Proposal for a Comprehensive Oregon Cyanobacterial Harmful Algal Bloom (CyanoHAB) Program

Theo Dreher, Gwen Bury, Wayne Carmichael, Oregon Lakes Association
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The problem: CyanoHABs (a bloom of microorganisms) occur widely and can be toxic. They occur in drinking water, recreational, and ranch-and-rangeland settings, affecting human, companion animal, livestock and ecological health. Their toxicity, unsightliness and foul smell can depress real estate values and tourism. We have had examples of CyanoHAB impacts in the last few years in Oregon: cyanotoxins in City of Salem drinking water (May/June 2018), 32 steers worth about $50,000 dying near Lakeview (June 2017), health advisories issued on the Willamette River in downtown Portland, as well as persistently massive and partially toxic blooms in Upper Klamath Lake. With CyanoHABs increasing with climate change, Oregon could see bigger problems, such as recent events in Lake Erie and Lake Okeechobee.

The need: ***Surveillance and monitoring*** should anticipate and track CyanoHABs. Sufficient lakes should be monitored to avoid non-monitored lakes either avoiding detrimental economic impacts or presenting unknown health risks in comparison to nearby monitored lakes. Stakeholders — drinking water providers and consumers, lake managers, ranchers, water resort proprietors, water recreationists, pet owners, advocates for healthy watersheds, fish and wildlife — need access to ***information, guidance and protective regulation***. Contingency plans for dealing with crises such as the Salem water emergency should be in place. A ***competitive research program*** should be dedicated to refining our understanding and detection of CyanoHABs in Oregon, and to uncovering the key specific drivers of CyanoHAB formation and persistence, guiding attempts to improve watershed health and avoid future CyanoHABs.

A ***comprehensive*** Oregon CyanoHABs Program should include: (a) statewide coverage, since CyanoHABs occur in all counties; (b) a scope that covers drinking water, recreational and rural/agricultural exposure concerns; (c) competitive research grants to ensure that the program is not only reactive, but also proactive in developing improved methods, better understanding, and guidance for CyanoHAB mitigation and enhancement of watershed health. An important component of a program would be centralized and knowledgeable support staff to interface with stakeholders and the public. These would be personnel able to build on the considerable toolkit and guidance provided by US-EPA.

How many water bodies? About 130 lakes (~25% of Oregon's lakes >50 acres) are estimated by DEQ to be at risk of CyanoHABs. Additional small water bodies (<50 acres) that are heavily visited should also be monitored. Samples from about 230 lakes have been analyzed by the State of Washington during the 11 years of its cyanotoxin monitoring program, although some lakes have been sampled infrequently. We recommend that an Oregon state-wide program should be capable of monitoring about 150 water bodies each year, with some water bodies not sampled every year (if they remain bloom-free).

Program elements

Program design is based on the existing Oregon program and aspirational program elements in Washington, Ohio and California. Program personnel in other states are uniformly willing to help transfer their best practices to Oregon.

A. Lake monitoring and sampling

Travel to lakes can be expensive and time-consuming. Thus, a distributed sampling plan using standardized sampling and shipping methodology is most effective, as used by the Washington

State CyanoHAB program. Sampling would be conducted by lake managers, watershed councils, water districts, drinking water utilities, etc. Sampling and shipping costs distributed to lake stakeholders saves central costs and defers some costs to program beneficiaries. It will also be beneficial to implement a ***satellite-based remote surveillance strategy*** based on NOAA-generated data (which is gathered every one or two days) converted to a Cyanobacterial Index that can be presented together with other data via an interactive web-based map backed by retrievable spreadsheets. California has recently developed such an interface, which can be used to monitor CyanoHABs in remote lakes, thereby saving physical visits until needed. Remote sensing can help to optimize in-person monitoring, but cannot be used on small lakes or during times when there is cloud cover.

Sampling frequency will be seasonal, varying based on regulatory requirements (drinking water) and risk priorities set by factors such as toxigenic history, bloom intensity and public exposure. OHA currently has good experience in assessing sampling protocols but has no jurisdiction in requiring sampling other than for drinking water systems. Recent recognition of widespread occurrence of cyanotoxins produced by benthic cyanobacteria attached to structures, sediment and rocks in lakes and rivers will need to be considered in the monitoring program, as will policy concerning extension of monitoring to include anatoxin-a(s) and BMAA.

B. Sample analyses

(a) Phycological identification and cyanobacterial cell counts through morphological assessment with microscope; ID to genus level.

(b) Toxin analyses focused on microcystins & nodularins, anatoxin-a, cylindrospermopsins, and saxitoxins: primary focus on ELISA assays, with some LC-MS/MS analyses; used to trigger health advisories (this regulatory capacity is currently in place at OHA, but underfunded).

(c) Q-PCR genetic analysis for toxin and identification genes; a sensitive technique used for understanding and identifying CyanoHABs in each water body, and for early warning detection.

These analyses must be reliable and fast:48-hr turn-around for most drinking water and recreational samples but 24-hr when raw (intake) drinking water has high toxin levels and when toxins are suspected in finished drinking water. This favors ***a centralized testing model***, such as in Washington State, where King County Environmental Labs conducts analyses (a) and (b). In Ohio, the Ohio-EPA conducts analyses (a), (b) and (c), but toxin analyses (b) and maybe (c) are often conducted by drinking water utilities or commercial labs. In Oregon, DEQ currently can only test for toxins (b) via ELISA, though at least two drinking water providers (Salem, EugeneWEB) are setting up this capacity also. The other analyses would need to be out-sourced to commercial or cooperating government labs.

Q-PCR (genetic) analysis has been spear-headed by OhioEPA and not yet adopted widely. OHA is considering Q-PCR for the Permanent Cyanotoxin Rules that apply to drinking water providers (replacing the Temporary Rules put in place after the Salem toxin event). We support such a move. There is not currently a government-funded lab performing these analyses within Oregon.

C. Regulatory oversight

(a) Establishment and enforcement of regulatory requirements for CyanoHAB testing frequency and methodology, and setting action levels for the various cyanotoxins, principally relying on US-EPA expertise.

(b) Interpretation of sample analyses and management of responses when detections exceed guideline values. Provision for appropriate signage for posting at lakes during advisories. Assistance in communicating the consequences and public health risks to the public when toxin exceedances occur (this was a problem in Salem, summer 2018).

US-EPA provides excellent guidance in these areas. OHA currently does a very good job of (a) and part of (b). Much of this capacity was established during the period of a 5-year CDC grant (~2008-2012). Currently, no OHA personnel are assigned only to CyanoHABs, and the CyanoHABs program is badly underfunded.

D. Education and publication of CyanoHAB data

(a) Publication of the results of state-wide analyses rapidly in a publicly accessible website format, including an interactive map with underlying data retrievable in spreadsheet format. Washington, Ohio and California provide examples. OHA currently only lists advisories.

(b) Provision of training and public awareness programs relating to CyanoHABs. US-EPA provides excellent support for such activities; these were provided by OHA during the period of the CDC grant, but are hardly provided at all currently.

E. Competitive research program

Program components A-C are crucial, but they are reactive and will not contribute to improved methods, understanding and CyanoHAB mitigation. A competitive research program should be dedicated to refining our understanding and detection of CyanoHABs in Oregon, and to uncovering the key specific drivers of CyanoHAB formation and persistence in Oregon, guiding attempts to improve watershed health and avoid future CyanoHABs. Washington State has such a program ($150,000 per year). Funds should not be awarded in-house and should be directed at ***knowledge generation***. OWEB provides funds for watershed enhancement activities that could mitigate CyanoHABs.

F. Associated actions to reduce nutrient inputs to water bodies

The underlying cause of CyanoHABs is eutrophication, the addition of excess nutrients to water bodies. We have the means to regulate and prevent most point-source pollution instances, but two sources of nutrient inputs that are distributed and poorly regulated should be addressed: (a) leaky septic systems: we should empower DEQ to test for leaks on private property, or require compliance as tested by others to be reported to DEQ periodically; (b) livestock with direct access to streams and lakes: we should intensify efforts to keep livestock out of streams and water bodies.

Cost estimates (per annum)

These are very rough at present, based in part on comparison to programs in other states.
Program, regulatory oversight and education: 4 FTE (2 each to OHA and DEQ), ~$500,000
Lake sampling & analysis for cyanobacteria and toxins: $100,000
Q-PCR analyses for toxin and cyanobacterial ID genes: ?
Satellite surveillance program: ?
Competitive grants program: $200,000
TOTAL: $800,000-1M

Where should the program be housed?

OHA is the natural agency for handling aspects related to health risks. OHA already has in-house experience in regulatory and education aspects related to both drinking water and recreational/agricultural CyanoHABs.

DEQ currently has a Drinking Water Protection Program addressing surface waters (lakes and reservoirs) and thus also has in-house expertise. DEQ has the capacity for ELISA toxin analysis and could thus handle the tasks of sample analysis (including cyanobacterial ID by microscopy) and publication of results. DEQ also has some experience with satellite surveillance and is the agency with expertise and tools to address the broader aspect of watershed health as it relates to CyanoHABs. DEQ is the natural choice to administer the competitive grants program.

In staffing a CyanoHABs program, we strongly recommend setting salaries and position descriptions to attract ***well trained scientists***. This does not always seem to have been a priority with state agencies, resulting in false economies.

Prioritization

Top priority: (a) bring OHA to a staffing level that is capable of supporting regulatory and educational/outreach aspects of a CyanoHABs program. These capacities currently exist at a reduced level and have been conducted by OHA in the past, and they can be rebuilt.

(b) Establish permanent funding for DEQ to conduct ELISA analyses for cyanotoxins and to build a web- and map-based interactive reporting tool for publishing results. This would replicate most of the capacity of the WA State program.

Summary: CyanoHABs toxin testing for public safety

Regulatory oversight: OHA
Sampling: local entities
Lab analysis: DEQ or approved in-house or out-sourcing
Public communication: OHA (advisories, education), DEQ (publish results)

Second priority: Add capacity for satellite-based lake monitoring and for PCR-based analysis of samples. LC-MS/MS analysis of toxins may remain reliant on out-sourcing. Other analyses can also be outsourced to commercial or other government labs.

Second priority: Set up competitive research grants program.

(We are not prioritizing between the two second priority choices)