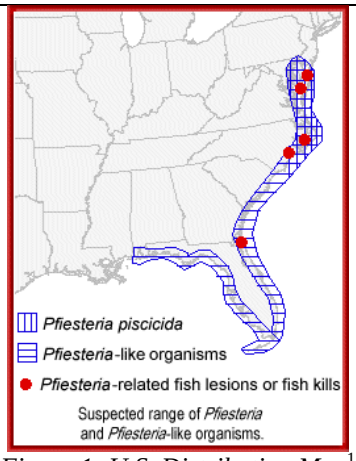
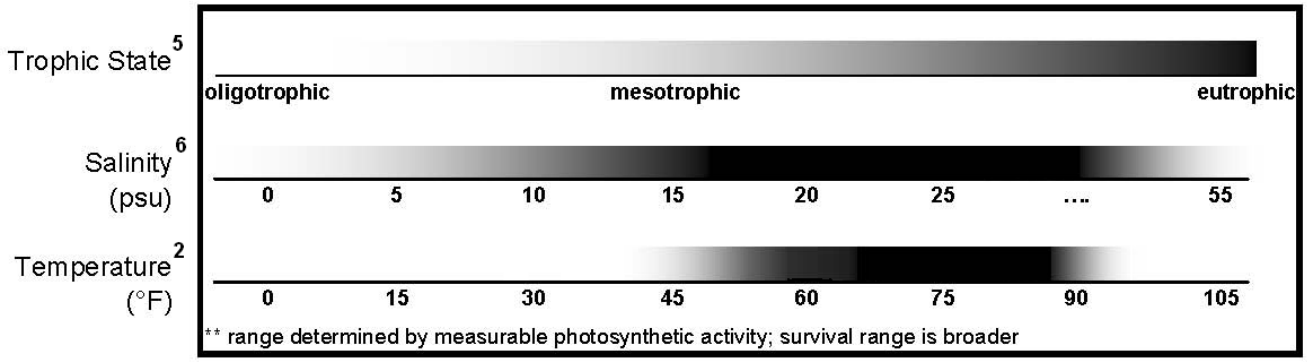
| Dinoflagellate | “Cell from Hell”; “Ambush Predator”; “Phantom Dinoflagellate” |
|---|---|

| **I. Current Status and Distribution** | | ***Pfiesteria piscicida*** |
|---|---|---|
| **a. Range** | **Global/Continental** | **Wisconsin** |
| **Native Range**<br>Native to United States coasts[1] |  <br>*Figure 1: U.S. Distribution Map*[1] | Not recorded in Wisconsin[1,2] |
| **Abundance/Range**<br>Widespread:<br><br>Locally Abundant:<br>Sparse: | <br>Brackish coastal waters from Delaware to North Carolina[1]<br>Undocumented<br>Undocumented | <br>Not applicable<br><br>Not applicable<br>Not applicable |
| **Range Expansion**<br>Date Introduced:<br>Rate of Spread: | <br>Not introduced; believed to be native[1]<br>First discovered in 1988[1,3]; estimated 1 billion fish killed in fall 1991[4]; has not been found in freshwater lakes, streams, or other inland water[1,2] | <br>Not applicable<br>Not applicable |
| **Density**<br>Risk of Monoculture:<br>Facilitated By: | <br>Undocumented<br>Undocumented | <br>Unknown<br>Unknown |
| **b. Habitat** | Warm, brackish, poorly flushed waters, high levels of nutrients[1] | |
| **Tolerance** | Chart of tolerances: Increasingly dark color indicates increasingly optimal range | |




| **Preferences** | Shallow, brackish, slow-moving waters (typical of estuaries); temperature of 75°F; abundant fish population; high levels of nutrients (nitrogen and phosphorous)[7] |
|---|---|

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| **c. Regulation** | |
| Noxious/Regulated: | *Not regulated* |
| Minnesota Regulations: | *Not regulated* |
| Michigan Regulations: | *Not regulated* |
| Washington Regulations: | *Not regulated* |
| **II. Establishment Potential and Life History Traits** | |
| **a. Life History** | Marine/estuarine dinoflagellate[1]; flagellated, amoeboid, and cyst stages[8] |
| **Fecundity** | Undocumented |
| **Reproduction** | Sexual; Asexual; highly complex life cycle, 24 reported forms, several of which can produce toxins[1] |
| Importance of Gametes: | Produces anisogamous gametes (sexual)[5] |
| Vegetative: | Produces temporary cysts (asexual)[5] |
| **Hybridization** | Undocumented |
| **Overwintering** | |
| Winter Tolerance: | Cysts can stay dormant in sediment[2]; undocumented cyst temperature tolerance |
| Phenology: | Potentially a problem from April through October[9] |
| **b. Establishment** | |
| **Climate** | |
| Weather: | Temperate to tropical[5] |
| Wisconsin-Adapted: | Cysts can stay dormant in sediment; cyst temperature tolerance unknown[2] |
| Climate Change: | Likely to facilitate growth and distribution[5] |
| **Taxonomic Similarity** | |
| Wisconsin Natives: | Unknown |
| Other US Exotics: | Unknown; other *Pfiesteria*-like organisms (PLOs) from Delaware to Gulf of Mexico[1] |
| **Competition** | |
| Natural Predators: | Flagellated stages vulnerable to some protozoan ciliates (e.g. *Stylonychia* cf. *putrina*), rotifers (e.g. *Brachionus plicatilis*), and microcrustacean copepods (e.g. *Acartic tonsa* Dana)[10] |
| Natural Pathogens: | Undocumented |
| Competitive Strategy: | Heterotrophs: can consume other organisms and perform photosynthesis[1]; can survive in cyst form until optimal conditions present itself; considered a generalist that can target a wide array of fish and shellfish[11] |
| Known Interactions: | Fish are not killed by infection of *Pfiesteria*, but by the toxins released or by secondary infections[1]; causes lesions in many species of fish, such as Atlantic menhaden[1] and in shellfish[5] |
| **Reproduction** | |
| Rate of Spread: | Very quick; can switch from cyst stage to flagellated (potentially toxic) in a matter of minutes |
| Adaptive Strategies: | Can form dormant cyst stages when environmental conditions are not optimal |
| **Timeframe** | Toxic outbreaks of *Pfiesteria* are typically very short (less than a few hours), but once fish are weakened by toxins, lesions or fish kills may persist for days or weeks[1]; 15 minutes is long enough to complete the process of killing a fish[12] |

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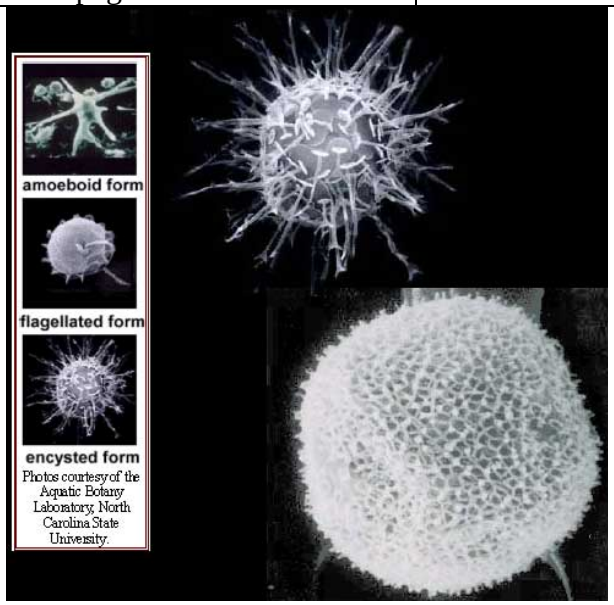
| **c. Dispersal** | |
| Intentional: | Unlikely |
| Unintentional: | Wind and water currents, waterfowl, aquaculture waters[11]; trawling activities may help suspend benthic stages and nutrients in the water column[11] |
| Propagule Pressure: | Undocumented |



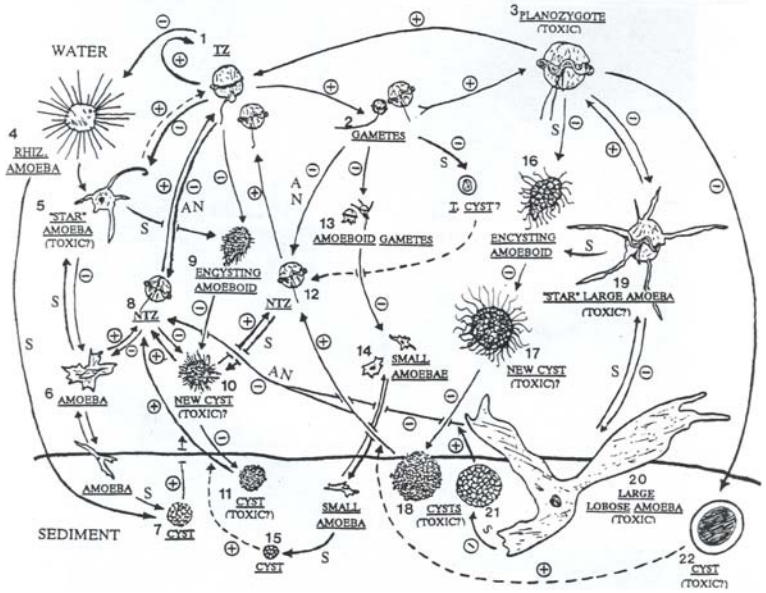




*Figure 2: Courtesy of the Aquatic Botany Laboratory, North Carolina State University*
*Figure 3: Courtesy of J.M. Burkholder and H.B. Glasgow, Jr.*[11]

| **III. Damage Potential** | |
|---|---|
| **a. Ecosystem Impacts** | |
| **Composition** | Can cause major fish kills when toxins are released[1]; no associated mortalities or symptoms reported for seabirds or marine mammals[7]; can cause shellfish kills/distress when toxins are released[11]; feeds on bacteria, algae, and microfauna when fish are not present[10]; can kill in fresh or ocean water, but is deadliest in brackish water (salinity of 15psu)[4] |
| **Structure** | Hypothesized to play multiple roles in estuarine microbial food webs[10] |
| **Function** | Undocumented |
| **Allelopathic Effects** | Can become toxic in the presence of fish (triggered by secretions or excrement in water)[1] |
| **Keystone Species** | Undocumented |
| **Ecosystem Engineer** | Undocumented |
| **Sustainability** | Undocumented |
| **Biodiversity** | Undocumented |
| **Biotic Effects** | Undocumented |
| **Abiotic Effects** | Water in which *Pfiesteria* is found often has low dissolved oxygen levels[7] |
| **Benefits** | Undocumented |
| **b. Socio-Economic Effects** | |
| **Benefits** | Undocumented |
| Caveats | Not applicable |
| **Impacts of Restriction** | Increase in monitoring, education, and research costs |

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| **Negatives** | Exposure to water with toxins may cause cognitive impairment such as memory loss and confusion, as well as skin lesions, respiratory distress, eye irritation, and gastro-intestinal problems[1]; no evidence that consumption of infected seafood causes human health problems[1]; state closures of water bodies can occur, hindering commercial fishing and recreation[1] |
| **Expectations** | Reduction of point and non-point pollution into water bodies may help limit toxic events |
| **Cost of Impacts** | Decreased recreational and aesthetic value; decline in ecological integrity; increased research expenses |
| **"Eradication" Cost** | Undocumented |
| **IV. Control and Prevention** | |
| **a. Detection** | |
| Crypsis: | Very high; several other unnamed *Pfiesteria*-like species and similar dinoflagellates |
| Benefits of Early Response: | High; ability to close off affected areas in order to reduce potential human health problems |
| **b. Control** | |
| **Management Goal 1** | Eradication |
| Tool: | Concentrated sulfuric acid or ammonium hydroxide[4]; 35 days of desiccation[4] |
| Caveat: | Impossible in the natural environment; highly negative effects on other organisms |
| Cost: | Undocumented |
| Efficacy, Time Frame: | 20% of cysts can still survive this extremely harsh treatment[4] |
| Monitoring: | Very difficult to monitor due to complex life cycle and rapid stage transformations[2]; research must be conducted in a limited-access level III biohazard containment system[13] |

[1] U.S. Environmental Protection Agency. 1998. What you should know about *Pfiesteria piscicida*. EPA 842-F-98-011. Washington, DC: USEPA Office of Water. Retrieved December 28, 2010 from: http://www.epa.gov/nscep/index.html

[2] New Jersey Department of Health and Senior Services. 2000. *Pfiesteria*: Background Information and Contingency Plan. Retrieved December 28, 2010 from: www.state.nj.us/health/pfiesteria.pdf

[3] Chesapeake Bay Journal. October 1997. Pfiesteria facts. Retrieved December 28, 2010 from: http://www.bayjournal.com/article.cfm?article=2181

[4] Boyle, R.H. 1996. Phantom: The tenacious scientist and the elusive fish killer. Natural History 105(3):16-19.

[5] National Museum of Natural History. Identifying Harmful Marine Dinoflagellates. Retrieved December 28, 2010 from: http://www.nmnh.si.edu/botany/projects/dinoflag/Taxa/Ppiscicida.htm

[6] Sullivan, B.E. and R.A. Andersen. 2001. Salinity tolerances of 62 strains of *Pfiesteria* and *Pfiesteria*-like heterotrophic flagellates (Dinophyceae). Phycological Research 49(3):207-214.

[7] Buck, E.H., C. Copeland, J.A. Zinn and D.U. Vogt. 1997. *Pfiesteria* and Related Harmful Blooms: Natural Resource and Human Health Concerns. Retrieved December 28, 2010 from: http://cnie.org/NLE/CRSreports/Marine/mar-23.cfm

[8] Steidinger, K.A., J.M. Burkholder, H.B. Glasgow, Jr., C.W. Hobbs, J.K. Garrett, E.W. Truby, E.J. Noga and S.A. Smith. 1996. *Pfiesteria piscicida* gen. et sp. nov. (Pfiesteriaceae fam. nov.), a new toxic dinoflagellate with a complex life cycle and behavior. Journal of Phycology 32(1):157-164.

[9] North Carolina Department of Environment and Natural Resources. 1997. What you should know about Pfiesteria and NC's waters. Retrieved December 28, 2010 from: http://www.enr.state.nc.us/files/pfies.htm

[10] Burkholder, J.M. and H.B. Glasgow, Jr. 1997. *Pfiesteria piscicida* and other *Pfiesteria*-like dinoflagellates: behavior, impacts, and environmental controls. Limnology and Oceanography 42(5):1052-1075.

[11] Burkholder, J.M., H.B. Glasgow, Jr., and C.W. Hobbs. 1995. Fish kills linked to a toxic ambush-predator dinoflagellate: distribution and environmental conditions. Marine Ecology Progress Series 124:43-61.

[12] Hagar, M. and L. Reibstein. The 'Cell from Hell': Pfiesteria strikes again in the Chesapeake Bay. Newsweek. 25 Aug. 1997.

[13] Doyle, M.E. 1998. Toxins from Algae/Cyanobacteria. University of Wisconsin Food Research Institute. Retrieved December 28, 2010 from: http://fri.wisc.edu/docs/pdf/algtoxin.pdf