2021 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.

2021 After Hours fish kill duty roster: Nick Kaltenbach, Chris Luckett, and Charles Poukish.

Others who participated in 2021 investigations:
Vicki Blazer (USGS-EESC), Cody Bittinger (MDE-LMA-MP), Kevin Brittingham (BA-EPS), Randy Denny (MDE-WSA-CP), Steve Doctor (DNR-FBS), Jaron Hawkins (MDE-LMA-MP), Roman Jesien (MCBP), Jody Johnson (DNR-FBS), Greg Kolarik (MDE-WSA-CP), Kevin Kelly (DNR-NRP), Ken Mack (MO-DEP), Steve Martin (MO-DEP), Mark Matsche (DNR-FWHP), Joe Miller (MDE-WSA-CP), Mark Rockman (MO-DEP), Kevin Rosemary (DNR-FWHP), Barbara Santana (MDE-FSP), Erik Shafer (MDE-LMA-MP), Alex Torella (MO-DEP), Kenny Wampler (DNR-FBS), Erik Zlokovits (DNR-FBS)

Cooperating agencies in 2021:

MDE- Emergency Response Division (ERD)
Land Management Admin-Mining Program (MDE-LMA-MP)
Water and Science Admin-Compliance Program (MDE-WSA-CP)
Water and Science Admin-Field Services Program (FSP)
Water and Science Admin-Wetlands & Waterways Prog. (MDE-WWP)

DNR- Fishing and Boating Services (DNR-FBS)
Natural Resources Police (DNR-NRP)
Oxford Cooperative Lab, Fish & Wildlife Health Program (DNR-FWHP)
TEA-Tidewater Ecosystem Assessment Division
MANTA-Monitoring and Non-Tidal Assessment Division
Coastal Bays Program (MD-CBP)

Maryland Coastal Bays Program (MCBP)
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 2021. 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 four: two by the Water and Science Administration (Compliance Program) and one each by the Field Services Program (Shellfish Compliance Division) and Land Management Administration, Mining Program. Maryland DNR groups participated in seven: Five by the Fishing and Boating Service, and one each by the Natural Resources Police and Fish and Animal Health Program. The Maryland Coastal Bays Program Participated in two. The Montgomery County Department of Environmental Protection participated in three. The Baltimore County Department of Environmental Protection and Sustainability participated in one. The United States Geological Survey and Park Service each participated in one.

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 58 fish kills were reported in 2021, and 40 were considered significant enough to warrant on-site investigation. This represents the second lowest number of reports received for a year since 1985 and was 56.9% of the historic average of 102 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 2021, seventy percent of reported kills occurred during the five-month period between May 1 and September 30 (Figure 1). Sixty percent occurred during the four-month period of May 1 through August 31. Nonetheless, fish kill reports from May through September fell well below historic averages.

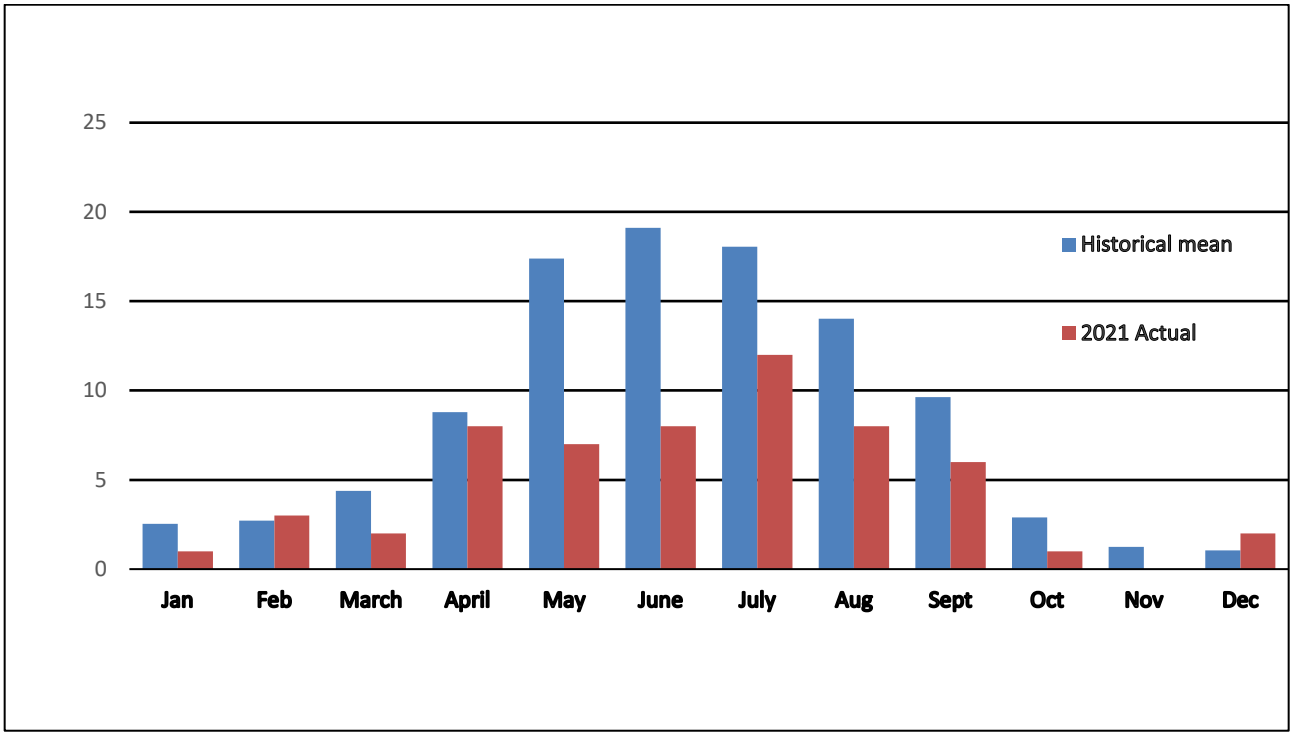


Figure 1. Fish kill reports received by month.

Chesapeake Bay Water Quality

2021 began with below average freshwater inputs from January thru May. Salinities at most river mouths were above average. The concurrent reduction in nutrient inputs resulted in much better than average dissolved oxygen conditions for much of the year. The early June hypoxia report was the best on record and the Chesapeake Bay dead zone (the percentage of the mainstem of the bay where dissolved oxygen is below 2 mg/l) was below average in size through July. August was the third hottest on record. That, with increased rainfall and below average winds resulted in increased stratification in the Bay. Hypoxic areas grew in August to a point that was larger than average. By the end of 2021, the annual summary of hypoxia concluded that the year was slightly better than average (MD DNR, Eyes on the Bay 2021).

Water temperatures in the Chesapeake Bay and many tributaries were about average (some below average) for most of the spring and summer. A warm fall resulted in water temperatures to fall slower than normal. By October, surface water temperatures were well above average. The slow cooling down continued into December 2021 (MD DNR, Eyes on the Bay 2021).

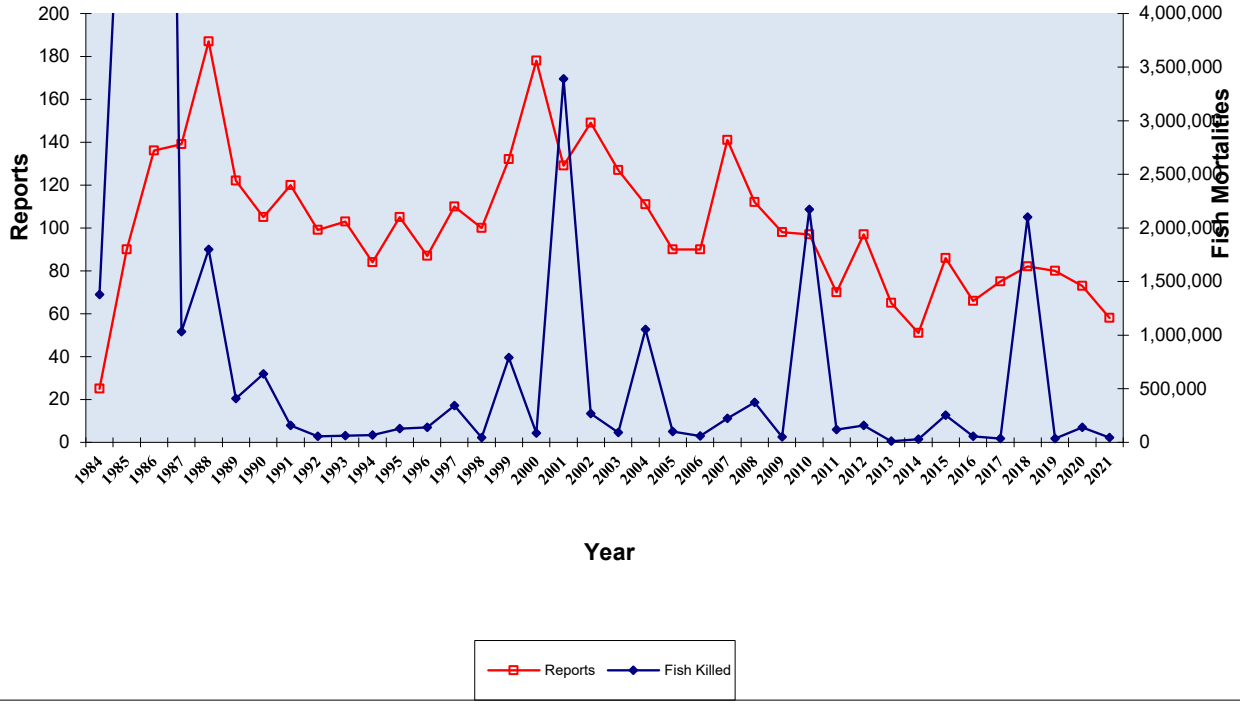
The percentage of fish kills in estuarine waters and the percentage attributed to low dissolved oxygen were both below average in 2021.

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 2021 (45,166) is 3.90 percent of the 36-year average of 1,159,264 (the median is 149,549). It was the sixth lowest annual total recorded since 1984.

Figure 2. Reports and Fish Mortalities



Distribution of Fish Kills

Every county except Cecil, Garrett, Somerset and Wicomico was affected by fish kills in 2021 (Table 1). The highest number (8) occurred in Anne Arundel County. Montgomery had the second highest occurrence with 6. Baltimore and Queen Anne's Counties had the third highest occurrence with 5. Kent and Worcester Counties had the fifth highest with 4. Of these six jurisdictions, all but Worcester rank in the top eleven for historical reports. Anne Arundel County has had the most reported kills (712) since 1984. Baltimore County ranks second highest with 394. 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 2021.

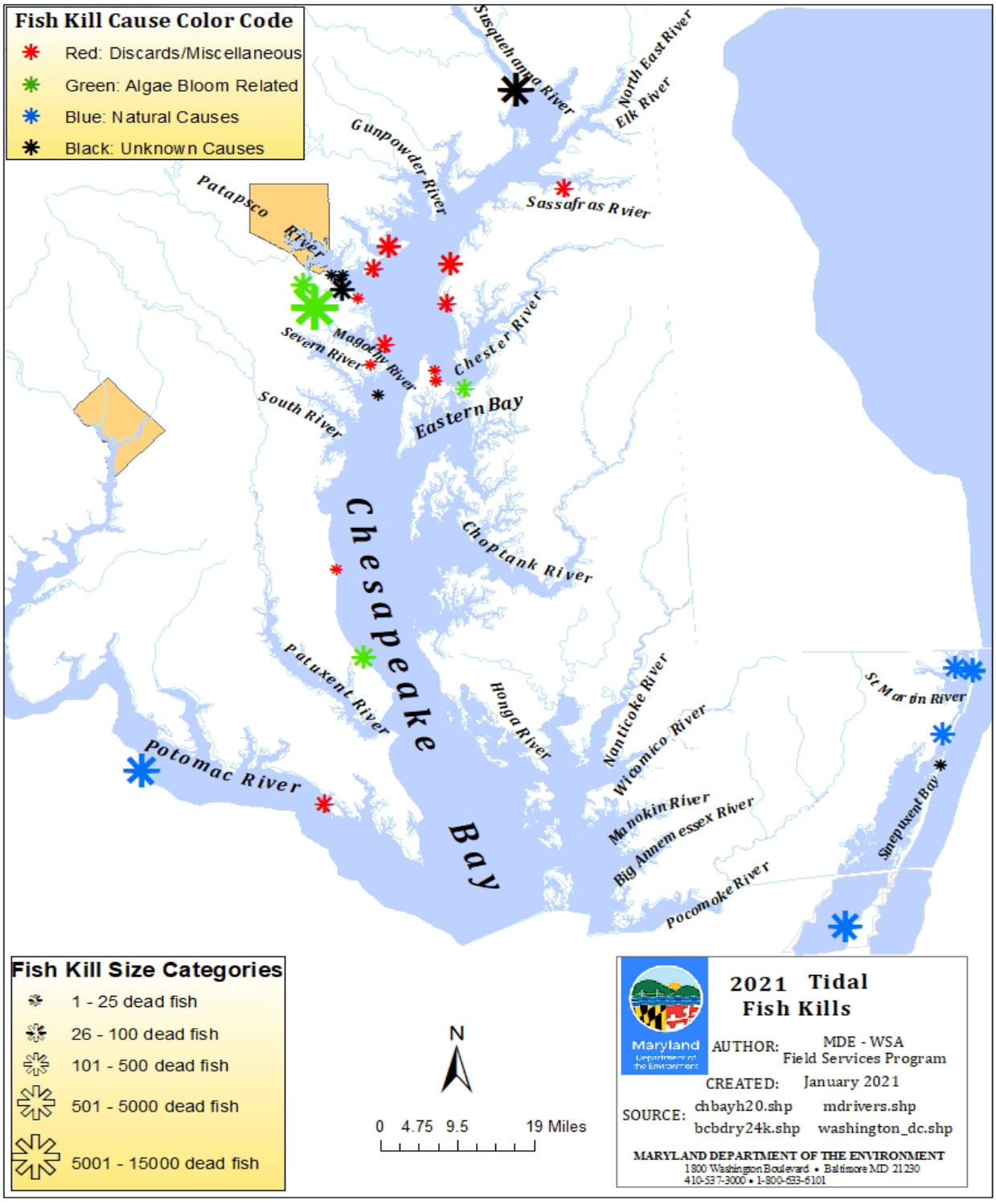
Table 1: Fish Kill Reports by County.

County	# Reports (2021)	# Reports (1984-2020)
Allegany	1	37
Anne Arundel	8	712
Baltimore	5	394
Baltimore City	2	118
Calvert	3	194
Caroline	3	77
Carroll	2	103
Cecil	0	216
Charles	2	139
Dorchester	1	74
Frederick	4	123
Garrett	0	45
Harford	2	185
Howard	1	83
Kent	4	133
Montgomery	6	167
Prince Georges	1	168
Queen Anne's	5	174
Somerset	0	65
St. Mary's	1	218
Talbot	0	100
Washington	1	64
Wicomico	0	107
Worcester	4	114
TOTAL*	56*	3810*

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

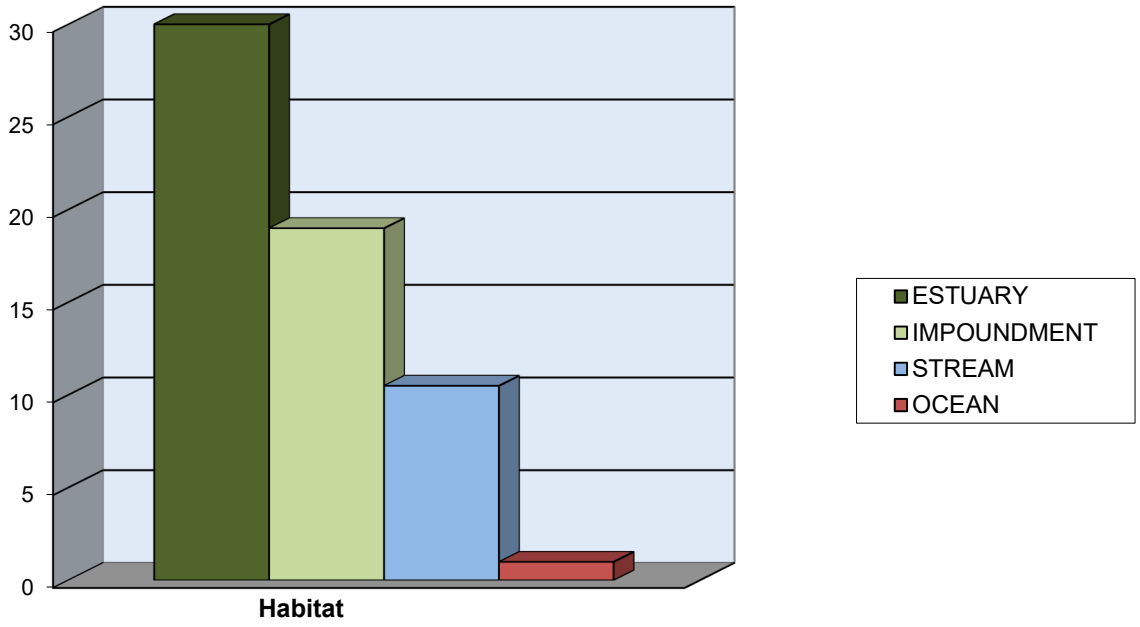
Figure 3 shows the geographical distribution, magnitude, and causes of tidal water fish kills that occurred in 2021.

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



Reported fish kills occurred in various aquatic habitats. There were eighteen reported from impoundments, ten from free-flowing streams, and twenty-nine from estuarine waters (Figure 4). The number of reports from estuarine waters was the lowest since 1984 and nineteen below the historic average. The number of reports from impoundments was ten below average. The number from streams was four below average. The percentage of fish kill reports from estuarine waters (50.00%) was also below the historical average (58.42%).

Figure 4. 2021 Fish Kills by Environment



Causes of Fish Kills

Of the 58 events reported, 52 were classified as fish kills, and six were determined to be non-kills or insignificant events where no dead fish were found.

Probable cause was determined in 39 of the 53 fish kills (Table 2). Natural causes were implicated in 22 events, including 10 cases of oxygen depletion, and 9 cases of

seasonal or spawning stress, two cases of stranding, and one case of disease were determined. The remaining events included 11 caused by fishing discards, 1 case of entrapment in man-made structures, and 5 pollution cases. There were 13 cases where the cause was undetermined.

Table 2: Probable causes of fish kill reports, 2020.

Probable cause	**2021 Only**	***Percent of Annual Total***	**# of Reports 1984-2021**	***Percent of Historic Total***
Natural	22	37.93%	1562	40.37%
Disease	1		239	
Low dissolved O_2	10		909	
Seasonal / Spawning stress	9		244	
Stranding	2		75	
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	8.62%	308	7.96%
Agriculture	0		34	
Municipal sewage	0		46	
Industrial discharge	1		58	
Swimming pool discharge	0		19	
Fuel/Oil spills	0		32	
Unidentified source	0		57	
Construction	1		14	
Municipal discharge	3		33	
Pond Management chemicals	0		15	
Miscellaneous	12	20.69%	841	21.74%
Discards	11		603	
Entrapment	1		164	
Stocking stress, pond Mgmt.	0		66	
Scientific discards, exotic species control	0		8	
Unknown	13	22.41%	875	22.62%
Non-kill	6	10.34%	283	7.31%
TOTAL	**58**		**3869**	

In 2021, 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, Levanderia 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 2021, two fish kills were attributed to low dissolved oxygen caused directly by an algal bloom, although most low dissolved oxygen cases are indirectly due to excel algae.

Events by Number of Fish Involved

Approximately 45,166 fish mortalities were confirmed in 2021. An additional 961 invertebrates, amphibians and other aquatic animals also died totaling 46,166 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 2021.

The largest kill (#221010) occurred April 9th in the Rocky Gorge (Duckett) Reservoir (Howard/Prince George's'/Montgomery). Approximately 21,233 gizzard shad died as a result of seasonal stress. This event involved exclusively sub-adults, approximately 4" in size and no other species were involved. Spring and winter die offs of gizzard shad are a common spring and winter event, driven by temperature changes and intra-population stressors.

The second largest kill (#221021) occurred May 25th in Marley Creek (Anne Arundel County). Approximately 10,005 fish died (three species, but almost exclusively Atlantic menhaden) as a result of low dissolved oxygen triggered by a bloom of the dinoflagellate *Levanderina fissa* (17,776 cells/ml).

The third largest kill (#22143) occurred August 3rd in Chincoteague Bay at the Assateague Island National Wildlife Refuge (Accomack County, Virginia). Approximately 5,000 Atlantic menhaden in shallow water along a causeway entering the park. The National Park Service attributed the event to low dissolved oxygen. The event was

concurrent with another smaller but similar event (#221044) that occurred in Sinepuxent Bay (Worcester County).

The fourth largest kill (#221051) occurred September 1st in the Potomac River (Charles County) along the shoreline of Colonial Beach Virginia. Approximately 2,043 fish died (13 species) as the remnants of Hurricane Ida passed thru. An intrusion of hypoxic water likely pushed the fish to the shoreline where they became stranded in a shallow depression behind beach stabilization rip rap.

Another notable event scenario (# 221028, 221033) occurred in Maryland's Coastal Bays. Every year, horseshoe crabs spawn during summer full-moon high tides. Approximately ten percent of them die each year due to spawning stress and stranding by the falling tide. Several hundred of these dead crabs became concentrated in the canal network near 94th Street in Ocean City. Their decomposition odors generated considerable public comment and resulted in a volunteer effort to remove them. This scenario also occurred in the same magnitude and location in 2016. Dead end canals in the Coastal Bays have a history of periodic poor water quality, fish kills, collecting dead algae and debris.

Pollution Caused Events

Intense local pollution or other direct anthropogenic causes were implicated in five Maryland events that totaled approximately 272 fish, 170 salamanders, and one 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.

- (#221052) occurred September 12th in the Jones Falls in Cold Spring (Baltimore City). Approximately 171 fish (five species) died as a result of a discharge from a vinegar plant. The discharge was both low in pH and contained chlorine.
- (#221003) occurred February 25th in an unnamed tributary of Sligo Creek in Forest Glen (Montgomery County). Approximately 36 fish (four species) and 170 salamanders died as a result of excessive road salt runoff (chloride pollution).
- (#221054) occurred September 21st in Herring Run (Baltimore City). Approximately 30 fish (two species) died during ongoing construction along the stream and in the flood plain. It is believed that sediment caused the mortalities.
- (#221002) occurred February 1st in an unnamed tributary of Stemmers Run in Overlea (Baltimore County). Approximately 29 fish (two species) died as a result of excessive road salt runoff (chloride pollution).
- (#221032) occurred July 6th in an unnamed tributary of Rock Creek in Rockville (Montgomery County). Approximately 6 fish (1 species) and a crayfish died after a fire at a recycling facility was extinguished. Water used

to extinguish the burning tires and automobiles ran off into the small stream. No effects were observed in Rock Creek below the confluence.

Species Involved

Fish kills in 2021 affected at least 29 species of fish, representing 17 families and 11 orders (Table 3). Non-piscine species affected included horseshoe crabs, blue crabs, crayfish, salamanders, frogs, snapping turtles, red bellied cooters, musk turtles, and a bottlenose dolphin. Approximately 1,600 fish were unidentified.

Table 3: Species and Numbers of Individuals Affected by Fish Kills in 2021.

Arthropoda	
Xiphosura	
Lumulidae	
***Limulus polyphemus*_horseshoe crab**	**700**
Arthropoda	
Decapoda	
Portunidae	
***Callinectes sapidus* - blue crab**	**35**
Cambaridae (unidentified crayfish)	**1**
Chordata-Amphibia	
Plethodontidae	
***Eurycea bislineata* – northern two lined salamanders**	**170**
Ranidae (unidentified frogs)	
***Lithobates catesbeianus* – American bullfrog**	**50**
Chordata-Reptilia	
Chelydridae	
***Chelydra serpentina* – common snapping turtle**	**1**
Emydidae	
***Pseudemys rubriventiis* – northern red-bellied cooter**	**2**
Kinosternidae	
***Sternotherus odroatus* – common musk turtle**	**1**
Chordata- Mammalia	
Delphinidae	
***Tursiops truncates* – common bottlenose dolphin**	**1**
Chordata-Osteichthyes	
Unidentified bony fish	**1,575**
Anguillaformes	
Anguillidae	
***Anguilla rostrata* - American eel**	**7**
Atheriniformes	
Atherinopsidae	
***Menidia menidia* – Atlantic silverside**	**12**
Scombriformes	
Stromateidae	
***Peprilus paru* - harvestfish**	**1**
Salmoniformes	
Salmonidae	
***Oncorynchus mykiss* – rainbow trout**	**5**
***Salmo trutta* – brown trout**	**5**
Clupeiformes	
Clupeidae	
***Brevoortia tyrannus* - Atlantic menhaden**	**15,843**
***Dorosoma cepedianum* - gizzard shad**	**21,813**
Engraulidae	
***Anchoa mitchilli* – bay anchovy**	**3**

Siluriformes	
Ictaluridae	
Unidentified catfish	**51**
***Amieurus nebulosus* – brown bullhead**	**1**
Cypriniformes	
Cyprinidae	
Unidentified minnow	**16**
***Cyprinus carpio* - common carp/koi**	**1**
***Rhinichthys atratulus* - blacknose dace**	**30**
***Semotilus atromaculatus* – creek chub**	**27**
***Semotilus corporalis* - fallfish**	**1**
Catostomidae	
***Catostomus commersoni* - white sucker**	**181**
***Moxostoma erythrurum* – golden redhorse**	**46**
Aulopiformes	
Synodontidae	
***Synodus foetens* – inshore lizardfish**	**1**
Plueronectiformes	
Achiridae	
***Trinectes maculatus* – hogchoker**	**50**
Paralichthyidae	
***Paralichthys dentatus* – summer flounder**	**3**
Acanthuriformes	
Scianidae	
***Cynoscion regalis* – weakfish**	**3**
***Leiostomus xanthurus* - spot**	**405**
***Micropogonias undulatus* – Atlantic croaker**	**162**
Perciformes	
Centrarchidae	
***Lepomis gibbosus* - pumpkinseed**	**15**
***Lepomis macrochirus* - bluegill**	**1,085**
***Lepomis sp.*- unidentified sunfish**	**24**
***Micropterus salmoides* - largemouth bass**	**32**
***Pomoxis nigromaculatus* - black crappie**	**1,355**
Moronidae	
***Morone americana* - white perch**	**2,080**
***Morone saxatilis* - striped bass**	**323**
Percidae	
***Etheostoma olmstedi* – tessellated darter**	**7**
Pomatomidae	
***Pomatomus salatrix* - bluefish**	**3**

References

MD DNR, Eyes on the Bay web site, 2021