Dissolved Oxygen Impacts on the Biological Integrity of Key Habitats and Species

Breakout: Dissolved Oxygen Impacts on the Biological Integrity of Key Habitats and Species

Targeted Technical Uncertainties examples

- What are the DO requirements for the most sensitive species, including an adequate margin of safety?
- How should the duration and spatial extent of lower DO events be considered relative to the needs of the most sensitive species?
- What is the best method to estimate the uncertainty in these DO benchmarks?

Research Action: Dissolved Oxygen threshold values for Puget Sound species (MWQ RC5.1.1 & 5.1.2)

1. Identify species that may be at the highest risk for exposure to anthropogenic-related DO depletion.
2. Perform a **literature review** focusing on the sensitivity of the species of interest to low DO.
3. Utilize **model output** data to produce spatially explicit exposure maps that identify areas of greatest species-risk, and includes a description of which species are at risk in each area.

Discussion Questions

1. Which **species and habitats should be prioritized** for consideration in the next year?
   For example: shallow vs. deep water, benthic vs. pelagic, commercial importance, species and lifecycle stage
2. How should we **consider sensitivity** of these species to stressors?
   For example: severity (above sub lethal) vs. acute (some data available now) sensitivity
3. What **existing literature and monitoring data** can be included in an initial desktop study?

Biological Endpoints Breakout Group: Initial Thoughts

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Puget Sound Partnership
Workshop on "Science Supporting Nutrient Management"
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Existing Ocean and Estuarine Water Quality Criteria for Oxygen and pH are not Biologically Relevant

- Criteria that are expressed as deviation from natural are problematic to interpret
  1. We almost always have insufficient temporal baseline of data to clearly define
  2. Attempt to compare with minimally disturbed "reference" are confounded by shifting baselines of anthropogenic effects

- Baseline of "natural variability" is shifting due to climate change
  - e.g Increased water temperatures lower oxygen solubility, increased stratification

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POLICY FORUM | ENVIRONMENTAL REGULATION

Dissolved oxygen and pH criteria leave fisheries at risk

Regulations have not kept pace with scientific understanding of coastal hypoxia and acidification

STEPHEN J. TOMASETTI AND CHRISTOPHER J. GOBLER

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Common Method for Developing Site Specific Dissolved Oxygen Criteria: Virginia Province Approach (VPA: EPA 2000)

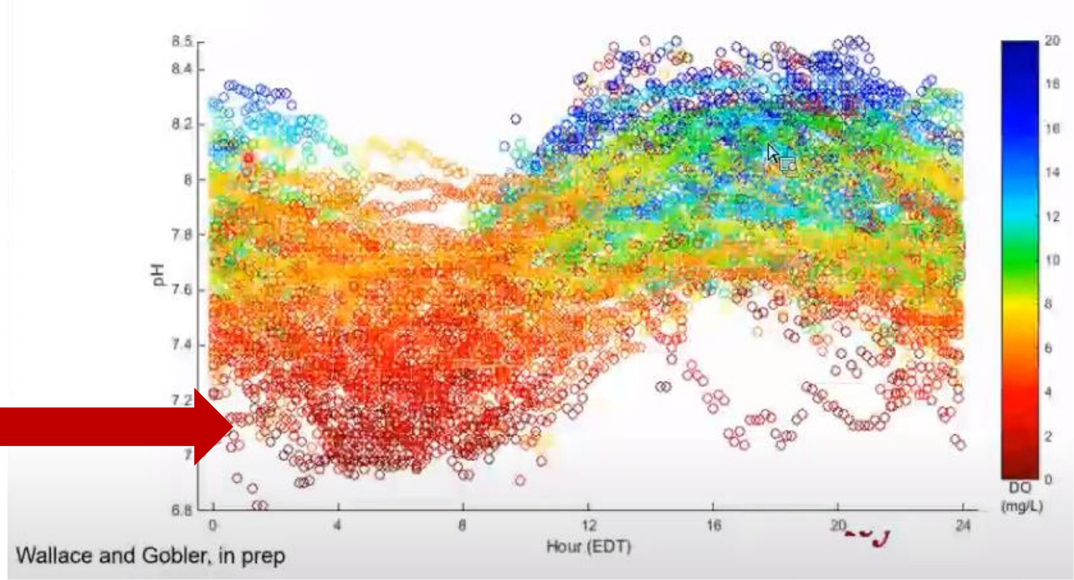
- Identify fish and invertebrate indicator species
- Review existing data on tolerance of organisms to low DO:
  - Juvenile and adult survival (acute)
  - Growth, reproduction (chronic)
- Identify most sensitive endpoints with respect to individual species
  - In absence of data, consider "nearest relative"
- If appropriate, calculate numeric criteria for consideration/discussion

Scientific Challenges of VPA Approach

- Very little data to define sublethal endpoints for Pacific West Coast species
  - Most data are sourced from EPA experiments conducted decades ago to support DO objectives in Chesapeake Bay

- Does not consider multiple stressors
  - Typically ignores temperature effects on physiological tolerance
  - EPA experiments kept pH artificially high, while in nature they covary, adding an additional, unaccounted for stress

High DO Coincides with high pH



Low DO Coincides with low pH

Recommendations

- Identify key data gaps through literature review first

- Invest in coupled chemical and biological monitoring
  - Characterize DO regime
  - Compare chemistry (and physics) with species abundance

- Collect experimental datasets of physiological tolerances for most sensitive species
  - Focus on sublethal endpoints (e.g. growth, reproduction)

- Consider comparative approaches to setting DO criteria
  - Metabolic index is an example

Oxygen loss and biological effects: Why the Metabolic Index?

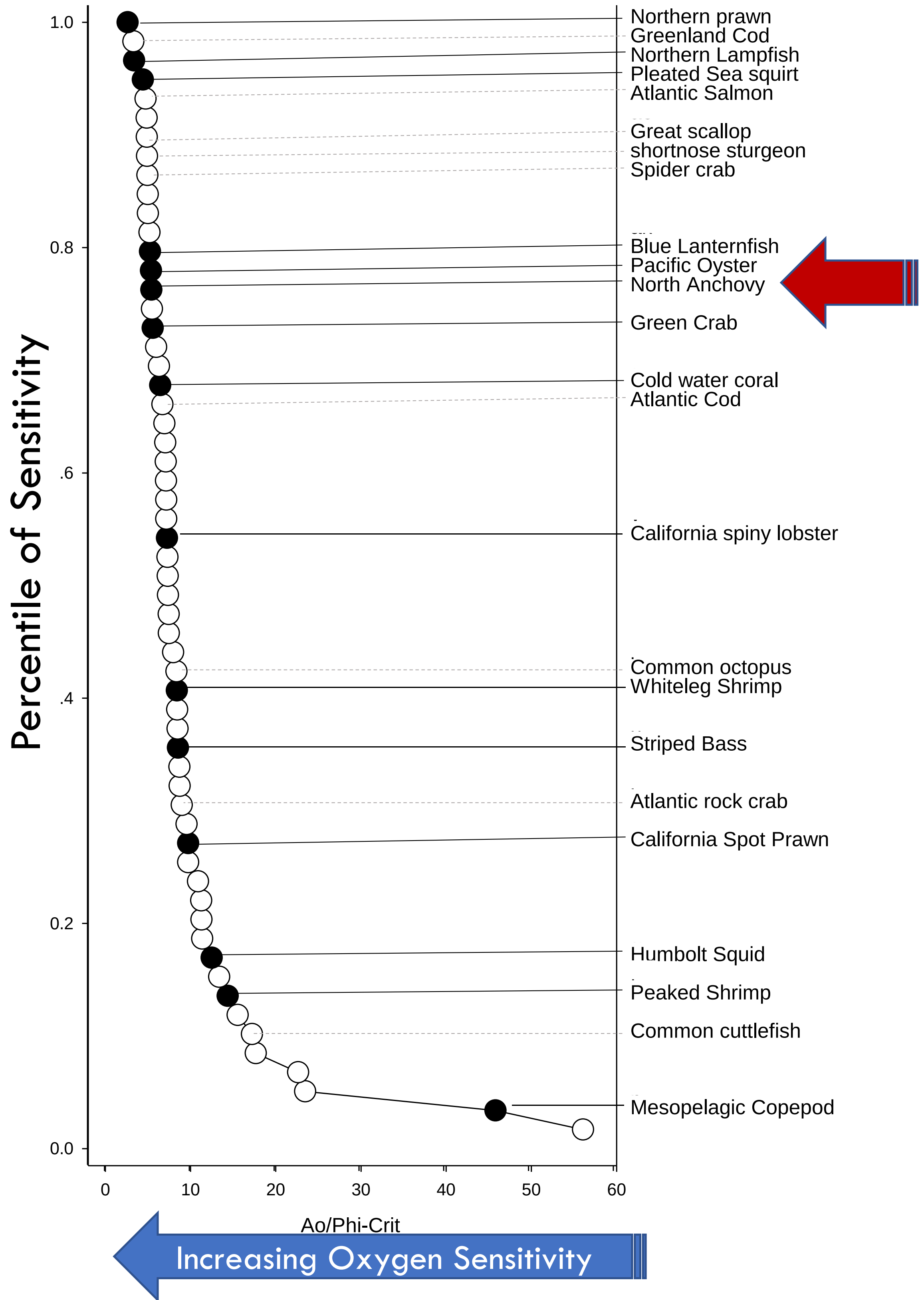
- Historical precedence is to use oxygen concentration (mg/L) to set biologically relevant thresholds
- However, the partial pressure of O_2, pO_2, is what is sensed by biology (drives gas exchange)
- Further, biological sensitivity to oxygen is temperature-dependent
  - Oxygen thresholds can vary 2-fold across temperature range

The Metabolic Index combines pO_2 with temperature-dependent biological responses to oxygen in order to define "aerobically available habitat"

Metabolic Index –Which Value to Choose

Chose oxygen sensitivity representative of northern anchovy

- Epipelagic
- Represents 75th percentile of aerobic sensitivity across all taxa
  - Median of epipelagic taxa
- Commercially and ecologically important
- Validated for California Current with a published case study
  - Strong correspondence to observed abundance data



QUESTIONS?

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Fish and invertebrate spatial distributions to inform the Atlantis model for Puget Sound

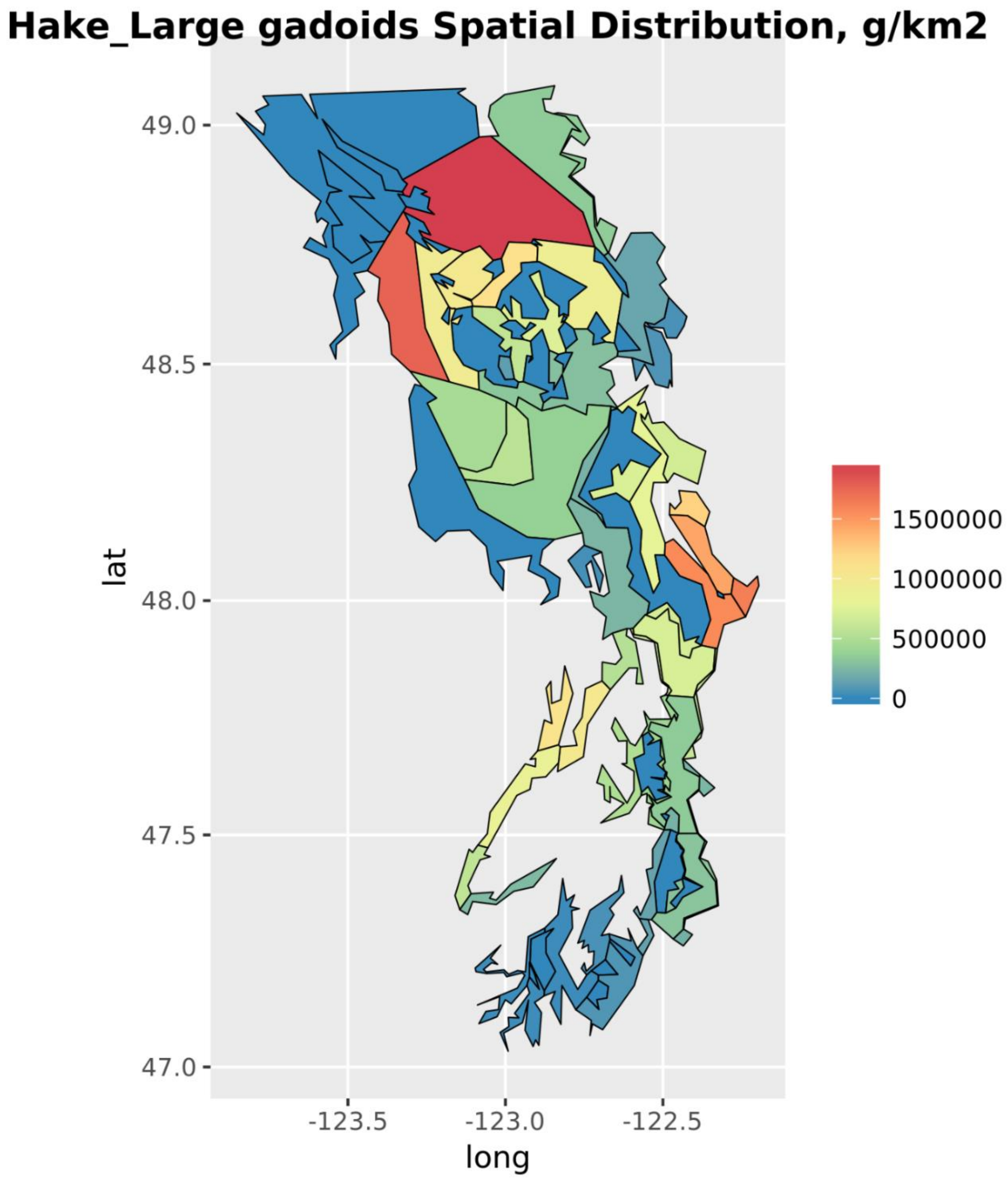
Hem Nalini Morzaria-Luna[1]

Isaac Kaplan[2], Raphael Girardin[3], Chris Harvey[2], Michael Schmidt[1], Elizabeth A. Fulton[4], and Parker MacCready[5]

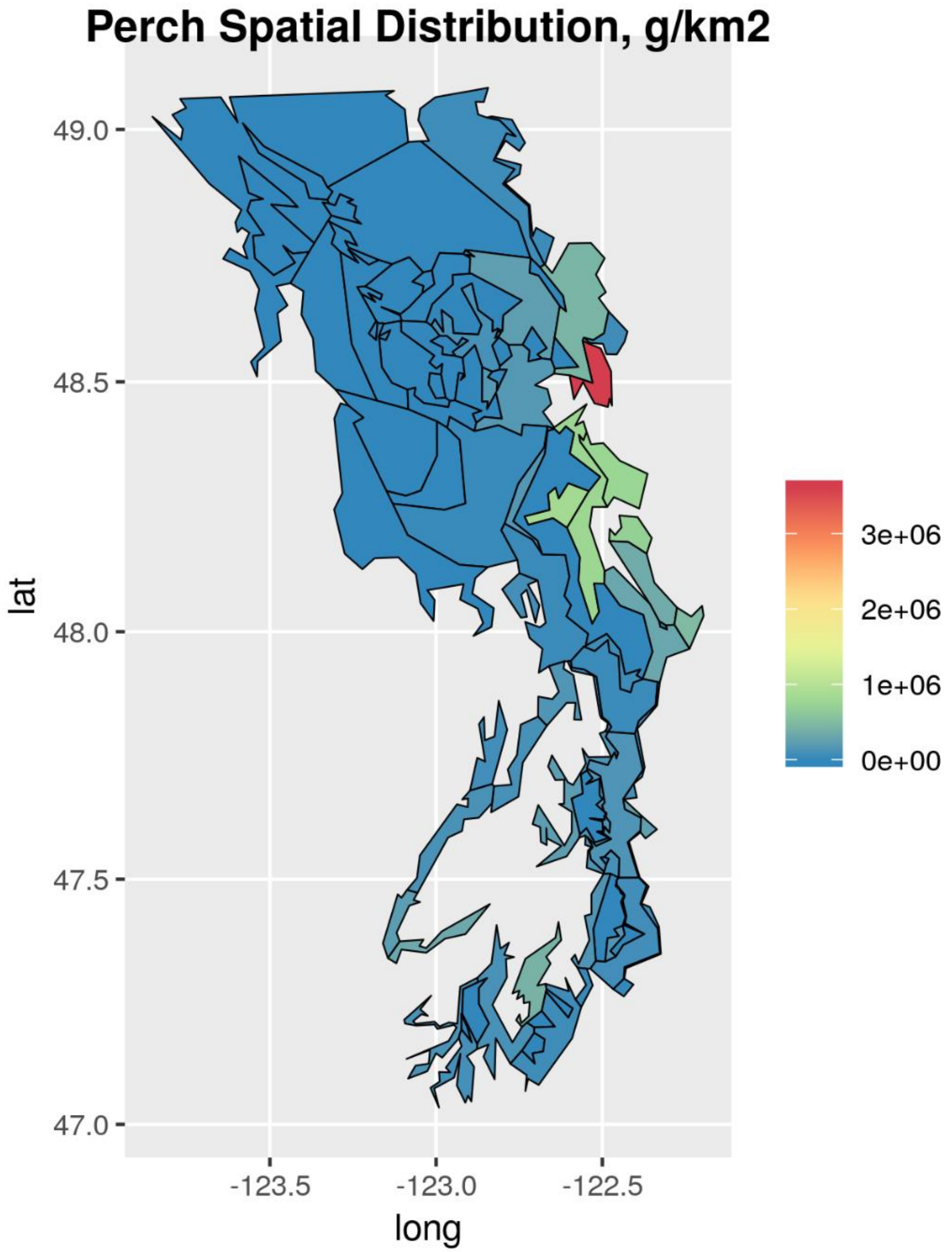
1. Long Live the Kings; 2. NOAA Northwest Fisheries Science Center; 3. IFREMER, Boulogne-sur-mer, France. 4. CSIRO Marine and Atmospheric Research. 5. University of Washington

Fish

- Herring
- Salmon
- Surfperch
- Hake & large gadoids
- Large demersal predators
- Demersal rockfish
- Midwater rockfish
- Small demersal fish
- Small-mouthed flatfish
- Piscivorous flatfish
- Spiny dogfish
- Skates
- Ratfish



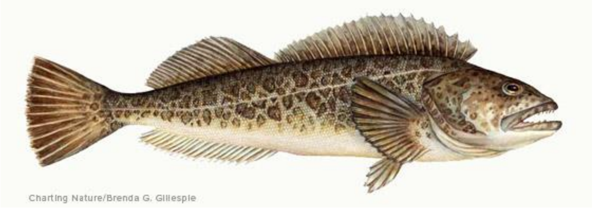
Hake_Large gadoids Spatial Distribution, g/km2
49.0
48.5
48.0
47.5
47.0
lat
-123.5
-123.0
-122.5
long
1500000
1000000
500000
0

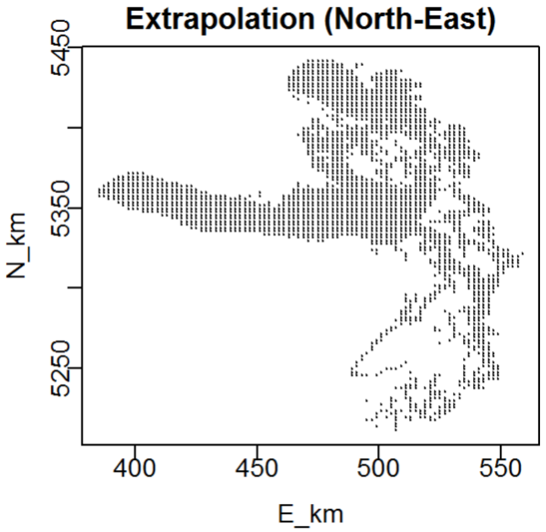


Perch Spatial Distribution, g/km2
49.0
48.5
48.0
47.5
47.0
lat
-123.5
-123.0
-122.5
long
3e+06
2e+06
1e+06
0e+00

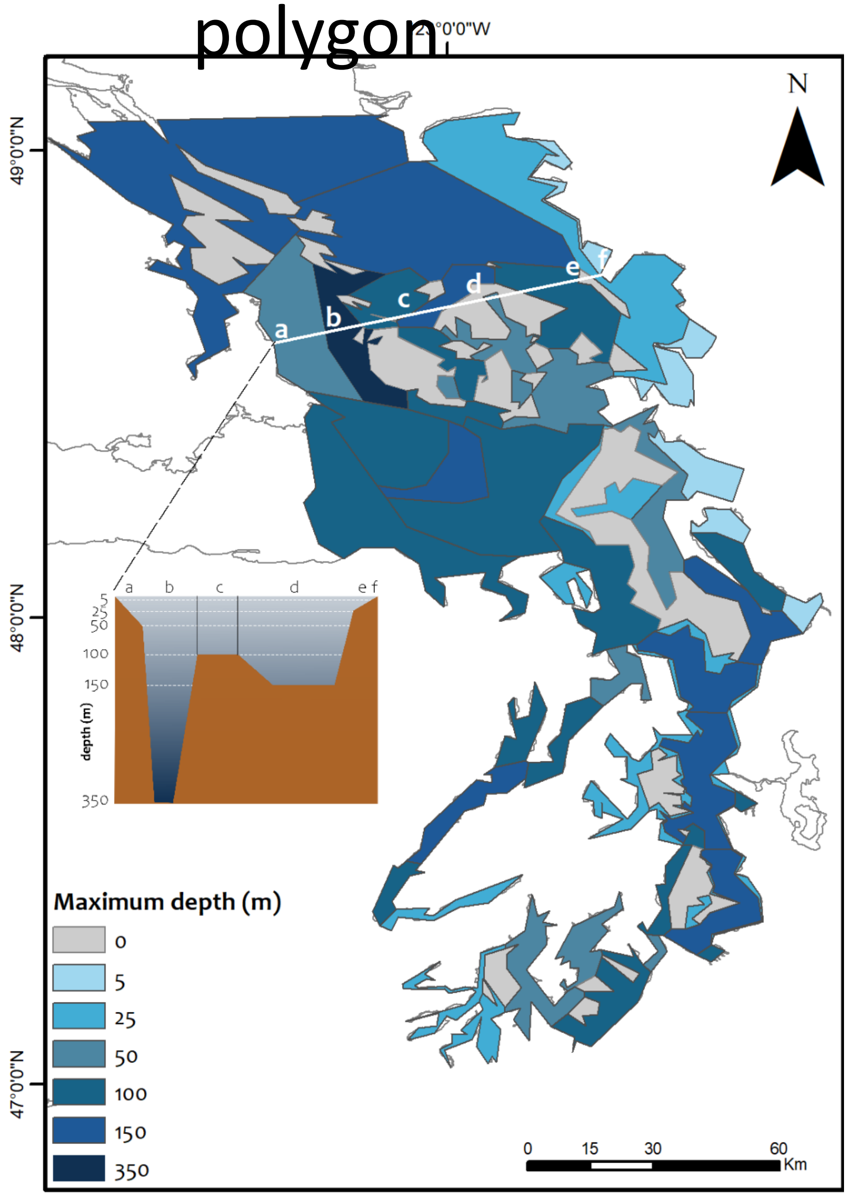
Survey data

Estimate catch rate by





Average catch rate per AMPS polygon



Biomass per functional group