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MEMORANDUM

To: All on Attached List

From: David L. Wegner, Acting Manager
Technical Service Center, Environmental Resources Service
Glen Canyon Environmental Studies Group

Subject: Results of Quarterly Water-Quality Monitoring Trip - Lake Powell

Enclosed for your information are the results of the February 1995 Quarterly Water-Quality Monitoring Survey of Lake Powell conducted by the Bureau of Reclamation. This report represents a different format than has previously been disseminated. Your comments, suggestions, and feedback are encouraged.

Introduction

The Bureau of Reclamation's current water-quality monitoring program on Lake Powell and its tailwaters consists of three main features: (1) quarterly lake-wide surveys of physical, chemical, and biological conditions; (2) monthly water-quality profiles and biological sampling of the Lake Powell forebay; and (3) continuous monitoring of the Glen Canyon Dam tailwater below the dam and at Lees Ferry
for temperature, salinity, and dissolved oxygen.

Data from this program is processed by the Glen Canyon Environmental Studies (GCES) office and stored in a relational database format for subsequent retrieval and analysis. This database contains 30 years of information from various phases of Reclamation's long-term monitoring effort on Lake Powell. The results presented here are from the most recent quarterly survey, conducted from February 23 to February 28, 1995.

Methods and Developments

Full lake-wide surveys are conducted quarterly in which water-quality oxidation/reduction potential profiles of temperature, specific conductance, dissolved oxygen, pH, and turbidity are measured at approximately twenty stations on Lake Powell. Recent technological developments with data storage and instrumentation have allowed rapid collection of this type of data, resulting in improved spatial resolution of these measurements. Secchi transparency, weather conditions, and other observations are recorded at each station. At selected locations, water samples are collected and processed in the field for the laboratory determination of major ionic constituents, nutrients, and, in some cases, selected trace elements. Biological samples for chlorophyll, phytoplankton, and zooplankton were also collected. Lake-wide surveys are accomplished with the use of Reclamation's 31-foot Uniflite vessel, which has been in operation on Lake Powell since 1969.

Beginning with the February 1995 survey, shipboard alkalinity measurements were performed on all collected water samples to gather baseline data for carbonate precipitation dynamics. Also, the use of an underwater viewing

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scope was employed to standardize secchi transparency measurements. This scope allows for the reduction of surface interference and operator subjectivity when determining water transparency. Further evaluation of this technique and its relation to more traditional methods is required.

A map has recently been developed by the GCES office using a geographic information system. Using this map, sampling stations may be located using a global positioning system, from which geographical coordinates and river channel distances from selected reference points can be determined for each station. This information will form the basis of a revised flexible coding scheme for reservoir sampling stations. For example, LPSJR193 refers to a Lake Powell station on the San Juan River arm 19.3 kilometers from the San Juan confluence. This code will replace the arbitrary code SCUCLP15 for the Cha Canyon station.

Results

The information presented here is a summary of the water quality profiles collected on the February trip. The results of the chemical and biological analyses are not yet available at this time.

Water quality profiles were conducted at 21 stations on the Colorado, San Juan, and Escalante arms of Lake Powell. Three additional side canyons were also measured. These stations are listed in Table 1 (below).

Table 1

STATIONS SAMPLED ON THE FEBRUARY 1995 LAKE POWELL WATER-QUALITY MONITORING SURVEY

STATION	KILOMETERS	STATION	KILOMETERS
Main Channel Stations (distance from dam)		**San Juan Arm (distance from main channel)**	
Wahweap	2.4	Cha Canyon	19.3
Crossing of the Fathers	45.3	Lower Piute Bay	32.9
Oak Canyon	90.5	Upper Piute Bay	43.1
Escalante	116.9		
Iceberg Canyon	140.0	**Escalante Arm (distance from main channel)**	
Lake Canyon	158.9	Davis Gulch	11.9
Bullfrog Bay	169.2	Willow Creek	20.0
Moki Canyon	177.2	Garces Island, abv	27.6
Knowles Canyon	193.2	Escalante inflow	31.2
Lower Good Hope Bay	208.5		
Scorup Canyon	225.5	**Miscellaneous Stations (off main channel)**	
Hite Basin	238.7	Navajo Canyon	12.4
Hite Marina	247.8	West Canyon	4.1
Colorado River inflow, Sheep Canyon	262.2	Pace Canyon	3.9

Individual profiles of six selected stations on the Colorado River main channel are included in this report. These profiles represent changes in five basic water quality parameters (temperature, specific conductance, dissolved oxygen, pH, ORP, and turbidity) with depth.

Also included in this report are isopleth plots of the basic water-quality parameters mentioned above. These plots represent a two-dimensional cross-section of the Lake Powell main channel (or tributary arm) from the dam (or a tributary confluence) to the inflow. Each line or isopleth on the plot represents the same value of a given parameter throughout the lake. This is similar to isopleths of temperature patterns commonly seen on weather maps. This type of representation of water quality is extremely valuable in showing patterns that exist throughout the lake such as inflow density currents, thermal stratification patterns, or areas of low dissolved oxygen.

Discussion

From the figures presented here, it can be seen that Lake Powell had begun its annual warming cycle. Surface temperatures in the main channel were approximately 11°C (52°F) compared to bottom temperatures of 7°C (45°F). This relatively small difference in temperature will increase through the year as the lake surface continues to warm. In early 1995, the upper portions of Lake Powell (the epilimnion) had mixed by convective cooling to a depth of approximately 40 m. This depth increased to 50 m in the forebay at the Wahweap station, possibly due to influence by penstock withdrawal.

Dissolved oxygen levels were close to saturation in most of the lake with the exception of the deep waters (hypolimnion) in the downstream portion of the reservoir near the dam. In these areas, dissolved oxygen reached a level of 2 mg/L, which represents the lowest levels ever seen in this portion of Lake Powell. Whether the oxygenated density currents of the winter inflow will be of sufficient volume to replenish these low oxygen levels in the lower portion of the reservoir remains to be seen in future months. The dissolved oxygen isopleth shows this replenishment process happening to some degree in the main channel from the inflow at Hite to 100 km from Glen Canyon Dam.

Because of Lake Powell's relatively small surface area to volume ratio, great depth, and strong saline stratification, convective mixing was unable to penetrate the bottom two-thirds of the lake. Specific conductance patterns show the density relationship between the denser saline waters of the hypolimnion and the lighter, to more dilute waters of the epilimnion. This is evidenced by the persistent chemocline at the 40 to 50 m depth. The turbidity isopleth plot demonstrates the higher turbidity levels at depth in the upper portion of the reservoir as the winter inflows move along the lake bed.

The pH isopleths roughly mimic the pattern seen in oxygen levels. As oxygen is consumed by bacterial respiration, carbon dioxide is produced and pH decreases. Thus, low pH levels usually are associated with low dissolved oxygen levels and vice versa.

Isopleths of the San Juan arm show a strong salinity stratification (or chemocline) at a depth of about 50 m. This represents the maximum amount of this year's winter mixing and results in a layer of lower oxygen isolated in the hypolimnion. The San Juan was not sampled above Upper Piute Bay due to logistical difficulties.

Patterns in the Escalante Arm show a lesser degree of winter mixing and what appears to be an advective inflow with some degree of oxygen demand at a depth of about 45 m. Lowest oxygen levels are seen at kilometer 20 (Willow Creek).

Conclusion

This report was developed as a means of disseminating information collected by Reclamation's Lake Powell Water-Quality Monitoring Program to those interested in Lake Powell conditions and the effects of Glen Canyon Dam's withdrawal patterns on the limnology of the reservoir. Please direct any questions or requests for further information to Bill Vernieu or Susan Hueftle at (520)556-7363, or by e-mail to bvernieu@slcm03.uc.usbr.gov. Your comments, suggestions, and feedback are encouraged. To eliminate needless mailings, please indicate your desire to remain on this list of recipients for future reports.

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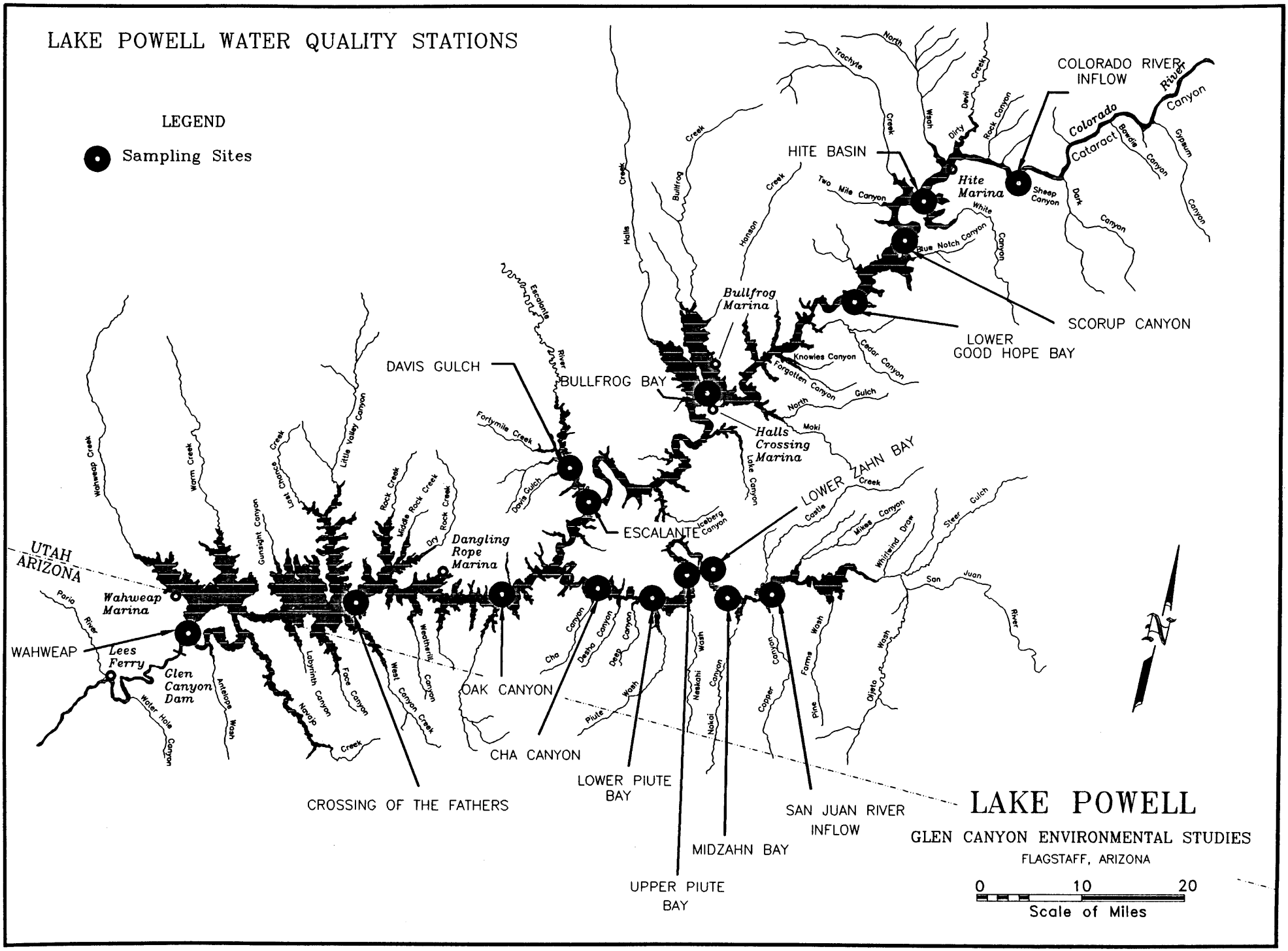
LAKE POWELL WATER QUALITY STATIONS
LEGEND
Sampling Sites
COLORADO RIVER INFLOW
HITE BASIN
Hite Marina
SCORUP CANYON
LOWER GOOD HOPE BAY
Bullfrog Marina
DAVIS GULCH
BULLFROG BAY
Halls Crossing Marina
LOWER ZAHN BAY
ESCALANTE
Dangling Rope Marina
UTAH
ARIZONA
Wahweap Marina
WAHWEAP
Lees Ferry
Glen Canyon Dam
OAK CANYON
CHA CANYON
LOWER PIUTE BAY
CROSSING OF THE FATHERS
SAN JUAN RIVER INFLOW
MIDZAHN BAY
UPPER PIUTE BAY
LAKE POWELL
GLEN CANYON ENVIRONMENTAL STUDIES
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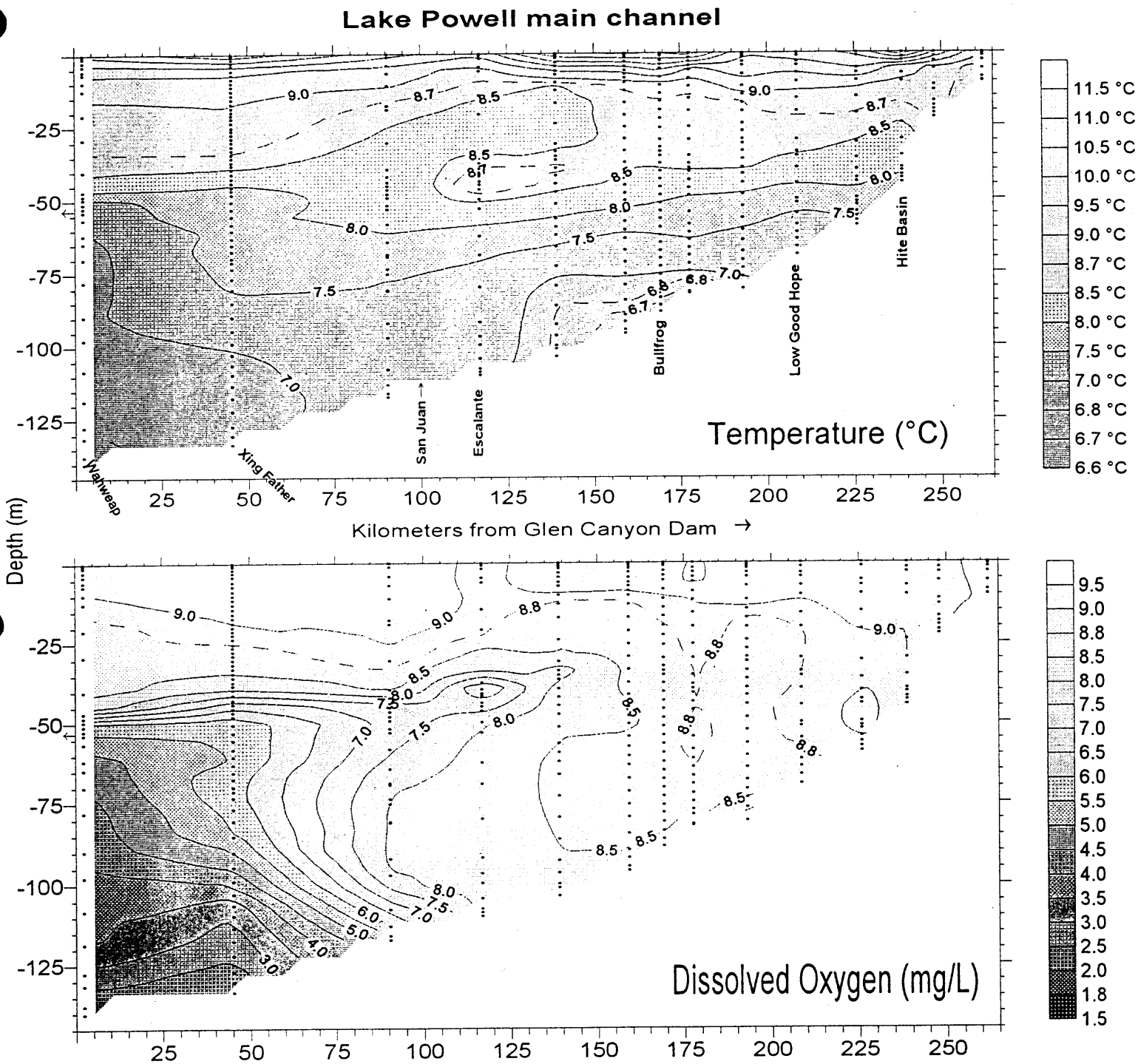
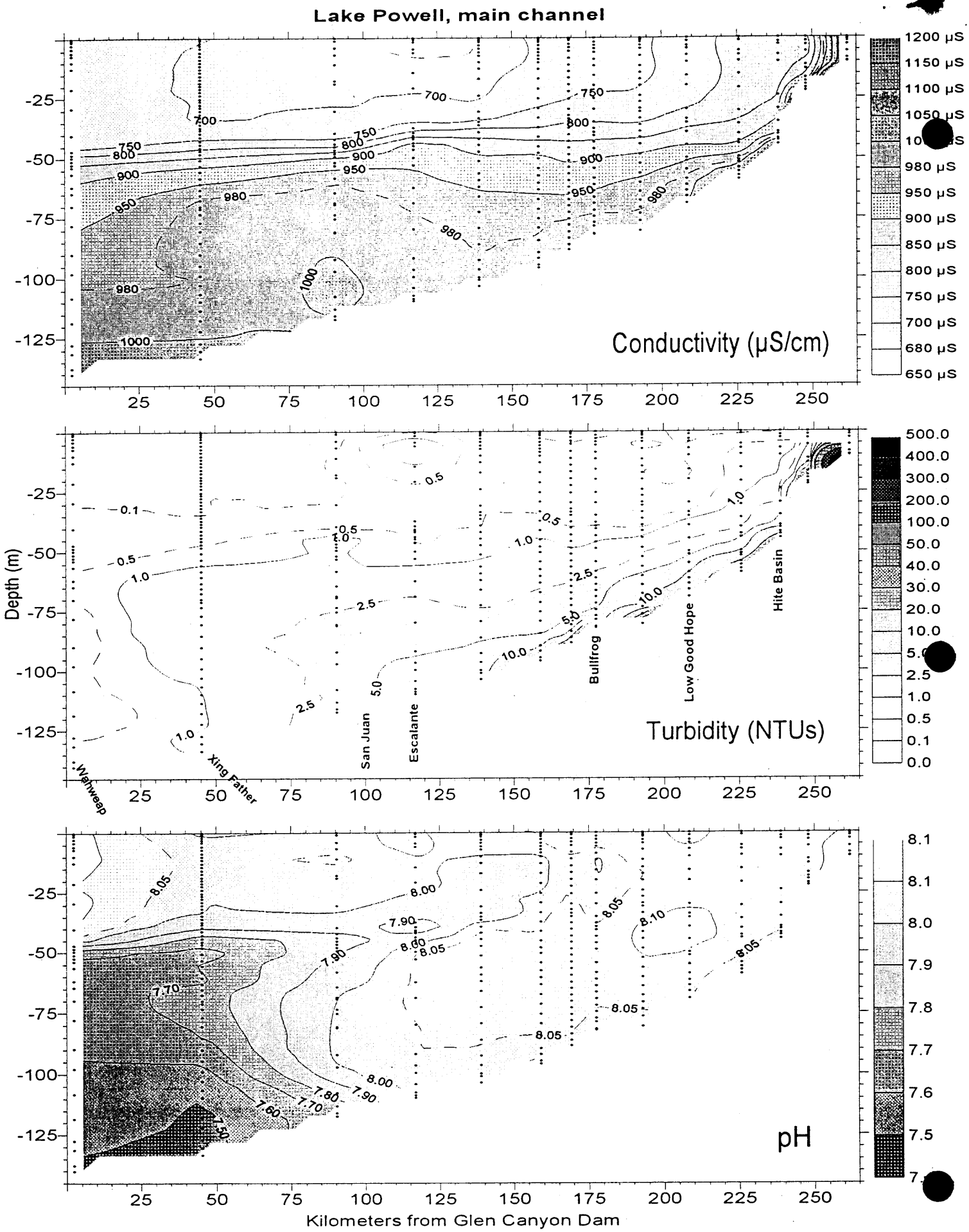
Scale of Miles

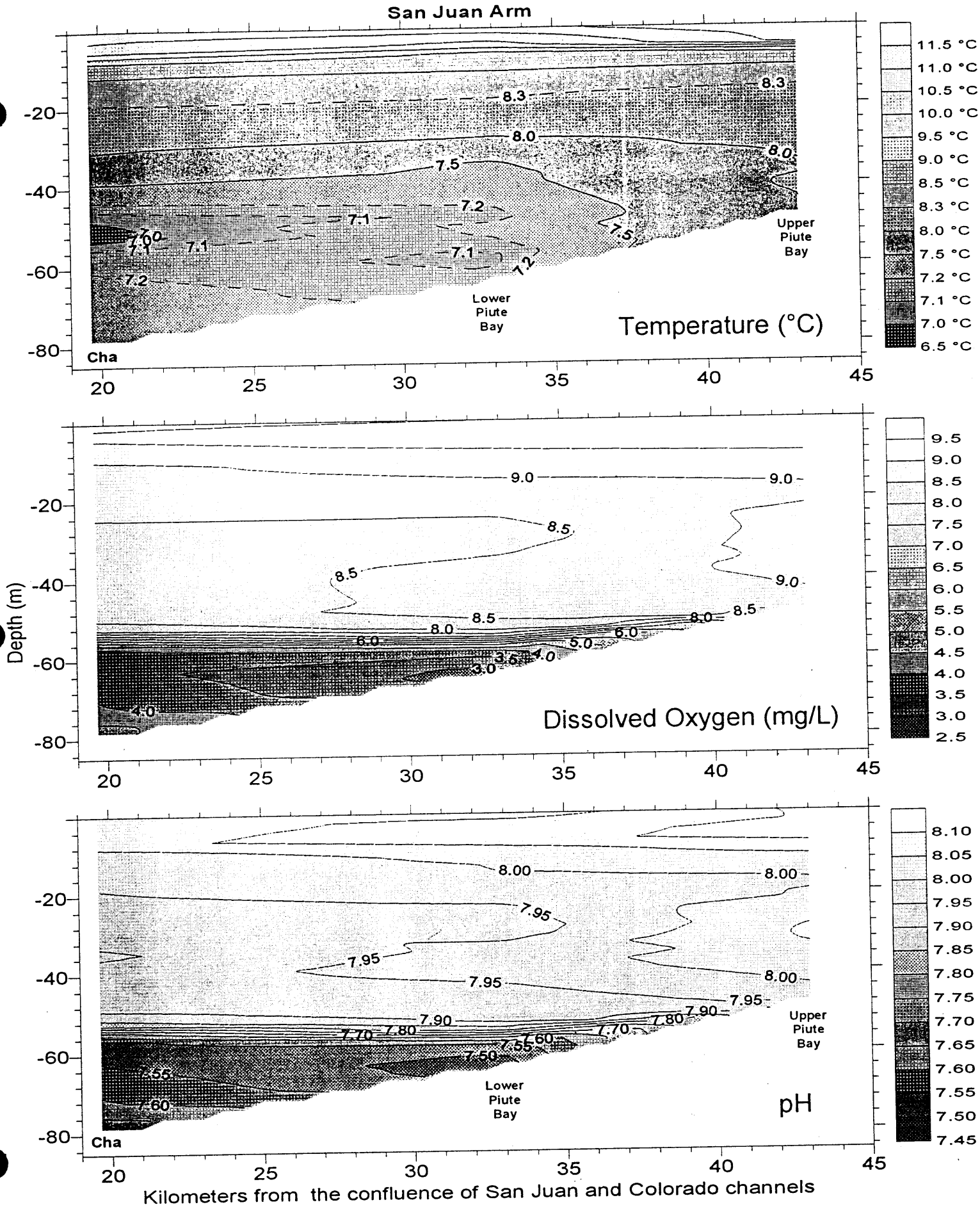


Temperature (°C) and dissolved oxygen (mg/L) for the main channel of Lake Powell, February 23 to 26, 1995. Penstock depth at dam (km=0) is 53.4 meters.

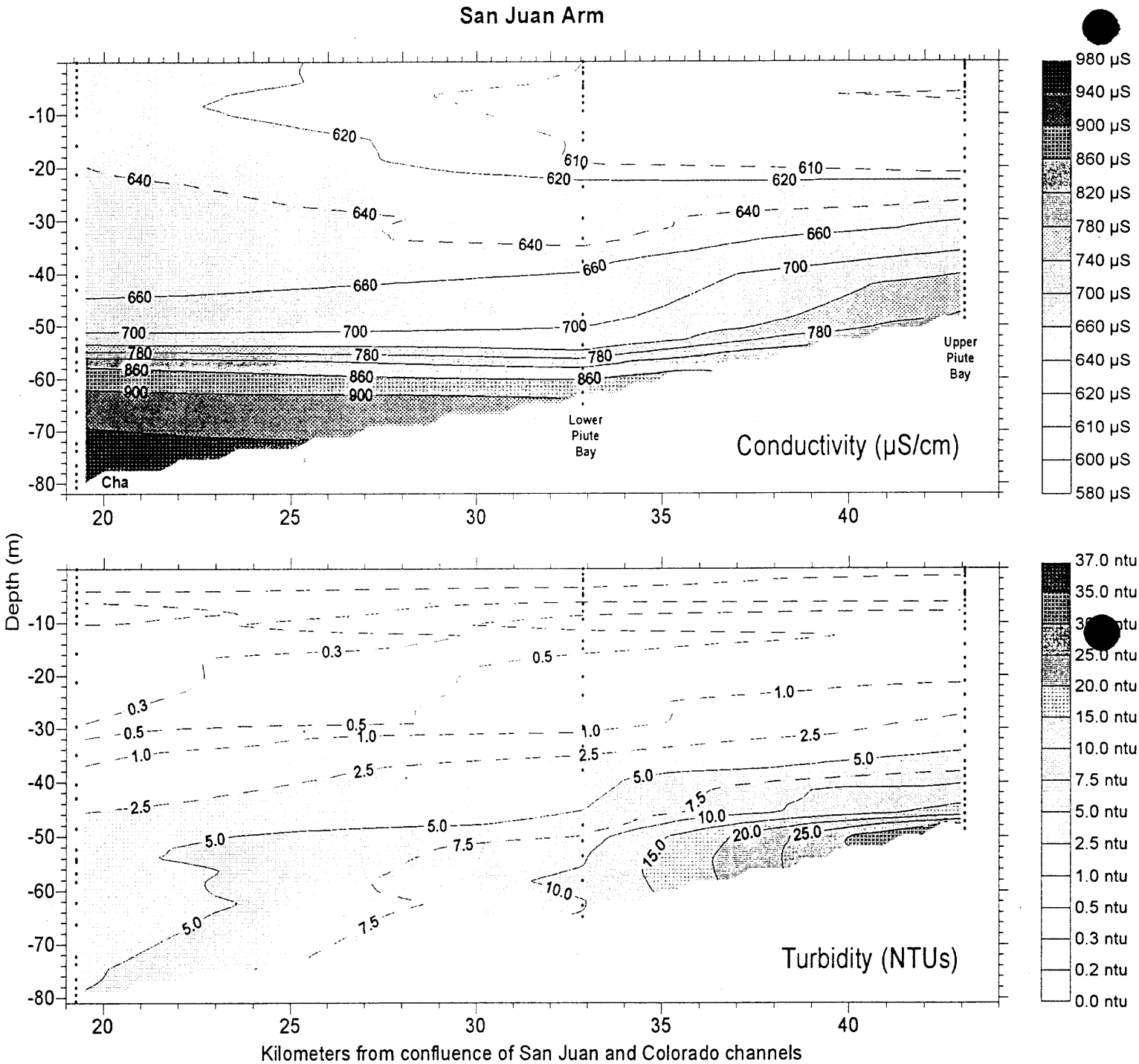
Dots represent actual data points. Dashed isopleth lines represent contours out of the normal sequence of the scale, but which are included for added resolution to aid interpretation.



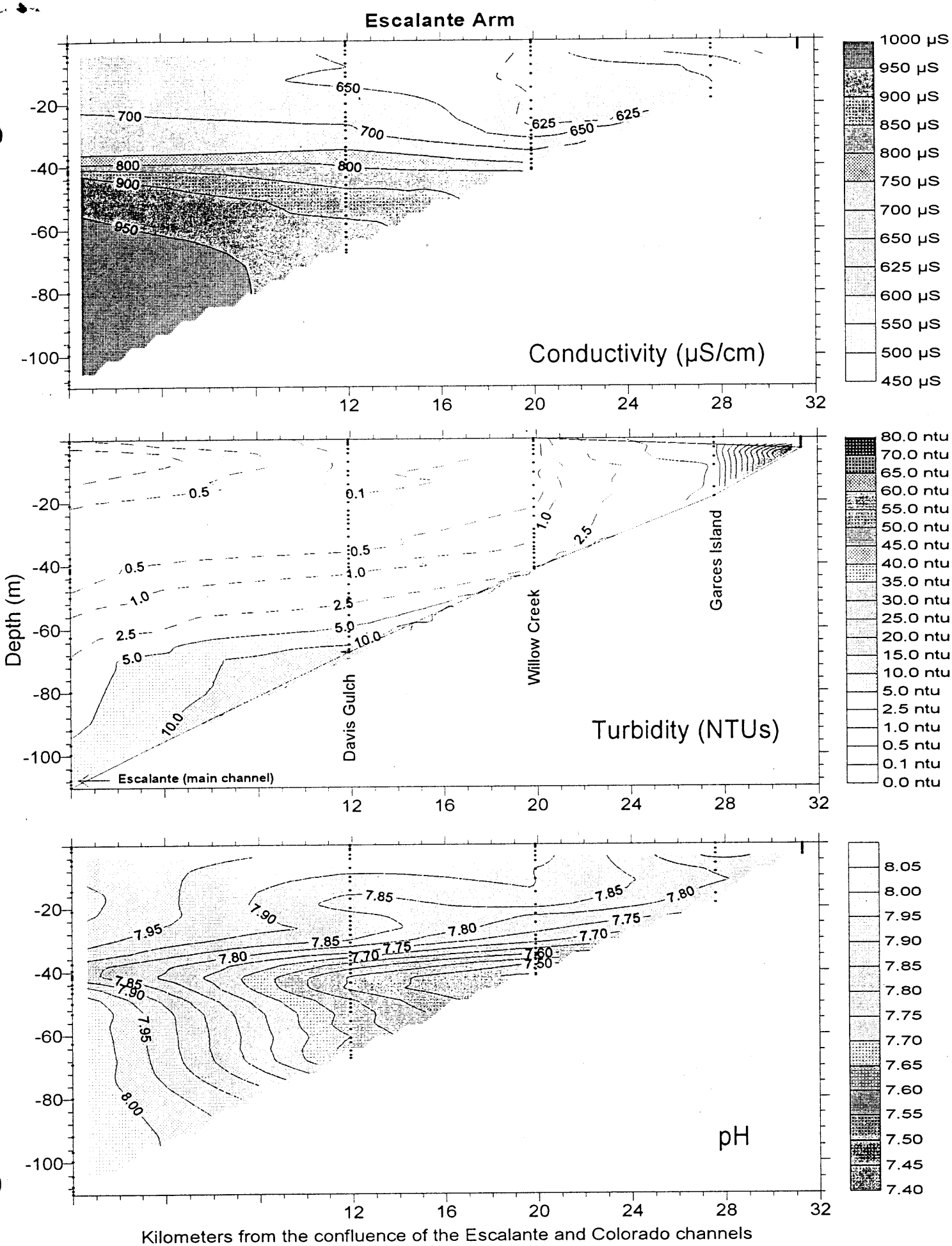
Conductivity (uS/cm), Turbidity (NTUs) and pH for the main channel of Lake Powell, February 23 to 26, 1995. Dots represent data points in profile. Penstock depth at dam is 53.4 m.



Temperature (°C), dissolved oxygen (mg/L), and pH in the San Juan Arm of Lake Powell, February 27, 1995, from Piute Bay to Cha Canyon.

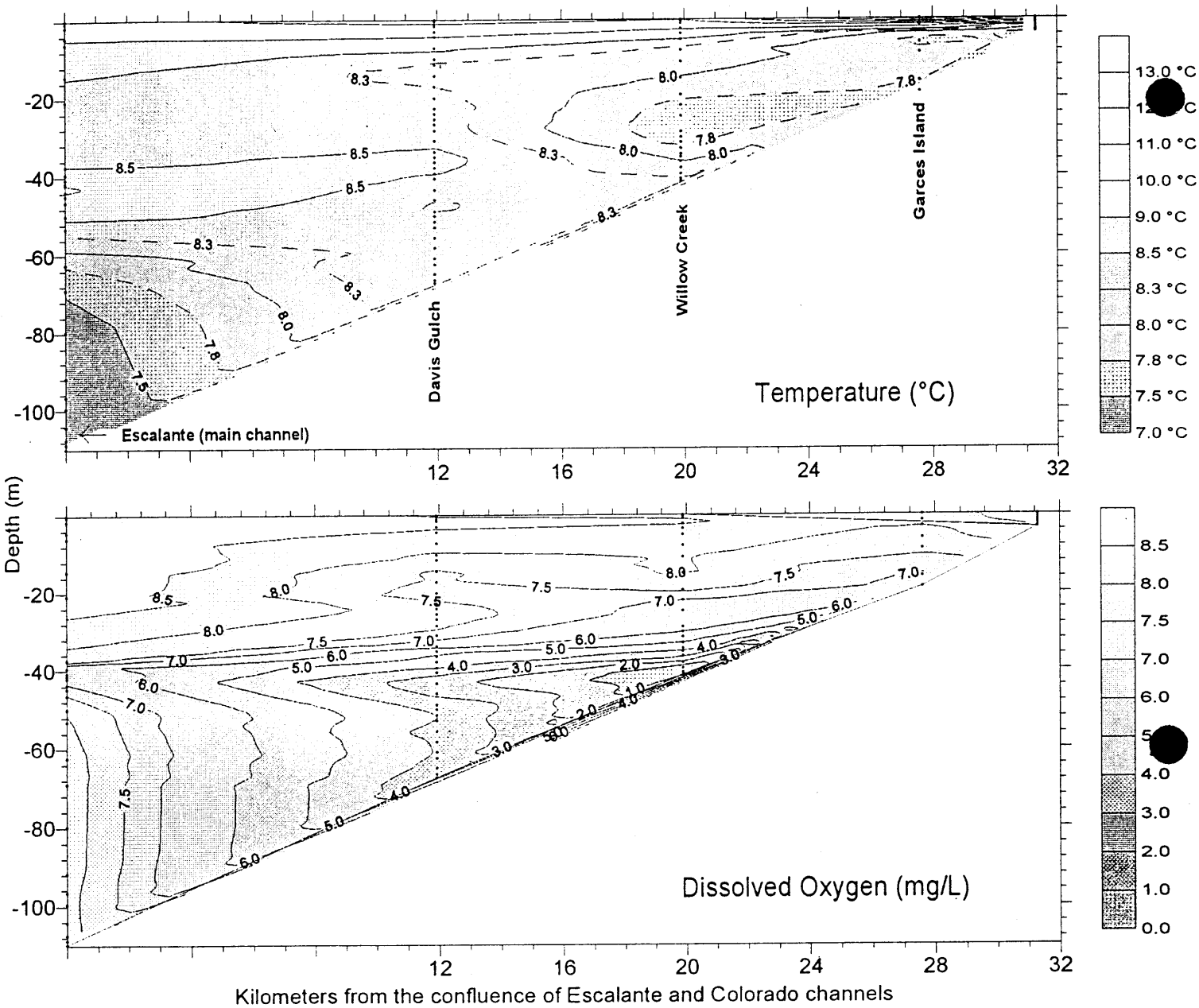


Conductivity (µS/cm) and turbidity (NTUs) in the San Juan arm of Lake Powell on February 27, 1995, Cha Canyon to Piute Bay.



Conductivity (µS/cm), turbidity (NTUs) and pH on the Escalante arm of Lake Powell on February 24, 1995.

Escalante Arm

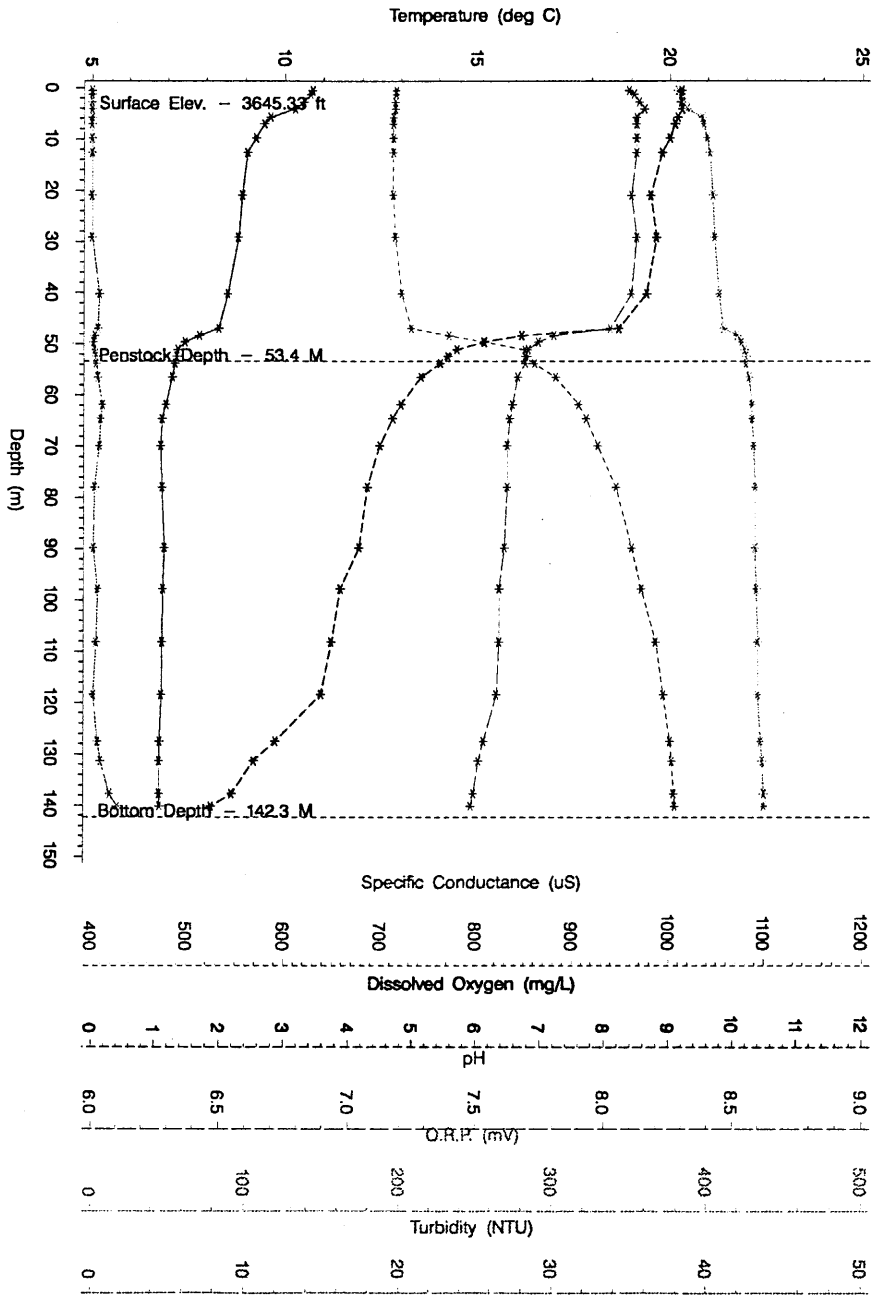


Temperature (°C), and dissolved oxygen (mg/L) in the Escalante arm of Lake Powell, February 24, 1995.

Wahweap

SCUCLP12

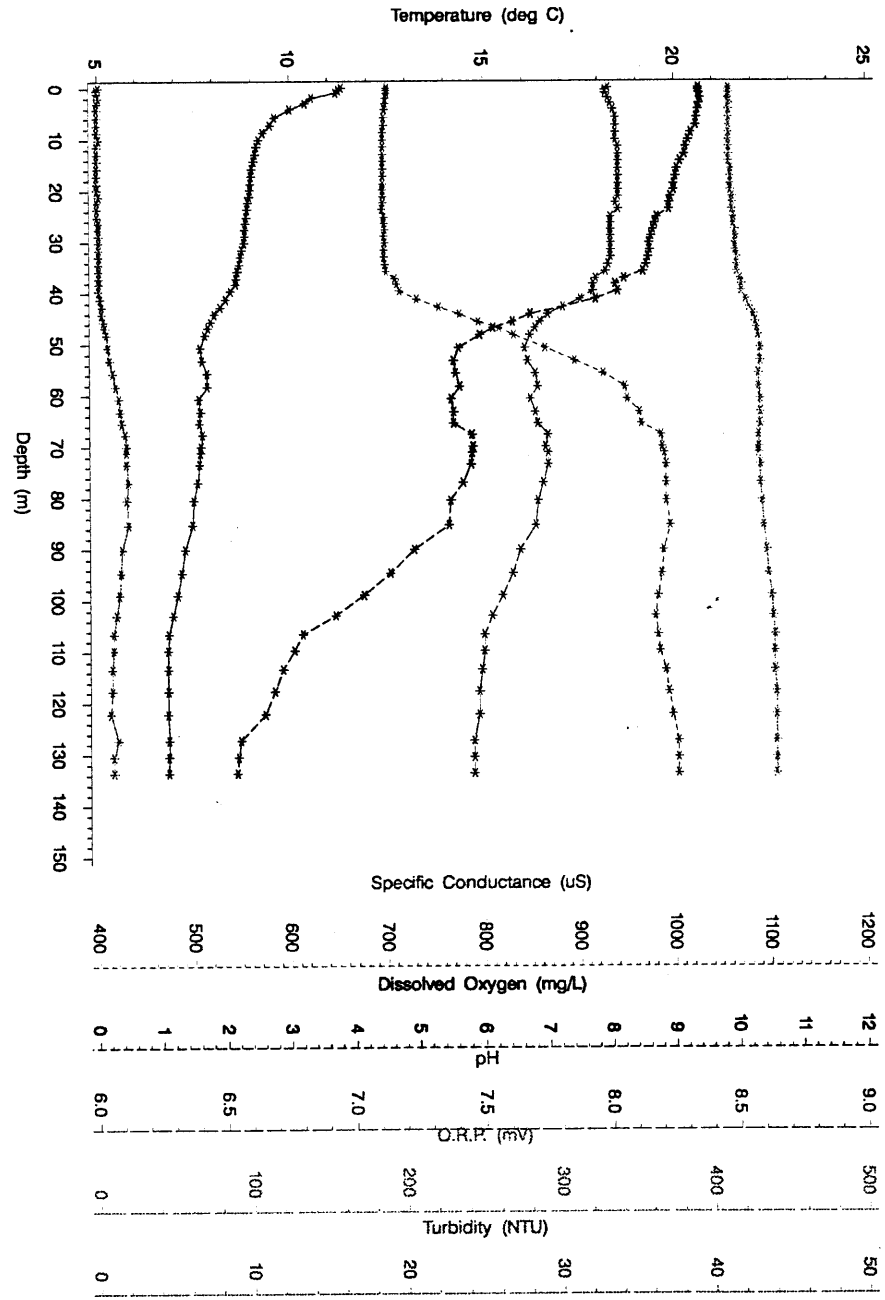
February 23, 1995



Crossing of the Fathers

SCUCLP13

February 23, 1995



Escalante

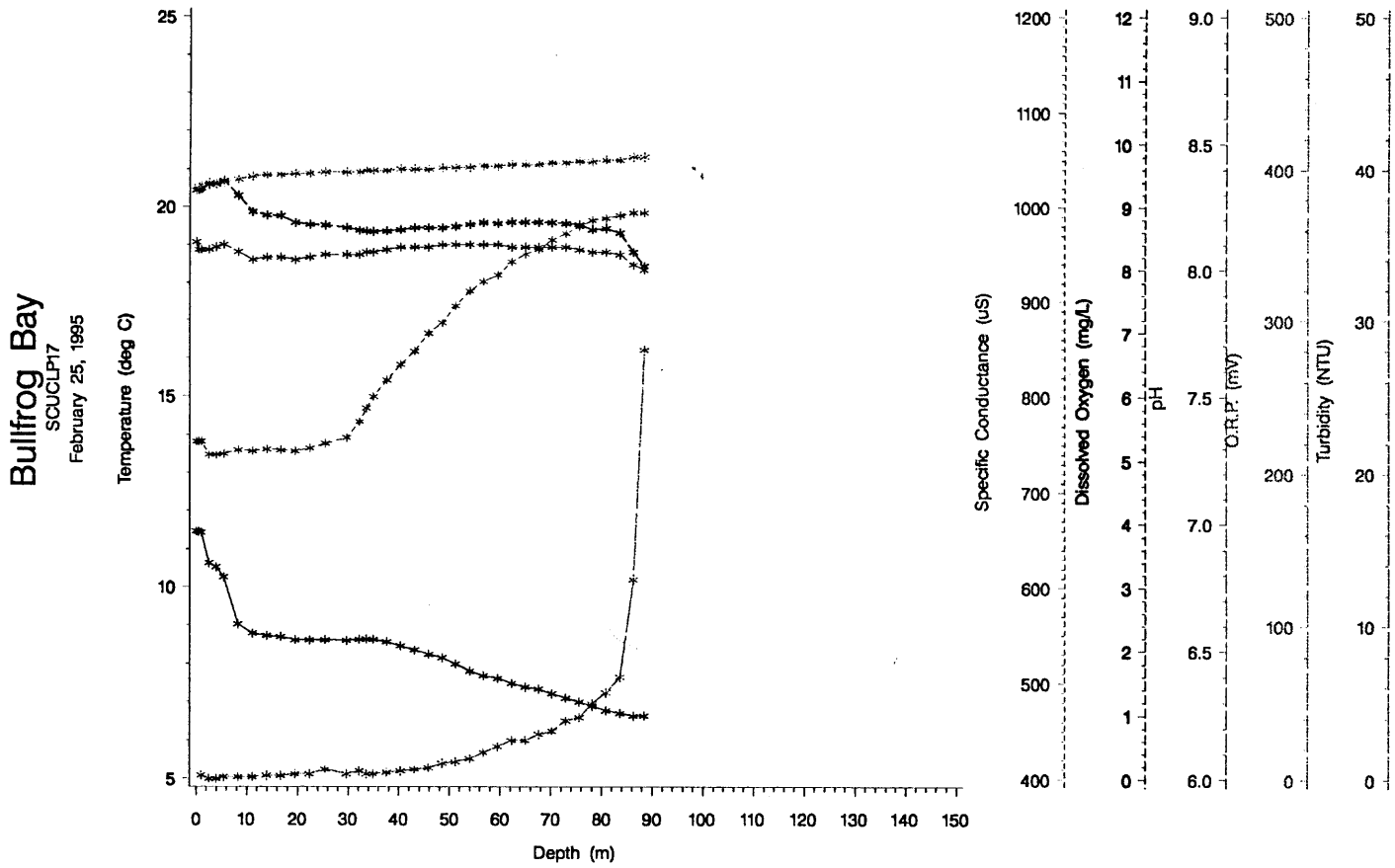
SCUCLP16

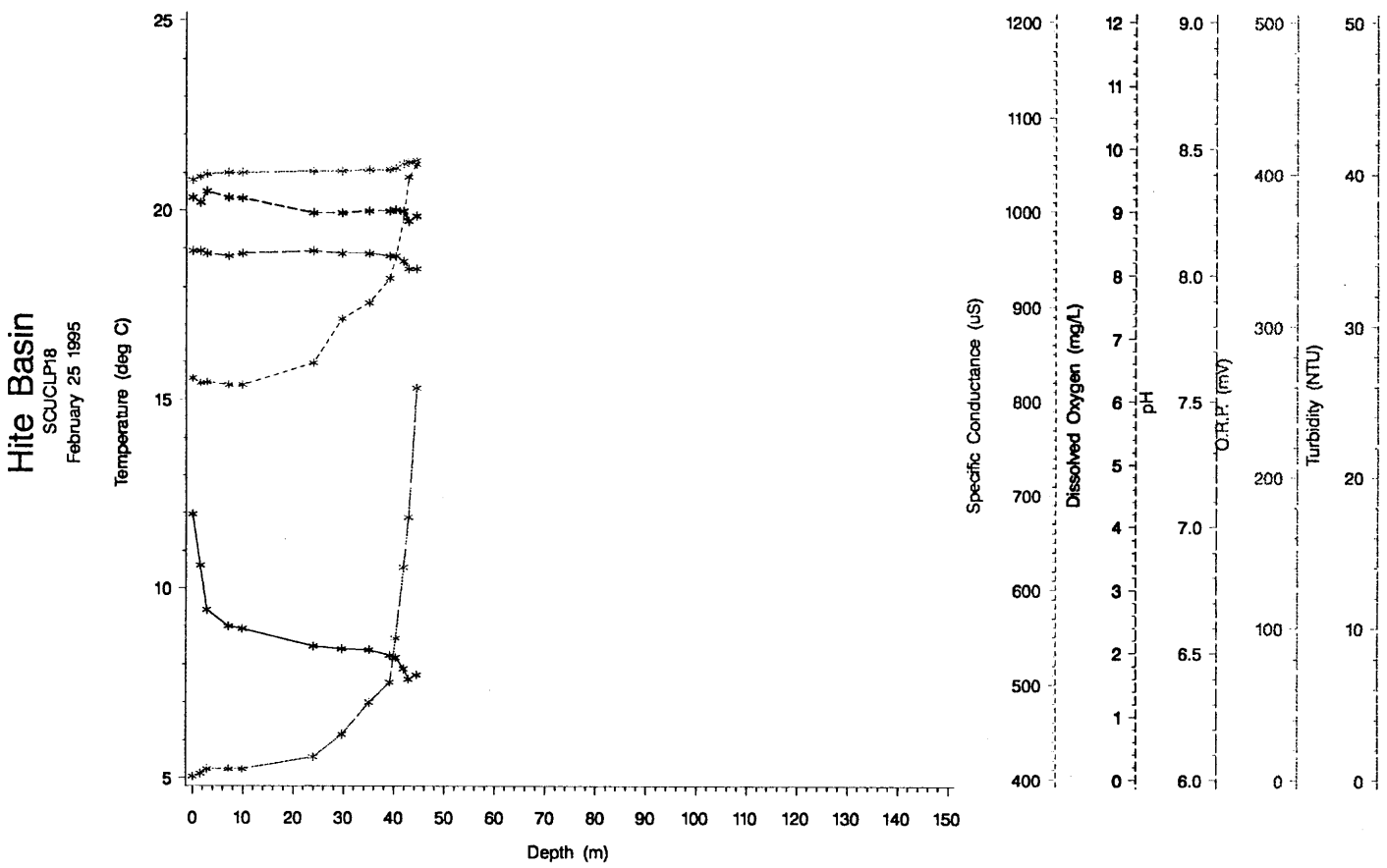
February 24, 1995

Lower Good Hope Bay

SCCR1180

February 26, 1995


Bullfrog Bay
SCUCLP17
February 25, 1995
Temperature (deg C)
Depth (m)
Specific Conductance (uS)
Dissolved Oxygen (mg/L)
pH
O.R.P. (mV)
Turbidity (NTU)


Hite Basin
SCUCLP18
February 25 1995
Temperature (deg C)
Depth (m)
Specific Conductance (uS)
Dissolved Oxygen (mg/L)
pH
O.R.P. (mV)
Turbidity (NTU)