WQS Triennial Review – Issue Paper:

EPA §304(a) Recommended Criteria—Microcystins and Cylindrospermopsin

Introduction

Under section 304(a) of the Clean Water Act, the US Environmental Protection Agency (EPA) is to develop and publish water quality criteria that reflect the latest scientific knowledge on the effects of a constituent concentration on animal and human health. These criteria are published as recommendations to states and authorized tribes for use in setting their water quality standards. While EPA provides scientific recommendations to protect aquatic life and recreation uses, these do not substitute for the Clean Water Act or EPA's regulations, nor are they regulations themselves. As a practical matter, EPA uses recommended §304(a) criteria as one factor for determining whether to approve a state's water quality standards. Revisions to Idaho water quality standards must be approved by EPA before they are applicable for Clean Water Act purposes. States must consider adopting new or updated Clean Water Act §304(a) criteria recommendations as part of their triennial review as described under 40 CFR 131.50(a).

In December 2016, EPA published draft Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin (EPA 2016).

In May 2019, the EPA finalized the draft Human Health Recreational…Criteria (EPA 2019). States must consider adopting new or updated Clean Water Act §304(a) criteria recommendations as part of their triennial review as described under 40 CFR 131.50(a). As such, Idaho will review Recommended Human Health Recreational Ambient Water Quality Criteria for Swimming Advisories for Microcystins and Cylindrospermopsin. Here we present these new EPA §304(a) criteria recommendations.

Discussion

Currently, Idaho does not have criteria for toxins produced by cyanobacteria, although EPA has issued new recommended aquatic life criteria for these toxics. In 2016, EPA developed a risk assessment of the cyanotoxins - microcystins and cylindrospermopsin. Unlike most traditional bacterium or pollutants, cyanobacteria and the toxins they can produce are an integral component of healthy aquatic ecosystems and are ubiquitous in Idaho waters. Many cyanobacteria are capable of producing toxins, referred to as cyanotoxins, which can adversely affect human health. Under the right conditions of water temperature, light, pH, nutrient availability, and other factors, cyanobacteria can reproduce rapidly, forming what are commonly referred to as cyanobacterial harmful algal blooms (HABs).

Microcystins and Cylindrospermopsin

Different physical and chemical processes are involved in the persistence, breakdown, and movement of microcystins and cylindrospermopsin in aquatic systems as described below.

Microcystins

Microcystins are more thoroughly researched than cylindrospermopsin, and the information in this section is a summary of the information available in the 2019 EPA guidance. The EPA's Recommended Criteria (EPA 2019), Health Effects Support Documents (HESD) (EPA 2015a and EPA 2015b) and Drinking Water Health Advisories (EPA 2015c and EPA 2015d) describe both toxins in greater detail.

In aquatic environments, microcystins tend to remain within the cyanobacterial cell and are released in substantial amounts as the cells age and die. Microcystins are stable compounds and have been observed to persist for 21 days to two to three months in solution and up to six months in dry scum. Environmental conditions such as temperature, pH, presence of light, salinity, and presence of certain aquatic bacteria can influence the rate of microcystin degradation. Microcystins can persist even after a cyanobacterial bloom is no longer visible (Lahti et al. 1997b and Zastepa et al. 2014 in EPA 2019).

Cylindrospermopsin

Cylindrospermopsin is a highly water soluble alkaloid. In sediments, cylindrospermopsin has very little interaction with sandy and silt sediments. This reduces its residence time in sediments and limits the opportunity for microbial degradation (Klitzke et al. 2011 in EPA 2019). Cylindrospermopsin is relatively stable in the dark and at temperatures from 4°C to 50°C for up to five weeks (ILS 2000 in EPA 2019) and is also resistant to changes in pH and remains stable in natural water bodies for up to eight weeks in pH ranging from 4 to 10 (Funari and Testai 2008 in EPA 2019).

Health Effects

The studies summarized below for microcystins and cylindrospermopsin are described in detail in the EPA's HESDs and Drinking Water Health Advisories for these two cyanotoxins (EPA 2015a, 2015b, 2015c, 2015d).

Microcystins

The observed effects to animals given acute oral or injected doses of microcystin-LR include effects to the liver, reproductive, developmental, kidney, and gastro-intestinal systems with most laboratory studies demonstrating that the liver is the primary target organ. For individual study details see the EPA's HESD for microcystins (EPA 2015a). Liver effects are summarized in EPA 2019 (Table 5-1).

Cylindrospermopsin

The available studies for cylindrospermopsin show that the liver and kidneys are the primary targets for cylindrospermopsin toxicity, caused by physical changes to red blood cells (summarized in U.S. EPA 2019, Table 5-2). These effects were observed in mice given single or repeated doses of purified cylindrospermopsin by oral or injected doses (U.S. EPA 2019).

Human Studies

The EPA identified case study reports on adverse health effects from oral exposures to microcystins. As with the animal studies, the available evidence indicates the human liver is the target organ for human toxicity (U.S. EPA 2019).

The EPA did not find any studies for recreational exposure to cylindrospermopsin. Data on the human health effects of cylindrospermopsin based on studies related to drinking water indicate that human kidneys and liver are affected by cylindrospermopsin exposure (U.S. EPA 2015c).

Current Rules

The recreational criteria for microcystins and cylindrospermopsin are recommended as values for issuing recreation advisories and for adoption as criteria for water quality standards. Table 1 shows the toxin values Idaho has used since 2017 for issuing recreational water health advisories and Table 2 show the recommended values and criteria.

DEQ is seeking comments on whether DEQ should consider rulemaking to adopt numeric microcystin and cylindrospermopsin water quality criteria.

Table 1. Idaho Recreational health advisory recommendations for microcystins and cylindrospermopsins

Application of Recommended Values	***Microcystin Concentration (µg/L)***	***Microcystis Cell Count (cells/mL)***	***Cylindrospermopsin Concentration (µg/L)***	***Species other than Microcystis Total Cell Count (cells/mL)***
Recreational Water Quality Threshold	*4*	*20,000*	*8*	*40,000*

Table 2. EPA §304(a) recommended recreational criteria for Microcystins and Cylindrospermopsin.

Application of Recommended Values	***Microcystins***			***Cylindrospermopsin***		
	Magnitude (µg/L)	***Duration***	***Frequency***	***Magnitude (µg/L)***	***Duration***	***Frequency***
Recreational Water Quality Criteria	*8*	*1 in 10-day assessment period across a recreational season*	*More than 3 excursions in a recreational season, not to be exceeded in more than one year*	*15*	*1 in 10-day assessment period across a recreational season*	*More than 3 excursions in a recreational season, not to be exceeded in more than one year*

References

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