

# Status of the Southeastern Bering Sea

## – Upper Trophic Level and Aggregate Indicators

Linking Ecosystem-Based  
Management Goals with  
Ecosystem Research

**FATE**  
Fisheries  
And The  
Environment



# I. ECOSYSTEM ASSESSMENT

## Objectives for Ecosystem Protection:

### 1. Maintain predator-prey relationships

- a. pelagic forage availability
- b. spatial/temporal conc. of fishery impact on forage fish
- c. removals of top predators
- d. introduction of non-native species

**CLIMATE and FISHING**

```
graph TD; A[CLIMATE and FISHING] --> B[1. Maintain predator-prey relationships]; A --> C[2. Maintain diversity]; A --> D[3. Maintain energy flow and balance];
```

### 2. Maintain diversity

- a. species diversity
- b. functional (trophic, structural habitat) diversity
- c. genetic diversity

### 3. Maintain energy flow and balance

- a. human-induced energy redirection
- b. system impacts attributable to energy removal



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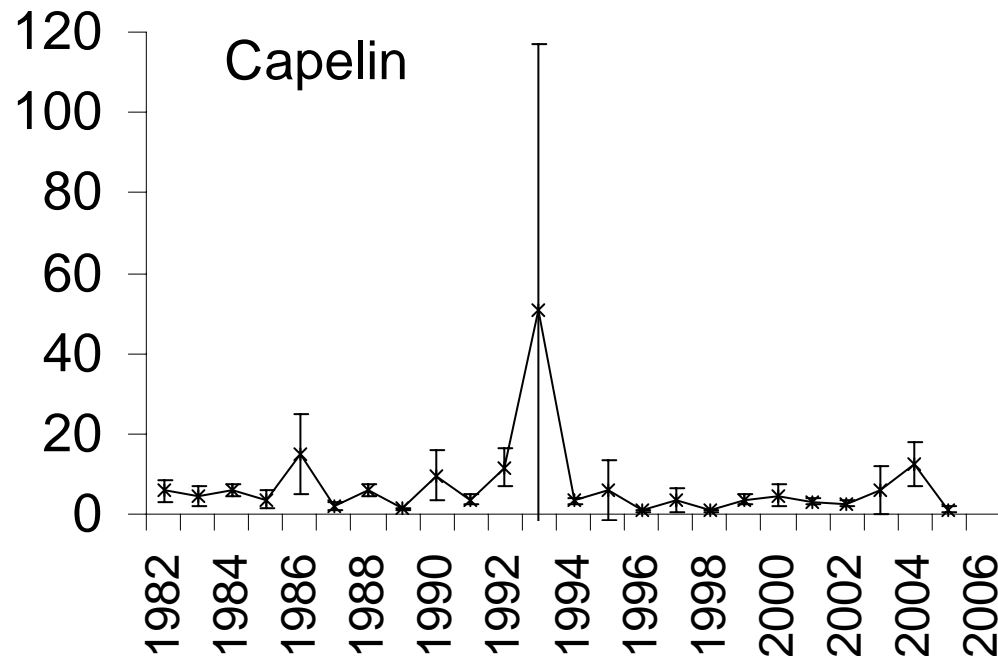
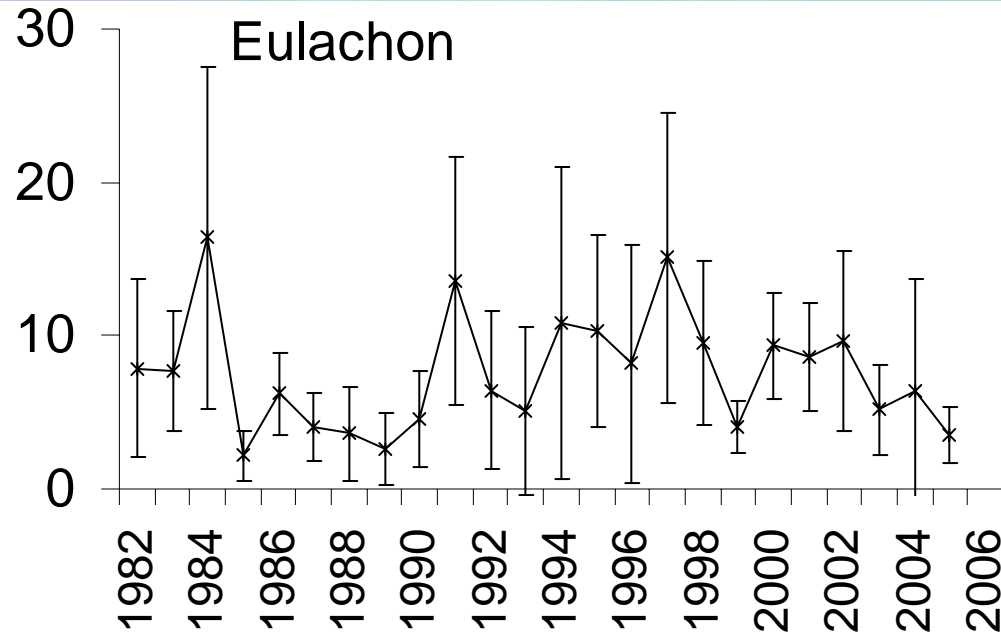
1. **Maintain predator-prey relationships by examining:**
  - a. **pelagic forage availability**

**Significance threshold:** changes outside natural variability for prey relative to predator demands

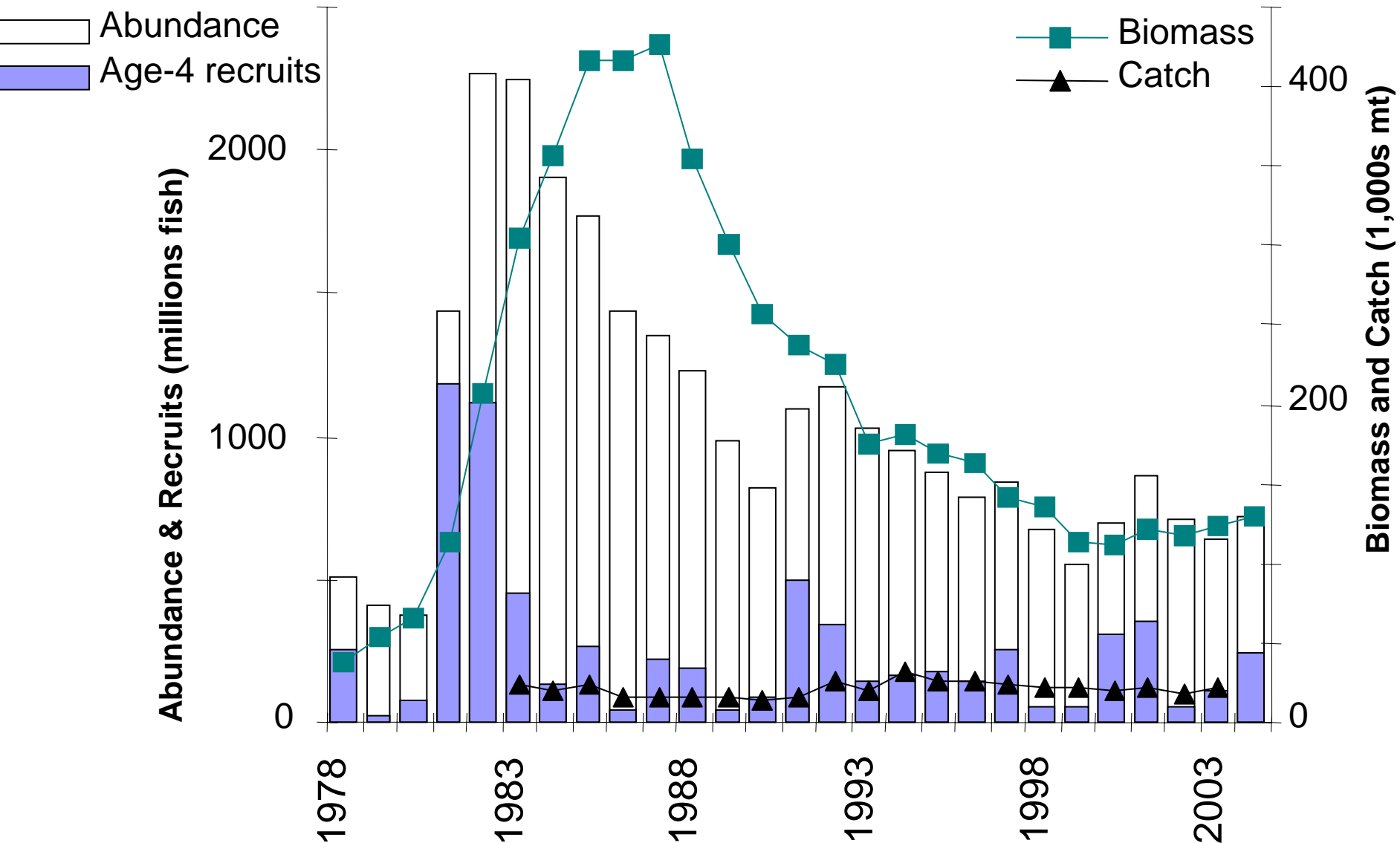
## **Indicators:**

- NMFS bottom trawl survey catches of forage fish
- BASIS surveys -age-0 pollock (BS)
- ADFG herring
- Groundfish trends
- Groundfish fishery bycatch amounts
- Bristol Bay sockeye salmon

# FORAGE -NMFS (Lauth)



# FORAGE - Togiak Herring (F. West)



# FORAGE – Juvenile sockeye and pollock

## -BASIS (Eisner et al.)

2000

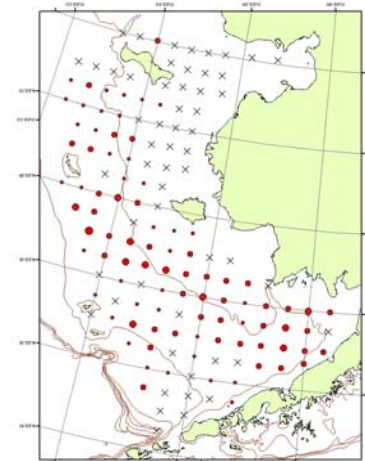
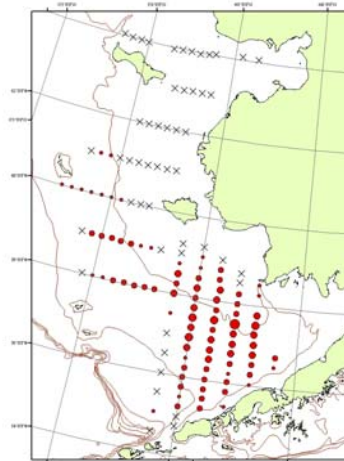
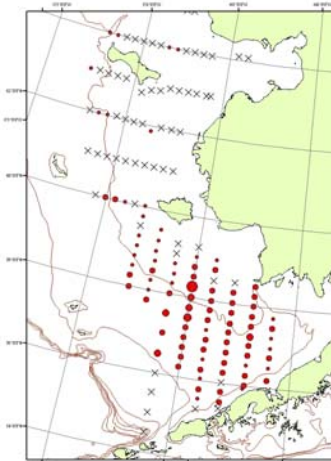
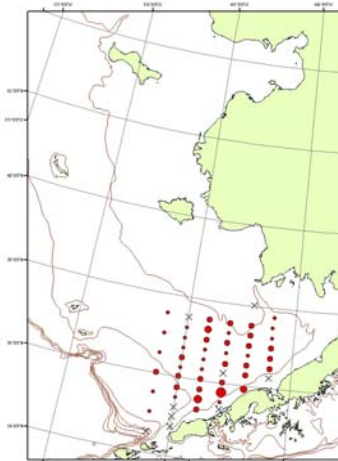
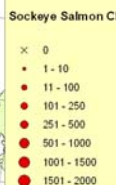
2001

2002

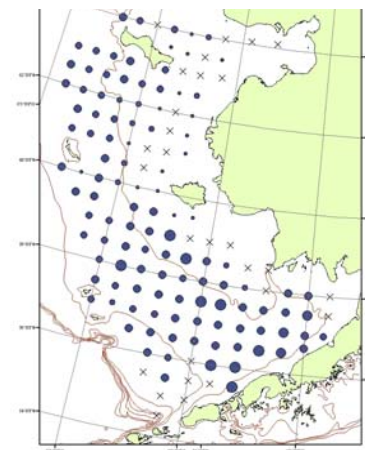
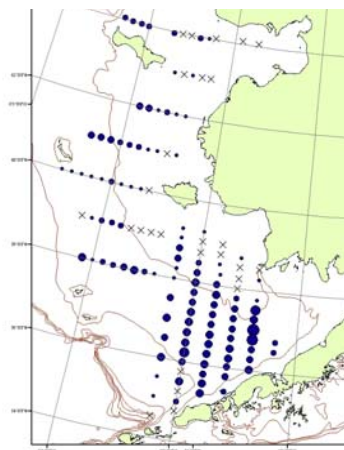
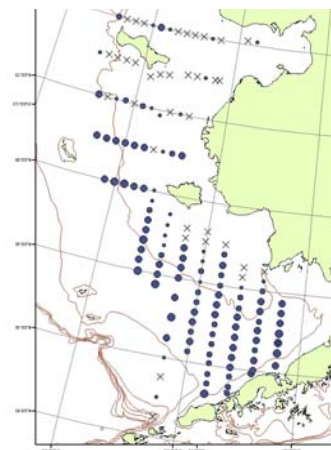
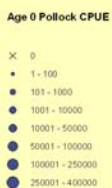
2003

2004

Juvenile  
Sockeye  
Counts

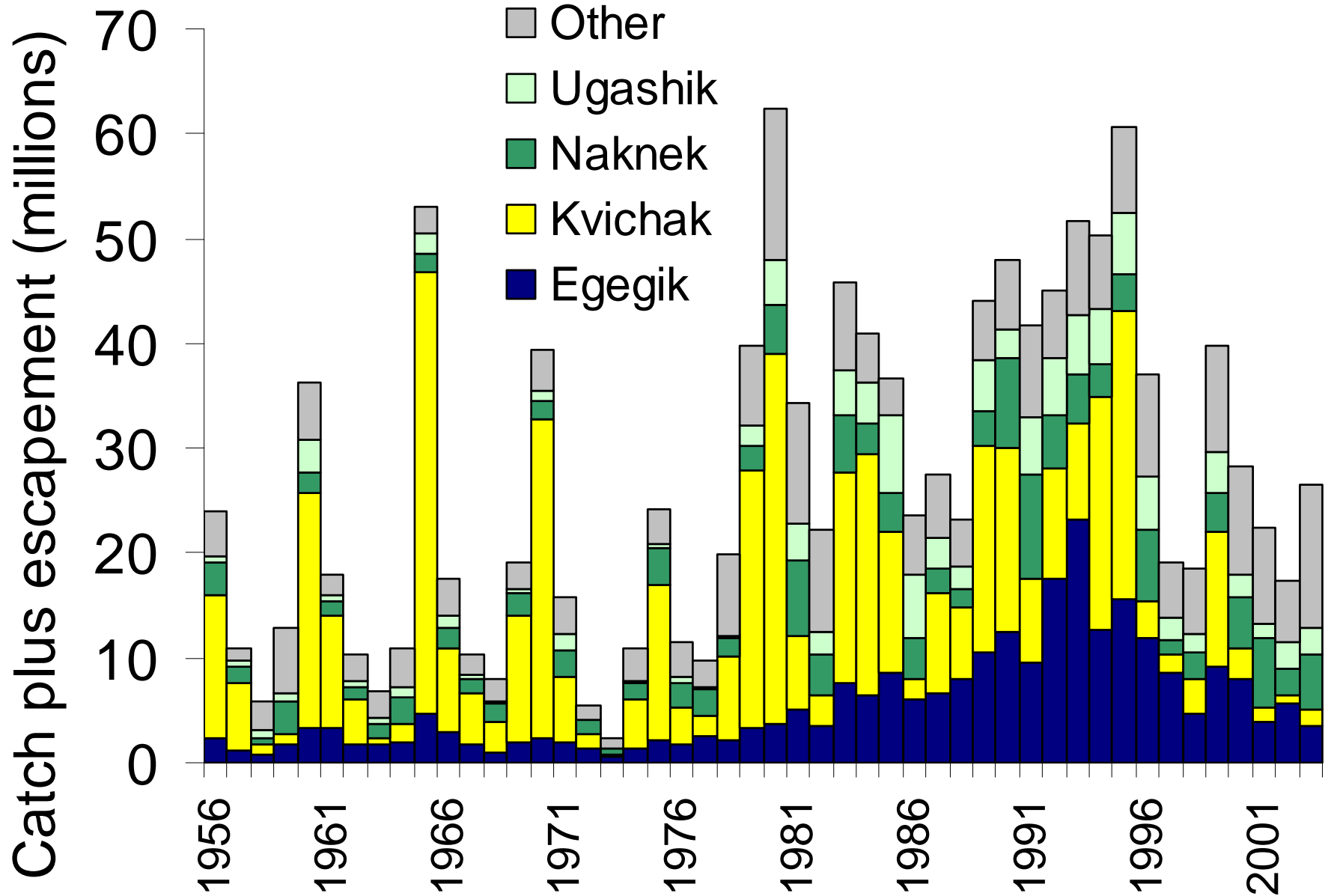


Age-0  
Pollock  
Counts





# Bristol Bay Sockeye Salmon (L. Fair)



R/S Anomalies

## 1976/77 shift

## 1988/89 shift

## Other shift

YFS

ATF

POLLOCK

ROCK SOLE

COD

NORTHERNS

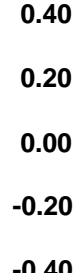
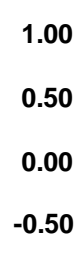
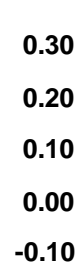
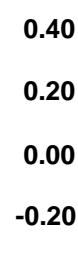
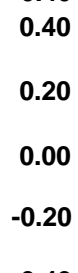
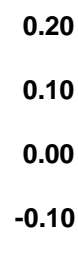
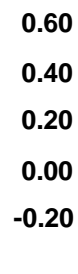
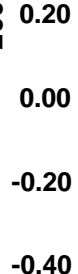
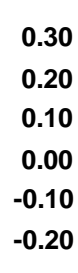
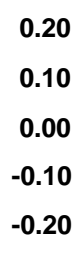
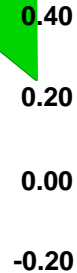
FH SOLE

GT

AI ATKA

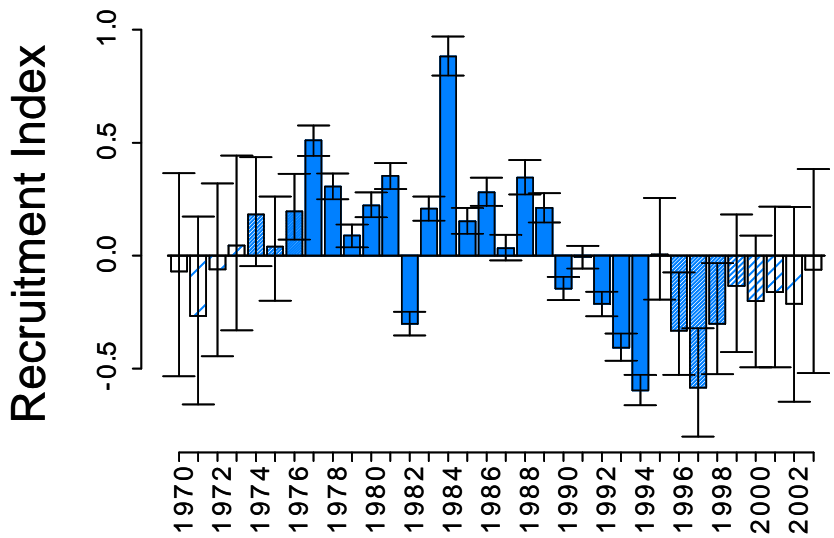
AK PLAICE

POP

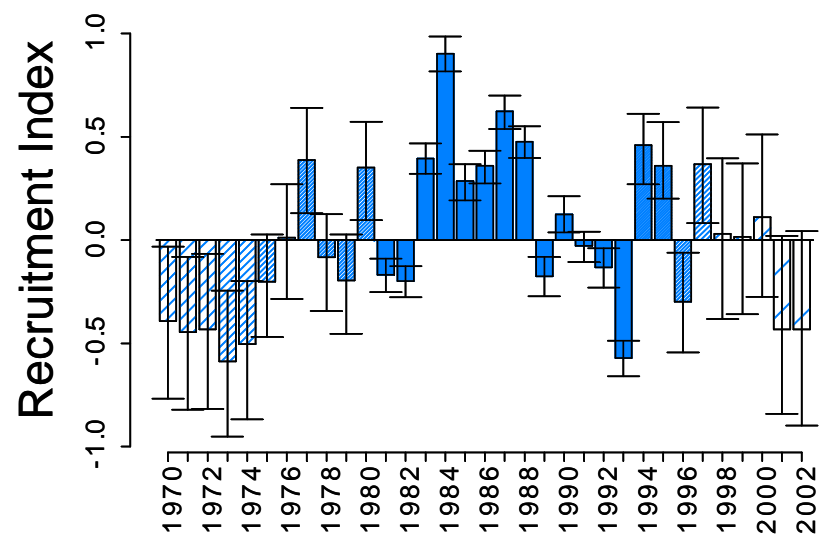


# Groundfish – Combined Std. Indices of Recruitment and Survival (Mueter)

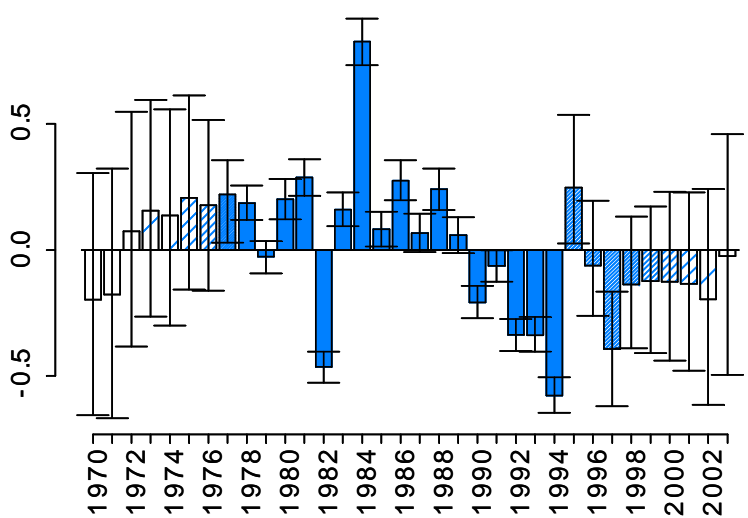
## Bering Sea



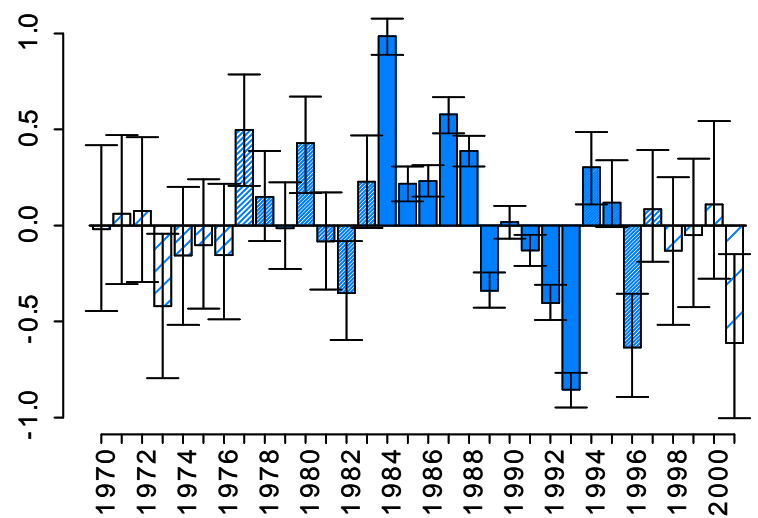
## Gulf of Alaska

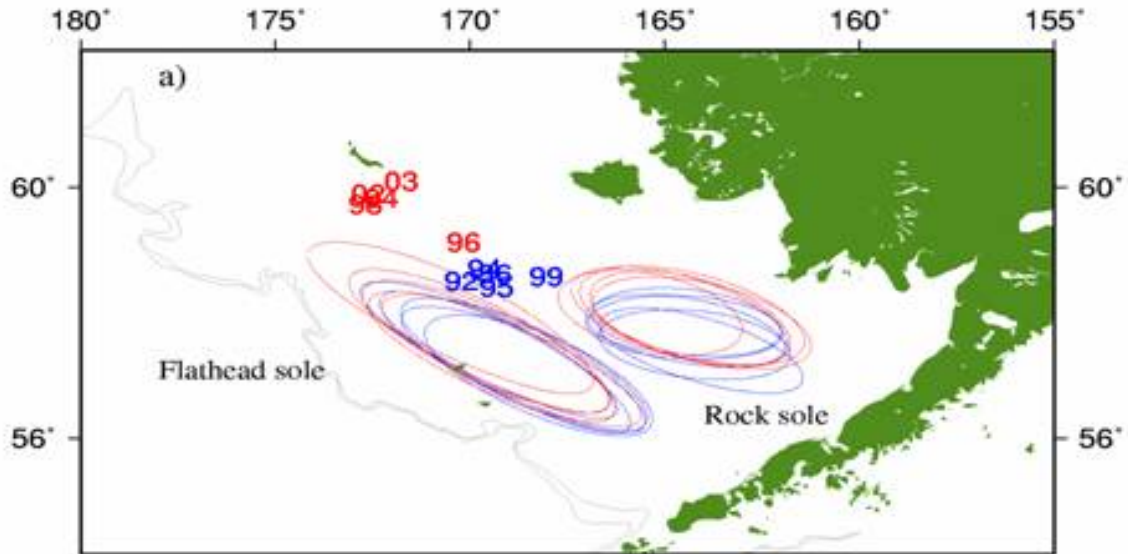


## Bering Sea

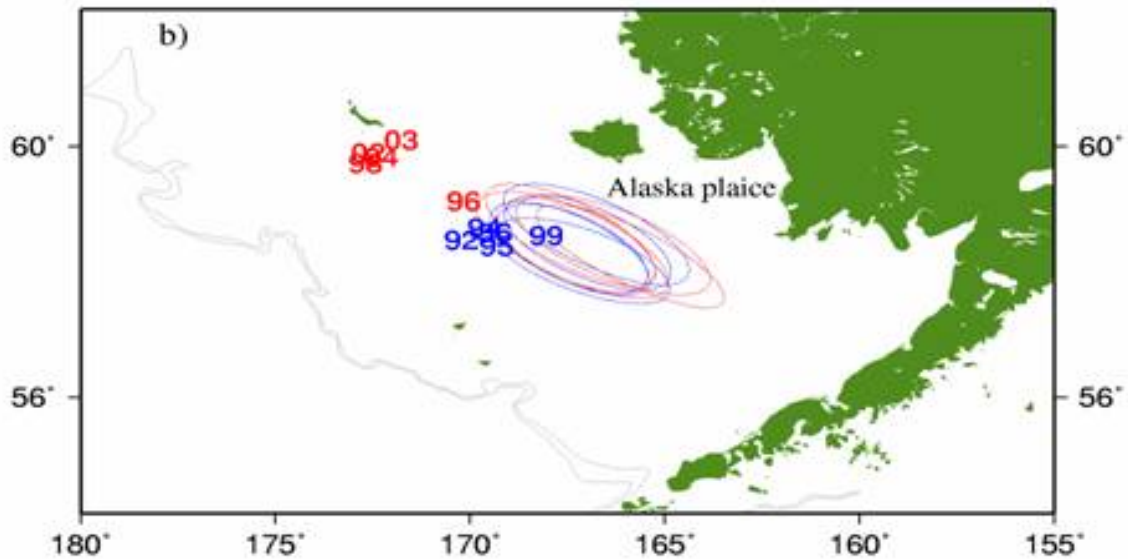


## Gulf of Alaska





## Biological Response to Climate Flatfish Distribution-(Spencer)



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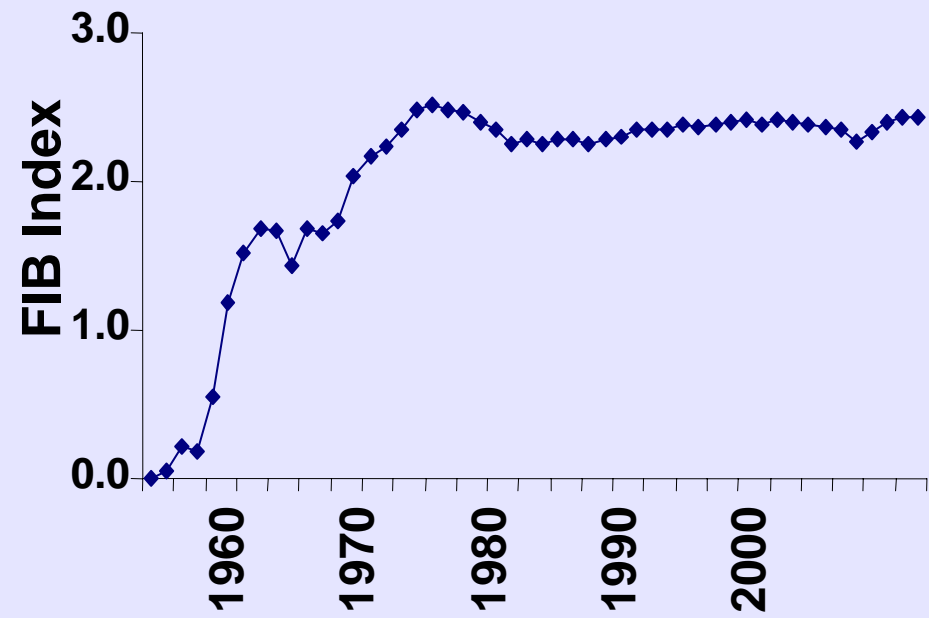
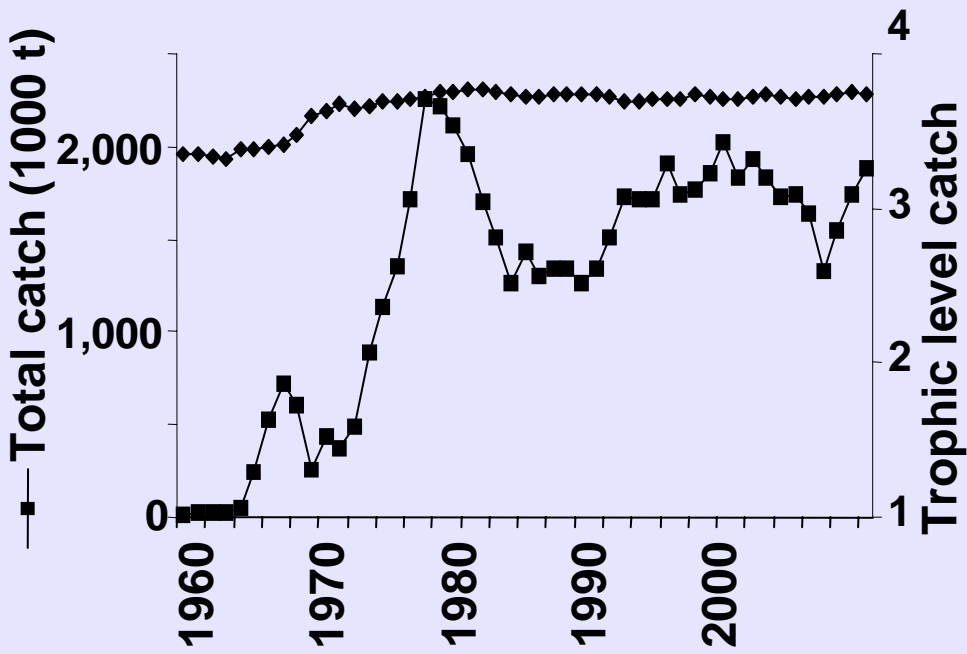
### c. removals of top predators

**Significance threshold:** catches high enough to cause biomass of top predator(s) to fall below min. biol. acceptable limits

#### **Indicators:**

- Trophic level of the catch
- Population status of top predators
- Fishing takes of top predators
- Seabird incidental take

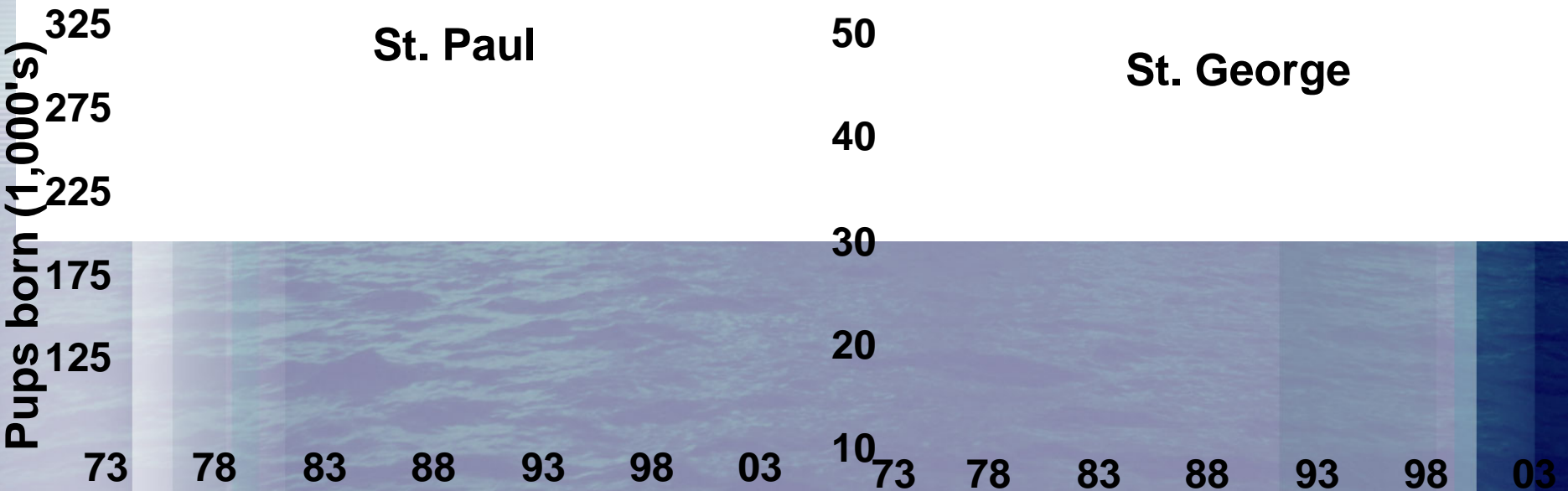
# TOP PREDATORS – Trophic level of the catch



**FIB= index that shows a decline in TL only when catches do not increase as expected**

# TOP PREDATORS

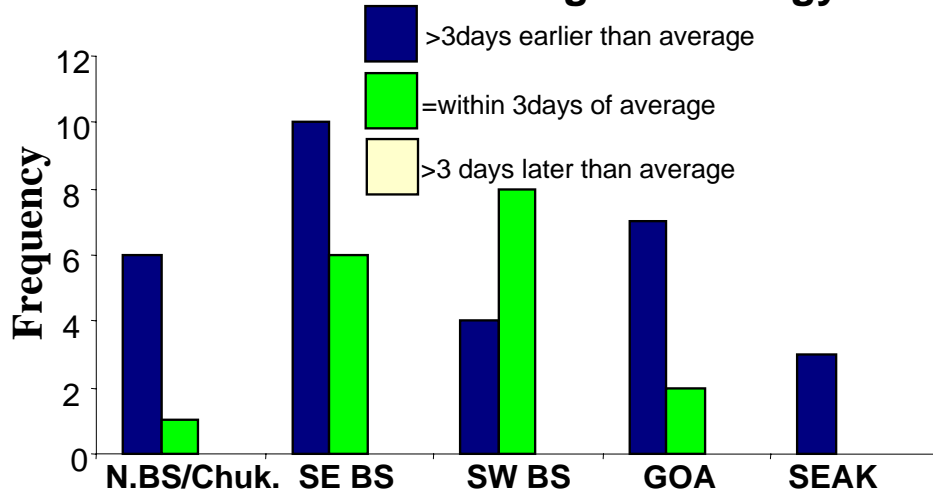
- Northern fur seal pup production continued decline (Sinclair et al.)



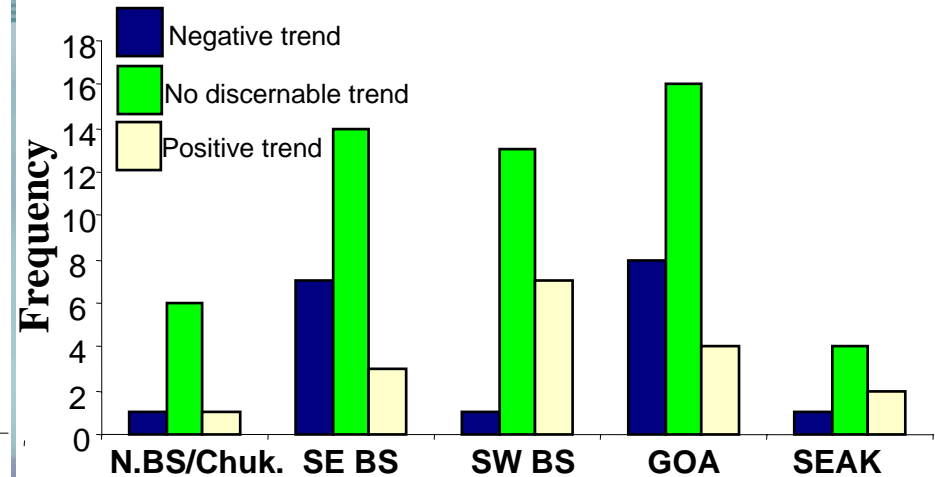


# TOP PREDATORS – Seabirds (Fitzgerald et al.)

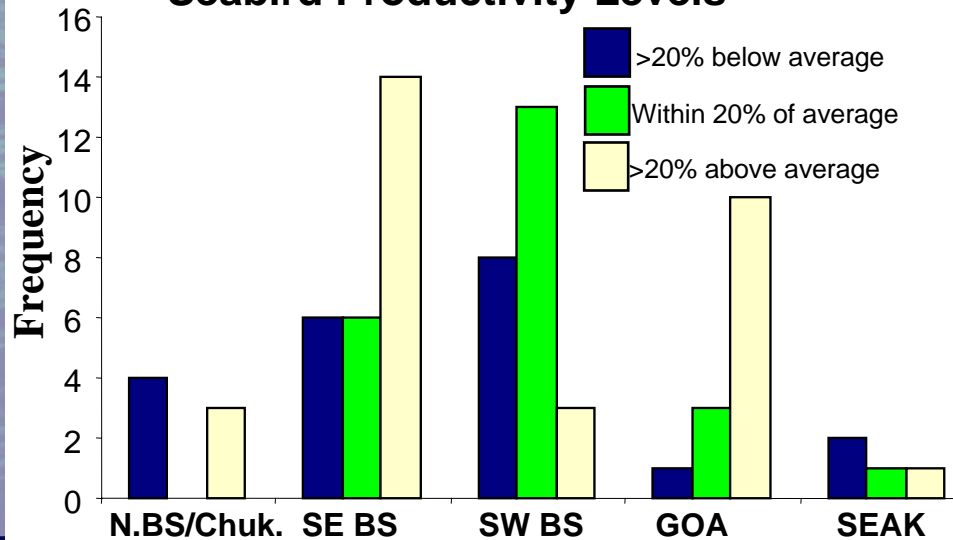
## Seabird Breeding Chronology



## Seabird Population Trends

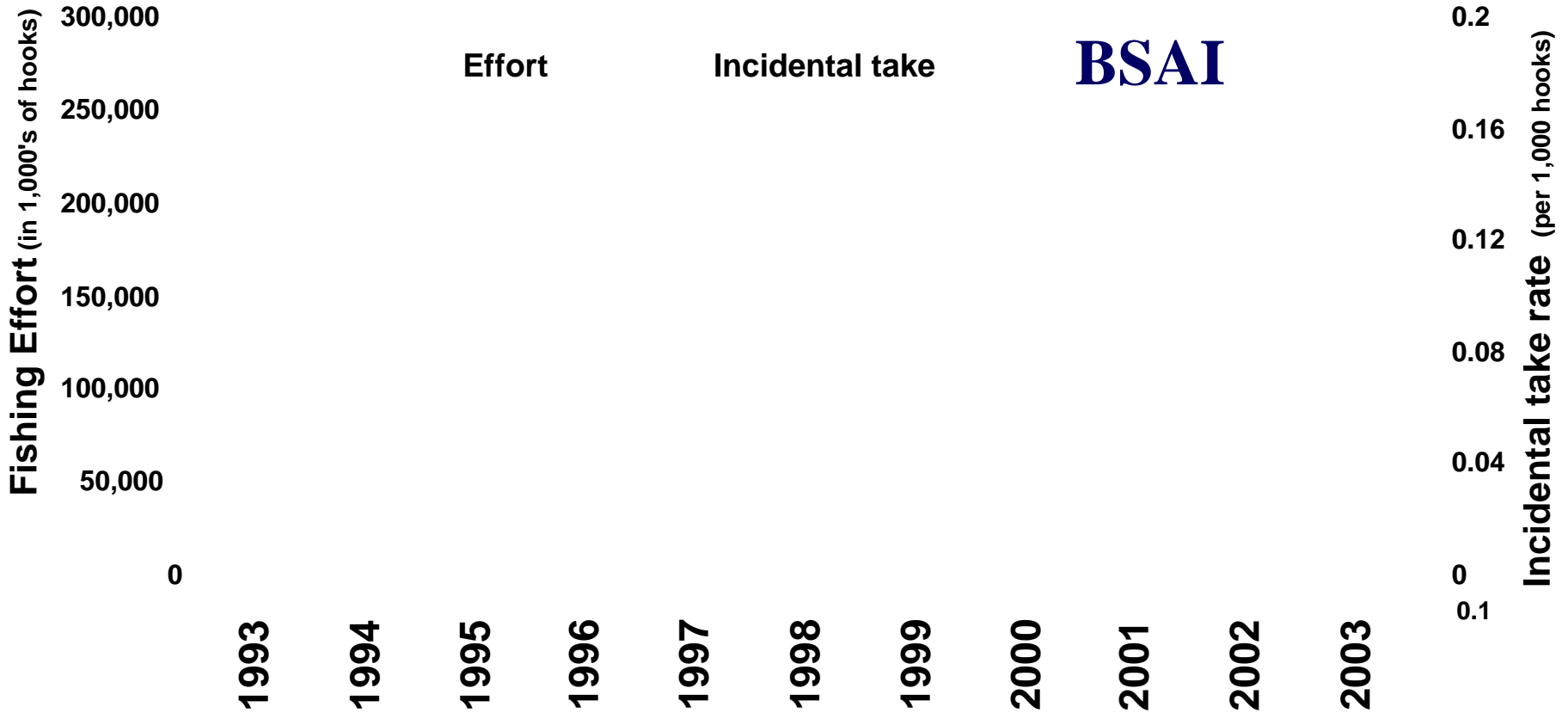


## Seabird Productivity Levels

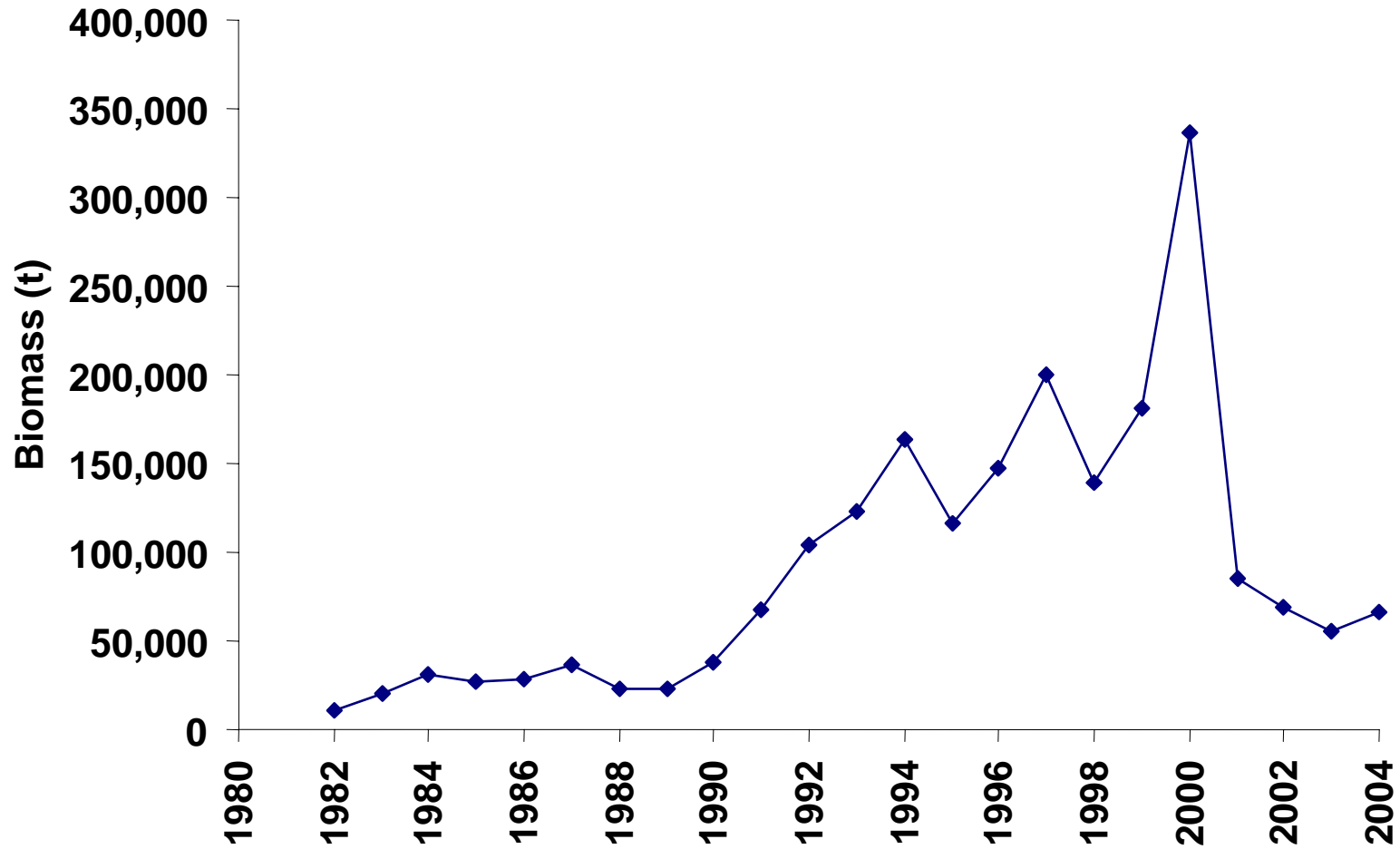


# TOP PREDATORS

## Seabird Incidental Take (Fitzgerald et al.)



# PREDATOR - Bering Sea Jellyfish (Walters)



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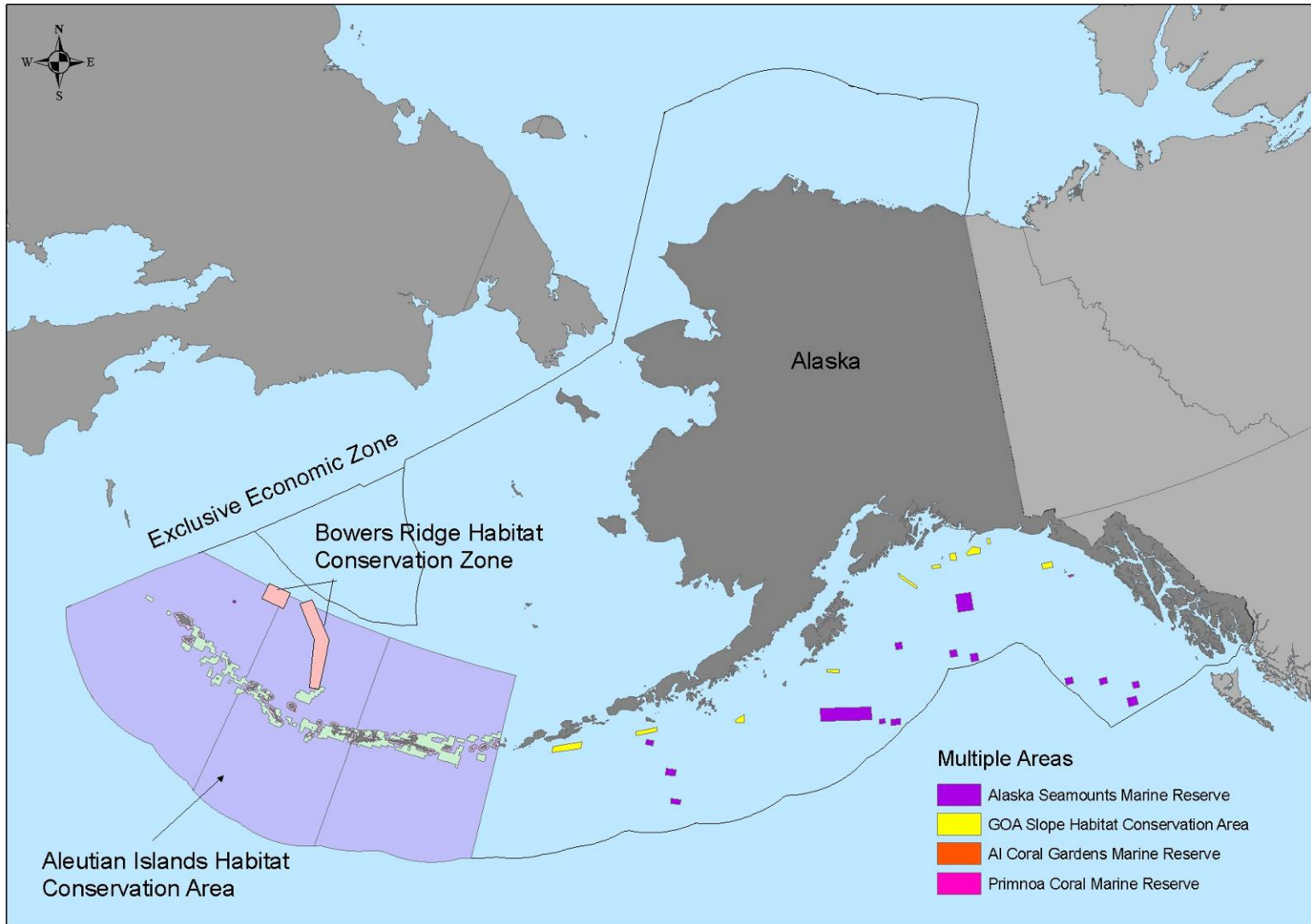
## 2. Maintain diversity by examining: a. species diversity

**Significance threshold:** catch high enough to cause biomass to fall below or be kept from recovering from min. biol. acceptable limits

### **Indicators:**

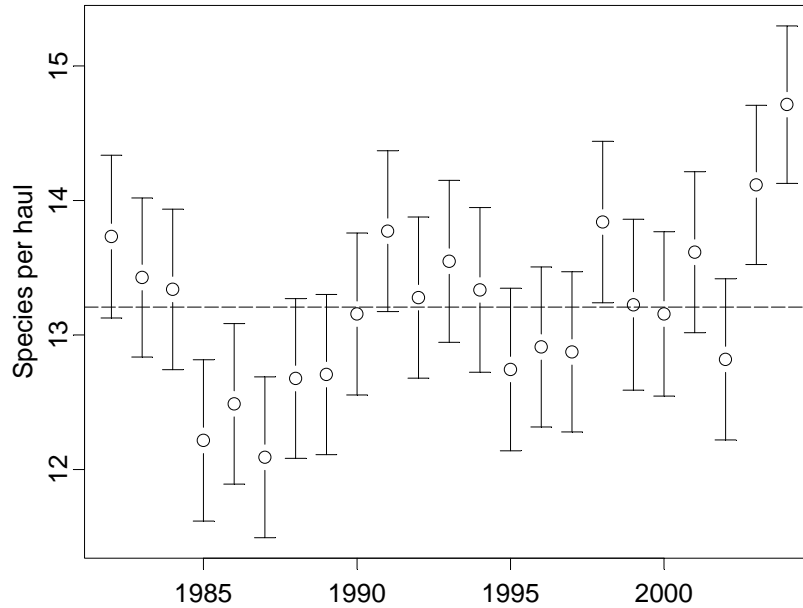
- Status of protected and managed stocks relative to thresholds
- Species richness and diversity
- Areas closed to fishing
- Pop'n trends -other nontarget species from surveys (eg. eelpouts)
- Bycatch trends of sensitive species lacking population estimates

# Ecosystem Mngt Info. –Area closures (Coon)

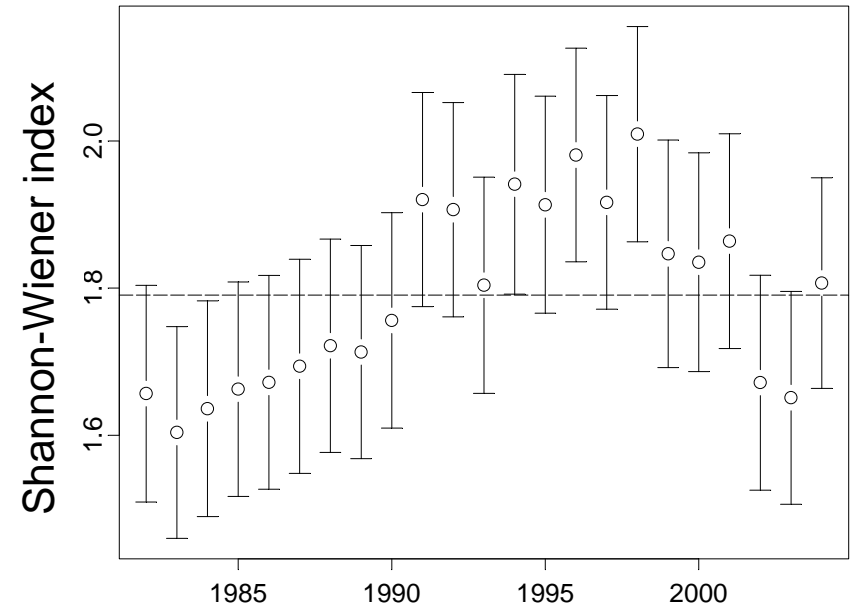


# SPECIES DIVERSITY –

## Species richness



## and diversity (Mueter)



**Richness= number of species per haul**

**Diversity= function of number of species and relative abundance per haul**

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# Objectives for Ecosystem Protection:

## 2. Maintain diversity by examining:

### b. Functional (trophic and structural habitat) diversity

**Significance threshold:** catch high enough to cause change outside observed natural variability

#### Indicators:

- guild or size diversity

- bottom gear effort

- HAPC biota bycatch

- habitat research:

  - Distribution of deep-water corals in AI

  - Seafloor mapping and colonization studies

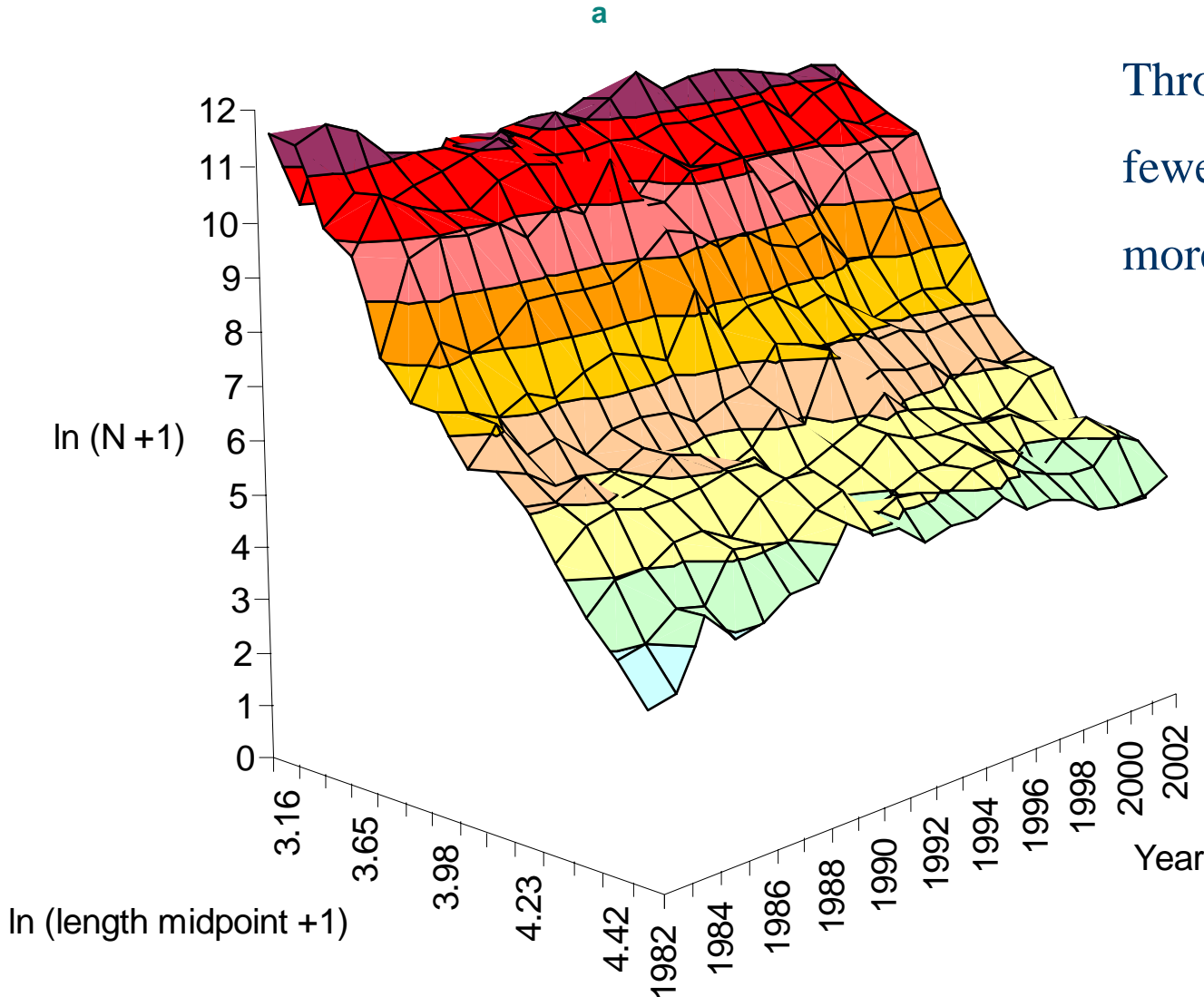
  - Effects of trawling on benthic habitat

  - Growth and recruitment of coral

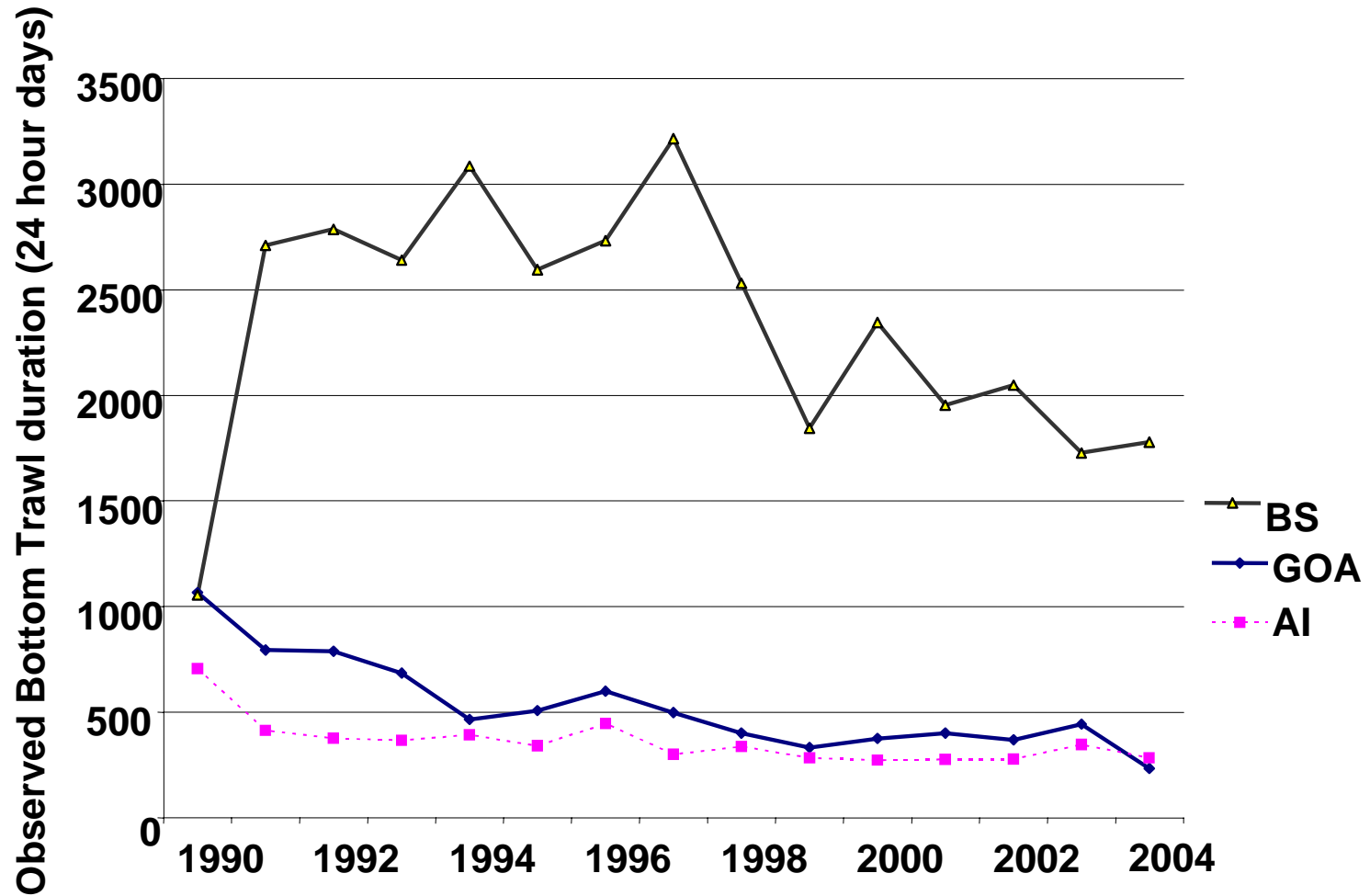
  - Spatial and temporal patterns in BS invertebrate assemblages

# Demersal fish community size spectrum, 1982-2002

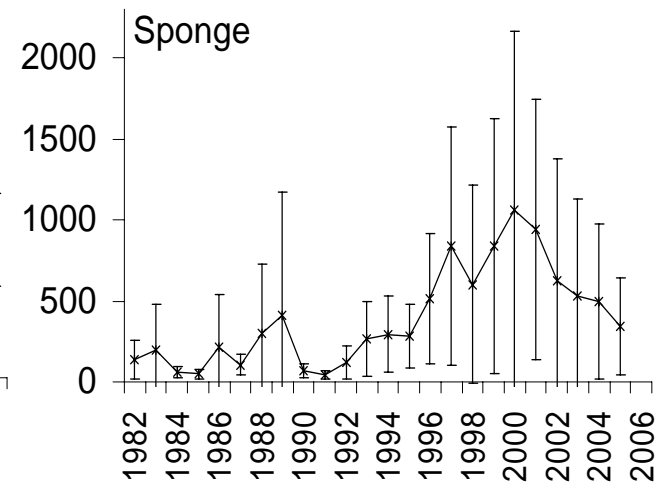
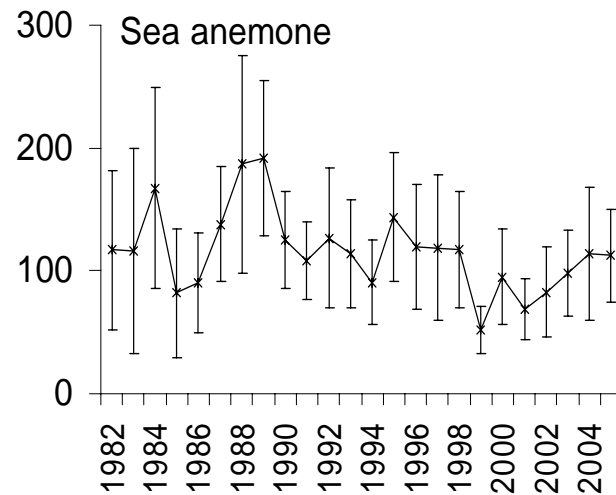
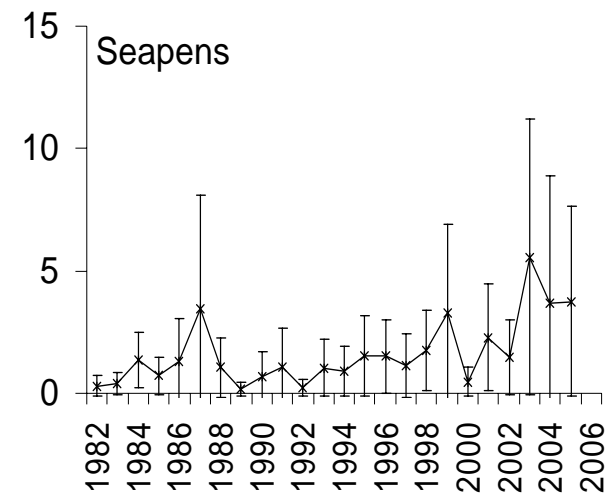
(Bartkiw et al.)



# SPECIES DIVERSITY- Bottom trawl effort (Coon)



# FUNCTIONAL DIVERSITY – HAPC Biota (Lauth)



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# Objectives for Ecosystem Protection:

3. **Maintain energy flow and balance by examining:**
  - a. **human-induced energy redirection**

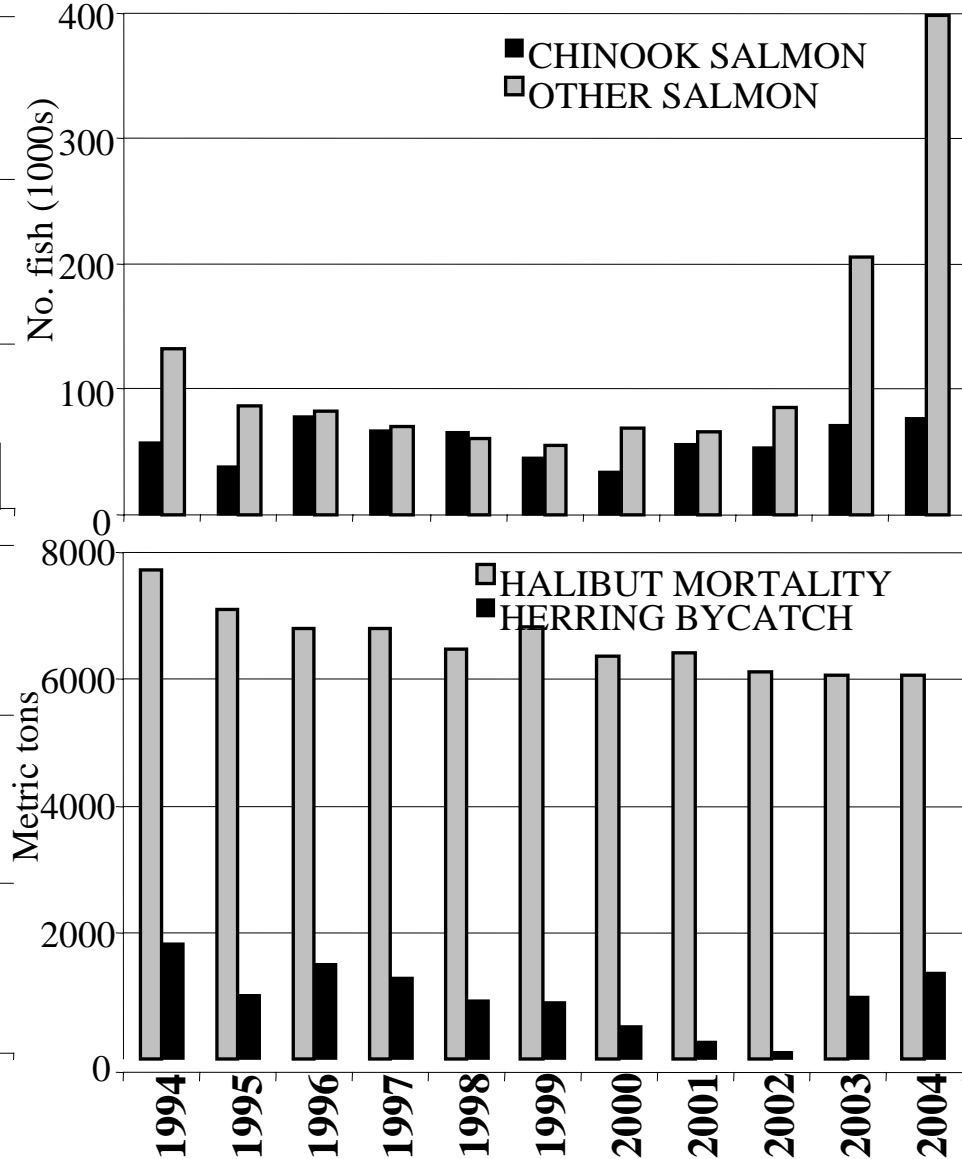
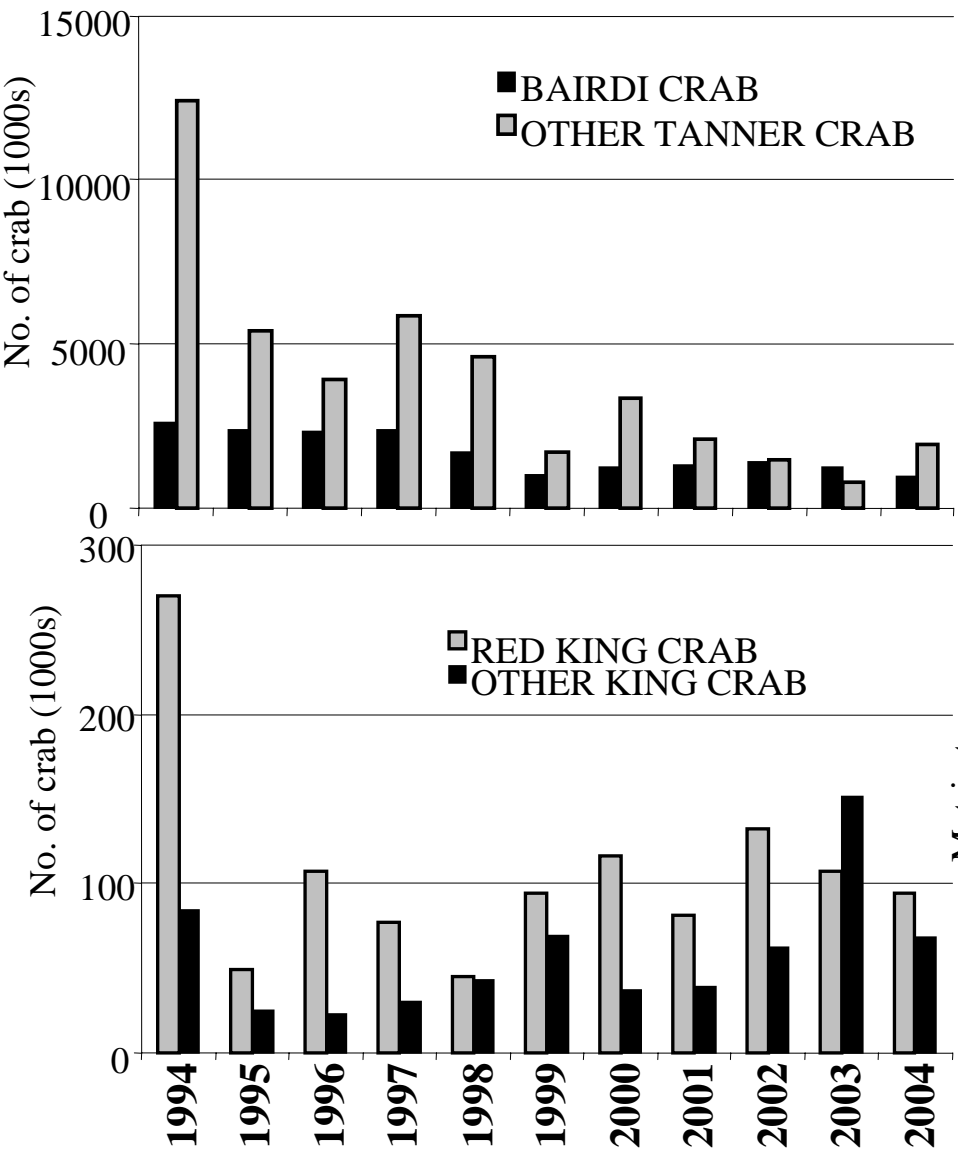
**Significance threshold:** long-term changes in system biomass, respiration, production, energy-cycling due to discards and offal

## **Indicators:**

- Prohibited species bycatch amounts
- Nontarget catch and discards
- Groundfish discards
- Trends in scavenger species

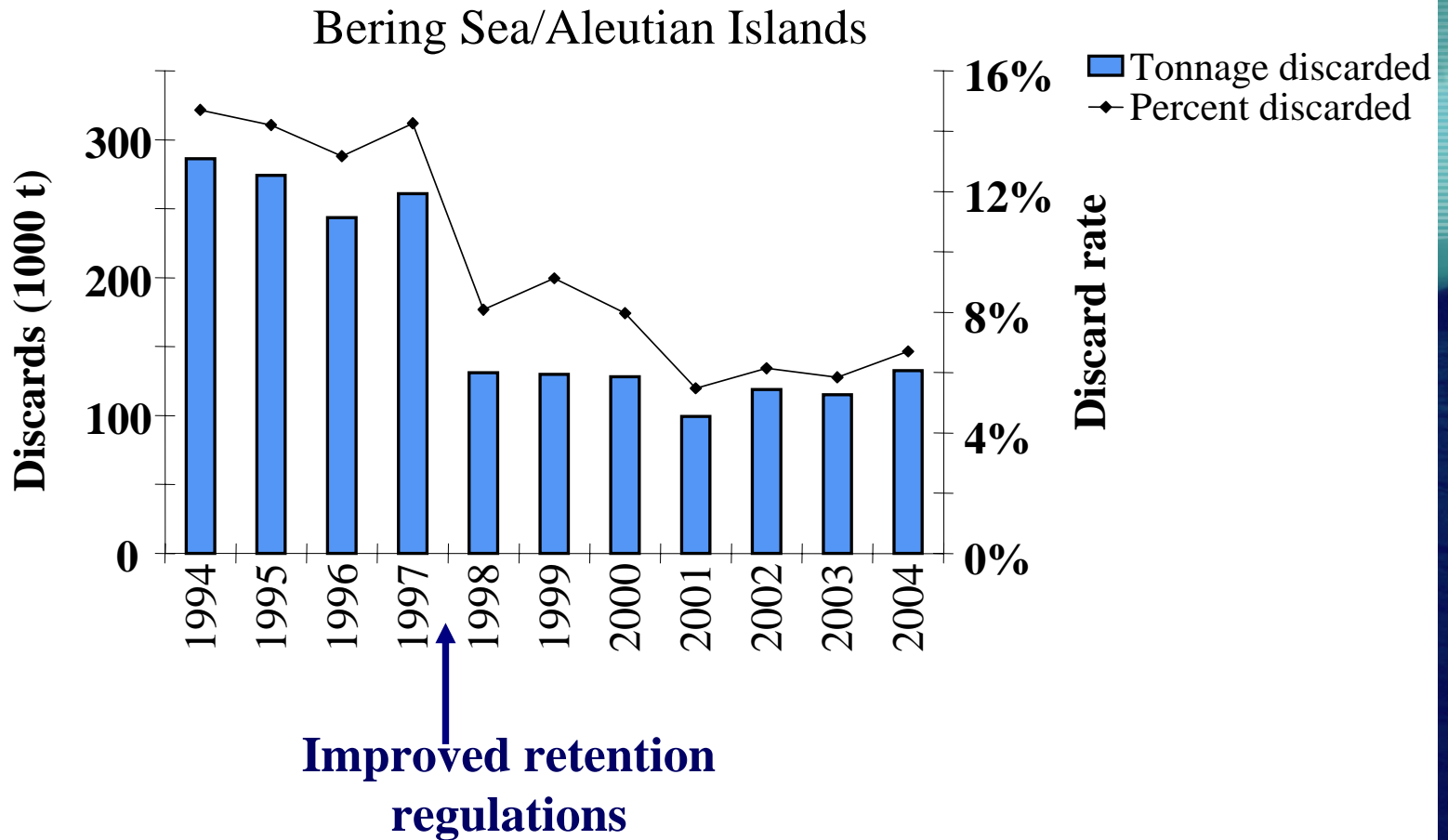
# ENERGY REDIRECTION

## Prohibited Catch (Hiatt and Terry)



# ENERGY REDIRECTION

## Discards (Hiatt and Terry)





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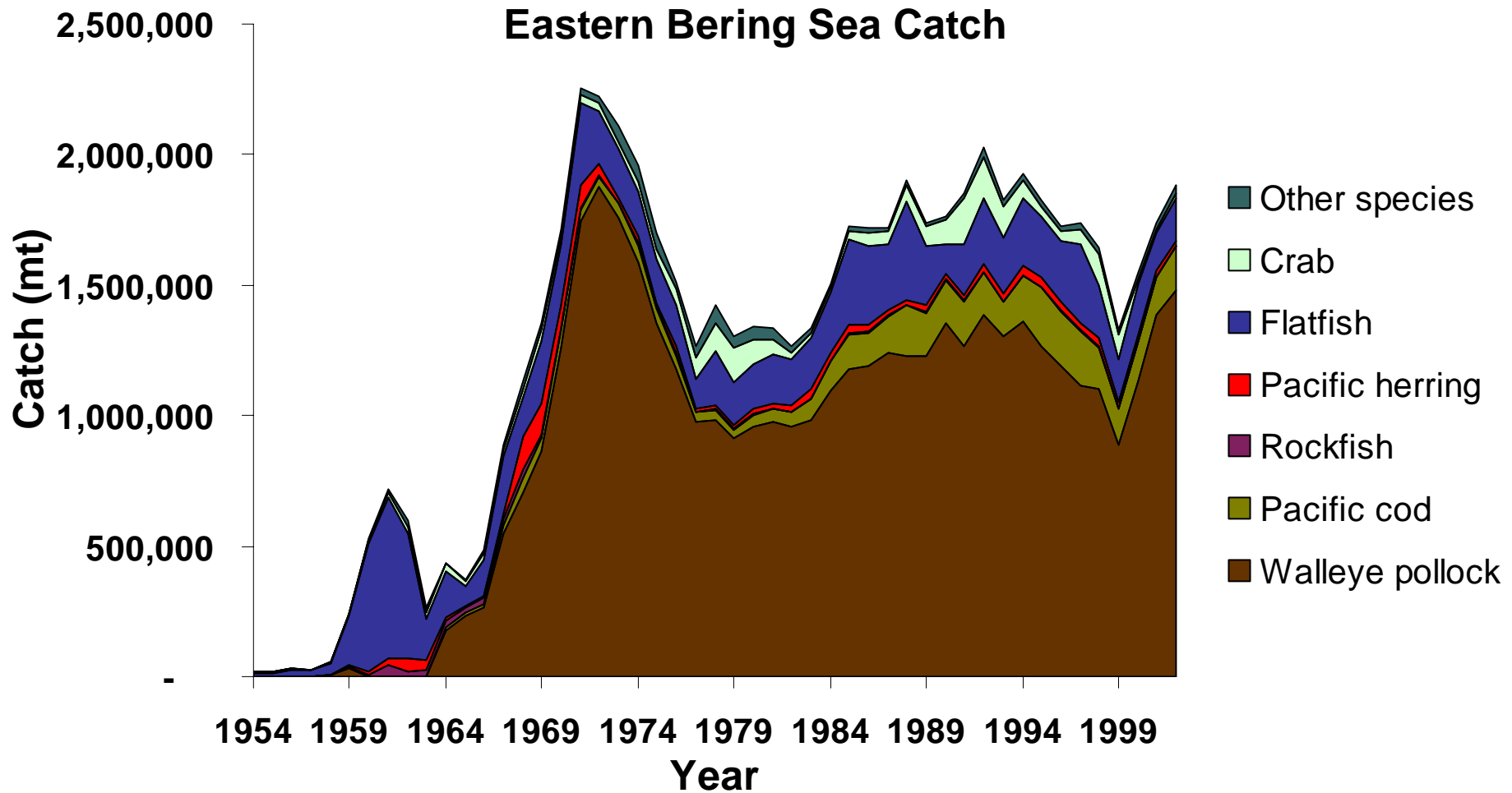
3. **Maintain energy flow and balance by examining:**
  - b. **system impacts attributable to energy removal**

**Significance threshold:** long-term changes in system biomass, respiration, production, energy-cycling due to fishery removals of energy

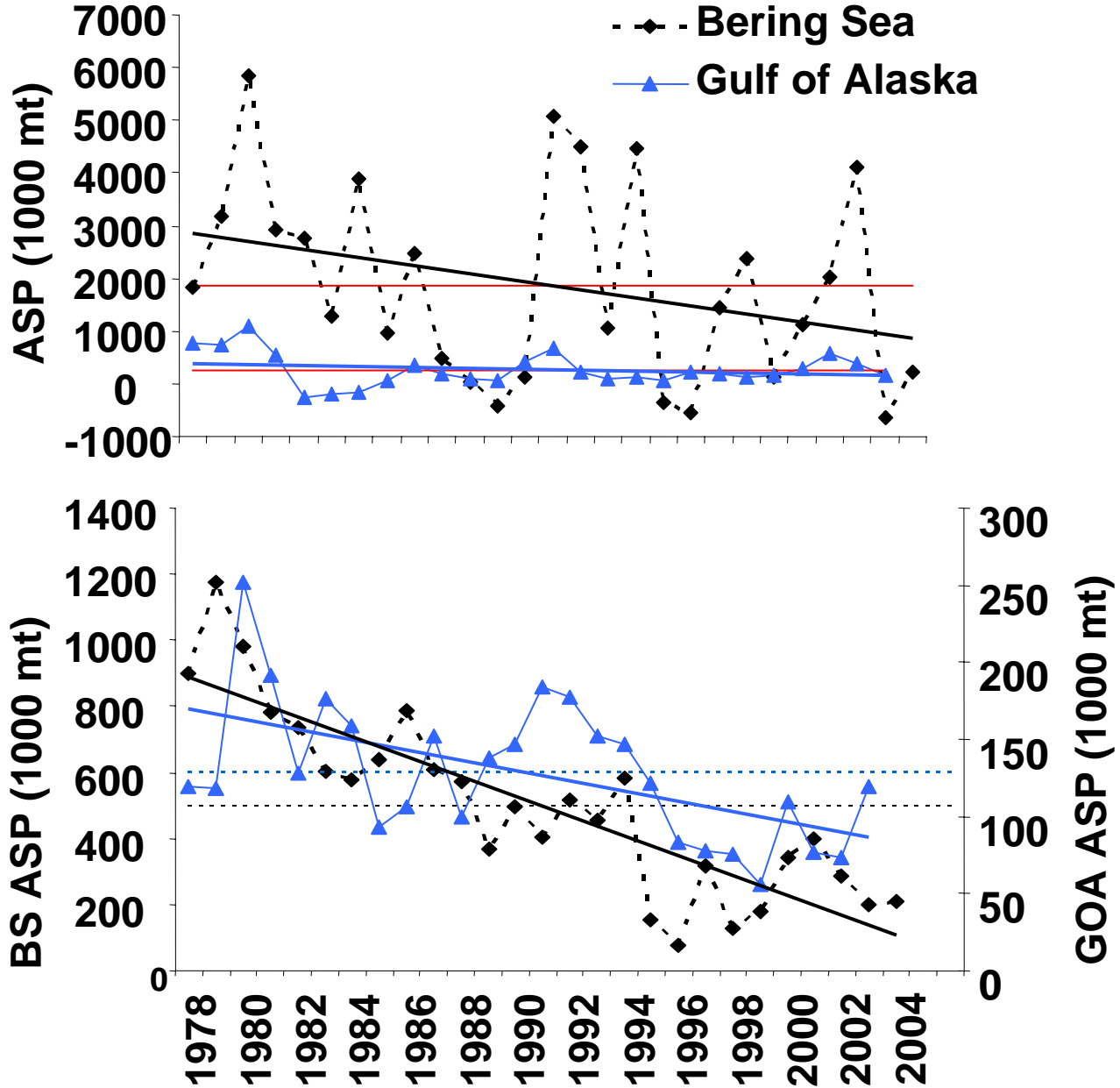
**Indicators:**

-Total catch relative to production

# ENERGY REMOVAL - Total Catch



# ENERGY REMOVAL- ASP (Mueter)



# Management Goals

## Groundfish FMP Goals

- Prevent overfishing
- Promote sustainable fisheries and communities
- Preserve food web
- Manage incidental catch and reduce bycatch and waste
- Avoid impacts to seabirds and marine mammals
- Reduce and avoid impacts to habitat
- Promote equitable and efficient use of fishery resources
- Increase Alaska native consultation
- Improve data quality, monitoring and enforcement

## Ecosystem Assessment Objectives

- Maintain predator-prey relationships
- **Maintain diversity**
- Maintain energy flow and balance

# Groundfish FMP Goals

# Ecosystem Considerations Indices

Prevent overfishing	Status of stocks, annual surplus productivity
Promote sustainable fisheries and communities	Fishing overcapacity programs
Preserve food web	Pelagic forage availability, spatial/temporal conc. of fishery impact on forage fish, removals of top predators, introduction of non-native species
Manage incidental catch and reduce bycatch and waste	Prohibited species, discards, bycatch, scavenger population trends
Avoid impacts to seabirds and marine mammals	Seabird and mammal incidental take, population abundance, productivity, and chronology trends
Reduce and avoid impacts to habitat	EFH research, effects of fishing gear on habitat research
Promote equitable and efficient use of fishery resources	Fishing overcapacity programs, groundfish fleet composition
Increase Alaska native consultation	ANTEK of climate regimes
Improve data quality, monitoring and enforcement	

# Executive Summary

- **CLIMATE**

- North Pacific in uncertain state
- BS continues to warm, less sea ice and earlier retreat

- **BIOLOGY**

- BS summer zooplankton biomass: low 2000-2004
- BS jellyfish biomass: low 2000-2004
- Warming trend may affect flatfish distribution
- Most seabirds show no discernable population trend
- 2002 seabird breeding chronology was early
- 2004 N. fur seal pups born continued to decline
- ASP in BS decreased from 1978-2004

- **FISHERY EFFECTS**

- 2003 and 2004 increases in herring and other salmon bycatch
- 2003 seabird incidental take rate same as 2002



# Alaska Fisheries Science Center Resource Ecology and Ecosystem Modeling



REEM > Ecosystem Considerations Chapter For 2006



Welcome to the Ecosystem Considerations Chapter web pages. This report includes an ecosystem assessment, contributions with updated status and trend indices, and ecosystem-based management indices and information for the Bering Sea (BS), Aleutian Islands (AI) and the Gulf of Alaska (GOA) ecosystems. The following features are available through this web site:

- [Download the Chapter](#) in its entirety as a PDF (approx. 10 MB)
- [Browse the contributions individually](#) where each individual contribution includes the primary author's contact information and associated metadata
- [Data access](#) for most contributions
- Data use is contingent upon compliance with the [AFSC Data Use Conditions](#)
- A brief [description](#) of the Chapter contents
- A collection of [links relevant to the Chapter](#) contents
- Contact [Jennifer Boldt \(Editor\)](#) for further information

[contact](#) • [privacy](#) • [disclaimer](#) • [accessibility](#)

**Website: Geoff Lang**  
**<http://access.afsc.noaa.gov/reem/ecoweb/index.cfm>**



# Summary

- **No noted significant adverse impacts of fishing on the ecosystem** (relating to predator/prey interactions, energy flow/removal, or diversity).
- **There are gaps in understanding the system-level impacts and spatial/temporal effects of fishing on community structure and prey availability.**
- **Future: incorporate predictions from multispecies models.**
- **Need research, validation of models, and models focused on understanding spatial processes, and improvements in monitoring systems**
- **A range of possible climate scenarios and plausible effects on recruitment should be entertained.**