2023 Fish Kill Summary

Maryland Department of the Environment
Water and Science Administration
Bioregulatory Monitoring and Response Division
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. If appropriate, findings shall be acted upon to require the reparation of any damage done and the restoration of the water resources affected, to the 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 Bioregulatory Monitoring and Response Division coordinates an on-call interagency staff to ensure that all fish kill reports 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, 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 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.

2023 After Hours fish kill duty roster: Nick Kaltenbach, Chris Luckett, and Charles Poukish.

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Cooperating agencies in 2023:

MDE-	Emergency Response Division (ERD)
	Water and Science Admin-Compliance Program (MDE-WSA-CP)
	Water and Science Admin-Field Invest & Env Resp. Program (FIERP)
DNR-	Fishing and Boating Services (DNR-FBS)
	Natural Resources Police (DNR-NRP)
	Oxford Cooperative Lab, Fish & Wildlife Health Program (DNR-FWHP)

Maryland Coastal Bays Program (MD-CBP)
MEMA-Maryland Emergency Management Administration
MES- Maryland Environmental Service
MDA- Maryland Dept. of Agriculture, Pesticide Regulation Division
University of Maryland- Institute for Marine and Environmental Technology (IMET)
Virginia Department of Environmental Quality (VA-DEQ)

Virginia Department of Health, Division of Shellfish Sanitation (VDH-DSS)
Baltimore Co. Dept. of Environmental Protection & Sustainability (BA-EPS)
Montgomery County Department of Environmental Protection (MO-DEP)
Montgomery County Parks (MO-Parks)

A thanks also goes to the concerned citizens of Maryland for alerting us and providing vital 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 MDE in the calendar year 2023. 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 was 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 28 investigations, and all investigations were coordinated through this office. Other MDE groups participated in nine investigations: five by the Water and Science Administration's Compliance Program and four by the Field Investigation and Environmental Response Program. Maryland DNR groups participated in seven investigations: seven by the Fishing and Boating Service, three by the Fish and Animal Health Program, and one by the Natural Resources Police. The Maryland Coastal Bays Program participated in one. The Montgomery County Department of Environmental Protection participated in five investigations, and Montgomery County Parks participated in two.

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 59 fish kills were reported in 2023, and 42 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 58% of the historic average of 101.8 reports per year. Most fish kills occur in tidal waters during warmer months when waters become warm and stratified, and hypoxia becomes more common. In 2023, seventy-one percent of reported kills occurred during the five-month period between May 1 and September 30 (Figure 1). Sixty-three percent occurred during the four-month period of June 1 through September 30. Fish kill reports from March through August fell well below historic averages. While most fish kill reports still occur in the warmest months, the total number of events have been well below average for the past ten years.

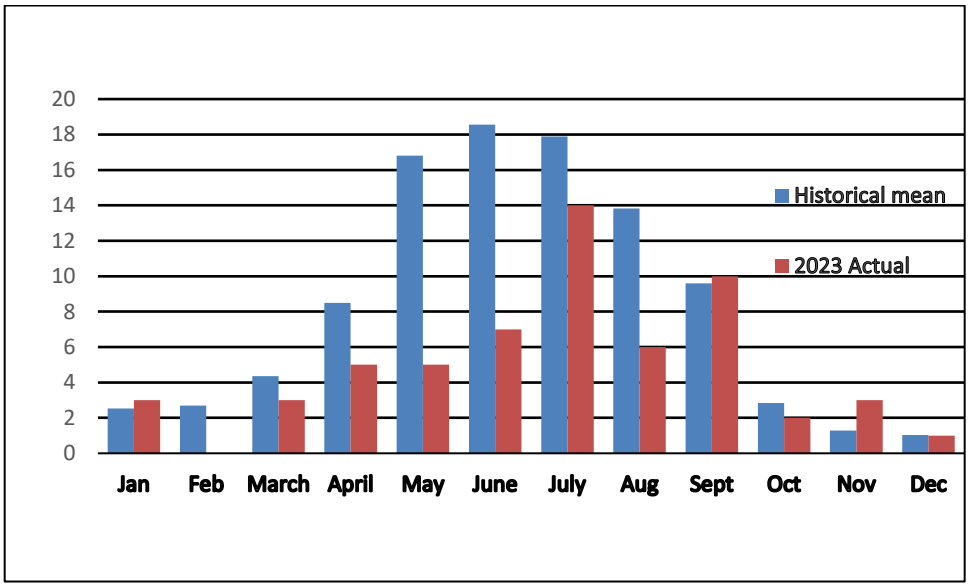


Figure 1. Fish kill reports received by month.

Chesapeake Bay (tidal) Water Quality

In most years, periods of intense heat, cold, drought, or heavy precipitation (resulting in nutrient inputs) create conditions that help explain adverse effects on aquatic life, including fish kills. MD DNR's extensive tidal monitoring network provides an excellent dataset of water quality conditions throughout much of the State. The data is publicly available on their "Eyes on the Bay" page.

2023 was a year without historic heatwaves, cold spells, and rain events. In fact, the year was unusually dry except for the month of September. The year began with average salinities in most tidal waters. As spring came, salinities gradually increased to above average where they remained through August. September rain brought increased flows and reduced salinities into the average range (slightly below average for some locations). The general dry trend returned and continued through the rest of the year, and the year ended with above-average bay salinities. Water temperatures were slightly above average most of the year. They were well above average for the month of September and eventually returned to average in November.

Dissolved oxygen in the Chesapeake Bay began slightly below average in the early months but were often above average throughout most of the summer. This could be a function of low nutrient input into the bay due to reduced rainfall.

By the end of 2023, the annual summary of hypoxia performed by DNR concluded that the year was slightly better than average (MD DNR, Eyes on the Bay 2023). The annual dead zone was reported to be the tenth smallest in the past 38 years.

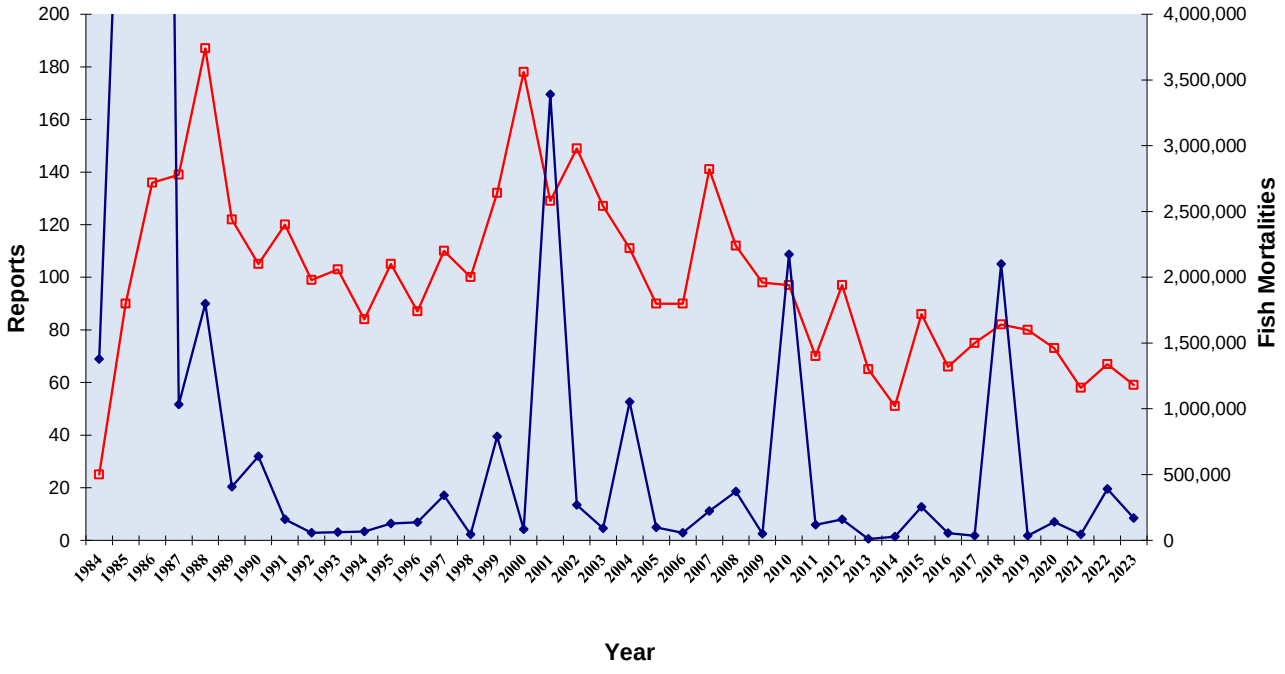
The percentage of fish kills reported in estuarine waters (50%) was a slightly below the historic average (57%). The percentage of kills attributed to low dissolved oxygen (22%) was at the historic average in 2023.

Magnitude of Events

MDE estimates the number of fish and other animals involved in each event. Single events may dominate the total number of mortalities in a year (Figure 2). 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 menhaden schools became smaller and less plentiful in the Chesapeake Bay, the number and magnitude of these kills fell. Similarly, the sudden icing over of shallow wetlands in the winter of 2017-18 resulted in large mortalities of shoreline fish species that dominated the yearly totals for this period.

The total fish mortalities in Maryland for 2023 (169,848) is 15.2 percent of the 40-year average of 1,115,335 (but, nearly equal to the median of 158,528). It was the nineteenth highest annual total recorded since 1984.

Figure 2. Reports and Fish Mortalities



Distribution of Fish Kills

Every county, except Carroll, Howard, Kent, and Somerset, was affected by fish kills in 2023 (Table 1). The highest number (nine) occurred in Baltimore County. Anne Arundel County had the second highest occurrence with seven. Montgomery had the third highest with six. Wicomico County had the fourth highest occurrence with five. Worcester County had the fifth highest with four. Of these five jurisdictions, three rank in the top eight in number of historical reports. Anne Arundel County has had the most reported kills (729) since 1984. Baltimore County ranks second highest with 410. 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 has been at the center of the highest densities of toxic dinoflagellates (e.g., *Karlodinium veneficum*) with 15 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. No fish kills attributable to *Karlodinium veneficum* were observed in 2023.

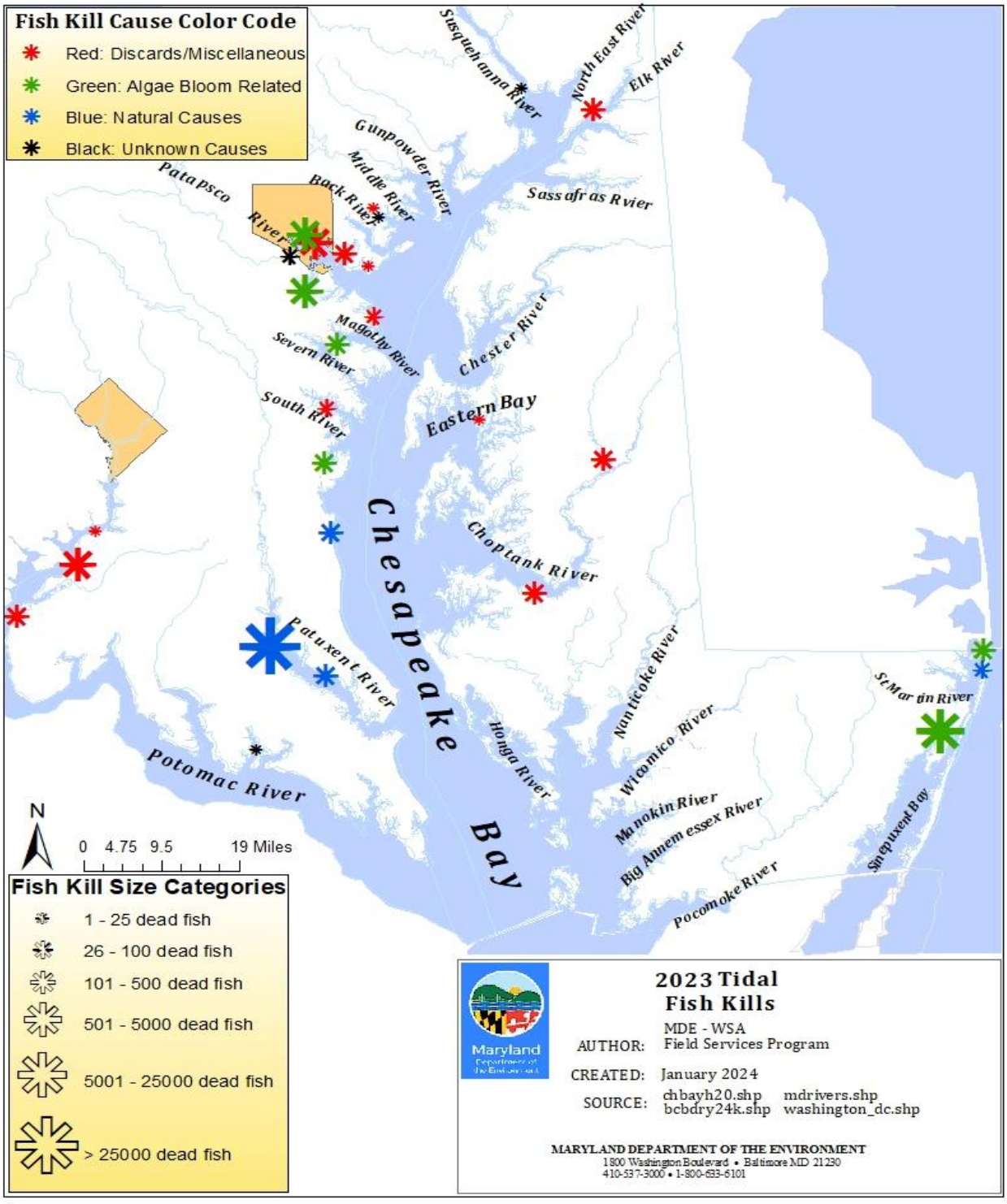
Table 1: Fish Kill Reports by County.

County	# Reports (2023)	# Reports (1984-2023)
Allegany	1	40
Anne Arundel	7	729
Baltimore	9	410
Baltimore City	1	121
Calvert	3	200
Caroline	2	81
Carroll	0	105
Cecil	2	220
Charles	2	141
Dorchester	1	77
Frederick	1	126
Garrett	1	48
Harford	3	189
Howard	0	85
Kent	0	135
Montgomery	6	177
Prince Georges	1	170
Queen Anne's	2	179
Somerset	0	65
St. Mary's	3	222
Talbot	3	109
Washington	2	66
Wicomico	5	113
Worcester	4	123
TOTAL*	58*	3931*

**Totals do not include five kills reported out of state or statewide events.*

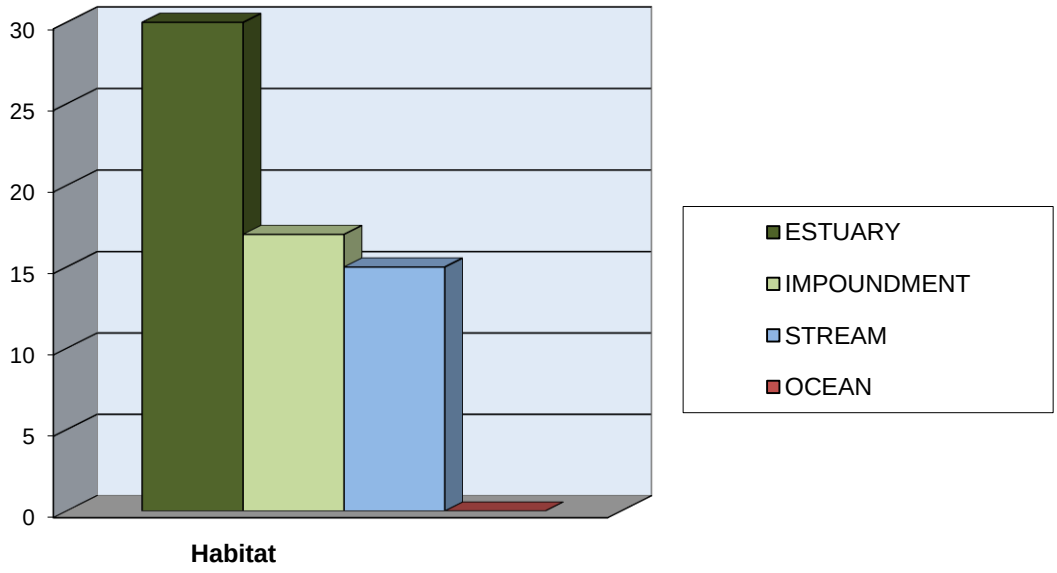
Figure 3 shows the geographical distribution, magnitude, and causes of tidal water fish kills that occurred in 2023.

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



Reported fish kills occurred in various aquatic habitats. There were 16 reported from impoundments, 14 from free-flowing streams, and 29 from estuarine waters (Figure 4). The number of reports from estuarine waters was 28 below the historic average. The number of reports from impoundments was 12 below average. The number of reports from these environments has been below average for more than 10 years now. The number from streams was equal to the historic average. The *percentage* of fish kill reports from estuarine and impounded waters was a slightly below historical average, and the percentage of reports from streams was well above historical average (23.7% vs 14.29%). Many of the stream reports also involved enforcement actions by State and local agencies. A consistent number of acute pollution related issues and the interdependence of this office and these agencies probably explain why the number of stream reports has not dropped relative to the number from other environments.

Figure 4. 2023 Fish Kills by Environment



Causes of Fish Kills

Of the 59 events reported, 51 were classified as fish kills, and eight were determined to be non-kills or insignificant events where no dead fish were found.

Probable cause was determined in 42 of the 51 fish kills (Table 2). Natural causes were implicated in 21 events, including 13 cases of oxygen depletion, three cases of seasonal or spawning stress, three cases of stranding, and two cases of disease. The remaining events included 12 caused by fishing discards, two cases of entrapment in man-made structures, and six pollution cases. There were nine cases where the cause was undetermined.

Table 2: Probable causes of fish kill reports, 2023.

Probable cause	**2023 Only**	***Percent of Annual Total***	**# of Reports 1984-2023**	***Percent of Historic Total***
Natural	21	35.59%	1617	40.48%
Disease	2		242	
Low dissolved O_2	13		945	
Seasonal / Spawning stress	3		254	
Stranding	3		81	
Salinity/Osmotic shock	0		9	
Thermal shock/Freezing	0		41	
Toxic algae bloom	0		22	
Toxic algae/water quality synergism	0		16	
Storm surge	0		1	
Lightning Strike	0		1	
Predation	0		5	
Pollution	6	10.17%	319	7.98%
Agriculture	0		34	
Municipal sewage	0		46	
Industrial discharge	1		63	
Swimming pool discharge	3		22	
Fuel/Oil spills	0		32	
Unidentified source	1		59	
Construction	1		15	
Municipal discharge	0		33	
Pond Management chemicals	0		15	
Miscellaneous	15	25.42%	868	21.73%

Discards	12		625	
Entrapment	2		167	
Stocking stress, pond Mgmt.	1		67	
Scientific discards, exotic species control	0		9	
Unknown	9	15.25%	895	22.40%
Non-kill	8	13.56%	296	7.41%
TOTAL	**59**		**3995**	

In 2023, no fish kills were 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, and 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, Levanderina fissa (*formerly *Gyrodinium uncatenum and G. instriatum*)) are not known to be toxic in Maryland, but occasionally bloom to high enough levels resulting in fish kills caused by high biochemical oxygen demand (B.O.D). In 2023, one fish kill was attributed to low dissolved oxygen caused directly by an algal bloom, even though most low dissolved oxygen cases are indirectly due to excess nutrients and algae.

Events by Number of Fish Involved

Approximately 169,848 fish mortalities were confirmed in 2023. An additional 12,111 invertebrates, amphibians, and other aquatic animals also died, totaling 181,959 organisms for the year.

In an average year, approximately 5-10 fish kills of more than 10,000 fish are noted. In 2023, there were only three events of this magnitude.

The largest kill (#2023047) occurred September 12th in Washington Creek, a tributary of the Patuxent River (Saint Mary's Co). Approximately 100,000 Atlantic menhaden died after being stranded in the remote, shallow headwaters of the creek.

The second largest kill (#2023008) occurred April 17th in a raceway at the Albert Powell State Trout Hatchery in Hagerstown (Washington Co.). Approximately 25,000 rainbow trout fingerlings died as a result of low oxygen. Investigation revealed that an unknown individual closed a discharge valve reducing water flow and resulting in the suffocation of the fish. Natural Resources Police took the case, investigating it as a likely case of sabotage, but the responsible party was not identified.

The third largest kill (#2023051) occurred September 17th in Ayers Creek (Worcester Co.). Approximately 20,000 fish died (almost exclusively Atlantic menhaden) of low dissolved oxygen in the creek. This event was preceded by heavy rainfall.

Pollution Caused Events

Intense local pollution or other direct anthropogenic causes were implicated in six Maryland events that totaled approximately 2,952 fish, 338 salamanders, 10 tadpoles, 4 crayfish, 1,004 aquatic insect larvae, and 10,400 oligochaete worms. Approximately eight pollution caused fish kills occur each year. All pollution related events are referred to the appropriate enforcement agencies for follow-up procedures.

- (#2023009) occurred April 24th in an unnamed tributary of Rock Creek in North Kensington (Montgomery Co). Approximately 2,505 fish (six species), 10,000 oligochaete worms, 1,000 midge larvae, and 100 slugs died as a result of a discharge of an unknown toxin. It is believed the source could be a swimming pool. Almost two miles of stream were affected.
- (#202316) occurred May 27th in Roland Run in Riderwood (Baltimore County). Approximately 756 fish (twelve species), 100 oligochaete worms, and ten crayfish died as result of a discharge of chlorine, most likely from a nearby swim club. Over 0.5 stream miles were affected.
- (#2023006) occurred March 30th in an unnamed tributary of Bucks Branch in Potomac (Montgomery Co). Approximately 272 fish (six species), 328 salamanders, 100 oligochaete worms, four crayfish, and four cranefly larvae died as a result of a discharge of chlorine (bleach) from a power washing contractor.

- (#2023011) occurred April 28th in Long Branch in Silver Spring (Montgomery Co). Approximately 100 fish (two species) and 300 oligochaete worms died after staff at a community swimming pool mishandled and discharged chlorine and muriatic acid into the stream.
- (#2023040) occurred August 14th in Little Falls Branch in Chevy Chase (Montgomery Co). Approximately 25 fish (two species), ten salamanders, and ten tadpoles died as a result of a discharge of muriatic acid at a community swimming pool.
- (#2023020) occurred June 21st in Coquelin Run in Chevy Chase (Montgomery Co). Approximately 50 fish (unknown number of species) died after a high pH discharge entered the stream from a Purple Line (subway) construction site. Grouting material was mishandled and mistreated, resulting in its discharge and impact on the stream.

Fish Kills of Special interest

One fish kill (#2023039) occurred August 8th in Beaver Creek immediately downstream of the Albert Powell Trout Hatchery in Hagerstown (Washington Co). This stream has a reproducing brown trout population which is supported by the cold water discharge from the hatchery spring. It is a popular fly-fishing destination. Approximately 400 brown trout (disproportionately adults) and a mix of about 80 other fish representing five other species died. The kill occurred during or immediately after a very strong hail storm. At least 2.5" of rain fell in a short period of time and the stream level rose by at least 12". The dead fish were discovered the following morning when a DNR Fisheries crew arrived to conduct a scheduled population assessment. By then, the water had begun to recede and some of the dead fish were well out of the water. More than ten people from MDE and DNR participated in the assessment and investigation. The storm, which triggered the kill, also erased much of the potential evidence. High temperature spikes were ruled out. Nutrient, BOD, pesticide, and chlorine samples all yielded unremarkable results. It remains unknown whether the mortalities were due to natural factors or anthropogenic constituents in runoff which were not tested for (or a combination of effects).

Species Involved in Fish Kills

Fish kills in 2023 affected at least 42 species of fish, representing 16 families and 12 orders (Table 3). Non-piscine species affected included horseshoe crabs, blue crabs, crayfish, salamanders, oligochaete worms, slugs, midge (Chironomidae) larvae, cranefly (Tipulidae) larvae, snapping turtles, mallard ducks and other waterfowl. Approximately 133 fish were unidentified.

Table 3: Species and Numbers of Individuals Affected by Fish Kills in 2023.

Mollusca **Physidae** **Physa sp. – snail** **Philomycidae** **Unidentified slug**	 **30** **100**
Arthropoda **Xiphosura** **Lumulidae** ***Limulus polyphemus* - horseshoe crab**	 **40**
Anellida **Lumbricidae – oligochaete worm**	 **10,500**
Arthropoda **Decapoda** **Portunidae** ***Callinectes sapidus* - blue crab** **Cambaridae** **unidentified crayfish**	 **44** **14**
Chordata – Amphibia **Plethodontidae** ***Eurycea bislineata* - Northern two-lined salamander** **Ranidae** **unidentified tadpoles**	 **338** **10**
Arthropoda **Insecta** **Chironomidae – unidentified midges** **Tipulidae** ***Tipula sp*. – cranefly larvae**	 **1,000** **4**
Chordata – Reptilia **Chelydridae** ***Chelydra serpentina* - diamondback terrapin**	 **7**
Chordata – Aves **Unidentified waterfowl** **Anseriformes** **Anatidae** ***Anas platyrhynchos* – mallard duck**	 **14** **10**
Chordata – Chondrichthyes **Myliobatiformes** **Rhinopteridae** **Rhinoptera bonasis – cownose ray**	 **28**
Chordata – Osteichthyes **unidentified bony fish**	 **88**
Anguilliformes **Anguillidae** ***Anguilla rostrata* - American eel**	 **3**

Atheriniformes	
Atherinopsidae	
***Menidia menidia* – Atlantic silverside**	**96**
Cyprinodontiformes	
Fundulidae	
***Fundulus sp.* – unidentified killifish**	**34**
Salmoniformes	
Salmonidae	
***Oncorynchus mykiss* – rainbow trout**	**25,010**
***Salmo trutta* – brown trout**	**400**
Clupeiformes	
Alosidae	
Alsoa pseudoharenfus – alewife	**1**
***Brevoortia tyrannus* - Atlantic menhaden**	**124,320**
Dorosomatidae	
***Dorosoma cepedianum* - gizzard shad**	**4,763**
Siluriformes	
Ictaluridae	
unidentified catfish	**379**
***Amieurus natalus* – yellow bullhead**	**5**
***Amieurus nebulosus* – brown bullhead**	**281**
***Ictalurus furcatus* – blue catfish**	**2,450**
Scorpaeniformes	
Cottidae	
***Cottus caeruleomentum* – blue ridge sculpin**	**20**
Cottus sp. n.– checkered sculpin	**20**
Lepisosteiformes	
Lepisosteidae	
Lepisosteus osseus – longnose gar	**20**
Cypriniformes	
Cyprinidae	
unidentified minnow	**5**
***Campostoma anomalum* – central stoneroller**	**1**
***Clinostomus funduloides* – rosyside dace**	**30**
***Cyprinus carpio* - common carp/koi**	**27**
***Margariscus margarita* – pearl dace**	**10**
***Notropis buccatus* – silverjaw minnow**	**2**
***Notropis hudsonius* – spottail shiner**	**7**
***Pimephales notatus* – bluntnose minnow**	**68**
***Rhinichthys atratulus* - blacknose dace**	**2,550**
***Rhinichthys cataractae* - longnose dace**	**267**
***Semotilus atromaculatus* – creek chub**	**325**
Catostomidae	
***Catostomus commersoni* - white sucker**	**160**

Acanthuriformes	
Scianidae	
***Cynoscion nebulosus* – spotted seatrout**	**1**
***Leiostomus xanthurus* – spot**	**251**
Perciformes	
Centrarchidae	
***Lepomis auritus* – redbreast sunfish**	**100**
***Lepomis cyanellus* – green sunfish**	**3**
***Lepomis gibbosus* - pumpkinseed**	**83**
***Lepomis macrochirus* – bluegill**	**5,022**
***Lepomis microlophus* – redear sunfish**	**6**
***Lepomis sp*.- unidentified sunfish**	**500**
***Micropterus dolomieu* – smallmouth bass**	**2**
***Micropterus salmoides* - largemouth bass**	**651**
***Pomoxis nigromaculatus* - black crappie**	**1,150**
***Pomoxis* sp. – crappie species**	**15**
Moronidae	
***Morone americana* - white perch**	**196**
***Morone saxatilis* - striped bass**	**256**
Percidae	
***Etheostoma blennioides* – greenside darter**	**11**
***Etheostoma flabellare* – fantail darter**	**30**
***Etheostoma olmstedi* – tesselated darter**	**201**

References

MD DNR, Eyes on the Bay web site, 2024