Drift-Foraging and Bioenergetics Growth Model for Rainbow Trout in the Lees Ferry Tailwater

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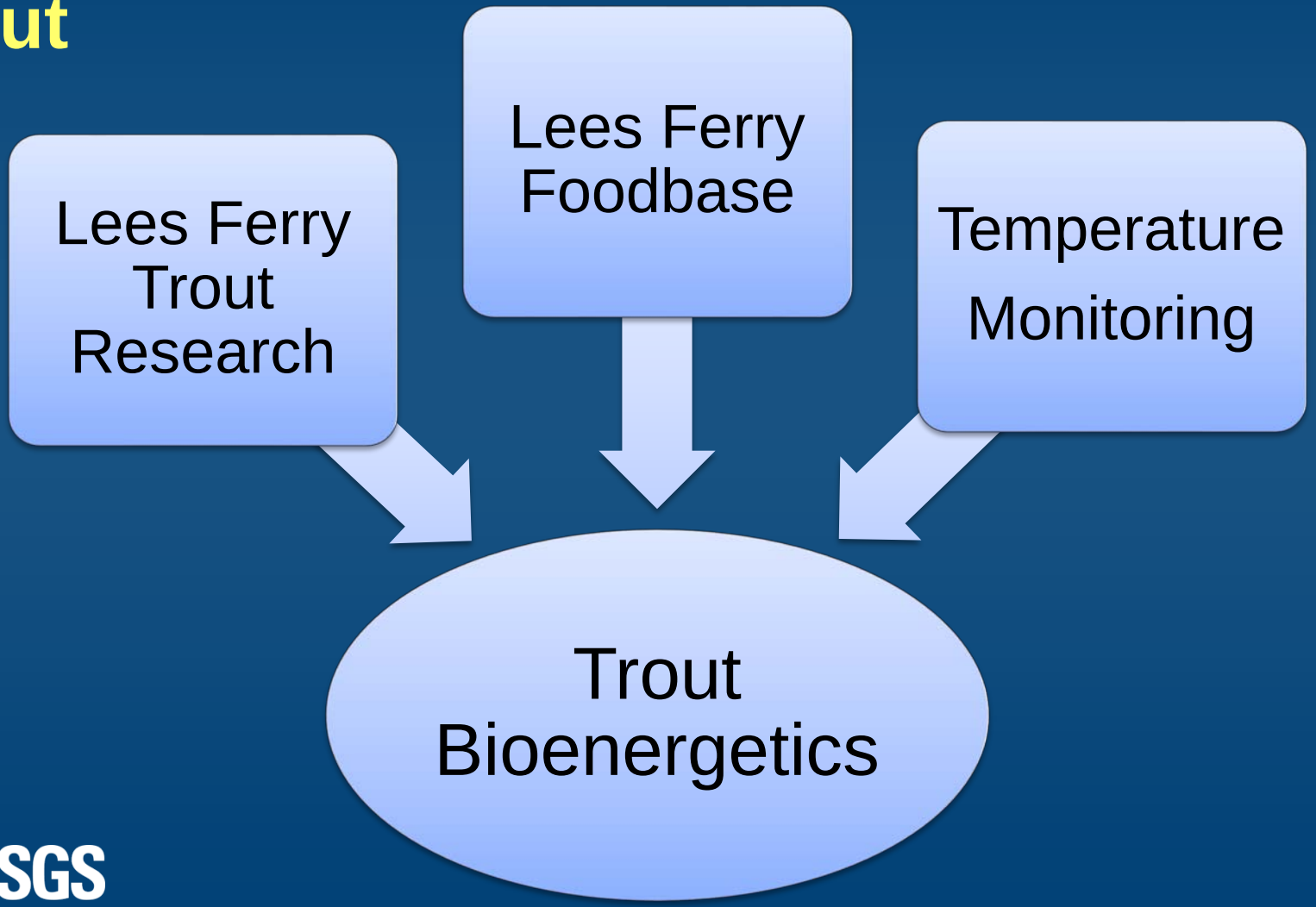
Grand Canyon Monitoring & Research Center

USGS

Project Element H3: Development of a bioenergetics model for large rainbow trout



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Questions:

- How does the prey size distribution influence growth?
- How does the proportion of Gammarus relative to other taxa influence growth?
- How does prey abundance influence growth?
- How do different temperature regimes influence growth?

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Model

Foraging

Consumption
Energetic Costs
– Foraging
– Resting

Bioenergetics

Growth
Metabolism
Waste
Reproduction

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Input

Biological

Invertebrate Drift

Physical

Temperature
Daylight

Parameters

Length – Weight
Bioenergetics
Other…

Model

Foraging

Consumption
Energetic Costs
– Foraging
– Resting

Bioenergetics

Growth
Metabolism
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Model

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Consumption
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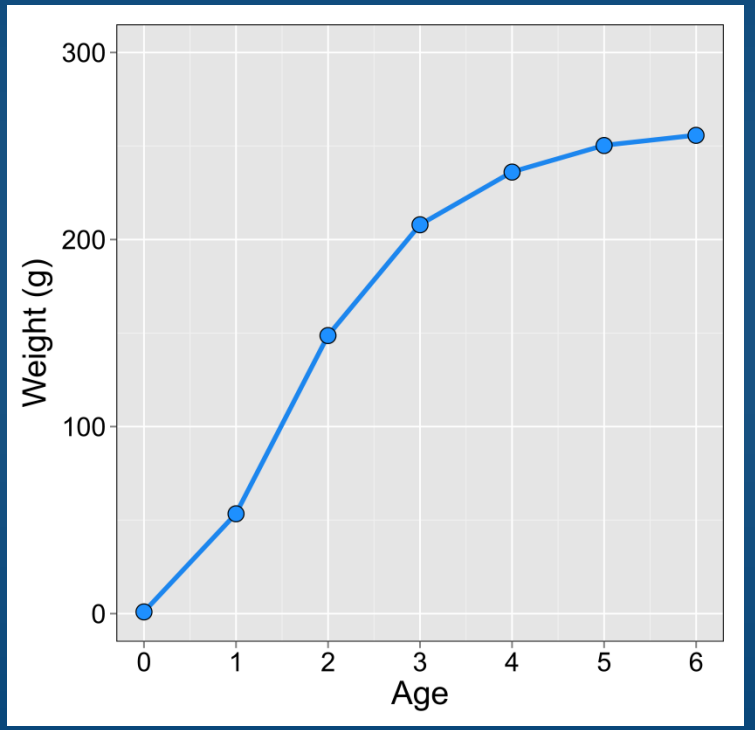
Bioenergetics

Growth
Metabolism
Waste
Reproduction

Output



Model Validation

- **Compare predicted growth with observed**

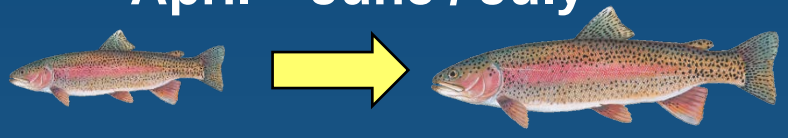
NO Data

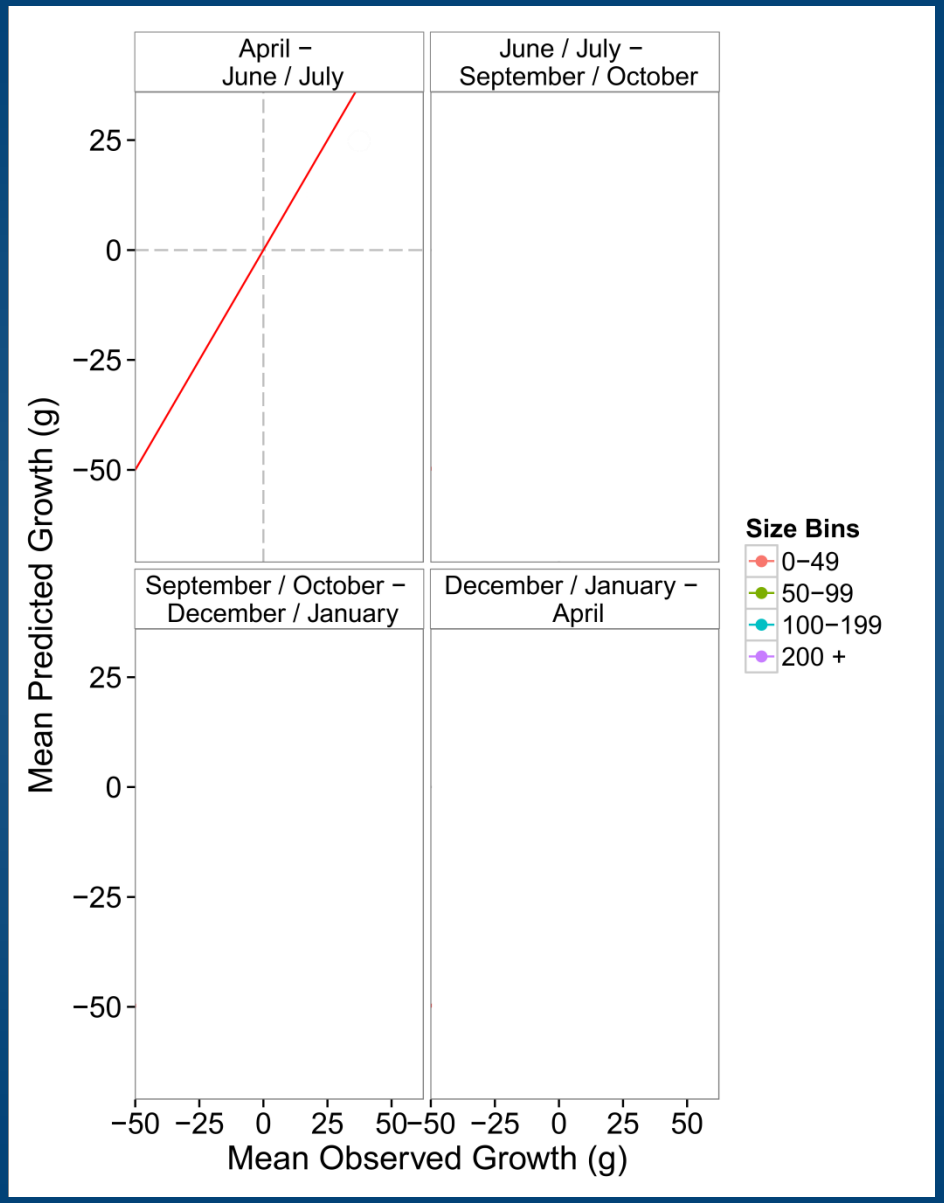
April – June / July

Model Validation

NO Data

April – June / July





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Model Validation

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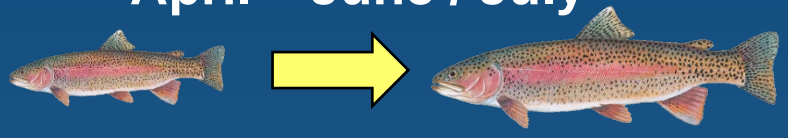
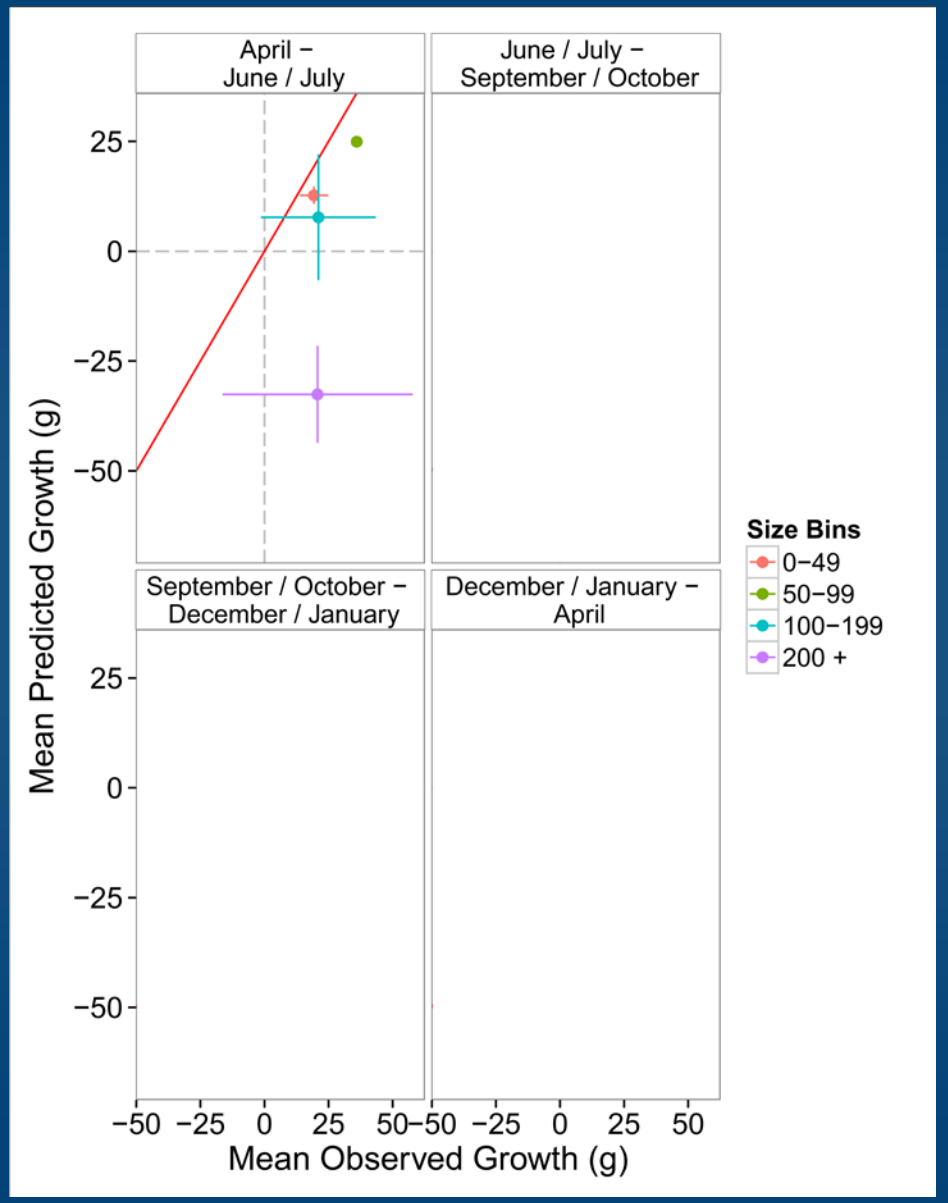
April – June / July





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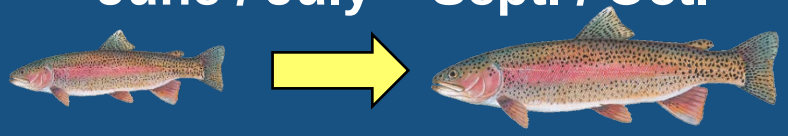
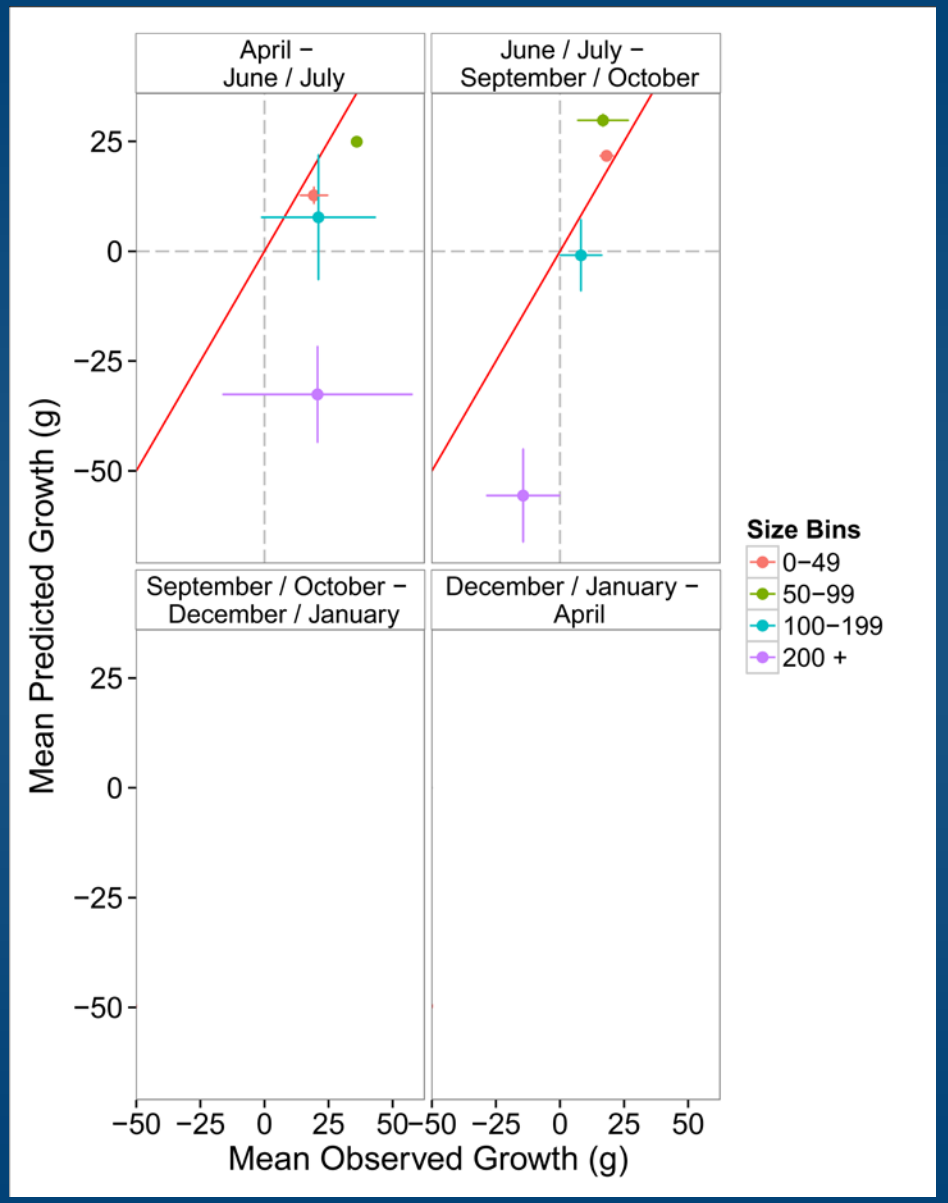
Model Validation

NO Data

April – June / July

June / July – Sept. / Oct.





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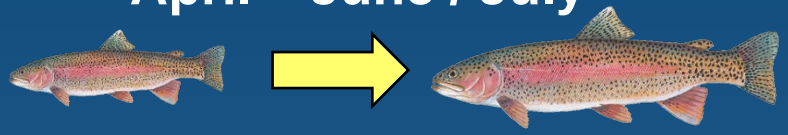
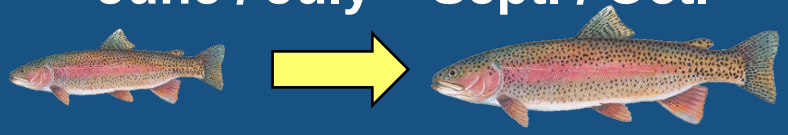
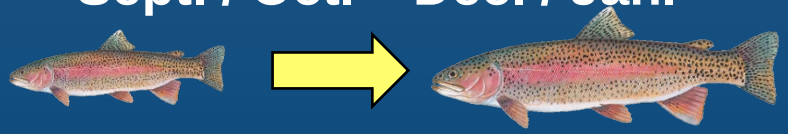
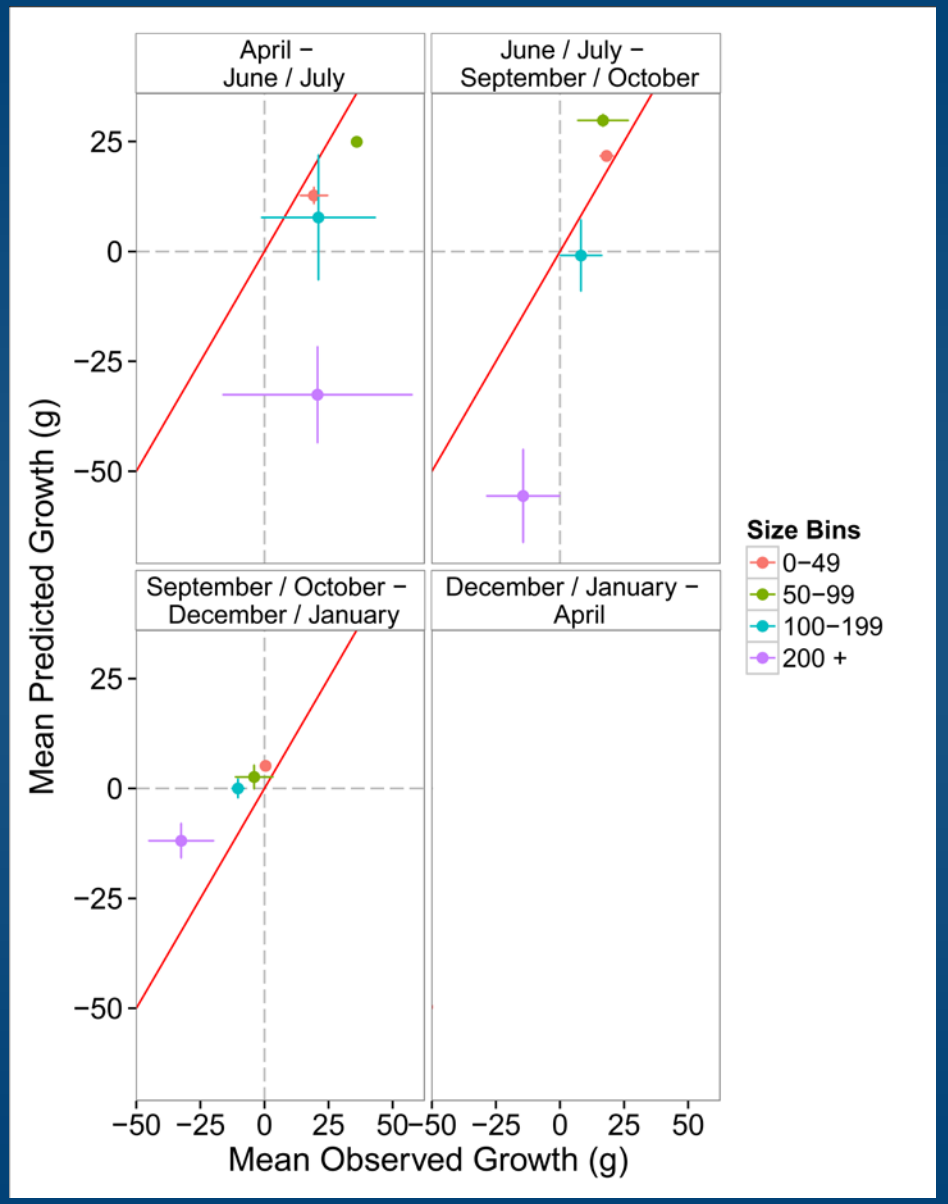


June / July – Sept. / Oct.



Sept. / Oct. – Dec. / Jan.





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Model Validation

NO Data

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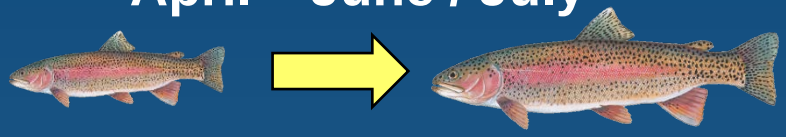
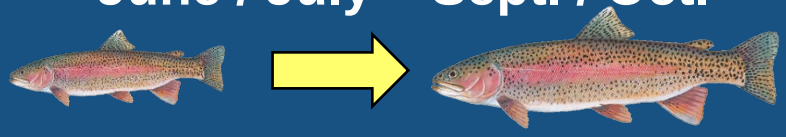
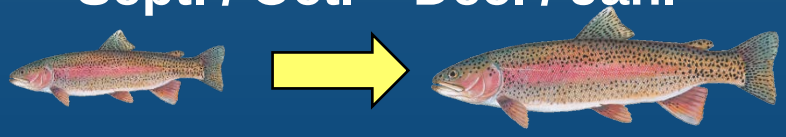


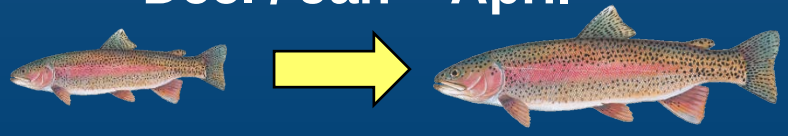
June / July – Sept. / Oct.



Sept. / Oct. – Dec. / Jan.



Dec. / Jan – April



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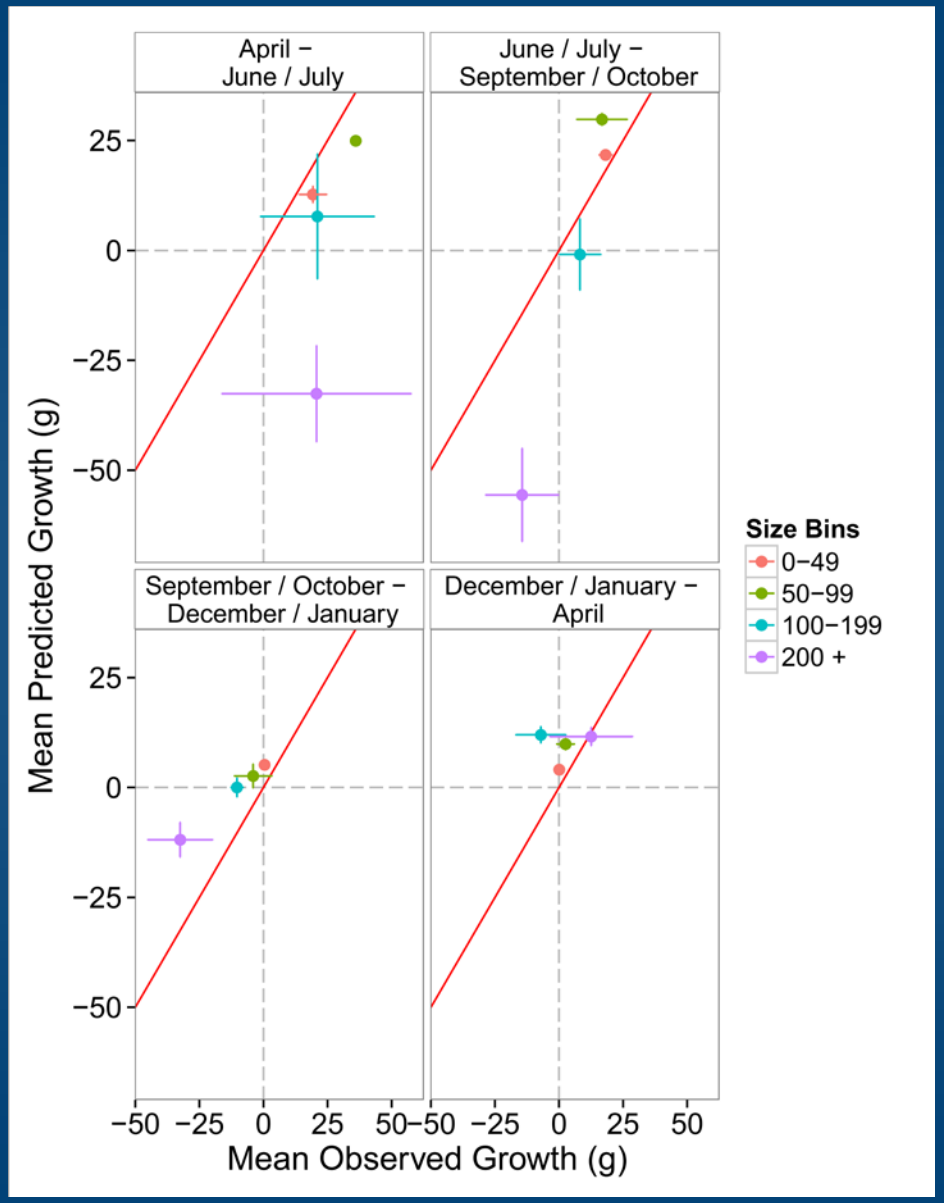
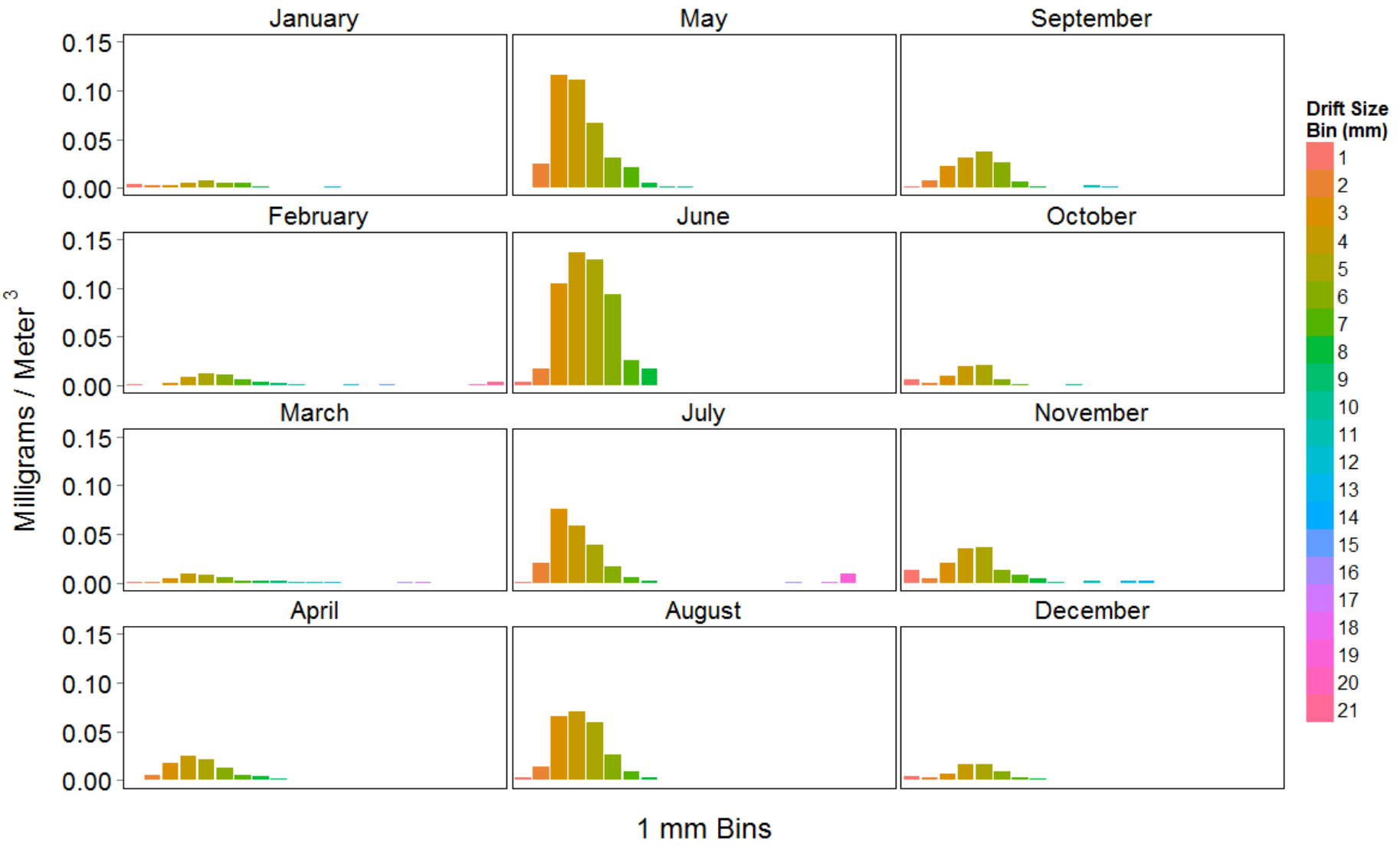
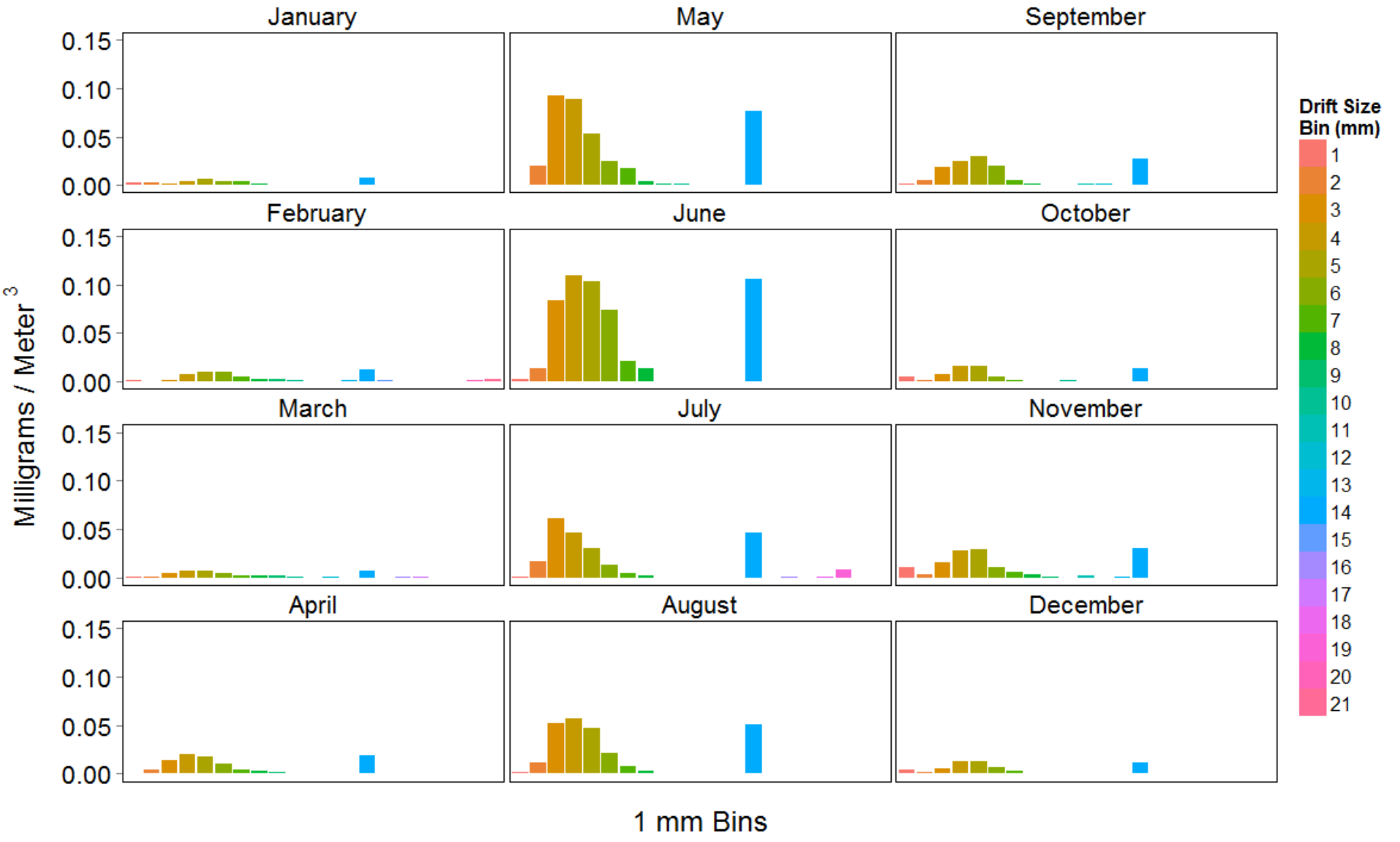


Invertebrate Drift – Size Distribution



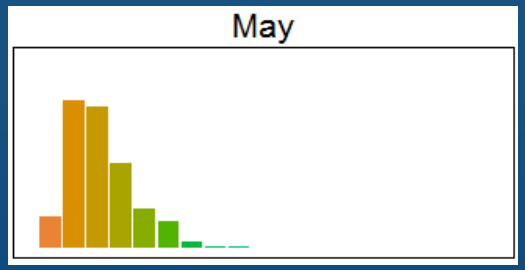
Invertebrate Drift – Size Distribution

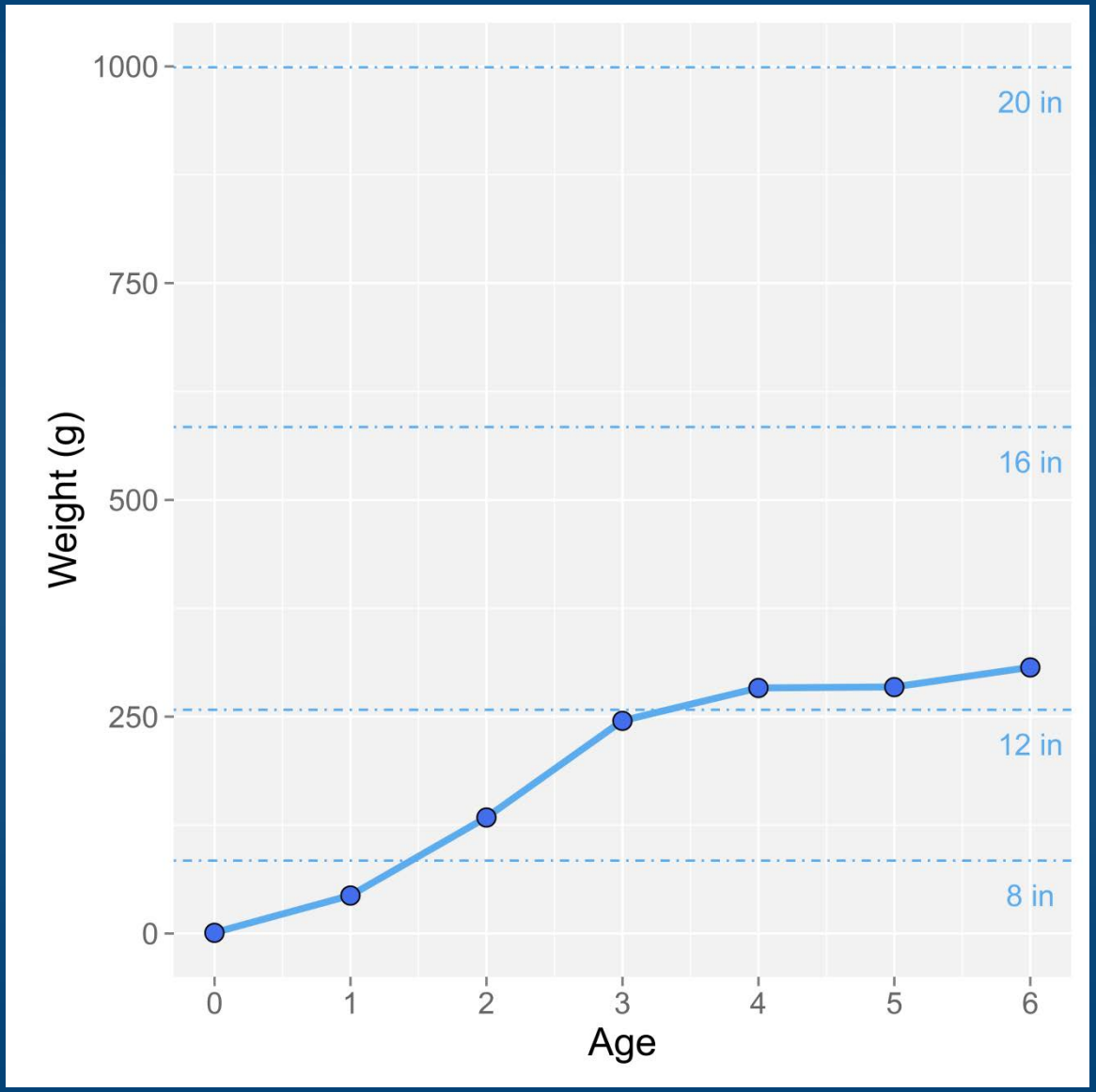


Coupled Foraging and Bioenergetics Model

Lees Ferry

- Current Conditions





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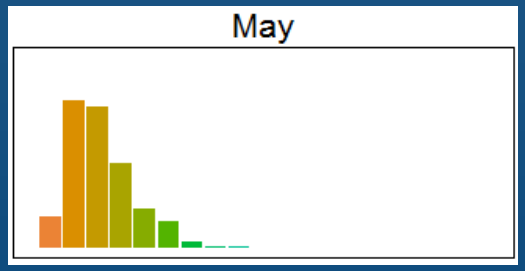
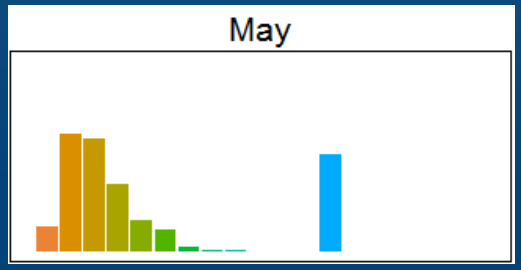
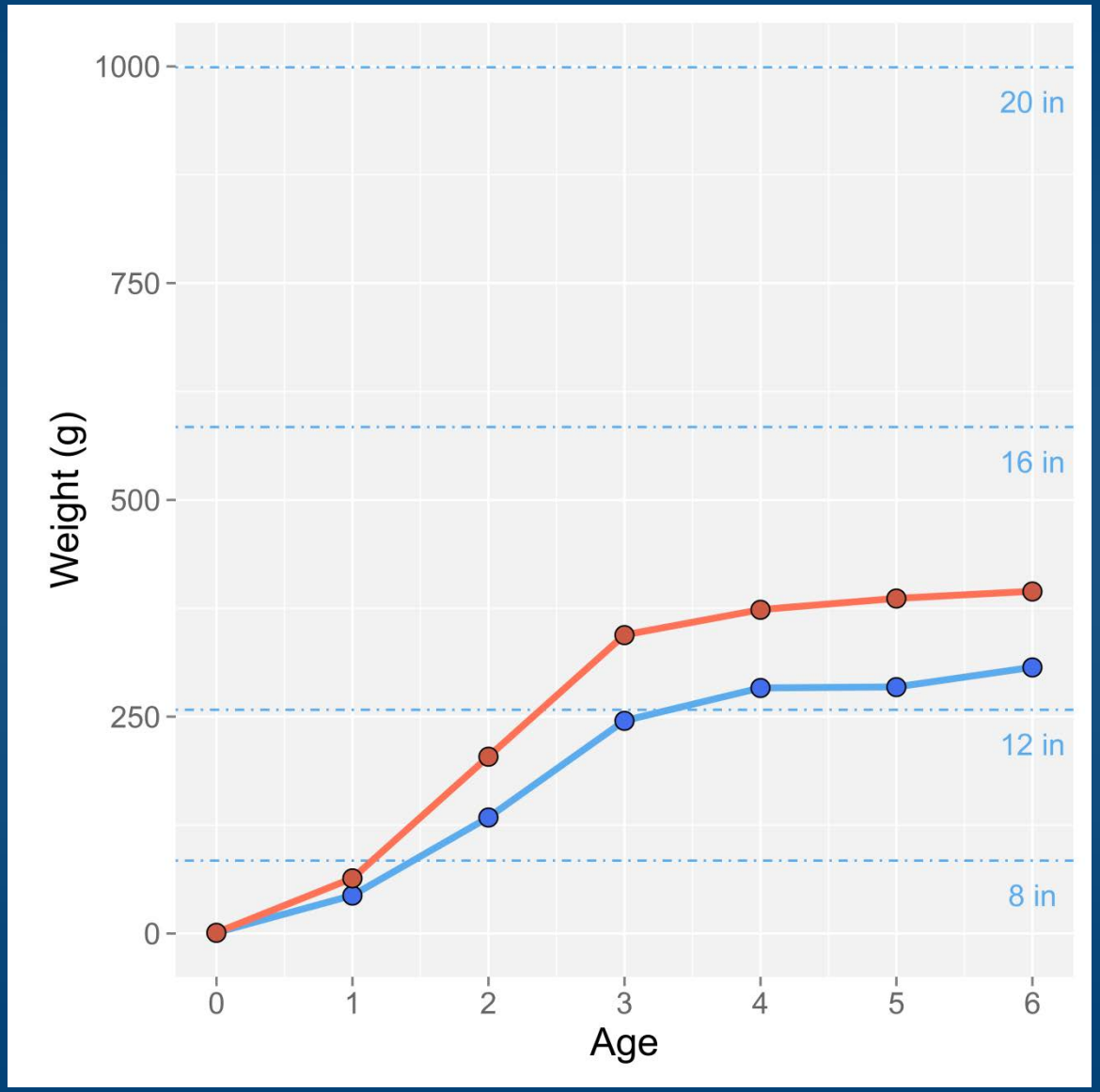
Coupled Foraging and Bioenergetics Model

Lees Ferry

- Current Conditions
- Larger Sized Prey
  - 20% increase in 13mm prey



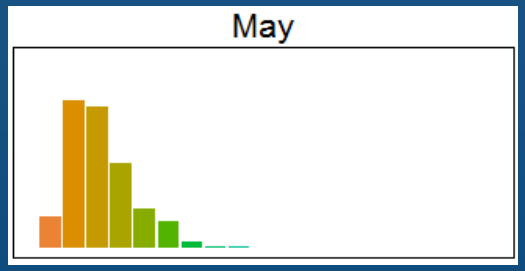


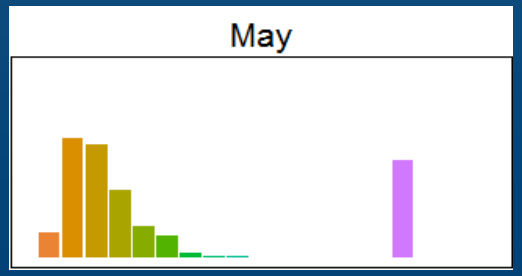


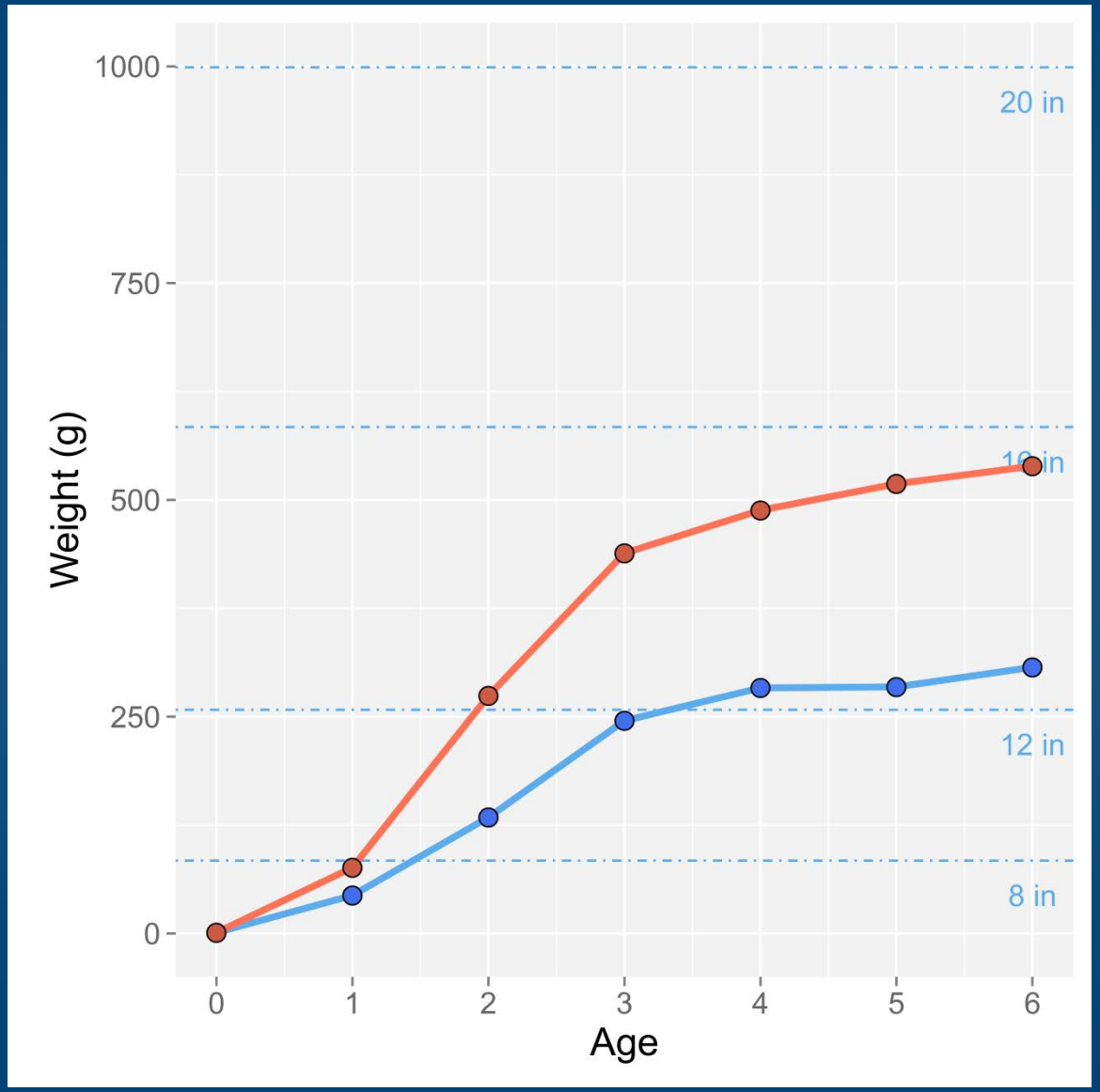
Coupled Foraging and Bioenergetics Model

Lees Ferry

- Current Conditions
- Larger Sized Prey
  - 20% increase in 16mm prey







Coupled Foraging and Bioenergetics Model

Lees Ferry

- Current Conditions
- Gammarus increased to make up 50% of prey biomass

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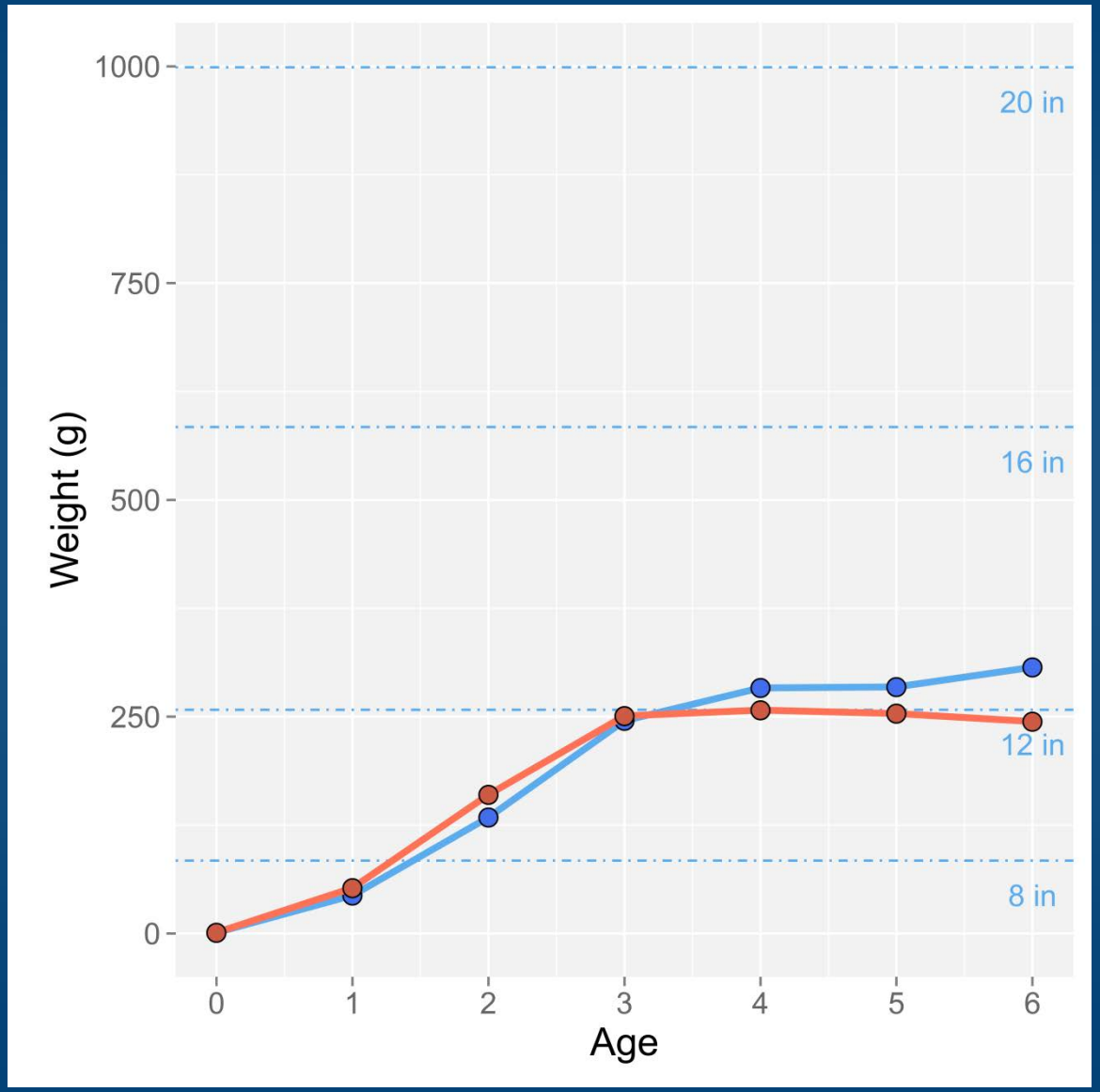
Coupled Foraging and Bioenergetics Model

Lees Ferry

- Current Conditions
- Gammarus increased to make up 50% of prey biomass



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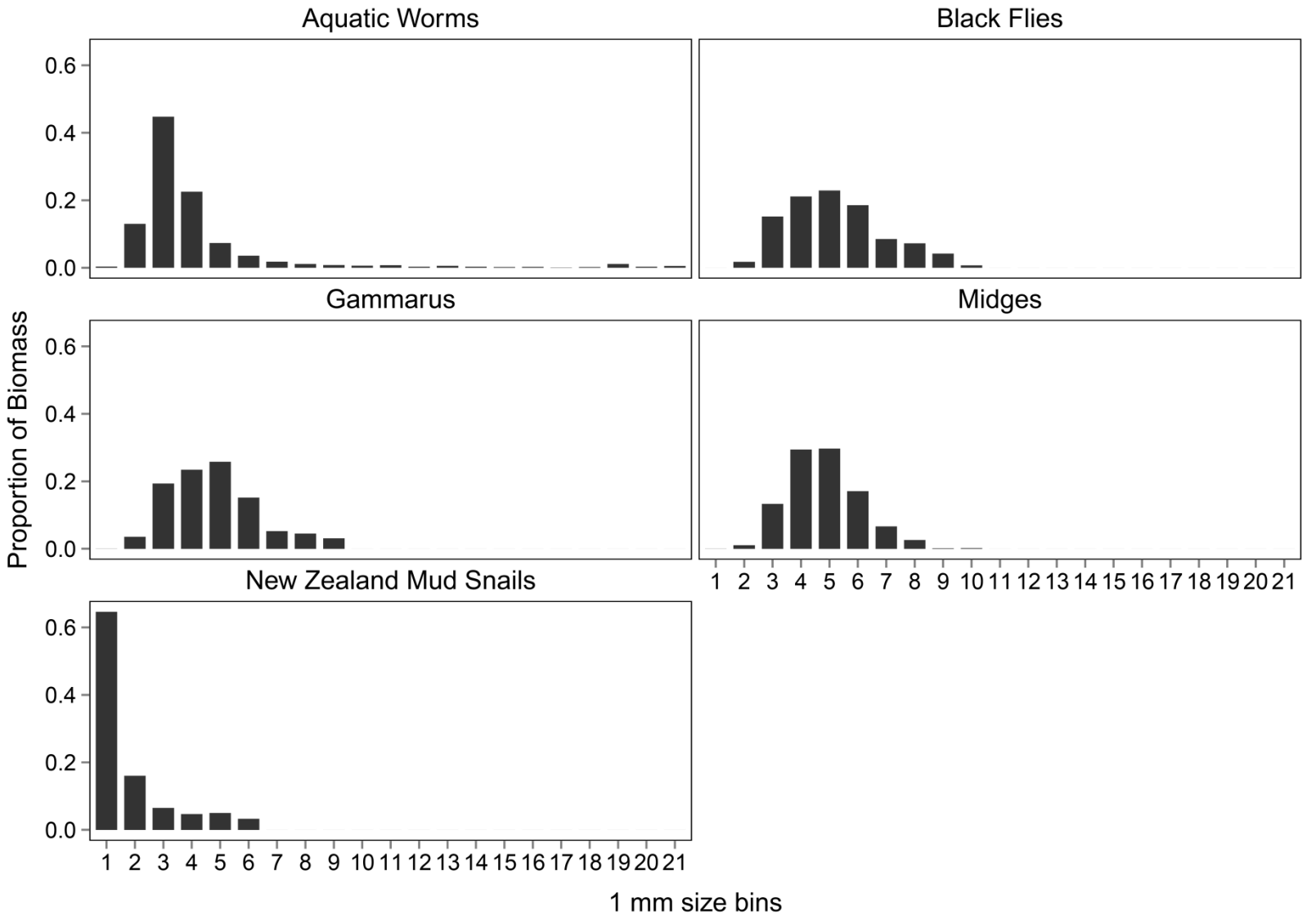
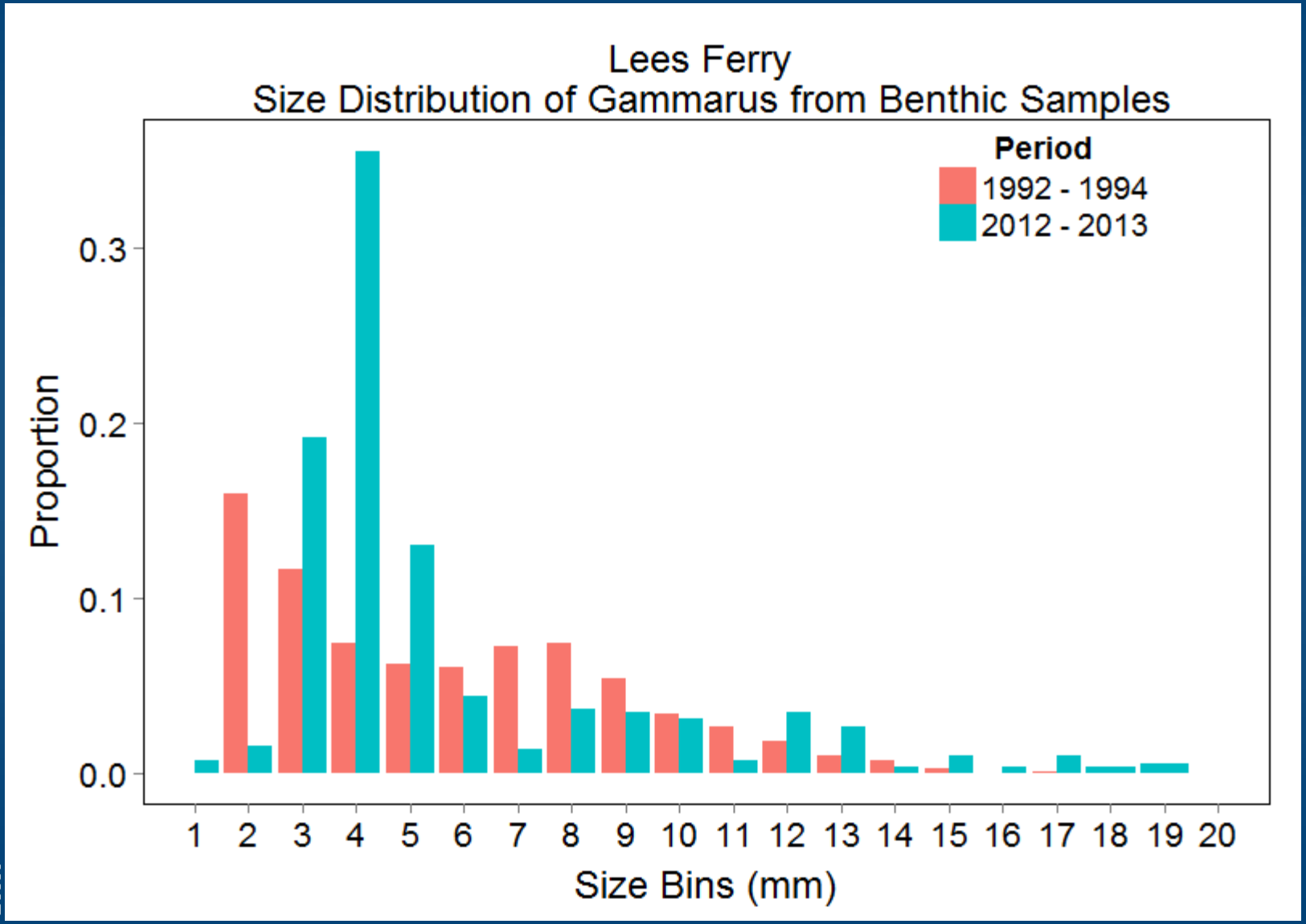
Coupled Foraging and Bioenergetics Model

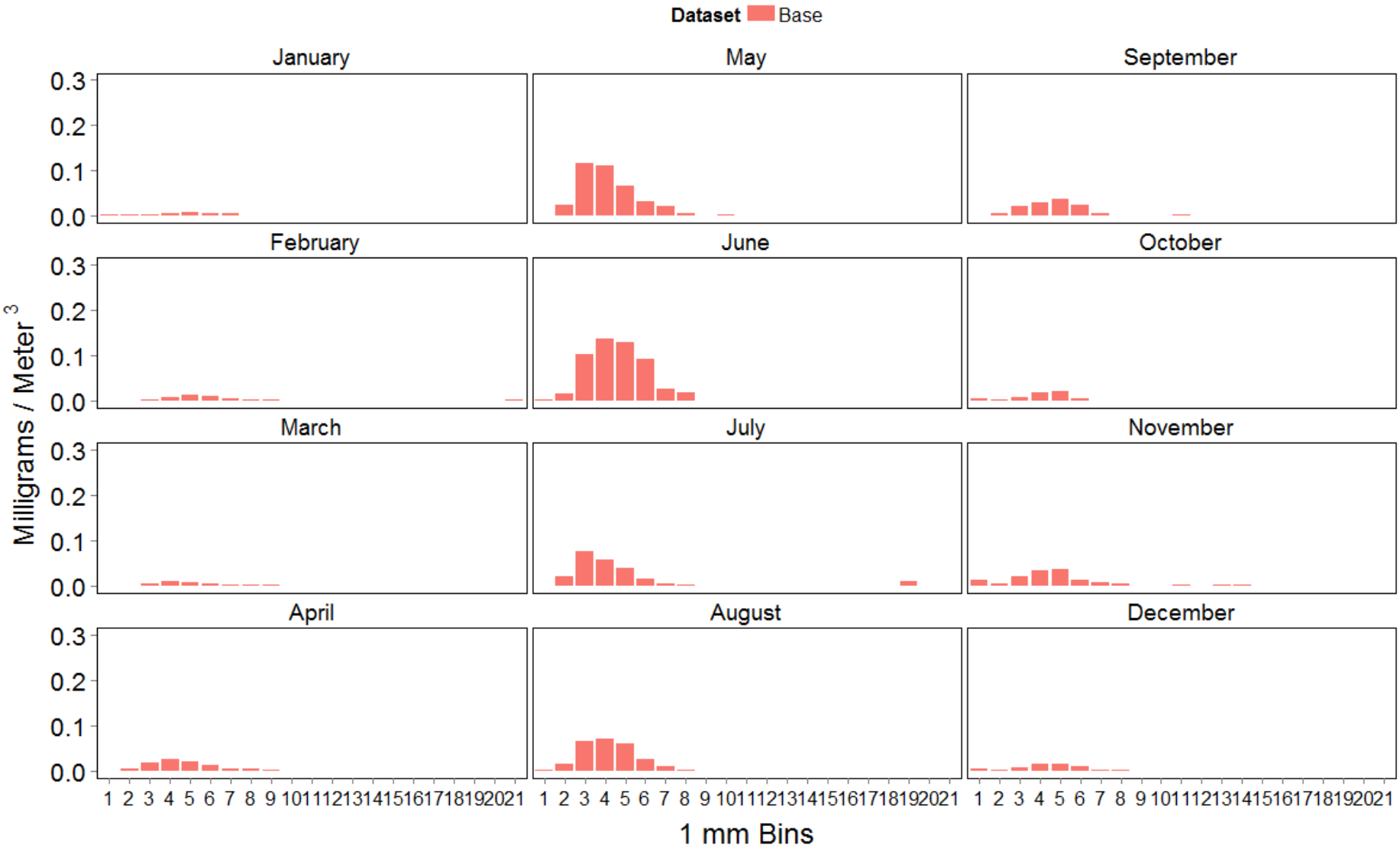


Coupled Foraging and Bioenergetics Model

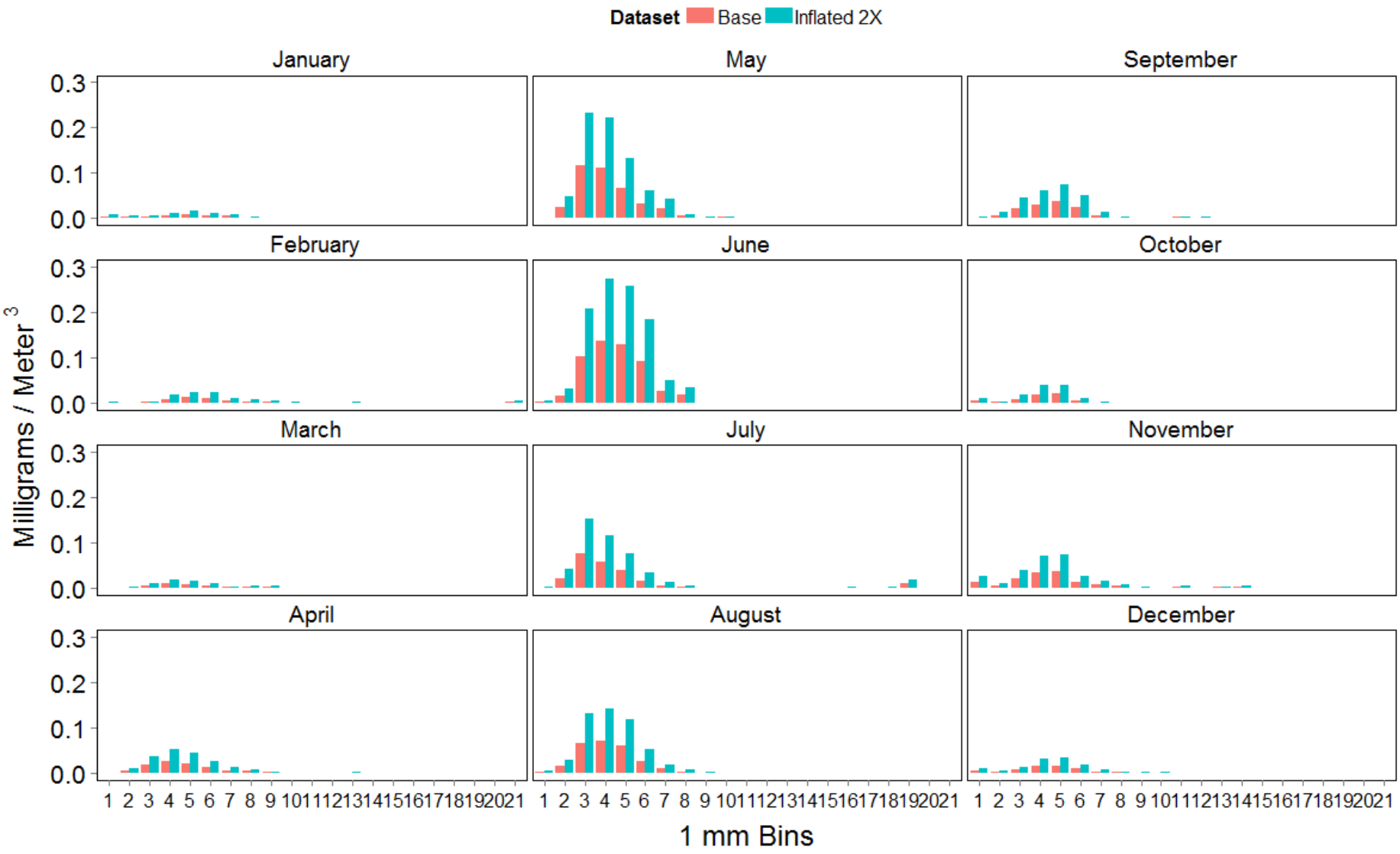


1992 – 1994 data from Ayers and McKinney 1996

Invertebrate Drift



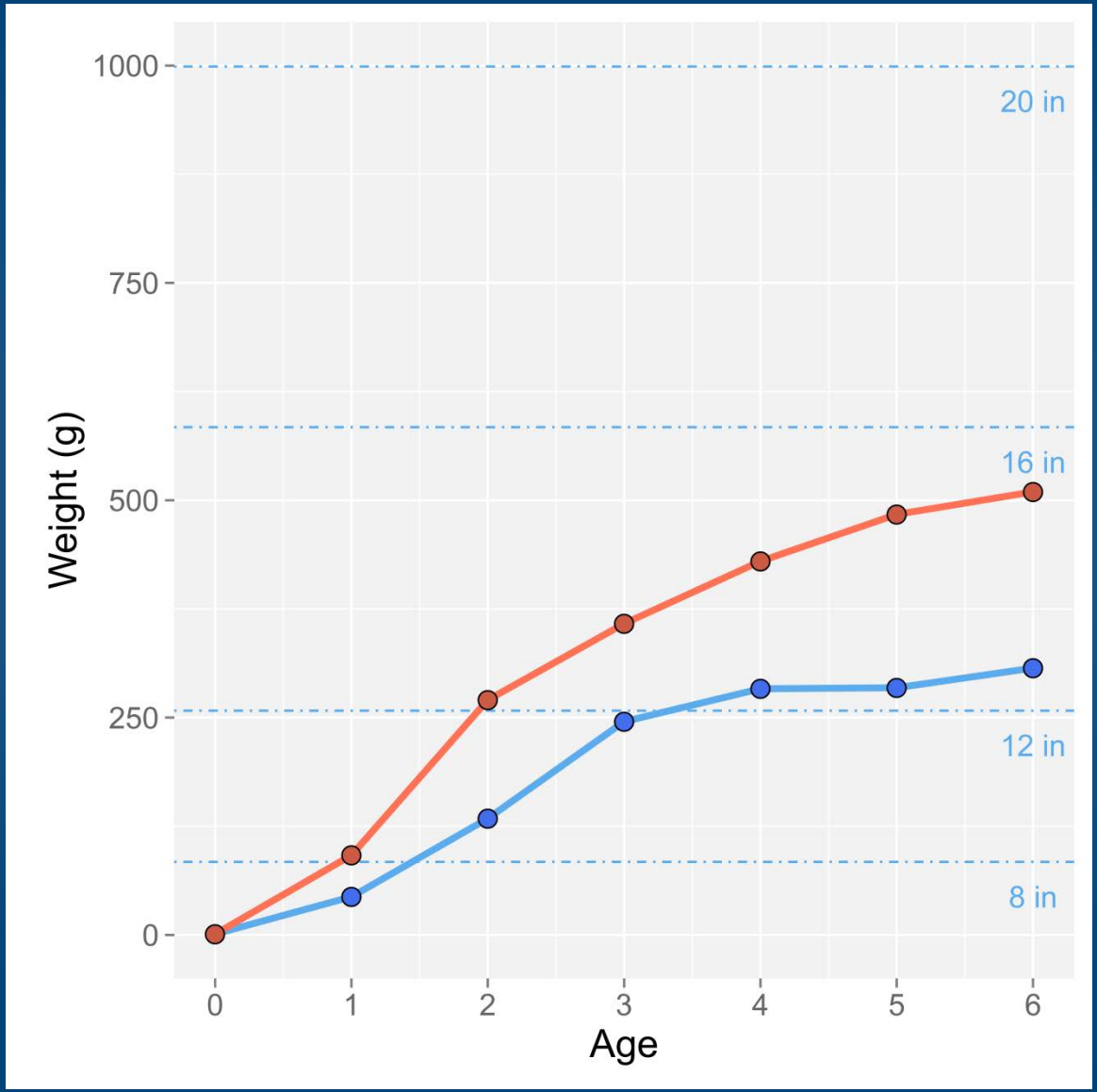
Invertebrate Drift



Coupled Foraging and Bioenergetics Model

Lees Ferry

- Current Conditions
- Increased Prey
  - 2 fold increase



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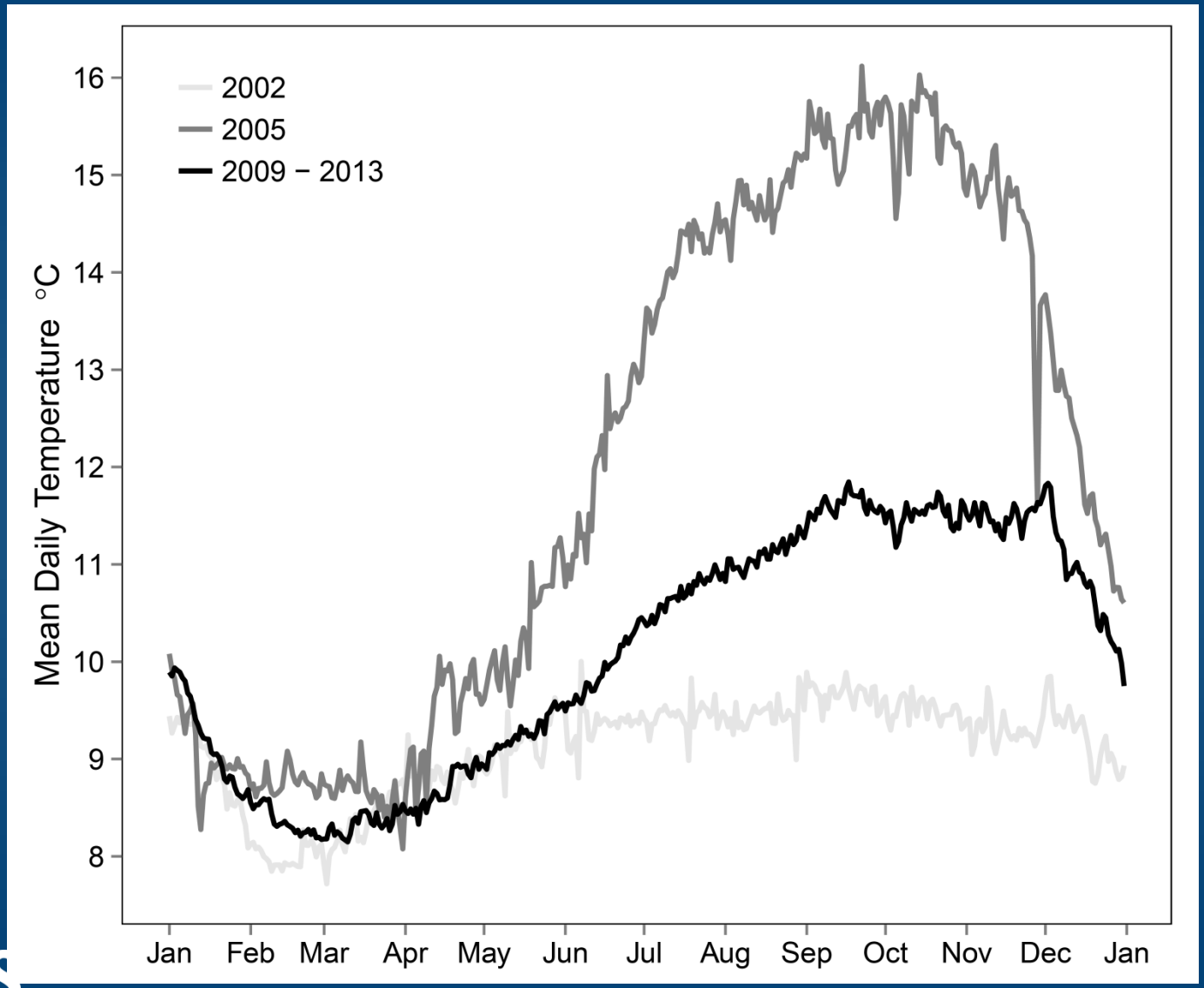
Coupled Foraging and Bioenergetics Model



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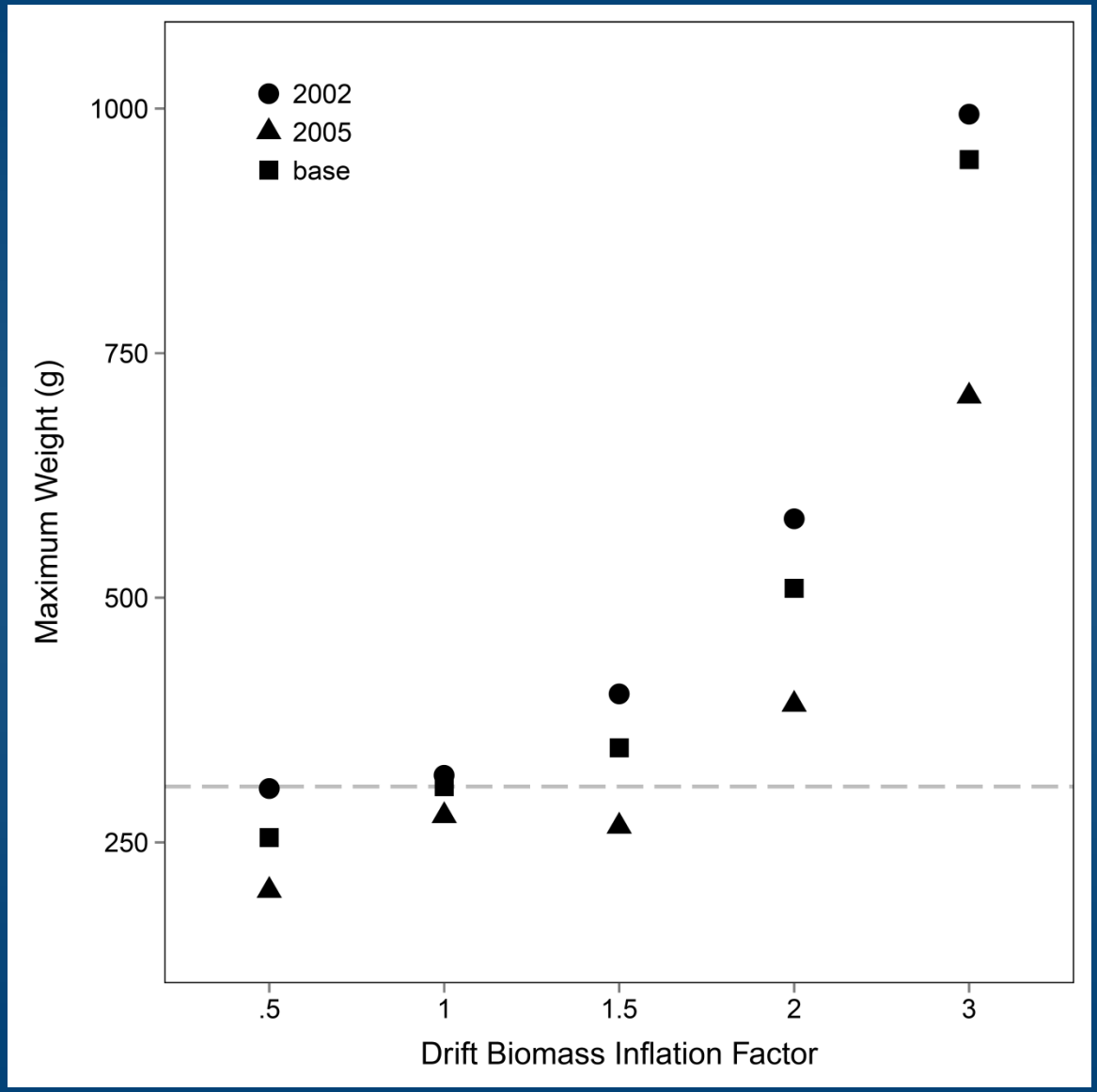
Coupled Foraging and Bioenergetics Model

Lees Ferry

- Same prey availability
- 2002 – cool
- 2005 – warm
- Base – avg. 2009 – 2013



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Questions:

- How does the prey size distribution influence growth?
  - Larger prey = increased growth, even with no increase in prey biomass.

- How does the proportion of Gammarus relative to other taxa influence growth?
  - Higher proportion Gammarus ≠ increased growth

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Questions:

- How does prey abundance influence growth?
  - Increased prey biomass = increased growth
- How do different temperature regimes influence growth?
  - More growth under cooler water temperatures

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Future Applications

- **Turbidity – Explore the effects of turbidity on trout foraging & growth**
  - ***Project Element 9.7 – Application of a bioenergetics model in a seasonally turbid river.***
- **Individual Based Model**

Lees Ferry → **LCR**