



Aquatic Invasive Species (AIS) Action Plan: Didymo

This action plan is a living document and will be updated, as needed, to reflect the status of the species in Pennsylvania.

Natural History

Description: “Didymo” is a microscopic diatom alga also colloquially known as ‘rock snot’.

Taxonomy

Common name: **Didymo**
Family : **Gomphonemataceae**
Species: *Didymosphenia geminata*
ITIS Taxonomic Serial Number: **591283**

ITIS-Integrated Taxonomic Information System.

Morphology: *Didymosphenia geminata* (Bacillariophyta) is a very large (>100 microns), single-celled, ‘coke-bottle’ shaped alga known as a diatom (Figure 1a.). Diatoms are structurally unique because their cell walls contain silica (SiO₂). This gives mats of the species a characteristic ‘wet cotton’ feel when handled, which distinguishes it from species of filamentous algae which generally are slimy to the touch. *D. geminata* cells produce an extracellular, branched stalk which can form strong attachments to a variety of substrates, including plants (epiphytic) and hard substrates such as stones (epilithic) (Figure 1b.). This branched stalk is comprised of complex polysaccharides and proteins that

are resistant to degradation by bacteria or fungi.



Figures.

- 1a** (Top). Stalked didymo cells.
(Photo: Walt Butler Maryland DNR).
- 1b** (Middle). Didymo clump from upper Delaware River.
(Photo: by Tim Daley PA DEP).



Origin: Didymo is thought to be native to the northern regions of Europe, Asia, and other cool water areas in the northern hemisphere; however, in recent years it has expanded in range and habitat tolerance to include streams in warmer climates.

Food Preferences: Photosynthetic organism that can be both phosphorus and nitrogen limited.

Reproductive behavior: The life history of most diatoms includes both vegetative and sexual reproduction although the sexual stage has not so far been documented in *D. geminata*. When a *D. geminata* cell divides via vegetative cell division, the stalk also divides, forming dense mats (nuisance blooms) under certain environmental conditions (Spaulding and Elwell 2007).

Notable Characteristics: Stalked *D. geminata* consolidate in mats of up to 20 cm (~ 8 inches) in thickness on the bottom of infected waterways.

Historic Vectors: The method(s) by which *D. geminata* spread across northern North America approximately 100 years ago are unknown. The earliest record of *D. geminata* in North America is from Cleve (1894-1896) who reported it from Vancouver Island, British Columbia. Boyer, 20 years later, reported *D. geminata* in the Delaware River in the vicinity of Philadelphia, Pennsylvania (1916). In general, historical reports of *D. geminata* are sparse and voucher specimens uncommon (Spaulding and Elwell 2007).

Current Pathways/Vectors: Dispersal mechanisms are not well understood but likely are tied to angling and other stream recreation activities. Kilroy (2005) documented the ability of *D. geminata* to

survive outside of a stream in cool, damp, dark conditions for at least 40 days. Recreational equipment that may sustain *D. geminata* environments suitable for survival include: neoprene waders, wetsuits, felt-soled wading boots, fishing tackle and compartments on boats and other equipment.

Preferred Habitat: The ecological distribution for *D. geminata* appears to have expanded from more boreal, montane habitats (nutrient-poor) to aquatic habitats with higher nutrient levels. Limited information is available on the thermal requirements for successful vegetative reproduction but suggested water temperatures range from 4-27° C (39-80° F) (Kilroy *et al.* 2005; Stoddard *et al.* 2005). *D. geminata* appears to thrive in streams and rivers with stable substrates, particularly hard rock catchment areas (larger substrates resistant to higher stream velocities) and regulated rivers (smaller substrates but stable flow regimes). *D. geminata* can tolerate high water velocity (>1 m³/s) but the diatoms appear to become dislodged during storm events which cause significant bedload shift and downstream mobilization of sediment. Specific minimum water velocity requirements for *D. geminata* are currently unknown (Kilroy 2004). *D. geminata* requires high light conditions for growth, and reports generally indicate that shaded environments may limit growth. Turbidity may also be a factor limiting growth (Kilroy 2005). Noga (2003) noted that brown-stained water from peat bogs appeared to limit *D. geminata* growth and suggested that water clarity may be limiting. Reported didymo pH requirements vary but, in general, the alga seems to prefer relatively high pH streams.



Distribution and Status

Distribution: Nationally, *D. geminata* has been confirmed in at least 14 states. The majority of confirmed occurrences are in Colorado, Idaho, and Montana.

D. geminata has been confirmed in the East and West Branches of the Delaware River (New York and Pennsylvania) as well as in the Delaware River mainstem as far south as Callicoon, New York (Daley and Silldorff, personal communication). The extent of the species' distribution in Pennsylvania beyond the upper 27.5 miles of the Delaware River mainstem and the West Branch is unknown (Figure 2). The status of *D. geminata* in the Delaware River could be considered a range expansion, although natural occurrences have not been reported previously for this stretch of river and range expansion by natural causes should be considered unlikely. *D. geminata* has also been confirmed in Maryland just south of the Pennsylvania border at Gunpowder Falls in Baltimore County and in the Savage River in western Maryland (Maryland DNR, personal communication).

Pennsylvania Legal Status: Currently not regulated in 58 Pa. Code §71.6 and §73.1.

Threats

Ecological: *D. geminata* appears to cause macroinvertebrate community shifts due to the diatom's extensive coverage of exposed substrates. These shifts are generally characterized by the reduction of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) (*aka* EPT taxa) due to habitat loss and replacement by more pollution-tolerant taxa (e.g. chironomids) (Spaulding and Elwell 2007). Another unpublished study in Montana demonstrated an increase in dipteran taxa (e.g. chironomids) and loss of EPT taxa.

The effect of *D. geminata* on freshwater mussel populations is unknown. However, due to the ability of nuisance blooms to cover stream substrates to a depth of 20cm (about 8 inches), mussels may suffer from reduced ability to suspension feed, and reduced ability to move during low flow periods may lead to their desiccation. Sediment accumulating on top of *D.*

geminata mats may bury mussels completely. Although *D. geminata* blooms have been observed to have supersaturated dissolved oxygen levels within the concentrated stalk masses (Larned *et al.* 2006), mussel kills could occur if mass *D. geminata* die-off produces anoxic conditions associated with decomposition. Of particular concern are the effects of *D. geminata* on Pennsylvania's population of endangered dwarf wedgemussel (*Alasmidonta*

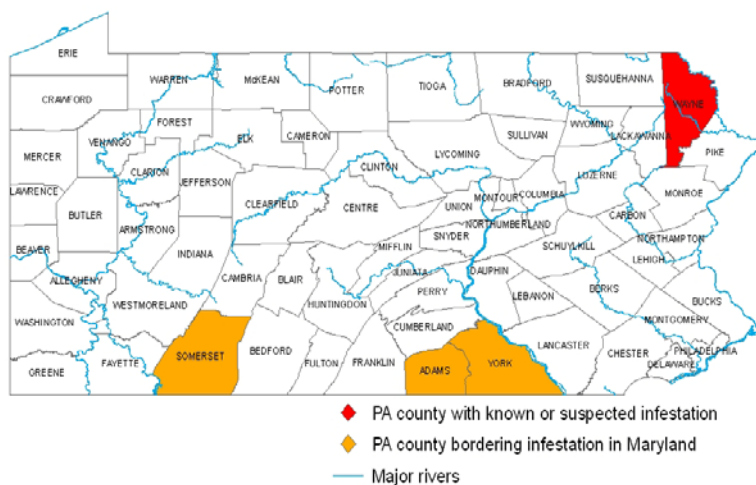


Figure 2. Pennsylvania distribution of Didymo (*Didymosphenia geminata*) (April, 2011).



heterodon) in the upper Delaware River. Studies examining the effects of *D. geminata* on freshwater mussel communities are needed.

The direct effects of *D. geminata* on sport fish, primarily trout, and other fish species have not been well studied. However, community shifts in benthic macroinvertebrates and reduction of their biomass may have a ripple-effect throughout higher trophic levels. As with freshwater mussels, *D. geminata* die-offs could cause fish mortality due to low dissolved oxygen levels.

Economic: While detailed economic threat studies of *D. geminata* impacts in the United States evidently have not yet been conducted, a 2006 report to Biosecurity New Zealand identified seven potential didymo related economic threats to that country. Potential economic impacts to many of the following, due to the effects of *D. geminata*, are likely applicable to Pennsylvania: 1) commercial and sport fisheries; 2) municipal, industrial and agricultural water intake; 3) community, municipal and domestic drinking water; 4) local recreation values; 5) tourism expenditures; 6) local existence values; and 7) existence values associated with extinction of native species (New Zealand 2006).

Human health: The frustules (hard, silica shells of the diatom) can be present in the water column downstream of nuisance blooms. As a result, people swimming in areas downstream of large blooms of *D. geminata* may experience eye irritation or itchiness similar to pollen reactions.

Management

Management Goals: Didymo already resides in Pennsylvania border waters. Therefore

management of the species needs to focus on containing or eliminating the existing populations to prevent their spreading to additional waterways.

Containment and Prevention Options: Efforts to stop the spread of *D. geminata* within Pennsylvania need to focus on containing the existing Delaware River population and to closely monitor the Maryland populations at Gunpowder Falls and the Savage River and the Pennsylvania waters near those areas.

- Initiate a public education effort to acquaint the populace with the threat of and measures to prevent the spread of didymo.
- Advocate inclusion of didymo on the invasive species lists in 58 Pa. Code §71.6 and §73.1.
- Encourage the incident reporting of aquatic invasive species within Pennsylvania. Online reporting can now be conducted at the following PFBC web site:
http://www.fish.state.pa.us/promo/form/ais_reporting.htm
- Advocate development of water hauler disinfection procedures and regulations within Pennsylvania.
- Keep informed about the potential use of DNA-based detection methodologies and also about any new developments concerning the use of biocides effective against didymo.
- Investigate didymo infected waters within Pennsylvania and inventory nearby or suspected waters.



- Research the issues of anglers spreading aquatic invasive species and the banning of relevant personnel fishing gear.
- Initiate and support research to establish the ecologic requirements of didymo and to determine its effects on fish, benthic fauna, freshwater mussel communities and other aquatic resources.

Rapid Response Options:

- Application of algaecides per existing protocols.

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