Aquatic Invasive Species (AIS) Control Plan:

Golden Alga

This control plan is a living document that will be updated, as needed, to reflect the status of the species within Pennsylvania.

Natural History

Description: Golden Alga is a single-celled, flagellated, photosynthetic microorganism that is capable of releasing toxins which can cause extensive kills of gill-breathing aquatic animals.

Taxonomy

Common name**: Golden Alga**
Family: **Prymnesiaceae**
Species: ***Prymnesium parvum***
Integrated Taxonomic Information System (ITIS) Serial Number: **2170**

Morphology: Each cell has two hair-like flagella used to swim through the water (Figure 1). There is also a shorter stiff hair-like structure called a haptonema, which can be used to attach the cell to other cells or objects (Sallenave 2018; Figure 1). Each cell has a C-shaped or "saddle shaped" chloroplast which contributes to the yellow-green color of the organism (Sallenave 2018; Figure 1).

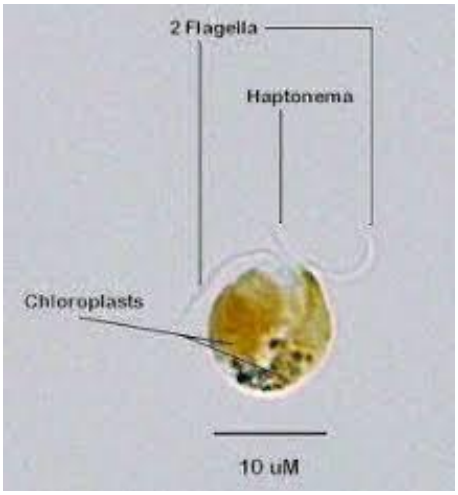

Figure 1. Micrograph of Golden Alga morphology. Source: University of Nevada.

Origin: Golden Alga is spreading globally through multiple introductions from discrete locales; the strain occurring in the United States likely originated in Europe (Lutz-Carrillo et al. 2010). In the United States, Golden Alga was first reported in water samples from a 1985 fish kill on the Pecos River, Texas (Southard et al. 2010). Since then, it has been reported in scattered locations mainly in the southern and western United States (Sallenave 2018). In Pennsylvania, Golden Alga may have been introduced from the south-central part of the United States.

Food Preferences: Golden alga can manufacture its own food when abundant nitrogen and phosphorus are available or, when these nutrients are limited, it releases chemical substances called prymnesins that allow it to envelop and digest bacteria and other algae (Barkoh and Fries 2010). These prymnesins also inhibit growth of other alga, giving it a competitive edge over other

species and leading to the potential for large blooms (Barkoh and Fries 2010).

Reproduction: This organism typically reproduces asexually through simple cell division. Fish kills generally occur at cell counts > 50 -100 million cells per liter. Golden Alga can form dormant cysts when stressed or conditions become unfavorable. Sexual reproduction exists but is not well documented outside of the laboratory (Edvardsen and Paasche 1998).

Notable Behavioral Characteristics: Golden Alga exhibits a characteristic swimming motion of moving forward while spinning on its longitudinal axis.

Historic Vectors: Numerous and non-specific. Both natural (birds, mammals) and anthropogenic (bilge water, industrial equipment, fishing gear) vectors have been proposed (Sallenave 2018).

Current Pathways/Vectors: Because of the distances involved (North Carolina being the previously closest state with infestations), circumstantial evidence points toward possible introduction of Golden Alga to Pennsylvania/West Virginia waters by means of cells (possibly encysted) carried on industrial equipment, which later spread by unknown means.

Preferred Habitat: In general, Golden Alga is found in brackish waters but tolerates a wide range of conditions (Salenave 2018). The species has a salinity range of ~1- 40 PSU (Practical Salinity Unit) and a temperature range of about 5°C to 35°C (41°F to 95°F). Besides salinity and temperature, many factors influence the growth of this species including phosphorus (P) and nitrogen (N) levels, cationic substance levels, and pH. Toxic blooms of the Golden Alga typically occur during cooler water temperatures and periods of limited nutrients (Sallenave 2018).

Distribution and Status

Distribution: Golden Alga has been reported from at least 14 countries among every continent but Antarctica (Southard et al. 2010). In the US, at least 23 States, including Pennsylvania and West Virginia, have reported Golden Alga. In Pennsylvania, Golden Alga has been documented in Greene County within the Dunkard Creek and Whiteley Creek watersheds (Figure 2).

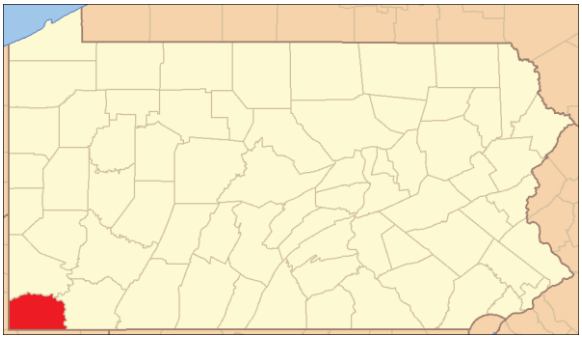

Figure 2. County-level distrbution of Golden Alga in Pennsylvania (December 2020).

Pennsylvania Legal Status: As of April 2021, Golden Alga is not regulated in 58 Pa. Code §71.6 and §73.1.

Threats

Toxicity: Blooms of Golden Alga release toxins under stressed conditions, such as when nutrients become limited (Sallenave 2018). Golden Alga can release several chemical compounds called prymnesins that combine with cations (such as magnesium [Mg++] and calcium [Ca++]) in the water to make toxins. The type of toxin created is dependent on the water chemistry and usually there is a combination of toxins in the water. The toxins cause cells without protective layers, such as on the surface of gills and fins, to fail. Exposed cells either die due to chemical damage or lyse due to excessive osmotic pressure (Sallenave 2018). In fish, the gills become so badly damaged that they are unable to function, and blood vessels in the gills hemorrhage. Affected fish behave as if there is not enough oxygen in the water. They travel at the top of the water surface or rest on the bottom in edges and shallow areas, and ultimately succumb to asphyxiation (Sallinave 2018; Figure 3). These toxic effects extend to other aquatic organisms, including amphibians, invertebrates, plankton, and bacteria (Barkoh and Fries 2010).

Human Health: Golden Alga toxins have no apparent lethal effect on non-gill breathing organisms; therefore, it is not known to be a human health concern (Texas Parks and Wildlife 2009; Sallenave 2018).

Figure 3. Fish kill resulting from Golden Alga bloom. Source: Michael Hooper (USGS).

Environmental and Economic: Severe economic losses can occur from fish kills caused by Golden Alga (Figure 3). Recent economic losses to communities and hatcheries in Norway and Texas, for example, are estimated in millions of U.S. dollars (Barkoh and Fries 2010; Sallenave 2018). Despite years of research on Golden Alga, no proven strategies have been developed to prevent or mitigate bloom formation or toxicity effects in large water bodies (Barkoh and Fries 2010).

In Pennsylvania, fisheries in colonized waters having the potential to reach the optimal conditions necessary for a Golden Alga bloom are at risk of producing large fish kills. This occurred in 2009 within Dunkard Creek in Greene County, which decimated populations of many fish species, freshwater mussels, and Mudpuppy

Salamanders (C. Urban, personal communication).

Management

Management Goals: Golden Alga already resides in Pennsylvania. Therefore, management of the species must focus on containing or eliminating existing populations, on preventing their spread, and on preventing new incursions of the species from out of state.

Containment and Prevention Actions: Efforts to stop the spread of Golden Alga in Pennsylvania need to focus on containing the existing Dunkard Creek and Whiteley Creek populations (both in Greene County), on identifying potential habitat for new incursions, and on preventing the alga from infesting those areas:

- Initiate a public education effort to acquaint the populace with the threat of and measures to prevent the spread of Golden Alga. Because Golden Alga can potentially spread on recreational equipment such as boating gear, waders, and fishing tackle, education efforts should include best practices to disinfect gear. These include completely draining water from watercraft bilges, live wells, and other areas; allowing all materials or equipment to fully dry for at least three days; or disinfection with 10% bleach solution (Sanninave 2018).

- Request Federal and Pennsylvania State agencies to monitor for Golden Alga during routine water quality sampling. This can be accomplished by examining water samples for Golden Alga via microscopy or by Environmental DNA (eDNA) sampling (Sallinave 2018).

- Consider the inclusion of Golden Alga on the invasive species lists in 58 Pa. Code §71.6 and §73.1.

- Encourage the incident reporting of aquatic invasive species within Pennsylvania. Although Golden Alga may be difficult to identify outside of a laboratory setting, the reporting of suspected observations is encouraged. Online reporting can now be conducted at the following PFBC web site: https://pfbc.pa.gov/forms/reportAIS.htm as well as PA iMapInvasives at: https://www.paimapinvasives.org/ and at the national level, USGS Nonindigenous Aquatic Species website: https://nas.er.usgs.gov/SightingReport.aspx

- Discuss the water hauler disinfection procedures and regulations within Pennsylvania with appropriate state partners and initiate guidance or regulatory oversight to prevent the spread of AIS such as Golden Alga.

- Initiate and support research to elucidate the ecological requirements of Golden Alga in Pennsylvania waters and develop strategies to prevent or mitigate bloom formation. This includes engaging with appropriate state and

federal partners to monitor Golden Alga in Pennsylvania watersheds, particularly in the southwestern region of the Commonwealth.

Rapid Response Options:

- Implement public outreach efforts in the vicinity of a Golden Alga bloom.

- Consider application of algaecides such as ammonium sulfate or copper-based algicides to control small blooms in ponds or lakes, following cost-benefit analysis considering possible impacts to non-target species (e.g., fish, amphibians). Treatment is often unachievable in flowing water or large water bodies (Sallinave 2018).

References

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