Water Quality



Impacts to Water Quality from Land Use or What is Pollution?



Pollution is:

The addition of excessive carbon to a system

- The addition of large amounts of materials to water that causes adverse changes in a system
- Effects upon water bodies caused by human activities
- To make foul or unclean; dirty

Types of Pollution: Point Sources of Water Pollution

- End of Pipe
 Waste water treatment plants
 - Industrial plants
- Landfills



Non-Point Sources of Water Pollution

- Agriculture
 - Fertilizers
 - Herbicides
 - Pesticides
 - Manure
 - Water withdrawals
 - Sedimentation
 - Soil impaction



Sources of Non-Point Water Pollution



- Roads/Bridges
- Parking lots
- Construction
- Storm drains
- Homes
 - Lawns
 - Cleaning supplies
 - Pets
 - Leaking Septic systems
- Golf Courses
 - Water fowl

Possible Effects on Water Quality

- Adds chemicals which may be toxic to aquatic animals and plants
- Adds sediment which smothers animals and plants
- Raises water temperature

- Adds nutrients which cause noxious plant growth
- Reduces available oxygen
- Reduces or changes water flow



Methods for Water Quality Monitoring

Chemical Sampling

- Dissolved Oxygen (DO)
- r pH (acidity)
- Nutrients (Phosphorus & Nitrogen)
- Salinity
- Heavy Metals (Mercury, Copper, etc.)
 VOC's, pesticides, oil, etc.



Chemical Sampling

Advantages

- Relatively easy to collect
- Cost effective for some parameters

- Good statewide program in place through URI Watershed Watch
- Volunteers easily trained to collect samples

Disadvantages

- Only provides a "snap shot" of water quality
- Does not measure everything that could affect habitat quality
- Usually requires laboratory analysis

Physical Parameters



- Temperature
- Suspended solids or
 - turbidity
- Substrate composition
- Stream flow
- Vegetated banks
- Debris for habitat

Physical Parameters

Advantages

- Gives a more holistic view of habitat
- Identifies likely stream populations

Can be used to make initial assessments

Disadvantages

- Requires training
- Relies on subjective measurements
- Does not measure everything that could affect habitat quality
- Does not look at water chemistry

Biological Sampling

- Aquatic plants
- Obligate mammals
- Birds
- **F**ish
- Reptiles and amphibians
- Macroinvertebrates
 - Insects
 - Arachnids
 - Crustaceans
 - Mollusks
 - Worms



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Biological Sampling

- Advantages
 - Animals live in the water a good portion of their lives
 - Species richness and population distributions can indicate current or recent disturbances
 - Macroinvertebrates are easy to collect
- Disadvantages
 - Requires training
 - Family identification can be difficult
 - Data base difficult to maintain

Must have standardized collection and ID methods

Aquatic Benthic Macroinvertebrates As Water Quality Indicators

What Classifies an Insect?



- 1. Three segmented body
- 2. Three pairs of legs
- 3. Two pairs of wings or rudimentary wings

Complete Metamorphism



Incomplete Metamorphism





Aquatic Insect Orders Ephemeroptera (Mayflies) **Odonata** (Dragonflies & Damselflies) **Plecoptera** (Stoneflies) Hemiptera (True Bugs) **Trichoptera** (Caddisflies) Lepidoptera (Moths) **Coleoptera** (Beetles) Megaloptera (Dobsonflies, fishflies, alderflies) **Diptera** (True flies)

Tolerance Values

11-

How much pollution can you stand?

Intolerant to:

- Low levels of DO
- High Water Temperature

- High Amounts of Sediment in Water
- Nutrient Enrichment
- Toxic chemicals and heavy metals

Tolerance Values

On a scale of 0-10

0 = no tolerance 10 = very tolerant to pollution and low DO

General Tolerance Ranges for Orders of Macroinvertebrates

- February Ephemeroptera (Mayflies) 0-7
- Plecoptera (Stoneflies) 0-4
- Trichoptera (Caddisflies) 0-8
- Odonota (Dragonflies) 1-3 (Damselflies) 5-9
- Megaloptera (Dobsonflies) 0-4
- Diptera (True Flies) 2-10
- Coleoptera (Beetles) 2-5
- Crustacea (Crayfish, Scuds, Sowbougs) 4-7
- Mollusca (Snails, Clams) 6-8
- Igochaeta, Hirudinea (Worms, Leeches) 8-10

Habitat Requirements for Low Tolerance Organisms

- **r** Riffles
- Mostly low order streams

- Clear, cold water
- High oxygen content
- Well shaded
- Cow nutrients
- Relatively undisturbed



16-

Macroinvertebrates

Quick Review

- Kingdom (Animalia)
 - -Phylum (Arthropoda)
 - -Class (Insecta)
 - -Order (Plecoptera)
 - -Family (Perlidae)



- Genus (Paragnetina)
- species (media)

Infra-Class: <u>Paleoptera</u> (old winged) ex: Ephemeroptera & Odonata Infra-Class: <u>Neoptera</u> (new winged) ex: All other Aquatics

For Comparison

- Kingdom (Animalia)
 Phyllum (Chordata)
 Class (Mammalia)
 Order (Carnivora)
 Family (Canidae)
 - Genus (Canis)
 - * Species (familiaris)
 - + Variety (Golden Retriever)



Ephemeroptera (Mayflies)



Ephemeroptera

Identification

- 3 caudal filaments
- combination of gills
- one tarsal claw
- developing wing pads





Ephemeroptera (Mayflies)

 675 Species in 20 Families, Evolved 280-300 mya (carboniferous)

Two adult stages, Most are univoltine

- Gills on abdominal segments (usually)1-7
- 3 (sometimes 2) long caudal filaments

Primarily grazers and collector-gatherers (algae or detritus), most are herbivores or detritivores,

 Majority in cool, clean headwater streams (some species prefer lentic (pond) environments)

- Tolerance value for species ranges from 0-7
- Greatest diversity found in 2nd and 3rd order streams

Most require a high DO content (some can withstand fairly low conditions)

Ephemeroptera



Heptageniidae





Gills start on abdominal segment 1



Ameletidae



Baetidae



Plecoptera (Stoneflies)


Plecoptera

General Info.

- Clean, Cold, fast moving, highly oxygenated streams
- Reach greatest diversity in North America
 - HBI for species 0-4
- Crawlers





Plecoptera (Stoneflies)

614 species are know from North America

- Often the top predators in the invertebrate food chain
- They are important in biological monitoring
- Distinguishing characteristics: two long cerci, relatively long antenna
- Compound eyes, two or three ocelli, chewing mouthparts, two pairs of thoracic
- Wing-pads, and three segmented tarsi with two claws on each tarsus



Nemouridae



Perlidae





Trichoptera (Caddisflies- Netspinners/Casemakers)

Trichoptera

General Info.

- Greatest diversity in cool lotic systems
 - HBI for species 0 8
- C-F, C-G, SCR, SHR, PRD







University of Illinois Department of Entomology

Trichoptera (Caddisflies) (1400 Species)

Netspinners larvae use silk from their labial glands to construct retreats and nets, to filter or gather food such as algae, detritus,

Netspinners or freeliving are mostly predators- on other arthropods

Casemakers larvae construct portable cases that are barrel-shaped, purse like, or saddle-shaped

Casemakers are mostly herbivores that feed on periphyton

All larvae pupate in completely closed cocoon

Have simple eyes, chewing mouthparts, very short antennae, 3 pairs of thoracic legs, single tarsal claw, and fleshy prolegs on the last abdominal segment

Many larvae have single or branched gills on the abdominal segments, respiration is through the integument and abdominal gills

Casemakers Limnephilidae



Odontoceridae





Helicopsychidae



Netspinners

Hydropsychidae









Odonata

Paleoptera

Anisoptera - Dragonflies







Odonata

General Info.

- Greatest diversity in lowland streams and ponds (Lentic)
 - HBI for species 1-9
- Move via rectal "jet propulsion" (VIDEO)!!!!!
- Beneficial predators (prey on "pest" insects)



Odonata (Dragonflies/Damselflies)

- 9 families and 47 species
- 2 suborders Anisoptera and Zygoptera
- Lower lip (labium) is long and elbowed and is folded back against the head when not feeding
- Wing pads are present on the thorax
- Three pairs of segmented legs, two claws



- No gills are found on the sides, but damselflies have three flat, elongate gills on the end of the abdomen
- Body is either long and stout or oval and somewhat flattened.
 Head is narrower than the thorax and abdomen
- In dragonflies, three short, stiff, pointed structures occur on the end of the abdomen, forming a pyramid-shaped valve

Odonata











Coleoptera

- Means the "Sheath Winged"
- Greatest spp. richness of all insects
- Secondary invaders of aquatic realm

Identification

- · All adults w/ hardened fore wings-
- W/ chewing mouthparts
- Larvae are variable (refer to keys)









Coleoptera (Beetles)

- 20 aquatic families and 1,000 species
- Head has thick hardened skin

Thorax and abdomen of most kinds have moderately hardened skin, but the abdomen has thin, soft skin in some kinds

No wing pads occur on the thorax

Three pairs of segmented legs extend from the thorax in most kinds, but some kinds have no segmented legs

No structures project from the sides of the abdomen in most kinds, but some kinds have flat plates or stout filaments

No prolegs or tapering filament occurs on the end of the abdomen

Coleoptera

General Info

- Broad range of Habitats
- Never really the dominant group in lotic systems
 - HBI for species 2 6
- Respiration thru:
 - · Self contained bubbles
 - Cuticular
 - Plastron (hairs)
 - · Piercing plant tissues





Elmidae



Psephenidae







Megaloptera

- Hellgramites and Alderflies
- Small order
- Poor fliers
- · Can burrow into substrate during drought

Identification

- W/ lateral abdominal filaments ____
- Abdomen terminates in either 2 prolegs w/ 2, hooks each or a single filament.







Megaloptera (Helgamites)

C 2 families 46 species

Head and thorax have thick, hardened skin, while the abdomen has thin, soft skin.

- Prominent chewing mouthparts project in front of the head.
- No wing pads occur on the thorax
- Three pairs of segmented legs extend from the thorax

Seven or eight pairs of stout, tapering filaments stick out from the sides of the abdomen

F End of the abdomen has either a pair of prolegs with two claws on each proleg, or a single long, tapering filament

Megaloptera

General Info

- Only larvae are terrestrial
- Highly predaceous (aggressive)
- Lotic and Lentic
 - HBI for species 4



Diptera

Brachycera



Nematocera









Diptera

General Info.

- Exhibit both Open & Closed respiratory systems.
- Found in every aquatic habitat.

except open ocean

• Can withstand extreme conditions

ex. Ephydridae - petroleum

• HBI for species 0 - 10



Diptera (True Flies)

- 29 aquatic families 3,500 species
- Complete metamorphosis
- Elongate, soft, and fleshy and resemble maggots
- Head may be capsule-like, separate structure with thick hard skin
- Head may be partially reduced on the rear margin, or may be greatly reduced to just mouth parts that protrude from the thorax
- No wing pads
- No segmented legs, may have prolegs
- Thorax and abdomen are entirely of soft, thin skin



Crustacea

Gammaridae (scuds)





Asellidae (sow bugs)



FBI = 8 HBI for species = 8 slow crawlers (do not swim) resemble terrestrial sow bugs

Decapoda



Mollusca

Gastropoda (snails)



Pelecypoda (clams)



FBI = 7HBI for species = 5 - 8usually small in size FBI = 6 HBI for species = 6 - 8 can become large



Oligochaeta

FBI = 9

HBI for species = 5 - 10

Resemble typical earth worm


Hirudinea

Leeches

FBI = 7







				STF	REAM	s and	O RIVERS		MACROINVERTEB	RATE	E DA	TA E	NTF	RY SHEET				
						-	Level II	- Identify to	Family (primarily)				-					
Site # :	# : Beaver R 4, downstream of dam					of dan			River/Stream:		Beaver R				River			
Sample Date:	8/19/04								Sampler Name/s:	Guillot, Au				uillot, Aube, Urs	SO			
Date of Lab Work:	8/30/04					Ave. # Organisms	39	39			# squares on tray: 1							
		-							# of replicates:	3	1	1	1	<- # squares p	bicked	each replic	ate	
Replicate #		1	2	3					Replicate#		1	2	3			1.0	average	
Families in					Avg.	Τх			Families in Major					Avg. D	Тх			
						Avg.									Avg.			
Major Group	Т	D	D	D	D	D	FFG	Richness	Group	Т	D	D	D		D	FFG	Richness	
EPHEMEROPTER	RA (I	Mayf	lies)						TRICHOPTERA (Ca	addis	flies)						
Baetidae	4	1			0.3	1.3	GC/SC	0.3	Brachycentridae	1		1		0.3	0.3	FC/GC	0.3	
Baetiscidae	3				0.0	0.0	GC	0.0	Glossosomatidae	0			1	0.3	0.0	SC	0.3	
Caenidae	7				0.0	0.0	GC	0.0	Helicopsychidae	3				0.0	0.0	SC	0.0	
Ephemerellidae	1				0.0	0.0	GC/SC	0.0	Hydropsychidae	4	3	2		1.7	6.7	FC	0.7	
Ephemeridae	4				0.0	0.0	GC	0.0	Hydroptilidae	4				0.0	0.0	GC/SC/SH	0.0	
Heptageniidae	4	1		2	1.0	4.0	SC/GC	0.7	Lepidostomatidae	1				0.0	0.0	SH	0.0	
Leptophlebiidae	2				0.0	0.0	GC	0.0	Leptoceridae	4				0.0	0.0	GC/SH/PR	0.0	
Metretopodidae	2				0.0	0.0	GC	0.0	Limnephillidae	4		1		0.3	1.3	SH/SC/GC	0.3	
Oligoneuriidae	2				0.0	0.0	FC	0.0	Molannidae	6				0.0	0.0	SC	0.0	
Polymitarcylidae	2				0.0	0.0	GC	0.0	Odontoceridae	0	3	24	4	10.3	0.0	SH	1.0	
Potomanthidae	4				0.0	0.0	GC	0.0	Philopotamidae	3		2		0.7	2.0	FC	0.3	
Siphlonuridae	7				0.0	0.0	GC	0.0	Phryganeidae	4				0.0	0.0	SH	0.0	
Tricorythidae	4				0.0	0.0	GC	0.0	Polycentropodidae	6				0.0	0.0	FC/PR	0.0	
					0.0	0.0		0.0	Psychomyiidae	2				0.0	0.0	GC	0.0	
					0.0	0.0		0.0	Rhyacophilidae	0			4	1.3	0.0	PR	0.3	
Subtotal Ephem	erop	otera			1.3	5.3		1.0	Sericostomidae	3				0.0	0.0	SH	0.0	
PLECOPTERA (Stoneflies)													0.0	0.0		0.0		
Capniidae	1				0.0	0.0	SH	0.0	14 24 24 2	2				0.0	0.0		0.0	
Chloroperlidae	1				0.0	0.0	GC/PR	0.0	Subtotal Trichoptera 15.0 10.3				3.3					
Leuctridae	0	4	3	1	2.7	0.0	SH	1.0	DIPTERA (True Flies)									
Nemouridae	2				0.0	0.0	SH	0.0	Athericidae	2				0.0	0.0	PR	0.0	
Peltoperlidae	0				0.0	0.0	SH	0.0	Blephariceridae	0				0.0	0.0	SC	0.0	
Perlidae	1	2		3	1.7	1.7	PR	0.7	Ceratopogonidae	6				0.0	0.0	PR	0.0	
Perlodidae	2				0.0	0.0	PR	0.0	Chironomidae	7				0.0	0.0	ALL	0.0	
Pteronarcyidae	0				0.0	0.0	SH	0.0	Empididae	6				0.0	0.0	PR	0.0	
Taeniopterygidae	2				0.0	0.0	SH	0.0	Simuliidae	6				0.0	0.0	FC	0.0	
					0.0	0.0		0.0	Tabanidae	6				0.0	0.0	PR	0.0	
					0.0	0.0		0.0	Tipulidae	3	6	10	9	8.3	25.0	GC/PR/SH	1.0	
Subtotal Plecoptera 4.3 1.7						1.7	OTHER					0.0	0.0		0.0			
									a set of the set					0.0	0.0		0.0	
Key to Column Headings:												0.0	0.0		0.0			
T = Family Pollution Tolerance Value								Subtotal Diptera					8.3	25.0		1.0		

Replicate #		1	2	3					Replicate#		1	2	3				
Families in					Avg.	Тх			Families in Major					Avg. D	ТΧ		
						Avg.									Avg.		
Major Group	Т	D	D	D	D	D	FFG	Richness	Group	Т	D	D	D		D	FFG	Richness
MEGALOPTERA	MEGALOPTERA (Dobsonflies, alderflies, fishflies)					flies)		ISOPODA (Sowbugs)									
Corydalidae	0			1	0.3	0.0	PR	0.3	Asellidae	8				0.0	0.0	SH/GC	0.0
Sialidae	4				0.0	0.0	PR	0.0						0.0	0.0		0.0
					0.0	0.0		0.0	and the second					0.0	0.0	2	0.0
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1					0.0	0.0	-	0.0	Subtotal Isopoda					0.0	0.0		0.0
Subtotal Megaloptera 0.3 0.0						0.3	DECOPODA (Crayfish)										
LEPIDOPTERA (Mot	hs)							Cambaridae	6				0.0	0.0	GC	0.0
Pyralidae	5				0.0	0.0	SH	0.0						0.0	0.0	1.5	0.0
					0.0	0.0		0.0						0.0	0.0		0.0
					0.0	0.0	1	0.0	Subtotal Decapoda	a				0.0	0.0		0.0
Subtotal Lepido	pter	a			0.0	0.0		0.0	OTHER (non-families w/tolerance v					alues)			
COLEOPTERA	eetl	es)	-			-			Class Oligochaeta	8				0.0	0.0	GC	0.0
Dystiscidae	8				0.0	0.0	PR	0.0	Class Hirudinea	10				0.0	0.0	PR	0.0
Elmidae	4	6	6	6	6.0	24.0	GC/SC/SH	1.0	Class Gastropoda	7				0.0	0.0	SC	0.0
Psephenidae	4				0.0	0.0	SC	0.0	Class Pelecypoda	7				0.0	0.0	FC	0.0
Gyrinidae	4				0.0	0.0	PR	0.0	Order Hemiptera	8				0.0	0.0	PR	0.0
Hydrophilidae	8				0.0	0.0	PR	0.0						0.0	0.0		0.0
Subtotal Coleop	tera				6.0	24.0		1.0	Unidentified					0.0	0.0	1214	0.0
ODONATA (Drag	onfl	lies,	dam	selfi	ies)				Subtotal Other non-family					0.0	0.0		0.0
Aeshnidae	3		2		0.7	2.0	PR	0.3	TOTAL			Density	Tx av.D ric		richness		
Calopterygidae	5				0.0	0.0	PR	0.0	All Organisms					39	71		10
Coenagrionidae	9				0.0	0.0	PR	0.0	Functional Feedin	g Gr	oup	Tota	ls:				
Cordulegastridae	3				0.0	0.0	PR	0.0	Total Predators	-	1	-	-	9			
Corduliidae	5				0.0	0.0	PR	0.0	Total Shredders		-	18					
Gomphidae	1	1	4	3	2.7	2.7	PR	1.0	Total Filterers			-		3			
Lestidae	9				0.0	0.0	PR	0.0	Total Gatherers			2		6			
Libellulidae	9				0.0	0.0	PR	0.0	Total Scrapers		_	_		3			
Macomiidae	3				0.0	0.0	PR	0.0	Total all Feeding	Grou	ps			39			
					0.0	0.0		0.0	- 2.5		-						
					0.0	0.0		0.0		-		-					
Subtotal Odonata 3.3 4.7					1.3				-	-							
AMPHIPODA (Scuds)										_			-				
Gammaridae	4				0.0	0.0	GC	0.0									
Talitridae	8				0.0	0.0	GC	0.0		-		-	-		1		
					0.0	0.0		0.0				-			-		
					0.0	0.0		0.0			2.	-			-		
Subtotal Amphi	pod	а			0.0	0.0		0.0									

METRICS Summary	Expected response to impact						
Org. Density / sample	39						
Taxa Richness	10	Decline					
EPT Richness	6	Decline					
% Predators	24.4	Decline					
% Shredders	46.3	Decline					
% Oligochaeta	0.0	Rise					
% Diptera	21.6	Rise					
% Chironomidae	0.0	Rise					
Family Biotic Index	1.84	Rise					
% Filters	6.5	Rise					
% Contrib. Dom. Taxa	26.7	Rise					
% Hydropsych. of Trich	11.1	Rise					
% Trichoptera	38.8	Decline					
% model affinity	0.38	Decline					
EPT/Chironomid	#DIV/0!	Decline					
Scrapers/Filterers	1.24	Decline					
% Gatherers	14.8						
% Scrapers	8.0	Decline					





Multimetric Indices

- graphical analysis of biological response to human disturbance
- uses local or regional reference streams
- combines several community characteristics into one score

Multivariate Models

 computer model interpretation of physical and biological stream characters

• uses a large database of reference streams to generate a score comparing the macros that were observed to what macros the model expected



