An Agent-Based Model of Diel Vertical Migration in *Mysis diluviana*

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1

Structure

- Introduction
- Methods
- Results
- Future Efforts

2

Introduction

3

Mysis diluviana

- "*Mysis*" are a macro-invertebrate crustacean in Lake Champlain.
- Transfer nutrients from bottom to surface waters.
- Exhibit a behavior known as diel vertical migration.

4

The Model

- Modeling helps deal with the cost and man-hours needed to sample *Mysis.*
- Agent-based and Monte Carlo style.
- Works on an hourly time-step over an entire year.

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Sub-Models

- Main model is fed by data-generating sub-models.
- Input comes in the form of *Mysis* migration extent (or Mysocline) and …
- Food availability and variability for the pelagic (surface) waters.

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Methods

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Language

- The entire model was coded in R.
- This makes it easier to share the code with peers for future investigation and expansion.
- Shiny Servers and RMarkdown furthered the accessibility.

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Agent-Based Modeling

- Simulates an individual *Mysis* throughout the entire year.
- At every hour draws are taken from probability distributions for decision making.
- Many individuals are simulated to get an idea of population-wide trends.

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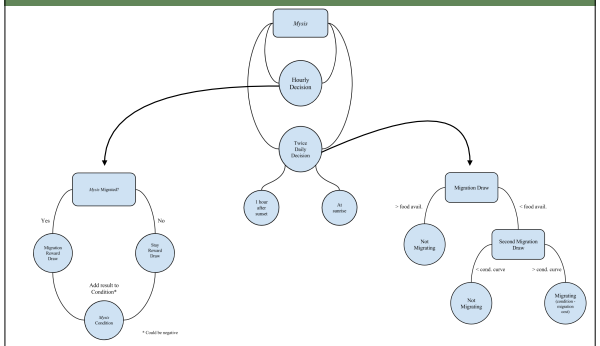
Model Structure



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Mysocline

- Light intensity levels

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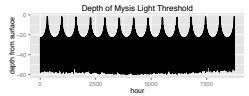
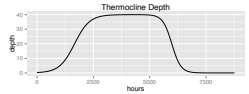
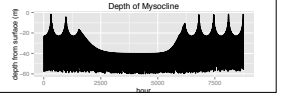
- Temperature profile

  =

- Mysocline







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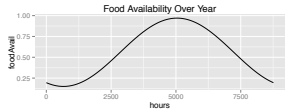
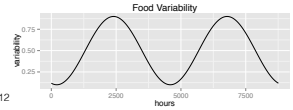
Food Availability



- Normalized measure of food quality and quantity in the pelagic environment to the benthic environment.
- Directly maps to probability of migrating, scales feeding reward.
- Paired with food variability to approximate seasonal variability.



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Interactive App

- Model was put into a shiny server.
- Allows the model to be utilized by those who might be new to or intimidated by code.
- Reproducible results.

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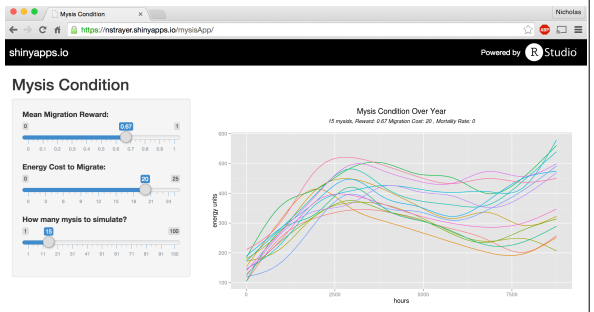
https://nstrayer.shinyapps.io/mysisApp/



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Results

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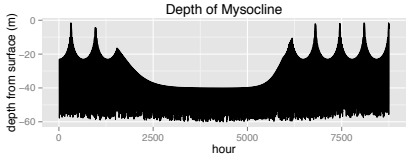
The Mysocline



- Highlights seasonal fluctuations in migration extent
- Early spring and late fall are light bounded.
- Late spring, summer and early fall are thermocline bound

16

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A Single Run

- Each line represents a single M*ysis.*
- We can see seasonal trends in condition values.
- Indicates that the cost of migration weighed with the variability of reward is dangerous.

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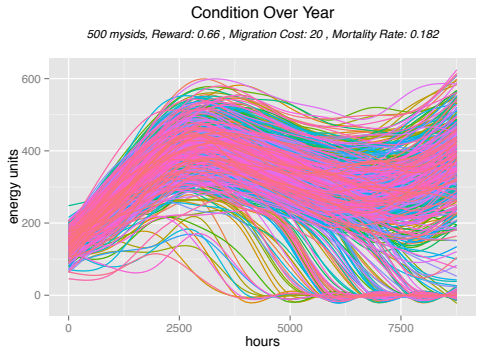

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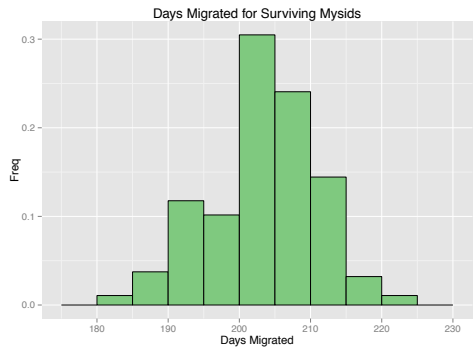

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Sensitivity Analysis

- The model was run over a range of average feeding reward values and migration costs.
- Follows expected trends based upon ecological theory (y = x line).
- Greater sensitivity to migration cost changes than feeding reward.

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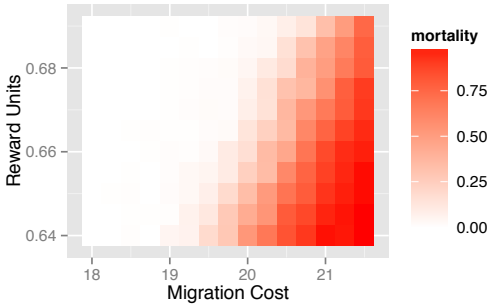

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21

Future Directions

22

Where To Go Now?

- Probe the possibility of multiple stable migration patterns.
- Dig in to specific aspects of the model. E.g. predation risk, benthic food availability
- Utilize real data in model inputs such as thermocline depth and food availability. (Oh, and to validate.)

23

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24