Perennial Stream, Intermittent Habitat: Impact of Urban BMPs on Fish

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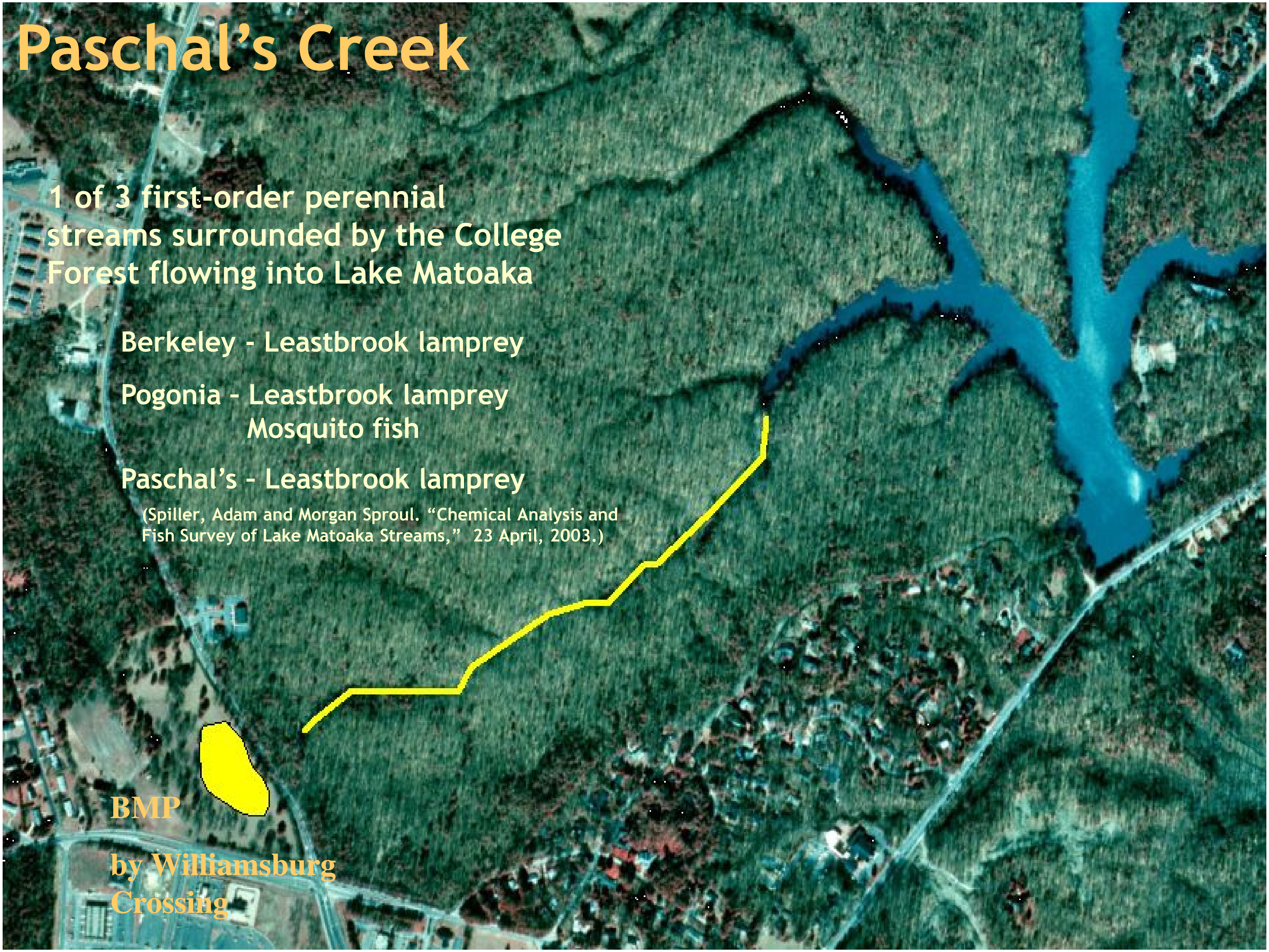
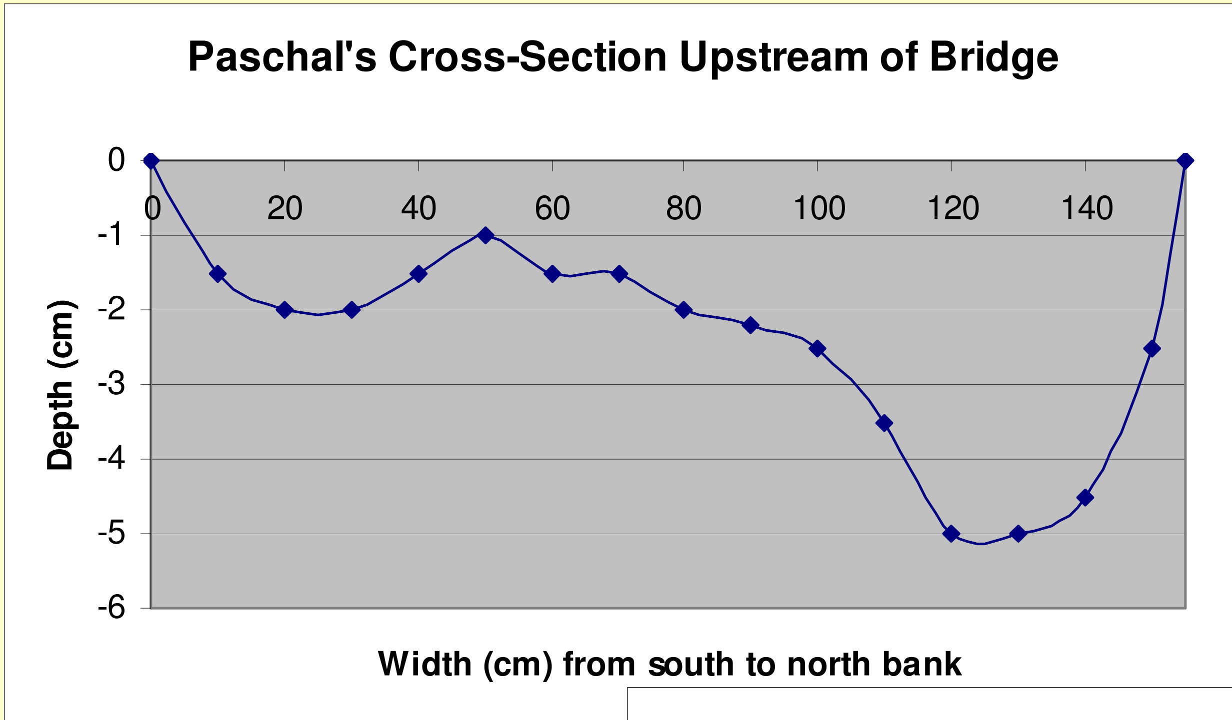

Paschal's Creek
1 of 3 first-order perennial streams surrounded by the College Forest flowing into Lake Matoaka
Berkeley - Leastbrook lamprey
Pogonia - Leastbrook lamprey
Mosquito fish
Paschal's – Leastbrook lamprey
(Spiller, Adam and Morgan Sproul. "Chemical Analysis and Fish Survey of Lake Matoaka Streams," 23 April, 2003.)
BMP
by Williamsburg Crossing

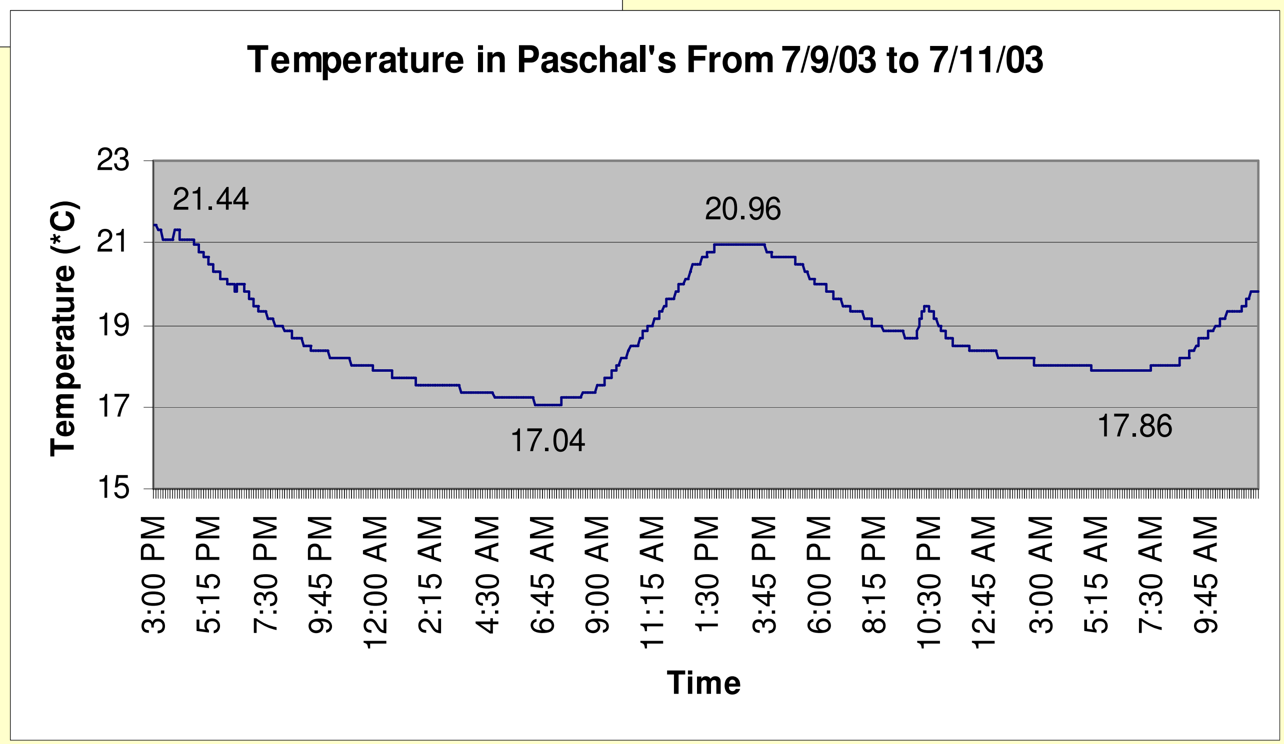


Average depth = 2.2 cm

Channel width < 2 m

Temperature Range

$17^0 - 22^0$ Celsius



SOME AVERAGES …

Surface current velocity = 0.06 m/s

Conductivity = 271 mS

Dissolved oxygen = 8.8 ppm

Sandy and unstable substrate

Historically few fish

Primarily fed by groundwater

BMP located at the headwaters of Paschal's connects runoff from Williamsburg Crossing (geologically outside Matoaka's watershed)

What correlations exist between physical characteristics of habitats and the presence or absence of fish?

HYPOTHESIS

Low depth is a limiting factor for
fish populations in Paschal's

Habitats with sufficient cover - litter, debris, undercut banks, logs - are preferred

THEREFORE, creating pools with adequate depth and cover will result in fish in these habitats.

METHODS

Survey for fish and habitats to collect baseline data.

- Dipnet to collect fish at each pool
- Identified the fish, and measured total length and weight of each fish
- Recorded maximum depth of each habitat, distance from the previous habitat, and observations about the habitat formation type

	June 12, 2003		June 24, 2003	
Site	Number of Fish	Max Depth (cm)	Number of Fish	Max Depth (cm)
1	1 Rosyside dace	12.5	4 Rosyside dace	17
2	1 Rosyside dace	11	0	-
3	1 Creek chub	11.5	0	-
4	1 Rosyside dace	10	0	-
5	0	-	5 Rosyside dace	21.5

Create new habitats that are at least 10 cm deep and sample for fish again.

1st attempt

2nd attempt

Six 24-in. cement edgers
4.7 L buckets with maximum depth of 17.5cm

Heavy storm with 3 inches of rain on Friday night, July 18, 2003, resulted in dramatic changes in the streambed.

Edger #1 on June 30, 2003

Edger #1 on July 22, 2003


Site 1
Previous Max Depth = 12.5 cm
New Max Depth = 72 cm
Width = 2.84 m
Length = 5.4 m

None of my artificial habitats survived

… but plenty of pools to sample, so onward!

Methodology

• set up large, mesh seine with floats and weights just below the habitat to collect fish darting out of the habitat and down the stream

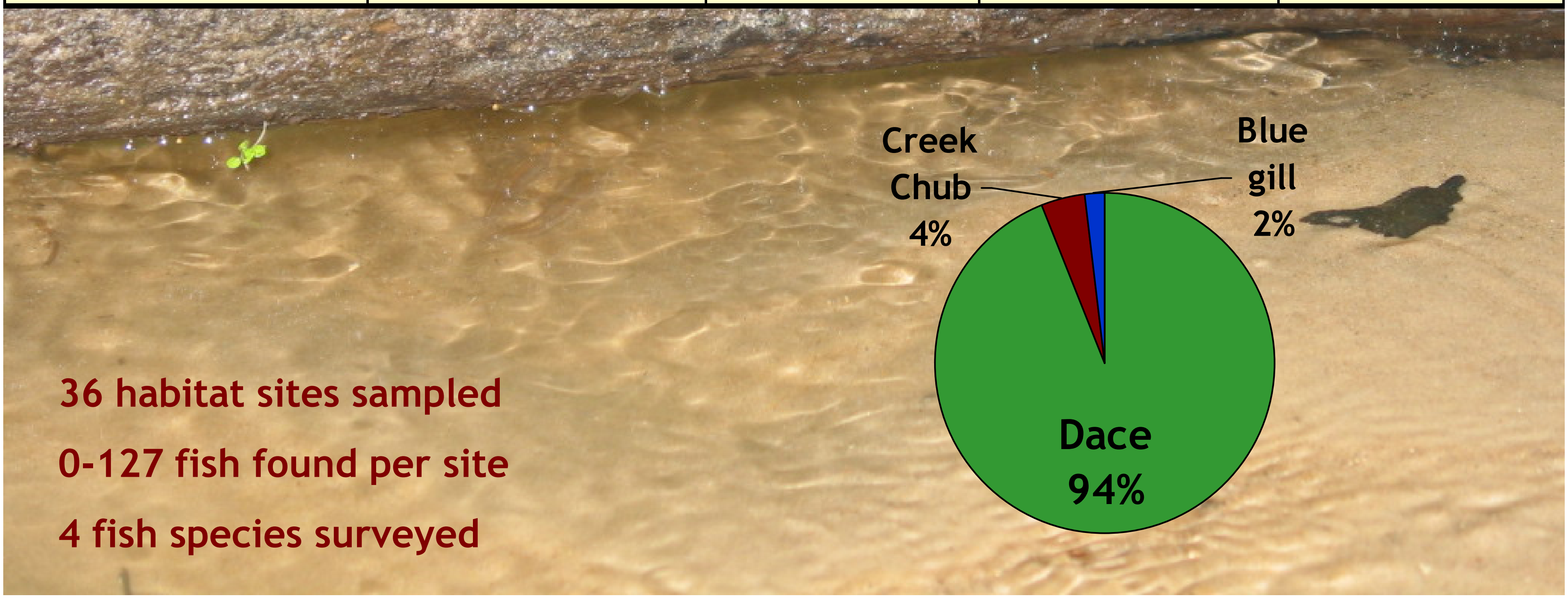
• used a fine seine with two wooden pole handles to collect fish in larger pools and a large dipnet to sample smaller pools and areas

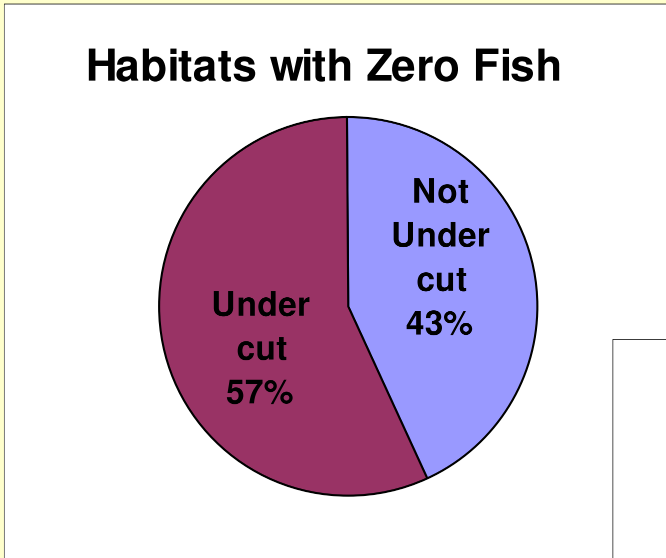
• sampled until zero fish were collected in two consecutive sweeps

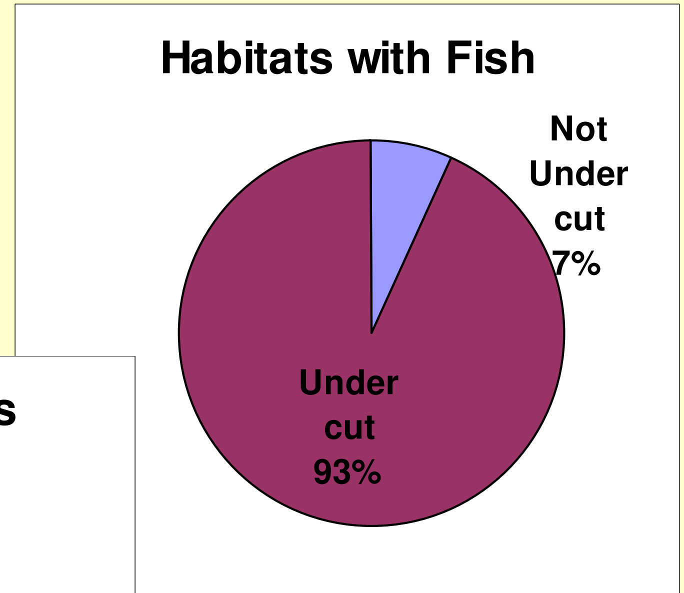
- Identified species
- Recorded total length

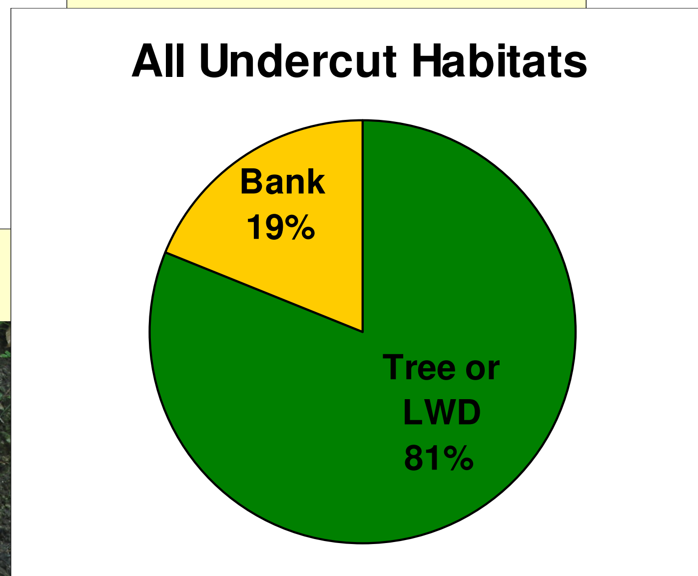
- Habitat length and width
- Channel width
- Maximum and average depth
- Distance from previous habitat
- Habitat shape – presence/absence of an undercut cover provided by bank, tree, or log
- Percent litter/debris
- Presence/absence of amphipods and/or salamander larvae and noted any other fauna in the habitats

Species Name	Common Name	Number of Fish	Median Length (mm)	Average Length (mm)
Clinostomus funduloides	Rosyside dace	503	42	41.6
Semolitus atromaculatus	Creek chub	19	63	54.5
Lepomis macrochirus	Bluegill	10	51	48.6
Gambusia holbrooki	Mosquito fish	1	38	38
Total Number of Fish		**533**		




Habitats with Zero Fish
Not Under cut 43%
Under cut 57%


Habitats with Fish
Not Under cut 7%
Under cut 93%


All Undercut Habitats
Bank 19%
Tree or LWD 81%


Undercut bank

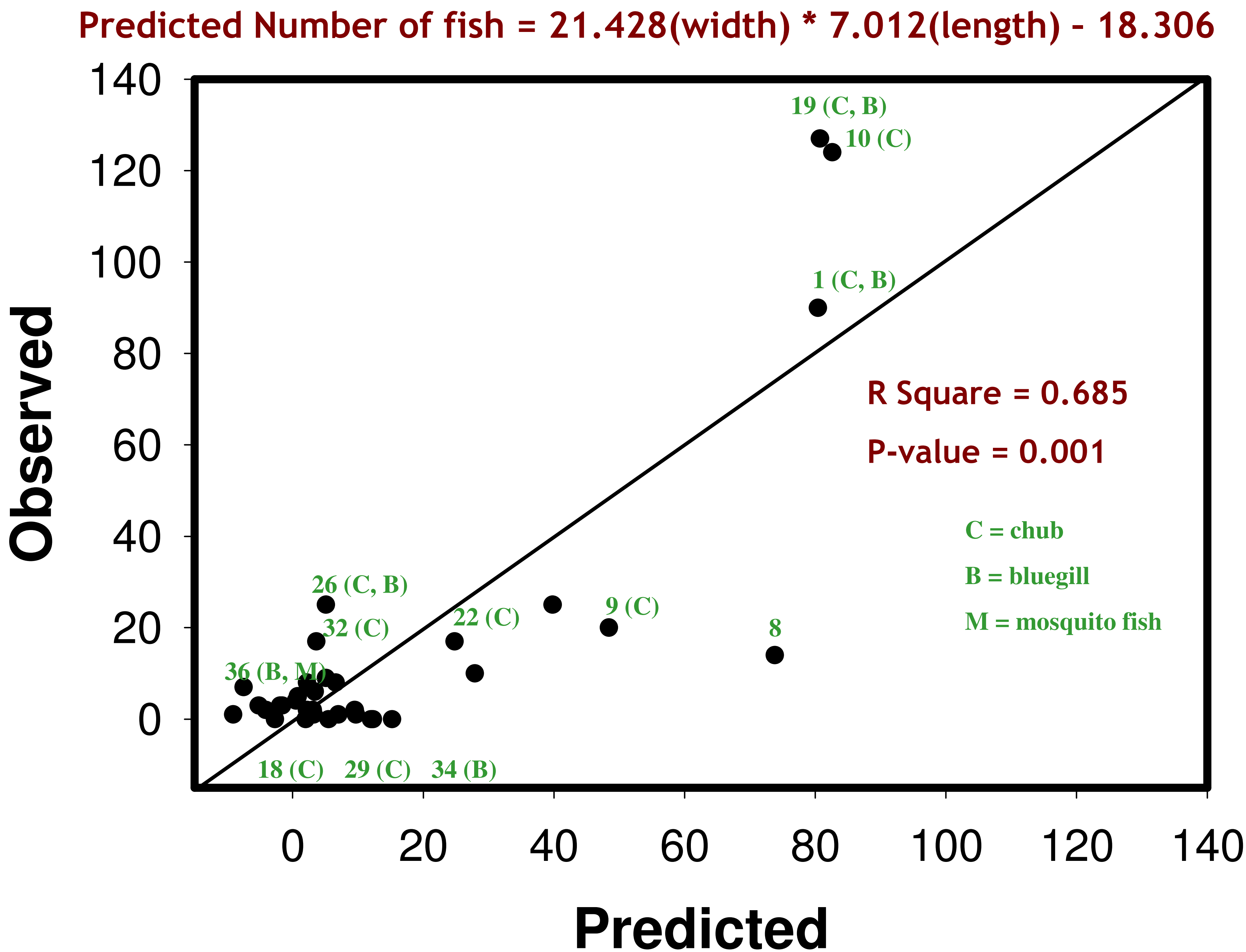

Log/tree form undercut area

R-Square and P-values for simple linear regressions of each independent variable against the number of fish.

Independent Variables	R-Square	P-value
Length[1]	0.468	<0.001
Width[1]	0.553	<0.001
Maximum Depth	0.358	<0.001
Average Depth	0.114	0.051
% Litter/Debris	0.001	0.865
Volume[2]	0.440	<0.001

[1]Site 3 (outlier) eliminated for regression analysis

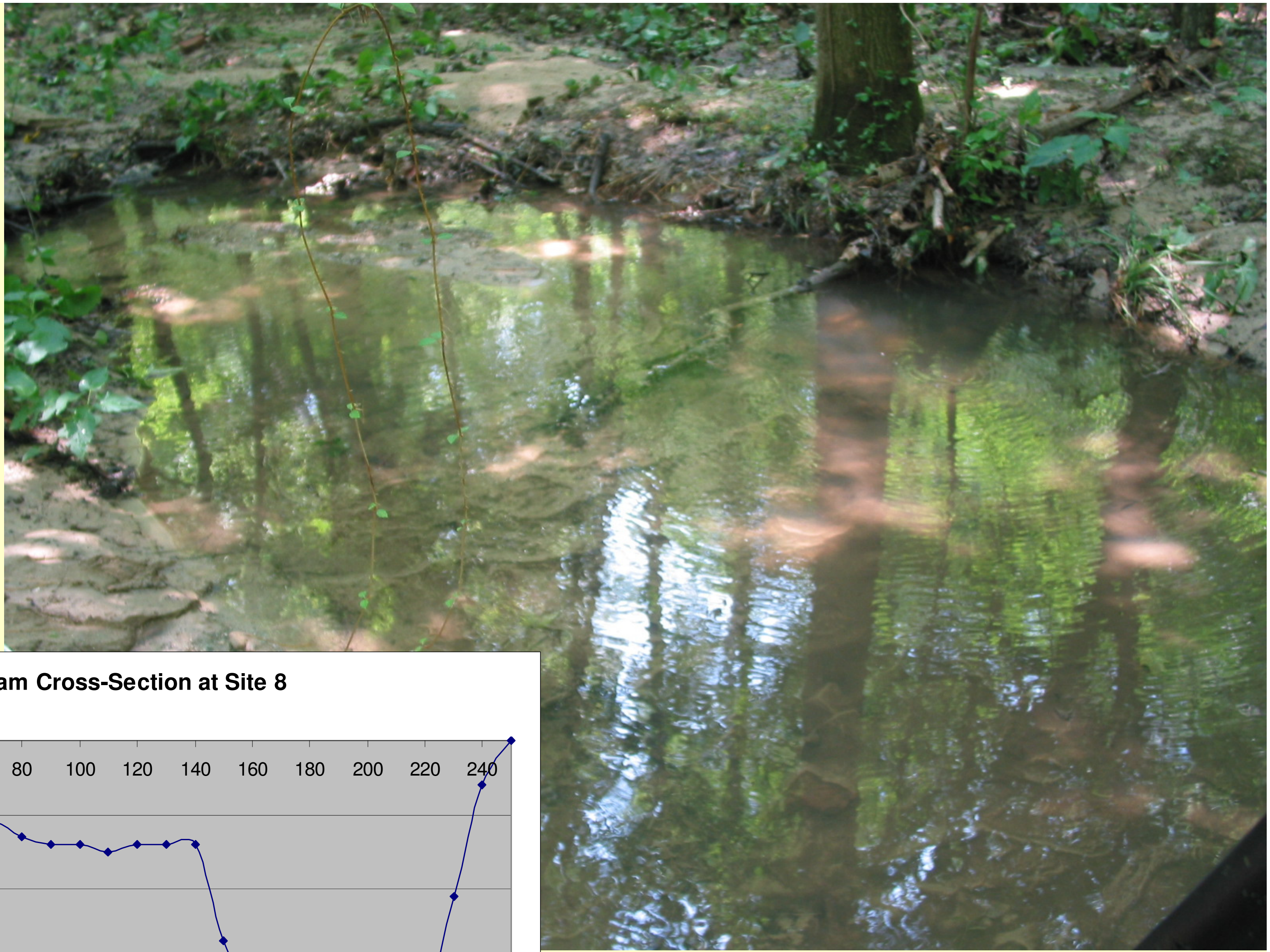
[2]Volume
= [length*width/4*pi] * average depth

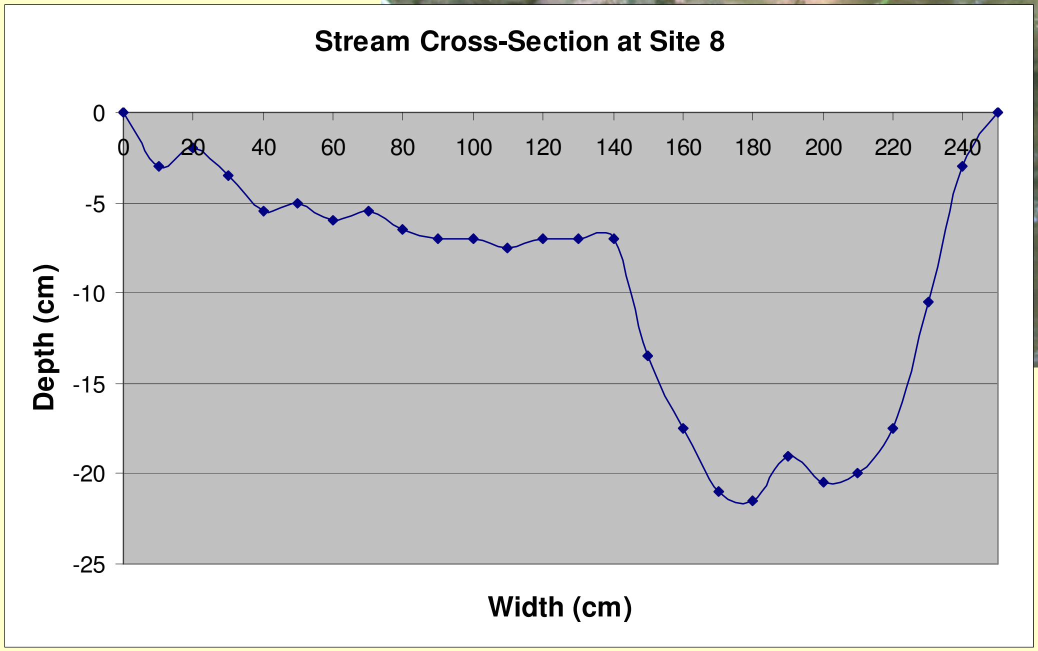

Predicted Number of fish = 21.428(width) * 7.012(length) - 18.306
140
120
100
80
60
40
20
0
Observed
19 (C, B)
10 (C)
1 (C, B)
R Square = 0.685
P-value = 0.001
C = chub
B = bluegill
M = mosquito fish
26 (C, B)
32 (C)
22 (C)
9 (C)
8
36 (B, M)
18 (C)
29 (C)
34 (B)
0
20
40
60
80
100
120
140
Predicted

Site 8

Width = 2.4 m

Length = 5.8 m





To summarize …

Length and width together account for 68.5% of the variation.

Maximum or average depth and % litter are not as useful in predicting number of fish.

Volume may still be a significant and useful predictor for number of fish but the calculation needs to be improved.

The presence of undercut banks, primarily provided by large, woody debris, is also significant for fish habitats.

More questions than answers ...

- An extraordinary increase in the number of dace in Paschal's was observed the week following the storm.
  - **Where did they come from?**
- Large habitats now disappearing as pools are filling in with sand.
  - **Where will they go?**

Rosyside dace in the BMP!

Rosyside dace in the outfall pool!

And yet more questions
... to be tackled next summer!

Is the dace population in Paschal's sustained by periodic overflow from the BMP? What would happen if dace were introduced into Pogonia or Berkely North?

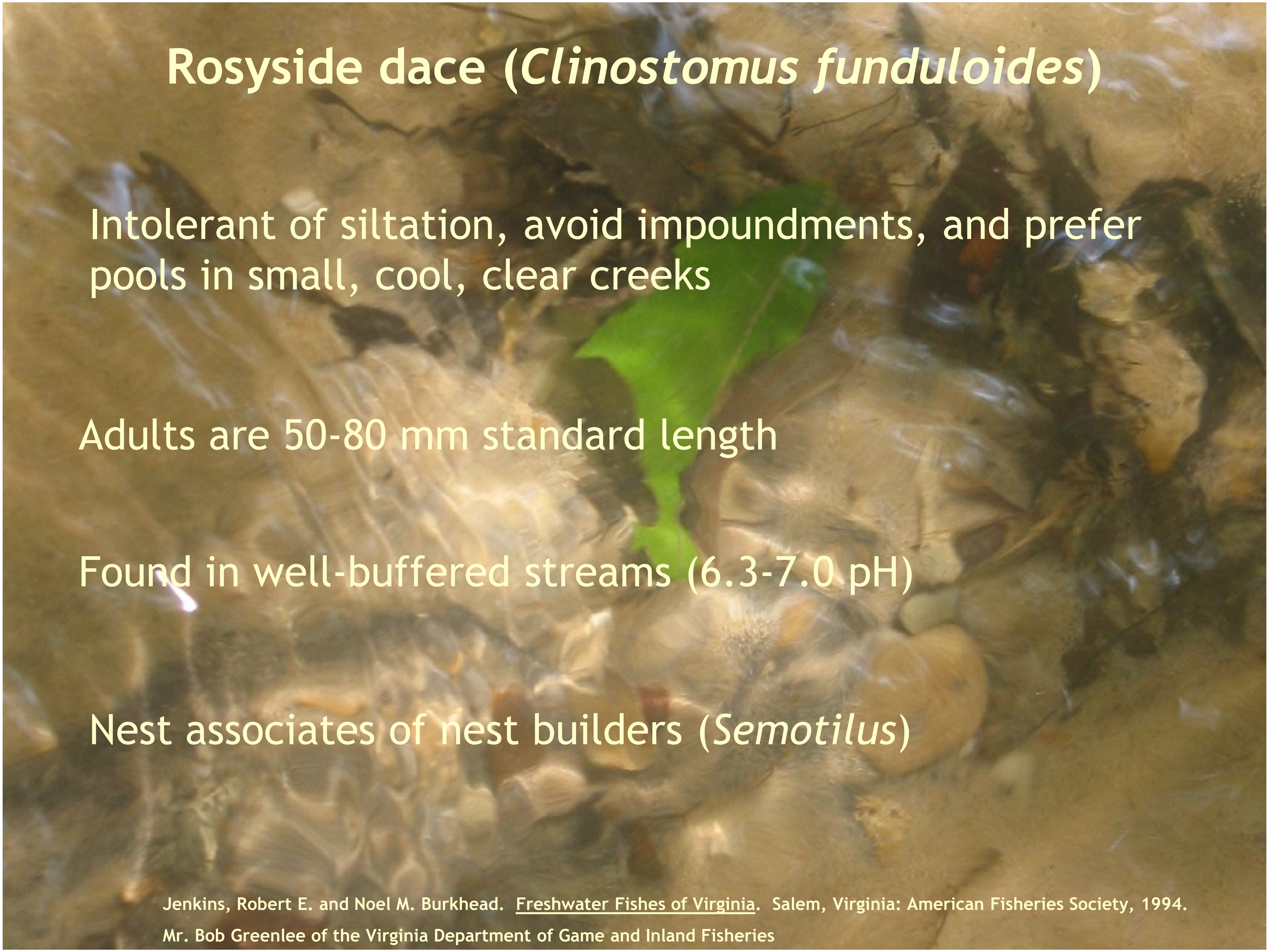
How do fish utilize the habitats in Paschal's?

- Fish migration along the stream
- Successional study of stream habitats after disturbance events

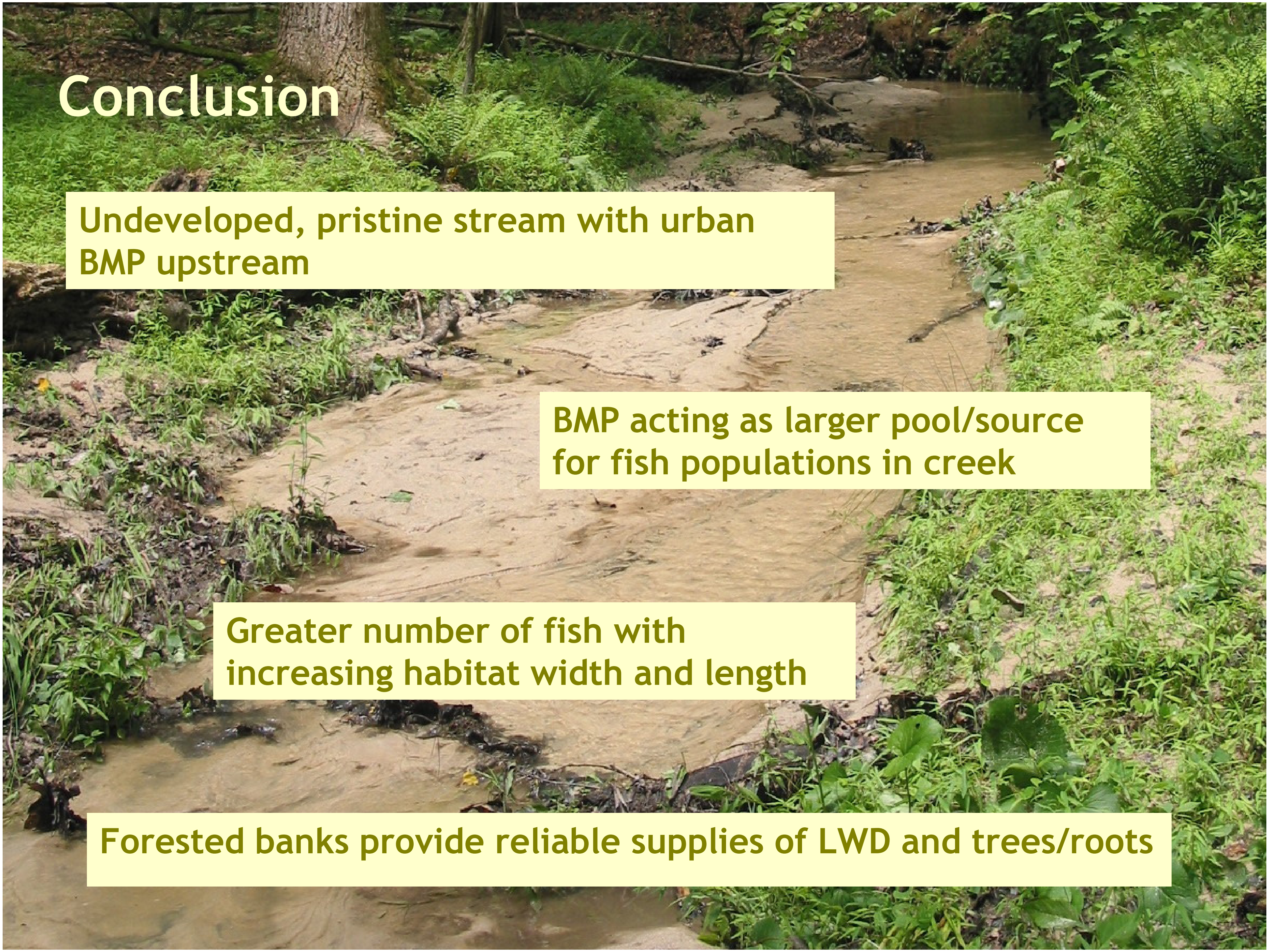
What is the role of creek chubs in Paschal's?

They're not fish but they're still cute ...

- Study with salamander larvae


Rosyside dace (*Clinostomus funduloides*)
Intolerant of siltation, avoid impoundments, and prefer pools in small, cool, clear creeks
Adults are 50-80 mm standard length
Found in well-buffered streams (6.3-7.0 pH)
Nest associates of nest builders (*Semotilus*)
Jenkins, Robert E. and Noel M. Burkhead. Freshwater Fishes of Virginia. Salem, Virginia: American Fisheries Society, 1994.
Mr. Bob Greenlee of the Virginia Department of Game and Inland Fisheries


Rosyside dace
or Golden shiner?


Conclusion
Undeveloped, pristine stream with urban BMP upstream
BMP acting as larger pool/source for fish populations in creek
Greater number of fish with increasing habitat width and length
Forested banks provide reliable supplies of LWD and trees/roots

Frog about to jump into the dipnet

Banded water snake

Itty bitty crayfish looking jealously at creek chub ingesting a worm

Salamander species Randy has never seen before

Big Thank You's to …

Everyone at the Keck Lab …

Tim for your GIS expertise and helping me find random stuff around the lab …

And last but definitely not least, Randy for all your help and always coming to my emotional rescue!