2016 Fish Kill Summary

Maryland Department of the Environment
Science Services Administration
Fish Kill Investigation Section

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Purpose

A special responsibility mandated by Environmental Article Section 4-405C requires management and control agencies to investigate the occurrence of damage to aquatic resources, including, but not limited to, mortality of fish and other aquatic life. The investigations should determine the nature and extent of each occurrence and endeavor to establish the cause and sources of the occurrence. If appropriate, findings shall be acted upon to require the reparation of any damage done and the restoration of the water resources affected, to a degree necessary to protect the best interest of the state.

Until 1984, fish kill investigations in the state were the responsibility of the Department of Natural Resources. In 1984, this function was transferred to the Office of Environmental Program's Division of Water Quality Monitoring within the Department of Health and Mental Hygiene. Effective July 1, 1987, the Office of Environmental Programs became part of the Maryland Department of the Environment (MDE).

The MDE Field Evaluation Division coordinates an on-call interagency staff to ensure that all reports of fish kills in the state are promptly addressed. While MDE attempts to investigate all reported events, reports with fewer than 25 dead fish, those for which there is a priori information or incidents that are reported more than 72 hours after they occurred are not always investigated. Information obtained by interviewing the complainant, knowledge of fisheries, and or scientific activity and historical data from the vicinity occasionally eliminates the need to investigate reports.

A summary report of fish kills is prepared annually. A database has been established and is available for all reported incidents occurring since 1984.

Acknowledgements

Many organizations and individuals contribute to the efforts necessary in the field and office to bring this report to completion each year. To those inadvertently not cited, your efforts are greatly appreciated.

2016 After Hours fish kill duty roster: Nick Kaltenbach, Chris Luckett, and Charles Poukish.

Others who participated in 2016 investigations:
Rima Abouzeid (MDE WMA), Kathleen Basset (MDE-FOP), Steve Doctor (DNR-FS), Hogan (MDE-WMA), Jody Johnson (DNR-FS), Dave Jordahl (MO-DEP), Alan Klotz (DNR-FS), Dan McCann (MO-DEP), Alan Place (UM-IMET), Amanda Postakis (MD-CBP), Matt Sell (DNR-FS), Jerry Stivers (DNR-FS), Ed Watson (MDE WMA), Ross Williams (DNR-FS), Adam Wood (VDH-DSS)

Cooperating agencies:

- MDE- Environmental Assessment and Standards Program
  - Field Operations Program (FOP)
  - Emergency Response Division (ERD)
  - Office of Communications and Digital Strategy
  - Water Management Administration- Compliance Program
- DNR- Fisheries Service
  - Natural Resources Police
  - Oxford Cooperative Lab, Fish & Wildlife Health Program
  - Tidewater Ecosystem Assessment Division
  - MANTA-Annapolis Field Office
  - Coastal Bays Program (MD-CBP)
  - Wildlife and Heritage Program
- MDA- Animal Health Laboratory
  - Pesticide Regulation Division
- University of Maryland
  - Institute for Marine and Environmental Technology
  - Veterinary Services
- USGS-Fish Health Branch
- Virginia Department of Environmental Quality (VA-DEQ)
- Virginia Department of Health Division of Shellfish Sanitation
- Montgomery County Department of Environmental Protection (MO-DEP)

Thanks also go to the concerned citizens of Maryland for alerting us to and providing vital initial information regarding fish kills throughout the state; and to any individual or agency inadvertently omitted from this list.

Summary

This report contains a summary of fish kills reported to Maryland Department of the Environment in calendar year 2016. After the completion of investigations and/or communications with witnesses or knowledgeable officials, a probable cause is usually determined for fish kills. The data presented were gathered from field investigations and discussions with reporting persons and officials.

Teams consisting of two or more agencies conducted several of the investigations. MDE Fish Kill Investigation Section personnel conducted 24 investigations. Other MDE groups participated in four: three by the Water Management Administration and one by the Field Operations Program-Shellfish Compliance Division. The Maryland DNR-Fisheries Service participated in six. The Maryland Natural Resources Police participated in one. The University of Maryland's Institute of Marine and Environmental Technology participated in one. The Montgomery Department of Environmental Protection participated in two. Two events in the Potomac River were investigated by the Virginia Department of Health, Division of Shellfish Sanitation.

Number of Events

Fish kill events typically vary from year-to-year depending upon rainfall, water quality, temperature, ice cover, variations in fish populations, and disease outbreaks. A total of 66 fish kills were reported in 2016, and 39 were considered significant enough to warrant on-site investigation. This represents the third lowest number of reports received

for a year since 1985, and was 61% of the historic average of 108 reports per year. Most fish kills occur in tidal waters during warmer months when waters become warm and stratified, and hypoxia becomes more common. Eighty percent of reported kills occurred during the six month period between April 1 and September 30 (Figure 1). Sixty-five percent occurred during the four month period of June 1 through September 30.

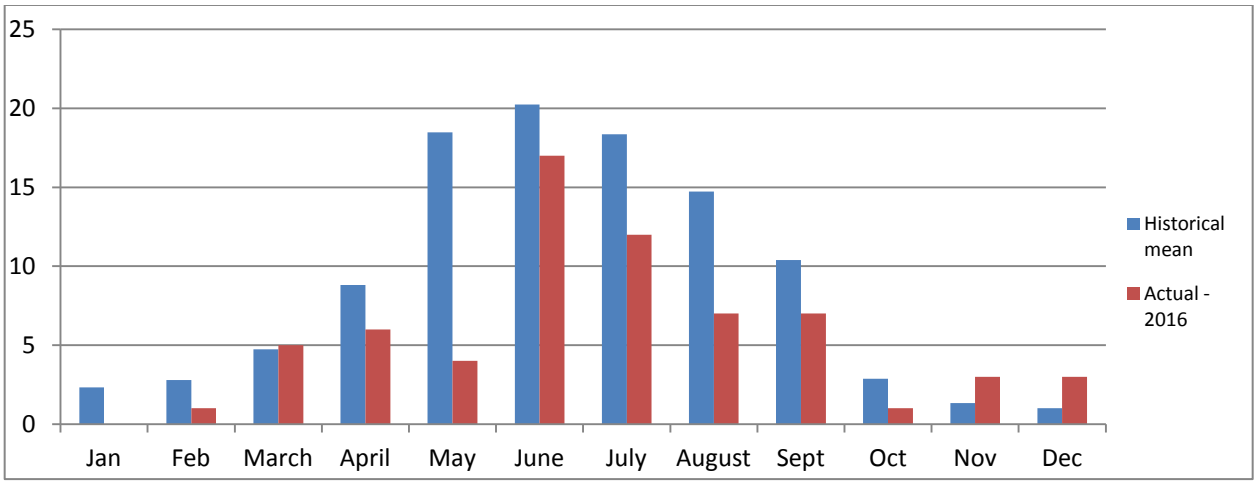


Figure 1. Fish kill reports received by month.

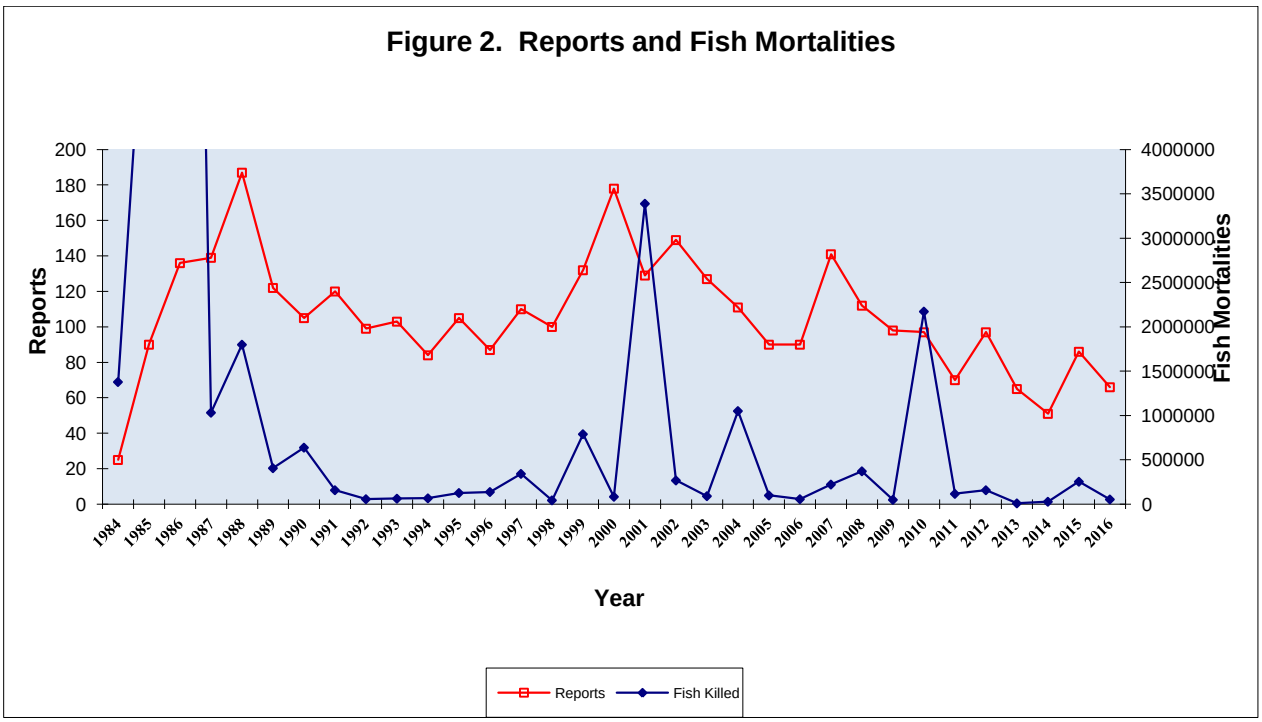
The early months of 2016 were characterized by relatively mild weather. Spring and early summer was characterized by frequent but moderate rainfall. The absence of prolonged dry, hot spells reduced water quality issues and resulted in a shrunken summer "dead zone" in the Chesapeake Bay and its tributaries (EPA Bay Program). Rainfall became scarce during late summer and fall. As a result, salinity rose in the upper Chesapeake Bay and its tidal tributaries. Air and water temperatures remained warm into December. This pattern resulted in fewer fish kills during the warmest months and initiated a widespread bloom of the ichthyotoxic dinoflagellate, *Karlodinium veneficum* in the upper Chesapeake Bay as far north as the Northeast River (which is typically fresh).

In November and December, the salinity in much of upper Chesapeake Bay and its tidal embayments was about 7 ppt.

Magnitude of Events

MDE estimates the number of fish and other animals involved in each reported event. Single events may dominate the total number of fish killed in a year (figure2). For instance, in the 1980's large schools (in the millions) of young-of-year menhaden were involved in several very large kills as a result of corralling in shallow, oxygen depleted headwaters. These events strongly skew the long-term average. As schools of menhaden became smaller and less plentiful in the Chesapeake Bay, the number and magnitude of menhaden kills has dropped. The total fish mortalities in Maryland for 2016 (54,602) is only 4.3 percent of the 32-year average of 1,263,453. It was the fifth lowest annual total recorded since 1984.

Figure 2. Reports and Fish Mortalities



Distribution of Fish Kills

Every county except Dorchester, Somerset, Talbot, and Wicomico was affected by fish kills in 2015 (Table 1). The highest number (10) occurred in Anne Arundel County. Charles County had the second highest occurrence with 8. Worcester had the third highest with 6, and Calvert, Saint Mary's, and Baltimore Counties were tied for fourth with 5. Other counties with notable numbers of events were Montgomery and Queen Anne's with 4 each. Of these seven jurisdictions, all but Worcester rank in the top ten for historical reports. Anne Arundel County has had the most reported kills (642) since 1984. Baltimore County ranks second highest with 361. Counties with abundant tidal shoreline and high population densities experience the most fish kill reports. These factors increase the likelihood of reports being made and typically exemplify localized anthropogenic impact. Additionally, Anne Arundel County historically is at the center of the highest densities of toxic dinoflagellates (e.g. *Karlodinium veneficum*), with fifteen historical incidents. Fish kills attributed to Karlotoxin (either alone or in concert with low Dissolved Oxygen, or high salinity) have accounted for 38 fish kills since 2002. One fish kill attributable to *Karlodinium veneficum* was observed in 2016.

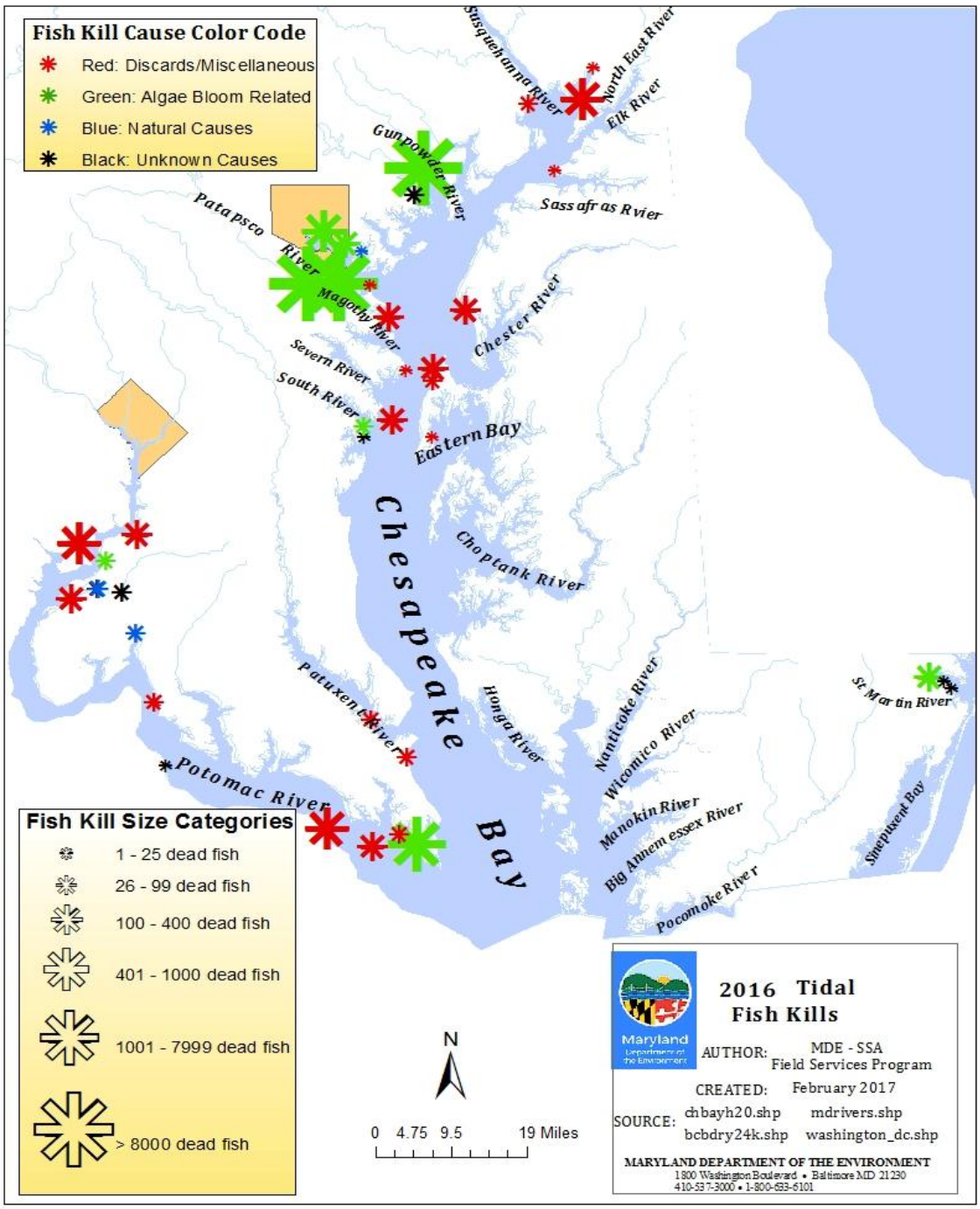
Table 1: Fish Kill Reports by County.

County	# Reports (2016)	# Reports (1984-2016)
Allegany	1	34
Anne Arundel	10	642
Baltimore	5	361
Baltimore City	2	105
Calvert	5	171
Caroline	1	67
Carroll	1	101
Cecil	2	205
Charles	8	129
Dorchester	0	65
Frederick	1	109
Garrett	2	44
Harford	2	167
Howard	1	78
Kent	2	116
Montgomery	4	149
Prince Georges	1	155
Queen Anne's	4	153
Somerset	0	61
St. Mary's	5	184
Talbot	0	92
Washington	2	60
Wicomico	0	104
Worcester	6	97
TOTAL*	65*	3449

**Totals do not include kills reported out of state.*

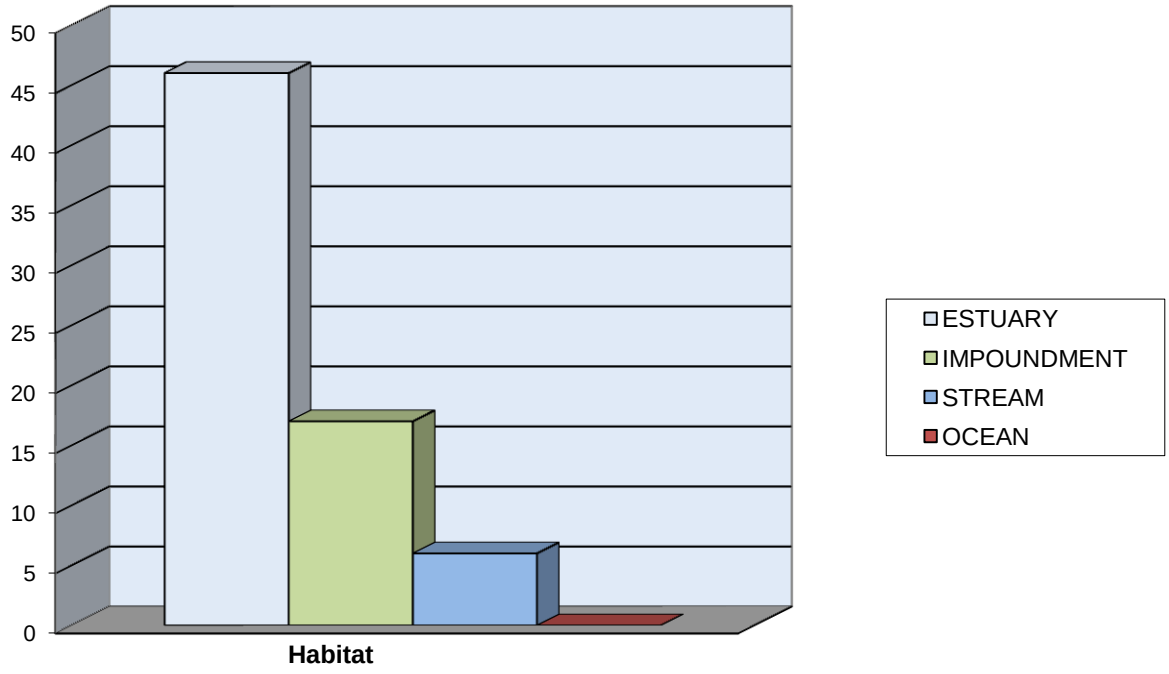
Figure 3 shows the geographical distribution, and magnitude of tidal fish kills, including the causes attributed to them in 2016.

Figure 3: Distribution of fish kills throughout Maryland tidal waters.



Reported fish kills occurred in various aquatic habitats. There were sixteen reported from impoundments, five from free flowing streams, and forty-five from estuarine waters (Figure 4). The number of reports from all environments was below average.

Figure 4. 2016 Fish Kills by Environment



Causes of Fish Kills

Of the 66 events reported, 62 were classified as fish kills. Four were determined to be a non-kill or insignificant events where no dead fish were found.

Probable cause was determined in 51 of the 62 fish kills (Table 2). Natural causes were implicated in 25 events, including 13 cases of oxygen depletion, 5 cases of winter/seasonal/spawning stress, 4 cases of stranding, and one each of disease,

predation, and toxic algae. The remaining events included 24 caused by fishing discards, 2 pollution cases, and 11 cases where the cause was undetermined.

Table 2: Probable causes of fish kill reports, 2016.

Probable cause	**2016 Only**	***Percent of Annual Total***	**# of Reports 1984-2016**	***Percent of Historic Total***
Natural	25	37.88%	1432	40.90%
Disease	1		235	
Low dissolved O_2	13		834	
Seasonal / Spawning stress	5		224	
Stranding	4		65	
Salinity shock	0		3	
Thermal shock	0		28	
Toxic algae bloom	1		22	
Toxic algae/water quality synergism	0		16	
Storm surge	0		1	
Predation	1		4	
Pollution	2	3.03%	283	8.08%
Agriculture	0		32	
Municipal sewage	0		46	
Industrial discharge	0		52	
Swimming pool discharge	0		19	
Fuel/Oil spills	0		30	
Unidentified source	0		54	
Construction	0		11	
Municipal discharge	1		25	
Pond Management chemicals	1		14	
Miscellaneous	24	36.36%	733	20.94%
Discards	24		515	
Entrapment	0		146	
Stocking stress, pond Mgmt.	0		64	
Scientific discards, exotic species control	0		8	
Unknown	11	16.67%	805	22.99%
Non-kill	4	6.06%	248	7.08%
TOTAL	**66**		**3501**	

In 2016, one fish kill was attributed to toxins produced by the dinoflagellate, *Karlodinium veneficum*. This algae is a long term resident of Chesapeake Bay. Although previously thought to be non-toxic, aka. *Gyrodinium estuariale*, it was associated with fish kills for many years. Around 2002, researchers at the University of Maryland corrected the misidentification and isolated potent ichthyotoxins (i.e. Karlotoxins) released by *K. veneficum*. Bioassay experiments performed at UM demonstrated the specific dose response associated with Karlotoxin. Since then, this office has worked to combine pertinent data from fish kill investigations (phytoplankton identification and enumeration, water quality, UM Karlotoxin analysis and dose response data) to diagnose kills caused by Karlotoxin. Since then, 38 Karlotoxin associated kills have involved 479,028 fish mortalities. No known human health effects are associated with these phenomena.

Other nuisance algae species (e.g. *Prorocentrum minimum, Gyrodinium uncatenum*) are not known to be toxic in Maryland, but may occasionally bloom to high enough levels to cause fish kills resulting from high Bio-chemical Oxygen Demand (B.O.D).

Events by Number of Fish Involved

Approximately 54,602 fish mortalities were confirmed in 2016. An additional 753 invertebrates and other aquatic animals also died totaling 55,355 organisms for the year.

In an average year approximately 5-10 fish kills in excess of 10,000 fish are noted. Two kills involved more than 10,000 fish in 2016.

The largest kill (#216065) began December 18th in three contiguous tributaries in the upper Gunpowder River (Baltimore and Harford Counties). Approximately 20,553 fish

(ten species) died when an unseasonably late bloom of the toxic dinoflagellate, *Karlodinium veneficum*, occurred. It is believed that the coincidence of rising salinity, nutrient availability from the encroaching salt wedge, and warm temperatures triggered and allowed the late persistence of the bloom. MD DNR monitoring data during November and December showed that a widespread bloom of K. veneficum existed in the upper Chesapeake Bay from the Northeast River south to the Gunpowder River. This region is usually too fresh and cool in November to support a bloom of the normally summer-time species. However this year the salinity in the region was approximately 7ppt and the water temperatures were above the historic seasonal averages. Results from several samples taken during the kill revealed that toxin levels varied from 168 ng/ml-18.25 ng/ml. This range in concentration is high enough to kill fish from less than one hour of exposure to several hours. Most of the affected fish were freshwater species. The estuarine species (e.g. white perch, brown bullhead, striped bass) likely fled into saltier water and were largely unaffected by the event. It is believed that rising salinity concentrated most of the freshwater species into the fresher headwaters of the tributaries and the combined effects of Karlotoxin and osmotic stress killed them. A comprehensive report was published by MDE on this event: http://www.mde.state.md.us/programs/Water/319NonPointSource/Documents/Fish%20Kills/GUNPOWDER%20FISH%20KILL%20DEC2016Final.pdf .

The second largest event (#216056) occurred September 20th in Furnace Creek, a tributary of the Patapsco River in Anne Arundel County. Approximately 13,501 fish (two species, mostly Atlantic menhaden) died of low dissolved oxygen during a bloom of the dinoflagellate Gyrodinium sp.

The third largest kill (#216057) occurred September 21st in Marley Creek, also a tributary of the Patapsco River in Anne Arundel County. Approximately 8,000 Atlantic menhaden died of low dissolved oxygen during a bloom of the dinoflagellate Gyrodinium sp.

The fourth largest kill (#216040) occurred July 26th in a tidal pond that had lost its connection to the Potomac River in Ridge (Saint Mary's County). Approximately 5,320 fish (3 species) died of low water level/low dissolved oxygen. The pond was only inches deep.

Pollution Caused Events

Intense local pollution or other direct anthropogenic causes were implicated in two Maryland events, killing approximately 1,139 fish. Approximately eight pollution caused kills occur in a typical year. Both pollution-caused kills were referred to the appropriate enforcement agencies for follow-up procedures.

- (#216058) occurred September 24th in a golf course pond in Potomac (Montgomery County). Approximately 1,000 fish (5 species) died immediately after an herbicide was introduced to control algae. The biochemical oxygen demand associated with the decomposing algae reduced the dissolved oxygen to lethal levels.
- (#216041) occurred July 27th in Sligo Creek in Silver Spring (Montgomery County). Investigation revealed that 139 fish (9 species) died after a water main break resulted in a discharge of chlorinated water and sediment into the stream.

Species Involved

Fish kills in 2016 affected at least 33 species of fish, representing 17 families and 11 orders (Table 3). Non-piscine species affected were: unidentified duck (1), American toad (50), horseshoe crab (552), blue crab (100), and shore shrimp (50). Approximately 560 fish were unidentified.

Table 3: Species and Numbers of Individuals Affected by Fish Kills in 2015.

Arthropoda	
Xiphosura	
Limulidae	
***Limulus polyphemus*-horseshoe crab**	**552**
Decapoda	
Palaemonidae	
***Palaemonetes sp*.-shore shrimp**	**50**
Portunidae	
***Callinectes sapidus*-blue crab**	**100**
Chordata	
Amphibia	
Bufonidae	
Anaxyrus americanus-American toad	**50**
Reptilia	
Anseriformes	
Anatidae-Unidentified duck	**1**
Agnatha	
Petromyzontiformes	
Petromyzontidae	
***Lampetra aepyptera*-least brook lamprey**	**1**
***Petromyzon marinus*-sea lamprey**	**3**
Chondrichthyes	
Myliobatiformes	
Rhinopteridae	
***Rhinoptera bonasus*-cownose ray**	**26**
Osteichthyes	
Unidentified bony fish	**560**
Anguillaformes	
Anguillidae	
***Anguilla rostrata*-American eel**	**31**
Atheriniformes	
Atherinidae	
***Menidia menidia*-Atlantic silversides**	**50**

Clupeiformes	
Clupeidae	
***Alosa mediocris*-hickory shad**	**60**
***Alosa pseudoharengus*.-alewife**	**30**
***Brevoortia tyrannus*-Atlantic menhaden**	**22,689**
***Dorosoma cepedianum*-gizzard shad**	**12,067**
Engraulidae	
***Anchoa mitchilli*-bay anchovy**	**50**
Salmoniformes	
Esocidae	
***Esox niger*-chain pickerel**	**1**
Cypriniformes	
Cyprinidae	
***Carassius auratus*-goldfish**	**70**
***Cyprinus carpio*-common carp/koi**	**3,916**
***Notropis hudsonis*-spottail shiner**	**447**
***Rhinichthys atratulus*-blacknose dace**	**57**
***Rhinichthys cataractae*-longnose dace**	**17**
***Semotilus atromaculatus*–creek chub**	**13**
Catostomidae	
***Catostomus commersoni*-white sucker**	**27**
Siluriformes	
Ictaluridae	
Unidentified catfish	**82**
***Ameiurus nebulosus*-brown bullhead**	**23**
***Ictalurus punctatus*-channel catfish**	**781**
Perciformes	
Centrarchidae	
***Lepomis cyanellus*-green sunfish**	**4**
***Lepomis gibbosus*-pumpkinseed**	**2,246**
***Lepomis macrochirus*-bluegill**	**2,511**
***Lepomis sp*.-unidentified sunfish**	**783**
***Micropterus salmoides*-largemouth bass**	**444**
***Pomoxis nigromaculatus*-black crappie**	**166**
Channidae	
***Channa argus*-northern snakehead**	**1**
Percidae	
***Etheostoma olmstedi*-tessellated darter**	**5**
***Perca flavescens*-yellow perch**	**1,551**
Pomatomidae	
Pomatomus salatrix-bluefish	**80**
Percopsiformes	
Moronidae	
***Morone americana*-white perch**	**5,248**
***Morone saxatilis*-striped bass**	**485**
Sciaenidae	
***Micropogonus undulatus*-atlantic croaker**	**75**
Plueronectiformes	
Achiridae	
***Trinectes maculatus*-hogchoker**	**2**