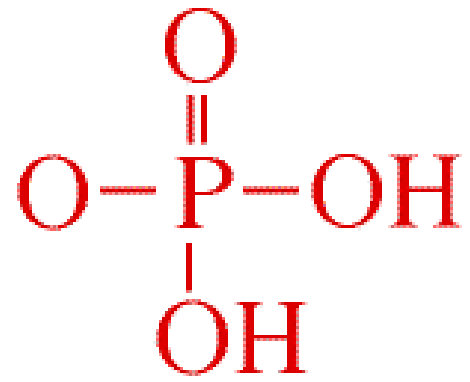
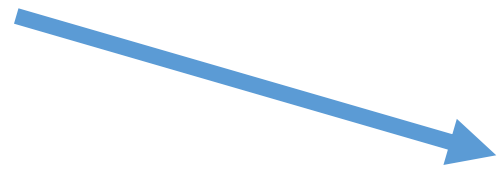
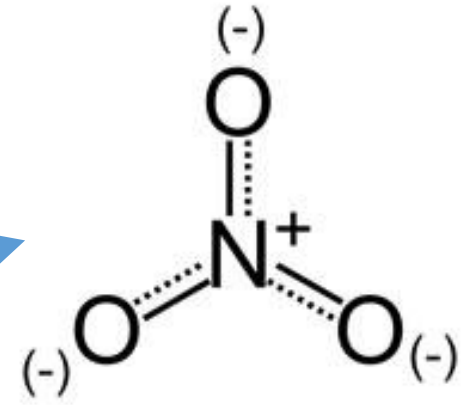
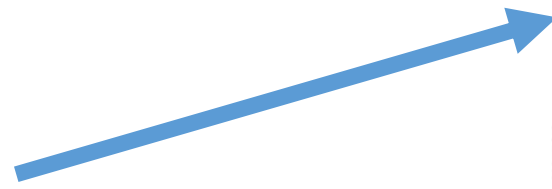


The Effects of Caffeine on Linked Aquatic-Terrestrial Food Webs

Melanie M. Marshall
Bowling Green State University



Pharmaceuticals and PCP's?



I Avoid Triclosan. Do You?



Centex
Antibacterial Handwash

Hygienically removes germs



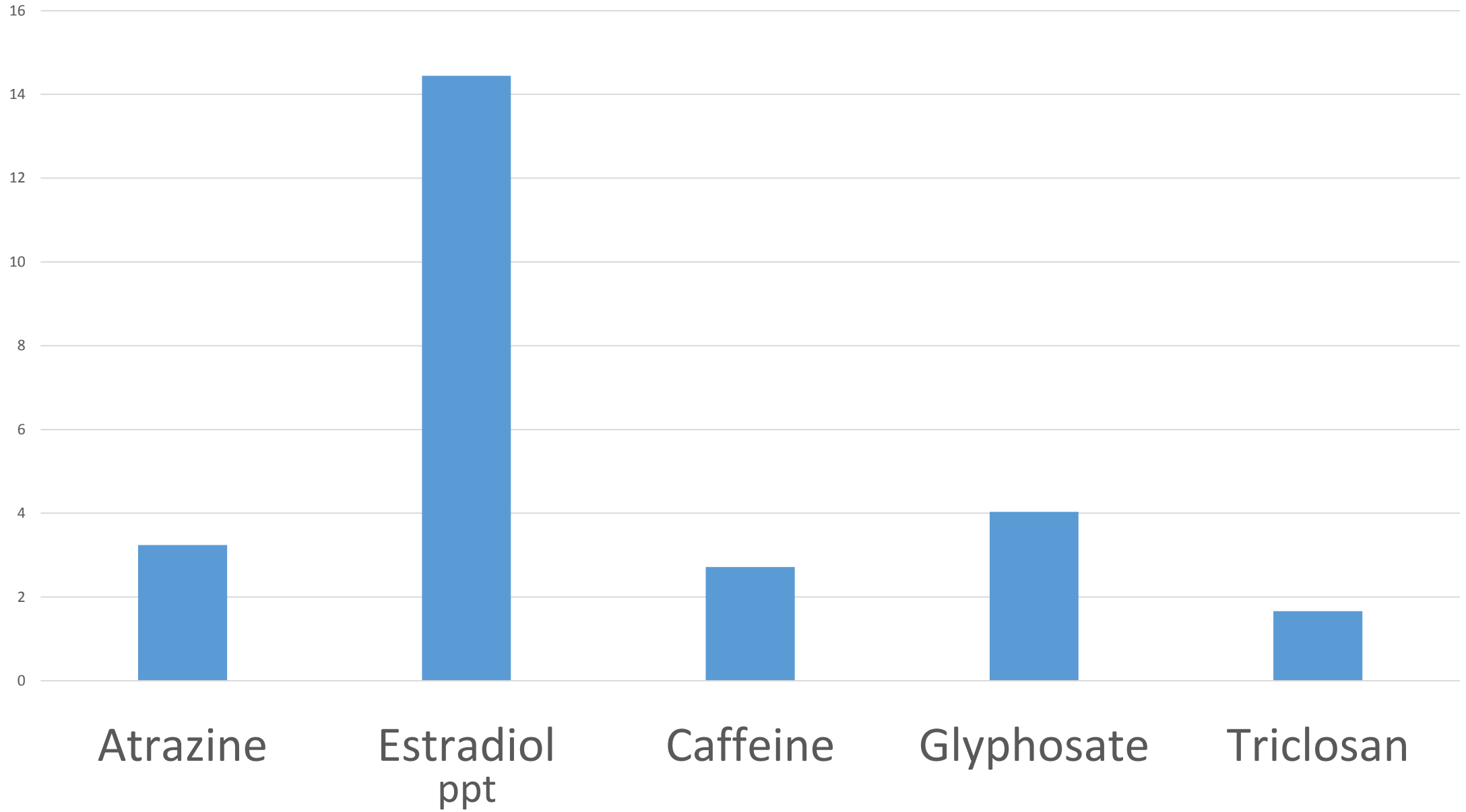
- ✓ Safe
- ✓ Gentle
- ✓ Effective
- ✓ Moisturising



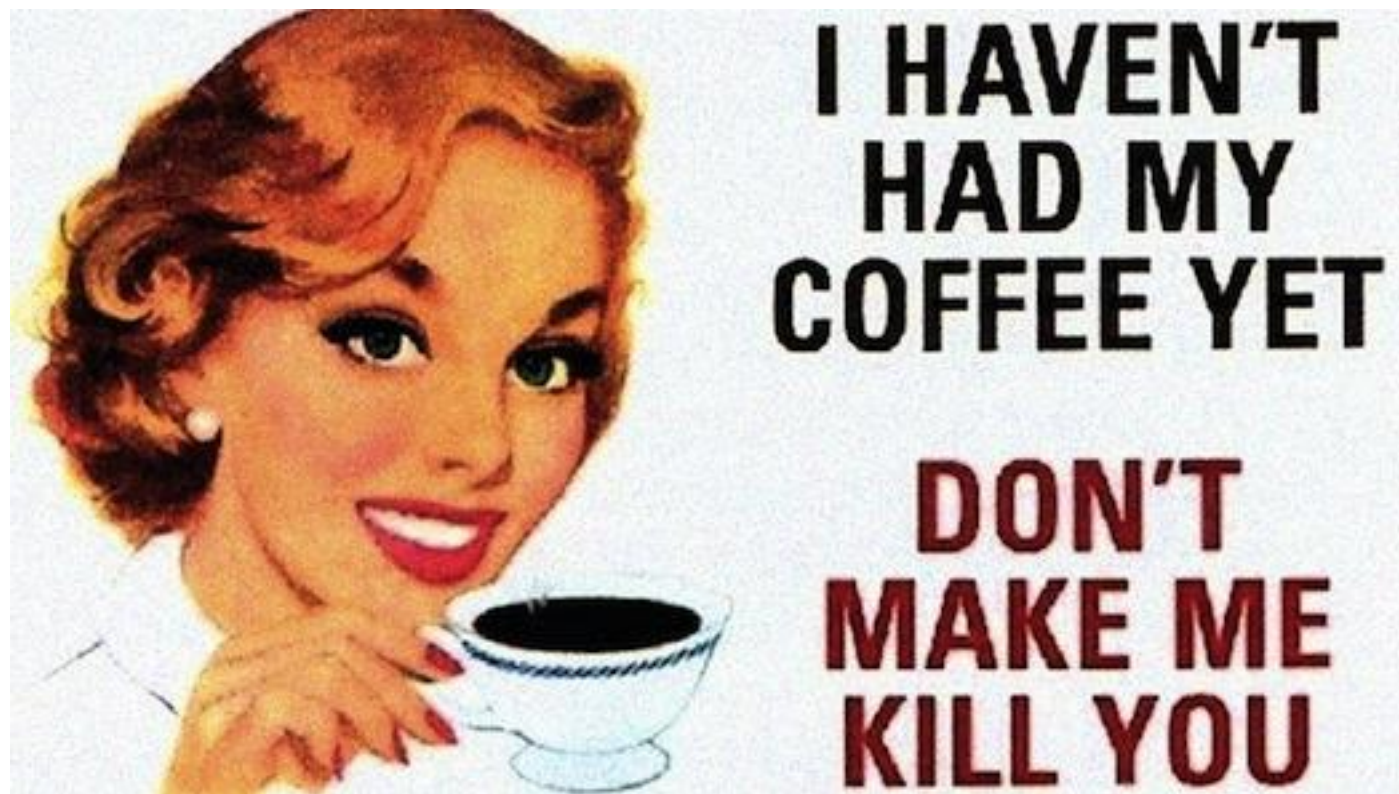
Original
500ml e







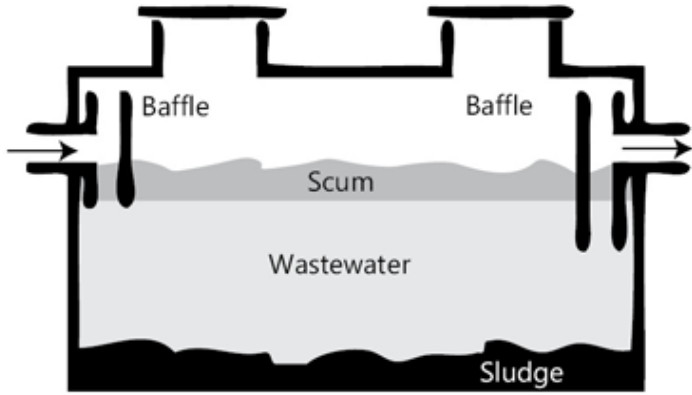






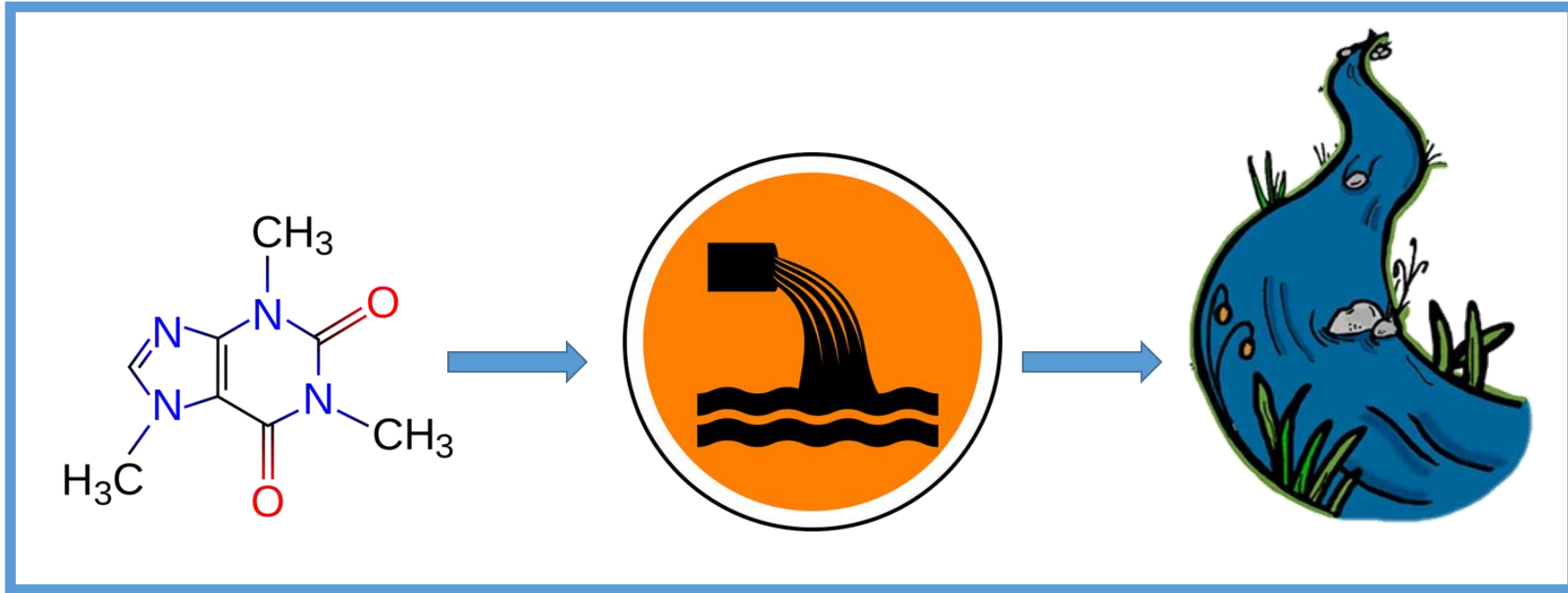
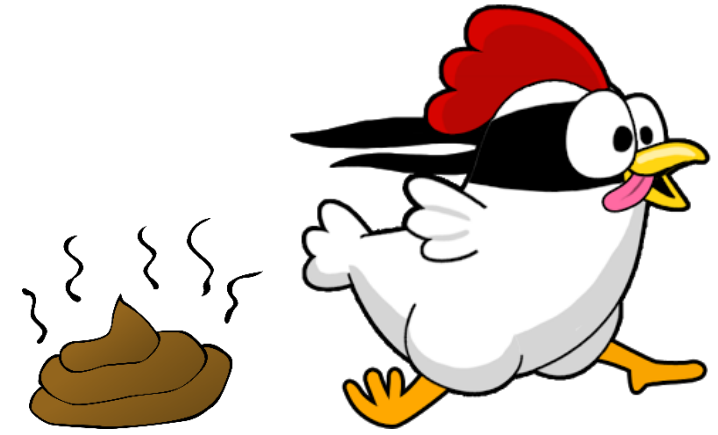
According to Buerge et. al. 2003:

- Global average consumption:
 - 70 mg/person/day
 - 460,000 kg/day
- United States:
 - 210 mg/person/day
 - 63,000 kg/day

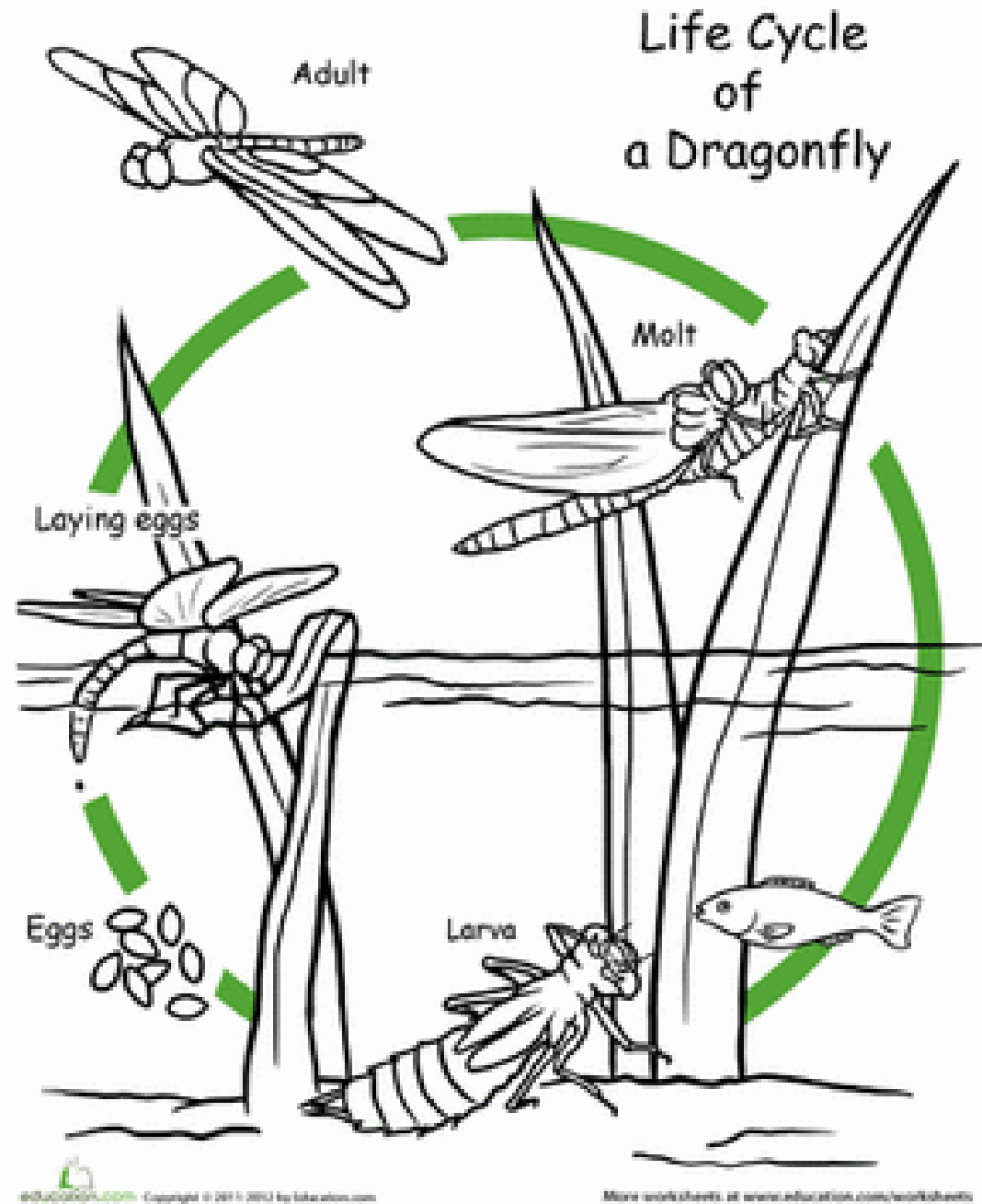


Typical Septic Tank

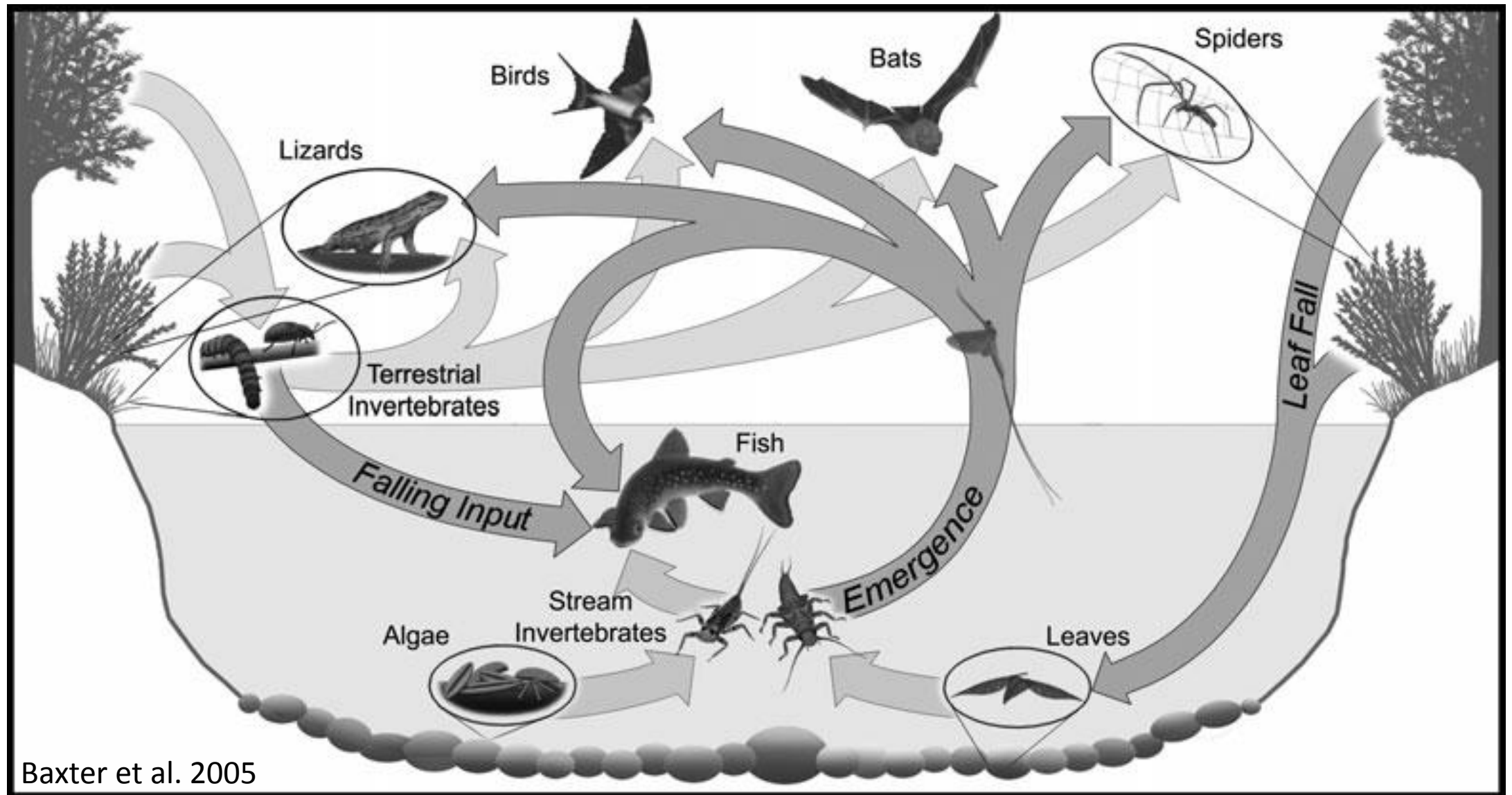
Possible Contributors



Emergent Insects

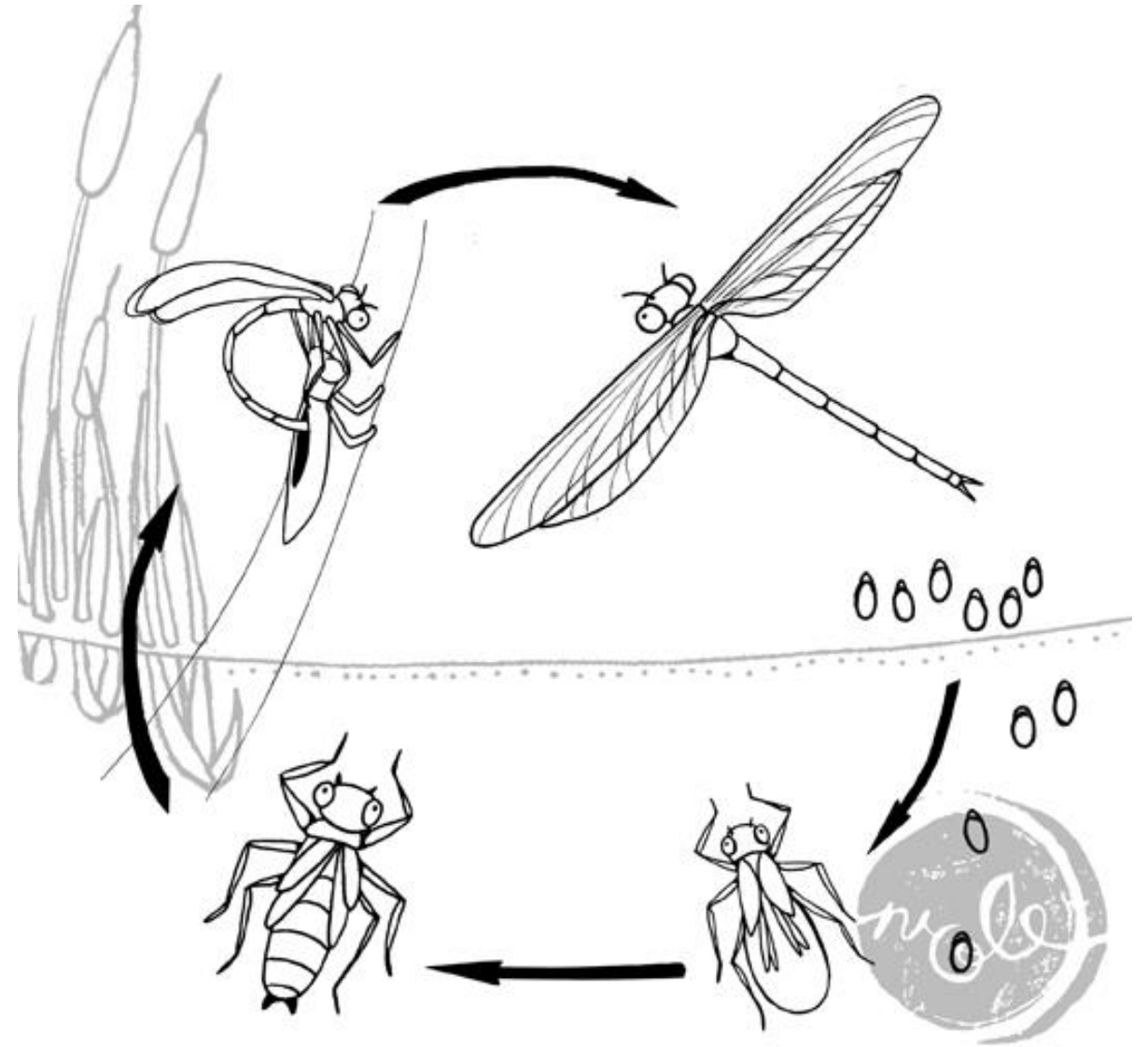


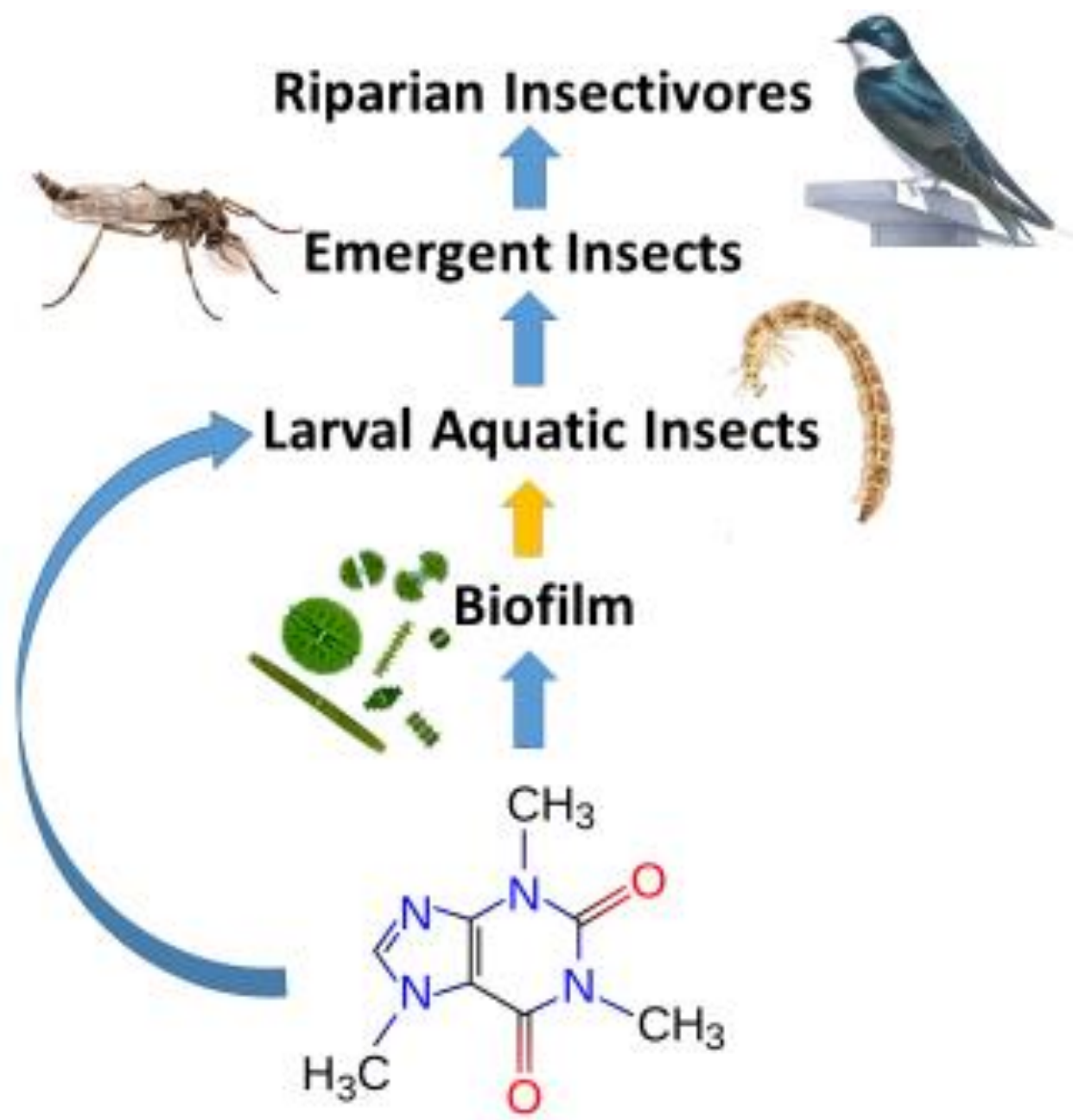
Aquatic-Terrestrial Linkage



Aquatic-Terrestrial Linkage

- Kraus et al. 2014
 - Decline of emergent insects along a metals gradient
- Walters et al. 2008
 - ^{13}C and ^{15}N isotopes
 - Aquatic contaminants in riparian predators





Biofilm Components



1. Algal Biomass

2. Bacterial Biomass

3. Fungal Biomass



Andrey Voronkov/NPI



Gina Mikel
www.scientificillustrator.com



Invertebrates





Riparian
Insectivores



Hypotheses

1. Decline in photosynthetic components of biofilm
 - Decreasing nutritional value
 - Less food for larval aquatic insects
2. Direct negative effect on aquatic insects
 - Fewer adult emergent insects
 - Less food for riparian predators



Maumee

1. Haskins
2. Liberty Center
3. Napoleon
4. Defiance

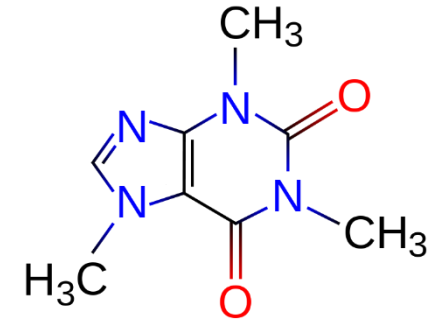
Sandusky

1. Fremont
2. Tiffin
3. Bascom
4. Sycamore

Portage

1. Pemberville
2. Bowling Green
3. Bloomdale
4. Fostoria

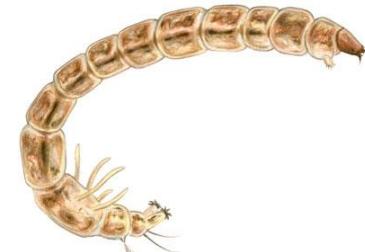
- Caffeine Testing



- Biofilm Sampling

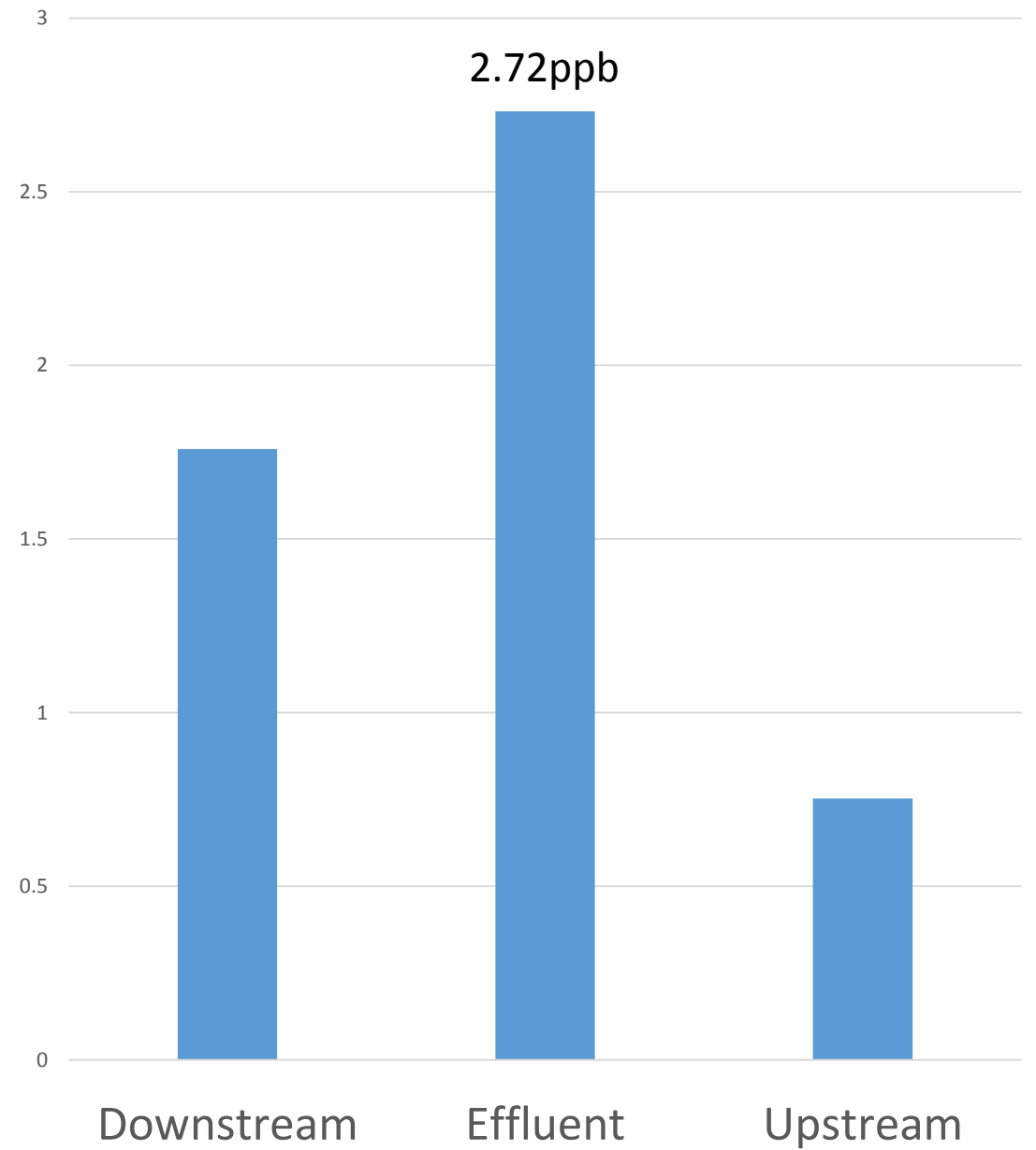
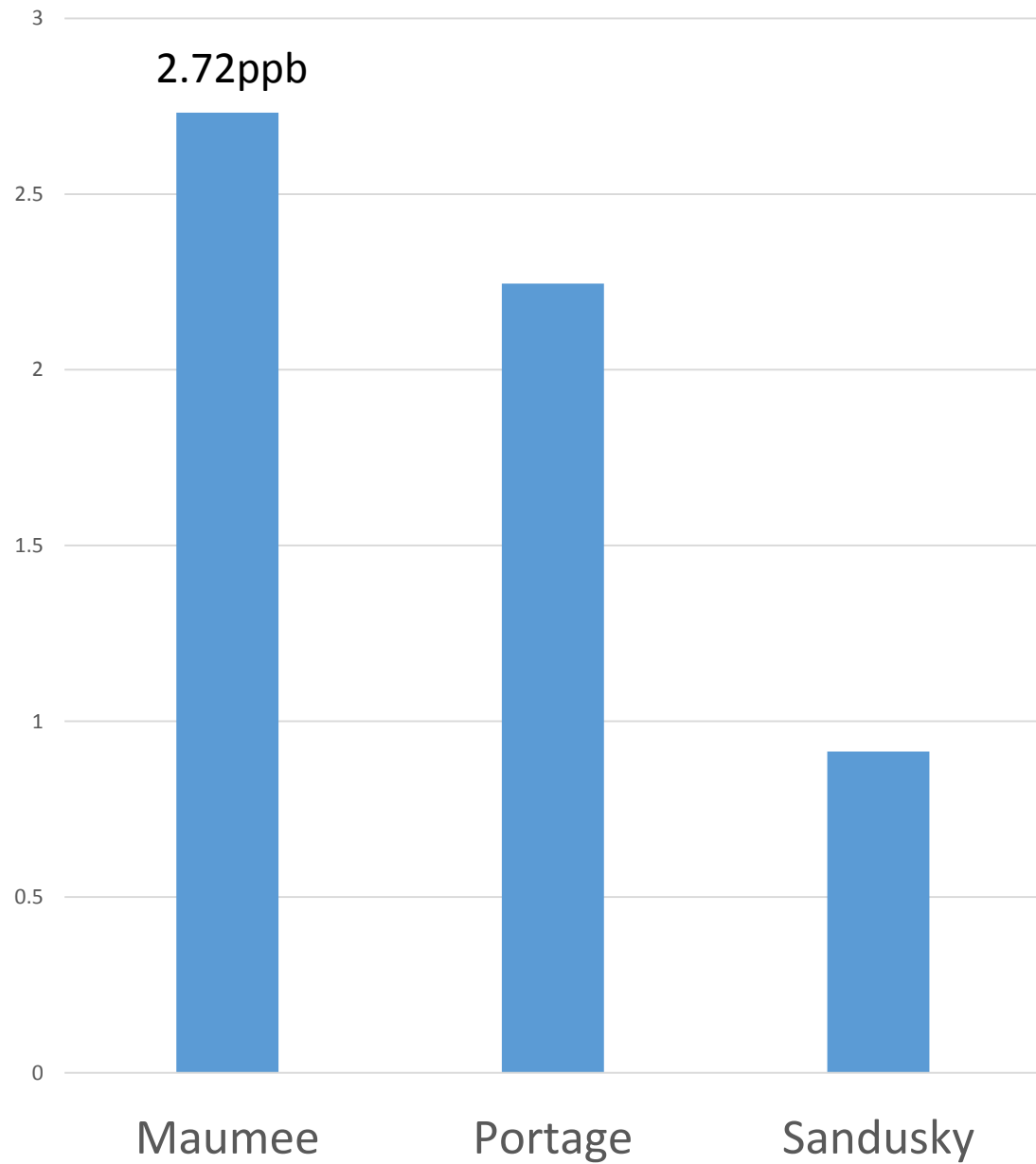


- Emergent Insect Sampling



Caffeine Concentrations - ELISA



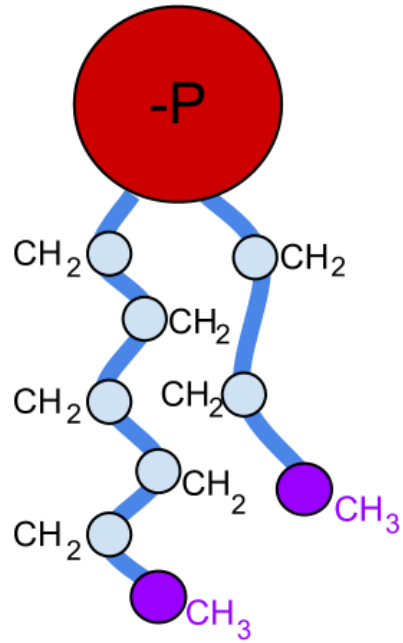


Biofilm

1. Abundance
2. Composition
3. Nutritional value



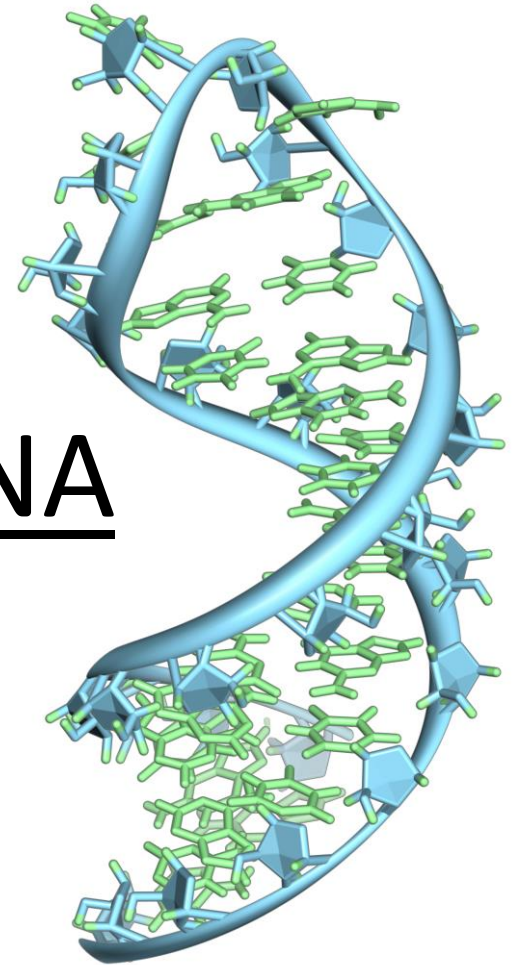
PLFA



Stoichiometry

C:N:P

16s rRNA



Decrease in biofilm P uptake?



Higher caffeine \longrightarrow More P in the water that is available for use by toxic algae blooms?

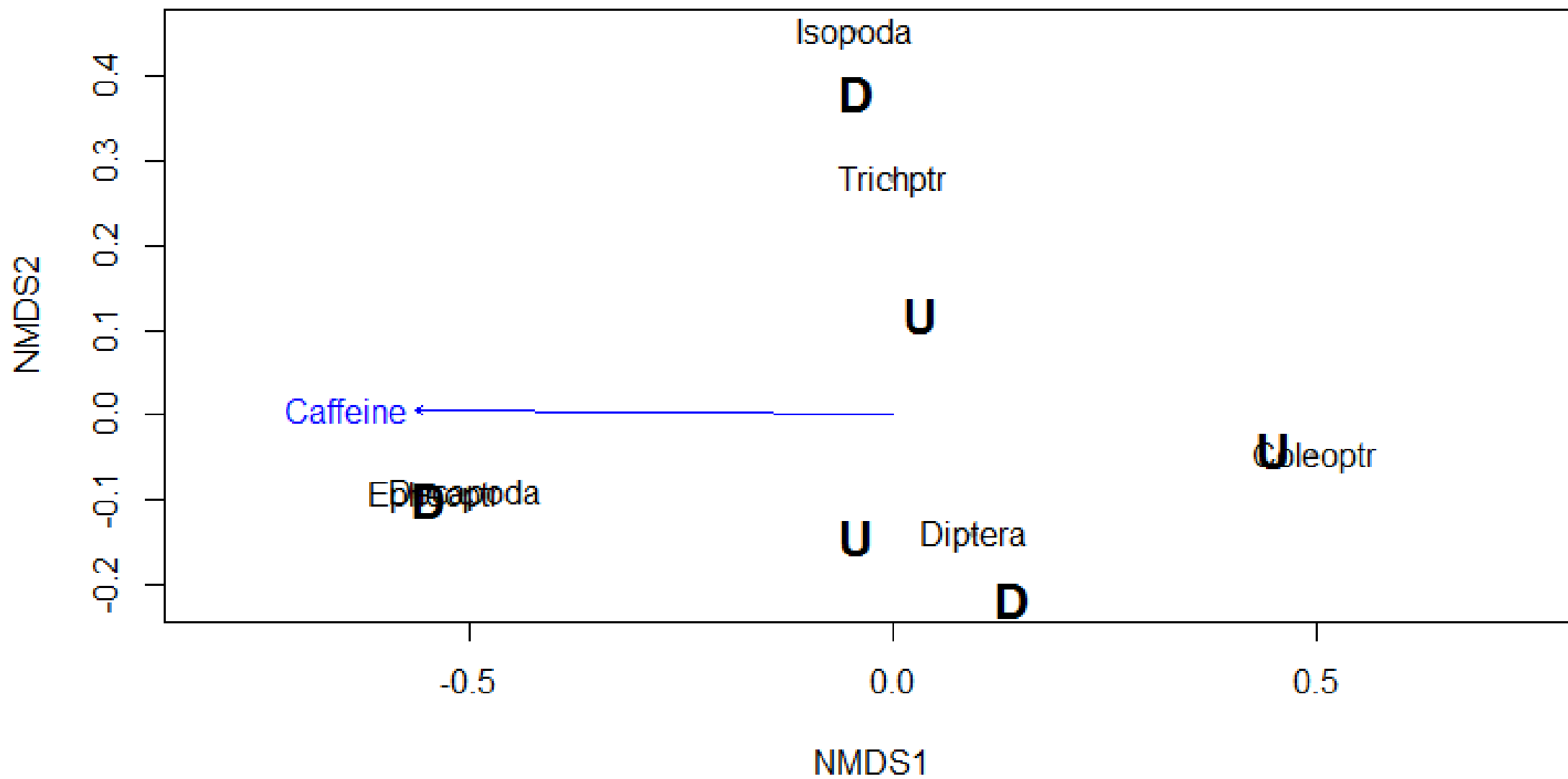
Aquatic Insect Larvae



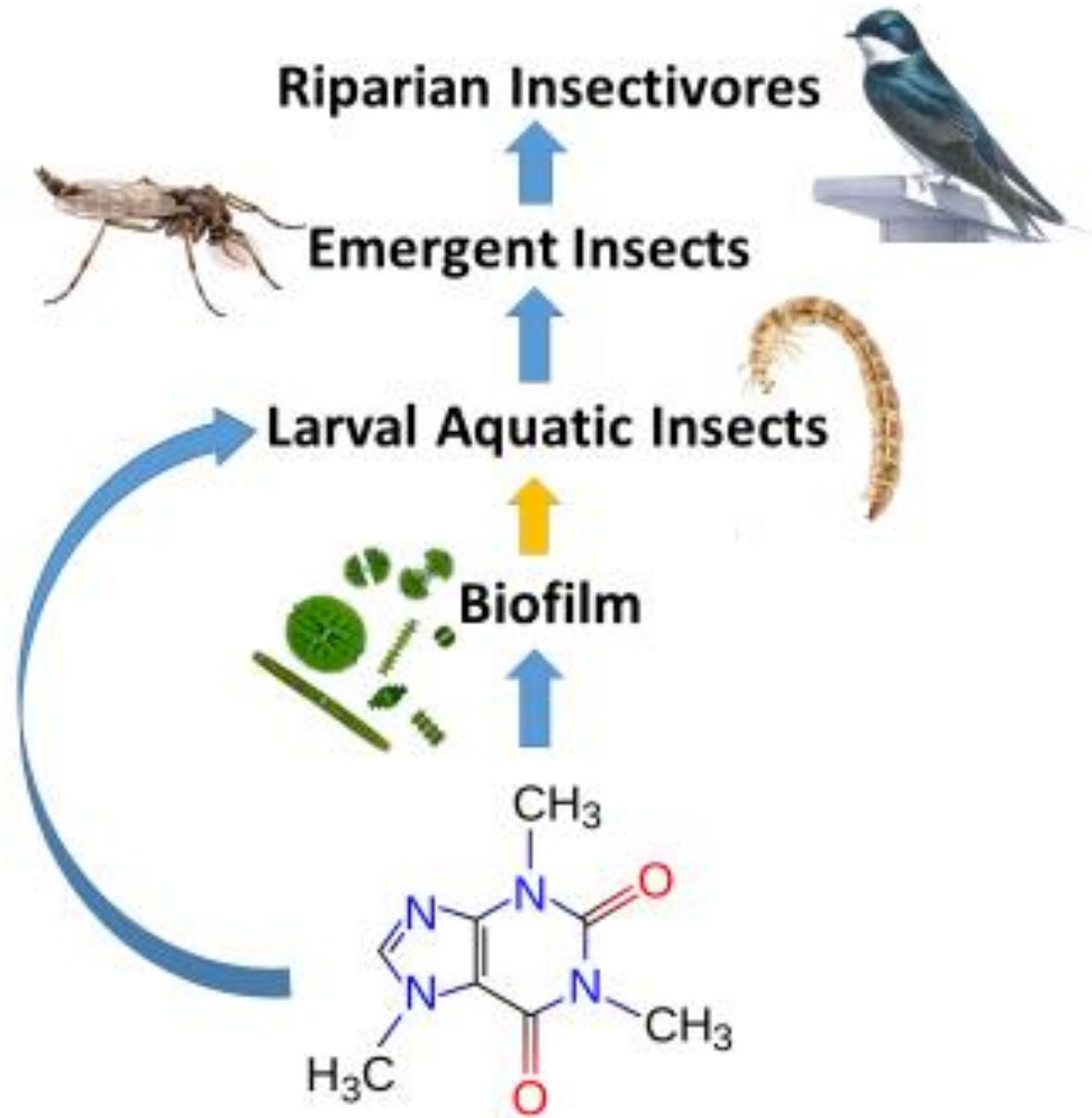


Aquatic Insect Larvae

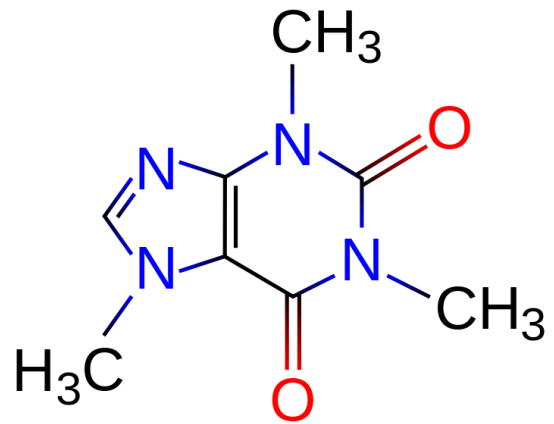
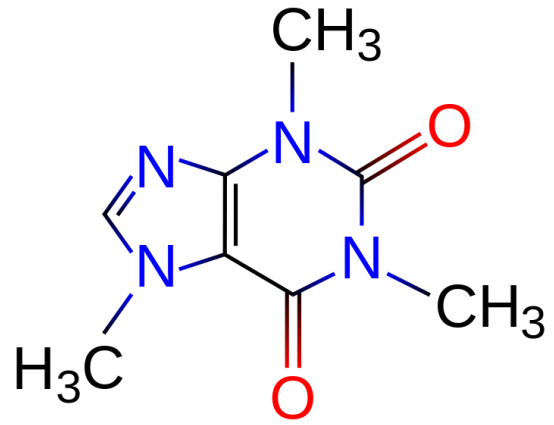




Direct and Indirect Effects on Emergent Insects



Lab Studies



Field Studies

1. Observational



Field Studies

2. Manipulative

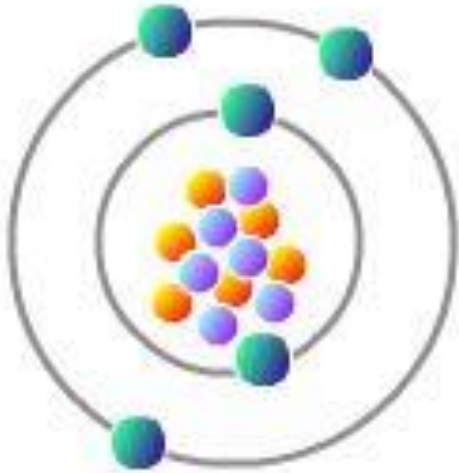


Other Studies

- Meta-analysis
- Citizen Study



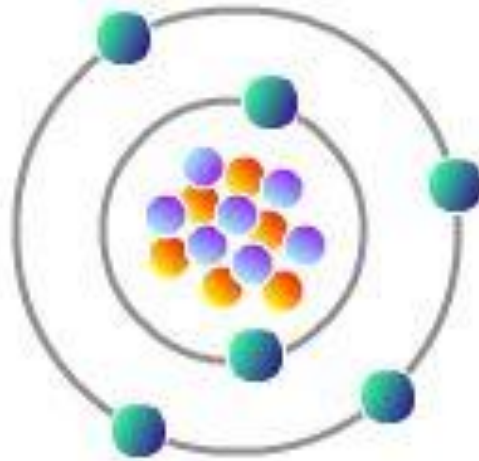
Other Studies



Carbon

● 6 Protons

● 6 Neutrons

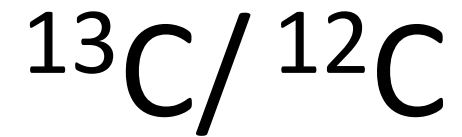


Carbon-13

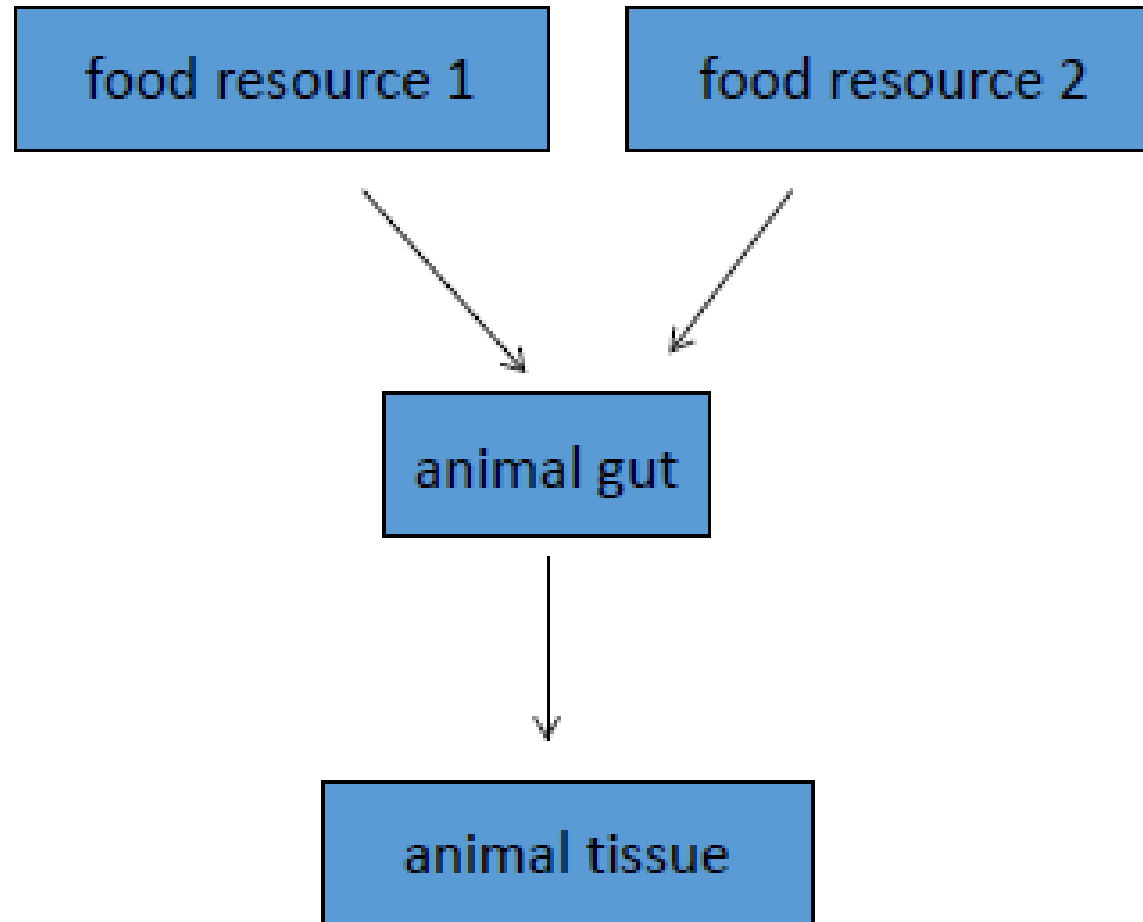
● 6 Protons

● 7 Neutrons

Stable Isotope Ratios



You are what you eat!



Other Studies

- Stable Isotopes – Quantify reliance of predators on emergent insects vs terrestrial insects



$\delta^{13}\text{C}$ and $\delta^{15}\text{N}$

Purpose

1. **Caffeine** – deserves attention
2. **Emergent Insects** – connect food webs
3. **Linked Food Webs** – need to better understand
4. **Wastewater Treatment** – needs re-evaluated
5. **Freshwater Resources** – essential environmental concern

Dr. Kevin McCluney

Dr. George Bullerjahn

Dr. Paul Moore

Dr. Laura Johnson

Haley Ingram

Nadya Mirochnitchenko

Wastewater Plants in the
Maumee, Sandusky, and Portage
Watersheds

