Integrated Ecosystem Assessment on the West Coast of Vancouver Island for planning and management

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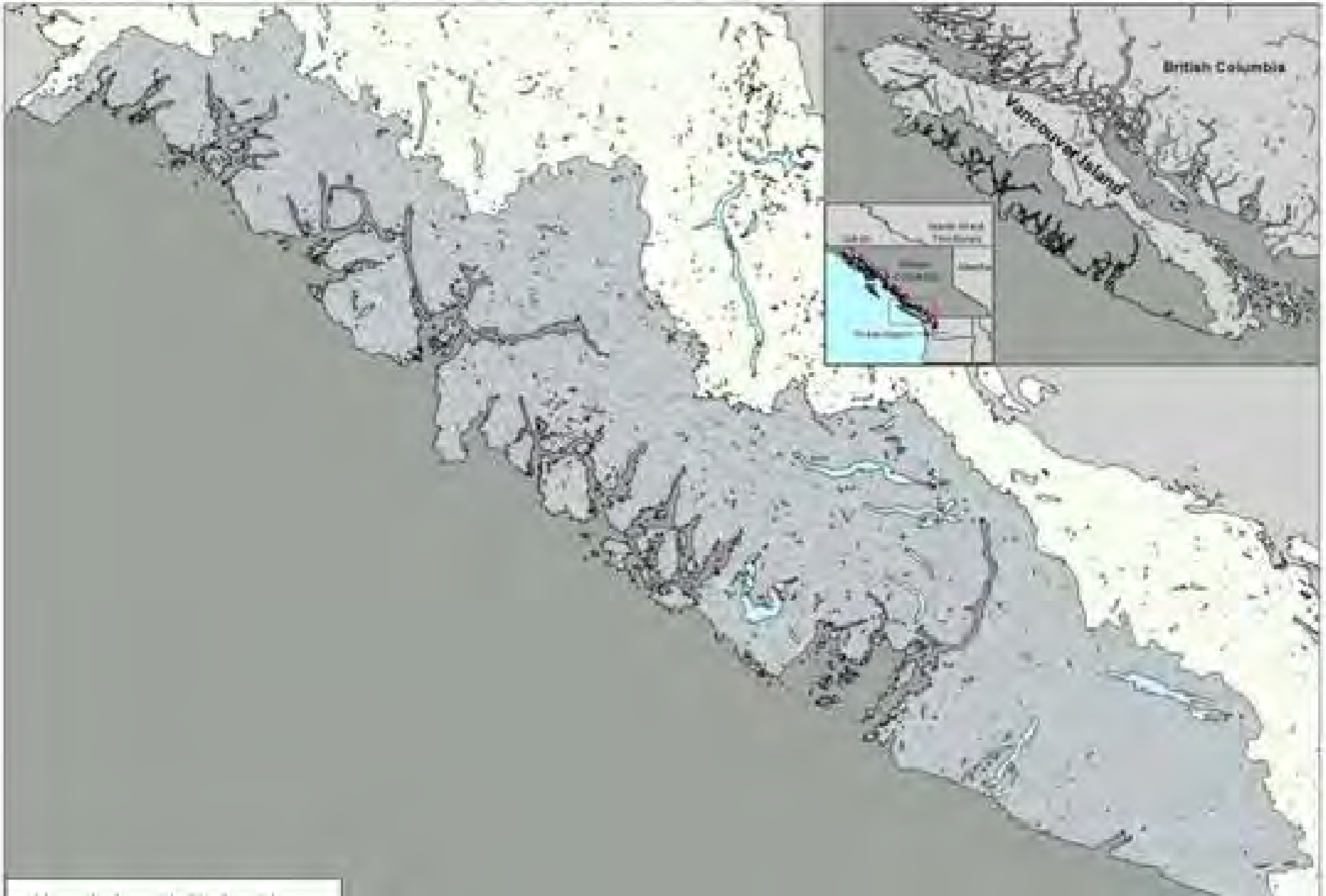
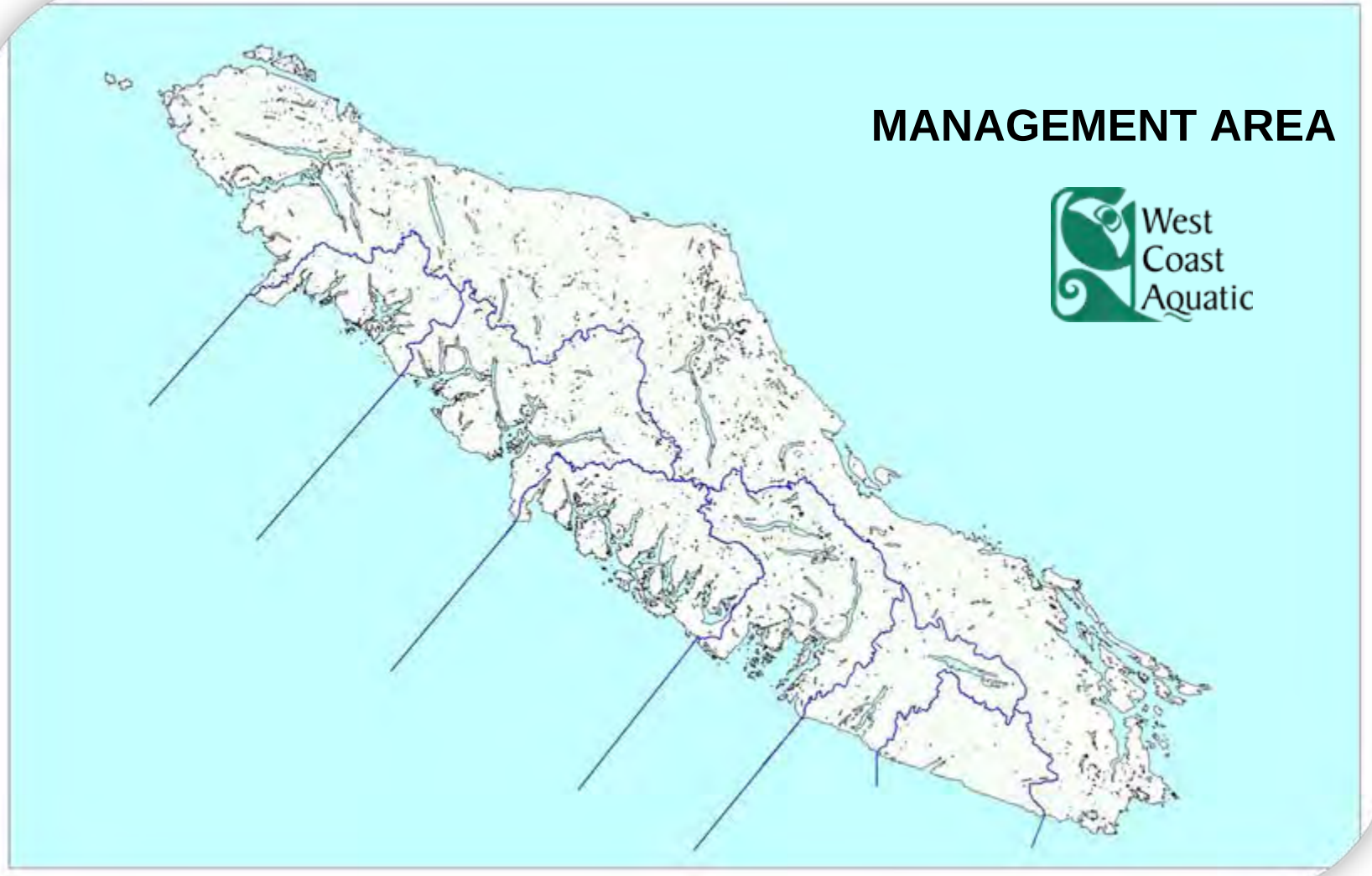
PEW FELLOWS PROGRAM
IN MARINE CONSERVATION

Vancouver Island

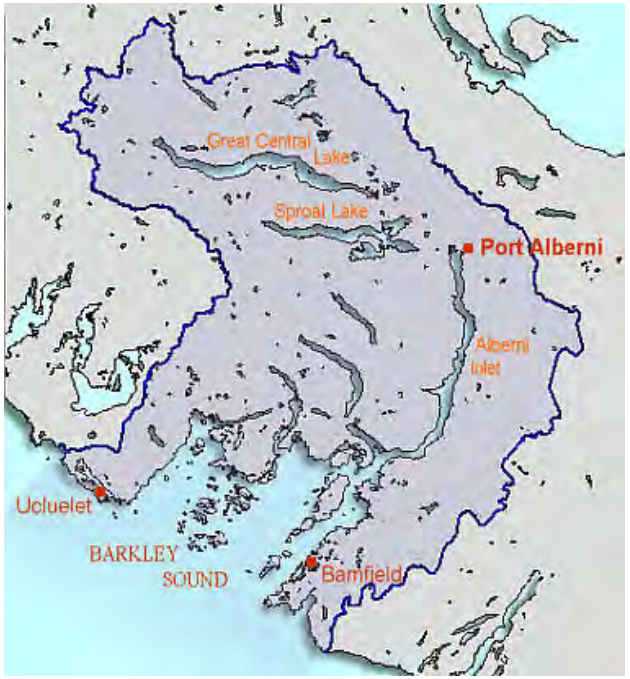


Vancouver Island



Case studies

Clayoquot Sound



Barkley Sound

Barkley Sound

Overall goals

1. **Coastal and Ocean Plan for the West Coast of Vancouver Island**
   - Ecosystem-based
   - Integrated
   - Sustainable
   - Participatory
   - Collaborative
2. **Monitoring social-ecological system health**
3. **Strategies to cope with changes**

Talk outline

- West Coast Aquatic
- Integrated Ecosystem Assessment
  - Elements and Stressors
  - Goals, Objectives, and Indicators
  - Management Strategies and Evaluation

Approach

Don’t get lost in the details.

Simplify!

West Coast Aquatic

A forum for the coastal communities, individuals and bodies affected by aquatic resource management to participate more fully with governments in all aspects of the management of aquatic resources in the West Coast Vancouver Island area.

Participation & Representation

8 Government Appointees
- 2 from Nuu-chah-nulth
- 2 from Federal Government
- 2 from Provincial Government
- 2 from Local Government

jointly appoint

8 Non-Government Appointees
- Tourism
- Environment
- Aquaculture
- Labour
- Processing
- Commercial Harvesting
- Recreational Harvesting
- Aboriginal Harvesting

16 Member Board
- Decisions made by consensus
- Guided by principles including Hishukish Ts'awalk and Iisaak

Staff
Executive Directors, Administration, Director of Marine Planning, Science Director, Communication Director, First Nations Outreach

Constituencies
Communities, government departments, tourism associations, environmental groups, commercial fishers, food fishery, etc...

Hishukish Ts'awalk – All things are one

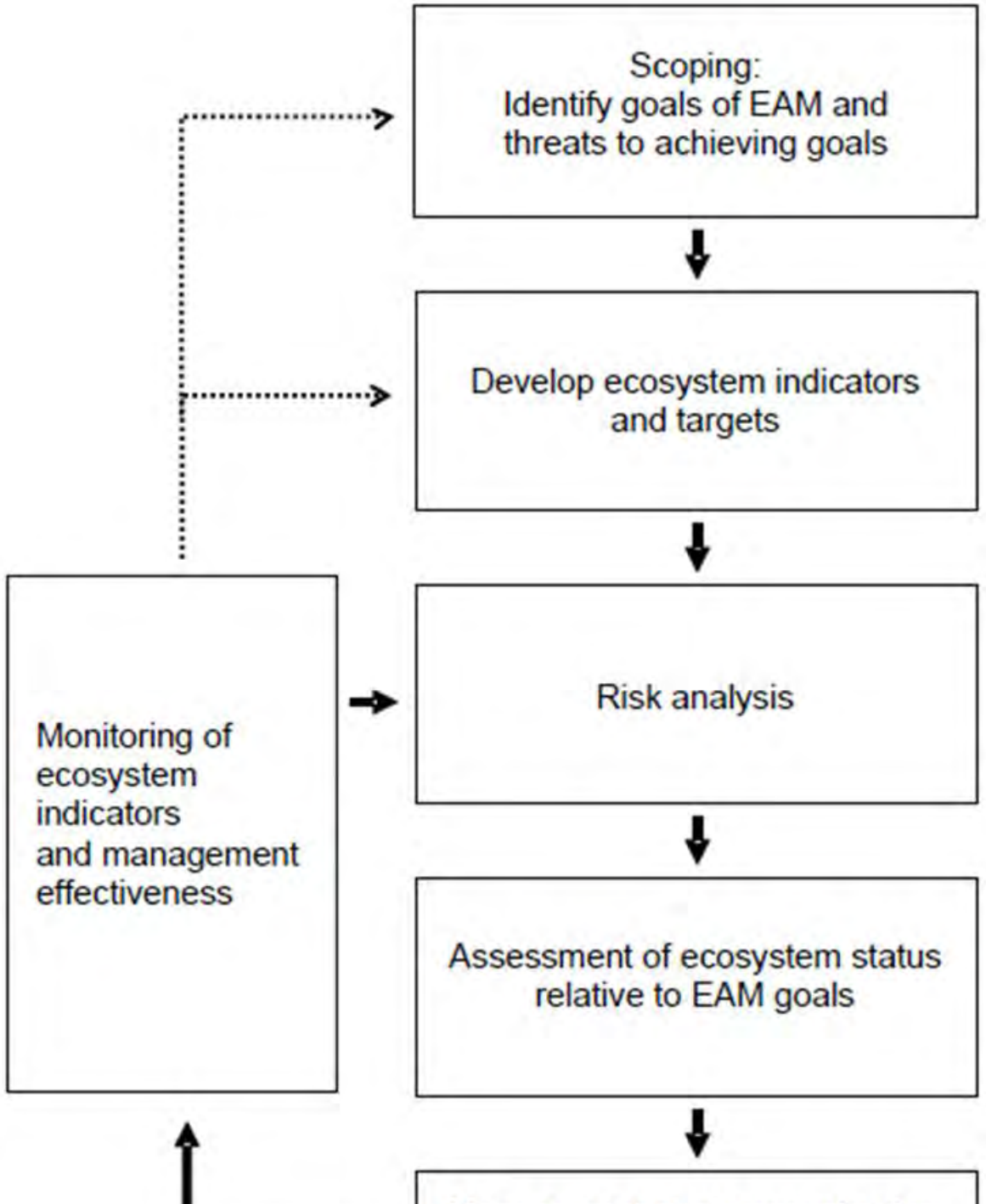
Isaak – Respect

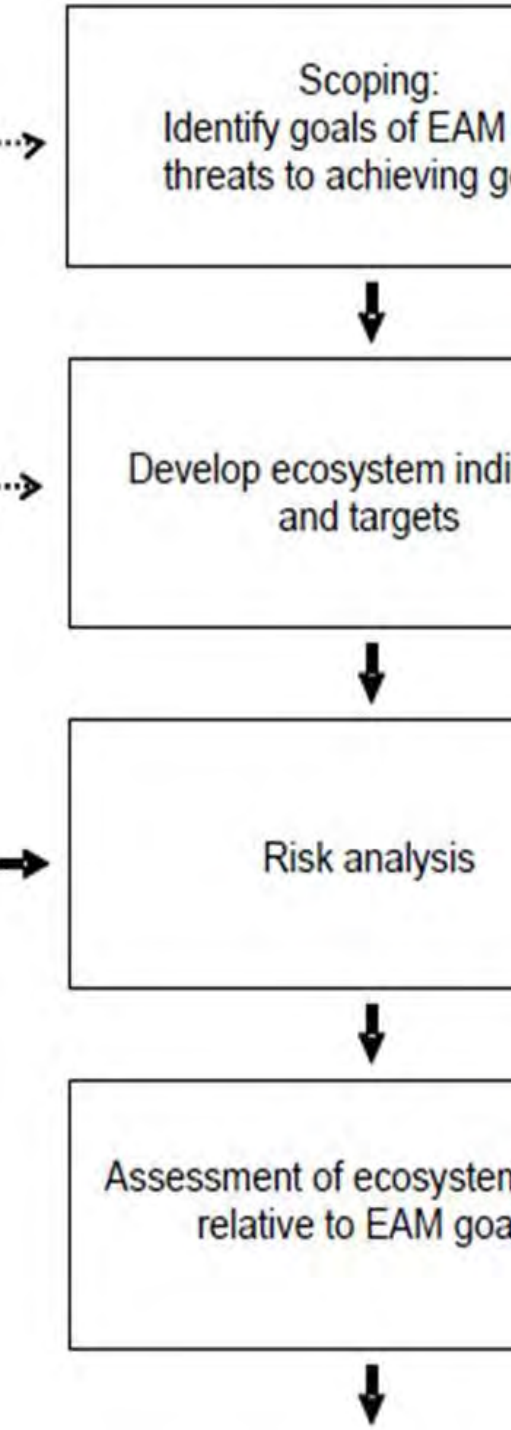
OVERALL PLANNING GOALS

- Healthier Ecosystem
- More Jobs and Training
- Increased Access to Opportunities
- Stronger Partnerships and Pride
- Vibrant Recreation and Culture
- New knowledge and tools
- Good Management

Integrated Ecosystem Assessment

Levin et al. 2009





- **Understand the social-ecological system**
- **Identify system elements and stressors**
- **Identify issues, goals, objectives**

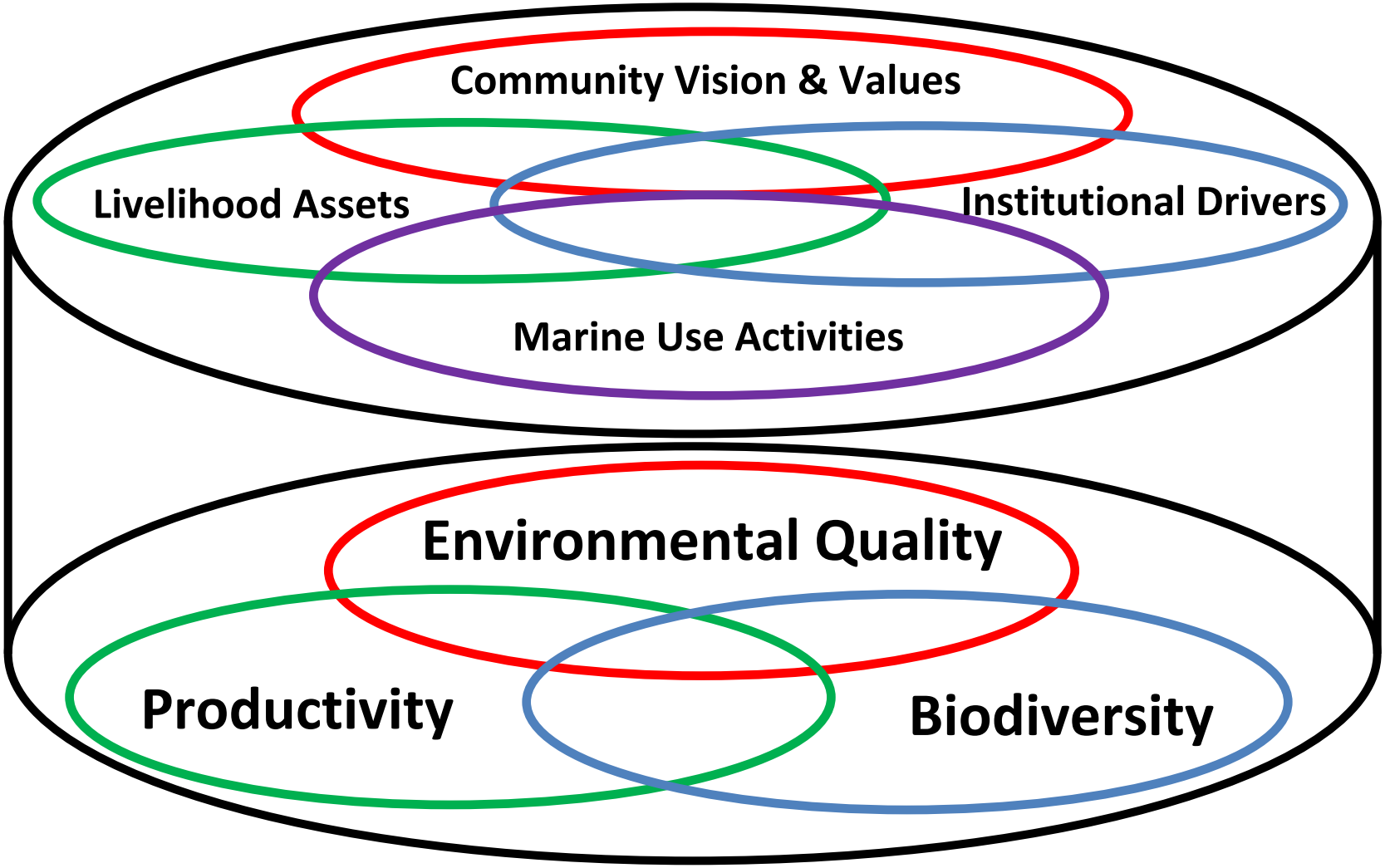
- **Identify state and pressure indicators**
- **Select working indicators**
- **Identify benchmarks and targets**

- **Staged evaluation of the sensitivity and status of individual indicators**

- **Assess the status of the whole ecosystem**
- **Assess perceptions of ecosystem health**

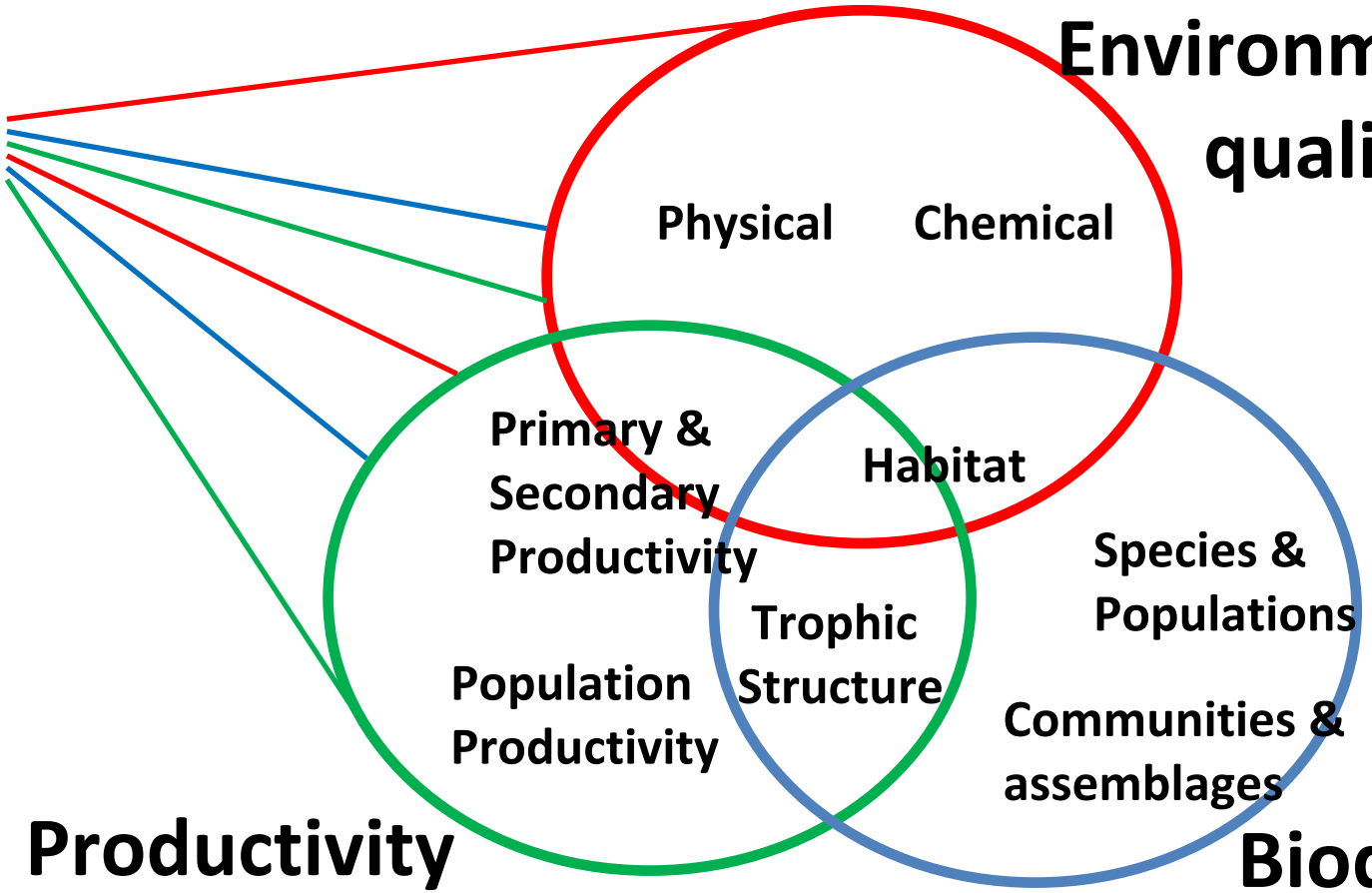

Tourism
Recreation
Commercial Fishing
Sport Fishing
Subsistence
Airborne contamination
Precipitation
Alaska Current
Eddy
Aleutian Low Pressure
WIND
Ekman Transport
Continental Shelf Break
Shelf-break front
Alaska Coastal Current
Coastal Communities
Freshwater runoff
fry
Salmon Migration
Adults
Sea Birds
W
N
Plankton
Phytoplankton
Zooplankton
Forage Fish
Marine mammals
Turbulence
Photic boundary
Downwelling
Shelf break Front
Carbon pump
DETRITUS
NUTRIENTS
Large Fish
Lunar forcing
GULF OF ALASKA
Sill
Tidal mixing
Overwintering copepods
"Old carbon"
Continental shelf
Benthic

The Social-Ecological System

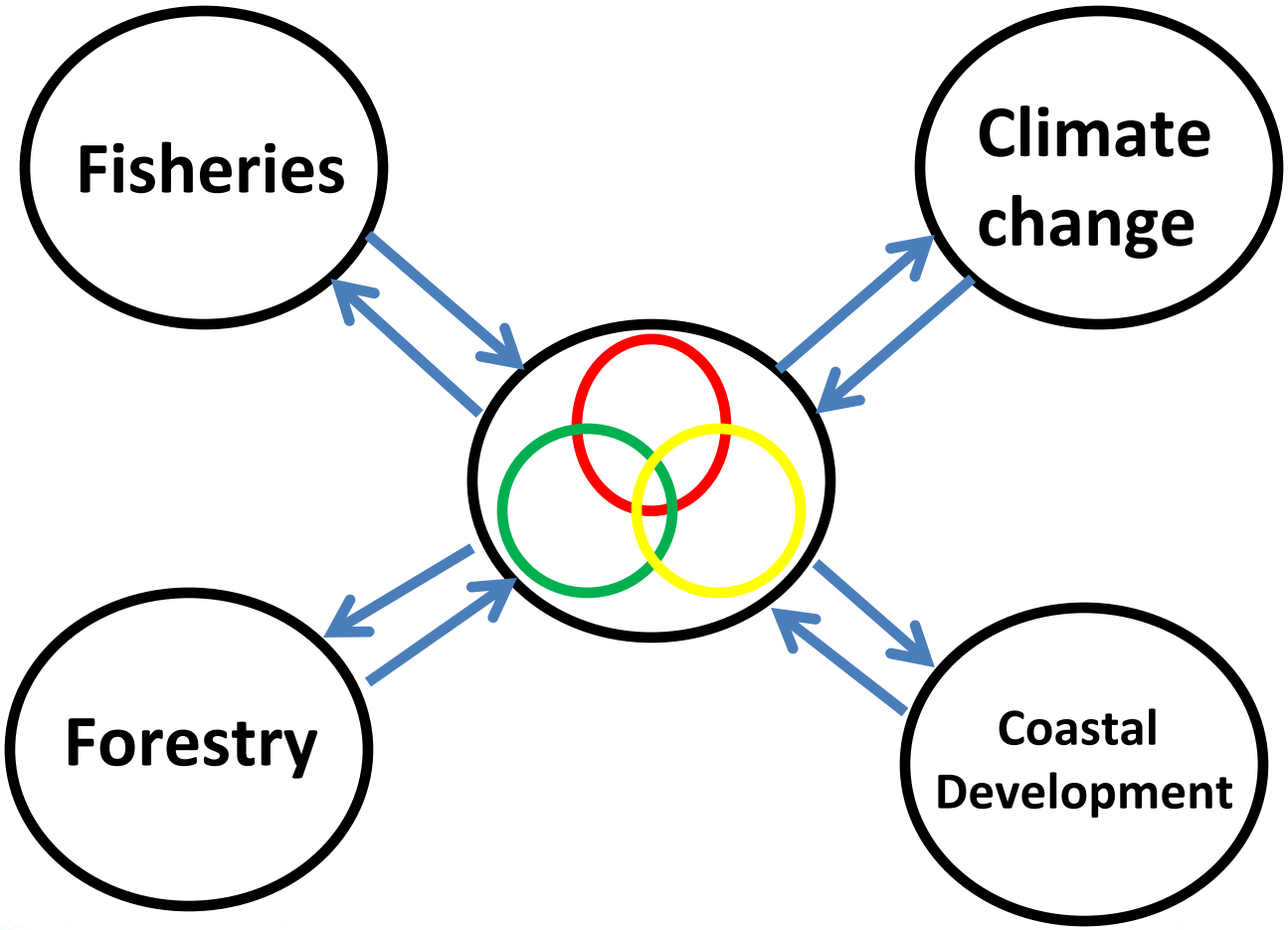


"The Hockey Puck Model"

Ecosystem Realms & Elements



Multiple Human Stressors



STRESSORS UNPACKED

Agriculture
land-based effects
pollution from fertilizer, animal waste

Aquaculture
Nutrient enrichment
Toxic pollutants
habitat effects
parasites
genetic mixing

Boats and ships
antifouling paint
catastrophic oil spills
fuel and oil leakage
sewage

Watershed modification
other watershed modification
Coastal development & bulkheading
Commercial Buildings
Residential buildings
Roads, High voltage transmission lines, natural gas pipelines, seismic lines
Urban Sprawl
Water body alteration: damming, diking, channelizing, or culverting lakes, rivers, streams, etc.

Diseases: Marine organisms

Fishing
Bycatch
Commercial
Habitat damage
Recreational
Sport fishing
Subsistence
Illegal and unreported

Forestry
log booms
nutrient changes
sediment runoff
water temp changes

Global change
Changes in upwelling & productivity
Lowered oxygen in ocean
Ocean acidification
Salinity changes
Sea level rise
Snowpack and precipitation changes
Storm activity changes
Water temperature changes

Pollution
Bio-concentrating trace pollutants
Dioxin contamination
excessive nutrients
From energy use: drilling, hydroelectric,

Mercury contamination
nutrient enrichment
Plastics
Point-source chemical
Pulp-mill effluent
Sewage effluent
Styrofoams
toxic biochemicals
Urban runoff
Noise

Recovery of sea otters
Recovery of seals / sea lions

Non-extractive recreation and tourism
Interference with animal behaviour

Scientific research and educational

Governance: Dysfunctional

Harmful algal blooms

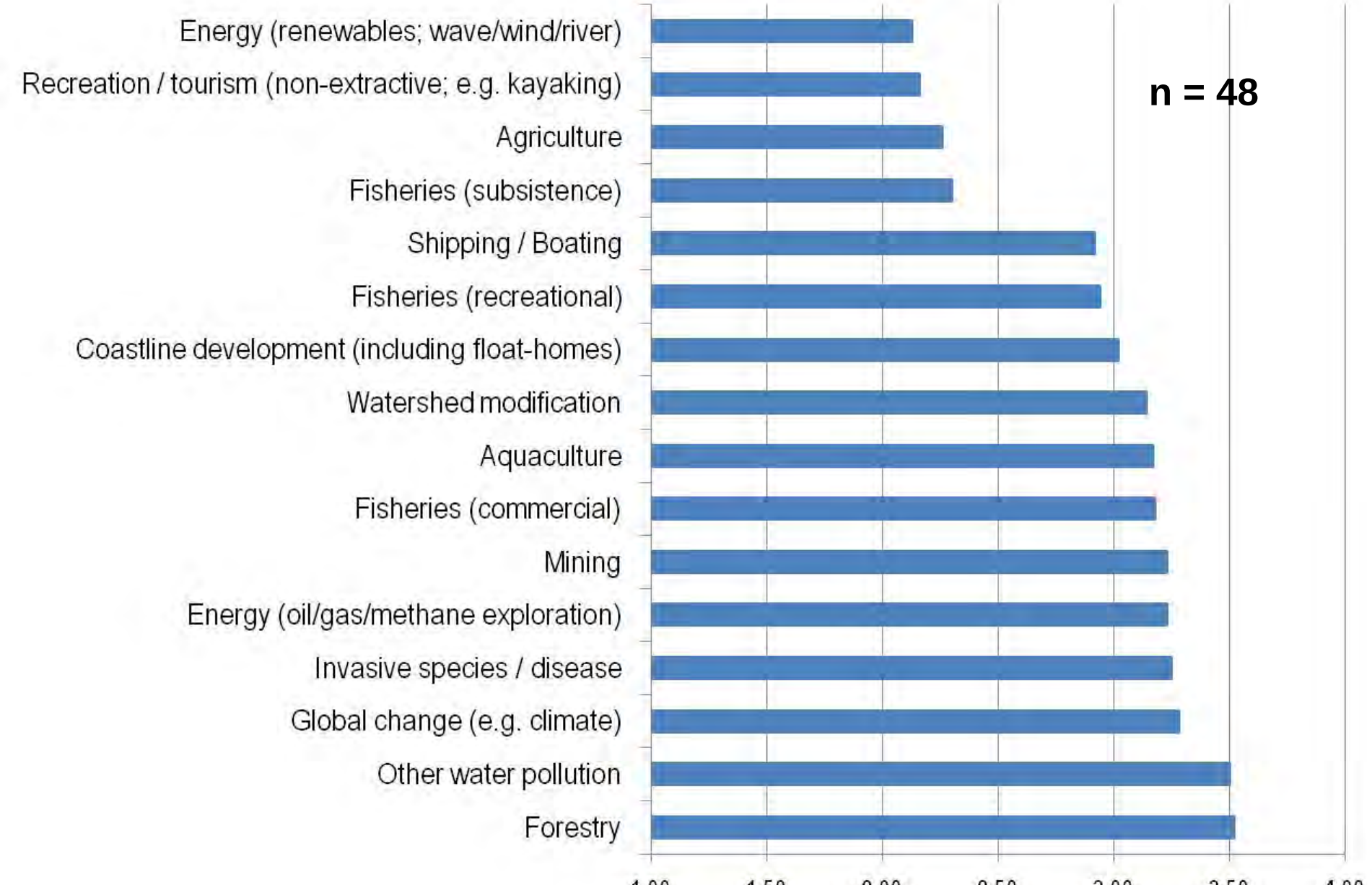
Invasive species

Military and strategic

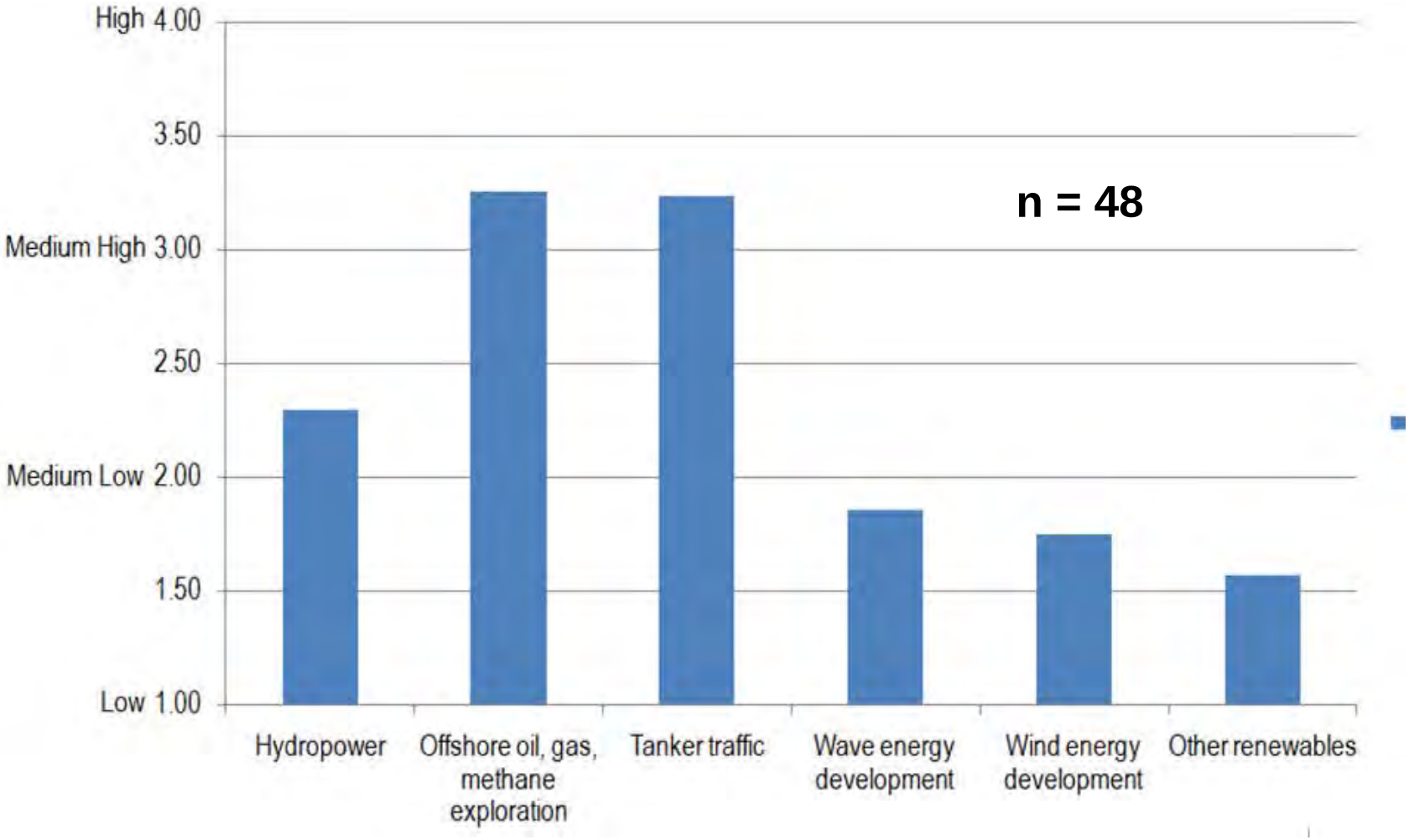
Poaching

Management of natural resources: Poor

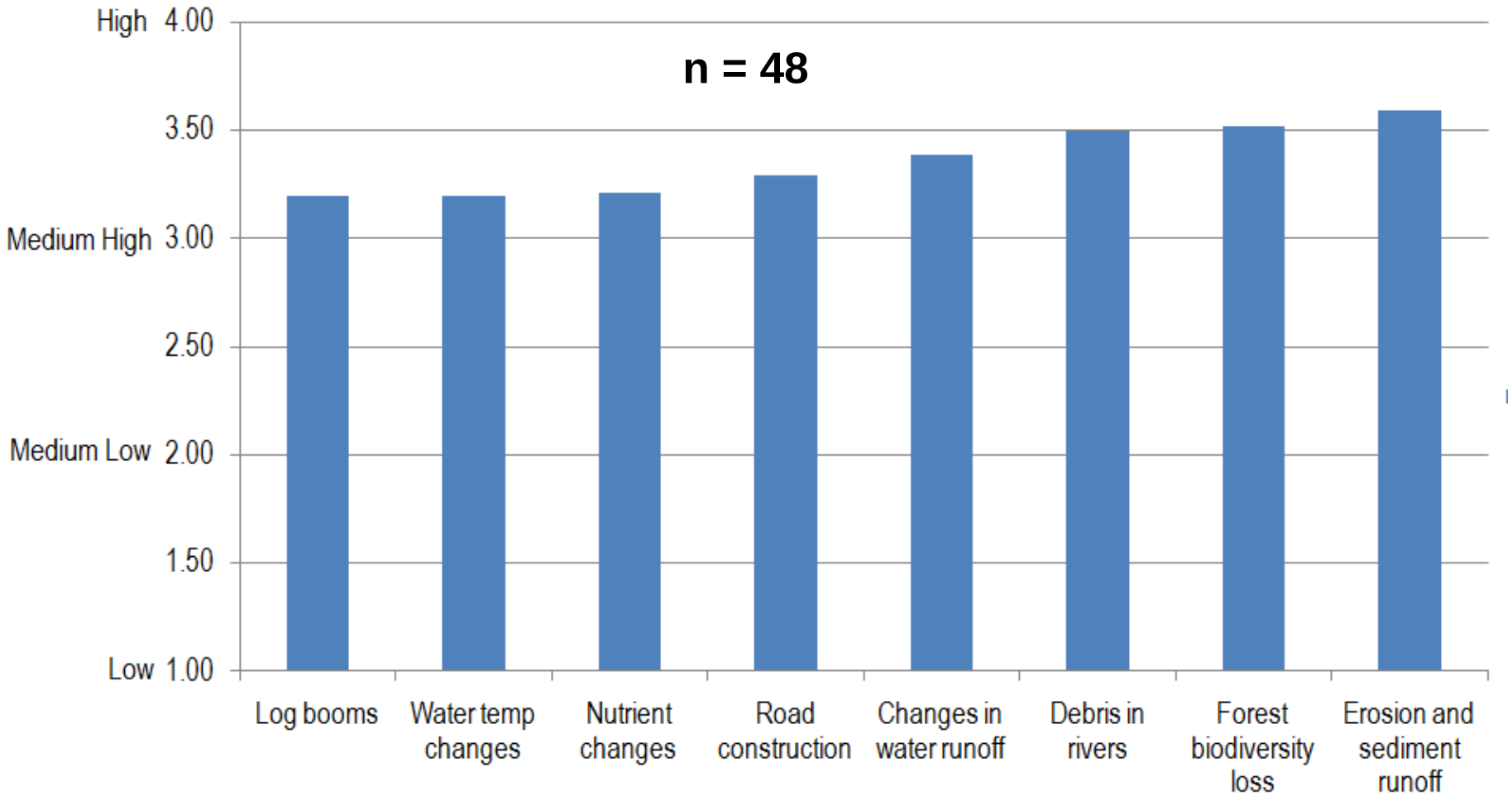
Degree of stress exerted



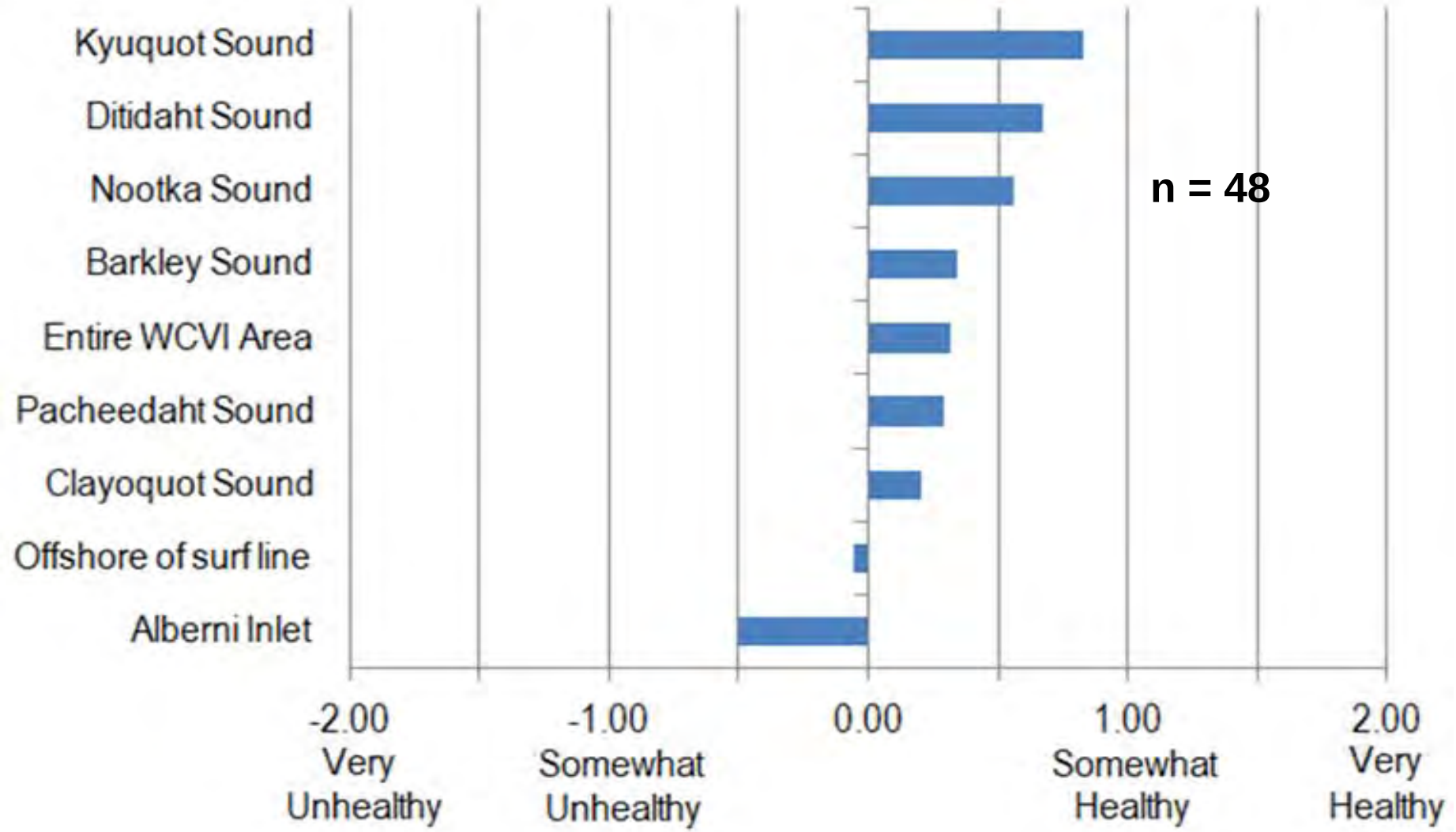
Relative stress by energy-related activities



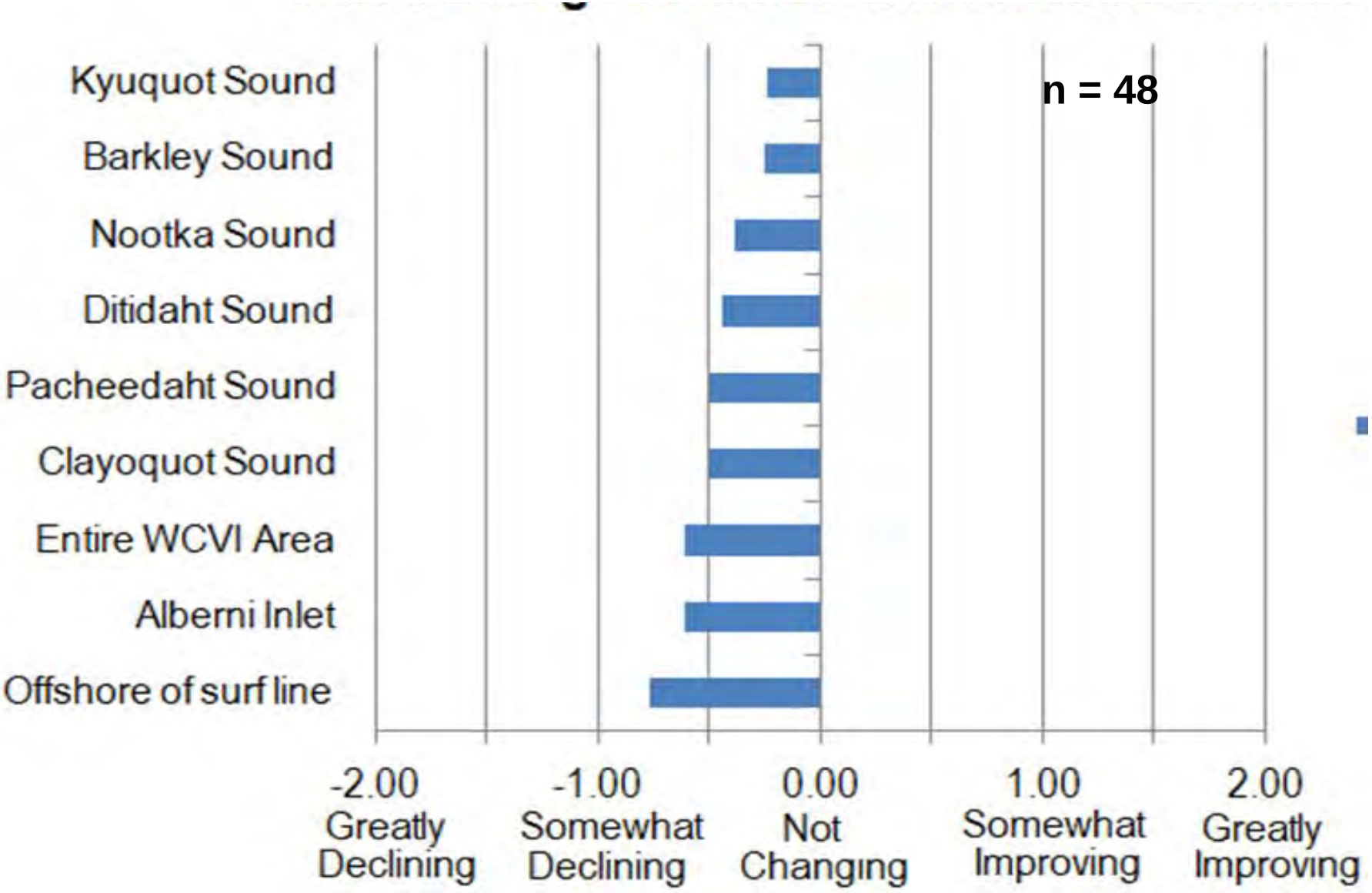
Relative stress by forestry activities



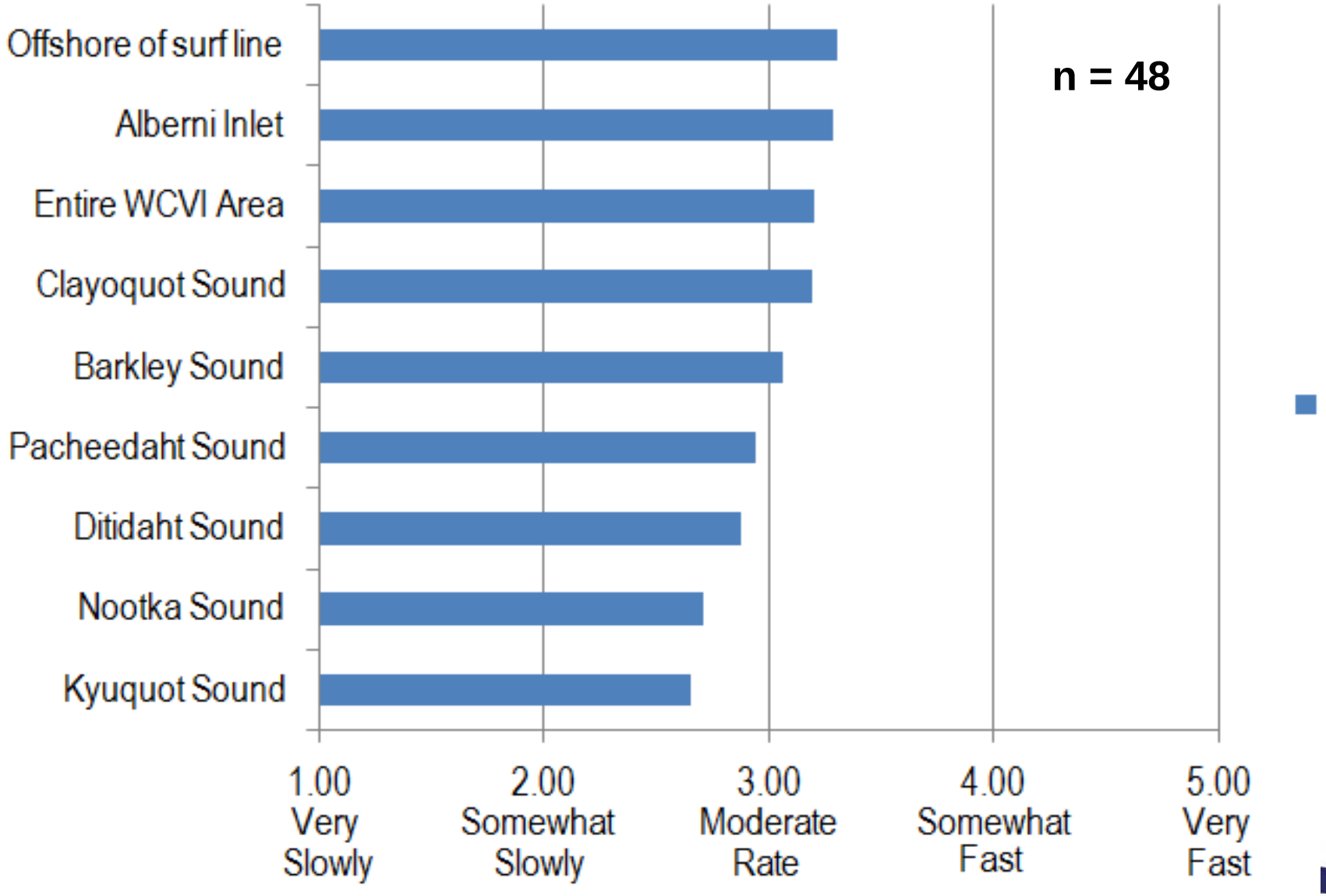
Rated health of marine areas



Rated change in health



Rated speed of change in health

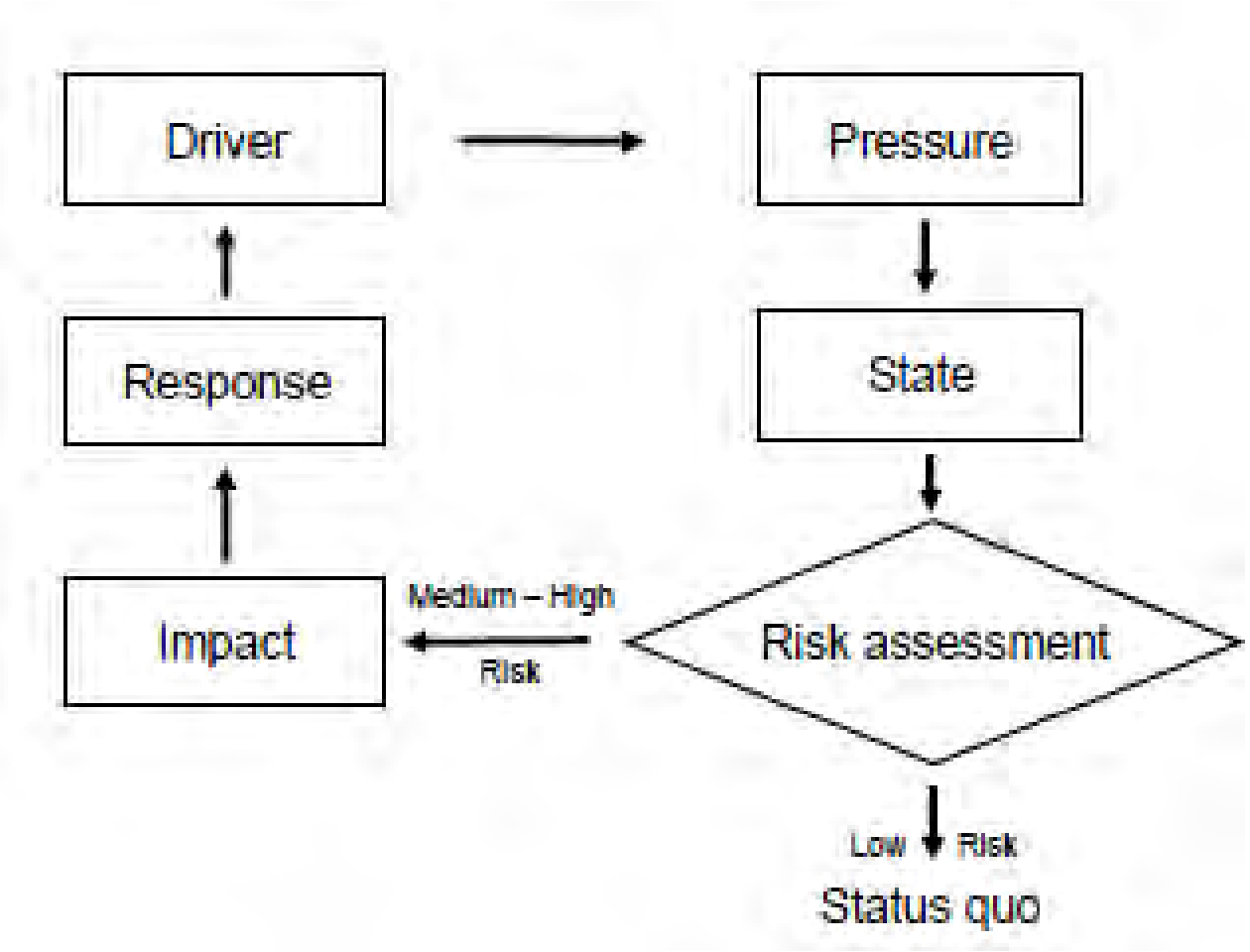


Goals and objectives

- Goal: Healthy Ecosystem
- Objectives:
  - Restore, maintain, and conserve biodiversity, structure, and function of biological communities
  - Restore, maintain, and conserve the physical and chemical environments, including the integrity of habitats
- Get specific

Select indicators

DPSIR Framework



State indicator categories

Realm	Element	Indicator Categories
Biodiversity	**Communities / Assemblages**	Kelp forest communities
		Seagrass communities
		Intertidal communities
		Rocky bottom communities
		Soft bottom communities
		Sponge reef communities
		Plankton communities
		Nekton communities
	Species/ Populations	Seabirds and shorebirds
		Invasive & unusual species & marine diseases
		Charasmatic large megafauna
		Groundfish and demersal fishes
		Forage fishes
		Pacific salmon species
		Commercial shellfish
		Other invertebrates

State indicator categories

Realm	Element	Indicator Categories
Productivity	Primary and Secondary Productivity	All plankton and ichthyoplankton biomass, assemblage, richness, and evenness
		Chlorophyll a
		Macroalgae and microphytobenthos
		Benthic secondary producers
	Trophic Structure	Whole system indices
		Fishing and catch indices
	Population Productivity	Productivity, biomass, and abundance of various species

State indicator categories

Realm	Element	Indicator Categories
Marine Environmental Quality	Physical	Climate/oceanographic indices
		Climate and weather parameters
		Physical oceanographic parameters
		Estuarine water quality
	Chemical	Toxins and lesions in wildlife
		Other benthic biota indices
		Chemical parameters of water quality
		Contaminants in water and sediment
	Habitat	Shoreline integrity
		Habitat modification
		Human stressors per habitat

Candidate indicators of chemical marine environmental quality

Chemical	Dissolved Oxygen
	Biochemical Oxygen Demand (BOD)
	N concentration (nitrate, nitrite, ammonia)
	P concentration (TP—total phosphorous, SRP—soluble reactive phosphate)
	Red tides (phytoplankton bloom) occurance and cover
	PSP and shellfish toxin outbreak incidence and severity
	Toxic chemical concentrations in offshore waters
	Fish tissue contaminants index
	Chemical oxygen demand (COD)
	Fecal coliform contamination in recreation areas
	Number of contaminated sites by category
	Inorganic Carbon
	Trophic State Index (TSI)
	acidity (pH), alkalinity
	Copper
	Gold
	Mercury
	other metals
	Cadmium
	Area closed to fishing by dioxin and furan contamination
	Area of sediments that have contaminant levels above sediment quality guidelines
	Level of contaminants in representative non-migratory organisms
	Area of shellfish bed closure by state/province by year
	Background sediment quality in Inlets
	Dioxins in sediment
	Tributyltin concentration levels
	PCBs in sediment
	PBDEs insediment
	DDT in sediment
	Oil on seabirds
	The AZTI Marine Biotic Index (AMBI)
	Bentix
	Macrofauna Monitoring Index
	Benthic Response Index (BRI)
	Area of sediment with contaminant levels above SQ guidelines
	Organochlorine contaminant (OC) bioaccumulation in seabirds
	Organochlorine contaminant (OC) bioaccumulation in marine mammals
	Seagrass Nutrient Pollution Index
	Heavy metal (HM) bioaccumulation in seabirds
	Plastic particles in stomachs of seabirds
	Contaminants in marine organisms
	Contamination in sediment, benthos and fish by pesticides and heavy metals
	PSP toxins in shellfish
	Amount of dissolved or particulate waste produced by fish farms
	Areas of shellfish bed closure
	Dissolved organic carbon in water
	Hydrocarbons
	Organotins
	Polychlorinated biphenyls

Candidate indicators of species and population biodiversity

Criteria for indicator selection

- **Ease of understanding**
- **Ease of measurement**
- **Cost efficiency**
- **Availability of historical data**
- **Sensitivity to stressors**
- **Responds predictably and in a known way to stressors**
- **Specificity of response to stressors**
- **Anticipatory of broader ecosystem changes**
- **Integrative**

Dale, V. H. and S. C. Beyeler. 2001. Challenges in the development and use of ecological indicators. Ecological Indicators **1**:3-10.
Rice, J. C. and M. J. Rochet. 2005. A framework for selecting a suite of indicators for fisheries management. ICES Journal of Marine

Applying selection criteria

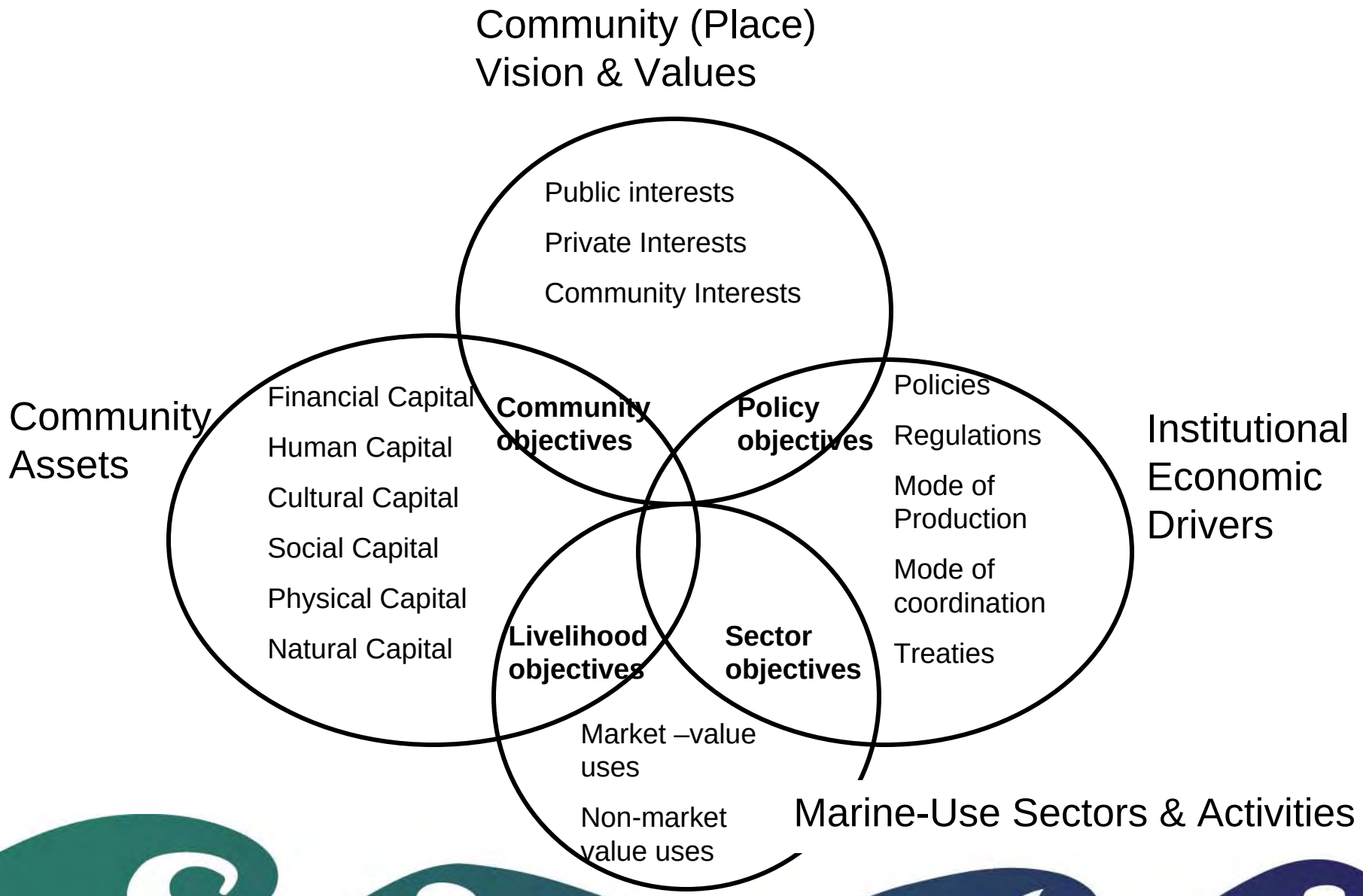
1. Please rate the following indicators based on the following criteria:

Easy to understand
Easy to measure
Cost efficient
Historical data available
Sensitivity to stressors
Responds predictably and in a known way to stressors
Specificity of response to particular stressors
Anticipatory of broader ecosystem changes

	Easy to understand	Easy to measure	Low cost	Existing data	Sensitivity	Responsiveness	Specificity	Anticipatory
Mean trophic level of the ecosystem								
Mean trophic level of the landings								
Kelp forest cover								
Eeelgrass cover								
Cold water coral cover								
Sponge habitat cover								
Intertidal diversity								
Benthic invertebrate diversity								
Benthic fish community								

Excellent
Good
Moderate
Bad

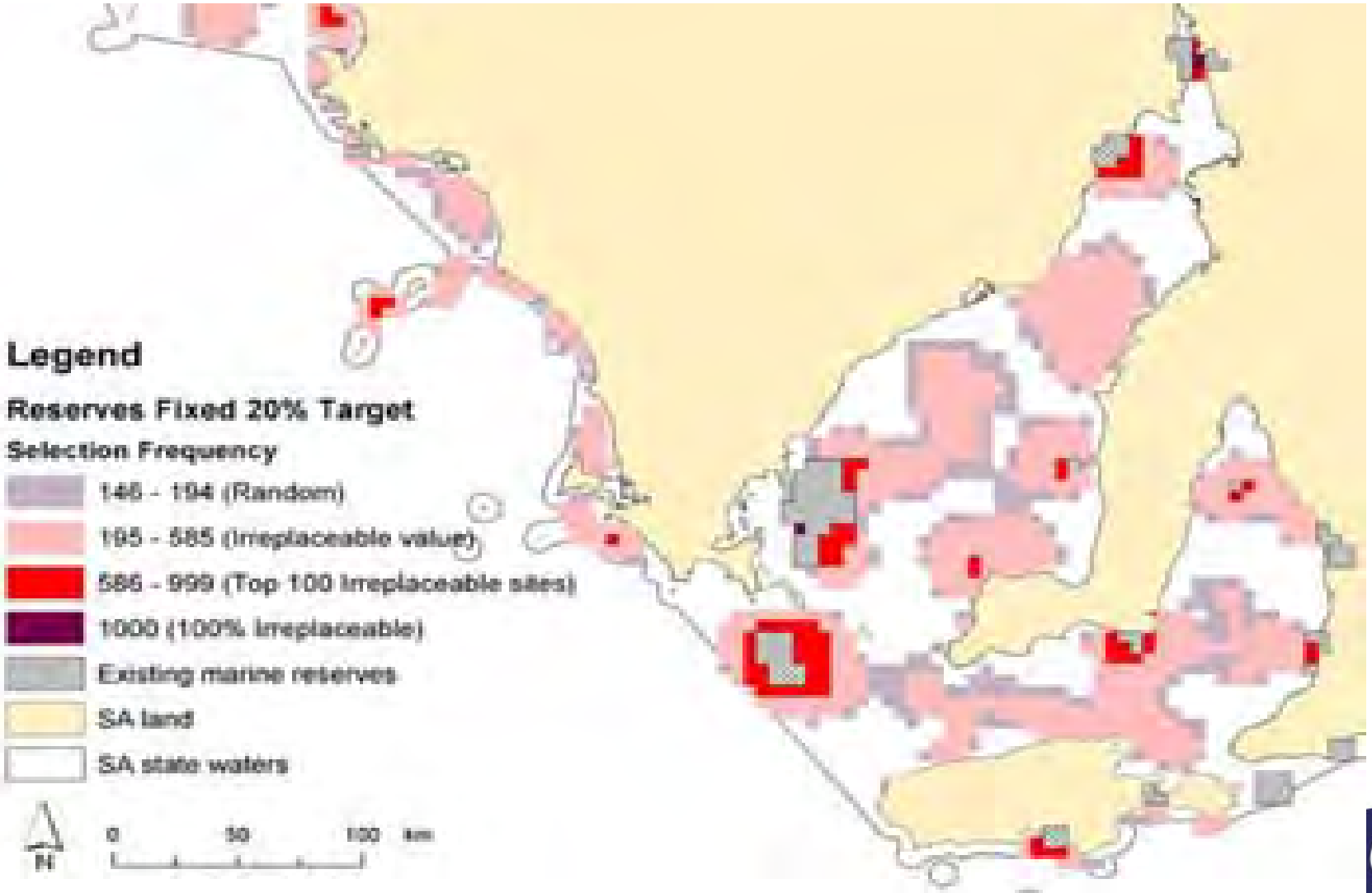
The elements of the socio-economic system



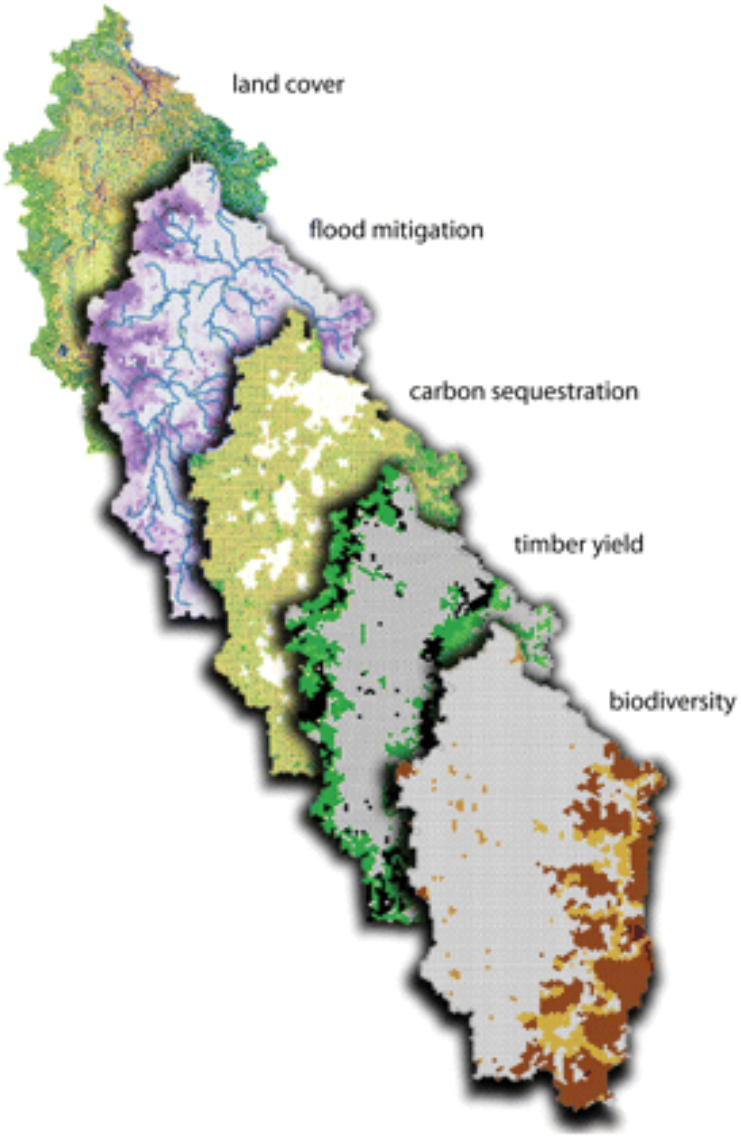
Benchmarks and Targets

- Expert workshops with partners
  - Fisheries and Oceans Canada
  - Parks Canada
  - Coastal First Nations
  - Other partners in the region
- Other literature and expert input

Develop Management Options
e.g. MarZone – protected site selection

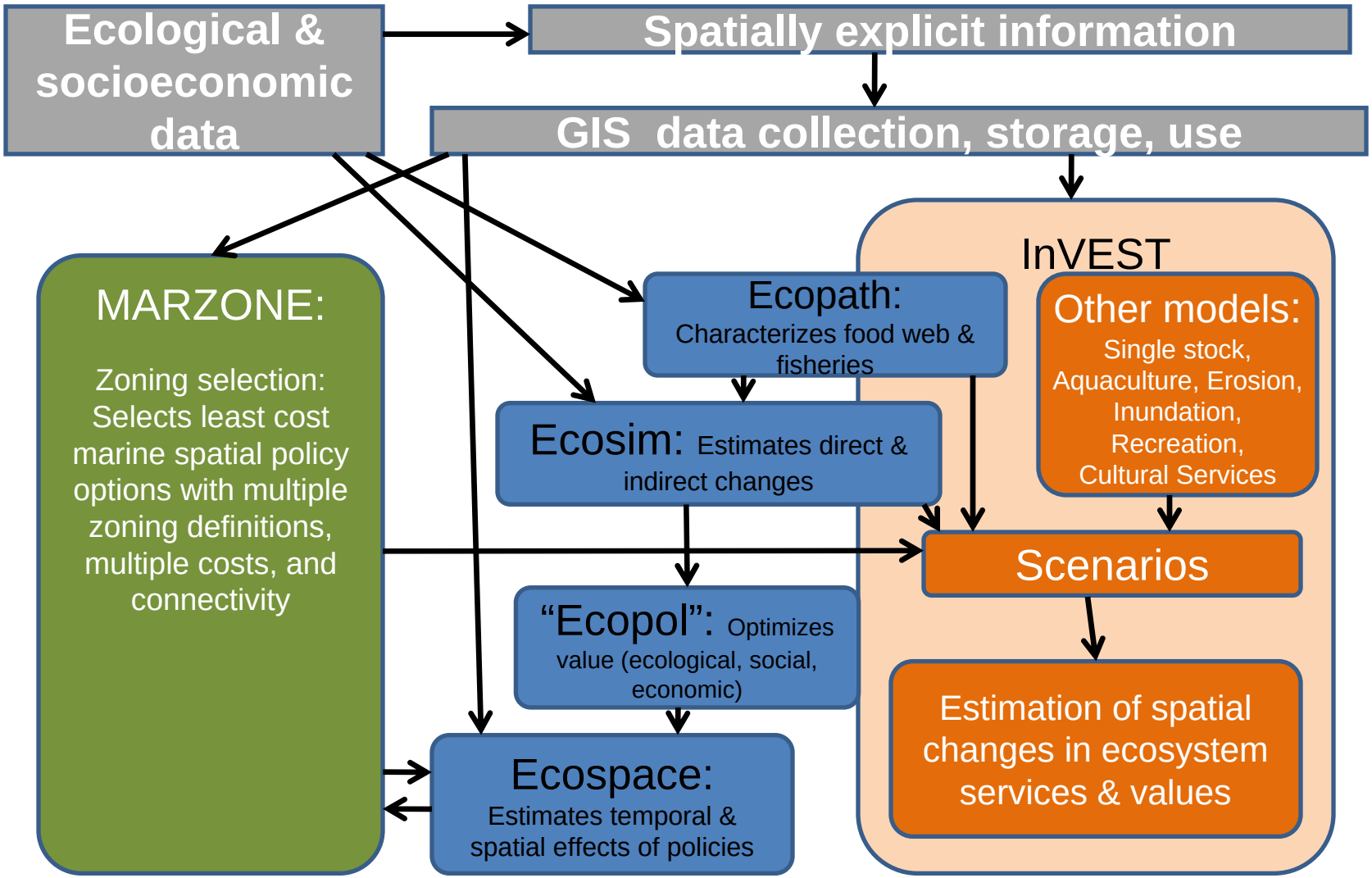


InVEST – Scenarios of Ecsystem Services



PNAS – The Natural Capital Project

Major decision support tools for WCVI Coastal and Ocean Planning



Next steps

- Management strategy development and implementation
- Monitoring program
  - Benchmarks and targets
  - Monitoring for Status and Trends
  - Evaluating Management Strategies

Acknowledgements

- Gordon and Betty Moore Foundation
- DFO
- Parks Canada
- Pew Fellows Program in Marine Conservation
- University of Victoria
- Western Economic Diversification, Industry Canada
- And many others...

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