

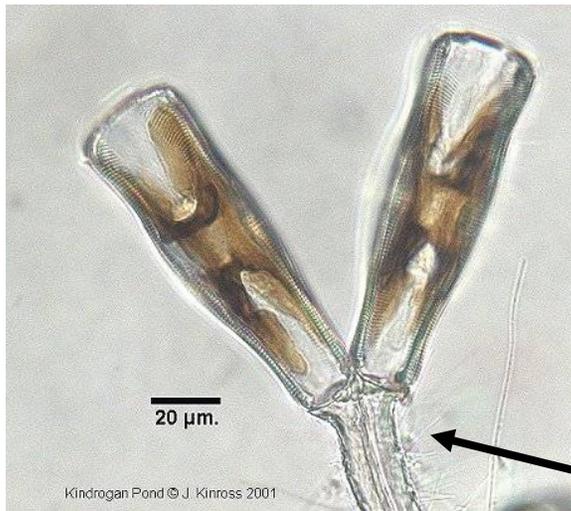
US EPA ARCHIVE DOCUMENT

Didymosphenia geminata - a new potentially
invasive diatom in New England rivers

Leslie J. Matthews, Steve Fiske and Brian Duffy

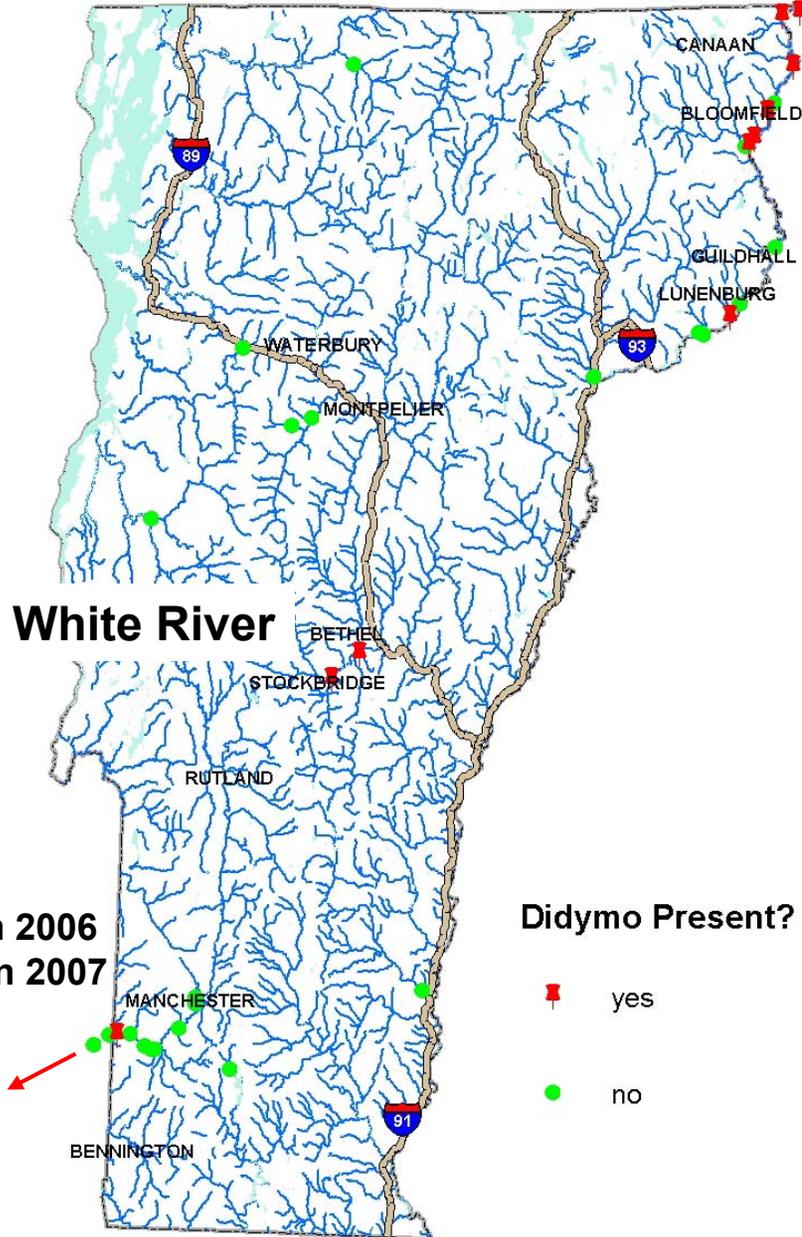
Didymosphenia geminata

- Single-cell, freshwater diatom
- Large, ornate diatom cell (80-140 μm length)
- Considered a 'trophy species' by Victorian-era naturalists



Stalk

First official report of didymo in Northeast U.S. – June 2007



Connecticut River

White River

Batten Kill,
observed in NY in 2006
confirmed in VT in 2007

Delaware River, NY

Didymo Present?

 yes

 no

Field Identification



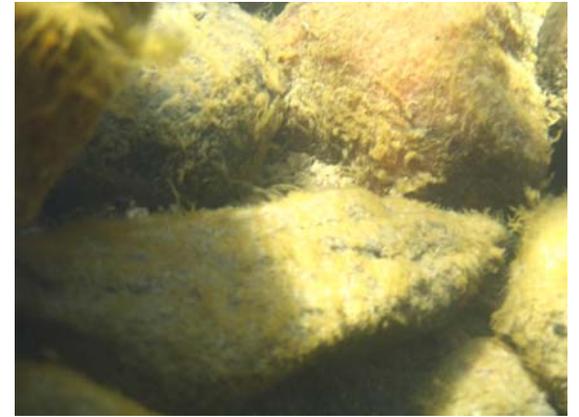
Sample should match three of the "yes" descriptions below

	YES	NO
Location	Mostly clear flowing water with rocky bottom, may be attached to plants	Deep silty areas with no rocks or plants, highly colored waters.
Color	Tan, light brown or whitish	Green or dark brown/black clear or transparent
Texture	Clumps or ropy strands, rough cottony feel, fibrous	Thin layers, slippery or gelatinous
Appearance	No leaves or roots (BUT may attach to leaves or stems). Sometimes mistaken for fiberglass, toilet paper or tissue.	Has leaves or roots looks like an aquatic plant

Field Identification

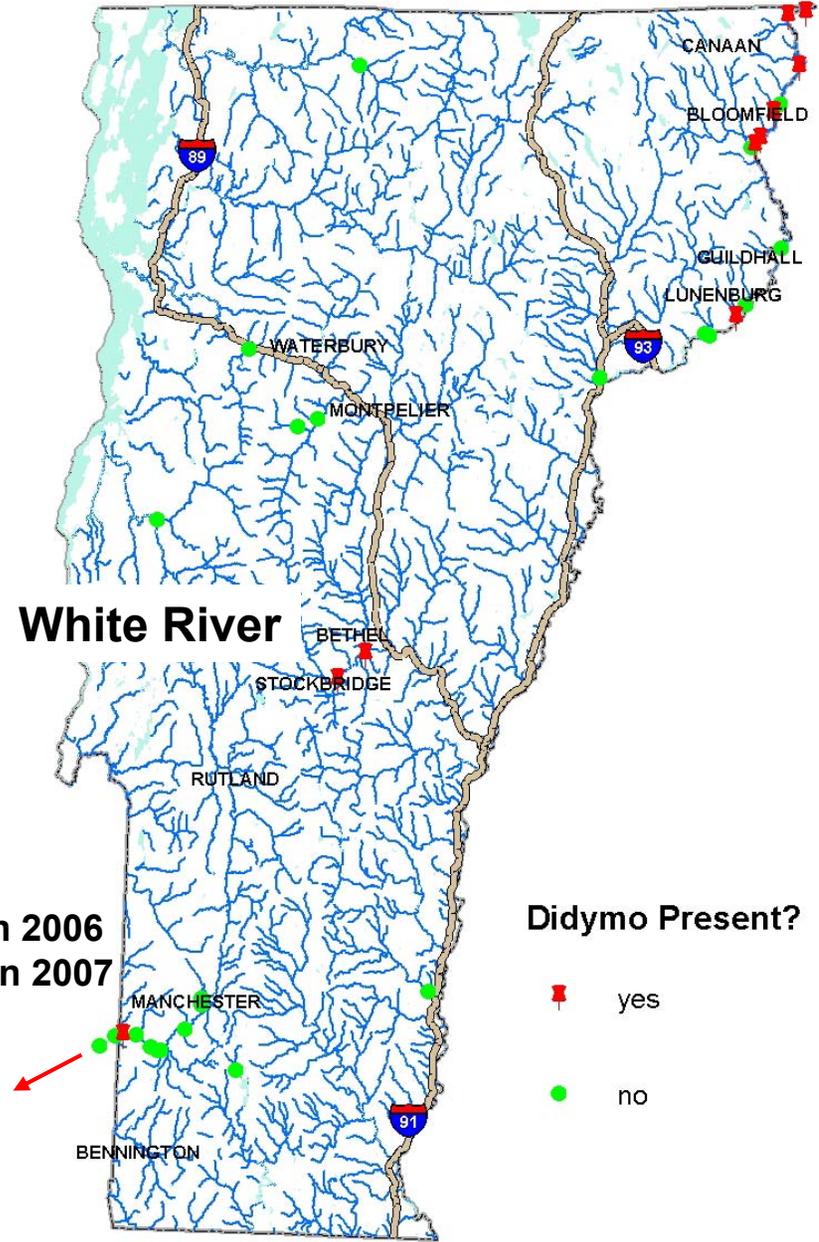
In practice, can be tricky!

White River, Vermont



Conn River – NH DES

First official report of didymo in Northeast U.S. – June 2007



Connecticut River

White River

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observed in NY in 2006
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Delaware River, NY

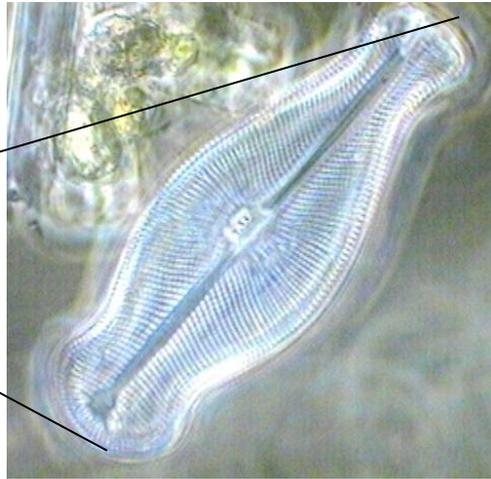
Didymo Present?

-  yes
-  no

Microscopic Identification

Valve View

80-140 μm

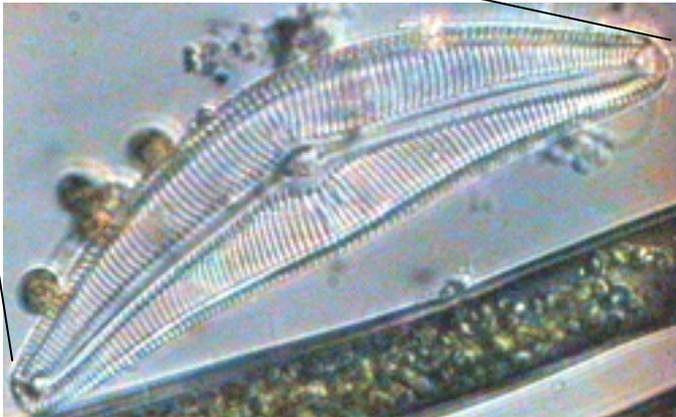


Girdle View



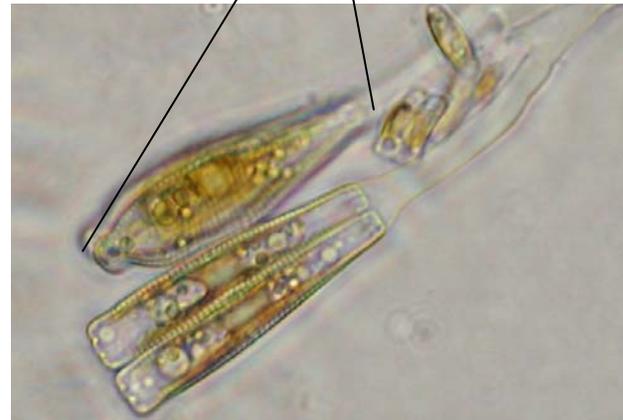
Didymosphenia geminata

115-140 μm



Cymbella mexicana

30-40 μm



Gomphonema sp.

Should "didymo" be considered a cryptogenic species in the Northeast U.S.?

World Wide Distribution – USGS

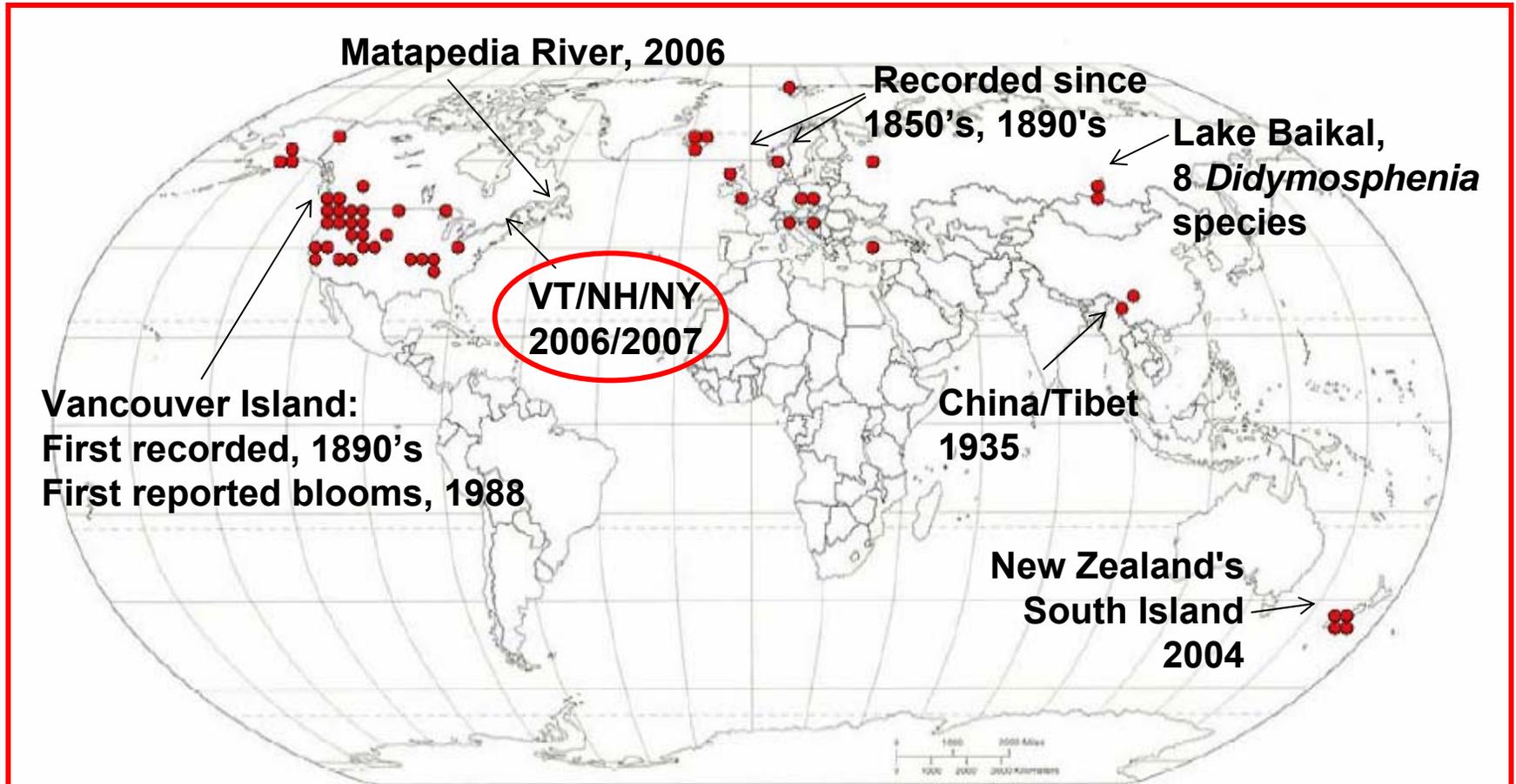
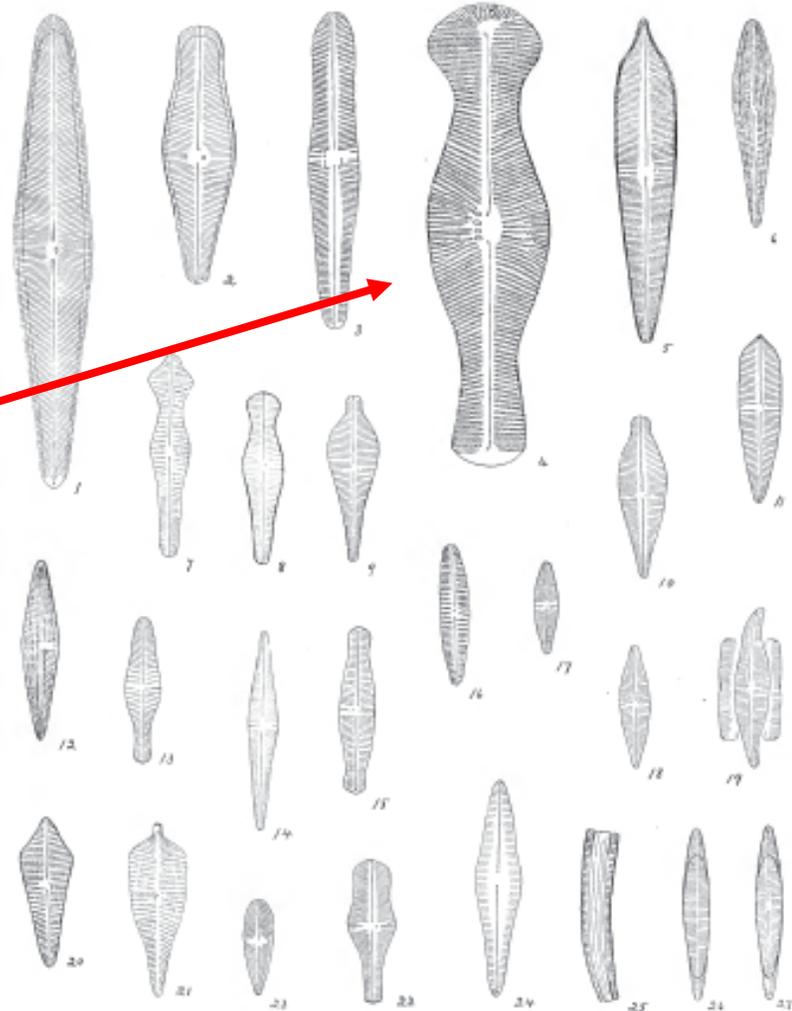


FIGURE 7. Confirmed presence and published records of *D. geminata* from around the world. Dots do not represent number of reports, but show rough geographic area of populations. (Map by Sarah Spaulding, US Geological Survey).

Annotated by Leslie Matthews, VT DEC



The Diatomaceae of Philadelphia and Vicinity
- Charles S. Boyer, 1916

“*Gomphonema geminatum*”
- blue clay deposits near Philadelphia

“Freshwater and marine plants of Rhode Island”

1988

Robert G. Sheath

Marilyn M. Harlin

13% of samples collected included diatoms i.d.'d as

Didymosphenia geminata

Didymo – *aquatic nuisance species?*

- Expanding distribution
- Seems to have gained new tolerances for various environmental factors
- Produces inordinate amounts of stalk material (cell itself not harmful)
- Aesthetic, ecological, hydrological, impacts due to ‘mats’
- No method for eradication
- Most algae blooms are associated with excess nutrification; didymo thrives in nutrient-poor, clear, otherwise un-impacted streams



VT/NH Connecticut River



Tennessee



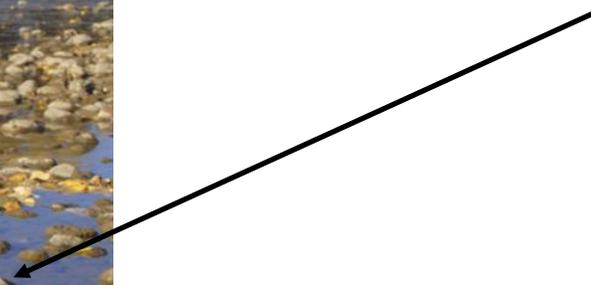
New Zealand

Effects on Stream Ecology

- Didymo 'mats' alter the physical habitat and primary production/nutrient cycling in stream ecosystems?
- Overall abundance of macroinvertebrates increases in mats
- Mayflies, stoneflies, and caddisflies (EPT's; FISH FOOD!) decrease proportionately, chironomid midges, oligochaetes (worms) increase proportionately
- Negative impacts on water chemistry? DO? pH?
- 'Mixed' results in scientific literature; many on-going studies



Didymo on rocks!



Skeena River, British Columbia

Specific Fisheries Studies



- **Norway – Atlantic salmon**
 - Didymo first documented over 150 yrs ago
 - Widely distributed, common in unpolluted lakes and rivers
 - No significant effect seen on the catch of Atlantic salmon
 - Few complaints about fouling of gear
 - Algal mats slough off before spawning begins, not affecting reproduction.
- **Iceland – brown trout, sea trout, Atlantic salmon**
 - Didymo was first reported in 1994, since spread to most rivers
 - No obvious effects on juvenile fish densities, but no data on condition or fitness
 - Complaints from the fishing community about fouled gear
 - No educational/spread prevention efforts were undertaken – at the time, no one really considered didymo a problem.
- **British Columbia – steelhead/Pacific salmon**
 - Nuisance blooms first began in 1988, primarily in steelhead fishing streams
 - No other environmental changes
 - Comparisons of spawner and juvenile densities of steelhead (multi-year freshwater juvenile life history) and pink and chum salmon (minimal freshwater rearing time) showed no compelling impacts associated with didymo.
- **Rapid Creek, South Dakota – brown trout**
 - Nuisance blooms observed on a 20mile stretch between two reservoirs since 2002
 - Brown trout population has experienced significant declines in adult age classes that coincided with the appearance of didymo
 - Nutrient enrichment management was undertaken but results have not been reported

New Zealand – Trout

- No negative effect on invertebrate drift density
- No evidence that didymo negatively affects trout growth
- Electrofishing studies in May 2006 revealed no impact but didymo levels were only moderate; subsequent additional studies could not be completed (ran out of \$\$\$)



Vermont's initial response



WARNING



You **MAY** be carrying the invasive alga
Didymosphenia geminata ('Didymo' or 'Rock Snot')

STOP ROCK SNOT

BEFORE entering and **AFTER** leaving this water:

CHECK Remove **all** visible clumps of algae and plant material from fishing gear, waders, clothing, water shoes and sandals, canoes, kayaks **and anything else** that has been in the water

CLEAN Using **HOT** tap water and lots of soap: **Scrub** boats and other "hard" items thoroughly; **Soak** clothes, felt-soled wading boots and other "soft" items for **30 minutes!!!**

Get more information:

Contact the VT DEC at 802-241-3777

Or visit:

www.vtwaterquality.org

www.des.state.nh.us/wmb/exoticspecies

www.maddogtu.org/didymo.html

Please do your part – Don't Spread Didymo!



Tuesday, Jul. 24, 2007



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Didymo (A.k.A. Rock Snot)

Didymo (a.k.a. rock snot) found in Vermont and New Hampshire

Didymo is the common name for *Didymosphenia geminata*, an invasive freshwater diatom species (microscopic algae). Didymo can form extensive 'blooms' on the bottoms of rocky river beds, essentially smothering aquatic life forms such as macroinvertebrates (aquatic insects), native algae, and other organisms. Additionally, the physical appearance of the bloom is aesthetically unpleasing, and can reduce the recreational values of a waterbody. Didymo uses stalks to attach to rocks and plants in a river system. The diatom creates these stalks, which can form masses 10-12 inches thick on the river bottom, and trail for lengths of 2-3 feet in the current. It is actually these stalks that are more problematic than the algae. The algae will eventually die off and decompose, while these stalks tend to persist for several months on the river bottom.



STOP ROCK SNOT

Sightings in New Hampshire

NH DES Limnology Center
29 Hazen Drive
Concord, NH 03301
603-271-2248 or 603-271-3414
asmagula@des.state.nh.us
or
jconnor@des.state.nh.us

Sightings in Vermont

Didymo identification, Water Quality Division
103 S. Main St., Bldg 10N, First Floor
Waterbury VT 05671-0408
(802) 241 - 3770 or 241 - 3777
Angela.Shambaugh@state.vt.us
or
Leslie.Matthews@state.vt.us

CHECK - Remove all visible clumps of algae and plant material from fishing gear, waders, clothing, water shoes and sandals, canoes and kayaks, *and anything else* that has been in the water.

CLEAN - Using HOT tap water and lots of soap: **Scrub** boats and other "hard" items thoroughly; **Soak** clothes, felt-sole waders and other "soft" items for **30 minutes!!!!**

More Information...

[Frequently Asked Questions](#)

[How to tell if you are seeing Didymo](#)

[Didymo Signage for Posting](#) [pdf]

[Map of Current Distribution](#)

[New Hampshire Press Release](#)

[Vermont Press Release](#) [pdf]

[US EPS Website on Didymo](#)

Best Management Practices to Prevent AIS Spread

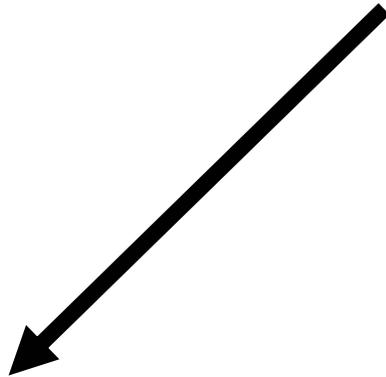
- Follow appropriate **disinfection procedures** before traveling between different bodies of water or watersheds
- Use a simple, **portable disinfection kit** if you must move between waterbodies
- **Designate** sets of waders/boots for different watersheds if appropriate
- Consider **rubber-soled** wading boots with cleated Korkers or Aquastealth-soled wading boots (available from Patagonia and Simms), which are easier to disinfect quickly.
- For anglers: **fish downstream** within a watershed if possible...
- When possible, fish only in a **single waterbody in a single day**



Absorbent items (felt-soled boots, clothing, wetsuits, sandals, anything else that takes time to dry out)



**MUST BE SOAKED
AT LEAST 30 MINUTES**



100% Cell Mortality in 1 Minute

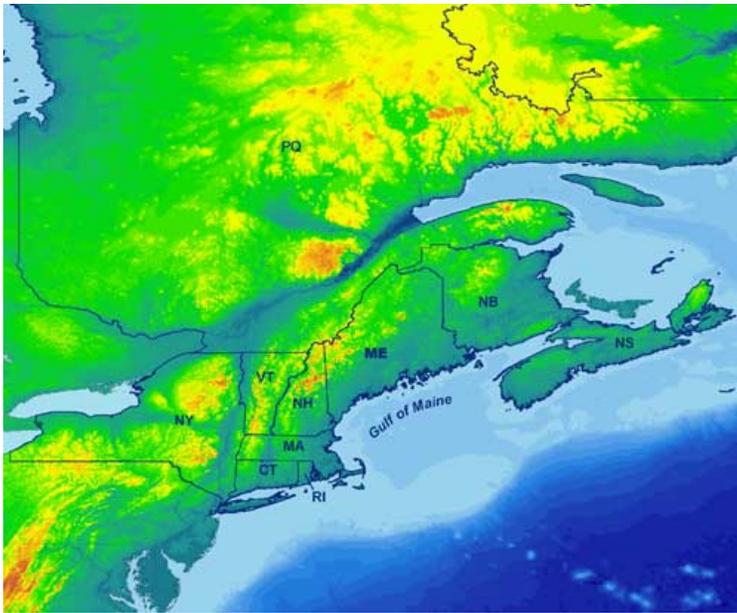
- 5% Dishwashing detergent
(*not* “environmentally friendly” products)
- 5% “nappy” cleaner (hydrogen peroxide based)
- 5% Sodium chloride
- 2% Household bleach
- 1% Virkon disinfectant
- 0.012% Benzalkonium chloride (quaternary ammonium disinfectant) (~ 2% Quat-128)

Viable cell –stained lysosomes



Dead cell – no uptake of stain





Regional Coordination

- Public outreach messages
- Outreach to angling industry
- Research

Vermont Resources Available:

- Identification guide
- Sample submission form
- Draft disinfection protocol for Agency staff
- Draft "commercial" disinfection protocol, for fishing guides, etc.
- Draft proposal for surveillance and monitoring



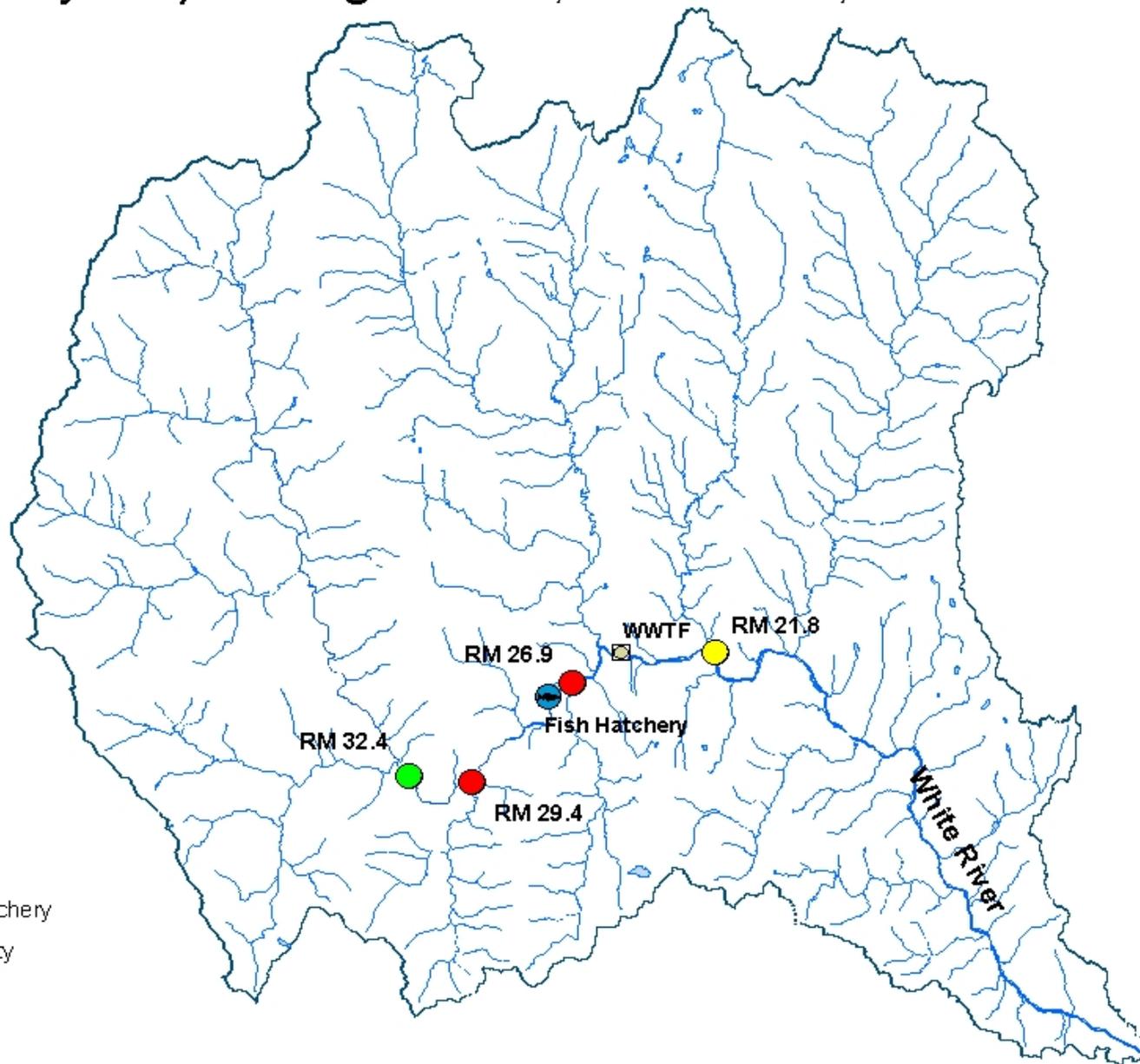




Preliminary Macroinvertebrate Assessment Results for *Didymosphenia geminata* Impacts, White River, VT

- White River assessment sites and periphyton cover
- Vermont Macroinvertebrate Assessment Methods
- Macroinvertebrate metrics as applied to Vermont Biocriteria
- Conclusions and Recommendations

Macroinvertebrate Monitoring Sites Assessed for Effects of *Didymosphenia geminata*, White River, VT



Monitoring Sites

-  20% *Didymogem* cover
-  75-100% *Didymogem* cover
-  Control
-  White River National Fish Hatchery
-  Waste Water Treatment Facility
-  Rivers and Streams (1:100k)

Site Characteristics



RM 26.9 - 75% *Didymo*



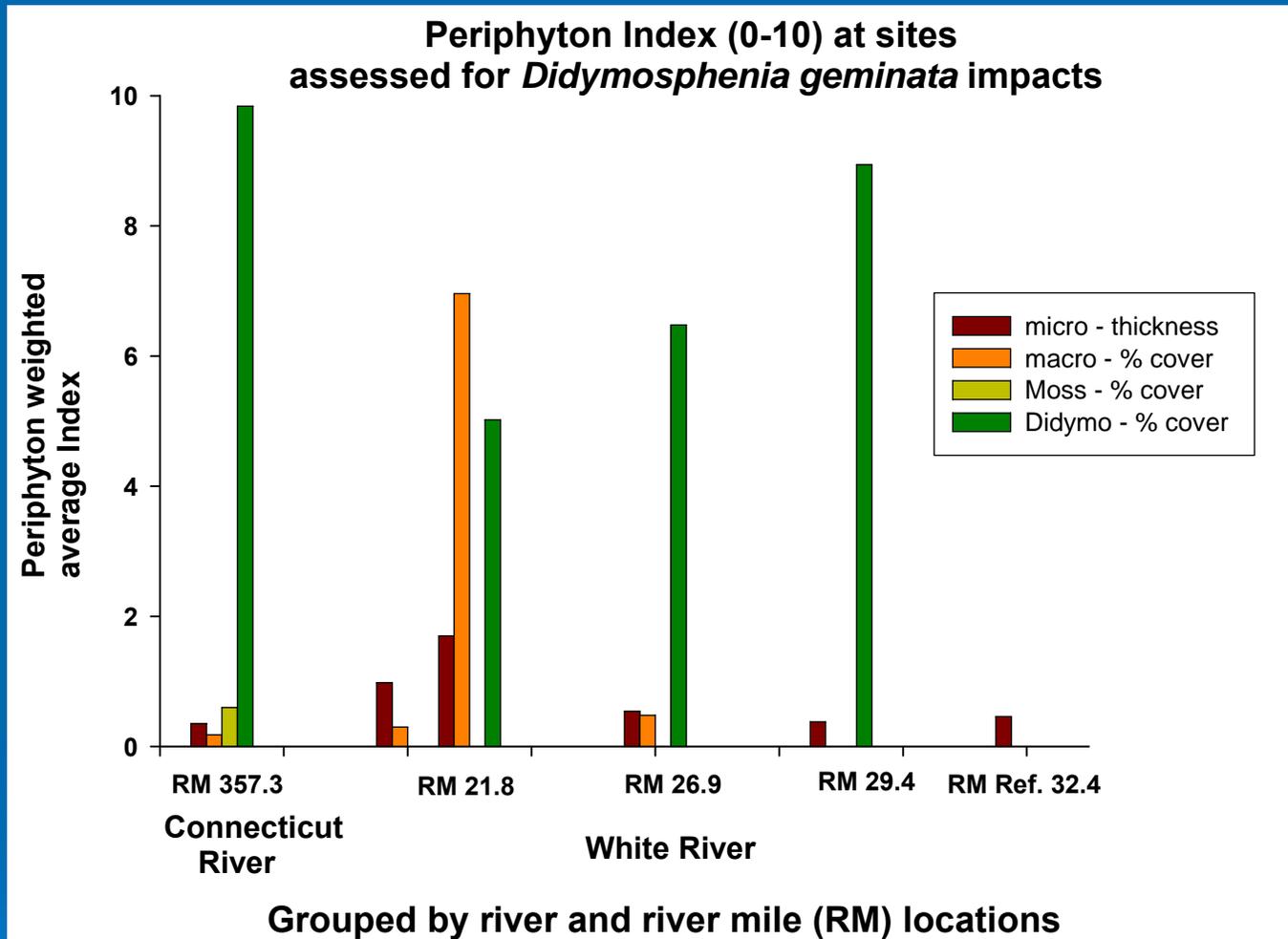
RM 32.4 - Reference

- Medium High Gradient (MHG) stream type
- Open canopied sites
- Phosphorus, alkalinity slightly elevated at RM 21.8 (downstream)

Periphyton Cover As Part of the Pebble Count



- All wetted substrate, coarse gravel and larger, categorized for % moss cover, % macroalgae cover, % *Didymo* cover, and microalgae thickness
- Moss, Macro, *Didymo* Periphyton Index calculation
 - $((0\%*0)+(<5\%*2)+(5-25\%*6)+(>25\%*10))/100$



- Collected as part of the pebble count

Vermont Macroinvertebrate Sampling and Assessment



- 1 meter² riffle Kick Net sample

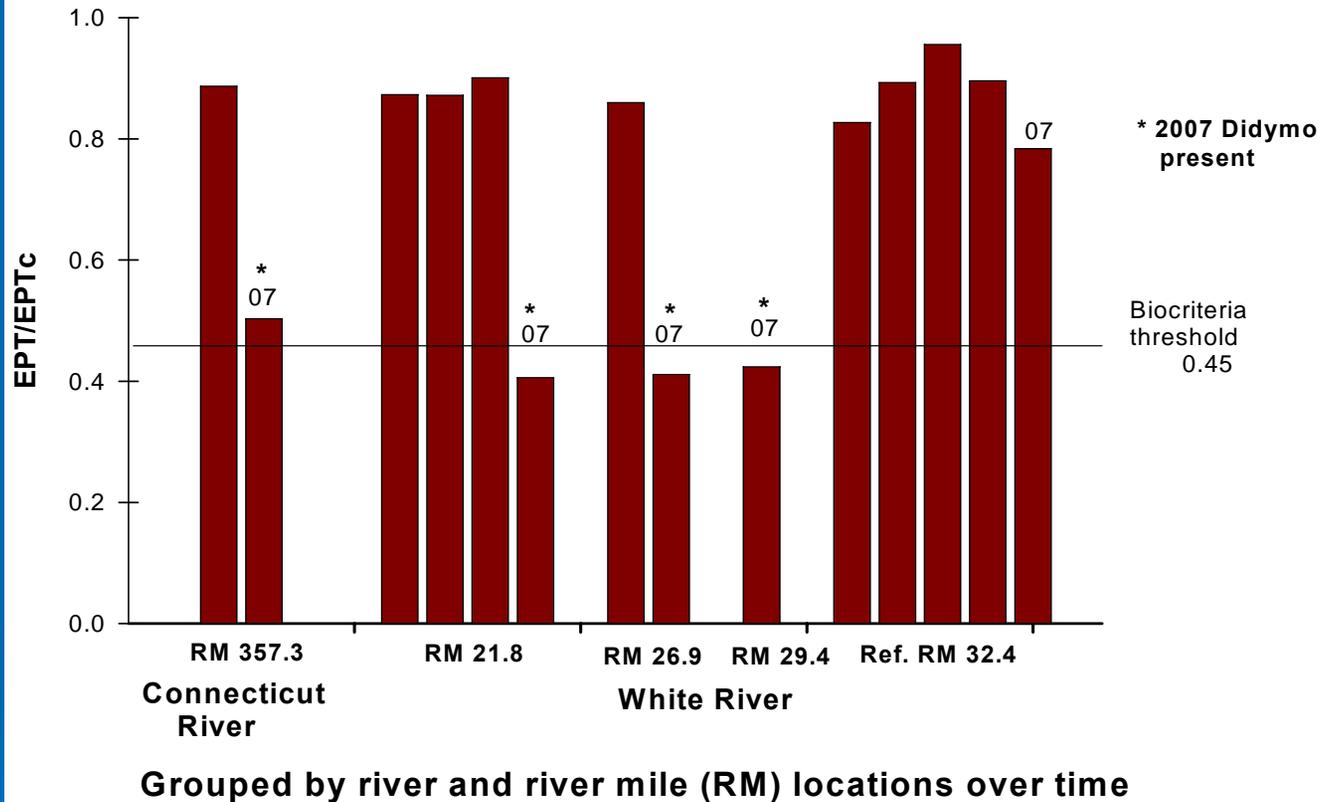


- ¼ subsample and a 300 animal minimum



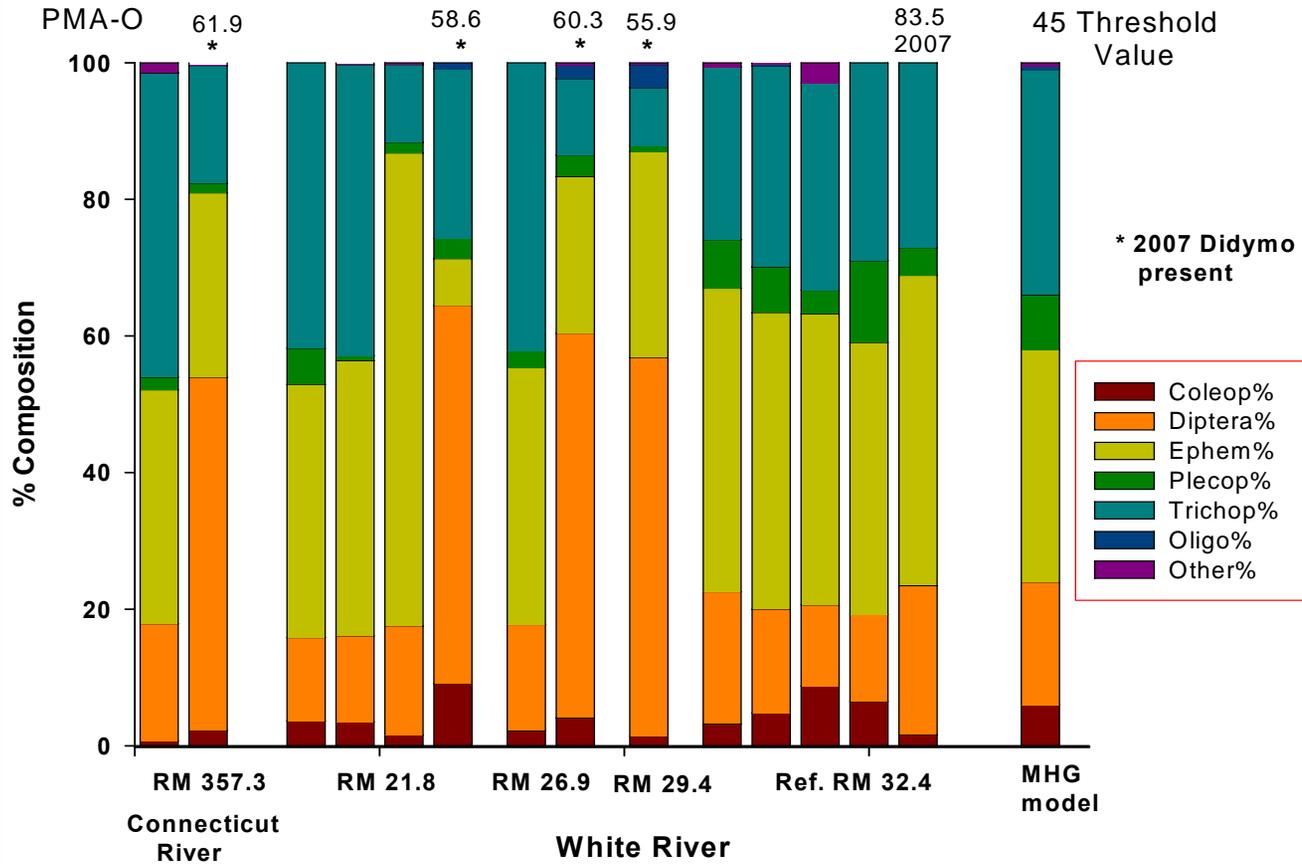
- Animals IDed to genus and species
- 8 metrics calculated and applied to VT Biocriteria

**EPT/EPT&Chironomidae ratio at sites assessed
for *Didymosphenia geminata* impacts**



- EPT/EPT&Chironomidae was the most consistently affected metric

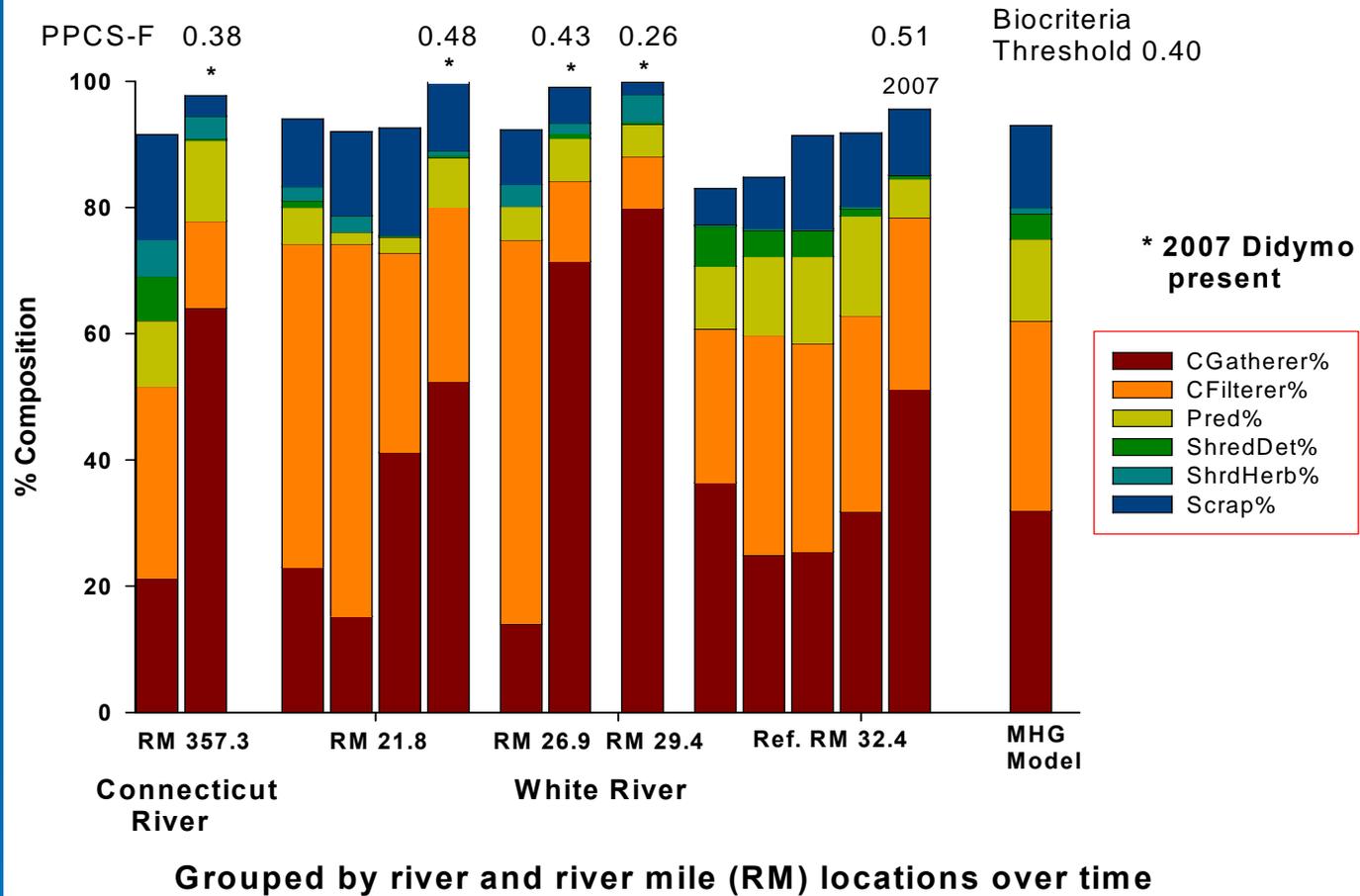
Macroinvertebrate Order Percent Composition at sites assessed for *Didymosphenia geminata* impacts



Grouped by river and river mile (RM) locations over time

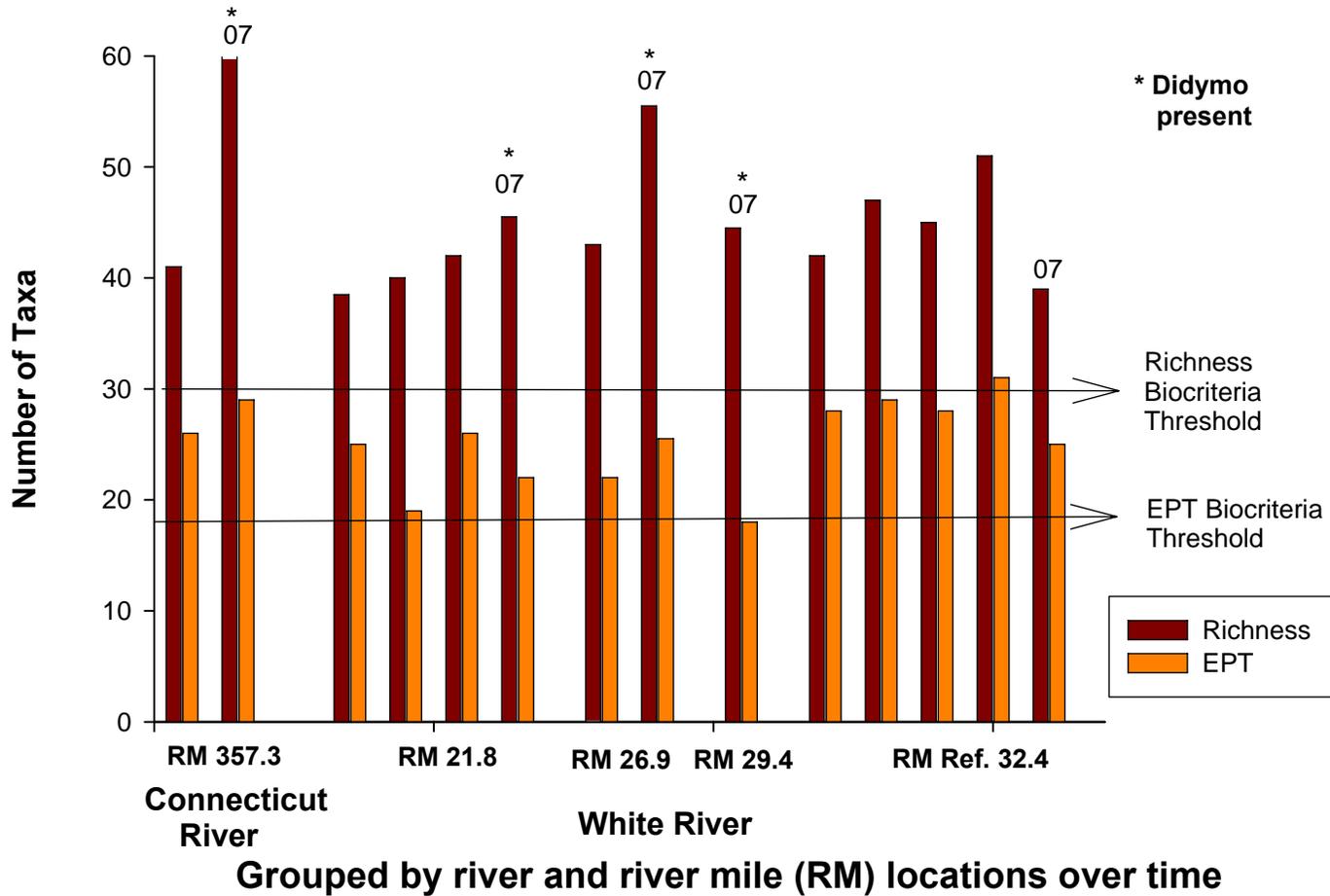
- Marked increase in Diptera, primarily Chironomidae
- Marked decrease in Trichoptera

Macroinvertebrate Functional Group Percent Composition at sites assessed for *Didymosphenia geminata* impacts

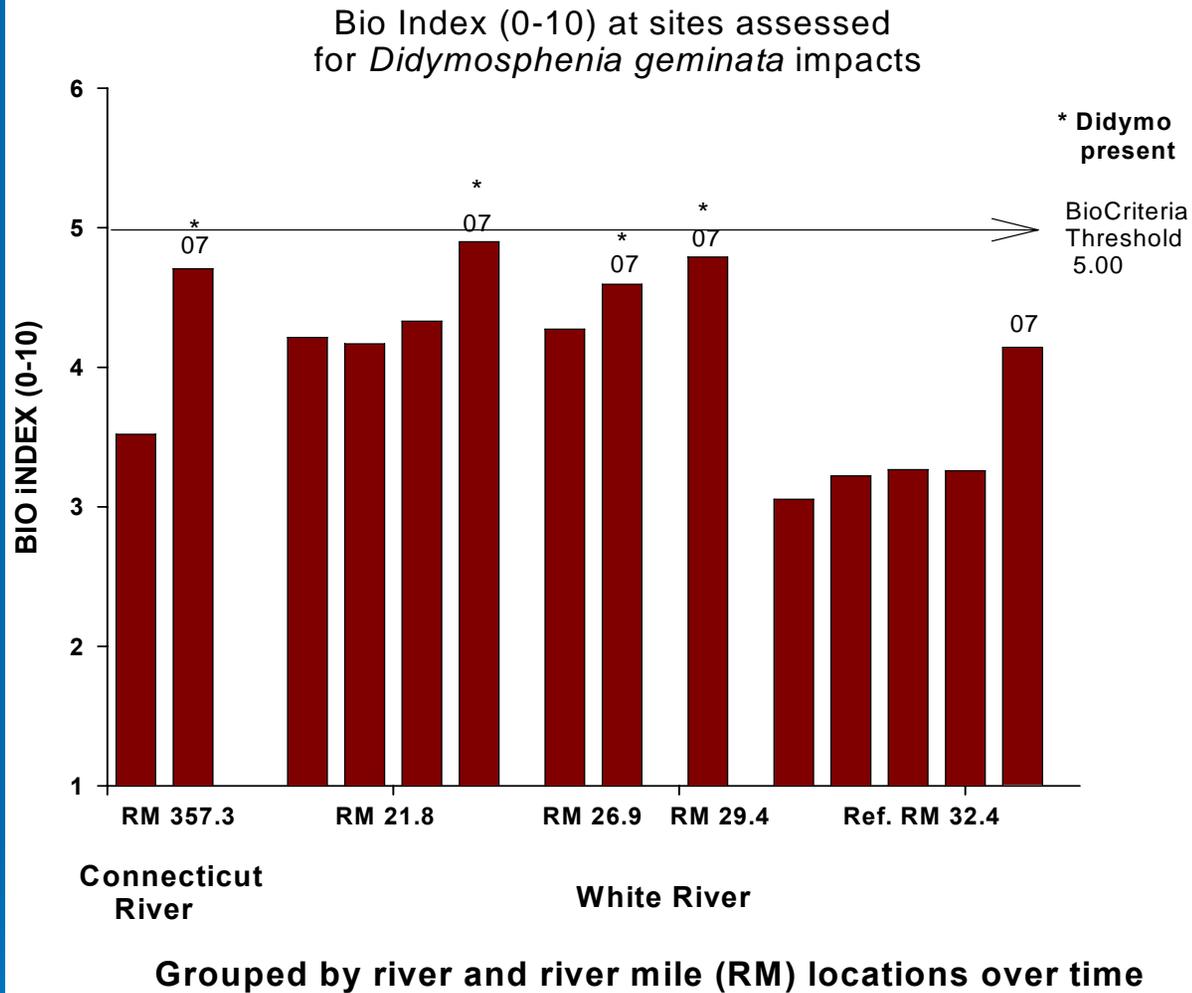


- Collector-gatherer hyper-dominance at sites with 75-100% *Didymo* cover

Taxa and EPT richness at sites assessed for *Didymosphenia geminata* impacts

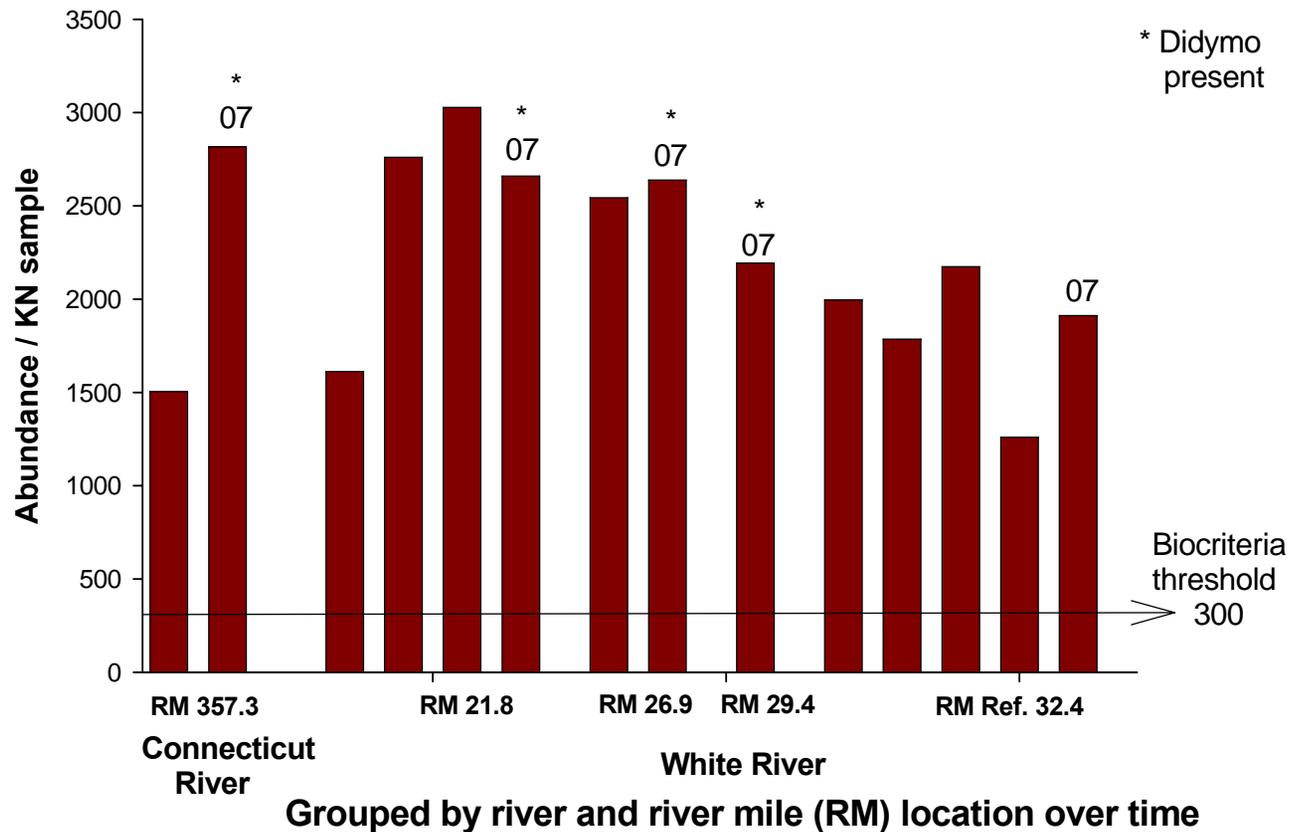


- Increase in taxa and EPT richness at *Didymo* sites



- BI increased across all sites sampled

**Macroinvertebrate abundance/m² KN sample
at sites assessed for *Didymosphenia geminata* impacts**



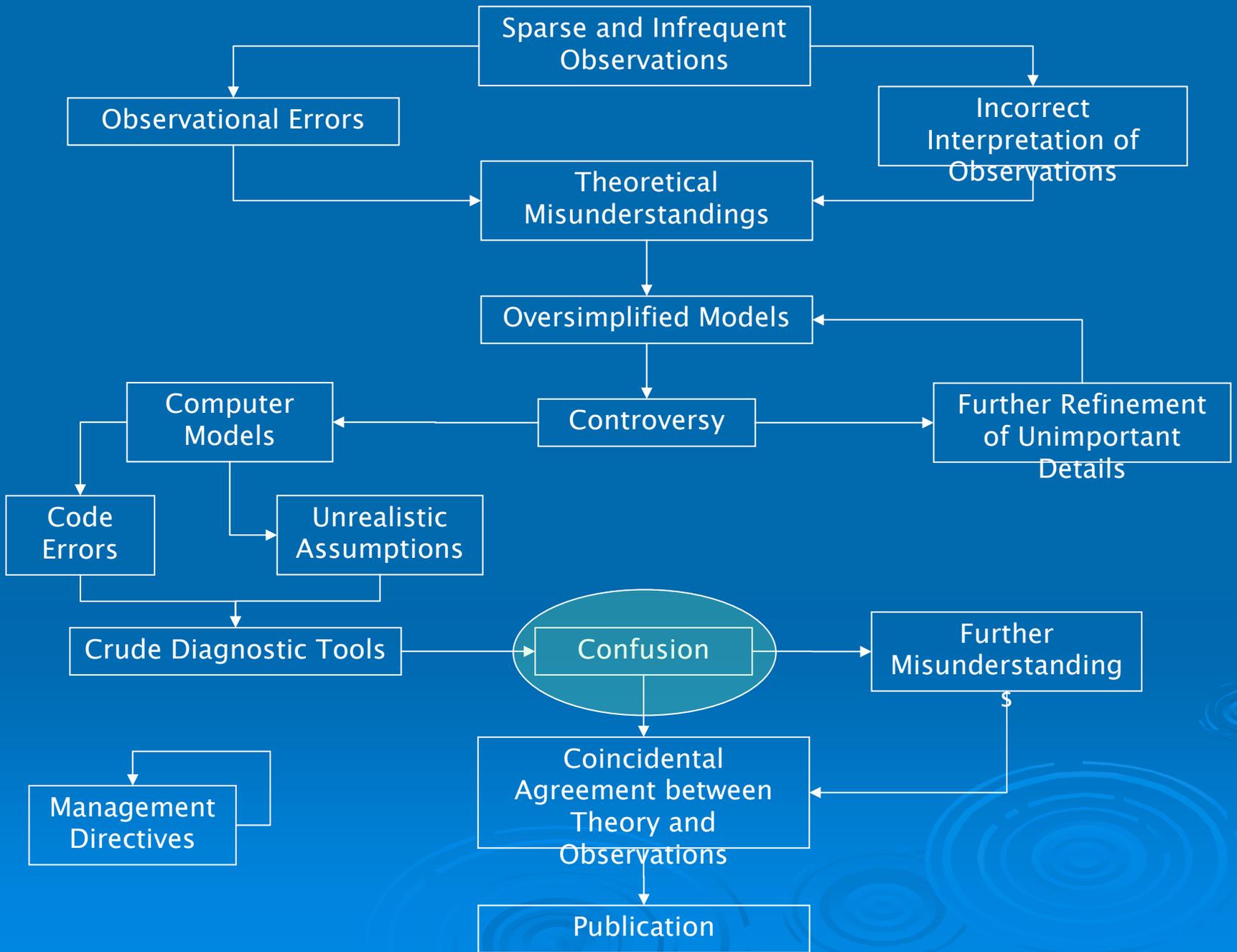
- Overall abundance relatively unaltered

Conclusions

- Most responsive metrics were
 - EPT/EPT&chironomidae ratio
 - Bio Index
 - PPCS-functional groups
- Shift in macroinvertebrate community order
 - Diptera (Chironomidae) increased in abundance and % composition
 - Trichoptera decreased in abundance and % composition
- Shift in functional group composition
 - Collector Gatherers abundance and % composition increased
 - Collector Filterers abundance and % composition decreased
- Macroinvertebrate community response was similar to nutrient enriched streams with high macro algae cover
- Overall community assessment of Fair – indicating non-support of VT Class B Aquatic Life Biocriteria

Recommendations

- Continue and expand stream monitoring at rivers with high *Didymosphenia geminata* cover to better determine environmental requirements and limitations
 - Determine temporal and seasonal impact on macroinvertebrate community and water chemistry
 - Expand fish biomonitoring and impacts on fisheries
- Intensive surveillance to determine extent of species



Current and Historical macroinvertebrate community assessments and metrics from sites evaluated

for impacts of *Didymogema* on macroinvertebrate community integrity in 2007

Asterick location with 75-100% cover of *Didymogema* in 2007

Location	Site	Date	Assess	Density	Rich	Ept	PMA-O	BI	Oligo %	Ept/EptC	PPCS-F
Connecticut R	357.3	9/1992	Exc	1503.4	41.0	26.0	79.8	3.52	0.1	0.89	0.74
Connecticut R	357.3	10/2007	Good-Fair	2816.0	60.0	29.0	61.9	4.71	0.0	0.50	0.38
White River	21.8	10/1992	Ex-Vgood	1611.5	38.5	25.0	86.5	4.21	0.0	0.87	0.65
White River	21.8	9/2001	Vgood	2760.0	40.0	19.0	82.8	4.17	0.0	0.87	0.46
White River	21.8	9/2006	Ex-Vgood	3028.0	42.0	26.0	62.5	4.33	0.0	0.90	0.47
White River	21.8	10/2007	Fair	2660.0	45.5	22.0	58.6	4.90	0.9	0.41	0.48
White River	26.9	9/2001	G-Fair	2544.0	43.0	22.0	87.8	4.27	0.0	0.86	0.39
White River*	26.9	10/2007	Fair	2638.0	55.5	25.5	60.3	4.60	1.9	0.41	0.43
White River*	29.4	10/2007	Fair	2194.0	44.5	18.0	55.9	4.79	3.4	0.42	0.28
White River	32.4	10/1993	Exc	1996.0	42.0	28.0	86.6	3.05	0.0	0.83	0.66
White River	32.4	10/994	Exc	1786.0	47.0	29.0	89.9	3.22	0.3	0.89	0.72
White River	32.4	9/1995	Exc	2174.0	45.0	28.0	86.2	3.27	0.0	0.96	0.77
White River	32.4	9/1996	Exc	1260.0	51.0	31.0	90.2	3.26	0.0	0.90	0.71
White River	32.4	10/2007	Vg-Good	1912.0	39.0	25.0	83.5	4.14	0.0	0.78	0.51
Reference mean				1797.0	45.8	27.0	83.0	3.20	0.1	0.90	0.64
Biocriteria Class B				>300	>30	>18	>45	<5.00	<12.0	>0.45	>0.40

**WQ parameters at locations sampled to assess
the impact of *Didymosphenia geminata* from White River, VT
Upper Conneticut River, NH/VT**

Location	Site	Date	Turb NTU	TP ug/l	TDP ug/l	TN mg/l	TNOX mg/l
Conn. R	357.3	10/17/07	1.3	9.5	5.9	0.3	0.1
White River	21.8	10/16/07	0.6	8.7	6.4	0.2	0.1
	26.9	10/16/07	0.4	4.5	3.4	0.2	0.1
	29.4	10/16/07	0.4	5.1	3.2	0.2	0.1
	32.4	10/16/07	0.2	4.2	3.3	0.2	0.1

**WQ parameters at locations sampled to assess
the impact of *Didymosphenia geminata* from White River, VT
Upper Conneticut River, NH/VT**

Stream	Site	Date	Color pco	Temp °c	pH stu	Alk mg/l	Cond unhoms/cn	Cl mg/l	SO4 mg/l
Conn. R	357.3	10/17		7	7.21	20.6	61.9	2.5	3.7
White River	21.8	10/16	10	13	8.22	38.4	128.2	9.6	6.6
	26.9	10/16	10	11	7.96	22.2	75.6	5.5	5.5
	29.4	10/16	10	11	8.02	20.8	73.0	5.3	5.4
	32.4	10/16	10	7.5	7.97	20.6	73.0	5.2	5.5

Macroinvertebrate Monitoring Sites Assessed for Effects of *Didymosphenia geminata*, Upper Connecticut River, VT/NH



Monitoring Sites

-  75-100% Didymogem cover
-  Town Boundaries
-  Streams and Rivers (1:100k)

