Understanding Malheur Lake Turbidity and Potential Restoration Strategies

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1. Background

Malheur Lake is a large, shallow lake in southeastern Oregon within the Malheur National Wildlife Refuge. The basin is endorheic with no outflow from the lake, and surface-water inputs to the lake are the Silvies River from the north and the Donner und Blitzen River from the south (fig. 1). When the refuge was established, Malheur Lake contained healthy communities of both emergent and submerged vegetation that supported populations of migratory water birds and other fauna. Common carp (Cyprinus carpio) were introduced to the basin in the 1920s. Over the following decades, carp populations increased which negatively affected water quality and migratory bird food resources. The lake has shifted from a clear, vegetated state to a turbid state where few aquatic plants can survive. The U.S. Geological Survey and U.S. Fish & Wildlife Service are studying the causes of the high turbidity in the lake and the effects of carp on water quality. Findings will help determine viable restoration strategies with the intent of returning the lake to a clear, vegetated system.

2. Turbidity and Light Extinction

• Data collected in 2018 in Malheur Lake revealed a sharp decline in photosynthetic light in the water column due to turbidity (figs. 2 & 3).
• Photosynthetic light, also referred to as photosynthetically active radiation (PAR), ranges from 400 to 700 nm and is the spectral range that plants use for photosynthesis.
• By approximately 20 cm from the surface, PAR is approaching zero. Photosynthetic light does not penetrate the water column and is not available to plants below ~20 cm.

3. The Goal of Restoration

Restoration practices could aim to create more gradual light extinction with depth, which allows PAR to reach plants deeper in the water column (fig. 4).

4. What causes the high turbidity?

1. Common carp are benthic feeders with a suction-feeding technique.
   a. Suction-feeding and movement suspends sediment in the water column.
   b. Carp physically uproot aquatic vegetation leaving sediments exposed.
2. Wind is another driver of turbidity.
   a. Wind energy is transferred to the water, creating waves with circular orbits (fig. 6). The amount of erosion/suspension depends on wind strength, sediment characteristics, depth, and wind direction.
   b. Malheur Lake’s large area of exposed water means long wind fetch, which increases wave action and erosion/suspension.
   c. Continuous data sondes deployed in the lake (NE and SE) sites and wind data collected at a nearby meteorological station revealed a strong relation between wind and turbidity on short time scales (up to a few days) associated with weather and diurnal wind patterns (fig. 7).


• Quantify in-lake nutrient storage (nitrogen and phosphorus), capturing seasonal and inter-annual variability.
• Quantify external nutrient loads (inputs to the lake) through time.
• Determine organic, inorganic, and bioavailable fractions of nutrients.
• Quantify internal recycling (relation between resuspension and nutrient concentration).
• Determine role of nitrogen-fixing cyanobacteria in nitrogen balance.

6. Conclusions

• Malheur Lake has shifted from a clear, vegetated lake to a turbid, non-vegetated lake.
• Currently, the turbidity in the lake prevents PAR from penetrating the water column, where aquatic plants require it for survival.
• High turbidity in the lake is a result of carp behavior, resuspension of sediment due to wind, and the phytoplankton community.
• Nutrients within the lake may be supporting the phytoplankton community.
• Managing nutrients in the lake may be one way to reduce turbidity, allowing more aquatic vegetation to grow. Aquatic vegetation would also reduce wind fetch and erosion/suspension.