HERBICIDE TREATMENTS: ARE THEY LINKED TO FISH KILLS?

BRIAN GUNDERMAN | SOUTHERN LAKE MICHIGAN UNIT MANAGER, MICHIGAN DNR FISHERIES DIVISION

Every year, biologists from the Michigan Department of Natural Resources (DNR) receive dozens of fish kill reports from anglers and lakefront property owners. Roughly 20% of these fish kills are winterkill events due to oxygen deprivation under ice cover. However, most of the remaining 80% of the fish kill reports occur during May-September. It is not unusual for people reporting fish kill events during that period to list herbicide treatments as the suspected cause. Do these claims have any credibility? If so, is there anything that lake associations can do to reduce the risk of fish kills after herbicide treatments?

Like many things in ecology, the answers to those questions are complex. In an ideal world, we would be able to definitively identify the cause of every fish kill event. However, several factors make this ideal an impossible goal. Many fish kills are not reported at all or are not reported until days or weeks after the actual mortality event. In addition, numerous varieties of microorganisms quickly multiply in fish after their death. Thus, laboratory examinations for pathogens and signs of chemical damage can only be performed on fish that were alive or very freshly dead at the time of collection. Water quality sampling is also of limited utility if the fish kill is not reported in a timely manner, as the conditions that caused the event are often of short duration.

The first part of the present analysis was to determine the number of recent fish kill reports that coincided with herbicide applications. (For the sake of brevity, I will use the general term herbicide to refer to both herbicides that target rooted plants and algaecides that target planktonic and filamentous algae.) Many fish kills on inland lakes and ponds are reported online using the DNR's Eyes in the Field form. For the present analysis, fish kills reported during May-September in 2018-2022 were cross-referenced with herbicide treatment data in the Michigan Department of Environment, Great Lakes, and Energy's (EGLE) MiEnviro Portal. Out of 102 events, only nine fish kills occurred within two weeks of a documented herbicide treatment. However,

PHOTO CREDIT: ADDIE DUTTON – MDNR
AN ACCUMULATION OF DEAD BLUEGILLS AND BLACK CRAPPIES DURING A FISH KILL ON A SOUTHWEST MICHIGAN LAKE

the situation appears to be different in the southern part of the state where active vegetation management is more common. During the same four-year period, the Southern Lake Michigan Management Unit received 34 additional fish kill reports via phone and email. The reported observation dates for 10 of these fish kill events were within 14 days of a documented herbicide treatment. Thus, this review revealed 19 events during 2018-2022 where there was potential for herbicide treatments to be directly or indirectly responsible for a fish kill.

(CONTINUED ON PAGE 27)

(CONTINUED FROM PAGE 26)

The factors influencing the effects of herbicide treatments on fish health can be divided into three broad categories: treatment attributes, environmental conditions, and fish ecology. Relevant treatment attributes include the type of chemical(s) used, chemical concentrations, size of treatment area, and location of the treatment relative to congregations of fish (e.g., fish spawning sites). Obviously, larger-scale treatments with higher concentrations are more likely to affect fish than small-scale treatments at lower concentrations. Copper-based products and certain endothall formulations also typically have higher toxicity to fish than other herbicides. Toxicity effects of herbicides are not limited to direct mortality and can include sub-lethal effects such as damage to olfactory receptors and lateral line neurons, respiratory impairments, and endocrine system disruption (DeQuattro and Karsov 2016; Kennedy et al. 2012; Linbo et al. 2006; Carreau and Pyle 2005; Henry and Atchison 1986). Indirectly, herbicide treatments can affect fish by temporarily forcing them to leave the treatment area and also through modification of vegetation beds and nearshore habitat. In combination, these sub-lethal effects of herbicides can render fish more vulnerable to death by predators, disease, pollution, or environmental stressors.

Environmental conditions strongly affect the stress level of fish. Temperature and dissolved oxygen concentrations are the key variables of interest. Phelps et al. (2019) analyzed 225 fish kill events in Minnesota and concluded that maximum nighttime land surface temperature was the most important factor in fish mortality. Various studies also have demonstrated that water temperatures above the optimum for a particular fish species reduce the ability to tolerate exposure to herbicides or pollutants (Nin and Rodgher 2021; Wagner et al. 2017; Vardia and Durve 1981). Dissolved oxygen levels in nutrient-rich lakes often decline during periods of hot, calm weather, whereas the metabolic rate for fish increases with increasing temperature. Thus, fish in these systems often are being pinched by both temperature and oxygen at the same time.

Spawning stress is another factor that plays a critical role in many fish mortality events. From their review of the Minnesota data, Phelps et al. (2019) noted that sunfish (such as largemouth bass, bluegill, pumpkinseed, and black crappie) were the most common species in fish kill events, and that the highest frequency of fish kills was observed in June during the spawning seasons for these species. In Michigan, we see the same pattern. Due to the

(CONTINUED ON PAGE 28)

HERBICIDE TREATMENTS: ARE THEY LINKED TO FISH KILLS?

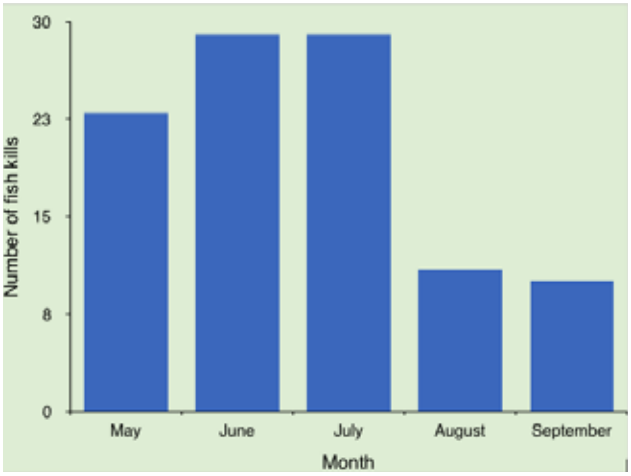
(CONTINUED FROM PAGE 27)

PHOTO CREDIT: MATT DIANA – MDNR
A BLUEGILL WITH EXTERNAL SYMPTOMS OF COLUMNARIS DISEASE

wide variations in climate from north to south in our state, sunfish can spawn from May through early July. These three months had the highest numbers of fish kill reports through the Eyes in the Field system.

Most fish kill events are the culmination of a series of causes. For example, the following scenario occurs every year in southern Michigan. Bluegills are stressed from spawning activity. At the same time, a period of hot weather causes water temperatures to rise rapidly. Herbicide is applied to control algae and invasive plant species. This combination of stressors depresses the immune system, and bacteria already present in the lake infect bluegills and result in an outbreak of columnaris disease.

In summary, herbicide treatments can increase the risk of a fish kill, especially when fish are already stressed from other factors. Lake associations and their contractors can minimize the risk of a fish kill by avoiding treatments during periods of hot weather.



NUMBER OF FISH KILL EVENTS REPORTED BY MONTH USING THE DNR'S EYES IN THE FIELD ONLINE FORM DURING 2018-2022.

CITED REFERENCES

Carreau, N. D., and G. G. Pyle. 2005. Effect of copper exposure during embryonic development on chemosensory function of juvenile fathead minnows (Pimephales promelas). Ecotoxicology and Environmental Safety 61:1-6.

DeQuattro, Z. A., and W. H. Karsov. 2016. Impacts of 2,4-dichlorophenoxyacetic acid aquatic herbicide formulations on reproduction and development of the fathead minnow (Pimephales promelas). Environmental Toxicology and Chemistry 35:1478-1488.

Henry, M. G. and G. J. Atchison. 1986. Behavioral changes in social groups of bluegills exposed to copper. Transactions of the American Fisheries Society 115:590-595.

Kennedy, C. J., P. Stecko, B. Truelson, and D. Petkovich. 2012. Dissolved organic carbon modulates the effects of copper on olfactory-mediated behaviors of Chinook salmon. Environmental Toxicology and Chemistry 31:2281-2288.

Linbo, T. L., C. M. Stehr, J. P. Incardona, and N. L. Scholz. 2006. Dissolved copper triggers cell death in the peripheral mechanosensory system of larval fish. Environmental Toxicology and Chemistry 25:597-603.

Nin, C. J., and S. Rodgher. 2021. Effect of a temperature rise on metal toxicity for the aquatic biota: a systematic review. Brazilian Journal of Environmental Sciences 56:710-720.

Phelps, N. B. D., I. Bueno, D. A. Poo-Muñoz, S. J. Knowles, S. Massarani, R. Rettkowski, L. Shen, H. Rantala, P. L. F. Phelps, and L. E. Escobar. 2019. Retrospective and predictive investigation of fish kill events. Journal of Aquatic Animal Health 31:61-70.

Vardia, H. K., and V. S. Durve. 1981. The toxicity of 2,4-D to Cyprinus carpio var. Communis in relation to the seasonal variation in the temperature. Hydrobiologia 77:155-159.

Wagner, J. L., A. K. Townsend, A. E. Velzis, and E. A. Paul. 2017. Temperature and toxicity of the copper herbicide (NautiqueTM) to freshwater fish in field and laboratory trials. Cogent Environmental Science 3:1339386.