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*Reply*

# Response to Comments for "An Ecological Function Approach to Managing Harmful Cyanobacteria in Three Oregon Lakes: Beyond Water Quality Advisories and Total Maximum Daily Loads (TMDLs)", *Water* 2019, *11*, 1125

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**Abstract:** The commenter's key argument is that Diamond Lake's problem is strictly one of biomass, i.e., introduction of the invasive Tui Chub fish. There are a few things to note in that respect. The Tui Chub is a bait fish. It is a lower-order prey fish for higher-order trout/salmonid species. Tui Chub is zooplanktivorous. Since the Tui Chub feed on zooplankton, if they themselves are prey for other species (or are being "culled" by artificial means), and there is no other entity to feed on the plankton and algae, the result would be a mass of plankton/algae bloom (i.e., harmful algal blooms (HABs)). This would lead to anoxic conditions in the euphotic zone, which puts even more stress on the higher-order trout/salmonid species. Our work found that the biological community (i.e., invertebrates and fish) are lagging indicators (i.e., response indicators).

**Keywords:** Cyanobacteria; ecological function; ecosystems; Harmful Algal Bloom (HAB); harmful cyanobacterial bloom (CyanoHAB); Proper Functioning Condition (PFC); Total Maximum Daily Load (TMDL); Non-Point Source (NPS); Point Source (PS); Oregon Department of Environmental Quality (ODEQ); Best Management Practice (BMP)

## 1. Introduction

These observations indicate that the Diamond Lake ecosystem was stressed earlier, allowing the Tui Chub population to explode, because there were not enough (trout/salmonid) fish to feed on the Tui Chub, resulting in a biomass imbalance, as noted in the commenter's argument. The state of Oregon planted rainbow trout in Diamond Lake since 1910. Rainbow trout do not spawn in lakes; they spawn in streams. However, Tui Chub spawn in the shallow waters of Diamond Lake. The director of the Pyramid Lake Fisheries Department notes that, in Pyramid Lake, the Tui Chub can reach 10–12 inches, and are they predators which compete with smaller rainbow trout for the same food. However, the Tui Chub are under control because they are the primary food source for the Lahontan cutthroat trout (LCT) over 19 inches in length [1]. The LCT are definitely keeping the Tui Chub population under control. In using LCT to control the Tui Chub population, their use is limited to no more than 500,000 per year to ensure that the LCT has enough food (Tui Chub) to eat [1]. The only way that the Tui Chub can become dominant is by severely removing LCT [1]. In Diamond Lake, for the Tui Chub population to increase and dominate the biomass of the lake, the trout (i.e., higher-order prey) had to undergo a massive reduction, or a continuous reduction over a long period of time (approximately 30 years as per the commenter's response), which would mean a long-term/chronic loss of stream spawning habitat for the trout.

## 2. Sediment and Tui Chub

In Eilers et al. [2], the authors discussed sediment accumulation rates (SARs) and discussed human use activities around the lake, and they tried to correlate SARs with the increased presence of Tui Chub. This is speculative. Determining the flow rates in cubic feet per second for Silent Creek, using a United States Environmental Protection Agency (US EPA) report [3], provides information indicating that the creeks around Diamond Lake have enough power, possible during spring snow melt, to move silt and clays and fine sands into the lake. In the Lightcap 2004 report [4], there is a graph of Figure X (an empirical model of the relationship between zooplankton and fish in Diamond Lake); however, something has to happen to support that relationship, and, since fish are a lagging (response) indicator, that "something" should be related to the increase in SARs for those time periods.

## 3. Discussion

We overlaid SARs (Figure 4, Eilers et al. [2]), diatom-inferred pH (Figure 9, Eilers et al. [2]), and percent diatom community (Figure 8, Eilers et al. [2]), and it appears that the diatoms (Figure 9) decrease in relation to an increase in SARs (Figure 4), and the associated increase in planktonic activity (Figure 8); a supplementary (overlaid) figure is enclosed as a separate document. In Eilers et al. [2], in the "Reconciling Watershed Development, Fisheries Changes, and Sediment History" section, first paragraph, the authors' justification for abandoning upland issues ignores the "near–far" effect (near corresponds to the shore zone development around the lake; far corresponds to forest management within the watershed). The authors disregard the upland areas because the streams are short and do not have much power. However, the EPA report [3] indicates that, during snow melt, the stream's peak flow is powerful enough to move clays, silts, sand, and, depending on the year, fine gravel. It appears that much of the sand and gravel is being trapped in the low-gradient portion of the stream and by the fringing riparian areas. Eilers et al. [2] also disregard the loss of riparian along the eastern shore due to human activity and roads. Our hypothesis is that the watershed and shoreline activity is associated with the SARs, with impacts on the fisheries as a result.

## 4. Conclusions

The key point of the original journal article [5] was to discuss the use of different approaches together to improve the management of a watershed and the waterbodies within it. The intent was not to criticize the use of total maximum daily loads (TMDLs) by the State of Oregon. The idea was to demonstrate that TMDLs, in conjunction with other methodologies, represent the best management practice for improving the health of waterbodies. When reviewing the commenter's response, journal article, and our own article, there are areas where we agree with the commenter, and our approach, although different from the commenter's, e.g., not focused on the lake processes, reaches the same conclusion. Both approaches are valid and both are "right" with respect to developing methodologies to enhance water monitoring and water management programs.

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**Conflicts of Interest:** The authors declare no conflict of interest.

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