

**North Carolina Division of Water Resources
Annual Report of Fish Kill Events
2017**

North Carolina Department of Environmental Quality
Division of Water Resources
Raleigh, NC

November 2017

2017 Fish Kill Overview

As of November, 2017, the Division of Water Resources (DWR) investigated 18 fish kill events across North Carolina and provided reports under its investigation protocols. In addition, 52 sightings of fish kill activity were reported by the public to DWR via its online app. Some public sightings were accounted for in DWR reports but there remained a number of unconfirmed public reports throughout the state. Confirmed and unconfirmed kill activity was reported during the year in 14 of the state's 17 major river basins and in 34 counties.

Fish kill information for the current year is posted weekly from June to November on the DWR fish kill website: <http://portal.ncdenr.org/web/wq/ess/fishkillsmain>. This report will also be available on the DWR website after approval.

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|--|-------------------|
| • Confirmed Kill Events investigated by DWR | 18 |
| • Kill Events Reported by Public | 52 |
| • River Basins with Reported Kill Activity | 14 (of 17) |
| • Counties with Reported Kill Activity | 34 |

Fish Kill Investigations

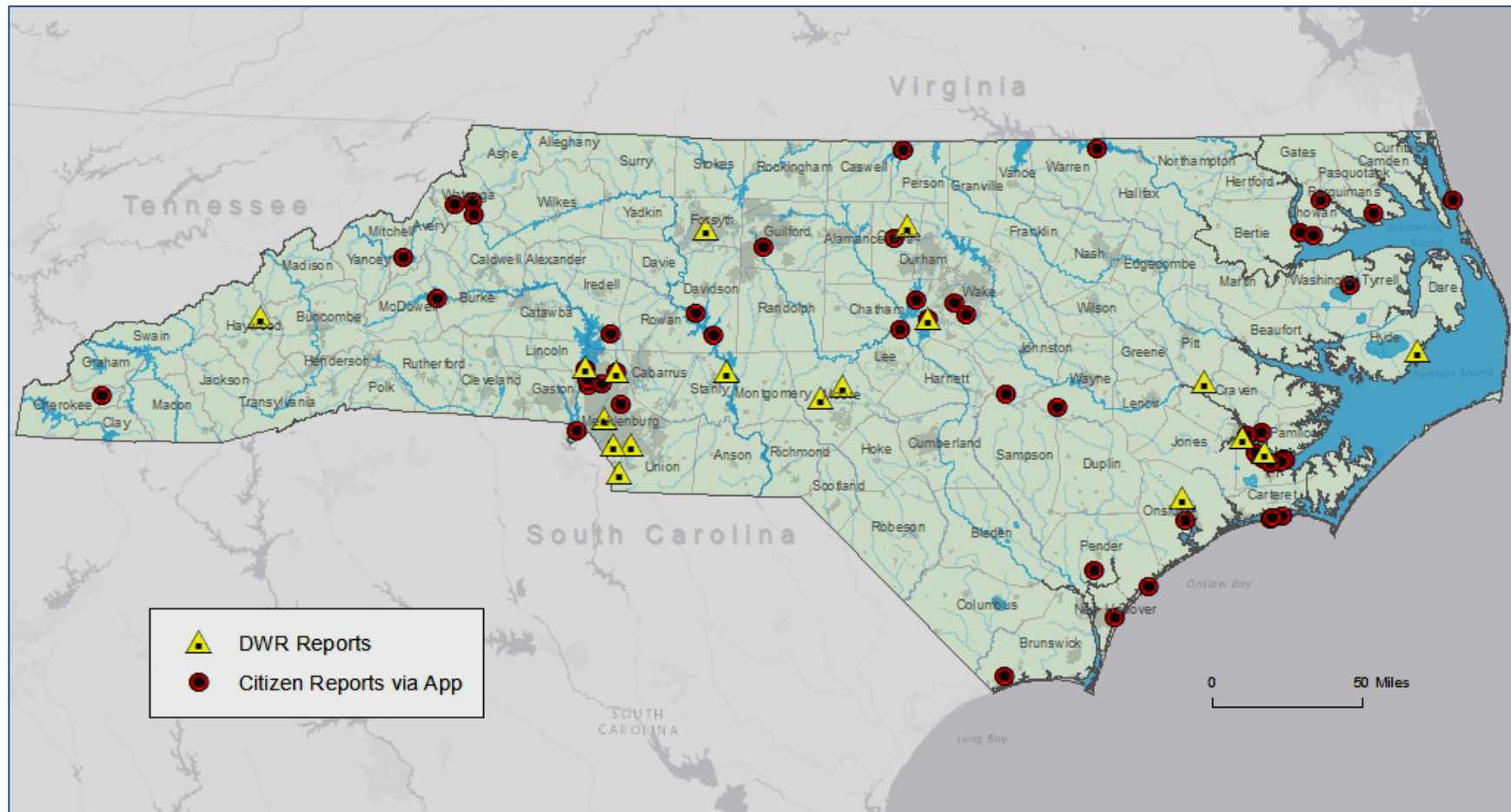
The reporting of fish kill activity across North Carolina is based on protocols established by the North Carolina Division of Water Resources (DWR) in 1996. The protocols were developed with assistance from DWR Regional Office staff, North Carolina Wildlife Resources Commission biologists, and Division of Marine Fisheries personnel 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 DWR's Water Sciences Section (WSS) where the data are compiled and reviewed. Fish kill investigation forms, laboratory test results, and supplemental information regarding fish kill events are sent to the WSS and entered into a central database where the information can be managed and reported. The procedure also requires the notification of appropriate state officials and scientists associated with the investigation of such events. The protocols have proven successful in standardizing reporting methods and enhancing the quality and quantity of information reported from fish kill events.

During 2016 DWR staff developed a mobile app that can be used by the general public to report fish kill activity across the state (see Appendix 2). The app can be accessed through a smart phone, tablet, or PC running Android or iOS platforms. It was developed so that the public could easily report locational and anecdotal information to DWR. Improved reporting of kill events will hopefully assist DWR staff with gaining a better understanding of the scale and magnitude of annual activity and thus develop a better and more complete response. The app is not designed to replace current DWR fish kill investigation procedures nor does it serve as a tool for the proper assessment of kill events. Information submitted via the app is to be passed to the appropriate regional office for follow up or further investigation under existing DWR fish kill investigation protocols, as would be the case if fish kill events were called in directly to regional offices. A link to the app is located on the DWR home page and the Water Sciences Section home page:

<https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page>.

This document is a summary of fish kill events reported to the DWR from January to October, 2017. The report is mandated under NC General Statutes §143B-279.7 (c).

Figure 1: DWR fish kill reports and fish kill app reports during 2017



DWR Fish Kill Investigations.

DWR regional staff provided formal reports for 18 events during 2017 (Figure 1, Appendix 1). Investigations occurred throughout the state from the coast, across the Piedmont and in Haywood county. Inland fish kills investigated by DWR were generally reported throughout the Piedmont, with a cluster of events in the Charlotte area. Inland kills were most often attributed to fluctuations in dissolved oxygen levels and to various spills of chemicals and municipal sewage. Fish mortality associated with inland events was reported as being relatively low, involving 1800 individuals or less.

Larger fish kill events were reported along the coast, following observed historical patterns. DWR staff investigated five events reported in coastal waters located in Onslow, Craven, and Hyde counties. The most significant event occurred in the lower Neuse Estuary near New Bern and reportedly involved at least a half million fish. The kill appeared to span a period of several days involving mainly Atlantic menhaden. During the event there were multiple sightings of stressed and dying fish along the Neuse and in tributaries from New Bern to Slocum Creek. The lower Neuse and Pamlico estuaries have historically experienced adverse environmental conditions for fish populations such as low dissolved oxygen, high water temperatures, and fluctuating salinities. Consequently, these areas often produce some of the more severe kill events reported annually (see map Appendix 3).

Citizen Reports to DWR

Over 50 reports of fish kill activity were received from the public during 2017, most often via the DWR mobile app. Public reports were received from June to October and described events statewide in 26 counties. Public reports were reviewed and forwarded as soon as possible to the appropriate regional office staff for further investigation. In many cases, through additional follow-up, DWR regional staff determined that the reported event did not warrant additional investigation and use of resources (i.e. few fish involved or the report was received too long after actual sighting). In other cases DWR and cooperating agency personnel were unable to confirm anecdotal information provided by citizens through app reporting. The lack of DWR follow-up investigations in these instances was often a result of staffing and resource constraints. Proper investigations could therefore not occur or were performed too long after the fact. The mobile reporting app did, however, prove useful in notifying regional staff of possible fish kill activity and as a means for initial contact with regards to dead fish and related algal bloom sightings (see below). Public use of the mobile app appears to be on the increase as report submissions were up from 26 to 52 during 2017.

Harmful Algal Blooms Associated With Fish Kills

Algal samples were collected by investigators in conjunction with five fish kill events during 2017. Results indicated all algal species identified by DWR staff were typical for local estuarine and freshwaters during the summer season and none were cited as a major factor in any kill events. Some forms of algae in North Carolina waters have the

potential to produce toxins capable of harming aquatic life. None of the fish kill events were attributed to algal toxins in North Carolina during 2017.

2017 Discussion

DWR and cooperating agencies formally investigated 18 fish kill events during the 2017 season. The total included smaller events in inland waterbodies attributed to dissolved oxygen depletion and spills of various substances. The year's largest event occurred along the coast in October and fit a familiar historical pattern where nutrient and organic loading coupled with water column stratification had depleted dissolved oxygen levels in coastal waters during warm months (hypoxia). Data from the North Carolina Modmon Program and measurements from DWR investigators indicated that sudden shifts in wind direction and velocity caused mixing of the water column and upwelling of hypoxic layers that resulted in a protracted event along the Neuse Estuary near New Bern. During the same period NCDMF staff confirmed sores among the kill population. Four-inch menhaden, most with sores, were observed along the Neuse from Union Point along the shoreline down to the Flanner's Beach area (Craven Co.). By the Fall, many of the younger transient menhaden populations have made their move out to more stable waters before the winter season. The remaining populations are typically weakened by stressful estuarine conditions of salinity, temperature and oxygen fluctuations, thus rendering them prone to the pathogens such as the slime mold *Aphanomyces invadens* (Appendix 4).

The 2017 season marked the second year where the DWR fish kill reporting app was available for public use. Over 50 fish kill sightings were reported via the app during the year, an increase from 2016. Typically, public reports were forwarded to the appropriate regional staff as soon as possible. As was the case in 2016, not all public sightings were verified by DWR personnel using standardized protocols. The disparity was a result of decisions made within the regional offices based on time and staff resources. These decisions dictated what information received from the public could be further investigated. Staff resources are particularly limited with regards to fish kill investigations within the coastal regions. The Estuarine Monitoring Team (EMT) has acknowledged missing responses to fish kill reports despite efforts to investigate multiple simultaneous events while conducting their primary functions. Some coastal regions have experienced a marked increase in blue-green algal blooms in the past three years. Resources required to deal with the bloom complaints has increased significantly as EMT staff can receive up to four complaints a week. EMT resources have been further strained as a result of additional obligations involving assistance in academic projects, general field duties, and expertise provided to other regional staff.

Since its introduction in 2016, the DWR fish kill reporting app appears to provide an effective and simple web-based tool for the public to initiate contact and provide preliminary information to DWR staff regarding kill events across North Carolina. This tool provides an opportunity to gather more information on various events across the state, but does not necessarily provide guaranteed response and investigation by DWR. Comparison of data for reported versus investigated events may be utilized to better

quantify the number of events statewide and further develop appropriate response measures performed by the DWR.

Appendix 1: Summaries of Confirmed 2017 Fish Kill
Events Listed by County

Total 2017 Fish Kills: 20

Total 2017 Fish Mortality: 513,250

2017 Fish Kill Events (by County)

Date	Kill Number	Waterbody	Location	Mortality	Comments
Craven					
6/13/2017	WA17001	Private Pond	UT to Swift Creek	275	Low Dissolved Oxygen observed at time of investigation. The kill started approximately 2-3 days previous the investigation. The pond is in-line with a ditch/stream connected to Swift Creek, and was receiving no flow, nor discharging, at the time of investigation, and it appeared to have been many days (since last rain about a week prior) since it last had any flow. Plant nursery and hog farm on the same drainage feature, and an observation was made by Mr. O'Brien that the only thing he'd noticed to change over time was the land application of waste from the hog farm on a field across Harris Road. Pond at it's deepest is 10' deep, but shallow near both outfalls/inlets. Phytoplankton analysis revealed a healthy and diverse algal population typical for ponds of this size. No unusual phytoplankton were observed that would explain the milky discoloration reported by the property owner.
9/1/2017	WA17002	Drainage Ditch feeding Middletown Creek	Middletown	3,000	Based on previous precipitation of 2.25 inches coupled with an impoundment drawdown, water quality, specifically dissolved oxygen, was depleted rapidly. As a result, fish utilizing the canal experienced low dissolved oxygen (<0.5 mg/L). The connection to creek was one small culvert and tide was likely coming in to prevent escape. Blue crabs appeared to move to the shoreline edge, however, many were unable to survive the conditions at the time. White egrets and blue heron were present and likely consumed a portion of the dead fish, some likely sank, with remainder floating.
9/19/2017	WA17003	Lake Clermont	James City	2,000	Homeowners around Lake Clermont noticed dead fish over the course of a few days on September 17th. A violent thunderstorm came through the area the prior evening. Previous weather included hot, stagnant days. The lake is shallow and has no connectivity to state waters, as indicated by NCWRC staff. Staff believed the culprit of the kill was most likely low DO and turnover due to the precipitation event.
10/9/2017	WA17004	Neuse River	Near New Bem	500,000	EMT staff attempted visited the northern and southern shorelines of the kill areas where complaints were observed on Monday October 9th as EMT wasn't made aware of the kill until then. After speaking with the Neuser Riverkeeper and other locals, the kill seemed to begin sometime between Thursday and Friday previously. Possible strong southerly winds upwelled some hypoxic waters that have been building over the previous few weeks from the strong saline stratification - a problem typical for drought months. Supporting data were recorded by the Modmon program. The waters had also cooled slightly and there were also some localized strong storm events in some areas. The slime mold Aphanomyces invadens was observed as water temperatures start to cool down into fall. NCDMF staff confirmed sores among the kill population along the southerly side October 7th and 11th. Four inch menhaden, all with sores, were observed from Union Point along the shoreline down to the Flanner's Beach area.

Physical data recorded on the northern/southern shoreline from the following Monday at Kennel's Beach and Union Point/Persimmon's Restaurant and Marina, respectively, based on the most recent complaints. The north shore was normal, very turbid and the wind was blowing 20 knots from the south. The south side indicated low DO near 4 mg/L with 5 ppt salinities.

Localized kills were also observed in Fairfield harbor (Northwest Creek) and at the mouth of Broad

2017 Fish Kill Events (by County)

Date	Kill Number	Waterbody	Location	Mortality	Comments
					Creek, and Slocum Creek (october 20th).
					Total Kills for County: 4 Total Mortality for County: 505,275
Forsyth					
1/24/2017	WS17001	Peters Creek	Winston Salem	200	Illegal discharge of red dye from Haynes finishing plant reported. Dead fish observed by county health department personnel .
					Total Kills for County: 1 Total Mortality for County: 200
Haywood					
6/1/2017	AS17001	Bald Creek	near Waynesville	100	A farmer located at 1286 Bald Creek Road admitted to discharging wet concrete into Bald Creek; a tributary to Crabtree Creek and the Pigeon River. The total volume of concrete discharged is unknown but is thought to be less than 10 cubic yards. Downstream observers described the stream turning milky white and fish jumping out of the water, which was followed by the die-off. An extensive stream walk bracketed the fish kill between 1286 Bald Creek Road and Upper Crabtree Road; a distance of 1.12 miles. More than 100 dead fish were observed, which primarily consisted of creek chubs and hog suckers. The BIMS incident number is 201700986.
					Total Kills for County: 1 Total Mortality for County: 100
Mecklenburg					
4/21/2017	MO17002	Private Pond	near Ballantyne	360	Neighbors observed an algal bloom days prior to the fish kill event. No algal bloom observed at the time of the investigation. All sample sites observed were hypoxic. Several schools of live fish were observed at the time.
7/13/2017	MO17005	Mountain Island Lake	below Cowans Ford Dam	325	Staff from Charlotte-Mecklenburg Storm Water Services (CMSWS) responded to a citizen request reporting that a large number of dead fish were observed in upper Mountain Island Lake on Thursday, July 13. Staff investigating observed dead catfish floating from the mouth of McDowell Creek cove all the way up to Cowan's Ford Dam. This dispersal of the dead fish suggest that the kill occurred behind the dam and the flow from the turbine generation pushed the fish downstream. Near the NC-73 bridge, Spidel observed that the water was a much darker green color and not as clear as normal. Visibility was limited to <1m when secchi depths are normally 3-4m. Another observation was that the water in the prop wash of the boat turned milky-white and stayed this color for a while. The water quality measurements obtained on the 13th did not suggest any problems with the water other than the oxygen being supersaturated. Spidel collected samples for algae, chlorophyll α , metals, and nutrients. The kill appeared to have run its course at this time as no gasping or struggling fish were observed. Lab results for the samples collected on the 13th did not indicate any toxicity issues that could have led to the fish kill. The algae samples were evaluated by David Buetow (CMSWS staff) and the only abnormal finding was that benthic diatoms and organic debris were found in surface grab samples. These benthic diatoms suggest that a turn over event could have occurred at the base of Cowan Fords Dam the week of July 10th where the water column is 14.4m deep. When Spidel recorded a complete depth profile in the tailrace of the dam on the morning of July 14th,

2017 Fish Kill Events (by County)

Date	Kill Number	Waterbody	Location	Mortality	Comments
					<p>the water column was completely mixed with only 0.5 mg/L DO difference between the surface and bottom (14.4m) measurements. The temperature was the same throughout the profile 26.8 °C, confirming the well mixed water column. The water was a lot more clear and did not have the green color observed on the previous day. Secchi depth samples on 7/14/2017 were within normal values of 3-4m.</p> <p>Staff analyzed the data for the month of July from the USGS water quality monitoring station at the NC-73 bridge. Supersaturated oxygen levels (levels reached 10.5 mg/L) suggests that upper Mountain Island experienced a plankton/algae bloom the week of July 10th. The bloom created a pronounced diurnal oxygen fluctuation ranging from 4.6 to 10.5 mg/L and the normal operations at Cowan's Ford Dam likely exacerbated the observed variation. On July 12, the day that the kill occurred, oxygen concentrations fluctuated from 4.6 mg/L at 09:45 to 10.5 mg/L at 15:00 and dropped from 10.3 mg/L to 6.3 mg/L in a matter of 15 minutes when the turbine operation began at approximately 16:00. This fluctuation, in combination with the high-water temperatures most likely initiated an acute kill event.</p>
7/28/2017	MO17004	Private Pond	Huntersville	200	<p>A fish kill occurred on Tuesday, July 25, but Mecklenburg County was not informed until Thursday, July 27 in the late afternoon. Staff visited the pond on Friday, July 28 and observed approximately 15 dead redear sunfish that were several days old, no active kill was occurring during the visit. Spidel spoke with Tracie Richardson, owner of Southern Pond Management. Her crew collected the dead fish on Wednesday, July 26. The species and size information came from Ms. Richardson. The kill observations were from a citizen that lives adjacent to the pond. No pollution problems were observed at any time during the kill. The weather was extremely hot for 3 days prior to the kill and a severe thunderstorm with high winds occurred 2 days before the kill was observed. Anecdotal evidence suggests that a turnover event occurred and created the kill.</p>
8/19/2017	MO17006	Tributary to Briar Creek	Charlotte	460	<p>While tracking the fish kill upstream, investigators observed a 4" plastic pipe discharging water into the creek at approximately 1 gal/min. The specific conductivity of this water was 2588 µS/cm, and the pH was 6.01. This pipe was found to be connected to a catch basin at Myers Park Country Club. Vehicles and equipment are washed over this catch basin. The water may have been contaminated with fertilizers or other pollutants. No dead fish were observed upstream of this discharge. The golf course staff stopped the discharge by 15:00. A Notice of Violation was issued to Myers Park Country Club for an illicit connection. Follow-up inspections were conducted on 8/20 and 8/21; no newly dead or stressed fish were observed.</p>
8/31/2017	MO17007	Tributary to Six mile Creek	Charlotte	120	<p>Investigators with Charlotte-Mecklenburg Storm Water Services responded to a fish kill at the location on 8/31/17. Staff found a recently active sewer overflow adjacent to the creek that feeds a pond. Homeowner had reportedly removed >70 fish from the manmade pond where the fish kill occurred. Water quality parameters were taken at the pond, as well as up and downstream of the pond. During the initial inspection a rain event was occurring and by the following day many of the dead fish had been washed away, physical signs of sewage in the creek and pond had reduced, and water quality parameters were recovering to normal levels.</p>

Total Kills for County: 5 Total Mortality for County: 1,465

2017 Fish Kill Events (by County)

Date	Kill Number	Waterbody	Location	Mortality	Comments
Moore					
5/9/2017	FA17002	Lake Echo	Seven Lakes	100	Aquatic herbicide applied 7-10 days before event. Listed Algaecides and Herbicides applied included: Clipper Herbicide, Captain/Cutrine Plus, Aquathol Super K, and Reward.
5/9/2017	FA17001	Lake Sequoia	Seven Lakes	150	Aquatic herbicide applied 7-10 days before event. Listed Algaecides and Herbicides applied included: Clipper Herbicide, Captain/Cutrine Plus, Aquathol Super K, and Reward.
Total Kills for County: 2 Total Mortality for County: 250					
Onslow					
3/29/2017	WL17001	UT to Mill Creek	Jacksonville	35	Event discovered by City Street Dept and reported by City stormwater staff. No obvious cause evident. DO and pH levels were normal and stream had flow. No sheen or discoloration was obvious other than the background iron. Water depth averaged 3-6" with pools of 1-1.5'. Surveyed upstream locations for possible source, but none identified and fish found alive just upstream of Cardinal Road and further upstream. Dead and distressed fish were just upstream of Cardinal Road down to Indian Drive.
Total Kills for County: 1 Total Mortality for County: 35					
Orange					
4/26/2017	RA17001	Private Pond	near Hillsborough	250	Pond owner noticed over 200 fish (multiple species including at least 50 bass) gasping for air at surface on April 22nd. Pond was green at the time and was an orange/rust color when event was reported to RRO on April 24th. The area experienced heavy rain during April 23-24 before RRO personnel arrived to investigate on April 26th. Field personnel noted algal bloom was minor during sampling with surface accumulation along the shoreline. Meter readings did not suggest an ongoing bloom. Dissolved oxygen (D.O.) was 7.8 mg/L and pH was 6.4. An active algal bloom usually increases D.O. to at least 9 mg/L (110% saturation) with a pH reading of at least 8. The algal sample indicated a bloom of the colonial bluegreen alga Coelosphaerium.
Total Kills for County: 1 Total Mortality for County: 250					
Stanly					
7/24/2017	MO17003	Badin Lake	near Badin	1,800	Blueback herring were only species affected. Other species of fish seen swimming in area. High water temps and low dissolved oxygen suspected as cause for event.
7/24/2017	MO17003	Badin Lake	near Badin	1,800	Blueback herring was only species affected. Other species seen swimming unharmed in the area. High water temps and low dissolved oxygen suspected as cause for the event.

2017 Fish Kill Events (by County)

Date	Kill Number	Waterbody	Location	Mortality	Comments
7/24/2017	MO17003	Badin Lake	near Badin	1,800	Blueback herring

Total Kills for County: 3 Total Mortality for County: 5,400

Union

3/28/2017	MO17001	Rone Branch	Waxhaw	50	Kill occurred after 6000 gallon sewage overflow near Waxhaw.
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Total Kills for County: 1 Total Mortality for County: 50

Wake

6/2/2017	RA17002	Private Pond	near New Hill	225	Discolored water and surface film noted at site. The sample contained very little algae and did not appear to be an algal bloom. The most common algae seen were small round diatoms and some cells of the euglenoid Trachelomonas (Figure 1). The total algal density was 1,900 units/ml and the total biovolume was 500 mm ³ /m ³ . Dissolved oxygen was 0.15 mg/L (3% saturation), and the pH was 6.5. Diatoms and Trachelomonas are common in the state's freshwater ponds and lakes during warm weather. Euglenoids such as Trachelomonas are sometimes an indicator of organic nutrients. Site owner reported seeing a fish kill at site during June 2016.
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Total Kills for County: 1 Total Mortality for County: 225

Appendix 2: DWR Fish Kill Report App



Report a fish kill to NC Division of Water Resources

Use this app to report a fish kill to Division of Water Resources staff for further investigation.

1. Enter Information

Your Name

Optional
How may we contact you?

Optional
Date of fish kill

Waterbody where event occurred

Nearest town or landmark

County

Approximate area (river miles, acres)

How long did the event last?

Any other comments

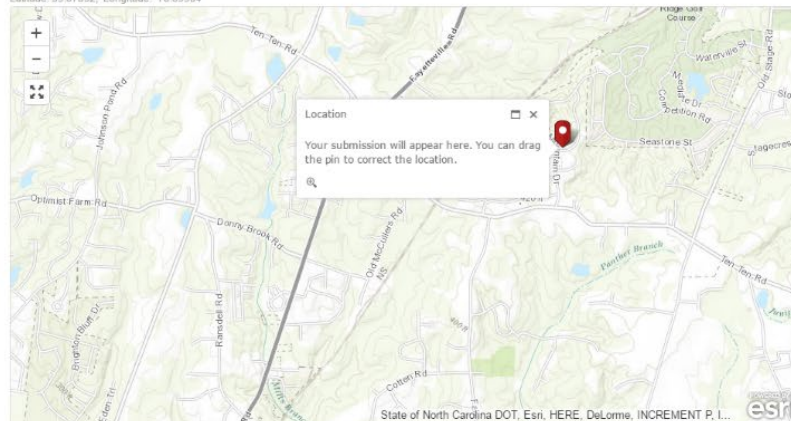
2. Select Location

Specify the location for this entry by clicking/tapping the map or by using one of the following options.

Search

Find address or place

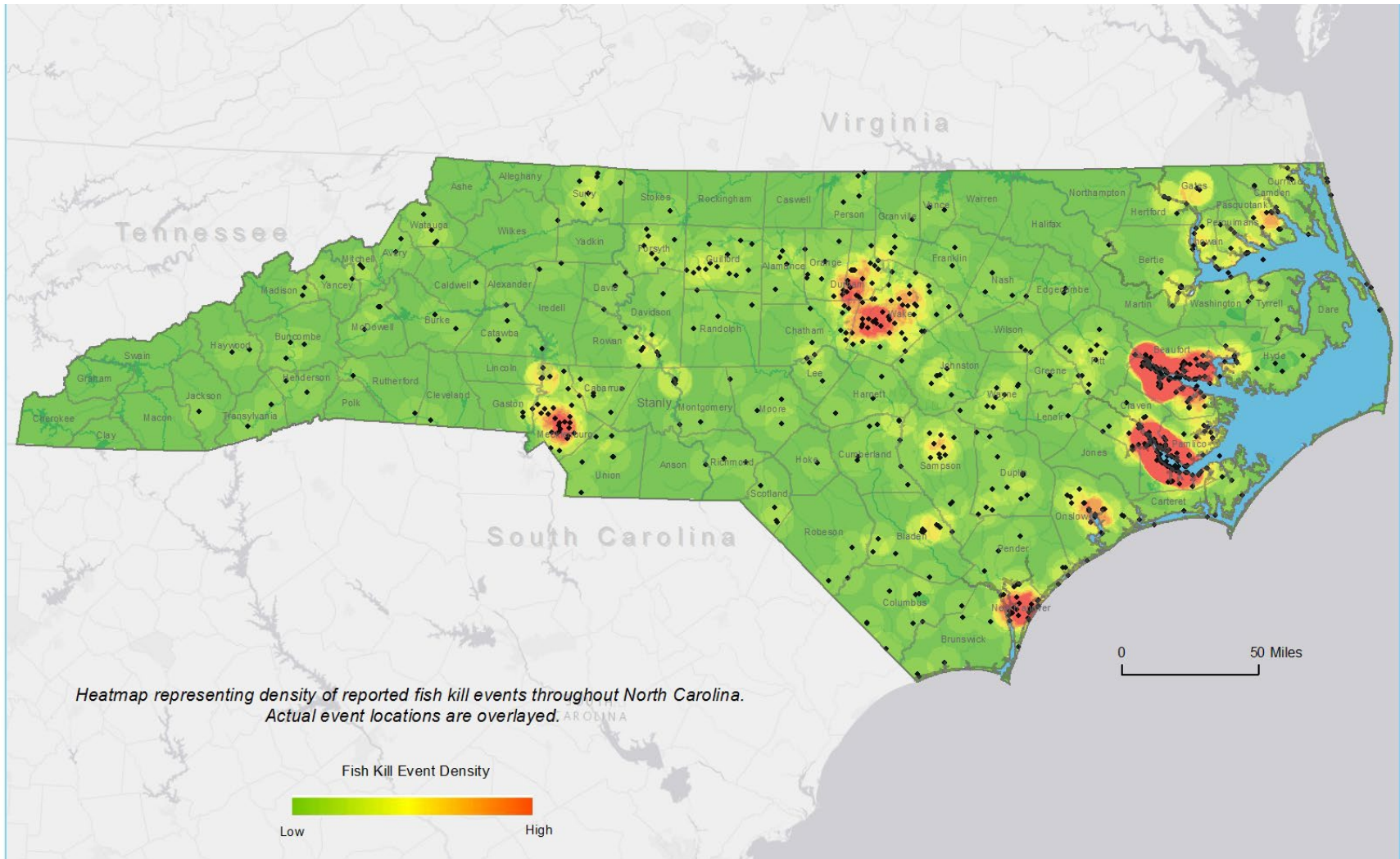
Latitude: 35.67032, Longitude: -78.65504



3. Complete Form

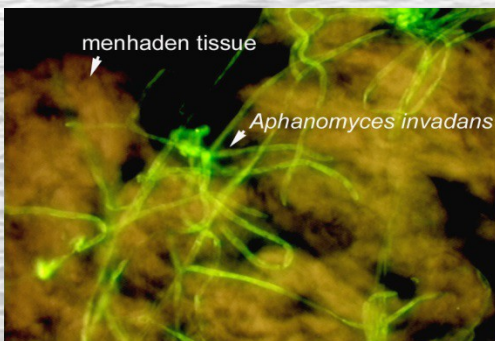
Add this information to the map

Appendix 3: Fish Kill Event Density in North Carolina 1996 - 2016



Appendix 4: Fish Lesions in North Carolina Estuaries

- ❖ Work by numerous investigators starting in the 1980s has shown that the majority of observed lesions (sores) on fish in North Carolina estuaries are due to the species of water mold, *Aphanomyces invadans*. This finding has been confirmed since 2006 using an *A. invadans* species-specific molecular assay developed by Vandersea et al. (2006). This pathogen has been found in Australia, Southeast Asia, Japan, Europe and the United States in both fresh and brackish (estuarine) waters. The organism infects both wild and cultured fish.
- ❖ *A. invadans* produces spores that grow best in the low salinity portion of estuaries. These low salinity areas serve as nurseries for large populations of juvenile Atlantic menhaden, the most commonly infected fish in the southeastern United States. *A. invadans* also grows best at intermediate temperatures. Consequently, fish observed with sores or lesions in North Carolina estuaries tend to be more abundant in the spring and fall and much less common in the middle of the summer or in winter.
- ❖ Heavy *A. invadans* infections can cause fish kills, but this appears to be rare. In most cases the infection plays a secondary role, weakening the fish and making them more susceptible to low oxygen or other adverse environmental factors. In North Carolina estuaries, environmental records indicate that over 90% of fish kills are due to low dissolved oxygen levels.
- ❖ ***Aphanomyces invadans* does not infect humans and poses no threat to human health.**



Menhaden tissue infected with Aphanomyces invadans, courtesy NOAA



Lesioned Menhaden