

Ecosystem-based Science for Management of Alaskan Fisheries

Patricia A. Livingston

NOAA-Fisheries

Alaska Fisheries Science Center Seattle, WA,
USA

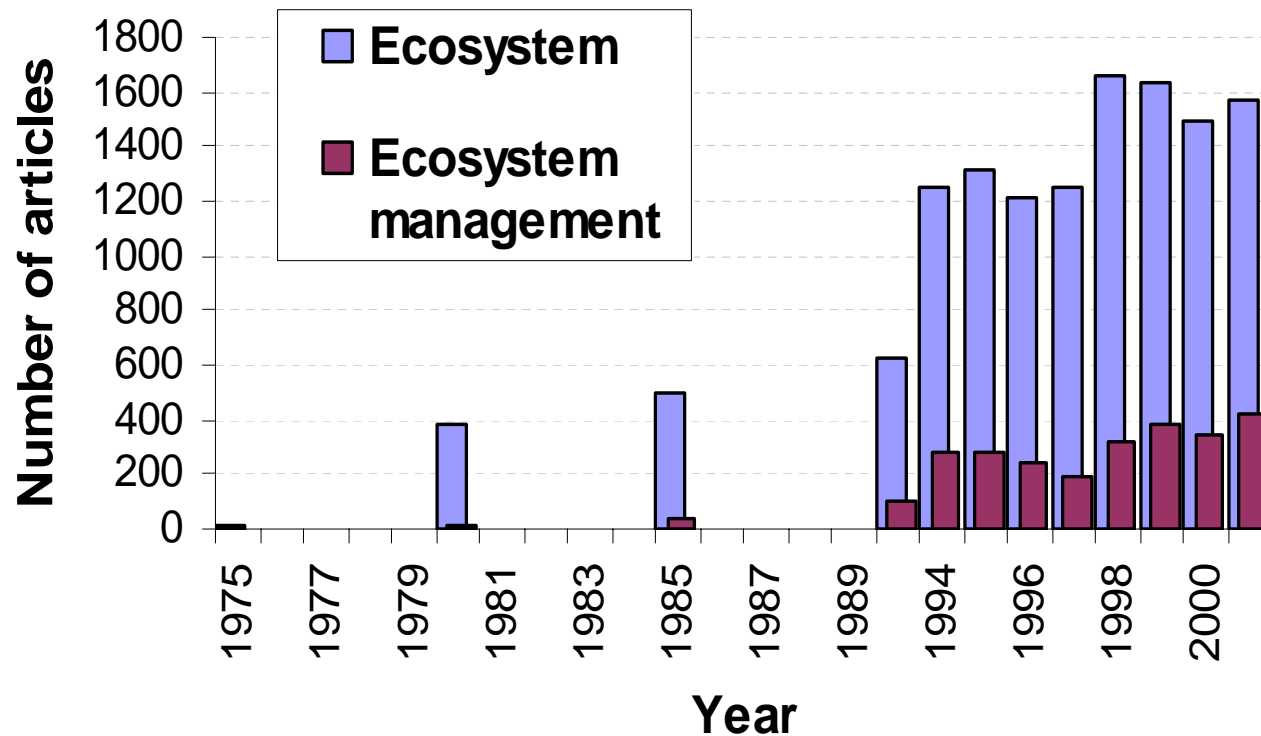


Overview

- Background on ecosystem research and ecosystem management
- Alaskan context
- Present ecosystem-based management and research activities
- Future challenges

FOCUS ON ECOSYSTEMS

ASFA Citations



Ecosystem Definitions

ECOSYSTEM

- Populations and communities of interacting organisms and physical environment with characteristic trophic structure and material (energy) cycles

ECOSYSTEM-BASED MANAGEMENT

- Definitions are varied
- NOT managing the ecosystem but rather managing humans
- Management decisions that take ecological information into account
- Takes a long-term view of sustainability

Areas of Ecosystem Research

**Fisheries
Oceanography**

**Predator-prey
interactions**

**Human
Impacts**

**Habitat
Identification**

Research Approaches

Process Studies

Modeling

**Field Survey
Monitoring**

**Retrospective
analysis**



THE ALASKAN CONTEXT

- Federally-managed groundfish populations
- Relatively conservative exploitation rates combined with productive fish stocks but declining mammal and bird stocks
- Pro-active management: ecosystem committee, ecosystem considerations chapter



IMPROVED ECOSYSTEM ADVICE

- Ecosystem-oriented Management **Goals**
- Management **Tools**
- Expansion of **scientific advice** to include broad spectrum of ecosystem research



ECOSYSTEM-ORIENTED MANAGEMENT GOALS

- Maintain **biodiversity**
- Maintain and restore **habitats** of fish and prey
- Maintain system **sustainability** (human consumption and non-extractive uses.)
- Maintain the concept that **humans** are part of the ecosystem

Ecosystem-based Management Actions Taken

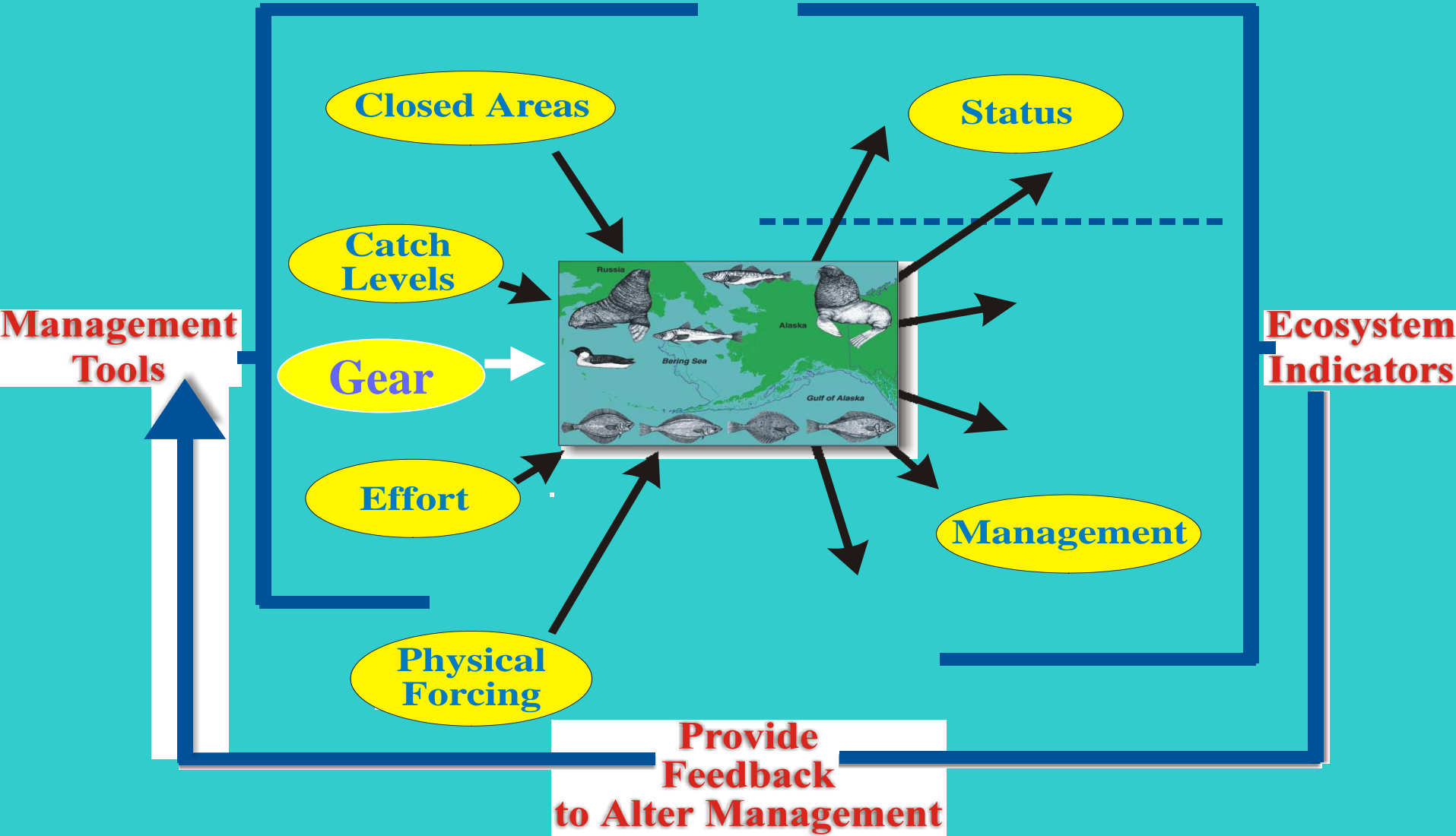
- TAC less than ABC for individual stocks
- OY cap on total groundfish yield
- No target fisheries on forage
- Short-tailed albatross take restrictions, Seabird bycatch mitigation devices
- No fishing in Steller sea lion foraging area and minimum biomass threshold for sea lion prey
- Trawl closures, bottom trawling restrictions
- Bycatch and discard controls



Ecosystem Measures and Influences

Influences

Outcomes





ECOSYSTEM INDICATORS

MANAGEMENT

- Provide early warning of human effects
- Track efficacy of previous management efforts

STATUS

- Link ecosystem research to traditional fisheries advice
- Provide new understanding of ecosystem connections

MANAGEMENT INDICATORS

- Bycatch/discard amounts
- Area closed to fishing
- Trophic level and total amount of catch
- Effort levels and controls

ECOSYSTEM STATUS INDICATORS

- Status and trend indicators of
 - **Physical environment** (PDO, ice cover, etc)
 - **Habitat** (contaminants, benthos, sediments)
 - **Living Marine Resources**
(phytoplankton, zooplankton, forage fish, invertebrates, non-target fish species, marine mammals, seabirds)
 - **Community or Ecosystem level**
(diversity, trophic level, model results)

History of the Ecosystem Considerations Advice

- **Began in 1995 by the NPFMC Groundfish Plan Teams**
- Provide Council with information on climate changes on fish stocks and effects of fishing on ecosystem
- **1995-1999 editions provided a variety of background information**
- 2000+ editions attempted to standardize content and focus on historical trend (change indicators) and evaluation of present status

Ecosystem Considerations Advice

- Accompanies traditional stock assessment advice to fishery managers
- Provides stock assessment scientists with ecosystem information that can be incorporated into single species assessments in either qualitative or quantitative ways
- Track ecosystem-based management efforts and their efficacy
- Track ecosystem changes and provide assessment of present status
- Provide baseline to assess predictions of future ecosystem change

ECOSYSTEM-BASED MANAGEMENT GOAL: SUSTAINABILITY

Management Measures: Conservative Harvest Levels, OY cap

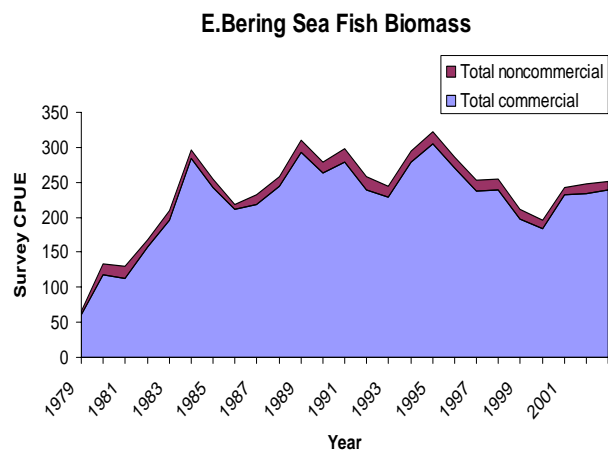
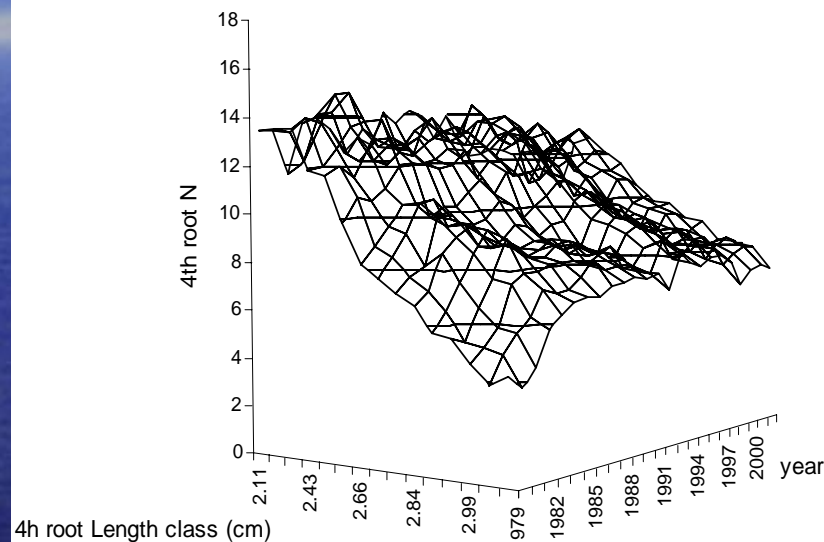
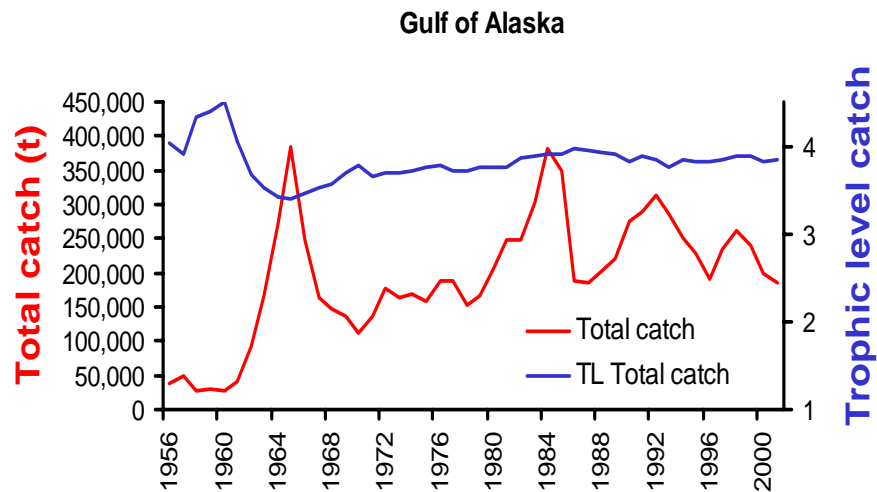
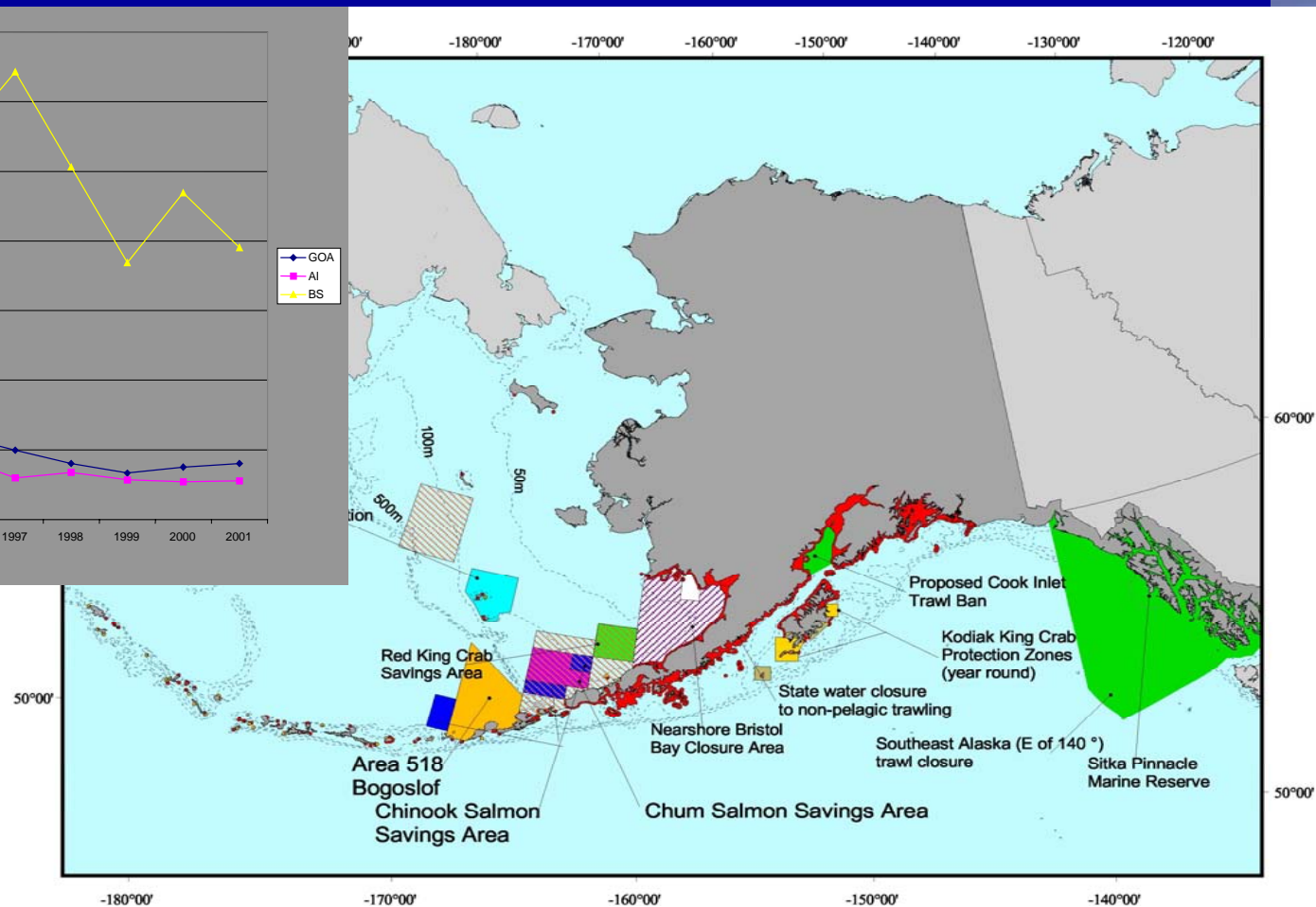
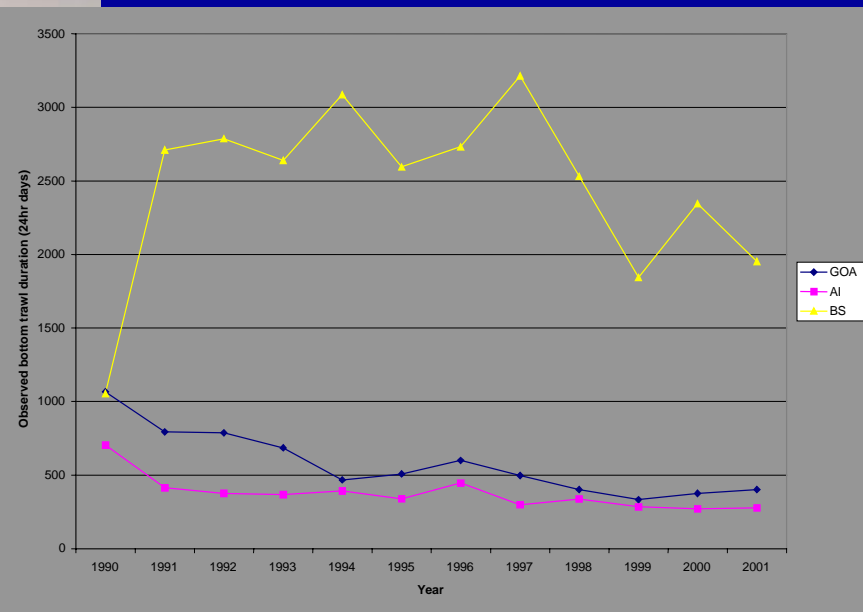


Table 1. Status of groundfish and crab stocks managed under federal fishery management plans off Alaska, 2001.

FMP	Number of Stocks by Overfished Category			
	Overfished	Not Overfished	Unknown	Total
GOA Groundfish	0	9	93	102
BSAI Groundfish	0	13	100	113
Crab	2	4	14	20
Salmon	0	5	0	5
Scallop	0	1	0	1

ECOSYSTEM-BASED MANAGEMENT GOAL: MAINTAIN AND RESTORE FISH HABITAT

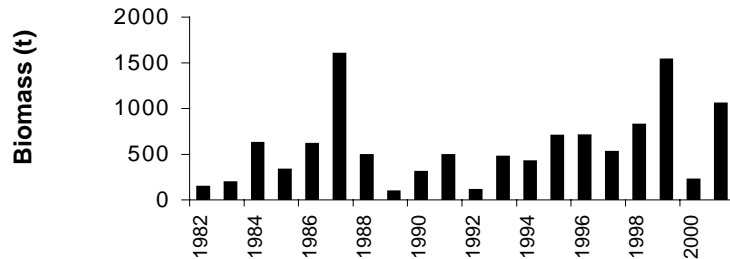
Management Measures: Time/Area closures, gear restrictions



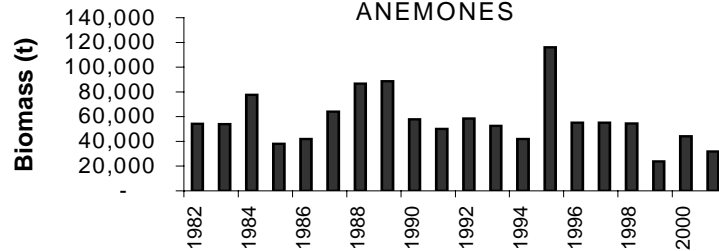
ECOSYSTEM STATUS:

Functional Diversity of Structural biota

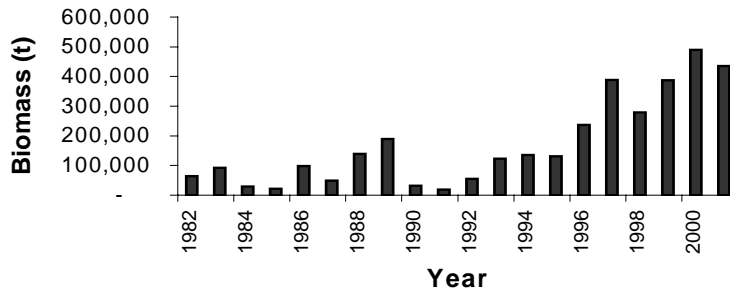
SEAPENS/WHIPS



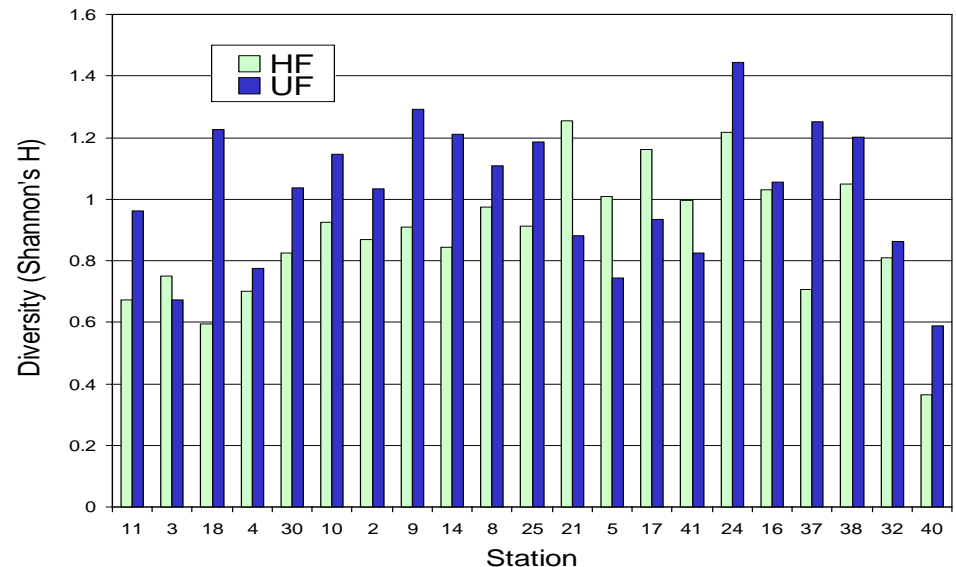
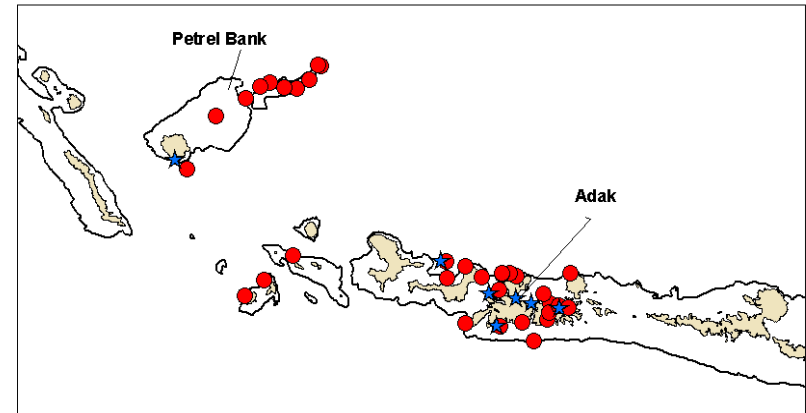
ANEMONES



SPONGE



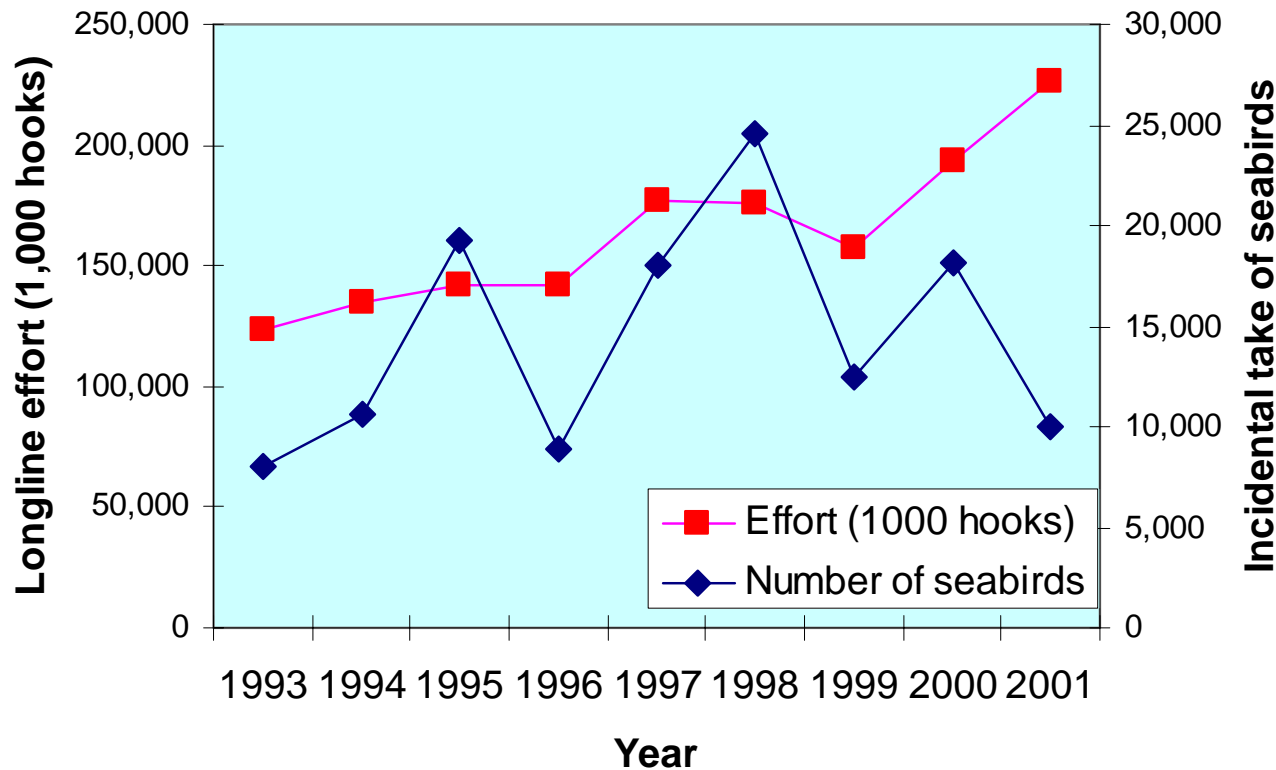
Aleutian Coral Explorations



ECOSYSTEM-BASED MANAGEMENT GOALS:

Maintain and Restore Fish Habitat and Protect Biodiversity

MANAGEMENT MEASURES: Gear allocations and Seabird bycatch mitigation devices



ECOSYSTEM-BASED MANAGEMENT GOAL: Maintain Diversity

MANAGEMENT MEASURE: Spatial catch restrictions for protection of sea lion foraging areas

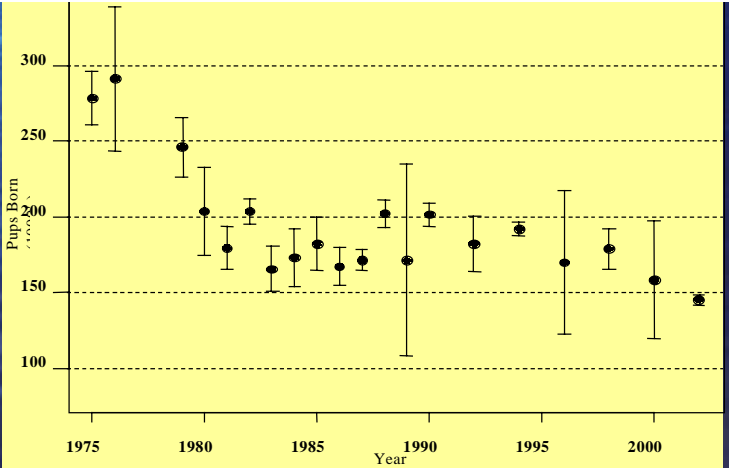
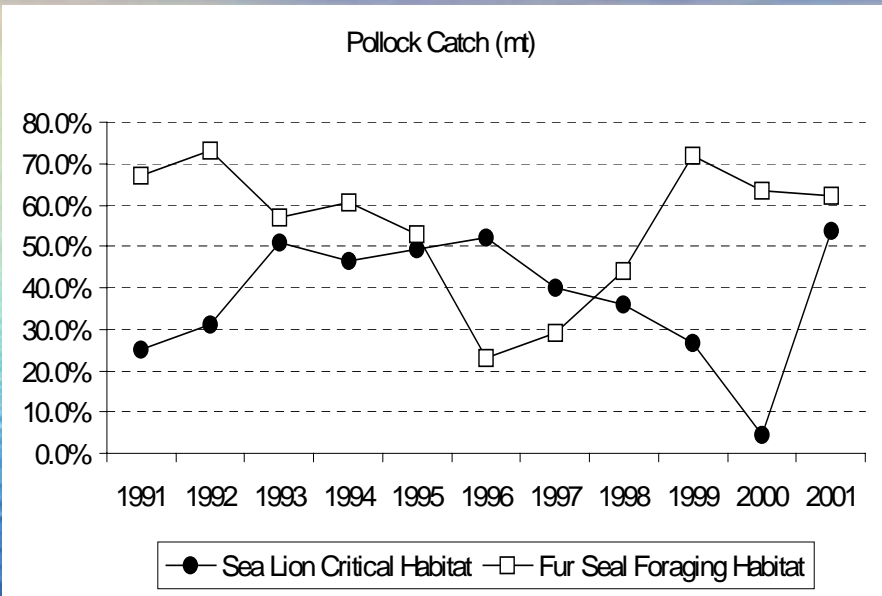
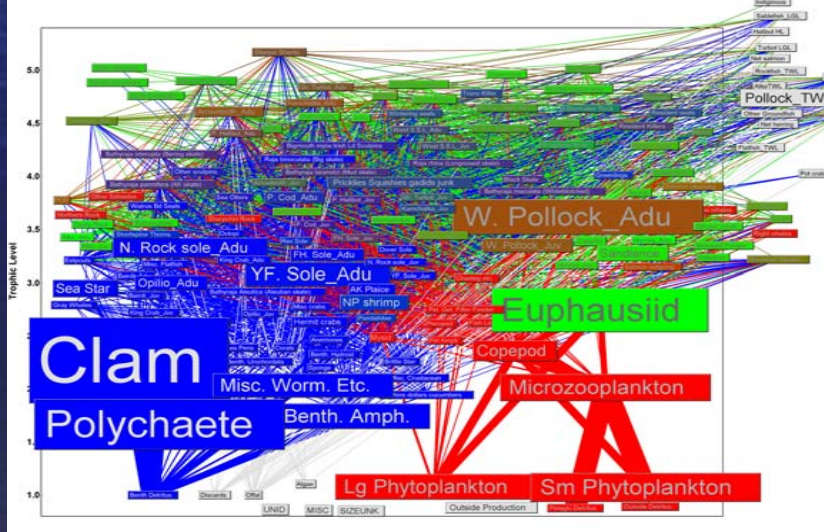
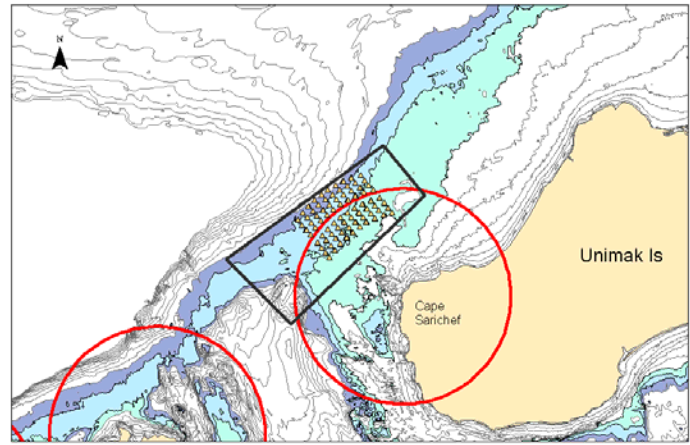


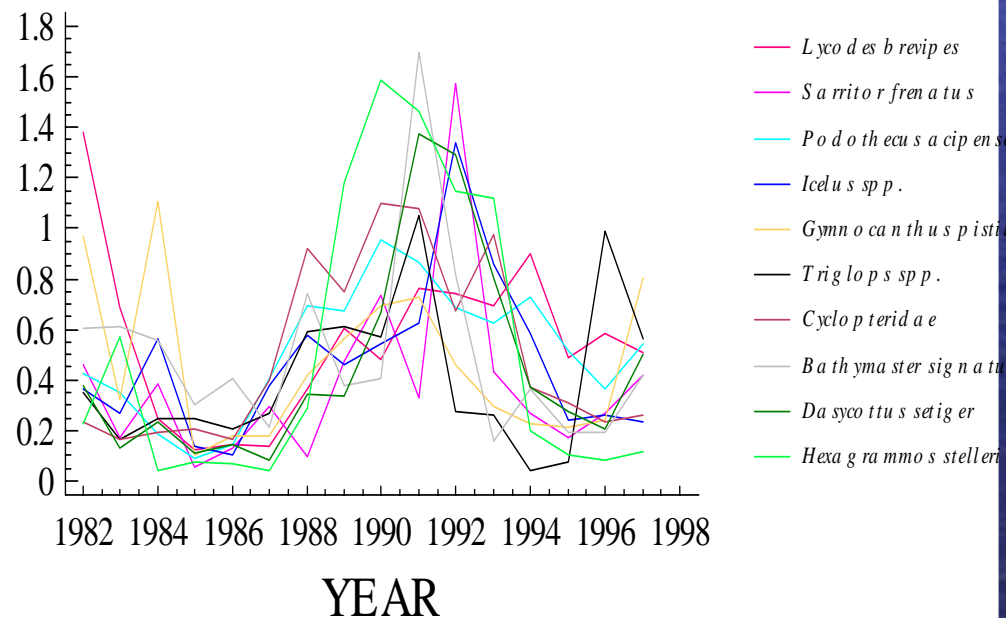
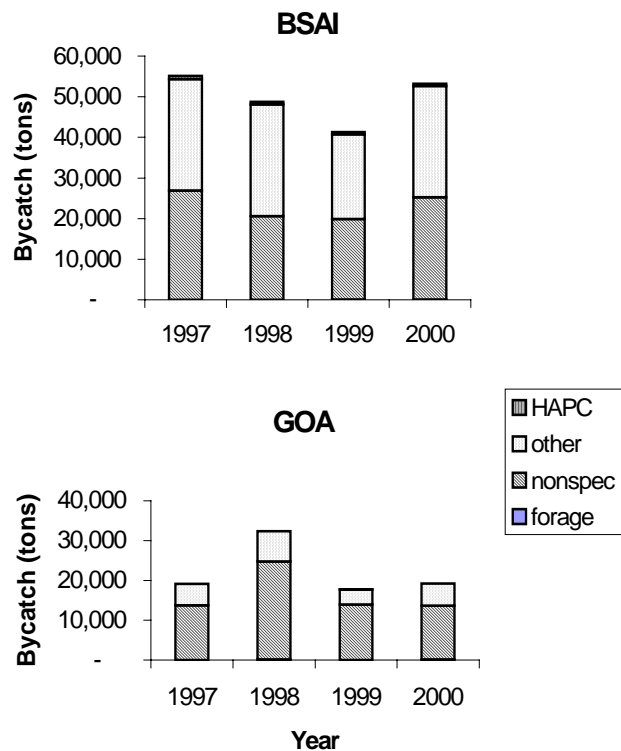
Figure 3. Cod Pol Local Abundance Study Area on Cape Sanchef. Triangles indicate 2003 study sites, shaded depths 70-90 m.



ECOSYSTEM-BASED MANAGEMENT GOAL:

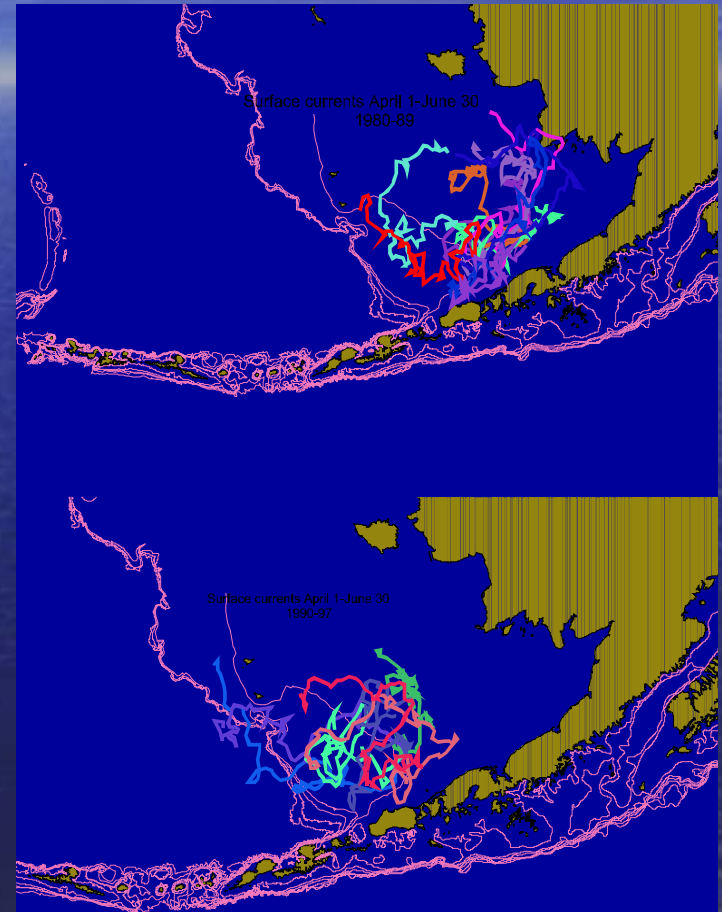
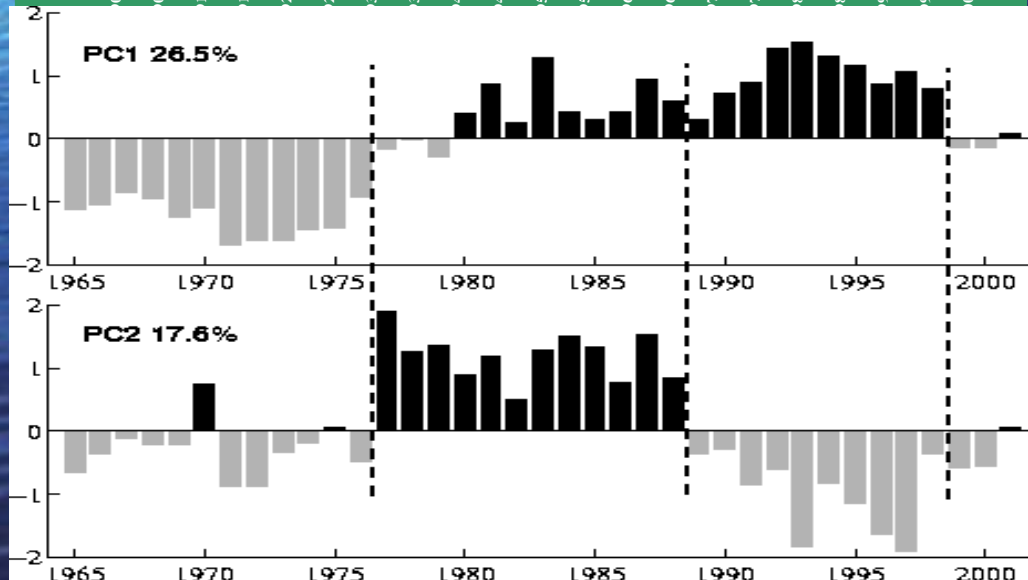
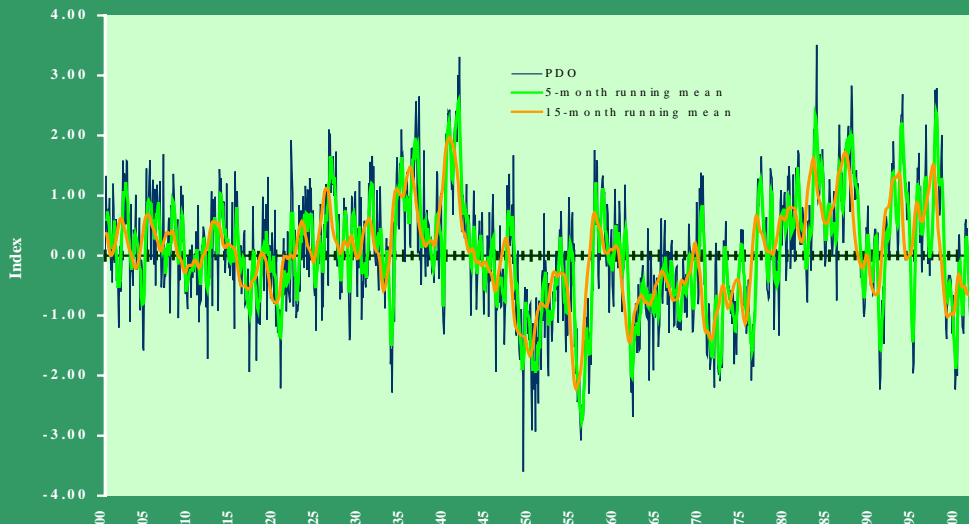
MAINTAIN DIVERSITY

Management Measure: Maximum Retainable Bycatch



ECOSYSTEM STATUS: Physical Environment and Links to Production

Pacific Decadal Oscillation



Integration into stock assessment process

- **Ecosystem-based single-species assessment**
 - **Ecosystem Effects on Stock**
 - Prey abundance/availability
 - Predator population trends
 - Climate effects on recruitment
 - Habitat changes on survival/growth
 - **Fishery Effects on the Ecosystem**
 - Fishery contribution to all categories of bycatch
 - Fishery concentration in space/time (competition with other predators)
 - Fishery effects on large-size target fish, age-at-maturity, fecundity

Moving Beyond Status and Trends

- Ecosystem Considerations Section provides Status and Trends but lacks perspective on possible future trends: **prediction**
- Provide guidance on possible **aggregate effects** of fishing and climate that are not captured under single species assessments

Next Steps

- **Ecosystem-level assessment**
 - **Use historical change indicators and predictive indicators from multispecies/ecosystem models to advise on aggregate and long-term implications of fishing and ecosystem change**
 - **Predator/prey relationships**
 - **Energy/flow balance**
 - **Habitat and Diversity**
 - **Advise on changes in aggregate catch levels, species mix of catch, discard amounts, and systems of closed areas**
 - **Regime shift status may help guide recruitment scenarios used to drive predictive models**

Predictive Model Approaches

- Multispecies Bycatch Model
 - Provides **indicators** of type and amount of incidental catch
- Multispecies virtual population analysis and forecast models for the eastern Bering Sea
 - Future changes in **dominant target species** including predator/prey interactions
- Mass-balance/biomass dynamics (Ecopath/Ecosim)
 - Provide a **whole ecosystem view** – dynamics of species/groups not included in single-species and multispecies models

Important Ingredients for an Ecosystem-based Approach

- **Fishery Management Monitoring/Research**
 - Accurate estimates of removals and discards of target, nontarget in time/space
 - Conservative single species harvests
 - Gear effects on habitat and nontarget species
 - Gear research to minimize bycatch
 - Adaptive management (experimental approach)
- **Ecosystem Research**
 - Monitoring from physics and up (composition, abundance, biological characteristics)
 - Developing understanding of mechanisms through experimental/process-based research
 - Improve understanding of organism behavior to changing conditions
 - A variety of models from state of the art stock assessments to ecosystem-level to address a variety of questions