ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-3397
PAT QUINN, GOVERNOR **JOHN J. KIM**, INTERIM DIRECTOR

MEMORANDUM

DATE: August 31, 2012

TO: Joe Rush, Candlewick Lake Manager

CC: Maggie Carson, IEPA Public Information Officer
Gregg Good, IEPA Bureau of Water
Tiffanie Denny, Illinois Dept. of Public Health

FROM: Thomas Hornshaw, Ph.D.

SUBJECT: Algal Toxins in Fish

As the Chair of the Illinois Fish Contaminant Monitoring Program, I am happy to respond to your request for information about eating fish from waters that are experiencing a bloom of cyanobacteria, also known as blue-green algae. As you may already be aware, blue-green algae are capable of producing toxins, the most common and best studied of which is microcystin. These toxins can cause a variety of health effects depending on the type of toxin, the level of toxin in the water, the length of exposure, the route of exposure, and a person's individual susceptibility to a toxin. Effects attributed to toxin exposure include skin rashes and blisters, eye and nose irritation, breathing problems from inhalation exposure, and diarrhea and vomiting from lower-level ingestion to more serious effects such as liver, kidney, and nervous system damage from higher-level ingestion exposure. There are no standards or regulations for algal toxins in water, but the World Health Organization has issued guidance for microcystin (MC) in waters that serve as drinking water sources at 1 microgram per liter (ug/l) and 20 ug/l for recreational waters. There are also no standards or regulations for algal toxins in fish, but as described below the state of Ohio has derived a "do not eat" fish filet level of 28 micrograms of MC per kilogram of fish (ug/kg). Also as described below, the 20 ug/l World Health Organization guidance for recreational waters is recommended as a water concentration that should be protective of the 28 ug/kg concentration in fish filets.

Regarding your question about the safety of fish when algae blooms are present, there are two ways of judging the acceptability of algal toxin levels in the edible portions of fish. The first involves directly measuring the amounts of MC in fish filets and comparing the results against acceptability criteria. For example, the state of Ohio has developed criteria based on procedures used by the Great Lakes states (Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory, 1993). Using a provisional (and not finalized)

4302 N. Main St., Rockford, IL 61103 (815)987-7760
595 S. State, Elgin, IL 60123 (847)608-3131
2125 S. First St., Champaign, IL 61820 (217)278-5800
2009 Mall St., Collinsville, IL 62234 (618)346-5120
9511 Harrison St., Des Plaines, IL 60016 (847)294-4000
5407 N. University St., Arbor 113, Peoria, IL 61614 (309)693-5462
2309 W. Main St., Suite 116, Marion, IL 62959 (618)993-7200
100 W. Randolph, Suite 10-300, Chicago, IL 60601 (312)814-6026

Reference Dose (an estimate of an exposure that should be safe for a lifetime) from USEPA of 3 micrograms of MC per kilogram of body weight per day (ug/kg/d), Ohio determined that filet concentrations of 7-27 micrograms of MC per kilogram of fish filet (ug/kg) are acceptable for eating one meal per month, and concentrations of 28 or more ug/kg should not be eaten. It should be noted that most commercial laboratories are not equipped to analyze fish for MC, so it may be necessary to arrange for method development by a commercial or university laboratory before sampling.

The second approach would be to indirectly estimate a fish tissue MC level by developing a "bioconcentration factor" (BCF; an estimate of the ratio of a chemical in a tissue versus the amount of that chemical in water) and then multiplying the measured water concentration by the BCF. There is little information available on BCFs for MC, but three data sets can be used to estimate a range of BCFs for MC in fish filets. In one study, Adamovsky et al. (2007) exposed common and silver carp to a cyanobacterial bloom for two months and measured MC at 1.4-29 ug/kg in silver carp and 3.3-19 ug/kg in common carp, and calculated BCFs ranging from 0.6 to 1.7 for filets.

In another study, Poste et al. (2011) measured MC in water and fish from 9 lakes in Uganda and 2 in North America, Lakes Ontario and Erie. The North American lake data included 10 species from Lake Ontario and 7 from Lake Erie, 4 of which were common to both lakes. The measured MC levels in these 4 species (freshwater drum, white perch, yellow perch, and walleye) and the measured water MC levels (Lake Ontario 0.9 ug/l, Lake Erie 1.3 ug/l) can be used to estimate BCFs for MC. The filet MC concentrations for Lake Ontario ranged from 0.8 to 4.5 ug/kg, and the calculated BCFs ranged from 0.89 to 5.0. Similarly, for Lake Erie the fish concentrations ranged from 2.4 to 23.9 ug/kg, and the corresponding BCFs ranged from 1.85 to 18.4. It should be noted that the BCF of 18.4 for Lake Erie was for walleye and the next lowest BCF was 4.31, while the Lake Ontario walleye BCF was 2.33 and it was also the second lowest among the four species.

In a recent monitoring effort by the Ohio EPA (personal contact) in a lake for which consumption advisories have been previously issued, 14 black crappie samples were collected for MC analysis in June 2012, with values from <0.9 to 25.71 ug/kg. Samples of lake water were also analyzed for MC in this time period, with concentrations between 30-45 ug/l. Using the maximum crappie concentration, a BCF range can be calculated at 0.57 to 0.86. In a previous effort, 25 crappie samples were collected in July 2011 for MC analysis with levels of <1.2 to 70.43 found, and the water MC concentrations in this time period ranged from 5 to 34 ug/l. Again using the maximum crappie concentration and the range of water concentrations, a BCF range of 2.1 to 14.1 can be calculated.

Using these estimates of BCFs for MC in fish filets (excluding the walleye BCF of 18.4 as being unrepresentative), with a range of 0.57 to 14.1, and the 28 ug/kg concentration in filets derived by Ohio as the "do not eat" level, the calculated water MC concentrations at which do not eat advice would be appropriate are in the range of 2.0 to 49.1 ug/l. Since the World Health Organization's guidance of 20 ug/l for recreational waters falls within this range, this guidance is selected as a water MC concentration at which to recommend no consumption of fish from cyanobacterial-affected waters.