

Progress in US Ecoregion Definitions for Ocean Ecosystems: Including an Alaskan Example

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What is the definition of an ecosystem approach to management?

NOAA defines an ecosystem approach to management as one that is:

- Adaptive
- Regionally directed
- Takes account of ecosystem knowledge
- Takes account of uncertainty
- Considers multiple external influences
- Strives to balance diverse societal objectives

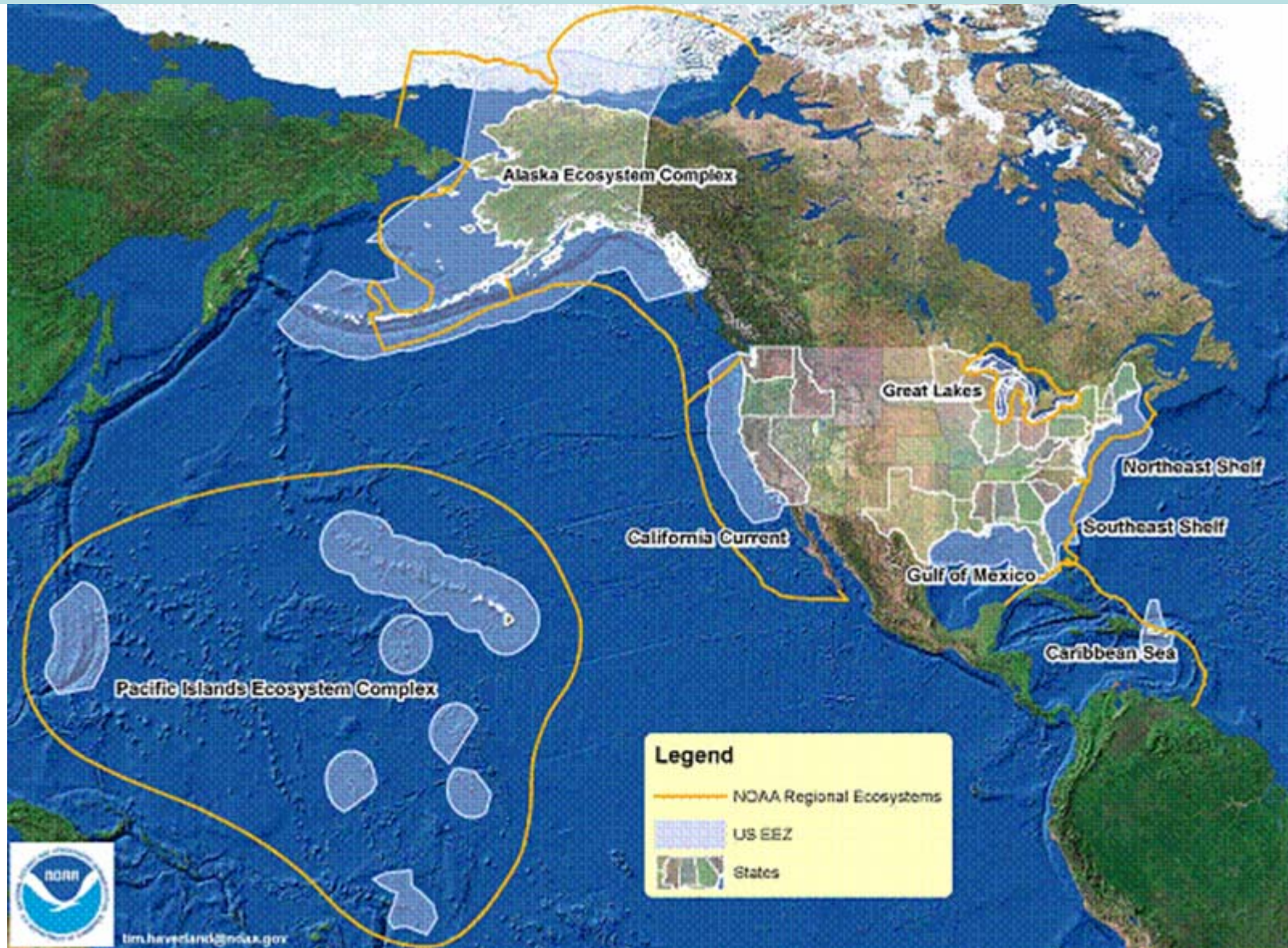
What are marine ecosystems, and how will they be delineated?

An ***ecosystem*** is a **geographically specified system of organisms (including humans), the environment, and the processes that control its dynamics.**

The ***environment*** comprises the **biological, chemical, physical, and social conditions that surround organisms.** Therefore, when appropriate, the term environment should be qualified as biological, chemical, physical, and/or social.

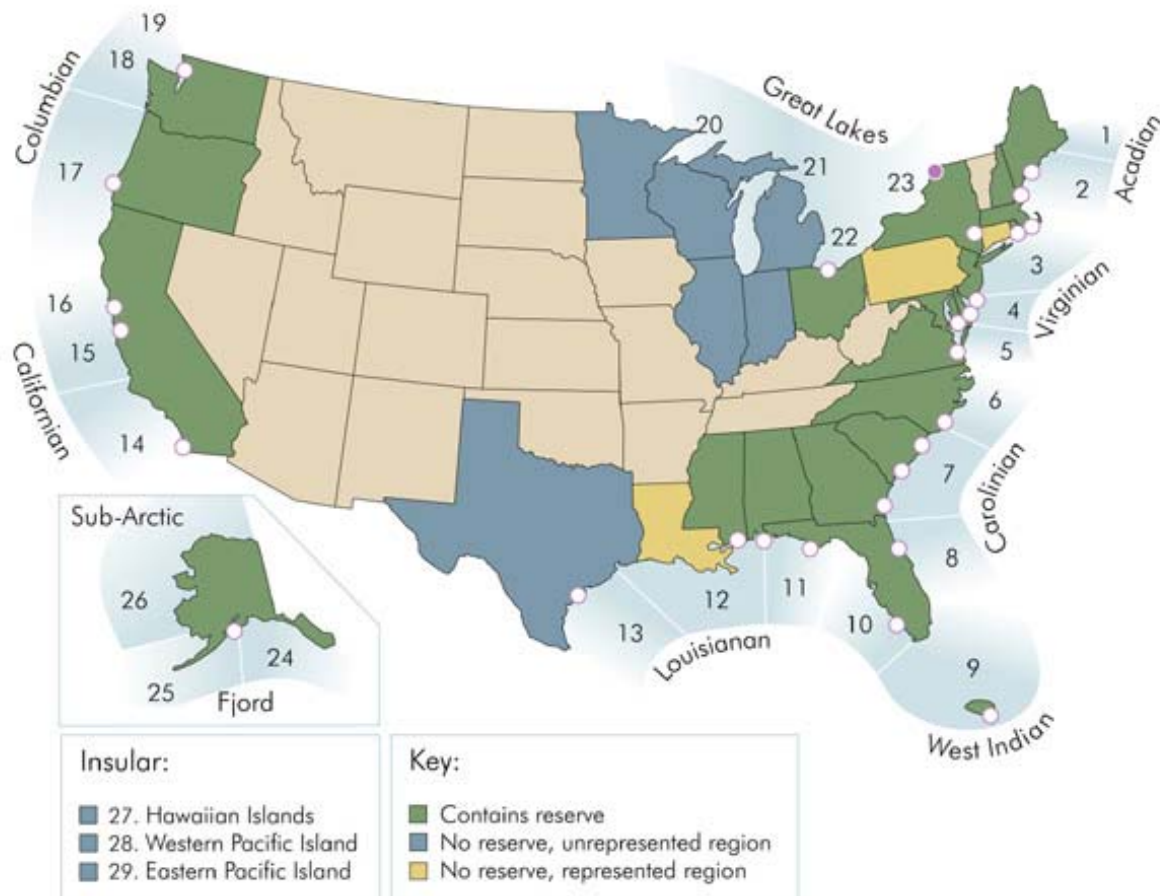
Delineation of the scale of individual ecosystems is **based on the spatial extent of the system dynamics** that are to be studied or influenced through management. Specific ecosystem boundaries are based on discontinuities in the geographic distribution of ecosystem characteristics and management jurisdictions. This will lead to specifying ecosystems at a hierarchy of scales with boundaries that sometimes overlap.

US Large Marine Ecosystem Boundaries



Current Representation of the National Estuarine Research Reserve System Biogeographic Coverage

- A biogeographic region is a geographic area with similar dominate plants, animals and prevailing climate. There are 11 major biogeographic regions around the coast, with 29 sub regions.



Ecoregions Classification Order

Ecodomains



An ecodomain is an area of broad climatic uniformity. There are three terrestrial and one oceanic ecodomain occurring in British Columbia. Ecodomains are meant to be mapped at 1:30,000,000 for use in global environmental strategies.

Ecodivisions



An ecodivision is an area of broad climatic and physiographic uniformity. There are seven ecodivisions occurring within British Columbia. Ecodomains and ecodivisions place British Columbia in a global context. Ecodivisions are meant to be mapped at 1:7,500,000 for use in national state of the environment reporting.

Ecoprovinces



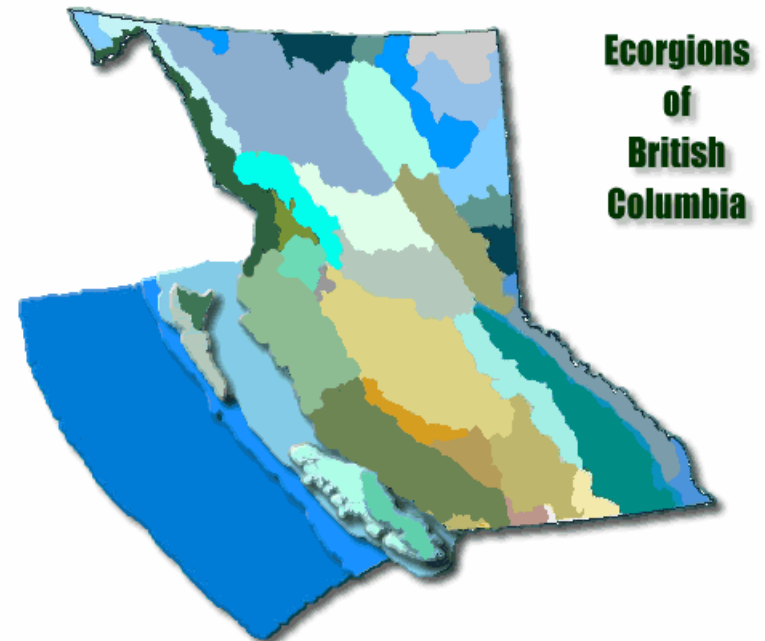
An ecoprovince is an area with consistent climatic or oceanography, relief and regional landforms. There one oceanic, two marine / terrestrial and seven terrestrial ecoprovinces occurring within British Columbia. Ecoprovinces are meant to be mapped at 1:2,000,000 for use in provincial state of the environment reporting.

Ecoregions



An ecoregion is an area with major physiographic and minor macroclimatic or oceanographic variation. There are 43 ecoregion in British Columbia of which 39 are terrestrial. Ecodivisions are meant to be mapped at 1:500,000 for regional strategic planning.

Ecoregion Classification System



NMFS Ecoregion Workshop

October 2005

- Develop operational protocols for initial definition of ecosystem sub-area boundaries, incorporating relevant biological and oceanographic/hydrological information categories included in guidelines to date, drawing on international experience.
- Describe how protocols may differ for information-poor vs. information-rich systems, including appropriate descriptive and analytic tools.
- Develop guidelines for weighting different information categories in the development of sub-area boundaries.
- Describe the initial specifications for descriptions of ecosystem sub-areas.

Candidate Criteria for Definition of Subregions

The workshop identified four major categories of criteria to define subregions within LMEs:

- Bottom topography/physiography
- Circulation/oceanography
- Biological characteristics
- Coastal/ inland extend/ watershed/marine catchment area

Two levels were identified for each category:

- Minimum requirement applicable nation-wide (“National Minimum”)
- Essential to many regions but not to all (“Regionally Essential”)

Large Scale Features

Large scale features with defined criteria:

- Bottom topography/physiography
- Circulation/oceanography
- Biological characteristics
- Coastal/inland extent/Watershed/Marine catchment area

Example: Specific Criteria

Large scale feature: Circulation/Oceanography

National Minimum:

- Dominant currents (surface and depth), including gyres, plumes, upwelling, transport and advection
- Water mass characterization:
 - Sea surface temperature
 - Ocean temperature structure (Temperature profile)
 - Salinity
 - Stratification (including hypoxic zones)

Regionally Essential:

- Tides
- Ice cover
- Water quality variables
 - Turbidity
 - Suspended sediment
- Water mass characterization
 - Dissolved oxygen (including hypoxia)
 - Nutrient dynamics (concentration, sources and fluxes)
 - Tidal range/flood patterns and periodicity
- Frontal probability
- Holistic large-scale modifiers and their influence on dynamics (means, variances, maxima and minima), e.g., NAO

Example: Specific Criteria

Large scale feature: Biological Characteristics

- National Minimum:
- *Species composition*
- *Fish*
- *Marine mammals*
- *Sea turtles*
- *Sea birds*
- *Flora*
- *Assemblage definitions*
- *Primary production or chlorophyll proxy*
- Regionally Essential:
- *Benthic species composition*
- *Genetic structure (including stock structure differentiation)*
- *Age structure/ size structure (including nursery and breeding grounds)*
- *Benthic production/detrital input (concentration, sources and fluxes)*
- *Flora (inshore/offshore variance; endemism)*
- *Productivity*
- *By source*
- *Fish/fishery productivity*
- *Whole system productivity*
- *Trophic interactions*
- *Migratory patterns*



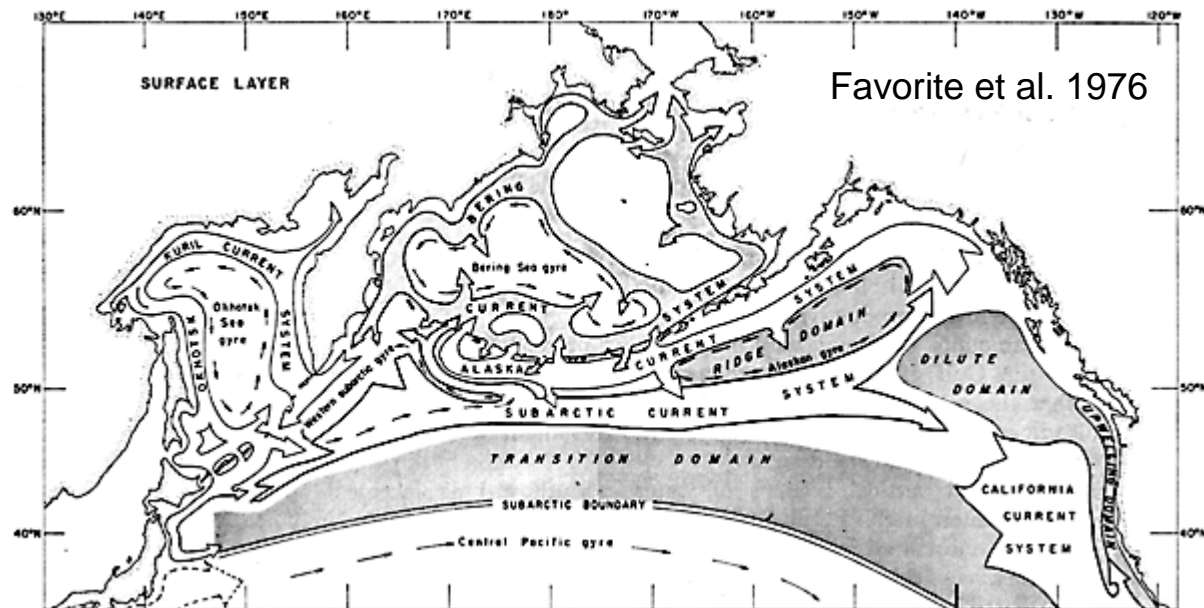
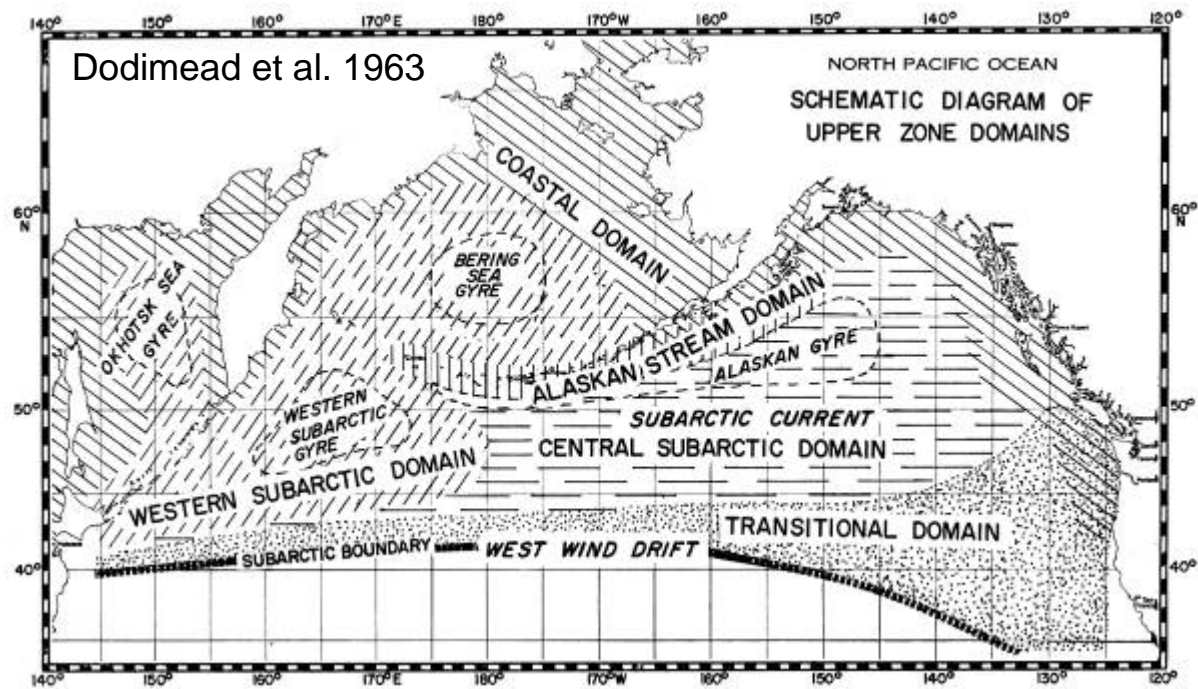
Next Steps

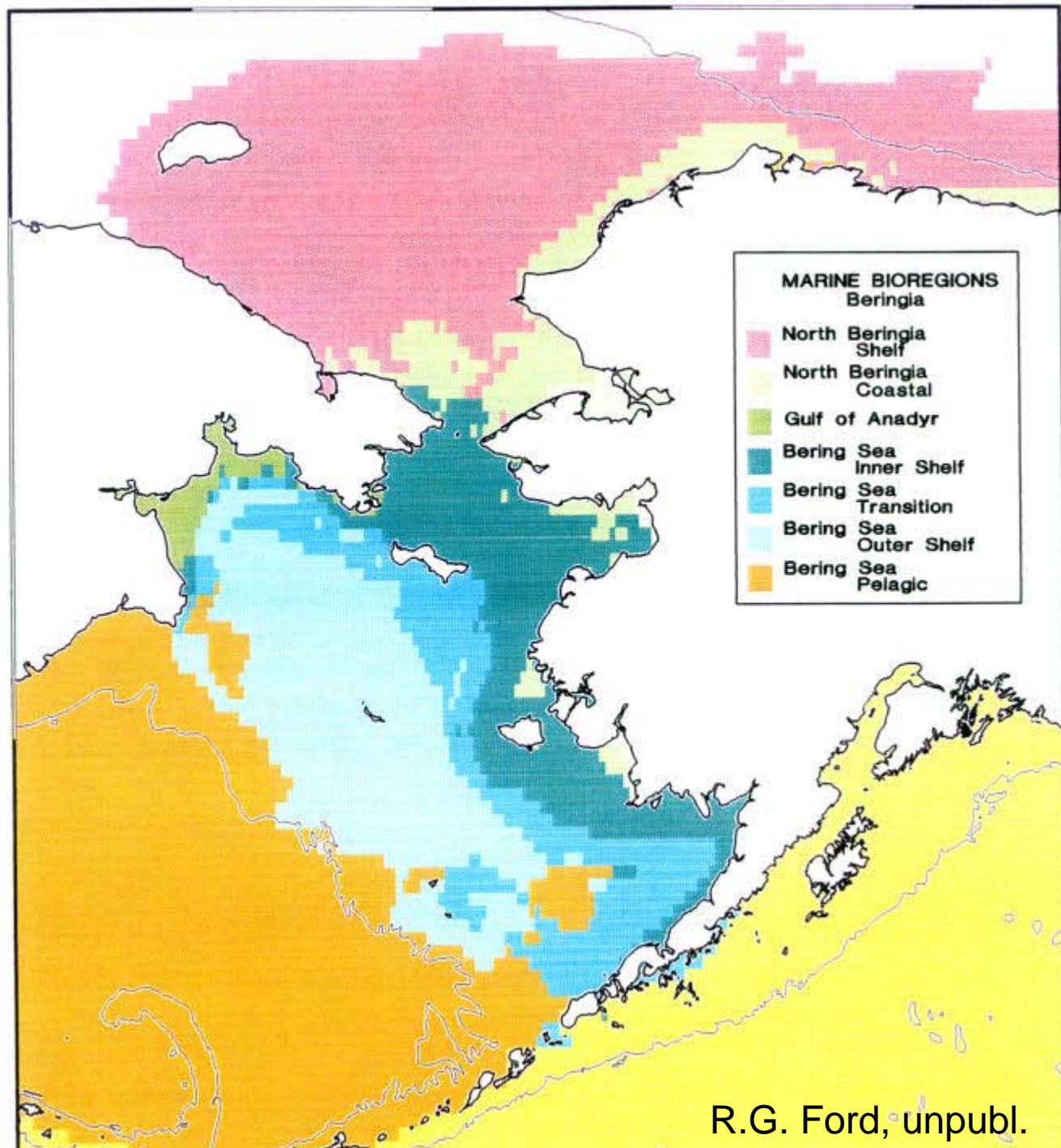
- **Apply and test the delineation criteria: each region**
- **Incorporate stakeholder concerns (scientific peers) through a vetting approach**
- **Obtain a final product that is uniform across regions**

Marine Eco-regions of Alaska (a work in progress)

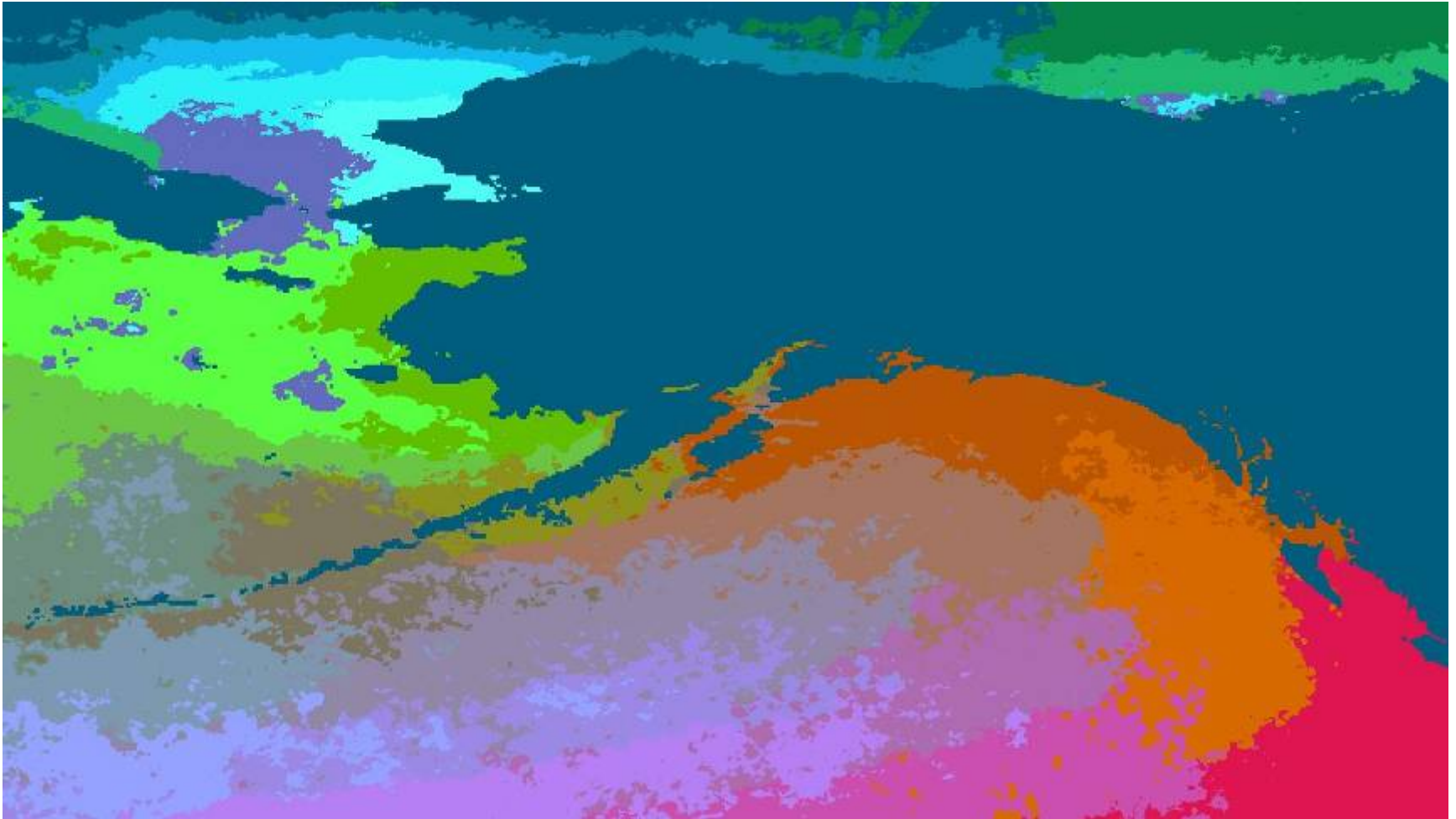
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Gary Drew (USGS), Dave Douglas (USGS),
Marc Romano (USGS), Alan Springer (UAF),
Tom Weingartner (UAF) and Lowell Fritz (NMFS)





R.G. Ford, unpubl.



Pathfinder SST: 1985-2002 Monthly Averages

4 "band" image of monthly averages: May, June, July, August

PCA Image of the 4-band image from above

ISODATA (parametric) clustering of the 3-band PCA image above (25 classes requested)

Displayed: 25 classes (clusters)

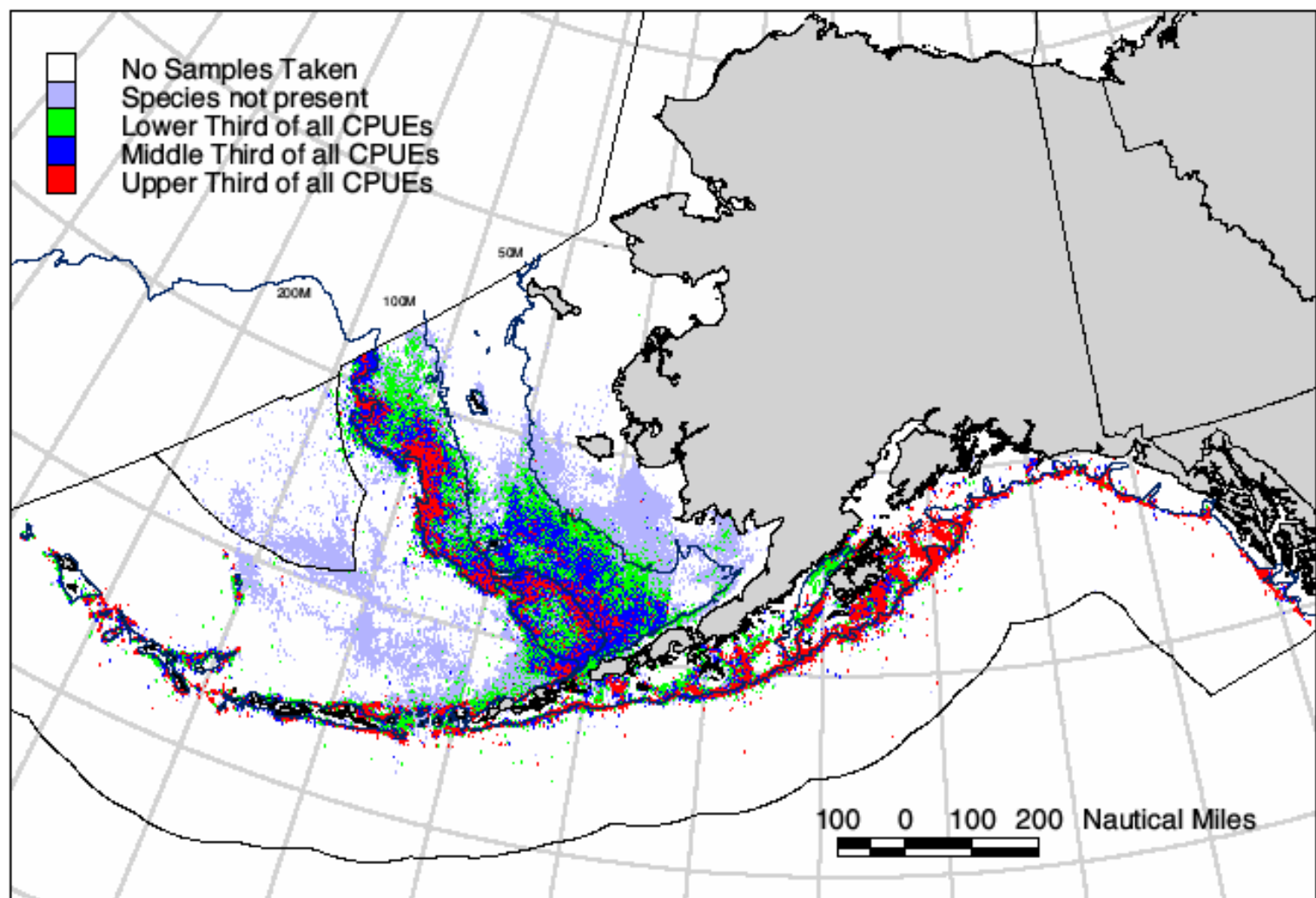
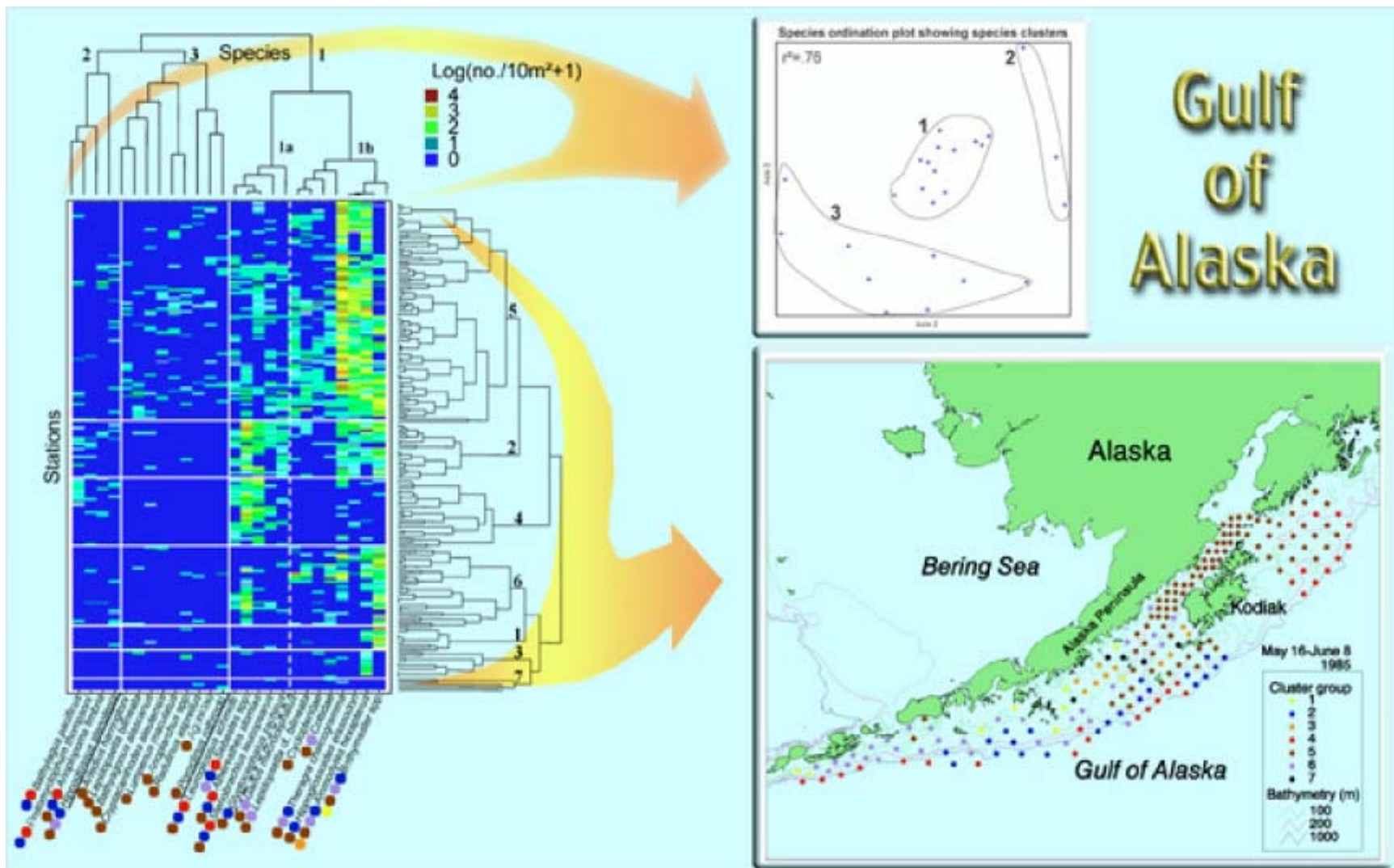
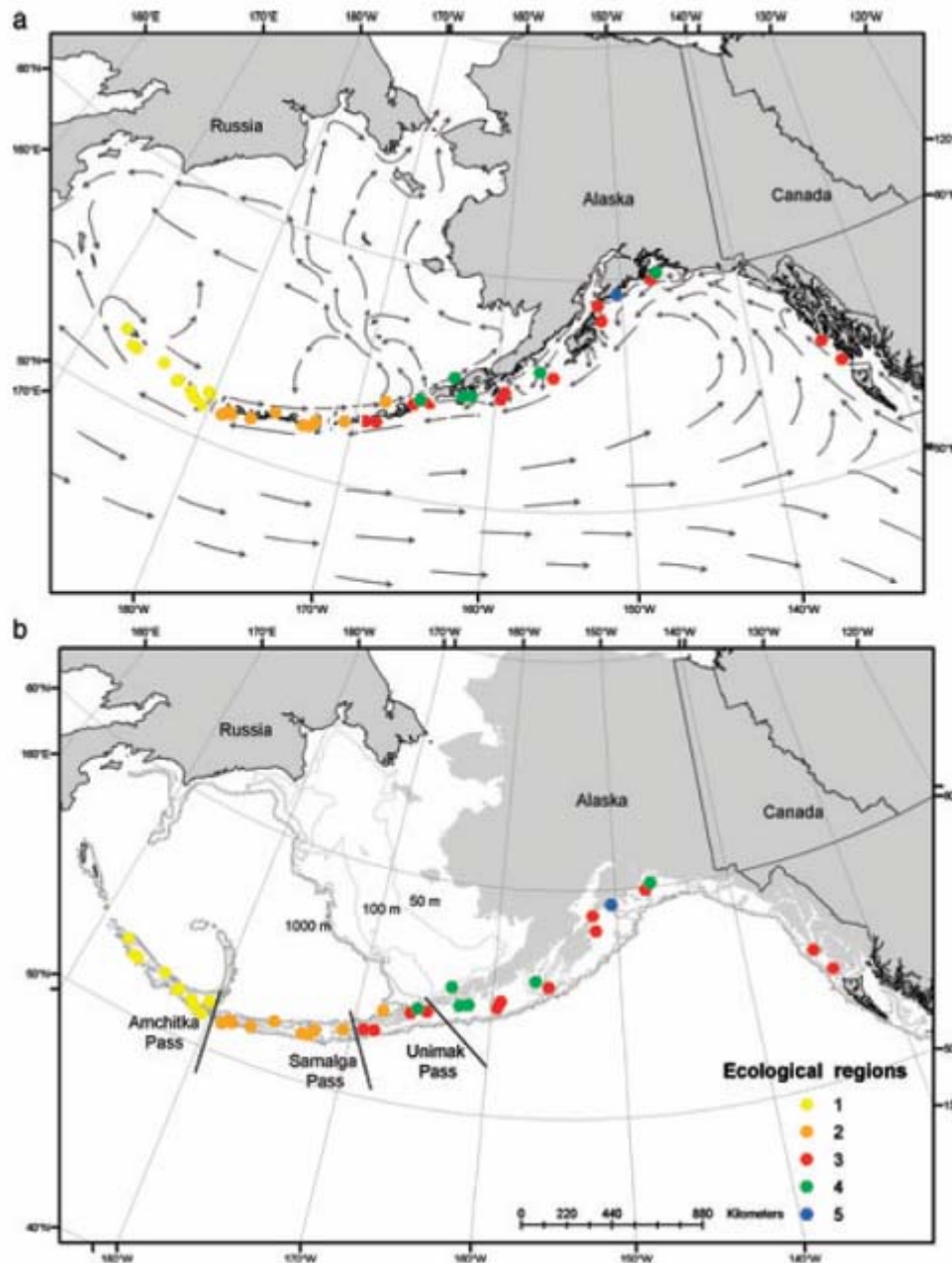


Figure 10. Arrowtooth flounder catch per unit effort (CPUE) summary of Alaskan trawl groundfish observer data.



Doyle et al. (U. Washington, AFSC)

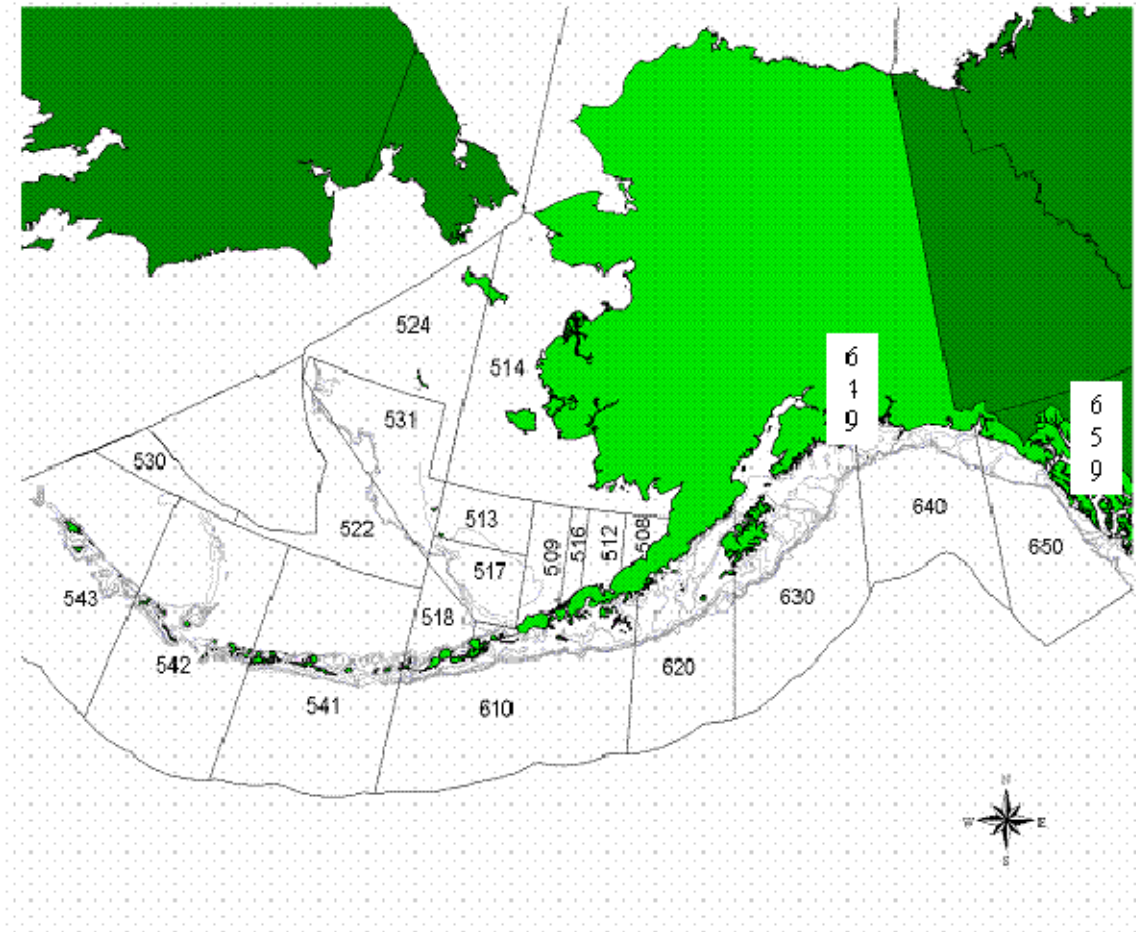


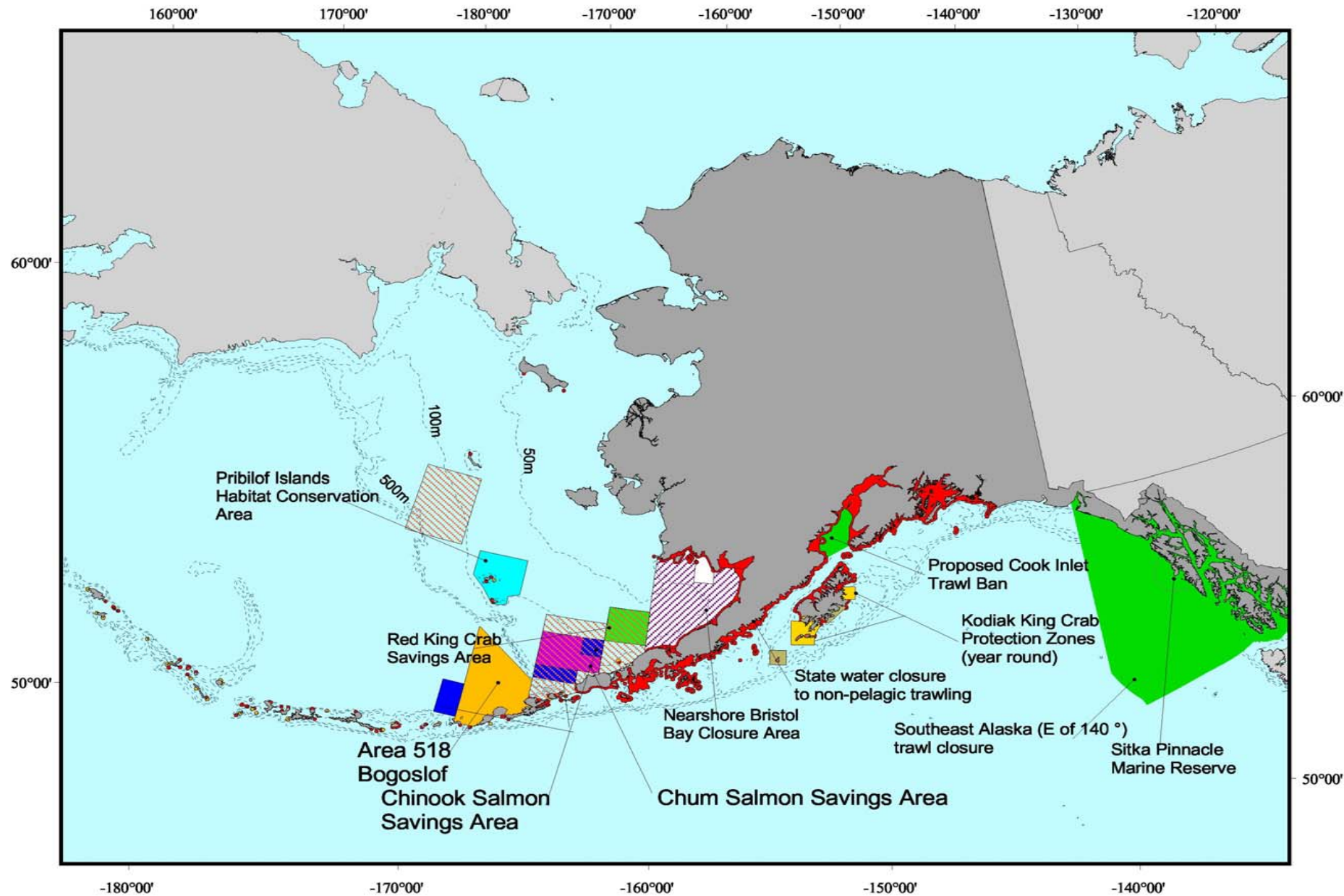
Steller sea lion
Habitat classification
(Call & Loughlin 2005)

By Depth, SST,
Substrate, Trend
Diet diversity

Figure 5. The five ecological regions, determined by the Jenks classification, mapped in relation to (a) mean ocean currents and SST of the North Pacific, Bering Sea and GOA, and (b) in relation to the major Aleutian Island passes.

Groundfish Fishery Management Regions







Marine Ecoregions
of Alaska

Conclusions

- 1) 26 marine ecoregions
- 2) Structuring obvious cross-shelf
- 3) Structuring subtle along shelf
- 4) More analysis needed (combining physical and biological)
- 5) Useful tool for interpreting meso-scale variability