Controlling Didymo: effective decontamination strategies and recommendations for public outreach

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Introduction

•The appearance of didymo blooms **(Figure 1**) in new streams has generally been linked to fly-fishing activity and the use of felt-soled waders (Bothwell et al. 2009).
•Our work on didymo in New York streams indicated that there were large discrepancies in how fishermen were being advised to decontaminate their gear.
•A broad survey of didymo decontamination products was conducted by Kilroy et al. in 2007, but very little work has been done to evaluate the effectiveness of products since then.
•In order to maintain the quality of freshwater streams around the United States, a universal method for controlling didymo must be established along with effective outreach and education.
•We used surveys and experimental methods to determine effective decontamination strategies.

Methods

Fishermen Survey

•Fly-fishing is considered a vector of didymo transportation, so we conducted a survey of fly fishermen.
•Goals of the survey were: 1) to determine what fishermen thought about didymo as an invasive species and 2) to find out what they did for didymo decontamination.
•The survey was conducted online over 8 weeks in early 2012 though postings on the Trout Unlimited home page, blog, and Facebook and on Orvis's online newsletter, Twitter, and Facebook, and several other personal web pages.
•Analyzed results of 639 total responses from across the United States and Canada.

State Agency Survey

•Conducted an informal survey during the summer of 2010, when didymo blooms first became a widespread emerging threat in northeastern United States.
•We focused on Maine, Massachusetts, Rhode Island, Connecticut, New York, New Hampshire, Pennsylvania, and Vermont.
•We determined the individual states' regulations and guidelines regarding didymo control by contacting staff at these agencies and looking at their websites.
•We were interested in: 1) the extent to which state agencies provided information about didymo through signage and/or websites, 2) what methods the state agencies recommended for decontaminating fishing gear/boats.

Decontamination Experiment

•We filled 1L Nalgene bottles with the following commonly used decontaminant products:
-2% household bleach
-10% salt water
-1% Virkon Aqua
-2% Clorox® bleach
-10% Green Works® bleach (hydrogen peroxide-based)
-5% Dawn® dish detergent
-5% Green Works® dish detergent (97% naturally-derived)
•During summer 2010 and 2011, we collected weekly *D. geminata* samples from the Esopus Creek and the Rondout Creek in New York State.
•We set up five paired replicates of a decontaminant product and control (tap) water (**Figure 2**).
•We submerged *D. geminata* samples in the decontaminant product and controls for one minute.
•We stained decontaminated *D. geminata* cells with 0.5% w/v neutral red solution to assess their viability.
•Using a microscope set at 400x total magnification, we determined whether or not the decontaminated and stained *D. geminata* cells were living/dead.

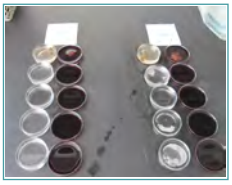

Figure 2. Our experimental design consisted of five replicates of control water and neutral red solution (left) and five replicates of decontaminant product and neutral red solution (right).

Acknowledgements

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Figure 1. The *D. geminata* bloom covering the rocks at our sample collection site on the Esopus Creek, NY.

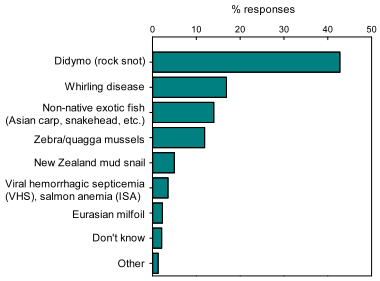

Figure 3. Fishermen's responses to the question "Which aquatic invasive species is of the single greatest concern in the coldwater streams you fish in?" (n = 623).

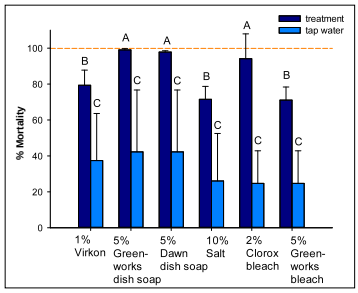

Figure 4. Treatments were significantly more effective than tap water. Letters show significant differences among the treatments. Data are means (n = 10) with standard error.

Literature Cited

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Kilroy, C., A. Lagerstedt, A. Davey, and K. Robinson. 2007. Studies on the survivability of the invasive diatom *Didymosphenia geminata* under a range of environmental and chemical conditions. National Institute of Water and Atmospheric Research, New Zealand, Client Report CHC2006-116, NIWA Project MAF06506. Christchurch, New Zealand.

Results

Fishermen Survey

•639 fishermen responded to the survey with an average response rate of 76%.
•Approximately 50% of responders accessed the survey via Trout Unlimited and 50% via Orvis.
•Didymo was overwhelmingly the species of greatest concern among fishermen surveyed (**Figure 3**).
•Fishermen's concerns regarding invasive species came from news stories (26%) and conservation organizations (23%), as well as from conversations with friends, family, or colleagues (13%) and posted signs (9%).
•Relatively few fishermen first learned about the invasive species from state agency web sites (7%), fishing stores (4%), guides or outfitters (3%), or when they got a fishing license (2%).
•There was a wide range of approaches to and challenges for decontamination (**Table 1**).
•Many fishermen seemed to interpret 'Clean' in 'Check, Clean, Dry' as rinsing with tap water.
•Most people conducted some sort of decontamination (81%), which was typically done at the end of a fishing trip (62%) but was only rarely done between every site (18%).

Decontamination Experiment

•Decontamination products were always more effective at killing didymo cells than controls (tap water) (**Figure 4**, paired t-test, $P < 0.0001$).
•Effectiveness was higher for Dawn® dish detergent, Green Works® dish detergent, and Clorox® bleach than for the other decontamination products (**Figure 4**, Tukey's honestly significantly different test, $P > 0.01$).

State Agency Survey

•Recommendations from state agencies in the northeastern United States varied widely.
•Some state agencies only suggested one decontamination method, whereas others offered as many as six different techniques.

Table 1. Responses to 'How often do you clean your gear?' (n=590), 'If you do clean, what parts of your gear do you clean' (n=502), and 'If you do clean any gear, what do you do?' (n =437) were sorted and categorized to show the proportion of who fishermen decontaminated their gear and the method they used.

Decontamination?		Method	%
		Bleach	21
Yes – waders	**45%**	Other chemical*	7
Yes – all gear	**36%**	Salt	3
		Dry	8
		Freeze	3
		Soap/detergent	14
		Rinse	**42**
		Have separate gear	3
No	19%		

*e.g. Marine Spray Nine, 409, detol, quaternary ammonia, copper sulfate, or Tilex Mold and Mildew

Conclusions

•Didymo is the aquatic invasive species of greatest concern among fly fishermen (**Figure 3**).
•Currently, there is no universal recommendation for decontaminating gear for didymo in the United States.
•Approximately 55% of fishermen reported not knowing what they were supposed to do/buy or not knowing they had to decontaminate their gear.
•Only 9% of fishermen learned about invasive species through fishing guides, fishing stores, and at the purchase of their fishing license.
•Both dish detergent and bleach were the most effective methods of killing didymo cells (**Figure 4**).
•Based on our findings, we recommend: 1) targeted and consistent outreach and education strategies be developed through related national nonprofit organizations (e.g., Trout Unlimited), 2) decontamination stations at fishing access sites be installed, and 3) didymo signage and online information should be universal across all state agencies.