

# **Applications of coral species distribution models (SDMs) in British Columbia, Canada**

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(VMEs) in the North Pacific Ocean  
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# Purpose



- 1) Map distributions of four orders of cold-water coral in British Columbia
- 2) Evaluate the overlap between bottom-contact fishing activity and coral habitat
- 3) Identify opportunities to reduce fishery-related impacts

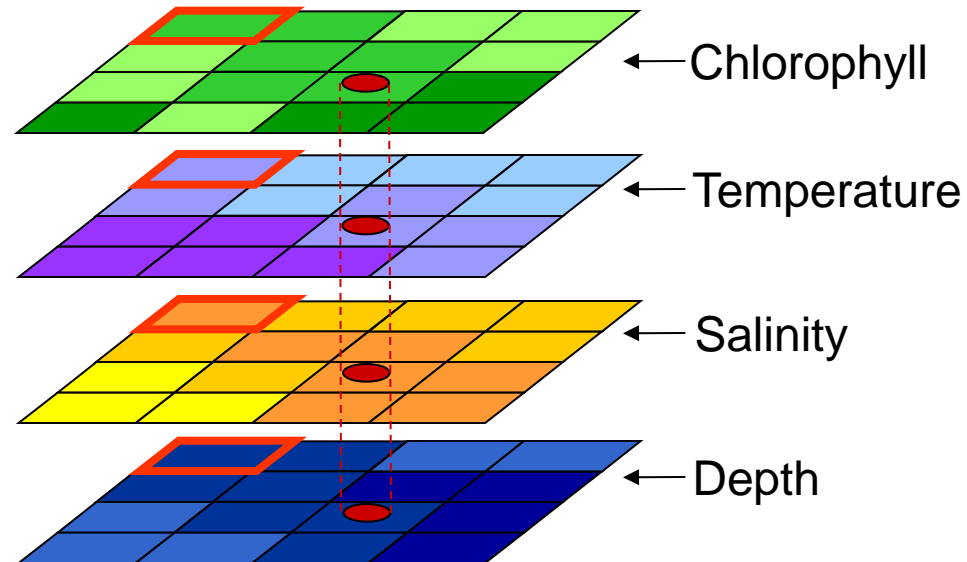
# Challenges

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- Deep-sea research is expensive, logistically challenging
- Coral distributions are largely unknown
- Most datasets are fishery-dependent
- Reliance on predictions from species distribution models in unsurveyed areas

# Species distribution models

- Relate occurrence data to background environmental variables to determine a species' niche



- Predict the distribution of suitable habitat for coral

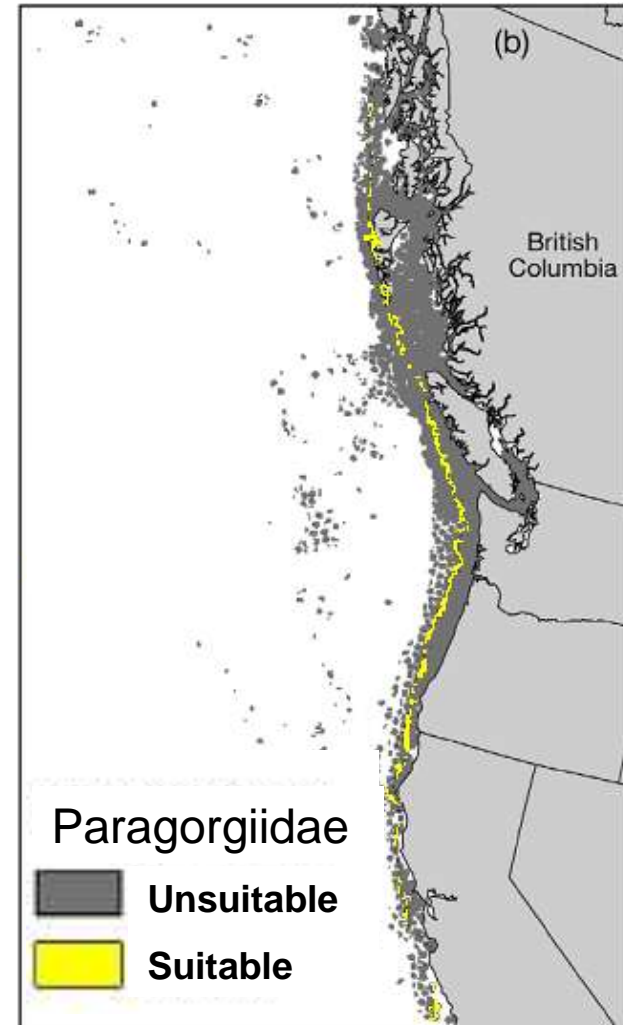
$$\text{Green} + \text{Purple} + \text{Orange} + \text{Blue} = \text{niche}$$

- e.g. Random forest, boosted regression, Maxent

# Predicted coral suitable habitat: Published examples



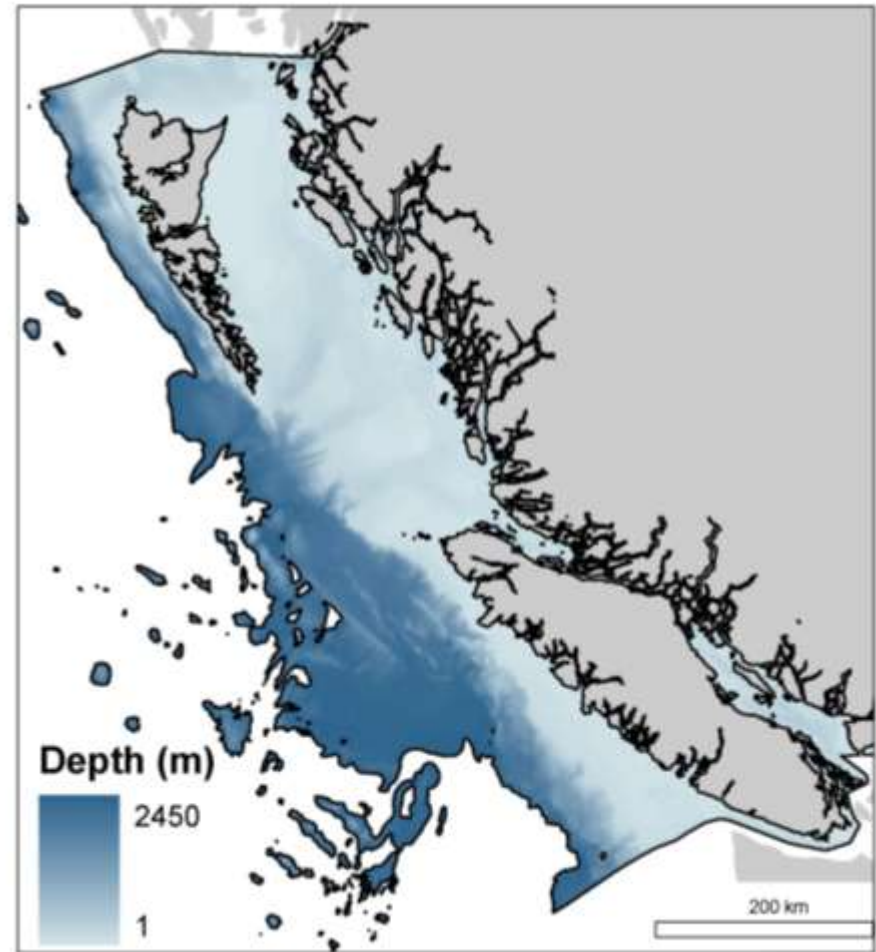
- Bryan and Metaxas (2007)  
*MEPS*
- Yesson et al. (2012)  
*Journal of Biogeography*
- Davies and Guinotte (2011)  
*PLOS|one*
- Tittensor et al. 2009,  
*Journal of Biogeography*



# British Columbia Environmental data



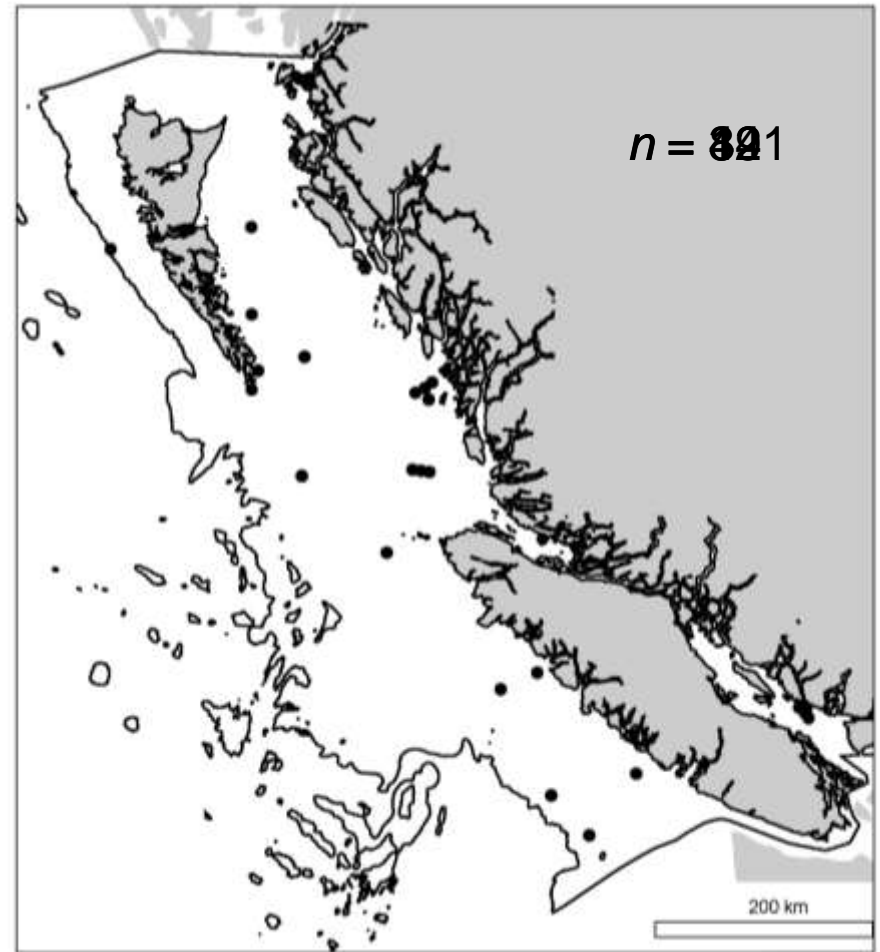
- 2450m depth cutoff
  - 500 m x 500 m grid
    - Bathymetry
    - Slope
    - Chlorophyll *a* conc.
    - Tidal velocity
    - Temperature
    - Salinity
    - Current speed
- } Summer and winter values



# British Columbia Coral data



- Criteria:
  - Expert identification
  - Spatial information
- Four orders of coral:
  - Alcyonacea
  - Antipatharia
  - Pennatulacea
  - Scleractinia

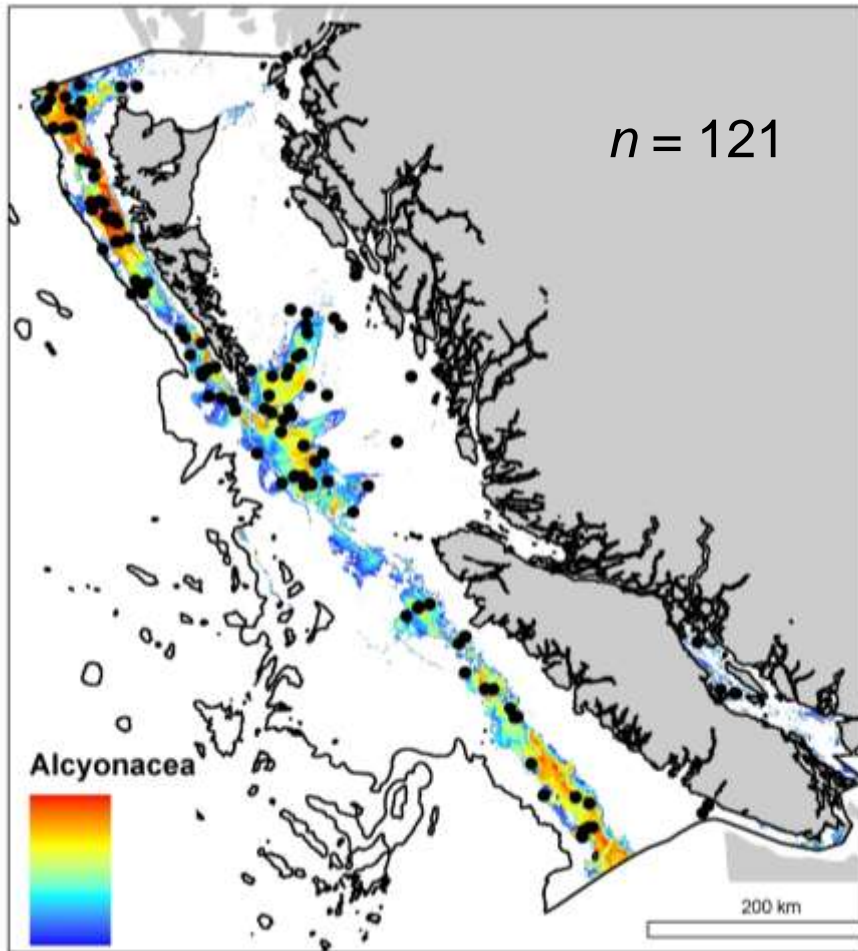


# SDM method: Maxent



- Maximum-likelihood method
- Starts with a uniform distribution
- Iteratively updates the probability of occurrence at known coral locations
- Produces a continuous map of probability of occurrence, based on presence-only data

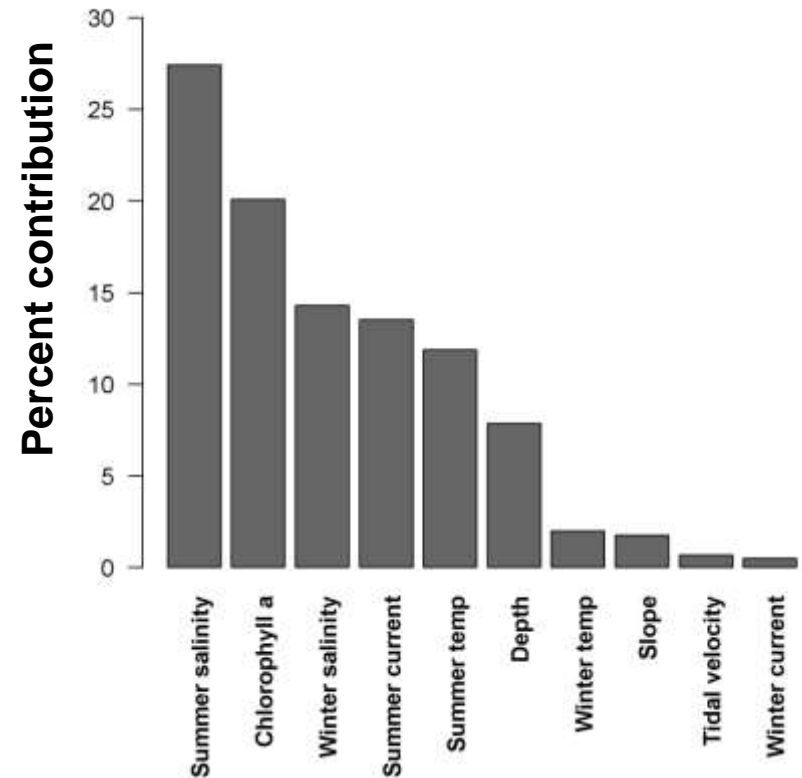
# Suitable Habitat: Alcyonacea



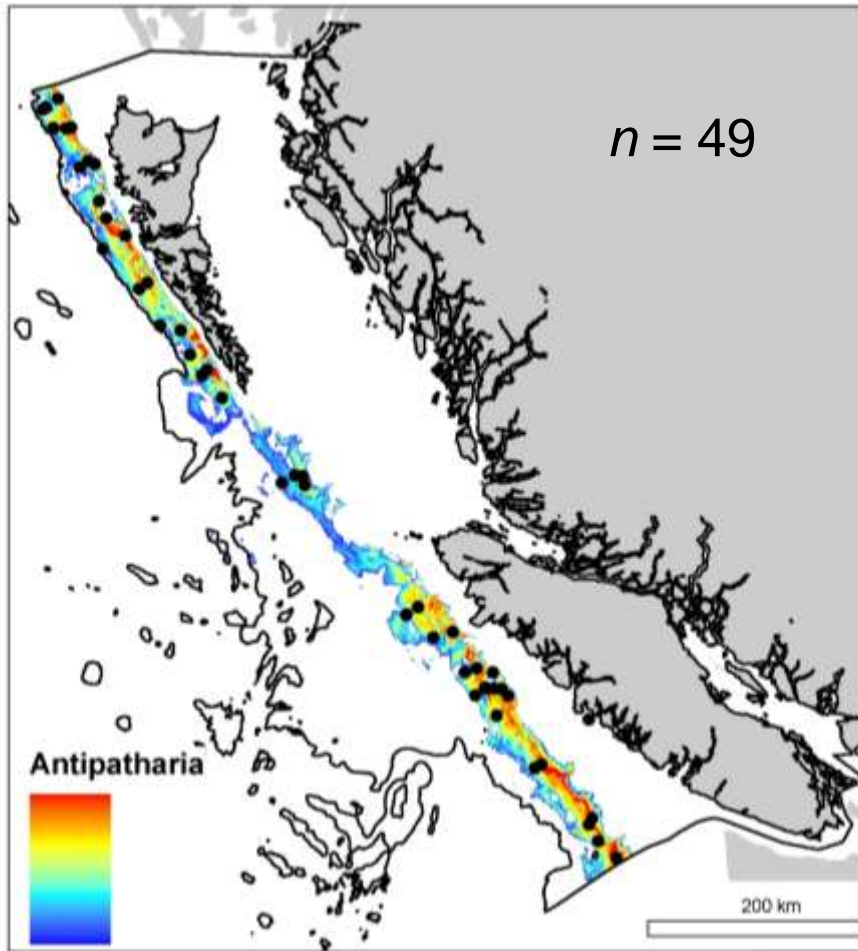
AUC: 0.908

Sensitivity: 0.88

Omission: 0.12



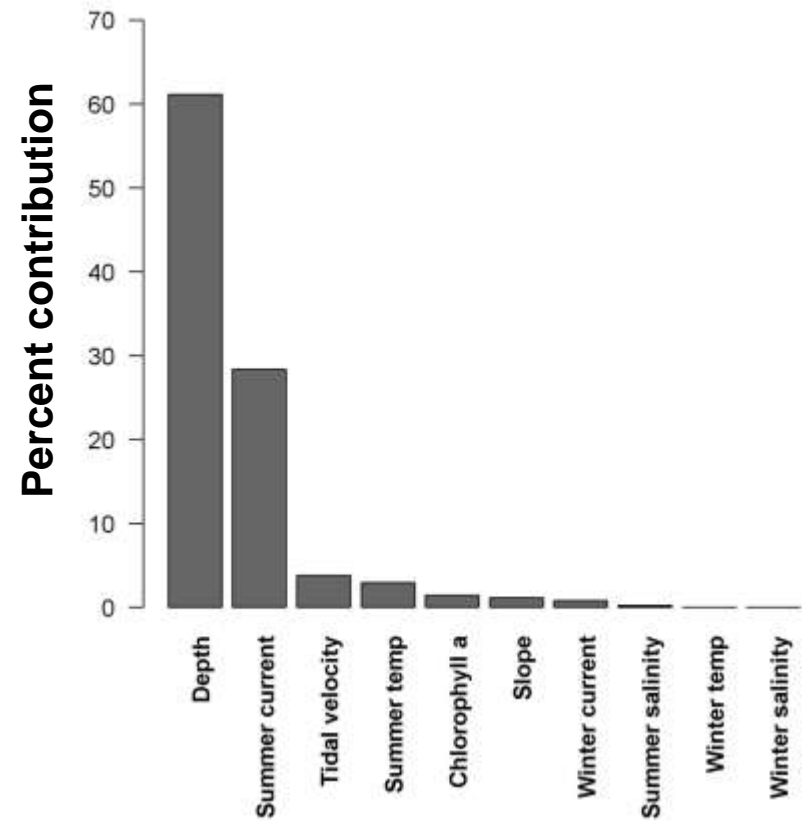
# Suitable Habitat: Antipatharia



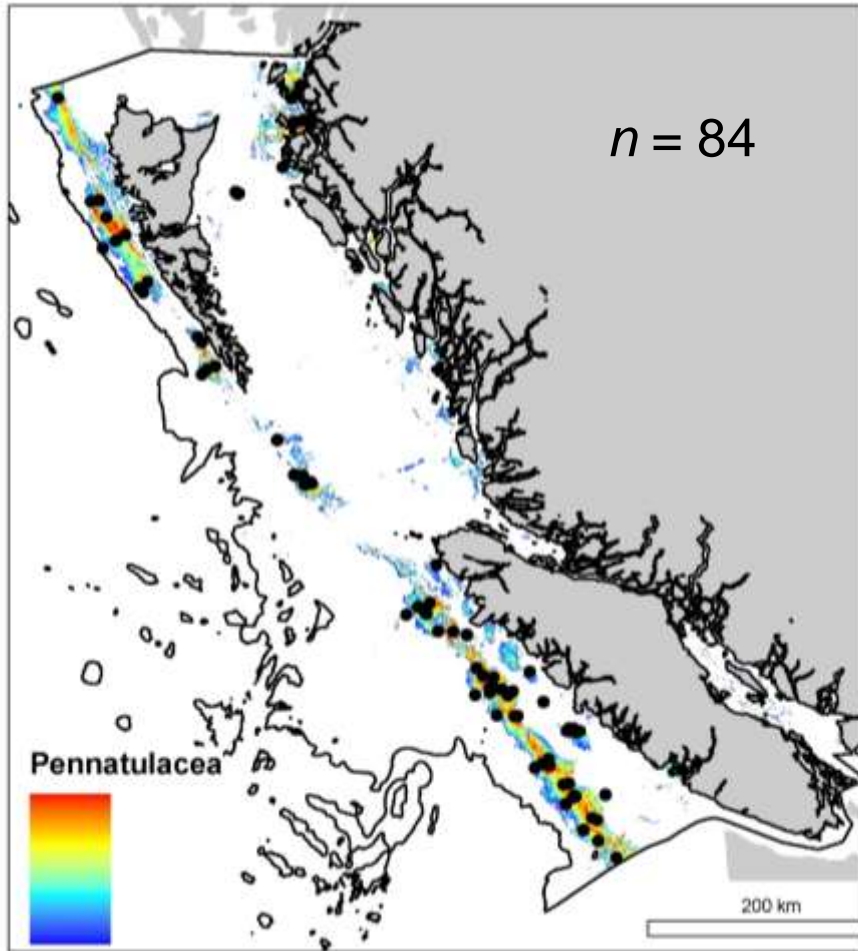
AUC: 0.940

Sensitivity: 0.94

Omission: 0.06



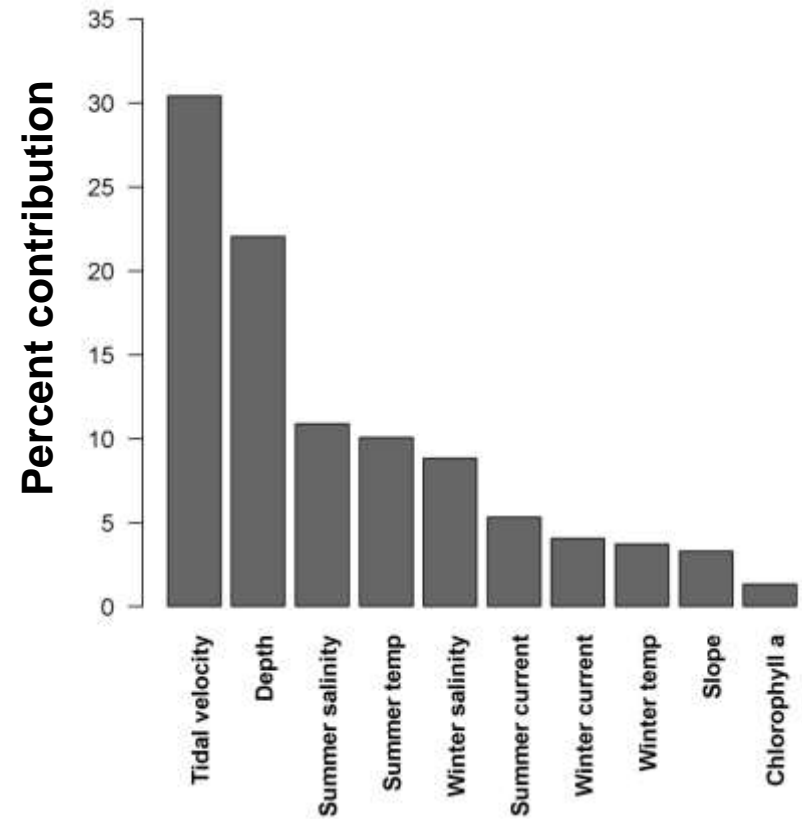
# Suitable Habitat: Pennatulacea



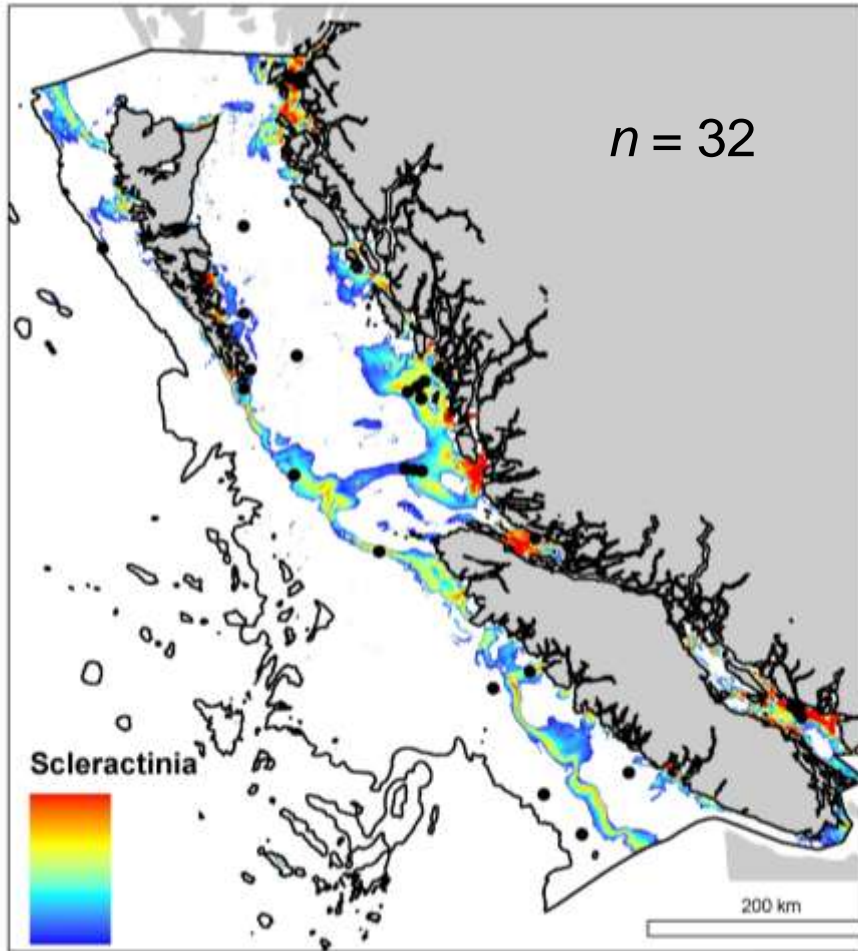
AUC: 0.947

Sensitivity: 0.90

Omission: 0.10



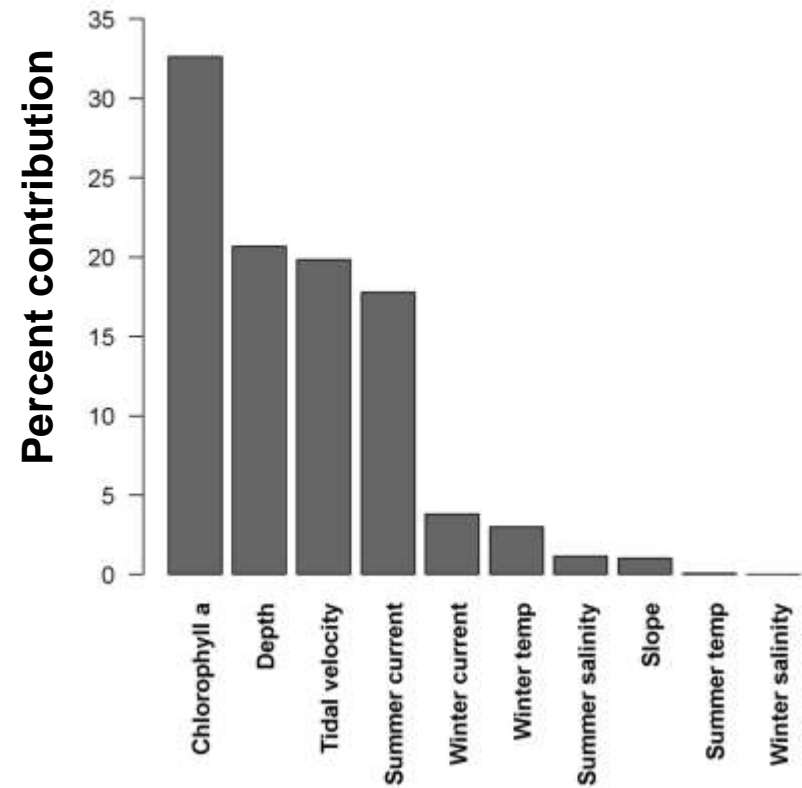
# Suitable Habitat: Scleractinia



AUC: 0.864

Sensitivity: 0.84

Omission: 0.16

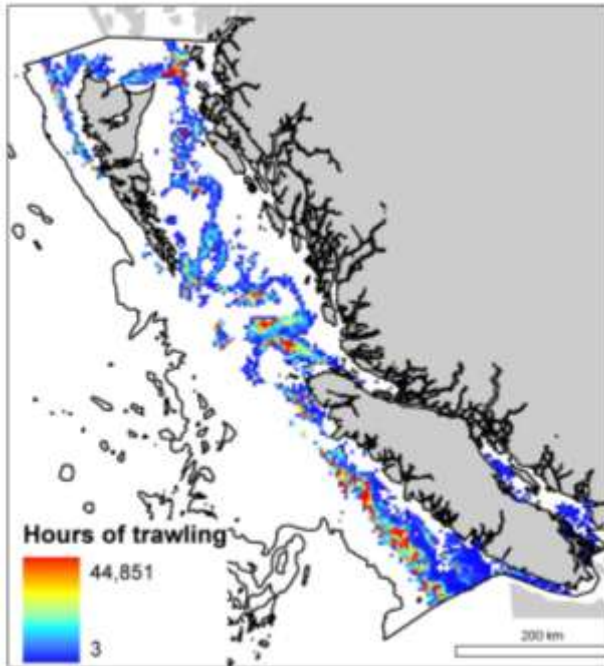


# Overlap: Fishing activity

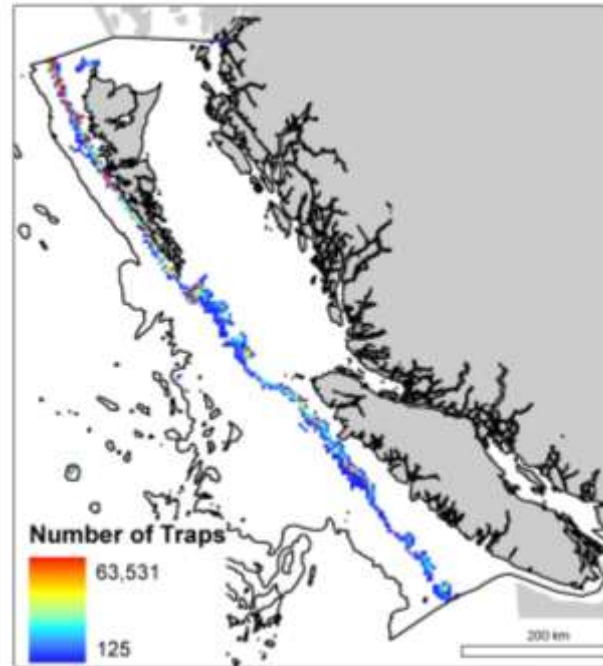


Data on fishing effort in a 4 km grid

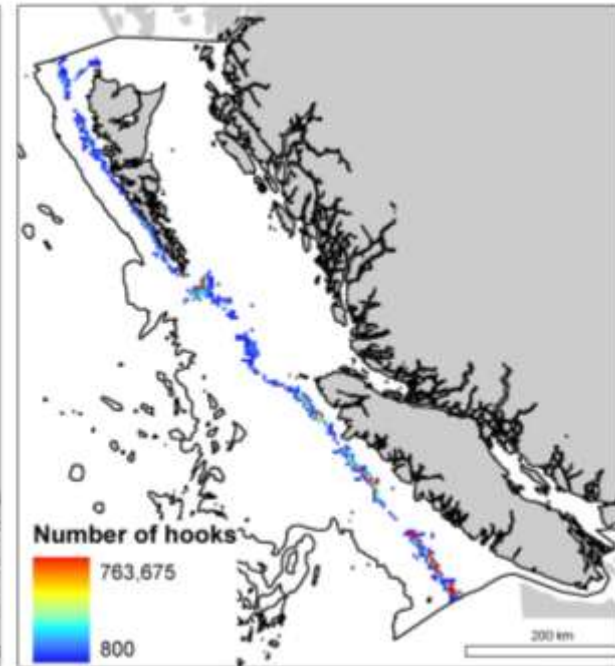
Data summed over all years (1996-2004)



Groundfish  
Trawl

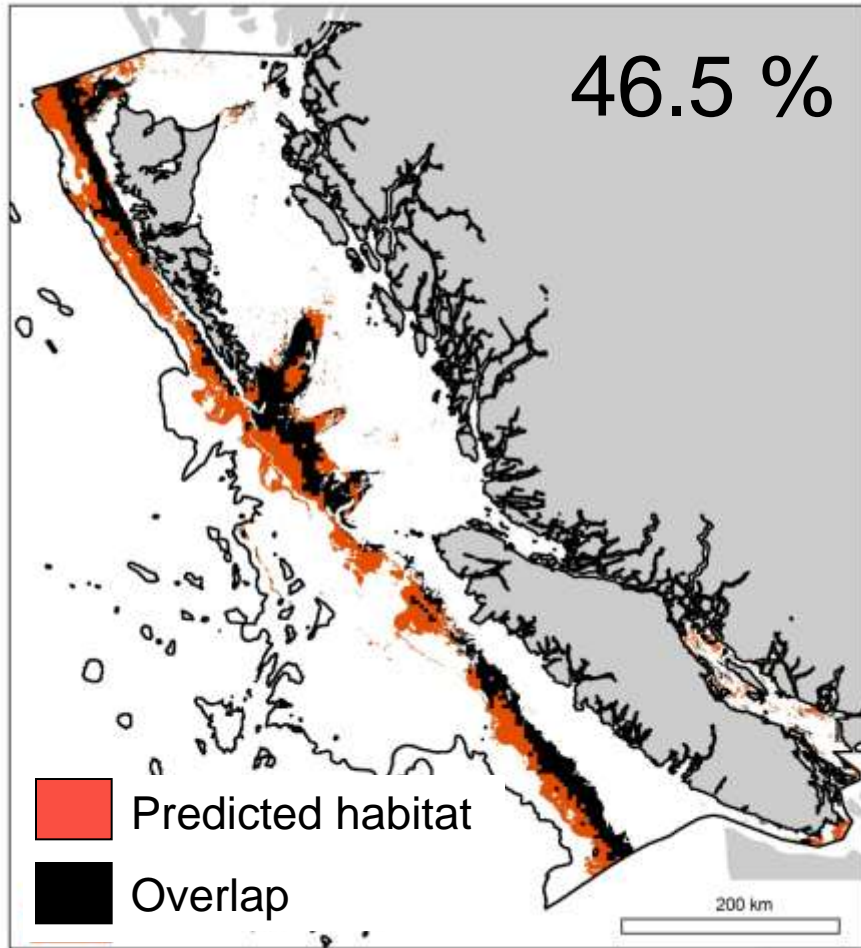


Sablefish  
Trap

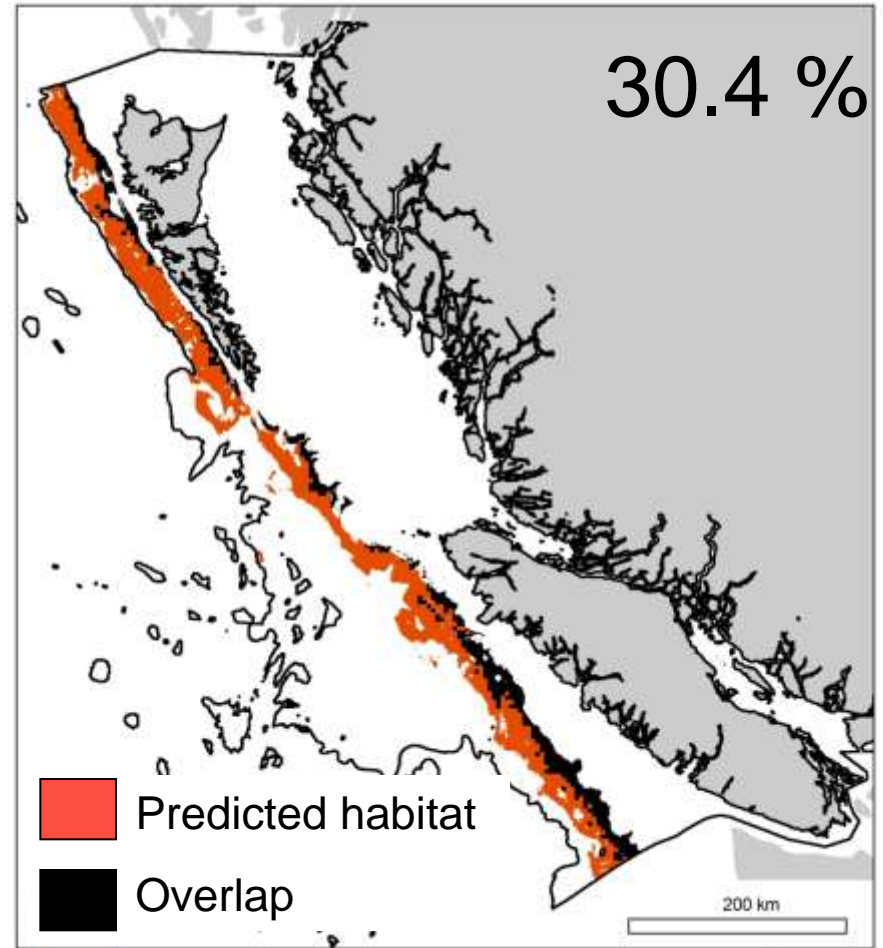


Sablefish  
Longline

# Overlap: Fishing overlap

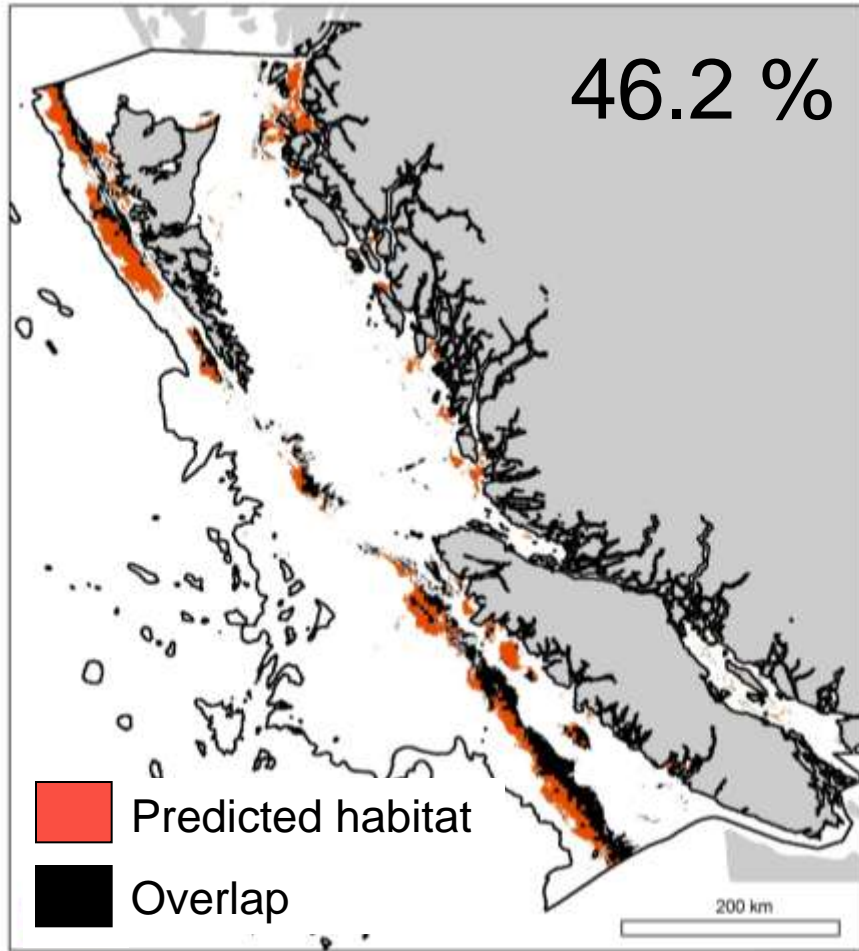


Alcyonacea

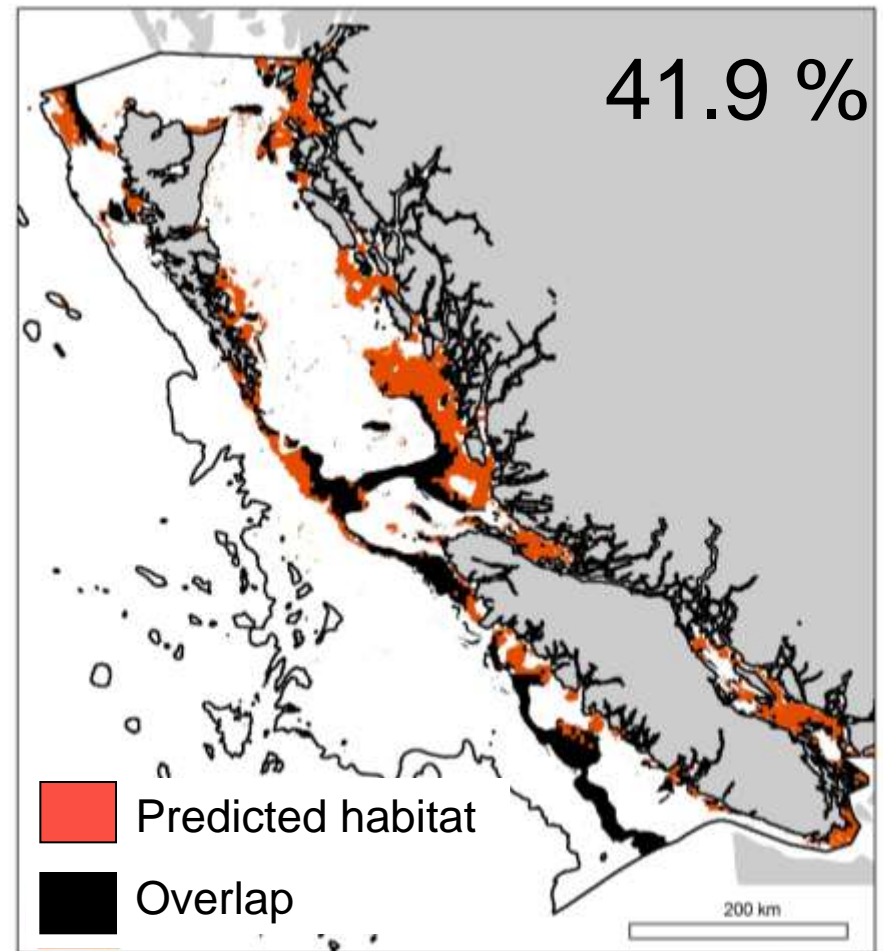


Antipatharia

# Overlap: Fishing overlap



Pennatulacea



Scleractinia

# Optimization of closures in Hecate Strait, BC

(Lagassé, Knudby, Curtis, Finney and Cox, in prep)

MARXAN Analysis

Achieve conservation target (% predicted suitable habitat protected)

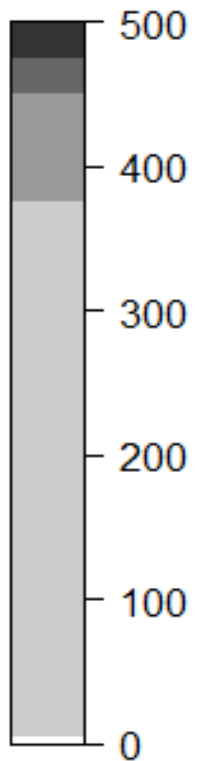
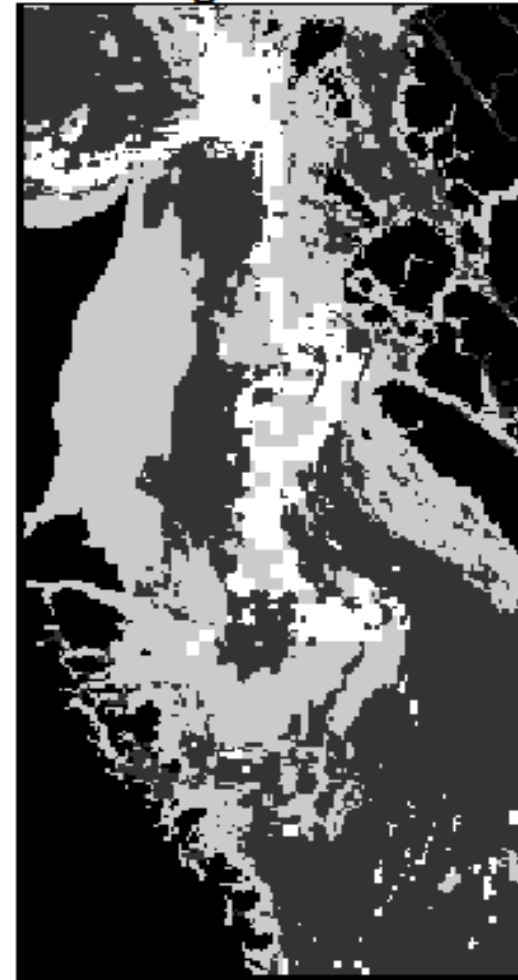
While minimizing losses in landings value from groundfish trawl fisheries

(1996-2012)

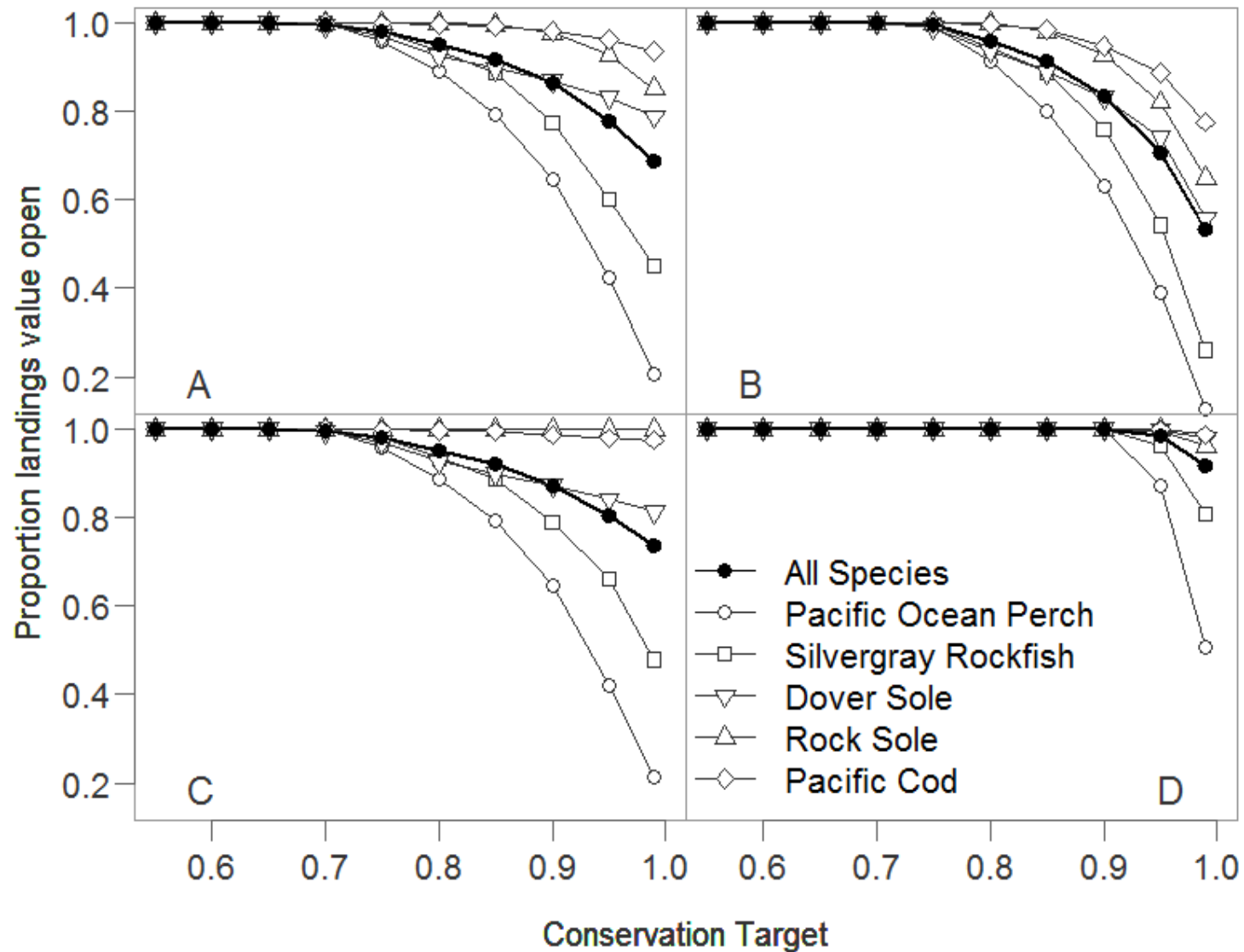
Target = 0.8



Target = 0.99



# Analysis of fishery-conservation trade-off in Hecate Strait (Lagassé et al., in prep)



# Discussion Points



- Species distribution models (SDMs) build on known occurrences by identifying additional areas of suitable habitat in un-surveyed areas.
- Can be useful to predict overlap with fishing and identify opportunities to reduce impacts; but few SDMs are ground truthed with independent benthic surveys.
- Estimates of overlap between known and predicted coral distributions and fished areas are substantial (30-46%); BC analysis suggests a win-win trade-off where a small loss in landings value has a disproportionate benefit to coral.
- Similar work proposed for offshore and high seas seamounts in NE Pacific Ocean based on recent and planned field studies.

# Acknowledgements



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- Peterman, Ed Gregr
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- Anders Knudby
- Sean Cox

