

Interagency Fish Kill Response



Guidance Document and Protocol



Department of Natural Resources
Pollution Control Agency
Department of Agriculture
Department of Health

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Introduction

The Minnesota Department of Agriculture (MDA), the Minnesota Pollution Control Agency (MPCA), the Minnesota Department of Health (MDH), and the Minnesota Department of Natural Resources (DNR) have responsibilities to conserve and protect the natural resources of Minnesota and to promote the public health, safety, and welfare of the people. The purpose of this document is to outline the operational guidelines for the coordination and response of these agencies to a fish kill. This guidance and protocol are meant to fulfill the requirements in Minn. Stat. § 103G.2165 – Development of Fish Kill Response Protocol. This document will be reviewed and updated every five years at a minimum.

Regulatory authorities

Each agency in Minnesota has different regulatory authorities granted by the legislature. Statutes refer to the general and permanent laws of the state. Rules are delegated legislation assigned by the legislature and grouped under the agency that administers them. The following statutes/rules apply and help determine the roles of each agency in a fish kill response:

DNR

- Minn. Stat. § 97A.025 - Ownership of wild animals belongs to the state for the benefit of the people of Minnesota
- Minn. Stat § 97A.345 - Gives the DNR Commissioner the authority to prescribe dollar value to wild animals
- Minn. R. 6133.0080 - Lists the restitution values for game fish
- Minn. R. 6133.0090 - Lists the restitution values for minnows

MDA

- Minn. Stat. ch. 18B - Pesticide Control Law gives MDA the authority to regulate pesticides including the terrestrial application of pesticides to agricultural crops, structures, and other nonaquatic environments
- Minn. Stat. ch. 18C - Fertilizer, Soil amendment and Plant Amendment Law gives MDA authority to regulate fertilizer including its storage, handling, distribution, use, and disposal
- Minn. Stat. ch. 18D - Agricultural Chemical Liability Act (1989) gives authority to require immediate notification of spills, the right to access and enter private property for investigation purposes, and administrative or civil penalties for violations of storage, transportation, or use of agricultural chemicals
- Minn. Stat. ch. 115B - Gives MDA authority to take corrective actions to prevent, minimize or mitigate damage to the public health and welfare or the environment from the release of a hazardous substance

MPCA

- Minn. Stat. ch. 11 6- Establishment of the MPCA outlining its mission and authorities

- Minn. Stat. ch. 115 - Gives the MPCA the authority to administer and enforce all laws relating to the pollution of any of the waters of the state and to investigate the extent, character, and effect of the pollution of the waters of this state and to gather data and information necessary or desirable in the administration or enforcement of pollution laws
- Minn. Stat. ch. 115B - Gives MPCA authority to take corrective actions to prevent, minimize or mitigate damage to the public health and welfare or the environment from the release of a hazardous substance
- Minn. Stat. ch. 115C - Gives MPCA authority to take corrective actions to prevent, minimize or mitigate damage to the public health and welfare or the environment from petroleum tank releases
- Minn. Stat. ch. 115E - Gives the MPCA authority to assess prevention and preparedness of specified regulated companies

MDH

- Minn. Stat. ch. 144 - Gives MDH authority for the Drinking Water Protection Program
- Minn. R. ch. 4720 - Governs public water systems
- U.S. Code, Title 42, ch. 6A, subchapter XII - Federal Safe Drinking Water Act
- Minn. Stat. ch. 103I - Statutory authority for Minnesota's Wellhead Protection Program

Note regarding tribal sovereignty and fish kills occurring on tribal land: tribes have Clean Water Act authorities that will be identified at the outset of any fish kill investigation.

Definitions and causes of fish kills

This section defines the specific terms used in this document as they relate to fish kill investigations in Minnesota.

Fish Kill: the sudden death of a number of fish, typically caused by an acute pollution event in a water body.

Minn. Stat. § 103G.216, REPORTING FISH KILLS IN PUBLIC WATERS, subd. 1 defines "fish kill" as an incident resulting in the death of 25 or more fish within 1 linear mile of a flowing water or 25 or more fish within a square mile of a nonflowing water, excluding fish lawfully taken under the game and fish laws.

- This definition applies to the initial reporting requirement only. Agencies may follow-up or investigate any fish kill/die-off of any magnitude, if deemed appropriate.

Fish die-off: Similar to fish kill but more often related to environmental factors or winterkill/summerkill situations. They are not typically handled with an interagency investigative response.

Winterkill: General term referring to a die-off of fish in a water body during winter under ice for various reasons including, but not limited to, conditions leading to low dissolved oxygen (DO) or complete freeze-down of shallow water bodies.

Summerkill: General term referring to a die-off of fish in a water body during peak summer temperatures for various reasons, including low levels of oxygen.

Fish can die from one or multiple factors, such as the following:

- Infectious or noninfectious diseases
- Behavior: including stranding and spawning related stress
- High temperature/low water level
- Low DO - Winterkill; summerkill; aquatic plant and algae die offs
- Chronic excessive nutrients, sewage or wastewater release (causing significant temperature changes, low DO, or blooms of algae)
- Chemical spill (oil/fuel, pesticide, fertilizer, etc.)
- Pollutant runoff (e.g. sediment runoff, manure runoff, pesticides)

General interagency fish kill response protocol

This protocol/guidance describes the general procedures that are expected of agencies during responses to fish kills. During a fish kill investigation, each responding agency has respective jurisdiction and authorities; the State's approach to a fish kill is structured to follow these responsibilities. Additionally, each agency has their own internal procedures, protocols, and guidance to follow during a response that are referenced in the roles/responsibilities and agency-specific protocols section. A single protocol

cannot capture all of the possible steps/procedures for every fish kill situation for each agency. As such, this document guides and describes the general interagency procedures required.

Fish die-offs typically do not require interagency response efforts. Generally, fish kills that do not threaten health and safety of the public would not require an emergency response, but still merit evaluation and an appropriate level of response. In some cases, fish kills can occur as a result of an emergency incident (e.g., natural disasters, hazardous material releases, etc.). When an emergency incident arises, the agencies (MPCA, MDA, DNR, and MDH) unify efforts and staffing to efficiently attempt to minimize damage and exposure. This includes engaging and overseeing a regulated party's response to mitigate the conditions that may cause a fish kill. The Minnesota Emergency Operations Plan (MEOP) defines roles and responsibilities for the state agencies response during emergencies and requires agencies to coordinate, plan, prepare and train for emergencies. The MEOP assigns lead roles to MDA for pesticide and fertilizer incidents and to MPCA for environmental impacts from the release of hazardous substances, oil and/or other pollutants. DNR leads surveying fish kills when a discharge/release is not suspected and serves a support role whenever a pollutant discharge/release causes injury to fish, wildlife, waterways and/or public lands. In cases when a fish kill presents a threat to public health and safety, the agencies coordinate with the MDH.

Triaging fish kill reports and executing notifications and communications

The following procedures, flowcharts, and guides (Figure 1, Figure 2, and Appendix A: Interagency process for investigation of fish kills) are established to efficiently assess and manage reports of fish deaths that come to the Minnesota Duty Officer (MDO) and ensure effective coordination among State agencies.

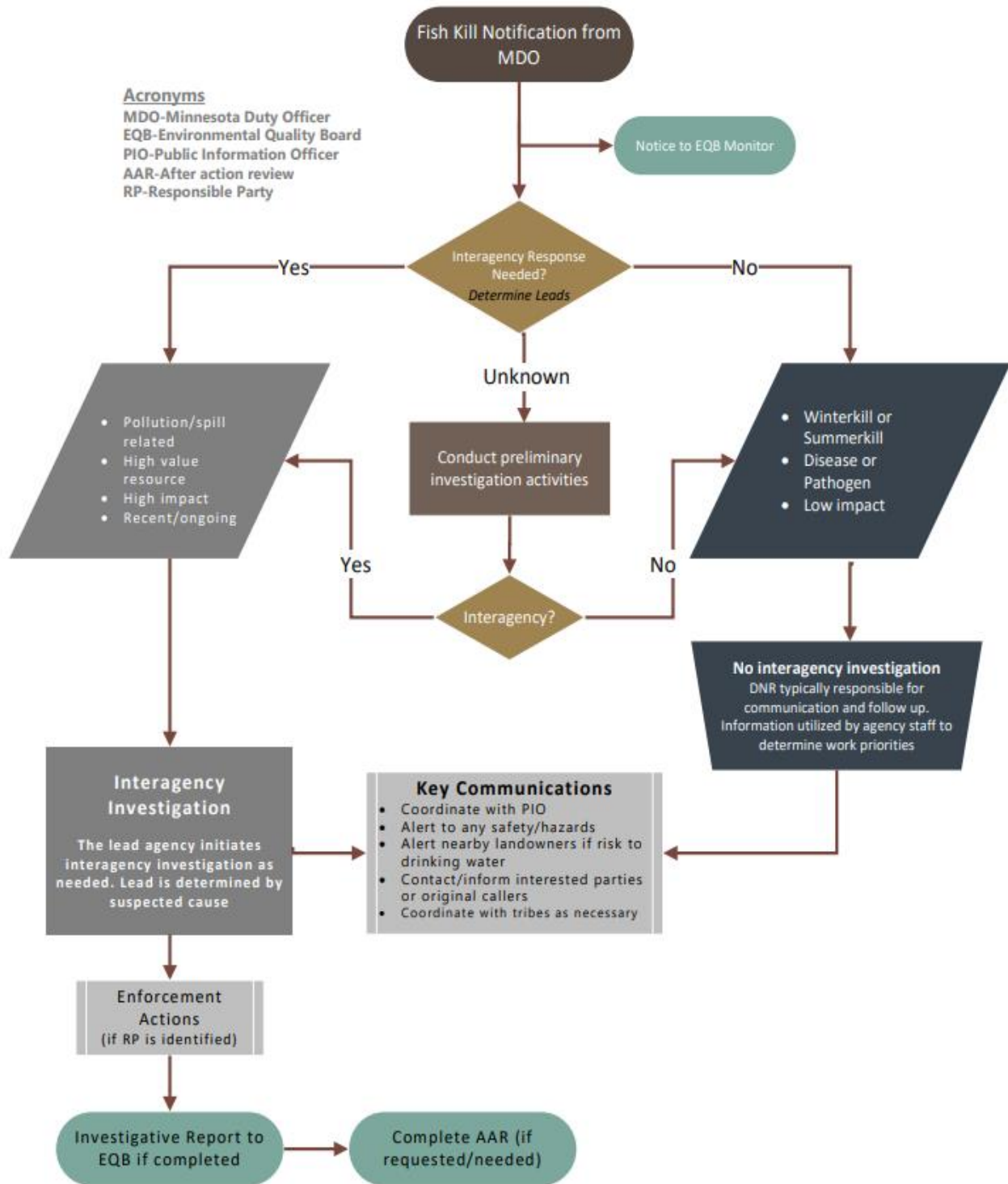
The MDO program at the Department of Public Safety is currently the single point of contact to which fish death reports made by the public should be submitted. The MDO program is used to request state-level assistance for emergencies, serious accidents or incidents, or for reporting hazardous substances and petroleum spills. The MDO is available 24 hours per day, seven days per week (1-800-422-0798). The MDO receives many reports of fish death each calendar year. For example, for the period of October 2022 through mid-July 2023, more than 340 reports of fish having died were received, with only 17 of those pertaining to rivers or streams; the vast majority were reports of dead fish (die-offs) observed on pond or lakes.

- Any observations of dead fish or information about potential fish kill causes or responsible parties should be reported to the MDO immediately to ensure all the appropriate state agencies are notified.
- When agency staff learn of dead fish through means other than the MDO Program, a report to the MDO must be made within one hour, preferably by the party(ies) that observed the incident in the field. All incidents of dead fish observed in the field need to be reported to the MDO within four hours (Minn. Stat. § 103G.216, subd.2).
- After receiving a report of dead fish, the MDO notifies the MPCA, MDA, DNR, and MDH within one hour (Minn. Stat. § 103G.216, subd.2). Those state agency contacts are as follows:

- DNR Incident Response Specialist (not on-call but available during work hours).
 - MDA On-call Team Coordinator (on-call).
 - MPCA Emergency Response (ER) Program staff (on-call).
 - MDH Environmental Health Duty Officer Liaison (not on-call but available during work hours).
- These agency contacts independently evaluate each report received and use professional judgment to determine an urgency level for each. Reports that may require immediate response are forwarded on to appropriate program staff within each agency.
 - After notification, agency program staff coordinate and triage the reports to determine the appropriate level of response and investigation for each. The DNR makes initial assessments regarding reports that indicate likely winterkill or summerkill. Most winterkill and summerkill incidents, while likely indicative of long-term water quality impacts (nutrient enrichment driving algal productivity/eutrophication, impacting DO dynamics and potential lethal oxygen depletion) are not subject to interagency response efforts.
 - On weeknights, holidays, and weekends it may not be possible to reach some program staff (agencies lack on-call program staff with duties to execute field response work following a fish kill report). In such cases DNR Conservation Officers are typically the best initial agency contact. Conservation Officers are not trained to execute a full investigation of a fish kill but they can provide an initial response, gather field observations and execute communications.
 - Due to resource limitations, there may be delays in agency staff responding to fish kills that are reported on weeknights, holidays and weekends. As noted in the Future Development Needs section, contracts with private entities may be used to support response work going forward.

Figure 1 describes the general triage approach including notifications and communications, determinations of interagency response, and where investigations and key communications occur, including the final step of reporting.

Figure 1. Fish kill reporting, communications, and triage steps to determine level of response



Individual Agency Response

The triage process determines agency lead or leads and if an interagency response is needed. The level of response and lead assignments are based on the associated potential causes (Figure 2). In some cases an individual agency may execute a follow up desktop analysis and/or site visit to further assess the nature and extent of a fish kill described in an incident report. In many cases, DNR Fisheries staff can confirm winterkill, summerkill and disease-caused fish kills with no associated acute pollutant loading. The additional information that may be used to determine level of response includes:

- Reports, photos, or video that include information indicating a pollutant spill or release or pollutant runoff vs reports that indicate environmental factors/fish pathogen as the cause.
- Desktop analysis and/or field observations regarding waterbody characteristics and setting: stream and river fish kills are not typically due to winterkill or summerkill. Severe fish kills in the waters of pristine trout streams are typically due to an acute pollution event and addressed via an interagency response and investigation. Conversely, the vast majority of pond and lake fish kills are due to multiple contributing factors leading to winterkill and summerkill and are generally not associated with a pollutant spill/release, thus not requiring an interagency response. Fish death in an urban lake closely following a rain event could require an interagency response if acute pollution is the suspected cause.
- Number of days elapsed since the fish died: the definitive cause of fish death is often difficult to determine, due to factors such as the passage of time between fish death and the time of discovery and reporting. Professional judgement of time elapsed between fish death and discovery will be considered when determining response.
- Species reported and impacts to high value resources.

Coordination of response/lead assignments

If the triage determination concludes that a field investigation is needed, fish kill team members (MPCA, DNR, and MDA) will coordinate with program staff who will communicate to determine the appropriate initial response based on the potential cause of the fish kill. The MDH Source Water Protection Supervisor is notified by the lead agency within 24 hours of the determination that a field investigation is required. Assigned staff will be informed by the agencies that a response is underway and will become involved if there are concerns regarding impacts to drinking water or fish consumption. The lead agency will also notify the MDH Source Water Protection Supervisor within 24 hours if it is determined that a field investigation is not required.

Each agency has unique authorities, expertise, knowledge and resources that can aid in the investigation of a fish kill. An interagency response is initiated by the lead (see below) investigating agency. The investigative activities comprising a fish kill response can be highly variable depending on whether the event requires interagency response:

Interagency Response:

- Response typically led by MPCA or MDA.

- Most likely a fish kill caused by an acute pollution event.
- Fish kill reports will be addressed via a coordinated interagency response as needed (described in subsequent sections of this document). The fish kill is reported in the subsequent edition of the EQB Monitor. If an investigation occurs, the investigative report is shared via the EQB Monitor once it is completed.

Local Government Units ([LGUs] local recreational entities, watershed organizations and tribes) may be notified by investigators, either immediately or after an investigation is underway. Contact to the local unit of government may start with the local law enforcement agencies and expand to include other entities. (Example: coordination with County Feedlot officers.) Any fish kill impacting tribal land must be coordinated with the respective tribe.

No Interagency Response:

- There is no “lead” agency for these events because there is typically no interagency response or investigation.
- The DNR is responsible for communications and information management pertaining to these events:
 - Die-off, winterkill, or summerkill event.
 - Disease-pathogen related fish kill investigations.
 - If the initial suspected cause is a DNR lake permitted aquatic herbicide application.
- Fish kill reports **not requiring interagency response** are shared with all agencies, logged and reported in the subsequent edition of the EQB Monitor. These fish kill reports often do not typically require immediate staff response or detailed investigation/follow up, but they are utilized as data in on-going agency efforts to inform fish management decisions and reduce pollutant loading to surface waters. Agency staff track reports of these events as valuable data for understanding long term trends associated with fish kills in Minnesota.
 - Select die-off events may require immediate or more urgent response and communication or coordination if they are severe/extensive, or due to a rare disease, etc.

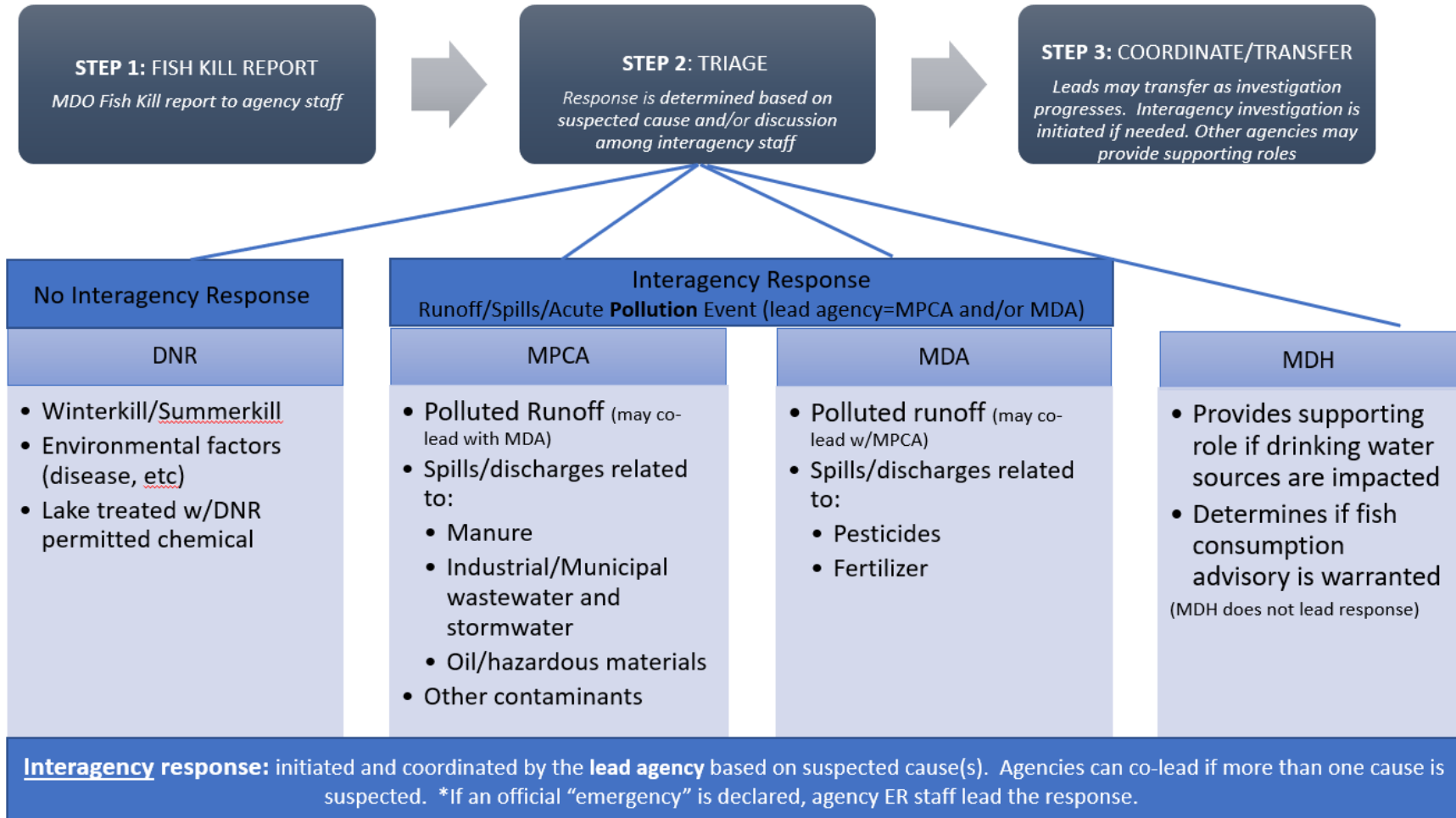
Determining the lead for interagency investigations: (graphically represented in Figure 2).

- The MPCA or MDA will be the lead responding agency when a spill/release or pollutant is the initial suspected cause; this includes possible polluted runoff following rain events. The MDA and MPCA may co-lead in these instances if appropriate, especially when the specific pollutant cause(s) are unknown or being investigated.
 - Typically, the MPCA program staff lead the response for MPCA. Most fish kills are not considered emergencies and thus are not led by ER staff and ER contractors are not utilized. However, during an emergency response incident that results in a fish kill the MPCA ER program staff will be the lead. Staff use activation threshold criteria defined in

the MPCA ER Standard Operating Guidelines (SOG) to determine official emergency situations. In an emergency situation, DNR, MDA, and MDH support fish kill response per their respective areas of expertise (see subsequent section on page 18).

- Non-lead agencies will support the initial investigation to confirm the cause and assist as needed or requested by the lead agency.
- The MDH will not lead fish kill investigations, but rather work to support investigations to determine risk and potential impact to drinking water supplies and will help identify wells that should be sampled. The MDH will address citizen concerns regarding drinking water and will issue fish consumption advisories if necessary.
- In some cases, it will be immediately known if the cause is related to an acute pollutant discharge; in other cases, the lead agency may change as the cause of the fish kill is further understood.

Figure 2. Determination of the lead agency and response during a fish kill investigation.



Interagency fish kill investigations

In the event an investigation is needed, the following responsibilities, activities and communications are performed and coordinated by the lead agency.

Lead agency's responsibilities

- Appoint a staff member to lead the investigation and act as the incident commander (IC). Agencies typically utilize a unified command during interagency response to a fish kill. An individual lead agency does not instruct or guide field staff from other responding agencies.
- Consider development of an Incident Action Plan (IAP) which establishes the incident objectives, strategies and assists with coordinating field staff, lab personnel, and communications between agencies and other partners.
- Appoint appropriate program staff (e.g., feedlot staff at MPCA or fisheries staff at DNR) and subject matter experts (e.g., limnologists) to assist as needed.
- Initiate an interagency response if needed and coordinate with other program or agency staff
 - Develop a channel/location of sharing information and coordinating meetings among interagency staff.
- Transfer the lead investigating agency designation as necessary based on determination of the cause of the fish kill.
- Act as initial point of contact for media inquiries and communications.
- Lead/coordinate the development of an interagency fish kill investigation report, if needed.

Initial investigation activities

- The lead agency coordinates the gathering of information regarding the fish kill (reference the respective agency protocols/guidance, and roles/responsibilities for various sampling in Appendix B). The following initial investigation activities are typically performed by the agency with the corresponding area of expertise. However, some initial investigation activities are executed by the first person(s) on site. This can be variable, or a combination of staff and may not always be someone from the lead agency.
 - Location and extent of the kill (including name of water body, type of water body, nearest town/township, county, Lat/Long coordinates, public land survey (PLS), public lands/easement in the vicinity).
 - Number of dead fish observed, fish species, sizes, activity prior to death.
 - Notes about any observed living fish in the investigation area, or lack thereof.
 - Weather conditions, current and leading up to fish kill event (DNR Climatology Office [website](#) provides useful information in this regard).

- Evidence of pollution/discharge, including detailed photos or comparison photos if source is suspected.
- Description of highwater marks, flow conditions, water clarity, color, and floating or accumulated debris.
- Description and photos of the surrounding watershed including land use, recreational activities, and access to the water body (Consider utilizing DNR [WHAF](#) Tool).
- Determine the potential risk to drinking water based upon regional surface water and groundwater interaction (MDH).
- Identify and communicate any surface water exposure hazards or safety concerns to local and state public health department.
- Identify initial response objectives, priorities, and immediate resource requirements.
- Determine potential need/use for drones during the field visit.
- Desktop analysis of potential sources based on geography and hydrogeology.
- Desktop analysis of point source information, including application records
- Obtain local knowledge of area/watershed.
 - DNR [Area Fishery Office](#) and [Lakefinder](#)/invasive species data.
 - MPCA Regional Office and impaired waters historical data ([MPCA Impaired Waters Viewer](#)).
 - MDH public and private [well locations](#), spring shed information, local geology.
 - Watershed district/watershed management organization.
 - Coordinate with local partners.
 - Coordinate and communicate with tribes, if applicable. Tribes may hold TEK (traditional ecological knowledge) that will help inform investigations.
- Initial field and sampling activities (more detail on sampling considerations for interagency fish kill investigations are in Appendix B. Agency specific fish kill “kit” information is found in Appendix D, E, F).
 - Perform field analysis of temperature, pH, and DO.
 - Collect water samples for analysis.
 - Consider any sampling/evidence and documentation needs related to potential litigation.
 - Collect dead and dying fish for fish health analysis (see DNR investigation of fish [kills](#) guidance for maintaining quality samples for shipment and specifics on fish parts/organs to be analyzed).

Laboratory sample submission

Each agency will follow procedures and sampling protocols related to proper handling and storage of samples to maintain sample quality and integrity (see various existing sampling protocols). Refer to appendix D, E, and F to see agency fish kill kit information. Appendix G includes water quality analyses associated with various fish kill causes and should be used as a guide for sample collection and analysis during an investigation. Typical activities related to sample submission performed by MPCA/MDA include:

- Determine and alert appropriate labs of incoming high priority samples.
 - MDH and MDA laboratories have the capability and standing contracts to run multiple parameters (consider contract support needs and protocol).
- Samples to be tested for agricultural chemicals are submitted to MDA lab.
- Samples to be tested for fish diseases/fish health analysis are submitted to DNR Fish Health Laboratory.
- Samples for water quality are submitted to the MDH/MDA lab.
- Use Chain of Custody to safeguard sample integrity and document sample possession. Sample types from different agencies could require multiple chain of custody forms be filled out during an investigation.
- Utilize PRJ00075 (EQuIS Project Code) to submit and store fish kill water chemistry sample results (MPCA and MDA).
 - After samples are submitted, provide station establishment information (Sample Code or Lat/Long) info to EQuIS staff.

Public information regarding the safety and response to incident/event

- The lead responding agency will coordinate public information (see Appendix C).
- MDH will coordinate with local public health officials on the communication of any impacts to the public regarding the incident. Public health impacts could include the exposure to waterborne pathogens or toxic chemicals through consumption of contaminated drinking water, dermal exposure to contaminants through water use activities, or the consumption of fish.
- MDH is responsible for issuing fish consumption advisories if warranted.
- Subject matter experts will be engaged as appropriate.
- Information that is not public will be kept confidential. During an investigation all data should be considered confidential/not public. “Not public data” may be shared among agencies during the investigation (landowner data, application records, and locations of threatened and endangered species), but cannot be released per Minnesota Statute until the investigation is complete. All efforts should be made, particularly in email communications, to label not public data.

Incident closure/reporting

- The DNR Fish Kill Investigation Protocols specifically state that the DNR field component of the investigation will cease “one week after the last dead fish has been observed in the field, using their professional judgment, or per direction of management.” Other agencies may find the need to extend the field investigation beyond a week.
- The lead investigating agency will provide notification to partners when the field investigation portion of the response is closed.
- Restitution and enforcement coordination.
 - Each agency will determine enforcement of violation(s) related to respective jurisdictions.
 - Permit violations - MPCA (115.03)
 - Pesticide/Fertilizer violations - MDA (18B and 18C)
 - Natural Resource Damage Assessment - DNR/MPCA as Co-Trustees
 - Penalties and compensations will be brought forward by individual agencies as appropriate.
- **Fish kill Investigative reports**
 - All involved agencies are responsible for documenting and tracking their own activities related to a fish kill investigation. Timing of reporting will be largely dependent on length/complexity of investigation and enforcement actions involved. In some cases (e.g. fish kills caused by pollutant runoff in agricultural watersheds) investigation and enforcement actions may be prolonged due to complexity and/or number of landowners upstream of a fish kill location.
 - Respective agency reporting is typically sufficient to document investigation results and conclusions. In exceptional cases, a unified interagency fish kill investigation report may be drafted. The interagency fish kill team will determine whether or not a unified report is necessary, based on the following considerations:
 - An examination of the sufficiency of the individual agency reports.
 - Fish kill type, magnitude, and extent.
 - If an interagency fish kill investigative report will be drafted, the lead investigating agency will also lead the development of the report. That agency will maintain ownership of the document until it is approved for release by all agencies involved.
 - If developed, the interagency fish kill investigative report will include the following, at a minimum:
 - Overview of the fish kill.

- Summary of the investigation, including maps of the affected area with sample locations of fish tissue, water samples, and other samples/results, as well as the locations and counts of species of dead fish.
 - Results of the investigation focused on the determination of the cause.
 - Recommendations and prevention measures, if applicable.
 - Data that must be kept confidential per state law will not be included in a report.
 - Final fish kill investigative reports will be published on agency websites and the EQB monitor.
- **After Action Review**
 - Critiquing the response can be valuable to understand whether the needs of the individual agencies, as well as the combined group, were met to effectively respond to the event. An After Action Review (AAR) can identify inefficiencies, information gaps, and communication issues, amongst other things. The goal of such a review is to identify and address needs for the future and opportunities to modify and improve the existing response plan.
 - An AAR may be scheduled following a fish kill investigation when requested by one or more state agencies involved. All partners involved will be invited to participate in the critique.
 - A representative from the lead investigation agency will schedule and facilitate AAR meetings as needed; such meetings can cumulatively inform subsequent revisions of this guidance document.
- **Restoration Plan**
 - Determine the need for a restoration plan (natural recovery or active restoration).
 - Fisheries assessments and long-term monitoring needs will be determined by DNR.

Areas of expertise

DNR

- Knowledge of the water bodies in the state
- Knowledge of which water bodies in the state have threatened and endangered species
- Knowledge of which water bodies in the state are infested with aquatic invasive species (AIS), including which AIS are present
- DNR Fisheries – Knowledge of fish identification, fish habitats and stressors to fish health
 - Access to boats and field instrumentation (pH and DO meters)

- Fish pathology laboratory that has the capability to conduct necropsies and disease testing
- Area Fisheries staff are often familiar with the roads and bridge crossings over water bodies. They also know what ambient conditions are in many lakes and streams
- Conservation Officers are area based and have access to off-road equipment and boats
- DNR-owned land

MDA

- Knowledge of legal pesticide registration, application, and labelling
- Knowledge of surface water contamination by agricultural chemicals
- Knowledge of sample collection and chain of custody for enforcement
- MDA Laboratory
 - Knowledge of analytical tests on water, animal tissue, and other matrices
 - Expertise to advise other agencies on the proper sampling containers to be used for a variety of sample types to be analyzed for a variety of parameters

MPCA

- Knowledge of ambient chemistry and biological data for water bodies, including water quality monitoring data
- Knowledge of biological data available, sampling, and access to field equipment for chemistry, fish and macroinvertebrate sampling. Biologists work with identification, life history and community health knowledge of aquatic communities across the state
- Knowledge of water body impairments and stressor information for water bodies
- Knowledge and locational data for regulated facilities and activities
 - Feedlots and manure spreading
 - Industrial and municipal wastewater facilities
 - Industrial and municipal storm water
 - Waste disposal
 - Other regulated pollution activities
- Knowledge of release mitigation strategies including containment and recovery of oil and hazardous substances
- Access to ER contractors for rapid deployment for sampling and mitigation equipment, supplies and personnel
- Sampling procedures and protocols, monitoring locations, and chain of custody expertise

MDH

- Risk assessment of pollutants impacts on downgradient public and private wells
- Knowledge of localized connection of surface waters to ground waters
- Expertise in unsafe contaminant levels in drinking water
- Expertise in coordinating with local public health officials on public response
- Readily available data regarding public and private wells including well construction records, geology and aquifer information
- Determination of fish consumption advisories

Roles/responsibilities and agency specific protocols

Minn. Stat. §103G.2165 requires that this guidance and protocol describe methods and operating procedures pertaining to fish kill investigative sampling and field work. The various sampling roles of each agency and example strategies that may be used during a fish kill investigation are shown in **Appendix B**. It includes sampling considerations related to planning and field sampling during an interagency fish kill investigation. Not all the sampling activities listed in the table will occur during each fish kill investigation; rather the table provides considerations related to each type of sampling that could occur. Each agency follows its own set of protocols and procedures to complete sampling and fish kill investigative work, described generally below.

DNR

The DNR depends on multiple documents for the investigation fish kills, including the American Fisheries Society Publication #35 (2017), The US Fish and Wildlife “[Field Manual for the Investigation of Fish Kill](#)” (1990), and the [DNR Fish Kill Investigation Protocol](#) (2016).

MDA

The MDA has internal guidelines to fish kill response based on existing protocols for ER, incident investigation, sampling, and documentation. Departmental resources are available based on the needs of the investigation, including labeling, nonpoint sources, remediation, and enforcement.

The MDA’s Laboratory Services provides an array of analytical capabilities on water, soil, animal tissue, and other matrices. Lab personnel carefully follow internal protocols on sample handling, documentation, standardization, and methodology.

MPCA

The MPCA’s ER Program reviews reports from the MDO 24 hours a day, 7 days a week. ER staff compare each incident to emergency activation thresholds established in MPCA’s guidance. If an activation threshold is met, ER staff are empowered and authorized to take actions necessary to mitigate the pollution.

For nonemergency incidents in which a responsible party is regulated by a specific program of the MPCA, the ER program transfers the incident to that program. ER staff are not involved in nonemergency incidents per MPCA protocols.

The MPCA's response to fish kills is outlined in the standard operating guideline for surface water emergencies (SOG) and the MPCA Emergency Operations Plan (EOP). These are internal documents that outline the MPCA's program contacts, health and safety considerations, sampling guidelines and follow up actions for responding to all types of emergencies that may affect surface waters. Several other programs at the MPCA may be involved with a fish kill incident and could utilize procedures and protocols established by their respective programs. These include: Industrial and Municipal Waste Water, Feedlots, Hazardous Waste, Tanks, Remediation, Stormwater, and other water programs. Staff from the MPCA's Environmental Analysis and Outcomes Division and Watershed Division often lead or assist with monitoring and assessment of water quality and/or biological sampling during fish kill investigations.

MDH

If it is determined that the fish kill is a result of unnatural causes or pollutants, MDH is notified, and a hydrologist is assigned to investigate. The MDH has developed a DWP-Spill/Fish Kill response protocol to follow during a fish kill investigation that involves drinking water/contaminated groundwater. The MDH hydrologist will review the localized geology where the fish kill occurred to evaluate the surface water to groundwater interaction within the area. An assessment of the health risk to public and private wells within the vicinity will be made based upon the potential surface water to groundwater connection. This assessment will be utilized by MDH's Unit Supervisors to make decisions regarding any possible follow up actions. If there is no health risk then MDH's role is complete. If the hydrologist determines that drinking water is at risk, MDH will determine which wells should be prioritized for sampling. The MDH will lead the collaboration with the local public health officials to provide communications to the public regarding any potential health risks or concerns. The MDH also uses [sample collection procedures](#) based on suspected contaminant.

Safety considerations

Staff responding to fish kills incidents must be cautious of the potential hazards associated with working around water and the unknown cause of fish mortality. Staff must comply with all required safety training. Work in teams of two or more when possible. If there is any question about whether it's safe to proceed - DO NOT. Report any safety concerns to your supervisor and investigative partners, then wait for further instructions. Staff should contact a physician immediately if they start to feel ill following field work. Staff must follow their agency's protocol for reporting injuries. At a minimum, all staff responding to a fish kill must be aware of:

Physical Hazards

- Be aware of changing weather conditions; use sunscreen, stay hydrated, and dress appropriately for the weather conditions.

- Slips, trips, and falls are significant causes of injuries. Extra caution needs to be taken when working in natural/non-maintained areas. Be constantly aware of your footing and surroundings when navigating rough, uneven terrain.

Chemical Hazards

- Assess the situation and determine if it's safe to enter the area and proceed with the investigation. Be aware of strange odors, discolored water, abandoned and/or leaking containers, dead plants and animals, as these could be signs of a chemical spill/release. If you notice any noxious odors or see evidence of potentially toxic chemicals present, it may not be safe to enter the area.
- Watch for signs of illegal dumping/discharges, which may be near outfalls or discharge pipes. Look for signs of tracking which would indicate where material was potentially released.

Environmental Hazards

- Wear an approved personal flotation device (PFD) when working on a watercraft. Follow your agency's safety protocol for PFD when working near and/or in the water. Use personal protective equipment (PPE) as needed such as waders/boots, hats, and gloves.
- Be aware and avoid dangerous plant and animal life; poison ivy, poison sumac, and stinging nettles are common in many areas of Minnesota. Ticks, mosquitos, and snakes are also common. Avoid exposure to wooded or brushy habitat when possible. Use repellants on clothing and body and perform full-body checks for ticks. Be aware of wild animals, dogs and other domesticated animals as they can be unpredictable and should be avoided.
- Communicate calmly and respectfully with concerned citizens. Property owners and members of the public can be concerned when unknown activity is occurring on or near their property. Ask permission to access private property and contact a DNR Conservation Officer or local law enforcement for assistance with access.

Interagency networking and training

The DNR, MDA, MDH, and MPCA will identify staff from their respective agencies to participate in collaborative and specific response training. Staff will be offered opportunities to meet and network with their agency counterparts and attend training developed by members of the Interagency Fish Kill Response Group. The training may be regionally based and include staff from all participating agencies. The goal is to improve relationships and increase the communications between the staff that likely will work together during an actual fish kill investigation. The training will include:

- Detailed information related to this document
- Safety considerations for responders to a fish kill
- Overview on the roles, responsibilities and expertise of each agency
- Expectations of the management structure (ICS) and communications between agencies

- Discussion on the State’s response to fish kill scenarios, including exercises to test preparedness
- Documentation and information sharing

Future development needs

The following list represents the potential resource/development needs for responding to fish kills in Minnesota.

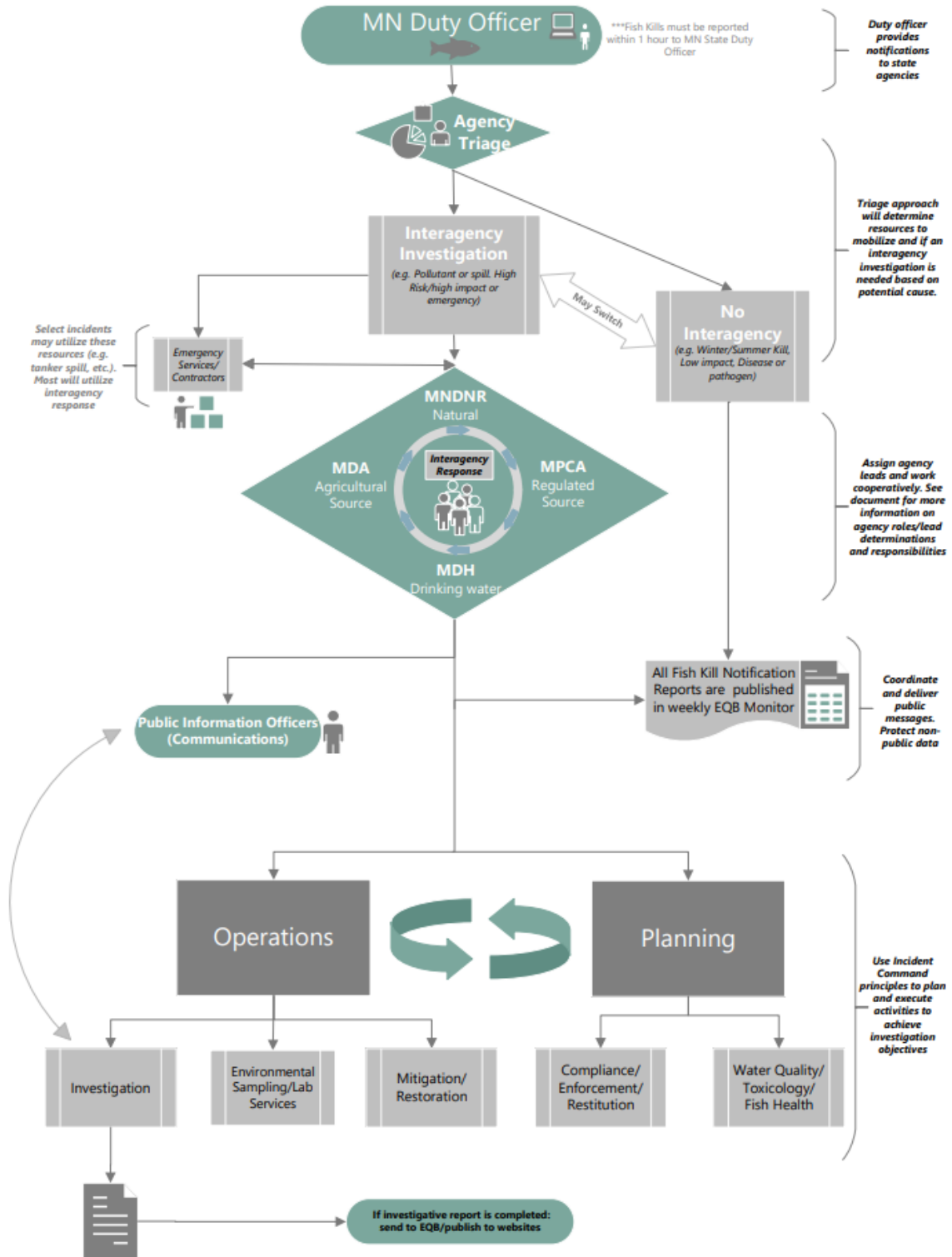
1. Outside contracting or improvement in availability/resources for fish tissue testing of pesticides and heavy metals. There is not currently capacity to test fish for these contaminants. Current capability for fish necropsies includes detection of bacteria/parasites/viruses only. Improved capacity could link selected contaminants to cause of mortality in fish, including contaminants of emerging concern. This information would support better case resolution, identification of responsible parties, and collection of valuable epidemiological data on fish kills.
2. Integrated public fish kill reporting database and improved tracking system (Examples below). A database for public reports of fish kills, tabulating them over time, would allow for better tracking fish kill incident data. This in turn could be utilized to examine trends, hotspots, re-occurring events, and correlation with index of biological integrity. It could also provide a better public-facing fish kill webpage that helps explain the significance of most nonemergency fish kills. It could also allow for automated triage of certain types of fish kills, an automated notification tree, and an automated data entry for fish kill reports. Some examples to build upon include:
 - a. [Fish Kill \(arcgis.com\)](https://arcgis.com)
 - b. [DNR Reporting \(state.mi.us\)](https://state.mi.us)
3. Dedicated time to tabulating and studying fish kills to help learn more and tell the story. This informs management focus, proactive communications, and a risk management approach.
4. Partnering and coordinating with local units of government to respond to fish kills.
5. Better understanding (auditing) of fish kills investigation labor costs and equipment.
6. Funding for improved response efforts, including contracts with private entities to support field response (e.g. during weekend or evening response work), grants, or legislative allocation. This also includes dedicating staff resources to continue to work on fish kill efforts; tracking and coordinating efforts to improve response to fish kills, communicating/conducting training, and responsibility to keep this document updated while coordinating staff assignments among agencies, etc.
7. Discussion and determination of appropriate training (ICS, etc.) for all staff responding to fish kills, including safety training like HAZWOPER awareness training.

Updating of this document

This document will be reviewed and updated if needed, every five years. Each spring, agency contact information and the list of contents in each agency’s Fish Kill Response Kit should be reviewed, to account for changes in potential pollutants or analytical laboratory methodology. All web links in this document should be reviewed for accessibility and missing/broken links replaced.

Appendix A: Interagency process for investigation of fish kills

The flow chart depicts the organizational structure of any fish kill response. A single agency may populate all roles or unified command may fulfill roles with personnel from multiple agencies.



Appendix B: Interagency strategies/roles for fish kill sampling

INTERAGENCY STRATEGIES AND ROLES FOR FISH KILL SAMPLING			
This table shows various sampling roles and gives considerations related to planning and field sampling during an interagency fish kill investigation. Not every sampling activity listed will occur during each fish kill investigation; rather the table provides considerations related to each type of sampling that could occur. Each agency has specific protocols and guidance documents that will be followed for the sampling activities listed.			
TYPE OF SAMPLING	LEAD AGENCY/ROLE	PLANNING/RECONNAISSANCE CONSIDERATIONS	FIELD SAMPLING AND LOCATION CONSIDERATIONS
AQUATIC LIFE SAMPLING	DNR: Fish MPCA: Macroinvertebrates	<ul style="list-style-type: none"> ❖ Determine if previous aquatic life sampling sites exist in the area (DNR or MPCA site). ❖ If previous biological data exists, resample those locations and analyze community information for comparability. ❖ Match/co-locate aquatic life sampling to surface water sampling locations. ❖ Determine if macroinvertebrate sampling is needed, if so contact MPCA biological staff. 	<ul style="list-style-type: none"> ❖ Determine locations impacted and extent of dead fish. Choose sampling points upstream, downstream, and within the affected area. ❖ Determine if any live fish or recently expired fish are present/any can be sent in for fish health analysis. ❖ Note tributaries, springs, and other factors that could contribute to the causes or impact. Collect samples upstream/downstream and within affected area. ❖ Add new sites as needed to cover extent of the kill. ❖ Check under rocks for living macroinvertebrates.
SURFACE WATER SAMPLING	MPCA: General Water Chemistry MDA: Pesticides	<ul style="list-style-type: none"> ❖ Consult with Area hydrologists for local stream conditions to determine scale of response. ❖ Determine if previous water chemistry sampling site exists on stream. Match/co-locate aquatic life/surface water stations where possible. ❖ Review maps, watershed boundaries, road crossings, tributaries, springs, and potential pollution sources. ❖ Refer to MDA/MPCA water sampling protocols/fish kill kit lists for general sampling guidance for parameter lists/bottles needed. ❖ Submit all data collected to EQulS database; use fish kill project: PRJ00075. Establish any new site locations in EQulS soon after sampling. ❖ Notify labs of incoming samples. 	<ul style="list-style-type: none"> ❖ Field <u>verify</u> any tributaries, springs, and other factors/sources of pollution that could contribute to the causes or impact. ❖ Choose sampling points upstream, downstream, and within the affected areas. Utilize extent of dead fish to help choose sampling points. ❖ Document water level changes (i.e., bent over grass, debris deposits, if visible). ❖ Document (photos/sample, etc.) potential pollutant/contaminant path from source to surface water. ❖ Sample any foam/film/scum, flows (or “puddles”) in draws or tributaries upstream of fish kill. Take many photos and document appearance. ❖ Consider time elapsed since fish kill event and if downstream sampling would capture cause. ❖ Consider multiple rounds of sampling at the same site to capture cause, especially if conditions change quickly during the investigation (i.e., rainfall in near term forecast that may re-mobilize pollutants).

<p>GROUNDWATER SAMPLING</p>	<p>MDH: DWSMA, Public Water Suppliers, Private Wells MDA: groundwater sampling for agricultural chemicals</p>	<ul style="list-style-type: none"> ❖ Consult with Area hydrologists for local stream conditions to determine scale of response. ❖ Evaluate the risk to public and private water supplies within the fish kill area. <ul style="list-style-type: none"> ➤ Utilize geological maps/GIS and resources to determine risk potential of groundwater impact. ➤ Evaluate well proximity and stratigraphy. ❖ Contact public water suppliers within the fish kill area if warranted. ❖ Coordinate outreach efforts of local public health officials and local units of governments to private well owners within the fish kill area if warranted. 	<ul style="list-style-type: none"> ❖ Sample public water supplies that utilize surface water as their source of drinking water within the fish kill area. ❖ Sample public water supplies that are determined to be at risk within the fish kill area. ❖ Provide guidance and technical assistance to local partners to sample private well that are determined to be at risk within the fish kill area.
<p>SOIL SAMPLING</p>	<p>MDA: Soil Sampling for agricultural chemicals</p>	<ul style="list-style-type: none"> ❖ Soil Samples can be taken if an agricultural chemical incident/ spill/release occurs. ❖ Review additional reports. ❖ Consult with agency for impact area. ❖ Document volume/ area impacted. ❖ Consider point vs. non-point event. ❖ Determine grab vs. composite sample. 	<ul style="list-style-type: none"> ❖ Use composite soil samples to characterize a large area or volume of soil as needed. ❖ Record distances and locations of sampling areas and proximity to surface waters. ❖ Sample above highwater mark. <ul style="list-style-type: none"> ❖ Areas around drain tile, rills, outfalls.

Appendix C: Fish kill communications guidance

Disclaimer: This document is an appendix to the Guidance for an Interagency Fish Kill Response. This document is a working document. This document may change over time.

Scope and summary

Following fish kills that are of significant public interest, pose on-going safety or public health hazards, involve extensive geographic areas or are addressed via an investigative report, agencies will work together to address questions from the public, media, and potentially stakeholders and public officials. This appendix provides a general guidance for such communications.

Fish kill communication protocols

When a fish kill is reported and an interagency response is initiated, the following communications protocols should be followed:

1. Staff from all four agencies must immediately alert their respective leadership below:
 - **DNR** -- Fisheries Section Manager, Fish and Wildlife Director, Assistant Commissioner for Fish and Wildlife, Communications Director, Fish and Wildlife Outreach Section Manager, Ecological and Water Resources Director
 - **MPCA** – ER Unit Supervisor, Safety and Emergency Management Section Manager, Communications Supervisor, Watershed Unit Supervisor and Section Manager, Watershed Division Director, EAO Unit Supervisor and Section Manager
 - **MDA** – Chemical ER Unit Supervisor, Chem ER Consultant, Pesticide and Fertilizer Management Division Director, Communications Director, Assistant Commissioner, Inspection Unit Supervisor, On-call Team Staff, Inspection Unit Manager, ER Director
 - **MDH**-Source Water Protection Supervisor, Water Policy Manager, Research Scientist- Fish and Game Consumption Guidance Environmental Surveillance and Assessment Section, Community Public Water Supply Unit Supervisor, Communication and Strategic Initiatives Unit Supervisor
2. Communication leaders from each agency (or their delegates) will contact each other as soon as possible and share information about what is known and next actions. A communication plan will be developed using the template below.
3. Staff from all four agencies will provide their leadership and communications directors with a description of what is currently known about the fish kill. This includes basic information, such as who is involved, where the kill occurred and when, the extent of the fish kill, and any other data that is available, such as weather conditions.
4. Fish kill response teams will determine with their Communications leadership how media requests will be managed. Talking points should be developed and utilized per agency protocols. The DNR staff may use a preapproved general statement to address initial media inquiries. See DNR Fish Kill protocol.

5. Staff will always stay within their lanes of expertise.
6. Information from MDO reports pertaining to fish kills are posted to the weekly EQB Monitor publication
7. Fish kill investigative reports that are completed will be posted to the EQB Monitor.

Roles and responsibilities

1. DNR staff will lead communications where it has been determined that pollutants are not suspected.
2. MPCA, MDA, and MDH will support the initial communications tasks.
3. If the cause is determined or suspected to be nonnatural and from a regulated activity or pollutant, the appropriate regulatory agency (MPCA or MDA) will take the lead in communications.
 - Staff from nonlead agencies should not discuss the details of an investigation without prior approval from the lead agency.
 - DNR will support ongoing communications efforts by the lead agency until the investigation is closed.
 - All pertinent inquiries from the media and the public will be shared among agencies.
4. Data that are confidential per state law will not be shared with the public, media, etc. as governed by agency data practices laws and policies. State staff investigating a fish kill may share confidential data among themselves.

Investigations: Do not speculate

In active, ongoing investigations, it is essential that staff members on the interagency team DO NOT speculate about the potential cause of a fish kill. Speculation can limit the scope of the investigation, wrongly point the finger at a specific cause, hamper collecting evidence and determining the source, and can result in inaccurate conclusions and inappropriate response actions. If the investigation is ongoing, the appropriate response to requests for details from media or others is: **“The fish kill is an open, active investigation, so by law I cannot discuss specific details about the case.”** (DNR/MPCA Minn. Stat. § 13.82, MDA Minn. Stat. § 13.39, subd. 2(a).)

Audiences

- Media and the public - Provide appropriate and up to date information to media if necessary
- Governor’s Office - Provide appropriate and timely information on situation to designated Governor’s Office Communications staffer
- Public officials - Provide notifications to local public officials and state legislators that represent the impacted area
- Stakeholders - Provide appropriate information to specific stakeholder groups impacted by fish kill

- EQB Monitor—A list of fish kills reported will be posted in the weekly EQB monitor and any investigative reports that are completed will also be posted

Communication Goals

- Acknowledge a fish kill has occurred
- Communications specialists should maintain situational awareness
- Monitor media interest regarding the incident
- Work with partner agencies on messaging, talking points, and responding to reporters
- Interagency cooperation and transparency should remain top priorities; however, case confidentiality and integrity should always be maintained
- Staff should always collaborate with communications staff when requests for information are received
- If a fish kill occurs in an area with high connectivity between surface and groundwater, a goal will be to communicate potential health risks to downstream/downgradient private and public well owners that may be impacted; this can be done in coordination with local public health offices

Key talking points

- The MDA, DNR, MDH and the MPCA have a long history of working together on fish kill incidents where a cause is not immediately known.
- The MEOP assigns lead roles to MDA and MPCA for the response to environmental impacts from the release of hazards materials, oil, and/or other pollutants. The DNR is assigned a support role whenever a discharge/release causes injury to fish, wildlife, waterways, and/or public lands. The MDH will communicate any potential health risks to the public.

Communications plan template

The following communication plan will be used to outline dates, tasks, products, and staff who will communicate about a fish kill. It can be cut and pasted into a separate document. Communications staff from DNR, MDA, MDH, and MPCA will work with the interagency team to initiate this plan and work together to develop a summary, talking points, key stakeholders, and audiences and key actions and dates. DNR also has a “Fisheries Preapproved Fish Kill Messaging” guidance document in the DNR Fish Kill protocol that may be utilized during an investigation.

Fish Kill Communications Action Plan

Date:

Fish kill summary:

Talking points:

Key stakeholders and audiences:

Timeline:

Date	Action and Notes	Staff

Appendix D: MPCA fish kill kit

The MPCA has a “Fish Kill Kit/Sampling Guide” to use as reference during a fish kill. This guide determines what bottles, parameters, and supplies are needed in response to a certain pollution related fish kill incidents. All MPCA offices/labs that do water quality sampling should have these supplies readily available:

A) **Sample Containers.** A combination or selection of these bottles can be used if the cause or parameters needed are known. However, for most fish kill incidents, each site/sample needs:

- Sterile microbiology bottle – 1 x 120-mL contains preservative
- General chemistry bottle – 2 x 1 liter plastic (one bottle for general chemistry, one for BOD)
- Nutrient bottle – 1 x 250 mL, with preservative (H₂SO₄)
- Metals bottle – 1 x 250 mL, with preservative (HNO₃)
- Pesticide bottle – 1-liter amber glass (Consult with MDA before collecting)

**In rare cases, other bottles and samples may be needed for sampling. Consulting with specific program staff is required for sampling of parameters like VOC's and Gasoline Range organics (40 mL glass vials), SVOC/SOC's, (1 L amber glass, unpreserved), or Diesel Range Organics (1L Amber, HCL).*

B) **Water quality sonde.** Sondes are be used for field measurements of pH, DO, temperature and conductivity

C) **Other Supplies:** Field book, field data sheets/COC forms-lab sheet, Camera, pens, permanent marker, disposable gloves, plastic bags, cooler/ice, boots/waders

Appendix E: MDA fish kill kit

A Fish Kill Kit contains supplemental equipment for fish kill sampling. Each kit contains enough bottles for four separate samples. Contents of each kit includes:

- 8-1L amber glass bottles
- 4-2L plastic bottles
- Mr. Longarm extendable pole for sampling
- Fish and water sampling procedures
- Fish species poster
- Bottle labels
- Lab Sample Submission Forms
- DNR General Permit: Transport Water for Water Quality Sampling
- AIS Labels

Kits are cached at the following headquarters:

- 625 Robert St N, St. Paul, MN 55155
- 422 Belgrade Ave, Ste 104, Mankato, MN 56003
- 1509 N 1st Ave, Fergus Falls, MN 56537
- 119 N Drury St, Redwood Falls, MN 56283
- 3555 9th St NW, Ste 350, Rochester, MN 55901
- 16 Minnesota Ave W, Glenwood, MN 56334
- 3725 12th St N, St. Cloud, MN 56303

Appendix F: DNR fish kill kit

Below is the guidance that DNR Fisheries provides to staff regarding what should be in their fish kill kits.

Water Sampling Kit. The water sampling kit consists of an insulated cooler which contains:

A) Sample Containers. The insulated cooler contains three sets of bottles for the collection of water samples that will be submitted for laboratory analysis. Each bottle set includes the following types of sample containers:

- Sterile bacteriological bottle - 2 x 100-ml, containing sodium thiosulfate to neutralize chlorine if present
- General chemistry bottle - 2-liter plastic
- Pesticide bottle - 2 x 1-liter amber glass

B) Water Chemistry Field Kit. For on-site water-quality screening purposes, the kit contains the following items:

- pH test strips
- Chlorine color field kit
- Ammonia field kit

C) Fish Sampling Kit

- Clean cooler
- Clean, large plastic bags
- Ice pack
- Labels

D) Other Supplies Evidence Inventory and Transmittal forms, field data sheets, fish count sheets, labels, custody seals, pens, permanent marker, disposable gloves, plastic bags, safety glasses, paper towels, scissors, strapping tape, cooler, ice, field DO, temperature, and pH meters, if available.

Appendix G: Parameter lists

Table 1. Parameters and reference values/standards for water quality in the context of fish kills. The nature of the fish kill investigation will determine which monitoring parameters or samples are collected/analyzed (not everything listed in table is sampled for every fish kill). Note: Toxic effects can occur at levels below these benchmarks/standards when multiple pollutants are involved. Many water quality standards referenced in this table have been developed based on chronic concentrations, not acute (lethal) levels which must be considered when determining potential stress or toxicity.

	Parameter	Rationale for sampling and/or sources	Benchmark/ Standard or Reference Values	Interpretation
Field Parameters	Conductivity	Indicates groundwater vs surface water sources and indicates pollutant presence	> 1000 $\mu\text{S}/\text{cm}$ is often concerning. Normal range for most MN streams is ~ 400-800 $\mu\text{S}/\text{cm}$; varies regionally	Higher conductivity can indicate severe pollution. Rainwater has low conductivity
	Dissolved Oxygen (DO)	Various pollutants stream/lake processes impact oxygen. Correlates to high BOD. Most common cause of fish kills	< 5 mg/L is concerning and stressful to fish. < 1-2 mg/L is likely lethal. More on DO stress/standards here .	Coldwater fish are tolerant of low DO than warmwater fish. Stream oxygen often rebounds fast
	pH	Pollution indicator. Needed for unionized ammonia calculation	6.5-8.5 is the standard range. More on pH stress/standards here .	pH out of the normal range can indicate pollution
	Temperature	Needed for unionized ammonia calculation and general info. Urban areas may be more prone to temp spikes. Cold water holds more oxygen than warm water	Dependent on stream type and existing thermal regime. More on temp stress/standards here .	Temperature out of normal or rapid fluctuations can be stressful and even lethal to fish. Warmwater holds less oxygen than coldwater
	VOCs	PID meter can measure VOCs (Volatile Organic Compounds) or chemicals that can vaporize into air	Meter response indicates contamination/presence of VOCs	Can be used as a field measurement for contaminated soil and water
Water Chemistry Samples	GC/LC Pesticides	Pesticides commonly used in Minnesota	Various. See EPA AQL benchmarks or standards in MN. WQ standards exist for select few pesticides.	Results above AQL benchmarks or standards are problematic/cause for concern.
	Bacteria (<i>E. coli</i>/ fecal coliform)	Indicates potential for animal or human waste presence	<i>E. coli</i> Standard: 126 org/100mL =monthly geometric mean. 1260 org/100mL =maximum standard.	Higher surface water <i>E. coli</i> values are associated with runoff. Fecal coliform tests (presence/absence) are typically used for drinking water.
	Total Suspended Solids (TSS)	Sediment occurs during runoff events and often indicates other pollutants may be present	Standards are dependent on stream type and based on chronic exposures.	Extremely high values often occur with runoff
	Chloride (CL)	Detect KCl from fertilizers	MPCA standard is 230 mg/L ; acute value of 860 mg/L	Corresponds to elevated conductivity
	BOD (Biological Oxygen Demand)	Measure the amount of organic matter that bacteria can oxidize in water	WQ standard (for eutrophication) varies based on region from 1.5-3 mg/L , depending on	3-8 mg/L = moderately polluted water. >10 mg/L strongly indicates pollution

	Parameter	Rationale for sampling and/or sources	Benchmark/ Standard or Reference Values	Interpretation
			region. More stress/standards here .	
	Total Phosphorus (TP)	Indicates human/pollution activity. Includes both dissolved and particulate forms; particulate is higher with increased soil particles (TSS)	Various levels can be present depending on the stream type. More info on stress/standards here .	High levels are not toxic but correlate with other high pollutant and/or sediment presence.
	Dissolved Orthophosphorus	Dissolved phosphorus portion that indicates human/pollution activity. This form is readily available to plants/algae	Various. Refer to total phosphorus standards and compare proportion to total phosphorus	If a large percentage of TP is dissolved ortho, it could be related to runoff from feedlots/septic/wastewater
	Total Kjeldahl Nitrogen (TKN)	Amount of organic nitrogen+ammonium+ammonia. High in manure and sewage	> 3 mg/L is potentially concerning. Approx 60% of TKN can be ammonia	High TKN indicates potentially high ammonia.
	Total Ammonia (NH3)	Ag/manure runoff or a spill of fertilizer	> 1 mg/L is alarming. More on ammonia stress/standards here .	Toxicity is from unionized ammonia; a function of pH and water temperature-calculated separately from total ammonia
	Nitrate + Nitrite (NO3 + NO2)	Amount of inorganic nitrogen. Indicates human activity/pollution	AQL standard in development, 60 mg/L is the proposed acute (max) standard. More on nitrate stress/standards here .	Toxicity a function concentration and exposure time
	Metals	All metals can be toxic at high concentrations. Some metals such as copper, zinc, and nickel can be part of fertilizers and pesticides. Copper sulfate can be high in dairy manure	Various, AQL criteria exist for select metals including mercury, lead, nickel, copper, zinc. Copper is naturally occurring from 0.20 to 30 µg/L. Sensitive invertebrate species mean acute value is 2.37 µg/L.	Toxicity is a function concentration and exposure time

Table 2. Parameter suites to consider based on potential suspected contaminants.

Analysis / Parameter	Contaminant of Concern					
	Manure	Wastewater	Petroleum	Food Product	Industrial Chemical/Unknown	Ethanol
General Chemistry pH, Conductivity, DO, TSS, Turbidity, CL, SO4, BOD	X	X		X	X	X
Nutrients TP, OP, TKN, NH3, NO3+NO2	X	X			X	X
Metals *Metals total/dissolved		X			X	
Bacteriological <i>E. coli</i> /fecal coliform	X	X		X	X	
Volatile Organic Compounds (VOCs)			X		X	X
Semi-volatile Organic Compounds (SVOCs)					X	
Diesel Range Organics (DRO)			X		X	
Gasoline Range Organics (GRO)			X		X	

*Metals, Total: calcium, magnesium. Metals, Dissolved: arsenic, cadmium, chromium, cobalt, copper, lead, nickel, potassium, sodium, zinc. If a municipal or industrial facility is suspected as the cause of the fish kill we should consult: 1) their NPDES permits for their own metals requirements, 2) any industrial users agreements between municipalities and industrial contributors, and 3) MSDS sheets from the suspected industrial facility. Based on a review of this information, additional metal analytes may be requested in addition to what is suggested above.