Seasonal Changes in Aquatic Macroinvertebrate Biomass and Community Structure in Salmon Spawning Streams

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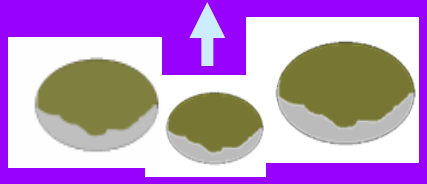
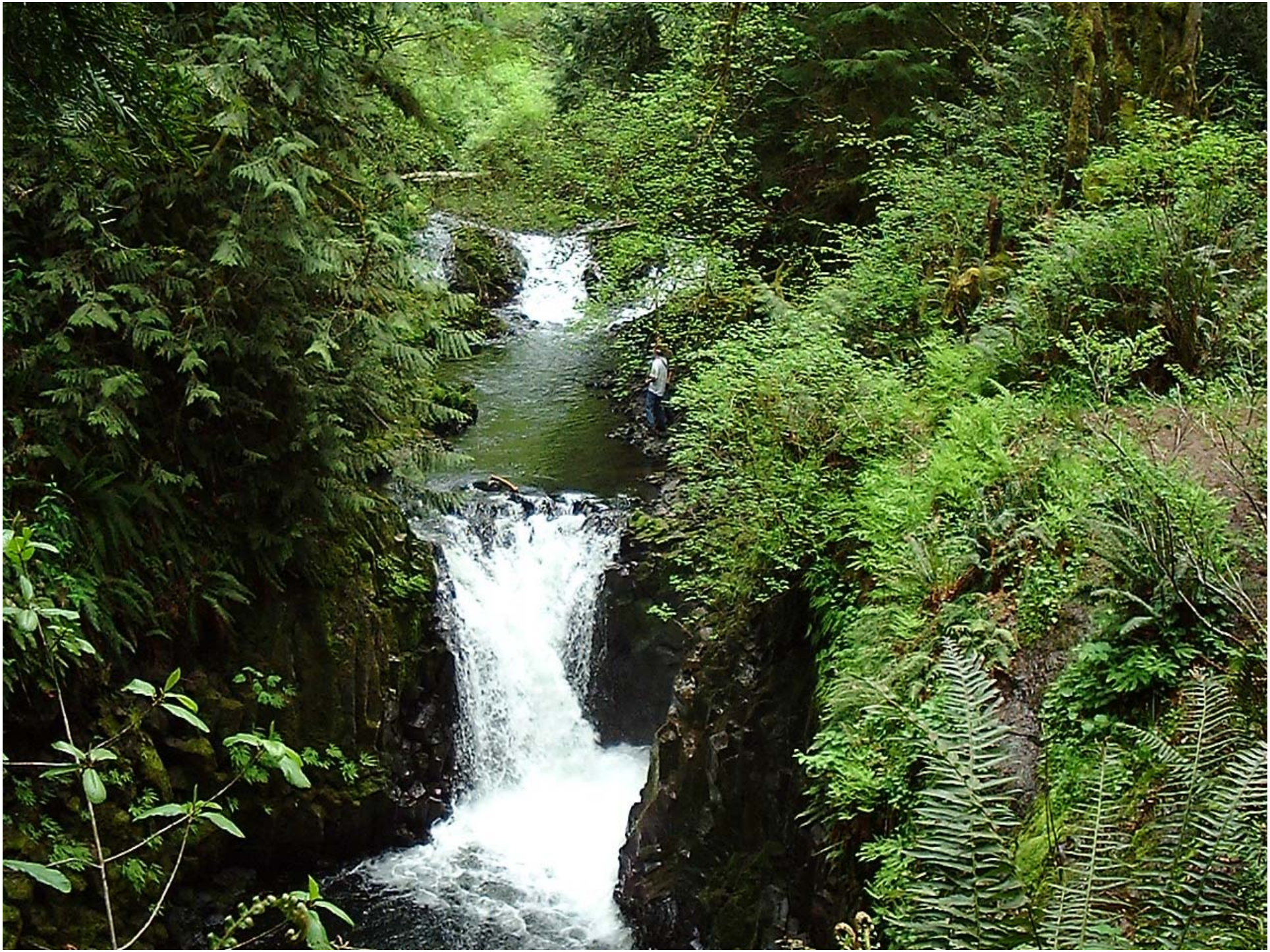
Cycle of Salmon Nutrients



Salmon Nutrients vs. Forest Fertilization

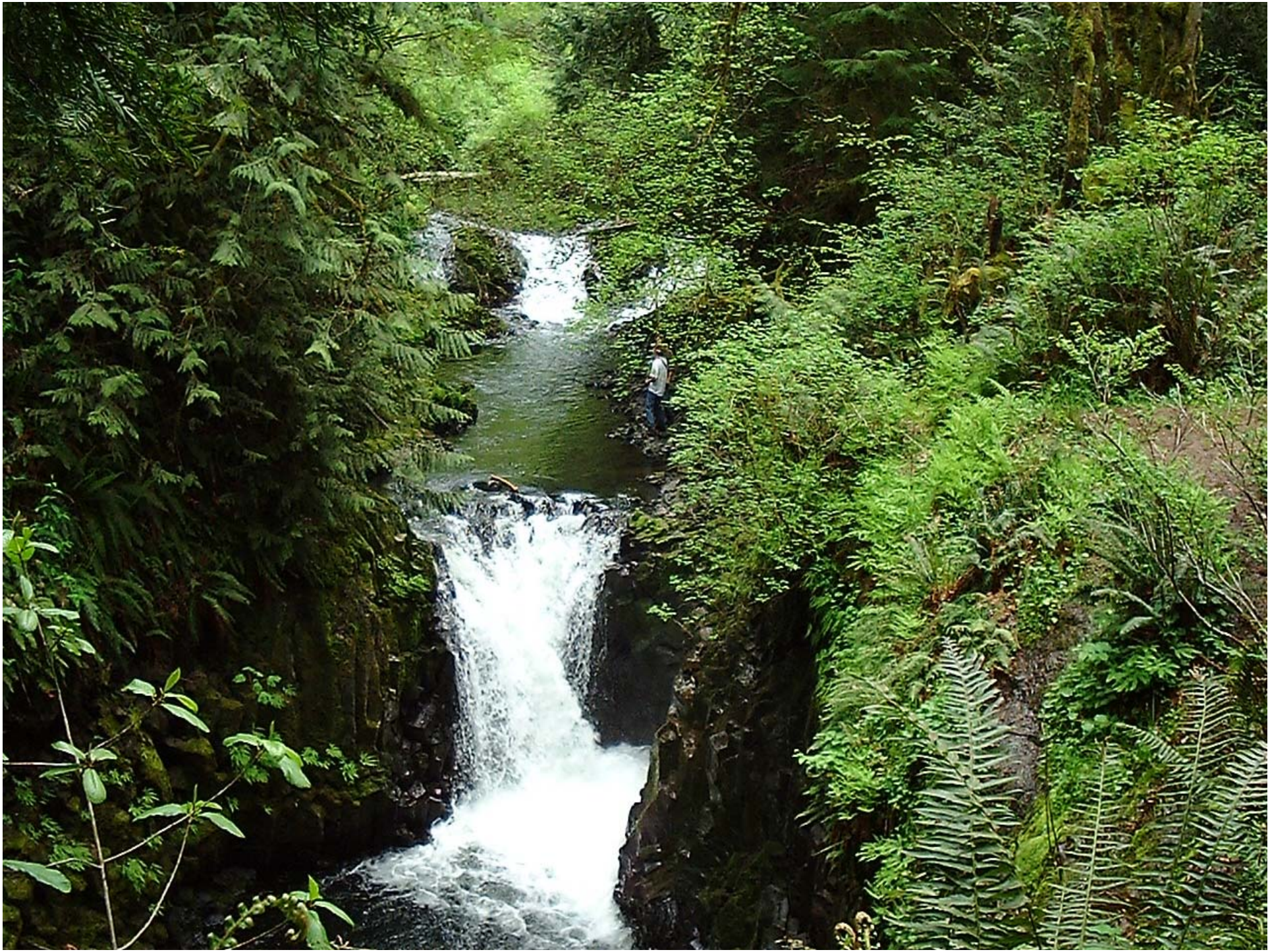
- Artificial fertilization
  - 224 kg of N / hectare / 5 years
    - 200 lbs / acre
  - ***4.5 g / m^2 / year***
    - 0.015 oz / ft^2
- Nitrogen from salmon
  - ***105 g / m^2 / year***
    - 0.344 oz / ft^2
    - **Over 20 times as much!**



Goals

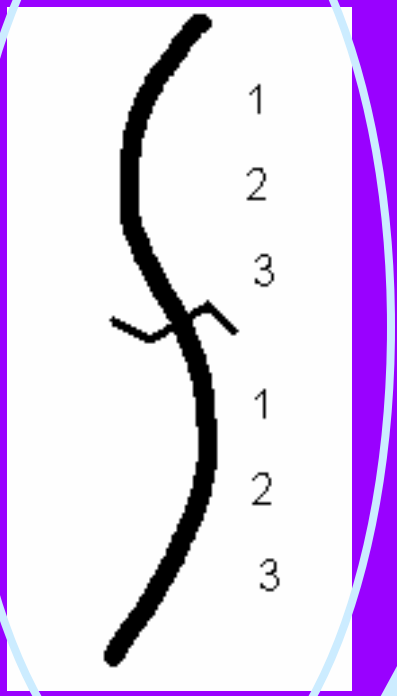
- To determine if salmon spawning reaches support a greater biomass of aquatic macroinvertebrates.
- To determine pathway of salmon nutrients through the macroinvertebrate community.


Victoria
Lake Chelan Nat'l Recreation Area
Boulder River
Susie and Field Creeks
Olympic National Park
Everett
5
3
Seattle
Deer Creek tribs
167
90
Federal Way
Tacoma
Lakewood
Kennedy Creek
Olympia
Mt Rainier National Park

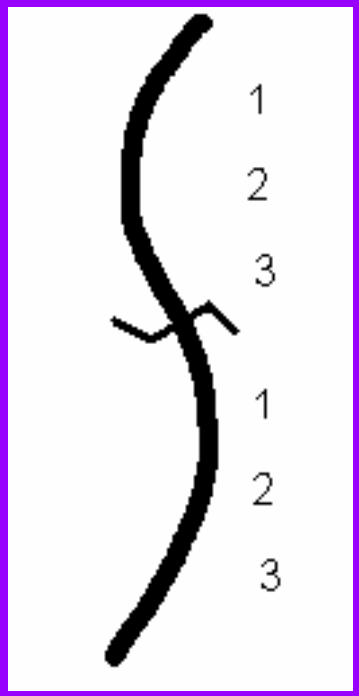


Kennedy: Compare Seasonal Changes

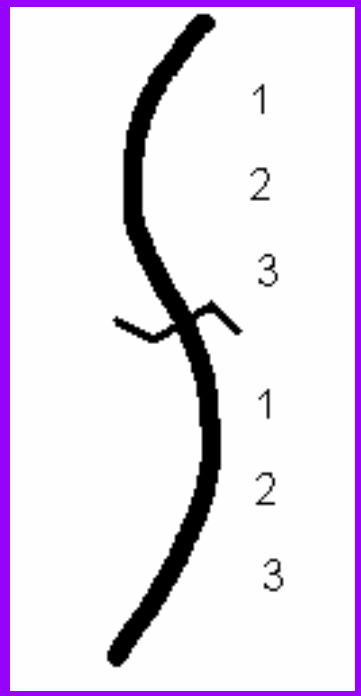
Summer



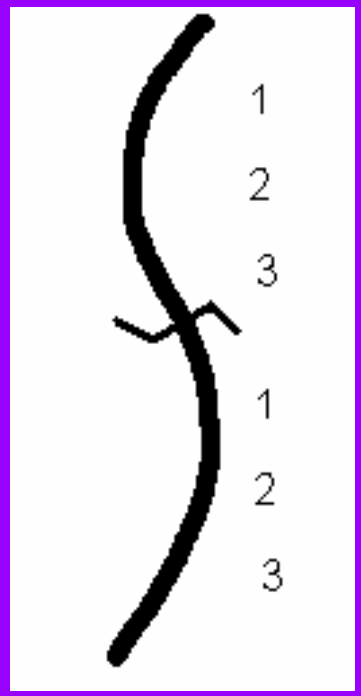
Fall

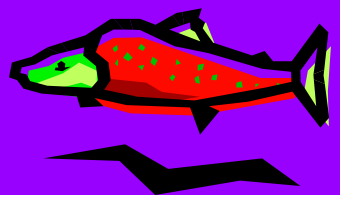


Winter



Spring

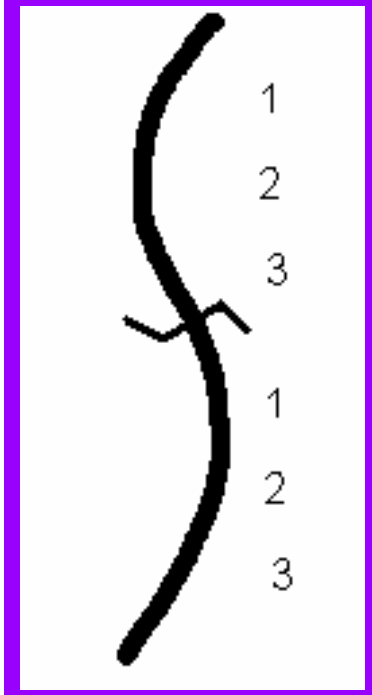




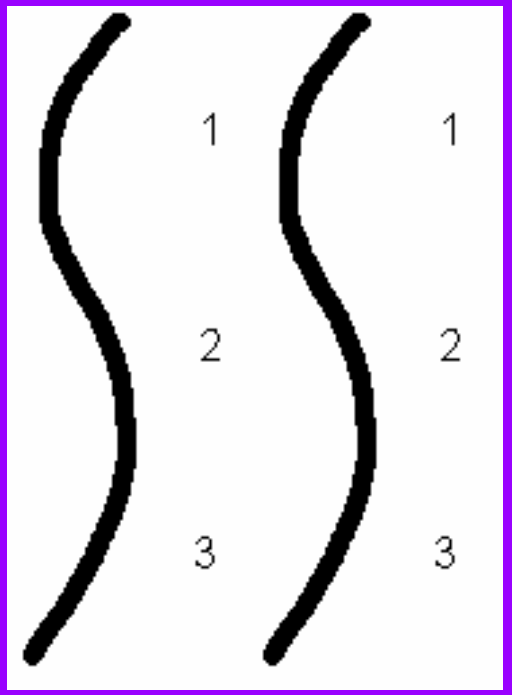
Chum salmon spawn

Compare 4 Watersheds in Summer Only

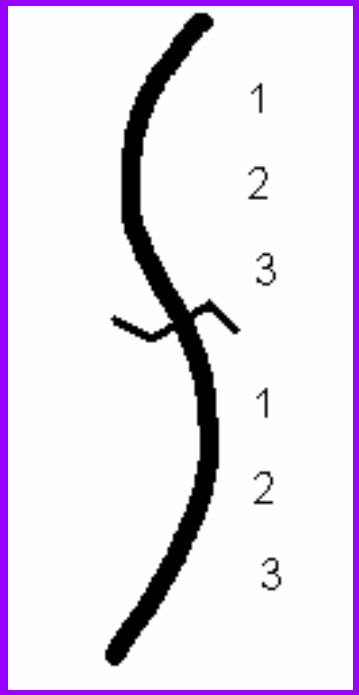
Kennedy



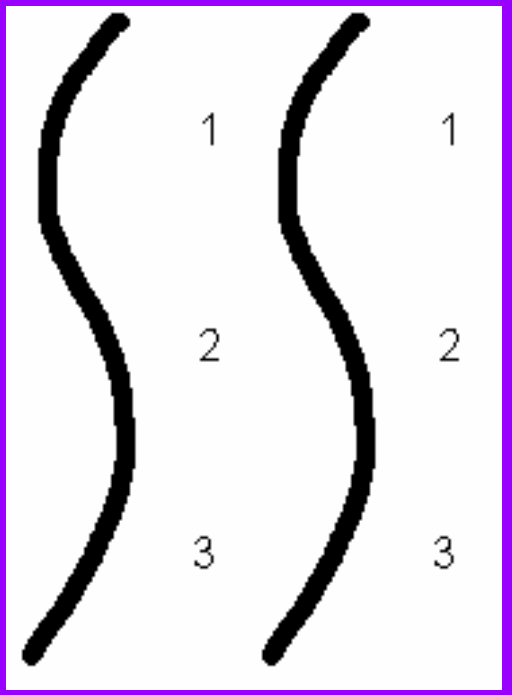
Deer Tribs



Boulder



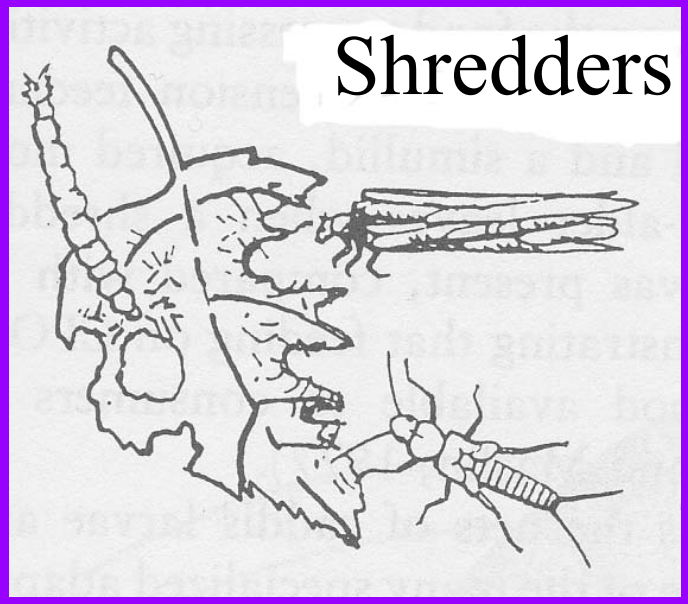
N. Peninsula



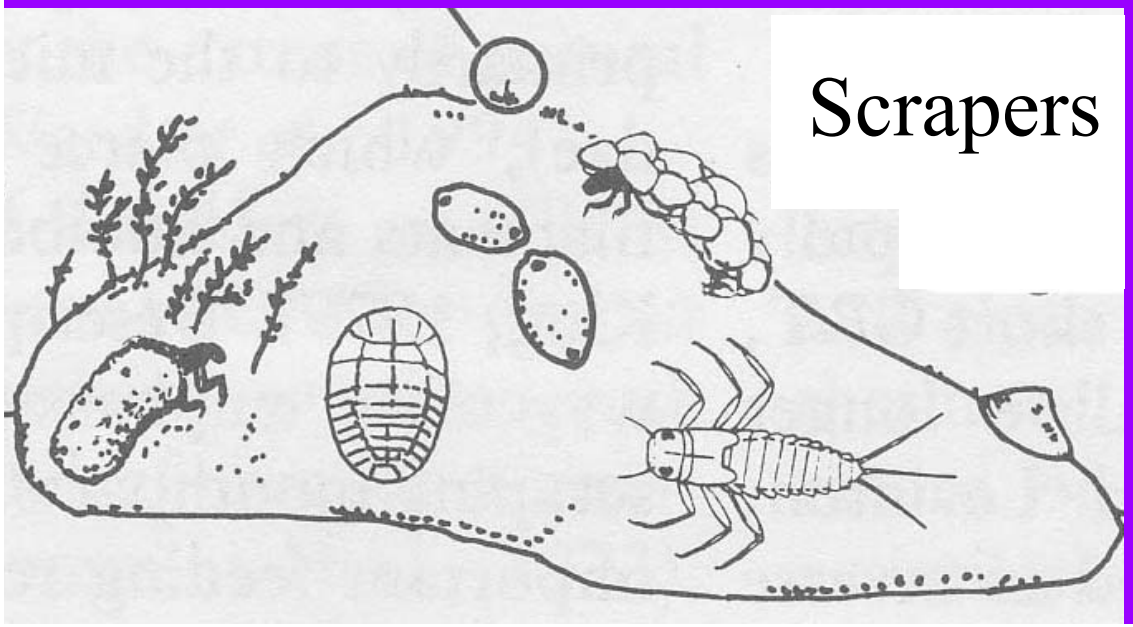
Identify to genus (subfamily for Chironomidae)

- Divide into series of size-classes corresponding to instars

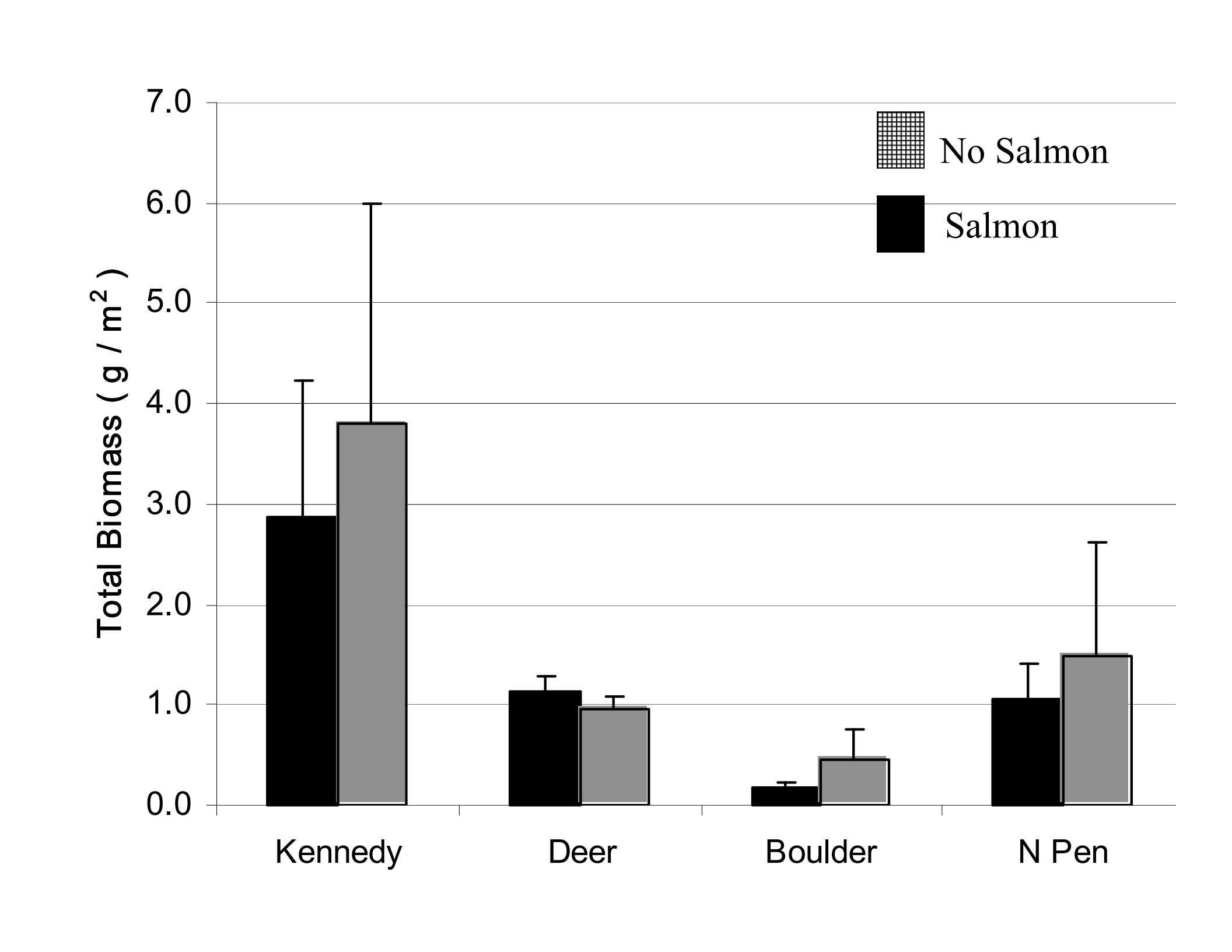
Functional Feeding Groups

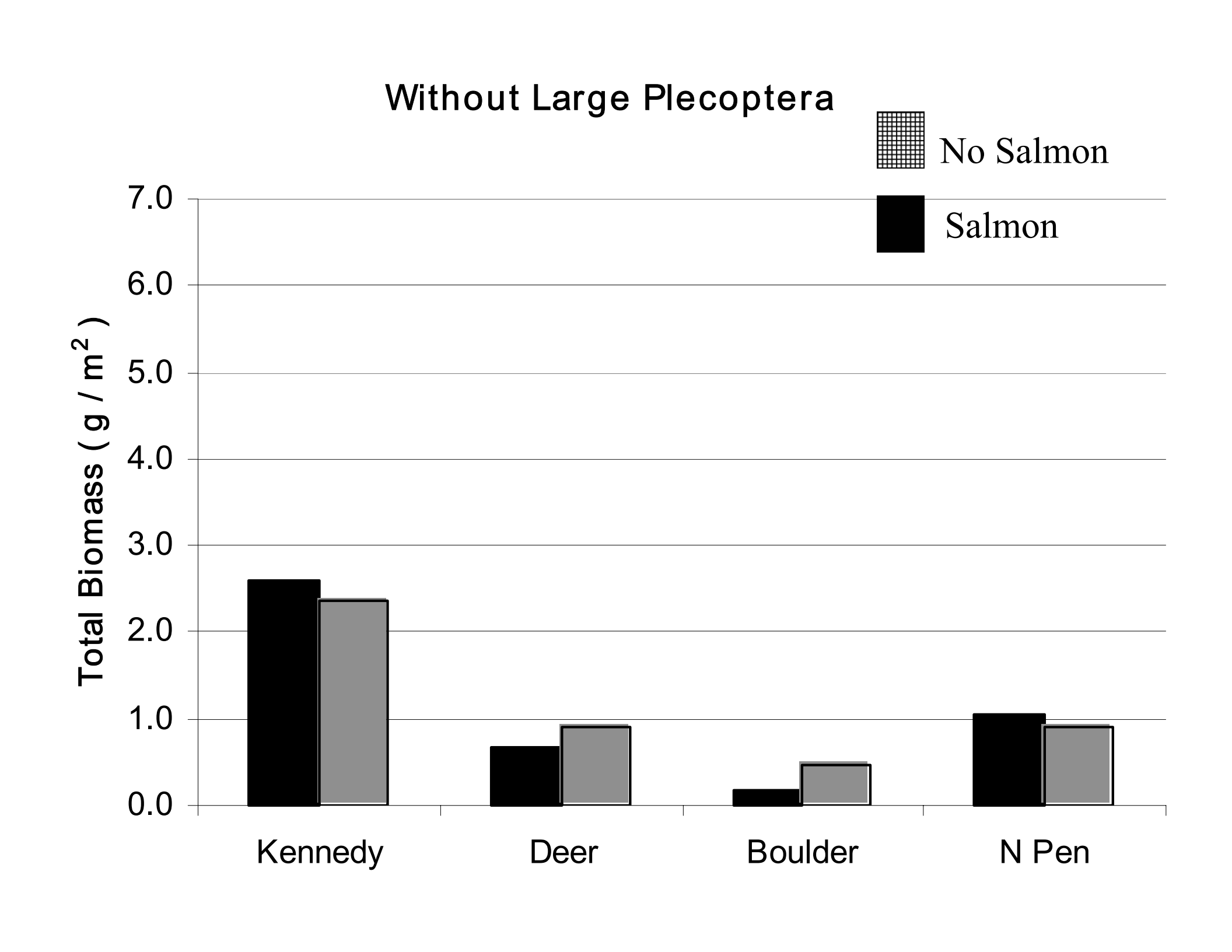


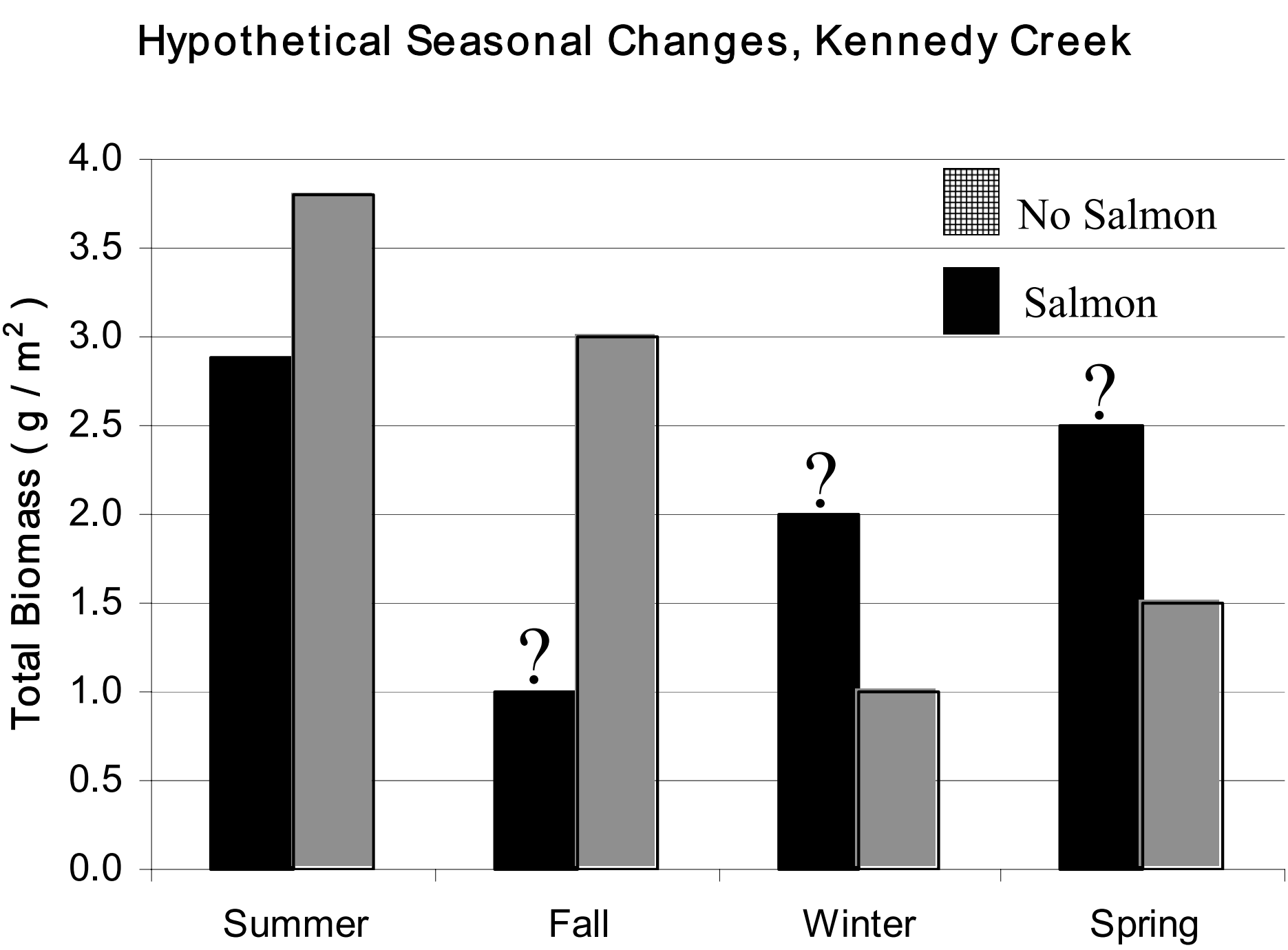
Direct Consumption
of Salmon



Indirect
Consumption
(via fertilized algae)


7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Total Biomass (g / m2)
No Salmon
Salmon
Kennedy
Deer
Boulder
N Pen

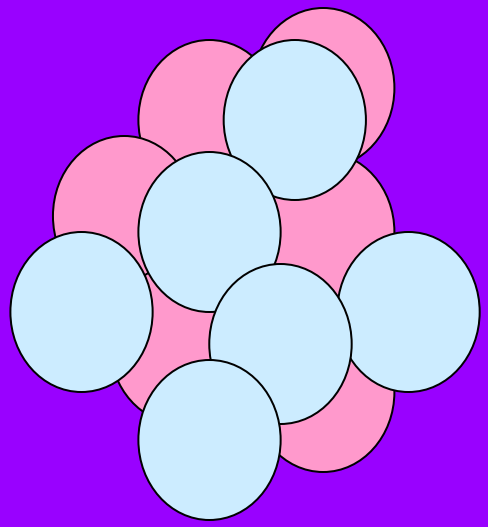

Without Large Plecoptera
No Salmon
Salmon
Total Biomass (g / m2)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Kennedy
Deer
Boulder
N Pen


Hypothetical Seasonal Changes, Kennedy Creek
Total Biomass (g / m2)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
No Salmon
Salmon
?
?
?
Summer
Fall
Winter
Spring

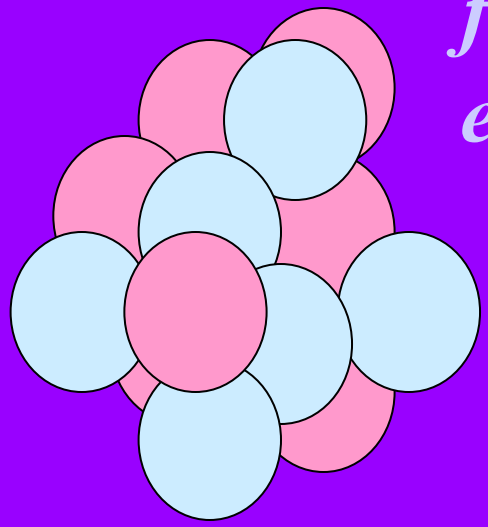
Goals

- To determine if salmon spawning reaches support a greater biomass of aquatic macroinvertebrates.
- To determine pathway of salmon nutrients through the macroinvertebrate community.
- To link macroinvertebrate changes to salmon by tracing salmon C & N.

Stable Isotopes of Carbon



Carbon 12 nucleus



Carbon 13 nucleus

proton neutron

Same

protons

electrons

form same bonds

enter same reactions

Different

neutrons

nuclear weight

rates of diffusion

bond strengths

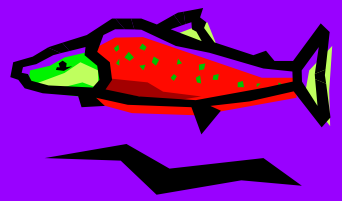
^{13}C : ^{12}C in Base Food Sources

$CO_{2\ atmosphere} \approx -7$ ‰

1. Diffuse through stomates
2. Diffuse through leaf
3. Dissolve & diffuse across cell membrane
4. Carboxylation by rubisco

$\approx$ -30.3 ‰

1. Dissolve into water
2. Diffuse across cell membrane
3. Carboxylation by rubisco
4. Through food web to salmon



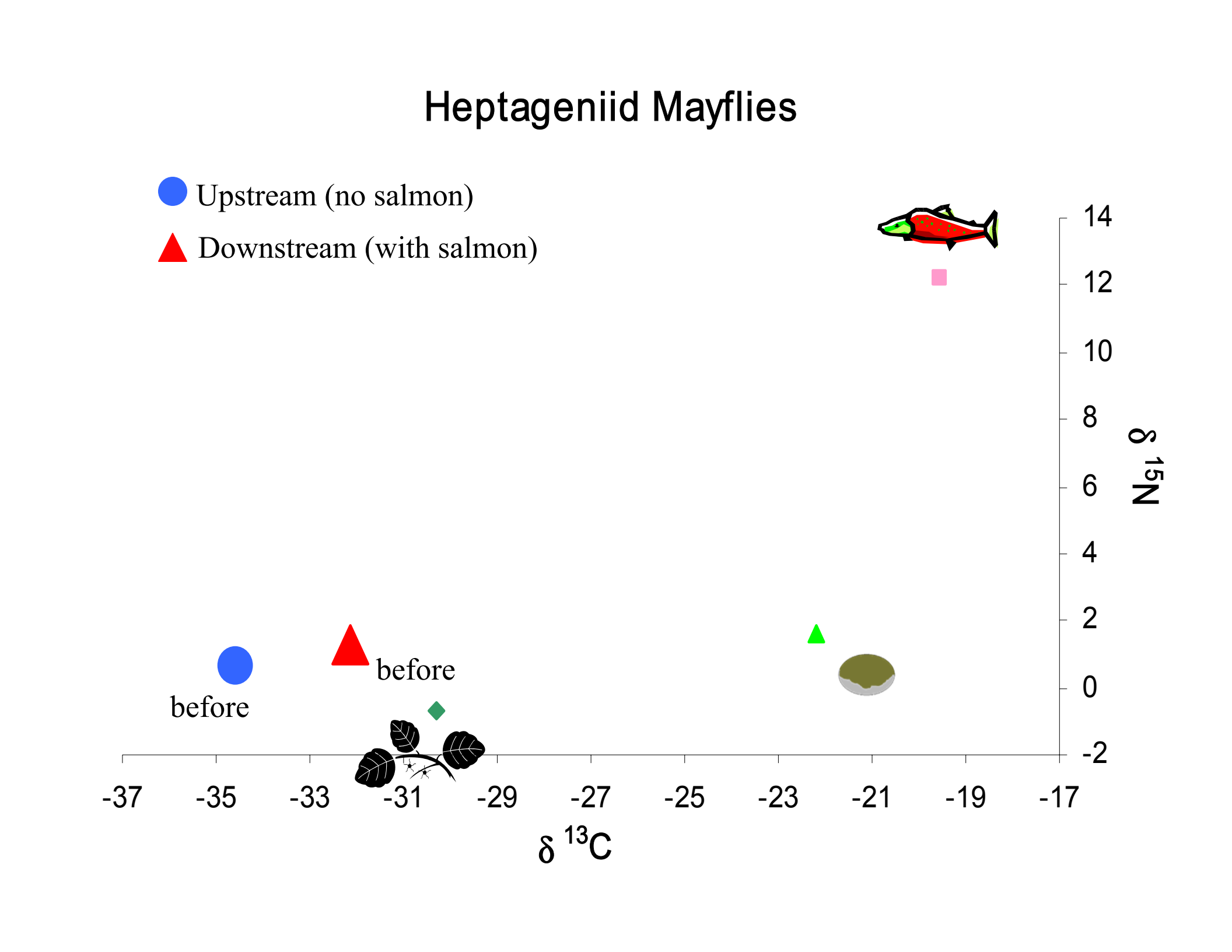
$\approx$ -19.6 ‰

Proportion salmon in diet = [(insect tissue * $\delta^{13}C_{insect}$) - (insect tissue * $\delta^{13}C_{leaves}$)] / ($\delta^{13}C_{salmon} - \delta^{13}C_{leaves}$)

Sampling for Isotope Analysis

Food Sources	Insects
Leaves	Before spawning
bigleaf maple	1 month after spawning
red alder	3 months after spawning
Salmon	5 months after spawning
Algae	

Heptageniid Mayflies



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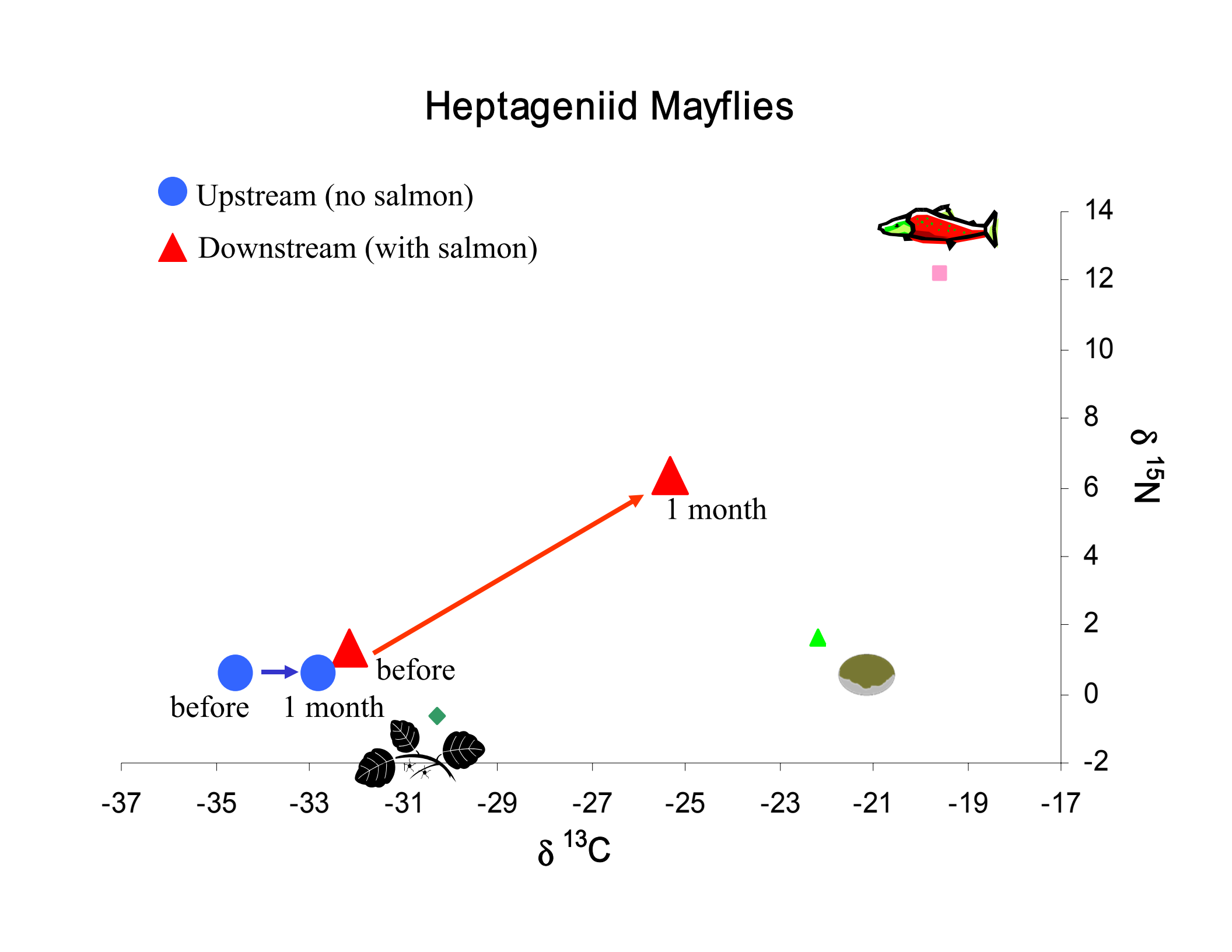

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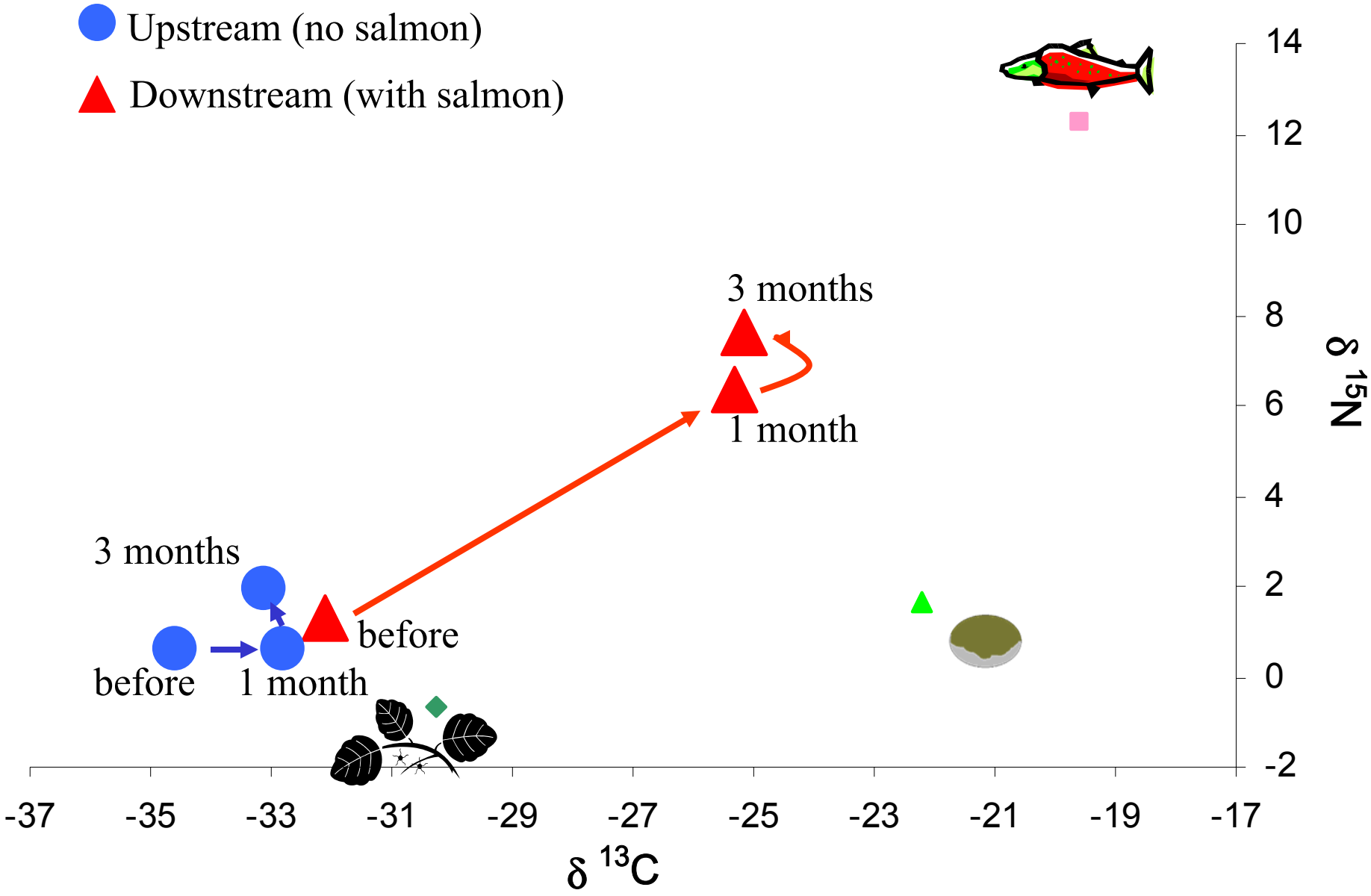
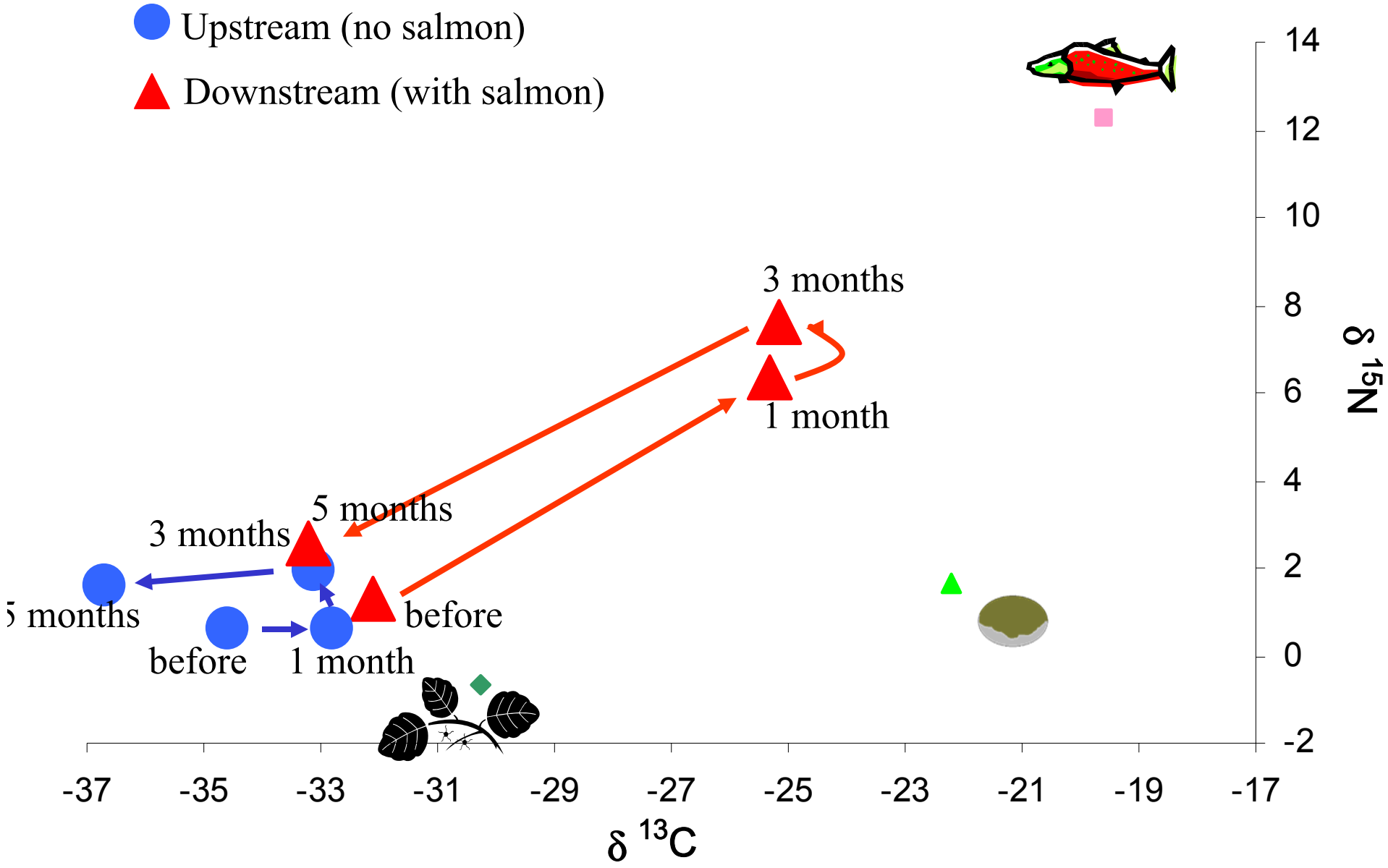
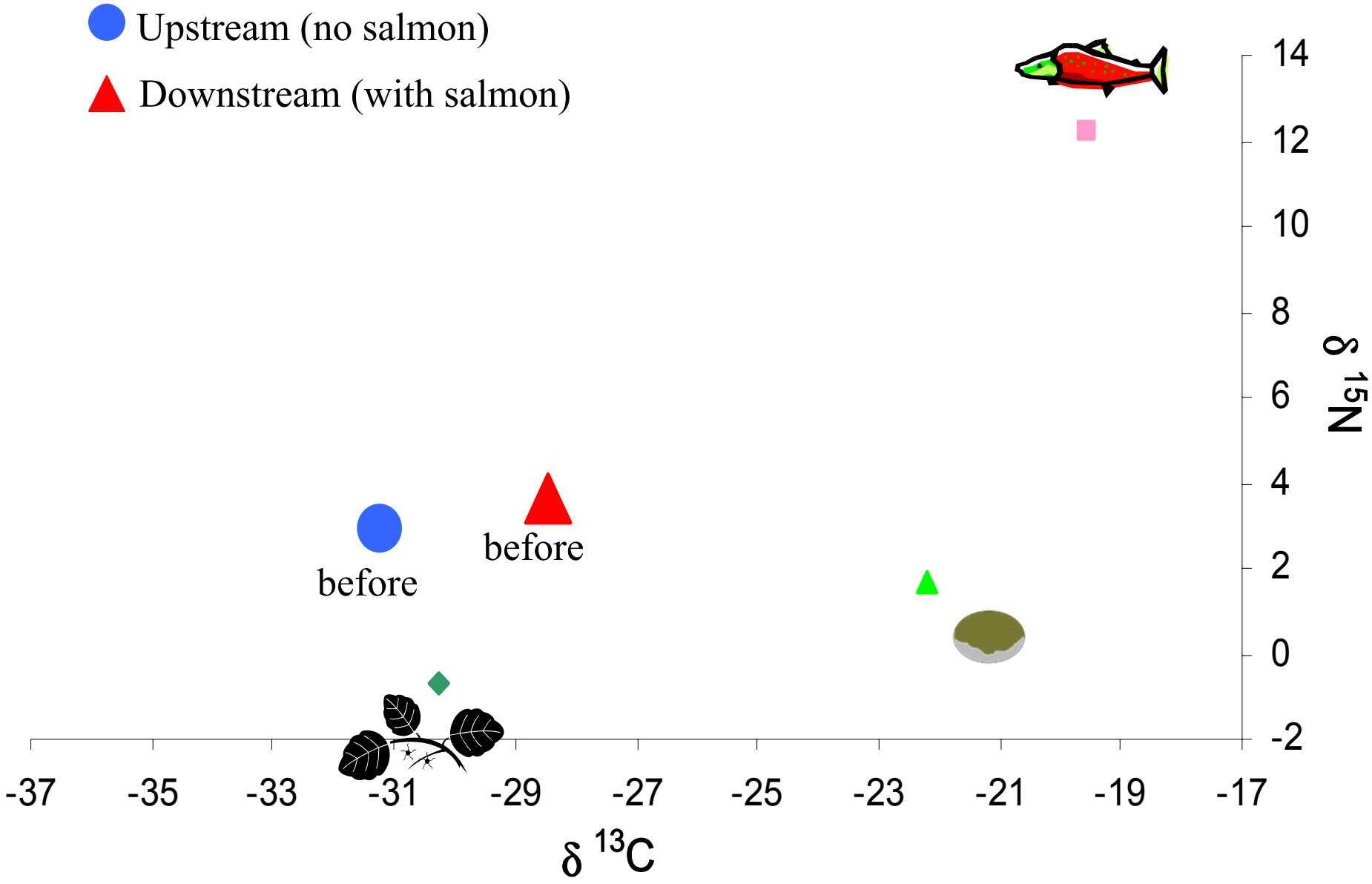


Heptageniid Mayflies



Calineurid Stoneflies



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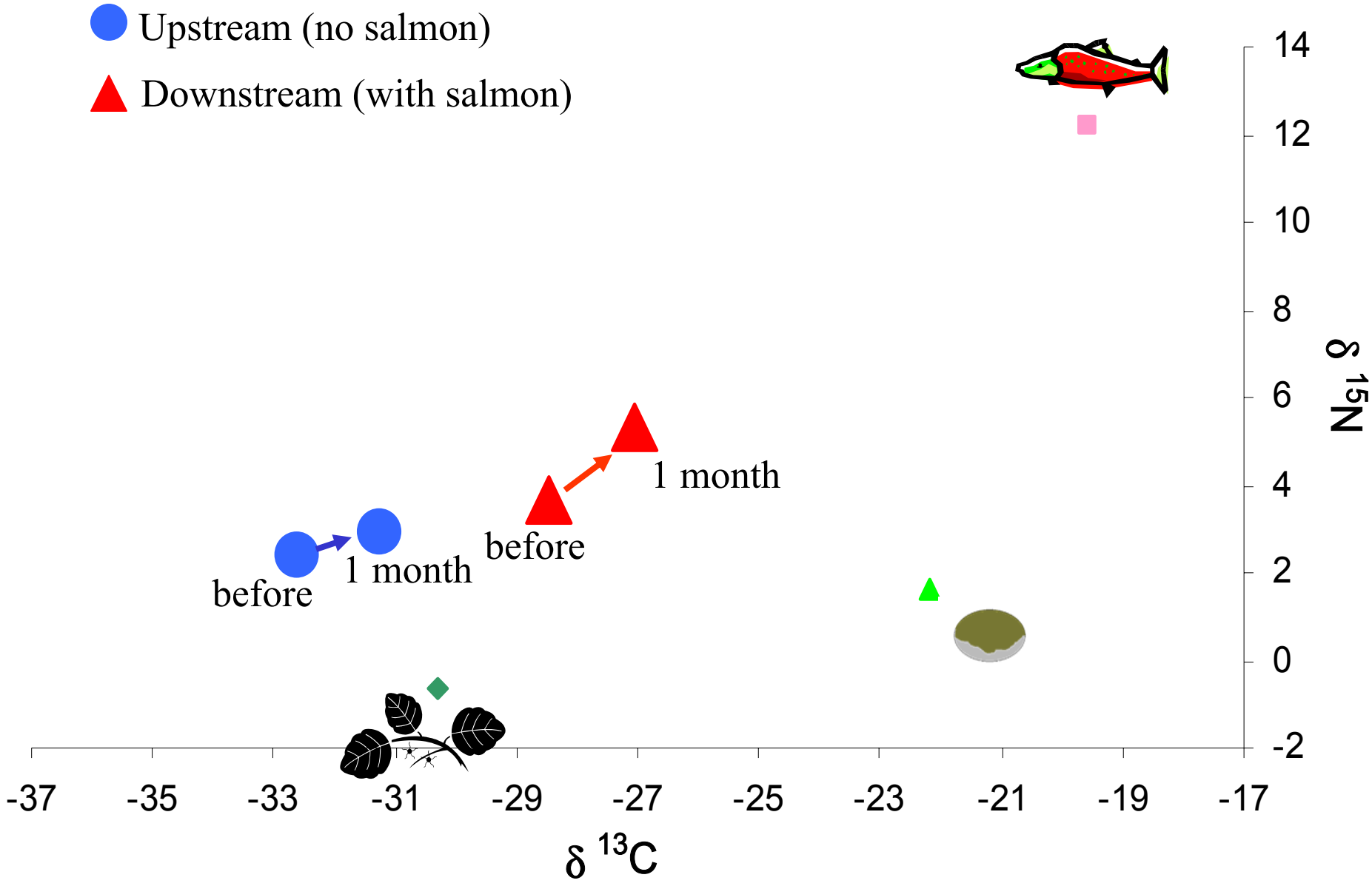

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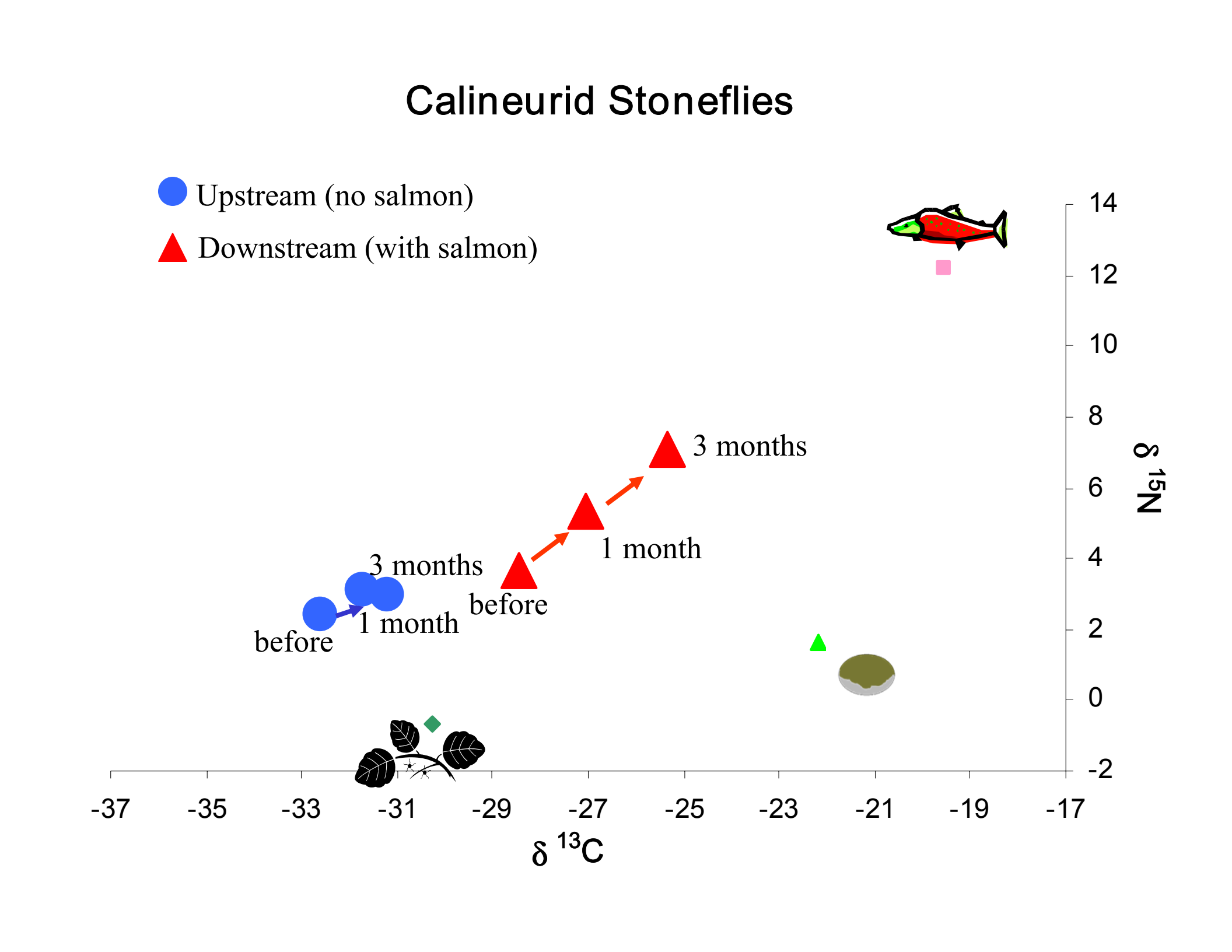
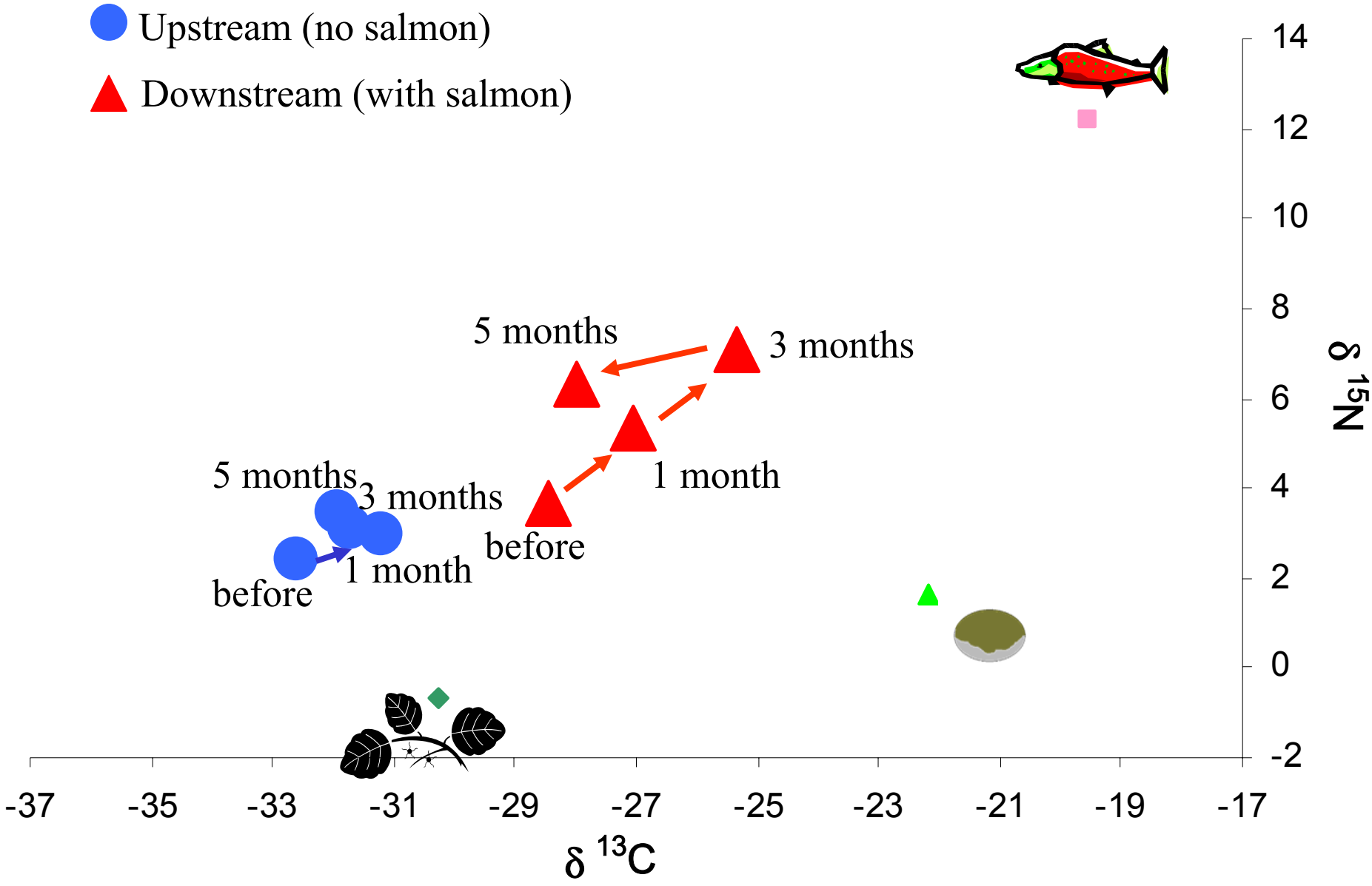


Calineurid Stoneflies



Contribution of Study to Stream and Fish Management

- Effect of salmon nutrients on insect community structure and production throughout a year.

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  - **Via functional feeding groups.**

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- Effect of salmon nutrients on insect community structure and production throughout a year.
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- **Insight into how insects transfer nutrients from adult to juvenile salmon.**
  - **We know which insects salmon usually eat.**

Contribution of Study to Stream and Fish Management

- Effect of salmon nutrients on insect community structure and production throughout a year.
- Which nutrient uptake pathways are the most important.
- Insight into how insects transfer nutrients from adult to juvenile salmon.
- **Insight into how changes to streams can affect nutrient transfer.**
  - **–e.g., increased sedimentation decreases habitat for blackflies and midges.**

Committee Members

Robert Gara (Chair), UW Prof. of Entomology

Robert Bilby, Weyerhaeuser Corp.

Rick Edwards, USDA Forest Service

Peter Kiffney, NOAA Fisheries

Robert Naiman, UW Prof. of River Ecology

Sources of Funding

College of Forest Resources

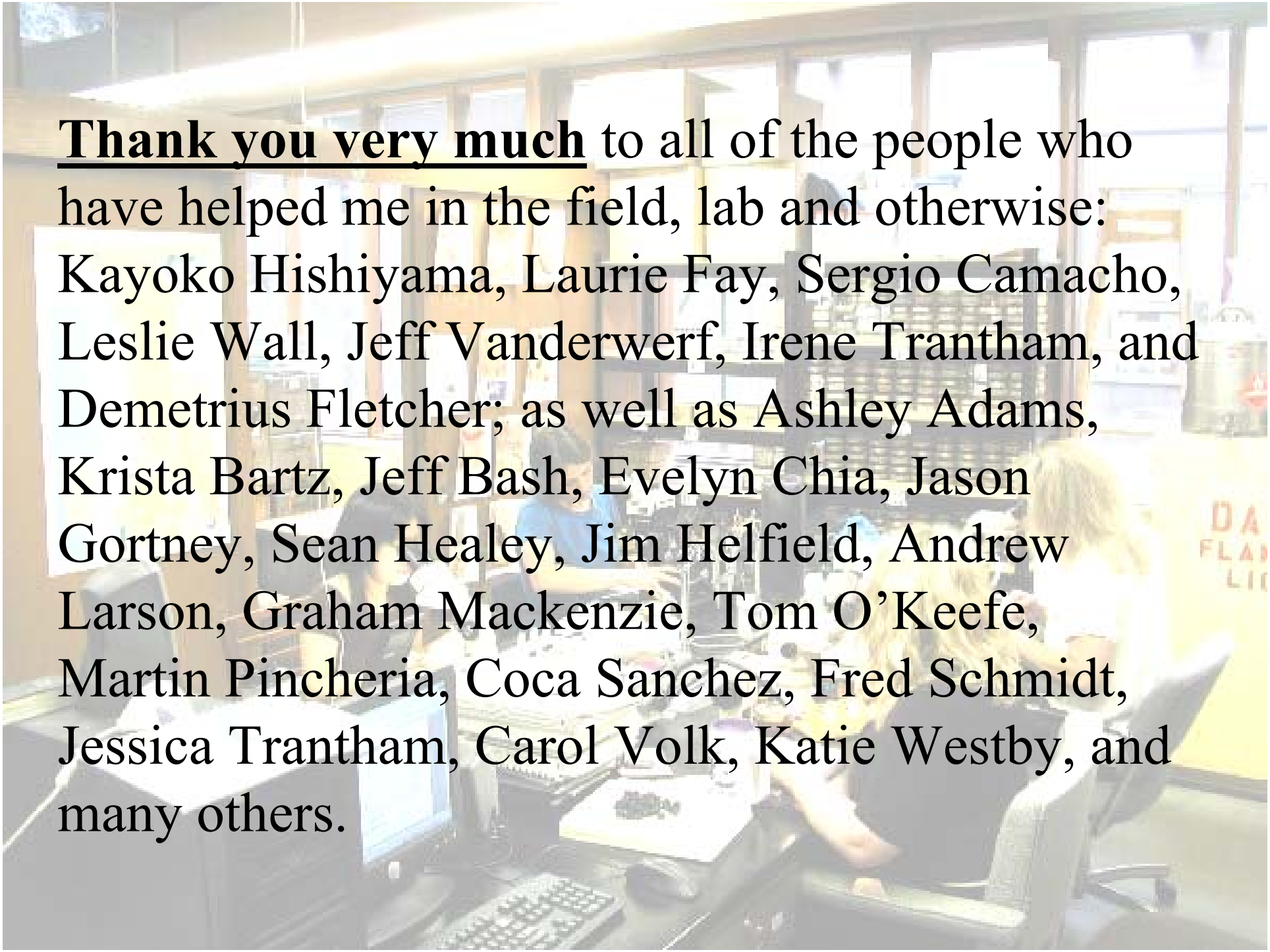
Olympic Natural Resources Center

Center for Water and Watershed Studies

Washington Fly Fishing Club

American Water Resources Assoc.

Wild Steelhead Coalition



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