A simulation model for estimating the growth and production of jellyfish (*Aurelia aurita*)

Hui Liu
Texas A&M University Galveston Campus

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Outline

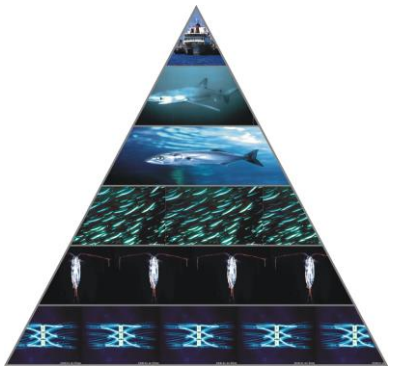
- Limitations for estimating zooplankton production
- IBM model for *Aurelia aurita* in the Gulf of Mexico
- Simulations for Natural Cohort Method
- Simulations for Artificial Cohort Method

Estimating Zooplankton Production

- A bottleneck limiting estimations of zooplankton production

$$P_{2nd} = \sum_{i=1}^{n} G_i \times B_i$$

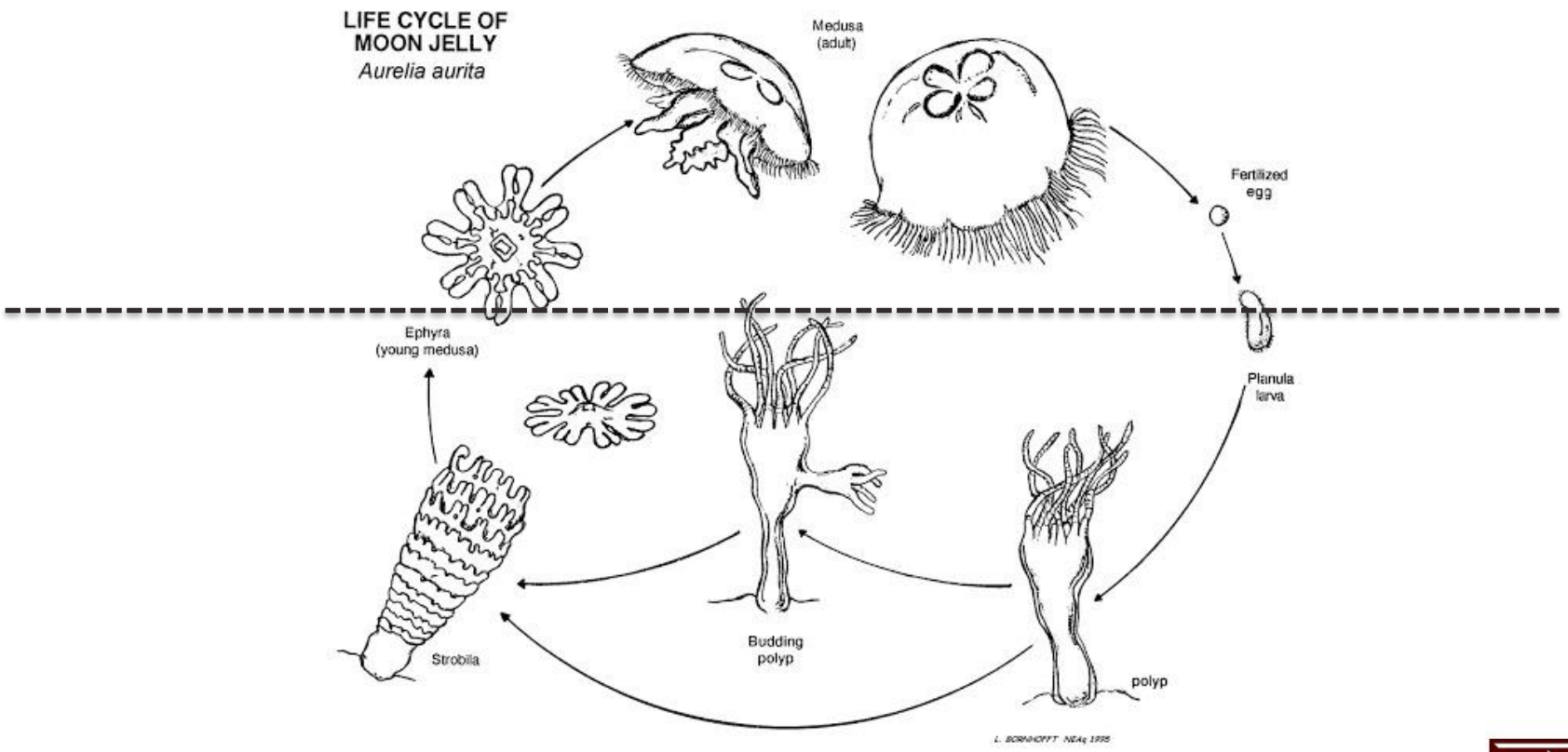
- Natural cohorts, artificial cohorts and egg production
- Lack of consensus on these methods for measuring zooplankton growth (Hirst et al. 2005, Kimmerer et al. 2007, Liu et al. 2013, Kobari et al. 2019)



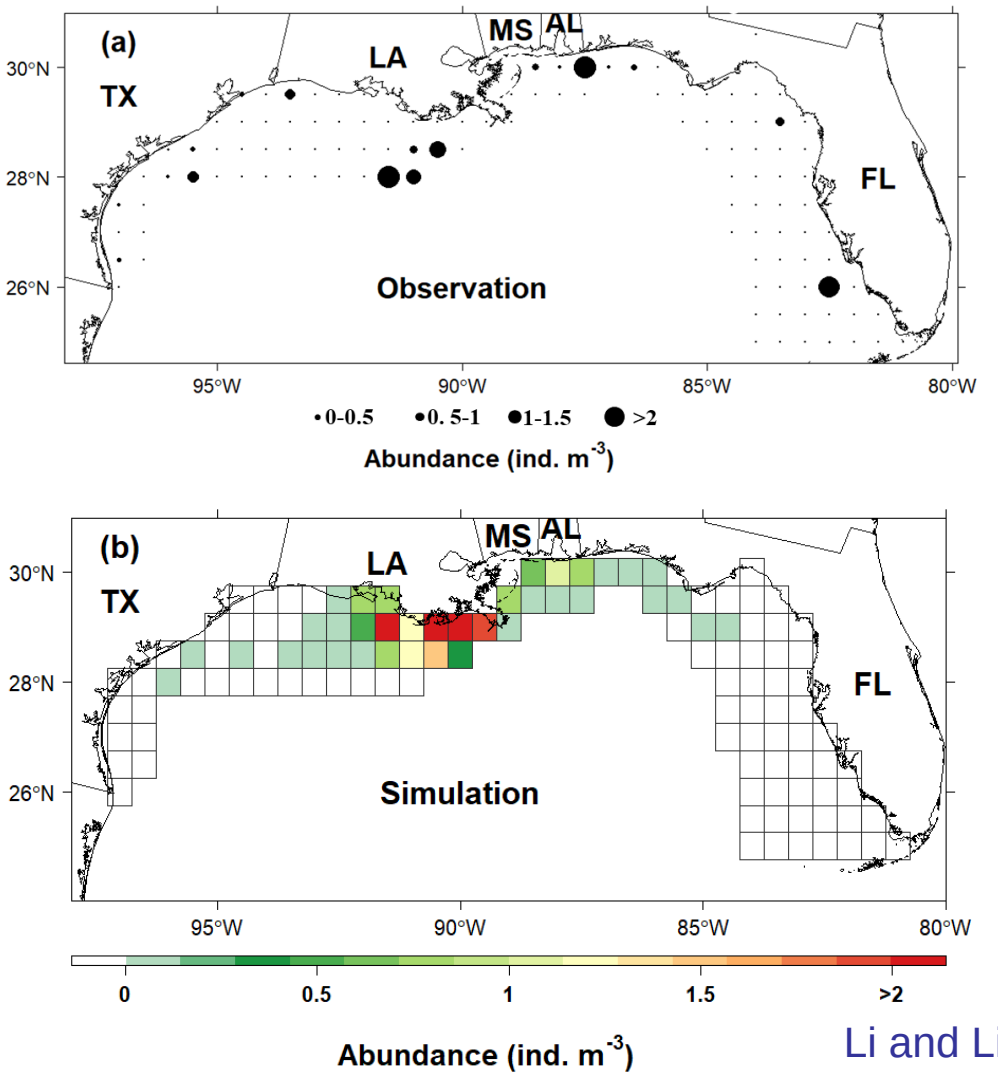
Modeling Approach

- A IBM for copepods (Bi and Liu 2017)
- A stage-structured IBM of jellyfish *Aurelia aurita*
- Four stages: ephyra, young medusa, adult medusa, and polyp.
- Biological processes
- Environmental drivers:
  - zooplankton biomass
  - surface temperature
  - bottom temperature
  - bottom salinity

Life Cycle of Moon Jelly



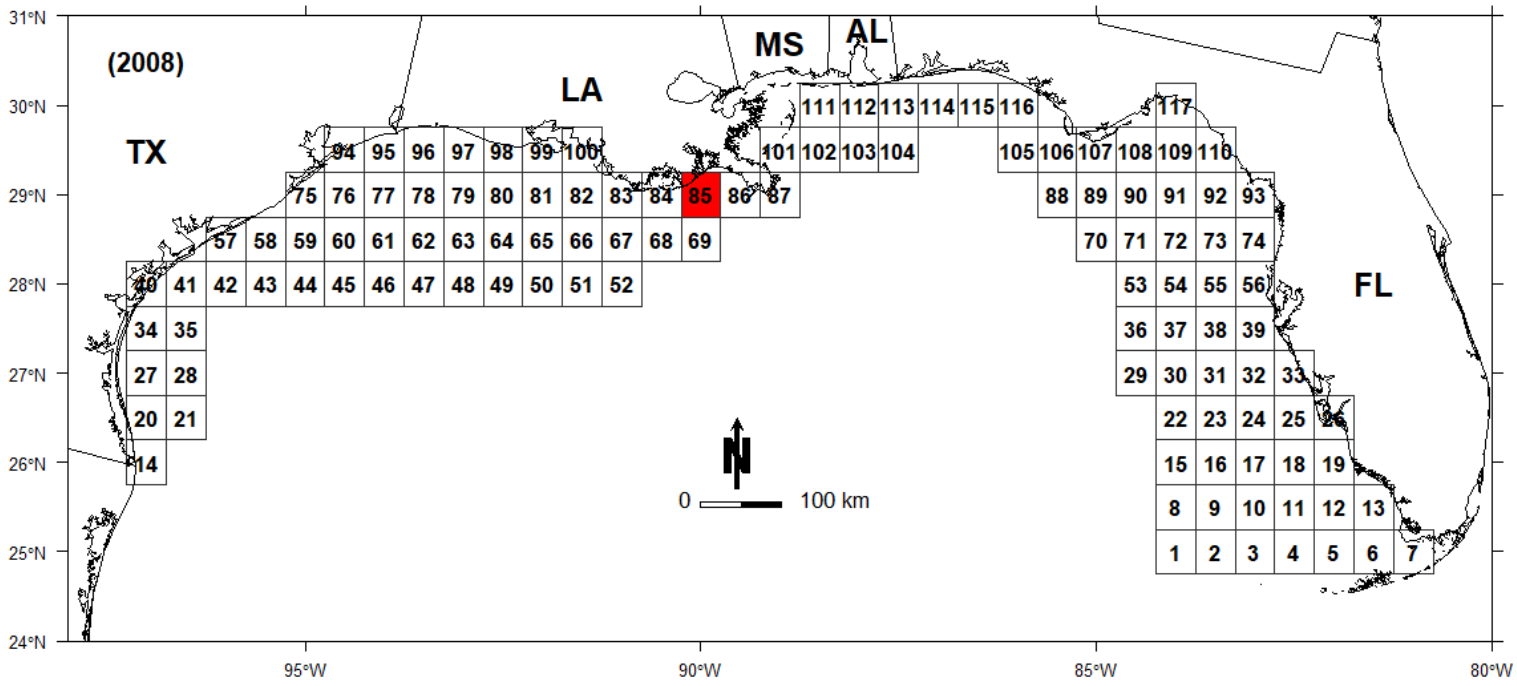
Jellyfish IBM in the Gulf of Mexico



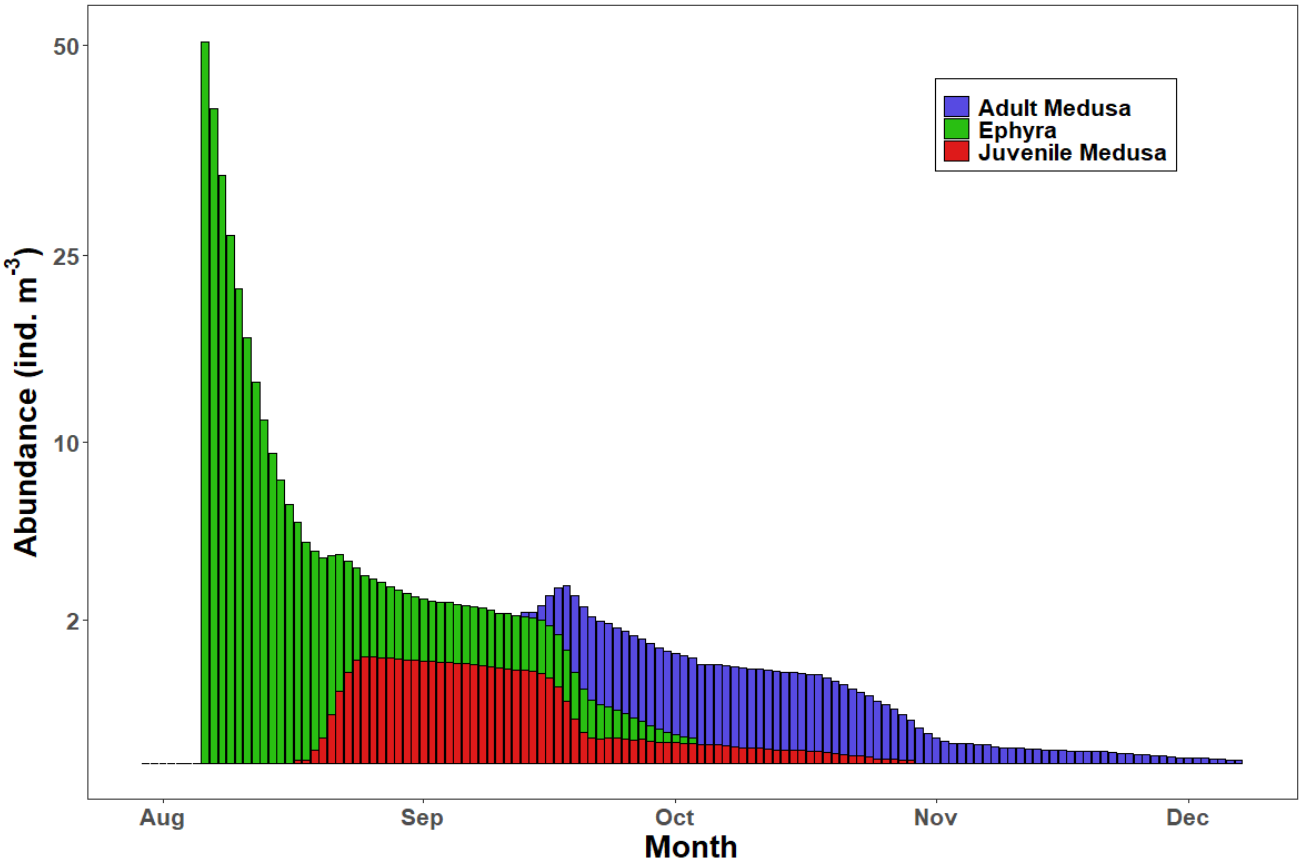
- Spatial Resolution: 1/2°
- Time Step: 1 day
- Model Period: Jan 1 to Dec 31
- Initial Population: Polyps only
- Blooms: Fall (Robinson and Graham, 2013)
- Strobilation Initiated: falling temperature (Holst 2012), food conditions (Wang and Li 2015)

Li and Liu (to be submitted)

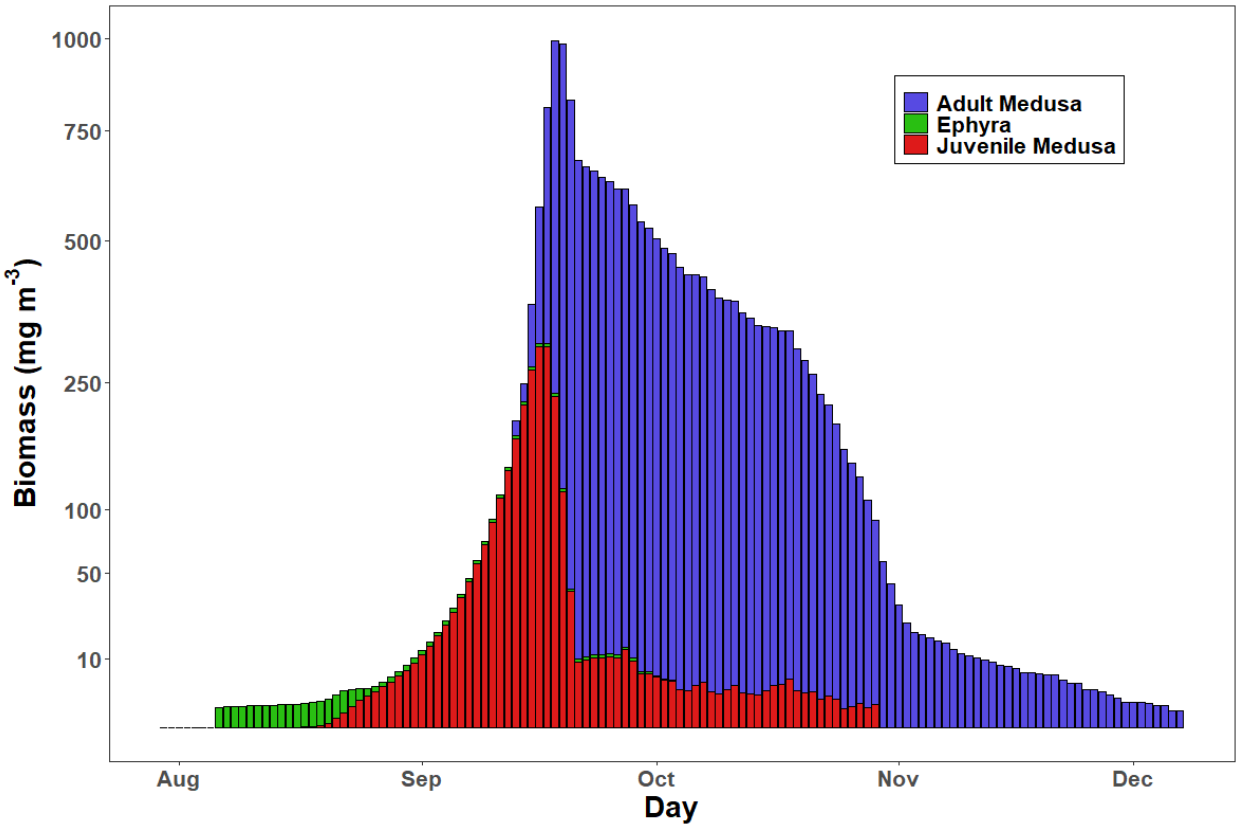
Study Site


(2008)
TX
LA
MS
AL
FL
31°N
30°N
29°N
28°N
27°N
26°N
25°N
24°N
95°W
90°W
85°W
80°W
0
100 km

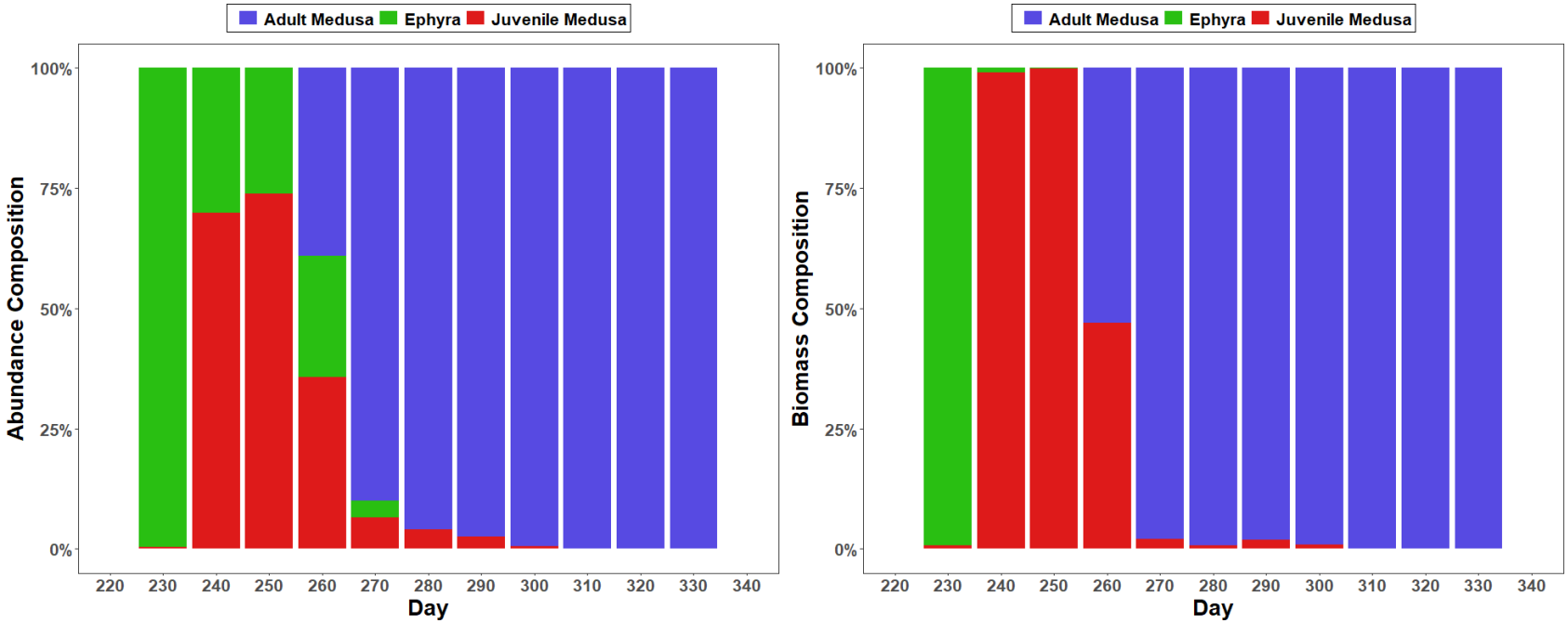
Simulated Populations in Density

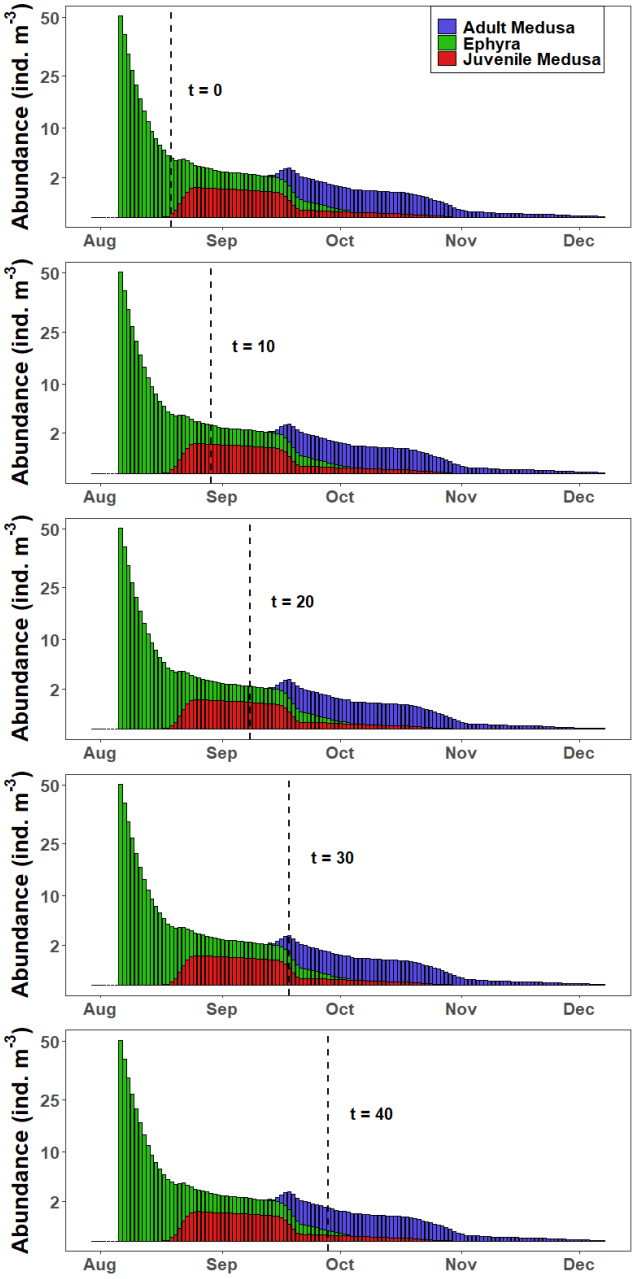


Simulated Populations in Biomass

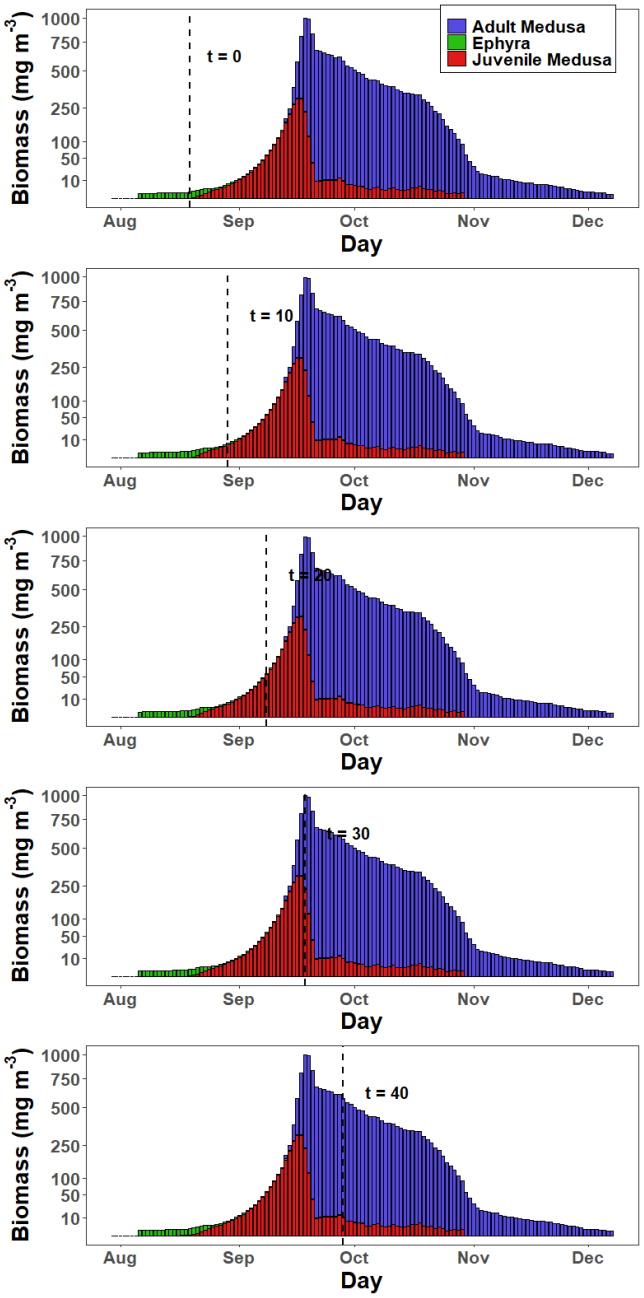


Simulated Population Structure



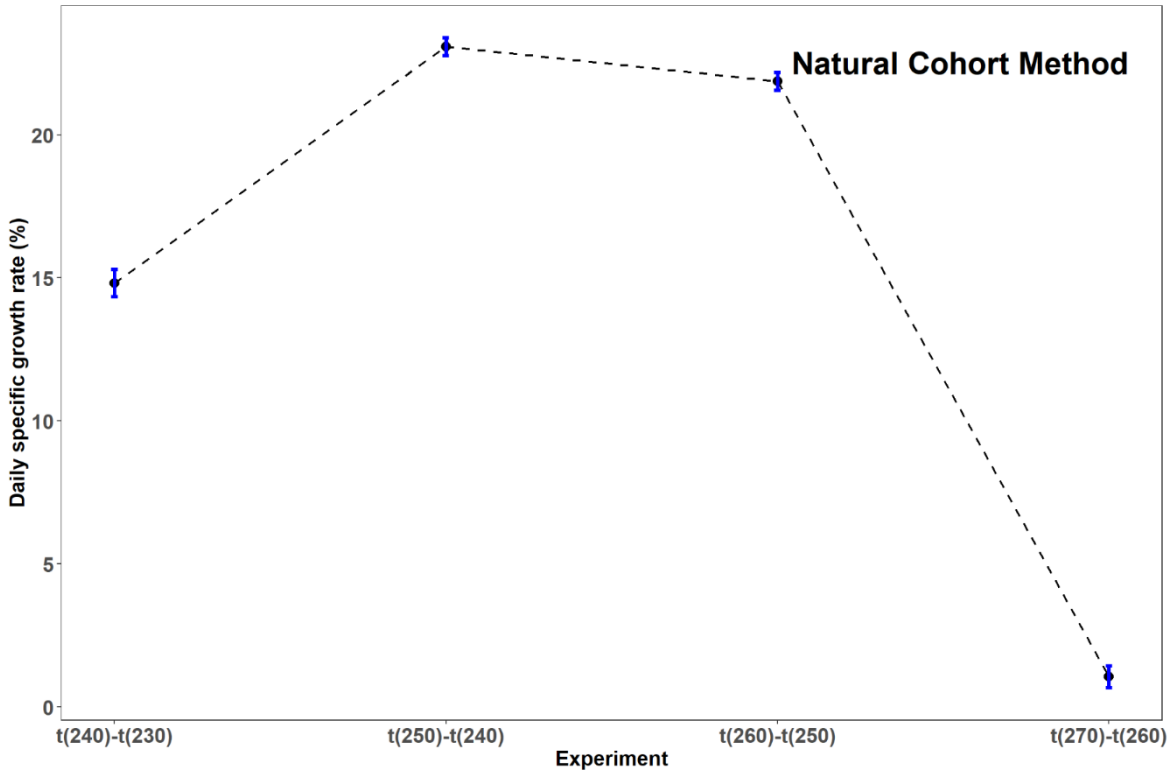


- Assumed in enclosed waters
- Experiment Timing: may target on different population structures in density



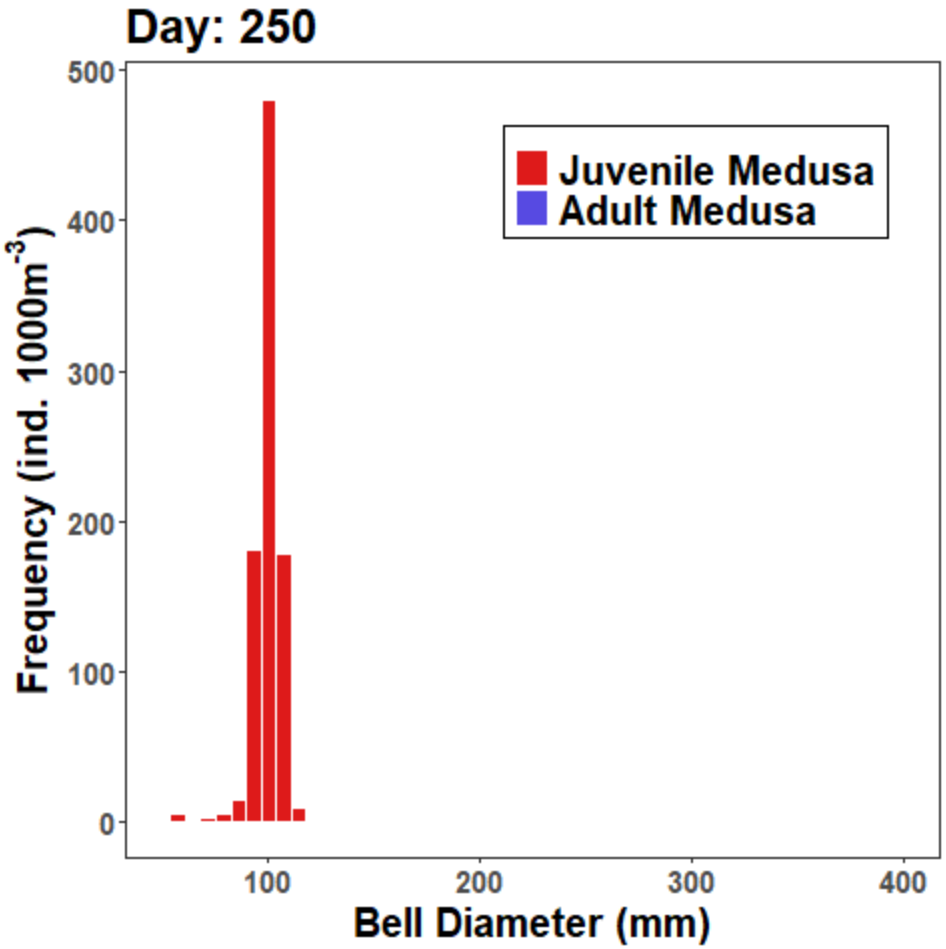
- Assumed in enclosed waters
- Experiment Timing: may target on different population structures in biomass

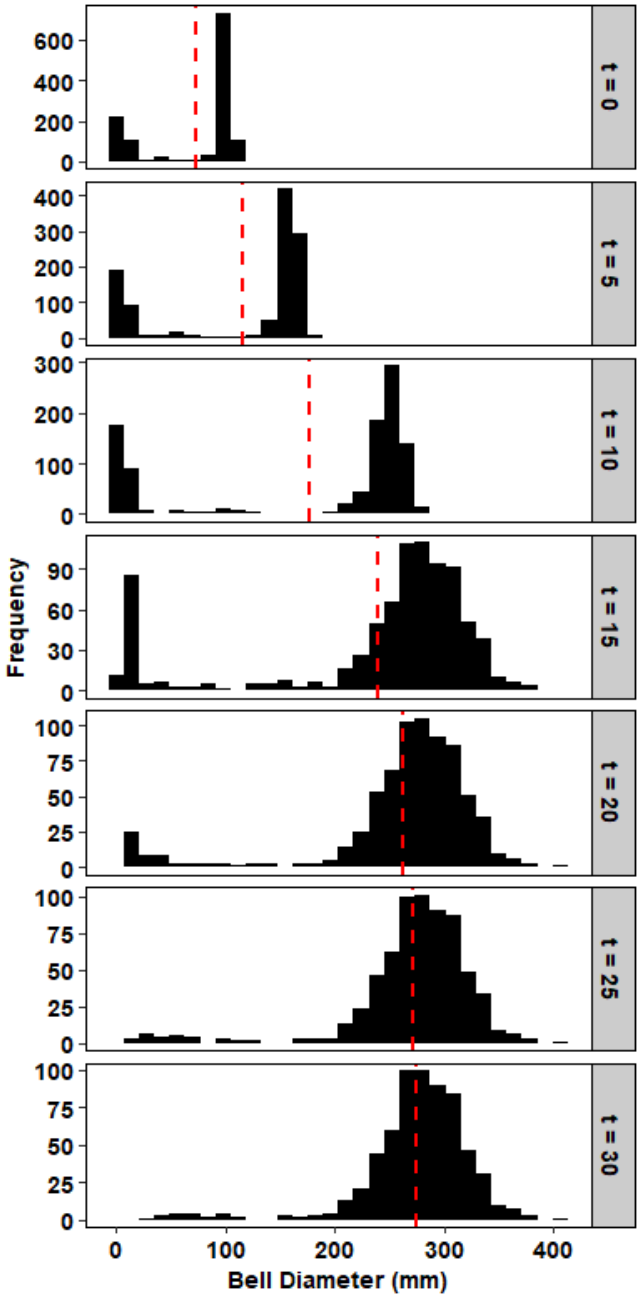
Estimated Daily Growth Rates



- Assumed in enclosed waters
- Daily Growth Rate: <0.25 (Olesen et al 1994)

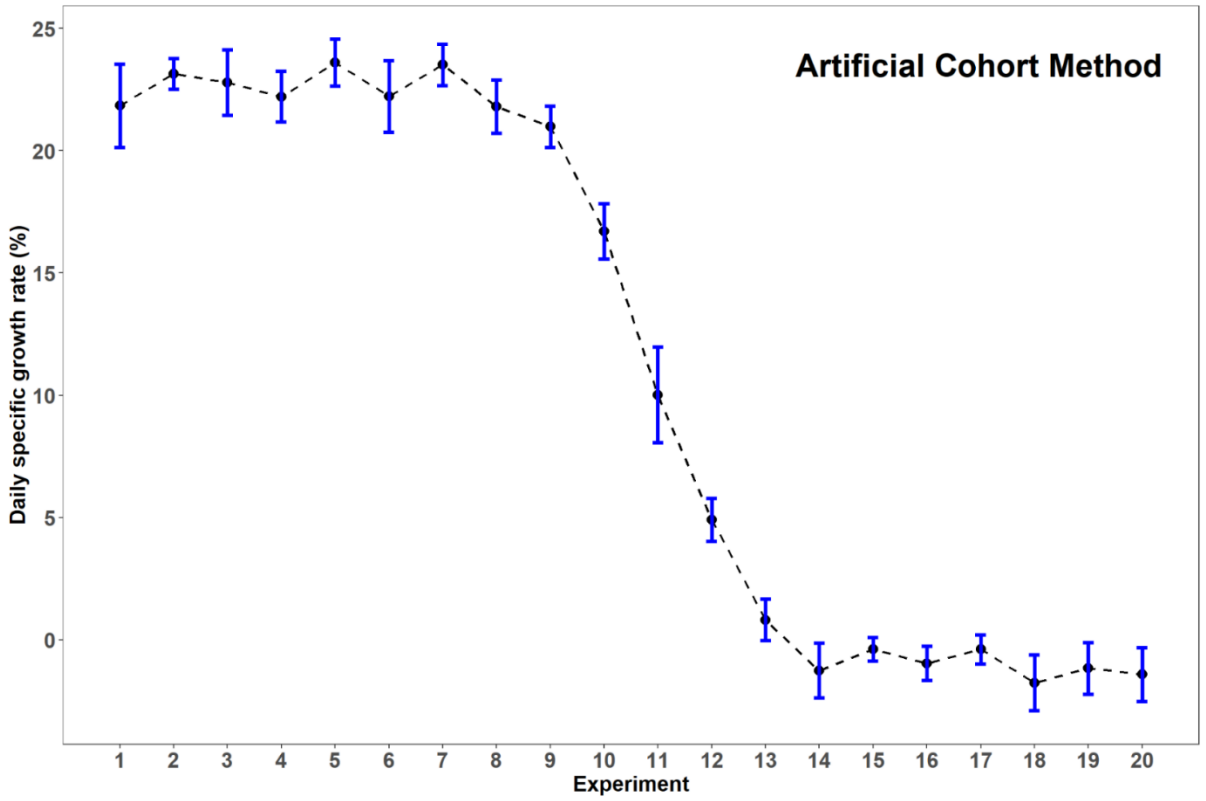
Simulated Artificial Cohorts





Frequency distributions of Artificial Cohorts over Time

Estimated Daily Growth Rates



- Assumed frequent experiments in open waters
- Daily Growth Rate: <0.25 (Hernroth and Gröndahl, 1983; Olesen et al 1994)

Recap

- Modeling approach shows potentials for estimating zooplankton growth rate
- Caveats of the approach dependent on the model
- Measurements of life history rates highly needed
- Further validations of the approach with direct measurements

Thank You