# Developing Indicators

Current Report Cards

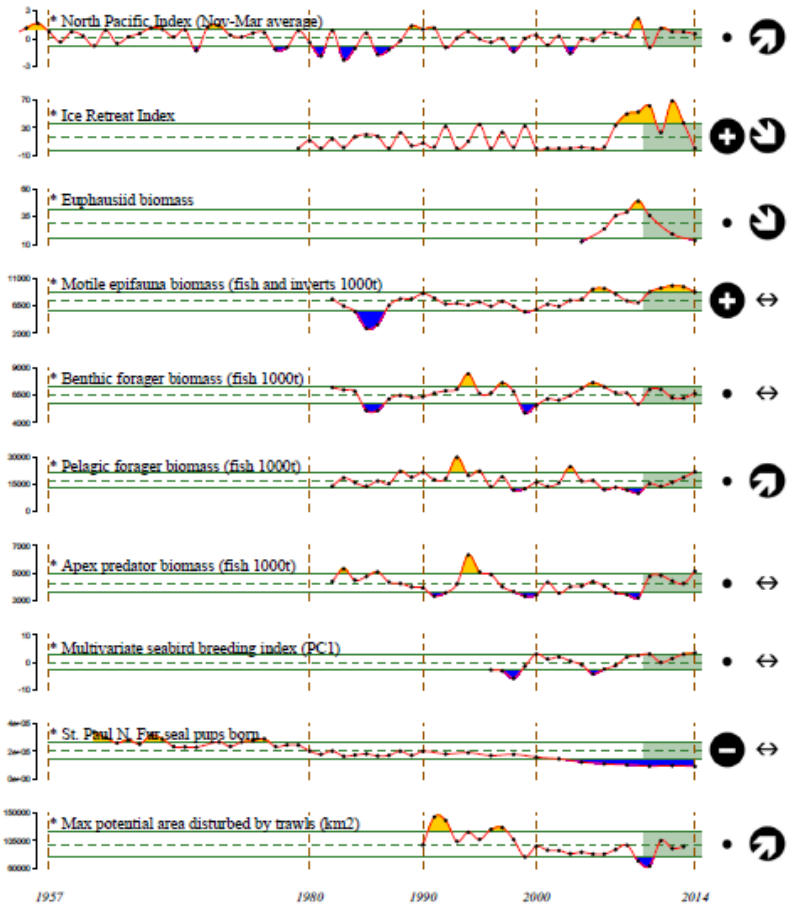
New EBS Report Card Possibilities

Evaluating Indicators

# Developing Indicators: Report Cards

## Eastern Bering Sea 2014 Report Card

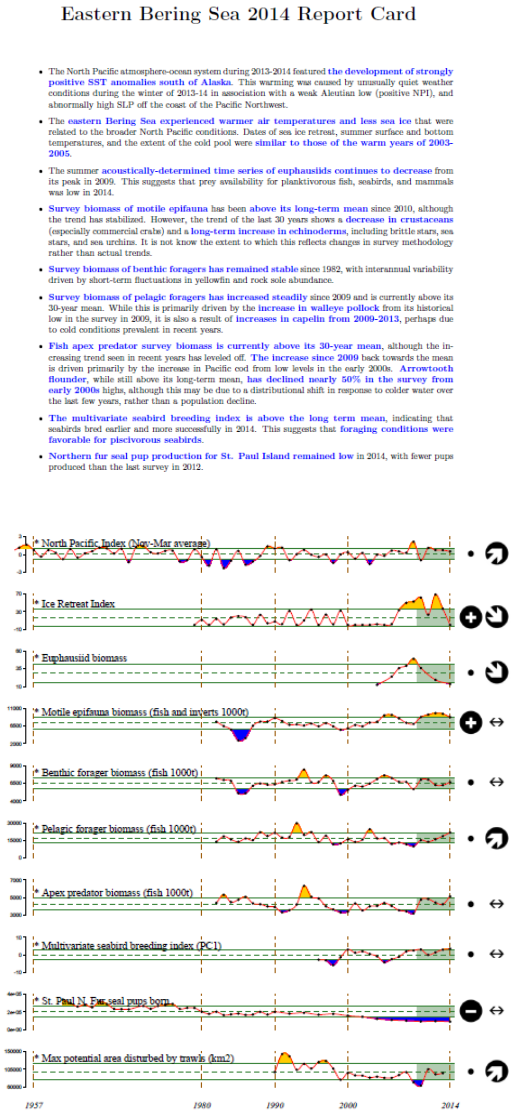
- The North Pacific atmosphere-ocean system during 2013-2014 featured **the development of strongly positive SST anomalies south of Alaska**. This warming was caused by unusually quiet weather conditions during the winter of 2013-14 in association with a weak Aleutian low (positive NPI), and abnormally high SLP off the coast of the Pacific Northwest.
- The **eastern Bering Sea experienced warmer air temperatures and less sea ice** that were related to the broader North Pacific conditions. Dates of sea ice retreat, summer surface and bottom temperatures, and the extent of the cold pool were **similar to those of the warm years of 2003-2005**.
- The summer **acoustically-determined time series of euphausiids continues to decrease** from its peak in 2009. This suggests that prey availability for planktivorous fish, seabirds, and mammals was low in 2014.
- **Survey biomass of motile epifauna** has been **above its long-term mean** since 2010, although the trend has stabilized. However, the trend of the last 30 years shows a **decrease in crustaceans** (especially commercial crabs) and a **long-term increase in echinoderms**, including brittle stars, sea stars, and sea urchins. It is not know the extent to which this reflects changes in survey methodology rather than actual trends.
- **Survey biomass of benthic foragers has remained stable** since 1982, with interannual variability driven by short-term fluctuations in yellowfin and rock sole abundance.
- **Survey biomass of pelagic foragers has increased steadily** since 2009 and is currently above its 30-year mean. While this is primarily driven by the **increase in walleye pollock** from its historical low in the survey in 2009, it is also a result of **increases in capelin from 2009-2013**, perhaps due to cold conditions prevalent in recent years.
- **Fish apex predator survey biomass is currently above its 30-year mean**, although the increasing trend seen in recent years has leveled off. **The increase since 2009** back towards the mean is driven primarily by the increase in Pacific cod from low levels in the early 2000s. **Arrowtooth flounder**, while still above its long-term mean, **has declined nearly 50% in the survey from early 2000s** highs, although this may be due to a distributional shift in response to colder water over the last few years, rather than a population decline.
- **The multivariate seabird breeding index is above the long term mean**, indicating that seabirds bred earlier and more successfully in 2014. This suggests that **foraging conditions were favorable for piscivorous seabirds**.
- **Northern fur seal pup production for St. Paul Island remained low** in 2014, with fewer pups produced than the last survey in 2012.



# Current Report Cards: EBS and AI

"Team-based Synthesis Approach"

- Created Ecosystem Assessment Synthesis teams: regional scientific experts, fisheries managers, others
- Met 1-2 times
- Chose structuring themes to guide indicator selection
- Developed list of 8-10 indicators:
  - "vital signs"
  - updatable



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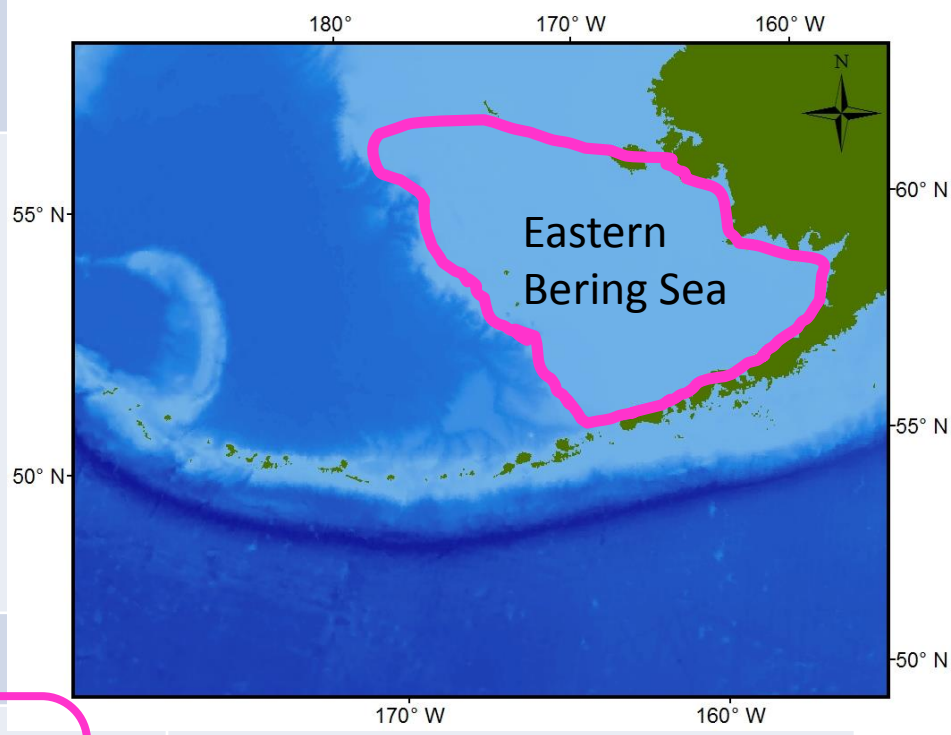
# Ecosystem comparison

| | Eastern Bering Sea | Aleutian Islands |
|---|---|---|
| Habitat | Broad, flat, muddy shelf.<br>Valuable fisheries.<br>Fish-related research. | |
| Team members:<br>NOAA<br>Academia<br>Management<br>Commercial<br>Other Fed<br>Non Profit<br>Research sponsor | <br>17<br>2<br>1 (3) | |
| Structuring theme | Production | |
| Indicator focus | Broad, community-level, indicators of ecosystem-wide productivity, and those most informative for managers | |



# Results

| Indicators |
| --- |
| Climate |
| Zooplankton |
| Forage fish |
| Fish biomass |
| Marine Mammals |
| Seabirds |
| Humans |

# Results

## EASTERN BERING SEA

** Recalculated in 2014*

- North Pacific Index
- Ice Retreat Index
- Euphausiids/Copepods*
- Motile epifauna biomass
- Benthic foragers biomass
- Pelagic foragers biomass
- Fish apex predator biomass
- St Paul fur seal pups
- St Georg[illegible]hick-billed murre reproductive success
- Area trawled*

| Indicators |
| --- |
| Climate |
| Zooplankton |
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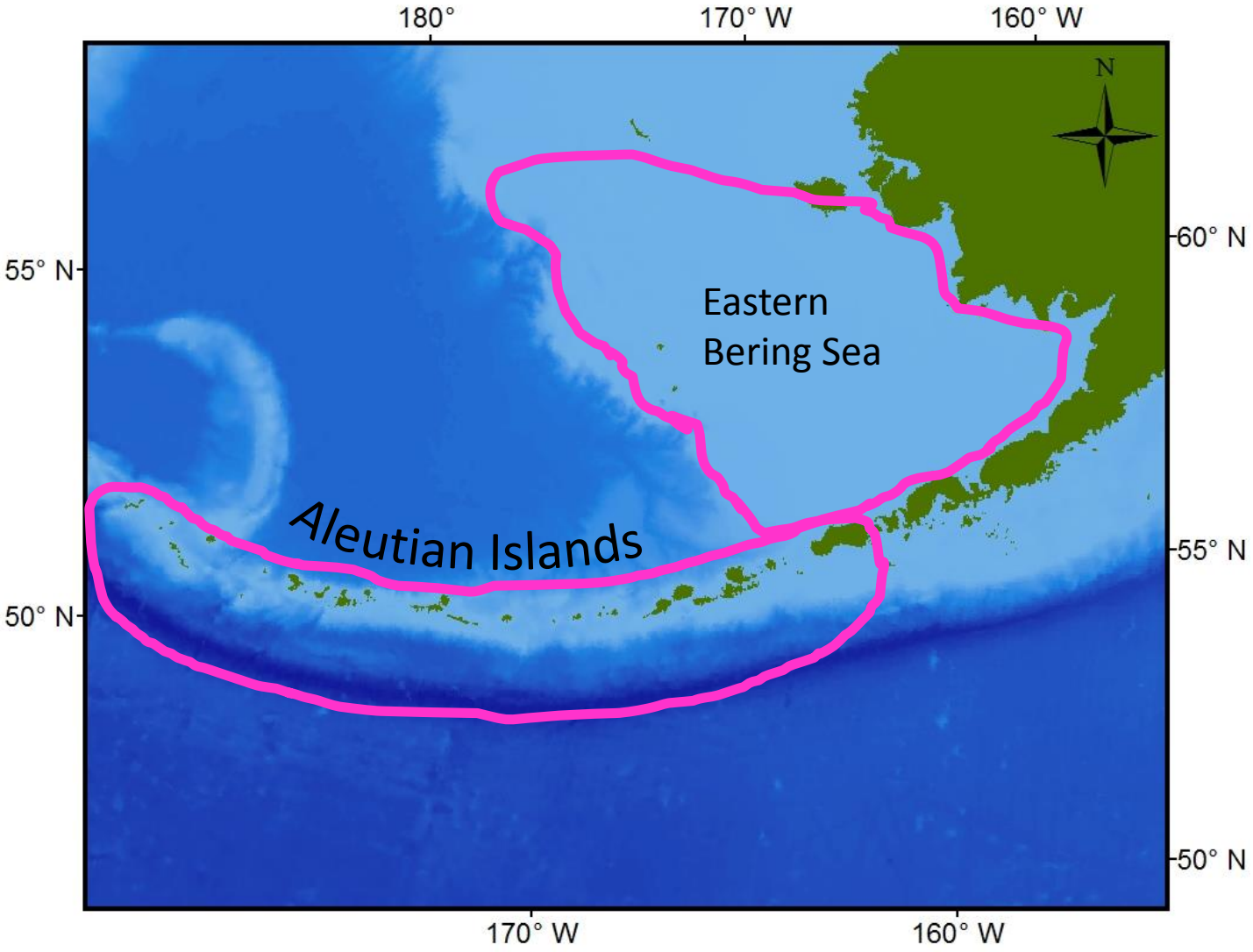
** Multivariate seabird index*

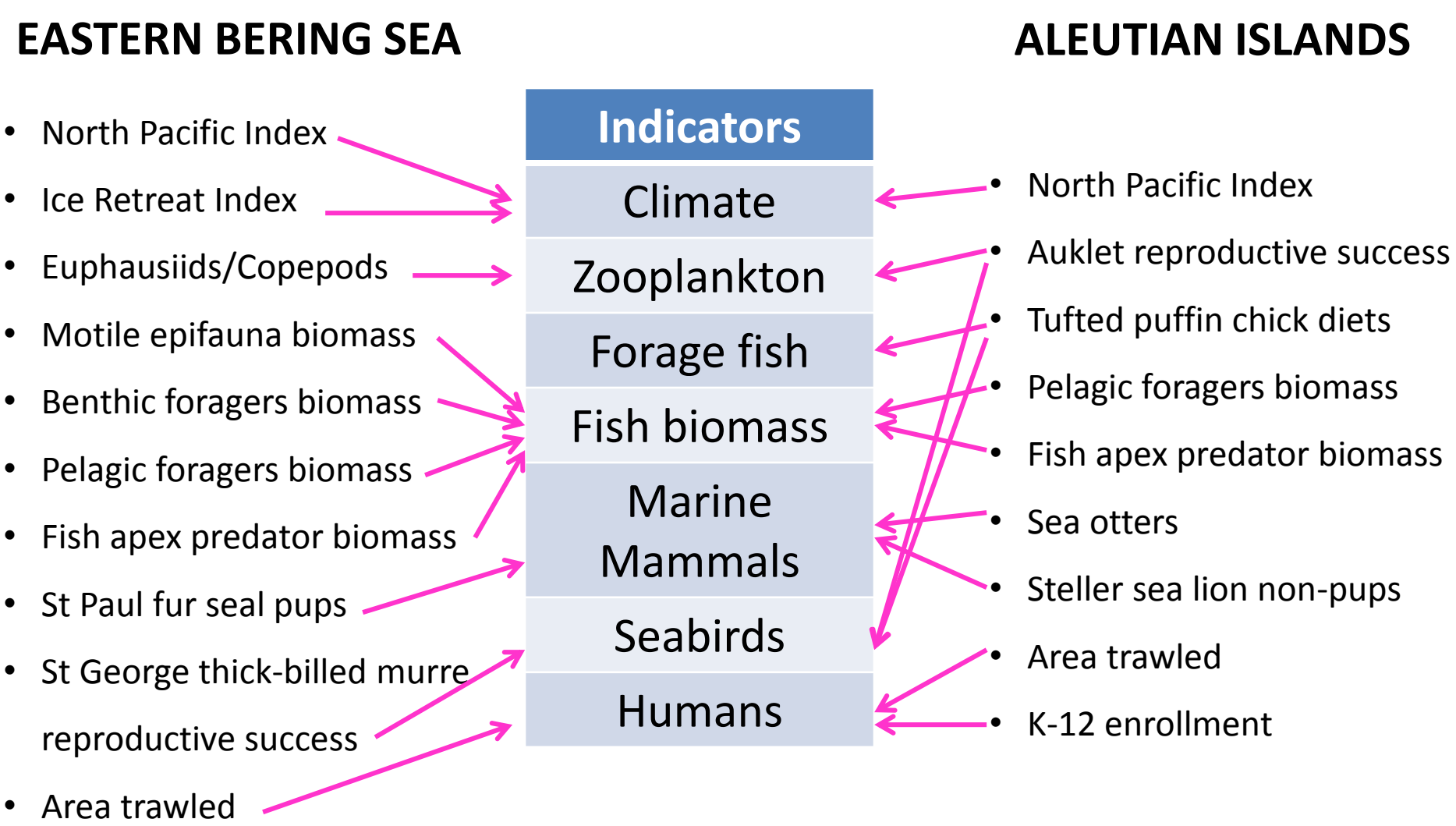
# Aleutian Islands



# Ecosystem comparison

| | Eastern Bering Sea | Aleutian Islands |
|---|---|---|
| Habitat | Broad, flat, muddy shelf.<br>Valuable fisheries ->
Lots of fish-related research. | Extensive rocky island chain, deep trenches, oceanic basins.
Smaller-scale fisheries (and research) |
| Team members:<br>NOAA<br>Academia<br>Management<br>Commercial<br>Other Fed<br>Non Profit<br>Research sponsor | <br>17<br>2<br>1 (3) | <br>10<br>4<br>1<br>1<br>2<br>1<br>1 |
| Structuring theme | Production | Variability |
| Indicator focus | Broad, community-level, indicators of ecosystem-wide productivity, and those most informative for managers | Characterize global attributes with local behavior |

# Some similarities, some differences



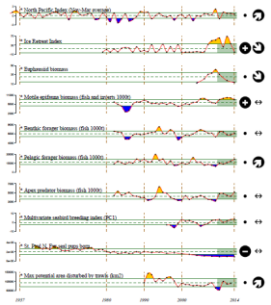
# Indicator Selection: Conclusions

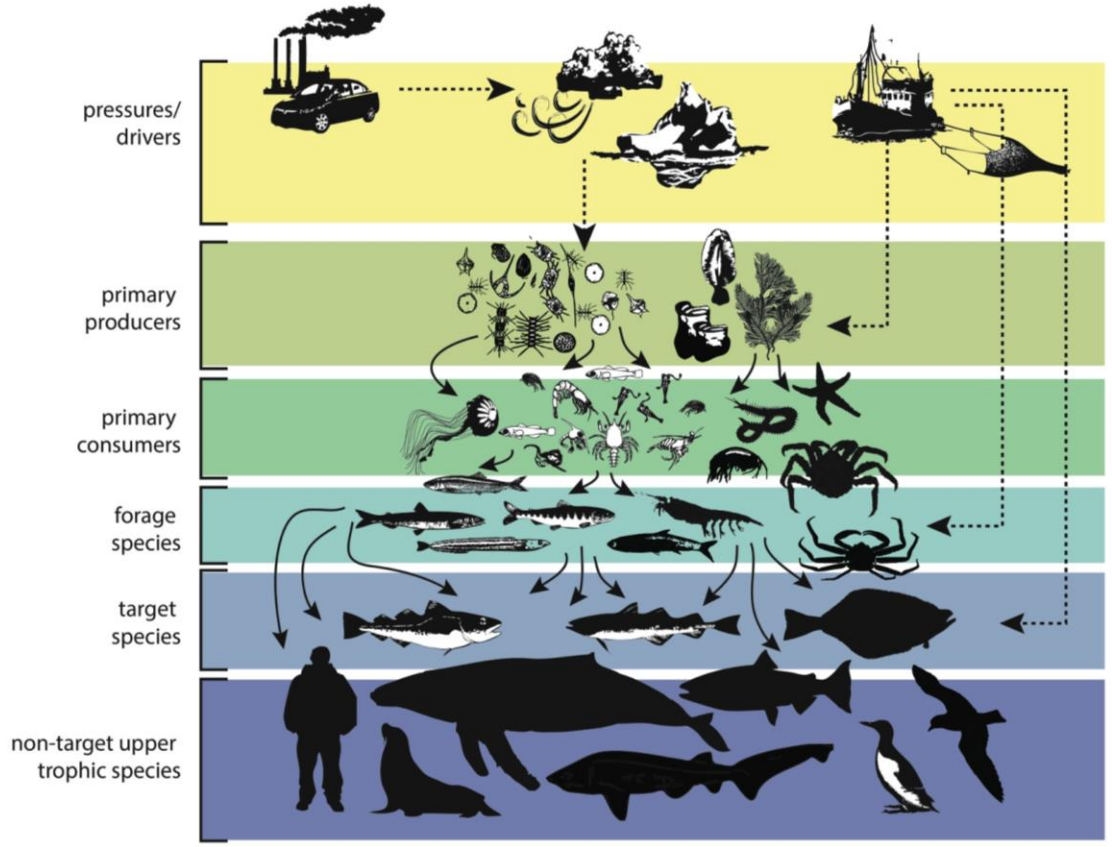
1. Indicator selection influenced by:
    - Physical and biological nature of ecosystem
    - Extent of regional scientific knowledge
    - Expertise and interests of Team members/stake holders
2. Assessment development should be iterative process with frequent review by managers

*Original plan: Revisit and revise assessments periodically (~ 3-5 yrs) – time to revisit the EBS!*

# Report Cards for different conceptual model components

Indicators to be selected for each pathway and trophic level





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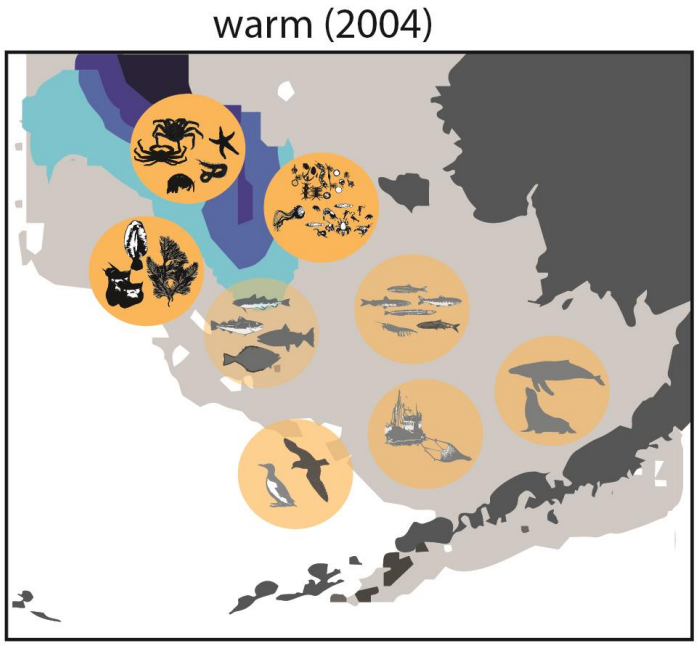
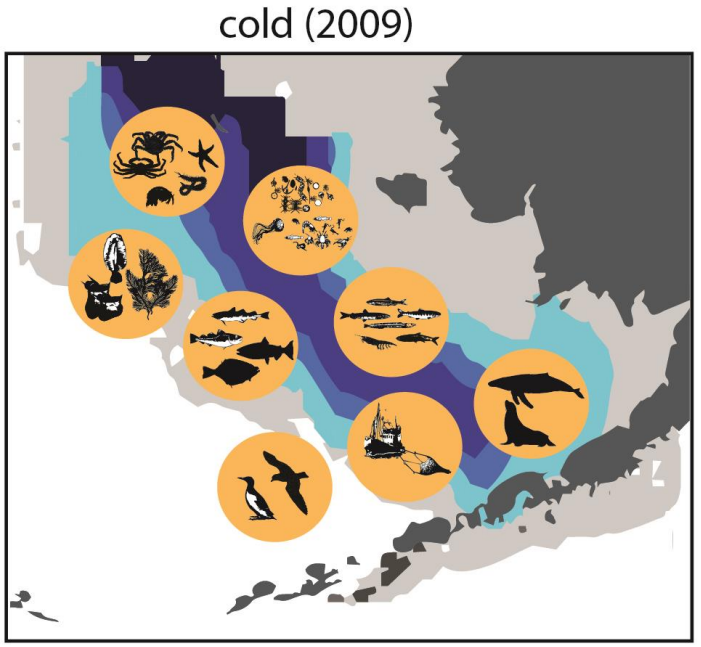
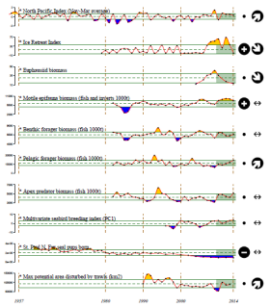
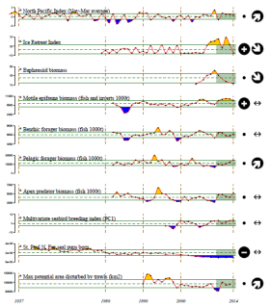


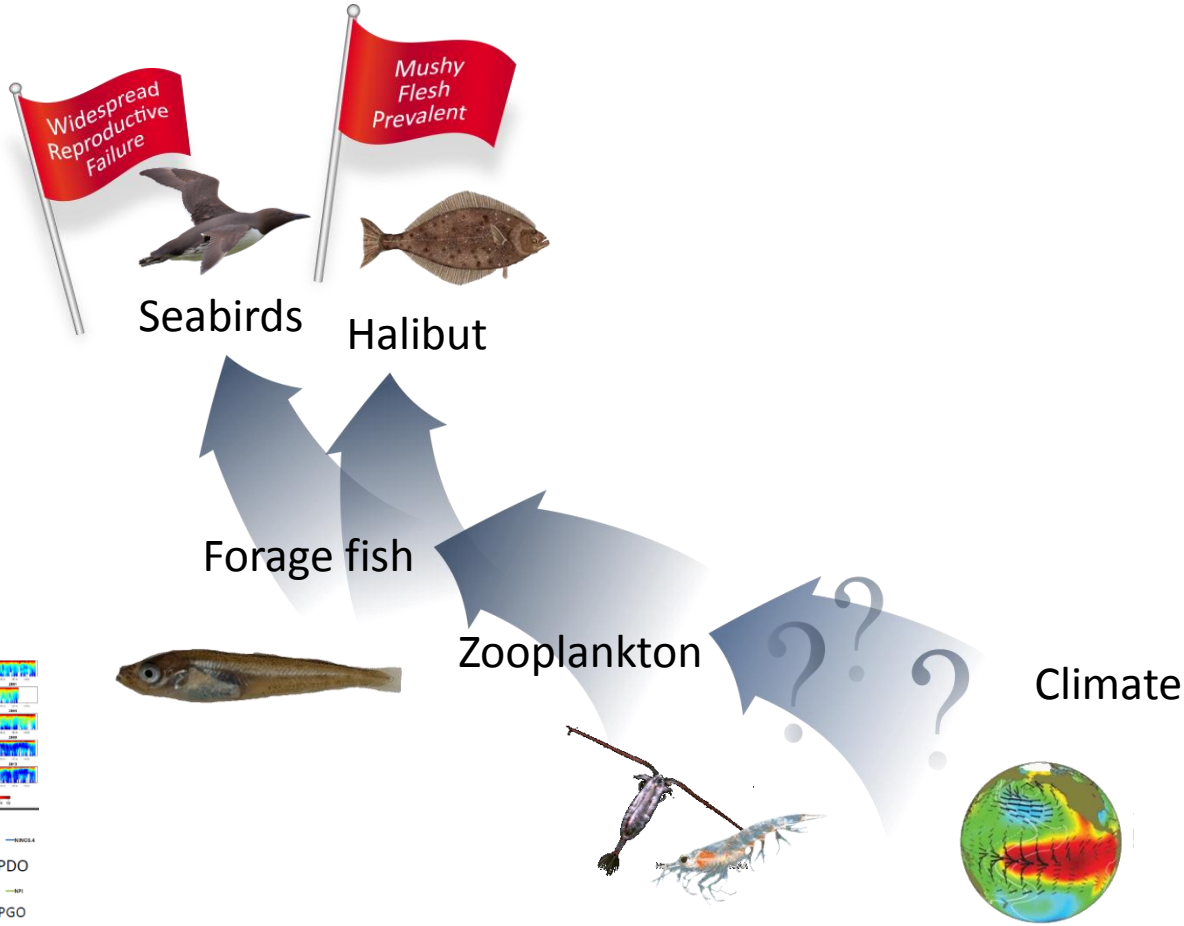



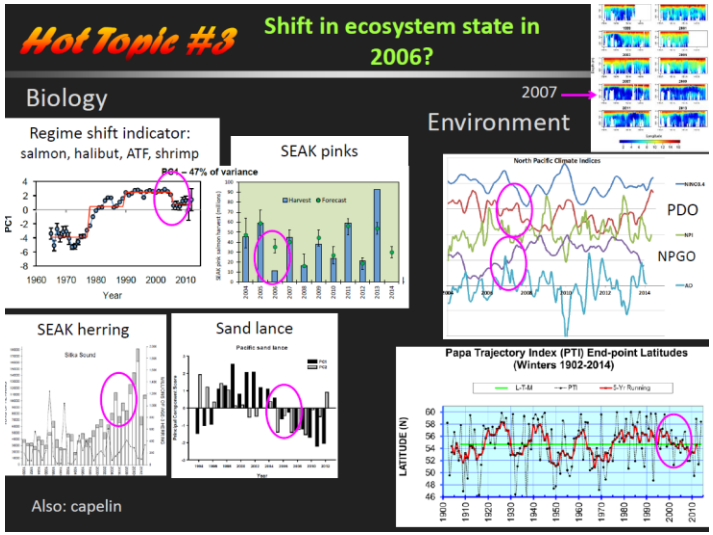


# Evaluating Indicators

Qualitative

- Synthesis

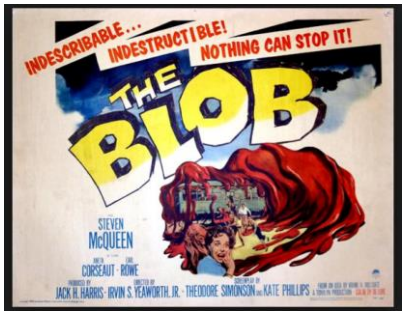


# Evaluating Indicators

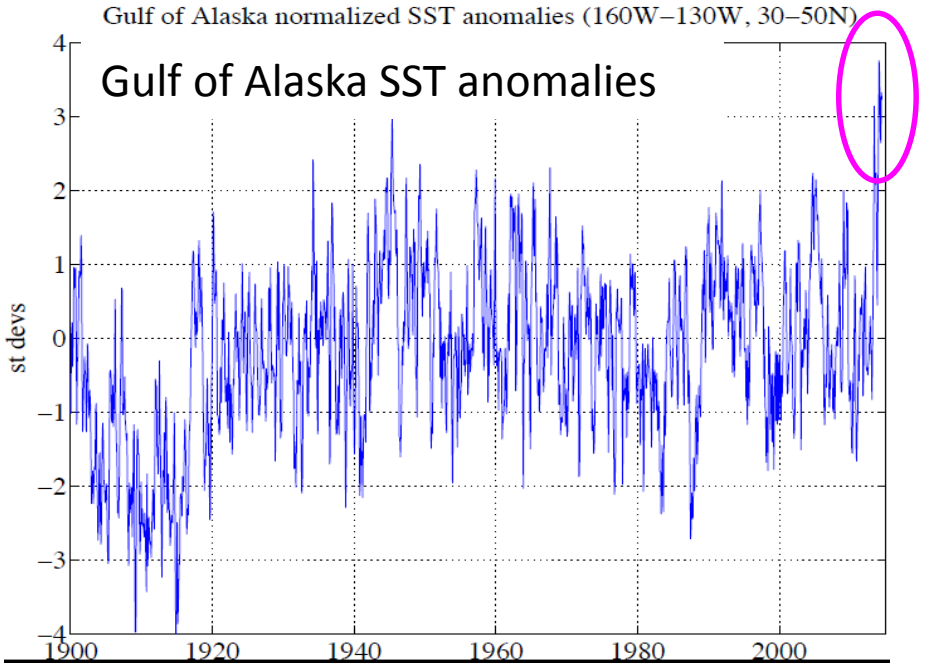
Qualitative

- Synthesis




As we build modeling and predictive capacity, we will still need qualitative synthesis to:

- capture events outside the bounds of current models
- detect impacts of the unexpected



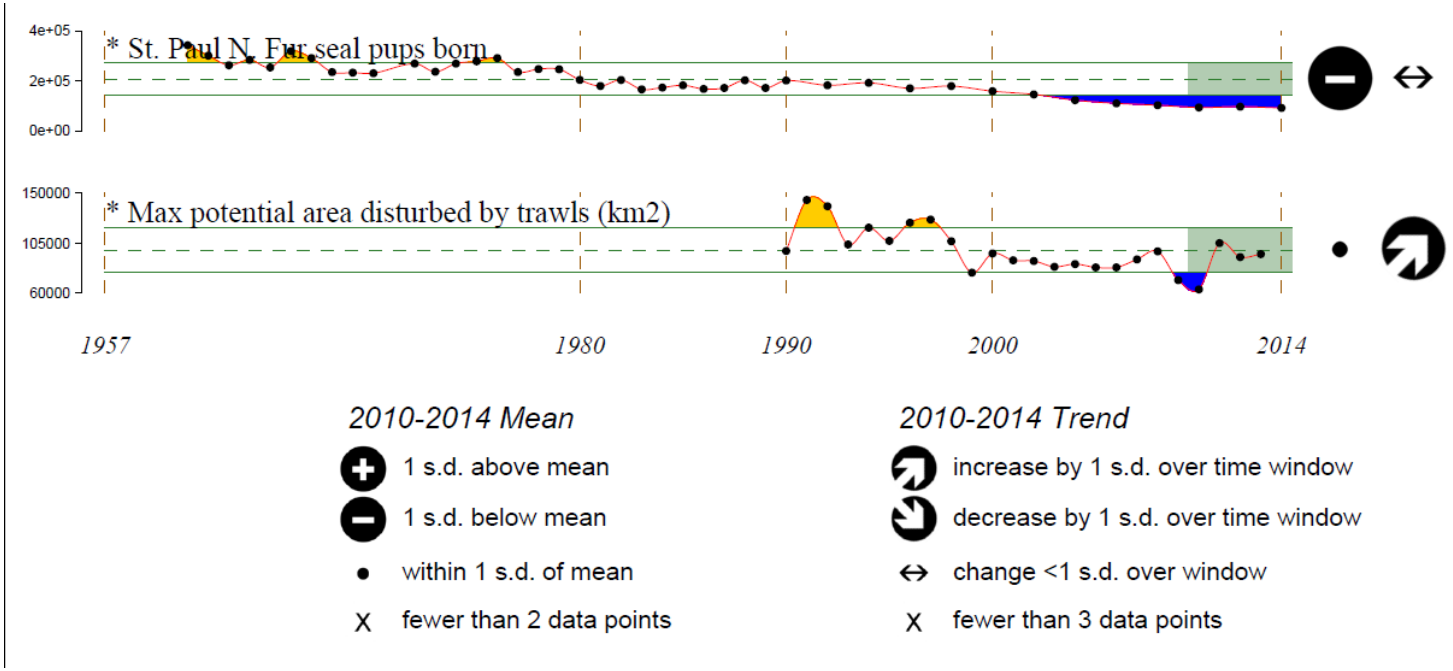
# Evaluating Indicators

Qualitative

- Synthesis

Qualitative/Quantitative

- Recent 5 year mean relative to long-term mean
- Recent 5 year trend



# Evaluating Indicators

Qualitative

- Synthesis

Qualitative/Quantitative

- Recent 5 year mean relative to long-term mean
- Recent 5 year trend

Quantitative

- Thresholds

Use GAMs to determine critical points where small changes in fishing and environmental pressure results in abrupt change in ecosystem status

Vol. 521: 1–17, 2015
doi: 10.3354/meps11165

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Published February 17

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FEATURE ARTICLE

## Critical points in ecosystem responses to fishing and environmental pressures

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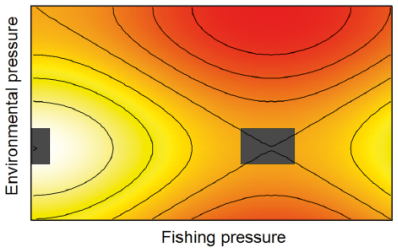
[2]NOAA, National Marine Fisheries Service, 28 Tarzwell Drive, Narragansett, RI 02882, USA
[3]*Present address:* International Council for the Exploration of the Sea (ICES), Copenhagen V 1553, Denmark
[4]*Present address:* School for Marine Science and Technology, University of Massachusetts Dartmouth, Fairhaven, MA 02719, USA

ABSTRACT: Ecosystem dynamics are often influenced by both environmental and anthropogenic pressures. Increased demand for living marine resources has resulted in global declines of targeted species, which are often managed under a single-species paradigm that does not fully incorporate ecosystem considerations such as ecological interactions or environmental factors. Ecosystem-based fisheries management (EBFM) is a more holistic approach that concurrently addresses human, ecological, and environmental factors influencing living marine resources and evaluates these considerations collectively on a system level. For EBFM, reference points associated with management action need to be quantified. Methods have been developed to assign decision criteria to ecological indicators' response to human-use pressures, yet few efforts have established decision crite-




Critical points (gray polygons) quantified on a surface of ecosystem response dependent upon fishing and environmental pressures.

*Image: S. I. Large*

# Evaluating Indicators

Qualitative

- Synthesis

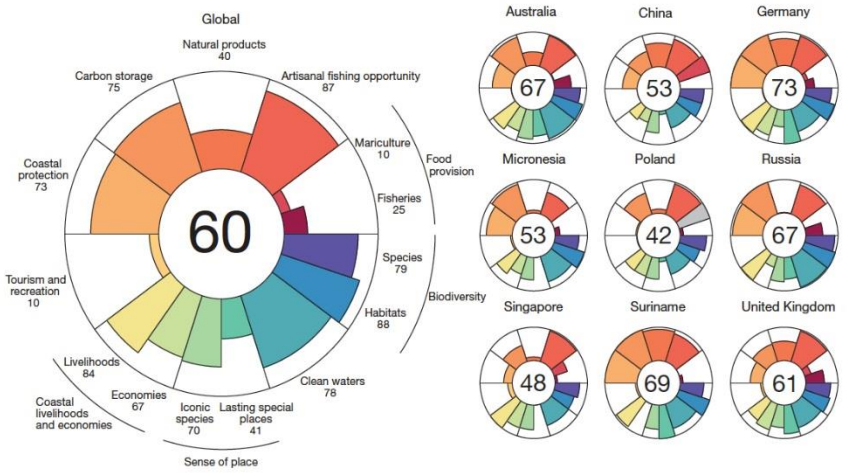
Qualitative/Quantitative

- Recent 5 year mean relative to long-term mean
- Recent 5 year trend

Quantitative

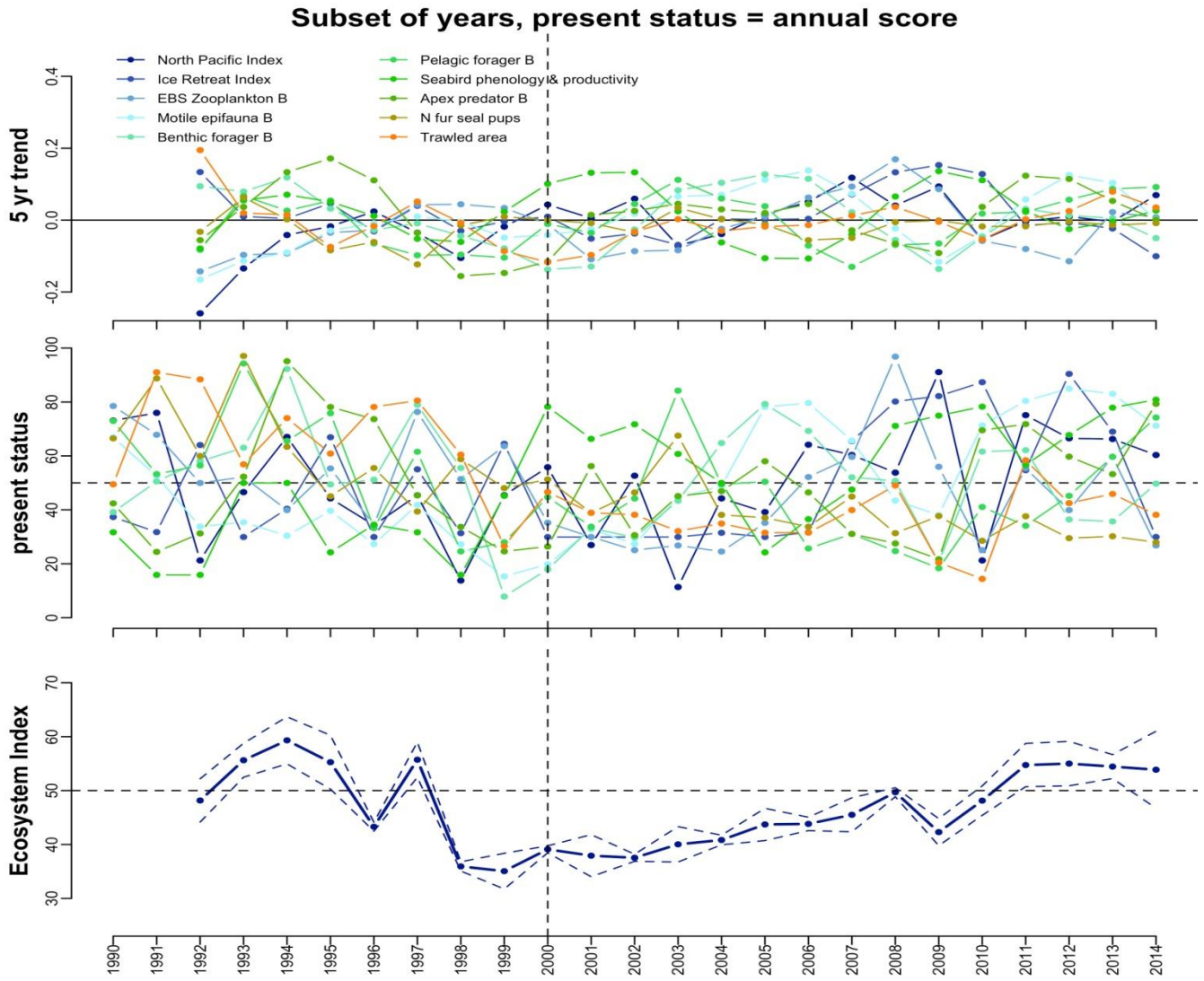
- Thresholds
- Ecosystem reference points
  - OHIAK and PCA

## Ocean Health Index




HALPERN et al. | N AT U R E | VO L 4 8 8 | 3 0 AU G U S T 2 0 1 2

# Ecosystem Reference Point: OHIAK



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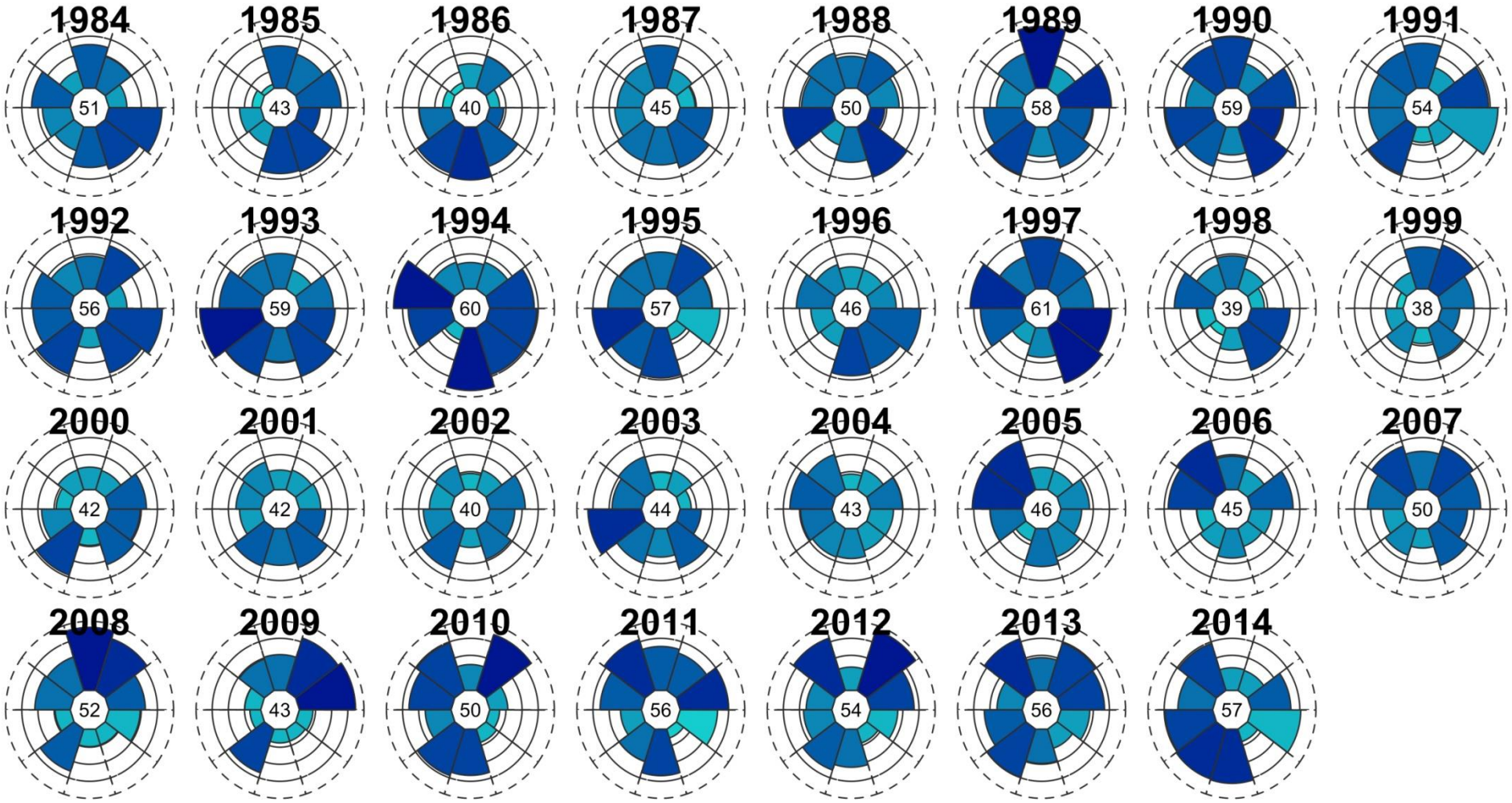

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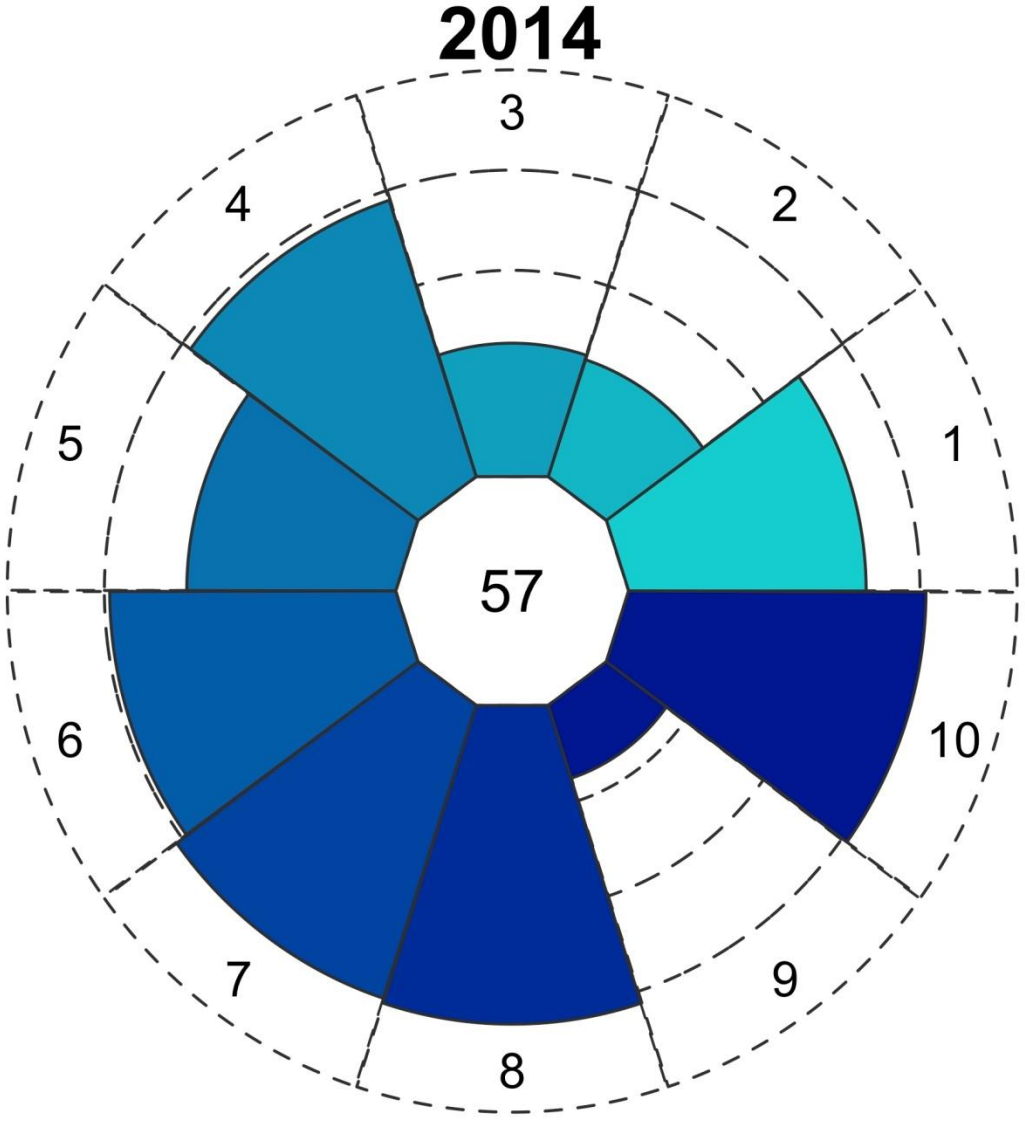



1) North Pacific Index

2) Ice Retreat Index

3) EBS Zooplankton B

4) Motile epifauna B

5) Benthic forager B

6) Pelagic forager B

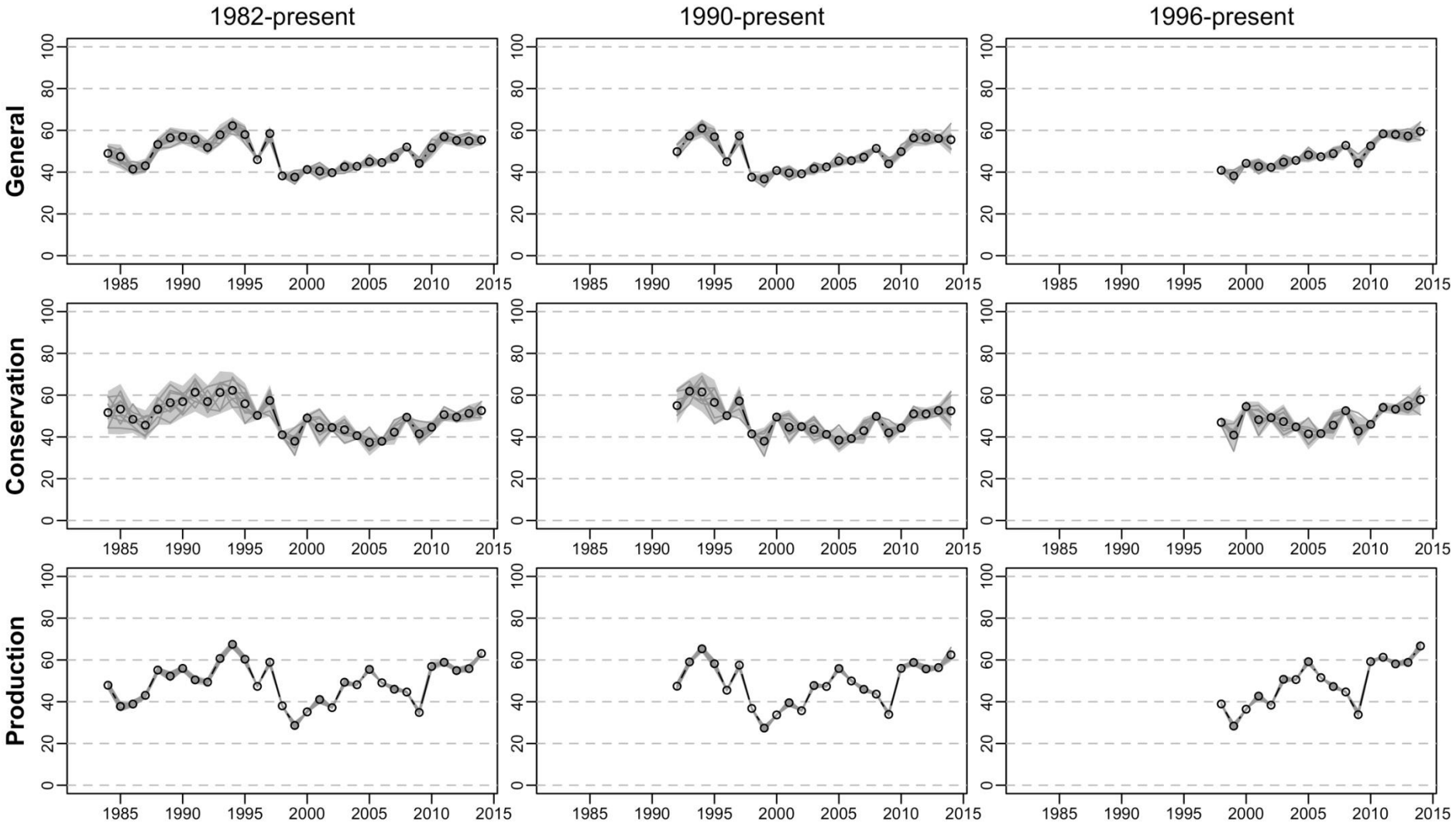
7) Seabird phenology & productiv

8) Apex predator B

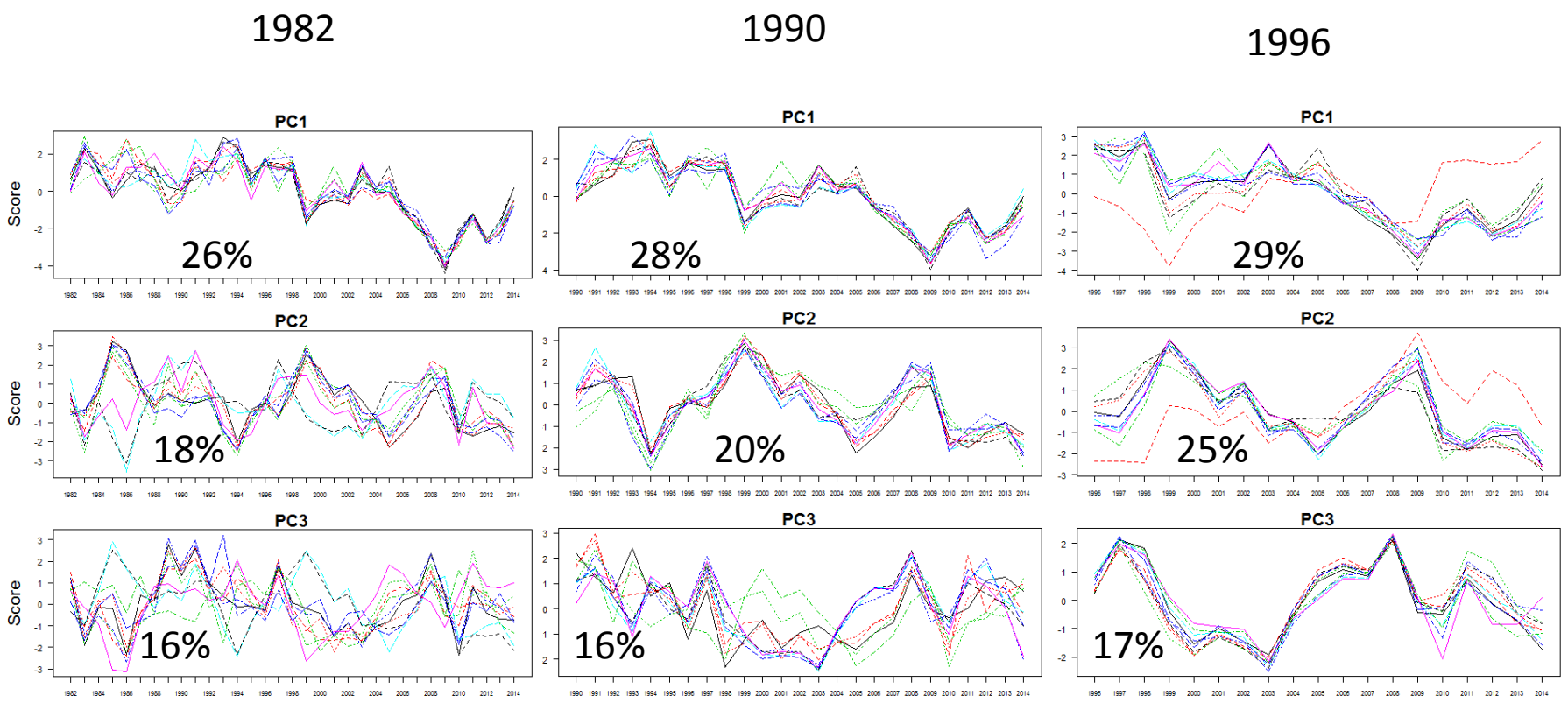
9) N fur seal pups

10) Trawled area

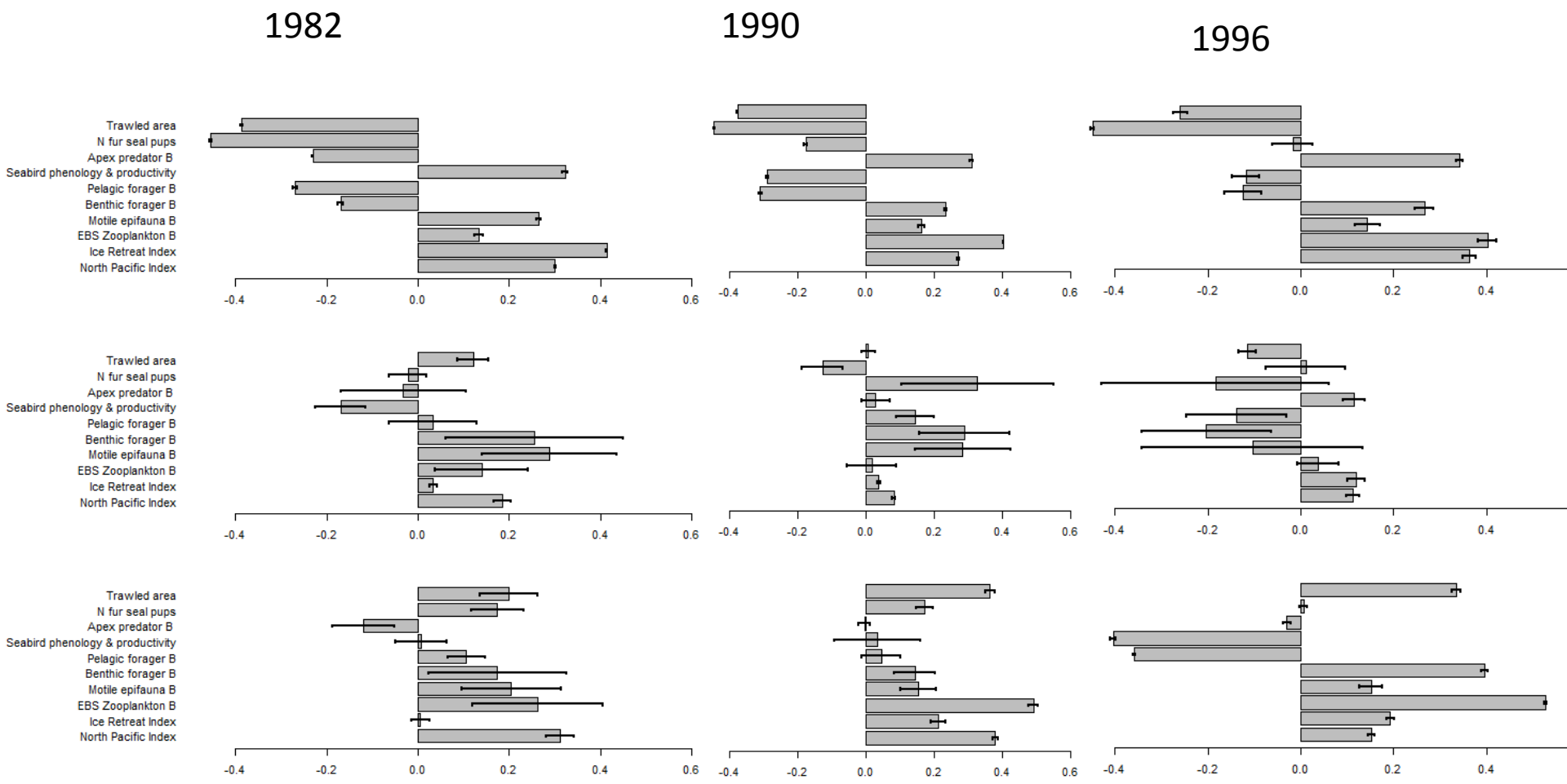
# Ecosystem Reference Point: OHIAK



# Ecosystem Reference Point: PCA



# PCA Loadings



# Index comparison