Amelia Rhodeland

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Final Assessment Paper

Harmful Algal Blooms in Detroit Lake

Introduction

Algae blooms are natural occurrences, the frequency and awareness of which has increased in the last several decades (Anderson, Glibert, & Burkholder, 2002; Lundell, Buccola, & Bellringer, 2019). Depending on the species, blue-green algae (referred to as cyanobacteria in the scientific community) may produce any combination of four toxins that can be harmful to humans -- microcystins, cylindrospermopsin, saxitoxin, and anatoxin (Carpenter, 2019; Lundell, Buccola, & Bellringer, 2019). The presence of cyanobacteria (and the associated toxins) in Detroit Lake, Oregon has recently become an issue due to a variety of factors. These factors include the increasing ability of technology to identify the presence of cyanobacteria and growing public awareness of algal blooms and their potentially harmful effects. Additional possible factors affecting the presence of harmful algal blooms (HABs) are explored below.

Visual description

For the visual depiction of the system, see Appendix A.

Narrative description

The importance of addressing HABs in Detroit Lake became apparent in the summer of 2018, during a “perfect storm” of circumstances that resulted in a number of unfortunate outcomes.

In 2018, the Oregon Health Authority (OHA) made advisory levels for algae toxins more stringent. During the summer months of 2018, Detroit Lake experienced algal blooms which produced two of the four possible harmful toxins that cyanobacteria can produce -- microcystins and cylindrospermopsin. These toxins exceeded the levels set by OHA, resulting in a string of recreation advisories for recreation on the lake, including swimming, water skiing, and power boating. For a map of the Willamette River Basin, see Figure 1 in Appendix B.

In addition to the recreation advisories, high toxicity levels were found in Salem's drinking water, which is downstream from Detroit Lake. The levels were such that two drinking water advisories were issued for the City of Salem. The advisories, which were issued on May 29 and June 6, were directed at vulnerable populations, such as young children and the elderly (The Novak Consulting Group, 2018). The advisories resulted in a declaration of emergency by Oregon Governor Kate Brown, with assistance from the National Guard to distribute water around the city (Guevarra, 2018).

During this period, the US Army Corps of Engineers (USACE) delayed their regular operation of Detroit Dam, which typically includes the use of spillways "to deliver more seasonally-appropriate water temperature… for endangered Chinook Salmon and Steelhead" (Lundell, Buccola, & Bellringer, 2019). Such delays may negatively impact the spawning and rearing activity of Chinook salmon and steelhead, two federally protected species for whom the USACE must manage Detroit Dam activities appropriately.

Stakeholders and decision-makers

- **City of Salem, Public Works Department** manages the water supply for the city of Salem and conducts monitoring of the reservoir. A phone interview was conducted with Lacey Goeres-Priest, Water Quality Supervisor for Salem's Public Works Department.

- **US Army Corps of Engineers (USACE)** manages Detroit Dam and Big Cliff Dam. Their dam management creed includes “flood risk management measures, hydropower demands, temperature management for ESA [Endangered Species Act] listed species and recreation” (Anderson, Glibert, & Burkholder, 2002). They also conduct water quality monitoring. An email interview was conducted with Tina Lundell (Water Quality Supervisor), Holly Bellringer (Biologist), and Norman Buccola (Water Quality Engineer), and a follow-up phone interview was conducted with Tina and Norman only.
- **USGS Oregon Water Science Center** conducts scientific research to help land managers such as the USACE make informed decisions. A phone interview was conducted with Kurt Carpenter, Research Hydrologist.
- **US Forest Service** and **Oregon Parks and Recreation Department** manage much of the recreation in and around Detroit Lake, including boat ramps, campgrounds, and day-use areas. The lake is within the Detroit Ranger District of the Willamette National Forest. Forest Service staff may also collect water quality samples (Lundell, Buccola, & Bellringer, 2019).
- **Oregon Health Authority** issues recreational and drinking water quality advisories and provides other public health services, such as education and outreach.

Affected parties

- **Residents of Salem.** The health of vulnerable Salem residents was threatened by cyanotoxins in Salem’s drinking water.
- **Federally listed species.** USACE must manage the dam for the Chinook salmon and steelhead, which entails use of the spillways.
- **Recreators on Detroit Lake, including pets.** During summer 2018, recreators were often warned to avoid swimming and high-speed water activities on Detroit Lake (Oregon Health Authority, 2018).

Contributing topics

- **Ability to monitor for cyanobacteria and toxins.** The increased ability and interest in monitoring for algal blooms is relatively recent.
- **Growing public awareness.** As the issue was publicized through OHA's health advisories and resultant media coverage, members of the public had questions about this new public-health topic, necessitating the development of new public information material (Anderson, Glibert, Burkholder, 2002; Goeres-Priest, 2019).
- **Climate change.** Warming climate will cause a growth in algal blooms (Watson & Titus, 2019).
- **Inadequate water treatment technology.** During the 2018 water advisories, the cyanotoxin made its way through the Geren Island water treatment facility and into Salem's drinking water, which had never happened before. The City of Salem worked with Carollo Engineers to develop and implement a new technique to remove cyanotoxins within just three weeks (Goeres-Priest, 2019; Guevarra, 2018).
- **Delays from the lab.** Water quality samples had to be sent to a lab in Texas, thus delaying results by days. This complicated the decision-making process for managers (Goeres-Priest, 2019).

Broad challenges

- **Communication.** Interviewees noted that communication and collaboration across various organizations proved challenging, at least initially.
- **Protocol.** At the time of the water advisories, it was commonplace for jurisdictions to issue boil water advisories, but vulnerable population drinking water advisories were more rare, so there was no protocol in place to issue and manage such advisories (Goeres-Priest, 2019).

- **Scientific research.** Relatively little is known about cyanobacteria genetics (Carpenter, 2019), limiting scientific understanding and minimizing the ability of natural resource managers to predict and respond to HABs. Additionally, monitoring for HABs can be difficult as wind conditions and water depth levels can affect the ease with which a bloom can be located (Carpenter, 2019).

Possible solutions

- **Communication.** Interviewees reported that, during the summer of 2018, communication improved and the organizations involved began to get a feel for their roles, resulting in helpful collaboration.
- **Protocol.** Since going through the process in 2018, protocol for issuing drinking water advisories should be better set for future use.
- **Scientific research.** Additional research to understand and identify cyanotoxins will assist with problem mitigation.
- **Water treatment technology.** In addition to the activated carbon which is now a step in Salem's water treatment process, the city is also investing $50 million dollars in the design and construction of an ozone treatment facility as a longer-term solution for removing cyanotoxins (City of Salem, 2019; Goeres-Priest, 2019).
- **Water quality monitoring technology.** In coordination with USGS, the City of Salem purchased and installed a hyperspectral camera, which measures water quality at various depths throughout the reservoir.

Reflection

The systems analysis process proved helpful. A key component of this analysis was the development of a visual description of the system. To create my visual description, I first reviewed an

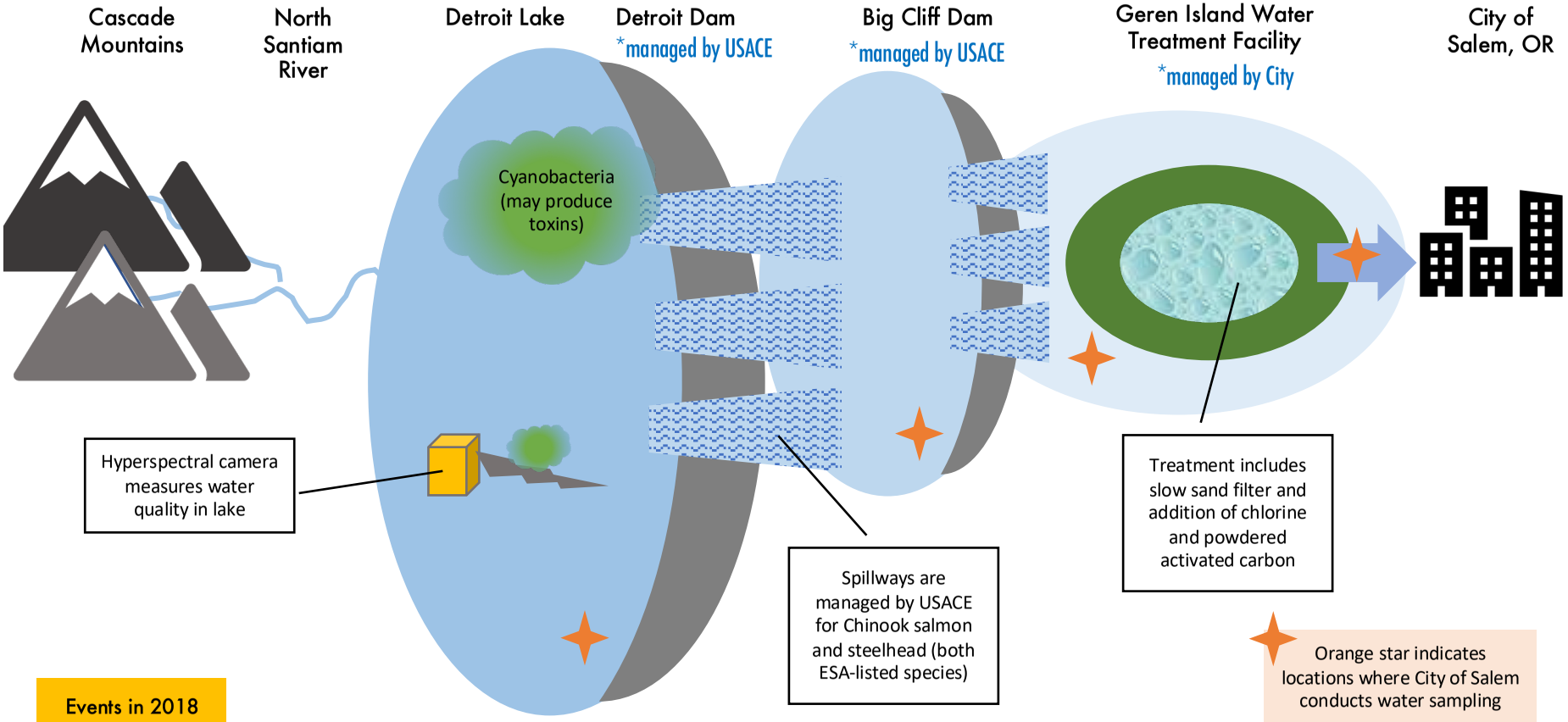
existing graphic depicting the water source and treatment process of Salem's water (City of Salem, 2019). I roughly interpreted this graphic, through the lens of the understanding I gained during my interviews with stakeholders. Upon this interpretation, I overlaid other insights that had been garnered through the interviews.

In addition to the graphical representation, I created a visual timeline. This timeline was extremely valuable to help me merge the varied timelines and elements that had been presented by interviewees.

After creating both visual and narrative descriptions, I have come to an unexpected conclusion -- in many ways, this situation is not an environmental conflict. Admittedly, there are a variety of different interests represented by a stable of stakeholders and decision-makers. And yet, it appears that the parties involved have a solid understanding of and respect for each others' positions, fostering a collaborative environment in which natural resource managers work together for the common good. This is a rare and wonderful thing. Despite the high-stakes, high profile situation, each interviewee mentioned their collaboration with the other entities in monitoring water quality, improving technology, and mitigating cyanobacteria's harmful effects. Perhaps this is because I spoke only with hydrologists from each organization, and they could relate through their scientific discipline. Regardless, their support of each other and ability to problem-solve in a stressful situation was an impressive feat of public service.

Appendix A. Visual description

Harmful Algal Blooms in Detroit Lake



Events in 2018

The problem

- OHA and EPA made advisory algal toxin levels more stringent
- Cyanobacteria bloom in Detroit Lake
- Bloom produced two toxins
- Toxins traveled downstream to City of Salem's water treatment facility
- Slow sand filtration system did not remove toxins (though it had in the past)
- Oregon Health Authority issued water advisories for Salem in May and June

The solution

- USACE's spillway operation was delayed for three weeks to allow water treatment
- In late June, new water treatment technique applied by Carollo Engineers
- Hyperspectral camera installed in Detroit Lake
- Partners emphasize importance of cross-collaboration and communication

Source: City of Salem. (2019). Salem's Drinking Water. Retrieved from City of Salem website: https://www.cityofsalem.net/Pages/drinking-water.aspx
For other sources, see "References."

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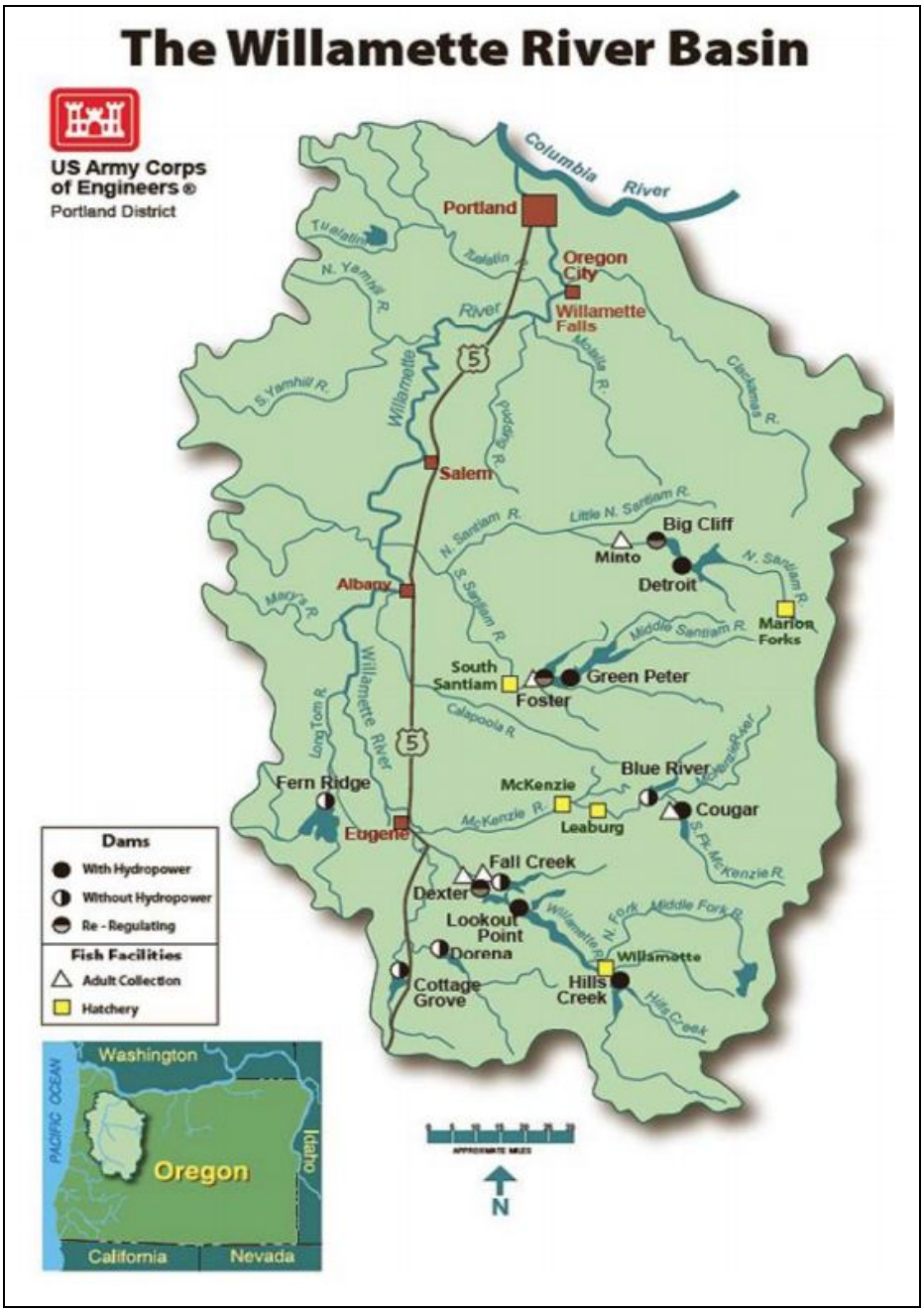
Appendix B.

Figure 1. Willamette River Basin and Reservoir Projects



Source: US Army Corps of Engineers, Portland District, 2017.

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