MONTANA FISH AND GAME DEPARTMENT
FISHERIES DIVISION

JOB PROGRESS REPORT

State Montana Title Flathead Lake Fisheries Study

Project No. F-33-R-4 Title The seasonal measurements of the basic

Job No. I-b water chemistry, water temperature, plankton

& bottom organisms in Flathead Lake

Period Covered July 1, 1969 through December, 1970

ABSTRACT

Surface plankton, water chemistry, light penetration and water temperature were measured concurrently with the fish sampling program on this lake to assist in determining the quality of the aquatic habitat and to note changes that might influence movement and distribution.

Estimated monthly production rates and peaks were made from a summary of the plankton data. Volumes of total surface plankton have peaked in the month of July during the last three years.

Significant changes that occurred in the water quality characteristics are described. Characteristics summarized are: pH, total alkalinity, standard conductance and dissolved oxygen concentrations.

Variations in measurements of light penetration (secchi disc) and thermal profiles are described.

BACKGROUND

A study on any aquatic organism has to include a description of the water in which it lives. Acquisition of basic limnological data is an essential part of the background information for a study of fish prior to a determination of the changes in the environment and its effect on fish growth, movement and distribution.

OBJECTIVES

The objectives of this job are to measure the basic chemical, physical and biological characteristics of the lake concurrent with the fish sampling program. This data will be a basis for measuring the factors that influence the movement of fish and their distribution.

PROCEDURES

Concurrent with the fish sampling program, certain limnological characteristics such as surface plankton, water chemistry, light penetration and water temperature were measured to assist in defining the aquatic environment and to note changes that might influence fish movement and distribution.

Estimates of surface plankton concentrations were made by gravimetrically measuring total surface plankton collected in a tow net. The net had a 45 cm diameter opening with 0.1061 mm mesh silk collecting bag. A flow meter mounted in the mouth of the net measured the water velocity through the net. Water volumes were then calculated for each two minute haul. The data on plankton concentrations were expanded and are expressed as the volume of total surface plankton per acre foot (ml/AF) of water. The samples were preserved for future reference.

Water temperature profiles were made by using a resistance thermometer coupled to a depth sensor unit (Bathythermonitor). Water depths were recorded for each 1° F. change in water temperature in compiling station profiles. Secchi disc readings were made whenever temperature data were taken.

Water quality measurements, based on Standard Methods, 1965 were made for the following characteristics: total alkalinity, dissolved oxygen, pH, and standard conductance. Analyses were made on samples collected from the surface and at levels from 50 to 65 feet below the surface.

Analysis of the water sample was done as soon as possible after collection, generally within four hours. The pH readings were made with a-line-operated electric pH meter that was calibrated with a standard buffer. Conductance readings were made on a battery operated resistance meter. Specific readings were standarized to 77° F. (25° C) and are expressed in micromhos/cm. Uniformity in dissolved oxygen and alkalinity determinations are assured by correcting the normality of the titrants with standard solutions at the time of measurements. Oxygen concentrations are expressed in ppm and by the percent of saturation at an elevation of 3,000 msl.

FINDINGS

Surface Plankton

Plankton collections during the present sampling period, September 1969 through December 1970 were made to assess the conditions during fish collections, to determine annual trends in total surface plankton production and to assist with other plankton studies being conducted by graduate students working at the Yellow Bay Biological Station, University of Montana.

Young (1935) first reported on the phytoplankton of the lake and described seasonal pulses. He found the maximum production during a period, April through June, with minor peaks occuring in the fall. More recently Morgan (1968) found the phytoplankton to be seasonally distributed vertically and horizontally. The distribution was influenced by currents, available nutrients, temperature and light penetration. The dominant algal genera he found present

are listed in decreasing order: Tabellaria, Fragilaria, Rhizosolenia, Dinobryon, Stephanodiscus and Asterionella. Moghadam (1969) found no significant correlation between water chemistry and diatom distribution. The only correlation demonstrated that more species were found to occur in areas of higher silica concentrations. Yearly trends in production of total surface plankton were reported by Hanzel (1970) as he described variations in production between areas and by seasons.

The plankton data collected during the recent fish sampling program offers comparative data to illustrate annual production rates, Figure 1. The maximum production period for the year 1968, 1969 and 1970 occurred during the months of May through July with lesser peaks in the spring and fall. Abnormally warm weather during the months of February and March, 1968 yeilded high spring concentrations of 3,042 and 6,548 ml/AF, respectively. The largest monthly production figures during the three years of this study occurred in July. The 1968 maximum, 10,822 ml/AF, was the largest monthly average. Maximum figures for 1969 and 1970 reached similar July peaks; they were 7,859 and 7,760 ml/AF, respectively. Although the peaks of maximum production occurred during the same month, production variations were evident when comparing the monthly range figures during the three year period (Figure 1).

Water Chemistry

Water chemical data for Flathead Lake have been described by Elrod (1929), Young (1935), Potter and Baker (1961), Morgan (1968), Moghadam (1969) and most recently by Hanzel (1970). Only the important changes will be discussed for each water quality characteristic measured during the period September 1969 through December 1970. This report includes the analyses of water from 28 stations for the period September-December 1969, 13 stations for June-August 1970, and 25 stations for October-December 1970.

pH - hydrogen ion concentration

The pH values of surface waters ranged from 7.65 in June to 8.50 in December. The only obvious change noted in the patterns of pH values occurred during the fall and winter months of 1970 when waters were found to be more alkaline. Previously, winter highs had reached a maximum of only 8.30 units. The largest variation in pH values between surface samples and sub-surface occurred during July and August when the sub-surface reading were less basic.

Total Alkalinity

Seasonal averages for total alkalinity (methyl orange) varied from 85 ppm is the spring to 91 ppm in the winter. This range represents no important change from previous records. The highest alkalinity readings were again found in the outlet areas of the lake. Monocarbonates, as indicated by phenophthailein, appeared in August of 1970 and persisted in most samples through both winter seasons. Previously, monocarbonates were noticed in early July and had disappeared during September. Monocarbonate concentrations during the period ranged from 1 to 8 ppm and were recorded to depths of 96 feet.

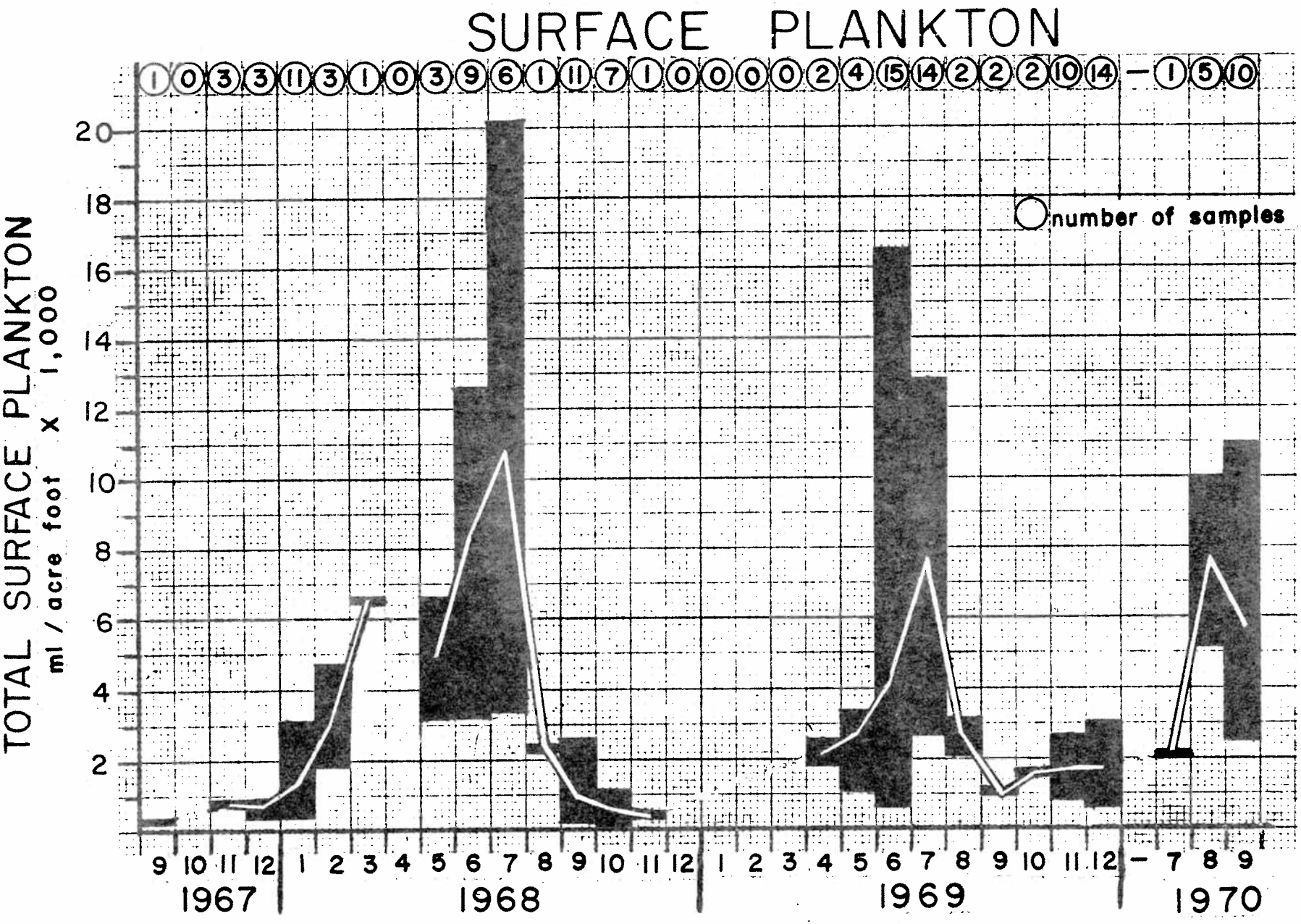

Figure 1. The monthly (line) and range (bar) of total surface plankton concentrations in Flathead Lake, October 1967 through August 1970. Volumes expressed in 1,000 ml/AF.

Standard Conductance

Seasonal averages for standard conductance varied from 171 to 175 micromhos/cm. The high readings at the surface generally occurred in the late winter while low readings were found in the spring. Summer conductance in the surface waters for the east shoreline stations were slightly higher, approximately 10 micromhos/cm greater, than stations in other areas of the lake. The conductance of sub-surface samples, (50 to 100 feet below the surface) were generally lower but were within 10 micromhos/cm of corresponding surface water samples.

Abnormally high conductances in sub-surface samples were recorded at two stations in Big Arm Bay during the fall of 1970. These readings of 234 and 227 micromhos/cm, were nearly twice the readings of corresponding surface waters. The cause of the abnormal readings was not determined. Thermal patterns at both stations showed a very sharp and narrow thermocline with the upper thermocline limits occurring at the 50 foot level. Temperature within the four foot thermocline, dropped 15° F.. Conductance readings at the 100 foot level at these stations were similar to the surface readings station.

Dissolved Oxygen

Dissolved oxygen concentrations ranged from 6.8 to 12.0 ppm during the sample period. Prior to the establishment of a summer thermocline, oxygen concentrations averaged nearly 90 percent saturation. Surface samples increased to 100 percent saturation in July, after statification and persisted through mid August. Sub-surface oxygen also increased but was generally 10 percent of saturation less than for surface samples. The maximum surface and minimum sub-surface oxygen concentrations of 123 and 73 percent, respectively, occurred at the same mid-lake station on July 28, 1970. Stations within one mile vicinity showed the same oxygen pattern with surface measurements super-saturated and sub-surface measurements with minimum dissolved oxygen during the week prior to and on the same date.

The lowest surface concentration, 82 percent of saturation, occurred at two stations located in Big Arm and Big Fork Bays on August 14, 1970. These low readings were found at stations more than 12 miles apart and on opposite sides of the lake and occurred during the season when most other stations were 100 percent saturation or more. Oxygen below the thermocline was 88 and 80 percent, respectively at these two stations. Fall and winter concentration levels in the lake ranged between 88 and 95 percent saturation.

Light Penetration

Light penetration, as determined by the secchi disc, ranged from 3 to 38 feet during the period. Secchi disc readings were greatest during mid August and late December when maximum depth of 38 feet was recorded. Measurements between the two maximum readings, decreased to 17 feet in November and then progressively increased throughout December. The reduced light penetration during November was attributed to sediments held in suspension by wind agitated water.

Water Temperature

Young (1935) described the thermal patterns of the lake and found thermocline formation to occur as early as May. The formation of the thermocline in recent years appear to be later and may mot be completely formed until July, Figure 2.

A pecularity in the position of the thermocline was noted in the temperature profiles of stations in the northwest half of the lake. Profiles in this area were characterized by double thermoclines that were separated by as much as 40 feet on June 22, 1970 (see temperature profile, Figure 2). As the temperatures continued to warm, the upper thermocline zone sank and the lower one broadened until they met and formed the typical single thermocline. Generally the total temperature drop within these double zones were the same as the drop experienced within the typical thermoclines found in adjacent areas.

Annual changes and the extent of the seasonal warming patterns of the lake were evident when comparing maximum depths of the thermocline layer. Depths of the upper limit of the thermoclines ranged from 60 feet below the surface in 1970 to 80 feet in 1969 and reached depths during 1967 and 1968 of 57 and 63 feet, respectively. Comparative temperatures recorded at an 80 foot level during these years also indicates the varying amounts of heat absorbed by the lake. Temperatures at this 80 foot level were 46°, 48°, 57° and 48° F. for the years 1967 through 1970, respectively.

Variation of thermocline depth between areas were also evident. Periodic temperature profiles taken along a transect across the lake on July 8 and 9, 1969 illustrates such variations, Figure 3. The upper limits of the thermocline on these dates ranged from 38 feet at Station 2 on the west side to 18 feet at Station 11 on the east side of the lake. Wind action did stir and rearrange the stratified layers during the summer period. Generally water temperatures along the east shoreline were warmer than those along the west shoreline but thermocline depth was deeper along the western areas. Isothermic conditions were reached by fall when the temperatures cooled to 46° F.

RECOMMENDATIONS

It is recommended that monitoring the basic water chemistry and physical characteristics of the lake and the assessing of plankton production be continued as long as the fisheries investigation is in progress. It is through accumulation of this background data that accurate assessment can be made of the relationship of fish growth, movement and distribution.

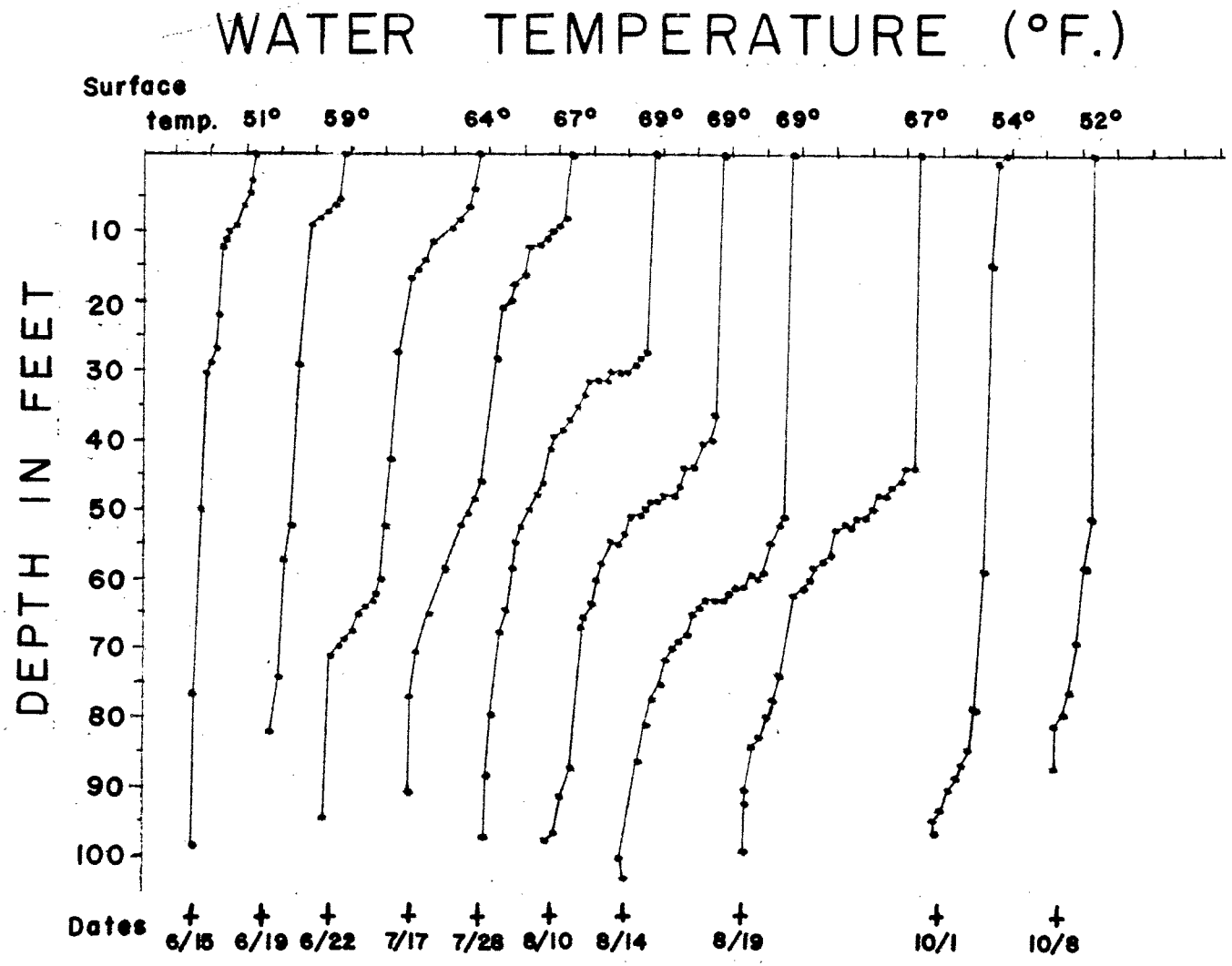

Figure 2. The formation, development and disappearance of the thermocline in Flathead Lake during 1970; depicted by periodic temperature profiles at a northern sample station. Temperature intervals are 5 degrees Fahrenheit on the graph with one degree changes noted in the profiles by dots.

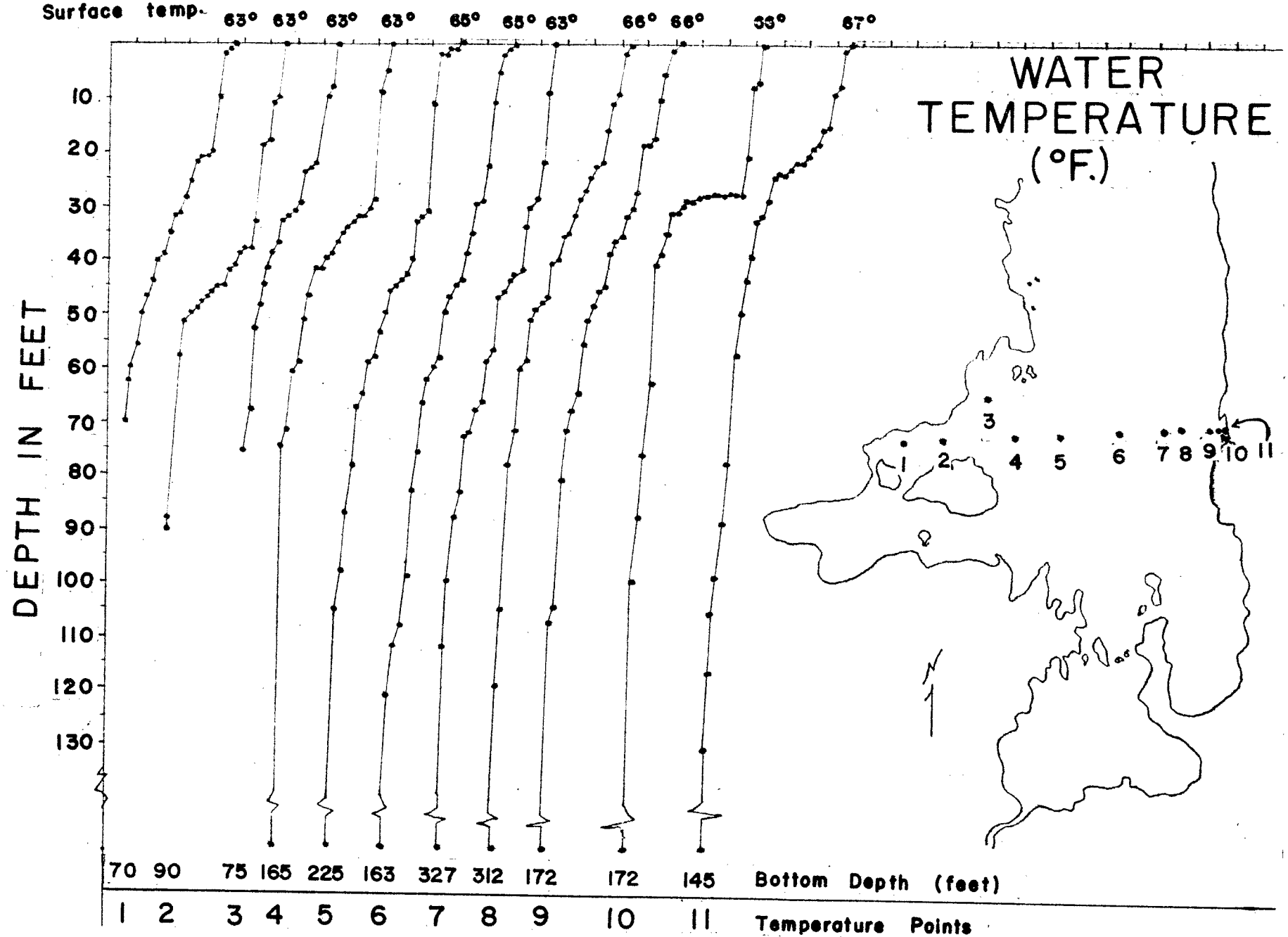

Figure 3. Water temperature profiles along a west to east transect across Flathead Lake, on July 8 and 9, 1969. Temperature intervals are 5 degrees Fahrenheit with one degree changes noted in each profile by dots.

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