A Biological Production Index for the Northern California Current

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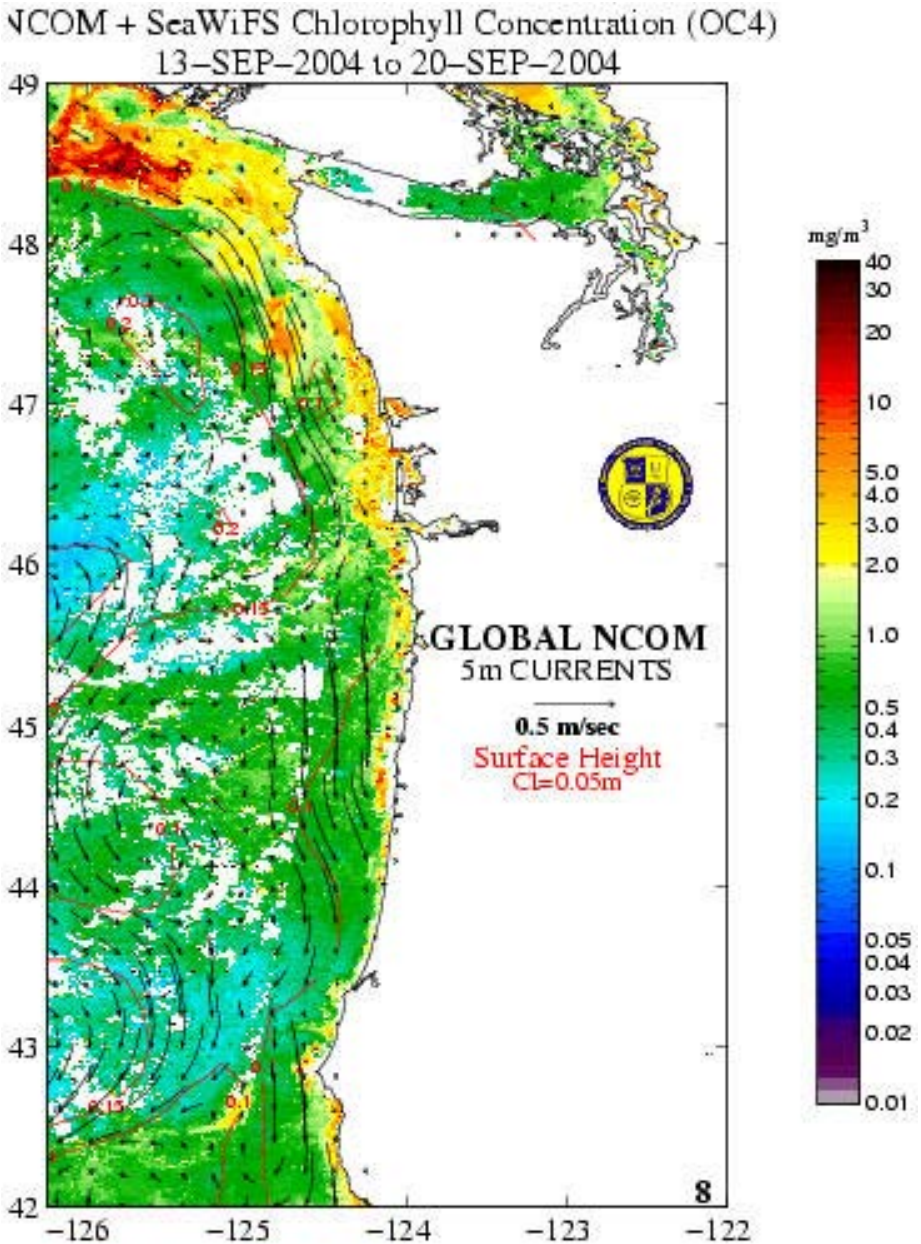
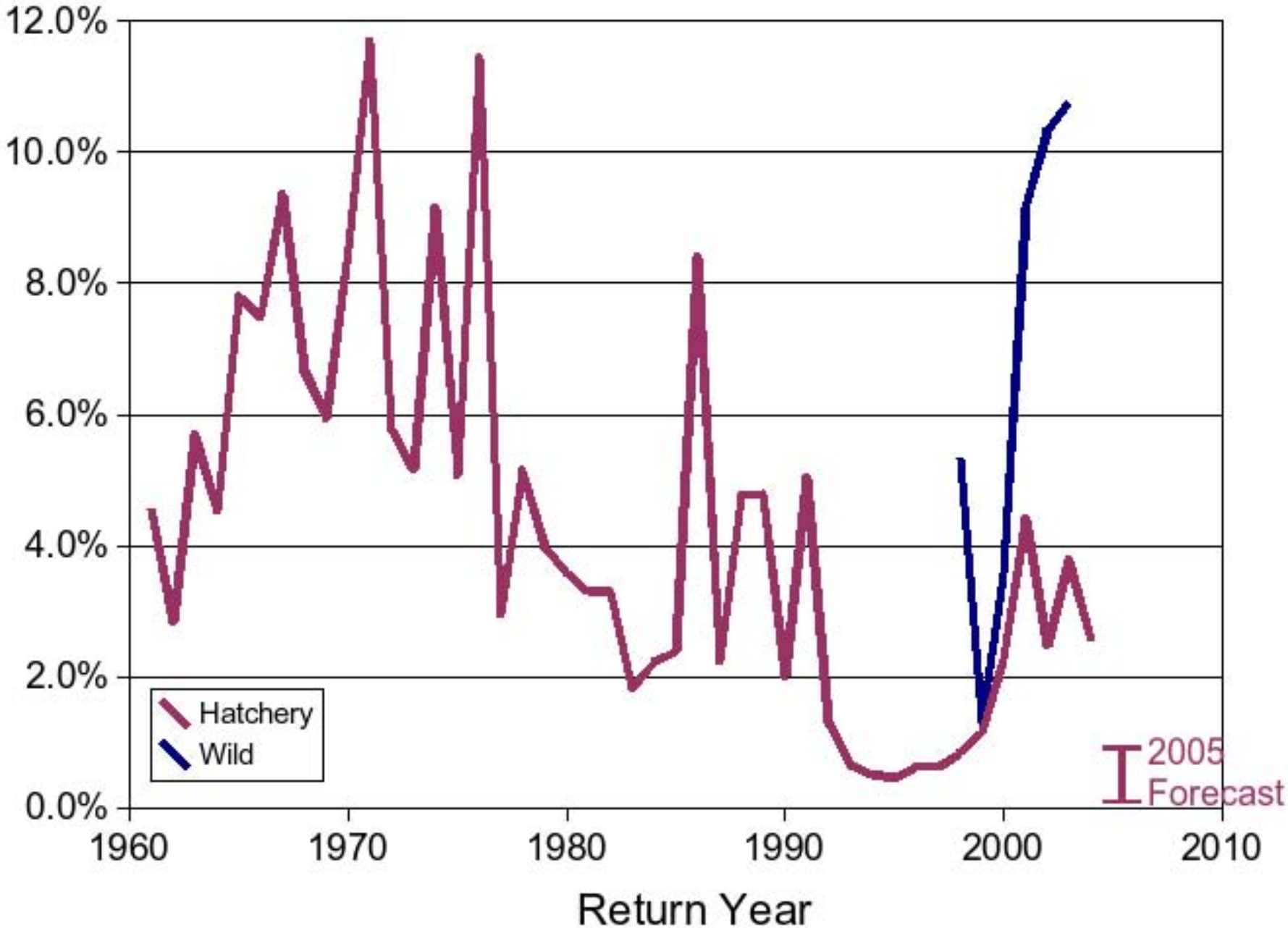
Outline



Courtesy of The Naval Reasearch Laboratory - Stennis Space Center

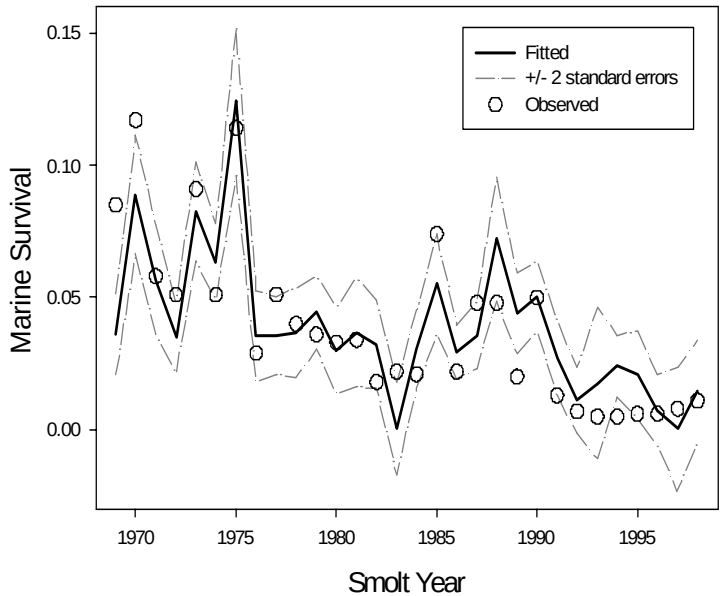
- Problem: Ecological indicators to forecast coho salmon marine survival
- Approach: Bio-physical plankton modeling
- Methods
- Results
- Conclusions

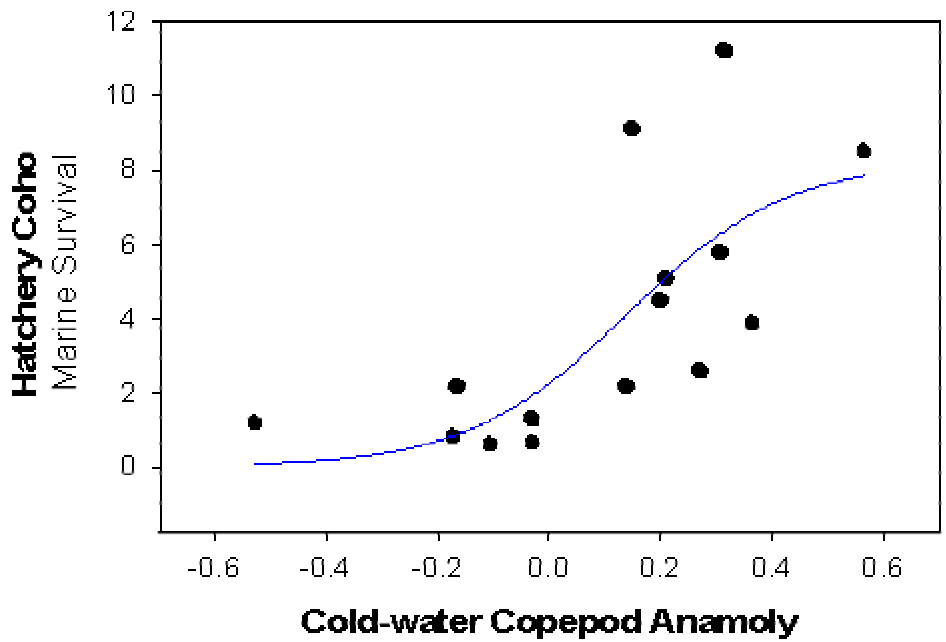
Oregon Coho Salmon Marine Survival



Existing Indices

- A number of attempts have been made to explain this variation with indices of ocean condition
- Two recent ones:
  - Loggerwell et al. 2003
    (Fish. Oceanogr. 12(3):1-15)
  - Peterson & Schwing 2003
    (Geophys Res. Lett. 30(17):1896)

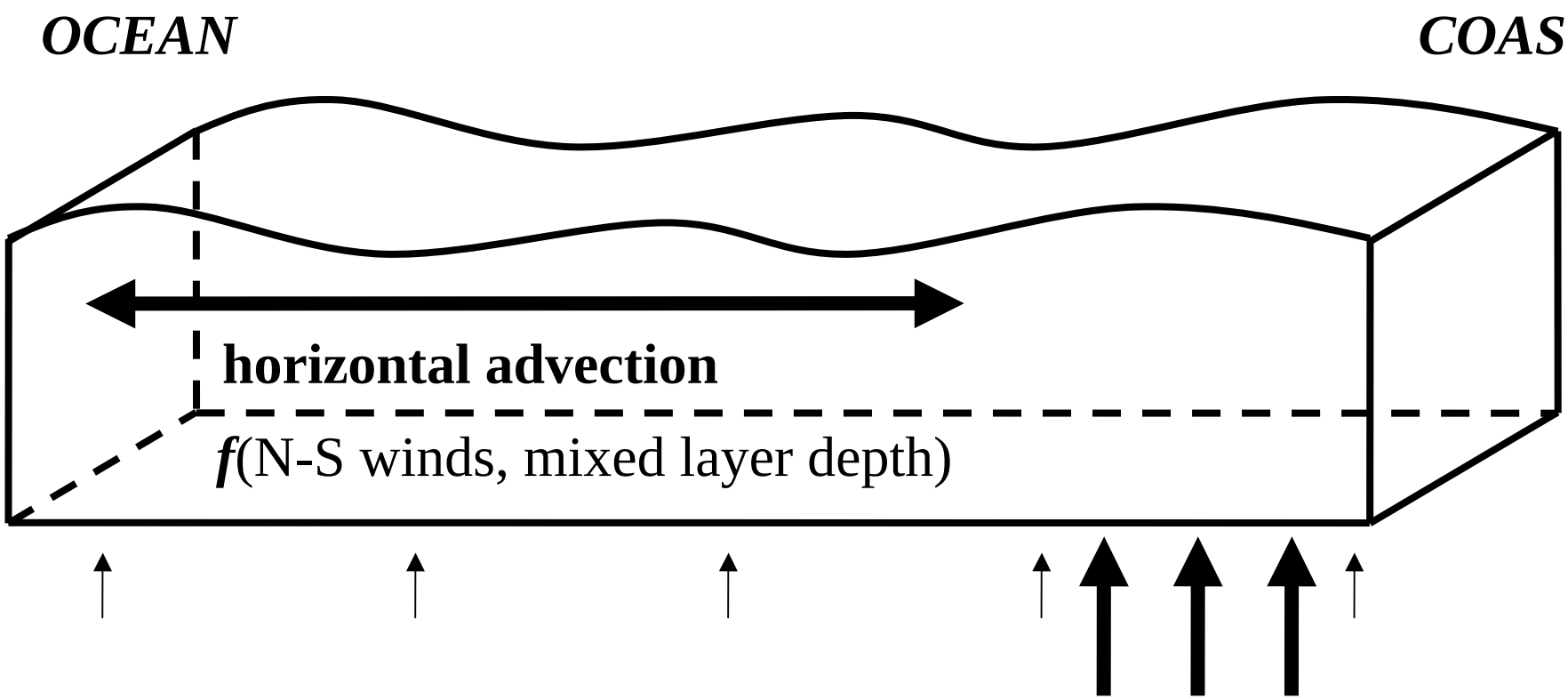




Conceptual Approach

- Upwelling has been successfully used as a predictor of juvenile coho salmon survival.
- The hypothesized mechanism is via nutrient supply, with upwelling affecting food availability during the early ocean phase (April-June).
- So, we should get better predictions by using an index of zooplankton production rather than just upwelling. This can be done by:
  - Developing a biophysical model of zooplankton production for the NCC
  - Calibrate it to existing data
  - Hindcast based on historic environmental data

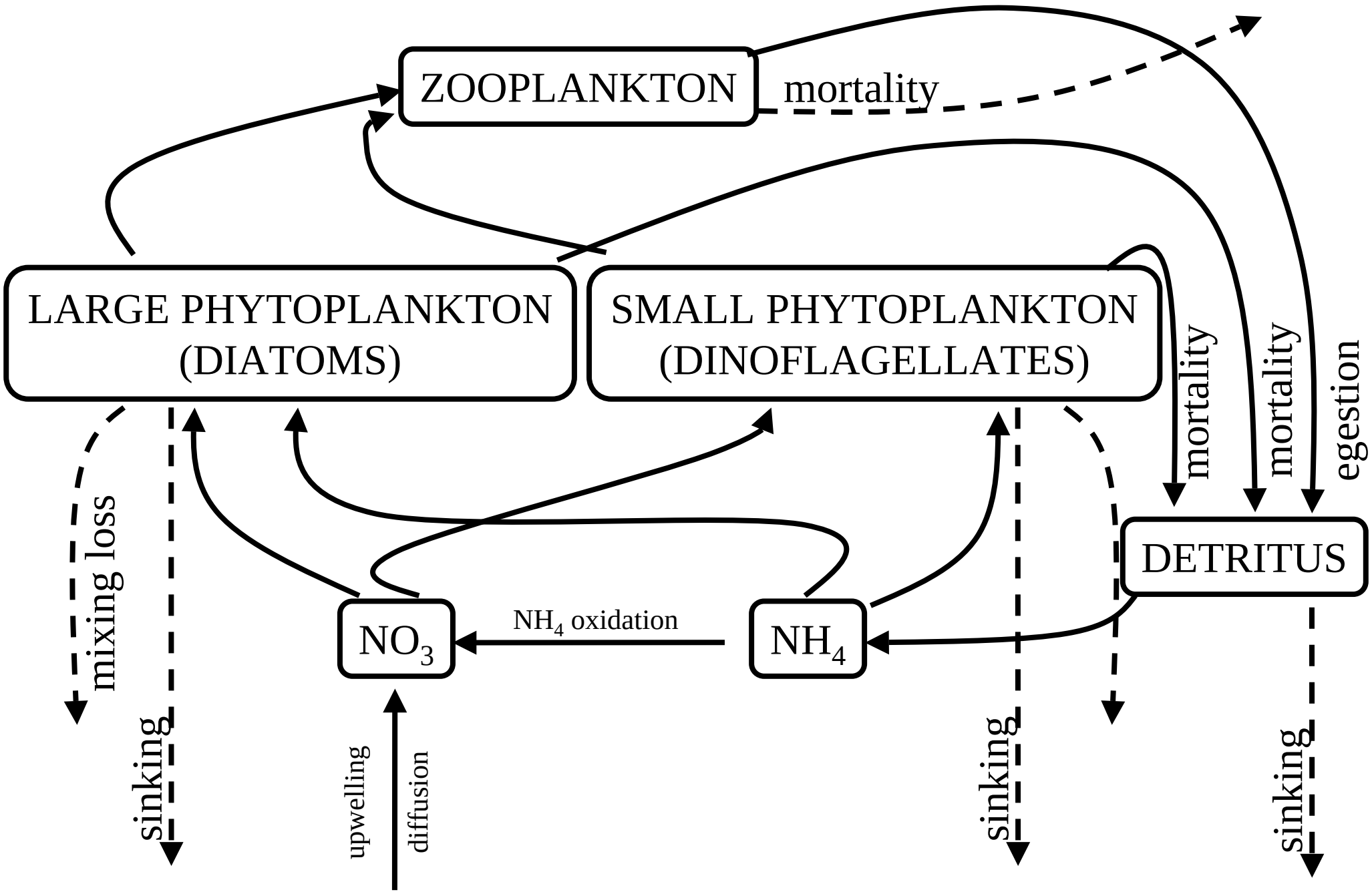
Physics Model



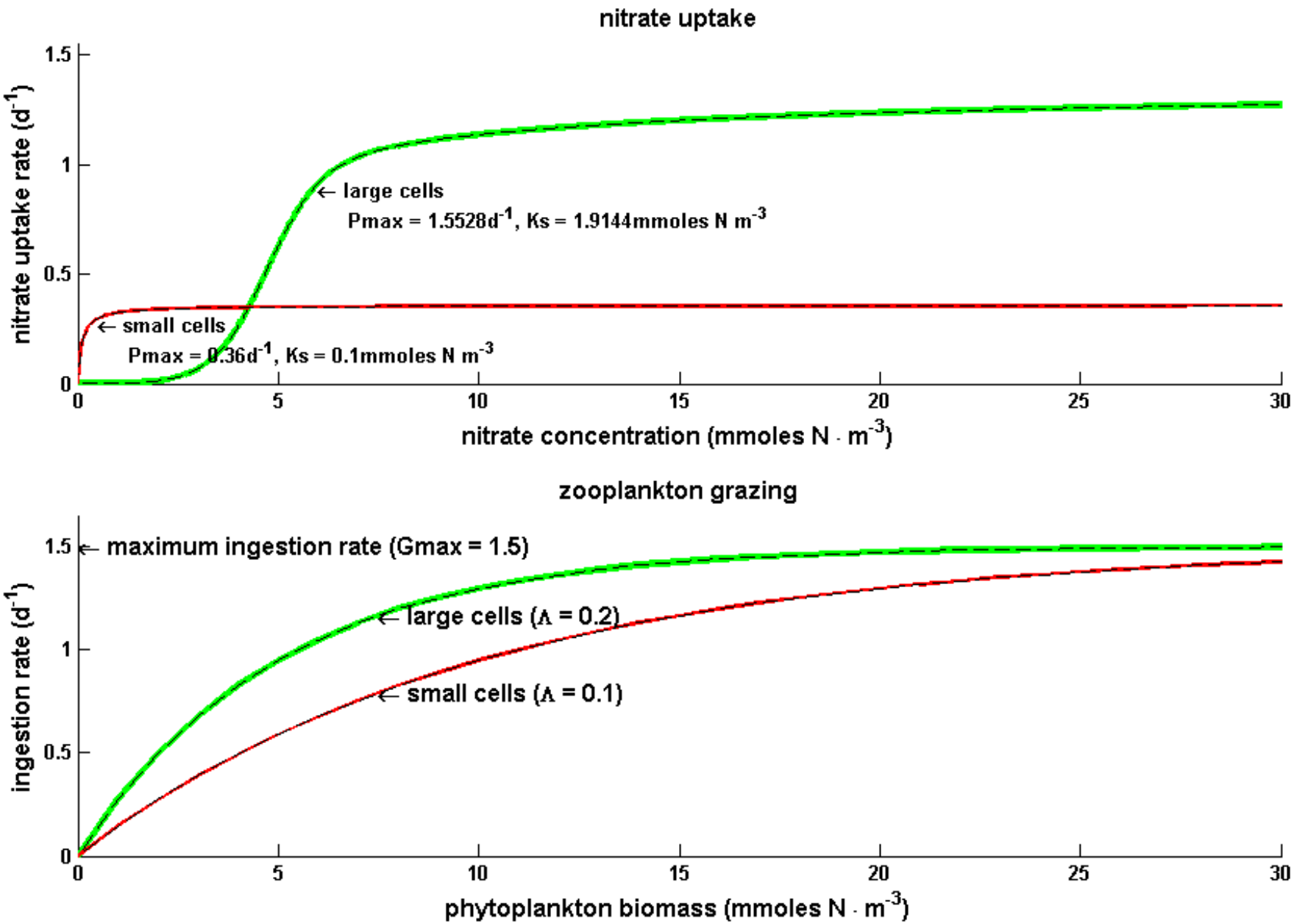
vertical diffusion of NO_3
f(constant)

upwelling of NO_3
f(N-S winds, 10km domain)

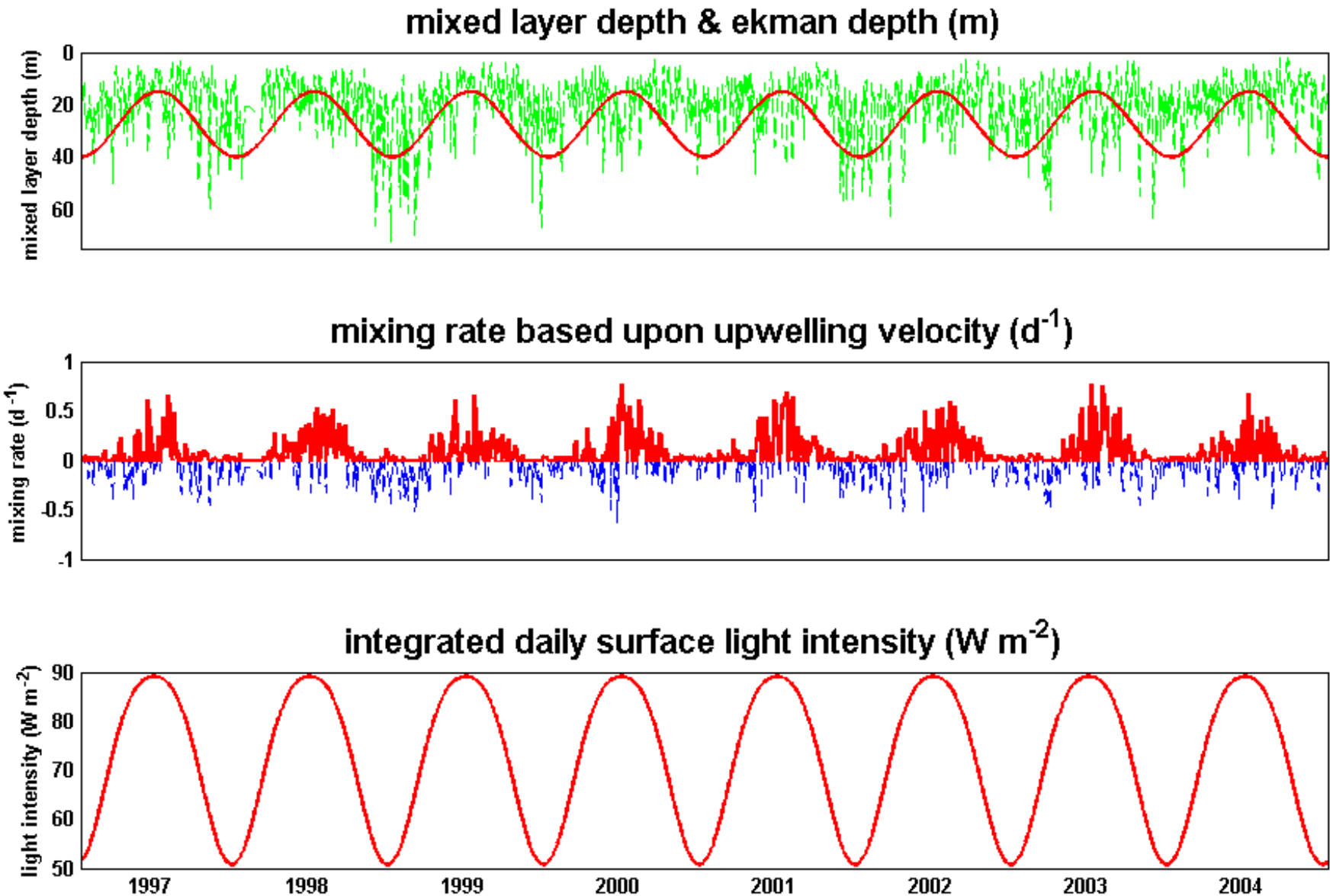
Plankton Model: NNPPZD



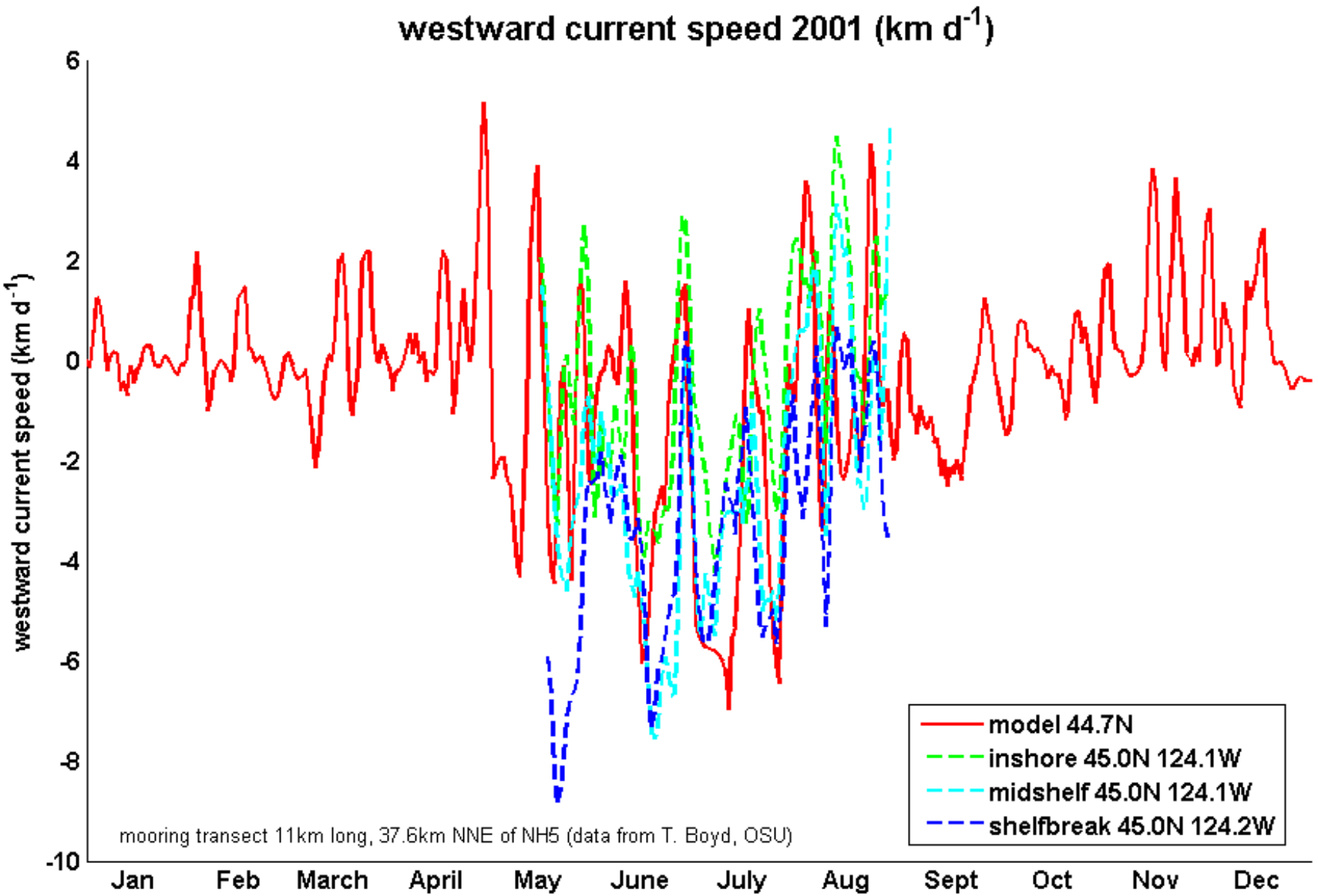
Phytoplankton Dynamics



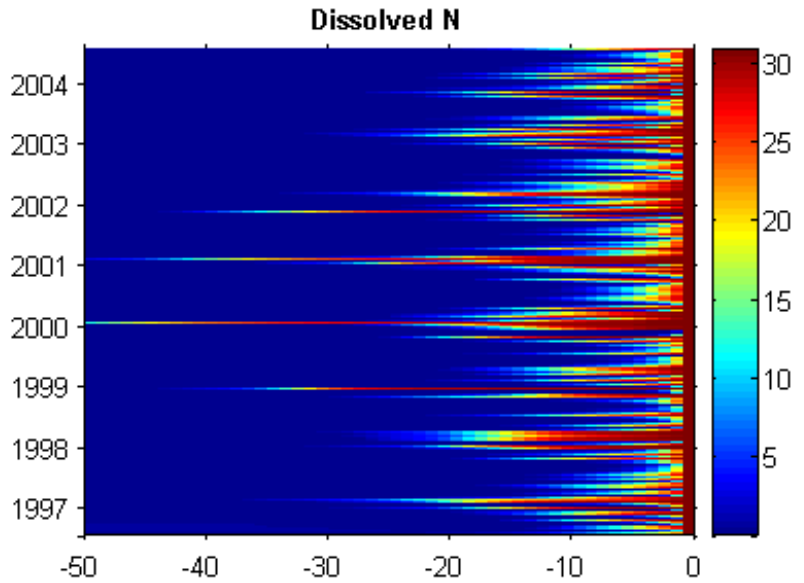
Physical Drivers

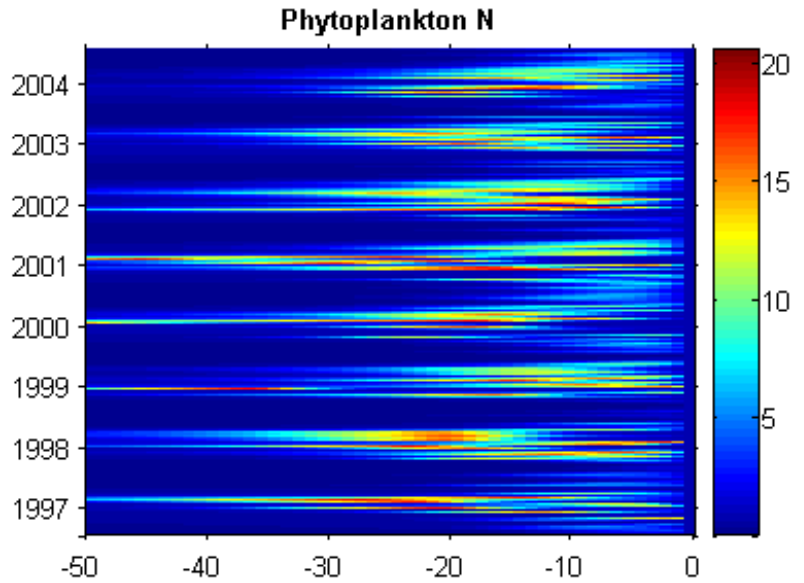


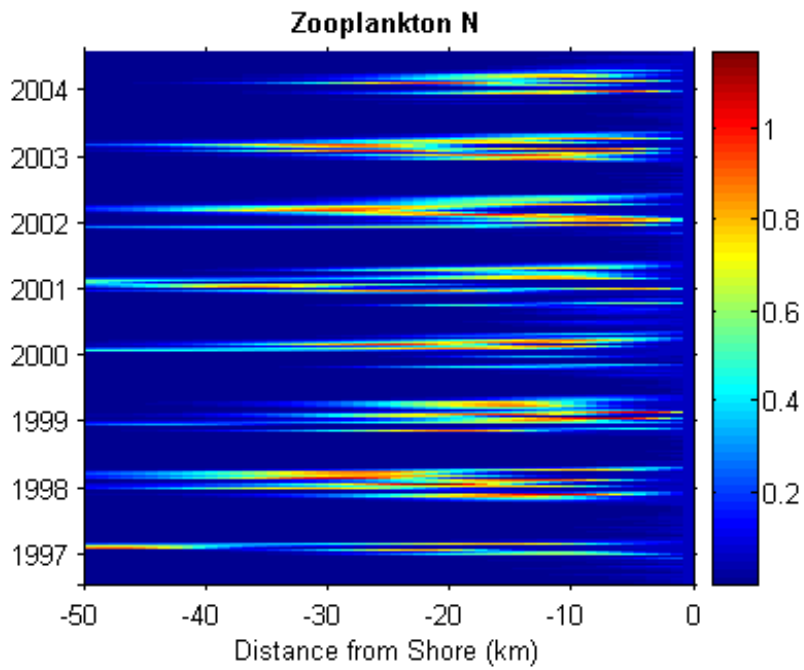
Transport Model: 2001

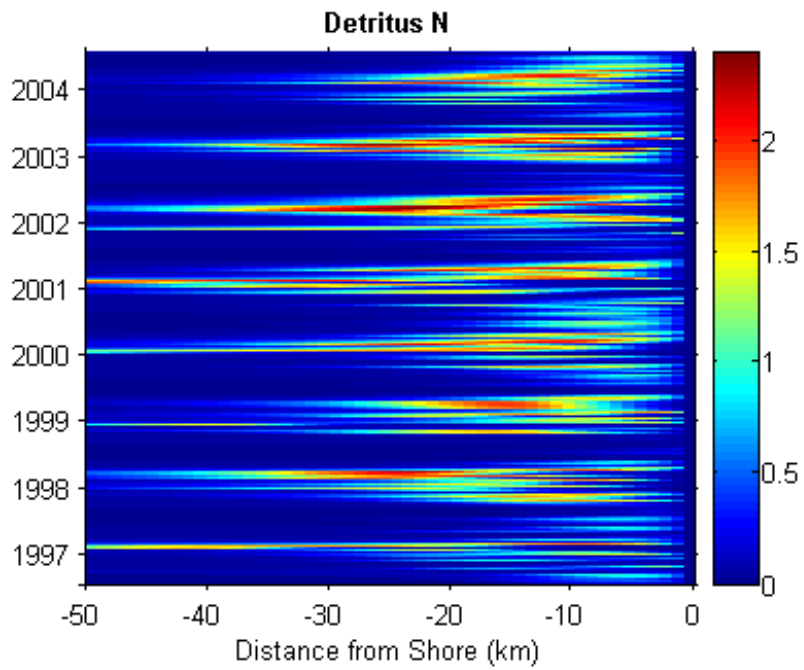


Biological Model

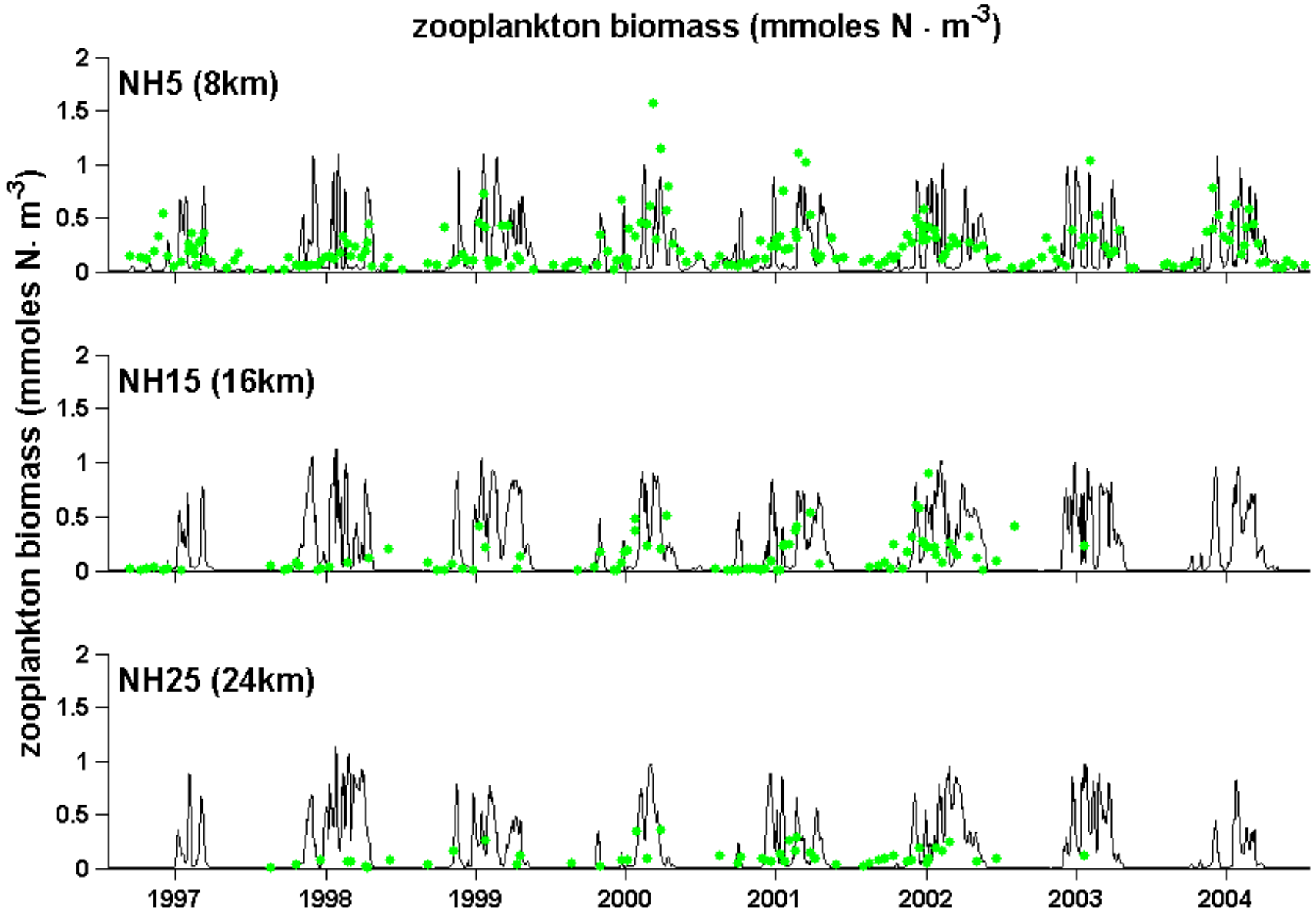




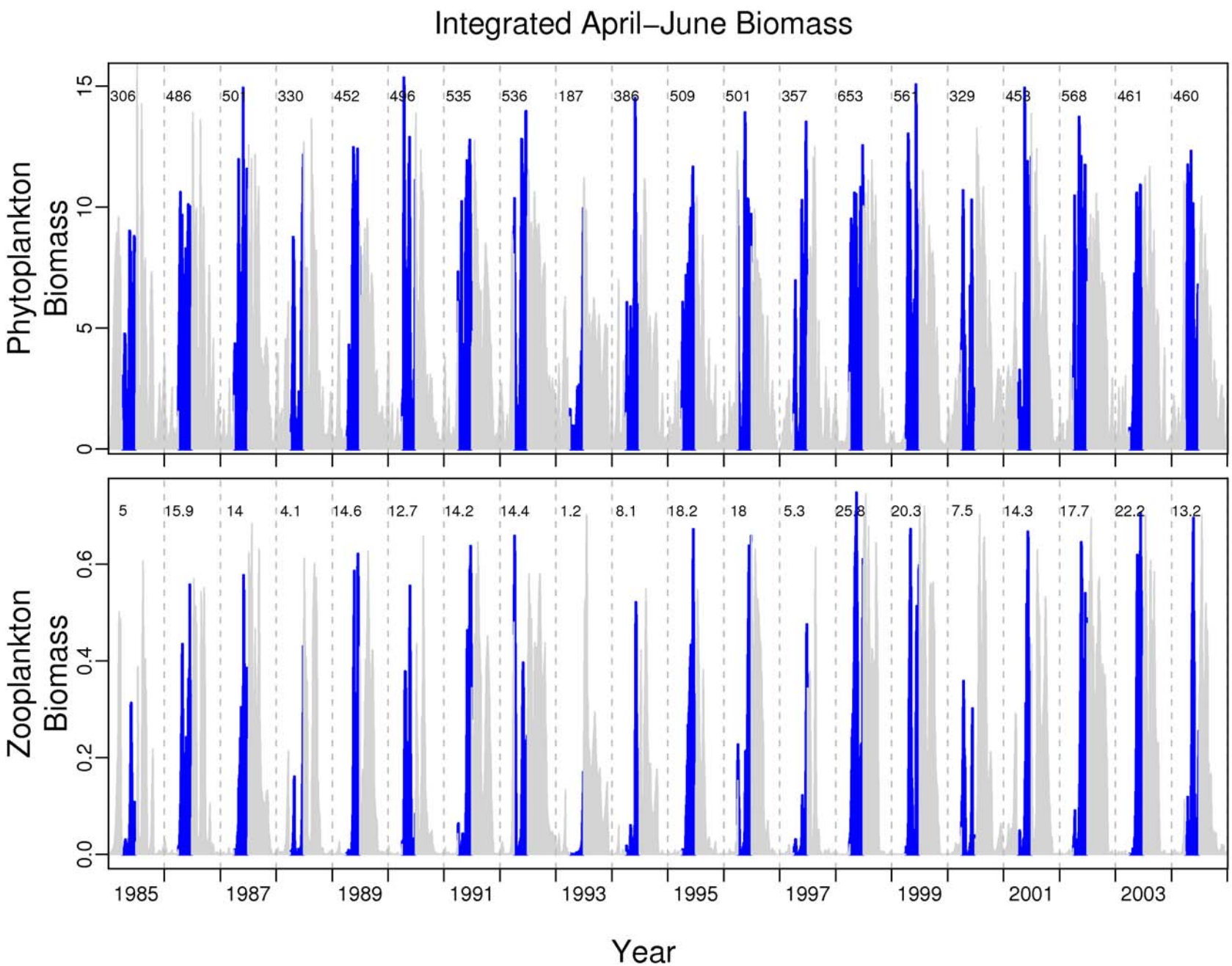




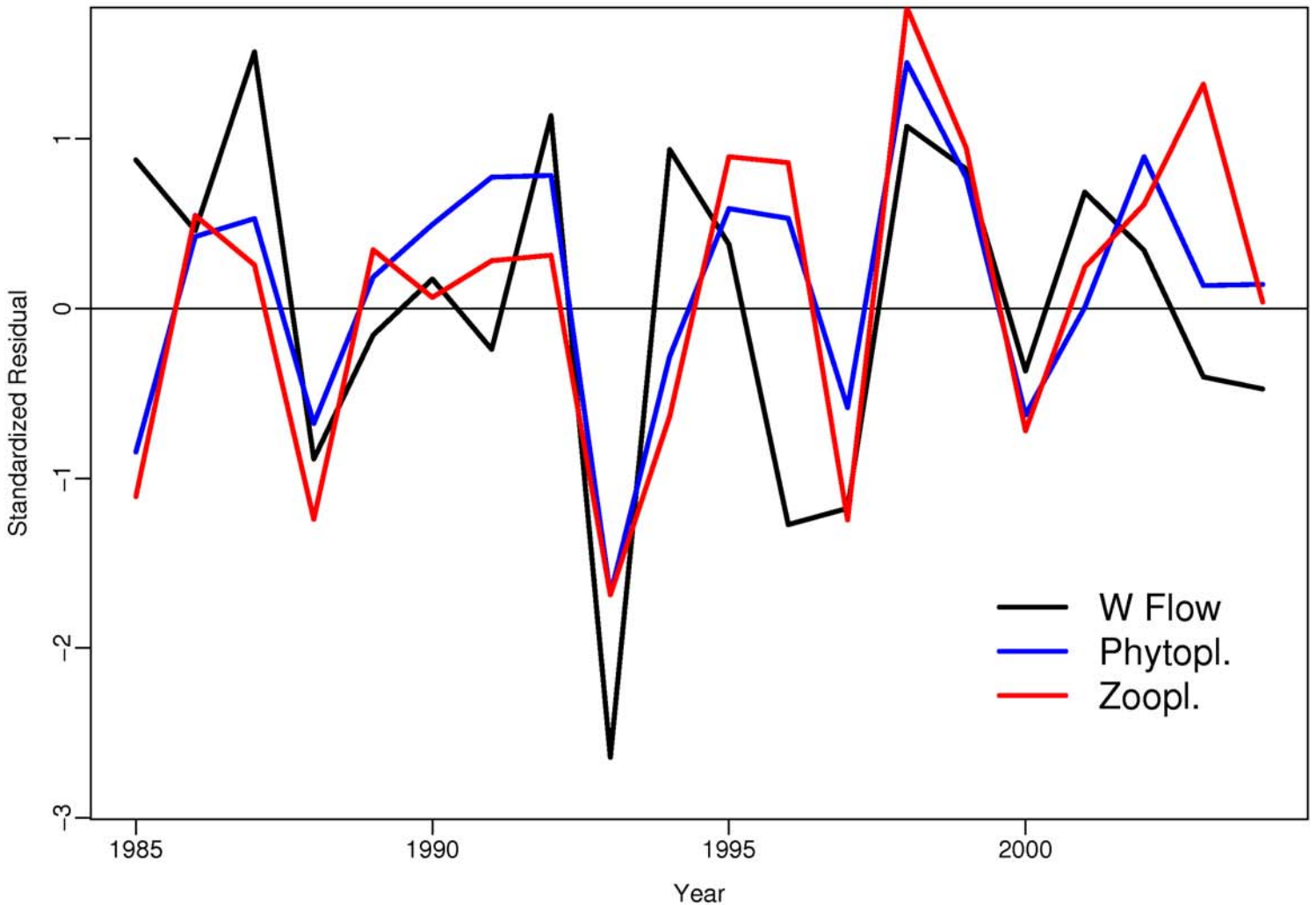
Zooplankton Prediction vs. Data



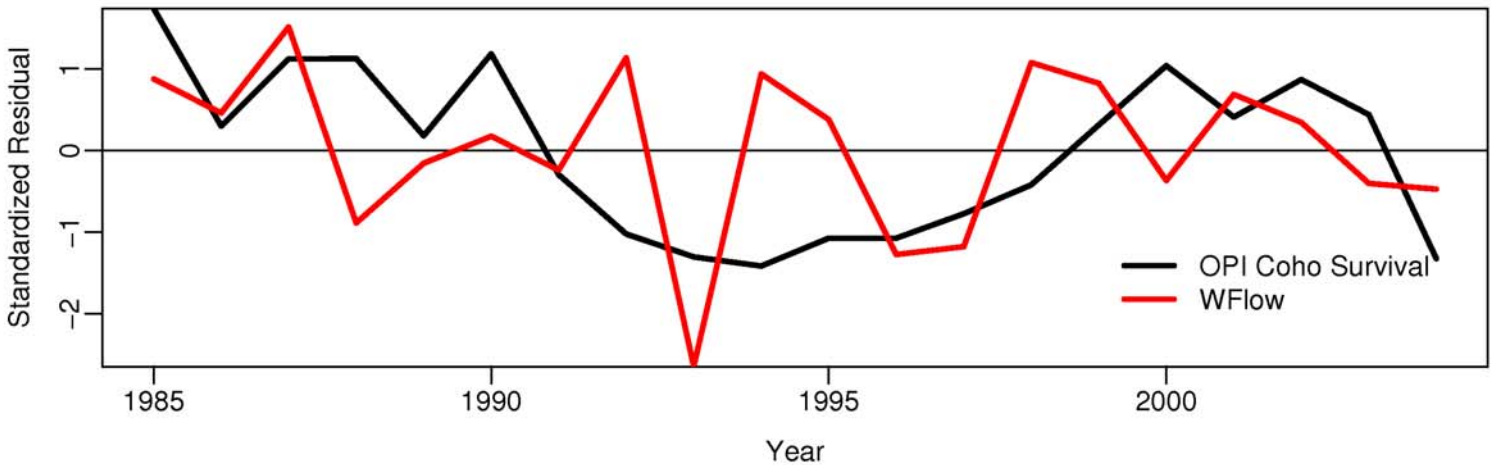
Zooplankton Biomass Index



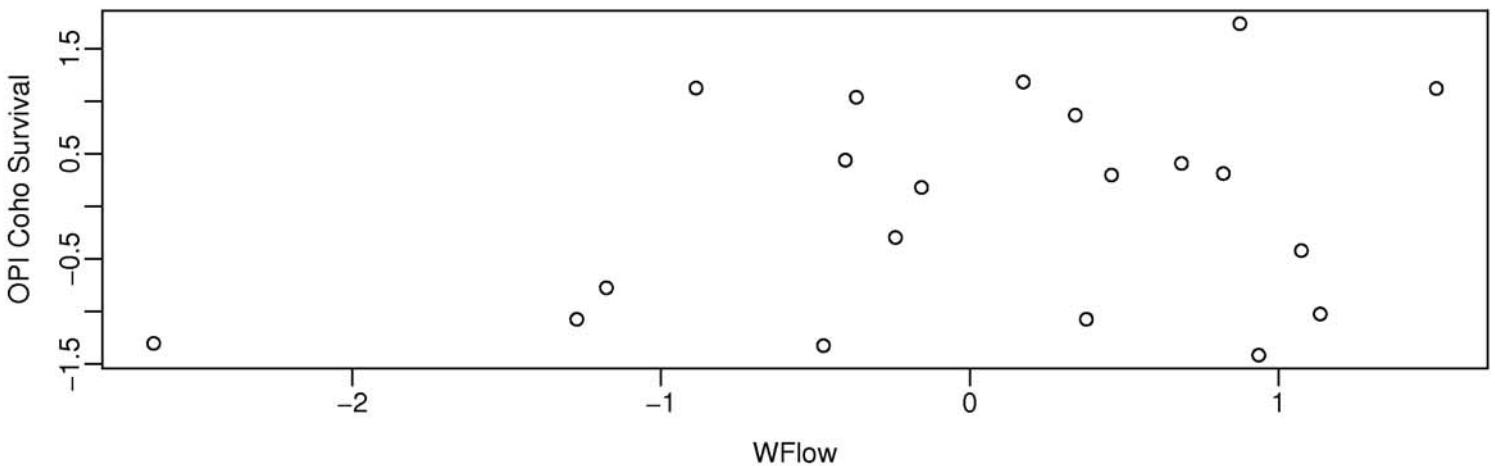
Biology vs. Upwelling



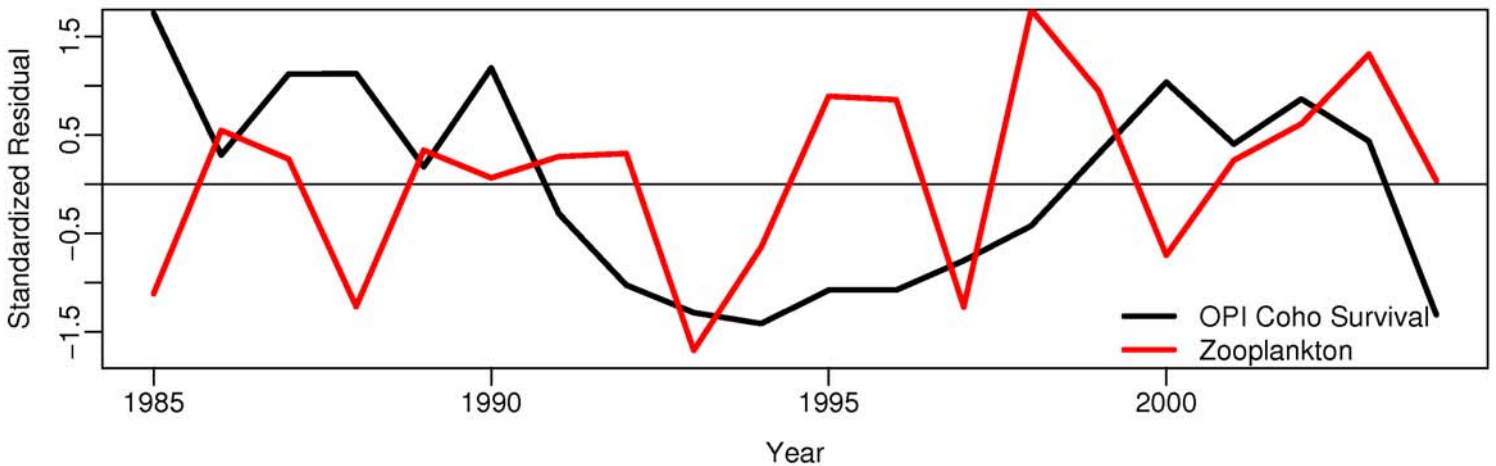
Upwelling vs. Coho Survival



Correlation: 0.30



Zooplankton vs. Coho Survival



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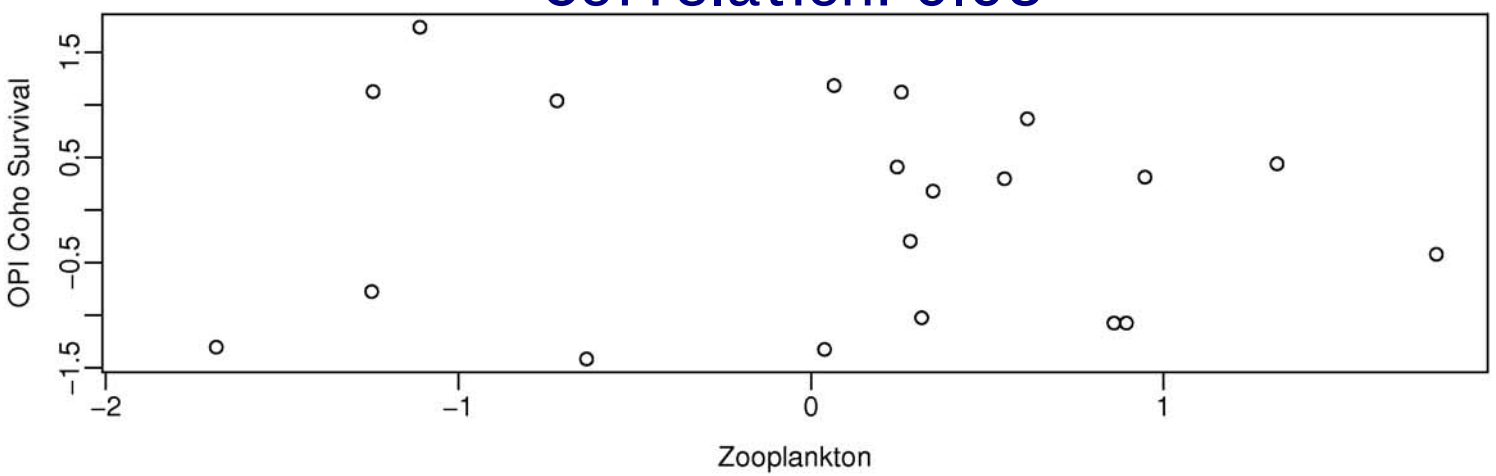

Conclusions

- Biophysical model reproduces observed nutrient and plankton dynamics moderately well.
- We can back-calculate a 20-year index of spring zooplankton biomass from wind-driven upwelling.
- However, the resulting index is a worse predictor for coho salmon survival than upwelling itself.
- Why? Two possibilities:
  - 1. The model produces garbage.
  - 2. The "upwelling effect" on coho is not a bottom-up food supply effect. Maybe:
    - Upwelling is a proxy for temperature effects.
    - Upwelling is an indicator of broader regional circulation.

Next Steps

- Finish calibrating the biophysical model, see if predictions improve.
- Look at other forms of the production index:
  - Other time periods for integrating production
  - Timing of production rather than level of production
    - “Biological Spring Transition”
- Try production index for predicting other species, in particular strict planktivores.