



**Division of Water Quality  
Annual Report of  
Fish Kill Events 1997**

Water Quality Section  
Environmental Sciences Branch  
Raleigh, NC

December 1997

## **Executive Summary**

Field investigators reported 57 significant fish kills during the period of June to November 1997. Significant kills are those where mortality equals or exceeds 25 fish. Reported mortality counts ranged from 25 to 50,000 with most estimates ranging from 100 to 1,000 individuals. Kill events resulted in the loss of over 91,000 fish composed of 26 freshwater and 9 saltwater species. Most kill events (72%) occurred in the Cape Fear, Yadkin/PeeDee, and Neuse River basins. While most kills in 1996 occurred in the eastern half of the state as a result of hurricane effects, 1997 kills were the result of more typical water quality problems. Kills were distributed across the state from Pamlico Sound to as far west as Transylvania County.

The following report is mandated under Section 4 of Chapter 633 of the 1995 North Carolina General Assembly Session Laws.

## Introduction

In 1996 the DWQ Environmental Sciences Branch (ESB), in consultation with Regional Office staff, North Carolina Wildlife Resources biologists, and Division of Marine Fisheries personnel instituted a new fish kill investigation procedure. The procedure is used by the DWQ Regional Offices and other agencies to collect and track information on fish kills throughout the state. Fish kill data are recorded on a standardized form and sent to the ESB where the data are compiled and reviewed. The procedure also requires the notification of appropriate state officials and scientists associated with the investigation of such events. Fish kill investigation forms and supplemental information sent to the ESB are compiled in a central database where the information



can be managed and retrieved for use in reporting to concerned parties. Fish kill data are also reviewed as part of the DWQ efforts to monitor water quality trends across the state.

Kill events occurring in 1997 were investigated, reported, and tracked for the second full year under the new protocols. The protocols continued to perform well as a tool for tracking kill events and appeared to be fully adopted by the various state agencies responsible for field investigations. Efforts to cross-reference ESB data with public complaints and reports in the media revealed that field investigators accounted for nearly all significant kill events in 1997.

A number of improvements to DWQ fish kill monitoring efforts were initiated in 1997. ESB fish kill information was moved to a more powerful relational database system which made data management and retrieval more efficient. Additionally, the yearly data was made available to the public on the Internet at the ESB Fish Kill Event Update website (<http://207.4.102.3/fishkill.htm>). The DWQ has also sought the support of pathologists from the NCSU College of Veterinary Medicine. NCSU pathologists have been asked to examine diseased and distressed fish collected from fish kill sites or troubled waterbodies. Their input will aid in efforts to assess the overall health of fish populations associated with river basins where fish kills occur. Another significant improvement to DWQ fish kill monitoring efforts has been the establishment of the Neuse River Rapid Response Team (NRRRT) during 1997. The four-member team responds to reports of fish kills, algal blooms, and other water quality problems in the lower Neuse River and its tributaries, and the result has been a more accurate and complete assessment of these events in the lower Neuse drainage.

The ESB has also initiated the process of tracking diseased and distressed fish sightings reported to field investigators. Through this effort, the DWQ hopes to expand its monitoring of the state's waterways to include fish health related events that do not meet criteria necessary for tracking under the division's current fish kill investigation protocol.

Diseased/distressed sightings are confirmed by field investigators and tracked by the ESB using similar methods as fish kill investigations, however; the information is maintained in a separate data set from kill event reports. Poor water quality in trouble spots throughout North Carolina's waterways has produced sublethal effects on fish populations. The need to track sublethal problems has become apparent in DWQ efforts to effectively monitor water quality.

### **Suspected Causes of Fish Kills**

Causes of fish kills may or may not be obvious to investigators depending on a host of factors and situations. Many kill events can safely be attributed to a cause, but others remain unconfirmed or unclear since many investigations are after the fact and often composed of subjective information. The ESB reviews and tracks suspected causes of fish kill events conveyed by field investigators as part of kill monitoring efforts. Suspected causes aid in evaluating potential water quality trends and problems, and assist scientists and decision-makers with formulating future courses of action. Suspected causes should not be viewed as a definitive label for a particular event.

*Dissolved Oxygen Depletion:* Dissolved oxygen (DO) depletion was suspected as a cause or contributing factor in one third (21 of 57) of the fish kill events in 1997. Fish kills associated with low DO levels were reported statewide and often occurred after heavy rain events or during periods of dry weather and low flow. Anoxic conditions continued to occur in the lower Neuse and Tar/Pamlico basins as nutrient and organic loading coupled with water column stratification depleted DO levels during the summer months. Fish kills also occurred as a result of sewage spills that created substantial demands for DO during the release and breakdown of the wastes.

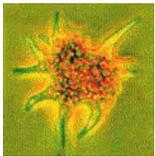
*Sewage and Toxic Substance Spills:* Spills of toxic substances and sewage caused nearly 30% (17 of 57) of fish kills during 1997. Waste spills either depleted DO levels in receiving streams or induced kills outright through physical or chemical toxicity. Kill events induced by sewage spills were reported throughout North Carolina but were particularly prominent in Durham County where 4 spills (2 million gallons of sewage) involved over 5,000 fish. Although several waste spills were reported from agricultural operations, the majority resulted from ruptured or malfunctioning municipal systems. Spills of toxic substances - far less common than sewage spills - included gasoline, hydrochloric acid, sodium hypochlorite, and chloropyrofos.



*Algal Blooms:* The eutrophication of waters throughout North Carolina has resulted in an increase in phytoplankton blooms and subsequent fish kill events. Phytoplankton blooms cause DO and pH fluctuations, as well as DO depletion through diurnal cycles and decomposition. These changes often precede fish kill events. Several species of phytoplankton also release toxins during the course of a bloom which are detrimental to aquatic life. Blooms were suspected as a cause or contributing factor in nearly 20% (11 of 57) of fish kill events in 1997.



*Pfiesteria:* Since its identification in the early 1990's, the dinoflagellate *Pfiesteria piscicida* has been blamed for massive fish kill events in estuarine systems in North Carolina, especially the Neuse and Tar/Pamlico basins. *Pfiesteria* has a complex life cycle with at least three look-alike species that are indistinguishable under light microscopy. The presence of finfish can stimulate certain morphological stages of the organism to emit a neurotoxin that attacks the fish. Scientists consider *Pfiesteria* levels of 250-300 cells/ml to be toxic or capable of inducing fish kills (Burkholder et. Al., 1995).



The ESB laboratory does not have the capability to speciate *Pfiesteria* and its look-alikes nor determine if the organism is a direct causative factor in fish disease and mortality. The ESB does, however, use light microscopy to monitor *Pfiesteria*-like organisms in water samples collected in areas associated with fish kills, stressed/diseased fish events, and algal blooms. Results of the monitoring efforts indicated that *Pfiesteria*-like organisms were present in water column samples from just 2 of the 57 fish kill events for 1997. This surprisingly poor correlation is further complicated by the fact that monitoring results also showed toxic levels of *Pfiesteria* look-alikes in at least two dozen instances during the year where no fish kills occurred (see stressed and diseased fish reports below).

The ESB will continue to monitor *Pfiesteria* levels in conjunction with fish kill investigations. Presently these organisms remain poorly understood as a factor in fish kill events as is their interaction with other causes.

*Unknown Causes:* Causes for fish kill events are listed as unknown when investigators fail to suggest clear causative factor(s). Investigations may not yield definitive causes when they are performed too long after an event, or when a number of factors are suspected but not confirmed. Unknown causes were listed for 28% (16 of 57) of fish kills in 1997.

## **Fish Species Affected**

Fish kills in 1997 affected at least 26 species of freshwater fish and 9 species of estuarine or saltwater fish. Freshwater species most commonly identified during investigations included largemouth bass, sunfishes, catfishes, shad and suckers. Estuarine species most commonly encountered included menhaden and croaker. Menhaden, which have historically been the subject of large fish kills along the coast, were cited in only 5 kill events during 1997. Menhaden were, however, observed as stressed and/or diseased in numerous coastal investigations and citizen complaints.



Additional animals were observed at about 17% of the 1997 kill events. These included crabs, crayfish, jellyfish, clams, mussels, frogs, insects, and turtles. Only clams, crabs, and jellyfish were present in significant numbers during kill investigations.

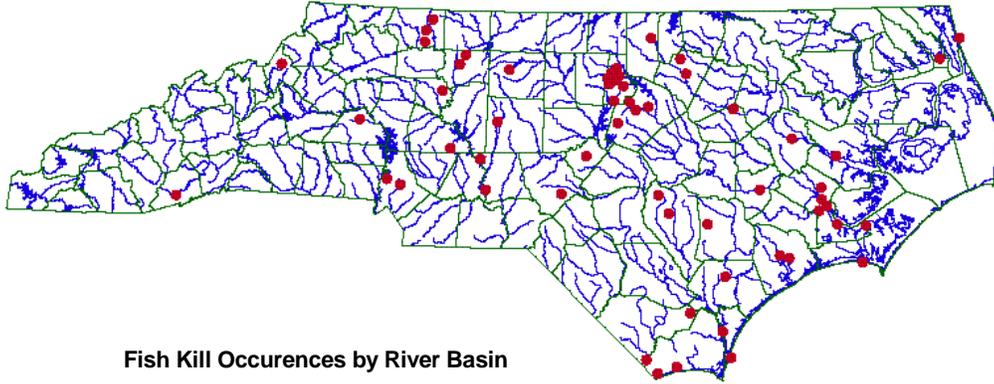
## **Fish Mortality**

Mortality estimates ranged from 25 to over 50,000 individuals. A majority (75%) of the reported kill events produced estimates from 25 to 1,000 fish. Large scale and catastrophic kill events seen in previous years were not witnessed by investigators during 1997. Total mortality for all species, statewide was reported at over 91,000 fish, making 1997 a relatively light year when compared to mortality totals in other years this decade. Reported kills during 1991, 1992, 1995, and 1996 involved fish counts ranging from hundreds of thousands to over one million. Mortality may have been kept to a minimum in 1997 through better responses in cases of sewage and waste spills, and by more favorable weather conditions (ie: cooler and drier than normal periods in the summer months) with regard to DO depletion and algal blooms.

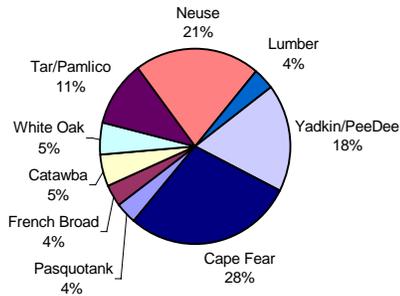
## **River Basin Event Summaries**

Fish kills occurred in 9 of the 17 major river basins across North Carolina in 1997. Most reported events occurred in the Cape Fear, Yadkin/Pee Dee, and Neuse drainages. Kill events occurred from Pamlico Sound westward as far as Transylvania County. Few kill events were reported in the northeast corner and western third of the state. Details of all 1997 kill events are listed in Appendix A.

**Fish Kill Events Reported to the NC Division of Water Quality  
April to November 1997**



**Fish Kill Occurences by River Basin**



*Pasquotank Basin:*

Only two fish kills were reported in the Pasquotank basin during the year. A small kill in Camden Co. near Camden Point Shores was apparently the result of low DO. A substantial clam kill was reported off Corolla Light and is thought to have occurred as a result of disturbances from an offshore storm. No finfish were reported affected in the Corolla kill.

*Tar/Pamlico Basin:*

Six moderate to small fish kills were reported in the Tar/Pamlico basin from June to August. Two sewage spills from the municipalities of Oxford and Sharpsburg (Granville and Nash counties) released over 1.2 million gallons of waste and killed a total of nearly 400 fish in the upper Tar drainage. Problems with DO and algal blooms produced kills in several impoundments throughout the basin, and unknown factors caused kills and disease in menhaden near Goose Creek State Park (Beaufort, County.).

### *Neuse Basin:*

The Neuse basin had 12 reported kills from June to November with the most intense activity occurring in July. The upper Neuse experienced numerous sewage spills from municipal and industrial sources in Durham and Wake counties. These spills released over 1.5 million gallons of waste and affected 1,500 to 2,000 fish. Lower portions of the Neuse basin experienced problems with algal blooms and depleted DO affecting thousands of fish. *Pfiesteria*-like organisms were identified at a kill of menhaden in Adams Creek (Carteret County.) and in the Neuse River near Carolina Pines (Craven County) in late July. The kill near Carolina Pines affected 50,000 finfish (mostly juvenile croaker not exhibiting sores or other symptoms of a *Pfiesteria* attack) as well as 2,000 crab and jellyfish, and was the largest reported kill in 1997.

### *White Oak Basin:*

The White Oak basin experienced 3 small fish kills during the 1997 season, 2 in the New River drainage and one in the Atlantic Ocean near Fort Macon (Carteret County.). Low DO levels were reported as a factor in the New River events, both of which occurred in the Jacksonville area. The Fort Macon event resulted from unknown causes but many of the affected croaker exhibited red and eroded fins. Fish samples were sent to NCSU for analyses (see pathology reports below).

### *Cape Fear Basin:*

Sixteen fish kill events were reported in the Cape Fear basin during the 1997 season - more than in any other drainage. Upper sections of the Cape Fear drainage suffered a number of spill-related events. A chemical spill in Greensboro and several sewage spills near Durham and Sanford released nearly 1.8 million gallons of pollutants and affected over 5,000 fish. Reported problems with DO and algal blooms were associated with events in the lower reaches of the Cape Fear. Most of these kills occurred in July and August during periods of dry weather and low flow.

### *Yadkin/Pee Dee Basin:*

Ten kill events were reported in the Yadkin/Pee Dee basin stretching from Surry to Montgomery counties. Spills of sewage, pesticides, and agricultural waste were blamed for the loss of over 4,000 fish. Pervasive conditions of algal blooms and DO depletion produced kill events similar to those reported in other basins during hot and dry periods. One large shad kill was observed in Randolph County during the early Spring. Shad kills are often the result of breeding stress and changing environmental conditions.

*Lumber Basin:*

Three events involving 1,000 fish or less were reported in the Lumber watershed. The events were associated with agricultural runoff as well as hot weather and low flow conditions.

*Catawba Basin:*

Three events recorded in the Catawba basin during 1997 were associated with urban areas and spill activity. A kill of 800 fish at Freedom Park Lake in Charlotte was attributed to a leaky sewer line and low DO levels. Other events in Catawba and Mecklenburg counties involving over 400 fish were blamed on spills of sodium hypochlorite and gasoline.

*French Broad Basin:*

The French Broad basin contained only two small events during the year. Unknown causes were to blame for a small kill of trout in Transylvania County, near Rosman, and a sewage spill from the Town of Newland WWTP caused a kill of trout and minnows in Avery County.

**Large Fish Kills (Mortality  $\geq$  1,000 fish)**

Investigators reported 15 events where fish mortality exceeded 1,000 fish.

*Lake Reece near Asheboro, Randolph County, Yadkin/Pee Dee Basin, May 19*

Investigators reported a fish kill of over 5,000 shad in Lake Reece just west of Asheboro. The event was similar to other large shad kills that seem to occur in piedmont reservoirs during the spring. Recent heavy rains and flooding coupled with stress from spawning were suspected as a cause.



*Dison's Creek, Montgomery County, Yadkin/Pee Dee Basin, May 27*

DWQ personnel responded to a hog waste spill from the N.G. Purvis Riverside Farm. Investigators reported a dark colored waste entering Dison's Creek from the farm as well as over 1000 fingerling size fish dead in the creek. Affected species included bass, sunfishes, catfishes, and suckers. DWQ staff members assessed benthic macroinvertebrate populations at the site approximately one week after the event. Results showed good bioclassifications upstream and downstream of the spill.

*Page Lake near RDU Airport, Wake County, Neuse Basin, July 3*

This kill of 1,000 bass, sunfishes, and crappie was caused by a draw-down of Page and Brier Reservoirs for construction of I-540. Most of the dead fish were observed in the upper

sections of Page Lake and Stirrup Iron Creek. The lake is a county owned flood control structure with no public access.

*Bearskin Swamp near Salemburg, Sampson County, Cape Fear Basin, July 10*

Hot, dry conditions are suspected to have contributed to the kill of mostly bass, sunfishes, and catfishes. Low DO levels were noted in some reaches of the swamp during the investigation. Fish were observed gasping at the surface and lethargic. Total mortality was estimated at around 2,000 fish.

*Neuse River near Carolina Pines, Craven County, Neuse Basin, July 22*

Dissolved oxygen depletion along the Neuse River was suspected as the major cause of this event. No sores were observed on fish and 90% of the dead fish were croaker. Total mortality was estimated around 50,000 fish making the event the largest of the year.

*Adams Creek near Merrimon, Carteret County, Neuse Basin, July 22*

Investigators from the Neuse Rapid Response Team reported a kill of at least 2,000 fish (croaker, perch and menhaden). About one-half of the fish were reported as having bloody gills. The DWQ/ESB staff measured *Pfiesteria*- like organisms at 111 cells/ml in samples collected from the scene. Trawlers were also seen in the area prior to the kill. The cause remains unknown.

*Unnamed Tributary to South Buffalo Creek, Guilford County, Cape Fear Basin, July 27*

A kill of 3,500 fish was caused by a spill of 18,000 gallons of hydrochloric acid from the Worth Chemical Company in Greensboro. Species included carp, sunfishes, catfishes, and minnows.

*Northeast Creek/Burden Creek, Durham County, Cape Fear Basin, July 27*

A mechanical failure and subsequent sewage spill from the Triangle WWTP caused a kill of over 1,300 sunfish, bass, catfishes, and shad. The event caused a release of 1.6 million gallons of sewage into the Burden/ Northeast Creek catchment.

*Watts Farm Pond near Shallotte, Brunswick County, Lumber Basin, August 6*

Investigators suspected a toxic event which killed 1,000 fish at this private farm pond. The cause, however, was listed as unknown. The owner observed a mosquito truck in the area days before but county officials did not confirm it.

*Swift Creek/Mahlers Creek, Wake County, Neuse Basin, August 13*

A sewage spill from a collection line to the Garner WWTP was responsible for this kill of 1,000 fish. The spill was estimated from 500,000 to 1 million gallons and affected multiple species including catfishes, suckers, sunfishes, bass, and shad. NCWRC biologists performed the assessment.

*Coon Creek near Oxford, Granville County, Tar/Pamlico Basin, August 19*

A sewage spill of 1.2 million gallons from an Oxford pumping station resulted in a kill of over 3,500 fish. Low flow conditions during the event allowed for little dilution of the waste,

consequently, low DO and elevated coliform counts were detected up to 3 miles downstream. The kill affected sunfishes, catfishes, suckers, minnow species, and darters.

*Little Coharie Creek at Sinclair Lake, Sampson County, Cape Fear Basin, August 21*

No cause was established for this kill of 3,000 fish. DO levels were not critical during the investigation and the fish had been dead for several days when NCWRC biologists arrived on the scene. Affected species included bass, catfishes, sunfishes, and suckers.

*Pond in Mary Dell Estates near Durham, Durham County, Cape Fear Basin, August 26*

Low dissolved oxygen levels were suspected as a cause in this kill of over 4900 sunfishes, catfishes, and largemouth bass. An abundance of duck and goose waste was also noted near the pond as well as several lawn service trucks in the area.

*Carolina Beach Lake, New Hanover County, Cape Fear Basin, September 4*

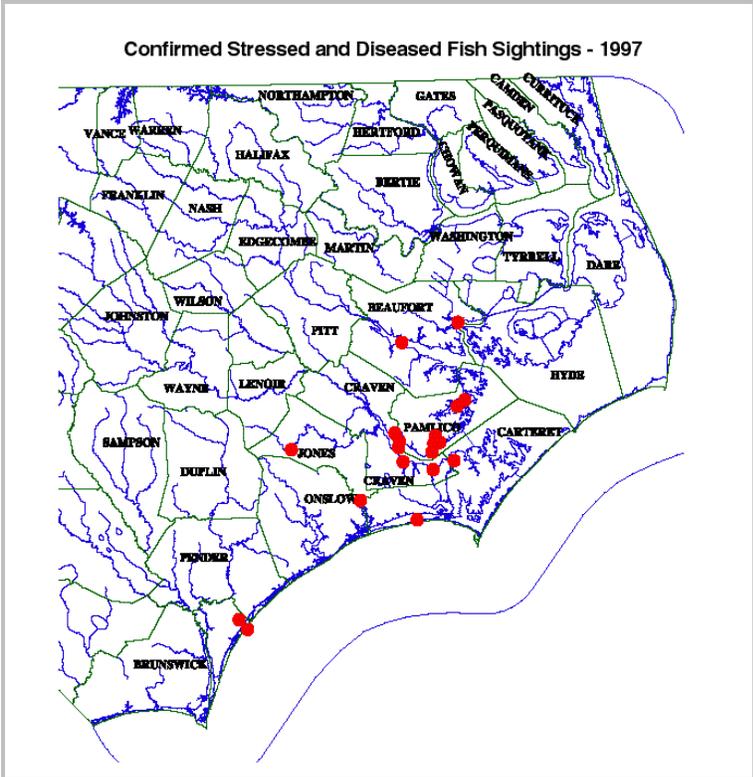
An algal bloom was blamed for this kill of nearly 1,500 fish in a coastal impoundment. Most fish affected were mullet, but sunfishes and pinfish were also present. Investigators ruled out toxic spills and *Pfiesteria* as causative factors.

*Lovills Creek at Mount Airy, Surry County, Yadkin/ Pee Dee Basin, October 7*

A sewage leakage from a junction in the Town of Mount Airy sewage lines caused this kill of over 3,000 bass, sunfishes, catfishes, perch and minnows. DO levels were reported as acceptable (>4.0 mg/L) during the event leading investigators to suspect another agent in the sewage as a possible cause for the kill.

### Stressed and Diseased Fish Reports

In addition to monitoring fish kill events, the DWQ initiated the process of tracking stressed and diseased fish sightings reported to field investigators during 1997. The DWQ expanded monitoring efforts to include fish health related events that do not meet criteria necessary for tracking under the division's current fish kill investigation protocol. Poor water quality in trouble spots throughout North Carolina's waterways has produced sublethal effects on fish populations that warrant investigation and tracking, but remain unaccounted for in DWQ fish kill assessments. Stressed/diseased sightings are therefore compiled and reviewed by the DWQ to further augment fish kill data from the state's waters.



Investigators confirmed 21 stressed or diseased fish events in North Carolina during 1997. Numerous additional complaints were relayed to various agencies but could not be confirmed by investigators. Most events involved menhaden, a species often observed in poor condition during the summer months in coastal rivers and estuaries. Investigators often observed stressed or diseased menhaden when other species in the immediate area appeared fine. A majority of fish were reported as suffering from ulcerative lesions in conjunction with lethargy or gasping behavior. Other observations included fin erosion, flared or bloody gills, fungal infections and various inflamed tissues. Stressed/diseased sightings were limited to the coastal plain from Pamlico Sound south to New Hanover County (see Appendix B). Confirmed sightings were especially frequent in the Neuse basin, apparently as a result of improved monitoring efforts by the Neuse River Rapid Response Team.

*Pfiesteria* has been frequently associated with stressed/diseased events as well as fish kills. *Pfiesteria* has been closely linked to the type of ulcerative lesions described on fish specimens from this and previous years. The DWQ identified *Pfiesteria*-like organisms in water samples collected from 10 of the 21 stressed/diseased locations in 1997. *Pfiesteria* cell counts ranged from 12 to 1,479 cells/ml. Cell counts exceeding 250-300 cells/ml - a level suggested by scientists as being toxic - were measured at 5 of the 21 locations

### **North Carolina State University Fish Pathology Results**

As part of efforts to monitor fish kill or stressed/diseased events, the DWQ has sought the support of pathologists from the NCSU College of Veterinary Medicine. NCSU pathologists were asked to examine fish collected from fish kill sites or troubled waterbodies and offer additional expertise in DWQ investigations. During the summer and early fall of 1997, pathologists examined 72 fish (menhaden, Atlantic croaker, white mullet, flounder, red drum, and bluegill, and 1 cownosed ray) from 10 different sites where fish kills or stressed fish were observed. Gross examinations were performed on all fish. Wet mount preparations of gills and histopathological examinations were performed on selected fish with representative lesions.

*Gross findings:* Many fish had one to several lesions of the skin and underlying musculature which were often circular and often centered on the anal pore. These lesions ranged from 4 mm to >3 cm in diameter, were of variable depth. Lesions were most severe in the menhaden, although a few of the Atlantic croaker and mullet had small lesions. Several groups of mullet and Atlantic croaker had only caudal fin erosions, which were of variable severity. A few of these fish had small skin ulcers as well.

*Microscopic findings:* No remarkable lesions were found in the wet mount preparations of gill tissue. Within the inflamed tissues, special stains revealed abundant mixed bacteria and fungal growth which were probably secondary infections (Law, 1997).



*Summary:* In general, most of the observed lesions were compatible with the “ulcerative mycosis” lesions of menhaden reported by Noga, *et al.* in 1986 (Journal of Fish Diseases 9:47-53) and later attributed to the “dermonecrotic toxin” produced by the *Pfiesteria* organism (Burkholder *et al.*, 1992; Noga *et al.*, 1996; Baden, unpublished data, 1997). These findings do not, however, indicate a specific cause for disease and may reflect the affects of multiple water quality and pathological factors. The cause of the fin erosions observed in Atlantic croaker is undetermined. Fin erosions may be attributed to a number of infectious as well as chemical/toxic agents (Law, 1997).

### **The Neuse River Rapid Response Team**

The Neuse River Rapid Response Team, a work unit of the DWQ, was established in 1997 to respond to fish kills, algal blooms, and other water quality problems in the lower Neuse basin. Based in New Bern, the 4 member team has drastically reduced the Division's response times to water quality events. In addition to event responses, the team performs weekly transects of dissolved oxygen measurements in the lower Neuse River and tributary creeks, as well as monthly base-line monitoring surveys from Streets Ferry, above New Bern, to the Pamlico Sound. Data are reviewed by the DWQ and shared with other researchers and institutions. This information is used in efforts to interpret how physical and chemical conditions act as stress factors to fish and invertebrate populations. Water quality parameter findings are summarized in weekly updates and posted on a world- wide web page maintained by the N.C. Department of Environment, and Natural Resources (<http://207.4.102.3/#BAG>).



### Summary /Future Efforts:

Fish kill events in 1997 were the result of many factors that have been associated with fish mortality in prior years. Point source spills appeared to be the primary cause in several basins during the year. Such events were often caused by ruptured or malfunctioning waste management systems. Problems with low DO levels and algal blooms affected waters across the state as the result of nutrient enrichment and eutrophication. In addition to these factors, the presence of *Pfiesteria* continues to be a factor in estuarine water quality. Many questions remain regarding the organism's natural history, effects on humans and wildlife, and role in fish kill events. The organism is at the center of the public forum, and as a result, considerable resources on the state and federal level have been mobilized to answer these questions.

Efforts to monitor fish kill and fish health events within the DWQ continue to be a priority in the assessment of water quality statewide. The protocols established in 1996 have proven successful and have been fully adopted by most of the state's frontline investigators. The establishment of a DWQ fish kill event website has made the information available to all interested parties. The refinement of current protocols continues, as do efforts to further review historical kill information and improve the Division fish kill record database.

