Biological Monitoring of Surface Water Quality Near the PAPA

{ A brief review and summary through the present

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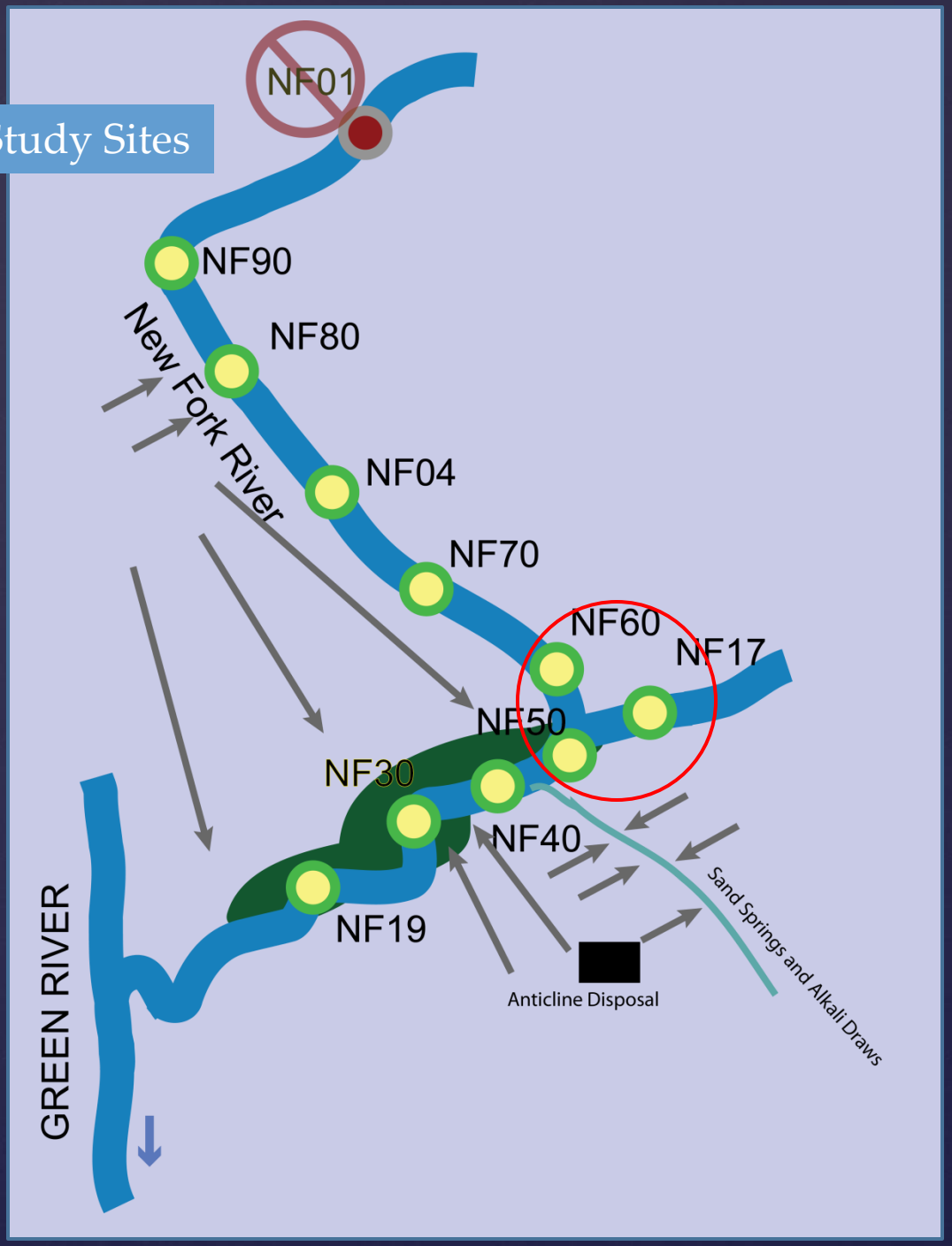
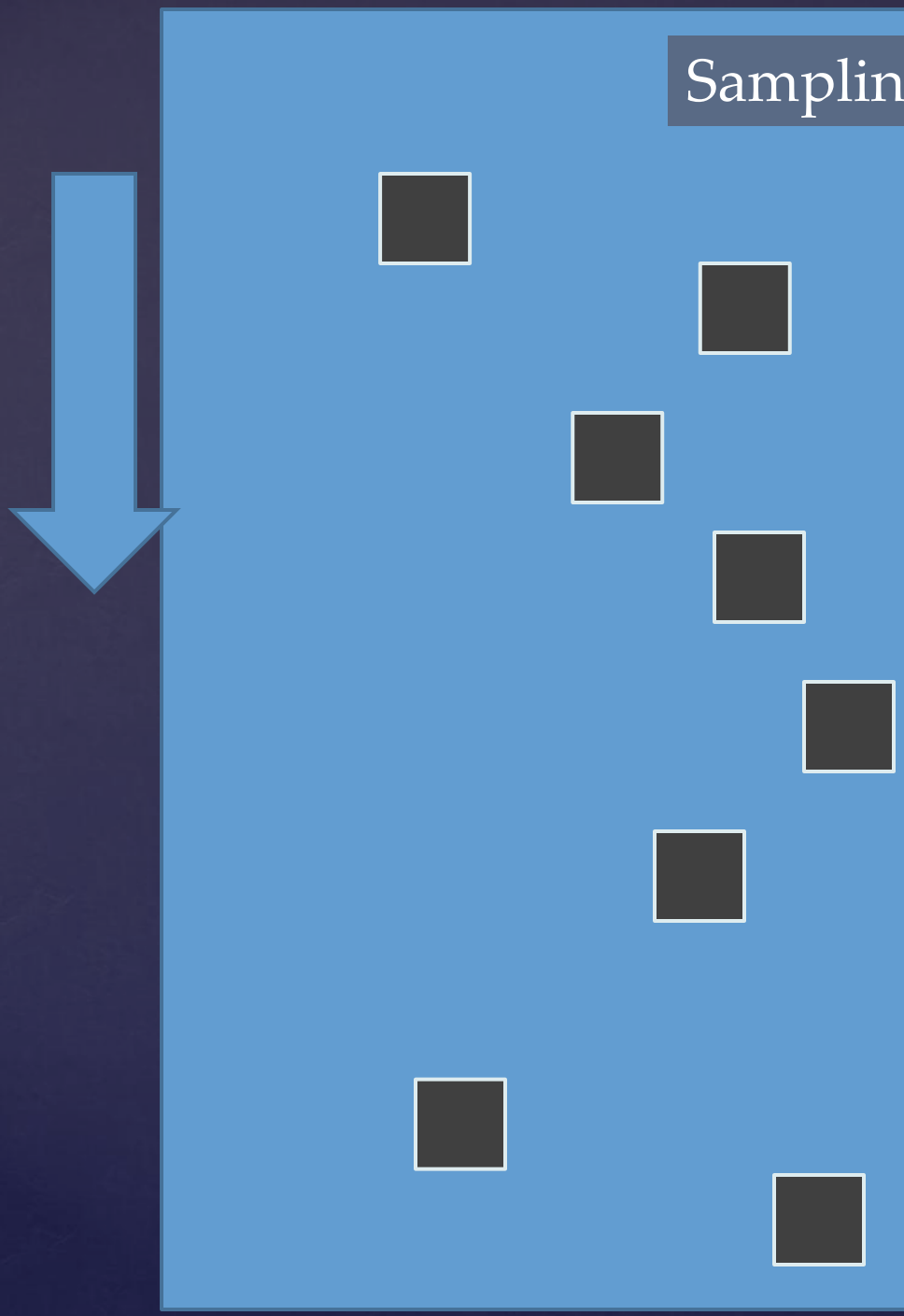
Biological monitoring

- Biological monitoring is important for this project, because it frames the collective effects of development in terms that are ecologically relevant.
- The target biological assemblage is the macroinvertebrates: river-dwelling insects, snails, and worms (etc.)

Schematic location of Study Sites



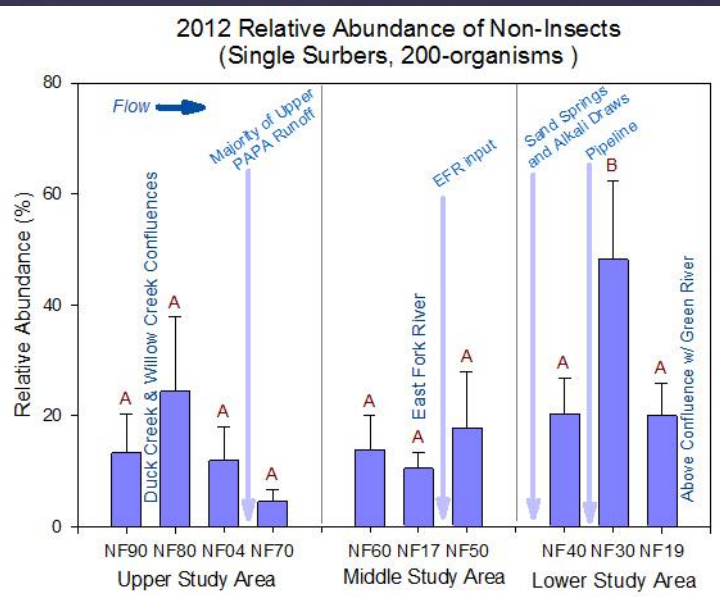
Sampling Plan at each Site

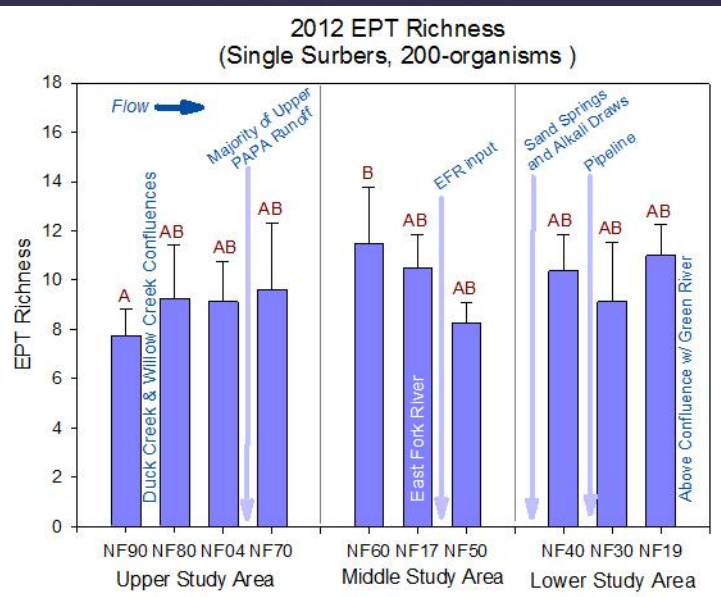


- 8 Samples per site
- Stratified by flow,

Data collected for each point sample:

- Bugs,
- Flow,
- Substrate


2012 Relative Abundance of Non-Insects
(Single Surbers, 200-organisms)
Relative Abundance (%)
Flow
Majority of Upper PAPA Runoff
Duck Creek & Willow Creek Confluences
EFR input
East Fork River
Sand Springs and Alkali Draws
Pipeline
Above Confluence w/ Green River
NF90 NF80 NF04 NF70
NF60 NF17 NF50
NF40 NF30 NF19
Upper Study Area
Middle Study Area
Lower Study Area


2012 EPT Richness
(Single Surbers, 200-organisms)
EPT Richness
Flow
Majority of Upper PAPA Runoff
Duck Creek & Willow Creek Confluences
EFR input
East Fork River
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Upper Study Area
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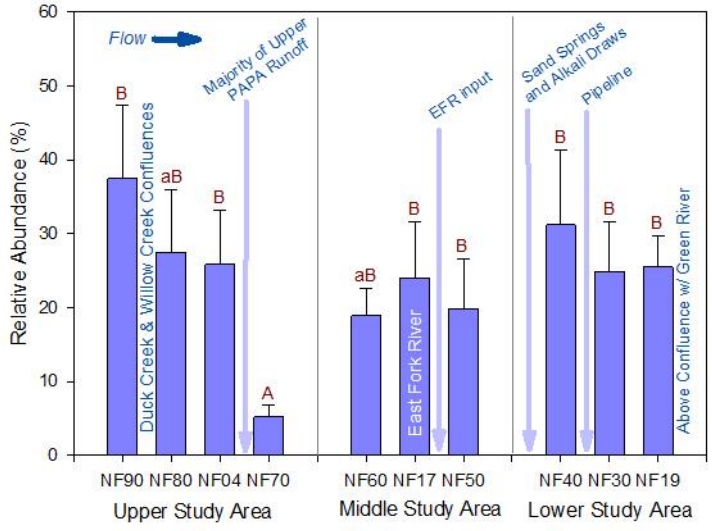
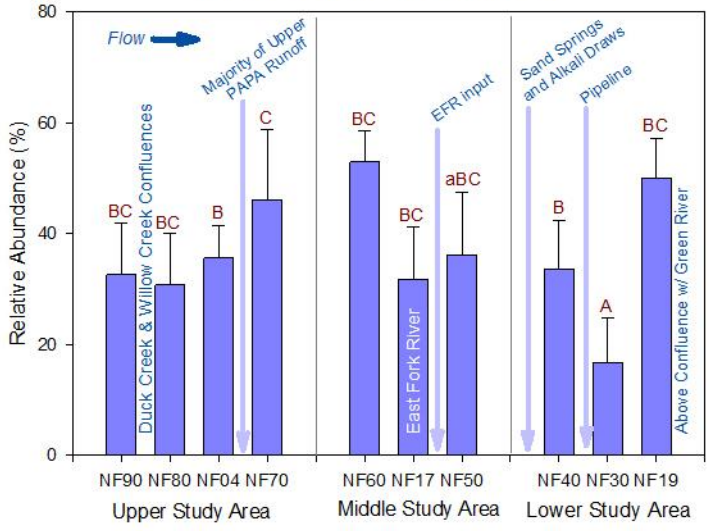

2012 Relative Abundance of Chironomid Midges
(Single Surbers, 200-organisms)
Relative Abundance (%)
Flow
Majority of Upper PAPA Runoff
Duck Creek & Willow Creek Confluences
EFR input
East Fork River
Sand Springs and Alkali Draws
Pipeline
Above Confluence w/ Green River
NF90 NF80 NF04 NF70
NF60 NF17 NF50
NF40 NF30 NF19
Upper Study Area
Middle Study Area
Lower Study Area


2012 Relative Abundance of EPT Orders
(Single Surbers, 200-organisms)
Relative Abundance (%)
Flow
Majority of Upper PAPA Runoff
Duck Creek & Willow Creek Confluences
EFR input
East Fork River
Sand Springs and Alkali Draws
Pipeline
Above Confluence w/ Green River
NF90 NF80 NF04 NF70
NF60 NF17 NF50
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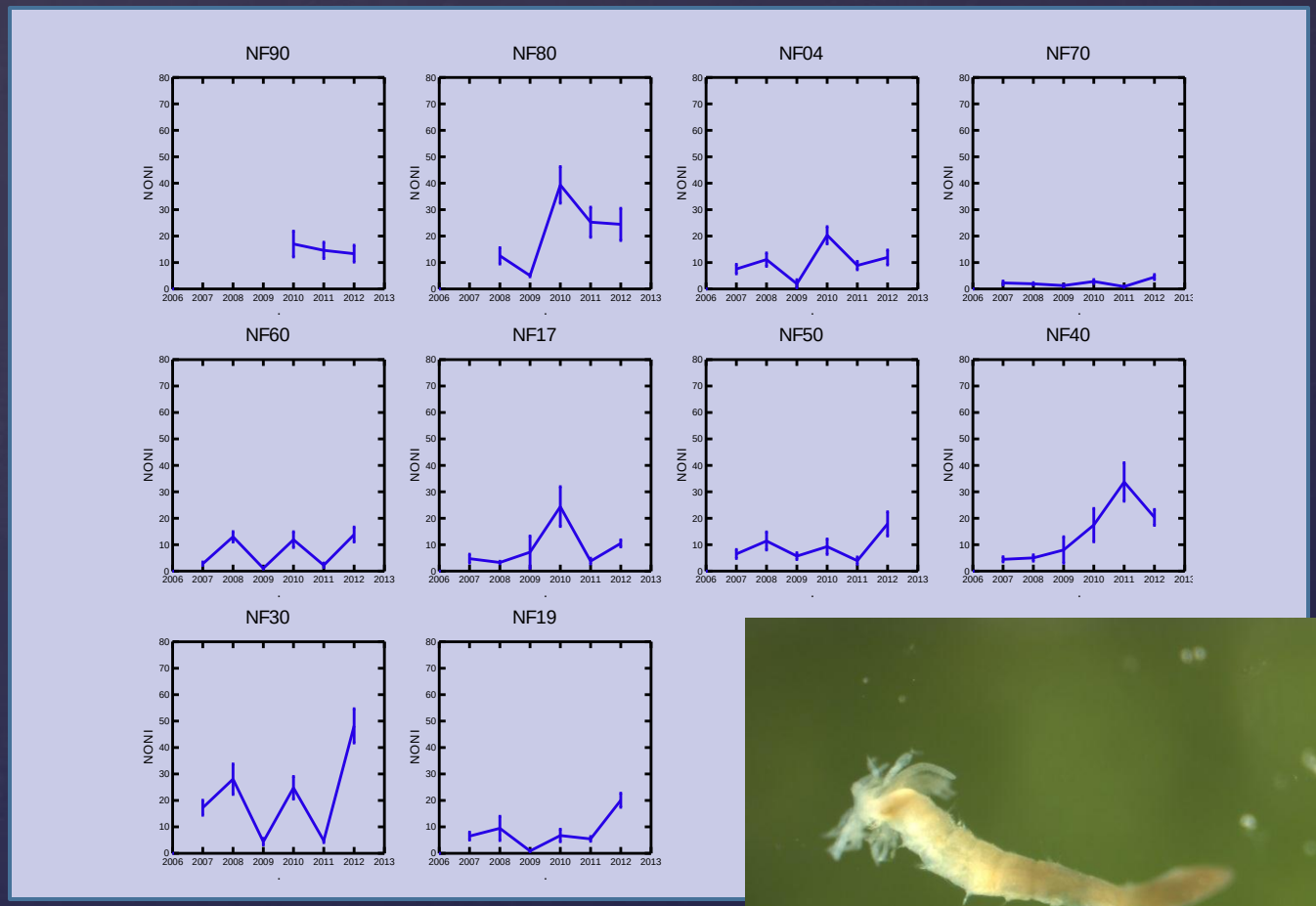
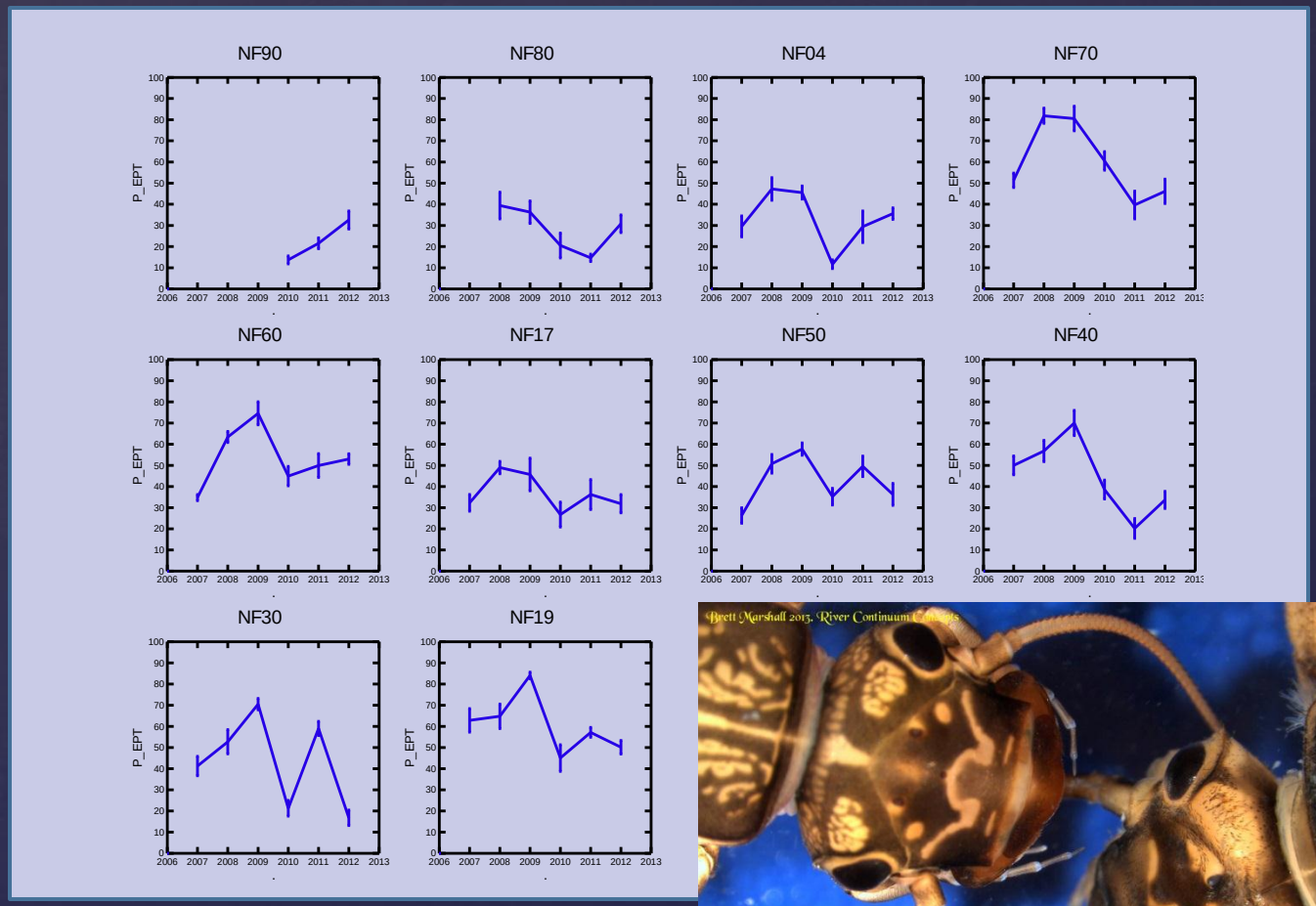
Upper Study Area
Middle Study Area
Lower Study Area

Percent Non-Insect abundance over time…



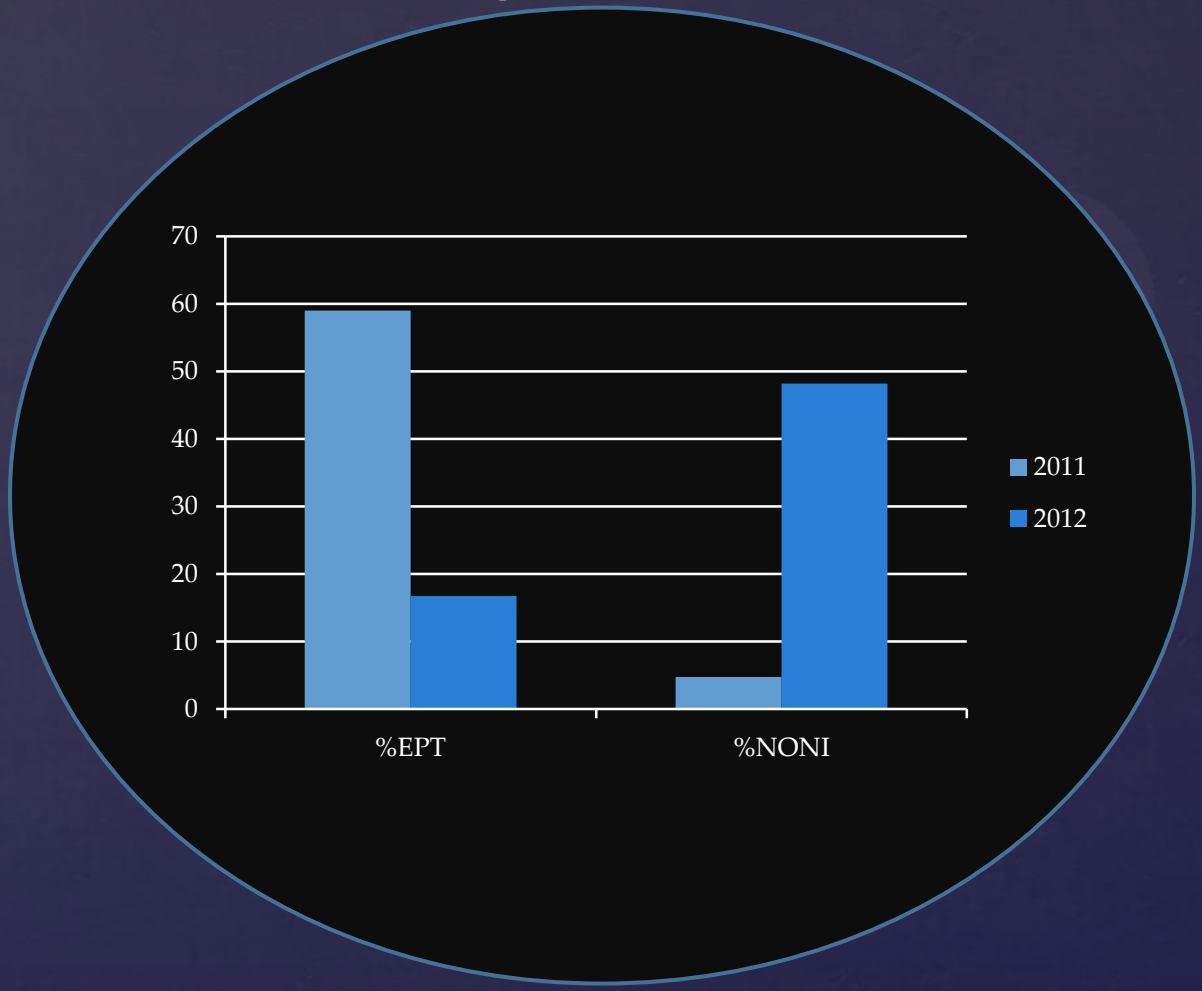
Percent EPT abundance over time…



Two Limitations / Problems

1. Water Quality measures vs. Quantitative Ecological Measures
2. *Didymosphenia geminata*

NF30 Change from 2011-2012



Two Scenarios whereby worms can become dominant

Scenario 1

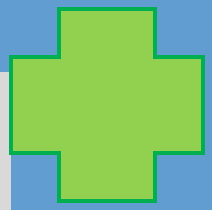
EPT and others experience increased mortality, or decreased success, releasing worms from competition and predation.

Worms become abundant, other animals become less-abundant or absent

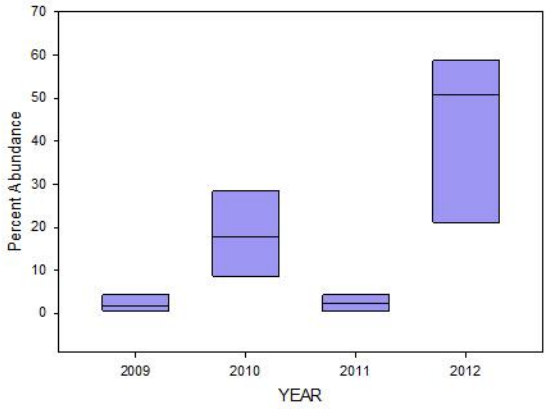
Scenario 2

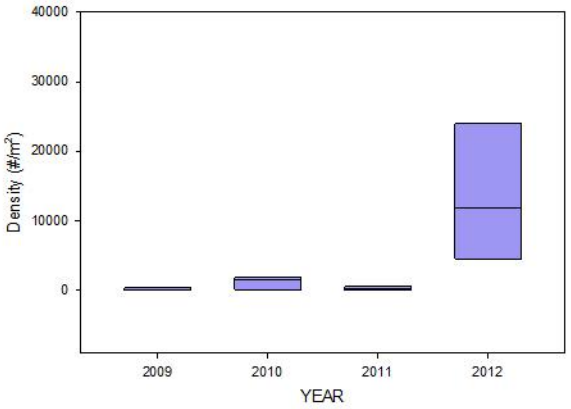
Worms find beneficial niches, habitat or food which are not available to other animals.

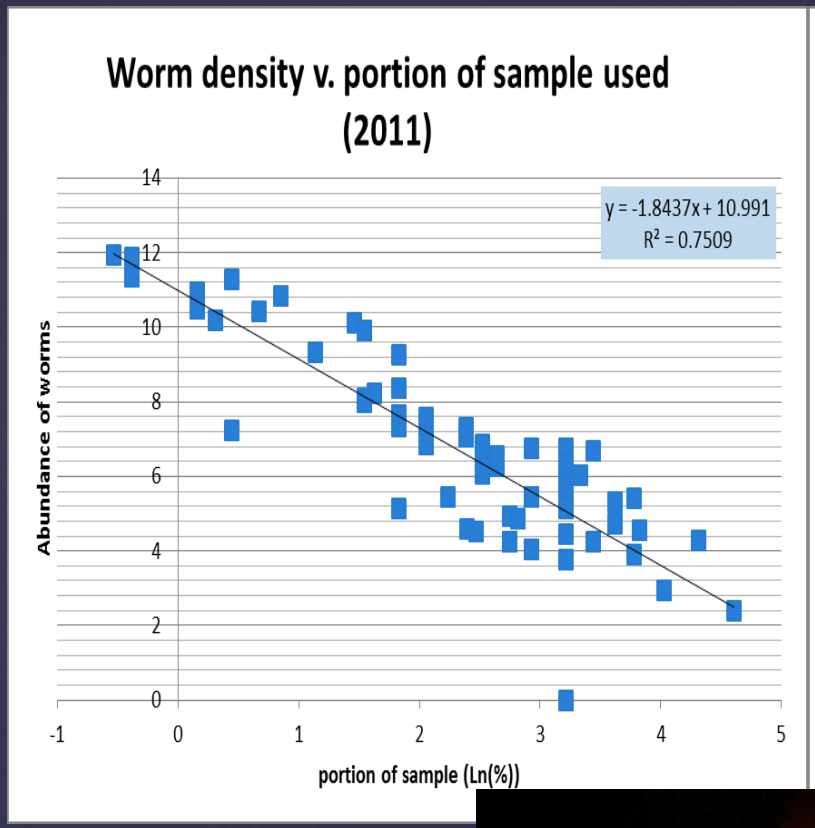
Worms become abundant, other animals do not change in abundance

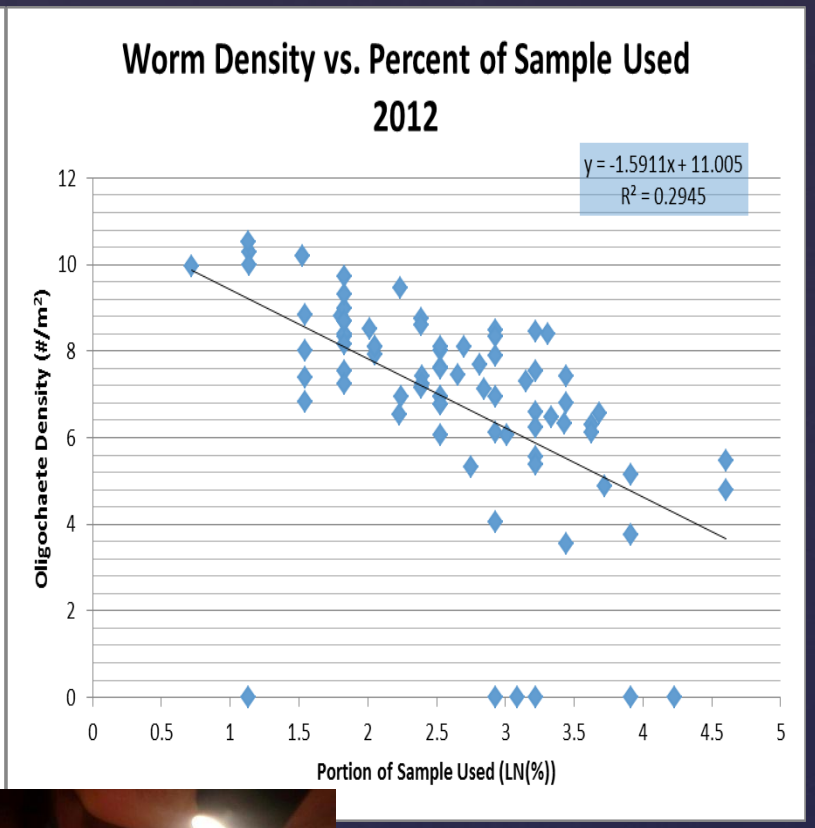


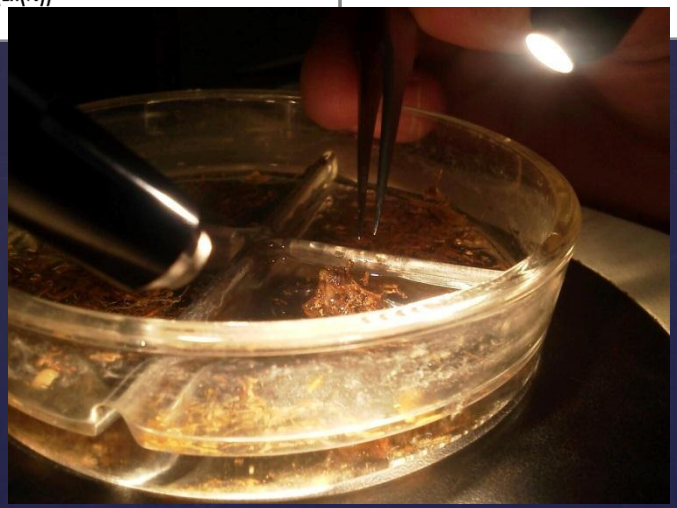
DENSITY

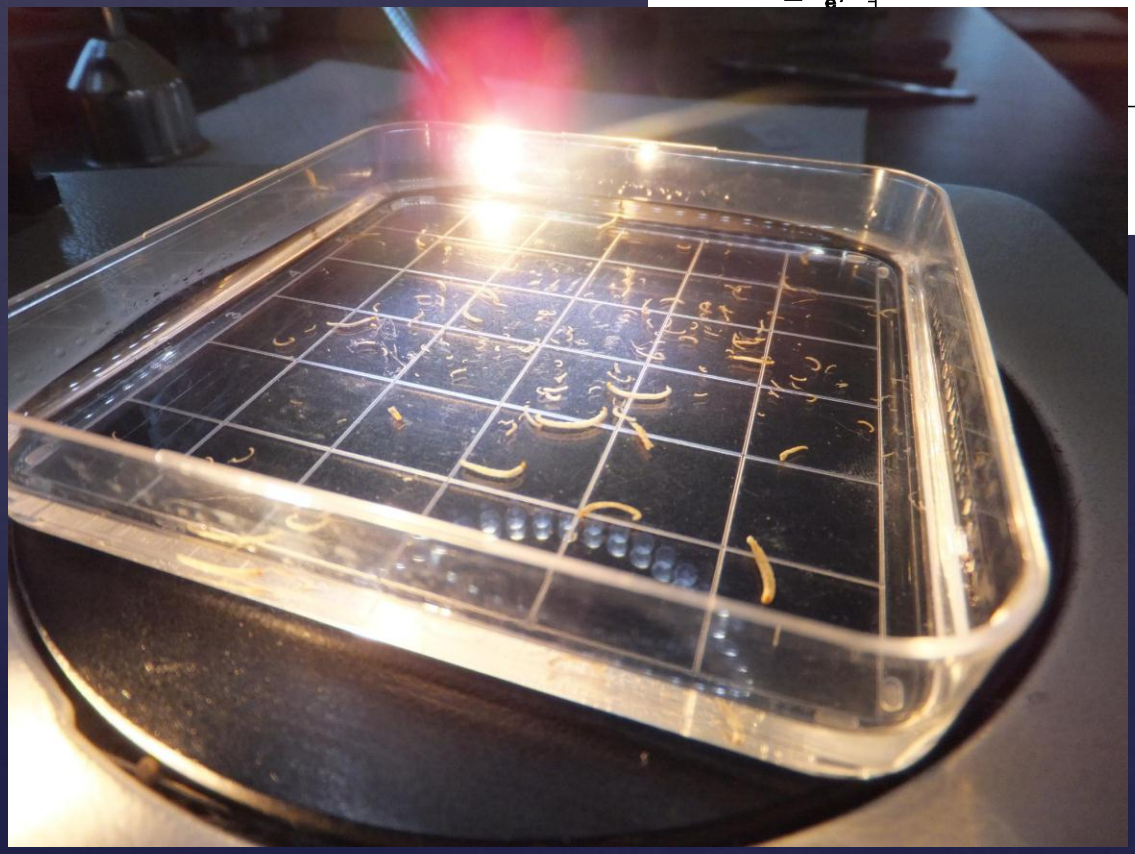

Median Worm % Abundance at NF30
Percent Abundance
70
60
50
40
30
20
10
0
2009
2010
2011
2012
YEAR

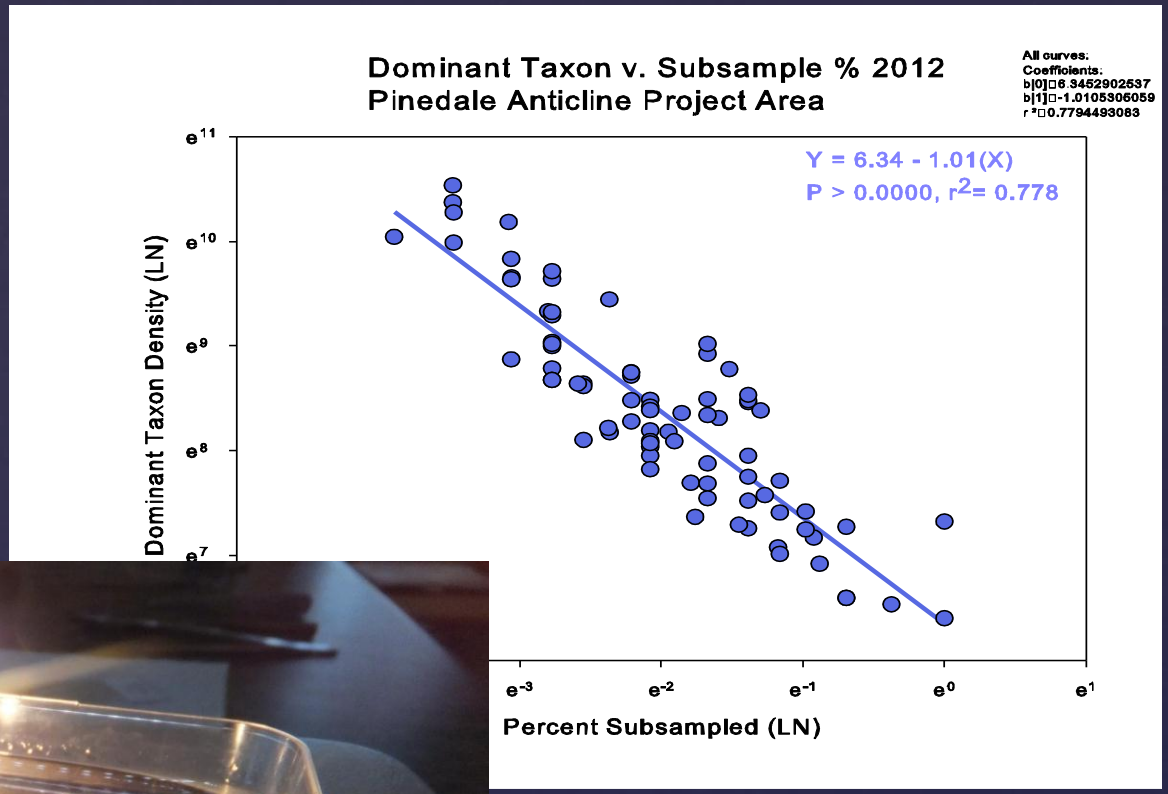

Median Worm Density at NF30
Density (#/m²)
40000
30000
20000
10000
0
2009
2010
2011
2012
YEAR

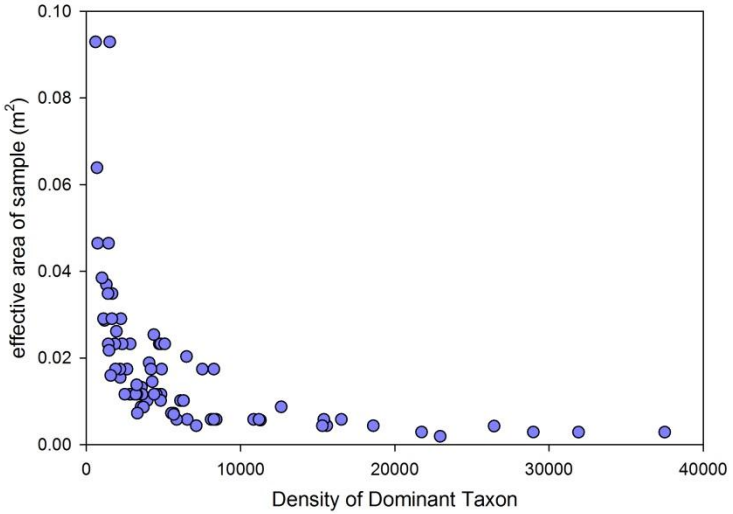

Worm density v. portion of sample used (2011)
y = -1.8437x + 10.991
R² = 0.7509
Abundance of worms
portion of sample (Ln(%))
0
2
4
6
8
10
12
14
-1
0
1
2
3
4
5

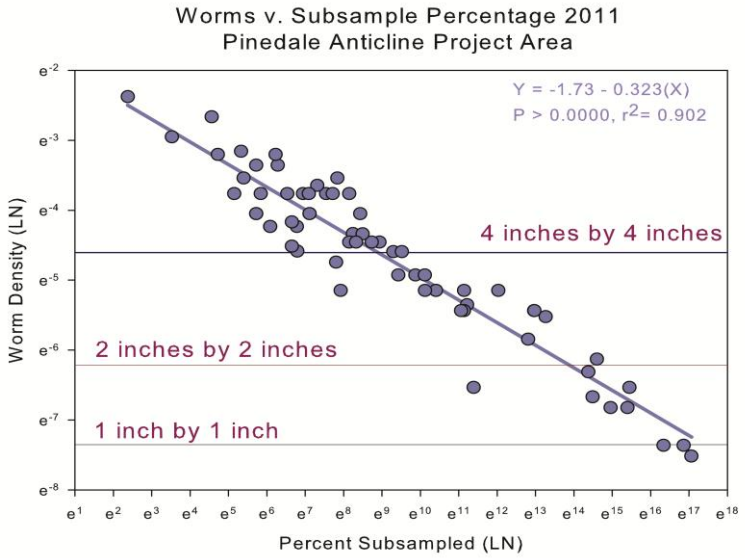

Worm Density vs. Percent of Sample Used 2012
y = -1.5911x + 11.005
R² = 0.2945
Oligochaete Density (#/m²)
Portion of Sample Used (LN(%))
0
2
4
6
8
10
12
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

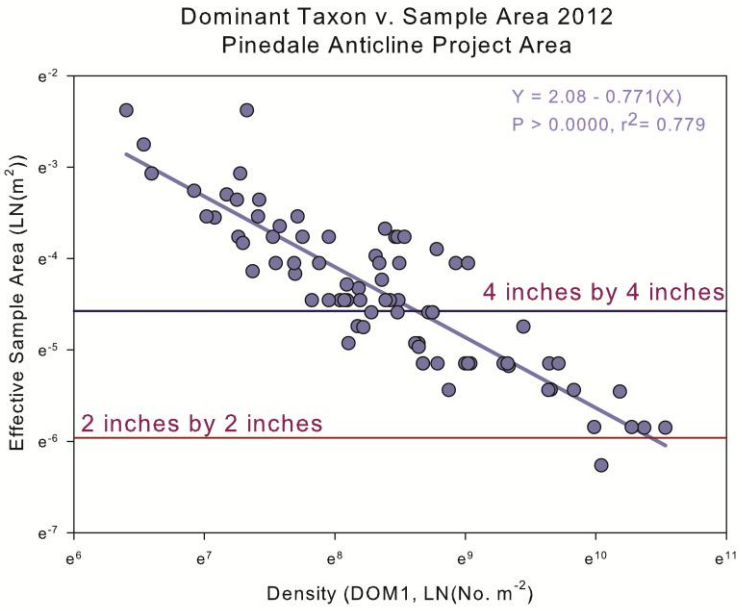


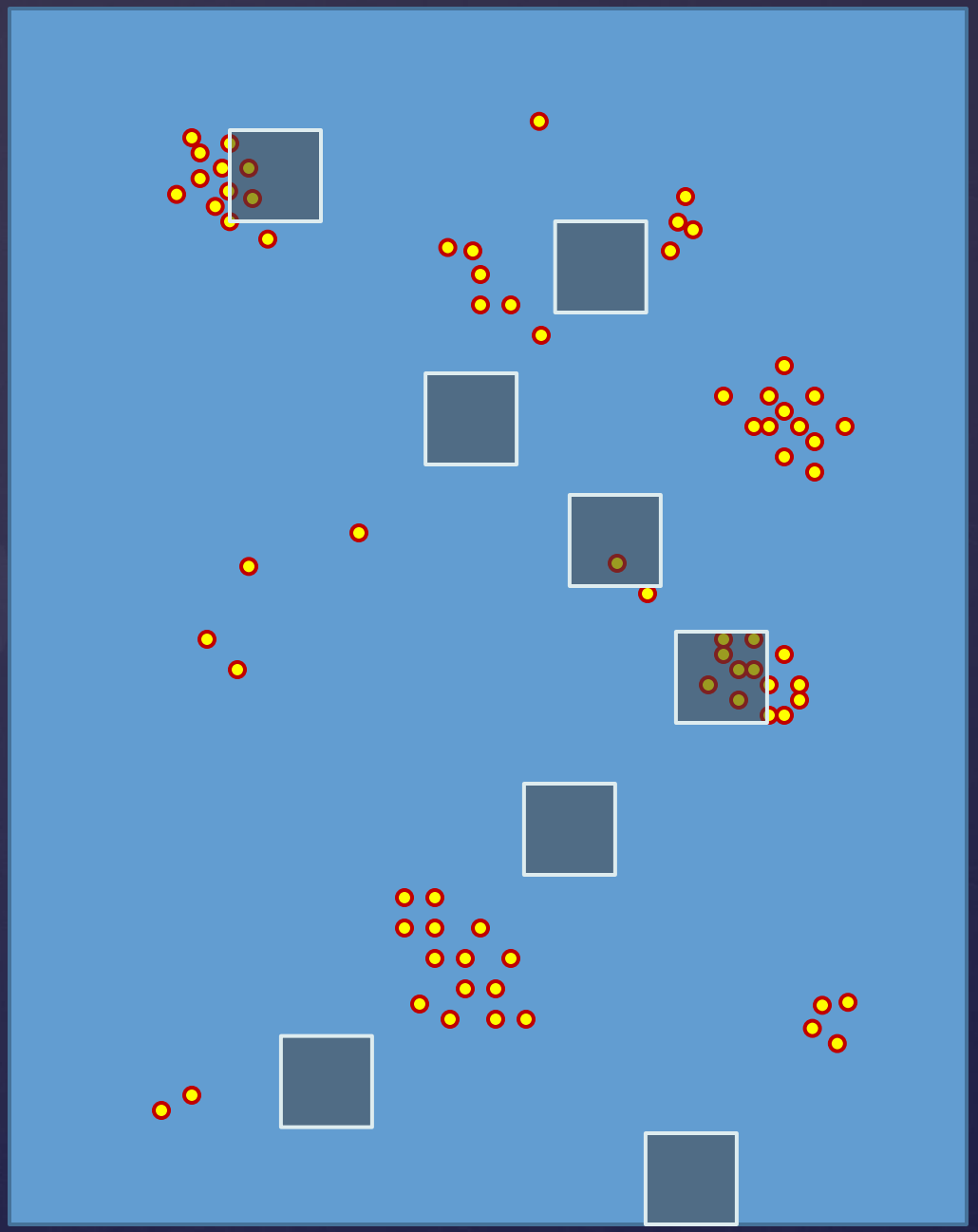


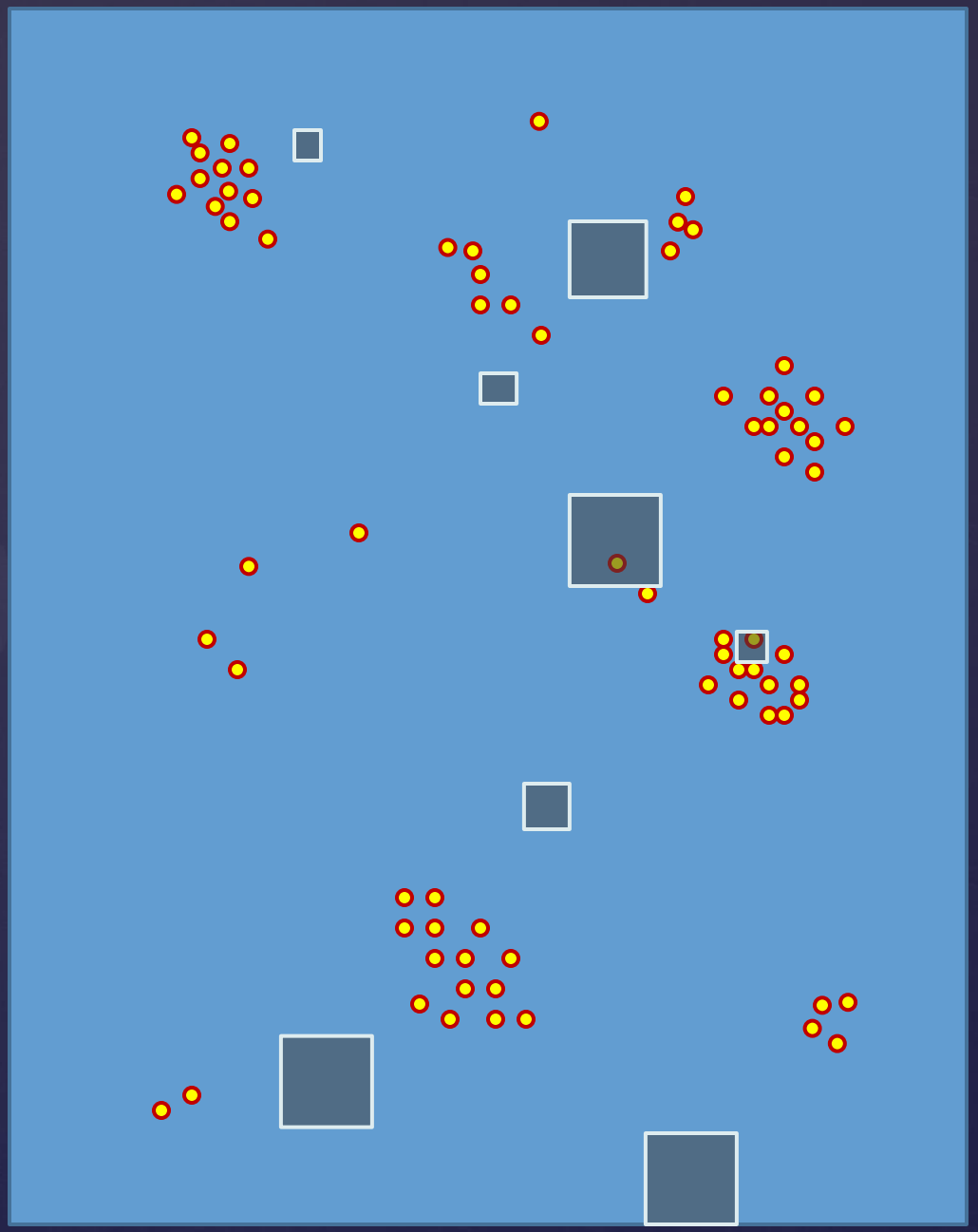

Dominant Taxon v. Subsample % 2012
Pinedale Anticline Project Area
All curves:
Coefficients:
b[0]□6.3452902537
b[1]□-1.0105306059
r²□0.7784493083
Y = 6.34 - 1.01(X)
P > 0.0000, r2= 0.778
Dominant Taxon Density (LN)
e11
e10
e9
e8
e7
e-3
e-2
e-1
e0
e1
Percent Subsampled (LN)


Dominant Taxon Density and Effective Area Sampled;
New Fork River, Sublette County WY (2012)
effective area of sample (m2)
0.10
0.08
0.06
0.04
0.02
0.00
0
10000
20000
30000
40000
Density of Dominant Taxon


Worms v. Subsample Percentage 2011
Pinedale Anticline Project Area
Y = -1.73 - 0.323(X)
P > 0.0000, r2= 0.902
4 inches by 4 inches
2 inches by 2 inches
1 inch by 1 inch
Worm Density (LN)
Percent Subsampled (LN)


Dominant Taxon v. Sample Area 2012
Pinedale Anticline Project Area
Y = 2.08 - 0.771(X)
P > 0.0000, r2= 0.779
4 inches by 4 inches
2 inches by 2 inches
Effective Sample Area (LN(m2))
Density (DOM1, LN(No. m-2))





How to deal with this…(?)

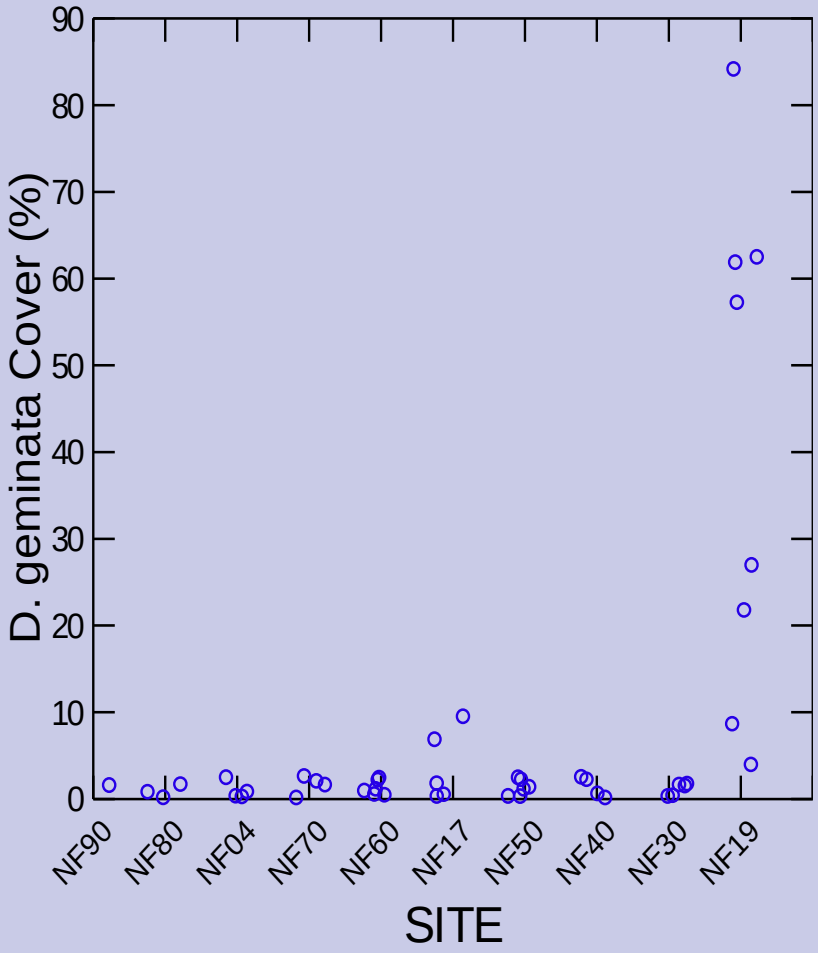
1. Acknowledge that the PAPA surface water biological program is unable to address basic ecological issues relating to invertebrate density.

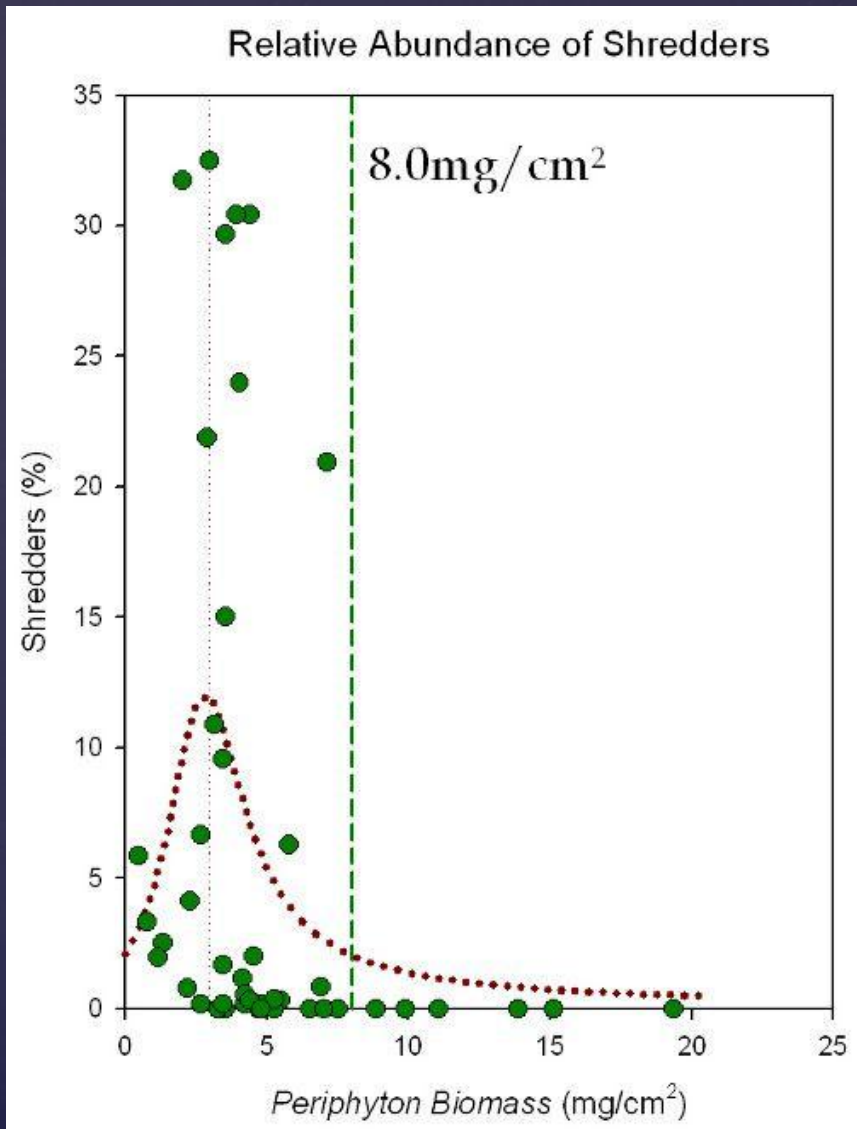
2. Increase the subsampling target from >200/sample (>1600 per site) to >300/sample (2400 per site) or >400 /sample (3200 per site).

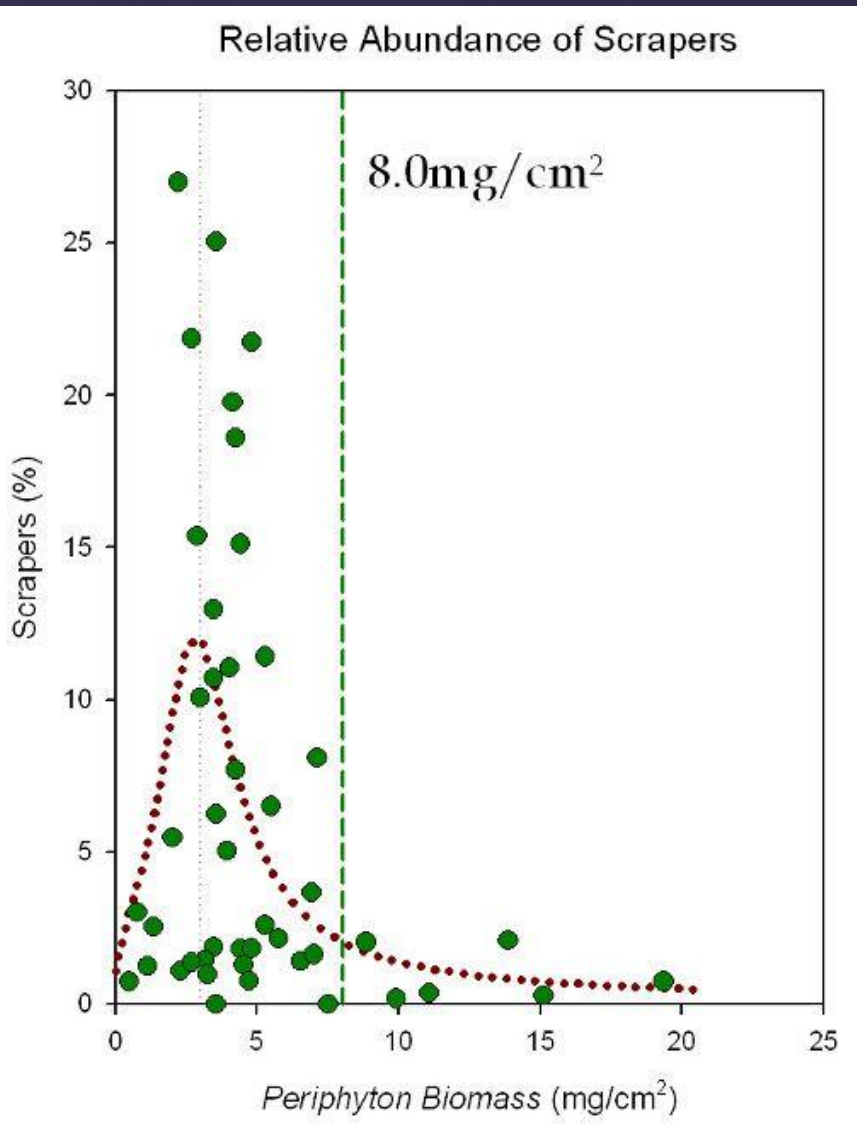
3. Split the sample into coarse and fine fractions, process them separately, electronically composite them latter. This effectively splits the sample into two separate samples.

4. Process a fixed percentage of all samples, rather than a "fixed-count" subsample.
5. Process entire samples.

Didymosphenia geminata


D. geminata Cover (%)
90
80
70
60
50
40
30
20
10
0
NF90
NF80
NF04
NF70
NF60
NF17
NF50
NF40
NF30
NF19
SITE


Relative Abundance of Shredders
8.0mg/cm2
Shredders (%)
0
5
10
15
20
25
30
35
Periphyton Biomass (mg/cm2)


Relative Abundance of Scrapers
8.0mg/cm2
Scrapers (%)
0
5
10
15
20
25
30
Periphyton Biomass (mg/cm2)

Summary:

So far the effects of development were relatively minor and spatially localized.

There are some improvements to the design that need to be implemented so that the monitoring program can answer the questions posed in PAWG meetings in the past.

Cost and benefits

The proposed fix for density measures increases lab budget by ~2x, AND analysis / reporting by about 10%.

The proposed fix for didymo and periphyton in general ads some field work, some lab work and some analysis work. probably about 10% overall.


Brett Marshall 2013. River Continuum Concepts
Doroneuria sp.,+ Megarcys sp.