Investigating the effects of mean primary productivity, life stage and feeding interaction on marine predator mass

EEB313
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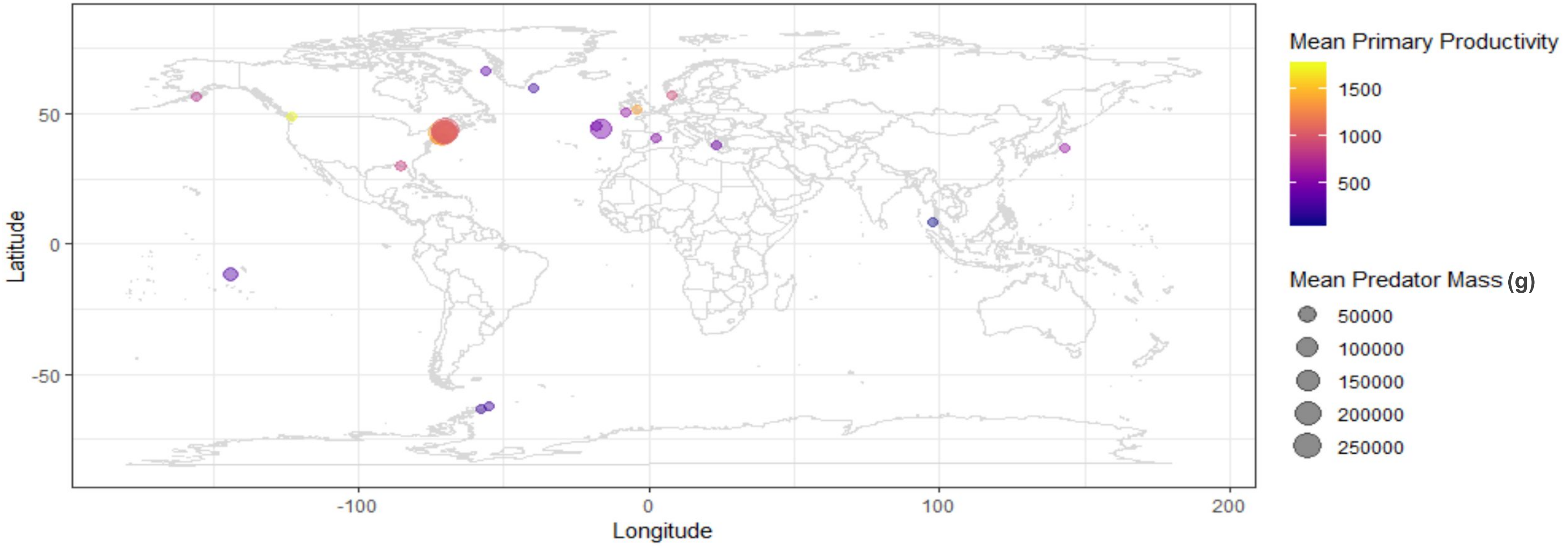
Background

- Barnes et al (2008) compiled metadata on marine predator characteristics, their prey, and environmental conditions over 60 years
    - 34,931 observations
    - 27 geographic locations
    - Coastlines to deep sea
    - Range from fish larva (~40g) to Atlantic bluefin tuna (~380 kg).

Predator mass varies globally – why?



Hypotheses

Is a predator's size related to its trophic position?

We expected feeding behaviour, life stage, and the energy available in the ecosystem to influence the predator's body mass. (Tucker & Rogers, 2016)

1. Predators from habitats with smaller mean primary productivity (MPP) are expected to be smaller.
2. Younger predators expected to be smaller than older predators.
3. Planktivorous predators expected to be smaller than piscivorous/predacious predators
4. Thus, younger, planktivorous predators expected to be smaller than piscivorous/predacious predators.

Methods

- Data cleaning
    - Filtering for quality
    - Removing predator lifestage levels with low sample size or ambiguity
- Spatial analysis
    - Sites closer together have more similar mean predator masses
- Modelling
    - Meeting assumptions, such as taking log of predator mass to approach normality.

Data Analysis - Linear Mixed Effects Model Selection

Predicted predator mass using 18,383 observations:

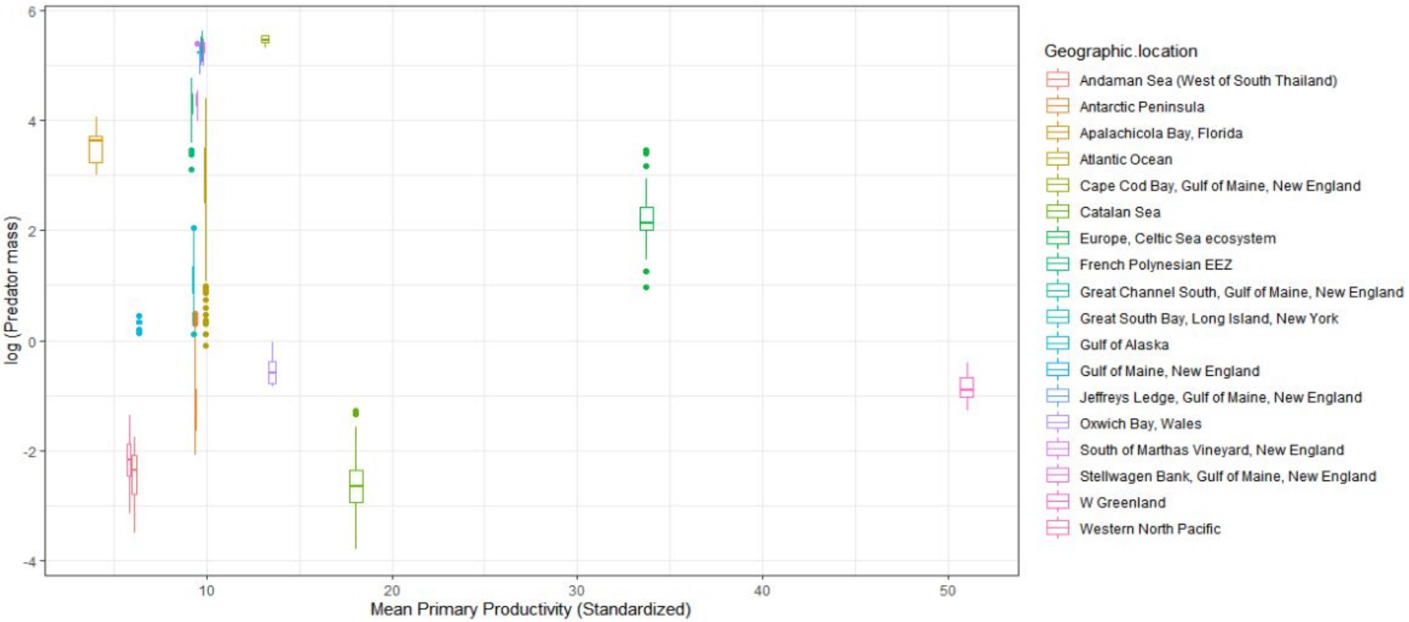
1. MPP
2. Predator's life stage (larval, juvenile and adult)
3. Level in the food web (predacious, piscivorous and planktivorous)
4. The interaction of life stage and feeding type

We used random effects to account for non-independence due to predators being caught and measured in different ways in different years across the world

Final model (with lowest AIC) had a marginal R^2 : 0.721

All were significant predictors, except MPP.

Results - Mean Primary Productivity



Not in final model- Why?

Abundance of predators vs their mass

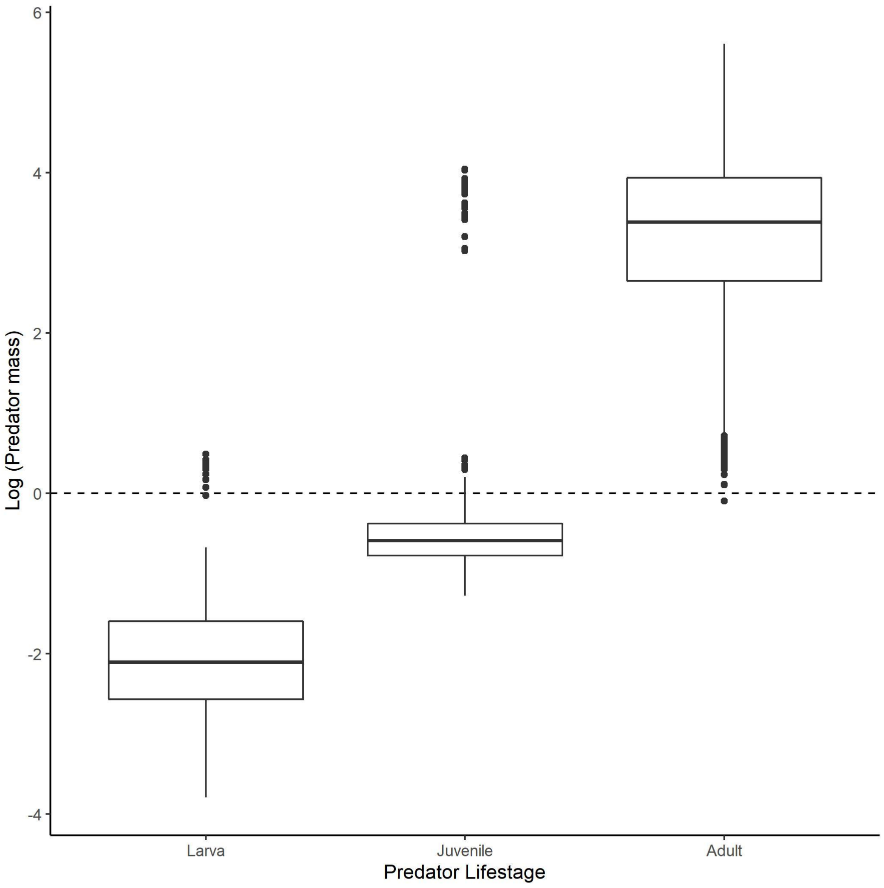
Habitat suitability

Organic debris runoff

(Tanentzap et al. 2014)

Results - Predator Life Stage

- Predator mass is significantly lower for larval predators than adult predators
- Intuitive - because of the natural progression of marine organism life stages:
- Egg → Larva → Fry → Juvenile → Adult

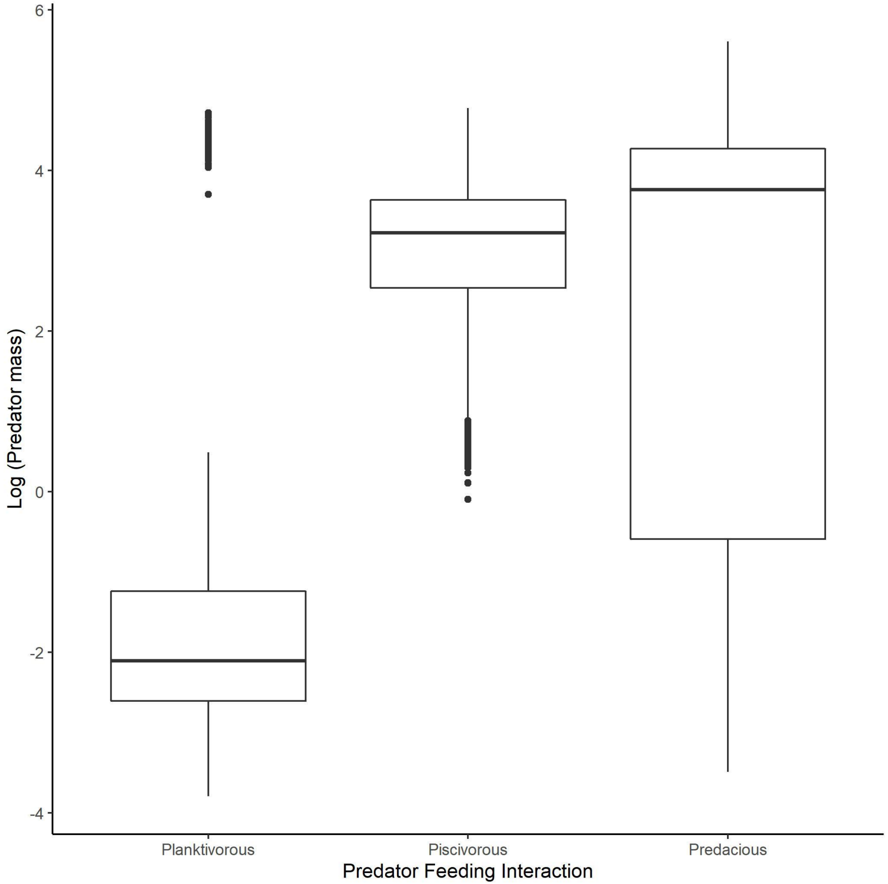


Results - Feeding Interaction

- Predators that are planktivorous have significantly lower mass than piscivorous predators

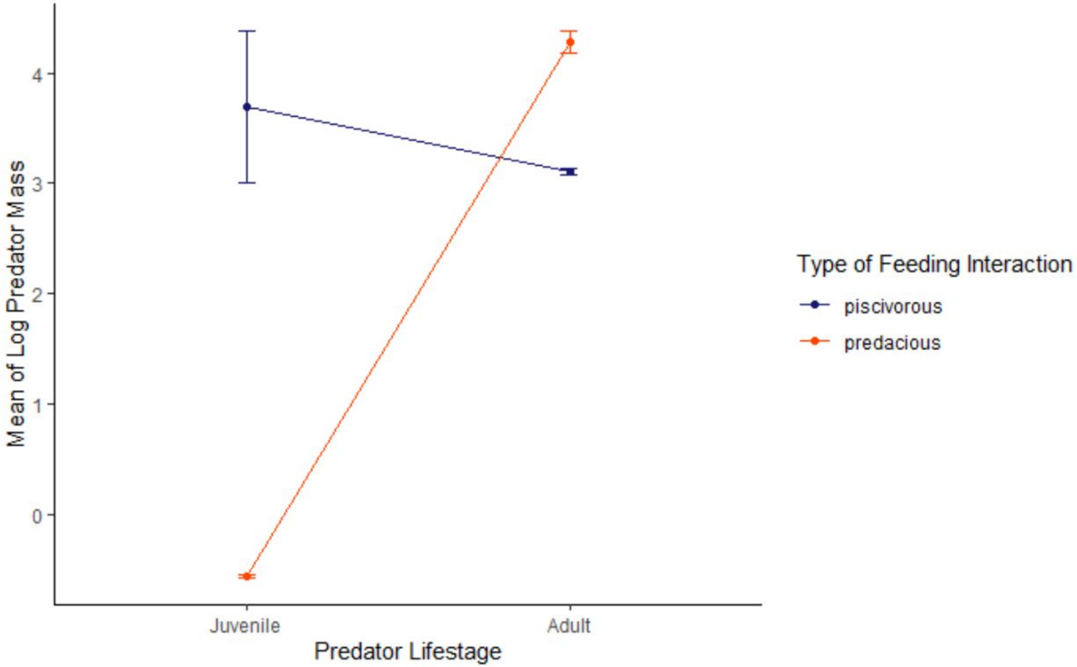
- Predacious predators have higher mass than piscivorous predators

- Previous research has identified a relationship between larger predator mass and consumption of a greater range of prey (Barnes et al. 2008)



Results - Predator Life Stage and Feeding Interaction

- Difference between juvenile and adult predator mass is greater when predator is predacious
- When fish are juvenile, they are limited in mobility and gape size, so their feeding interaction strongly corresponds to their mass
- When older, the feeding interaction is less prominent



Conclusion

Overall, we found that trophic position can predict predator size via lifestage, feeding preferences, and their interaction.

However, more information on the energy available in a system besides primary productivity is needed to support this.

We were limited by data loss from filtering for sufficiently high quality data, some studies being decades apart, and a lack of information on environmental conditions.

References

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