Effects of Fireworks on Inland Lakes: A Primer

By Dr. Jennifer L. Jermalowicz-Jones, MLSA Science Advisor

INTRODUCTION:

Our inland lakes are a valuable water resource that are utilized for recreational and navigational activities and also provide a sense of place in addition to enhancing property values. Inland lakes have been under multiple threats over time due to development, land use issues, invasive species, pollution, erosion, etc. Little is known about the effects of fireworks on the water quality and aquatic biota of inland lake, but this question re-surfaces frequently among riparians. It is important to understand these impacts in order to take appropriate steps to reduce harm to our lakes and preserve them for future generations. This will be the first article of many on this topic over the next few years as we learn more about impacts of fireworks and other materials on our lakes.

COMPONENTS IN FIREWORKS AND FATE IN THE LAKES:

In order to understand the impacts of fireworks on the water quality of inland lakes, we must first understand the chemical components and their unique characteristics. The majority of fireworks consist of cations such as calcium and magnesium and anions such as chloride. In addition, heavy metals such as copper, barium, aluminum, iron, antimony, lithium, strontium, titanium are present. Other molecules such as carbon, phosphorus, oxygen, potassium, sodium, sulfur and zinc are additionally present. Combustion from ignited fireworks is commonly known to produce fumes with sulfur, nitric oxide, and ozone.

The primary components in pyrotechnic substances are perchlorate potassium salts and ammonium. Perchlorate in particular has been demonstrated to have a half-life of 29 days and in one study of reflective ponds in New York state, was present in concentrations 30-1,480 times higher than background levels following firework displays (Wu et al., 2011). In lakes, a big concern is the finding that sediments in lakes may not be able to effectively remove perchlorate via chemical adsorption (Wilkin et al., 2007). The EPA has established a reporting limit of 0.02 mg/l for perchlorate and thus concentrations greater than this in sediments should be further investigated for possible bioaccumulation. In a study on Lake George (USA) during the period of June 17-July 25, perchlorate concentrations were below the detection limit in both the water column and lake sediments. Lake George is 28,800 acres in surface area and has an average depth of approximately 70 feet (Lake George Association) and this may indicate that larger, deeper lakes can tolerate inputs more readily than shallow-water lakes due to dilution and attenuation. That study also determined that levels of barium and antimony remained below detectable levels.

(Continued on page 24)

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(Continued from page 23)

A study by Vecchi et. al, (2008) in Italy demonstrated that strontium in particular had the highest levels of magnitude compared to baseline concentrations in the air with up to 120 times the baseline levels. This is significant because small airborne particles can easily be deposited onto lake surfaces and interact with the lake chemistry.

One particular concern is the lack of oversight in the development of fireworks to regulate their content prior to sales. The American Fireworks Standards Laboratory (AFSL) developed a testing program which meets U.S. federal requirements: however, the testing process is currently voluntary for all imports and manufacturers. As riparians, we are all aware of the importance of regulations in protecting water quality---think of why we regulate E. coli at beaches!

EFFECTS ON AQUATIC LIFE:

Heavy metals alone can contribute to reproductive and developmental impacts on aquatic animals (Meeker et al., 2009). At very high concentrations (677 ppm) ammonium perchlorate was found to have devastating impacts on spawning of Zebrafish but at lower concentrations (18 ppm) the effects were negligible (Patino et al., 2009). Additionally, the exposure to concentrations of 10 ppm and 100 ppm of ammonium perchlorate to larval fathead minnows (present in many Michigan lakes), resulted in developmental retardation, lack of scales, and poor pigmentation in a study by Crane et al., (2005). There are many more examples of the effects of firework ingredients on different taxa of aquatic life.

CONCLUSIONS:

Although there is strong evidence that fireworks may impair the water quality and aquatic life within lakes, much more research needs to be conducted on Michigan lakes of varying size, depth, and population. The lower concentrations of firework chemicals measured during the Lake George study could indicate that larger, deeper lakes are less prone to measurable concentrations following large-scale firework events. The reflection ponds studied in Albany, New York had measurable quantities of firework chemicals and thus may indicate that shallower waterbodies are more vulnerable to accumulation. Undoubtedly, Fourth of July events are an important part of our American culture and celebration and also support community social and cultural capitals. However, we must balance the continuing research findings of firework impacts on aquatic environments with our long-held traditions.

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