Selecting model domains and boundaries in ecosystem modeling of the U.S. West Coast: process determines scale

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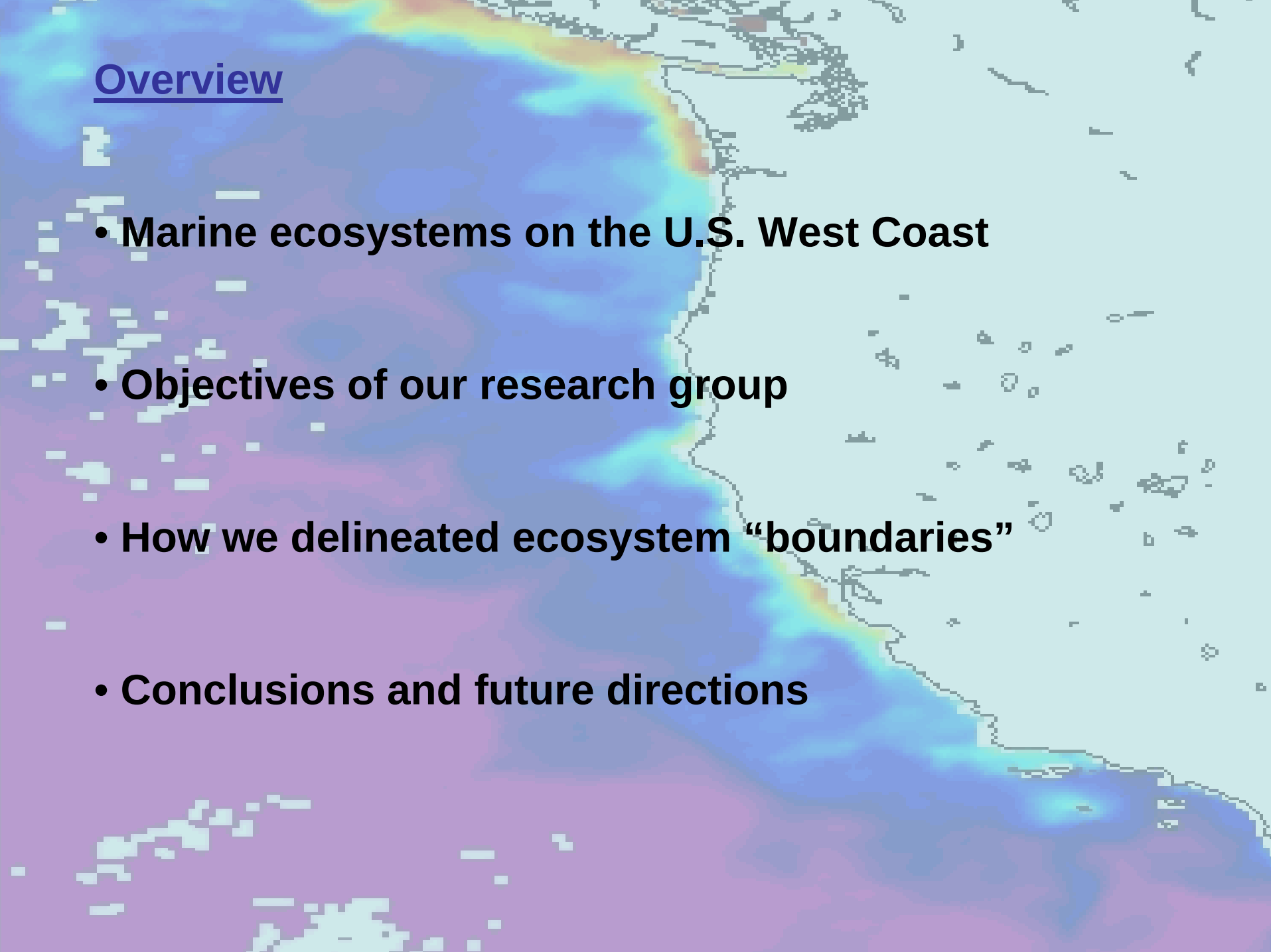


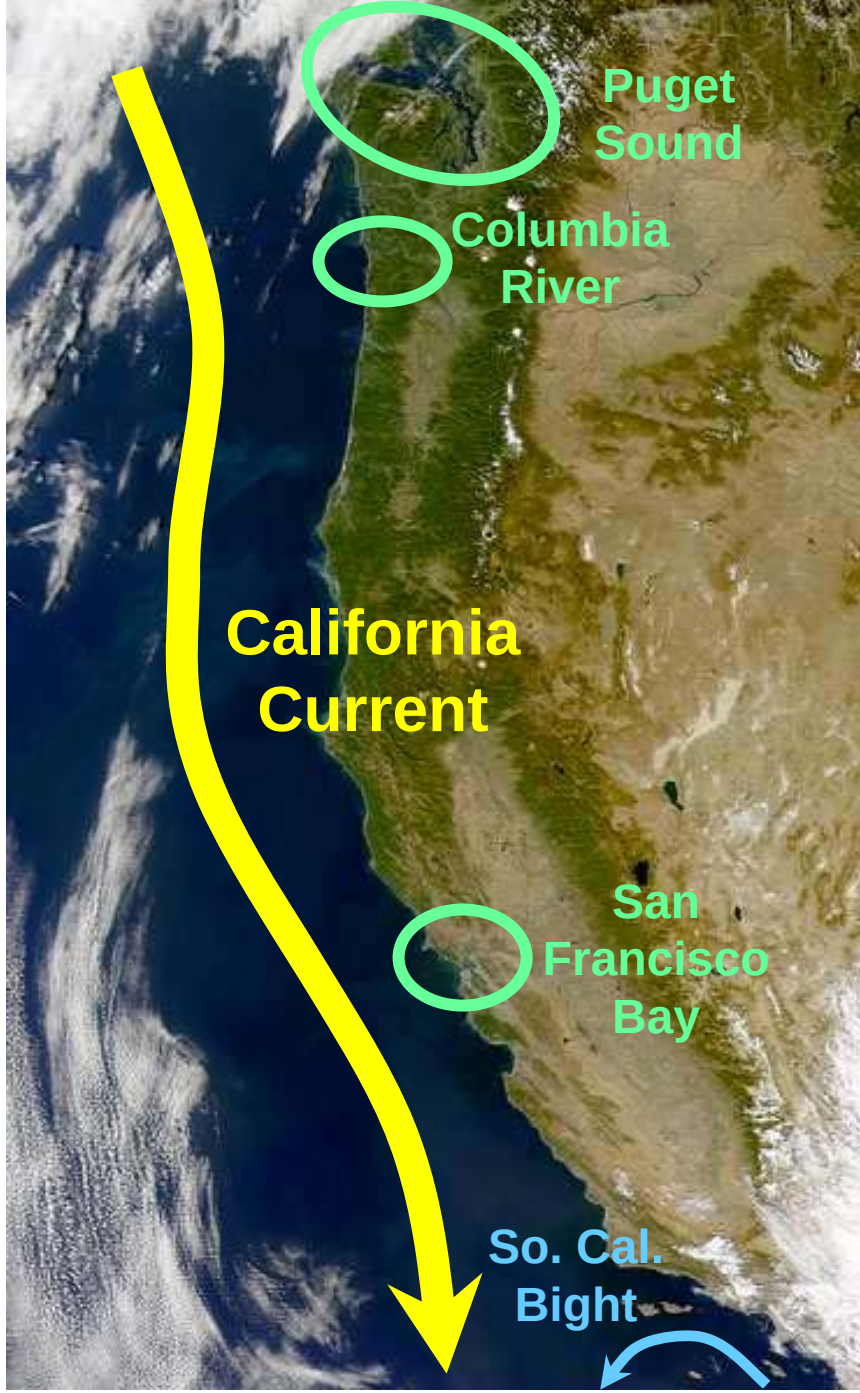
Overview

- Marine ecosystems on the U.S. West Coast
- Objectives of our research group
- How we delineated ecosystem “boundaries”
- Conclusions and future directions

Dominant marine ecosystem: The California Current

Other major open coastal ecosystem: Southern California Bight

Major coastal/estuarine ecosystems: Puget Sound, Columbia River estuary, and San Francisco Bay



Our program's research focus: The California Current

- **This is where most of the federally managed fisheries occur (EEZ)**

- **Comparable to the spatial distribution of the targeted species**

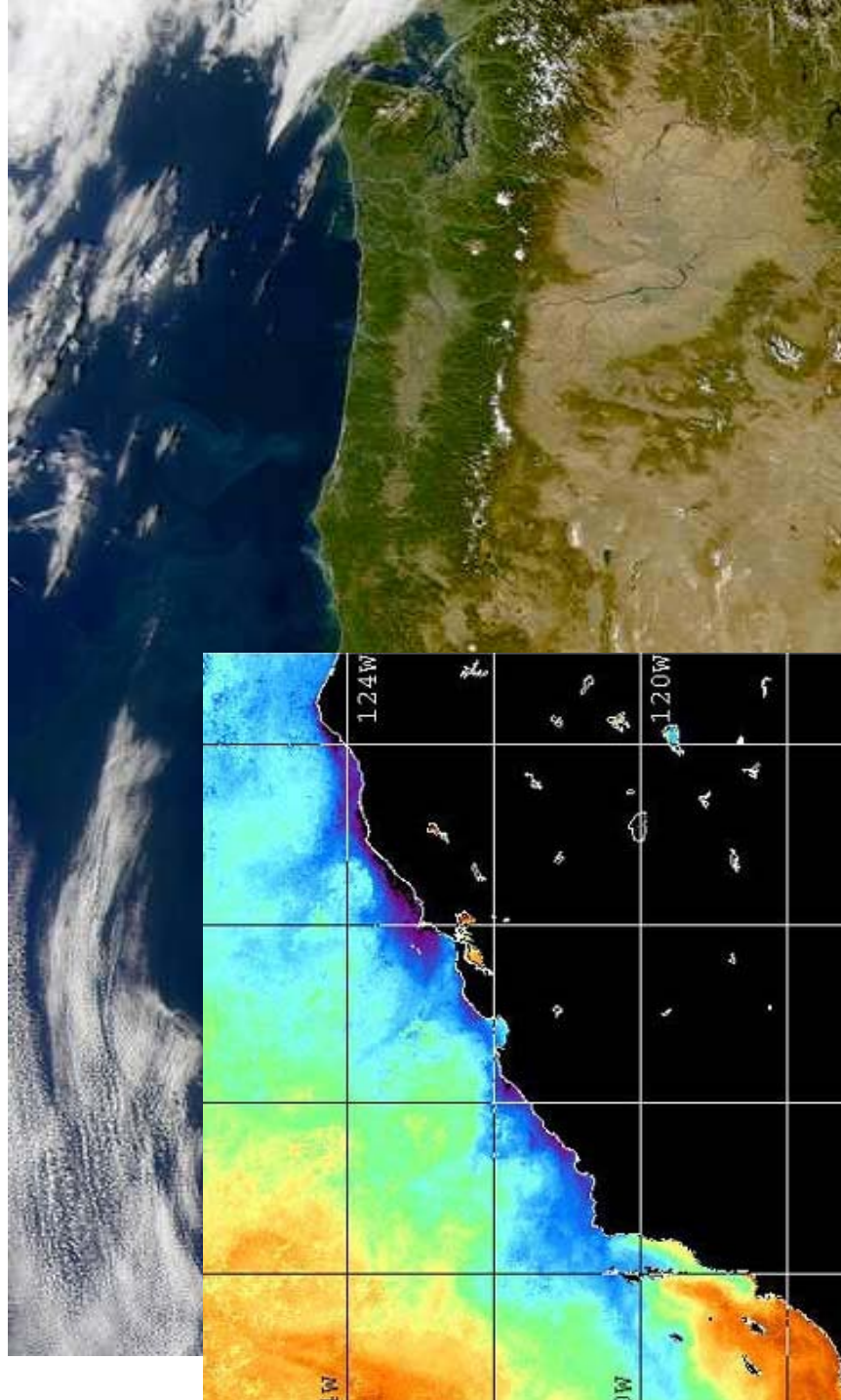
- **Also where associated and potentially fragile communities are found**

California Current Ecosystem

- **Main feature: California Current**
  - **South-flowing current**
  - **Shelf break to ~1000 km offshore**
  - **Surface to ~500 m deep**
  - **Numerous jets, eddies**

- **Coastal upwelling drives much of the area's primary production**

- **Geological features**
  - **Narrow shelf**
  - **Capes, points**
  - **Submarine canyons and banks**



California Current Ecosystem

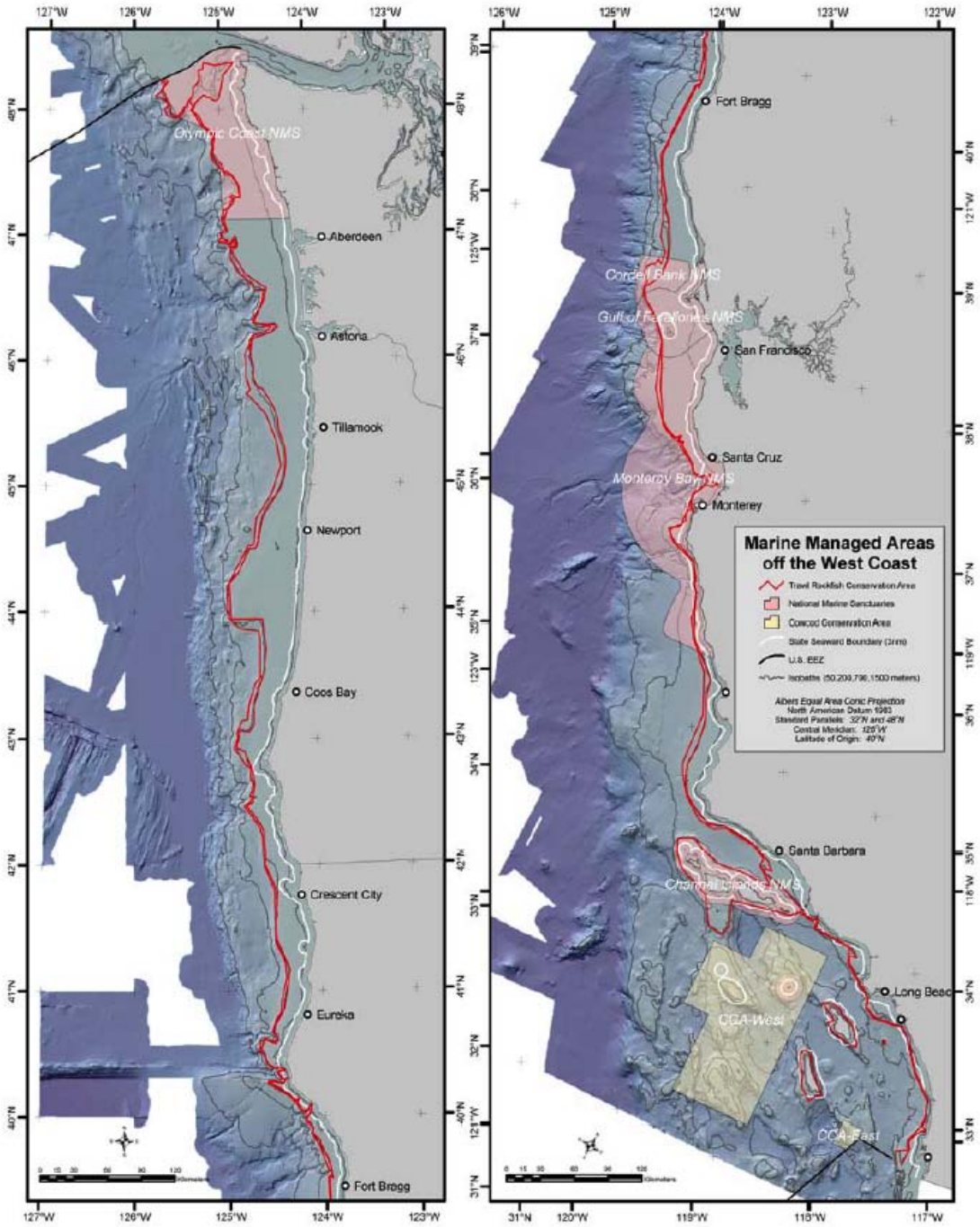
- Wide range of functional groups
  - Some highly sedentary
  - Some mobile within system
  - Some make long seasonal migrations, leave area entirely

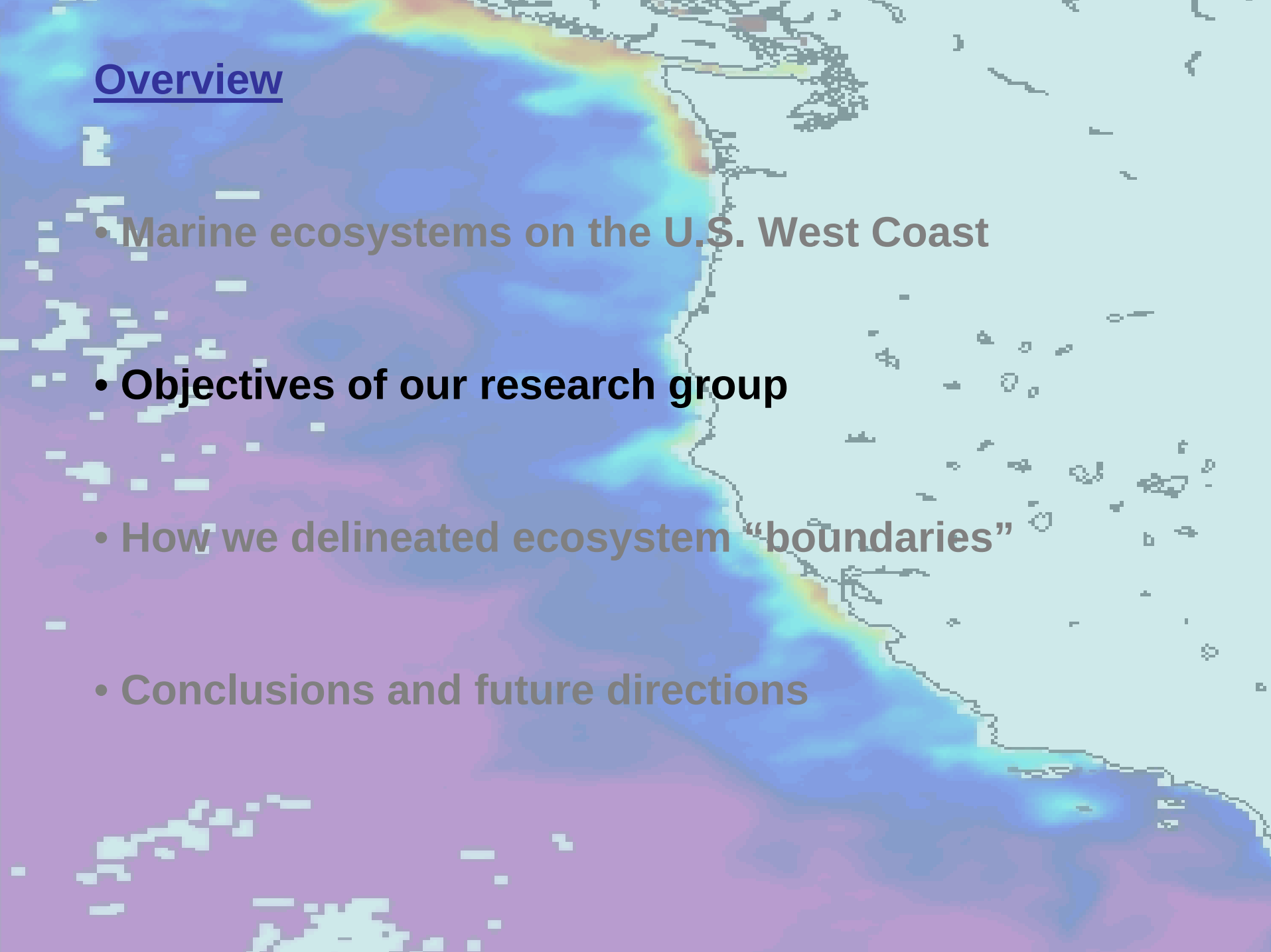
- Human activities:
  - Fishing, mariculture
  - Shipping, transportation
  - Species introductions
  - Industrial activities
  - Dumping, dredging
  - Military use
  - Land use, eutrophication
  - Conservation actions

Subject to large-scale seasonal fishing closures

Example: Groundfish Conservation Areas, enacted since 2002; no bottom trawling

Darkblotched rockfish, *Sebastes crameri*





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Our goal: a spatially explicit ecosystem model to examine management alternatives

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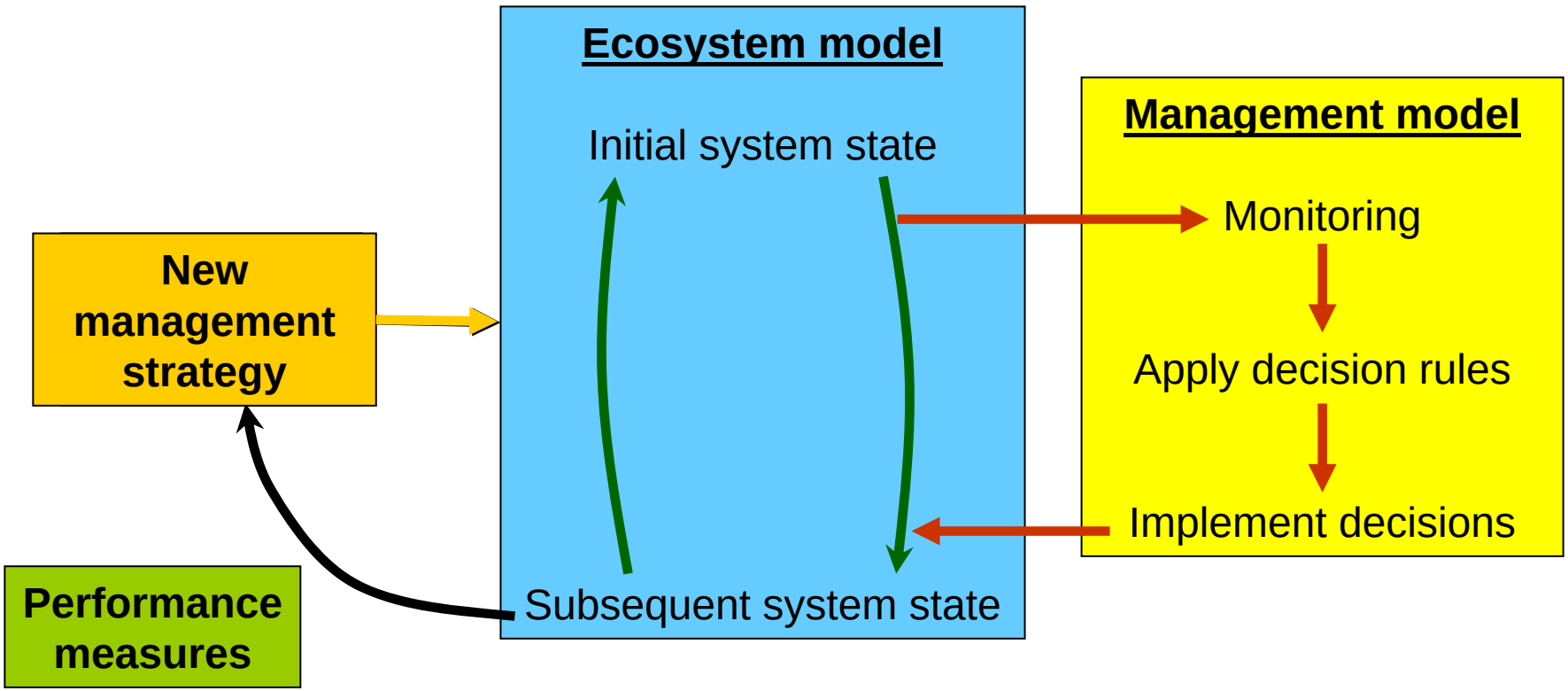
We wish to understand the role of (among other things):

- **key "functional groups"**
- **spatial and temporal closures**
- **harvest strategies (e.g., ITQs)**
- **environmental variability**

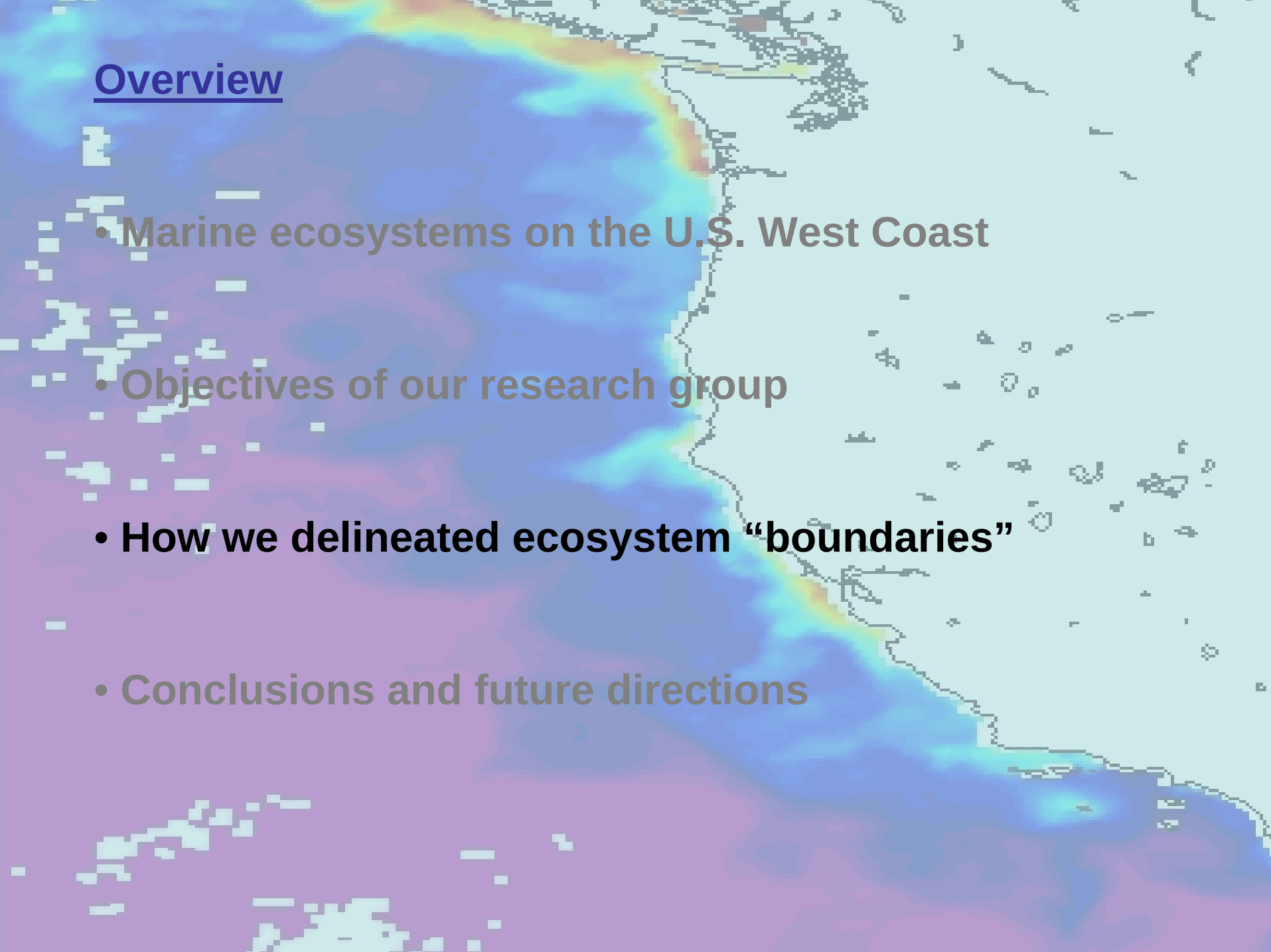
…and to identify trade-offs, data gaps, and key hypotheses

Strategic and qualitative!
(Not tactical and quantitative!)

Iterative loop of management strategy evaluation



- **We will interpret model outputs in a qualitative way**
- **That, in turn, allows us more flexibility in, e.g., defining boundaries**



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Latitudinal "boundaries"

Cape Flattery

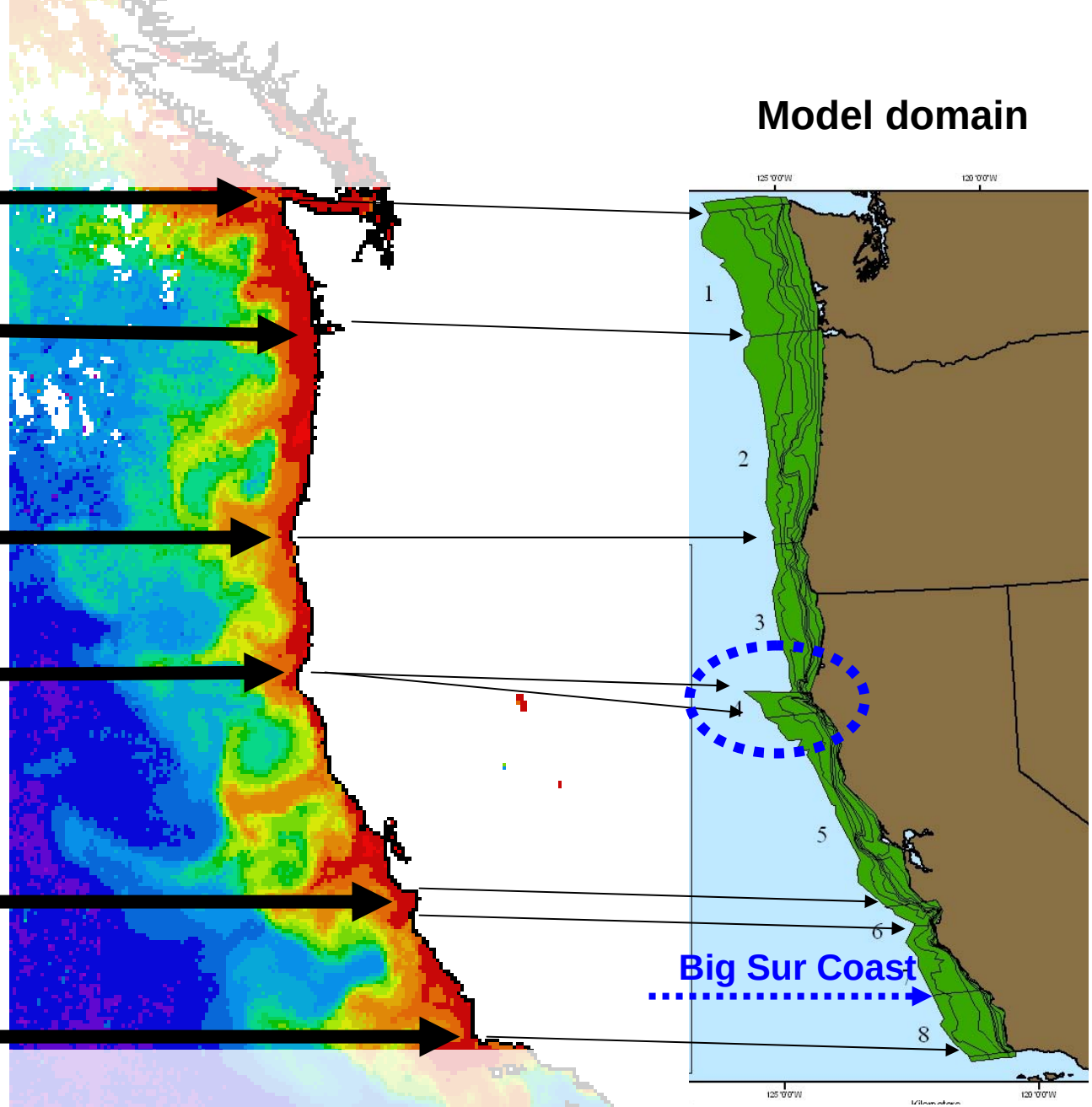
Columbia R., Astoria Canyon

Cape Blanco

Cape Mendocino

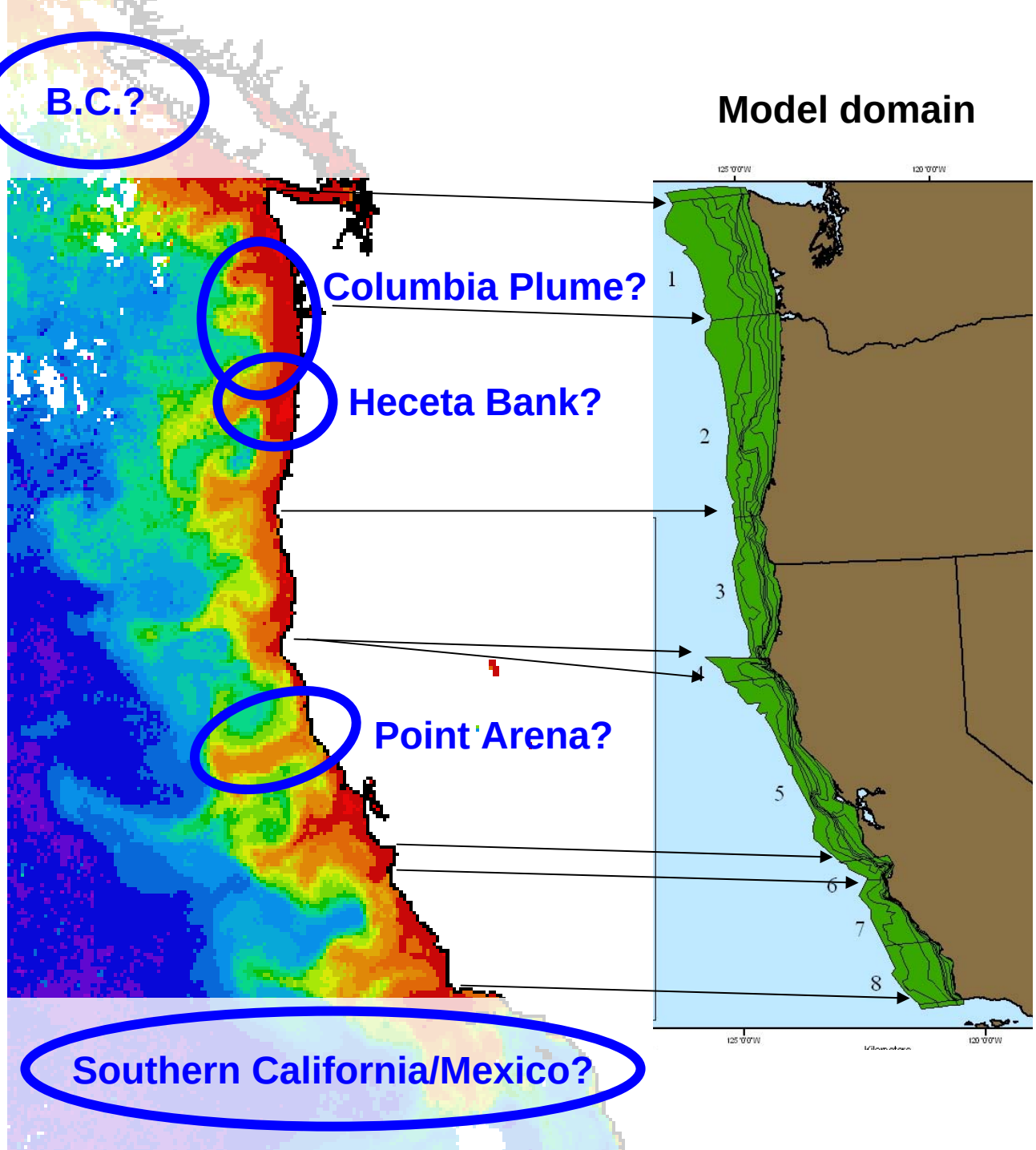
Monterey Bay, Monterey Canyon

Point Conception



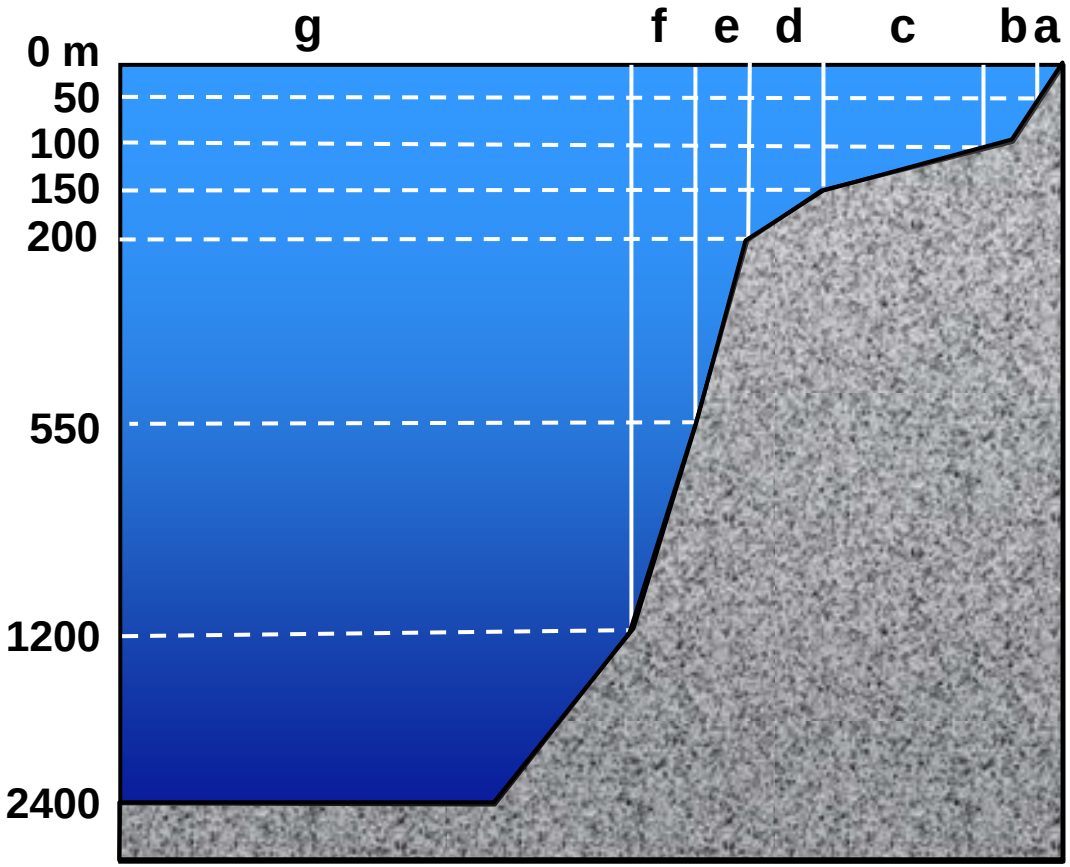
Latitudinal "boundaries"

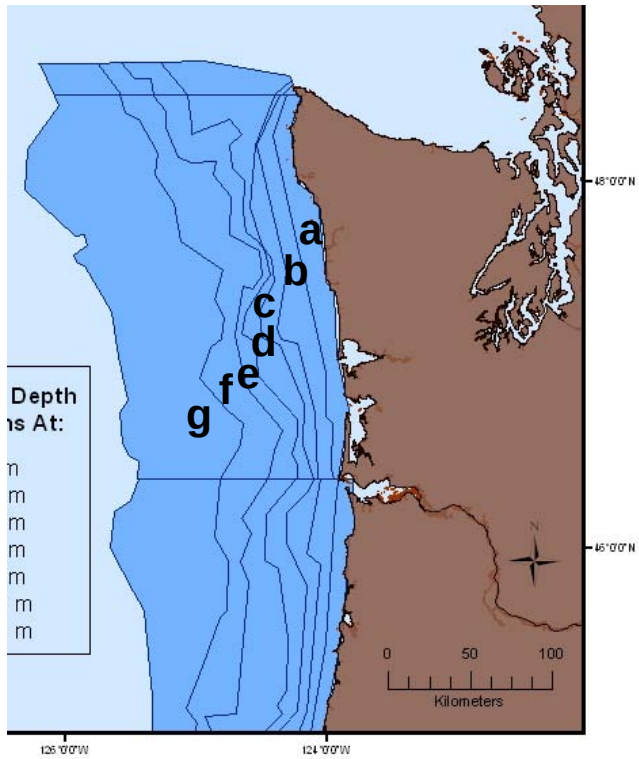
Did we leave out anything important?



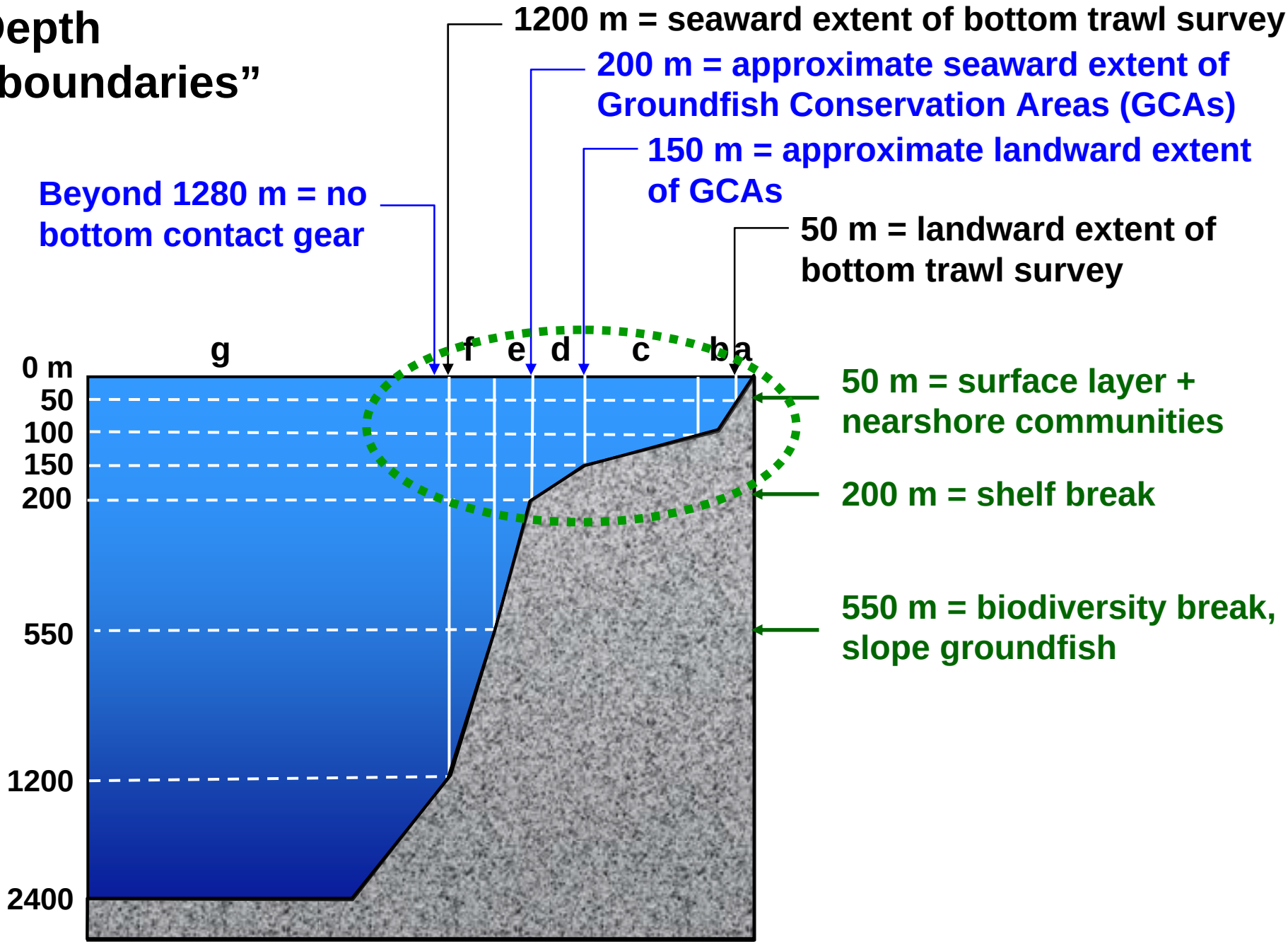
Depth
“boundaries”

7 layers; allows for some spatial detail
but limited by how narrow the shelf/slope is.

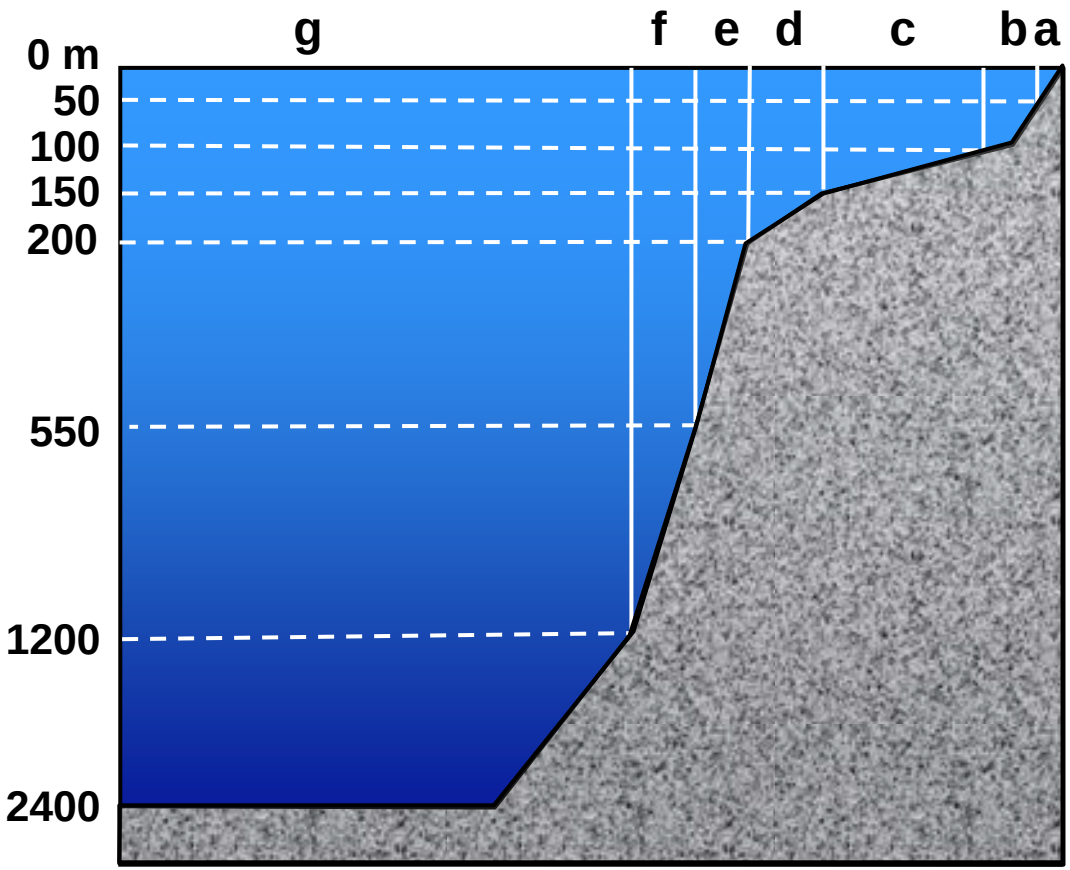




Depth "boundaries"



Depth “boundaries”

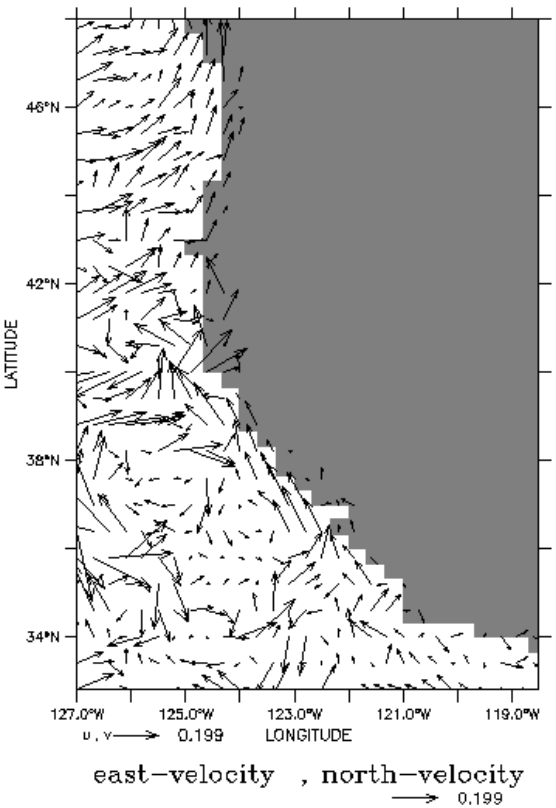


Did we leave out anything important?

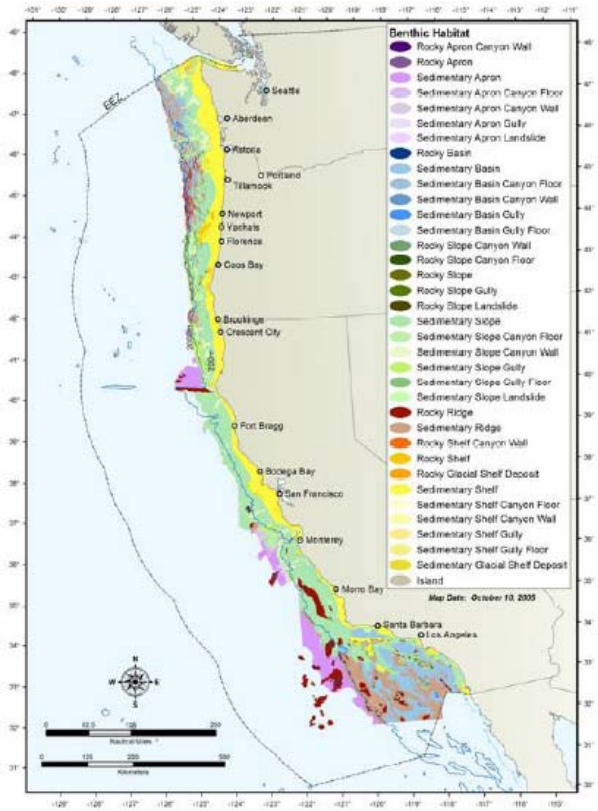
- Some unique bathymetric features
  - Islands
  - Seamounts
  - Canyons
  - High relief areas
- 20-m depth contour
  - Chlorophyll max
  - Upwelling
  - Kelp forests

Data scaling: some key inputs are ~10 km x 10 km

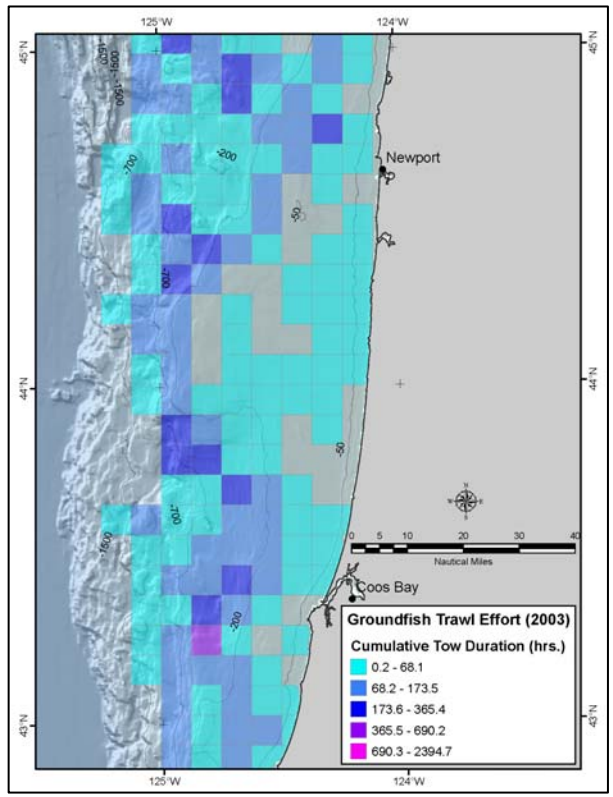
Oceanographic fluxes (water, salinity, temperature)



Benthic habitat types



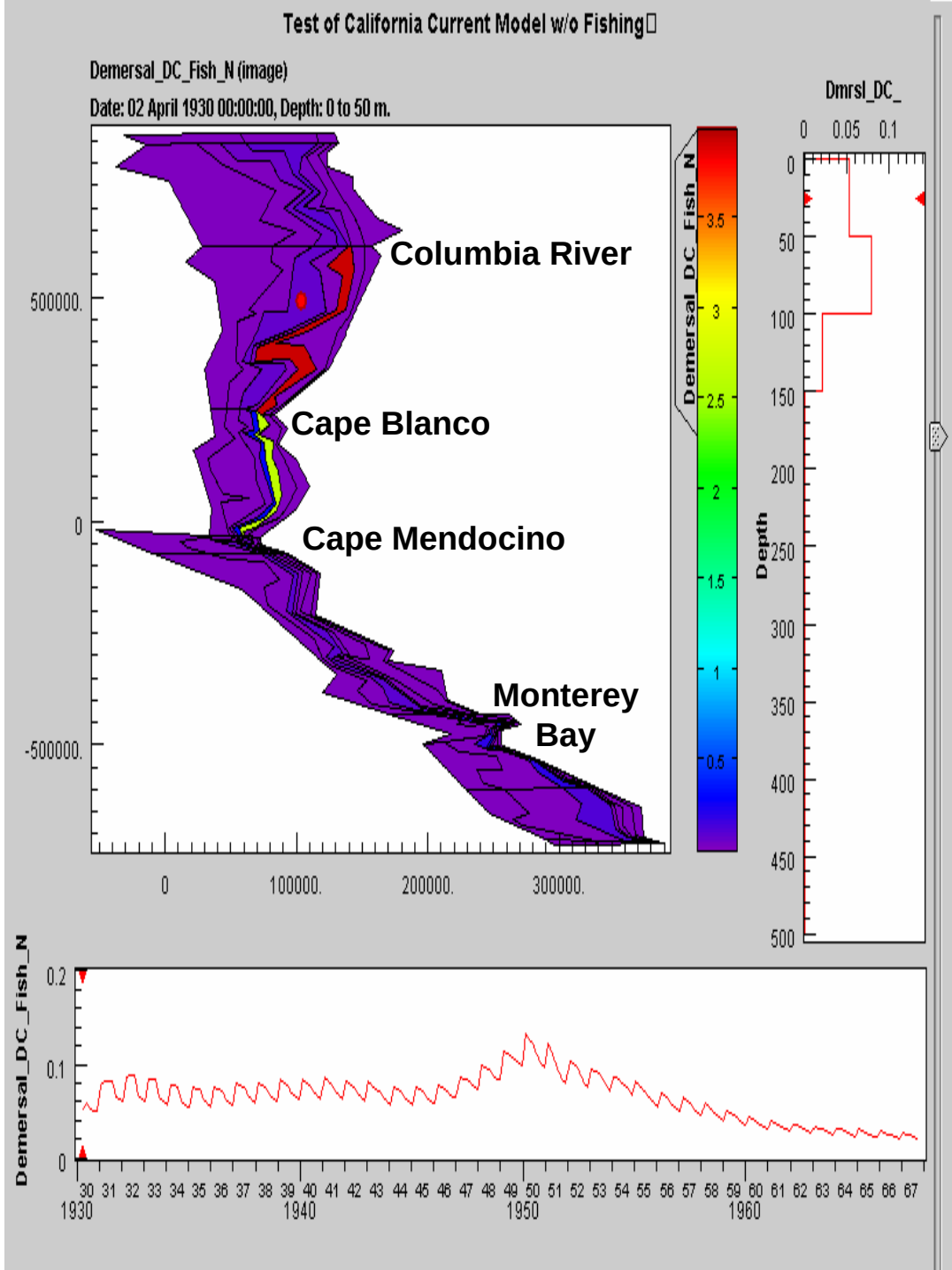
Fishing effort (bottom trawling)

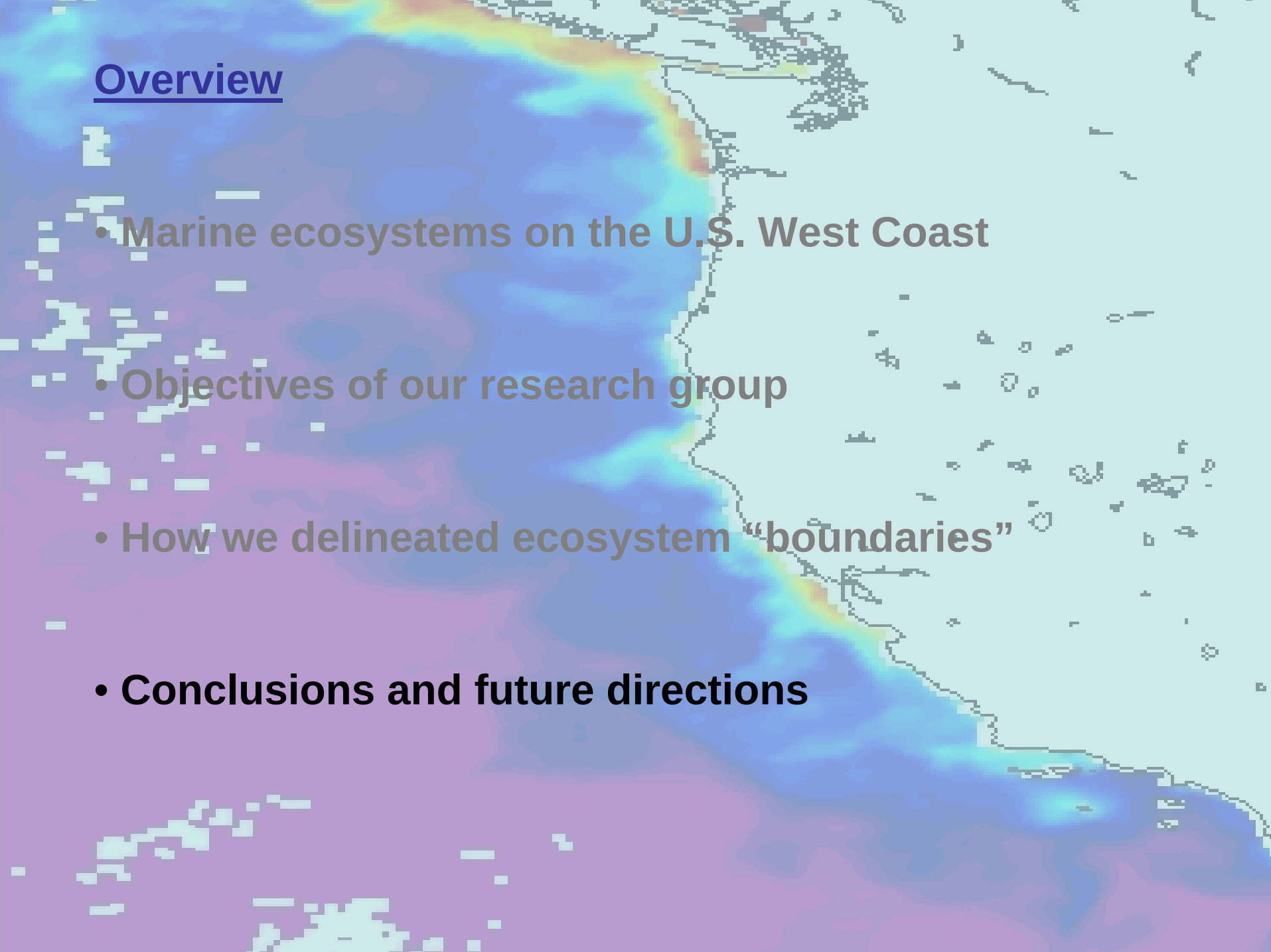


Some sample output

Biomass of Small Slope Rockfish in mg N/m^3

(includes splitnose rockfish, aurora rockfish, longspine thornyhead)





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- Our questions are large scale, general, mainly concern fishing (e.g., “What is the effect of the Groundfish Conservation Area?”)
- Underlying processes are also general
- Scale is quite coarse
- “Boundaries” are not very precise, but were based on:
    - Oceanography, geomorphology
    - Ecology
    - Data availability
- For our purposes, imprecise boundaries are probably okay

Tradeoffs that we had to consider

Model variable	Tradeoff(s)
Model domain	Our questions vs. all questions Data availability vs. accuracy Complexity vs. practicality
Number of polygons	Detail vs. run time Questions vs. assumptions Coastal scale vs. local scale
Depth of bathymetric contours	Ecology vs. management Data availability vs. accuracy

Topics we probably cannot study at this scale:

- **Small MPAs**
- **Intertidal/estuarine questions (e.g., shellfish aquaculture)**
- **Local impacts (e.g., oil spills)**
- **The dynamics of the Columbia River plume**
- **Recovery strategies for most individual species**