Aquatic Invasive Species (AIS) Action Plan:

Golden Alga

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: Golden alga, is a single cell (microscopic), flagellated member of the haptophytes that is capable of releasing toxins which can cause extensive kills of aquatic animals.

Taxonomy

Common name**: golden alga**
Family: **Prymnesiaceae**
Species: ***Prymnesium parvum***
ITIS Taxonomic Serial Number: **2170**

ITIS-Integrated Taxonomic Information System.

Morphology: Each cell has two hair-like flagella used to swim through the water. 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. The cell has a C-shaped chloroplast that wraps around the middle and is where the yellow-green color is seen. (Texas 2009a).

Figure 1. Golden Alga.
(Photo: Dr. Carmelo Tomas, University of North Carolina at Wilmington).

Origin: Worldwide distribution - Research by Lutz-Carrillo *et al*. (2010) suggests that *P. parvum* is spreading globally through multiple introductions from discrete locales, and that the strain occurring in the United States originated in Europe. The alga was first identified in the U.S. in water samples from a 1985 fish kill on the Pecos River, Texas. Since then four additional Texas river systems, the Brazos, Canadian,

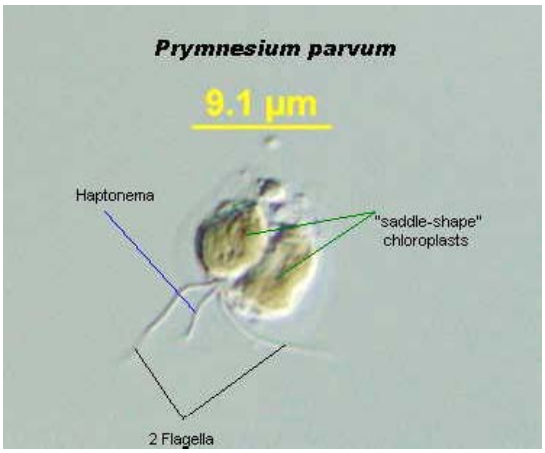

Figure 2. Golden Alga.
(Photo: Greg Southard, TPWD).

Colorado, and Red, have been affected. Pennsylvania *P. parvum* 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: Usually asexual through simple cell division. Fish kills generally occur at cell counts > 50 -100 million cells per liter. *P. parvum* can form dormant cysts when stressed or conditions become unfavorable for the alga. Sexual reproduction exists but is not well documented outside of the laboratory.

Notable Behavioral Characteristics: The alga exhibits a characteristic swimming motion of moving forward while spinning on its longitudinal axis (Texas 2009a).

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

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

Preferred Habitat: Despite being reported worldwide, the organism remains fairly obscure and relatively little has been reported about its environmental requirements. In general, *P. parvum* is found in brackish waters but tolerates a wide range of conditions. 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 affect the species' growth rate including phosphorus (P) and nitrogen (N) levels, cationic substance levels, and pH. Toxic blooms of the alga occur at salinity levels of 1-12 PSU, temperatures of 10°C to 25°C (50°F to 77°F), and at fairly high P and N levels (Texas 2009a).

Distribution and Status

Distribution: Eighteen states, including Pennsylvania and West Virginia, have reported golden alga. In Pennsylvania, golden alga has been documented in Greene County in the Dunkard Creek and Whiteley Creek watersheds (Figure 3).

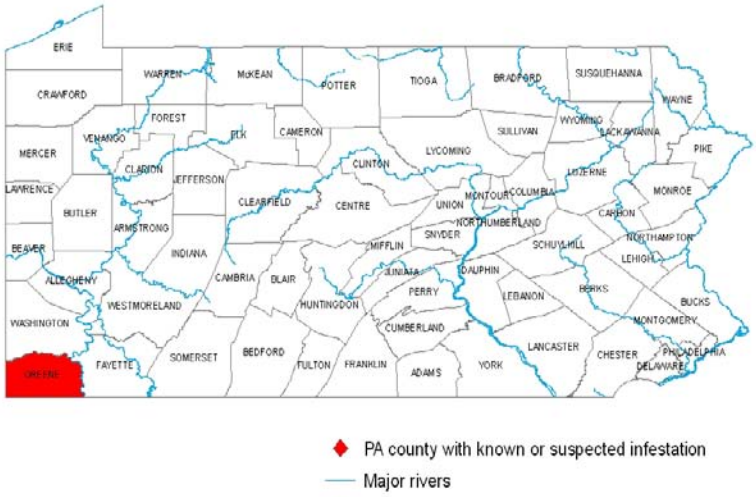

Figure 3. Pennsylvania distribution of Golden Alga (*Prymnesium parvum)* April, 2011.

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

Threats

Toxicity: *P. parvum* releases at least two 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 (Texas 2009a). In fish, the gills become so badly damaged that they are unable to function, and blood vessels in the gills hemorrhage. At the same time, the toxins and other waterborne chemicals enter into the circulatory system resulting in damage to internal organs. 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. These toxic effects extend to other aquatic organisms, including amphibians, invertebrates, plankton, and bacteria (*in* Barkoh and Fries 2010).

According to experiences in Texas, golden alga toxins have no apparent lethal effect on non-gill breathing organisms. Cattle, predators, scavengers, birds and other animals have been observed drinking water during a bloom, and many eat the dead fish during on-going golden alga fish kills with no apparent effects. This trait separates golden alga from the related algae that cause the infamous ‘red tides’. Officials from the Texas Department of State Health Services have stated that the golden alga is not known to be a human health problem (Texas 2009b).

Environmental and Economic: Severe economic losses can occur from the fish kills caused by golden alga. Recent economic losses to communities and

hatcheries in Norway and Texas, for example, are estimated in millions of U.S. dollars (Oh and Ditton, 2005; Johnsen *et al*., 2010; Southard *et al*., 2010 in Barkoh and Fries 2010). At one Texas hatchery, several hundred thousand striped bass were killed by a bloom. 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 waters having the potential to reach the optimal conditions necessary for a *P. parvum* bloom are at risk of being virtually wiped out. This was demonstrated in 2009 in Dunkard Creek in Greene County. Other at risk waters include those being affected by mineral resource extraction such as streams in the Marcellus shale fields.

Management

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

Containment and Prevention Actions: Efforts to stop the spread of *P. parvum* within Pennsylvania need to focus on containing the existing Dunkard Creek and Whiteley Creek populations (both in Greene County).

- Initiate a public education effort to acquaint the populace with the threat of and measures to prevent the spread of golden alga.
- Request Federal and PA State government agencies to monitor for aquatic invasive species during routine water quality sampling. For golden alga, request these agencies to monitor for the alga in streams with high chloride/TDS levels, especially in previously infected waters.
- Encourage Federal and PA State government agencies to share statewide knowledge of elevated chloride/TDS waterways within the Commonwealth.
- Advocate 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. 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.
- Initiate and support research to establish the ecological requirements of golden alga and to develop strategies to prevent or mitigate bloom formation.

Rapid Response Options:

- Implement public outreach efforts in the vicinity of a golden alga bloom.
- Application of algaecides per existing protocols.

References

Barkoh, Aaron and Loraine T. Fries, 2010. Aspects of the Origins, Ecology, and Control of Golden Alga (*Prymnesium parvum):* Introduction to the Featured Collection. Journal of the American Water Resources Association (JAWRA) 46(1):1-5. DOI: 10.1111/j.1752-1688.2009.00394.x

Edvardsen, B. and A. Larsen. Phylogeny, Life History, Autecology and Toxicity of *Prymnesium parvum,* PowerPoint presentation.

Lutz-Carrillo, D.J., G.M. Southard, and L.T. Fries, 2010. Global Genetic Relationships Among Isolates of Golden Alga (*Prymnesium parvum).* Journal of the American Water Resources Association. 46(1):24-32.

Texas Parks and Wildlife Department. 2007. Guidelines for Golden Alga (*Prymnesium parvum*) Management Options for Ponds and Small Reservoirs (Public Waters) in Texas.

Texas Parks and Wildlife. 2009a. The Biology of Golden Alga, (*Prymnesium parvum*). http://www.tpwd.state.tx.us/landwater/water/environconcerns/hab/ga/bio.phtml April 26, 2010.

Texas Parks and Wildlife. 2009b. Golden Alga. Management Data Series 236: Management of *Prymnesium parvum* at Texas State Fish Hatcheries. http://www.tpwd.state.tx.us/landwater/water/environconcerns/hab/ga/ April 26, 2010.