

# Controls on Arctic mosquito (*Aedes nigripes*) populations in western Greenland

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- Pests to humans and wildlife





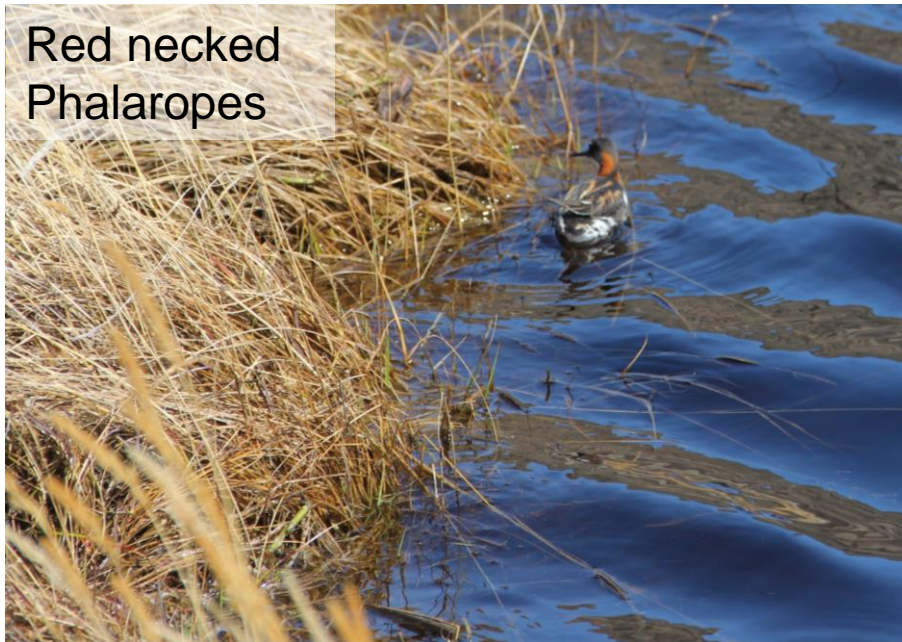
- Important role in aquatic and terrestrial food webs



Diving beetles



Wolf spiders



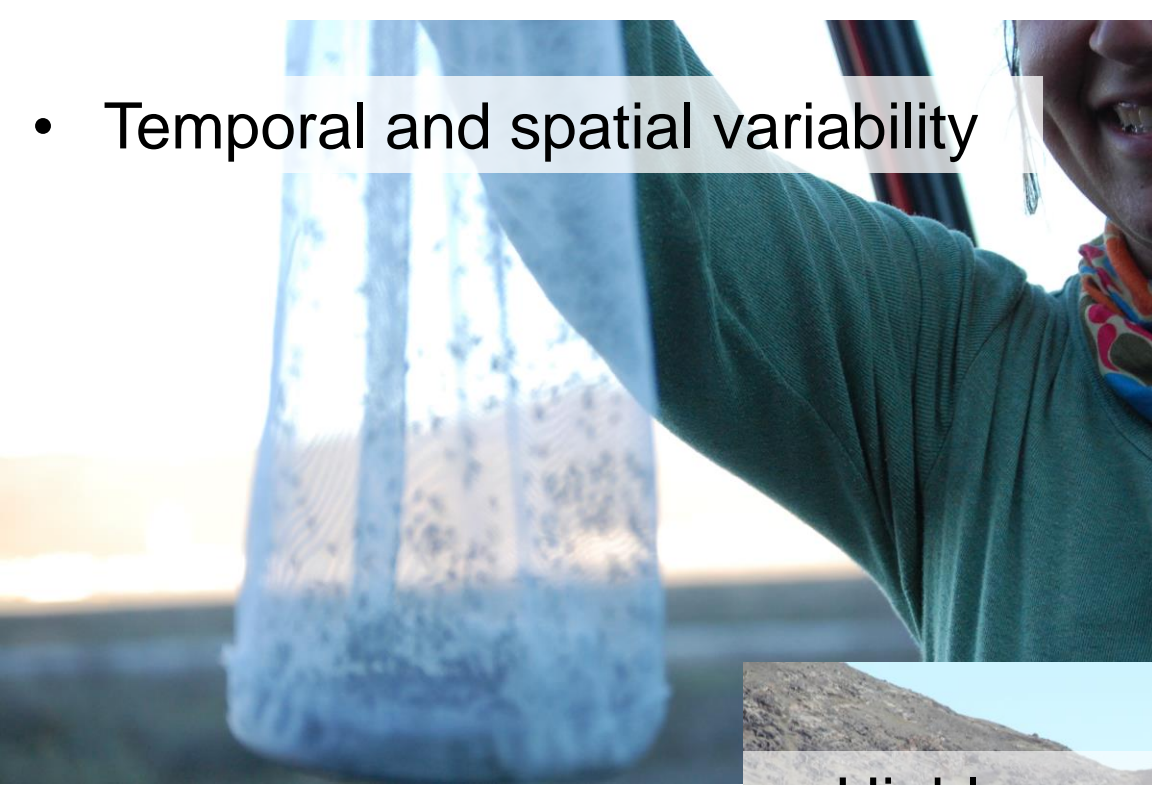
Red necked  
Phalaropes



Long-jawed  
orb weavers



- Temporal and spatial variability



- Highly sensitive to changing environmental conditions

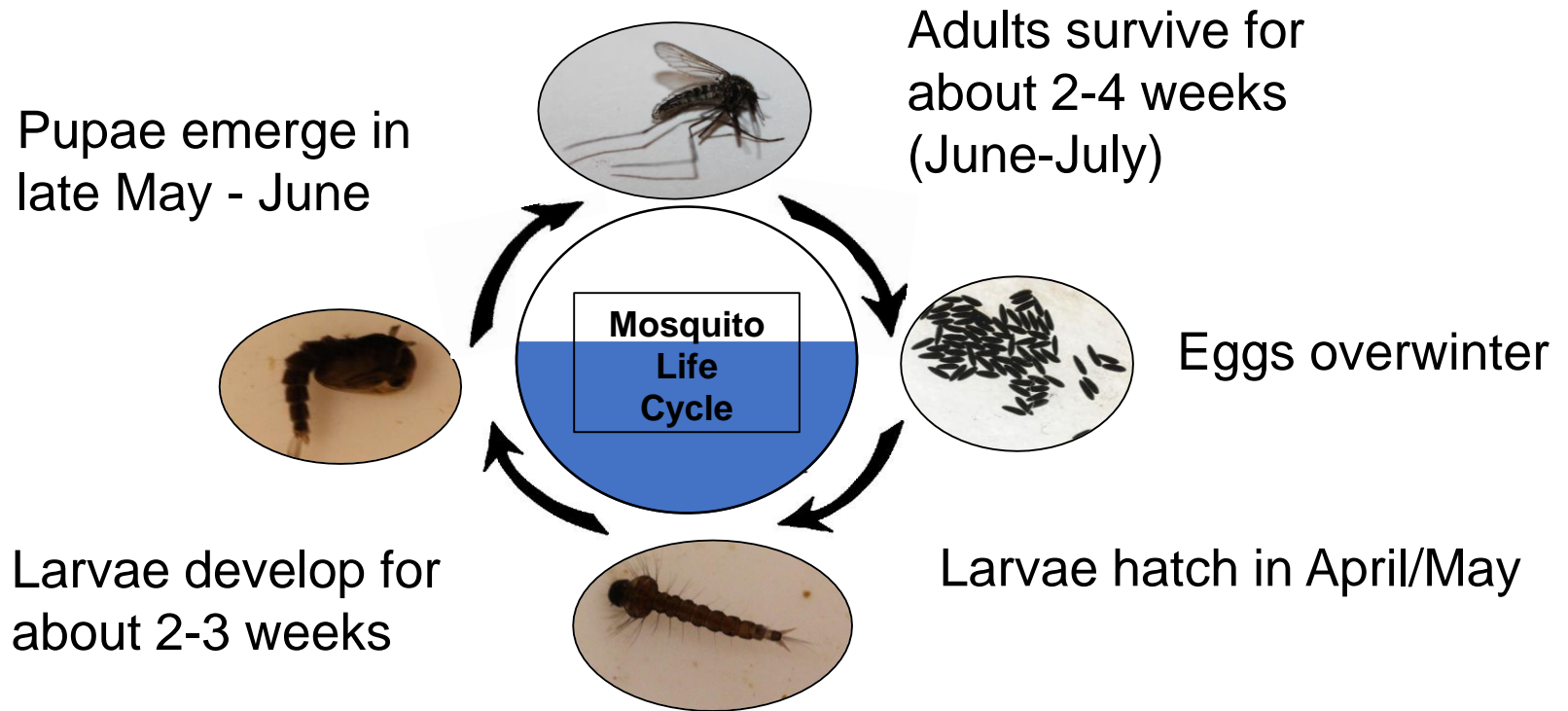




- ~38 spp in Arctic and subarctic
- Mostly *Aedes*
- *Aedes nigripes* = most abundant

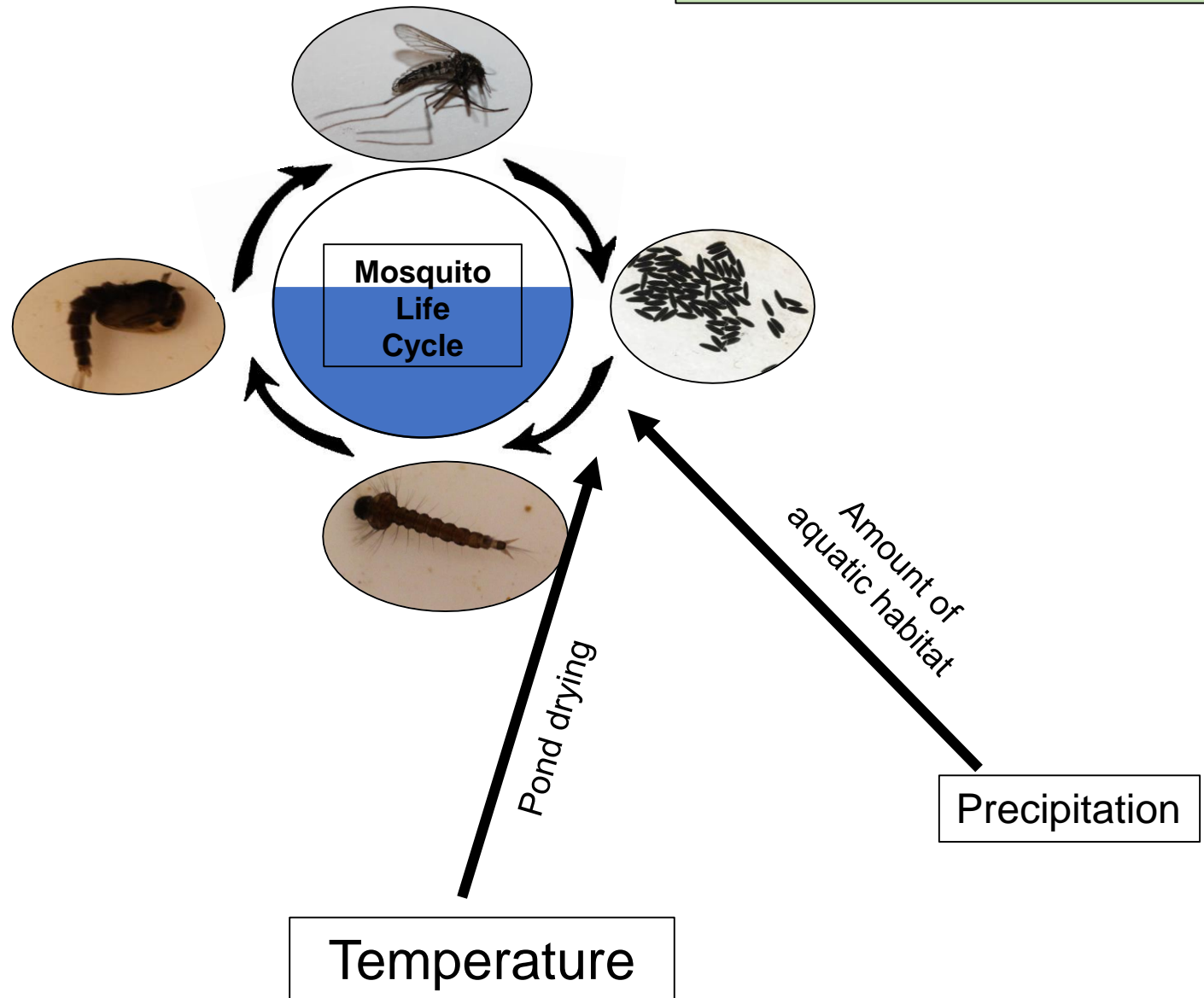
### No indication of arthropod-vectorred viruses in mosquitoes (Diptera: Culicidae) collected on Greenland and Svalbard

Jana Müllerová<sup>1,2</sup> · Jana Elsterová<sup>1,2,3</sup> · Jiří Černý<sup>1,3</sup>  · Oleg Ditrich<sup>2</sup> · Jakub Žárský<sup>4</sup> · Lauren E. Culler<sup>5,6</sup> · Helge Kampen<sup>7</sup> · Doreen Walther<sup>8</sup> · Stephen J. Coulson<sup>9,10</sup> · Daniel Růžek<sup>1,3</sup> · Libor Grubhoffer<sup>1,2</sup>



- Annual life cycle
- Complex life cycle (aquatic → terrestrial)

Abiotic  
Density-Independent



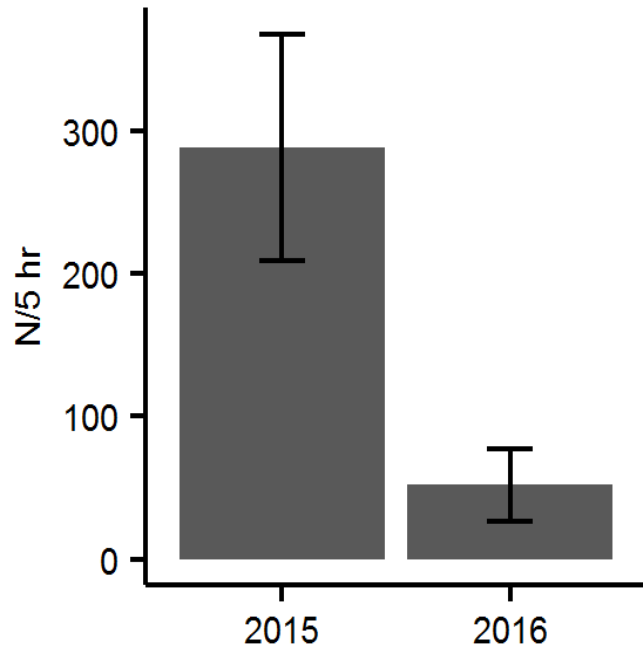








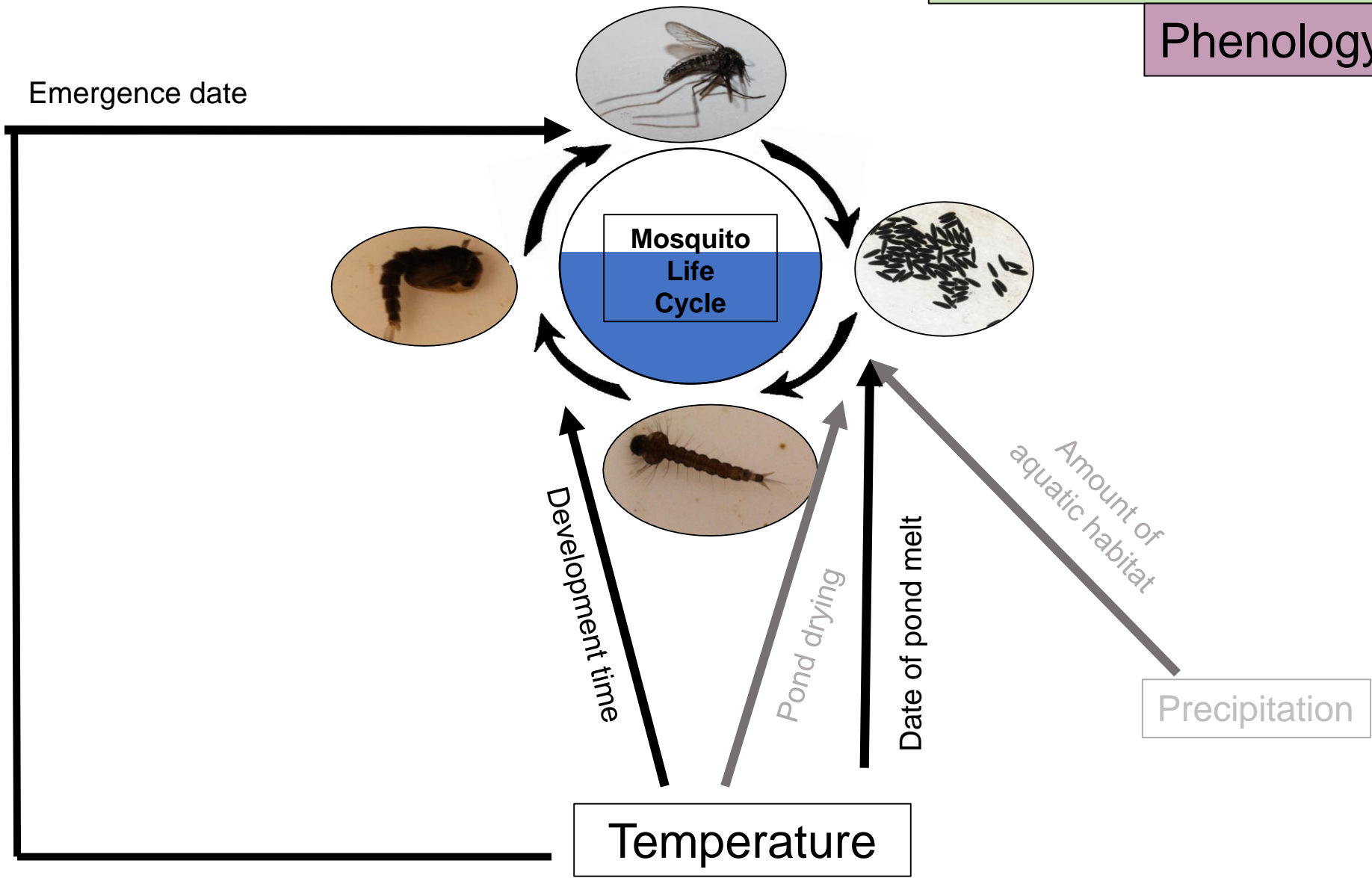
In unusually warm and dry years there are fewer adult mosquitoes

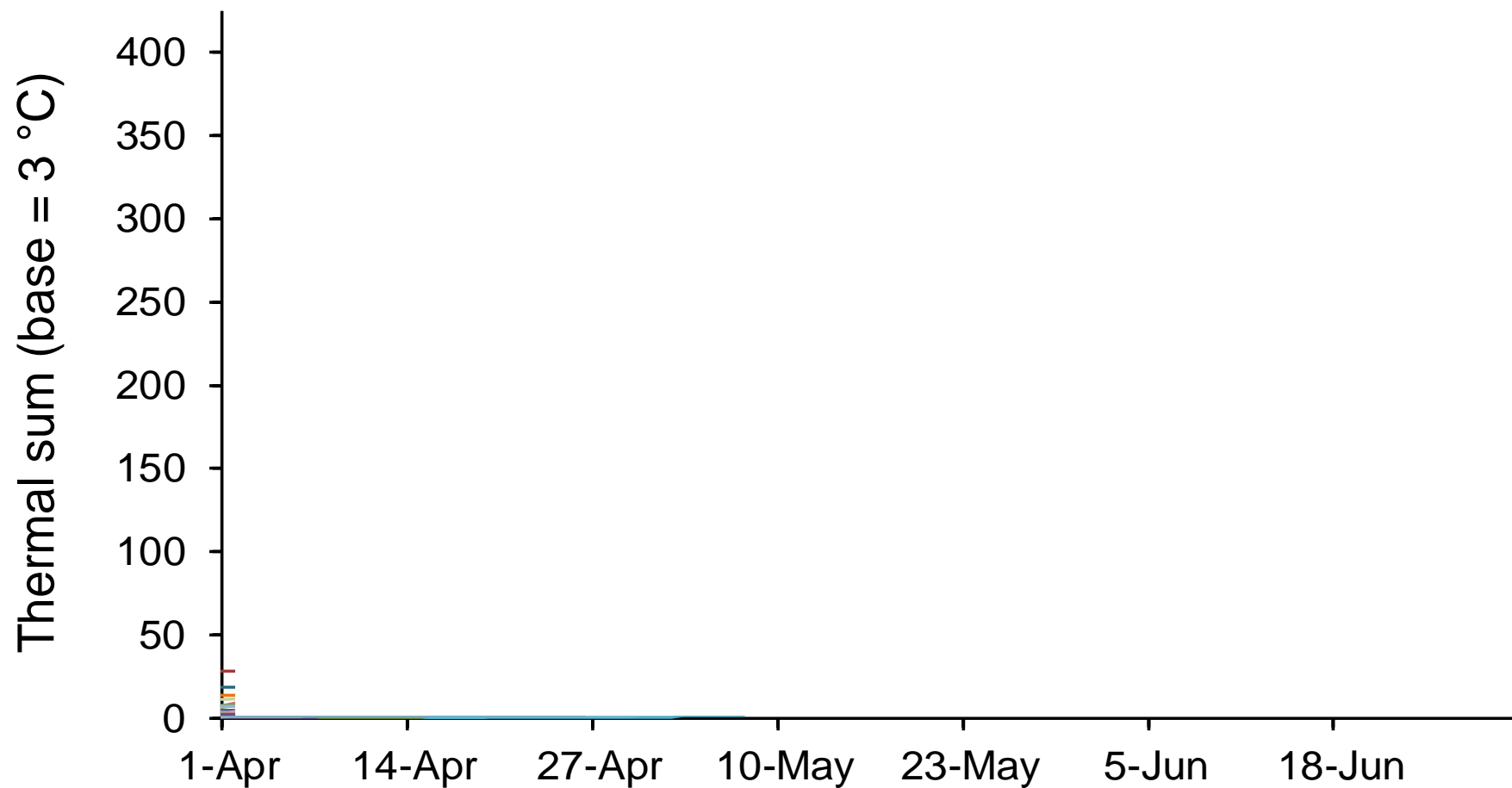


Black pond 2015

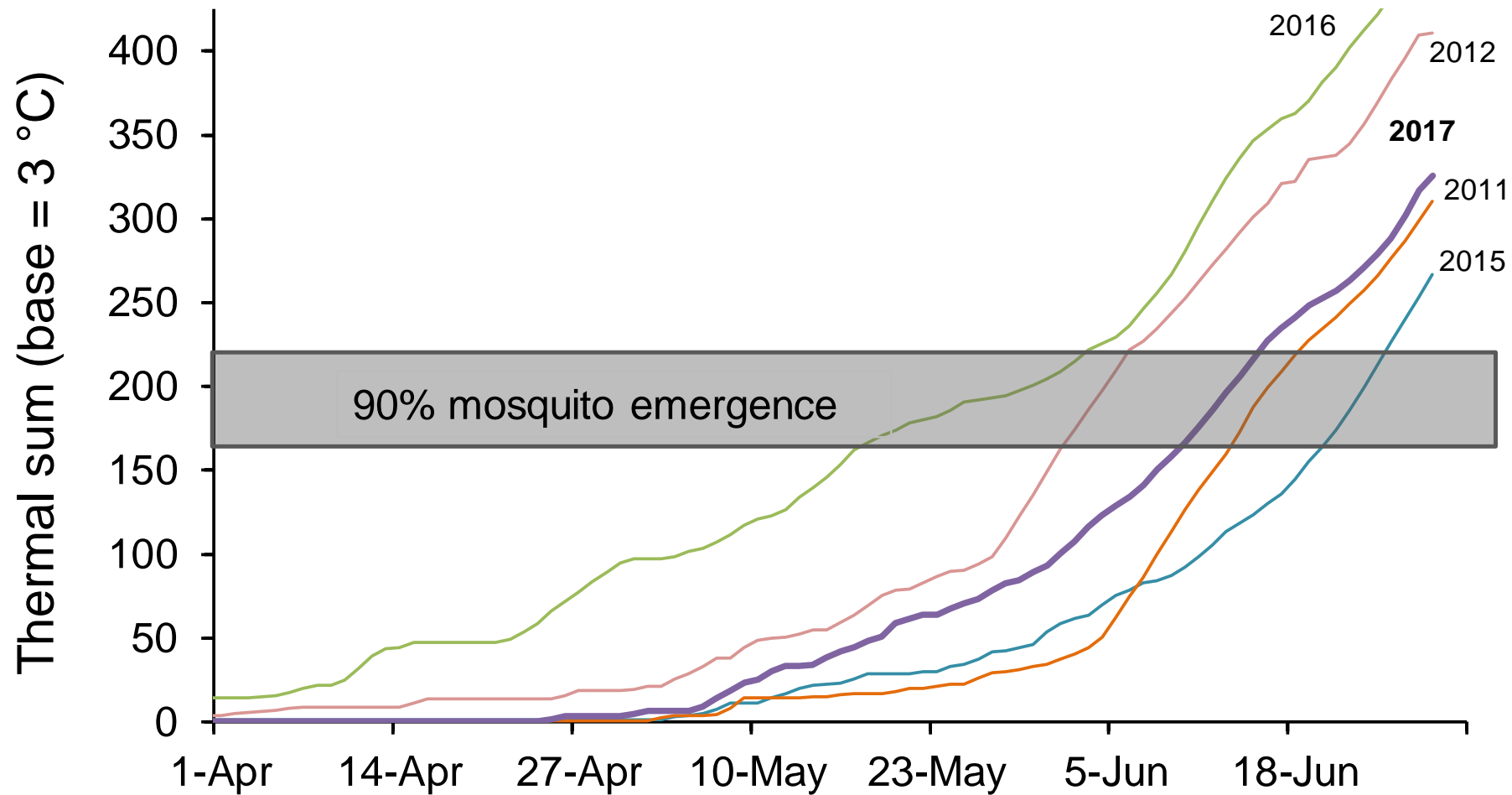


Abiotic  
Density-Independent  
Phenology

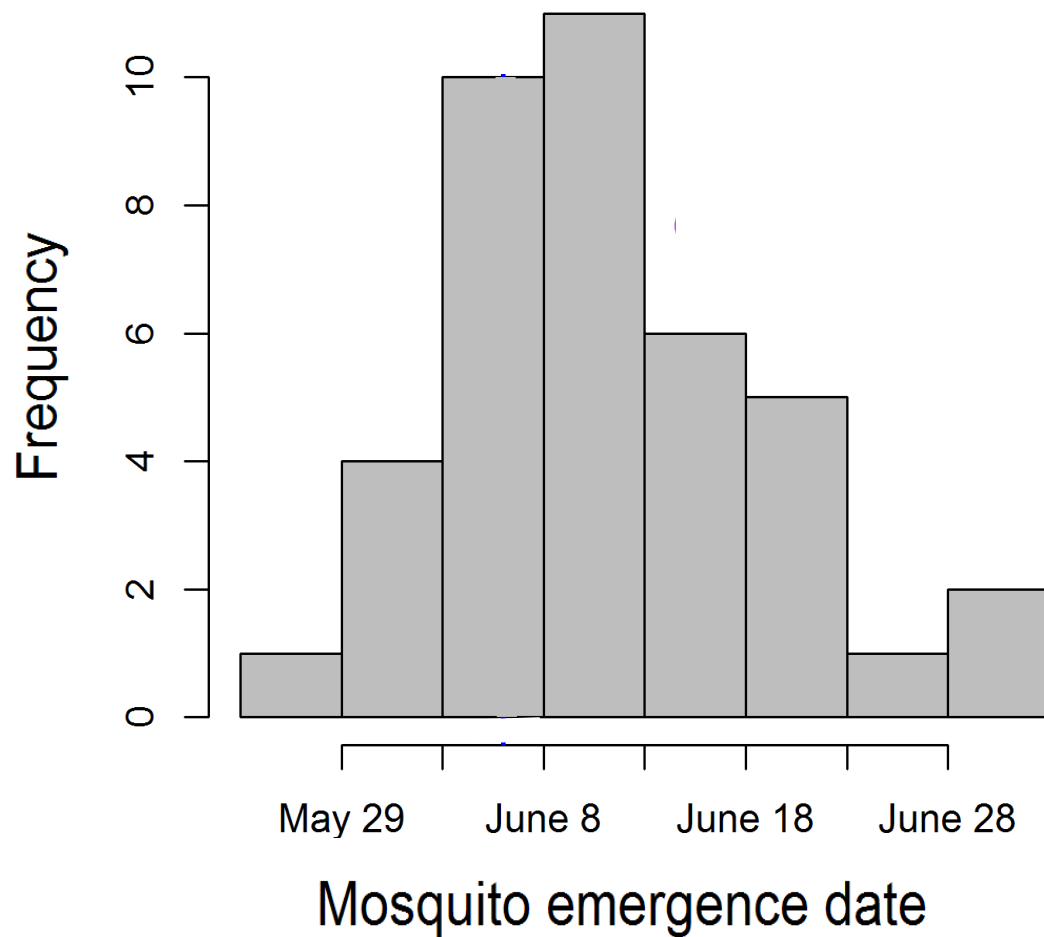




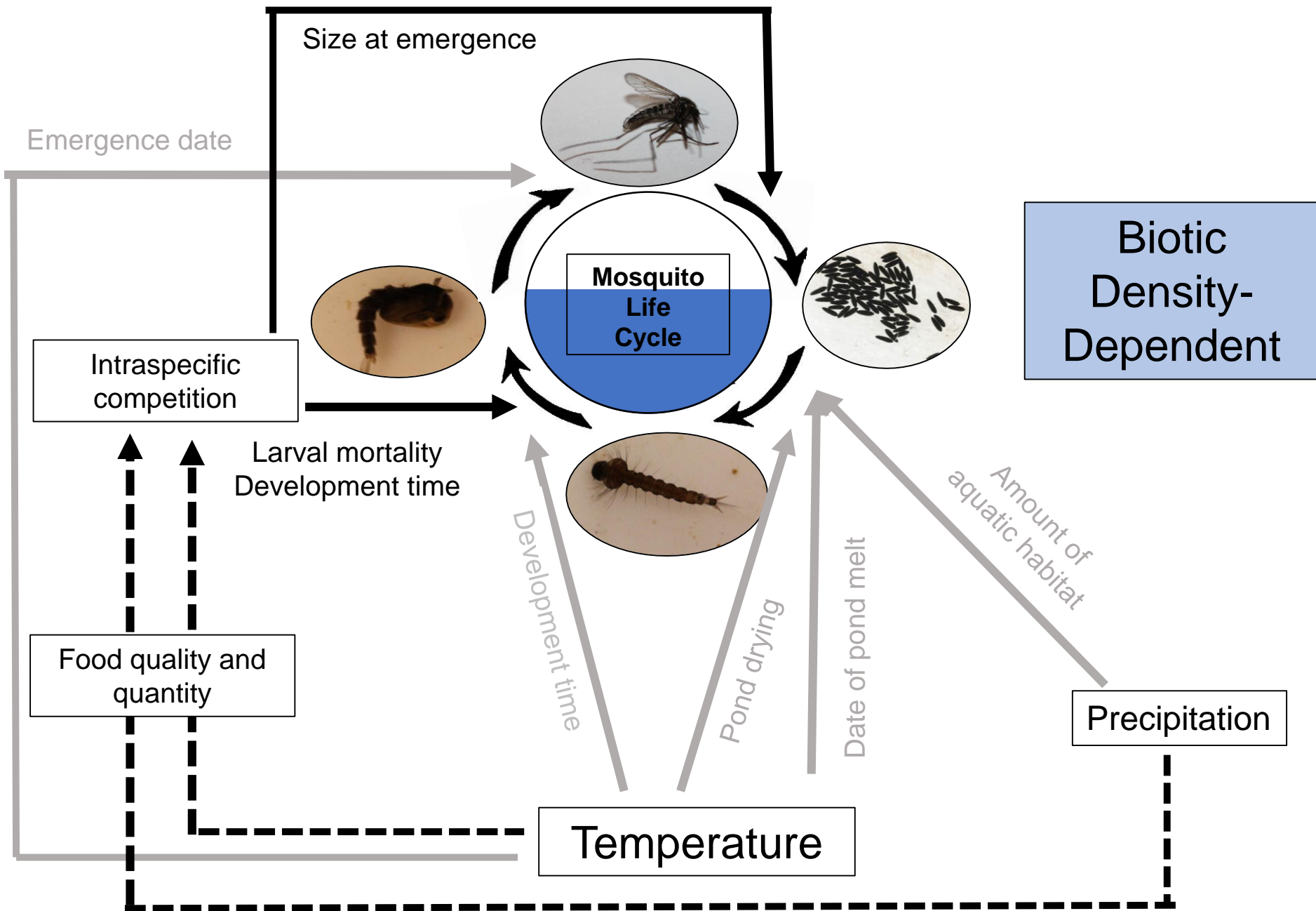




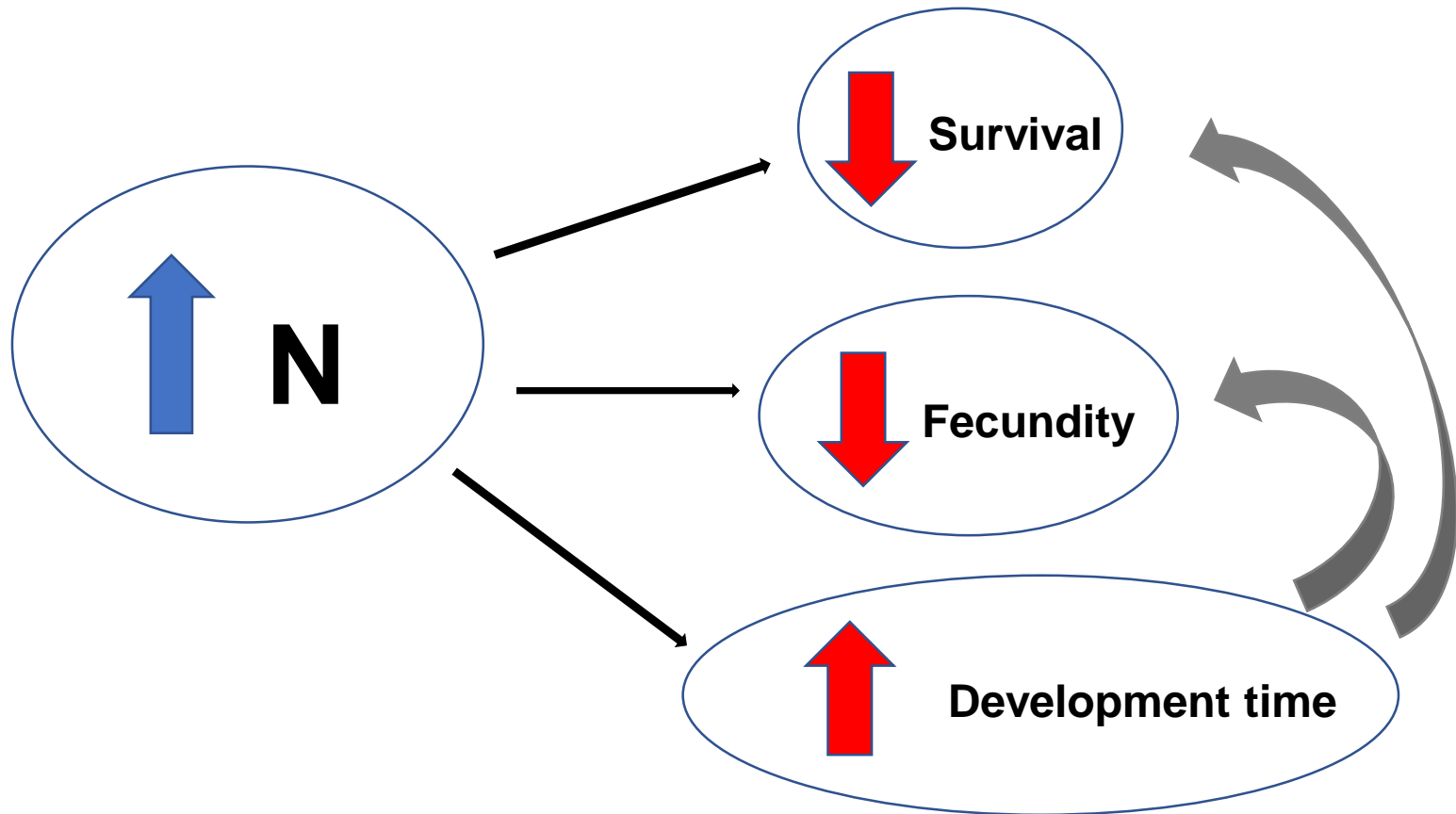
Modeled  
emergence date  
1974-2017







How are Arctic mosquito populations regulated by density-dependent processes during immature development?





# How are Arctic mosquito populations regulated by density-dependent processes during immature development?

Abundance surveys  
across ponds

2011, 2012, 2017, 2018



Lab experiments



Field experiments



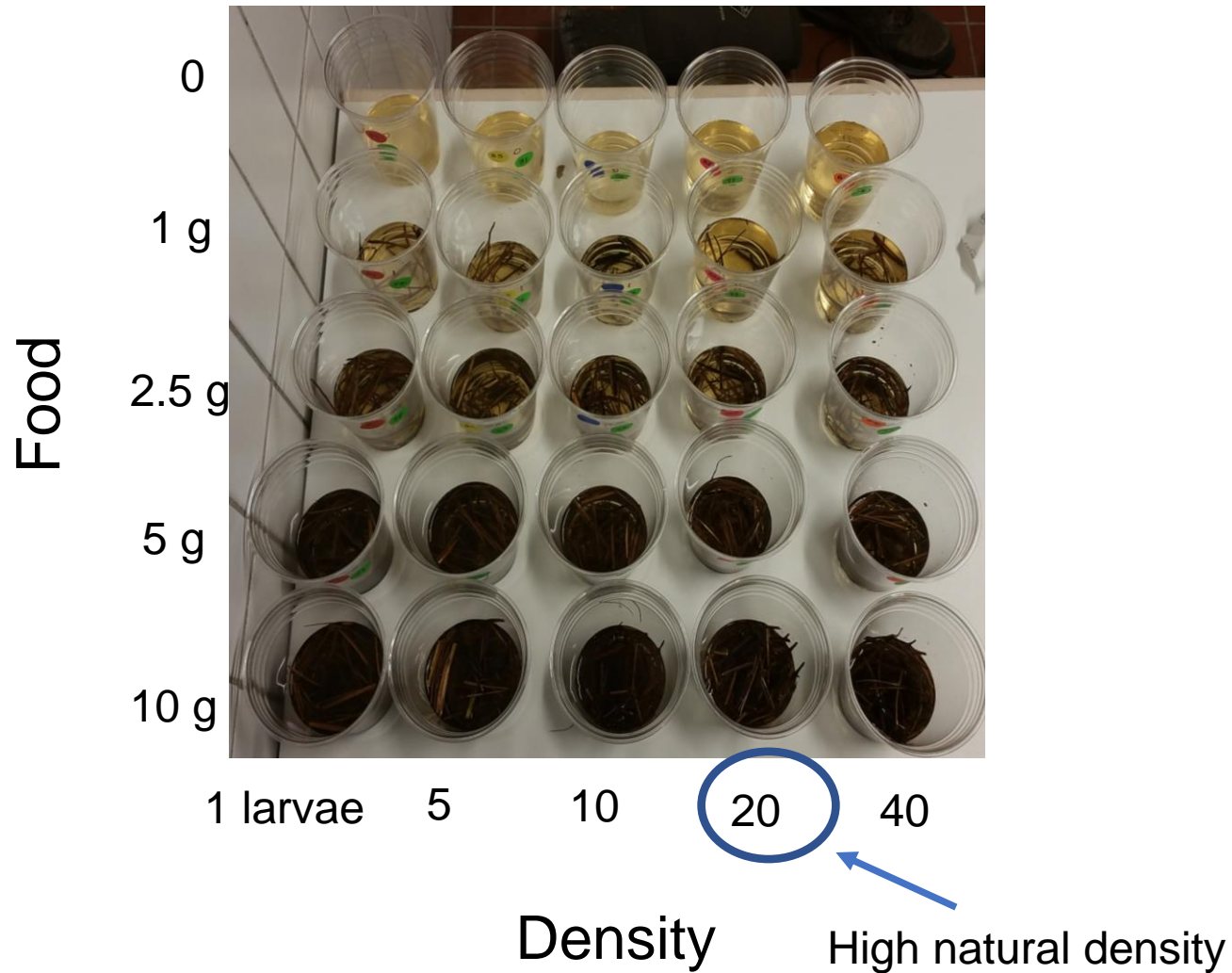
What is the strength of density-dependent mortality due to intraspecific resource competition?



- Collected 1<sup>st</sup> instar larvae from field
- Manipulated larval densities and amount of food (g of plant detritus)
- Temperature chambers set at 9° C
- Counted # live larvae every 3 days.

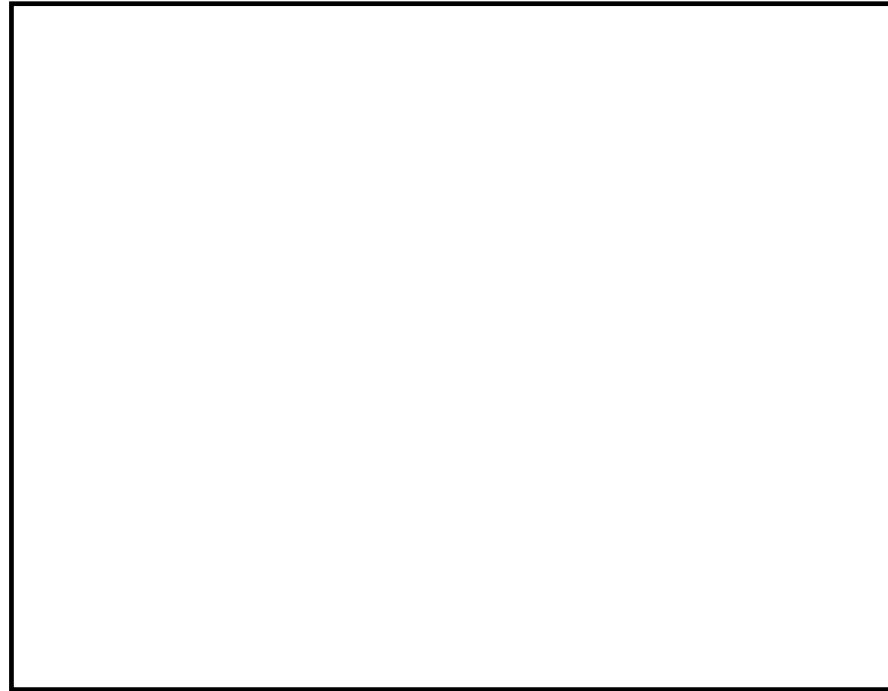


# Resource competition lab experiment





Density after 2 weeks



Density at beginning of experiment



1 larvae

5

10

20

40

Food

10 g

5 g

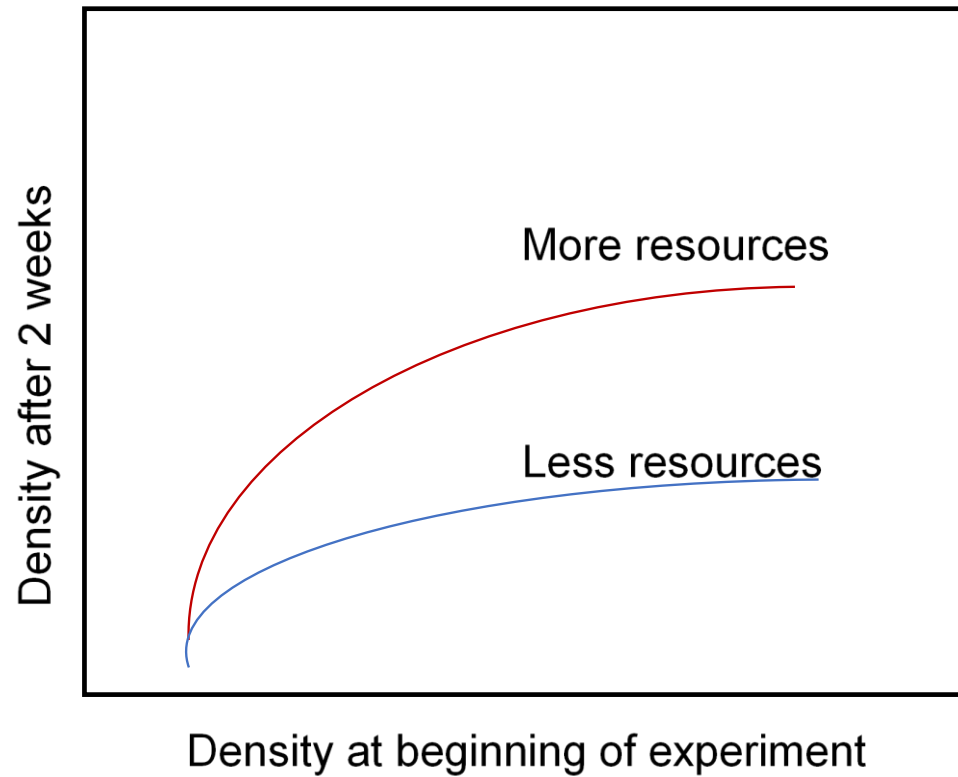
2.5 g

1 g

0 g



# Theoretical model 1:



Food

10 g

5 g

2.5 g

1 g

0 g



1 larvae

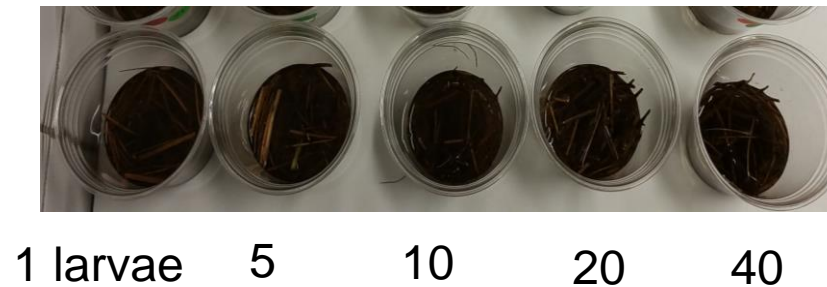
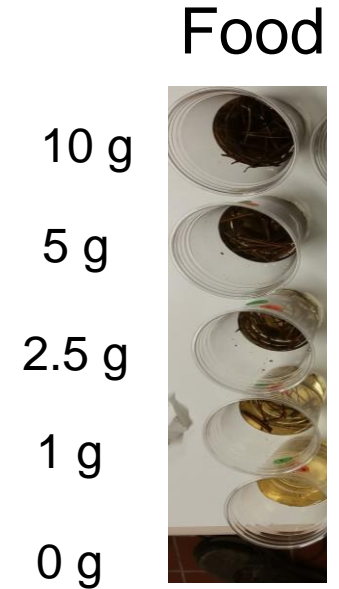
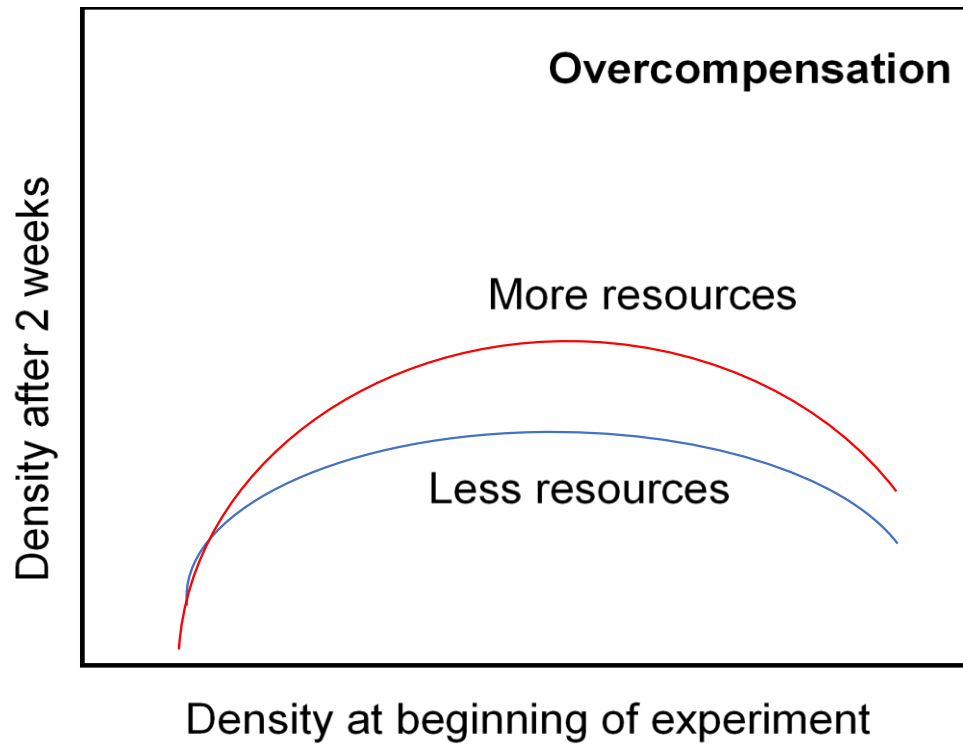
5

10

20

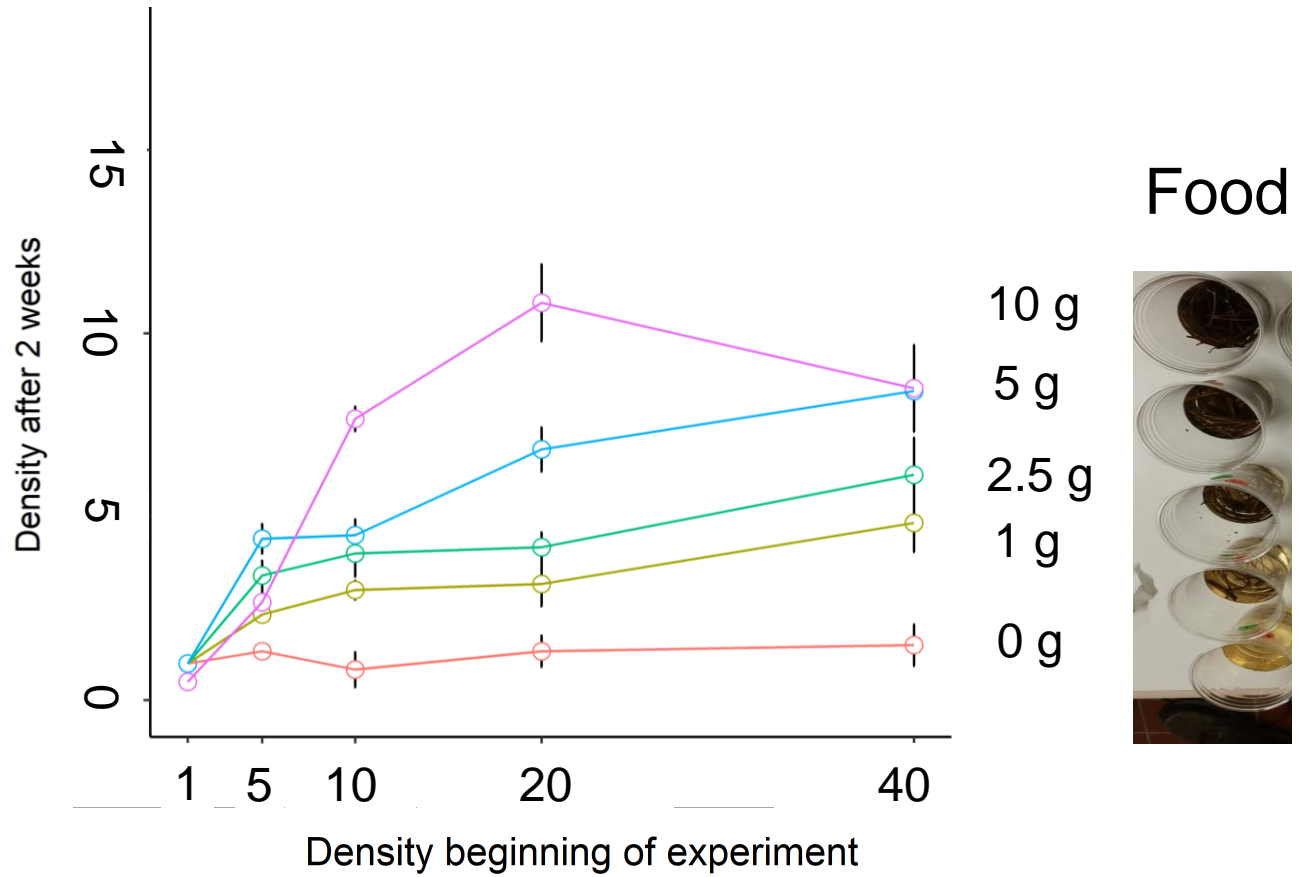
40

## Theoretical model 2:



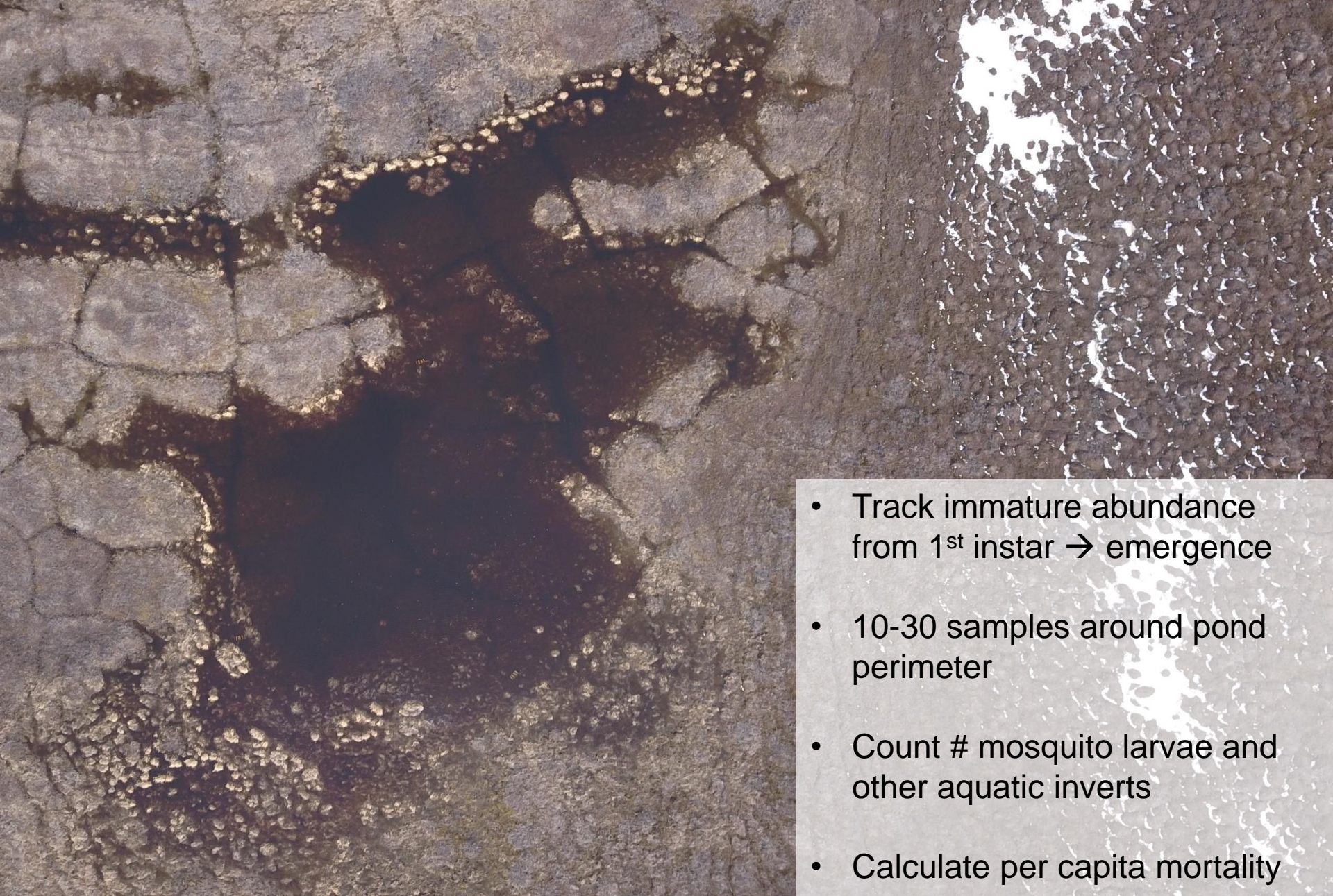


# Results: Resource competition experiment





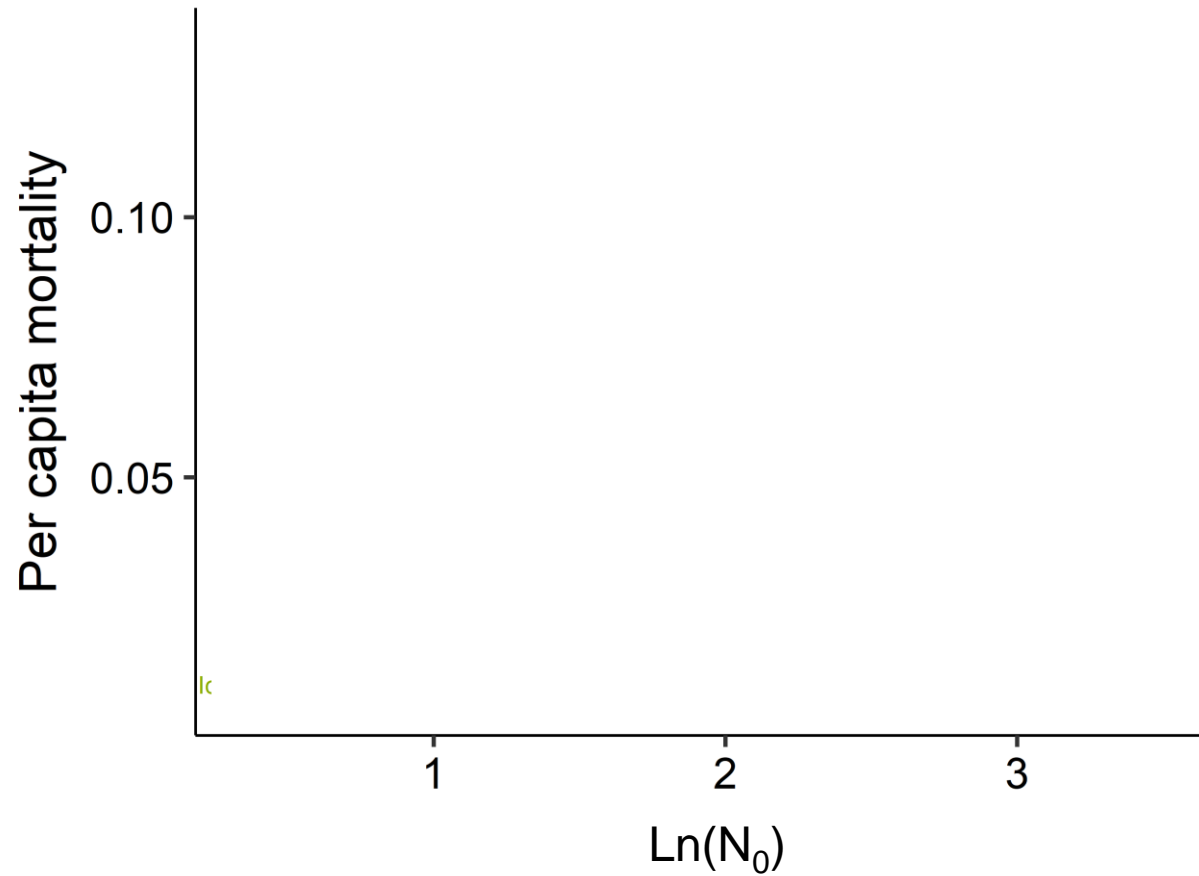
Is there evidence for strong density-dependence in nature?



- Track immature abundance from 1<sup>st</sup> instar → emergence
- 10-30 samples around pond perimeter
- Count # mosquito larvae and other aquatic inverts
- Calculate per capita mortality

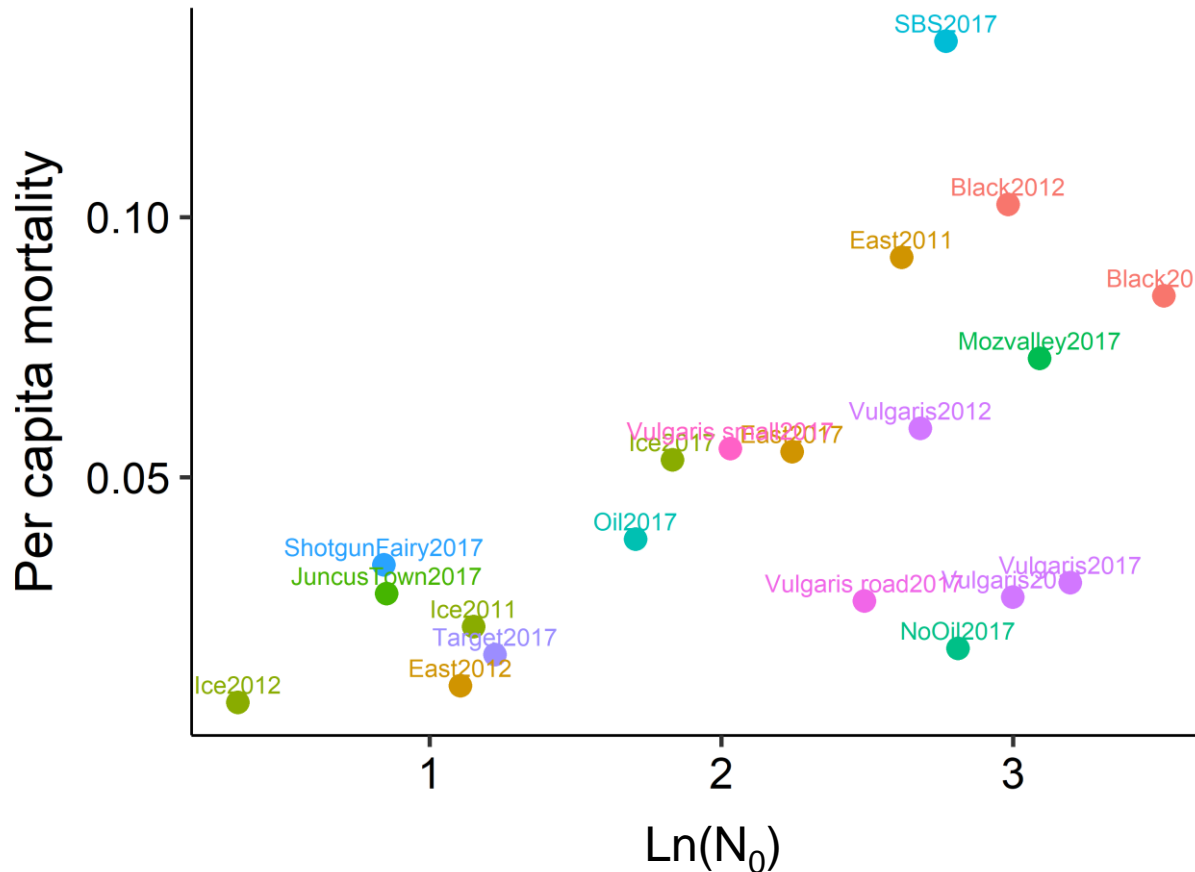


Is there evidence of increased mortality with more individuals?

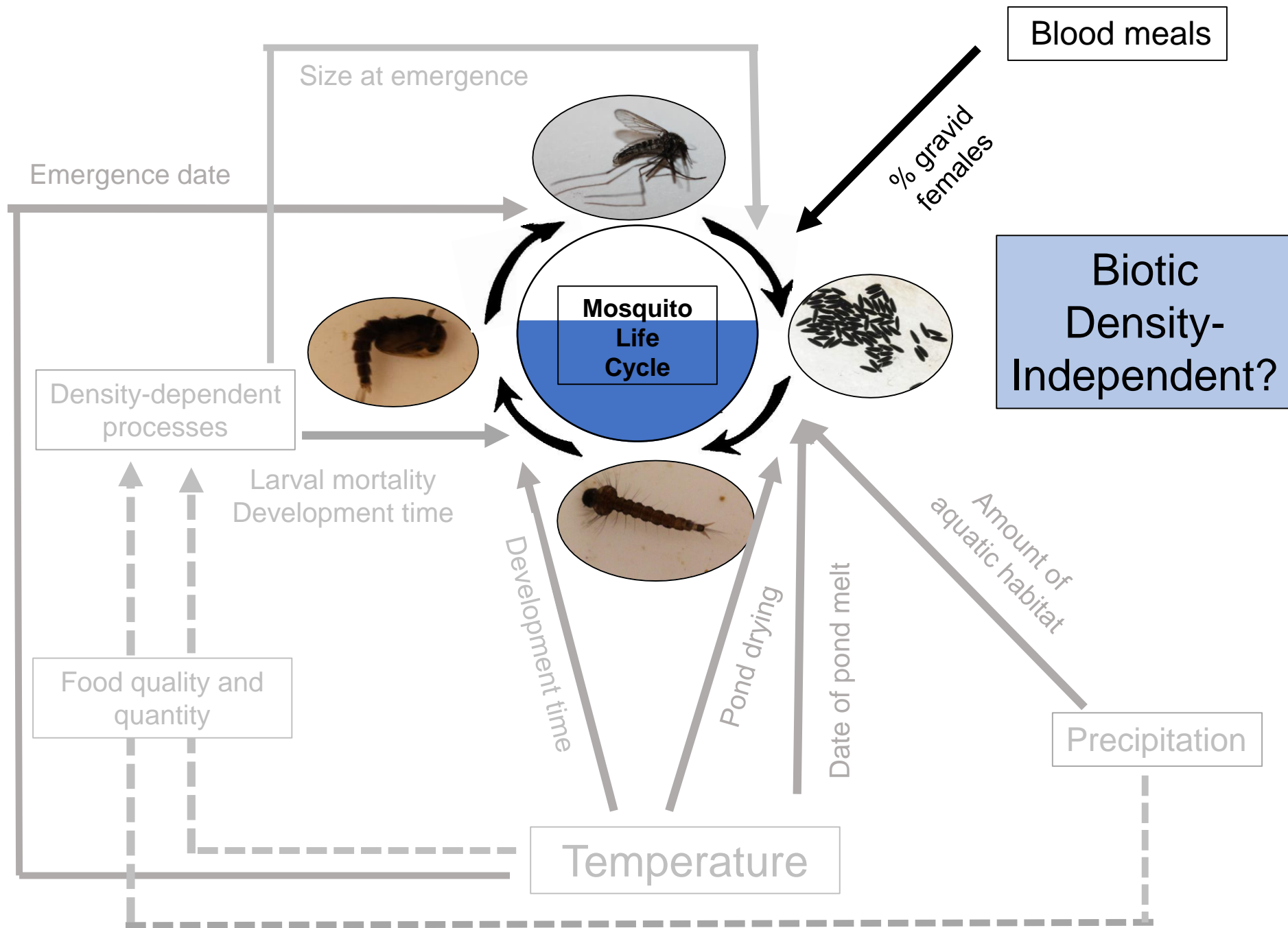




Is there evidence of increased mortality with more individuals?



- **Strong evidence for negative density dependence**
- **Could increased variance be accounted for by resource base?**



## Spatial heterogeneity in the abundance and fecundity of Arctic mosquitoes

LAUREN E. CULLER <sup>1,2,3,†</sup> MATTHEW P. AYRES,<sup>2,3</sup> AND ROSS A. VIRGINIA<sup>1,2</sup>

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Dr. Lauren Culler



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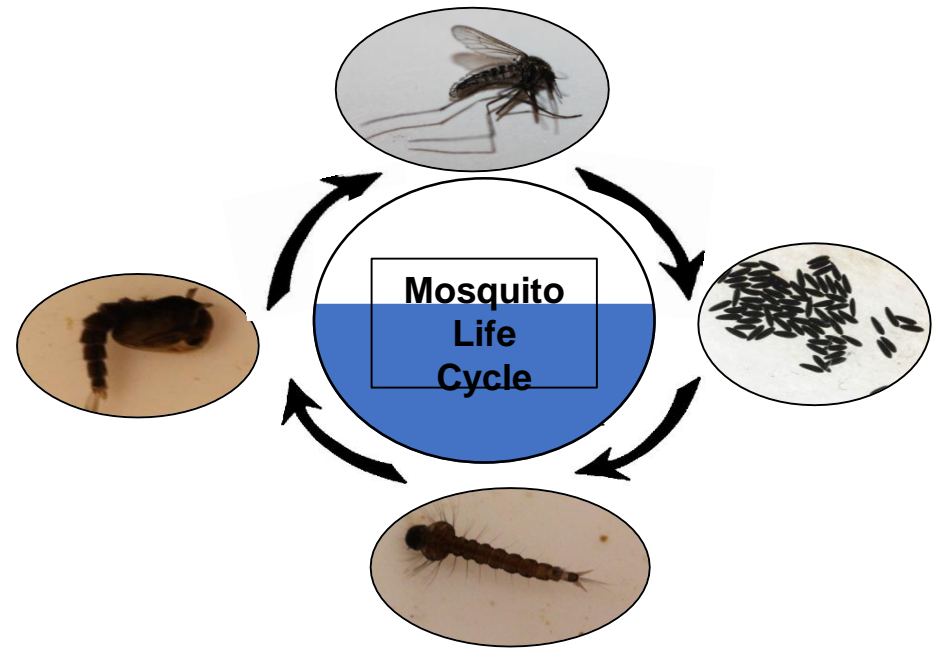
Table 1. A summary of data, model inputs, and simulations.

Data	Pond 1	Pond 2	Pond 3	Pond 4	Town
Number <sub>t</sub>	219	134	1470	68	1654
Proportion(gravid)	0.19	0.22	0.43	0.01	0.07
#eggs gravid	49	42	61	51†	53
Number <sub>t+1</sub> , $p(s) = 0.1$	102	62	1928	2	307
Number <sub>t+1</sub> , $p(s) = 0.5$	510	310	9640	9	1534
Number <sub>t+1</sub> , $p(s) = 0.9$	918	557	17,351	16	2761

- **Some places on the landscape are hotspots for population growth**
- **Investigating if source and sink dynamics are correlated w/ landscape features**

# Conclusions

- Arctic mosquito populations highly variable and sensitive to thermal and hydrologic changes
  - Both direct and indirect mechanisms
- Mechanisms range from density-independent to density dependent
- Model system for understanding population dynamics of organisms with complex life cycles (CLCs) in a rapidly changing world





# Acknowledgments

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Governali, Rebecca Finger,  
Hannah Marr, Balt von Huene  
Reyn Hutton

Ayres and Virginia Labs





# Is there evidence for strong density-dependence in nature?

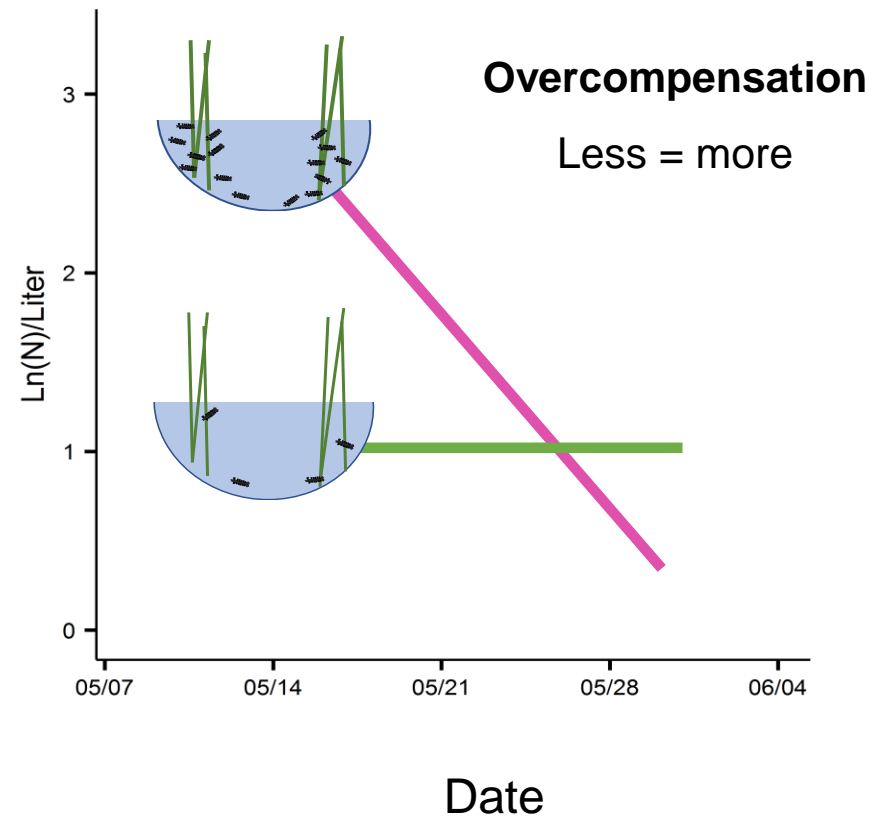
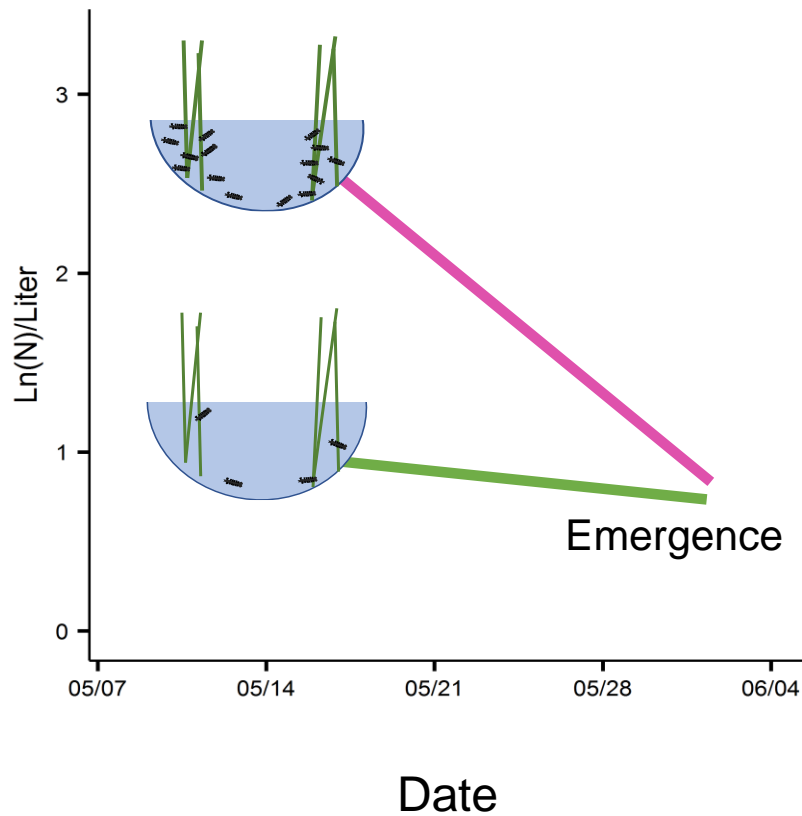


- Environmental gradient from town to the Greenland ice sheet
- 8 ponds surveyed in 2018
- 4 ponds with a 4 year time series (2011-12, 2017-18)



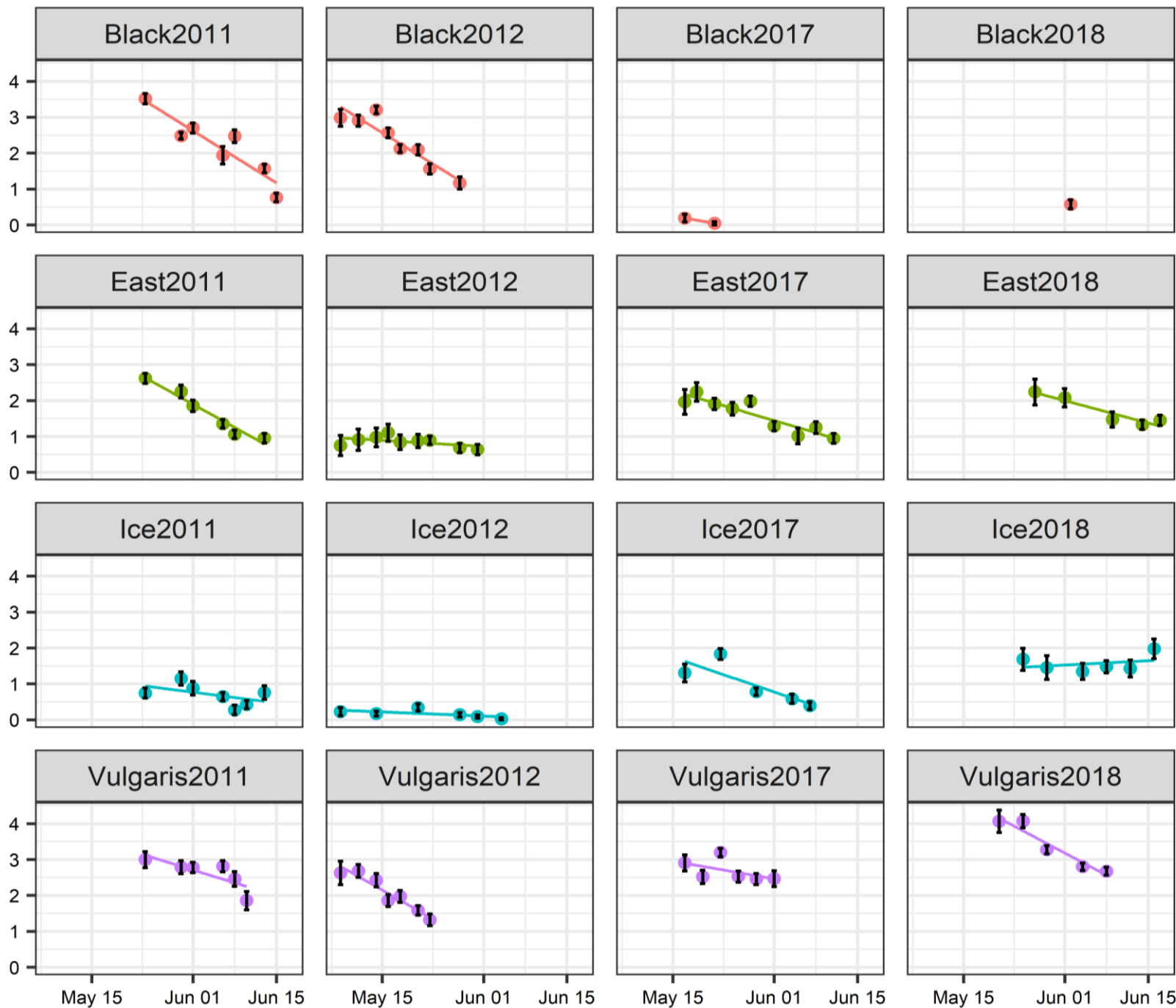
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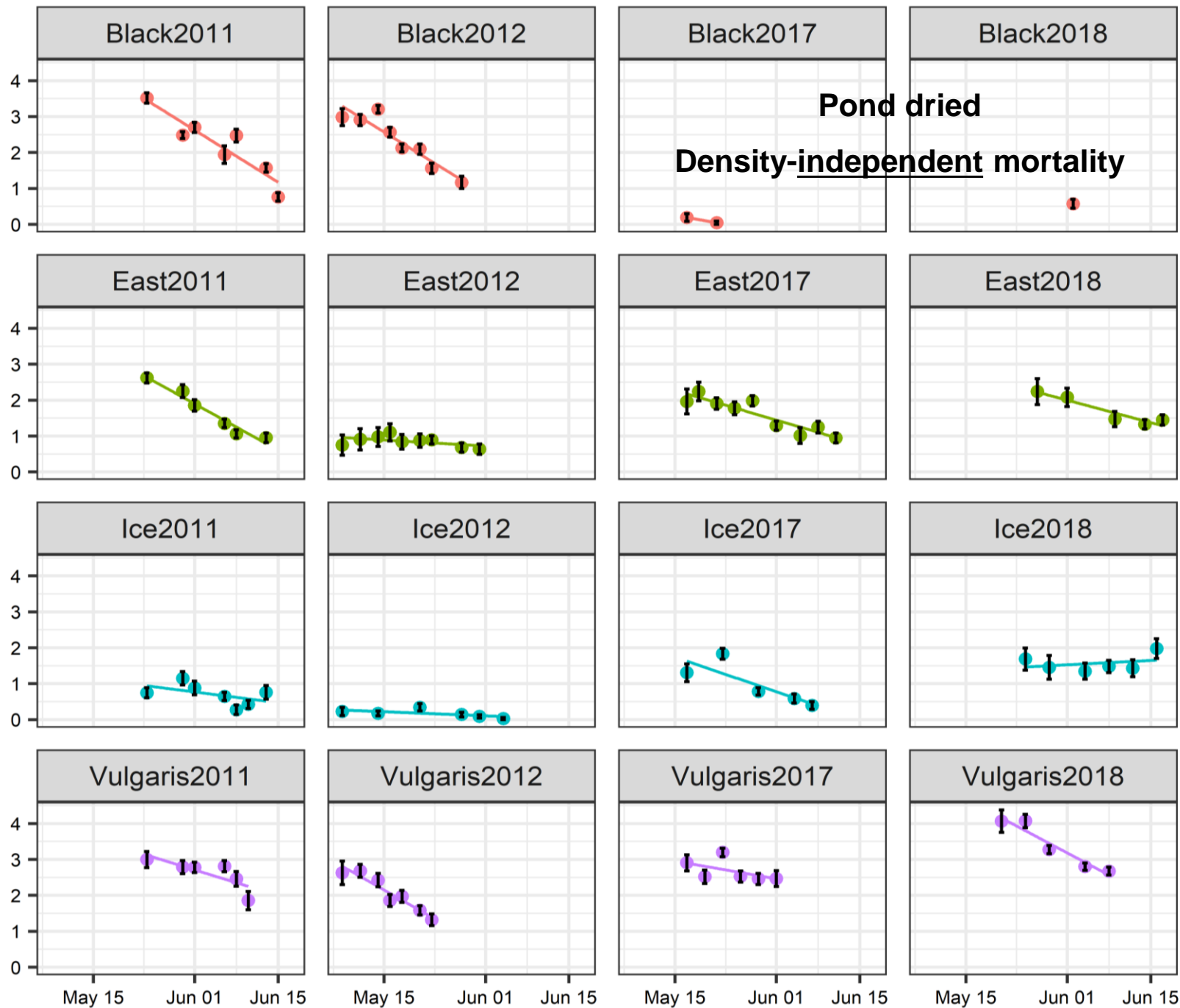


$\ln(1+N/\text{liter})$



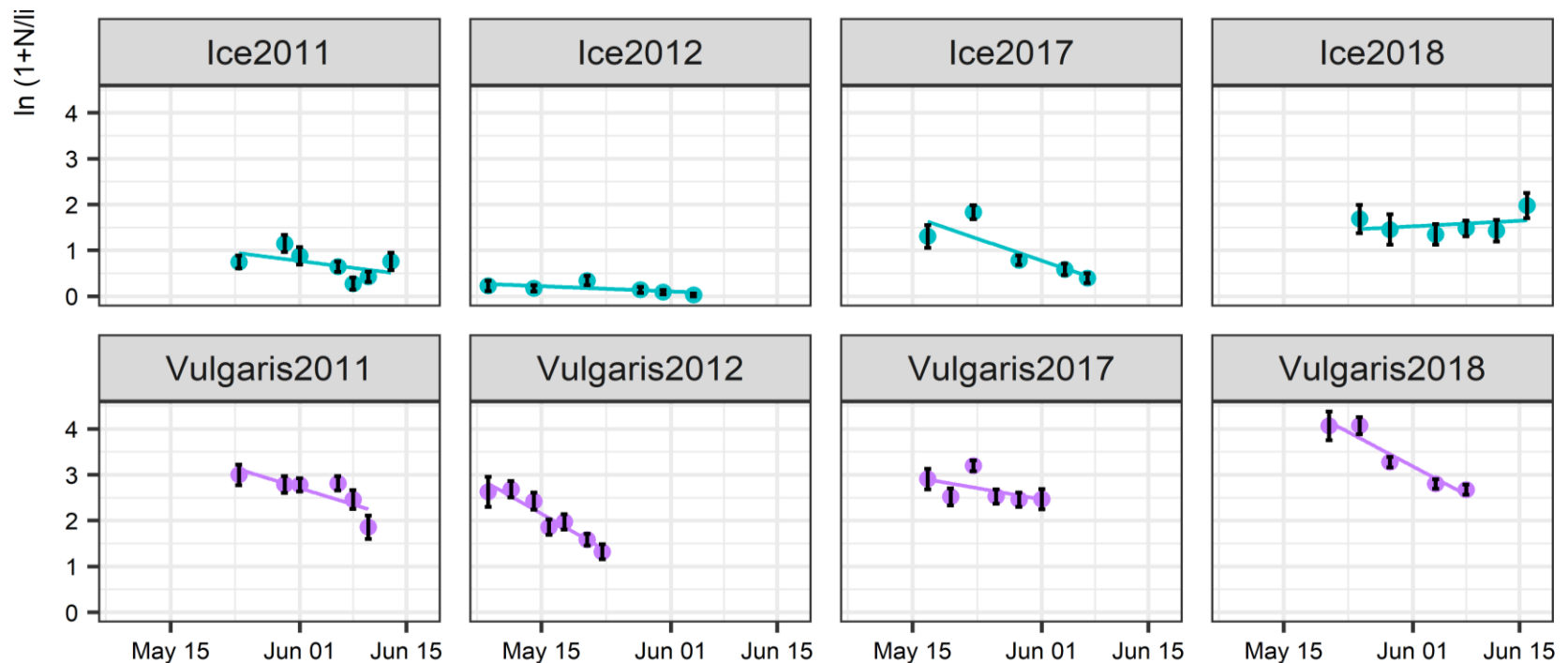


$\ln(1+N/\text{liter})$



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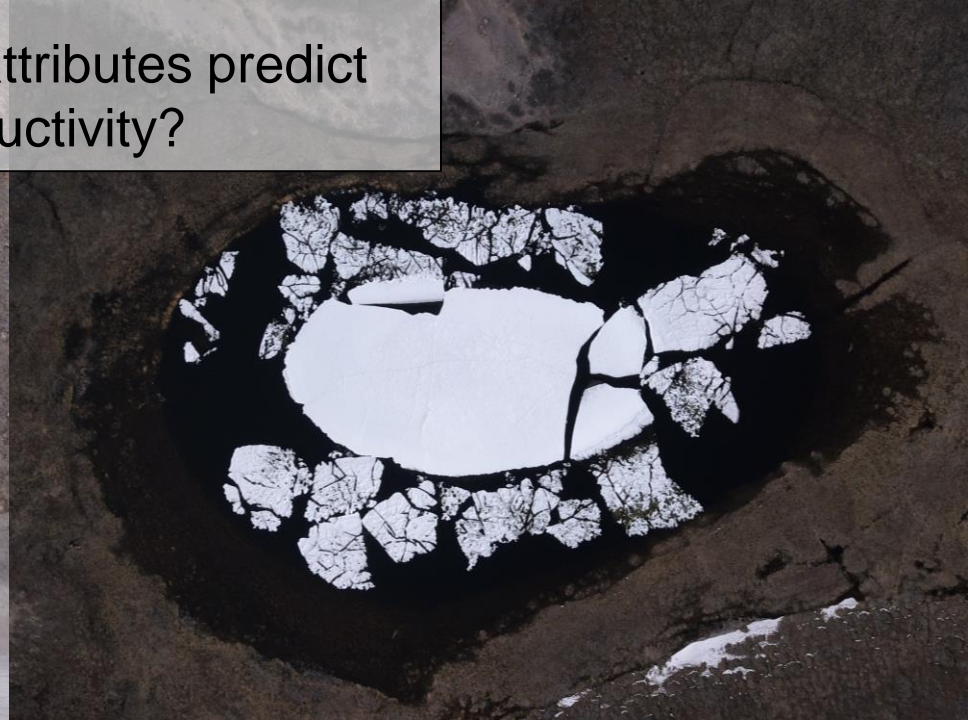
- **Variation in density and per-capita mortality across sites and years**
- **Steeper slopes associated with higher density?**







- How do habitats vary in food resources for mosquito larvae?
- What abiotic attributes predict resource productivity?





# Food resource experiment



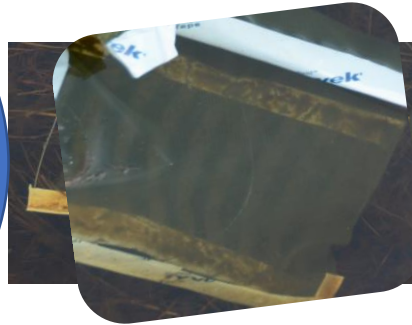
- Established bio-film meters to collect for mosquito larvae right after pond thaw (mosquito hatch)

## Pre

Early biomass of biofilm



## Cage



## No Cage

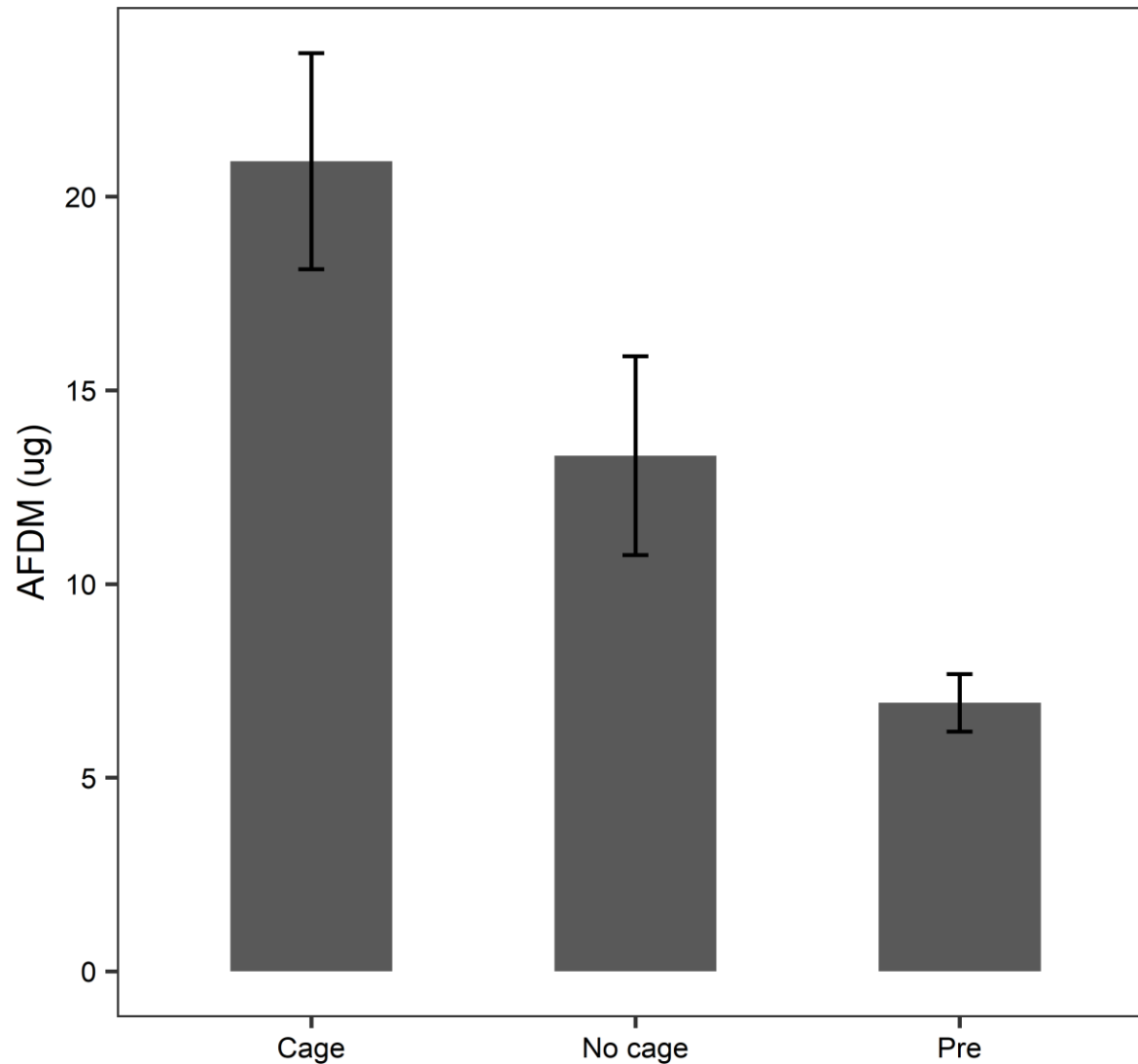
Late biomass of biofilm



- ~10 days later
- Harvested the “Pre” Treatment
- Put a mesh cage around one remaining bio-film meter
  - Mosquitoes excluded, small organisms not excluded







- Biomass of biofilm tends to increase throughout season
- There is higher biofilm biomass when you exclude grazers