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DE Terlizzi
University of Maryland Cooperative Extension Center of Marine Biotechnology, dterlizz@umd.edu

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Pfiesteria Hysteria, Agriculture, and Water Quality in the Chesapeake Bay: The Extension Bridge over Troubled Waters

Abstract
Public fear of environmental problems from toxic chemicals to toxic microbes can lead to overreaction in consumer behavior and public policy. When the dinoflagellate Pfiesteria piscicida became synonymous with water quality degradation in the Chesapeake Bay and was linked to human health concerns, the agricultural and environmental communities were polarized. Public fear in spite of relatively low risk led to the passage of the Water Quality Improvement Act in 1998. An Extension education program to reduce public fear and clarify the science is presented as a case study of Extension education in the midst of conflict over environmental issues.

D. E. Terlizzi
Sea Grant Water Quality Specialist
University of Maryland Cooperative Extension Center of Marine Biotechnology
Baltimore, Maryland
dterlizz@umd.edu

Introduction

In an essay titled "The Burden of Skepticism," the late astronomer Carl Sagan noted that in this era of "too much information" it was critical to maintain skepticism of new or developing ideas. However, Sagan emphasized, the "burden" of this skepticism was to risk rejection of potentially important new issues. This essay appeared in *Why People Believe Weird Things* (Shermer, 1998), which considers a number of recent examples of uncritical public acceptance, often based on fear, of scientific information. This may be especially true in the environmental field, where public fears of environmental phenomena are inversely related to perceived ability control these phenomena, so issues as seemingly disparate as shark attacks or pesticide contaminants in food and ground water may result in similar public over-reaction, even hysteria.

The occurrence of toxic algae events may cause similar human reactions. Whether manifested in large-scale fish deaths or human poisoning from shellfish consumption, public fear is aroused and regular media coverage of these events may exacerbate fear or potentiate the public to react irrationally to relatively minor, low-risk situations.

Consider the case of the dinoflagellate *Pfiesteria piscicida* in the Chesapeake Bay. Dinoflagellates are microscopic components of the phytoplankton communities common in estuarine and coastal waters worldwide. A small percentage of them are toxic, and ingestion of contaminated seafood can result in illness and death. *Pfiesteria* received extensive media coverage as a result of its association with fish kills in North Carolina and widely publicized accounts of human illness from exposure to *Pfiesteria*, including bizarre behaviors and loss of short-term memory. Reports of its unusual life history and its ability to "morph" through multiple stages along with reports of attacking fish and "eating" grisly open sores or lesions in them (Glasgow, Burkholder, Schmechel, Tester, & Rublee, 1995) contributed to the view that *Pfiesteria* was more of a threat than other harmful algae.

In the Chesapeake Bay, dinoflagellates are a normal and important part of the summer phytoplankton communities (Glibert & Terlizzi, 1999). It has been known for some time that species known to be toxic in other regions occurred in the Bay (Marshall, 1996), and it was a recurring question why there were no toxic events in the Chesapeake. In a sense, the Chesapeake was vulnerable, but had not experienced the toxic algal events that appeared to be occurring with increasing frequency world-wide (Hallegraeff, 1993).

This article is a case study of the so-called "*Pfiesteria* hysteria" in the Chesapeake Bay in 1997 from an Extension perspective. There was a need to present the public with scientific information about the ecology of harmful algae while clarifying the uncertainties including the possible role of agriculturally derived nutrients in the "outbreaks" as they were termed of *Pfiesteria.* The "burden" of skepticism in this case included conflict with environmental advocates eager to accept and promote the view that *Pfiesteria* was caused by nutrient contamination from intensive poultry production in the region.

Coping with the Nutrient Problem

Ecological impacts of nutrient pollution have been the overriding management concern in the Chesapeake Bay for decades. In response, The Chesapeake Bay Program, a combined state and federal program concerned with restoration of the Bay, has addressed the problem through nutrient reduction at the point and non-point source levels. Public education has been a key component in the Chesapeake restoration effort including the activities of the Chesapeake Bay Program, and various advocacy (e.g., Chesapeake Bay Foundation) and non-advocacy (e.g., Sea Grant) organizations. As a result, public awareness of the role of nutrients and their sources, including (perhaps especially) agriculture, in the decline of the Chesapeake is high.

To combat agriculturally derived nutrients, Maryland initiated a voluntary Nutrient Management Program in 1989 using Extension consultants funded through the Maryland Department of Agriculture and Maryland Department of the Environment (Perkinson, 1994). Although increasingly adopted by the agricultural community, failure to reach the 40% nutrient reduction goals established by the Chesapeake Bay Program resulted in growing perceptions of the environmental community that voluntary nutrient management programs were not effective. Attempts to develop legislation mandating nutrient management by the Maryland agricultural community were not successful in the early 1990s, leaving environmentalists frustrated and concerned that a major source of the non-point nutrient load to the Bay was not being adequately regulated.

The *Pfiesteria* Focusing Event

Ernst (2003) has recently discussed the complex interaction between the Chesapeake Bay Program, resource management agencies, the Chesapeake Bay Foundation, and political action. He applies the "issue-attention" cycle model developed by Downs (1972) to Chesapeake Bay management. This model consists of five stages:

1. The pre-problem stage
2. The alarmed discovery and euphoric enthusiasm stage
3. The cost realization stage
4. The decline of intense public interest stage
5. The post-problem stage

The best opportunity for developing nutrient management legislation would be during the "alarmed discovery and euphoric enthusiasm stage" which characterized the period in which the Chesapeake Bay Agreement, calling for 40% nutrient reductions, was developed in the 1980s. However, opportunities develop for change through specific events, termed "focusing events," even in the "post problem stage" of Chesapeake Bay Policy. These focusing events attract public attention and catalyze policy change (Downs, 1972; Birkland, 1997).

Public concern about water quality in the Chesapeake increased dramatically during a nationally publicized focusing event, the "*Pfiesteria* hysteria" of 1997. Reports of human symptoms of *Pfiesteria* exposure included short-term memory loss, respiratory problems, and numbness in extremities (Glasgow et al., 1995). Concerns about human health and the possible association of *Pfiesteria* with agricultural nutrients resulted in polarization of the agricultural and environmental communities. The co-occurrence of the dinoflagellate *Pfiesteria piscicida* with lesions and fish mortalities in the Chesapeake in 1997 was preceded by several events causing public concern:

- Peer-reviewed publications describing an unusually complex life history, including over 20 stages, toxic effects on fish, human health impacts, and connections with agriculturally derived nutrients.
- A popular account of the discovery and human health impacts of *Pfiesteria*, *And the Waters Turned to Blood* by Rodney Barker, that increased public concern.
- Prominent media coverage of *Pfiesteria piscicida* (e.g., *New York Times*) with descriptions of *Pfiesteria* like "cell from hell."

The *Pfiesteria* hysteria of 1997 was preceded in 1996 by a large fish kill in an estuarine aquaculture facility (Hyrock Farm) using water from a tributary of the Chesapeake with a low cell density of *Pfiesteria* and suspiciously high cell density of *Gyrodinium galatheanum* (now called *Karlodinium micrum*) (Terlizzi et al., 2000; Deeds et al., 2002). The presence of *Pfiesteria* in these

fish kills prompted reports in both popular and technical literature that *Pfiesteria* was the culprit. In a less emotional climate this observation might have broadened analysis and interpretation of the problem.

However, intense media coverage before and during the *Pfiesteria* hysteria potentiated the public and during the summer of 1997 heightened public fear and altered consumer behavior in Maryland toward seafood and recreational use of the Bay (Strand, 1999). In addition, 1997 was an election year, and the campaign of an incumbent, environmental governor was increasing momentum along with media coverage of the *Pfiesteria* issue and public fears.

Consumer panic resulted in a $43 million loss in seafood sales (Lipton, 1999). The description of health impacts among Maryland Commercial fishermen and others with high exposure levels (Grattan et al., 1998) led to the conclusion that the *Pfiesteria* "outbreak" was a clear linkage between Chesapeake Bay water quality and human health. The fish lesion and mortality events associated with *Pfiesteria* occurred in Bay tributaries of the lower eastern shore of Maryland, which had developed high soil phosphorous levels as a consequence of N-based fertilizer recommendations and the use of poultry litter from the large poultry industry centered there (Coale, 1999).

As a result, agriculturally derived nutrients were now linked to *Pfiesteria*, fish lesions, and fish mortality and ultimately were a threat to human health. Nevertheless, some scientists remained skeptical and maintained that these connections were circumstantial. In terms of its power as a focusing event, the *Pfiesteria* hysteria satisfied all of the criteria used by environmental groups seeking to mobilize public reaction on an environmental issue:

- It was a "breaking" media event;
- There were compelling images of destruction (lesions and fish kills);
- There was a clearly defined villain;
- There was human drama.

The Water Quality Improvement Act of 1998 was proposed, requiring mandatory nutrient management planning in place of voluntary incentive-based programs. Evidence for the magnitude of concern that *Pfiesteria* threatened human health is the Congressional allotment in 1998 of $18 million to *Pfiesteria* projects, including the Chesapeake Bay, in spite of what some scientists regarded as circumstantial evidence. This allotment was a funding level similar to that of the annual Chesapeake Bay Program annual budget (Ernst, 2003).

The Extension "Bridge"

The guiding philosophy of Sea Grant Extension programs is a non-advocacy approach in addressing coastal, marine, and estuarine issues (Bacon, 2000). In the *Pfiesteria* hysteria of 1997, environmentalists and the agricultural community were in conflict, and the environmental community appeared to use the *Pfiesteria* focusing event to create the nutrient management legislation to control agricultural nutrients that had been unsuccessful earlier. The agricultural community felt that their voluntary contributions to nutrient reduction were being ignored and that the normal rigor of the scientific method had been disregarded. At one gathering of poultry producers protesting the Water Quality Improvement Act, Frank Perdue, founder of the eponymous, vertically integrated Poultry company, was observed carrying a sign stating "good sense, good science."

During the media frenzy that occurred during the fish lesion and mortality events of 1997 and prior to the passage of the Water Quality Improvement Act (WQIA) of 1998, the author made over 50 presentations to committees of the Chesapeake Bay program, resource agency personnel, agricultural groups, environmental groups, college classes, and concerned citizens. In addition to direct educational methods news columns, he employed feature articles in the Maryland Sea Grant Publication *Maryland Aquafarmer* and interviews (radio, television, and video). The goal was to provide current technical information on the nature of harmful algal blooms including *Pfiesteria* to educate clientele on the role of nutrients and environmental factors in algal blooms and to reduce public fear. This approach was based conceptually on the relationship between hazard and public outrage that results in public perception of risk (Hutcheson, 1999; Sandman, 1987). In the case of *Pfiesteria* in the Chesapeake, the hazard may be relatively small, so outrage determines the perception of risk.

During the *Pfiesteria* "hysteria" of 1997, educational approaches from some environmental groups were designed to increase outrage and perception of risk. For example, one Bay advocacy group released a fund-raising flyer displaying fish with lesions and raised the question, "is this the future of the Bay?" The non-advocacy approach acknowledged water quality problems in the Bay but attempted to reduce public fear through presentation of the science and discussion of the limits of the information available to guide decisions. The following points were incorporated into presentations.

- Dinoflagellates are normal components of the Bay phytoplankton community, and, although a number of species were present in the Bay that are known to be toxic elsewhere (Marshall,

1996), this was the first apparent toxic event in the Bay that accounted for some of the concern.

- Nutrients are one factor thought to be involved in the increased appearance of harmful algal blooms (Hallegraeff, 1993). The Chesapeake Bay clearly has a nutrient problem; however, the linkages of Harmful algal blooms to nutrients are not always clear (Anderson, Glibert, & Burkholder, 2002).

- Dinoflagellates other than *Pfiesteria* may be involved in the fish health issues observed. For example, an aquaculture fish kill was dominated by *Karlodinium micrum* (Terlizzi et al., 2000; Deeds et al., 2002)

- The association of dinoflagellates other than *Pfiesteria* but of similar size resulted in the use of the term "*Pfiesteria*-like," which is misleading because of the hyperbole associated with *Pfiesteria* and scientific challenges to *Pfiesteria* biology, including toxicity and aspects of its life history.

Outcomes

The WQIA was adopted by the Maryland General Assembly in 1998. The agricultural community was resistant, feeling that additional work to clarify the link between nutrients and *Pfiesteria* was necessary.

Paolisso (1999) notes that an important outcome of the *Pfiesteria* hysteria and debate surrounding the WQIA was the "emergence of a widely held view of farmers as polluters who need to be regulated" and that the environmental contributions and economic concerns of farmers were not adequately included in the debate. Concerns about human health led Environmentalists to argue in favor of the WQIA and contributed to the polarity of environmentalists and the agriculture community, who felt that their role in improvement of the environment through voluntary adoption of agricultural best management practices was overlooked (Paolisso & Maloney, 2000). Perhaps the most serious long-term consequence of the passage of the WQIA in response the health concerns of *Pfiesteria* is the alienation of the agricultural community. Since the passage of the WQIA the following has occurred.

- The complex, unique life history of *Pfiesteria*, its ability to cause lesions, and the presence of a toxin have been challenged by various investigators (Blazer, et al., 1999; Litaker, 2002; Berry et al. 2002).

- *K. micrum* a dinoflagellate associated with the 1996 aquaculture fish kills (Terlizzi et al., 2000) and some of the events in the Chesapeake Bay have been shown to be toxic. (Deeds et al., 2002).

- Although *Pfiesteria* is widely distributed in the Bay and may be correlated with nutrients, there have been no fish health or human health consequences on the scale of those reported in 1997.

- There are increasing reports that *K. micrum* is a possible cause of fish mortality in the Chesapeake (Goshorn et al., 2002).

- There is evidence that some of the practices required under the WQIA may actually increase nutrient release into the Chesapeake.

The comprehensive, stringent control of nitrogen and phosphorous through the WQIA could be justified by the concerns about oxygen reduction and decline of submersed aquatic vegetation in the Bay. However, the impetus for this legislation, *Pfiesteria piscicida,* may not be as serious a concern in the Chesapeake as was thought during the panic of 1997. It is possible that *K. micrum*, which was present in some of the Chesapeake fish kills in 1997, and the fish kills at Hyrock farm in 1996, 1997, and 1999 that were attributed to *Pfiesteria* is the real concern. Therefore, the WQIA may be as some have described "the right law for the wrong reasons."

Recent research suggests that the WQIA may increase nutrient run-off to the Bay, indicating the WQIA may have the wrong outcomes as well (Maryland Center for Agroecology, unpublished press release www.agroecol.umd.edu). When presented with evidence suggesting *Pfiesteria* may not be responsible for fish kills and *K. micrum* is the likely culprit in the Chesapeake as appears to be the case in the aquaculture kills at Hyrock farm, some argue that it is not important because *something* is killing fish. However, in terms of public perception and value as a focusing event to effect change, it is very important for the following reasons.

- There are no claims that *K. micrum* is toxic to humans.

- *K. micrum* has a simple life history in contrast to that reported for *Pfiesteria* and in common with many other dinoflagellates.

- Monitoring and management for human or ecosystem health protection are routine for many harmful algal species and could be applied to *K. micrum* in the Chesapeake.

Since the *Pfiesteria* hysteria in 1997, a toxic dinoflagellate (*Dinophysis acuminata*) caused the

closure of oyster beds, and blooms of the toxic cyanobacterium *Microcystis* caused a beach closure without public over reaction. So it appears likely that if the events of the Chesapeake were attributed to a toxic dinoflagellate rather than the "cell from hell" as *Pfiesteria* had been described in the media, its value as a focusing event that led to the passage of the WQIA would have been limited.

In summary, this Extension effort yielded a number of outcomes that have significant implications for management of the Chesapeake and for other Extension professionals facing similar issues.

- The combination of Extension programming and applied research involved contributed to the discovery of *K. micrum* as the first confirmed toxic dinoflagellate in the bay.
- *K. micrum* is now a focal point of harmful algal monitoring in the Chesapeake.
- Citizen awareness of harmful algae, causes, and impacts in the Chesapeake increased and may help to avert "hysterias" in the future.

Extension and Environmental Advocacy

One of the potential consequences of non-advocacy education in an emotionally charged, polarized environmental issue is, ironically, the appearance of advocacy. For example, in one presentation on *Pfiesteria,* nutrients ,and agriculture to a group of poultry growers, one participant remarked "looks like he's on our side." In another presentation to a group of environmental writers/communicators, a prominent leader in the Bay Environmental community asked, "how can you question the linkages between nutrients and *Pfiesteria* and not be an apologist for Frank Perdue?" (the nationally prominent poultry integrator from the eastern shore of Maryland).

Extension educators will increasingly deal with sensitive environmental problems, and they need to be aware that in an emotionally charged climate like the *Pfiesteria* "hysteria" of Maryland, non-advocacy can appear to be advocacy by simply pointing out the limitations of the science we are charged with extending. Ensuring that all of the voices are heard, even in an Extension non-advocacy role, can make entry into conflict unavoidable.

There is also the problem of public perception of science. For example, Kenner (1998) notes, "Our society is awash in politicized science; very often the public recognizes it and distrusts research, scientists and associated organizations because of it." In the "*Pfiesteria* hysteria," both the problem--the *Pfiesteria*-agricultural nutrient-human health connections and the cure, mandatory nutrient management imposed on the agricultural community by the environmental interests--had political components.

Science by its very nature does little to resolve this. For example, Holling (1995) notes that in science "there are not only conflicting voices but conflicting modes of inquiry." And in events like the "*Pfiesteria* hysteria," these conflicts are amplified through media coverage.

Blockstein (2002) discusses the reluctance of many scientists to participate in political issues because of the risk of creating the appearance of advocacy. Extension professionals may be even more reluctant because our mission is the dissemination of research-based knowledge, but environmental issues with prominent media coverage may challenge this paradigm. Blockstein suggests the following to maintain credibility when scientific information is limited:

- Follow the facts and tell the truth.
- Obey the rules of science.
- Present caveats.
- Identify uncertainty.
- Distinguish between guesswork and uncertainty.
- Avoid hyperbole.

This is sound advice for both research scientists and Extension educators dealing with complex, volatile environmental issues, and following these guidelines may serve to ease the burden of skepticism.

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