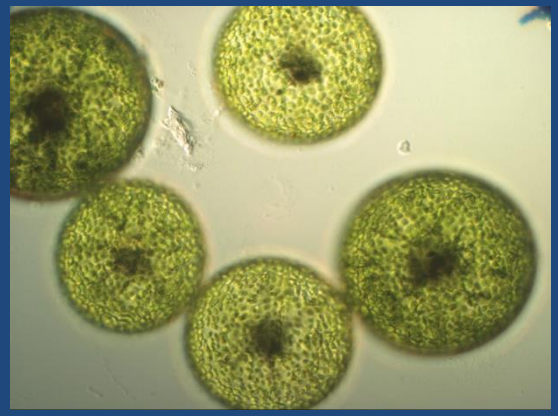
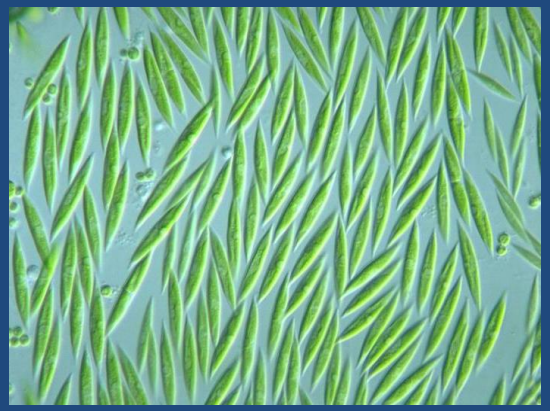
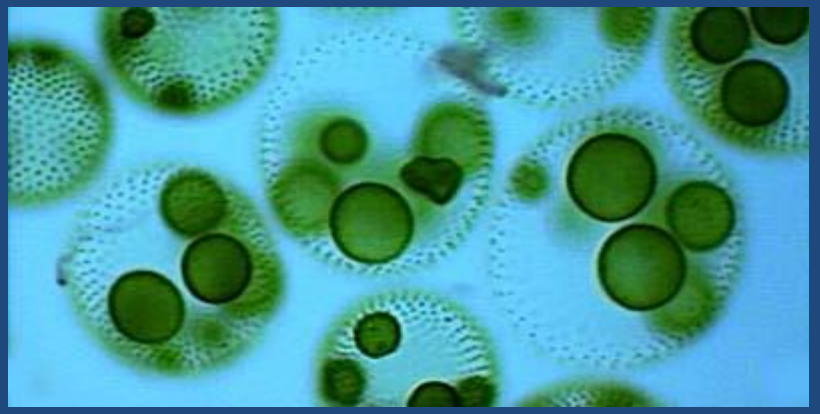




Algae Monitoring 101

Kathryn Christopher[1], David Arscott[2] and Gregory Barren[1]

Presented by: Kathryn Christopher

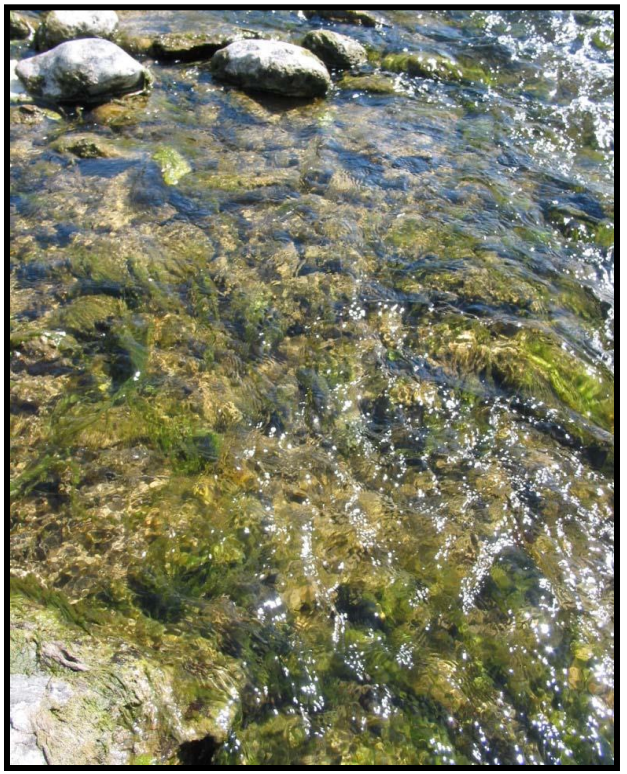
[1]The Academy of Natural Sciences of Drexel University, [2]Stroud Water Research Center


Why Monitor Algae?

- Indicator of nutrient status
  - Effect on dissolved oxygen variability, swings in pH, other impacts list previously/below
- Indicator species may be specific to certain types of pollutants
- Recreational impacts/complaints
  - Excessive growths – slippery, sticky, goopy, ugly…
  - Senescence period – odors, decomposition
- Surveillance for nuisance algae
  - E.g., “rock snot”, “toxic algal blooms” (certain cyanobacteria/blue green algae)
- Influences on benthic macroinvertebrate communities or on fish communities

Algal blooms

- Prolific algal growth can lead to
  - Changed invertebrate composition that may reduce fish production
  - Foul smell and recreational impairment
  - Altered taste in fish meat
  - Toxic algal blooms



Photos: D. Arscott, Stroud Water Research Center

Some monitoring approaches

- Visual assessments
  - Color, turbidity
- Collection for community analyses
  - Microscopy and/or DNA leads to genus/species IDs
  - Development and use of IBIs (next slide)
- Standing stock biomass/biovolume
  - Chlorophyll-*a,* other chlorophylls, ash-free dry mass (organic matter)
- Measuring stream-bed metabolism
  - Integrative measure that includes all biotic compartments contributing to photosynthesis/respiration – mostly algae and bacteria in streams (sometimes mosses and other aquatic plants)

What is an IBI?

- An index of biological integrity (IBI) is a collection of metrics which describe the structure and function of an ecosystem based on its biota.
  - Based on multiple metrics (e.g. # of taxa, abundance of one or several taxa, # of pollution tolerant taxa, etc.)

- Metric values are converted to scores and yield a total IBI score. These scores can be translated into easily-interpreted quality classifications.
  - Sites are "scored" and classified as excellent/good/fair/poor.

- There are different types of indices
  - Multi-metric index (MMI), Water Quality Score (WQS), Benthic Index of Biological Integrity (B-IBI),
  - IBIs are specific to biological community of interest: fish, macroinvertebrates, algae, birds
  - Often, IBIs are developed *regionally* and therefore there is some variability in the number and types of metrics that may compose an IBI

Things to consider before beginning

- What is your reason for monitoring? What are you evaluating?
- What is the best method for your needs and resources?
- Timing
  - Some species and forms of algae are present most of the year, but algae are most prolific from June to August.
  - To assess yearly trends, be consistent in the time of year you monitor.

Understanding Temporal Algal Patterns

- Hydrological control
  - Physical forces of abrasion, sediment mobility mediated by changes in stream discharge (e.g. dams, reservoirs)
- Storm events
  - Sudden high flow rates can also lead to “scouring” after large storm events. Wait 10 days for algae to rebound before monitoring.
- Seasonal blooms
  - Not all blooms have same relationships of growth, decay, dormancy phases with temperature, light, nutrient availability, or control of biomass by grazing invertebrates and/or fish
    - But some general patterns – summer warm, nutrient rich
      - Bloom paradox – Didymo (“Rock snot”) – cool/oligotrophic conditions

Ecology: Stream Algae

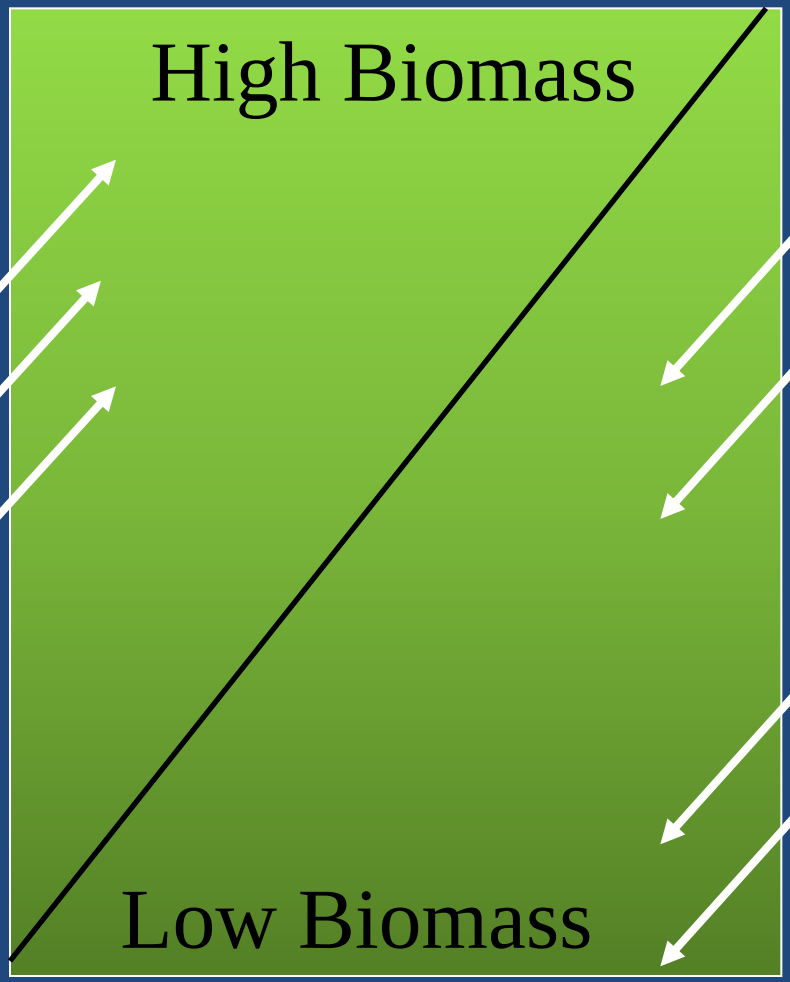
Biomass Gains

Resources

Nutrients

Light

Temperature



Biomass Loss

Disturbance

Scouring/sloughing

Substrate movement

Grazing

Invertebrates

fish

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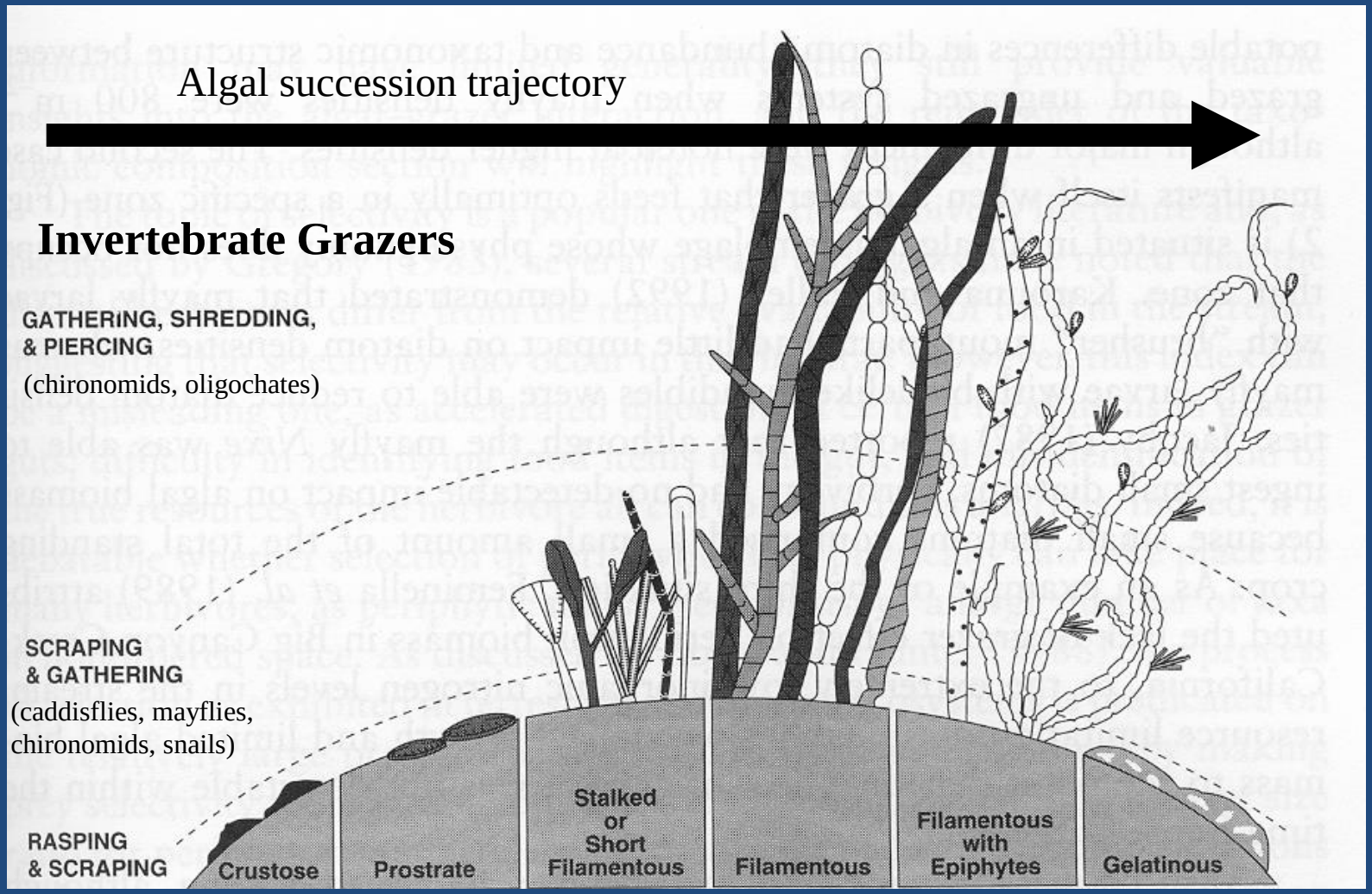
Modified from Biggs 1996

Ecology: Stream Algae

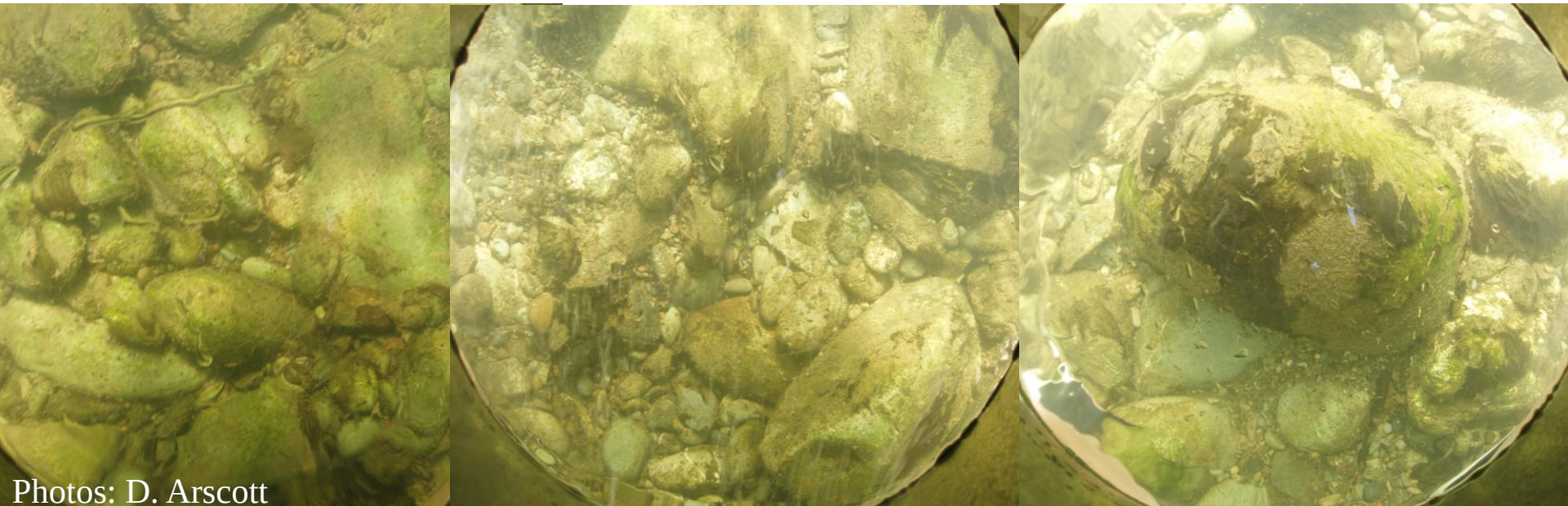
Grazing & Succession



Modified from Steinman (1996)

Example of Visual Observation Monitoring

- Pre-flush – flow/flood release from dam
- Post-flush



Photos: D. Arscott

Visual assessments can be very simple and informative

Point-transect observations

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Example Visual Point-Transect Observation Field Sheet

Periphyton (on exposed surfaces)			**Stone number:**									
		Peri.	**Transect 1** (if applicable)					**Transect 2** (if applicable)				
		score	1	2	3	4	5	6	7	8	9	10
Thin mat/film:	green	7										
(under 0.5 mm thick)	light brown	10										
	black/dark brown	10										
Medium mat:	green	5										
(0.5-3 mm thick)	light brown	7										
	black/dark brown	9										
Thick mat:	green/ light brown	4										
(over 3 mm thick)	black/dark brown	7										
Filaments, short	green	5										
(under 2 cm long)	brown/reddish	5										
Filaments, long	green	1										
(over 2 cm long)	brown/reddish	4										

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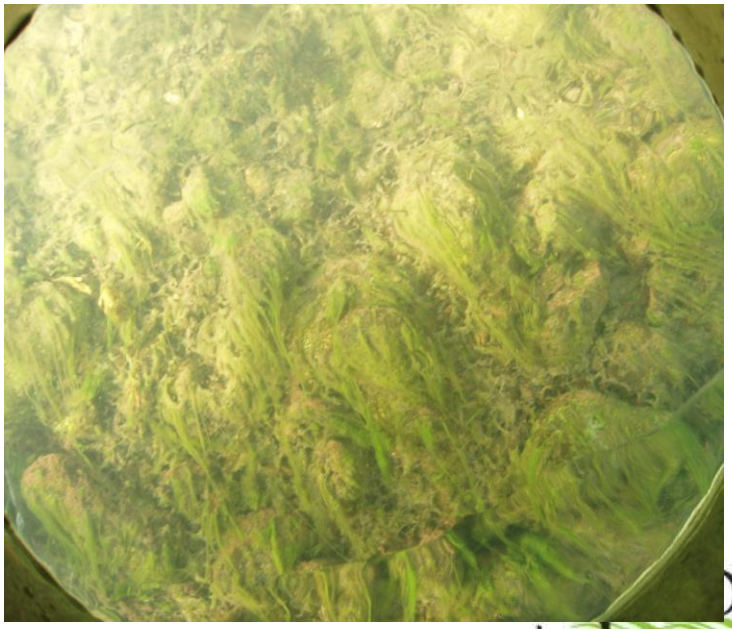
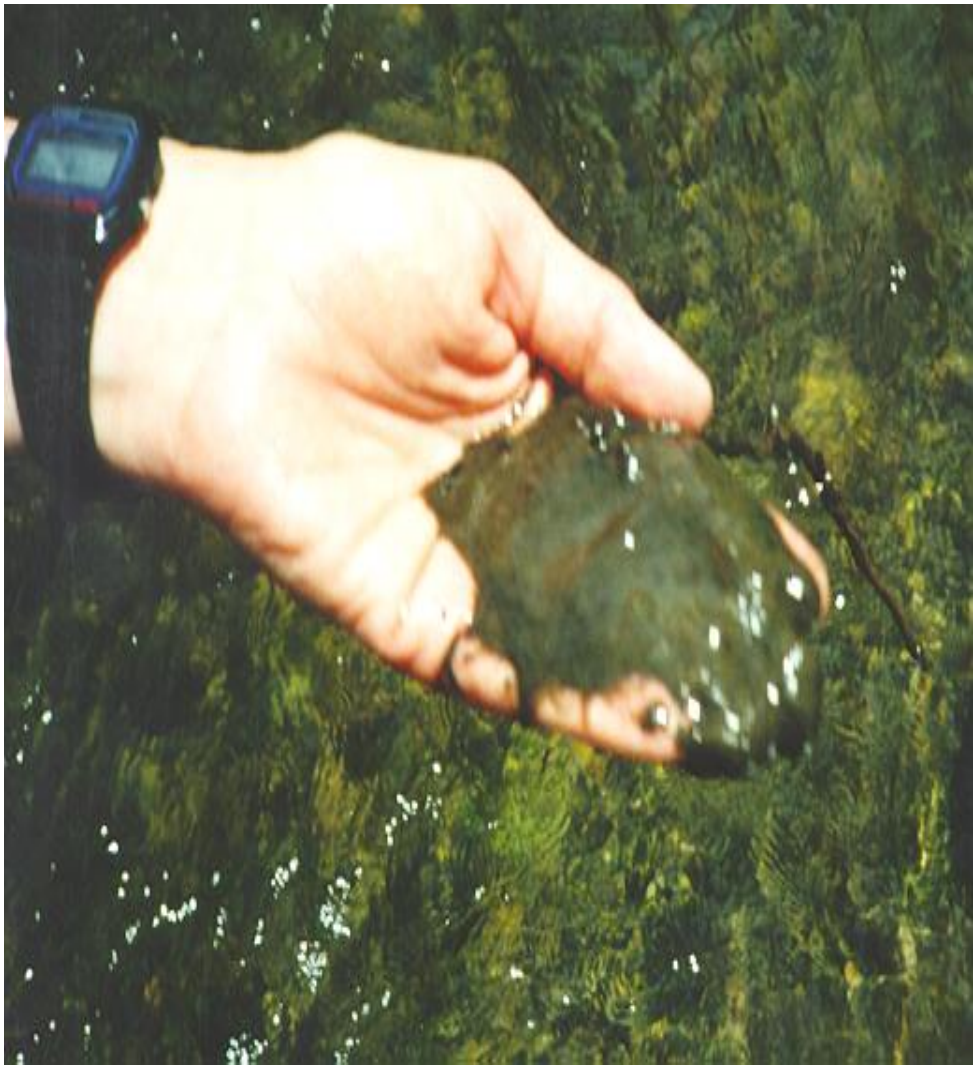
Example Nuisance Algae Monitoring

- Reduced flow variability implicated as cause of periphyton blooms downstream from the Opuha Dam (New Zealand)
  - *Phormidium* and filamentous greens



Photos: D. Arscott

Myriophyllum/algae slury & silt on bed of Moawhango River downstream of dam



Photos: D. Kelly

Visual Assessment Sheet

Completed by: _____

Delaware River Watershed Initiative 2016

Reviewed by: _____

Algae Rapid Assessment Report

Site ID: _____ Date: _____ Time: _____

Overall coverage:

% of substrates covered with algae ..... ☐

% of substrates covered with moss..... ☐

Circle one: **Very heavy (>2cm)** **Heavy (5mm-2cm)** **Average (1-5mm)** **Light (0.5-1mm)** **Slimy (slight visual)** **Barren (none)**

Algae composition:

% Filamentous algae (green or reddish) ..... ☐ Max. length (cm): ☐

% Diatoms (films, stalks, filamentous) ..... ☐

- Stalked diatom forms (e.g. Didymosphenia / Gomphonema) present? (circle one): **YES** **NO**
- Filamentous diatoms (browns strands flowing in water) present? (circle one): **YES** **NO**

% Blue-Green / Green Algae (films, non-filamentous) ..... ☐

From Biggs, Kilroy et al. 2002

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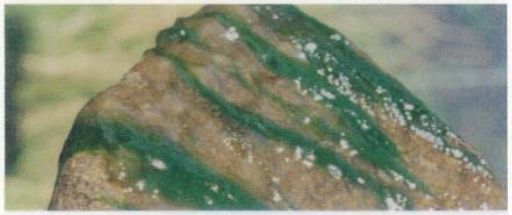
Short filaments (less than about 2 cm long)

Green



Brown/reddish

Long filaments (more than about 2 cm long)

Green

Brown/reddish

From Biggs, Kilroy et al. 2002

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Monitoring

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Quantifying Periphyton Chlorophyll *a* standing stocks

Photos: D. Arscott

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Photos: D. Arscott

Photos: D. Arscott

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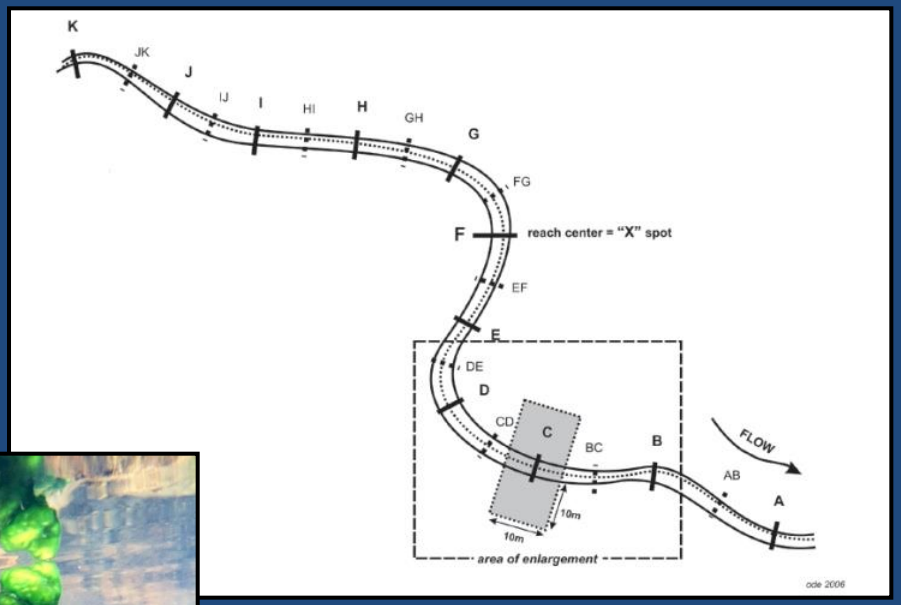
Algal **Community Sampling** and Analysis

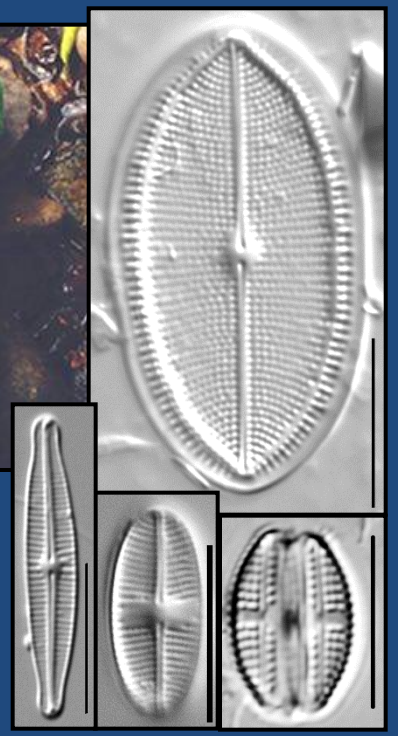
- Field collection of material
- Microscopy identification
- Interpretation

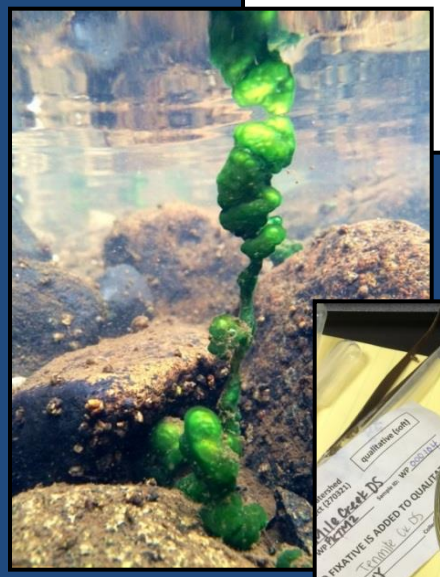
ANS Algae Monitoring

SWAMP
Surface Water Ambient Monitoring Program

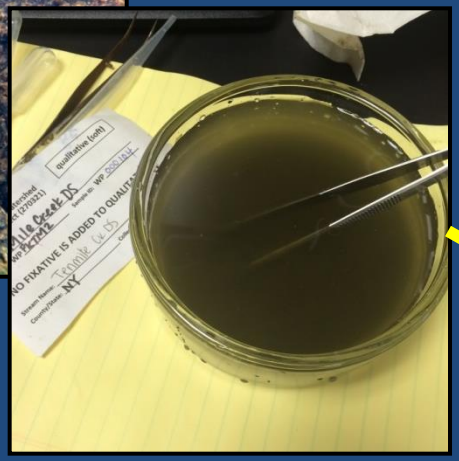


Quantitative samples





Qualitiative samples



Algal community data

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Site ID: _____ Completed by (initials): _____

Site name: _____ Date: _____ Reviewed by (initials): _____

Record substrate size class and flow type for each algae sample collected at each transect. Circle where sample was collected (Left Ctr, Ctr, Right Ctr)

Algae Samples and substrate

A	LEFT	1m LEFT	LEFT CTR	CENTER	RIGHT CTR	1m RIGHT	RIGHT
Dist LB (m)							
Depth (m)							
Size class							
Embed (%)							
Flow type							
B	LEFT	1m LEFT	LEFT CTR	CENTER	RIGHT CTR	1m RIGHT	RIGHT
Dist LB (m)							
Depth (m)							
Size class							
Embed (%)							
Flow type							
C	LEFT	1m LEFT	LEFT CTR	CENTER	RIGHT CTR	1m RIGHT	RIGHT
Dist LB (m)							
Depth (m)							
Size class							
Embed (%)							
Flow type							
D	LEFT	1m LEFT	LEFT CTR	CENTER	RIGHT CTR	1m RIGHT	RIGHT
Dist LB (m)							
Depth (m)							
Size class							
Embed (%)							
Flow type							
E	LEFT	1m LEFT	LEFT CTR	CENTER	RIGHT CTR	1m RIGHT	RIGHT

Size classes:

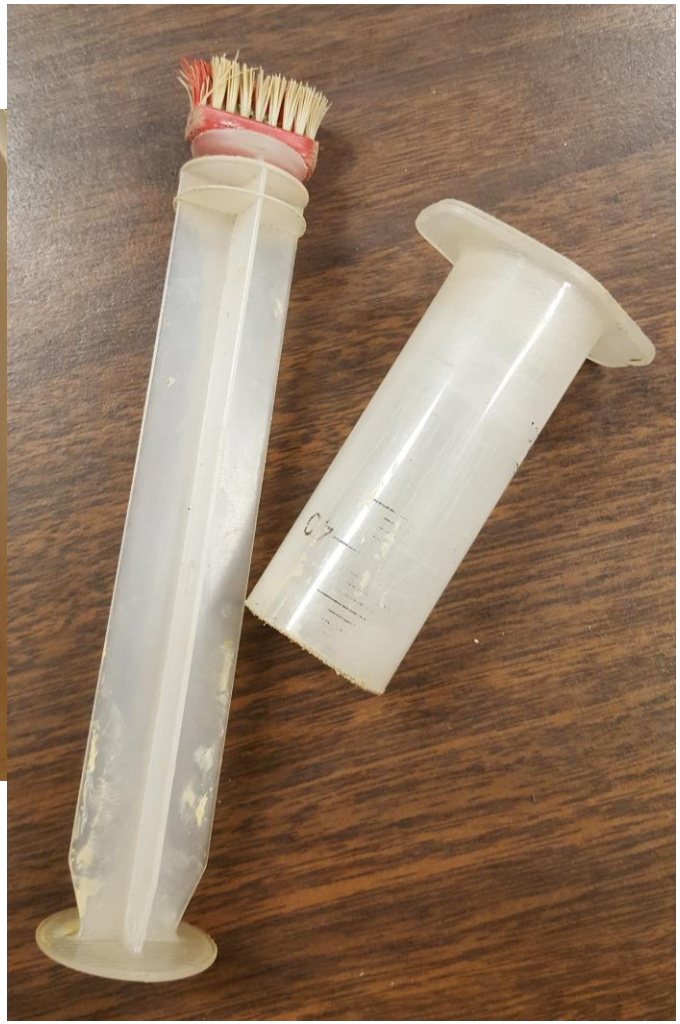
RS: smooth bedrock (>car)
RR: rough bedrock (>car)
RC: concrete / asphalt
XB: large boulder (1 - 4m)
SB: small boulder (250mm – 1m)
CB: cobble (tennis ball – basketball)
GC: coarse gravel (marble – tennis ball)
GF: fine gravel (ladybug – marble)
SA: sand (gritty; up to ladybug)
FN: silt / clay / muck (not gritty)
HP: Hardpan (firm, consolidated fine substrate)
WD: wood (any size)
OT: other (write in)

Flow type:

RA: rapid
RI: riffle
GL: glide/run
P: pool

Walking the Transect

Our Tools



The “Scum-Getter”

Composite Sample

Composite Sample

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Chlorophyll-*a* Lab work

https://images-na.ssl-images-amazon.com/images/I/31MobcIzRaL.jpg
http://cdn.deseretnews.com/images/article/contentimage/1721581/1721581.jpg
https://farm6.staticflickr.com/5558/15029799978_ea3e947e26_z_d.jpg
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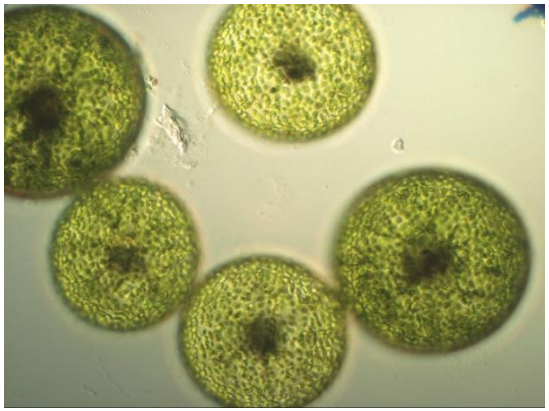
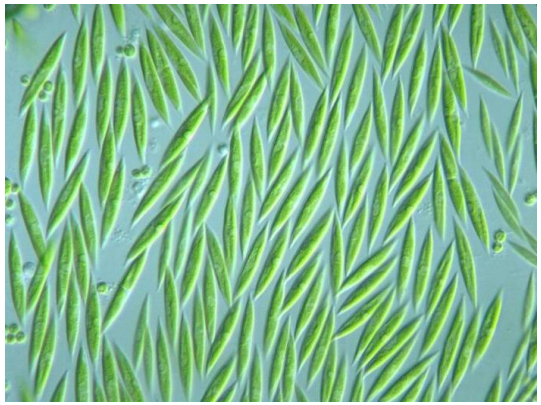
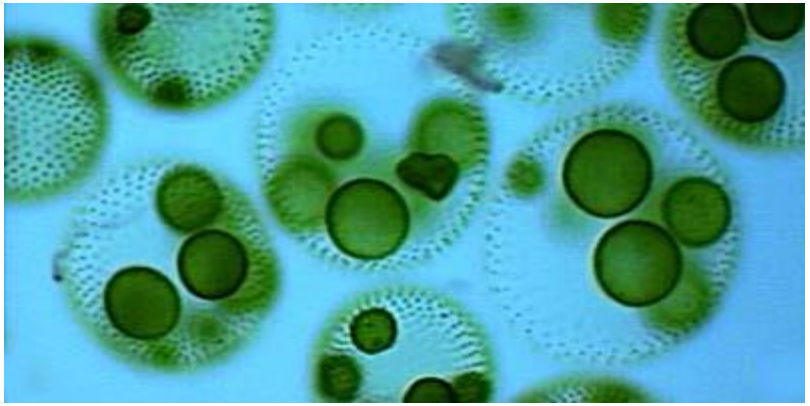
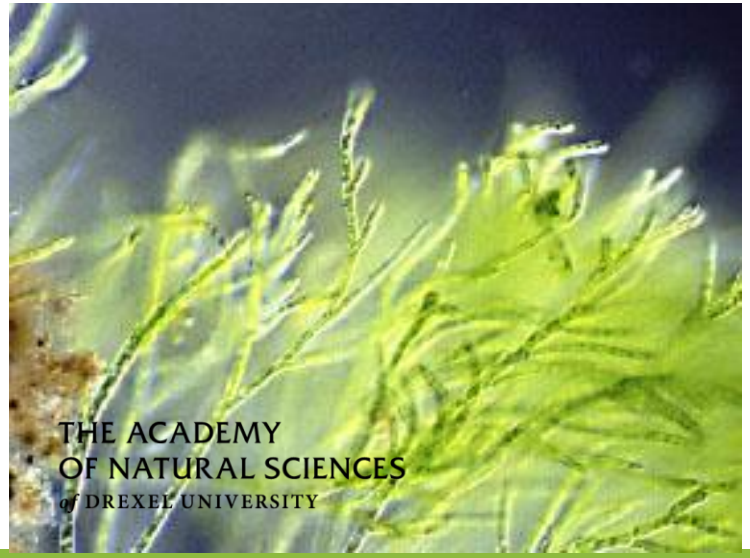
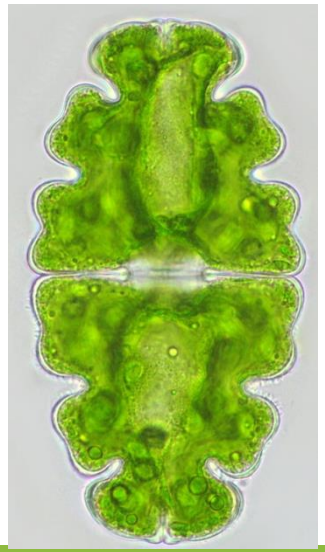




Taxonomic ID of Algae

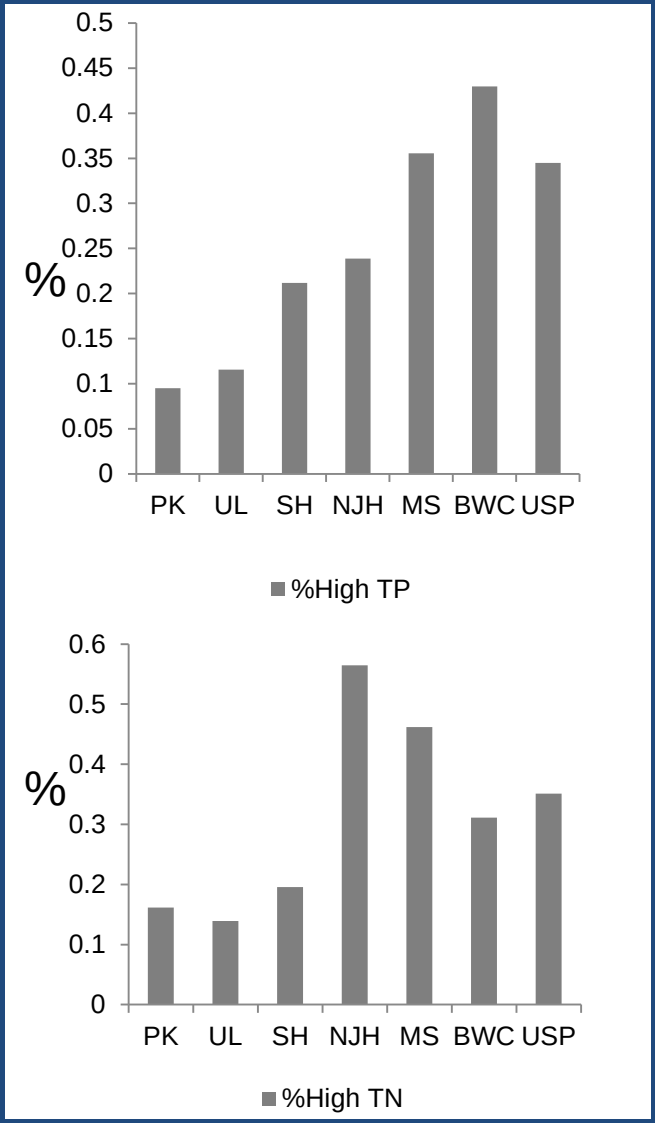
Alison Minerovic & Marina Potapova
The Academy of Natural Sciences of Drexel University






Ecology: DRWI results

Nutrients



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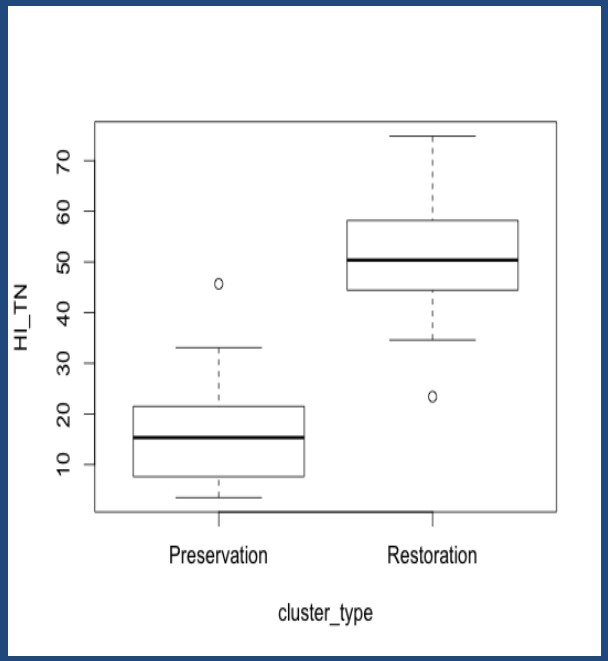
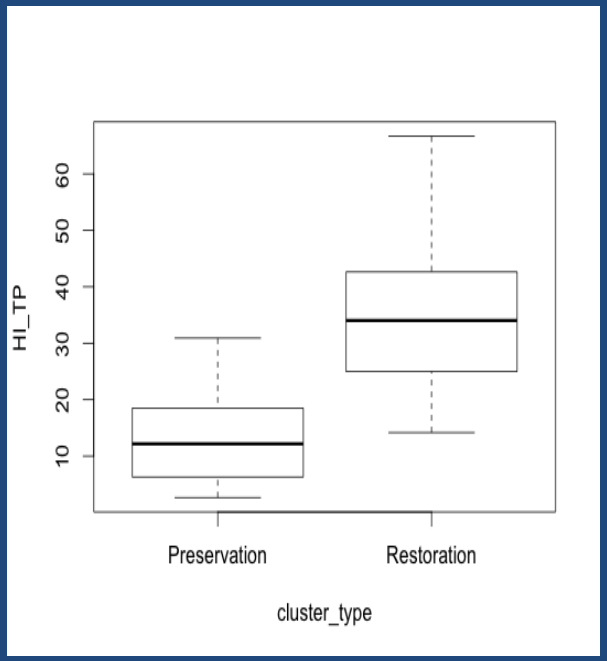
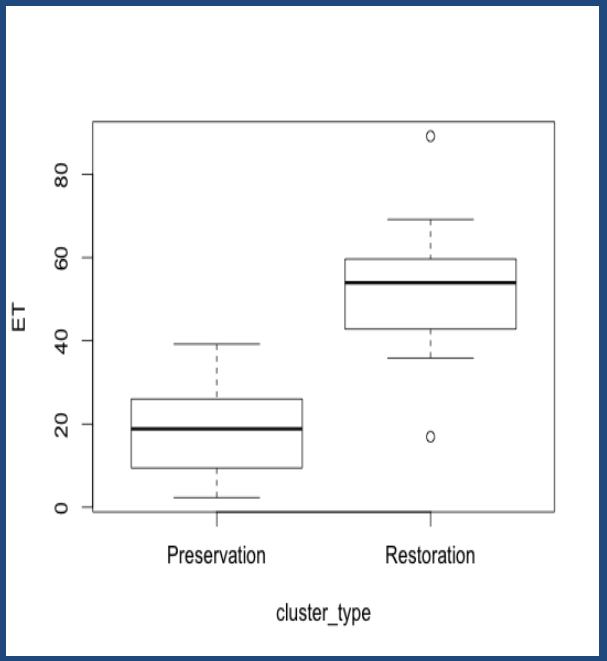
Ecology: DRWI results

Nutrients







Habitat Assessments

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High Gradient Monitoring Sheet (Page 1 of 2)

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regimes	All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (slow is <0.3 m/s, deep is >0.5 m)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity / depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. In stream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

TOTAL HABITAT SCORE FOR THIS PAGE:

Visual Habitat Assessments

Submission ID_____

DRWI - Visual Habitat Assessment

Adapted from the New Jersey Department of Environmental Protection Volunteer Monitoring Program

General Sheet

* **Site Name/ID #:** _____ * **Watershed Management Area:** _____

* **Waterbody Name:** _____ * **County:** _____

* **Segment Identification**

Beginning at Latitude/Longitude: _____

Estimate of Segment Length (aim for 100m): _____

* **Survey Team:** _____

* **Time:** _____ * **Date:** _____

* **Today's Weather:** ☐Clear ☐Partly Cloudy ☐Overcast ☐Light Rain
(Check all that apply) ☐Steady Rain ☐Heavy Rain ☐Snow ☐Heavy Snow Melt

Rainfall:
Days since last rain: _____

Air Temperature: _____ ° C

Water Temperature: _____ ° C

Water Conditions: Circle the term that fits best for each category.

Odor:	Normal Sewage Petroleum Chemical Anaerobic (rotten eggs) Other
Turbidity:	Clear Slightly turbid Turbid
Surface Coating:	None Oily Foam Scum Other
Stream Flow:	Slow Moderate Swift Combination

Stream Characteristics: Circle the term that fits best for each category.

Stream Width:	_____, _____, _____, _____, _____			
Stream Depth:	_____, _____, _____, _____, _____			
Stream Velocity:	_____, _____, _____, _____, _____ (V=D/T)			
Canopy:	Open Mostly Open Partly Open Mostly Closed Closed			
Woody Debris:	Abundant Moderate Rare			
Woody Debris:	Free floating Attached Both			
Predominant Aquatic Vegetation:	Rooted emergent Rooted submergent Rooted floating Free floating No vegetation			
Algae Growth:	Abundant Moderate Rare			
Algae Location:	Filamentous Periphyton None			
Litter Concentration:	Present Absent			
Structures:	Bridges	Culverts	Dams	Other

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Delaware River Watershed Initiative

2015

Completed by: _____

Reviewed by: _____

Channel/Riparian Cross-Section Form – Streams

Site ID: _____

Site Name: _____

Date: _____

Transect (circle one): A B C D E F G H I J K Extra side channel

Canopy cover measurements (all transects)

Densiometer

					Avg.
Left					
Center					
Right					

Bank measurements (all transects)

Wetted width (xxx.x m) _____-_____

Bar width (if present, xx.x m) _____-_____

Bankfull width (xxx.x m) _____-_____

Bank measurements (transects A, F, K)

	Bank angle (0-360°)	Undercut distance (m)
Left		
Right		

Bankfull height (L) _____-_____

Banfull height (R) _____-_____

Incised height (L) _____-_____

Incised height (R) _____-_____

Fish cover/other

Cover in channel

0 = Absent (0%)
1 = Sparse (<10%)
2 = Moderate (10-40%)
3 = Heavy (40-75%)
4 = Very Heavy (>75%)

Filamentous algae	0	1	2	3	4
Macrophytes	0	1	2	3	4
Woody debris >0.3m (BIG)	0	1	2	3	4
Brush/woody debris <0.3m (SMALL)	0	1	2	3	4
Live trees or roots	0	1	2	3	4
Overhanging veg =<1m of surface	0	1	2	3	4
Undercut banks	0	1	2	3	4
Boulders	0	1	2	3	4
Artificial structures	0	1	2	3	4

Visual Riparian Estimates

0 = Absent (0%)	D = Deciduous
1 = Sparse (<10%)	C = Coniferous
2 = Moderate (10-40%)	E = Broadleaf Evergreen
3 = Heavy (40-75%)	M = Mixed
4 = Very Heavy (>75%)	N = None

Riparian vegetation cover	Left Bank					Right Bank				
Canopy (>5m high)										
Vegetation type	D	C	E	M	N	D	C	E	M	N
BIG trees (Trunk >0.3m DBH)	0	1	2	3	4	0	1	2	3	4
SMALL trees (Trunk <0.3 DBH)	0	1	2	3	4	0	1	2	3	4
Understory (0.5 – 5m high)										
Vegetation type	D	C	E	M	N	D	C	E	M	N
Woody shrubs & saplings	0	1	2	3	4	0	1	2	3	4
Non-woody herbs, grasses, forbs	0	1	2	3	4	0	1	2	3	4
Ground cover (<0.5m high)										
Woody shrubs & saplings	0	1	2	3	4	0	1	2	3	4
Non-woody herbs, grasses, forbs	0	1	2	3	4	0	1	2	3	4
Barren, bare dirt or duff	0	1	2	3	4	0	1	2	3	4

Human Influence	0 = not present	P = >10m	C = within 10 m	B = on bank				
	Left Bank				Right Bank			
Wall/dike/revetment/riprap/dam	0	P	C	B	0	P	C	B
Buildings	0	P	C	B	0	P	C	B
Pavement/cleared lot	0	P	C	B	0	P	C	B
Road/railroad	0	P	C	B	0	P	C	B
Pipes (inlet/outlet)	0	P	C	B	0	P	C	B
Landfill/trash	0	P	C	B	0	P	C	B
Park/lawn	0	P	C	B	0	P	C	B
Row crops	0	P	C	B	0	P	C	B
Pasture/range/hay field	0	P	C	B	0	P	C	B
Logging operations	0	P	C	B	0	P	C	B
Mining activity	0	P	C	B	0	P	C	B

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Delaware River Watershed Ini

2015

Completed by: _____

Reviewed by: _____

Site ID: _____

Site Name: _____

B C D E F

H I J K Extra side channel

Canopy cover measurements (all transects)

Densiometer

					Avg.
Left					
Center					
Right					

Absent (0%)	D = Deciduous
Sparse (<10%)	C = Coniferous
Moderate (10-40%)	E = Broadleaf Evergreen
Heavy (40-75%)	M = Mixed
Very Heavy (>75%)	N = None

Bank measurements (all transects)

Wetted width (xxx.x m) _____.____

Bar width (if present, xx.x m) _____.____

Bankfull width (xxx.x m) _____.____

Bank measurements (transects A, F, K)

	Bank angle (0-360°)	Undercut distance (m)
Left		
Right		

Bankfull height (L) _____.____

Banfull height (R) _____.____

Incised height (L) _____.____

Incised height (R) _____.____

	Left Bank				Right Bank			
Canopy (>5m high)								
	E	M	N		D	C	E	M	N
	2	3	4		0	1	2	3	4
	2	3	4		0	1	2	3	4
Understory (0.5 – 5m high)								
	E	M	N		D	C	E	M	N
	2	3	4		0	1	2	3	4
	2	3	4		0	1	2	3	4
Ground cover (<0.5m high)								
Woody shrubs & saplings	0	1	2	3	4	0	1	2	3	4
Non-woody herbs, grasses, forbs	0	1	2	3	4	0	1	2	3	4
Barren, bare dirt or duff	0	1	2	3	4	0	1	2	3	4

Macrophytes	0	1	2	3	4			
Woody debris >0.3m (BIG)	0	1	2	3	4			
Brush/woody debris <0.3m (SMALL)	0	1	2	3	4			
Live trees or roots	0	1	2	3	4			
Overhanging veg =<1m of surface	0	1	2	3	4			
Undercut banks	0	1	2	3	4			
Boulders	0	1	2	3	4			
Artificial structures	0	1	2	3	4			

Human Influence

0 = not present P = >10m C = within 10 m B = on bank

	Left Bank				Right Bank			
Wall/dike/revetment/riprap/dam	0	P	C	B	0	P	C	B
Buildings	0	P	C	B	0	P	C	B
Pavement/cleared lot	0	P	C	B	0	P	C	B
Road/railroad	0	P	C	B	0	P	C	B
Pipes (inlet/outlet)	0	P	C	B	0	P	C	B
Landfill/trash	0	P	C	B	0	P	C	B
Park/lawn	0	P	C	B	0	P	C	B
Row crops	0	P	C	B	0	P	C	B
Pasture/range/hay field	0	P	C	B	0	P	C	B
Logging operations	0	P	C	B	0	P	C	B
Mining activity	0	P	C	B	0	P	C	B

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