In Response to the State Water Resources Control Board Order Nos. 98-05 and 98-07

COMPLIANCE REPORTING

STREAM MONITORING

FISH MONITORING

WATERFOWL MONITORING

RUNOFF FORECAST AND OPERATIONS

May, 2001

Los Angeles Department of Water and Power

STATE WATER RESOURCES CONTROL BOARD

2001 MAY 24 AM 11:21

DIV. OF WATER RIGHTS SACRAMENTO

May 15, 2001

Mr. Harry Schueller, Chief
Division of Water Rights
State Water Resources Control Board
901 P Street
Sacramento, California 95814

Dear Mr. Schueller:

Compliance with State Water Resources Control Board Order Nos. 98-05 and 98-07

Pursuant to the State Water Resources Control Board (SWRCB) Order Nos. 98-05 and 98-07 and in accordance with the terms and conditions of the Los Angeles Department of Water and Power (LADWP) Mono Basin water right license Nos. 10191 and 10192, enclosed is a submittal entitled "Compliance Reporting", which contains the four reports required by SWRCB. The reports are as follows:

- Mono Basin Operations for Runoff Year 2001-2002
- Fishery Monitoring Report for Rush, Lee Vining, Parker, and Walker Creeks 2000
- Mono Basin Tributaries Restoration: Lee Vining, Rush, Walker and Parker Creeks - Monitoring Results and Analyses for Water Year 2000
- 2000-2001 Mono Basin Waterfowl Habitat and Population Monitoring

In addition to the four reports, the binder also includes a report entitled "Compliance with State Water Resources Control Board Order Nos. 98-05 and 98-07". This report summarizes LADWP's restoration and monitoring activities performed during Runoff Year (RY) 2000 and the restoration and monitoring activities proposed for RY 2001.

The filing of the reports and the restoration and monitoring performed by LADWP in the Mono Basin fulfills LADWP's requirements for RY 2000 as set forth in Order Nos. 98-05 and 98-07. Copies of the report have been provided to the interested parties.

If you have any questions, please contact Mr. Peter Kavounas at (213) 367-1032.

Sincerely,

ORIGINAL SIGNED BY:
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Enclosures

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Mono Basin Restoration

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Compliance with State Water Resources Control Board Decision 1631 and Order Nos. 98-05 and 98-07

May, 2001

Los Angeles Department of Water and Power

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1. INTRODUCTION

Pursuant to State Water Resources Control Board (SWRCB) Decision 1631 and Orders No. 98-05 and 98-07 (Orders), the Los Angeles Department of Water and Power (LADWP) is to undertake certain activities in the Mono Basin to be in compliance with the terms and conditions of its water right licenses 10191 and 10192. In particular, the Orders state that LADWP is to undertake activities to restore and monitor the fisheries, stream channels, and waterfowl habitat. This summary provides an overview of all of the activities LADWP and its consultants completed during Runoff Year (RY) 2000 for compliance. The summary also provides a list of planned work/activities for RY 2001.

Runoff Year 2000 was the second full field season after the adoption of the Orders. As such, LADWP is continuing the implementation of its revised Stream and Stream Channel Restoration Plan, revised Grant Lake Operation and Management Plan, and revised Waterfowl Habitat Restoration Plan. This required, among other things, renewing consultants contracts, scheduling field crews and other resources, coordinating with various other agencies, and preparing work plans. LADWP completed most of the planned work/activities for compliance. Due to circumstances outside the Department's control, some activities were not completed. This report details the work/activities undertaken and some of the activities involving projects that the Department was not able to complete.

2. WORK PERFORMED DURING RUNOFF YEAR 2000

2.1 Restoration Activities

2.1.1 Streams

In 2000, LADWP undertook and completed several measures that were outlined in the Mono Basin Stream and Stream Channel Restoration Plan (1996). These included:

- Studied the feasibility of channel rewatering on Rush Creek;
- Coordinated and consulted with Caltrans on the culvert replacement project for Rush, Lee Vining, Walker, and Parker creeks at Highway 395;
- Commissioned a conceptual engineering and design for sediment passage facilities on Lee Vining Creek;
- Continued with the grazing moratorium;
- Continued no irrigation policy during peak flows;
- Continued efforts to rehabilitate the Rush Creek Return Ditch;
- Provided base flows, stream restoration flows, and export in accordance with the Orders;
- Removed gravel bags from Lee Vining Creek; and
- Completed construction of a Web Site to display Mono Basin hydrologic data.

Channel Rewatering (3D): LADWP staff met with Scott McBain and Darren Mierau of McBain and Trush to discuss rewatering the abandoned east side channel in Reach 3D on Rush Creek. Bill Trush is analyzing the pros and cons of rewatering abandoned channels in the Rush Creek bottomland . Dr. Trush will propose recommendations on options available for this site and other sites located on lower Rush Creek.

Culverts: LADWP staff met with Caltrans in August 2000 to discuss their construction activities associated with the project to widen Highway 395.

Sediment Bypass Study: On June 15, 2000, LADWP amended R2 Resource Consultants Inc. (R2) contract to include a task to analyze and design a sediment bypass systems for Lee Vining Creek utilizing sluice gates on the weir wall. R2 has been given the task assignment to perform the work. The results of their analysis and conceptual design will be completed in late Fall 2001.

Grazing Moratorium: There was no grazing on LADWP's land in the Mono Basin during RY 2000. The grazing moratorium is still in effect and has been expanded to all lands in the Mono Basin.

Irrigation Practices: There was no LADWP irrigation in the Mono Basin during RY 2000. All irrigation in the Mono Basin was suspended in RY 2000.

Rehabilitation of Rush Creek Return Ditch: During 2000, LADWP met with DFG to address issues pertaining to fish habitat in the ditch. The discussions have been ongoing and significant progress has been made that should enable LADWP to proceed with construction/rehabilitation activities during late summer-early fall 2001.

Base Flows and Stream Restoration Flows: During RY 2000, Lee Vining, Walker, and Parker creeks were maintained in "flow through" conditions and met all flow requirements. Rush Creek exceeded its base flow requirements. Since the Rush Creek Return Ditch has not yet been restored to its original capacity, LADWP provided peak flows to lower Rush Creek by spilling Grant Lake reservoir. The reservoir was forced to spill to create a flow through condition. The peak occurred on June 20th and was 193 cfs. Exports from the basin began on August 1st after the peak had passed and continued until March 31, 2001. The rate of export ranged from 32 cfs to 40 cfs and the total export was approximately 15,958 acre-feet.

Removal of Bags of Spawning Gravel: LADWP staff in March opened and distributed one layer of bags (approximately 20 bags per layer) containing spawning gravel into Lee Vining Creek.

Web Page: Construction was completed on LADWP's web site to display Mono Basin hydrologic data. Work was performed by Beavins Systems and Psomas.

2.1.2 Waterfowl

In RY 2000, LADWP continued its waterfowl habitat monitoring and restoration program. The following is a summary of activities.

- Monitored Mono Lake elevation;
- Implemented a prescribed burn program; and
- Established vegetation transects.

Mono Lake: Mono Lake elevation was monitored on a weekly basis. There was very little change in Mono Lake's elevation. The lake elevation during RY 2000 ranged from 6,384.8 on Aprill, 2000 to 6,383.8 msl on March 31, 2001. The average surface area during RY 2000, based on the Pelagos Corp. 1986 bathymetric study, was approximately 72 sq. miles or 46,000 acres. The average salinity based on Jones & Stokes 1993 Mono Basin EIR was approximately 75 g/l. Salinity levels measured by UC Santa Barbara differed from the average in that the salinity levels are measured at several locations and elevations and the lake is currently meromictic.

Prescribed burn program: During RY 2000, LADWP continued development of its prescribed burn program for the Mono Basin. LADWP coordinated with the California Department of Forestry (CDF) and the California Department of Parks and Recreation Cstate Parks) in putting together a CDF plan to burn the northern section of Warm Springs in early

2001. The CDF plan was circulated to State Parks, Inyo National Forest and interested parties for comments. Due to concerns expressed with the burn protocol, LADWP held a meeting in February 2001 with CDF and the State Parks. During the meeting, it was learned that CDF did not have a Memorandum of Understanding (MOU) with State Parks. Since the burn is primarily on state lands managed by State Parks, CDF was not able to perform the burn. LADWP anticipates working with State Parks to jointly conduct a burn in early 2002.

Vegetation transects were established at Simon Spring, Warm Spring, DeChambeau Embayment, and the deltas of Rush and Lee Vining creeks during RY 1999. No transect data was collected during RY 2000.

2.2. Monitoring

2.2.1 Stream Channel

Contract and Scope of Work: In September 2001, LADWP amended the contract with Dr. Trush (McBain and Trush) to continue the stream channel monitoring program on Rush, Lee Vining, Walker, and Parker creeks through fiscal year 2003. A new Scope of Work was developed that complies with the requirements of SWRCB Order No 98-07.

Monitoring and Reporting: McBain and Trush during RY 2001 continued their monitoring program developed in RY 1997 and 1998 following the White and Blue book principles. Planmap sites were established per the White and Blue books monitoring protocol. There are 3 sites on Rush Creek, 2 sites on Lee Vining Creek, 1 site on Walker Creek and 1 site on Parker Creeks. A report for RY 2000 was prepared by McBain and Trush detailing the monitoring activities and requirements. The report entitled "Mono Basin Tributaries Restoration: Lee Vining, Rush, Walker, and Parker Creeks – Monitoring Results and Analyses for Water Year 2000" is included in Section 4 of Compliance Reporting. (Note: The report title identifies the monitoring period as WY 2000, although it covers the April 2000 to March period 2001. Traditionally, the April to March period is called Runoff Year, whereas Water Year refers to the October to September period.

2.2.2 Fishery

Contract and Scope of Work: In September 2000, LADWP amended the contract with Chris Hunter to continue fish population surveys on monitor Rush, Lee Vining, Walker, and Parker creeks. A new Scope of Work was developed that complies with the requirements of SWRCB Order No. 98-07.

Monitoring and Reporting: Mr. Hunter continued the monitoring program developed in RY 1997 and 1998 following the White and Blue book principles. Mr. Hunter surveyed the 3 planmap sites on Rush Creek the 2 on Lee Vining Creek and each of the planmap sites on Walker and Parker creeks. A report entitled "Fisheries Monitoring Report for Rush, Lee Vining, Parker and Walker creeks 2000" is included in Section 3 of Compliance Reporting. The report details the fish population surveys and monitoring requirements.

In addition to Mr. Hunter's fish population surveys, LADWP and DFG agreed on and developed a creel census for Lee Vining Creek. The purpose of the creel survey was to estimate the fishing pressure brought on by the amended fishing regulation that allows a take of two fish per day per person. DFG, through the oversight of Debra Hawk, funded and performed the RY 2000 creel survey. The results of the survey were provided to Mr. Hunter.

2.2.3 Waterfowl

Oversight: During RY 2000, LADWP nominated Brian White, LADWP biologist to oversee the waterfowl restoration and monitoring program. On March 21, 2001, the SWRCB approved Dr. White's appointment.

Oversight of the Monitoring Program: During RY 2000, Dr. White met with the researchers responsible for collecting data in the Mono Basin. Dr. White also reviewed historical data and reports.

Monitoring in the Mono Basin: During RY 2000, LADWP amended the Mono Basin monitoring contracts with the following consultants to continue collecting data as required by Order No. 98-05:

- UC Santa Barbara (John Melack and Robert Jellison) for monitoring limnology and secondary producers at Mono Lake; and
- Hubbs-Sea World Institute (Joseph Jehl) for waterfowl population survey at Mono Lake.

During RY 2000, LADWP also contracted with I. K. Curtis Inc. and AirPhoto USA to provide aerial photography services to produce GIS compatible aerial photography of the Mono Basin with a scale of 1:2400 or 1 inch = 200 feet.

LADWP personnel collected hydrology data for the four streams and Mono Lake.

LADWP field crews removed Salt Cedar plants from the Rush Creek delta. LADWP personnel are working with the Mono Lake Committee to have volunteers continue the eradication of the plant. Other agencies will be encouraged to participate.

2.3. Informational Meetings

The LADWP sponsored two meetings during RY 2000 for the experts and interested persons to present and discuss restoration and monitoring activities, hydrology and other issues related to the Mono Basin. The first meeting was held on April 27, 2000 in Sacramento. The second meeting was held on November 17, 2000 in Sacramento.

April Meeting: This meeting provided an opportunity for the stream monitoring experts to present their finding of RY 1999 monitoring activities and discuss their proposed RY 2000 scope of work. In addition, the preliminary RY 2000 runoff forecast was discussed.

Attendees in addition to LADWP personnel included the following: Experts – Dr. Trush, Mr. Hunter, Mike Ramey, and Dudley Reiser. Interested persons – Jim Canaday (SWRCB), Heidi Hopkins and Peter Vorster (MLC), Gary Smith (DFG), Katie Bolomo and Bonnie Noles (People for Mono Basin Preservation (PMBP)) via conference call, and Ken Anderson (State Parks).

November Meeting: This meeting provided an opportunity for the stream monitoring experts and waterfowl experts to present and discuss their RY 2000 activities. The meeting also provided an opportunity to provide an overview of the runoff recap for 2000.

Attendees in addition to LADWP personnel included the following: Experts – Dr. Trush and Mr. Hunter. Interested persons – Jim Canaday (SWRCB), Ms. Hopkins and Mr. Vorster (MLC), and Mr. Smith (DFG).

3. ACTIVITIES PLANNED FOR RUNOFF YEAR 2001

3.1 Restoration

3.1.1 Streams

Channel Rewatering: In Reach 3D plans are being developed to determine the best alternative for rewatering the abandoned east side channel. Additional channel rewatering, as proposed in the Stream and Stream Channel Restoration Plan, may be contemplated for Rush Creek once Dr. Trush completes his evaluation on the effects of channel rewatering on the restoration process.

Revegetation: There are no plans this season for planting Jeffery pines on Lee Vining or Rush Creek. If the opportunity arises to plant Jeffery pines, LADWP will coordinate with the Mono Lake Committee.

Road Closures: There are no plans this season to close roads in the floodplain of Rush Creek. The remaining roads will be left open until restoration activities are completed. There is still a need to bring in heavy equipment to some of the proposed restoration sites.

Bags of Spawning Gravel: LADWP will distribute the remaining bags of gravel into Lee Vining Creek from the bags located immediately upstream of the old diversion dam. LADWP will also remove rebar from the site.

Coordinate with Caltrans: LADWP will continue monitoring Caltrans progress on the installation of new culverts during the highway widening project to ensure restoration and monitoring activities are proceeding as planned.

Return Ditch: LADWP will continue its discussions with DFG on the rehabilitation of the Return Ditch. If an agreement can be reached in the immediate future, LADWP will make every effort to complete the necessary work this season.

Sediment Bypass: LADWP will continue working with R2 on the development of a conceptual design and engineering for installing sediment passage on Lee Vining Creek.

Permits and Approvals: LADWP will obtain all necessary permits and approvals from the Water Quality Control Board, Army Corp of Engineers, and from DFG. Environmental documents, if necessary, will be prepared to comply with the requirements of the California Environmental Quality Act.

3.1.2 Waterfowl

Prescribed Burn Program: LADWP will work with State Parks to design an implement a burn in early 2002.

Channel Rewatering: There are no plans to rewater the channels described in the waterfowl plan until Dr. Trush completes his evaluation on the effects of rewatering distributaries on the restoration of the stream system.

3.2 Monitoring

3.2.1 Streams

Dr. Trush will continue the monitoring program on Rush, Lee Vining, Walker, and Parker creeks.

3.2.2 Fishery

Mr. Hunter will continue the fish population monitoring program on Rush, Lee Vining, Walker, and Parker creeks.

LADWP is working with DFG to put together a program to perform the second year of creel surveys on Lee Vining Creek.

3.3.3 Waterfowl

Expert: Dr. White will oversee the waterfowl-monitoring program.

Limnology: Dr. Jellison and Dr. Melack will continue limnological monitoring in the Mono Basin.

Waterfowl Population Surveys: Dr. Jehl will continue waterfowl population surveys in the Mono Basin.

Aerial photography: LADWP will conduct aerial photography of the Mono Basin in a GIS compatible format.

Hydrology: LADWP will continue to monitor the elevation of Mono Lake and to collect hydrologic data in the Mono Basin.

3.3. Informational Meetings

Bi-annual Meetings: LADWP will host two meetings with the researchers and interested parties to discuss restoration and monitoring activities in the Mono Basin. As in previous years, the meetings will be held prior to and after the field season. The first meeting has been scheduled for May 1, 2001.

4.0. Physical Projects Remaining

4.1 Streams

- Channel Rewatering on Rush Creek: No construction activities have been conducted on several channels on lower Rush Creek. The decision on whether to proceed with the original stream plan is currently being analyzed.
- Road Closures on Rush Creek: Several roads on lower Rush Creek identified for closures will remain opened until all restoration activities have been completed.
- Sediment on Lee Vining, Walker and Parker Creeks: LADWP has authorized R2 to prepare conceptual engineering and design for passing sediment on Lee Vining Creek.
- Rehabilitation/Maintenance of Mono Gate Return Ditch: LADWP is planning on performing the construction work on the Return Ditch during RY 2001 and 2002.

4.2 Waterfowl

- Channel Rewatering on Rush Creek: No construction activities have been conducted on several channels on lower Rush Creek. The decision on whether to proceed with the original stream plan is currently being analyzed.
- Prescribed Burn Program: Discussions with State Parks are ongoing with a anticipated burn in early 2002.

2

Mono Basin Operations for Runoff Year 2001-2002 - Preliminary

The May 1, 2001 Mono Basin forecast for the runoff[1] 2001-02 Runoff Year is 90,800 acre-feet or 77% of normal[2]. This year is a "dry normal" year, as defined by the State Water Resources Control Board (SWRCB) Order No. 98-05 year-type designations.

To meet the flow requirements of the SWRCB Order No. 98-05, the Los Angeles Department of Water and Power (LADWP) intends to follow the Guidelines shown in Figure 1. The runoff forecast indicates that the LADWP will most likely not be able to fill and spill Grant Lake during this runoff season. Nevertheless, LADWP intents to divert approximately 20 cfs to Grant Lake from Lee Vining Creek as soon as the flows allow and continue diverting until just before the peak occurs on Lee Vining Creek.

The Mono Gate Return Ditch has not yet been rehabilitated to its design capacity of approximately 380 cfs, consequently, LADWP will not be able to provide the minimum stream restoration flows of 200 cfs for 7 days to Rush Creek. To mitigate this circumstance, LADWP will instead ramp up the Return Ditch to a current maximum flow of 160 cfs for 7 days. Dry and Dry-Normal year stream restoration flows provide little or no benefit to the fluvial geomorphological process however, the flows do provide some benefit to the vegetation and to groundwater recharge.

LADWP anticipates exporting its full entitlement (16,000 acre-feet), at a constant rate, as soon as the peak flow has passed or when its has been determined that there is no chance of spilling.

Table 2 "Grant Lake Operations Model - Statistical Summaries" summarizes the "educated guess" of distribution of monthly flows in the Mono Basin streams and LADWP facilities for the 2001-02 Runoff Year. These flows do not represent minimum or maximum flows, or targets any kind; they merely provide a possible scenario of the flow distribution in the basin, assuming average climatic conditions subsequent to the forecast date. The actual flows will likely be different.

Figures 2 through 8 are graphs depicting data from a single similar year type and do not represent the forecasted runoff. The graphs are provided for illustration purposes only.

The values of expected magnitude and timing of the peak flows in Rush, Lee Vining, Walker and Parker creeks were generated by a predictive model, and are shown in Table 1.

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1 Based on the April 1, 1999 runoff forecast.

2 Using the 1941-1990 average of 122,124 acre-feet.

Table 1

	Peak Flow Magnitude (cfs)	Timing
Rush Creek @ Damsite	184	June 5
Parker Creek above Conduit	38	June 18
Walker Creek above Conduit	24	June 14
Lee Vining Creek	178	June 3

The model uses regression analysis of historical data to predict future events. Since the actual values depend heavily on ambient temperatures that are difficult to accurately predict with any degree of certainty, it is more than likely that the values in Table 1 are not accurate. It is intended that they be used as an indicator of magnitude and timing of the peak flows. These predictions are based on the May 1, 2001 forecast, and assume median precipitation for the following six months.

On April 1, 2001, Mono Lake's water surface elevation measured 6,383.8-ft. amsl (USGS datum) and storage in Grant Lake Reservoir was 38,000 acre-feet (80% of capacity). Given the most current forecast, and the proposed operations guideline, the elevation of Mono Lake is expected to be approximately 6383.2-ft. amsl at the end of the runoff year. This is graphically shown in Figure 9 "Mono Lake Elevation and Transition Export". The estimate is derived from modeling, and includes a number of assumptions such as normal precipitation conditions for the remainder of the year. The number is to be used as a general indicator.

<u>**Mono Basin Distribution List**</u>

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Grant Lake Operations Model - Statistical Summaries

2001 Runoff Year: Dry-Normal

Daily Flows

	Lee Vin. Creek Above Intake	Walker Creek Above Conduit	Parker Creek Above Conduit	Rush Creek @ Damsite	Lee Vin. Creek Release	Lee Vin. Conduit Diver.	Lower Walker Parker Flow	Lower Rush Cr. Release	Rush C. Bottom land Flow	Grant Lake Storage	Grant Lake Outflow	Grant Lake Spill	Mono Basin Export	Owens River Abv. E. Portal	Owens River Blw. E. Portal
	cubic feet/second									ac-ft	cubic feet/second				
Start										38,000					
Min	16	1	2	17	16	0	5	44	49	29,000	44	0	0	39	56
Ave	51	5	6	58	49	2	11	50	62	38,815	72	0	22	44	83
Max	197	22	34	115	197	20	55	160	177	43,710	160	0	53	60	115
End										29,370					

Monthly Average Flows

cubic feet/second	Lee Vin. Creek Above Intake	Walker Creek Above Conduit	Parker Creek Above Conduit	Rush Creek @ Damsite	Lee Vin. Creek Release	Lee Vin. Conduit Diver.	Lower Walker Parker Flow	Lower Rush Cr. Release	Rush C. Bottom land Flow	Grant Lake Storage (1st of Month)	Grant Lake Outflow	Grant Lake Spill	Mono Basin Export	Owens River Abv. E. Portal	Owens River Blw. E. Portal
Apr	73	2	5	87	73	0	7	47	54	38,000	47	0	0	48	65
May	101	8	6	88	82	18	14	72	86	40,540	72	0	0	50	67
Jun	132	16	19	94	129	4	35	80	115	42,490	80	0	0	46	63
Jul	65	8	13	64	65	0	20	47	67	43,250	47	0	0	41	58
Aug	31	4	7	39	31	0	12	47	59	43,710	47	0	0	44	61
Sep	30	3	6	34	30	0	8	47	55	42,750	47	0	0	42	59
Oct	29	4	5	40	29	0	8	44	52	41,590	46	0	2	44	63
Nov	25	7	3	44	25	0	10	44	54	41,190	97	0	53	43	112
Dec	22	3	3	36	22	0	6	44	50	38,360	97	0	53	44	114
Jan	35	3	3	52	35	0	5	44	49	34,970	97	0	53	43	113
Feb	44	2	3	52	44	0	5	44	49	32,630	97	0	53	43	113
Mar	29	3	3	72	29	0	6	44	50	30,510	97	0	53	43	113

Monthly Total Flows

acre-feet	Lee Vin. Creek Above Intake	Walker Creek Above Conduit	Parker Creek Above Conduit	Rush Creek @ Damsite	Lee Vin. Creek Release	Lee Vin. Conduit Diver.	Lower Walker Parker Flow	Lower Rush Cr. Release	Rush C. Bottom land Flow	Grant Lake Storage (Average)	Grant Lake Outflow	Grant Lake Spill	Mono Basin Export	Owens River Abv. E. Portal	Owens River Blw. E. Portal
Apr	4,322	122	299	5,173	4,322	0	421	2,797	3,218	39,068	2,797	0	0	2,829	3,841
May	6,203	475	384	5,412	5,073	1,131	859	4,449	5,308	41,978	4,449	0	0	3,077	4,123
Jun	7,875	927	1,149	5,570	7,657	218	2,076	4,745	6,821	42,358	4,745	0	0	2,765	3,776
Jul	4,008	464	775	3,929	4,008	0	1,239	2,890	4,129	43,566	2,890	0	0	2,544	3,590
Aug	1,905	269	449	2,371	1,905	0	718	2,890	3,608	43,285	2,890	0	0	2,684	3,729
Sep	1,789	164	338	2,020	1,789	0	502	2,797	3,299	42,240	2,797	0	0	2,510	3,522
Oct	1,764	234	279	2,448	1,764	0	512	2,705	3,218	41,412	2,825	0	119	2,688	3,852
Nov	1,496	418	184	2,622	1,496	0	601	2,618	3,220	39,909	5,746	0	3,128	2,540	6,680
Dec	1,331	166	214	2,186	1,331	0	380	2,705	3,086	36,562	5,964	0	3,259	2,700	7,005
Jan	2,160	156	171	3,203	2,160	0	326	2,705	3,032	33,824	5,964	0	3,259	2,666	6,970
Feb	2,471	137	150	2,861	2,471	0	288	2,444	2,731	31,639	5,387	0	2,944	2,370	6,258
Mar	1,777	158	211	4,398	1,777	0	369	2,705	3,075	29,472	5,964	0	3,259	2,634	6,939
Apr-Sep	26,102	2,422	3,394	24,476	24,754	1,349	5,816	20,567	26,383		20,567	0	0	16,409	22,580
Oct-Mar	10,999	1,269	1,209	17,719	10,999	0	2,477	15,884	18,361		31,851	0	15,967	15,599	37,703
Annual Total	37,101	3,690	4,603	42,194	35,752	1,349	8,293	36,451	44,744		52,418	0	15,967	32,008	60,283

Table 2

MONO BASIN OPERATIONS - PLANNING GUIDELINE B

Hydrologic Year Type:	Dry-Normal I
Forecasted Volume of Runoff (acre-feet):	83,655 < - ≤ 92,207

LOWER RUSH CREEK

Instream Flows:

	Apr-Sept	Oct-Mar
Flow (cfs)	47	44

Minimum base flows are those specified above or the inflow to Grant Lake reservoir, whichever is less. However, if the inflow is less than the dry year instream flow requirements, then dry year base flow requirements apply (Refer to Schedule A).

Stream Restoration Flows: 200 cfs for 7 days

- Begin ramping stream restoration flows on May 15.
- Ramping rate: 10% change ascending and descending, or 10-cfs incremental change, whichever is greater.

LEE VINING CREEK

Instream Flows:

	Apr-Sept	Oct-Mar
Flow (cfs)	54	40

Minimum base flows are those specified above or the stream flow at the point of diversion, whichever is less.

Stream Restoration Flows: Allow peak flow to pass point of diversion

- Begin ramping for stream restoration flows on May 15.
- Ramping rate: 20% change ascending and 15% change descending, or 10 cfs incremental change, whichever is greater.

Lee Vining Conduit Diversions:

- Divert flows in excess of base flows until May 15.
- Diversions may resume 7 days after the peak flow.

WALKER AND PARKER CREEKS

Instream Flows:

	Apr-Sept	Oct-Mar
Parker Creek (cfs)	9	6
Walker Creek (cfs)	6	4.5

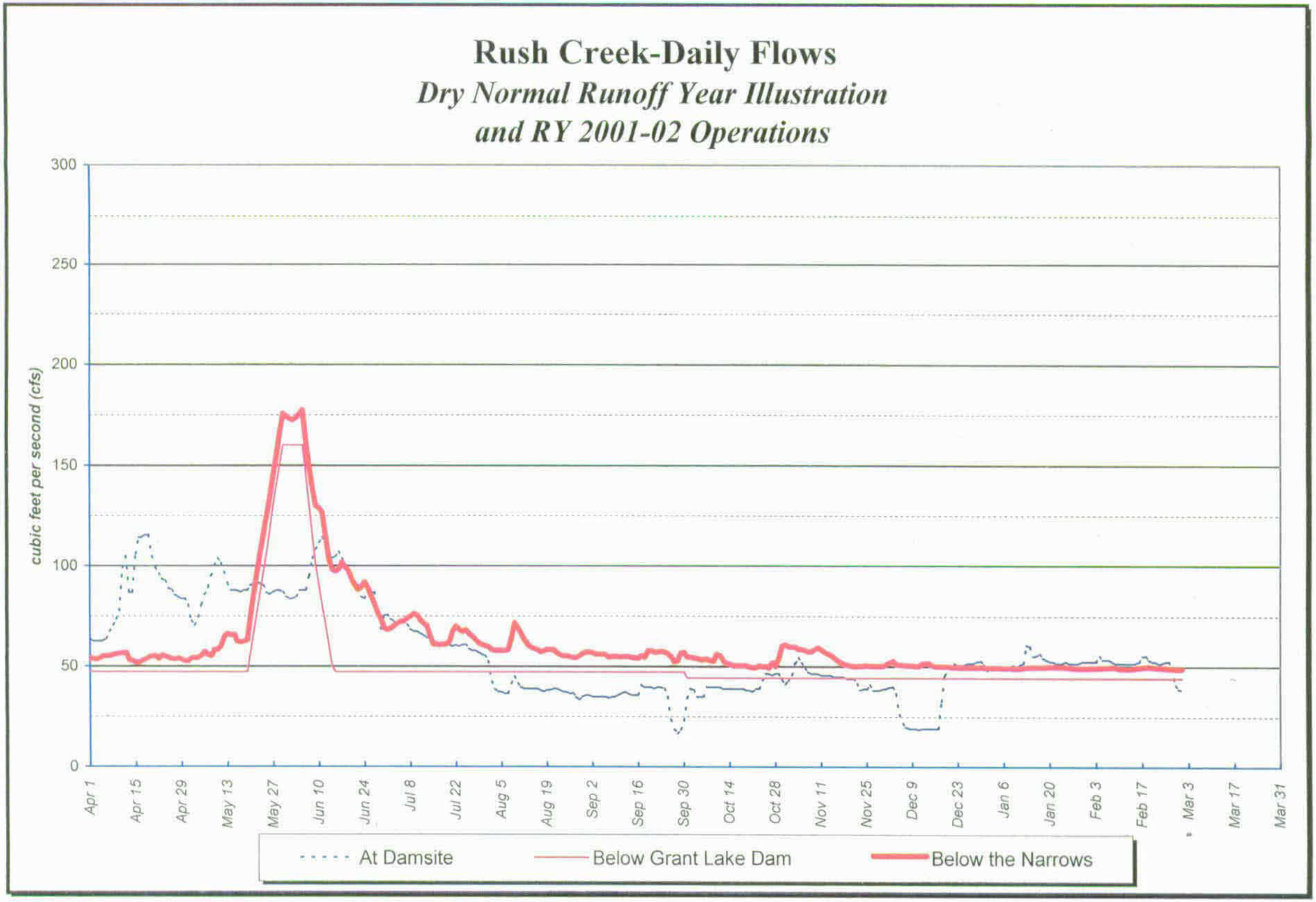
Minimum base flows are those specified above or the stream flow at the point of diversion, whichever is less.

Stream Restoration Flows: Allow peak flow to pass point of diversion

Lee Vining Conduit Diversions: None

MONO BASIN EXPORTS Maintain 22 cfs throughout the year.

Figure 1



Rush Creek-Daily Flows
Dry Normal Runoff Year Illustration
and RY 2001-02 Operations
cubic feet per second (cfs)
300
250
200
150
100
50
0
Apr 1
Apr 15
Apr 29
May 13
May 27
Jun 10
Jun 24
Jul 8
Jul 22
Aug 5
Aug 19
Sep 2
Sep 16
Sep 30
Oct 14
Oct 28
Nov 11
Nov 25
Dec 9
Dec 23
Jan 6
Jan 20
Feb 3
Feb 17
Mar 3
Mar 17
Mar 31
At Damsite
Below Grant Lake Dam
Below the Narrows

Figure 2

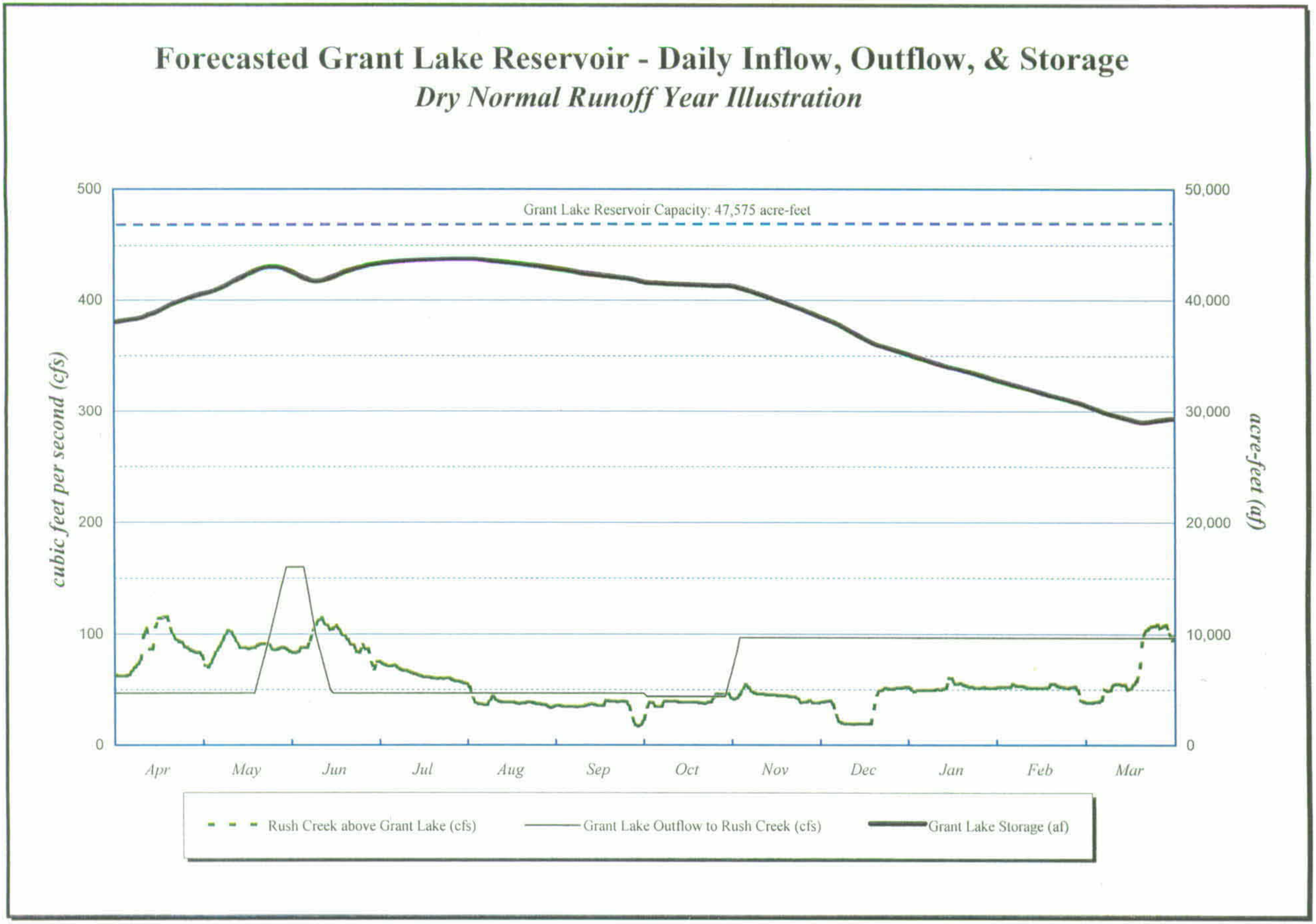
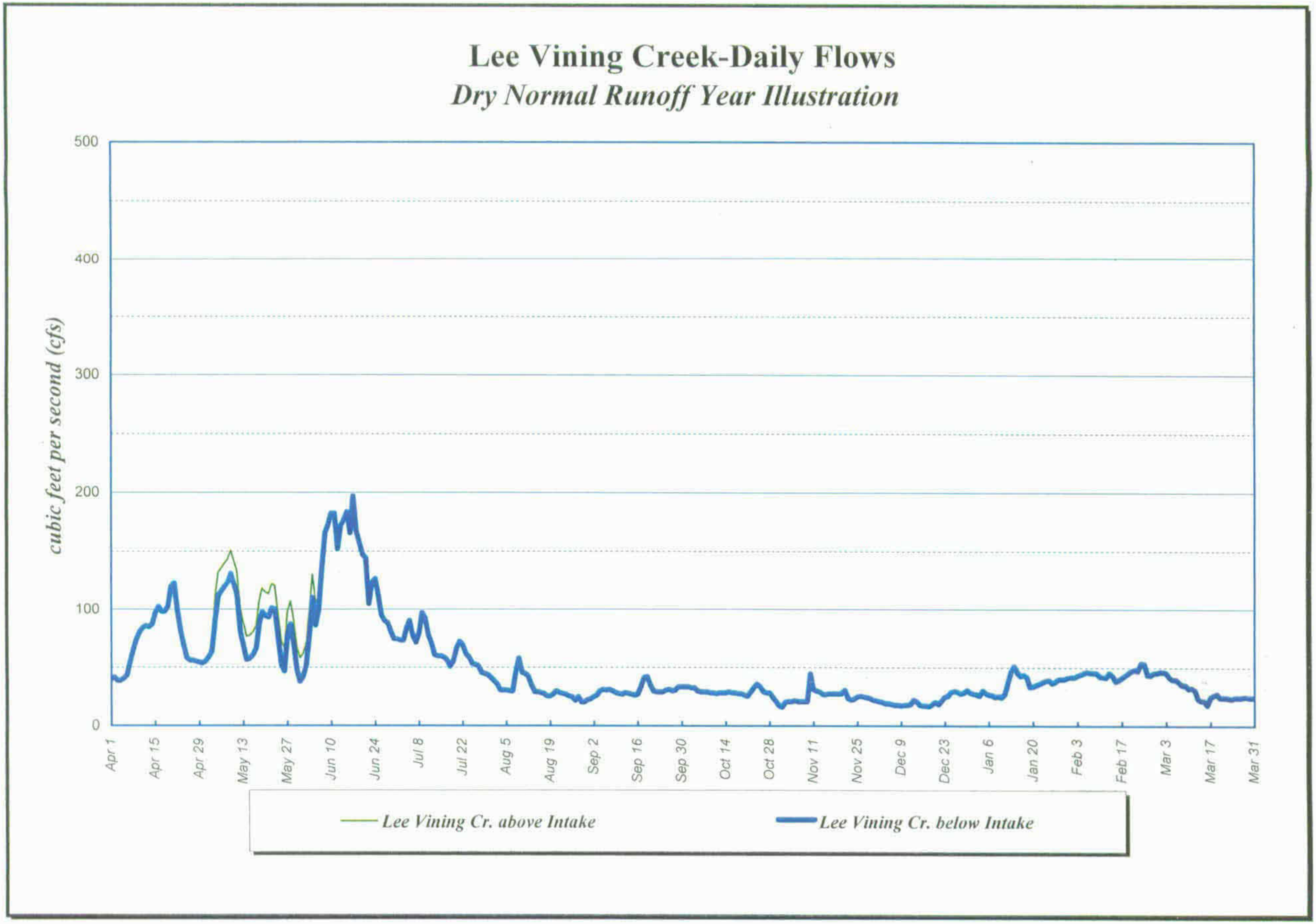


Figure 3

April, 2001


Lee Vining Creek-Daily Flows
Dry Normal Runoff Year Illustration
cubic feet per second (cfs)
500
400
300
200
100
0
Apr 1
Apr 15
Apr 29
May 13
May 27
Jun 10
Jun 24
Jul 8
Jul 22
Aug 5
Aug 19
Sep 2
Sep 16
Sep 30
Oct 14
Oct 28
Nov 11
Nov 25
Dec 9
Dec 23
Jan 6
Jan 20
Feb 3
Feb 17
Mar 3
Mar 17
Mar 31
Lee Vining Cr. above Intake
Lee Vining Cr. below Intake

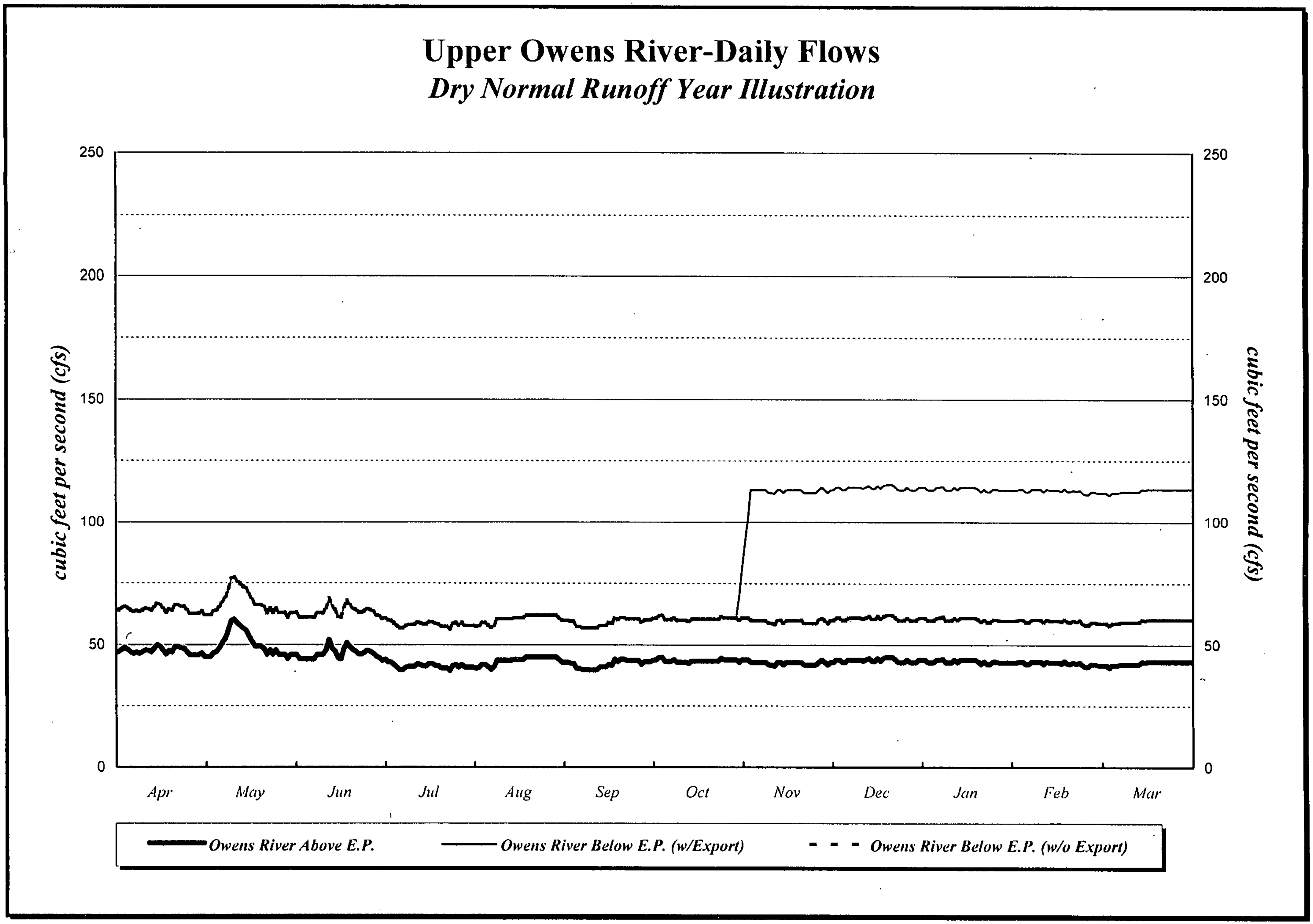

Upper Owens River-Daily Flows
Dry Normal Runoff Year Illustration
250
200
150
100
50
0
cubic feet per second (cfs)
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Owens River Above E.P.
Owens River Below E.P. (w/Export)
Owens River Below E.P. (w/o Export)

Figure 5

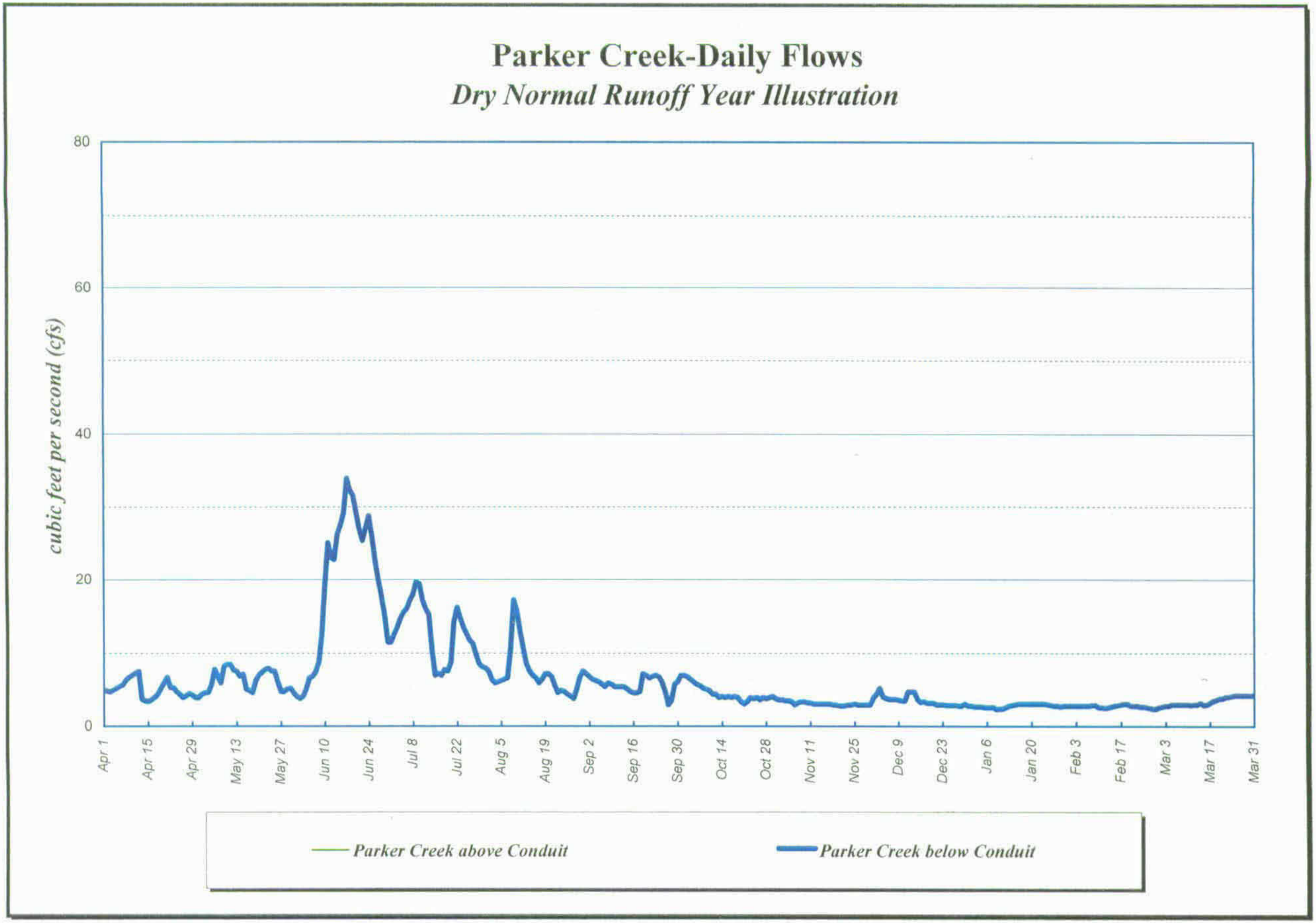
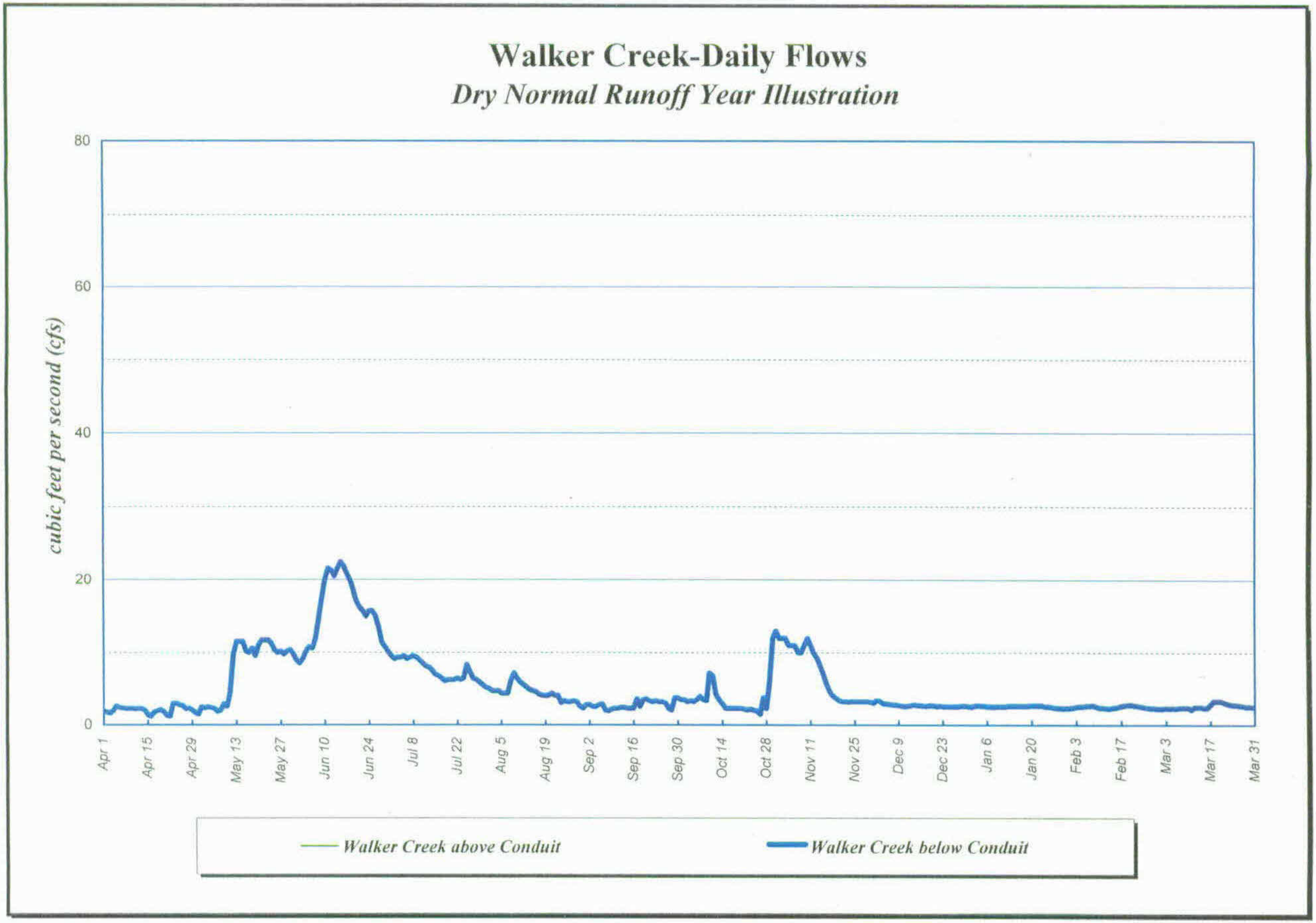

Parker Creek-Daily Flows
Dry Normal Runoff Year Illustration
80
60
40
20
0
cubic feet per second (cfs)
Apr 1
Apr 15
Apr 29
May 13
May 27
Jun 10
Jun 24
Jul 8
Jul 22
Aug 5
Aug 19
Sep 2
Sep 16
Sep 30
Oct 14
Oct 28
Nov 11
Nov 25
Dec 9
Dec 23
Jan 6
Jan 20
Feb 3
Feb 17
Mar 3
Mar 17
Mar 31
Parker Creek above Conduit
Parker Creek below Conduit

Figure 6


Walker Creek-Daily Flows
Dry Normal Runoff Year Illustration
80
60
40
20
0
cubic feet per second (cfs)
Apr 1
Apr 15
Apr 29
May 13
May 27
Jun 10
Jun 24
Jul 8
Jul 22
Aug 5
Aug 19
Sep 2
Sep 16
Sep 30
Oct 14
Oct 28
Nov 11
Nov 25
Dec 9
Dec 23
Jan 6
Jan 20
Feb 3
Feb 17
Mar 3
Mar 17
Mar 31
Walker Creek above Conduit
Walker Creek below Conduit

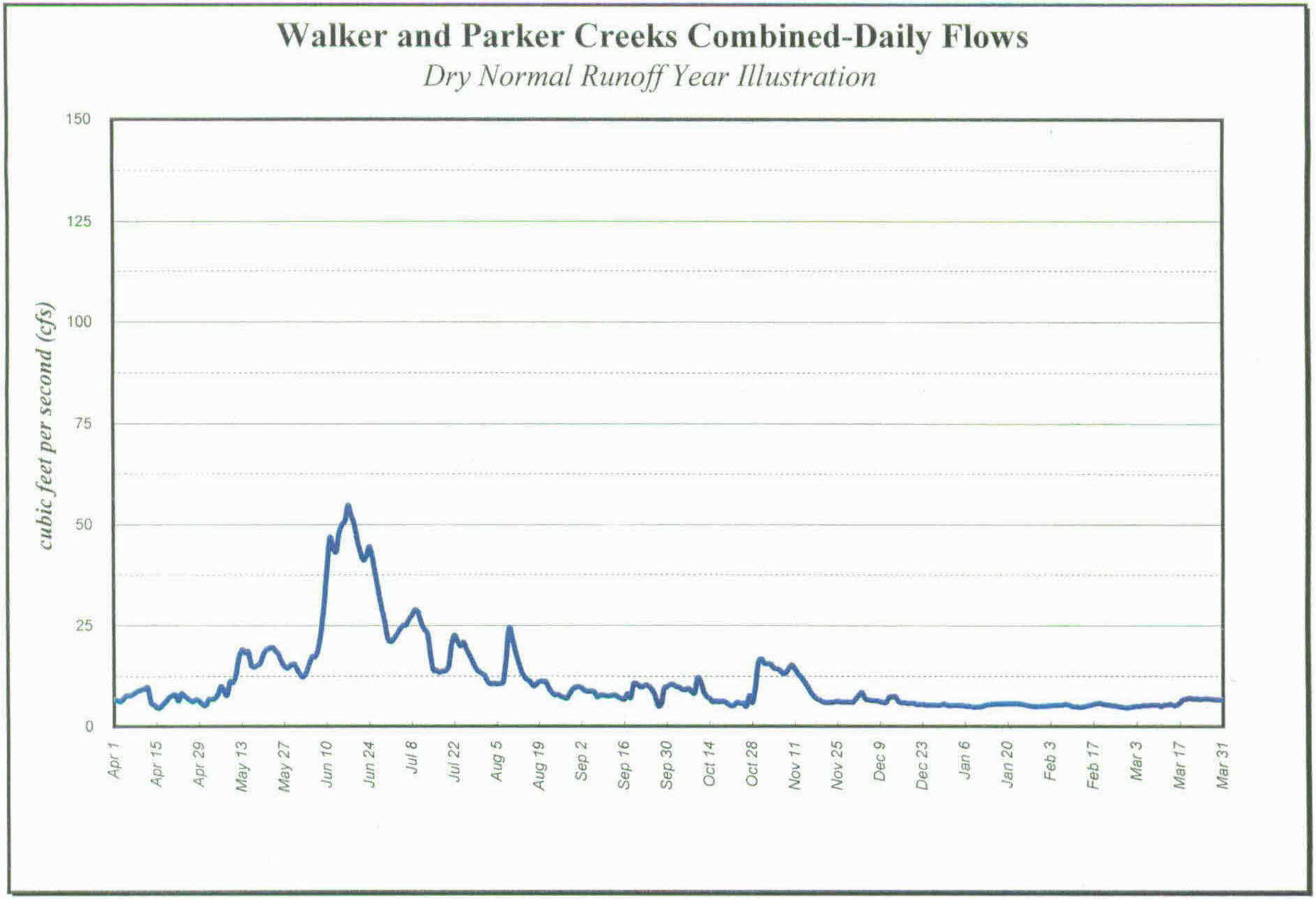
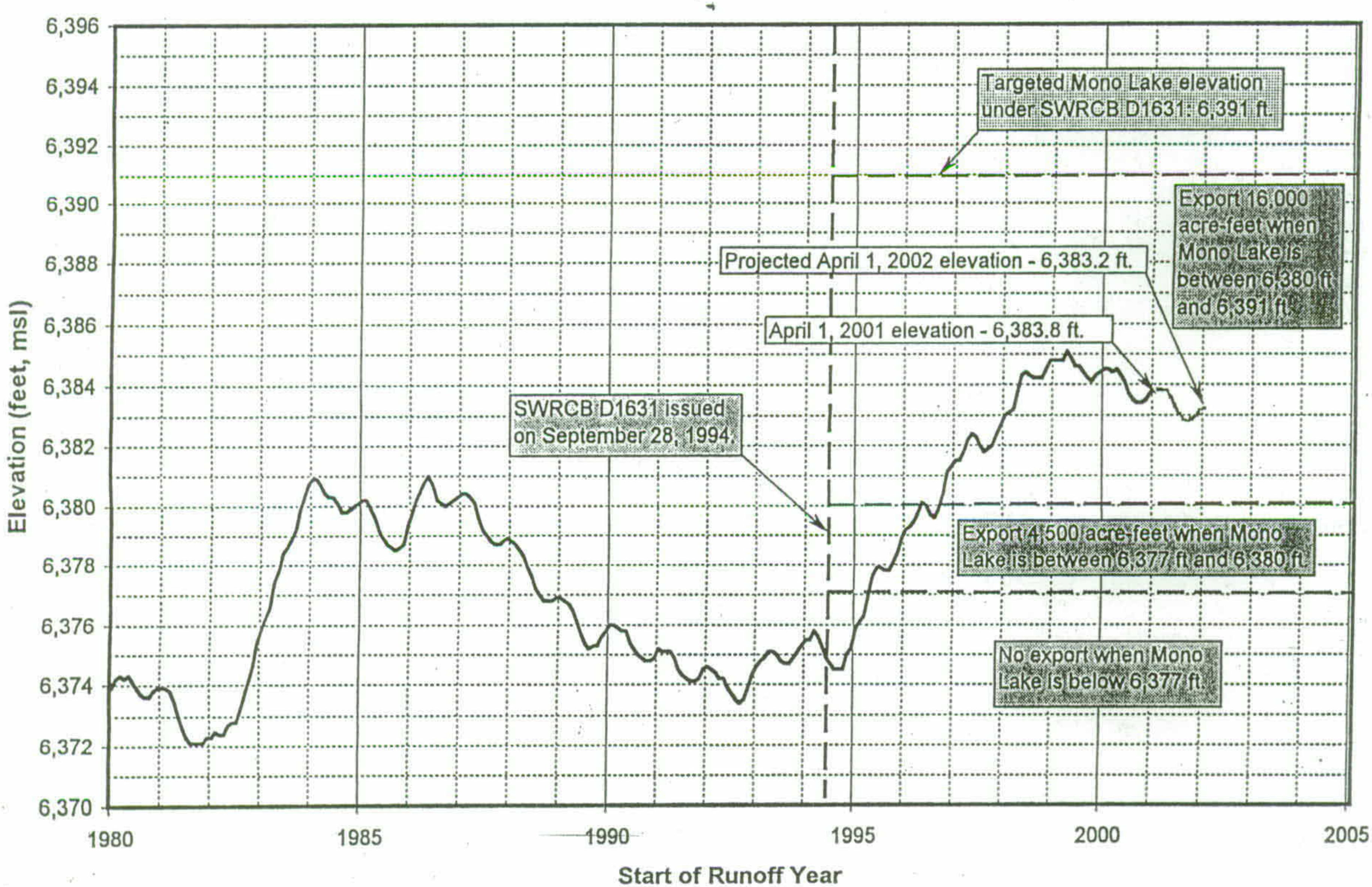

Walker and Parker Creeks Combined-Daily Flows
Dry Normal Runoff Year Illustration
cubic feet per second (cfs)
150
125
100
75
50
25
0
Apr 1
Apr 15
Apr 29
May 13
May 27
Jun 10
Jun 24
Jul 8
Jul 22
Aug 5
Aug 19
Sep 2
Sep 16
Sep 30
Oct 14
Oct 28
Nov 11
Nov 25
Dec 9
Dec 23
Jan 6
Jan 20
Feb 3
Feb 17
Mar 3
Mar 17
Mar 31

Figure 8

Mono Lake Elevation and Transition Period Exports

April 1980 - April 2005



Note: The time until the Mono Lake elevation reaches 6,391 ft is called the "Transition Period". Export rules change at the end of that interval.
*Based on Runoff Forecast Model developed in 1993.

4/11/01 by Simon Hsu
Mono Lake Elevation.xls

Figure 9

3

Fisheries Monitoring Report
For
Rush, Lee Vining, Parker and Walker Creeks
2000

Prepared by:	Chris Hunter Brad Shepard Ken Knudson Ross Taylor Darren Mierau
Prepared for:	Los Angeles Department of Water and Power
Date:	May 5, 2001

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Executive Summary

This report presents the results of the second year of fish population monitoring for Rush, Lee Vining, Parker and Walker creeks pursuant to State Water Resources Control Board (SWRCB) WR 98-07. We used electrofishing mark-recapture techniques to estimate trout populations of three sections of Rush Creek and two main stem sections of Lee Vining Creek. Fish population estimates for two Lee Vining Creek side channels and Parker and Walker creeks were made using electrofishing depletion methods. In addition we conducted reconnaissance elctrofishing on the Rush Creek canal.

Densities and standing crop estimates of Age 1 and older brown trout were lower in Rush, Parker and Walker creeks in 2000 than in 1999. Densities and standing crop of Age 1 and older brown trout were stable or increased in Lee Vining during the same time period. The main channel sections of Lee Vining had much had standing crops than the corresponding side channels. Condition factors for both brown trout and rainbow trout were higher in 2000 than in 1999 in all streams.

Young-of-the-year trout were extremely abundant in all sampled sections in both 1999 and 2000. This result indicated that spawning habitat is probably adequate to fully seed these streams with trout.

A single electrofishing pass made on a short reach of the Rush Creek canal yielded 92 brown trout and two rainbow trout. This sample had a disproportionately high percentage of trout larger than 300 mm (12 inches) compared to other sections of Rush Creek.

We compared the estimated fish population data for Rush and Lee Vining creeks to the termination criteria adopted by the SWRCB. The termination criteria are:

1. Lee Vining sustained catchable brown trout averaging 8-10 inches in length.
2. Rush Creek fairly consistently produced brown trout weighing ¾ to 2 pounds. Trout averaging 13 to 14 inches were also regularly observed.

The SWRCB requires us to recommend additional quantitative termination criteria for Rush and Lee Vining creeks as well as quantitative termination criteria for Parker and Walker creeks. The lack of historic fish population data makes it very difficult to make recommendations for quantitative termination criteria with confidence they are reasonable. We recommend that data collection be continued for a few more years before we attempt to define additional termination criteria.

Fish population estimates were made in seven stream sections during 2000 (Figure 1). Lengths of sample sections varied from 98 m in the Parker Creek section to 813 m in the County Road Section of Rush Creek (Table 1). In addition, a portion of the head of the Rush Creek canal from its outflow at the Grant Reservoir outlet to about 400 m down canal was sampled using a single electrofishing pass.

Study Area

Table 1. Total length (m), average wetted width (m), and total surface area of sample sections in Rush, Lee Vining, Parker, and Walker creeks sampled during August 30 to September 7, 2000.

Section	Length (m)	Width (m)	Area (sq m)
Rush – County Road	813	6.0	4878.0
Rush - Lower	405	5.4	2181.6
Rush – Upper	430	7.4	3182.0
Lee Vining – Lower	187	4.8	897.6
Lee Vining - Lower-B1	189	5.0	945.0
TOTAL Lower			1842.6
Lee Vining - Upper-main	330	5.8	1914.0
Lee Vining - Upper-A4	201	4.2	844.2
TOTAL Upper			2758.2
Parker	98	2.2	215.6
Walker	100	1.8	180.0

Due to the relative instability of the stream channels, particularly within the Rush Creek drainage, the sample sections have been changing over time. As these channels re-form, adjusting to the new flow regimes, pool-riffle structure is now becoming more evident. The dynamic nature of these channels has also resulted in many side channel and multiple channel reaches in these streams. In addition, the past and present aggressive approaches to reclaim stream channel structure, provide instream cover for fish, and spread water in hopes of increasing riparian vegetation has also contributed to the dynamic nature of these channels. The dynamic nature of these side channels

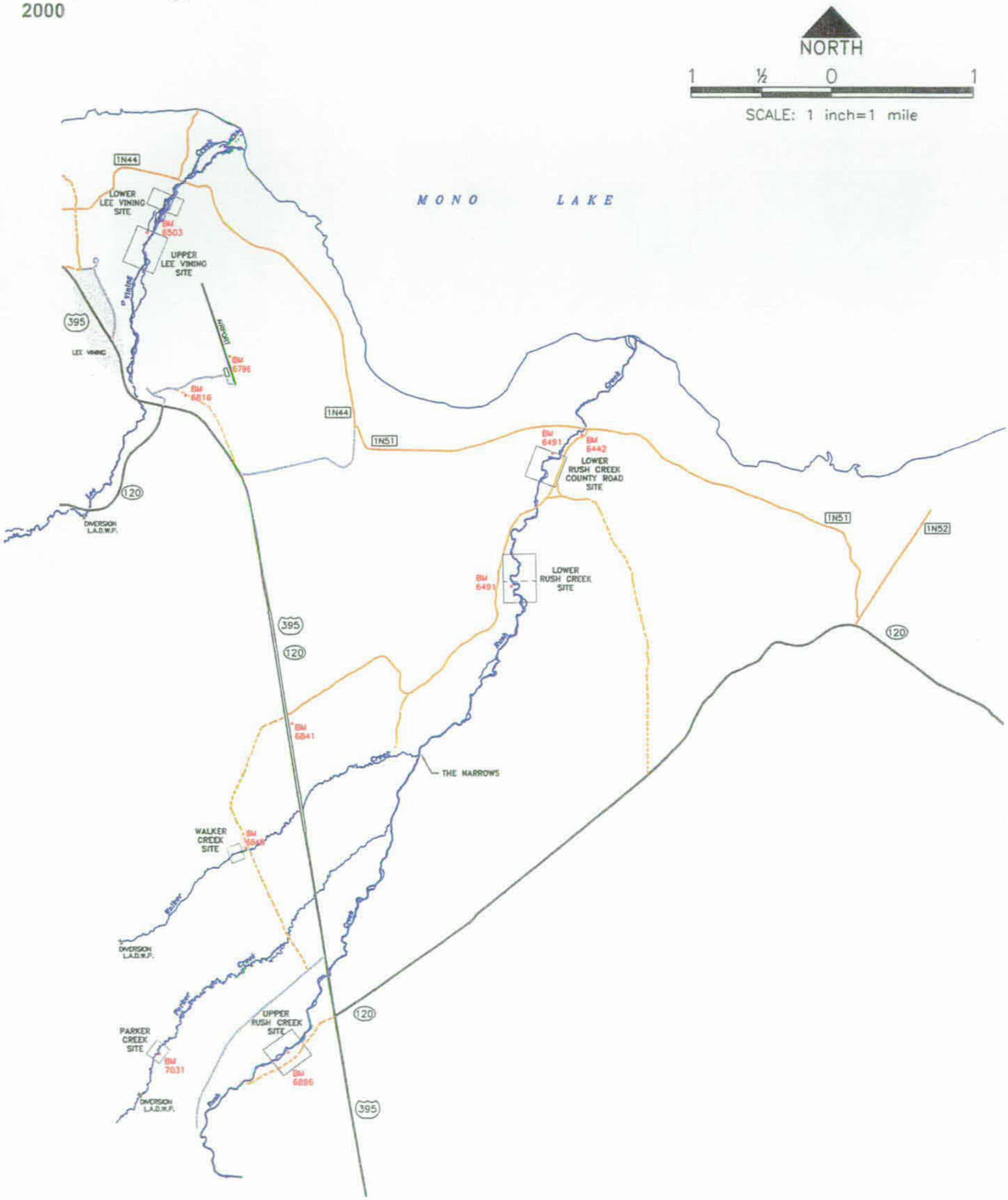

Figure 1. Map of study area showing sampling site locations (from McBain and Trush 2000).

makes consistent sampling extremely difficult due to water spreading over the flood plain and flowing through dense brush stands within the valley floor.

Sampling difficulties have been particularly problematic in Rush Creek. In the Lower Section a side channel diverts some of the flow from the main channel above the upper boundary of the established sample section onto the flood plain. We have not sampled this side channel because the water is spread out, extremely shallow, and flows through thick brush. However, it appears that this side channel is capturing progressively more of Rush Creek's flow through time and is also beginning to concentrate this flow into a more defined channel, especially in its upper reach. A similar situation occurs in the Upper Section of Rush Creek, where a side channel captures about half the flow. At the lower end of this side channel about half the water (a quarter of the total flow) flows back into the main channel, but the other half continues down-valley, spreading over the valley floor through a dense willow stand that is presently impossible to effectively sample, before flowing back into the main channel through several small rivulets. While the proportion of total available habitat within the sample sections represented by these un-sampled areas is presently low, it is likely to change over time and may increase. These situations are also occurring to a lesser extent in Lee Vining Creek sample sections. In all these cases, we have made every effort to isolate sampled habitats from un-sampled habitats using physical barriers such as block nets or temporary rock dams to meet assumptions of closed populations for sampling purposes. We have also measured lengths and widths of only sampled habitats to derive sampled area estimates.

Stream flow and water temperature data are on file with LAWP and Trush.

Methods

Mark-recapture estimates were made in three sections of Rush Creek and the main channel portions of two sections in Lee Vining Creek. Depletion estimates were made in Parker and Walker creeks and two side-channels in Lee Vining Creek. For mark-recapture estimate sections, fish were captured using a Smith-Root® 2.5 GPP electrofishing system that consisted of a Honda generator powering a variable voltage pulsator (VVP) that had a rated maximum output of 2,500 watts. This unit was set at 30 or less pulses per second to reduce risk of injury to fish and voltages were set to allow for capture of fish without harming fish. Obtaining this desired response in fish usually resulted in voltages ranging from 300 to 500 and amperes from 0.3 to 1.5. The generator and VVP unit were transported downstream in a small barge that also carried an insulated tub to transport captured fish (see cover photo). A person operating a mobile anode and a dip netter fished each half of the stream in a downstream direction (total of two anode operators and two dip netters). All netted fish were placed in the insulated tub within the barge shortly after capture. This barge system was also used for the single electrofishing pass made in the Rush Creek canal. Due to the depth of the canal, anode handlers and dip netters could not wade down the middle of the canal, consequently the barge was floated down the middle of the canal and a mobile anode handler and dip netter waded along each edge of the canal working towards the middle on their side.

Two Smith-Root® BP backpack electrofishers (Model 12B) were used to capture fish for depletion estimates in the Lee Vining Creek side-channels. A backpack electrofishing unit was used for depletion estimates in both the Parker and Walker creek sections. At least one dip netter worked with each backpack electrofisher and another crew member served as a backup dip netter and carried a live bucket in which all captured fish were placed immediately after capture.

To meet the assumption of closed populations for sampling purposes, all sample sections except the County Road Section of Rush Creek were blocked at both ends prior to sampling. The County Road Section of Rush Creek was long enough (813 m) that effects of movements at the ends of the sample section should have been low in proportion to the entire section. In the Upper and Lower Rush Creek sections and main channel portions of the Upper and Lower Lee Vining Creek sections, 12 mm mesh hardware cloth fences were installed at the upper and lower boundaries of the sections. These hardware cloth fences were installed by driving fence posts at approximately two-meter intervals through the bottom portion of the hardware cloth approximately 15 cm from its bottom edge. Rope was then strung across the top of each fence post and anchored to willows, fence posts, or trees on each bank. The hardware cloth was held vertically by wiring the top of the cloth to the rope with baling wire. Fences were cleaned and checked, usually at least once daily, for any possible dead fish between mark and recapture sampling. For the side channel portions of the Upper and Lower Lee Vining Creek sections and the sample sections in Parker and Walker creeks 12 mm mesh block seines were placed at sample section boundaries during depletion efforts.

All captured fish were held in either a tub within the barge, a bucket carried by a crewmember, or live cars within the stream channel. All captured fish were measured to the nearest mm (total length) and most were weighed to the nearest gram. In the Upper Rush Creek and County Road sections of Rush Creek, all captured fish had their upper caudal fin clipped to conduct mark-recapture estimates in these sections. In the Lower Rush Creek Section, all captured fish received a lower caudal clip. When clipping the caudal fin a scissors was used to make a straight vertical cut from the top, or bottom, of the caudal fin approximately 3 mm deep at a location about 3 mm from the posterior edge of the fin. All fish from Rush Creek, and the Rush Creek Ditch, were examined for old upper caudal clips that would identify them as having been handled in 1999. Length-weight regressions (Cone 1989) were calculated for brown trout in each section of Rush Creek by year to assess differences in length-weight relationships between sections and years. Log 10 transformations were made on both length and weight prior to running regressions.

Depletion population estimates were made using depletion estimators from consecutive electrofishing catches (Van Deventer and Platts 1989). Assumptions for valid depletion estimates using this estimator include:

1. The sampled population is closed. A "geographic" (White et al. 1982) boundary limits the population and emigration, immigration, births, or deaths do not occur during the sampling period ("demographic closure"; White et al. 1982).
2. The number of fish captured during each sampling effort are correctly counted and recorded and removed from the population.
3. Each fish within an estimated group of individuals (ie. species and size-class) has a constant and equal probability of capture during each sampling effort.

Assumption 1 can usually be easily met by blocking off the sampled section of stream with nets or fences to provide "geographic" closure and prevent immigration and emigration. The relatively short time frame to complete these estimates, generally within two to four hours, effectively eliminates concerns about births and deaths. Meeting assumption 2 only requires accurate recording of data and holding previously captured fish in a container from which they cannot escape during subsequent capture events. Assumption 3 is extremely difficult to meet and many studies have demonstrated that unequal capture probabilities occur among species, sizes, sex, and possibly individuals. In addition, capture probabilities likely decline for subsequent capture events, especially between the first capture event and subsequent capture events (see White et al. 1982 for a review of these studies and implications of not meeting this assumption).

Mark-recapture estimates were made in the County Road, Lower, and Upper Rush Creek sections and main channel portions of the Lower and Upper sections in Lee Vining Creek. Estimates were made using either a log-likelihood function estimator or, when the model fitting the log-likelihood function was significantly different than that observed for the data, the Chapman modification of the Peterson estimator (Montana Department of Fish, Wildlife and Parks, Mark-Recapture Program, beta version 5.0; Ricker 1975). This computer program develops a log-likelihood predictive function to estimate capture efficiencies for each size of fish captured. The program reports how well this modeled function actually fits the observed capture efficiencies using a Chi-square goodness of fit test. The program also compares modeled and observed capture efficiencies for each individual length class set by the user (25 mm for these data sets). When a significant Chi-squared difference is reported between modeled and observed capture efficiencies, or when predicted and observed capture efficiencies appear to be very different between a few of the length classes, we pooled length classes into groups with similar capture efficiencies and used the Chapman modification of the Peterson estimator to make estimates. Trout mortalities, whether the fish died during marking runs or were subsequently observed dead on the block fences, where not used in the calculations of estimates, but were added to the estimated numbers and were reported separately in tables. Assumptions for valid mark-recapture estimates include:

1. The same population closure assumptions detailed above.
2. Fish do not lose their marks during the experiment.
3. All marks are observed and recorded correctly during each recapture event.

4. Marked fish are either randomly distributed throughout the population, or distributed in proportion to the actual distribution of the population (ie. if more fish in the population are located in pool habitats then marked fish are released into pool habitats in nearly the same proportion as the overall population).
5. Either capture probabilities are constant, or differences in capture probabilities are accounted for in the estimator.

Block fences at the boundaries of the sample sections can help meet assumption 1; however, immigration and emigration is extremely difficult to totally eliminate, especially if fences cannot be maintained throughout the experiment. The assumption of no births or deaths can generally be met due to the relatively short duration of time between mark and recapture events (5 to 10 days); sampling at a time when births would not occur; and accounting for all deaths by removing those fish that died during the experiment from the estimate. Assumptions 2 and 3 are generally easy to meet by exercising care when marking fish during marking events, examining fish for marks during recapture events, and recording these data accurately. Assumption 4 can be met by physically re-distributing marked fish throughout the sampled section when they are released and allowing marked fish 5 to 10 days to naturally re-distribute within the sample section prior to conducting recapture events. The Montana Fish, Wildlife and Parks Mark-Recapture program accounts for differing capture efficiencies across fish of different lengths and each species was estimated separately to account for capture probability differences between species.

Biomass (kg/ha) was estimated for each section by averaging weights of all fish within each length class estimated, multiplying that average weight by the estimated number of fish for each length group, and then summing biomass estimates over all length classes. We calculated biomass estimates per section for all age 1 and older trout.

Results

Capture efficiencies estimated from log likelihood functions did not differ significantly from capture efficiency data for brown trout in the Upper and Lower Rush Creek sections and for both brown and rainbow trout in the main channel of the Upper Section of Lee Vining Creek (see Methods for explanation). Capture efficiencies estimated from log likelihood functions did not fit capture efficiency data for the remaining estimates, so modified Peterson estimators were used. Estimates are reported for each section below.

Rush Creek

County Road Section

The majority of the brown trout captured in the County Road Section of Rush Creek were from 50 to 100 mm and the longest brown trout captured was just under 300 mm (Figure 2). Few rainbow trout were captured and most of these were from 120 to 180

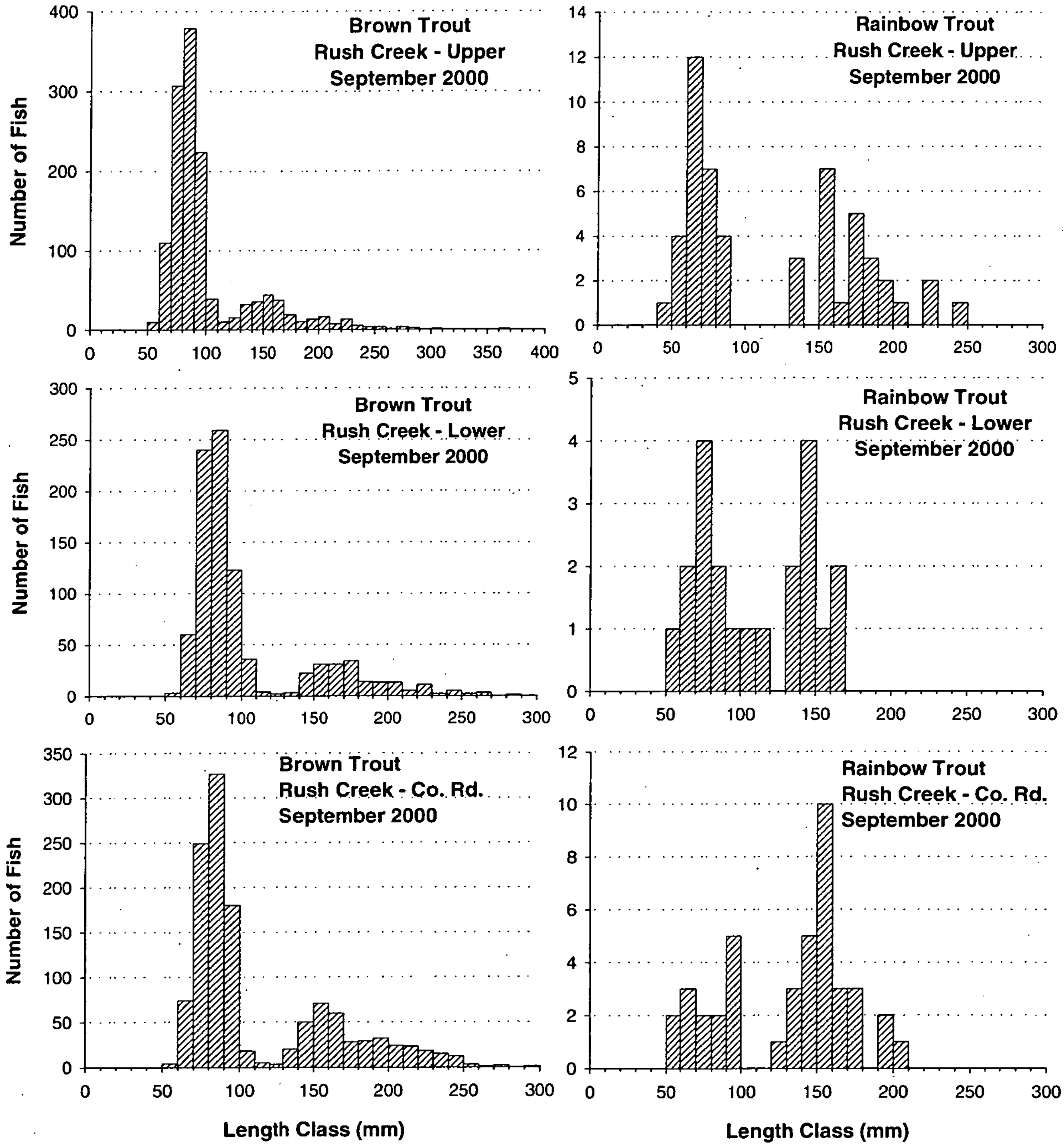

Figure 2. Length frequency histograms for brown (left) and rainbow trout (right) captured in the Upper (top), Lower (middle) and County Road (bottom) sections of Rush Creek from August 30 to September 7, 2000.

Table 2. Mark-recapture estimates showing number of fish marked (M), number captured on recapture run (C), number recaptured on recapture run (R), number of mortalities (Morts) between mark and recapture run, estimated number, and standard deviation (S.D.) by stream section, species and length group during August/September 2000. Estimator method is shown after species (LL=log likelihood; MP=modified Peterson).

Stream (Section) Species (Estimator) Length Group	Mark-Recapture M	C	R	Morts	Estimated[1] number	S.D.
Rush Creek (County Road Section)						
Brown Trout (MP)						
YOY	417	495	82	29	2497	223
125-174 mm	111	148	45	2	362	34
175 + mm	118	116	61	1	224	13
Rainbow Trout (MP)						
YOY	6	8	1	2	NP[2]	-
125 + mm	18	16	7	0	39	8
Rush Creek (Lower Section)						
Brown Trout (MP)						
YOY	444	416	146	14	1261	68
125-224 mm	117	123	69	2	208	10
225 + mm	18	15	14	0	19	1
Rainbow Trout (MP)						
YOY	11	2	1	0	NP[2]	-
125 + mm	5	7	3	0	11[3]	2
Rush Creek (Upper Section)						
Brown Trout (LL)						
YOY	524	556	72	49	4805	361
125-199 mm	113	104	20	2	416	28
200 + mm	28	39	11	0	136	14
Rainbow Trout (MP)						
YOY	13	20	7	30	36	6
125 + mm	10	19	4	0	43	12

Stream (Section) Species (Estimator) Length Group	Mark-Recapture M	C	R	Morts	Estimated[1] number	S.D.
Lee Vining Creek (Lower Section – Main Channel)						
Brown Trout (LL)						
YOY	21	43	4	0	224	74
125-199 mm	15	15	7	0	32	4
200 + mm	19	19	14	1	38	2
Rainbow Trout (MP)						
75 + mm	3	4	2	0	6[3]	1
Lee Vining Creek (Upper Section – Main Channel)						
Brown Trout (LL)						
YOY	33	82	9	2	471	108
125-199 mm	13	14	2	0	48	8
200 + mm	11	24	8	0	41	8
Rainbow Trout (LL)						
YOY	7	27	1	0	161	54
125 + mm	11	22	9	0	36	5

1 To arrive at a complete estimate the mortalities ("Morts") should be added to the "Estimated number".
2 "NP" denotes that an estimate was not possible for this size group.
3 The number of recaptured fish for these estimates were below 7, the number recommended for an unbiased modified Peterson estimate.

mm with another group from 50 to 100 mm (Figure 2). A few rainbow trout over 200 mm were also captured. This section supported an estimated 589 brown trout age 1 and older and 2,526 young-of-the-year (YOY; Table 2). Estimates of brown trout were relatively precise with standard deviations being less than 10% of the estimates. No estimate could be made for rainbow trout YOY, but the section supported an estimated 39 rainbow trout age 1 and older..

Lower Section

Length frequencies of brown trout captured in the Lower Section of Rush Creek were very similar to the distribution observed for the County Road Section (Figure 2). Fewer rainbow trout were captured in this section compared to the County Road Section and no rainbow trout over 200 mm were seen. This section supported an estimated 229 brown trout age 1 and older and 1,255 YOY (Table 2). Estimates of all size classes of brown trout were very precise with standard deviations being less than 5% of the estimates. Again, no estimate could reliably be made for YOY rainbow trout.

Upper Section

Length frequencies of brown trout captured in the Upper Section of Rush Creek were similar to the distribution observed for the County Road and Lower sections; however, one 366 mm long brown trout was captured (Figure 2). The length frequency of rainbow trout was similar to the County Road Section with a few more YOY rainbow trout seen in this Upper Section. The Upper Section of Rush Creek supported an estimated 554 age 1 and older brown trout and 4,854 YOY (Table 2). This section also supported an estimated 43 age 1 and older rainbow trout and 66 YOY rainbow trout.

Canal

A single electrofishing pass made in the Canal below the Grant Lake outlet structure captured 92 brown trout and two rainbow trout. The brown trout length frequency plot illustrated that this section supported numerous brown trout longer than 300 mm with several approaching 400 mm and one 509 mm in length (Figure 3). Three brown trout (lengths of 227, 336, and 383 mm) and one rainbow trout (218 mm) that had been fin clipped during the previous year's sampling with an upper caudal clip were recaptured in the canal. These fish most likely were clipped in the Upper Section of Rush Creek in 1999, but could have been clipped in the Lower Section.

Log(10) transformed length-weight regressions for brown trout had R^2-values over 0.98 for almost all sample events indicating that weight was strongly correlated to length (Table 3). Length-weight regressions for brown trout from Rush Creek indicated that brown trout captured during 2000 were in better condition (a fish of a certain length weighed more) than those captured during 1999 (blue versus red lines; Figure 4). Computation of condition factors by length group also showed the brown trout were in better condition during 2000 than 1999 (Figure 5). Overall, condition factors were relatively high.

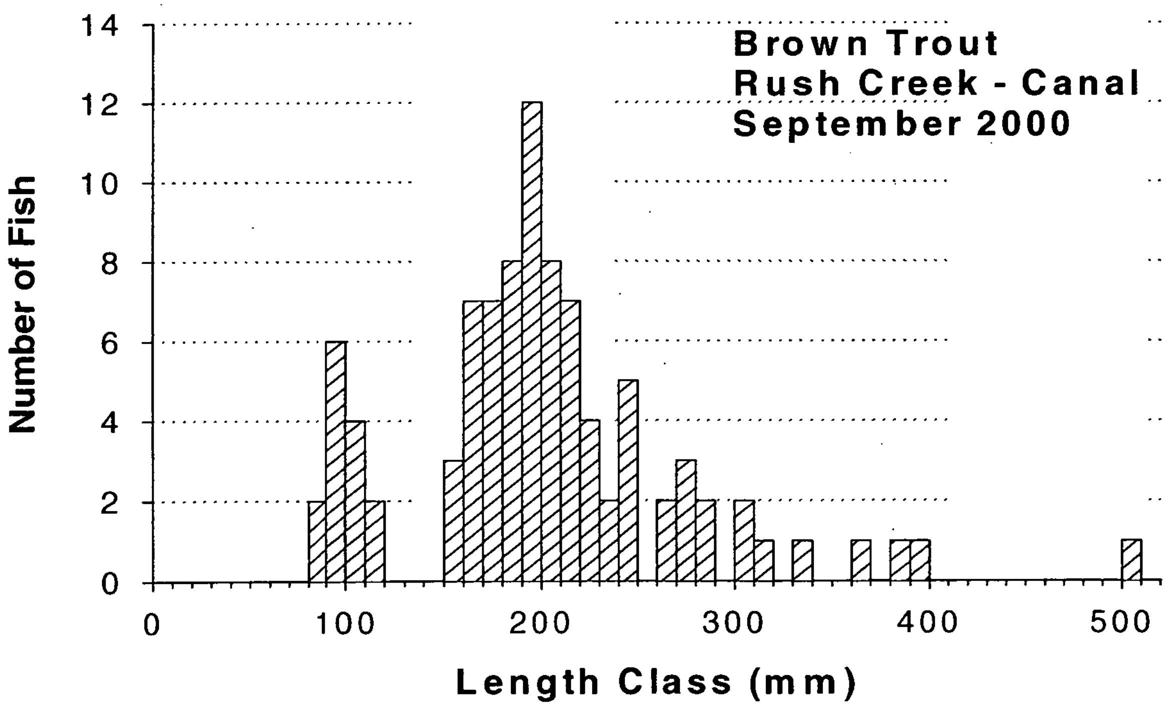

Figure 3. Length frequency histogram for brown trout captured in the Rush Creek canal immediately below the Grant Lake outlet during September 2000.

Table 3. Regression statistics for log transformed length (L) to weight (WT) relationships for brown trout captured in Rush Creek by sample section and year.

Section	Year	N	Equation	R^2	P
County Road	2000	412	Log(WT)=2.936*Log(L) – 4.827	0.987	< 0.01
Lower	1999	314	Log(WT)=3.027*Log(L) – 5.078	0.992	< 0.01
Lower	2000	230	Log(WT)=2.970*Log(L) – 4.894	0.984	< 0.01
Upper	1999	279	Log(WT)=2.923*Log(L) – 4.816	0.980	< 0.01
Upper	2000	309	Log(WT)=3.001*Log(L) – 4.958	0.981	< 0.01

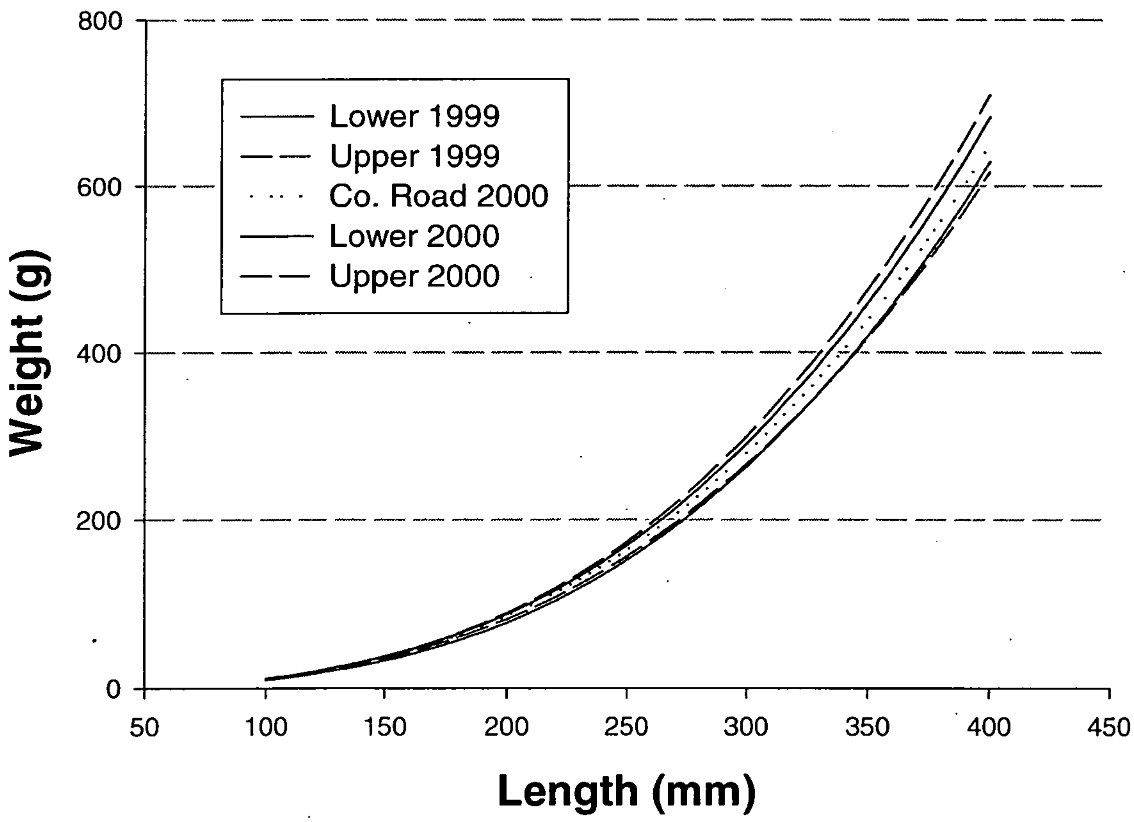

Figure 4. Length-weight regressions for brown trout captured in three sections of Rush Creek in 1999 and 2000. Legend shows the section and year.

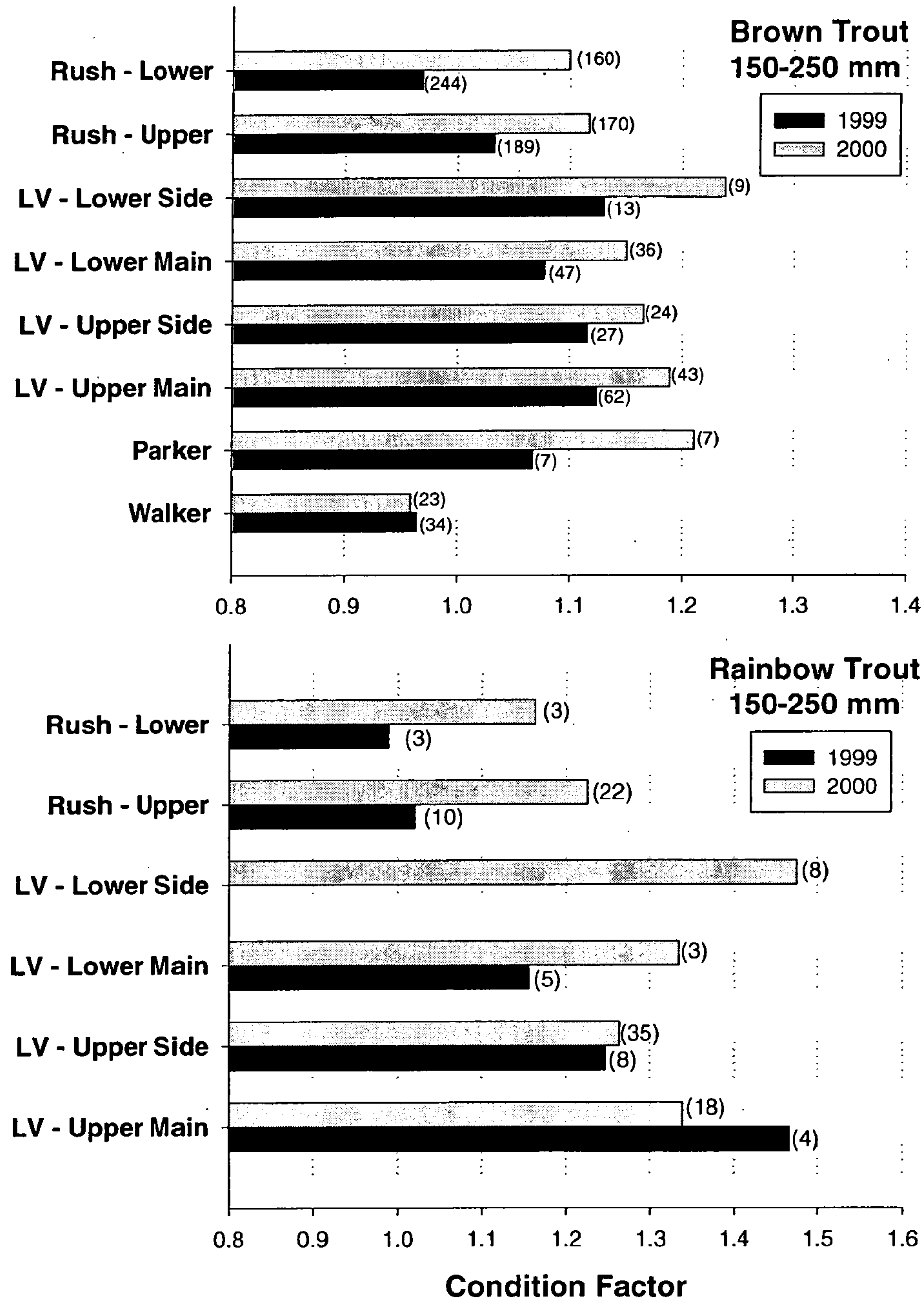

Figure 5. Condition factors for brown (top) and rainbow trout (bottom) 150 to 250 mm in length captured during 1999 and 2000 in sample sections of Mono Lake tributaries. Sample sizes are in parentheses next to bars.

Lee Vining Creek

Lower Section

More YOY brown trout (<125 mm) were captured in the side channel portion than in the main channel portion of the Lower Section of Lee Vining Creek. However, many more age 1 and older brown trout were captured in the main channel (Figure 6). Almost no YOY rainbow were captured in the main channel, but many were captured in the side channel. A few larger rainbow trout were also captured in the side channel. The main channel supported an estimated 224 YOY and 71 age 1 and older brown trout, while the side channel supported an estimated 83 YOY and 12 age 1 and older brown trout (Tables 2 and 4). An estimated 6 rainbow trout (only one of which was a YOY) inhabited the main channel, while an estimated 57 YOY and nine age 1 and older rainbow trout inhabited the side channel. The total trout standing crop was much higher in the main channel (100 kilograms/hectare) than in the side channel (15 kilograms/hectare) (Figure 10).

Upper Section

Many more YOY and a few more age 1 (140-200 mm) brown trout were captured in the main channel portion of the Upper Section in Lee Vining Creek than in the side channel portion (Figure 6). Many more rainbow trout were captured in the side channel portion, including several very large rainbow trout, than in the main channel portion of the Upper Section (Figure 6). However, the main channel portion of the Upper Section supported an estimated 473 YOY and 89 age 1 and older brown trout, and 161 YOY and 36 age 1 and older rainbow trout (Table 2). The side channel portion supported less brown and rainbow trout, an estimated 24 YOY and 38 age 1 and older brown trout, and 75 YOY and 42 age 1 and older rainbow trout (Table 4). The total trout standing crop was much higher in the main channel (170 kilograms/hectare) than in the side channel (60 kilograms/hectare) (Figure 10).

Parker Creek

Only brown trout were captured in Parker Creek and most of these were less than 100 mm (Figure 7). Parker Creek supported an estimated 48 YOY and 7 age 1 and older brown trout (Table 4).

Walker Creek

Only brown trout were captured in Walker Creek and most were less than 100 mm (Figure 7). Walker Creek supported an estimated 64 YOY and 24 age 1 and older brown trout (Table 4).

Rush Creek Water Temperatures

McBain and Trush maintained thermographs at the Return Canal, the Narrows and and the County Road Ford. Temperatures in the Return Canal were relatively constant throughout the year with a relatively narrow range of daily temperature fluctuations. The annual maximum temperature was 66.8 F, but summer temperatures typically remained below 64-65 degrees F. Temperatures at the Narrows were slightly higher on average: the annual maximum temperature exceeded 70 degrees F at least 8 days during late July and August. Minimum daily summer temperatures were in the mid 50's. Daily fluctuations were generally no more than 8 to 12 degrees F. Temperatures were slightly higher at the County Road Ford in Lower Rush Creek than at the Narrows. Peak daily temperatures reached or exceeded 70 degrees F during at least 22 days (data analysis extends only to August 15) compared to 8 at the Narrows. The maximum daily temperature at the Rush Creek County Road Ford was 71 degrees F and the largest daily fluctuation was 22 degrees.

Rush Creek temperatures are well below upper lethal temperatures, although the higher summer temperatures at the downstream stations commonly exceed the optimal temperature range for brown trout. Cooler water in the Canal may be one of the habitat attributes that appear to contribute to the higher densities of larger brown trout in the Canal.

Lee Vining Creek Creel Census

The California Department of Fish and Game conducted a creel census on Lee Vining Creek during the year 2000 fishing season to evaluate the effect of harvest on fish populations. The creel census was conducted from April 29 through October 29. A creel census clerk was on the stream for 78 of the 180 days included in the study. The stream was divided into two sections. The lower section, from the mouth of the creek upstream to Highway 395 is of most interest to this study. Anglers reported catching a total of 104 fish from this section ranging in size from 4-19 inches in length. All but 5 fish were released. Based upon these results and our fish population estimates it appears that any impact on the fish population of Lee Vining Creek was minimal.

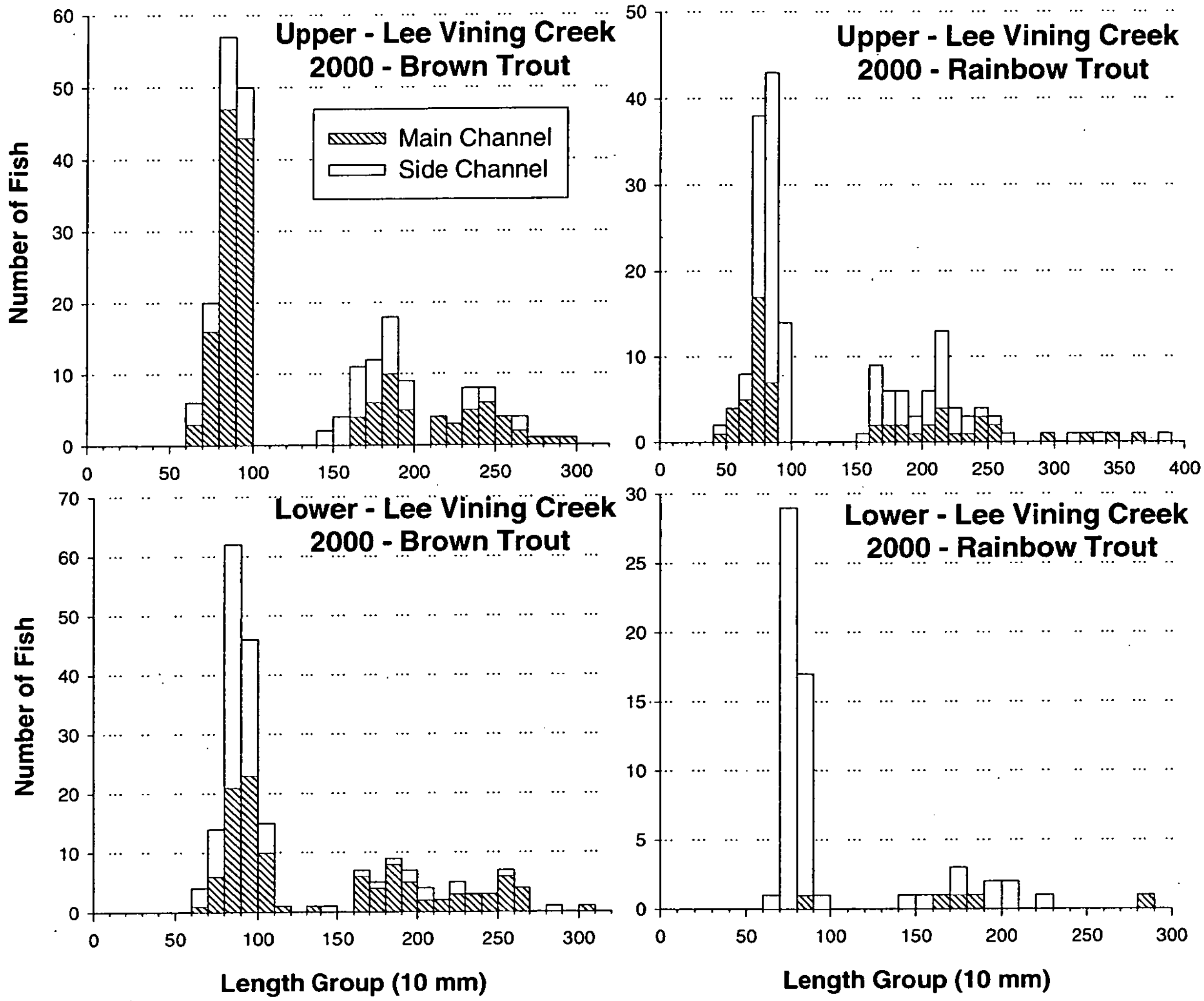

Figure 6. Length frequency histograms for brown (left) and rainbow (right) trout captured in the Upper (top) and Lower (bottom) sections of Lee Vining Creek during September 2000 showing those fish captured in the main channel (cross-hatched bars) and side channel (open bars) portions of each section.

Table 4. Depletion population estimates made in the side channel portions of the Lower and Upper sections of Lee Vining Creek and in Parker and Walker creeks during September 2000 showing number of fish captured on each pass, estimated number, and standard deviation (S.D.) by species and length group.

Stream (Section) Species Length Group	Number captured per pass 1	2	3	Estimated number	S.D.
Lee Vining Creek (Lower Side Channel)					
Brown Trout					
YOY (<115 mm)	65	15	-	83	3.0
115-199 mm	6	0	-	6	0
200 + mm	6	0	-	6	0
Rainbow Trout					
YOY (<115 mm)	32	15	-	57	8.9
115-199 mm	6	0	-	6	0
200 + mm	3	0	-	3	0
Lee Vining Creek (Upper Side Channel)					
Brown Trout					
YOY (<115 mm)	19	5	-	24	1.2
115-199 mm	31	0	-	31	0
200 + mm	7	0	-	7	0
Rainbow Trout					
YOY (<115 mm)	69	6	-	75	0.7
115-199 mm	16	2	-	18	0.5
200 + mm	22	2	-	24	0.4
Parker Creek					
Brown Trout					
YOY (<115 mm)	31	8	7	48	2.5
115-199 mm	4	2	0	6	0.4
200 + mm	1	0	0	1	-
Walker Creek					
Brown Trout					
YOY (<115 mm)	49	12	-	64	3.0
115-199 mm	18	2	-	20	0.5
200 + mm	4	0	-	4	-

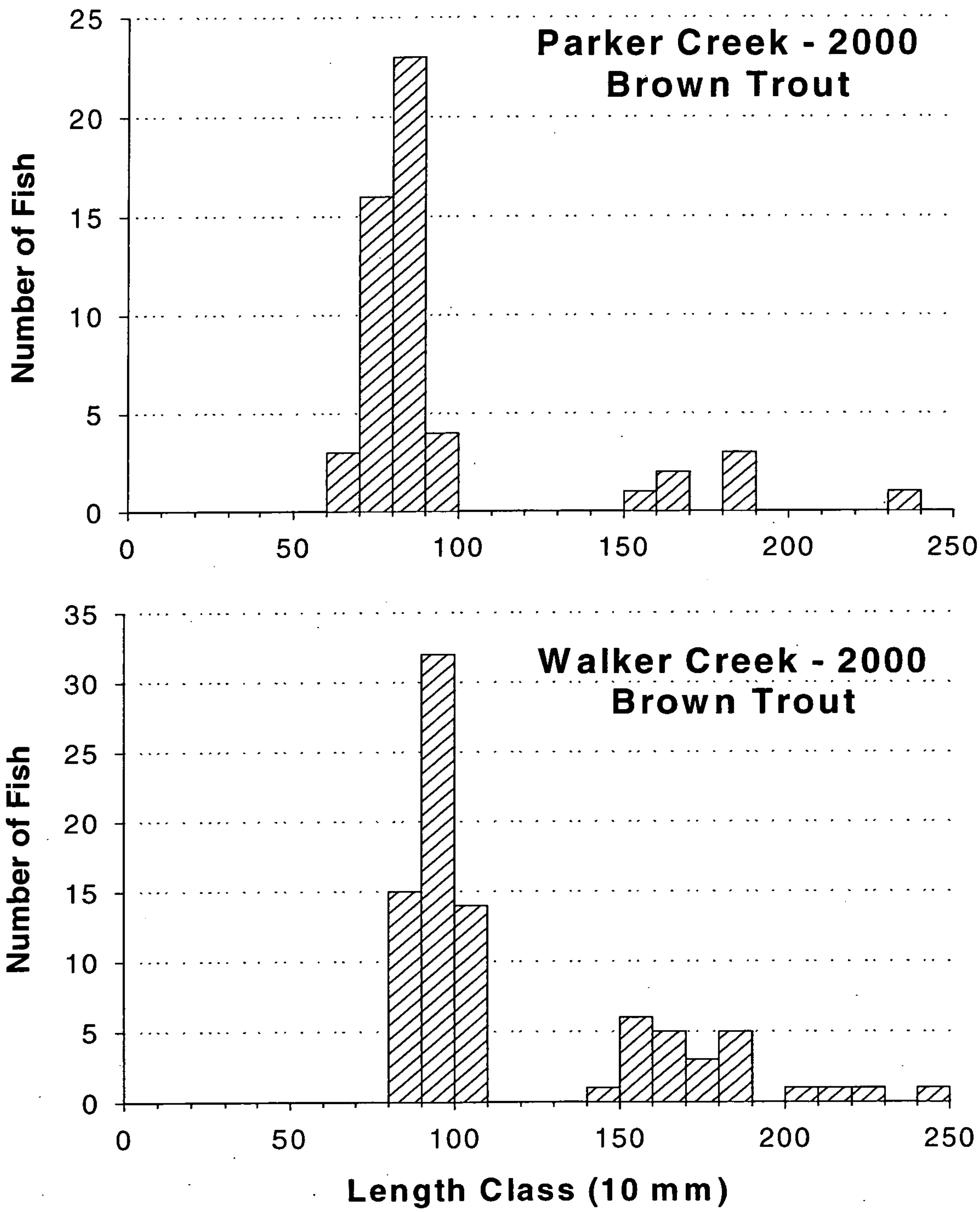

Figure 7. Length frequency histograms for brown trout captured in Parker (upper) and Walker (lower) creeks during September 2000.

Discussion

Reliability of Estimates

For all estimates we believe we met all assumptions except for closure of populations to emigration and immigration. We discuss the degree to which we believe we violated the assumption of populations that were closed to emigration and immigration for each estimate. Violation of the assumption that a population is closed to emigration and immigration could result in an over-estimate. Potential loss of marked fish from the sample area, or movement of unmarked fish from outside the sample area into the sample area, between mark and recapture efforts would lead to an under-estimate of capture efficiencies. Under-estimating capture efficiencies result in over-estimates of population numbers.

Rush Creek

Since no block fences were deployed at the boundaries of the County Road Section of Rush Creek, movement of fish into and out of the section between mark and recapture efforts may have affected this estimate. However, the relatively long length of the section (over 800 m) should have reduced this effect. The block fences at the boundaries of the Lower Section of Rush Creek remained in place and little to no fish movement into or out of this section between marking and recapture efforts likely occurred. The block fences at the boundaries of the Upper Section were difficult to maintain and these block fences, particularly at the upper boundary, were breached by debris and flows causing the portions of these fences to collapse on several occasions between the mark and recapture efforts. The lower block fence went down during the recapture event due to debris dislodged during sampling plugging the fence and causing it to fail. One fish marked in this section was found on the upstream side of the upstream fence and another was found in the Lower Section illustrating that some marked fish moved out of this section between mark and recapture efforts. It is also likely that some unmarked fish moved into this section from outside the section between the mark and recapture efforts. The failure to meet the population closure assumption probably seriously affected the accuracy of estimates in this Upper Rush Creek Section; however, the precision (reflected as standard deviations) was still relatively good.

Lee Vining Creek

The block fences at the boundaries of the main channel in both the Lower and Upper sections remained in place and little to no fish movement into or out of this section between marking and recapture efforts likely occurred. The block nets located at the boundaries of the side channels in both sections also remained in place during sampling, so little to no fish movement likely occurred during sampling.

Parker and Walker Creeks

The block nets located at the boundaries of both sections in these two creeks remained in place during sampling, so little to no fish movement likely occurred during sampling.

Estimate and Standing Crop Comparisons

Densities (number per hectare) of age 1 and older brown trout were generally lower in 2000 than in 1999, except in the main and side channel portions of the Upper Lee Vining Creek section and the main channel portion of the Lower Lee Vining Creek section (Figure 8). The 1999 depletion estimate for brown trout in Upper Rush Creek probably was an under-estimate. Walker and Upper Rush sections supported the highest densities of age 1 and older brown trout during these two years. Densities of age 1 and older rainbow trout were higher in 2000 or similar between years in all sections, but Lower Lee Vining (Figure 9). The Upper Lee Vining section had much higher densities of age 1 and older rainbow trout in 2000.

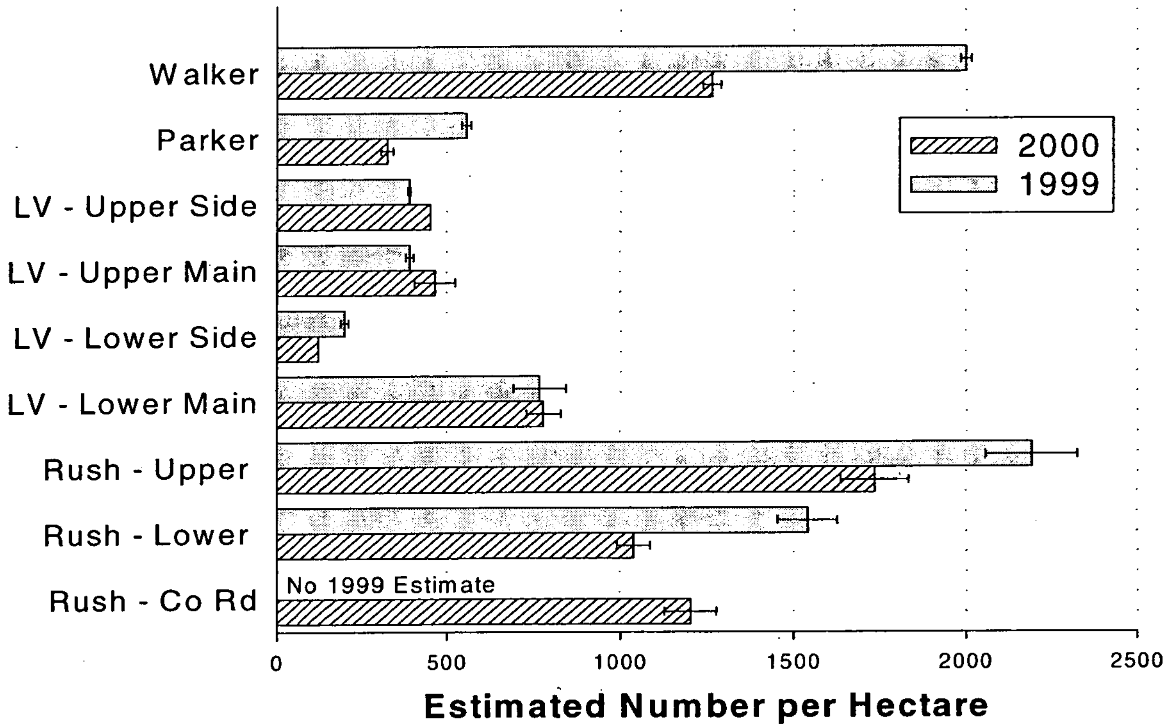

Figure 8. Estimated number (standard errors shown as capped horizontal lines) of age 1 and older brown trout per hectare in sections of Rush and Lee Vining creeks during September 1999 and 2000.

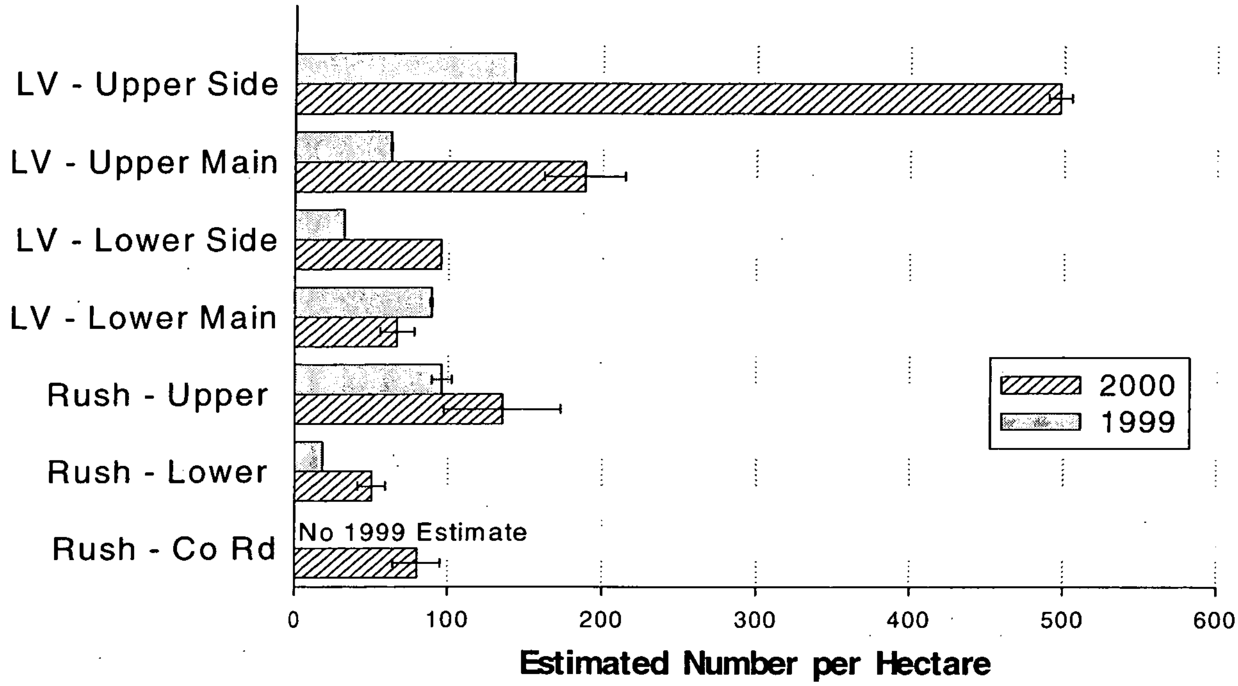

Figure 9. Estimated number (standard errors shown as capped horizontal lines) of age 1 and older rainbow trout per hectare in sections of Rush and Lee Vining creeks during September 1999 and 2000.

Estimates of trout standing crops (kg/hectare) were generally lower during 2000 than during 1999 in all stream sections, but those in Lee Vining and Parker creeks (Figure 10). Standing crop and density estimates were relatively concordant for all areas (Figures 8 and 9 versus 10). We are unsure why populations of trout declined in the Rush Creek drainage (all Rush, Parker, and Walker sections) from 1999 to 2000, while populations in Lee Vining Creek were stable or increased during this same time period (Figures 8 and 9). Much of the increase in trout densities observed in Lee Vining Creek was due to an increase in numbers of rainbow trout.

Both 1999 and 2000 sampling indicated that young-of-the-year trout, especially brown trout, were extremely abundant. This result indicates that spawning habitat is probably adequate for fully seeding these streams with trout. Factors limiting densities of age 1 and older trout probably operate after fry emerge from the substrate. We speculate that winter conditions, especially during the first year of life, likely control densities of juvenile trout. The influence of stream flow on survival of young fish may also be very important and monitoring the abundance of trout by size class through various flow regimes would allow us to better evaluate flow effects.

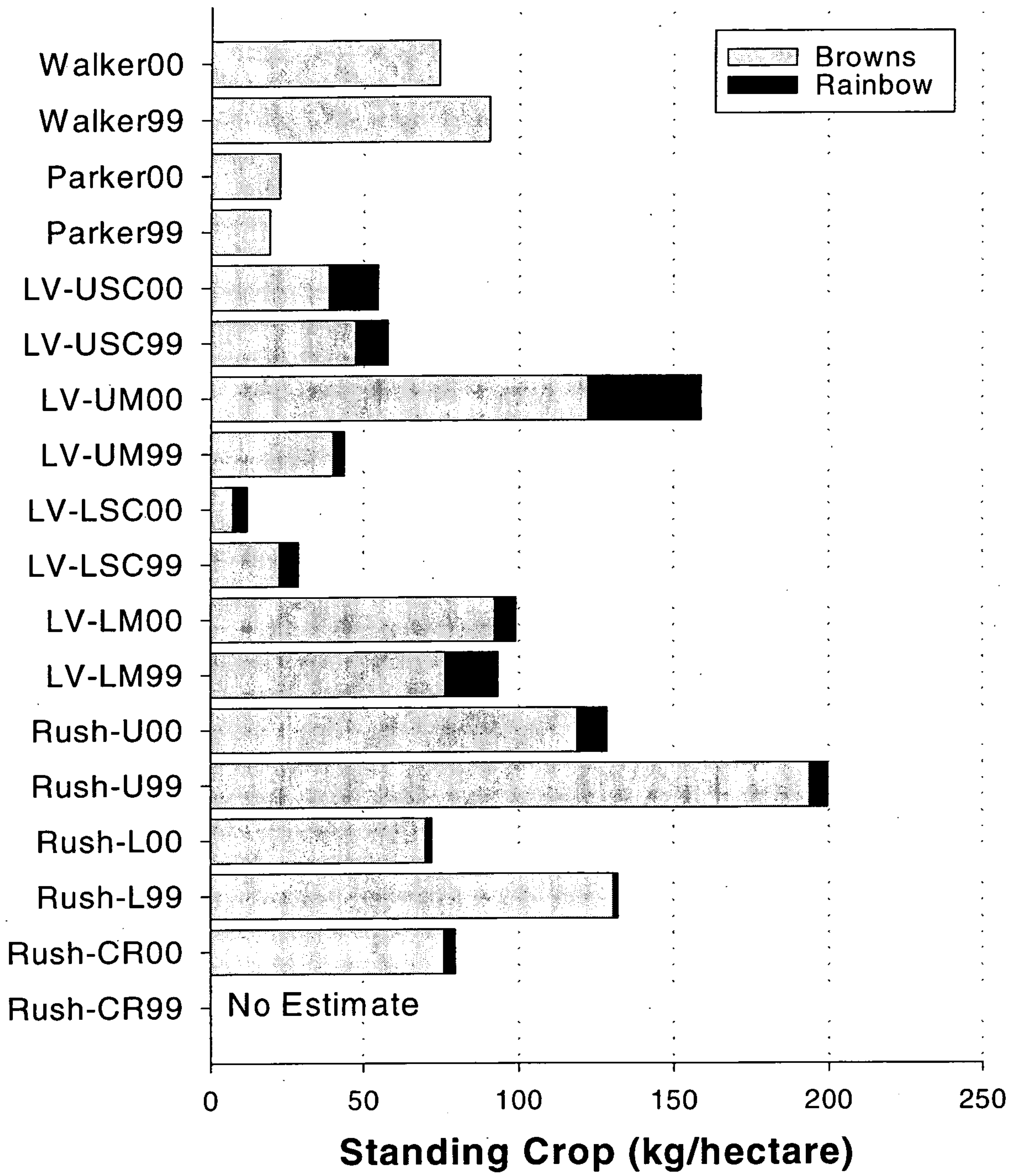

Figure 10. Standing crop (kg/hectare) of age 1 and older brown and rainbow trout in selected Mono Lake tributaries in 1999 and 2000. Vertical axis shows stream (LV = Lee Vining), section (U = Upper, L = Lower, SC = side channel, M = main channel, CR = County Road), and year.

Since the termination criteria concentrates on the abundance of larger "catchable" trout (">8 inches [203 mm] with some 13 to 15 inches [330 to 381 mm]") we feel a brief discussion of factors that probably influence these streams' capacity to support larger (> 200 mm) trout is warranted. We limit this discussion to a cursory review of the literature for now, but will provide a more detailed review at the conclusion of this study.

Brown trout generally seek deeper water associated with cover as they grow (Blades and Vincent 1969). Clapp et al. (1990) found that large (> 400 mm) radio-tagged brown trout in a Michigan stream typically selected deep (> 30 cm), slow (< 10 cm/s) water habitats that had heavy log cover during daytime hours. Cunjak and Power (1986) described winter habitat use of brook and brown trout in an Ontario River and found that age 1 and older brown trout occupied deeper water during the winter than during the summer with mean focal point depths at two different sites of 43 and 59 cm during the summer and 53 and 76 cm during the winter. Cunjak and Power also found that brown trout generally preferred deeper water than brook trout and that both species preferred positions beneath cover. They also found that brown and brook trout aggregated beneath cover in the winter, but saw no evidence of gregarious behavior during the summer. Hayes and Jowett (1994) found that brown trout in three New Zealand rivers preferred water that was 1.0 m deep (0.67 to 0.86 m were most commonly used) and optimal focal point water velocities (0.19-0.28 m/s) were lower than mean velocities. They found that depth and mean velocity consistently explained habitat selection (accounting for 33-85% of deviances in a logistic regression model). Näslund et al. (1998) reported that adult brown trout grew and survived better in pool habitats than in riffle habitats of Swedish streams. Newman and Waters (1989) found that trout densities and standing stocks differed significantly among eight continuous sampling sections along South Branch Creek, a limestone stream in southeastern Minnesota. These differences were relatively consistent between 3 years of study and were regulated by habitat differences between sections.

Movement patterns of brown trout in Mono Lake tributaries are presently not well known. Our data suggests that movement of brown trout within the Rush Creek drainage may be extensive. Movement patterns can be segregated into seasonal and diel. Seasonal movement of large (> 400 mm) brown trout in a Michigan stream ranged from 370 m to over 33 km (Clapp et al. 1990). These fish appeared to have separate winter and summer ranges. Individual fish used as many as four specific home sites during the spring-summer period and the average distance between these home sites was 386 m. Meyers et al. (1992) found that large (> 400 mm) brown trout moved from about 8 to 20 km during the spring and fall, but moved very little during the summer months in a Wisconsin stream system. Workman (1981) documented the re-founding of a sympatric brown and rainbow trout population in Sixteenmile Creek, Montana following their elimination via chemical poisoning of the lower 35.6 km of the stream. He found that age 1 and 2 year old trout from adjacent areas unaffected by the poison moved rapidly into the poisoned section, but older trout did not move into the poisoned reach. Since few mature-sized fish moved into the de-populated section, Workman did not consider this population recovered until the age 1 and 2 year old fish that moved into this section matured at age 3 and spawned. The re-founding of this population took at least four years.

Burnnell et al. (1998) studied diel movements of 268-446 mm brown trout in the southern Appalachian Chattaooga River and found the majority of fish moved less than 80 m and this distance generally encompassed a single pool-riffle complex. However, larger brown trout (>375 mm) moved greater total distances and had wider diel ranges than smaller trout.

Since seasonal movement information suggests that brown trout may require different habitats seasonally, we suggest that connectivity be maintained throughout the Rush Creek and Lee Vining Creek drainages, at least below existing LAWP dams. Maintaining connectivity will require ensuring that road crossings, or any other human structures, do not impede movement of fish in either an up- or downstream direction. Limited observation suggests that brown trout may be moving in and out of the Rush Creek diversion ditch from main Rush Creek. We have also observed, and been offered anecdotal information, that brown trout may move down into the estuarial portions of both Rush and Lee Vining Creek near Mono Lake, perhaps to take advantage of the abundant food resource offered by the brine shrimp.

Ultimately, recommendations will need to be made regarding flow regimes necessary for sustaining trout populations in Mono Lake tributaries. Wesche et al. (1987) described a model that accounted for 52% of the variation in brown trout standing stock (kg/hectare) which used cover availability and average annual base flow expressed as a percent of average annual daily flow. Jowett (1992) found that weighted useable area (WUA) and invertebrate biomass explained 64.4% of the variation in abundance of brown trout 200 mm and longer in 43 sites in New Zealand rivers. When flow data were included in an instream flow incremental methodology (IFIM) to estimate WUA for food production at median flow and WUA for adult brown trout drift-feeding habitat at mean annual low flow, Jowett found that the IFIM model explained 87.7% of the variation in brown trout at 59 sites.

A recent review of 236 habitat-flow curves for brown trout and 487 for rainbow trout developed using IFIM and PHABSIM procedures by Hatfield and Bruce (2000) indicated that mean annual discharge was the principal variable that predicted optimum flows for each life stage. They suggested that regressions they developed using mean annual discharge to predict optimum flows could be applied for project scoping, research planning, and adaptive management. Applying these regression equations using mean annual discharges and latitude and longitude to predict optimum flows resulted in predictions of 19 to 55 cfs for various life stages of brown trout and 8 to 16 cfs for rainbow trout in Rush Creek, 17 to 45 cfs for brown trout and 8 to 16 cfs for rainbow trout in Lee Vining Creek, 6 to 20 cfs for brown trout in Parker Creek, and 5 to 16 cfs for brown trout in Walker Creek (Table 5). These predicted optimum flows represent only starting points for evaluating instream flow needs for brown and rainbow trout in these creeks. We note that predictions of instream flow needs for fish assume a single thread channel that has

Table 5. Prediction of optimum flows needed for brown and rainbow trout by life stage in Rush, Lee Vining, Parker, and Walker creeks based on equations developed by Hatfield and Bruce (2000) using mean annual discharges (MAD) and latitude and longitude of the streams.

Stream	Species	Life Stage	Mean Annual Discharge	Equation	F	df	R-squared	Predicted Optimum Flow
Rush Creek	Brown	Fry	80	0.444 + 0.568*loge(MAD)	43.4	1, 45	0.491	19
		Juvenile	80	90.595 + 0.537*loge(MAD) - 18.705*loge(Longitude)	27.0	2, 48	0.529	34
		Adult	80	1.449 + 0.585*loge(MAD)	61.5	1, 47	0.567	55
		Spawning	80	1.822 + 0.478*loge(MAD)	21.8	1, 38	0.364	50
	Rainbow	Fry	80	- 0.946 + 0.784*loge(MAD)	142.3	1, 77	0.649	12
		Juvenile	80	- 15.543 + 0.593*loge(MAD) + 4.400*loge(Latitude)	170.7	2, 96	0.781	16
		Adult	80	- 6.636 + 0.641*loge(MAD) + 2.105*loge(Latitude)	165.3	2, 95	0.777	8
		Spawning	80	- 12.037 + 0.598*loge(MAD) + 3.623*loge(Latitude)	91.7	2, 71	0.721	13
Lee Vining Creek	Brown	Fry	64	0.444 + 0.568*loge(MAD)	43.4	1, 45	0.491	17
		Juvenile	64	90.595 + 0.537*loge(MAD) - 18.705*loge(Longitude)	27.0	2, 48	0.529	30
		Adult	64	1.449 + 0.585*loge(MAD)	61.5	1, 47	0.567	49
		Spawning	64	1.822 + 0.478*loge(MAD)	21.8	1, 38	0.364	45
	Rainbow	Fry	64	- 0.946 + 0.784*loge(MAD)	142.3	1, 77	0.649	10
		Juvenile	64	- 15.543 + 0.593*loge(MAD) + 4.400*loge(Latitude)	170.7	2, 96	0.781	16
		Adult	64	- 6.636 + 0.641*loge(MAD) + 2.105*loge(Latitude)	165.3	2, 95	0.777	8
		Spawning	64	- 12.0.7 + 0.598*loge(MAD) + 3.623*loge(Latitude)	91.7	2, 71	0.721	13
Parker Creek	Brown	Fry	12	0.444 + 0.568*loge(MAD)	43.4	1, 45	0.491	6
		Juvenile	12	90.595 + 0.537*loge(MAD) - 18.705*loge(Longitude)	27.0	2, 48	0.529	12
		Adult	12	1.449 + 0.585*loge(MAD)	61.5	1, 47	0.567	18
		Spawning	12	1.822 + 0.478*loge(MAD)	21.8	1, 38	0.364	20
Walker Creek	Brown	Fry	7	0.444 + 0.568*loge(MAD)	43.4	1, 45	0.491	5
		Juvenile	7	90.595 + 0.537*loge(MAD) - 18.705*loge(Longitude)	27.0	2, 48	0.529	9
		Adult	7	1.449 + 0.585*loge(MAD)	61.5	1, 47	0.567	13
		Spawning	7	1.822 + 0.478*loge(MAD)	21.8	1, 38	0.364	16

reached some sort of dynamic equilibrium in response to its flow and sediment regimes, valley gradient, and underlying soils and geology. Anthropogenic "tinkering" to adjust stream channels to achieve some perceived desired state will make it extremely difficult to reliably predict any response by fish to instream flows.

Methods Evaluation

The 1999 Fisheries Monitoring Report for Rush, Lee Vining, Parker and Walker creeks recommended changes to the fish population estimation methods described in the White book prepared by the Los Angeles Department of Water and Power (LADWP, 1997). These changes included conducting mark-recapture electrofishing estimates in all three sections in Rush Creek and the two main channel sample sections in Lee Vining Creek. Due to the large size of Rush Creek it was also recommended that a larger generator and electrofishing unit be used to increase sampling efficiencies.

All of the recommended methods changes were implemented in 2000. We believe that these new methods improved population estimates; however, we found it difficult to maintain block nets in the Upper Rush Creek Section.

The qualitative sampling of a short section of the Grant Lake ditch conducted in 2000 raises several questions. As reported earlier, a disproportionate number of large brown trout were captured in the ditch when compared with the rest of Rush Creek. The deep, cool, low velocity water and cover provided by the beds of elodea provide excellent habitat for large brown trout. Do these fish reside in the ditch year round? How does the presence of these fish in the ditch affect our evaluation of whether Rush Creek meets the termination criteria, particularly if these fish are distributed in Rush Creek during other times of the year?

The 1999 and 2000 sampling indicates there is tremendous reproduction in these streams. The data also reveals that there is considerable mortality between young-of-the-year and Age 1. One likely source of mortality is the severe winter conditions found in these high elevation streams. The best way to determine this is to sample the fish populations in the early spring to evaluate the impact of winter on the age class.

We propose to conduct sampling of the ditch and Rush Creek during early March 2001 to help answer these questions. We hypothesize that the thick beds of elodea will have winterkilled, forcing most of the larger brown trout to migrate out of the ditch to seek cover in the main creek. Our sampling of the ditch will test this hypothesis. We will also conduct reconnaissance level electrofishing sampling of the upper, lower and country road sections of Rush Creek to determine relative abundance of the young-of-the-year following the winter. Finally we propose to tag those fish 200 mm (8 inches) and longer. Angler returns of these tagged fish, as well as results of our fall sampling, will help document the movements of brown trout in Rush Creek. We also suggest adding the ditch as a permanent population monitoring site.

Termination Criteria

The agreed upon termination criterion for Lee Vining Creek is sustained catchable brown trout averaging 8-10 inches in length with some trout reaching 13 to 15 inches. Our sampling yielded 18 trout greater than 8 inches (~ 200 mm) per 100 m of channel in the upper main section (41 brown trout and 19 rainbow trout for the 330 m long section), 15 per 100 m in the upper side channel (A-4; 7 brown trout and 24 rainbow trout for the 201 m long section), 21 per 100 m in the lower main (39 brown trout and about 1 rainbow trout for the 187 m long section), and 5 per 100 m in the lower side channel (B-1; 6 brown trout and 3 rainbow trout for the 189 m long section). These numbers are much higher than the 7 trout greater than 8 inches per 100 meters in the upper section and 6 per 100 meters in the lower section last year. The only captured trout that exceeded 13 inches were four rainbow trout captured in the upper main channel and two rainbow trout captured in the upper side channel that ranged in length from 338 to 390 mm (13.3 – 15.4 inches). A few of these larger rainbow trout were identified as being of hatchery origin based on observed fin erosion. We do not believe that these numbers indicate the stream is meeting the termination criterion. Given the available habitat we hypothesize that this stream cannot support much higher densities of 8 inch. Additional sampling and literature review will be conducted to investigate this hypothesis.

The agreed upon termination criterion for Rush Creek states that Rush Creek fairly consistently produced brown trout weighing 0.75 to 2 pounds. Trout averaging 13 to 14 inches were also regularly observed. We only captured on brown trout in Rush Creek that met this criterion, a 366 mm (14.4 inch) brown trout captured in the upper section. However, four brown trout exceeding 14 inches (range: 368-509 mm or 14.4-20.0 inches) were collected in the ditch.

Recommended Termination Criteria

The 1999 report noted that there is virtually no data available that provides an accurate picture of the trout populations that these streams supported on a self-sustaining basis prior to 1941. We recommended that additional fish population data be collected from these streams for several years until we have a suitable amount of data upon which to base additional quantitative termination criteria. This continues to be our recommendation.

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4

Mono Basin Tributaries:
Lee Vining, Rush, Walker, and Parker Creeks

Monitoring Results and Analyses for Runoff Season 2000

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Pursuant to State Water Resource Control Board Decision 1631

May 10, 2001

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1.1. Introduction

Runoff Year 2000 - 2001 was officially the second year of monitoring as stipulated in SWRCB Order 98-05, but in fact represents the fourth consecutive year in which geomorphic and hydrologic data have been collected at established monitoring sites. Our monitoring program continued at three primary sites on Rush Creek, including Upper Rush, Lower Rush, and County Road sites (Figures 1 and 2), with additional observations and data collection at the re-watered channel near the Old 395 Bridge, the Yellowbird Channel site, and the 3D and Channel-2 sites. Monitoring on Lee Vining Creek continued at the Upper Main and A-4 channels, and the Lower Main and B-1 channels. Monitoring at Parker Creek and Walker Creek sites also continued. Runoff Year 2000 - 2001 had below "average" conditions. Because much of our geomorphic monitoring focuses on the role of floods in forming and maintaining geomorphic processes and alluvial features, monitoring was tailored to respond to the limited spring snowmelt peak flood.

1.2. Hydrology

1.2.1. Annual hydrographs

Annual hydrographs of daily average flows at LADWP gaging stations were plotted for Rush, Lee Vining, Parker, and Walker creeks (Figures 3 to 6) for Runoff Year 2000 - 2001. Annual hydrographs for Lee Vining Creek at the Intake (LADWP Gaging Sta. No. 5009) depict daily average flows through our Upper Lee Vining Creek and Lower Lee Vining Creek study sites. Annual hydrographs are available (or reconstructed) at four locations along Rush Creek: Rush Creek Unimpaired, Rush Creek at the Dam site, Rush Creek below the Return Ditch, and Rush Creek below the Narrows. Rush Creek Unimpaired Annual Hydrographs are synthetic, or computed natural flows, and represent discharge at the Dam Site if no regulation from SCE or LADWP occurred. Rush Creek Dam Site gaging station represents Rush Creek flows impaired by Southern California Edison (SCE) regulation only, contrasted to Rush Creek below the Return Ditch gaging site that represents impaired flow conditions. Rush Creek below the Narrows Annual hydrographs are synthetic: daily average discharges were derived by adding the gaging data for Rush Creek below the Return ditch (LADWP Gaging Sta. No. RCBR), to Walker Creek (LADWP Gaging Sta. No. 5002) and Parker Creek (LADWP Gaging Sta. No. 5003). Rush Creek below the Return Ditch provides the best discharge estimate through our Upper Rush Creek Study Site while Rush Creek below the Narrows provides the best daily average discharge estimate through our Lower Rush Creek and Rush Creek County Road study sites.

1.2.2. Snowmelt peak flow evaluation

Spring runoff magnitudes during Runoff Year 2000 - 2001 were similar to Runoff Year 1999 - 2000 peak runoff magnitudes (Table 1). Lee Vining Creek peaked at 288 cfs on May 28, 2000, with a recurrence interval of 1.72 yrs (unimpaired record), compared to 1.58 years in 1999, or 3.1 years on the impaired period of record. The unimpaired,computed. natural flow at Grant Lake Dam Site was approximately 502 cfs, equating to a 2.3-year flood on the unimpaired record (approximately the mean annual flood) and would have been an 11.6-year flood for the regulated period of record. Peak annual runoff above the Dam Site (inflow into Grant Lake) was 372 cfs on June 20, 2000. The peak daily average release into Rush Creek via the Return Ditch was 204 cfs (nearly identical to the previous year's peak of 201 cfs). The synthetic peak discharge for Rush Creek below the Narrows was 284 cfs on July 1, 2000, representing peak flow in Lower Rush Creek and County Road study sites.

1.2.3. Synoptic streamflow gaging

During runoff year 2000, discharge measurements were collected several times to continue observations on flow proportions in multiple channels. These measurements were made at the Lower Rush Creek reach in two locations: in the 10-Channel at the Valley-wide cross section (next to the piezometer), and in the mainstem at XS -9+82 downstream of the 10-Channel return. This allowed calculation of the flow proportion in the main channel through the planmapped reach. In Lee Vining Creek, discharge was measured in the main channel at XS 3+45, in the B-Connector channel (next to staff plate), and in the B-1 Channel at XS 6+08. This allowed calculation of the discharge in the A-4 Channel upstream of the B-Connector return channel. Flows were measured on the following days during the specified conditions:

Lower Rush Creek:	October 7, 1999 during fall low flow conditions (44.7 cfs); June 14, 2000 during the ascending limb of the spring runoff (90.3 cfs);
Lee Vining Creek:	October 8, 1999 during fall low flow conditions (25.6 cfs); June 1, 2000 during the ascending limb of the spring runoff (179.2 cfs); June 2, 2000 during the ascending limb of the spring runoff (182.1 cfs);

1.2.4. Lower Rush Creek gaging station

During late summer, we scoped out a location on the lower Rush Creek mainstem suitable for a continuously recording gaging station. The site was selected at the Count Road culvert crossing to allow year-round access to the gaging equipment (Figure 7). Our strategy is to employ temporary streamflow monitoring equipment until we determine that the site is suitable for the construction and operation of a permanent, long-term gage house. In November, we installed a GLOBAL WATER WL-14 WATER LEVEL LOGGER in a galvanized steel housing, attached to the concrete bridge abutment on the downstream, right bank of the abutment. The housing has a lid attached by a hinge, held closed by a padlock. The water level logger combines a water level sensor (pressure transducer) with a datalogger, and requires development of a stage-discharge rating curve to relate water level to discharge. Two three-foot sections of staff plate were placed near the water level sensor on the right bank, in the large plunge pool below the culvert. A cross section was installed in the straight section of creek upstream of the culvert as a long-term site for discharge measurements. A single discharge measurement was taken following equipment installation. An additional cross section was installed across the riffle crest of the plunge pool to monitor the downstream control of the pool elevation. The logger was calibrated and set to record water stage at 15 minute intervals.

We downloaded the datalogger in March with assistance from the LADWP Mono Basin hydrographers. These data are not presented, as we do not yet have a complete rating curve developed to convert the stage recordings to discharge.

1.3. Cross section surveys

Most monitoring cross sections were resurveyed, with surveys limited primarily to the bankfull channel. Several cross sections were not resurveyed because no observable changes occurred. Cross sections were plotted with Runoff Year 1999 - 2000 and 2000 - 2001 profiles and water surface stages to highlight subtle channel changes resulting from peak flows. Previous years' surveys were omitted for graphic clarity. Cross section plots are presented in Appendix A. Aluminum tags have been placed on all permanent rebar pins, specifying the cross section number and the newly acquired elevation (based on NADV, ft). Wood stakes were also replaced, marking cross section pin locations.

Figures 8 to 13 provide examples of minor channel changes documented by cross section surveys.. At Lower Rush Creek XS 7+25 (Figure 8, valley-wide cross section), the spring peak flow (284 cfs) caused no additional lateral channel migration, as has occurred during several successive years. However, large clumps of bank undercut and toppled into the channel during Runoff Year 1999 - 2000 were nearly completely scoured away in Runoff Year 2000 - 2001. Downstream at XS 03+30, this active section of channel showed only minor channel adjustments (Figure 9). At the County Road XS 02+17 (Figure 10), the right bank was undercut and slumped into the channel. Upper Rush Creek (peak discharge = 204 cfs) recorded essentially no change.. In Lee Vining Creek, the upper A4 channel was more active than the mainstem; the right bank of the A4 Channel XS 05+15 (Figure 11) continued to erode the outside of this sharp meander bend. Lateral channel migration of nearly 3 ft occurred, accompanied by similar deposition on the left bank migrating point bar. Several sets of marked rocks were buried during the spring event. Just downstream at XS 04+04 (Figure 12) the channel thalweg scoured approximately 0.6 ft deeper and became more defined. Cross sections in the upper mainstem of Lee Vining recorded essentially no change.. In lower Lee Vining, only XS 0+87 in the lower B-1 channel had notable change (Figure 13), and this was only slight erosion of the outer bend and deposition on the bar surface. In general, only channels with more confinement seemed subject to channel changes during low runoff years.For Lower Rush Creek cross sections, we developed rating curves relating water surface elevation (stage height) to discharge (Appendix A). Linear regressions of these curves predict discharge from stage height, and in some cases revealed a change in the stage-discharge relationship.

1.4. Headcutting in Lower Lee Vining Creek

We surveyed the thalweg of the Lower Lee Vining B-1 channel from the bottom of our planmapped reach downstream 560 ft to the confluence with the main channel (Figure 14). The main channel has migrating headcuts rapidly translating upstream through the mainstem and all secondary channels that will soon propagate through our lower planmapping reach. The cause for this recent headcut is the blow-out of the County Road crossing downstream. We want to be able to distinguish changes in planform morphology (in the Lower Lee Vining planmap site) attributable to fluvial processes from changes induced by headcutting.

1.5. Bed mobility

We continued bed mobility experiments at cross sections and other selected locations during peak flows. Before snowmelt runoff began, we reset all tracer rock and scour core experiments. We performed 100 rock pebble counts at all marked rock stations to observe if the bed substrate composition had changed from previous pebble counts. Tracer rocks were then re-selected based on new particle size calculations (or re-used if no changes were observed), repainted, and placed in the channel. Scour cores were also relocated, the surface layer removed to expose the painted tracer rock, and core topped off with freshly painted tracer gravel to the level of the surrounding substrate.

Following the peak spring snowmelt floods, we examined each marked rock and scour core cross section to observe tracer rock movement and scour depth. Tracer rocks were assumed to have moved if they were farther than one foot from the original cross section location. Tracerked rocks relocated downstream were measured for their size and distance moved.

In general, only minor channel bed scour occurred. Most scour core experiments were recovered in the same condition in which they were installed, i.e., no scour of the tracer rocks and no subsequent deposition. In Rush Creek, with peak flows in the upper/lower reaches of 204/284 cfs, the maximum scour recorded was 0.10 ft at XS 12+95, which is a steep, fast riffle at the upstream end of the Upper Rush Creek study reach. Table 2 summarizes the results of scour core experiments in upper and lower Rush Creek study sites. In Lee Vining Creek, peak flows were 288 cfs. Scour was also minimal at all cross section stations. The maximum scour was 0.24 ft, recorded in a very active fine gravel eddy deposit at XS 10+44. All other scour cores recorded less than 0.1 ft of scour. Table 3 summarizes results of scour core experiments in Lee Vining Creek.

The tracer rock experiments were intended to target thresholds for mobilization of surface particles; these experiments respond at lower peak flows than do the scour cores. On Rush Creek, tracer rock experiments ranged from no rock movement at stations out of the low-water channel, to moderate rock movement within the active channel. Table 4 summarizes results for all cross sections. XS –9+82 at the Lower Rush Creek study site is a good example of surface particle mobilization. This cross section is located below the return of the 10-Channel and therefore received the entire peak discharge magnitude of approximately 284 cfs. The tracer rocks were placed on a lateral bar developing in-channel. The cross section has relatively good channel confinement, and has been developing a more complex channel cross section in successive years. One D84 moved 2 ft downstream; 7 of 11 D50's, and 10 of 11 D31's moved. Tracer rocks near the thalweg moved more readily than those near the right bank, toward the backside of the developing bar. Thus, mobilization thresholds are lower near the thalweg at this cross section, and increase progressively toward the channel banks. The peak flood of 284 cfs could not mobilize the entire bed at XS –9+82. The "in-channel" tracer rocks at XS 7+70 showed similar results, with 5, 7, and 10 of 10 tracer rocks moving of the D_{31}, D_{50}, and D_{84} size classes, respectively, many 60 to 80 ft downstream. In the Upper Rush Creek site, with peak flow of 201 cfs, few tracer rocks were mobilized. At the (new) Rush Creek County Road site, the riffle at XS 15+19, had 1, 7, and 9 of the 12 D_{84}'s, D_{50}'s, and D_{31}'s, respectively, move downstream.
In Lee Vining Creek, results of tracer rock experiments were similar to Rush Creek. Table 5 summarizes results for all cross sections. In general, tracer rocks (D_{84}'s) were too large to be mobilized by the peak flow, but many intermediate and smaller rock sizes were transported short distances downstream. In the upper mainstem, the most rock movement was recorded at XS 9+31, which traverses a high-gradient riffle. Other cross sections showed little or no tracer rock mobilization. In the A-4 Channel, intermediate and large rock sizes at cross sections 4+04 and 5+15 were not mobilized, and less than 40% of the D_{31}'s were transported. The point bar at A-4 Channel XS 5+15 continued to aggrade the left bank point bar while eroding the outside meander bend; this process mobilized tracer rocks in-channel, and buried rocks along the point bar margin. In the upper B-1 Channel, placement of the root-wad in the channel just downstream of XS 6+08 created a backwater that altered hydraulics at the cross section; larger tracer rocks were not mobilized by 288 cfs (in 1999 274 cfs moved 60% of D_{84}'s and D_{50}'s), but 100% of the D_{31} rocks were mobilized. In lower Lee Vining, the most active channel was again the B-1 side channel (similar to the A-4 Channel upstream), in which cross sections 0+87 and 1+80 had near complete mobilization (83%) of the D_{50}'s and D_{31}'s, and 50% of the D_{84}'s. Several tracer rocks were relocated 100+ ft downstream. The lower LVC main channel XS 1+15 had minor tracer rock mobilization.

1.6. Planmapping

Planmapping documents morphological changes in the channel planform resulting (primarily) from annual peak flood events. Relatively low spring snowmelt runoff in Runoff Year 2000 - 2001resulted in minor planform changes in the monitoring sections. However, we observed several specific locations where minor planform channel adjustments occurred. At the Lower Rush Creek site, the 10-Channel has gradually captured more flow since its opening, and will likely continue this trend as a result of future high flow events. The entrance to the mainstem channel upstream of the planmapped reach continued to aggrade, forming a bar on the left bank that now blocks most flow from entering the main channel. This bar forces flow in two directions.First, upstream through the left bank willow thicket behind the forming bar, and then back into the existing main channel, directly down the 10-Channel. The thalweg where the 10-Channel splits from the main channel downcut (at least one foot) allows the 10-Channel to capture more flow. Further planform adjustment in this reach is likely in the next several years. A short distance downstream (~300 ft), the 10-Channel splits again; the left channel carries flow back to the main channel and the right channel continues as the 10-Channel proper. The entrance to the "10-Return Channel" that carries flow back to the mainstem also aggraded. A medial bar is forming at the entrance to the 10-Return Channel (XS-A, Figure 15) that may eventually block flow from returning to the main channel. This change is apparent in the air photo (Figure 16), showing the alternate bar sequence forming in the upper 10-Channel. Downstream of the 10-Return Channel split, increased flow during the past several years has lead to noticeable changes in the upper portion of the 10-Channel: the thalweg profile has increased in complexity, channel sinuosity is becoming apparent, bank erosion is occurring opposite the right bank bar, deposition on the downstream margin of the left bank bar, and the channelbed is coarsening. We began monitoring this reach more closely by installing two cross sections and a tracer rock set; additional data (planmaps, surveys, pebble counts) will be collected in Runoff Year 2001 - 2002 to better document changes.

In the lower Rush Creek planmapped reach, the meander cutoff adjacent the large lateral bar downstream of XS 7+25 also could capture more flow, as the channel continues to erode the outside meander bend. This could result in loss of the channel segment from XS 7+25 downstream to XS 0+86, similar in length to the "million-dollar-bend" meander cutoff. At Lee Vining Creek, minor planform adjustments occurred at two similar sites on wide meander bends on the A-4 channel (XS 5+15) and B-1 channel (XS 1+15). Both sites are steadily eroding the right bank, building left bank point bars, and deepening associated corner pools.

1.7. Termination criteria

SWRCB Order 98-08 establishes seven termination criteria for determining when the stream monitoring program may be terminated. In McBain and Trush (2000), these criteria were reviewed following one formal year and two informal years of monitoring. Given the low peak discharges in Water Year 2000 (October 1999 through September 2000), we expected to find no measurable changes in gross fluvial processes capable of affecting the geomorphic termination criteria presented in McBain and Trush (2000). The summer'2000 field data for channelbed scour and mobility corroborate this finding (presented in this annual report). Vegetation surveys, for assessing the riparian vegetation termination criteria, were postponed until this field season (summer'2001) due to last year's contracting delay. Termination criteria addressing fish populations are addressed in Chris Hunter's Runoff Season 2000 annual report.

2. AUGMENTATION OF RUSH CREEK PEAK FLOWS

Runoff Years 1999 - 2000 and 2000 - 2001 were "average" hydrologic years. Spring snowmelt runoff in Rush Creek during these years had unregulated peak flows of approximately 405 cfs and 502 cfs, with associated recurrence intervals of 1.5 years and 2.3 years[1]. However, the flow volume required to fill Grant Lake (total capacity = 47,500 acre feet), combined with SCE power generation operations in the upper watershed, significantly dampened the actual peak flow magnitudes downstream of Grant Reservoir and below the Narrows. Peak discharges were 201 cfs and 204 cfs at Rush Creek below Return Ditch in 1999 and 2000, respectively, and 247 and 284 cfs below the Narrows. Alteration in magnitude and timing of flow peaks impacted critical processes in Rush Creek: bed mobility and scour, riparian plant regeneration, and floodplain construction.

1 Actual Rush Creek peak flows at Grant Reservoir (RCR), which account for only SCE operations were 222 cfs and 372 cfs in 1999 and 2000, respectively.

Data from bed mobility experiments in Rush Creek indicate unregulated peak flows would have exceeded critical thresholds for surface particle mobility and scour during the past two years. In Lower Rush Creek, for example, peak discharge exceeding the 400 to 500 cfs range mobilized approximately 80 to 100% of the D_{84} tracer rocks at XS 10+10 (Figure 17) in the active channel (excludes tracer rocks on floodplain surfaces), and resulted in average scour depths of 91 mm at lower Rush Creek cross sections, and maximum scour depths ranging up to 190 mm. This depth of scour equates to more than 3 times the D_{84} particle size of 62 mm at XS 10+10. Peak flows were reduced approximately 60% by SCE and Grant Lake regulation (Figure 3), which resulted in substantially lower bed mobility. At Lower Rush Creek cross sections, the 200 to 210 cfs flow range achieved only partial bed mobility: only 0-20% of D_{84} tracers were mobilized at several cross sections and only 30-60% of D_{84} tracer movement occurred at the more active alluvial features. Depth of scour, averaged over all monitoring stations was barely measurable at 3 mm in Lower Rush Creek.

The peak magnitude andtiming, the rate of spring snowmelt recession, and the timing of seed dispersal are primary factors influencing riparian vegetation along Rush and Lee Vining creeks. In spring, seeds require suitable substrate with adequate soil moisture to germinate (Figure 18). Seedling root growth must then keep pace with drawdown (recession) in the groundwater table to avoid desiccation. These specific environmental conditions are typically provided each year only during a short "window of opportunity." Survival during successive years' growth cycles to reach sexual maturity also requires that plants initiate on depositional surfaces high enough to survive scouring flows and extended inundation. This complex set of partially conflicting requirements (germination at lower elevations to avoid desiccation but establishment on higher elevations to avoid scour and inundation), combined with broad differences in species-specific phenology[2], physiologic tolerances, and anatomy, determines the regeneration success of each riparian species. Because these factors are not ideal in all runoff years, successful recruitment to sexual maturity may occur only sporadically, perhaps once every 10 to 15 years or longer.

We observed poor recruitment of younger age classes of cottonwood along Rush Creek compared to Lee Vining Creek, suggesting that one or several conditions required for successful germination and initiation are not being met. Delays in the timing of the snowmelt peak caused by SCE and Grant Lake regulation (approximately two week lag), and the subsequent rate of recession, may significantly reduce or eliminate successful recruitment of cottonwoods. Additionally, the magnitude of the peak, even if timed to correspond to seed dispersal period, may be too small in many water year types to promote cottonwood germination in suitable floodplain locations. In addition to preventing cottonwood recruitment in suitable locations, alterations to the snowmelt peak and recession may also preferentially select species better adapted to germinate and survive on lower-elevation geomorphic surfaces, such as narrowleaf willow.

As provided in the SWRCB order,
In this Runoff Year 2000 report we present preliminary information discussing the potential for augmenting Rush Creek peak flows. The only "place" to obtain a significant volume of flow from Lee Vining Creek is from the spring snowmelt hydrograph. Our investigations in Mono Basin tributaries and other river systems suggest that certain components of the snowmelt hydrograph, specifically the peak magnitude and timing, and the ramping rate of the descending limb of the hydrograph are vitally important hydrograph components, necessary to promote and sustain critical geomorphic and riparian vegetation processes.

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2 *Phenology* is the annual cycle of bud swelling in spring, duration of flowering, length of time for fruit development, period of seed dispersal, timing of leaf abscission, and length of dormancy .

We are therefore considering the benefits and impacts of diverting flows from the ascending limb of the Lee Vining snowmelt hydrograph to augment the Rush Creek peak. We evaluated the volume of water available from this portion of the hydrograph using the past six water years, Runoff Years 1995 to –2000. For this evaluation, we imposed a "window of diversion" above and below which no diversion was allowed. This diversion window would protect baseflow requirements as well as preserve the entire peak magnitude and recession. For example, a "50/200 cfs window" would allow diversion only when 'Lee Vining Creek at Intake' streamflows exceeded 50 cfs, and diversion would cease when flows exceeded 200 cfs (Figures 19-23). We also imposed a condition that diversion would occur only after March 31, and would cease when (1) flows exceeded the threshold and (2) the annual peak flow was eminent. Finally, we maintained the SWRCB limit of 150 cfs diversion. Our preliminary evaluation showed that a substantial volume of water would be available in most water years. Using the example above of a 50/200 cfs window, the average annual diversion exceeds 4,000 af (Table 6). Reducing the baseflow (but maintaining the 150 cfs cap on diversions) provided more water for diversion, ranging from 4,600 af to 5,300 af, with 40/190 cfs and 30/180 cfs diversion windows, respectively. Last, stretching the 150 cfs limit of diversion to a 30/200 cfs window provided more than 6,000 af of average annual diversion.

Two options exist for augmenting flows to Rush Creek: direct or indirect augmentation. Indirect augmentation would transport the diverted water into Grant Lake to augment the reservoir elevation and eventually cause the reservoir to "fill and spill." This alternative would provide better management of diversion from Lee Vining (i.e., reduced risk of impacting the Lee Vining Creek peak), because diversion could minimize impacts to the Lee Vining Creek snowmelt hydrograph by diverting during the ascending limb before the peak occurred. This alternative would therefore maximize the volume of water sent to Rush Creek, and might achieve a higher peak flow (compared to direct augmentation), because a Grant Lake spill could be supplemented with the maximum release from the Rush Creek Ditch and could also correspond with Walker and Parker peak flows. However, diversion to Grant Lake would provide less control over the timing of the peak in Rush Creek. Grant Lake storage capacity is 47,575 af, and carry-over capacity from winter usually ranges above 35,000 af. Adding 4,000 to 8,000 af of water to Grant Lake during the early snowmelt period, combined with steadily increasing Rush Creek runoff during this same period, could allow the reservoir to spill, but the timing of the peak would still depend on the Rush Creek runoff regulated by SCE, and on filling Grant Lake.

Direct augmentation option would release up to 150 cfs from Lee Vining Creek directly into Rush Creek via the siphon and conduit. Direct augmentation could supplement releases from the Rush Creek Return Ditch to achieve a slightly higher peak, but provide much better control of the peak timing. The maximum capacity of the Rush Creek Return Ditch is presently 160 cfs (Steve McBain, personal communication), so higher peaks require spilling the reservoir. This flow (160 cfs), supplemented with the Lee Vining Creek diversion of 150 cfs maximum, may not achieve the magnitude of flows required for channel maintenance. Maximum peak flows from this operation scenario likely would not exceed 350 cfs above the Narrows and 420 cfs below the Narrows, if timed to correspond to Parker and Walker Creek peaks. But with the capacity of the Rush Creek Return Ditch enlarged (as planned by LADWP) to convey up to 380 cfs, maximum peak flows achievable by direct augmentation could reach approximately 500 and 570 cfs above and below the Narrows (timed with Parker and Walker peaks). This scenario could then provide flows in the range of bankfull discharge, and greater, with some operational control over the timing of the peak. LADWP indicated a preference for the direct augmentation option (Steve McBain, personal communication).

To further evaluate these peak flow augmentation alternatives and their effects on Rush and Lee Vining creeks, we will integrate the following information for the next annual report:

- dates of unregulated peak flows on Rush, Parker, Walker, and Lee Vining creeks;
- data on carry-over storage in Grant Reservoir (modeled or post-Settlement Agreement data);

- evaluation of the feasibility and risks of diverting during the ascending limb of Lee Vining Creek hydrograph to avoid eliminating the Lee Vining Creek peak event;
- cottonwood phenology (duration and peak of seed release) on Rush Creek;
- requirements to attain 150 cfs conveyance capacity in the Rush Creek siphon;

3. SIDE CHANNEL MANAGEMENT

A policy and/or adaptive management plan for all side channel construction and maintenance in the Rush Creek and Lee Vining Creek valley bottomlands is still under review. On Lee Vining Creek we propose continued maintenance only of the A4 channel. The B1 connector is filling-in with sand and probably will prevent the exchange of baseflows between the mainstem and A4 channels in the near future. The Mono Lake Committee, LADWP, and Hunter/Trush at the November 2000 meeting recommended Channel 11 and 14 not be re-opened at present. Because of the significant downcutting (induced by lake lowering), these former channelbeds are perched several feet above the contemporary channelbed. The Channel 13-14 complex is unique. Fortunately (though this windfall is temporary), the waterfall at the downstream end of the10-Channel now diverts several cfs against the right bank valley wall. This flow then enters a maze of small distributaries threading the Channel 13 floodplain/terrace.

Other side channels in the Rush Creek bottomlands, 1A, 4bii, and 8, are slated for re-opening in SWRCB Order 98-05, but may not be warranted. The lack of high flows routed down the Mono Ditch has seriously hampered our investigation of how side-channels and their entrances function. This summer we will collect additional information, then present our findings during a field meeting in early-September to discuss management options. If earth-moving is recommended, it can be completed well before winter sets-in because the construction work would require only a few days (pending permitting). If additional monitoring is warranted (e.g., more flood effects must be monitored), the nature and quantitative purpose of recommended monitoring can be established.

4. RUSH CREEK 3D CHANNEL RECONSTRUCTION

Two earlier visions of restoring the 3D Channel just upstream of the Narrows on Rush Creek (before the SWRCB Order) were drafted. The RTC Scientist's Work Plan (October Draft 1995, p.80) states: *The abandoned east-side channel in Reach 3D, extending from elevation 6,639 to 6,614 shall be reconfigured and rewatered. This channel should be restored as the main channel and only 5 cfs designed to flow down the present main channel when flows in Rush Creek are 47 cfs below Grant Dam.* The Mono Basin Stream Restoration Plan (LADWP December 1, 1995, p.35) states: *The abandoned east side channel in Reach 3D, extending from elevation 6639 to 6614, will be rewatered. Initial rewatering will divert approximately 15 cfs of the main channel flow. Any future increases in flow will be staged over a minimum of 5 years to allow for riparian re-establishment and prevention of excessive erosion. The degree of diverted flows will depend upon channel readiness. Increased stream length, decreased gradient (hence decreased stream power), and increased fisheries habitat are anticipated. However, if major reconstruction of the existing or proposed channel is required to enable this diversion to operate, the proposal may not be adopted. The desire is to open the channel entrance and let flow create the* *habitat.* Both advocate eventual relocation from the present mainstem (near the left valley wall) to the former channel along the opposite valley wall.

In late 2000, we surveyed thalweg profiles down the present and former mainstem of Reach 3D to estimate the volume of excavated material needed to re-water the former channel (Figure 24). Today's mainstem channel is exhibiting limited signs of initial meandering, although the last few annual hydrographs have not exceeded threshold flows necessary to continue this trend. In the November 2000 meeting in Sacramento, another restoration option for Reach 3D was considered: keep the channel where it is and monitor whether the annual hydrograph could increase channel sinuosity and improve pool depths. Limited flows still could be diverted into the former mainstem channel (i.e., toward the south valley wall) to stimulate woody riparian vegetation. But a wholesale channel reconstruction may not be necessary. The November meeting ended with the goal of exploring all options. We are scheduled to revisit the 3D Channel in early May, and again in June if necessary, to quantify all potential reconstruction options. A brief report on these options will be distributed to concerned parties. The field trip proposed for examining multiple side channels will double as a site inspection of the 3D Channel. Depending on the outcome, and approval by SWRCB, the actual construction (if necessary) could still be completed before winter or, if the recommendation requires reconstruction of the former mainstem, may have to wait until next year.

5. PROPOSED REVEGETATION ON RUSH CREEK BELOW NARROWS

Jeffery pine plantings have been proposed for an area along Rush Creek just downstream of the Narrows (Figure 25). Portions of the proposed site may not be suitable for planting. The geomorphic unit mapping indicates that most of the proposed area is middle to higher terrace, with only a small area closer to the creek low terrace (Figure 26). Minor or no flooding, shallow groundwater tables, and sandy substrates have previously been identified as site characteristics leading to successful Jeffrey pine plantings. Much of the proposed site is significantly higher than the streambed, consists of coarse substrate, and is densely covered by sagebrush. Other areas have finer, sandy substrates and is covered with rabbit brush. Areas farther from the channel, consisting of sand, are the most suitable sites for Jeffery pine plantings.

5.1. Pilot project

Since restoration efforts began in the early 1990's, past revegetation efforts have focused on lodgepole pine, Jeffery pine, and black cottonwood. Planting success has been previously quantified in terms of survival/mortality only. This pilot project proposes to (1) plant multiple species (Tables 7-8), (2) use new irrigation techniques, and (3) quantify and evaluate the physical factors that lead to successful plantings.

By increasing the complexity of the project there is a commensurate increase in effort. However, using small-scale revegetation (+4.0 acres) as a pilot would allow some flexibility to try new approaches without a big investment. Furthermore, by taking this approach, we could also broaden our understanding of the revegetation process and identify the factors that lead to successful, cost-effective planting along the Eastern Sierra.

During the early summer of 2001 we will dig several test pits at the proposed planting area to assess site suitability. Test pits will be dug to the ground water elevation, and soil stratigraphy will be qualitatively described. Before the test pits are backfilled, piezometers (groundwater monitoring devices) should be installed in the test pits to document pre-revegetation groundwater conditions and post revegetation conditions. Groundwater proximity to the ground surface is a valuable tool for determining the suitability of the site for plantingbecause sites with shallow groundwater tables require less irrigation and increase revegetation success.

5.2. Patch type and locations

Two patch types are proposed for planting in this pilot project: Jeffery pine and black cottonwood patch types. Both patch types include species common to the Rush Creek riparian corridor and which have been planted in other areas of the riparian corridor successfully, but are still primarily planted with Jeffery pine or cottonwood (Tables 7 and 8). This revegetation approach increases riparian corridor vegetation by planting stand types found within the contemporary and pre-diversion corridor and results in a more diverse stand structure sooner. Only one age class will be planted however, herbaceous and woody plants will eventually colonize these surfaces because the maturing plantings will raise the groundwater, modify the microclimate, deliver leaf litter, and provide a seed source. Eventually when the stream migrates across this surface, mature Jeffery and lodge pole pine would enter the stream providing a volume of wood currently unavailable in this reach.

A black cottonwood patch type is proposed for the area next to the creek (see plate titled "Mono Basin Rush Creek revegetation"). This black cottonwood planting would increase riparian stand continuity and structural diversity by filling in the sagebrush dominated "gaps" between mixed willow patches. A tree-dominated stand type adjacent to the mixed willow stands will increase canopy structural diversity considerably. The close proximity to the channel and a shallow groundwater table in these areas indicate a high potential for success.

5.3. Implementation

Early spring plantings are optimal for this revegetation work. Hardwood cuttings can be made and stockpiled in late winter or fall and stored in a refrigerator until planting. Cuttings should be made just at the onset of dormancy, or when buds are swelling at the beginning of the growing season. Tree seedlings are usually available in late May and can be planted anytime during the growing season with irrigation.

There are some mechanistic aspects of the design to consider as well. The planting design must be simple enough to implement, and yet have a "random" pattern. I propose to use a triangular spacing pattern with each plant installed either 8 ft or 10 ft on center. If we have considerable flexibility with the folks (i.e., Mono Lake Committee or other volunteer groups) that do the plantings, then we can use different patterns. To determine the number of plants needed for this project, a triangular spacing pattern was assumed.

All the species proposed for revegetation at this site have been successfully planted at other sites in the Mono Basin. Hardwood cuttings and tree seedlings provided by the USDA Forest service nursery will be planted in holes dug by hand. Only the bareroot stock will require irrigation. Plant quantities required for this revegetation are listed in Tables 7 and 8.

5.4. Irrigation

There is also the consideration of irrigation. For plants that are installed using cuttings, no irrigation will be required because the cutting will be planted into the ground water table. For plants that are installed using nursery grown rooted stock, some form of irrigation will be required.

While traditional irrigation methods (e.g., drip, sprinkler, etc.) are not possible at these sites, there are potential solutions that could be implemented that would also make planting numerous species more feasible. Because this project is a pilot, more than one irrigation technique can be used, or multiple types applied to one plant. The remoteness of the site, proximity of the ground surface to the water table, and long term release of water to the plant rather than periodic watering are all points to consider when developing an irrigation system. One potential method is applying hydrated polymer crystals that retain water mixed into the backfill material when planting rooted stock; this method can be used in conjunction with other irrigation methods. Once the crystals are dry, however, they provide no water, but will rehydrate when water is applied. A potential water source is a product called Dri-water, made from water, cellulose, and aluminum sulfate. A quart container of Dri-water is inserted at the ground surface next to the plated tree time of planting and slowly releases water to the plant over 90 days. One, 1-quart Dri-water will supply enough water to a tree seedling for 90 days; two quarts per two year old seedling will be sufficient irrigation for the first year. A combination of hydrated polymers at the bottom of the hole and Dri-water at the top encourages roots to grow deeper the first year, potentially to the water table. No irrigation is proposed after the first year. Figure 25 illustrates the proposed planting scheme.

5.5. Monitoring

The goal is to revegetate where necessary, to improve riparian vegetation coverage and complexity on geomorphic surfaces that were covered with riparian vegetation but have been converted to rabbit brush or sagebrush. Monitoring will focus not only on the revegetation success, but also document how revegetation evolves into a multiage, structurally diverse and species-rich riparian forest.

To evaluate revegetation development, 5 meter radius circular plots will be established within each patch type planted, and band transects will be used (Bonham 1989, Kent and Coker 1992). Circular plots are randomly placed within a patch type using CAD software. Within each circular plot, plant species, each species estimated percent cover, maximum and average height, youngest, and oldest hardwood age, stem number (for hardwoods < 7.5 cm) and diameter at breast height and stem number (for plants > 7.5 cm) will be measured. Additionally, permanent 2 meter wide band transects will be sampled along valley wide cross sections established in alternate bar reaches during geomorphic sampling, and along three cross sections where piezometers are established (Figure 25). Plant species, estimated plant species cover, hardwood age class, average and maximum canopy height, substrate transitions, and soil moisture will be quantified during band transect sampling.

A cost estimate has not been developed for this project because several factors are uncertain (e.g.,irrigation, who will implement the project, extent of monitoring etc.). However this next season we will be working closely with LADWP to develop a comprehensive cost estimate so the project may be implemented in late spring of 2002.

6. ANTICIPATED MONITORING ACTIVITIES DURING RUNOFF YEAR 2001 - 2002

The following activities are referenced by fiscal year, as presented in our Scope of Work. FY 2002 begins July 1, 2001 and ends June 30, 2002.

Task A. Aerial Photography and Orthorectification are being managed by LADWP staff and contractors.

Task B. Channelbed Monitoring and Planmapping in Rush, Lee Vining, Parker, and Walker study sites will continue in Runoff Year 2001 - 2002. The spring snowmelt runoff is not anticipated to be large, likely in the range of flows observed the past two years. However, documenting subtle changes in geomorphic conditions are central to our monitoring activities. We will survey the Rush Creek 4C thalweg, and potentially other reaches that manifest dynamic thalweg changes, including reaches in Lee Vining Creek with migrating headcuts.

Task C. Synoptic Streamflow Gaging. Development of stage-discharge rating curves for Rush Creek in the Runoff Year 2000 report indicated that changes in cross section morphology are slowly shifting rating curve relationships. We will continue to measure streamflows in primary and secondary channels to document streamflow allocations. Additionally, we will attempt to measure spring snowmelt peaks in the field to better evaluate flow proportions during spring peaks.

Task D. Lower Rush Creek gaging station. We will continue to collect data from the WaterLevel Logger, and measure streamflow to develop a rating curve for this station in cooperation with LADWP staff. Upon evaluation of the quality of data at this site, we will proceed with developing plans and a budget for constructing a real-time gaging station in lower Rush Creek. Construction could proceed this year.

Task E. Riparian Monitoring and Assessment. Task E-1 (species composition and relative abundances on geomorphic surfaces, and Task E-2 (quantify age and size-class distributions for riparian tree communities) will be completed in Runoff Year 2001 - 2002. Task E-3 may be initiated, depending on staff time availability. The Task E-4 budget will be applied to purchase equipment and develop a study plan, then follow with implementation.

The Rush Creek bottomlands do not have the younger age classes of cottonwoods characteristic of lower Lee Vining Creek. Although our results are preliminary, a two-week lag between the earlier snowmelt floods of Lee Vining Creek relative to Rush Creek's snowmelt floods may be eliminating successful black cottonwood recruitment in the Rush Creek bottomlands. We will: (1) evaluate the phenology of black cottonwood (timing of each life history stage) for both streams, (2) investigate potential limiting factors (e.g., cottonwood demographics, seed and nursery site availability), and (3) apply a model similar to the Mahoney and Rood (1998) recruitment box to assess interrelationships of flow timing and stream channel hydraulic geometry.

Task F. Channel Construction Projects. As elaborated above, we will prepare a technical memorandum for distribution during mid-summer describing alternative restoration strategies for the Rush Creek 3D Channel above the Narrows. We will then proceed with development of detailed implementation plan.

Task G. Stream Channel Dynamics. We will continue channelbed mobility, floodplain deposition, and scour experiments at all monitoring stations.

Task H. Annual Report. Activities will include preparation of an annual report, with DRAFT copy completed by March 01, 2002.

Task I. Meetings and Environmental Review. This activity will continue according to planned meetings.

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FIGURES

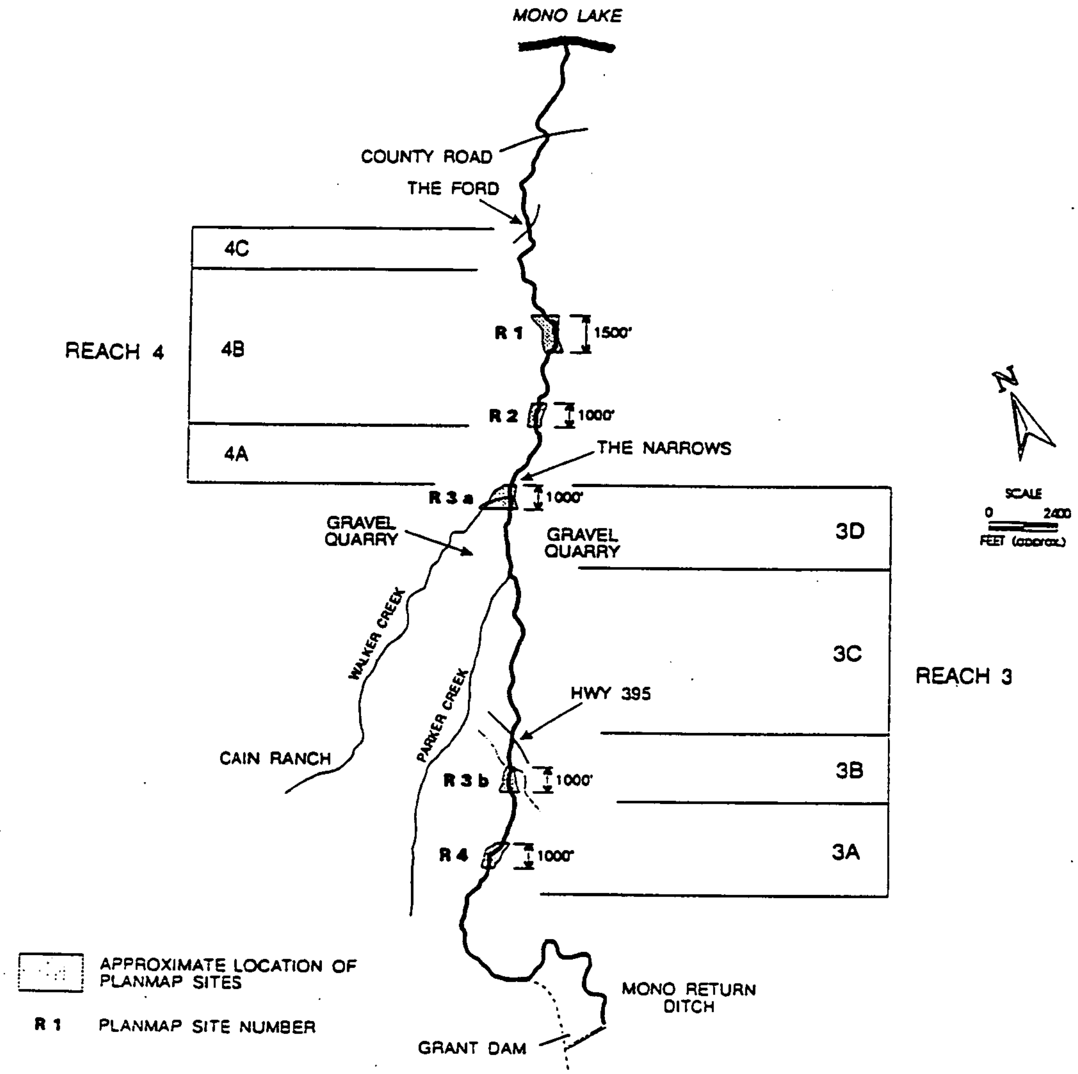


Figure 1. Rush Creek below Grant Lake, reach delineation and approximate planmap site locations.

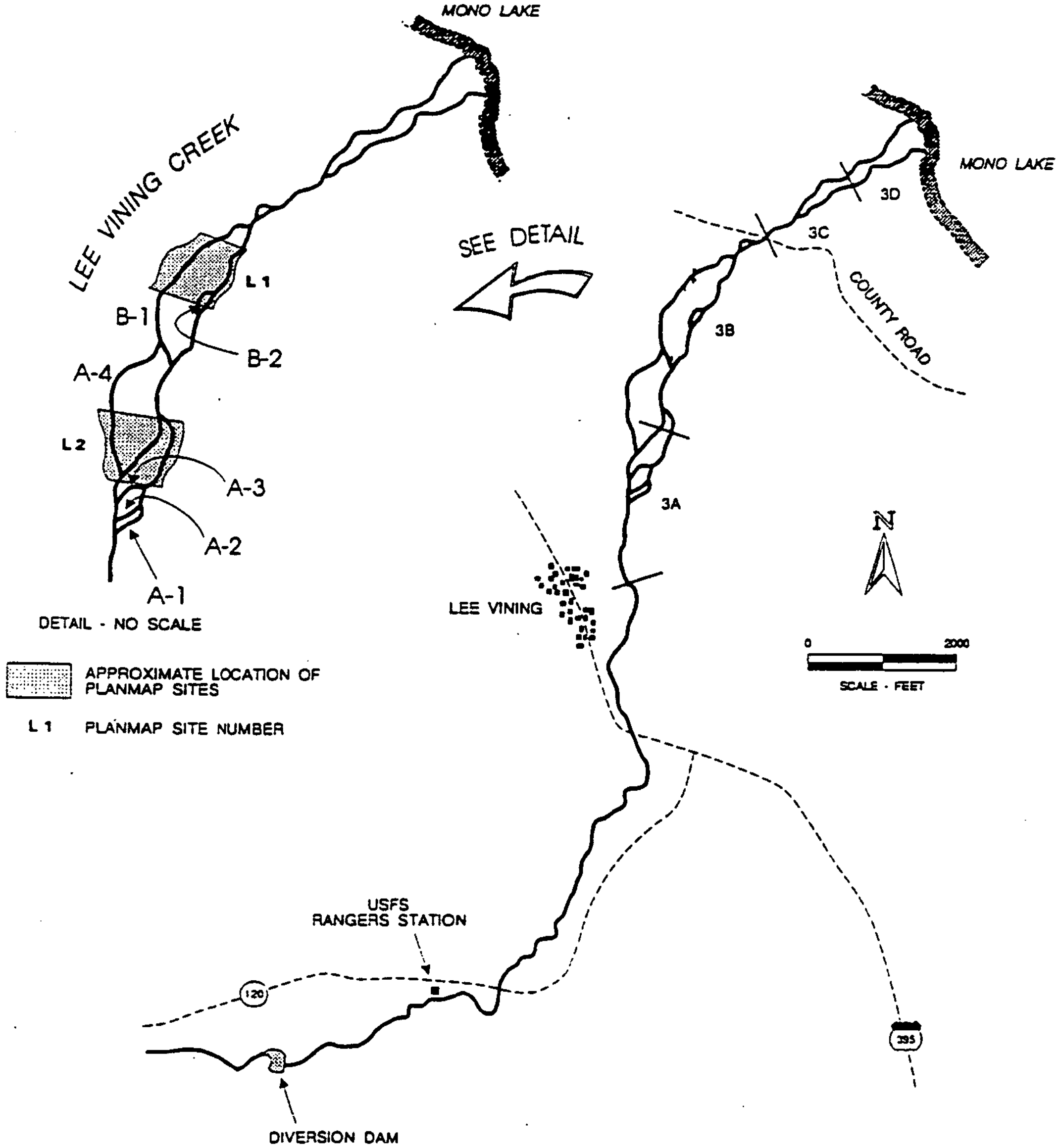


Figure 2. Lee Vining Creek below intake, reach delineation and approximate planmap site locations.

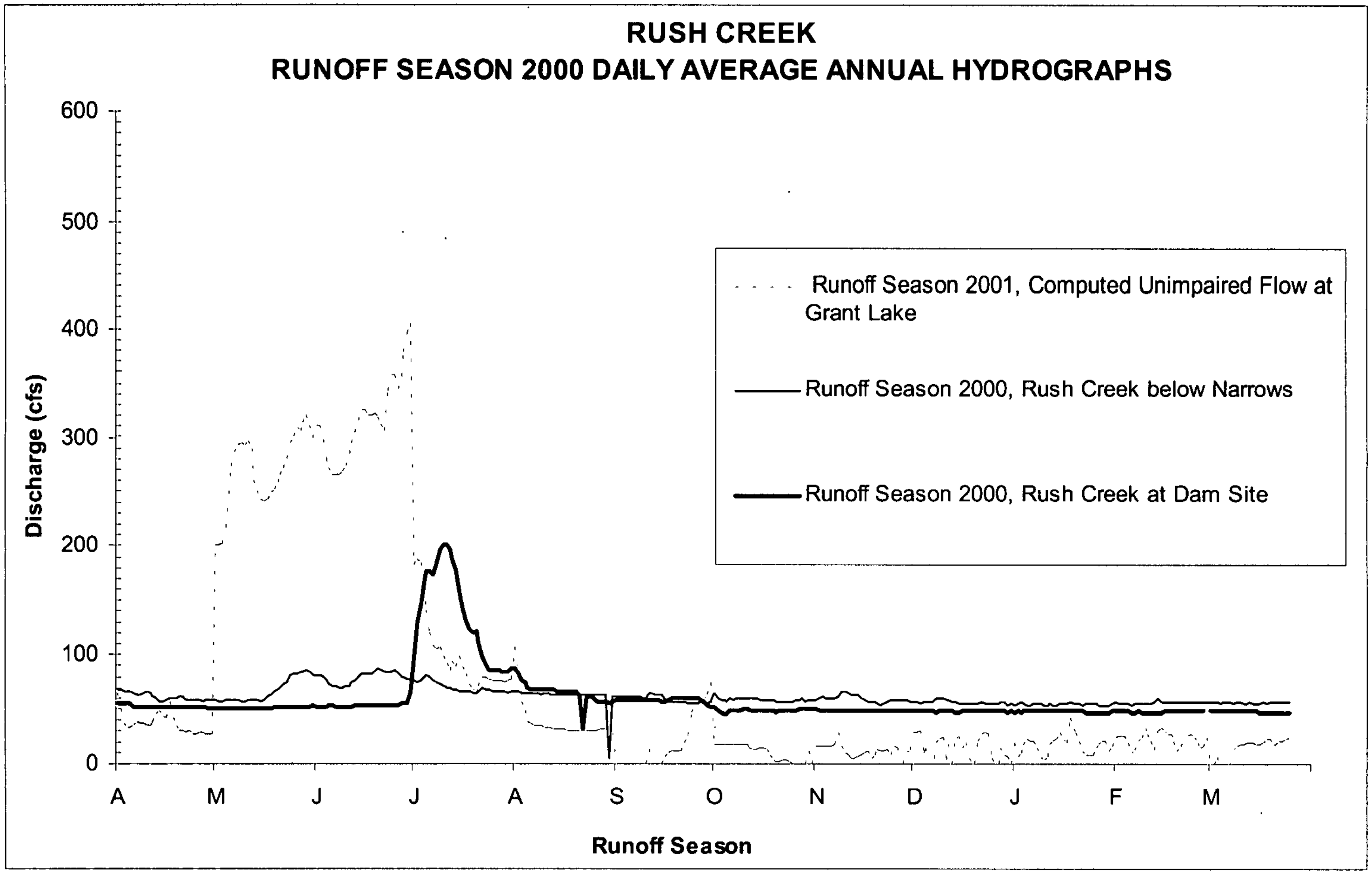


Figure 3. Runoff season 2000 daily average annual hydrograph for Rush Creek.

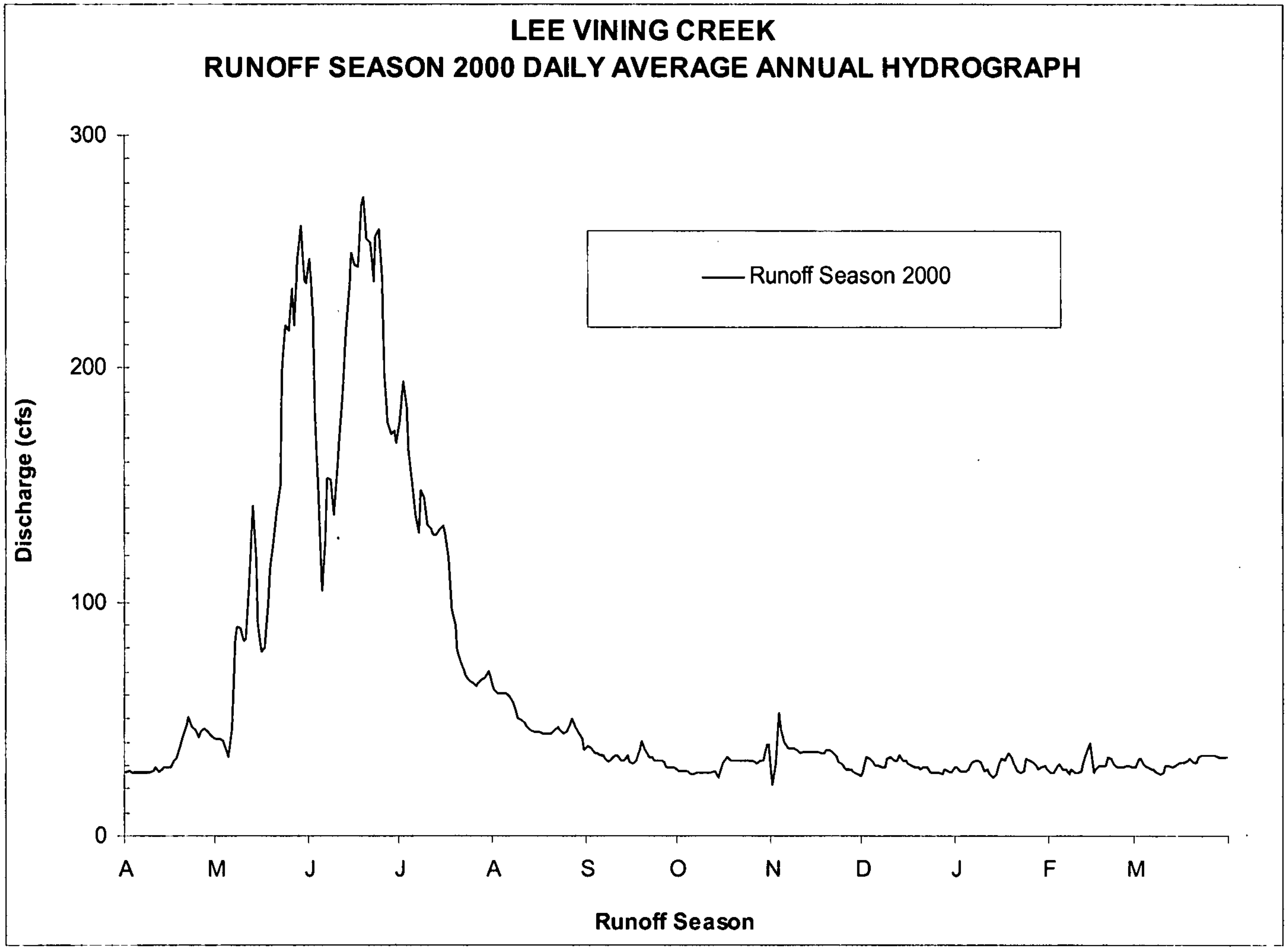


Figure 4. Runoff season 2000 daily average annual hydrograph for Lee Vining Creek.

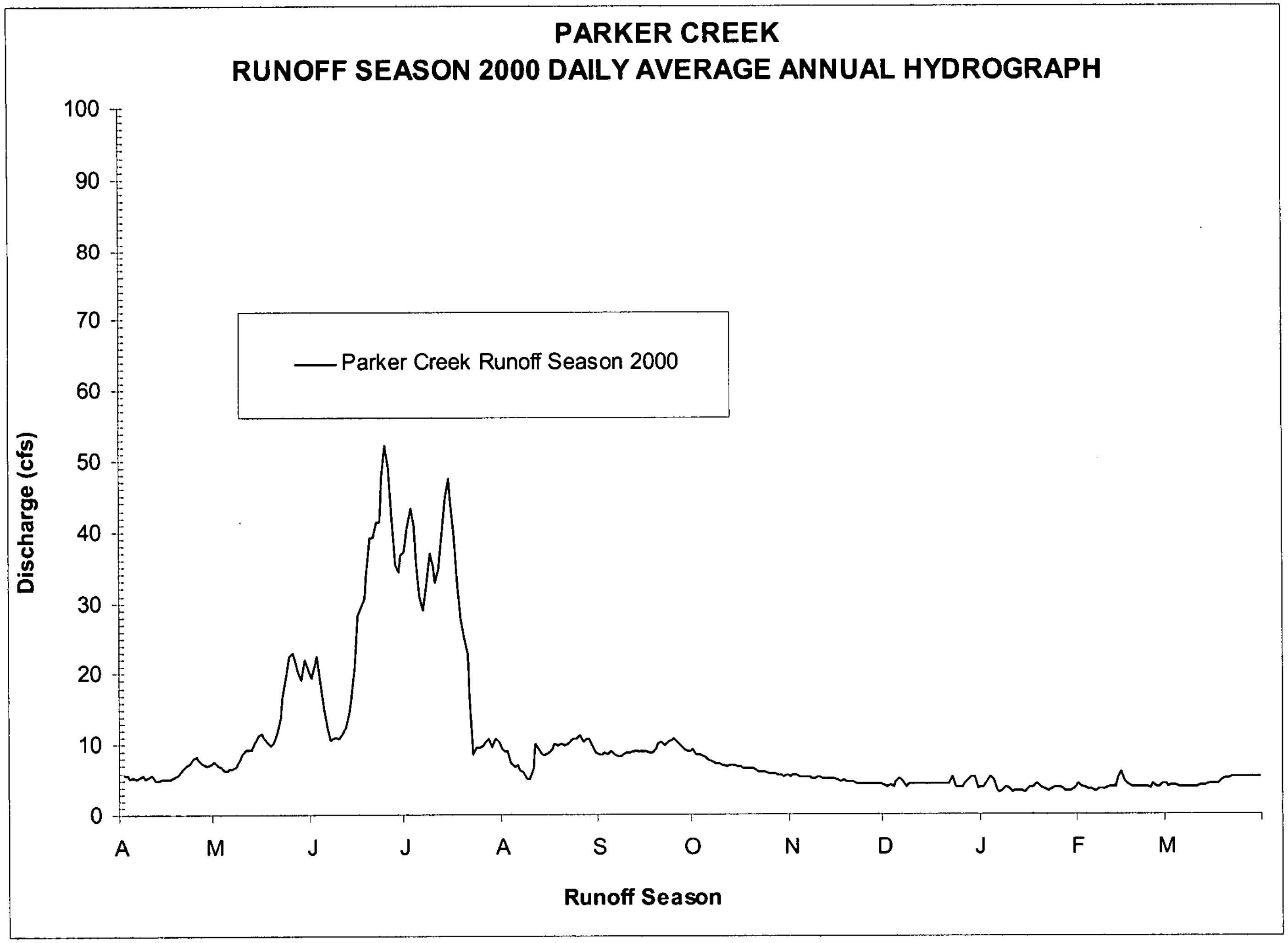


Figure 5. Runoff season 2000 daily average annual hydrograph for Parker Creek.

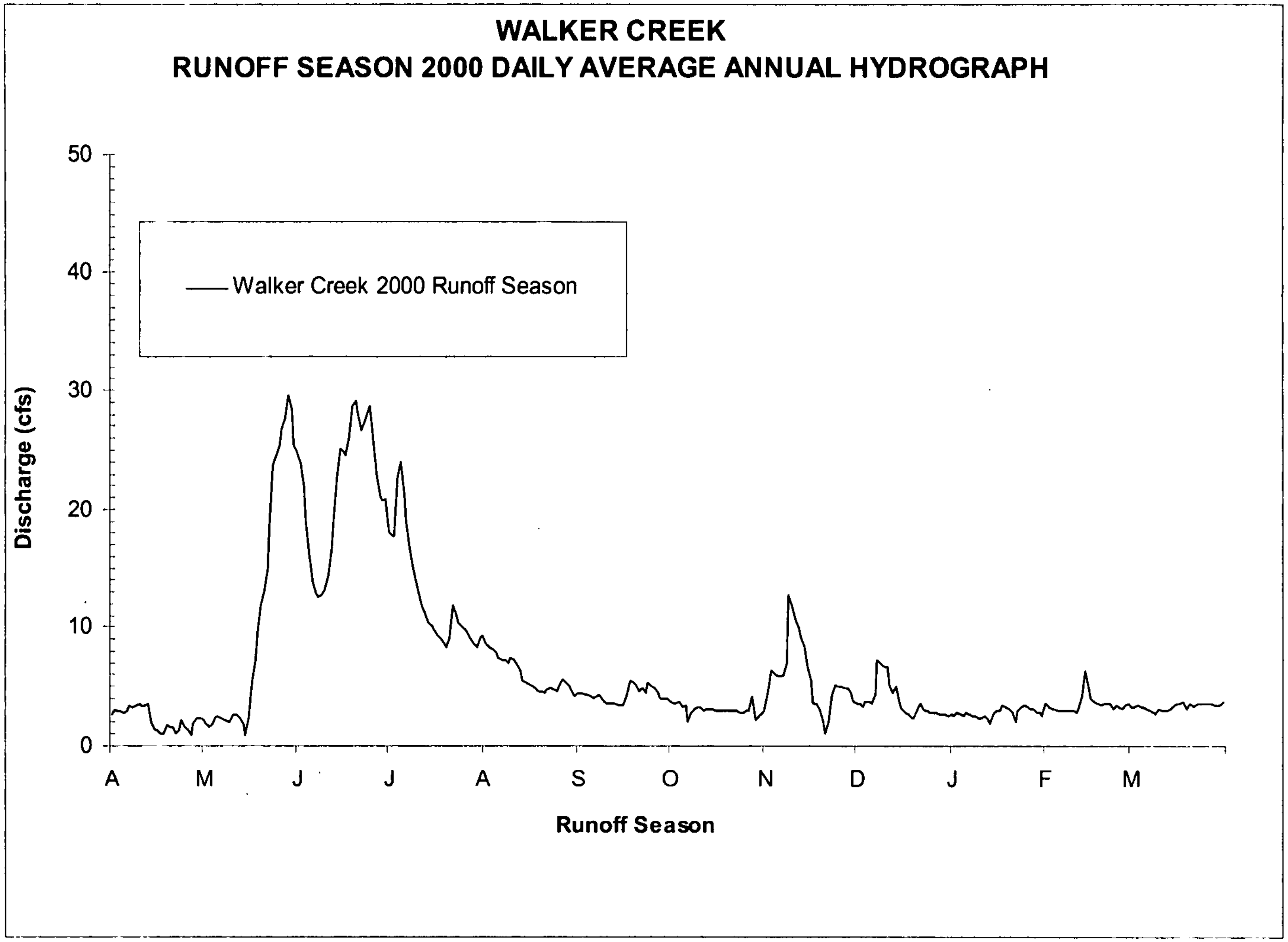


Figure 6. Runoff season 2000 daily average annual hydrograph for Walker Creek.

Figure 7. Rush Creek gaging station installation at the County Road culvert.

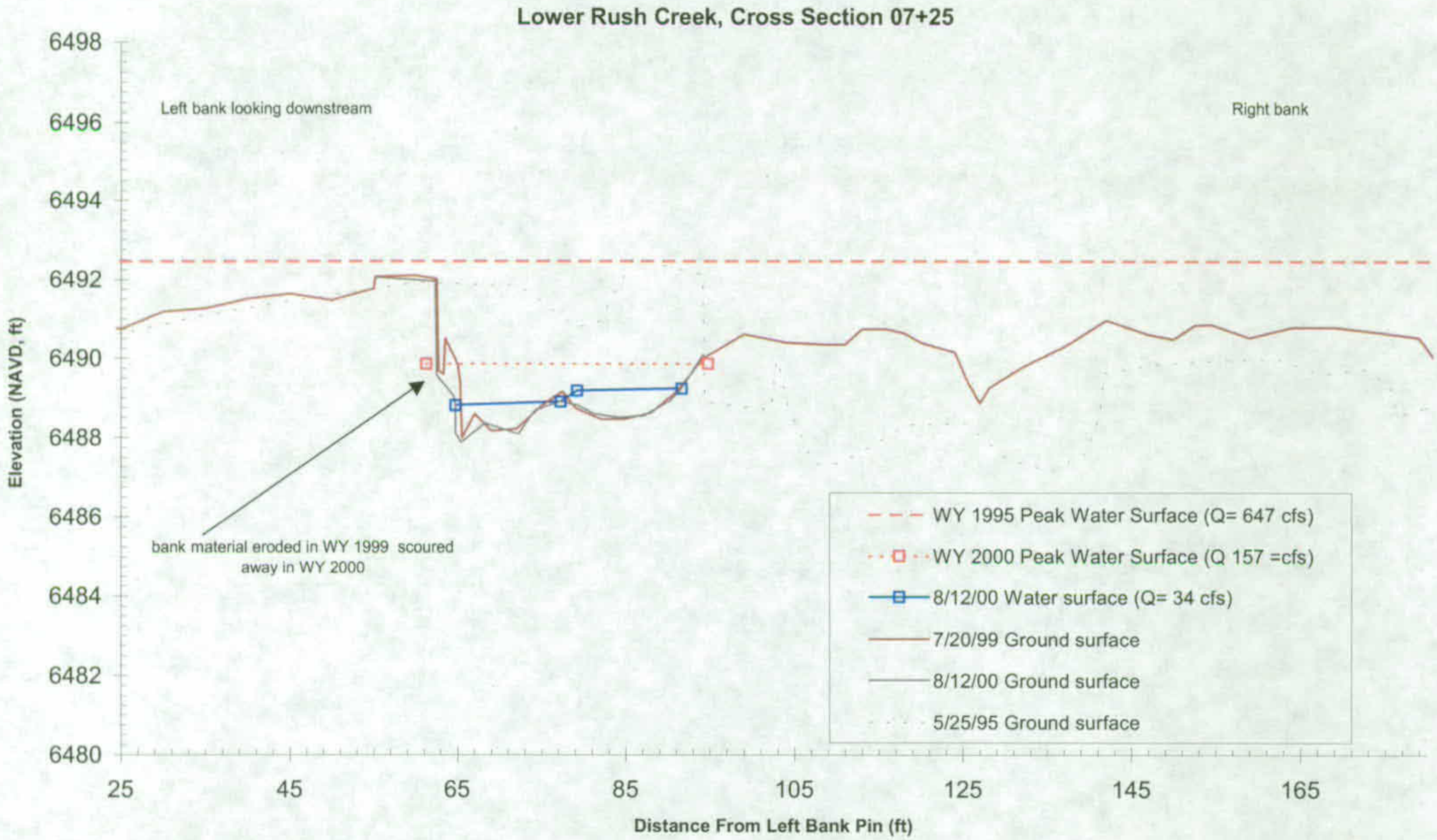


Figure 8. Lower Rush Creek Site XS 07+25.

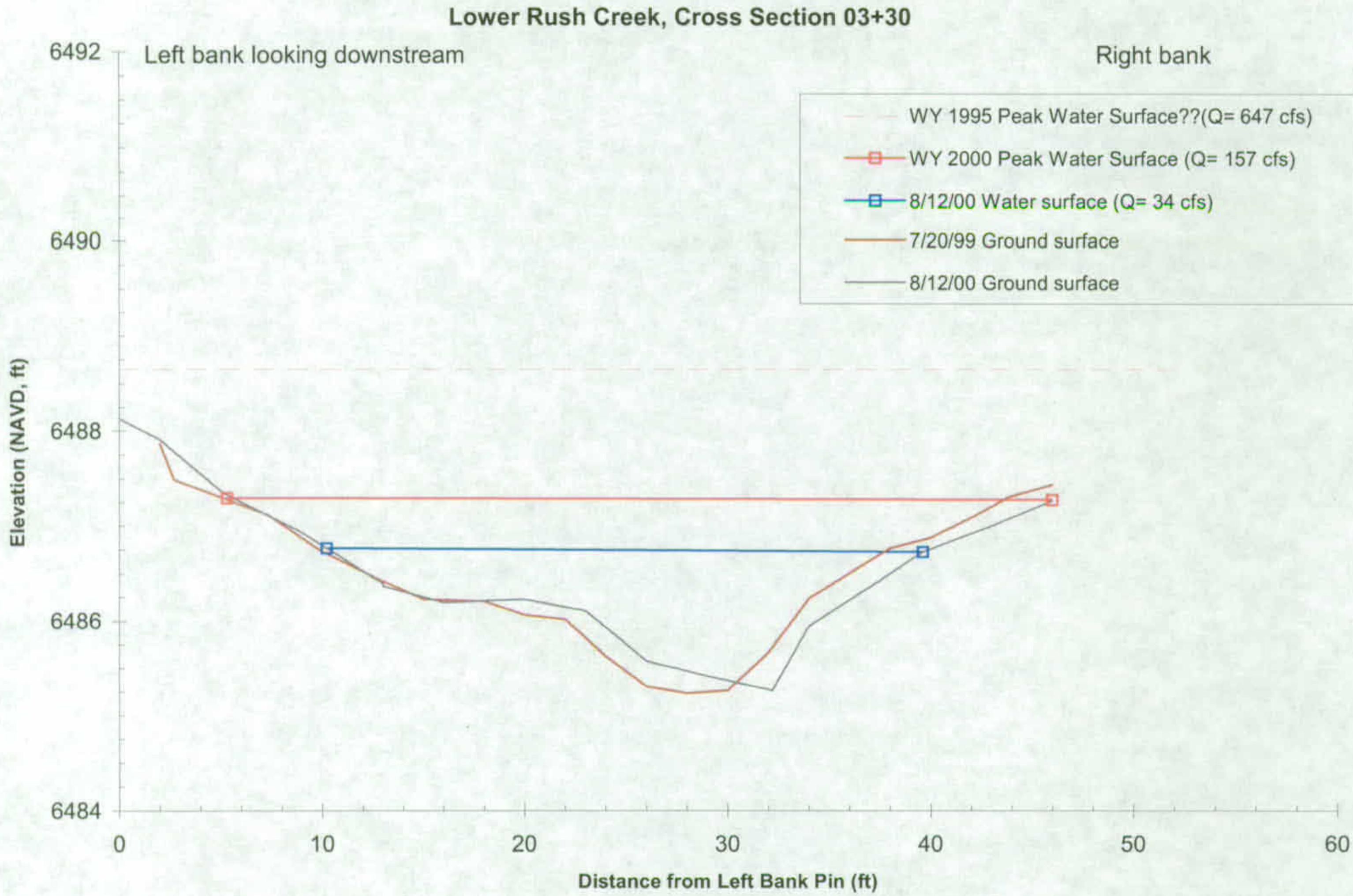


Figure 9. Lower Rush Creek Site XS 03+30.

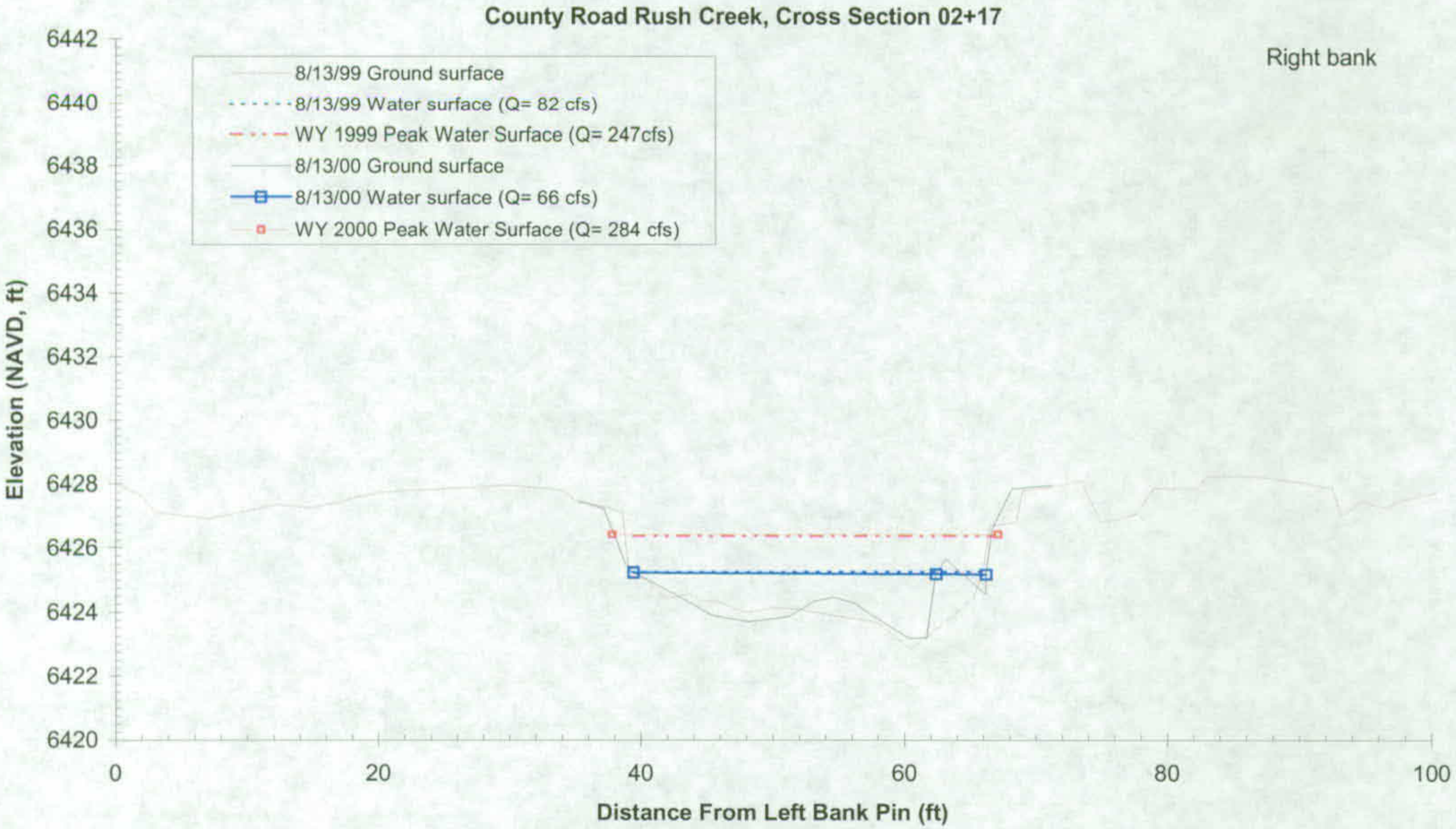


Figure 10. Rush Creek County Road Site XS 02+17.

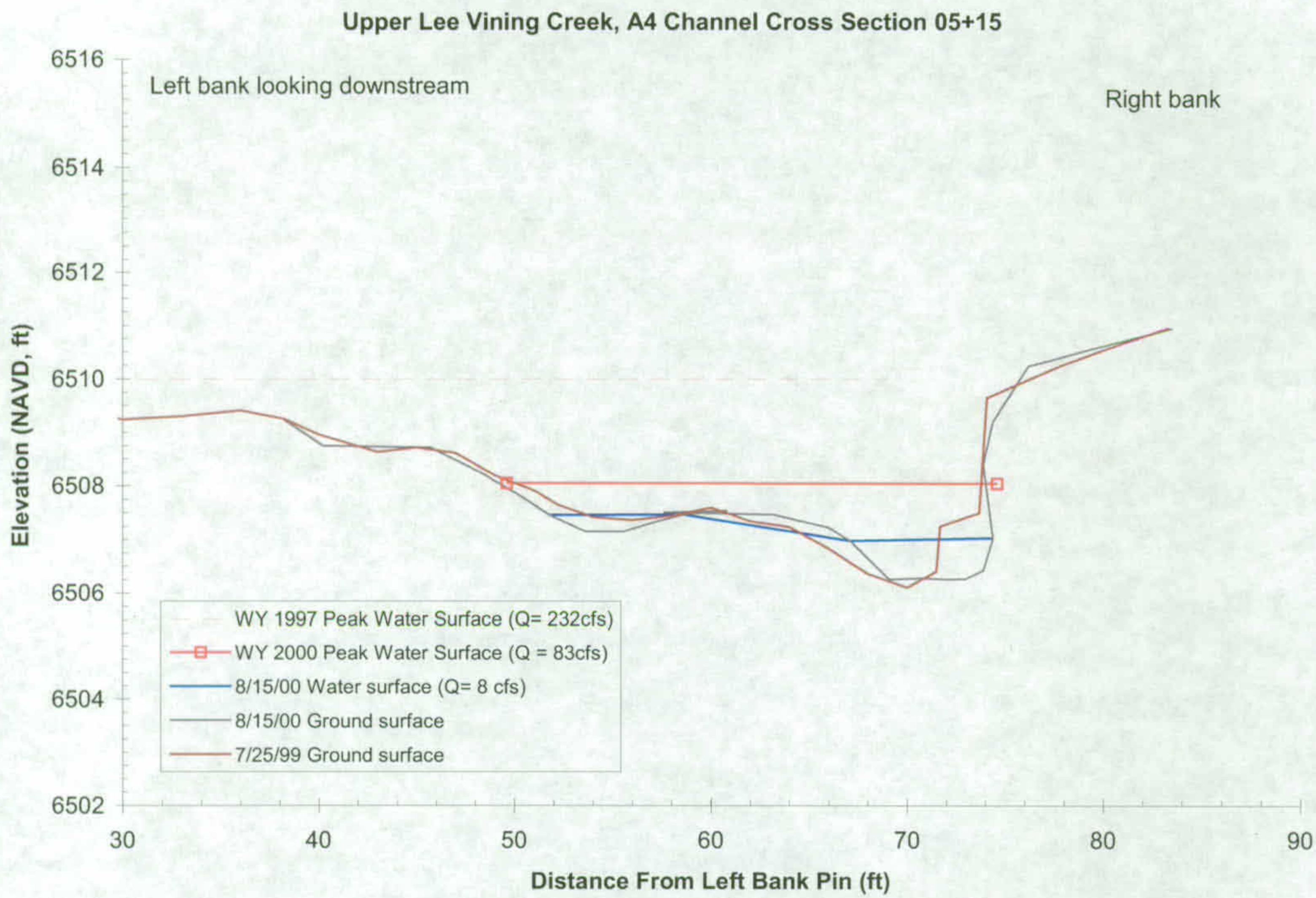


Figure 11. Upper Lee Vining Creek A-4 Site XS 05+15.

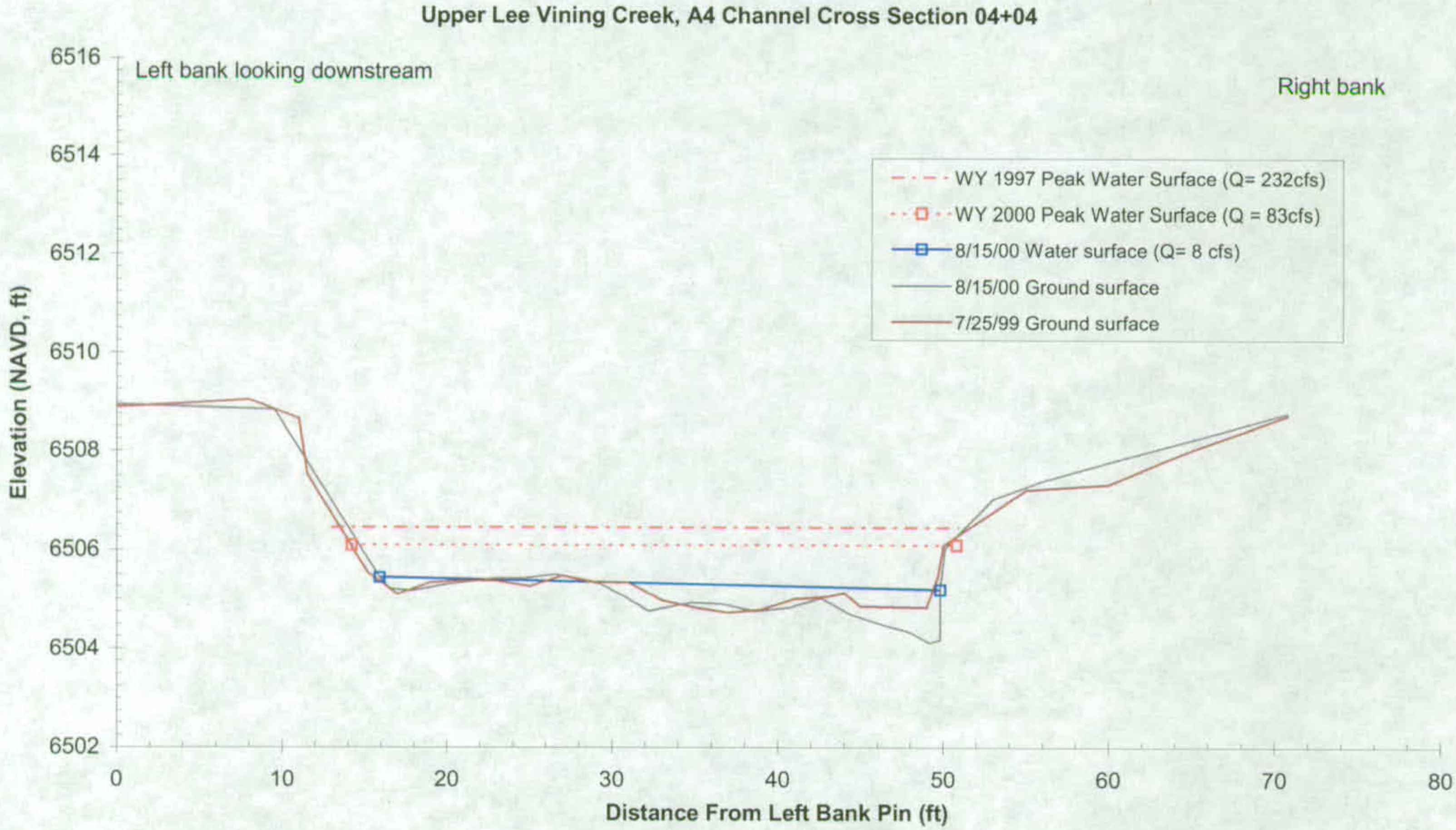


Figure 12. Upper Lee Vining Creek A-4 Site XS 04+04.

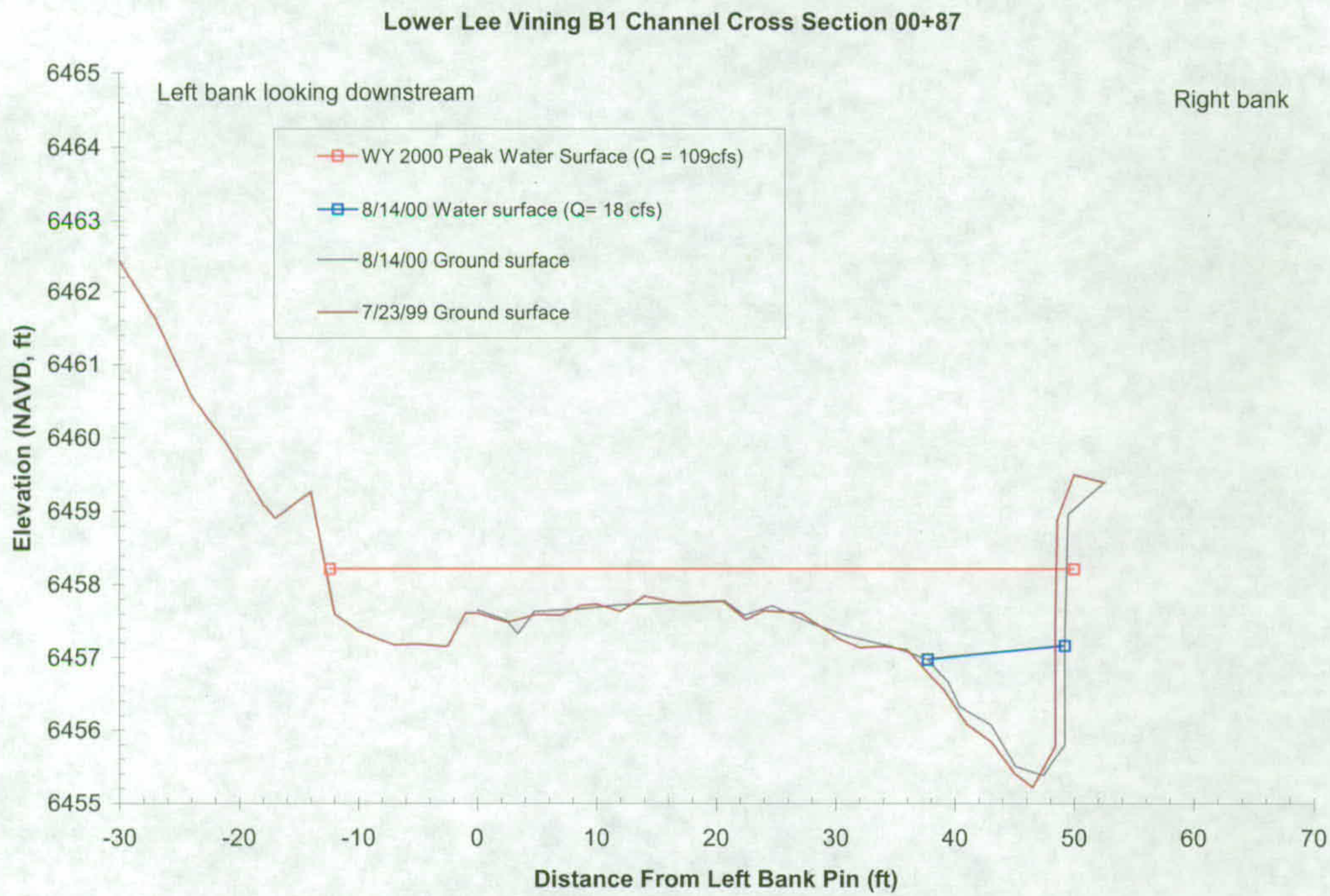


Figure 13. Lower Lee Vining Creek B-1 Site XS 00+87.

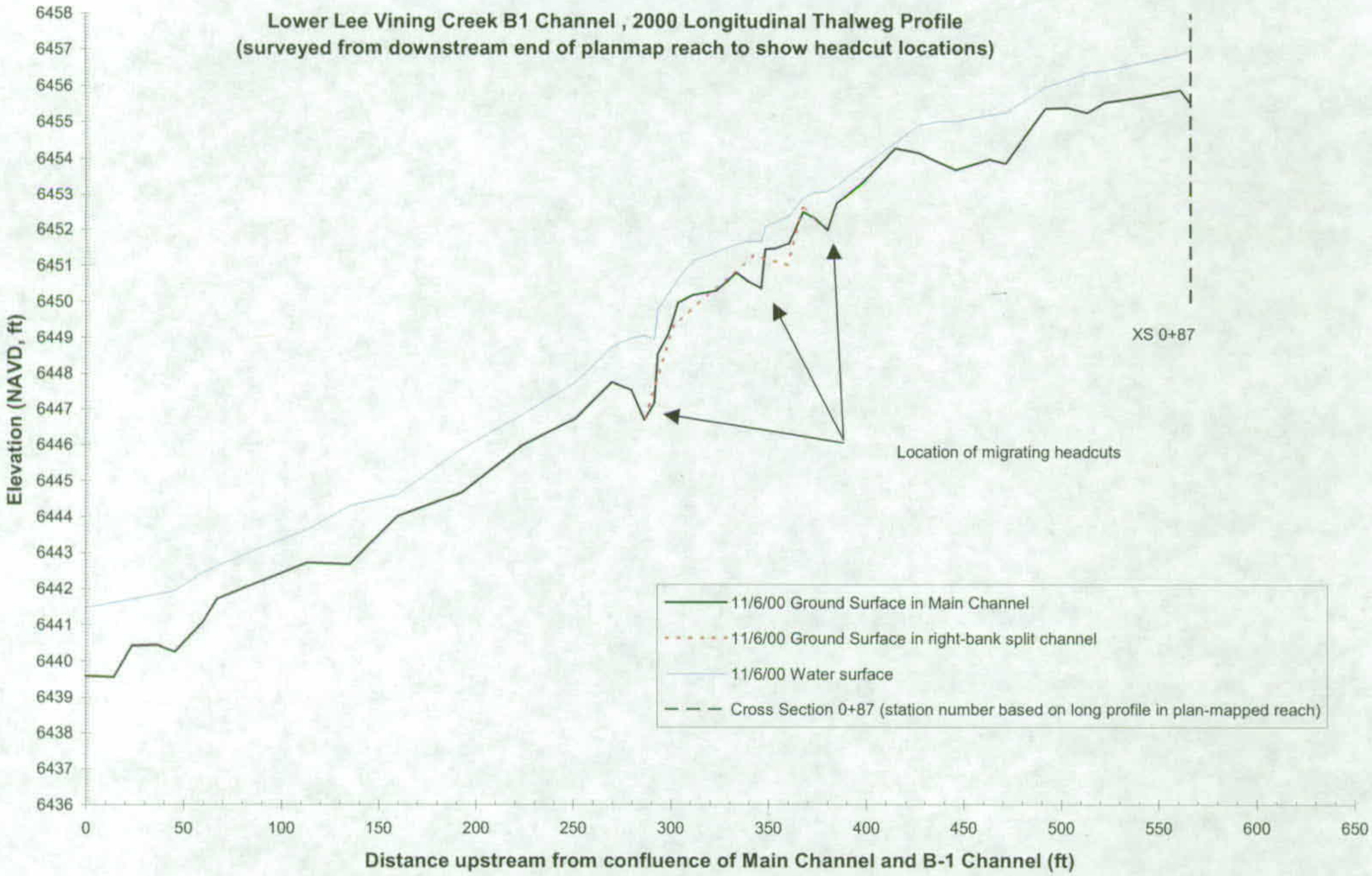


Figure 14. Lower Lee Vining Creek B-1 Channel thalweg survey of headcuts.

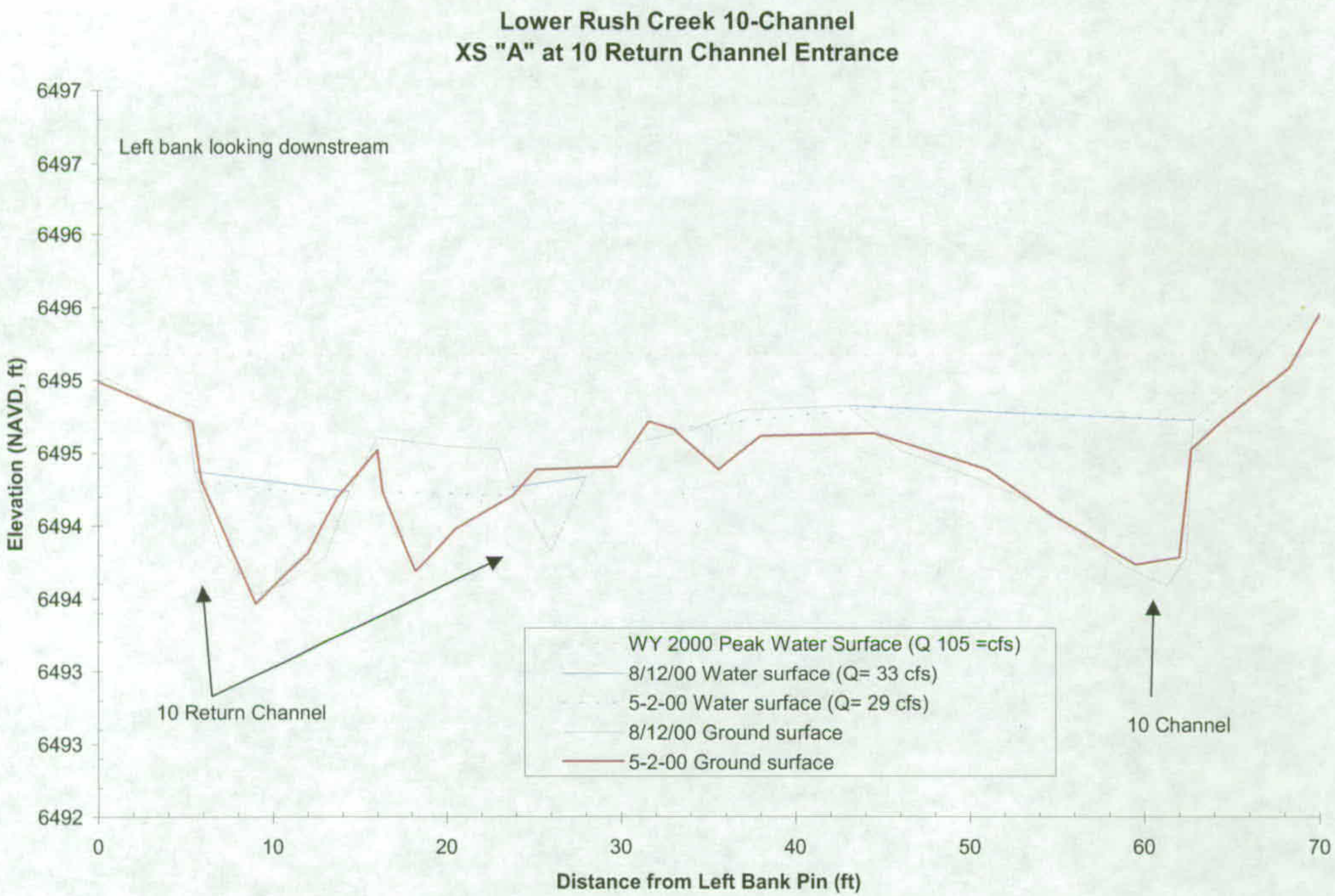


Figure 15. Lower Rush Creek 10-Channel XS A.

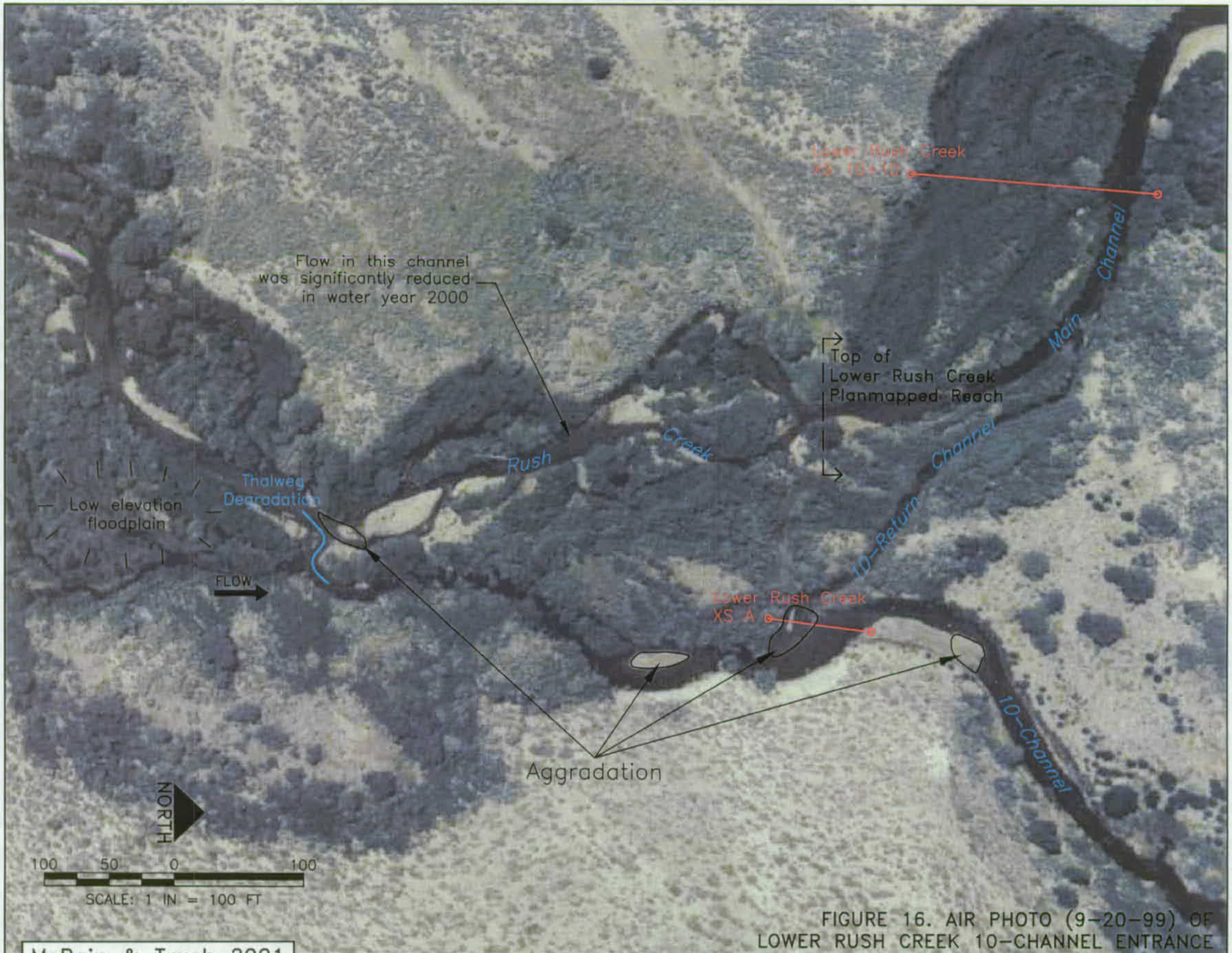


FIGURE 16. AIR PHOTO (9-20-99) OF
LOWER RUSH CREEK 10-CHANNEL ENTRANCE

McBain & Trush 2001

3/23/01

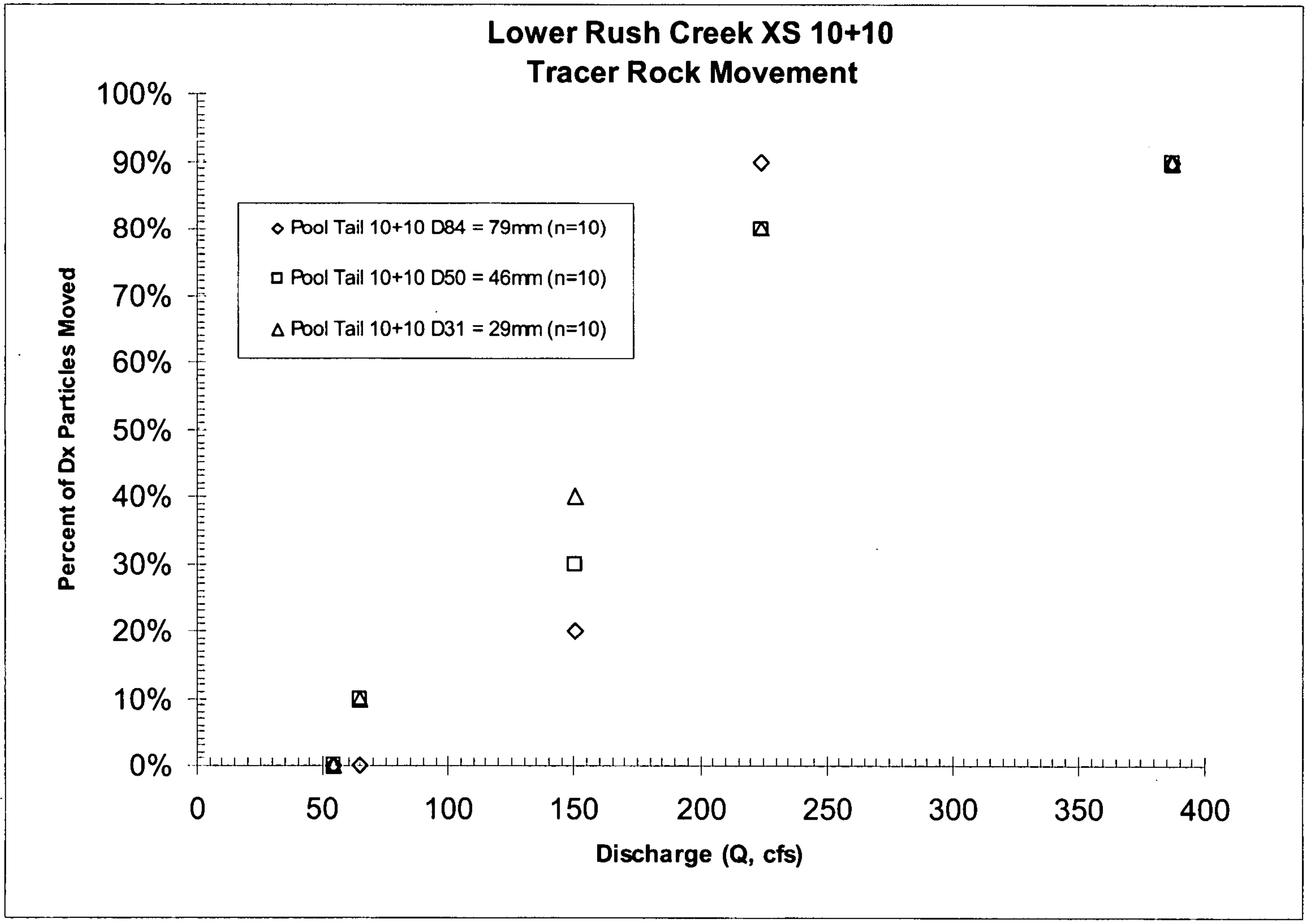


Figure 17. Tracer rock measurements at Lower Rush Creek XS 10+10.

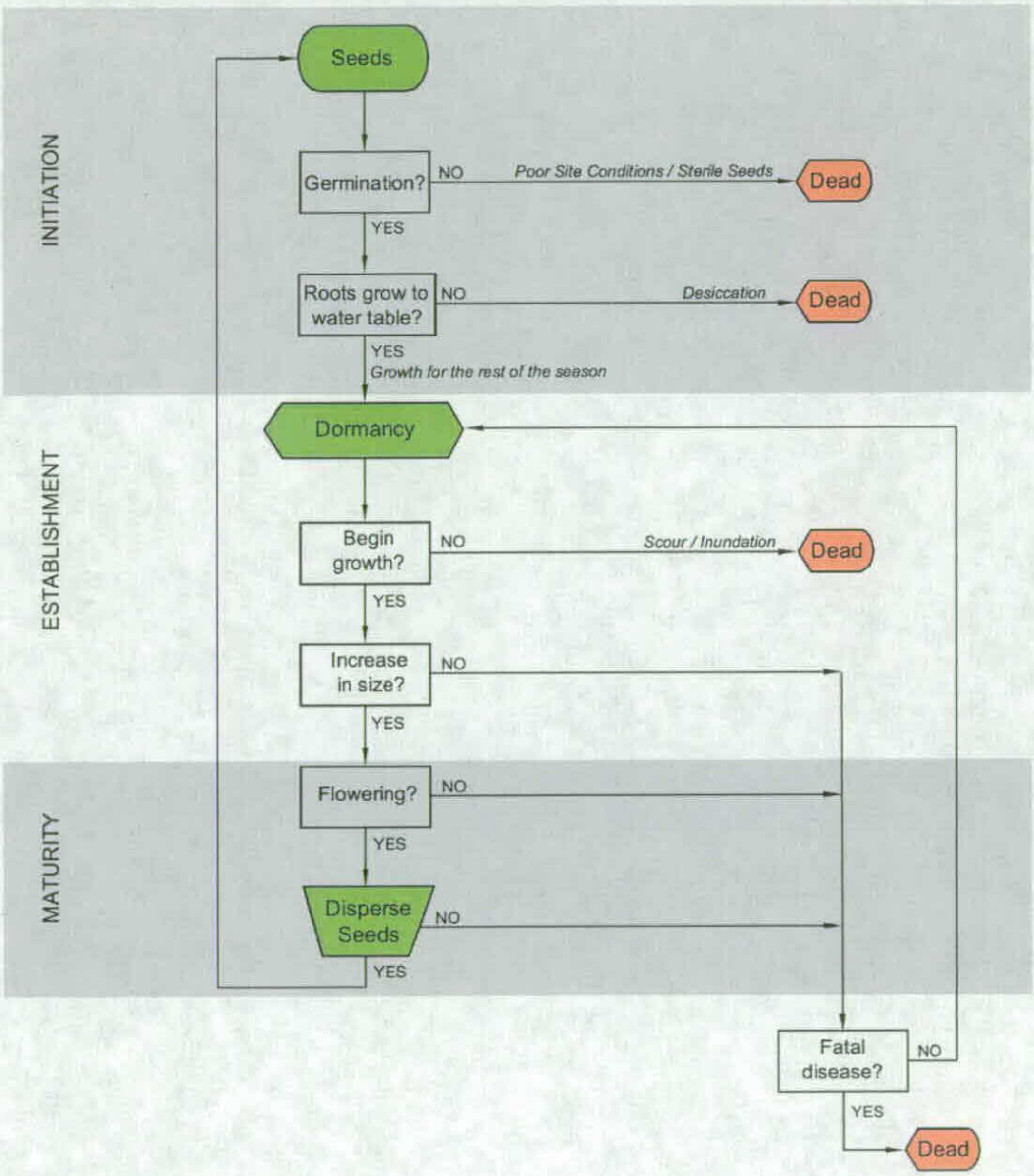


Figure 18. Riparian hardwood species life cycle.

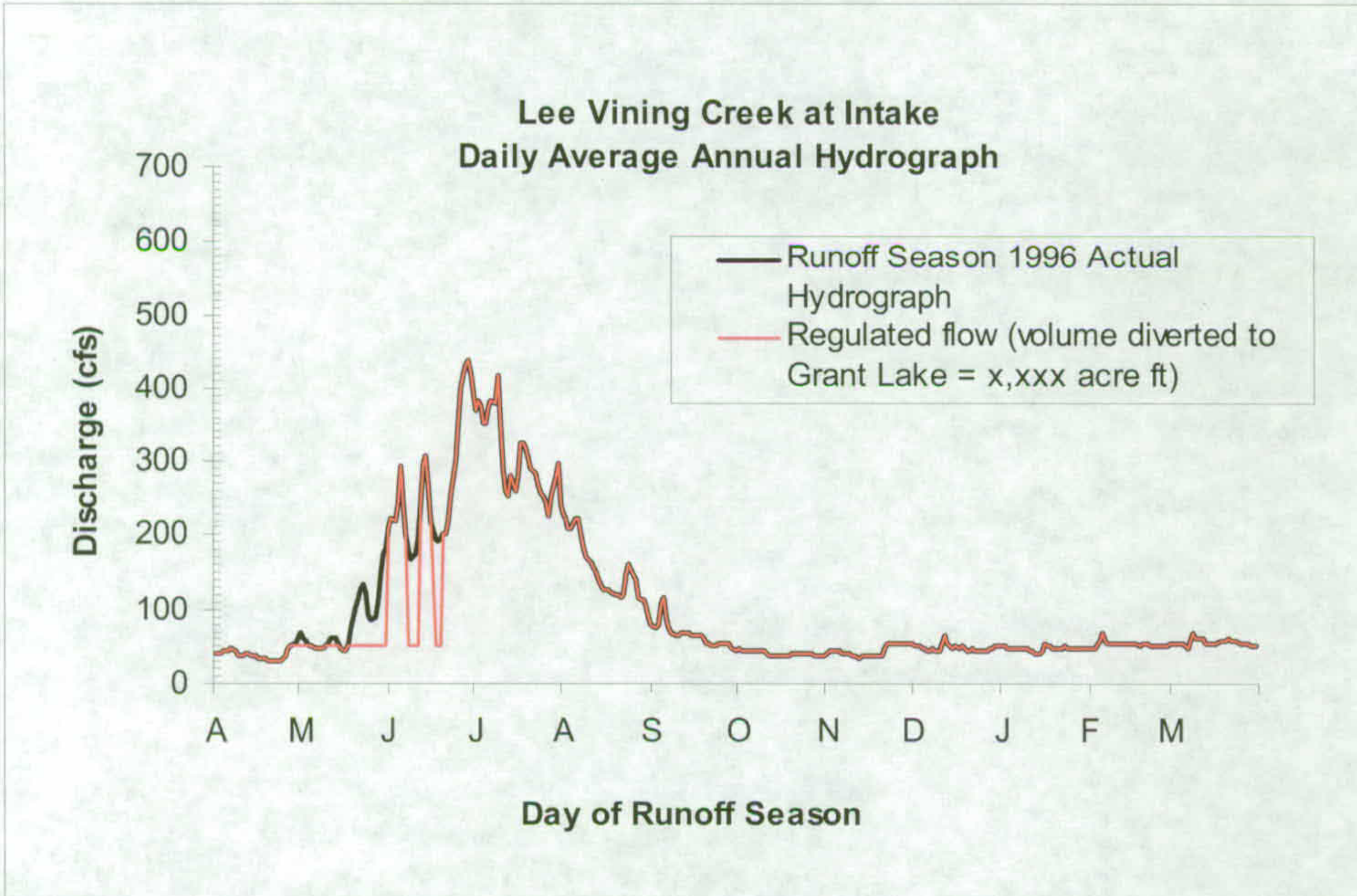


Figure 19. Runoff Season 1996 hypothetical diversion from Lee Vining Creek spring snowmelt hydrograph to augment Rush Creek peak flows.

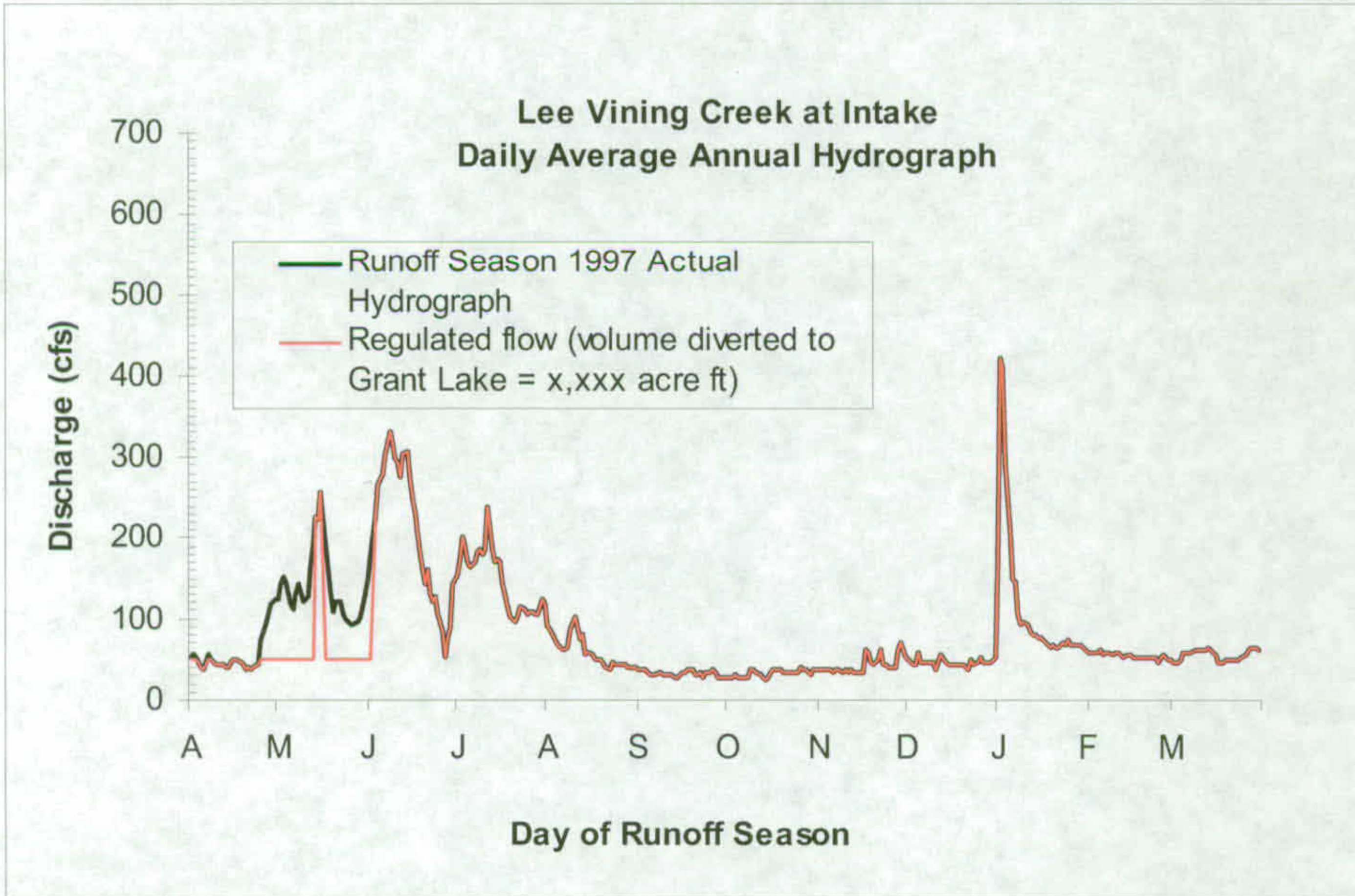


Figure 20. Runoff Season 1997 hypothetical diversion from Lee Vining Creek spring snowmelt hydrograph to augment Rush Creek peak flows.

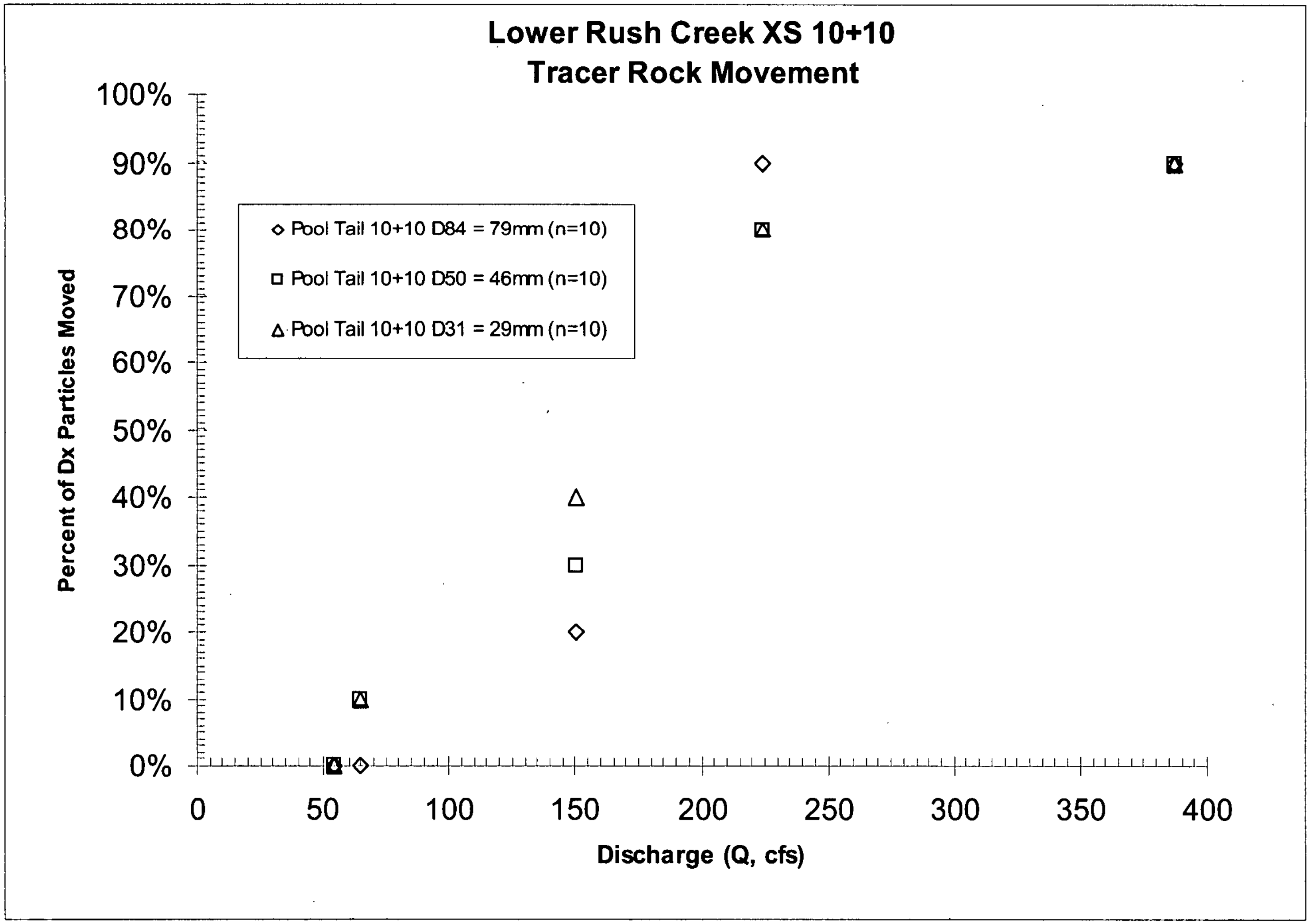


Figure 17. Tracer rock measurements at Lower Rush Creek XS 10+10.

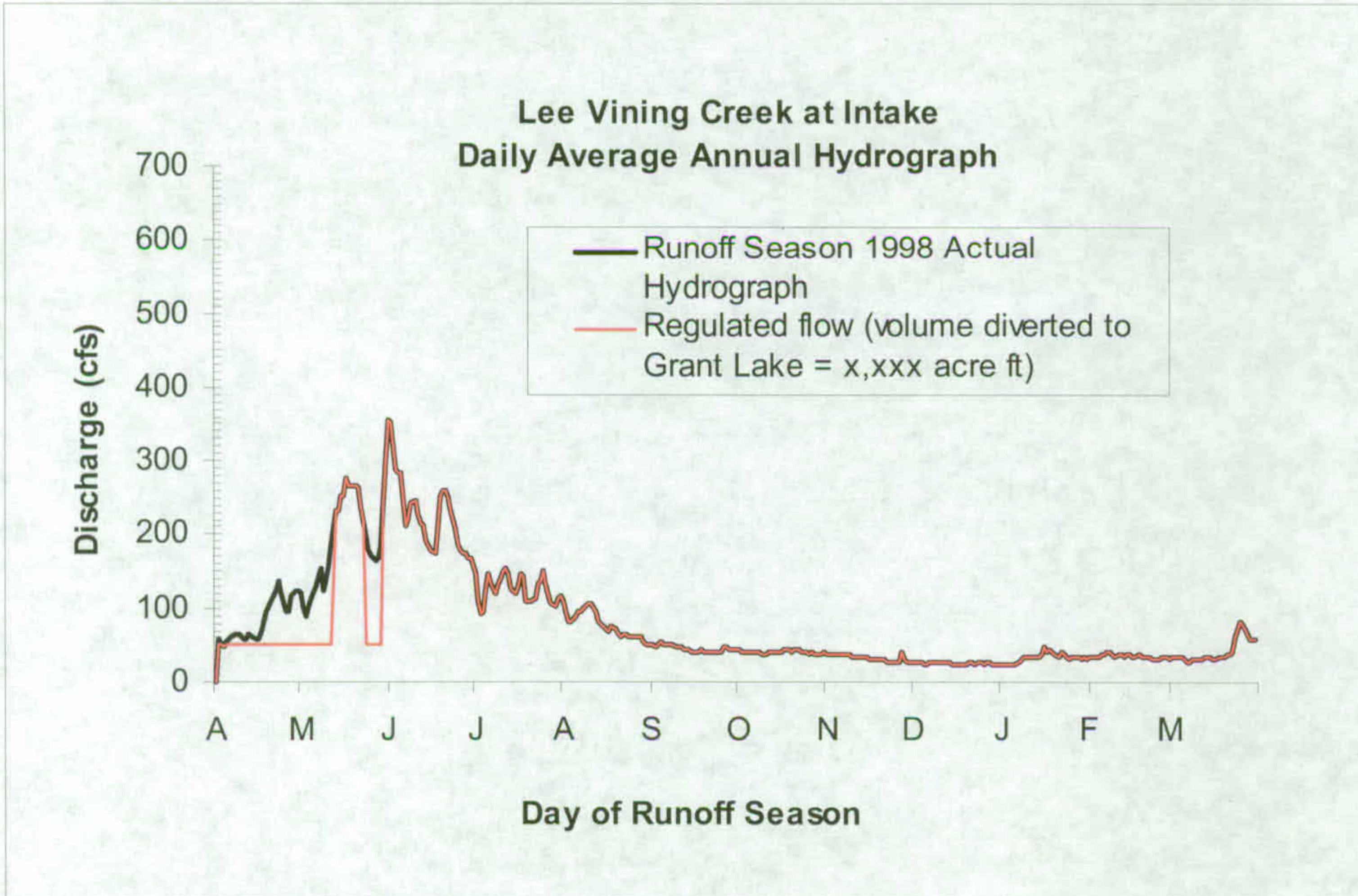


Figure 21. Runoff Season 1998 hypothetical diversion from Lee Vining Creek spring snowmelt hydrograph to augment Rush Creek peak flows.

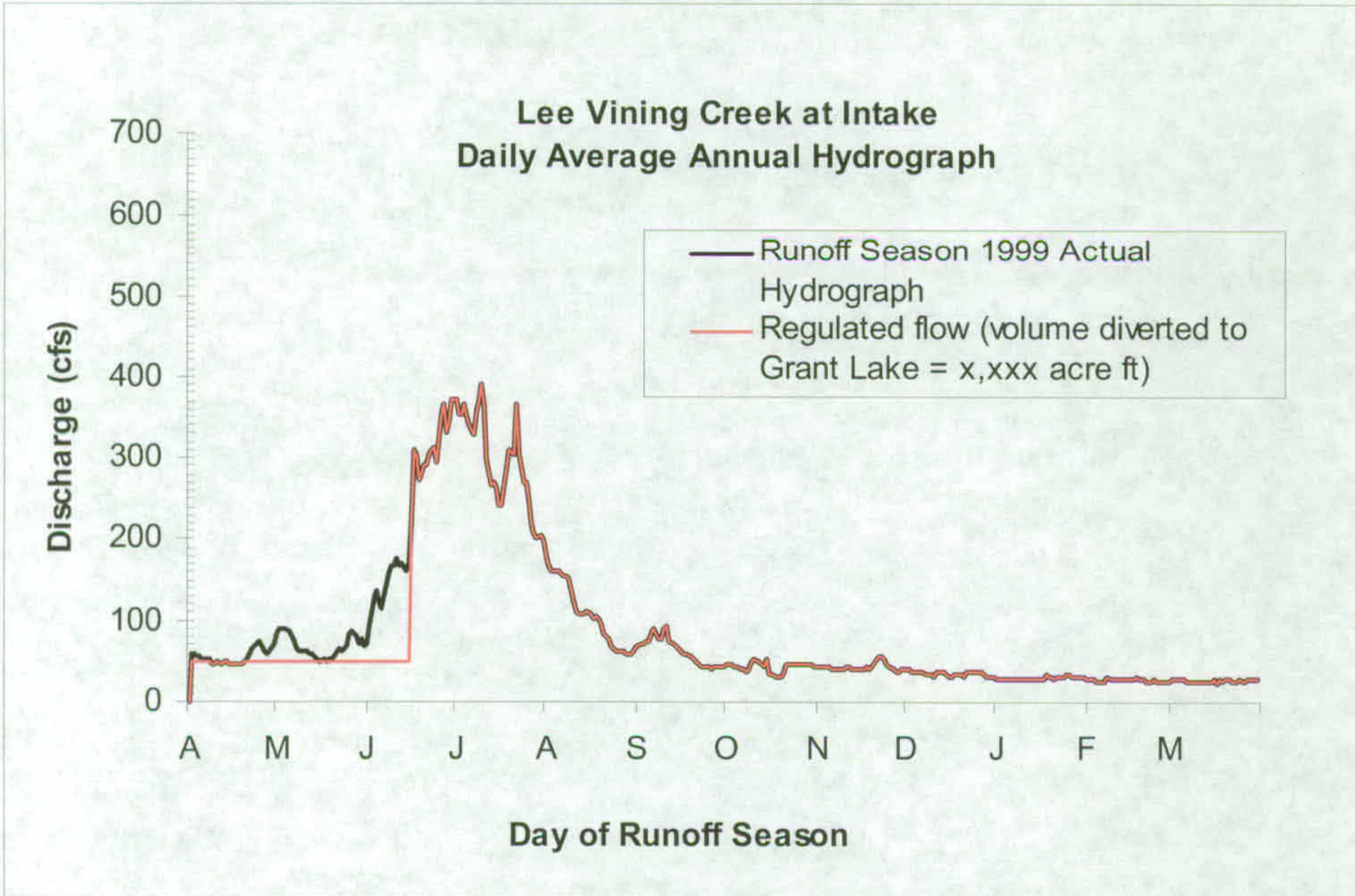


Figure 22. Runoff Season 1999 hypothetical diversion from Lee Vining Creek spring snowmelt hydrograph to augment Rush Creek peak flows.

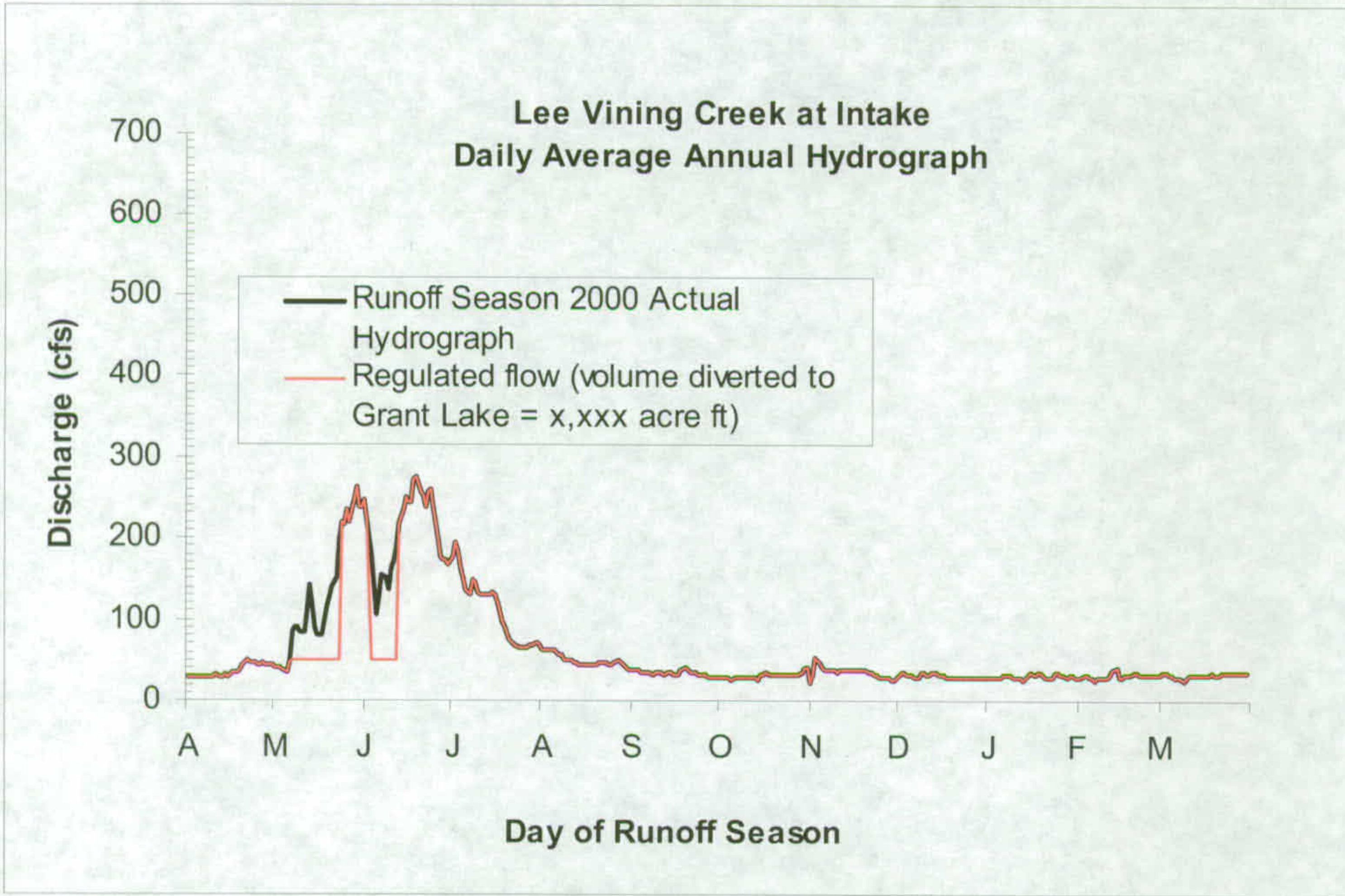


Figure 23. Runoff Season 2000 hypothetical diversion from Lee Vining Creek spring snowmelt hydrograph to augment Rush Creek peak flows.

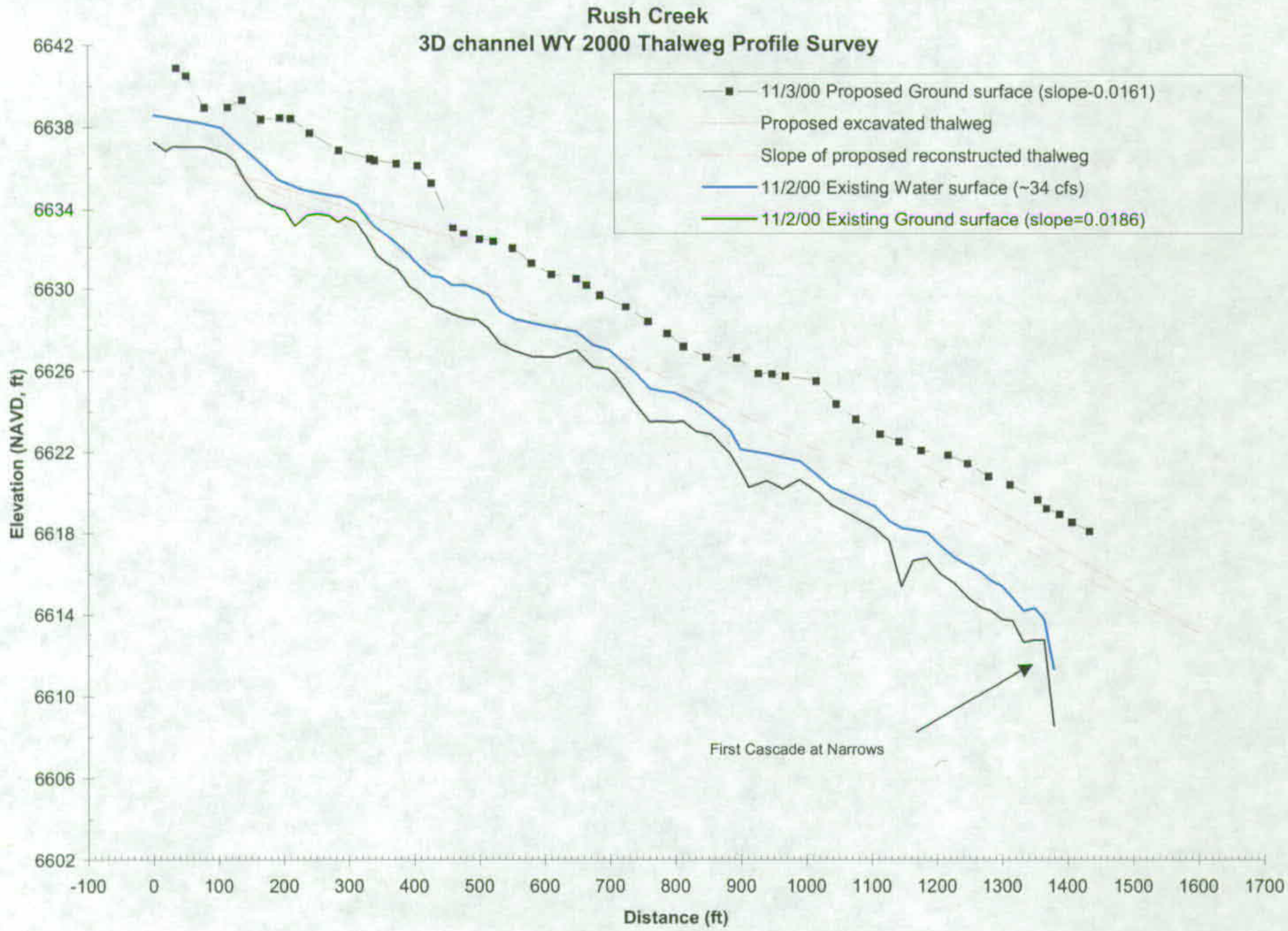


Figure 24. Thalweg survey of Rush Creek existing and potential 3D channel locations.

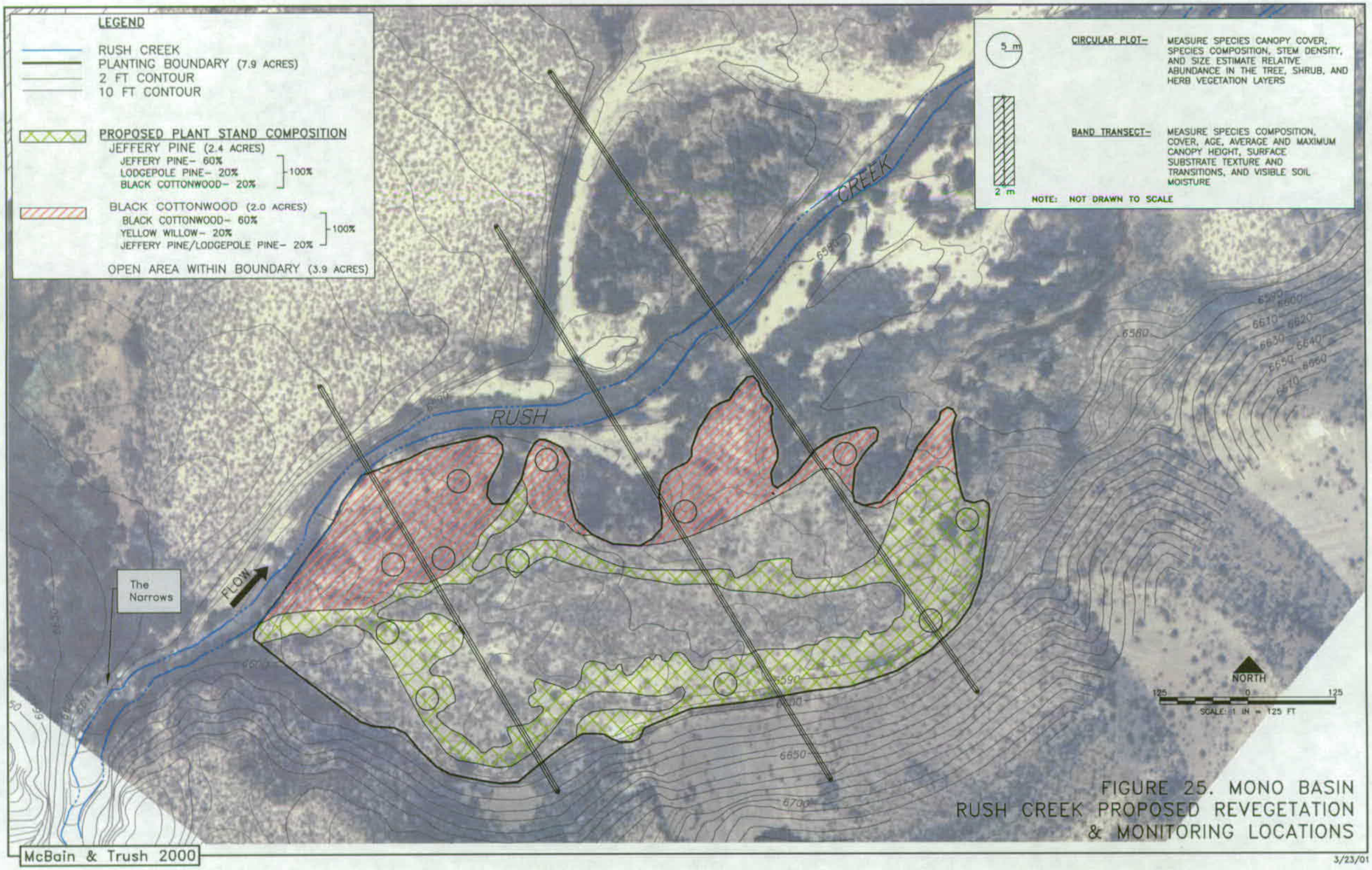


FIGURE 25. MONO BASIN
RUSH CREEK PROPOSED REVEGETATION
& MONITORING LOCATIONS

3/23/01

FIGURE 26. MONO BASIN
RUSH CREEK EXISTING VEGETATION
& GEOMORPHIC UNITS

TABLES

Table 1. Summary of peak flow magnitudes, dates, and recurrence intervals for Rush Lee Vining, Parker, and Walker creeks.

Station	*Peak Daily Average Discharge (cfs)*	*Instantaneous Peak Discharge (cfs)* [4]	*Peak Date*	*Recurrence Interval-Unimpaired Record (yrs)* [5]	*Recurrence Interval-Regulated Record (yrs)* [6]	*1999 Peak Discharge*
Rush Creek Unimpaired [1]	502		20-Jun-00	2.3	11.6	405
Rush Creek at Damsite (5013)	372	381	20-Jun-00	1.3	5.9	266
Grant Lake Release to Mono Lake (GLRML)	204		30-Jun-00	0.6	1.9	201
Rush Creek blw Narrows (unimpaired) [2]	582					
Rush Creek blw Narrows (actual) [3]	284		1-Jul-00			247
Lee Vining Creek at Intake (5009)	258	288	28-May-00	1.7	3.1	274
Parker Creek (5003)	49	52.4	25-Jun-00		2.9	52
Walker Creek (5002)	31	32.3	28-May-00		2	30

[1] Computed natural flows, assuming no flow regulation;

[2] Computed by adding Rush Creek Unimpaired+Parker+Walker;

[3] Computed by adding RCBRD+Parker+Walker;

[4] Only gauged stations provide instantaneous peak discharges; stations that are calculated provide only the maximum daily discharge;

[5] Based on Flood Frequency regressions (Unimpaired Record) from Hasencamp (1994).

[6] Based on Flood Frequency regressions (Regulated Record) from Hasencamp (1994).

Table 2. Summary of Rush Creek scour core experiments for runoff season 2000.

RUSH CREEK BED SCOUR EXPERIMENT SUMMARY FOR RUNOFF SEASON 2000
UPPER RUSH CREEK PEAK DISCHARGE = 204 cfs ON JUNE 30, 2000
LOWER RUSH CREEK PEAK DISCHARGE = 284 cfs ON JULY 1, 2000

REACH	CHANNEL	CROSS SECTION	CORE #	PEAK DISCHARGE IN CHANNEL (cfs)	SCOUR DEPTH (ft)	REDEPOSITION DEPTH (ft)	GEOMORPHIC UNIT
UPPER	MAIN	0+74	1	204	-0.06	0.06	Pool tail
			2	204	0.03	0.00	Pool tail
			3	204	-0.05	0.00	Pool tail
		5+45	1	204	0.00	0.00	Eddy deposit
			2	204	0.00	0.20	Lee deposit
		9+40	1	204	0.00	0.00	Point bar, within low water channel
			2	204	0.00	0.00	Point bar, within low water channel
		12+95	1	204	-0.09	0.00	Pool tail
			2	204	-0.10	0.00	Pool tail
LOWER	MAIN	10+10	1	170	0.08	0.00	Pool tail
			2	170	0.02	0.09	Pool tail
		7+70	1	170	0.00	0.00	Upper point bar/floodplain
		7+25	1	170	0.00	0.00	Upper point bar/floodplain
		5+49	1	170	-0.06	0.09	Riffle (transverse bar), within low water channel
			2	170	-0.07	0.19	Riffle (transverse bar), within low water channel
			3	170	0.02	0.14	Riffle (transverse bar), within low water channel
			4	170	-0.04	0.00	Riffle (transverse bar), within low water channel
		4+08	1	170	> 0.00	> 0.00	Point bar, within low water channel
			2	170	> 0.00	> 0.00	Point bar, within low water channel
		3+30	1	170	0.05	0.03	Pool tail, but really a transverse bar @ high Q's
			2	170	> 0.05	0.00	Pool tail, but really a transverse bar @ high Q's
		0+86	1	170	0.00	0.00	Upper point bar/floodplain
			2	170	-0.05	0.00	Middle of point bar
			3	170	-0.01	0.00	Point bar, within low water channel
			4	170	-0.01	0.00	Point bar, within low water channel
		-1+57	1	Channel abandoned by meander cut-off, considerable deposition			
			2	Cross section no longer monitored			

Table 3. Summary of Lee Vining Creek scour core experiments for runoff season 2000.

PEAK DISCHARGE = 288 cfs ON MAY 28, 2000

REACH	CHANNEL	CROSS SECTION	CORE #	PEAK DISCHARGE IN CHANNEL (cfs)	SCOUR DEPTH (ft)	REDEPOSITION DEPTH (ft)	GEOMORPHIC UNIT
UPPER	MAIN	13+92	1	204	-0.04	0.11	Eddy deposit of coarse sand
			2	204	0.06	0.07	Eddy deposit medium gravels
		10+44	1	204	-0.24	0.00	Eddy deposit, spawning gravels
			2	204	-0.08	0.37	Eddy deposit/exposed bar
		3+73	1	204	0.00	0.00	Eddy deposit of coarse sands
			2	204	0.03	0.15	Eddy deposit medium gravels
LOWER	B-1	0+87	1	204	-0.05	0.05	Point bar deposit, pea gravels

Table 4. Summary of Rush Creek tracer rock experiments for runoff season 2000.

LOWER RUSH CREEK PEAK DISCHARGE = 284 cfs ON , June 30, 2000

REACH	CHANNEL	CROSS SECTION	PARTICLE SIZE (mm)	PARTICLE SIZE CLASS	NUMBER OF TRACER ROCKS PLACED	NUMBER OF TRACER ROCKS MOBILIZED	PERCENT OF TRACER ROCKS MOBILIZED	GEOMORPHIC UNIT	NOTES
LOWER	MAIN	-9+82 (H)	125	D_{84}	11	1	9%	Riffle	One rock moved 2 ft downstream
			63	D_{50}	11	7	64%	Riffle	No rocks recovered
			44	D_{31}	11	10	91%	Riffle	No rocks recovered
		rocks placed at stations 46, 48, ...70.							
		-5+07 (D)	110	D_{84}	10	0	0%	Riffle	No rocks moved.
			52	D_{50}	10	2	20%	Riffle	Two rocks moved, 35 and 40 ft downstream
			36	D_{31}	10	3	30%	Riffle	No rocks recovered
		rocks placed at stations 75, 77.5, ...105.							
		4+08	56	D_{84}	10	2	20%	Point Bar	Rocks not found
			35	D_{50}	10	2	20%	Point Bar	Rocks not found
			28	D_{31}	10	6	60%	Point Bar	On D30 moved 30 ft downstream
		rocks placed at stations 140,142,144,...152							
		7+25	99	D_{84}	8	0	0%	Lower Point Bar	Rock moved downstream 27 ft.
			53	D_{50}	8	0	0%	Lower Point Bar	Rocks moved downstream up to 46 ft. Three rocks were not found.
			40	D_{31}	8	1	13%	Lower Point Bar	One rock moved downstream 5 ft. Most rocks were not found.
		Facies II rocks placed at stations 23, 27, ...37.							
		7+25	43	D_{84}	7	0	0%	Upper Point Bar	No rocks moved.
			26	D_{50}	7	0	0%	Upper Point Bar	No rocks moved.
			19	D_{31}	7	0	0%	Upper Point Bar	No rocks moved.
		Facies I rocks placed at stations 50, 52, ...62							
		7+70	99	D_{84}	10	5	50%	Channel Bed	Five rocks recovered, moved from 35 ft up to 56 ft downstream.
			53	D_{50}	10	7	70%	Channel Bed	Three rocks recovered, moved from 50 ft up to 81 ft downstream.
			40	D_{31}	10	10	100%	Channel Bed	One rock recovered, moved 73 ft downstream.
		Facies II rocks placed at stations 26, 28, ...38.							
		7+70	43	D_{84}	7	0	0%	Point Bar	No rocks moved.
			26	D_{50}	7	0	0%	Point Bar	No rocks moved.
			19	D_{31}	7	0	0%	Point Bar	Rocks not found, assumed missing (not transported) because of channel bed mobilization patterns at cross section 07+25.
		Facies I rocks placed at stations 50, 52, ...62							
		10+10	78	D_{84}	13	3	23%	Pool Tail	Three rocks recovered, at 27, 40, and 60 ft downstream
			46	D_{50}	13	8	62%	Pool Tail	One rock recovered, moved 39 ft downstream.
			28	D_{31}	13	10	77%	Pool Tail	One rock recovered, moved 10 ft downstream.
		rocks placed at stations 19, 21, ...37							
	10-Channel	10B	108	D_{84}	12	2	17%	Channel Bed	No rocks recovered
			64	D_{50}	12	2	17%	Channel Bed	One rock recovered, moved 3 ft
			44	D_{31}	12	4	33%	Channel Bed	One rock recovered, moved 5 ft
		rocks placed at stations 18, 19, 20, ...							

Table 4. Summary of Rush Creek tracer rock experiments for runoff season 2000 (continued).

UPPER RUSH CREEK PEAK DISCHARGE = 201 cfs ON , July 10,1999

REACH	CHANNEL	CROSS SECTION	PARTICLE SIZE (mm)	PARTICLE SIZE CLASS	NUMBER OF TRACER ROCKS PLACED	NUMBER OF TRACER ROCKS MOBILIZED	PERCENT OF TRACER ROCKS MOBILIZED	GEOMORPHIC UNIT	NOTES
UPPER	Main	0+74 (A)	132	D_{84}	17	0	0%	Riffle	No rocks moved.
			65	D_{50}	17	2	12%	Riffle	One rock moved downstream less than a foot.
			38	D_{31}	17	2	12%	Riffle	Rock moved less than a foot.
			26	D_{16}	0	0	0%	Riffle	Rock moved less than two feet.
		rocks placed at stations 50, 52, ...82.							Not monitored
		5+45 (B)	122	D_{84}	10	0	0%	Riffle	No rocks moved.
			75	D_{50}	10	2	20%	Riffle	Rocks moved downstream 11 and 29 ft.
			62	D_{31}	10	3	30%	Riffle	One rock recovered 15 ft downstream
			49	D_{16}	0	0	0%	Riffle	One rock moved less than a foot, all others were not found.
		rocks placed at stations 10, 12, ...28.							
		9+40	88	D_{84}	7	0	0%	Pool Tail	No rocks moved.
			46	D_{50}	7	0	0%	Pool Tail	No rocks moved.
			29	D_{31}	7	0	0%	Pool Tail	No rocks moved.
			18	D_{16}	7	0	0%	Pool Tail	No rocks moved.
		rocks placed at stations 30, 32, ...42.							
		11+68				0		Riffle	No rocks moved.
		six large boulders were painted and placed on cross section at stations 10, 12, ...20 with assorted "b" diameter sizes.							
		12+95 (C)	140	D_{84}	9	0	0%	Pool Tail	No rocks moved.
			77	D_{50}	9	2	22%	Pool Tail	Two rocks moved 5 and 20 ft downstream
			53	D_{31}	9	2	22%	Pool Tail	One rock recovered 25 ft dowsntream
		rocks placed at stations 11, 14, ... 35							

Table 5. Summary of Lee Vining Creek tracer rock experiments for runoff season 2000.

PEAK DISCHARGE = 258 cfs ON May 28, 2000

REACH	CHANNEL	CROSS SECTION	PARTICLE SIZE (mm)	PARTICLE SIZE CLASS	NUMBER OF TRACER ROCKS PLACED	NUMBER OF TRACER ROCKS MOBILIZED	PERCENT OF TRACER ROCKS MOBILIZED	GEOMORPHIC UNIT	NOTES
UPPER	MAIN	3+45	210	D_{84}	14	3	21%	Riffle	Rocks moved 2, 7, and 12 ft downstream.
			104	D_{50}	14	2	14%	Riffle	Rocks moved 3 and 4 ft downstream
			84	D_{31}	14	1	7%	Riffle	One rock moved 3 ft.
		rocks placed at stations 56, 58, ...84.							
		6+61	175	D_{84}	12	0	0%	Point Bar	No rocks moved.
			95	D_{50}	12	0	0%	Point Bar	No rocks moved.
			66	D_{31}	12	0	0%	Point Bar	No rocks moved.
		rocks placed at stations 38, 40, 42,...60							
		9+31	144	D_{84}	11	0	0%	Riffle	No rocks moved.
			77	D_{50}	11	2	18%	Riffle	Rocks not found
			54	D_{31}	11	2	18%	Riffle	Rocks not found
		rocks placed at stations 58, 61, 64, ...124.							
		9+31	144	D_{84}	11	0	0%	High Gradient Riffle	No rocks moved.
			77	D_{50}	11	5	45%	High Gradient Riffle	Rocks moved from 1,2 6, to 15 ft downstream
			54	D_{31}	11	6	55%	High Gradient Riffle	Rocks only moved less than 2 ft.
		rocks placed at stations 109, 111, 113,....							
		13+92	256	D_{84}	12	0	0%	Riffle	No rocks moved.
			95	D_{50}	12	0	0%	Riffle	No rocks moved.
			58	D_{31}	12	0	0%	Riffle	No rocks moved.
		rocks placed at stations 42, 44, 46, ...64							
	A4	4+04	165	D_{84}	10	2	20%	Medial Bar	Rocks moved 1 and 4 ft downstream
			112	D_{50}	10	3	30%	Medial Bar	Rocks moved 1 and 3 ft downstream
			90	D_{31}	10	4	40%	Medial Bar	Rocks moved 1 ft downstream
		rocks placed at stations 16, 19, 22, ...43.							
		5+15	160	D_{84}	11	0	0%	Point Bar	Three rocks were buried by deposition
			60	D_{50}	11	1	9%	Point Bar	Moved rock not recovered; additional rocks were buried by deposition
			35	D_{31}	11	4	36%	Point Bar	Two rocks moved 25, and 31 ft downstream; two rocks buried.
		rocks placed at stations 44, 47, ...65.							
		6+80	250	D_{84}	8	0	0%	Riffle	No rocks moved.
			115	D_{50}	8	0	0%	Riffle	No rocks moved.
			86	D_{31}	8	3	38%	Riffle	One rock recovered 20 ft downstream
		rocks placed at stations 12.5, 14.5, 16.5, 18.5, 21.5, 24.5 (stn 12.5 missing D31)							
	B1	06+08	240	D_{84}	8	0	0%	Riffle	No rocks moved.
			125	D_{50}	8	1	13%	Riffle	Rock moved 1 ft.
			81	D_{31}	8	8	100%	Riffle	Three rocks recovered, moved 1 and 2 ft downstream; others not recovered.
		rocks placed at stations 24, 26, 28, 30, 32, 34, 36, 38							

Table 5. Summary of Lee Vining Creek tracer rock experiments for runoff season 2000 (continued).

PEAK DISCHARGE = 258 cfs ON May 28, 2000

REACH	CHANNEL	CROSS SECTION	PARTICLE SIZE (mm)	PARTICLE SIZE CLASS	NUMBER OF TRACER ROCKS PLACED	NUMBER OF TRACER ROCKS MOBILIZED	PERCENT OF TRACER ROCKS MOBILIZED	GEOMORPHIC UNIT	NOTES
LOWER	MAIN	01+15	205	D_{84}	7	1	14%	Riffle	Rock moved downstream 3 ft.
			106	D_{50}	7	1	14%	Riffle	Rock moved downstream 4 ft.
			65	D_{31}	7	2	29%	Riffle	One rock moved downstream 8 ft, one rock moved less than a foot.
		rocks placed at stations 18, 20, 23, 26, 29, 32, 35.							
	B1	01+80	153	D_{84}	6	1	17%	Riffle	Rock moved less than a foot
			74	D_{50}	6	5	83%	Riffle	Two rocks moved less than a foot, one rock moved 2 feet, and two rocks were not found.
			54	D_{31}	6	6	100%	Riffle	Rocks not found
		rocks placed at stations 12, 14, ...22.							
	B1	00+87	98	D_{84}	12	8	67%	Point Bar	Rocks moved downstream up to 104 ft. Some rocks were not found, one rock at stn 35.5 was buried under the emerging point bar.
			56	D_{50}	12	10	83%	Point Bar	Rocks moved downstream up to 69 ft. Most rocks were not found.
			40	D_{31}	12	9	75%	Point Bar	Rocks not found
		rocks placed at stations 25, 26.5, 28, 29.5, 31, 32.5, 34, 35.5, 37, 38.5, 40, 41.5.							

Table 6. Alternative Lee Vining Creek diversion windows for Rush Creek flow augmentation.

Runoff Season	*Unregulated LVC Flow (af)*	*Regulated LVC Flow (af)*	*Volume Diverted to Grant Lake (af)*	*Percent of Total Flow Diverted*	*Percent of Grant Reservoir Capacity*
Based on Baseflow/Highflow Diversion Thresholds: 50/200					
1996	56,177	50,792	5,385	10%	11%
1997	66,317	61,080	5,237	8%	11%
1998	62,336	58,090	4,246	7%	9%
1999	46,205	42,170	4,035	9%	8%
2000	40,373	38,518	1,855	5%	4%
		Average Annual Diversion (af) =	***4,152***		
Based on Baseflow/Highflow Diversion Thresholds: 40/190					
1996	56,177	50,463	5,714	10%	12%
1997	66,317	60,463	5,854	9%	12%
1998	62,336	56,663	5,673	9%	12%
1999	46,205	41,831	4,374	9%	9%
2000	40,373	37,759	2,614	6%	6%
		Average Annual Diversion (af) =	***4,846***		
Based on Baseflow/Highflow Diversion Thresholds: 30/180					
1996	56,177	49,329	6,847	12%	14%
1997	66,317	60,161	6,156	9%	13%
1998	62,336	55,175	7,161	11%	15%
1999	46,205	41,580	4,625	10%	10%
2000	40,373	36,785	3,588	9%	8%
		Average Annual Diversion (af) =	***5,675***		
Based on Baseflow/Highflow Diversion Thresholds: 30/200					
1996	56,177	48,683	7,494	13%	16%
1997	66,317	59,217	7,100	11%	15%
1998	62,336	55,175	7,161	11%	15%
1999	46,205	40,636	5,569	12%	12%
2000	40,373	36,785	3,588	9%	8%
		Average Annual Diversion (af) =	***6,182***		

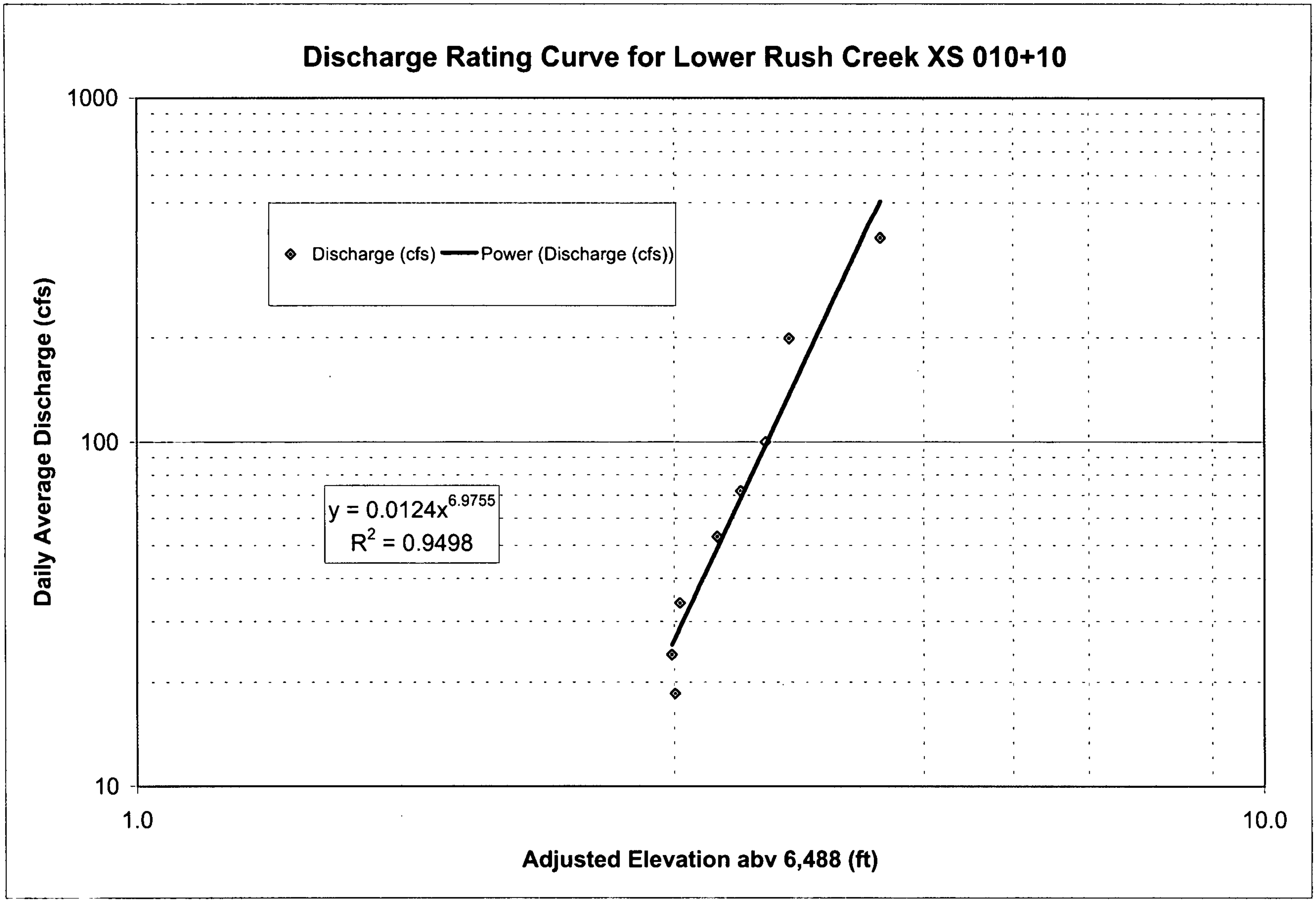
Table 7. Jeffery Pine Patch Type (2.4 acres)

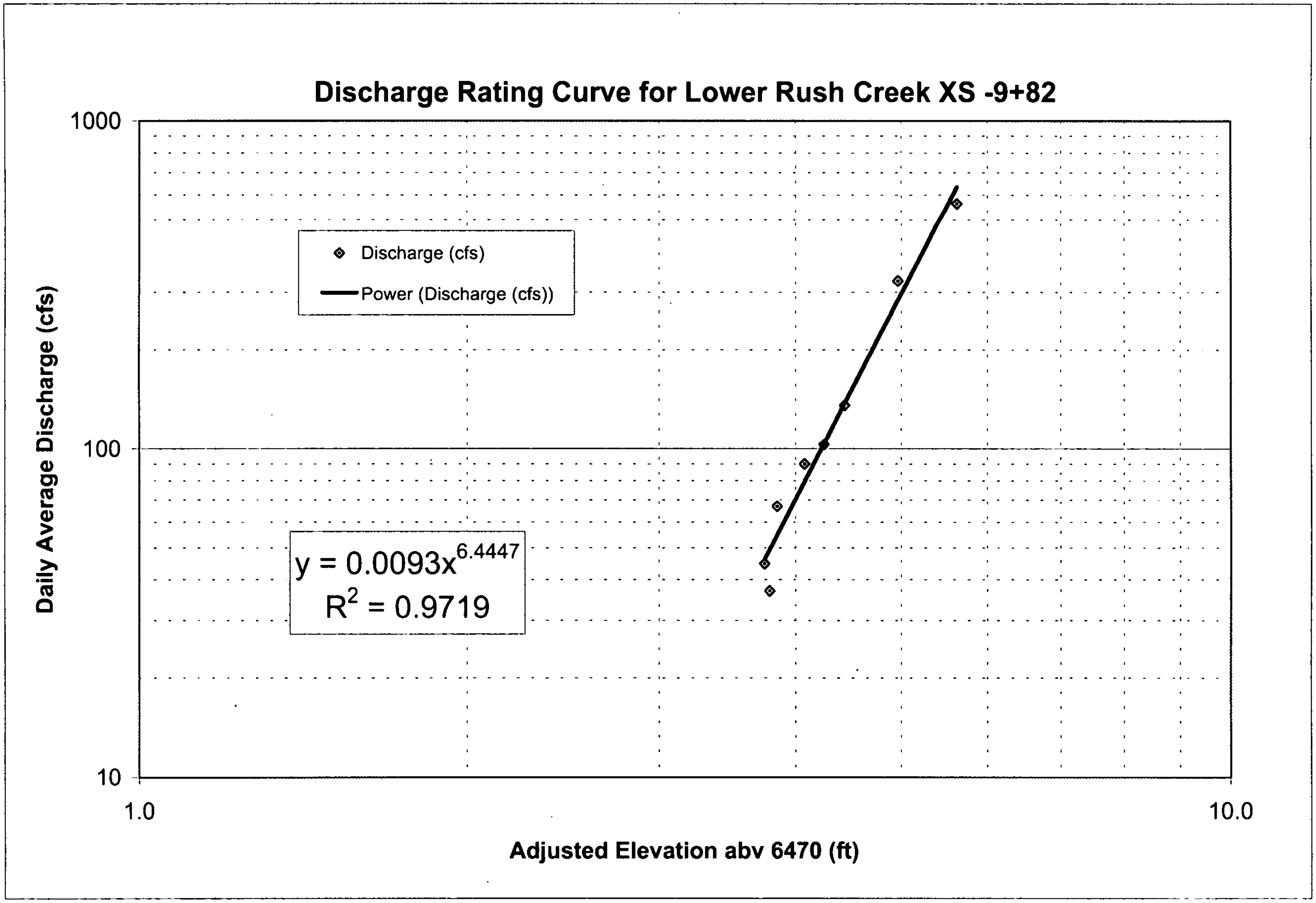
Species	**8 ft on center**	**10 ft on center**
Jeffery pine (*Pinus jeffreyi*); 60%	1132	724
Lodgepole pine (*Pinus contorta* ssp. *murryana*); 20%	377	241
Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*); 20%	377	242
Total number of plants	1886	1207

Table 8. Black Cottonwood Patch Type (2.0 acres)

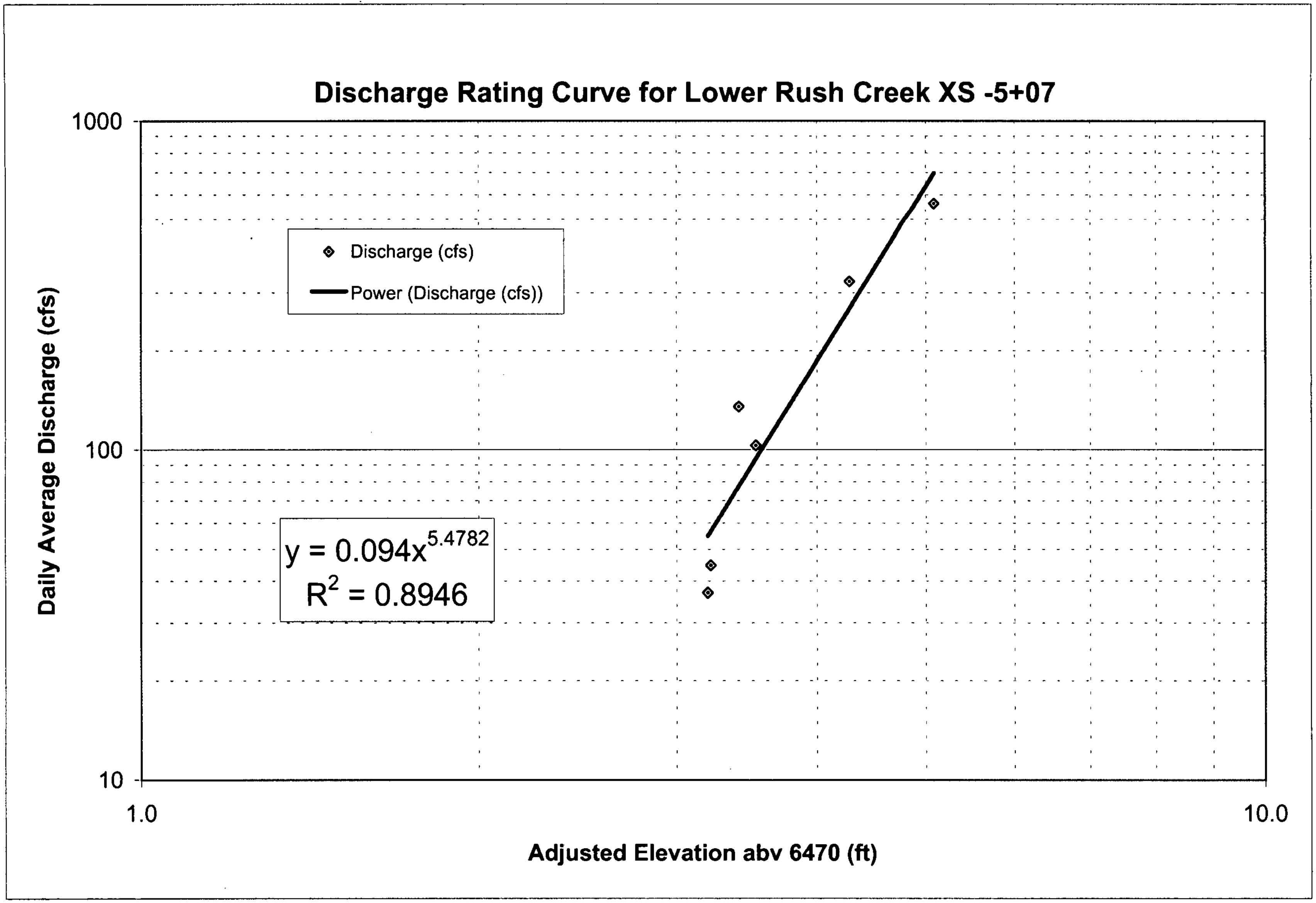
Species	**8 ft on center**	**10 ft on center**
Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*); 60%	943	604
Pacific willow (*Salix lucida* ssp. *lasiandra*); 20%	315	201
Jeffery pine (*Pinus jeffreyi*); 20%	314	201
Total number of plants; 100%	1572	1006

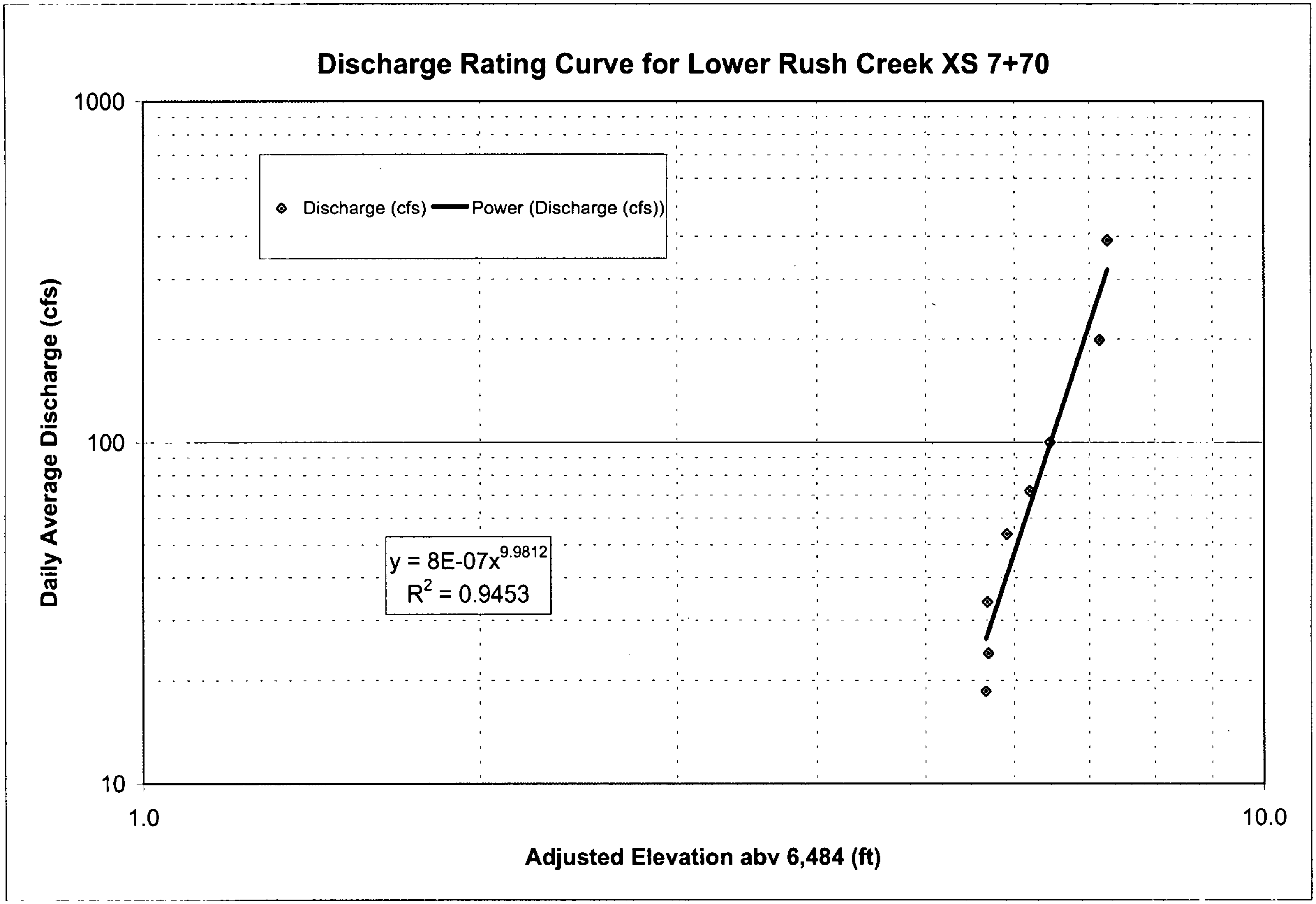
APPENDIX A: STREAMFLOW DISCHARGE MEASUREMENTS FOR RUNOFF SEASON 2000 AND DISCHARGE RATING CURVES FOR LOWER RUSH CREEK.

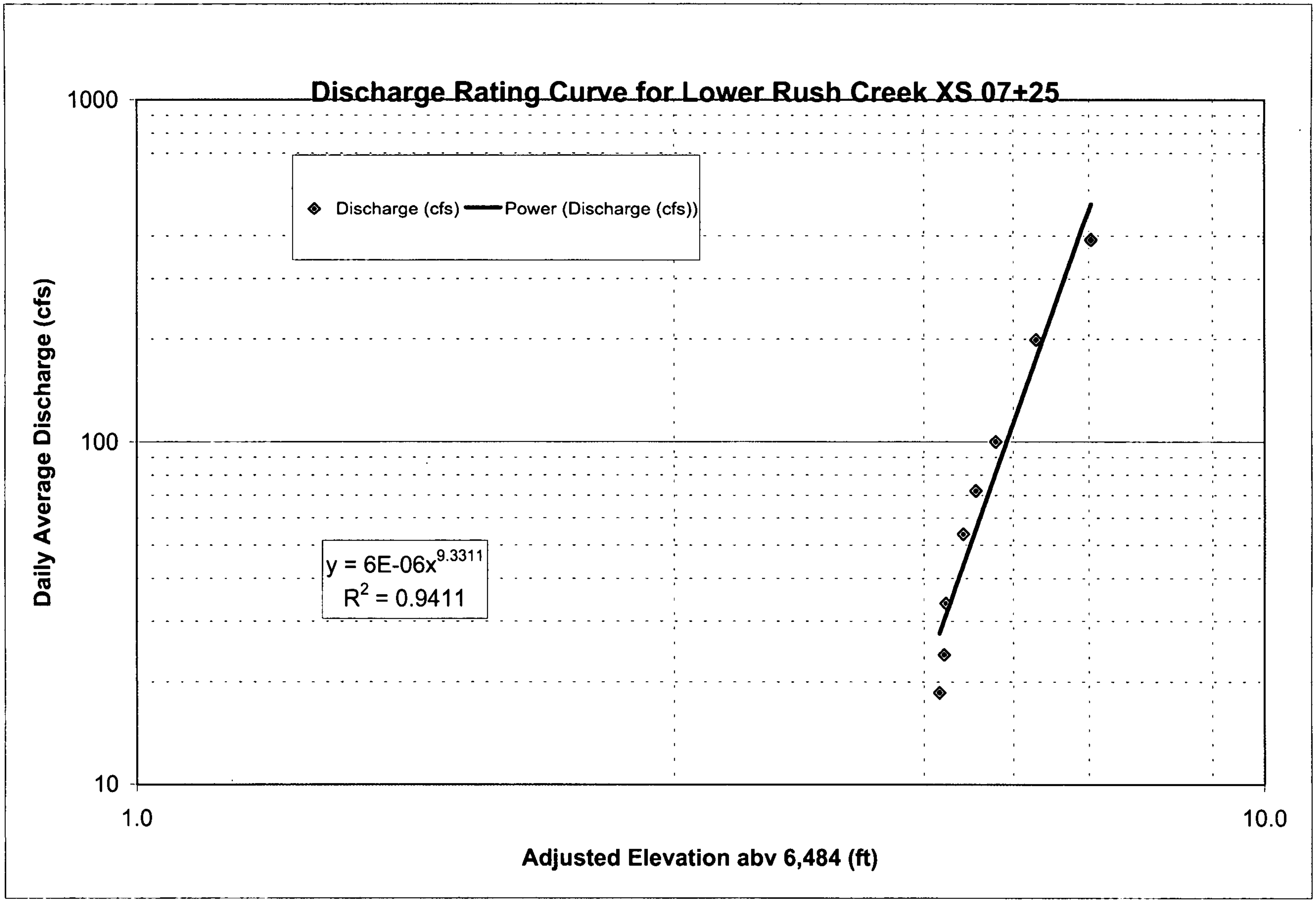

Discharge Rating Curve for Lower Rush Creek XS 010+10
1000
100
10
1.0
10.0
Daily Average Discharge (cfs)
Adjusted Elevation abv 6,488 (ft)
Discharge (cfs)
Power (Discharge (cfs))
y = 0.0124x^6.9755
R^2 = 0.9498

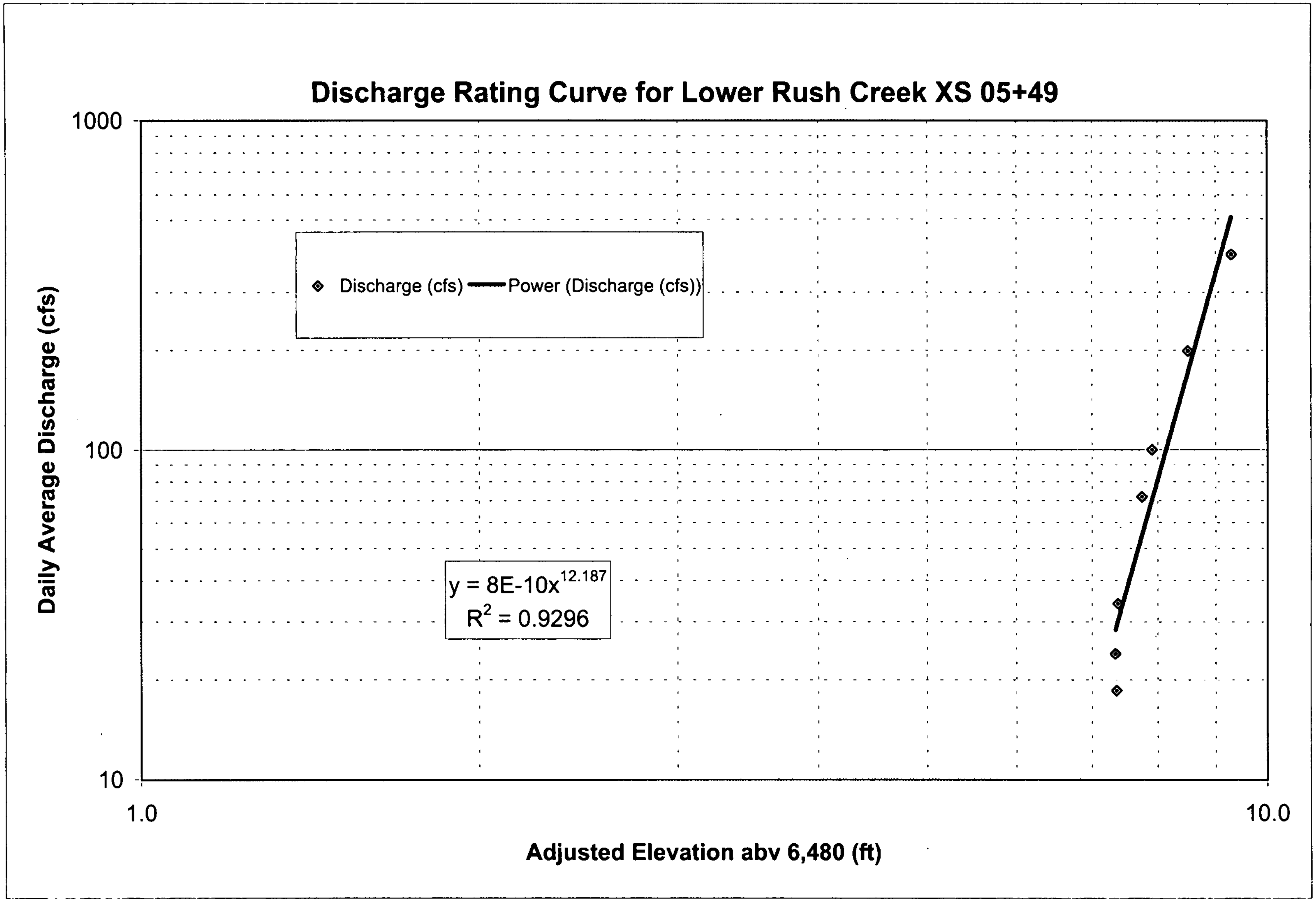


Discharge Rating Curve for Lower Rush Creek XS -9+82
Daily Average Discharge (cfs)
1000
100
10
1.0
10.0
Adjusted Elevation abv 6470 (ft)
Discharge (cfs)
Power (Discharge (cfs))
y = 0.0093x^6.4447
R^2 = 0.9719

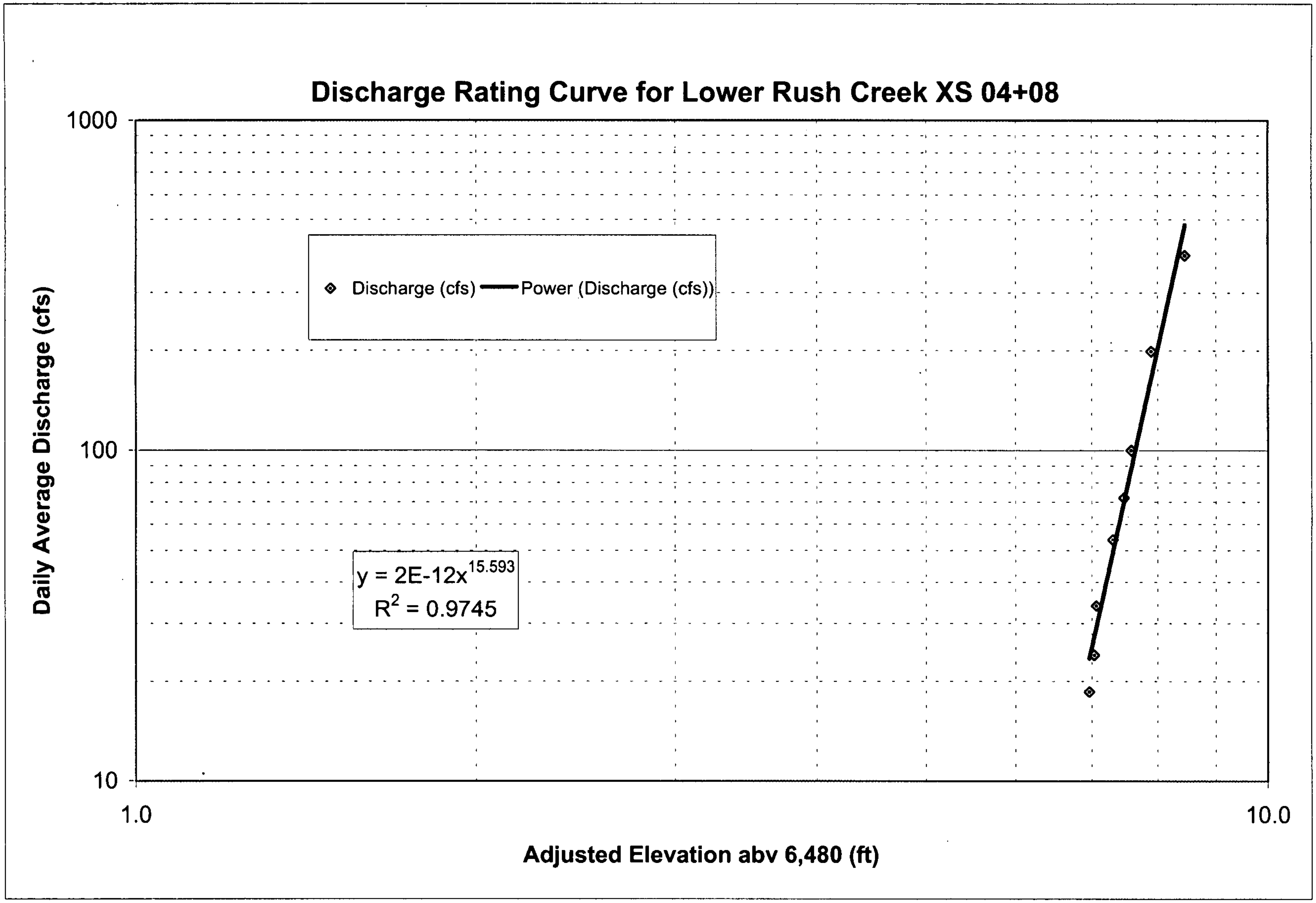

Discharge Rating Curve for Lower Rush Creek XS -5+07
Discharge (cfs)
Power (Discharge (cfs))
y = 0.094x^5.4782
R^2 = 0.8946
1000
100
10
1.0
10.0
Daily Average Discharge (cfs)
Adjusted Elevation abv 6470 (ft)


Discharge Rating Curve for Lower Rush Creek XS 7+70
Discharge (cfs)
Power (Discharge (cfs))
$y = 8E\text{-}07x^{9.9812}$
$R^2 = 0.9453$
1000
100
10
1.0
10.0
Daily Average Discharge (cfs)
Adjusted Elevation abv 6,484 (ft)

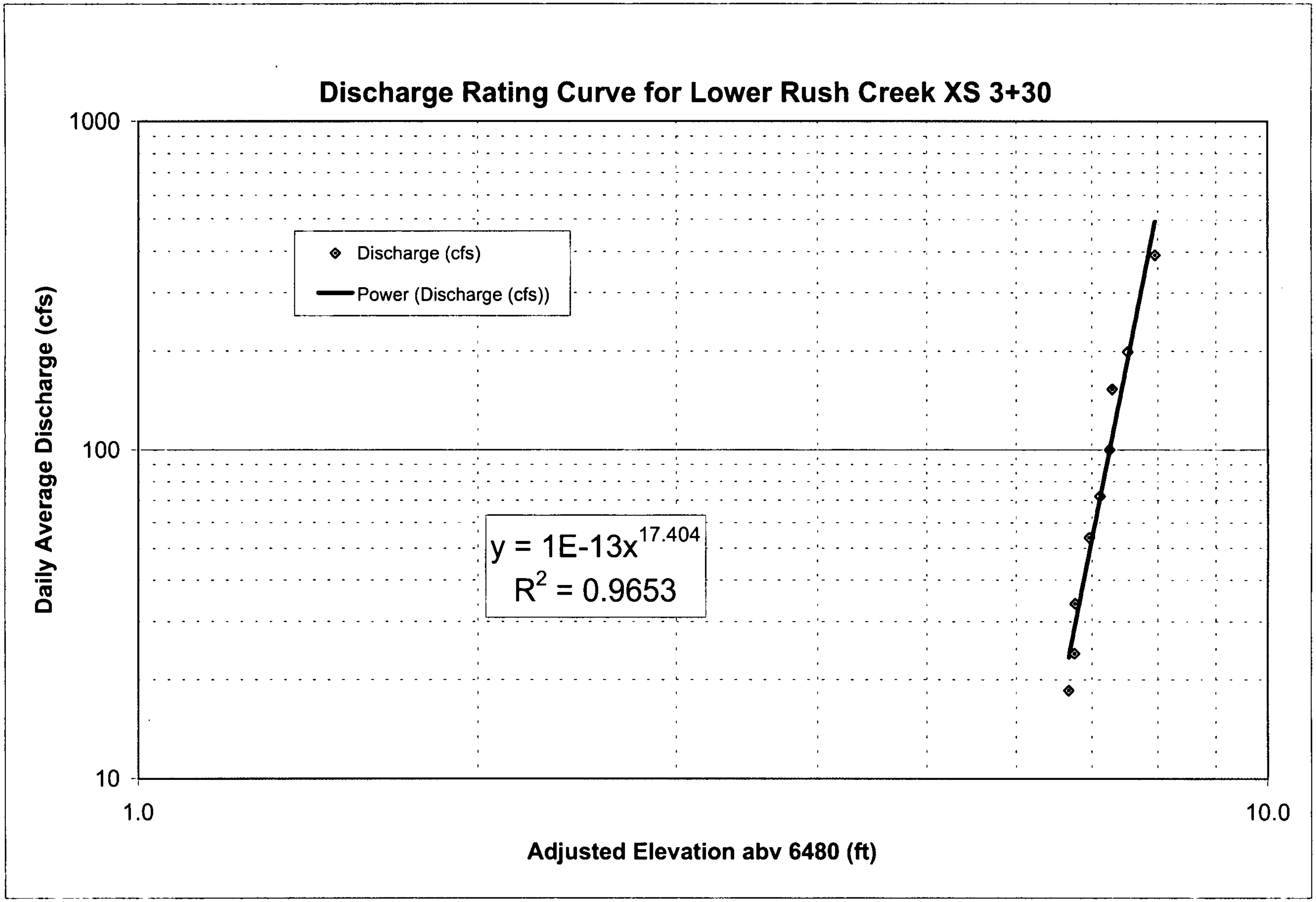

Discharge Rating Curve for Lower Rush Creek XS 07+25
Discharge (cfs)
Power (Discharge (cfs))
y = 6E-06x^9.3311
R^2 = 0.9411
1000
100
10
1.0
10.0
Daily Average Discharge (cfs)
Adjusted Elevation abv 6,484 (ft)

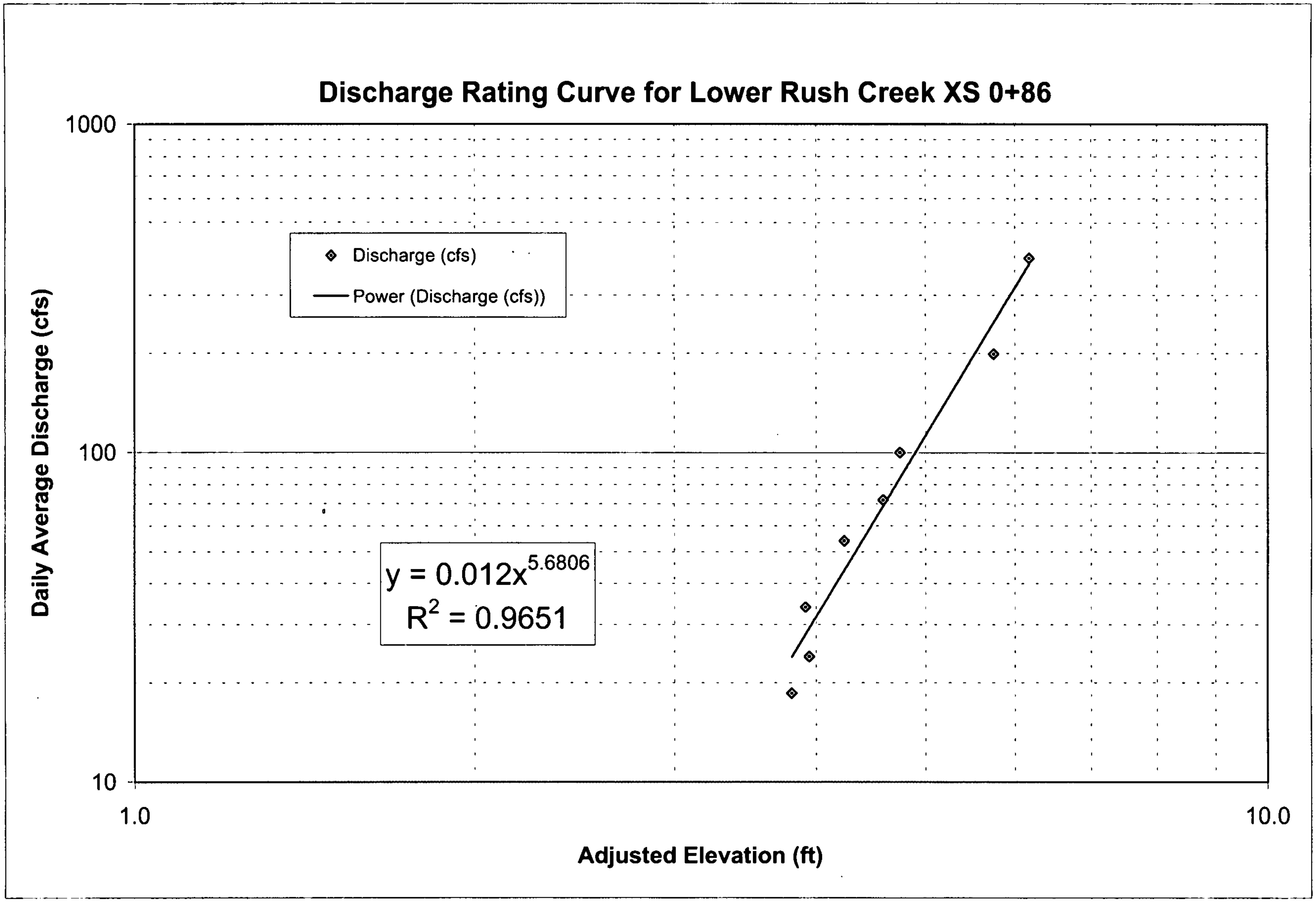


Discharge Rating Curve for Lower Rush Creek XS 05+49
1000
100
10
1.0
10.0
Daily Average Discharge (cfs)
Adjusted Elevation abv 6,480 (ft)
Discharge (cfs)
Power (Discharge (cfs))
y = 8E-10x^12.187
R^2 = 0.9296



Discharge Rating Curve for Lower Rush Creek XS 04+08
Daily Average Discharge (cfs)
1000
100
10
Discharge (cfs)
Power (Discharge (cfs))
y = 2E-12x^15.593
R^2 = 0.9745
1.0
10.0
Adjusted Elevation abv 6,480 (ft)


Discharge Rating Curve for Lower Rush Creek XS 3+30
1000
100
10
1.0
10.0
Discharge (cfs)
Power (Discharge (cfs))
y = 1E-13x^17.404
R^2 = 0.9653
Daily Average Discharge (cfs)
Adjusted Elevation abv 6480 (ft)


Discharge Rating Curve for Lower Rush Creek XS 0+86
Discharge (cfs)
Power (Discharge (cfs))
y = 0.012x^5.6806
R^2 = 0.9651
Daily Average Discharge (cfs)
1000
100
10
1.0
10.0
Adjusted Elevation (ft)

Water Year | Msmt #

McBain & Trush

Trinity River Gaging

Meas. No. 01-01

Comp. by ________

Checked by ________

Discharge Measurement Notes

Station name LOWER RUSH 10-CHANNEL Units (SI/English)

Date 11-4-00 Hydrographers Darren Mierau Tom Wesley

Width ~18 ft Area ________ Vel. ________ G.H. ________ Disch. ________

Method ________ No. secs ________ G.H. change ________ in ________ hrs. Susp. ________

Method coef. ________ Hor. angle coef. ________ Susp. coef. ________ G.H. of zero flow ________

Time	Gage Reading Recorder	Gage Reading Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ________

Battery voltage ________

Type of meter Price AA Meter No. ________

Date rated ________ for rod, other

Meter ________ ft. above bottom of weight

Spin before meas. ________ after ________ seconds

Meas. Plots ________ % diff. from rating ________

Wading, cable, ice, boat, upstr., dowstr,. side, bridge ________

feet, mile, above, below, gage and ________

Piezometer (Valley-Wide) XS on

Channel-10

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Shallow margins w/ Elodea upstr. of XS

Flow conditions Low-Flow Weather Clear

Air ________ F@ ________ Water ________ F@ ________

Gage ________ Record removed ________

Control ________

Remarks ________

Measurement #______ **Discharge Measurement Raw Data Sheets**

RUSH CRK 10 Channel

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity point	Velocity mean in vert.	At Adj. for hor. angle	Area	Discharge	Notes
											1547 begin 1614 END
	12.4	0.5	0.0	Ø	Ø						LEW (left edge water)
135°	13.4	1.0	0.3	3	43.40						alder causing Eddy
30°	14.4	1.0	0.5	4	45.46						
	15.4	1.0	0.5	10	44.40						
	16.4	1.0	0.7	18	43.23						
	17.4	1.0	0.8	24	43.35						
	18.4	1.0	0.90	25	41.60						
	19.4	1.0	0.90	29	43.97						
	20.4	1.0	0.90	31	42.21						
	21.4	1.0	0.90	33	42.60						
	22.4	0.8	0.95	38	41.80						
	23.0	0.55	0.95	40	41.95						
	23.5	0.5	0.95	45	46.22						
	24.0	0.5	0.90	42	43.44						
	24.5	0.5	0.90	42	41.83						
	25.0	0.5	0.90	42	41.76						
	25.5	0.5	0.90	44	42.53						
	26.0	0.5	0.9	34	41.29						
	26.5	0.75	0.8	34	41.95						
	27.5	1.0	0.8	40	77.89						
	28.5	1.3	0.6	3	40.71						
	30.1										REW

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'

Time of each velocity measurement must be >40 seconds

McBain & Trush
Trinity River Gaging

Meas. No. 01-01
Comp. by
Checked by

Discharge Measurement Notes

Station name RUSH CREEK CULVERT Units (SI/English)

Date 11-4, 19 2000 Hydrographers Darren Mierau & Tom Wolsky

Width 20 ft. Area ____ Vel. ____ G.H. ____ Disch. ____

Method ____ No. secs. ____ G.H. change ____ in ____ hrs. Susp. ____

Method coef. ____ Hor. angle coef. ____ Susp. coef. ____ G.H. of zero flow ____

Time	Gage Reading: Recorder	Outside
12 40	1.07	
14 20	1.07	
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ____
Battery voltage ____

Type of meter AA Meter No. ____

Date rated ____ for rod, other

Meter ____ ft. above bottom of weight

Spin before meas. ____ after ____ seconds

Meas. Plots ____ % diff. from rating ____

Wading, cable, ice, boat, upstr., dowstr,. side, bridge 100

feet, mile, above, below, gage and CTY RD

Cross section placed ~100 ft upstream of the Rush Creek County Rd CULVERT

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Narrow stream, fairly even bottom, no eddy's in margins

Flow conditions low flow Weather Clear

Air ~48°F F@ 13:40 Water ____ F@ ____

Gage ____ Record removed ____

Control ____

Remarks FIRST MSMT AT THIS NEW SITE, INSTALLED FOR RATING CURVE DEVELOPMT.

Measurement # 01-07 **Discharge Measurement Raw Data Sheets**

	Angle Coef.	Tape dist.	Width	Depth	Revolutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
		4.3	1	0.0								LEW
1		5.3	1	0.9	9	43.0	.48				.43	
2		6.3	1	1.3	14	41.6	.75				.98	
3		7.3	1	1.4	35	42.0	1.84				2.57	
4		8.3	1	1.45	37	41.4	1.97				2.85	
5		9.3	1	1.55	40	41.3	2.14				3.32	
6		10.3	1	1.4	44	41.4	2.34				3.27	(13.42)
7		11.3	1	1.4	55	42.1	2.86				4.01	
8		12.3	1	1.4	36	41.4	1.91				2.68	
9		13.3	1	1.3	24	41.7	1.27				1.66	
10		14.3	1	1.2	46	41.4	2.44				2.93	
11		15.3	1	1.2	42	41.2	2.24				2.69	
12		16.3	1	1.15	33	41.7	1.74				2.00	
13		17.3	1	1.15	39	41.1	2.09				2.40	
14		18.3	1	1.15	32	41.2	1.71				1.97	(20.34)
15		19.3	1	0.9	28	41.2	1.50				1.35	
16		20.3	1	0.75	21	40.9	1.11				0.83	
17		21.3	1	0.55	11	41.6	.60				0.33	
18		22.3	1	0.3	8	43.6	.42				0.13	(2.64)
		23.6	1.15	0.0								REW
												36.4
												Q = 37.36 from a spreadsheet

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. 01-01

Comp. by

Checked by

[~100ft upstream of XS-9+82]

Discharge Measurement Notes

Station name LOWER RUSH @ XS-9+82 MAIN CHANNEL Units (SI/English)

Date ______, 19__ Hydrographers D. [illegible] & T. [illegible]

Width ______ Area ______ Vel. ______ G.H. ______ Disch. ______

Method ______ No. secs. ______ G.H. change ______ in ______ hrs. Susp. ______

Method coef. ______ Hor. angle coef. ______ Susp. coef. ______ G.H. of zero flow ______

Time	Gage Reading Recorder	Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______

Battery voltage ______

Type of meter Price AA Meter No. ______

Date rated ______ for rod, other

Meter ______ ft. above bottom of weight

Spin before meas. ______ after ______ seconds

Meas. Plots ______ % diff. from rating ______

Wading, cable, ice, boat, upstr., dowstr,. side, bridge ______

feet, mile, above, below, gage and ______

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section ______

Flow conditions Uniform (low flow) Weather Clear Sunny - cold ~45°F ?

Air ______ F@ ______ Water ______ F@ ______

Gage ______ Record removed ______

Control Riffle crest downstream ~25'

Remarks Temporary XS upstream of old [illegible] XS ~40' downstream

This [illegible] XS is ideal with uniform flow & shape

Measurement #______

Discharge Measurement Raw Data Sheets

ASH CK below Willow & Parker

Begin ~ 1620
1640 [illegible]
1700 END

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	3.8			Ø							Left edge Water (LEW)
	5.0	1.1	0.85	16	41.63	.86				1.79	
	6.0	0.5	0.75	20	42.3	1.05				.79	
	7.0	0.5	.65	21	42.8	1.09				.71	
	8.0	0.5	0.75	22	42.45	1.10				.82	
	9.0	0.5	0.80	23	42.20	1.21				.97	
	10.0	0.5	0.70	25	41.28	1.34				.94	(6.02)
	11.0	0.5	0.60	24	41.62	1.28				.77	
	12.0	0.5	0.65	23	41.31	1.24				.80	
	13.0	0.5	0.65	27	42.5	1.40				.91	
	14.0	0.5	0.65	23	42.14	1.21				.78	Behind Boulder
	15.0	0.5	0.80	28	42.40	1.46				1.17	
	16.0	0.5	0.80	30	42.93	1.54				1.23	5.66
	17.0	0.5	0.75	32	41.53	1.70				1.27	
	18.0	0.5	0.80	27	42.48	1.40				1.12	
	19.0	0.5	0.90	26	41.84	1.37				1.24	
	20.0	0.5	0.90	29	47.55	1.35				1.21	
	21.0	0.5	1.0	26	41.87	1.37				1.37	
	22.0	0.5	0.90	30	41.12	1.61				1.45	
	23.0	0.5	1.05	31	41.22	1.66				1.74	9.4
	24.0	0.5	1.05	30	41.53	1.59				1.67	
	25.0	0.5	0.90	30	43.00	1.54				1.39	38.69
	26.0	0.5	1.10	34	41.29	1.81				2.00	
	27.0	0.5	1.15	35	42.00	1.83				2.10	Q = 36.97 (from
	28.0	0.5	1.20	37	40.98	1.99				2.38	Spreadsheet)
	29.0	0.5	1.10	44	41.88	2.31				2.54	
	30.0	0.5	1.00	49	41.58	2.59				2.59	
	31.0	0.5	1.00	41	41.79	2.16				2.16	
	32.0	0.95	1.00	16	43.30	.82				.78	17.61
	32.7			Ø							REW

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'

Time of each velocity measurement must be >40 seconds

JUNE 14 '00
= 37.41 cfs

McBain & Trush
Trinity River Gaging

Meas. No. 00-02
Comp. by
Checked by

Discharge Measurement Notes

Station name Lower Rush 10 - Channel Units (SI/English)

Date 6-14, 19 2000 Hydrographers Darren Mierau

Width ____ Area ____ Vel. ____ G.H. ____ Disch. ____

Method ____ No. secs. ____ G.H. change ____ in ____ hrs. Susp. ____

Method coef. ____ Hor. angle coef. ____ Susp. coef. ____ G.H. of zero flow ____

Time	Gage Reading Recorder	Gage Reading Outside
0900	DM	1.31 ft
10:55	Start	
11:26	End	
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ____

Battery voltage ____

Type of meter AA Meter No. MT

Date rated ____ for rod, other

Meter ____ ft. above bottom of weight

Spin before meas. ____ after ____ seconds

Meas. Plots ____ % diff. from rating ____

Wading, cable, ice, boat, upstr., dowstr,. side, bridge ____

feet, mile, above, below, gage and at 10-channel
Valley-wide XS

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section 10-Channel Valley Wide even, laminar flow, rectang shape XS

Flow conditions Ascending Spring Flood Weather Clear & Warm

Air ____ F@ ____ Water ____ F@ ____

Gage ____ Record removed ____

Control ____

Remarks ____

Measurement #00-02 **Discharge Measurement Raw Data Sheets**

	Angle Coef.	Tape dist.	Width	Depth	Revolutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
		11.2										LEW
		~~12.0~~										
1		13.0		.5	6	40.9						
2		14.0		.65	14	42.1						
3		15.0		.90	16	45.4						
4		16.0		.90	32	41.4						
5		17.0		1.1	31	43.3						
6		18.0		1.15	34	41.6						
7		19.0		1.35	38	41.6						
8		20.		1.35	39	42.2						
9		21.0		1.30	47	42.3						
10		22.0		1.30	45	42.2						
11		23.0		1.25	47	42.3						
12		24.0		1.25	53	42.4						
13		25.0		1.20	51	42.0						
14		26.0		1.20	46	42.0						
15		27.0		1.15	43	41.4						
16		28.0		1.0	38	42.8						
17		29.0		0.8	17	57.7						
18		30.0		0.5	4	56.0						
		31.3										REW

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

6-4-98

DISCHARGE MEASUREMENTS AT RUSH CREEK, LOWER SITE ON 3 CHANNELS. MAINSTEM U.S. OF 10 CONNECTOR, 10 CONNECTOR AND 10 CHANNEL D.S. OF CONNECTOR.

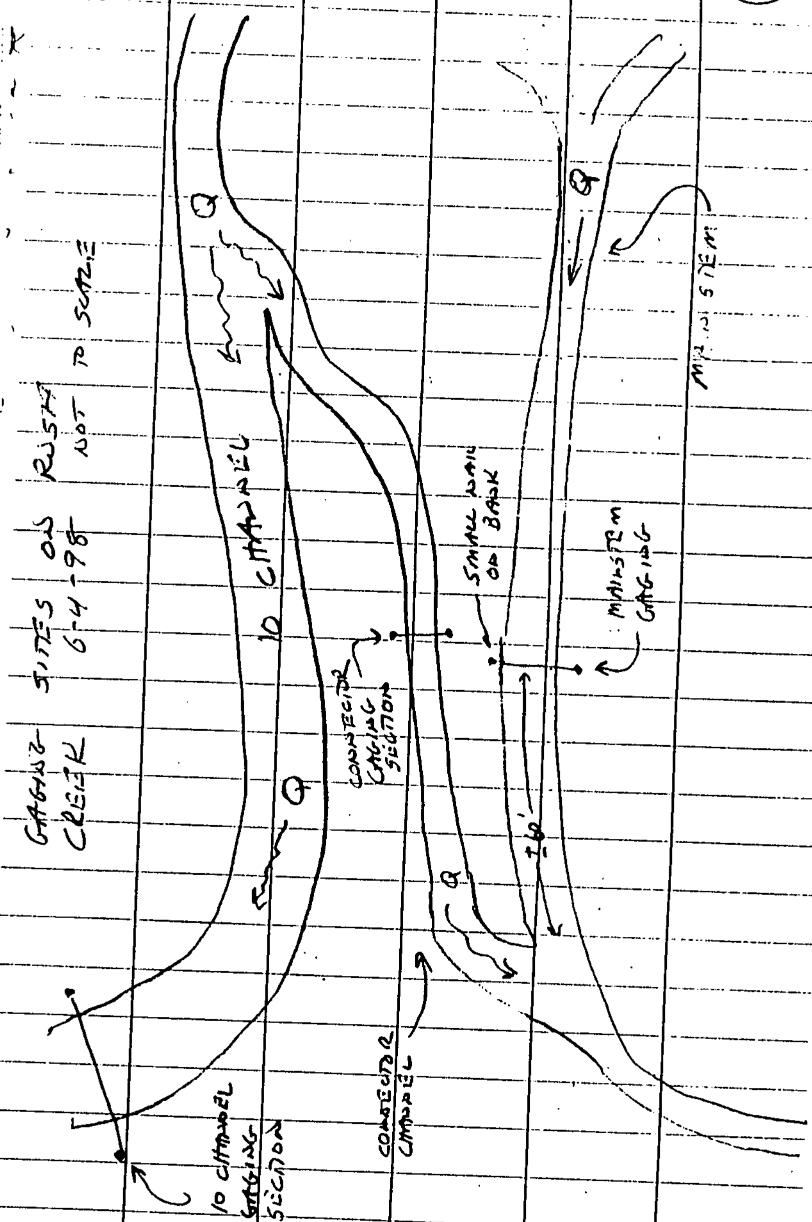
THESE ARE THE SAME CHANNELS THAT WERE MEASURED IN 1997 BUT WE ARE NOT SURE OF THE LOCATION OF THE 97 MEASUREMENTS.

1997 MEASUREMENTS WERE TIME-FLOAT

MEASUREMENT #'S

LRC - 9801A
- 9801B
- 9801C

DATA IS ON SEPARATE SHEET



for 1999 Gaging Location for 10 channel is the same

However we are now gaging the Main-stem at XS-09+82

RC10 CHANNEL Q98.XLS
ENTERED

MONO

McBain & Trush

~~Trinity River~~ Gaging
MONO

Discharge Measurement Notes

Meas. No. LRC-9801C
Comp. by ______
Checked by ______

Station name RUSH CREEK 10 CHANNEL Units (SI/English) ft, cfs

Date 6-4, 1998 Hydrographers MIERAU, MERRILL

Width 17.1 Area 11.26 Vel. 2.06 G.H. — Disch. 23.17

Method 0.6 No. secs. 16 G.H. change 0 in 0.5 hrs. Susp. —

Method coef. — Hor. angle coef. — Susp. coef. — G.H. of zero flow —

Time	Gage Reading Recorder	Gage Reading Outside
16:20	—	—
16:38	—	—
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______

Battery voltage ______

Type of meter AA Meter No. 595

Date rated — for rod, other

Meter — ft. above bottom of weight

Spin before meas. 53:09 min after 225 seconds

Meas. Plots — % diff. from rating —

Wading, cable, ice, boat, upstr., dowstr,. side, bridge ≈ 140

feet, mile, above, below, gage and 10 CONNECTOR CHANNEL

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section MINOR SURFACE WAVES, SMALL SUBSTRATE

Flow conditions STEADY Weather BREEZY, CLEAR

Air — F@ — Water — F@ —

Gage — Record removed —

Control DOWNSTREAM RIFFLE

Remarks NOT AN ESTABLISHED CROSS SECTION

Measurement # 1RC-9801c **Discharge Measurement Raw Data Sheets** Page 1 of 1

IP=2.0

Angle Coef.	Tape dist.	Width	Depth	Revolutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	4.9										REW
	6.0	1.05	0.3	6	40	.35		.35	.32	.11	
	7.0	1.0	0.4	14	43	.73		.73	0.4	.29	
	8.0	1.0	0.5	20	41	1.08		1.08	0.5	.54	
	9.0	1.0	0.7	33	41	1.77		1.77	0.7	1.24	
	10.0	1.0	0.9	43	40	2.36		2.36	0.9	2.13	
	11.0	1.0	0.95	54	40	2.96		2.96	0.95	2.81	
	12.0	1.0	1.0	46	40	2.53		2.53	1.0	2.53	
	13.0	1.0	1.0	43	40	2.36		2.36	1.0	2.36	
	14.0	1.0	1.1	43	40	2.36		2.36	1.1	2.60	
	15.0	1.0	0.9	50	41	2.68		2.68	0.9	2.41	ON ROCK
	16.0	1.0	0.8	47	41	2.52		2.52	0.8	2.01	
	17.0	1.0	0.75	43	41	2.31		2.31	0.75	1.73	
	18.0	1.0	0.7	34	40	1.87		1.87	0.7	1.31	
	19.0	1.0	0.6	22	41	1.19		1.19	0.6	.71	
	20.0	0.85	0.4	13	40	.73		.73	0.34	.25	
	20.7		0.3	8	42	.44		.44	0.30	.13	
	22.0										LEW

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

RC10CONNQ98.XLS

McBain & Trush

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MONO

Meas. No. LRC-9801B
Comp. by
Checked by

Discharge Measurement Notes

Station name RUSH CR. 10-CONNECTOR Units (SI/English) ft, cfs

Date 6-4, 19 98 Hydrographers MIERAU & MERRILL

Width 8.2 Area 4.68 Vel. 1.22 G.H. — Disch. 5.73

Method 0.6 No. secs. 12 G.H. change 0 in 0.75 hrs. Susp. —

Method coef. — Hor. angle coef. — Susp. coef. — G.H. of zero flow —

Time	Gage Reading Recorder	Gage Reading Outside
15:50	—	—
16:15	—	—
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa.

Battery voltage

Type of meter AA Meter No. 595

Date rated — for rod, other

Meter — ft. above bottom of weight

Spin before meas. 3:09 after 2:25 seconds

Meas. Plots — % diff. from rating —

Wading, cable, ice, boat, upstr., dowstr,. side, bridge 70

feet, mile, above below, gage and Main channel

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section NARROW SECTION, UNEVEN BED

Flow conditions steady Weather Breezy, Clear

Air F@ Water F@

Gage — Record removed —

Control downstream riffle

Remarks No Thermometer.

Measurement # LRC-98-01B Discharge Measurement Raw Data Sheets

IP = 0.1

Angle Coef.	Dist. from initial point	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	2.7										REW
	3.8	0.8	0.55	11	42	.59		.59	.44	.26	
	4.3	0.5	0.7	24	41	1.3		1.3	.35	.45	
	4.8	0.5	0.7	28	41	1.51		1.51	.35	.53	
	5.3	0.5	0.8	23	41	1.24		1.24	.40	.50	
	5.8	0.5	0.8	25	42	1.32		1.32	.40	.53	
	6.3	0.5	0.85	34	40	1.87		1.87	.43	.80	
	6.8	0.5	0.8	28	41	1.51		1.51	.44	.66	
	7.4	0.6	0.75	30	41	1.62		1.62	.41	.67	
	7.9	0.5	0.55	31	40	1.71		1.71	.28	.47	on rock
	8.4	0.5	0.7	19	40	1.06		1.06	.35	.37	
	8.9	0.5	0.65	13	40	.73		.73	.49	.36	
	9.9	1.0	0.35	8	46	.40		.40	.35	.14	
	10.9										LEW

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5
Time of each velocity measurement must be >40 seconds

IENTERED
RCMAINQ98.XLS

MONO

McBain & Trush

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MONO

Meas. No. LRC-9801 A
Comp. by
Checked by

LOWER RUSH CRK Discharge Measurement Notes

Station name MAINSTEM U.S. 10 CONNECTOR Units (SI/English) ST, CFS

Date 6-4, 19 98 Hydrographers MIERAU & MERRILL

Width 15.5 Area 14.26 Vel. 2.55 G.H. — Disch. 36.40

Method 0.6 No. secs. 14 G.H. change 0 in 0.75 hrs. Susp. —

Method coef. — Hor. angle coef. — Susp. coef. — G.H. of zero flow —

Time	Gage Reading Recorder	Outside
15:24	—	—
15:45	—	
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa.

Battery voltage

Type of meter AA Meter No. 595

Date rated — for rod, other

Meter — ft. above bottom of weight

Spin before meas. 3:09 after 2:25 seconds

Meas. Plots — % diff. from rating —

Wading, cable, ice, boat, upstr., dowstr,. side, bridge 60

feet, mile above, below, gage and 10 CONNECTOR

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section SMALL NAIL ON RIGHT BANK

Flow conditions STEADY Weather BREEZY, CLEAR

Air — F@ — Water — F@ —

Gage — Record removed —

Control DOWNSTREAM RIFFLE

Re[redacted]ks CROSS SECTION NOT IDENTIFIED W/ PAST MEASUREMENT

[redacted]o THERMOMETER

Measurement # LRC-9501A **Discharge Measurement Raw Data Sheets**

IP = 0.6

Angle Coef.	Dist. from initial point	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	1.2	—	—								REW
	2.1	0.9	0.45	13	42	.69		.69	.41	.28	
	3.0	0.95	1.1	36	40	1.98		1.98	1.05	2.07	
	4.0	1.0	1.25	49	40	2.69		2.69	1.25	3.36	
	5.0	1.0	1.4	73	40	3.99		3.99	1.4	5.59	
	6.0	1.0	1.3	73	40	3.99		3.99	1.3	5.19	ON ROCK
	7.0	1.0	1.4	65	40	3.56		3.56	1.4	4.98	
	8.0	1.0	1.2	50	41	2.68		2.68	1.2	3.21	
	9.0	1.0	1.1	56	40	3.07		3.07	1.1	3.37	
	10.0	1.0	1.1	45	41	2.41		2.41	1.1	2.65	
	11.0	1.0	0.9	33	41	1.77		1.77	0.9	1.60	
	12.0	1.0	0.85	47	42	2.46		2.46	0.85	2.09	
	13.0	1.0	0.8	29	40	1.13		.13	0.8	.10	
	14.0	1.0	0.7	26	41	1.40		1.4	0.7	.98	
	15.0		0.6	21	41	1.14		1.14	.81	.92	
	16.7										LEW

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

ENTERED
RC395Q98.XLS

MONO

McBain & Trush

~~Trinity River~~ Gaging
MONO

Meas. No. URC - 9801
Comp. by ______
Checked by ______

Discharge Measurement Notes

Station name OLD 395 BRIDGE Units (SI/English) FT. CFS

Date 6-3, 1998 Hydrographers MIERAU + MERRILL

Width 28.1 Area 23.03 Vel. 2.54 G.H. N/A Disch. 58.48

Method 0.6 No. secs. 17 G.H. change 0 in 0.5 hrs. Susp. —

Method coef. — Hor. angle coef. — Susp. coef. — G.H. of zero flow —

Time	Gage Reading Recorder	Outside
16:19	N/A	N/A
16:47		
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______
Battery voltage ______

Type of meter AA Meter No. 595

Date rated — for rod, other

Meter — ft. above bottom of weight

Spin before meas. 2:50 after 2:57 seconds

Meas. Plots ______ % diff. from rating ______

Wading, cable, ice, boat, upstr., dowstr., side, bridge 20 feet, mile, above, below gage and OLD 395 BRIDGE

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section SMOOTH SURFACE, SMALL SUBSTRATE, 1 BIG ROCK NEAR RIGHT BANK

Flow conditions STEADY Weather CLEAR / WINDY

Air COLD!! F@ ______ Water COLD!! F@ ______

Gage — Record removed —

Control RIFFLE 10 FT. DOWNSTREAM

Remarks 1ST MEASUREMENT AT THIS SITE, NO THERMOMETER IN BOX

Measurement #RC-9801 **Discharge Measurement Raw Data Sheets** Page 1 of 1

Angle Coef.	Dist. from initial point	Width	Depth	Revolutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	15.4	–	0	–	–						LEW
	17.0	1.55	0.5	21	41		1.14		0.775	0.88	
	18.5	1.5	0.8	61	41		3.26		1.20	3.91	
	20.0	1.5	1.3	50	40		2.74		1.95	5.34	
	21.5	1.5	1.25	73	42		3.80		1.875	7.125	
	23.0	1.5	1.55	71	41		3.79		2.325	8.81	
	24.5	1.5	1.3	56	40		3.07		1.95	5.99	
	26.0	1.5	1.15	53	41		2.84		1.725	4.90	
	27.5	1.5	0.9	50	43		2.55		1.35	3.44	ON ROCK
	29.0	1.5	1.15	49	41		2.62		1.725	4.52	
	30.5	1.5	1.2	38	41		2.04		1.8	3.67	
	32.0	1.5	1.1	36	40		1.98		1.65	3.27	
	33.5	1.5	0.75	27	41		1.46		1.125	1.64	
	35.0	1.5	1.0	32	42		1.68		1.5	2.52	
	36.5	1.5	0.75	27	41		1.46		1.125	1.64	
	38.0	1.5	0.3	24	40		1.33		0.45	0.60	BEHIND ROCK
	39.5	1.5		–	–		0				BEHIND ROCK ZERO VELOCITY
	41.0	2.0	0.25	9	45		0.46		0.50	0.23	FLOW AROUND ROCK
	43.5	–	0	–	–						REW
									Σ	58.5	

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

43.5

McBain & Trush

Trinity River Gaging

Meas. No. 9802

Comp. by BRM

Checked by

Discharge Measurement Notes

Station name Rush Creek Connector 10 channel Units (SI/English) ft. cfs

Date 7/3, 1998 Hydrographers Merrill Bair

Width 12.4 Area 17.24 Vel. 4.21 G.H. – Disch. 72.61

Method 0.6 No. secs. 19 G.H. change – in – hrs. Susp. –

Method coef. – Hor. angle coef. – Susp. coef. – G.H. of zero flow –

Time	Gage Reading Recorder	Gage Reading Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa.

Battery voltage

Type of meter AA Meter No. 595

Date rated – for rod, other

Meter – ft. above bottom of weight

Spin before meas. +90 after +90 seconds

Meas. Plots – % diff. from rating –

Wading, cable, ice, boat, upstr., dowstr,. side, bridge 70

feet, mile, above, below, gage and MAIN CHANNEL

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section USUAL UNREFERENCED CROSS SECTION LARGE WAVES ON SURFACE.

Flow conditions STEADY Weather CLEAR

Air F@ Water F@

Gage Record removed

Control DOWNSTREAM RIFFLE

Remarks

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
1.0	2	1.15	1.4	60	41	3.21		3.21	1.61	5.16	
1.0	2.5	.5	1.5	80	40	4.37		4.37	.75	3.28	
1.0	3	.5	1.6	100	41	5.32		5.32	.80	4.26	
1.0	3.5	.5	1.6	105	41	5.59		5.59	.80	4.47	
1.0	4	.5	1.8	80	42	4.16		4.16	.90	3.75	
1.0	4.5	.5	1.9	85	40	4.64		4.64	.95	4.41	
1.0	5	.5	1.9	100	41	5.32		5.32	.95	5.06	
1.0	5.5	.5	1.8	100	40	5.46		5.46	.90	4.91	
1.0	6	.5	1.9	85	40	4.64		4.64	.95	4.41	
1.0	6.5	.5	2.1	80	40	4.37		4.37	1.05	4.59	
1.0	7	.5	2.1	100	42	5.20		5.20	1.05	5.46	
1.0	7.5	.5	1.9	105	40	5.73		5.73	.95	5.44	
1.0	8	.5	2.1	100	41	5.32		5.32	1.05	5.59	
1.0	8.5	.5	2	85	41	4.53		4.53	1.00	4.53	
1.0	9	.5	1.9	60	40	3.29		3.29	.95	3.12	
1.0	9.5	.5	1.8	40	41	2.15		2.15	.90	1.93	
1.0	10	.5	1.1	35	42	1.84		1.84	.55	1.01	
1.0	10.5	.5	1.0	35	42	1.84		1.84	.50	.92	
1.0	11	1.05	.6	10	43	.53		.53	.63	.33	
	0.2										LEW
	12.6										REW

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

7-3-98: Discharge on 10 Channel Connector of Rush Creek - just upstream of the confluence with the Main

*There is ~ 2cfs flowing through the Right Bank willows

*Meter set to 1 click equals 5 revolutions

Stn	Time (sec)	Clicks	Width (ft)	depth (ft)	Area ϕ	Velocity	Q	Notes	
0.20	O	O	O	O	O	O	O	Left edge of water	1
2.00	41	13	1.15	1.4				a lot of woody debris along the left bank. This verticle is the first station past it	
-.									
2.50	40 sec	17	0.5	1.5	0.75				2
3.00	41 sec	21	0.5	1.6	0.80			ALL CLICK VALUES SHOULD BE	3
3.50	41 sec	22	0.5	1.6	0.80			REDUCED BY ONE.	4
4.00	42 sec	17	0.5	1.8	0.90				5
4.50	40 sec	18	0.5	1.9	0.95			ENTERED BRM	6
5.00	41 sec	21	0.5	1.9	0.95			07-07-98	7
5.50	40 sec	21	0.5	1.8	0.90				8
6.00	40 sec	18	0.5	1.9	0.95				9
6.50	40 sec	17	0.5	2.1	1.05				10
7.00	42 sec	21	0.5	2.1	1.05				11
7.50	40 sec	22	0.5	1.9	.95			On a rock	12
8.0	41 sec	21	0.5	2.1	1.05				13
8.5	41 sec	18	0.5	2.0	1.0				14
9.0	40 sec	13	0.5	1.9	0.95				15
9.5	41 sec	9	0.5	1.8	0.90				16
10.0	42 sec	8	0.5	1.1	0.55				17
10.5	42 sec	8	0.5	1.0	0.50				[illegible]
11.0	43 sec	3		0.6					[illegible]
12.6								Right Edge of water	

FB #5

McBain & Trush

Trinity River Gaging

Meas. No. 9802

Comp. by BEm

Checked by ________

Discharge Measurement Notes

Station name Rush Creek Main Channel above the 10 connector Units (SI/English) CSS SC

Date 7/3, 1998 Hydrographers Merrill + Bair

Width 19.7 Area 29.09 Vel. 4.32 G.H. — Disch. 125.56

Method 0.6 No. secs. 21 G.H. change — in — hrs. Susp. —

Method coef. — Hor. angle coef. — Susp. coef. — G.H. of zero flow —

Time	Gage Reading Recorder	Gage Reading Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ________

Battery voltage ________

Type of meter AA Meter No. 595

Date rated — for rod, other

Meter — ft. above bottom of weight

Spin before meas. +90 after +90 seconds

Meas. Plots — % diff. from rating —

Wading, cable, ice, boat, upstr., dowstr,. side, bridge 70

feet, mile, above, below, gage and 10 CONNECTOR CHANNEL

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section LARGE WAVES ON SURFACE

Flow conditions STEADY Weather CLEAR

Air — F@ — Water — F@ —

Gage — Record removed —

Control DOWNSTREAM RIFFLE

Remarks ________

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
1.0	5	1.35	.6	30	40	1.66		1.66	.81	1.34	
1.0	6	1.0	.7	50	41	2.68		2.68	.70	1.87	
1.0	7	1.0	.7	65	43	3.31		3.31	.70	2.32	
1.0	8	1.0	.8	65	44	3.24		3.24	.80	2.59	
1.0	9	1.0	1.0	60	41	3.21		3.21	1.0	3.21	
1.0	10	1.0	1.2	70	41	3.73		3.73	1.2	4.48	
1.0	11	1.0	1.3	80	45	3.89		3.89	1.3	5.05	
1.0	12	1.0	1.5	70	40	3.83		3.83	1.5	5.74	
1.0	13	1.0	2	80	41	4.26		4.26	2.0	8.53	
1.0	14	1.0	2.2	90	42	4.68		4.68	2.2	10.3	
1.0	15	1.0	2.3	100	41	5.32		5.32	2.3	12.24	
1.0	16	1.0	2.4	115	42	5.97		5.97	2.4	14.33	
1.0	17	.75	2.5	115	42	5.97		5.97	1.88	11.20	
1.0	17.5	.5	2.5	120	43	6.09		6.09	1.25	7.61	
1.0	18	.5	2.5	110	42	5.71		5.71	1.25	7.14	
1.0	18.5	.5	2.4	105	40	5.73		5.73	1.20	6.87	
1.0	19	.5	2.3	[illegible]	42	[illegible]		5.2	1.15	5.98	
1.0	19.5	.5	2.1	90	[illegible]	[illegible]		4.91	1.05	5.16	
1.0	20	.75	2.0	60	40	[illegible]		3.29	1.5	4.93	
1.0	21	1.0	1.9	35	41	1.88		1.88	1.9	3.57	
1.0	22	1.0	1.0	20	40	1.11		1.11	1.0	1.11	
	3.3										LEW
	23.0										REW

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

7-3-98 Discharge on Main Channel of Rush Creek - just above the 10 connector channel

Price AA # 595 (McBain Truck)
→ Set to 1 click for every 5 revolutions

Stn	Time(sec)	Clicks	width(ft)	depth(ft)	Area ft²	Velocity	Q	Notes
3.3	0	0	0	0	0	0	0	Left edge of water
5.0	40 sec	7	1.4	0.6	.84			(1)
6.0	41 sec	11	1.0	0.7	0.7			(2)
7.0	43 sec	14	1.0	0.7	0.7			(3)
8.0	44 sec	14	1.0	0.8	0.8			(4)
9.0	41 sec	13	1.0	1.0	1.0			(5)
10.0	41 sec	15	1.0	1.2	1.2			(6)
11.0	45 sec	17	1.0	1.3	1.3			(7)
12.0	40 sec	15	1.0	1.5	1.5			(8)
13.0	41 sec	17	1.0	2.00	2.0			(9)
14.00	42	19	1.0	2.20	2.2			(10)
15.00	41	21	1.0	2.30	2.3			(11)
16.00	42	24	1.0	2.40	2.4			(12)
17.00	42	24	0.75	2.50	1.88			(13)
17.50	43	25	0.50	2.50	1.25			(14)
18.00	42	23	0.50	2.50	1.25			(15)
18.50	40	22	0.50	2.40	1.20			(16)
19.00	42	21	0.50	2.30	1.15			(17)
19.50	40	19	0.50	2.10	1.05			(18)
20.00	40	13	0.75	2.00	1.75			(19)
21.00	41	8	1.0	1.90	1.00			(20)
22.00	40	5	1.0	1.00				(21)
23.00								Right edge of water

NOTE: ALL CLICKS NOTED ON PREVIOUS PAGE SHOULD BE REDUCED BY ONE. THERE WAS A SYSTEMATIC ERROR IN COUNTING

ENTERED 07-07-98
BRM

FB#5

McBain & Trush

Trinity River Gaging

Meas. No. 9802

Comp. by BRM

Checked by

Discharge Measurement Notes

Station name Rush Crk 10 channel Units (SI/English) CFS, FT.

Date 7/3, 1998 Hydrographers Merrill + Bair

Width 36.6 Area 33.33 Vel. 3.81 G.H. — Disch. 126.95

Method 0.6 No. secs. 23 G.H. change — in — hrs. Susp. —

Method coef. — Hor. angle coef. — Susp. coef. — G.H. of zero flow —

Time	Gage Reading Recorder	Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa.

Battery voltage

Type of meter AA Meter No. 595

Date rated — for rod, other

Meter — ft. above bottom of weight

Spin before meas. +90 after +90 seconds

Meas. Plots — % diff. from rating —

Wading, cable, ice, boat, upstr., dowstr,. side, bridge 80

feet, mile, above, below gage and 10 CONNECTOR SPLIT

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section TAKEN ON WIDE SHALLOW BEND

Flow conditions STEADY Weather CLEAR

Air — F@ — Water — F@ —

Gage — Record removed —

Control DOWNSTREAM RIFFLE

Remarks

Measurement # 9802 **Discharge Measurement Raw Data Sheets**

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
1.0	7.8	1.45	.9	50	40	2.74		2.74	1.31	3.58	
1.0	9	1.10	1.3	70	43	3.56		3.56	1.43	5.09	
1.0	10	1.0	1.5	85	41	4.53		4.53	1.50	6.79	
1.0	11	1.0	1.6	70	41	3.73		3.73	1.60	5.98	
1.0	12	1.0	1.5	100	40	5.46		5.46	1.50	8.18	
1.0	13	1.0	1.4	95	41	5.06		5.06	1.40	7.08	
1.0	14	1.0	1.2	105	41	5.59		5.59	1.20	6.70	
1.0	15	1.0	1.3	90	41	4.79		4.79	1.30	6.23	
1.0	16	1.0	1.1	110	41	5.85		5.85	1.10	6.44	
1.0	17	1.0	1.2	75	41	4.0		4.0	1.20	4.80	
1.0	18	1.0	1.1	90	40	4.91		4.91	1.10	5.40	
1.0	19	1.0	1.1	70	42	3.65		3.65	1.10	4.01	
1.0	20	1.5	1.0	100	42	5.20		5.20	1.50	7.80	
1.0	22	2.0	1.0	90	40	4.91		4.91	2.0	9.83	
1.0	24	2.0	.9	75	40	4.10		4.10	1.80	7.38	
1.0	26	2.0	.9	60	42	3.13		3.13	1.80	5.63	
1.0	28	2.0	.8	55	43	2.81		2.81	1.60	4.49	
1.0	30	2.0	1.9	55	40	3.01		3.01	3.80	11.45	
1.0	32	2.0	.8	60	40	3.29		3.29	1.60	5.26	
1.0	34	2.0	.5	55	42	2.87		2.87	1.00	2.87	
1.0	36	2.0	.3	30	44	1.51		1.51	.60	.90	
1.0	38	2.0	.3	20	50	.89		.89	.60	.54	
1.0	40	2.55	.55	10	[illegible]	.40		.40	1.29	.51	
	6.1										LEW
	42.7										REW

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

7-3-98 10 Channel downstream of of the connector - Discharge Measurement - Rush Creek

Price "AA" 594 Meter set to 1 click equals 5 revolutions

Stn	Time	Clicks	width	depth	Area	Velocity	Q	Notes
6.1	0	0	0	0	0	0	0	Left edge of Water
7.8	40 sec	11	1.45	0.9				1
9.0	43 sec	15	1.10	1.3	1.43			2
10.00	41 sec	18	1.00	1.50	1.50			3
11.00	41 sec	15	1.00	1.60	1.60			4
12.00	40 sec	21	1.00	1.50	1.50			5
13.00	41 sec	20	1.00	1.40	1.40			6
14.00	41 sec	22	1.00	1.20	1.20			7
15.00	41 sec	19	1.00	1.30	1.30			8
16.00	41 sec	23	1.00	1.10	1.10			9
17.00	41 sec	16.	1.00	1.20	1.20			10
18.00	40 sec	19	1.00	1.10	1.10			11
19.00	42 sec	15	1.00	1.10	1.10			12
20.00	42 sec	21	1.50	1.00	1.50			13
22.00	40 sec	19	2.00	1.00	2.00			14
24.00	40 sec	16	2.00	0.9	1.80			15
26.00	42 sec	13	2.00	0.9	1.80			16
28.00	43 sec	12	2.00	0.8	1.60			17
30.00	40 sec	12	2.00	1.90	3.80			18
32.00	40 sec	13	2.00	0.8	1.60			19
34.00	42 sec	12	2.00	0.5	1.00			20
36.00	44 sec	7	2.00	0.3	0.60			21

ALL CLICKS ARE REDUCED BY ONE DUE TO A SYSTEMATIC ERROR

ENTERED 7-7-98
BRM

FB #5

10 channel downstream of the connector - Discharge measuement · CONTINUED

Sta	Time	Clicks	width	depth	Area	Velocity	Q	Notes
38.00	50	5	2.00	0.3	0.60			
40.00	58	3	2.35	0.55	.			
42.70	0	0	0	0	0	Right edge of water		

Brian Guesses 80 cfs in 10
60 cfs in connector
110 cfs in main
ALL WAY OFF!

FB #5

Menu/FlowDATA/Qmst/RC10channel 10/29, kw

9/13/96 Rush creek 10 channel discharge measurement

measurement taken on Valley wide cross section (XS 7+25) where it crosses 10 channel, tape tied on Piezometer on LB approx 10 ft from Left bank of 10 channel

SPin test - OK

Darren M... - Pulse M
Scott M... - Notes

measurement rated excellent due to smooth uniform flow and pea gravel bottom

Begin measurement @ 5:30 pm
End measurement @ 6:10 pm

STN(ft)	depth(ft)	Rev's	time(sec)	Vel (ft/s)	Dir. (ft²)	Q. (cfs)		NOTES
13	0	—	—	0	—	0		Left bank waterline
14	0.45	13	44	0.66	0.45	0.30		
15	0.60	17	42	0.90	0.51	0.46		
15.7	0.75	22	42	1.34	0.53	0.71		
16.4	0.90	20	40	1.11	0.59	0.65		
17.1	0.85	32	41	1.72	0.60	1.03		on cobble
17.8	1.1	35	42	1.84	0.77	1.41		
18.5	1.15	34	41	1.83	0.71	1.47		
19.2	1.25	38	40	2.09	0.87	1.83		
19.9	1.25	41	40	2.25	0.87	1.96		
20.6	1.4	40	40	2.20	0.98	2.16		
21.3	1.4	38	40	2.09	0.98	2.05		
22	1.4	46	42	2.41	0.98	2.36		
22.7	1.4	49	42	2.56	0.98	2.51	18.90	
23.4	1.4	45	40	2.47	0.98	2.42		
24.1	1.3	46	41	2.46	0.91	2.24		
24.8	1.3	44	41	2.35	0.91	2.15		
25.5	1.25	45	40	2.47	0.875	2.16		
26.2	1.25	44	41	2.35	0.875	2.06		
26.9	1.2	44	40	2.42	0.84	2.03		
27.6	1.2	37	40	2.04	0.84	1.71		

FB#5

server/Model/Flowdata/Qmsmt/RCXSH 10/2 KW

9/13/99 Rock creek discharge measurement at XS-H

STN(ft)	depth(ft)	Revs	time(sec)	Vel(ft/s)	Area(ft²)	Qi(cfs)
40.6	0	—	—	0	-	0
41	2.0	66	40	3.61	2.3	8.30
42	2.2	67	41	3.58	2.2	7.88
43	2.3	51	41	2.73	2.3	6.28
44	2.2	59	42	2.87	2.2	6.32
45	2.1	60	40	3.27	2.1	6.90
46	1.9	62	42	3.23	1.9	6.14
47	1.8	60	40	3.28	1.8	5.90
48	1.7	64	40	3.50	1.7	5.95
49	1.5	65	41	3.47	1.5	5.21
50	1.6	70	42	3.65	1.6	5.83
51	1.6	58	40	3.18	1.6	5.09
52	1.5	56	41	2.99	1.6	4.79
53	1.35	52	40	2.65	1.35	3.85
54	1.30	64	41	3.42	1.3	4.44
55	1.30	62	40	3.39	1.3	4.41
56	1.3	56	40	3.07	1.3	3.99
57	1.3	62	40	3.39	1.3	4.44
58	1.1	52	40	2.85	1.1	3.14
59	1.2	51	41	2.73	1.2	3.28
60	1.15	56	40	3.07	1.44	4.42
61.5	1.2	63	41	3.36	1.8	6.05
63	1.1	51	40	2.80	1.65	4.61

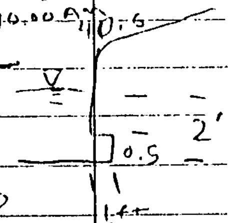
Tape was not quite perpendicular to flow on XS-H, so we moved tape up stream slightly!

1. Begin measurement @ 9:30 AM
End measurement @ 10:00 AM

NOTE

LB water edge

Undercut bank



A = 0.5(2) + 0.4(2) + 0.5(1) = 2.3

large cobble upstream

FB#5

9/13/98 Rush creek discharge measurement at XS "H"

STN (ft)	depth (ft)	Revs	time (sec)	Vel (ft/s)	Area (ft²)	Q_i (cfs)
64.5	1.0	59	40	3.23	1.5	4.85
66	0.8	55	42	2.87	1.2	3.44
67.5	0.8	61	40	3.33	1.2	4.00
69	0.85	39	41	2.09	1.27	2.66
70.5	0.7	33	41	1.77	0.87	1.54
71.5	0.55	30	40	1.66	0.55	0.91
72.5	0.45	36	41	1.94	0.45	0.87
73.5	0.3	23	45	1.13	0.23	0.26
74.0	0	—	—	0	—	0

NOTES

Right edge of water

$\Sigma Q_i = 135.7$

$Q = 135.7$ cfs

ave water surface elevation on XS "H" =

$$\frac{83.03 + 82.92}{2} = 82.97'$$

Staff gage upstream of XS 0+86 = 1.17'
@ 10:30 AM

FB#5

McBain & Trush

Trinity River Gaging

Meas. No. 99-01

Comp. by Zeb

Checked by Darren

Discharge Measurement Notes

Station name Lower Rush Cr. 10 channel @ pizzometer station Units (SI/English) ft/cfs

Date 5/6, 1999 Hydrographers Zeb Stecker & Darren Mierau

Width 12.5 ft Area 5.86 ft^2 Vel. 1.78 fps G.H. ______ Disch. 10.44

Method ______ No. secs. ______ G.H. change ______ in ______ hrs. Susp. ______

Method coef. ______ Hor. angle coef. ______ Susp. coef. ______ G.H. of zero flow ______

Time	Gage Reading Recorder	Outside
5:30		
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______

Battery voltage ______

Type of meter Price AA Meter No. 5595

Date rated ______ for rod, other

Meter ______ ft. above bottom of weight

Spin before meas. 141 after ______ seconds

Meas. Plots ______ % diff. from rating ______

Wading, cable, ice, boat, upstr., dowstr,. side; bridge 5 ft

feet, mile, above, below, gage and pizzometer @ 10 channel riffle

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Smooth bottom & even flow, shallow on LB

Flow conditions Winter baseflow Weather Warm & Clear

Air ______ F@ ______ Water ______ F@ ______

Gage ______ Record removed ______

Control ______

Remarks ______

$Q = AV$

Measurement #_____ **Discharge Measurement Raw Data Sheets**

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	8.5										left edge water
	10.0	1.25	.2	21	42.96	1.09				.27	
	11.0	.85	.3	27	41.47	1.44				.37	
	11.7	.7	.5	34	41.73	1.81				.63	
	12.4	.7	.6	44	42.17	2.29				.89	
	13.1	.7	.6	39	41.91	2.05				.86	
	13.8	.7	.7	45	41.23	2.40				1.26	
	14.5	.7	.7	43	42.19	2.24				1.02	
	15.1	.7	.6	43	41.75	2.26				.88	
	15.8	.7	.6	38	41.66	2.01				.84	
	16.5	.7	.5	36	41.73	1.90				.67	
	17.2	.7	.6	34	41.61	1.80				.70	
	17.8	.65	.6	32	42.15	1.68				.65	
	18.5	.7	.7	33	42.57	1.71				.84	
	19.2	.7	.6	20	41.81	1.06				.45	
	19.9	.7	.4	6	49.37	.28				.10	
	21.0										right edge water
										10.42	cfs

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. 99-01

Comp. by Zcb

Checked by Darren DD

Discharge Measurement Notes

Station name Lower Rush Creek @ XS-H below 10-channel return Units (SI/English) ft/cfs

Date 5-6, 1999 Hydrographers Dalten & Zcb

Width 26.2 ft Area 29.02 ft² Vel. 1.80 fps G.H. ____ Disch. 52.16 cfs

Method ____ No. secs. ____ G.H. change ____ in ____ hrs. Susp. ____

Method coef. ____ Hor. angle coef. ____ Susp. coef. ____ G.H. of zero flow ____

Time	Gage Reading Recorder	Gage Reading Outside
5:02		
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ____

Battery voltage ____

Type of meter Price AA Meter No. 5595

Date rated ____ for rod, other

Meter Price AA ft. above bottom of weight

Spin before meas. 141 after ____ seconds

Meas. Plots ____ % diff. from rating ____

Wading, cable, ice, boat, upstr., dowstr., side, bridge 200

feet, mile, above, below, gage and 10 channel return

Measurement rated excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section rectangular, uniform depth, laminar flow

Flow conditions low-flow Weather Warm & partial clouds

Air ____ F@ ____ Water ____ F@ ____

Gage ____ Record removed ____

Control ____

Remarks ____

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	2.7										left edge water
	3.5		0.7	17	43.0	.88				.71	
	5.0		0.9	29	42.1	1.52				2.05	
	6.5		1.0	26	42.3	1.36				2.04	
	8.0		1.0	30	42.0	1.58				2.37	
	9.5		0.9	32	41.2	1.71				2.31	
	11.0		1.0	35	42.4	1.82				2.73	
	12.5		1.05	35	42.0	1.84				2.89	
	14.0		1.1	34	41.5	1.81				2.98	
	15.5		1.1	36	41.4	1.92				3.16	
	17.0		1.3	35	41.8	1.85				3.60	
	18.5		1.25	43	41.5	2.28				4.27	
	20.0		1.3	42	41.6	2.22				4.33	
	21.5		1.35	47	42.0	2.51				5.08	
	23.0		1.4	40	41.6	2.12				4.44	
	24.5		1.45	35	42.5	1.82				3.95	
	26.0		1.55	32	43.8	1.61				3.75	
	27.5		1.2	17	44.3	.86				1.49	
	28.9										Right edge water

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

Entered 6-22-99 . J.Bair

McBain & Trush

~~Trinity River~~ Gaging
Mono Lake

Meas. No. ______
Comp. by J.Bair
Checked by ______

Discharge Measurement Notes

Station name Rush Creek, Mainstem Units (SI/English) English

Date 6-4-99, 19____ Hydrographers John Bair

Width ______ Area ______ Vel. ______ G.H. ______ Disch. ______

Method 0.6 No. secs. ______ G.H. change ______ in ______ hrs. Susp. ______

Method coef. ______ Hor. angle coef. ______ Susp. coef. ______ G.H. of zero flow ______

Time	Gage Reading: Recorder	Gage Reading: Outside
13:50	Start	
15:15	END	
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______

Battery voltage ______

Type of meter ______ Meter No. ______

Date rated ______ for rod, other

Meter ______ ft. above bottom of weight

Spin before meas. ______ after ______ seconds

Meas. Plots ______ % diff. from rating ______

Wading, cable, ice, boat, upstr., dowstr,. side, bridge ______

feet, mile, above, below, gage and ______

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section - 09+82 (our bedload mobility cross section

Flow conditions ______ Weather Overcast, some light snow showers

Air ______ F@ ______ Water ______ F@ ______

Gage ______ Record removed ______

Control ______

Remarks ______

REW 73
LEW = 41

Measurement #_____ **Discharge Measurement Raw Data Sheets** Page ___ of ___

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity point	At mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	41.0									Ø	Left water edge
	42.0		1.95	65	42.1						
	43.0		1.95	50	40.2						
	44.0		1.80	50	41.0						
	45.0		1.75	60	44.9						
	46.0		1.75	50	42.5						
	47.0		1.55	55	43.5						
	48.0		1.40	50	46.4						
	49.0		1.30	55	42.7						
	50.0		1.20	55	42.2						
	51.0		1.1	55	42.2						
	52.0		1.1	55	43.0						
	53.0		1.0	50	44.0						
	54.0		1.0	39	42.0						
	55.		0.85	41	42.0						
	56.0		0.90	50	43.0						
	57.0		0.90	42	41.3						
	58.		1.00	39	42.1						
	59.0		0.90	55	47.0						
	60.0		0.80	50	43.0						
	61.0		0.80	55	43.4						
	62.0		0.90	45	40.9						
	63.0		0.80	33	40.6						
	64.0		0.70	30	54.1						
	65.0		0.70	45	45.1						
	66.0		0.55	33	44.6						
	67.0		0.50	46	41.9						
	68.0		0.40	37	42.1						
	69.0		0.55	17.	44.1						
	71.0		0.50	16	44.2						
	42.5		2.00	55	42.2						

Note: This measurement belongs to weir

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

72.8 is the Right edge of water

Entered J. Bair 6-22-99

McBain & Trush
~~Trinity River~~ Gaging
Mono Lake

Meas. No. ______
Comp. by J. Bair
Checked by ______

Discharge Measurement Notes

Station name Lower Rush Creek, 10 channel Units (SI/English) English

Date June 4, 1999 Hydrographers J Bair

Width 19.5 Area 10.51 Vel. 1.68 G.H. ______ Disch. 17.67

Method 0.6 No. secs 28 G.H. change — in ______ hrs. Susp. ______

Method coef. ______ Hor. angle coef. ______ Susp. coef. ______ G.H. of zero flow ______

Time	Gage Reading Recorder	Gage Reading Outside
11:15 AM	Start	
12:30 PM	Finish	
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______

Battery voltage ______

Type of meter Price AA Meter No. 594

Date rated ______ for rod, other

Meter ______ ft. above bottom of weight

Spin before meas. OK after 90 seconds

Meas. Plots ______ % diff. from rating ______

Wading, cable, ice, boat, upstr., dowstr,. side, bridge ______

feet, mile, above, below, gage and ______

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section ______

Flow conditions ______ Weather Overcast, snowy

Air ______ F@ ______ Water ______ F@ ______

Gage ______ Record removed ______

Control Clear

Remarks We need to install a permanent cross section at this channel 10

LEW = 2.7 ft

24 x 96 → 30 - 40 min

Measurement #_____ **Discharge Measurement Raw Data Sheets**

	Angle Coef.	Tape dist.	Width	Depth	Revolutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
		2.2		0	0						∅	Left edge of water
1		6.5		0.35	23	42.4						
2		7.0		0.4	24	42.9						
3		7.5		0.5	33	43.3						
4		8.0		0.55	30	45.0						
5		8.5		0.50	34	41.7						
6		9.0		0.45	28	42.7						
7		9.5		0.60	28	43.5						
8		10.0		0.60	39	44.7						
9		10.5		0.60	34	42.5						
10		11.0		0.60	36	42.8						
11		11.5		0.65	43	42.0						
12		12.0		0.60	42	46.5						
13		12.5		0.70	40	42.6						
14		13.0		0.80	40	41.5						
15		13.5		0.85	42	46.3						
16		14.0		0.80	36	41.2						
17		14.5		0.75	36	41.6						
18		15.0		0.80	36	42.2						
19		15.5		0.85	36	41.6						
20		16.0		0.80	37	41.4						
21		16.5		0.80	36	42.6						
22		17.0		0.80	35	42.7						
23		17.5		0.90	30	40.7						
24		18.0		0.85	36	41.0						
25		18.5		0.80	37	41.7						
26		19.		0.70	30	43.1						
27		19.5		0.65	23	41.4						
28		20		0.60	11	41.2						
29		22.2		0							∅	Right edge of water
30												

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

lower Rush lo-channel

Discharge Measurement Notes

Meas. No. 1 + 2 (2 pages)

Comp. by T. Worsley

Checked by ______

Station name XS A of Ten Channel Rush Ck Units (SI/English) English (feet in tenths)

Date 21 July, 19 99 Hydrographers D. Mierau, T. Worsley

Width ______ Area ______ Vel. ______ G.H. ______ Disch. ______

Method ______ No. secs. 40 G.H. change 0 in 1 hrs. Susp. ______

Method coef. ______ Hor. angle coef. ______ Susp. coef. ______ G.H. of zero flow ______

Time	Gage Reading Recorder	Outside
1440		
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______

Battery voltage ______

Type of meter Marsh McBirney Meter No. ______

Date rated ______ for rod, other

Meter ______ ft. above bottom of weight

Spin before meas. ______ after ______ seconds

Meas. Plots ______ % diff. from rating ______

Wading, cable, ice, boat, upstr., dowstr,. side, bridge Wading

feet, mile, above, below, gage and at Piezometer station

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section excellent XS (homogeneous) flow uniform

Flow conditions uniform + even Weather clear sunny

Air 80°F F@ ______ Water 63°F F@ ______

Gage ______ Record removed ______

Control ______

Remarks Compares Marsh McBirney w/ price AA

Measurement # 1 **Discharge Measurement Raw Data Sheets**

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	11.0'		0								Left Edge of Water
	12.0'	1.0	0.4		40.0	0.40	6/10			.16	
	13.0'		0.6			0.72				.43	
	14.0'		0.9			0.81				.73	
	15.0'		1.0'			1.34				1.34	
	16.0'		1.1'			1.48				1.63	
	17.0'		1.25			1.71				2.14	
	18.0'		1.30			1.95				2.53	
	19.0'		1.40			2.12				2.97	
	20.0'		1.40			2.12				2.97	
	21.0		1.45			2.11				3.06	
	22.0		1.40			2.26				3.16	
	23.0		1.40			2.47				3.46	
	24.0		1.40			2.72				3.81	
	25.0		1.40			2.55				3.57	
	26.0		1.35			2.46				3.32	
	27.0		1.20			2.54				3.05	
	28.0		1.10			1.95				2.14	
	29.0	1.0	0.95			0.72				.68	
	30.0	1.2	0.50			0.32				.19	
	31.4										
										41.34	

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

31.5 REW

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

Measurement # 2 **Discharge Measurement Raw Data Sheets**

Price AA measure (water - 63°f) XSA of 10 Channel (air 80°f) Rush Ck

Angle coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	11.0		Ø								1410 (time)
	12.0	1.0	0.3	10	43.41		.53			.16	
	13.0		0.5	13	42.34		.70			.35	
	14.0		0.8	15	42.13		.80			.64	
	15.0		1.0	23	45.72		1.12			1.12	
	16.0		1.1	30	42.23		1.57			1.73	
	17.0		1.2	33	42.15		1.73			2.07	
	18.0		1.3	36	42.67		1.86			2.42	
	19.0		1.35	39	42.05		2.04			2.76	
	20.0		1.40	43	41.97		2.25			3.15	
	21.0		1.40	44	42.67		2.27			3.18	
	22.0		1.4	48	42.34		2.49			3.49	
	23.0		1.35	47	42.13		2.45			3.31	
	24.0		1.35	48	42.09		2.51			3.38	
	25.0		1.30	49	41.95		2.57			3.34	
	26.0		1.30	47	42.09		2.45			3.19	
	27.0		1.15	44	41.61		2.32			2.67	
	28.0		1.05	31	43.02		1.59			1.67	
	29.0	1.0	0.90	13	44.38		0.66			.60	
	30.0	1.2	0.45	4	44.02		0.23			.27	
	31.4		Ø								1510
										39.50	

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

Measurement #_____ **Discharge Measurement Raw Data Sheets** Page ___ of ___

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity		Adj. for hor. angle	Area	Discharge	Notes
						At point	mean in vert.				

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. 1

Comp. by T. Worsley

Checked by ______

Discharge Measurement Notes

Station name RUSH CK. ~90' upstrm XS - 9+82 Units (SI/English) English tenths of feet

Date 21 July, 19 99 Hydrographers D. Mierau T. Worsley

Width ______ Area ______ Vel. ______ G.H. ______ Disch. ______

Method ______ No. secs. 25 G.H. change ______ in ______ hrs. Susp. ______

Method coef. ______ Hor. angle coef. ______ Susp. coef. ______ G.H. of zero flow ______

Time	Gage Reading Recorder	Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______

Battery voltage ______

Type of meter Marsh McBirney Meter No. ______

Date rated ______ for rod, other

Meter ______ ft. above bottom of weight

Spin before meas. ______ after ______ seconds

Meas. Plots ______ % diff. from rating ______

Wading, cable, ice, boat, upstr., dowstr,. side, bridge ______

feet, mile, above, below, gage and ______

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section ______

Flow conditions ______ Weather ______

Air ______ F@ ______ Water ______ F@ ______

Gage ______ Record removed ______

Control ______

Remarks ______

Measurement # 1 **Discharge Measurement Raw Data Sheets**

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity point	Velocity At mean in vert.	Adj. for hor. angle	Area	Discharge	begin 1713 END 1732 Notes
	2.3										LEW
	3.0	.85	0.8	—	25	0.42	6/10	Ø		.28	(~ 90 feet upstrm)
	4.0	1.0	1.15			1.70				1.95	XS -9+82
	5.0		1.00			2.27				2.27	
	6.0		1.15			2.11				2.43	
	7.0		1.25			2.46				3.08	
	8.0		1.25			2.35				2.94	
	9.0		1.25			2.84				3.55	
	10.0		1.30			2.70				3.51	
	11.0		1.35			2.93				3.96	
	12.0		1.30			2.84				3.69	
	13.0		1.40			2.79				3.91	
	14.0		1.35			2.77				3.74	35.31
	15.0		1.45			3.27				4.74	
	16.0		1.40			3.12				4.37	
	17.0		1.45			3.05				4.42	
	18.0		1.55			3.19				4.94	
	19.0		1.65			2.93				4.83	
	20.0		1.60			2.85				4.56	
	21.0		1.65			2.81				4.64	
	22.0		1.65			2.90				4.78	
	23.0		1.65			2.99				4.93	
	24.0		1.65			3.05				5.03	
	25.0		1.60			2.97				4.75	
	26.0		1.70			2.64				4.49	
	27.0		1.75			2.77				4.85	
	28.0	1.0	1.70			2.65				4.50	
	29.0	.9	1.50			1.99				2.69	
	29.8										REW
										103.83	

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. 99-01

Comp. by ____

Checked by ____

Discharge Measurement Notes

Station name Lower Rush main channel in planmap Units (SI/English) English (feet in tenths)

Date 21 July, 1999 Hydrographers D. Micrau T. Worsley

Width ____ Area ____ Vel. ____ G.H. ____ Disch. ____

Method ____ No. secs. ____ G.H. change ____ in ____ hrs. Susp. ____

Method coef. ____ Hor. angle coef. ____ Susp. coef. ____ G.H. of zero flow ____

Time	Gage Reading Recorder	Gage Reading Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ____

Battery voltage ____

Type of meter Marsh McBirney Meter No. ____

Date rated ____ for rod, other

Meter ____ ft. above bottom of weight

Spin before meas. ____ after ____ seconds

Meas. Plots ____ % diff. from rating ____

Wading, cable, ice, boat, upstr., dowstr., side, bridge 10

feet, mile, above, below, gage and XS 10+10

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section shallow uniform depth & laminar flow

Flow conditions receding spring runoff Weather Sunny clear ~25mph SW winds

Air 90° F@ 1600 Water 63 F@ 1600

Gage ____ Record removed ____

Control ____

Remarks This discharge is the total flow through planmap reach, for comparison to calculated flow from (main Q) - (loch Q)

Measurement #1

Discharge Measurement Raw Data Sheets

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes (Begin 1755 END 1810)
	6.4		0								LEW
	8.0	1.8	0.3		25	0.46				.25	
	10.0	2	0.7			1.43				2.00	
	12.0	2	0.5			1.43				1.43	
	14.0	2	0.5			1.44				1.44	
	16.0	2	0.55			2.08				2.29	
	18.0	2	0.65			2.23				2.90	
	20.0	2	0.90			2.68				4.82	
	22.0	2	0.95			2.85				5.41	
	24.0	2	1.10			2.79				6.14	
	26.0	2	1.10			2.95				6.49	
	28.0	2	1.20			3.18				7.63	
	30.0	2	1.2			3.04				7.30	
	32.0	2	1.2			2.85				6.84	
	34.0	2	1.0			2.97				5.94	
	36.0	2	1.0			2.39				4.78	
	38.0	2	0.7			1.76				2.46	
	40.0	2	0.7			1.47				2.06	
	42.0	2	0.5			1.31				1.31	
	43.0	1.1	0.5			1.00				.55	
	44.2		0								REW 1810 END
										72.04	

Q = 71.72 :- Excel workbook

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

June 14, 2000
Q= 112.42 cfs

McBain & Trush
Trinity River Gaging

Meas. No. 00-02
Comp. by
Checked by

Discharge Measurement Notes

Station name Lower Rush XS - 9+82 Units (SI/English)
Date 6-14-00 Hydrographers Darren Mierau
Width ____ Area ____ Vel. ____ G.H. ____ Disch. ____
Method ____ No. secs. ____ G.H. change ____ in ____ hrs. Susp. ____
Method coef. ____ Hor. angle coef. ____ Susp. coef. ____ G.H. of zero flow ____

Time	Gage Reading Recorder	Outside
11:36	1.31	@XS 0+86
11:48	START MSMT	
1235	END MSMT	
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ____
Battery voltage ____

Type of meter AA Meter No. MT
Date rated ____ for rod, other
Meter ____ ft. above bottom of weight
Spin before meas. ____ after ____ seconds
Meas. Plots ____ % diff. from rating ____
Wading, cable, ice, boat, upstr., dowstr,. side, bridge ____
feet, mile, above, below, gage and ____

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Lower Rush XS - 9+82. Upstr. ~ 60 ft. no undercut banks, even flow + bottom profile
Flow conditions Moderate abv. baseflow Weather Clear. warm
Air ____ F@ ____ Water ____ F@ ____
Gage ____ Record removed ____
Control ____

Remarks ____

Measurement # 00-02 **Discharge Measurement Raw Data Sheets**

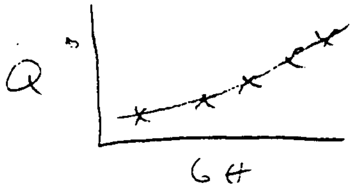
REV/TIME X 2.18 + .020 = V

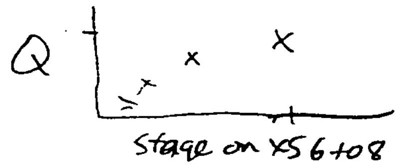
Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	3.4	—	—	-							LEW
	4.0	0.8	0.9	27	41.6	1.43		—		1.03	
	5.0	1.0	1.1	41	40.9	2.20				2.42	Flow deflected from MWD
	6.0	1.0	1.1	30	41.2	1.61				1.77	
	7.0	1.0	1.1	42	40.8	2.26				2.49	
	8.0	1.0	1.1	42	42.0	2.20				2.42	
	9.0	1.0	1.0	46	41.3	2.45				2.45	
	10.0	1.0	1.1	46	41.6	2.43				2.67	
	11.0	1.0	1.05	38	42.4	1.97				2.07	
	12.0	1.0	1.05	50	41.9	2.62				2.75	20.07
	13.0	1.0	1.0	44	42.8	2.26				2.26	
	14.0	1.0	1.0	46	42.0	2.41				2.41	
	15.0	1.0	1.1	40	42.2	2.09				2.29	
	16.0	1.0	1.2	46	41.4	2.44				2.93	
	17.0		1.2	49	41.4	2.60				3.12	
	18.0		1.3	48	41.5	2.54				3.30	
	19.0		1.2	46	42.0	2.40				2.88	
	20.0		1.2	52	41.2	2.77				3.32	22.51
	21.0		1.3	54	42.4	2.80				3.64	
	22.0		1.3	48	42.5	2.49				3.24	
	23.0		1.4	49	42.4	2.54				3.56	
	24.0		1.4	53	42.4	2.74				3.84	
	25.0		1.5	35	42.0	1.84				2.76	Cobble upstr. of meter
	26.0		1.5	54	41.7	2.84				4.26	
	27.0		1.4	56	41.3	2.98				4.17	25.47
	28.0		1.45	52	41.3	2.76				4.00	
	29.0		1.45	55	41.8	2.89				4.19	
	30.0		1.5	60	42.5	3.10				4.65	90.07 cfs
	31.0		1.5	60	42.5	3.10				4.65	
	32.0	1.0	1.25	51	41.8	2.68				3.35	
	33.0	.8	1.10	25	[illegible]	1.34				1.18	22.02

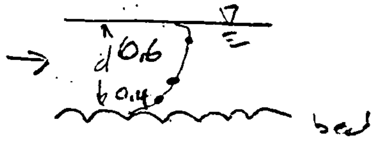
Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

33.6 → [illegible]







McBain & Trush

Trinity River Gaging

Meas. No. 9802

Comp. by BRM

Checked by ______

Discharge Measurement Notes

Station name Lee Vining Creek, B-1 channel (connector + A4) Units (SI/English) ______

Date June 18, 1998 Hydrographers Hied, Hopkins, Scott McBain

Width 21.0 Area 25.91 Vel. 4.89 G.H. see XS6+08 for stage on cross section Disch. 126.7

Method 0.6d No. secs 30 G.H. change 0 in ______ hrs. Susp. ______

Method coef. ______ Hor. angle coef. ______ Susp. coef. ______ G.H. of zero flow ______

Time	Gage Reading Recorder	Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______

Battery voltage ______

Type of meter Price AA Meter No. 500595

Date rated ______ for rod, other

Meter ______ ft. above bottom of weight

Spin before meas. OK after 90 seconds

Meas. Plots ______ % diff. from rating ______

Wading, cable, ice, boat, upstr., dowstr,. side, bridge 50 feet mile, above, below downst gage and of A4 to B-1 connector

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Smooth flow, some flow loss on right side thru debris jam

Flow conditions high, clear, smooth flow Weather Sunny, 75-70°F

Air ______ F@ ______ Water ______ F@ ______

Gage ______ Record removed ______

Control ______

Remarks ______

Measurement #_____ **Discharge Measurement Raw Data Sheets**

.8666 1.889

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	6		0.2	0			0		.65	0.0	Left edge of water
	6.5	.5	0.7	39	45		1.91		.26	.50	
	7	.5	0.95	39	45		1.91		.48	.91	
	7.5	.5	1.3	45	45		2.20		.65	1.43	
	8	.5	1.7	58	45		2.83		.85	2.40	
	8.5	.5	1.8	56	45		2.73		.90	2.46	
	9	.5	1.8	85	45		4.13		.90	3.72	
	9.5	.5	1.7	110	45		5.33		.85	4.53	
	10	.5	1.7	110	45		5.33		.85	4.53	
	10.5	.5	1.7	95	45		4.61		.85	3.92	
	11	.5	1.85	75	45		3.65		.93	3.37	
	11.5	.5	1.9	110	45		5.33		.95	5.07	
	12	.5	1.95	110	45		5.33		.98	5.20	
	12.5	.5	1.95	105	45		5.09		.98	4.97	
	13	.5	1.9	105	45		5.09		.95	4.84	
	13.5	.5	1.95	100	45		4.85		.98	4.73	
	14	.5	1.95	22 110	45		5.33		.98	5.20	
	14.5	.5	2.1	29 145	45		7.02		1.05	7.37	
	15	.5	2.2	150	45		7.26		1.10	7.99	
	15.5	.5	2.2	150	45		7.26		1.10	7.99	
	16	.5	2.1	105	45		5.09		1.05	5.35	behind large cobble
	16.5	.5	2.0	18 90	45		4.37		1.00	4.37	
	17	.5	2.0	90	45		4.37		1.00	4.37	
	17.5	.5	1.9	25 125	45		6.06		.95	5.75	
	18	.5	1.8	130	45		6.30		.90	5.67	
	18.5	.5	1.8	140	45		6.78		.90	6.10	
	19	.5	1.6	130	45		6.30		.80	5.04	
	19.5	.5	1.6	120	45		5.82		.80	4.65	
	20	.5	1.3	70	45		3.41		.65	2.21	

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. ________

Comp. by ________

Checked by ________

Discharge Measurement Notes

Station name Lee Vining Creek, B-1 channel (connector + A4) Units (SI/English) ________

Date ________, 19____ Hydrographers ________________

Width ________ Area ________ Vel. ________ G.H. ________ Disch. ________

Method ________ No. secs. ________ G.H. change ________ in ________ hrs. Susp. ________

Method coef. ________ Hor. angle coef. ________ Susp. coef. ________ G.H. of zero flow ________

Time	Gage Reading: Recorder	Gage Reading: Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ________

Battery voltage ________

Type of meter ________ Meter No. ________

Date rated ________ for rod, other

Meter ________ ft. above bottom of weight

Spin before meas. ________ after ________ seconds

Meas. Plots ________ % diff. from rating ________

Wading, cable, ice, boat, upstr., dowstr,. side, bridge ________

feet, mile, above, below, gage and ________

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section ________________

Flow conditions ________________ Weather ________________

Air ________ F@ ____ Water ________ F@ ________

Gage ________________ Record removed ________

Control ________________

Remarks ________________

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	20.5	.5	1.3	65	45		3.16		.65	2.06	
	21		1.3				Ø		2.60	0.0	Rt edge of main channel
	24.5		0.25				Ø		.56	Ø	one small side channel
	25 25.5	1	0.25	30	45		1.47		.25	.37	
	26.5		0.25				Ø		3.19	Ø	
	34		0.3				Ø		5.48	Ø	side channel
	35.25 36.5	2	0.8	69	45	–	3.36		1.60	5.37	
	37.25 38		0.6				Ø		10.95	Ø	

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

ENTERED
LVCMAIN Q98.XLS

MONO

McBain & Trush
Trinity River Gaging

Meas. No. LV-9801A
Comp. by ____
Checked by ____

Discharge Measurement Notes

Station name LEE VINING CRK. MAIN CHANNEL Units (SI, English) FT, CFS

Date 6-5, 19 98 Hydrographers MIERAN, MERRILL

Width 13.2 Area 23.46 Vel. 3.22 G.H. — Disch. 75.53

Method 0.6 No. secs. 20 G.H. change 0 in 0.5 hrs. Susp. —

Method coef. — Hor. angle coef. — Susp. coef. — G.H. of zero flow —

Time	Gage Reading Recorder	Gage Reading Outside
11:50	—	—
12:20	—	—
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ____

Battery voltage ____

Type of meter AA Meter No. 595

Date rated — for rod, other

Meter — ft. above bottom of weight

Spin before meas. 2:57 after 2:25 seconds

Meas. Plots — % diff. from rating —

Wading, cable, ice, boat, upstr., dowstr,. side, bridge 4

feet, mile, above, below, gage and XS 3+73

MAIN CHANEL

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section LARGE SURFACE WAVES, ROUGH UNEVEN BED

Flow conditions STEADY Weather LIGHT OVERCAST

Air — F@ — Water — F@ —

Gage — — Record removed —

Control DOWNSTREAM RIFFLE CREST

Remarks UN REFERENCED SECTION

Measurement #_____ **Discharge Measurement Raw Data Sheets** Page ___ of ____

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	1.7										LEW
	2.5		1.5	33	42	1.73		1.73	1.35	2.34	
	3.5		1.3	40	40	2.2		2.2	1.3	2.86	ON ROCK
	4.5		1.8	52	40	2.85		2.85	1.8	5.13	
	5.5		1.6	84	40	4.59		4.59	1.6	7.34	
	6.5		1.8	80	40	4.37		4.37	1.35	5.90	
	7.0		1.9	71	40	3.88		3.88	.95	3.69	
	7.5		1.8	63	40	3.45		3.45	.95	3.28	
	8.0		1.9	59	40	3.23		3.23	.95	3.07	
	8.5		1.9	48	40	2.63		2.63	.95	2.5	
	9.0		1.9	45	40	2.47		2.47	.95	2.35	ON ROCK
	9.5		2.15	45	41	2.41		2.41	1.08	2.59	
	10.0		2.4	53	40	2.91		2.91	1.20	3.49	
	10.5		2.5	63	41	3.36		3.36	1.25	4.21	
	11.0		2.5	67	41	3.58		3.58	1.25	4.47	
	11.5		2.5	74	42	3.85		3.85	1.25	4.82	
	12.0		2.5	76	40	4.15		4.15	1.25	5.19	
	12.5		2.4	60	41	3.21		3.21	1.20	3.85	
	13.0		2.4	44	41	2.36		2.36	1.20	2.83	
	13.5		1.3	60	41	3.21		3.21	.65	2.08	ON LARGE ROCK
	14.0		1.4	68	41	3.63		3.63	.98	3.56	" "
	14.9										REW

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

ENTERED
LVCBIQ98.XLS

MDWD

McBain & Trush

~~Trinity River~~ ~~G~~aging
MDWD

Discharge Measurement Notes

Meas. No. LV-9801C
Comp. by ______
Checked by ______

Station name B-1 CHANNEL LEE VINING Units (SI/English) FT, CFS

Date 6-5, 1998 Hydrographers MIERAU

Width 14.3 Area 15.66 Vel. 3.23 G.H. — Disch. 50.53

Method 0.6 No. secs. ______ G.H. change 0 in 0.5 hrs. Susp. —

Method coef. — Hor. angle coef. — Susp. coef. — G.H. of zero flow —

Time	Gage Reading Recorder	Gage Reading Outside
13:00	—	—
13:30	—	—
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______

Battery voltage ______

Type of meter AA Meter No. 525

Date rated — for rod, other

Meter — ft. above bottom of weight

Spin before meas. 2:57 after 2:29 seconds

Meas. Plots — % diff. from rating —

Wading, cable, ice, boat, upstr., dowstr,. side, bridge ≈ 50

feet, mile, above, below, gage and MODELLING CROSS SECTION

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section LARGE SURFACE WAVES - ROUGH UNEVEN BED

Flow conditions STEADY Weather LIGHT OVERCAST

Air — F@ — Water — F@ —

Gage — Record removed —

Control DOWNSTREAM RIFFLE

Remarks UNREFERENCED CROSS SECTION - LARGE BOULDER BED

Measurement # LV-9801C **Discharge Measurement Raw Data Sheets** Page 1 of 1

	Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
		2.9										LEW
1		3.5		0.6	38	42	1.99		1.99	.48	.96	
2		4.5		0.5	69	40	3.77		3.77	.38	1.41	
3		5.0		0.8	72	40	3.94		3.94	.60	2.36	
4		6.0		1.5	49	40	2.69		2.69	1.13	3.02	
5		6.5		1.8	63	40	3.45		3.45	.90	3.10	
6		7.0		1.5	58	41	3.10		3.10	.75	2.32	
7		7.5		1.4	94	41	5.01		5.01	.70	3.50	
8		8.0		1.5	90	40	4.91		4.91	1.13	5.53	
9		9.0		1.9	68	40	3.72		3.72	1.43	5.30	
10		9.5		1.5	83	40	4.53		4.53	.75	3.40	
11		10.0		1.7	58	40	3.18		3.18	.85	2.70	
12		10.5		1.4	65	40	3.56		3.56	.70	2.49	
13		11.0		1.3	62	41	3.31		3.31	.65	2.15	
14		11.5		1.3	61	40	3.34		3.34	.65	2.17	
15		12.0		1.25	53	40	2.91		2.91	.63	1.82	
16		12.5		1.25	42	41	2.25		2.25	.63	1.41	
17		13.0		0.8	47	40	2.58		2.58	.60	1.55	
18		14.0		0.85	30	42	1.58		1.58	.85	1.34	
19		15.0		1.0	43	43	2.20		2.2	1.0	2.2	
20		16.0		0.8	37	40	2.04		2.04	.88	1.79	
		17.2										REW

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

ENTERED LVCBCONNQ98.XLS

McBain & Trush

Trinity River Gaging

Meas. No. MONO LV9801B

Comp. by ________

Checked by ________

Discharge Measurement Notes

Station name Lee Vining Creek B-connector chan. Units (SI English) ft, cfs

Date June 5, 1998 Hydrographers Merrill & Meeran

Width 11.6 Area 6.56 Vel. 2.41 G.H. — Disch. 15.8

Method 0.6 No. secs. 21 G.H. change 0 in 0.5 hrs. Susp. —

Method coef. — Hor. angle coef. — Susp. coef. — G.H. of zero flow —

Time	Gage Reading Recorder	Outside
12:28	—	—
12:55	—	—
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ________

Battery voltage ________

Type of meter AA Meter No. 595

Date rated — for rod, other

Meter — ft. above bottom of weight

Spin before meas. 2:57 after 2:25 seconds

Meas. Plots ________ % diff. from rating ________

Wading, cable, ice, boat, upstr., dowstr,. side, bridge 10

feet, mile, above, below gage and green stake f below mainstem

Measurement rated: excellent (2%), good (5%), fair (8%) poor (over 8%) based on following conditions: Cross section surface waves, shallow

Flow conditions steady Weather light overcast

Air ________ F@ ____ Water ________ F@ ________

Gage ________ Record removed ________

Control downstream riffle

Remarks XS located 15 ft below D. Parkinson Habitat Marker #

	Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
		3.4										LEW
1		4.4	0.8	.45	30	41	1.62		1.62	.36	.58	
2		5.0	0.55	.40	31	41	1.67		1.67	.22	.37	
3		5.5	.5	.35	30	41	1.62		1.62	.18	.28	
4		6.0	.5	.35	34	41	1.83		1.83	.18	.32	
5		6.5	.5	.40	46	40	2.53		2.53	.20	.51	
6		7.0	.5	.45	43	40	2.36		2.36	.23	.53	
7		7.5	.5	.50	47	40	2.58		2.58	.25	.64	
8		8.0	.5	.60	61	40	3.34		3.34	.30	1.00	
9		8.5	.5	.60	36	42	1.89		1.89	.30	.57	
10		9.0	.5	.55	68	40	3.72		3.72	.28	1.02	
11		9.5	.5	.55	73	41	3.89		3.89	.28	1.07	
12		10.0	.5	.70	58	41	3.10		3.10	.35	1.08	
13		10.5	.5	.70	45	41	2.41		2.41	.35	.84	
14		11.0	.5	.60	44	42	2.30		2.30	.30	.69	
15		11.5	.5	.80	76	40	4.15		4.15	.40	1.66	
16		12.0	.5	.90	43	41	2.31		2.31	.45	1.04	
17		12.5	.5	.80	17	41	.92		.92	.40	.37	
18		13.0	.5	.80	22	41	1.19		1.19	.40	.48	
19		13.5	.5	.80	57	40	3.12		3.12	.40	1.25	
20		14.0	.5	.70	51	40	2.80		2.80	.35	.98	
21		14.5	.5	.80	24	41	1.30		1.30	.40	.52	
		15.0										REW

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. 9802

Comp. by BRm

Checked by

Discharge Measurement Notes

Station name Lee Vining Creek, Main Channel (between XS 3+45 and 3+73) ~ halfway Units (SI/English)

Date June 18, 19 98 Hydrographers Heidi Hopkins, Scott McBain

Width 46.0 Area 42.35 Vel. 3.81 G.H. Disch. 161

Method 0.6d No. secs. 26 G.H. change in hrs. Susp. —

Method coef. — Hor. angle coef. — Susp. coef. — G.H. of zero flow —

Time	Gage Reading Recorder	Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa.

Battery voltage

Type of meter Price AA Meter No. 500595

Date rated — for rod, other

Meter — ft. above bottom of weight

Spin before meas. OK after 90 seconds

Meas. Plots % diff. from rating

Wading, cable, ice, boat, upstr., dowstr,. side, bridge

feet, mile, above, below, gage and

1/2 way between XS 3+45 and 3+73

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Standing waves up to 1/2 ft, submerged boulders sheltered meter at several stations

Flow conditions Clear, turbulent Weather Clear

Air F@ Water F@

Gage — Record removed —

Control riffle crest, clear

Remarks

Measurement #_____ **Discharge Measurement Raw Data Sheets**

Angle Coef.	Tape dist.	Width	Depth	Revolutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	11.5		Ø	0			Ø		Ø	Ø	left edge of water surf
	17	4.25	1.0				Ø		4.25	Ø	backwater
	18.5 20	2.25	0.8	23	45		1.13	30°	1.80	2.03	
	20.75 21.5	1.5	0.7	35	45		1.34		1.05	1.41	
	22.25 23	1.5	0.8	47	45		1.72	30°	1.20	2.06	
	23.75 24.5	1.5	0.9	48	45		2.34	30°	1.35	3.16	
	25.25 26	1.5	1.0	61	45		2.97	15°	1.50	4.46	
	26.75 27.5	1.5	1.1	62	45		3.02	15°	1.65	4.98	
	28.25 29	.75	1.1	83	45		4.03	15°	1.38	5.54	
	29.5 30	1	1.2	100	45		4.85	10°	1.20	5.82	
	30.5 31	1	1.5	125	45		6.06	10°	1.50	9.09	
	32	1	1.5	120	45		5.82	10°	1.50	8.73	
	33	1	1.7	115	45		5.58	Ø	1.70	9.49	
	34	1	1.6	110	45		5.33		1.60	8.53	
	35	1	1.7	120	45		5.82		1.70	9.89	
	36	1	1.8	125	45		6.06		1.80	10.91	
	37	1	1.8	70	45		3.41		1.80	6.14	behind rock
	38	1	1.9	90	45		4.37		1.90	8.3	still behind rock
	39	1	2.0	95	45		4.61		2.00	9.22	? ?
	40	1	1.9	85	45		4.13		1.90	7.85	
	41	1	1.8	130	45		6.30		1.80	11.34	
	42	1	1.8	105	45		5.09		1.80	9.16	
	43	1	1.9	100	45		4.85		1.90	9.22	
	44	1	1.8	90	45		4.37		1.80	7.87	
	44.5 45	.75	2.1	65	45		3.16		1.58	4.98	
	45.25 45.5	.5	1.4	35	45		1.72		.70	1.20	
	45.75 46		Ø	0			Ø		0		Right edge of water surface

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. 9802

Comp. by BRM

Checked by ______

Discharge Measurement Notes

Station name Lee Vining Creek, in B-1 connector   Units (SI/English) ______

Date June 18, 1998   Hydrographers Heidi Hopkins, Scott McBain

Width 13.5   Area 7.79   Vel. 3.55   G.H. 24   Disch. 27.61

Method 0.6d   No. secs. ______   G.H. change 0 in ______ hrs.   Susp. —

Method coef. —   Hor. angle coef. —   Susp. coef. —   G.H. of zero flow —

Time	Gage Reading Recorder	Gage Reading Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______

Battery voltage ______

Type of meter Price AA   Meter No. 500595

Date rated — for rod, other

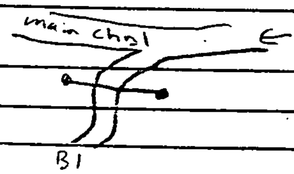
Meter — ft. above bottom of weight

Spin before meas. OK after 90 seconds

Meas. Plots — % diff. from rating —

Wading, cable, ice, boat, upstr., dowstr,. side, bridge 30

feet, mile, above, below, gage and ~~below~~ downstream of B-1 channel entrance



Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Smooth, but shallow.

Flow conditions Smooth, some rock shielding Weather clear

Air ______ F@ ______   Water ______ F@ ______

Gage ______ Record removed ______

Control riffle itself (banks)

Remarks ______

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	0.5 1.25		0.3	0			⊖				Left edge of water surface
	2 2.25	1	0.3	27	45		1.33		.30	0.04	
	2.5 2.75	0.5	0.4	61	45		2.97		.30	0.59	
	3 3.00	.5	0.4	61	45		2.97		.20	0.59	
	3.5	.5	0.4	45	45		2.2		.20	0.44	somewhat behind rock
	4	.5	0.4	56	45		2.73		.20	0.55	
	4.5	.5	0.4	34	45		1.67		.20	0.33	
	5	.5	0.5	59	45		2.88		.25	0.72	
	5.5	.5	0.6	61	45		2.97		.30	0.89	
	6	.5	0.7	100	45		4.85		.35	1.70	
	6.5	.5	0.7	115	45		5.58		.35	1.95	
	7	.5	0.8	95	45		4.61		.40	1.84	
	7.5	.5	0.8	85	45		4.13		.40	1.65	
	8	.5	0.75	90	45		4.58		.38	1.72	
	8.5	0.5	0.8	75	45		3.65		.40	1.46	
	9.0	0.5	1.0	110	45		5.33		.50	2.67	
	9.5	0.5	1.0	100	45		4.85		.50	2.43	
	10	0.5	0.95	100	45		4.85		.48	2.30	
	10.5	0.5	0.95	85	45		4.13		.48	1.96	
	11	0.5	0.8	85	45		4.13		.40	1.65	
	11.5	0.5	0.6	34	45		1.67		.30	.50	
	12	0.5	0.5	38	45		1.86		.25	.47	
	12.5	0.5	0.5	29	45		1.4248		.25	.36	
	13	0.5	0.4	4	45		.21		.20	.04	
	13.5		0	0			⊖				water's edge on Right bank

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

7-2-98

B1 connector Timed float

Measurement

Place cross section five feet upstream of the PVC pipe covered rebar on the right bank

FLOAT SECTION IS 10 FT LONG

REPLICATE	TIME			
	VERT 1	VERT 2	VERT 3	VERT 4
1	1.92	1.93	1.05	1.25
2	1.60	2.05	1.26	1.28
3	2.48	1.97	1.06	1.43
4	1.84	1.84	1.36	1.46
5	1.96	1.80	0.88	1.43

CHANNEL IS DIVIDED INTO FOUR EQUAL CELLS APPROX 3' WIDE. 0.3' DEEP TO 0.6' DEEP ACROSS CHANNEL

ENTERED 7-6-98
BRM

XS - 3+45

MARKED ROCKS NOTES:
THREE LEFTMOST SETS ARE INTACT.
REMAINING SETS ARE DISCURNED W/
D_{50} < D84 OBSERVABLE UP TO 12'
DOWNSTREAM. WATER IS TOO TURBULENT
FARTHER DOWNSTREAM TO SEE ROCKS.

XS 3+73
TWO SCOUR CORES NOT OBSERVED,
GRAVEL DEPOSIT APPEARS SCOURED AND
FINER.

TIME FLOAT DISCHARGE ACROSS XS
3+73. DISTANCE IS 30 FT, 15 FT
EITHER SIDE OF XS.

REPLICATE #	TIME VERT 1	VERT 2	VERT 3
1	4.25	2.42	2.77
2	4.49	2.33	2.56
3	3.98	2.50	3.33
4	3.56	2.51	2.94
5	4.25	2.56	2.37
	LEFT 1/3	CENTER 1/3	RIGHT 1/3

OF CHANNEL

ENTERED 7-6-98 BRM

NOT ABLE TO MEASURE WIDTH
CELLS ARE

(3)

7-2-98

TIME FLOAT MSMT AT BED MOBILITY CROSS SECTION IN B-1 CHANNEL, LENGTH IS 40 FT

CHANNEL IS DIVIDED INTO THIRDS W/ FLAT SHELF 3 FT WIDE ALONG LEFT BANK ≈ 4 INCHES DEEP.

REPLICATE	TIME		
	VERT 1	VERT 2	VERT 3
1	5.07	3.67	4.44
2	3.91	3.94	3.97
3	3.88	3.76	4.19
4	5.16	3.92	3.72
5	3.40	3.42	4.33

NOT ABLE TO MEASURE WIDTHS OF CELLS APPROX 3' 4' 3' RESPECTIVELY LEFT TO RIGHT

ENTERED BRM 7-6-98

FB#5

7-17-98 Lee Vining Creek
Cross Section 13+92
WSEL Survey

STN	FS	BS	HI	Elev
		5.155	144.925	139.77
	8.43		144.925	

TIME - FLOAT MSMT @ B-1
CHANNEL 40 FT SECTION (SEE XS FOR AREA)

	LEFT	MIDDLE	RIGHT
REPLICATE	VERT 1	VERT 2	VERT 3
1	7.60	4.40	4.66
2	10.99	4.17	4.19
3	6.01	4.14	4.86
4	5.36	3.82	4.62
5	10.28	3.72	4.31

ENTERED
BRM 7-20-98

B-1 CONNECTOR FOUND SCOUR CORE ROCK OR D_{3}, ≥ 15mm AT SITE SITE. SCOUR CORE ROCK FOUND ≈30 FT DS OF CONNECTOR IN MAIN CHANNEL ANOTHER ID LOWER B-CONNECTOR ≈50-60 mm ROCK IN A-4 AT CONFLUENCE W/ B-1 CONNECTOR.

FB#6

(5)

139.77
5.155
134.615
8.43
136.445

Notes
Top of left bank pin cross section 13+92
Water surface elevation taken ~ channel near left bank of cross section 13+92

B-1 CONNECTOR TIME FLOAT
SECTION 15 15' LONG, DEPTH 15?

	3"	4"	5"	6"
REPLICATE	VERT 1	VERT 2	VERT 3	VERT 4
1	2.91	3.27	3.08	1.82
2	3.01	3.32	2.08	2.48
3	3.61	3.41	2.23	2.20
4	2.64	2.97	2.03	2.45
5	3.35	3.59	2.65	2.23
	LEFT			RIGHT

X 3.5 FT WIDE

ENTERED
7-20-98 BRM

7-17-98 LEE VINING CREEK
TIME FLOAT MSMT. @ XS 3+73
MAIN CHANNEL SECTION = 40 ST

REPLICATE	VERT 1	VERT 2	VERT 3
1	3.96	4.07	3.97
2	4.49	4.21	4.34
3	4.31	4.04	4.87
4	4.02	4.32	4.00
5	3.91	4.12	4.07
	LEFT	MIDDLE	RIGHT

ENTERED 7-20-98
BRM

(7)

FB#6

FB#6

Main Ch. [illegible]

Sc [illegible]
10/29 RW

9/11/98 Lee Vining Cr.
Main Chan
+73

Darren Mierau Not
Scott McBain Pri

STN (ft)	Dep (ft)	Revs	Time (sec)	Vel. (fps)	Horiz. Angle (°)	Corrected Velocity	Area (ft²)	Q (cfs)	NOTES	Computer Calc of Q
15.0	0	—	—	0				0	Left Edge Water	
23.0	0.40	5	42	-0.28			2.6	-0.73	Negative Flow	
28.0	0.20	2	40	-0.13			0.95	-0.12	Negative Flow	
32.5	1.10	5	43	0.27			3.3	0.89		
34.0	1.30	22	40	1.22	30°	1.06	1.62	1.71		
35.0	1.30	22	42	1.16	15°	1.10	1.2	1.32		1.46
36.0	1.20	33	41	1.77	15°	1.68	1.2	2.02		
37.0	1.35	45	40	2.47	15°	2.35	1.35	3.17		3.22
38.0	1.30	42	41	2.25	15°	2.14	1.30	2.78		2.83
39.0	1.40	43	42	2.25	15°	2.14	1.40	2.99		3.15
40.0	1.50	43	40	2.36	0°		1.50	3.54		
41.0	1.50	50	40	2.74			1.12	3.07		
41.5	1.55	37	42	1.94			0.78	1.51		
42.0	1.45	47	41	2.52			0.72	1.81	ON BOULDER	
42.5	1.50	40	42	2.10			0.75	1.57	" "	
43.0	1.7	55	43	2.81			0.85	2.38	" "	
43.5	1.8	56	40	3.07			0.90	2.76		
44.0	1.75	55	42	3.14			0.88	2.76		
44.5	1.80	70	41	3.73			0.90	3.36		
45.0	1.70	75	42	3.90			0.85	3.32		
45.5	1.75	70	40	3.83			0.88	3.37		
46.0	1.55	65	41	3.47			0.78	2.71	ON BOULDER	

* (CONTINUES ON PREVIOUS PAGES - 76 & 77)

FB#6

9/11/98 Lee Vining Creek discharge msmnt A4-B1 Channel, measurement taken 9ppt ft ups: new m... B1 cross section 6+08 Small to medium boulders, measurement fair

10:40

Darren Mierau - Scott McBain

Price AA Notes

STN(ft)	depth(ft)	Rev's	time(sec)	Vel (ft/s)	Area(ft²)	Q (cfs)	Notes
2.2	0	—	—	0	—	0	left edge of water
2.6	0.4	35	41	1.90	0.22	0.42	
3.3	0.85	34	42	1.78	0.51	0.91	
3.8	0.65	49	40	2.69	0.36	0.97	on boulder
4.4	1.15	50	41	2.68	0.69	1.85	
5.0	1.4	47	41	2.52	0.77	1.94	
5.5	1.55	58	40	3.18	0.77	2.45	
6.0	1.7	58	40	3.18	0.85	2.70	
6.5	1.8	69	41	3.68	0.90	3.31	
7.0	1.8	72	40	3.94	0.81	3.19	
7.4	1.7	67	41	3.58	0.68	2.43	
7.8	1.7	51	43	2.60	0.68	1.77	
8.2	1.9	43	40	2.36	0.95	2.24	Behind boulders
8.8	1.4	60	40	3.28	0.77	2.53	" "
9.3	1.6	40	42	2.10	0.72	1.51	on boulder
9.7	1.5	43	40	2.36	0.67	1.59	
10.2	1.45	48	42	2.51	0.65	1.64	
10.6	1.5	52	42	2.72	0.60	1.63	
11.0	1.4	49	41	2.62	0.63	1.65	
11.5	1.1	42	40	2.31	0.55	1.27	
12.0	1.1	37	40	2.04	0.55	1.12	
12.5	1.0	33	40	1.82	0.45	0.82	
12.9	0.8	18	41	0.98	0.48	0.47	
13.7	0	—	—	0	—	0	

Σ = 38.4 cfs

Begin GH @ 10:40 = 1.01'

End GH @ 11:15 = 1.01'

$\boxed{\text{WGH} = 1.61'}$

$\boxed{Q = 38.4}$

9/11/98 Lee Vining Creek B-1 connector discharge measurement, Spin test - 2:47 sec
Darren Mierau - Price AA
Scott McBain - Notes
measurement taken 10 ft upstream of staff gage, approx 20' downstream of main channel to B-1 channel split

F:SEW|Mmo|Flowdata/Qmsmt/LVCB Conn Q 98 73
10/28 KW

STN (ft)	depth (ft)	Revolutions	time (sec)	Velocity (ft/s)	Area (ft²)	discharge (cfs)		Notes
5.8	0	0	—	0	—	0		Left edge of water
6.8	0.3	10	41	0.55	0.56	~~0.28~~	.14	in rose bushes
7.5	0.4	54	40	2.96	~~0.68~~ .34	~~2.02~~	1.00	
8.5	0.3	26	41	1.40	0.30	0.42		
9.5	0.25	16	42	0.85	0.25	0.21		
10.5	0.3	22	41	1.19	0.30	0.36		
11.5	0.35	42	40	2.31	0.35	0.81		
12.5	0.40	32	40	1.76	0.30	0.53		
13.0	0.40	39	41	2.09	0.20	0.42		
13.5	0.40	48	40	2.36	0.20	0.[illegible]		
14.0	0.50	26	41	1.40	0.25	0.35		
14.5	0.55	72	41	3.84	0.28	1.07		
15.0	0.60	68	40	3.72	0.30	1.11		
15.5	0.50	61	41	3.26	0.25	0.81		
16.0	0.70	70	40	3.83	0.35	1.34		
16.5	0.60	60	40	3.28	0.30	0.98		
17.0	0.70	52	41	2.78	0.35	0.97		
17.5	0.65	36	40	1.98	0.26	0.52		
17.8	0.60	24	42	1.26	~~0.66~~ .33	0.84	.42	
18.6	0	—	—	0	—	0		Right edge of water

Begin GH @ 10:00 AM = 0.67'
End GH @ 10:30 AM = 0.70'
$\boxed{\text{WMGH} = 0.69'}$

Σ = 13.6 cfs

$\boxed{Q = 13.6 \text{ cfs}}$

$\boxed{\text{Computer Q} = 11.99 \text{ cfs}}$

FB#6

McBain & Trush

Trinity River Gaging

Meas. No. 99-01

Comp. by Zeb

Checked by Darren DR

Discharge Measurement Notes

Station name Lower Lee Vining Mainstem above XS-A (below Channel split) Units (SI/English)

Date 5-6, 1999 Hydrographers Darren & Zeb

Width 13.2 ft Area 17.76 ft² Vel. .72 G.H. n/a Disch. 7.75

Method ______ No. secs. ______ G.H. change ______ in ______ hrs. Susp. ______

Method coef. ______ Hor. angle coef. ______ Susp. coef. ______ G.H. of zero flow ______

Time	Gage Reading: Recorder	Gage Reading: Outside
2:00		
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______

Battery voltage ______

Type of meter Price AA Meter No. 5595

Date rated ______ for rod, other

Meter ______ ft. above bottom of weight

Spin before meas. 141 after ______ seconds

Meas. Plots ______ % diff. from rating ______

Wading, cable, ice, boat, upstr., dowstr,. side, bridge ______

feet, mile, above, below, gage and ______

at XS Y

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Bouldery cross section, shallow along LB

Flow conditions Winter base flow Weather Hot & Sunny

Air ______ F@ ______ Water 52°F F@ ______

Gage ______ Record removed ______

Control ______

Remarks ______

Measurement # 99-1 **Discharge Measurement Raw Data Sheets**

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	7.7										Left edge water 7.70
	8.5		0.4	22	42.86	1.14				.3	
	90		0.4	5	42.24	.28				.06	
	9.5		.4	12	43.65	.62				.12	
	10		.4	25	41.78	1.32				.26	
	10.5		.55	25	41.70	1.33				.36	
	11		.45	5	48.14	.25				.06	
	11.5		.5	34	42.18	1.78				.44	
	12		.8	24	48.12	1.11				.44	
	12.5		.7	33	41.47	1.75				.61	
	13		.5	39	42.84	2.01				.50	
	13.5		.5	30	41.35	1.6				.40	
	14		.8	29	41.41	1.55				.62	
	14.5		1.0	24	42.10	1.26				.63	
	15		.9	27	41.91	1.42				.64	
	15.5		.5	28	42.28	1.46				.37	Top of rock
	16		.9	16	42.66	.84				.38	
	16.5		1.0	19	42.25	1.00				.50	
	17		.3	21	41.80	1.12				.17	
	17.5		.6	4	41.70	.49				.20	
	18.5		.4	20	42.64	1.04				.42	
	19.5		.5	6	41.92	.33				.15	
	20.3		.5	6	41.88	.33				.12	
	21										right edge water
											water temp. = 53°
										7.75	

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

Q measurement taken at newly installed cross section XS-Y on lower LV B-1 channel, located ~ 100 ft upstream from bottom of mapped reach

McBain & Trush
Trinity River Gaging

Meas. No. 99-01
Comp. by Zeb
Checked by Darren

Discharge Measurement Notes

Station name lower Lee Vining B1 channel XS-Y Units (SI/English) ______

Date 5/6, 1999 Hydrographers Darren Mierau, Zeb Stecher

Width 13.0 ft Area 8.23 ft² Vel. 2.04 fps G.H. ______ Disch. 16.78 cfs

Method ______ No. secs. ______ G.H. change ______ in ______ hrs. Susp. ______

Method coef. ______ Hor. angle coef. ______ Susp. coef. ______ G.H. of zero flow ______

Time	Gage Reading: Recorder	Gage Reading: Outside
1:30		
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______
Battery voltage ______

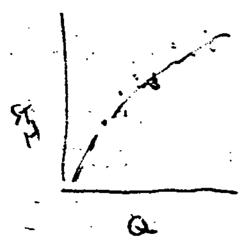
Type of meter Price AA Meter No. 5595

Date rated —— for rod, other 5595

Meter —— ft. above bottom of weight

Spin before meas. 141 sec after —— seconds

Meas. Plots —— % diff. from rating ——



Wading, cable, ice, boat, upstr., dowstr,. side, bridge ~200 feet, mile, above, below, gage and bottom of plan-mapped reach.

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Uniform laminar flow, rectangular XS

Flow conditions Winter baseflow Weather Hot & Sunny

Air ~30 F@ 3 PM Water 52°F F@ 3 PM

Gage ______ Record removed ______

Control Riffle

Remarks ______

Measurement # 99-1 **Discharge Measurement Raw Data Sheets** Page 1 of ___

Angle Coef.	Tape dist.	¢ Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	11.5	0.5	0.0			V		∅		↓	left Edge Water
	12.0	0.5	0.7	31	42.4	1.61		1.61	.35	.56	
	12.5	0.5	0.7	37	42.1	1.94		1.94	.35	.68	
	13.0		0.5	34	43.0	1.74		1.74	.25	.44	
	13.5		0.7	42	42.4	2.18		2.18	.35	.76	
	14.0		0.6	50	41.0	2.68		2.68	.3	.8	
	14.5		0.8	26	43.0	1.34		1.34	.4	.54	
	15.0		0.6	51	41.6	2.69		2.69	.25	.67	
	15.5		0.9	12	41.9	0.64		0.64	.45	.29	Behind upstream boulder
	16.0		0.8	45	42.3	2.34		2.34	.4	.94	
	16.5		0.7	28	41.2	1.50		1.50	.35	.53	
	17.0		0.6	23	41.7	1.22		1.22	.3	.37	
	17.5		0.5	26	52.5	1.1		1.1	.25	.27	Behind upstream boulders
	18.0		0.5	28	41.8	1.48		1.48	.25	.37	
	18.5		0.55	45	42.0	2.36		2.36	.28	.65	
	19.0		0.8	50	42.1	2.61		2.61	.4	1.04	
	19.5		0.9	36	42.6	1.86		1.86	.45	.84	
	20.0		0.8	51	42.5	2.63		2.63	.4	1.05	
	20.5		0.4	50	42.1	2.61		2.61	.2	.52	
	21.0		0.6	35	43.0	1.79		1.79	.3	.54	
	21.5		0.9	50	42.0	2.61		2.61	.45	1.18	
	22.0		0.8	55	41.6	2.9		2.9	.4	1.16	
	22.5		0.7	50	42.3	2.6		2.6	.35	.91	
	23.0		0.6	46	42.4	2.38		2.38	.3	.72	
	23.5		0.6	41	42.0	2.15		2.1	.45	.97	
	24.5		0.0								Right edge water
										16.92	

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

DMW

McBain & Trush

Trinity River Gaging

Meas. No. 99-01

Comp. by Zeb

Checked by Dallen

Discharge Measurement Notes

Station name Upper Lee Vining B-t Channel upstream of XS 06+80 Units (SI/English) ft/cfs

Date 5/6/, 1999 Hydrographers Zeb Stecker & Darren Mierau

Width 7.5 ft Area 11.13 ft^2 Vel. 1.29 fps G.H. ____ Disch. 14.34 cfs

Method 6/10 No. secs. 40 G.H. change ∅ in ____ hrs. Susp. ____

Method coef. ____ Hor. angle coef. ____ Susp. coef. ____ G.H. of zero flow ____

Time	Gage Reading Recorder	Gage Reading Outside
3:00		0.40 ft
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ____

Battery voltage ____

Type of meter Price AA Meter No. 5595

Date rated ____ for rod, other

Meter ____ ft. above bottom of weight

Spin before meas. 2 min. 21 sec after ____ seconds

Meas. Plots ____ % diff. from rating ____

Wading, cable, ice, boat, upstr., dowstr,. side, bridge 100

feet, mile, above, below, gage and XS 06+80

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Deep channel & fast velocity, large boulders

Flow conditions Winter base flow Weather Clear & warm

Air ____ F@ ____ Water ____ F@ ____

Gage ____ Record removed ____

Control Riffle

Remarks ____

Measurement # 99-01 **Discharge Measurement Raw Data Sheets**

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	8.5										right edge water
	9.0		1.3	10	47.44	.48				.31	
	9.5		1.3	21	44.44	1.05				.68	
	10		1.6	31	42.12	1.63				1.30	
	10.5		1.6	30	41.45	1.60				1.28	
	11		1.5	22	41.66	1.17				1 .88	
	11.5		1.8	29	41.01	1.56				1.41	
	12		1.9	41	41.56	2.17				2.06	
	12.5		2.0	40	41.31	2.13				2.13	
	13		1.7	44	41.38	2.34				1.99	
	13.5		1.9	21	41.79	1.12				1.06	
	14		1.8	11	42.43	.59				.53	
	14.5		1.6	8	45.78	.40				.32	
	15		1.5	7	44.98	.36				.40	
	16										right edge water
										14.34	

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. 99-01

Comp. by Zeb

Checked by Darren

Discharge Measurement Notes

Station name Upper LeeVining B-Connector 10 ft upstream of staff gage Units (SI/English) ft/cfs

Date 5-6, 1999 Hydrographers Darren & Zeb

Width 12.6 ft Area 5.17 ft² Vel. 1.46 fps G.H. ____ Disch. 7.54 cfs

Method 6/10 No. secs. 40 G.H. change ____ in ____ hrs. Susp. ____

Method coef. ____ Hor. angle coef. ____ Susp. coef. ____ G.H. of zero flow ____

Time	Gage Reading: Recorder	Gage Reading: Outside
3:30		0.61
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ____

Battery voltage ____

Type of meter Price AA Meter No. 5595

Date rated ____ for rod, other

Meter ____ ft. above bottom of weight

Spin before meas. 141 after ____ seconds

Meas. Plots ____ % diff. from rating ____

Wading, cable, ice, boat, upstr., dowstr,. side, bridge 10

feet, mile, above, below, gage and above staff gage on B-connector

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Very shallow XS, w/ Price AA meter

Flow conditions Winter baseflow Weather Clear & warm

Air ____ F@ ____ Water ____ F@ ____

Gage ____ Record removed ____

Control Entrance to B-connector from mainstem

Remarks ____

Measurement # 9901 **Discharge Measurement Raw Data Sheets**

Angle Coef.	Tape dist.	Width	Depth	Revolutions	Time in seconds	Velocity point	Velocity At mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	2.5										left edge water
	3.5		.25	8	41.20	.44				.08	
	4		.25	30	45.73	1.45				.18	
	4.5		.30	32	41.73	1.69				.25	
	5		.35	32	40.96	1.73				.30	
	5.5		.2	9	48.80	.42				.06	
	6.5		0.3	8	44.52	.41				.12	
	7.5		.3	22	42.70	1.14				.34	
	8.5		.35	23	42.57	1.20				.31	
	9		.5	19	42.78	.99				.25	
	9.5		.45	31	41.34	1.66				.37	
	10		.6	27	44.00	1.41				.41	
	10.5		.6	23	41.87	1.22			7	.37	
	11	.5	.6	47	42.01	2.46				.74	
	11.5		.7	45	41.44	2.39				.84	
	12.0		.6	37	42.82	1.9				.57	
	12.5		.7	28	41.87	1.48				.52	
	13		.8	42	41.81	2.21				.88	
	13.5		.6	41	41.13	2.19				.66	
	14		.55	12	45.89	.59				.26	
	15.1										right edge of water

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

Upper LVC

McBain & Trush
Trinity River Gaging

Meas. No. 99-01
Comp. by ZCB
Checked by Darren

Discharge Measurement Notes

Station name Upper Lee Vining Main Channel above B-connector Units (SI/English) ft / cfs

Date 5-6, 1999 Hydrographers Zeb & Darren

Width 32.6 ft Area 36.70 ft² Vel. 1.20 fps G.H. ______ Disch. 25.16

Method 6/10 No. secs. 40 G.H. change ______ in ______ hrs. Susp. ______

Method coef. ______ Hor. angle coef. ______ Susp. coef. ______ G.H. of zero flow ______

Time	Gage Reading Recorder	Outside
4:00		∅
	(sensor	survey)
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		
Conversion equa.		
Battery voltage		

Type of meter Price AA Meter No. 5545

Date rated ______ for rod, other

Meter ______ ft. above bottom of weight

Spin before meas. 141 after ______ seconds

Meas. Plots ______ % diff. from rating ______

Wading, cable, ice, boat, upstr., dowstr., side, bridge 10

feet, mile, above, below, gage and XS 3+45

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Fairly uniform flow conditions, slightly bouldery

Flow conditions Winter baseflow Weather Warm & sunny

Air ______ F@ ______ Water 52° F@ 2 PM

Gage ______ Record removed ______

Control Riffle

Remarks ______

Measurement # 99-01 **Discharge Measurement Raw Data Sheets**

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	14.2										left edge water
	15.0		0.2	15	43.7	.77				.14	
	16.0		0.25	23	42.4	1.2				.38	
	17.5		0.6	16	42.3	.84				.76	
	19.0		0.6	16	42.7	.84				.75	
	20.5		0.4	20	41.8	1.06				.64	
	22.0		0.65	28	42.3	1.46				1.43	
	23.5		0.8	27	43.3	1.38				1.66	
	25.0		0.5	24	42.7	1.25				.93	
	26.5		0.8	25	42.1	1.31				1.58	
	28.0		0.9	29	43.4	1.48				1.99	
	29.5		0.5	21	41.6	1.12				.84	
	31.0		0.45	22	47.5	1.03				.70	
	32.5		1.0	25	43.1	1.28				1.93	
	34.0		0.7	26	42.9	1.34				1.41	
	35.5		1.4	19	42.3	1.00				2.10	
	37.0		1.2	25	41.7	1.33				2.63	
	38.8		0.6	24	41.7	1.27				1.15	Top of rock
	40.0		1.1	27	41.8	1.43				2.12	
	41.5		0.45	26	42.8	1.34				.91	
	43.0		0.3	18	42.8	.94				.49	
	45.0		0.6	11	44.2	.56				.64	
	46.8		0.0								Right edge water
										25.16	

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

B1 Survey

(87)

6-3-99 B1 Connector Discharge - Upper Lee Vining Creek

∡	Sta	Width	Depth	Area	Revs	Time	Velocity	Q	Notes
	13.0		0.50		80	41.7			
	13.5		0.70		61	41.6			
10°	14.0		0.60		55	43.8			
	14.5		0.50		67	41.8			
	15.0		0.40		37	42.3			
	15.5		0.60		42	42.2			
10°	16.0		0.65		[illegible]	42.0			
	16.5		0.65		5	49.0			
	19.0								[illegible]

Q = 17. cfs

B1 Connector Staff plate. 0.72 @ 1:55 PM

B1 Channel staff plate 1.17 @ 16:35 PM

FB#8

OWEL Survey

6-3-99 | B1 Channel Connector Discharge Measurement | J. Bair - G. Reis

Entered J. Bair 6-21-99 Entered

Spin test = Ok after 90 sec

X	Sta *	Width	Depth *	Area	Revs *	Time *	Velocity	Q	Notes
	0.5								Left edge of water
	1.5		0.35		33	42.3			
	2.0		0.25		35	41.9			
15°	2.5		0.30		60	42.2			
10°	3.0		0.70		65	42.4			
1°	3.5		0.35		36	42.6			
	4.0		0.40		38	43.0			
	4.5		0.40		55	43.1			
	5.0		0.40		38	42.4			
	5.5		0.30		36	41.8			
	6.0		0.40		42	42.4			
	6.5		0.40		35	42.2			
	7.0		0.40		24	42.6			
	7.5		0.45		15	43.1			
	8.0		0.45		38	42.2			
	8.5		0.45		36	42.3			
	9.0		0.40		55	42.6			
	9.5		0.40		52	41.8			
	10.0		0.50		50	45.1			
	10.5		0.30		45	41.7			
	11.0		0.45		55	42.0			
20°	11.5		0.60		90	44.6			
	12.0		0.50		60	44.0			
	12.5		0.40		71	41.5			REW [illegible] LEW = 0.3'

FB#8

WSEL Survey

6-3-99 Main Channel - Upper Location
Discharge Measurement

Discharge taken on Cross Section 345 (81)
Entered J. Bair 6-21-99

∡	Sta	Width	Depth	Area	Revs	Time	Velocity	Q	Notes
	42.00								Left edge of water
	55.00		0.90		07	41.8			1 click = 1 rev
10°	56.50		1.00		60	42.4			
10°	58.00		1.40		63	42.7			
10°	59.00		1.10		80	46.1			
10°	61.00		0.90		20	57.9			1 click = 5 revs
10°	62.50		1.20		17	43.5			
5°	64.00		0.90		18	44.0			
3°	65.50		1.10		15	43.5			
	67.00		1.30		17	41.9			
	68.50		1.15		16	44.0			
	70.00		1.35		17	42.7			
	71.50		1.40		14	42.0			
	73.00		0.95		14	42.8			
	74.50		0.80		20	42.2			
	76.00		1.15		13	43.0			
	77.50		0.20		17	42.8			
	79.00		1.30		12	43.1			
	80.50		1.00		12	42.6			
	82.00		1.10		13	43.5			
	83.50		1.15		13	42.9			
	85.00		1.00		47	42.1			1 click = 1 rev
20°	86.50		0.50		28	42.7			
	93.00								Right edge of water

Q = 142.02

REW 93

FB#8

CWSL Survey

A-4 Change Upper V... Creek Discharge Measurement

Discharge taken at cross Section 0.6+66 (9?)

	Sta	Width	Depth	Area	Revs	Time	Velocity	Q	Notes
X	10.0		0						Left edge of water
	11.5		0.7		27	42.5			
	12.0		0.8		21	42.9			
	12.5		0.3		25	41.8			
	13.0		1.1		36	41.8			
	13.5		1.1		47	42.2			
	14.0		1.0		65	42.0			
	14.5		0.9		18	43.9			1 click 4 revs
	15.0		1.2		19	42.4			
	15.5		1.5		14	42.9			
	16.0		1.6		18	42.6			
	16.5		1.6		17	42.3			
	17.0		1.75		18	43.0			
	17.5		1.8		18	43.9			
	18.0		1.75		20	58.7			
	18.5		1.8		13	43.9			
	19.0		1.8		12	43.8			
	19.5		1.5		12	42.1			
	20.0		1.6		55	42.9			1 click = 1 rev
	20.5		1.7		80	44.2			
	21.0		1.3		80	44.7			Entered
	21.5		1.6		50	41.6			J. Bair 6-21-99
	22.0		1.5		60	43.1			Q = 56 cfs
	22.5		1.3		50	44.0			
	23.0		1.0		23	42.6			Rew 25.0 10

FB#8

McBain & Trush

Trinity River Gaging

Meas. No. 99-03

Comp. by Dallen Mevan

Checked by ______

Discharge Measurement Notes

Station name Upper Lee Vinms Main Channel Units (SI/English) Ft/sec

Date 7-26, 1999 Hydrographers Dallen Mevan (notes) Tom Weisley (meter)

Width ______ Area ______ Vel. ______ G.H. ______ Disch. ______

Method 0.6 No. secs. 40 G.H. change ______ in ______ hrs. Susp. ______

Method coef. ______ Hor. angle coef. ______ Susp. coef. ______ G.H. of zero flow ______

Time	Gage Reading Recorder	Outside
10:50	0.0	
11:20	0.0	
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______

Battery voltage ______

Type of meter Marsh McBirney Meter No. USFWS

Date rated — for rod, other

Meter — ft. above bottom of weight

Spin before meas. — after — seconds

Meas. Plots — % diff. from rating ______

Wading, cable, ice, boat, upstr. dowstr,. side, bridge 10.0 ft

feet, mile, above, below, gage and XS 3+30

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Ripply surface near Thalweg; flow angle near LB

Flow conditions Receding snowmelt runoff Weather Clear + calm

Air ~ 85° F@ ______ Water ______ F@ ______

Gage ______ Record removed ______

Control ______

Remarks ______

50.88

12.45

16.30

28.75

~ 67.18

Measurement # 99-03 **Discharge Measurement Raw Data Sheets**

100896
.017

	Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
		13.7										left Edge water
1		15.0	1.4	0.32			.02				.01	
2		16.5	1.5	0.67			1.12				1.12	
3		18.0	1.5	0.5			1.49				1.12	
4		19.5	1.5	0.5			1.37		35°		1.03	
5		21.0	1.5	0.68			1.39		35°		1.42	4.70
6		22.5	1.5	0.70			1.74		35°		1.82	
7		24.0	1.5	0.8			1.98		35°		2.38	
8		25.5	1.5	0.7			1.99		25°		2.09	
9		27.0	1.5	0.95			2.22		20°		3.16	
10		28.5	1.5	0.8			2.40		10°		2.88	
11		30.0	1.5	0.9			2.29		0°		3.92	16.25
12		31.5	1.5	1.2			1.91		0°		3.44	
13		33.0	1.5	1.05			1.99		0°		3.44	
14		34.5	1.5	1.1			2.37		0°		3.13	
15		36.0	1.5	1.42			1.22		0°		2.60	*
16		37.5	1.5	1.0			1.63				2.44	*
17		39.0	1.5	1.2			1.65				2.97	18.02 *
18		40.5	1.5	1.0			2.40				3.60	
19		42.0	1.5	1.0			2.17				3.26	
20		43.5	1.5	0.95			1.43		15°		2.04	
21		45.0	1.5	0.82			1.74		30°		2.14	11.03
22		46.5	1.35	0.6			1.09		30°		0.88	
		47.7										Right edge water
											50.88	= Q
						Q =	48.43 cfs					(~~not~~ adjusted for angles)
							Corrected for	angle				
		47.7										REW

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. 99-03

Comp. by Darren Mierau

Checked by ____

Discharge Measurement Notes

Station name Upper Lee Vining B-connector Units (SI/English) Ft/sec.

Date 7-26, 1999 Hydrographers Darren Mierau / Tom Woolsley

Width ____ Area ____ Vel. ____ G.H. ____ Disch. ____

Method ____ No. secs. ____ G.H. change ____ in ____ hrs. Susp. ____

Method coef. ____ Hor. angle coef. ____ Susp. coef. ____ G.H. of zero flow ____

Time	Gage Reading Recorder	Outside
1215	0.67	
1252	0.68	
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ____

Battery voltage ____

Type of meter Marsh McBirney Meter No. USFWS #7

Date rated ____ for rod, other

Meter ____ ft. above bottom of weight

Spin before meas. ____ after ____ seconds

Meas. Plots ____ % diff. from rating ____

Wading, cable, ice, boat, upstr., dowstr,. side, bridge 8 ft

feet, mile, above, below, gage and B-connector staff plate

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section is shallow with moderate surface turbulence

Flow conditions ____ Weather ____

Air ____ F@ ____ Water ____ F@ ____

Gage ____ Record removed ____

Control ____

Remarks Estimated maximum stage height on B-connector staff plate = 0.81 based on filamentous algal growth on staff plate surface

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity point	At mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	3.3										left edge water
	3.5	.35	0.2			0.0				0	
	4.0	.5	.32			.80				.13	
	4.5	.5	.34			1.24				.21	
	5.0	.5	.33			1.94				.32	cum.
	5.5	.5	.38			1.95				.37	1.03
	6.0	.5	.28			.98				.14	1.17
	6.5	.5	.30			.91				.14	1.31
	7.0	.5	.32			1.28				.20	1.51
	7.5	.5	.30			1.26				.19	1.70
	8.0	.5	.35			1.48				.26	1.96
	8.5	.5	.28			1.73				.24	2.20
	9.0	.5	.30			1.79				.27	2.47
	9.5	.5	.35			1.27				.22	2.69
	10.0	.5	.40			1.51				.30	2.99
	10.5	.5	.42			2.03				.43	3.42
	11.0	.5	.35			1.73				.30	3.72
	11.5	.5	.45			1.18				.27	3.99
	12.0	.5	.65			2.19				.71	4.70
	12.5	.5	.75			2.81				1.05	5.75
	13.0	.5	0.80			2.94				1.18	6.93
	13.5	.5	.85			2.75				1.17	8.10
	14.0	.5	.90			2.67				1.20	9.30
	14.5	.5	.75			3.93				1.47	10.77
	15.0	.5	.62			2.77				.86	11.63
	15.5	.5	.60			2.73				.82	12.45
	16.0	.35	.20			.03				.00	12.45 In weeds
	16.2										REW
	16.2										

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. ________

Comp. by ________

Checked by ________

Discharge Measurement Notes

Station name Upper Lee Vining Ck A B-1 channel Units (SI/English) feet in tenths

Date 27 July, 1999 Hydrographers D. Mierau T. Worsley

Width ________ Area ________ Vel. ________ G.H. ________ Disch. ________

Method ________ No. secs. ________ G.H. change ________ in ________ hrs. Susp. ________

Method coef. ________ Hor. angle coef. ________ Susp. coef. ________ G.H. of zero flow ________

Time	Gage Reading Recorder	Gage Reading Outside
1330		0.40
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ________

Battery voltage ________

Type of meter Marsh McBirney Meter No. ________

Date rated ________ for rod, other

Meter ________ ft. above bottom of weight

Spin before meas. ________ after ________ seconds

Meas. Plots ________ % diff. from rating ________

Wading, cable, ice, boat, upstr., dowstr., side, bridge B1 Staff

feet, mile, above, below, gage and ________

~ 200' dwn strm of gage

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section ________

Flow conditions ________ Weather ________

Air ________ F@ ________ Water ________ F@ ________

Gage ________ Record removed ________

Control ________

Remarks ________

Measurement # 99-03 **Discharge Measurement Raw Data Sheets**

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	4.5	0									Left Edge Water
	5.0	.75	0.5			0.23				.09	
	6.0	.75	0.4			1.49				.45	
	6.5	.5	.68			2.99				1.02	
	7.0	.5	.68			3.04				1.03	
	7.5	.5	.70			3.27				1.14	
	8.0	.5	1.0			2.59				1.30	5.03
	8.5	.5	1.0			3.65				1.82	
	9.0	.5	0.8			3.88				1.55	
	9.5	.5	0.92			4.07				1.87	
	10.0	.5	.82			4.20				1.72	
	10.5	.5	.65			4.98				1.62	8.58
	11.0	.5	1.0			5.09				2.54	
	11.5	.5	.88			5.48				2.41	
	12.0	.5	.88			3.97				1.75	
	12.5	.5	1.0			4.63				2.31	
	13.0	.5	1.35			3.84				2.59	11.6
	13.5	.5	1.40			2.74				1.92	
	14.0	.65	1.6			1.56				1.675	
	14.8										Right Edge Water
										28.75 cfs	= Q
	14.8										

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. 0002

Comp. by J. Bair Entered

Checked by

Discharge Measurement Notes

Station name Lee Vining Creek - A4 Channel Units (SI/English) Imperial

Date June 1, ~~19~~ 2000 Hydrographers Daniel Klause (MLC), J. Bair

Width 16.5 ft Area 17.44 Vel. 2.99 fps G.H. ____ Disch. 52.98 cfs

Method 0.6 No. secs. 22 G.H. change ____ in ____ hrs. Susp. ____

Method coef. ____ Hor. angle coef. ____ Susp. coef. ____ G.H. of zero flow ____

Time	Gage Reading Recorder	Gage Reading Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ____

Battery voltage ____

Type of meter Price "AA" Meter No. 594

Date rated ____ for rod, other

Meter ____ ft. above bottom of weight

Spin before meas. Ok after 90 seconds

Meas. Plots ____ % diff. from rating ____

Wading, cable, ice, boat, upstr., dowstr. side, bridge 1.5

feet, mile, above, below, gage and in the A4 Channel

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section ____

Flow conditions ____ Weather warm, clear

Air ____ F@ ____ Water ____ F@ ____

Gage ____ Record removed ____

Control ____

Remarks Taken Between 06+80 & 5+25 cross section -

Measurement # 0002 **Discharge Measurement Raw Data Sheets**

	Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
		6.5										Left edge of water, Begin 15:40
1		8.5		.85	40	43.4						
2		9.0		.9	45	43.0						
3		9.5		1.15	30	43.6						
4		10.0		1.3	51	45.3						
5		10.5		1.3	70	43.2						
6		11		1.4	63	48.5						
7		11.5		1.4	65	42.9						
8		12		1.3	80	48.3						
9		12.5		1.6	70	41.7						
10		13		1.6	60	44.9						
11		13.5		1.5	70	41.3						
12		14		1.4	70	46.4						
13		14.5		1.4	60	40.9						
14		15		1.4	80	45.4						
15		15.5		1.4	80	44.3						
16		16		1.3	80	40.0						
17		16.5		1.7	70	40.8						
18		17		1.5	35	41.1						behind rock
19		18		1.5	60	40.7						behind rock
20		19		1.1	70	41.5						
21		20		.8	60	48.1						
22		21		.55	3	59.8						
23		23										End time 16:20
24												

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. 0003

Comp. by J. Bair Entered

Checked by ____

Discharge Measurement Notes

Station name Lee Vining Creek A4-Channel Units (SI/English) Imperial

Date June 2, ~~19~~ 2000 Hydrographers Paul McFarland (MLC), John Bair

Width 16.5 ft Area 18.55 Vel. 2.97 G.H. ____ Disch. 55.09

Method 0.6 No. secs. 24 G.H. change ____ in ____ hrs. Susp. ____

Method coef. ____ Hor. angle coef. ____ Susp. coef. ____ G.H. of zero flow ____

Time	Gage Reading Recorder	Gage Reading Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ____

Battery voltage ____

Type of meter Price "AA" Meter No. 594

Date rated ____ for rod, other

Meter ____ ft. above bottom of weight

Spin before meas. ok after 90 seconds

Meas. Plots ____ % diff. from rating ____

Wading, cable, ice, boat, upstr., dowstr,. side, bridge ____

feet, mile, above, below, gage and ____

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section ____

Flow conditions ____ Weather ____

Air ____ F@ ____ Water ____ F@ ____

Gage ____ Record removed ____

Control ____

Remarks Discharge taken between cross sections 06+80 - 05+25

Measurement #_____ **Discharge Measurement Raw Data Sheets** Page 1 of ____

	Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
1		5.5		—	—	—						left edge of water - 15.10 begin
2		7.5		1	45	45.1						
3		9		1.15	35	44						
4		9.5		1.15	80	46.5						
5		10		1.45	70	46.4						
6		10.5		1.5	60	41.8						
7		11		1.4	70	47.2						
8		11.5		1.5	80	45.2						
9		12		1.6	70	43						
10		12.5		1.45	70	43.4						
11		13		1.5	70	43.9						
12		13.5		1.4	60	41.9						
13		14		1.3	80	44.1						
14		14.5		1.45	70	43.6						
15		15		1.5	80	41.7						
16		15.5		1.5	100	42.4						
17		16		1.7	50	44.3						Behind Boulder
18		16.5		1.7	33	41.5						Behind Boulder
19		17		1.7	90	46.9						Behind Boulder
20		17.5		1.4	70	50						
21		18		1.35	70	45.4						
22		18.5		1.3	70	45.9						
23		19		.9	60	48.7						
24		20		.7	21	42						
25		21		.3								
26		22										Right edge of water - 15.54 end

rt edge water - 22
lft edge water - 5.5

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

Parshall flume 1.98 @ 19:25

McBain & Trush

Trinity River Gaging

Meas. No. 0003

Comp. by J. Bair Entered

Checked by ________

Discharge Measurement Notes

Station name Lee Vining Creek - Mainstem Units (SI/English) Imperial

Date June 02, ~~19~~ 2000 Hydrographers Paul McFarland (MCC), J. Bair

Width 45.5 Area 42.32 Vel. 3.05 G.H. ______ Disch. 127.01

Method 0.6 No. secs. 30 G.H. change ______ in ______ hrs. Susp. ______

Method coef. ______ Hor. angle coef. ______ Susp. coef. ______ G.H. of zero flow ______

Time	Gage Reading Recorder	Gage Reading Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ______

Battery voltage ______

Type of meter Price "AA" Meter No. 3 94

Date rated ______ for rod, other

Meter ______ ft. above bottom of weight

Spin before meas. Ok after 90sec seconds

Meas. Plots ______ % diff. from rating ______

Wading, cable, ice, boat, upstr., dowstr,. side, bridge ______

feet, mile, above, below, gage and ______

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section 03+45 - Pool tail w/ many boulders

Flow conditions Rising Stage Weather ______

Air ______ F@ ______ Water ______ F@ ______

Gage ______ Record removed ______

Control ______

Remarks Hit and miss w/ Hydraulic shadow of large boulders

Measurement #_____ **Discharge Measurement Raw Data Sheets**

112.5 REW
47.0
45.5

	Angle Coef.	Tape dist.	Width	Depth	Revolutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	-	47.0										Left edge of water 11:25
1		54.5		.65	42	44.2						
2		55		.85	50	44.7						
3		57		1.13	50	49.9						
4		59		1.35	65	45.5						
5	5°	61		1.2	60	43.8						
6	30°	63		1.25	70	44						
7	30°	64		1.0	70	46.3						
8	20°	65		1.15	70	40.8						
9	15°	66		1.15	80	43.1						
10	5°	67		1.3	80	42.8						
11		68		1.45	70	55.7						
12		69		1.3	60	46.0						
13		70		1.6	60	42.1						
14		71		1.55	70	45.3						
15		72		1.5	60	43.6						behind boulder
16		73		1.3	80	46						behind boulder
17		74		1.45	70	42.9						behind boulder
18		75		1.1	70	48.1						
19		76		1.1	60	47.9						
20		77		1.2	90	43.7						
21		78		1.2	80	47.5						
22		79		1.3	40	32.9						Hydraulic shadow?
23	5°	80		1	70	44.3						
24	10°	81		1	70	46.3						
25	5°	82		.9	80	45.1						
26	10°	83		1.1	70	47						
27	5°	84		.85	70	47.6						
28	10°	86		.9	45	45.2						
29	5°	87		.35	30	41.7						
30		92		.4	44	42.4						super Funky

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

92 < [illegible] REW - 112.5 [illegible]

McBain & Trush
Trinity River Gaging

Meas. No. 0002
Comp. by J. Bair Entered
Checked by ____

Discharge Measurement Notes

Station name Mainstem Lee Vining Creek XS 03+45 Units (SI/English) English
Date June 1, ~~98~~ 2000 Hydrographers Dan Gause (MLC), J. Bair
Width 45.7 Area 42.46 Vel. 2.99 G.H. ____ Disch. 122.12
Method 0.6 No. secs. ____ G.H. change ____ in ____ hrs. Susp. ____
Method coef. ____ Hor. angle coef. ____ Susp. coef. ____ G.H. of zero flow ____

Time	Gage Reading: Recorder	Gage Reading: Outside
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ____
Battery voltage ____

Type of meter Price "AA" Meter No. 594
Date rated ____ for rod, other
Meter ____ ft. above bottom of weight
Spin before meas. OK after >90 seconds
Meas. Plots ____ % diff. from rating ____
Wading, cable, ice, boat, upstr., dowstr,. side, bridge ____
feet, mile, above, below, gage and ____

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section ____
Flow conditions falling stage Weather Clear, warm
Air ____ F@ ____ Water ____ F@ ____
Gage ____ Record removed ____
Control Clear
Remarks Cross section is in poor gaging location at higher flows - need to look for other sites

Measurement #00-01

Discharge Measurement Raw Data Sheets

	Angle Coef.	Sta Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity point	Velocity At mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
		46.7		0								Left edge of water Began 11:30
1		55.0		.7	50	43.5						
2		56.0		1.05	50	47.4						
3		58.0		1.30	60	45.0						
4		59.5		1.15	50	41.4						
5		61.0		1.15	70	43.0						
6	30°	62.5		1.15	60	46.9						
7	15°	64.0		.85	17	44.8						1 click / 5 revs
8	5°	65.5		1.10	16	42.6						
9	5°	67.0		1.30	14	42.6						
10		68.0		1.40	10	42.9						
11		69.0		1.25	11	44.2						
12		70.0		1.60	9	46.0						
13		71.0		1.50	60	40.8						1 click/1 rev
14		72.0		1.60	75	42.0						
15		73.0		1.35	90	41.1						
16		74.0		1.60	50	43.5						behind a boulder
17		75.0		1.20	70	42.2						
18		76.0		1.15	75	40.8						
19		77.0		1.10	75	40.9						
20		78.0		1.40	70	41.34						
21		79.0		1.15	35	44.5						
22	5°	81.0		.95	70	42.6						
23	15°	83.0		1.20	65	42.0						
24	5°	85.0		.90	54	44.4						
25	5°	87.0		.45	27	42.5						
26	30°	92.0		.40	17	45.2						super funky
	-	92.4		0	0	0						Right Edge End 12:45

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. 0002

Comp. by J. Bair Entered

Checked by

Discharge Measurement Notes

Station name Lee Vining Creek - B1 connector Units (SI/English) English

Date June 1, ~~19~~ 2000 Hydrographers Daniel Clause (MLC); J. Bair

Width 14.6 Area 7.05 Vel. 2.28 G.H. Disch. 16.05

Method 0.6 No. secs. 12 G.H. change in hrs. Susp.

Method coef. Hor. angle coef. Susp. coef. G.H. of zero flow

Time	Gage Reading Recorder	Gage Reading Outside
13:55		0.66
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa.

Battery voltage

Type of meter ~~Pygmy~~ Price "AA" Meter No.

Date rated for rod, other

Meter ft. above bottom of weight

Spin before meas. after seconds

Meas. Plots % diff. from rating

Wading, cable, ice, boat, upstr., dowstr,. side, bridge

feet, mile, above, below, gage and

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section had less than 20 sections

Flow conditions Weather Clear, warm

Air F@ Water F@

Gage Record removed

Control

Remarks

LEW = 1.2 ft

REW = 15.8

Measurement #_____ **Discharge Measurement Raw Data Sheets**

	Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity At point	Velocity mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
		1.2										Left Water Edge Begin 13:55
1		2.5		.45	34	41.3						
2		3.0		.35	45	44.3						
3		3.5		.40	43	44.7						
4		4.0		.40	33	41.7						
5		4.5		.35	30	41.6						
6		8.5		.35	46	44.3						
7		9.0		.40	35	42.6						
8		9.5		.50	50	45.9						
9		10.0		.60	50	43.1						
10		10.5		.75	65	44.0						
11		11.0		.75	55	45.4						
12		11.5		.80	60	42.7						
13		12.0		.90	60	46.8						
14		12.5		1.00	60	43.2						
15		13.0		.95	80	41.6						
16		13.5		.85	32	39.8						
17		14.0		.65	10	42.7						
18		15.8										14:30 end time REW
19												
20												
21												

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

McBain & Trush

Trinity River Gaging

Meas. No. 0003

Comp. by J. Bair Entered

Checked by

Discharge Measurement Notes

Station name Lee Vining - B1 connector Units (SI/English) Imperial

Date June 2, ~~10~~ 2020 Hydrographers Paul McFarland (MLC), J. Bair

Width ____ Area ____ Vel. ____ G.H. ____ Disch. ____

Method Q6 No. secs. ____ G.H. change ____ in ____ hrs. Susp. ____

Method coef. ____ Hor. angle coef. ____ Susp. coef. ____ G.H. of zero flow ____

Time	Gage Reading Recorder	Outside
13:00		0.69
13:50	-	0.67
Weighted M.G.H		
G.H. correction		
Correct M.G.H.		

Conversion equa. ____

Battery voltage ____

Type of meter Price "AA" Meter No. S94

Date rated ____ for rod, other

Meter ____ ft. above bottom of weight

Spin before meas. OK after 90 seconds

Meas. Plots ____ % diff. from rating ____

Wading, cable, ice, boat, upstr., dowstr,. side, bridge ____

feet, mile, above, below, gage and ____

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%) based on following conditions: Cross section Clear, stage higher than yesterday

Flow conditions ____ Weather Clear, warm

Air ____ F@ ____ Water ____ F@ ____

Gage ____ Record removed ____

Control ____

Remarks ____

Measurement #______ **Discharge Measurement Raw Data Sheets** Page i of ____

Angle Coef.	Tape dist.	Width	Depth	Revo-lutions	Time in seconds	Velocity point	Velocity At mean in vert.	Adj. for hor. angle	Area	Discharge	Notes
	6.0										Left edge of water 13:05 Begin
	7.5		.45	27	41.9						
	8		.5	45	43.5						
	8.5		.45	30	44						
	9		.4	38	44.16						
	9.5		.4	31	44.3						
	10		.4	42	43.2						
	10.5		.4	30	47.2						
	11		.45	42	44.1						
	11.5		.4	35	42.3						
	12		.4	50	45.3						
	12.5		.4	44	48.5						
	13		.4	45	47.3						
	13.5		.45	50	42.6						
	14		.5	70	42.8						
	14.5		.5	60	47						
	15		.65	50	47.9						
	15.5		.75	50	41.0						
	16		.9	38	43.4						
	16.5		.9	70	42.8						
	17		1	70	44.2						
	17.5		.9	80	43.4						
	18		.85	90	47.4						
	18.5		.65	3	44.1						Eddy fence
	21.4										Right edge 13:46 end

Price AA: if rev>40, V=2.17 (rev/seconds) + 0.03
if rev<40, V=2.18 (rev/seconds) + 0.02

Use 0.2/0.8 method if depth>2.5'
Time of each velocity measurement must be >40 seconds

2000-2001 Mono Basin Waterfowl Habitat and Population Monitoring Report

May, 2001

Los Angeles Department of Water and Power

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Appendices

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II. 2000 Annual Report – "Mixing and Plankton Dynamics in the Mono Lake, California

III. 2000 Mono Lake Vegetation and Habitat Mapping

IV. 2000 Mono Basin Vegetation Monitoring Report

V. Waterfowl Populations at Mono Lake, California, 2000

1. INTRODUCTION

This report presents a synthesis and review of monitoring data collected in 2000 and prior years to evaluate the restoration and utilization of waterfowl habitat in the Mono Basin. The report primarily covers restoration and monitoring since September 1994, when Mono Lake Basin Water Rights Decision 1631 was adopted by the California State Water Resources Control Board (SWRCB); a summary of previous restoration and monitoring activities is also presented. This report is the second in a series of annual reports that will document monitoring results in and around Mono Lake with respect to waterfowl habitat and use.

1.1 Background – Water Right Decision 1631 And Order 98-05

Mono Lake Basin Water Right Decision 1631 set the stabilization lake level for Mono Lake at 6,392 feet above mean sea level (amsl), which is 20 feet above its post-diversion low stand of 6,372 feet in 1981. One of the considerations put forth in Decision 1631 for setting the stabilization lake level at 6,392 feet was to restore waterfowl habitat lost as a result of the decline in Mono Lake's water level. However, this level is predicted to only partially restore habitat conditions as they existed prior to diversions in 1940. To mitigate this loss of waterfowl habitat between pre-diversion conditions and those at a lake level of 6,392 feet, Decision 1631 required that a waterfowl restoration plan be developed and implemented. Decision 1631 also specified that the restoration plan include a monitoring program to evaluate changes in waterfowl habitat resulting from rising lake level and other restoration actions.

In response to Decision 1631, Los Angeles Department of Water and Power (LADWP) retained three waterfowl experts to develop a waterfowl restoration plan for the Mono Basin. Based largely on a 1995 report by these experts, LADWP submitted the Mono Basin Waterfowl Habitat Restoration Plan to the SWRCB in February 1996. The waterfowl experts' report is Appendix I of the Waterfowl Habitat Restoration Plan.

The SWRCB issued Order 98-05 in 1998, which addressed stream and waterfowl restoration and Grant Lake operations and management. In addition to the restoration of waterfowl habitat brought about by the increase in lake level to 6,392 feet, Order 98-05 prescribed several waterfowl habitat restoration measures for the Mono Basin that were presented in the 1996 Mono Basin Waterfowl Restoration Plan. These measures included:

- rewatering of Rush Creek distributaries;
- creation or enhancement of waterfowl habitat at County Ponds, Black Point area, or in shallow scrapes in wetland areas near Mono Lake; and
- implementation of a prescribed burn program in lake fringing marshes.

Order 98-05 also specified that LADWP monitor the hydrology, limnology, riparian and lake-fringing wetland vegetation, and waterfowl populations of the Mono Basin in accordance with the provisions of the Waterfowl Habitat Restoration Plan dated February 29, 1996.

Order 98-05 required that the monitoring program be carried out under the direction of a waterfowl expert or experts approved by the SWRCB Chief of the Division of Water Rights. Dr. Brian N. White was approved by the SWRCB as the waterfowl expert to oversee the waterfowl monitoring program and to report annually on its results starting in 2001. Several individuals, either contracted or employed by LADWP, are currently involved in collecting monitoring data, including Dr. Joseph Jehl (waterfowl population counts and activity budgets), Dr. Robert Jellison (limnological data), and Dr. David Martin (vegetation data and aerial photography interpretation).

1.2 Objectives Of Report

The primary goal of this report is to document waterfowl habitat and population monitoring and restoration in the Mono Basin as of December 2000. Following the requirements of Order 98-05, the specific objectives are to report on:

A. the results of waterfowl population surveys and studies;

B. the status of waterfowl habitat restoration projects;

C. the recovery of waterfowl habitat from increased streamflow and lake level;

D. other information relevant to restoration/recovery of wildlife habitat.

In addition to these required objectives, this second annual waterfowl restoration report includes a summary of previous monitoring data and efforts

1.3 Organization Of Report

Section 2 summarizes previous research and monitoring studies relevant to the restoration of waterfowl habitat in the Mono Basin. Section 3 documents the results of all 2000 monitoring activities, including subsections on hydrology, limnology, vegetation and habitat, and waterfowl population surveys and studies. This section addresses Objective A while giving an overview of the entire monitoring effort. Section 4 provides a status of waterfowl habitat restoration projects (Objective B), and Section 5 presents information on the recovery of waterfowl habitat from increased streamflow and lake level (Objective C).

In addition to the main report, we have attached several appendices. These appendices consist of individual monitoring reports authored by the investigators responsible for each monitoring component, including hydrology, limnology, vegetation and habitat, and waterfowl population surveys (Objective D).

2. SUMMARY OF RESTORATION MEASURES AND WATERFOWL MONITORING ACTIVITIES PRIOR TO ORDER 98-05

This section summarizes the status of waterfowl habitat restoration measures and reviews monitoring and research related to waterfowl habitat that have taken place prior to Order 98-05. Waterfowl habitat restoration measures include actions resulting from Decision 1631 and those conducted outside of Decision 1631 requirements. Waterfowl monitoring studies can be most broadly defined as any previous research that pertains to the Mono Lake ecosystem or more narrowly defined to include only studies specifically addressing waterfowl populations and habitat conditions prior to and following the initiation of restoration actions. This summary will focus on the more narrow definition of monitoring, although other ecosystem-level studies will be mentioned where relevant.

2.1 Restoration Measures

Order 98-05 2000 include increases in lake level and stream flows and modifications of surrounding habitat. Increases in stream flows and lake level will be described in Section 2.2 below.

2.1.1 Stream Flow and Lake Level

The flow in Rush Creek was maintained year round at 19 cfs following high flows in 1983 and subsequently increased as a result of Decision 1631. The flow in Lee Vining Creek was maintained at 4 cfs following high flows in 1986 and subsequently increased as a result of Decision 1631. A defined flow regime for both streams has been specified in Order 98-05 that takes into account flows needed for stream restoration and fish habitat, as well as increasing lake level.

From the recent low stand of 6,373.4 feet occurring in December 1992, the lake level generally increased through December 1998. At the end of 1998, the water surface of Mono Lake reached 6,384.3 feet. During 1995 a rise in the lake level of 3.3 feet resulted in a chemically stratified lake condition known as meromixis, which has continued to the present. On April 1, 2001, the elevation of Mono Lake was 6384.5 feet. Mono Lake salinity at this elevation is approximately 80 to 85 g/l total dissolved solids. To reach the stabilization lake level of 6,392 feet established by Decision 1631, the lake level must rise another 7.5 feet.

2.1.2 DeChambeau/County Ponds Complex

The DeChambeau Ponds were originally created in 1915, when an oil test well tapped an aquifer of hot artesian water. The water was directed into a series of three ponds, and as many as seven ponds once existed. The ponds had deteriorated over several decades up to 1992 and their habitat value to waterfowl had diminished considerably.

In 1992, the U.S. Forest Service (USFS), Caltrans, the Mono Lake Committee (MLC), and Ducks Unlimited collaborated on a project to restore three degraded ponds and create two more ponds. The project was largely completed in September 1995, although work has continued since then to improve the functioning of the ponds. The project consisted of rebuilding dikes below old ponds, construction of a new check dam and dike to create new ponds, installation of water control structures, sealing of ponds with bentonite, and constructing a new well, pump, pumphouse, and pipeline. As a result of the original project, four ponds were created (one with an island), while one pond was considered too expensive to line with bentonite. The new well was found to be too expensive to run and consequently not used. The USFS has subsequently reworked the hot water artesian well and pipeline to increase the flow of water to 180 gallons per minute, which is maintaining approximately 9 acres of water surface at DeChambeau Ponds and also providing water to the County Ponds.

The County Ponds below the DeChambeau Ponds are natural basins that were inundated by Mono Lake prior to diversions in 1941. Following their exposure from the receding lake, they periodically filled with water during high runoff periods and provided ephemeral freshwater waterfowl habitat. In 1997 water diverted from Mill Creek to the DeChambeau Ranch was directed to the West County Pond via a ditch and the pond filled to a depth of 3.6 feet with a surface area of approximately 3 acres. In 1998 the ditch from DeChambeau Pond #5 was replaced with a pipe, and flow was directed to the east County Pond. However, the East County Pond did not hold water, and it subsequently drained.

2.1.3 Experimental Burning

An experimental burn program of Mono Lake wetlands was initiated in 1995 under the direction of the California Department of Parks and Recreation. These actions were implemented prior to Order 98-05, which requires LADWP to conduct a burn program in lake-fringing wetlands (subject to approval of the Chief of the Water Rights Division, SWRCB,).

In November 1995 approximately 12 acres of marsh were burned near Simons Springs in two different patches, one along the lakeshore and the other inland. The intensity of the burn was variable, depending on what species were dominant. In February 1997 a second burn was conducted at Simons Springs along the lakeshore.

2.1.4 Rewatering Rush Creek Distributaries

There has been no activity to rewater the distributaries identified in the Waterfowl Habitat Restoration Plan. The original goal was to rewater two to three distributaries for stream as well as waterfowl habitat restoration purposes per year. Three were rewatered on Rush Creek above Highway 395 in 1999. Those distributaries were done in accordance with the Stream and Stream Channel Restoration Plan and provide limited waterfowl habitat. Dr. Bill Trush, the stream monitoring expert, recently expressed his opinion that rewatering distributaries on Rush Creek should be discontinued until the effects on the stream can be further evaluated.

2.1.5 Other Measures

Other than those mentioned above, we are aware of no other Mono Basin waterfowl restoration measures that have been implemented prior to Order 98-05. Other waterfowl restoration measures identified in Order 98-05 include using shallow scrapes to make open water areas within lake-fringing wetlands.

2.2 Monitoring Activities

2.2.1 Stream Flow and Lake Level

Monitoring of stream flow in the Mono Basin is conducted by LADWP for Rush, Lee Vining, Walker, and Parker creeks and by Southern California Edison for Mill and Wilson creeks. Stream flow measurements recorded by LADWP are available and will be accessible through an Internet web page in the near future.

In addition, a monitoring program for stream restoration was specified in Order 98-05, which is being conducted by Bill Trush of McBain and Trush and Chris Hunter, an independent consultant, under contract to LADWP. This monitoring program includes detailed assessment of changes in stream geomorphology resulting from changes in flow and specific restoration actions. The monitoring program also includes fish population surveys.

The lake level is monitored biweekly by LADWP from a staff gage located near the mouth of Lee Vining Creek on the shore of Mono Lake. Lake level is recorded as elevation (in feet) above mean sea level (amsl). A correction factor of 0.4 feet is added to the gage reading to make the elevation consistent with U.S. Geological Survey datum. Both LADWP and the MLC maintain records of the lake level.

2.2.2 Limnology

There has been considerable research on the Mono Lake aquatic ecosystem, largely beginning with Mason's (1967) study of Mono Lake limnology. A thorough description of Mono Lake limnological and aquatic ecology studies is found in the Mono Basin EIR and in Jellison et al. (2001). Only a brief overview will be presented here.

Mason (1967) documented abiotic and biotic conditions in Mono Lake, including a description of the plankton communities. An interdisciplinary study (Winkler et al., 1977) was the next major effort made toward understanding the Mono Lake ecosystem. The group studied the ecology of phytoplankton, brine shrimp, and alkali flies, emphasizing the interactions with nutrient levels and salinity.

Starting in 1979, scientists from the University of California, Santa Barbara (UCSB) Marine Science Institute began an intensive study of limnology at Mono Lake. John Melack and Robert Jellison have been the principal investigators of the UCSB group and have had several collaborators. Early in the UCSB program, Lenz (1982, 1984) studied Mono Lake brine shrimp populations using systematic sampling techniques and examined brine shrimp food-web relationships. In 1982, the UCSB group initiated a much broader sampling effort and array of studies that continue today. Their work has produced a durable, systematic set of physical and biological data from standardized locations around Mono Lake. The work of the UCSB group has resulted in a detailed, not necessarily complete, understanding of life history, development, growth, grazing rates, production, abundance, and salinity tolerance of brine shrimp. In addition, to the UCSB group's work, LADWP has carried out limited surveys of phytoplankton and brine shrimp since 1974. The UCSB group has produced annual monitoring reports of Mono Lake limnology since 1987.

Since 1995, and previously in the mid 1980s, a considerable amount of monitoring and research in Mono Lake have been directed at the effects of meromictic conditions on brine shrimp dynamics and production (Table 1). Because meromixis prevents complete vertical mixing of the lake in the fall, nutrients (especially nitrogen) and their effects on algal biomass and productivity have been an important component of limnological studies. The effects of meromixis have been of increasing concern because meromictic conditions are projected to persist for as long as several decades due to greater than expected runoff in lake tributaries in 1995 and continued freshwater inputs.

Beginning in 1991, a dynamic reservoir simulation model (DYRESM) was developed and applied at Mono Lake by Romero and Melack (1996). The DYRESM was used to simulate the likelihood of meromixis among five lake elevations and assess the effects of prolonged drought and runoff variability. Efforts to refine DYRESM are ongoing.

Investigation of plankton dynamics is ongoing and has included several approaches. Initial studies utilized long-term laboratory experiments and were directed primarily at effects of increasing salinity. However, these laboratory studies did not predict the magnitude of changes observed in field studies. A cohort model of *Artemia* population dynamics was also developed to explain field data. Modeling of plankton dynamics have subsequently been improved by coupling *Artemia* dynamics with nitrogen fluxes, incorporating results from additional laboratory experiments, and application of multi-transfer models.

2.2.3 Waterfowl Habitat

Waterfowl habitat conditions around Mono Lake prior to diversions were determined from examination of aerial photographs taken in 1940.

Post-diversion vegetation around Mono Lake was sampled and classified by Burch et al. (1977) resulting in the description of several vegetation or community types and their relation to various environmental factors. Mapping of lake-fringing vegetation around Mono Lake in the 1980s was conducted by Dummer and Cowell in 1985. Though their maps do not emphasize waterfowl habitat, the maps do provide information useful in characterizing waterfowl habitat.

Mapping of point-of-reference conditions (August 22, 1993) for lake-fringing wetlands around Mono Lake was completed by Jones and Stokes Associates for the Mono Basin. The Jones and Stokes study was based on aerial photographs taken on May 23, 1991 and on extensive ground truthing, in which each wetland was surveyed on foot. Qualitative descriptions of waterfowl habitat around Mono Lake both before and after diversions were also provided in the Mono Basin EIR.

Prior to 1997, there was no systematic monitoring of waterfowl habitat around Mono Lake. However, some incidental descriptions of waterfowl habitat in certain areas around the lake were provided in waterfowl monitoring reports conducted by Lin (1997) and Lin and Jehl (1998).

Pre-diversion channel and riparian conditions along the Rush Creek bottomlands have been characterized in the Mono Basin EIR. Stine described riparian and channel conditions based on 1930 and 1940 aerial photographs, historical ground photographs, and interviews with local residents. He concluded that prior to diversions the Rush Creek bottomlands had multiple channels within an extensive cottonwood-willow riparian woodland. Although Beschta did not address riparian conditions of the Rush Creek bottomlands in detail, he did assess the question of multiple channels. He concluded that prior to 1941, Rush Creek had a single channel, with segments of relic channels present within the floodplain and with numerous rills that collected water from seeps and springs and conveyed it to Rush Creek. While the geomorphic and hydrologic basis of waterfowl habitat conditions in the Rush Creek bottomlands is not entirely clear, both Beschta's and Stine's studies indicate that there were areas of standing or flowing water within the cottonwood-willow woodland. These areas would likely have been attractive to small numbers of breeding waterfowl and to migrating waterfowl from Mono Lake during inclement weather.

Post-diversion riparian conditions in the Rush Creek bottomlands were characterized by Stromberg and Patten (1989) who described Rush Creek riparian conditions as they existed in the 1980s. The Mono Basin EIR also provided a description of channel and riparian conditions and quantified areas of major vegetation types.

2.2.4 Waterfowl Populations

Mono Lake provides a permanent, saline, shallow to deep water body for migratory waterfowl traveling through the expansive arid Great Basin during the fall. It is especially attractive to species that exploit hyper-saline environments. Of these species the ruddy duck (*Oxyura jamaicensis)* and northern shoveler *(Anas clypeata)* are most abundant at Mono Lake. Systematic surveys have only recently been conducted for migratory populations of waterfowl and are essentially non-existent for breeding ducks at Mono Lake. Prior to 1948 only journal and personal recollections of waterfowl abundance exist in the record.

In 1948, Walter Dombrowski conducted the first systematic waterfowl survey reported for Mono Lake. There were no systematic waterfowl surveys for Mono Lake through the 1950s, 1960s, and early 1970s. A waterfowl survey was conducted by Winkler et al. (1977). Various individuals and groups through the 1970s and 1980s have collected additional, sporadic waterfowl data. A professional wildlife biologist who has hunted Mono Lake for waterfowl hundreds of times during the 1980s and early 1990s estimates the current lake wide fall population at about 11,000 ducks. Joseph Jehl estimated the population in recent years at 15,000 ducks. Both Taylor and Jehl observed that ruddy ducks and northern shovelers continue to predominate in the fall population. A National Research Council (NRC) study in the mid 1980s summarized existing information about the Mono Lake ecosystem. With respect to birds, the NRC study focussed on phalaropes and gulls, with virtually no mention of waterfowl.

In the 1990s several systematic waterfowl surveys were conducted. The California Department of Fish and Game (CDFG) has collected some data using aircraft. Fall CDFG aerial waterfowl surveys were conducted in 1993,1998, 1999 and 2000. The Mono Lake Committee has surveyed the entire Mono Lake for all birds using a cadre of volunteers since 1997.

Joseph Jehl of Hubbs Sea World Research Institute under contract with LADWP, has conducted the most comprehensive waterfowl surveys at Mono Lake. These surveys have been conducted since 1995. Surveys have consisted of aerial (except 1995), ground, and boat counts at different intervals between summer and late fall. The 1996, 1997, 1998, and 1999 2000 efforts also included waterfowl surveys at Bridgeport Reservoir and Crowley Lake. Waterfowl behavior was studied during the same survey periods, with a major time budget study being conducted in 1997.

3. RESULTS OF 2000 MONITORING ACTIVITIES

Results of monitoring activities that occurred in 2000 are summarized in this section. In most cases, specific reports have been produced that address these activities in more detail. These reports on lake limnology, vegetation sampling, and waterfowl habitat mapping, and waterfowl populations are included as appendices to this report.

3.1 Hydrology

Mono Lake elevation fell by approximately 0.9 foot during the 2000 calendar year (Table 2). Lake level was 6384.3 feet on January 7, 2000 and 6383.4 feet on December 7, 2000 (data from LADWP using USGS datum). Peak lake level was 6,384.5 feet in July 2000. Lake level in January 2000 was 0.1 feet higher than the previous January (1999), however lake level at the end of 2000 was 0.7 feet lower than at the end of 1999. At a 6,383-foot lake level, estimated lake area is 45,350 acres and estimated volume is 2,596,336 acre feet.

Stream flows in Rush, Walker, Parker, and Lee Vining creeks by month for all of 1999 are shown in Table 3. Peak flows for major Mono Basin streams gaged by LADWP were:

- Rush Creek: 374 cfs on June 21 at the dam site and 260 cfs on June 30 below the narrows,
- Walker Creek: 31 cfs on May 29 and 27 cfs on June 17,
- Parker Creek: 46 cfs on June 17 and 49 cfs on June 25, and
- Lee Vining Creek: 258 cfs on May 28 and 210 cfs on June 16.

Water was diverted for export from Rush Creek from January to early April. Diversions for export were suspended from early April until July 20 to provide peak flows in Rush Creek. After July 20, exports were resumed at an average flow rate of 23 cfs. There were no diversions from Walker Creek, Parker Creek, or Lee Vining Creek for export during 2000. The report is attached as Appendix I.

Personnel from the Mono Lake Committee collected data from a network of piezometer stations located in the stream complexes of Rush and Lee Vining creeks. There are six piezometer wells in Rush Creek and ten in Lee Vining Creek.

3.2 Lake Limnology

Limnology monitoring data in 2000, as in previous years, was collected by Robert Jellison and his collaborators at the Marine Science Institute, University of California, Santa Barbara. A detailed account of 2000 mixing and plankton dynamics in Mono Lake can be found in Jellison et al. (2001), which is included as Appendix II to this report. Their 2000 research continues the long-term investigations into the highly variable and dynamic Mono Lake aquatic environment.

Limnological monitoring indicated that meromictic conditions present since 1996 in Mono Lake continued in 2000. However, a drop of 0.9 feet in lake level since 1998 appeared to moderate effects of meromixis on several physical, chemical, and biological parameters.

As of the end of 2000, meromictic conditions have been present in Mono Lake for six consecutive years. During this time there has been no fall overturn, when the lake normally mixes to the bottom. Consequently, nitrogen has accumulated in the monimolimnion (below the chemocline) and been depleted in the mixolimnion (above the chemocline). Reduced nitrogen availability led to reduced phytoplankton productivity and biomass through 1999, but both appear to have recovered in 2000.

The 2000 data show a moderation of meromixis since 1999. Some notable differences between 2000 and 1999 include:

- the midsummer surface-to-bottom density gradient declined from 12.2 kg m^{-3} in 1999 to 10.5 kg m^{-3} in 2000;
- the depth of the chemocline descended from ~ 21 m in 1999 to ~ 24 m in 2000;
- monimolimnetic ammonium concentrations increased from 483 μM in December 1999 to 683 μM by December 2000.
- estimated primary production was 63% higher in 2000 than in 1999;
- peak midsummer *Artemia* abundance was the lowest on record;

Limnological parameters that have showed little to no change in 2000 compared to 1996 through 1999 include:

- a single late-summer peak in *Artemia* abundance compared to the two peaks typical of monomictic years;
- mean annual *Artemia* biomass; and
- total annual *Artemia* cyst production.

Of direct importance to waterfowl and other water birds is the spatial and temporal occurrence of adult *Artemia* at Mono Lake. Vertical distribution of *Artemia* in the water column may play a role on food availability for waterfowl, especially for dabbling duck species. Mean weight of *Artemia* individuals may also have some bearing on meeting avian energy demands. *Artemia* biomass has remained relatively constant in Mono Lake from 1993 to 2000 (approximately 8 to 9 g m^{-2} dry weight), except for a noticeably lower biomass in 1997 (< 6 g m^{-2}). *Artemia* biomass, however, was much higher during 1987 through 1990 (11 to 18 g m^{-2}), which included both the end of a meromictic period (1987-1988) and several monomictic years (1989-1990). Mean length of adult females, a measure of *Artemia* size, was slightly higher in 2000 compared to 1996-99, but lower than 1987-95. These data suggest that *Artemia* biomass and individual size is not showing a progressive decline during the latest meromictic period,. but is remaining fairly stable. It is uncertain whether this pattern of stability will continue if the current period of meromixis continues for a several years or even decades, as predicted.

3.3 Vegetation and Habitat

Aerial photography of waterfowl habitat was acquired pursuant to Order 98-05,. Other vegetation monitoring pertaining to waterfowl habitat included that associated with experimental burning.

3.3.1 Aerial Photography

Methods

Aerial photography was taken on September 7, 2000 (Appendix III). The scale of photography was 1 inch = 2,000 feet, or 1:24,000 (original scale on 9 inch x 9 inch negatives or contact prints). The aerial photography was converted from negatives to a digital, composite image by AirPhoto USA using their proprietary "Stable Earth Digital Ortho Rectification Process." Optimum resolution on the digital composite image was indicated to be at a scale of 1 inch = 130 feet, or 1:2,400. A GIS database of cover class polygons was developed with ESRI ArcView software, using on-screen digitizing over a backdrop of imported images from the AirPhoto USA digital, composite image.

Results

Most of the 2000 marsh habitat in lake fringing wetlands around Mono Lake were in the Simons Springs area, (~165 acres), with Warm Springs (~66 acres) and DeChambeau Embayment (~26 acres) also having substantial marsh areas. Wet meadow (probably equivalent to "mixed marsh" of Jones and Stokes EIR) was most abundant in the County Park (~44 acres), Mill-Wilson Delta (~21 acres), and DeChambeau Embayment and DeChambeau Ponds (~19 acres) areas. Extensive alkaline wet meadow areas occurred in the Warm Springs (~233 acres), Simons Springs (~179 acres), and East Beach (~106 acres) areas.

Small amounts of freshwater ponds exist in the Simons Springs, East Beach, and Black Point areas (< 1 acre each), with another ~10.6 acres of pond habitat in the DeChambeau/County Ponds complex. Extensive areas of ephemeral brackish lagoon are found in the Warm Springs (~30 acres), South Beach (~24 acres), and North Beach (~21 acres) areas. North Beach also had a large amount of hypersaline lagoon (~105 acres). There were ~2.4 and ~0.5 acres of ria habitat in the Rush Creek and Lee Vining Creek deltas, respectively.

3.3.2 Experimental Burning

Monitoring of experimental burn areas in 2000 consisted of the vegetation transects at Warm Springs sampled by Martin (2001). *Scirpus* was the dominant on each of six transects that run parallel to the lakeshore (Appendix IV). These 2000 data will provide background information for an experimental burn that is tentatively scheduled for February-March 2002.

3.3.3 DeChambeau/County Ponds Habitat Creation and Enhancement

Monitoring of habitat at the DeChambeau/County ponds complex included qualitative observations by Larry Ford of USFS. Mapping based on 1999 aerial photography identified approximately 4.1 acres of open water, 20 acres of marsh and wet meadow at DeChambeau Ponds; and 0.5 acres of open water and 17 acres of wet meadow at the West County Pond. Restoration efforts conducted by USFS and the National Fish and Wildlife Foundation added a fifth pond supporting 1.25 acres of water surface to the Dechambeau complex and rewatered the East County Pond for a gain of 2.2 acres of water surface.

3.4 Waterfowl Population Surveys

Joseph Jehl of Hubbs Sea World Research Institute, under contract to LADWP, carried out waterfowl population monitoring at Mono Lake in 2000. Jehl's work continues a waterfowl monitoring effort by himself and associates that has been conducted annually since 1995. The 1999 summary presented here is drawn from Jehl (2001), which is included as Appendix V to this report.

Several methods were employed in 2000 to assess waterfowl populations at Mono Lake and nearby lake and wetland complexes, including boat, aerial, and foot surveys at multiple times during the year. Data collected at Mono Lake in 2000 included numbers of breeding waterfowl, migratory waterfowl, and waterfowl utilizing the DeChambeau/County ponds complex. Observations of waterfowl using prescribed burn areas (Simons Springs), wetland and lagoon areas were also made. Complete shoreline surveys were conducted to provide an index of total waterfowl abundance at Mono Lake, Bridgeport Reservoir, and Crowley Lake. Survey activities were conducted for the period of May through early December with emphasis on the period between June and November.

3.4.1 Mono Lake: Breeding Waterfowl

The only waterfowl species consistently found to occur, as a breeder within the lake-bordering wetlands, was the gadwall. In 2000, 16-20 pairs of gadwall nested along the lake itself. An additional pair nested at the DeChambeau Pond area.

The 1999 total nesting population of breeding waterfowl in Mono Lake and associated wetlands was estimated by Jehl to be 19 to 23 pairs. The main hatching period was late June to mid July. Jehl estimated 205 locally produced juveniles to be present at the lake in 2000. Nine adults and 13 juvenile gadwall were captured and banded in 1999 as part of a study on various aspects of gadwall biology.

3.4.2 Mono Lake: Migrating Waterfowl

Shoreline surveys conducted by boat were the principal means used to collect waterfowl estimates at Mono Lake. In 2000, 16 species of ducks, geese, and allied waterbirds were recorded within the Mono Lake ecosystem. The mallard, northern shoveler, green-winged teal, and northern pintail were the most common dabbling ducks. Northern shoveler was the most common dabbler in September and October, and green-winged teal were most common in November.

The Ruddy Duck (in the stiff-tailed duck tribe) is the most abundant migrating duck species at Mono Lake. Numbers of Ruddy Duck were estimated to be 1,515 in early December, which was the peak number at Mono Lake in 2000. The peak total waterfowl count (all species) was 10,657 in mid-October. There were >13,000 individual waterfowl recorded for all survey periods, however it is not known how many of these individuals were present from one survey period to the next. Overall, fewer waterfowl were encountered in 2000 than in 1999.

3.4.3 DeChambeau/County Ponds Surveys

Pond surveys concentrated on the DeChambeau/County ponds complex. The total waterfowl count by month and pond is summarized in Table 4. This summary also includes the Eared Grebe, Pied-billed Grebe, Clark's Grebe, American Coot, California Gull, Common Moorhen, Killdeer, Wilson's Phalarope, California Gull and Forster Tern which are not considered waterfowl species. One pair of breeding gadwall were found at the DeChambeau Ponds. The peak waterfowl count at DeChambeau/County ponds complex was 227 on August 11, with most of the ducks located at County Pond 1 (the west pond).

3.4.4 Aerial and Other All-Lake Censuses

Comparative waterfowl surveys were conducted on October 6-8 at Mono Lake, Crowley Lake and Bridgeport Reservoir. The Bridgeport survey was done from a boat. The other two surveys were done by air. The survey counts were 6,741 total waterfowl at Crowley Lake, 4,750+ at Bridgeport Reservoir, and 2,307 at Mono Lake.

3.4.5 Waterfowl Use of Prescribed Burn Areas

Observations were made of prescribed burns in the Simons Springs area. Jehl indicated that observations from both plane and boat revealed no evidence of waterfowl use of the burned areas.

3.4.6 Behavioral Studies

S. I. Bond of Hubbs-Sea World Research Institute, under the direction of Joseph Jehl, spent a week (September 28 through October 3) at Mono Lake observing the distribution and behavior of ducks. Observational data included activities, habitat use, and daily movements of waterfowl along the shoreline. Attempts to place radio collars on Ruddy Ducks to facilitate a time budget study were unsuccessful as too few individuals could be captured to make the project scientifically sound. The last Ruddy Duck time budget study was conducted in 1997.

4. STATUS OF RESTORATION MEASURES

Several ongoing restoration measures pertaining to waterfowl took place in 2000. The lake level decreased 0.9 feet but enhancement work continued on the DeChambeau/County Ponds complex.

4.1 Lake Level

The average lake level for 2000 was 6,384.2 feet (using the level at the beginning of each month). This is a 9.6-foot increase toward the target lake level of 6,391 feet since the 1994 Decision 1631. The lake level needs to rise another 6.8 feet from the 2000 average lake level to reach the target lake level.

4.2 DeChambeau/County Ponds Complex

Restoration activities conducted during 2000 by the USFS at the DeChambeau/County Ponds Complex included filling of the East County Pond and construction of a fifth pond in the Dechambeau complex. To connect the Dechambeau ponds to the Wilson Creek water source 10,100 feet of 12 inch pipe was installed. The USFS burned part of the DeChambeau meadow to remove thatch and open up surface water in depression areas.

4.3 Experimental Burning

LADWP did not conduct any experimental burning in 2000 but participated in planning sessions for a proposed burn in February-March 2002. The intended location of the 2002 burn is in the Warm Springs area. The California Department of Parks and Recreation has agreed to be the lead agency in the Warm Springs burn.

4.4 Rewatering of Rush Creek Distributaries

There were no direct actions taken toward rewatering distributaries in Rush Creek during 2000. Bill Trush, one of the scientists directing stream restoration and monitoring in the Mono Basin, recommended that decisions to open up channels 8 and 11 of Rush Creek be delayed to see how the channels in the Rush Creek bottomlands respond naturally to the current flow regime.

5. RECOVERY OF WATERFOWL HABITAT

This section summarizes the recovery of waterfowl habitat in the Mono Basin. The habitat being monitored includes the lake, ephemeral brackish lagoons and open water ponds, lake-fringing wetlands, freshwater ria and stream deltas, and distributaries of Rush Creek.

5.1 Lake Level

Mono Lake elevation fell by approximately 0.9 foot during the 2000 calendar year (Table 2). Lake level was 6384.3 feet on January 7, 2000 and 6383.4 feet on December 7, 2000 (data from LADWP using USGS datum). Peak lake level was 6,384.5 feet in July 2000. Lake level in January 2000 was 0.1 feet higher than the previous January (1999), however lake level at the end of 2000 was 0.7 feet lower than the end of 1999. At a 6,383-foot lake level, estimated lake area is 45,350 acres and estimated volume is 2,596,336 acre feet.

5.2 Ephemeral Brackish Lagoons

Ephemeral brackish lagoons along the shore at South Beach, Simons Spring, East Beach, Warm Springs, North Beach, Black Point, Bridgeport Creek (east of DeChambeau Embayment), and Mill-Wilson delta were little changed since 1999, when they totaled over 100 acres, indicating that this type of habitat was relatively abundant and widely distributed around the lake.

Ephemeral brackish lagoons changed markedly from 1989 to 1999. Only 1 acre of "ponds and lagoons" were mapped by Jones and Stokes (1993) under point-of-reference conditions. In contrast, 109 acres of ephemeral brackish lagoons and 8.5 acres of freshwater ponds were mapped in 1999. However, the 1999 mapping included 7.1 acres of freshwater ponds within the DeChambeau/County Ponds complex, which were not included by Jones and Stokes (1993). Brackish lagoons mapped in 1999 include ponds and lagoons formed by extensive littoral bars and, in the South Beach area, inundation of pre-existing swales, which may have been deflationary features formed since the lake receded after 1941. Although most of these brackish lagoons are likely to be transient, they nonetheless are potentially important as waterfowl habitat until an equilibrium lake level is reached

5.3 Lake-Fringing Wetlands and Marshes

One of the most prominent changes anticipated with increasing the lake level is an overall decrease in marsh area, primarily due to inundation of marsh areas by the rising lake and "spring-line sapping" (i.e., desiccation of wetland supported by springs as beveling cuts an escarpment at a higher equilibrium shoreline). Marsh area was little changed from 1999 when it totaled ~302 acres. This area, however, should likely be combined with wet meadow (~83 acres) to compare to Jones and Stokes (1993) point-of-reference marsh area. Combined marsh and wet meadow area at a lake level of 6,384.6 feet was ~385 acres compared to 988 acres of marsh mapped at a lake level of 6,376 feet. This decrease occurred in most areas where marsh was present in lake-fringing wetlands.

There was also a decrease in alkaline wet meadow from point-of-reference conditions, assuming that the 1999 wet alkaline meadow type is roughly equivalent to Jones and Stokes (1993) alkali meadow formation. There were ~1,521 acres of alkali meadow mapped in 1989 and 582 acres of wet alkaline meadow mapped in 1999. Again, decreases occurred in most areas around the lake; Warm Springs and East Beach were two exceptions, as alkaline wet meadow increased in these two areas.

The overall area of wetland/riparian scrub increased from point-of-reference conditions (~236 acres) to 2000 (~335 acres). Increases were most apparent in the Wilson-Mill creek delta areas and Horse Creek Embayment, although there were also smaller increases in Rush Creek Delta and Lee Vining Creek Delta.

5.4 Rush Creek Distributaries

As a result of increased flows in Rush Creek, actions to open up Channel 10, and natural processes, there are several places in Rush Creek bottomlands that provide favorable habitat. Rewatering Channel 10 does appear to have benefited waterfowl habitat in the Rush Creek bottomlands. The abandoned or active channels along the eastern valley wall seem to be conducive to the development of small areas of good habitat, particularly for small breeding birds. Rewatering in these areas along the eat valley appears to be a function of high water table and spring activity, as well as opening up Channel 10.

5.5 Freshwater Rias and Riparian Habitat in Stream Deltas

Ria habitat has developed in the deltas of both Rush and Lee Vining Creek. Freshwater ria habitat was ~2.5 acres in Rush Creek and ~0.5 in Lee Vining Creek. There were also shoreline bars present across the months of Mill and Wilson creek that likely resulted in freshwater to brackish conditions there.

Table 1. Mono Lake Mixing History 1964-Present

1964-1982	1983-1987	1988-1989	1990-1994	1995	1996-Present
Monomictic	Meromictic	Transition	Monomictic	Transition/ Meromictic	Meromictic

Table 2. 1999 Mono Lake Monthly Elevations (feet amsl) in LADWP Bishop Aqueduct Data.

Jan 7	Feb 3	Mar 2	Apr 4	May 4	Jun 1	Jul 6	Aug 3	Sep 8	Oct 4	Nov 9	Dec 7
6384.3	6384.3	6384.4	6384.5	6384.5	6384.4	6384.5	6384.3	6384.0	6383.7	6383.5	6383.4

Table 3. Mean monthly discharge (cfs) in Lee Vining, Rush, Walker, and Parker Creeks for 1999[1].

Month	Lee Vining Creek	Rush Creek	Walker Creek	Parker Creek	Rush Creek below Narrows (estimated)
January	29.8	46.3	2.75	3.77	52.82
February	29.8	47.4	3.46	4.03	54.89
March	31.4	47.1	3.29	4.67	55.06
April	50.7	46.3	3.48	6.10	55.88
May	122.0	48.9	12.20	16.80	77.90
June	166.0	69.6	20.70	35.00	125.30
July	71.6	91.2	8.91	22.50	122.61
August	45.1	47.1	4.67	16.40	68.17
September	28.0	47.6	3.06	8.23	58.89
October	28.7	43.6	2.39	4.98	50.97
November	31.4	42.9	6.60	3.72	53.22
December	28.4	45.5	2.65	3.25	51.4

[1] All flow data from LADWP. Flows at Lee Vining Creek are spill from intake, at Rush Creek below dam (plus spillway); at Walker and Parker creeks under conduit. Estimated flow in Rush Creek below Narrows is sum of Rush, Walker, and Parker creeks.

Table 4. Summary of Waterfowl & Waterbirds Counted at the Dechambeau and County Pond Complex (Jehl 2000).

Dates (2000)	Total Number of Species on Each Date: DeChambeau Ponds	Total Number of Species on Each Date: County Ponds	Total Waterfowl (number of individuals)	Total Other Water Birds (number of individuals)	Total All Water Birds (number of individuals)
May 3	7	3	41	517	558
June 1	5	3	10	469	476
July 7	3	4	13	325	338
July 30	3	5	36	522	558
August 11	2	7	228	55	283
September 5	5	6	84-89	16	100
October 6	3	5	36	155	191
October 23	2	3	8	62	70
November 13	2	0	0	10	10
December 7	1	0	0	1	1
Total Season Count			456-461	2132	2585-2590

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FINAL PROGRAMMATIC REPORT

Project Name: DeChambeau Ponds (CA) Restoration
Project Number: 97-186

In November, 1997, the Inyo National Forest entered into a Challenge Cost Share Agreement with the National Fish and Wildlife Foundation in support of restoration of the DeChambeau Ponds complex on the north shore of Mono Lake. This restoration work was necessary to mitigate the changes in the Mono Basin ecosystem precipitated by nearly fifty years of stream diversions to the City of Los Angeles. While these diversions were curtailed by the 1994 State Water Resources Control Board decision that established a management level of Mono Lake at an elevation of 6,392 feet above sea level, it was recognized that this management level, twenty-five feet below the 1941 elevation, would not fully restore lake-fringing wildlife/waterfowl habitat. This project was envisioned to assist in restoration of freshwater habitat adjacent to the highly saline and alkaline Mono Lake by maximizing the freshwater pond acreage while adhering to a minimal water budget. Earlier projects by Ducks Unlimited and the U.S. Forest Service had established a pond system of approximately ten acres.

The restoration covered by this grant was initiated in a step-by-step process to determine the effect of each individual project on the desired outcome. The initial phase was to improve our ability to deliver water to the DeChambeau/County Ponds complex which included several aspects: (1) we replaced sixty feet of damaged pipe to improve our use of the hot water artesian well in the DeChambeau Ponds area; (2) we installed a canal gate at our Wilson Creek diversion to replace the, nearly one hundred year-old head gate, which improved our ability to control and measure the flow of water into our ditches; (3) we constructed a control structure in DeChambeau pond #4 to allow us to manage the elevation of that pond and to control and measure the flow of water to the County Ponds; and (4) we installed five hundred feet of twelve inch pipe below pond #4 and six hundred feet of ten inch pipe near the County ponds to eliminate some major erosion problems in these areas.

The second phase began in October, 1998 with the installation of 2,100 feet of twelve inch pipe connecting the DeChambeau ponds and the County ponds. This allowed the transport of water across the silty and volcanic soils without the excessive percolation losses that we had been experiencing and permitted a flow of water to reach the County ponds during the spring and fall low-flow periods and even during the winter when the water would, otherwise, freeze. This new pipeline made it possible to proceed with the development of the East County Pond. This natural depression is below the 1941 shoreline of Mono Lake and was exposed as the lake level dropped, first becoming a lagoon at the edge of the lake and later being left high and dry as the lake continued to recede. Our first attempts to re-water this pond failed due to the high permeability of the volcanic soils, 3 cubic feet per second of water created less than one acre of marsh. With the new pipeline in place, we excavated the pond bottom and added and covered a layer of bentonite. When we began to run water in the spring, we had a 2.2 acre pond that is being maintained with 35 gallons (.08 cfs) of water per minute with water depths to accommodate shorebirds, and dabbling and diving ducks.

The final phase of the restoration project funded under this NFWF grant was intended to further increase pond surface acreage and improve the water delivery system. We designed and built a fifth pond in the DeChambeau complex in the vicinity of the Ducks Unlimited pond #5. This pond wasn't completed during the Ducks Unlimited project and was not able to maintain any surface water area within our water budget. This pond was engineered, excavated and bentonited, and has added 1.25 acres of water surface to the system with an expenditure of 12 gallons of water per minute. The maximum water depth of this pond is 18 inches providing habitat for dabbling ducks, wading birds and shorebirds. We also installed 10,100 feet of 12 inch pipe to connect our water source at Wilson Creek with the pond complex. Water delivery has continued to be the major problem with the DeChambeau/County Ponds complex, especially during the spring and fall when water flows became insufficient to overcome the percolation and evaporation of the open ditches. This pipeline will allow the delivery of water to the pond system with as little as one cubic foot per second available which would have not been possible with the ditch system. The pipe was purchased under the NFWF grant while the contracted work was funded by the Forest Service.

This NFWF grant has enabled us to double the freshwater surface acreage in the DeChambeau/County Pond complex, add several acres of marsh wetland, and to transport water efficiently, staying well within our water budget. We will continue to monitor and use adaptive management practices within the pond complex to maximize the benefit to waterfowl, shorebirds and other wildlife.

ROGER PORTER
Scenic Area Manager

APPENDIX I

SUMMARY OF LADWP'S OPERATIONS AND RUNOFF IN THE MONO BASIN FOR RUNOFF YEAR 2000-01

(LETTER DATED NOVEMBER 3, 2000)

M^c Bain

Identical letter sent to all on attached list

November 3, 2000

Mr. Christopher Hunter
616 Wintergreen Crt.
Helena, Montana 59601

Dear Mr. Hunter:

Update on Mono Basin Operations During 2000-01 Runoff Year

This year's runoff for the Mono Basin (Figure 1) could be termed "typical" with no significant events occurring. The peaks on most of the creeks came later than forecasted and the magnitudes for three of the four creeks were higher than forecasted. Rush Creek at Dam Site was considerably higher than forecasted.

The following is a summary of Los Angeles Department of Water and Power's (LADWP) operations to date in the Mono Basin for the 2000-01 runoff year:

- Mono Basin Exports: Exports were suspended in early April to assure a Grant Lake spill, and were curtailed until the peak had passed on Rush Creek. Exports were resumed on July 20th at an average flow rate of 23 cfs (Figure 2). The exports will continue through the remainder of the runoff year, and are expected to conclude in late March 2000. The flow rate will be increased to approximately 40 cfs to provide LADWP its allowable maximum export of 16,000 acre-feet.
- Walker Creek: There were no diversions for export during the year. The creek experienced two peaks. The first peak occurred May 29th with a magnitude of 31 cfs (average daily) and the second peak with a magnitude of 27 cfs occurred on June 17th. The two peaks did not exceed the forecasted magnitude of 35 cfs (Figure 3).
- Parker Creek: There were no diversions for export during the year. The creek experienced two peaks. The first peak occurred June 17th with a magnitude of 46 cfs (average daily) and the second peak occurred June 25th with a magnitude of 49 cfs. The second peak exceeded the forecasted magnitude of 47 cfs (Figure 4).

- Lee Vining Creek: There were no diversions for export during the year. There were two peaks on Lee Vining Creek measured below the Conduit. The first peak occurred on May 28th with a peak of 258 cfs (average daily) which was slightly higher than forecasted. The second peak occurred on June 16th with a magnitude of 210 cfs (Figure 5).

  There was no augmentation made to Rush Creek flows. There was, however, diversions made from Lee Vining Creek for the purpose of maximizing spill capability at Grant Lake. The diversions commenced on May 1st and were terminated on May 12th because of unseasonable low temperatures and Southern California Edison reducing their outflow at their power plant. A maximum average flow of approximately 30 cfs was diverted.

- Rush Creek: Grant Lake's elevation on April 1, 2000 was 7,120.3 ft amsl, 9.7 ft below the lip of the spillway, providing another opportunity to spill and pass the peak to lower Rush Creek. To promote the spill and assure that the spill would be occurring when the peak flow was most likely to arrive, releases to Mono Gate Return Ditch were maintained slightly above Rush Creek minimum flows. Exports to the Owens River were also suspended in early April. In addition, water from Lee Vining Creek was diverted to Grant Lake. A peak inflow into Grant Lake (Rush Creek at Damsite) of 222 cfs was forecasted to occur the week of June 10th. On June 25th, Grant Lake reservoir began to spill. Rush Creek at Damsite experienced its peak on June 21st with a magnitude of 374 cfs (average daily) (Figure 6, 7, and 8). Rush Creek below the confluence of the Return Ditch and Grant Lake spill channel experienced a flow of approximately 208 cfs (average daily) on June 30th.

  Rush Creek below the narrows experienced on June 30th a flow magnitude of approximately 260 cfs (average daily) (Figure 8).

- The timing of the Mono Basin peak runoff occurred one to three weeks later than predicted for three of the four creeks. Lee Vining Creek experienced a peak one week earlier than predicted. Three creeks also experienced flow magnitudes greater than those forecasted. The table below compares April 1st forecasted magnitudes and timing to those actually measured:

	Predicted		Measured	
	Magnitude	Timing	Magnitude	Timing
Rush Creek @ Damsite	222 cfs	June 10	374 cfs	June 21
Parker Creek	47 cfs	June 18	49 cfs	June 25
Walker Creek	35 cfs	June 13	31 cfs	May 29
Lee Vining Creek	245 cfs	June 6	258 cfs	May 28

- Grant Lake Reservoir: Releases from the reservoir to Rush Creek were maintained slightly above the minimum and exports were suspended on April 9th to facilitate a spill. Grant Lake began spilling on June 25th and continued through July 23rd, achieving a maximum spill of 150 cfs on June 30th (Figure 9).

If you have any questions or need additional information regarding operations, please contact me at (760) 873-0225.

Sincerely,

ORIGINAL SIGNED BY
CLARENCE E. MARTIN
FOR

GENE L. COUFAL
Manager
Aqueduct Business Group

SBM:lge

Enclosures

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Eugene L. Coufal
Clarence E. Martin
James C. Campbell
L. Wayne Hopper
Brian B. Tillemans
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People for Mono Basin Preservation
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Ms. Heidi Hopkins
Mono Lake Committee
P.O. Box 29
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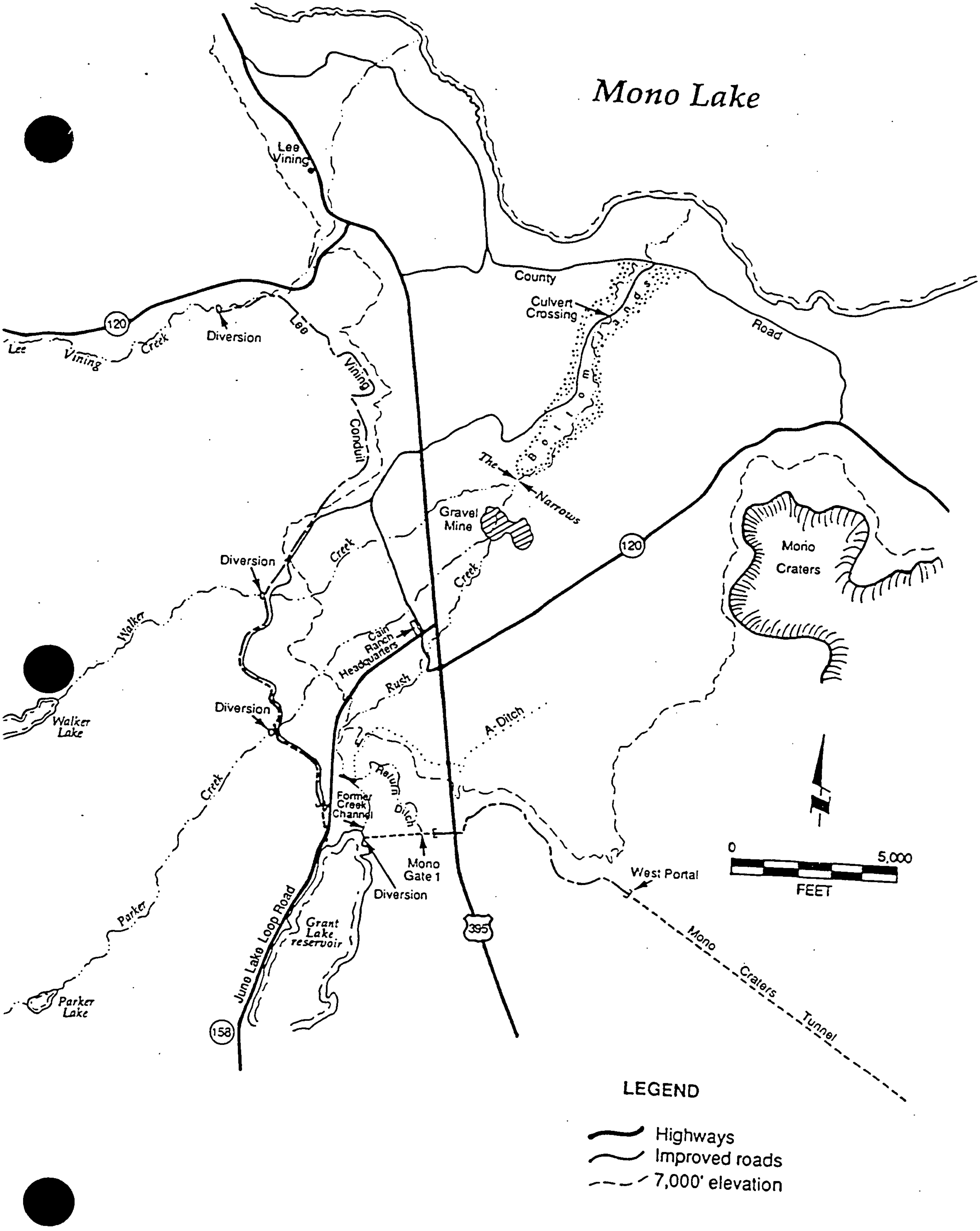
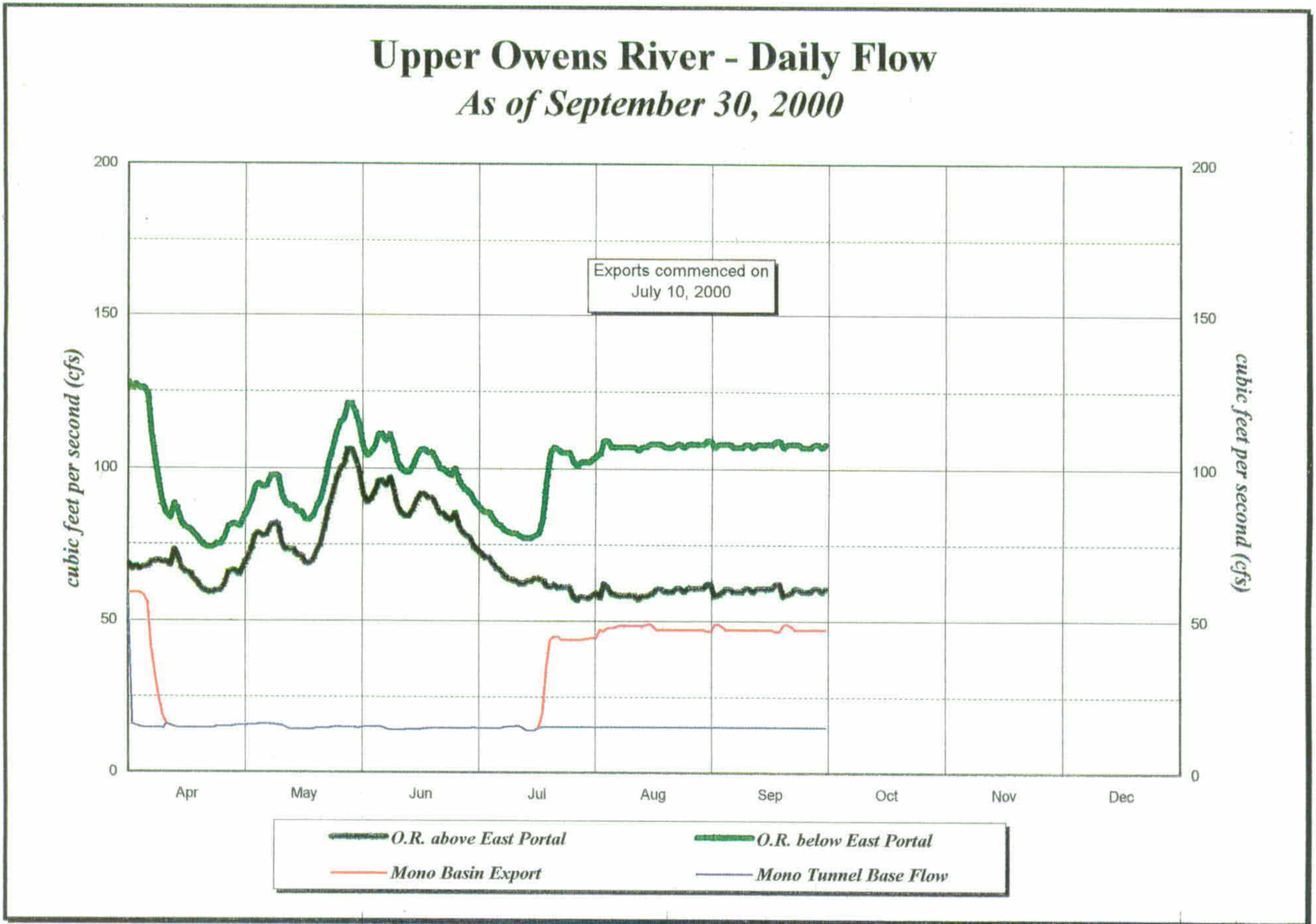


Mono Lake
Lee Vining
120
Lee Vining Creek
Diversion
Lee Vining Conduit
County Road
Culvert Crossing
Bottomlands
The Narrows
Gravel Mine
Mono Craters
Diversion
Walker Creek
Walker Lake
Rush Creek
Cain Ranch Headquarters
A-Ditch
Diversion
Return Ditch
Former Creek Channel
Mono Gate 1
Diversion
West Portal
0
5,000
FEET
Parker Creek
Parker Lake
Grant Lake reservoir
June Lake Loop Road
158
395
Mono Craters Tunnel
LEGEND
Highways
Improved roads
7,000' elevation

Figure 1



Upper Owens River - Daily Flow
As of September 30, 2000
Exports commenced on July 10, 2000
cubic feet per second (cfs)
200
150
100
50
0
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
O.R. above East Portal
O.R. below East Portal
Mono Basin Export
Mono Tunnel Base Flow

Figure 2

Walker Creek above Conduit- Average Daily Flow
2000 Runoff Season

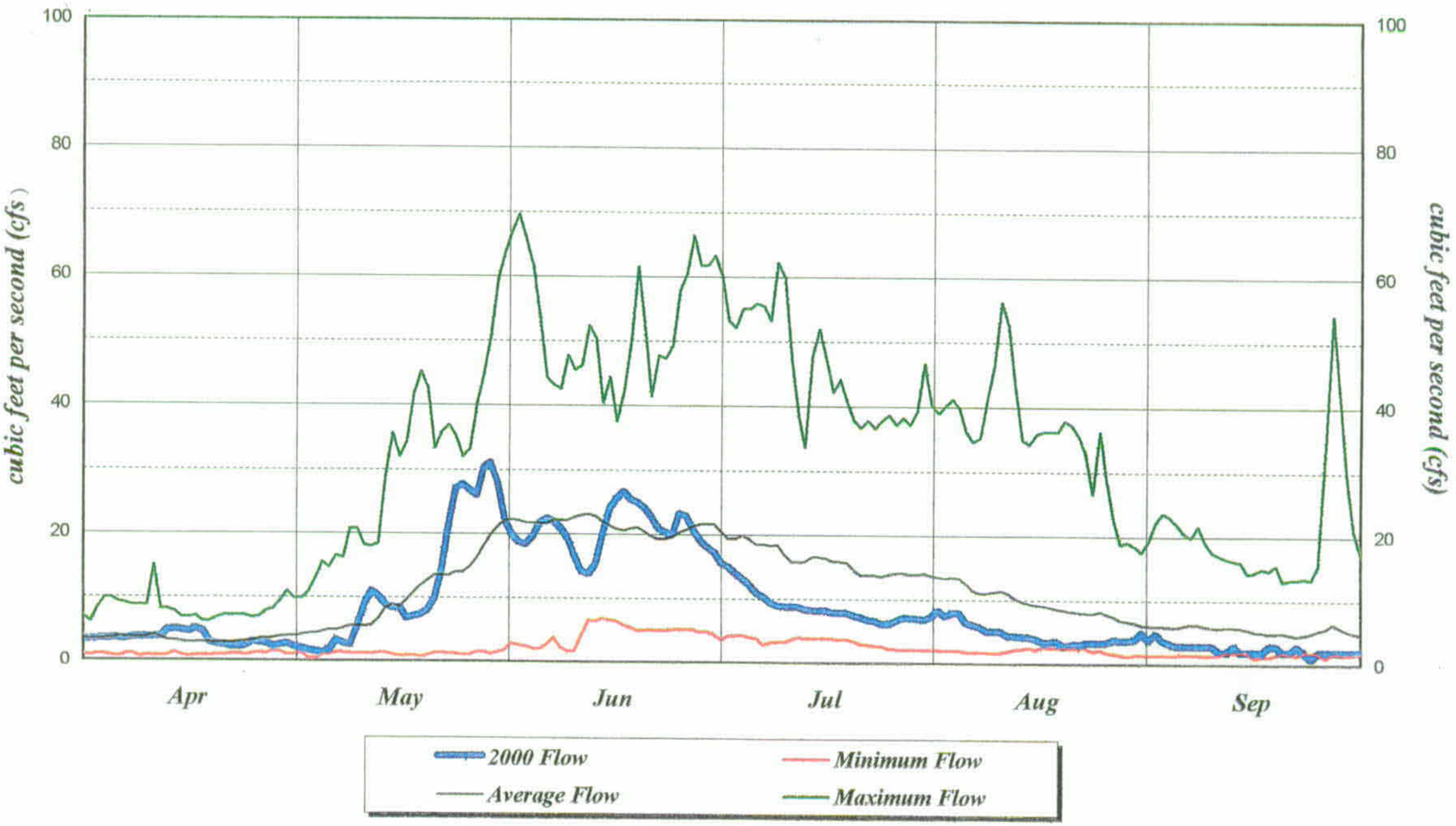
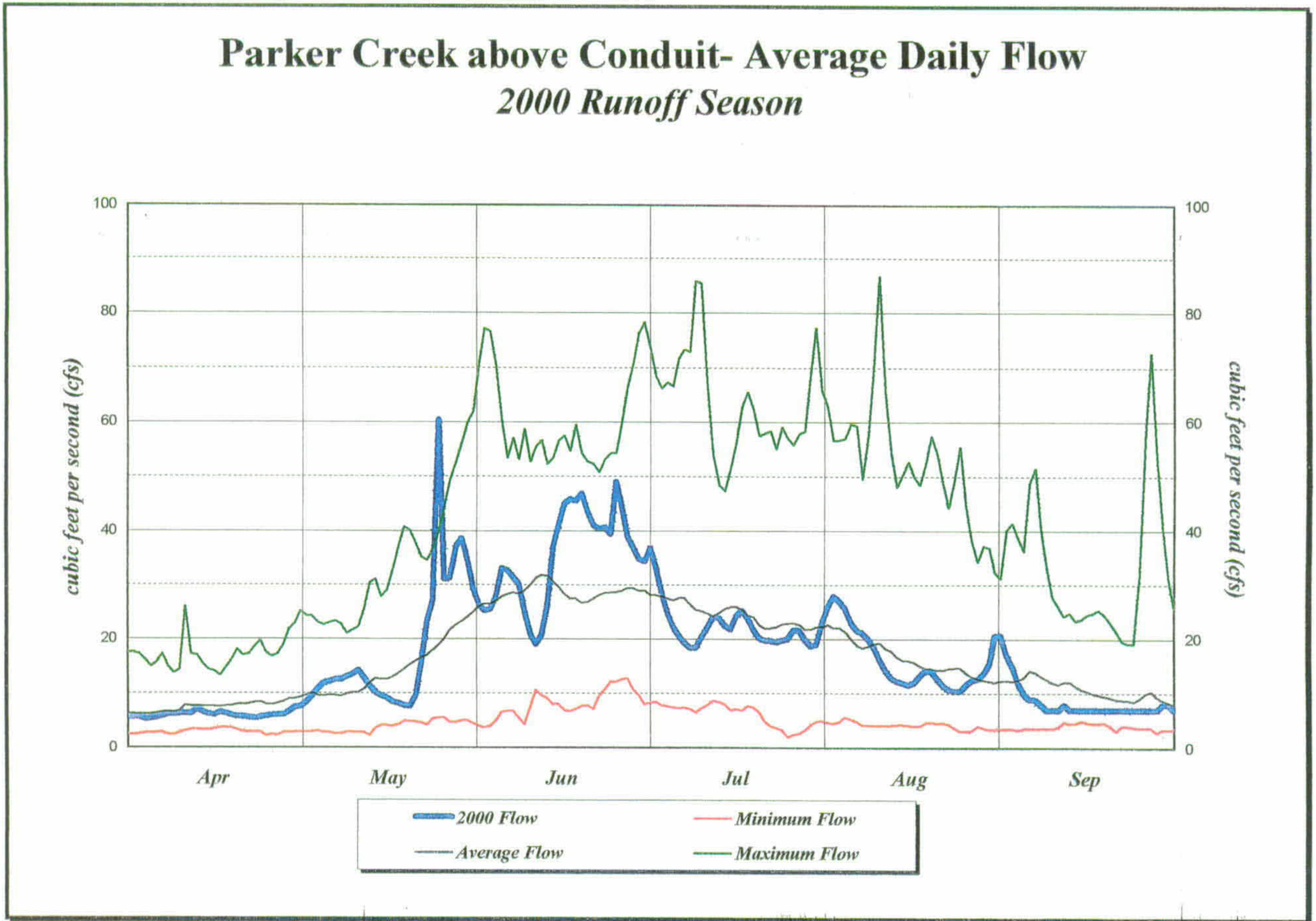


Figure 3



Parker Creek above Conduit- Average Daily Flow
2000 Runoff Season
cubic feet per second (cfs)
cubic feet per second (cfs)
100
80
60
40
20
0
Apr
May
Jun
Jul
Aug
Sep
2000 Flow
Minimum Flow
Average Flow
Maximum Flow

Figure 4

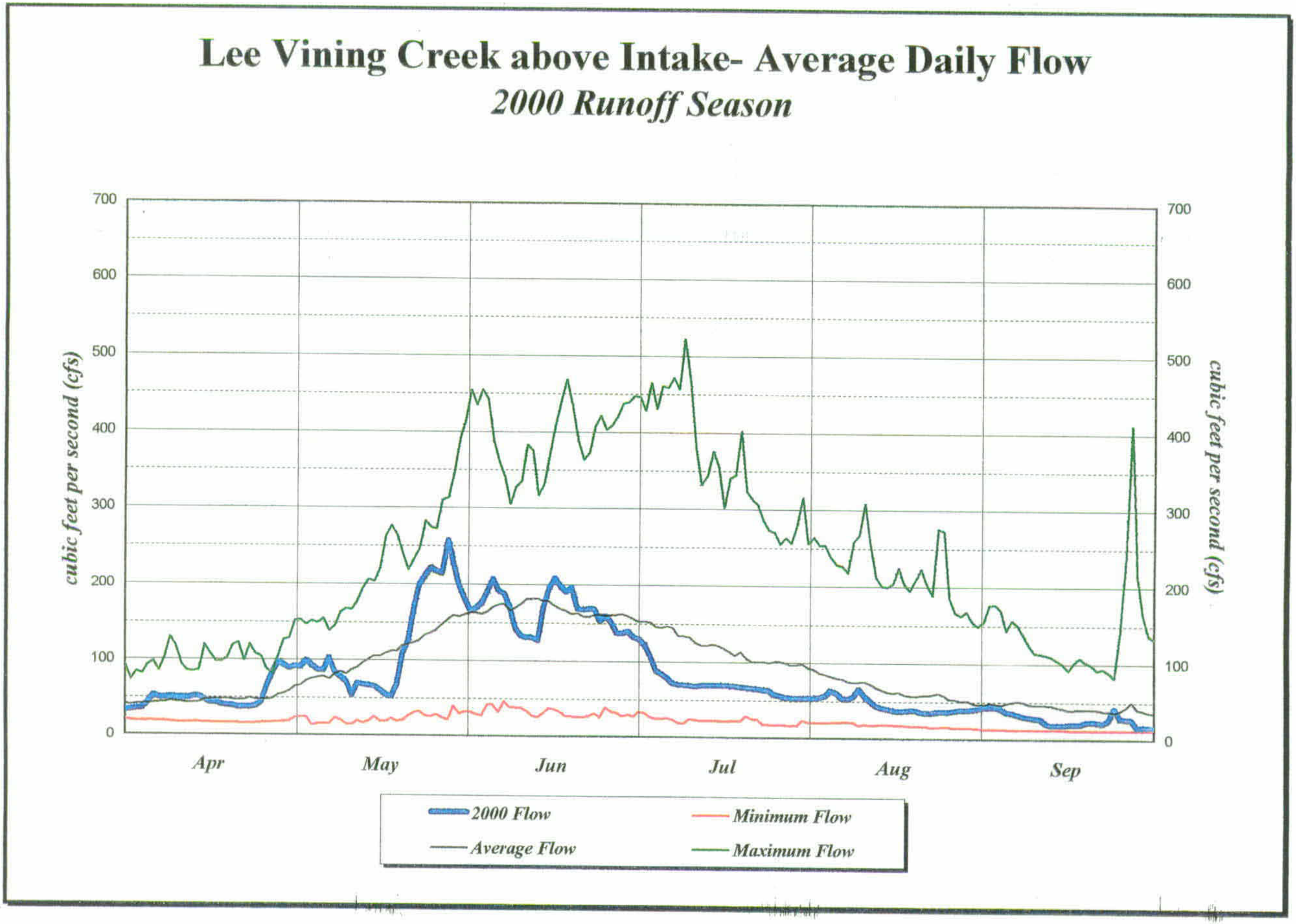
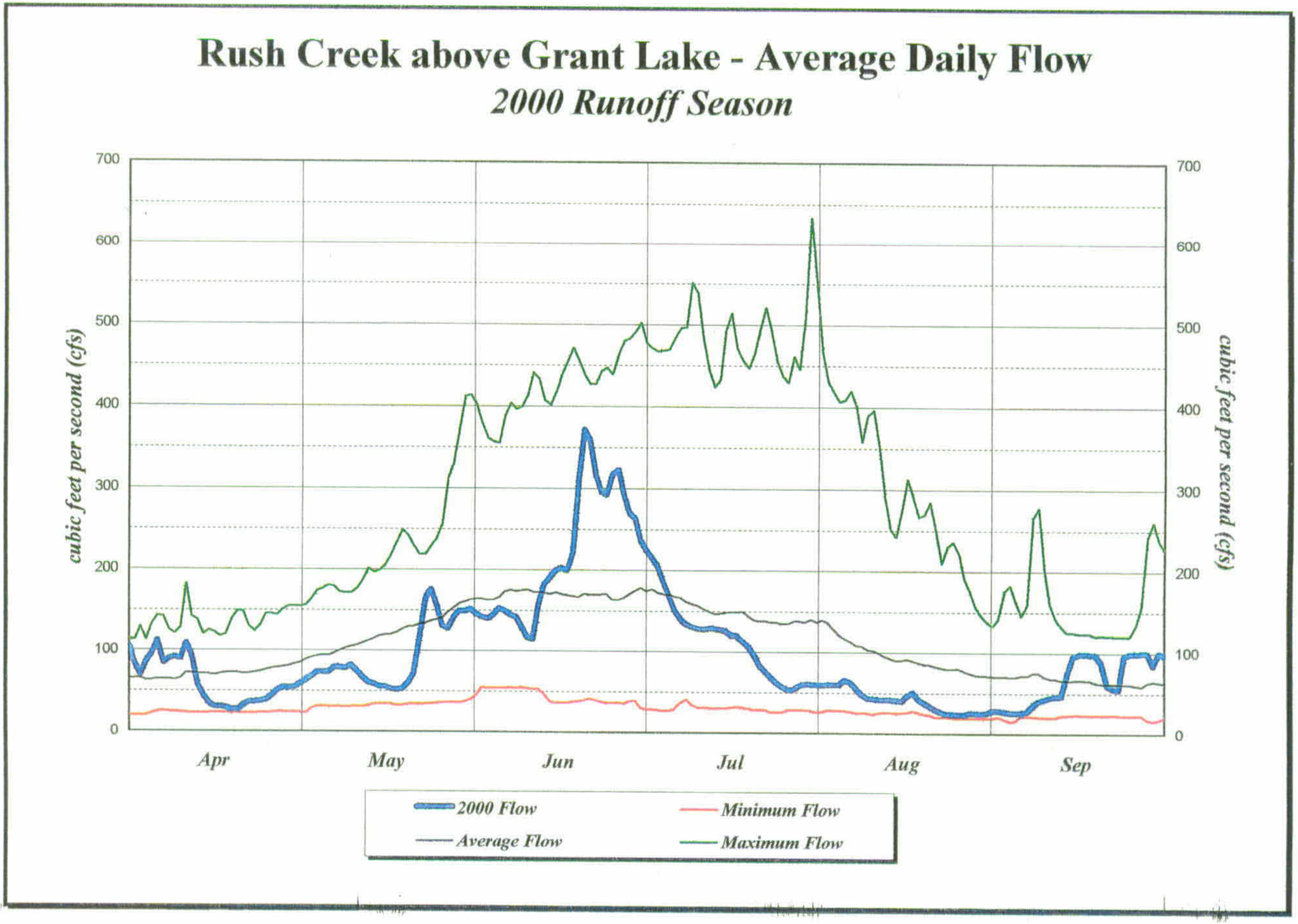
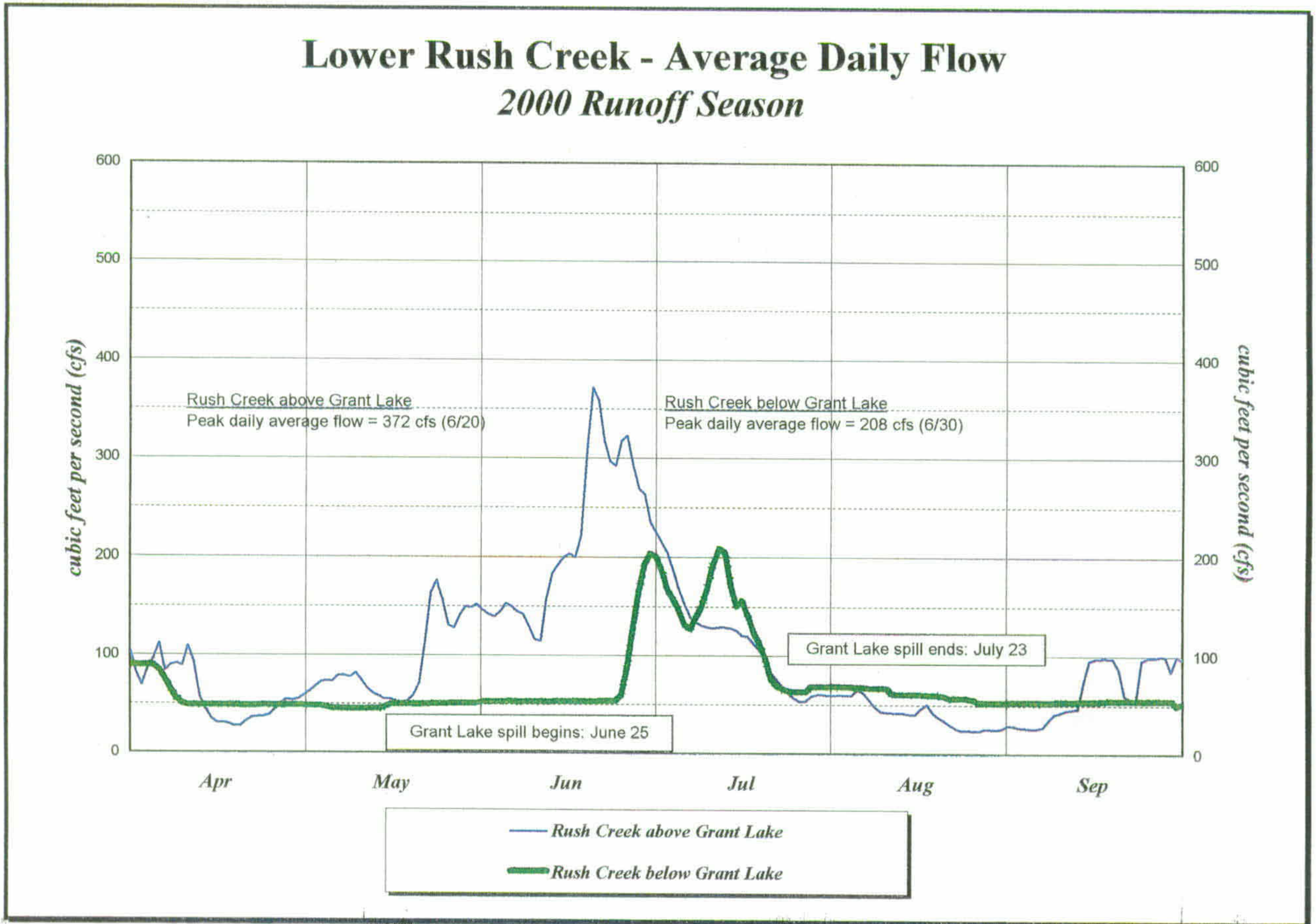

Lee Vining Creek above Intake- Average Daily Flow
2000 Runoff Season
cubic feet per second (cfs)
0
100
200
300
400
500
600
700
Apr
May
Jun
Jul
Aug
Sep
2000 Flow
Minimum Flow
Average Flow
Maximum Flow

Figure 5



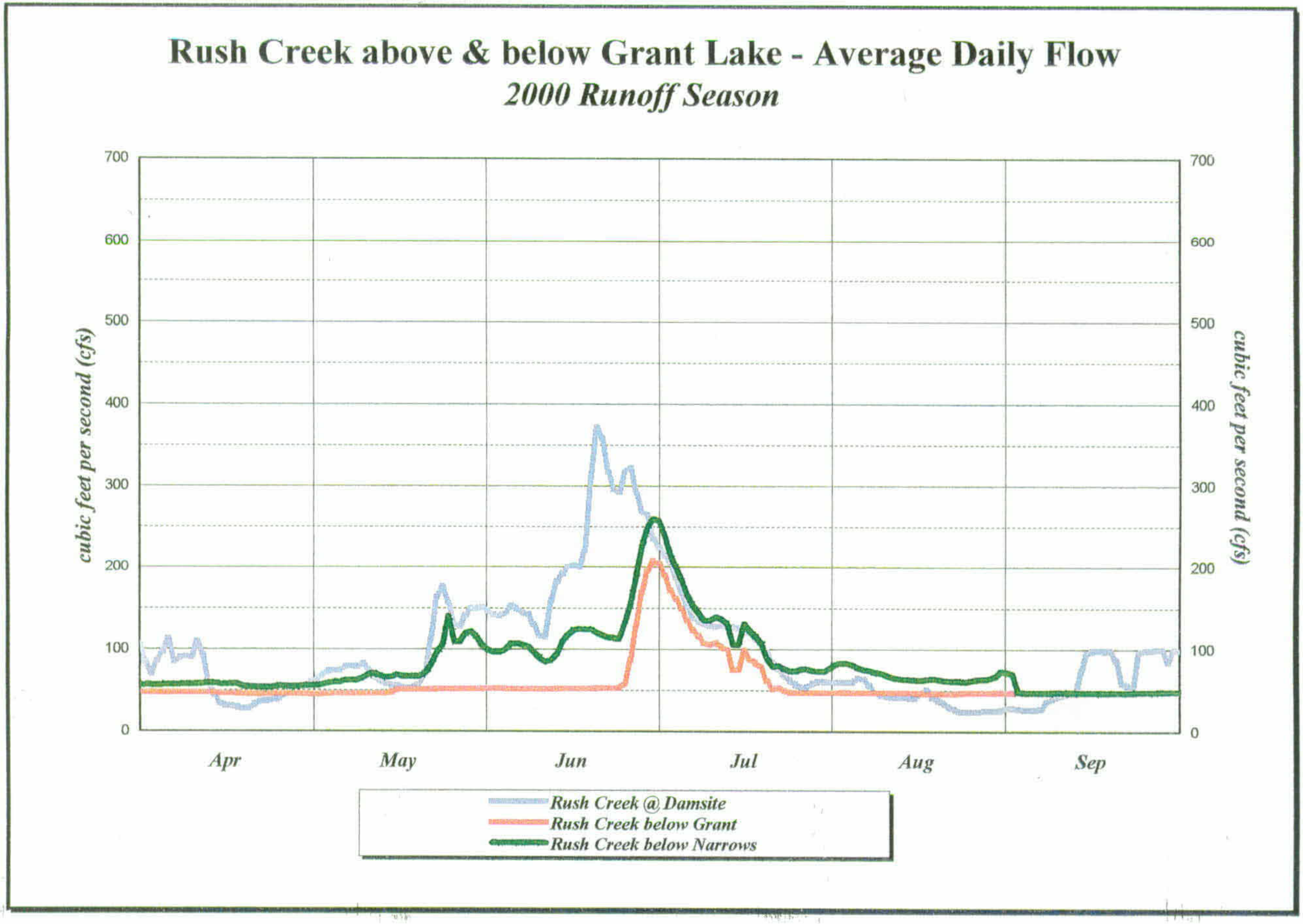
Rush Creek above Grant Lake - Average Daily Flow
2000 Runoff Season
cubic feet per second (cfs)
700
600
500
400
300
200
100
0
Apr
May
Jun
Jul
Aug
Sep
2000 Flow
Minimum Flow
Average Flow
Maximum Flow

Figure 6



Lower Rush Creek - Average Daily Flow
2000 Runoff Season
cubic feet per second (cfs)
600
500
400
300
200
100
0
Rush Creek above Grant Lake
Peak daily average flow = 372 cfs (6/20)
Rush Creek below Grant Lake
Peak daily average flow = 208 cfs (6/30)
Grant Lake spill ends: July 23
Grant Lake spill begins: June 25
Apr
May
Jun
Jul
Aug
Sep
Rush Creek above Grant Lake
Rush Creek below Grant Lake

Figure 7



Rush Creek above & below Grant Lake - Average Daily Flow
2000 Runoff Season
700
600
500
400
300
200
100
0
cubic feet per second (cfs)
Apr
May
Jun
Jul
Aug
Sep
Rush Creek @ Damsite
Rush Creek below Grant
Rush Creek below Narrows

Figure 8

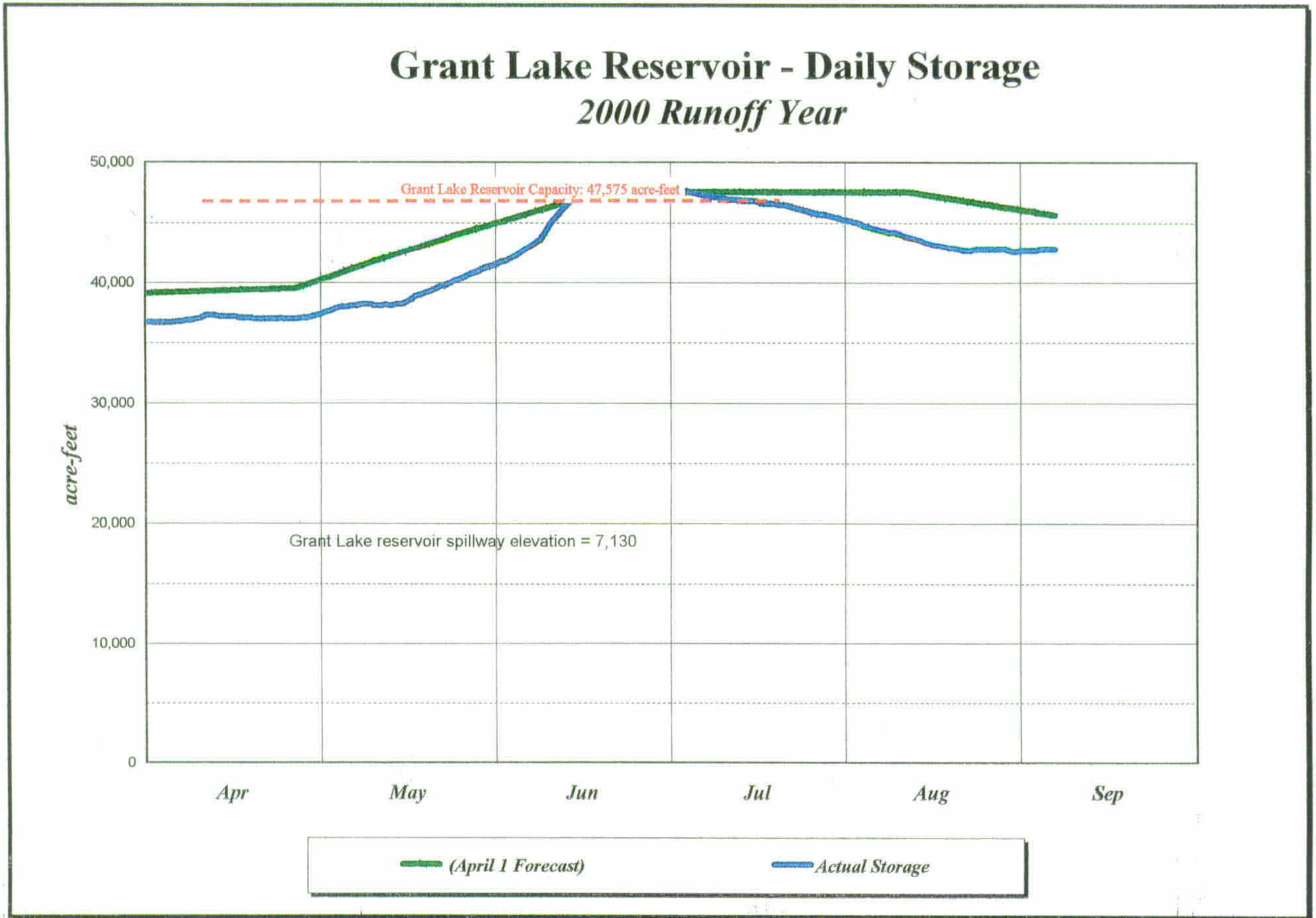

Grant Lake Reservoir - Daily Storage
2000 Runoff Year
50,000
40,000
30,000
20,000
10,000
0
acre-feet
Grant Lake Reservoir Capacity: 47,575 acre-feet
Grant Lake reservoir spillway elevation = 7,130
Apr
May
Jun
Jul
Aug
Sep
(April 1 Forecast)
Actual Storage

Figure 9

APPENDIX II

2000 ANNUAL REPORT
MIXING AND PLANKTON DYNAMICS IN MONO LAKE, CALIFORNIA

2000 ANNUAL REPORT

MIXING AND PLANKTON DYNAMICS IN MONO LAKE, CALIFORNIA

Robert Jellison, Sandra Roll, and John M. Melack

Marine Science Institute

University of California

Santa Barbara, CA 93106

2000 ANNUAL REPORT

MIXING AND PLANKTON DYNAMICS IN MONO LAKE, CALIFORNIA

Robert Jellison, Sandra Roll, and John M. Melack

Marine Science Institute

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Santa Barbara, CA 93106

Submitted: 15 April 2001

TABLE OF CONTENTS

EXECUTIVE SUMMARY

During 2000, UCSB researchers continued the Los Angeles-funded long-term (1982–2000) limnological monitoring of the plankton dynamics in Mono Lake as required by the State Water Resources Control Board of California. The monitoring program includes a wide array of physical, chemical, and biological measurements related to describing and understanding the seasonal plankton dynamics. This report includes a background of previous findings (1982–99) from this limnological monitoring (Chapter 1), a detailed description of the methods employed (Chapter 2), and results and discussion of monitoring data collected during 2000 (Chapter 3).

Chapter 1 describes the seasonal plankton dynamics observed from 1979 through 1999, a period which encompassed a wide range of varying hydrologic and annual vertical mixing regimes. In brief, long-term monitoring has shown that Mono Lake is highly productive compared to other temperate salt lakes, that this productivity is nitrogen-limited, and that year-to-year variation in the plankton dynamics has largely been determined by the complex interplay between varying climate and hydrologic regimes and the resultant seasonal patterns of thermal and chemical stratification which modify internal recycling of nitrogen. Any expected effects due to variations in salinity over the range observed during this period would be masked by these more dominant processes.

Chapter 2 provides a detailed description of the laboratory and field methods employed. Several changes were made this year in methodology and sampling design to enhance the efficacy of the monitoring program. These include the addition of vertical net tows for direct determination of *Artemia* biomass, additional sampling stations for instar and

fecundity analysis, the acquisition of several new sensors for in situ profiling, and a reduction in the total number of stations sampled for population estimates.

Chapter 3 describes the results of our limnological monitoring program during 2000. Persistent chemical stratification (meromixis) continued but weakened due to evaporative concentration of the upper mixed layer accompanying a net 0.7 m annual decline in surface elevation and slight freshening of water beneath the chemocline. The midsummer difference in density between 2 and 28 m attributable to chemical stratification has declined from 14.9 kg m^{-3} in 1998 to 12.2 kg m^{-3} in 1999 to 10.5 kg m^{-2} in 2000. Most likely of greater significance to the overall plankton dynamics is the marked midwinter deepening (ca. 2 m) of the chemocline. Not only were significant amounts of ammonium-rich monimolimnetic water entrained, but less of the lake is now effectively meromictic. At present only 38% of the lake's area and 16% of the volume beneath the chemocline.

Algal biomass, as characterized by the concentration of chlorophyll *a*, was higher in 2000 compared to 1999 and varied in the mixolimnion from a midsummer low of 1.4 µg chl *a* l^{-1} to the December high of 54.2 µg chl *a* l^{-1}. The December value is the highest observed during the entire 21 years. The estimated annual primary production in 2000 increased 63% over 1999 to 484 g C m^{-2} yr^{-1} only slightly below the mean annual production (508 g C m^{-2} yr^{-1}) during the recent 5-yr period of monomixis (1990–94). Thus, while meromixis persists in 2000, the combined effects of declining lake levels, the reduced proportion of the lake beneath the chemocline, and increased upward fluxes of ammonium due to the large buildup of monimolimnetic ammonium have offset, to some degree, the effect of the absence of winter holomixis.

The *Artemia* population in 2000 was characterized by fairly rapid development of the 1st generation, a large pulse of ovoviviparous reproduction in June, and an unusual decline in late-summer adults. Instar analysis indicated that first generation hatching peaked in March, with abundances similar to those of 1999 (ca. 33,000 m^{-2} in 1999, ca. 26,000 m^{-2} in 2000). Rapid development of the 1st generation of *Artemia* and ample food led to a large pulse of nauplii (93,119 m^{-2}) in June. This naupliar peak was higher than in 1998 (64,400 m^{-2}) and 1999 (60,600 m^{-2}). However, recruitment of these nauplii into juveniles and adults was low in 2000. These late summer abundances are the lowest of the past 20 years with the exception of 1986 abundances, which were only slightly lower. The generally lower numbers of adult *Artemia* observed in 2000 were partially offset by slightly larger sizes of individuals that presumably resulted from higher availability of food. The 2000 mean annual *Artemia* biomass (8.2 g m^{-2}) was 12% below the long-term mean of 9.7 g m^{-2} and only slightly less than calculated in 1999 (8.9 g m^{-2}).

In Mono Lake, oviparous (cyst) reproduction is always much higher than ovoviviparous (live-bearing) reproduction. Despite decreased numbers of adults during 2000 compared to 1999, increased individual fecundity, resulting from larger individual sizes and higher food availability, resulted in a total annual cyst production similar to 1999 (4.03×10^6 m^{-2} in 2000 versus of 4.17×10^6 m^{-2} in 1999). The 2000 total annual cyst production was 16% below the long-term (1983–99) mean of 4.77×10^6 m^{-2}, but well above the lowest value observed in 1997 (2.54×10^6 m^{-2}).

In summary, decreased chemical stratification and increased algal biomass, primary productivity, and cyst production all indicate that the effects of the current episode of meromixis on the lake's productivity are lessening. These changes are partly due to the entrainment of nutrients associated with declining lake levels partly due to deepening of the chemocline. Because now the chemocline is deeply positioned, the monimolimnion encompasses a smaller proportion of the lake and the ammonium concentration is exceptionally high beneath the chemocline, we expect the ongoing effects of meromixis to be lessened even if the lake begins to rise. However, the low summer abundance of adult *Artemia* and their early decline in 2000 was somewhat anomalous. We will closely monitor this phenomenon during 2001.

ACKNOWLEDGEMENTS

Laboratory work was performed at the Sierra Nevada Aquatic Research Lab and University of California, Santa Barbara. Pete Kirchner assisted with field sampling and laboratory analyses. This work was supported by a grant from the Los Angeles Department of Water and Power to R. Jellison and J. M. Melack at the Marine Science Institute, University of California, Santa Barbara.

LIMNOLOGICAL MONITORING COMPLIANCE

This report fulfills the Mono Lake limnological monitoring requirements set forth in compliance with State Water Resources Control Board Order Nos. 98-05 and 98-07. The limnological monitoring program consists of four components: meteorological, physical/chemical, phytoplankton, and brine shimp population data. Meteorological data are collected continuously at a station on Paoha Island, while the other three components are assessed on eleven monthly surveys (every month except January). A summary of previous monitoring is included in Chapter 1, the methodology employed is detailed in Chapter 2, and results and discussion of the monitoring during 2000 presented in Chapter 3. The relevant pages, tables, and figures for the specific elements of each of the four required components are given below.

	Text	Tables	Figures
Meteorological			
Wind Speed	28		2
Wind Direction	28		
Air Temperature	29		3
Incident Radiation	29		4
Humidity	29		5
Precipitation	29		6
Physical/Chemical			
Water Temperature	30	1	8
Transparency	35	5	
Underwater light	35		15
Dissolved Oxygen	37	6	16
Conductivity	32	2	9
Ammonium	38	7	17
Phosphate	40		
Phytoplankton			
Chorophyll *a*	40	8	18
Primary production	47		27
Artemia			
Abundance	44	9	23
Instar distribution	42	10	22
Fecundity/Length	45	12	24
Reproductive parameters	44	11	24,29
Biomass	48		28

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CHAPTER 1
INTRODUCTION

Background

Saline lakes are widely recognized as highly productive aquatic habitats, which in addition to harboring unique assemblages of species, often support large populations of migratory birds. Saline lake ecosystems throughout the world are threatened by decreasing size and increasing salinity due to diversions of freshwater inflows for irrigation and other human uses (Williams 1993); notable examples in the Great Basin of North America include Mono Lake (Patten et al. 1987), Walker Lake (Cooper and Koch 1984), and Pyramid Lake (Galat et al. 1981). At Mono Lake, California, diversions of freshwater streams out of the basin beginning in 1941 led to a 14 m decline in surface elevation and an approximate doubling of the lake's salinity.

In 1994, following two decades of scientific research, litigation, and environmental controversy, the State Water Resources Control Board (SWRCB) of California issued a decision to amend Los Angeles' water rights to "establish fishery protection flows in streams tributary to Mono Lake and to protect public trust resources at Mono Lake and in the Mono Lake Basin" (Decision 1631). The decision restricts water diversions until the surface elevation of the lake reaches 1,948 m and requires long-term limnological monitoring of the plankton dynamics.

Long-term monitoring of the plankton and their physical, chemical, and biological environment is essential to understanding the effects of changing lake levels. Measurements of the vertical distribution of temperature, oxygen, conductivity, and nutrients are requisite for interpreting how variations in these variables affect the plankton populations. Consistent methodologies were employed during the 21-yr period, 1979–2000, and have yielded a standardized data set from which to analyze seasonal and year-to-year changes in the plankton. Lakewide monitoring was conducted during eleven surveys in 2000, once each month from February through December.

Seasonal Mixing Regime and Plankton Dynamics

Limnological monitoring at Mono Lake can be divided into several periods corresponding to two different annual circulation patterns, meromixis and monomixis, and the transition between them.

Monomictic and declining lake levels, 1964–82

The limnology of Mono Lake, including seasonal plankton dynamics, was first documented in the mid 1960s (Mason 1967). During this period Mono Lake was characterized by declining lake levels, increasing salinity, and a monomictic thermal regime. No further limnological research was conducted until summer 1976 when a broad survey of the entire Mono Basin ecosystem was conducted (Winkler 1977). Subsequent studies (Lenz 1984; Melack 1983, 1985) beginning in 1979, further described the seasonal dynamics of the plankton. During the period 1979–81, Lenz (1984) documented a progressive increase in the ratio of peak summer to spring abundances of adult brine shrimp. The smaller spring generations resulted in greater food availability and much higher ovoviviparous production by the first generations, leading to larger second generations. Therefore, changes in the size of the spring hatch can result in large changes in the ratio of the size of the two generations.

In 1982, an intensive limnological monitoring program funded by LADWP was established to monitor changes in the physical, chemical, and biological environments in Mono Lake. This monitoring program has continued to the present. Detailed descriptions of the results of the monitoring program are contained in a series of reports to LADWP

(Dana *et al.* 1986, 1992; Jellison *et al.* 1988, 1989, 1990, 1991, 1994, 1995b, 1996a, 1997, 1998b, 1999, 2000) and are summarized below.

Meromixis, 1983–87

In 1983, a large influx of freshwater into Mono Lake resulted in a condition of persistent chemical stratification (meromixis). A decrease in surface salinities resulted in a chemical gradient of ca. 15 g total dissolved solids l^{-1} between the mixolimnion (the mixed layer) and monimolimnion (layer below persistent chemocline). In subsequent years evaporative concentration of the surface water led to a decrease in this gradient and in November 1988 meromixis was terminated.

Following the onset of meromixis, ammonium and phytoplankton were markedly affected. Ammonium concentrations in the mixolimnion were reduced to near zero during spring 1983 and remained below 5 µM until late summer 1988. Accompanying this decrease in mixolimnetic ammonium concentrations was a dramatic decrease in the algal bloom associated with periods when the *Artemia* are less abundant (November through April). At the same time, ammonification of organic material and release from the anoxic sediments resulted in a gradual buildup of ammonium in the monimolimnion over the six years of meromixis to 400 to 500 µM. Under the previous monomictic conditions, ammonium, which accumulated beneath the thermocline during the summer, was mixed into the upper water column during the autumn overturn.

Artemia dynamics were also affected by the onset of meromixis. The size of the first generation of adult *Artemia* in 1984 (31,000 m^{-2}) was nearly ten times as large as observed in 1981 and 1982, while peak summer abundances of adults were much lower. Following this change, the two generations of *Artemia* were relatively constant during the meromictic period from 1984 to 1987. The size of the spring generation of adult *Artemia* only varied from 23,000 to 31,000 m^{-2} while the second generation of adult *Artemia* varied from 33,000 to 54,000 m^{-2}. The relative sizes of the first and second generation are inversely correlated. This is at least partially mediated by food availability as a large first generation results in decreased algal levels for second generation nauplii and vice versa. During 1984 to 1987, recruitment into the first generation adult class was a nearly constant but small percentage (about 1 to 3%) of the cysts calculated to be available (Dana *et al.* 1990). Also, fecundity showed a significant correlation with ambient algal concentrations (r^2, 0.61).

In addition to annual reports submitted to Los Angeles and referenced herein, a number of published manuscripts document the limnological conditions and algal photosynthetic activity during the onset, persistence, and breakdown of meromixis, 1982–90 (Jellison *et al.* 1992; Jellison and Melack 1993a, 1993b; Jellison *et al.* 1993; Miller *et al.* 1993).

Response to the breakdown of meromixis, 1988–89

Although complete mixing did not occur until November 1988, the successive deepening of the mixed layer during the period 1986–88 led to significant changes in the plankton dynamics. By spring 1988, the mixed layer included the upper 22 m of the lake and included 60% of the area and 83% of the lake's volume. In addition to restoring an annual mixing regime to much of the lake, the deepening of the mixed layer increased the nutrient supply to the mixolimnion by entraining water with very high ammonium concentrations (Jellison *et al.* 1989). Mixolimnetic ammonium concentrations were fairly high during the spring (8–10 μM), and March algal populations were much denser than in 1987 (53 vs. 15 μg chl *a* l^{-1}).

The peak abundance of spring adult *Artemia* in 1988 was twice as high as any previous year from 1979 to 1987. This increase could have been due to enhanced hatching and/or survival of nauplii. The pool of cysts available for hatching was potentially larger in 1988 since cyst production in 1987 was larger than in the four previous years (Dana *et al.* 1990) and significant lowering of the chemocline in the autumn and winter of 1987 allowed oxygenated water to reach cysts in sediments which had been anoxic since 1983. Cysts can remain dormant and viable in anoxic water for an undetermined number of years. Naupliar survival may also have been enhanced since chlorophyll *a* levels in the spring of 1988 were higher than the previous four years. This hypothesis is corroborated by the results of the 1988 development experiments (Jellison *et al.* 1989). Naupliar survival was higher in the ambient food treatment relative to the low food treatment.

Mono Lake returned to its previous condition of annual autumnal mixing from top to bottom with the complete breakdown of meromixis in November 1988. The mixing of previously isolated monimolimnetic water with surface water affected biotic components of the ecosystem. Ammonium, which had accumulated to high levels (600 μM) in the monimolimnion during meromixis, was dispersed throughout the water column raising surface concentrations above previously observed values (>50 μM). Oxygen was diluted by mixing with the anoxic water and consumed by the biological and chemical oxygen demand previously created in the monimolimnion. Dissolved oxygen concentration immediately fell to zero. *Artemia* populations experienced an immediate and total die-off following deoxygenation. Mono Lake remained anoxic for a few months following the breakdown of meromixis in November 1988. By mid-February 1989, dissolved oxygen concentrations had increased (2–3 mg l^{-1}) but were still below those observed in previous years (4–6 mg l^{-1}). The complete recovery of dissolved oxygen concentrations occurred in March when levels reached those seen in other years.

Elevated ammonium concentrations following the breakdown of meromixis led to high chlorophyll *a* levels in spring 1989. Epilimnetic concentrations in March and April were the highest observed (40–90 µg chl *a* l^{-1}). Subsequent decline to low midsummer concentrations (<0.5–2 µg chl *a* l^{-1}) due to brine shrimp grazing did not occur until late June. In previous meromictic years this decline occurred up to six weeks earlier. Two effects of meromixis on the algal populations, decreased winter-spring concentrations and a shift in the timing of summer clearing, are clearly seen over the period 1982–89.

The 1989 *Artemia* population exhibited a small first generation of adults followed by a summer population over one order of magnitude larger. A similar pattern was observed from 1980–83. In contrast, the pattern observed during meromictic years was a larger first generation followed by a summer population of the same order of magnitude. The timing of hatching of *Artemia* cysts was affected by the recovery of oxygen. The initiation of hatching occurred slightly later in the spring and coincided with the return of oxygenated conditions. First generation numbers in 1989 were initially high in March (ca. 30,000 individuals m^{-2}) and within the range seen from 1984–88, but decreased by late spring to 4,200 individuals m^{-2}. High mortality may have been due to low temperatures, since March lake temperatures (2–6°C) were lower than the suspected lethal limit (ca. 5–6°C) for *Artemia* (Jellison *et al.* 1989). Increased mortality may also have been associated with elevated concentrations of toxic compounds (H_2S, NH_4+, As) resulting from the breakdown of meromixis.

High spring chlorophyll levels in combination with the low first generation abundance resulted in a high level of fecundity that led to a large second generation of shrimp. Spring chlorophyll *a* concentrations were high (30–44 μg chl *a* l^{-1}) due to the elevated ammonium levels (27–44 μM) and are typical of pre-meromictic levels. This abundant food source (as indicated by chlorophyll *a*) led to large *Artemia* brood sizes and high ovigerity during the period of ovoviviparous reproduction and resulted in the large observed summer abundance of *Artemia* (peak summer abundance, 93,000 individuals m^{-2}). Negative feedback effects were apparent when the large summer population of *Artemia* grazed the phytoplankton to very low levels (<0.5–2 μ g chl *a* l^{-1}). The low algal densities led to decreased reproductive output in the shrimp population. Summer brood size, female length, and ovigerity were all the lowest observed in the period 1983–89.

Small peak abundance of first generation adults were observed in 1980–83, and 1989. However, the large (2–3 times the mean) second generations were only observed in 1981, 1982, and 1989. During these years, reduced spring inflows resulted in less than usual density stratification and higher than usual vertical fluxes of nutrients thus providing for algal growth and food for the developing *Artemia* population.

Monomictic conditions with relatively stable lake levels, 1990–94

Mono Lake was monomictic from 1990 to 1994 (Jellison *et al.* 1991, Dana *et al.* 1992, Jellison *et al.* 1994, Jellison *et al.* 1995b) and lake levels (6374.6 to 6375.8 ft asl) were similar to those in the late 1970s. Although the termination of meromixis in November 1988 led to monomictic conditions in 1989, the large pulse of monimolimnetic ammonium into the mixed layer led to elevated ammonium concentrations in the euphotic zone throughout 1989, and the plankton dynamics were markedly different than 1990–94. In 1990–94, ammonium concentrations in the euphotic zone decreased to levels observed prior to meromixis in 1982. Ammonium was low, 0–2 μM, from March through April and then increased to 8–15 μM in July. Ammonium concentrations declined slightly in late summer and then increased following autumn turnover. This pattern of ammonium concentrations in the euphotic zone and the hypolimnetic ammonium concentrations were similar to those observed in 1982. The similarities among the years 1990–94 indicate the residual effects of the large hypolimnetic ammonium pulse accompanying the breakdown of meromixis in 1988 were gone. This supports the conclusion by Jellison *et al.* (1990) that the seasonal pattern of ammonium concentration was returning to that observed before the onset of meromixis.

Spring and summer peak abundances of adult *Artemia* were fairly constant throughout 1990 to 1994. Adult summer population peaks in 1990, 1991, and 1992 were all 35,000 m^{-2} despite the large disparity of second generation naupliar peaks (280,000, 68,000, and 43,000 m^{-2} in 1990, 1991, and 1992, respectively) and a difference in first generation peak adult abundance (18,000, 26,000, and 21,000 m^{-2} in 1990, 1991, and 1992, respectively). Thus, food availability or other environmental factors are more important to determining summer abundance than recruitment of second generation nauplii. In 1993, when freshwater inflows were higher than usual and thus density stratification enhanced, the summer generation was slightly smaller (21,000 m^{-2}). Summer abundance of adults increased slightly (29,000 m^{-2}) in 1994 when runoff was lower and lake levels were declining.

Meromictic conditions with rising lake levels, 1995–present

The winter (1994/95) period of holomixis injected nutrients which had previously accumulated in the hypolimnion into the upper water column prior to the onset of thermal and chemical stratification in 1995 (Jellison *et al.* 1996a). During 1995, above normal runoff in the Mono Basin coupled with the absence of significant water diversions out of the basin led to rapidly rising lake levels. The large freshwater inflows resulted in a 3.4 ft rise in surface elevation and the onset of meromixis, a condition of persistent chemical stratification with less saline water overlying denser more saline water. Due to holomixis during late 1994 and early 1995, the plankton dynamics during the first half of 1995 were similar to those observed during the past four years (1991–94). Therefore 1995 represents a transition from monomictic to meromictic conditions. In general, 1995 March mixed-layer ammonium and chlorophyll *a* concentrations were similar to 1993. The peak abundance of summer adult *Artemia* (24,000 m^{-2}) was intermediate to that observed in 1993 (21,000 m^{-2}) and 1994 (29,000 m^{-2}). The effects of increased water column stability due to chemical stratification only became evident later in the year. As the year proceeded a shallower mixed layer, lower mixed-layer ammonium and chlorophyll *a* concentrations, slightly smaller *Artemia*, and smaller brood sizes compared to 1994 were all observed. The full effects of the onset of meromixis in 1995 were not evident until 1996.

Chemical stratification persisted and strengthened throughout 1996 (Jellison *et al.* 1997). Mixolimnetic (upper water column) salinity ranged from 78 to 81 g kg^{-1} while monimolimnetic (lower water column) were 89–90 g kg^{-1}. The maximum vertical density stratification of 14.6 kg m^{-3} observed in 1996 was larger than any year since 1986. During 1996, the annual maximum in Secchi depth, a measure of transparency, was among the highest observed during the past 18 years and the annual minimum was higher than during all previous years except 1984 and 1985 during a previous period of meromixis. While ammonium concentrations were <5 μM in the mixolimnion throughout the year, monimolimnetic concentrations continued to increase. The spring epilimnetic chlorophyll *a* concentrations (~5–23 μg chl *a* l^{-1}) were similar to those observed in previous meromictic years, but were much lower than the concentrations observed in March 1995 before the onset of the current episode of meromixis. During previous monomictic years, 1989–94, the spring maximum epilimnetic chlorophyll *a* concentrations ranged between 87–165 μg chl *a* l^{-1}.

A single mid-July peak in adults characterized *Artemia* population dynamics in 1996 with little evidence of recruitment of second generation *Artemia* into the adult population during late summer. The peak abundance of first generation adults was observed on 17 July (34,600 m^{-2}), approximately a month later than in previous years. The percent ovigery during June 1996 (42%) was lower than that observed in 1995 (62%), and much lower than that observed 1989–94 (83–98%). During the previous meromictic years (1984–88) the female population was also slow to attain high levels of ovigery due to lower algal levels. The maximum of the mean female length on sampling dates through the summer, 10.7 mm, was shorter than those observed during 1993, 1994, and 1995 (11.7, 12.1, and 11.3 mm, respectively). In 1996, brood size ranged from 29 to 39 eggs $brood^{-1}$ during July through November. The summer and autumn brood sizes were smaller than those observed during 1993–95 (40 to 88 eggs $brood^{-1}$), with the exception of September 1995 (34 eggs $brood^{-1}$) when the brood size was of a similar size to September 1996 (33 eggs $brood^{-1}$).

Chemical stratification continued to increase in 1997 as the surface elevation rose an additional 1.6 ft during the year. The midsummer difference in density between 2 and 28 m attributable to chemical stratification increased from 10.4 kg m^{-3} in 1996 to 12.3 kg m^{-3} in 1997. The lack of holomixis during the previous two winters resulted in depleted nutrient levels in the mixolimnion and reduced abundance of phytoplankton. In 1997, the spring (February–April) epilimnetic chlorophyll *a* concentrations at 2 m (~2–3 μg chl *a* l^{-1}) were lower than those observed during 1996 (~5–8 μg chl *a* l^{-1}), and other meromictic years 1984–89 (1.6–57 μg chl *a* l-1), and much lower than those observed during the spring months in the last period of monomixis, 1989–95 (~15–153 μg chl *a* l^{-1}). Concomitant increases in transparency and the depth of the euphotic zone were also observed. As in 1996, a single mid-July peak in adults characterized the Artemia population dynamics in 1997 with little evidence of recruitment of second generation *Artemia* into adults. The peak midsummer adult abundance (27,300 m^{-2}) was slightly lower than 1996 but similar to 1995 (24,400 m^{-2}). The mean length of adult females was 0.2–0.3 mm shorter than the lengths observed in 1996 and the brood sizes lower, 26–33 eggs $brood^{-1}$ in 1997 compared to 29 to 53 eggs $brood^{-1}$ in 1996.

In 1998 the surface elevation of the lake rose 2.2 ft. The continuing dilution of saline mixolimnetic water and absence of winter holomixis led to increased chemical stratification. The peak summer difference in density between 2 and 28 m attributable to chemical stratification increased from 12.3 kg m^{-3} in 1997 to 14.9 kg m^{-3} in August 1998. The 1998 peak density difference due to chemical stratification was higher than that seen in any previous year, including 1983–84. The lack of holomixis during the previous three winters resulted in depleted nutrient levels in the mixolimnion and reduced abundance of phytoplankton. Chlorophyll *a* concentrations at 2 m generally decreased from 14.3 μg chl *a* l^{-1} in February to 0.3 μg chl *a* l^{-1} in June, when the seasonal chlorophyll *a* concentration minimum was reached. After that it increased to 1–2 μg chl *a* l^{-1} during July–October and to ~8 μg chl *a* l^{-1} in early December. In general, the seasonal pattern of mixolimnetic chlorophyll *a* concentration was similar to that observed during the two previous meromictic years, 1996 and 1997, in which the spring and autumn algal blooms are much reduced compared to monomictic years.

As in 1996 and 1997, a single mid-July peak in adults characterized the Artemia population dynamics in 1998 with little evidence of recruitment of second generation *Artemia* into adults. The peak abundance of adults observed on 10 August (34,000 m^{-2}) was slightly higher than that observed in 1997 (27,300 m^{-2}) and, while similar to the timing in 1997, approximately two weeks to a month later than in most previous years. The mean female length ranged from 9.6 to 10.3 mm in 1998 and was slightly shorter than observed in 1996 (10.1–10.7 mm) and 1997 (9.9–10.4 mm). Mean brood sizes in 1998 were 22–50 eggs $brood^{-1}$. The maximum brood size (50 eggs $brood^{-1}$) was within the range of maximums observed in 1995–97 (62, 53, and 33 eggs $brood^{-1}$, respectively), but was significantly smaller than has been observed in any other previous year 1987–94 (81–156 eggs $brood^{-1}$).

Meromixis continued but weakened slightly in 1999 as the net change in surface elevation over the course of the year was -0.1 ft. The midsummer difference in density between 2 and 28 m attributable to chemical stratification declined from 14.9 kg m^{-3} in 1998 to 12.2 kg m^{-3}. The lack of holomixis during the past four winters resulted in depleted inorganic nitrogen concentrations in the mixolimnion and reduced abundance of phytoplankton. In 1999, the spring (February–April) epilimnetic chlorophyll *a* concentrations at 2 m (10–16 μg chl *a* l^{-1}) were similar to those observed in 1998 but slightly higher than the two previous years of meromixis, 1997 (~2–3 μg chl *a* l^{-1}) and 1996 (~5–8 μg chl *a* l^{-1}). However, they are considerably lower than those observed during the spring months of the last period of monomixis, 1989–95 (~15–153 μg chl *a* l^{-1}). As in all of the three immediately preceding years of meromixis, 1996–98, the *Artemia* population dynamics in 1999 were characterized by a single late-summer peak in adults with little evidence of recruitment of second generation *Artemia* into adults. The peak midsummer adult abundance (38,000 m^{-2}) was slightly higher than 1996 (32,200 m^{-2}), 1997 (27,300 m^{-2}), and 1998 (34,000 m˙2). The mean length of adult females was slightly longer (10.0–10.7 mm) than 1998 (9.6–10.3 mm) and similar to 1996 (10.1–10.7 mm) and 1997 (9.9–10.4 mm), while the range of mean brood sizes (27–48 eggs $brood^{-1}$) was similar (22–50 eggs $brood^{-1}$; 1996–98).

Long-term integrative measures: annual primary productivity, mean annual *Artemia* biomass and egg production

The availability of dissolved inorganic nitrogen or phosphorus has been shown to limit primary production in a wide array of aquatic ecosystems. Soluble reactive phosphorus concentrations are very high (>400 μM) in Mono Lake and thus will not limit growth. However, inorganic nitrogen varies seasonally, and is often low and potentially limiting to algal growth. A positive response by Mono Lake phytoplankton in ammonium enrichments performed during different periods from 1982 to 1986 indicates inorganic nitrogen limits the standing biomass of algae (Jellison 1992). In Mono Lake, the two major sources of inorganic nitrogen are brine shrimp excretion and vertical mixing of ammonium-rich monimolimnetic water.

Algal photosynthetic activity was measured from 1982 to 1992 (Jellison and Melack, 1988, 1993a; Jellison *et al.* 1994) and clearly showed the importance of variation in vertical mixing of nutrients to annual primary production. Algal biomass during the spring and autumn decreased following the onset of meromixis and annual photosynthetic production was reduced (269–462 g C m^{-2} yr^{-1}; 1984 to 1986) compared to non-meromictic conditions (499–641 g C m^{-2} yr^{-1}; 1989 and 1990) (Jellison and Melack 1993a). Also, a gradual increase in photosynthetic production occurred even before meromixis was terminated because of increased vertical flux of ammonium due to deeper mixing into ammonium-rich monimolimnetic water. Annual production was greatest in 1988 (1,064 g C m^{-2} yr^{-1}) when the weakening of chemical stratification and eventual breakdown of meromixis in November resulted in large fluxes of ammonium into the euphotic zone.

Estimates of annual primary production integrate annual and seasonal changes in photosynthetic rates, algal biomass, temperature, and insolation. Although measurements of photosynthetic rates were discontinued in 1992, most of the variation in photosynthetic rates can be explained by regressions on environmental covariates (i.e. temperature, nutrient, and light regimes) (Jellison and Melack 1993a, Jellison *et al.* 1994). Therefore, estimates of annual primary production using previously derived regressions and current measurements of algal biomass, temperature, and insolation are included as part of the limnological monitoring program (see chapter 3). These estimates of annual primary production indicate a period of declining productivity (1994–1997) associated with the onset of meromixis and increasing chemical stratification, followed by an increasing production during 1998 and 1999 despite continuing meromixis.

The mean annual biomass of *Artemia* was estimated from instar-specific abundance and length-weight relationships for the period 1983–99. The mean annual biomass has varied from 5.34 to 17.6 g m^{-2} with a 16-yr mean of 9.8 g m^{-2}. The highest estimated mean annual biomass (17.6 g m^{-2}) occurred in 1989 just after the breakdown of meromixis during a period of elevated phytoplankton nutrients (ammonium) and phytoplankton. The lowest annual estimate was in 1997 following two years of meromixis and increasing density stratification. Mean annual biomass was somewhat below the long-term mean during the first 3 years of the 1980s episode of meromixis and then above the mean the next 3 years as meromixis weakened and ended. The lowest annual biomass of *Artemia* (5.3 g m^{-2}) was observed in 1997, the second year of the current episode of meromixis. However, annual biomass increased in 1998 and 1999 to near the long-term mean.

Scientific publications

In addition to the long-term limnological monitoring, the City of Los Angeles has partially or wholly funded a number of laboratory experiments, analyses, and analytical modeling studies resulting in the following peer-reviewed research publications by University of California, Santa Barbara (UCSB) researchers.

Dana, G. L. and P.H. Lenz. 1986. Effects of increasing salinity on an *Artemia* population from Mono Lake, California. Oecologia 68:428-436.

Dana, G. L., R. Jellison, and J. M. Melack. 1990. *Artemia monica* egg production and recruitment in Mono Lake, California, USA. Hydrobiologia 197:233-243.

Dana, G. L., R. Jellison, J. M. Melack, and G. Starrett. 1993. Relationships between *Artemia monica* life history characteristics and salinity. Hydrobiologia 263:129-143.

Dana, G. L., R. Jellison, and J. M. Melack. 1995. Effects of different natural regimes of temperature and food on survival, growth, and development of Artemia. J. Plankton Res. 17:2115-2128.

Jellison, R. 1987. Study and modeling of plankton dynamics in Mono Lake, California. Report to Community and Organization Research Institute, Santa Barbara.

Jellison, R., G. L. Dana, and J. M. Melack. 1992. Ecosystem responses to changes in freshwater inflow to Mono Lake, California, p. 107–118. In C. A. Hall, Jr., V. Doyle-Jones, and B. Widawski [eds.] The history of water: Eastern Sierra Nevada, Owens Valley, White-Inyo Mountains. White Mountain Research Station Symposium 4. Univ. of Calif., Los Angeles.

Jellison, R., Romero, J., and J. M. Melack. 1998a. The onset of meromixis during restoration of Mono Lake, California: Unintended consequences of reducing water diversions. Limnol. Oceanogr.Limnol. Oceanogr. 43:706-711.

Jellison, R. and J. M. Melack. 1988. Photosynthetic activity of phytoplankton and its relation to environmental factors in hypersaline Mono Lake, California. Hydrobiologia 158:69-88.

Jellison, R., and J. M. Melack. 1993a. Algal photosynthetic activity and its response to meromixis in hypersaline Mono Lake, California. Limnol. Oceanogr. 38:818–837.

Jellison, R., and J. M. Melack. 1993b. Meromixis in hypersaline Mono Lake, California I. Vertical mixing and density stratification during the onset, persistence, and breakdown of meromixis. Limnol. Oceanogr. 38:1008–1019.

Jellison, R., L. G. Miller, J. M. Melack, and G. L. Dana. 1993. Meromixis in hypersaline Mono Lake, California II. Nitrogen fluxes. Limnol. Oceanogr. 38:1020–1039.

Jellison, R., G. L. Dana, and J. M. Melack. 1995a. Zooplankton cohort analysis using systems identification techniques. J. Plankton Res. 17:2093–2115.

Jellison, R., R. Anderson, J. M. Melack, and D. Heil. 1996b. Organic matter accumulation in Mono Lake sediments during the past 170 years. Limnol. Oceanogr. 41:1539–1544.

Miller, L. G., R. Jellison, R. S. Oremland, and C. W. Culbertson. 1993. Meromixis in hypersaline Mono Lake, California III. Breakdown of stratification and biogeochemical response to overturn. Limnol. Oceanogr. 38:1040–1051.

Romero, J.R. and J.M. Melack. 1996. Sensitivity of vertical mixing to variations in runoff. Limnol. Oceanogr. 41:955–965.

Romero, J. R., R. Jellison, J. M. Melack. 1998. Stratification, vertical mixing, and upward ammonium flux in hypersaline Mono Lake, California. Archiv fuer Hydrobiol. **142:** 283-315.

Romero, J.R., J.C. Patterson, and J. M. Melack. 1996. Simulation of the effect of methane bubble plumes on vertical mixing in Mono Lake. Aquat. Sci. **58:**210–223.

Other related current research

A wide array of research is being conducted at Mono Lake and UCSB researchers are actively collaborating with several other projects. These include a series of NSF-funded research grants on the internal mixing dynamics of Mono Lake (S. MacIntyre, UCSB), an NSF-funded microbial observatory at Mono Lake (J. Hollibaugh and S. Joye, Univ. Georgia; J. Zehr, UCSC) and research into the effects of *Artemia* abundance on feeding and reproductive success of California Gulls (D. Winkler, Cornell; J. Jehl, Hubbs Sea-World Institute).

CHAPTER 2
METHODS

Meteorology

Continuous meteorological data is collected at the Paoha station located on the southern tip of Paoha Island. The station is approximately 30 m from the shoreline of the lake with the base located at 1948 m asl, several meters above the current surface elevation of the lake. Sensor readings are made every second and stored as either ten minute or hourly values. A Campbell Scientific CR10 datalogger records up to 3 weeks of measurements and radio frequency telemetry is used to download the data weekly.

Wind speed and direction (RM Young wind monitor) are measured at a height of 3 m above the surface of the island and are averaged over a 10-minute interval. The maximum wind speed during the ten-minute interval is also recorded. The 10-minute wind vector magnitude, wind vector direction, and the standard deviation of the wind vector direction are computed from the measurements of wind speed and wind direction and stored. Hourly measurements of average photosynthetically available radiation (PAR, 400 to 700 nm, Li-Cor 192-S) and total rainfall (Qualimetrics 601 I-B tipping bucket), and ten minute averages of relative humidity (Vaisalia HMP35C) and air temperature (Vaisalia HNV35C and Omnidata ES-060) are also made and stored.

The Cain Ranch meteorological station is located approximately 7 km southwest of the lake at an elevation of 2088 m. Throughout the 1980s, LADWP measured wind and temperature at this station. Currently UCSB maintains and records hourly averages of incoming shortwave (280 to 2800 nm; Eppley pyranometer), longwave radiation (3000 to 50000 nm; Eppley pyrgeometer) and PAR (400 to 700 nm; Li-Cor 192-S) at this site.

Sampling Regime

Eleven lakewide surveys were conducted in 2000 at approximately monthly intervals. During winter, the plankton dynamics change relatively slowly and thus a survey was not conducted during January. *Artemia*, temperature, conductivity, oxygen, ammonium, chlorophyll *a*, and Secchi depth were sampled on every survey. In June 2000, we added collection of additional net tows at 12 stations for the direct determination of *Artemia* biomass, added two buoyed stations in the far eastern portion of the lake, and ceased sampling at non-buoyed intermediate stations. A detailed description of these changes and their rationale is included in Appendix A.

Field Procedures

In situ profiles

Water temperature and conductivity were measured at eight buoyed, pelagic stations (2, 3, 4, 5, 6, 7, 8, and12) (Figure 1). From February through May, profiles were taken with a high-precision, conductivity-temperature-depth profiler (CTD) (Sea-Bird Electronics, model Seacat SBE 19). In May, 2000 we acquired (on loan from the University of Georgia) a Seacat SBE19 equipped with additional sensors to measure photosynthetically available radition (PAR), fluorescence (695 nm), and transmissivity (660 nm). These additional sensors will enable a much more accurate quantification of the vertical variation in phytoplankton and particularly the mid-depth maximum.

From February through May, the CTD was deployed with a free-fall rate of ~0.25–0.35 m s^{-1} and recorded temperature and conductivity every 0.5 seconds. Raw temperature data were shifted upward 1.6 scans (~800 ms) relative to the pressure data to allow for the slower response of the thermistor. Beginning in June, the new CTD was deployed by lowering at 0.1-0.2 m s^{-1}. An analysis of salinity spiking from the mismatch in the time response of the conductivity and temperature sensors indicated a 1.7 s displacement of the temperature data provided the best fit. The pumped fluorometer data requires a 3.7 s shift, and other sensors (pressure, PAR, transmissivity) required a distance offset based on their relative placement. As density variations in Mono Lake can be substantial due to chemical stratification, pressure readings were converted to depth by integrating the mass of the water column above each depth.

Conductivity readings at in situ temperatures (C_t) were standardized to 25°C (C_{25}) using

$$C_{25} = \frac{C_t}{1 + 0.02124(t-25) + 9.16 \times 10^{-5}(t-25)^2}$$

where t is the in situ temperature. To describe the general seasonal pattern of density stratification, the contributions of thermal and chemical stratification to overall density stratification were calculated based on conductivity and temperature differences between 2 and 28 m at station 6 and the following density equation:

$$\begin{aligned}\rho(t, C_{25}) = 1.0034 + 1.335 \times 10^{-5} t - 6.20 \times 10^{-6} t^2 + 4.897 \times 10^{-4} C_{25} \\ + 4.23 \times 10^{-6} C_{25}^2 - 1.35 \times 10^{-6} t C_{25}\end{aligned}$$

The relationship between total dissolved solids and conductivity for Mono Lake water was given by:

$$TDS(g\,kg^{-1}) = 3.386 + 0.564 \times C_{25} + 0.00427 \times C_{25}^2.$$

To obtain TDS in grams per liter, the above expression was multiplied by the density at 25°C for a given standardized conductivity given by:

$$\rho_{25}(C) = 0.99986 + 5.2345 \times 10^{-4} C + 4.23 \times 10^{-6} C^2$$

A complete description of the derivation of these relationships is given in Chapter 4 of the 1995 Annual Report.

From February through May 2000, light attenuation was measured at one centrally located station (Station 6) using a LI-COR light meter (LI-COR, model LI-250) equipped with a submersible PAR light sensor (LI-COR, model LI-192S). From May through December, light attenuation was recorded using the Sea-Bird profiler, which was equipped with a submersible PAR light sensor (LI-COR, model LI-1000).

Throughout 2000, dissolved oxygen was measured at one centrally located station (Station 6). Dissolved oxygen concentration was measured with a Yellow Springs Instruments temperature-oxygen meter (YSI, model 58) and probe (YSI, model 5739). A new probe was purchased in August 2000. The oxygen electrode is calibrated at least once each year against Miller titrations of Mono Lake water (Walker *et al.* 1970).

Water samples

Chlorophyll and nutrient samples were collected from seven to eleven depths at one centrally located station (Station 6). In addition, 9-m integrated samples for chlorophyll *a* determination and nutrient analyses were collected with a 2.5 cm diameter tube at seven stations (Station 1, 2, 5, 6, 7, 8, and 11) (Figure 1). Samples for nutrient analyses were filtered immediately upon collection through Gelman A/E glass-fiber filters, and kept chilled and dark until returned to the lab. Water samples used for the analysis of chlorophyll *a* were filtered through a 120-μm sieve to remove all stages of *Artemia*, and kept chilled and dark until filtered in the laboratory.

Artemia samples

The *Artemia* population was sampled by one net tow from each of twelve, bouyed stations (Figure 1). Samples were taken with a plankton net (1 m x 0.30 m diameter, 120 μm Nitex mesh) towed vertically through the water column. Samples were preserved with 5% formalin in lake water.

Laboratory Procedures

Water samples

Upon return to the laboratory, chlorophyll samples were filtered onto 47 mm Whatman GF/F filters and kept frozen until the pigments were analyzed. From 1987 through May 2000, Mono Lake chlorophyll *a* samples were filtered onto Gelman A/E filters, which have a pore size of ca. 1.0 µm. The recognition that a small fraction of picoplankton may pass through these filters prompted an additional protocol in which the the A/E filtrates from 2, 12, 20, and 28 m depth profiles from station 6 were filtered onto Whatman GF/F filters (ca. 0.7 microns effective pore size) . The chlorophyll *a* means and standard deviations of GF/F-filtered A/E filtrate for 2, 12, 20, and 28 m were 0.419 ± 0.412 (n=55), 0.570 ± 0.403 (n=55), 1.043 ± 0.321 (n=55), and 1.401 ± 0.550 (n=38) µg chl l^{-1}, respectively. During periods of low chlorophyll (<5 µg chl l^{-1}), A/E filtrate onto GF/F filters produced chl *a* values of ca. 20% those from the A/E filters. During periods of higher chlorophyll (>5 µg chl l¯1) the relative amount captured by a second filtration onto GF/F filters was 3.9%. Beginning in June 2000, GF/F filters were used exclusively for chlorophyll *a* determinations.

Chlorophyll *a* was extracted and homogenized in 90% acetone at room temperature in the dark. Following clarification by centrifugation, absorption was measured at 750 and 663 ηm on a spectrophotometer (Milton Roy, model Spectronics 301), calibrated once a year by Milton Roy Company. The sample was then acidified in the cuvette, and absorption was again determined at the same wavelengths to correct for phaeopigments. Absorptions were converted to phaeophytin-corrected chlorophyll *a* concentrations with the formulae of Golterman (1969). During periods of low phytoplankton concentrations (<5 µg chl *a* l^{-1}), the fluorescence of extracted pigments was measured on a fluorometer (Sequoia-Turner, model 450) which was calibrated against the spectrophotometer using large-volume lake samples and fresh lettuce. Ammonium concentrations were measured using the indophenol blue method (Strickland and Parsons 1972). In addition to regular standards, internal standards were analyzed because the molar extinction coefficient is less in Mono Lake water than in distilled water. Oxygen gas was bubbled into Mono Lake water and used for standards and sample dilutions. Oxygenating saline water may help reduce matrix effects that can occur in the spectrophotometer (S. Joye, pers. comm.)

Artemia samples

Artemia abundances were counted under a stereo microscope (6x or 12x power). Depending on the density of shrimp, counts were made of the entire sample or of subsamples made with a Folsom plankton splitter. Samples were split so that a count of 150 to 200 animals was obtained. Shrimp were classified into adults (instars > 12), juveniles (instars 8–11), and nauplii (instar 1–7) according to Heath's classification (Heath 1924). Adults were sexed and the adult females were divided into ovigerous and non-ovigerous. Ovigerous females included egg-bearing females and females with oocytes. Adult ovigerous females were further classified according to their reproductive mode, ovoviviparous or oviparous. A small percentage of ovigerous females were unclassifiable if eggs were in an early developmental stage. Nauplii at seven stations (Stations 1, 2, 5, 6, 7, 8, and 11) were further classified as to instars 1–7.

Live females were collected for brood size and length analysis from seven buoyed stations (Stations 1, 2, 5, 6, 7, 8, and 11) with 20-m vertical net tows and kept cool and in low densities during transport to the laboratory. Immediately on return to the laboratory, females were randomly selected, isolated in individual vials, and preserved. Brood size was determined by counting the number of eggs in the ovisac including those dropped in the vial, and egg type and shape were noted. Female length was measured from the tip of the head to the end of the caudal furca (setae not include).

Long-term integrative measures of productivity

Primary Production

Photosynthetically available radiation (PAR, 400-700 nm) was recorded continuously at Cain Ranch, seven kilometers southwest of the lake, from 1982 to 1994 and on Paoha Island in the center of the lake beginning in 1991 with a cosine-corrected quantum sensor. Attenuation of PAR within the water column was measured at 0.5-m intervals with a submersible quantum sensor. Temperature was measured at 1-m intervals with a thermistor and wheatstone bridge circuit calibrated against a certified thermometer and accurate to 0.05°C prior to 1992 and with a conductivity-temperature-depth profiler (Seabird, SB19) from 1992 to 2000 (see Methods, Chapter 2). Phytoplankton samples were filtered onto glass fiber filters and extracted in acetone (See Methods, Chapter 2).

Photosynthetic parameters were estimated based on regression of 1991 and 1992 photosynthetic parameters against temperatures. The chlorophyll-normalized light-saturated uptake rates from carbon uptake measurements performed in 1991 and 1992 were highly correlated with water temperature. The exponential equation:

$$P_m^B = 0.237 \times 1.183^T \quad n=42,\ r^2=0.86$$

where T is temperature (°C) explained 86% of the overall variation. As found in previous analyses (Jellison and Melack 1993), there was a strong correlation between light-limited and light-saturated rates. A linear regression on light-saturated rates explained 82% of the variation in light-limited rates:

$$\alpha^B = 2.69 + (1.47 \times P_m^B) \qquad n=42, r^2=0.82$$

Both light-limited and light-saturated carbon uptake rates are within the range reported in other studies. During 1995, rising lake levels and greater salinity stratification most likely reduced the vertical flux of nutrients and thus may have affected the photosynthetic rates. However, previous regression analyses (Jellison and Melack 1993), using an extensive data set collected during periods of different nutrient supply regimes, indicates little of the observed variance in photosynthetic rates can be explained by simple estimate of nutrient supply. The above regressions explain most of the variance in photosynthetic rates and thus provide a reasonable alternative to frequent, costly field and laboratory measurements using radioactive tracers. The differences in annual phytoplankton production throughout the period, 1982–1992, resulted primarily from changes in the amount of standing biomass; year to year changes in photosynthetic parameters during the years they were measured (1983–92) were not correlated with annual production. While photosynthetic parameters were not measured in 1993–99, other major factors determining primary production were measured throughout the year.

Estimates of daily integral production were made using a numerical interpolative model (Jellison and Melack 1993). Inputs to the model include the estimated photosynthetic parameters, insolation, the vertical attenuation of photosynthetically available irradiance and vertical water column structure as measured by temperature at 1 m intervals and chlorophyll a from samples collected at 4–6 m intervals. Chlorophyll-specific uptake rates based on temperature were multiplied by ambient chlorophyll a concentrations interpolated to 1-m intervals. The photosynthetically available light field was calculated from hourly-integrated values at the onshore monitoring site, measured water column attenuation, and a calculated albedo. The albedo was calculated based on hourly solar declinations. All parameters, except insolation that was recorded continuously, were linearly interpolated between sampling dates. Daily integral production was calculated by summing hourly rates over the upper 18 m.

Artemia biomass and reproduction

Average daily biomass and annual cyst and naupliar production provide integrative measures of the *Artemia* population allowing simple comparison among years. Prior to 2000, *Artemia* biomass was estimated from stage specific abundance and adult length data, and weight-length relationship determined in the laboratory simulating in situ conditions of food and temperature (see Jellison and Melack 2000 for details). Beginning in 2000, biomass was determined directly by drying and weighing of *Artemia* collected in vertical net tows.

The resulting biomass estimates are approximate because actual instar-specific weights may vary within the range observed in the laboratory experiments. However, classifying the field samples into one of the three categories will be more accurate than using a single instar-specific weight-length relationship. Because length measurements of adult females are routinely made, they were used to further refine the biomass estimates. The adult female weight was estimated from the mean length on a sample date and one of the three weight-length regressions determined in the laboratory development experiments. As the lengths of adult males are not routinely determined, the average ratio of male to female lengths determined from individual measurements on 15 dates from 1996 and 1999 was used to estimate the average male length of other dates.

Naupliar and cyst production was calculated using a temperature-dependent brood interval, ovigery, ovoviviparity versus oviparity, fecundity, and adult female abundance data from seven stations on each sampling date.

Table 10. Lakewide Artemia instar analysis, 2000.

	Instars									
	1	2	3	4	5	6	7	8-11	adults	total
Mean:										
2/24	11,730	178	0	0	0	0	0	0	0	11,905
3/16	20,285	416	0	0	0	0	0	0	0	20,701
4/19	5,869	8,763	9,229	2,713	879	225	57	0	0	27,733
5/20	7,700	4,668	4,883	2,736	2,495	1,261	671	4,078	4,346	32,837
6/15	63,237	14,993	690	483	299	184	92	5,507	17,085	102,570
7/17	3,624	2,972	417	92	60	0	0	1,595	23,736	32,498
8/15	483	1,374	911	368	207	98	29	89	21,949	25,508
9/14	310	471	897	1,029	379	144	75	75	10,170	13,550
10/16	256	353	296	310	144	238	132	221	4,214	6,166
11/13	80	30	20	57	33	74	87	74	111	567
12/5	129	121	57	23	43	72	57	32	57	592
Standard error of mean:										
2/24	3,718	73	0	0	0	0	0	0	0	3,777
3/16	9,896	258	0	0	0	0	0	0	0	10,025
4/19	2,342	3,036	2,797	956	500	126	53	0	0	9,065
5/20	1,071	486	514	614	562	416	254	736	729	3,517
6/15	10,575	2,507	537	79	102	96	59	1,305	2,916	14,294
7/17	834	633	111	45	28	0	0	759	7,835	8,869
8/15	95	402	373	104	93	50	23	26	7,571	8,156
9/14	133	183	405	556	143	71	56	26	2,971	2,839
10/16	62	71	83	72	32	66	16	48	1,020	1,118
11/13	28	13	14	24	4	16	16	26	27	98
12/5	68	76	36	15	15	40	32	16	18	285
Percentage in different age classes:										
2/24	98.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
3/16	98.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
4/19	21.2	31.6	33.3	9.8	3.2	0.8	0.2	0.0	0.0	100.0
5/20	23.4	14.2	14.9	8.3	7.6	3.8	2.0	12.4	13.2	100.0
6/15	61.7	14.6	0.7	0.5	0.3	0.2	0.1	5.4	16.7	100.0
7/17	11.2	9.1	1.3	0.3	0.2	0.0	0.0	4.9	73.0	100.0
8/15	1.9	5.4	3.6	1.4	0.8	0.4	0.1	0.3	86.0	100.0
9/14	2.3	3.5	6.6	7.6	2.8	1.1	0.6	0.6	75.1	100.0
10/16	4.2	5.7	4.8	5.0	2.3	3.9	2.1	3.6	68.3	100.0
11/13	14.1	5.3	3.5	10.1	5.8	13.1	15.3	13.1	19.6	100.0
12/5	21.8	20.4	9.6	3.9	7.3	12.2	9.6	5.4	9.6	100.0

CHAPTER 3

RESULTS AND DISCUSSION

During 1995, above normal runoff coupled with the current reduced volume of Mono Lake resulted in the second largest annual lake level rise this century. The large influx of freshwater initiated a period of persistent chemical stratification or meromixis. Strong chemical stratification has continued through the present as diversions of freshwater streams out of the Mono Basin have been minimal and the surface elevation of the lake has continued to rise. A previous episode of meromixis that was initiated by record runoff in 1982-83 ended 6 years later when the salinity of the mixolimnion (surface mixed layer) eventually became greater than that of the monimolimnion (bottom layer beneath chemocline) due to evaporative concentration and low inputs of freshwater. Given the management goal of raising the lake level to 6391 ft, the current episode of meromixis is likely to continue much longer (Jellison *et al.* 1998a). In this chapter, we describe the physical, chemical, and biological conditions in Mono Lake during 2000, the sixth year of what is likely to be an extended period of meromixis.

Meteorological Data

Wind Speed and Direction

Mean daily wind speed varied from 1.0 – 10.7 ms^{-1} over the year, and averaged 3.4 m s^{-1} (Fig. 1). The daily maximum 10-min averaged wind speeds averaged 2.4 times mean daily wind speeds and the maximum recorded wind speed was 28.3 m s^{-1} on 21 December. The mean monthly wind speed is fairly constant (coefficient of variation, 15%) and only varied from 2.4 m s^{-1} in December to 4.1 m s^{-1} in May. Wind direction through the year was consistently from the southwest. The monthly vector-averaged wind direction was 210 degrees, and ranged from 186 – 222 degrees over the year.

Air Temperature

Mean daily air temperature ranged from a minimum of –5.3°C on 11 November to a maximum of 23°C on 30 July (Fig. 3). Air temperatures ranged from 4.1°C to 33.0°C during the summer (June through August) and from –14.1°C to 13.5°C during the winter (December through February)

Incident Photosynthetically Available Radiation

Photosynthetically available radiation (400-700 nm) exhibits a regular sinusoidal curve varying from about 20 Einsteins m^{-2} day^{-1} in mid-December to 65 ~Einsteins m^{-2} day^{-1} in mid-June (Fig. 4). Daily values that diverge from the curve indicate overcast or stormy days. During 2000, the annual mean was 37.9 Einsteins m^{-2} day^{-1}, with daily values ranging from 4.8 Einsteins m^{-2} day^{-1} on 15 January to 65.0 Einsteins m^{-2} day^{-1} on 30 May.

Relative Humidity and Precipitation

Mean daily relative humidity followed a general pattern of high values in January and February, decreasing to lows in May through August, and increasing through December (Fig. 5). The yearly mean was 52.5%, with a maximum of 93.6% occurring on 23 January, and a minimum of 20.3% on 30 May (Fig. 5).

During 2000, annual precipitation at the Paoha Island meteorological station was 64.7 mm. Most precipitation fell in January (19.8 mm) and February (13.4 mm). Very little precipitation occurred during May through July (0.7mm) and none was recorded during December. The peak daily precipitation (6.6mm) occurred on 13 February. The detection limit for the tipping bucket gage is 1 mm of water. As the tipping bucket is not heated, the instrument is less accurate during periods of freezing due to sublimation or other losses of falling snow.

Surface Elevation

In 2000, the surface elevation of Mono Lake rose only 0.4 ft early in the year, peaking at 6384.1 ft asl (USGS datum) where it remained from March through July. This surface elevation is 0.9 ft below the June 1999 high point of 6385.0 ft (Fig. 7). During late summer and autumn, evaporative loss and low runoff and precipitation caused a gradual decline to 6383.0 ft by the end of the year, 1.1 ft below the December 1999 elevation. Thus, a net annual decline of 0.7 ft in surface elevation occurred in 2000; significantly more than the 0.1 ft decline observed in 1999.

Temperature

The annual pattern of thermal stratification in Mono Lake results from seasonal variations in climatic factors (e.g. air temperature, solar radiation, wind speed, humidity) and their interaction with density stratification arising from freshwater inputs. The timing and magnitude of freshwater inputs, primarily precipitation and inflowing streams that mix into the upper portion of the water column, effect vertical mixing and thus the seasonal pattern of thermal stratification. The annual pattern of seasonal thermal stratification observed during 1990–94 is typical of large temperate lakes, with the lake being thermally mixed during holomixis in the late autumn through early winter. This pattern was altered during a previous episode of meromixis (1982-89) and similarly in the current episode of meromixis 1995–00; (Fig. 8, Table 1) due to vertical salinity gradients associated with ongoing meromixis.

Aside from the absence of a winter period of holomixis, the most notable difference in the thermal regime during 1996–00 compared to monomictic years is the presence of significant inverse thermal stratification at mid-depths. This inverse thermal stratification was observed from December 1995 through April 1996 and from November

1996 through May 1999 (throughout 1997 and 1998). In 2000, inverse thermal stratification of 1.5 °C was observed during February and March but disappeared by May due to warming of the metalimnion. On the 24 February profile, the upper water column was well-mixed with a temperature of ca. 3.4°C, while below the mixolimnion the temperature increased to ca. 5.0°C. Elimination of this inverse thermal stratification was due entirely to warming of the metalimnion, as the temperature of the monimolimnion (region beneath the the chemocline) remained constant at 4.9-5.0°C throughout the year (Table 1). Monimolimnetic temperatures did not vary from 1999, but were slightly cooler and more constant then observed in 1997 and 1998 (5.0-5.2°C and 4.9-5.1°C, respectively). The chemocline deepened to 24 m in April 2000 and remained there throughout the year. This is 2 m deeper than in 1999, and 7 m deeper than in 1998.

By mid-March 2000, a seasonal thermocline had formed at 4 m. The thermocline persisted and deepened over the summer, to 10 m by August. Unlike 1999, no secondary thermocline developed above this seasonal thermocline in 2000. After August, the epilimnion began to cool and deepen, and by December the water column was nearly isothermal at 6.3°C above the chemocline at 23-24 m.

Mean epilimnetic temperatures were consistently warmer in February through June 2000 than in respective months of 1999 or 1998 (Table 1). The near-surface water temperatures also warmed faster, increasing ca. 3°C from Feb.-Mar. (3.4-6.5°C), compared to ca. 2°C from Feb.-Mar. 1999 (2.1-4.0°C). By mid-March when the shallow thermocline had developed, the near-surface water had warmed to 8.7°C, 2 degrees warmer than in 1999 and 1998. Epilimnetic water temperature reached an annual maximum in mid-August of 20.4°C, similar to the annual maximum in 1999 (20.7°C), but a month later. Autumnal cooling rates were similar to 1995–99, slower than in 1993–94. Slower rates of cooling in 1995–00 were caused in part by reduced entrainment of colder metalimnetic water due to strong chemical stratification. The December 2000 mixed layer temperature (6.3°C) was about 1 degree cooler than December 1999 (7.4°C), but within the range for 1995-98 (5.6-6.6°C). The December mixed-layer temperatures from 1995-00 were significantly warmer than in 1993 (4.7°C) and 1994 (5.0°C).

Conductivity and Salinity

Salinity, expressed as total dissolved solids, can be calculated from conductivity measurements corrected to a reference temperature (see Methods). Because total dissolved solids are conservative at the current salinities in Mono Lake, salinity decreases as the volume of the lake increases due to inputs of freshwater in excess of evaporative losses.

In 2000, conductivity in the mixoliminion increased slightly, from 78.1 mS cm^{-1} in February to 78.4 mS cm^{-1} in May, but decreased to the annual low of 77.4 mS cm^{-1} by June (Fig. 9, Table 2). Subsequent evaporative concentration resulted in a conductivity increase to the annual maximum of 80.1 mS cm^{-1} in December. The mixolimnetic salinity (TDS) therefore ranged from (72.6-76.0 g kg^{-1}). The minimum conductivity and salinity observed in 2000 was similar to the minimum in 1999 (76.8 mS cm^{-1}, 71.9 g kg^{-1}). The maximum conductivity and salinity, however, increased to levels similar to 1998 (ca. 80 mS cm^{-1}, 75.8g kg^{-1}).

Mean monimolimnetic conductivities and salinities in 2000 exhibited a small annual decrease from 86.9 mS cm^{-1} (84.6 g kg^{-1}) in February to 86.7 mS cm^{-1} (84.4 g kg^{-1}) in December. Monimolimnetic conductivities and salinities have decreased slightly each year since the beginning of the current period of meromixis (from 90.3 mS cm^{-1} in

December 1995), indicating a small amount of vertical mixing or the presence of subsurface freshwater inflows.

During 2000 the water column above the chemocline was generally well-mixed and the gradient at the chemocline was significantly steeper and sharper than in previous meromictic years (Table 2, Fig. 9). Also, mixolimnetic deepening has resulted in the chemocline being pushed downward from 18-21 m in December 1999 to ~21 m in February 2000 and further to 24 m in December 2000.

Density Stratification: Thermal and Chemical

The large seasonal variation in freshwater inflows associated with a temperate climate and year-to-year climatic variation leads to complex patterns of seasonal density stratification. Much of the year-to-year variation in the plankton dynamics observed during the past 21 years at Mono Lake can be attributed to marked differences in chemical stratification resulting from variation in freshwater inflows.

As in previous meromictic years, density stratification was evident throughout the year in 2000 (Fig. 10, Table 3). Density of water below 28 m ranged from 1.077–1.078 g cm^{-3}, while minimum densities of 1.063–1.069 g cm^{-3} were recorded near the surface (< 4 m). The annual density minimum (1.063 g cm^{-3}) occurred in July, during the same time of year, but higher than the 1999 minimum (1.061 g cm^{-3}). The 2000 density minimum was similar to the 1997 minimum (1.064 g cm^{-3}) but lower than in 1996 (1.066 g cm^{-3}) or 1995 (1.068 g cm^{-3}). The highest density gradients occurred at mid-depths at the interface of the mixolimnion and the perennially isolated monimolimnion. The density gradient at the top of the monimolimnion was extremely sharp and steep throughout 2000 (ca. 0.0030-0.0049 g cm^{-3} m^{-1}). The depth of the maximum density gradient increased from 22-23 m in February - April to 23-24 m in May – December.

Although the current episode of meromixis is expected to persist for some years into the future, the deepening of the persistent chemocline during the past two years, effectively reduces that portion of the lake that does not undergo holomixis. At the current chemocline depth and surface elevation only 38% of the total area and 16% of the total volume of the lake lie beneath the clemocline.

A comparison of the density differences between 2 and 28 m due to thermal versus chemical stratification indicates chemical density stratification continued to predominate throughout 2000 (Fig. 11, Table 4). Annual peaks in density differences due to chemical stratification increased each year 1995-98 (from 8.1 kg m^{-3} in August 1995 to 10.4 kg m^{-3} in July 1996, to 12.3 kg m^{-3} in July 1997, to 14.9 kg m^{-3} in August 1998), but in 1999 the annual peak decreased to near 1997 levels (12.2 kg m^{-3} in July 1999). The annual peak in 2000 again decreased from 1999, to near 1996 levels (from 12.2 to 10.6 kg m^{-3}). Chemical density stratification still contributed almost 4 times as much as temperature to the overall density stratification (14.1 versus 3.6 kg m^{-3}). Data from the December 2000 survey indicate that density stratification due to salinity was 7.8 kg m^{-3} compared to 1.9 kg m^{-3} due to temperature. The December chemical stratification was lower in 2000 than any other year since 1995 (9.9 kg m^{-3}, 1999; 11.7 kg m^{-3}, 1998; 9.7 kg m^{-3}, 1997; 7.9 kg m^{-3}, 1996; 6.0 kg m^{-3}, 1995). As in 1999, in February 2000 an inverse thermal gradient resulted in decreasing the density gradient due to chemical stratification (10.0 kg m-3) by –0.27 kg m^{-3}.

December conductivity profiles from 1994-99 (Fig. 12) show that there was an increase in mixolimnetic conductivities due to summer evaporative concentration of surface water while monimolimnetic conductivities decreased, resulting in an overall decrease in chemical stratification during 2000. The overall maximum density stratification due to both thermal and chemical effects in was 14.1 kg m^{-3}, a decrease from the 1999 maximum of 16.3 kg m^{-3}, but similar to the maximum observed in 1996 (14.5 kg m^{-3}).

Summer thermal stratification regularly contributes 3.5 to 4.5 kg m^{-3} of density stratification between 2 and 28 m. During most monomictic years, the density stratification due to temperature is lessened by inverse salinity stratification due to evaporative concentration of surface water during late summer. This inverse salinity stratification promotes vertical mixing of nutrients and late summer deepening of the mixed layer. During meromictic years, density stratification is enhanced by salinity stratification, and late summer vertical fluxes of nutrients and deepening of the mixed layer are inhibited.

Transparency and Light Attenuation

In 2000, average lakewide transparencies as determined by Secchi depth were between 1.8-1.9 m during February-April (Fig. 13, Table 5). These values were similar to those observed during 1994 and 1995 following periods of winter holomixis and slightly less (reflecting more phytoplankton) than 1996–99. Secchi depth increased to 4.9 m by mid-May due to grazing by the developing 1st generation of *Artemia*. The increase in May was greater than observed in 1999 (3 m compared to 1 m in 1999), but similar to May transparencies in 1998 and 1994 (both ca. 4.5-4.8 m). Transparency continued to increase and by mid-June Secchi depth had increased to 7.1 m. The annual maximum

Secchi depth in July was 7.5 m, significantly shallower than the maximums observed in 1994-99 (2-4.4 m).

The timing of the maximum Secchi depth in 2000 was similar to that in 1996-99 and 1994, but over a month earlier than in 1995. Secchi depth began to decrease in August (6.2 m) and continued to decrease through late summer, reaching 1.3 m in November-December. This is shallower than the range of December tranparencies in 1994-98 (2.0-2.8 m), but similar to 1999 (1.5), and similar to Secchi readings during December 1993-94 before the onset of this period of meromixis (1.5-1.6 m). The 2000 annual minimum (1.2 m) occurred in April, and was similar in depth and timing to the annual minimums of 1995-98. Reduced upward flux of nutrients accompanying meromixis reduces the annual autumn algal bloom during periods of meromixis. But in 1999 and 2000, deepening of the mixed layer entrained ammonium-rich monimolimnetic water, and thus provided nutrients to an autumn-winter algal bloom.

Overall, in 2000 transparencies were shallower than in previous years, owing to an autumn algal bloom that was most likely enhanced not only by increased nutrient fluxes, but also by an unusually low abundance of summer and autumn *Artemia.*

Secchi depth is an integrative measure of light attenuation within the water column. Because absorption is exponential with depth, the long-term variation in Secchi depth is most appropriately viewed on a logarithmic scale. The annual maximum Secchi depth in 2000 was lower than that observed during the past 21 years, except 1979, 1980, and 1993, and lower than in any of the previous meromictic years (Fig. 14). The annual minimum Secchi depth was similar to 1995 and 1996 and lower than in any other of the years during the present meromictic period 1995-00. The 2000 annual minimum was also lower than 1983 and 1984 during the previous period of meromixis, but higher than all previous monomictic years, except 1994. These changes reflect an increase in phytoplankton due to entrained nutrient-rich water from a deepening mixed-layer early in the year, enhanced upward nutrient fluxes during the summer due to a lessening of chemical stratification and very high monimolimnetic ammonium concentrations, and decreased *Artemia* grazing due to unusually low late season abundance.

The attenuation of PAR within the water column varies seasonally, primarily as a function of changes in algal biomass. In 2000, the depth of the euphotic zone, operationally defined as the depth at which only 1% of the surface insolation is present, varied from 7-8 m in the spring and winter to 14–17 m in the summer (Fig. 15). The depth of the euphotic zone was generally shallower throughout 2000 compared to 1999 and other meromictic years, reflecting the higher algal biomass observed this year.

Dissolved Oxygen

Dissolved oxygen concentrations are primarily a function of salinity, temperature, and the balance between photosynthesis and overall community respiration. In the euphotic zone of Mono Lake, dissolved oxygen concentrations are typically highest during the spring algal bloom. As the water temperature and *Artemia* population increase through the spring, dissolved oxygen concentrations decline. Beneath the euphotic zone, bacterial and chemical processes deplete the oxygen once the lake stratifies.

In March 2000, dissolved oxygen was 6.5 mg l^{-1} (Fig. 16, Table 6). The depth of the anoxic zone was 22-23 m, having deepened from 20 m in December 1999. The annual maximum surface oxygen concentration occurred in April (7.8 mg l^{-1}), one month later than in 1999 or 1998. Mixolimnetic dissolved oxygen declined through July, when the annual low concentration was ca. 4.2 mg l^{-1}. The range of oxygen concentrations (±

3.6 mg l^{-1}) over the year was slightly greater than in 1999 ($\pm$ 2.8 mg l^{-1}). The anoxic zone (depth below which dissolved oxygen concentrations are <0.5 mg l^{-1}) deepened further to 24 m in December 2000. While the absence of any winter period of holomixis continued to maintain anoxic conditions beneath the chemocline, the deepening of the chemocline has resulted in a smaller anoxic volume (16% of total lake). The annual maximum oxygen concentration occurred in April at the surface. In April the water column was fairly well stratified and oxygen decreased from the surface to the oxycline. Mid-depth oxygen concentration maxima were observed in March at 4-5 m (7.3 mg l^{-1}), in May at 10 m (5.6 mg l^{-1}), in June at 11 m (5.3 mg l^{-1}), and in July at 13 m (4.7 mg l^{-1}). These dissolved oxygen values are within the range observed in previous years. In September and October the upper water column was well-mixed above 12 m, resulting in a homogenous oxygen mixolimnion.

Nutrients (ammonium)

Nitrogen is the primary limiting macronutrient in Mono Lake as phosphate is in super-abundance (350-450 µM) throughout the year (Jellison *et al.* 1994). External inputs of nitrogen are low relative to recycling within the lake (Jellison *et al.* 1993). Ammonium concentrations in the euphotic zone reflect the dynamic balance between excretion by shrimp, uptake by algae, upward vertical fluxes through thermo- and chemocline(s), release from sediments, ammonia volatilization, and small external inputs. Because a large portion of particulate nitrogen, in the form of algal debris and *Artemia* fecal pellets, sink to the bottom and are remineralized to ammonium in the hypolimnion (or monimolimnion during meromixis), vertical mixing controls much of the internal recycling of nitrogen.

During 2000, ammonium concentrations in the euphotic zone were low (0.1-1.1 μM) throughout the year except during May and June (Fig. 17, Table 7). During these two months, ammonium concentrations near the surface were slightly higher (2.0-2.6 μM) due to Artemia grazing and excretion and decreased algal uptake. *Artemia* grazing results in decreased phytoplankton and thus algal ammonium uptake. This pattern is similar to that observed in 1998 and 1999 when concentrations increased slightly each month from April to June then decreased in July and were generally very low the rest of the year, except that in 1999 the ammonium at 2 m was slightly elevated in October (1.1 μM). In 1996, the euphotic zone ammonium concentrations reached a higher mid-summer peak June–August (2.2–3.7 μM), whereas in 1997, the ammonium concentrations in the euphotic zone remained low all year (0.4–0.9 μM) and never exhibited a mid-summer peak. Ammonium concentrations at 2 m were similar during February and March 1996–00 (0.6–0.9 μM). However, during May–July 1997 ammonium concentrations at 2 m (0.4–0.5 μM) were significantly lower than in 1996 and 1998–00 (0.8–3.5 μM). During September–December, ammonium concentrations were lower at 2 m (0.1-0.6 μM) than in 1996–99 (0.6–0.9 μM).

During February 2000, ammonium concentrations in the monimolimnion continued to their 5-year increase during meromixis (445 μM compared to 369–394 μM at 28–35 m in 1999, 286–334 μM at 28–35 m in 1998, 181 μM at 28 m in 1997 and 73 μM at 24 m in 1996). Monimolimnetic ammonium concentrations increased substantially throughout the year with concentrations at 28 m reaching 683 μM by December (compared with 164, 276, 403, and 483 μM at 28 m in December of 1996, 1997, 1998 and 1999, respectively). At 35 m ammonium concentrations reached 808 μM in December 2000 (Table 7). The present accumulation, over the last 6 years, is much higher than during monomictic years, and higher that observed during the 1983–88 episode of meromixis. During the mid-80s period of meromixis, ammonium built up to ~600 μM during the 6 years (Jellison *et al.* 1989).

Soluble reactive phosphate concentrations were above 550 μM throughout the water column. These concentrations are several orders of magnitude above those that are saturating for phosphate uptake by phytoplankton, and thus variations will have no effect on the plankton dynamics.

Algal Biomass (chlorophyll a)

Algal biomass, as characterized by the concentration of chlorophyll *a*, varied in the mixolimnion from 1.4 to 54.2 μg chl *a* l^{-1} in 2000 (Fig. 18, Table 8). Chlorophyll *a* at 2 m decreased from 16.5 μg chl *a* l^{-1} in February to 7.9 μg chl a l^{-1} in March, before increasing to 18.7 μg chl *a* l^{-1} in April. Concentrations were low throughout the summer (1.4-1.9 μg chl *a* l^{-1}) due to high grazing by *Artemia*, but increased from 1.9 μg chl *a* l^{-1} in August to the annual surface maximum of 54.2 μg chl *a* l^{-1} by December. The annual minimum chlorophyll *a* (1.4 μg chl *a* l^{-1}) was slightly higher than the minimum in 1999 (0.9 μg chl *a* l^{-1}), while the December maximum was well above the range of maxima observed in 1996-99 (8-25 μg chl *a* l^{-1}). Prominent mid-depth maxima were observed at 24 m in February-April (32-44 μg chl *a* l^{-1}), and at 16-22 m in May-November (34-63 μg chl *a* l^{-1}), and again at 24 m in December (59 μg chl *a* l^{-1}) (Table 8). Monimolimnetic (28 m) concentrations of chlorophyll *a* were relatively constant, varying from 29 to 40μg chl *a* l^{-1}, similar to the range observed in previous years.

A Seabird Seacat profiler equipped with a transmissometer, PAR sensor, and fluorometer was acquired and deployed on routine surveys beginning in July 2000. This enabled a much better characterization of the vertical distribution of fluorescing and light absorbing particles than sampling with a Van Dorn bottle. Regressions of chlorophyll *a* determinations versus in situ fluorescence taken throughout the water column from July through December yielded a strong correlation ($r^2 = 0.77$; Fig. 19) and indicate the usefulness of fluorescence to characterize chlorophyll *a* distributions. However, there is a fair amount of scatter about the regression on any given day, and thus an accurate estimate of chorophyll *a* requires depth and date specific comparisons to laboratory chlorophyll *a* extractions. Nevertheless, even without detailed comparisons, variations in fluorescence indicate complex vertical variation in the water column properties.

Fluorescence profiles show pronounced peaks at 16-18 m in July-September, slightly deeper and less pronounced at 22-23 m in October, and then a very pronounced and narrow peak at 24 m in December (Fig. 20). These profiles provide a much more detailed picture of the vertical complexity of the plankton than possible by sampling individual depths with the Van Dorn sampler. It is clear that large populations of photosynthesizing organisms may develop at the top of the nutricline, and likely that this population consists of a recently identified novel phytoplankton (C. Roesler pers. commun.) adapted to very low light levels. The 17 July 2000 in situ profile shows the existence of a thin, but pronounced, fluorescence peak at low light level, just beneath the oxycline and above the nutricline (ammonium gradient) (Fig. 21). The complex interplay between biogeochemical processing by micro-organisms and in situ light, oxygen, density, nutrient gradients is a major focus of the NSF-funded Microbial Observatory at Mono Lake.

Artemia Population Dynamics

Population Overview

The *Artemia* population in 2000 was characterized by the fairly rapid development of the 1st generation, a large pulse of ovoviviparous reproduction in June, and an unusual decline in late-summer adults. Instar analysis indicated that first generation hatching peaked in March, with abundances similar to those of 1999 (ca. 33,000 m^{-2} in 1999, ca. 26,000 m^{-2} in 2000). Rapid development of the 1st generation of *Artemia* led to a large pulse of nauplii (93,119 m^{-2}) in June (Table 9a). This naupliar peak was higher than in 1998 (64,400 m^{-2}) and 1999 (60,600 m^{-2}). However, recruitment of these nauplii into juveniles and adults was very low in 2000. Juvenile peak abundances were much lower (5017 m^{-2}) than the annual peak in 1999 (35,600 m^{-2}) or 1998 (29,135 m^{-2}) and the annual adult maximum (23,736 m^{-2}) was at the low end of the range of abundances from 1982–99 (Table 9a, Fig. 22). The adult abundance decreased slightly in August (22,000 m^{-2}) and then further to 11,900 m^{-2} by 14 September. These late summer abundances are lowest of the past 20 years with the exception of 1986, which were slightly lower. This unusual decline in late summer adults must result from either unusually low recruitment or increased adult mortality.

Nauplii (Instars 1-7)

Hatching of over-wintering cysts typically becomes significant by late-February, as water temperatures warm after a cold dormancy period (Dana 1981), and continues through May. As in all previously sampled years, with the exception of 1989 when anoxic conditions following the breakdown of meromixis delayed the beginning of the spring hatch until the beginning of March, significant hatching had occurred by the first sampling date of 24 February 2000. Naupliar numbers increased through June, when a peak in mean lakewide abundance of 93,119 m^{-2} was observed (Table 9a). This peak naupliar abundance was higher than in 1998 (64,400 m^{-2}) and 1999 (60,600 m^{-2}), and higher than the range recorded during 1991-1994 (13,000-35,000 m^{-2}), but lower than the unusually high peak abundances seen in 1983 (204,260 m^{-2}), 1989 (112,568 m^{-2}), and 1990 (281,110 m^{-2}). After June 2000, naupliar abundances decreased substantially to 9512 m^{-2} by July, and then continued to decrease through November.

Ovoviviparous second generation nauplii hatched from May through August of 2000 (Table 11a). Peak ovoviviparous hatching occurred in June, when ovoviviparously reproducing females comprised 4.2 percent of fecund females (Table 11c). The percent of ovoviviparous females was somewhat lower in 2000 compared to previous years (8 % in 1999, 12% in 1998). However, adult *Artemia* may rapidly switch reproductive mode and monthly sampling may not accurately capture the peak of ovoviviparous reproduction.

A lack of naupliar recruitment from July to September has been evident in past years, with naupliar instar stages (3-7) absent in *Artemia* samples (1984, 1987, 1989, 1990-1991, 1996-1998). This pattern was less pronounced in 1999, and was not visible in 2000. Except for instars 6 and 7 in July, all size classes were represented from May through December (Table 10). Naupliar abundances remained similar to higher than those in 1999 through October, but declined in November and December, when instar 1 abundance was ca.100 m^{-2} (Table 11a).

Juveniles (Instars 8-11)

In 2000 the annual juvenile maximum occurred in May (5017 m^{-2}; Table 9a, Fig. 22) and was lower than the range in peaks observed 1993-1999 (9700-32,200 m^{-2}). The timing of maximum abundance was similar to that observed in 1993-1994 and 1996-

1997, but a month earlier than in 1998 and 1999. Juvenile abundance decreased rapidly to 1360 m^{-2} in July and further to 55 m^{-2} in August. Given that the peak naupliar abundance in 2000 was higher than the range of values for 1989-1994, and 1998-1999 and the resulting adult abundance lower, naupliar and juvenile mortality appears to have been higher than usual.

Adults

Adult abundance in 2000 increased to an annual maximum of 22,384 m^{-2} in July (Fig. 22, Table 9a). Abundances from February through July were at the low end of the range observed 1983-1999 (excluding outlier years 1983, 1988, and 1989) (Fig. 23). The annual maximum was not the lowest abundance observed during July, but it was the lowest peak annual abundance recorded. Adult abundances were up to 4 times greater on the southwest side of the lake in both 1999 and 2000 (Table 9a).

The maturation of *Artemia* is dependent on water temperature and food availability (Dana *et al.* 1995). In mid-June 2000 the mean mixolimnetic temperature was 18.4°C, three degrees warmer than 1998 or 1999, and within the range observed during June 1993-94 and 1996-97 (14.6-18°C) (Table 1). The mean chlorophyll *a* concentration in June was also higher in 2000 (1.4 $\mu g\ l^{-1}$) than in either 1998 (0.3$\mu g\ l^{-1}$) or 1999 (0.9 $\mu g\ l^{-1}$) (Table 8). Thus neither temperature nor food availability can explain the lack of recruitment into the adult population of the large number of nauplii observed in June. While a change in algal species to those of lower food quality or edibility could account for the lack of recruitment, individual fecundity (see below) was high and suggests ample food.

In 2000, ovigerous females were first observed on the May survey (993 m^{-2}), one month earlier than in 1999 or 1998, but similar to dates of appearance in 1993-94 and

1996-97 (Fig. 24,Table 11a). In May, ovigerous females comprised 58% of all adult females (Table 11c). The number of ovigerous females increased to the year's maximum in July (6424 m^{-2}), then decreased in August (911 m^{-2}) and September (1445 m^{-2}), before decreasing to zero in December. The percent ovigerity ranged between 75-90% of the total female population from June through October and was similar to 1999 (62-99%), except that in 1999 ovigerity was low in June (14%). Lower ovigerity early in the year is known to reflect slower maturation rates. During previous meromictic years (1984-1988), the female population was slow to attain high levels of ovigerity owing to lower algal biomass. It is likely, since maturation did not appear to be slow in 2000, that the population saw increased mortality and lack of recruitment to either the juvenile and/or adult stages.

Ovoviviparity of adult females reached a peak of only 4.2 % on 15 June. The percent of ovoviviparous females decreased to 1.3 % in July and remained <1% for the remainder of the year (Fig. 24, Table 11c). The peak in 2000 was lower than the range observed during 1990-99 (8-70 %).

Mean female length ranged from 10.5 to 11.6 mm in 2000 (Table 12). The maximum length was higher than the range of maxima from 1996-99 (10.3 to 10.7 mm), but at the low end of the range of maxima during the period 1987-95 (11.6 to 13.7 mm). The mean female length decreased from 11.2 mm in May to 10.5 mm in June, indicating juvenile recruitment into the adult stage. Mean female length increased to the annual maximum (11.6 mm) in September. Shorter lengths of fecund females during the summers of 1996-99 reflect lower ambient algal concentrations. The large females observed in September most likely reflects increased chlorophyll *a* concentrations (3.4 $\mu g\ l^{-1}$) compared to recent years (1.4 $\mu g\ l^{-1}$ in 1999, 1.2 $\mu g\ l^{-1}$ in 1998) (Table 8).

Mean brood size of ovigerous females in June 2000, when the first generation of *Artemia* matured, was 68 eggs brood^{-1}. Maximum brood size occurred in May (110 eggs brood^{-1}), with similarly large broods produced in October (96 eggs brood^{-1}) (Table 12). Large brood sizes in May and June led to high naupliar abundances early in the season (Table 9a, Fig. 22). Both maximum and June brood sizes in 2000 were higher than the maximum brood sizes in 1999 (48 eggs brood^{-}1) and 1998 (50 eggs brood^{-1}), both occurring in June. During the meromictic years 1984-1988 and 1995-2000, as well as 1991-92 and 1994, early summer brood sizes were moderate (20-70 eggs brood^{-1}). Peak brood size in 1984-1988 and 1991-1994 occurred in October or November. From 1997-1999 the peak occurred in June, and in 1996 it occurred in May. Differences in brood size are largely related to algal abundance and individual size. Larger brood sizes in 2000 are therefore expected given the observed larger individuals and more algal biomass.

Artemia Summary Statistics, 1979-2000

Year to year variation in climate, hydrological conditions, vertical stratification, food availability, and possibly salinity have led to large differences in *Artemia* dynamics. During years when the first generation was small due to reduced hatching, high mortality, or delayed development, (1981, 1982, and 1989) the second generation peak of adults was 2-3 times the long term average (Fig. 25). Seasonal peak abundances were also significantly higher (1.5-2 times the mean) in 1987 and 1988 as the 1980s episode of meromixis weakened and nutrients that had accumulated beneath the chemocline were transported upward. However, in most years the seasonal peaks of adult abundance were similar (30–40,000 m^{-2}) and the seasonal (1 May to November 30) mean of adult abundance is remarkably constant (14–20,000 m^{-2}). However, adult *Artemia* abundance is anomalously low during 2000. All three statistics (peak, 22,400 m^{-2}; mean, 10,600 m^{-2}; and median, 9080 m^{-2}) are only half the long-term (1979-99) averages (peak, 45,800 m^{-2}; mean, 20,400 m^{-2}; and median, 19,600 m^{-2}).

During most years, the seasonal distribution of adult abundance was roughly normal or lognormal. However, in several years the seasonal abundance was not described well by either of these distributions. Therefore, the abundance-weighted centroid of temporal occurrence was calculated to compare overall seasonal shifts in the timing of adult abundance. The center of the temporal distribution of adults varied from day 205 (24 July) to 230 (18 August) in the 23 years from 1979 to 2000 (Fig. 26). During five years when there was a small spring hatch (1980–83, and 1989) the overall temporal distribution of adults was much later (24 August – 9 September) and during 1986 an unusually large 1st generation shifted the seasonal temporal distribution much earlier to 9 July. During 2000, the overall temporal distribution of adults was two weeks earlier (29 June) than the long-term mean (11 August).

Long-term integrative measure of productivity

Planktonic primary production

Daily estimates of primary production in 2000 ranged from 0.3 to 2.9 g C m^{-2} d^{-1}. This daily range is higher than observed during 1996–98, but within the previously reported range including monomictic periods (Figure 27) (Jellison and Melack 1988, 1993a; Jellison *et al.* 1994, Jellison *et al.* 1995b, Jellison *et al.* 1996a, Jellison *et al.* 1997). The estimated total annual production of 484 g C m^{-2} yr^{-1} in 2000 represents a

63% increase over the 1999 estimate of 297 g C m^{-2} yr^{-1} and continues the upward trend from the low value estimated in 1997 (149 g C m^{-2} yr^{-1}). The 2000 estimated planktonic primary production is nearly identical to the long-term (1982–99) mean of 467 g C m^{-2} yr^{-1} and similar to the mean annual production (508 g C m^{-2} yr^{-1}) during the last monomictic period from 1990–94. Thus, while meromixis persists in 2000, the combined effects of declining lake levels, the reduced proportion of the lake beneath the chemocline,and increased upward fluxes of ammonium due to the large buildup of monimolimnetic ammonium have offset the effect of the absence of winter holomixis. It is not clear to what extent each of these factors is responsible and continuing meromixis may still reduce the availability of nutrients during periods of rising lake levels.

There are no comparable long-term studies of algal production in other large, deep hypersaline lakes. The annual estimates of planktonic photosynthesis found in this study (149–1063 g C m^{-2} yr^{-1}) are generally higher than other hypersaline lakes in the Great Basin: Great Salt Lake (southern basin), 145 g C m^{-2} yr^{-1} (Stephens and Gillespie 1976); Soap Lake, 391 g C m^{-2} yr^{-1} (Walker 1975); and Big Soda, 500 g C m^{-2} yr^{-1} (350 g C m^{-2} yr^{-1} phototrophic production) (Cloern *et al.* 1983).

Artemia biomass and egg production

Artemia biomass was estimated from instar-specific population data and previously derived weight-length relationships for the period 1982–99. Variation in weight-length relationships among sampling dates was assessed from 1996–99 and found to lead to errors of up to 20% in the annual estimates. Thus, in 2000 we implemented direct drying and weighing of vertical net tow samples collected explicitly for biomass determinations.

In 2000, *Artemia* biomass increased from ca. 0.5 g dry weight m^{-2} during the February and March surveys to 30.3 g dry weight m^{-2} in mid-August before declining to near zero (0.05 g dry weight m^{-2}) in early December (Fig. 28). The 2000 mean annual biomass of 8.2 g m^{-2} is 12% below the long-term mean of 9.7 g m^{-2} and slightly less than calculated in 1999 (8.9 g m^{-2}). The generally lower numbers of adult *Artemia* observed in 2000 were partially offset by a slightly larger size of individuals that presumably resulted from higher food availability. The highest estimated mean annual *Artemia* biomass (17.6 g m^{-2}) occurred in 1989 just after the breakdown of meromixis during a period of elevated phytoplankton nutrients (ammonium) and phytoplankton. Mean annual biomass was somewhat below the long-term mean during the first 3 years of the 1980s episode of meromixis and then above the mean during the next 3 years as meromixis weakened and ended. Except for lower values in 1997, *Artemia* biomass has remained relatively constant since 1993 and was only slightly higher during 1990–92.

In Mono Lake, oviparous (cyst) reproduction is always much higher than ovoviviparous (live-bearing) reproduction (Fig. 29). Despite lower numbers of adults during 2000 compared to 1999, increased individual fecundity, resulting from larger size and higher food availability, resulted in a total annual cyst production similar to 1999 (4.03×10^6 m^{-2} in 2000 versus of 4.17×10^6 m^{-2} in 1999). The 2000 total annual cyst production was 16% below the long-term (1983–99) mean of 4.77×10^6 m^{-2} and well above the lowest value observed in 1997 (2.54×10^6 m^{-2}). In general, cyst production was lower during years following the onset of meromixis and higher during the breakdown of meromixis and during monomictic periods.

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Table 1. Temperature at Station 6, 2000 (°C)

	Dates									
Depth (m)	2-24	3-16	4-19	5-20	6-15	7-17	8-15	9-14	10-16	12-5
1	3.32	6.91	8.76	13.04	18.41	19.66	20.49	17.35	14.62	6.11
2	3.25	6.59	8.62	13.07	19.30	19.60	20.45	17.28	14.58	6.13
3	3.19	6.10	8.69	12.48	18.21	19.77	20.45	17.26	14.58	6.16
4	3.17	5.41	8.57	11.99	18.16	19.89	20.44	17.44	14.63	6.20
5	3.20	5.44	8.59	11.57	17.88	19.90	20.44	17.44	14.67	6.29
6	3.22	5.16	8.61	11.50	17.39	19.79	20.44	17.37	14.68	6.30
7	3.27	4.76	8.65	11.11	17.02	19.40	20.44	17.28	14.75	6.26
8	3.33	4.48	8.74	10.80	16.34	19.13	20.44	17.21	14.85	6.26
9	3.35	4.17	8.36	10.55	15.46	18.71	20.44	17.10	14.85	6.27
10	3.40	4.01	7.75	10.31	14.07	18.29	20.37	16.95	14.77	6.28
11	3.43	3.92	7.05	10.21	13.19	17.56	19.96	16.88	14.71	6.27
12	3.43	3.86	6.00	10.23	11.97	13.26	18.98	16.29	14.77	6.28
13	3.43	3.80	5.17	10.21	10.99	11.85	17.39	15.56	14.82	6.26
14	3.42	3.66	4.77	9.57	9.86	10.71	12.39	15.06	14.79	6.28
15	3.42	3.60	4.55	8.34	8.95	9.83	10.06	14.13	14.78	6.32
16	3.43	3.52	4.34	7.38	8.25	9.08	9.23	12.48	14.76	6.38
17	3.49	3.50	4.20	6.85	7.45	8.02	8.18	9.87	14.42	6.38
18	3.48	3.52	4.15	6.29	6.92	7.42	7.58	8.64	12.60	6.38
19	3.51	3.52	4.08	5.66	6.24	6.93	7.07	7.86	9.72	6.38
20	3.51	3.53	4.05	5.20	5.89	6.34	6.60	7.10	7.67	6.36
21	3.51	3.55	4.00	4.92	5.65	5.95	6.15	6.74	7.04	6.34
22	3.57	3.66	4.04	4.80	5.41	5.78	5.85	6.21	6.39	6.34
23	4.27	4.11	4.17	4.56	5.01	5.49	5.45	5.75	5.94	6.33
24	4.89	4.65	4.53	4.57	4.78	5.02	5.14	5.25	5.39	5.70
25	5.12	4.94	4.83	4.81	4.76	4.93	5.03	5.08	5.18	5.27
26	5.10	5.05	4.99	4.92	4.85	4.87	4.94	5.02	5.10	5.12
27	5.08	5.05	5.03	4.94	4.89	4.90	4.94	5.00	5.03	5.05
28	5.04	5.03	5.03	4.94	4.91	4.92	4.93	4.98	4.98	5.02
29	5.02	5.01	5.02	4.95	4.93	4.92	4.93	4.98	4.98	4.98
30	5.00	5.00	5.01	4.95	4.94	4.94	4.93	4.97	4.97	4.96
31	4.98	4.98	5.00	4.96	4.95	4.94	4.94	4.99	4.96	4.95
32	4.97	4.97	4.99	4.99	4.97	4.95	4.94	4.97	4.97	4.95
33	4.97	4.96	4.98	4.98	4.97	4.95	4.94	4.96	4.97	4.95
34	4.96	4.96	4.97	4.97	4.98	4.96	4.94	4.95	4.95	4.95
35	4.96	4.95	4.98	4.97	4.97	4.97	4.95	4.95	4.97	4.94
36	4.95	4.94	4.98	4.98	4.97	4.97	4.95	4.95	4.95	4.94

Table 2. Conductivity (mS/cm at 25°C) at Station 6, 2000

Depth (m)	Dates 2-24	3-16	4-19	5-20	6-15	7-17	8-15	9-14	10-16	12-5
1	78.06	78.02	78.14	78.44	77.44	77.96	78.87	79.18	79.53	80.12
2	78.31	78.16	78.33	78.64	77.77	78.12	78.87	79.17	79.55	80.08
3	78.39	78.33	78.40	78.67	78.31	78.27	78.87	79.17	79.59	80.08
4	78.38	78.46	78.41	78.68	78.48	78.41	78.87	79.23	79.63	80.08
5	78.40	78.56	78.44	78.75	78.55	78.43	78.86	79.42	79.63	80.14
6	78.43	78.57	78.44	78.78	78.63	78.41	78.86	79.44	79.62	80.23
7	78.42	78.55	78.46	78.71	78.64	78.42	78.87	79.49	79.72	80.23
8	78.44	78.58	78.50	78.69	78.55	78.38	78.87	79.49	79.72	80.25
9	78.47	78.61	78.47	78.69	78.52	78.31	78.87	79.55	79.69	80.25
10	78.47	78.62	78.41	78.67	78.45	78.30	78.85	79.52	79.64	80.25
11	78.50	78.62	78.43	78.67	78.48	78.22	78.89	79.52	79.72	80.26
12	78.55	78.62	78.51	78.71	78.59	78.19	78.87	79.34	79.81	80.26
13	78.61	78.62	78.60	78.74	78.66	78.31	78.90	79.30	79.82	80.26
14	78.63	78.62	78.65	78.68	78.74	78.41	78.49	79.23	79.81	80.25
15	78.64	78.65	78.73	78.59	78.85	78.59	78.68	79.43	79.82	80.27
16	78.67	78.69	78.74	78.62	78.85	78.64	78.74	79.37	79.80	80.29
17	78.72	78.71	78.76	78.72	78.99	78.57	78.58	79.35	79.25	80.30
18	78.74	78.73	78.81	78.79	79.17	79.03	78.64	79.12	78.02	80.30
19	78.80	78.75	78.81	78.94	79.27	79.27	78.81	79.25	78.62	80.31
20	78.86	78.78	78.85	79.15	79.43	79.47	78.94	79.69	79.42	80.32
21	78.90	78.84	79.02	79.50	79.61	80.00	79.36	80.14	79.99	80.36
22	80.96	80.56	80.47	80.25	79.97	80.29	79.91	80.50	80.63	80.39
23	85.17	85.15	84.13	83.27	82.83	81.97	82.06	82.01	82.76	82.96
24	86.09	86.13	85.83	85.91	85.68	85.45	85.03	85.51	85.17	85.41
25	86.30	86.47	86.25	86.47	86.30	85.89	85.60	85.99	85.84	86.12
26	86.52	86.74	86.51	86.64	86.59	86.28	85.95	86.30	86.12	86.45
27	86.69	86.89	86.70	86.78	86.72	86.53	86.11	86.38	86.27	86.58
28	86.80	87.01	86.82	86.89	86.80	86.63	86.28	86.45	86.41	86.67
29	86.87	87.10	86.90	86.97	86.89	86.69	86.36	86.48	86.48	86.76
30	86.93	87.16	86.96	87.11	86.95	86.75	86.44	86.53	86.52	86.81
31	86.98	87.21	87.02	87.11	87.01	86.78	86.49	86.54	86.58	86.85
32	87.02	87.25	87.08	87.13	87.06	86.81	86.53	86.60	86.60	86.88
33	87.05	87.27	87.13	87.13	87.11	86.84	86.58	86.65	86.64	86.88
34	87.08	87.29	87.15	87.19	87.15	86.86	86.61	86.67	86.67	86.89
35	87.10	87.31	87.15	87.21	87.18	86.87	86.64	86.69	86.67	86.91
36	-	-	-	-	-	86.88	86.68	86.71	86.70	86.92

Table 3. Density (g/cm3) at Station 6, 2000

Depth (m)	2-24	3-16	4-19	5-20	6-15	7-17	8-15	9-14	10-16	12-5
1	1.0670	1.0664	1.0662	1.0656	1.0629	1.0631	1.0638	1.0652	1.0664	1.0690
2	1.0673	1.0666	1.0665	1.0658	1.0630	1.0633	1.0638	1.0652	1.0664	1.0689
3	1.0674	1.0669	1.0665	1.0660	1.0640	1.0634	1.0638	1.0652	1.0665	1.0689
4	1.0674	1.0672	1.0666	1.0661	1.0642	1.0635	1.0638	1.0652	1.0665	1.0689
5	1.0674	1.0673	1.0666	1.0663	1.0643	1.0635	1.0638	1.0654	1.0665	1.0690
6	1.0675	1.0673	1.0666	1.0664	1.0646	1.0635	1.0638	1.0655	1.0665	1.0691
7	1.0675	1.0674	1.0666	1.0664	1.0647	1.0637	1.0638	1.0656	1.0666	1.0691
8	1.0675	1.0675	1.0666	1.0664	1.0648	1.0637	1.0638	1.0656	1.0666	1.0691
9	1.0675	1.0675	1.0667	1.0665	1.0650	1.0638	1.0638	1.0657	1.0665	1.0691
10	1.0675	1.0676	1.0667	1.0665	1.0653	1.0639	1.0638	1.0657	1.0665	1.0691
11	1.0675	1.0676	1.0669	1.0665	1.0656	1.0641	1.0640	1.0657	1.0666	1.0691
12	1.0676	1.0676	1.0671	1.0666	1.0660	1.0652	1.0643	1.0657	1.0667	1.0691
13	1.0676	1.0676	1.0674	1.0666	1.0663	1.0657	1.0649	1.0659	1.0667	1.0691
14	1.0677	1.0676	1.0675	1.0667	1.0667	1.0661	1.0658	1.0659	1.0667	1.0691
15	1.0677	1.0677	1.0676	1.0668	1.0670	1.0665	1.0665	1.0664	1.0667	1.0691
16	1.0677	1.0677	1.0677	1.0670	1.0671	1.0667	1.0668	1.0668	1.0667	1.0691
17	1.0678	1.0678	1.0677	1.0672	1.0674	1.0668	1.0668	1.0674	1.0661	1.0691
18	1.0678	1.0678	1.0678	1.0674	1.0677	1.0675	1.0670	1.0674	1.0652	1.0691
19	1.0679	1.0678	1.0678	1.0677	1.0680	1.0679	1.0673	1.0677	1.0666	1.0692
20	1.0679	1.0678	1.0678	1.0680	1.0682	1.0682	1.0675	1.0683	1.0679	1.0692
21	1.0680	1.0679	1.0680	1.0685	1.0685	1.0689	1.0681	1.0689	1.0687	1.0692
22	1.0704	1.0699	1.0697	1.0693	1.0689	1.0692	1.0688	1.0694	1.0695	1.0693
23	1.0753	1.0752	1.0740	1.0729	1.0723	1.0712	1.0714	1.0713	1.0721	1.0723
24	1.0763	1.0763	1.0760	1.0761	1.0758	1.0755	1.0749	1.0755	1.0751	1.0753
25	1.0765	1.0767	1.0765	1.0767	1.0765	1.0760	1.0757	1.0761	1.0759	1.0762
26	1.0768	1.0770	1.0768	1.0769	1.0769	1.0765	1.0761	1.0765	1.0763	1.0767
27	1.0770	1.0772	1.0770	1.0771	1.0770	1.0768	1.0763	1.0766	1.0764	1.0768
28	1.0771	1.0774	1.0771	1.0772	1.0771	1.0769	1.0765	1.0767	1.0766	1.0769
29	1.0772	1.0775	1.0772	1.0773	1.0772	1.0770	1.0766	1.0767	1.0767	1.0771
30	1.0773	1.0775	1.0773	1.0775	1.0773	1.0771	1.0767	1.0768	1.0768	1.0771
31	1.0773	1.0776	1.0774	1.0775	1.0774	1.0771	1.0767	1.0768	1.0768	1.0772
32	1.0774	1.0777	1.0775	1.0775	1.0774	1.0771	1.0768	1.0769	1.0769	1.0772
33	1.0774	1.0777	1.0775	1.0775	1.0775	1.0772	1.0769	1.0769	1.0769	1.0772
34	1.0775	1.0777	1.0775	1.0776	1.0775	1.0772	1.0769	1.0770	1.0770	1.0772
35	1.0775	1.0777	1.0776	1.0776	1.0776	1.0772	1.0769	1.0770	1.0770	1.0772
36	-	-	-	-	-	1.0772	1.0770	1.0770	1.0770	1.0773

Table 4. Temperature, conductivity, and density stratification (x 0.0001 g/cm3) at Station 6, 2000

Date	Temperature		Conductivity		Density Difference due to		
	2 m	28 m	2 m	28 m	Temperature	Conductivity	Both
2-24	3.25	5.04	78.31	86.80	-2.7	100.4	97.7
3-16	6.59	5.03	78.16	87.01	2.7	104.5	107.1
4-19	8.62	5.03	78.33	86.82	6.6	100.1	106.7
5-20	13.07	4.94	78.64	86.89	17.1	97.2	114.2
6-15	19.30	4.91	77.77	86.80	35.7	105.6	141.3
7-17	19.60	4.92	78.12	86.63	36.7	99.6	136.3
8-15	20.45	4.93	78.87	86.28	39.7	86.8	126.4
9-14	17.28	4.98	79.17	86.45	29.1	85.6	114.6
10-16	14.58	4.98	79.55	86.41	21.1	80.8	102.0
12-5	6.13	5.02	80.08	86.67	1.9	78.3	80.1

Table 5. Secchi Depths (m), 2000

Station	2-24	3-16	4-19	5-20	6-15	7-17	8-15	9-14	10-16	11-13	12-5
					Dates						
Western sector:											
1	1.50	1.60	1.50	4.75	7.80	9.00	6.50	7.80	2.50	1.20	1.39
2	1.30	1.65	1.20	5.10	8.00	8.80	6.69	7.59	3.09	1.14	1.50
3	1.30	1.70	1.10	4.40	7.25	7.90	6.50	5.50	2.50	1.39	1.39
4	1.40	1.70	1.30	5.60	8.00	7.69	6.09	5.50	2.75	1.29	1.39
5	1.50	1.70	1.00	5.10	6.75	8.19	6.40	5.30	2.79	1.64	1.29
6	1.40	1.60	1.00	4.90	7.50	8.00	6.75	5.40	2.90	1.20	1.20
13	1.30	1.60	1.10	-	-	-	-	-	-	-	-
14	1.40	1.50	1.10	-	-	-	-	-	-	-	-
21	1.30	-	1.20	-	-	-	-	-	-	-	-
Old#12	1.40	1.60	1.10	-	-	-	-	-	-	-	-
Avg.	1.38	1.63	1.16	4.97	7.55	8.26	6.49	6.18	2.76	1.31	1.36
S.E.	0.02	0.02	0.05	0.16	0.20	0.21	0.10	0.48	0.09	0.08	0.04
n	10.00	9.00	10.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Eastern sector:											
7	1.40	1.35	1.00	5.00	6.80	6.69	5.59	4.69	2.90	1.20	1.20
8	1.40	1.50	1.40	4.20	6.40	6.25	6.25	4.50	3.00	1.25	1.10
9	-	-	-	-	6.00	6.59	6.40	5.00	2.75	»1.00	1.20
10	1.30	1.50	1.30	5.25	6.30	7.00	6.40	4.69	3.09	»1.00	1.20
11	1.10	1.50	1.30	5.20	6.75	6.25	5.50	5.00	2.70	»1.00	1.10
12	1.10	1.70	-	5.50	7.20	7.00	5.59	4.09	2.59	1.14	1.10
15	1.10	1.40	1.10	-	-	-	-	-	-	-	-
16	1.30	1.65	1.20	-	-	-	-	-	-	-	-
17	1.30	1.40	1.30	-	-	-	-	-	-	-	-
19	1.50	1.50	1.30	-	-	-	-	-	-	-	-
20	1.40	1.40	1.20	4.20	-	-	-	-	-	-	-
Avg.	1.29	1.49	1.23	4.89	6.58	6.63	5.96	4.66	2.84	1.20	1.15
S.E.	0.05	0.04	0.04	0.23	0.17	0.14	0.18	0.14	0.08	0.03	0.02
n	10.00	10.00	9.00	6.00	6.00	6.00	6.00	6.00	6.00	3.00	6.00
Total Lakewide											
Avg.	1.33	1.56	1.19	4.93	7.06	7.45	6.22	5.42	2.80	1.27	1.26
S.E.	0.03	0.03	0.03	0.13	0.19	0.27	0.13	0.33	0.06	0.05	0.04
n	20.00	19.00	19.00	12.00	12.00	12.00	12.00	12.00	12.00	9.00	12.00

Table 6. Dissolved oxygen (mg/l) at Station 6, 2000

	Dates									
Depth (m)	3-16	4-19	5-20	6-15	7-17	8-15	9-14	10-16	11-13	12-5
0	6.4	8.0	4.5	4.4	5.5	4.9	5.1	6.7	5.1	6.3
1	6.5	7.7	4.6	4.5	5.4	4.9	5.1	6.8	5.2	6.4
2	6.7	7.9	4.5	4.4	5.4	4.9	5.1	6.8	5.2	6.4
3	7.2	7.7	4.6	4.6	5.4	4.8	-	6.7	5.3	6.0
4	7.3	7.5	4.7	4.7	5.3	4.9	5.1	6.7	5.2	5.7
5	7.3	7.4	4.8	4.8	5.3	4.8	-	6.8	5.1	5.5
6	7.2	7.2	5.0	4.9	5.3	4.9	5.2	6.8	5.0	5.5
7	7.2	7.2	5.1	5.0	5.4	4.9	-	6.9	4.9	5.4
8	7.1	6.9	5.2	5.0	5.4	4.9	5.3	6.8	4.7	5.3
9	7.0	6.9	5.3	5.1	5.4	4.8	-	6.6	4.7	5.3
10	6.2	6.4	5.6	5.2	5.4	4.8	5.2	6.1	4.6	5.3
11	5.8	6.4	5.2	5.3	5.5	4.6	-	4.9	4.6	5.4
12	5.1	4.7	5.1	5.2	5.6	4.5	4.5	3.7	4.6	5.3
13	5.0	4.2	4.7	5.0	5.6	4.4	-	2.9	4.7	5.3
14	4.3	3.1	4.5	3.7	5.5	3.5	3.2	2.9	4.7	5.3
15	4.2	2.3	4.4	2.8	4.0	2.3	-	2.9	4.9	5.2
16	3.8	2.2	4.1	1.6	2.0	1.6	2.3	2.1	5.1	5.1
17	3.8	1.9	3.4	0.9	1.3	1.4	-	0.4	5.2	5.1
18	3.3	1.3	3.0	-	0.3	0.4	1.4	0.4	5.2	5.1
19	3.2	1.0	2.6	-	0.3	0.4	-	0.3	5.2	5.2
20	2.9	0.8	1.9	-	0.3	0.4	-	0.3	5.2	5.3
21	2.6	0.6	1.3	-	0.3	0.4	-	0.3	4.6	5.1
22	1.6	-	1.0	-	0.3	-	-	0.3	3.2	5.0
23	0.5	-	-	-	0.3	-	-	0.3	0.3	4.9
24	-	-	-	-	0.3	-	-	0.3	0.3	0.4
25	-	-	-	-	0.3	-	-	0.3	0.3	0.4
26	-	-	-	-	-	-	-	0.3	0.3	0.3

Table 7. Ammonium at Station 6, 2000 (μM)

Depth (m)	2-24	3-16	4-19	5-20	6-15	7-17	8-15	9-14	10-16	11-13	12-5
					Dates						
1	-	-	-	-	-	-	-	-	-	-	-
2	0.6	0.9	0.5	2.0	2.6	1.1	-	0.1	0.2	0.6	0.4
3	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	0.4	1.0	0.6	0.4	1.0	1.2	0.0	0.1	0.2	0.5	0.4
9	-	-	-	-	-	-	-	-	-	-	-
10	0.4	1.0	1.6	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-
12	0.6	0.3	0.7	0.7	1.2	1.1	1.4	1.0	-	0.6	0.2
13	-	-	-	-	-	-	-	-	0.1	-	-
14	-	-	-	-	1.2	1.2	2.1	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-
16	0.8	1.3	1.4	0.5	4.3	2.5	2.5	2.6	0.3	0.5	0.3
17	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	29.0	23.4	0.9	-
20	0.3	0.8	7.3	12.6	24.4	24.5	101.4	31.0	35.1	0.8	0.4
21	-	-	-	-	-	-	-	57.9	60.5	0.7	-
22	2.3	2.0	31.7	-	70.9	99.0	-	-	-	-	-
23	-	-	-	166.8	-	-	-	-	-	-	-
24	330.6	448.5	418.6	-	432.2	473.7	665.7	456.2	400.9	596.1	384.8
25	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-
28	-	536.7	512.7	-	-	605.0	733.9	641.3	-	538.0	683.2
29	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	540.2	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-
35	445.7	559.6	552.9	549.8	610.4	740.6	730.3	-	803.7	828.6	807.9

Table 8. Chlorophyll a (µg/l) at Station 6, 2000.

	Dates										
Depth (m)	2-24	3-16	4-19	5-20	6-15	7-17	8-15	9-14	10-16	11-13	12-5
1	-	-	-	-	-	-	-	-	-	-	-
2	16.5	7.9	18.7	1.5	1.4	2.0	1.9	3.4	11.5	51.1	54.2
3	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	18.0	13.3	20.9	7.3	2.8	1.6	2.2	7.3	6.7	41.9	53.1
9	-	-	-	-	-	-	-	-	-	-	-
10	18.3	15.6	28.9	9.7	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-
12	18.1	21.3	34.3	15.9	2.1	2.6	2.0	9.2	-	42.2	55.2
13	-	-	-	-	-	-	-	-	5.3	-	-
14	-	-	-	31.0	4.1	2.1	0.7	-	-	-	-
15	-	-	-	42.2	-	-	-	-	-	-	-
16	18.4	24.0	34.2	49.0	2.5	2.2	1.2	15.3	6.7	42.4	47.6
17	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	50.7	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	43.2	28.8	33.6	-
20	22.3	21.4	32.0	35.0	31.4	42.3	33.0	63.2	32.6	38.2	51.8
21	-	-	-	-	-	-	-	45.5	34.8	40.6	-
22	23.5	20.4	26.5	-	24.0	27.1	35.3	-	-	-	-
23	-	-	-	33.5	-	-	-	-	-	-	-
24	32.1	40.5	43.9	-	34.9	31.5	26.4	31.7	30.3	35.3	59.0
25	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-
28	28.5	31.4	32.0	-	39.8	36.3	27.7	30.1	25.3	31.7	33.1
29	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	39.8	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	35.6	-	-	-	-	-	-	-

Table 9a. Artemia lake and sector means, 2000.

	Instars 1-7	8-11	adult male	adult fem ?	adult fem e	adult fem c	adult fem n	adult fem tot	adult total	total
Lakewide Mean:										
2/24	12,856	0	0	0	0	0	0	0	0	12,856
3/16	14,085	0	0	0	0	0	0	0	0	14,085
4/19	23,245	0	0	0	0	0	0	0	0	23,245
5/20	24,749	5,017	3,166	523	724	469	0	1,717	4,883	34,648
6/15	93,119	4,789	9,403	691	1,583	3,789	198	6,261	15,664	113,571
7/17	9,512	1,360	15,381	654	679	5,590	80	7,004	22,384	33,256
8/15	2,916	213	13,679	30	612	4,566	54	5,262	18,940	22,069
9/14	2,559	168	7,471	178	215	1,268	0	1,660	9,131	11,858
10/16	2,056	397	4,474	45	97	285	0	428	4,901	7,354
11/13	340	83	76	2	38	0	0	40	116	539
12/5	513	67	44	0	17	0	0	17	60	641
Western Sector Mean:										
2/24	6,356	0	0	0	0	0	0	0	0	6,356
3/16	8,784	0	0	0	0	0	0	0	0	8,784
4/19	12,113	0	0	0	0	0	0	0	0	12,113
5/20	28,008	4,829	2,978	483	644	456	0	1,583	4,561	37,398
6/15	90,195	6,412	11,858	684	2,066	4,252	268	7,270	19,128	115,734
7/17	8,478	2,240	24,655	919	1,019	7,203	107	9,249	33,903	44,621
8/15	2,871	67	21,247	40	671	5,701	107	6,519	27,767	30,704
9/14	3,541	228	10,838	121	322	1,878	0	2,321	13,159	16,928
10/16	2,723	506	6,787	80	121	533	0	734	7,522	10,751
11/13	262	57	77	0	34	0	0	34	111	429
12/5	332	10	34	0	27	0	0	27	60	402
Eastern Sector Mean:										
2/24	19,356	0	0	0	0	0	0	0	0	19,356
3/16	18,855	0	0	0	0	0	0	0	0	18,855
4/19	36,604	0	0	0	0	0	0	0	0	36,604
5/20	21,489	5,205	3,353	563	805	483	0	1,851	5,205	31,898
6/15	96,043	3,166	6,948	698	1,100	3,327	127	5,252	12,200	111,408
7/17	10,547	480	6,107	389	339	3,977	54	4,759	10,865	21,891
8/15	2,961	359	6,110	20	553	3,431	0	4,004	10,114	13,434
9/14	1,576	107	4,105	235	107	657	0	999	5,104	6,787
10/16	1,388	288	2,160	10	74	37	0	121	2,280	3,957
11/13	496	134	74	7	47	0	0	54	127	758
12/5	694	124	54	0	7	0	0	7	60	879

(?): undifferentiated egg mass (e): empty ovisac
(c): cysts (n): nauplii (na): missing data

Table 9b. Standard errors of Artemia sector means (Table 9a), 2000.

	Instars		adult	adult	adult	adult	adult	adult	adult	
	1-7	8-11	male	fem ?	fem e	fem c	fem n	fem tot	total	total
SE of Lakewide Mean:										
2/24	2,455	0	0	0	0	0	0	0	0	2,455
3/16	3,450	0	0	0	0	0	0	0	0	3,450
4/19	5,895	0	0	0	0	0	0	0	0	5,895
5/20	2,367	606	345	139	111	111	0	194	398	2,533
6/15	9,889	820	1,183	158	290	447	27	781	1,915	10,375
7/17	1,499	462	3,626	246	197	1,300	20	1,570	4,833	5,515
8/15	697	79	3,499	15	124	1,029	54	1,134	4,505	4,832
9/14	788	47	1,638	53	61	380	0	437	1,948	2,016
10/16	482	108	1,360	17	34	136	0	167	1,478	1,997
11/13	56	20	21	2	8	0	0	8	19	80
12/5	213	35	6	0	8	0	0	8	10	247
SE of Western Sector Mean:										
2/24	1,194	0	0	0	0	0	0	0	0	1,194
3/16	1,509	0	0	0	0	0	0	0	0	1,509
4/19	5,252	0	0	0	0	0	0	0	0	5,252
5/20	3,973	929	530	186	150	140	0	121	597	4,464
6/15	12,403	1,310	1,567	288	471	659	34	1,216	2,770	12,804
7/17	1,341	787	4,707	469	334	2,343	34	2,758	6,697	7,627
8/15	1,014	38	5,470	27	172	1,958	107	2,147	7,440	8,211
9/14	1,272	84	2,483	40	102	664	0	761	2,973	2,551
10/16	900	199	2,298	27	66	237	0	289	2,479	3,507
11/13	53	23	33	0	11	0	0	11	29	84
12/5	245	7	4	0	15	0	0	15	18	264
SE of Eastern Sector Mean:										
2/24	3,824	0	0	0	0	0	0	0	0	3,824
3/16	6,169	0	0	0	0	0	0	0	0	6,169
4/19	8,244	0	0	0	0	0	0	0	0	8,244
5/20	2,147	858	476	223	171	186	0	380	546	2,298
6/15	16,525	435	1,136	163	234	599	7	893	1,915	17,543
7/17	2,767	94	1,140	133	113	951	17	1,105	2,198	4,897
8/15	1,053	132	1,023	14	192	555	0	647	1,666	2,341
9/14	854	32	1,053	98	38	212	0	293	1,168	1,046
10/16	185	81	845	7	26	18	0	41	847	792
11/13	70	13	13	7	7	0	0	7	7	71
12/5	355	63	10	0	4	0	0	4	12	421

(?): undifferentiated egg mass (e): empty ovisac
(c): cysts (n): nauplii (na): missing data

Table 9c. Percentage in different classes for Artemia sector means (Table 9a), 2000.

	Instars 1-7	Instars 8-11	adult male	adult fem ?	adult fem e	adult fem c	adult fem n	adult fem tot	adult total	total
Lakewide (%):										
2/24	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
3/16	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
4/19	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
5/20	71.4	14.5	9.1	30.5	42.2	27.3	0.0	5.0	14.1	100.0
6/15	82.0	4.2	8.3	11.0	25.3	60.5	3.2	5.5	13.8	100.0
7/17	28.6	4.1	46.3	9.3	9.7	79.8	1.1	21.1	67.3	100.0
8/15	13.2	1.0	62.0	0.6	11.6	86.8	1.0	23.8	85.8	100.0
9/14	21.6	1.4	63.0	10.7	13.0	76.4	0.0	14.0	77.0	100.0
10/16	28.0	5.4	60.8	10.5	22.7	66.6	0.0	5.8	66.6	100.0
11/13	63.1	15.4	14.1	5.0	95.0	0.0	0.0	7.4	21.5	100.0
12/5	80.0	10.5	6.9	0.0	100.0	0.0	0.0	2.7	9.4	100.0
Western Sector (%):										
2/24	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
3/16	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
4/19	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
5/20	74.9	12.9	8.0	30.5	40.7	28.8	0.0	4.2	12.2	100.0
6/15	77.9	5.5	10.2	9.4	28.4	58.5	3.7	6.3	16.5	100.0
7/17	19.0	5.0	55.3	9.9	11.0	77.9	1.2	20.7	76.0	100.0
8/15	9.4	0.2	69.2	0.6	10.3	87.5	1.6	21.2	90.4	100.0
9/14	20.9	1.3	64.0	5.2	13.9	80.9	0.0	13.7	77.7	100.0
10/16	25.3	4.7	63.1	10.9	16.5	72.6	0.0	6.8	70.0	100.0
11/13	61.1	13.3	17.9	0.0	100.0	0.0	0.0	7.9	25.9	100.0
12/5	82.6	2.5	8.5	0.0	100.0	0.0	0.0	6.7	14.9	100.0
Eastern Sector (%):										
2/24	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
3/16	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
4/19	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
5/20	67.4	16.3	10.5	30.4	43.5	26.1	0.0	5.8	16.3	100.0
6/15	86.2	2.8	6.2	13.3	20.9	63.3	2.4	4.7	11.0	100.0
7/17	48.2	2.2	27.9	8.2	7.1	83.6	1.1	21.7	49.6	100.0
8/15	22.0	2.7	45.5	0.5	13.8	85.7	0.0	29.8	75.3	100.0
9/14	23.2	1.6	60.5	23.5	10.7	65.8	0.0	14.7	75.2	100.0
10/16	35.1	7.3	54.6	8.3	61.2	30.6	0.0	3.1	57.6	100.0
11/13	65.4	17.7	9.8	13.0	87.0	0.0	0.0	7.1	16.8	100.0
12/5	79.0	14.1	6.1	0.0	100.0	0.0	0.0	0.8	6.8	100.0

(?): undifferentiated egg mass (e): empty ovisac
(c): cysts (n): nauplii (na): missing data
The fem-?,e,c,n percentages are of the total females.

Table 10. Lakewide Artemia instar analysis, 2000.

	Instars 1	2	3	4	5	6	7	8-11	adults	total
Mean:										
2/24	11,730	178	0	0	0	0	0	0	0	11,905
3/16	20,285	416	0	0	0	0	0	0	0	20,701
4/19	5,869	8,763	9,229	2,713	879	225	57	0	0	27,733
5/20	7,700	4,668	4,883	2,736	2,495	1,261	671	4,078	4,346	32,837
6/15	63,237	14,993	690	483	299	184	92	5,507	17,085	102,570
7/17	3,624	2,972	417	92	60	0	0	1,595	23,736	32,498
8/15	483	1,374	911	368	207	98	29	89	21,949	25,508
9/14	310	471	897	1,029	379	144	75	75	10,170	13,550
10/16	256	353	296	310	144	238	132	221	4,214	6,166
11/13	80	30	20	57	33	74	87	74	111	567
12/5	129	121	57	23	43	72	57	32	57	592
Standard error of mean:										
2/24	3,718	73	0	0	0	0	0	0	0	3,777
3/16	9,896	258	0	0	0	0	0	0	0	10,025
4/19	2,342	3,036	2,797	956	500	126	53	0	0	9,065
5/20	1,071	486	514	614	562	416	254	736	729	3,517
6/15	10,575	2,507	537	79	102	96	59	1,305	2,916	14,294
7/17	834	633	111	45	28	0	0	759	7,835	8,869
8/15	95	402	373	104	93	50	23	26	7,571	8,156
9/14	133	183	405	556	143	71	56	26	2,971	2,839
10/16	62	71	83	72	32	66	16	48	1,020	1,118
11/13	28	13	14	24	4	16	16	26	27	98
12/5	68	76	36	15	15	40	32	16	18	285
Percentage in different age classes:										
2/24	98.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
3/16	98.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
4/19	21.2	31.6	33.3	9.8	3.2	0.8	0.2	0.0	0.0	100.0
5/20	23.4	14.2	14.9	8.3	7.6	3.8	2.0	12.4	13.2	100.0
6/15	61.7	14.6	0.7	0.5	0.3	0.2	0.1	5.4	16.7	100.0
7/17	11.2	9.1	1.3	0.3	0.2	0.0	0.0	4.9	73.0	100.0
8/15	1.9	5.4	3.6	1.4	0.8	0.4	0.1	0.3	86.0	100.0
9/14	2.3	3.5	6.6	7.6	2.8	1.1	0.6	0.6	75.1	100.0
10/16	4.2	5.7	4.8	5.0	2.3	3.9	2.1	3.6	68.3	100.0
11/13	14.1	5.3	3.5	10.1	5.8	13.1	15.3	13.1	19.6	100.0
12/5	21.8	20.4	9.6	3.9	7.3	12.2	9.6	5.4	9.6	100.0

Table 11a. Artemia reproductive summary, lake and sector means, 2000.

	Adult Females					
	Total	Ovig	e	?	c	n
Lakewide Mean:						
2/24	0	0	0	0	0	0
3/16	0	0	0	0	0	0
4/19	0	0	0	0	0	0
5/20	1,717	993	724	523	469	0
6/15	6,261	4,678	1,583	691	3,789	198
7/17	7,004	6,325	679	654	5,590	80
8/15	5,262	4,650	612	30	4,566	54
9/14	1,660	1,445	215	178	1,268	0
10/16	428	330	97	45	285	0
11/13	40	2	38	2	0	0
12/5	17	0	17	0	0	0
Western Sector Mean:						
2/24	0	0	0	0	0	0
3/16	0	0	0	0	0	0
4/19	0	0	0	0	0	0
5/20	1,583	939	644	483	456	0
6/15	7,270	5,205	2,066	684	4,252	268
7/17	9,249	8,229	1,019	919	7,203	107
8/15	6,519	5,848	671	40	5,701	107
9/14	2,321	1,999	322	121	1,878	0
10/16	734	614	121	80	533	0
11/13	34	0	34	0	0	0
12/5	27	0	27	0	0	0
Eastern Sector Mean:						
2/24	0	0	0	0	0	0
3/16	0	0	0	0	0	0
4/19	0	0	0	0	0	0
5/20	1,851	1,046	805	563	483	0
6/15	5,252	4,152	1,100	698	3,327	127
7/17	4,759	4,420	339	389	3,977	54
8/15	4,004	3,451	553	20	3,431	0
9/14	999	892	107	235	657	0
10/16	121	47	74	10	37	0
11/13	54	7	47	7	0	0
12/5	7	0	7	0	0	0

(?): undifferentiated egg mass (e): empty ovisac
(c): cysts (n): nauplii (na): missing data

Table 11b. Standard errors of Artemia reproductive summary (Table 11a), 2000.

	Total	Ovigery	Adult Females e	?	c	n
Standard Error of Lakewide Mean:						
2/24	0	0	0	0	0	0
3/16	0	0	0	0	0	0
4/19	0	0	0	0	0	0
5/20	194	149	111	139	111	0
6/15	781	513	290	158	447	27
7/17	1,570	1,399	197	246	1,300	20
8/15	1,134	1,079	124	15	1,029	54
9/14	437	383	61	53	380	0
10/16	167	152	34	17	136	0
11/13	8	2	8	2	0	0
12/5	8	0	8	0	0	0
Standard Error of Western Sector Mean:						
2/24	0	0	0	0	0	0
3/16	0	0	0	0	0	0
4/19	0	0	0	0	0	0
5/20	121	134	150	186	140	0
6/15	1,216	759	471	288	659	34
7/17	2,758	2,476	334	469	2,343	34
8/15	2,147	2,058	172	27	1,958	107
9/14	761	672	102	40	664	0
10/16	289	263	66	27	237	0
11/13	11	0	11	0	0	0
12/5	15	0	15	0	0	0
Standard Error of Eastern Sector Mean:						
2/24	0	0	0	0	0	0
3/16	0	0	0	0	0	0
4/19	0	0	0	0	0	0
5/20	380	281	171	223	186	0
6/15	893	688	234	163	599	7
7/17	1,105	1,012	113	133	951	17
8/15	647	562	192	14	555	0
9/14	293	268	38	98	212	0
10/16	41	20	26	7	18	0
11/13	7	7	7	7	0	0
12/5	4	0	4	0	0	0

(?): undifferentiated egg mass (e): empty ovisac
(c): cysts (n): nauplii (na): missing data

Table 11c. Artemia percentages in different reproductive categories (Table 11a), 2000.

	Total	Ovigery	Adult e	Females ?	c	n
Lakewide Mean (%):						
2/24	0.0	0.0	0.0	0.0	0.0	0.0
3/16	0.0	0.0	0.0	0.0	0.0	0.0
4/19	0.0	0.0	0.0	0.0	0.0	0.0
5/20	100.0	57.8	42.2	52.7	100.0	0.0
6/15	100.0	74.7	25.3	14.8	95.0	5.0
7/17	100.0	90.3	9.7	10.3	98.6	1.4
8/15	100.0	88.4	11.6	0.6	98.8	1.2
9/14	100.0	87.0	13.0	12.3	100.0	0.0
10/16	100.0	77.1	22.7	13.6	100.0	0.0
11/13	100.0	5.0	95.0	100.0	0.0	0.0
12/5	100.0	0.0	100.0	0.0	0.0	0.0
Western Sector Mean (%):						
2/24	0.0	0.0	0.0	0.0	0.0	0.0
3/16	0.0	0.0	0.0	0.0	0.0	0.0
4/19	0.0	0.0	0.0	0.0	0.0	0.0
5/20	100.0	59.3	40.7	51.4	100.0	0.0
6/15	100.0	71.6	28.4	13.1	94.1	5.9
7/17	100.0	89.0	11.0	11.2	98.5	1.5
8/15	100.0	89.7	10.3	0.7	98.2	1.8
9/14	100.0	86.1	13.9	6.1	100.0	0.0
10/16	100.0	83.7	16.5	13.0	100.0	0.0
11/13	100.0	0.0	100.0	0.0	0.0	0.0
12/5	100.0	0.0	100.0	0.0	0.0	0.0
Eastern Sector Mean (%):						
2/24	0.0	0.0	0.0	0.0	0.0	0.0
3/16	0.0	0.0	0.0	0.0	0.0	0.0
4/19	0.0	0.0	0.0	0.0	0.0	0.0
5/20	100.0	56.5	43.5	53.8	100.0	0.0
6/15	100.0	79.1	20.9	16.8	96.3	3.7
7/17	100.0	92.9	7.1	8.8	98.7	1.3
8/15	100.0	86.2	13.8	0.6	100.0	0.0
9/14	100.0	89.3	10.7	26.3	100.0	0.0
10/16	100.0	38.8	61.2	21.3	100.0	0.0
11/13	100.0	13.0	87.0	100.0	0.0	0.0
12/5	100.0	0.0	100.0	0.0	0.0	0.0

(?): undifferentiated egg mass (e): empty ovisac
(c): cysts (n): nauplii (na): missing data
Total, ovigery, and e given as percentages of total number of females.
? given as percentage is of ovigerous females.
Cyst and naup given as percentages of individuals with differentiated egg masses.

Table 12. Artemia fecundity summary, 2000.

	#eggs/brood mean	SE	%cyst	%indented	female length mean	SE	n
Lakewide Mean:							
5/20	109.5	6.8	100.0	34.0	11.2	0.1	7
6/15	68.1	2.7	100.0	1.0	10.5	0.1	12
7/17	60.0	1.8	100.0	43.0	10.9	0.1	12
8/15	39.8	2.8	100.0	59.0	10.6	0.2	7
9/14	81.8	5.9	100.0	80.0	11.6	0.1	7
10/16	96.0	10.3	97.0	55.0	11.2	0.6	6
Western Sector Mean:							
5/20	104.1	16.2	100.0	7.0	11.0	0.2	3
6/15	68.6	2.6	100.0	0.0	10.5	0.2	6
7/17	59.4	2.1	100.0	24.0	10.8	0.1	6
8/15	39.1	4.8	100.0	45.0	10.5	0.1	4
9/14	80.3	6.6	100.0	75.0	11.5	0.1	4
10/16	106.4	5.9	95.0	57.0	11.8	0.5	4
Eastern Sector Mean:							
5/20	113.5	4.5	100.0	55.0	11.3	0.2	4
6/15	67.6	5.1	100.0	2.0	10.6	0.2	6
7/17	60.7	3.2	100.0	62.0	11.1	0.1	6
8/15	40.7	2.8	100.0	77.0	10.8	0.3	3
9/14	83.8	12.4	100.0	86.0	11.6	0.2	3
10/16	75.2	27.2	100.0	50.0	9.9	0.9	2

n in the last column refers to number of stations averaged together.
Ten females were collected and measured from each station.

Table 13. Summary Statistics of Adult *Artemia* Abundance from 1 May through 30 November, 1979–2000.

Year	Mean	Median	Peak	Centroid*
1979	14118	12286	31700	216
1980	14643	10202	40420	236
1981	32010	21103	101670	238
1982	36643	31457	105245	252
1983	17812	16314	39917	247
1984	17001	19261	40204	212
1985	18514	20231	33089	218
1986	14667	17305	32977	190
1987	23952	22621	54278	226
1988	27639	25505	71630	207
1989	36359	28962	92491	249
1990	20005	16775	34930	230
1991	18129	19319	34565	226
1992	19019	19595	34648	215
1993	15025	16684	26906	217
1994	16602	18816	29408	212
1995	15584	17215	24402	210
1996	17734	17842	34616	216
1997	14389	16372	27312	204
1998	19429	21235	33968	226
1999	20221	21547	38439	225
2000	10550	9080	22384	210

*Centroid calculated as the abundance-weighted mean day of occurrence.

FIGURE CAPTIONS

Fig. 1. UCSB sampling stations at Mono Lake. Solid circles represent permanently moored buoys. Open circles represent old intermediate stations.

Fig. 2. Wind speed; daily mean and 10-min. maximum, 2000.

Fig. 3. Daily air temperature; mean, maximum, and minimum, 2000.

Fig. 4. Daily photosynthetically available radiation, 2000.

Fig. 5. Mean daily relative humidity, 2000.

Fig. 6. Daily precipitation, 2000.

Fig. 7. Mono Lake surface elevation (ft asl), 1979–00, USGS datum.

Fig. 8. Temperature (°C) at station 6, 2000.

Fig. 9. Conductivity (mS cm^{-1} corrected to 25°C) at station 6, 2000.

Fig. 10. Density (kg m^{-3}) at station 6, 2000.

Fig. 11. Density difference (10^{-4} g cm^{-3}) between 2 and 28 m at station 6 due to temperature and chemical stratification from 1983 through 2000.

Fig. 12. Winter salinity stratification, 1994–00.

Fig. 13. Mean lakewide Secchi depth (m), 1994–00. Error bars show standard errors of the lakewide estimate based on 12-20 stations.

Fig. 14. Mean lakewide Secchi depth ($\log_{10}$ m) 1979–00.

Fig. 15. Light attenuation (% of surface) at station 6, 2000. Dots denote the dates and depths of samples.

Fig. 16. Dissolved oxygen concentration (mg O_2 l^{-1}) at station 6, 2000.

Fig. 17. Ammonium concentration (µM) at station S630, 2000. Dots denote the dates and depths of samples.

Fig. 18. Concentration of chlorophyll *a* (µg chl *a* l^{-1}) at station 6, 2000. Dots denote the dates and depths of samples.

Fig. 19. Linear regression of fluorescence versus chlorophyll a. All samples are same-day comparisons, but include samples without discrete time and depth sample profiling.

Fig. 20. Seasonal fluorescence profiles at station 6, 2000.

Fig. 21. In situ profiles on 17 July 2000 at station 6. Plot includes temperature (°C), conductivity (mS cm^{-1}), density, fluorescence, and % irradiance (PAR) collected in situ with the Seabird profiler, dissolved oxygen (D.O.) (mg l^{-1}), collected in situ with the YSI D.O. meter, and ammonium (μM) and chlorophyll a (μg l^{-1}), from laboratory analyses of water samples.

Fig. 22. Lakewide *Artemia* abundance during 2000: nauplii (instars 1-7), juveniles (instars 8-11), and adults (instars 12+).

Fig. 23. Reproductive characteristics of *Artemia* during 2000: lakewide mean abundance of total females and ovigerous females (top), percent of females ovoviviparous and ovigerous (middle), and brood size (bottom). Vertical lines are the standard error of the estimate.

Fig. 24. Lakewide estimates of adult *Artemia* based on 3-20 stations, 1982–00 (see Methods). The mean relative error of the lakewide estimates is 20-25%.

Fig. 25. Summary statistics of the seasonal (1 May through 30 November) lakewide abundance of adult *Artemia*, 1979–00. Values are based on interpolated daily abundances.

Fig. 26. Temporal center of abundance-weighted centroid of the seasonal (1 May through 30 November) distribution of adult *Artemia*, 1979–00. Centroid is based on interpolated daily abundances of adult *Artemia*.

Fig. 27. Annual phytoplankton production estimates (g C m^{-2}), 1982–00.

Fig. 28. Mean annual *Artemia* biomass, 1983–00. Data for the period 1982–99 estimated from instar-specific population data and previously derived weight-length relationships. In 2000 an explicit tow was collected and the entire tow dried and weighed.

Fig. 29. Annual Artemia reproduction, ovoviviparous (live-bearing) and oviparous (cyst-bearing), 1983–00.

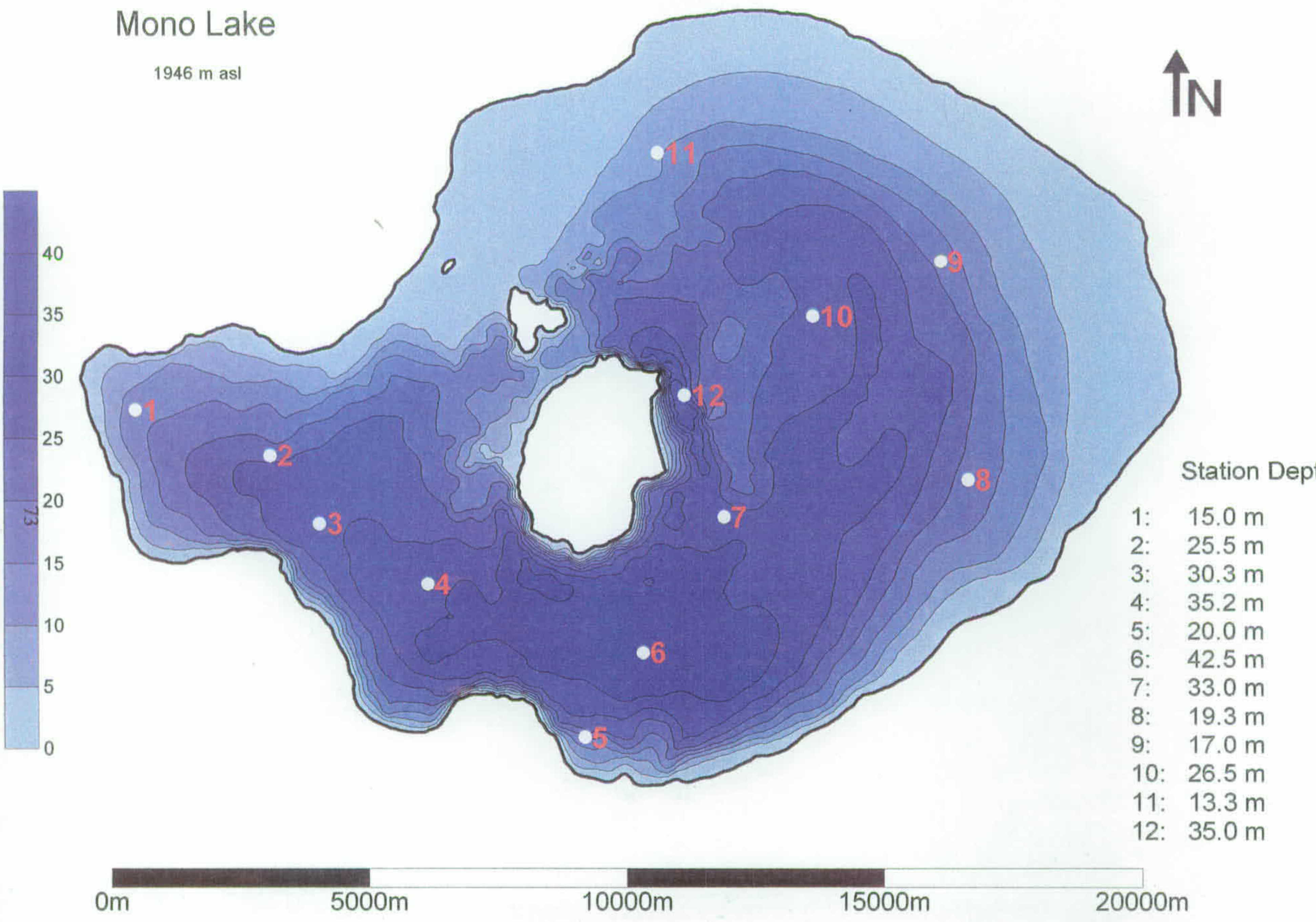

Mono Lake
1946 m asl
N
40
35
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
Station Depths
1: 15.0 m
2: 25.5 m
3: 30.3 m
4: 35.2 m
5: 20.0 m
6: 42.5 m
7: 33.0 m
8: 19.3 m
9: 17.0 m
10: 26.5 m
11: 13.3 m
12: 35.0 m
0m
5000m
10000m
15000m
20000m

Figure 1

2000 Wind Speed

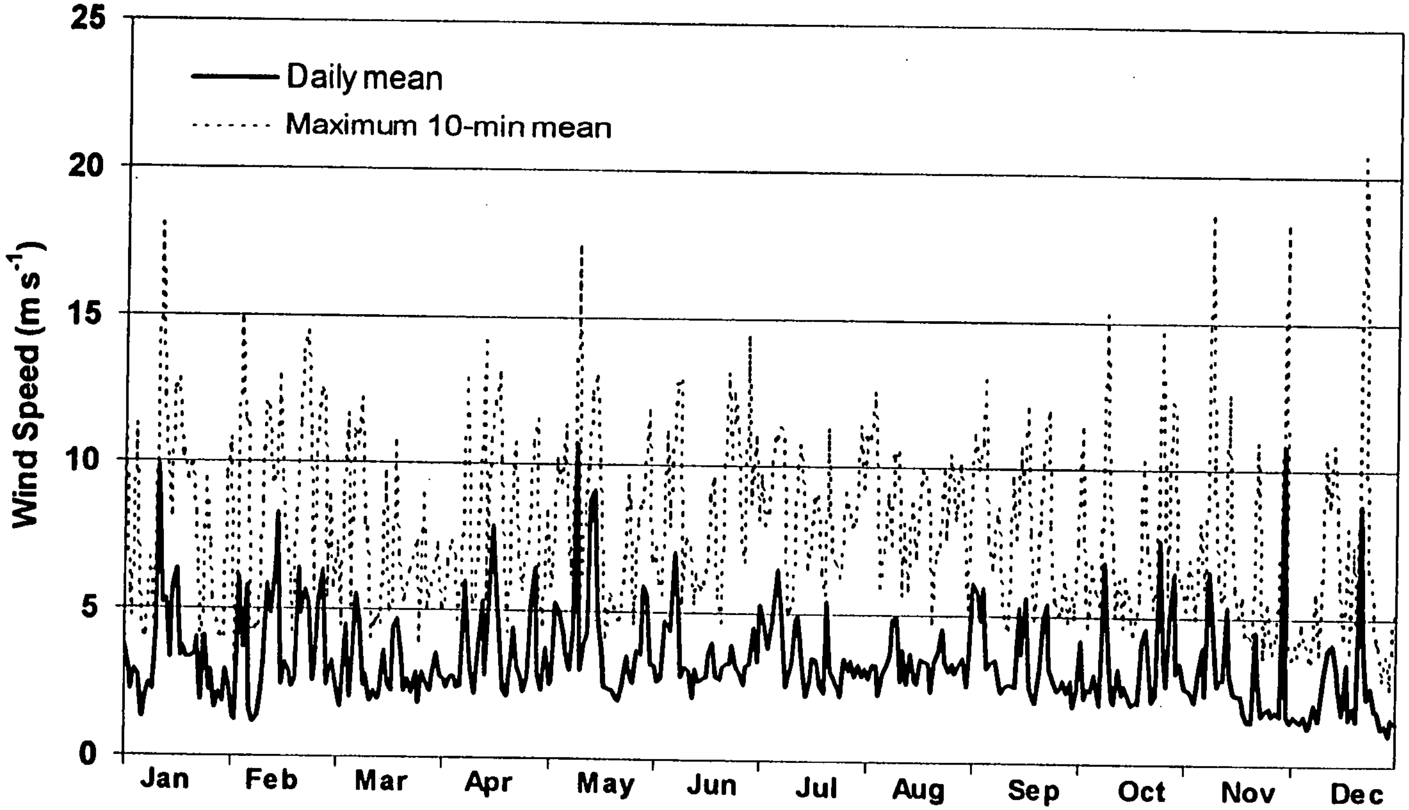


Figure 2

2000 Daily Air Temperature

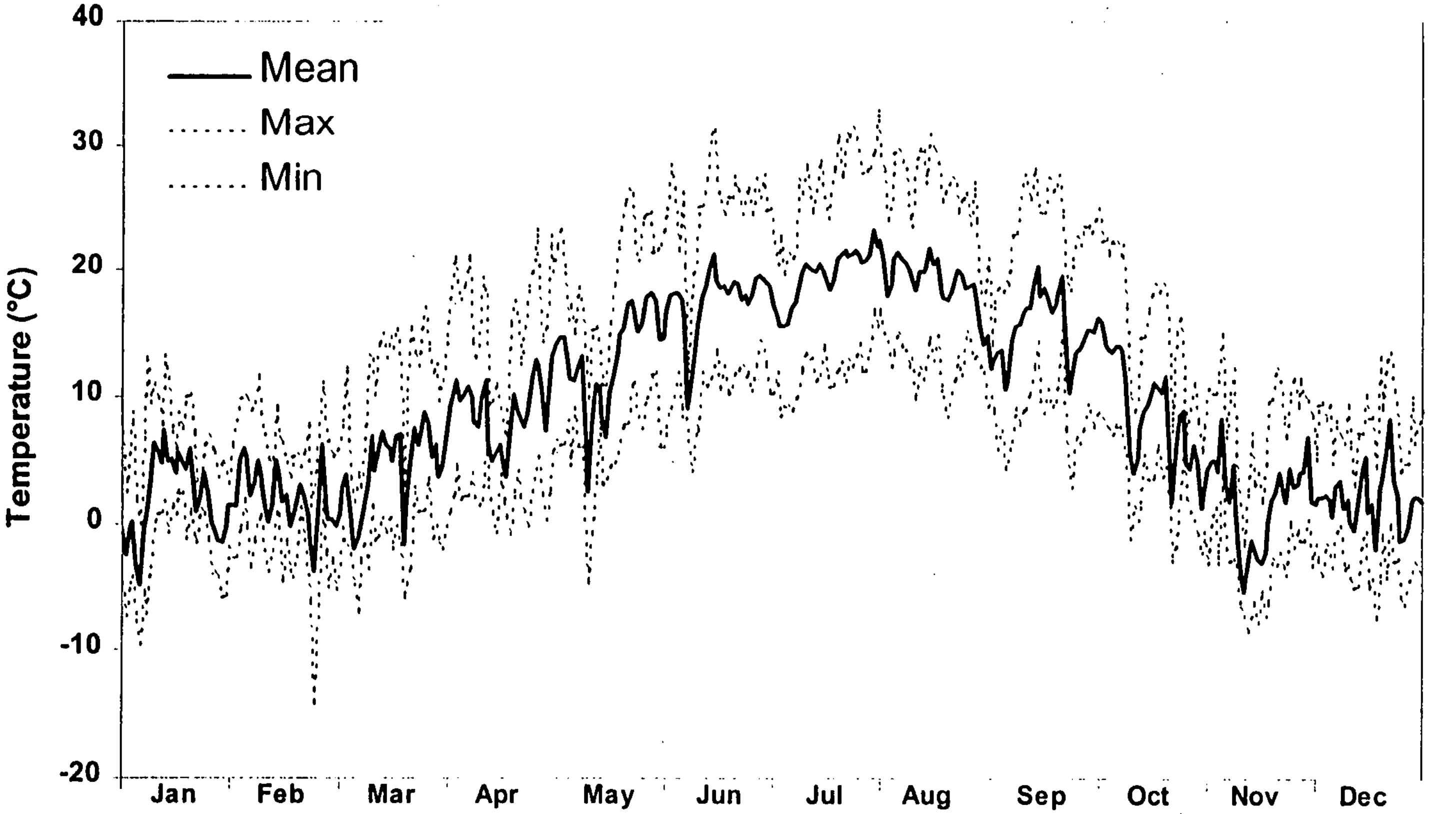


Figure 3

2000 Photosynthetically Available Radiation

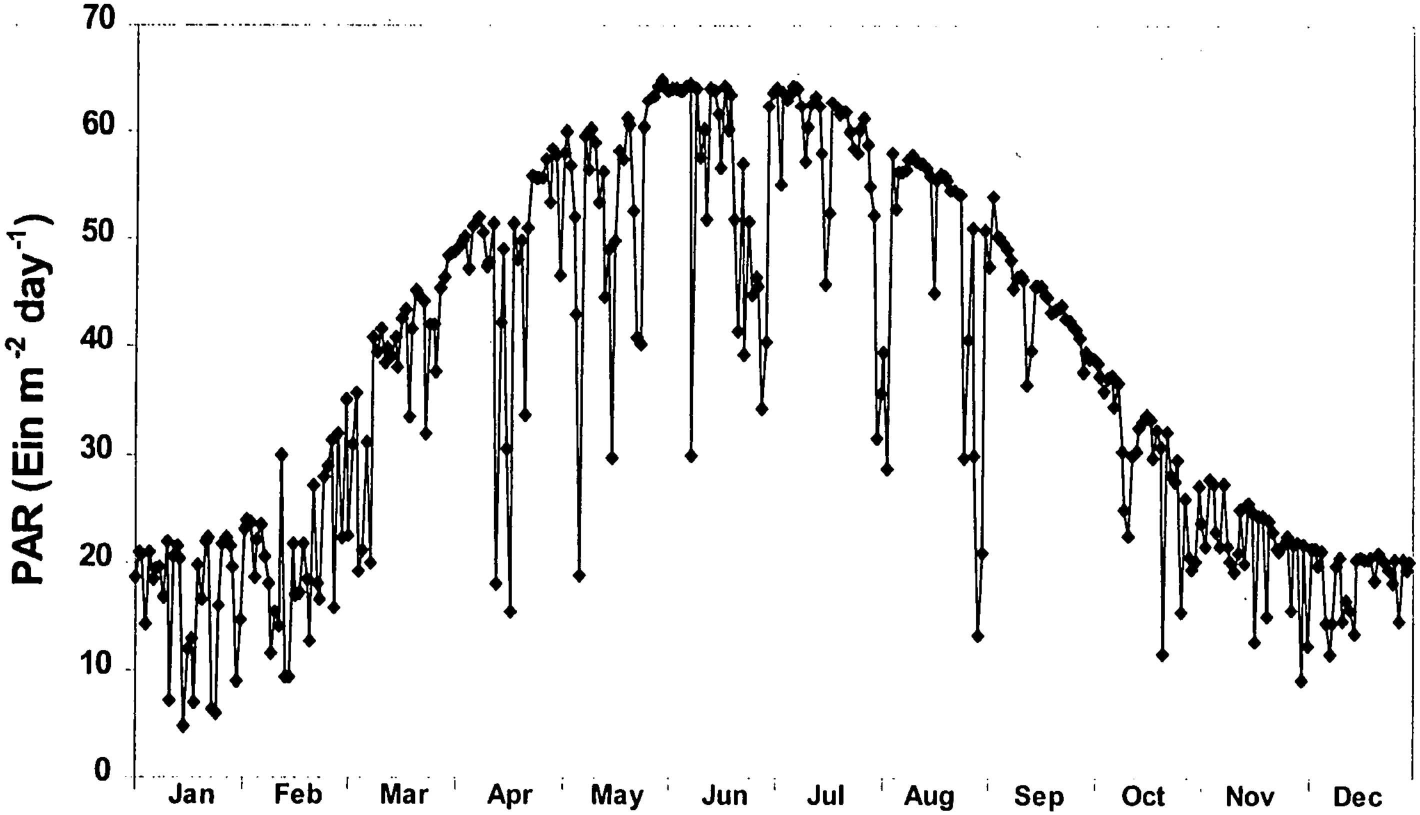


Figure 4

2000 Mean Daily Relative Humidity

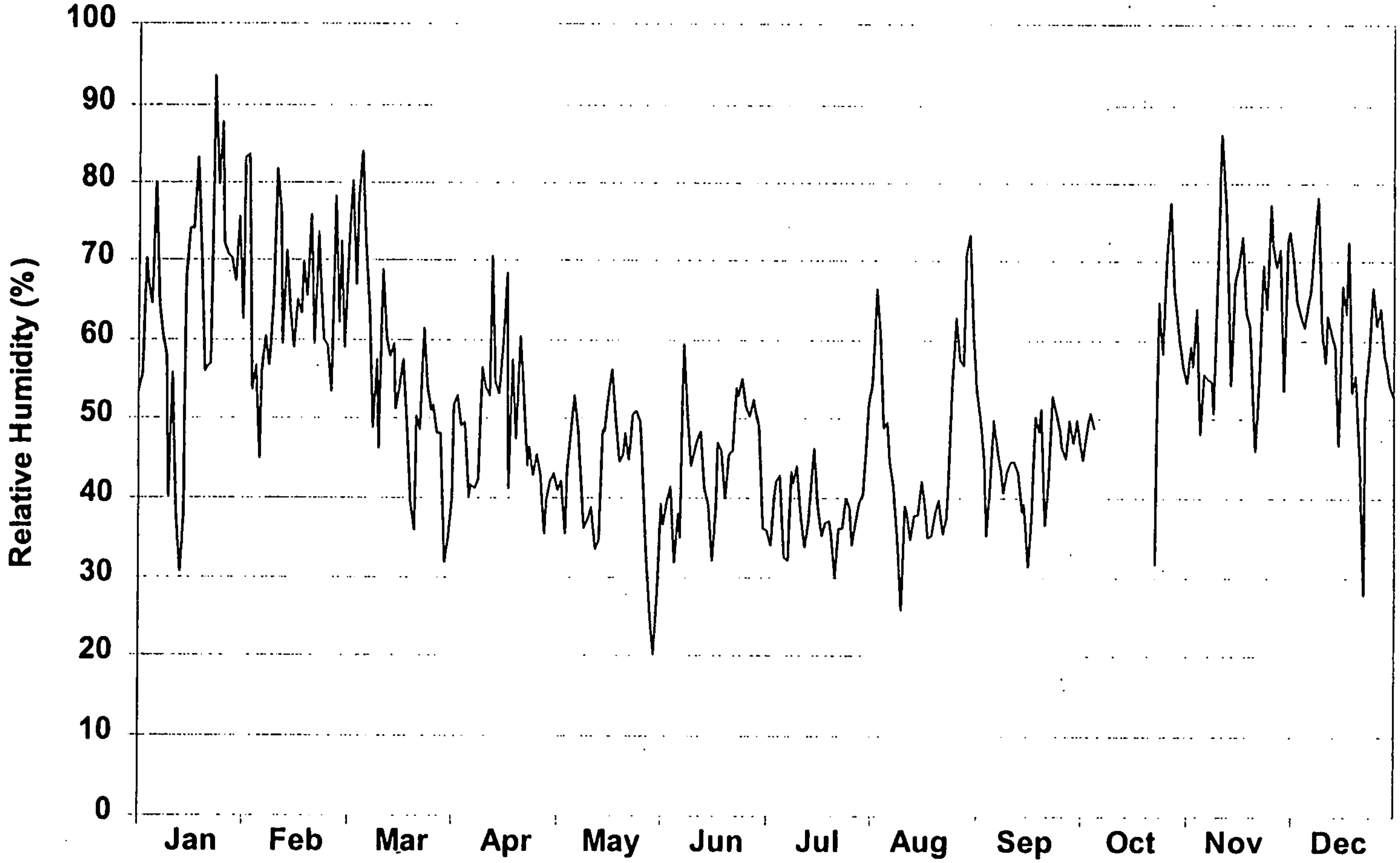


Figure 5

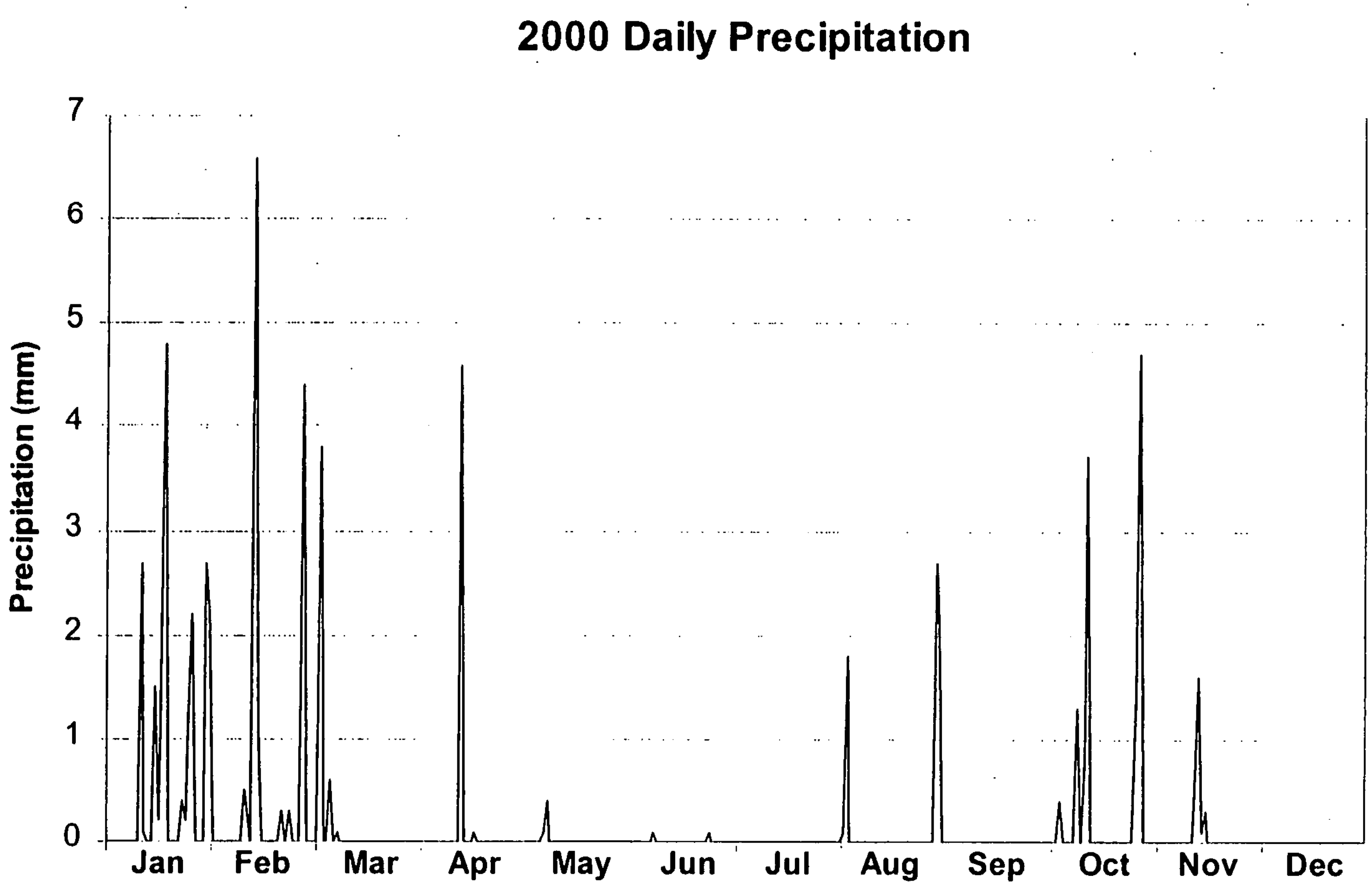

2000 Daily Precipitation
Precipitation (mm)
0
1
2
3
4
5
6
7
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Figure 6

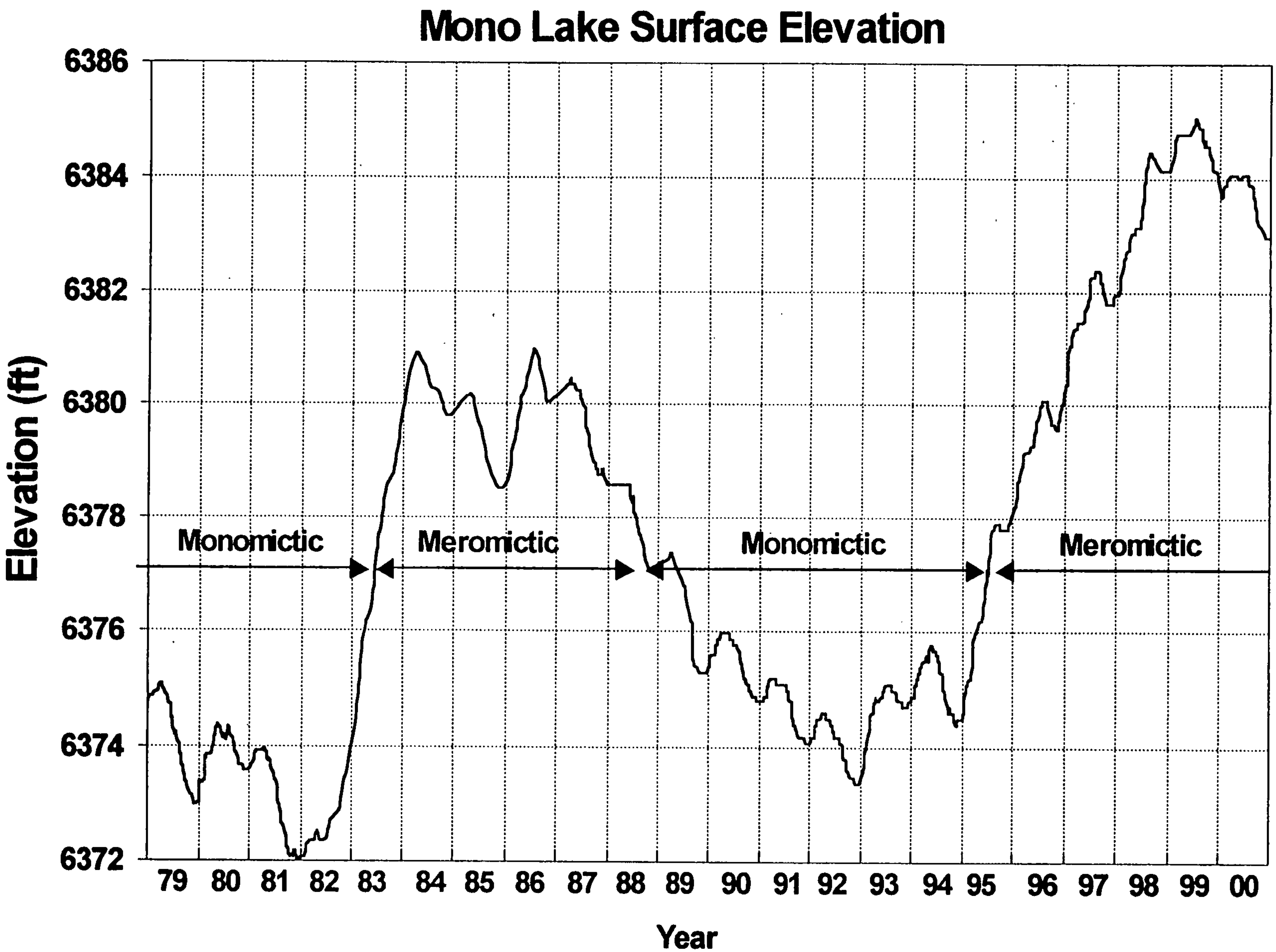
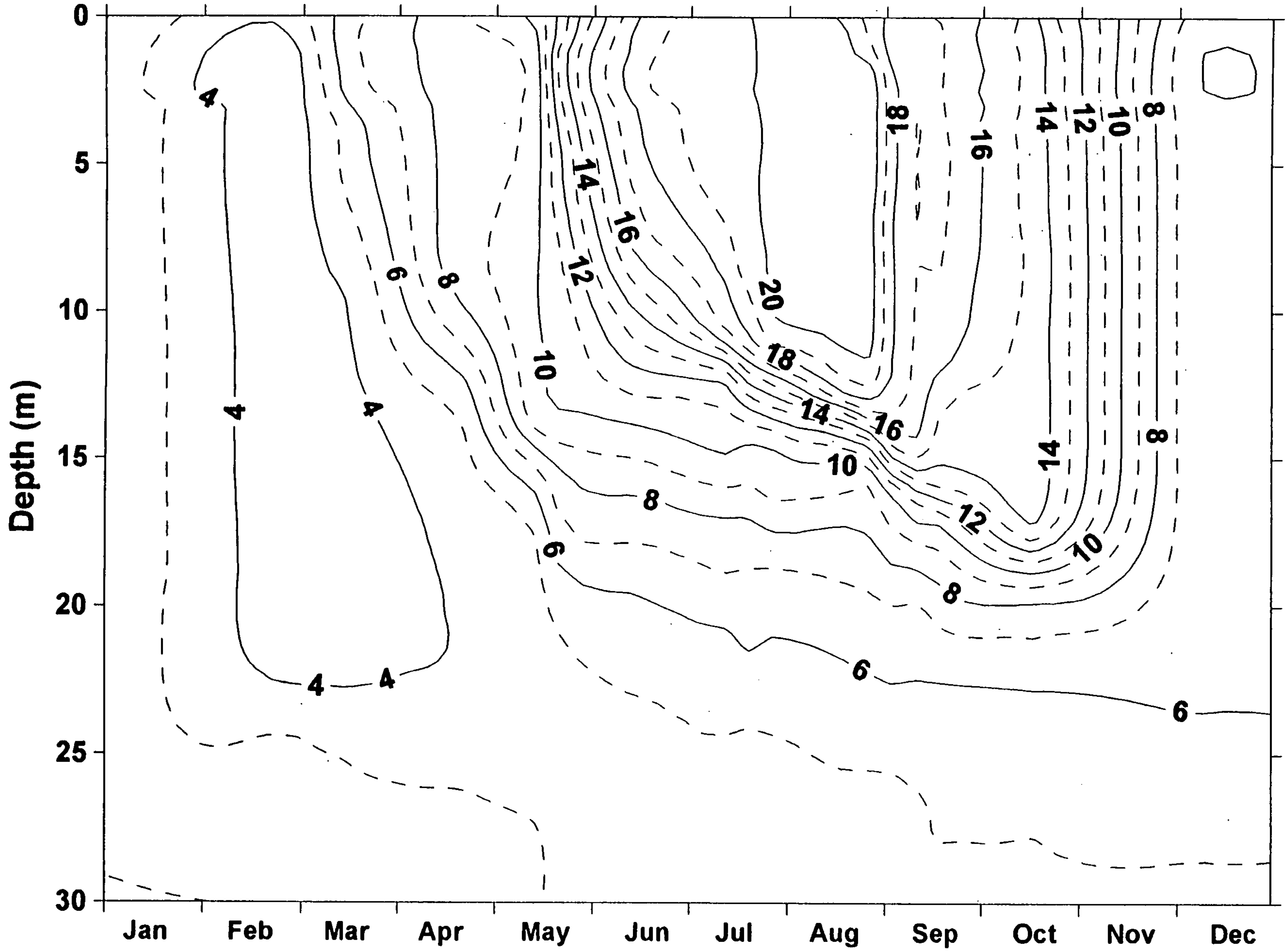
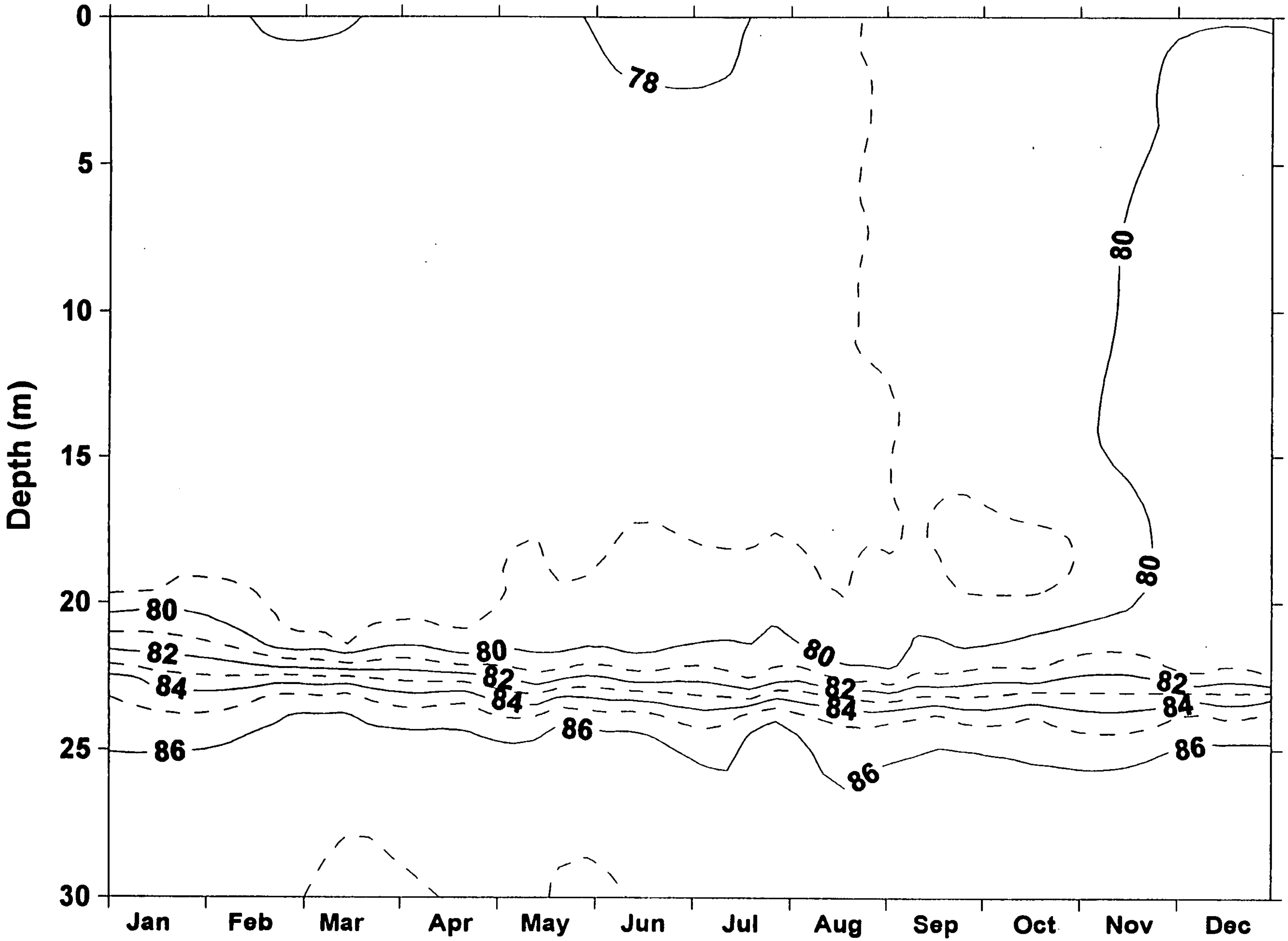

Mono Lake Surface Elevation
Elevation (ft)
6386
6384
6382
6380
6378
6376
6374
6372
Monomictic
Meromictic
Monomictic
Meromictic
79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00
Year

Figure 7



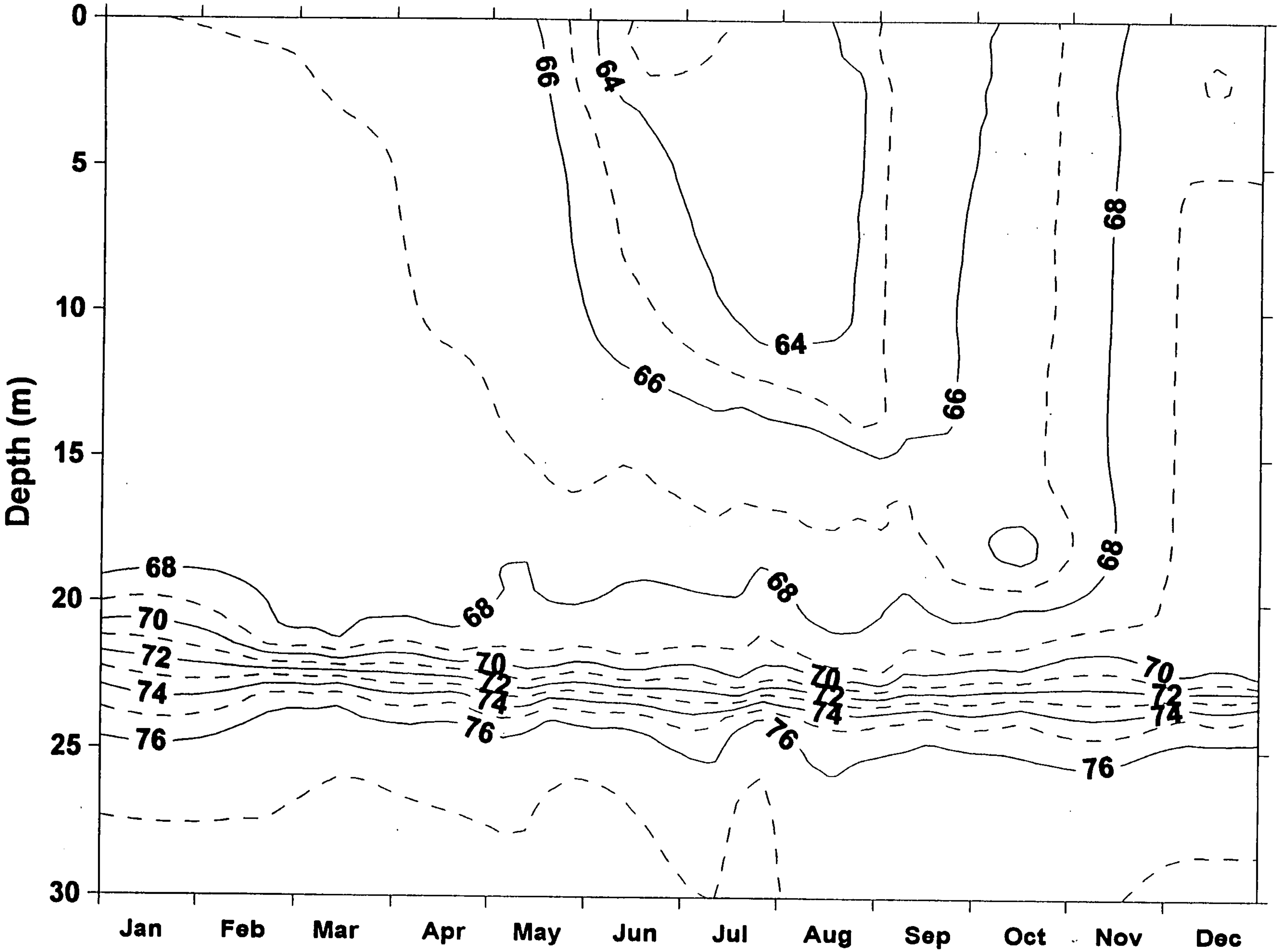
Temperature (°C) at Station 6, 2000

Figure 8



Conductivity (mS/cm) at Station 6, 2000

Figure 9



Excess Density (kg/m3) at Station 6, 2000

Figure 10

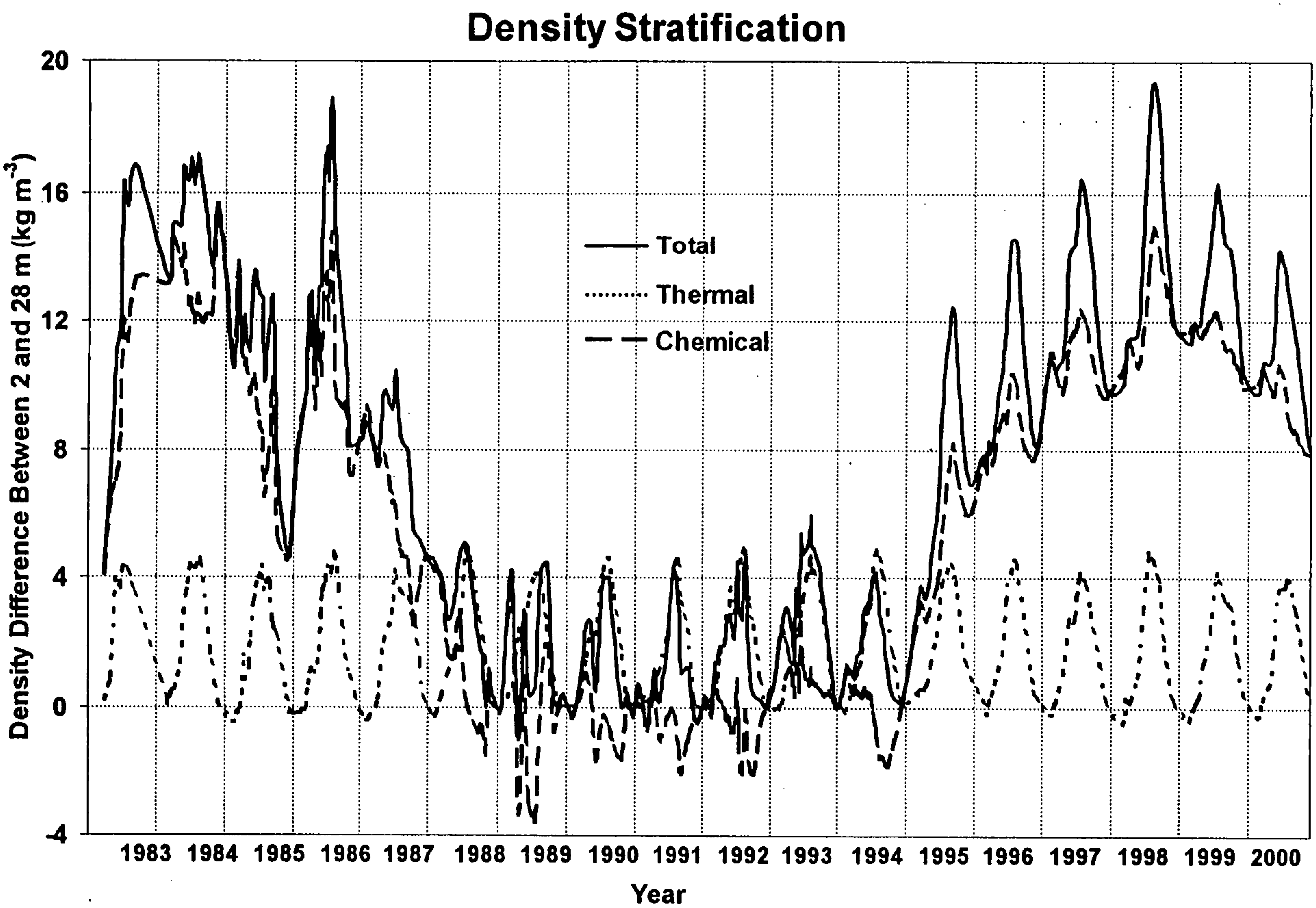

Density Stratification
Density Difference Between 2 and 28 m (kg m-3)
Year
Total
Thermal
Chemical
20
16
12
8
4
0
-4
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000

Figure 11

December Chemical Stratification at Mono Lake

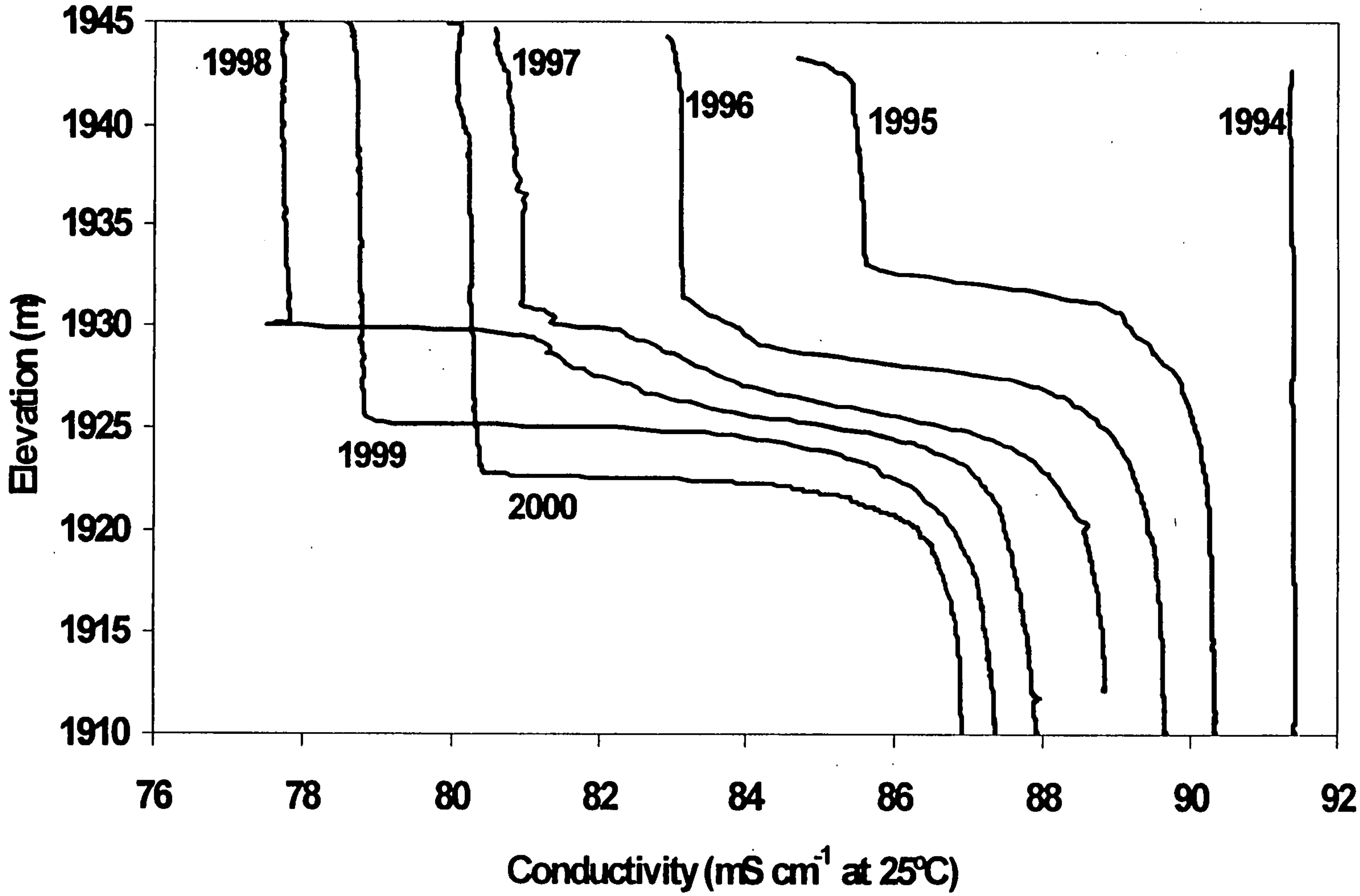


Figure 12

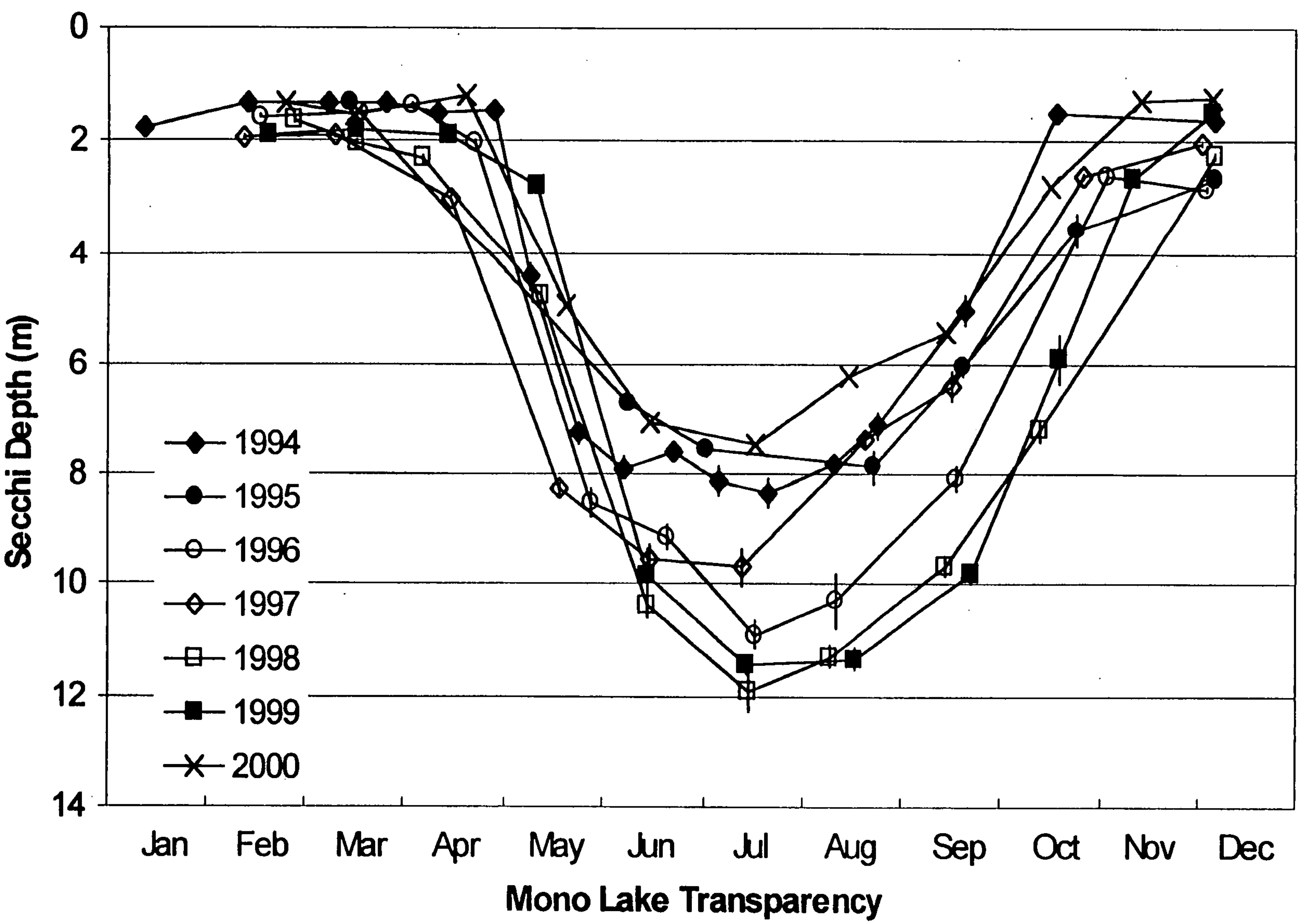
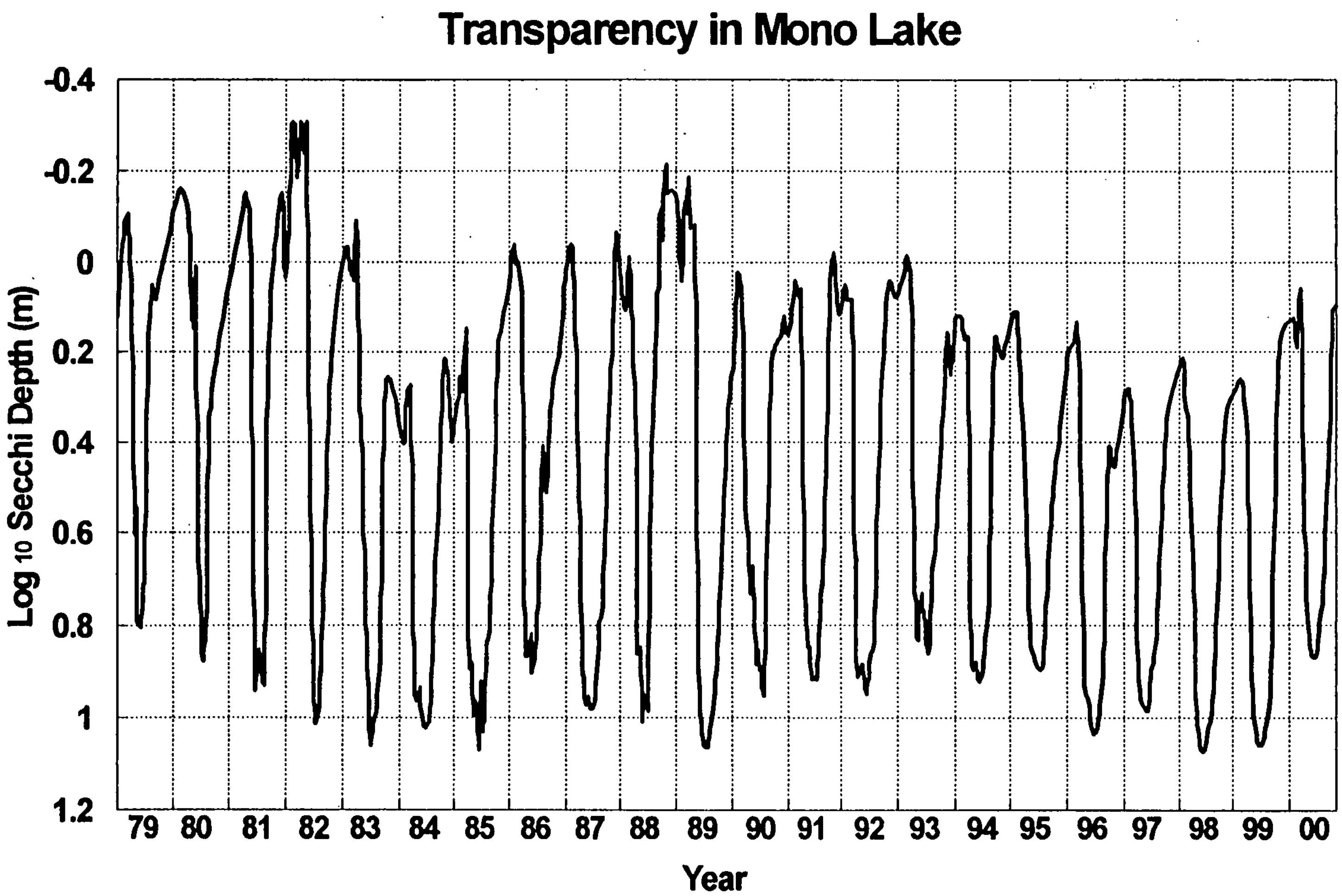
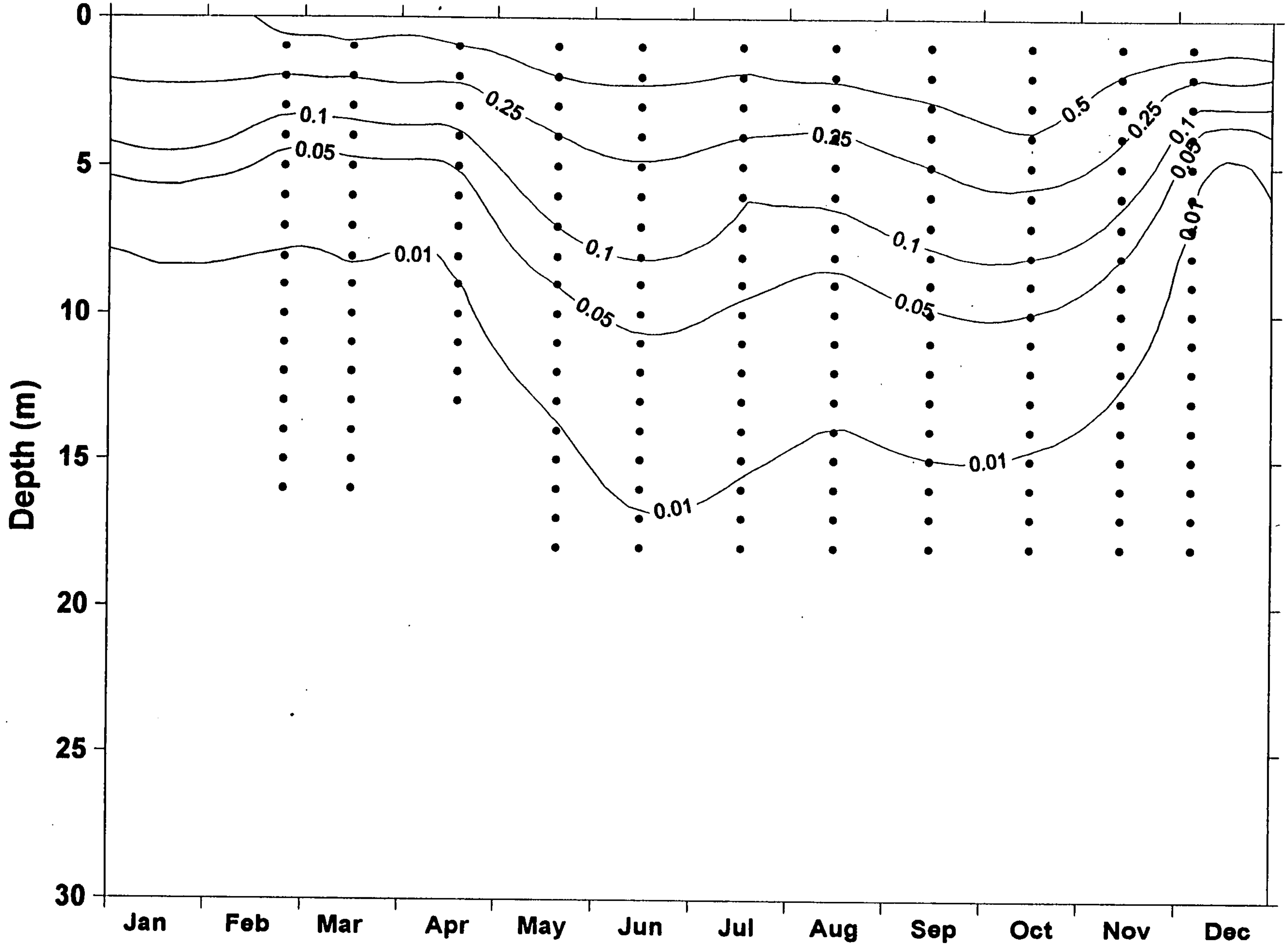

Secchi Depth (m)
0
2
4
6
8
10
12
14
1994
1995
1996
1997
1998
1999
2000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Mono Lake Transparency

Figure 13



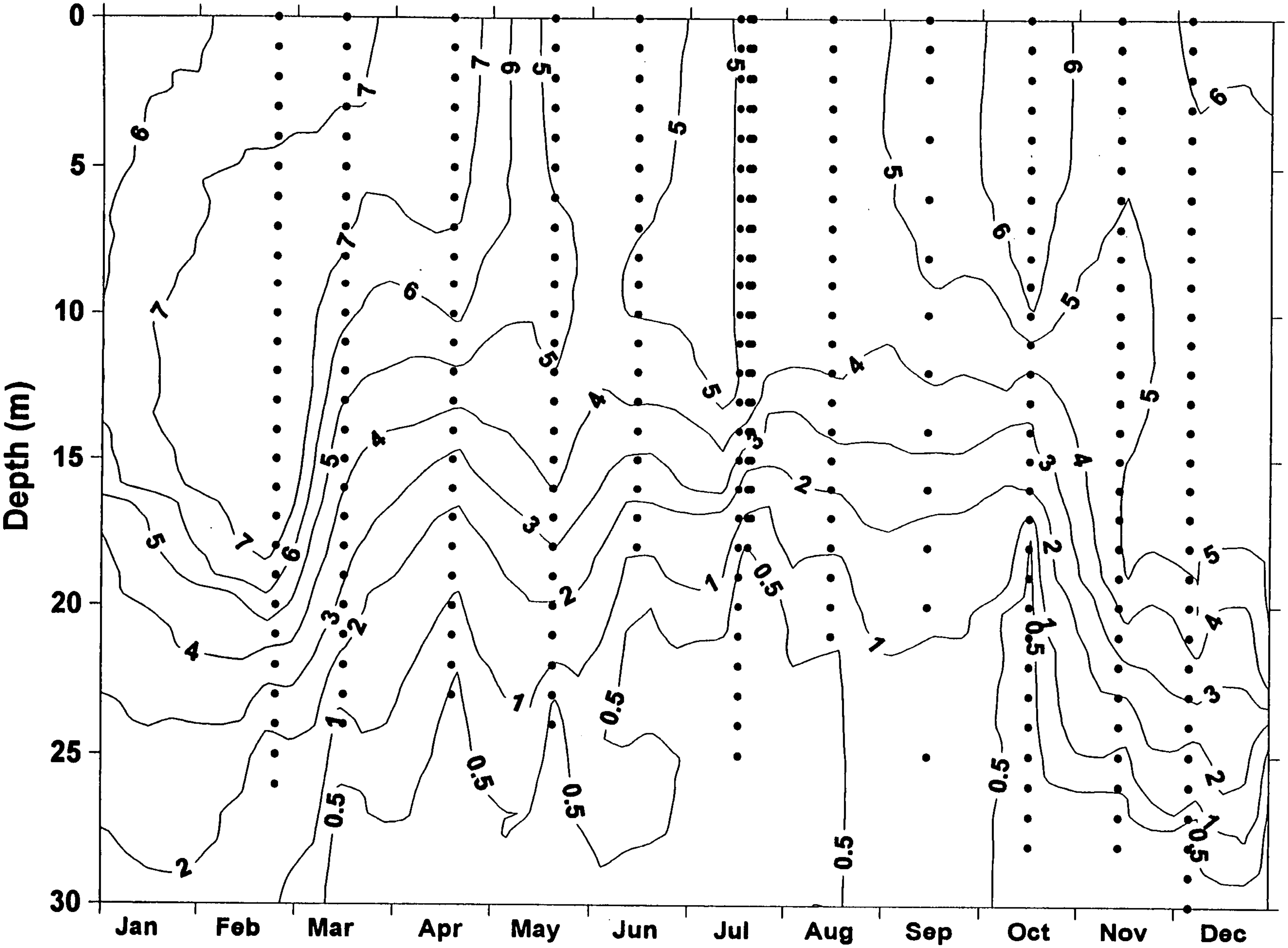
Transparency in Mono Lake
Log 10 Secchi Depth (m)
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00
Year

Figure 14



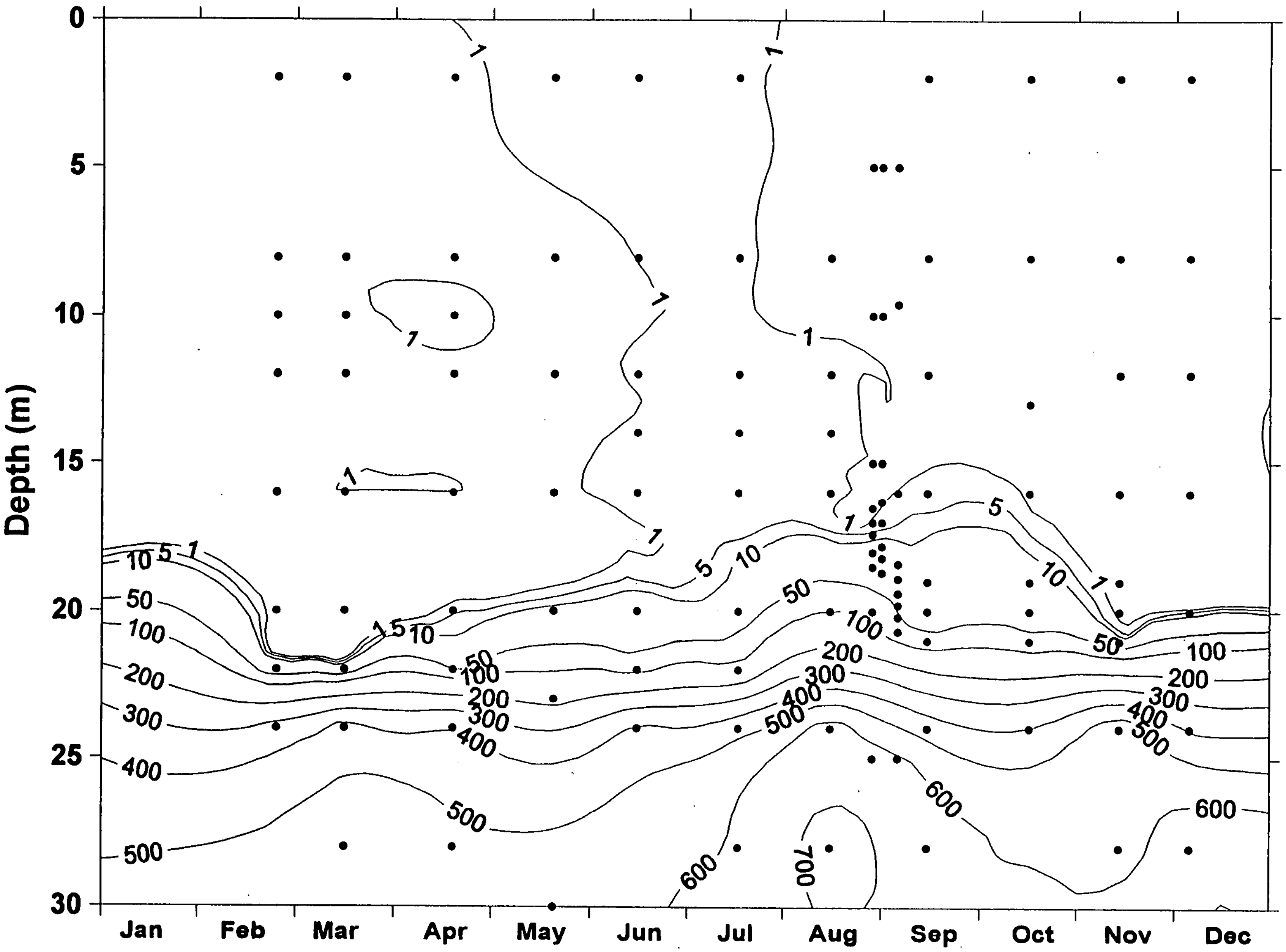
2000 Light Attenuation (fraction of surface)

Figure 15



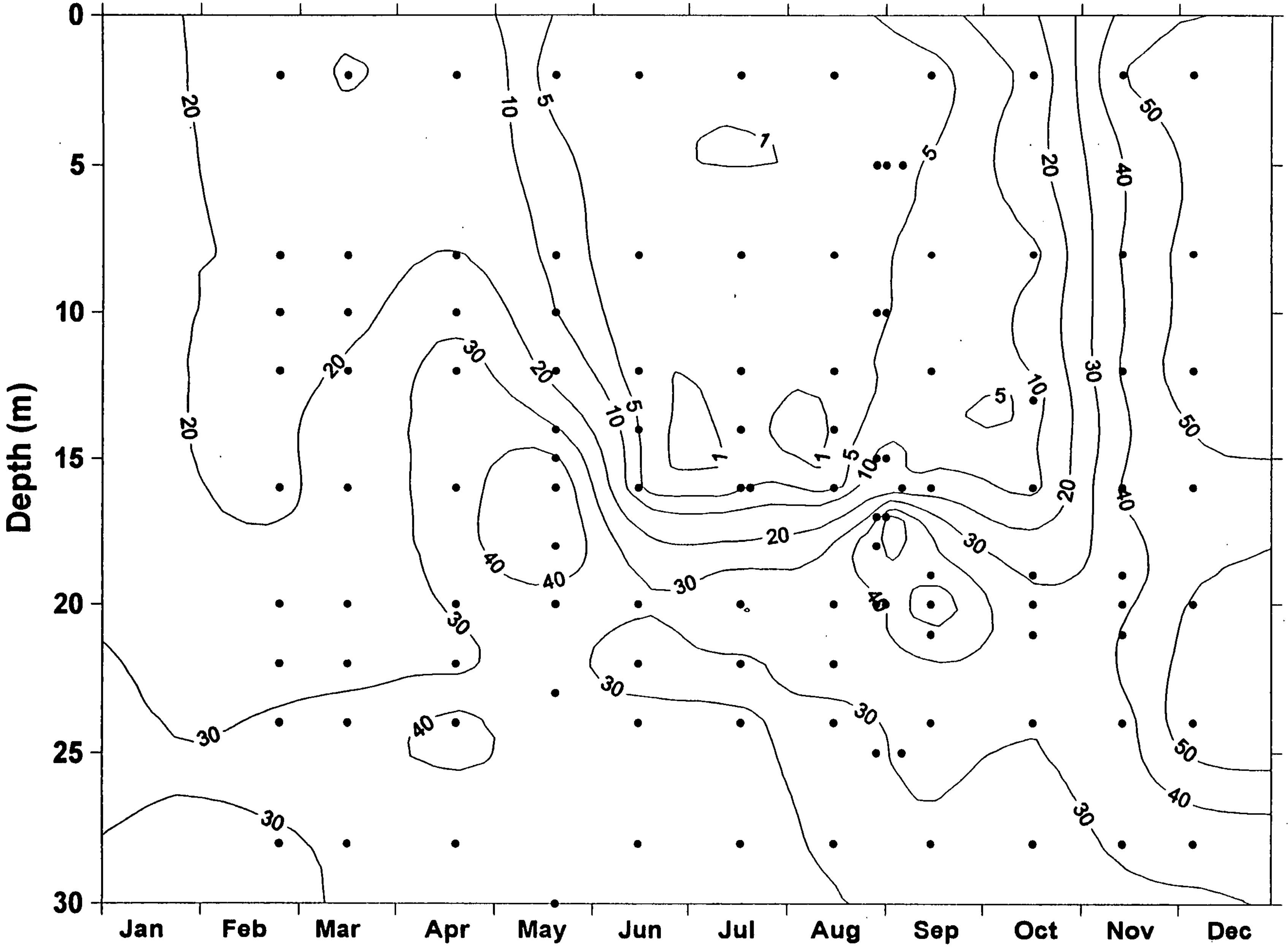
Dissolved Oxygen (mg/l) at Station 6, 2000

Figure 16



Ammonium (uM) at Station 6, 2000

Figure 17



Chlorophyll a (ug/l) at Station 6, 2000

Figure 18

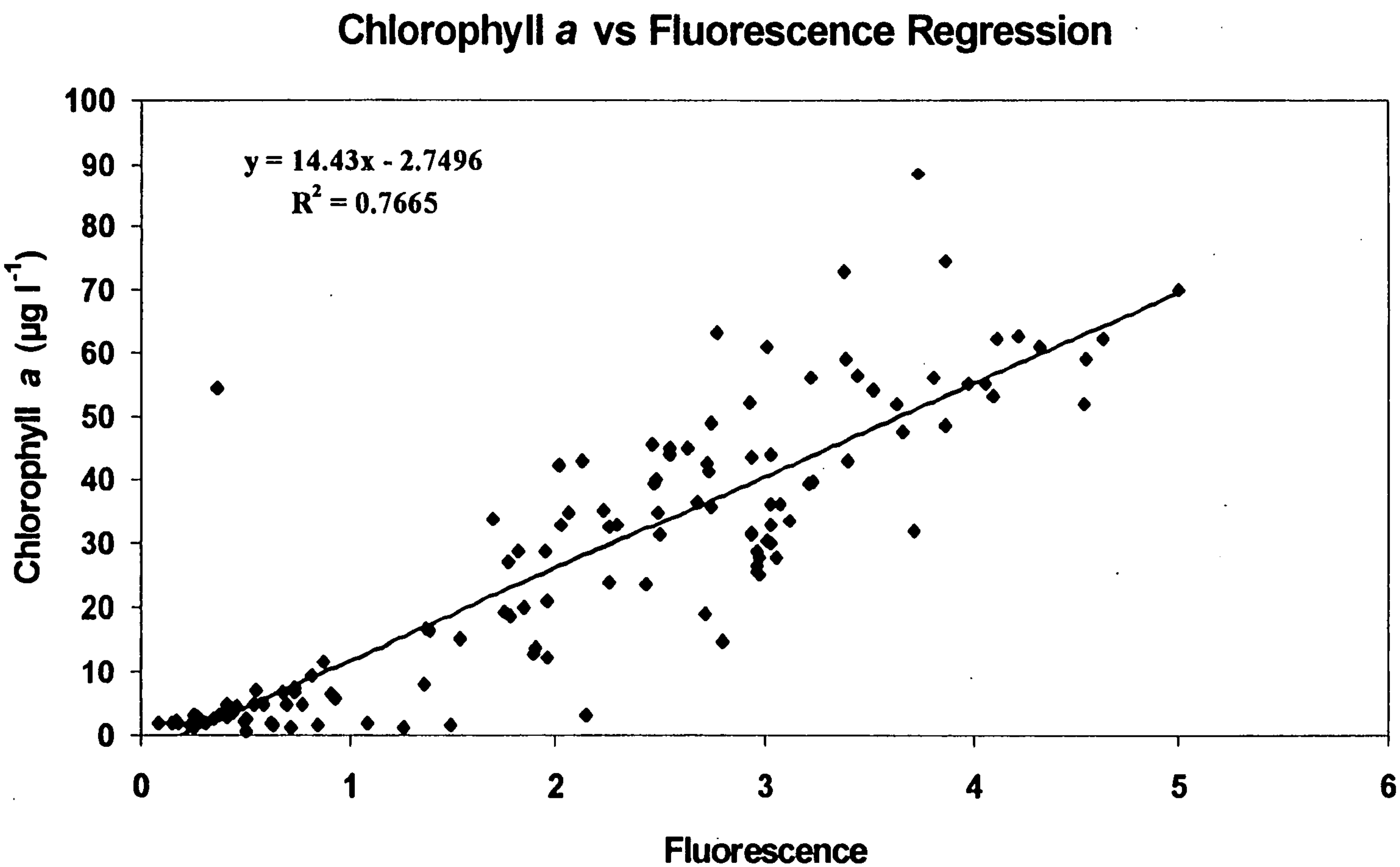

Chlorophyll a vs Fluorescence Regression
y = 14.43x - 2.7496
R² = 0.7665
Chlorophyll a (µg l⁻¹)
Fluorescence
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6

Figure 19

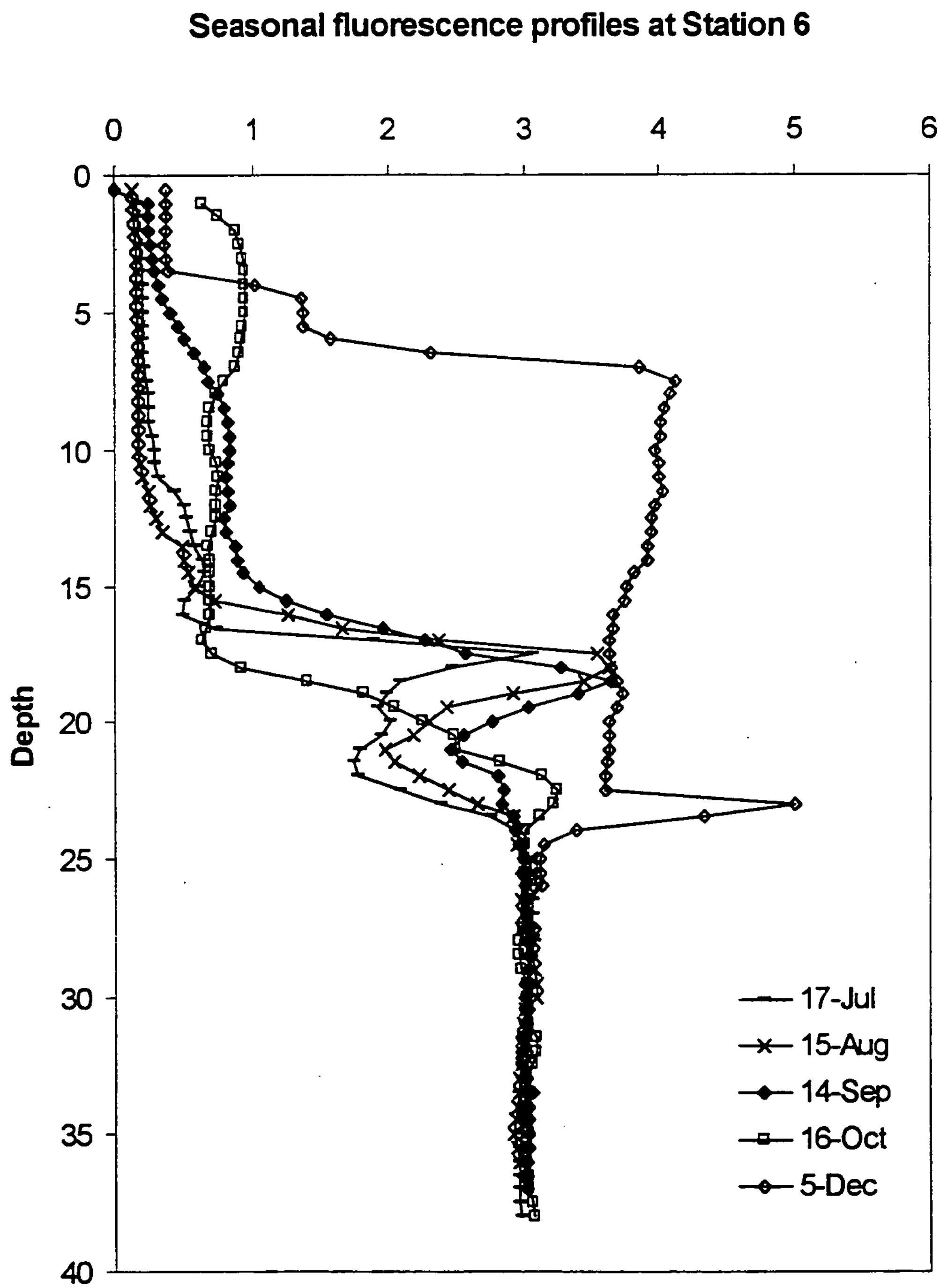
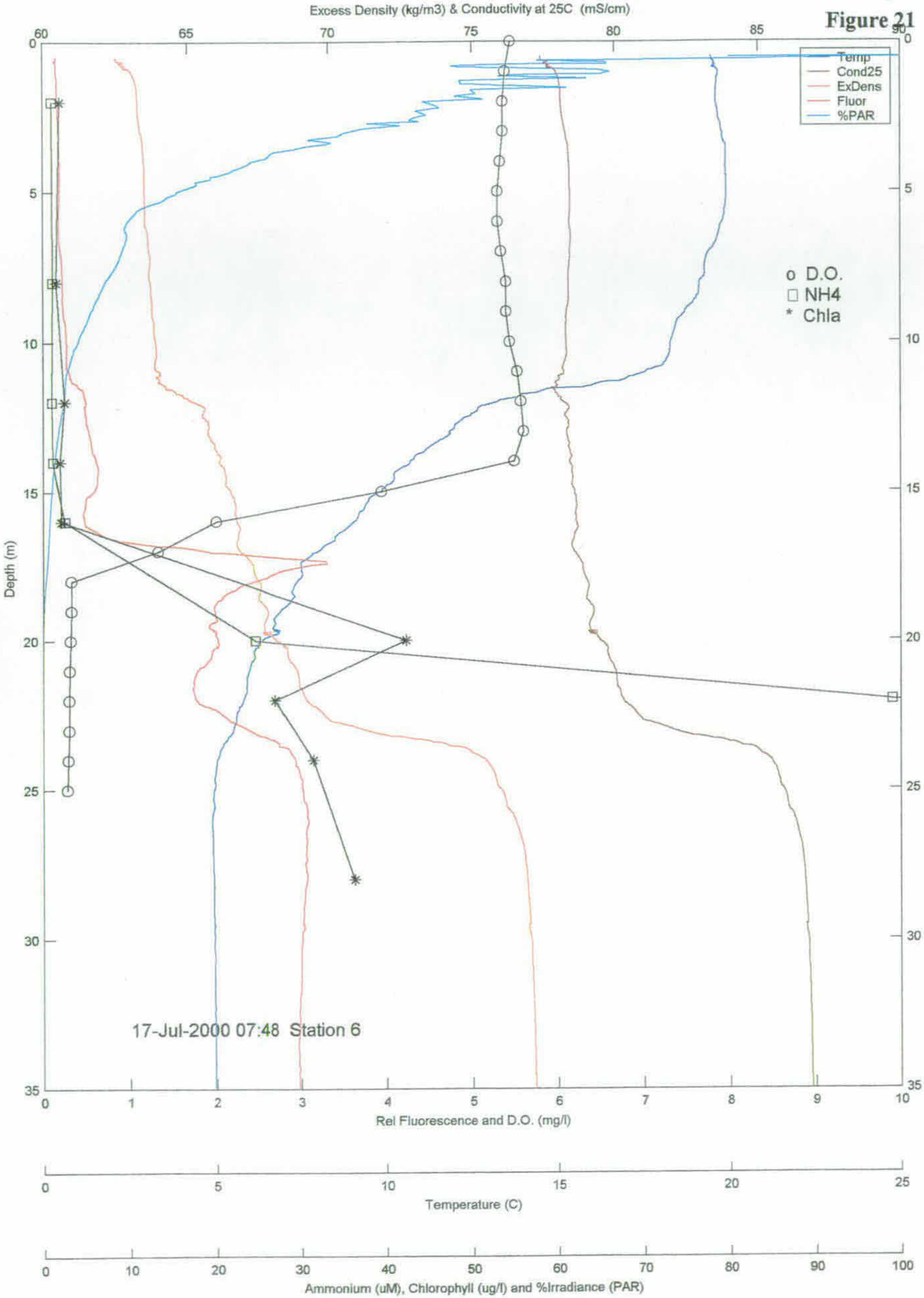

Seasonal fluorescence profiles at Station 6
0
1
2
3
4
5
6
0
5
10
15
20
25
30
35
40
Depth
17-Jul
15-Aug
14-Sep
16-Oct
5-Dec

Figure 21



Excess Density (kg/m3) & Conductivity at 25C (mS/cm)
60
65
70
75
80
85
90
Temp
Cond25
ExDens
Fluor
%PAR
o D.O.
□ NH4
* Chla
Depth (m)
0
5
10
15
20
25
30
35
17-Jul-2000 07:48 Station 6
0
1
2
3
4
5
6
7
8
9
10
Rel Fluorescence and D.O. (mg/l)
0
5
10
15
20
25
Temperature (C)
0
10
20
30
40
50
60
70
80
90
100
Ammonium (uM), Chlorophyll (ug/l) and %Irradiance (PAR)

2000 Artemia Population

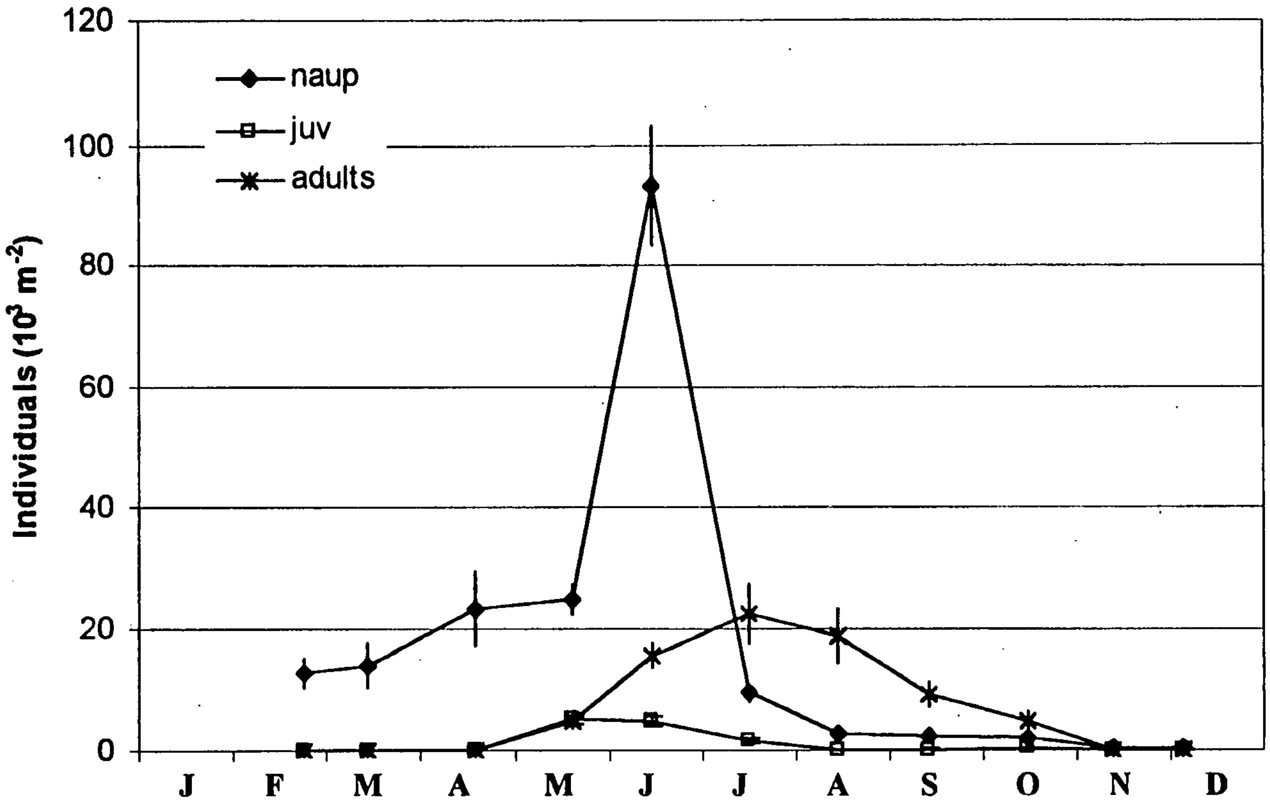
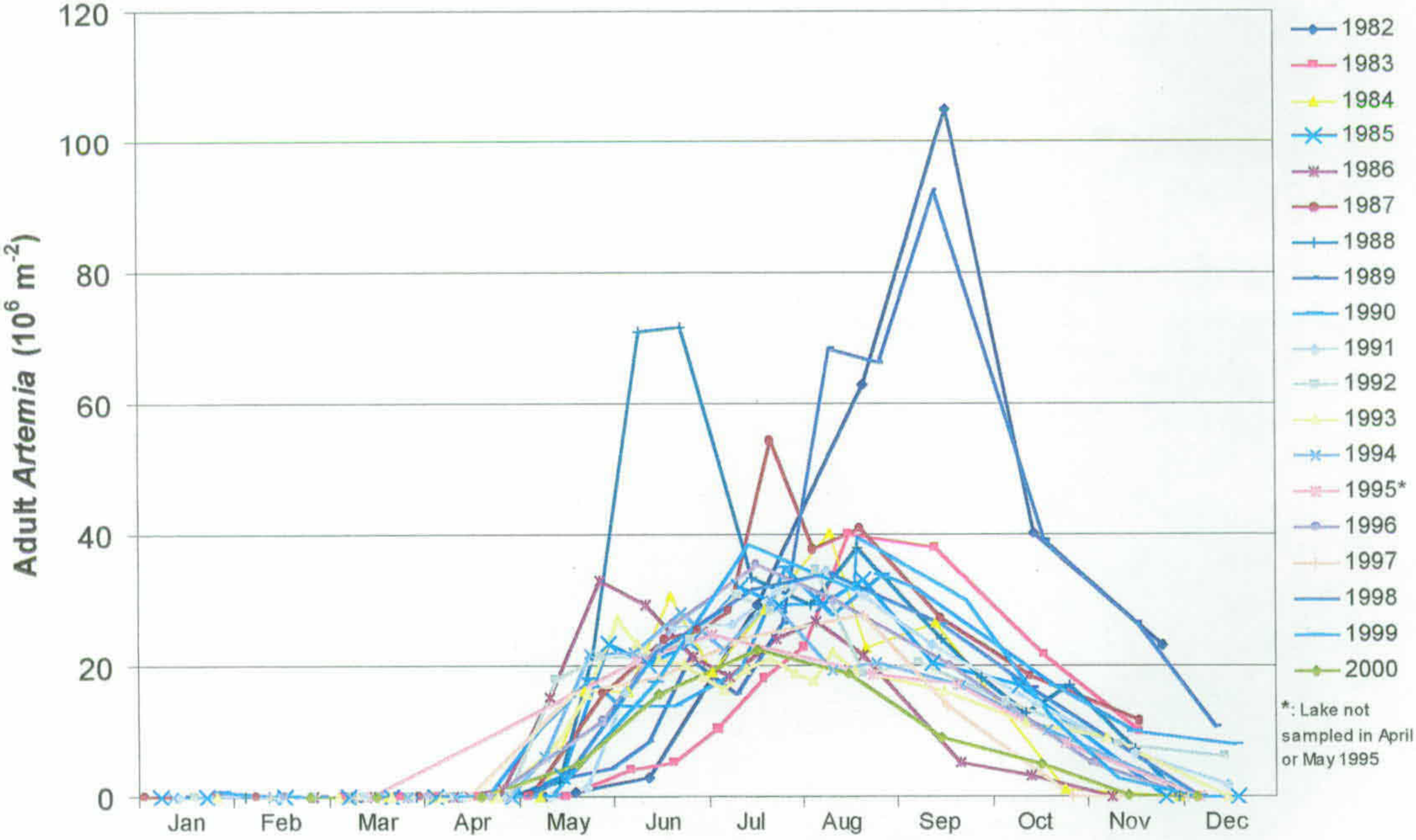


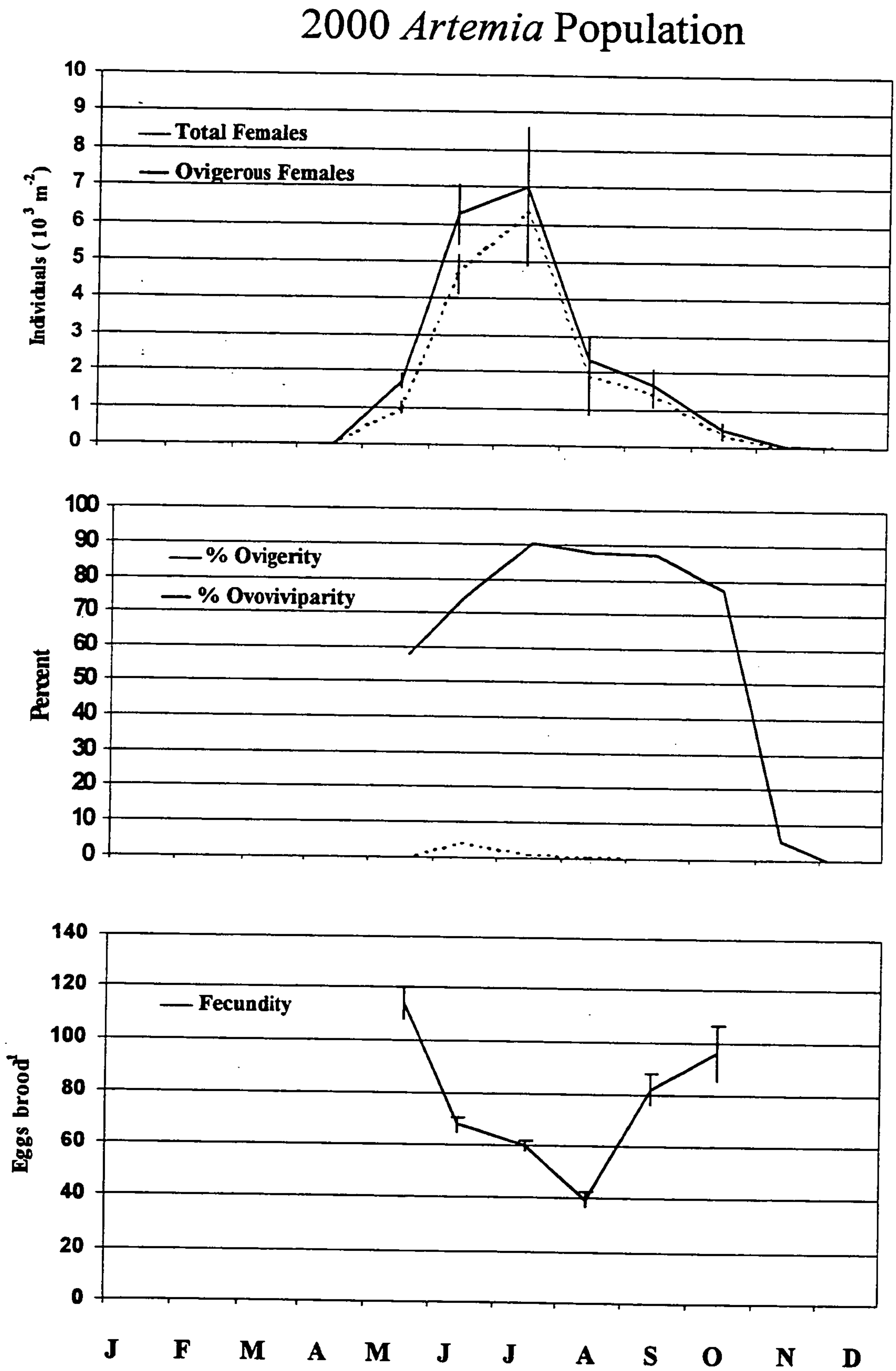
Figure 22

Adult *Artemia* Abundance



95

Figure 23


2000 *Artemia* Population
Individuals (10^3 m^{-2})
Total Females
Ovigerous Females
0
1
2
3
4
5
6
7
8
9
10
Percent
% Ovigerity
% Ovoviviparity
0
10
20
30
40
50
60
70
80
90
100
Eggs brood^{-1}
Fecundity
0
20
40
60
80
100
120
140
J F M A M J J A S O N D

Adult *Artemia* Summary Statistics

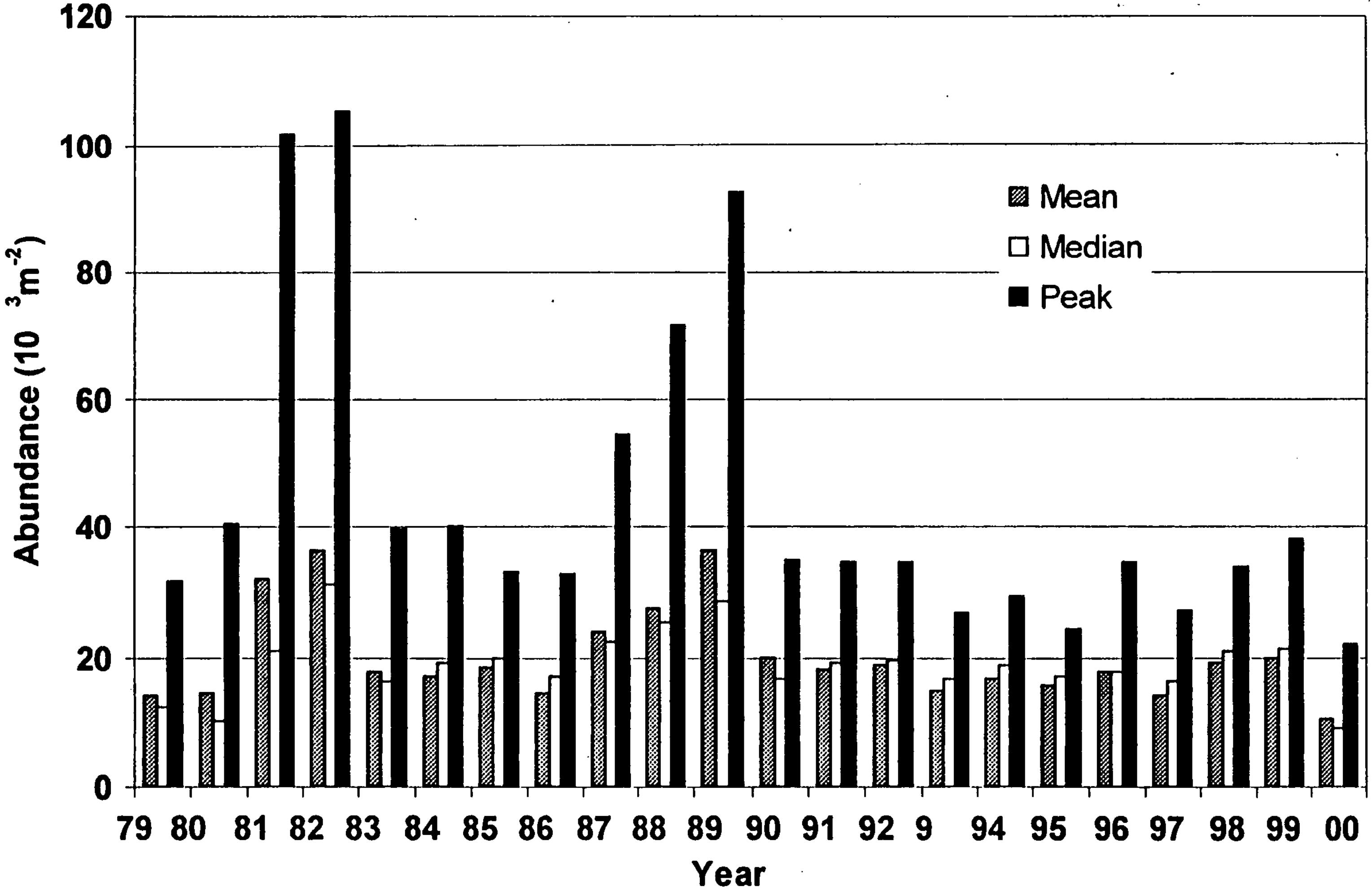


Figure 25

Adult *Artemia* Temporal Distribution

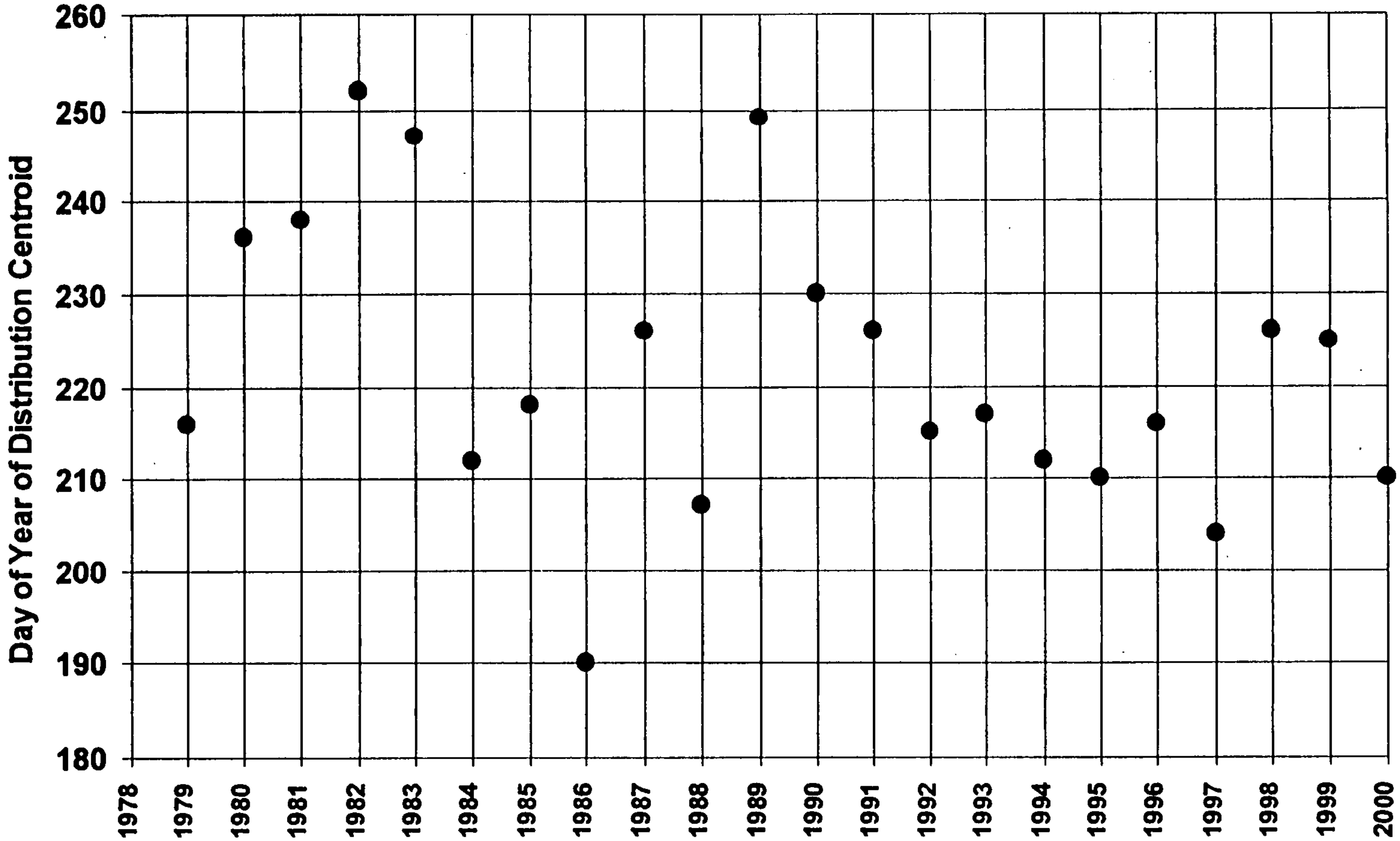
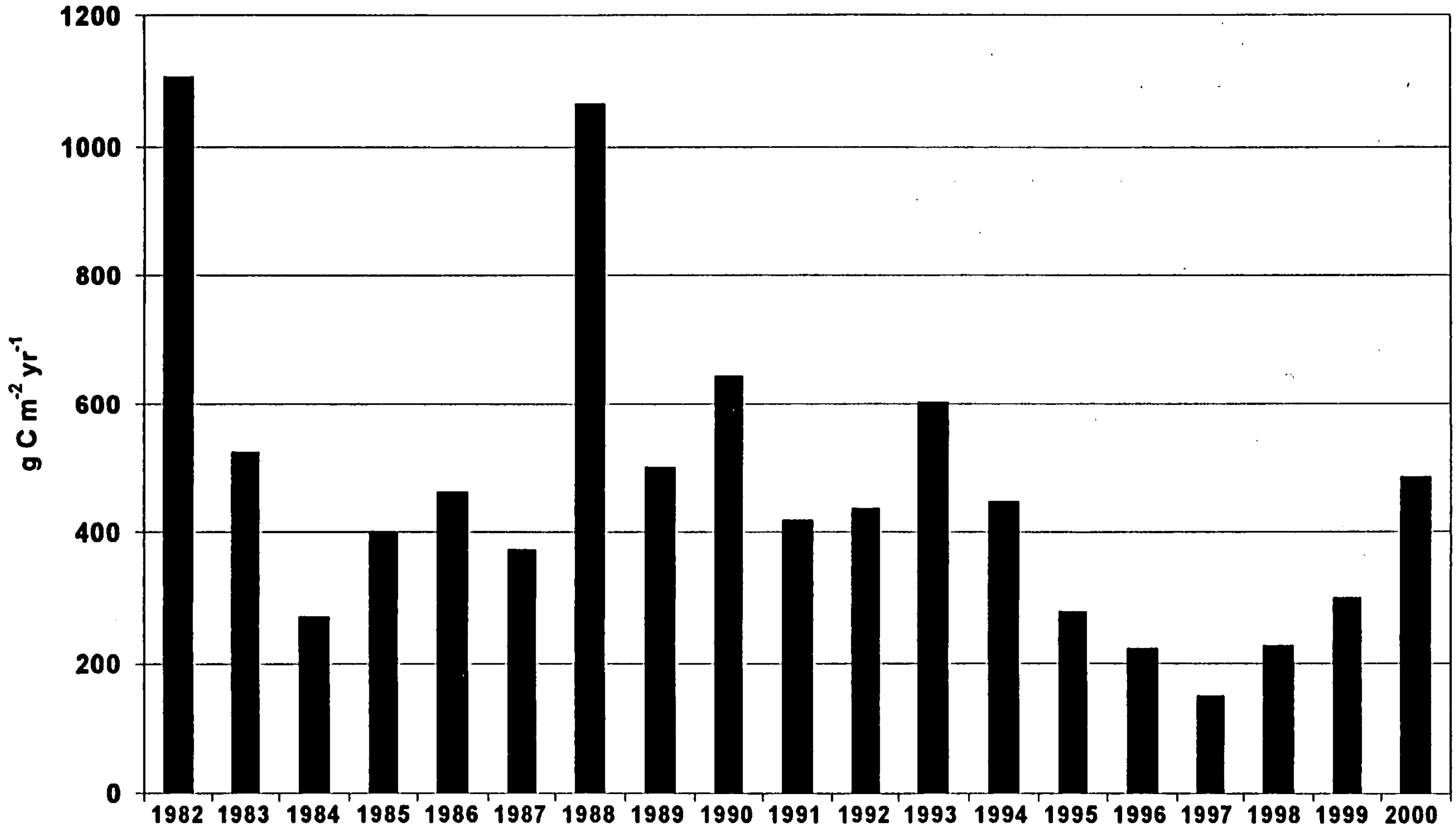


Figure 26



Annual Primary Production

Figure 27

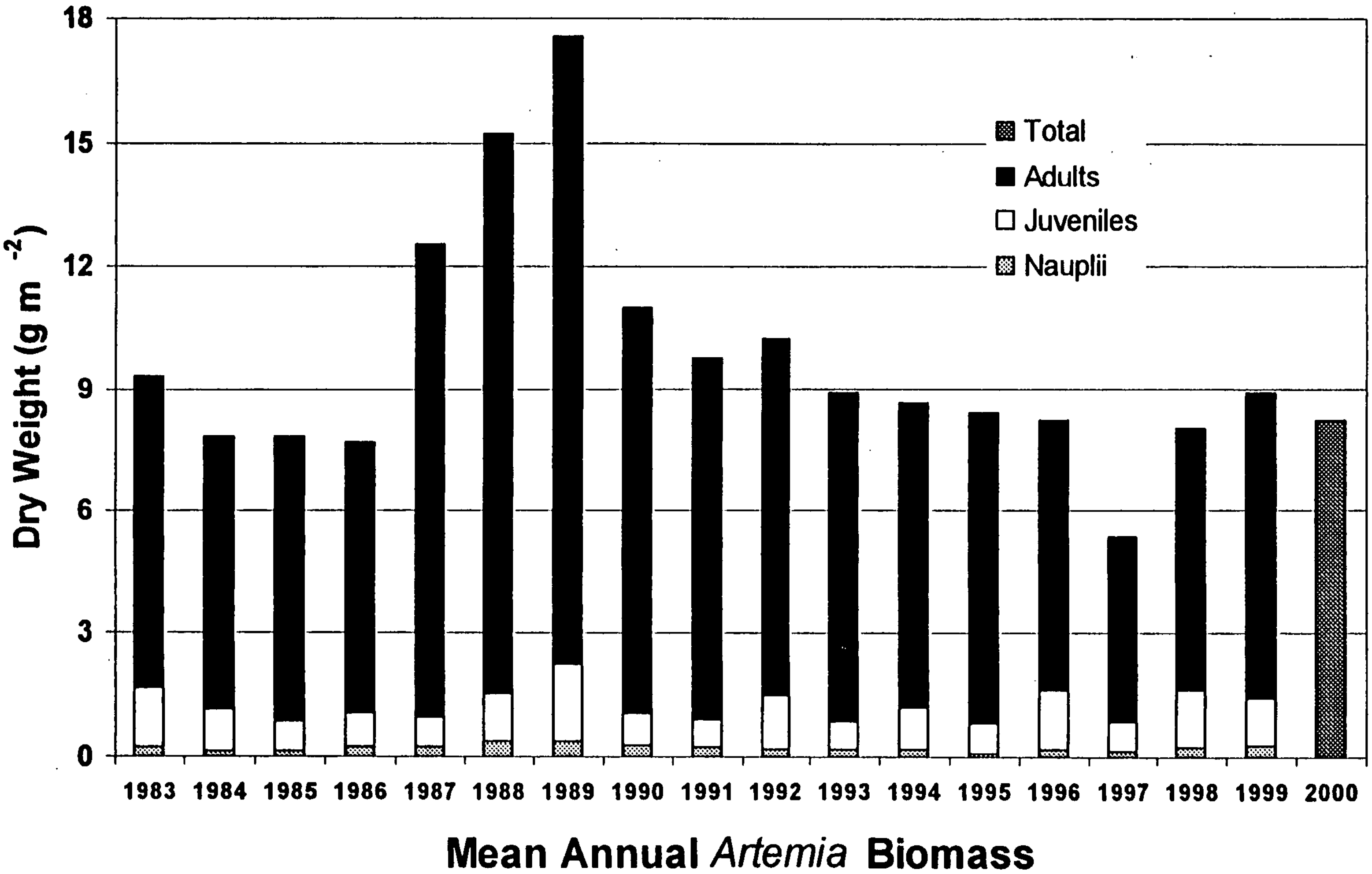

Dry Weight (g m -2)
18
15
12
9
6
3
0
Total
Adults
Juveniles
Nauplii
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Mean Annual *Artemia* Biomass

Figure 28

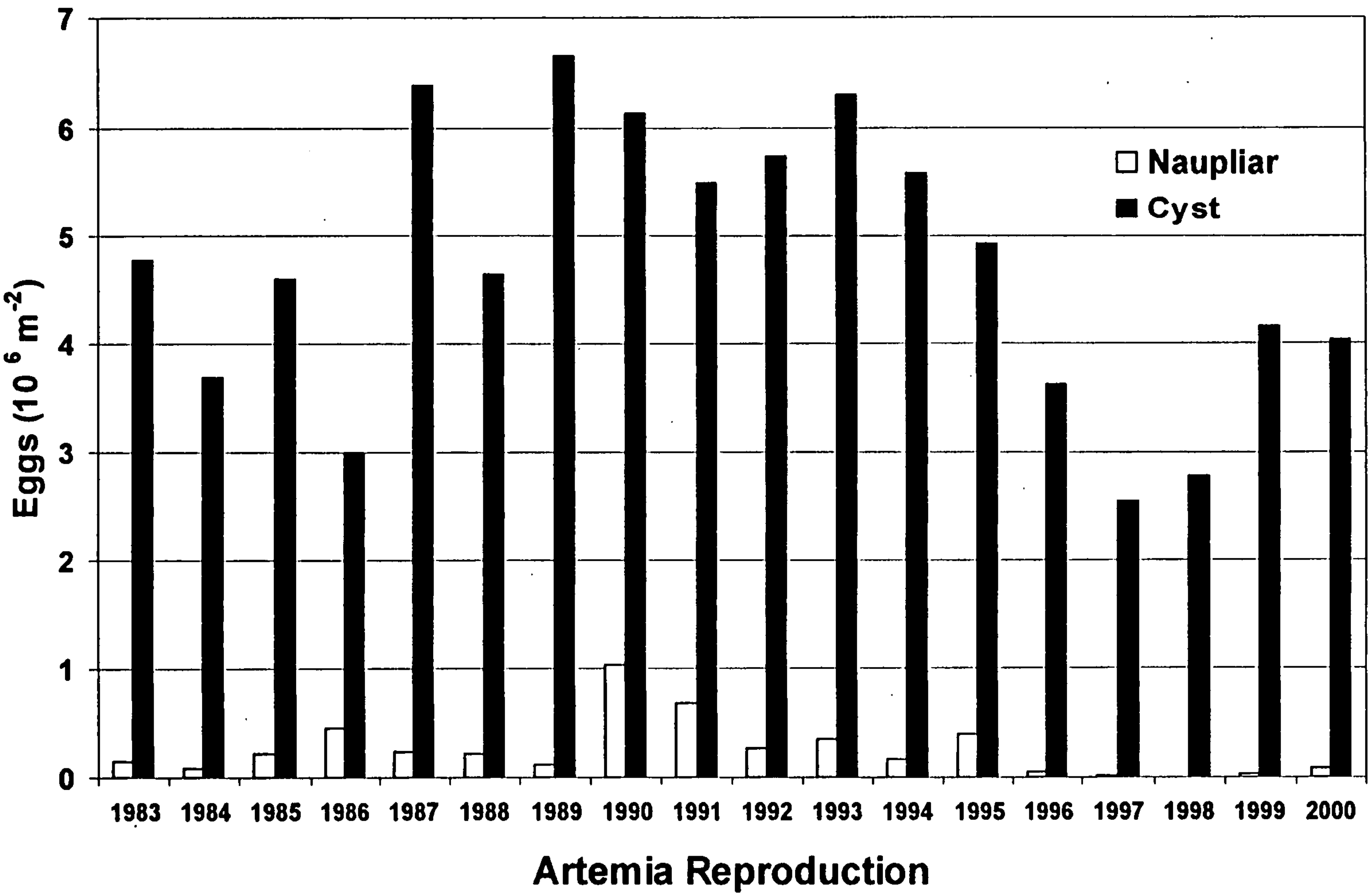

Naupliar
Cyst
Eggs (10^6 m^{-2})
0
1
2
3
4
5
6
7
1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
Artemia Reproduction

Figure 29

APPENDIX A: CHANGES TO LONGTERM LIMNOLOGICAL MONITORING

Background and rationale for implemented changes

Periodic review of the sampling design of long-term monitoring programs in relation to ongoing results and changing priorities is desirable. Given limited funds, the consideration of sampling design changes must balance the necessity of maintaining the consistency necessary for valid statistical analyses against the benefits of any proposed changes. UCSB researchers have conducted limnological research at Mono Lake beginning in 1979. Beginning in 1982, a major portion of this research has been funded by the City of Los Angeles and consisted of monitoring a suite of physical, chemical, and biological variables throughout the year. In 1994, the SWRCB conditioned the water rights of Los Angeles and required continued limnological monitoring as part of their water rights license during the restoration of Mono Lake. Thus, limnological monitoring is expected to continue into the future and most likely at least until the SWRCB reviews Los Angeles' Mono Basin water rights in 2014. Given this extended time frame and recognized short-comings of the previous sampling program, which are described below in detail, we implemented several changes which, while providing more accurate and additional information, maintain consistency with previous monitoring data. The changes derived from 1) the desire for better estimation of lakewide secondary (*Artemia*) productivity, 2) dynamics associated with an ongoing episode of meromixis, and 3) the needs of active research on vertical mixing and bacterial dynamics.

Previous sampling regime

Seasonal monitoring of the endemic brine shrimp, *Artemia monica*, was initiated in 1979 and has continued through present. Initial interest focused on seasonal and year-to-year changes in the population dynamics with attention to the effects of changing salinity on individual life-history characteristics. This necessitated staging and counting individuals as opposed to determining total biomass. Much of the interest beginning with the EIR proceedings (ca. 1990) shifted toward year-to-year differences in total secondary productivity. Secondary production was calculated for all the years through 1999 based on individual counts, adult length, and weight-length regressions based on weights of individuals reared in the laboratory and collected in the field. As the weight-length ratio varies markedly between and within years, an accurate determination with this method was costly and included errors associated with all the various factors involved in calculating total biomass. A much more direct and accurate method of estimating total and average annual biomass is direct weighing of all the individuals from net tows.

As the surface elevation of the lake rises, the lake is expanding disproportionately in the northeastern half of the lake. During meromictic episodes, a major portion of sediments remain anoxic throughout the year. The relative proportion of anoxic sediments in the various sectors of the lake vary due to widely varying bottom topography. The bathymetry of the northeastern half of Mono Lake is much more gently sloping than the southwestern half/ Also, larger portion of the sediments in the northeastern half of the lake are exposed to oxygen during the winter/spring mixing. As a result, *Artemia* hatch more abundantly in the northeast. The previous distribution of sampling stations under-sampled this sector relative to the southwestern half of the lake. The southwestern sector of the lake has historically been over-sampled due to its easier and safer access. As the lake rises this bias would become more pronounced.

For most of the period of long-term monitoring of the *Artemia* population (1982-1993), duplicate or triplicate vertical net tows were collected at 10 stations (1-8, 11, 12)(Figure 1). In 1993 analysis of variance indicated it was more efficient for purposes of estimating lake and sector means to increase the number of stations with a single net tow at each one. Thus, from 1994 to May 2000, 10 additional stations were added on transects between the existing ones. This resulted in a higher density of stations in the southwestern and western portions of the lake relative to the northeastern half of the lake which consist predominately of gently sloping bottom topography.

The vertical mixing dynamics of Mono Lake have been the focus of several past and current NSF-funded studies. Past and current episodes of meromixis with their reduced vertical flux of nutrients and subsequent trophic level impacts have illustrated the importance of understanding vertical mixing processes in the lake. Recent results suggest the dominant mixing mechanism deep within the lake occurs due to breaking of internal waves on the sloping bottom. This should lead to discernible spatial patterns in the availability of nutrients and thus affect phytoplankton and zooplankton. Prior to May 2000 we collected a single vertical profile of ammonium and chlorophyll *a* from a central deep station (6) and an integrated sample of the upper 9-m of the water column from five stations (1,2,6, 7, and 11). It became desirable to have mixed-layer samples from an additional station lying along a transect extending from near to offshore in the southern sector, and an additional one in the eastern sector of the lake.

Sampling design changes implemented in 2000

We now collect and make collective weight measurements of individuals at 12 stations for the purpose of determining seasonal and year-to-year changes in *Artemia* biomass. As staging and counts of individuals provide additional information necessary for interpreting changes in the brine shrimp dynamics, we continue to collect and process these samples. We increased the number of 9-m integrated samples from 5 to 7 stations by adding stations 5 and 8 (Figure 1).

To accommodate these changes, we reduced the number of stations sampled for *Artemia* population counts from the previous 20 which over-sampled the southwestern and western portions of the lake to the present 12 and reduced the number of stations at which fecundity are determined from 10 to 7. Table 1, below, is a summarized schematic of sample types, and number and identity of stations sampled under the previous and present design.

Table 1. Changes in sampling design

Sample	Old design(s)(1982-1999)	New design (2000+)
Total *Artemia* Dry weight of net tow	None	12 buoyed stations (10,11,8,9,S10,S30,6, ET5.6, 2, 4, buoyed installation at station 18, and a new bouyed station NE of old station 18)
Artemia staging and counts	10 bouyed (1982-1993), all 20 (1993-1999)	same 12 stations as above
9-m integrated of NH4 and Chla	2-3 bouyed (6,11,S30: 1982-1993), 5 bouyed (10,11,S30,6,2: 1993-1999)	7 buoyed (10,11,S10,S30,6,ET5.6,2)
Artemia fecundity	10 bouyed (1982-1999)	7 buoyed (10,11,S10,S30,6,ET5.6,2)

Long-term consistency

The present stations for *Artemia* sampling include all ten of the stations sampled from 1982 to 1993 and two additional stations in the northeast half of the lake. Thus the stations are more evenly distributed across the lake and long-term consistency is maintained. Fecundity determinations are determined at 7 of the previously sampled 10 stations with little loss of accuracy and no discernible bias.

Artemia *abundance*

Analysis of both total numbers of Artemia and total number of adults from 1994-1999 indicated that reducing the number of stations from 20 to 12 introduced no discernible bias and only slightly increased the relative standard error associated with lakewide abundance. The lakewide means based on twenty or 12 stations were very nearly identical throughout the period. The mean relative standard error for the entire period increased from 14.8 to 18.2%; slightly less than the theoretical increase based on random sampling of normally distributed population. Similar results were obtained from considering only adults.

Fecundity

Analysis of fecundity data from 1994 through 1999 indicated that decreasing the number of stations from 10 to 7 had no discernible effect on the overall abundance estimate. The relative error associated with lake fecundity estimates is low relative to abundance and only increased from 4.8 to 6.1% when we decreased the number of stations sampled to seven.

APPENDIX III

2000 MONO LAKE VEGETATION AND HABITAT MAPPING

2000 Mono Basin Vegetation and Habitat Mapping

May, 2001

Los Angeles Department of Water and Power

1. Introduction

As one component of waterfowl restoration monitoring described in Section 4.d (2) of order 98-05, Los Angeles Department of Water and Power (LADWP) is required to undertake annual aerial photography of waterfowl habitat. The aerial photography needs to be "... sufficient for use in annual waterfowl population studies and sufficient to identify annual changes in vegetation in waterfowl habitat areas."

This report documents the aerial photography of Mono Lake shoreline areas and the waterfowl habitat quantified in 2000.

2. Methods

The aerial photography and examination of vegetation mapping of Mono Basin waterfowl habitat was comprised of three separate steps. Methods of each step were fully described in the 1999 Mono Basin Vegetation and Habitat Mapping Report (LADWP 1999). The aerial photography for 2000 was taken on September 7, 5 days later than the 1999 flight (Figure 1). There were a few differences between 1999 and 2000 aerial photography. Instead of using color infrared film as was used in 1999, real color film was used in 2000. The scale of the photography was also changed. Instead of 1:36,000 or 1" = 3000', the 2000 photography has a scale of 1:24000 or 1" = 2000'.

A GIS database was developed from the 1999 imagery using ESRI ArcView software. ArcView GIS software was also used to compare vegetation and waterfowl habitat conditions between 1999 and 2000. The two years of aerial photography were layered 2000 over 1999. When the images are layered in this fashion, the view can be toggled back and forth between the two. The vegetation cover class polygons developed from the 1999 imagery were then layered on the 2000 imagery. The edges of the polygons were examined to determine if there was a match between the image and the polygon. If there were any questionable edges, the polygon was viewed over the 1999 imagery to determine if the differences were due to differences in the imagery or vegetation change (Figure 2). In some cases, the edge of a polygon did not appear to line up with a visible vegetation boundary. However, when the 1999 image was viewed, the boundary became more obvious and understandable when viewed over the 2000 image.

The most noticeable change between 1999 and 2000 was the extent of exposed lakeshore. Mono Lake elevation dropped from 6387.7 to 6387.0. A result of this decline was a variable increase in exposed shoreline from between 0.5 m to 30 m. This variability can be explained in lake-edge slope differences at various locations around the lake.

There were few if any changes in the lake fringing wetland vegetation that could be distinguished from the aerial photography. The areas of waterfowl habitat delineated in 1999 appear very similar in 2000. In the 1999 report (LADWP 1999), it was suggested that annual mapping was not necessary for the entire lake-fringing wetland area but that several locations should be examined annually. These included the area from Navy

Beach to Warm Springs, DeChambeau Embayment, and the delta areas of Lee Vining and Rush Creeks. Examination of these areas (Figure 2 and Figure 3) indicated that there were no large changes, even in the ephemeral brackish lagoons that are along the lake margin.

Examination of both years of aerial photography and the results of vegetation monitoring at Warm Springs indicate that annual flights of aerial photography are unnecessary. The LADWP has a contract in place for 2001 aerial photography. If review of these photos supports these conclusions, it is recommended that a schedule similar to that of the vegetation monitoring. Aerial photography will be obtained at five-year intervals if the level of Mono Lake does not change more than 2 feet. If lake level change is greater than 2 feet, or if there is an above normal runoff year, new aerial photographs will be taken. In the event of an above normal year or a change greater than 2 feet, the five year time clock will be reset.

Figure 1. Aerial images of Mono Lake. The top photo was taken September 2, 1999 using color infrafed film. The bottom photo was taken in real color on September 7, 2000.

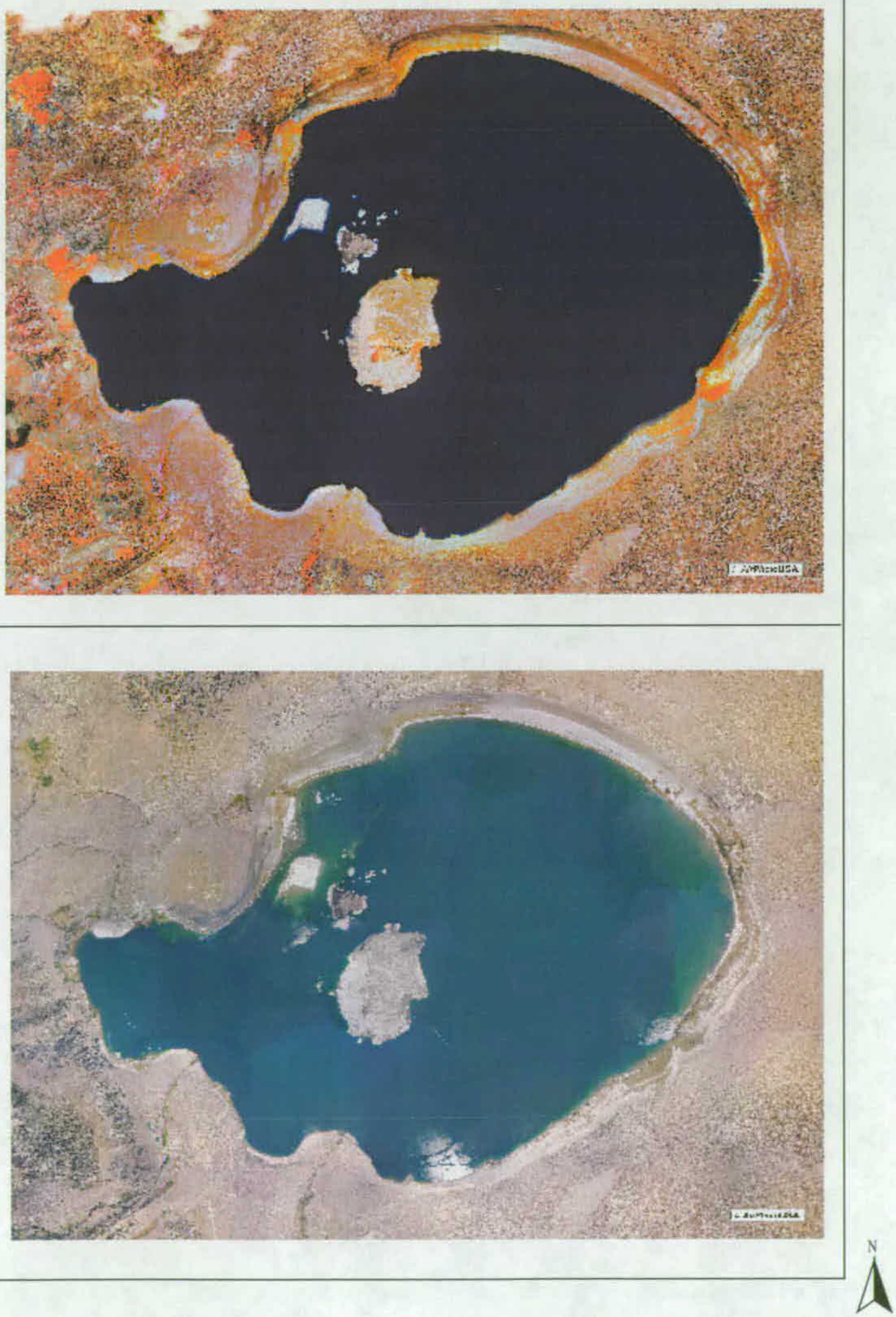
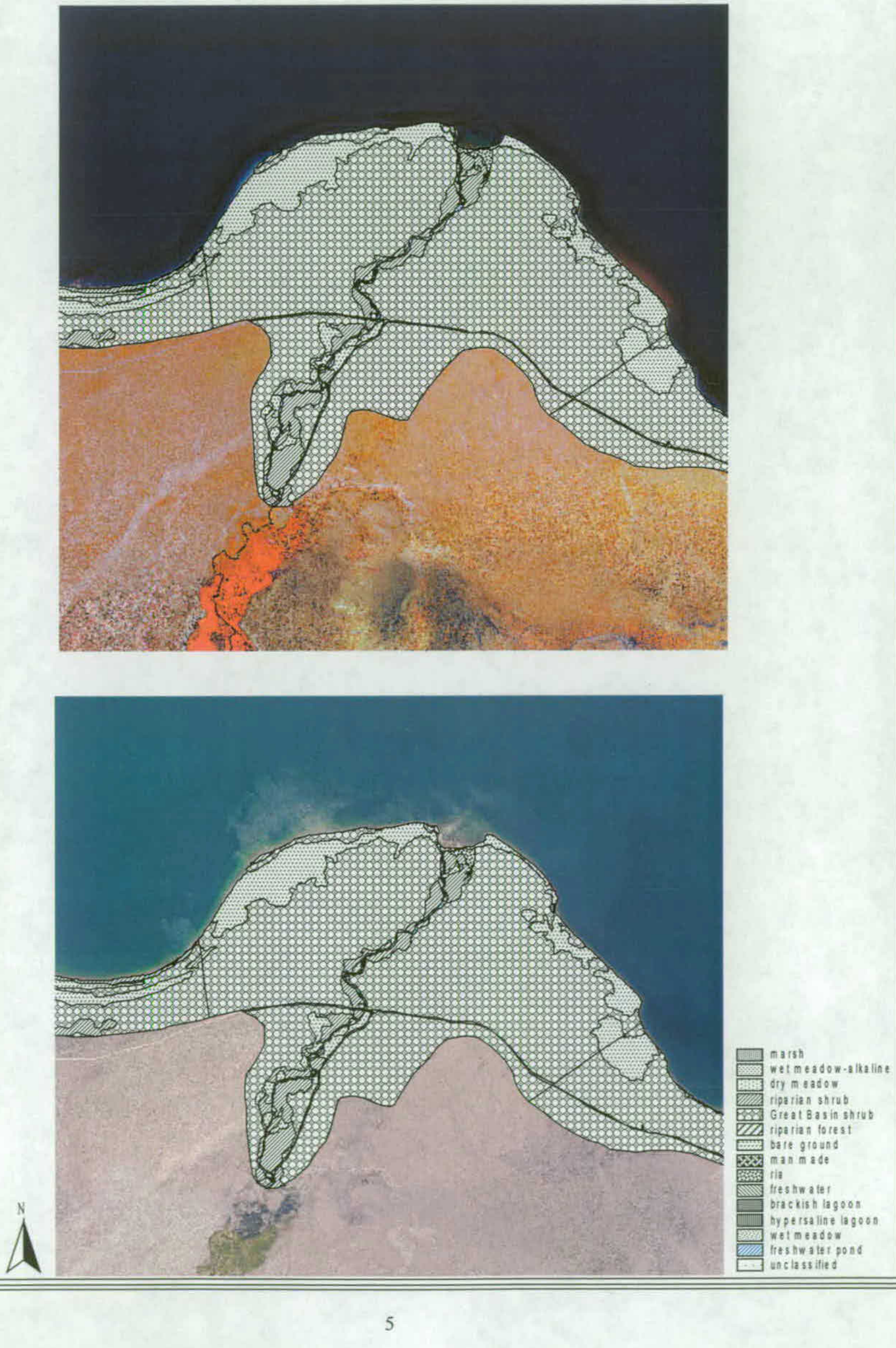


Figure 2. Rush Creek delta area in 1999 (top) and 2000 (bottom). Polygons are vegetation community types as delineated from the 1999 images. There were no large changes in the vegetation communities between the two years.

Figure 3. Vegetation communities of the Rush Creek delta.



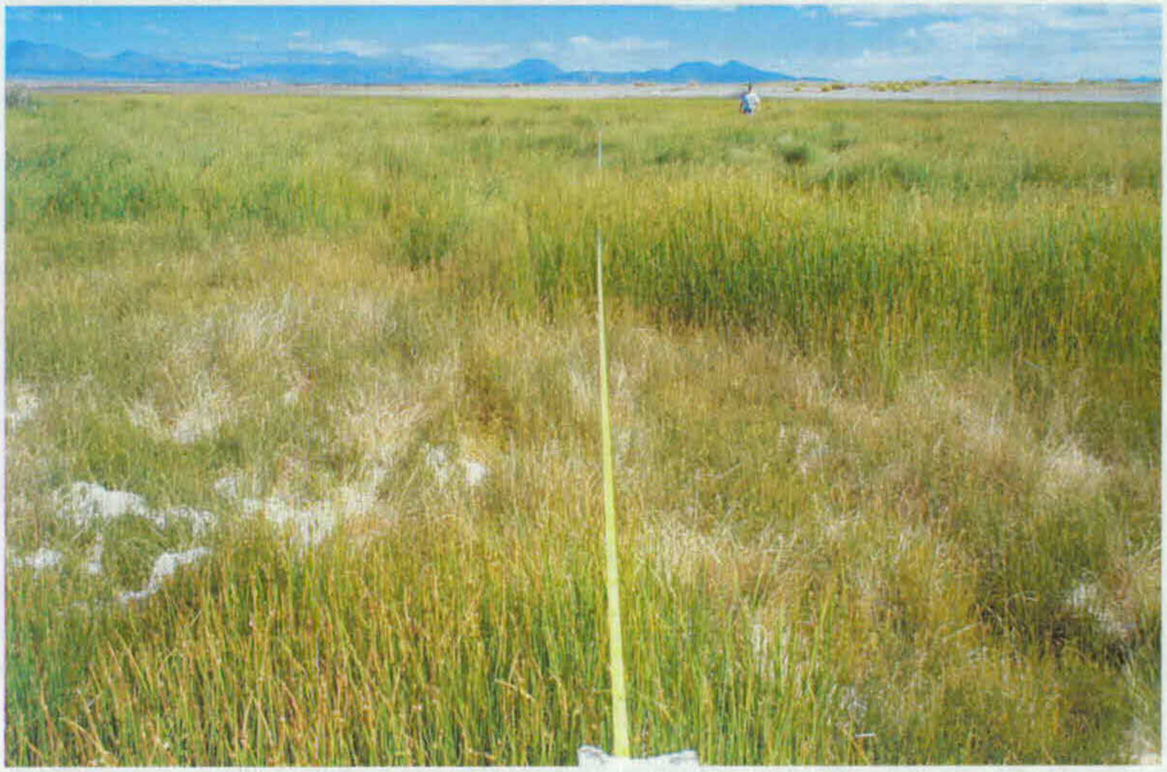
APPENDIX IV

2000 MONO LAKE VEGETATION MONITORING REPORT

2000

Mono Lake Vegetation

Monitoring Report



Prepared by

David W. Martin, Ph.D.
Watershed Resource Specialist
Los Angeles Department of Water and Power
300 Mandich Street Bishop, CA

Mono Lake Vegetation Monitoring

Introduction

Vegetation monitoring began in the riparian areas of Rush and Lee Vining Creeks and at several locations in the lake fringing wetlands of Mono Lake in 1999 (Fig 1). These efforts were undertaken to fulfill State Water Board obligations as directed in Decision 1631 and Order No. 98-05 and are generally described in the Mono Basin Waterfowl Habitat Restoration Plan. The objective of these monitoring efforts is to determine wetland changes as lake levels rise and how those changes may relate to waterfowl activity in the region and to determine the effectiveness of a burning program that is in the developmental phase. Under the restoration plan, the monitoring interval was set to five year intervals or after extremely wet years.

Vegetation Monitoring

During the 1999 wetland vegetation monitoring, Warm Springs, which is located on the east side of Mono Lake, was identified as a location where burning would have a good chance of creating additional open water habitat for waterfowl. During the 2000-growing season, biologist for The Los Angeles Department of Water and Power conducted a second year of vegetation-monitoring activities in the wetlands at Warm Springs. None of the other riparian or wetland sites that were established in 1999 were monitored (monitoring interval is 5 years or after extremely wet years).

Vegetation monitoring was conducted along permanent transects using the point intercept method to determine species composition and cover for each site. Species in the vicinity of each transect but not "hit" were also listed on the data sheets. Caution was taken to minimize disturbance to extant vegetation along the permanent transects. Three permanent transects were established perpendicular to the Mono Lake shoreline in 1999, one additional transect was established in 2000 (Fig. 1). Transects were randomly located within the marsh areas at each site. Transects extended from the current lake elevation (6385 ft) to approximately 6392 ft (≈ 550 m). At 100 m intervals along each permanent transect, 50 m long sampling transects were established (n=6) parallel to the lakeshore. Sampling transects ran either north or south from the permanent transect. The direction was randomly chosen. Average cover and species composition presented in Table 1. Values are averages of the three sampling points of approximately equal distance from the lakeshore. Cover and composition for 2000 did not differ significantly from 1999.

Burning

The Mono Lake Waterfowl Habitat Restoration Technical Advisory Group recommended that the natural role of fire in the lake fringing wetlands be restored. The purpose of this burning program at Mono Lake is to create open freshwater ponds preferred by waterfowl taxa and to improve the vigor of the extant vegetation.

The Waterfowl Habitat Restoration Plan describes the general mechanism by which the LADWP would conduct the burning program. Initial experimental burns were to be conducted on relicted lands in order to gain knowledge for future fire prescriptions. The LADWP was to work with California Department of Forestry (CDF) and their Vegetation Management Program (VMP) to conduct the burns. During the winter of 2000-2001, a burning plan was drafted by CDF and sent to interested parties for comment (Appendix I). In reviewing these comments with LADWP and

CDF personnel, it was determined that the CDF would not be able to conduct the burns on relicted lands. These lands are under the management of the California Department of Parks and Recreation. That agency is not a signor of the VMP Memorandum of Understanding with California Department of Forestry. The LADWP has contacted California Department of Parks and Recreation to determine if there is an avenue through which personnel from that agency will be able to conduct the experimental burning program.

Salt Cedar Control

For the past two years, personnel from LADWP have worked on removing salt cedar from the Rush Creek delta area. The Department has discussed a more involved program with many of the parties involved in the Mono Basin. During the 2001 field season, efforts to identify areas of infestation will be intensified and a GIS built to help in eradication efforts.

Figure 1. Warm Springs wetland complex. The green points are the approximate endpoints of the sampling transects.

Table 1. Species list and average cover of each for the six sampling transects at the Warm Springs Wetland Vegetation monitoring area. Transect 1 is closest to the lake while transect 6 is furthest from the lake.

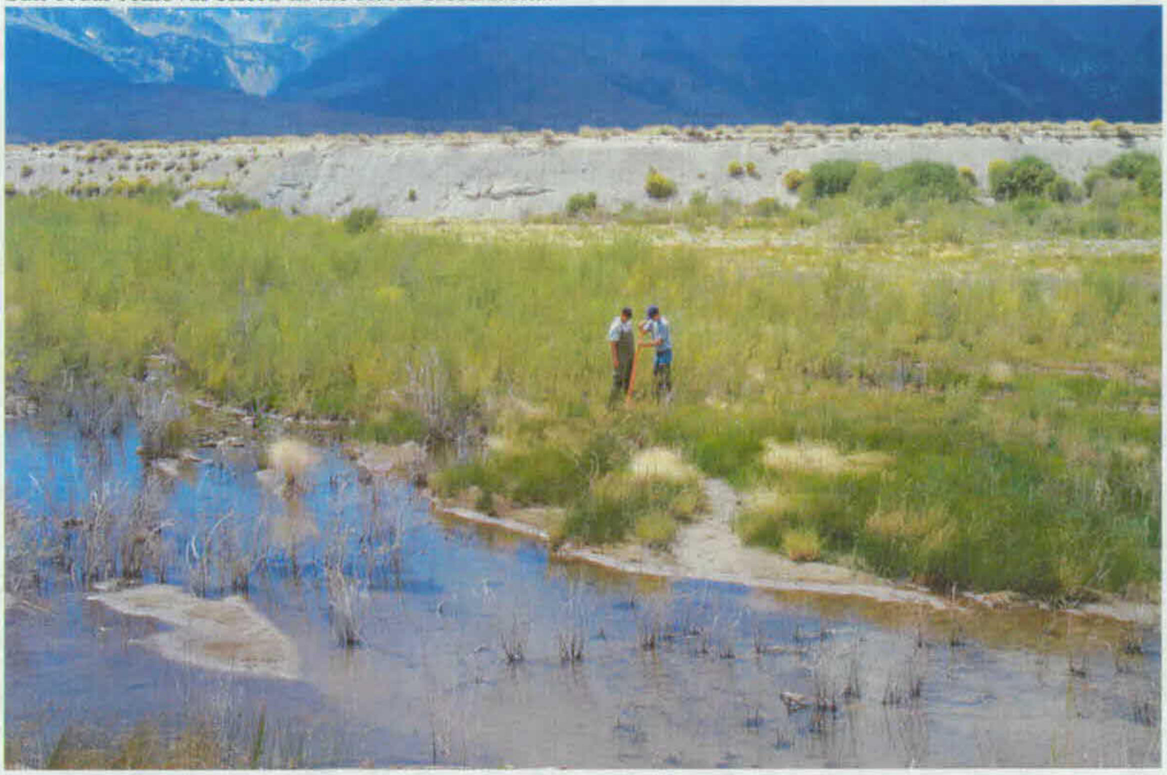
	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6
Bare	10.67	--	--	28.0	2.67	3.33
Litter	6	3.33	8.67	30.0	13.33	8.00
Water	0.67	0.67	11.33	--	0.67	--
Bassia hyssopifolia	0.67	--	--	--	--	--
Disticilis spicata	2.67	--	--	6.67	2.00	--
Epilobium Ciliatum	1.33	--	--	--	--	--
Nitrophila Occidentalis	0.67	--	--	--	1.33	--
Juncus balticus	--	--	0.67	--	--	--
Scirpus acutis	--	--	3.33	--	--	0.67
Scirpus pungens	--	18.00	53.33	--	16.67	51.33
Low growing *Scirpus spp.*	70.7	75.3	22.1	35.33	58.67	36.67
Triglochin Concinna	6.0	2.67	--	--	0.67	--
Unknown annual forb	0.67	--	0.67	--	4.0	--

Appendix I.

Natural resources staff began salt cedar control in the Mono Basin this week. Two range science students working for the department removed approximately 700 plants from the Rush Creek Delta. The department is taking a proactive approach in hopes that this highly invasive species will not reach the nearly uncontrollable numbers that it has elsewhere in the watershed.

In addition to these efforts, the Mono Lake Committee, with the consent of the USDA Forest Service, California State Parks, and the Department of Water and Power initiated salt cedar removal as a part of their restoration days activities.

Salt cedar removal efforts in the Rush Creek Delta.



“Weed wrench” being utilized to remove salt cedar. This tool is very effective at removing the root of the salt cedar to ensure that the plant does not resprout.

STATE OF CALIFORNIA—THE RESOURCES AGENCY

GRAY DAVIS, Go

DEPARTMENT OF FORESTRY AND FIRE PROTECTION

San Bernardino Ranger Unit
3800 Sierra Way
San Bernardino, California 92405
(909) 881-6900

January 18, 2001

Mr. Dale Schmidt
Los Angeles Department of Water and Power
300 Mandich Street
Bishop, CA 93514

RE: Warm Springs Prescribed Burn Project

Attached is a copy of the Incident Action Plan (IAP) for this project. It incorporates many of the issues discussed in our November 8, 2000 correspondence. This IAP represents the minimum requirements necessary to safely conduct the burning operation. The burn prescription parameters have only been described in general terms in the IAP. A more specific prescription will be developed as the Vegetation Management Contract process progresses.

Please advise us when your Department and any other agencies with review and approval over-site have completed their evaluation. Once CDF receives written confirmation the plan has been approved by all appropriate agencies we will complete a VMP contract. While the VMP contract is being prepared Fire Crews from the Owens Valley Conservation Camp will begin the preparatory work on the perimeter control lines.

As always, we look forward to a continued cooperative relationship with the Los Angeles Department of Water and Power on this project.

Sincerely,

Tom O'Keefe
Unit Chief

By Kenneth P. Toy

Kenneth P. Toy
Division Chief

INCIDENT OBJECTIVES	1. Incident Name WARM SPRINGS BURN	2. Date March	3. Time 0700

4. Operational Period

1000 to 1700

5. General Control Objectives for the Incident (include alternatives)

Under prescription burn approximately 10 acres to include the southern Warm Springs pond.

To accomplish this task we will establish fire control lines 15' wide on the north, south and east sides of the project. The firelines will consist of 3' to soil, ice or mud with 6' weedeated to stubble on each side, for a total fireline of 15'. The north and south firelines will run from the lake edge to the east approximatly 250 meters. Then tie the line together between the north and south. Safety zones will be in predetermined locations on the corners and midway on the north and south lines. These safety zones will be 150' x 150' of stubble or sparse weedeated vegetation except for Safety Zones 3 and 4. These zones will be constructed to bare mineral soil.

As an escape contingency secondary lines will be established to the north and south of the project. These lines will be cut the same as the project firelines, but in a more sparse area to cut down on line construction.

The access road to the project will be improved and maintained throughout the duration of the operation.

The road will be accessible for 2 wheel drive crew buses and engines all the way to the staging area. Parking must be allowed off the roadway at staging for water tender and other through traffic.

6. Weather Forecast for Period

To be Determined, but will not have any weather systems in the 3 day forecast.

7. General Safety Message

All personal protective equipment (PPE) will be utilized by all personnel assigned. Use caution while driving, use headlights, chock blocks, and park off

The roadway to allow for through traffic. Any civilian observers are to remain out of the fire area. A designated observation area will be established

For non-fire personnel.

LCES

8. Attachments (mark if attached)

- ☒ Organization List - ICS 203
- ☒ Div. Assignment Lists - ICS 204
- ☒ Communications Plan - ICS 205
- ☒ Medical Plan - ICS 206
- ☒ Incident Map
- ☐ Traffic Plan
- ☐ (Other)
- ☐
- ☐

9. Prepared by (Planning Section Chief)	10. Approved by (Incident Commander)
Craig Williams	Larry Martinez

ORGANIZATION ASSIGNMENT LIST

1. Incident Name
Warm Springs Burn

2. Date	3. Time

4. Operational Period
1000 - 1700

Position	Name
5. Incident Commander and Staff	
Incident Commander	CDF
Deputy	LADWP
Safety Officer	CDF
Information Officer	CDF/LADWP
Liaison Officer	

6. Agency Representative

Agency	Name
CDF	
LADWP	
CSP	
USFS	
WRB BLM	

7. Planning Section

Chief	CDF
Deputy	
Resources Unit	
Situation Unit	
Documentation Unit	
Demobilization Unit	
Technical Specialists	
Human Resources	
Training	

8. Logistics Section

Chief	CDF
Deputy	
Supply Unit	
Facilities Unit	
Ground Support Unit	
Communications Unit	
Medical Unit	
Security Unit	
Food Unit	

9. Operations Section

Chief	CDF
Deputy	

a. Branch I - Division/Groups

Branch Director		
Deputy		
Division/Group	A	CDF
Division/Group	B	CDF
Division/Group	Staging	CDF
Division/Group		
Division/Group		

b. Branch II - Division/Groups

Branch Director		
Deputy		
Division/Group		
Division/Group		
Division/Group		
Division/Group		
Division/Group		

c. Branch II - Division/Groups

Branch Director		
Deputy		
Division/Group		
Division/Group		
Division/Group		
Division/Group		
Division/Group		

d. Air Operations Branch

Air Operations Branch Director	
Air Attack Supervisor	
Air Support Supervisor	
Helicopter Coordinator	
Air Tanker Coordinator	

10. Finance Section

Chief	
Deputy	
Time Unit	
Procurement Unit	
Compensation/Claims Unit	
Cost Unit	

Prepared by (Resource Unit Leader)
Craig S. Williams

DIVISION ASSIGNMENT LIST	1. Branch	2. Division/Group A
3. Incident Name Warm Springs Burn	4. Operational Period Date: Time:	

5. Operations Personnel

Operations Chief		Division/Group Supervisor	
Branch Director		Air Attack Supervisor No.	

6. Resources Assigned this Period

Strike Team/Task Force/ Resource Designator	Leader	Number Persons	Trans. Needed	Drop Off PT./Time	Pick Up PT./Time
OVY#		17	NO	Staging	
OVY#		17	NO	Staging	

7. Control Operations

Keep fire to the north and west of the established fireline. Remember Environmental concerns, do not use foam or fusees.

Firing will be done under the direction of the firing officer ONLY.

Watch for spotting over the line.

8. Special Instructions

Use backpumps to hold and mopup. Only fill backpumps from watertenders in staging.

Know your Escape Routes and Safety Zones

LCES

9. Division/Group Communication Summary

Function	Frequency	System	Channel	Function	Frequency	System	Channel
Command		King NIFC		Logistics		King NIFC	
Tactical Div/Group		King NIFC		Air to Ground		King NIFC	

Prepared by (Resource Unit Ldr.)	Approved by (Planning Sect. Ch.)	Date	Time

DIVISION ASSIGNMENT LIST	1. Branch	2. Division/Group B

3. Incident Name	4. Operational Period
Warm Springs Burn	Date: Time:

5. Operations Personnel

Operations Chief		Division/Group Supervisor	
Branch Director		Air Attack Supervisor No.	

6. Resources Assigned this Period

Strike Team/Task Force/ Resource Designator	Leader	Number Persons	Trans. Needed	Drop Off PT./Time	Pick Up PT./Time
OVY#		17	NO	Staging	
OVY#		17	NO	Staging	

7. Control Operations

Keep fire to the south and west of the established fireline. Remember Environmental concerns, do not use foam or fusees.

Firing will be done under the direction of the firing officer ONLY.

Watch for spotting over the line.

Protect the northern pond or the burn research comparison will be lost.

8. Special Instructions

Use backpumps to hold and mopup. Only fill backpumps from watertenders in staging.

Know your Escape Routes and Safety Zones

LCES

9. Division/Group Communication Summary

Function	Frequency	System	Channel	Function	Frequency	System	Channel
Command		King NIFC		Logistics		King NIFC	
Tactical Div/Group		King NIFC		Air to Ground		King NIFC	

Prepared by (Resource Unit Ldr.)	Approved by (Planning Sect. Ch.)	Date	Time

DIVISION ASSIGNMENT LIST	1. Branch	2. Division/Group Staging Group
3. Incident Name Warm Springs Burn	4. Operational Period Date: Time:	

5. Operations Personnel

Operations Chief		Division/Group Supervisor	
Branch Director		Air Attack Supervisor No.	

6. Resources Assigned this Period

Strike Team/Task Force/ Resource Designator	Leader	Number Persons	Trans. Needed	Drop Off PT./Time	Pick Up PT./Time
OVY#	FC	17	NO	Staging	
E3563	FC	3	NO	Staging	
DWP/WT		2	NO	Staging	
DWP/WT		2	NO	Staging	
USFS/ Engine		2	NO	Staging	
T/D 3543	HFEO	2	NO	Poleline Rd.	

7. Control Operations

All resources to remain in staging until requested by the IC.
Be in full PPE and ready to respond within 1 minute of request.
Watch for spotting over lines. No foam or use of fusees.

8. Special Instructions

Use backpumps to hold and mopup. Only fill backpumps from watertenders in staging.

Know your Escape Routes and Safety Zones

L C E S

9. Division/Group Communication Summary

Function	Frequency	System	Channel	Function	Frequency	System	Channel
Command		King NIFC		Logistics		King NIFC	
Tactical Div/Group		King NIFC		Air to Ground		King NIFC	

Prepared by (Resource Unit Ldr.)	Approved by (Planning Sect. Ch.)	Date	Time

INCIDENT RADIO COMMUNICATIONS PLAN	1. Incident Name Warm Springs Bu	2. Date/Time Prepared	3. Operational Period Date/Time 1000 - 1700

4. Basic Radio Channel Utilization

Radio Type/Cache	Channel	Function	Frequency/Tone	Assignment	Remarks
King NIFC	1	Command	151.355 Rx 159.300 Tx	Command tone 4	IC / OPS / BDU
King NIFC	3	CDF Tac 3	151.175 Direct	Div. A & B	Firing / Crews
King NIFC	5	FS Tac 2	168.200 Direct	Interagency	Use only if needed for escape fire
King NIFC	8	Mono Co.	153.860 Rx 155.760 Tx	Ambulance	For communications with Medic 2
King NIFC					
King NIFC					
King NIFC					
King NIFC					

5. Prepared by (Communications Unit)

Craig S. Williams

MEDICAL PLAN	1. Incident Name Warm Springs Burn	2. Date Prepared	3. Time Prepared	4. Operational Period 1000-1700

5. Incident Medical Aid Station

Medical Aid Stations	Location	Paramedics	
		Yes	No
E3563	Staging area		X

6. Transportation

A. Ambulance Services

Name	Address	Phone	Paramedics	
			Yes	No
Medic 2	June Lake FD, Hwy 158 June Lake, Ca.	911	X	
Sierra Life Flight	Bishop Airport, Bishop Ca.	760-872-2201	X	

B. Incident Ambulances

Name	Location	Paramedics	
		Yes	No

7. Hospitals

Name	Address	Travel Time		Phone	Helipad		Burn Center	
		Air	Grnd		Yes	No	Yes	No
Mammoth SME	185 Sierra Park Way, Mammoth Ca.		1.5	760-934-3311		X		X
Bishop ER	150 Pioneer Ln., Bishop Ca.		2	760-873-5811		X		X
Washoe Med. Ctr	77 Pringle Way, Reno Nv.	1	4	775-982-4100	X		X	
Sherman Oaks BC	Los Angeles, Ca.	2	6	213-793-2424	X		X	

8. Medical Emergency Procedures

Supervisor will contact Warm Springs operations of injury. Supervisor will evaluate and provide primary care. Operations will arrange for proper transportation, depending on the nature of the injury or illness.

9. Prepared by (Medical Unit Leader)	10. Reviewed by (Safety Officer)
Craig S. Williams	

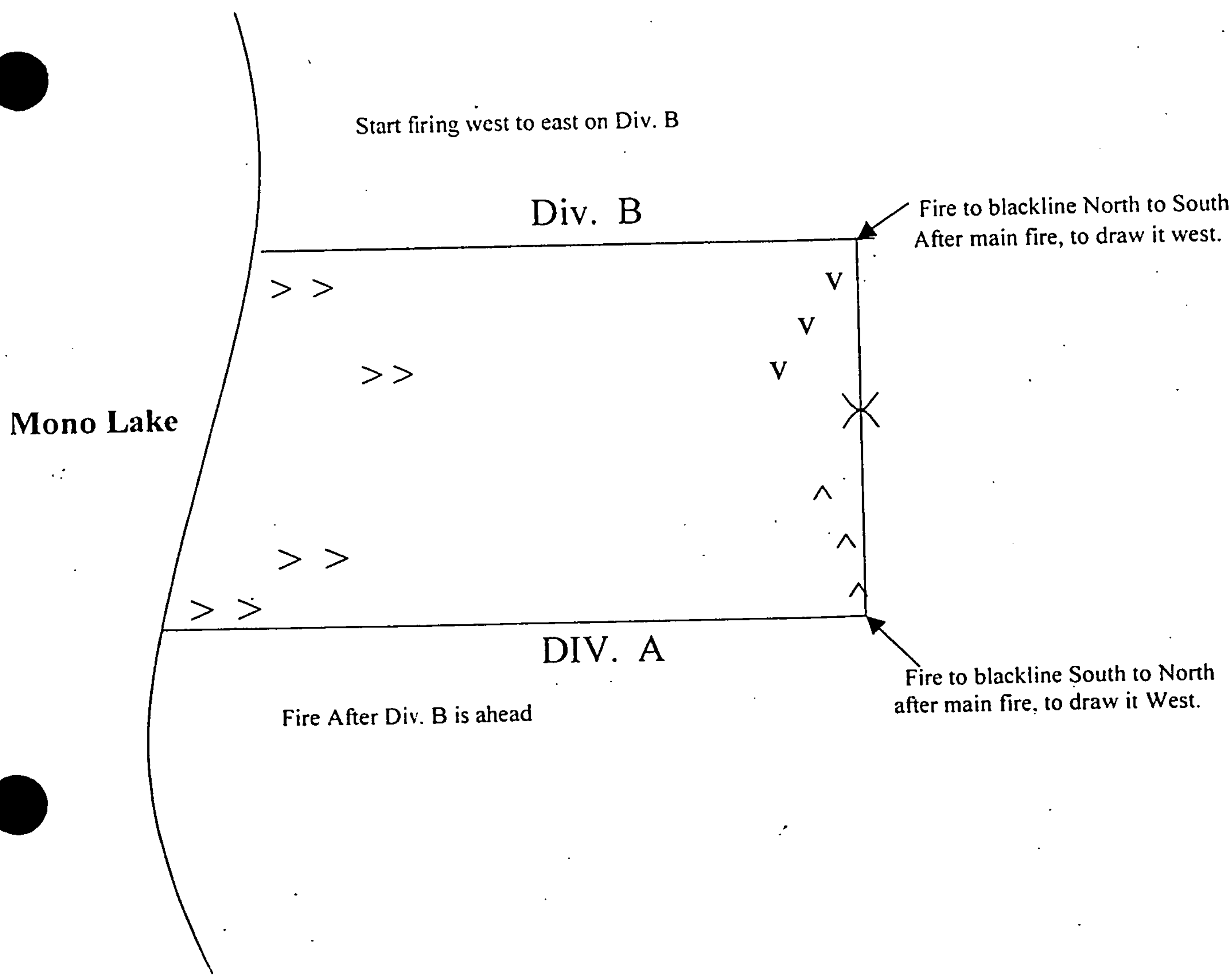
ICS 206

Warm Springs Firing Plan

The firing will be under the direction of the firing officer. No tactics will be employed without the permission of the firing officer. The division supervisors will act as safety officers during the firing operation and remain with the firing team. The firing teams will consist of 1 FC and 3 Inmate firefighters. The remainder of the crew will be spread out to watch for spots and shall have 8 back pumps and tools. All 4 crews assigned to divisions A & B will have firing teams ready at all 4 corners. Drip torches are to be used with 3 per firing team. NO fusees.

Firing will begin only if the test burn goes as planned and the wind is favorable. Firing should be started by 1100 hours and no firing will be done after 1300 hours.

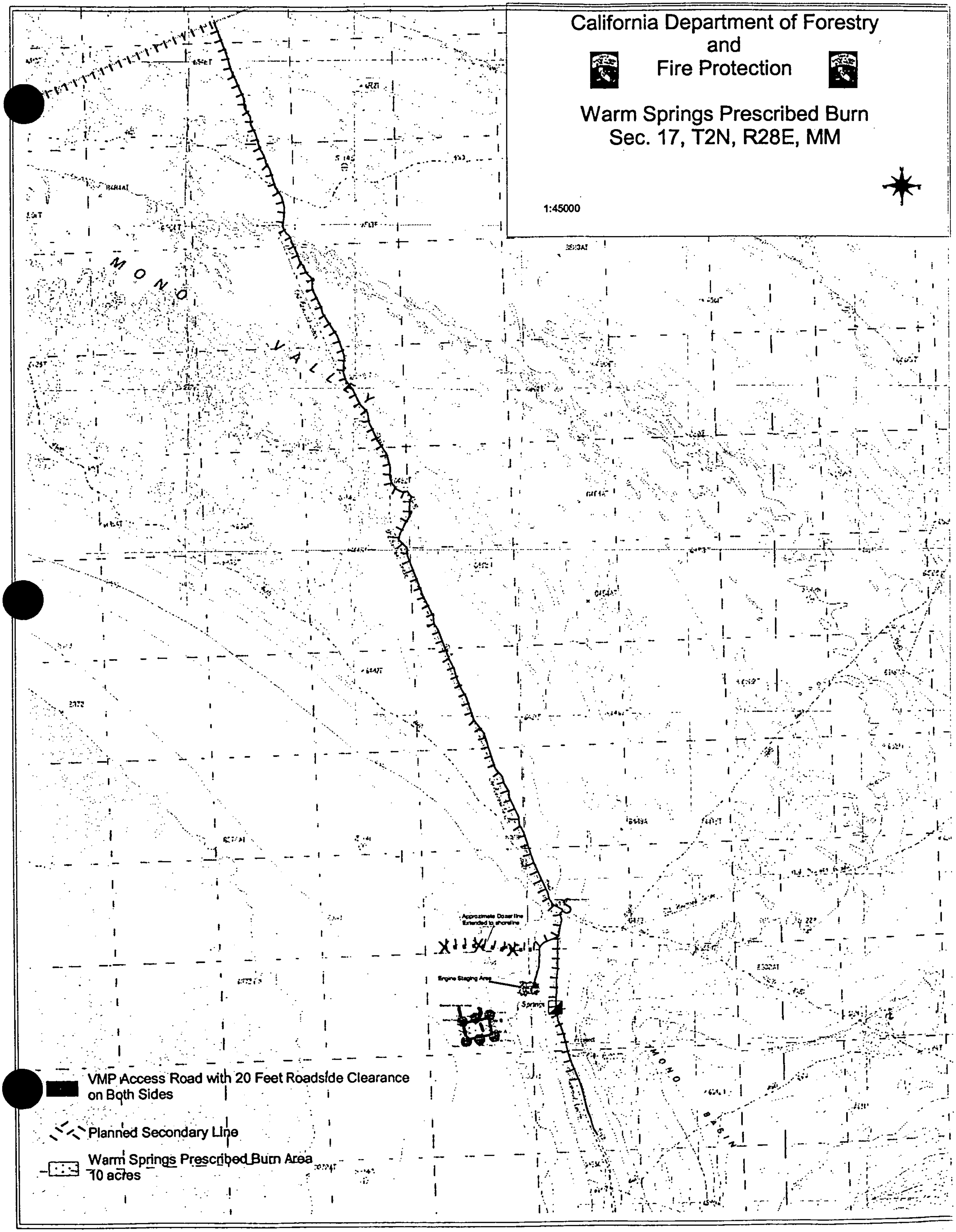
The firing sequence will go as follows with some possible variations in tactics if needed for a safe and complete burn. Division B will start the firing from the lake toward the east, not allowing the fire to get ahead of them or lighting too much to control its behavior. Division A will start firing after the firing officer has deemed that Division B is far enough ahead for a good blackline. As division B approaches the corner the 2nd Division B firing team will start firing south to blackline the east side. The same strategy will be used on Division A as they approach the corner with the 2nd Division A firing team. This should complete the exterior firing and if any interior cleanup firing is needed it will be done only if deemed safe.



Escape Fire Situation Analysis

With fire there is always the possibility of an escape due to unforeseen circumstances. With this in mind if the fire does escape the control lines and cannot be contained safely, we will back off to the nearest secondary line. Using equipment in staging and reassigning other equipment from divisions A and B through operations we will fire from the secondary line to contain the fire. This could mean a loss of the area to the north where the research pond is located.

In the event the secondary lines do not hold the fire, more aggressive firefighting efforts would be put into play, including more line construction, hoselays, and firing from other fuel breaks. All firefighting efforts will be used in accordance with CDF policy and with safety in mind. This also takes into consideration the environmental concerns of all participating agencies.


California Department of Forestry
and
Fire Protection
Warm Springs Prescribed Burn
Sec. 17, T2N, R28E, MM
1:45000
MONO VALLEY
MONO BASIN
Approximate Dozer line Extended to shoreline
Engine Staging Area
Springs
VMP Access Road with 20 Feet Roadside Clearance on Both Sides
Planned Secondary Line
Warm Springs Prescribed Burn Area 10 acres

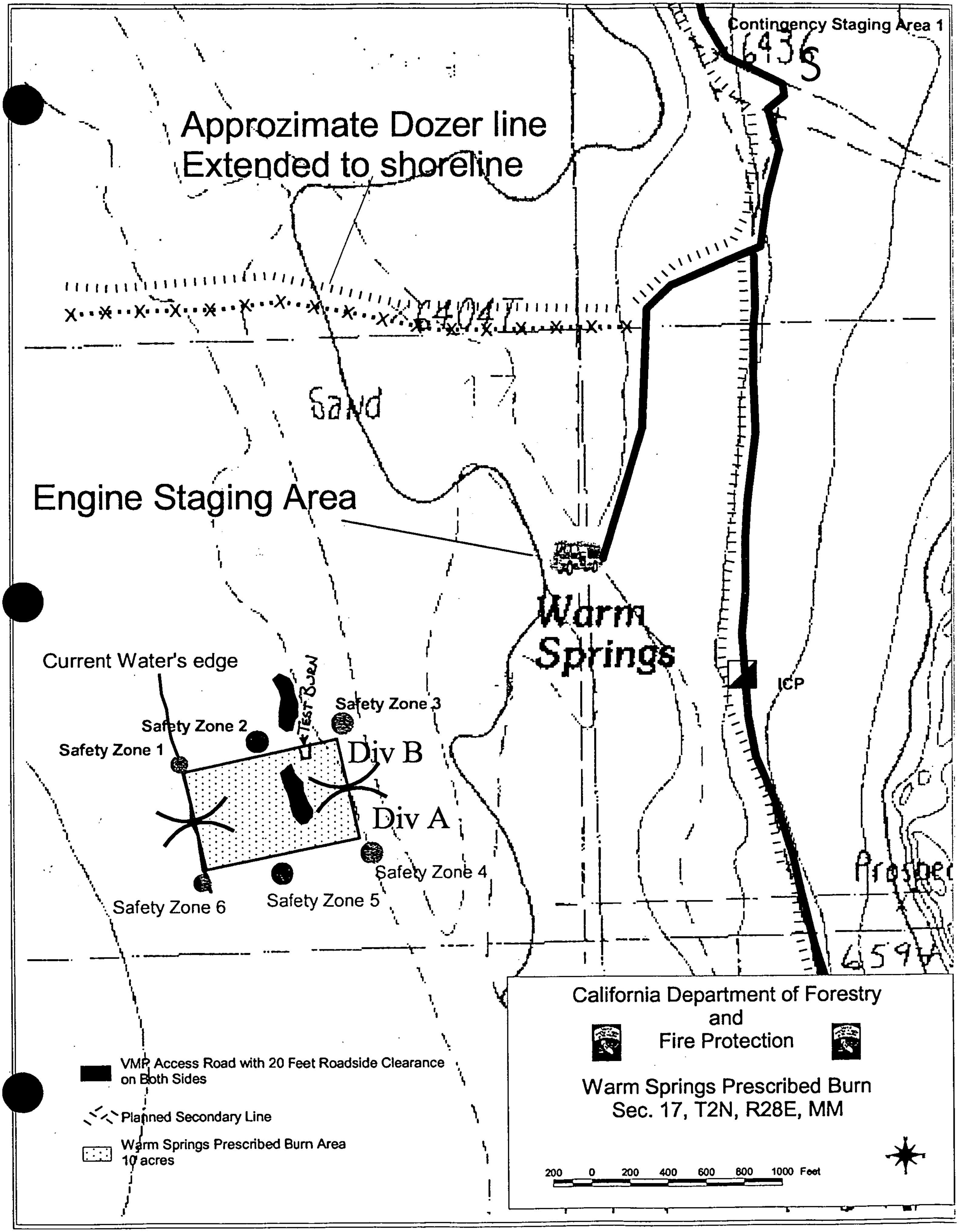
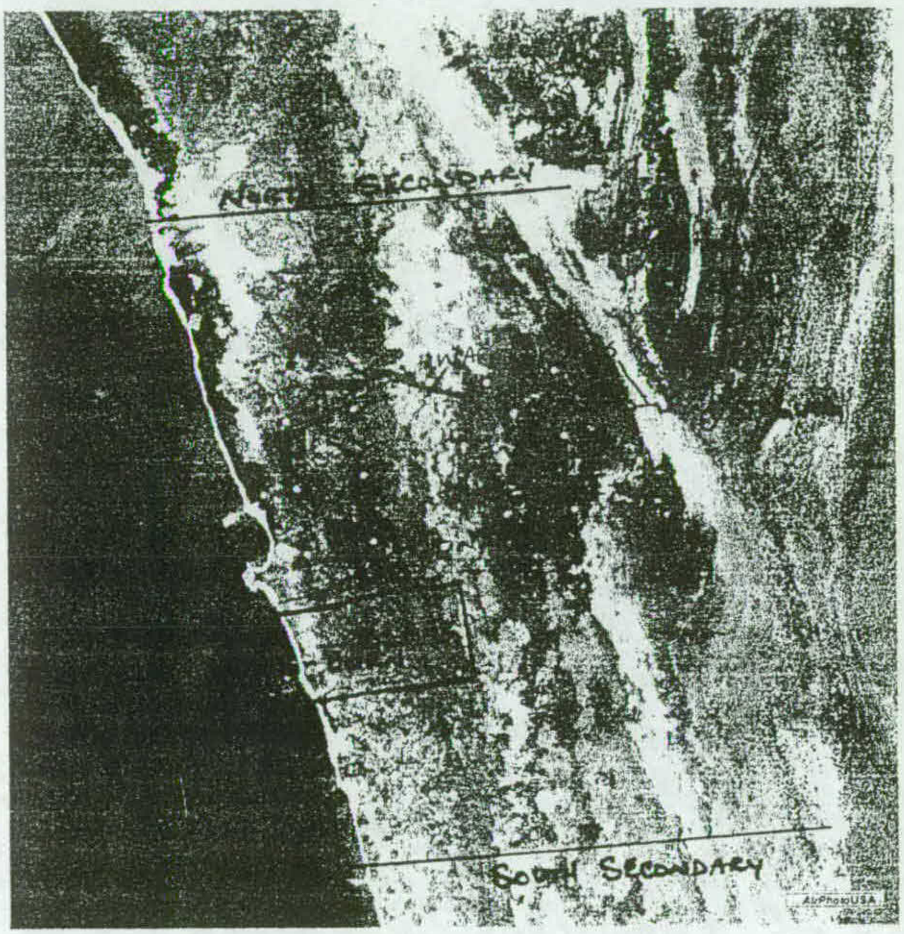
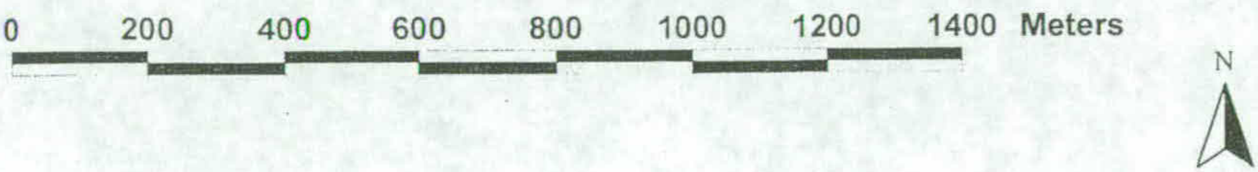

Contingency Staging Area 1
6436
Approzimate Dozer line
Extended to shoreline
6404T
Sand
17
Engine Staging Area
Warm
Springs
ICP
Current Water's edge
Test Burn
Safety Zone 3
Safety Zone 2
Safety Zone 1
Div B
Div A
Safety Zone 4
Safety Zone 5
Safety Zone 6
VMP Access Road with 20 Feet Roadside Clearance on Both Sides
Planned Secondary Line
Warm Springs Prescribed Burn Area 10 acres
California Department of Forestry
and
Fire Protection
Warm Springs Prescribed Burn
Sec. 17, T2N, R28E, MM
200 0 200 400 600 800 1000 Feet

Figure 3. Warm Springs vegetation monitoring site. Marked locations indicate sampling transect enpoints. Values presented inTable 2 are averages of sample transects of approximate equal distance from the lake shore.



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APPENDIX V

WATERFOWL POPULATIONS AT MONO LAKE, CALIFORNIA, 2000

WATERFOWL POPULATIONS AT MONO LAKE, CALIFORNIA, 2000

Joseph R. Jehl, Jr.

Hubbs Sea World Research Institute

Technical Report 2001-311

April 2001

NOTICE

WATERFOWL POPULATIONS AT MONO LAKE, CALIFORNIA, 2000.

Joseph R. Jehl, Jr.

Abstract.--This report summarizes monitoring studies on waterfowl populations at Mono Lake, California, and adjacent wetlands during the breeding and fall migration seasons 2000. The data were gathered to meet the requirements of State Water Resources Control Board Orders 98-05 and 98-07.

On 7 shoreline censuses conducted between late July and early December, I encountered 13,410 waterfowl of 16 species. Northern Shovelers, Green-winged Teal, Mallard, and Northern Pintail comprised about 80% of the waterfowl sightings (Ruddy Ducks excluded). Peak numbers occurred in October. On 7 surveys of freshwater ponds along the north shore in the same interval we encountered about 385 waterfowl of 11 species. Cinnamon Teal comprised slightly over 50% of the sightings. These ponds provided foraging and breeding habitat for a few waterfowl, but contributed little to overall abundance.

Ruddy Duck are the dominant species on the lake in fall. They seemed to be present in usual numbers, although their center of concentration seems to be shifting away from Black Point

Fewer waterfowl were encountered than in 1999. There were also differences in distribution. The Wilson/Mill Creek Delta remained a major concentration point, but the Sammann's Springs area was essentially ignored. The south shore between Navy Beach and Sammann's Springs attracted few birds because the fringing ponds had mostly dried out by early autumn.

There was no evidence that waterfowl used areas near Sammann's Springs that had been burned to create waterfowl habitat.

Data comparing waterfowl populations at Mono Lake, Bridgeport Reservoir and Crowley Lake are presented.

INTRODUCTION

Hubbs-Sea World Research Institute initiated research on the biology and ecology of waterbirds at Mono Lake, California in 1980. The goals were to gather data on the dominant species using saline lake habitats, namely California Gull, Eared Grebe, Wilson's Phalarope, and Red-necked Phalarope. In 1995, the State Water Quality Control Board requested information on waterfowl, to include species composition, timing and peak of migration periods, population size, distribution, behavior, and comparative data on waterfowl abundance at nearby lakes. This report is intended to comply with the monitoring requirements outlined in State Water Resources Control Board Orders 98-05 and 98-07.

METHODS AND RATIONALE

Definitions. Waterfowl refers to members of the Anatidae (ducks and geese). For clarity in this report, the Ruddy Duck is treated separately because its biology at Mono Lake differs from that of other ducks and geese.

Census Methods

Boat--Mono Lake.

To determine waterfowl numbers, I make full shoreline censuses of Mono Lake and fringing habitats that can support waterfowl. I make at least two surveys in June and July, to detect the presence, location, and success of breeding ducks. In the main waterfowl migration period, August through November, I census migrants at approximate 3-week intervals. I use a 14-foot Boston Whaler boat equipped with a 35 HP outboard motor and cruise 100-200 m from shore around the entire periphery.

I use a standard survey route, starting at the LADWP boat launch and continuing counterclockwise around the lake. The census starts at about 0800 and is completed by early afternoon. If the censuses cannot be completed in one day because of bad weather, any uncensused areas are surveyed as soon thereafter as feasible, usually the following day.

I count all waterfowl and record their numbers on a standard form (see Appendix I, Tables 1, 2). Data are recorded by general areas suggested by the State Water Resouces Board area (Fig. 1). Insofar as possible, counts at Wilson Creek (area 11) and Mill Creek (area 12) are kept separate. However, because disturbed birds often move back and forth in this small region, data from some censuses may be pooled. These movements are indicated on the forms whenever possible. If birds cannot be identified to species (e.g.,

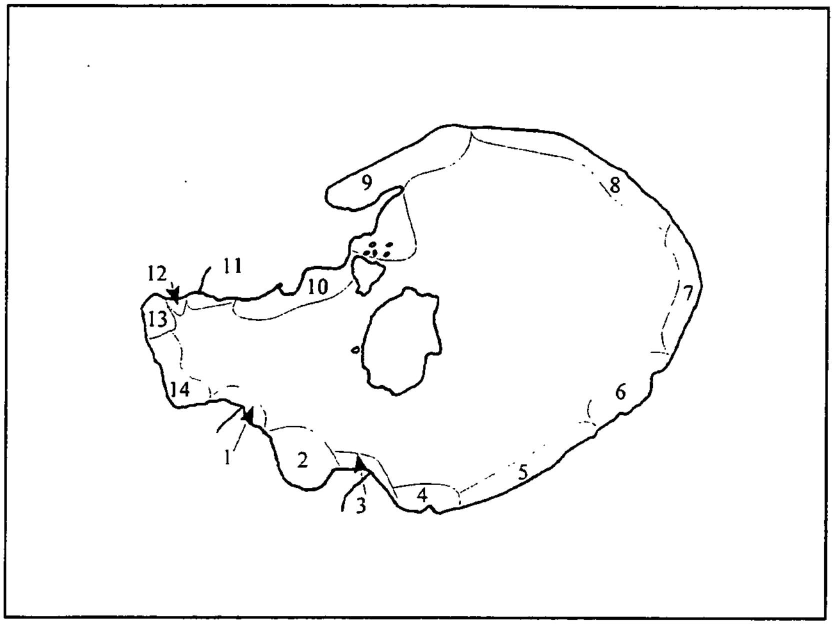

FIGURE 1. Observation areas used in lakewide waterfowl censuses: 1) Lee Vining Creek, 2) Ranch Cove, 3) Rush Creek, 4) South Tufa, 5) South Shore, 6) Sammann's Springs, 7) Warm Springs, 8) NE Shore, 9) Black Point E, 10) Black Point W, 11) Wilson Creek, 12) Mill Creek, 13) County Park, 14) West Shore.

when flocks flush at a distance), I estimate the size of the flock and, if possible , the relative percentage of each species, and from this calculate the number of each species involved. I also note the presence of other waterbirds, except for Eared Grebes, which are too numerous to count without using aerial photography (see Boyd and Jehl 1998). Scientific names are given in Appendix II.

For futher information on usage of nearshore ponds and lagoons, I go ashore in any area where coverage from the boat may be incomplete. In addition, I make 6-8 surveys by foot of the south shore ponds over the fall migration season. Data so gathered are added to the boat survey figures.

All but one of the species (Ruddy Duck) that use Mono Lake are closely tied to the vicinity of freshwater or slightly brackish situations (marshes, creek mouths, seeps), and except when disturbed occur within 50 m of shore. As a result, boat surveys are the most effective way to determine the size and composition of the population. They allow closer approach than air or foot censuses and provide better data on numbers and species composition. They also provide access to all shoreline areas and creek mouth areas, except for a few freshwater seeps east of Black Point, which at some lake levels are inaccessible because of submerged rocks. Boat censuses allow coverage of the entire lake in one day, and cause minimal disturbance. Foot surveys are impractical because of the great area that must be covered, and because a walking human causes birds to move around, leading to the chance of over- or undercounting. I judge that counts are accurate to within ± 15%.

Ruddy Duck.-- I report information on the Ruddy Duck separately, because its distribution at Mono Lake differs from that of other waterfowl. It is not constrained by proximity to fresh water. Indeed, the bulk of the population is often offshore, where birds are undetectable among the hundreds of thousands of Eared Grebes. Accordingly, the species cannot be fully censused by near-shore transects. Cross-lake transects provide a rough index to population size and distribution, but are impractical on a large scale because of the size of the lake and the problem of detection. Aerial surveys (below) are no better, because Ruddies do not fly in response to a plane. Thus, at most times, population estimates are only approximate.

Foot. Concomitant with the shoreline survey schedule (above), I census all fresh water ponds [Dechambeau Ponds (5) and County Ponds (2)] on the north shore near Black Point. Counts are made on foot, usually in the late afternoon (1700-1900), when some ducks move from the main lake to freshwater feeding locations. The number of birds using these ponds is so small that counting errors do not exceed 5%. This area is heavily visited by hunters, tourists, and birders, which can affect the number of birds that may be encountered.

Air. Aerial surveys at Mono Lake follow the same route as the boat surveys. They are made from an elevation of about 200 feet above lake level and at a speed of about 80 mph. Usually there are two counters, one on each side of the aircraft, in addition to the pilot. Aerial surveys also provide a good indication of overall abundance and distribution, and allow observations at a small creek mouth on the north shore that is sometimes inaccessible by boat. However, they tend to be less precise than boat surveys, because waterfowl flush at greater distances, which makes estimates of flock size and species identification more difficult. Their utility for counting Ruddy Ducks at Mono Lake (only) is noted above.

Comparative surveys

To determine the importance of Mono Lake relative to other nearby waterfowl habitats, I surveyed two large freshwater lakes in the vicinity: Bridgeport Reservoir and Crowley Lake. These surveys are done by air, if possible, using procedures similar to those at Mono Lake, except that each lake is flown twice, and the mean count is used in determining total numbers. Ruddy Ducks can be counted at these fresh-water lakes, because Eared Grebes are scarce. If weather conditions for these are not suitable, or if a plane is not available, surveys are done on land.

Land censuses at Bridgeport Reservoir are made from the road along the entire south side of the lake, using a 20-60 × spotting scope. This provides good information on total numbers, but limited information on species composition because many dabbling ducks congregate on the distant northwest shore.

Land censuses at Crowley Lake are made from vantage points on the northeast corner and along the entire west shore, from the mouth of Hot Creek to the dam. Because very few dabbling ducks occur along the eastern shore (there is little suitable habitat), this procedure is satisfactory for determining abundance and species composition lakewide.

RESULTS

Mono Lake

Between 1 June and 7 December I conducted 11 waterfowl censuses (7 boat, 4 plane) (Appendix I, Table 1). An additional boat survey of the western half of the lake was made on 3 May. In addition between 3 May and 14 November, I made 10 censuses of waterfowl on the north shore ponds (Appendix I, Table 2).

Breeding waterfowl

The June and July surveys emphasized breeding waterfowl. The Gadwall is the only duck that breeds commonly and consistently on the fringes of Mono Lake. In 2000, 16-20 pairs nested near the main lake, with an additional pair at the Dechambeau Ponds (Fig. 2). The population was estimated at 30-35 pairs in 1999. The main nesting area was along the western arm, between Wilson Creek and Ranch Cove. No more than one pair nested in Samman's Springs, which for many years has been a good breeding area.

Hatching began in late June [evidenced by a brood with large (414 g) young on 8 July and another with young to 700 g on 30 July] and continued into mid-July (young 419 g on 12 August). The size of ducklings indicated a peak hatch in the first week of July.

Through 6 September, when the last unfledged juveniles were seen, I could account for about 92 young. Production was surely much lower than in 1999, when I estimated 205 juveniles on 15 August.

In most years, a few adult male Gadwall molt locally. On 1 June, nearly 200 Gadwall (mostly adult males), along with other ducks, were in a lagoon near Warm Springs. These were not seen later and presumably molted elsewhere. Most of 47 Gadwall at Wilson Creek on 8 July were adult males that were unable to fly, and at least 6 nonflying males were still present on 6 September.

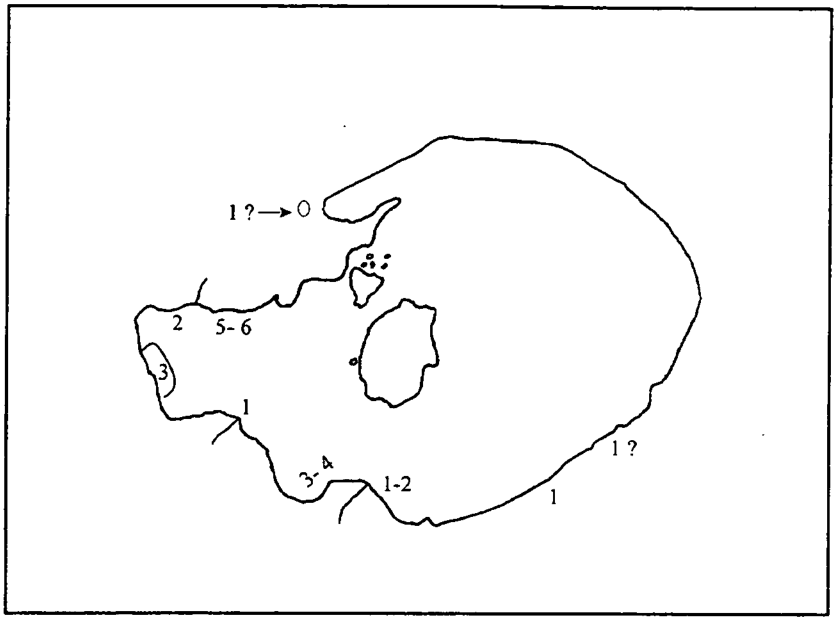

FIGURE 2. Number of Gadwall pairs as determined in mid-July-early August 2000, is shown by location.

For studies of food habits, growth, and migration, I captured and banded 9 adults and 13 juveniles. Analysis of Gadwall biology will be presented elsewhere.

Other duck species nest occasionally. A female Northern Pintail with 7 young appeared on County Pond 1 on 30 July, and some young were still there on 11 August; another female bred near Pond 3 on the south shore and guarded 2 large (500g) young on 8 July. A duck with 5 young near Sammann's Springs on 11 August was not seen clearly and may have been a Mallard.

Mono Lake: Migrating waterfowl

The 16 ducks (6 species) on the western end of the lake on 3 May were migrants. The same was true of > 400 ducks (11 species) on 1 June, most of which were in freshwater lagoons along the south shore and at Warm Springs. The only potential breeding waterfowl were about 18 scattered pairs of Gadwall and 1 pair of Mallards at Lee Vining Creek. By 8 July the transients had departed. Ten male Redheads were probably on a molt migration.

The first obvious fall migrants (mainly Cinnamon Teal, with a scattering of Mallards and Northern Pintails) were present on 30 July. Numbers then increased into late October before dropping off sharply in mid-November (Fig. 3). Exclusive of Ruddies, 8,898 waterfowl of 15 species were recorded. Northern Shovelers, Green-winged Teal, Mallards, and Northern Pintails predominated (Table 1), with Northern Shovelers comprising 65% of the individuals identified to species.

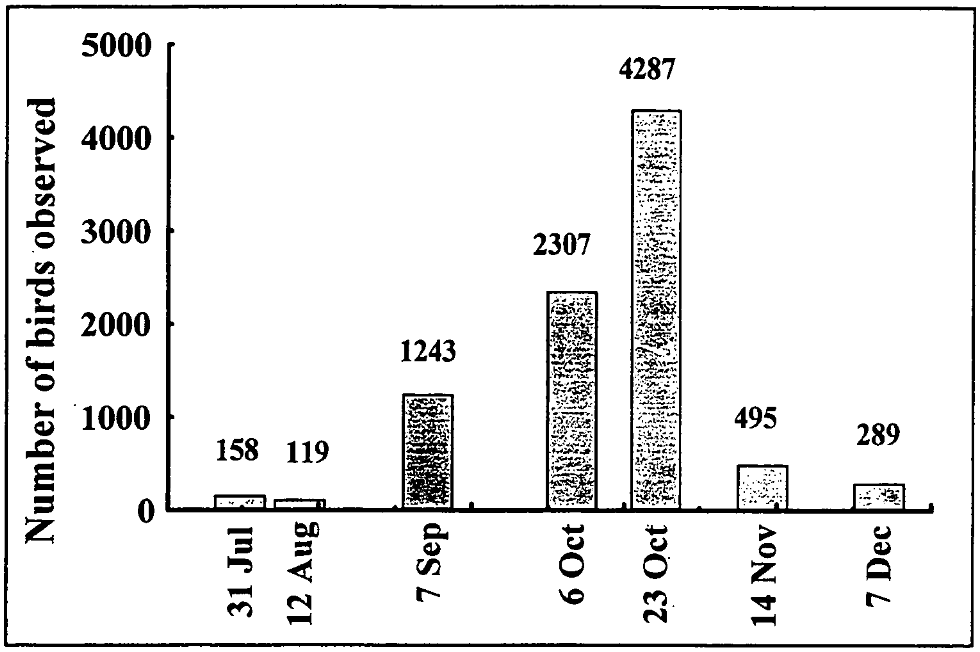

FIGURE 3. Waterfowl (excluding Ruddy Ducks) observed on shoreline censuses of Mono Lake, 2000. This graph excludes flightless Gadwall juveniles (July-August); after fledging, however, these birds become indistinguishable from other Gadwall, so that counts in September may include local young in addition to migrants.

Migration timing of the commonest species is shown in Figure 4. In most years, Northern Shoveler reach peak abundance in September (Jehl pers. obs.). In 2000, the peak was several weeks later (>3200 on 23-24 October).

Ruddy Duck

The Ruddy Duck is the commonest duck through most of the fall. The main influx starts in mid-September and birds are present into early winter. This species cannot be censused with great accuracy at Mono Lake; both boat and air techniques greatly underestimate population size in mid season. They can be counted most accurately in late September, when just arriving, and in late fall after grebes have left. This was the case on 7 December 2000, when I counted 1515 (and estimated 1800-2000) on an aerial survey conducted under ideal conditions.

In 2000, the number of birds detected was relatively low (Fig. 4, see below).

TABLE 1. Waterfowl detected on shoreline censuses on Mono Lake, CA, 2000.

Species								TOTAL	Percent
	30 Jul-1 Aug[a]	11-12 Aug	6-8 Sep	6-7 Oct[b]	23-24 Oct	14-Nov	7-Dec		
Waterfowl									
Snow Goose						5	4	9	0.10
Ross's Goose						2	1	3	0.03
Canada Goose				5	28	2	6	41	0.46
Brant					2			2	0.02
Gadwall	33	15	55					103	1.16
American Wigeon					8			8	0.09
Mallard	10	20	133	180	83	196	83	705	7.92
Blue-winged Teal				2				2	0.02
Cinnamon Teal	45	22	125		2			194	2.18
Northern Shoveler		38	370	1230	3207	2	11	4858	54.60
Northern Pintail		6	260	250				516	5.80
Green-winged Teal		2	150	180	≅ 300	258	122	≅ 1012	≅ 11.37
Redhead		1		20				21	0.24
Bufflehead					5			5	0.06
Red-breasted Merganser							6	6	0.07
Unidentified ducks	70	15	150	440	652	30	56	1413	15.88
TOTAL Waterfowl*	158	119	1243	2307	4287	495	289	**8898**	
Ruddy Duck		5	500	855	774	863+	1515	4512+	

a Combined high counts of boat censuses on 30 July and 1 August and aerial census on 31 July.

b Combined high counts of boat censuses on 6-7 October and aerial census on 7 October.

* Excludes Ruddy Duck

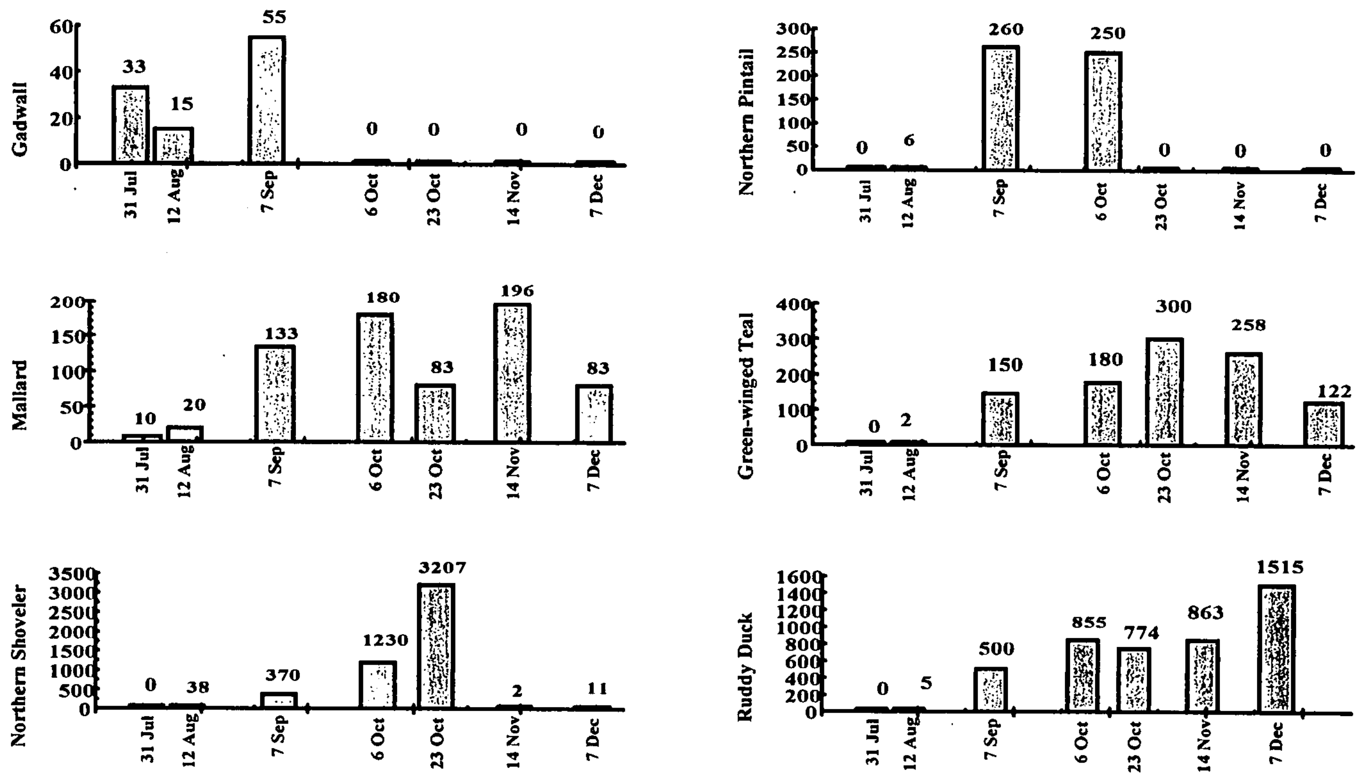

FIGURE 4. Fall migration timing of the commonest ducks at Mono Lake, 2000.

North Shore Ponds

One pair of Northern Pintail and perhaps 1 pair of Gadwall were the only ducks known to have nested on the Dechambeau/County ponds in 2000. At least 1 pair of Coots reared young on each of Dechambeau Ponds 1, 2, and 3.

The timing of fall migration parallels that on the main lake. On 7 surveys (Table 2) I recorded about 385 waterfowl. Cinnamon Teal accounted for about half of all sightings. Ruddy Ducks and Northern Shovelers, which are abundant on Mono Lake, rarely appear. Coots are most common and consistent waterbird migrants, with a peak of 155 on 6 October and one still present on a partly frozen pond on 7 December. Details are presented in Appendix I, Table 2.

The attractiveness of the ponds varies through the year. In 2000, both of the County Ponds held water through the season and together attracted nearly 80% of the waterfowl in May-December and nearly 90% in fall migration (July-Dec). They also replaced Dechambeau 4 as the preferred bathing/drinking site for California Gulls. Marsh vegetation continued to proliferate in the Dechambeau Ponds, to the extent that the surface of Pond 3 was often clogged with weeds. A new pond (Dechambeau 5) was under construction in mid-October. It held water by early December, but will require time to develop habitats suitable for aquatic birds.

Comparison with other lakes

I made comparative surveys of Mono Lake, Crowley Lake, and Bridgeport Reservoir on 6-8 September and 7-8 October (Tables 3, 4). In September, a minimum of 90% of the ducks in the region were at Bridgeport Reservoir, where low water made good feeding opportunities. Waterfowl at Crowley Lake were only half as numerous as at Mono Lake. October counts at both Bridgeport and Crowley were higher than at Mono.

The number of waterfowl at Crowley Lake in September relative to that at Bridgeport Reservoir was much lower than might have been expected. This may have resulted from high levels of human disturbance: the area was being heavily fished by people in boats and float tubes. In October, numbers at Crowley were larger than at Bridgeport. By that season, fishing pressure is greatly reduced.

Interpretation of these data is complicated by several factors that vary from year to year. These include foraging conditions (particularly variable at Bridgeport Reservoir); migration timing; levels of human disturbance (see below); and the perennial difficulty in detecting Ruddy Ducks on Mono Lake (but not elsewhere) from a plane.

In any event, waterfowl numbers (excluding Ruddy Ducks) at Mono Lake are usually smaller than on other lakes (Table 5).

TABLE 2. Waterfowl detected on freshwater ponds on the north shore of Mono Lake, CA, 2000.

Species								TOTAL
	30-Jul	11-Aug	5-Sep	6-Oct	23-Oct	13-Nov**	7-Dec***	
Waterfowl								
White-fronted Goose				20*				20
Canada Goose	7							7
Gadwall	12	1	12	3				28
American Wigeon				8				8
Mallard		55	12					67
Cinnamon Teal	15	167	14-19					196-201
Northern Shoveler		2	20	2				24
Northern Pintail	1	2	5	1				9
Green-winged Teal			5	1				6
Redhead			2					2
Unidentified ducks			14					14
TOTAL Waterfowl******	35	227	84-89	35	0	0	0	**381-386**
Ruddy Duck	1	1		1	8			11

* Fly over: Attempted to land

** Four of seven ponds frozen

*** Three of seven ponds frozen

**** Excludes Ruddy Duck

TABLE 3. Waterbird populations at Bridgeport Reservoir, Mono Lake, and Crowley Lake, 6-8 September 2000.

	Bridgeport Res.	Mono Lake	Crowley Lake
Method	Land	Boat	Aerial
Date	7-Sep	6-8 Sep	8-Sep
Species			
Waterfowl			
Canada Goose	1020		
Gadwall	✓	55	
Mallard	✓	133	
Cinnamon Teal		125	
Northern Shoveler	✓	370	
Northern Pintail	✓	260	
Green-winged Teal	✓	150	
Redhead	✓		
Unidentified	15,000-23,000[a]	150	680
TOTAL Waterfowl*	16,000-24,000	1243	680
Ruddy Duck	0	500	0
Other Species			
Pied-billed Grebe	10		
Eared Grebe	300		30
Western Grebe	350		200
American White Pelican	150		171
Double-crested Cormorant	300		150
Great Blue Heron			20
Cattle Egret			20
American Coot	13,270	250	3200

✓ = Present

* Excludes Ruddy Duck

[a] Rough flying conditions, distance and extreme sun glare precluded accurate species determination.

Observers: Bridgeport Reservoir - J. Jehl

Mono Lake - J. Jehl, D. Marquart

Crowley Lake - J. Jehl, P. Dewitt

TABLE 4. Waterbird populations at Bridgeport Reservoir, Mono Lake, and Crowley Lake, 7-8 October 2000.

	Bridgeport Res.	Mono Lake	Crowley Lake
Method	Land	Aerial/Boat	Aerial
Date	7-Oct	6-7 Oct	8-Oct
Species			
Waterfowl			
Canada Goose	100	5	390
Gadwall	10		
Mallard	150	180	✓
Blue-winged Teal		2	
Cinnamon Teal			
Northern Shoveler	2740	1230	✓
Northern Pintail	✓	250	✓
Green-winged Teal	✓	180	350
Redhead		20	1
Unidentified ducks	1750	440	6000*
TOTAL Waterfowl**	4750+	2307	6741
Ruddy Duck	<100	855	1050
Other Species			
Common Loon			3
Pied-billed Grebe	✓		
Eared Grebe	✓	>1,000,000	80
Western Grebe	80	2	250
American White Pelican	13		80
Double-crested Cormorant	12	2	
Great Blue Heron			
Cattle Egret			
American Coot	250	317	960
Wilson's Phalarope		2	
Red-necked Phalarope		800	

✓ = Present

* Northern Shoveler, Mallard and Northern Pintail

** Excludes Ruddy Duck

Observers: Bridgeport Reservoir - J. Jehl, H. Ellis
Mono and Crowley lakes - J. Jehl, H. Ellis, P. DeWitt

TABLE 5 Comparative counts of waterfowl at Bridgeport, Mono, and Crowley lakes. Numbers of Ruddy Ducks are given in parentheses.

Year	Date	Bridgeport	Mono	Crowley
1996	9 Sep	2871 (0)	1225 (40)	-
1997	17 Sep	27,050 (0)	2338 (6)	12,035 (600)
1999	17 Sep	8350 (106)	3576 (627)	10,716 (750)
2000	6-8 Sep	16-24K (0)	1243 (500)	680 (0)
1996	16 Oct	6860 (0)	2153 (360)	8516 (3840)
1997	14-15 Oct	3908 (2845)	1662 (500)	2000 (500)
1998	17 Oct	-	6230 (4250)	-
1999	14 Oct	4948 (400)	10,657 (3998)	4562 (1300)
2000	7-8 Oct	4850 (<100)	3162 (855)	7791 (1050)

DISCUSSION

Data gathered in 2000 supplemented those gathered in earlier surveys (1995-1999; see Appendix IV).

Annual comparisons

Censuses at Mono Lake from 1996-2000 (Fig. 5) are presented to show total waterfowl, waterfowl excluding Ruddy Ducks, and Ruddy Ducks. (Summary data from 1995-1999 are given in Appendix IV.) In general, numbers and phenology of waterfowl, excluding Ruddy Ducks, at Mono Lake were similar in all years. Differences in the size of the fall flights occur from year to year in response to production in the breeding grounds, and timing varies in response to weather conditions farther north. The relatively high number of ducks (dominated by Northern Shoveler) seen on 23-24 October 2000, for example, is suggestive of a late flight, because Shoveler numbers usually peak in September.

How closely these numbers correspond to the actual numbers of migrants using Mono Lake cannot be determined without information on length of stay (turnover times). Some species (e.g., Green-winged Teal, Northern Shoveler) probably have a relatively long stay, but the rarer species probably pass through in a day or so, because they are usually encountered only once and have limited, if any, foraging opportunities.

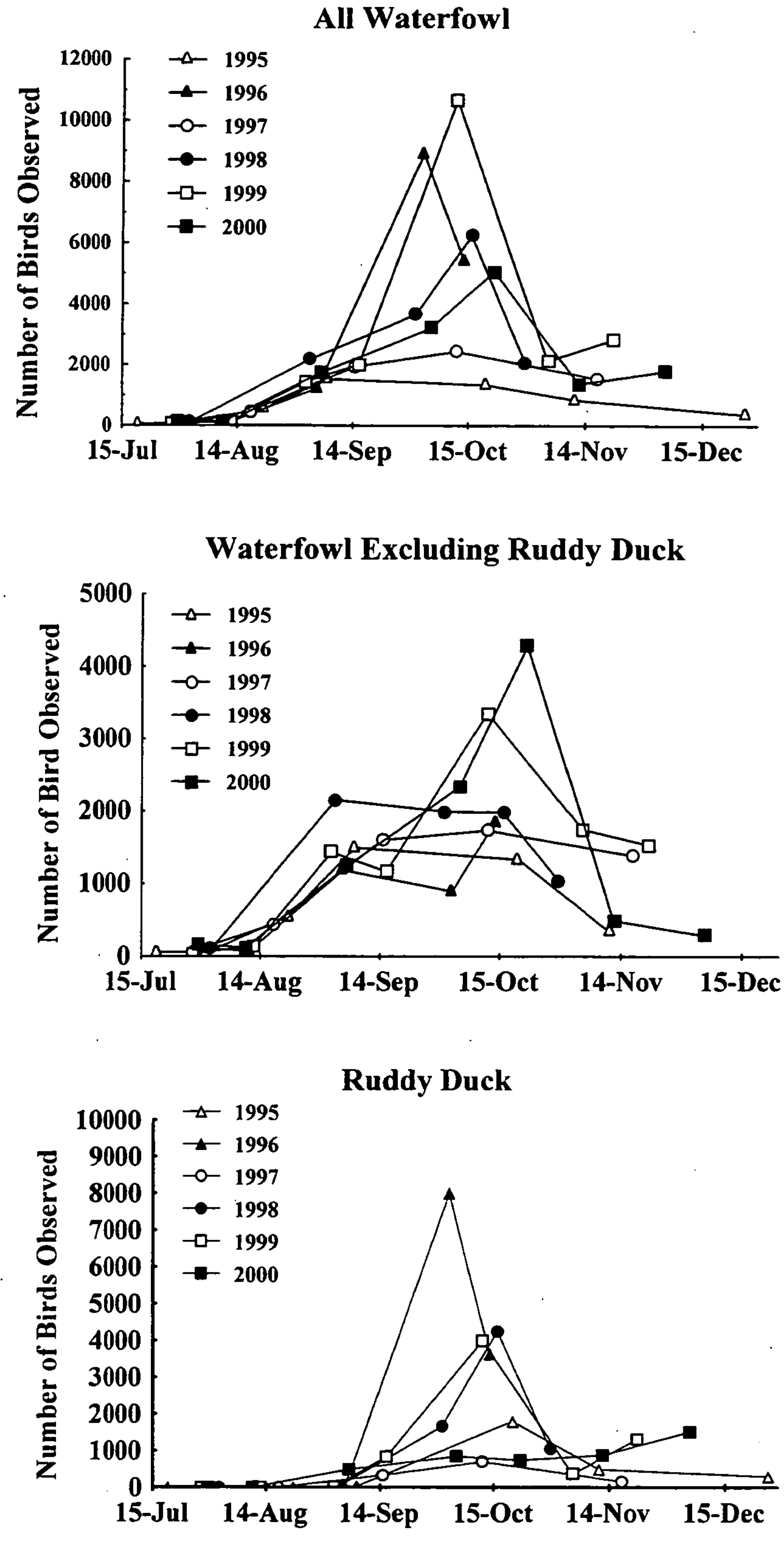

FIGURE 5. Waterfowl censuses at Mono Lake, 1995-2000.

In former years the Wilson/Mill creek delta and the Sammann's Springs area were major concentration points for migrants. In 2000, Sammann's Springs seemed to attract relatively fewer migrating ducks. It was also essentially ignored by nesting ducks, migrating Wilson's and Red-necked phalaropes, and staging Eared Grebes, which can usually be found there by the thousands in late summer and fall. In addition, the main distribution of Ruddy Ducks has shifted away from the tufa shoals east of Black Point. Whether these shifts were associated with a changing lake level, which would affect the size and distribution of freshwater seeps, may be clarified with future studies.

The lack of waterfowl using the south shore area was obviously due to the drying of the ponds in later summer and early fall.

Controlled Burning

One aspect of the Recovery Plan called for burning marsh vegetation near Sammann's Springs to create waterfowl habitat. A 50-acre plot was burned January 1998, and a 5-acre plot had been burned three years earlier (D. Carle, Flames on ice. Mono Lake Newsletter 21(4): 4, 1999). On one foot transect and four aerial overflights I saw no waterfowl in either of these areas. In my opinion the burning program is neither cost effective or biologically useful. Consideration of this continuing activity is recommended, as it is likely to destroy, not create, nesting habitat. Kruse and Bowen (J. Wildl. Manage. 60:233-246, 1996) found that burning practices "..demonstrated little benefit [for enhancing] waterfowl populations."

In anticipation of additional burning in winter 2000-2001, I made two surveys in the Warm Springs marshes in summer 2000 to determine the pre-burn composition of the breeding avifauna.

Time budgets

Because ducks are highly mobile, easily frightened, and often disturbed, classical time budget studies of individual birds or groups can rarely be carried out long enough to be meaningful. Data gathered in 1999 (Appendix V, Table 1) illustrate the difficulty in obtaining any significant data.

Useful data can be gathered on Ruddy Ducks, because they rarely fly and can be studied for long periods. Winli Lin collected significant data on Ruddy Ducks in several different areas of the lake on 15 September - 15 October 1997 (Appendix V, Table 2, and figures). She found that there were great differences in behavior between birds at the North Shore ponds vs. the open lake. At the ponds Ruddies spend most of their time (86%) foraging, whereas at locations on the lake they averaged 19%. She also found that there was a strong temporal component, with birds on the open lake foraging about 13% of the time in the morning (0800-1200), 17% in midday (1200-1600), and 25% in late afternoon/evening (1600-2000). From other observations (in prep.), we believe that this species probably feeds mostly at night, but we have not had the ability or technology to test that hypothesis. We hope to expand our data in fall 2001 by using radio-tagged birds to study movements, length of stay, and foraging behavior.

Acknowledgments

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APPENDIX I

Table 1. Results of shoreline censuses of waterfowl and other aquatic birds at Mono Lake, CA, 2000.

Table 2. Results of waterfowl censuses at freshwater ponds on the north shore of Mono Lake, CA, 2000.

APPENDIX 1

TABLE 1. Results of shoreline censuses of waterfowl and other aquatic birds at Mono Lake, CA, 2000.

Date: 3 May 2000 Survey: Boat Observers: J. Jehl

Species	LV Ck.*	Ranch Cove	Rush Ck	So Tufa	So Shore	Sammann's	Warm Sp	NE Shore	Blk PT E	Blk Pt W	Wilson Ck	Mill Ck	Co Park	W Shore	Other	Total	Comments
Waterfowl																	
Canada Goose																	
Gadwall	2															2	males
American Wigeon																	
Mallard	2															2	
Cinnamon Teal																	
Northern Shoveler																	
Northern Pintail	1															1	
Green-winged Teal										2						2	
Redhead	2															2	
Lesser Scaup																	
Bufflehead																	
Unidentified ducks																	
TOTAL Waterfowl**	7	ND	ND	ND	ND	ND	ND	ND	ND	2	0	0	0	ND	ND	9	
Ruddy Duck											1				6	7	
Other Species																	
Common Loon																	
Pied-billed Grebe																	
Western Grebe																	
American Coot																	

ND = No Data

* Birds in creek

** Excluding Ruddy Duck

APPENDIX I, Table 1.

Waterfowl at Mono Lake, CA Date: 1 June 2000 Survey: Boat Observers: J. Jehl, H. Ellis

Species	LV Ck.	Ranch Cove	Rush Ck	So Tufa	So Shore	Sammann's	Warm Sp	NE Shore	Blk PT E	Blk Pt W	Wilson Ck	Mill Ck	Co Park	W Shore	Other	Total	Comments
Waterfowl																	
Canada Goose										1						1	molting
Gadwall	2 (1 pr)	2 (1pr)	4 (2 pr)		200 (1pr)	2 (1pr)	75		20		14 (7 pr)	6 (3 pr)	2 (1 pr)	2 (1 pr)		329	
American Wigeon							2									2	
Mallard	2 (1 pr)				10	1	12		3							28	
Cinnamon Teal						2	6									8	
Northern Shoveler					2	3	2									7	
Northern Pintail					8	6	30		4							48	
Green-winged Teal						2										2	
Redhead							10		4							14	
Lesser Scaup					2											2	
Bufflehead																	
Unidentified ducks																	
TOTAL Waterfowl*	4	2	4	0	222	16	137	0	31	1	14	6	2	2	0	**441**	
Ruddy Duck								1				1				2	non flying
Other Species																	
Common Loon																	
Pied-billed Grebe																	
Western Grebe																	
American Coot																	
Black-necked Stilt						4										4	
American Avocet						30										30	
Wilson's Phalarope						30										30	

pr = Pair
* Excluding Ruddy Duck

APPENDIX 1, Table 1.

Waterfowl at Mono Lake, CA   Date: 8 July 2000   Survey: Boat   Observers: J. Jehl

Species	LV Ck.	Ranch Cove	Rush Ck	So Tufa	So Shore	Sammann's	Warm Sp	NE Shore	Blk PT E	Blk Pt W	Wilson Ck/ Mill Ck	Co Park	W Shore	Other	Total	Comments
Waterfowl																
Canada Goose																
Gadwall	2		1							1	47 (1br)		1 (br)		52	
American Wigeon																
Mallard			1												1	
Cinnamon Teal																
Northern Shoveler																
Northern Pintail					2 (br)						2				4	
Green-winged Teal											1				1	
Redhead											10				10	
Lesser Scaup																
Bufflehead																
Unidentified ducks												2			2	
TOTAL Waterfowl*	2	0	2	0	2	ND	ND	ND	ND	1	60	2	1	0	**70**	
Ruddy Duck											2				2	
Other Species																
Common Loon																
Pied-billed Grebe																
Western Grebe																
American Coot											2				2	

br = Brood

ND = No Data

* Excluding Ruddy Duck

APPENDIX I[redacted]1.

Waterfowl at [redacted]Lake, CA   Date: 30 July, 1 August 2000   Su[redacted]Boat   Observers: J. Jehl, J. St. Leger   [redacted]e 4

Species	LV Ck.	Ranch Cove	Rush Ck	So Tufa	So Shore	Sammann's	Warm Sp	NE Shore	Blk PT E	Blk Pt W	Wilson Ck	Mill Ck	Co Park	W Shore	Other	Total	Comments
Waterfowl																	
Canada Goose																	
Gadwall	1 (4y)	2 (12y)									27 (40y)			3 (20y)		33*	@ 8 broods
American Wigeon																	
Mallard																	
Cinnamon Teal														1		1	
Northern Shoveler																	
Northern Pintail																	
Green-winged Teal																	
Redhead																	
Lesser Scaup																	
Bufflehead																	
Unidentified ducks			10	2												12	
TOTAL Waterfowl*	1	2	10	2	0	0	ND	ND	ND	ND	27^{+}		0	4	0	46	
Ruddy Duck																	
Other Species																	
Common Loon																	
Pied-billed Grebe																	
Western Grebe																	
American Coot																	

y = Young

Wilson Creek/Mill Creek - 27 adults including approximately 20 males in molt and 5-6 females with at least 40 young (y)

ND= No Data

* Excluding juvenile birds

** Excluding Ruddy Duck

Waterfowl at Mono Lake, CA Date: 31 July 2000 Survey: Aerial Observers: J. Jehl, P. Dewitt

Species	LV Ck.	Ranch Cove	Rush Ck	So Tufa	So Shore	Sammann's	Warm Sp	NE Shore	Blk PT E	Blk Pt W	Wilson Ck	ill C	Co Park	W Shore	Other	Total	Comments
Waterfowl																	
Canada Goose																	
Gadwall	2				15*											17	No broods
American Wigeon																	
Mallard						10										10	
Cinnamon Teal					20	10	15									45	
Northern Shoveler																	
Northern Pintail																	
Green-winged Teal																	
Redhead																	
Lesser Scaup																	
Bufflehead																	
Unidentified ducks					10	30	20		10							70	
TOTAL Waterfowl**	2	0	0	0	45	50	35	0	10	0	0	0	0	0	0	**142**	
Ruddy Duck																	
Other Species																	
Common Loon																	
Pied-billed Grebe																	
Western Grebe																	
White-faced Ibis					2											2	
American Coot						1										1	

* On one pond

** Excluding Ruddy Duck

APPEN[illegible], Table 1.

Waterfowl at Mono Lake, CA   Date: 11-12 August 2000   Survey: Boat   Observers: J. Jehl, J. D. Jehl

Species	LV Ck.	Ranch Cove	Rush Ck	So Tufa	So Shore	Sammann's	Warm Sp	NE Shore	Blk PT E	Blk Pt W	Wilson Ck/ Mill Ck		Co Park	W Shore	Other	Total	Comments
	11-Aug	→				→	12-Aug	→							→		
Waterfowl																	
Canada Goose																	
Gadwall		1(5y)				1(5y)					13 (4br with 40y)					15*	
American Wigeon																	
Mallard		1			6	4	8?				1					20	
Cinnamon Teal						20	2?									22	
Northern Shoveler					3	2					25	8				38	
Northern Pintail						6										6	
Green-winged Teal											2					2	
Redhead		1														1	
Lesser Scaup																	
Bufflehead																	
Unidentified ducks					4					1	10					15	
TOTAL Waterfowl**	0	3	0	0	13	33	10	0	0	1	59		0	ND	0	**119**	
Ruddy Duck															5	5	2 non flying
Other Species																	
Common Loon																	
Pied-billed Grebe																	
Western Grebe																	
American Coot																	

y = Young

br = Brood

* Excluding juvenile birds

** Excluding Ruddy Duck

APPENDI[illegible]able 1.

Waterfowl at Mono Lake, CA   Date: 6 - 8 September 2000   Survey: Boat   Observers: J. Jehl, D. Marquart

Species	LV Ck.	Ranch Cove	Rush Ck	So Tufa	So Shore	Sammann's	Warm Sp	NE Shore	Blk PT E	Blk Pt W	Wilson Ck/ Mill Ck	Co Park	W Shore	Other	Total	Comments
	6-Sep	→					→	8-Sep	→					→		
Waterfowl																
Canada Goose																
Gadwall					5						50(6y)*				55	*unfledged
American Wigeon																
Mallard	1				80	2					50				133	
Cinnamon Teal	15				20	80					10				125	
Northern Shoveler					150	20					200				370	
Northern Pintail					45	15					200				260	
Green-winged Teal					20	80					50				150	
Redhead																
Lesser Scaup																
Bufflehead																
Unidentified ducks					150										150	
TOTAL Waterfowl**	16	0	0	0	470	197	0	0	0	0	560	ND ***	ND ***	0	**1243**	
Ruddy Duck									500						500	5-10% were non flying
Other Species																
Common Loon																
Pied-billed Grebe																
Western Grebe																
American Coot									200		50				250	

* Only brood on lake. y = Young.

** Excluding Ruddy Duck

*** Not able to census. No Data

APPEND[illegible] Table 1.

Waterfo[illegible]ono Lake, CA   Date: 6-7 October 2000   [illegible]ey: Boat   Observers: J. Jehl, D. Marquart   [illegible]ge 8

Species	LV Ck.	Ranch Cove	Rush Ck	So Tufa	So Shore	Sammann's	Warm Sp*	NE Shore	Blk PT E	Blk Pt W	Wilson Ck/ Mill Ck	Co Park	W Shore	Other	Total	Comments
Waterfowl																
Canada Goose																
Gadwall																
American Wigeon																
Mallard	1					50				5	50		10		116	
Blue-winged Teal											2				2	
Cinnamon Teal																
Northern Shoveler						300				55	605	5			965	
Northern Pintail						20					30				50	
Green-winged Teal	2										50				52	
Redhead											2				2	
Lesser Scaup																
Bufflehead																
Unidentified ducks	15				60	100					20			5	200	
TOTAL Waterfowl**	18	0	0	0	60	470	0	0	0	60	759	5	10	5	1387	
Ruddy Duck	0	0	0	0	200	50	0	15	50	0	0	40	250	250	855	
Other Species																
Common Loon														1	1	
Pied-billed Grebe																
Western Grebe												2			2	
American Coot						300					1	14		2	317	
Wilson's Phalarope														2	2	
Red-necked Phalarope														800	800	

* Not censused by boat. Data from aerial survey of 7 October.

** Excluding Rudy Duck

APPENDIX I, Table 1.

Waterfowl at Mono Lake, CA   Date: 7 October 2000   Survey: Aerial   Observers: J. Jehl, P. DeWitt, H. Ellis

Species	LV Ck.	Ranch Cove	Rush Ck	So Tufa	So Shore	Sammann's	Warm Sp	NE Shore	Blk PT E	Blk Pt W	Wilson Ck/ Mill Ck	Co Park	W Shore	Other	Total	Comments
Waterfowl																
Canada Goose							5								5	
Gadwall																
American Wigeon																
Mallard						80	50				50				180	
Cinnamon Teal																
Northern Shoveler						500	300		280		150				1230	
Northern Pintail						80			120		50				250	
Green-winged Teal						80	50				50				180	
Redhead									20						20	
Lesser Scaup																
Bufflehead																
Unidentified	4				36				100	300					440	
TOTAL Waterfowl**	4	0	0	0	36	740	405	0	520	300	300	0	0	0	2305	
Ruddy Duck								15							15	
Other Species																
Common Loon																
Pied-billed Grebe																
Western Grebe																
Double-crested Cormorant		2													2	
American Coot																

* Estimate

** Excluding Ruddy Duck

APPEND[illegible]able 1.
Waterfowl at Mono Lake, CA   Date: 23-24 October 2000   Survey: Boat   Observers: J. Jehl, C. Franson

Species	LV Ck.	Ranch Cove	Rush Ck	So Tufa	So Shore	Sammann's	Warm Sp	NE Shore	Blk PT E	Blk Pt W	Wilson Ck	Mill Ck	Co Park	W Shore	Other	Total	Comments
Waterfowl																	
Canada Goose						13							15			28	
Brant													2			2	
Gadwall																	
American Wigeon											8					8	
Mallard						20			50	8			5			83	
Cinnamon Teal											2					2	
Northern Shoveler	5					5			30	2	2850	300	15			3207	
Northern Pintail																	
Green-winged Teal	195										30	250				@ 300	Arrow indicates movement of birds
Redhead																	
Lesser Scaup																	
Bufflehead											5					5	
Unidentified ducks						2			300*		300		50			652	
TOTAL Waterfowl**	200	0	0	0	0	40	0	0	380	10	3195	550	87	0	0	4287	
Ruddy Duck		50	10		4			10	100	350	30	50	50	50	70	774	minimum
Other Species																	
Common Loon																	
Pied-billed Grebe													1			1	
Western Grebe															1	1	
Northern Phalarope								1								1	
American Coot	10														1	11	

* in evening at mouth of marsh. @ 150 next day (24th)

** Excluding Ruddy Duck

APPENDIX [redacted]able 1.

Waterfowl [redacted]o Lake, CA   Date: 14 November 2000   Aerial [redacted]servers: J. Jehl, P. Dewitt

Species	LV Ck.	Ranch Cove	Rush Ck	So Tufa	So Shore*	Sammann's	Warm Sp	NE Shore	Blk PT E	Blk Pt W	Wilson Ck	Mill Ck	Co Park	W Shore	Other	Total	Comments
Waterfowl																	
Snow Goose									5							5	
Ross's Goose									2							2	
Canada Goose								2								2	
Gadwall																	
American Wigeon																	
Mallard							150	40	6							196	
Cinnamon Teal																	
Northern Shoveler								2								2	
Northern Pintail																	
Green-winged Teal							8				250					258	
Redhead																	
Lesser Scaup																	
Bufflehead																	
Unidentified ducks							15	15								30	
TOTAL Waterfowl**	0	0	0	0	0	0	173	59	13	0	250		0	0	0	495	
Ruddy Duck	0	30	0	0	30	3	0	Ö	Ö	300	?	Ö	Ö	300	200	863	minimum
Other Species																	
Common Loon																	
Pied-billed Grebe																	
Western Grebe															3	3	
American Coot																	

* South shore ponds dry (5) or frozen (2)

** Excluding Ruddy Duck

Ö = Present; no count

APPEND[illegible]able 1.

Waterfowl at Mono Lake, CA Date: 7 December 2000 Survey: Aerial Observers: J. Jehl, D. House, P. DeWitt

Species	LV Ck.	Ranch Cove	Rush Ck	So Tufa	So Shore	Sammann's	Warm Sp	NE Shore	Blk PT E	Blk Pt W	Wilson Ck	Mill Ck	Co Park	W Shore	Other	Total	Comments
Waterfowl																	
Snow Goose										4						4	
Ross's Goose										1						1	
Canada Goose						6										6	
Gadwall																	
American Wigeon																	
Mallard							25		58							83	
Cinnamon Teal																	
Northern Shoveler		10							1							11	
Northern Pintail																	
Green-winged Teal									2		50		70			122	
Redhead																	
Lesser Scaup																	
Bufflehead																	
Red-breasted Merganser														6		6	
Unidentified ducks						5			50	1						56	
TOTAL Waterfowl*	0	10	0	0	0	11	25	0	111	6	50	0	70	6	0	**289**	
Ruddy Duck		75	50	130			520	50						490	200	1515	
Other Species																	
Common Loon																	
Pied-billed Grebe																	
Western Grebe														1		1	
American Coot																	

* Excluding Ruddy Duck

TABLE 2. Results of waterfowl censuses at freshwater ponds on the north shore of Mono Lake, CA, 2000.

Date: 3 May 2000 17:00

	Dechambeau Ponds				Co Ponds		Other	Total
Species	1	2	3	4	1	2		
Waterfowl								
Canada Goose	3							3
Gadwall	4	2		2				8
American Wigeon								
Mallard		1						1
Cinnamon Teal	20	2		1				23
Northern Shoveler								
Northern Pintail	4	1						5
Green-winged Teal								
Redhead								
Lesser Scaup								
Bufflehead						1		1
Unidentified ducks								
TOTAL Waterfowl*	31	6	0	3	0	1	0	**41**
Ruddy Duck								
Other Species								
Pied-billed Grebe	1							1
American Coot	6	4	4		2			16
California Gull	0	0	0	0	0	500		500

* Excluding Ruddy Duck

APPENDIX I, Table 2.

Waterfowl at freshwater ponds. Date: I June 2000 17:45

	Dechambeau Ponds				Co Ponds		Other	Total
Species	1	2	3	4	1	2		
Waterfowl								
Canada Goose								
Gadwall	3					2		5
American Wigeon								
Mallard								
Cinnamon Teal	4 (2 pr)							4
Northern Shoveler								
Northern Pintail	1							1
Green-winged Teal								
Redhead								
Lesser Scaup								
Bufflehead								
Unidentified								
TOTAL Waterfowl*	8	0	0	0	0	2	0	**10**
Ruddy Duck								
Other Species								
American Coot	2	2	6			8		18
Common Moorehen		1						1
California Gull						450		450

Absence of gulls on Pond 4 in unique at this season. All moved to Co Pond 2.

All ponds very high. Gulls pulling weed for nests.

* Excluding Ruddy Duck

APPENDIX I, Table 2.

Waterfowl at freshwater ponds. Date: 7 July 2000 17:00

	Dechambeau Ponds				Co Ponds		Other	Total
Species	1	2	3	4	1	2		
Waterfowl								
Canada Goose								
Gadwall			1	2	3	4		10
American Wigeon								
Mallard								
Cinnamon Teal								
Northern Shoveler								
Northern Pintail								
Green-winged Teal								
Redhead								
Lesser Scaup								
Bufflehead								
Unidentified ducks	3							3
TOTAL Waterfowl*	3	0	1	2	4	3	0	**13**
Ruddy Duck								
Other Species								
Clark's Grebe					1			1
American Coot			5	4		5		14
Killdeer				2		4		6
Wilson's Phalarope				1				1
California Gull				300				300
Forster Tern				3				3

* Excluding Ruddy Duck

APPENDIX I, Table 2.

Waterfowl at freshwater ponds. Date: 30 July 2000 16:30

Dechambeau Ponds					Co Ponds		Other	Total
Species	1	2	3	4	1	2		
Waterfowl								
Canada Goose						7		7
Gadwall					11	1		12
American Wigeon								
Mallard								
Cinnamon Teal				12		3		15
Northern Shoveler								
Northern Pintail						1 (7y)		1
Green-winged Teal								
Redhead								
Lesser Scaup								
Bufflehead								
Unidentified ducks								
TOTAL Waterfowl*	0	0	0	12	11	12	0	35
Ruddy Duck		1						1
Other Species								
American Coot	5 (br)	3 (br)	10 (3y)		3	1		22
Wilson's Phalarope				500				500

* Excluding Ruddy Duck

br = Brood

y = Young

Island in Pond 4 is fully vegetated

Teal starting to migrate

APPENDIX I, Table 2.

Waterfowl at freshwater ponds. Date: 11 August 2000 18:30

	Dechambeau Ponds				Co Ponds		Other	Total
Species	1	2	3	4	1	2		
Waterfowl								
Canada Goose								
Gadwall						1		1
American Wigeon								
Mallard					50	5		55
Cinnamon Teal					150	17		167
Northern Shoveler						2		2
Northern Pintail					1 (br)	1		2
Green-winged Teal								
Redhead								
Lesser Scaup								
Bufflehead								
Unidentified ducks								
TOTAL Waterfowl*	0	0	0	0	201	26	0	**227**
Ruddy Duck					1			1
Other Species								
American Coot	4	10 (br)	8 (br)	1	2			25
Wilson's Phalarope				30				30

br = Brood

* Excluding Ruddy Duck.

Survey 1830-1915. All surveys PM to account for maximum ducks.

Lots on CP #1. All pond full. #2 and #3 getting clogged.

Note: a few Wilson's Phalaropes still around.

APPENDIX I, Table 2.

Waterfowl at freshwater ponds. Date: 5 September 2000 17:30

	Dechambeau Ponds				Co Ponds		Other	Total
Species	1	2	3	4	1	2		
Waterfowl								
Canada Goose								
Gadwall					12*			12
American Wigeon								
Mallard				5		7		12
Cinnamon Teal			3	6 ↔	5	5		14-19
Northern Shoveler						20		20
Northern Pintail				5				5
Green-winged Teal				5				5
Redhead						2		2
Lesser Scaup								
Bufflehead								
Unidentified ducks					14			14
TOTAL Waterfowl**	0	0	3	21	31	34	0	**84-89**
Ruddy Duck								
Other Species								
American Coot	1	5	10					16

* Probably local brood
** Excluding Ruddy Duck

Cinnamon Teal moving around

Co. Pond 1 continues to perform

Photo'd all ponds at sunset for report

APPENDIX I, Table 2.

Waterfowl at freshwater ponds. Date: 6 October 2000 17:15

	Dechambeau Ponds				Co Ponds		Other	Total
Species	1	2	3	4	1	2		
Waterfowl								
White-fronted Goose						20*		20
Canada Goose								
Gadwall						3		3
American Wigeon						8		8
Mallard								
Cinnamon Teal								
Northern Shoveler				2				2
Northern Pintail						1		1
Green-winged Teal						1		1
Redhead								
Lesser Scaup								
Bufflehead								
Unidentified								
TOTAL Waterfowl**	0	0	0	2	0	33	0	35
Ruddy Duck				1				1
Other Species								
American Coot		131		24				155

* Fly over: Attemped to land

** Excluding Ruddy Duck

APPENDIX I, Table 2.

Waterfowl at freshwater ponds. Date: 23 October 2000 16:00

	Dechambeau Ponds				Co Ponds		Other	Total
Species	1	2	3	4	1	2		
Waterfowl								
Canada Goose								
Gadwall								
American Wigeon								
Mallard								
Cinnamon Teal								
Northern Shoveler								
Northern Pintail								
Green-winged Teal								
Redhead								
Lesser Scaup								
Bufflehead								
Unidentified								
TOTAL Waterfowl*	0	0	0	0	0	0	0	**0**
Ruddy Duck				1	7			8
Other Species								
Pied-billed Grebe					1			1
American Coot	55	2		3	1			61

* Excluding Ruddy Duck

Observed at 16:00-17:00. Heavy construction started at new pond 5.

Waterfowl at freshwater ponds. Date: 13 November 2000 16:00

	Dechambeau Ponds					Co Ponds		Other	Total
Species	1	2	3	4	5	1	2		
				FROZEN	FROZEN	FROZEN	FROZEN		
Waterfowl									
Canada Goose									
Gadwall									
American Wigeon									
Mallard									
Cinnamon Teal									
Northern Shoveler									
Northern Pintail									
Green-winged Teal									
Redhead									
Lesser Scaup									
Bufflehead									
Unidentified ducks									
TOTAL Waterfowl*	0	0	0	0	0	0	0	0	**0**
Ruddy Duck									0
Other Species									
Eared Grebe			2 juv						2
American Coot		6	2						8

* Excluding Ruddy Duck

APPENDIX I, Table 2.

Waterfowl at freshwater ponds. Date: 7 December 2000 16:00

	Dechambeau Ponds					Co Ponds		Other	Total
Species	1	2	3	4	5	1	2		
	FROZEN					FROZEN	FROZEN		
Waterfowl									
Canada Goose									
American Wigeon									
Gadwall									
Green-winged Teal									
Mallard									
Northern Pintail									
Cinnamon Teal									
Northern Shoveler									
Redhead									
Lesser Scaup									
Bufflehead									
Unidentified ducks									
TOTAL Waterfowl*	0	0	0	0	0	0	0	0	0
Ruddy Duck									0
Other Species									
American Coot		1							1

* Excluding Ruddy Duck

APPENDIX II

Common and scientific names of birds mentioned in this report.

APPENDIX II

Common and scientific names of birds mentioned in this report. Nomenclature follows the American Ornithologits' Union. 1998. Check-list of North American Birds. 7th ed. American Ornithologists' Union, Washington, DC.

Common Loon	*Gavia immer*
Pied-billed Grebe	*Podilymbus podiceps*
Eared Grebe	*Podiceps nigricollis*
Western Grebe	*Aechmophorus occidentalis*
Clark's Grebe	*Aechmophorus clarkii*
American White Pelican	*Pelecanus erythrorhynchos*
Double-crested Cormorant	*Phalacrocorax auritus*
Great Blue Heron	*Ardea herodias*
Cattle Egret	*Bubulcus ibis*
White-faced Ibis	*Plegadis chihi*
White-fronted Goose	*Anser albifrons*
Snow Goose	*Chen caerulescens*
Ross's Goose	*Chen rossii*
Canada Goose	*Branta canadensis*
Brant	*Branta bernicla*
Gadwall	*Anas strepera*
American Wigeon	*Anas americana*
Mallard	*Anas platyrhynchos*
Blue-winged Teal	*Anas discors*
Cinnamon Teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
Northern Pintail	*Anas acuta*
Green-winged Teal	*Anas crecca*
Redhead	*Aythya americana*
Lesser Scaup	*Aythya affinis*
Bufflehead	*Bucephala albeola*
Red-breasted Merganser	*Mergus serrator*
Ruddy Duck	*Oxyura jamaicensis*
Common Moorhen	*Gallinula chloropus*
American Coot	*Fulica americana*
Killdeer	*Charadrius vociferus*
Black-necked Stilt	*Himantopus himantopus*
American Avocet	*Recurvirostra americana*
Wilson's Phalarope	*Phalaropus tricolor*
Red-necked Phalarope	*Phalaropus lobatus*
California Gull	*Larus californicus*
Forster's Tern	*Sterna forsteri*

APPENDIX III

Photographs of waterfowl habitat in the Mono Lake area, 2000.

APPENDIX III

PHOTOGRAPHS OF WATERFOWL HABITAT IN THE MONO LAKE AREA, 2000

1. South shore Pond 1 at Monument Rock, 8 July 00.

2. South shore Pond 1 at Monument Rock, 14 October 00. Note extensive drying.

3. Rush Creek Mouth, 8 July 00.

4. Rush Creek, just upstream from mouth 8 July 00.

5. Kayakers disturbing gulls and waterfowl, Rush Creek mouth, 6 September 00.

Photos 6- 16 taken consecutively from Monument Rock counterclockwise to Black Point/Wilson Creek during aerial survey 31 July 00

6. South Shore, Monument Rock area, 31 July 00. Brackish lagoons left center, freshwater ponds middle center.

7. South shore and lagoons, 31 July 00

8. Freshwater pond, south shore 31 July 00

9. South shore Pond 7, 31 July 0

10. Freshwater habitat, South Shore ponds, 31 July 00

11. Brackish lagoon at creek mouth, Warm Spring 31 July 00.

12. South shore panorama, looking east to Sammann's Springs, 31 July 00

13. Brackish lagoon, northeast shore, 31 July 00.

14. Mouth Bodie Creek, northeast shore. Lagoon is hypersaline. 31 July 00.

15. Marsh area to east of Black Point, 31 July 00.

16. Tufa shoals area near tip of Black Point, 31 July 00.

17. Shoreline from Black Point looking west to Wilson Creek and County Park, 31 July 00.

18. Extensive sedge marsh, scheduled to be subjected to controlled burn, 2 June 00.

19. Same marsh and lagoon (nearly dry) on 12 August 00.

20. South Shore Pond No. 2, 14 October 00. Nearly dry, no waterfowl habitat.

21.South Shore Pond No. 3, 14 October 00. Nearly dry, no waterfowl habitat.

22. South Shore Pond 5, 14 October 00. Dry, hypersaline, no waterfowl habitat.

23. South Shore Pond 7, 14 October 00. Pond low but still contains fresh water and attracted occasional ducks.

24. Dechambeau Pond 2, 6 October 00

25. Dechambeau Pond 3, 6 October 00

26. Dechambeau Pond 5, under construction, 27 October 00

27. County Pond 1, 6 October 00

28. County Pond 2, 6 October 00

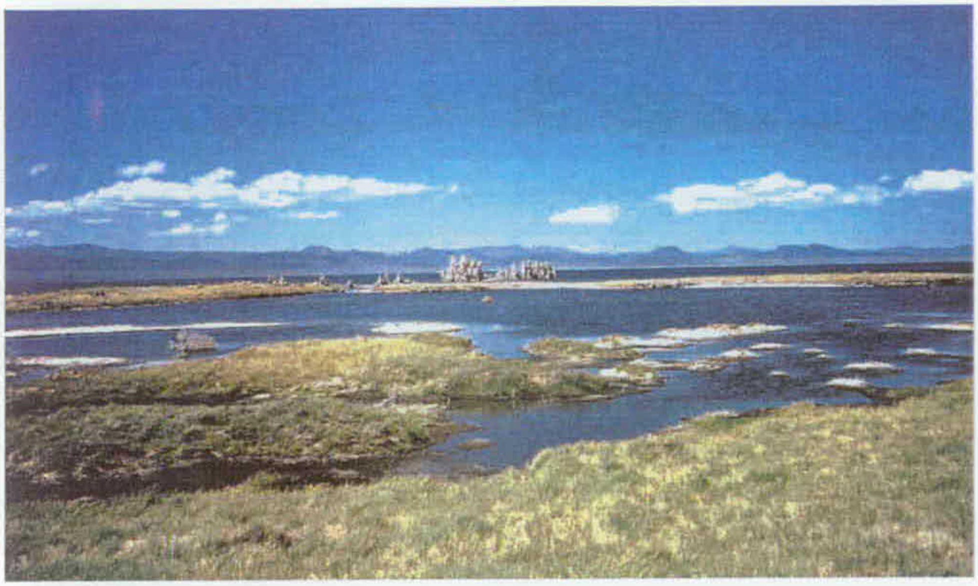


FIGURE 1. South Shore Pond 1 at Monument Rock, 8 July 2000.

FIGURE 2. South Shore Pond 1 at Monument Rock, 14 October 2000. Note extensive drying.

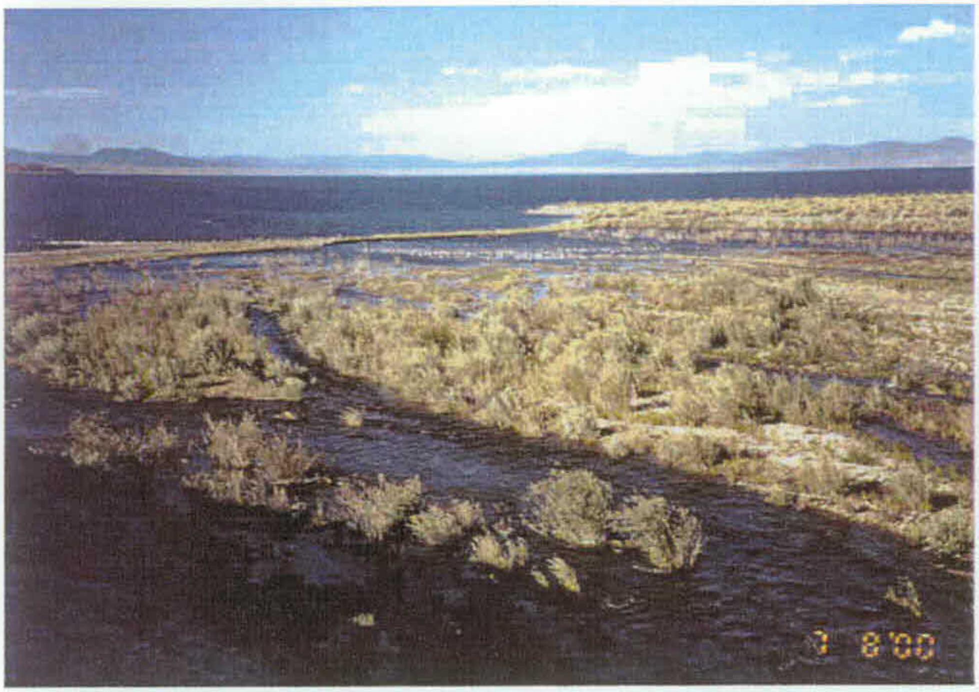


FIGURE 3. Rush Creek mouth, 8 July 2000.

FIGURE 4. Rush Creek, just upstream from mouth, 8 July 2000.

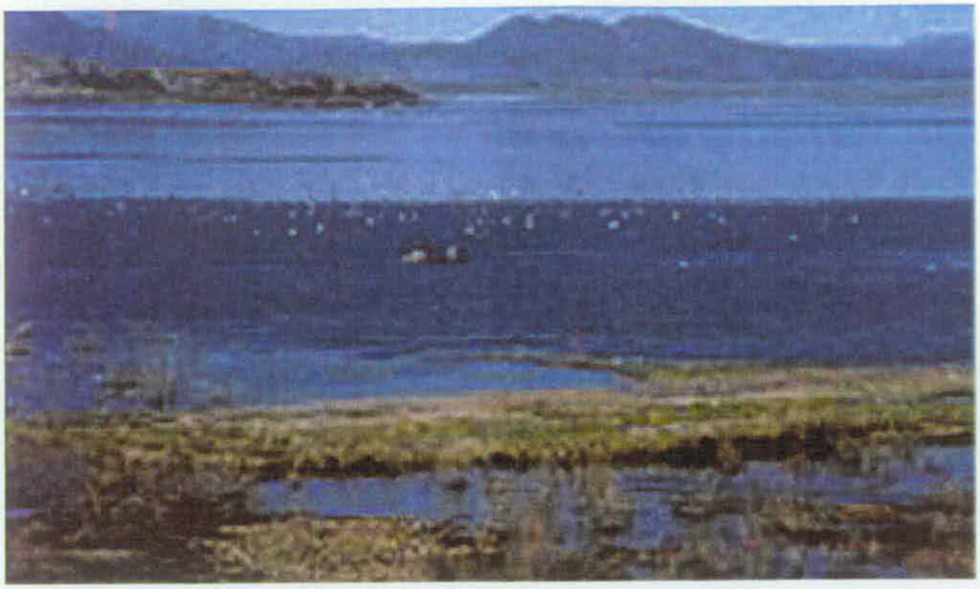


FIGURE 5. Kayakers disturbing fulls and waterfowl, mouth Rush Creek 6 September 2000.

Photos 6-17 taken consecutively from Monument Rock counterclockwise to Black Point/Wilson Creek during aerial survey, 31 July 2000.

FIGURE 6. South Shore, Monument Rock area, 31 July 2000. Brackish lagoons left center, freshwater ponds middle center.

FIGURE 7. South Shore and lagoons, 31 July 20000.

FIGURE 8. Freshwater pond, South Shore, 31 July 2000.

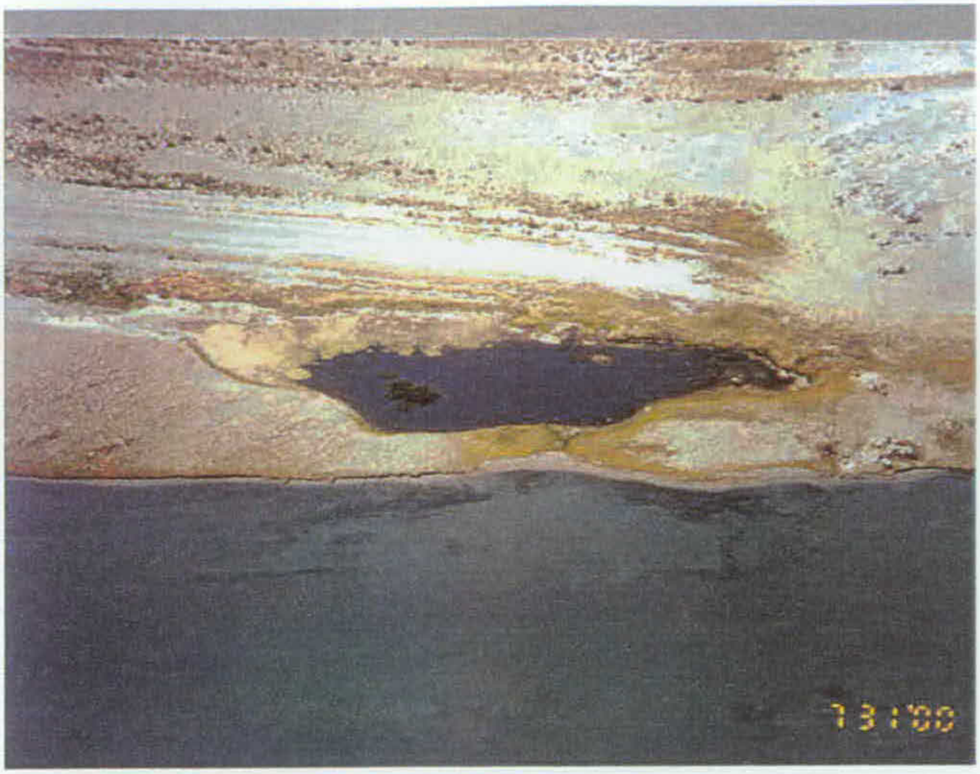


FIGURE 9. South Shore Pond 7, 31 July 2000.

FIGURE 10. Freshwater habitat, South Shore ponds, 31 July 2000.

FIGURE 11. South Shore panorama, looking east to Sammann's Springs, 31 July 2000.

FIGUR 12. Brackish lagoon at creek mouth, Warm Spring, 31 July 2000.

FIGURE 13. Brackish lagoon, northeast shore, 31 July 2000.

FIGURE 14. Mouth Bodie Creek, northeast shore. Lagoon is hypersaline. 31 July 2000.

FIGURE 15. Marsh area to east of Black Point, 31 July 2000.

FIGURE 16. Tufa shoals area near tip of Black Point, 31 July 2000.

FIGURE 17. Shoreline from Black Point looking west to Wilson Creek and County Park, 31 July 2000.

FIGURE 18. Extensive sedge marsh, scheduled to be subjected to controlled burn, 2 June 2000.

FIGURE 19. Same marsh and lagoon (nearly dry) on 12 August 2000.

FIGURE 20. South Shore Pond No. 2, 14 October 2000. Nearly dry, no waterfowl habitat.

FIGURE 21. South Shore Pond No. 3, 14 October 2000. Nearly dry, no waterfowl habitat.

FIGURE 22. South Shore Pond No. 5, 14 October 2000. Dry, hypersaline, no waterfowl habitat.

FIGURE 23. South Shore Pond, No. 7, 14 October 2000. Pond low but still contains fresh water and attracted occasional ducks.

FIGURE 24. Dechambeau Pond 2, 6 October 2000.

FIGURE 25. Dechambeau Pond 3, 6 October 2000.

FIGURE 26. Dechambeau Pond 5, under construction, 27 October 2000.

FIGURE 27. County Pond1, 6 October 2000.

FIGURE 28. County Pond 2, 6 October 2000.

APPENDIX IV

Results of all lake censuses at Mono Lake, 1995-1999.

Table 1. 1995

Table 2. 1996

Table 3. 1997

Table 4. 1998

Table 5. 1999

Table 1. Waterfowl detected on shoreline censuses on Mono Lake, CA, 1995.

Species	20-21 Jul	2 Aug	23 Aug	8-11 Sep	21-22 Oct	13 Nov	28-29 Dec[b]	Total
Waterfowl								
Canada Goose	28					9		37
Gadwall	12br, 60y[a]	50	50	225	20	1		346
American Wigeon				1		1		2
Mallard				210	252	15		477
Cinnamon Teal		1	50	5				56
Northern Shoveler	9	2	450	1000	615	30		2106
Northern Pintail				30	60	120		210
Green-winged Teal			4	20	385	160	45	614
Redhead	4			2		8		14
Lesser Scaup								
Bufflehead		2					3	5
Unidentified Ducks	9						16	25
Total Waterfowl*	50	55	554	1493	1332	344	64	**3892**
Ruddy Duck			1	35	1800++	500	300	2636++

br = Brood

y = Young

[a] At Mill Creek.

[b] Census continued to western edge of lake, County Park, Mill-Wilson Creek Delta.

* Excluding Ruddy Duck

Table 2. Waterfowl detected on shoreline censuses on Mono Lake, CA, 1996.

Species	31 Jul-2 Aug	13 Aug	5-8 Sep	3 Oct	14-15 Oct	Total
Waterfowl						
White-fronted Goose					1	1
Canada Goose	2				64	66
Cackling Goose					12	12
Gadwall	85 (26y)	40 (12y)	59	10	15	209
American Wigeon			20	16	10	46
Mallard	4	9	33	20	550	616
Cinnamon Teal	4	4	15	20	3	46
Northern Shoveler	1	11	950	652	449	2063
Northern Pintail			13	83	381	477
Green-winged Teal	3	13	61	81	308	466
Redhead	1		34	12	45	92
Lesser Scaup						
Bufflehead						
Unidentified Ducks				1	8	9
Total Waterfowl*	100	77	1185	895	1846	**4103**
Ruddy Duck			40	≅ 8000	3640	≅ 11640

y = Young

* Excluding Ruddy Duck

Table 3. Waterfowl detected on shoreline censuses on Mono Lake, CA, 1997.

Species	29-30 Jul	19 Aug	16 Sep	13-14 Oct	19-20 Nov	Total
Waterfowl						
Snow Goose					1	1
Ross Goose					3	3
Canada Goose	6			14		20
Gadwall	4 (4br)	15 (2br)	17	17	12	65
American Wigeon		30	32	3	10	75
Mallard	17	205	66	100	500	888
Cinnamon Teal		30	9	10		49
Northern Shoveler		107	1150	1090	98	2445
Northern Pintail	1	37	214	100	29	381
Green-winged Teal		8	101	171	566	846
Redhead			11			11
Lesser Scaup				1		1
Bufflehead					1	1
Unidentified Ducks	4	10		228	20	262
Total Waterfowl*	32	442	1600	1734	1240	**5048**
Ruddy Duck	1	2	340	707[a]	165[a]	1215[a]

br = Brood

* Excluding Ruddy Duck

[a] Ruddy Duck counts are minimum.

TABLE 4. Waterfowl detected on shoreline censuses on Mono Lake, CA, 1998.

Species						TOTAL
	2-4 Aug	4-5 Sep	1-2 Oct	17 Oct*	31-Oct	
Waterfowl						
Canada Goose	20		1	20		41
Brant						
Gadwall	10	42	5		2	59
American Wigeon				200		200
Mallard	12	21	12	50	70	165
Blue-winged Teal						
Cinnamon Teal		10				10
Northern Shoveler		≅2000	1557	160	61	3778
Northern Pintail	26		53	50	3	132
Green-winged Teal	29	60	52	100	20	261
Redhead		14	3			17
Lesser Scaup						
Bufflehead			1			1
Red-breasted Merganser						
Unidentified ducks		6	309	1400	890	2605
TOTAL Waterfowl**	97	2153	1993	1980	1046	**7269**
Ruddy Duck	2	21	1665	4250	1050	6988

* Aerial survey. S. Boyd

**Excluding Ruddy Duck

TABLE 5. Waterfowl detected on shoreline censuses on Mono Lake, CA, 1999.

Species	14-Jul	20-30 Jul	14-Aug	3-4 Sep	17-18 Sep	13-14 Oct	6-Nov	23 Nov*	TOTAL
Waterfowl									
Canada Goose	5	4		14			65	56	144
Brant									
Gadwall	10	19	21	37	199	2		5	293
American Wigeon					9		2	3	14
Mallard	14	6	14	155	84	2657	305	114	3349
Blue-winged Teal									
Cinnamon Teal	1	4	8	50	40				103
Northern Shoveler			5	671	512	910	265	74	2437
Northern Pintail	2	2	61	150	10	2563	171	110	3069
Green-winged Teal			24	280	122	390	680	790	2286
Canvasback						3			3
Redhead		2		10	5				17
Lesser Scaup	1						1		2
Bufflehead							2		2
Red-breasted Merganser							1		1
Hooded Merganser								2	2
Goldeneye (sp)								3	3
Unidentified ducks		2	6	66	185	131	260	372	1022
TOTAL Waterfowl**	33	39	139	1433	1166	6656	1752	1529	**12747**
Ruddy Duck		2	4	13	848	3998	375	1315	6555

* Boat survey west end; aerial survey all lake

** Excluding Ruddy Duck

APPENDIX V

Table 1. Field notes, S. I. Bond.

Table 2. Time budgets of Ruddy Ducks at Mono Lake by time of day at various locations around the lake. Data collected 15 September - 15 October 1997.

Table 3. Time budgets of Ruddy Ducks at Mono Lake by location. Data collected 15 September - 15 October 1997.

Figure 1. Activity patterns of Ruddy Ducks at Mono Lake, 0800-1200.Data collected 15 September - 15 October 1997.

Figure 2. Activity patterns of Ruddy Ducks at Mono Lake, 1200-1600.Data collected 15 September - 15 October 1997.

Figure 3. Activity patterns of Ruddy Ducks at Mono Lake, 1600-2000.Data collected 15 September - 15 October 1997.

Figure 4. Activity patterns of Ruddy Ducks at Mono Lake by site. Data collected 15 September - 15 October 1997.

Table 1. Field data on activities of waterfowl at Mono Lake on 28 September - 3 October 1999.
S. I. Bond

28 September Mono Lake.

Arrived at the ranch at 17:00. Drove to the west end of the lake arriving at 18:00. Red-necked Phalaropes were seen flying about and feeding several hundred yards offshore.

Ruddy Ducks were offshore, moving into the west end. No feeding was seen. When they were 50-75 yards offshore there was preening and bathing. I only saw feeding when they were within 25 yards of the shore and that did not occur until 18:40. Dives were 15-25 sec.

29 September

Drove to the W end and observed Ruddies for an hour. The birds were 100-150 yards offshore mixed with Eared Grebes. Nearly all the Ruddies were resting with less than 1% diving. Dive times were from 12 to 27 sec. (18, 23, 22, 24,24, 16, 25, 27, 16, 12, mean=20.7).

Drove to Dechambeau Ponds and the County Ponds. On Dechambeau Pond #3 I found 32 American Coots including 7 young of the year, feeding and resting. No ducks on any of the other ponds. (10:00).

10:15. County Pond 1. As I drove up 30 unidentified ducks (IUD) flew off toward the lake. I stopped and observed: 2 Northern Pintail, 7 Am. Coots, 2 Am Wigeon, 12 unidentified ducks, 2 Eared Grebes (feeding) 1 Pied -billed Grebe (feeding) and 2 Killdeer. The Pintail flew away at 10:31. By 10:50 all the ducks had gone leaving only the grebes, still feeding. 11:10 two unidentified ducks returned to west shore line, feeding.

12:15. Drove down to mouth of Lee Vining Creek. No birds.

15:45- 17:30. Drove to Monument Rock and the South Shore ponds. Pond directly W had no birds, not even gulls. The Pond directly S had 35-40 Gadwall sitting (until they saw me), 3 Am Wigeon, 2 Mallards,.and 3 Northern Shovelers.

Three Northern Harriers were flying about. Many Ruddies, Am. Coots and Eared Grebe (feeding) in the bay area SE of Monument.

Next pond east was full of Cgulls (150) at the East end bathing. No ducks .

The wind kicked up out of the NNE and the gull starting pilling into the above pond.

30 September

Hiked down Wilson Creek to its mouth on the west side at 09:00.

A few ducks were seen in the marsh area. A small flock of Ruddies about 30 yards off. I saw only two dives in 25 minutes. Ten UID ducks were flying back and forth of the fresh water area and landed 150 yards off shore.

The ducks were on the far side of area I could see. Five Northern Shovelers were resting and preening. By 10:10 they were feeding at the surface and heading out into the lake.

All birds off shore. At 10:18 three Northern Shovelers flew into the area and began bathing and drifting into the sticks (out of sight).

10:30 Ruddies off shore resting and preening. No new movement in the area except that Coots were in and out paddling and resting.

15:30 Drove to mouth of Rush Creek. There were white caps on the lake. I saw only four ducks in the mouth feeding in the shallow water.

15:45 23 ducks appeared from the weeds swimming into the open protected area. Bathing and preening.

The wind was gusting so hard that it made using the scope difficult if not impossible.

16:00 All the duck moved off the sand bar and swim into the dead vegetation.

White caps and foam on the lake! I could see no ducks off shore.

The gulls were moving down the sand bar and this may have discouraged the ducks.

No Ruddy Ducks were seen in the area. Approximately 20 UID ducks (had light blue wing covertts) were feeding in the dead scrub at the river opening. 16:30 . End observations.

West End. 17:00 and the lake is flat. About (200) of Ruddy Ducks off shore (150-200 yd) resting/preening. Fifteen were within 10 yd of shore feeding with Eared Grebes. Drives were: 13.7, 19.6, 20.0, 19.0 sec, mean 18.1 sec.

By 17:30 more birds were moving into shore and dive times were shorter (@ 10-12 sec. shallow water?). The birds on the lake were still resting.

17:50. After feeding inshore the birds swam out 50 yd, joining others and preened.

18:00. No feeding on the lake, only resting.

All the Ruddies have moved offshore.

18:40. Four Ruddies are 20 yd off feeding in a group of Red-necked Phalaropes.

18:45. Only two Ruddies remained.

19:00. The above ducks were still diving near the Red-necked Phalaropes.

1 October

08:00.South Shore. Eleven UID ducks left the second pond (Monument Rock) and flew toward the west. Five Northern Shovelers were surface feeding (flies?) in Pond # 1.

08:20. Six Gadwall and two N Shovelers feeding.

08:26. From a pond farther east of where I was sitting 26 UIDs flew off toward the west.

One Northern Harrier flew over the area. It appeared to be going after blackbirds.

08:41. Two N Shovelers land in Monument Pond, begin feeding on the surface. 40 UIDs are just east of Monument Rock feeding. No diving or "tip-up".

08:50-08:55 Three Mallards feeding on the surface, presumably on flies. Four Gadwall are tipping up.

09:20. Gull Pond hnd about 12 gulls, no ducks. 3 o/oo.

09:30. Monument Pond east had five N Pintails feeding. 3 o/oo.

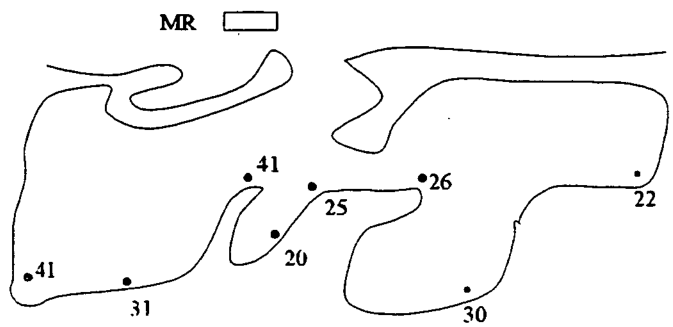
Next pond, Tufa Pond, had no birds. This is very small and shallow. 2 o/oo with green alga starting.

Tule Pond, the next one, is nearly closed by alga.

10:15. Gull Pond held four N Shovelers, five Cinn. Teal and seven UID, all resting/swimming.

10:30-10:45. all the ducks were standing/resting.

Took salinities of Monument Rock Pond. See below.



West Side. 15:00. Area north of Tioga Lodge. Only see Ruddies drifting N off shore with most of them having their heads tucked. No diving.

15:38. Some bathing and wing flapping.

15:47. One pair of Mallards, feeding at the surface. They are sweeping their head back and forth as they moved about. No "tip-ups".

15:58. One Clark's Grebe was seen paddling north. Not feeding.

16:04. Two Gadwall 10 yd off surface feeding. The Ruddies started moving closer to shore.

16:13. A Redhead drifted through the partially submerged vegetation and disappeared.

16:17. Ruddies near shore are diving, offshore resting/preening.

16:28. Mallards and Gadwall swimming south, no feeding. Area getting shaded.

16:45 More Ruddies pile into the area but most are just resting. 33 Gadwall/Mallard seen feeding on the surface.

16:48. Four Am Coots in the flock of Ruddies preening.

16:55. Ruddies continue moving closer to shore with more diving.

2 October

07:00 **West End**. At "sneaker beach" Ruddies are thinly scattered 100 yd offshore resting. 10-12 are within 50 yd diving.

07:30. I moved to the pullout just north of Tioga Lodge. There are fresh water tules along the edge. Birds are still scattered offshore resting/preening.

07:34. A Northern Harrier flew in close and all the Ruddies and grebes headed out to deeper water.

07:38. A mixed flock of Gadwall and Mallards (38), hiding in the close vegetation are flushed by the N Harrier, circle around and come back close to the shore.

07:42. The duck are bathing and preening, no feeding. Ruddies are still offshore resting.

08:00. Two Am. Coots appeared in close feeding at the surface.

08:15. Six Cgulls moved into the area, surface feeding.

08:30. One Gadwall and four Mallards are preening and surface feeding in close to the vegetation.

08:33. There are no Ruddies in close. All are offshore resting and preening. Ducks just swimming about close to shore. The ducks move out 60 yd shaking their heads side-to-side. Flicking off water?

08:47. Four Ruddies moved within 50 yd and begin diving.

09:00. No changes. It is a hazy day with high thin clouds, no wind. The local radio station blames the haze on wild fires in California and Nevada.

Wilson Creek. Arrived at 14:00 on the east side of the mouth. Three Ruddies and three Am Coots were swimming about.

14:20. Three N Shovelers, three Gadwall and six Green-winged Teal moved into the protected area. The Shovelers did some bathing the rest were resting.

14:25. Most Ruddies were resting offshore. One, which was about 45 yd off was diving. Times were: 17.4, 24.5, 22.8, 19.8, 27.7, mean=17.8 sec.

Things remained quite for the next 15 min when 11 Mallards flew into the protected area headed to weedy area then turned and drifted back out. I saw no feeding. Coots in the area were surface feeding.

15:25. Northern Harrier flew over the region, circling several time but the ducks did not react.

About 15:45 the wind picks up and a group of 12-15 UIDs circle around and head west.

Off shore one Ruddy started wing flapping and was soon joined by others. This continued for four minutes. They would stop, rest and then start again. End observations.

16:45. Drove to Dechambeau Ponds arriving at 16:45. I was met with two humanoids and two wet Labrador Retrievers. The dogs had already hit Pond 1. Pond 2 had one Coot, Pond 3 held 38 Coots resting and feeding and one Gadwall.

While driving to County Pond (16:53) 12-15 UIDs were flying in.

16:55. 19 Canada Geese flew in from the lake and started feeding. Mallards, N Shovelers, Gadwall, and N Pintail were feeding.

17:20. The geese caught sight of me and took off toward Negit Island along with the ducks.

3 October

It is 12:00 and I can barely see Black Point from the ranch because of the thick haze.

12:15. South Shore. Got to the parking area east of Navy Beach and there was one truck parked. Saw a guy and his three dogs walking near Pond 1. When I got there, no birds were present.

12:20. Monument Pond had 30 gulls resting near the duck. 20 UIDs were at the far east end feeding, 8 N Shovelers and 5 Mallards were surface feeding near the west end and resting.

12:40. Eight White-fronted Geese flew over from the east and continued west.

13:00. Gulls leave. No change in the ducks behavior. The Mallards swim along with the tip of their bill just in the water and when they come upon a large cluster of flies they make a slight lung at them. Some of the ducks very close to shore have their bills just below the surface. Maybe feeding on the pupa attached to the vegetation.

13:45. A mixed flock of 21 birds flew in including 7 Am Wigeon.

14:00. Moved on to Gull Pond where 15 gulls and 35 ducks (Mallards, Gadwalls?, N Shovelers) were resting.

Other ponds to the east were empty.

Table 2. Time budgets of Ruddy Ducks at Mono Lake by time of day at various locations around the lake. Data collected 15 September -15 October 1997.

0800-1200	Activity (% of Total Observation time)							Activity (in minutes)						
Site	Dive	Sleep	Sit	Swim	Preen	Bathe	Total No. Ducks	Dive	Sleep	Sit	Swim	Preen	Bathe	Total Observation Time
NW Lagoon 1		40	40		20		17		30	30		15		75
Old Marina	19	62	11	1	7		54	22	74	13	1	8		118
Wilson Creek	27	73					23	17	46					63
Mill Creek	6	94					20	5	85					90
County Pond	100						2	75						75
Total	30	54	10	0	5	0	116	119	235	43	1	23	0	421
1201-1600	Activity (% of Total Observation time)							Activity (in minutes)						
Site	Dive	Sleep	Sit	Swim	Preen	Bathe	Total No. Ducks	Dive	Sleep	Sit	Swim	Preen	Bathe	Total Observation Time
Black Point	21	32	47				45	40	60	90				190
County Park	100						13	15						15
County Pond	83	17					18	71	15					86
Dech #2	100						3	5						5
Mill Creek		89	11				10		77	10				87
Old Marina	7	52	20	21			35	8	64	25	26			123
South Tufa	19	58	17	6			26	17	51	15	5			88
Total	47	35	14	4	0	0	150	156	267	140	31	0	0	594
														503
1601-2000	Activity (% of Total Observation time)							Activity (in minutes)						
Site	Dive	Sleep	Sit	Swim	Preen	Bathe	Total No. Ducks	Dive	Sleep	Sit	Swim	Preen	Bathe	Total Observation Time
County Park	67	33					15	50	25					75
County Pond			100				5			12				12
Dech #4	100						5	13						13
Mill Creek	16	54	4	21	4	1	86	59	203	15	80	15	7	379
Wilson Creek	33	33		34			14	20	20		20			60
Total	43	24	21	11	1	0	125	142	248	27	100	15	7	539

Table 3. Time budgets of Ruddy Ducks at Mono Lake by location. Data collected 15 September -15 October 1997.

	Activity (% of Total observation Time)						Activity (in minutes)							
Site	Dive	Sleep	Sit	Swim	Preen	Bathe	Total No. Ducks	Dive	Sleep	Sit	Swim	Preen	Bathe	Total Observation Time
Black Point	21	32	47	0	0	0	45	40	60	90				190
County Park	72	28	0	0	0	0	28	65	25					90
County Pond	84	9	7	0	0	0	25	146	15	12				173
Dechambeau Ponds	100	0	0	0	0	0	8	18						18
Mill Creek	12	66	5	15	3	0	116	64	365	25	80	15	2	551
Wilson Creek	30	54	0	16	0	0	37	37	66		20			123
Old Marina	13	61	13	10	4	0	89	30	138	30	22	8		228
South Tufa	19	58	17	6	0	0	26	17	51	15	5			88
NW Lagoon 1	0	40	40	0	20	0	17		30	30		15		75
Total	39	38	14	5	3	0	391	417	750	202	127	38	2	1536

FIGURE 1

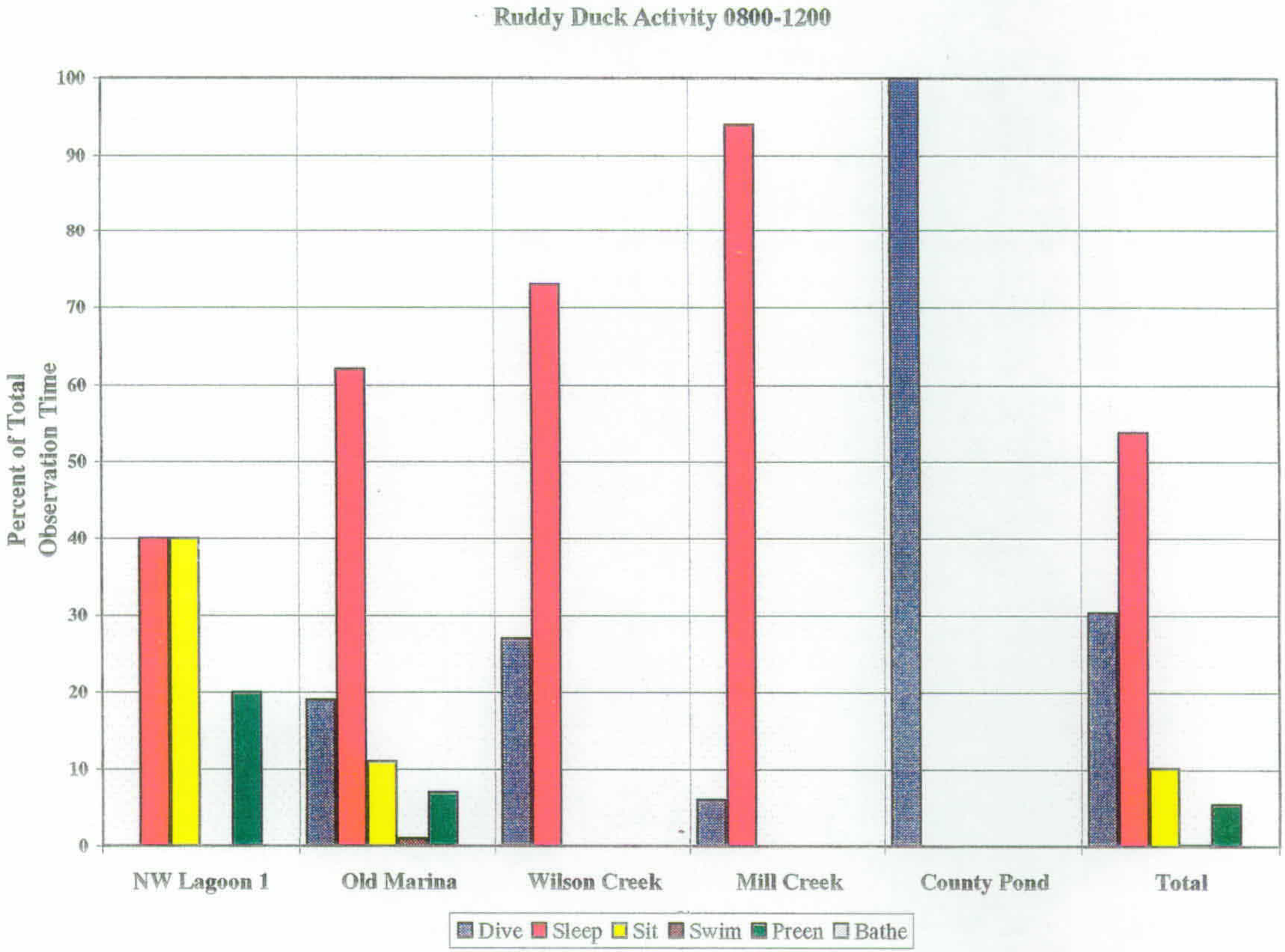

Ruddy Duck Activity 0800-1200
Percent of Total Observation Time
100
90
80
70
60
50
40
30
20
10
0
NW Lagoon 1
Old Marina
Wilson Creek
Mill Creek
County Pond
Total
Dive
Sleep
Sit
Swim
Preen
Bathe

FIGURE 2

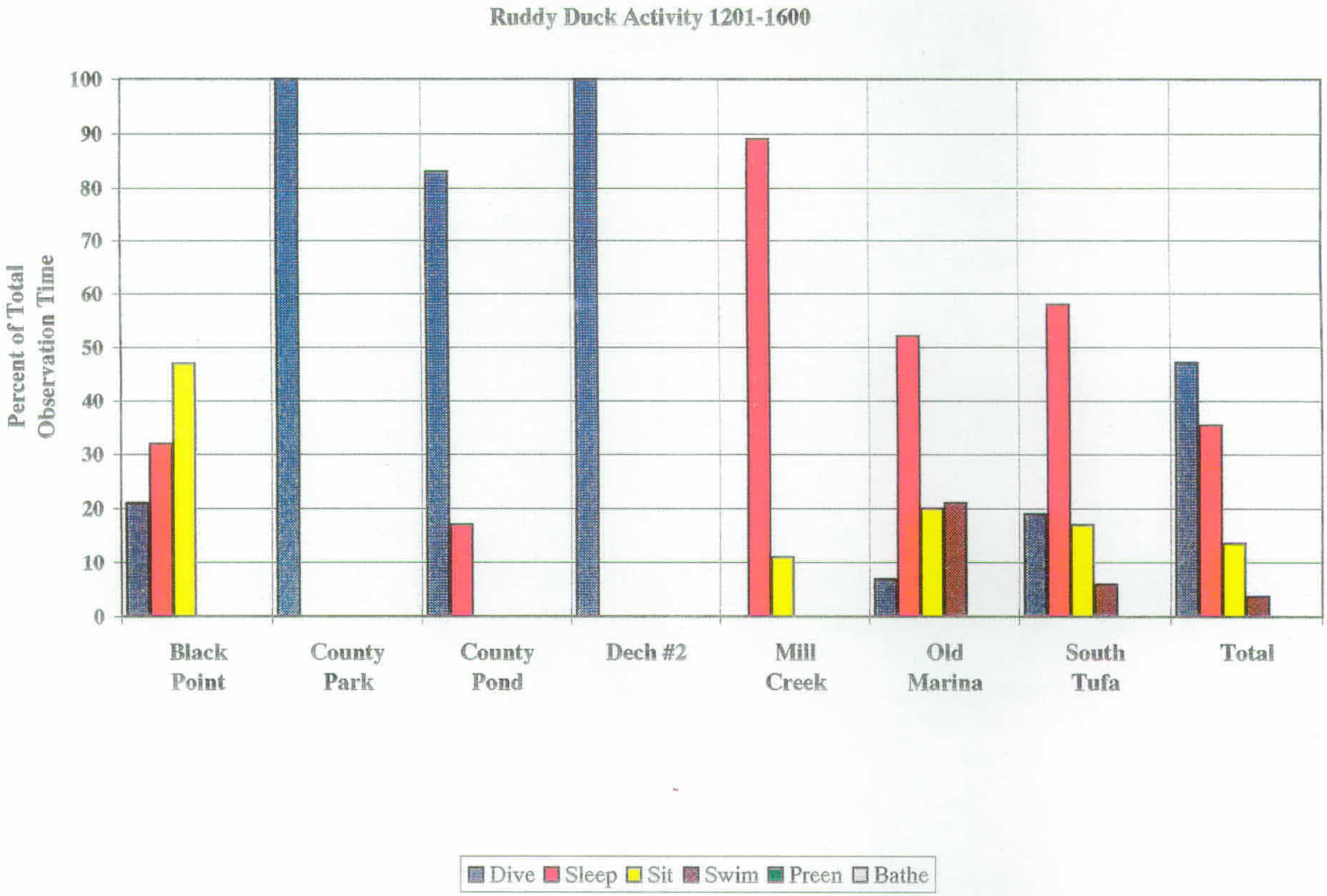

Ruddy Duck Activity 1201-1600
Percent of Total Observation Time
100
90
80
70
60
50
40
30
20
10
0
Black Point
County Park
County Pond
Dech #2
Mill Creek
Old Marina
South Tufa
Total
Dive
Sleep
Sit
Swim
Preen
Bathe

FIGURE 3

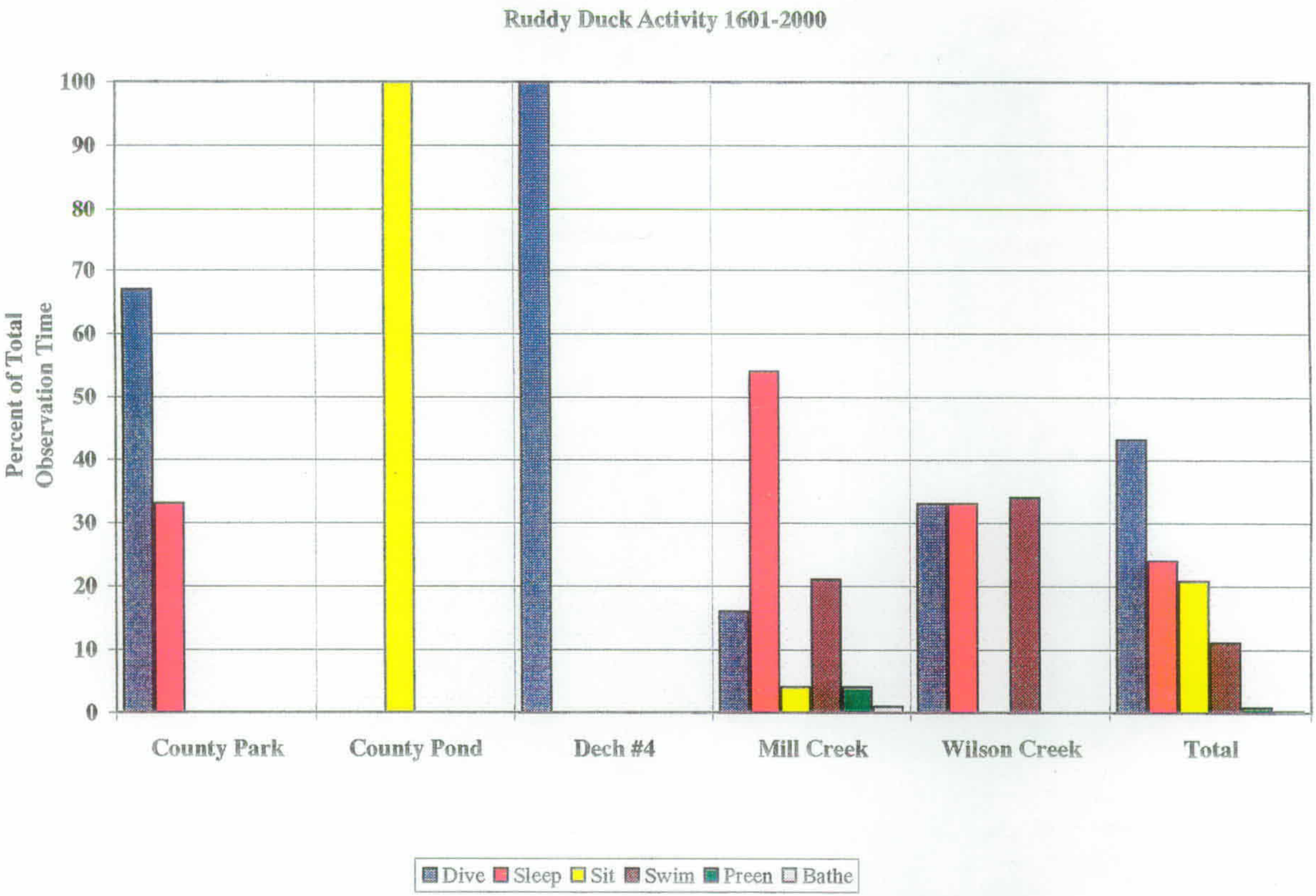
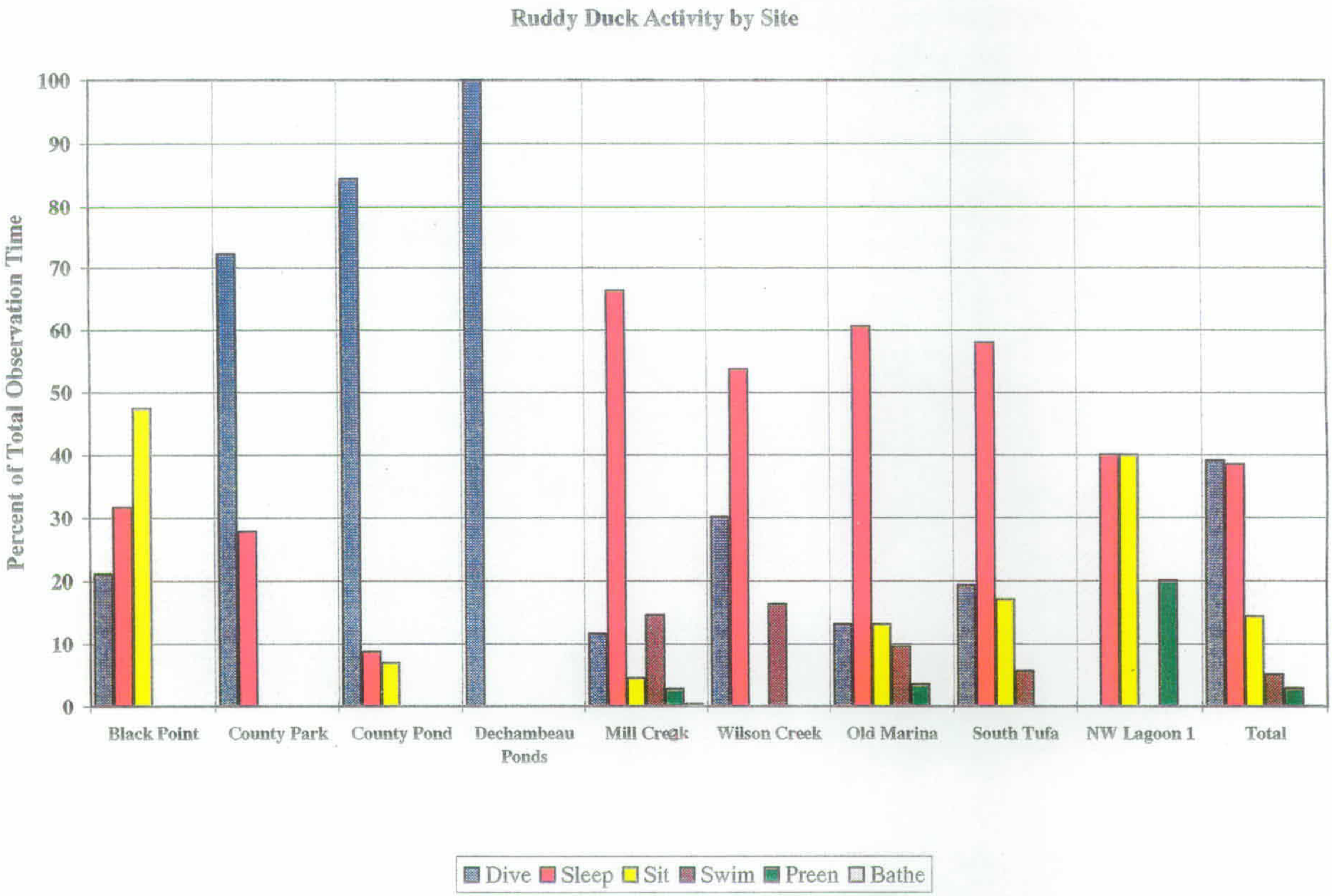

Ruddy Duck Activity 1601-2000
100
90
80
70
60
50
40
30
20
10
0
Percent of Total Observation Time
County Park
County Pond
Dech #4
Mill Creek
Wilson Creek
Total
Dive
Sleep
Sit
Swim
Preen
Bathe

FIGURE 4


Ruddy Duck Activity by Site
Percent of Total Observation Time
100
90
80
70
60
50
40
30
20
10
0
Black Point
County Park
County Pond
Dechambeau Ponds
Mill Creek
Wilson Creek
Old Marina
South Tufa
NW Lagoon 1
Total
Dive
Sleep
Sit
Swim
Preen
Bathe