Trinity River Macroinvertebrate Drift Study – 1st Year Findings

Chris Laskodi (YTF), Thomas Starkey-Owens (HSU), and Alison O'Dowd (HSU)

June 19, 2019

Trinity River Macroinvertebrate Drift Study

Goal: Quantify macroinvertebrate densities and species assemblages and measure drift to evaluate the hypotheses that flow management can make food more available/abundant for salmonids.

Partners

- Trinity River Restoration Program
- US Fish and Wildlife Service
- Hoopa Tribal Fisheries
- Yurok Tribal Fisheries
- Humboldt State University

Objectives

Describe

Invertebrate species composition, abundance and biomass in drift and benthos

Juvenile Chinook salmon (*Oncorhynchus tshawytscha*) diet

Compare

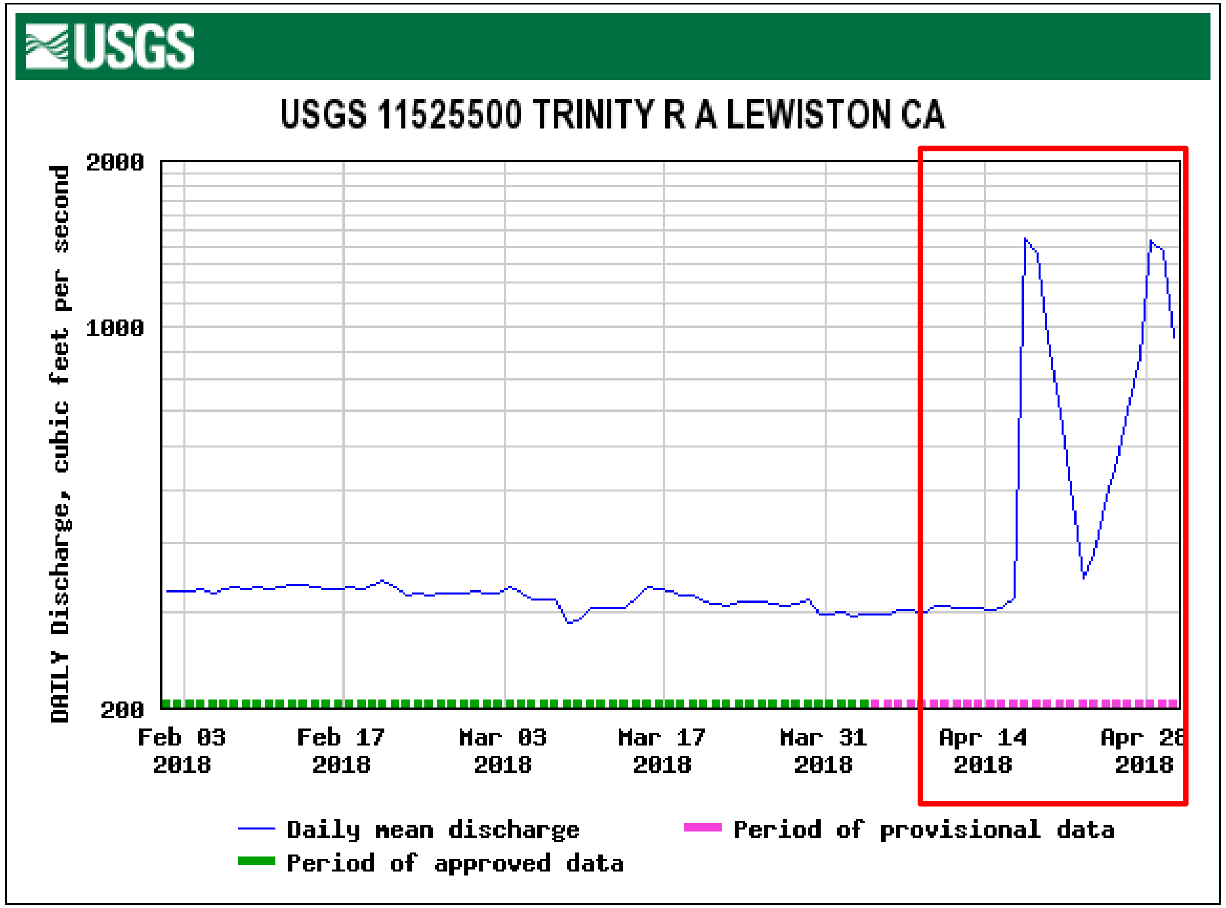
Daily and seasonal (February-April) variation found in drift, benthos and diets

Flow conditions between study sites

Inform

Future research on experimental flow

Flow management on the Trinity River, below Lewiston dam



Hydrograph representing flow release from Lewiston dam from February 1-April 30, 2018 (USGS).

<table>
<tr><th>2018</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th><th>16</th><th>17</th><th>18</th><th>19</th><th>20</th><th>21</th><th>22</th><th>23</th><th>24</th><th>25</th><th>26</th><th>27</th><th>28</th><th>29</th><th>30</th></tr>
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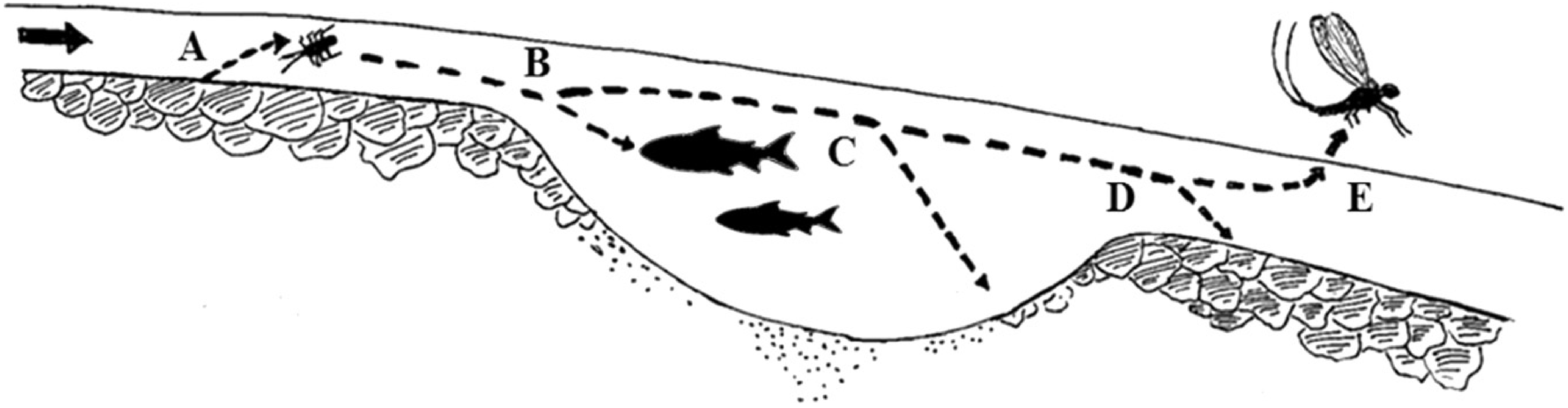
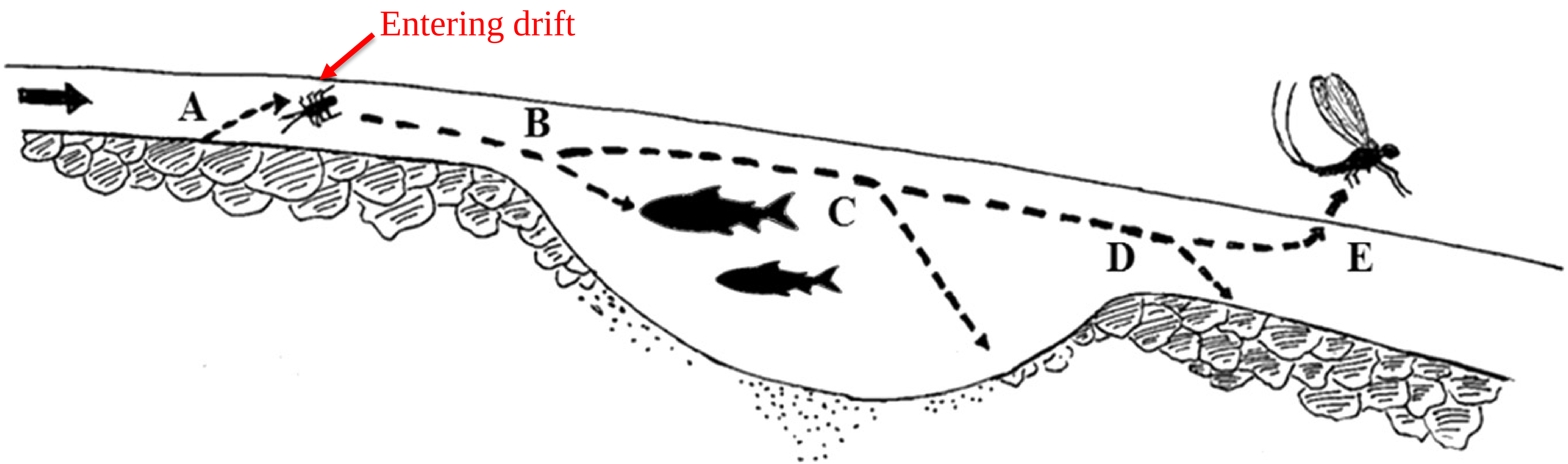
2018 sampling schedule

Invertebrate drift exit



Drift entry is shown at A as an invertebrate departs the substrate and becomes entrained in the water column. Invertebrates exit drift through predation (B), passive settlement (C), active settlement (D), or emergence (E) (Naman et al. 2015).

Invertebrate drift exit



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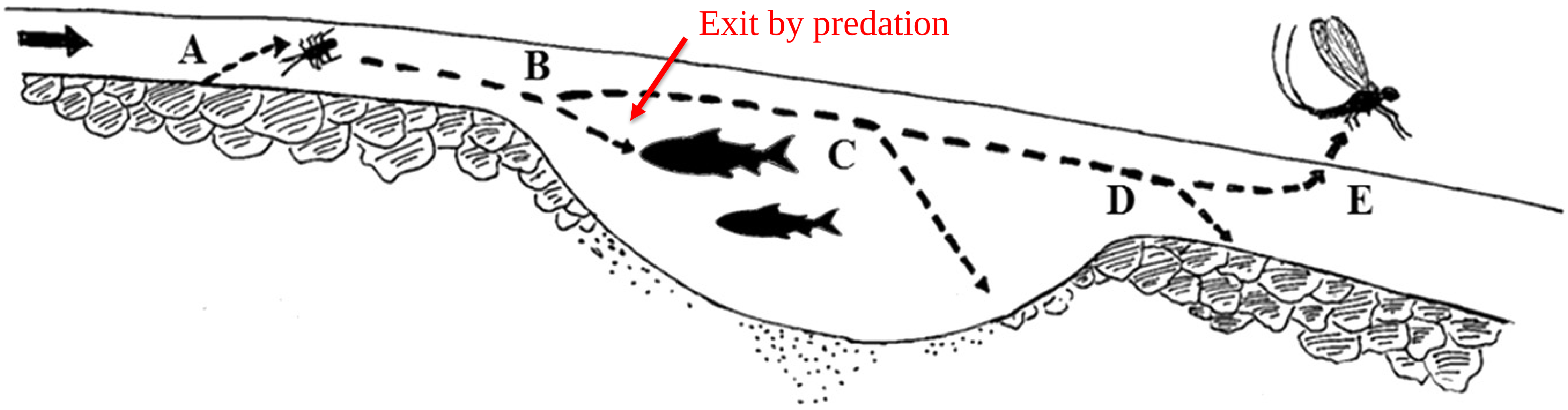

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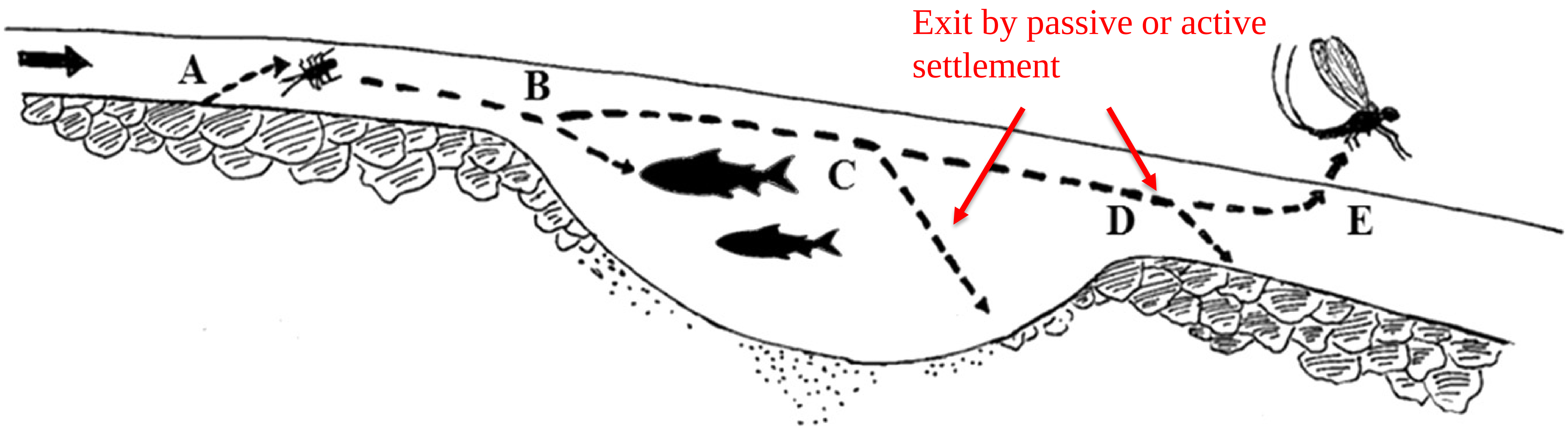

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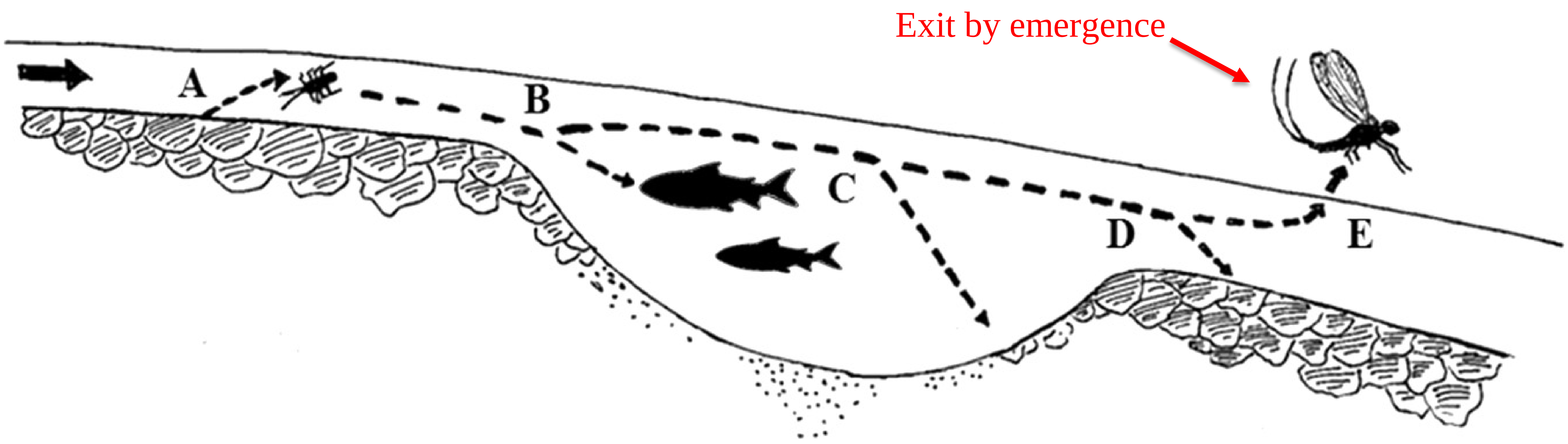

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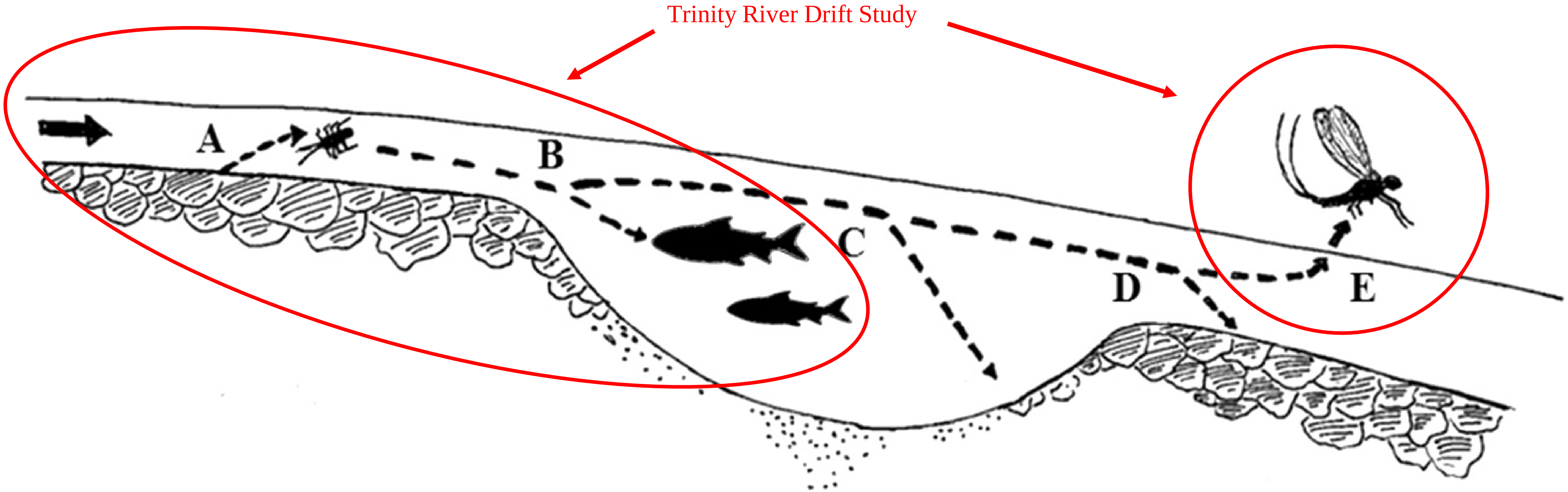

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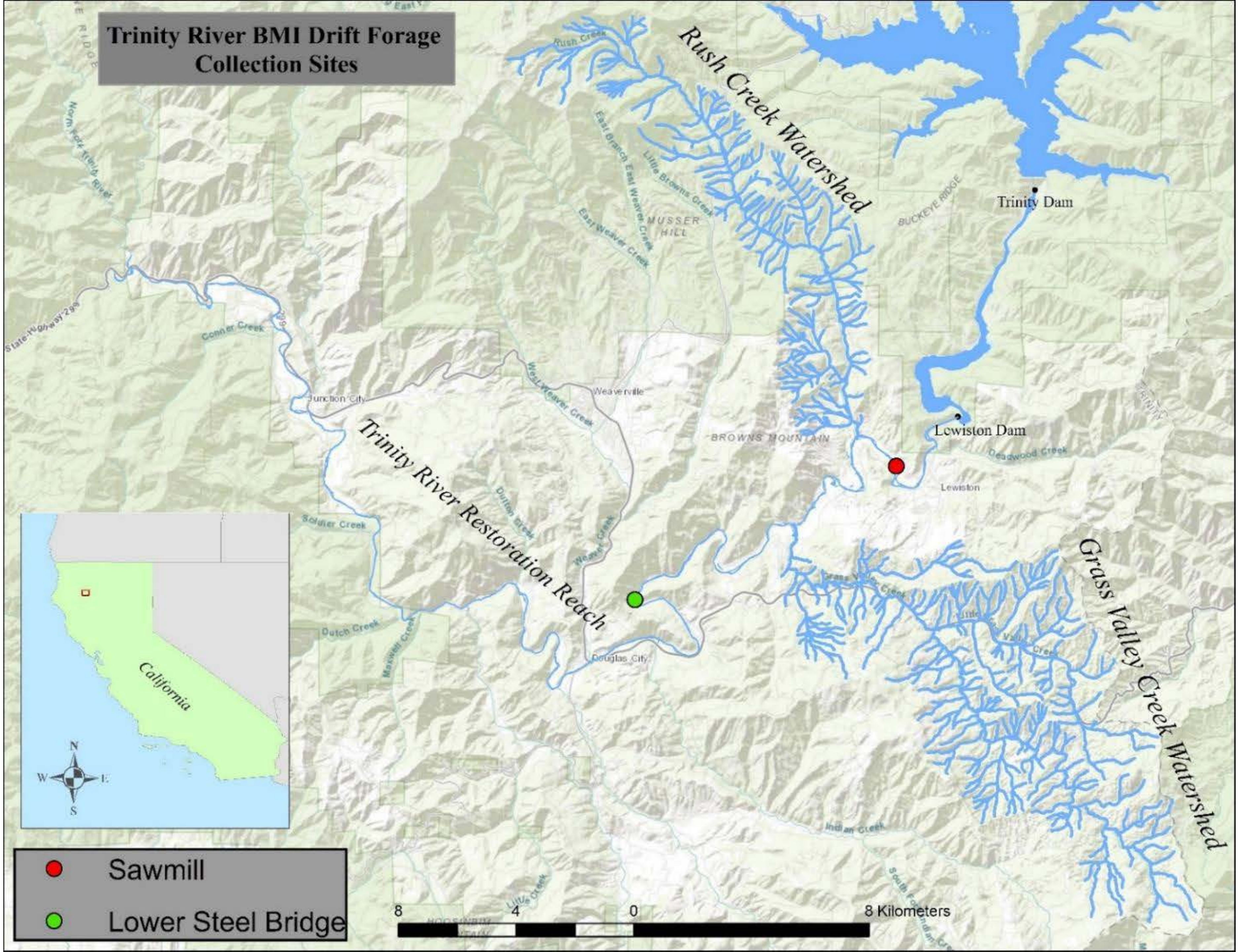


Trinity River BMI Drift Forage Collection Sites
Rush Creek Watershed
Trinity River Restoration Reach
Grass Valley Creek Watershed
Trinity Dam
Lewiston Dam
Lewiston
Weaverville
Junction City
Douglas City
Rush Creek
East Branch East Weaver Creek
Little Browns Creek
East Weaver Creek
MUSSER HILL
BUCKEYE RIDGE
BROWNS MOUNTAIN
Deadwood Creek
Conner Creek
Soldier Creek
Dutch Creek
Indian Creek
California
N
S
W
E
Sawmill
Lower Steel Bridge
8
4
0
8 Kilometers

Sawmill

~5 km downstream of Lewiston
No tributary influence

Trinity river at Sawmill, Jan. 2018, by Thomas S-O

Lower Steel Bridge

~21 km downstream of Lewiston

Rush Creek

Grass Valley Creek

Trinity river at Steel Bridge, Jan. 2018, by Thomas S-O

Field Methods

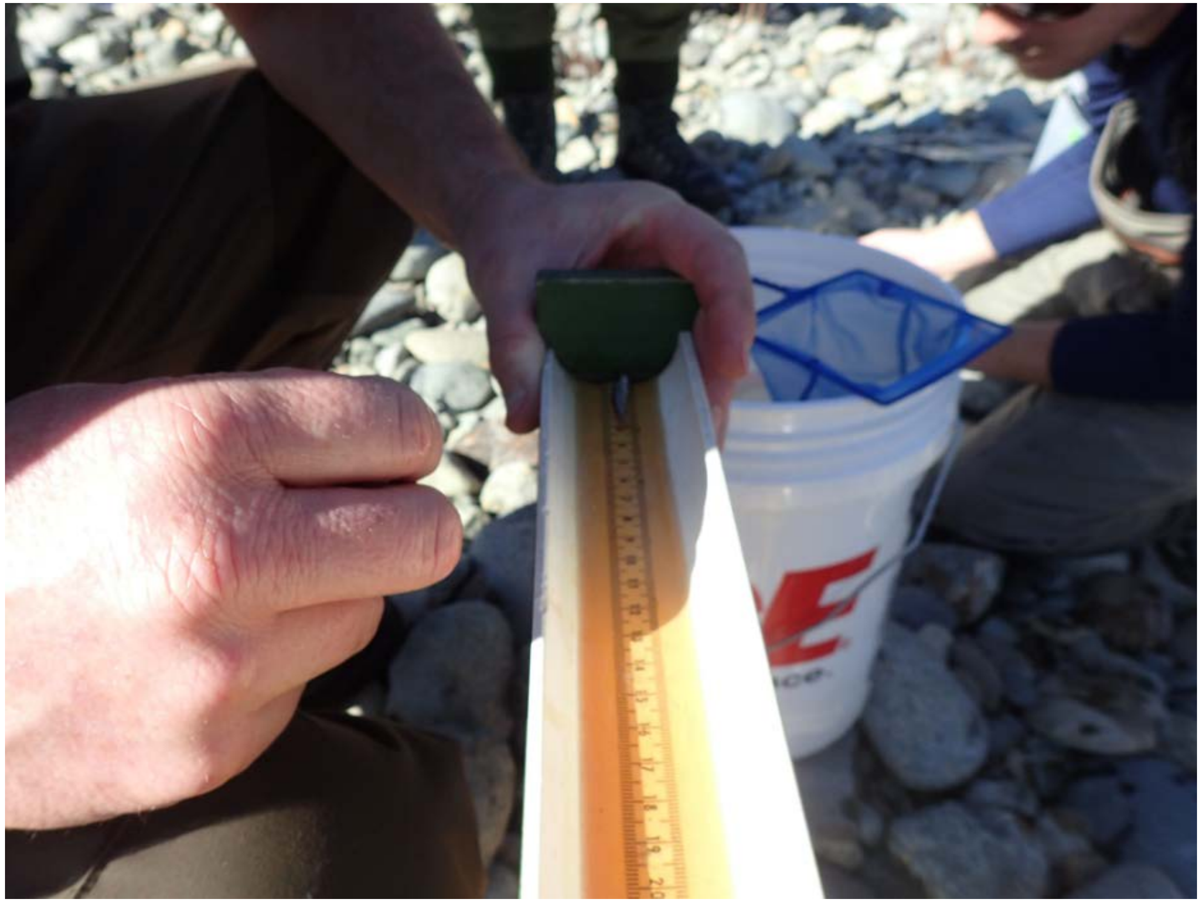
Sample Type	Total number of samples collected	Sampling method
Drift	168	1 sq. ft. drift net (2 hours)
Benthic	14	Surber sampler (3 minutes)
Diet: Lavage	480	Seine, gastric lavage
Diet: Sacrifice	100	Seine, MS-222
Total	762	

Field Methods

Seining for juvenile Chinook salmon at on the Trinity river at Steel Bridge. Apr 2018. Photo by Thomas S-O

Successful seine of mostly juvenile Chinook salmon on the Trinity river at Steel Bridge. Apr. 2018. Photo by Thomas S-O.

Field Methods

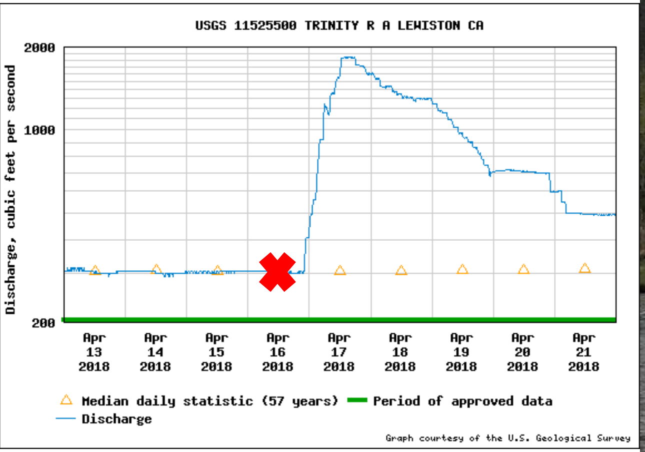


Measuring juvenile Chinook salmon on the Trinity river at Sawmill. Feb. 2018. Photo by Eric Wiseman.

Temp, dissolved oxygen, and flow measured in front of each drift net on the Trinity river at Steel Bridge. Apr. 2018. Photo by Thomas S-O.

Sawmill ~350 cfs
April 16, 2018

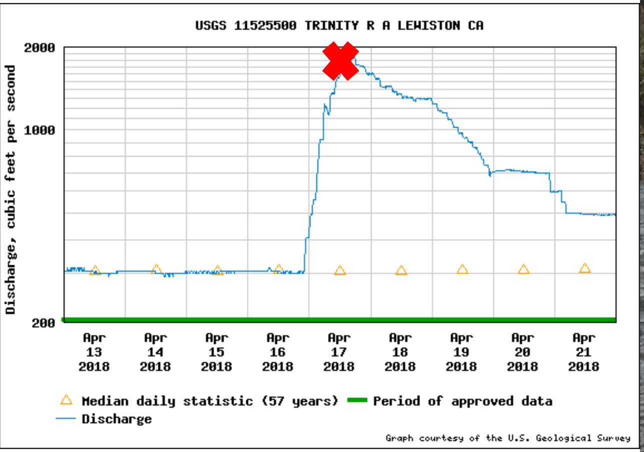
Baseline conditions
February-April 2018



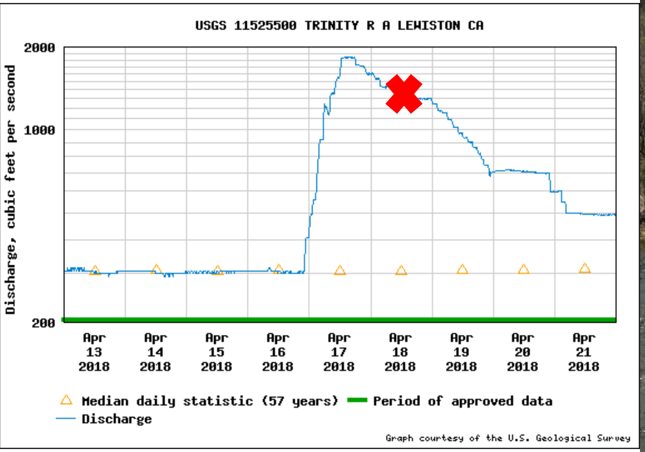
(Looking upstream)

Sawmill ~1800 cfs

April 17, 2018



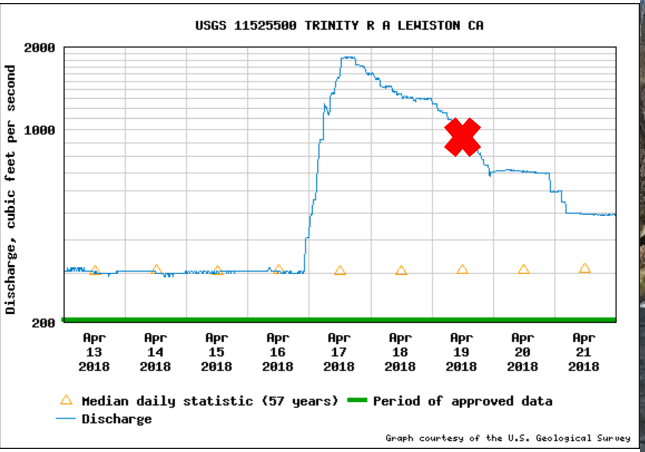
Sawmill ~1300 cfs
April 18, 2018



(Looking upstream)

Sawmill ~1,000 cfs

April 19, 2018



(Looking upstream)

Laboratory Methods

Invertebrate identification

Aquatic insects to Family
Aquatic Non-insects to Class or Order
Terrestrial invertebrates to Order

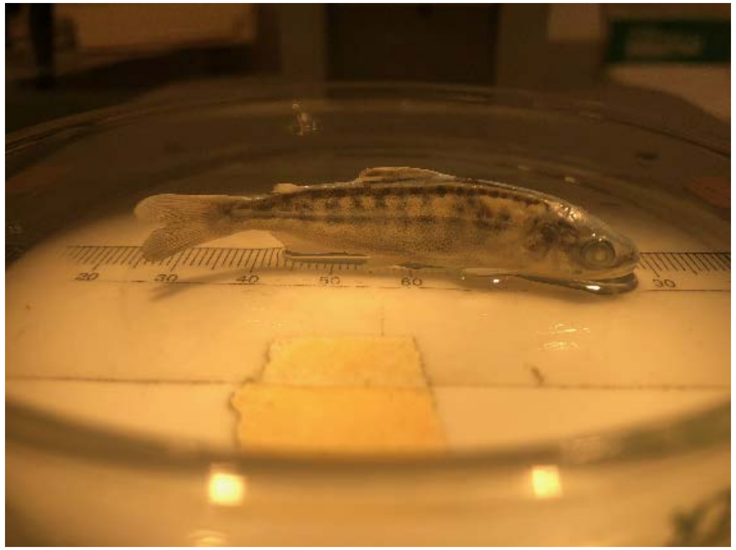


Image 1. Juvenile Chinook sacrifice to be dissected.

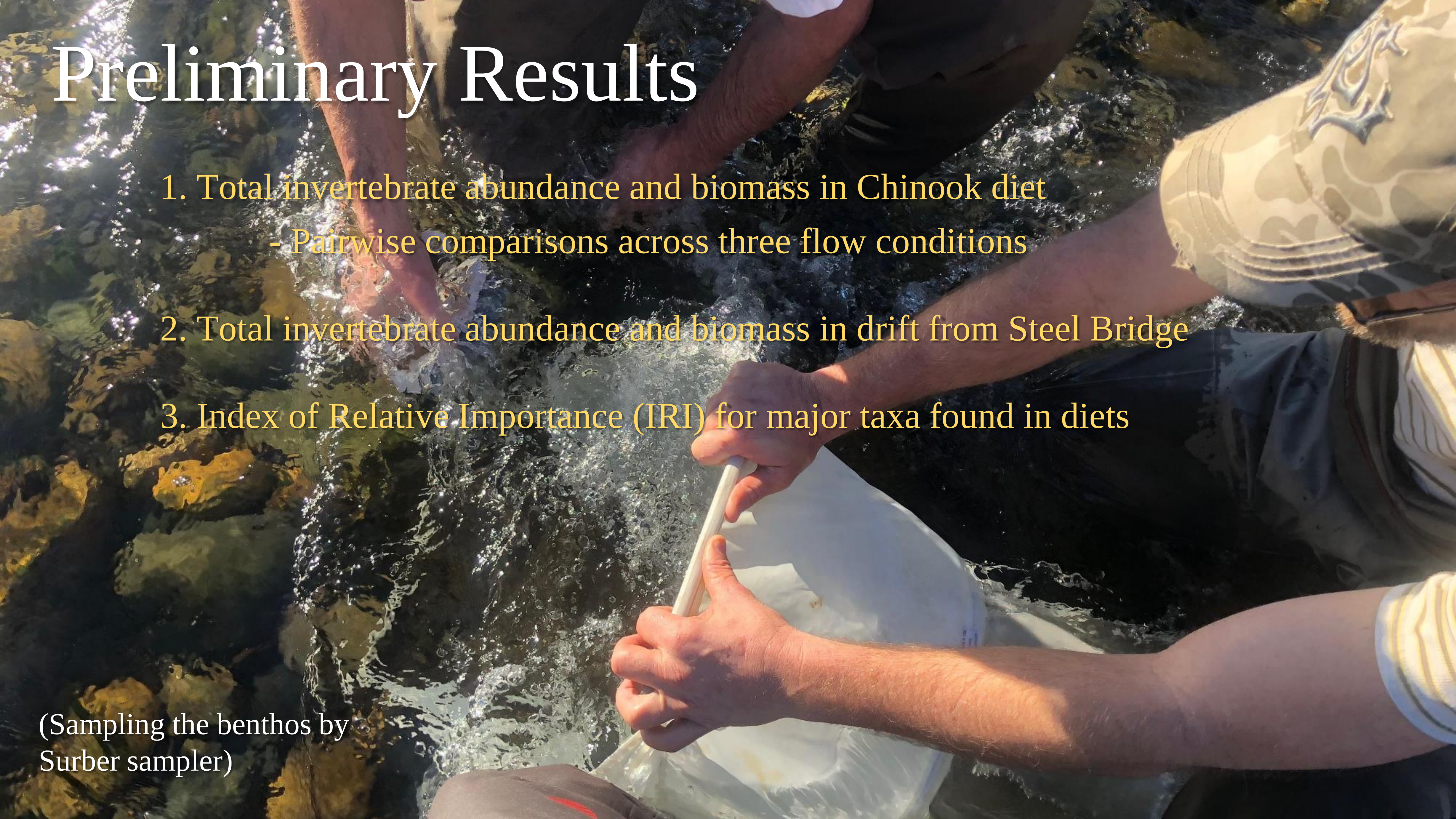
Image 2. Springtail <1mm (Collembola)

Basic length-mass regression

$M=aL^b$
Where a and b are published constants,
L=length(mm)
M=mass(mg)

Image 3. Small minnow mayfly’s, family Baetidae.

Image 4. “Large” predatory stonefly



Preliminary Results

1. Total invertebrate abundance and biomass in Chinook diet
   - Pairwise comparisons across three flow conditions

2. Total invertebrate abundance and biomass in drift from Steel Bridge

3. Index of Relative Importance (IRI) for major taxa found in diets

(Sampling the benthos by Surber sampler)

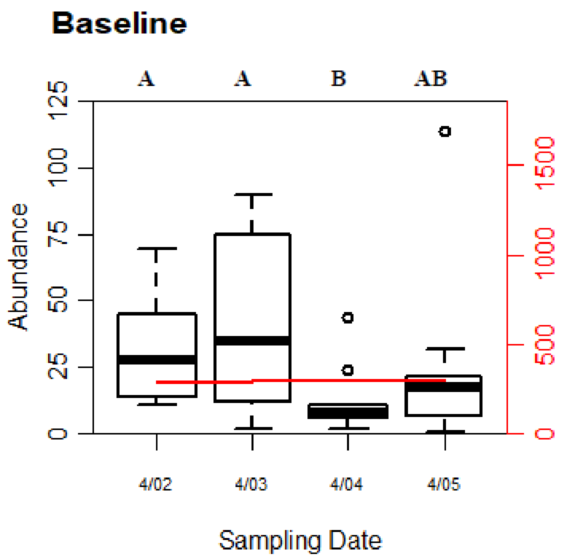
Preliminary Results

1. Total invertebrate abundance and biomass in Chinook diet
   - Pairwise comparisons across three flow conditions

(Sampling the benthos by Surber sampler)

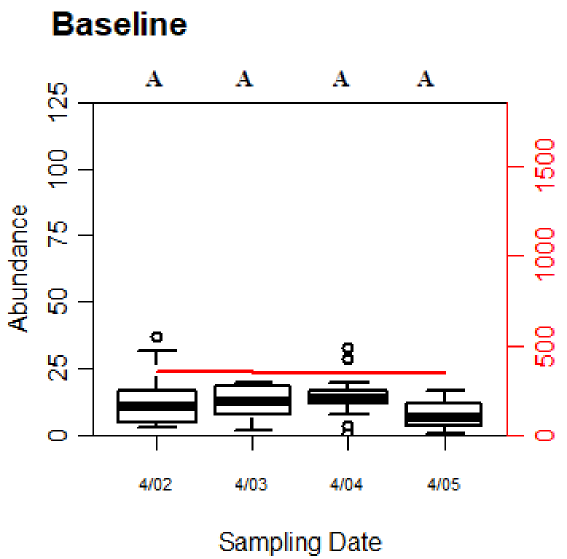
Invertebrate **abundance** in juvenile Chinook diet

Sawmill



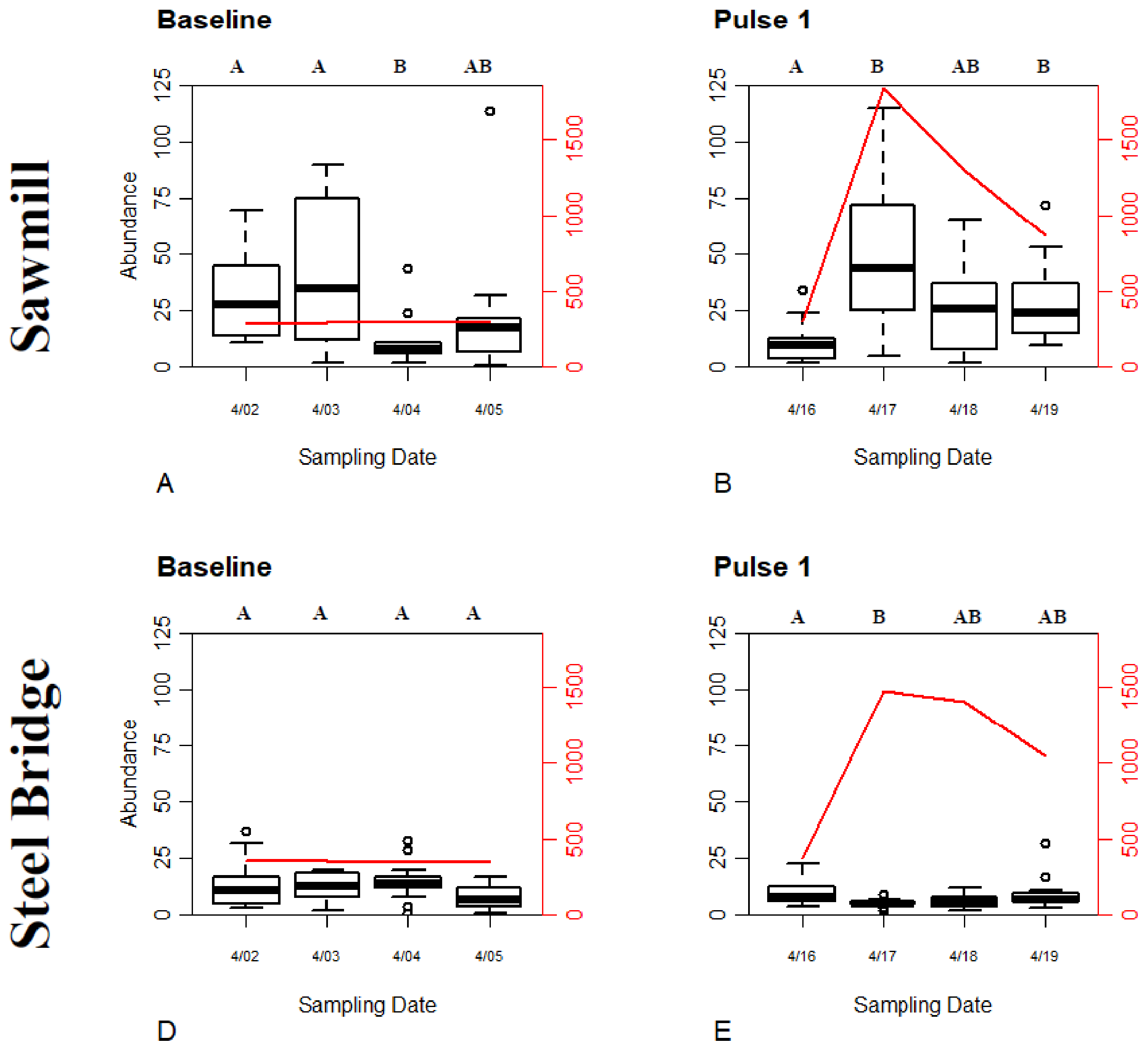
A

Steel Bridge

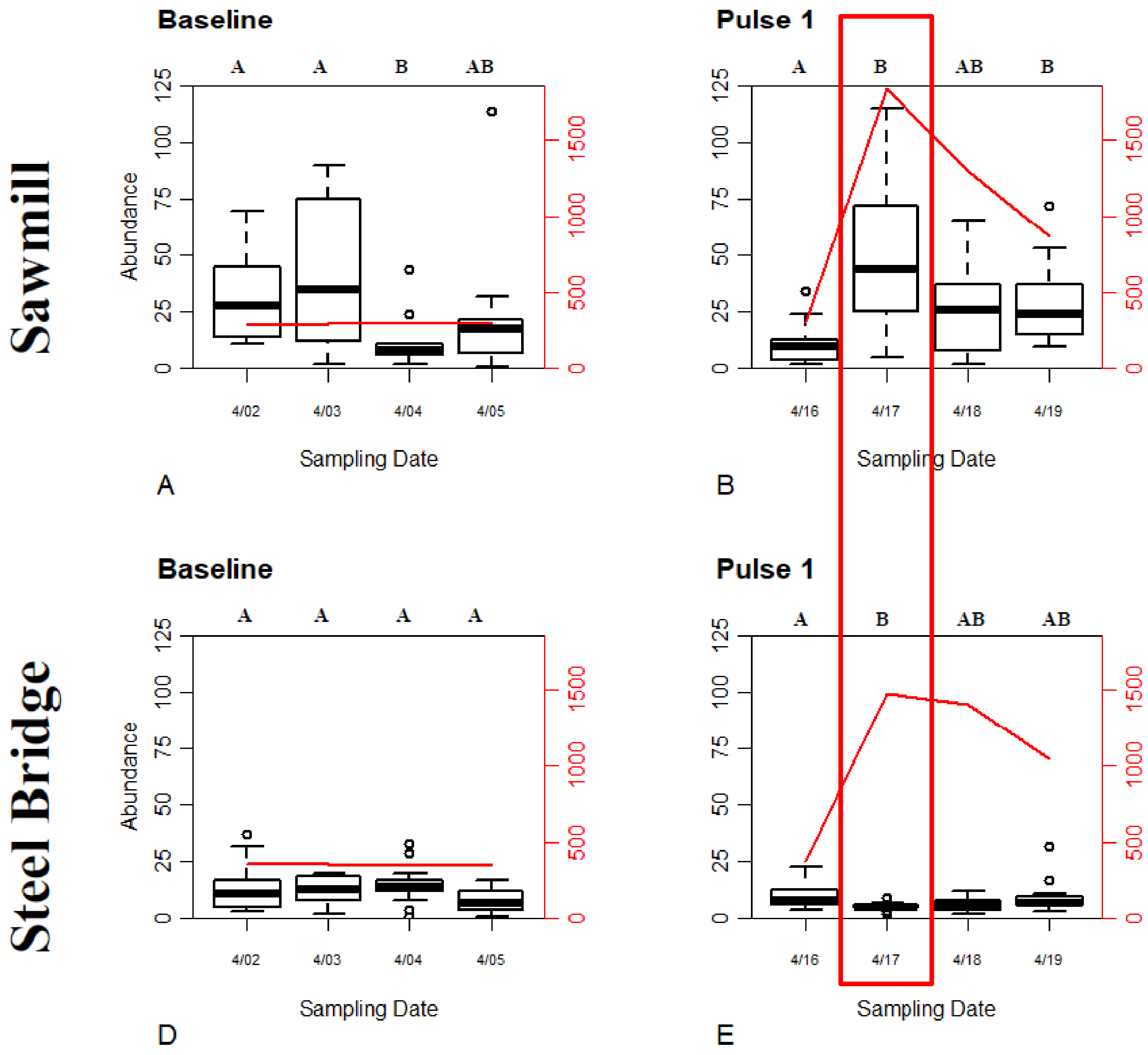


D

Invertebrate **abundance** in juvenile Chinook diet



Invertebrate **abundance** in juvenile Chinook diet



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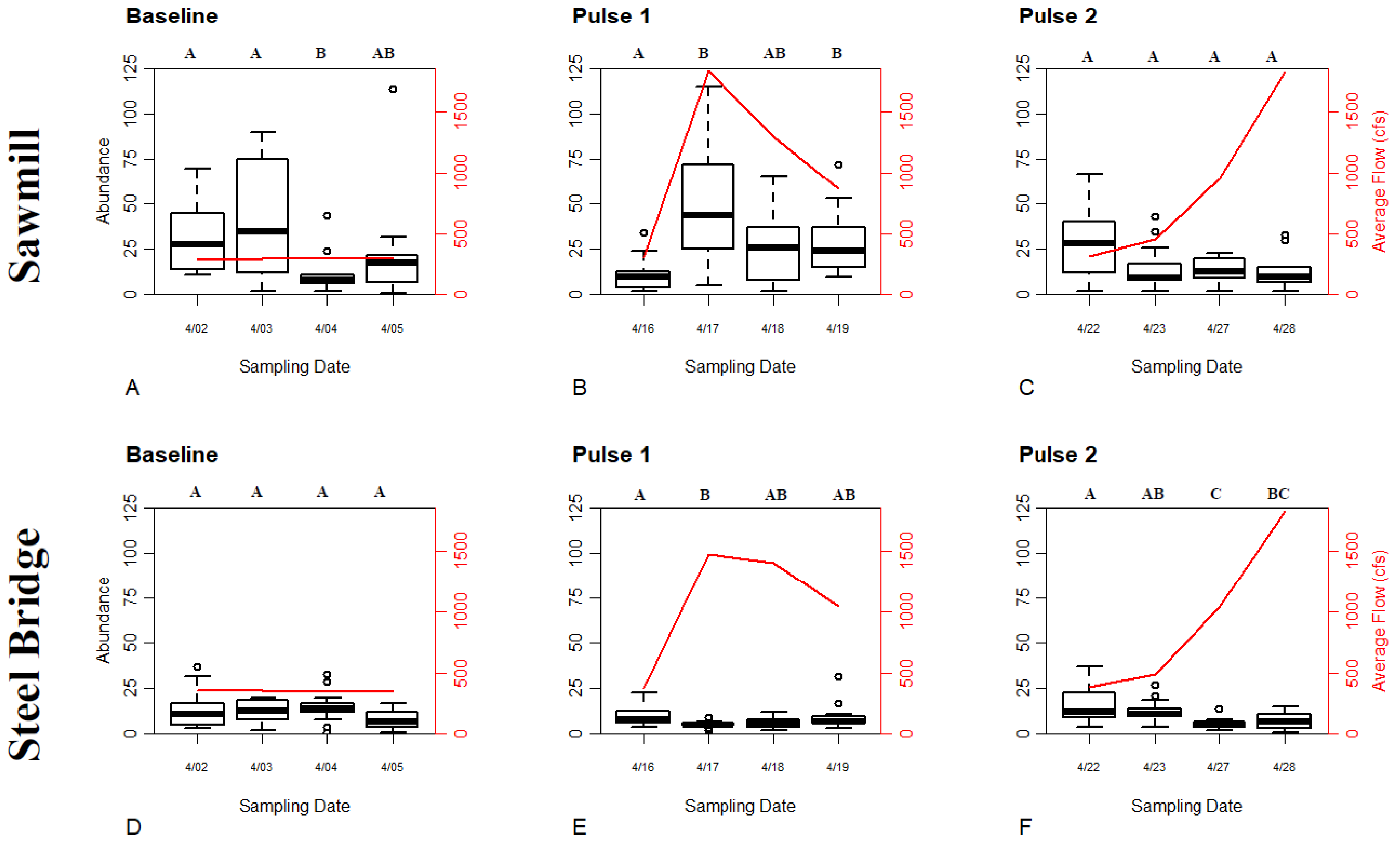

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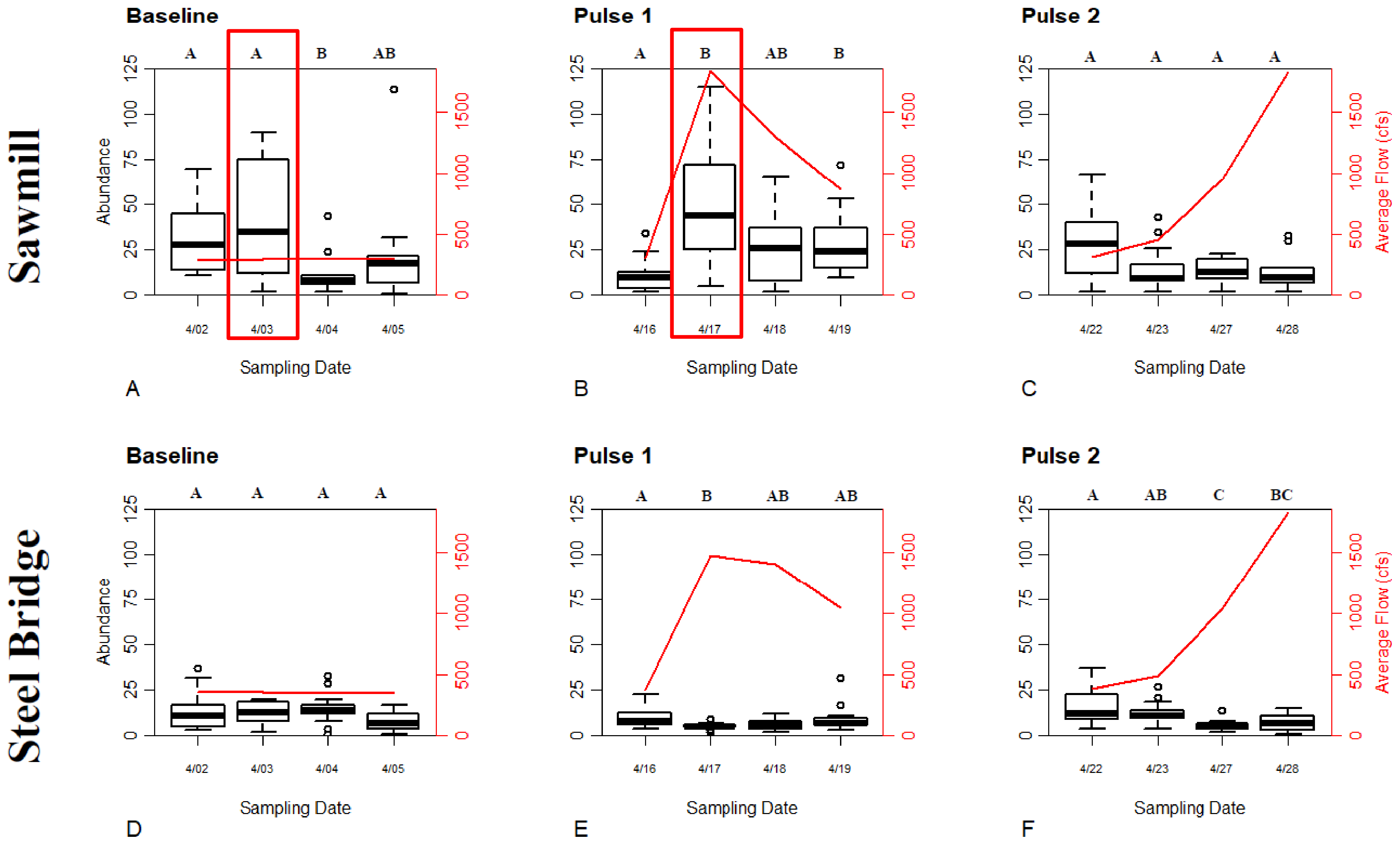
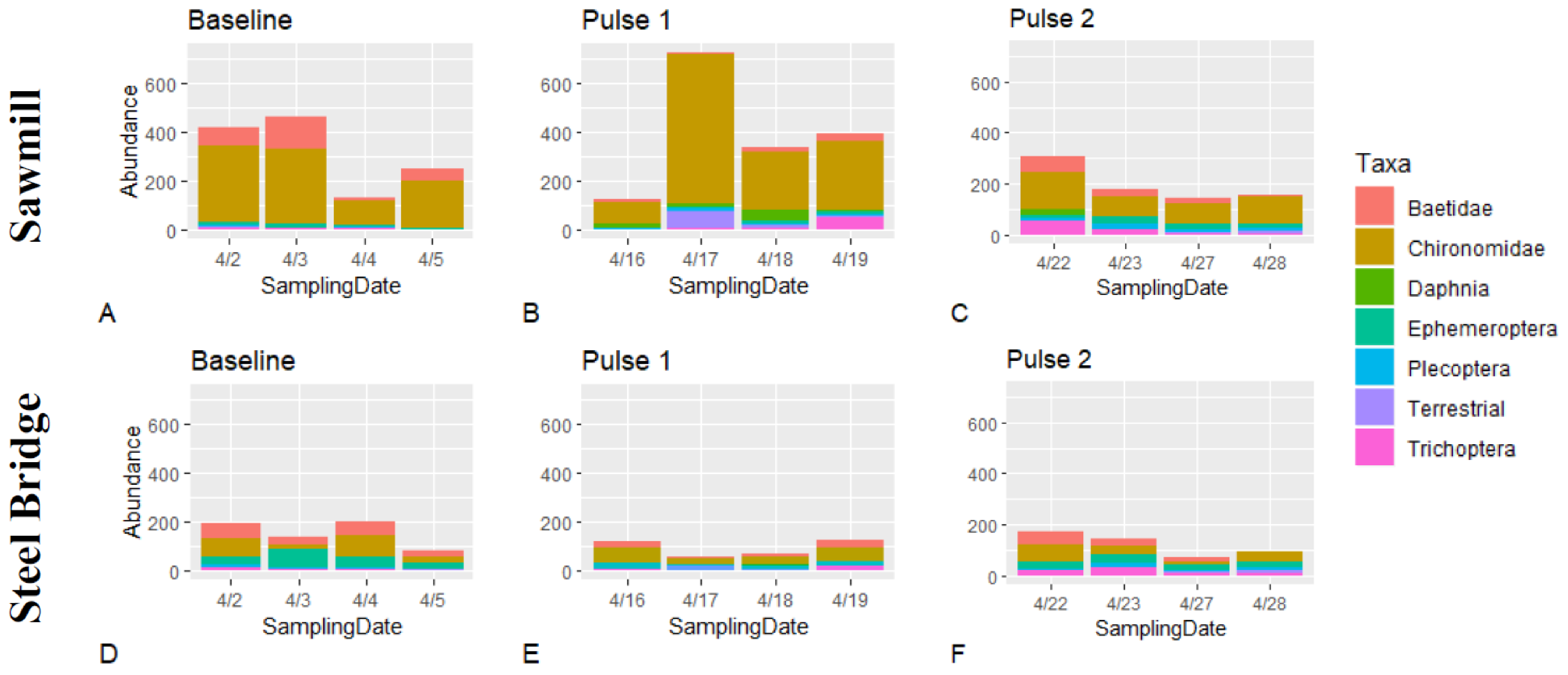


Total invertebrate abundance and composition in juvenile Chinook diet



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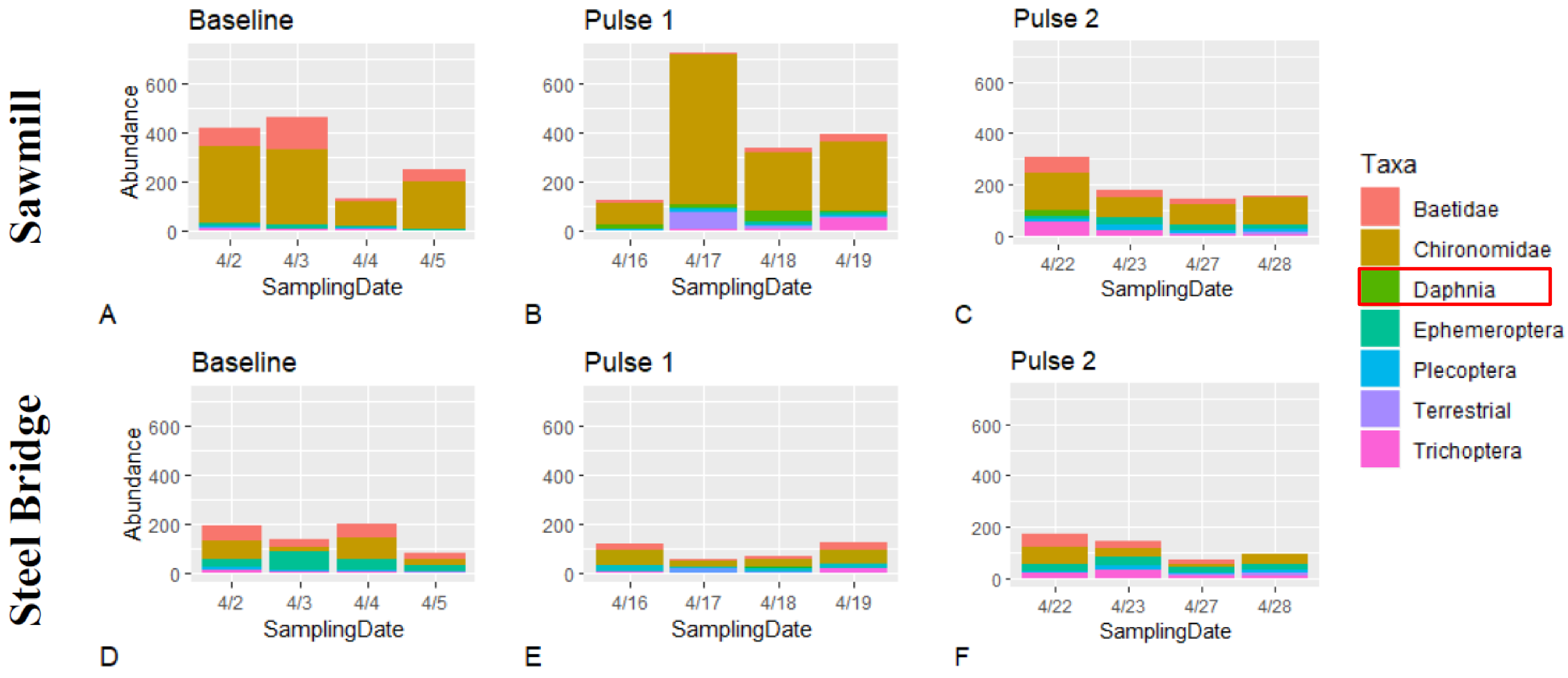
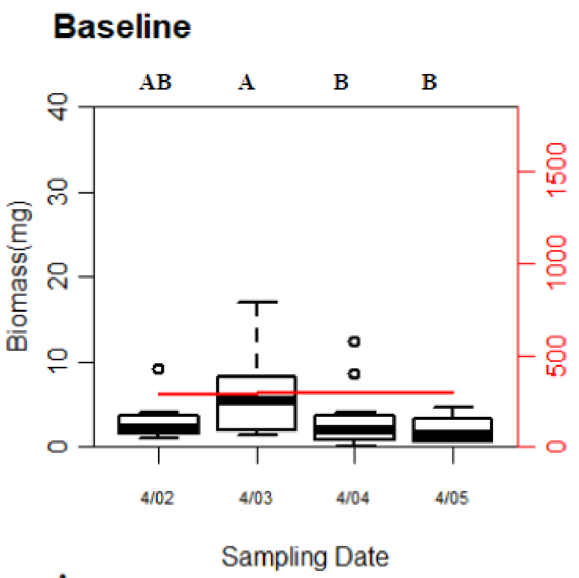


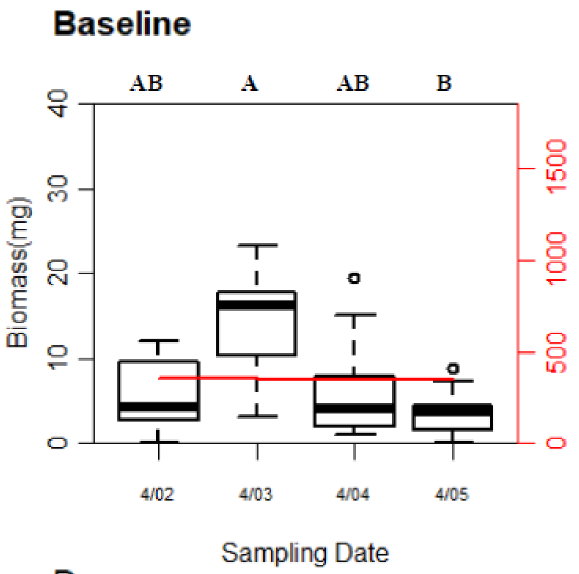
Invertebrate **biomass (mg)** in juvenile Chinook diet

Sawmill



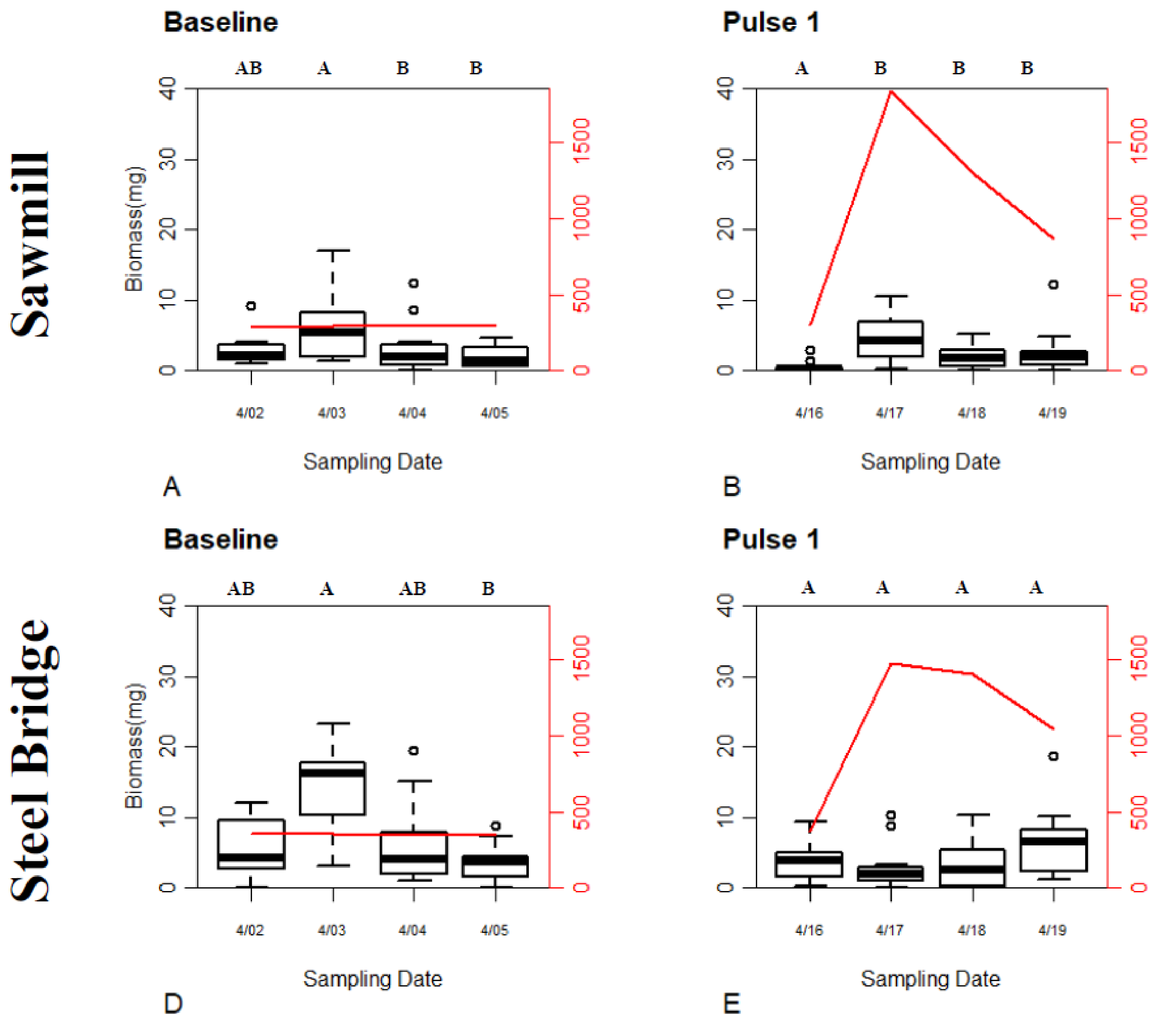
A

Steel Bridge

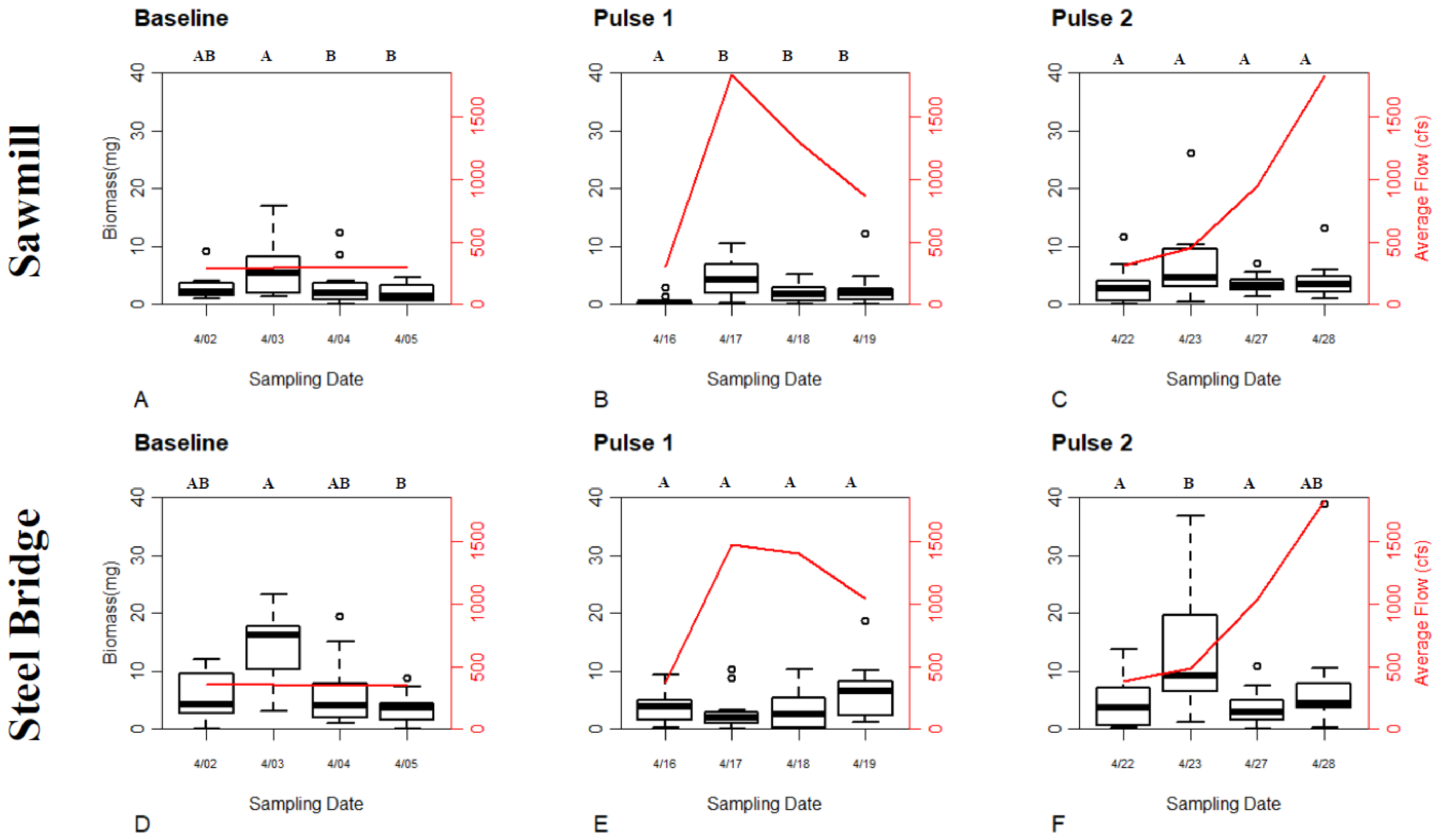


D

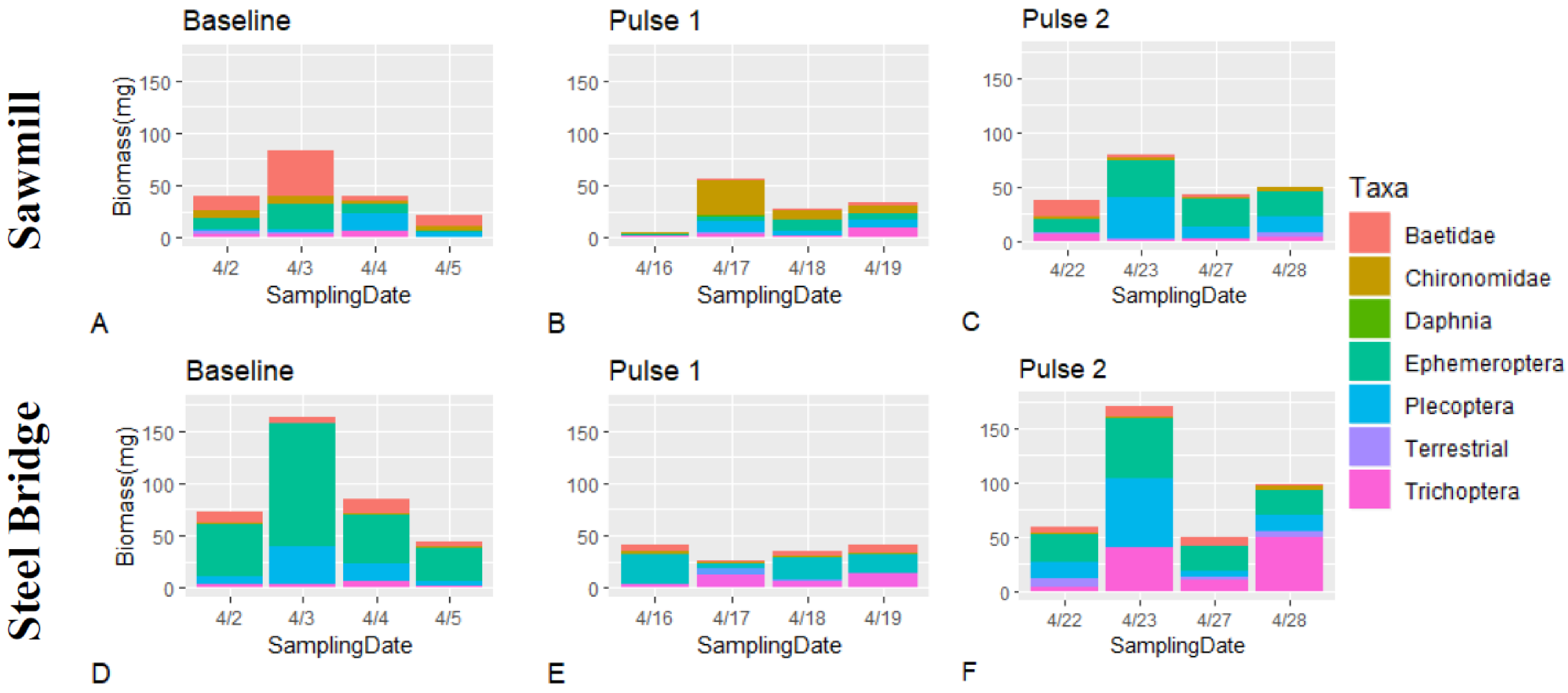
Invertebrate **biomass (mg)** in juvenile Chinook diet



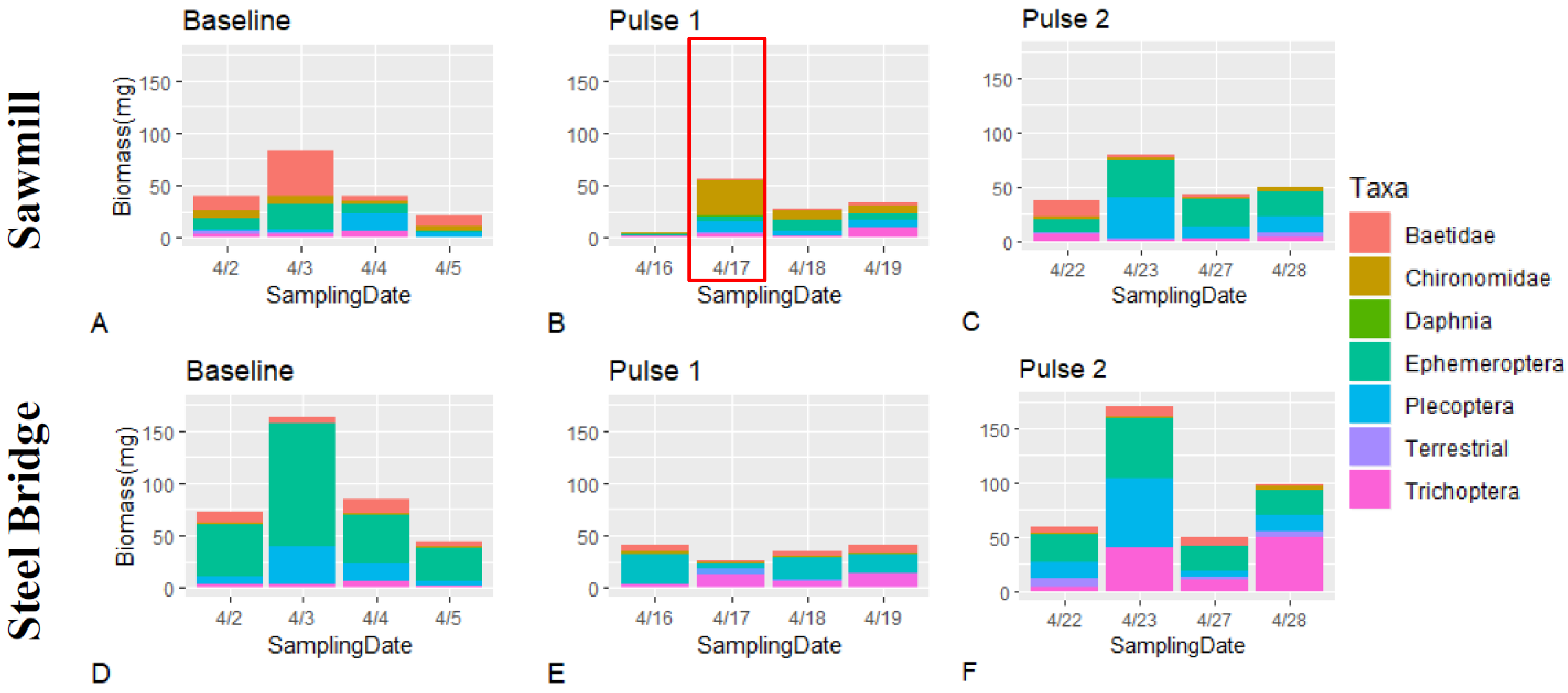
Invertebrate **biomass (mg)** in juvenile Chinook diet



Total invertebrate biomass (mg) and composition in juvenile Chinook diet



Total invertebrate biomass (mg) and composition in juvenile Chinook diet



Preliminary Results

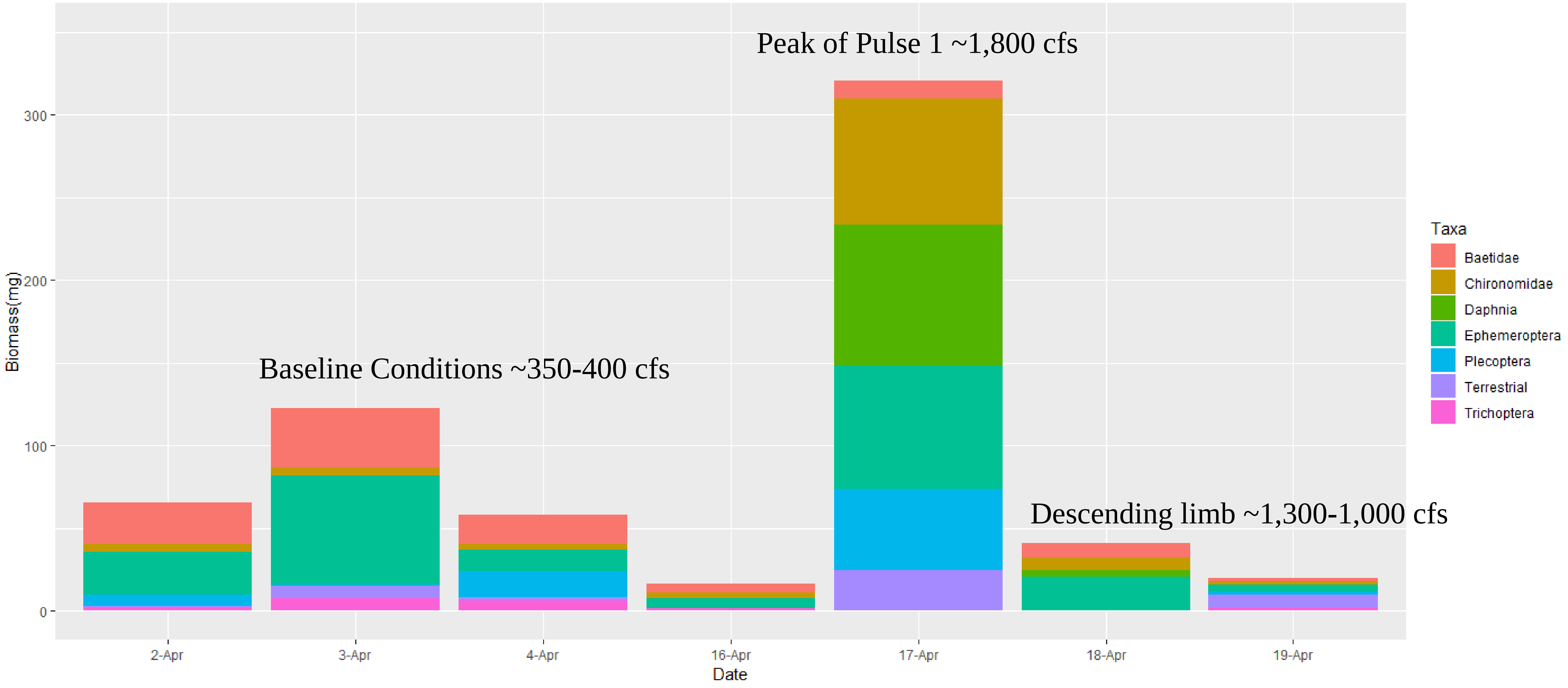
1. Total invertebrate abundance and biomass in Chinook diet
   - Pairwise comparisons across three flow conditions

2. Total invertebrate abundance and biomass in drift from Steel Bridge

(Sampling the benthos by Surber sampler)

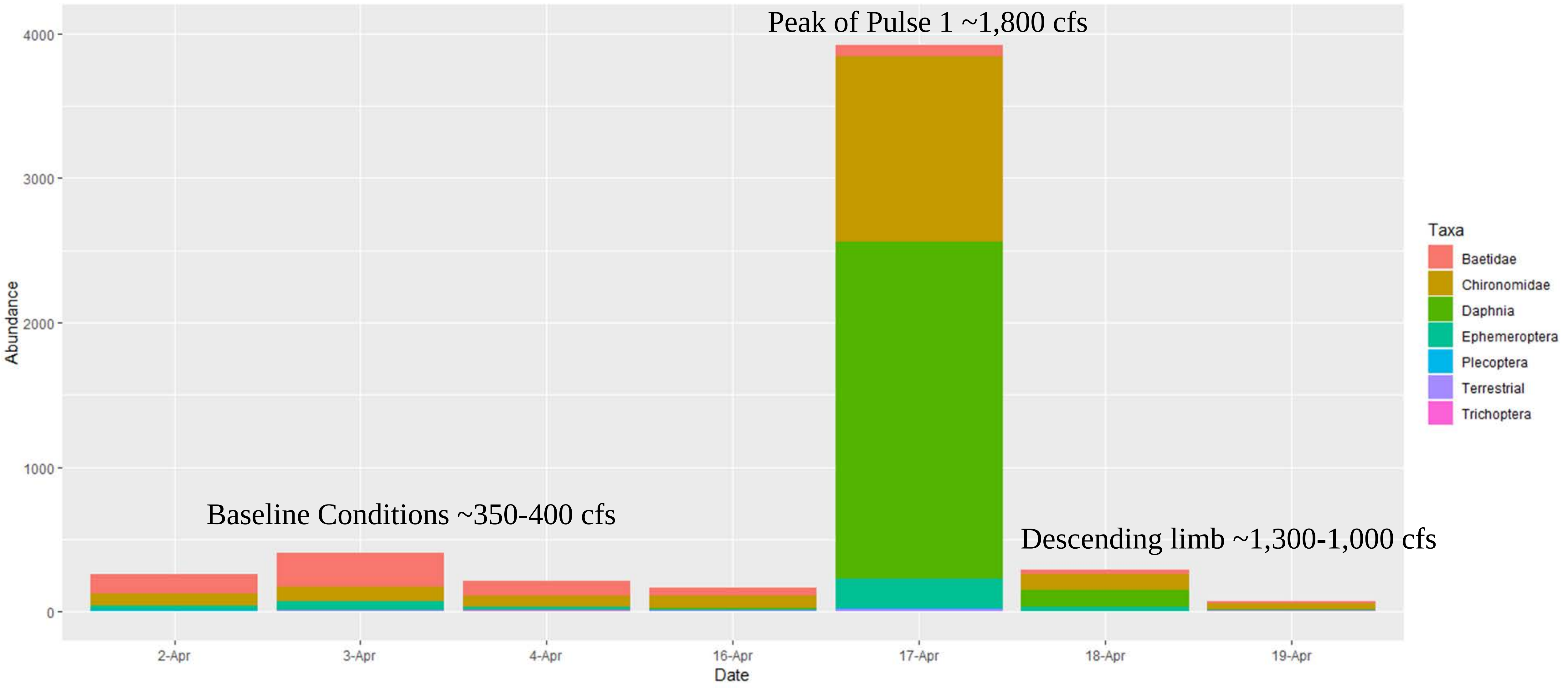
Total invertebrate biomass (mg) in a 2 hour drift samples at **Steel Bridge**

5.6x more invertebrate biomass collected during peak of pulse 1 (4/17/18) compared to baseline conditions



Total invertebrate abundance in a 2 hour drift samples at **Steel Bridge**

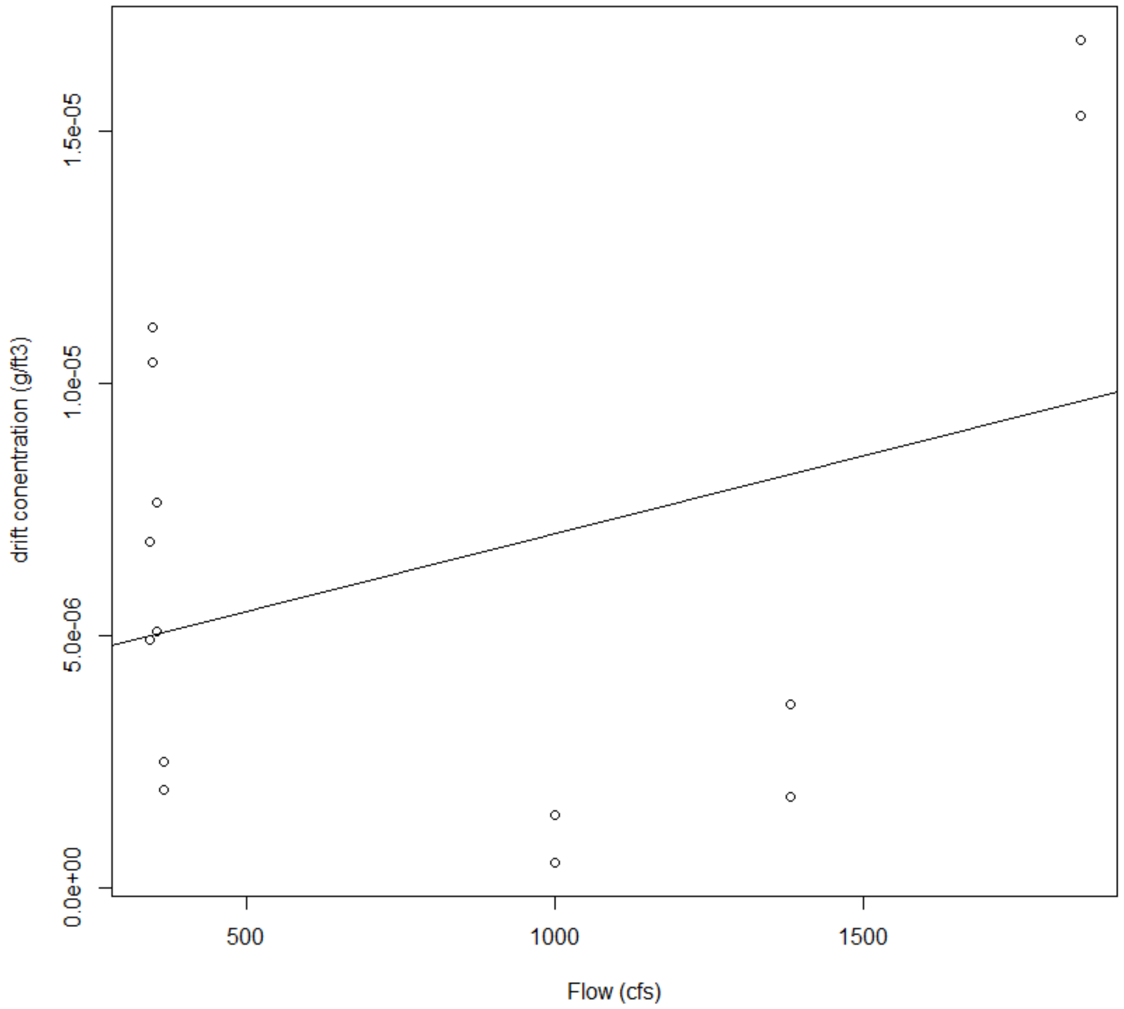
13x more invertebrates present during peak of pulse 1 (4/17/18) compared to baseline conditions



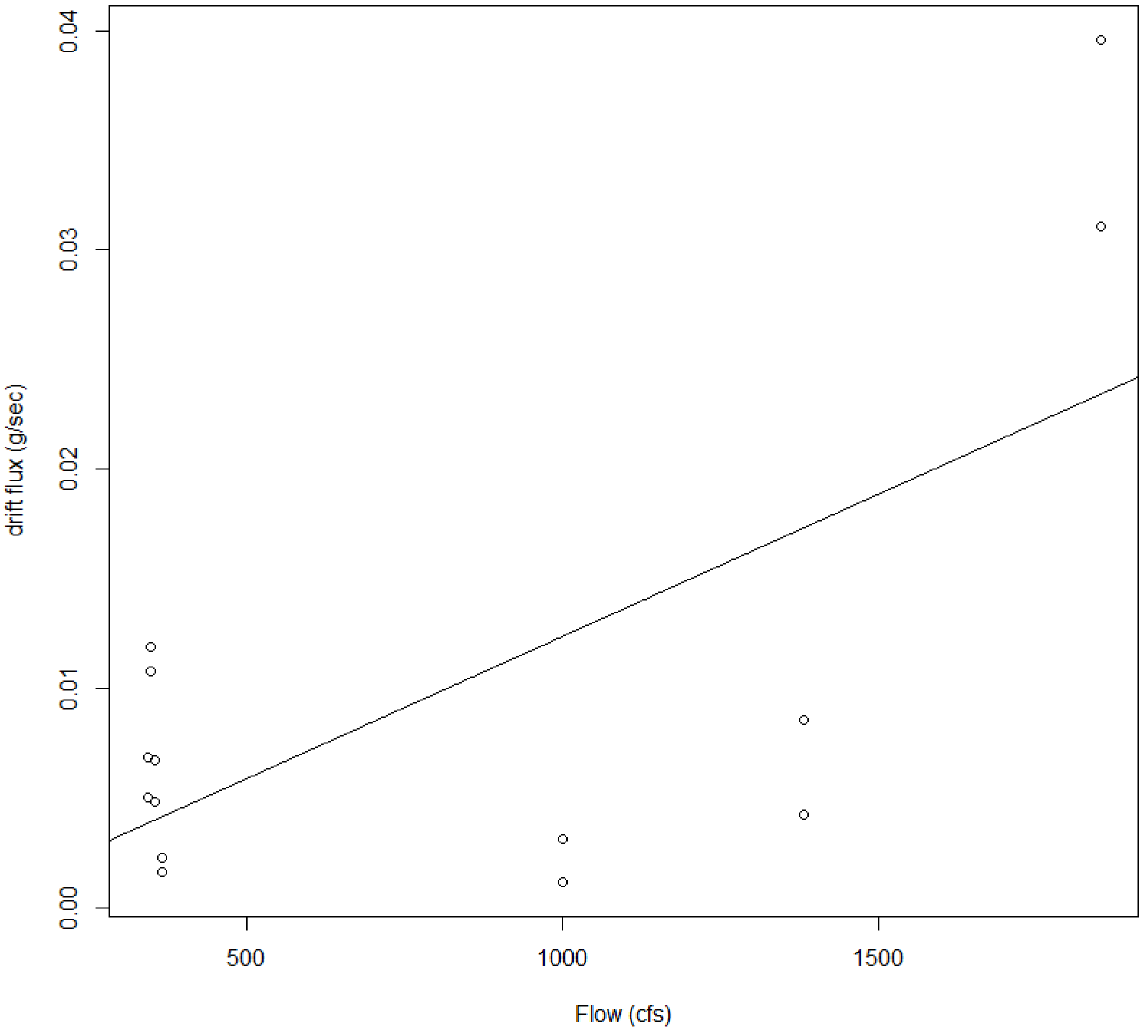
Drift concentration (g/ft3) and **drift flux (g/second)** at **Steel Bridge**

- Baseline, April 2-5th & Pulse 1, April 16-19th

grams/ft3



grams/second



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3. Index of Relative Importance (IRI) for major taxa found in diets

(Sampling the benthos by
Surber sampler)

Index of Relative Importance (IRI):

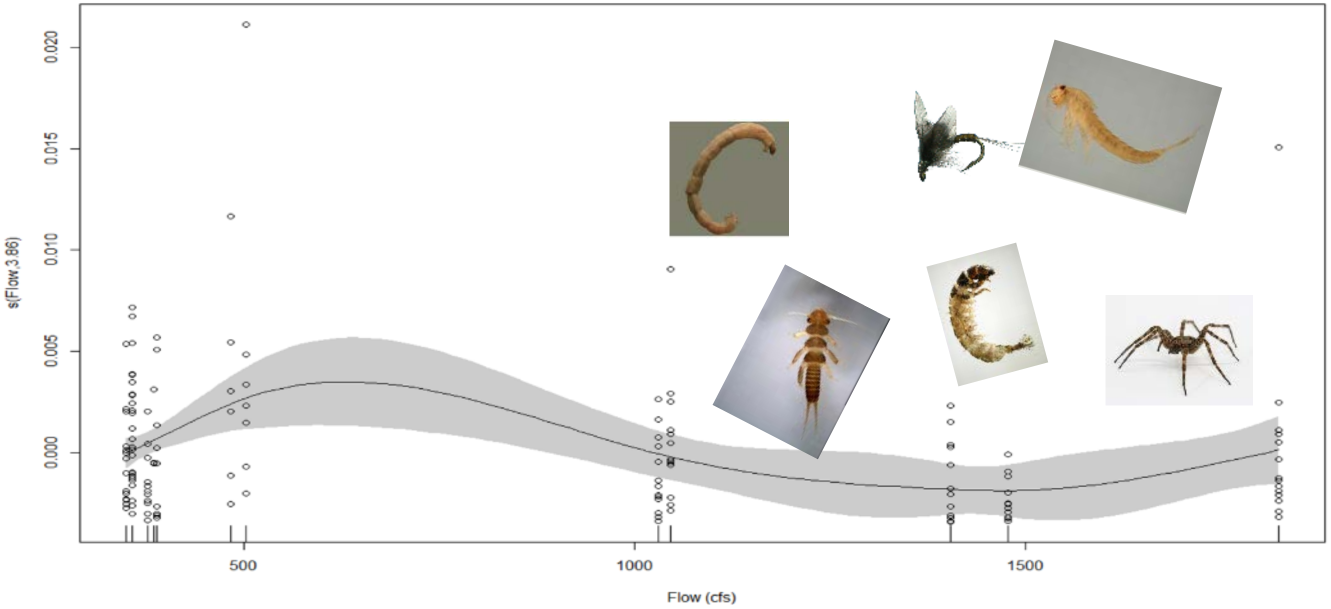
April Baseline flow conditions

Emergent Mayflies:	8,069
Heptageniidae	
Ephemerellidae	
Leptophlebiidae	
Chironomidae	3,152
Baetidae	3,146
Plecoptera	571
Trichoptera	444

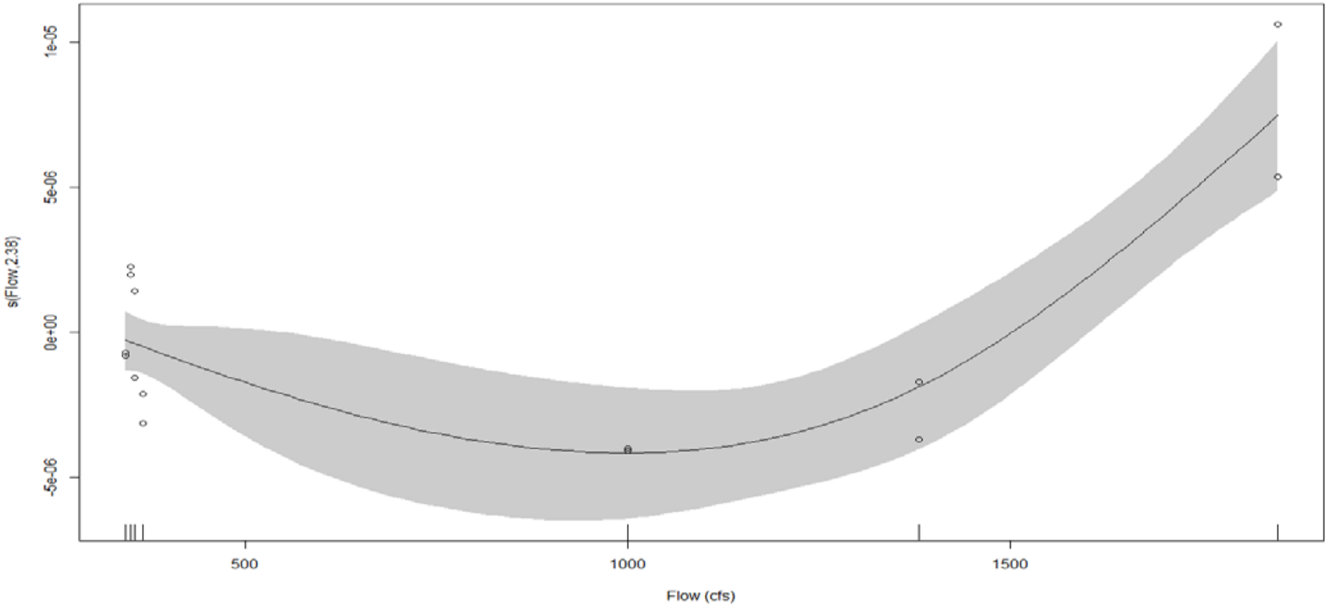
April Augmented flow conditions

Emergent Mayflies:	2,997
Heptageniidae	
Ephemerellidae	
Leptophlebiidae	
Chironomidae	2,532
Baetidae	1,249
Plecoptera	1,285
Trichoptera	1,636
Terrestrials	261
Daphnia	

Gut fullness g(inverts)/g(body mass)



Drift concentration (g/ft3)



Next Steps

Bioenergetics approach?

gut fullness x juvenile population estimate

Drift and Benthic processing @ Sawmill

Data entry and analysis

AFS oral presentation, Reno, NV

Table 1. Total number of samples collected from the entire sampling schedule of the Trinity River Macroinvertebrate Drift Study. Samples were collected from February-April 2018.

Sample Type	Total number of samples collected	Number of samples processed	% Complete
Drift	168	72	43%
Benthic	14	4	29%
Diet: Sacrifice	100	100	100%
Diet: Lavage	480	480	100%
Total	762	656	86%

Table 2. Expected timeline for the remainder of processing and analysis to be completed for the Trinity River Macroinvertebrate Drift Study.

Task	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Sample Processing	**2019**	**2019**	**2019**	**2019**	**2019**	**2019**	**2019**	**2019**	**2019**			
Data Analysis					**2019**	**2019**	**2019**	**2019**	**2019**	**2019**	**2019**	**2019**
Annual Progress Report	**2019**											
Final Report												**2019**

Questions?

References

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Anderson, N.H. and D.M. Lehmkuhl. (1968). Catastrophic drift of insects in awoodland stream. *Ecology* 49(2): 198–206.

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Brittain J.E. and T.J. Eikeland. (1988). Invertebrate drift — A review. *Hydrobiologia* 166: 77–93.

Gibbins C., D. Vericat and R.J. Batalla. (2007). When is stream invertebrate drift catastrophic? The role of hydraulics and sediment transport in initiating drift during flood events. *Freshwater Biology* 52: 2369–2384.

Hammock, B.G., N.Y. Krigbaum and M.L. Johnson. (2012). Incorporating invertebrate predators into theory regarding the timing of invertebrate drift. *Aquatic Ecology* 46(2): 153–163.

Malmqvist, B., and P. Sjostrom. (1987). Stream drift as a consequence of disturbance by invertebrate predators. *Oecologia* 74: 396–403.

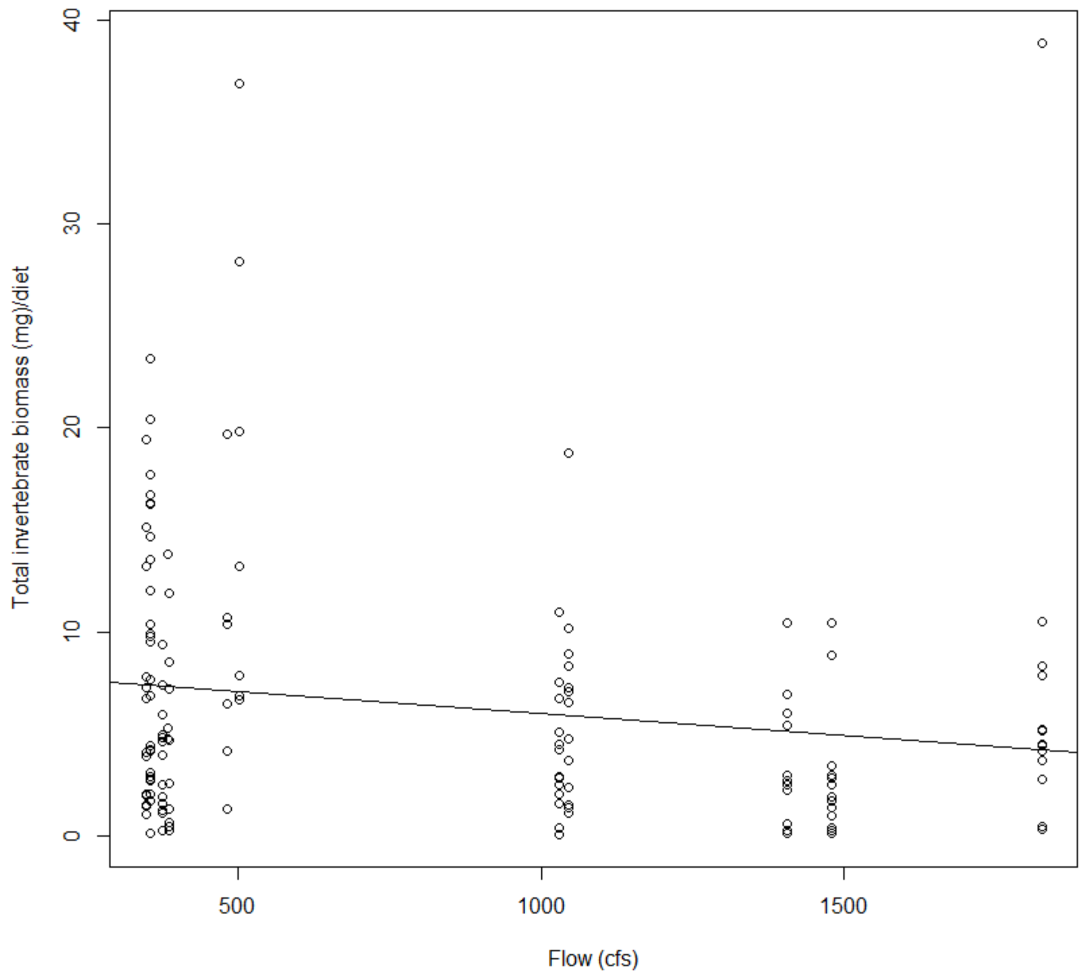
Peckarsky, B.L. (1980). Predator-prey interactions between stoneflies and mayflies: behavioral observations. *Ecology* 61(4): 932–943.

USGS: Daily Data for California: Streamflow; https://waterdata.usgs.gov/ca/nwis/current/?type=dailydischarge&group_key=basin_cd

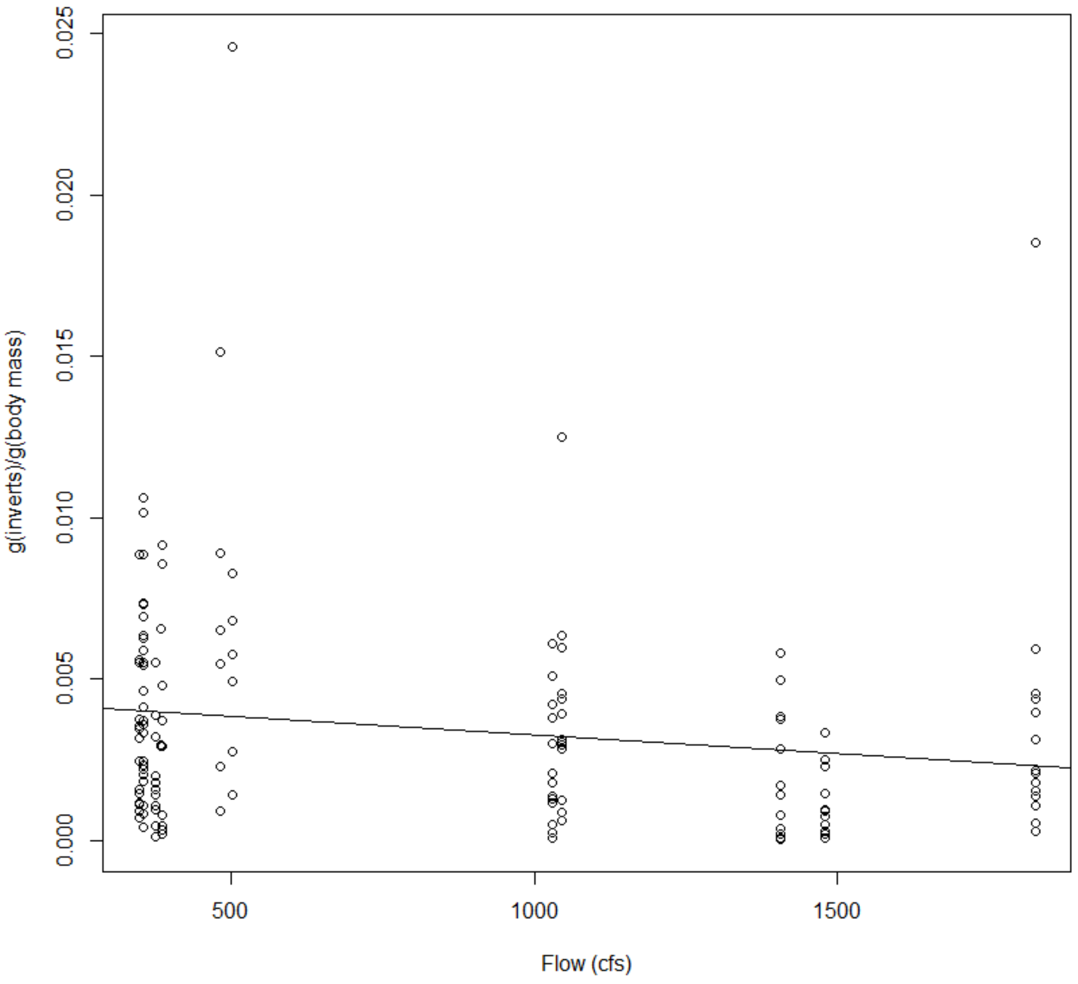
Juvenile Chinook diet at Steel Bridge

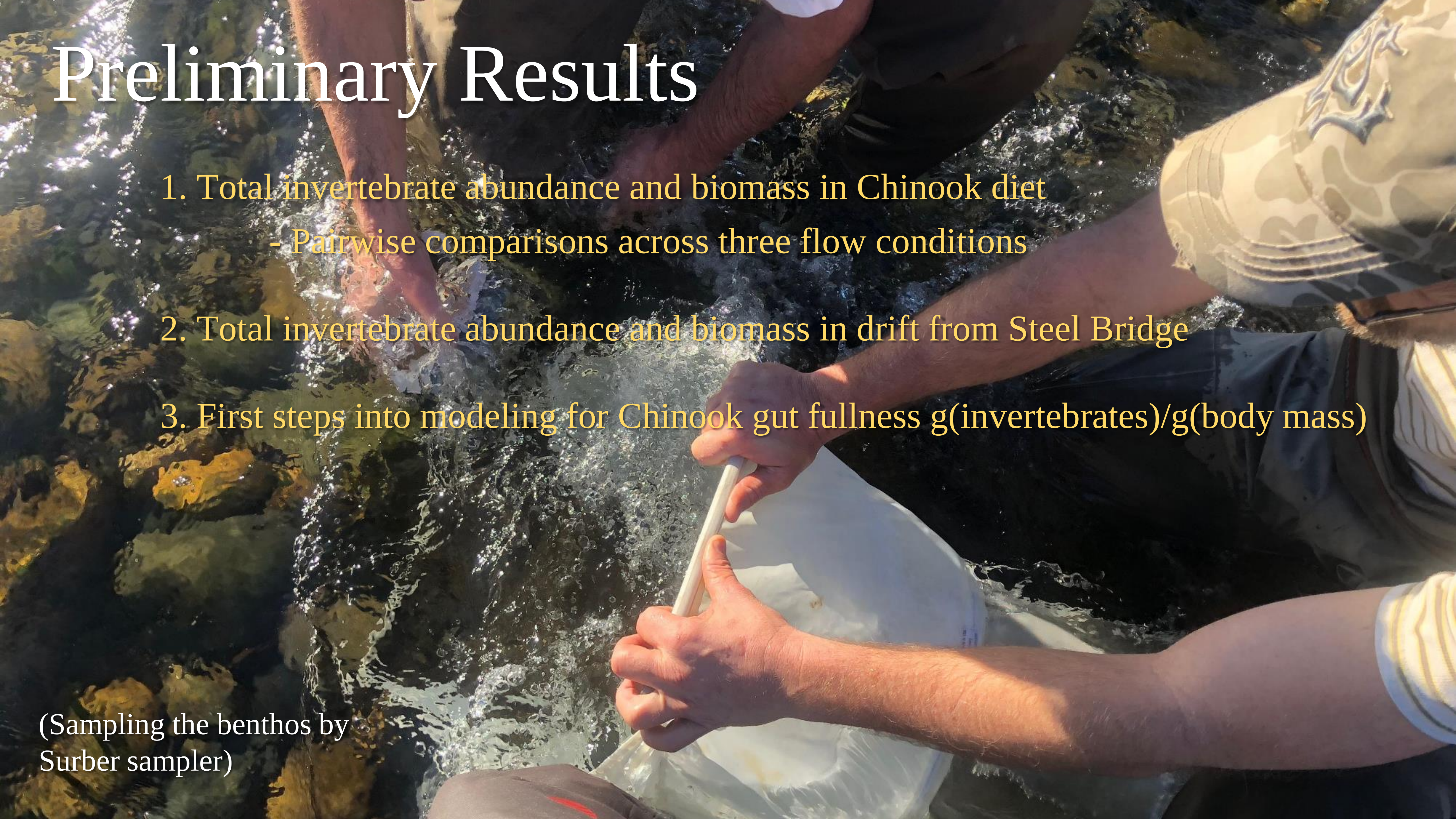
- Baseline, April 2-5th , Pulse 1, April 16-19th & Pulse 2, April 22-25th

Total biomass (mg)/diet



Juvenile Chinook gut fullness





Preliminary Results

1. Total invertebrate abundance and biomass in Chinook diet
   - Pairwise comparisons across three flow conditions

2. Total invertebrate abundance and biomass in drift from Steel Bridge

3. First steps into modeling for Chinook gut fullness g(invertebrates)/g(body mass)

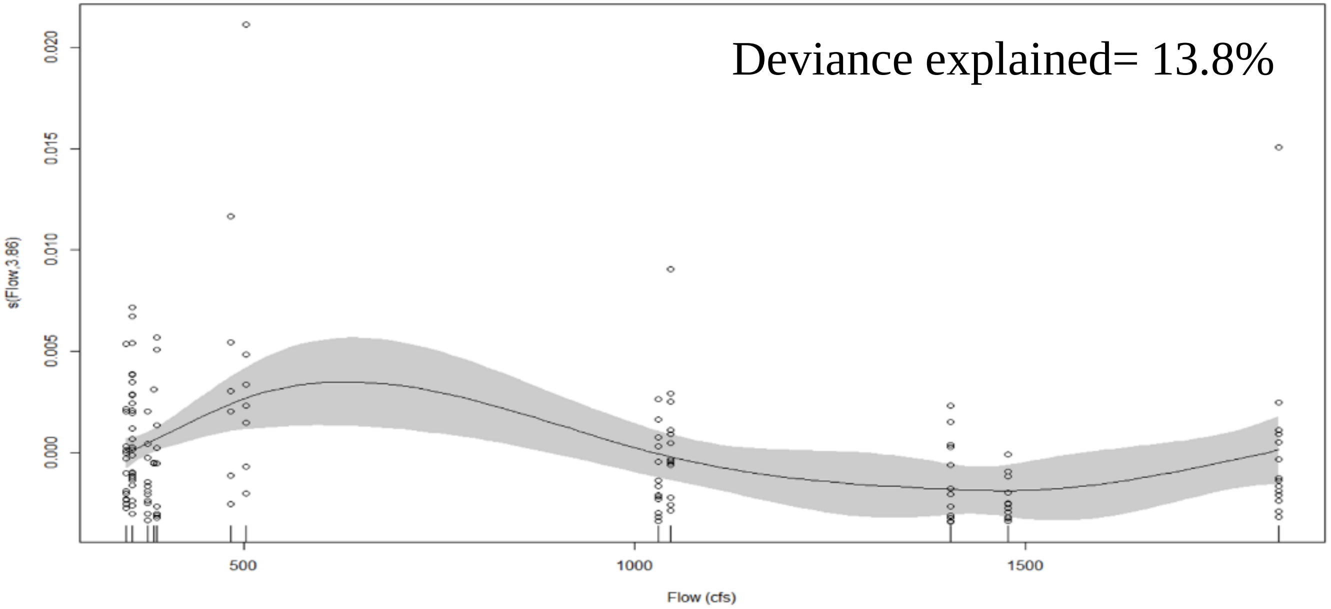
(Sampling the benthos by Surber sampler)

Non-parametric approach (GAMs):

Juvenile Chinook gut fullness at **Steel Bridge**

- Baseline, April 2-5th
- Pulse 1, April 16-19th
- Pulse 2, April 22-25th

Gut fullness g(inverts)/g(body mass)

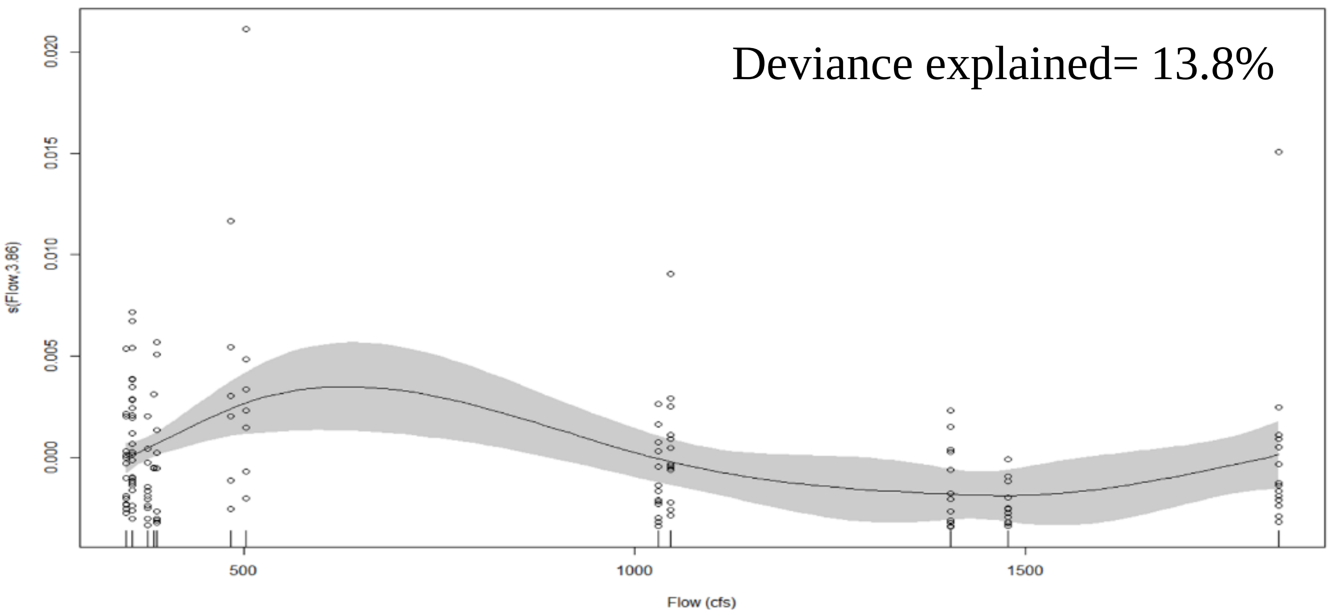


General additive models (GAMs):

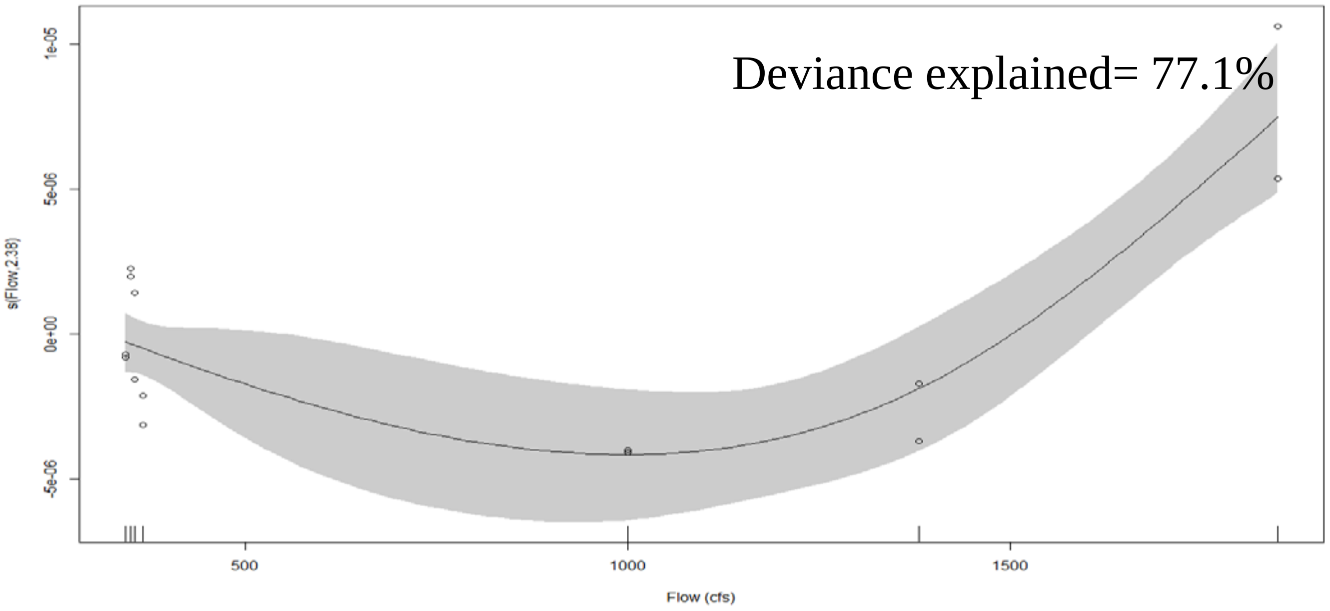
Juvenile Chinook gut fullness at **Steel Bridge**
- Baseline, April 2-5th
- Pulse 1, April 16-19th
- Pulse 2, April 22-25th

Invertebrate drift concentration at **Steel Bridge**
- Baseline, April 2-5th
- Pulse 1, April 16-19th

Gut fullness g(inverts)/g(body mass)



Drift concentration (g/ft3)

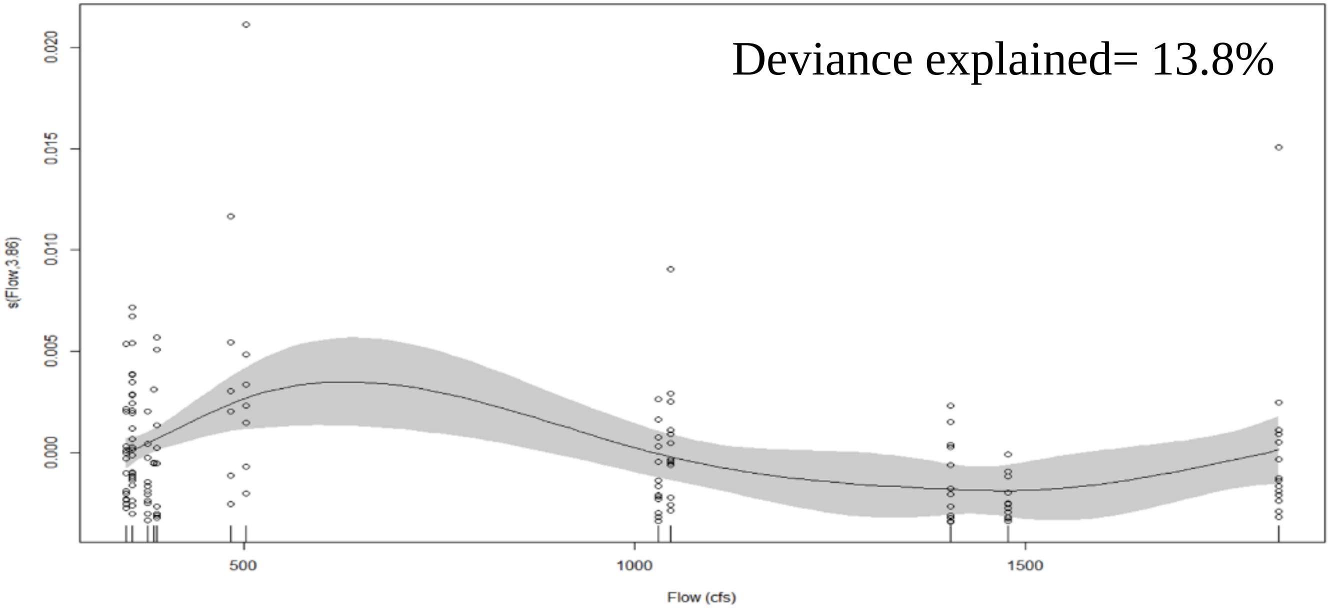


General additive models (GAMs):

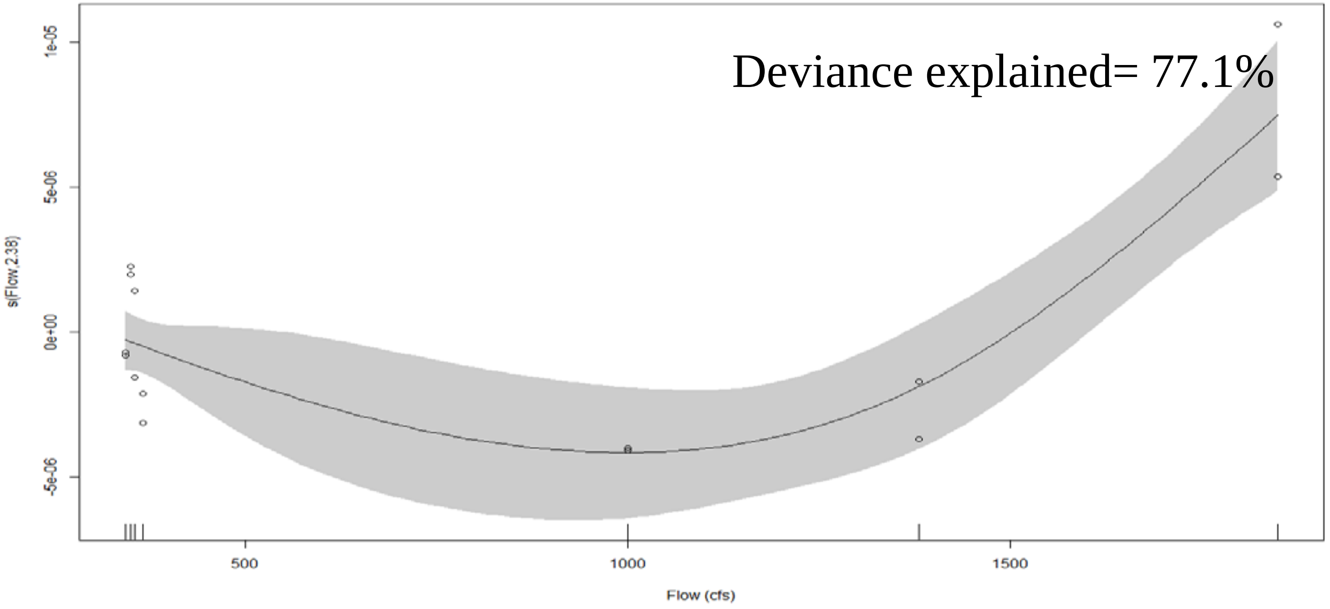
Juvenile Chinook gut fullness at **Steel Bridge**
- Baseline, April 2-5th
- Pulse 1, April 16-19th
- Pulse 2, April 22-25th

Invertebrate drift concentration at **Steel Bridge**
- Baseline, April 2-5th
- Pulse 1, April 16-19th

Gut fullness g(inverts)/g(body mass)



Drift concentration (g/ft3)

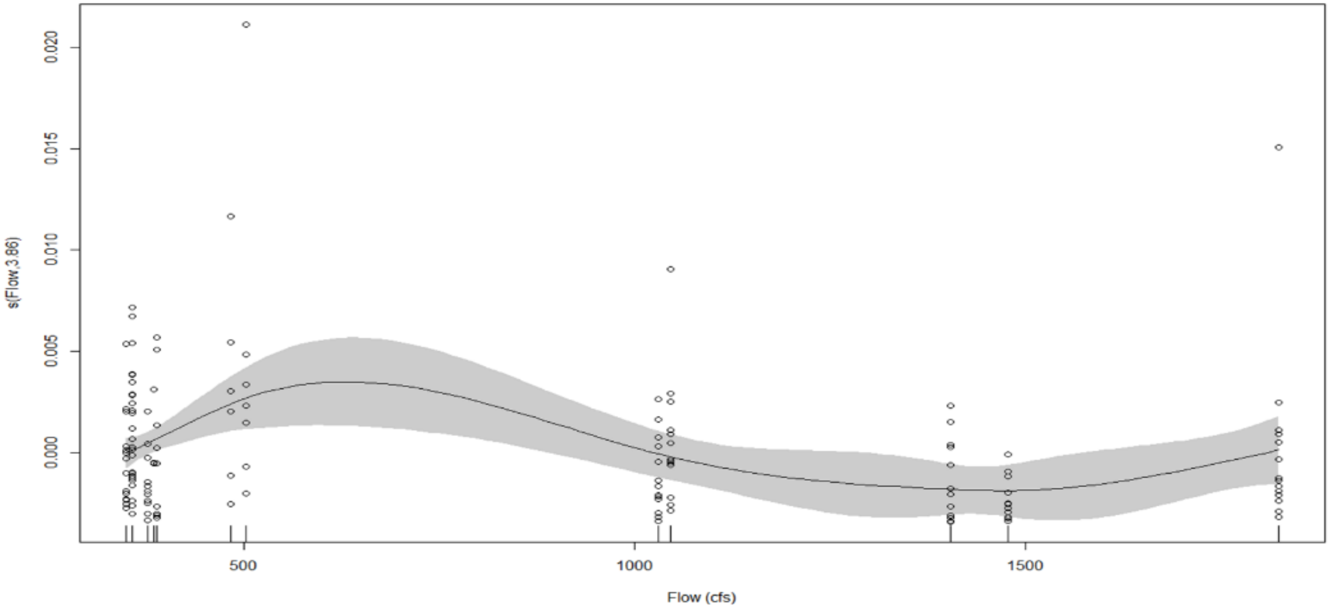


Index of Relative Importance (IRI):

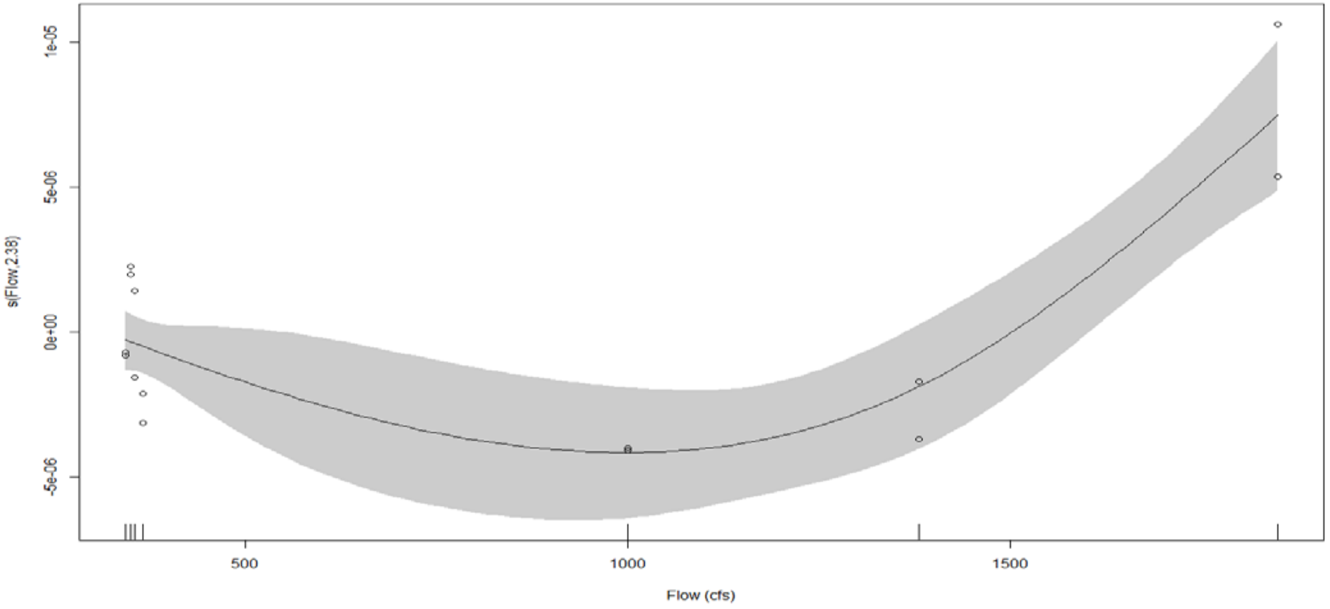
April Baseline flow conditions

Emergent Mayflies:	8,069
Heptageniidae	
Ephemerellidae	
Leptophlebiidae	
Chironomidae	3,152
Baetidae	3,146
Plecoptera	571
Trichoptera	444

Gut fullness g(inverts)/g(body mass)



Drift concentration (g/ft3)



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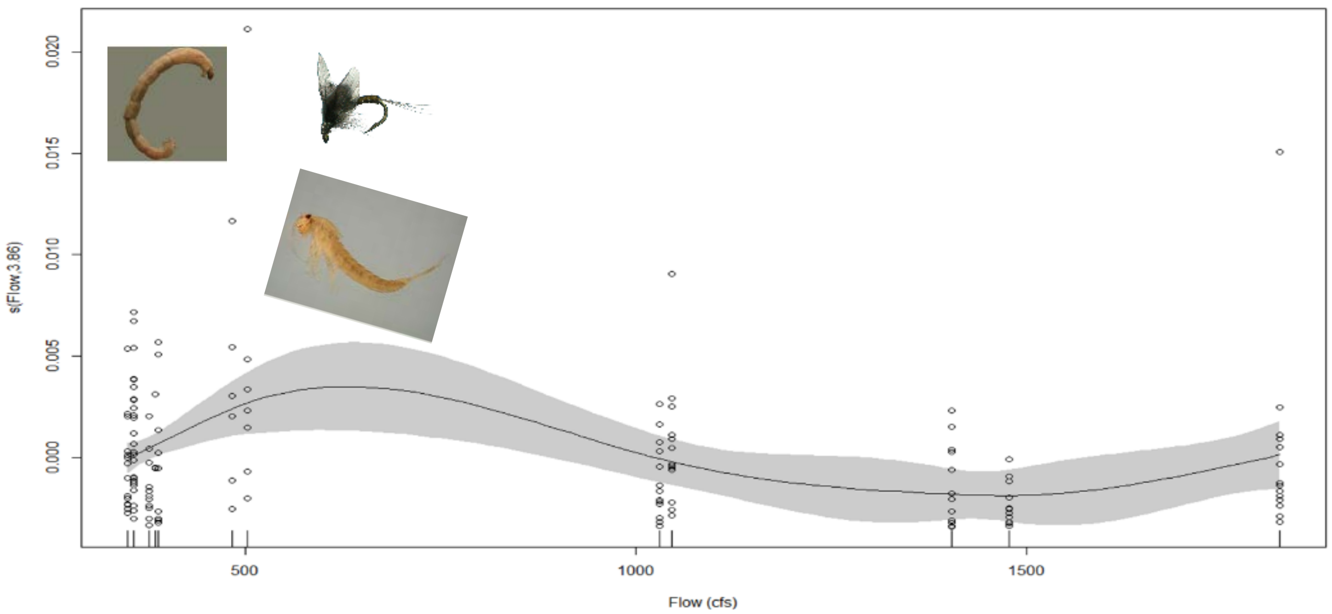

Drift concentration (g/ft3)