1992-1993

BEAR LAKE MONITORING

DATA SUMMARY

Prepared for:

BEAR LAKE REGIONAL COMMISSION
Fish Haven, Idaho

Prepared by:

ECOSYSTEMS RESEARCH INSTITUTE
Logan, Utah

September 1993
During this monitoring period, water quality data was collected between June 24, 1992 and July 27, 1993 for Bear Lake and the Bear Lake watersheds. The purpose of this monitoring program has been two-fold. First, selected stations in the watershed were sampled to determine the effect of stream reclamation (Big Creek) and to evaluate current water quality conditions in Swan Creek and at Lifton Station.

The second purpose of the monitoring program was to obtain data on the current water quality conditions of Bear Lake and to maintain the current water quality database.

In addition, a special study was undertaken on May 10, 1993, one day after the failure of the Lifton Causeway, in order to determine the magnitude of water quality impacts to Bear Lake.

The following represents a summary of water quality data collected on Bear Lake and the Bear Lake Watersheds during 1992 and 1993. The data are discussed under separate headings.

Watersheds

Three watersheds were sampled as part of this investigation. Lifton Station, Swan Creek, and two stations on Big Creek were monitored.

Big Creek represents the third largest source of water to Bear Lake and is located at the southernmost end of the lake. Two locations were sampled, located above and below the streambank reclamation work undertaken on the Willis Ranch. The results of these investigations can be seen in Figure 1. The data indicates that the wetland complex is still removing soluble nitrogen (nitrate, nitrite, and ammonia) and phosphorus.

The lowest concentrations occurred in the winter (October to February) and reached a maximum in March and April. The peak concentrations for total inorganic nitrogen (600 µg/l) were similar to past years. While total inorganic nitrogen peaked only once, phosphorus (ortho- and total) had two peaks. The first corresponded to the nitrogen maximum, while the second (July sample) corresponded to peak irrigation season. In 1992, the April peak was more pronounced that the July peak. The opposite pattern was found in 1993.

This may reflect the difference between dry (1992) and wet (1993) years.
FIGURE 1. Water quality data collected at two stations in Big Creek during 1992 and 1993.
The temporal data for the two remaining watersheds (Swan Creek and Lifton Station) can be seen in Figure 2.

Swan Creek, which is the second largest single source of water to Bear Lake, is located near the Idaho-Utah border on the west side of the lake. Total and ortho-phosphorus, as well as total inorganic nitrogen were equal to or lower in concentration during the spring of 1993 when compared to the spring peaks in 1992. Swan Creek also had similar ortho-phosphate and total inorganic nitrogen concentrations as Big Creek.

Lifton Station represents the inflow of the Bear River into Bear Lake. The Bear River is the largest source of water to Bear Lake. The water quality data collected during 1992-1993 indicated that the Bear River had the worst water quality of any stream monitored. A peak total phosphorus concentration of 769 \( \mu g/l \) was observed on May 10, 1993, corresponding to the breach in the Lifton Causeway. At the conclusion of the washout, the Bear River at Lifton Station had dropped to 360 \( \mu g/l \).

The effect on Bear Lake will be discussed under a separate section.

**Bear Lake**

Bear Lake was sampled eleven times during this monitoring program. A single station at the deep hole (approximately 200 feet deep) was sampled at 10 meter intervals. A summary of the current monitoring data compared to the data from last year can be seen in Figure 3 through 7.

Figure 3 represents the total and ortho-phosphate concentrations in Bear Lake during 1992 and 1993. As with data collected during 1992, the 1993 concentrations for both the surface and bottom waters were regularly above 10 \( \mu g/l \). The highest concentrations occurred on June 30, 1993 (70 \( \mu g/l \) surface and 50 \( \mu g/l \) bottom). Ortho-phosphate did not show a major peak in concentration during the 1992-1993 monitoring. Maximum concentration was 7 \( \mu g/l \) found in the hypolimnion in July 1992.

The peak concentrations of total inorganic nitrogen and total nitrogen in the surface waters did not exceed 60 \( \mu g/l \) and 400 \( \mu g/l \), respectively. However, both total inorganic nitrogen and total nitrogen concentrations in the hypolimnion showed increases over the 1992 levels. Most of the increase in total inorganic nitrogen was nitrate (Figure 5).
FIGURE 2. Water quality monitoring results for total phosphorus, ortho-phosphate, and total inorganic nitrogen data for Swan Creek, Big Creek and Lifton Station.
FIGURE 3. The total phosphorus and ortho-phosphate concentrations in Bear Lake.
FIGURE 4. The total nitrogen (TN) and total inorganic nitrogen (TIN) concentrations in Bear Lake.
FIGURE 5. The nitrate and ammonia concentrations in Bear Lake.
Water transparency as measured with a Secchi disk reached a maximum of 6.5 meters on July 27, 1993 (Figure 6). The pH for the surface and bottom remained relatively constant, between 8.5 and 9.0. During periods of stratification, the hypolimnion was as much as 0.5 pH units lower than the corresponding epilimnetic values. This may indicate decomposition within the hypolimnion.

Temperatures and dissolved oxygen concentrations represent the last water quality parameters measured as part of the routine monitoring program. It has been noted in previous annual reports that the surface temperatures of Bear Lake had risen to a high of 23.5°C during the summer (August 1992). This trend of increasing epilimnetic temperatures was reversed during 1993 (Figure 7). Maximum temperatures in the surface waters reached only 18.5°C during 1993.

The past trend toward improved dissolved oxygen concentrations in the hypolimnion also was reversed during 1993. Summer hypolimnetic concentrations were reduced to 5.9 mg/l, the lowest summer level since August 1987.

Summary

As a summary, all water quality parameters for Bear Lake have been plotted from October 1980 to August 1993.

These data can be seen in Appendix I, Figures I-1 through I-10. It is interesting to note that the major peak in total phosphorus concentration which occurred in the summer of 1991 (Figure I-1) was preceded by an unexplained hypolimnetic pH drop (Figure I-7). The onset of the phosphorus increase and the pH drop correspond to each other.
FIGURE 7. The temperature (°C) and dissolved oxygen concentrations in Bear Lake.
On May 7 and 8, 1993, the causeway adjacent to the Lifton Pumping Station broke and allowed uncontrolled Mud Lake water to enter Bear Lake. Bed sediments from Mud Lake were entrained by the flowing water (Figure 8). On Monday, May 10, 1993, a special study was undertaken to document the extent of the sediment input into Bear Lake and to determine its effect on the water quality of that ecosystem.

A north-south transect was established starting at Lifton Station and ending at the long-term monitoring station (Bear Lake middle). The data can be seen in Table 1 and Figures 9 through 13.

Secchi disk transparency was affected the most by the inflowing sediment. Water clarity was affected 6,000 feet into the lake three days after the event (Figure 9). Total suspended solids, total phosphorus and ortho-phosphate (Figures 10, 11 and 12) also showed elevated concentration 2,800 feet into the lake, while nitrate (Figure 13) was still elevated at 3,500 feet. Although the sediment plume was observed at a distance of 9,500 feet into the lake, the water quality conditions at these furthest stations on May 10, 1993 were only slightly degraded over the adjacent non-impacted areas. The monitoring data at the middle Bear Lake monitoring stations collected on June 30, 1993 did show an increase in concentration of total phosphorus throughout the entire water column.
FIGURE 8. A view of the aftermath of the causeway failure looking south (above) and north (below) of Bear Lake.
FIGURE 9. The secchi disk transparency at ten Bear Lake stations plotted against distance from the causeway break into Bear Lake. Inserted bars represent data immediately adjacent, but outside the sediment plume.
FIGURE 10. The total suspended solids concentration at ten Bear Lake stations plotted against distance from the causeway break into Bear Lake. Inserted bars represent data immediately adjacent, but outside the sediment plume.
FIGURE 11. The total phosphorus concentration at ten Bear Lake stations plotted against distance from the causeway break into Bear Lake. Inserted bars represent data immediately adjacent, but outside the sediment plume.
FIGURE 12. The ortho-phosphate concentration at ten Bear Lake stations plotted against distance from the causeway break into Bear Lake. Inserted bars represent data immediately adjacent, but outside the sediment plume.
<table>
<thead>
<tr>
<th>SITE</th>
<th>S.D.</th>
<th>Turbidity</th>
<th>TSS</th>
<th>NO₃</th>
<th>OP</th>
<th>TP</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Muddy, lots of carp.</td>
</tr>
<tr>
<td>C</td>
<td>11</td>
<td>1,000</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>Muddy water, cattails floating on surface.</td>
</tr>
<tr>
<td>D</td>
<td>15</td>
<td>1,500</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>Not as muddy, large pieces of wood and cattails floating on surface.</td>
</tr>
<tr>
<td>E</td>
<td>30</td>
<td>2,800</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>Not as muddy, large pieces of wood and cattails floating on surface.</td>
</tr>
<tr>
<td>F</td>
<td>40</td>
<td>3,500</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>Lots of reeds and snails floating.</td>
</tr>
<tr>
<td>G</td>
<td>50</td>
<td>5,100</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>Lots of large wooden planks.</td>
</tr>
<tr>
<td>H</td>
<td>6100</td>
<td>6,100</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>Water appears to be clear. A piece of wood.</td>
</tr>
<tr>
<td>I</td>
<td>7,800</td>
<td>7,800</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>Large pieces of wood.</td>
</tr>
<tr>
<td>J</td>
<td>9,500</td>
<td>9,500</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>Some reeds. Strange bubble masses on surface.</td>
</tr>
<tr>
<td>K</td>
<td>11,000</td>
<td>11,000</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>Clear water. Nothing on surface.</td>
</tr>
<tr>
<td>BLM</td>
<td>190</td>
<td>190</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>Clear water. Nothing on surface.</td>
</tr>
</tbody>
</table>

TABLE 1. The results of the special study collected on May 10, 1993.
APPENDIX I

Long-term Water Quality Data
FIGURE I-1. The concentrations of total phosphorus in the surface and bottom waters of Bear Lake between October 1980 and August 1993.
FIGURE I-3. The concentrations of nitrate in the surface and bottom waters of Bear Lake between October 1980 and August 1993.
FIGURE I-4. The concentrations of ammonia in the surface and bottom waters of Bear Lake between October 1980 and August 1993.
FIGURE I-5. The concentrations of total inorganic nitrogen in the surface and bottom waters of Bear Lake between October 1980 and August 1993.
FIGURE I-6. The concentrations of dissolved oxygen in the surface and bottom waters of Bear Lake between October 1980 and August 1993.
FIGURE I-8. The pH of the surface and bottom waters of Bear Lake between October 1980 and August 1993.