Trophic Interactions Workgroup Update

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SPIS-CRISPS-WO#5 Trophic Interactions

Trophic Interactions Workgroup Objectives

1. Identify the major algal grazers and their consumers. ***Food Web Structure**

2. Determine algal growth and grazing rates of small grazer species. ***Species Interactions**

3. Assess the potential for top-down (consumer) control of key grazers in the ecosystem. ***Consumer Effects**

Objective 1: Food web Structure

1. **What are the major pathways of energy flow and material transport?**

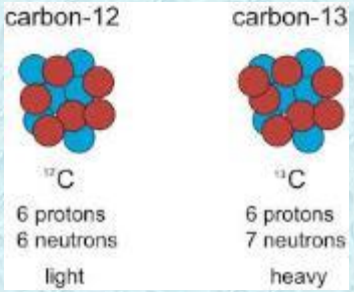
2. **Which grazers consume benthic filamentous algae (a.k.a, nuisance algae) and to what degree?**

3. **Which predators consume algal grazers?**

Objective 1: Methods

- Stable Isotope Analysis-SIA ($\delta^{13}C$ & $\delta^{15}N$)
  - **Integrated** signal of consumers' dietary choices
  - Isotopic mixing models provide estimates of the **proportional dietary contributions** from discrete resource pools
- Stomach/Scat Content Analysis-SCA
  - **'snap-shot'** of diet in time
  - Confirm predator-prey links: **Who's eating who?**
  - Inform isotopic models: **'prior information'**

Stable Isotope Analysis-SIA



Ratio of heavy to light isotopes (^{13}C:^{12}C, ^{15}N:^{14}N)

$\delta X\ (‰) = [R_{sample} / R_{standard} - 1] \times 1000$, where X is element of interest

You are what you eat (± discrimination, $\Delta X_{tissue-diet}$)

$\delta^{13}C$ has Small discrimination $\Delta\ ^{13}C_{tissue-diet} \approx 1.0‰ \pm 0.5$

-Differs among plants with different photosynthetic pathways (i.e., C3, C4, CAM, etc.)

-Varies in aquatic producers due to **$\delta^{13}C$ of dissolved inorganic carbon-DIC sources , $\delta^{13}C$-CO_2aq** and **$\delta^{13}C$-HCO_3^- ,** as well as relative concentrations of **[CO_2aq],** and **[HCO_3^-].**

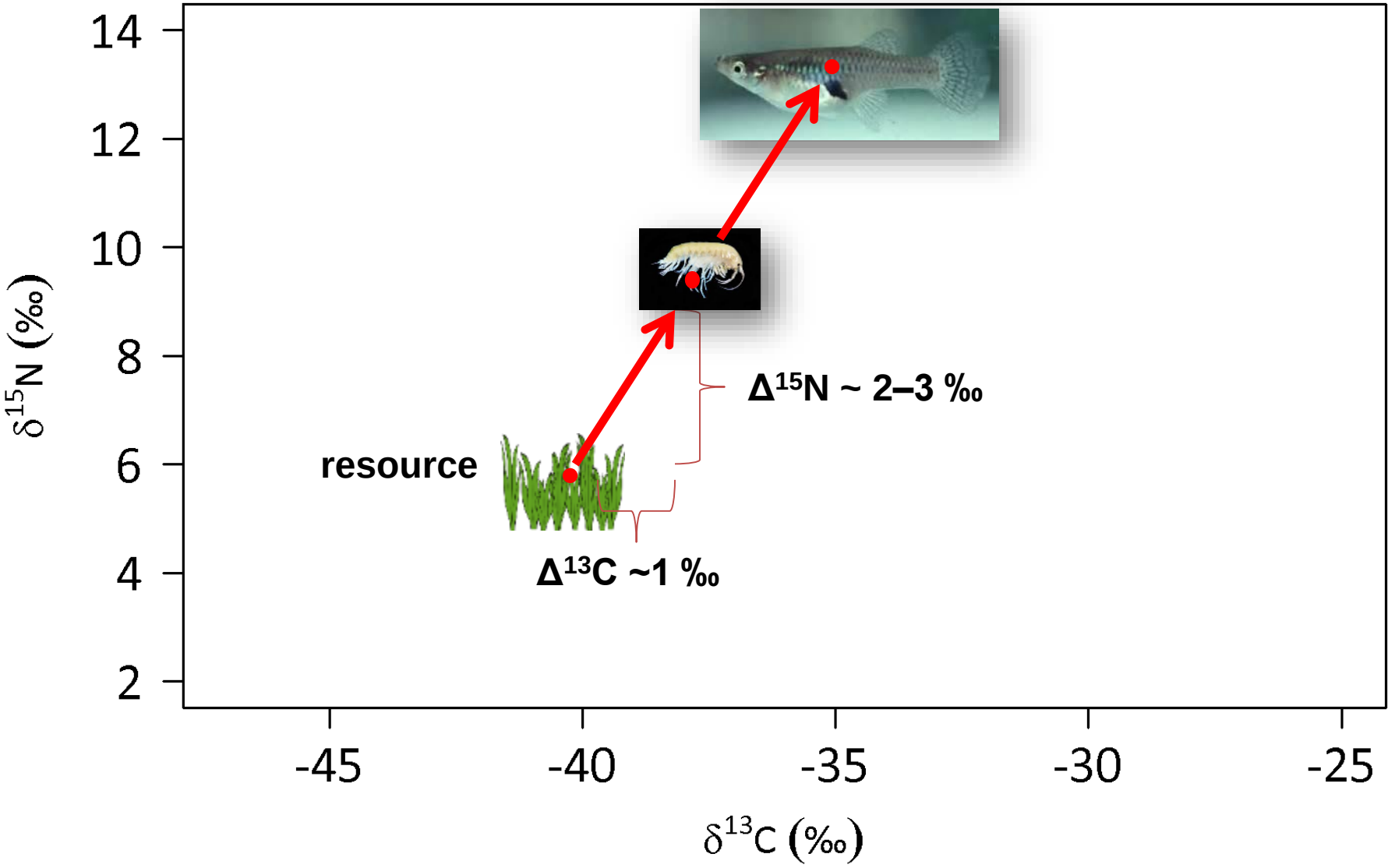
-Indicator of **carbon pools (resource categories)** used by consumers

$\delta^{15}N$ has Larger discrimination $\Delta\ ^{15}N_{tissue-diet} \approx 2.2‰ \pm 0.7$

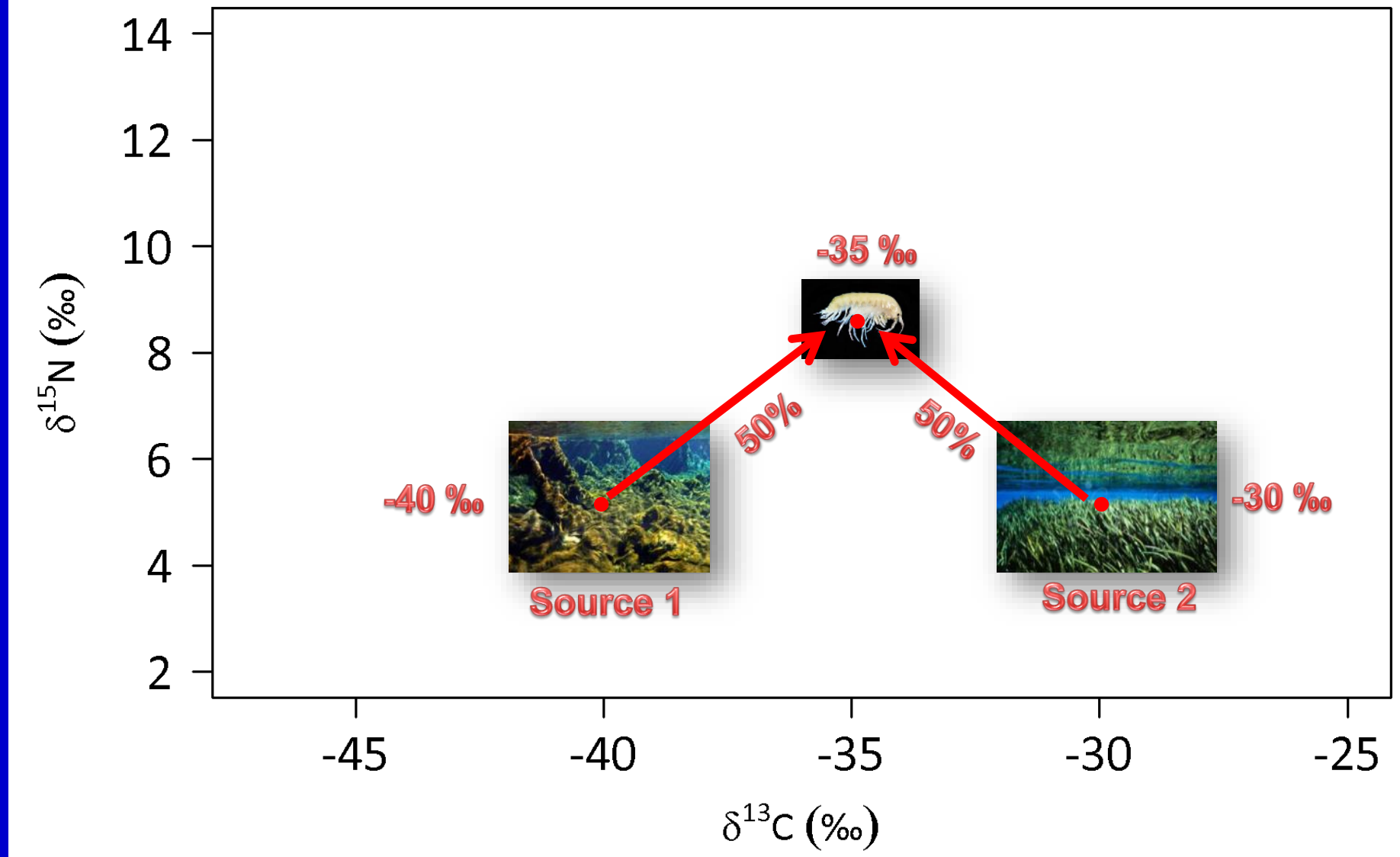
-Indicator of **nitrogen sources** and **cycling processes** at food web base

-Quantify **trophic level** of consumers

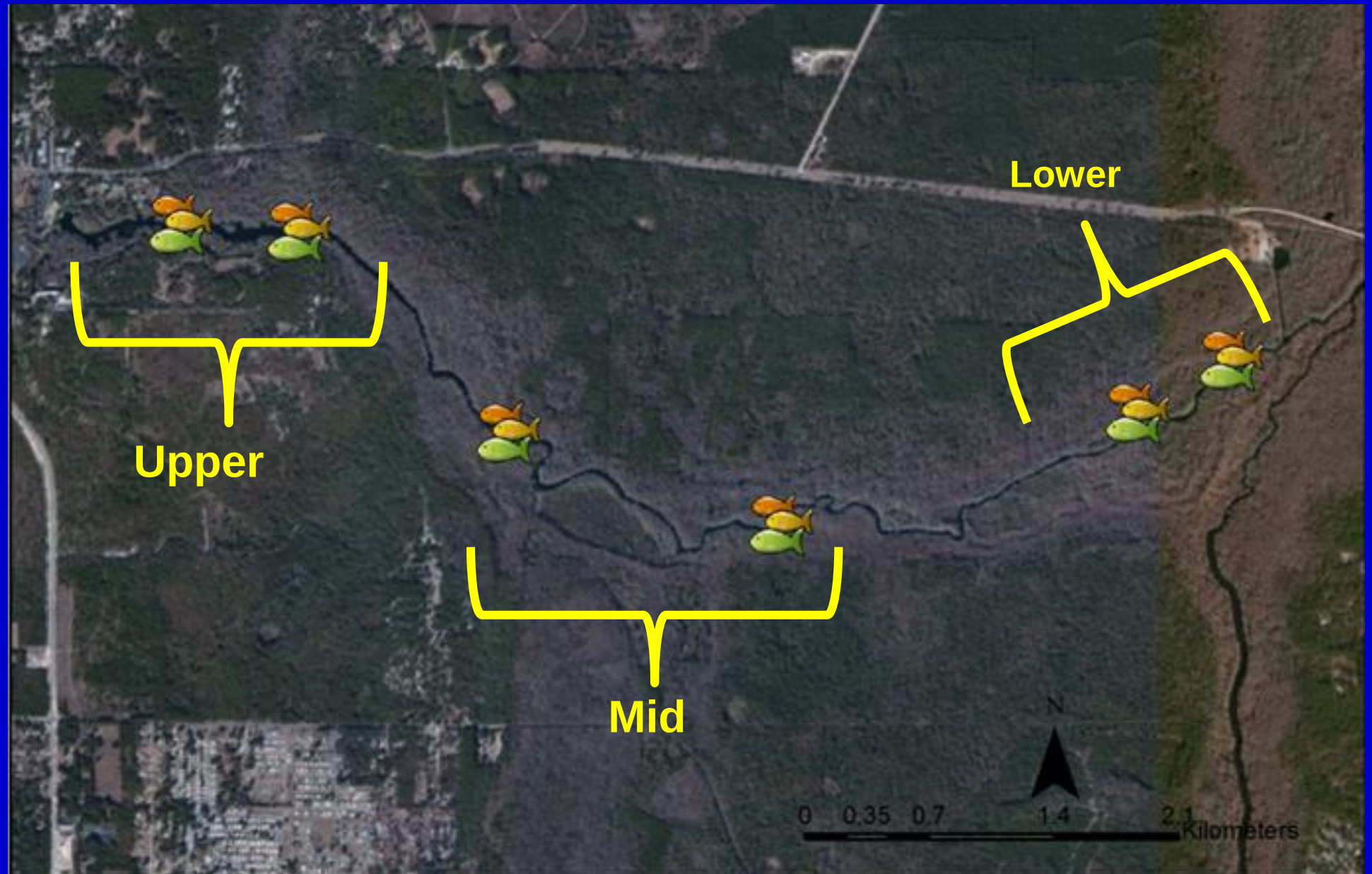
Isotopic Discrimination: $\Delta X_{tissue\text{-}diet}$



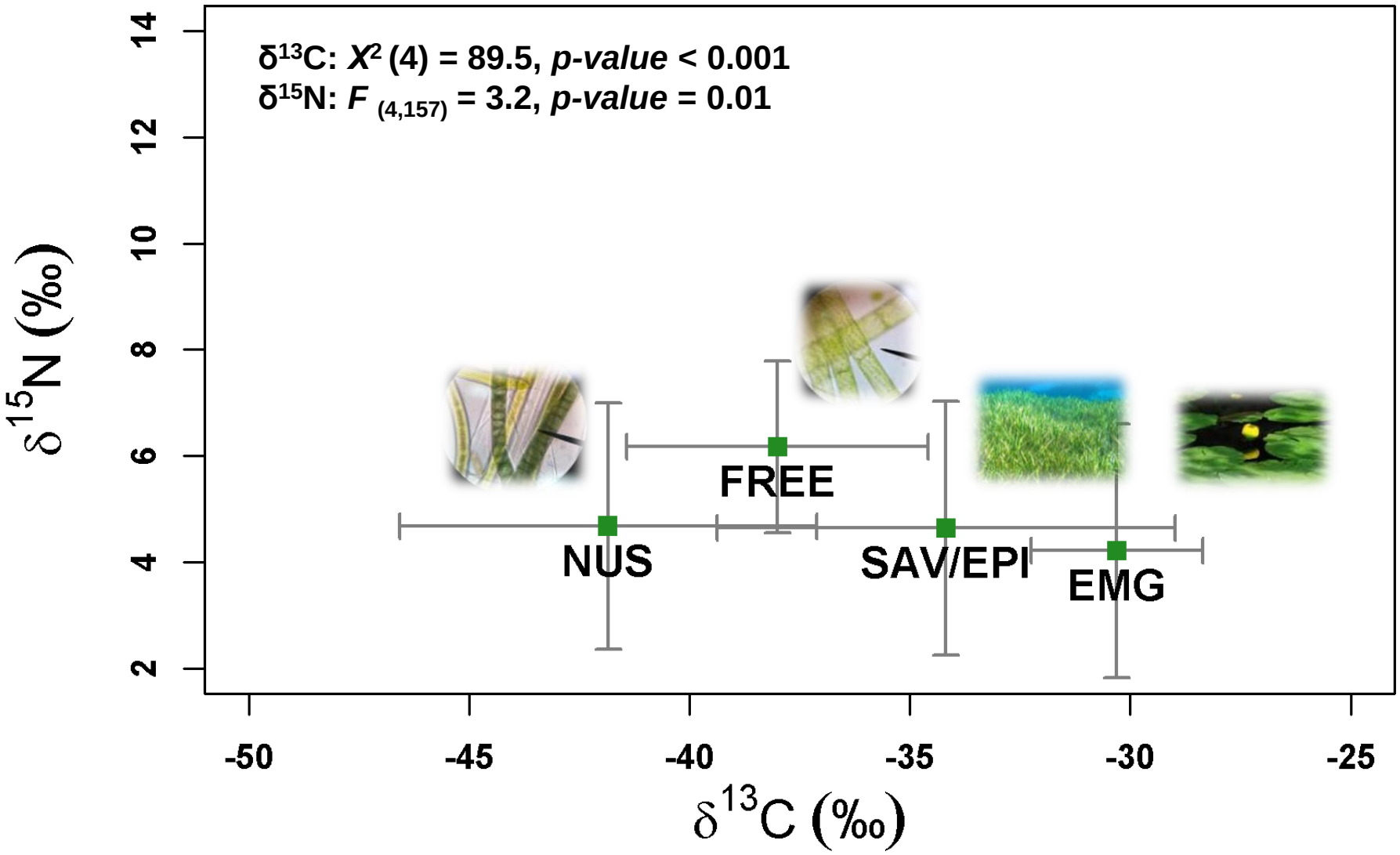
Isotopic Mixing: Multiple Sources



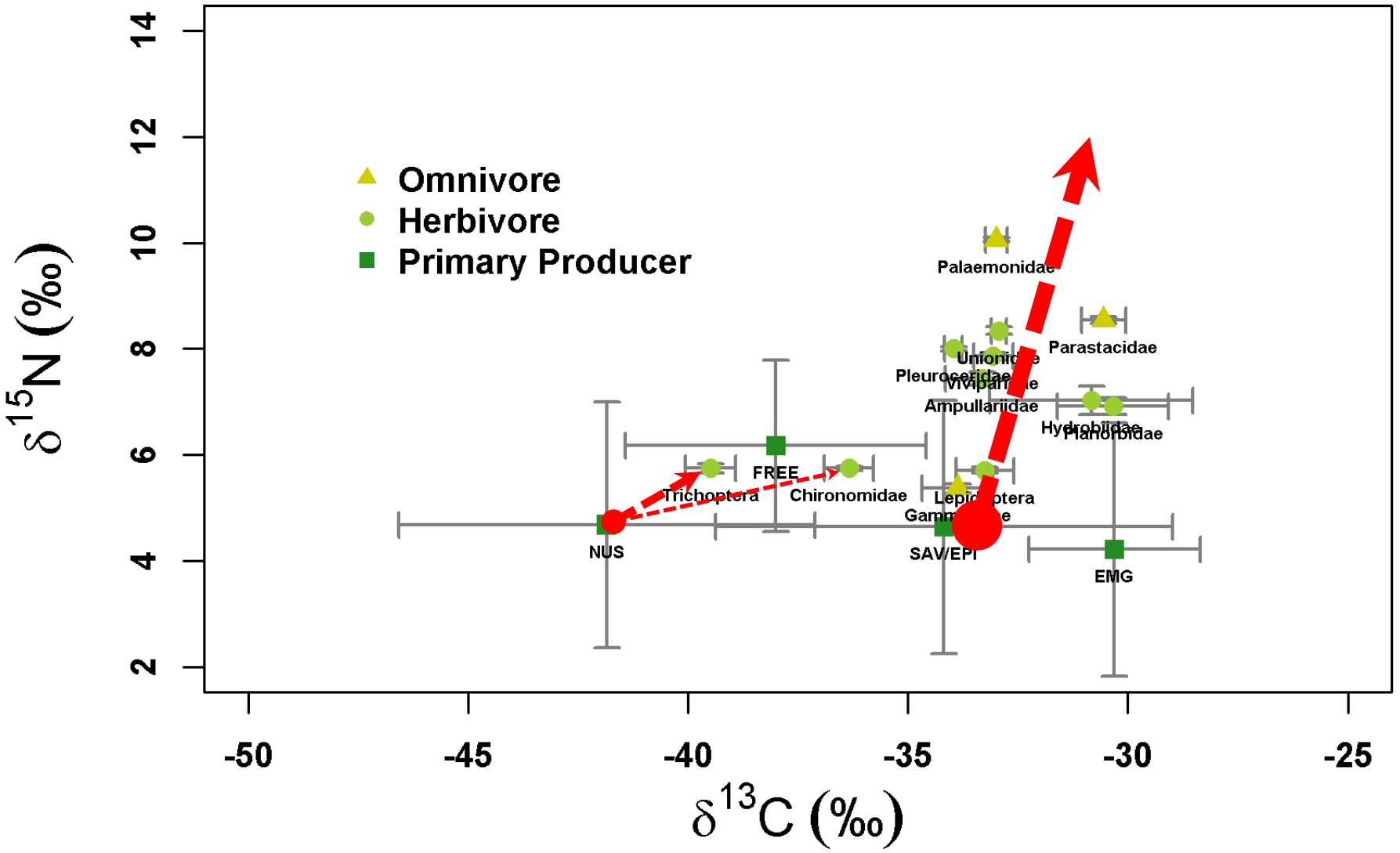
Sampling Sites



Primary Producer Groups (Sources)

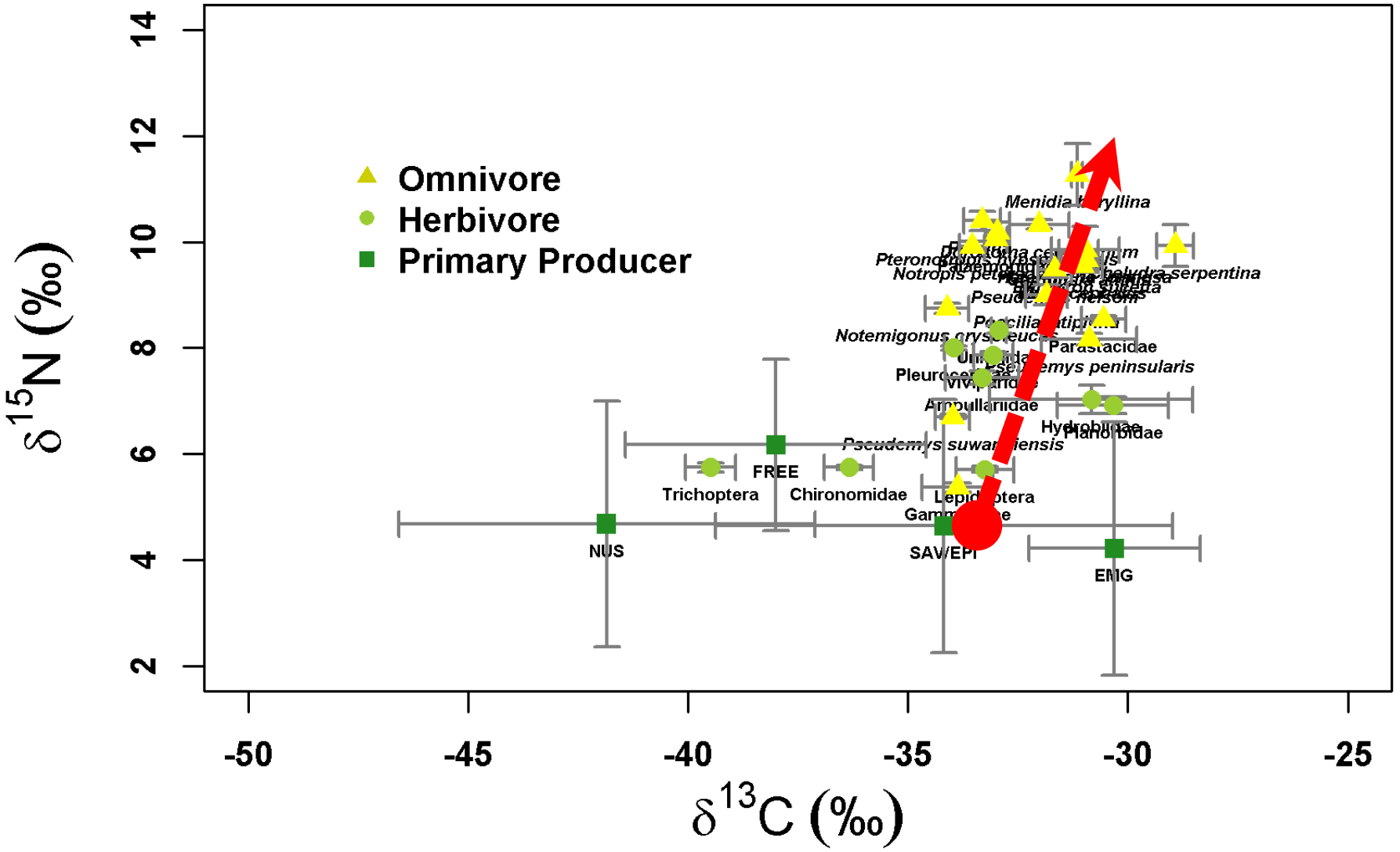


Herbivores and Omnivores (inverts)



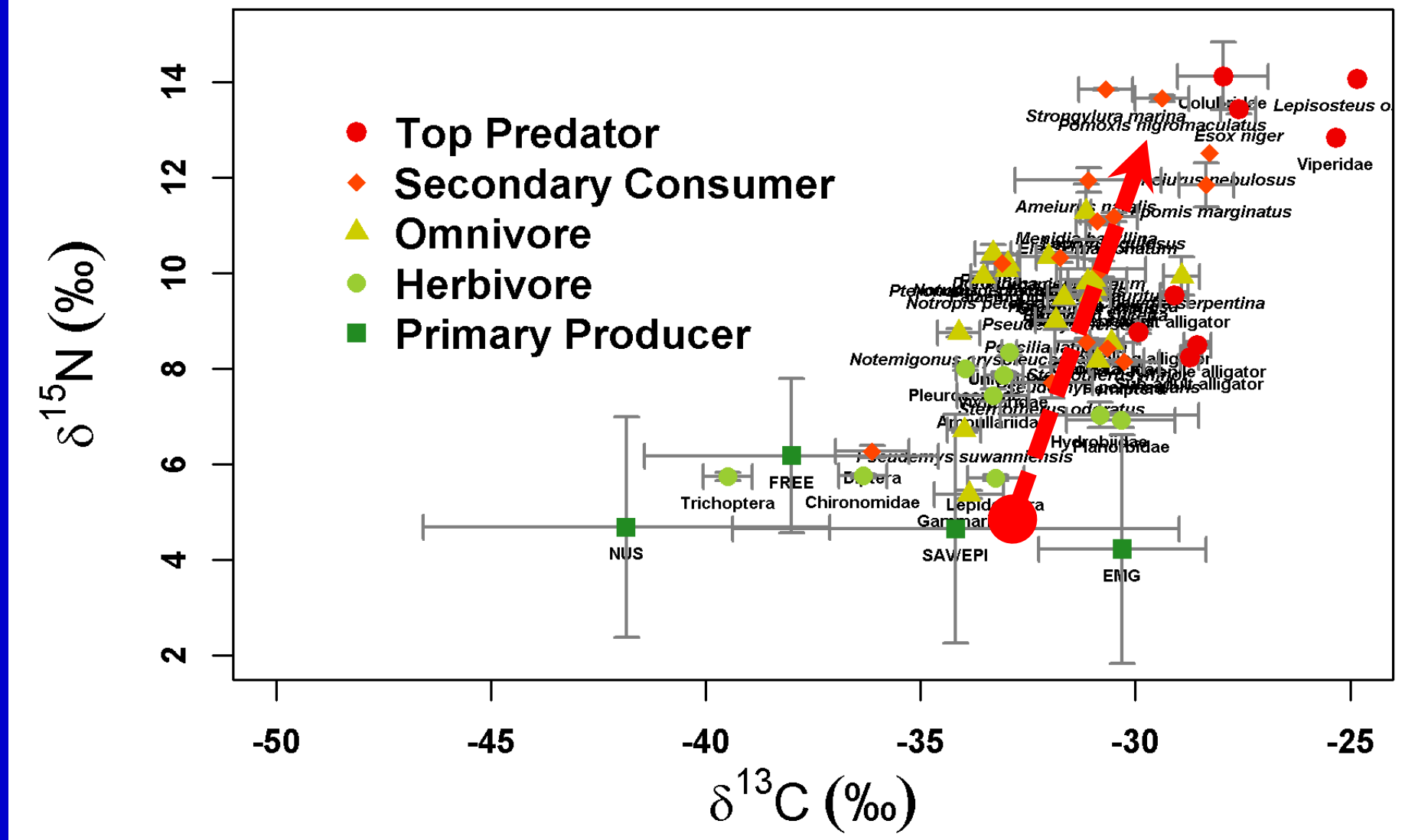
Flow of biomass/energy

Herbivores and Omnivores



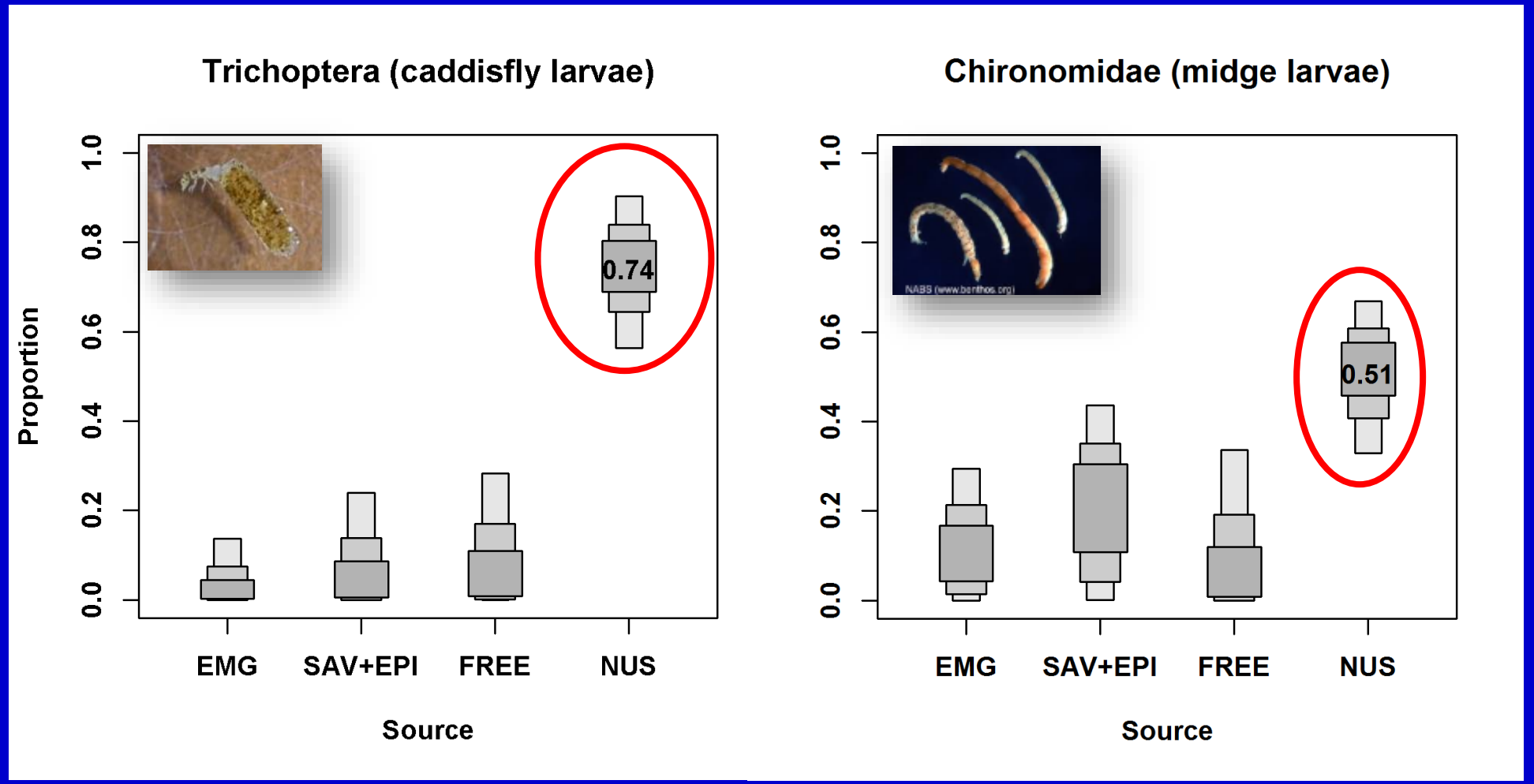
Flow of biomass/energy

Secondary Consumers and Top Predators



Flow of biomass/energy

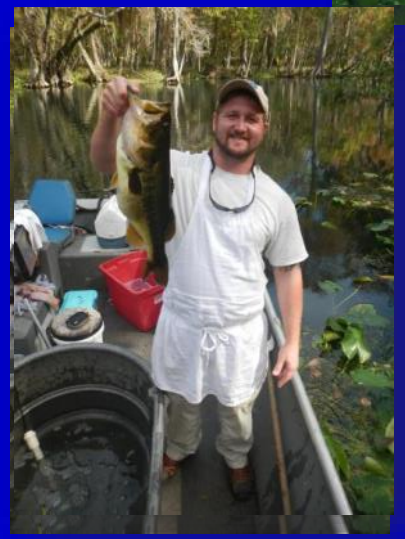
Isotopic Mixing Model Results




What about predators?
Who is eating the algal grazers?

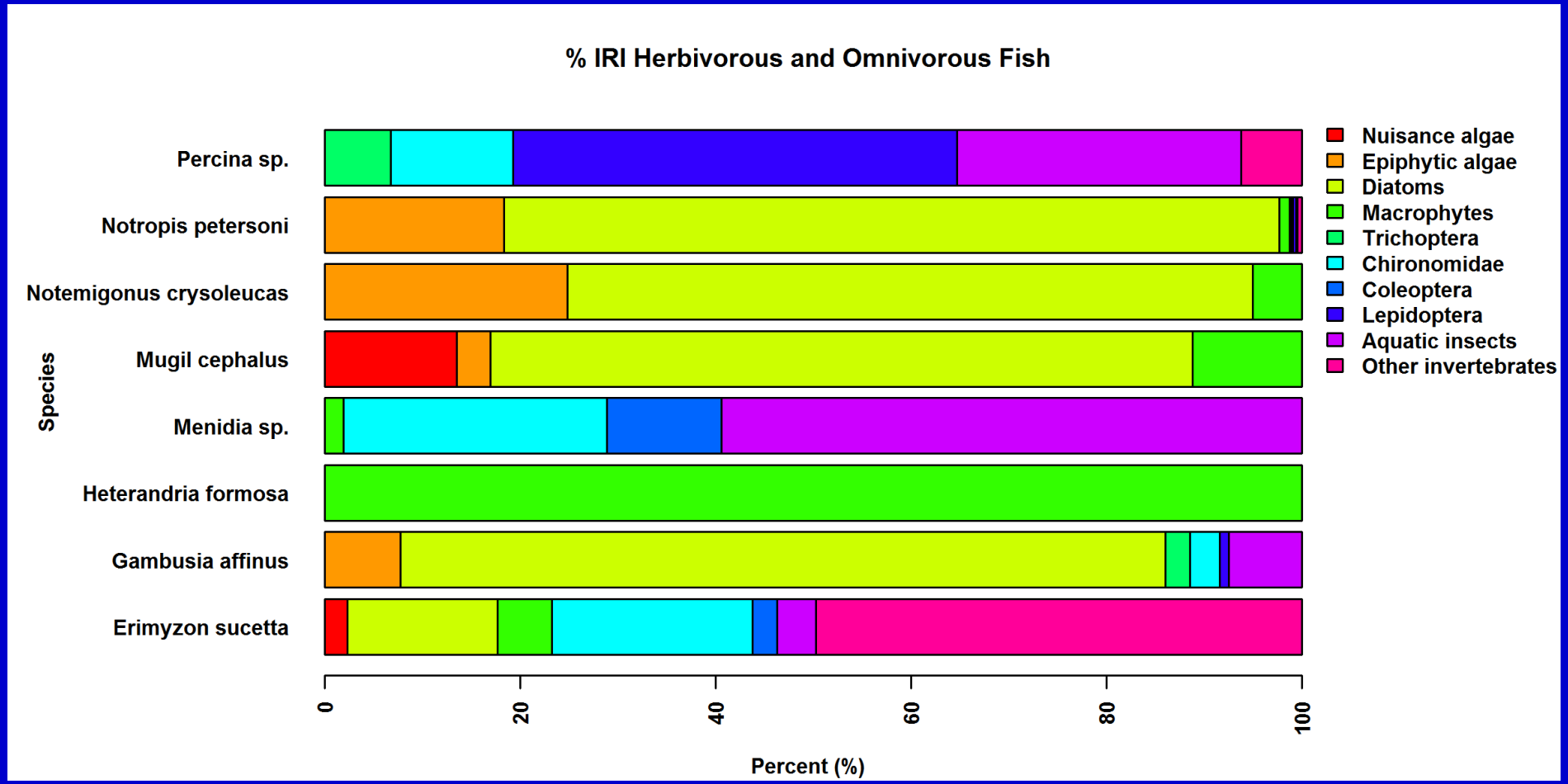
Stomach Content Analysis (SCA)

Fish

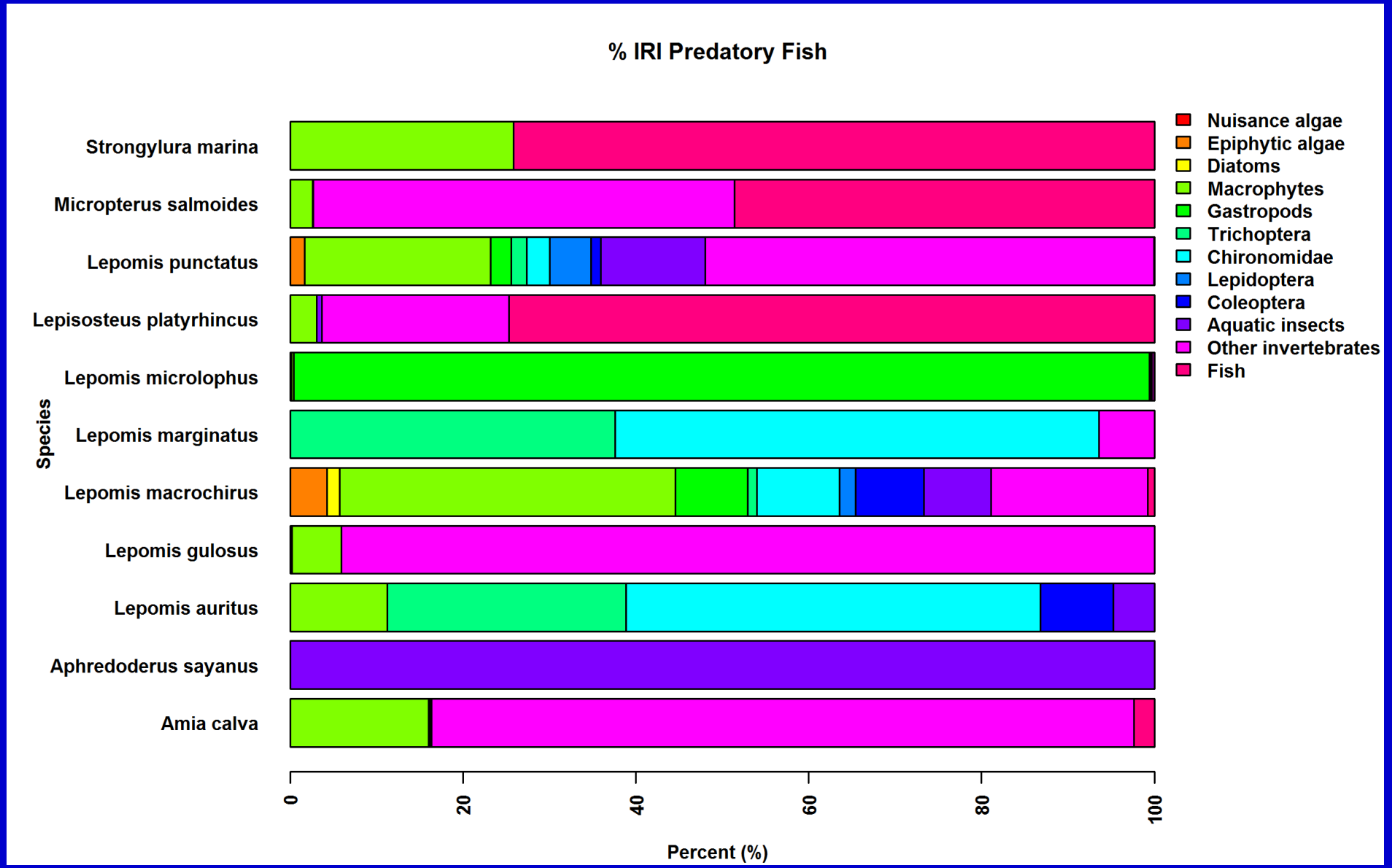


Alligators

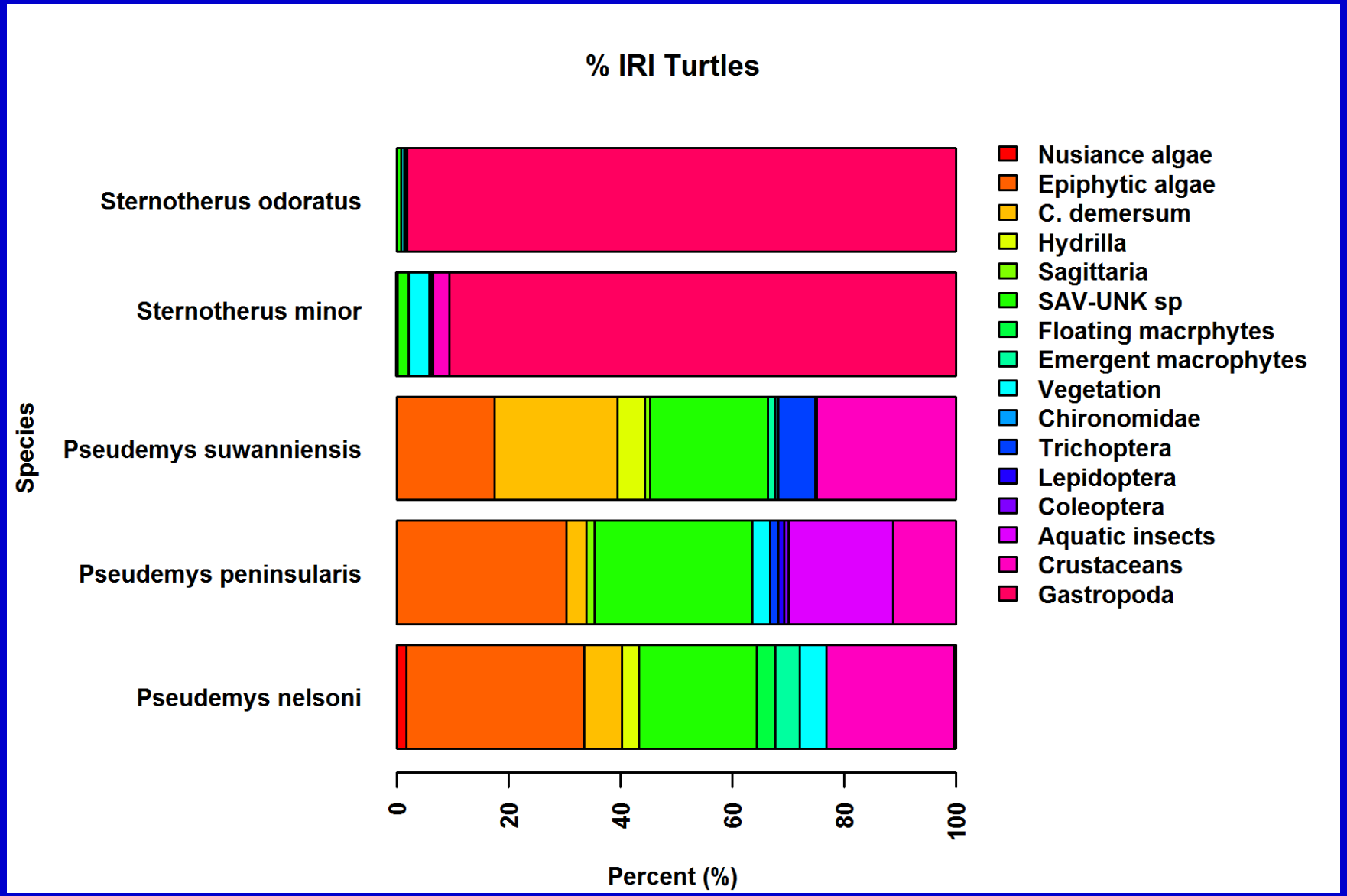
Turtles (scat)



1. Diatoms highly important resource.
2. Trichopterans and chironomids relatively unimportant prey.
3. Little evidence of nuisance algal consumption.

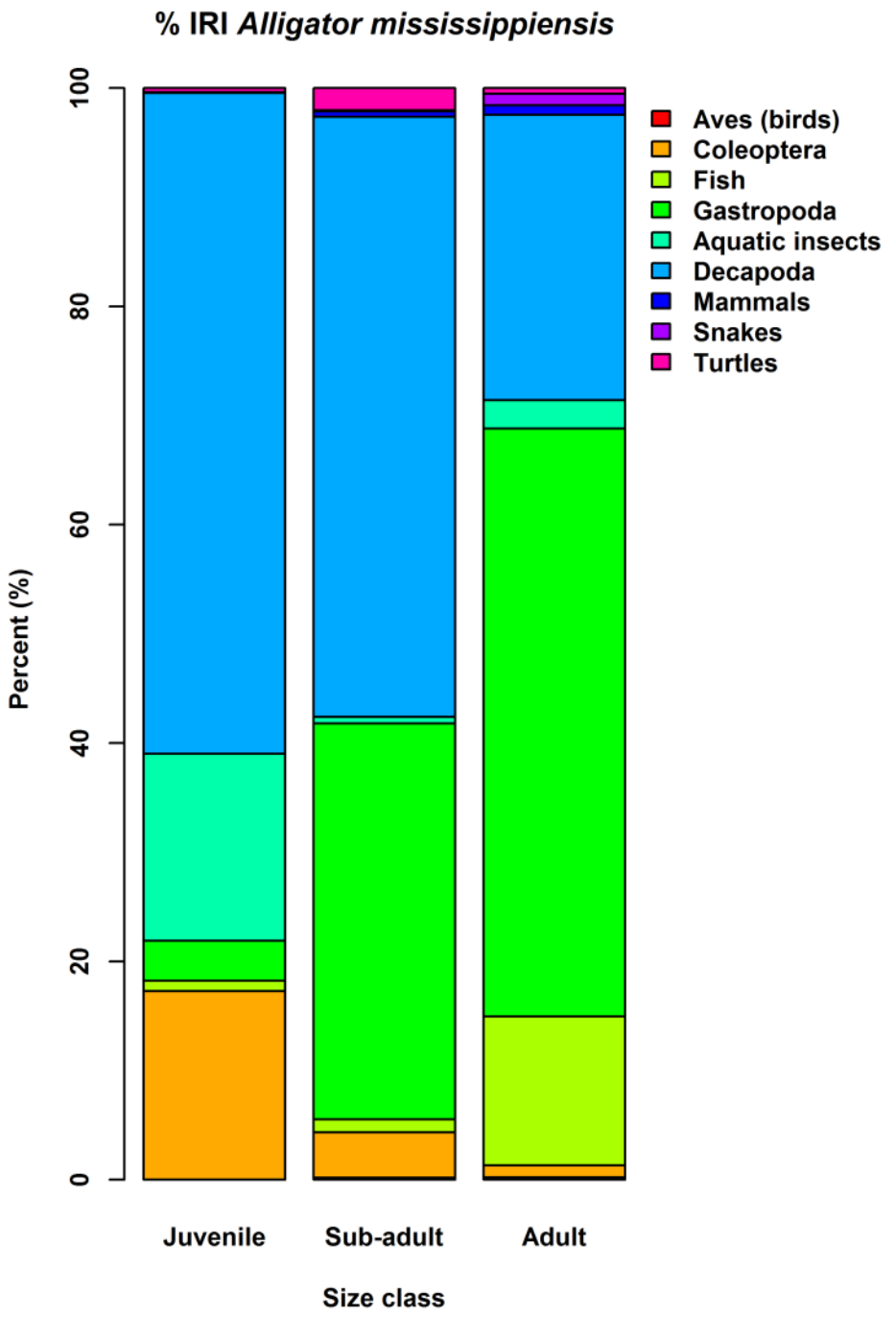


1. *L. marginatus* and *L. auritus* major predators of trichopterans.
2. *L. microlophus* major gastropod predator.
3. Other invertebrates (i.e., decapods , amphipods) and fish are primary prey for most species



1. *S. odoratus* and *S. minor* chiefly predators of small benthic gastropods (i.e., physids, hydrobiids, planorbids)
2. River cooters (*Pseudemys* spp.) mainly consume macrophytes and to lesser extent small invertebrates.

Alligators


% IRI *Alligator mississippiensis*
Percent (%)
0
20
40
60
80
100
Juvenile
Sub-adult
Adult
Size class
Aves (birds)
Coleoptera
Fish
Gastropoda
Aquatic insects
Decapoda
Mammals
Snakes
Turtles

Objective 1: Conclusions

- Nuisance filamentous contributes little to aquatic food web
- Few grazers heavily rely of nuisance algae
  - **Invertebrates**:

Trichopterans>Chironomids>Rhagionids>Amphipods>Lepidopterans>Gastropods

  - **Vertebrates**:

Shiners > Darters

- Major predators of algal grazers include Redear Sunfish, other Sunfish species, and kinosternid turtles
- Alligators are **not** 'Apex predators' rather they primarily feed on species occupying lower trophic levels (i.e., gastropods, decapods, insects)

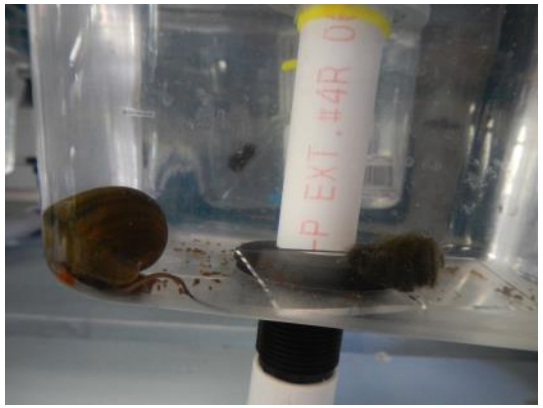
Objective 2: Species Interactions-Grazing

1) Will gastropod and decapod grazers consume filamentous algae?

2) Is there potential for these grazer species to exert top-down control over filamentous algae?

- **Grazer taxa:** *Elimia floridensis*, *Viviparus georgianus*, *Pomacea paludosa*, *Planorbella scalaris*, *Palaemonetes paludosus*, and *Procambarus fallax*
- **Macroalgae:** *Lyngbya*, *Vaucheria*, *Spirogyra*, *Rhizoclonium*, *Cladophora,* and mixed *Rhizoclonium* + *Cladophora*
- **Submerged macrophytes (SAV):** *Hydrilla verticillata*, *Ceratophyllum demersum*, *Sagittaria kurziana*, *Vallisneria americana*, and *Najas guadalupensis.*

Objective 2: Grazer Experiments

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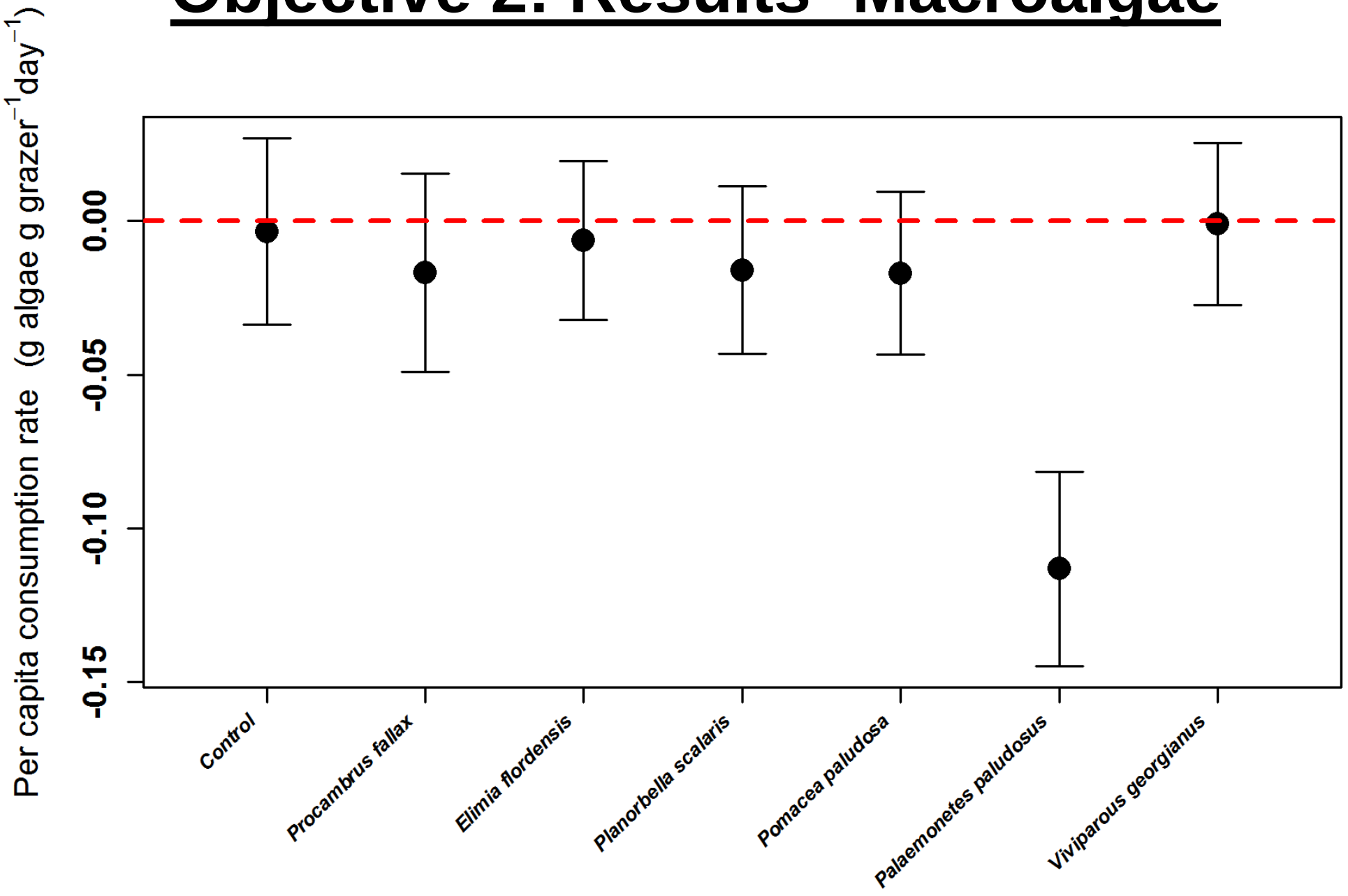
Objective 2: Results- Macroalgae



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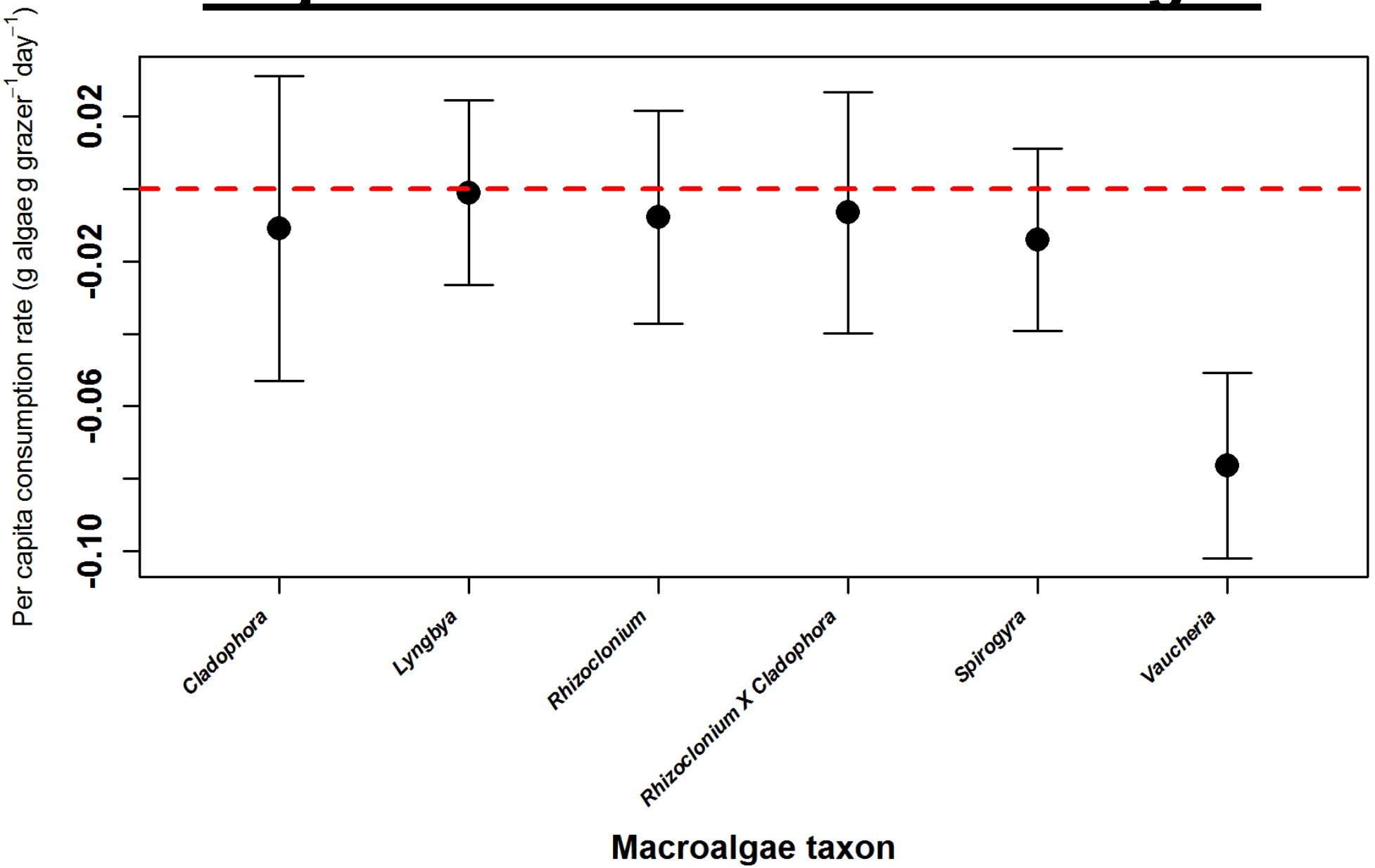
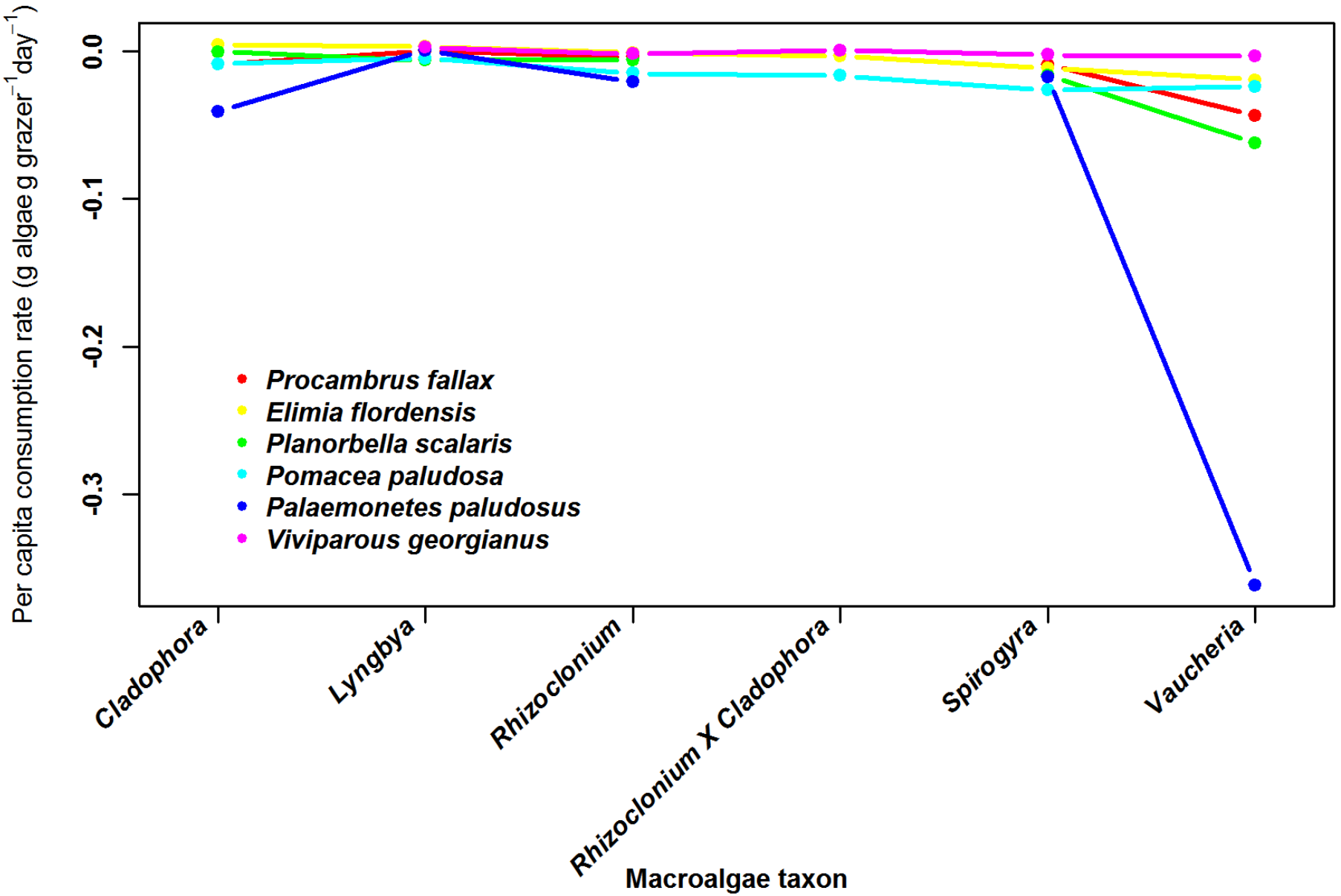


Objective 2: Results- Macroalgae



Objective 2: Summary-Macroalgae

- Grazer capacity =

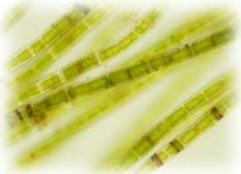
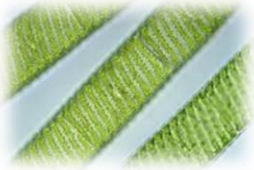
Grass shrimp > Apple snail > Crayfish > Planorbids > Other gastropods

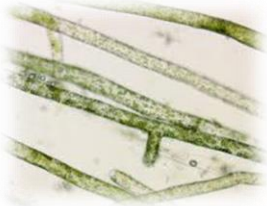




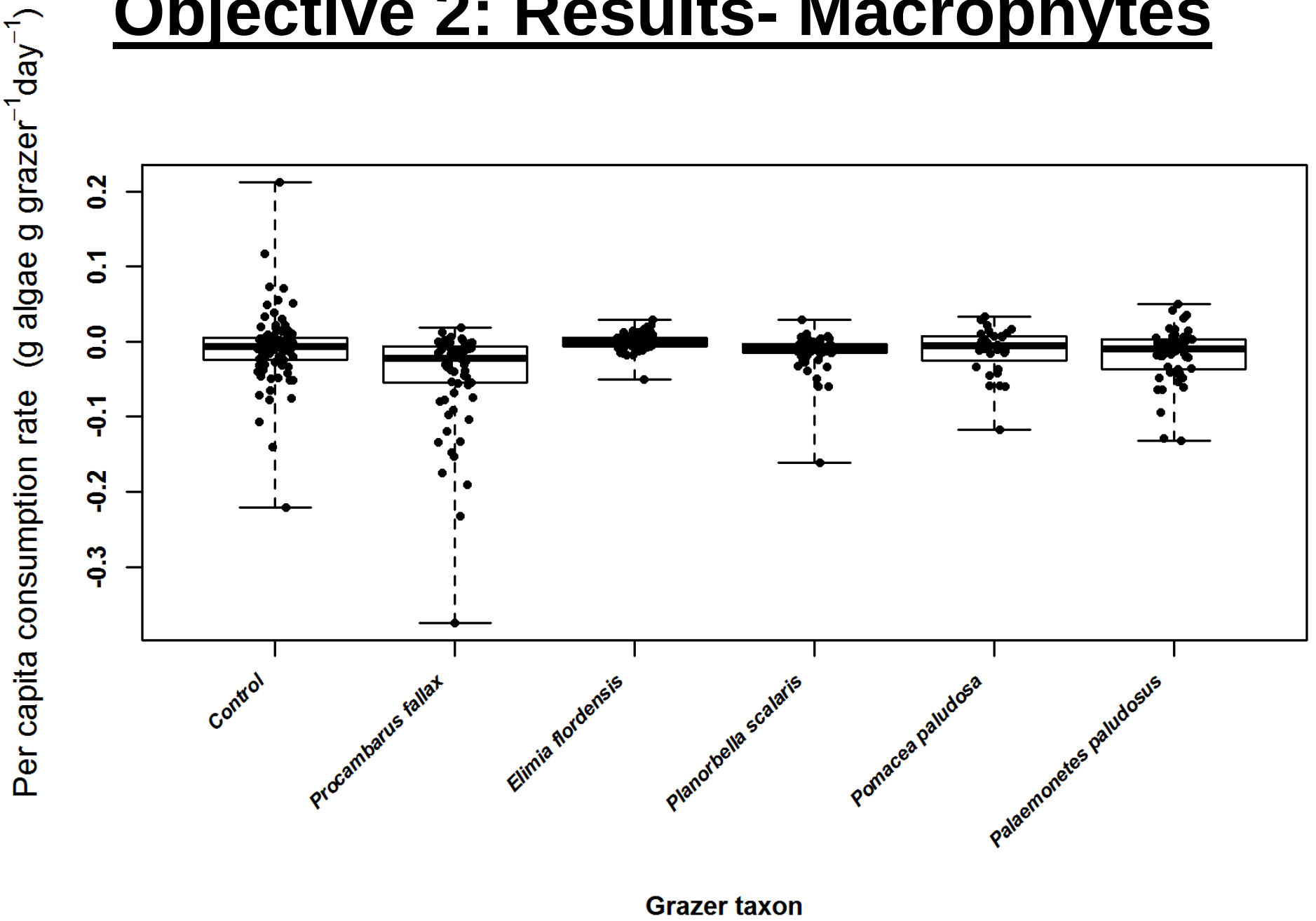

- Macroalgae Preference =

Vaucheria > Spirogyra > Rhizoclonium X Cladophora > Rhizoclonium> Lyngbya > Cladophora

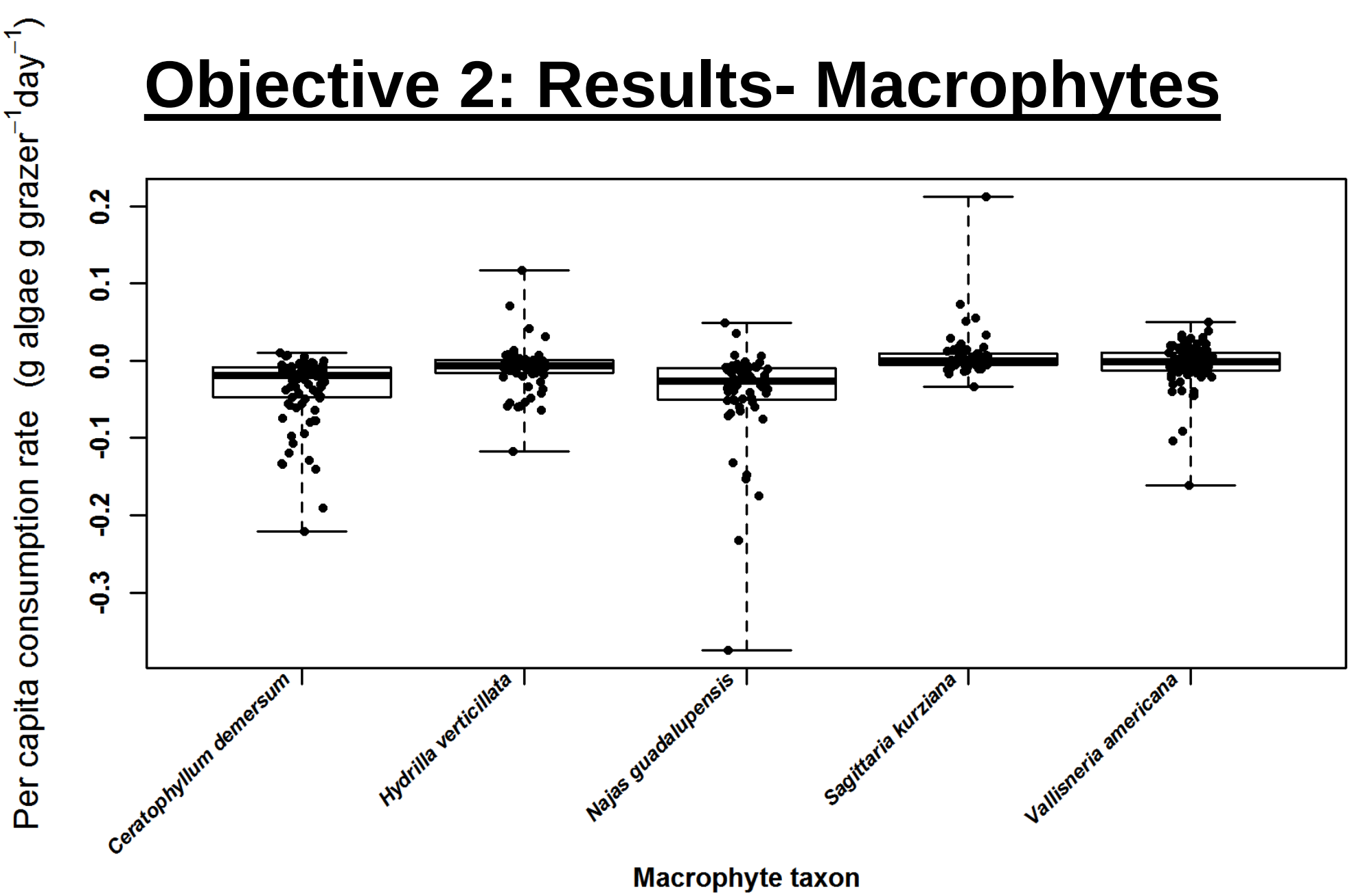





Objective 2: Results- Macrophytes



Objective 2: Results- Macrophytes



Objective 2: Summary-Macrophytes

- Grazer capacity =

  Crayfish > Grass shrimp > Apple snail > other gastropods






- Macrophyte preference =

  Najas > *Ceratophyllum* > *Hydrilla* > *Sagittaria* > *Vallisneria*





Objective 3: Consumer Effects

1. What is the impact of removing predation pressure on the herbivore community, particularly aquatic insects, crustaceans, and gastropods?

2. Is more epiphytic algal biomass consumed by grazers in the absence of predation?

3. Does SAV benefit?

Exclusion Cage Design

Frame

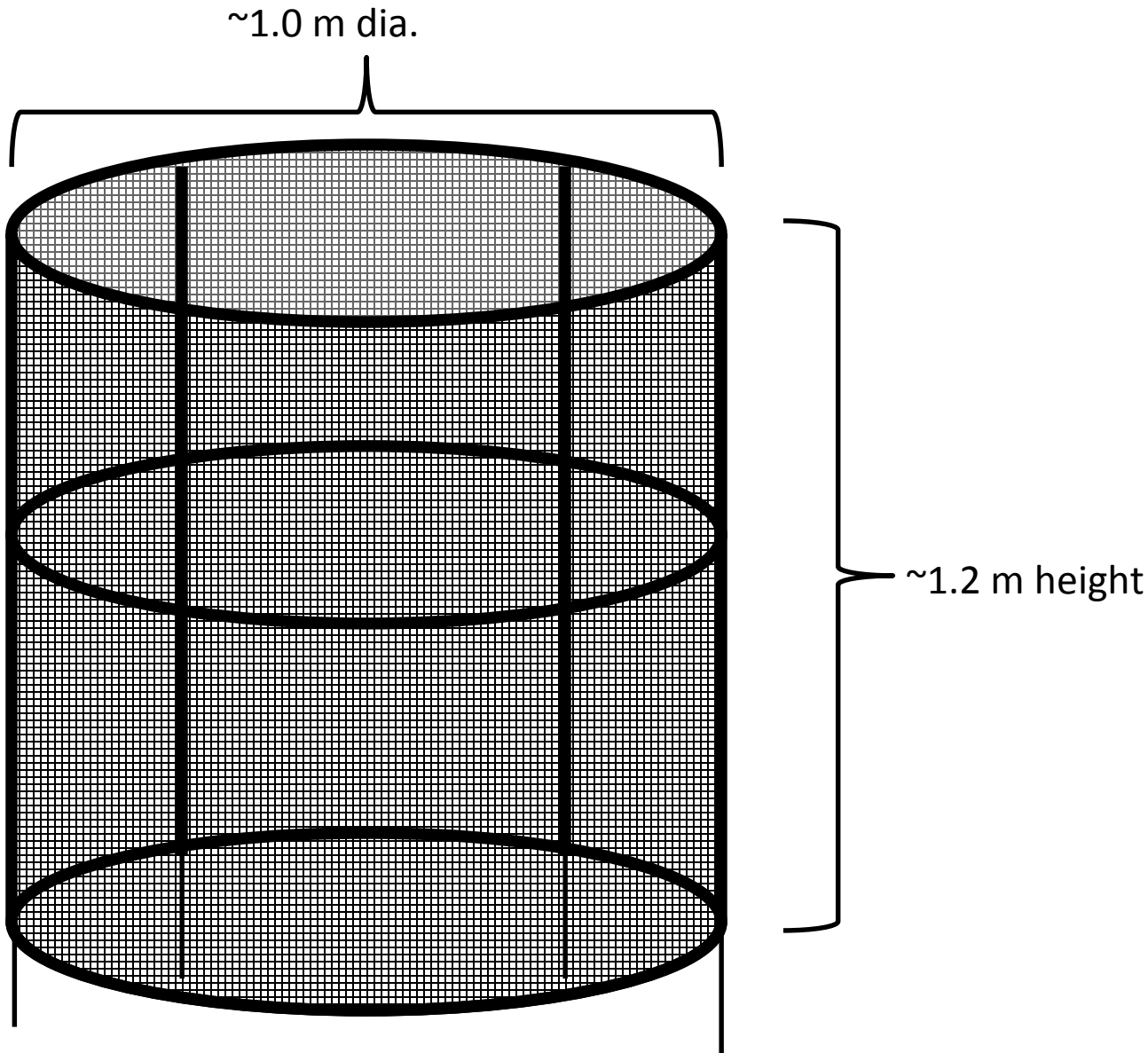
-0.625 cm Galvanized Steel Rods and hoops
-All welded
-rods extend into substrate

Mesh

-2.5 cm mesh Hexagonal
-Vinyl Coated Galvanized Steel
-Secured with Galvanized Hog Rings

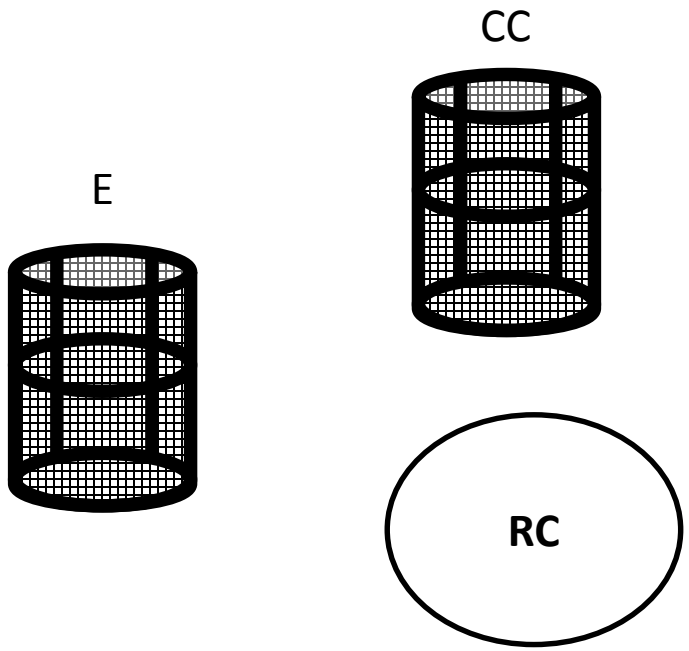
Signage

-Flagging tape at top of cage
-Sign at each array (see slide 4)



Cage Array Design

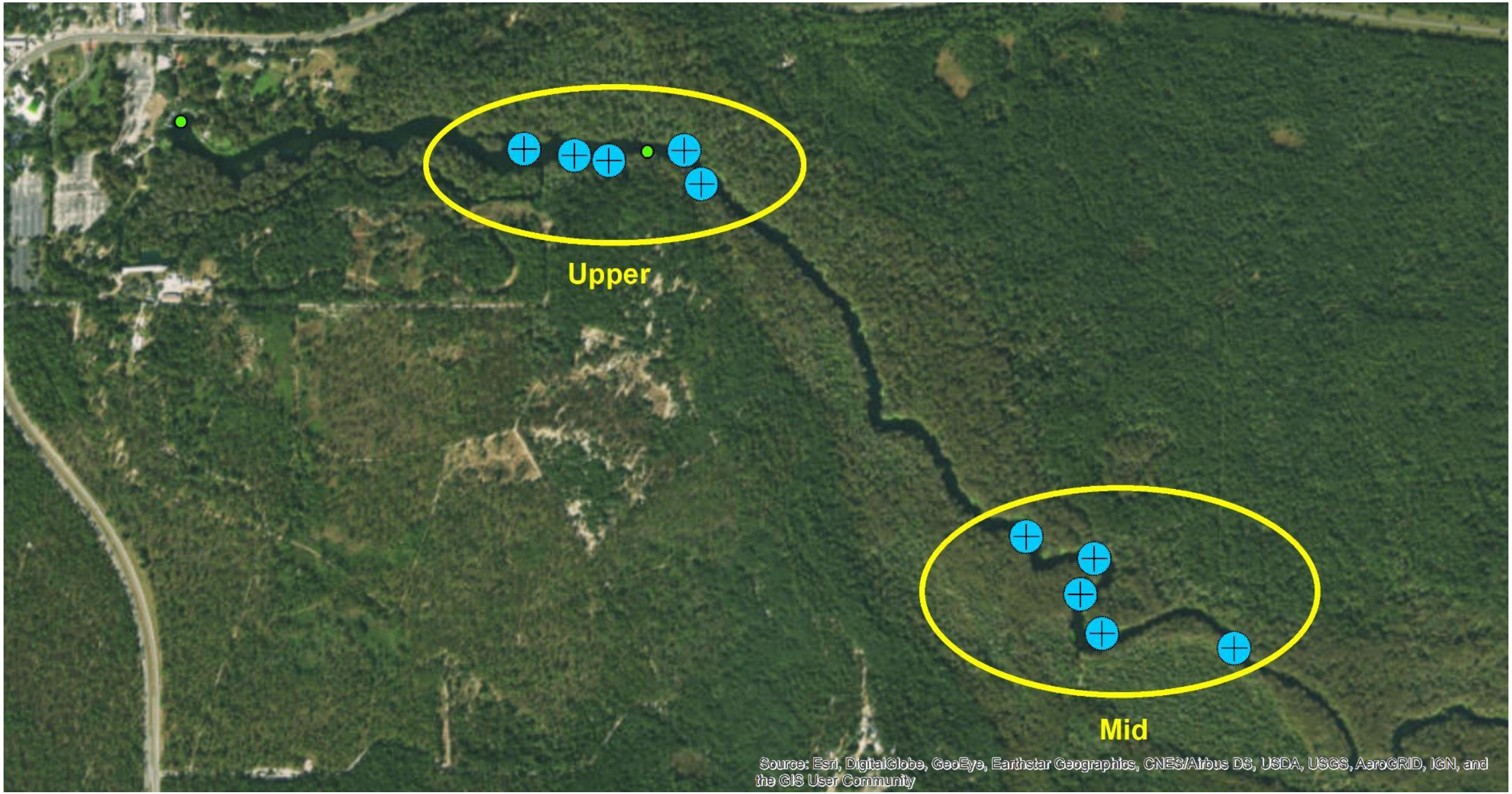
2 cages per array

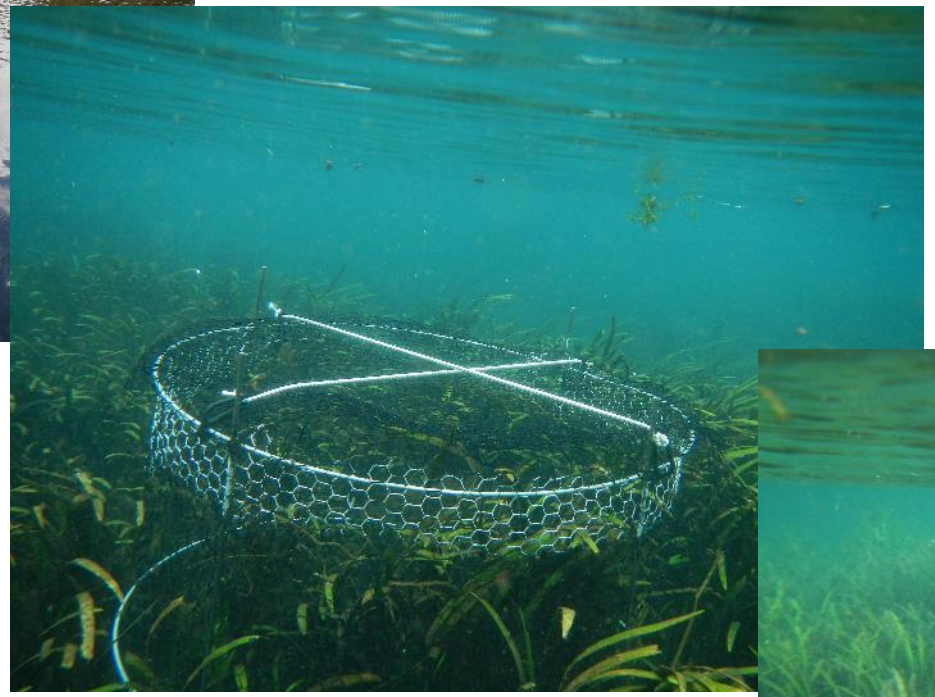


Array

-1 Exclusion Cages-E
-1 Cage Control-CC
-1 Reference Control-RC

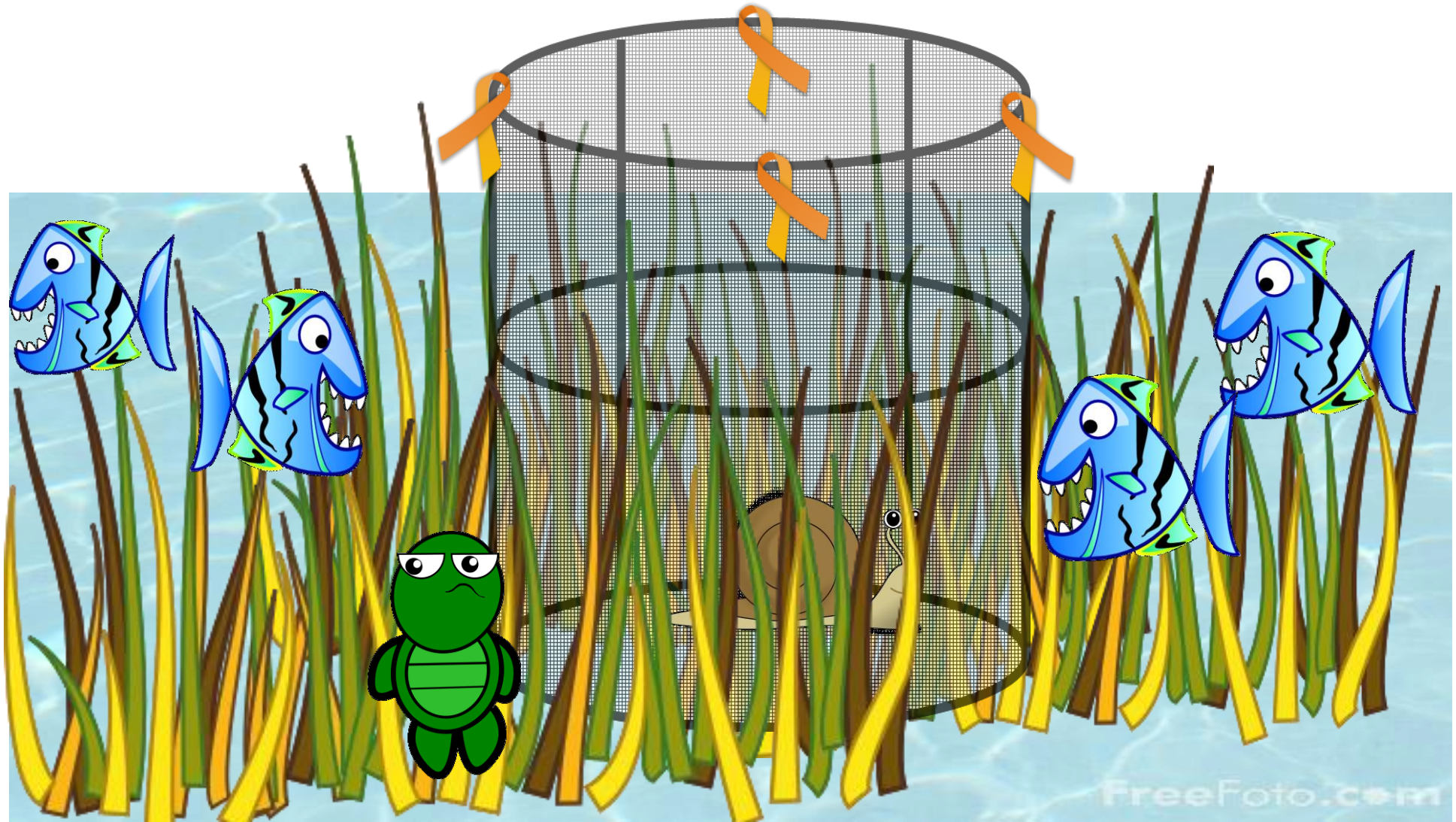
*Cage Control treatment will have entire panels of mesh removed from cage to allow organisms uninhibited access while replicating shading and flow effects of true exclusion cages (basically an exclusion cage with ½ the mesh removed).
*Reference Control is simply a monitoring area with same spatial footprint as cages.


Upper
Mid
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Cages may be fully submerged

Cages may protrude from water's surface



Schedule

- Installed and initial sampling: Oct. 2016
  - Processing samples (SAV biomass, epiphytic algae, and invertebrate abundance and biomass).
- Monitoring once per week to clean/repair cages
- SAV growth: March/April 2017
- Breakdown and final sampling: April/May 2017

Questions?