

Didymo Control: Increasing the Effectiveness of Decontamination Strategies and Reducing Spread

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ABSTRACT: Nuisance algal blooms formed by the benthic diatom *Didymosphenia geminata* (didymo) have been spreading rapidly, with negative ecological and economic effects. This microscopic alga is transported on fishing equipment, and controlling the spread of didymo involves proper cleaning of gear. Our study experimentally tested several common decontamination treatments and determined the response of state agencies and fishermen to decontamination procedures. In testing decontamination products, we found that dish liquid detergent was the most effective, followed by bleach, Virkon, and salt. Decontaminants were more effective on cells that were not still attached to their stalks. From the fishermen's perspective, didymo was the aquatic invasive species of highest concern, but there was a wide range of approaches to didymo control. Our final recommendations concentrate on the importance of comprehensive information sources and standards for didymo decontamination and education, specifically, and for invasive/nuisance species more generally.

INTRODUCTION

Nonnative and nuisance species represent one of the largest threats to biodiversity in aquatic systems (Dudgeon et al. 2006). *Didymosphenia geminata*, commonly known as “didymo” or “rock snot,” is a species of diatom that is currently associated with nuisance blooms in streams. The diatom was historically widespread (Blanco and Ector 2009; Whitton et al. 2009), but the nuisance blooms appear to be a more recent phenomenon (Blanco and Ector 2009; Bothwell et al. 2009; Segura 2011), the causes of which remain poorly understood. In the northeastern United States, didymo blooms were officially confirmed in 2007 in New York, Vermont, and New Hampshire. Since then, didymo blooms have been found in five additional streams just within New York—one of which was confirmed right after ice melt in March 2011. The number of affected rivers and streams is likely to continue to rise across the United States in the future (Kumar et al. 2009).

Like many nuisance species, didymo presents both ecological and economic threats (Branson 2006; Spaulding and Elwell 2007; Kumar et al. 2009). When large mats are present, didymo may impact plant, invertebrate, and fish communities (Larned

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RESUMEN: Los afloramientos nocivos generados por la diatomea *Didymosphenia geminata* (didymo) se han expandido rápidamente, provocando efectos ecológicos y económicos negativos. Esta alga microscópica es transportada en equipos de pesca y su control implica una limpieza adecuada de los artes. En este estudio experimental se prueban varios tratamientos descontaminantes y se estudia la respuesta de las agencias estatales y de los pescadores ante los procedimientos de descontaminación. Al probar los productos descontaminantes, se encontró que el líquido detergente para trastes fue el más efectivo, seguido por los blanqueadores, el Virkon y la sal. Los descontaminantes probaron ser más efectivos en las células que aun no se encontraban fijas a su tallo. Desde la perspectiva de los pescadores, didymo fue la especie acuática invasiva de mayor cuidado, pero hubo una enorme variedad de enfoques para el control del alga. Las recomendaciones finales se concentran, de manera general, en la importancia de fuentes de información comprensibles, estándares para la descontaminación por didymo y educación, y de manera particular en el control de especies invasivas/nocivas.

et al. 2007; Bergey et al. 2009; Blanco and Ector 2009; Kilroy et al. 2009; Gillis and Chalifour 2010; James et al. 2010). Impacts to aesthetics are common, with reports of unsightly masses that appear like strands of toilet paper, generating mistaken public concerns about sanitation and sewer malfunctions (Kilroy 2004). The heavy, slippery brownish mats degrade swimming areas, although direct human impacts may be limited to swimmers complaining of eye irritation after swimming in affected areas (Kilroy 2004). Economic impacts include fouling of water intakes that can affect water supply (Kawecka and Sanecki 2003) and, in heavily infested areas, didymo may be linked to a decline in tourism and freshwater angling, particularly fly fishing. In the United States, fly fishing is a \$0.9 billion dollar industry that involves 5.6 million people (The Outdoor Foundation 2010). Fly fishermen spend an average of 15.6 days fishing each year and about half of all excursions are overnight trips, which provide additional benefits to local economies (Outdoor Industry Association 2006).

The appearance of didymo blooms in new streams has generally been linked to fly fishing activity and the use of felt-soled waders (Bothwell et al. 2009). When didymo appear in new

incorporate human activities (Hulme 2009). Predictive models could be developed based on behaviors and preferences of fishermen and used to identify hotspot sites where nuisance/invasive species might be likely to appear as well as for targeting key locations for decontamination stations (Rothlisberger et al. 2010). In the context of didymo, these models would be particularly useful for states where the species has not yet been detected but its arrival is imminent (i.e., Oregon) and could be coupled to other relevant invasive species (e.g., whirling disease, New Zealand mudsnail). This landscape-level approach is useful for within regions and across state boundaries, scales that are becoming increasingly important for invasive species management (Peters and Lodge 2009; Epanchin-Niell et al. 2010; Paini et al. 2010).

Finally, our recommendations are broadly applicable to other species, and our study adds more support to recent calls to create a more comprehensive national approach to invasive species management that would allow for better coordinated responses (Lodge et al. 2006; Peters and Lodge 2009; Paini et al. 2010). Having a national-level task force or center that could make immediate recommendations would be more efficient and effective than having individual states reinvent the wheel, which in the case of didymo seems to lead to inconsistencies and confusion. Ultimately, a nationally coordinated response would create a more rapid and consistent regulatory approach that would facilitate proactive measures, assess spatial and temporal dynamics at relevant scales, and allow for appropriate flexibility in management strategies over time.

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