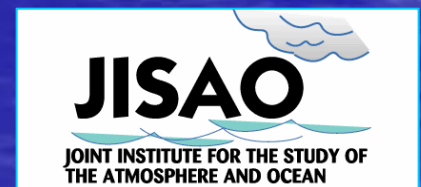


A Framework for Ecosystem Impacts Assessment Using an Indicator Approach

Patricia A. Livingston¹, K. Aydin¹, J. Boldt², J. Ianelli¹,
and J. Jurado-Molina²

¹Alaska Fisheries Science Center Seattle, WA, USA

²JISAO, University of Washington, Seattle, WA USA



Overview

- Alaskan context
- Evolution and Description of the Framework
 - Documentation of status and trends
 - Evaluation of past and present impacts
 - Prediction of future trends and management options

US Legislation on Environmental Protection

**National
Environmental
Protection
Act
1969**

**Clean Water
Act
1972**

**Magnuson-Stevens Fishery
Conservation and
Management Act
1976**

**Marine Mammal
Protection Act
1972**

**Endangered
Species Act
1973**

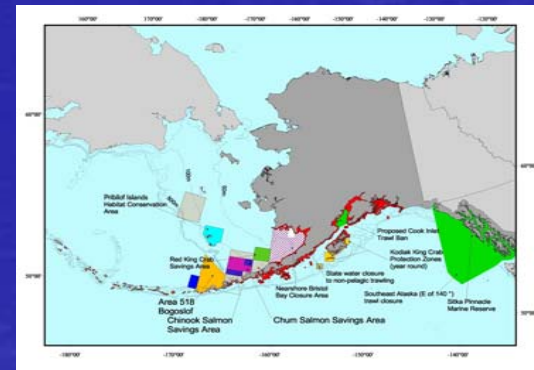
Ecosystem-based Management Actions

- 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

Conservative single species targets

$$\text{Catch} \leq \text{TAC} \leq \text{ABC} < \text{OFL}$$

CAP on TOTAL TARGET CATCH
Total yield < 2 million tonnes



Key Pieces of the Framework

Establish assessment
Framework, objectives,
Thresholds, indicators



Gather information
Historical status
and trends
Ecosystem components
and stressors



Generate management
Alternatives,
Future scenarios
MODELS for Prediction



Expert judgment
to analyze impacts
And provide advice



DECISION

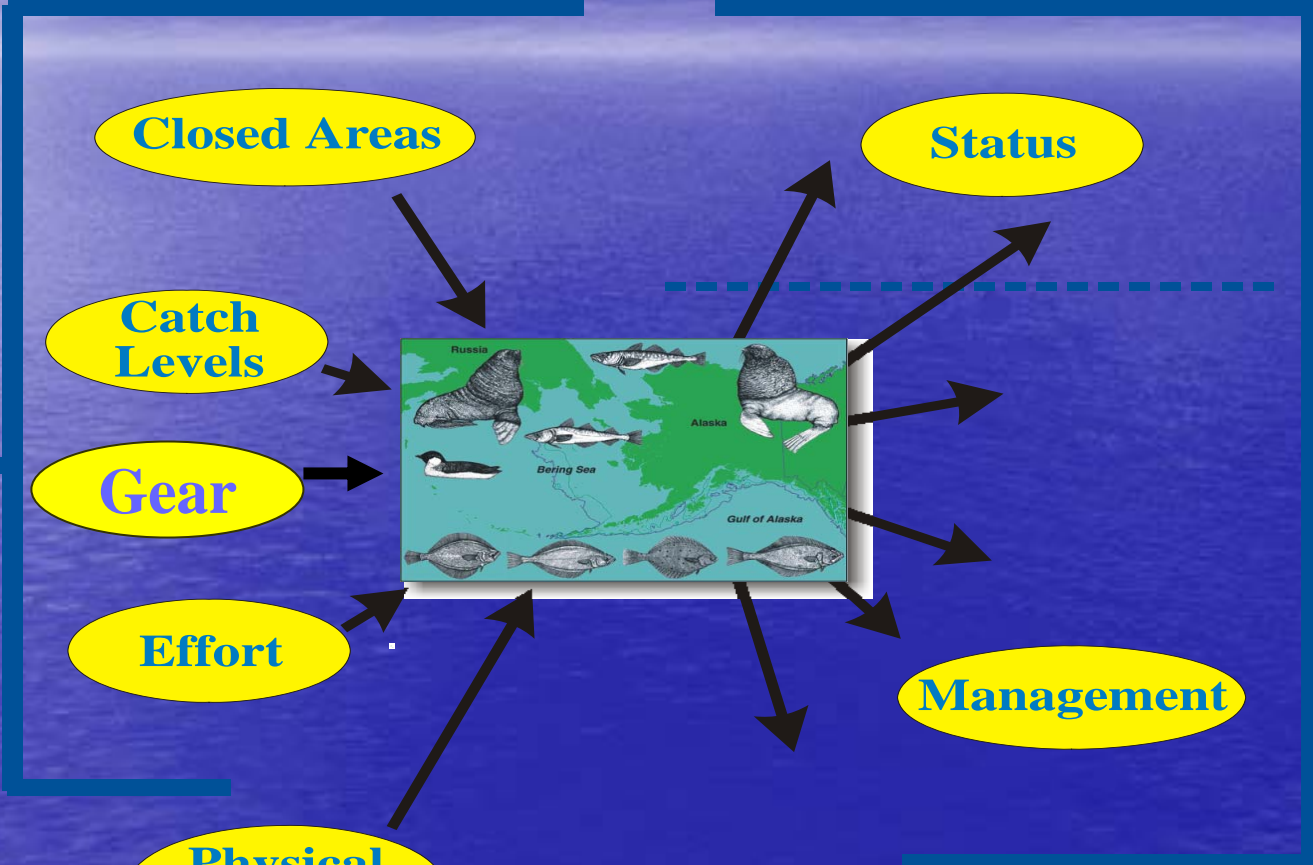


Ecosystem Measures and Influences

Influences

Outcomes

**Management
Tools**



**Ecosystem
Indicators**

**Provide
Feedback
to Alter Management**

Ecosystem Impacts Assessment Framework:

Objectives, sub-objectives, ecosystem indicators

SUBOBJECTIVES

- More focused, tangible
- Relate to key areas/issues for protection
- May vary across ecosystems depending on differences in threats, stressors, ecosystem characteristics
- Thresholds relate to legal mandates under various laws

INDICATORS

- Measures of particular ecosystem attributes
- Qualitative analysis of change used when targets/thresholds are not defined
- Requires expert judgment

Ecosystem Processes

ECOSYSTEM DEFINITION

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

OBJECTIVES FOR ECOSYSTEM PROTECTION

- Maintain Predator/prey relationships
- Maintain Energy/flow balance
- Maintain Habitat and Diversity

Objectives for Ecosystem Protection:

- **Maintain predator-prey relationships**
 - pelagic forage availability
 - spatial/temporal conc. of fishery impact on forage fish
 - removals of top predators
 - introduction of non-native species

CLIMATE and FISHING

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graph TD; A[CLIMATE and FISHING] --> B[➤ Maintain predator-prey relationships]; A --> C[➤ Maintain diversity]; A --> D[➤ Maintain energy flow and balance];
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- **Maintain diversity**
 - species diversity
 - functional (trophic, structural habitat) diversity
 - genetic diversity

- **Maintain energy flow and balance**
 - human-induced energy redirection
 - system impacts attributable to energy removal

Ecosystem Impacts Assessment Framework:

Objectives, sub-objectives, ecosystem indicators

OBJECTIVE: MAINTAIN PREDATOR/PREY RELATIONSHIPS

SUBOBJECTIVE1: Sustain top predator populations

THRESHOLD: Catch levels high enough to cause the biomass of one or more top level predator species to fall below minimum biologically acceptable limits

INDICATORS:

- Population status of top predator species
- Bycatch levels of sensitive top predators that lack population estimates (sharks, birds)
- Trophic level of the catch

Effects Analysis

Objective	Subobjective	Significance Threshold	Indicators
Predator-prey relationships	Pelagic forage availability	Fishery induced changes outside the natural level of abundance or variability for a prey species relative to predator demands	Population trends in pelagic forage biomass (quantitative - pollock, Atka mackerel, catch/bycatch trends of forage species, squid and herring)
	Spatial and temporal concentration of fishery impact on forage	Fishery concentration levels high enough to impair the long term viability of ecologically important, nonresource species such as marine mammals and birds	Degree of spatial/temporal concentration of fishery on pollock, Atka mackerel, herring, squid and forage species (qualitative)
	Removal of top predators	Catch levels high enough to cause the biomass of one or more top level predator species to fall below minimum biologically acceptable limits	Trophic level of the catch Sensitive top predator bycatch levels (quantitative: sharks, birds; qualitative: pinnipeds) Population status of top predator species (whales, pinnipeds, seabirds) relative to minimum biologically acceptable limits
	Introduction of nonnative species	Fishery vessel ballast water and hull fouling organism exchange levels high enough to cause viable introduction of one or more nonnative species, invasive species	Total catch levels

Effects Analysis (cont.)

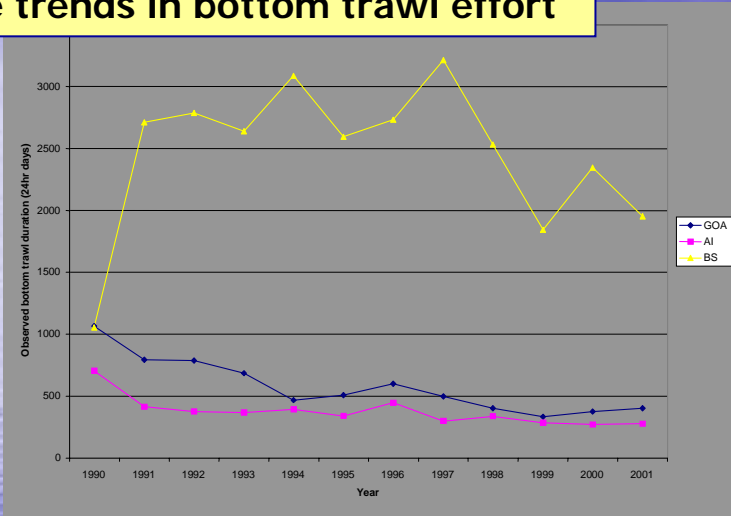
Objective	Subobjective	Significance Threshold	Indicators
Energy flow and balance	Energy re-direction	Long-term changes in system biomass, respiration, production or energy cycling that are outside the range of natural variability due to fishery discarding and offal production practices	Trends in discard and offal production levels (quantitative for discards) Scavenger population trends relative to discard and offal production levels (qualitative) Bottom gear effort (qualitative measure of unobserved gear mortality particularly on bottom organisms)
	Energy removal	Long-term changes in system-level biomass, respiration, production or energy cycling that are outside the range of natural variability due to fishery removals of energy	Trends in total retained catch levels (quantitative)

Effects Analysis (cont.)

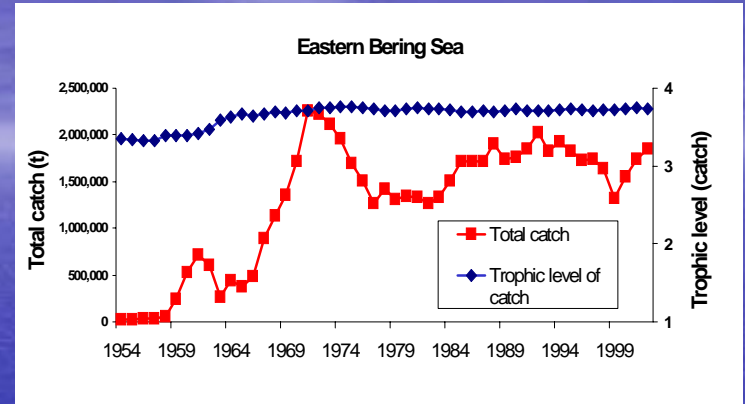
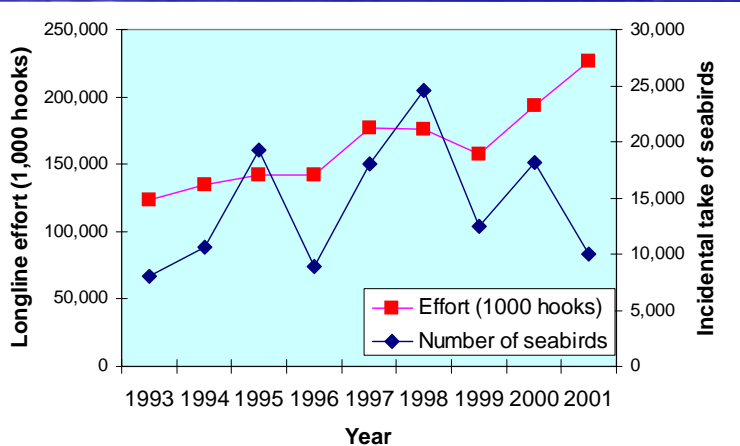
Objective	Subobjective	Significance Threshold	Indicators
Diversity	Species diversity	Catch removals high enough to cause the biomass of one or more species (target, nontarget) to fall below or to be kept from recovering from levels below minimum biologically acceptable limits	Population levels of target, nontarget species relative to MSST or ESA listing thresholds, linked to fishing removals (qualitative) Bycatch amounts of sensitive (low potential population turnover rates) species that lack population estimates (quantitative: sharks, birds, HAPC biota) Number of ESA listed marine species Area closures
	Functional (trophic, structural habitat) diversity	Catch removals high enough to cause a change in functional diversity outside the range of natural variability observed for the system	Guild diversity or size diversity changes linked to fishing removals (qualitative) Bottom gear effort (measure of benthic guild disturbance) HAPC biota bycatch
	Genetic diversity	Catch removals high enough to cause a loss or change in one or more genetic components of a stock that would cause the stock biomass to fall below minimum biologically acceptable limits	Degree of fishing on spawning aggregations or larger fish (qualitative) Older age group abundances of target groundfish stocks

MANAGEMENT INDICATORS

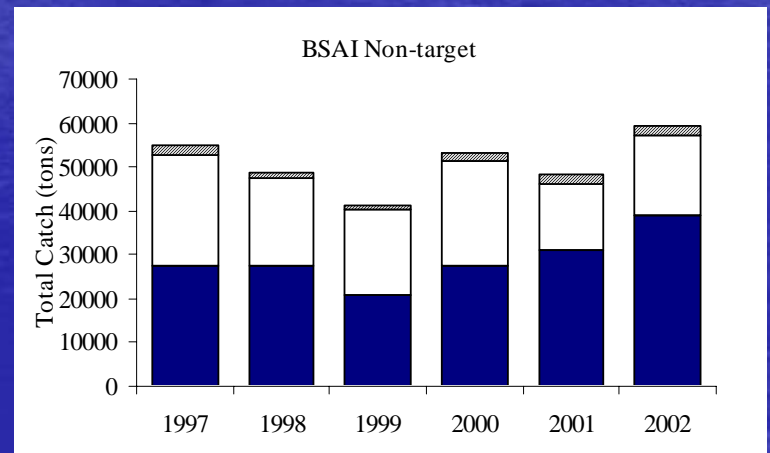
Time trends in bottom trawl effort



Seabird bycatch and fishing effort



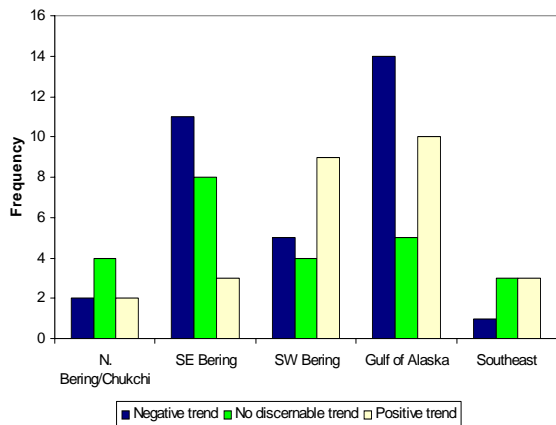
Total catch and trophic level of catch



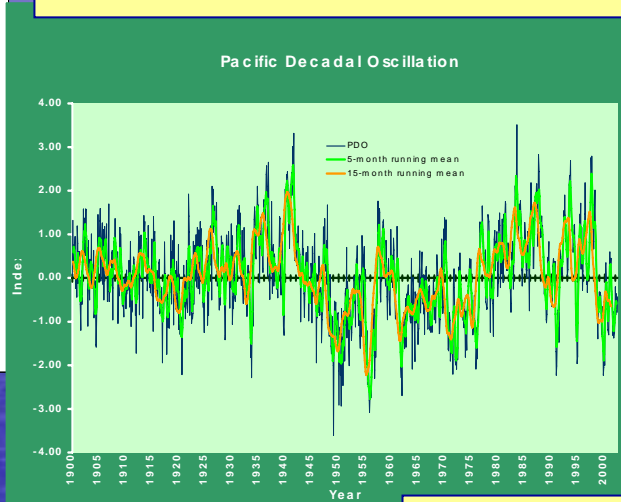
Amount and composition of non-target fish species in catch

ECOSYSTEM STATUS INDICATORS

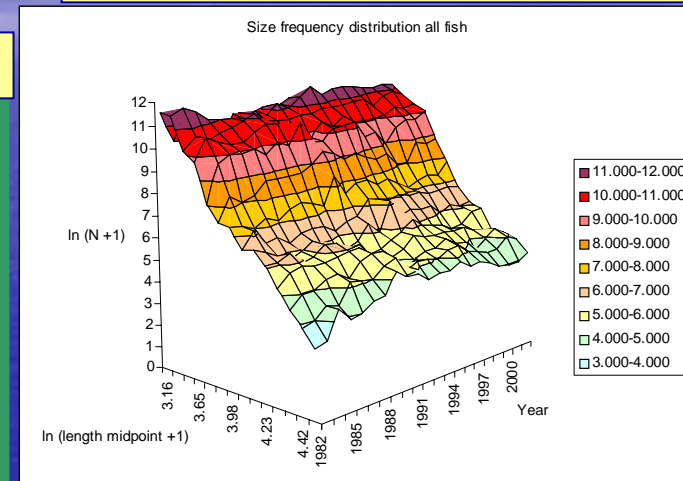
Seabird population trends



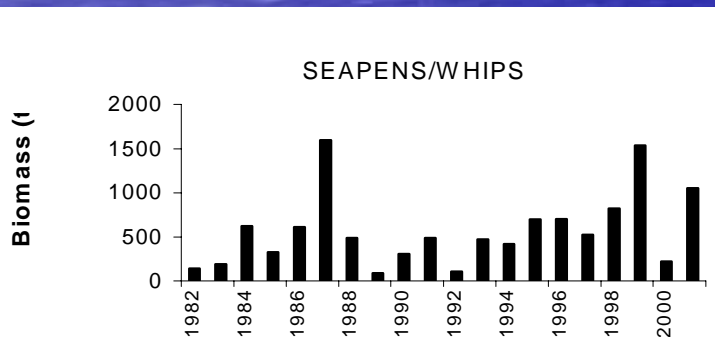
Environmental fluctuations



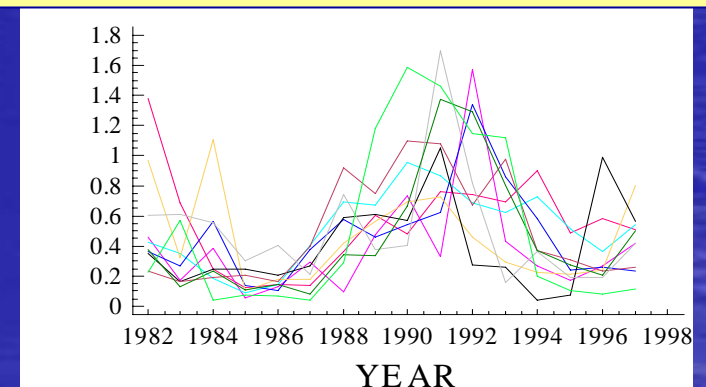
Fish community size spectrum



Status of structural habitat biota



Population trends of non-target fish species



The Framework: Part 1 **Evaluate Present Status** Ecosystem Considerations Section

- Accompanies single species stock assessment advice to North Pacific Fishery Management Council since 1995
- Provides status and historical trend information of ecosystem components using scientific information from a variety of experts and agencies: Assess Present Status
- Contains species, community, and ecosystem-level indicators and indicators of environmental and human impacts
- Track efficacy of ecosystem-based management efforts
- Meets the national fishery management scientific information requirement (National Standard 2) to include information on past, present, and possible future condition of the stocks, marine ecosystems, and fisheries being managed in the stock assessment and fishery evaluation reports provided to managers.

The Framework Part 2:

Moving Beyond Status and Trends

- Requires an **ecosystem impacts assessment framework**
- Prediction of possible future trends under various management strategies: **MODELS**
- Provide guidance on possible **aggregate effects** of fishing and climate that are not captured under single species assessments
- Uses **NEPA** as the umbrella legislation for providing an ecosystem-based management framework that considers the ecosystem first

Ecosystem Impacts Assessment Framework: **PREDICTION**

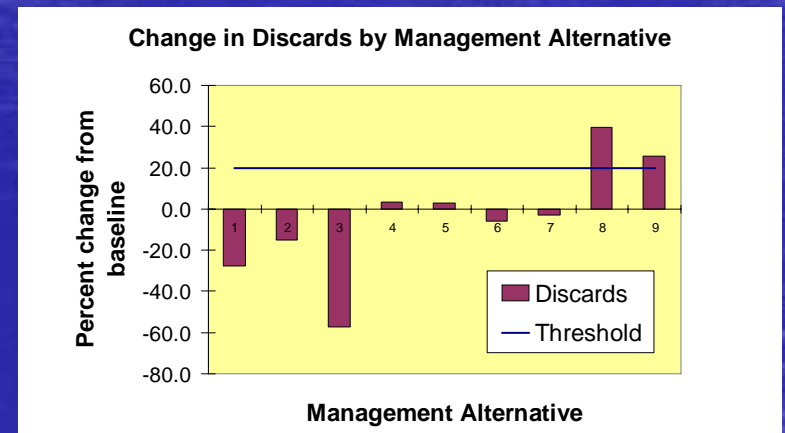
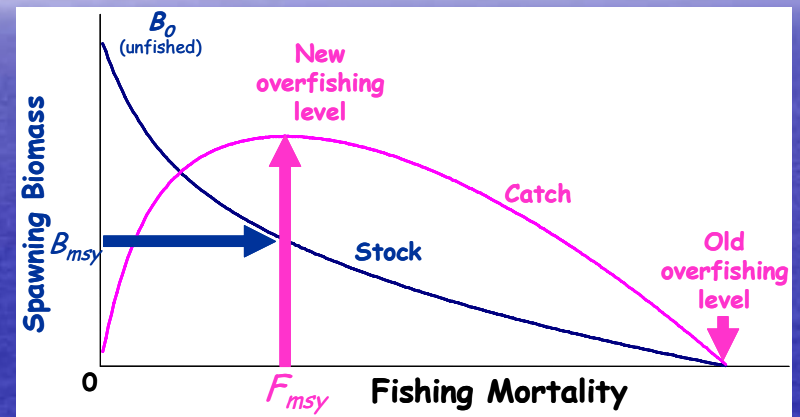
KEY CONSIDERATIONS

1. **MODELS** that incorporate processes of interest
2. **MANAGEMENT ALTERNATIVES** to evaluate
 - Annual quota-setting
 - Management strategy evaluation of policies
3. **SCENARIOS** of future environmental state

Impacts Analysis

Elements:

- Predefined thresholds or amounts of acceptable change in an indicator
- Expert judgment
- Falling below threshold or too much change in indicator triggers action or eliminates management alternative
- Performed at ecosystem and individual fishery level





Future Challenges

- **Improve predictive capability with regard to climate and human impacts on ecosystems: model refinement and regime shift analysis to drive recruitment scenarios**
- **More explicit definition of ecosystem-based management objectives: may require public involvement in defining specific regional objectives for management**
- **Developing objective criteria and sensitive indicators to measure the success in achieving desired ecosystem state or condition (or avoidance of undesirable states)**
- **More formalized decision-making framework**