The aquatic plants of central Utah and their distribution

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Brigham Young University - Provo
THE AQUATIC PLANTS OF CENTRAL UTAH
AND THEIR DISTRIBUTION

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Typed by Gerald E. Bessey
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CHAPTER I

INTRODUCTION

Statement of the problem.—It was the purpose of this study to determine what aquatic plants were common to central Utah and to outline the ecological factors that control their distribution. The main emphasis throughout has been upon the more macroscopic aquatic plants. Such algae were included as was warranted by their size, abundance and importance in the various habitats in which they grew.

As this study progressed it became evident that there was a need for a broad survey-type study of the aquatic plants that would include essentially all of the wet lands of the central Utah region. These waters are highly variable as to source, chemical and physical constitution and plant populations. Furthermore, since their variability is quite typical of most waters of the Wasatch front, they appeared to offer a place of fruitful study where a contribution to Utah aquatic biology could be made.

The area of study closely corresponds to the boundaries of Utah County, although some collections were made outside the county, particularly to the east, in Wasatch County. The study was initiated in the spring of 1955 when the study stations were chosen. Field work was done during the summers of 1956, 1957, and 1959.

Plants included in the study. Aquatic plants exhibit several degrees of dependency upon their fluid environment for support and dissolved minerals and gases. Those included in this study were of the free-floating,
suspended, submerged-attached, and emergent types. The floating and suspended varieties are so lacking in supporting tissue that they must be entirely supported by the water. Gaseous exchange is made with the water as well. The submerged-attached variety are anchored in the soil substrate and derive mineral ions from the soil while carbon dioxide and oxygen exchange is made directly with the water. The emergent aquatics most nearly approach terrestrial species in habit. They are rooted in the wet soil and have shoots that project through a variable depth of water to the surface and beyond. Many such aquatics possess an aerenchyma tissue consisting of tubes through which oxygen passes from the upper leaves to the roots. Typically the epidermal tissues and associated cuticle are thinner in comparison to more land-dwelling species. Strengthening fibers are likewise less well developed. Terrestrial species growing in wet soil were not included in this study.

Review of the literature—A review of the literature reveals a general paucity of research in botanical limnology in Utah. The earliest and perhaps most important study was done by Cottam (2) in 1926. His was a comprehensive, descriptive ecological study of the flora of Utah Lake and the surrounding lands of Utah Valley. The algae were not considered but his study did include many of the aquatic higher plants. He reported three aquatic plant associations in the marsh formation of the lake. The pondweed association included the following species: Potamogeton filiformis, Potamogeton paeion gunes, Batrachium trichophyllum, Ceratophyllum demersum, Zannichellia palustris, Potamogeton interior, Lemna minor, Lemna trisulca, Spirodela polyrhiza, Azolla caroliniana, and Chara. The bulrush-cattail-reed association was composed primarily of Scirpus validus, Typha latifolia, Typha angustifolia, and Phragmites communis. The sedge association included societies of Rorippa, Berula, Polygonum,
Sagittaria, and Carex. He reported that Utah Lake water had greatly increased in salinity from earlier times. He ascribed this to the increased use of stream water for irrigation of farm land and its subsequent outfall into the lake.

A number of phycological studies have been made. One of the earliest of such studies was made by Snow (11) who reported the presence of 49 genera and 127 species of algae in Utah Lake, many of which had never been reported for the area. Norrington (7) in 1927, reported the algae she found in certain mountain lakes and streams of the Wasatch and Uinta ranges in Utah. Her paper included a list of algae from these regions with ecological notes. Samuelson (10) has compared the algal populations in streams in Red Butte and Emigration canyons. Emigration canyon streams had been highly subjected to human influences while those of Red Butte canyon were less disturbed and more natural. He found algal populations three times larger in Red Butte canyon than in Emigration canyon and attributed these differences to alterations in the habitat. The most recent study of Utah algae was completed in 1958 by Pratt (8) who investigated the effects of physical factors on periodicity in certain algal populations at Salem Lake. He concluded that the temperature and the length of the photoperiod were most important in determining algal periodicity. One study was a direct effort to note the effect of human influences upon aquatic life forms in the Provo River. Dustans (3) work was mainly concerned with the aquatic insects, however, as noted in dredged and undredged portions of the river.

A study of the flora of the Great Salt Lake region was reported by Flowers (5) in 1934. He analyzed the waters of the Great Salt Lake for gross mineral content, hydrogen-ion concentration, turbidity and for the presence of particular salt compounds. He reported the occurrence of six
species of algae in the lake and only one aquatic seed plant, *Potamogeton pectinatus*.

Tanner (13) in 1930 and 1931 reported in a series of two papers the changing physical and chemical characteristics of Utah Lake water over a 20-year period. Some 26 species of algae were listed as being present in the lake. He further noted that the salinity of the lake water had quadrupled in the 20-year interval.

Wakefield (14) conducted a study of the successional changes on the Utah Lake shoreline over a six-year period when the lake waterline was rapidly receding. He noted that newly exposed shoreline was soon occupied by *Xanthium*, *Salsola*, *Salix*, *Tamarix*, and *Populus*.

Description of the study area.--The white man has done much to alter the natural habitat of aquatic species in the last 100 years. The diversion and damming of rivers for irrigation, the dredging of rivers for flood control and roadbank protection, and the pollution of streams and lakes have resulted in several complex damaging effects upon the aquatics of the area.

The study areas from which data were obtained can be conveniently classified as given below. They include most places having a perennial surface water flow of accumulation. The distribution of the sites is shown on a map of Utah county (figure 1).

**Perennial River Drainage Areas**

Waters of this category are the principal streams that flow into Utah Lake. Beginning at the north and proceeding southward, they are American Fork River, Battle Creek, Grove Creek, Provo River, Hobble Creek, Spanish Fork River, Peteetneet, Santaquin and Currant Creeks. The upper Jordan River that drains Utah Lake to the north was also included.
Provo River has a drainage area of 640 square miles that extends from the western reaches of the Uinta Mountains through the Wasatch Mountains at about 40 degrees, 25 minutes north latitude, to Utah Lake. Its waters drain siliceous soils in its upper reaches and calcareous soils in the lower areas through the Wasatch front.

Spanish Fork River drains a watershed about equal to that of Provo River, but does not have so great a discharge. It rises near Soldier Summit, and, after joining two main tributaries, North and Thistle Creeks, it flows down a canyon through the main ridge of the Wasatch Mountains and enters Utah Lake at the head of a large embayment of the lake that extends between Payson and Springville. Mountains of its watershed are principally calcareous in nature. The balance of the streams mentioned are comparatively small, with the exception of American Fork River.

Highland Lakes

Lakes situated at elevated locations in the Wasatch Range of the study area include Payson Lakes adjacent to the Nebo Scenic Loop road east of Mt. Nebo, and Salamander Lake on the eastern slope of Mt. Timpanogos.

Lowland Lakes and Ponds

The largest single lowland lake is Utah Lake, situated in Utah Valley. It receives water from a drainage area covering some 2,600 square miles. On the average it has a length of 21 miles, a width of 7 miles, and a maximum surface area of 93,000 acres. Its average depth is about 8 feet, with a maximum of 13 feet. The size of Utah Lake is highly variable due to variations of precipitation, inflow, outflow for irrigation, and evaporation losses. Perhaps more note has been taken of the changes in Utah Lake than other aquatic habitats of the area. Carter (1) has represented it to have been a beautiful body of water of great clarity and lush aquatic populations during the early days of man's habitation.
of Utah Valley. Mrs. Nellie Harris has related times of swimming in Utah Lake when it was clear and blue in color. Large trout were caught from its waters. Today the lake shows little resemblance to such a picture. Its most evident characteristic at present is high turbidity. A wind storm can be observed to whip the lake into a turbid mixture. Due to the colloidal nature of the bottom sediment it hardly commences settling when more wind action again repeats the cycle. Dr. Vasco Tanner has expressed to the writer the opinion that the introduction of carp and other herbivorous fishes has been partly responsible for the loss of the aquatic populations which formerly provided stability to the lake floor.

The principal standing bodies of water, other than Utah Lake, are Lehi Pond and Salem Lake. Lehi Pond is located about midway between Lehi and American Fork cities, one-fourth mile south of U. S. Highway 91. It receives water from several artesian and surface sources and drains southward into Utah Lake. Salem Lake is located at Salem, Utah, in the southern portion of the county and is bisected on its lower end by Highway 91. Nearly all waters are derived from deep artesian sources that eventually drain in a northwesterly direction into Utah Lake.

One additional aquatic environment of interest includes a series of ponds commonly called Goshen Warm Springs, located 6 miles east of Goshen about one-half mile south of highway 6. Collections and samples were taken at a variety of additional sites, such as Goshen Reservoir, Tanner Reservoir, Genola Reservoir, Spring Lake, and a number of sloughs and farm ponds dotted throughout the area. Also included was a spring located west of Fairfield, in Cedar Valley.

Geology.--Utah Valley is situated in north-central Utah in the extreme eastern part of the Great Basin. The Wasatch Range, the westernmost of the Rocky Mountain system, borders the valley on the east. A
relatively low range, the East Tintic Range, borders the valley on the southwest, the Oquirrh range on the northwest. Its northern border is the Traverse Mountain which constitutes a natural dam to Utah Lake, while the southern border is a low plateau of alluvial fill.

During Pleistocene times Utah Valley was occupied by Lake Bonneville, a predecessor of Great Salt Lake and Utah Lake. Almost flat unconsolidated sediment underlies the valley, the borders of which are marked by a unique series of terraces that indicate the various shorelines of the old lake.

For a better understanding of the Wasatch mountains as contributors to modern streams, the writer quotes from Richardson's (9) description of the geology of the region as follows:

"The Wasatch Mountains are composed of a complex mass of sedimentary, igneous, and metamorphic rocks that have been folded and faulted. In age the rocks range from precambrium to tertiary and constitute a thickness of about 50,000 feet. In the 'narrow's where the Jordan River flows through the Traverse Mountains, practically horizontal Pleistocene gravels, which form the great embayment at the point of the mountain, are unconformably underlain near the river level by fine-textured sediments that dip southeastward at an angle of 40°. The rocks in general are quartzite and limestone of Carboniferous age, but local Cambrian sediments also occur. The highlands that border the valleys of Utah Lake and Jordan River on the west are for the most part composed of the same rocks that occur in the Wasatch Mountains, but the structural relations are completely hidden by the deep filling of the intervening valleys. The Lake Mountains or Pelican Hills, west of Utah Lake, are composed of Carboniferous limestone and quartzites which constitute a low synclinal fold, and are separated from the Traverse Mountains by a narrow strip of Pleistocene deposits. The East Tintic Range, a complex mass of sedimentary and igneous rocks forms the southwestern border of Utah Lake Basin. The low spur of the Tintic Mountains known as Long Ridge lies south of Goshen and consists of Andesite in its southern part, while southeast dipping Carboniferous limestone outcrop in the gorge of Currant Creek."

During Tertiary time the general area was occupied by oceanic waters covering Paleozoic sediments many thousands of feet deep. The late Tertiary brought crustal movements that caused the formation of several lakes that were fed in Quarternary times by glaciers. Lake Bonneville constitutes the last large body of water to occupy a region
that was destined later to become a desert. Lake Bonneville occupied a considerable part of western Utah and extended into adjacent parts of Nevada and Idaho. During the late Quarternary times, there was a gradual receding of the lake level until its present remnants were formed, the Great Salt Lake and Utah Lake.

According to Richardson, past studies on water sources of the region reveal the following facts:

"The underground water supply of the valleys of Utah Lake is maintained by the snow and rain that fall upon their drainage areas. A remarkable series of thermal springs is associated with the great fault at the western base of the Wasatch Mountains. These occur at intervals along the entire extent of the range, and other warm springs, which may also have a connection with faults, are located within the area under consideration. Association with faults suggest a deep-seated origin, which accounts for the high temperature of the water."
CHAPTER II

METHODS AND MATERIALS

Research Design.--Several features of the habitat were studied including dissolved oxygen content, hydrogen-ion concentration, turbidity, water depth, gross mineral content and temperature. Current speed of many streams was noted where it was thought pertinent. Such data were taken along a transect at five to ten meter intervals. Measurements were made at a large number of stations in order to give a rather broad picture of existing conditions.

The vegetation was measured at the study stations for species presence, frequency along the transect, and relative abundance.

Measurement of the environment.--The oxygen content was determined by the Rideal-Steward modification of the Winkler method for dissolved oxygen determination. The water samples were obtained as follows: a one-liter bottle and a 250-milliliter bottle were secured in a wooden frame and connected by means of rubber tubing attached to short lengths of glass tubing extending through rubber stoppers. A second piece of glass tubing in the stopper of the larger bottle was connected to a 4-foot length of rubber tubing. This apparatus was weighted and suspended from the top by a rope. By closing the upper end of the rubber tubing the apparatus could be lowered without water entering the bottle. With release of the tubing the water at the desired depth was admitted first to the small bottle from which it passed into the larger bottle. By the time the larger bottle was filled with water, the water of the smaller
bottle had been completely changed more than four times, thus avoiding any great error which may have been associated with direct sampling with a sample bottle. Preliminary preparation was completed in the field in order that a long storage period would not cause a serious change in the oxygen content of the sample. Final titration was done in the laboratory.

Temperature determinations were made with a Taylor Six-model maximum-minimum thermometer. Since waters of rivers and streams showed no appreciable difference in temperature from surface to bottom, due to the mixing action of the stream flow, only surface determinations were made. In measuring stream water temperature, a water sample was obtained in a gallon container into which the thermometer was placed for two minutes before a reading was made. When measuring a standing body of water a surface temperature was noted and, in addition, a minimum temperature from either the bottom or at the lowest zone of the aquatic plant distribution. In lake or pond use, the instrument was weighted for submergence. The instrument was read while the bulb was submerged in the water.

An estimate of minerals dissolved in the waters was obtained through conductivity measurement made with the use of a salt bridge meter. The water sample cup of the meter was filled to level full from a clear glass sampling bottle, and the determinations were made in the usual manner. The results were expressed in parts per million.

All hydrogen-ion concentration determinations were made with the Beckman pH meter in the laboratory.

Turbidity was measured with a Secchi disk, an instrument devised to show the depth to which light can be seen to penetrate water.

The current speed of rivers or streams was measured by floating a white, thin wooden disk along a meter stick held parallel to the current and noting the distance covered per second.
Plant studies--The vegetation was measured through the use of a continuous or an interrupted belt transect of contiguous quadrats one meter square placed to bisect as many of the aquatic species present as possible. The interrupted belt transect was only used when the transect exceeded 100 meters in length. Occurrence of each species was noted in each quadrat of the transect. Frequency data are graphically presented in the results section. Species presence was determined for the entire sample at each of the stations. Sample presence was calculated as the proportion of the stations at which the species occurred. Abundance of each species was estimated at each station according to five categories of abundance as follows: ubiquitous, abundant, frequent, occasional, rare. Representative specimens of species studied are at the Brigham Young University Herbarium.

Location of study stations--The location of the study stations by range, township and section are given in the table below. Each will be referred to by name and number, as seem desirable, throughout this paper. A map of Utah County showing the location of the study stations is shown in Figure 1.
Fig. 1.—Map of Utah County showing the location of study stations
<table>
<thead>
<tr>
<th>Station Number</th>
<th>Station Name</th>
<th>Station Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Oxbow Pond</td>
<td>S.E. quarter of section 26, T.4 S., R.1 W.</td>
</tr>
<tr>
<td>2</td>
<td>Jordan River</td>
<td>S.E. quarter of section 26, T.4 S., R.1 W.</td>
</tr>
<tr>
<td>3</td>
<td>American Fork River</td>
<td>N.W. quarter of section 32, T.4 S., R.2 E.</td>
</tr>
<tr>
<td>4</td>
<td>Artesian marsh</td>
<td>N.W. quarter of section 17, T.5 S., R.1 E.</td>
</tr>
<tr>
<td>5</td>
<td>Utah Lake</td>
<td>S.W. quarter of section 5, T.7 S., R.1 E.</td>
</tr>
<tr>
<td>6</td>
<td>Utah Lake spring</td>
<td>S.W. quarter of section 5, T.7 S., R.1 E.</td>
</tr>
<tr>
<td>7</td>
<td>Salamander Lake</td>
<td>S.W. quarter of section 34, T.4 S., R.3 E.</td>
</tr>
<tr>
<td>8</td>
<td>Riverside pond</td>
<td>S.W. quarter of section 7, T.5 S., R.4 E.</td>
</tr>
<tr>
<td>9</td>
<td>Roadside slough</td>
<td>S.W. quarter of section 15, T.5 S., R.1 E.</td>
</tr>
<tr>
<td>10</td>
<td>West Lehi Pond</td>
<td>S.E. quarter of section 16, T.5 S., R.1 E.</td>
</tr>
<tr>
<td>11</td>
<td>Slough</td>
<td>S.E. quarter of section 5, T.7 S., R.2 E.</td>
</tr>
<tr>
<td>12</td>
<td>Meadow marsh</td>
<td>S.W. quarter of section 19, T.6 S., R.3 E.</td>
</tr>
<tr>
<td>13</td>
<td>Provo River</td>
<td>N.W. quarter of section 24, T.6 S., R.2 E.</td>
</tr>
<tr>
<td>14</td>
<td>Provo River</td>
<td>S.E. quarter of section 27, T.5 S., R.3 E.</td>
</tr>
<tr>
<td>15</td>
<td>Pothole</td>
<td>S.E. quarter of section 9, T.7 S., R.2 E.</td>
</tr>
<tr>
<td>16</td>
<td>Slough</td>
<td>S.W. quarter of section 10, T.7 S., R.2 E.</td>
</tr>
<tr>
<td>17</td>
<td>Farm pond</td>
<td>S.W. quarter of section 10, T.7 S., R.2 E.</td>
</tr>
<tr>
<td>18</td>
<td>Big Dry Creek</td>
<td>S.E. quarter of section 11, T.7 S., R.2 E.</td>
</tr>
<tr>
<td>19</td>
<td>Utah Lake</td>
<td>S.W. quarter of section 16, T.7 S., R.2 E.</td>
</tr>
<tr>
<td>20</td>
<td>Mud Lake</td>
<td>section 22, T.7 S., R.2 E.</td>
</tr>
<tr>
<td>21</td>
<td>Utah Lake</td>
<td>N.E. quarter of section 5, T.7 S., R.2 E.</td>
</tr>
<tr>
<td>22</td>
<td>Provo River</td>
<td>S.E. quarter of section 5, T.7 S., R.2 E.</td>
</tr>
<tr>
<td>23</td>
<td>Upper Payson Lake</td>
<td>section 19, T.10S., R.3 E.</td>
</tr>
<tr>
<td>24</td>
<td>Lower Payson Lake</td>
<td>section 19, T.10S., R.3 E.</td>
</tr>
<tr>
<td>25</td>
<td>Millrace</td>
<td>S.E. quarter of section 36, T.6 S., R.2 E.</td>
</tr>
<tr>
<td>26</td>
<td>Ironton Pond</td>
<td>S.W. quarter of section 21, T.7 S., R.3 E.</td>
</tr>
<tr>
<td>27</td>
<td>Vivian Park pond</td>
<td>center of section 26, T.5 S., R.3 E.</td>
</tr>
<tr>
<td>28</td>
<td>Burt Spring Pond</td>
<td>S.W. quarter of section 1, T.8 S., R.3 E.</td>
</tr>
<tr>
<td>29</td>
<td>Salem Pond</td>
<td>N.E. quarter of section 11, T.8 S., R.2 E.</td>
</tr>
<tr>
<td>30</td>
<td>Genola Reservoir</td>
<td>S.W. quarter of section 34, T.9 S., R.2 E.</td>
</tr>
<tr>
<td>31</td>
<td>Goshen Springs</td>
<td>S.W. quarter of section 8, T.9 S., R.1 E.</td>
</tr>
<tr>
<td>32</td>
<td>Goshen Reservoir</td>
<td>N.W. quarter of section 15, T.8 S., R.1 W.</td>
</tr>
<tr>
<td>33</td>
<td>Goshen pothole</td>
<td>N.W. quarter of section 15, T.9 S., R.1 W.</td>
</tr>
</tbody>
</table>
CHAPTER III

RESULTS

All of the quantitative measurements of the vegetation and environment were made during the month of August, 1959. The weather in August is characteristically warm with clear skys. A note has been made where conditions other than this prevailed on a particular day. The time of day for the environment measurements is given in order to determine how comparable the temperature data are between the various stations. Single transects were used at each station with the exception of stations 5, 6, 13, 19, 21, 22, and 32 where two transects were used.

The physical and chemical data are reported upon the framework of a transect profile which shows the depth of the water along the transect and water temperature in degrees Fahrenheit at selected points. The hydrogen-ion and dissolved mineral concentrations are reported below the profile at points along the transect where the samples were taken. The dissolved oxygen content of the water is usually reported within the profile at the positions shown.

The vegetation data are reported in tabular form showing the frequency and abundance of each species along the transect. Species present at the station but not located along the transect are also listed.

Summarization of the water conditions associated with each aquatic plant species and its greatest abundance are shown on table 73. A list of aquatic plant species by station is shown on table 74 along with their area frequency. Species collected in the study area but not found at any
of the study stations are also included. Ecological notes for the principal aquatic plants of the area commence on page 64.

Station Observations

<table>
<thead>
<tr>
<th>Station</th>
<th>Location</th>
<th>Time</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station 1</td>
<td>Jordan Oxbow Pond</td>
<td>8:00 AM</td>
<td>August 21, 1959</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The water of the pond was derived from underground sources. The pond was open and unshaded, located in a deep pocket protected from the wind. The pond margin was composed mostly of typha and scirpus. The Seechi disk disappeared at a depth of 32 inches.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station 2</td>
<td>Jordan River</td>
<td>10:00 AM</td>
<td>August 21, 1959</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The transect was located on the depositing shore of the river. Current speed along the transect was .25 meters/sec. The Seechi disk disappeared at a depth of 8 inches.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station 3</td>
<td>American Fork River</td>
<td>11:00 AM</td>
<td>August 6, 1959</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The bottom of the stream was composed of large boulders. The water was clear and moving at a rate of 1 meter/sec. Scant plant life was present in the stream proper. The borders of the stream were quite shaded.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station 4</td>
<td>Artesian Marsh</td>
<td>3:00 PM</td>
<td>August 6, 1959</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The water of the marsh was derived from an artesian source that flows throughout the year. The plant population was a lush growth of emergent aquatics.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station 5</td>
<td>Utah Lake</td>
<td>11:00 AM</td>
<td>August 5, 1959</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Seechi disk was visible to a depth of 15 inches. The water level had been receding. The station was located on the eroding shore of the lake.

Station 6 Utah Lake Spring 12:00 noon August 21, 1959

The water of the north-south transect was derived from an artesian source which followed a channel to the southern tip of the transect and then meandered through a scirpus belt in an eastward direction to Utah Lake. Transect 2 of this station measured its east-west composition.

Station 7 Salamander Lake 2:00 PM August 20, 1959

The Seechi disk was visible at a depth of 21 inches. Salamanders were present in the lake. The lake was formed by a natural pocket in which the water table was exposed throughout the year.

Station 8 Riverside Pond 11:00 AM August 22, 1959

The water level had receded just previous to visiting the station. All submerged aquatics looked in very poor condition. The water came from surface runoff which was caught in a depression formed by a road embankment.

Station 9 Lehi Slough 3:00 PM August 21, 1959

The slough had slow-moving clear water that was choked with vegetation. The water came from an artesian source. The banks of the slough were high and no human or animal influences were evident but those of muskrats.

Station 10 West Lehi Pond 10:00 AM August 20, 1959

The Seechi disk disappeared at a depth of 4 feet. The entire transect
area was well shaded and undisturbed. Carp were present in the pond. Aquatics were limited to the shore areas of shallow water depth.

**Station 11**  Slough  8:00 AM  August 25, 1959

The channel of the slough was formed by a roadbank on the west and an excavated wall on the east. It was situated 200 yards from Utah Lake. The water surface was of the same elevation as the lake suggesting that it was derived from the water table. The Seechi disk disappeared at a depth of 22 inches.

**Station 12**  Meadow Marsh  10:00 AM  August 25, 1959

The marsh was formed in the lower end of a pasture. The water was received from a canal supplied water from Provo River. Water at the inlet of the pasture had the following properties: a pH of 7.9, a dissolved oxygen content of 4.7 ppm, a dissolved mineral content of 195 ppm and a temperature of 60 degrees F. The marsh showed evidence of being walked through by cows. The lower end of the marsh had extremely mucky soils.

**Station 13**  Provo River  9:00 AM  August 23, 1959

The station was located along a fast moving section of the "river bottom" at the Carterville Bridge. The Seechi disk was visible at the bottom of the stream. Much of the stream was exposed to sunlight for a good portion of the day. The bottom was composed of rocks and boulders.

**Station 14**  Provo River  9:00 AM  August 22, 1959

The station was located on the river in the canyon at the wooden dam below Vivian Park. The Seechi disk disappeared at a depth of .6
meters. The current speed was .3 meters/sec. in the center of the channel.

**Station 15**  
Pothole  
10:00 AM  
August 13, 1959

The station was formed by a pocket at the airport roadside. The pond seemed to be formed by the surface of the water table. The bottom was extremely mucky and smelly. The reagents for the dissolved oxygen determinations did not respond in the usual fashion so no such data was obtained. The Secchi disk was barely visible at a depth of one meter.

**Station 16**  
Slough  
11:00 AM  
August 11, 1959

The water of the station was derived from Provo River after its passage through a series of irrigation ditches. The Secchi disk was only visible to a depth of 3 feet. The slough was fully covered with spirotela and azolla. The hydrodictyon formed a continuous mat below the surface aquatics.

**Station 17**  
Farm Pond  
9:00 AM  
August 12, 1959

The pond was man-made formed by its owner as a fishing pond. Earlier in the year the owner dumped some 27 truck loads of manure into the pond to promote plankton growth. The plant growth was luxuriant. Water of the pond was derived from the Provo River through irrigation ditches. The water was rich in plankton but free of sedimentary suspension. Observation of the bottom-attached plants was difficult due to the heavy cover surface vegetation formed which greatly shaded the water.
Station 18 Big Dry Creek 10:00 AM August 12, 1959

The station was located along a wide section of the creek where the water was slow-moving. Provo River supplied the water of the creek. The station was essentially covered with cladophora which overlayed dense forests of elodea. The water of quads 1 through 12 was derived from underground sources which then flowed into the main stream channel. The stream was so filled with vegetation that current speed was impossible to measure. In general terms, it seemed to move very slowly.

Station 19 Utah Lake 9:00 AM August 13, 1959

The water level had been rapidly receding at this station. Many hummocks of potamogeton were observed on the exposed shoreline. The Seechi disk was only visible to a depth of 6 inches.

Station 20 Mud Lake-arm of Utah Lake 10:00 AM August 14, 1959

The station was located in perhaps the most turbid body of water in the county. The Seechi disk was visible to a depth of only 4 inches. A survey of 600 yards of the moist shoreline revealed no exposed aquatics. A boat tour of the lake failed to reveal any aquatics other than Scirpus acutus. There were several hundred carp observed in this study which stirred the bottom silt at every movement.

Station 21 Utah Lake 1:00 PM August 14, 1959

Transect 1 was used to sample the vegetation of the shallow water. Transect 2 was situated to reveal the aquatics of the recently exposed shoreline. The Seecchi disk disappeared at a depth of 5 inches. A wide extra-transect survey in deeper water revealed no visible aquatics.
Station 22  Provo River  9:00 AM  August 14, 1959

The transect was situated so as to measure the vegetation of the river just previous to entry into Utah Lake. No aquatics were observed in the main channel of the river but were limited to a 2 meter zone near the shore. The Seechi disk disappeared at a depth of 3 inches.

Station 23  Upper Payson Lake  10:00 AM  August 15, 1959

This was a naturally formed lake with a mucky bottom. The Seechi disk was visible to a depth of 32 inches. The transect was located at the west end of the lake where a stream entered. The day of sampling was cool and cloudy.

Station 24  Lower Payson Lake  2:00 PM  August 15, 1959

The lake was man-made with a rocky bottom. The Seechi disk was visible at a depth of 2 meters. The day was cool and cloudy. A westerly wind had blown a dense cover of lemna into the east end of the lake where it was piled in heavy hummocks.

Station 25  Millrace  10:00 AM  August 26, 1959

The Millrace is a well established stream which receives its water from Provo River. In the region of the station it supported a lush growth of submerged and emergent aquatics. It was fully exposed to sunlight, but protected from the wind by a low bank and short willows on its margin. The water speed was very slow at points along the transect other than through the main channel. The bottom was heavily silted and mucky.
Station 26  Ironton Pond  2:00 PM  August 18, 1959

This was a deep pond in a sink filled with water from an artesian source. The Seechi disk was visible to a depth of 2 meters. The southeast end of the transect was well shaded. The vegetation was rather lush where the water depth would permit it.

Station 27  Vivian Park Pond  12:00 noon  August 20, 1959

The pond was shallow formed by back waters of Provo River. It was used for boating. The station was shaded on its southern border by a north facing cliff. The bottom was rocky.

Station 28  Burt Spring Pond  2:00 PM  August 22, 1959

The pond had very clear water obtained from underground sources. The vegetation was very robust. The bottom of the pond in the vicinity of the transect was very mucky and was generally so throughout.

Station 29  Salem Pond  3:00 PM  August 27, 1959

The pond was being used for power boating. Fragments of many aquatics were common at the lower end of the pond. The Seechi disk was visible to a depth of 30 inches. Observation of aquatics below this depth was very difficult. The day was warm but overcast.

Station 30  Genola Reservoir  1:00 PM  August 22, 1959

The Seechi disk was visible to a depth of 1 meter. The bottom was heavily silted. No vegetation was evident between quads 15 and 190 of the transect. The reservoir was fully exposed to sunlight and wind action.
The pond was rocky along its bottom. The day of observation was warm but somewhat overcast. The water was very clear. The pond was quite exposed to wind action.

The reservoir was man-made and possessed great turbidity. The Seechi disk disappeared at a depth of 4 inches. Carp were present. The southern margins of the reservoir were covered with wide bands of typha and scirpus.

The pothole was formed by a natural depression and supplied water from the reservoir. The bottom was very mucky and deep. The two species of Lemma formed a continuous mat over the pond.
### TABLE 2

**PHYSICAL AND CHEMICAL FEATURES STATION 1**

<table>
<thead>
<tr>
<th>NW</th>
<th>Distance along transect in meters</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>05 10 15 20 25 30 35 40 45 50</td>
<td></td>
</tr>
</tbody>
</table>

**Temperature in degrees Fahrenheit**

- top: 65 65 66 67 66 65 65 66 65 66
- bottom: 64 64 64 64 63 63 63 64

**Depth in meters**

- bottom: 64 64 64 63 63 63 64

**pH and dissolved minerals in parts per million**

- pH: 8.9 9.0 9.0 9.0 9.0 9.0 9.0 9.0
- dissolved minerals: 670 573 586 573 586 573 586 573

### TABLE 3

**DISTRIBUTION OF VEGETATION STATION 1**

<table>
<thead>
<tr>
<th>NW</th>
<th>Species frequency along transect</th>
<th>SE</th>
<th>Species abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>05 10 15 20 25 30 35 40 45 50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Myriophyllum verticillatum**: A
- **Scirpus acutus**: A
- **Typha latifolia**: 0
- **Ceratophyllum demersum**: F
- **Lemna minor**: 0
- **Gladophora sp.**: 0
- **Potamogeton pectinatus**: 0

* A= abundant, 0= occasional, F= frequent

* Lines indicate occurrence of plant along the transect.
Fig. 2.—Plot of Jordan Oxbow Pond showing location of transect

Table 4

<table>
<thead>
<tr>
<th>Distance along transect in meters</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 5 10 15 20 25 30 35 40</td>
<td></td>
</tr>
<tr>
<td>84 84 85 84 84 84 top</td>
<td></td>
</tr>
<tr>
<td>4.4 ppm. oxygen 4.4 ppm.</td>
<td></td>
</tr>
<tr>
<td>temperature oxygen</td>
<td></td>
</tr>
<tr>
<td>Depth in meters</td>
<td></td>
</tr>
<tr>
<td>2 3</td>
<td></td>
</tr>
<tr>
<td>84 84 84 84 84 84 bottom</td>
<td></td>
</tr>
<tr>
<td>temperature</td>
<td></td>
</tr>
<tr>
<td>PH</td>
<td></td>
</tr>
<tr>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td>569 ppm. 550 ppm. 570 ppm.</td>
<td></td>
</tr>
<tr>
<td>Dissolved minerals</td>
<td></td>
</tr>
</tbody>
</table>

Table 5

Distribution of vegetation Station 2

<table>
<thead>
<tr>
<th>Species frequency along transect</th>
<th>N</th>
<th>Species abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 5 10 15 20 25 30 35 40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phalaris arundinacea</td>
<td></td>
<td>Occasional</td>
</tr>
<tr>
<td>Typha latifolia</td>
<td></td>
<td>Occasional</td>
</tr>
<tr>
<td>Scirpus acutus</td>
<td></td>
<td>Frequent</td>
</tr>
<tr>
<td>Potamogeton latifolius</td>
<td></td>
<td>Occasional</td>
</tr>
</tbody>
</table>
TABLE 6

PHYSICAL AND CHEMICAL FEATURES STATION 3

<table>
<thead>
<tr>
<th>N</th>
<th>Distance along transect in meters</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 05 10 15 20 25 30 35 40</td>
<td></td>
</tr>
<tr>
<td>temperature in degrees Fahrenheit</td>
<td>.1 57 56 56 56 56 56 56</td>
<td></td>
</tr>
<tr>
<td>water depth in meters</td>
<td>.4 - .3 - .2 - .1 -</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>8.2 ---------------- 8.2 ---------------- 8.2</td>
<td></td>
</tr>
<tr>
<td>dissolved minerals</td>
<td>208 ppm -------------- 208 ppm -------------- 208</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 7

DISTRIBUTION OF VEGETATION STATION 3

<table>
<thead>
<tr>
<th>N</th>
<th>Species frequency along transect</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 05 10 15 20 25 30 35 40</td>
<td></td>
</tr>
<tr>
<td>Vaucheria sp.</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Nostoc sp.</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Equisetum arvense</td>
<td>R</td>
<td></td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along trans.  
  * 0 = occasional, R = rare

Fig. 3.--Plot of Jordan River station showing location of transect

Fig. 4.--Plot of American Fork River station showing location of transect
<table>
<thead>
<tr>
<th>Species</th>
<th>Frequency along transect</th>
<th>Species abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sagittaria cuneata</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Alisma plantago-aquatica</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>Hippurus vulgaris</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Typha angustifolia</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Scirpus acutus</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>Mimulus guttatus</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>Bidens cernua</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Sium suave</td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Lemna minor</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Spirodea polyrhiza</td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Polygonum amphibium</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>Juncus torreyi</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Eleocharis macrastachya</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Bragrostis hypnoides</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Chara sp.</td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Potamogeton pectinatus</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Cladophora sp.</td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Ranunculus aquatilis</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>Alopecurus aequalis</td>
<td></td>
<td>O</td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along transect.

* A = abundant, F = frequent, O = occasional, R = rare
### TABLE 9

**PHYSICAL FEATURES STATION 4**

<table>
<thead>
<tr>
<th>N</th>
<th>Distance along transect in meters</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| temperature in degrees F. | top | 64 | 63 | 66 | 65 |
| water depth in cm.        | -   | 63 | 63 | 64 | 65 |

*Scale: 1" = 15 meters*

---

**Fig. 5.**--Plot of Artesian Marsh showing location of transect

---

**Fig. 6.**--Plot of Utah Lake station no. 5 showing the location of transect

*Scale: 1" = 20 meters*
### TABLE 10

**PHYSICAL AND CHEMICAL FEATURES STATION 5**

<table>
<thead>
<tr>
<th>Distance along transect in meters</th>
<th>Temperature in degrees Fahrenheit</th>
<th>Water depth</th>
<th>pH</th>
<th>Dissolved minerals along transect ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0  5  10  15  20  25  30  35  40  45  50  55  60  65  70</td>
<td>top 90  90  89  89</td>
<td>bottom 89  89  87</td>
<td>8.4  8.6  8.6</td>
<td>648  635  650</td>
</tr>
</tbody>
</table>

### TABLE 11

**DISTRIBUTION OF VEGETATION STATION 5**

<table>
<thead>
<tr>
<th>Species frequency along transect</th>
<th>Species abundance*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scirpus acutus</td>
<td>F</td>
</tr>
<tr>
<td>Salicornia rubra</td>
<td></td>
</tr>
<tr>
<td>Typha angustifolia</td>
<td>0</td>
</tr>
<tr>
<td>Potamogeton latifolius</td>
<td>0</td>
</tr>
</tbody>
</table>

* lines indicate occurrence of plant along transect.

* F = frequent, 0 = occasional

### TABLE 12

**PHYSICAL AND CHEMICAL FEATURES STATION 5**

<table>
<thead>
<tr>
<th>Distance along interrupted belt transect</th>
<th>temp. in degrees F.</th>
<th>water depth in cm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>0  5  10  15  20  25  30  35  40  45  50  55</td>
<td>top 87  87  88  88  88  87</td>
<td>8.3  8.4  8.4</td>
</tr>
</tbody>
</table>
TABLE 13
DISTRIBUTION OF VEGETATION STATION 5

<table>
<thead>
<tr>
<th>S</th>
<th>Species frequency along transect</th>
<th>N</th>
<th>Species abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>05</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>25</td>
<td>Scirpus acutus</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>35</td>
<td>F</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>45</td>
<td>Potamogeton latifolius</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>55</td>
<td>O</td>
</tr>
</tbody>
</table>

/ Lines indicate occurrence of plant along transect.
* F = frequent, O = occasional

TABLE 14
PHYSICAL AND CHEMICAL FEATURES STATION 6

<table>
<thead>
<tr>
<th>N</th>
<th>Distance along transect in meters</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>05</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>temperature in degrees F.</th>
<th>top</th>
<th></th>
<th>74</th>
<th>74</th>
<th>74</th>
<th>74</th>
<th>74</th>
<th>74</th>
<th>74</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td>water depth in cm.</td>
<td>25</td>
<td>7.3</td>
<td>7.4</td>
<td>7.4</td>
<td>7.4</td>
<td>7.4</td>
<td>7.3</td>
<td>7.3</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>722 ppm</td>
<td>715 ppm</td>
<td>730 ppm</td>
<td>740 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dissolved minerals</td>
<td>4.5 ppm</td>
<td>4.6 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dissolved oxygen along transect</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 15
DISTRIBUTION OF VEGETATION STATION 6

<table>
<thead>
<tr>
<th>N</th>
<th>Species frequency along transect</th>
<th>S</th>
<th>Species abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>05</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Typha angustifolia</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spirogyra sp.</td>
<td>F</td>
</tr>
<tr>
<td>Chara sp.</td>
<td>F</td>
</tr>
<tr>
<td>Scirpus paludosus</td>
<td>O</td>
</tr>
<tr>
<td>Scirpus olneyi</td>
<td>O</td>
</tr>
</tbody>
</table>

/ Lines indicate occurrence of plant along transect.*See above
TABLE 16

PHYSICAL AND CHEMICAL FEATURES STATION 6

<table>
<thead>
<tr>
<th>W Distance along transect in meters</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>0  05  10  15  20  25  30  35  40  45  50  55  60  65  70</td>
<td></td>
</tr>
<tr>
<td>------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>75 temp. 76</td>
<td>77</td>
</tr>
<tr>
<td>in degrees F.</td>
<td>77</td>
</tr>
<tr>
<td>79</td>
<td>80</td>
</tr>
<tr>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td>15 depth in 7.3--------------------</td>
<td></td>
</tr>
<tr>
<td>cm. 750 ppm------------------------</td>
<td>755</td>
</tr>
<tr>
<td>ppm dissolving minerals along transect</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 17

DISTRIBUTION OF VEGETATION STATION 6

<table>
<thead>
<tr>
<th>W Species frequency along transect</th>
<th>Species abundance*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0  05  10  15  20  25  30  35  40  45  50  55  60  65  70</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>-</td>
<td>Typha angustifolia</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Spirogyra sp.</td>
</tr>
<tr>
<td></td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Scirpus paludosus</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Potamogeton pectinatus</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Scirpus acutus</td>
</tr>
<tr>
<td></td>
<td>A</td>
</tr>
</tbody>
</table>

* Lines indicate the occurrence of plant along transect.
* A = abundant, F = frequent, O = occasional

---

Fig. 7.—Plot of Utah Lake Spring showing the location of transects.
TABLE 18
PHYSICAL AND CHEMICAL FEATURES STATION 7

<table>
<thead>
<tr>
<th>SW</th>
<th>Distance along transect in meters</th>
<th>NE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>05</td>
</tr>
<tr>
<td></td>
<td>top</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>bottom</td>
<td>68</td>
</tr>
<tr>
<td>temp. in degrees F.</td>
<td>25</td>
<td>64</td>
</tr>
<tr>
<td>water depth in cm.</td>
<td>50</td>
<td>72</td>
</tr>
<tr>
<td>pH</td>
<td>8.1</td>
<td>7.9</td>
</tr>
<tr>
<td>dissolved minerals along transect</td>
<td>260 ppm</td>
<td>260 ppm</td>
</tr>
</tbody>
</table>

TABLE 19
DISTRIBUTION OF VEGETATION STATION 7

<table>
<thead>
<tr>
<th>SW</th>
<th>Species frequency along transect</th>
<th>NE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>05</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Glyceria borealis</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Eleocharis macrostachya</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Eleocharis acicularis</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Ranunculus aquatilis</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Alopecurus aequalis</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Sparganium simplex</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Potamogeton alpinus</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Callitriche autumnalis</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Brachythecium rivulare</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Elatine triandra</td>
<td>R</td>
</tr>
</tbody>
</table>

* Lines indicate the occurrence of plant along transect.  
* F = frequent, O = occasional, R = rare

Fig. 8.--Plot of Salamander Lake showing location of transect.

Scale: 1" = 30 meters
### TABLE 20

**PHYSICAL AND CHEMICAL FEATURES STATION 8**

<table>
<thead>
<tr>
<th>W</th>
<th>Distance along transect in meters</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 05 10 15 20 25 30 35 40 45</td>
<td></td>
</tr>
<tr>
<td>temperature in degrees F. top</td>
<td>68 68 68 67 66</td>
<td></td>
</tr>
<tr>
<td>water depth in centimeters</td>
<td>25 - 64 65 67 66</td>
<td></td>
</tr>
</tbody>
</table>

Temperature in top: 68 deg F.
Water depth in centimeters: 25 cm.

7.5 to 7.9 pH and 433 ppm to 340 ppm dissolved minerals.

### TABLE 21

**DISTRIBUTION OF VEGETATION STATION 8**

<table>
<thead>
<tr>
<th>W</th>
<th>Species frequency along transect</th>
<th>E</th>
<th>*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 05 10 15 20 25 30 35 40 45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chara sp.</td>
<td>U</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cladophora sp.</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Zannichellia palustris</strong></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carex retrorsa</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lemma minor</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sparganium sp.</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equisetum arvense</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potamogeton foliosus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Potamogeton pectinatus</strong></td>
<td>O</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limnosella aquatica</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sagittaria cuneata</strong></td>
<td>F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $F$=frequent, $O$=occasional, $R$=rare, $U$=ubiquitous

---

**Fig. 9.**—Plot of Riverside Pond showing location of transect.

Scale: 1" = 20 m.
### Table 22
PHYSICAL AND CHEMICAL FEATURES STATION 9

<table>
<thead>
<tr>
<th>N Dist. along transect in met.</th>
<th>S</th>
<th>0</th>
<th>05</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>top temperature</td>
<td>--</td>
<td>74</td>
<td>74</td>
<td>73</td>
<td>73</td>
<td>73</td>
<td>73</td>
<td>73</td>
</tr>
<tr>
<td>dissolved oxygen</td>
<td>--</td>
<td>3.0 ppm</td>
<td>3.1 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>water depth in centimeters</td>
<td>25</td>
<td>72</td>
<td>72</td>
<td>70</td>
<td>69</td>
<td>71</td>
<td>71</td>
<td>71</td>
</tr>
<tr>
<td>bottom temperature</td>
<td>--</td>
<td>8.0</td>
<td>8.0</td>
<td>8.0</td>
<td>8.0</td>
<td>8.0</td>
<td>8.0</td>
<td>8.0</td>
</tr>
<tr>
<td>dissolved minerals</td>
<td>--</td>
<td>319 ppm</td>
<td>319 ppm</td>
<td>319 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>along transect</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 23
DISTRIBUTION OF VEGETATION STATION 9

<table>
<thead>
<tr>
<th>N</th>
<th>Species frequency along tran.</th>
<th>0</th>
<th>05</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>Species abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Juncus torreyi</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Typha latifolia</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rorippa nasturtium-aquaticum</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chara sp.</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sagittaria cuneata</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lemna minor</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Berula erecta</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scirpus paludosus</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scirpus olneyi</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Lines indicate the occurrence of plant along transect.  
* A = abundant, F = frequent, O = occasional, U = ubiquitous.

---

Scale: 1" = 15 meters

---

Fig. 10.—Plot of Lehi slough showing location of transect.
### Table 24

**Physical and Chemical Features Station 10**

<table>
<thead>
<tr>
<th>E</th>
<th>Distance along transect in meters</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>05</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

- **Temperature in degrees F.**
  - Top: 66
  - 5.5 ppm dissolved O₂

- **Water depth in meters**
  - Top: 65
  - Bottom: 65

- **pH and dissolved minerals**
  - 8.2
  - 324 ppm

### Table 25

**Distribution of Vegetation Station 10**

<table>
<thead>
<tr>
<th>E Species freq. along transect</th>
<th>Abundance *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potamogeton foliosus</td>
<td>F</td>
</tr>
<tr>
<td>Myriophyllum verticillatum</td>
<td>O</td>
</tr>
<tr>
<td>Chara sp.</td>
<td>O</td>
</tr>
<tr>
<td>Cladophora sp.</td>
<td>F</td>
</tr>
<tr>
<td>Utricularia minor</td>
<td>F</td>
</tr>
<tr>
<td>Typha latifolia</td>
<td>O</td>
</tr>
<tr>
<td>Lemna minor</td>
<td>F</td>
</tr>
<tr>
<td>Berula erecta</td>
<td>O</td>
</tr>
<tr>
<td>Ricciocarpus natans</td>
<td>R</td>
</tr>
<tr>
<td>Ranunculus aquatilis</td>
<td>R</td>
</tr>
<tr>
<td>Spirodela polyrhiza</td>
<td>O</td>
</tr>
<tr>
<td>Rorippa nasturtium-aquaticum</td>
<td>O</td>
</tr>
<tr>
<td>Potamogeton pectinatus</td>
<td>O</td>
</tr>
<tr>
<td>Sparganium sp.</td>
<td>R</td>
</tr>
<tr>
<td>Zannichellia palustris</td>
<td>O</td>
</tr>
</tbody>
</table>

*Lines indicate plant occurrence along transect.

* F = frequent, O = occasional, R = rare

**Fig. 11.**—Plot of West Lehi Pond showing location of transect.
### TABLE 26

**PHYSICAL AND CHEMICAL FEATURES STATION 11**

<table>
<thead>
<tr>
<th>N</th>
<th>Distance along transect in meters</th>
<th>S</th>
<th>0</th>
<th>05</th>
<th>10</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>water depth in meters</td>
<td></td>
<td>68</td>
<td>66</td>
<td>66</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>temp. in degrees Fahrenheit</td>
<td></td>
<td>67</td>
<td>top</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>pH and dissolved minerals along transect</td>
<td></td>
<td>8.5</td>
<td>8.0</td>
<td>324 ppm</td>
<td>324 ppm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>top</td>
<td>bottom</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 27

**DISTRIBUTION OF VEGETATION STATION 11**

<table>
<thead>
<tr>
<th>Species</th>
<th>Species frequency along transect</th>
<th>Species abundance*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potamogeton pectinatus</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Ranunculus aquatilis</td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Ceratophyllum demersum</td>
<td></td>
<td>U</td>
</tr>
<tr>
<td>Leersia crysoides</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Potamogeton latifolius</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Lemma minor</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Typha latifolia</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Scirpus acutus</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

* lines indicate occurrence of plant along transect.
* A = abundant, F = frequent, O = occasional, U = ubiquitous

Fig. 12.—Plot of slough at station 11 showing the location of transect.
TABLE 28

PHYSICAL AND CHEMICAL FEATURES STATION 12

<table>
<thead>
<tr>
<th>E</th>
<th>Distance along transect in meters</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 02 04 06 08 10 12 14 16 18 20 22 24 26 28 30 32 34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-60 60 60 60 61 61</td>
<td></td>
</tr>
</tbody>
</table>

- water depth in cm.
- temperature in degrees F.
- top
- bottom
- 4.7 ppm dissolved oxygen

pH and 7.2

DISTRIBUTION OF VEGETATION STATION 12

<table>
<thead>
<tr>
<th>E</th>
<th>Species frequency along transect</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chara sp.</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Lemna minor</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Scirpus validus</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Juncus torreyi</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Typha latifolia</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Sagittaria cuneata</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Sium suave</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Mimulus guttatus</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Rorippa nasturtium-aquaticum</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Equisetum arvense</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Solanum dulcamara</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Juncus saximontanus</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Glyceria elata</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Cladophora sp.</td>
<td>0</td>
</tr>
</tbody>
</table>

Fig. 13.—Plot of Meadow Marsh showing location of transect.

Scale: 1" = 15 meters

TRANSECT

N

d lines indicate occurrence of plant along transect. A = abundant, F = frequent, 0 = occasional.
### TABLE 30

**PHYSICAL AND CHEMICAL FEATURES STATION 13**

<table>
<thead>
<tr>
<th>S</th>
<th>Distance along transect in meters</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10 20 30 40 50</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>water depth in cm.</th>
<th>temperature in degrees F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>59</td>
<td>60</td>
</tr>
<tr>
<td>59</td>
<td>61</td>
</tr>
<tr>
<td>59</td>
<td>60</td>
</tr>
<tr>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

**Bottom Soil Texture**

<table>
<thead>
<tr>
<th>0</th>
<th>10 20 30 40 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>large rocks</td>
<td>sand and small rocks</td>
</tr>
</tbody>
</table>

**Current Speed**

<table>
<thead>
<tr>
<th>0</th>
<th>1 meters/ sec.</th>
<th>1.5 meters/ sec.</th>
<th>1 meter/ sec.</th>
<th>calm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>meters/ sec.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Water Chemistry**

<table>
<thead>
<tr>
<th>0</th>
<th>10 20 30 40 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.8</td>
</tr>
<tr>
<td>dissolved min.</td>
<td>190 ppm</td>
</tr>
<tr>
<td>dissolved O₂</td>
<td>5.4 ppm</td>
</tr>
</tbody>
</table>

**Along transect**

### TABLE 31

**DISTRIBUTION OF VEGETATION STATION 13**

<table>
<thead>
<tr>
<th>S</th>
<th>Species frequency along transect</th>
<th>N</th>
<th>Abundance*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>05 10 15 20 25 30 35 40 45 50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chara sp.</th>
<th>Ranunculus aquatilis</th>
<th>Zannichellia palustris</th>
<th>Gladophora sp.</th>
<th>Enteromorpha sp.</th>
<th>Anacharis canadensis</th>
<th>Lemma minor</th>
<th>Drepanoclados revolvens</th>
<th>Brachythecium populeum</th>
<th>Amblystegium varium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>A</td>
<td>A</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>R</td>
<td>R</td>
</tr>
</tbody>
</table>

* Lines indicate occurrence along transect. † See table 29.
TABLE 32
PHYSICAL FEATURES STATION 13

<table>
<thead>
<tr>
<th>Distance along transect in met.</th>
<th>0</th>
<th>05</th>
<th>10</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>59</td>
</tr>
<tr>
<td>temp. in degrees F.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>W</td>
<td>-</td>
<td>-</td>
<td>59</td>
<td>-</td>
</tr>
<tr>
<td>water depth in centimeters</td>
<td>25</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Fig. 14.—Plot of Provo River, station 13, showing location of transect.

TABLE 33
DISTRIBUTION OF VEGETATION STATION 13

<table>
<thead>
<tr>
<th>Species</th>
<th>Freq. along transect</th>
<th>Abundance *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veronica americana</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Solanum dulcamara</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Cladophora sp.</td>
<td>-</td>
<td>F</td>
</tr>
<tr>
<td>Zannichellia palustris</td>
<td>-</td>
<td>A</td>
</tr>
<tr>
<td>Enteromorpha sp.</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Vaucheria sp.</td>
<td>-</td>
<td>0</td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along transect.
* A = abundant, F = frequent, 0 = occasional.

TABLE 34
DISTRIBUTION OF VEGETATION STATION 14

<table>
<thead>
<tr>
<th>Species</th>
<th>Freq. along transect *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranunculus aquatilis</td>
<td>F</td>
</tr>
<tr>
<td>Zannichellia palustris</td>
<td>0</td>
</tr>
<tr>
<td>Potamogeton latifolius</td>
<td>A</td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along transect.
* A = abundant, F = frequent, 0 = occasional.
TABLE 35

PHYSICAL AND CHEMICAL FEATURES STATION 14

<table>
<thead>
<tr>
<th>Distance along transect in meters</th>
<th>N 0</th>
<th>05</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>top temp. F. deg.</td>
<td>58</td>
<td>58</td>
<td>58</td>
<td>58</td>
<td>58</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>water depth in meters</td>
<td>1-</td>
<td>180 ppm dissolved mineral</td>
<td>2-</td>
<td>4.4 ppm diss. O2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>7.7</td>
<td>pH</td>
<td>7.8</td>
<td>pH</td>
<td>7.8</td>
<td>pH</td>
<td>7.8</td>
</tr>
<tr>
<td>water depth in meters</td>
<td>1-</td>
<td>180 ppm dissolved mineral</td>
<td>2-</td>
<td>4.4 ppm diss. O2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>7.7</td>
<td>pH</td>
<td>7.8</td>
<td>pH</td>
<td>7.8</td>
<td>pH</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Fig. 15.--Plot of Provo River, station 14, showing location of transect

TABLE 36

PHYSICAL AND CHEMICAL FEATURES STATION 15

<table>
<thead>
<tr>
<th>E meters</th>
<th>Distance along transect in meters</th>
<th>W meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>water</td>
<td>67</td>
<td>72</td>
</tr>
<tr>
<td>depth in</td>
<td>68</td>
<td>68</td>
</tr>
<tr>
<td>meters</td>
<td></td>
<td>top temp.</td>
</tr>
<tr>
<td>4 inches of depth</td>
<td>8.6</td>
<td>8.5</td>
</tr>
<tr>
<td>24 inches of depth</td>
<td>559 ppm</td>
<td>559 ppm</td>
</tr>
<tr>
<td>dissolved minerals</td>
<td>559 ppm</td>
<td>559 ppm</td>
</tr>
<tr>
<td>pH</td>
<td>8.5</td>
<td>8.5</td>
</tr>
<tr>
<td>dissolved minerals</td>
<td>559 ppm</td>
<td>559 ppm</td>
</tr>
</tbody>
</table>

TABLE 37

DIST. OF VEGETATION STATION 15

<table>
<thead>
<tr>
<th>Species frequency along transect</th>
<th>E meters</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>05</td>
</tr>
<tr>
<td>Cladophora sp.</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Chara sp.</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td>Scirpus acutus</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Scirpus nevadensis</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Lines indicate occurrence of plant along transect.
* 0 = occasional, U = ubiquitous.

Fig. 16.--Plot of pothole, station 15, showing location of transect
### TABLE 38

**PHYSICAL AND CHEMICAL FEATURES STATION 16**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Distance along transect in meters</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>04</td>
<td>08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>temp. in degrees F.</td>
<td>top</td>
<td>74</td>
<td>72</td>
</tr>
<tr>
<td>bottom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>water depth in meters</td>
<td></td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Surface determinations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>8.0</td>
<td>8.0</td>
<td>8.0</td>
</tr>
<tr>
<td>dissolved minerals</td>
<td>353 ppm</td>
<td>393 ppm</td>
<td>383 ppm</td>
</tr>
<tr>
<td>along transect</td>
<td>Bottom determinations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>8.0</td>
<td>7.9</td>
<td>7.9</td>
</tr>
<tr>
<td>dissolved minerals</td>
<td>367 ppm</td>
<td>383 ppm</td>
<td>373 ppm</td>
</tr>
</tbody>
</table>

### TABLE 39

**DISTRIBUTION OF VEGETATION STATION 16**

<table>
<thead>
<tr>
<th>Species</th>
<th>N</th>
<th>Frequency along tran. S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typha latifolia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azolla caroliniana</td>
<td></td>
<td>U</td>
</tr>
<tr>
<td>Lemma minor</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Spirodela polyrhiza</td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Cladophora sp.</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Ceratophyllum demersum</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Hydrodictyon sp.</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Polygonum coccineum</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Sparganium eurocarpum</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Scirpus validus</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along transect.
* A = abundant, F = frequent, O = occasional, U = ubiquitous

---

Fig. 17.—Plot of slough, station 16, showing location of transect
### TABLE 40

**PHYSICAL AND CHEMICAL FEATURES STATION 17**

<table>
<thead>
<tr>
<th>SW</th>
<th>Distance along transect in meters</th>
<th>NE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>05</td>
</tr>
<tr>
<td>temperature in degrees F.</td>
<td>top</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>bottom</td>
<td>71</td>
</tr>
<tr>
<td>water depth in meters</td>
<td>2</td>
<td>8.7</td>
</tr>
<tr>
<td></td>
<td>4 inches of depth</td>
<td>253 ppm</td>
</tr>
<tr>
<td></td>
<td>30 inches of depth</td>
<td>253 ppm</td>
</tr>
</tbody>
</table>

### TABLE 41

**DISTRIBUTION OF VEGETATION STATION 17**

<table>
<thead>
<tr>
<th>SW</th>
<th>Species</th>
<th>frequency along transect</th>
<th>NE</th>
<th>* Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Typha latifolia</td>
<td>-</td>
<td>-</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Solanum dulcamara</td>
<td>-</td>
<td>-</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Scirpus acutus</td>
<td>-</td>
<td>-</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Sparganium europaeum</td>
<td>-</td>
<td>-</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Cladophora sp.</td>
<td>-</td>
<td>-</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Ceratophyllum demersum</td>
<td>-</td>
<td>-</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Equisetum arvense</td>
<td>-</td>
<td>-</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Chara sp.</td>
<td>-</td>
<td>-</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Potamogeton folius</td>
<td>-</td>
<td>-</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Lemna minor</td>
<td>-</td>
<td>-</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Ranunculus aquatilis</td>
<td>-</td>
<td>-</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Potamogeton pectinatus</td>
<td>-</td>
<td>-</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Polygonum coccineum</td>
<td>-</td>
<td>-</td>
<td>O</td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along transect.

* A = abundant, F = frequent, O = occasional, U = ubiquitous, R = rare

Scale: 1" = 45 meters

Fig. 18.--Plot of farm pond showing location of transect.
TABLE 42

PHYSICAL AND CHEMICAL FEATURES STATION 18

<table>
<thead>
<tr>
<th>NE Distance along transect in meters</th>
<th>SW</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>05</td>
</tr>
<tr>
<td>temperature in degrees F.</td>
<td><strong>top</strong> 72 72 67 68 70 70 74</td>
</tr>
<tr>
<td>- 2.5 ppm dissolved O₂</td>
<td><strong>bottom</strong> 64 66 50 66 66 65</td>
</tr>
<tr>
<td>water depth in meters</td>
<td>1</td>
</tr>
<tr>
<td>upwelling of underground water</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>depth of 4&quot;</td>
</tr>
<tr>
<td>dissolved minerals</td>
<td>depth of 30&quot;</td>
</tr>
<tr>
<td>pH</td>
<td>depth of 4&quot;</td>
</tr>
<tr>
<td>dissolved minerals</td>
<td>depth of 30&quot;</td>
</tr>
</tbody>
</table>

TABLE 43

DISTRIBUTION OF VEGETATION STATION 18

<table>
<thead>
<tr>
<th>Species</th>
<th>NE Species frequency along transect</th>
<th>SW</th>
<th>Abundance*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spirodela polyrhiza</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Spirogyra sp.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cladophora sp.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Amacharis canadensis</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Zannichellia palustris</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ranunculus aquatilis</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Scirpus olneyi</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Phalaris arundinacea</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rorippa nasturtium-aquaticum</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Minimus guttatus</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Typha latifolia</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Potamogeton foliusus</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Scirpus acutus</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lemma minor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sium suave</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along transect.
* A = abundant, F = frequent, O = occasional, U = ubiquitous.

Fig. 19.—Plot of Big Dry Creek Station showing location of transect.
TABLE 44

PHYSICAL AND CHEMICAL FEATURES STATION 19

<table>
<thead>
<tr>
<th>Transect 1.</th>
<th>E</th>
<th>Distance along transect in meters</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>05 10 15 20 25 30 35 40 45 50</td>
<td></td>
</tr>
<tr>
<td>temperature in degrees F.</td>
<td>-72</td>
<td>71 70 68 67 65 67 67 67 67</td>
<td></td>
</tr>
<tr>
<td>water depth in cm.</td>
<td>-8.9--8.9--8.9--8.9 pH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ppm dissolved min.</td>
<td>559 ppm--559 ppm--559 ppm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transect 2.</th>
<th>E</th>
<th>Distance along transect in meters</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>05 10 15 20 25 30 35 40 45 50</td>
<td></td>
</tr>
<tr>
<td>temperature in degrees F.</td>
<td>-71</td>
<td>70 70 70 70 70 70 70 72 72</td>
<td></td>
</tr>
<tr>
<td>water depth in cm.</td>
<td>-8.8--8.8--8.8--8.8 pH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ppm dissolved min.</td>
<td>559 ppm--559 ppm--559 ppm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 45

DISTRIBUTION OF VEGETATION STATION 19

<table>
<thead>
<tr>
<th>Transect 1.</th>
<th>E</th>
<th>Species frequency along transect</th>
<th>W</th>
<th>*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>05 10 15 20 25 30 35 40 45 50 Abundance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scirpus acutus</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Potamogeton pectinatus</td>
<td>-</td>
<td>-</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Potamogeton latifolius</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Scirpus acutus</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Potamogeton pectinatus</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Potamogeton latifolius</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along transect.
* O = occasional, R = rare.

Fig. 20.—Plot of Utah Lake, station 19, showing location of transects.

Scale: 1" = 30 meters
TABLE 46

PHYSICAL AND CHEMICAL FEATURES STATION 20

<table>
<thead>
<tr>
<th>N Dist. along transect in meter E</th>
<th>0</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
<th>150</th>
<th>180</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>temp. in degrees F.</strong></td>
<td>72</td>
<td>74</td>
<td>74</td>
<td>74</td>
<td>74</td>
<td>74</td>
<td>75</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>8.9</td>
<td>9.3</td>
<td>9.4</td>
<td>9.3</td>
<td>8.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>bottom water depth in cm.</strong></td>
<td>25</td>
<td>68</td>
<td>70</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>73</td>
</tr>
<tr>
<td><strong>dissolved minerals along transect</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 21. -- Plot of Mudlake showing location of the transect.

TABLE 47

DISTRIBUTION OF VEGETATION STATION 20

<table>
<thead>
<tr>
<th>N</th>
<th>Species frequency along transect</th>
<th>E</th>
<th>Abundance*</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Scirpus acutus</td>
<td>F</td>
<td></td>
</tr>
</tbody>
</table>

* Each short section of line indicates the occurrence of the plant in a meter quadrangle along the transect. * F = frequent.

TABLE 48

PHYSICAL AND CHEMICAL FEATURES STATION 21

<table>
<thead>
<tr>
<th>S</th>
<th>Distance along transect in meters</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>temp. in degrees F.</td>
<td>84</td>
<td>84</td>
</tr>
<tr>
<td>pH</td>
<td>8.9</td>
<td>8.9</td>
</tr>
<tr>
<td>dissolved minerals</td>
<td>524 ppm</td>
<td>524 ppm</td>
</tr>
<tr>
<td>water depth in cm.</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 22. -- Plot of station 21 showing transect locations and plant occurrence.
### TABLE 49
PHYSICAL AND CHEMICAL FEATURES STATION 22

<table>
<thead>
<tr>
<th>Transect 1</th>
<th>E Distance along transect in meters</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 5 10 15 20 25 30</td>
<td></td>
</tr>
<tr>
<td>temp. in degrees F.</td>
<td>81 81 81 82 78 79 79</td>
<td></td>
</tr>
<tr>
<td>water depth in meters</td>
<td>8.4 pH 8.4 8.4 8.4</td>
<td>299 ppm dissolved minerals 299 ppm 299</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transect 2</th>
<th>E Distance along transect in meters</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 5 10 15 20 25 30</td>
<td></td>
</tr>
<tr>
<td>temp. in degrees F.</td>
<td>81 81 81 81 81 81 81</td>
<td></td>
</tr>
<tr>
<td>water depth in meters</td>
<td>5 5 5 5 5 5 5</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 50
DISTRIBUTION OF VEGETATION STATION 22

<table>
<thead>
<tr>
<th>E Species frequency along transect</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 05 10 15 20 25 30 Species Abundance*</td>
<td></td>
</tr>
<tr>
<td>Transect 1</td>
<td>Potamogeton latifolius</td>
</tr>
<tr>
<td>Transect 2</td>
<td>Potamogeton latifolius</td>
</tr>
<tr>
<td></td>
<td>Potamogeton crispus</td>
</tr>
</tbody>
</table>

* Lines indicate plant occurrence along transect.
* F = frequent, R = rare.

Scales: 1" = 15 meters main channel of river

--- Transect 1 ---

--- Transect 2 ---

shoreline

--- Fig. 23. -- Plot of Provo River, station 22, showing location of transect. ---
### TABLE 51

**PHYSICAL AND CHEMICAL FEATURES STATION 23**

<table>
<thead>
<tr>
<th>E</th>
<th>Distance along transect in meters</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>05 10 15 20 25 30 35 40</td>
<td></td>
</tr>
</tbody>
</table>

- **temp. in degrees F.**
  - top: 63 63 63 63 64 64 64 64
  - bottom: 63 63 63 63 64 64
- **dissolved O₂**
  - 3.1 ppm
- **pH**
  - 7.5 7.5 7.7 7.7 7.7 7.7 7.4
- **dissolved minerals**
  - 1.31 ppm 1.24 ppm 1.24 ppm 1.29 ppm

- **water depth in meters**
  - 1
- **depth of 2"**
  - dissolved minerals: 1.31 ppm 1.24 ppm 1.24 ppm 1.29 ppm
  - pH: 7.7 7.7 7.7 7.7 7.7
  - at the bottom: dissolved minerals 1.31 ppm 1.24 ppm 1.22 ppm 1.29 ppm

### TABLE 52

**DISTRIBUTION OF VEGETATION STATION 23**

<table>
<thead>
<tr>
<th>E</th>
<th>Species frequency along transect</th>
<th>W</th>
</tr>
</thead>
</table>
| 0 | 05 10 15 20 25 30 35 40          | Abundance*

- **Potamogeton gramineus** P
- **Sagittaria cuneata** P
- **Eleocharis palustris** P

* Lines indicate occurrence of plant along transect.
* P = frequent.

---

**Fig. 24.** Plot of Payson Lake, station 23, showing location of transect.
### TABLE 53

**PHYSICAL AND CHEMICAL FEATURES STATION 24**

<table>
<thead>
<tr>
<th>E Distance along tran., in m</th>
<th>0</th>
<th>05</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top temp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water depth</td>
<td>62</td>
<td>62</td>
<td>62</td>
<td>62</td>
<td>63</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>pH</td>
<td>7.5</td>
<td>----</td>
<td>----</td>
<td>7.4</td>
<td>----</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>Dissolved minerals</td>
<td>47</td>
<td>ppm</td>
<td>----</td>
<td>59</td>
<td>ppm</td>
<td>----</td>
<td>59</td>
</tr>
<tr>
<td>Bottom temp.</td>
<td>60</td>
<td>60</td>
<td>61</td>
<td>58</td>
<td>59</td>
<td>61</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 54

**DISTRIBUTION OF VEGETATION STATION 24**

<table>
<thead>
<tr>
<th>E Species frequency along tran.,</th>
<th>0</th>
<th>05</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>Species abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lemma minor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>U</td>
</tr>
<tr>
<td>Sparganium angustifolium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Potamogeton foliosus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Spirogyra sp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Limosella subulata</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along transect.  
* F = frequent; O = occasional, U = ubiquitous.

---

**Fig. 25.--Plot of Fayson Lake, station 24, showing location of transect.**
TABLE 55
DISTRIBUTION OF VEGETATION STATION 25

<table>
<thead>
<tr>
<th>S</th>
<th>Species frequency along transect</th>
<th>N</th>
<th>Species abundance*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>05</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Catabrosa aquatica</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Glyceria grandis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agrostis semiverticillata</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scirpus validus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Asolla caroliniana</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lemma minor</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Juncus balticus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chara sp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Potamogeton latifolius</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zannichellia palustris</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ranunculus circinatum</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spirogyra sp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phalaris arundinacea</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bidens cernua</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rorippa masturium-aquaticum</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Veronica anagallis-aquatica</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Typha latifolia</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Juncus torreyi</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anacharis canadensis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vaucheria sp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mimulus guttatus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sium sueve</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eleocharis macrostachya</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equisetum arvense</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lemna cyclosta</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Batrachospermum sp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scirpus pallidus</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

continued.....
Table 55 cont'd...

Species present at station, not distributed along transect. Abundance

<table>
<thead>
<tr>
<th>Species</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juncus longistylus</td>
<td>R</td>
</tr>
<tr>
<td>Scirpus acutus</td>
<td>O</td>
</tr>
<tr>
<td>Dactyloctenium sp.</td>
<td>O</td>
</tr>
<tr>
<td>Hygroamblystegium varium</td>
<td>R</td>
</tr>
<tr>
<td>Leptodictyum riparium</td>
<td>R</td>
</tr>
<tr>
<td>Fontinalis duriae</td>
<td>R</td>
</tr>
<tr>
<td>Scirpus microcarpus</td>
<td>O</td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along transect.
* A = abundant, F = frequent, O = occasional, R = rare.

### TABLE 56

**PHYSICAL AND CHEMICAL FEATURES STATION 25**

<table>
<thead>
<tr>
<th>S</th>
<th>Distance along transect in meters</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>05</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>----</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>61</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>58</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>7.5</td>
<td>7.4</td>
</tr>
<tr>
<td></td>
<td>290 ppm</td>
<td>290 ppm</td>
</tr>
</tbody>
</table>

Fig. 26.—Plot of Millrace, station 25, showing location of transect.
TABLE 57

PHYSICAL AND CHEMICAL FEATURES STATION 26

<table>
<thead>
<tr>
<th>SE distance along transect in meters</th>
<th>NW</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05</td>
<td>68</td>
</tr>
<tr>
<td>10</td>
<td>68</td>
</tr>
<tr>
<td>15</td>
<td>70</td>
</tr>
<tr>
<td>20</td>
<td>70</td>
</tr>
<tr>
<td>25</td>
<td>70</td>
</tr>
<tr>
<td>30</td>
<td>70</td>
</tr>
</tbody>
</table>

Temperature in degrees F.

- Top: 68 68 70 70 70 70
- Bottom: 66 66 66 66 66

pH and dissolved min.:
- 3 = 8.4, 8.3, 8.3
- ppm: 457, 460, 450

At depth of 20" water depth in meters:
- 5
- 6

TABLE 58

DISTRIBUTION OF VEGETATION STATION 26

<table>
<thead>
<tr>
<th>Species</th>
<th>SE Species freq. along transect</th>
<th>NW</th>
<th>* Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lemna cycloptasa</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Azolla caroliniana</td>
<td></td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Ceratophyllum demersum</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Myriophyllum verticillata</td>
<td></td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Potamogeton pectinatus</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Potamogeton foliosus</td>
<td></td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Cladophora sp.</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Scirpus acutus</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Scirpus olneyi</td>
<td></td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Typha latifolia</td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along transect.
* F = frequent, O = occasional, R = rare.

Fig. 27.—Plot of Ironton Pond showing location of transect.
TABLE 59

PHYSICAL AND CHEMICAL FEATURES STATION 27

<table>
<thead>
<tr>
<th>NW</th>
<th>Distance along transect in meters</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>05</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>temp.</td>
<td>top -</td>
<td>5.4 ppm dissolved oxygen</td>
</tr>
<tr>
<td>bot.</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>water depth in cm.</td>
<td>-150</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>8.6</td>
<td>8.6</td>
</tr>
<tr>
<td>dissolved minerals</td>
<td>113 ppm</td>
<td>113 ppm</td>
</tr>
</tbody>
</table>

TABLE 60

DISTRIBUTION OF VEGETATION STATION 27

<table>
<thead>
<tr>
<th>NW</th>
<th>Species frequency along transect</th>
<th>SE</th>
<th>Abundance*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>05</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Chara sp.</td>
<td></td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Ceratophyllum demersum</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Potamogeton pectinatus</td>
<td></td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Potamogeton foliosus</td>
<td></td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Potamogeton latifolius</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along transect.
F = frequent, O = occasional, U = ubiquitous.

Scales 1" = 30 meters

Fig. 28. -- Plot of Vivian Park Pond showing location of transect.
TABLE 61
PHYSICAL AND CHEMICAL FEATURES STATION 28

<table>
<thead>
<tr>
<th>W</th>
<th>Distance along transect in meters</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 05 10 15 20 25 30 35 40 45</td>
<td></td>
</tr>
<tr>
<td>temperature top in degrees F</td>
<td>64 62 62 56 58 64 64 60 60 60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>botton</td>
<td>60 57 56 53 52 52 50</td>
</tr>
<tr>
<td>pH</td>
<td>8.8--8.0</td>
<td></td>
</tr>
<tr>
<td>minerals</td>
<td>180 ppm--236 ppm</td>
<td></td>
</tr>
<tr>
<td>water depth in cm.</td>
<td>- - - - - - - -</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 62
DISTRIBUTION OF VEGETATION STATION 28

<table>
<thead>
<tr>
<th>W</th>
<th>Species</th>
<th>frequency along transect</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 05 10 15 20 25 30 35 40 45</td>
<td>Abundance *</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rorippa nasturtium-aquaticum</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cladophora sp.</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lemma minor</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chara sp.</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Berula erecta</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spirogyra sp.</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zannichellia palustris</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hippurus vulgar</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ranunculus circinatus</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mimulus guttatus</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Typha latifolia</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scirpus acutus</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

* and * See table 60.

Fig. 29.--Plot of Burt Spring Pond showing location of transect.

Scale: 1"= 45 meters
TABLE 63

PHYSICAL AND CHEMICAL FEATURES STATION 29

<table>
<thead>
<tr>
<th>W</th>
<th>Distance along transect in meters</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>05</td>
<td>10</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>67</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>67</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>498 ppm - 308 ppm - 308 ppm - 308 ppm - 308 ppm - dissolved minerals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>62</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>water depth in meters</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 30.--Plot of Salem Pond Station showing location of transect.
TABLE 65

PHYSICAL AND CHEMICAL FEATURES STATION 30

<table>
<thead>
<tr>
<th>W</th>
<th>Distance along discontinuous transect in meters</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>05</td>
<td>10 15→175→190 195 200 205 210 215 220 225</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>68 68</td>
</tr>
<tr>
<td></td>
<td>8.4-pH----------------------------------------</td>
<td>8.3------</td>
</tr>
<tr>
<td></td>
<td>201 ppm dissolved-----------------------------</td>
<td>238 ppm--</td>
</tr>
<tr>
<td></td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>1</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>water temp., in degrees F.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>water depth in meters</td>
<td></td>
</tr>
</tbody>
</table>

---

Fig. 31.—Plot of Genola Reservoir showing location of transect.

---

TABLE 66

DISTRIBUTION OF VEGETATION STATION 30

<table>
<thead>
<tr>
<th>W</th>
<th>Species frequency along discontinuous transect</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>05</td>
<td>10 15→175→190 195 200 205 210 215 220 225</td>
</tr>
<tr>
<td></td>
<td>Potamogeton pectinatus</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Potamogeton foliosus</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Potamogeton nodosus</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Cladophora sp.</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Zannichellia palustris</td>
<td>F</td>
</tr>
</tbody>
</table>

† Lines indicate occurrence of plant along transect.

* F = frequent, O = occasional.

Scale: 1"=70 meters
TABLE 67
PHYSICAL AND CHEMICAL FEATURES STATION 31

<table>
<thead>
<tr>
<th>E</th>
<th>Distance along transect in meters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>top</td>
<td>74</td>
</tr>
<tr>
<td>bottom</td>
<td>72</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>temperature in degrees F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>top</td>
</tr>
<tr>
<td>bottom</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dissolved O₂ ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.7 ppm dissolved O₂</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>water depth in meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.8----7.8----7.8 pH</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dissolved minerals ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>601 ppm---601 ppm---601 ppm</td>
</tr>
</tbody>
</table>

TABLE 68
DISTRIBUTION OF VEGETATION STATION 31

<table>
<thead>
<tr>
<th>Species</th>
<th>E Species frequency</th>
<th>Abundance *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ruppia maritima</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Potamogeton pectinatus</td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Spirogyra sp.</td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Typha angustifolia</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Scirpus olneyi</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along transect.

* A = abundant, F = frequent, 0 = occasional.

![Diagram](N transect)

Scale: 1" = 10 meters

Fig. 32.--Plot of Goshen Warm Spring Station showing location of transect.
### TABLE 69

**PHYSICAL AND CHEMICAL FEATURES STATION 32**

<table>
<thead>
<tr>
<th>Transect 1.</th>
<th>Distance along transect in meters</th>
<th>Transect 2.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>0 05 10 15 20 25 30 35</td>
<td>E W</td>
<td></td>
</tr>
<tr>
<td></td>
<td>66 66 66 66 67 67 67 68 top</td>
<td>66 66 66</td>
<td></td>
</tr>
<tr>
<td></td>
<td>65 65 65 65 65 65 65 bottom</td>
<td>current speed</td>
<td>.2 meter/sec.</td>
</tr>
<tr>
<td></td>
<td>64</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 water depth in meters</td>
<td>.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>at top 8.4 pH--------------------8.4----------------------------------8.2------------------8.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>498 ppm dissolved-----------------498 ppm----------------------------498 ppm-----------------498 ppm minerals</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bottom 7.8 pH--------------------8.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>498 ppm dissolved-----------------498 ppm----------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>minerals</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 70**

**DISTRIBUTION OF VEGETATION STATION 32**

<table>
<thead>
<tr>
<th>Transect 1</th>
<th>Transect 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>0 05 10 15 20 25 30 35</td>
</tr>
<tr>
<td>Chara sp.</td>
<td>- 0</td>
</tr>
<tr>
<td>Potamogeton pectinatus</td>
<td>- 0</td>
</tr>
<tr>
<td>Potamogeton nodosus</td>
<td>- - - - - - - - - - - F</td>
</tr>
<tr>
<td>Zannichellia palustris</td>
<td>-</td>
</tr>
<tr>
<td>Scirpus acutus</td>
<td>- A</td>
</tr>
<tr>
<td>Typha latifolia</td>
<td>A</td>
</tr>
<tr>
<td>Typha angustifolia</td>
<td>A</td>
</tr>
<tr>
<td>Ruppia maritima</td>
<td>- - - - - F</td>
</tr>
</tbody>
</table>

* Lines indicate occurrence of plant along transect.  
  * A = abundant, F = frequent, O = occasional.

---

![Diagram](image)

**Fig. 33.**--Plot of Goshen Reservoir Station showing location of transects.
TABLE 71

PHYSICAL AND CHEMICAL FEATURES STATION 33

<table>
<thead>
<tr>
<th>Species frequency along transect</th>
<th>W</th>
<th>0</th>
<th>05</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>E Abundance *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lemna trisulca</td>
<td></td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Lemna minor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>U</td>
</tr>
<tr>
<td>Chara sp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>U</td>
</tr>
<tr>
<td>Typha latifolia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>Berula erecta</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Bidens cernua</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Ceratophyllum demersum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Mimulus guttatus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>O</td>
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</tbody>
</table>

* Lines indicate occurrence of plant along transect.

Fig. 34.—Plot of Goshen Pothole, station 33, showing location of transect.
<table>
<thead>
<tr>
<th>Species</th>
<th>Hydrogen-ion Concentration</th>
<th>Soluble Salts in ppm</th>
<th>Temperature°F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Greatest Abundance</td>
<td>Range</td>
</tr>
<tr>
<td>Free-floating Aquatics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cladophora spp.</td>
<td>6.9-9.0</td>
<td>7.4-8.4</td>
<td>190-679</td>
</tr>
<tr>
<td>Spirogyra spp.</td>
<td>7.2-8.8</td>
<td>7.4-7.8</td>
<td>59-750</td>
</tr>
<tr>
<td>Azolla caroliniana</td>
<td>7.4-8.2</td>
<td>7.9</td>
<td>290-385</td>
</tr>
<tr>
<td>Spirodea polycyathia</td>
<td>7.3-8.1</td>
<td>8.0</td>
<td>299-498</td>
</tr>
<tr>
<td>Lemna cyclostada</td>
<td>7.4-9.0</td>
<td>7.4</td>
<td>290</td>
</tr>
<tr>
<td>Lemna minor</td>
<td>7.2-9.0</td>
<td>7.2-7.9</td>
<td>47-740</td>
</tr>
<tr>
<td>Lemna trisulca</td>
<td>7.2-7.3</td>
<td>* FR</td>
<td>498-740</td>
</tr>
<tr>
<td>Submerged Aquatics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chara spp.</td>
<td>6.0-8.8</td>
<td>8.0-8.6</td>
<td>113-740</td>
</tr>
<tr>
<td>Vaucheria spp.</td>
<td>7.4-8.2</td>
<td>7.5</td>
<td>190-290</td>
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<td>7.7-8.4</td>
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<tr>
<td>Potamogeton nodosus</td>
<td>7.8-8.3</td>
<td>* FR</td>
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<td>Potamogeton foliosus</td>
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<td>7.2-8.2</td>
<td>47-498</td>
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<tr>
<td>Ruppia maritima</td>
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<td>7.8</td>
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<tr>
<td>Zannichellia palustris</td>
<td>7.2-8.8</td>
<td>7.7-8.0</td>
<td>180-498</td>
</tr>
<tr>
<td>Elodea canadensis</td>
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<td>7.2-7.4</td>
<td>190-344</td>
</tr>
<tr>
<td>Ceratophyllum demersum</td>
<td>7.2-9.0</td>
<td>* FR</td>
<td>113-679</td>
</tr>
<tr>
<td>Ranunculus aquatilis</td>
<td>7.3-8.9</td>
<td>* FR</td>
<td>180-303</td>
</tr>
<tr>
<td>Ranunculus circlinatus</td>
<td>7.4-8.9</td>
<td>* FR</td>
<td>180-290</td>
</tr>
<tr>
<td>Myriophyllum</td>
<td>8.2-9.0</td>
<td>8.9</td>
<td>324-679</td>
</tr>
<tr>
<td>Verticillatrum</td>
<td>7.9-8.2</td>
<td>8.2</td>
<td>324-498</td>
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<tr>
<td>Emergent Marsh Aquatics</td>
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<td>Typha angustifolia</td>
<td>7.3-8.1</td>
<td>7.4</td>
<td>715-740</td>
</tr>
<tr>
<td>Typha latifolia</td>
<td>7.1-8.9</td>
<td>7.5-8.2</td>
<td>180-679</td>
</tr>
<tr>
<td>Sagittaria cuneata</td>
<td>6.9-8.1</td>
<td>* FR</td>
<td>122-433</td>
</tr>
<tr>
<td>Scirpus acutus</td>
<td>7.3-9.4</td>
<td>9.0</td>
<td>312-750</td>
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<td>Scirpus olney</td>
<td>8.0</td>
<td>8.0</td>
<td>319</td>
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<td>Scirpus validus</td>
<td>6.9-7.1</td>
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<td>220-260</td>
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<tr>
<td>Scirpus palludosus</td>
<td>7.3-8.0</td>
<td>8.0</td>
<td>319-750</td>
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<tr>
<td>Polygonum cucineum</td>
<td>7.9-8.9</td>
<td>* FR</td>
<td>213-383</td>
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</table>

* FR = Full range of conditions shown.

† Degrees Fahrenheit

Continued........
TABLE 7.3—Continued

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<tr>
<th>Species</th>
<th>Hydrogen-ion Concentration</th>
<th>Soluble Salts in ppm</th>
<th>Temperature°F</th>
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<tbody>
<tr>
<td></td>
<td>Greatest Range</td>
<td>Abundance</td>
<td>Greatest Range</td>
</tr>
<tr>
<td>Rorippa nasturtium-aquaticum</td>
<td>6.9-8.8</td>
<td>7.0-8.0</td>
<td>180-319</td>
</tr>
<tr>
<td>Hippurus vulgaris</td>
<td>8.0-8.1</td>
<td>8.1</td>
<td>236-240</td>
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<tr>
<td>Sium suave</td>
<td>7.4-8.1</td>
<td>8.1</td>
<td>290</td>
</tr>
<tr>
<td>Berula erecta</td>
<td>6.9-8.2</td>
<td>6.9-7.2</td>
<td>236-498</td>
</tr>
<tr>
<td>Bidens cernua</td>
<td>7.2-8.1</td>
<td>7.2</td>
<td>290-498</td>
</tr>
</tbody>
</table>

* FR = Full range of conditions shown.

† Degrees Fahrenheit
TABLE 74

AREA FREQUENCY OF AQUATIC PLANT SPECIES
AND THEIR DISTRIBUTION BY STATION

<table>
<thead>
<tr>
<th>Species Sample Presence and Scientific Name</th>
<th>Distribution by Station Number</th>
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<td></td>
<td>123456789 123456789 123456789 123</td>
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</table>

Thallophyta (algae)

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<tr>
<th>Species</th>
<th>Distribution</th>
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<tbody>
<tr>
<td>Batrachospernum sp.</td>
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<tr>
<td>Cladophora sp.</td>
<td>-</td>
</tr>
<tr>
<td>Chaetophora sp.</td>
<td>-</td>
</tr>
<tr>
<td>Chara spp.</td>
<td>-</td>
</tr>
<tr>
<td>Drepanalidja sp.</td>
<td>-</td>
</tr>
<tr>
<td>Enteromorpha sp.</td>
<td>-</td>
</tr>
<tr>
<td>Hydrodictyon sp.</td>
<td>-</td>
</tr>
<tr>
<td>Nostoc sp.</td>
<td>-</td>
</tr>
<tr>
<td>Spirogyra spp.</td>
<td>-</td>
</tr>
<tr>
<td>Stigonema sp.</td>
<td>-</td>
</tr>
<tr>
<td>Tetraspora sp.</td>
<td>-</td>
</tr>
<tr>
<td>Ulothrix sp.</td>
<td>-</td>
</tr>
<tr>
<td>Vaucheria sp.</td>
<td>0 10 20 30</td>
</tr>
</tbody>
</table>

Bryophyta

<table>
<thead>
<tr>
<th>Species</th>
<th>Distribution</th>
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</thead>
<tbody>
<tr>
<td>Amblystegium varium (Hedw.) Lindb.</td>
<td>-</td>
</tr>
<tr>
<td>Brachythecium populeum (Hedw.) B.&amp;S.</td>
<td>-</td>
</tr>
<tr>
<td>Brachythecium rivulare Bry. Kuv.</td>
<td>-</td>
</tr>
<tr>
<td>Cratoneuron filicinium (Hedw.) Roth</td>
<td>-</td>
</tr>
<tr>
<td>Drapanocladus aduncus (Bland) Warnst.</td>
<td>-</td>
</tr>
<tr>
<td>Drapanocladus revolvens (SW.;C.M.) Warnst. forma-</td>
<td>-</td>
</tr>
<tr>
<td>Fontinalis duriae Schimp.</td>
<td>-</td>
</tr>
<tr>
<td>Funaria hygrometrica Grout.</td>
<td>-</td>
</tr>
<tr>
<td>Hygroamblystegium irrigium (Wils.) Loeske.</td>
<td>-</td>
</tr>
<tr>
<td>Hydrohypnum bestii (Ren. &amp; Bryhn.) Broth.</td>
<td>-</td>
</tr>
<tr>
<td>Leptodictyum riparium (Schultz) Grout.</td>
<td>-</td>
</tr>
<tr>
<td>Riccia fluitans L.</td>
<td>-</td>
</tr>
<tr>
<td>Ricciocarpus natans (L.) Corda</td>
<td>0 10 20 30</td>
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</table>

Pteridophyta

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Distribution</th>
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<td>Salviniaidae</td>
<td>Azolla caroliniana Willd.</td>
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<td>Equisetaceae</td>
<td>Equisetum arvense L.</td>
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Continued........
<table>
<thead>
<tr>
<th>Species Name: Presence and Scientific Name</th>
<th>Distribution by Station Number</th>
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<tbody>
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<tr>
<td>Spermatophyta</td>
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<tr>
<td><em>Typhaceae</em></td>
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<tr>
<td>0.15 <em>Typha angustifolia</em> L.</td>
<td>---</td>
</tr>
<tr>
<td>0.51 <em>Typha latifolia</em> L.</td>
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<tr>
<td><em>Sparganiaceae</em></td>
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<tr>
<td>0.03 <em>Sparganium angustifolium</em> Michx.</td>
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</tr>
<tr>
<td>0.06 <em>Sparganium eurocarpum</em> Engelm.</td>
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<tr>
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<tr>
<td><em>Sparganium minimum</em> Fries.</td>
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<tr>
<td>0.03 <em>Sparganium multipedunculatum</em> (Morong)</td>
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</tr>
<tr>
<td><em>Najadaceae</em></td>
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<tr>
<td>0.03 <em>Potamogeton alpinus</em> Balbis</td>
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</tr>
<tr>
<td>0.03 <em>Potamogeton crispus</em> L.</td>
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</tr>
<tr>
<td>0.03 <em>Potamogeton gramineus</em> L.</td>
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<tr>
<td>0.27 <em>Potamogetonfoliosus</em> Raf.</td>
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</tr>
<tr>
<td>0.24 <em>Potamogeton latifolius</em> (Robbins)</td>
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<td>0.03 <em>Alisma-plantago-aquatica</em> L.</td>
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<td>0.18 <em>Sagittaria cuneata</em> Sheldon</td>
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<td><em>Gramineae</em></td>
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<tr>
<td>0.03 <em>Glyceria borealis</em> (Nash) Batchelder</td>
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<td><em>Glyceria elata</em> (Nash.) Hitch.</td>
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<td>0.03 <em>Phalaris arundinacea</em> L.</td>
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<td><em>Phragmites communis</em> Trin</td>
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<td><em>Poa pratensis</em> L.</td>
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Continued........}
<table>
<thead>
<tr>
<th>Species Name</th>
<th>Scientific Name</th>
<th>Distribution by Station Number</th>
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<td><strong>Cyperaceae</strong></td>
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<td>Dewey</td>
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<td>0.03 Carex retrorsa</td>
<td>Schw.</td>
<td></td>
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<tr>
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<td>(L.) R. &amp; S.</td>
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<tr>
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<td>Britt.</td>
<td></td>
</tr>
<tr>
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<td>(L.) R. &amp; S.</td>
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<tr>
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<td>Gray</td>
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<tr>
<td>0.03 Scirpus pallidus</td>
<td>(Britt.) Fernald</td>
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</tr>
<tr>
<td>0.06 Scirpus paludosus</td>
<td>(Britt.) Fernald</td>
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<td>(Engelm.) Greene.</td>
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<td><strong>Ranunculaceae</strong></td>
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<td>0.09 Ranunculus circinatus</td>
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<td>L.</td>
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<td>** Cruciferae**</td>
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<td>0.24 Rorippa nasturtium-aquaticum</td>
<td>R. Br.</td>
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Ecological Notes of Principal Aquatic Plants

Free-floating Aquatic Plants

**Cladophora** sp.--Cladophora was found to be one of the most widely distributed alga investigated. It was found in streams attached to rocks trailing in the current and in many ponds and streams and sloughs as a dense covering at the water surface. Water conditions of the lower Provo River between the mouth of Provo canyon and 16th South Street, Provo, were especially favorable for the species. Its growth in the Jordan River pothole was best for quiet-water habitats. It was never noted in highly turbid waters. The study shows that the plant grew best in clear water, exposed to full sunlight, and where the water temperature didn't exceed about 75 degrees. In some such cases, the plant growth proceeded so rapidly that surface filaments were pushed up out of the water where they dried leaving a white cast covering the green layers below. Ponds that were stagnant sustained only a limited cladophora growth. Its low frequency of occurrence and almost rare abundance at sites of moderate to heavy water turbidity might be explained by the reduced light available to a plant even a few inches under the water surface. Many highly turbid waters are also subject to considerable wind, which might be unfavorable for growth of cladophora.

**Spirogyra** spp.--No effort was made to identify the spirogyra collections to the species level. Microscopic observations showed filaments and cells to vary greatly among the collections indicating the presence of more than a single species. The most obvious and perhaps important limiting condition for these species was turbidity. It was limited in distribution to clear water where it usually grew at or near
the bottom in cushion masses. It was not noted in stagnant water. In five or six stations it was found in waters having a slight water flow. It was located in waters having a wide range of soluble salt concentration, from 59 to 750 ppm where the temperature didn't exceed 72 degrees. Its low frequency of 0.18 could be explained by the paucity of aquatic sites in the area that meet its requirement or to the time of year when observations were made.

*Azolla caroliniana*—This species grew luxuriantly and abundantly at the roadside slough at station 16. Here, the water surface was fully exposed to the direct rays of the sun and a mild current mixed the waters of the slough. The waters there were mildly basic, about 7.4 to 8.0 and cool. Conditions at this site seemed particularly suited for this species.

*Spirodela polyrhiza*—Spirodela was distributed exclusively in low-land waters not subject to stagnation. It was associated with *Lemna minor*, cladophora and azolla in many instances. In no case was it observed to be the dominant species. It flourished best under full sunlight where the waters were not highly turbid.

*Lemna cyclostata*—This was a very uncommon species. It flourished best at the Ironton Pond station. It formed an almost continuous cover over many of the rivulets that arose from a seep which flowed into the pond. The waters there were well shaded, cool, mildly basic, and low in soluble salts.

*Lemna minor*—Lemna was widely distributed among ponds, sloughs, lakes and protected streamsides of the study area. Its record-high frequency of 0.48 was exceeded only by *Typha latifolia* and *Scirpus acutus*. It flourished in waters of both high and low soluble salt concentrations. The waters where it grew were cool, in the mid-sixty temperature range, where it was moderately basic at about 7.4. Lemna was usually absent from highly
turbid waters. The species grew well in shaded as well as open areas. The waters of station 24 at Payson Lake sustained the species better than any others of the study. For three successive years the writer has observed an almost complete Lemna cover over the lake surface by mid-August.

Submerged Aquatic Plants

*Chara* spp.--Stonewort was the most widely distributed submerged aquatic of the study. Where present it formed a nearly complete mat over the bottom of the site. A silt or muck bottom soil seems necessary for its growth. It flourished best in shallow waters of low turbidity where the water surface barely covered the uppermost thalli. *Chara* was one of the few aquatics encountered that grew in stagnant waters. Growth was successful through a wide range of hydrogen-ion and soluble salt concentrations. It was most abundant in the cooler waters ranging from 52 to 74 degrees Fahrenheit. *Chara* was one of the few aquatics investigated that was often very abundant in waters having a very high concentration of soluble salts. *Chara* was noted in the pothole at station 15 in 1954 where a soluble salt determination of 1,041 ppm was taken.

*Vaucheria* sp.--This species was observed only in the American Fork and Provo River drainage areas. In these areas it was limited to shallow, sunlit waters that were largely free of turbidity. In most instances it formed a dark green mass over the silted stream bottom.

*Potamogeton pectinatus*--This species was widely distributed throughout the study area. It was found to grow well in a wide range of physical and chemical conditions. It flourished best in a number of farm pond situations where the turbidity was low. It was one of the few aquatics that grew in Utah Lake. Although it was widely distributed, it rarely became very abundant at any site. It grew best at the farm pond at station
17. A silted bottom seems necessary for its growth. It showed poor growth in stagnant situations.

**Potamogeton latifolius**—This species showed two striking differences in distribution with **Potamogeton pectinatus**. First, it was much more common in streams and, secondly, it was more widely distributed and abundant in Utah Lake. Its most luxuriant growth was observed near the wooden dam on Provo River at station 14. Here the shoots exceeded 1.5 meters in length. Its most limited growth was noted along the fluctuating eastern shoreline of Utah Lake. It was the only submerged aquatic noted in the Jordan River. The physical conditions of the waters where it grew were essentially the same as for **Potamogeton pectinatus**. Contrasting with **Potamogeton pectinatus**, however, it grew successfully in gravel and sand associated with many of the streams of the east side of the valley.

**Potamogeton nodosus**—This species was found exclusively in Goshen and Genola Reservoirs. Both habitats ranged from 7.8 to 8.3 in hydrogen-ion concentration, from 63 to 65 degrees in temperature, while the dissolved mineral concentration at Goshen Reservoir was about 230 ppm. and near 500 ppm. at Genola Reservoir. There was a definite decrease in its abundance at a water depth of 1.5 meters on the east end of the Genola site even though the adjoining waters were chemically and physically similar. It was found in the shallow waters of the Goshen Reservoir which were much more turbid. It was rooted in ponds having bottoms of silt soil which had open, unshaded surface waters.

**Potamogeton foliosus**—This species occurred only in waters having temperatures in the mid-sixty range where the turbidity was low. It made robust growth in the Genola Reservoir. In no instances was it observed in waters having higher than 500 ppm. of soluble salts. Its distribution seemed
little effected by the hydrogen-ion concentration of the water. An unusual feature of its growth is its ability to grow in deep water. Shoots were collected at Payson Lake from a water depth of 2.4 meters which exceeded this length by a tenth of a meter.

*Ruppia maritima.*--This species, known as, widgeon grass, was noted at only two stations. Its best growth was made in the rock bottomed sections of the Goshen Warm Springs where it was growing abundantly. The waters there remain about 70 degrees the year around and are very low in turbidity, though high in soluble salts at 600 ppm. It seems to be able to tolerate turbid waters as shown by its presence in the outflow canal of the Goshen Reservoir, perhaps the most turbid site in the study area. Ruppia was found too infrequently to obtain much information about the physical factors controlling its distribution.

*Zannichellia palustris.*--The most striking feature of the distribution of this species is its frequent and robust growth made in many clear-water sites. When present in turbid waters it was confined to the shoreline areas in water no more than a few inches in depth. The growth of zannichellia in abundance was definitely correlated with cool water, mild alkalinity and low soluble salt concentrations.

*Elodea canadensis.*--Elodea was found exclusively in the lower Provo River drainage below the Carterville Bridge and some of the irrigation canals near Utah Lake. It formed a dense mat over the surface waters of Big Dry Creek at station 18. Many irrigation canals in southwest Provo where the water was derived from Provo River contained elodea. Mildly basic waters seem most suited for this species where cool in temperature and where the soluble salts are light to moderate. In no instances was it found in any but running water situations.
**Ceratophyllum demersum.**—The species was distributed in waters of light to moderate turbidity usually in ponds but occasionally in streams as well. It grew best in the slough at station 11. Good growth was noted for the species over a wide range of water conditions. A muck or silt type soil was noted in every instance of its presence.

**Ranunculus aquatilis.**—This species was abundantly distributed in Provo River below the Deer Creek Dam for a distance of several miles where submerged sand bars remained from deposition. In this area it formed dense mats trailing in the water. The waters were cool, low in soluble salts and mildly basic. When present in turbid waters it was confined to shoreline areas where it tended to encroach over the pond surface. It occurred less abundantly at six additional stations.

**Ranunculus circinatus.**—This species occurred in waters essentially the same as those of Ranunculus aquatilis only less abundantly and less frequently.

**Myriophyllum verticillatum.**—This species was the only submerged aquatic observed that was limited to the waters of moderate to heavy soluble salt concentrations. It grew best in Ironton and Jordan Oxbow Ponds. In every instance, its occurrence was in waters about 60 degrees in temperature that were very alkaline in nature. When the plant was shaded its growth was greatly retarded. It grew well in rocky and silt soils as well.

**Urtricularia minor.**—Bladderwort was noted at only two stations, the West Lehi Pond and Salem Pond. In both cases it frequented shaded waters near the shoreline where there was moderate alkalinity and soluble salts. The plant body was noted to be very delicate and might easily become broken by heavy current or wave action. Few sites in the study area seemingly offer the protected waters required by this species.
Emergent Aquatic Plants

**Typha latifolia.**--This cattail species shared its high frequency of 0.51 with *Scirpus acutus*. It was found around well established ponds, streams, and sloughs. It grew best in the waters of the upper 70 degree temperature where the hydrogen-ion concentration was moderately basic and the soluble salts ranged between 300 and 400 ppm. This species occurred in both silt and rocky areas where the water conditions were suitable. The largest single stand of the species was at the south margin of Goshen Reservoir where the water was shallow throughout a rather wide bay.

**Typha angustifolia.**--This species was much less widely distributed than *Typha latifolia*. Its best growth was noted on the west shoreline of Utah Lake at station 6 where an artesian spring enters the lake. Here, a broad stand of plants covered the area through which the stream water passed as it flowed toward the lake. The waters were mildly basic but very high in soluble salts. In half of the stations where the species was present there was an artesian water source. In every instance, its occurrence was associated with very high soluble salt concentrations.

**Sagittaria cuneata.**--There was a clear correlation between arrowleaf abundance and mildly basic waters where the soluble salts did not exceed 400 ppm. Waters around the species were cool by area standards. In every instance it grew in a muck soil. The roots are white and very delicate and probably require a soft soil for successful growth. The plants always grew in open areas away from shade. The plant often grows in shallow stagnant pools of tepid water.

**Scirpus olneyi.**--There was a correlation between artesian waters and the presence and abundance of this species. All but the Big Dry Creek station it was associated with water from underground flows. At station
6 and 26 it grew in thick stands where the water rose to the ground surface and flowed to lower elevations. It was not observed in turbid, warm waters. It was noted in waters having a wide range of soluble salt concentrations where the hydrogen-ion concentration was near 8.0.

**Scirpus validus.**—This species was present at only three stations. In each case it occurred in running waters that were cold, mildly basic and low in soluble salts. The waters of all three stations were derived from the Provo River.

**Scirpus asutus.**—This was the most abundant aquatic of the study having a frequency of 0.51. In most cases it was the dominant aquatic at any location. It showed a definite requirement for a silt or muck soil for proper growth. Utah Lake shoreline areas seemed the best habitat for the species judging from its abundance there. It was the only species observed in the Mud Lake-arm of Utah Lake where the highest turbidity of the study was noted. It was rarely abundant at clear water sites perhaps due to competition with other aquatics which are more abundant in waters of low turbidity. The species either required or tolerated high soluble salt concentrations in the waters around it. It occurred predominately in very basic waters and is somewhat tolerant of a fluctuating water level. It grows best in very basic waters of high soluble salts associated with a silt soil.

**Scirpus paludosus.**—This somewhat rare scirpus was noted at only two stations. In both instances it occurred in shallow watered channels fed by mildly basic artesian waters which were low in turbidity. The soluble salts varied from 320 ppm, in one instance, to 750 ppm in another. Both habitats were exposed to full sunlight and were protected from the wind by soil banks. The few sites offering these conditions perhaps explains
its low frequency of 0.06.

**Polygonum amphibium.** Where present this aquatic was never noted as more than occasional in abundance. It was present in a wide range of water conditions. In each instance it was growing in waters moderate to high in hydrogen-ion concentration. It was always associated with the shoreline area or in a place of shallow water.

**Rorippa nasturtium-aquaticum.** This aquatic was limited in distribution to cold clear-water sites with waters low in soluble salts that were free of turbidity. Water of low hydrogen-ion concentration was also characteristic. It grew best in waters that were subject to flow. The plant was found to be very shade tolerant.

**Sium suave.** The conditions where this species grew were essentially the same as for **Rorippa nasturtium-aquaticum** although it was much less frequent.

**Berula erecta.** The conditions under which this species grew were about the same as those for **Rorippa nasturtium-aquaticum.** It was much more frequent and abundant than **Sium suave.**

**Mimulus guttatus.** The habitat requirements for mimulus was very similar to the above three species except that it occurs in more open areas exposed to full sunlight and was exclusively found associated with shallow running streams that were never more than moderately basic.

**Hippurus vulgaris.** Marestails in every instance was noted only in waters of artesian nature where the water was cold. Its presence was highly correlated with waters of low soluble salts, moderate alkalinity and low turbidity.
CHAPTER IV

DISCUSSION

Aquatic species occur where they do because of the opportunity for successful migration and favorable physical conditions. Although this study concerns primarily the latter factors, migration possibilities will be briefly evaluated. The study area is small and aquatic plants generally are widely dispersed and easily disseminated, yet it has many "open" areas which are free of much competition, a condition useful for species establishment. The waters are highly variable as to physical and chemical characteristics. Relatively little runoff water leaves the area after reaching the valley floor. The phoresis of many seeds is accomplished by resident and migratory wildfowl common to the area. Scores of man-made irrigation canals serve to further disseminate the species.

Favorable conditions for the growth of aquatic plants were shown by this study to consist of water that is relatively free of turbidity, cool, and not subject to stagnation. Furthermore, the most suitable hydrogen-ion concentration was from 7.2 to 8.0 and the soluble salt concentration up to about 600 ppm.

Measurement of certain physical and chemical characteristics of the waters of central Utah revealed considerable diversity among its wetland areas. Hydrogen-ion concentrations varied from 6.9, at places along the Provo River, to a high of 9.4 in Mud Lake, south of Provo. Soluble salts were in very low concentrations at Payson Lake where a concentration of 47 ppm. was found. In contrast, the high concentration of 750 ppm. was noted at the Goshen Reservoir. Most temperature readings were taken between 9:00 AM and 3:00 PM during the month of August. The coolest waters were
those of artesian sources such as at Burt Spring Pond at the mouth of Hobble Creek Canyon where a low temperature of 52 degrees was found. Utah Lake water in shallow western shore areas often rose to 90 degrees by mid-afternoon. Mud Lake and Goshen Reservoir were the most turbid sites visited. The waters of Provo and American Fork Rivers were generally very clear as were most artesian waters. Artesian flows, though cold and low in turbidity, were generally high in soluble salts. The artesian wells had hydrogen-ion concentrations of 7.4 to 8.2.

The hydrogen-ion concentration of water influences the availability of dissolved minerals to the aquatic plant. Each mineral has a pattern of varying availability through a hydrogen-ion concentration range. Some minerals are only readily obtainable to a plant along a narrow section of this range, others are about equally available throughout a wide part of the range. The concentration of hydrogen-ions may be a critical environmental factor where the soil solution is particularly low in certain minerals. Aquatic plants exert some influence on the hydrogen-ion concentration of the water through the exchange of carbon dioxide and possibly other activities.

The soil provides minerals to aquatic plants. They may receive them directly from the soil by exchange or from the soil solution which contains dissolved minerals. Free-floating plants get minerals from the pond water which is an extension of the soil solution above the ground surface. Such free-floating plants may be most critically affected by the dissolved mineral supply due to their distant removal from the mineral source. Rooted varieties, whether submerged or emergent, get most of their minerals from the soil.

The soluble mineral salt concentration of water is not only important as a source of minerals to plants but it affects the osmotic
pressure of the water as well. Such a site as Lehi Pond which has water high in soluble salts probably excludes many aquatic plants which find the osmotic pressure unfavorable to their growth.

Turbidity has the effect of reducing the amount of light available to the plants that grow in or under the water. Increased turbidity lowers the rate of photosynthesis and thereby retards growth. High turbidity and excessively high temperature operate together to the disadvantages of an aquatic because elevated temperature increases the rate of oxidation of photosynthetic products. Under certain conditions turbidity can have an abrasive effect upon the aquatics during active wave or current action.

Water current and waves are generally beneficial to aquatics in the absence of turbidity. They mix and change the solution around the plant which promotes better aeration and renew mineral supply. Stagnant water may result in poor aeration and limited micro-organism activities such as decomposition of organic residues at the pond bottom.

It was apparent to the writer that not all of the ecological factors that might influence aquatic plant distribution have been investigated in this study. Time considerations largely excluded detailed soil study and specific minerals ion concentrations of the sites. It was hoped that the present effort might reveal some special problems of a more detailed nature for future investigation.

The most widely distributed and abundant aquatics were *Scirpus acutus* and *Typha latifolia*. *Lemna minor* showed an ephemeral abundance equal to these species. *Chara* spp. was the most widely noted alga. The Najadaeae family was represented by ten species many of which were very abundant. The more important members of the family include *Potamogeton foliaceus*, *Potamogeton latifolius*, *Potamogeton pectinatus*, and *Zannichellia palustris*. The rare aquatics disclosed as present in the area included *Riccia fluitans*, *Ricciocarpus natans*, *Lemna cyclostasa*, *Lemna trisulca*,


Callitriche autumnalis, Callitriche palustris, Elatine triandra and Urtricularia minor.

It should be noted that the range of distribution of genera not identified to species was broad perhaps due to the occurrence of several species of different requirements being involved. The genus Chara, as an example, was distributed through the full range of all physical and chemical conditions noted. The one similarity between all sites was the muck or silt soil required by its tender thallus branches. Where a species was noted in a wide range of conditions but not abundantly so, biotic factors of competition should be looked to as important. Potamogeton pectinatus seems typical in this regard. In a number of pond situations it was heavily shaded by plants such as Cladophora and associated with ducks and coots which feed heavily upon the seeds and plants each year. There is, of course, the possibility that seed use for food by ducks might spread the distribution range of the species.

The species of Scirpus, which were identified, showed considerable variation in ecological requirements. The most selective of the species was Scirpus olneyi that was usually associated with artesian flows. Scirpus paludosus was restricted to sloughs with high banks and other protected places. It shared with Scirpus acutus a wide toleration of soluble salts from 213 to 750 ppm. Scirpus validus was not noted in waters having soluble salts exceeding 260 ppm. Scirpus acutus occurred in the widest range of conditions of any species of this genus. It was the only member of the group that successfully tolerated the water conditions common to Utah Lake.

The submerged aquatics were most effected by water turbidity. Chara made only a sparse and spindly growth in turbid waters while spirogyra seemed excluded altogether. Potamogeton latifolius, Ruppia maritima and some others
which produce leaves that rose to or near the water surface seemed least
affected by turbidity. It is important to note that the turbidity of many
valley sites such as Utah Lake is particularly damaging to the very class
of aquatics that growth habit could do much to stabilize the lake bottom.

The writer was impressed with the change that is occurring in many
aquatic sites of the area. The influence of man is being more sharply
felt each year. Salem Lake is being used considerably more for power boat-
ing than it was years ago. The lower end of the lake on several occasions
was strewn with fragments of submerged aquatics. This practice and other
more subtle human influences have probably been responsible for killing
out certain species from the area. According to Bertrand F. Harrison,
elodea was formerly common in Salem Lake though not observed in the course
of this study. It was also noted that Potamogeton praeclongus could not be
found anywhere in the area even though it was a common species in streams
around Utah Lake in 1926 as reported by Cottam (2). Potamogeton crispus
is a fairly new species to the county being collected by the writer from
a number of sites along the east shore of Utah Lake although not reported
by Cottam in his comprehensive study of Utah Lake flora. The species has
been reported for the state by Muenscher (6).

An interesting transplant of Nymphaea polysepala was observed at
Goshen Warm Springs in 1954. A few plants were collected from the Uinta
Mountains and brought there by Mr. Albert Morgan, of Goshen. They had made
a successful growth in one of the southern ponds for two years at that date
although the leaves appeared infected with an undetermined pathogen. Two
years later on a subsequent visit to the pond, the writer noted the plants
were gone, the reason was undetermined.

Presently, vast areas of Utah Lake are a biological desert, a condition
that has prevailed for several decades. One is impressed that here indeed is a badly managed natural resource. Reduction of its present turbidity would make possible a more full expression of its biological potentialities in terms of fish production and other uses. One encouraging trend noted by the writer was the soluble salt concentration of Utah Lake water. Clarke as quoted by Tanner(12) stated that Utah Lake water had quadrupled in this characteristic from 306 ppm. to 1254 ppm. between 1884 and 1904. He attributed this to the inflow of natural waters which had been diverted for irrigation previous to entry into the lake. One would suppose that such water use has increased since that date yet an average of 18 soluble salt determinations made during August at 6 stations along the west, north and east shorelines averaged 560 ppm. Such a reading could be obtained at many other sites in the study area showing that it was not excessively high. The highest reading for the lake was 740 ppm. taken on the west shoreline. Perhaps more extensive sampling would produce a higher average reading. It would appear, though, that the damaging trend toward higher salt concentrations has at least halted.

The periodicity of such algae as cladophora has probably played an important role in affecting the results of this study. During the research of 1959, the abundance of cladophora was greatly reduced at the Jordan Oxbow pond below previous years at a comparable time when the entire pond surface was covered with plant growth. One would suppose that a season of reduced cladophora growth would be conducive to the growth of submerged aquatics particularly where the water was turbid. According to past observations, *Myriophyllum verticillatum* and *Ceratophyllum demersum* were little effected by robust cladophora growth above them. Large portions of their shoots lay at the water surface only mildly shaded by such cover.
The deeper aquatics such as *Potamogeton pectinatus* would be most effected and perhaps more abundant under reduced cladophora growth. Also in 1959, the Burt Spring Pond and the farm pond at station 17 had cladophora present. Differing from the oxbow pond, however, these sites were nearly choked with cladophora. *Ceratophyllum demersum* had a frequency of 100 at the farm pond in spite of such cover. *Potamogeton pectinatus* and *Potamogeton foliosus* made a robust but not abundant growth under these conditions where the water was highly shaded and mildly turbid. This effect was noted less at Burt Spring Pond because the water was more clear and shallow. Cladophora makes its best growth in the Provo River during the cooler months of the year.

*Lemma minor* and other surface aquatics such as *Spirodela polyrhiza* and *Azolla caroliniana* were largely free from stations having high water turbidity such as Goshen Reservoir and Utah Lake. They were noted, however, in a variety of waters chemically similar to such sites. This study has shown that the above aquatics do best in sunlit waters which often means areas open to the wind. The writer has noted many small protected sites such as ditches where the species have grown well in highly turbid waters, kept so by human and animal influences. Their paucity at large open sites can be explained by the wind action which blows them into nearby emergent communities where crowding and heavy shade further retard their growth. Extreme crowding of lemma and the subsequent death of many plants has been observed by the writer at Payson Lake. Usually by mid-August the lake surface was covered with lemma. Westerly winds of the late summer transport and pile the plants in thick hummocks along the east shore.

A question which naturally arises from a study of this scope is the extent to which aquatics were distributed according to the site conditions
or by chance. Until the ecological requirements of each species is clearly outlined, the question is difficult to answer. It is particularly necessary to know the range of conditions under which a species can grow. Such water conditions as osmotic pressure and concentrations of mineral ions were not investigated. The growth of aquatics in the range of physical and chemical conditions common to the thirty three stations were noted and some definite concepts as to the variability of central Utah waters was gained. Whether these waters offer conditions requiring high toleration by the aquatics isn't fully known. It does appear, however, that the hydrogen-ion concentration and temperature become excessively high along the west shore of Utah Lake where few aquatics grow. It is entirely possible that some sites have elevated osmotic pressures damaging to many delicate submerged aquatics.

In chapter III the ecological notes for each species describe, insofar as this study has shown, the optimum physical conditions for the species and at which site or sites such conditions were found. In cases where obvious drops in frequency and abundance were associated with certain physical conditions they were also mentioned.

Comparison between the aquatic communities of Provo River and American Fork River are interesting in light of their chemical similarities. Both habitats showed soluble salt concentrations in the 200 ppm to 300 ppm range which were the lowest reading of the study for waters of the lower mountain and valley areas. The hydrogen-ion concentrations and dissolved oxygen levels were near 8.0 and 4 ppm, respectively, conditions which are certainly conducive to plant growth. Yet in spite of these important similarities, American Fork River was largely devoid of higher aquatic plants, while Provo River was host to a great variety of algae, mosses and aquatic higher plants. Both waters drain granitic soils in their
upper reaches and calcareous soils in their lower regions. Provo River, however, is much more exposed to calcareous rock and soil and gains most of its water from such areas. By way of contrast, American Fork River principally drains granitic soils. There is the possibility, therefore, that mineral rich limestone waters are in short supply in this river.

It seems unlikely, however, that this characteristic alone could explain the great disparity in aquatic populations between the two streams. Winter and spring temperature studies of the streams conducted in 1954-55 revealed that the habitats are essentially alike in this regard. The waters of both streams became increasingly warm the further their descent in the canyon proper when air temperature was higher than water temperature. In many instances Provo River water rose in temperature to the level of the air by the time it reached the Carterville Bridge area. Readings taken at 8:00 AM in August of 1959 at both streams and at comparable elevations were very similar. It is therefore felt that a temperature characteristic of American Fork River is not responsible for its low population of aquatics.

The American Fork River is composed of an almost continuous series of rapids from its headwaters to the mouth of the canyon. Bottom rocks and boulders are highly eroded. There is little or no soil at its base. The absence of soil and the presence of high water speed are probably very important in reducing aquatic communities in its waters. The comparative shallowness of its waters is also significant. Although Provo River has many rapids with comparable water speeds (1 meter/ sec.) to those of American Fork River it also has many stretches of more quiet water where soil deposition has occurred and where many aquatics have become established. The Provo River because of its size and drainage area has many more possibilities for plant migration into its lower reaches which is the section
that is being compared to the American Fork River.

During the course of the research and evaluation of the data several further problems relative to aquatic plant distribution have occurred to the writer. The environmental requirements of the submerged and floating aquatics could be further delineated through a widespread analysis of the waters of the region for specific mineral ions needed for plant growth. Specific differences should be sought among sites with surface waters and those of artesian sources. Also, careful comparisons should be made between streams which drain calcareous soils and granitic soils. The distribution of this class of aquatics could be further explained if the osmotic pressure was determined at many of these sites. Perhaps laboratory growth of certain species through a range of osmotic pressure conditions would prove instructive. Such data would help explain the absence of certain aquatics from Lehi Pond and Utah Lake.

The problem of the extent to which algal periodicity effects the distribution of other aquatics needs further investigation. As was stated, only cladophora was sufficiently abundant and periodic to be significant. The extent to which its rapid growth reduces the abundance and frequency of submerged aquatics was not quantitatively determined. Competitive roles of cladophora toward lelma and other floating aquatics also hasn't been examined other than to note that cladophora filaments elevate such plants out of the water where they die and become a part of the dead calcareous cast common to cladophora on its upper surface.

Of the free-floating aquatics, Spirodela polyrhiza appears to be a subject for further study. The species has an area frequency of 0.15, certainly not a comparatively low figure, yet it was never observed to be more than occasional in abundance at any site. Whether this observation
can be explained by factors of competition, seasonal influences, or slow growth and reproductive adaptations is not know.

It would be interesting to investigate the causes for the very low frequency noted for *Lemna trisulca*, *Lemna cycloptera* and *Utricularia minor*. They all made very abundant growth where present, but they seemed to be restricted to special sites offering favorable physical conditions.

Perhaps the most fruitful research topic suggested by the entire study relates to Utah Lake. Preparatory to a time when man will establish certain physical controls over conditions in the lake an investigation into the seasonal and annual changes of the chemical characteristics of Utah Lake water should be made. The future effects of sewage processing and lake shore diking could then be better evaluated in relationship to specific features of the lake important to the aquatics. Only then could one confidently plan and prepare for the time when the lake will again be a biologically fruitful member of the wetlands of central Utah.
CHAPTER V

SUMMARY

1. Aquatic vascular plants, mosses, liverworts and larger algae of Central Utah were studied at thirty-three stations.

2. The relationships between certain physical characteristics of the habitat and the presence and abundance of the aquatic plants was investigated.

3. **Scirpus acutus**, **Typha latifolia** and **Lemna minor** were found to be the most abundant and widely distributed aquatic species.

4. The most abundant aquatic plant populations were correlated with cool, non-stagnant waters low in turbidity and of mildly basic characteristics.

5. The largest area of water in the region, Utah Lake, supported the fewest aquatics in species and numbers probably due to the high turbidity, soluble salt concentrations and high hydrogen-ion concentrations found there.

6. The total number of species studied was one hundred and one which included thirteen species of mosses and aquatic liverworts, thirteen algal species, three species of the Pteridophyta and seventy-two species of aquatic seed plants.

7. Twelve species were associated with a specific environment.

8. Twenty-three species were quite general in their distribution.


The Aquatic Plants of Central Utah and Their Distribution

An Abstract of a Thesis Submitted to
The Department of Botany, Brigham Young University
in Partial Fulfillment of the Requirements
of the Degree of Master of Science

by
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ABSTRACT

A study of the aquatic plants of the central Utah region was made by means of a survey of some fifty aquatic sites. From among these sites thirty three stations were selected where quantitative measurement of the environment was made. The sites chosen were those in which the species and environment present appeared to offer data valuable to the study as a whole. Collections and identifications of all vascular plants, mosses, liverworts and the larger algae at each site were made.

The study disclosed the presence of thirteen algal species that were generally important members of the community. Included also were thirteen species of mosses and aquatic liverworts, three species of the Pteridophyta and seventy two species of aquatic seed plants in twenty two different families. In total, one hundred and one species were included in the study. Area wide frequency data were obtained for eighty five of these species. Most of the species present at each station were measured for frequency and abundance along a belt transect. Analyses and observations were made of water characteristics such as turbidity, temperature, current speed and the concentrations of soluble salts, dissolved oxygen and hydrogen-ions along the transect to provide information useful in explaining the distribution of the species present.

The habitats found to support the fewest aquatics considering their water volume were Utah Lake, including Mud Lake, Spanish Fork River,
and American Fork River. High water turbidity and high hydrogen-ion and soluble salt concentrations seem most responsible for this condition. The Spanish Fork River has been highly disturbed for years due to streambank erosion in its upper reaches. The American Fork River provided a rather cold and fast water habitat, generally unsuited for the aquatics of the region. It was also possibly lacking in some minerals needed by aquatics. Aquatic species were observed in greatest abundance and diversity along the Provo River drainage and in the artesian water supplied ponds and streams associated with the valley floor.

The most widely distributed and abundant aquatics were *Scirpus acutus* and *Typha latifolia*. *Lemna minor* showed an ephemeral abundance nearly equal to these species. *Chara* was the most widely noted alga. The Najadaceae family was represented by ten species many of which were very abundant. The more important members of the family include *Potamogeton foliosus*, *Potamogeton latifolius*, *Potamogeton pectinatus*, and *Zannichellia palustris*. The rare aquatics present in the area included *Riccia fluitans*, *Ricciocarpus natans*, *Lemna cyclostasia*, *Lemna trisulca*, *Callitriche autumnalis*, *Callitriche palustris*, *Elatine triandra* and *Utricularia minor*.

A total of thirty three species were studied at a sufficiently large number of stations, ranging from three to seventeen in number, to obtain some data about the physical and chemical features of the environment that exert control over their distribution. In general, the species grew best in waters that were relatively clear with a hydrogen-ion concentration from 7.2 to 8.5 and where the dissolved minerals did not
exceed about 600 ppm. Stagnant waters were found to provide a suitable habitat for very few species. Waters having a temperature exceeding eighty-five degrees were largely free of aquatic vegetation.

APPROVED