An aerial photograph of a pond or lake. The water is brownish, and the surface is covered with numerous green lily pads. Several dead fish are scattered across the water, some partially obscured by the lily pads. The fish appear to be of various species, including what looks like a largemouth bass and a bluegill. The overall scene suggests a fish kill event.

North Carolina Division of Water Quality
Annual Report of Fish Kill Events
2003

Water Quality Section
Environmental Science Branch
Raleigh, NC
December 2003

Introduction

The investigation of fish kill activity across North Carolina currently involves protocols established by the North Carolina Division of Water Quality (DWQ) in 1996. The protocols were developed with assistance from DWQ Regional Office staff, North Carolina Wildlife Resources Commission biologists, and Division of Marine Fisheries personnel as a means to improve the tracking and reporting of fish kill events throughout the state. Fish kill and fish health investigation data are recorded on a standardized form and sent to the Division's Environmental Sciences Branch (ESB) where the data are reviewed and compiled. Data from fish kill investigation forms, laboratory test results and supplemental information sent to the ESB are entered into a central database where the information can be managed, queried and reported. The procedure also requires the notification of appropriate state officials and scientists associated with the investigation of such events. In addition, reported kill information is updated weekly on the ESB website at: www.esb.enr.state.nc.us/Fishkill/fishkillmain.htm.

DWQ fish kill protocols have proven successful in standardizing the methods for investigations and improving the quality and quantity of information reported from the scene of a kill event. Meaningful conclusions about where and why fish kills occur across North Carolina demand accurate and timely data. It is the intent of DWQ to generate this information through the current investigation process.

This document is a summary of fish kill events reported to the DWQ from January to mid December, 2003. The report is mandated under Section 4 of Chapter 633 of the 1995 North Carolina General Assembly Session Laws.

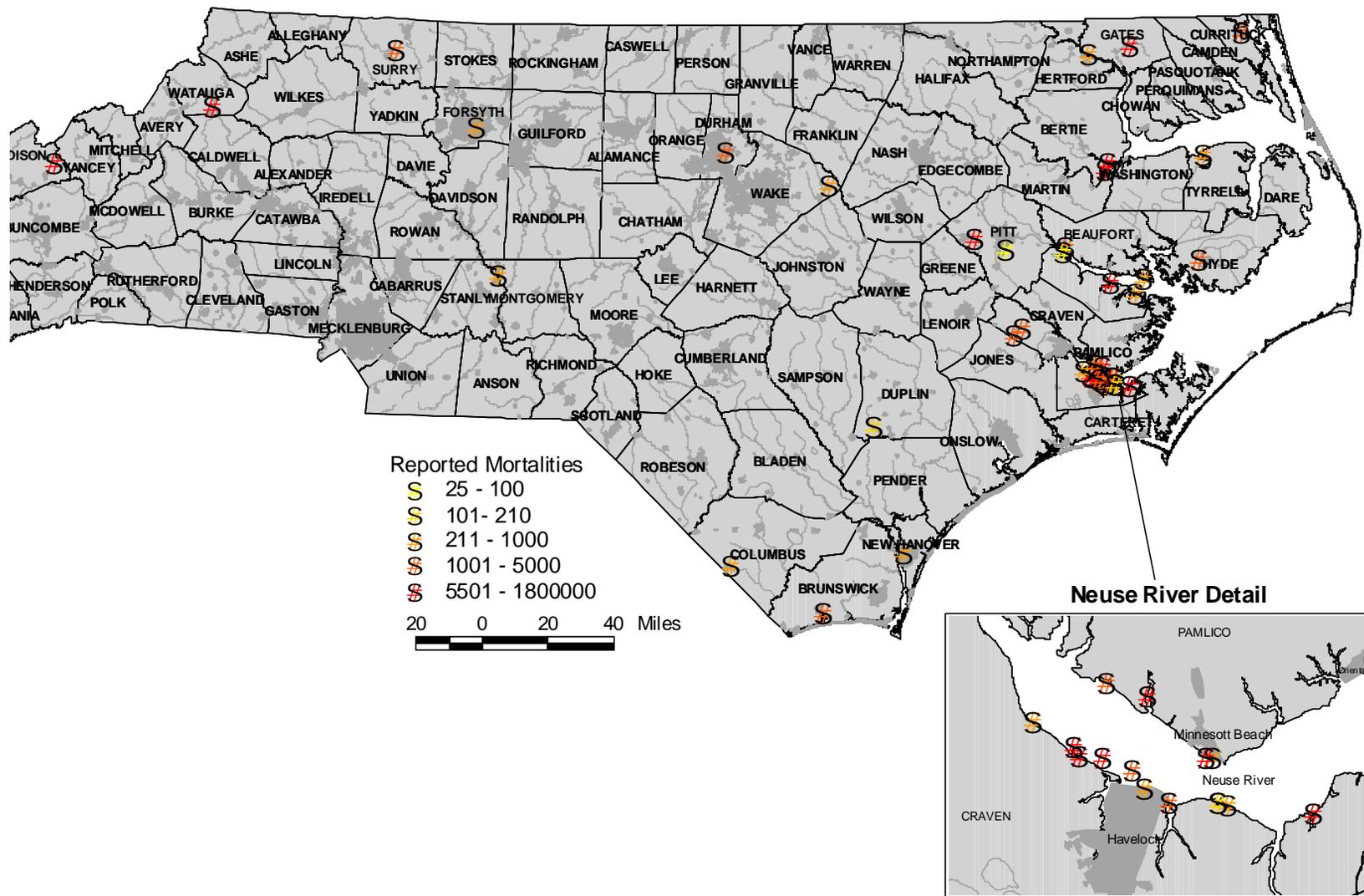
2003 Fish Kill Summary

Field investigators reported 43 fish kill events from January to December, 2003. Kill events were reported from coastal estuarine waters westward as far as Madison County. Kill activity was documented during the year in 10 of the state's 17 major river basins. The ESB tracks fish kill events when at least 25 fish are affected and the event is confirmed by investigators.

The cumulative fish mortality for all 2003 reports was over 3.6 million. This represents a significant increase over the 2002 total and is the highest mortality total since systematic fish kill reporting began in 1996. It is important to note that 3.1 million (86%) of the 2003 total was reported from just two large events on the Neuse River (See Notable Events below). Mortality totals for individual events ranged from 50 to 1.8 million with a median mortality of 1400. Reported activity was evenly divided between freshwater and estuarine waters although the largest events occurred in the estuaries. No reports were received from the Atlantic Ocean.

• Total Kill Events for 2003	43
• Cumulative Mortality for 2003	3,694,053
▪ <i>Estuarine</i>	<i>3,450,250</i>
▪ <i>Freshwater</i>	<i>243,803</i>
• Report Mortality Range	50 to 1.8 million
• Report Median Mortality	1400
• Basins with Activity	10 (of 17)
• Freshwater Kills	22
• Estuarine Kills	21
• Ocean Kills	None

Figure 1 : Fish Kill Events Reported to NCDWQ During 2003



Basin Activity

Investigators reported fish kill events in 10 of the state's 17 major river basins during 2003 (Figure 1, Table 1). Nearly half of the year's kills occurred in the Neuse Basin with activity being especially heavy below New Bern in the Neuse River estuary. A total of 15 kills were reported in the area of the Neuse stretching from New Bern to Long Creek. This area has been plagued by environmental factors such as low dissolved oxygen, high water temperatures, and fluctuating salinities. Activity in other river basins across North Carolina was relatively light although a number of severe fish kills were observed in the Chowan, Pasquotank and Roanoke basins following Hurricane Isabel in September (see Notable Events below). No fish kill reports were received from the Broad, Catawba, and White Oak basins in 2003. Since 1996 annual totals of statewide events peaked in 2001 with 77 reports but continued to decrease in 2003 to only 43, the lowest total for this time period. Most reports were received during the months of July, September, and October.

Table 1: Fish kill reports by basin, 1996 – 2003

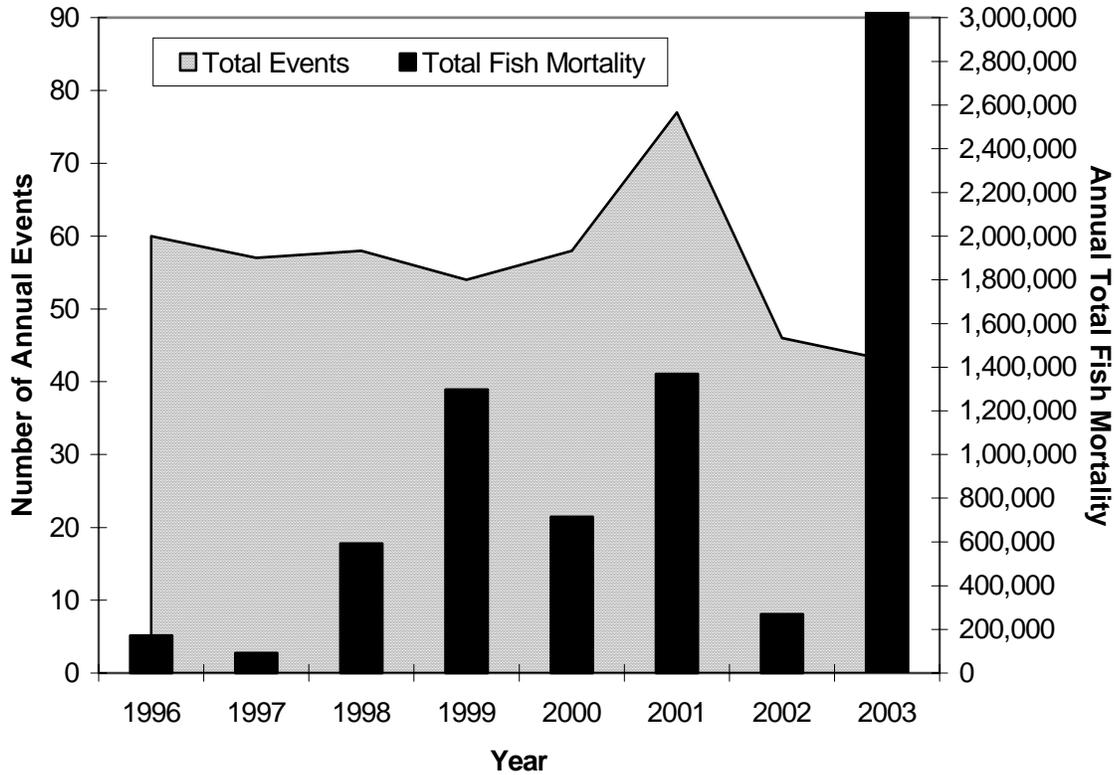
River Basin *	YEAR							
	1996	1997	1998	1999	2000	2001	2002	2003
Broad	None	None	None	1	None	None	None	None
Cape Fear	21	16	23	14	12	5	8	3
Catawba	None	3	1	3	2	4	1	None
Chowan	2	2	1	1	None	1	2	2
French Broad	None	2	3	1	None	None	1	1
Neuse	14	12	8	16	23	37	9	21
Lumber	4	3	5	None	2	None	None	2
Pasquotank	10	2	8	2	None	1	6	2
Roanoke	2	None	1	None	None	None	None	2
Tar/Pamlico	3	6	5	11	14	23	8	6
New/Watauga	None	None	None	1	None	None	None	2
White Oak	3	3	1	3	3	3	3	None
Yadkin	1	10	2	1	2	3	8	2
Yearly Totals	60	57	58	54	58	77	46	43

* No fish kill reports have been received from the Hiwassee, Little Tennessee, and Savannah basins since 1996.

Fish Mortality

Although 2003 produced the lowest number of fish kill events since 1996, the cumulative fish mortality for 2003 was the highest reported in the last eight years (Figure 2). Investigators reported a total of over 3.6 million fish killed for the year. The majority of the year's total (3.1 million) was reported from just two large events in the lower Neuse River near Carolina Pines. Fish mortality figures on 2003 reports ranged from 50 to 1.8 million with a median mortality of 1400 fish.

Figure 2: Reported annual fish kill events and mortality, 1996 to 2003

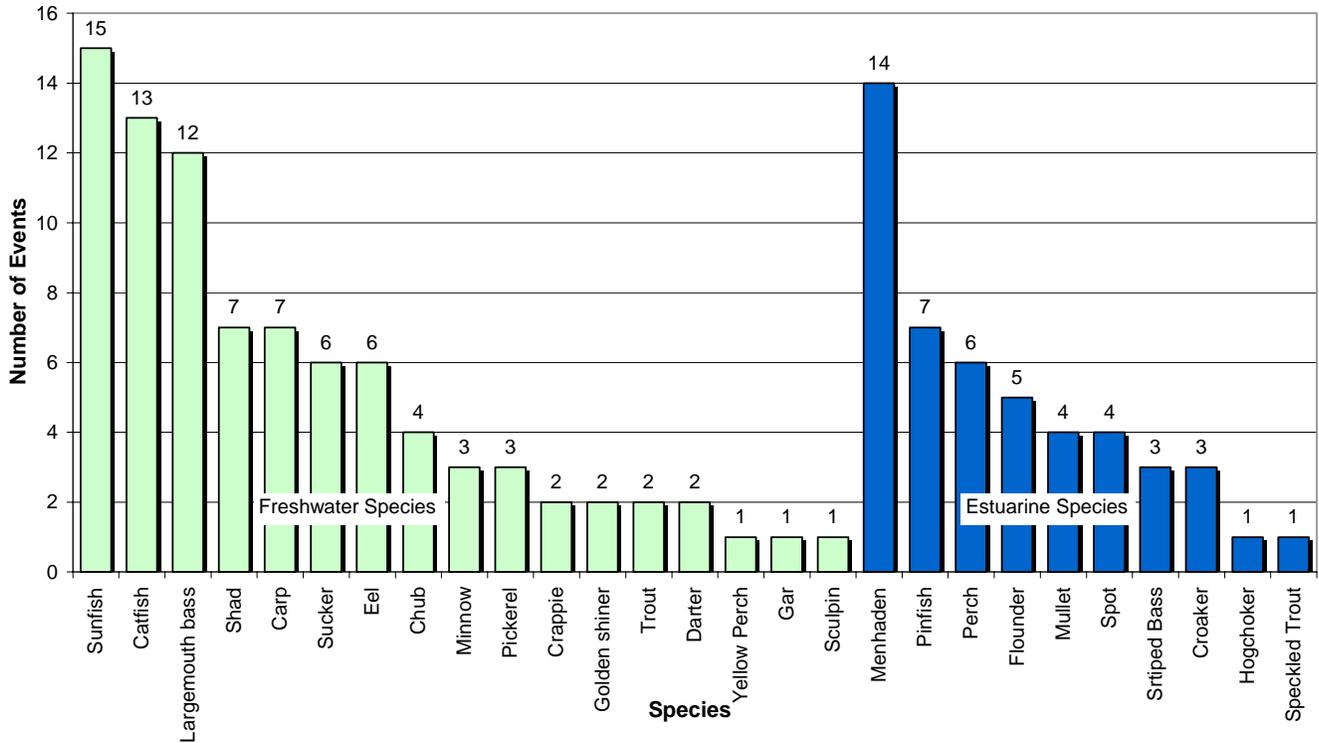


Fish and Other Species Reported

Fish kill events in 2003 involved 27 different species of fish in both estuarine and fresh waters (Figure 3). Freshwater species most commonly identified during investigations included sunfishes, catfishes, and largemouth bass. Estuarine species most commonly reported included menhaden, pinfish, and perch. Atlantic menhaden have historically been involved in a majority of estuarine kill events and have exhibited stress and disease in conjunction with fish kills. Menhaden often display gross or microscopic lesions along with chronic symptoms and fungal infections consistent with ulcerative mycosis described by Noga, et al (1993).

Other non-fish species were also cited on 13 reports. Freshwater species included aquatic insects, salamanders, frogs, turtles, snakes, and crayfish. Estuarine reports included two kills of *Macoma* clams in Beaufort County during June and July. Several reports also noted kills of blue crab in addition to finfish species.

Figure 3: Finfish observed during 2003 fish kill events

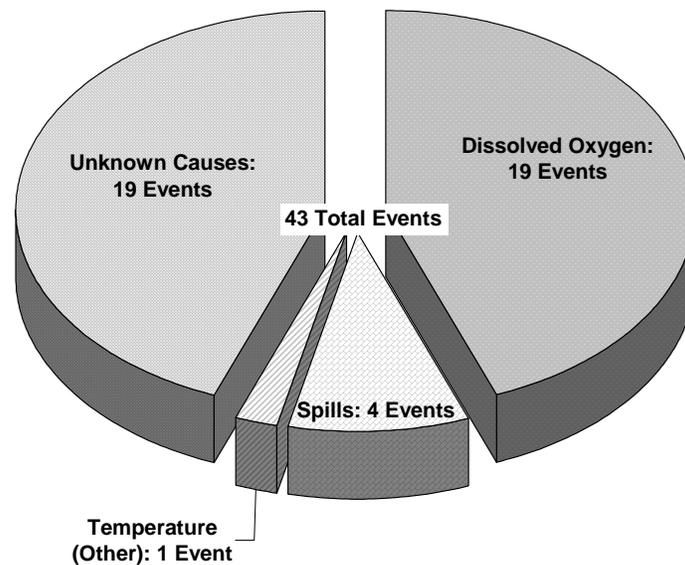


Suspected Causes of 2003 Events

Specific causes of fish kill events may or may not be obvious to investigators depending on a host of factors. Many causes are identified, but others remain unconfirmed or unclear due to an investigation occurring hours or days after the actual event. Kill events often result from many environmental conditions, and sorting out the major reason(s) why a fish kill occurs is frequently a difficult and often subjective task. Investigators are encouraged to submit suspected causes on reports along with supporting information as part of DWQ fish kill investigation protocols. Suspected cause reports aid in evaluating potential water quality trends and problems, and assist scientists and decision-makers with formulating future courses of action. Suspected causes on reports should not be viewed as a definitive label for a particular event.

Reported causes of 2003 kill events are summarized into four categories –dissolved oxygen (DO) induced events, spills, and other (miscellaneous) causes. Those events where no specific causes could be determined were assigned as “unknown” (Figure 4).

Figure 4: Reported Causes for 2003 Fish Kill Events



Dissolved Oxygen Depletion: Poor dissolved oxygen (DO) was cited as a factor in 19 kill events during 2003. DO depletion was also reported as a factor in the years largest fish kills observed in the lower Neuse estuary during August and September (see Notable Events). Events in the lower Neuse were associated with upwelling of hypoxic water from the river bottom or depletion of DO in warm shallow areas. Hypoxic conditions have historically occurred in North Carolina’s estuaries as nutrient and organic loading coupled with water column stratification deplete DO levels during the summer months. Several large fish kills in the Chowan/Pasquotank and Roanoke river basins were also attributed to DO depletion following Hurricane Isabel. Severe runoff, flooding of agricultural areas, and flushing of swamps and backwaters resulted in high inputs of oxygen demanding organic material into the northeastern North Carolina waters. The hurricane effects resulted in a DO level of 0.5 mg/L or less in portions of the Chowan and Roanoke rivers for a period of weeks. DO kills on several freshwater impoundments were associated with high water temperatures and heavy infestation of decomposing vegetation/algae.

Spills: Toxic spills may deplete DO levels in receiving streams or induce kills outright through physical or chemical toxicity. Spills were reported as a cause in four kill events during 2003 (Table 2).

Table 2: Spill-induced fish kills during 2003.

Date Investigated	Waterbody	County	Mortality	Comments
1/7/2003	California Creek	Madison	83000	Kill caused by a tanker truck spill of propionic acid directly into California Creek.
4/23/2003	Core Creek	Craven	1200	Kill likely caused by spill of chlorpyrifos. Analyses showed levels as high as 5.1 ppb in water samples.
5/3/2003	Grape Creek	Craven	2000	The kill was reported by a local citizen after noticing a white substance in a pile in the stream. The substance was toxic to aquatic organisms killing all aquatic fauna in the affected area. Three organophosphates were identified : chlorpyrifos, fenamiphos, and malathion.
10/15/2003	Middle Fork South Fork New River	Watauga	14300	Fish kill was the result of a 3000 gallon spill of sodium hydroxide from the town of Blowing Rocks water filtration plant. The spill caused a kill extending at least 5.8 miles below the plant. The pH of the stream below the spill was measured at 11.5. DWQ issued a notice of violation to the town.

Unknown Causes: Causes for kill events are reported as unknown when investigators fail to cite specific reasons for an event. Investigations may not provide definitive causes when they are conducted too long after an event and no clear factors are determined, or when causes are suspected but not confirmed. Investigators failed to cite or confirm causes for 19 of the year’s reports. Reports with unknown causes were received from both estuarine and fresh waters. Many of the reports with unknown factors involved atlantic menhaden in coastal estuaries with a high incidence of lesions.

Other: Investigators reported a kill of at least 2000 speckled trout on the Pamlico River during the month of January. Fish were seen dying over a broad area stretching from Blount’s Creek downstream to the Pungo Creek area. Investigators cited extremely low water temperatures as a cause for the event. Reports of cold weather events or “winter kill” are not uncommon in North Carolina. Records show the events usually occur in the months of January and February following periods of extreme cold.

ESB Examinations for Harmful Algae: During 2003, the ESB staff routinely examined water samples associated with estuarine fish kills for the presence of *Pfiesteria* and *Pfiesteria*-like organisms. ESB examinations were performed using light and epifluorescent microscopy. Suspect samples warranting further confirmation for toxic *Pfiesteria* species were also forwarded to UNC-Greensboro and the NCSU Center for Applied Aquatic Ecology for further tests. These tests include fish bioassays, scanning electron microscopy, and an RNA probe that can discern the presence of actual *Pfiesteria* cells. *Pfiesteria*-like cells examined by ESB staff during 2003 appeared as nontoxic obligate autotrophs and not forms historically associated with fish health events. At the time of this report, all confirmatory tests results have been reported as negative and all involved laboratories have reported that toxic *Pfiesteria* was not a causal factor in any of the 2003 events.

ESB staff members identified a number of dense algal blooms in the White Oak, Tar/Pamlico, and Neuse River basins. Some of these blooms were associated with fish kill events (occurring around the time of the event) but could not be determined as a cause. Notable were elevated levels of the algal flagellate *Heterosigma akashiwo*. The alga can produce brevetoxin and facilitate the growth of bacteria in fish. *H. akashiwo* has been associated with fish kills in other regions of the world but has yet to be linked to events in North Carolina. ESB staff members will continue to monitor the occurrence of the species.

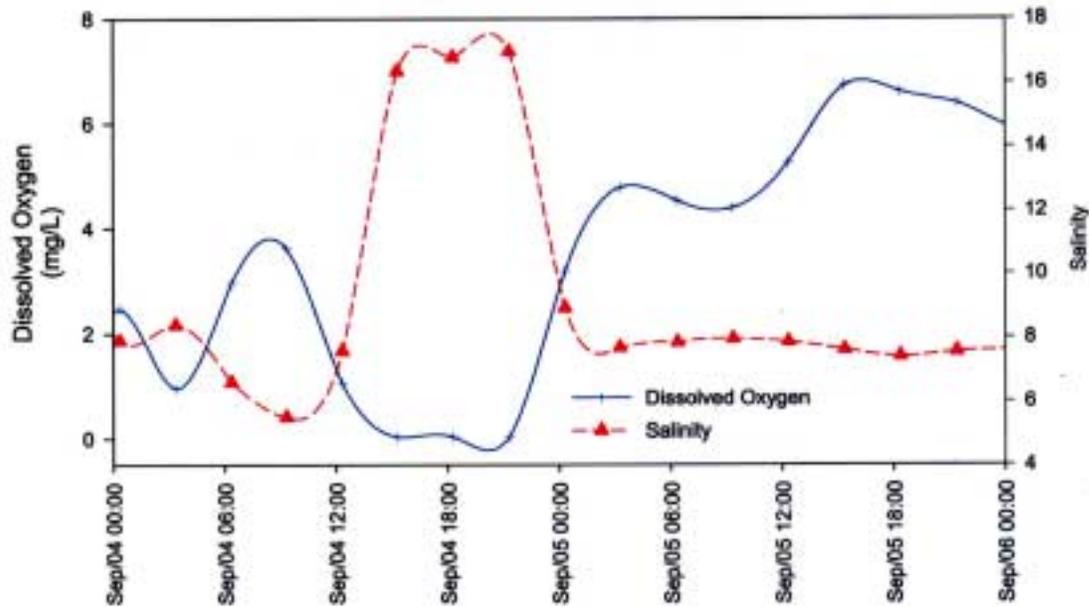
Notable Events

Pesticide Spills, Core Creek and Grape Creek, April and May, 2003: During the Spring of 2003 investigators reported fish kills on Core and Grape creeks near Cove City (Craven County) as a result of pesticide spills. The Core Creek event occurred in April apparently as a result of a spill of chlorpyrifos (Dursban), a broad range insecticide that poses acute toxicity risks to aquatic life. A second pesticide event occurred on Grape Creek, a tributary to Core Creek in early May. Water samples collected in the wake of both events showed chlorpyrifos levels as high as 5.1 ug/l in addition to the presence of fenamiphos (a highly toxic organophosphate) and malathion. The subsequent concern over the risk from dermal exposure and consumption of fish exposed to fenamiphos and the other organophosphates resulted in the Craven County Health Department temporarily posting a human health advisory in Core and Grape Creeks for swimming and fishing. During this time the DWQ performed fish tissue sampling in Core Creek to assess pesticide contamination. Fish tissue (as well as previous water samples) were delivered to Dr. Damian Shea of the North Carolina State University Department of Environmental and Molecular Toxicology for analyses. Dr. Shea reported no detectable levels of the target pesticides in fish tissue. Further water sampling throughout June showed chlorpyrifos, fenamiphos and other organophosphate levels had decreased below recommended levels of concern for ingestion and dermal exposure. The Craven County Health Department lifted the advisory for Core and Grape creeks in July.

Large Fish Kill Events, Neuse River near Carolina Pines, August And September 2003: The section of the lower Neuse River between New Bern and Minnesott Beach has historically been a trouble spot for fish kill activity. Fish kills in the area were especially prevalent during 2003 with 15 events reported. During late August and early September the Neuse River Response Team (NRRT) investigated two very large kill events near Carolina Pines (Craven County). Together the events involved at least 3.1 million individuals comprised of menhaden and other estuarine species. Data from US Geological Survey and North Carolina State University monitoring equipment indicated that mixing or upwelling of hypoxic water from stratified layers in the river was largely responsible for the kills. Instruments recorded a severe drop in DO levels in adjacent areas of the Neuse prior to both events (Figure 4). DO depletion matched an increase in wind speed that likely caused the mixing events. ESB staff analyses of phytoplankton samples collected during the events showed a very diverse mix of algal species commonly seen in the Neuse that may have also contributed to the fish kills. Pfiesteria-

like dinoflagellates were absent in phytoplankton samples or present at insignificant levels. NRRT reported few fish exhibiting lesions in either event.

Figure 4: NCSU Neuse River monitoring data near Carolina Pines showing depletion of dissolved oxygen and changes in salinity prior to fish kill – September 5, 2003



Hurricane Isabel Fish Kill Events, September 2003: On September 18 Hurricane Isabel came ashore on the Outer Banks as a category two storm and passed over the northeast region of North Carolina roughly from Ocracoke to Roanoke Rapids. The storm dumped from three to eight inches of rain in its path causing severe flooding in the Chowan/Pasquotank, Roanoke, Tar/Pamlico and Neuse drainages. Heavy rains flushed swamps and backwaters washing large quantities of oxygen demanding organic matter into rivers and estuaries. Investigators reported seven fish kill events directly related to Isabel. In addition, there were as many as twenty anecdotal reports of dying fish that could not be confirmed by response teams or agency staff.

Conditions were the worst in the Chowan and Roanoke rivers. DO levels on the Chowan were depressed for a period of weeks after the storm to as low as 0.2 to 0.3 mg/L from Tunis to 10.5 miles below Holiday Island. A kill was reported at Tuscarora Beach (400 fish), but reports of dispersed fish, dead and in distress, were numerous. Anecdotal reports suggest massive kills occurred throughout the Chowan in weeks following Isabel that were not recorded. The Roanoke River also suffered intense kill activity following Isabel. Approximately 21 river miles were affected from just above Jamesville to the river mouth below Plymouth. Over 93,000 dead fish were found in this stretch and thousands more were distressed. DO levels were at or below 0.42 mg/l throughout the entire zone.

2003 Summary

Investigators reported fish kill events in 10 of the state's 17 major river basins during 2003 with nearly half of the year's events occurring in the Neuse Basin. The number of fish kills reported across North Carolina during 2003 decreased from previous yearly figures to 43. This is the lowest number of reports since the DWQ began systematically tracking fish kill activity in 1996. Reported fish mortality, however reached the highest level since 1996 with over 3.6 million fish killed. Nearly half of the 2003 reports indicated DO depletion as a causal factor. Other reported causes included spills of toxic substances and winter kill.

Several notable events occurred during the year resulting in significant fish kills in eastern North Carolina. Pesticide spills in Grape and Core creeks in Craven County resulted in the Craven County Health Department posting a temporary advisory for the waterbodies. DO depletion in the Neuse River near Carolina Pines caused the year's two largest events that affected nearly 3.1 million fish. Hurricane Isabel caused severe flooding in the northeast corner of the state and subsequent fish kills on the Roanoke and Chowan rivers.

Total 2003 Fish Kills: 43

Total 2003 Fish Mortality: 3694053

2003 Fish Kill Events (by County)

Date	Kill Number	Waterbody	Location	Mortality	Comments
Beaufort					
1/24/2003	WA03001	Pamlico River	from Blounts Creek to Pungo Creek	2000	Investigators reported extremely low water temperatures. Areas of Pamlico R. reported frozen over. Low temperatures were cited a cause of kill.
6/30/2003	WA03008	Bond Creek	near Aurora	300	Original report was for 10,000 dead clams floating on surface, fish eating them. At the time of investigation only 300 clams counted. Clams reported floating about 36 hrs prior. Areas of low DO and warm surface water temps. Algae bloom also found in area. Clams were Macoma species.
7/2/2003	WA03009	Durham Creek	Bogus Pt.	148000	An estimated 148,000 clams were found mostly washed up in wrack lines on the shore along a 1.5 mile stretch of Durham Creek from Bogus Pt. down to Horse Pt. at Porter Creek. Low dissolved oxygen levels on the bottom of the water column are suspected as the cause of this kill.
7/23/2003	WA03012	Pamlico River	near Pamlico Beach	1000	Water quality meter readings at Pamlico Beach were within normal level, fish dying outside of Pamlico Beach area and being pushed by SW wind. Investigators reported 95-100% of fish had lesions.
10/1/2003	WA03023	Pond	off Hwy 17	86	Kill caused by low DO levels resulting from an influx of swamp water and organic matter following Hurricane Isabel. Some remaining fish found swimming in pond at time of investigation
Total Kills for County: 5 Total Mortality for County: 151386					
Bertie					
9/26/2003	WA03022	Cashie River	Windsor	22243	Kill caused by low DO levels resulting from an influx of swamp water and organic matter following Hurricane Isabel. Dead fish were found from Windsor to the mouth of the river and all DO readings were less than 0.5 mg/l. The heaviest concentration of fish was from the San Souci ferry crossing downstream to the mouth. Some of the fish appeared to be several days old and others were seen actively gasping at the surface. This kill was one of many reported in the aftermath of Isabel.
Total Kills for County: 1 Total Mortality for County: 22243					
Brunswick					
6/26/2003	WL03002	Palmer Lake	Shalotte	1400	Investigators observed discolored water from green to brown according to owner. Most probable cause of kill - extremely high water temperatures coupled with low DO resulting from an algae bloom and subsequent die-off.
Total Kills for County: 1 Total Mortality for County: 1400					
Columbus					
4/22/2003	WL03001	Lake Tabor	near Tabor City	400	Lake is heavily infested with vegetation, watermilfoil, bladderwort, filamentous algae, alligatorweed. Fish kill possibly caused by vegetation decomposing on the lake bottom and 7 to 10 days of prior cloudy weather preventing effective photosynthesis. Low dissolved oxygen levels measured below lake surface.

2003 Fish Kill Events (by County)

Date	Kill Number	Waterbody	Location	Mortality	Comments
					Total Kills for County: 1 Total Mortality for County: 400
Craven					
4/23/2003	WA03003	Core Creek	near Cove City	1200	Kill likely caused by spill of chlorpyrifos. Analyses showed levels as high as 5.1 ppb in water samples. Acute Toxicity tests using Ceriodaphnia (48 hr) showed an LC50 concentration of less than 20% after 21 hours. Investigators reported no signs of chlorpyrifos use in the area at the time of the kill.
5/3/2003	WA03004	Grape Creek	near Cove City	2000	The kill was reported on 5/3/03 by a local citizen after noticing a white substance in a pile in the stream. The substance was sampled for pesticides. The substance was toxic to aquatic organisms killing all aquatic fauna in the affected area. Three organophosphates were identified : chlorpyrifos, fenamiphos(a highly toxic organophosphate), and malathion.
7/15/2003	WA03011	Neuse River	Cherry Branch	288	NRRT counted 288 Atlantic menhaden on the beach at Cherry Branch. This kill appears to have occurred during the morning of 7/15. 95-100% of the fish had lesions and were juvenile. The area where the fish were found was shallow and hot which may have caused severe stress. There was an algae bloom at the time of investigation. Since no fish were dying at the time of investigation it is not known if this bloom played a role.
7/17/2003	WA03014	Neuse River	Cheery Point MCAS	400	Kill was reported at the waterfront along the seawall of Cherry Point. Team members tried to respond but could not due to weather and the investigation was carried over until the morning of 7/18/03. Upon investigation 400. Menhaden were counted on the beach and wash zone over and area of a half mile. About 95-100% of the fish had lesions. There were other live fish in the area and physical readings were within range to sustain fish activity. No chemical samples were taken.
7/30/2003	WA03015	Neuse River	near moth of Hancock Creek	3500	NRRT discovered dead fish along the bank and water surrounding the mouth of Hancock Cr. All fish appeared to have been dead for at least 18 hours. Most fish were juveniles, and none showed any lesions. Conditions in the area had been stratified for several days, with very low dissolved oxygen levels near the bottom. Low oxygen levels and high temperatures are believed to have killed the fish that were found in the shallow water area surrounding the mouth of Hancock Cr.
7/30/2003	WA03016	Neuse River	Cherry Branch	200	NRRT investigated a fishkill at Cherry Branch Ferry Terminal basin upon report from the Neuse River Foundation. Investigation was made at first light due to the late hour of the first notification. NRRT observed approximately 200 dead fish of various species in the ferry basin and outside of the breakwater surrounding the basin. No lesions were observed on any of the fish. Very hypoxic conditions were present at the time of investigation, and ferry staff reported observing large and small fish swimming along the surface gasping. The basin is roughly 7-10 feet deep and has limited circulation. In situ monitors nearby showed signs of an algae bloom and a mixing event of the stratified water column the evening prior to the kill. Severely depressed dissolved oxygen levels caused by high temperatures, algal bloom activity, and poor mixing of the water column within the ferry basin are believed to have caused this event. ESB staff determined no algal bloom was present from phytoplankton samples submitted.
8/18/2003	WA03017	Neuse River	near Carolina Pines	74500	Kill was reported at 0800 on 8-18-03 by a resident of Carolina Pines. Resident was on the beach the night of 8-17 and did not see anything, the next morning found fish along the beach and waters edge. Monitors in the area show a DO crash the night of 8-17-03. The fish were lesion free and the majority were spot (65%), with croaker (15%) and pinfish (10%). The balance of the total consisted of flounder, menhadden, crab, shad, silver perch and striped bass. Automated monitors in the area indicated that there had been a turnover event and a DO crash late the night before and in the early morning. Physical readings taken during the investigation were all within normal parameters and there were healthy fish in the area.

2003 Fish Kill Events (by County)

Date	Kill Number	Waterbody	Location	Mortality	Comments
8/31/2003	WA03018	Neuse River	Carolina Pines	1300000	Upon investigation DWQ staff found dead fish along a 5 mile stretch of the Neuse River and the adjacent southern shoreline. No lesions were visible on the dead fish which were 95% juvenile. Data from US Geological Survey monitors on Channel Marker 11 showed a severe drop in dissolved oxygen for that area on the evening of 8/30. This drop in dissolved oxygen matches an increase in wind speed which most likely caused the mixing or upwelling event. This phenomenon seems to have occurred over a extensive portion of the Neuse River from Flanners Beach to Slocum Creek and extended for a period of roughly 3 hours. This change in the dissolved oxygen levels in that area may have also been worsened by algal bloom activity. Estimates for the total mortality of this kill were made by shoreline transects over the entire distance of the kill as well as open water estimates which were then added together. Three preserved algal samples were collected on 8/31 and arrived at the Environmental Sciences Branch Lab on 9/3. All three samples contained a very diverse mix of algal species commonly seen in the Neuse. Algal concentrations indicated that a fairly dense algal bloom took place between Slocum and Hancock Creeks. No Pfiesteria-like dinoflagellates were seen in any of the samples.
9/5/2003	WA03019	Neuse River	Carolina Pines	1800000	NRRT received a call from Mr Rick Dove on the evening of 9/4 concerning a massive fishkill in progress on the Neuse River. Investigation showed mostly dead menhaden from Carolina Pines to Hancock Creek (Including an area inside Slocum Creek). Estimates of dead fish were made using open water transects as well as beach transects throughout the 5 mile area of the kill. Profiles of the water column during the investigation showed mixed conditions. Data from NCSU monitors at the time of the fishkill showed an upwelling event which moved hypoxic water from the bottom into the shallow areas of the river along the southern shoreline. An increase in windspeed is believed to have created the upwelling current along the southern shoreline. Very low numbers of fish with lesions were observed. Samples were taken in the area of the kill for phytoplankton as well as unpreserved samples for analysis of bacteria. ESB staff analyses of phyto samples showed a very diverse mix of algal species commonly seen in the Neuse. Algal concentrations indicated that fairly dense algal blooms took place at both sites. Only insignificantly low concentrations of Pfiesteria-like dinoflagellates were found in the Kennel Beach sample, and no Pfiesteria-likes were found in the Slocum Creek sample.
10/9/2003	WA03028	Neuse River	near Neuse Harbor	222	NRRT received a call about a small fishkill in the Neuse Harbor neighborhood along the Neuse River. Dead fish were found along a stretch of shoreline approximately 1/4 mile long. The kill was comprised of mostly menhaden which appeared to be from 6 to 24 hours old. Adult gizzard shad were also found in the kill, as well as several larger striped bass. These larger fish were very decomposed and believed to be bycatch from a gill net in the area. The dead menhaden most likely washed ashore after dying in deeper water. NRRT was in the area several days prior to this event and observed lesioned fish swimming near the surface. Northerly winds would have pushed any dying fish onto the shoreline where the dead fish were found.
10/11/2003	WA03031	Neuse River	Flanners Beach	1010	NRRT investigated a kill which spanned the full length of Flanners Beach with species including menhaden, shad, mullet, and striped bass. The kill was predominantly menhaden at roughly 1000 fish that had been on the beach for more than 48 hrs with 85% lesions. The other fish involved in the kill appeared to be net bycatch and some had been filleted. There were fishermen in the area that were net fishing from the beach.
10/11/2003	WA03029	Neuse River	Long Creek	34000	Fish were estimated to be dead for 24 - 48 hours. Investigators reported 100% of fish had lesions. No cause was specified.

2003 Fish Kill Events (by County)

Date	Kill Number	Waterbody	Location	Mortality	Comments
10/16/2003	WA03032	Neuse River	Cherry Branch Ferry Basin	200	Fish described as having lesions at time of investigation. Elevated dissolved oxygen levels measured at water surface.
Total Kills for County: 13 Total Mortality for County: 3217520					
Currituck					
6/19/2003	WA03006	Poyners Road Canal	near Sligo	1500	Hypoxic conditions observed in Tulls Creek at time of investigation. Kill confined to upper end of Poyners Road canal at access area. No dead fish were observed in Tulls Creek despite hypoxic conditions.
Total Kills for County: 1 Total Mortality for County: 1500					
Duplin					
9/11/2003	WL03004	Rockfish Creek	Near Wallace	190	Investigators noted the presence of aquatic weeds (Elodea, Fanwort, Water Willow, Duckweed) that choked the creek in many places. Fish seen moving into shallow areas.
Total Kills for County: 1 Total Mortality for County: 190					
Durham					
1/10/2003	RA03001	Private Pond	Glaxo Smith Kline main campus	2000	Cause of prolonged fish kill unknown. Fish described as acting lethargic and erratic. Sick herons associated with pond were submitted to Rollins Animal Lab (NCSU) for analyses. Birds showed heavy parasitism from nematodes.
Total Kills for County: 1 Total Mortality for County: 2000					
Forsyth					
9/11/2003	WS03002	Salem Creek		400	Water quality measurements were normal at time of investigation. Cause of kill could not be determined.
Total Kills for County: 1 Total Mortality for County: 400					
Gates					
9/24/2003	WA03027	Merchants Millpond	Silver Springs	10000	Low dissolved oxygen levels following Hurricane Isabel were reported by investigators and blamed for the event.
Total Kills for County: 1 Total Mortality for County: 10000					
Hertford					
9/22/2003	WA03030	Chowan River	Tuscarora Beach	400	Kill occurred after Hurricane Isabel. Live fish reported as lethargic and gasping at the surface. Dissolved oxygen at the time of the investigation was measured at 0.55 mg/L.
Total Kills for County: 1 Total Mortality for County: 400					

2003 Fish Kill Events (by County)

Date	Kill Number	Waterbody	Location	Mortality	Comments
Hyde					
4/19/2003	WA03002	Rose Bay Canal	near Lake Mattamuskeet	1234	Kill covered approx 1.67 mi. of Rose Bay canal that drains from Lake Mattamuskeet. The majority of the fish affected were carp which appeared to have been dead for 2-3 days. DO levels at the time of the investigation were within normal ranges (4.8 to 7.6 mg/l). Salinity levels were also low. One side of the canal appears to have been sprayed with an herbicide at some point. A water sample was collected to test for the presence of pesticides/herbicides that may have leaked into the canal from the canal side spraying or from local Ag fields. The results were negative for both pesticides and herbicides.
					Total Kills for County: 1 Total Mortality for County: 1234
Madison					
1/7/2003	AS03001	California Creek	north of Mars Hill	83000	Kill caused by a tanker truck spill of propionic acid directly into California Creek. NCWRC performed investigation and assessed a fine of around \$16000 for time and cost of fish. Fine forwarded to DWQ for collection.
					Total Kills for County: 1 Total Mortality for County: 83000
Martin					
9/24/2003	WA03021	Roanoke River	Jamesville, Plymouth	93500	Kill resulted from the flushing of swamp water into the river following Hurricane Isabel, and the subsequent drop in DO levels. The main kill zone stretched from Devils Gut 2.6 mi above Jamesville to the river mouth, a distance of 18.2 mi. , but dead and dying fish were found for several miles upriver of kill zone. All DO readings were below 0.5 mg/l and fish were actively seen gasping for air near the surface. Heaviest concentration of larger fish was near Plymouth. Untold numbers of juvenile fish are not reflected in kill total. Dark, tannic swamp water was seen mixing with the brown river water throughout the river.
					Total Kills for County: 1 Total Mortality for County: 93500
New Hanover					
9/22/2003	WL03003	Greenfield Lake	Wilmington	450	Lake was lowered prior to Hurricane Isabel. Resulting lake outfall had very low dissolved oxygen from the lake bottom. D.O = 0.08 mg/L at outfall where kill occurred.
					Total Kills for County: 1 Total Mortality for County: 450
Pamlico					
6/26/2003	WA03007	Beard Creek	near mouth	37000	During routine sampling NRRT discovered dead clams in Beards Creek. Clams were found floating just inside the mouth of the creek. The kill was suspected of being caused by a combination high water temperature, low dissolved oxygen, and possible location of the clams. Large numbers of asiatic clams often die for several reasons, these clams appear to have been transported downstream by high flow from freshwater input in the area. Clams were relatively homogenous in size 30-40mm.
7/11/2003	WA03010	Neuse River	Minnesott Beach	800	The kill consisted of approximately 800 juvenile to one year old Atlantic Menhaden washed on the beach at Minnesott. Fish were observed over an area of one mile starting at the DOT ferry basin moving west along the beach above Minnesott Country Club. The fish appear to be at least 48hours old with 95-100% lesions. The monitors in the area have recorded hypoxic conditions in the last few days which could be a contributing factor to the kill. No samples or measurements were taken due to the age and decomposition of the fish and the exact location of the kill is unknown.

2003 Fish Kill Events (by County)

Date	Kill Number	Waterbody	Location	Mortality	Comments
9/5/2003	WA03020	Neuse River	Kennels Beach	3500	NRRT discovered this fishkill while investigating a larger fishkill on the opposite side of the Neuse River. Upon making measurements on the northern side of the river and discovering that the estuary was in the process of an upwelling event, NRRT began looking for fish in distress. In the Kennels Beach/ Kendall Pt area Crabs and flounder were observed trying to leave the water. The strong smell of sulphur (anoxic water conditions) was present in the area. These conditions as well as fish in distress were found from Cooper Pt. to Myrtle Marsh Pt. At the time of investigation winds had switched 180° and were blowing from the north at around 12mph. This was moving surface water to the southern shoreline, and causing hypoxic bottom water to upwell on the northern shoreline. This event caused very low dissolved oxygen levels which stressed and killed the fish found along the shoreline. Samples were taken in the area of the fishkill and sent to ESB, NCSU, and UNCW. ESB staff analyses of phyto samples showed a very diverse mix of algal species commonly seen in the Neuse. Algal concentrations indicated that fairly dense algal blooms took place at both sites. Only insignificantly low concentrations of Pfiesteria-like dinoflagellates were found in the Kennel Beach sample, and no Pfiesteria-like were found in the Slocum Creek sample.
10/4/2003	WA03025	Neuse River	Kennels Beach, Minnesott	39109	Fish appeared to be dying off from large schools which were swimming close to the bottom of the river. There were no obvious environmental changes in that area of the river which may have caused stressfull conditions. Cause is undetermined at this time.
10/4/2003	WA03024	Neuse River	Minnesott Beach	3921	Fish appeared to be dying off from large schools which were swimming close to the bottom of the river. There were no obvious environmental changes in that area of the river which may have caused stressful conditions. Cause was undetermined at time of investigation.
Total Kills for County: 5					Total Mortality for County: 84330
Pitt					
6/14/2003	WA03005	Borrow Pit Pond	near Farmville	6000	Fish kill was taking place in a borrow pit (used for building the wastewater treatment plant 30+ years ago) next to the Farmville WWTP. Citizens said no rain had fallen in the last week, but there had been storms in the area elsewhere. Cloudy water in the pond suggested an algae/bacterial bloom had occurred, and led to low DO levels that is suspected to have killed some fish, and was causing others to struggle/gasp/seek the shore. This is the second fish kill in this pond; the other occurred on 01/25/02. The pond had a strong odor of corn or beets, like vegetation rotting or fermenting. ESB staff examined water samples and found considerable bacteria and debris but no bacterial or algal blooms.
7/28/2003	WA03013	UT to Fork Swamp	near Winterville	50	Fish were found dead in a subdivision stormwater drainage ditch that connects to Fork Swamp. Citizens first noticed the dead fish on Saturday (7/26) and the kill was reported to us and investigated on 7/28. Heavy rains several days prior had caused the ditches to flood. It appeared the fish moved into the ditch with the high water and may have been stranded when the water dropped out, succumbing to low DO. Flooding from the swamp may have contributed to low DO levels. Citizens reported smelling gas and a sheen on the water on Saturday, but no gas smell was noticed at the time of the invetigation. There was, however, a sheen present on the water from oxidizing bacteria.
Total Kills for County: 2					Total Mortality for County: 6050
Stanley					
5/28/2003	MO03001	Badin Lake	near Palmerville	1000	Most fish were seen around Palmerville. 8 Fish were sent to USFWS Lab in Warm Springs Georgia for Spring Viremia testing. Results were returned on 7/14/2003 and all fish tested negative for Spring Viremia. Cause of mortality is unknown.

2003 Fish Kill Events (by County)

Date	Kill Number	Waterbody	Location	Mortality	Comments
Total Kills for County: 1 Total Mortality for County: 1000					
Surry					
1/2/2003	WS03001	Private Pond	near Dobson	2050	Cause of kill unknown. Owner suspected pond was poisoned by vandals. Phyto sample sent to ESB showed no algal bloom occurring at time of investigation.
Total Kills for County: 1 Total Mortality for County: 2050					
Tyrrell					
9/24/2003	WA03026	Scuppernong River	near Columbia	300	Low dissolved oxygen levels following Hurricane Isabel were reported by investigators.
Total Kills for County: 1 Total Mortality for County: 300					
Wake					
9/10/2003	RA03002	Estes Pond	Zebulon	400	Suspected pond turnover. Previous weather was sunny, hot. Received approx. one inch of rain associated with a 20 degree temperature drop. Pond depth was stated by owner to be approx. 6 feet.
Total Kills for County: 1 Total Mortality for County: 400					
Watauga					
10/15/2003	WS03003	Middle Fork South Fork New River	Blowing Rock	14300	Fish kill was the result of a 3000 gallon spill of sodium hydroxide from the town of Blowing Rocks water filtration plant. The spill caused a kill at least 5.8 miles below the plant. The pH of the stream below the spill was measured at 11.5. DWQ issued a notice of violation to the town.
Total Kills for County: 1 Total Mortality for County: 14300					