Pond Habitat, Water Quality Assessment, and Management Recommendations
Blue Mesa Recreation Association, Powderhorn, CO

Report

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Prepared for:
Blue Mesa Recreation Association
2391 Blue Mesa Drive
Powderhorn, CO 81243

Prepared by:
Ernesto de la Hoz, MSc.
Aquatic Ecologist
Redfish Environmental, LLC
Logan, UT

www.eredfish.com

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1. INTRODUCTION

Redfish Environmental LLC (RedFISH) conducted a bathymetry assessment and collected water and sediment samples at the pond located in the Blue Mesa Subdivision - Unit 1, Colorado on November 3-4, 2016. The goals for the aquatic system are to maintain water storage, aesthetics, and provide suitable fish habitat and recreational fishing.

2. METHODS

2.1. Study Objectives

The main objective of this study was to assess water quality condition. We also conducted a bathymetry assessment to estimate the depth and volume of the pond. This information will be useful to help support pond management decisions.

2.2. Water Quality Sampling

Water quality parameters (temperature, pH, dissolved oxygen, conductivity) were measured in-situ with a portable instrument. Two water samples were collected for laboratory analysis; sample #1 was collected in the deepest part of the pond and sample #2 was collected in the shallow area of the pond near the inlet creek. Samples were processed at Utah State University analytical laboratory using standardized procedures.

2.3 Bathymetry and Sediment

A hand held sonar and GPS was used to collect depth information. The bathymetry assessment was based on transect data from the depth sounder on aerial photography. Depth measurements in shallow areas of the pond were collected with a stadia rod. Depth contours were generated using spatial analysis tools in ARCGIS. The depth of fine sediment at the pond floor was also recorded at various locations across the pond and a sediment sample was collected to determine organic matter content.

3. RESULTS

Water Quality

Results of the water chemistry analysis are detailed in Table 1, along with the ideal concentrations to maintain fish health.

TABLE 1. WATER QUALITY PARAMETERS

Parameter	Sample #1	Sample #2	Ideal (mg/L)
Ammonia – Total	0.5	0.48	< 1
Bicarbonate	163	170	> 20
Calcium	25.8	17.9	4-160
Carbonate	0.0	0.0	< 20
Chloride	7.11	6.42	< 75
Conductivity	289	286	---
Copper	<0.001	<0.001	< 0.01
Dissolved solids – Total	184	169	< 400
Iron	0.02	0.02	< 0.5
Magnesium	8.15	5.56	< 25
Manganese	0.002	0.004	< 10
Nitrate	<0.1	<0.1	< 5
pH	7.9	7.3	6.5-9
Phosphorous	0.08	0.14	0.005-0.5
Potassium	4.14	3.07	< 5
Sodium	9.43	7.83	< 75
Zinc	<0.001	<0.001	< 0.1

Dissolved oxygen (DO) concentrations measured on-site, ranged from 6.8 to 7.2 mg/l. A concentration of 5mg/L DO is recommended for optimum fish health.

Overall, the results of water quality analysis indicate the water in the pond is suitable for fish health. It should be noted that water quality problems faced by pond owners may not be resolved by the results of water quality laboratory testing. For example, a common problem and the leading cause of fish kills is low dissolved oxygen. The number of fish that die during an oxygen depleting event is determined by how low the DO concentrations gets and for how long the concentration remains low. Fish kills such as those previously observed in the pond at Blue Mesa Subdivision can occur when oxygen consumption increases due to over-abundance of aquatic plants or algae, or death and decay of organic matter (plant or algae die offs).

Bathymetry and Sediment

The pond has a surface area of approximately 11 acres and has a maximum depth of approximately 11 ft (Figure 1). More than 60 percent of the pond is three feet deep or less; about 11 percent of the pond has depths greater than seven feet. The pond holds approximately 36.5 acre-feet of water. The southern section of the pond comprises about 4 acres of shallow water. Average estimate sediment depth in this area was approximately 0.5 ft. Macrophytes and filamentous algae were abundant in this part of the pond. The northern section of the pond encompasses about two thirds of the total area, is characterized by deeper water, and less fine sediment on the pond floor; average sediment depth was approximately 0.2 ft (Figure 2). The organic matter content in sediment was approximately 19 percent.

4. ANALYSIS AND RECOMMENDATIONS

Water quality results only provide a snapshot of conditions at the time water samples were collected. Results indicated water quality condition is appropriate to sustain fish. However, given previous reports of fish kills, the single measurement provides no insight into the processes that affect water quality, how conditions vary throughout the year, or what factors caused fish mortality. For example, ammonia concentrations were within acceptable levels but they vary seasonally. The main source of ammonia in fish ponds is fish excretion and diffusion from the sediment. Large quantities of organic matter are produced by algae. Fecal solids excreted by fish and dead algae settle to the pond bottom, where they decompose. The decomposition of this organic matter produces ammonia, which diffuses from the sediment into the water column. An increase in ammonia concentration can also occur following heavy fish stocking in the pond.

There are two main processes that result in the loss or transformation of ammonia. The most important is the uptake of ammonia by algae and other plants. Plants use the nitrogen as a nutrient for growth. Algae use ammonia for photosynthesis; factors that increase overall algal growth will increase ammonia uptake (e.g., light, warm temperature, abundant nutrient supply).

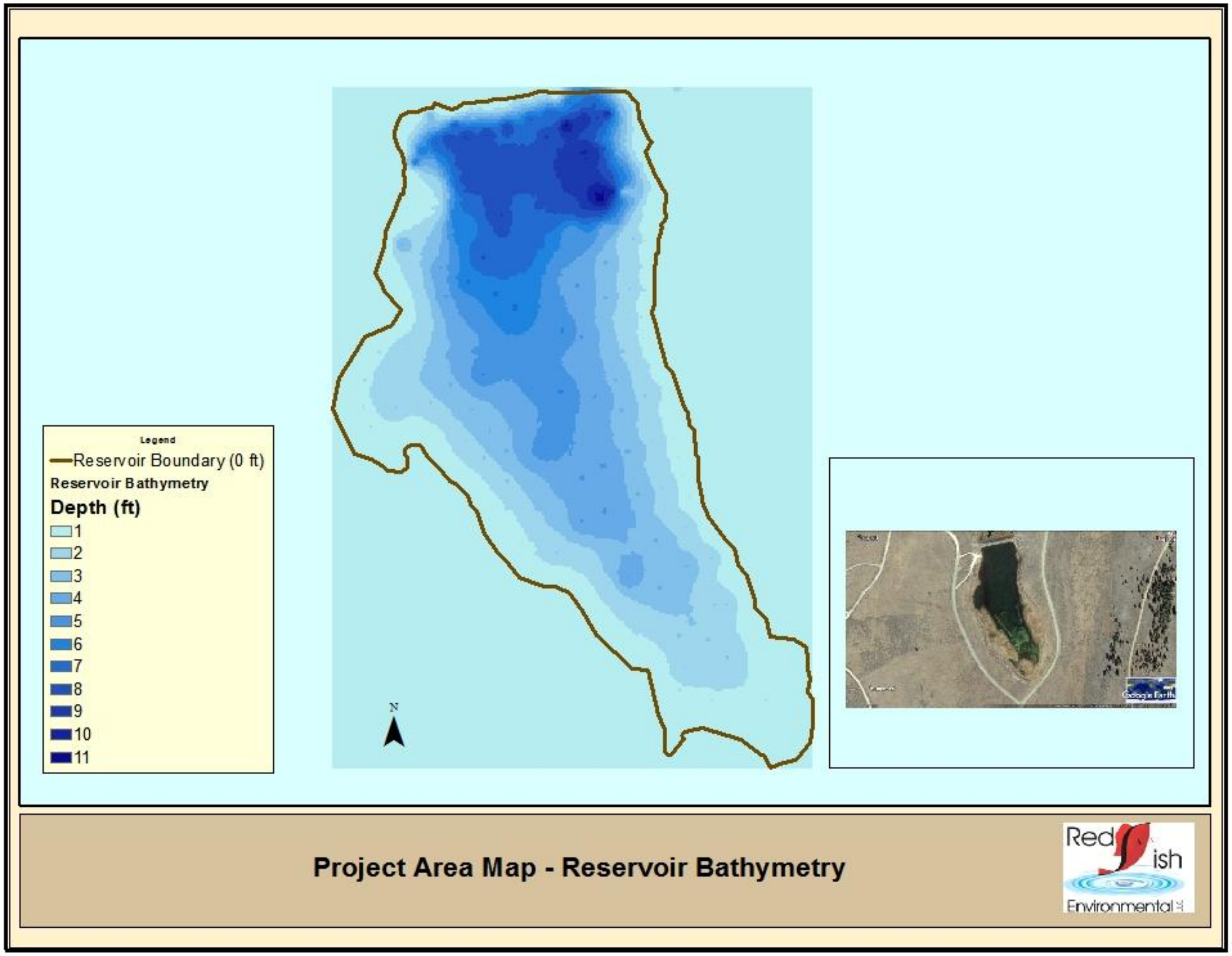

FIGURE 1. PROJECT AREA MAP. POND BATHYMETRY

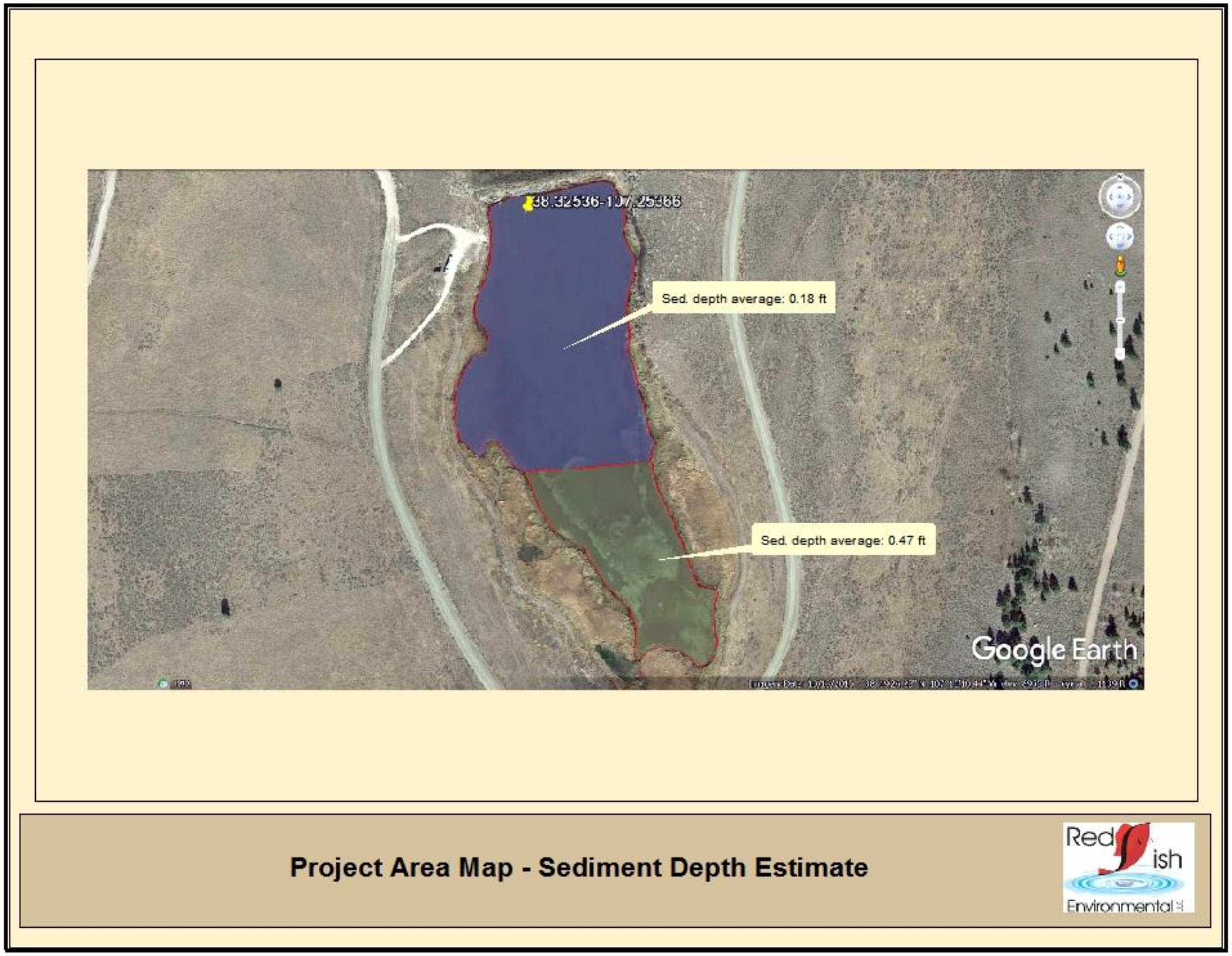

FIGURE 2. POND SEDIMENT DEPTH ESTIMATE

The other important process of ammonia transformation in fish ponds is nitrification. Bacteria oxidize ammonia in a two-step process, first to nitrite (NO_2) and then to nitrate (NO_3). The main factors that affect nitrification rate are ammonia concentration, temperature and DO concentration. During summer, ammonia concentration is typically low, therefore nitrification rates are also low. During winter, low temperature suppresses microbial activity. During spring and fall, ammonia concentration and temperature are moderate, conditions that favor maximum nitrification rates. Spring and fall peaks of nitrite concentration are commonly observed in fish ponds.

Some ponds have very dense algae blooms. These blooms are subject collapse (or crash) when algae suddenly die. When this occurs, ammonia concentration increases rapidly because ammonia removal by algal uptake has been reduced. Rapid decomposition of dead algae reduces the DO concentration and pH and increases ammonia and carbon dioxide concentrations. After the crash of an algae bloom, ammonia concentration can increase to concentrations that can affect fish.

Oxygen concentration at the time of sampling was adequate for fish. However, death and decay of macrophytes or algae can lead to drastic reduction in oxygen concentration. Oxygen depletion events can occur at anytime but they are most likely to cause fish kills during summer months. A decrease in oxygen production is caused by incidents such as cloudy weather and plant or algae die-offs that shut down photosynthesis. Heavy populations of plants or algae are the most important producers of oxygen in the system but they are also the most important users of oxygen. Overcast summer days often precipitate oxygen depletions. During cloudy weather, the intensity of light reaching surface waters is greatly diminished, resulting in a marked decrease in oxygen production from photosynthesis. Oxygen consumption, however, remains unchanged. This results in a net loss of oxygen over each 24-hour period. This loss of oxygen from decreased production is confounded by still, warm weather common on overcast summer days. Oxygen transfer is minimal because there is little or no wind/wave action. The net result over a period of several days is oxygen depletion that can lead to fish kills.

The following observations can help determine if low oxygen is the cause of a fish kill:

- All fish die at approximately the same time (often during the night or in the pre-dawn hours).
- Large fish may be affected more than small fish.
- Moribund fish may be seen at the surface gasping for oxygen.
- The weather immediately prior to the fish kill may have been hot, still and overcast. A severe thunderstorm may have occurred immediately prior to the fish kill.

- An oxygen depletion event severe enough to result in significant fish mortality is often observed in water with heavy populations of algae or aquatic plants.

If low DO is suspected as the cause of a fish kill the following can be done to reduce impacts on fish:

- If fish are dying from low DO it is critical to turn on an aerator. If emergency aeration is not available, little can be done to help the fish. To confirm the problem, oxygen levels should be tested while the fish kill is in progress.

- An oxygen depletion event can be predicted and, therefore, prevented by monitoring dissolved oxygen levels in the pond. The most efficient tool for measuring DO is an electronic oxygen meter. Chemical test kits are also available. These are more troublesome to run, but are accurate and do not require as great an investment by pond owners.

- Aeration systems can be turned on if DO levels drop below a concentration of 4 mg/L.

- Monitoring oxygen throughout the night may be impractical. Alternately, an oxygen depletion may be anticipated by measuring DO levels in the late afternoon (5–6 p.m.) and late evening (8–10 p.m.). The decline in DO during the night can be predicted by graphing DO concentration against time on standard graph paper. If the projected concentration of DO is below 4 mg/L before 7a.m. emergency aeration is recommended.

We recommend continued monitoring of water quality and particularly DO to stay ahead of potential problems. If equipment to test DO concentration (meter or test kit) is not available, the following observations and conditions can be used to anticipate oxygen depletion:

- Fish swim at or near the surface gulping air.

- There is a rapid change in water color to brown, black or gray, signifying loss of an algal bloom.

- A putrid odor arises from the water.

- There has been an extended period of hot cloudy weather.

- There is a heavy summer wind and a rainstorm.

Emergency aeration should be applied whenever fish show signs of oxygen depletion or when dissolved oxygen drops below 4 mg/L. Bottom diffused aeration systems enhance DO concentrations in the water column. Increased oxygen levels decrease concentrations of phosphorous, nitrogen, and other elements that contribute to poor water quality. Aeration can improved water clarity and fish health.

An emergency aerator can be installed and placed on an electric timer. The timer should have the aerator turn on during the late evening (10p.m. to midnight) and turn off after daylight (7–8 a.m.). Using an aerator is not a complete substitute for monitoring DO concentrations and an oxygen depletion event resulting in a fish kill may still occur. However, use of an aerator is recommended and will prevent many problems. The timing and fish stocking rates that have been used in the past should also be evaluated based on the volume of the pond and observed fish habitat conditions.

Chemical treatment of algae and macrophytes is no recommended because the accumulation of organic matter could have a negative effect on DO concentrations. Mechanical removal of algae mats and macrophytes in the shallow southern section of the pond can be considered; mechanical removal can limit new plant growth. Further, following mechanical removal of vegetation, the use of a bacterial suspension injection system can also be considered to help reduce bottom sludge and brake down existing nutrients and organic matter contained in the sediment.

Relevant Literature

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