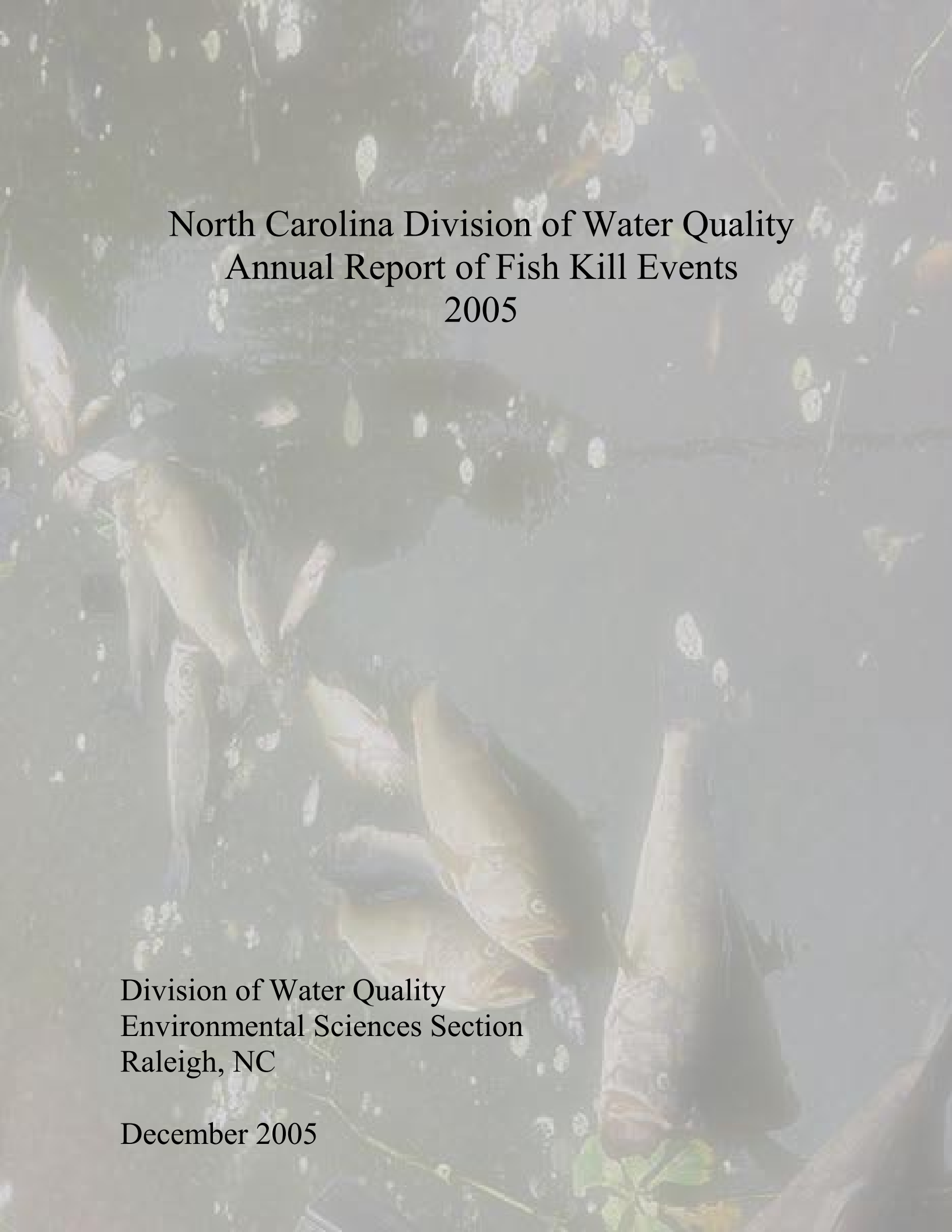


North Carolina Division of Water Quality
Annual Report of Fish Kill Events
2005

Division of Water Quality
Environmental Sciences Section
Raleigh, NC

December 2005

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 Section (ESS) where the data are reviewed and compiled. Data from fish kill investigation forms, laboratory test results and supplemental information sent to the ESS 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 ESS website at: **http://h2o.enr.state.nc.us/esb/Fishkill/fishkillmain.htm**.

DWQ fish kill protocols have proven successful in standardizing the methods for investigations and enhancing the quality and quantity of information reported from kill events. 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 accurate information through the current investigation process.

This document is a summary of fish kill events reported to the DWQ from January to mid December, 2005. The report is mandated under Section 4 of Chapter 633 of the 1995 North Carolina General Assembly Session Laws.

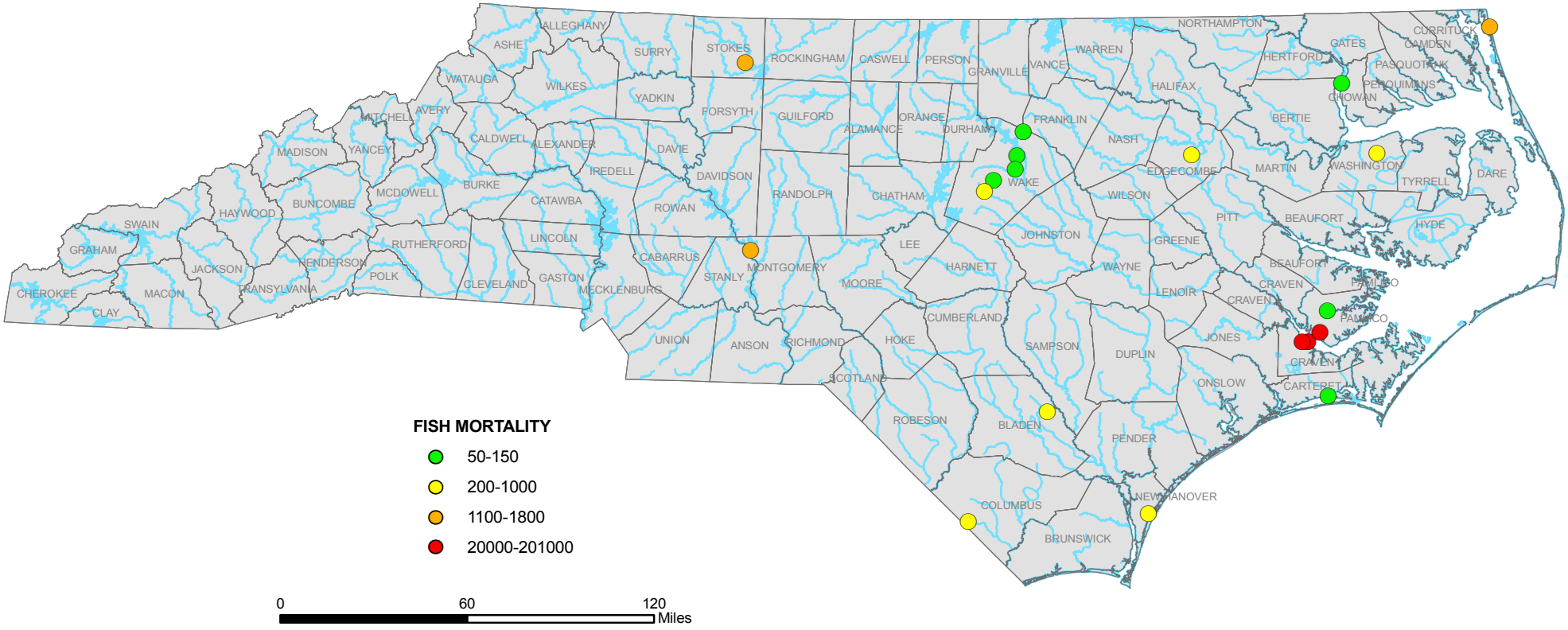
2005 Fish Kill Summary

Field investigators reported 19 fish kill events from January to December, 2005. Kill events were reported from coastal waters westward to the Piedmont as far as Stokes County. Kill activity was documented during the year in 9 of the state's 17 major river basins. The ESS tracks fish kill events when at least 25 fish are affected and the event is confirmed by trained investigators.

The cumulative fish mortality for all 2005 reports was 258,927. This figure represents a continued downward trend in total annual fish mortality reported since 2003. Mortality counts for individual events ranged from 50 to 201,000 with a median mortality of 510. The majority of events were observed in fresh waterbodies, however, the three largest events for the year occurred in estuarine waters. One event was observed in the Atlantic Ocean.

• **Total Kill Events for 2005**	**19**
• **Cumulative Mortality for 2005**	**258,927**
▪ ***Estuarine***	***250,670***
▪ ***Freshwater***	***6,657***
▪ ***Ocean***	***1,600***
• **Report Mortality Range**	**50 to 201,000**
• **Report Median Mortality**	**510**
• **Basins with Activity**	**9 (of 17)**
• **Freshwater Kills**	**14**
• **Estuarine Kills**	**4**
• **Ocean Kills**	**1**

Figure 1 : Fish Kill Events and Observed Mortality Reported to NCDWQ During 2005



Basin Activity

Investigators reported fish kill events in 9 of the state's 17 major river basins during 2005 (Figure 1, Table 1). Nearly one-half of the year's kills occurred in the Neuse Basin with the year's largest events occurring below New Bern in the Neuse River estuary. This area has been historically plagued by adverse environmental factors such as low dissolved oxygen, high water temperatures, and fluctuating salinities. Activity in other river basins across the state remained light throughout the season although a sizable event was reported at Badin Lake in the Yadkin basin. Since 1996 annual totals of statewide events peaked in 2001 with 77 reports but have decreased and remained relatively low during the last four years (Table1).

Table 1: Fish kill reports by basin, 1996 – 2005

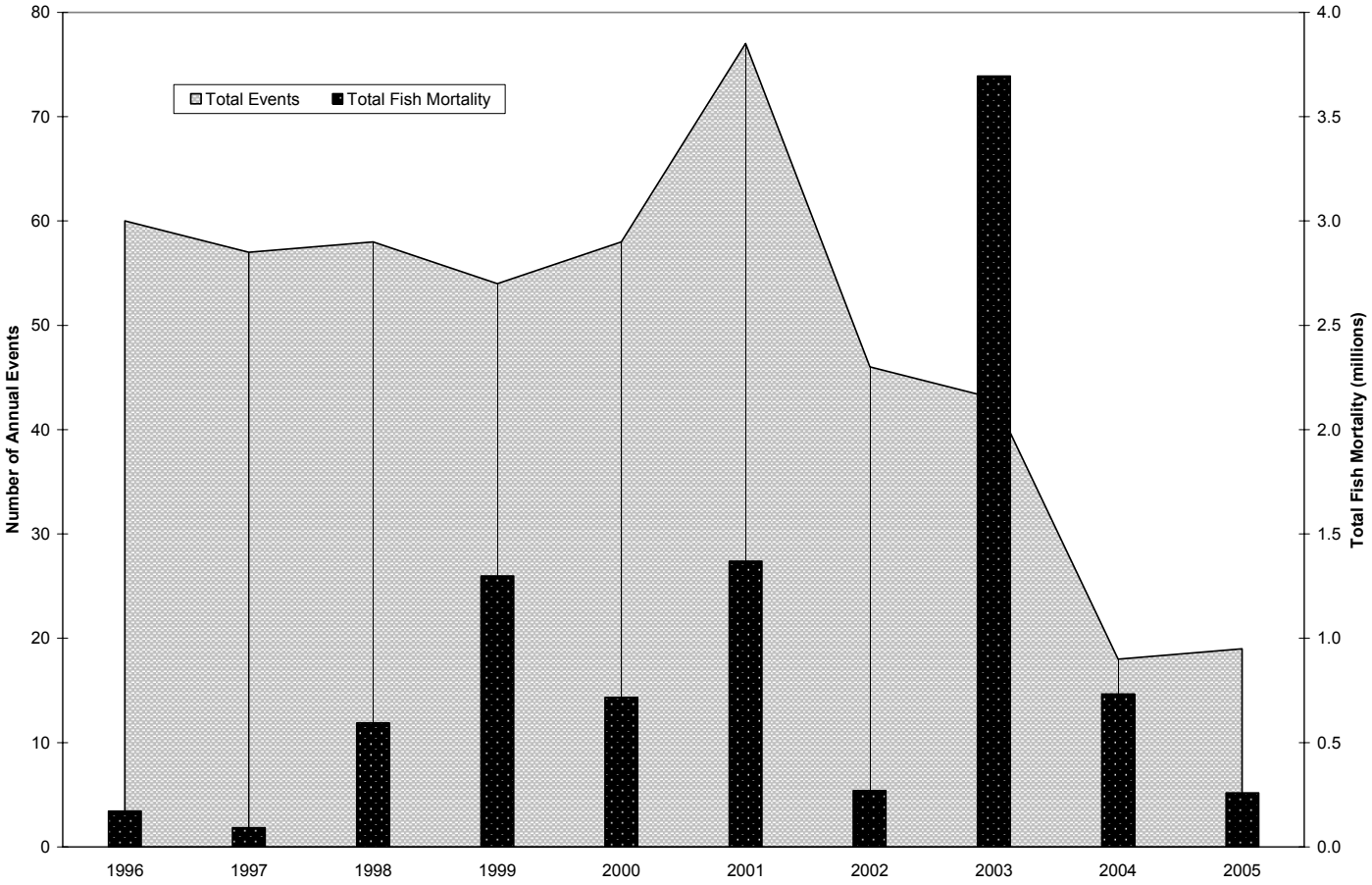
	YEAR										
River Basin*	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Basin Total**
Broad	None	None	None	1	None	None	None	None	None	None	**1**
Cape Fear	21	16	23	14	12	5	8	3	1	2	**105**
Catawba	None	3	1	3	2	4	1	None	None	None	**14**
Chowan	2	2	1	1	None	1	2	2	1	1	**13**
French Broad	None	2	3	1	None	None	1	1	None	None	**8**
Neuse	14	12	8	16	23	37	9	21	8	9	**157**
Lumber	4	3	5	None	2	None	None	2	1	1	**18**
Pasquotank	10	2	8	2	None	1	6	2	None	2	**33**
Roanoke	2	None	1	None	None	None	None	2	1	1	**7**
Tar/Pamlico	3	6	5	11	14	23	8	6	2	1	**79**
New/Watauga	None	None	None	1	None	None	None	2	None	None	**3**
White Oak	3	3	1	3	3	3	3	None	None	1	**20**
Yadkin	1	10	2	1	2	3	8	2	3	1	**33**
Yearly Totals	**60**	**59**	**58**	**54**	**58**	**77**	**46**	**43**	**17**	**19**	**491**

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

Fish Mortality

The 2005 season produced a cumulative fish mortality of just over one quarter million individuals (Figure 2). The majority of the year's total was reported from two events in the lower Neuse River near Flanner's Beach. The 2005 total represents the lowest count observed since 1997. Fish mortality figures on 2005 reports ranged from 50 to 201,000 with a median mortality count of 510 fish.

Figure 2: Reported annual fish kill events and mortality, 1996 to 2005



Finfish and Other Species Reported

Fish kill events in 2004 involved 15 different species of fish in both estuarine and fresh waters (Figure 3). Freshwater species most commonly identified during investigations included sunfishes, largemouth bass, and catfish. Estuarine species most commonly reported included menhaden 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.

Reports of non-finfish species involved in fish kills were infrequent during 2005. Over 3000 blue crab were included in one of the year's large events on the lower Neuse River. Other species appearing on reports included turtles and tadpoles.

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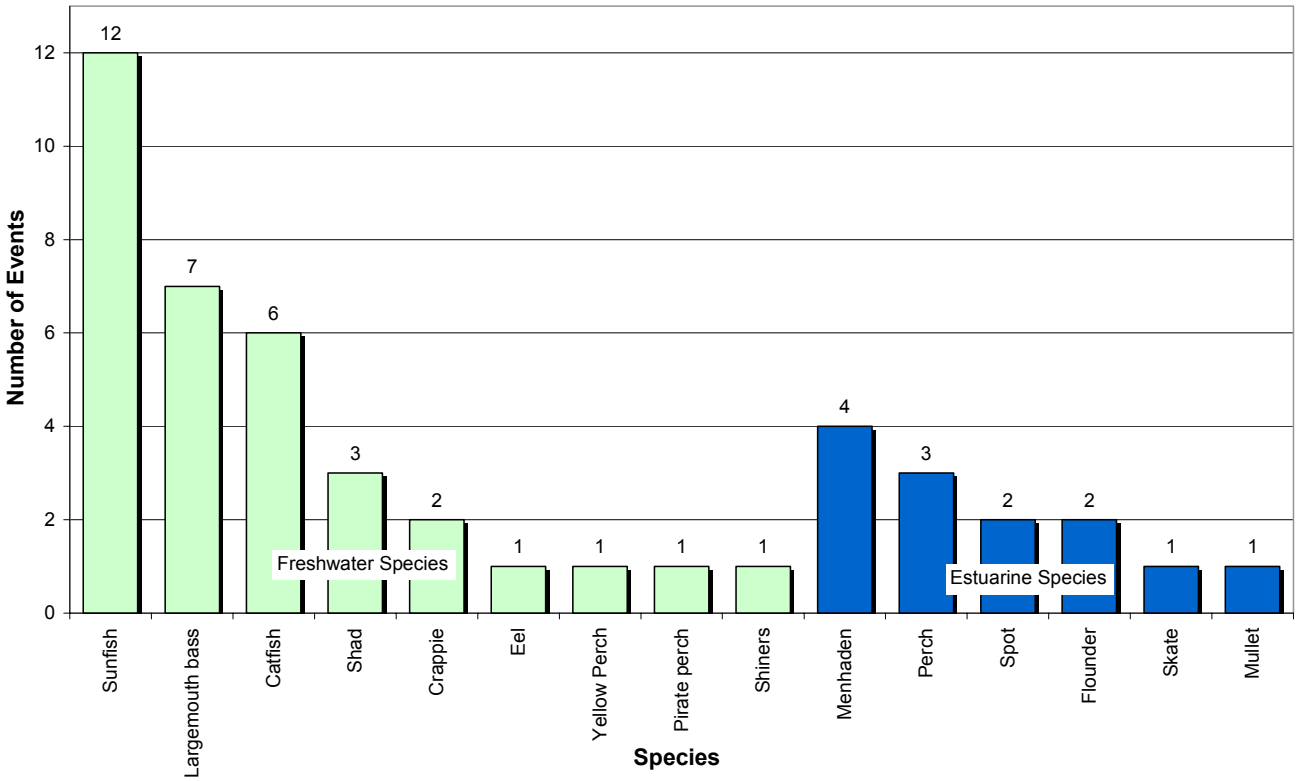
Figure 3: Finfish observed during 2005 fish kill events



Suspected Causes of 2005 Events

Specific causes of fish kill events may or may not be obvious to investigators depending on a number of factors. Causes are often 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 factors, and sorting out the major reason(s) why a fish kill occurs is frequently a difficult and often subjective task. Investigators generally monitor environmental conditions surrounding an event and are encouraged to submit suspected causes on reports along with supporting information. This information aids in evaluating potential water quality trends and problems, and assist scientists and decision-makers with formulating future courses of action. Reported causes should not be viewed as a definitive label for a particular event.

Reported causes of 2004 kill events included dissolved oxygen (DO) depletion, sewage and chlorine spills, and suspected bycatch from fishing operations. Those events where no specific causes could be determined were reported as "unknown" (Table 2).

Table 2: Major causes reported for 2005 fish kill events

Reported Cause	Number of Events
Unknown	8
Dissolved Oxygen Depletion	6
Spills	3
Bycatch	2
Algae Blooms	None

U*nknown 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 eight of the year's events. Events with unknown causes were reported mainly from freshwater ponds or lakes during 2005. Often the investigations yielded few clues and water quality measurements appeared normal.

Dissolved Oxygen Depletion: Low dissolved oxygen was cited as a factor in six kill events during 2004. DO depletion was reported as a factor in the year's largest fish kills observed in the lower Neuse estuary during July 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.

Spills: Toxic spills may deplete DO levels in receiving streams or induce kills outright through physical or chemical toxicity. During 2005 investigators reported a large sewage spill into Hewletts Creek in Wilmington. An estimated 3 million gallons of raw sewage flowed into the middle branch of the creek causing a kill of at least 200 fish. Investigators suspected many more fish were affected but could not be counted due to access difficulties within the watershed. An additional sewage spill was reported during the year in Pamlico County near Grantsboro as well as a chlorinated water line break in Wake County at Perry Creek. Both events together involved about 200 fish.

Bycatch: Discarded fish from nearby fishing operations was reported as a cause in two kill events during the year. A relatively large event involving mainly spot in the Atlantic Ocean (Currituck County) was linked to a seine net dump. Spot were observed scattered over a three-mile section of beach near the Curruitck National Wildlife Refuge. A second suspected bycatch event was documented on the Chowan River near Arrowhead

Beach (Chowan County). Investigators observed catfish with lesions and noted some fishing activity in the area.

Harmful Algae: Although there were no reports of harmful algae being a factor in 2005 fish kill events, ESS staff routinely examine water samples associated with kills for the presence of harmful species. Algal samples that contain significant amounts of Pfiesteria-likes or other potentially harmful algae are often sent to research laboratories throughout the state. The Center for Applied Aquatic Ecology in Raleigh has the ability to examine samples under scanning electron microscopy. Laboratories at the University of North Carolina at Greensboro and the National Oceanic and Atmospheric Administration laboratory in Beaufort can examine samples with molecular probes. Laboratories at UNC-Chapel Hill and UNC-Wilmington provide valuable taxonomic expertise. Algal samples and results are collected, exchanged, and discussed between DWQ and research laboratories as a professional courtesy.

Notable Events

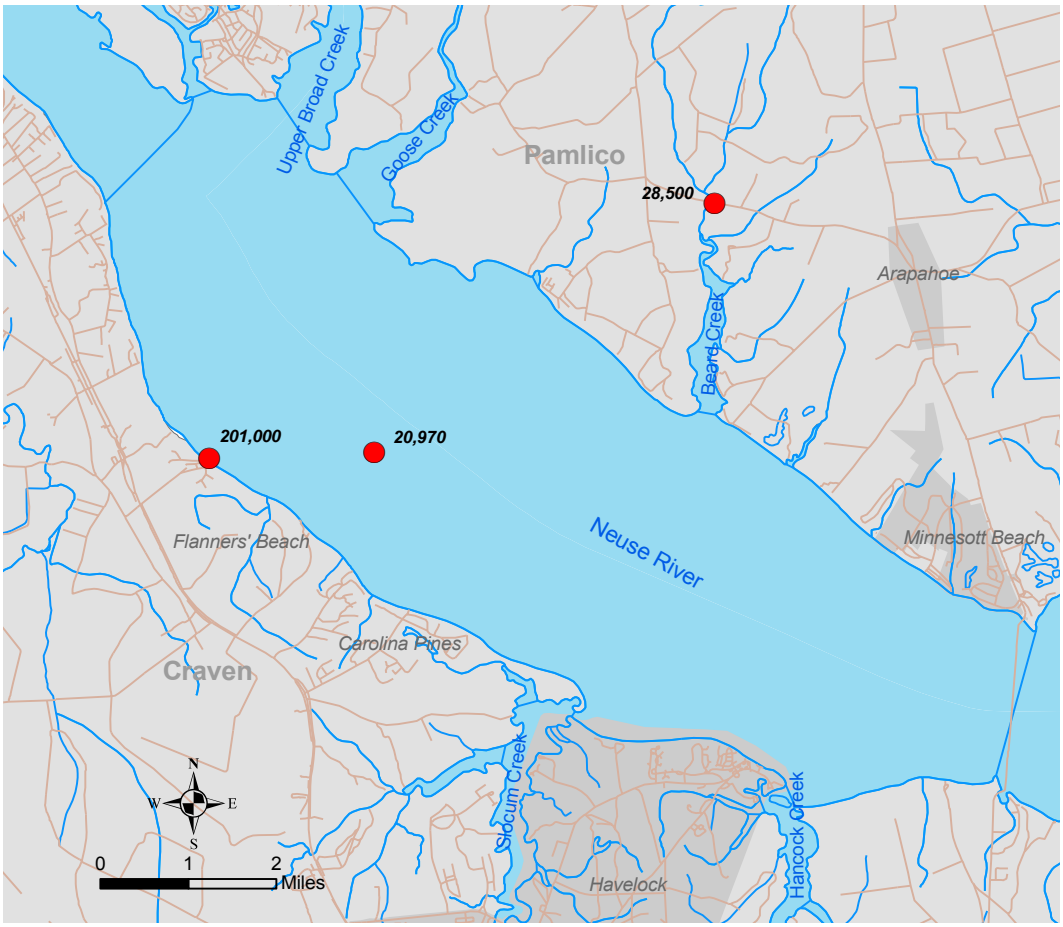
Neuse River and Beard Creek, July and September (Figure 4): The lower Neuse River below New Bern has historically been a trouble spot for fish kill activity. During July 2005, the Neuse River Response Team (NRRT) investigated two large fish kill events near Flanners Beach (Craven County). Together the events involved at least 221,970 individuals comprised mainly of atlantic menhaden and represented over 85% of the fish mortality reported statewide for the year.

Prior to the two events, data from US Geological Survey monitoring equipment in the area indicated a drop in DO levels and associated hypoxia in the water column. Hypoxic conditions have historically occurred in North Carolina's estuaries as nutrient and organic loading coupled with water column stratification deplete DO levels during warm months. Sudden shifts in wind direction and velocity when these conditions are present can cause mixing of the water column or an upwelling of the hypoxic layers.

During September, NRRT members also documented a large menhaden kill in Beard Creek, a tributary on the north side of the Neuse River near Arapahoe. Effects from Hurricane Ophelia were blamed for the event. Investigators reported that in the wake of the storm water from surrounding wetlands drained into the creek and depleted DO levels to a point that triggered a kill of over 28,000 fish.

Badin Lake, August: Badin Lake (Montgomery County) has experienced significant fish kills in recent years and the trend continued in 2005 with investigators reporting a kill of at least 1500 largemouth bass, and sunfish. Factors surrounding this year's event are similar to observations made at previous events on Badin, namely rapid water column destratification and anoxic conditions that squeeze adequate physical habitat for the lake's fish populations.

Figure 4: Large fish kill events and fish mortality reported on lower Neuse River and Beard Creek – July and September, 2005



2005 Summary

Investigators reported fish kill events in 9 of the state's major river basins during 2005. In general, kill activity in basins across the state was light when compared to yearly activity reported since 1996. The number of fish kills reported during 2005 totaled 19, on par with the lowest count of 17 reported in 2004. Reported fish mortality also remained at the lowest level since 1997 with just over one quarter million fish killed. The vast majority of the year's mortality (85%) occurred during two events in the lower Neuse River.

Notable events included the familiar phenomenon of fish kills in the Neuse River near Flanners Beach. This area continued to exhibit the water column stratification and subsequent hypoxia that plague shallow, poorly flushed estuaries. As a result, investigators documented large and events in the area during July. Hurricane Ophelia produced only one event, a menhaden kill in Beard Creek (Pamlico County) as a result of wetland drainage in the aftermath of the storm.

Since fish kills may represent the endpoint of a myriad of environmental factors, reasons for the drop in both mortality and kill events during 2004, and again in 2005, remain unclear. More favorable environmental conditions (ie: weather, hydrology, water chemistry) have been documented during periods of low fish kill activity, especially in the states coastal waters. Determining if a decrease in fish kill reports reflects natural changes or is the result of improved water quality requires continued long term monitoring and research.

2005 Fish Kill Event Summaries (by County)

Total 2005 Fish Kills: 19

Total 2005 Fish Mortality: 258927

Date	Kill Number	Waterbody	Location	Fish Species	Mortality	Comments
Bladen						
6/27/2005	FA05001	Black Lake	north end	Yellow Perch	1000	Investigators suspected die-off of yellow perch due to natural causes. No other species affected.
					Total Kills for County: 1	**Total Mortality for County: 1000**
Carteret						
10/19/2005	WA05005	Private Pond	Golf Course near Brandywine	Shad, Largemouth Bass	52	NRRT staff responded to a call about dead fish in a subdivision pond. The kill was three days old and the fish were badly decomposed. Physical water quality data appeared normal at the time of investigation. There were 49 gizzard shad and 2 large mouth bass washed up on the shore. The cause of the kill is unknown. Complainant was notified and asked to call immediately next time an event takes place.
					Total Kills for County: 1	**Total Mortality for County: 52**
Chowan						
5/24/2005	WA05001	Chowan River	Arrowhead Beach	Catfish	150	Kill affected only one species of fish (catfish). Lesions/sores noted on some fish. Investigators suspected bycatch discard from commercial fishing operation.
					Total Kills for County: 1	**Total Mortality for County: 150**
Columbus						
4/18/2005	WL05001	Lake Tabor		Sunfish, Crappie, Catfish, Bass	300	Chlorpyriphos (Dursban) detected in water samples.
					Total Kills for County: 1	**Total Mortality for County: 300**
Craven						
7/20/2005	WA05003	Neuse River	near Flanners Beach	Atlantic menhaden, Shad	20970	NRRT discovered a fishkill during regular ambient sampling. Investigation of the fish kill area showed primarily juvenile Atlantic Menhaden with approximately 10% lesions. The kill appeared to be 6-12 hours old, and was being transported across the river by wind to the east. USGS in-situ monitors at CM 11 showed a drop in dissolved oxygen throughout the water column the previous night. The age of the dead fish, and time of the drop in dissolved oxygen coincide enough to link this as a possible cause to the fish kill. Data from channel marker 11 is very close to the site of the fishkill investigation.

Date	Kill Number	Waterbody	Location	Fish Species	Mortality	Comments
7/21/2005	WA05004	Neuse River	near Neuse Harbor	Atlantic menhaden, Spot, White perch	201000	A fish kill was called in to NRRT from a citizen at 5:00 pm July, 21st. NRRT staff responded to this kill near the Neuse Harbor community. The fish kill event extended approximately 1 mile north of the Flanner's Beach area, over a 3/4-mile stretch of beach with a total mortality of 201, 245. Over 95% of this kill consisited of Atlantic Menhaden, with the remaining abundance to be blue crab, spot, and white perch. No lesions were observed. Judging from the condition of the fish, this kill could have occured within 6 to 12 hours prior to investigation. Real-time data from Channel Marker 11 indicated consistent hypoxic conditions for several days prior to the event, and an increase in wind strength and a directional shift in the early hours on the day of the kill. It is possible that these factors combined to cause localized upwelling, which may have exacerbated hypoxic conditions to already physiologically stressed fish.
					Total Kills for County: 2	**Total Mortality for County:** 221970
Currituck						
10/24/2005	WA05006	Atlantic Ocean	near Currituck NWR	Spot, Skate	1600	Investigation was done on site(10/23/05) by a Marine Patrol Officer. Information was relayed to PRRT via Morehead DMF communications. The officer found fish on beach from Currituck Beach, at off road access North toward VA line. Fish averaged 1/2-1 lb and were all spot, thought to be dumped from trawl or beach seine. On 10/24/05 DMF Wanchese office was contacted as asked if any further investiagion was made. Commercial beach seing was observed to be taking place in that area over the course of the weekend. On the final net fishermen caught to many fish to pull seine on beach and had to cut the net. This activity was likely the cause of the kill. DMF Wanchese employee's counted 1600 spot and 2 skates on the beach concentrated in a 1.25 mile area with scattered fish extending a total of 3 miles.
					Total Kills for County: 1	**Total Mortality for County:** 1600
Edgecombe						
7/8/2005	RA05005	Stormwater Pond	Mary Francis Center	Sunfish, Bass	510	Some lesions noted on fish. Lesions reported to be 1/4 inch in size. Cause unknown.
					Total Kills for County: 1	**Total Mortality for County:** 510
Montgomery						
8/31/2005	FA05002	Badin Lake		Largemouth bass, Bluegill, Redbreast SF	1500	Random DO readings in the area indicated lower than normal DO (as low as 2.8 mg/l at the surface with most readings near 3.5 mg/l at the surface and to 3m below surface. Large rainstorm in the area the prior night may have rapidly destratified the lake causing anoxic water to cause a partial fish kill. Approximately 1500-2000 fish of at least three species were estimated to have been killed. However this was not a complete kill as fish were seen swimming alive and being caught by anglers during our investigation. No additional reports were made after our investigation.
					Total Kills for County: 1	**Total Mortality for County:** 1500

Date	Kill Number	Waterbody	Location	Fish Species	Mortality	Comments
New Hanover						
7/3/2005	WL05002	Hewletts Creek	Wilmington	Mullet, Eel, Flounder, Sunfish, Menhaden	200	A raw sewage spill of 3,000,000 gallons from a pump station occurred July 1 in the middle branch of Hewletts Creek (freshwater section). UNCW scientists Mike Mallin and Doug Parsons sampled on July 3 by boat, just after high tide. Made it about halfway up the creek in the main channel. Encountered dead fish about 2 km downstream of spill site; counted about 100 in the channel (salinities 20 upstream, 35 at creek mouth), including mullet, 15 eels, 8 flounder, and numerous small fish. Lots of decomposing fish with birds and crabs feeding on them. Dissolved oxygen 1.9 mg/L. Went by truck to a bridge over the north branch, salinity 2 ppt, 200 dead fish along shore visible from bridge, DO 4.4 mg/L. Went to south branch to a bridge site, salinity 10.8, DO 2.4 mg/L, counted 140 dead fish near bridge; many more floating down with the outgoing tide. Strong sewage odor, obviously the sewage was sloshed upstream and downstream with the tides into all three channels. water temperatures 23.5-28.0 oC. Took samples for nutrients and fecal coliforms at 6 locations. Because of creek geography and access, investigators suspect numerous dead fish could not be counted. Numerous small unidentified fish were reported. Fecal coliform testing in the creek showed levels as high as 270,000 colonies per 100 milliliters.
					Total Kills for County: 1	**Total Mortality for County: 200**
Pamlico						
9/7/2005	WA05008	Canal off South Prong	near Grantsboro	Catfish, Pirate perch, Sunfish, Shiners	135	NRRT staff responded to a concerned citizen call September 9th, at approximately 11:40 a.m. The Pamlico county health department was notified. Mr. Buck noticed a foul sewage-like smell coming from the canal adjacent to his property. Upon arrival, staff noticed the odor and found decaying fish downstream of the culvert crossing Old Bay River Rd. Those that could be identified were catfish, pirate perch, sunfish, and shiners. Staff walked upstream of culvert noting a more putrid smell, more decaying fish, and ultimately found continuous discharge from a pipe approximately 20 yards upstream of culvert. Total dead fish counted was approximately 135. The pipe lead to a county sewer pipeline. It is uncertain whether this sewer line is connected to the Britthaven Community, situated northwest of the discharge. Fecal, BOD, and TSS samples were taken.
9/17/2005	WA05007	Beard Creek	near Arapahoe	Menhaden	28500	After Hurricane Ophelia, the winds shifted out of the southwest causing the receding flooded swamps to drain into Beard Creek. Swamp water drainage into the creek depleted dissolved oxygen, causing the fish kill.
					Total Kills for County: 2	**Total Mortality for County: 28635**
Stokes						
2/15/2005	WS05001	Private Pond	near Bailey Town	Sunfish, Bass, Crappie	1100	Water quality parameters appeared normal at time of investigation. Water was sampled for organics and metals contaminants. Cause unknown.
					Total Kills for County: 1	**Total Mortality for County: 1100**
Wake						
5/24/2005	RA05001	UT to Horse Creek	private pond	Sunfish	100	No water quality problems observed during investigation. Some fish appeared partially eaten. No fish observed dying or in distress at time of investigation. Cause unknown.

Date	Kill Number	Waterbody	Location	Fish Species	Mortality	Comments
5/31/2005	RA05002	UT to Perry Creek	near Raleigh	Catfish, Sunfish	100	Golfers first noticed a red color and dead fish on Monday (5/30/2005). Fine clay sediment noted in the stream bottom. On 6/1/2005, after contacting the City of Raleigh stormwater program, it was confirmed the sediment had come from a water line leak at a backflow preventer located on Camp Durant Rd. just north of the nature park. Mr. Duffy indicated a water line leak on Camp Durant Road was reported to City of Raleigh on Sunday 5/29. City of Raleigh personnel cut off the leak, but it resulted in sediment and chlorinated water draining through the adjacent Windsor Forest S D storm drain system. Most likely the combination of chlorinated water and sediment caused the fish kill.
6/29/2005	RA05003	Brentwood Lake	Raleigh	Sunfish, Catfish, Bass	60	Filamentous algae dentified as Oedogonium was prevalent in the lake at the time of the kill.
8/1/2005	RA05004	Raleigh City Park Pond	Powell Drive Park	Bass, sunfish	50	Fish kill begin at end of the week of July 25th and continued until August 1 according to Richard Costello of Raleigh Parks and Recreation. Counted fifty small fish either dead or decaying along the edge of the pond near the overflow. Other animals in the vicinity (frogs, ducks) did not appear affected. Pond approximately ninety five percent covered with duckweed. Low DO (0.15 to 2.86 mg/L) was measured at several sites in the pond and was the most likely cause of the kill.
8/18/2005	RA05006	Lochmere Lake	Cary	Shad	600	Water Temperature was 30.7 degrees Celsius at time of investigation. Locally heavy rains the previous night. All dead fish of one species. D.O. readings taken in area and above area were OK at time of investigation (5-6 mg/l at 4 pm) but readings taken early that morning by Town of Cary staff were reported as 2.2-3.5 mg/l.
					Total Kills for County: 5	**Total Mortality for County: 910**
Washington						
7/19/2005	WA05002	Property Line Canal	east of Roper	Sunfish, Catfish	1000	Investigators noticed very shallow water with no current outflow, input or spills. Observed dead fish along the shoreline of the canal. However, they did notice an abundance of small fish swimming in the shallow water. Tadpoles, frogs and turtles were active within the canal as well. As this fish kill occured in an extremely shallow canal, the event was associated with the extended period of extremely hot weather. Water temperatures likely exceeded 90F and dissolved oxygen during early morning hours was likely very low during the kill event.
					Total Kills for County: 1	**Total Mortality for County: 1000**

Michael F. Easley, Governor
William G. Ross Jr., Secretary
North Carolina Department of Environment and Natural Resources

Alan W. Klimek, P. E. Director
Division of Water Quality
Coleen H. Sullins, Deputy Director
Division of Water Quality

February 7, 2006

Memorandum

To: Johanna Reese
NCDENR, Legislative and Intergovernmental Affairs

From: Mark T. Hale
Environmental Sciences Section

Through Trish MacPherson
Jimmie Overton

Subject: Addendum to Division of Water Quality 2005 Annual Report of Fish Kill Events

Attached is an addendum to the 2005 Division of Water Quality annual fish kill report. The addendum summarizes several large menhaden kill events along the North Carolina coast that occurred after finalization of the original report last December. The events occurred from December 18 to 26 and were among the largest of the 2005 calendar year, affecting over 2 million fish.

Counting these additional events, 2005 produced 23 fish kill events (reported to DWQ) and a cumulative mortality of over 2.25 million fish.

Cc: Coleen Sullins
Jeff Manning

Addendum - Division of Water Quality Annual Report of Fish Kill Events
December, 2005

Notable Events

Wrightsville Beach, December 18, 2005: Division of Water Quality and Division of Marine Fisheries investigators reported a kill at Wrightsville Beach (New Hanover County) where a large number of small (4-5 inches in length) age 0 menhaden were observed on the beach side. Dead fish were observed down the entire length of Wrightsville Beach a distance of four miles. Further investigation revealed an extremely heavy concentration of dead menhaden in the old Mason's Inlet Channel behind Shell Island on the north end of Wrightsville Beach (Map 1) . This area was completely blanketed by dead fish at low tide with additional fish in the water below the low water line. Investigators suspected that large schools of menhaden were migrating south down the beach and a portion of the school entered Mason's Inlet and became entrapped in the small water body behind Shell Island. These fish died of suffocation either from a lack of oxygen or being physically stranded on the banks. The next falling tide carried some of these fish back into the ocean and down Wrightsville Beach although is was presumed that some of the fish on the beach side could have died in the ocean as well. The fish all appeared very healthy with none of the sores or lesions historically associated with fish health events. Samples of menhaden and water from the kill site were sent to Dr. Carm Tomas at UNCW for analyses of harmful components. Results of all samples were negative for toxins and harmful algae species associated with fish kill events. Investigators estimated that at least 2 million menhaden were involved in the Wrightsville Beach event.

Masonboro Island, December 23, 2005: Division of Marine Fisheries investigators observed dead and dying menhaden in Old Masonboro Channel, the Intracoastal Waterway, Shinn Creek and Banks Channel in New Hanover County (Map 1). The fish were observed dead either on the bottom or along the shorelines. Fish were also seen alive but in distress exhibiting behavior that has been associated with "spinning disease", a viral infection that acts to disorient fish so that they swim in circles. The kill was entirely age 0 menhaden. Water temperature, salinity and D.O. readings collected at the location of the kills were all within the range expected at that time of year. Investigators speculated that the kill involved tens of thousands of fish, however, it is possible that these fish were actually part of a larger school that entered Masonboro Inlet and that many more fish may have died in the ocean.

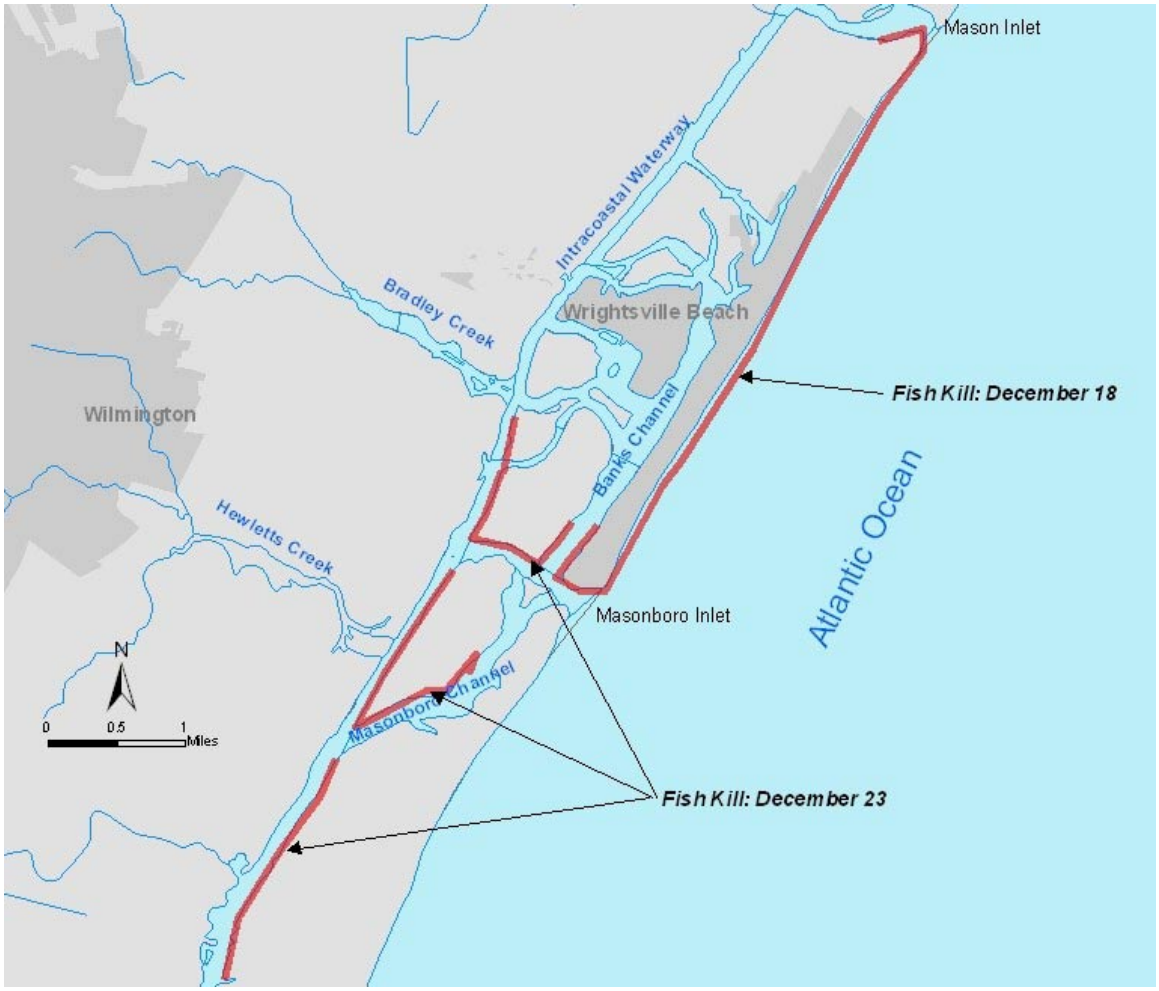
Topsail Island, Lea and Hutaff Islands, December 26, 2005: A fish kill was reported December 26 on the south end of Topsail Beach in Pender County. Marine patrol officers indicated that the fish were on a three mile stretch of the ocean beach in significant numbers and extended around the southern end of the island and a short

distance up Bank's Channel (Map 2) . Fish were also reported by citizens on the ocean side of Lea and Hutaff islands south of Topsail indicating that the kill may have occurred off Topsail Beach and spread down the coast. Only 4-5 inch menhaden were observed and the number of fish involved was estimated to be in the tens of thousands.

The menhaden kills reported in December around Wrightsville Beach and Topsail Island were linked to extremely high densities of small menhaden as they migrated down the coast. Bycatch from fishing operations was ruled out since the two known fishing companies, Beaufort Fisheries and Omega Protein, had not fished in the southern portion of North Carolina since the Spring. There was no evidence of harmful dinoflagellates or toxic algae nor was there any indication of pollutants that could cause such massive mortalities. No other species other than a few spiny dogfish were seen in association with the menhaden and is evidence that agents toxic to multiple fish species were not present.

Scientific literature describes an incident in 1997 that has many similarities to the December menhaden kills. The 1997 kill was attributed to suffocation of age 0 menhaden as they migrated down the coast in dense schools. Suffocation, either by lack of oxygen or sheer physical stress, was linked to the extreme density of the fish. Similarly, fisheries experts reported a very strong 2005 menhaden year class along the entire east coast. Concentrations similar to those observed in 1997 were reported in the area of the fish kills by fishermen and surfers. Observers reported large schools of apparently healthy menhaden seen under dead fish on the surface. The number of fish involved in the December kills is probably much higher than those actually reported as some of the fish were never stranded on the beaches and banks.

Map 1: Menhaden fish kill locations near Wrightsville Beach – December 18 and 23, 2005



Map 2: Menhaden fish kill location near Topsail Island – December 26, 2005