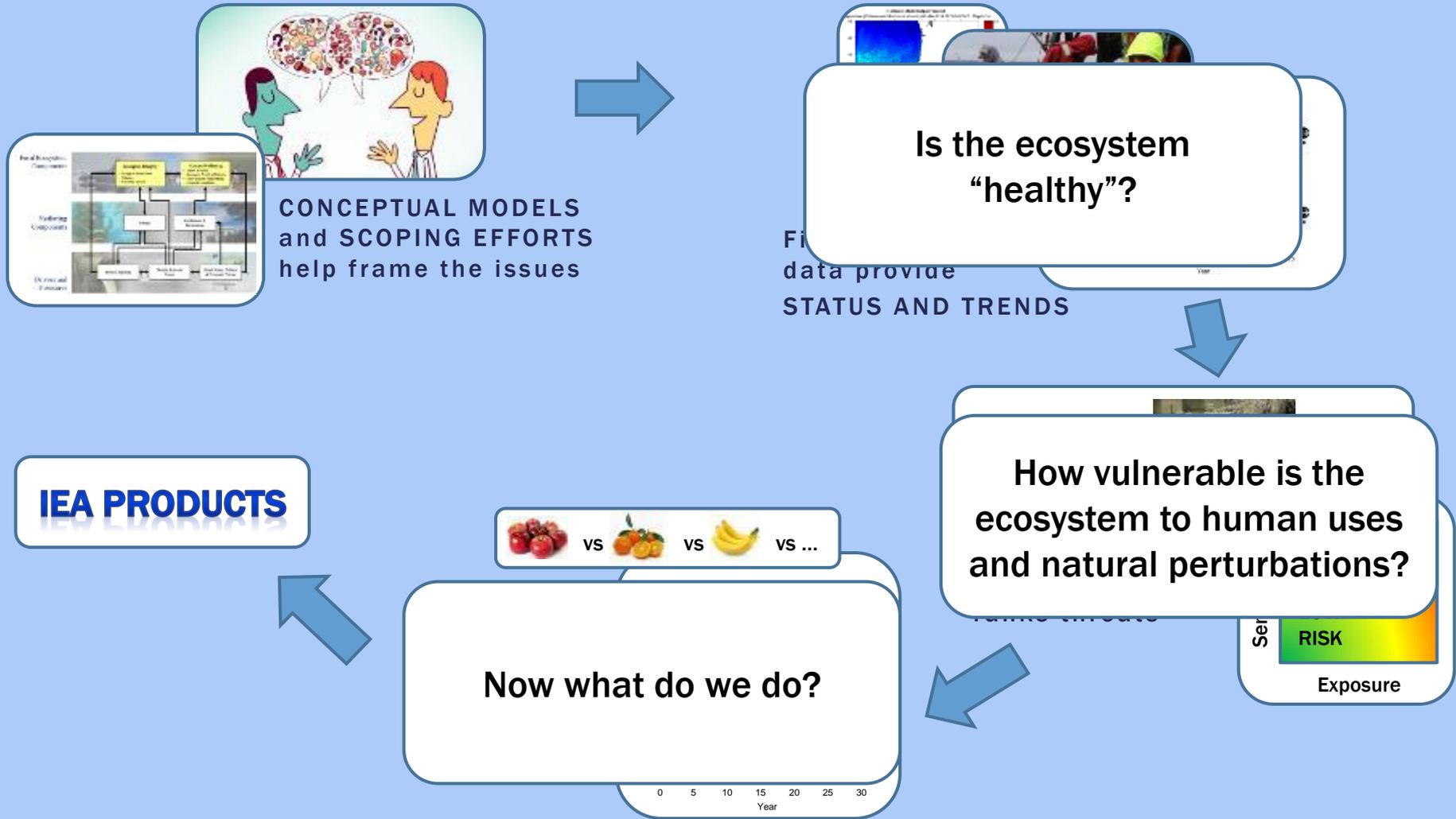
(e.g., climate, ocean upwelling)



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

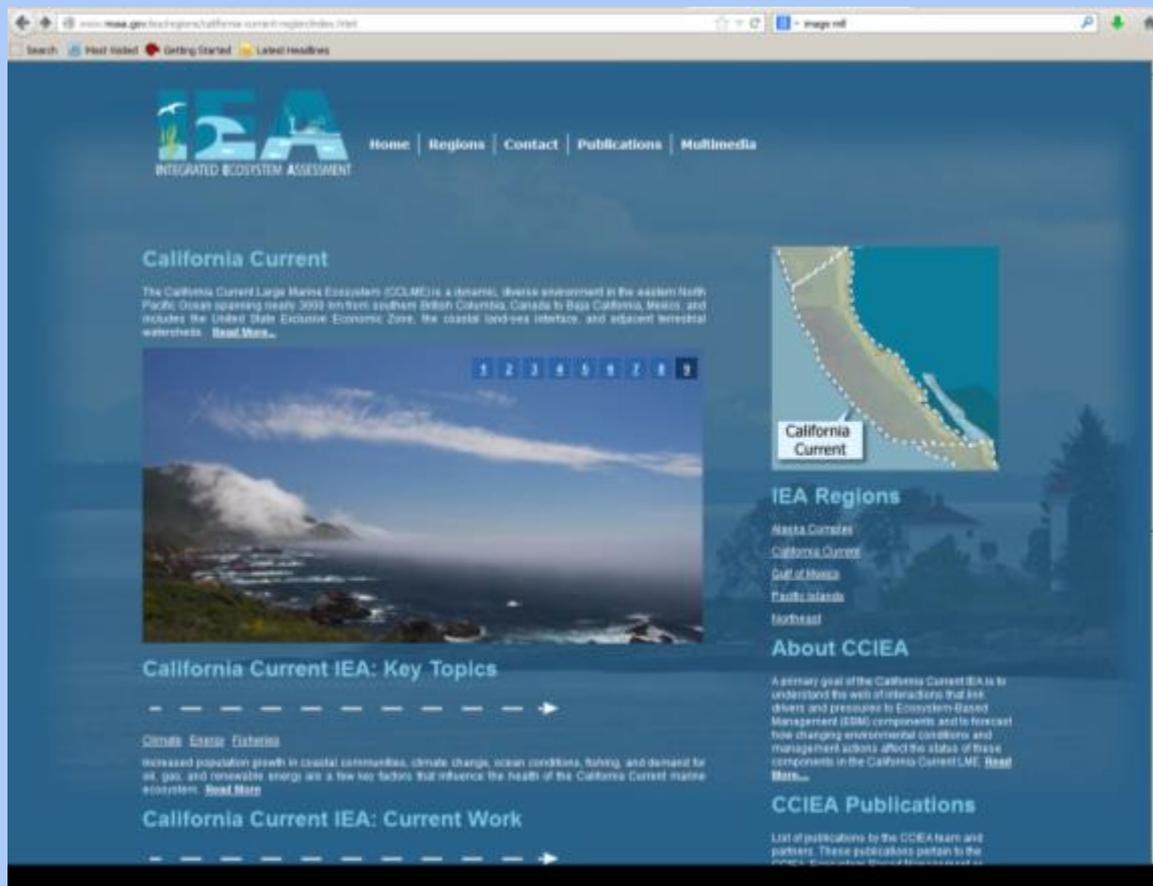


Key “customers” / partners

- Pacific Fisheries Management Council
 - Annual “State of the California Current” report
 - Fishery Ecosystem Planning
 - Essential Fish Habitat designations (e.g., groundfish)
- NOAA Managers
 - Protected species management (marine mammals, birds, salmon)
 - Forage fish and groundfish management
- Washington State Dept. Natural Resources/Ecology
 - Marine Spatial Planning process
- National Marine Sanctuary Program
 - Spatial planning, Habitat risk assessment, Condition reports

CCIEA WEBSITE

www.noaa.gov/iea/regions/california-current-region/



- Up-to-date research priorities and highlights
- Products
 - Findings
 - Reports formatted for easy web-based viewing
 - Peer reviewed
- Coming soon: web-based data portal and visualization tools

STATE OF THE CALIFORNIA CURRENT ECOSYSTEM IN 2013

California
Current
Integrated
Ecosystem
Assessment
Team



OVERVIEW



- **Climate and Ocean Drivers**
- **Components of Ecological Integrity**
- **Human Activities**
- **Human Wellbeing**

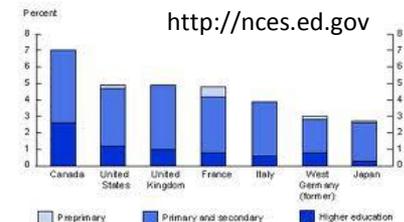
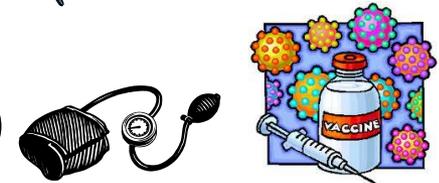
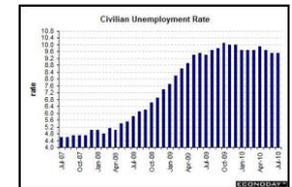
Ecosystem Indicators



- 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, Immuniz coverage (%)
- 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



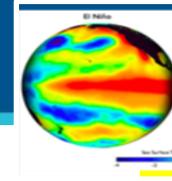
Ecological Components

- **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

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Social Drivers

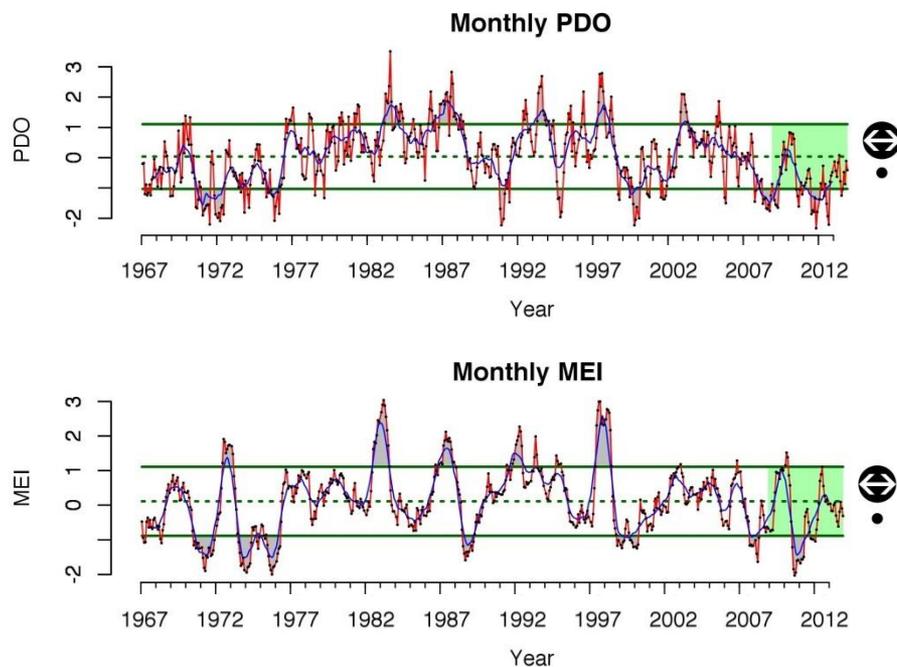
(e.g., population growth and settlement patterns, national and global economic and political systems, historical legacies, dominant cultural values, and class systems)

CLIMATE AND OCEAN DRIVERS



*The coast of
Santa Rosa Island
(NOAA Photo Library)*

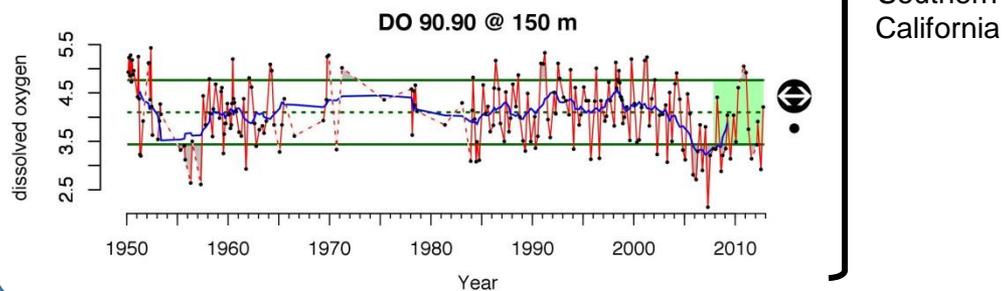
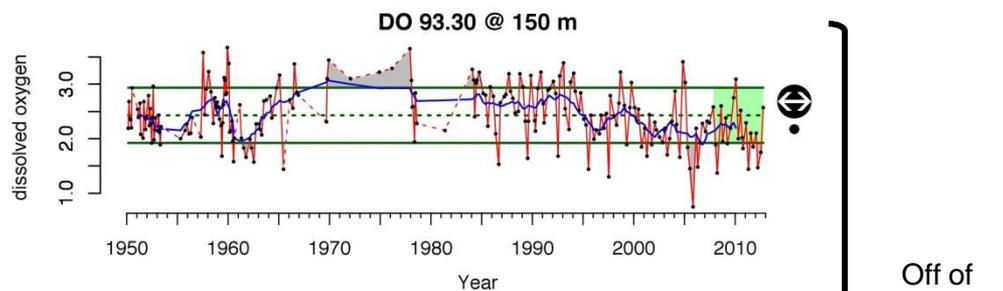
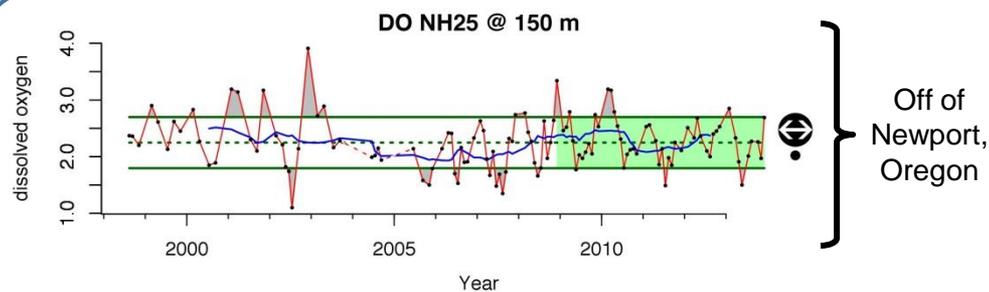
CLIMATE AND OCEAN DRIVERS



BASIN SCALE DRIVERS

- Temperature and upwelling indicators generally stable and close to long-term average
- Pointing toward cooler, more productive system

CLIMATE AND OCEAN DRIVERS



DISSOLVED OXYGEN (DO)

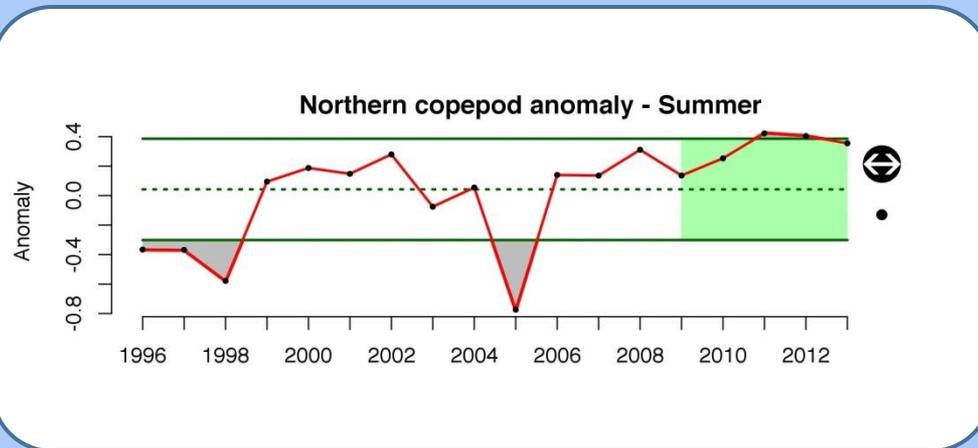
- Generally stable and mostly above “hypoxia” threshold (1.4 ml L^{-1})
- A localized process; these sites may not capture nearshore hypoxic events

COMPONENTS OF ECOLOGICAL INTEGRITY



*Cowcod rockfish,
Sebastes levis, over rocky
substrate and crinoids
(NOAA Photo Library)*

COMPONENTS OF ECOLOGICAL INTEGRITY

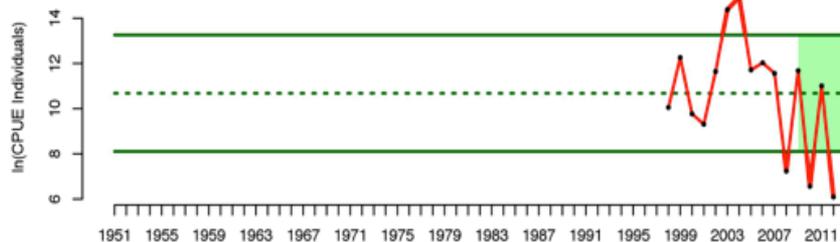


Zooplankton

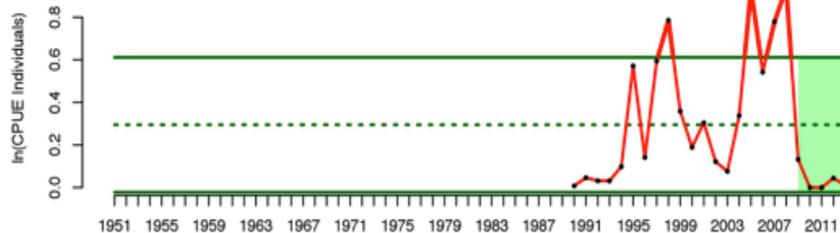
- Biomass anomaly is stable; relatively high values in most recent years suggest generally productive state
- High in fatty acids, valuable forage for salmon and other fishes

COMPONENTS OF ECOLOGICAL INTEGRITY

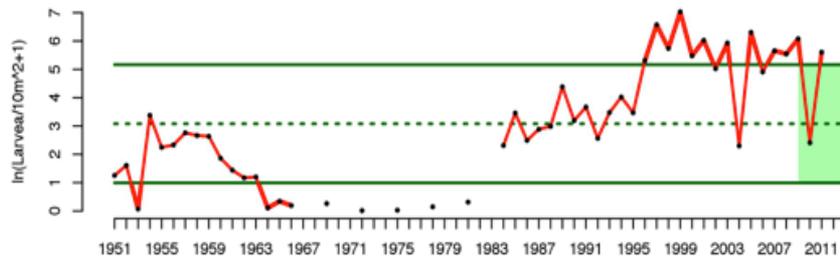
F. Northern California Current Sardine



D. Central California Current Sardine



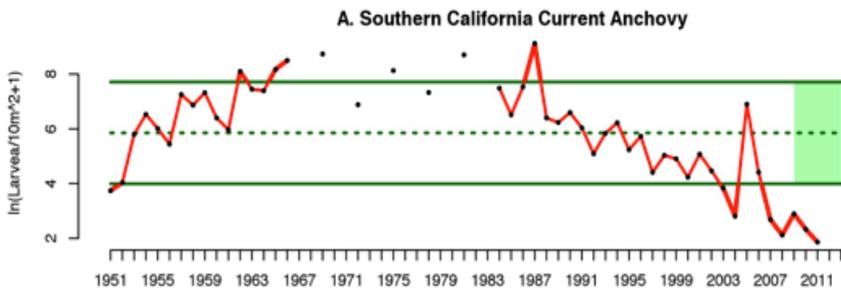
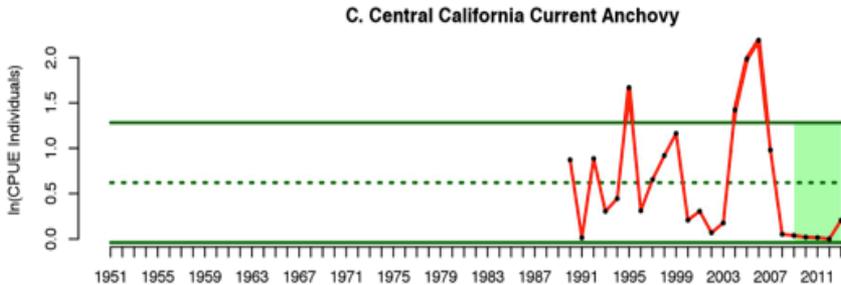
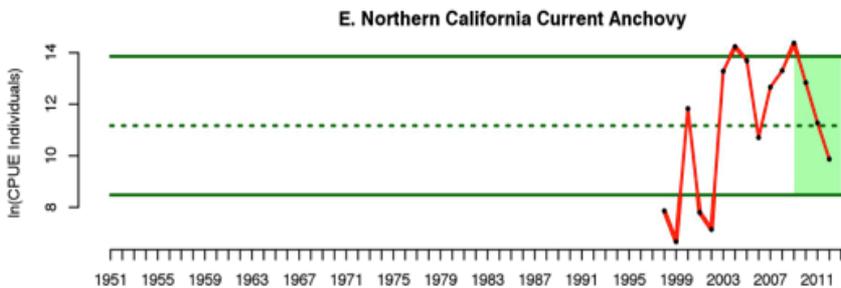
B. Southern California Current Sardine



SARDINE

- Sardine abundance is reduced in northern and central cruises

COMPONENTS OF ECOLOGICAL INTEGRITY



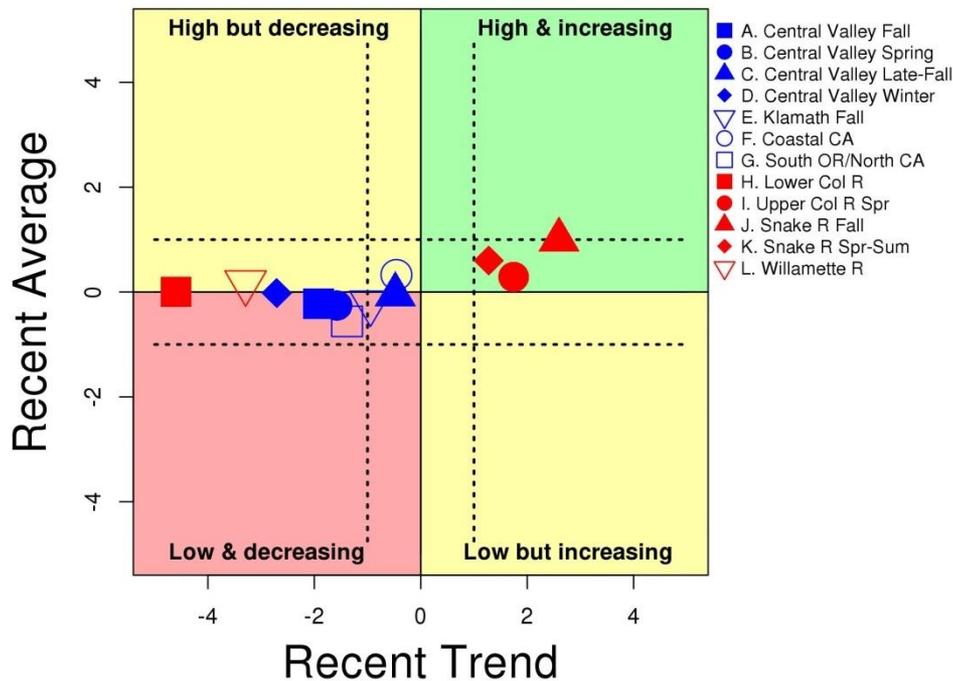
ANCHOVY

- Anchovy abundance is reduced in central and southern cruises

COMPONENTS OF ECOLOGICAL INTEGRITY



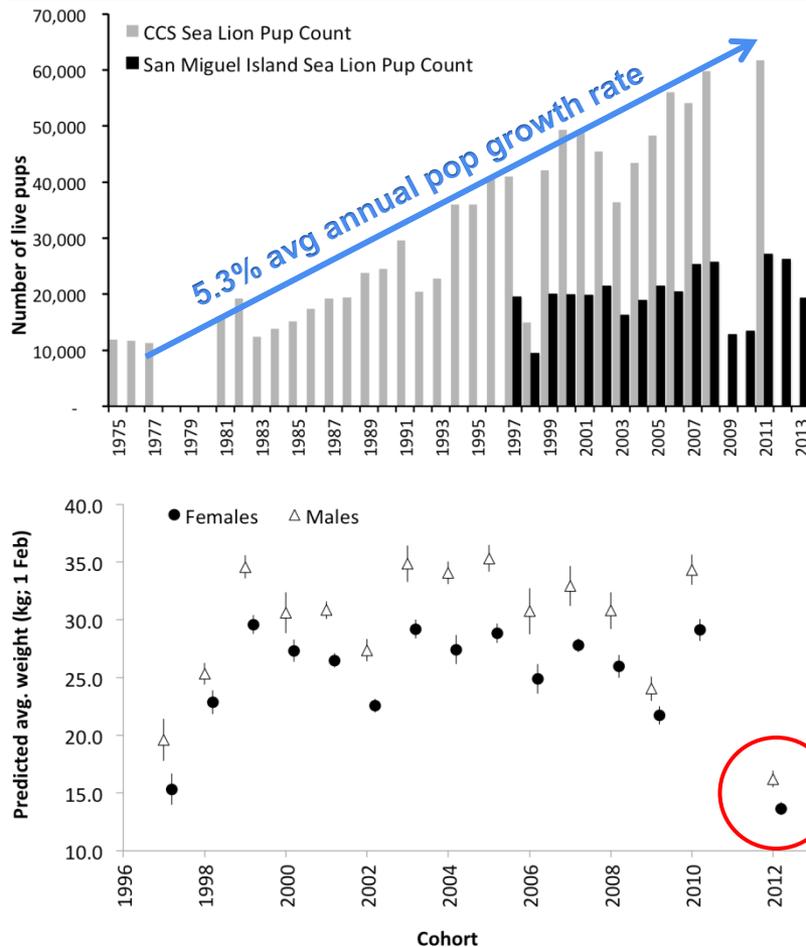
Chinook Salmon Escapement



CHINOOK SALMON

- Recent escapements have been average
- But, some increasing trends, several decreasing trends
- ENSO events have potential to negatively affect many of these stocks

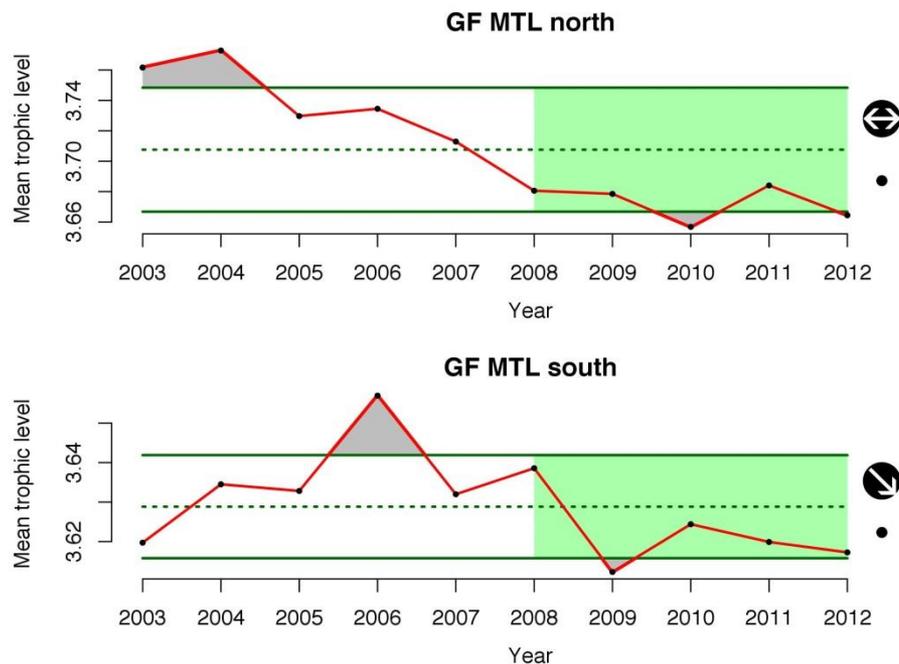
COMPONENTS OF ECOLOGICAL INTEGRITY



California sea lion pups

- Pup counts and pup growth are sensitive to prey availability
- Recent pup counts continued long-term increasing trend
- Pup growth index dropped sharply in 2012 (40 to 45% underweight)
- Unusual Mortality Event: 3x the normal number of stranded pups from January-April 2013

COMPONENTS OF ECOLOGICAL INTEGRITY



Groundfish trophic level

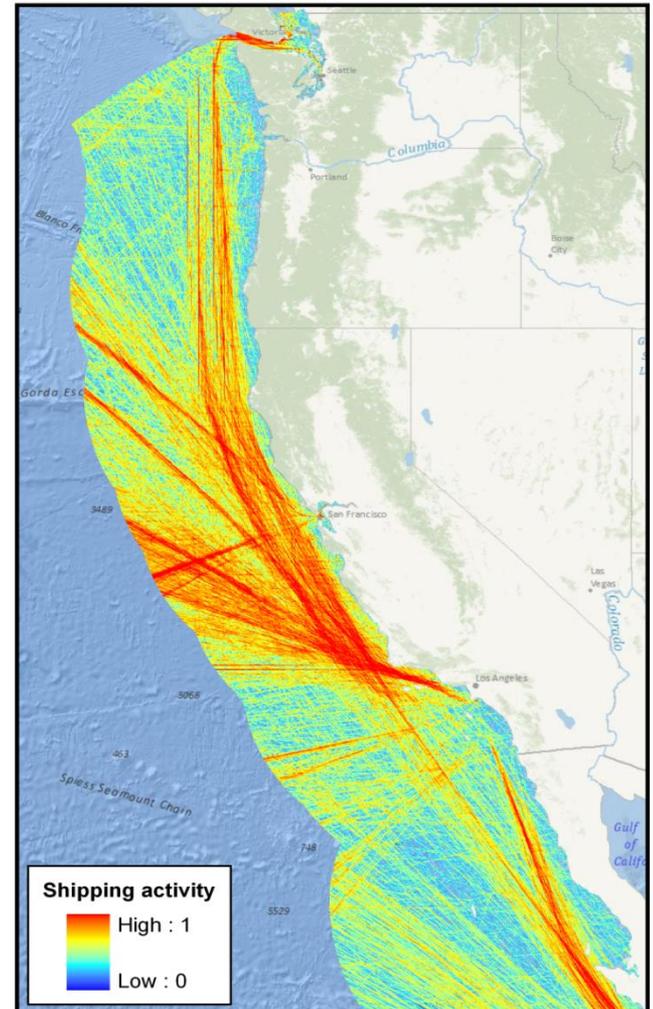
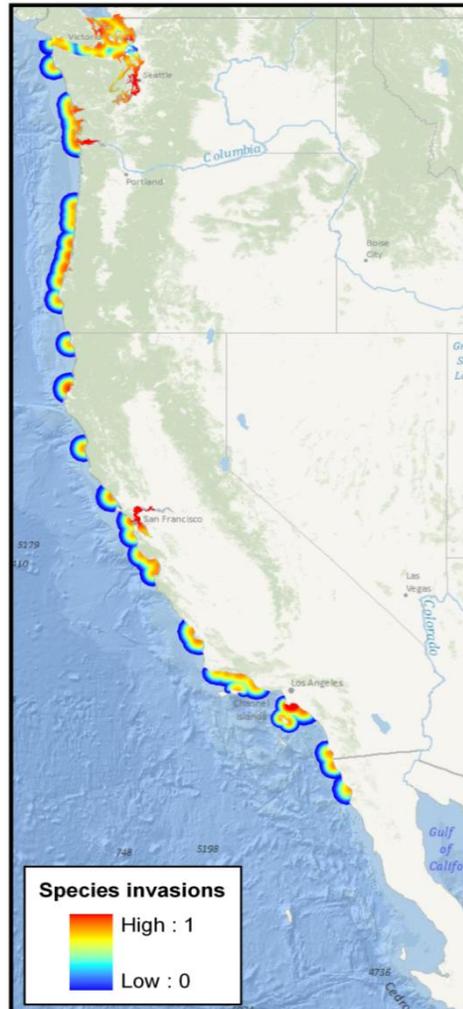
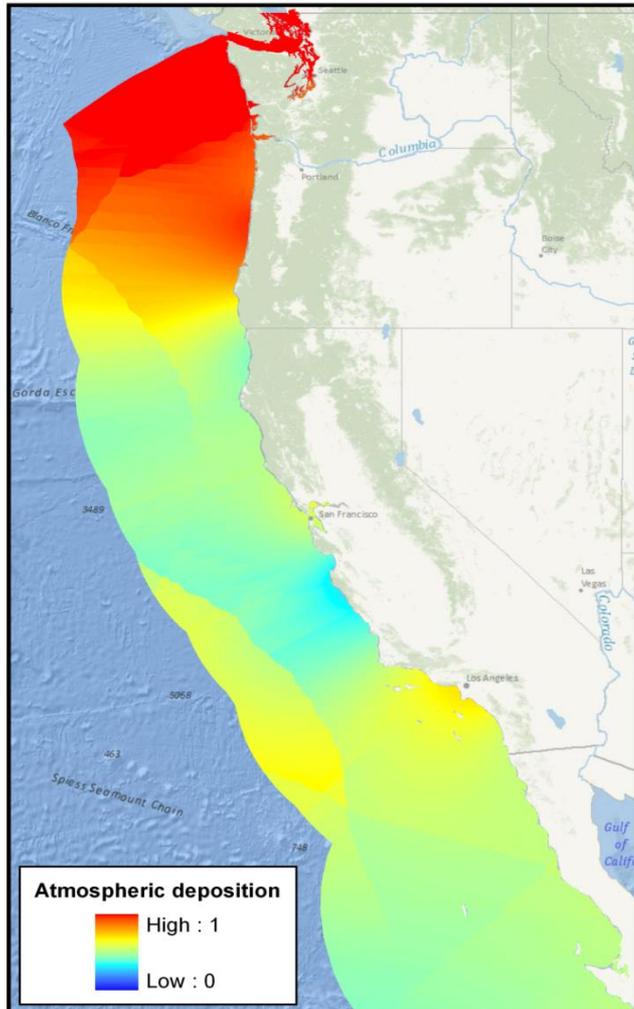
- Mean trophic level (MTL) indicates relative abundance of higher predators — e.g., sablefish, spiny dogfish, Pacific hake
- Derived from bottom trawl survey data north and south of Cape Mendocino
- In last 5 years, MTL stable in north (↔) but decreasing (↘) in south; both within 1 s.d. of long-term averages (•)
- May indicate less predation by groundfish on forage species

HUMAN ACTIVITIES

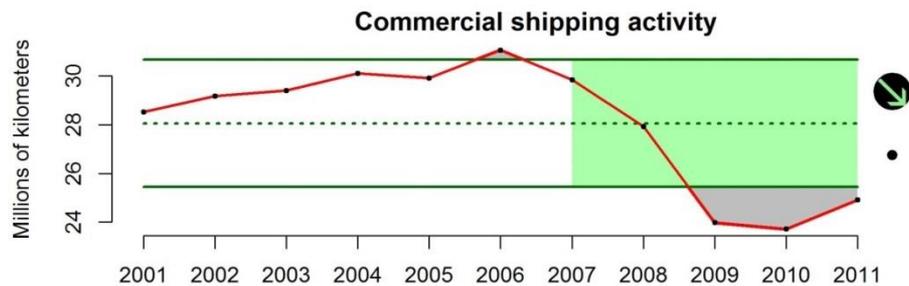


*Salmon troller
Seamaid off
Oregon coast
(Chris Toole)*

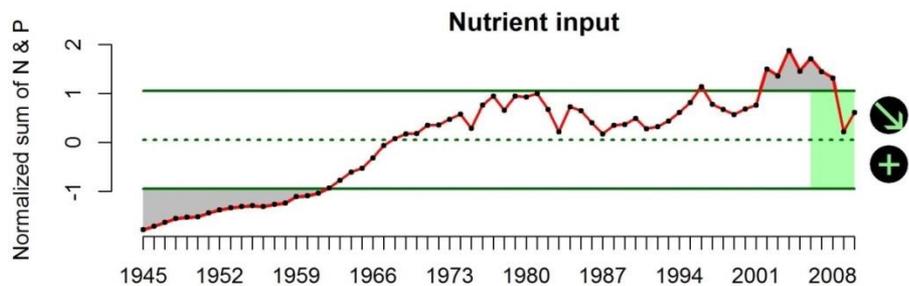
SPATIAL ANALYSES - HUMAN ACTIVITIES



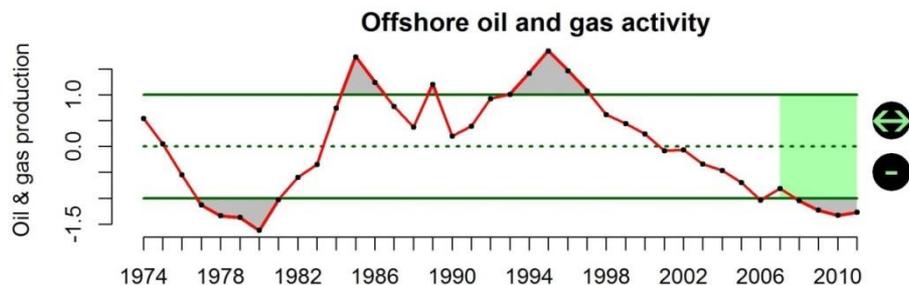
HUMAN ACTIVITIES



- Commercial shipping has declined

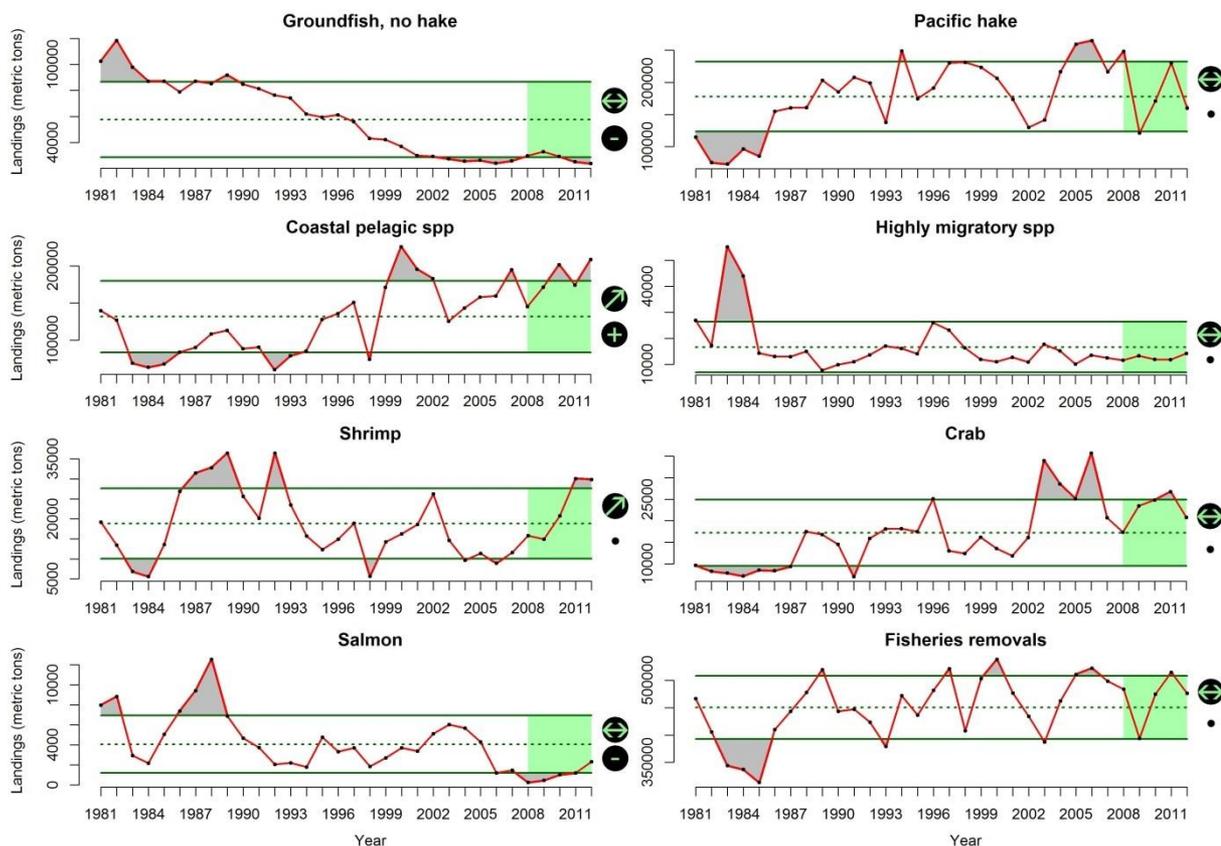


- Nutrient inputs (N & P fertilizers) elevated but declining recently



- Offshore oil and gas activity has leveled off following decline

HUMAN ACTIVITIES



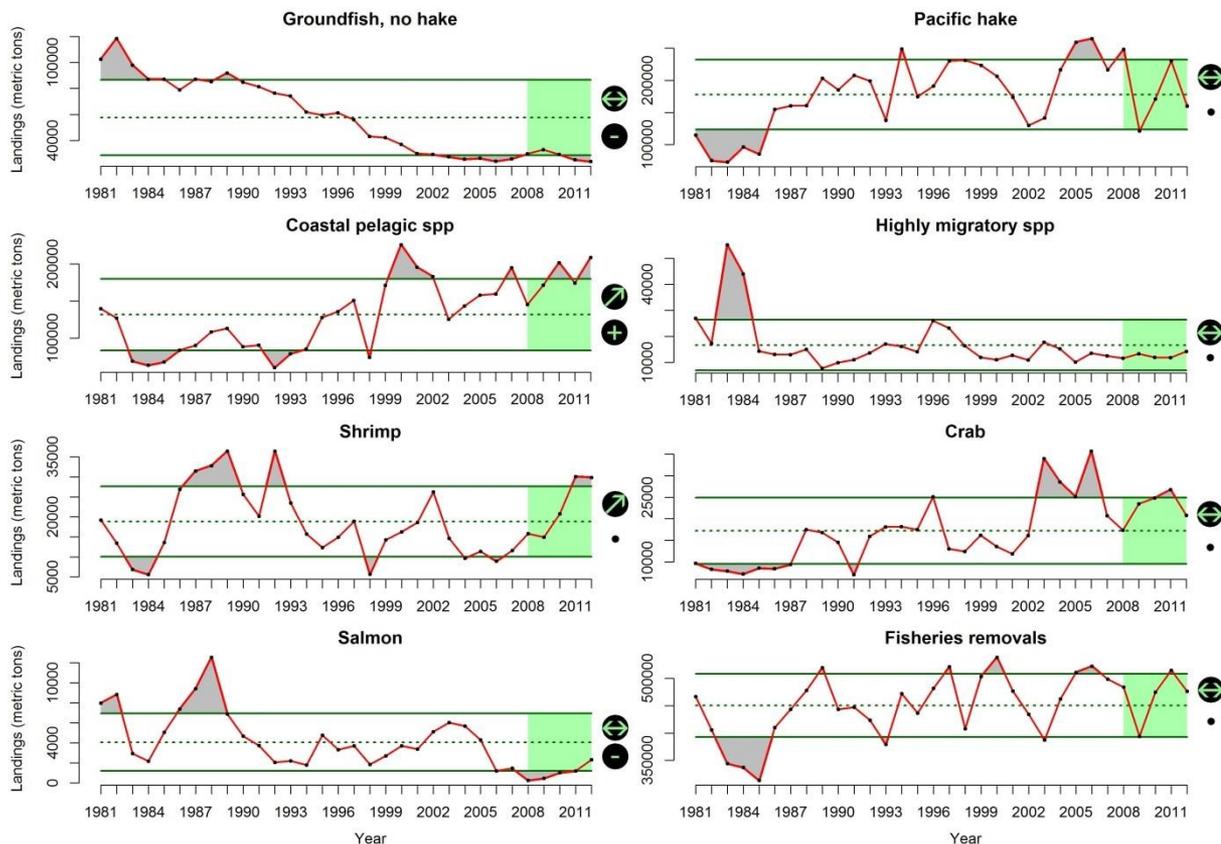
5-year trends in fisheries landings

- Stable (↔)
 - Groundfish (no hake)
 - Pacific hake
 - HMS
 - Crab
 - Salmon
 - Total removals

- Increasing (↗)
 - CPS
 - Shrimp

- Decreasing (↘)
 - None

HUMAN ACTIVITIES



5-year averages in fisheries landings

- Within 1 s.d. of long-term average (•)
 - Pacific hake
 - HMS
 - Crab
 - Shrimp
 - Total removals

- >1 s.d. above long-term average (+)
 - CPS

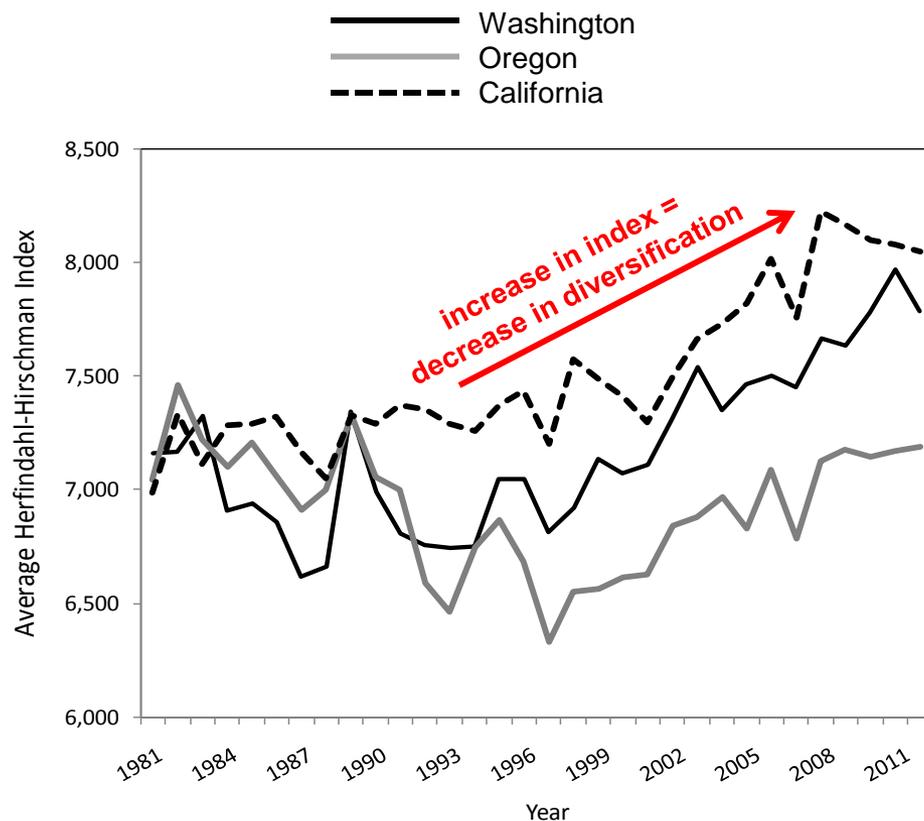
- >1 s.d. below long-term average (-)
 - Groundfish (no hake)
 - Salmon

HUMAN WELLBEING



*Anglers near Gig Harbor, WA
(Carol Baldwin, NOAA Photo Library)*

HUMAN WELLBEING



FLEET DIVERSIFICATION

- Revenue stability increases when fishing activity is diversified
- Diversification of West Coast Fleet is generally declining (HHI index \uparrow)
- Diversification and regulation interact

NEXT STEPS



- **Completion of:**
 - **Habitat component**
 - **Seabirds**

- **Significant progress and expansion of:**
 - **Human dimensions – human wellbeing indicators**

- **Continue Risk Assessments**

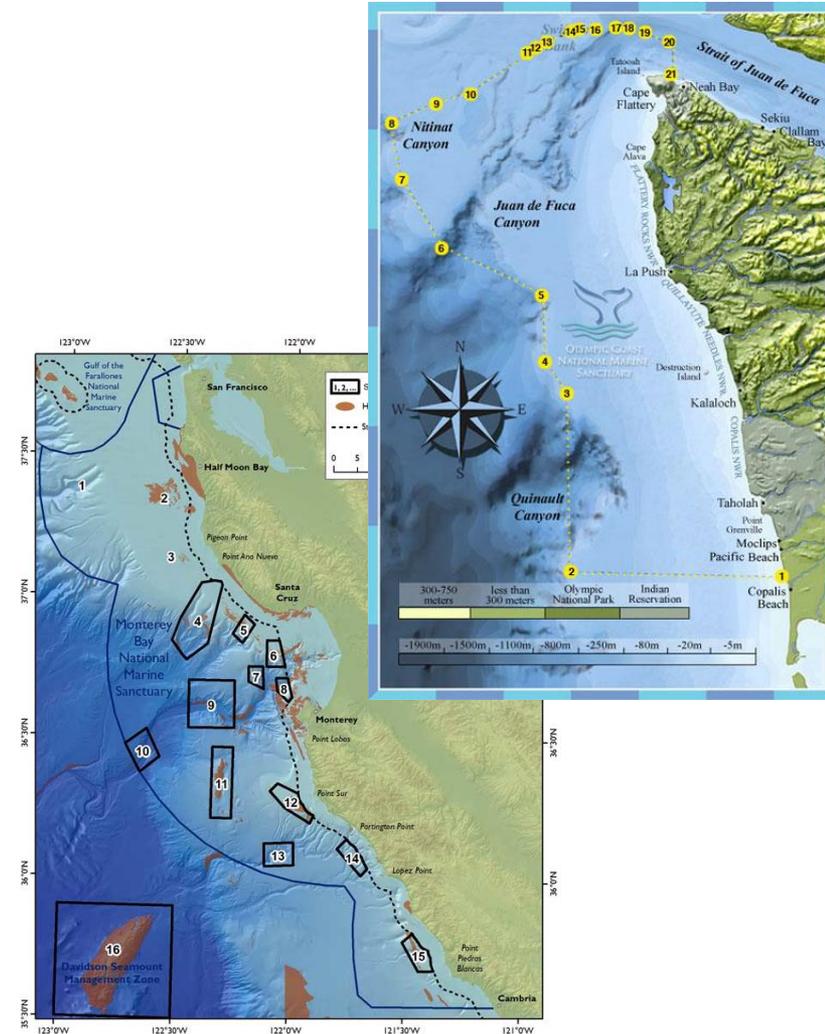
- **Expand management scenarios**

- **Integration**

National Marine Sanctuaries as IEA “Customers” & Partners

Primary Objective:

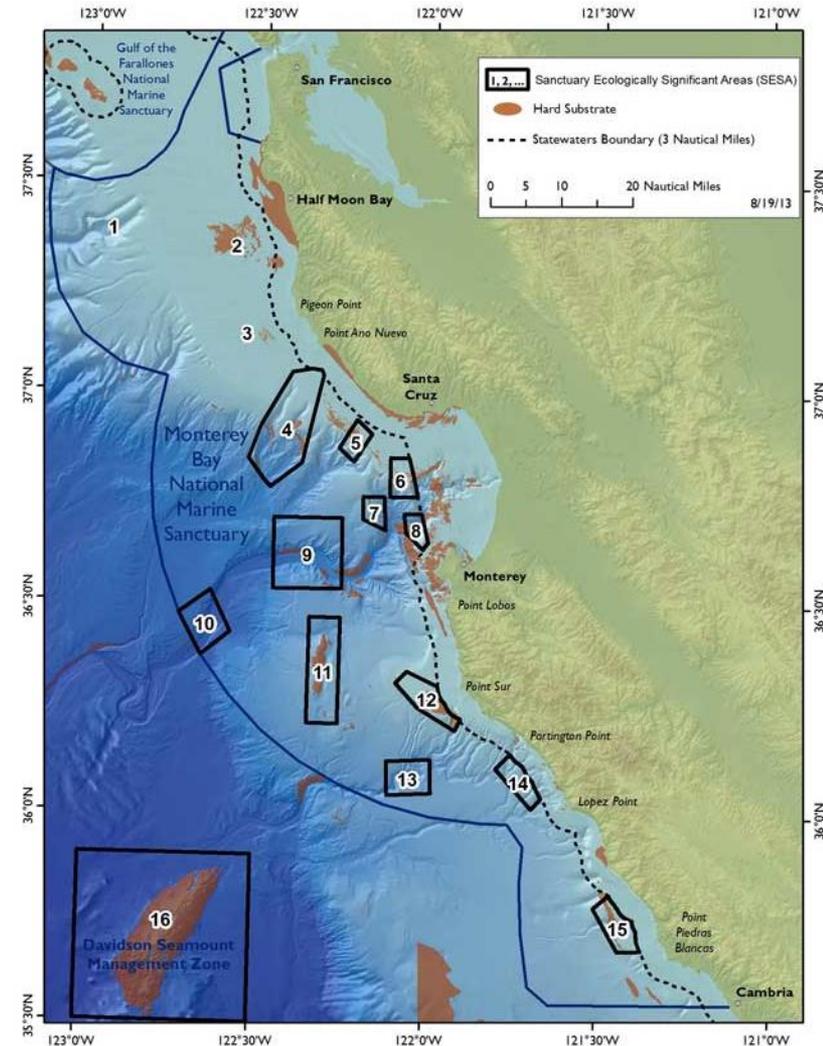
- Downscale and transfer products/processes from the coast-wide IEA for regional application



Ongoing Collaboration with Monterey Bay NMS

Approach:

- Identify focal **indicators** of ecosystem status and trends for Condition Report
- Generate **status and trend data** for selected indicators



Updating MBNMS 2009 Condition Report



Monterey Bay | CONDITION National Marine Sanctuary | REPORT 2009



September 2009



Habitat-based Indicators

Step 1: Select Habitats

Divide MBNMS into major habitat types that align with 3 environments in the condition report

Estuarine Environment



Nearshore Environment
(0 - 30 m)



Offshore Environment
(>30 m)



Habitat-based Indicators

Step 2: Compile Long-list

For each habitat compile a long-list of potential indicators

Sources of potential indicators:

- **CCIEA-developed indicators**
- MBNMS condition report
- Other West Coast indicator portfolios & indicator development efforts

Habitat-based Indicators

Step 3: Narrow Indicator list

Evaluate potential indicators based on:

- Relevance to MBNMS Condition Report
- Standardized indicator evaluation process
- Complementary indicator portfolios
- Representation across different habitat attributes
(Habitat specific vs. cross-habitat indicators)

Indicator Evaluation Process

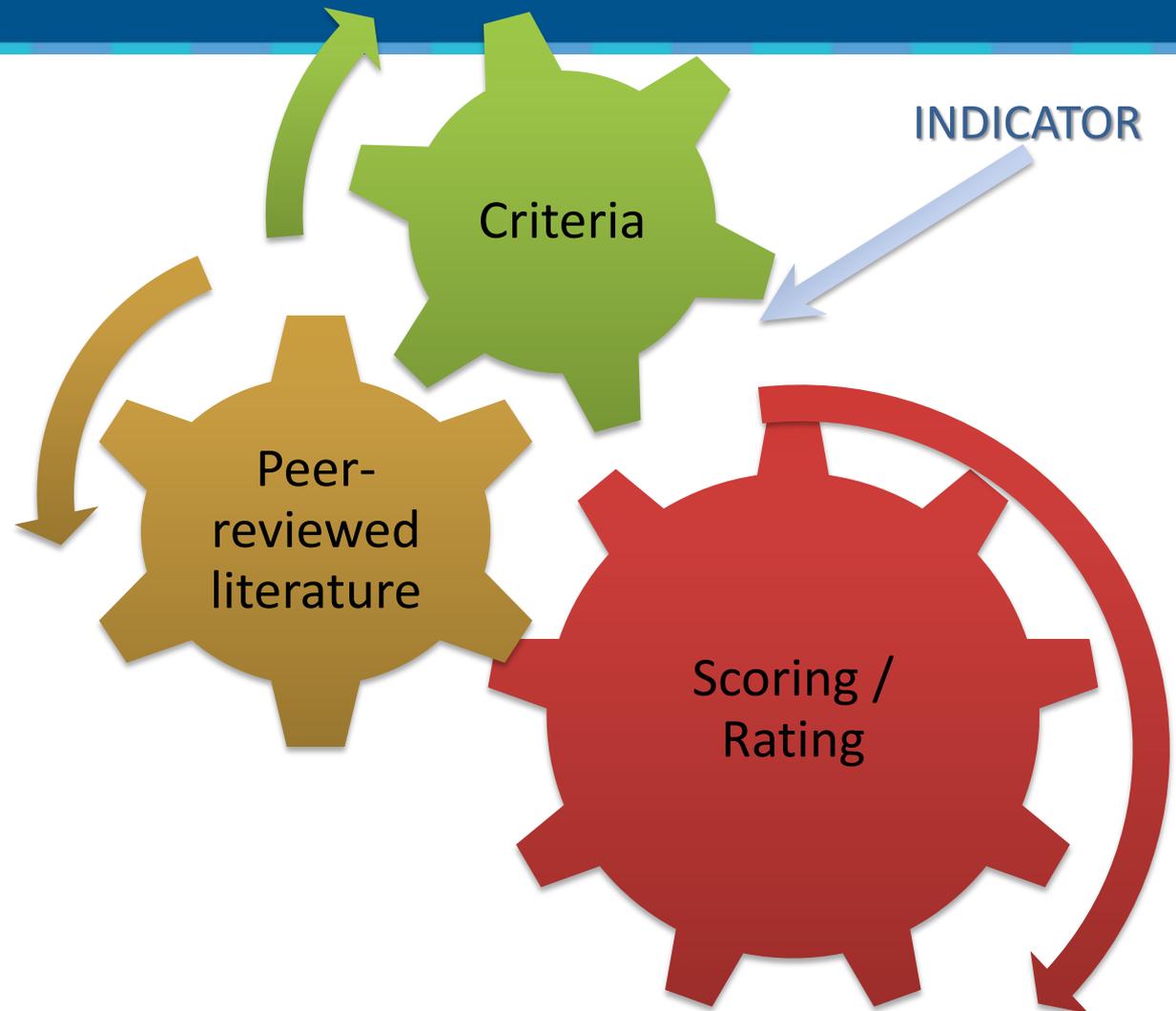
- Transparent
- Repeatable
- Scientifically Defensible
- Readily Updated



Indicator Evaluation Process

5 Steps:

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



Habitat-based Indicator Evaluation Criteria

Indicator Evaluation Criteria (Kershner et al. 2011)

Primary considerations (5)	Data considerations (7)	Other considerations (5)
<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• Compatible (region, national, international)

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

Rating indicators (49) by our criteria:

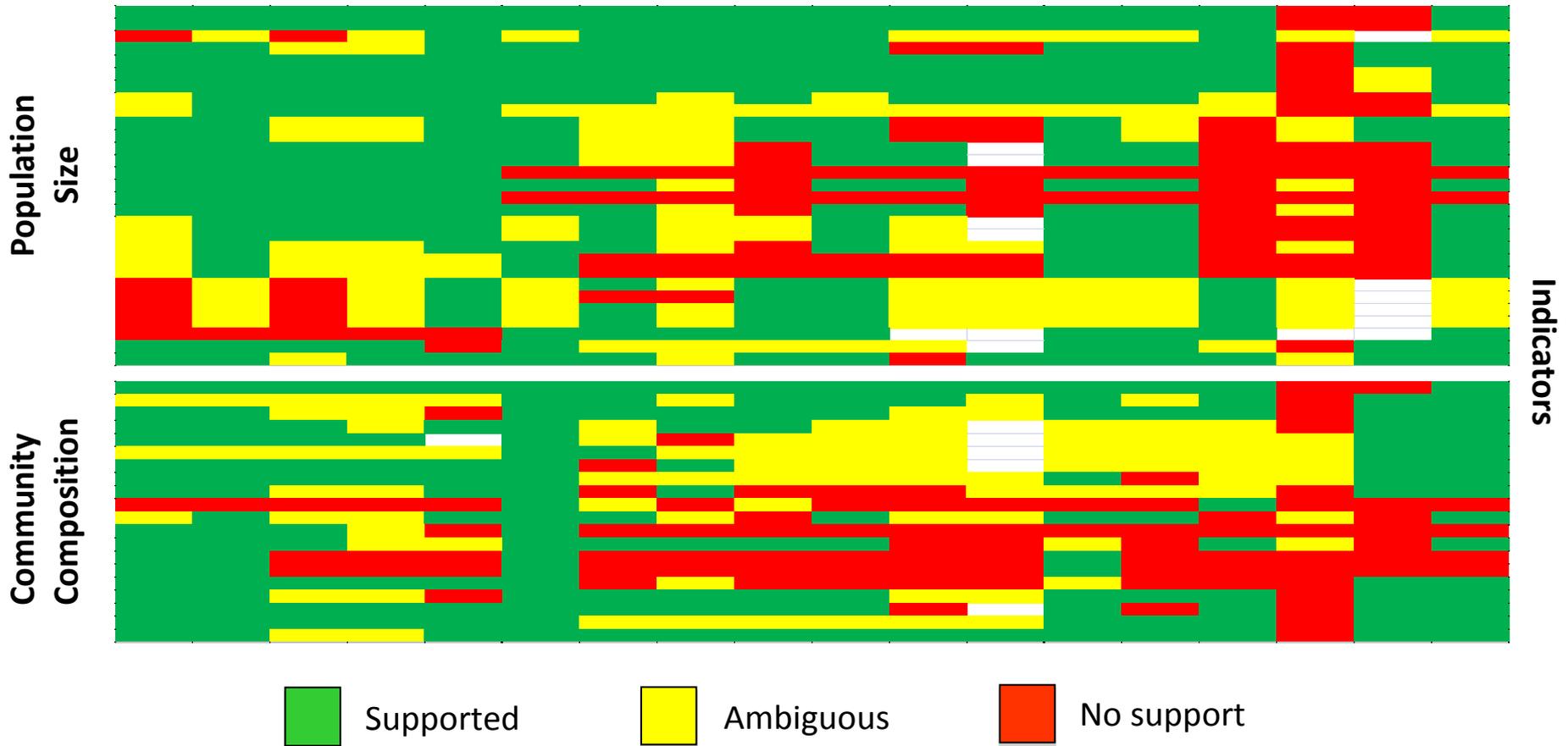
Goal: West Coast Groundfish

Criteria:

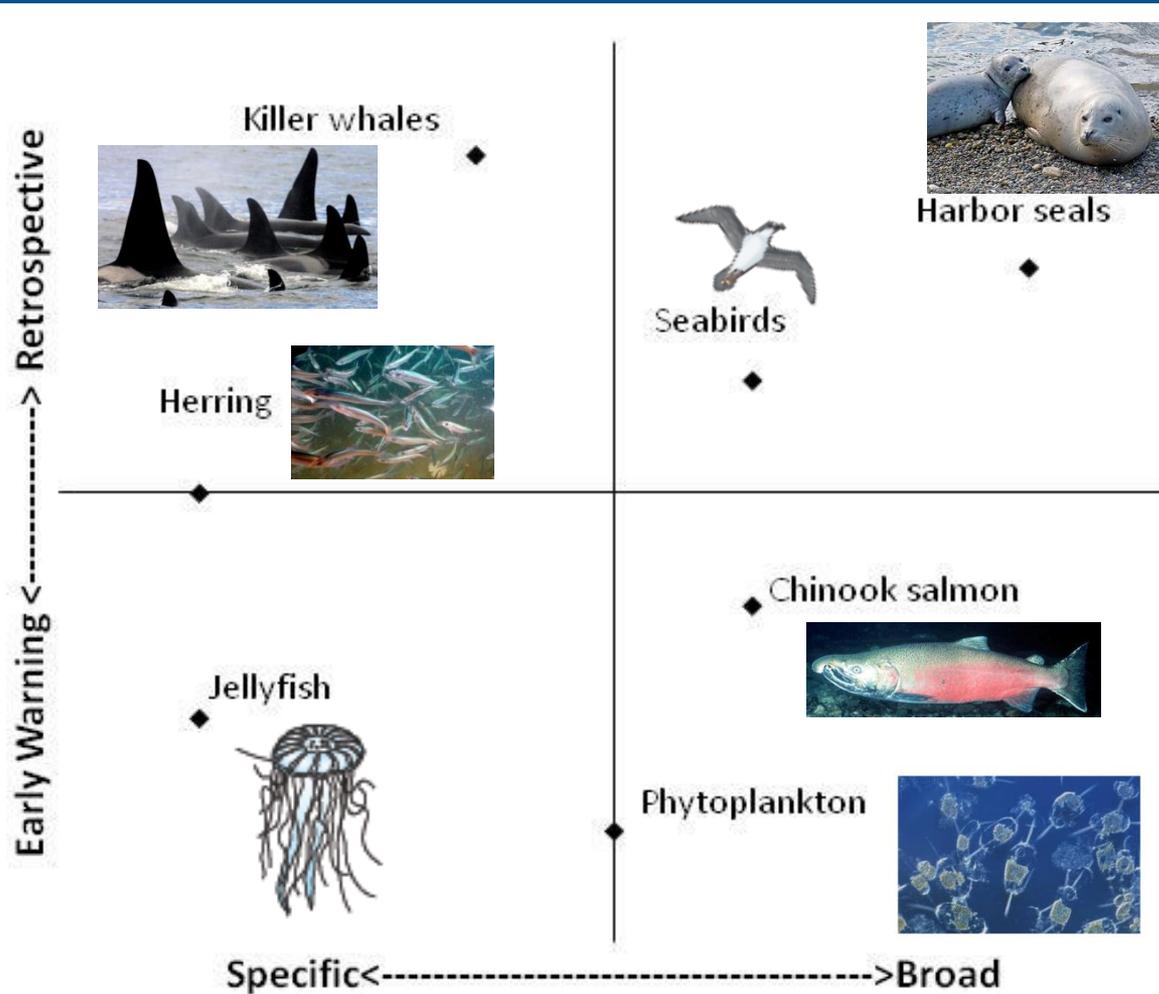
Primary

Data

Other



Portfolio Building Considerations: Complementarity



Deep Seafloor (>30 m) – Potential Indicators

1st tier

2nd tier

Need data

DO and hypoxia

Upwelling Index

SST

Marine Debris abundance

Trawling Distance

Fishery removals Commercial

Fishery removals Recreational

Rockfishes total abundance & size frequency

Top predator biomass

Demersal fish Diversity index

Corals & sponges

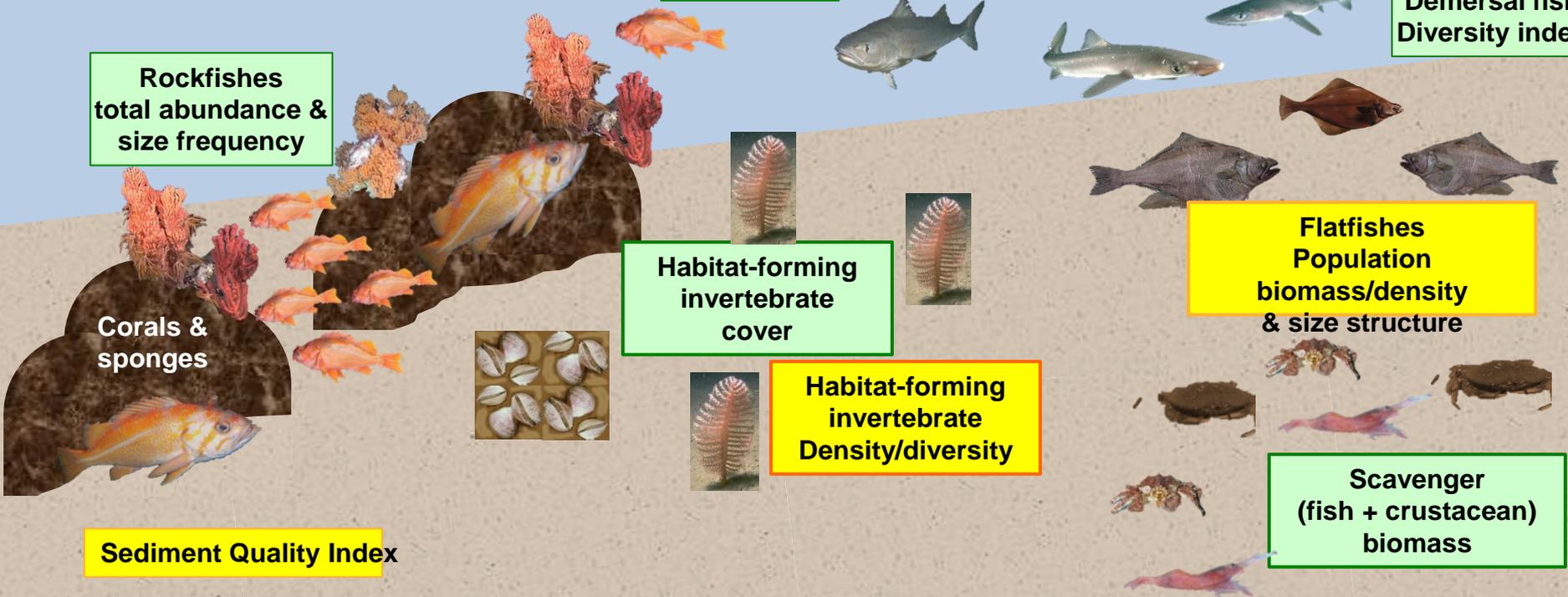
Habitat-forming invertebrate cover

Flatfishes Population biomass/density & size structure

Habitat-forming invertebrate Density/diversity

Scavenger (fish + crustacean) biomass

Sediment Quality Index



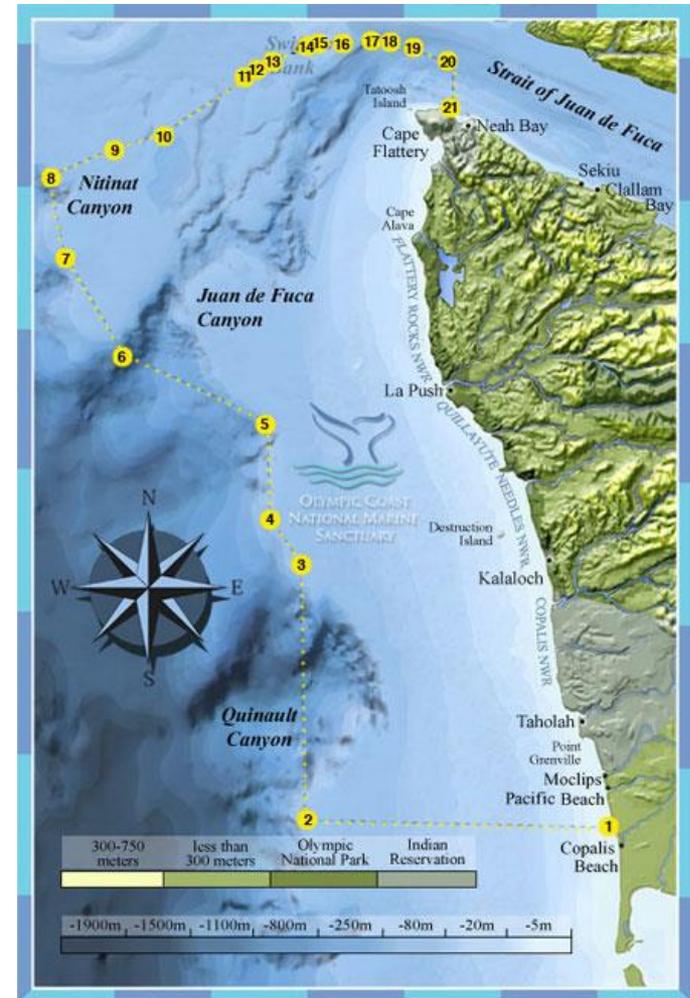
Question 14: What are the levels of human activities that may influence living resource quality and how are they changing?

Environment	Estuarine	Nearshore	Offshore	Seamount
2009 rating	?	▼	▲	
New 2014 rating needed?	Maybe Could re-evaluate trend with new data	YES change status to 'G' & trend to '▲'	YES Re-evaluated status and trend with new info [target for IEA modeling]	YES new status and trend needed (IEA modeling?)
Key New Info	<ul style="list-style-type: none"> Nutrients/pollutants as indicator of human activity trend 	<ul style="list-style-type: none"> BeachCOMBERS data Fishing activity (landings, CPFV, # MLPA violations) Marine debris (SOS, Rosevelt et al. 2013) 	<ul style="list-style-type: none"> vessel traffic (DeBeukelaer et al. 2014) BeachCOMBERS data fishing activity (EFH new data layers) MBARI marine debris cumulative human impacts (Halpern & Maxwell studies) 	<ul style="list-style-type: none"> vessel traffic (DeBeukelaer et al. 2014) fishing activity & regs (EFH new data layers) cumulative human impacts (Halpern & Maxwell studies)

- Good** Few or no activities occur that are likely to negatively affect living resource quality.
- Good/Fair** Some potentially harmful activities exist, but they do not appear to have had a negative effect on living resource quality.
- Fair** Selected activities have resulted in measurable living resource impacts, but evidence suggests effects are localized, not widespread.
- Fair/Poor** Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.
- Poor** Selected activities warrant widespread concern and action, as large-scale, persistent and/or repeated severe impacts have occurred or are likely to occur.

Collaboration with Olympic Coast NMS and Partners

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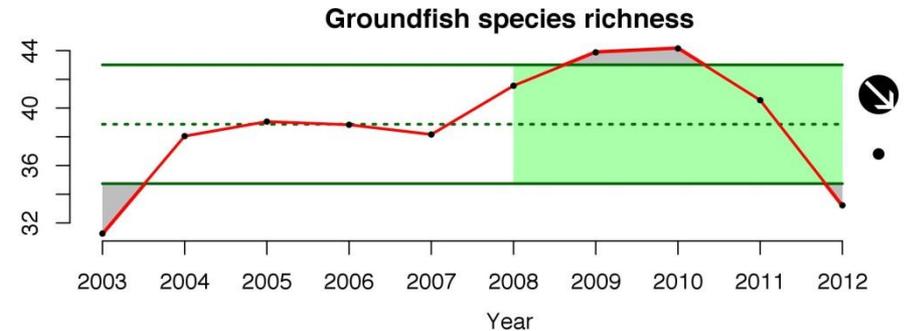
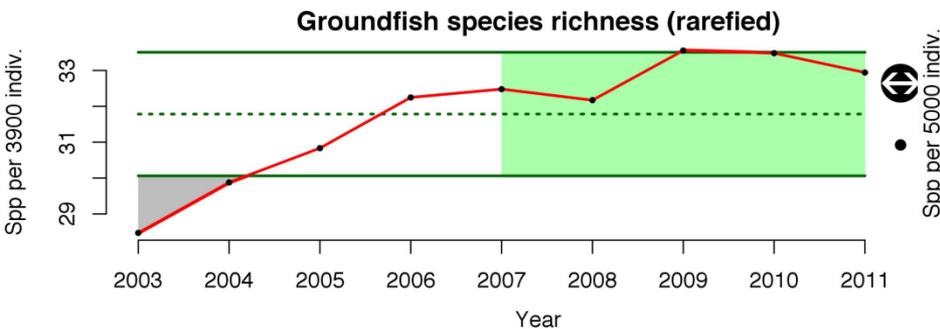
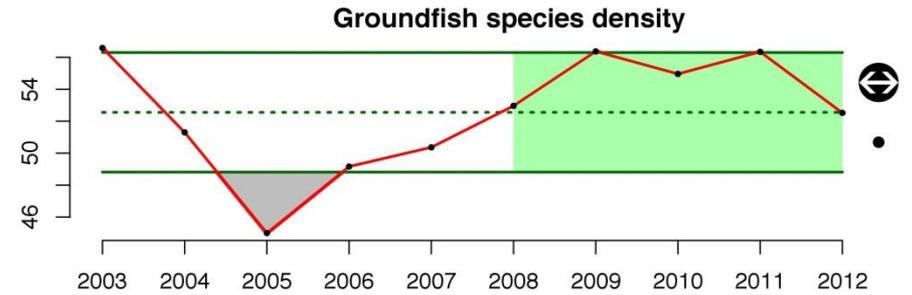
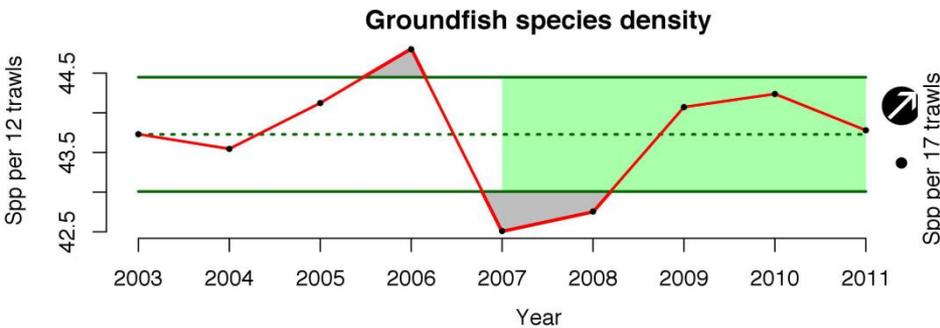
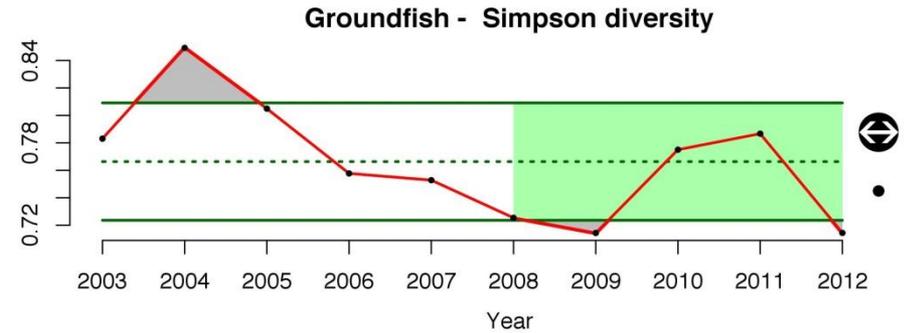
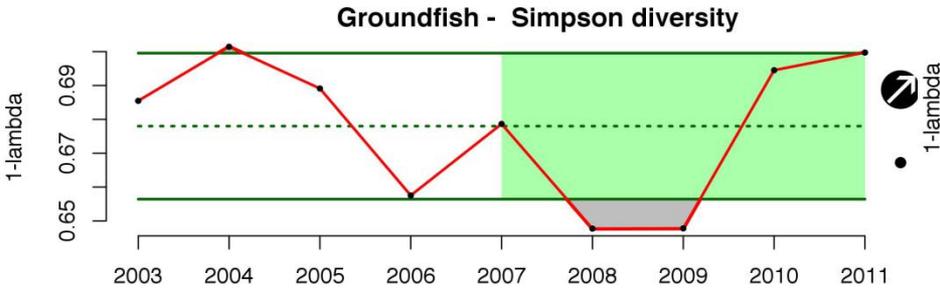
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Groundfish Diversity

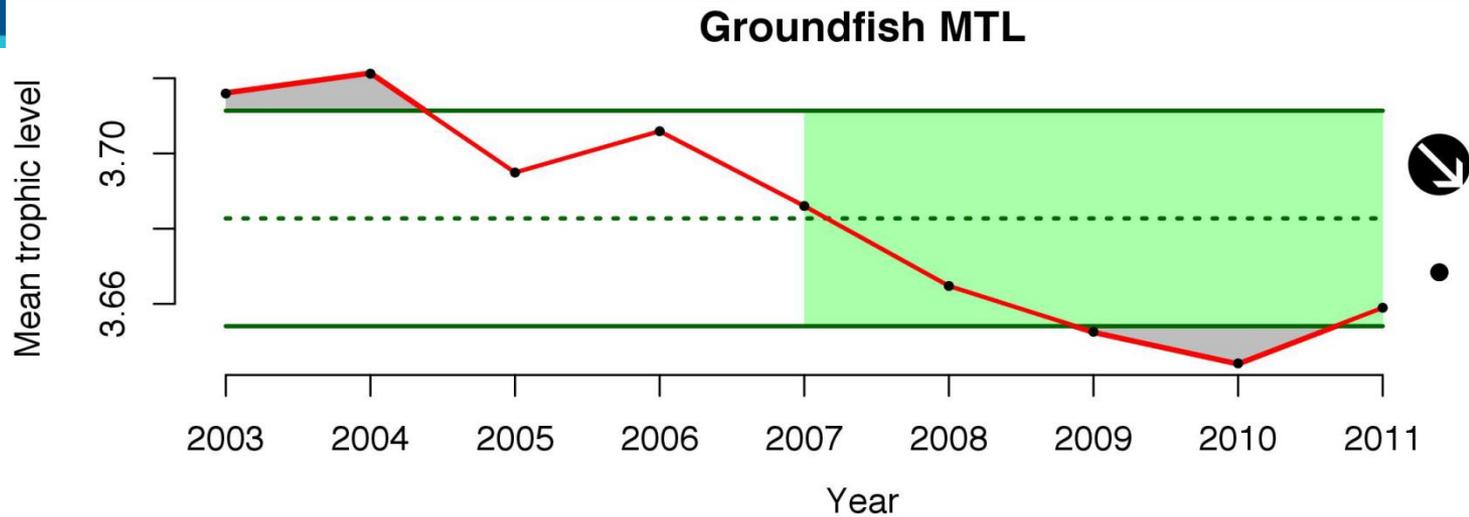
Ecosystem-wide

Olympic Coast

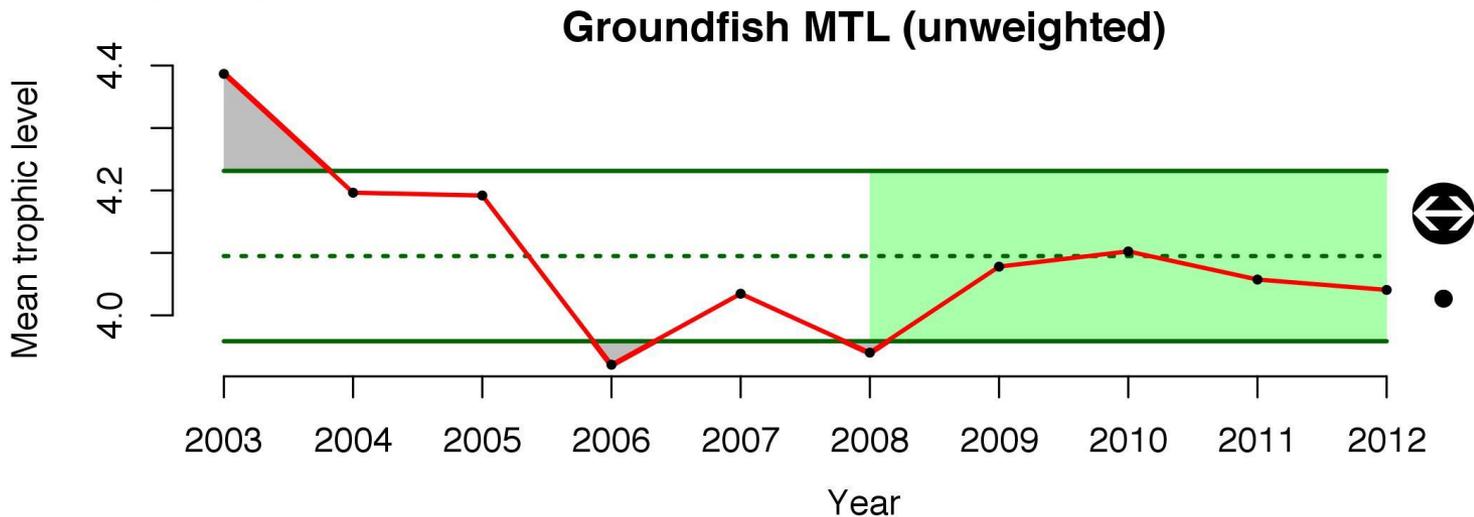


Groundfish Mean Trophic Level

Ecosystem-wide

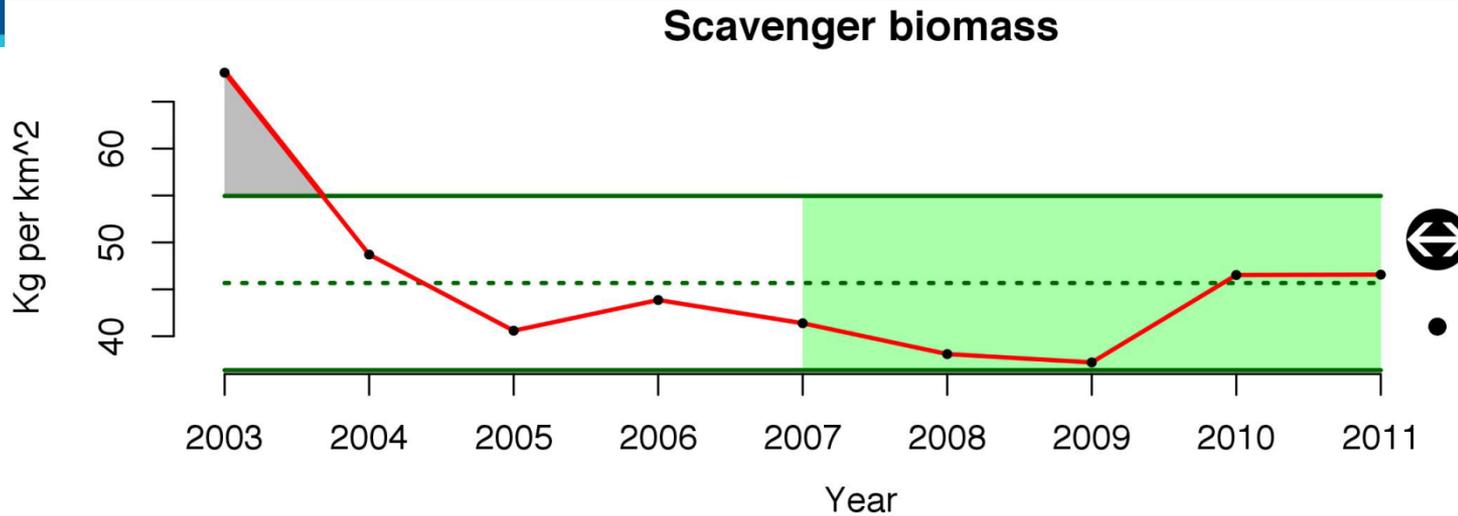


Olympic Coast



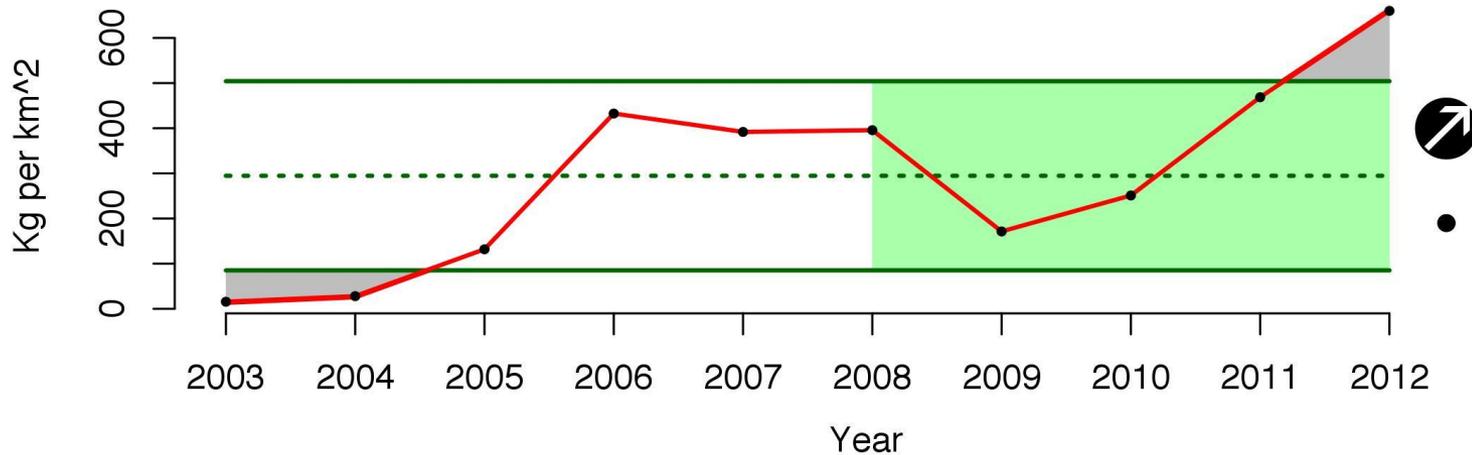
Scavenger Biomass

Ecosystem-wide



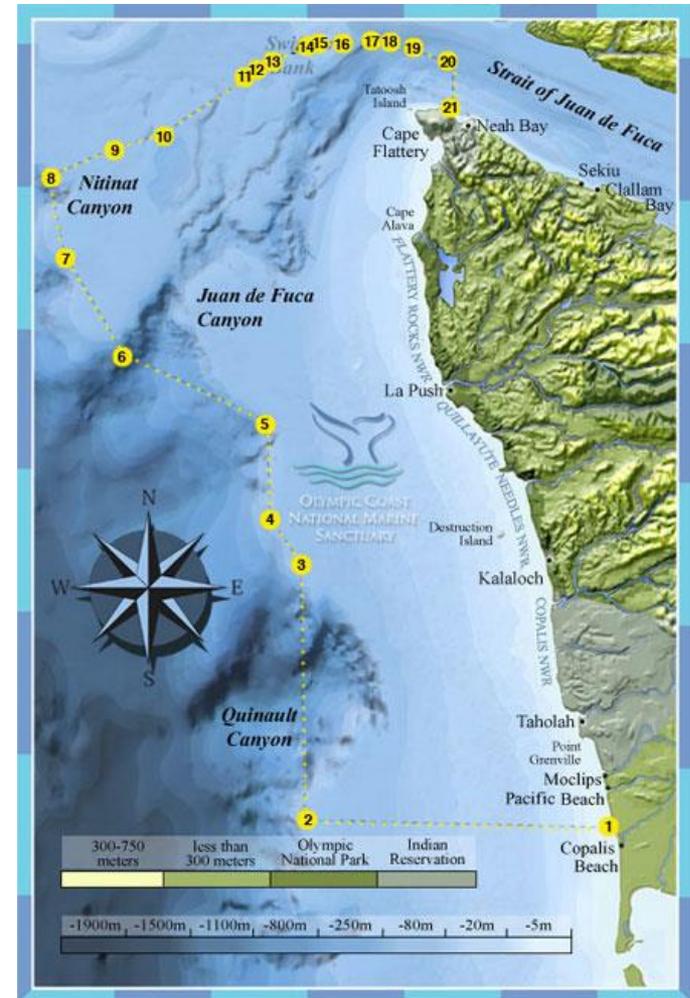
Olympic Coast

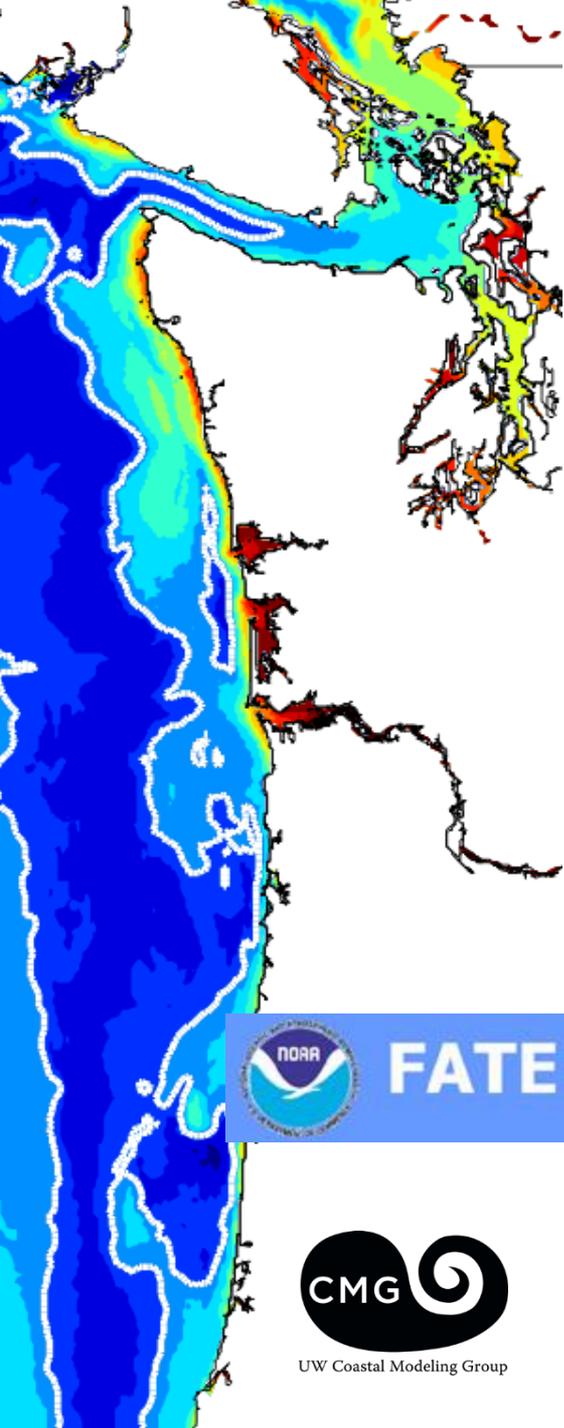
Crab biomass



Other Collaboration with Olympic Coast NMS and Partners

- OCNMS ocean buoy data
- Critical validation tool for regional climate models
- Development of habitat quality forecasts for important upper trophic levels (zooplankton, sardines, crab, etc.)





J-SCOPE - a seasonal forecast tool for fisheries and ecosystems

Nick Bond, Samantha Siedlecki,
Isaac Kaplan, Greg Williams, Al
Hermann, Jan Newton, Bill
Peterson, Phil Levin

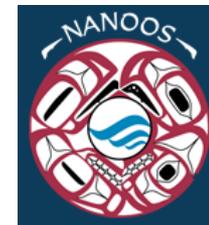


FATE

W UNIVERSITY of WASHINGTON

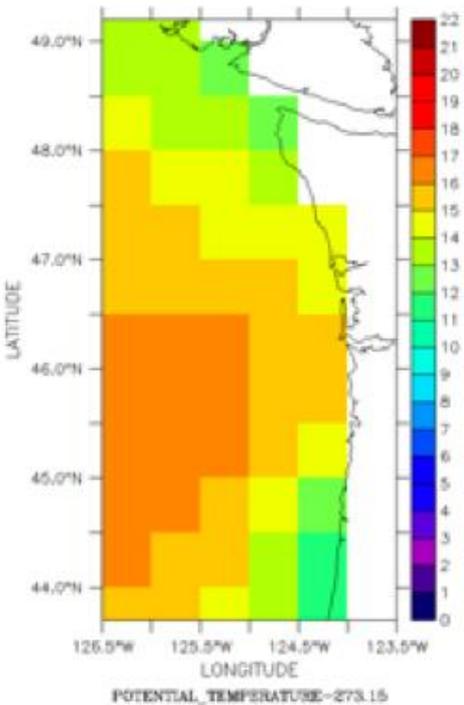


UW Coastal Modeling Group

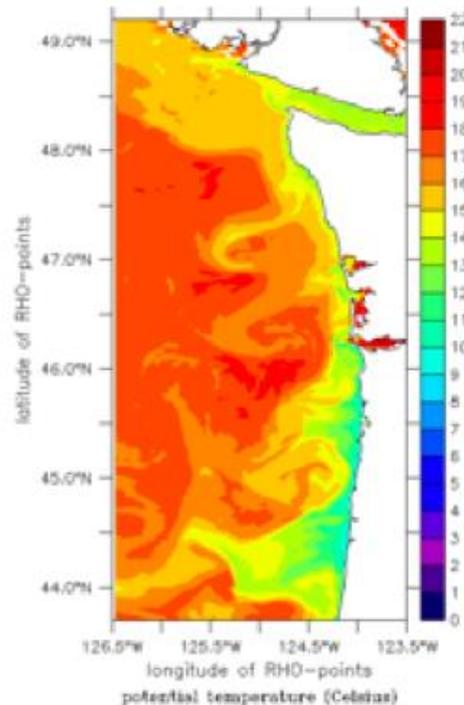


Goal: forecast up to 6-9 months of California Current ocean conditions

CFS

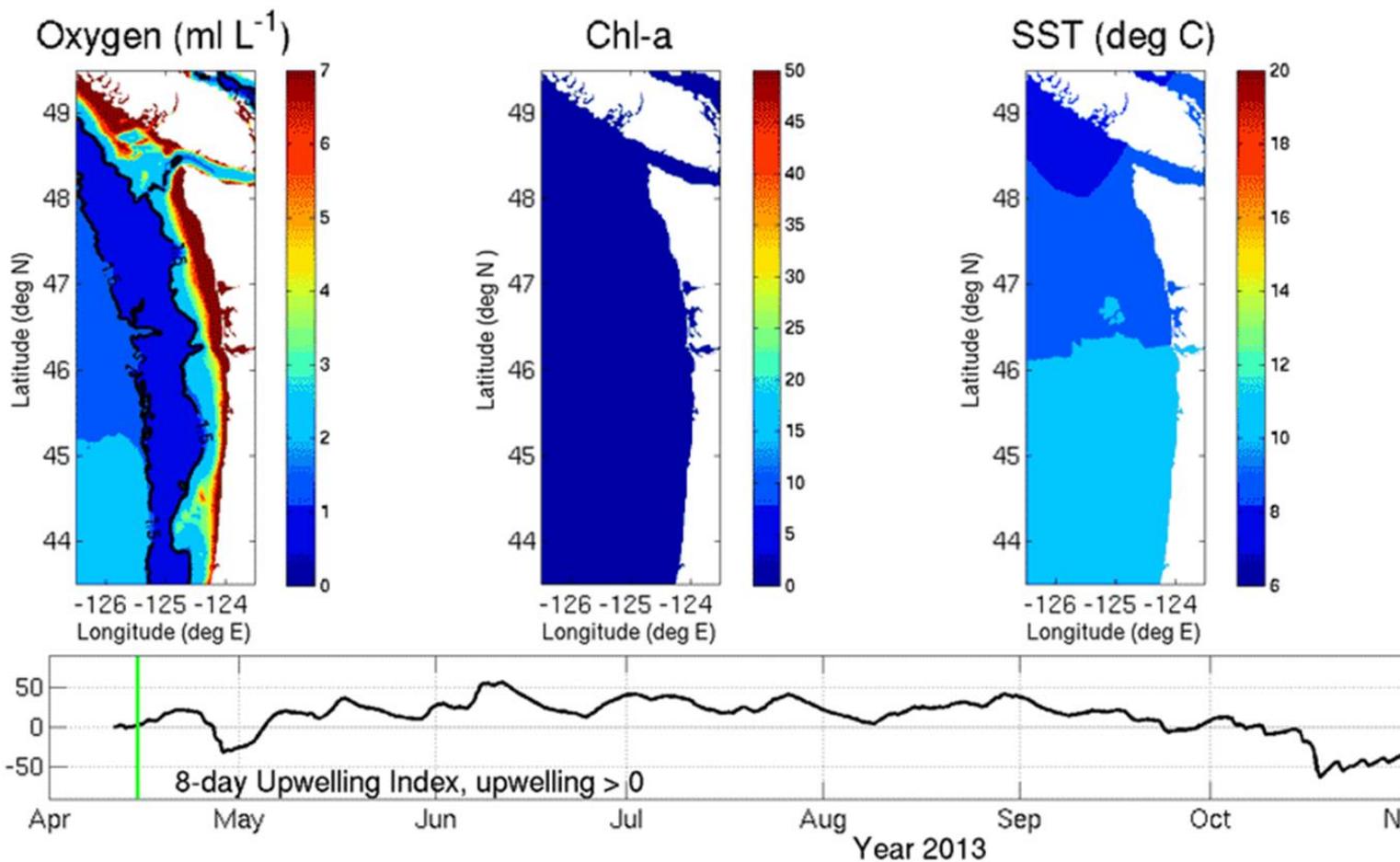


ROMS Forecast model



Temp (C)

- Climate Forecast System (**CFS**) for coarse scale (50km) predictions of ocean physics, 6-9 months in advance
- Regional Ocean Modeling System (**ROMS**) is available to downscale these results



J-SCOPE: forecasts 6-9 months of California Current ocean conditions

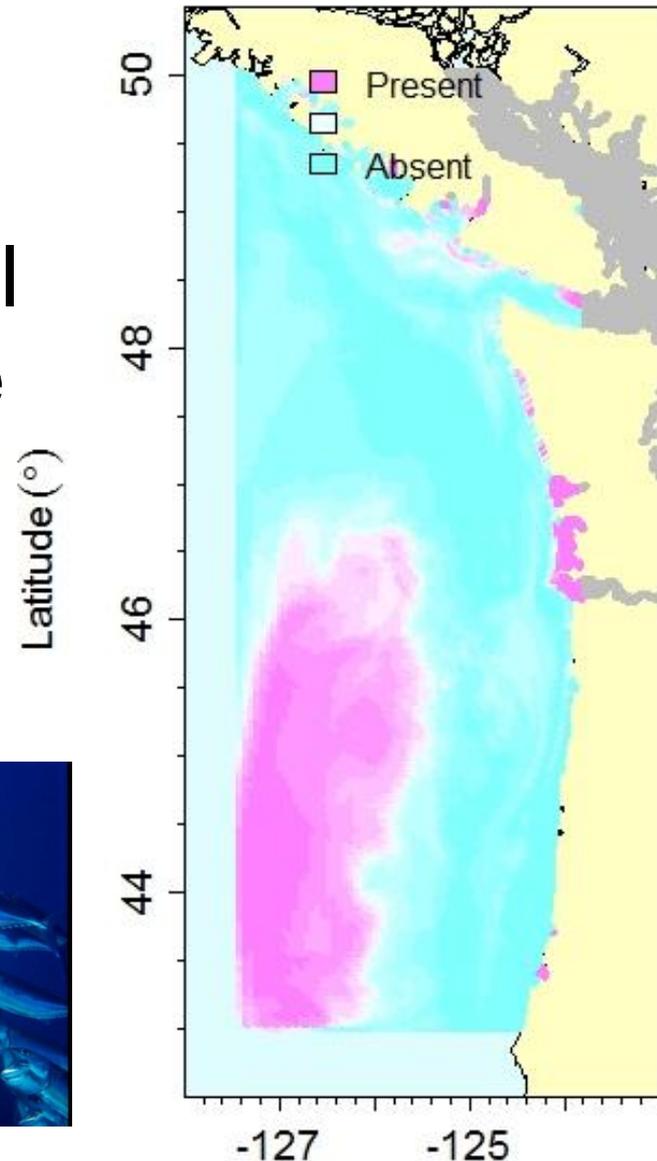
Will ROMS Ocean Conditions Predict Sardine Density?

Generalized Additive Model to predict sardine presence from ROMS

- Temperature
- Chl *a*
- Salinity
- Oxygen



Aug 2013, Sardine Reforecast



NEXT STEPS



- **Seeking Sanctuary and Community input**
 - Developing social indicators
 - Other time-series / data sources
 - Developing specific, Sanctuary-relevant management scenarios (e.g., shipping)

- **Questions...?**