2022 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 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 Bioregulatory Monitoring and Response 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.

2022 After Hours fish kill duty roster: Nick Kaltenbach, Chris Luckett, and Charles Poukish.

Others who participated in 2022 investigations:
James Bailey (DNR-TEA), Kevin Bull (MDE-WSA-CP), Matt Carter (VA-DEQ), Brett Coakley (DNR-FBS), Randy Denny (MDE-WSA-CP), Gretchen Eckstrom (MO-DEP), Rachael Gauza (MO-DEP), John Holt (MDE-FIERP), Wendy Huang (MDE_WSA-CP), Shelby Jefferson (DNR-PS), Roman Jesien (MD-CBP), Jody Johnson (DNR-FBS), Thomas Johnson (MDE-WSA-CP), Gil Lookingland (MDE-FIERP), Shawn Lowman (MDE-FIERP), Ken Mack (MO-DEP), Mark Matsche (DNR-FWHP), Brad Metzger (MDE-WSA-CP), Kevin Smith (DNR-WHP), Ryan Snader (MDE-FIERP), Nina Thomaselli (DNR-NRP), Ross Williams (DNR-FBS)

Cooperating agencies in 2022:

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)
Tidewater Ecosystem Assessment Division (TEA)
Maryland Park Service (DNR-PS)
Wildlife & Heritage Program (DNR-WHP)

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)
U.S. Geological Survey, Eastern Ecological Science Center (USGS-EESC)
U.S. Department of the Interior, National Park Service (USNPS)
Baltimore Co. Dept. of Environmental Protection & Sustainability (BA-EPS)
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 2022. 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 27 investigations, and all investigations were coordinated through this office. Other MDE groups participated in nine: Five by the Water and Science Administration (Compliance Program) and four by the Field Investigation and Environmental Response Program. Maryland DNR groups participated in eight: Three by the Fishing and Boating Service, and one each by the Natural Resources Police, Maryland Park Service, Wildlife and Heritage Program, Tidal Ecosystem Assessment Division, and the Fish and Animal Health Program. The Maryland Coastal Bays Program Participated in one. The Montgomery County Department of Environmental Protection participated in three. The Virginia Department of Environmental Quality 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 67 fish kills were reported in 2022, and 38 were considered significant enough to warrant on-site investigation. This represents the fifth lowest number of reports received for a year since 1985 and was 65.1% of the historic average of 102.9 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 2022, seventy-nine percent of reported kills occurred during the five-month period between May 1 and September 30 (Figure 1). Sixty-eight percent occurred during the three-month period of June 1 through August 31. Fish kill reports from April through July fell well below historic averages. A slow start to the fish kill season has become typical the past few years.

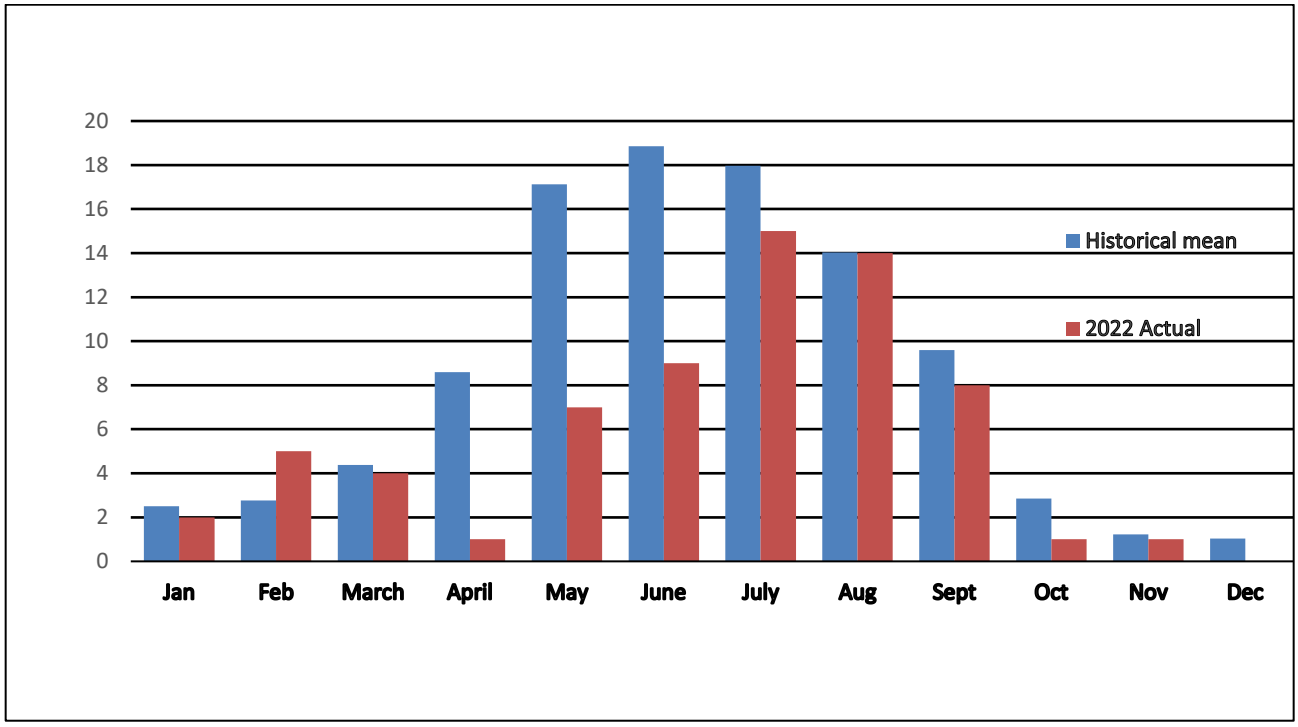


Figure 1. Fish kill reports received by month.

Chesapeake Bay (tidal) Water Quality

In most years, periods of intense heat or cold, drought or heavy precipitation (with 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.

2022 was a year without historic heatwaves, cold spells, rain events, or extreme dry weather. The year began with average to below average salinities in most tidal waters. A dry late spring resulted in estuarine salinities rising to above average, where they remained throughout the year. Temperatures in most of Maryland's estuarine waters remained average until the warm fall weather slowed normal seasonal cooling. Water temperatures rose to above historic averages in November and December. Dissolved oxygen in the upper Chesapeake Bay was average until November, when it fell slightly below average. This could be a function of warmer than average water temperature. In the lower bay, dissolved oxygen was above average at most tidal stations for most of the year.

By the end of 2022, the annual summary of hypoxia performed by DNR concluded that the year was slightly better than average (MD DNR, Eyes on the Bay 2022).

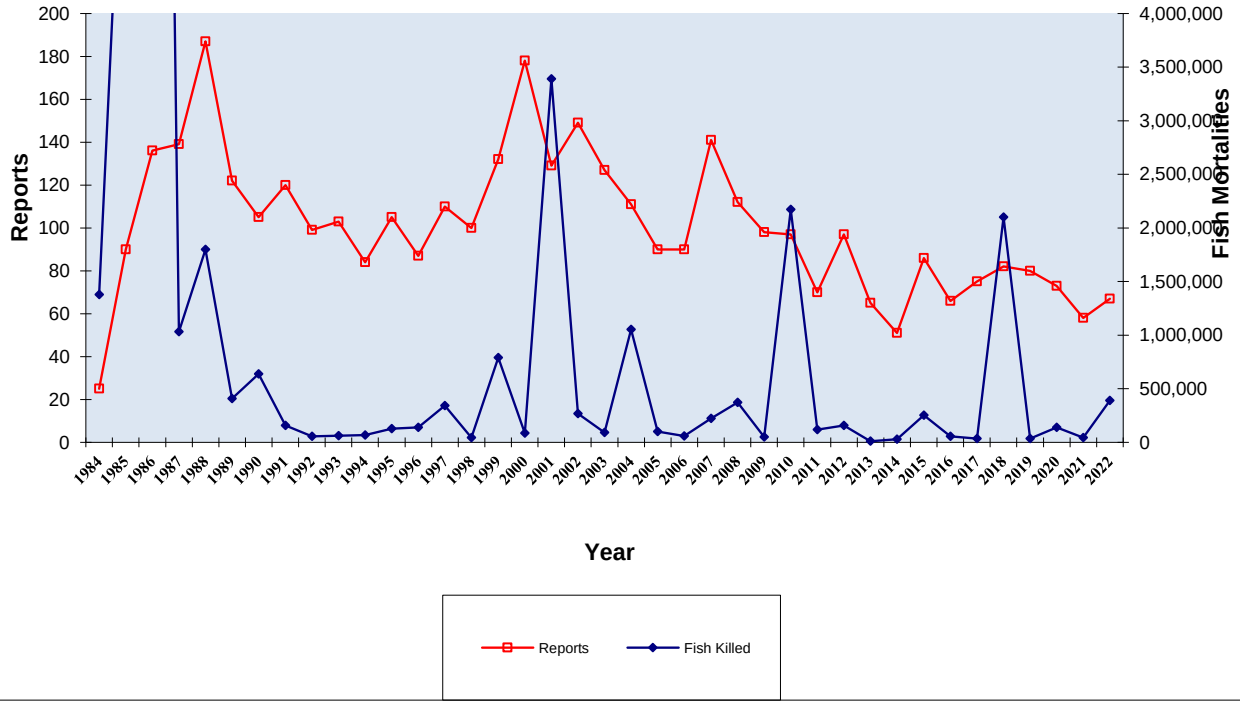
The percentage of fish kills reported in estuarine waters was at the historic average (57%). The percentage attributed to low dissolved oxygen was above the historic average in 2022. The uptick in low oxygen events is largely due to a number of anoxic intrusion events in the lower Potomac River along the Virginia shoreline and summertime blooms of the dinoflagellate, *Levanderina fissa* in Anne Arundel County (Table 1 and Figure 3).

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 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 2022 (391,516) is 34.4 percent of the 39-year average of 1,139,578 (But, above the median of 158,376). It was the thirteenth highest annual total recorded since 1984.

Figure 2. Reports and Fish Mortalities



Distribution of Fish Kills

Every county except Charles, Somerset and Washington was affected by fish kills in 2022 (Table 1). The highest number (10) occurred in Anne Arundel County. Baltimore County had the second highest occurrence with 7. Talbot had the third highest with 6. Worchester County had the fourth highest occurrence with 5. Montgomery County had the fifth highest with 4. Calvert and Queen Anne Counties had the sixth most with 3. Of these seven jurisdictions, all but Talbot and Worcester rank in the top eight in number of historical reports. Anne Arundel County has had the most reported kills (722) since 1984. Baltimore County ranks second highest with 401. 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. No fish kills attributable to *Karlodinium veneficum* were observed in 2022.

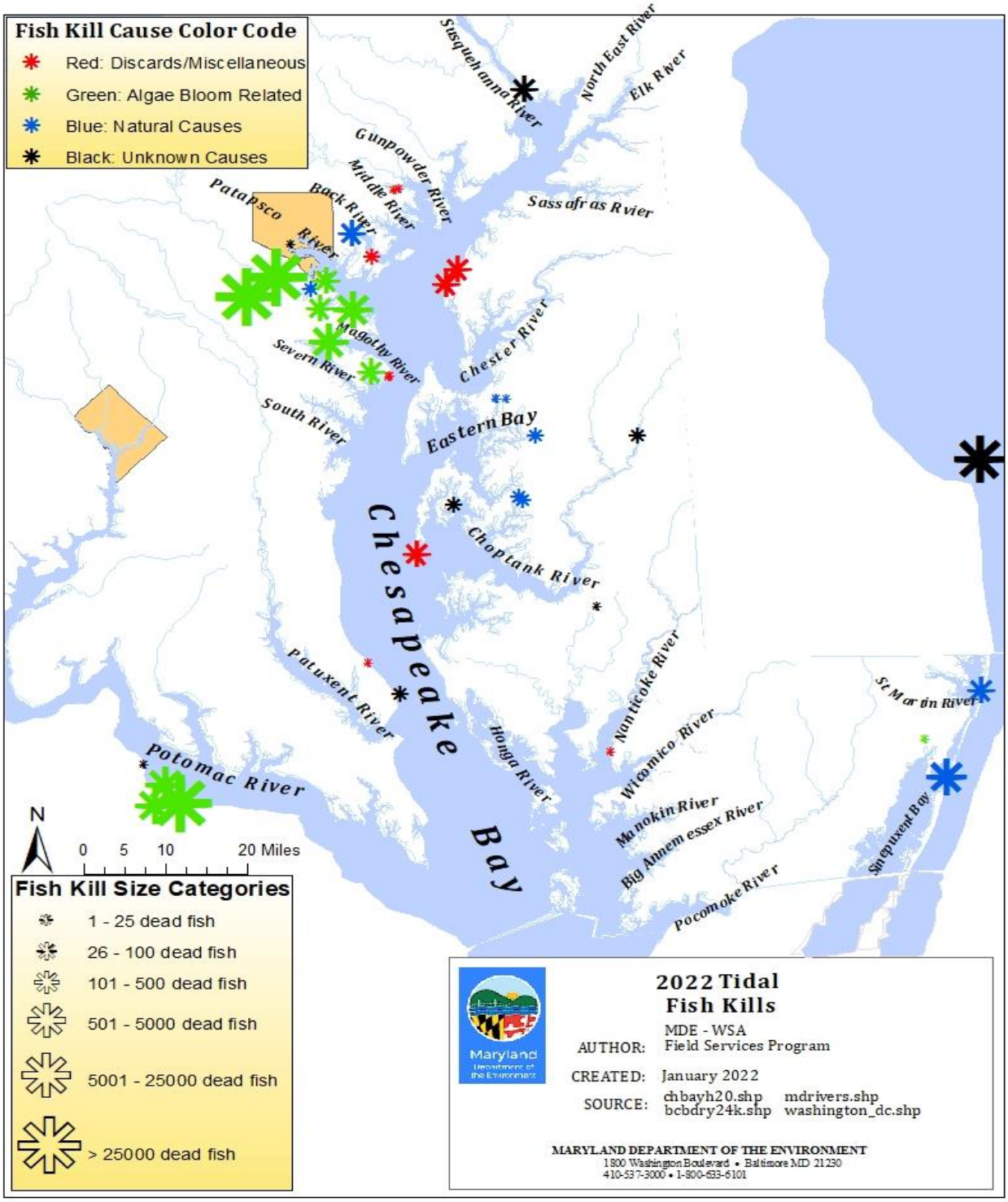
Table 1: Fish Kill Reports by County.

County	# Reports (2022)	# Reports (1984-2022)
Allegany	2	39
Anne Arundel	10	722
Baltimore	7	401
Baltimore City	2	120
Calvert	3	197
Caroline	2	79
Carroll	2	105
Cecil	2	218
Charles	0	139
Dorchester	2	76
Frederick	2	125
Garrett	2	47
Harford	1	186
Howard	2	85
Kent	2	135
Montgomery	4	171
Prince Georges	1	169
Queen Anne's	3	177
Somerset	0	65
St. Mary's	1	219
Talbot	6	106
Washington	0	64
Wicomico	1	108
Worcester	5	119
TOTAL*	62*	3872*

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

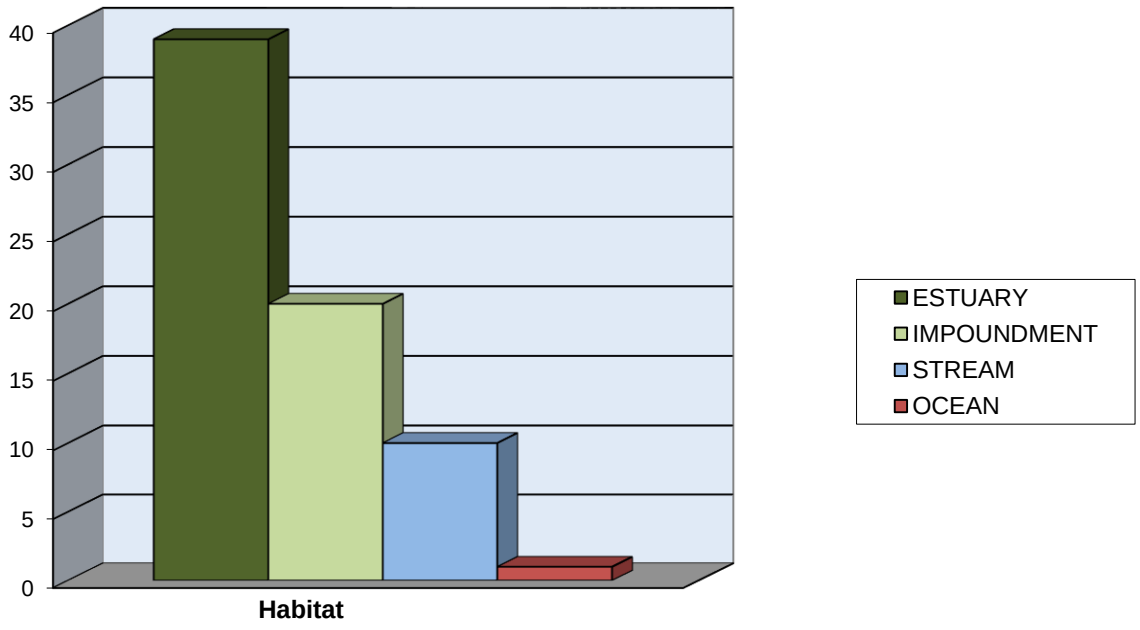
Figure 3 shows the geographical distribution, magnitude, and causes of tidal water fish kills that occurred in 2022.

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



Reported fish kills occurred in various aquatic habitats. There were nineteen reported from impoundments, nine from free-flowing streams, thirty-eight from estuarine waters, and one in the Atlantic Ocean (Figure 4). The number of reports from estuarine waters was nineteen below the historic average. The number of reports from impoundments was nine below average. The number from streams was five below average. The *percentage* of fish kill reports from each habitat type was very close to its historical average.

Figure 4. 2022 Fish Kills by Environment



Causes of Fish Kills

Of the 67 events reported, 62 were classified as fish kills, and five were determined to be non-kills 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 34 events, including 23 cases of oxygen depletion, seven cases of

seasonal or spawning stress, three cases of stranding, and one case of disease. The remaining events included 11 caused by fishing discards, 1 case of entrapment in man-made structures, and 5 pollution cases. There were 11 cases where the cause was undetermined.

Table 2: Probable causes of fish kill reports, 2022.

Probable cause	**2022 Only**	***Percent of Annual Total***	**# of Reports 1984-2022**	***Percent of Historic Total***
Natural	34	50.75%	1596	40.55%
Disease	1		240	
Low dissolved O_2	23		932	
Seasonal / Spawning stress	7		251	
Stranding	3		78	
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	5	7.46%	313	7.95%
Agriculture	0		34	
Municipal sewage	0		46	
Industrial discharge	4		62	
Swimming pool discharge	0		19	
Fuel/Oil spills	0		32	
Unidentified source	1		58	
Construction	0		14	
Municipal discharge	0		33	
Pond Management chemicals	0		15	
Miscellaneous	12	17.91%	853	21.67%
Discards	10		613	
Entrapment	1		165	
Stocking stress, pond Mgmt.	0		66	
Scientific discards, exotic species control	1		9	
Unknown	11	16.42%	886	22.51%
Non-kill	5	7.46%	288	7.32%
TOTAL	**67**		**3936**	

In 2022, 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, 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 to cause fish kills resulting from high Bio-chemical Oxygen Demand (B.O.D). In 2022, five fish kills were attributed to low dissolved oxygen caused directly by an algal bloom, although most low dissolved oxygen cases are indirectly due to excess nutrients and algae.

Events by Number of Fish Involved

Approximately 391,516 fish mortalities were confirmed in 2022. An additional 227 invertebrates, amphibians and other aquatic animals also died totaling 392,073 organisms for the year.

In an average year approximately 5-10 fish kills in excess of 10,000 fish are noted. Five kills involved more than 10,000 fish in 2022.

The largest kill (#222033) occurred July 6th in Marley Creek, a tributary of Curtis Creek and the Patapsco River (Anne Arundel). Approximately 184,000 fish died (primarily Atlantic menhaden) as a result of low dissolved oxygen. There were four fish kills in Marley Creek in 2022. All involved low dissolved oxygen. Since 1985, there have been 64 fish kills reported in the Curtis/Marley/Furnace Creek sub-estuary of the Patapsco River.

The second largest kill (#222038) occurred July 21st in the Potomac River adjacent to Westmoreland State Park and the George Washington Birthplace National Monument (Westmoreland County, VA). Approximately 92,850 fish died (four species, but primarily Atlantic menhaden) as a result of an intrusion of hypoxic bottom water to the shoreline. This location, due to its tidal currents, bathymetry, and exposure to prevailing winds commonly experiences events where bottom water (clear blue and sulfide smelling) replaces oxygenated surface water along the shoreline. This was the largest of three similar events that occurred there from July thru September.

The third largest kill (#222024) occurred June 7th in Marley Creek (Anne Arundel County). Approximately 66,940 fish died (twelve species but primarily Atlantic menhaden) due to low dissolved oxygen, triggered by a bloom of the non-toxic dinoflagellate, *Levanderina fissa*. This large celled algae is often associated with hypoxia and fish kills during the summer months.

The fourth largest kill (#222009) occurred in early March in the Atlantic Ocean and Lower Delaware Bay. More than 20,000 Atlantic menhaden died due to unknown causes. This event may have been associated with cold water kills in NY, NJ and CT, but there was speculation that it was disease related. Out of state agencies are investigating the possibility of a whirling disease like pathogen. There were no reports of these fish reaching Maryland beaches.

The fifth largest kill (#222031) occurred in July 2nd in the South Branch of the Patapsco River in Sykesville (Howard County). Approximately 14,152 fish died (nineteen species) due to the release of a suspected pesticide. Upon investigation, this event became an enforcement case. The case is nearing adjudication with MDE Inspection and Compliance and the Maryland Attorney General's office taking the lead.

Pollution Caused Events

Intense local pollution or other direct anthropogenic causes were implicated in five Maryland events that totaled approximately 14,223 fish, 50 tadpoles, 45 salamanders, and 12 crayfish. Approximately eight pollution caused fish kills occur each year. All pollution related events are referred to the appropriate enforcement agencies for follow-up procedures.

- (#222031) occurred July 2nd in the South Branch of the Patapsco River in Sykesville (Howard City). Approximately 14,152 fish (nineteen species) died as a result of a likely pesticide discharge. The adjudication of this case is not yet complete.
- (#222057) occurred August 28th in an unnamed tributary of Brice Run (a tributary of the Patapsco) in Randallstown (Baltimore County). Approximately 46 fish (two species) and 45 salamanders died as a result of a discharge of an unknown toxin. The kill coincided with the dumping of a large number of hypodermic needles and was responded to by MDE's Emergency Response Division.
- (#222012) occurred April 2nd in an ornamental pond in Cabin John (Montgomery County). Approximately 50 tadpoles and 12 crayfish died after a contractor discharged a house cleaning compound containing detergent and bleach into the pond. Montgomery County DEP took enforcement action.

- (#222067) occurred about November 6th in the Jones Falls near Cold Spring Park (Baltimore City). At least 20 fish (two or more species) died as a result of a likely low pH discharge (vinegar). The tardiness of the report precluded an investigation by this office.
- (#222015) occurred April 13th in an ornamental pond in Rockville (Montgomery County). Approximately 15 koi died after a pesticide was applied near the pond.

Species Involved

Fish kills in 2022 affected at least 47 species of fish, representing 16 families and 12 orders (Table 3). Non-piscine species affected included horseshoe crabs, blue crabs, crayfish, salamanders, Maryland terrapins, box turtles, and a mallard ducks. Approximately 133 fish were unidentified.

Table 3: Species and Numbers of Individuals Affected by Fish Kills in 2022.

Arthropoda **Xiphosura** **Lumulidae** ***Limulus polyphemus* - horseshoe crab**	**200**
Arthropoda **Decapoda** **Portunidae** ***Callinectes sapidus* - blue crab** **Cambaridae** **unidentified crayfish**	**212** **22**
Chordata - Amphibia **Plethodontidae** **unidentified salamanders** **Ranidae** **unidentified tadpoles**	 **45** **50**
Chordata - Reptilia **Emydidae** ***Malaclemmys terrapin*- diamondback terrapin** ***Terrapene carolina* – eastern box turtle**	 **16** **1**
Chordata - Aves **Anseriformes** **Anatidae** ***Anas platyrhynchos* – mallard duck**	 **10**
Chordata - Osteichthyes **unidentified bony fish**	 **133**
Anguilliformes **Anguillidae** ***Anguilla rostrata* - American eel**	 **2**
Atheriniformes **Atherinopsidae** ***Menidia menidia* – Atlantic silverside**	 **2,346**
Cyprinodontiformes **Fundulidae** ***Fundulus diaphanus* – banded killifish**	 **124**

***Fundulus heteroclitus* - mummichog**	**1,022**
***Fundulus majalis* – striped killifish**	**1,000**
Salmoniformes	
Salmonidae	
***Oncorynchus mykiss* – rainbow trout**	**6**
***Salmo trutta* – brown trout**	**6**
Unidentified trout	**1**
Clupeiformes	
Clupeidae	
***Brevoortia tyrannus* - Atlantic menhaden**	**272,979**
***Dorosoma cepedianum* - gizzard shad**	**744**
Engraulidae	
***Anchoa mitchilli* – bay anchovy**	**6**
Siluriformes	
Ictaluridae	
unidentified catfish	**14**
***Amieurus catus* – white catfish**	**13**
***Amieurus nebulosus* – brown bullhead**	**27**
***Amieurus* sp. – unidentified bullhead**	**1**
***Ictalurus furcatus* – blue catfish**	**1**
***Ictalurus punctatus* - channel catfish**	**20**
***Noturus insignis* - margined madtom**	**31**
Cypriniformes	
Cyprinidae	
unidentified minnow	**10**
***Campostoma anomalum* – central stoneroller**	**343**
***Carassius auratus* - goldfish**	**1**
***Cyprinus carpio* - common carp/koi**	**34**
***Exoglossum maxillingua* – cutlips minnow**	**1,097**
***Hybognathus regius* – eastern silvery minnow**	**22**
***Luxilus chrysocephalus* – striped shiner**	**22**
***Luxilus cornutus* – common shiner**	**935**
***Nocomis micropogon* – river chub**	**81**
***Notropis hudsonius* - spottail shiner**	**6**
***Notropis procne* - swallowtail shiner**	**754**
***Notropis rubellus* - rosyface shiner**	**6**
***Pimephales notatus* - bluntnose minnow**	**4,539**
***Rhinichthys atratulus* - blacknose dace**	**122**
***Rhinichthys cataractae* - longnose dace**	**613**
***Semotilus atromaculatus* – creek chub**	**5**
Catostomidae	
***Catostomus commersoni* - white sucker**	**1,417**
***Hypentelium nigricans* – northern hogsucker**	**611**
Scorpaeniformes	
Cottidae	
***Cottus caeruleomentum* – blue ridge sculpin**	**2,138**
Esociformes	
Esocidae	
***Esox niger* - chain pickerel**	**15**

Plueronectiformes	
Paralichthyidae	
***Paralichthys dentatus* – summer flounder**	**51**
Acanthuriformes	
Scianidae	
***Cynoscion nebulosus* – spotted seatrout**	**1**
***Leiostomus xanthurus* - spot**	**77,889**
***Micropogonias undulatus* – Atlantic croaker**	**16,101**
Perciformes	
Centrarchidae	
***Lepomis auritus* – redbreast sunfish**	**451**
***Lepomis gibbosus* - pumpkinseed**	**480**
***Lepomis macrochirus* - bluegill**	**1,736**
***Lepomis sp*.- unidentified sunfish**	**412**
***Micropterus dolomeiu* – smallmouth bass**	**444**
***Micropterus salmoides* - largemouth bass**	**235**
***Pomoxis nigromaculatus* - black crappie**	**150**
***Pomoxis* sp. – crappie species**	**6**
Moronidae	
***Morone americana* - white perch**	**805**
***Morone saxatilis* - striped bass**	**629**
Percidae	
***Etheostoma olmstedi* – tessellated darter**	**879**

References

MD DNR, Eyes on the Bay web site, 2023