LA DWP Los Angeles Department of Water & Power

BUILDING A STRONGER L.A.

May 13, 2021

Mr. Erik Ekdahl, Deputy Director
Division of Water Rights
State Water Resources Control Board
1001 I Street, 14th Floor
Sacramento, California 95814

Dear Mr. Ekdahl:

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

Pursuant to the State Water Resources Control Board (SWRCB) Decision No. 1631 and Order Nos. 98-05 and 98-07 (Orders), and in accordance with the terms and conditions of Los Angeles Department of Water and Power (LADWP) Mono Basin Water Rights License Nos. 10191 and 10192, enclosed is a compact disc (CD) containing a submittal, "Compliance Reporting May 2021", which contains the following four reports required by the Orders. Please note that for Runoff Year (RY) 2021-22, Mono Basin Operations follow the renewed Temporary Urgent Change Petition (TUCP) approved by SWRCB on April 1, 2021, as supported by the Mono Basin interested parties. The reports are as follows:

- Section 2: Mono Basin Operations: RY 2020-21 and Planned Operations for RY 2021-22. The planned operations through September 28, 2021 follow the renewed TUCP.

- Section 3: Mono Basin Fisheries Monitoring Report Rush, Lee Vining, and Walker Creeks 2020

- Section 4: A memo by Dr. Bill Trush documenting why there is no Stream Monitoring Report for RY 2020-21

- Section 5: Mono Basin Waterfowl Habitat Restoration Program 2020 Monitoring Report

In addition to these reports, the submittal also includes Section 1: the RY 2020-21 Status of Restoration Compliance Report that summarizes the status of LADWP's compliance activities in the Mono Basin to date and planned activities for the upcoming runoff year.

The filing of these reports along with the restoration and monitoring performed by LADWP in the Mono Basin fulfills LADWP's requirements for RY 2020-21 as set forth in Decision 1631 and the Orders, as well as the renewed TUCP.

Electronic copies of the submittal on CD will be provided to the interested parties listed on the enclosed distribution list. Hard copies of the submittal will be provided upon request.

If you have any questions, please contact Dr. Paul C. Pau, Eastern Sierra Environmental Group Supervisor, at (213) 367-1187.

Sincerely,

Anselmo G. Collins
Deputy Senior Assistant General Manager – Water System, and
Director of Water Operations Division

PCP:mt
Enclosures
c/enc: Distribution List
Dr. Paul C. Pau

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

COMPLIANCE REPORTING

Mono Basin Operations
Fisheries Monitoring
Stream Monitoring
Waterfowl Habitat & Population Monitoring

May 2021
Los Angeles Department of Water and Power

Section 1

Status of Restoration Compliance Report

Status of Restoration Compliance Report (SORC)

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

May 2021

Los Angeles Department of Water and Power

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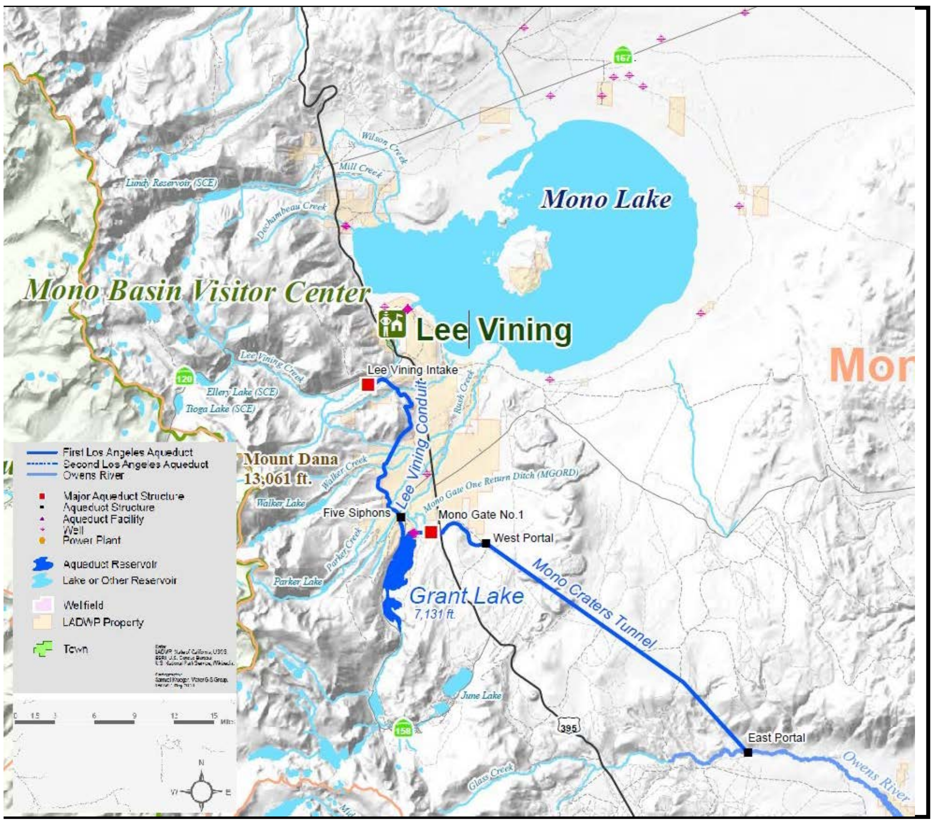
Introduction

Pursuant to State Water Resources Control Board (SWRCB) Decision 1631 and Order Nos. 98-05 and 98-07 (Orders), the Los Angeles Department of Water and Power (LADWP) is to undertake certain activities in the Mono Basin 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 monitor stream flows, and to restore and monitor the fisheries, stream channels, and waterfowl habitat. This chapter includes the Status of Restoration Compliance Report, which summarizes the status of LADWP compliance activities in the Mono Basin to date. It is expected that the Water Board will amend LADWP's water rights license. Following SWRCB adoption of the amended license, the new requirements will be reflected in future SORC Reports.

Figure 1: Map of Mono Basin showing major Streams and LADWP facilities.



Status of Restoration Compliance Report

The Status of Restoration Compliance Report ("SORC Report") is organized into the following sections:

1. **Introduction** – Description of the SORC Report
2. **Definitions** – Explanations of what each category represents
3. **Updates from Previous SORC Report** – Changes over the past year
4. **Plans for the Upcoming Runoff Year** – Planned activities for the upcoming year
5. **Requirements** – Categories of the entire list of LADWP's requirements in the Mono Basin
6. **Completion Plans** – Long term plans for completing all requirements
7. **Ongoing Items Definitions** – Ongoing activities necessary for LADWP operations in the Mono Basin.

1. Introduction:

The SORC Report details the status of the Los Angeles Department of Water and Power's (LADWP) restoration requirements in the Mono Basin as outlined by the State Water Resources Control Board (SWRCB) Decision 1631 and Order Numbers 98-05 and 98-07, and any subsequent decision letters distributed by the SWRCB. This initial structure and content of the SORC report was cooperatively prepared by LADWP and the Mono Lake Committee (MLC) through an extensive series of staff discussions and a workshop held in the Mono Basin in August 2005. LADWP and MLC believe this report represents the most thorough and complete listing of Mono Basin restoration requirements and their current status available in a unified document. These requirements are categorized as ongoing, complete, in progress, incomplete or deferred as defined below in Section 2. The final section of the SORC Report details how LADWP plans to proceed with those items not listed as ongoing or completed (i.e. items in progress, incomplete, and/or deferred).

The SORC Report will be submitted by LADWP to SWRCB as part of the annual Compliance Reporting. By April 1 each year, LADWP will update and submit a draft SORC Report to the interested parties. Within 21 days of the draft submission, LADWP will accept comments on the draft SORC Report from the interested parties. Then, LADWP will finalize the SORC Report, incorporating and/or responding to comments. The final SORC Report will then be included into the final Compliance Reporting to SWRCB by May 15 of each year.

It is expected that the Water Board will amend LADWP's current water rights license following a CEQA analysis of proposed actions related to the Mono Basin settlement agreement. The new requirements are expected to take effect immediately after the Water Board issues an order, amending the license. Subsequently, LADWP will access the necessity of continuing the SORC Report.

2. Definitions:

Below are the definitions of the categories where each requirement has been grouped.

A. <u>Ongoing</u> Items that are current and require continuous action (e.g. Maintain road closures in floodplains of Rush and Lee Vining Creeks)

B. <u>Complete</u> Items that have been finalized (e.g. Rehabilitation of the Rush Creek Return Ditch)

C. <u>In-Progress</u> Items started and not yet finalized because of time or the timeline extends into the future (e.g. Waterfowl monitoring and reporting)

D. <u>Incomplete</u> Items not yet started or not complete because plans for completion not finalized.

E. <u>Deferred</u> Items placed on hold which need input from the Stream Scientists and/or SWRCB before plans commence (e.g. Prescribed burn program)

3. Updates from Previous SORC Report:

Since the last SORC Report of May 15, 2020, there has been no change to the report and Section 4, the Plans for Runoff Year RY2020-21, will apply to RY2021-22.

4. Plans for the Upcoming Runoff Year:

During the upcoming runoff year, RY2021-22, LADWP plans to:

Continue with all requirements listed under Category A – Ongoing Items, as needed based on the runoff year, unless superseded by requirements under the April 2021 Temporary Urgency Change Petitions (TUCP).

5. Requirements:

This section lists and categorizes the individual requirements based on the status of each item. The requirements are derived from SWRCB Decision 1631, and/or Order Nos. 98-05 and 98-07, and/or any subsequent decision letters distributed by SWRCB. The requirements are either described in the cited section of the order and/or are described in the cited page of the specified plan and/or document (Stream Plan, Waterfowl Plan, GLOMP, etc.) that the Order references, and/or detailed in the SWRCB letter. On occasions, the requirements could be deviated through special permission granted by the SWRCB, such as in a Temporary Urgency Change Petitions (TUCP). Such activities are reported in the Annual Compliance Report. Plans for completing in-progress, incomplete, and deferred items are further explained in Section 6, Completion Plans. Finally, plans for those items described as ongoing are detailed in Section 7, Ongoing Items Description.

<u>Category A – Ongoing Items</u>

1. Maintain road closures in floodplains of Rush and Lee Vining Creeks – *Stream Work Order 98-05 order 1; Stream Plan p. 71-75*

2. Base flow releases – *Stream Management*
Order 98-05 order 2.a.; GLOMP p. 2, table A

3. Low winter flow releases – *Stream Management*
Order 98-05 order 2.b.

4. Annual operations plan – *Stream Management*
Order 98-05 order 3; GLOMP p. 103, 104

5. Notification of failure to meet required flows – *Stream Management*
Order 98-05 order 3

6. Grant operations and storage targets – *Stream Management*
Order 98-05 order 1.a.; Decision 1631 order 1; GLOMP p. 84

7. Amount and pattern of export releases to the Upper Owens River – *Stream Management*
Order 98-05 order 2; Decision 1631 order 7; GLOMP p. 84, 85

8. Diversion targets from streams – *Stream Management*
Order 98-05 order 2; GLOMP p. 85

9. Export amounts dependent on Mono Lake level – *Stream Management*
Decision 1631 order 6

10. Year type designation and guidelines – *Stream Management*
Order 98-05 order 2; Decision 1631 order 3; GLOMP p. 87-96

11. Dry and wet cycle contingencies for stream restoration flows and base flows – *Stream Management*
Order 98-05 order 2; GLOMP p. 97

12. Deviations from Grant Lake Operation Management Plan (GLOMP) – *Stream Management*
Order 98-05 order 2; GLOMP p. 98, 99

13. Ramping rates – *Stream Management*
Order 98-05 order 2; Decision 1631 order 2; GLOMP p. 90-96

14. Stream restoration flows and channel maintenance flows – *Stream Management*
Order 98-05 order 1.a.

15. Salt Cedar eradication – *Waterfowl*
Order 98-05 order 4.e.; Waterfowl Plan p. 27

16. Aerial photography every five years or following an extreme wet year event – *Monitoring*
    Order 98-05 order 1.b; Stream Plan p. 103

17. Make basic data available to public – *Monitoring*
    Order 98-05 order 1.b as revised by Order 98-07; Order 98-07 order 1.b(2); Stream Plan p. 110

18. Operation of Lee Vining sediment bypass – Stream Facility Modifications
    Order 98-05 order 2

19. Operation of the Rush Creek augmentation from the Lee Vining Conduit when necessary – *Stream Management*
    Order 98-05 order 2

20. Make data from all existing Mono Basin data collection facilities available on an internet web site on a same-day basis – *Stream Management*
    Order 98-05 order 2.c

<u>Category B – Completed Items</u>

1. Placement by helicopters of large woody debris into Rush Creek, completed fall 1999 – *Stream Work*
   Order 98-05 order 1; order 1.d.; Stream Plan p. 67, 68

2. Placement by helicopters of large woody debris into Lee Vining Creek, completed fall 1999 – *Stream Work*
   Order 98-05 order 1; order 1.d.; Stream Plan p. 67, 68

3. Rewater Rush Creek side channels in reach 3A, completed fall 1999 – *Stream Work*
   Order 98-05 order 1; Stream Plan p. 68-71

4. Rewater Rush Creek side channel in reach 3B, completed fall 1999 with changes (see LADWP annual Compliance Reporting, May 2000) – *Stream Work*
   Order 98-05 order 1; Stream Plan p. 68-71

5. Rewater Rush Creek side channel in reach 3D, completed fall 2002 with changes (see LADWP annual Compliance Reporting, May 2003) – *Stream Work*
   Order 98-05 order 1; Stream Plan p. 68-71

6. Revegetate approximately 250 Jeffrey Pine trees on Lee Vining Creek, completed in 2000 – *Stream Work*
   Order 98-05 order 1; Stream Plan p. 71-75

7. Revegetate willows on Walker Creek. No planting necessary in judgment of LADWP and MLC as area revegetated rapidly without intervention – *Stream Work*
   Order 98-05 order 1; Stream Plan p. 71-75

8. Revegetate willows on Parker Creek. No planting necessary in judgment of LADWP and MLC as area revegetated rapidly without intervention – *Stream Work*
Order 98-05 order 1; Stream Plan p. 71-75

9. Limitations on vehicular access in Rush and Lee Vining Creek floodplains, completed fall 2003 – *Stream Work*
Order 98-05 order 1; Stream Plan p. 78-80

10. Removal of bags of spawning gravel, completed fall 2003 – *Stream Work*
Order 98-05 order 1; Stream Plan p. 85, 86

11. Removal of limiter logs, completed 1996 – *Stream Work*
Order 98-05 order 1; Stream Plan p. 86

12. Removal of Parker Plug, completed by California Department of Transportation 2000 – *Stream Work*
Order 98-05 order 1; Stream Plan p. 87

13. Sediment bypass facility for Lee Vining Creek, completed winter 2005 – *Stream Facility Modifications*
Order 98-05 order 1.f.

14. Flood flow contingency measures, completed by California Department of Transportation's Highway 395 improvements in 2002 – *Stream Management*
Order 98-05 order 1; Stream Plan p. 76

15. Stream monitoring site selection, completed 1997 – *Monitoring*
Order 98-05 order 2; Stream Plan p. 109

16. Waterfowl and limnology consultants, completed 2004 – *Monitoring*
Order 98-05 order 4; Waterfowl Plan p. 27-29

17. Status report on interim restoration in Mono Basin, completed 2006 – *Other*
Decision 1631 order 8.d (3)

18. Cultural resources investigation and treatment plan report to SWRCB, completed 1996 – *Other*
Decision 1631 order 9, 10

19. Revegetate or assess the need to revegetate Rush Creek side channels in reach 3A five years after rewatering, assessed annually and reported in May 2006 Monitoring Report – *Stream Work*
Order 98-05 order 1; Stream Plan p. 71-75

20. Revegetate or assess the need to revegetate Rush Creek side channels in reach 3B five years after rewatering, assessed annually and reported in May 2006 Monitoring Report – *Stream Work*

Order 98-05 order 1; Stream Plan p. 71-75

21. Revegetate or assess the need to revegetate Rush Creek side channel in reach 3D and reported in May 2008 Monitoring Report – *Stream Work*
Order 98-05 order 1; Stream Plan p. 71-75

22. Rewater Rush Creek side channel 11 in reach 4C. Final review was conducted by the Stream Scientists. After presentation of the final review, LADWP followed the recommendations of the Stream Scientists not to do any action on the channel. This item is now approved by SWRCB and is therefore considered completed in 2008. – *Waterfowl*
Order 98-05 order 4.a., order 4.d.; Waterfowl Plan p. 22

23. Rewater Rush Creek side channel 14 in reach 4C. Final review was conducted by the Stream Scientists. After presentation of the final review, LADWP followed the recommendations of the Stream Scientists not to do any action on the channel. This item is now approved by SWRCB and is therefore considered complete in 2008. – *Stream Work*
Order 98-05 order 1; Stream Plan p. 68-71

24. Revegetate or assess the need to revegetate Rush Creek side channel 11 in reach 4C for five years following rewatering. LADWP followed the recommendations of the Stream Scientists not to do any action on the channel. This item is now approved by SWRCB and is therefore considered completed in 2008. – *Waterfowl*
Order 98-05 order 4.a., order 4.d.; Waterfowl Plan p. 22

25. Revegetate or assess the need to revegetate Rush Creek side channel 14 in reach 4C for five years after rewatering. LADWP followed the recommendations of the Stream Scientists not to do any action on the channel. This item is now approved by SWRCB and is therefore considered completed in 2008. – *Stream Work*
Order 98-05 order 1; Stream Plan p. 68-71

26. LADWP and MLC were to cooperatively revegetate pine trees on areas of Rush Creek and Lee Vining Creek including disturbed, interfluve, and upper terrace sites targeted from reach 3B through 5A on Rush Creek. In 2005, remaining suitable areas were assessed resulting in a map showing those areas where planting pine trees may be successful and would add to habitat complexity. LADWP and MLC investigated locations suitable for planting by LADWP and MLC staff and volunteers. Acceptable Jeffrey Pine seedlings were procured by LADWP and were planted by MLC and volunteers on all available suitable sites. This item is considered complete and is moved to Category B "Completed Items." However, MLC may continue to water these seedlings. MLC may also plant cottonwoods with volunteers as opportunities arise – Stream Work Order 98-05 order 1; Stream Plan p. 71-75

27. Rewater Rush Creek side channel 8 in reach 4B, completed March 2007 – *Waterfowl.* The further rewatering of Rush Creek side channel complex 8 in reach 4B was deferred by the Stream Scientists. Final review is being conducted by

McBain and Trush. After presentation of the final review, LADWP followed the recommendations of the Stream Scientists and SWRCB has approved the plan
Order 98-05 order 4.a., order 4.d; Waterfowl Plan p. 22

28. Rehabilitation of the Rush Creek Return Ditch, completed 2002 – *Stream Facility Modifications.* Since then, vegetation growth has slightly reduced ditch capacity. To restore maximum capacity of 380 cfs, the return ditch embankments were raised.
Order 98-05 order 1, order 1.c.; Stream Plan p. 85, appendix III

<u>Category C – In-Progress Items</u>

1. Placement by hand crews of large woody debris into Rush Creek on an opportunistic basis based on stream monitoring team recommendations – *Stream Work*
Order 98-05 order 1; order 1.d.; Stream Plan p. 67, 68

2. Placement by hand crews of large woody debris into Lee Vining Creek on an opportunistic basis based on stream monitoring team recommendations – *Stream Work*
Order 98-05 order 1; order 1.d.; Stream Plan p. 67, 68

3. Grazing moratorium for 10 years, assessed annually and status reported in May 2009 Monitoring Report. Grazing moratorium to continue until further notice. – *Stream Management*
Order 98-05 order 1; Stream Plan p. 83

4. Grant Lake Operation Management Plan (GLOMP) preparation for revisions – *Stream Management*
Order 98-05 order 2; GLOMP p. 103, 104

5. Waterfowl project funding – *Waterfowl*
Order 98-05 order 4.b.

6. Salt Cedar eradication reporting– *Waterfowl*
Order 98-05 order 4.e.; Waterfowl Plan p. 27

7. Stream monitoring team to perform duties – *Monitoring*
Order 98-05 order 1.b as revised by Order 98-07

8. Stream monitoring reporting to the SWRCB – *Monitoring*
Order 98-05 order 1.b as revised by Order 98-07; Order 98-07 order 1.b(2); Stream Plan p. 110

9. Development, approval, and finalization of stream monitoring termination criteria for Walker and Parker Creeks – *Monitoring Order 98-07*

10. Development, approval, and finalization of stream monitoring termination criteria for Lee Vining and Rush Creeks – *Monitoring*

Order 98-07

11. Hydrology monitoring and reporting – *Monitoring*
    Order 98-05 order 4; Waterfowl Plan p. 27

12. Lake limnology and secondary producers monitoring and reporting – *Monitoring*
    Order 98-05 order 4; Waterfowl Plan p. 27, 28

13. Riparian and Lake fringing wetland vegetation monitoring and reporting – *Monitoring*
    Order 98-05 order 4; Waterfowl Plan p. 27, 28

14. Waterfowl monitoring and reporting – *Monitoring*
    Order 98-05 order 4; Waterfowl Plan p. 28; LADWP's 2004 "Mono Lake Waterfowl Population Monitoring Protocol" submitted to SWRCB on October 6, 2004

15. Testing the physical capability for Rush Creek augmentation up to 150 cfs from the Lee Vining Conduit through the 5-Siphon Bypass facility – *Stream Management*
    Order 98-05 order 2; GLOMP p. 82, 83

16. Evaluation of the effects on Lee Vining Creek of Rush Creek augmentation for diversions up to 150 cfs through the Lee Vining Conduit – *Monitoring*
    Order 98-05 order 1.b.

17. Sediment bypass for Parker Creek – *Stream Facility Modifications*
    Order 98-05 order 1.f.

18. Sediment bypass for Walker Creek – *Stream Facility Modifications*
    Order 98-05 order 1.f.

Category D – Incomplete Items

None

Category E – Deferred Items

1. Recommend an Arizona Crossing or a complete road closure at the County Road Lee Vining Creek, if and when Mono County plans to take action – *Stream Work*
   Order 98-05 order 1; Stream Plan p. 78-80

2. Fish screens on all irrigation diversions – *Stream Facility Modifications*
   Order 98-05 order 1; Stream Plan p. 84

3. Prescribed burn program – *Waterfowl*
   Order 98-05 order 4.b.(3)c.; Waterfowl Plan p. 25, 26

4. Rewatering of Rush Creek side channel 1A in reach 4A.– *Stream Work*

Order 98-05 order 1; Stream Plan p. 68-71

5. Assessing the need to revegetate the areas affected by the side channel openings for Rush Creek side channel 1A in reach 4A – *Stream Work; Order 98-05 order 1; Stream Plan p. 68-71*

6. Assessing the need to revegetate the areas affected by the side channel openings for Rush Creek side channel 4Bii in reach 4B. – Stream Work Order 98-05 order 1; Stream Plan p. 68-71

7. Assessing the need to revegetate the areas affected by the side channel openings for Rush Creek side channel 8 in reach 4B.

8. Stream monitoring for 8-10 years to inform peak flow evaluation and recommendations including the need for a Grant Lake Reservoir Outlet – *Monitoring Order 98-05 order 1.b as revised by Order 98-07*

6. Completion Plans:

The following descriptions detail how LADWP plans to fulfill SWRCB requirements in the Mono Basin for each item above not categorized as complete or ongoing. This section will be reviewed annually by LADWP for revisions to reflect progress towards completion.

<u>Category C – In-Progress Items</u>

Item C1 – During walking surveys, large woody debris will be placed into Rush Creek and will continue to be done on an opportunistic basis based on recommendations made by the Monitoring Team. This item will remain "In-Progress" until the Monitoring Team indicates that no further work is required. At that time, this item will be considered complete and will be moved to Category B "Completed Items".

Item C2 – During walking surveys, large woody debris will be placed into Lee Vining Creek and will continue to be done on an opportunistic basis based on recommendations made by the Monitoring Team. This item will remain "In-Progress" until the Monitoring Team indicates that no further work is required. At that time, this item will be considered complete and will be moved to Category B "Completed Items".

Item C3 – The grazing moratorium in the Mono Basin was in effect until 2009. At this time LADWP does not intend to allow grazing on its lands in the Mono Basin and will continue the moratorium in 2019. This item will remain in the Category C "In Progress".

Item C4 – The Grant Lake Operation Management Plan (GLOMP) includes instructions to "review for revisions" every five years until Mono Lake reaches 6,391 feet above mean sea level. Although no revisions have been finalized to date, the plan was continuously under review. GLOMP is expected to be revised and replaced with

"Mono Basin Operations Plan" (MBOP) after the SWRCB amends LADWP Water Rights licenses. This item will remain in Category C "In-Progress Items" until the final operation/management plan is approved by SWRCB. It is expected that a final plan will be developed after the Water Board order. Once the plan is approved, this item will be considered complete and will be moved to Category B "Completed Items".

Item C5 – LADWP is to make available a total of $275,000 for waterfowl restoration activities in the Mono Basin. This money was to be used by the USFS if they requested the funds by December 31, 2004. Afterwards, any remaining funds are to be made available to any party wishing to do waterfowl restoration in the Mono Basin after SWRCB review. USFS has requested funds for a project estimated at $100,000. MLC has requested that the remainder of the funds be applied toward the total cost of the Mill Creek Return Ditch upgrade which would provide benefits for waterfowl habitat. The Mill Creek Return Ditch rehabilitation is a component of a Federal Energy Regulatory Commission (FERC) settlement agreement. These funds will continue to be budgeted by LADWP until such a time that they have been utilized. Currently, this money has been tentatively been included in the Settlement Agreement as part of Administrative of Monitoring Accounts to be administered by a Monitoring Administration Team (MAT). Once the full $275,000 has been utilized, this item will be considered complete and will be moved to Category B "Completed Items".

Item C6 – Progress of the salt cedar eradication efforts is reported in the annual reports following the vegetation monitoring efforts. This item will continue to be in progress until notice from SWRCB is received that LADWP's obligation for this in the Mono Basin is complete. Once this notice is received, this item will be moved to Category B "Completed Items".

Item C7 – The stream monitoring team continues to perform their required duties in the Mono Basin. This item will continue to be in progress until notice from SWRCB is received that LADWP's obligation for funding and managing the monitoring team in the Mono Basin is complete. Once this notice is received, this item will be moved to Category B "Completed Items", and LADWP will implement an appropriate monitoring program for the vegetation, stream morphology waterfowl, and fisheries.

Item C8 – Progress of the restoration efforts is reported in the annual reports. This item will continue to be in progress until notice from SWRCB is received that LADWP's obligation for this in the Mono Basin is complete. Once this notice is received, this item will be moved to Category B "Completed Items".

Item C9 – The Stream Scientists have submitted final recommendations for termination criteria on Walker and Parker Creeks in 2007 to the SWRCB. There has been no decision from SWRCB. Once the termination criteria are finalized by the Stream Scientists and approved by SWRCB, this item will be considered complete and will be moved to Category B "Completed Items".

Item C10 – The Stream Scientists have submitted final recommendations for termination criteria on Lee Vining and Rush Creeks in 2007 to the SWRCB. There has been no decision from SWRCB. Once approved by SWRCB, this item will be considered complete and will be moved to Category B "Completed Items".

Item C11 – LADWP will continue to monitor and report on the hydrology of the Mono Basin including regular Mono Lake elevation readings, stream flows, and spring surveys until SWRCB approves that all or portions of the hydrology monitoring is no longer required. Once this occurs, all or portions of this item will be considered complete and will be moved to Category B "Completed Items". Any portions of this requirement that are deemed to be ongoing by the SWRCB will be moved to Category A "Ongoing Items".

Item C12 – LADWP will continue to monitor and report on the Mono Lake limnology and secondary producers until SWRCB approves that limnological monitoring is no longer required. Once this occurs, this item will be considered complete and will be moved to Category B "Completed Items".

Item C13 – LADWP will continue to monitor and report on the vegetation status in riparian and lake fringing wetland habitats, which is done every 5 years until SWRCB approves that vegetation monitoring is no longer required. Once this occurs, this item will be considered complete and will be moved to Category B "Completed Items".

Item C14 – LADWP will continue to monitor and report on the waterfowl populations in the Mono Basin until SWRCB approves that waterfowl monitoring is no longer required. Once this occurs, this item will be considered complete and will be moved to Category B "Completed Items".

Item C15 – Testing augmentation of Rush Creek flows with water from Lee Vining Creek through the use of the Lee Vining Conduit is possible and can occur as needed as demonstrated during peak runoff in June 2005. The augmentation has been tested up to 100 cfs and the orders call for maximum augmentation to be 150 cfs. This will only be possible if adequate runoff is available in Lee Vining Creek after the peak operation is complete. Once augmentation is successfully tested through 150 cfs, this item will be moved to Category B "Completed Items".

Item C16 – Evaluation of the effects of Rush Creek augmentation on Lee Vining Creek needs to be completed to cover diversions up to 150 cfs. Once the evaluation is completed, this item will be moved to Category B "Completed Items".

Item C17 – Sediment bypass for Parker Creek is now in trial implementation stage. Once a plan is finalized by SWRCB and becomes part of LADWP's operation plans, this item will be moved to Category A "Ongoing Items".

Item C18 – Sediment bypass for Walker Creek is now in trial implementation stage. Once a plan is finalized by SWRCB and becomes part of LADWP's operation plans, this item will be moved to Category A "Ongoing Items".

Category D – Incomplete Items

None

Category E – Deferred Items

Item E1 – Pending further action by Mono County to improve the county road crossing at Lee Vining Creek, LADWP will write a letter to Mono County recommending an Arizona crossing at that point. Once LADWP writes this letter, or the parties agree that this is unnecessary; this item will be moved to Category B “Completed Items”.

Item E2 – LADWP was to place fish screens on all of its irrigation diversions in the Mono Basin. Subsequently LADWP ended all irrigation practices and hence does not need to install fish screens. If at a later date LADWP resumes irrigation, fish screens will be installed and this item will be moved to Category A “Ongoing Items”.

Item E3 – LADWP began a prescribed burn program with limited success. LADWP requested to remove this item from the requirements and the SWRCB instead ruled that the prescribed burn program will be deferred until Mono Lake reaches 6,391 ft. Once Mono Lake reaches 6,391 ft. LADWP will reassess the prescribed burn. Based on results from the assessment, LADWP will either reinstate the program or request relief from the SWRCB from this requirement. If LADWP reinstates the program this item will be moved to Category C “In-Progress Items”, however if LADWP requests, and is granted relief from this SWRCB requirement, this item will be moved to Category B “Completed Items”.

Item E4 - Rewatering of Rush Creek side channel 1A in reach 4A. Final review was conducted by the Stream Scientists. After presentation of the final review, LADWP followed the recommendations of the Stream Scientists not to do any action on the channel and was awaiting final decision by SWRCB. This item was approved by SWRCB and was therefore considered completed in 2008. Further work on Channel 1A was to be considered in the future if deemed appropriate. In 2014, as part of the pending new license, it has been included to be done in the future. Until the SWRCB approves the Settlement Agreement and amends LADWP’s license, it will be placed in Category E – “Deferred Item”.

Item E5 - Assessing the need to revegetate the areas affected by the side channel openings for Rush Creek side channel 1A in reach 4A will occur for five years following rewatering. LADWP followed the recommendations of the Stream Scientists not to do any action on the channel and was awaiting final decision by SWRCB. This item was approved by SWRCB and was therefore considered completed in 2008. Until the SWRCB approves the Settlement Agreement and amends LADWP’s license, it will be placed in Category E – “Deferred Item”.

Item E6 - Assessing the need to revegetate the areas affected by the side channel openings for Rush Creek side channel 4Bii in reach 4B five years following rewatering (2007) occurred in the summer of 2012. The results from the assessment following the fifth year after rewatering was reported in Section 4 of the 2013 report. The final assessment concluded that satisfactory revegetation has occurred through natural processes and was considered complete and was moved to Category B “Completed Items”. Until the SWRCB approves the Settlement Agreement and amends LADWP’s license, it will be placed in Category E – “Deferred Item”.

Item E7 - Assessing the need to revegetate the areas affected by the side channel openings for Rush Creek side channel 8 in reach 4B five years following rewatering (2007) occurred in the summer of 2012. The results from the assessment following the fifth year after rewatering were reported in Section 4 of the 2013 report. The final assessment concluded that satisfactory revegetation has occurred through natural processes and was considered complete and was moved to Category B “Completed Items”. Until the SWRCB approves the Settlement Agreement and amends LADWP’s license, it will be placed in Category E – “Deferred Item”.

Item E8 – The stream monitoring team is to evaluate the restoration program after “no less than 8 years and no more than 10 years” from the commencement of the restoration program. This evaluation is to cover the need for a Grant Lake outlet, Rush Creek augmentation, and the prescribed stream flow regime. According to SWRCB Order Nos. 98-05 and 98-07, evaluation of LADWP’s facilities to adequately provide proper flows to Rush Creek “*shall take place after two data gathering cycles but no less than 8 years nor more than 10 years after the monitoring program begins*”. The Monitoring Team submitted final recommendation, on April 30, 2010. LADWP had 120 days after receiving the recommendation from the monitoring team to determine whether to implement the recommendation of the monitoring team. On July 28, 2010, LADWP submitted a Feasibility Report evaluating the recommendations. In September 2013, LADWP entered into a Settlement Agreement with the Stakeholders and this Agreement is pending SWRCB’s approval via an amended Water Rights license. Until the SWRCB approves the Settlement Agreement and amends LADWP’s license, it will be placed in Category E – “Deferred Item”.

7. Ongoing Items Description:

See Section 5 for references where each requirement originates.

<u>Category A – Ongoing Items</u>

Item A1 – *Road closures*. Periodically LADWP personnel will visit all road closures performed by LADWP in accordance with SWRCB Order No. 98-05, Order 1, in the Lower Rush and Lee Vining Creek areas to assess their effectiveness. Where evidence exists that a road closure is ineffective, LADWP will improve the road closures through means such as additional barriers.

Item A2 – *Base flow releases*. LADWP normally will control flow releases from its facilities into Lower Rush, Parker, Walker, and Lee Vining Creeks according to agreed upon flow rate requirements as set forth in the SWRCB Decision 1631, Order Nos. 98-05 and Order 98-07, the Grant Lake Operations Management Plan, and any subsequent operations plans and decisions made by the SWRCB.

Item A3 – *Low winter flow releases*. Per the California Department of Fish and Wildlife recommendations, and SWRCB Order No. 98-05, order 2.b., LADWP will maintain winter flows into Lower Rush Creek below 70 cfs in order to avoid harming the Rush Creek fishery.

Item A4 – *Annual operations plan*. Per SWRCB Order No. 98-05, order 3, LADWP will distribute an annual operations plan covering its proposed water diversions and releases in the Mono Basin. Presently the requirement is to distribute this plan to the SWRCB and all interested parties by May 15 of each year.

Item A5 – *Notification of failure to meet flow requirements*. Per SWRCB Order No. 98-05, order 3, and SWRCB Decision 1631, order 4, if at the beginning of the runoff year, for any reason, LADWP believes it cannot meet SWRCB flow requirements, LADWP will provide a written explanation to the Chief of the Division of Water Rights by May 1, along with an explanation of the flows that will be provided. If unanticipated events prevent LADWP from meeting SWRCB Order No. 98-05 Stream Restoration Flow requirements, LADWP will notify the Chief of the Division of Water Rights within 20 days and provide a written explanation of why the requirement was not met. LADWP will provide 72 hours notice and an explanation as soon as reasonably possible for violation of SWRCB Decision 1631 minimum instream flow requirements.

Item A6 – *Grant storage targets*. LADWP will operate its Mono Basin facilities to maintain a target storage elevation in Grant Lake Reservoir between 30,000 and 35,000 acre-feet at the beginning and end of the runoff year. LADWP will seek to have 40,000 acre-feet in Grant Reservoir on April 1 each year at the beginning of wet and extreme wet years.

Item A7 – *Export release patterns to the Upper Owens River*. Per SWRCB Decision 1631, order 7, and SWRCB Order No. 98-05, order 2, LADWP will make exports from the Mono Basin to the Upper Owens River in a manner that will not have a combined flow rate below East Portal above 250 cfs. LADWP will perform ramping of exports at 20% or 10 cfs, whichever is greater, on the ascending limb, and 10% or 10 cfs, whichever is greater, on the descending limb of the hydrograph as measured at the Upper Owens River.

Item A8 – *Diversion targets from streams*. Per the 1996 GLOMP, diversion targets for exports from the Mono Basin will be divided between Rush, Lee Vining, Parker and Walker Creeks in the following manner. During all years except dry and extremely wet years, LADWP will seek to divert one-third to one-half of the export amount from Lee Vining Creek, with the remaining water coming from Rush Creek. Only during dry years when 16,000 acre-feet of export is permitted, LADWP will seek to divert from Parker and Walker Creeks. During extremely wet years, all exports will come from diversions off of Rush Creek. Parker and Walker Creeks are expected to be flow through after the SWRCB approves the Settlement Agreement and amends LADWP Water Rights licenses.

Item A9 – *Export amounts dependent on Mono Lake level*. LADWP export amounts follow those ordered by SWRCB Decision 1631, order 2.

Item A10 – *Year type designation and guidelines*. Per SWRCB Decision 1631, order 4, SWRCB Order No. 98-05, and GLOMP, LADWP will perform runoff year forecasts for the Mono Basin with preliminary forecasts being conducted on February 1, March 1, and April 1, with the forecast being finalized on or around May 1 if necessary. LADWP developed a draft May 1 forecast methodology without a need for May snow surveys. When Gem Pass snow pillow measures show an increase in water content between April 1 and May 1, the percentage change experienced by the pillow will be applied to all of the April 1st snow course survey measurements used in calculating the runoff. A slight adjustment to the calculation may be made for dry years. Additionally, the May 1st forecast will have measured April values.

Item A11 – *Dry and wet cycle contingencies for stream restoration flows and base flows*. During consecutive dry years LADWP will release channel maintenance flows (CMF) every other year. The CMF will commence in the second consecutive dry year. The channel maintenance flows for Rush Creek will be 100 cfs for five days, and for Lee Vining Creek it will be 75 cfs for five days. Ramping rates will be 10 cfs per day. The occurrence of a year type other than a dry year will terminate the dry year cycle. During consecutive wet years, LADWP will increase base flows above the minimum flow rate every other year. The increased base flows will commence in the second consecutive wet year. The occurrence of a year type other than a wet year will terminate the wet year cycle.

Item A12 – *Deviations from Grant Lake Operation Management Plan (GLOMP)*. LADWP must maintain operational flexibility to adjust or react to unpredictable circumstances.

Item A13 – *Ramping rates*. LADWP will continue to operate its Mono Basin facilities in order to provide SWRCB ramping flow requirements for Lee Vining, Parker, Walker, and Rush Creeks.

Item A14 – *Stream restoration flows and channel maintenance flows*. LADWP will continue to operate its Mono Basin facilities in order to provide peak flow requirements for Lee Vining, Parker, Walker, and Rush Creeks.

Item A15 – *Salt Cedar eradication*. LADWP will continue assisting in a Mono Basin wide effort to eradicate Salt Cedar (*Tamarisk*), and will continue to report on these efforts.

Item A16 – *Aerial Photography.* LADWP will capture aerial and/or satellite imagery of the Mono Basin (Stream Plan, 1" = 6,000' scale; SWRCB Order No. 98-05, Section 6.4.6(4), 1:6,000 scale) every five years or following an extreme wet year event, which resets the five year clock.

Item A17 – *Make basic data available to public*. Per SWRCB Order 98-05, Order 1.b., as revised by SWRCB Order No. 98-07, order 1.b(2), LADWP will continue to make all basic monitoring data available to the public.

Item A18 – *Operation of Lee Vining sediment bypass*. In order to bypass sediment past the Lee Vining diversion facility, LADWP will operate the Lee Vining Conduit control gate to assist with ramping flows towards peak with the intention of having it be in the completely open position while peak flows are passing the diversion facility. After peak flows have passed the facility, the Lee Vining Conduit control gate will slowly close assisting with ramping flows back down towards base flow condition.

Item A19 – *Operation of the Rush Creek augmentation from the Lee Vining Conduit when necessary*. At times when peak flow requirements in Rush Creek exceed facility capacities, and Grant Lake Reservoir is not spilling, LADWP will operate the Lee Vining Conduit 5-Siphon Bypass to bring water from Lee Vining Creek to Rush Creek to augment flows to the required levels.

Item A20 – Data from existing Mono Basin data collection facilities is available on a same-day basis on the LADWP.com internet web site. The data collection and reporting works, as with any other system, can experience periodic short term communication problems and/or technical difficulties, which may result in incorrect readings. LADWP will continue to monitor the data posting on a daily basis and will work to troubleshoot and correct problems as soon as possible. LADWP will continue to improve the data collection, computer, and communication systems as new technology(ies) become available.

Section 2

Mono Basin Operations

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

May 2020

Los Angeles Department of Water and Power

Section 2

Mono Basin Operations

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

May 2021

Los Angeles Department of Water and Power

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I. Introduction

Pursuant to State Water Resources Control Board (SWRCB) Decision 1631 and Order Nos. 98-05 and 98-07 (Orders), the Los Angeles Department of Water and Power (LADWP) undertakes certain activities in the Mono Basin in compliance with the terms and conditions of its water rights licenses 10191 and 10192. In addition to restoration and monitoring activities covered in this report, LADWP also reports on certain required operational activities.

II. Summary of Mono Basin RY 2020-21 Operations

For RY 2020-2021, Mono Basin operated under renewed Temporary Urgency Change Petitions (TUCPs; Attachments 1 & 2) approved by the SWRCB, pursuant to Water Code Section No. 1435. The renewed TUCPs allowed LADWP to temporarily deviate from the Stream Restoration Flow requirements as outlined in the SWRCB Order 98-05, and instead to follow the Stream Ecosystem Flows (SEFs) recommended by the SWRCB-appointed stream scientists in the 2010 Synthesis of Instream Flow Recommendations to the SWRCB and LADWP.

A. Rush Creek

The runoff from Rush Creek was approximately 30,135 AF which amounts to the total water delivered to Grant Lake Reservoir (GLR)'s 'Damsite'. The highest flow of 138.51 cfs occurred on May 30, 2020.

Rush Creek flows below 'the Narrows', which consist of Rush Creek releases (Return Ditch, Spill, and 5-Siphons augmentation) combined with Parker and Walker Creeks flows, had an approximate total of 38,971 AF. This flow terminated into Mono Lake.

RY 2020-2021 was forecasted as a Dry-Normal I year and followed the two TUCPs' requirements, as approved by the SWRCB in April, and October, 2020, respectively.

From April 1, 2020 through March 31, 2021, Rush Creek flows were generally implemented in accordance with Table 1F of Attachment 1. Except on August 26, 2020, LADWP informed SWRCB through email that for crew safety, the flows for Rush Creek and Lee Vining would be set at 25 cfs for the fish monitoring activities from September 4 - 18, 2020.

1. Rush Creek Augmentation

To meet high flow targets for lower Rush Creek, LADWP must at times employ facilities in addition to the MGORD which has a 380 cfs capacity limit. During wetter years, LADWP utilizes one or both of its additional facilities to release higher peak flows. These facilities include the 5-Siphons bypass, which can release up to 100 cfs from Lee Vining Creek, and the GLR Spillway which can release large reservoir spills into lower Rush Creek during the wetter years.

5-Siphons Bypass
Under the TUCP, the 5-Siphons were not utilized.

Grant Reservoir Spill
Grant reservoir did not spill.

B. Lee Vining Creek

From April 1, 2020 through September 28, 2020, Lee Vining Creek flows were generally implemented in accordance with Table 2B of Attachment 1. Lee Vining Creek had its highest flow on April 30, 2020 at 129.8 cfs. Total runoff for the year was approximately 23,770 AF.

From October 1, 2020 through March 31, 2021, Lee Vining Creek flows were implemented in accordance with Table 2C of Attachment 1.

C. Dry Cycle Channel Maintenance Flows

RY 2020-21 was forecasted as a Dry-Normal I year type, therefore dry cycle channel maintenance flows (CMF) were not required in accordance with Decision 1631, and separately, with the TUCP.

D. Parker and Walker Creeks

Under the TUCPs, Parker and Walker were operated as pass through for RY 2020-21.

Parker Creek had its highest flow on May 30, 2020 at 42.30 cfs. Total runoff for the year was approximately 6,670 AF.

Walker Creek had its highest flow on May 30, 2020 at 19.38 cfs. Total runoff for the year was approximately 2,966 AF.

E. Grant Lake Reservoir

GLR began the runoff year at approximately 27,009 AF (7,109.8 ft AMSL). The reservoir did not spill. Final storage volume by the end of the RY of March 31, 2021 was approximately 22,652.2 AF (7,104.74 ft AMSL).

F. Exports during RY 2020-21

During RY 2020-21, Mono Lake elevations were within the 6,381 ft – 6,383 ft range, allowing for up to 16,000 AF of exports per Decision 1631. LADWP exported 15,960 AF total from the Mono Basin, which is below the allowed 16,000 AF.

G. Mono Lake Elevations during RY 2020-21

In RY 2020-21, Mono Lake elevations were as shown in the following table. The Lake elevation was at 6,382.6 ft AMSL at the beginning of the runoff year, and ended the runoff year at 6,381.3 ft AMSL.

RY 2019-20 Mono Lake Elevation Readings

April 1, 2020	6,382.6
May 1, 2020	6,382.7
June 1, 2020	6,382.6
July 1, 2020	6,382.4
August 1, 2020	6,382.1
September 1, 2020	6,381.8
October 1, 2020	6,381.5
November 1, 2020	6,381.3
December 1, 2020	6,381.1
January 1, 2021	6,381.1
February 1, 2021	6,381.2
March 1, 2021	6,381.3
April 1, 2021	6,381.3

B. Proposed Mono Basin Operations Plan RY 2021-22

A. Forecast for RY 2021-22

The Mono Basin Operations Plan for RY 2021-22 from April 1 to September 28, 2021 has followed and will follow the renewed TUCP for a “Dry” year category, as approved by the SWRCB on April 1, 2021. Flow requirements are shown in **Attachment 3.** The Mono Basin’s April 1st forecast for Runoff Year (RY) 2020 for April to March period is 68,800 acre-feet (AF), or 58 percent of average using the 1966-2015 long term mean of 119,103 AF (**Attachment 4**). This value puts the year type within the “Dry” category.

LADWP will submit a timely Temporary Urgency Change Petition renewal application to the SWRCB for the Mono Basin Operations Plan from October 1, 2021 to March 31, 2022 if necessary.

B. Grant Lake Reservoir

GLR storage volume was 22,602.6 AF, corresponding to a surface elevation of 7,104.68 feet above mean sea level (AMSL) at the start of the runoff year. Using the closest available representative historical inflow data (2002 runoff year at 72.8 percent of normal), and above specified flows, GLR’s profile is projected to be as shown in **Attachment 5**. Forecasted scenarios will be relatively close only if this year’s hydrology turns out to be similar to the hydrology of the selected historical runoff year. Operations are subject to change with variations in actual hydrology during the upcoming runoff year.

C. Projected Mono Lake Elevations during RY 2021-22

Mono Lake began this runoff year at 6381.3 ft AMSL where it is forecasted to increase and end the runoff year at approximately 6,380.2 ft AMSL (**Attachment 6**).

ATTACHMENTS

Attachment 1

STATE OF CALIFORNIA
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
STATE WATER RESOURCES CONTROL BOARD

DIVISION OF WATER RIGHTS

In the Matter of Licenses 10191 and 10192 (Applications 8042 and 8043)

Los Angeles Department of Water and Power

ORDER APPROVING TEMPORARY URGENCY CHANGES

SOURCES: Rush Creek, Lee Vining Creek, Parker Creek, and Walker Creek

COUNTY: Mono

BY THE DEPUTY DIRECTOR FOR WATER RIGHTS:

1.0 SUBSTANCE OF THE TEMPORARY URGENCY CHANGE PETITIONS

On April 1, 2020, the State Water Resources Control Board (State Water Board) received Temporary Urgency Change Petitions (TUCPs) pursuant to California Water Code section 1435 from the Los Angeles Department of Water and Power (LADWP or Petitioner) requesting renewal of the TUCPs issued to LADWP on October 22, 2019 and approval of temporary changes to its water right Licenses 10191 and 10192 (Applications 8042 and 8043).

With the TUCPs, LADWP requests authorization to temporarily deviate from Stream Restoration Flow requirements as outlined in the State Water Board's Decision 1631 (D-1631) and Order 98-05 for Rush, Lee Vining, Parker, and Walker Creeks and instead follow the Stream Ecosystem Flows (SEFs) in the Draft Amended Licenses 10191 and 10192. The proposed TUCPs are a continuation of the Runoff Year (RY) 2019-2020 studies and previously approved TUCP Orders, dated April 16, 2019 and October 22, 2019. The TUCPs will cover the appropriate water-year type for the RY 2020--2021 from the date of the approved TUCP Order and ending on September 30, 2020. The purpose of the renewal of the temporary changes to the flow requirements is to collect another 180 days of flow data, and, in conjunction with the April 16, 2019 and October 22, 2019 TUCPs, test and evaluate the effects on resources from the implementation of the Rush and Lee Vining Creeks SEFs.

The temporary flow changes and the TUCPs are supported by California Trout, Inc. (CalTrout), the Mono Lake Committee (MLC), the California Department of Fish and Wildlife (CDFW), and the State Water Board-approved stream monitoring team (Stream Scientists).

The temporary flow modifications proposed by LADWP will not increase LADWP's annual export of 16,000 acre-feet[1] as specified in Decision 1631 (D-1631).

2.0 BACKGROUND

2.1 State Water Board Decision 1631, Orders WR 98-05 and WR 98-07, and Licenses 10191 and 10192

In D-1631, the State Water Board, modified Licenses 10191 and 10192 for the purpose of establishing instream flow requirements below LADWP's points of diversion on four affected streams tributary to Mono Lake. The decision also established conditions to protect public trust resources at Mono Lake. State Water Board Orders WR 98-05 and WR 98-07 (Orders) amended D-1631. Pursuant to D-1631 and the subsequent Orders, LADWP is required to conduct fisheries studies and stream monitoring activities until the program (or elements thereof) is terminated by the State Water Board. LADWP has been conducting fisheries studies and stream monitoring for over 20 years. These activities are conducted by the Stream Scientists who: (a) oversee implementation of the stream monitoring and restoration program, and (b) evaluate the results of the monitoring program and recommend modifications as necessary. In the Stream Scientists' April 30, 2010 *Synthesis of Instream Flow Recommendations Report* (Synthesis Report), they recommended modification of the flow regime and other aspects of the Mono Basin stream monitoring and restoration program.

2.2 Description of the Temporary Urgency Changes

The basis of temporary changes to the flow requirements is to allow LADWP to collect additional data, and to test and evaluate the effects on resources from the implementation of the SEFs, as identified in the *Mono Basin Operations Plan Under The April 2020 TUCP*, dated March 27, 2020. The renewal TUCPs request the following temporary changes:

1. Rush Creek - The Mono Basin's April 1st forecast for RY 2020-2021 is not yet available; however, it is projected that RY 2020-2021 will be either a Dry/Normal II, Dry/Normal I, or Dry water-year type. Rush Creek's SEFs will be set to the appropriate water-year type and follow either Table 1E for a Dry/Normal II, Table 1F

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[1] 16,000 acre-feet may be exported annually when Mono Lake elevation is at or above 6,380 feet and below 6,391 feet.

for a Dry/Normal I, or Table 1G for a Dry water-year type. See Rush Creek Stream Ecosystem Flows Tables 1E, 1F, and 1G.

2. Lee Vining Creek - The SEFs for Lee Vining Creek will follow Table 2A for a Dry/Normal II water-year type. If the RY 2020-2021 is forecasted to be a Dry/Normal I or Dry water-year type, Table 2B will be followed. See Lee Vining Stream Ecosystem Flows Tables 2A and 2B.

3. Parker Creek – All flow will be continuously bypassed.

4. Walker Creek - All flow will be continuously bypassed.

It has been noted and LADWP acknowledged that implementing Table 2B SEF flows for Lee Vining Creek presents challenges for LADWP with the current infrastructure. The current infrastructure does not function accurately when setting a constant diversion flow rate while Lee Vining Creek's flow rate fluctuates. Lee Vining Creek flow varies drastically on a day-to-day basis due to Southern California Edison's operations upstream of the Lee Vining Creek Intake. LADWP will implement Table 2B flow rates to the extent that current infrastructure allows and will conservatively operate to ensure flows in Lee Vining Creek do not drop below the minimum specified flows as outlined in Table 2B.

LADWP also noted an exception to the flows in Table 2B will be made in September 2020 during fish monitoring activities where Lee Vining Creek flows will be set to around 28 cubic feet per second (cfs) for up to two weeks in order to ensure the safety of the Stream Scientists and LADWP biologists performing the fish monitoring activities. The exact dates for the fish monitoring activities will be determined by LADWP later in the year.

LADWP will comply with Provisions 11(b)(2)i and 11(b)(2)ii of the Draft Amended Licenses 10191 and 10192 for the management of Grant Lake Reservoir (GLR). The terms require LADWP to follow rules and criteria for GLR storage to provide cold water flow in Rush Creek. LADWP shall reduce otherwise allowable exports to meet these rules and criteria and shall not reduce flows below the required SEFs. For the proposed TUCPs, LADWP shall store at least 20,000 acre-feet (AF) of water in GLR from July 1, 2020 through September 30, 2020. If GLR is below 25,000 AF of storage on July 1, 2020 in a Dry or Dry/Normal I water-year type, LADWP shall convey all available water diverted from Lee Vining Creek through the Five Siphons Bypass to augment cold-water flow in Rush Creek. Diversions through the Five Siphons Bypass for this purpose shall not continue past October 1, 2020. There shall be no augmentation to Rush Creek in other water-year types or for other purposes.

LADWP will communicate with the Mono Basin parties (MLC, CalTrout, CDFW), the Stream Scientists, and the State Water Board during the TUCPs' authorized period to coordinate and gain input as SEFs are implemented. Specifically, a conference call will be scheduled within a reasonable time before the end of this TUCP Order to discuss the operation plans for the RY 2020-2021, address questions, and seek Stream Scientists' input that may result from the operations plan. LADWP will also provide reasonable communication to update the parties, answer questions, and address unforeseen challenges as SEFs are delivered according to the April 1 forecast for RY 2020-21.

3.0 COMPLIANCE WITH CALIFORNIA ENVIRONMENTAL QUALITY ACT

LADWP, as Lead Agency pursuant to the California Environmental Quality Act (CEQA), prepared a Notice of Exemption for the *Mono Basin Temporary Operation Petition to State Water Resources Control Board* on March 26, 2020. LADWP found that the change is categorically exempt from CEQA, as the project is for the use of existing facilities with negligible or no expansion of existing use, for the purpose of maintaining fish and wildlife habitat areas, maintaining stream flows, and protecting fish and wildlife resources. (Cal. Code Regs., tit. 14, § 15301, subs. (i).).

The State Water Board has reviewed the information submitted by LADWP and has determined that the petitions qualify for an exemption under CEQA. The State Water Board will issue a Notice of Exemption for the temporary urgency change petitions.

4.0 PUBLIC NOTICE OF TEMPORARY URGENCY CHANGE PETITIONS

Pursuant to Water Code section 1438, subdivision (a), the State Water Board may issue a temporary urgency change order in advance of the required notice period. On April 16, 2020, the State Water Board issued a public notice of the temporary urgency changes pursuant to Water Code section 1438, subdivision (a). The comment period expires on May 18, 2020. Pursuant to Water Code section 1438, subdivision (b)(1), LADWP is required to publish the notice in a newspaper having a general circulation and published within the counties where the points of diversion are located. LADWP published the notice on April 16, 2020 in the Mammoth Times. The State Water Board posted the notice of the temporary urgency changes and distributed the notice through its electronic notification system.

5.0 COMMENTS REGARDING THE TEMPORARY URGENCY CHANGE PETITIONS

On March 25, 2020, LADWP held a conference call to discuss the proposed TUCPs with the MLC, CalTrout, CDFW, State Water Board staff, and the Stream Scientists. On March 26, 2020, LADWP informed State Water Board staff that a consensus to support the amended TUCPs was reached with the Mono Basin parties.

6.0 CRITERIA FOR APPROVING THE PROPOSED TEMPORARY URGENCY CHANGES

Water Code section 1435 provides that a permittee or licensee who has an urgent need to change the point of diversion, place of use, or purpose of use from that specified in the permit or license may petition for a conditional temporary change order. The State Water Board's regulations set forth the filing and other procedural requirements applicable to TUCPs (Cal. Code Regs., tit. 23, §§ 805, 806.) The State Water Board's regulations also clarify that requests for changes to permits or licenses other than changes in point of diversion, place of use, or purpose of use may be filed, subject to the same filing and procedural requirements that apply to changes in point of diversion, place of use, or purpose of use. (*Id.*, § 791, subd. (e))

Before approving a temporary urgency change, the State Water Board must make the following findings:

1. The Petitioner has an urgent need to make the proposed change;
2. The proposed change may be made without injury to any other lawful user of water;
3. The proposed change may be made without unreasonable effect upon fish, wildlife, or other instream beneficial uses; and
4. The proposed change is in the public interest.

(Wat. Code, § 1435, subd. (b)(1-4).)

6.1 Urgency of the Proposed Change

Under Water Code section 1435, subdivision (c), an "urgent need" means "the existence of circumstances from which the State Water Board may in its judgment conclude that the proposed temporary change is necessary to further the constitutional policy that the water resources of the state be put to beneficial use to the fullest extent of which they are capable and that waste of water be prevented . . . ." However, the State Water Board shall not find the need urgent if it concludes that the petitioner has failed to exercise due diligence in petitioning for a change pursuant to other appropriate provisions of the Water Code. (*Ibid.*)

In this case, there is an urgent need for the proposed changes in the license conditions regarding fish flows for the purpose of furthering protection of public trust resources. Furthermore, the TUCPs will provide LADWP almost a year and a half of continuous flow data and further provide valuable information on fisheries and riparian conditions.

6.2 No Injury to Any Other Lawful User of Water

There are no known lawful users of water that will be affected by the proposed changes to instream flows. Accordingly, granting these renewal TUCPs will not result in injury to any other lawful users of water

6.3 No Unreasonable Effect upon Fish, Wildlife, or Other Instream Beneficial Uses

As described above, the renewal of the temporary urgency changes will benefit the restoration activities of Rush, Lee Vining, Walker, and Parker Creeks and help with Grant Lake Reservoir management. No other fish or wildlife resources are implicated by the proposed change; accordingly, the proposed changes will not have unreasonable effects upon fish and wildlife resources.

6.4 The Proposed Change is in the Public Interest

The proposed changes would assist LADWP in maintaining the fishery resources in good condition. Maintenance of the fishery is in the public interest.

In light of the above, I find in accordance with Water Code section 1435, subdivision (b)(4) that the proposed changes are in the public interest, including findings to support change order conditions imposed to ensure that the changes are in the public interest.

Pursuant to Water Code section 1439, the State Water Board shall supervise diversion and use of water under this temporary change order for the protection of all other lawful users of water and instream beneficial uses.

7.0 STATE WATER BOARD DELEGATION OF AUTHORITY

On June 5, 2012, the State Water Board adopted Resolution 2012-0029, delegating to the Deputy Director for Water Rights the authority to act on petitions for temporary urgency change. This Order is adopted pursuant to the delegation of authority in section 4.4.1 of Resolution 2012-0029.

8.0 CONCLUSIONS

The State Water Board has adequate information in its files to make the evaluation required by Water Code section 1435.

I conclude that, based on the available evidence:

1. The Petitioner has an urgent need to make the proposed changes;

2. The proposed changes will not operate to the injury of any other lawful user of water;

3. The proposed changes, with conditions set forth in this Order, will not have an unreasonable effect upon fish, wildlife, or other instream beneficial uses; and

4. The proposed changes are in the public's interest.

ORDER

NOW, THEREFORE, IT IS ORDERED THAT: the petitions filed by the Los Angeles Department of Water and Power (LADWP) for renewal of the temporary urgency changes to Licenses 10191 and 10192 are approved, and this approval is effective from the date of this Order to September 30, 2020. All existing terms and conditions in Licenses 10191 and 10192 remain in effect, except as temporarily amended by the following terms.

1. For protection of streams and fisheries in Rush and Lee Vining Creeks, LADWP shall bypass flows below the points of diversion at the flow rates specified in Section 2.2 of the Order and shown in the tables below for the appropriate water-year type. The Stream Ecosystem Flows (SEFs) provided under this requirement shall remain in the stream channel and not be diverted for any other use.

2. LADWP shall submit to the Deputy Director for Water Rights on a monthly basis a written report that summarizes all activities conducted to ensure compliance with the requirements of this Order. The first monthly report is due at the end of the first complete month of this Order. LADWP shall submit a final report summarizing overall compliance with this Order no later than November 1, 2020.

3. This Order does not authorize any act that results in the taking of a threatened or endangered species, or any act that is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code sections 2050 to 2097) or the federal Endangered Species Act (16 U.S.C.A. sections 1531 to 1544). If a "take" will result from any act authorized under this Order, the licensee shall obtain authorization for an incidental take permit prior to construction or operation. Licensee shall be responsible for meeting all requirements of the applicable Endangered Species Act for the temporary urgency change authorized under this Order.

4. The State Water Board shall supervise the diversion and use of water under this Order for the protection of legal users of water and instream beneficial uses and for compliance with the conditions. Petitioner shall allow representatives of the State Water Board reasonable access to the project works to determine compliance with the terms of this Order.

5. The State Water Board reserves jurisdiction to supervise the temporary urgency changes under this Order, and to coordinate or modify terms and conditions, for the protection of vested rights, fish, wildlife, instream beneficial uses, and the public interest as future conditions may warrant.

6. The temporary urgency changes authorized under this Order shall not result in creation of a vested right, even of a temporary nature, but shall be subject at all times to modification or revocation in the discretion of the State Water Board. The temporary urgency changes approved in this Order shall automatically expire September 30, 2020, unless earlier revoked.

STATE WATER RESOURCES CONTROL BOARD

ORIGINAL SIGNED BY:

Erik Ekdahl, Deputy Director
Division of Water Rights

Dated: MAY 13 2020

Attachment: Tables 1E thru 2B

TABLE 1E:
RUSH CREEK STREAM ECOSYSTEM FLOWS FOR DRY/NORMAL II YEARS

Hydrograph Component	Timing	Flow Requirement	Ramping Rate
Spring Baseflow	April 1 – May 18	40 cfs	Maximum: 10% or 10 cfs*
Spring Ascension	May 19 – June 2	40 cfs ascending to 80 cfs	Target: 5% Maximum: 25%
Snowmelt Bench	June 3 – June 30	80 cfs	Maximum Ascending: 20% Maximum Descending: 10% or 10 cfs*
Snowmelt Flood and Snowmelt Peak	Starting between June 2 and June 15 with the 3-day peak between June 6 and June 21 coinciding with Parker and Walker Creek peaks	80 cfs ascending to 200 cfs, 200 cfs for 3 days, 200 cfs descending to 80 cfs	Target Ascending: 20% Maximum Ascending: 40% Maximum Descending: 10% or 10 cfs*
Medium Recession (Node)	July 1 – July 8	80 cfs descending to 48 cfs	Target: 6% Maximum: 10% or 10 cfs*
Slow Recession	July 9 – July 24	48 cfs descending to 30 cfs	Target: 3% Maximum: 10% or 10 cfs*
Summer Baseflow	July 25 – September 30	30 cfs target 28 cfs minimum	Maximum: 10% or 10 cfs*
Fall and Winter Baseflow	October 1- March 31	27 cfs target 25 cfs minimum and 29 cfs maximum	Maximum: 10% or 10 cfs*
			* whichever is greater

1

TABLE 1F:
RUSH CREEK STREAM ECOSYSTEM FLOWS FOR DRY/NORMAL I YEARS

Hydrograph Component	Timing	Flow Requirement	Ramping Rate
Spring Baseflow	April 1 – April 30	40 cfs	Maximum: 10% or 10 cfs*
Spring Ascension	May 1 – May 15	40 cfs ascending to 80 cfs	Target: 5% Maximum: 25%
Snowmelt Bench	May 16 – July 3	80 cfs	Maximum Ascending: 20% Maximum Descending: 10% or 10 cfs*
Medium Recession (Node)	July 4 – July 9	80 cfs descending to 55 cfs	Target: 6% Maximum: 10% or 10 cfs
Slow Recession	July 10 – July 30	55 cfs descending to 30 cfs	Target: 3% Maximum: 10% or 10 cfs*
Summer Baseflow	July 31 – September 30	30 cfs target 28 cfs minimum	Maximum: 10% or 10 cfs*
Fall and Winter Baseflow	October 1 - March 31	27 cfs target 25 cfs minimum and 29 cfs maximum	Maximum: 10% or 10 cfs*
			* whichever is greater

2

TABLE 1G:
RUSH CREEK STREAM ECOSYSTEM FLOWS FOR DRY YEARS

Hydrograph Component	Timing	Flow Requirement	Ramping Rate
Spring Baseflow	April 1 – April 30	30 cfs	Maximum: 10% or 10 cfs*
Spring Ascension	May 1 – May 18	30 cfs ascending to 70 cfs	Target: 5% Maximum: 25%
Snowmelt Bench	May 19 – July 6	70 cfs	Maximum Ascending: 20% Maximum Descending: 10% or 10 cfs*
Medium Recession (Node)	July 7 – July 12	70 cfs descending to 48 cfs	Target: 6% Maximum: 10% or 10 cfs*
Slow Recession	July 13 – July 28	48 cfs descending to 30 cfs	Target: 3% Maximum: 10% or 10 cfs*
Summer Baseflow	July 29 – September 30	30 cfs target 28 cfs minimum	Maximum: 10% or 10 cfs*
Fall and Winter Baseflow	October 1 - March 31	27 cfs target 25 cfs minimum and 29 cfs maximum	Maximum: 10% or 10 cfs*
			* whichever is greater

3

TABLE 2A:
LEE VINING CREEK STREAM ECOSYSTEM FLOWS

Timing: April 1 – September 30						Year-type: Extreme/Wet, Wet, Wet/Normal, Normal, Dry/Normal II				
Maximum ramping at the beginning and end of this period is 20%.										
Inflow	**Flow Requirement**									
30 cfs or less	Licensee shall bypass inflow.									
31 – 250 cfs	Licensee shall bypass flow in the amount corresponding to inflow which is displayed as blocks of 10 cfs (left-hand vertical column) and 1 cfs increments within such blocks (top horizontal row).									
	0	1	2	3	4	5	6	7	8	9
30		30	30	30	30	30	31	32	33	34
40	30	31	32	33	34	35	36	37	38	39
50	35	36	37	38	39	40	41	42	43	44
60	45	46	47	48	49	50	51	52	53	54
70	55	56	57	58	59	60	61	62	63	64
80	60	61	62	63	64	65	66	67	68	69
90	70	71	72	73	74	75	76	77	78	79
100	75	76	77	78	79	80	81	82	83	84
110	85	86	87	88	89	90	91	92	93	94
120	95	96	97	98	99	100	101	102	103	104
130	100	101	102	103	104	105	106	107	108	109
140	110	111	112	113	114	115	116	117	118	119
150	120	121	122	123	124	125	126	127	128	129
160	130	131	132	133	134	135	136	137	138	139
170	135	136	137	138	139	140	141	142	143	144
180	145	146	147	148	149	150	151	152	153	154
190	155	156	157	158	159	160	161	162	163	164
200	160	161	162	163	164	165	166	167	168	169
210	170	171	172	173	174	175	176	177	178	179
220	180	181	182	183	184	185	186	187	188	189
230	190	191	192	193	194	195	196	197	198	199
240	195	196	197	198	199	200	201	202	203	204
250	200									
251 cfs and greater	Licensee shall bypass inflow.									

TABLE 2B:
LEE VINING CREEK STREAM ECOSYSTEM FLOWS

Timing: April 1 – September 30						Year-type: Dry/Normal I, Dry				
Maximum ramping at the beginning and end of this period is 20%.										
Inflow	**Flow Requirement**									
30 cfs or less	Licensee shall bypass inflow.									
31 – 250 cfs	Licensee shall bypass flow in the amount corresponding to inflow which is displayed as blocks of 10 cfs (left-hand vertical column) and 1 cfs increments within such blocks (top horizontal row).									
	0	1	2	3	4	5	6	7	8	9
30		30	30	30	30	30	30	30	30	30
40	30	30	30	30	30	30	30	30	30	30
50	30	30	30	30	30	30	30	30	31	32
60	32	33	34	34	35	36	36	37	38	38
70	39	40	41	41	42	43	43	44	45	45
80	46	47	47	48	49	49	50	51	52	52
90	53	54	54	55	56	56	57	58	59	59
100	60	61	61	62	63	64	64	65	66	66
110	67	68	69	69	70	71	72	72	73	74
120	74	75	76	77	77	78	79	80	80	81
130	82	82	83	84	85	85	86	87	88	88
140	89	90	91	91	92	93	94	94	95	96
150	97	97	98	99	100	100	101	102	103	103
160	104	105	106	106	107	108	109	109	110	111
170	112	112	113	114	115	115	116	117	118	118
180	119	120	121	121	122	123	124	124	125	126
190	127	128	128	129	130	131	131	132	133	134
200	134	135	136	137	138	138	139	140	141	141
210	142	143	144	144	145	146	147	148	148	149
220	150	151	151	152	153	154	155	155	156	157
230	158	158	159	160	161	162	162	163	164	165
240	165	166	167	168	169	169	170	171	172	172
250	173									
251 cfs and greater	Licensee shall bypass inflow.									

Attachment 2

STATE OF CALIFORNIA
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
STATE WATER RESOURCES CONTROL BOARD

DIVISION OF WATER RIGHTS

In the Matter of Licenses 10191 and 10192 (Applications 8042 and 8043)

City of Los Angeles, Department of Water and Power

ORDER APPROVING TEMPORARY URGENCY CHANGES

SOURCES: Rush Creek, Lee Vining Creek, Parker Creek, and Walker Creek

COUNTY: Mono

BY THE DEPUTY DIRECTOR FOR WATER RIGHTS:

1.0 SUBSTANCE OF THE TEMPORARY URGENCY CHANGE PETITIONS

On September 18, 2020, the State Water Resources Control Board (State Water Board) received Temporary Urgency Change Petitions (TUCPs) pursuant to California Water Code section 1435 from the City of Los Angeles, Department of Water and Power, (LADWP or Petitioner) requesting renewal of the TUCPs issued to LADWP on May 13, 2020 and approval of temporary changes to water right Licenses 10191 and 10192.

With the TUCPs, LADWP requests authorization to temporarily deviate from Stream Restoration Flow requirements as outlined in the State Water Board's Decision 1631 (D-1631) and Order 98-05 for Rush, Lee Vining, Parker, and Walker Creeks and instead follow the Stream Ecosystem Flows (SEFs) in the Draft Amended Licenses 10191 and 10192. The proposed TUCPs are a continuation of the Runoff Year 2020-2021 studies and previously approved TUCP Orders, dated April 16, 2019, October 22, 2019, and May 13, 2020. The purpose of the renewal of the temporary changes to the flow requirements is to collect another 180 days of flow data, and in conjunction with the previously approved TUCP Orders, test and evaluate almost two full years of flow data of the effects on resources from the implementation of the Rush Creek and Lee Vining SEFs. The proposed renewal TUCPs will cover the flow requirements for a Dry – Normal I water-year type starting from the approval date of this Order and ending on March 31, 2021.

The temporary flow changes and the amended TUCPs are supported by the California Trout, Inc. (CalTrout), the Mono Lake Committee (MLC), the California Department of Fish and Wildlife (CDFW), and the State Water Board-approved stream monitoring team (Stream Scientists).

The temporary flow modifications proposed by LADWP will not increase LADWP's annual export of 16,000 acre-feet[1] as specified in D-1631.

2.0 BACKGROUND

2.1 State Water Board Decision 1631, Orders WR 98-05 and WR 98-07, and Licenses 10191 and 10192

In D-1631, the State Water Board modified Licenses, 10191 and 10192 for the purpose of establishing instream flow requirements below LADWP's points of diversion on four affected streams tributary to Mono Lake. The decision also established conditions to protect public trust resources at Mono Lake. State Water Board Orders WR 98-05 and WR 98-07 (Orders) amended D-1631. Pursuant to D-1631 and the subsequent Orders, LADWP is required to conduct fisheries studies and stream monitoring activities until the program (or elements thereof) is terminated by the State Water Board. LADWP has been conducting fisheries studies and stream monitoring for over 20 years. These activities are conducted by the Stream Scientists who: (a) oversee implementation of the stream monitoring and restoration program, and (b) evaluate the results of the monitoring program and recommend modifications as necessary. In the Stream Scientists' April 30, 2010 *Synthesis of Instream Flow Recommendations Report* (Synthesis Report), they recommended modification of the flow regime and other aspects of the Mono Basin stream monitoring and restoration program.

2.2 Description of the Temporary Urgency Changes

The basis of temporary changes to the flow requirements is to allow LADWP to collect additional data, and to test and evaluate the effects on resources from the implementation of the SEFs, as identified in the *Mono Basin Operations Plan Under The October 2020 TUCP*, dated September 14, 2020. The TUCPs request the following temporary changes:

1. Rush Creek - The Mono Basin's April 1st forecast for Runoff Year (RY) 2020-2021 is classified as a Dry–Normal I water-year type. The Rush Creek SEFs will follow a Dry–Normal I water-year type as follows:

Hydrograph Component:	Fall and Winter Baseflow
Timing:	October 1 – March 31
Flow Requirement:	27 cfs target, 25 cfs minimum, 29 cfs maximum
Ramping Rate:	Maximum: 10% or 10 cfs (whichever is greater)

[1] 16,000 acre-feet may be exported annually when Mono Lake elevation is at or above 6,380 feet and below 6,391 feet.

2. Lee Vining Creek – The Lee Vining SEFs will follow a Dry-Normal I water-year type as follows:

Timing:	October 1 – March 31
Flow Requirement:	16 cfs
Ramping Rate:	Maximum ramping at the beginning and end of this period and at all times is 20%.

3. Parker Creek – All flow will be continuously bypassed.

4. Walker Creek - All flow will be continuously bypassed.

LADWP will communicate with the Mono Basin parties (MLC, CalTrout, CDFW), the Stream Scientists, and the State Water Board during the TUCPs' authorized period to coordinate and gain input as SEFs are implemented. Specifically, a conference call will be scheduled within a reasonable time before the end of the proposed TUCPs to discuss the operations plan for the coming runoff year, address questions, and seek the Stream Scientists input that may result from the operations plan. LADWP will also provide reasonable communication to update parties, answer questions, and address unforeseen challenges as SEFs are delivered according to the April 1 forecast for RY 2020-21.

3.0 COMPLIANCE WITH CALIFORNIA ENVIRONMENTAL QUALITY ACT

LADWP as Lead Agency pursuant to the California Environmental Quality Act (CEQA), prepared a Notice of Exemption for the *Mono Basin Temporary Operation Petition to State Water Resources Control Board* on September 14, 2020. LADWP found that the change is categorically exempt from CEQA, as the project is for the use of existing facilities with negligible or no expansion of existing use, for the purpose of maintaining fish and wildlife habitat areas, maintaining stream flows, and protecting fish and wildlife resources. (14 Cal. Code Regs. § 15301(i).).

The State Water Board has reviewed the information submitted by LADWP and has determined that the petitions qualify for an exemption under CEQA. The State Water Board will issue a Notice of Exemption for the temporary urgency change petitions.

4.0 PUBLIC NOTICE OF TEMPORARY URGENCY CHANGE PETITIONS

On October 1, 2020, the State Water Board issued a public notice of the temporary urgency changes pursuant to Water Code section 1438, subdivision (a). The comment period expires on November 2, 2020. Pursuant to Water Code section 1438, subdivision (b)(1), LADWP is required to publish the notice in a newspaper having a general circulation and published within the counties where the points of diversion are located. LADWP published the notice on October 1, 2020 in the Mammoth Times. The State Water Board posted the notice of the temporary urgency changes on its website and distributed the notice through its electronic notification system.

5.0 COMMENTS REGARDING THE TEMPORARY URGENCY CHANGE PETITIONS

On September 9, 2020, LADWP held a conference call to discuss the proposed TUCPs and the *Mono Basin Operations Plan Under The October 2020 TUCP* (Operation Plan) with MLC, CalTrout, CDFW, State Water Board, and Stream Scientist, Dr. Bill Trush. At the conclusion of the conference call, a consensus was reached amongst the Mono Basin parties to support the TUCPs and Operation Plan.

6.0 CRITERIA FOR APPROVING THE PROPOSED TEMPORARY URGENCY CHANGES

Water Code section 1435 provides that a permittee or licensee who has an urgent need to change the point of diversion, place of use, or purpose of use from that specified in the permit or license, may petition for a conditional temporary change order. The State Water Board's regulations set forth the filing and other procedural requirements applicable to TUCPs (Cal. Code Regs., tit. 23, §§ 805, 806.) The State Water Board's regulations also clarify that requests for changes to permits or licenses other than changes in point of diversion, place of use, or purpose of use may be filed, are subject to the same filing and procedural requirements that apply to changes in point of diversion, place of use, or purpose of use. (*Id.*, § 791, subd. (e))

Before approving a temporary urgency change, the State Water Board must make the following findings:

1. The Petitioner has an urgent need to make the proposed change;
2. The proposed change may be made without injury to any other lawful user of water;
3. The proposed change may be made without unreasonable effect upon fish, wildlife, or other instream beneficial uses; and
4. The proposed change is in the public interest.

(Wat. Code, § 1435, subd. (b)(1-4).)

6.1 Urgency of the Proposed Change

Under Water Code section 1435, subdivision (c), an "urgent need" means "the existence of circumstances from which the State Water Board may in its judgment, conclude that the proposed temporary change is necessary to further the constitutional policy that the water resources of the state be put to beneficial use to the fullest extent of which they are capable and that waste of water be prevented." However, the State Water Board shall not find the need urgent, if it concludes that the petitioner has failed to exercise due diligence in petitioning for a change pursuant to other appropriate provisions of the Water Code. (Ibid.)

In this case, there is an urgent need for the proposed changes in the license conditions regarding fish flows for the purpose of furthering the protection of public trust resources. Furthermore, the TUCPs will provide LADWP another 180 days of flow data, and in conjunction with the TUCP Orders approved on April 16, 2019, October 22, 2019, and May 13, 2020, test and evaluate almost two years of continuous flow data and further providing valuable information on effects on fisheries and riparian conditions from implementation of the Rush and Lee Vining Creeks SEFs.

6.2 No Injury to Any Other Lawful User of Water

There are no known lawful users of water that will be affected by the proposed changes to instream flows. Accordingly, granting these renewal TUCPs will not result in injury to any other lawful users of water.

6.3 No Unreasonable Effect upon Fish, Wildlife, or Other Instream Beneficial Uses

The renewal of the temporary urgency changes will benefit the restoration activities of Rush, Lee Vining, Walker, and Parker Creeks and help with Grant Lake Reservoir management. No other fish, wildlife, or other instream beneficial use resources are implicated by the proposed changes; accordingly, the proposed changes will not have unreasonable effects upon fish and wildlife resources.

6.4 The Proposed Change is in the Public Interest

The proposed changes would assist LADWP in maintaining the fishery resources in good condition. Maintenance of the fishery is in the public interest.

In light of the above, I find in accordance with Water Code section 1435, subdivision (b)(4), that the proposed changes are in the public interest, including, findings to support change order conditions imposed to ensure that the changes are in the public interest.

7.0 CONSIDERATION OF PUBLIC TRUST RESOURCES

Prior to approval of a TUCP, the State Water Board must find that the proposed change may be made without unreasonable effect upon fish, wildlife, or other instream beneficial uses. In addition, the State Water Board has an independent obligation to consider the effect of approval of LADWP's petitions on public trust resources and to protect those resources where feasible. (National Audubon Society v. Superior Court (1983) 33 Cal. 3d 419 [189 Cal. Rptr. 346].) Public trust resources may include, but are not limited to, wildlife, fish, aquatic dependent species, streambeds, riparian areas, tidelands, and recreation in navigable waterways, as well as fisheries located in non-navigable waterways. As stated above, no other fish or wildlife resources, or other instream beneficial uses are implicated by the proposed changes; accordingly, the proposed changes will not have unreasonable effects upon fish and wildlife resources, and public trust resources will be protected.

Pursuant to Water Code section 1439, the State Water Board shall supervise diversion and use of water under this temporary change order for the protection of all other lawful users of water and instream beneficial uses.

8.0 STATE WATER BOARD DELEGATION OF AUTHORITY

On June 5, 2012, the State Water Board adopted Resolution 2012-0029, delegating to the Deputy Director for Water Rights, the authority to act on petitions for temporary urgency change. This Order is adopted pursuant to the delegation of authority in section 4.4.1 of Resolution 2012-0029.

9.0 CONCLUSIONS

The State Water Board has adequate information in its files to make the evaluation required by Water Code section 1435.

I conclude that, based on the available evidence:

1. The Petitioner has an urgent need to make the proposed changes;
2. The proposed changes will not operate to the injury of any other lawful user of water;
3. The proposed changes, with conditions set forth in this Order, will not have an unreasonable effect upon fish, wildlife, or other instream beneficial uses; and
4. The proposed changes are in the public interest.

ORDER

NOW, THEREFORE, IT IS ORDERED THAT: the petitions filed by the Los Angeles Department of Water and Power (LADWP) for renewal of the temporary urgency changes in Licenses 10191 and 10192 are approved, and this approval is effective from the date of this Order to March 31, 2021. All existing terms and conditions in Licenses 10191 and 10192 remain in effect, except as temporarily amended by the following terms.

1. For protection of fish in Rush and Lee Vining Creeks, LADWP shall bypass flow below the point of diversion at the flows specified in Section 2.2 of this Order. The Stream Ecosystem Flows provided under this requirement shall remain in the stream channel and not be diverted for any other use.

2. LADWP shall submit to the Deputy Director for Water Rights on a monthly basis a written report that summarizes all activities conducted to ensure compliance with the requirements of this Order. The first monthly report is due at the end of the first complete month of this Order. LADWP shall submit a final report summarizing overall compliance with this Order no later than May 1, 2021.

3. This Order does not authorize any act that results in the taking of a threatened or endangered species, or any act that is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code sections 2050 to 2097) or the federal Endangered Species Act (16 U.S.C.A. sections 1531 to 1544). If a "take" will result from any act authorized under this Order, the water right holder shall obtain authorization for an incidental take permit prior to construction or operation. The water right holder shall be responsible for meeting all requirements of the applicable Endangered Species Act for the temporary urgency changes authorized under this Order.

4. The State Water Board shall supervise the diversion and use of water under this Order for the protection of legal users of water and instream beneficial uses and for compliance with the conditions. Petitioner shall allow representatives of the State Water Board reasonable access to the project works to determine compliance with the terms of this Order.

5. The State Water Board reserves jurisdiction to supervise the temporary urgency changes under this Order, and to coordinate or modify terms and conditions, for the protection of vested rights, fish, wildlife, instream beneficial uses, and public interest as future conditions may warrant.

6. The temporary urgency changes authorized under this Order shall not result in creation of a vested right, even of a temporary nature, but shall be subject at all times to modification or revocation in the discretion of the State Water Board. The temporary urgency changes approved in this Order shall automatically expire March 31, 2021, unless earlier revoked.

STATE WATER RESOURCES CONTROL BOARD

ORIGINAL SIGNED BY:

Erik Ekdahl, Deputy Director
Division of Water Rights

Dated: OCT 15 2020

Attachment 3

STATE OF CALIFORNIA
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
STATE WATER RESOURCES CONTROL BOARD

DIVISION OF WATER RIGHTS

In the Matter of Licenses 10191 and 10192 (Applications 8042 and 8043)

City of Los Angeles, Department of Water and Power

ORDER APPROVING TEMPORARY URGENCY CHANGES

SOURCES: Rush Creek, Lee Vining Creek, Parker Creek, and Walker Creek

COUNTY: Mono

BY THE DEPUTY DIRECTOR FOR WATER RIGHTS:

1.0 SUBSTANCE OF THE TEMPORARY URGENCY CHANGE PETITIONS

On March 5, 2021, the State Water Resources Control Board (State Water Board) received Temporary Urgency Change Petitions (TUCPs) pursuant to California Water Code section 1435 from the City of Los Angeles, Department of Water and Power (LADWP) requesting approval of temporary changes to its water right Licenses 10191 and 10192 (Applications 8042 and 8043).

With the TUCPs, LADWP requests authorization to temporarily deviate from Stream Restoration Flow requirements as outlined in the State Water Board's Decision 1631 (D-1631) and Order 98-05 for Rush, Lee Vining, Parker, and Walker Creeks and instead follow the Stream Ecosystem Flows (SEFs) in the Draft Amended Licenses 10191 and 10192. The proposed TUCPs are a continuation of the Runoff Years (RY) 2019-2020 and 2020-2021, and previously approved TUCP Orders, dated April 16, 2019, October 22, 2019, May 13, 2020, and October 15, 2020 (TUCP Orders). The TUCPs will cover the appropriate water-year type for the RY 2021-2022 from April 1, 2021 and ending on September 28, 2021. The purpose of the renewal of the temporary changes to the flow requirements is to collect another 180 days of flow data, and in conjunction with the TUCP Orders, test and evaluate the effects on resources from the implementation of the Rush and Lee Vining Creeks SEFs.

The temporary flow changes and the TUCPs are in support from the California Trout, Inc. (CalTrout), the Mono Lake Committee (MLC), the California Department of Fish and Wildlife (CDFW), and the State Water Board-approved stream monitoring team (Stream Scientists).

The temporary flow modifications proposed by LADWP will not increase LADWP's annual export of 16,000 acre-feet[1] as specified in D-1631.

2.0 BACKGROUND

2.1 State Water Board Decision 1631, Orders WR 98-05 and WR 98-07, and Licenses 10191 and 10192

In D-1631, the State Water Board modified Licenses 10191 and 10192 for the purpose of establishing instream flow requirements below LADWP's points of diversion on four affected streams tributary to Mono Lake. The decision also established conditions to protect public trust resources at Mono Lake. State Water Board Orders WR 98-05 and WR 98-07 (Orders) amended D-1631. Pursuant to D-1631 and the subsequent Orders, LADWP is required to conduct fisheries studies and stream monitoring activities until the program (or elements thereof) is terminated by the State Water Board. LADWP has been conducting fisheries studies and stream monitoring for over 20 years. These activities are conducted by the Stream Scientists who: (a) oversee implementation of the stream monitoring and restoration program, and (b) evaluate the results of the monitoring program and recommend modifications as necessary. In the Stream Scientists' April 30, 2010 *Synthesis of Instream Flow Recommendations Report* (Synthesis Report), they recommended modification of the flow regime and other aspects of the Mono Basin stream monitoring and restoration program.

2.2 Description of the Temporary Urgency Changes

The basis of temporary changes to the flow requirements is to allow LADWP to collect additional data, and to test and evaluate the effects on resources from the implementation of the SEFs, as identified in the *Mono Basin Operations Plan Under The April 2021 TUCP*, dated February 24, 20121. The renewal TUCPs request the following temporary changes:

1. Rush Creek - The Mono Basin's April 1st forecast for RY 2021-2022 is not yet available; however, it is projected to be either a Normal, Dry/Normal II, Dry/Normal I, or Dry water-year type. Rush Creek's SEFs will be set to the appropriate water-year type and follow either:
   Table 1D for a Normal,
   Table 1E for a Dry/Normal II,
   Table 1F for a Dry/Normal I, or
   Table 1G for a Dry water-year type (see Tables on pages 9 - 12).
2. Lee Vining Creek – The SEFs for Lee Vining Creek will follow either:
   Table 2A for a Normal or Dry/Normal II, or
   Table 2B for a Dry/Normal I or Dry water-year type (see Tables on pages 13 - 14).

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[1] 16,000 acre-feet may be exported annually when Mono Lake elevation is at or above 6,380 feet and below 6,391 feet.

3. Parker Creek – All flow will be continuously bypassed.
4. Walker Creek – All flow will be continuously bypassed.

It has been noted and LADWP acknowledged that implementing Tables 2A and 2B SEFs for Lee Vining Creek presents challenges for LADWP with the current infrastructure. The current infrastructure does not function accurately when setting a constant diversion flow rate while Lee Vining Creek's flow rate fluctuates. Lee Vining Creek flow varies on a day-to-day basis due to Southern California Edison's operations upstream of the Lee Vining Creek Intake. LADWP will implement Tables 2A and 2B flow rates to the extent that current infrastructure allows and will conservatively operate to ensure flows in Lee Vining Creek do not drop below the minimum specified flows as outlined in Tables 2A and 2B. An exception to the flows will be made in September 2021 during fish monitoring activities where Rush and Lee Vining Creek flows will be set to around 25 cfs for up to two weeks in order to ensure the safety of the Stream Scientists and LADWP biologists performing the fish monitoring activities. The exact dates for the 2021 fish monitoring activities will be determined later in the year.

LADWP will comply with Provisions 11(b)(2)i and 11(b)(2)ii of the Draft Amended Licenses 10191 and 10192 for the management of Grant Lake Reservoir (GLR). The terms require LADWP to follow rules and criteria for GLR storage between July 1 and September 30 and provides for bypass of diverted water from Lee Vining Creek into Rush Creek under specific conditions.

LADWP will communicate with the Mono Basin parties (MLC, CalTrout, and CDFW), the Stream Scientists, and the State Water Board during the TUCPs' authorized period to coordinate and gain input as SEFs proceed. Specifically, a conference call will be scheduled within a reasonable time before the end of this TUCP Order to discuss the operations plan for the remaining runoff year, address questions, and seek the Stream Scientist input that may result from the operations plan. LADWP will also provide reasonable communication to update parties, answer questions, and address unforeseen challenges as SEFs are delivered according to the April 1 forecast for RY 2021-2022.

3.0 COMPLIANCE WITH CALIFORNIA ENVIRONMENTAL QUALITY ACT

LADWP, as Lead Agency pursuant to the California Environmental Quality Act (CEQA), prepared a Notice of Exemption for the *Mono Basin Temporary Operation Petition to State Water Resources Control Board* on February 24, 2021. LADWP found that the change is categorically exempt from CEQA, as the project is for the use of existing facilities with negligible or no expansion of existing use, for the purpose of maintaining fish and wildlife habitat areas, maintaining stream flows, and protecting fish and wildlife resources. (14 Cal. Code Regs. § 15301(i).). The State Water Board has reviewed the information submitted by LADWP and has determined that the petitions qualify for an exemption under CEQA. The State Water Board will issue a Notice of Exemption for the temporary urgency change petitions.

4.0 PUBLIC NOTICE OF TEMPORARY URGENCY CHANGE PETITIONS

Pursuant to Water Code section 1438, subdivision (a), the State Water Board may issue a temporary urgency change order in advance of the required notice period. On April 1, 2021, the State Water Board issued a public notice of the temporary urgency changes pursuant to Water Code section 1438, subdivision (a) and issued the TUCP Order. The comment period expires on May 3, 2021. Pursuant to Water Code section 1438, subdivision (b)(1), LADWP is required to publish the notice in a newspaper having a general circulation and published within the counties where the points of diversion are located. LADWP published the notice on April 1, 2021 in the Mammoth Times. The State Water Board posted the notice of the temporary urgency changes and distributed the notice through its electronic notification system.

5.0 COMMENTS REGARDING THE TEMPORARY URGENCY CHANGE PETITIONS

On February 16, 2021, LADWP held a conference call to discuss the proposed TUCPs with the MLC, CalTrout, CDFW, State Water Board staff, and the Stream Scientists. On February 22, 2021, LADWP informed State Water Board staff that a consensus to support the amended TUCPs was reached with the Mono Basin parties.

6.0 CRITERIA FOR APPROVING THE PROPOSED TEMPORARY URGENCY CHANGES

Water Code section 1435 provides that a permittee or licensee who has an urgent need to change the point of diversion, place of use, or purpose of use from that specified in the permit or license may petition for a conditional temporary change order. The State Water Board's regulations set forth the filing and other procedural requirements applicable to TUCPs. (Cal. Code Regs., tit. 23, §§ 805, 806.) The State Water Board's regulations also clarify that requests for changes to permits or licenses other than changes in point of diversion, place of use, or purpose of use may be filed, subject to the same filing and procedural requirements that apply to changes in point of diversion, place of use, or purpose of use. (*Id.*, § 791, subd. (e))

Before approving a temporary urgency change, the State Water Board must make the following findings:

1. the permittee or licensee has an urgent need to make the proposed change;

2. the proposed change may be made without injury to any other lawful user of water;

3. the proposed change may be made without unreasonable effect upon fish, wildlife, or other instream beneficial uses; and

4. the proposed change is in the public interest.
(Wat. Code, § 1435, subd. (b)(1-4).)

6.1 Urgency of the Proposed Change

Under Water Code section 1435, subdivision (c), an "urgent need" means "the existence of circumstances from which the State Water Board may in its judgment conclude that the proposed temporary change is necessary to further the constitutional policy that the water resources of the state be put to beneficial use to the fullest extent of which they are capable and that waste of water be prevented . . . ." However, the State Water Board shall not find the need urgent if it concludes that the petitioner has failed to exercise due diligence in petitioning for a change pursuant to other appropriate provisions of the Water Code. (Ibid.)

In this case, there is an urgent need for the proposed change in the license conditions regarding fish flows for the purpose of furthering protection of public trust resources. Furthermore, the TUCPs will provide LADWP almost two and a half years of continuous flow data and further provide valuable information on fisheries and riparian conditions.

6.2 No Injury to Any Other Lawful User of Water

There is no known water diverter below LADWP's point of diversions in the affected stream reaches. Accordingly, granting this TUCP will not result in injury to any other lawful user of water.

6.3 No Unreasonable Effect upon Fish, Wildlife, or Other Instream Beneficial Uses

As described above, the renewal of the temporary urgency changes will benefit the restoration of Rush, Lee Vining, Walker, and Parker Creeks and help with Grant Lake Reservoir management. No other fish, wildlife, or other instream beneficial use resources are implicated by the proposed change; accordingly, the proposed change will not have unreasonable effects upon fish and wildlife resources.

6.4 The Proposed Change is in the Public Interest

The proposed change would assist LADWP in maintaining the fishery resources in good condition. Maintenance of the fishery is in the public interest.

In light of the above, I find in accordance with Water Code section 1435, subdivision (b)(4) that the proposed change is in the public interest, including findings to support change order conditions imposed to ensure that the change is in the public interest.

7.0 CONSIDERATION OF PUBLIC TRUST RESOURCES

Prior to approval of a TUCP, the State Water Board must find that the proposed change may be made without unreasonable effect upon fish, wildlife, or other instream beneficial uses. In addition, the State Water Board has an independent obligation to consider the effect of approval of LADWP's petitions on public trust resources and to protect those resources where feasible. (National Audubon Society v. Superior Court (1983) 33 Cal. 3d 419 [189 Cal. Rptr. 346].) Public trust resources may include, but are not limited to, wildlife, fish, aquatic dependent species, streambeds, riparian areas, tidelands, and recreation in navigable waterways, as well as fisheries located in non-navigable waterways. As stated above, no other fish or wildlife resources, or other instream beneficial uses are implicated by the proposed changes; accordingly, the proposed changes will not have unreasonable effects upon fish and wildlife resources, and public trust resources will be protected.

Pursuant to Water Code section 1439, the State Water Board shall supervise diversion and use of water under this temporary change order for the protection of all other lawful users of water and instream beneficial uses.

8.0 STATE WATER BOARD DELEGATION OF AUTHORITY

On June 5, 2012, the State Water Board adopted Resolution 2012-0029, delegating to the Deputy Director for Water Rights the authority to act on petitions for temporary urgency change. This Order is adopted pursuant to the delegation of authority in section 4.4.1 of Resolution 2012-0029.

9.0 CONCLUSIONS

The State Water Board has adequate information in its files to make the evaluation required by Water Code section 1435.

I conclude that, based on the available evidence:

1. The licensee has an urgent need to make the proposed changes;

2. The proposed changes will not operate to the injury of any other lawful user of water;

3. The proposed changes, with conditions set forth in this Order, will not have an unreasonable effect upon fish, wildlife, or other instream beneficial uses; and,

4. The proposed changes are in the public interest.

ORDER

NOW, THEREFORE, IT IS ORDERED THAT: the petitions filed by the City of Los Angeles (LADWP) for temporary urgency changes in Licenses 10191 and 10192 are approved, and this approval is effective from April 1, 2021 to September 28, 2021. All existing terms and conditions in Licenses 10191 and 10192 remain in effect, except as temporarily amended by the following terms.

1. For protection of fish in Rush and Lee Vining Creeks, LADWP shall bypass flow below the point of diversion at the flows specified in the tables below for the applicable water year type. The Stream Ecosystem Flows provided under this requirement shall remain in the stream channel and not be diverted for any other use.

2. LADWP shall submit to the Deputy Director for Water Rights on a monthly basis a written report that summarizes all activities conducted to ensure compliance with the requirements of this Order. The first monthly report is due at the end of the first complete month of this Order. LADWP shall submit a final report summarizing overall compliance with this Order no later than November 1, 2021.

3. This Order does not authorize any act that results in the taking of a threatened or endangered species, or any act that is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code sections 2050 to 2097) or the federal Endangered Species Act (16 U.S.C.A. sections 1531 to 1544). If a "take" will result from any act authorized under this Order, the Petitioner shall obtain authorization for an incidental take permit prior to construction or operation. The Petitioner shall be responsible for meeting all requirements of the applicable Endangered Species Act for the temporary urgency change authorized under this Order.

4. The State Water Board shall supervise the diversion and use of water under this Order for the protection of legal users of water and instream beneficial uses and for compliance with the conditions. The Petitioner shall allow representatives of the State Water Board reasonable access to the project works to determine compliance with the terms of this Order.

5. The State Water Board reserves jurisdiction to supervise the temporary urgency changes under this Order, and to coordinate or modify terms and conditions, for the protection of vested rights, fish, wildlife, instream beneficial uses, and the public interest as future conditions may warrant.

6. The temporary urgency changes authorized under this Order shall not result in creation of a vested right, even of a temporary nature, but shall be subject at all times to modification or revocation in the discretion of the State Water Board. The temporary urgency changes approved in this Order shall automatically expire September 28, 2021, unless earlier revoked.

STATE WATER RESOURCES CONTROL BOARD

ORIGINAL SIGNED BY:

Erik Ekdahl, Deputy Director
Division of Water Rights

Dated: APR 01 2021

TABLE 1D: RUSH CREEK STREAM ECOSYSTEM FLOWS FOR NORMAL YEARS

Hydrograph Component	Timing	Flow Requirement	Ramping Rate
Spring Baseflow	April 1 – April 30	40 cfs	Maximum: 10% or 10 cfs*
Spring Ascension	May 1 – May 15	40 cfs ascending to 80 cfs	Target: 5% Maximum: 25%
Spring Bench	May 16 – June 11	80 cfs	Maximum: 20%
Snowmelt Ascension	June 12 – June 16	80 cfs ascending to 120 cfs	Target: 10% Maximum: 20%
Snowmelt Bench	June 17 – July 14	120 cfs	Maximum Ascending: 20% Maximum Descending: 10% or 10 cfs*
Snowmelt Flood and Snowmelt Peak	Starting between June 17 and June 25 with the 3-day peak between June 23 and July 3	120 cfs ascending to 380 cfs, 380 cfs for 3 days, 380 cfs descending to 120 cfs	Target Ascending: 20% Maximum Ascending: 40% Maximum Descending: 10% or 10 cfs*
Medium Recession (Node)	July 15 – July 26	120 cfs descending to 58 cfs	Target: 6% Maximum: 10% or 10 cfs*
Slow Recession	July 27 – August 17	58 cfs descending to 30 cfs	Target: 3% Maximum: 10% or 10 cfs*
Summer Baseflow	August 18 – September 30	30 cfs target 28 cfs minimum	Maximum: 10% or 10 cfs*
Fall and Winter Baseflow	October 1 – March 31	27 cfs target 25 cfs minimum and 29 cfs maximum	Maximum: 10% or 10 cfs*
			* whichever is greater

TABLE 1E: RUSH CREEK STREAM ECOSYSTEM FLOWS FOR DRY/NORMAL II YEARS

Hydrograph Component	Timing	Flow Requirement	Ramping Rate
Spring Baseflow	April 1 – May 18	40 cfs	Maximum: 10% or 10 cfs*
Spring Ascension	May 19 – June 2	40 cfs ascending to 80 cfs	Target: 5% Maximum: 25%
Snowmelt Bench	June 3 – June 30	80 cfs	Maximum Ascending: 20% Maximum Descending: 10% or 10 cfs*
Snowmelt Flood and Snowmelt Peak	Starting between June 2 and June 15 with the 3-day peak between June 6 and June 21 coinciding with Parker and Walker Creek peaks	80 cfs ascending to 200 cfs, 200 cfs for 3 days, 200 cfs descending to 80 cfs	Target Ascending: 20% Maximum Ascending: 40% Maximum Descending: 10% or 10 cfs*
Medium Recession (Node)	July 1 – July 8	80 cfs descending to 48 cfs	Target: 6% Maximum: 10% or 10 cfs*
Slow Recession	July 9 – July 24	48 cfs descending to 30 cfs	Target: 3% Maximum: 10% or 10 cfs*
Summer Baseflow	July 25 – September 30	30 cfs target 28 cfs minimum	Maximum: 10% or 10 cfs*
Fall and Winter Baseflow	October 1 – March 31	27 cfs target 25 cfs minimum and 29 cfs maximum	Maximum: 10% or 10 cfs*
			* whichever is greater

TABLE 1F: RUSH CREEK STREAM ECOSYSTEM FLOWS FOR DRY/NORMAL I YEARS

Hydrograph Component	Timing	Flow Requirement	Ramping Rate
Spring Baseflow	April 1 – April 30	40 cfs	Maximum: 10% or 10 cfs*
Spring Ascension	May 1 – May 15	40 cfs ascending to 80 cfs	Target: 5% Maximum: 25%
Snowmelt Bench	May 16 – July 3	80 cfs	Maximum Ascending: 20% Maximum Descending: 10% or 10 cfs*
Medium Recession (Node)	July 4 – July 9	80 cfs descending to 55 cfs	Target: 6% Maximum: 10% or 10 cfs
Slow Recession	July 10 – July 30	55 cfs descending to 30 cfs	Target: 3% Maximum: 10% or 10 cfs*
Summer Baseflow	July 31 – September 30	30 cfs target 28 cfs minimum	Maximum: 10% or 10 cfs*
Fall and Winter Baseflow	October 1 – March 31	27 cfs target 25 cfs minimum and 29 cfs maximum	Maximum: 10% or 10 cfs*
			* whichever is greater

TABLE 1G: RUSH CREEK STREAM ECOSYSTEM FLOWS FOR DRY YEARS

Hydrograph Component	Timing	Flow Requirement	Ramping Rate
Spring Baseflow	April 1 – April 30	30 cfs	Maximum: 10% or 10 cfs*
Spring Ascension	May 1 – May 18	30 cfs ascending to 70 cfs	Target: 5% Maximum: 25%
Snowmelt Bench	May 19 – July 6	70 cfs	Maximum Ascending: 20% Maximum Descending: 10% or 10 cfs*
Medium Recession (Node)	July 7 – July 12	70 cfs descending to 48 cfs	Target: 6% Maximum: 10% or 10 cfs*
Slow Recession	July 13 – July 28	48 cfs descending to 30 cfs	Target: 3% Maximum: 10% or 10 cfs*
Summer Baseflow	July 29 – September 30	30 cfs target 28 cfs minimum	Maximum: 10% or 10 cfs*
Fall and Winter Baseflow	October 1 – March 31	27 cfs target 25 cfs minimum and 29 cfs maximum	Maximum: 10% or 10 cfs*
			* whichever is greater

TABLE 2A: LEE VINING CREEK STREAM ECOSYSTEM FLOWS

Timing: April 1 – September 30						Year-type: Extreme Wet, Wet, Wet/Normal, Normal, Dry/Normal II				
Maximum ramping at the beginning and end of this period is 20%.										
Inflow	**Flow Requirement**									
30 cfs or less	Licensee shall bypass inflow.									
31 – 250 cfs	Licensee shall bypass flow in the amount corresponding to inflow which is displayed as blocks of 10 cfs (left-hand vertical column) and 1 cfs increments within such blocks (top horizontal row).									
	0	1	2	3	4	5	6	7	8	9
30		30	30	30	30	30	31	32	33	34
40	30	31	32	33	34	35	36	37	38	39
50	35	36	37	38	39	40	41	42	43	44
60	45	46	47	48	49	50	51	52	53	54
70	55	56	57	58	59	60	61	62	63	64
80	60	61	62	63	64	65	66	67	68	69
90	70	71	72	73	74	75	76	77	78	79
100	75	76	77	78	79	80	81	82	83	84
110	85	86	87	88	89	90	91	92	93	94
120	95	96	97	98	99	100	101	102	103	104
130	100	101	102	103	104	105	106	107	108	109
140	110	111	112	113	114	115	116	117	118	119
150	120	121	122	123	124	125	126	127	128	129
160	130	131	132	133	134	135	136	137	138	139
170	135	136	137	138	139	140	141	142	143	144
180	145	146	147	148	149	150	151	152	153	154
190	155	156	157	158	159	160	161	162	163	164
200	160	161	162	163	164	165	166	167	168	169
210	170	171	172	173	174	175	176	177	178	179
220	180	181	182	183	184	185	186	187	188	189
230	190	191	192	193	194	195	196	197	198	199
240	195	196	197	198	199	200	201	202	203	204
250	200									
251 cfs and greater	Licensee shall bypass inflow.									

TABLE 2B: LEE VINING CREEK STREAM ECOSYSTEM FLOWS

Timing: April 1 – September 30					Year-type: Dry/Normal I, Dry					
Maximum ramping at the beginning and end of this period is 20%.										
Inflow	**Flow Requirement**									
30 cfs or less	Licensee shall bypass inflow.									
31 – 250 cfs	Licensee shall bypass flow in the amount corresponding to inflow which is displayed as blocks of 10 cfs (left-hand vertical column) and 1 cfs increments within such blocks (top horizontal row).									
	0	1	2	3	4	5	6	7	8	9
30		30	30	30	30	30	30	30	30	30
40	30	30	30	30	30	30	30	30	30	30
50	30	30	30	30	30	30	30	30	31	32
60	32	33	34	34	35	36	36	37	38	38
70	39	40	41	41	42	43	43	44	45	45
80	46	47	47	48	49	49	50	51	52	52
90	53	54	54	55	56	56	57	58	59	59
100	60	61	61	62	63	64	64	65	66	66
110	67	68	69	69	70	71	72	72	73	74
120	74	75	76	77	77	78	79	80	80	81
130	82	82	83	84	85	85	86	87	88	88
140	89	90	91	91	92	93	94	94	95	96
150	97	97	98	99	100	100	101	102	103	103
160	104	105	106	106	107	108	109	109	110	111
170	112	112	113	114	115	115	116	117	118	118
180	119	120	121	121	122	123	124	124	125	126
190	127	128	128	129	130	131	131	132	133	134
200	134	135	136	137	138	138	139	140	141	141
210	142	143	144	144	145	146	147	148	148	149
220	150	151	151	152	153	154	155	155	156	157
230	158	158	159	160	161	162	162	163	164	165
240	165	166	167	168	169	169	170	171	172	172
250	173									
251 cfs and greater	Licensee shall bypass inflow.									

Attachment 4

2021 EASTERN SIERRA
RUNOFF FORECAST
April 1, 2021

APRIL THROUGH SEPTEMBER RUNOFF

	MOST PROBABLE VALUE (Acre-feet)	MOST PROBABLE VALUE (% of Avg.)	REASONABLE MAXIMUM (% of Avg.)	REASONABLE MINIMUM (% of Avg.)	LONG-TERM MEAN (1966 - 2015) (Acre-feet)
MONO BASIN:	**53,900**	**53%**	66%	41%	100,782
OWENS RIVER BASIN:	**144,900**	**48%**	62%	35%	299,885

APRIL THROUGH MARCH RUNOFF

	MOST PROBABLE VALUE (Acre-feet)	MOST PROBABLE VALUE (% of Avg.)	REASONABLE MAXIMUM (% of Avg.)	REASONABLE MINIMUM (% of Avg.)	LONG-TERM MEAN (1966 - 2015) (Acre-feet)
MONO BASIN:	**68,800**	**58%**	71%	44%	119,103
OWENS RIVER BASIN:	**226,800**	**55%**	68%	43%	409,199

NOTE - Owens River Basin includes Long, Round and Owens Valleys (not incl Laws Area)

MOST PROBABLE - That runoff which is expected if median precipitation occurs after the forecast date.

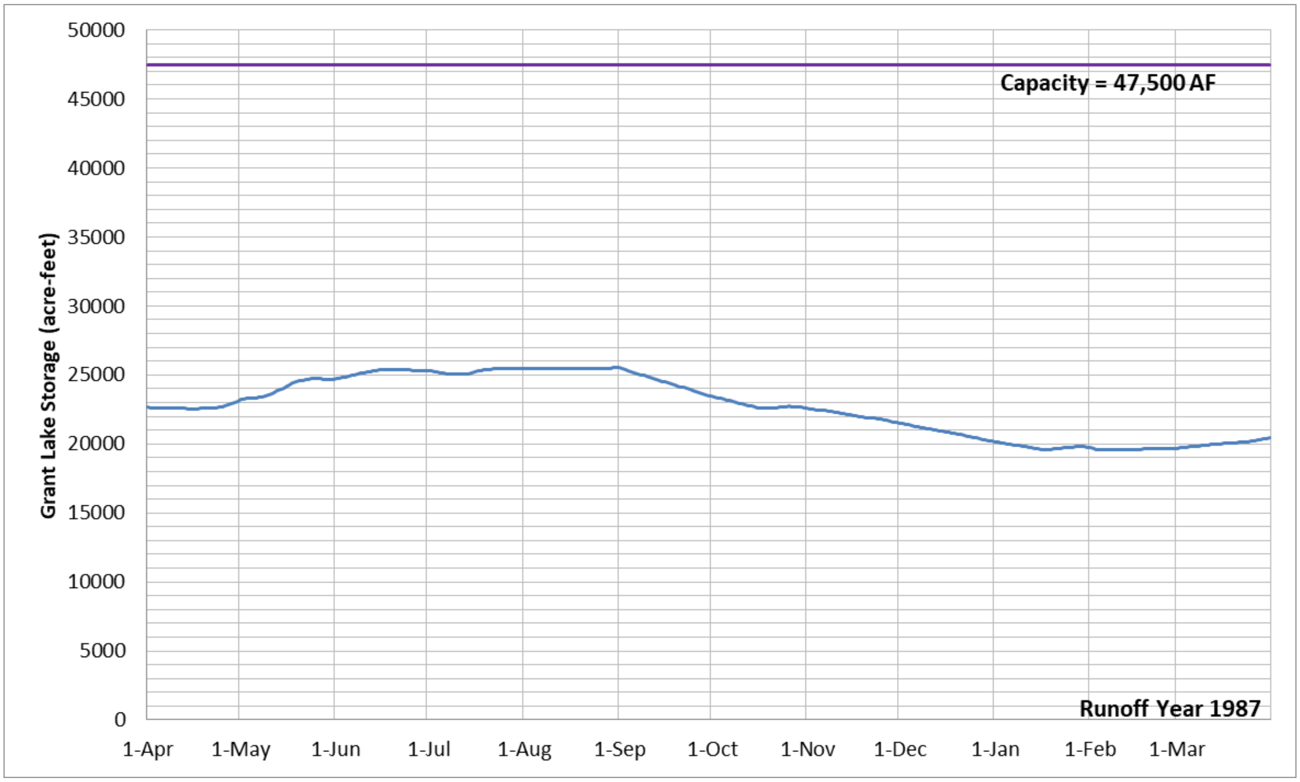
REASONABLE MAXIMUM - That runoff which is expected to occur if precipitation subsequent to the forecast is equal to the amount which is exceeded on the average once in 10 years.

REASONABLE MINIMUM - That runoff which is expected to occur if precipitation subsequent to the forecast is equal to the amount which is exceeded on the average 9 out of 10 years.

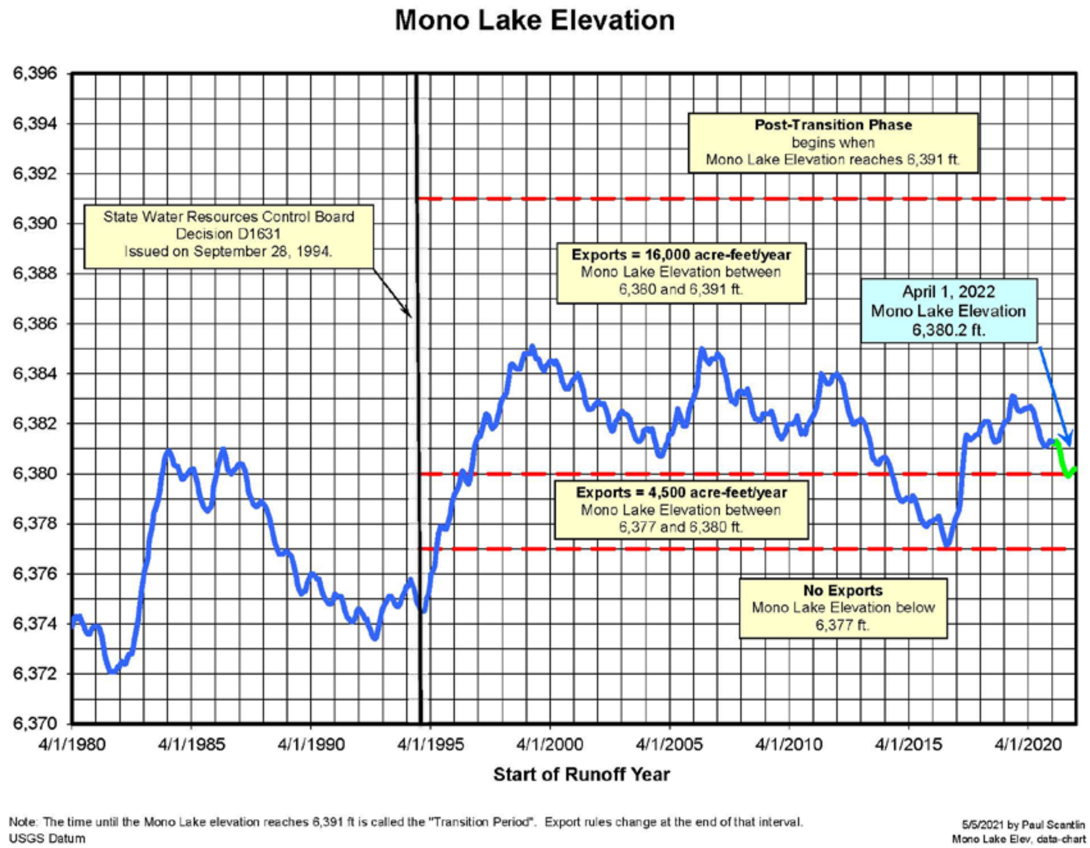
2021 Runoff Forecast 2.1 forecast 4/8/2021 4:11 PM

Attachment 5

RY 2021/22 Grant Lake Reservoir Storage Projection
Using 1987 (56.5% Year) Inflow (eSTREAM Release v3.2)



Attachment 6



Section 3

Mono Basin Fisheries Monitoring Report: Rush, Lee Vining, Parker, and Walker Creeks 2019

Mono Basin Fisheries Monitoring Report
Rush, Lee Vining, and Walker Creeks
2020

Prepared by Ross Taylor and Associates for

Los Angeles Department of Water and Power's Annual Compliance Report to the State Water Resources Control Board

Date: March 8, 2021

Table of Contents

Executive Summary

This report presents results of the 24th year of trout population monitoring for Rush, Lee Vining, and Walker Creeks pursuant to SWRCB's Water Right Decision 1631 (D1631) and the 22nd year following SWRCB Orders #98-05 and #98-07. Order #98-07 stated that the monitoring team would develop and implement a means for counting or evaluating the number, weights, lengths and ages of trout present in various reaches of Rush Creek, Lee Vining Creek, Parker Creek and Walker Creek. This report provides trout population and demographic data collected in 2020 as mandated by the Orders and the Settlement Agreement.

The 2020 runoff year (RY) was 71% of normal and classified a Dry-Normal 1 RY type, as measured on April 1st. The range of runoff that defines a Dry-Normal 1 RY is 68.5% - 72.5% (60% - 80% exceedence). The preceding eight years included a Wet RY of 140% in 2019, a Normal RY of 85% in 2018, a record Extreme-wet RY of 206% in RY 2017 and five consecutive below Normal RY years (RY 2016 was 74% of normal, RY 2015 was 25% of normal, RY 2014 was 48% of normal, RY 2013 was 66% of normal and RY 2012 was 55% of normal).

In 2020, due to the Creek Fire and numerous days with air quality levels rated extremely unhealthy to hazardous, we were unable to complete the capture-run sampling for electrofishing mark-recapture monitoring. This was the first time in 24 years that we failed to conduct the full sampling regime. Single pass electrofishing was conducted in the Lee Vining Creek main channel section and in three sections of Rush Creek – the MGORD, Upper Rush and the Bottomlands. Multiple-pass depletion electrofishing was conducted in the Lee Vining Creek side channel and in Walker Creek. The single pass electrofishing data were used to generate condition factors, relative stock densities, and growth rates and apparent survival rates from PIT tag recaptures. Average capture efficiencies from the 10 previous years were used to generate population estimates, density estimates, and standing crop estimates with the 2020 mark-run data collected in the Rush Creek sections and in the main channel section of Lee Vining Creek.

Population Estimates

The Upper Rush section supported an estimated 1,868 age-0 Brown Trout in 2020 compared to 2,647 age-0 fish in 2019. This section supported an estimated 859 Brown Trout 125-199 mm in length in 2020 compared to 616 fish in 2019. In 2020, Upper Rush supported an estimated 93 Brown Trout ≥200 mm in length compared to an estimate of 203 fish in 2019. In 2020, the Upper Rush section supported an estimated 253 Rainbow Trout <125 mm in length (418 fish in 2019), an estimated 119 Rainbow Trout 125-199 mm in length (145 fish in 2019), and an estimated nine Rainbow Trout ≥200 mm in length.

The Bottomlands section supported an estimated 662 age-0 Brown Trout in 2020 versus 638 age-0 fish in 2019. This section supported an estimated 364 Brown Trout 125-199 mm in length in 2020 compared to 433 fish in 2019. The Bottomlands section supported an estimated 67 Brown Trout ≥200 mm in 2020 compared to 64 fish in 2019.

The 2020 age-0 Brown Trout catch for the MGORD section of Rush Creek was 105 fish, no population estimate was generated because past catch efficiencies of age-0 fish in the MGORD were lacking. The 2020 population estimate for Brown Trout in the 125-199 mm size class equaled 446 fish and the 2020 population estimate of Brown Trout ≥200 mm in length in the MGORD was 583 fish.

Lee Vining Creek's main channel section supported an estimated 449 age-0 Brown Trout in 2020, compared to an estimated 414 age-0 fish in 2019. This section supported an estimated 171 Brown Trout 125-199 mm in length in 2020 compared to 118 fish in 2019. Lee Vining Creek's main channel supported an estimated 24 Brown Trout ≥200 mm in 2020 versus 48 fish in 2019.

A total of two Rainbow Trout were captured in Lee Vining Creek's main channel in 2020. These two fish were 149 mm and 173 mm in length.

The 2020 age-0 Brown Trout estimate for Walker Creek was 180 fish, compared to 179 fish in 2019. The 2020 population estimate for Brown Trout in the 125-199 mm size class equaled 139 fish, compared to 70 fish in 2019. The 2020 population estimate of Brown Trout ≥200 mm in length was 45 fish, compared to 34 fish in 2019.

In the Lee Vining Creek side channel, 16 Brown Trout were captured in three electrofishing passes during the 2020 sampling (21 fish in two passes during the 2019 sampling). The estimates for each size class were: <125 mm = 11 fish; 125-199 mm = 5 fish; and ≥200 mm= 0 fish. No Rainbow Trout were captured in the side channel in 2020. This was the 12th consecutive year that no age-0 Rainbow Trout were captured in the Lee Vining Creek side channel and the 10th consecutive year that no age-1 and older Rainbow Trout were captured.

Densities of Age-0 Brown Trout

In 2020, the Upper Rush section's estimated density of age-0 Brown Trout was 6,285 fish/ha and the Bottomlands section's estimated density of age-0 Brown Trout equaled 2,295 fish/ha. In Walker Creek, the 2020 density estimate of age-0 Brown Trout was 3,846 fish/ha.

The 2020 age-0 Brown Trout density estimate in the main channel of Lee Vining Creek was 3,451 fish/ha. In 2020, the age-0 Brown Trout density estimate in the Lee Vining Creek side channel equaled 299 fish/ha.

Densities of Age-1 and older (aka Age-1+) Brown Trout

In 2020, the Upper Rush section's estimated density of age-1+ Brown Trout was 3,203 fish/ha and the Bottomlands section's estimated density of age-1+ Brown Trout equaled 1,495 fish/ha.

In Walker Creek, the 2020 density estimate of age-1+ Brown Trout was 3,932 fish/ha. In the MGORD, the 2020 density estimate of age-1+ Brown Trout was 584 fish/ha.

The 2020 age-1+ Brown Trout density estimate in the main channel of Lee Vining Creek was 1,499 fish/ha. In 2020, the Lee Vining Creek side channel's density estimate of age-1 and older Brown Trout was 136 fish/ha.

Standing Crop Estimates

In 2020, the estimated standing crop for Brown Trout in the Upper Rush section was 171 kg/ha and the estimated standing crop for Rainbow Trout was 24 kg/ha, thus the total standing crop equaled 195 kg/ha. The estimated standing crop for Brown Trout in the Bottomlands section of Rush Creek was 84 kg/ha in 2020. The estimated standing crop for Brown Trout in Walker Creek was 240 kg/ha in 2020. The MGORD's estimated standing crop of Brown Trout equaled 81 kg/ha in 2020.

In 2020, the Lee Vining Creek main channel's estimated standing crop for Brown Trout equaled 95 kg/ha and the estimated standing crop of Rainbow Trout equaled 1 kg/ha, for a total standing crop of 96 kg/ha. The Lee Vining Creek side channel's total Brown Trout standing crop estimate was 10 kg/ha in 2020.

Condition Factors

In 2020, no sample sections had condition factors of Brown Trout 150 to 250 mm in length that exceeded 1.00 (considered a fish in average condition). In 2020, the condition factor of Brown Trout 150 to 250 mm in length equaled 0.98 in the MGORD section, 0.95 in the Upper Rush section, 0.95 in the Bottomlands section and 0.96 in Walker Creek. In 2020, the condition factors of Brown Trout 150 to 250 mm in length were 0.93 in the Lee Vining Creek main channel and 0.95 in the side channel. For Rainbow Trout, the condition factor was 0.94 in the Lee Vining Creek main channel in 2020.

Relative Stock Densities (RSD)

In the Upper Rush section, the RSD-225 equaled 14 for 2020, the third consecutive drop from the record RSD-225 value of 78 in 2017. This decrease was most likely influenced by greater numbers of fish smaller than 225 mm. The RSD-300 value was 1 in 2020. This low RSD-300 value in 2020 was influenced by the higher numbers of fish ≤225 mm caught and also a drop in the numbers of Brown Trout ≥300 mm.

In the Bottomlands section of Rush Creek, the RSD-225 for 2020 equaled 9, a small increase from the value of 8 for 2019. As in the Upper Rush section, the Bottomlands 2020 RSD-225 value was influenced by greater numbers of fish smaller than 225 mm. The RSD-300 value was 0 in 2020 because no Brown Trout ≥300 mm were captured.

In the MGORD, the RSD-225 value in 2020 was 48, the second lowest since the value of 42 in 2013. In 2020, the RSD-300 value was 13, an increase from the value of 10 in 2019. The RSD-375 value in 2020 was 2, the second lowest RSD-375 value for the 18 years of available data. In 2020, a total of 43 Brown Trout ≥300 mm in length were caught, including six fish ≥375 mm.

In 2020, RSD values in Lee Vining Creek were generated for the main channel only. The RSD-225 value equaled 14 for 2020. In 2020, no Brown Trout greater than 300 mm in length were captured in the Lee Vining Creek main channel, which resulted in a RSD-300 value of 0.

Introduction

Study Area

Between September 8th and 12th 2020, Los Angeles Department of Water and Power (LADWP) staff and Ross Taylor (the SWRCB fisheries scientist) conducted the annual fisheries monitoring surveys in six reaches along Rush, Lee Vining, and Walker creeks in the Mono Lake Basin. The six reaches were similar in length to those which have been sampled between 2009 and 2019 (Figure 1). Aerial photographs of the sampling reaches are provided in Appendix A.

Hydrology

The 2020 RY was 71% of normal and classified a "Dry-Normal 1" RY type, as measured on April 1st. The range of runoff that defines a Dry-Normal 1 year is 68.5% - 72.5% (60% - 80% exceedence). The preceding eight years included a Wet RY of 140% in 2019, a Normal RY of 85% in 2018, a record Extreme-wet RY of 206% in RY 2017 and five consecutive below "Normal" RY's (RY 2016 was 74% of normal, RY 2015 was 25% of normal, RY 2014 was 48% of normal, RY 2013 was 66% of normal and RY 2012 was 55% of normal). Under existing SWRCB orders and the Stream Restoration Flows (SRF), a Dry-Normal 1 RY prescribes a Rush Creek summer baseflow of 47 cfs from April 1st to September 30th, a seven-day peak release of 200 cfs, followed by baseflows of 44 cfs from October 1 through March 31. However, prior to April 1, 2020, LADWP submitted a Temporary Urgency Change Petition (TUCP) to the SWRCB to implement the Stream Ecosystem Flows (SEF) Dry-Normal 1 flow regime instead of the SRF's. The SEF Dry-Normal 1 flow regime has a 40 cfs baseflow for the month of April, followed by a spring ascension from 40 to 70 cfs over a 13-day period, followed by snowmelt bench of 80 cfs for 51 days, followed by a slow recession from 70 to 45 cfs and 45 to 27 cfs in July, and then a baseflow of 27 cfs (Figure 2). In Lee Vining Creek, the existing SWRCB orders (SRF's) require that the primary peak flow is passed downstream. However, in 2020 LADWP included the Lee Vining Creek in their TUCP to the SWRCB and implemented the diversion rate table and fall/winter baseflows consistent with the recommended SEF's.

The 2020 Rush Creek hydrograph at the MGORD followed the SEF flows for a Dry-Normal 1 RY, with the required spring ascension, followed by a ramp up to approximately an 80 cfs snowmelt bench from May 16th through July 5th (red line on Figure 2). After the snowmelt bench, flows receeded down to a summer baseflow by August 1st (red line on Figure 2). The flows upstream of GLR (At Damsite) depicted a range of peaks and drops in Rush Creek flows due to snowmelt runoff, SCE operations and possibly rain-storm peaks in August (blue line on Figure 2). Accretions from Parker and Walker creeks resulted in flow fluctuations through the spring and summer, and contributed to the peak of 147 cfs in Rush Creek below the Narrows on May 30th and a total of 51 days where flows exceeded 100 cfs (green line on Figure 2).

In 2020, multiple, small peaks occurred in Lee Vining Creek above the intake, with a peak of 130 cfs on April 30th (Figure 3). Consistent with the SEF diversion rate table, LADWP diverted flows from Lee Vining Creek to GLR when flows above the intake were >30 cfs (Figure 3). Flows in Lee Vining Creek were also diverted in September to provide for safer wading and electrofishing, resulting in flows of approximately 22 cfs for the duration of the fisheries sampling (Figure 3).

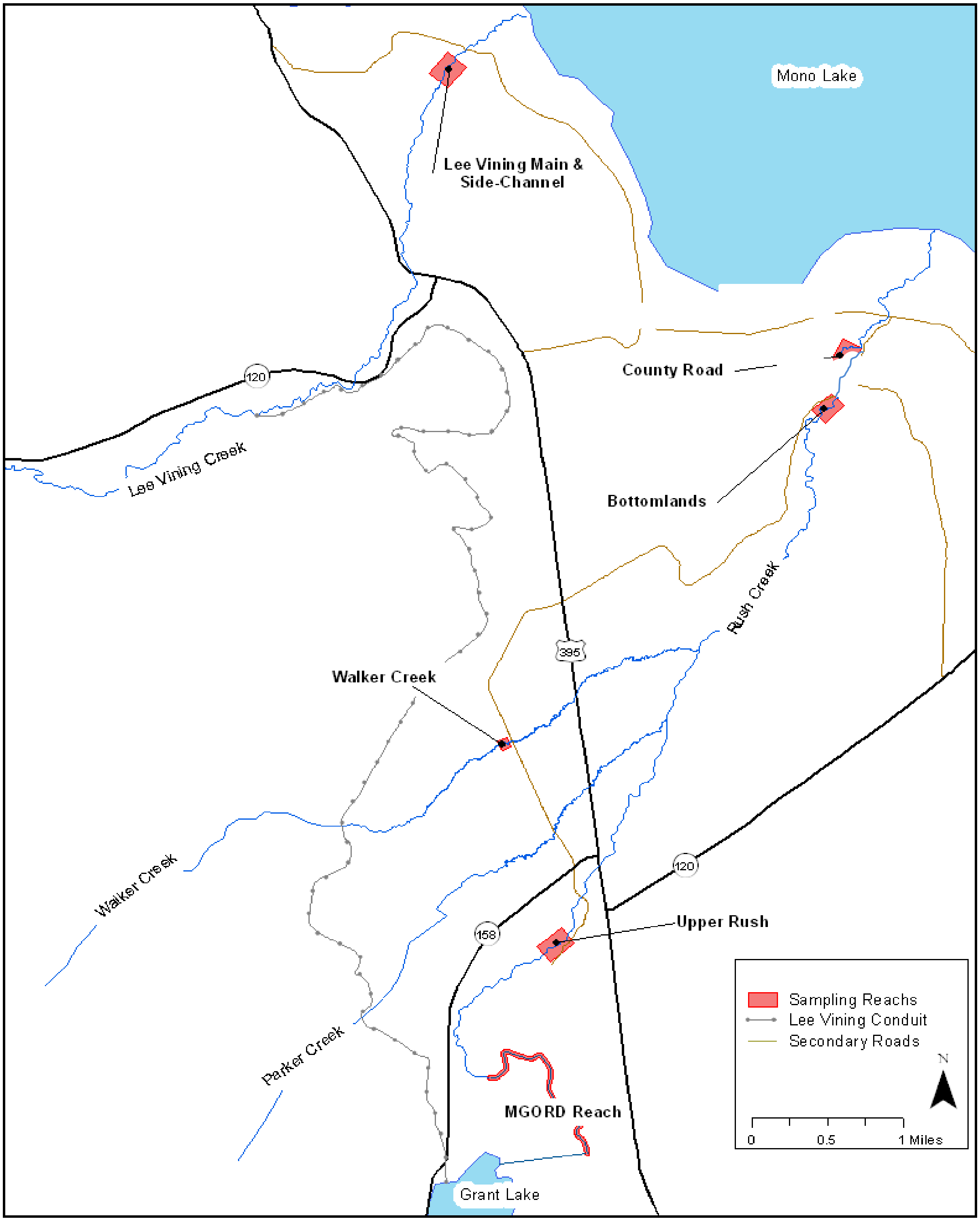


Figure 1. Annual fisheries sampling sites within Mono Basin study area, September 2020.

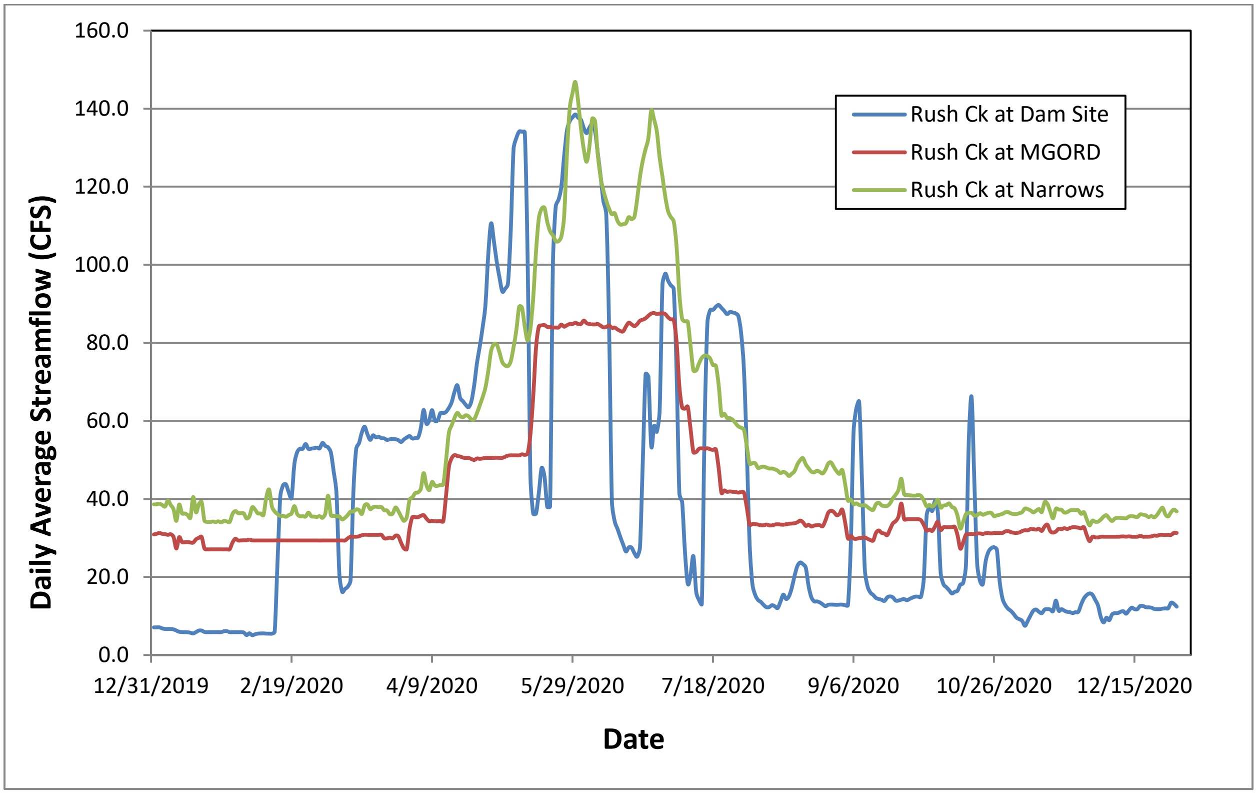


Figure 2. Rush Creek hydrographs between January 1st and December 31 of 2020.

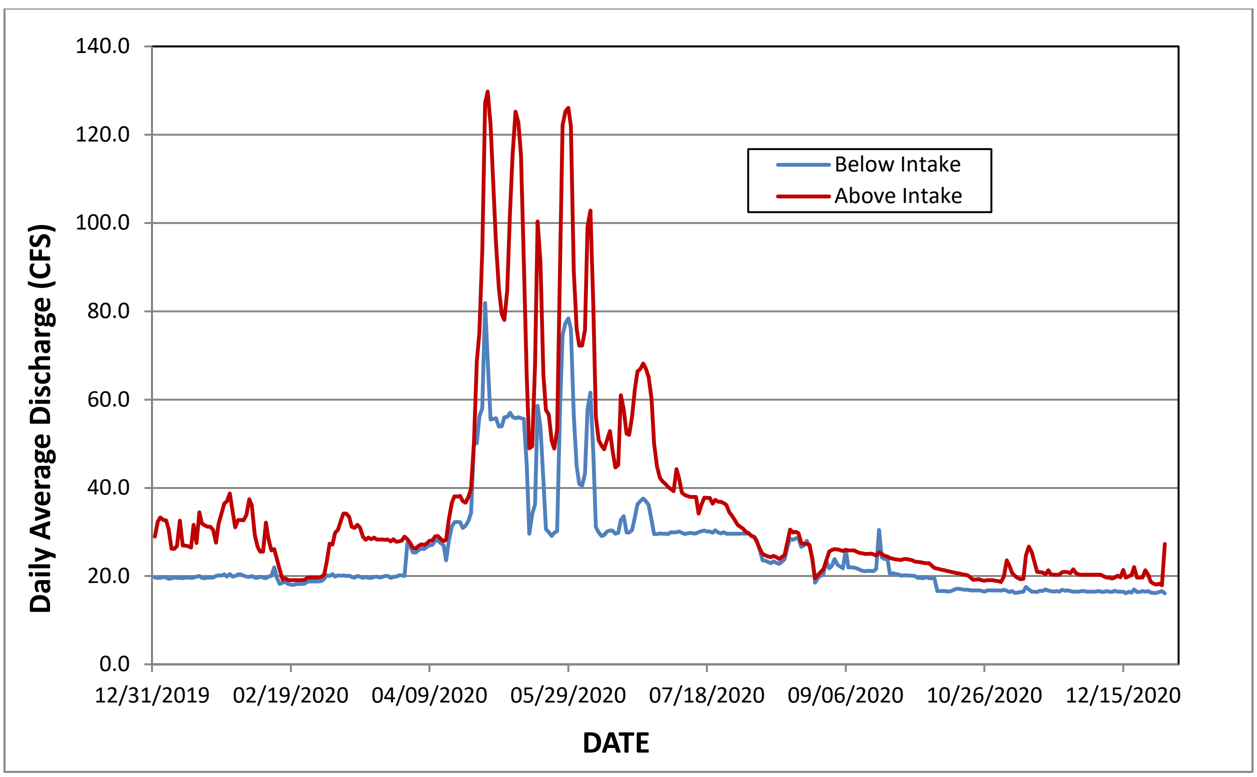


Figure 3. Lee Vining Creek hydrograph between January 1st and December 31st of 2020.

Grant Lake Reservoir

In 2020, storage elevation levels in GLR fluctuated from a low of 7,108.5 ft in mid-February to a high of 7,121.6 ft (Figure 4). In 2020, GLR continued to fill throughout April - July and reached its peak storage level on 7/29/20 – 8/1/20 (Figure 4).

During RY2020, GLR's elevation was 8.5 ft to 21.6 ft above the "low" GLR level as defined in the Synthesis Report by the Stream Scientists as a level where warm water temperatures should be a concern (<20,000 AF storage or approximately 7,100 ft elevation) (red horizontal line in Figure 4). However, the 2020 summer water temperature monitoring documented warmer water temperatures with sometimes large diurnal fluctuations, leading to less than favorable conditions for Brown Trout, at all Rush Creek locations downstream of GLR for variable lengths of the summer period, defined as July through September.

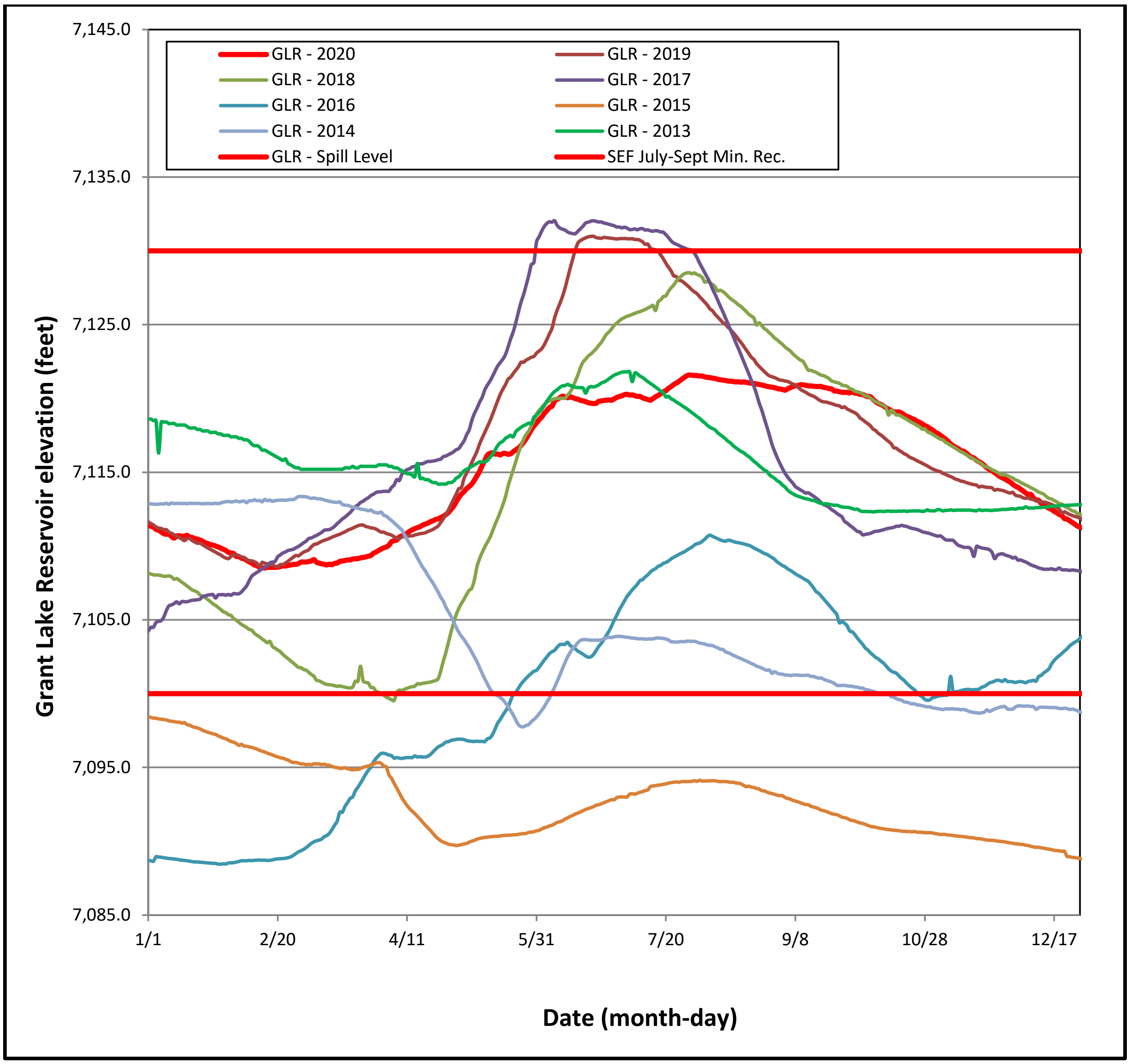


Figure 4. Grant Lake Reservoir's elevation between January 1st and December 31st 2013 - 2020.

Methods

The annual fisheries monitoring was conducted between September 8th and 12th of 2020. The intent in 2020 was to conduct our usual level of sampling, following the closed population mark-recapture and depletion methods used to estimate trout abundance. As mentioned in this report's introduction, the Creek Fire and hazardous air quality prevented us from completing the capture-runs required for the mark-recapture methodology. Thus, single electrofishing passes were made in the MGORD, Upper and Bottomlands sections of Rush Creek and in the Lee Vining Creek main channel section. The multiple-pass depletion method was used on the Lee Vining Creek side channel and Walker Creek sections.

The 2020 sampling was started with the assumption that mark-recapture estimates would be made, thus block fences were installed and maintained as described in previous annual fisheries reports (Taylor 2019; 2020).

Depletion estimates only required a temporary blockage to prevent fish movement in and out of the study area while conducting the survey. Temporary blockage of the sections was achieved with 3/16 inch-mesh nylon seine nets installed across the channel at the upper and lower ends of the study areas. Rocks were placed on the lead line to prevent trout from swimming underneath the seine net. Sticks were used to keep the top of the seine above the water surface. Both ends of the seine net were then tied to bank vegetation to hold it in place.

Equipment used to conduct mark-run electrofishing on Rush Creek included a six foot plastic barge that contained the Smith-Root© 2.5 GPP electro-fishing system, an insulated cooler, and battery powered aerators. The Smith-Root© 2.5 GPP electro-fishing system included a 5.5 horsepower Honda© generator which powered the 2.5 GPP control box. Electricity from the 2.5 GPP control box was introduced into the water via two anodes. The electrical circuit was completed by the metal plate cathode attached to the bottom of the barge.

Mark-runs on Rush Creek consisted of a single downstream pass starting at the upper block fence and ending at the lower block fence. In 2020, the field crew consisted of a barge operator, two anode operators, and five netters, two for each anode and a rover. The barge operator's job consisted of carefully maneuvering the barge down the creek and ensuring overall safety of the entire crew. The anode operator's job was to safely shock and hold trout until they were netted. The netter's job was to net and transport fish to the insulated cooler and monitor trout for signs of stress. Once the cooler was full, electrofishing was temporarily stopped to process the trout. The trout were then transferred from the cooler to live cars and placed back in the creek. The trout were then processed in small batches and then returned to a recovery live car in the creek. Once all the trout were processed at a sub-stop, the crew resumed electrofishing until the cooler was once again full.

The mark-run on the Lee Vining Creek main channel consisted of an upstream pass starting at the lower block fence to the upper block fence, a short 15-20 minute break, and then a downstream pass back down to the lower fence. The electrofishing crew consisted of two crew members operating Smith-Root© LR-24 backpack electrofishers, four netters, and one bucket carrier who transported the captured trout. Three live cars were placed within the Lee Vining Creek section (spaced approximately 70 meters apart from each other) and the bucket carrier periodically transferred fish from the bucket to the live cars to avoid over-crowding the bucket.

Due to the depth of the MGORD, all electrofishing and netting was done from inside a drift boat. The drift boat was held perpendicular to the flow by two crew members who walked it down the channel. The electrofishing barge was tied off to the upstream side of the drift boat and a single throw anode was used. A single netter used a long handled dipnet to net the stunned trout, which were then placed in an insulated cooler equipped with aerators. A safety officer sat at the stern of the drift boat whose job was to monitor the trout in the cooler, the electrofishing equipment, the electrofishing crew, and shut off the power should the need arise. A second safety officer walked the streambank and observed the in-stream operations. Once the cooler was full, the trout were moved to a live car and placed back in the creek for the shore-based crew to process before continuing the electrofishing effort.

For the Walker Creek and Lee Vining Creek side channel depletions, a single pass was considered an upstream pass from the lower seine net to the upper seine net followed by a downstream pass back to the lower seine net. One member of the electrofishing crew operated a LR-24 electrofisher; another member was the primary netter and a third member was the backup netter/bucket carrier. The other crew members processed the trout captured during the first pass while the electrofishing crew was conducting the second pass. Processed first-pass fish were temporarily held in a live car until the second pass was completed. If it was determined that only two passes were required to generate a suitable estimate, all fish were then released. If additional passes were needed, fish from each pass were held in live cars until we determined that no additional electrofishing passes were required to generate reasonable estimates.

To process trout during the mark-run, small batches of fish from the live car were transferred to a five gallon bucket equipped with aerators. Trout were then anesthetized, identified as either Brown Trout or Rainbow Trout, measured to the nearest millimeter (total length), and weighed to the nearest gram on an electronic balance. Trout were then “marked” with a small (< 3 mm) fin clip for identification during the recapture run. Trout captured in the Rush Creek Bottom-lands and MGORD sections received anal fin clips and trout captured in the Upper Rush section received lower caudal fin clips. Before placing trout into the aerated recovery bucket, each fish was examined for a missing adipose fin. Trout missing their adipose fin were then scanned for their Passive Integrated Transponder (PIT) tag number. Any trout missing their adipose fin that failed to produce a tag number when scanned were recorded as having “shed” the PIT tag; in most instances these fish were retagged. Partially regenerated adipose fins of fish with PIT tags were reclipped for ease of future identification. Once recovered, fish were then moved from the recovery bucket to a live car to be held until the day’s sampling effort was completed; this was done to prevent captured fish from potentially moving downstream into the actively sampled section. At the end of the electrofishing effort, fish were released from the live cars back into the sub-sections they had been captured in. Fish were then going to be provided a seven-day period to remix back into the section’s population prior to conducting the recapture-run; however the 2020 fisheries monitoring was cancelled five days after the final day of mark-run sampling.

Between 2009 and 2012, PIT tags were implanted in most age-0 trout in Rush and Lee Vining Creeks and in all ages of trout in the MGORD. No PIT tags were deployed in 2013; however the tagging program was resumed during the 2014-2020 field seasons. Starting in 2017, PIT tags implanted in trout caught in the MGORD were focused primarily on fish up to 250 mm in length, with the intent being to tag only age-0 and presumed age-1 trout.

All data collected in the field were written on data sheets and entered into Excel spreadsheets using a field laptop computer. Data sheets were then used to proof the Excel spreadsheets.

Calculations

To calculate the area of each sample section, channel lengths and wetted widths were measured within the sample reaches. Wetted widths were measured at approximately 10-meter intervals to 0.1 meter accuracy within each reach. Average wetted widths and reach lengths were used to generate sample section areas (in hectares), which were then used to calculate each section's estimates of trout biomass and density.

Population estimates were derived from the mark-run numbers by dividing the number of fish caught on the mark-run in a particular sample section by the section's average capture efficieny for the previous 10 years where sampling effort (size of crew) was similar. Capture effficiences from previous years were computed with capture-run data; dividing the numbers of recaptures by the total numbers of fish caught on the capture-run. These capture efficiencies were made for each size class of fish; <125 mm in length, 125-199 mm in length and ≥200 mm in length. Depletion estimates and condition factors were derived from MicroFish 3.0 software program. Population estimates were generated for three size groups of trout: <125 mm in length, 125-199 mm in length, and ≥200 mm in length (200 mm is approximately eight inches).

Mortalities

For the purpose of conducting the mark-recapture methodology, accounting for fish that died during the sampling process was important. Depending on when the fish died (i.e., whether, or not, they were sampled during the mark-run), dictated how these fish were treated within the estimation process. However, due to the Camp Fire and the inability to complete the mark-recapture sampling in 2020, the methods for handling mortalities were irrelevant and were omitted from this report. Please refer to previous annual reports for a description of these methods (Taylor 2019; 2020).

Length-Weight Relationships

Length-weight regressions (Cone 1989 as cited in Taylor and Knudson 2011) were calculated for all Brown Trout greater than 100 mm in all sections of Rush Creek. Regressions using Log10 transformed data were used to compare length-weight relationships by year and by section.

Fulton-type condition factors were computed in MicroFish 3.0 using methods previously reported (Taylor and Knudson 2012) for Brown Trout 150 to 250 mm. A trout condition factor of 1.00 was considered average (Reimers 1963; Blackwell et al. 2000).

Relative Stock Density (RSD) Calculations

Relative stock density (RSD) is a numerical descriptor of length frequency data (Hunter et al. 2007; Gabelhouse 1984). RSD values are the proportions (percentage x 100) of the total number of Brown Trout ≥150 mm in length that are also ≥225 mm or (RSD-225), ≥300 mm (RSD-300) and ≥375 mm or (RSD-375). These three RSD values are calculated by the following equations:

RSD-225 = [(# of Brown Trout ≥225 mm) ÷ (# of Brown Trout ≥150 mm)] x 100
RSD-300 = [(# of Brown Trout ≥300 mm) ÷ (# of Brown Trout ≥150 mm)] x 100
RSD-375 = [(# of Brown Trout ≥375 mm) ÷ (# of Brown Trout ≥150 mm)] x 100

Water Temperature Monitoring

Water temperatures were recorded (in degrees Fahrenheit) at various locations within Rush and Lee Vining creeks as part of the fisheries monitoring program. Data loggers were deployed by LADWP personnel from the Bishop Office in January and recorded data throughout the year in one-hour time intervals. Data loggers were downloaded at the end of the year and the data were summarized in spreadsheets. Water temperature data loggers were deployed at the following locations in 2020:

1. Rush Creek at Damsite – upstream of GLR.
2. Rush Creek – top of MGORD.
3. Rush Creek – bottom of MGORD.
4. Rush Creek – at Upper Rush/Old Highway 395 Bridge.
5. Rush Creek – above Parker Creek.
6. Rush Creek – below Narrows.
7. Rush Creek – at County Road crossing.
8. Lee Vining Creek – at County Road crossing.

For the fisheries monitoring program, the year-long data sets were edited to focus on the 2020 summer water temperature regimes (July – September) in Rush Creek. Analysis of summer water temperature included the following metrics:

1. Daily mean temperature.
2. Average daily minimum temperature.
3. Average daily maximum temperature.
4. Number of days with daily maximums exceeding 70^{o}F.
5. Number of hours with temperatures exceeding 66.2^{o}F.
6. Number of good/fair/poor potential growth days, based on daily average temperatures.
7. Number of bad thermal days based on daily average temperatures.
8. Maximum diurnal fluctuations.
9. Average maximum diurnal fluctuatios for a consecutive 21-day period.

Results

Channel Lengths and Widths

Differences in wetted widths between years can be due to several factors such as, magnitude of spring peak flows, stream flows at time of measurements, and locations of where the measurements were taken. Lengths, widths, and areas from 2019 were provided for comparisons (Table 1). In 2020, because of the Creek Fire, lengths and widths were not measured in the Rush Creek MGORD section and in the Walker Creek section; lengths and widths from 2019 were used instead (Table 1). Between 2019 and 2020, The Lee Vining Creek side channel decreased in length and width, resulting in an overall smaller wetted area (Table 1).

Table 1. Total length, average wetted width, and total surface area of sample sections in Rush, Lee Vining, and Walker creeks sampled between September 8-12, 2020. Values from 2019 provided for comparisons.

Sample Section	Length (m) 2019	Width (m) 2019	Area (m^2) 201	Length (m) 2020	Width (m) 2020	Area (m^2) 2020	Area (ha) 2020
Rush – Upper	381	7.9	3,009.9	381	7.8	2,971.8	0.2972
Rush - Bottomlands	437	7.3	3,190.1	437	6.6	2,884.2	0.2884
Rush – MGORD	2,230	7.9	17,617.0	2,230	7.9	17,617.0	1.7617
Lee Vining – Main	255	5.0	1,275.0	255	5.1	1,300.5	0.1301
Lee Vining - Side	195	2.3	448.5	175	2.1	367.5	0.0368
Walker Creek	195	2.4	468.0	195	2.4	468.0	0.0468

Capture Efficiencies

For the MGORD, Upper Rush, and Bottomlands sections of Rush Creek and the Lee Vining Creek main channel section, capture efficiencies for three size classes of Brown Trout were tabulated for the past ten years when crew sizes and sampling efforts were similar (Tables 2-5). Capture efficiencies for three size classes of Rainbow Trout were calculated for the Upper Rush section with capture-run data from 2018 and 2019 when sufficient numbers were caught for generating mark-recapture population estimates (Table 6). Prior to 2009, crew sizes were typically smaller, with often one netter per anode or backpack electrofisher. From 2009 to 2019, the mark-recapture crew size increased to two netters per anode or backpack electrofisher. In all of the sample sections, average capture efficiencies increased with size class of Brown Trout and Rainbow Trout (Tables 2-6).

Table 2. Capture efficiencies of Brown Trout in the MGORD Rush section, 2010 – 2018*.

SAMPLE YEAR	BNT <125 mm	BNT 125-199 mm	BNT <200 mm	# <125 mm on Recap	# 125-199 mm on Recap	# ≥200 mm on Recap
2018	N/A	0.13	0.23	7	16	153
2016	N/A	0.40	0.37	0	5	101
2014	N/A	0.17	0.28	13	60	195
2012	0.01	0.28	0.49	142	50	335
2010	N/A	0.32	0.42	1	57	359
5 Yr Average	**0.01**	**0.26**	**0.36**			

*MGORD is sampled in even years only for population estimates

Table 3. Capture efficiencies of Brown Trout in the Upper Rush section, 2010 – 2019.

SAMPLE YEAR	BNT <125 mm	BNT 125-199 mm	BNT <200 mm	# <125 mm on Recap	# 125-199 mm on Recap	# ≥200 mm on Recap
2019	0.21	0.46	0.56	395	219	73
2018	0.16	0.27	0.44	319	79	101
2017	0.25	0.08	0.65	81	13	68
2016	0.32	0.42	0.42	37	19	43
2015	0.46	0.52	0.68	241	149	72
2014	0.29	0.36	0.36	378	194	59
2013	0.19	0.41	0.46	569	184	67
2012	0.24	0.34	0.59	765	214	86
2011	0.11	0.32	0.50	674	245	96
2010	0.32	0.50	0.75	251	125	76
10 Yr Average	**0.25**	**0.37**	**0.54**			

Table 4. Capture efficiencies of Brown Trout in the Rush Creek Bottomlands section, 2010 – 2019.

SAMPLE YEAR	BNT <125 mm	BNT 125-199 mm	BNT <200 mm	# <125 mm on Recap	# 125-199 mm on Recap	# ≥200 mm on Recap
2019	0.17	0.38	0.37	102	152	19
2018	0.15	0.44	0.50	337	45	34
2017	0.21	0.29	0.61	29	17	36
2016	0.31	0.63	0.68	49	24	25
2015	0.32	0.51	0.66	165	55	41
2014	0.33	0.53	0.84	63	116	19
2013	0.26	0.37	0.50	125	134	14
2012	0.29	0.58	0.67	247	266	75
2011	0.24	0.46	0.50	185	136	96
2010	0.33	0.52	0.77	315	147	83
10 Yr Average	**0.26**	**0.47**	**0.61**			

Table 5. Capture efficiencies of Brown Trout in the Lee Vining section, 2009 – 2019*.

SAMPLE YEAR	BNT <125 mm	BNT 125-199 mm	BNT <200 mm	# <125 mm on Recap	# 125-199 mm on Recap	# ≥200 mm on Recap
2019	0.31	0.56	0.54	134	62	26
2018	0.18	0.32	0.64	60	22	11
2016	0.36	0.69	0.88	36	68	26
2015	0.57	0.57	0.80	122	108	35
2014	0.33	0.42	0.61	76	133	23
2013	0.33	0.62	0.85	133	166	13
2012	0.38	0.63	0.72	257	40	32
2011	0.41	0.63	0.83	34	19	24
2010	0.30	0.25	0.71	10	8	17
2009	0.29	0.41	0.56	7	71	18
10 Yr Average	**0.35**	**0.51**	**0.71**			

*No mark-recapture estimate made in 2017.

Table 6. Capture efficiencies of Rainbow Trout in the Upper Rush section, 2018 and 2019.

SAMPLE YEAR	RBT <125 mm	RBT 125-199 mm	RBT <200 mm	# <125 mm on Recap	# 125-199 mm on Recap	# ≥200 mm on Recap
2019	0.24	0.36	0.57	80	33	7
2018	0.21	0.28	0.50	87	7	10
2 Yr Average	**0.225**	**0.32**	**0.535**			

Trout Population Abundance

In 2020, a total of 835 Brown Trout ranging in size from 59 mm to 318 mm were captured on the single electrofishing pass in the Upper Rush section (Figure 5). For comparison, in 2019 a total of 956 Brown Trout were caught on the mark-run and in 2018 a total of 387 Brown Trout were captured on the mark-run in this section. In 2020, age-0 Brown Trout comprised 56% of the total catch (compared to 62% in 2019 and 67% in 2018). The Upper Rush section supported an estimated 1,868 age-0 Brown Trout in 2020 compared to 2,647 age-0 Brown Trout in 2019 (a 29% decrease).

In 2020, the 318 Brown Trout captured in the 125-199 mm size class comprised 38% of the total catch in the Upper Rush section (compared to 28% in 2019). The Upper Rush section supported an estimated 859 Brown Trout in the 125-199 mm size class in 2020, compared to 616 fish in 2019 (a 39% increase).

Brown Trout ≥200 mm in length comprised 6% of the Upper Rush total catch in 2020 (compared to 10% in 2019). In 2020, Upper Rush supported an estimated 93 Brown Trout ≥200 mm in length compared to an estimate of 203 fish in 2019 (a 54% decrease). In 2020, only one Brown Trout ≥300 mm in length was captured in the Upper Rush section (Figure 5).

A total of 100 Rainbow Trout were captured in the Upper Rush section comprising 11% of the section's total catch in 2020 (compared to 15% of the total catch in 2019). The 100 Rainbow Trout ranged in length from 59 mm to 317 mm and 57 of these were age-0 fish (Figure 6). Most of the Rainbow Trout appeared to be of naturally produced origin and population estimates were made using capture efficiencies from 2018 and 2019 (Table 6). In 2020, the Upper Rush section supported an estimated 253 Rainbow Trout <125 mm in length (418 in 2019), an estimated 119 Rainbow Trout 125-199 mm in length (145 in 2019), and an estimated nine Rainbow Trout ≥200 in length (13 in 2019) (Table 7).

Within the Bottomlands section of Rush Creek, a total of 384 Brown Trout were captured on the single electrofishing pass made in 2020 (Table 7), which ranged in size from 65 mm to 281 mm (Figure 7). For comparison, 298 Brown Trout were caught on the mark-run in 2019 and 365 Brown Trout were captured on the mark-run in 2018. Age-0 Brown Trout comprised 45% of the total catch in 2020 versus 40% of the total catch in 2019. The Bottomlands section supported an estimated 662 age-0 Brown Trout in 2020 versus 638 age-0 fish in 2019 (a 4% increase).

Brown Trout 125-199 mm in length comprised 45% of the total catch in the Bottomlands section in 2020 versus 52% of the total catch in 2019. This section supported an estimated 364 Brown Trout 125-199 mm in length in 2020 compared to 433 fish in 2019 (a 16% decrease).

Brown Trout ≥200 mm in length comprised of 10% of the total catch in 2020 (8% in 2019) with the largest trout 281 mm in length (Figure 7). The Bottomlands section supported an estimated 67 Brown Trout ≥200 mm in 2020 compared to 64 trout in 2019 (a 5% increase).

In 2020, five Rainbow Trout were caught in the Bottomlands section of Rush Creek during the single electrofishing pass. In comparison, 10 Rainbow Trout were caught in 2019 and no Rainbow Trout were caught in 2018 within the Bottomlands section. The five fish in 2020 ranged in size from 155 mm to 231 mm in total length and appeared to be of naturally produced origin.

Within the MGORD section of Rush Creek a total of 431 Brown Trout were captured during the single electrofishing pass made in 2020, compared to 343 Brown Trout caught in one pass in 2019. In 2020, these Brown Trout ranged in size from 74 mm to 540 mm (Figure 8). A total of 105 Brown Trout <125 mm in length were captured in 2020, which comprised 24% of the total catch of Brown Trout (67 age-0 fish were caught in 2019) (Figure 8). Because the capture efficiency data were so sparse for Brown Trout <125 mm in the MGORD, no population estimate was made with the 2020 data (Table 7).

In 2020, a total of 116 Brown Trout 125-199 mm in length were caught during the single electrofishing pass and comprised 30% of the total Brown Trout catch in the MGORD section (103 fish were caught in 2019). Using an average capture efficiency of 0.26, the MGORD supported an estimated 446 Brown Trout in the 125-199 mm size class in 2020 (Table 7).

In 2020, a total of 210 Brown Trout ≥200 mm in length were caught during the single electrofishing pass and comprised of 49% of the total catch in the MGORD section (50% in 2019). Using an average capture efficiency of 0.36, the MGORD supported an estimated 583

Brown Trout in the ≥200 mm size class in 2020 (Table 7). In 2020, 43 Brown Trout ≥300 mm were captured in the MGORD (28 fish ≥300 mm were captured during the single pass made in 2019). Six Brown Trout ≥375 mm in length were captured in 2020 (compared to 4 fish in 2019, 15 fish in 2018, 11 fish in 2017 and 20 fish in 2016), three of these fish were >400 mm in length and two of these fish were >500 mm in length (Figure 8).

Table 7. Rush Creek population estimates for 2020 showing total number of trout captured on the mark-run (M) and then multiplied by the 10-year average capture efficiency, by stream, section, date, species, and size class. BNT = Brown Trout. RBT = Rainbow Trout. N/A = not available. NP = not possible.

Stream / Section / Species / Date	Size Class (mm)	Mark Run #	Average Capture Efficiency	Estimate
Rush Creek				
MGORD Rush - BNT				
9/10/2020				
	0 - 124 mm	105	N/A	**NP**
	125 - 199 mm	116	0.26	**446**
	≥200 mm	210	0.36	**583**
Upper Rush - BNT				
9/9/2020				
	0 - 124 mm	467	0.25	**1,868**
	125 - 199 mm	318	0.37	**859**
	≥200 mm	50	0.54	**93**
Upper Rush - **RBT**				
9/9/2020				
	0 - 124 mm	57	0.225	**253**
	125 - 199 mm	38	0.32	**119**
	≥200 mm	5	0.535	**9**
Bottomlands – BNT				
9/11/2020				
	0 – 124 mm	172	0.26	**662**
	125 – 199 mm	171	0.47	**364**
	≥200 mm	41	0.61	**67**
Lee Vining Creek				
Main Channel – BNT				
9/11/2020				
	0 - 124 mm	157	0.35	**449**
	125 - 199 mm	87	0.51	**171**
	≥200 mm	17	0.71	**24**

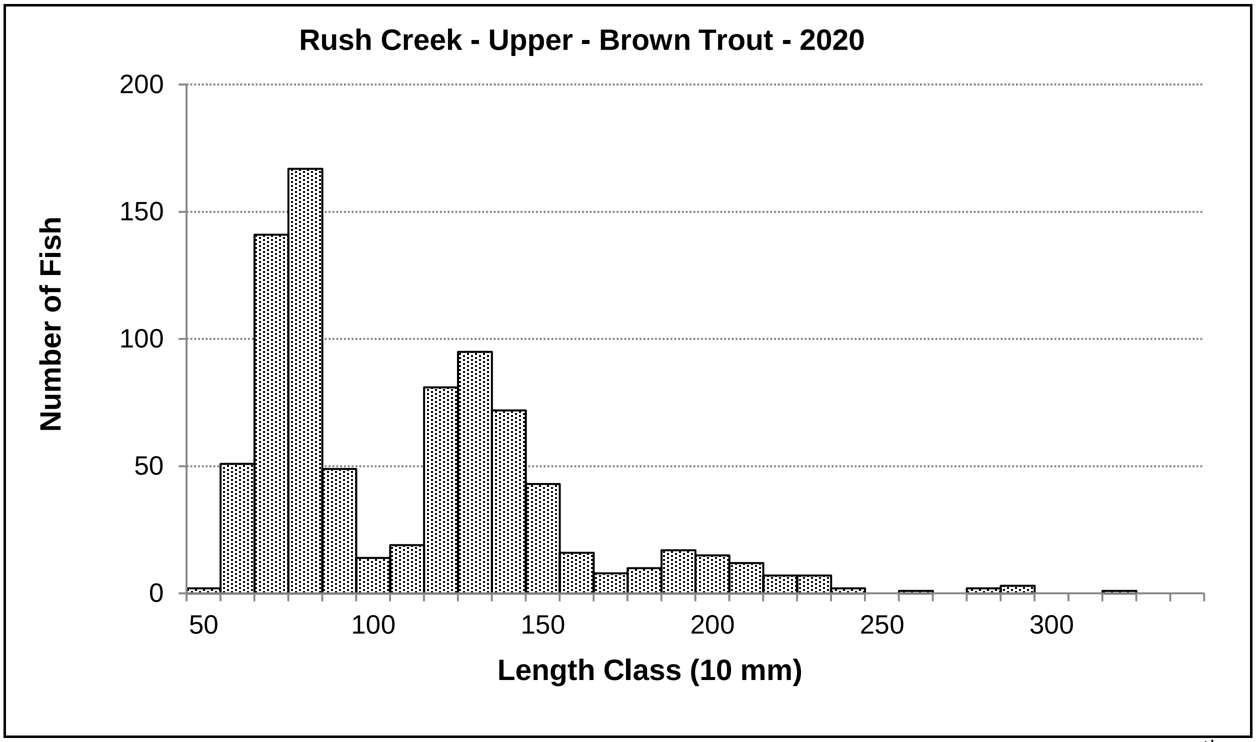


Figure 5. Length-frequency histogram of Brown Trout captured in Upper Rush, September 9th, 2020.

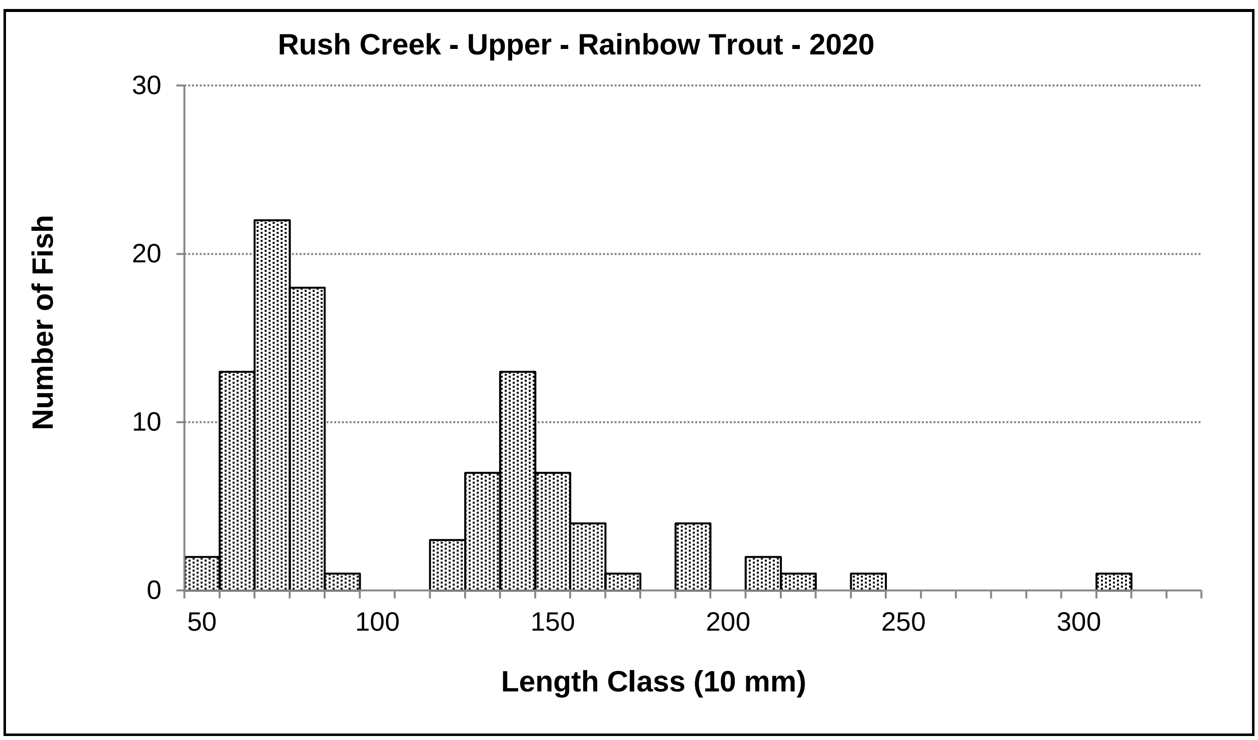


Figure 6. Length-frequency histogram of Rainbow Trout captured in Upper Rush, September 9th, 2020.

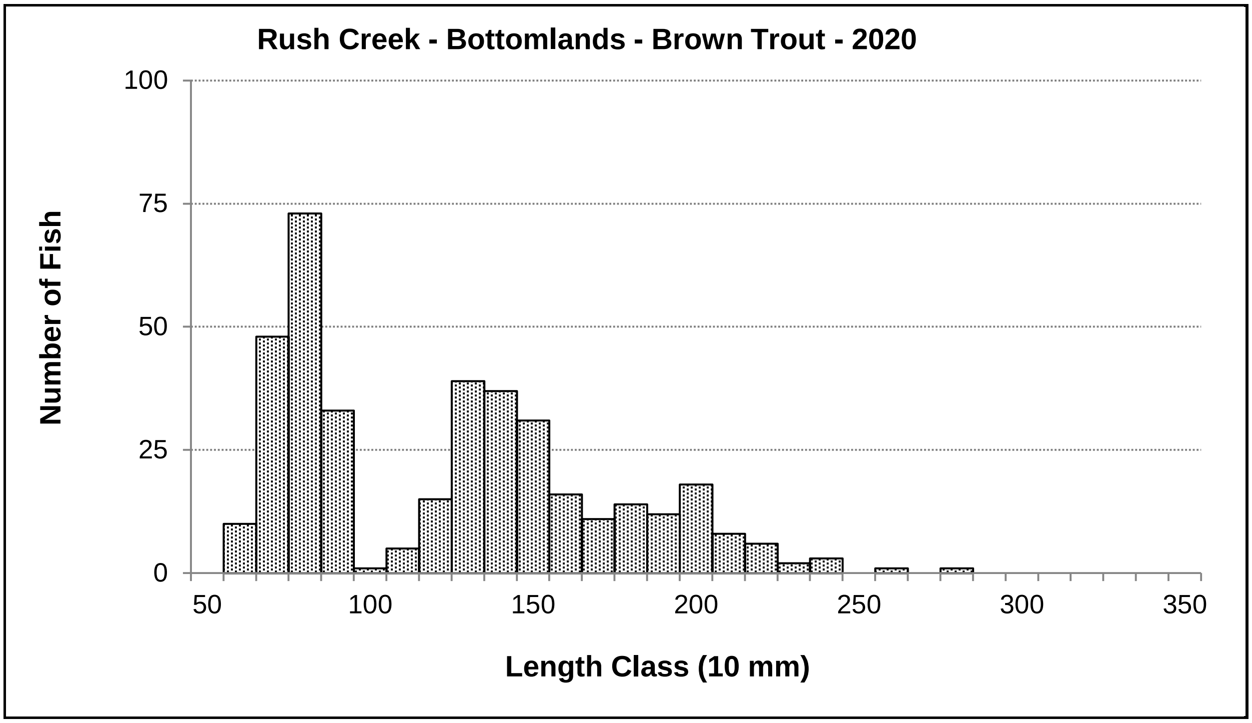


Figure 7. Length-frequency histogram of Brown Trout captured in the Bottomlands section of Rush Creek, September 11, 2020.

In 2020, 26 Rainbow Trout were captured in the MGORD section (Figure 9). In the previous seven years, the Rainbow Trout catch in the MGORD has ranged from zero to 40 fish. Most of the Rainbow Trout captured in 2020 appeared to be of natural origin, with several larger fish exhibiting signs of hatchery origin. Ten of the 40 Rainbow Trout were <125 mm, suggesting that successful reproduction of Rainbow Trout is occurring within the MGORD section of Rush Creek.

For the past 15 sampling years, electrofishing passes through the MGORD have produced the following total catch values (all size classes of Brown and Rainbow Trout):

- <u>2020</u> – Single pass = 457 trout.
- <u>2019</u> – Single pass = 361 trout.
- <u>2018</u> – Mark run = 233 trout. Recapture run = 188 trout. Two-pass average = 210.5 fish.
- <u>2017</u> – Single pass = 203 trout.
- <u>2016</u> – Mark run = 121 trout. Recapture run = 110 trout. Two-pass average = 115.5 fish.
- <u>2015</u> – Single pass = 176 trout.
- <u>2014</u> – Mark run = 206 trout. Recapture run = 268 trout. Two-pass average = 237 fish.
- <u>2013</u> – Single pass = 451 trout.
- <u>2012</u> – Mark run = 606 trout. Recapture run = 543 trout. Two-pass average = 574.5 fish.
- <u>2011</u> – Single pass = 244 trout.
- <u>2010</u> – Mark run = 458 trout. Recapture run = 440 trout. Two-pass average = 449 fish.

- 2009 – Single pass = 649 trout.
- 2008 – Mark run = 450 trout. Recapture run = 419 trout. Two-pass average = 434.5 fish.
- 2007 – Single pass = 685 trout.
- 2006 – Mark Run = 283 trout. Recapture run = 375 trout. Two-pass average = 329 fish.

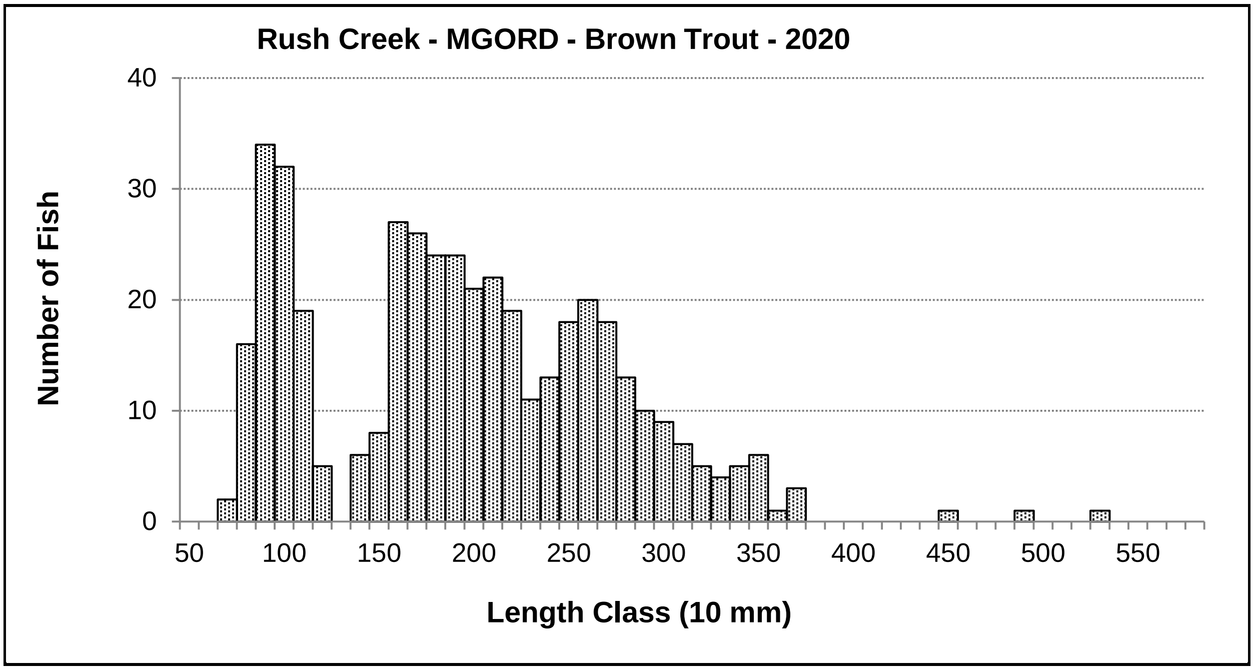


Figure 8. Length-frequency histogram of Brown Trout captured in the MGORD section of Rush Creek, September 10th, 2020.

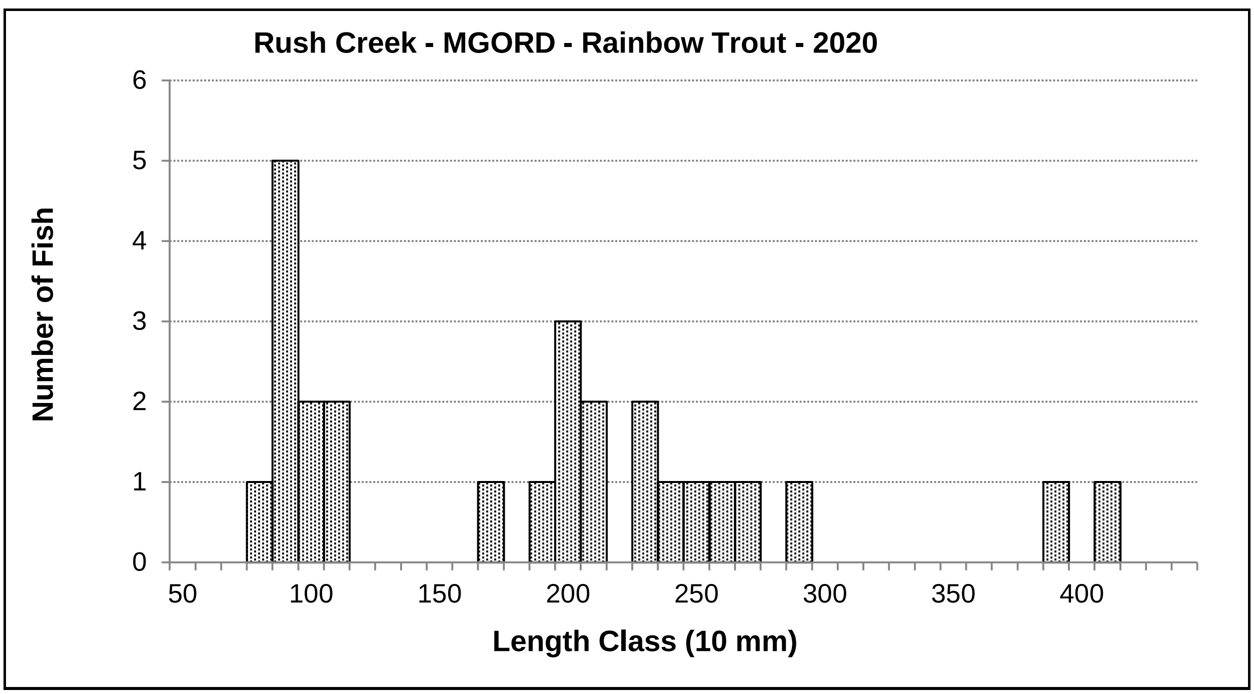


Figure 9. Length-frequency histogram of Rainbow Trout captured in the MGORD section of Rush Creek, September 10th, 2020.

Lee Vining Creek

In 2020, a total of 263 trout were captured on the one electrofishing pass made in the Lee Vining Creek main channel section versus 225 trout in 2019 on the mark-run (Table 7). Most (261 fish) of the trout captured in 2020 were Brown Trout and the two Rainbow Trout were both age-1 fish (149 and 173 mm in length). In 2020, Brown Trout ranged in size from 66 mm to 270 mm in length (Figure 10). Age-0 fish comprised 60% of the total Brown Trout catch in 2020, compared to 63% in 2019 and 62% in 2018. In 2020, the Lee Vining Creek's main channel section supported an estimated 449 Brown Trout in the <125 mm size class, compared to an estimated 414 Brown Trout in 2019, an 8% increase (Table 7).

In 2020, Brown Trout 125-199 mm in length comprised 33% of the total Brown Trout catch in Lee Vining Creek's main channel section (versus 27% in 2019). This section supported an estimated 171 Brown Trout 125-199 mm in length in 2020 (Table 7) compared to 118 fish in 2019 (a 45% increase).

In 2020, the population estimate of Brown Trout ≥200 mm in Lee Vining Creek's main channel was 24 fish (versus 48 fish in 2019 and 14 fish in 2018) (Table 7). No Brown Trout captured in 2020 were >300 mm in length (Figure 10).

No population estimate was generated for Rainbow Trout due to insufficient numbers of fish, with only two captured during the single electrofishing pass made in 2020.

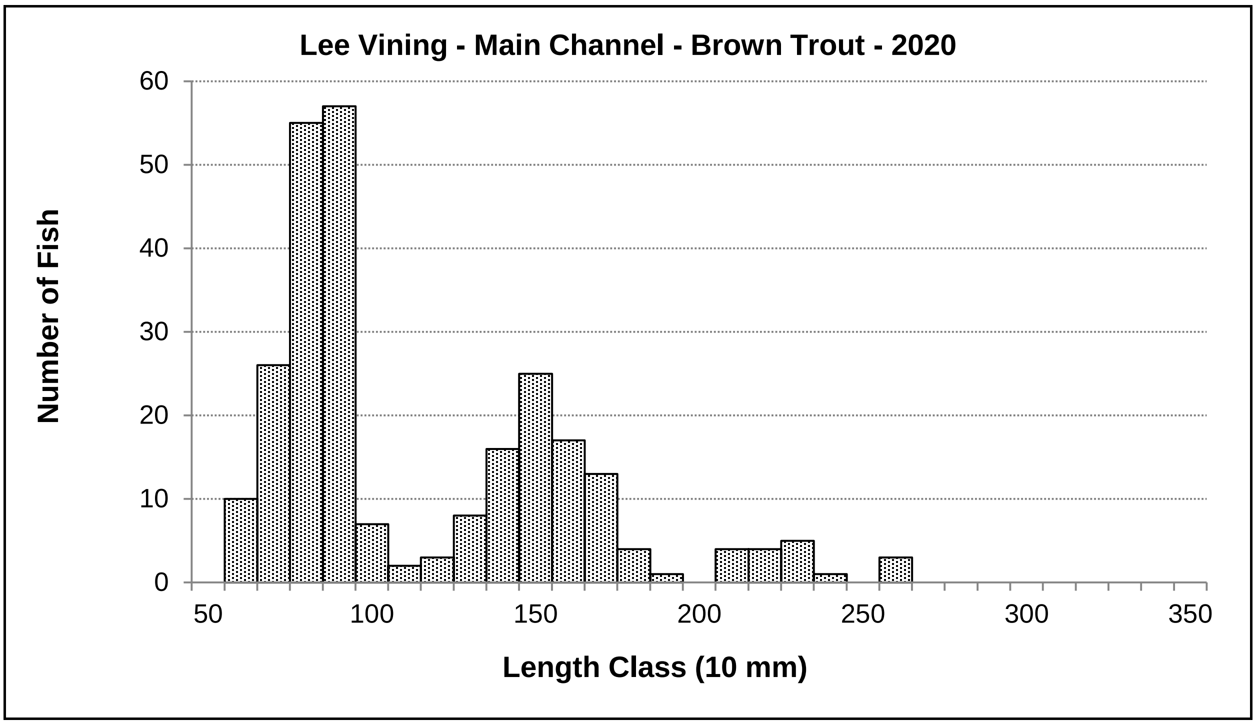


Figure 10. Length-frequency histogram of Brown Trout captured in the main channel section of Lee Vining Creek, September 11th, 2020.

In the Lee Vining Creek side channel, 16 Brown Trout were captured in three electrofishing passes made during the 2020 sampling (Table 8). Eleven age-0 fish were captured (<125 mm) in

2020 (Figure 11). The estimates for the three size classes equaled the catch numbers because no fish were captured on the third electrofishing pass (Table 8). No Rainbow Trout were captured in the side channel in 2020. This was the 12th consecutive year that no age-0 Rainbow Trout were captured in the Lee Vining Creek side channel and the 10th consecutive year that no age-1 and older Rainbow Trout were captured in the side channel.

Walker Creek

In 2020, 362 Brown Trout were captured in two electrofishing passes in the Walker Creek section (278 caught in 2019 and 175 caught in 2018) (Table 8). One hundred seventy-eight of these captured fish, or 49%, were age-0 fish ranging in size from 63 mm to 121 mm in length (Figure 12). The 2020 estimated population of age-0 Brown Trout for the Walker Creek section was 180 fish, one more fish than the 2019 estimate of 179 fish. For trout <125 mm in length, the estimated probability of capture during 2020 was 89% (Table 8).

Brown Trout in the 125-199 mm size class (139 fish) accounted for 38% of the total catch in 2020. The 2020 population estimate for Brown Trout in the 125-199 mm size class was 139 trout (a 96% increase from the 2019 estimate of 70) with an estimated probability of capture of 98% (Table 8).

Brown Trout ≥200 mm in length (45 fish caught) accounted for 12% of the total catch in 2020 (was also 12% in 2019). The 2020 population estimate for this size class was 45 Brown Trout with a probability of capture of 98% (Table 8). The largest Brown Trout captured in Walker Creek in 2020 was 266 mm in length (Figure 12).

In 2020, one Rainbow Trout was captured in Walker Creek; this fish was 196 mm in length.

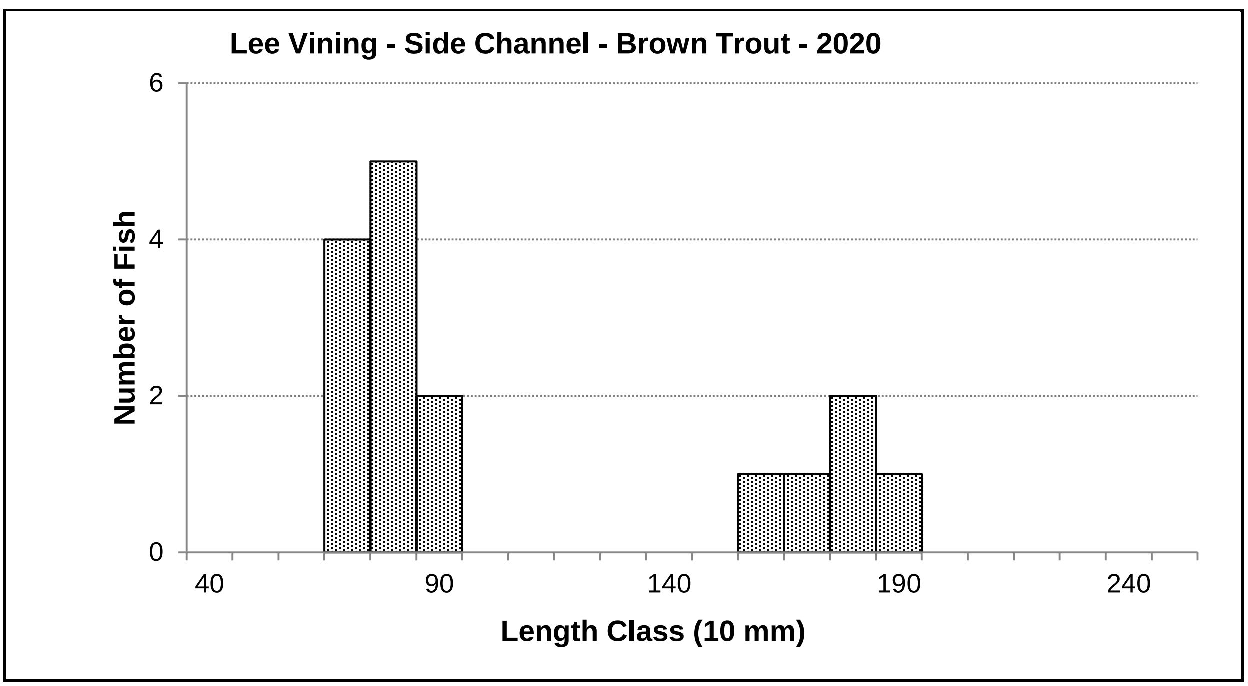


Figure 11. Length-frequency histogram of Brown Trout captured in the side channel section of Lee Vining Creek, September 12th, 2020.

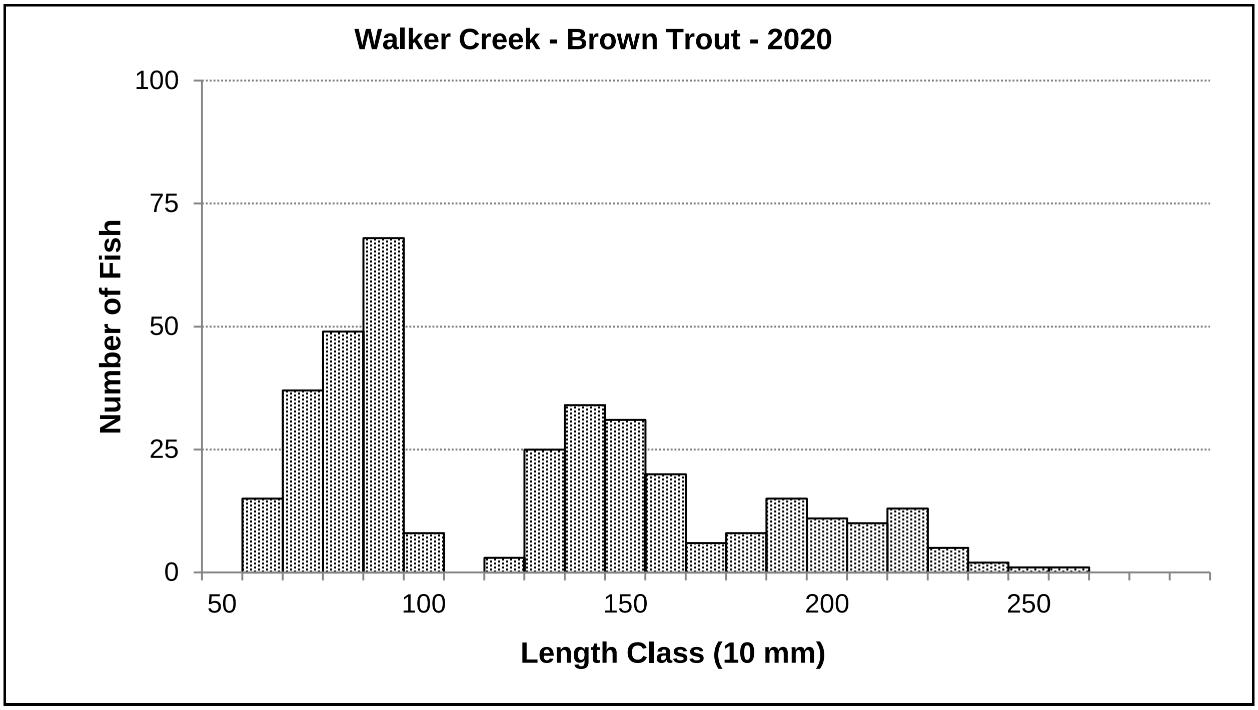


Figure 12. Length-frequency histogram of Brown Trout captured in Walker Creek, September 12th, 2020.

Table 8. Depletion estimates made in the side channel section of Lee Vining Creek and Walker Creek during September 2020 showing number of trout captured in each pass, estimated number, probability of capture (P.C.) by species and size class.

Stream - Section Date / **Species**	Size Class (mm)	Removals	Removal Pattern	**Estimate**	P.C.
Lee Vining Creek- Side Channel - 9/12/2020					
Brown Trout					
	0 - 124 mm	3	9 2 0	**11**	0.85
	125 - 199 mm	3	3 2 0	**5**	0.71
	200 + mm	3	0 0 0	**0**	N/A
Walker Creek - above old Hwy 395 - 9/12/2020					
Brown Trout					
	0 - 124 mm	2	160 18	**180**	0.89
	125 - 199 mm	2	136 3	**139**	0.98
	200 + mm	2	44 1	**45**	0.98

Catch of Rainbow Trout in Rush and Lee Vining Creeks

Beginning with the 2008 annual report through the 2016 annual report, we only reported catch summaries for Rainbow Trout in Rush Creek and did not attempt to estimate their populations. This decision was made because Rainbow Trout usually accounted for less than 5% of Rush Creek's total catch. However, since the 2017 sampling season, Rainbow Trout have comprised 10% to 18% of the total catch in Rush Creek, with sufficient numbers recaptured to generate population estimates for most of the size classes in most of the past four sampling seasons.

For the 2018 sampling, Rainbow Trout comprised 17.8% of the total catch in the Upper Rush section (168 Rainbow Trout/944 total trout). Nearly 85% of these Rainbow Trout were age-0 fish and most of the larger fish appeared to be naturally-produced, thus for 2018, Rainbow Trout were included in generating biomass estimates for the Upper Rush section. This substantial increase in age-0 Rainbow Trout may have occurred due to the recent, record low numbers of Brown Trout. In 2019, numerous Rainbow Trout were captured in the Upper Rush section and comprised 15% of the total catch (255 Rainbow Trout/1,703 total trout). Age-0 fish comprised 66% of the Rainbow Trout caught and age-1 fish comprised another 30% of the Rainbow Trout caught in 2019 and sufficient numbers were caught on both the mark and recapture runs to generate unbiased population estimates. In 2020, Rainbow Trout comprised 10.7% of the total catch in the Upper Rush section (100 Rainbow Trout/935 total trout) and catch efficiencies from the previous two years were used to generate 2020 population estimates (Table 7).

Between 1999 and 2012 Rainbow Trout numbers in Lee Vining Creek were variable, generally increasing during drier RY types and decreasing during wetter years. However, since 2012 the annual catch of Rainbow Trout in Lee Vining Creek has dropped steadily and dramatically. In 2012, a total of 235 Rainbow Trout were captured, including 226 age-0 fish. In 2013, 127 Rainbow Trout were captured (26 were age-0 fish), followed by 57 rainbows in 2014 (six were age-0 fish), 20 rainbows in 2015 (no age-0 fish), seven rainbows in 2016 (no age-0 fish), no rainbows in 2017, nine rainbows in 2018, four rainbows in 2019 and two rainbows in 2020. This large drop in Rainbow Trout numbers has occurred during the time period when CDFW shifted to stocking sterile catchable Rainbow Trout. We suggested that in years prior to 2012, supplementation of the Rainbow Trout population with reproductively viable hatchery Rainbow Trout originating from CDFW stocking (upstream of LADWP's point of diversion), and their successful spawning, probably, to a large degree, supported the Lee Vining Creek Rainbow Trout population (Taylor 2019).

Due to Rainbow Trout historically encompassing a large portion (10-40%) of the Lee Vining Creek trout population, an effort has been made to generate density and biomass values using the available data. In years when adequate numbers of Rainbow Trout have been captured, statistically valid density and biomass estimates have been generated. In years when less than adequate numbers of Rainbow Trout have been captured, catch numbers have been used to generate density and biomass estimates. Previous fisheries reports have discussed that while catch numbers were not statistically valid they were consistently lower than statistically valid estimates and allowed for comparison between all sampling years (Taylor 2019). An unbiased estimate of age-0 Rainbow Trout in Lee Vining Creek was last made in 2013 and 2015 was the last year that sufficient numbers of age-1+ Rainbow Trout were caught to generate an unbiased estimate of fish in the 125-199 mm size class.

Relative Condition of Brown Trout

Linear regressions of log-length to log-weight for captured Brown Trout ≥ 100 mm indicated strong correlations between length and weight (r^2 values 0.98 and greater; Table 9). Slopes of these relationships were near 3.0 indicating isometric growth, which was assumed to compute fish condition factors, was reasonable.

Table 9. Regression statistics for $\log_{10}$ transformed length (L) to weight (WT) for Brown Trout 100 mm and longer captured in Rush Creek by sample section and year. The 2020 regression equations are in ***bold*** type.

Section	Year	N	Equation	r^2	P
Bottomlands	***2020***	***223***	***$Log_{10}(WT) = 2.9792*Log_{10}(L) – 4.9754$***	***0.98***	***<0.01***
	2019	310	$Log_{10}(WT) = 2.9631*Log_{10}(L) – 4.9409$	0.99	<0.01
	2018	226	$Log_{10}(WT) = 2.9019*Log_{10}(L) – 4.8059$	0.99	<0.01
	2017	160	$Log_{10}(WT) = 3.0398*Log_{10}(L) – 5.0998$	0.99	<0.01
	2016	132	$Log_{10}(WT) = 3.0831*Log_{10}(L) – 5.2137$	0.99	<0.01
	2015	301	$Log_{10}(WT) = 3.0748*Log_{10}(L) – 5.1916$	0.99	<0.01
	2014	238	$Log_{10}(WT) = 3.0072*Log_{10}(L) – 5.0334$	0.98	<0.01
	2013	247	$Log_{10}(WT) = 2.7997*Log_{10}(L) – 4.591$	0.98	<0.01
	2012	495	$Log_{10}(WT) = 2.8149*Log_{10}(L) – 4.6206$	0.98	<0.01
	2011	361	$Log_{10}(WT) = 2.926*Log_{10}(L) – 4.858$	0.99	<0.01
	2010	425	$Log_{10}(WT) = 2.999*Log_{10}(L) – 5.005$	0.99	<0.01
	2009	511	$Log_{10}(WT) = 2.920*Log_{10}(L) – 4.821$	0.99	<0.01
	2008	611	$Log_{10}(WT) = 2.773*Log_{10}(L) – 4.524$	0.99	<0.01
Upper Rush	***2020***	***426***	***$Log_{10}(WT) = 2.9187*Log_{10}(L) – 4.8382$***	***0.99***	***<0.01***
	2019	686	$Log_{10}(WT) = 2.9667*Log_{10}(L) – 4.9298$	0.99	<0.01
	2018	391	$Log_{10}(WT) = 2.9173*Log_{10}(L) – 4.8237$	0.99	<0.01
	2017	309	$Log_{10}(WT) = 3.0592*Log_{10}(L) – 5.1198$	0.99	<0.01
	2016	176	$Log_{10}(WT) = 3.0702*Log_{10}(L) – 5.1608$	0.99	<0.01
	2015	643	$Log_{10}(WT) = 2.9444*Log_{10}(L) – 4.8844$	0.99	<0.01
	2014	613	$Log_{10}(WT) = 2.9399*Log_{10}(L) – 4.8705$	0.99	<0.01
	2013	522	$Log_{10}(WT) = 2.9114*Log_{10}(L) – 4.816$	0.99	<0.01
	2012	554	$Log_{10}(WT) = 2.8693*Log_{10}(L) – 4.721$	0.99	<0.01

Table 9 (continued).

Section	Year	N	Equation	r^2	P
Upper Rush	2011	547	$Log_{10}(WT) = 3.006*Log_{10}(L) – 5.014$	0.99	<0.01
	2010	420	$Log_{10}(WT) = 2.995*Log_{10}(L) – 4.994$	0.99	<0.01
	2009	612	$Log_{10}(WT) = 2.941*Log_{10}(L) – 4.855$	0.99	<0.01
	2008	594	$Log_{10}(WT) = 2.967*Log_{10}(L) – 4.937$	0.99	<0.01
	2007	436	$Log_{10}(WT) = 2.867*Log_{10}(L) – 4.715$	0.99	<0.01
	2006	485	$Log_{10}(WT) = 2.99*Log_{10}(L) – 4.98$	0.99	<0.01
	2005	261	$Log_{10}(WT) = 3.02*Log_{10}(L) – 5.02$	0.99	<0.01
	2004	400	$Log_{10}(WT) = 2.97*Log_{10}(L) – 4.94$	0.99	<0.01
	2003	569	$Log_{10}(WT) = 2.96*Log_{10}(L) – 4.89$	0.99	<0.01
	2002	373	$Log_{10}(WT) = 2.94*Log_{10}(L) – 4.86$	0.99	< 0.01
	2001	335	$Log_{10}(WT) = 2.99*Log_{10}(L) – 4.96$	0.99	< 0.01
	2000	309	$Log_{10}(WT) = 3.00*Log_{10}(L) – 4.96$	0.98	< 0.01
	1999	317	$Log_{10}(WT) = 2.93*Log_{10}(L) – 4.84$	0.98	< 0.01
MGORD	***2020***	***383***	***$Log_{10}(WT) = 3.0144*Log_{10}(L) – 5.0575$***	***0.98***	***<0.01***
	2019	314	$Log_{10}(WT) = 2.9774*Log_{10}(L) – 4.9282$	0.98	<0.01
	2018	350	$Log_{10}(WT) = 3.0023*Log_{10}(L) – 5.0046$	0.98	<0.01
	2017	159	$Log_{10}(WT) = 3.0052*Log_{10}(L) – 5.0205$	0.99	<0.01
	2016	183	$Log_{10}(WT) = 3.0031*Log_{10}(L) – 5.3093$	0.99	<0.01
	2015	172	$Log_{10}(WT) = 3.131*Log_{10}(L) – 5.0115$	0.99	<0.01
	2014	399	$Log_{10}(WT) = 2.9805*Log_{10}(L) – 4.9827$	0.98	<0.01
	2013	431	$Log_{10}(WT) = 2.8567*Log_{10}(L) – 4.692$	0.98	<0.01
	2012	795	$Log_{10}(WT) = 2.9048*Log_{10}(L) – 4.808$	0.99	<0.01
	2011	218	$Log_{10}(WT) = 2.917*Log_{10}(L) – 4.823$	0.98	<0.01
	2010	694	$Log_{10}(WT) = 2.892*Log_{10}(L) – 4.756$	0.98	<0.01
	2009	689	$Log_{10}(WT) = 2.974*Log_{10}(L) – 4.933$	0.99	<0.01
	2008	862	$Log_{10}(WT) = 2.827*Log_{10}(L) – 4.602$	0.98	<0.01
	2007	643	$Log_{10}(WT) = 2.914*Log_{10}(L) – 4.825$	0.98	<0.01
	2006	593	$Log_{10}(WT) = 2.956*Log_{10}(L) – 4.872$	0.98	<0.01
	2004	449	$Log_{10}(WT) = 2.984*Log_{10}(L) – 4.973$	0.99	<0.01
	2001	769	$Log_{10}(WT) = 2.873*Log_{10}(L) – 4.719$	0.99	<0.01
	2000	82	$Log_{10}(WT) = 2.909*Log_{10}(L) – 4.733$	0.98	<0.01

Condition factors of Brown Trout 150 to 250 mm in length in 2020 decreased from 2019 values in five sections and remained the same in one section (Figures 13 and 14). In 2020, no sections had Brown Trout condition factors ≥1.00, thus all condition factors were less than average (Figures 13 and 14).

Brown Trout in the Upper Rush section had a condition factor of 0.95 in 2020 a decrease from 0.99 in 2019 (Figure 13). The Upper Rush section has had Brown Trout condition factors ≥1.00 in 10 of 21 sampling seasons (Figure 13).

Brown Trout in the Bottomlands section of Rush Creek had a condition factor of 0.95 in 2020, same as the value in 2019 (Figure 13). In 13 years of sampling, the Bottomlands section has failed to generate a Brown Trout condition factor ≥1.00 (Figure 13).

The MGORD's 2020 Brown Trout condition factor was 0.98, a drop from the value of 1.01 in 2018 and 2019 (Figure 13). In 2020, condition factors for larger Brown Trout in the MGORD were also computed: fish ≥300 mm had a condition factor of 0.93 (0.98 in 2019) and fish ≥375 mm had a condition factor of 1.04 (also 1.04 in 2019).

In 2020, the condition factor for Brown Trout in Lee Vining Creek's main channel was 0.93 and in the side channel the condition factor was 0.95 (Figure 14). The 2020 values were the third straight year of decreases since 2017 values (Figure 14). For the tenth year in a row, no age-1+ Rainbow Trout were captured in the Lee Vining Creek side channel. In 2020, Rainbow Trout in Lee Vining Creek's main channel had a condition factor of 0.94, a decrease from 1.08 in 2019 (Figure 14).

In Walker Creek, Brown Trout had a condition factor of 0.96 in 2020, a decrease from 0.98 in 2019 and 1.02 in 2018 (Figure 13). Brown Trout condition factors in Walker Creek have been ≥1.00 in 12 of the 21 sampling years (Figure 13).

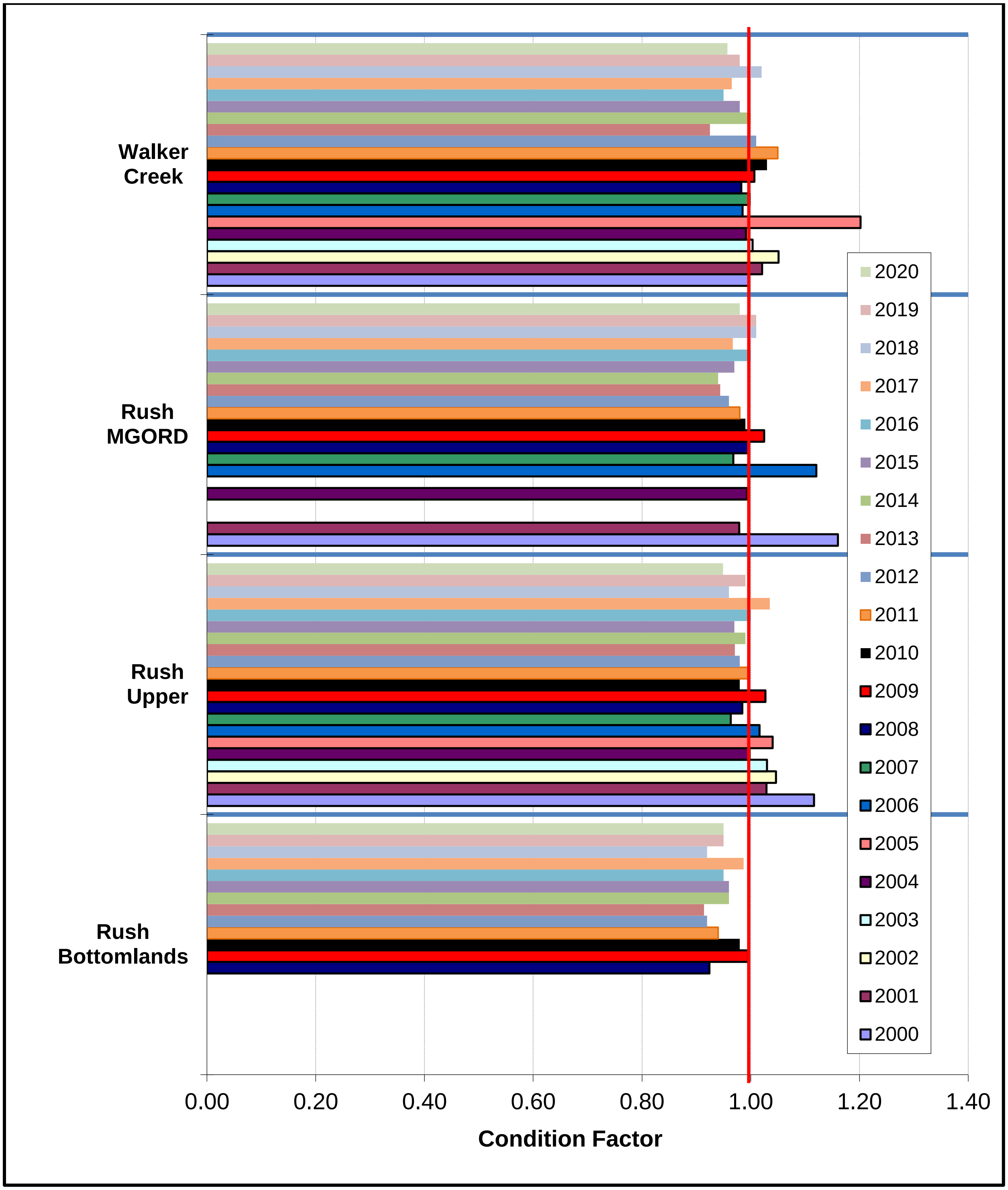


Figure 13. Condition factors for Brown Trout 150 mm to 250 mm in length from sample sections of Rush Creek and Walker Creeks from 2000 to 2020.

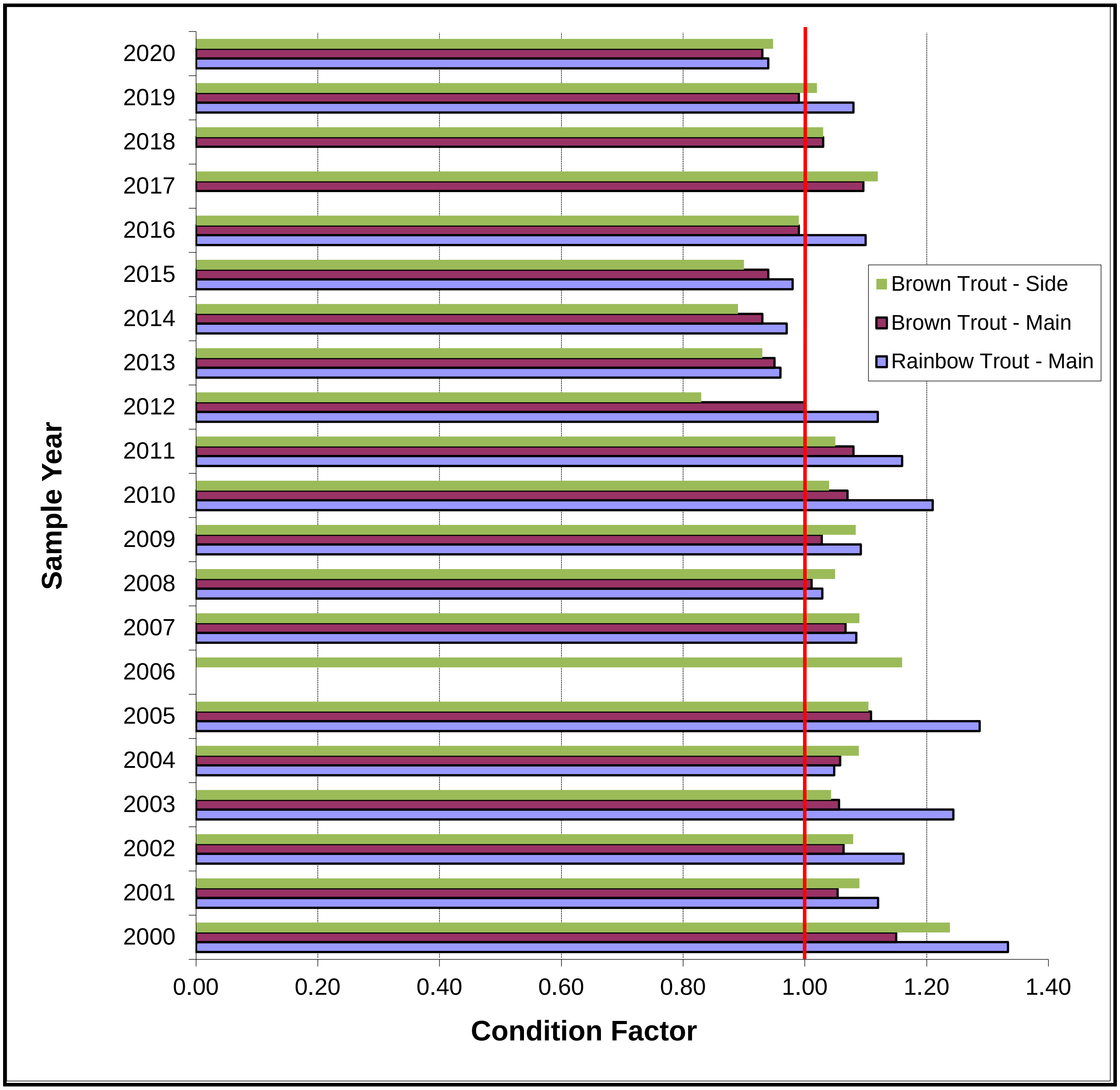


Figure 14. Comparison of condition factors for Rainbow Trout and Brown Trout 150 to 250 mm in length from the main channel and side channel sections of Lee Vining Creek from 2000 to 2020. Main channel was not sampled in 2006 due to high flows. No Rainbow Trout 150 to 250 mm in length were captured in the main channel in 2017 and 2018.

Estimated Trout Densities Expressed in Numbers per Hectare

Age-0 Brown Trout

The Upper Rush section had an estimated density of 6,285 age-0 Brown Trout/ha in 2020, a decrease of 29% from 2019's estimate of 8,794 age-0 Brown Trout/ha (Figure 15). The 2020 density estimate in the Upper Rush section was 29% lower than the 21-year average of 5,837 age-0 Brown Trout/ha.

The Bottomlands section of Rush Creek had a density estimate of 2,295 age-0 Brown Trout/ha in 2020, a 15% increase from 2019's estimate of 2,000 age-0 trout/ha (Figure 15). When compared to the 13-year average of 2,102 age-0 Brown Trout/ha, the 2020 estimate was 9% higher.

In Walker Creek, the 2020 density estimate of 3,846 age-0 Brown Trout/ha was a 0.5% increase from the 2019 estimate of 3,825 age-0 trout/ha (Figure 15). The 2020 density estimate was 10% higher than the 22-year average of 3,503 age-0 trout/ha (Figure 15).

In 2020, the estimated density of age-0 Brown Trout in the main channel section of Lee Vining Creek was 3,451 age-0 trout/ha, which was a 6% increase from the 2019 density estimate of 3,247 age-0 trout/ha (Figure 16). After a 96% decrease during the five consecutive dry/below average RYs, the age-0 Brown Trout density estimates increased 13-fold. The 21-year average density estimate for the main channel section of Lee Vining Creeks equaled 1,778 age-0 Brown Trout/ha (Figure 16).

In 2020, the estimated density of age-0 Brown Trout in the side channel section of Lee Vining Creek equaled 299 age-0 fish/ha (Figure 16). Since 2014, no age-0 Brown Trout were caught in the side channel section in four out of seven sampling years (Figure 16). The 22-year average density estimate for the side channel section of Lee Vining Creeks equaled 319 age-0 Brown Trout/ha (Figure 16).

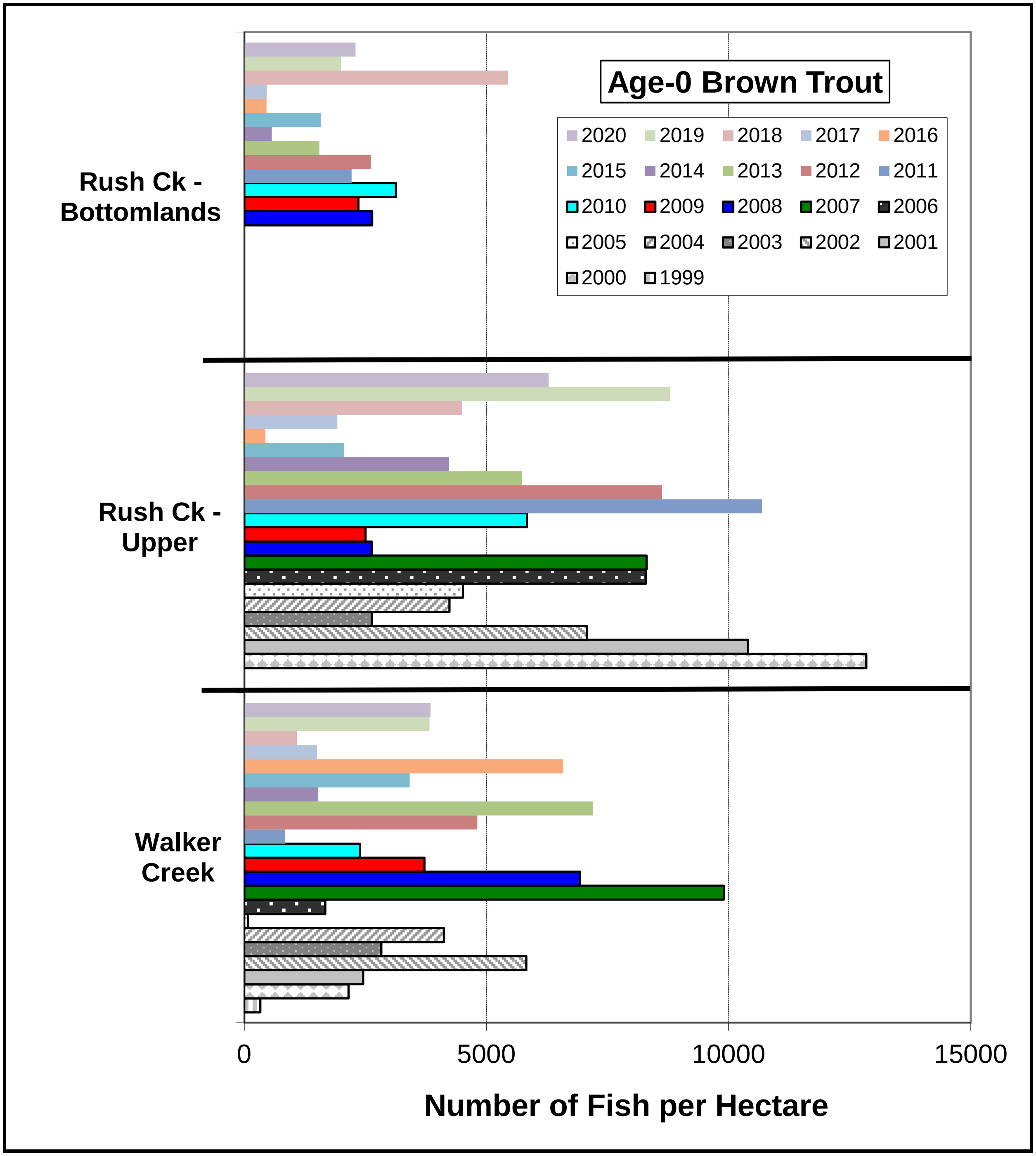


Figure 15. Estimated number of age-0 Brown Trout per hectare in Rush Creek and Walker Creek from 1999 to 2020.

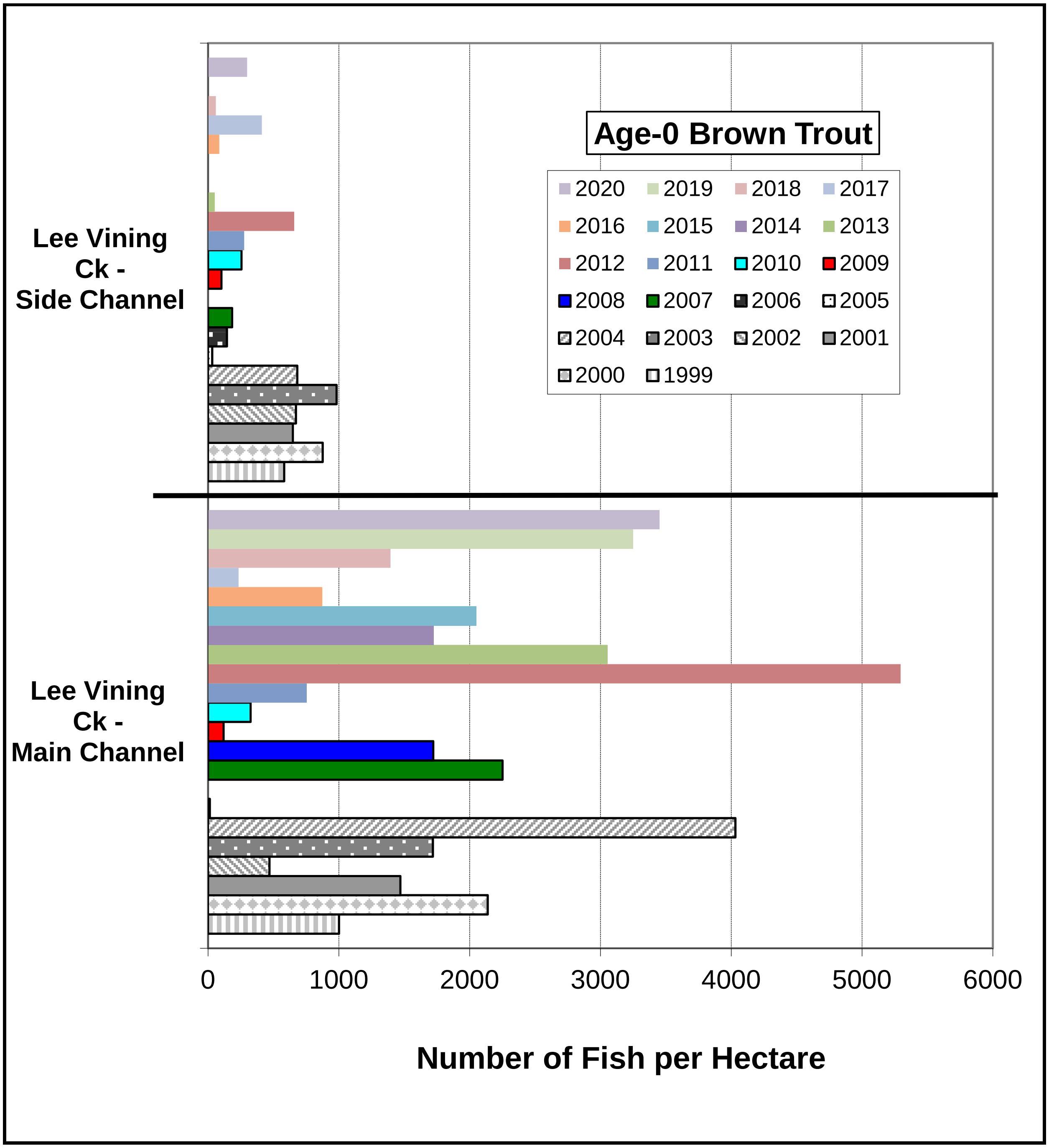


Figure 16. Estimated number of age-0 Brown Trout per hectare in Lee Vining Creek from 1999 to 2020.

Age-1 and older (aka Age-1+) Brown Trout

The Upper Rush section had an estimated density of 3,203 age-1+ Brown Trout/ha in 2020, an increase of 18% from the 2019 estimate of 2,721 trout/ha (Figure 17). After a 75% decrease during the five consecutive dry/below average RYs, the age-1+ Brown Trout density estimates have increased by 546% between the 2016 and 2020 sampling seasons. The 2020 estimate was more than twice as large as the 22-year average of 1,501 age-1+ Brown Trout/ha.

The estimated density of age-1+ Brown Trout in the Bottomlands section of Rush Creek in 2020 was 1,495 fish/ha, a 4% decrease from the 2019 estimate of 1,558 age-1+trout/ha (Figure 17). After an 86% decrease during the five consecutive dry/below average RYs, the age-1+ Brown Trout density estimates have increased by 510% between the 2016 and 2020 sampling seasons. The 2020 density estimate of age-1+ Brown Trout/ha was 35% higher than the 13-year average of 1,110 age-1+ Brown Trout/ha.

The estimated density of age-1+ Brown Trout in the MGORD section of Rush Creek in 2020 was 584 fish/ha, a 36% increase from the 2018 estimate of 430 age-1+trout/ha (Figure 17). Since 2011, for the 10 seasons where density estimates were generated for the MGORD, the long-term density estimate of age-1+ Brown Trout/ha equaled 462 age-1+ Brown Trout/ha.

The 2020 density estimate for age-1+ Brown Trout for the Walker Creek section was 3,932 age-1+trout/ha which was a 77% increase from the 2019 estimate of 2,222 age-1+ trout/ha (Figure 17). The 2020 density estimate of age-1+ Brown Trout was 103% higher than the 22-year average of 1,936 age-1+ Brown Trout/ha.

The 2020 density estimate for age-1+ Brown Trout in the Lee Vining main channel section was 1,499 trout/ha, a 15% increase from the 2019 estimate of 1,302 age-1+ trout/ha(Figure 18). Since 2017, the density estimate of age-1+ Brown Trout has increased nearly eight-fold in the Lee Vining Creek main channel section (Figure 18).

In 2020, the side channel of Lee Vining Creek supported an estimated density of 136 age-1+ Brown Trout/ha, a decrease of 71% from the 2019 estimate of 468 age-1+ Brown Trout/ha (Figure 18). As discussed in previous annual reports, this side channel has experienced variations in the amount of flow that enters the channel due to changes in the geomorphology of the channel’s inlet over time. These variable flows have resulted in highly variable annual wetted areas, which has been a major factor driving density and standing crop estimates for this section. Consequently, the lowest catch of fish (seven in 2015) resulted in the largest density estimate because so little water flowed down the side channel this particular year (Table 10). In September of 2018, more flow continued to enter the top of the side channel, which increased the wetted area within the sampling section to the highest amount since the 2010 and 2011 sampling seasons (Table 10). Since 2018, the side-channel wetted area has decreased; by 12% between 2018 and 2019, and in September of 2020 the wetted area decreased by 18% compared to 2019 (Table 10).

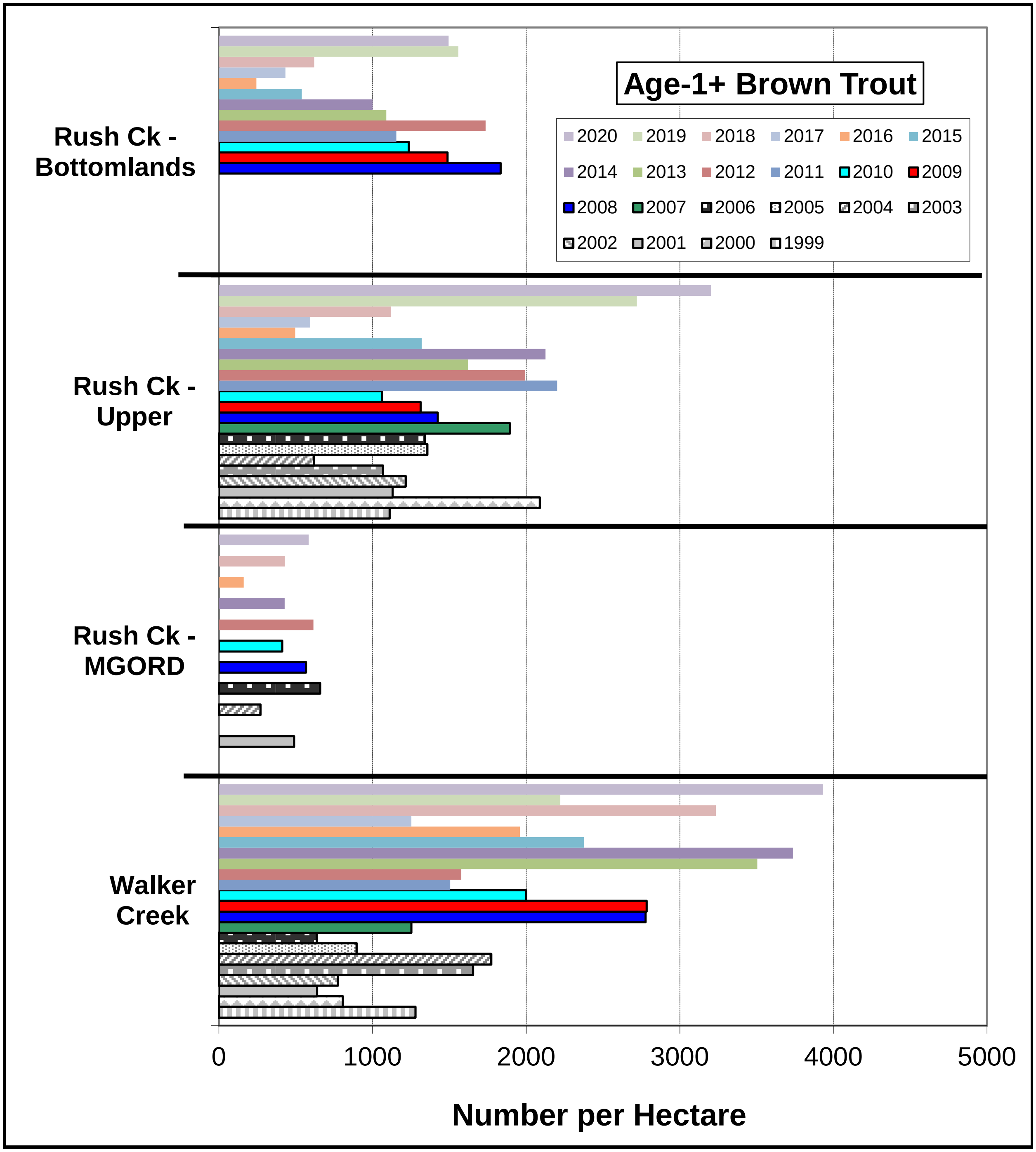


Figure 17. Estimated number of age-1 and older Brown Trout per hectare in sections of Rush and Walker Creeks from 1999 to 2020.

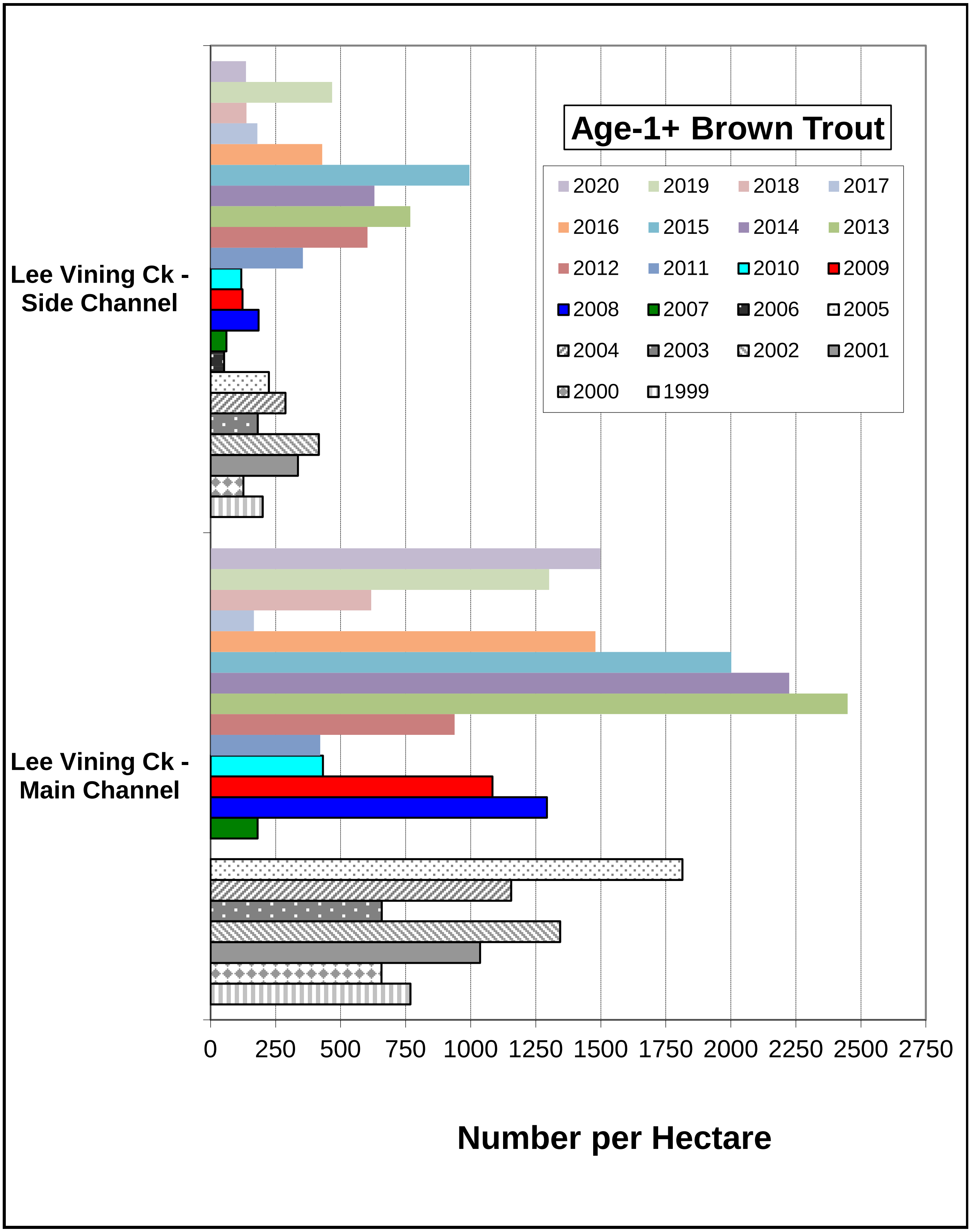


Figure 18. Estimated number of age-1 and older Brown Trout per hectare in sections of Lee Vining Creek from 1999 to 2020.

Table 10. Wetted surface area and total numbers of trout captured in the Lee Vining Creek side channel, from 2007 to 2020.

Sample Year	Wetted Channel Area (m^2)	Total Number of Trout Captured
2007	487.5	22
2008	487.5	20
2009	487.5	26
2010	507.0	20
2011	507.0	30
2012	365.0	45
2013	328.0	16
2014	190.5	12
2015	70.3	7
2016	232.9	12
2017	389.4	23
2018	507.0	10
2019	448.5	21
2020	**367.5**	**16**

Age-0 Rainbow Trout

In 2020, for the 12th consecutive year no age-0 Rainbow Trout were captured in the Lee Vining Creek side channel. In the Lee Vining Creek main channel, no age-0 Rainbow Trout were captured during the 2020 sampling.

The Upper Rush section supported an estimated density of 851 age-0 Rainbow Trout/ha in 2020, a decrease of 39% from the 2019 estimate of 1,389 age-0 Rainbow Trout/ha.

Age-1 and older (aka Age-1+) Rainbow Trout

No age-1 and older Rainbow Trout were captured in the Lee Vining Creek side channel during 2020, making it the 10th consecutive year when none were captured. In 2020, a total of two age-1 and older Rainbow Trout were captured in the Lee Vining Creek main channel.

The Upper Rush section supported an estimated density of 431 age-1+ Rainbow Trout/ha in 2020, a decrease of 18% from the 2019 estimate of 525 age-1+ Rainbow Trout/ha.

Estimated Numbers of Trout per Kilometer

The Upper Rush section contained an estimated 7,402 Brown Trout/km (all size classes combined) in 2020, which was a 20% decrease from the 2019 estimate of 8,910 Brown Trout/km (Table 11). The estimated density of age-1+ Brown Trout in 2020 was 2,499 fish/km; a 19% increase from the 2019 estimate of 2,105 age-1+ fish/km (Table 11).

The Upper Rush section also contained an estimated 1,095 Rainbow Trout/km (all size classes combined) in 2020, a 26% decrease from 2019's estimate of 1,481 Rainbow Trout/km (Table 11). However, in 2020 the density estimate included 431 age-1+ Rainbow Trout versus 406 age-1+ Rainbow Trout in 2019.

The Bottomlands section contained an estimated 2,501 Brown Trout/km (all size classes combined) in 2020, which was a 19% increase from the 2019 estimate of 2,094 fish/km (Table 11). In 2020, the estimate of 986 age-1+ Brown Trout/km represented a 13% decrease from the 2019 estimate of 1,137 age-1+ Brown Trout/km (Table 11).

The Lee Vining Creek main channel contained an estimated 2,526 Brown Trout/km and eight Rainbow Trout/km (all size classes combined) in 2020, which was a 14% increase from the 2019 estimate of 2,299 fish/km (Table 12). In 2020, the estimate of 767 age-1+ Brown and Rainbow Trout/km represented a 14% increase from the 2019 estimate of 675 age-1+ trout/km (Table 12).

The Lee Vining side channel contained an estimated 92 Brown Trout/km (all size classes combined) in 2020, a 15% decrease from the 2019 estimate of 108 fish/km (Table 12). For age-1+ Brown Trout, the 2020 density estimate was 29 Brown Trout/km which was a 73% decrease from the 2019 density estimate 108 fish/km (Table 12).

Table 11. Estimated total numbers (number of age-1 and older in parentheses) of Brown Trout per kilometer of stream channel for Rush Creek sample sections from 2009 to 2020.

Collection Location	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Rush Creek, Upper Rush	3,444 (1,186)	5,726 (881)	10,821 (1,833)	8,288 (1,556)	6,105 (1,347)	4,574 (1,530)	2,468 (963)	766 (406)	1,863 (440)	4,835 (963)	8,910 (2,105)	**7,402 (2,499)**
Rush Creek, Bottom-lands	2,961 (1,146)	3,405 (963)	2,725 (929)	3,208 (1,279)	1,980 (817)	1,098 (700)	1,422 (362)	523 (179)	637 (308)	4,608 (471)	2,094 (1,137)	**2,501 (986)**

Table 12. Estimated total numbers of Brown and Rainbow Trout (number of age-1 and older in parentheses) per kilometer of stream channel for Lee Vining Creek sample sections from 2009 to 2020.

Collection Location	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Lee Vining, Main Channel	1,192 (1,023)	518 (326)	727 (258)	4,361 (506)	3,765 (1,867)	2,444 (1,471)	2,027 (1,043)	1,973 (989)	216 (90)	1,189 (436)	2,299 (675)	**2,534 (767)**
Lee Vining, Side Channel	133 (108)	103 (36)	159 (87)	257 (123)	131 (123)	95 (95)	100 (100)	97 (97)	130 (40)	51 (36)	108 (108)	**92 (29)**

Estimated Trout Standing Crops (kg/ha)

The total (Brown and Rainbow Trout) estimated standing crop in the Upper Rush section was 195 kg/ha in 2020, a 33% decrease from the record 291 kg/ha in 2019 (Table 13 and Figure 19). Rainbow Trout comprised 24.4 kg/ha of the 2020 standing crop estimate and was the second highest biomass of Rainbow Trout estimated in Upper Rush in the past 22 years. When compared to the 22-year average of 157 kg/ha, the 2020 standing crop estimate was approximately 24% greater (Figure 19).

The estimated standing crop for Brown Trout in the Bottomlands section of Rush Creek was 84 kg/ha in 2020, an 8% decrease from 91 kg/ha in 2019 (Table 13 and Figure 19). When compared to the 13-year average of 82 kg/ha, the 2020 standing crop estimate was approximately 2% greater (Figure 19).

The estimated standing crop for Brown Trout in the MGORD section of Rush Creek was 81 kg/ha in 2020, a 15% decrease from 95 kg/ha in 2018 (Table 13 and Figure 19). For the 10 seasons where Brown Trout standing crop estimates were generated for the MGORD; the average value equaled 87 kg/ha.

The estimated standing crop for Brown Trout in Walker Creek was 240 kg/ha in 2020, a 34% increase from the 2019 estimate of 179 kg/ha (Table 13 and Figure 19). The 2020 standing crop estimate was the second greatest value recorded in Walker Creek over the 22-year sampling period and the long-term average for this period is 144 kg/ha.

The estimated total standing crop for Brown and Rainbow Trout in the Lee Vining Creek main channel in 2020 was 96 kg/ha; a decrease of 50% from the 2019 estimate of 192 kg/ha (Table 14 and Figure 20). The 2020 estimated standing crop included 0.6 kg/ha of Rainbow Trout (Figure 21). The long-term average for the 21-year sampling period is 124 kg/ha.

The estimated standing crop of Brown Trout in the Lee Vining Creek side channel was 10 kg/ha in 2020, which represented a 60% decrease from the 2019 estimate of 25 kg/ha (Table 14 and Figure 20). No Rainbow Trout were captured in the Lee Vining Creek side channel in 2020 and none have been sampled in the side channel section for ten consecutive years (2011-2020).

Table 13. Comparison of Brown Trout standing crop (kg/ha) estimates between 2015 and 2020 for Rush Creek sections. These six years include two drier years of 2015-2016, followed by the extremely wet RY 2017, the normal RY 2018, the wet RY 2019 and dry-normal-1 RY 2020.

Collection Location	2015 Total Standing Crop (kg/ha)	2016 Total Standing Crop (kg/ha)	2017 Total Standing Crop (kg/ha)	2018 Total Standing Crop (kg/ha)	2019 Total Standing Crop (kg/ha)	2020 Total Standing Crop (kg/ha)	Percent Change Between 2019 and 2020
Rush Creek – Upper	123	62	123	188*	291**	195***	-33%
Rush Creek - Bottomlands	59	34	50	103	91	84	-7%
Walker Creek	183	172	85	245	179	240	+34%

*includes 18.7 kg/ha of Rainbow Trout **includes 36.5 kg/ha of Rainbow Trout ***includes 24.4 kg/ha of Rainbow Trout

Table 14. Comparison of total (Brown and Rainbow Trout) standing crop (kg/ha) estimates between 2015 and 2020 for the Lee Vining Creek sections. These six years include two drier years of 2015-2016, followed by the extremely wet RY 2017, the normal RY 2018, the wet RY 2019 and dry-normal-1 RY 2020. The Rainbow Trout portion of the main channel's total estimated biomass is provided within the parentheses.

Collection Location	2015 Total Standing Crop (kg/ha)	2016 Total Standing Crop (kg/ha)	2017 Total Standing Crop (kg/ha)	2018 Total Standing Crop (kg/ha)	2019 Total Standing Crop (kg/ha)	2020 Total Standing Crop (kg/ha)	Percent Change Between 2019 and 2020
Lee Vining Creek - Main Channel	150 (12.5)	113 (8.2)	21 (0)	70 (0)	192 (4.6)	96 (0.6)	-50%
Lee Vining Creek – Side Channel	45	31	20	7	25	10	-60%

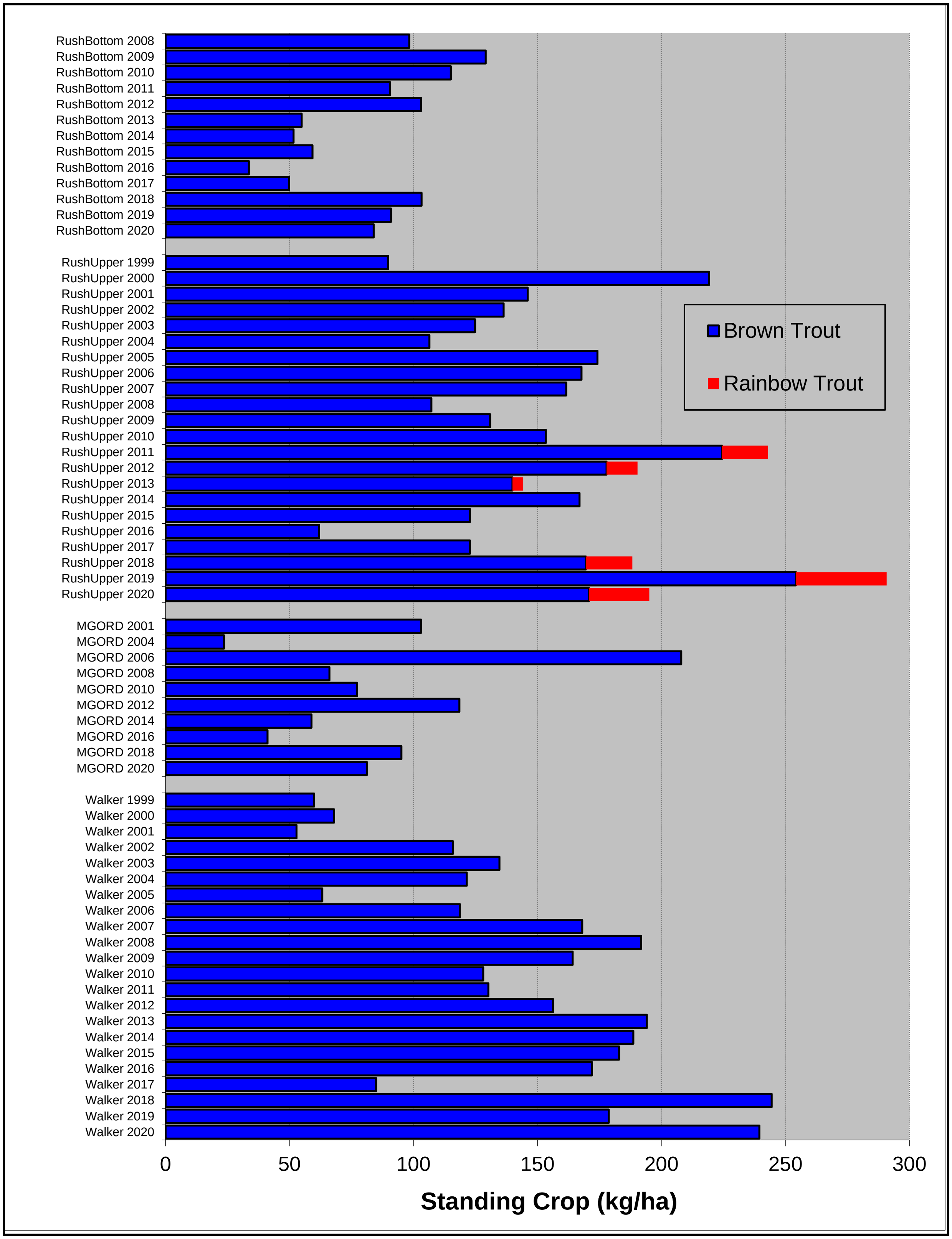


Figure 19. Estimated total standing crop (kilograms per hectare) of Brown Trout in Rush Creek sample sections from 1999 to 2020. NOTE: After 2001, MGORD estimates only made during even years.

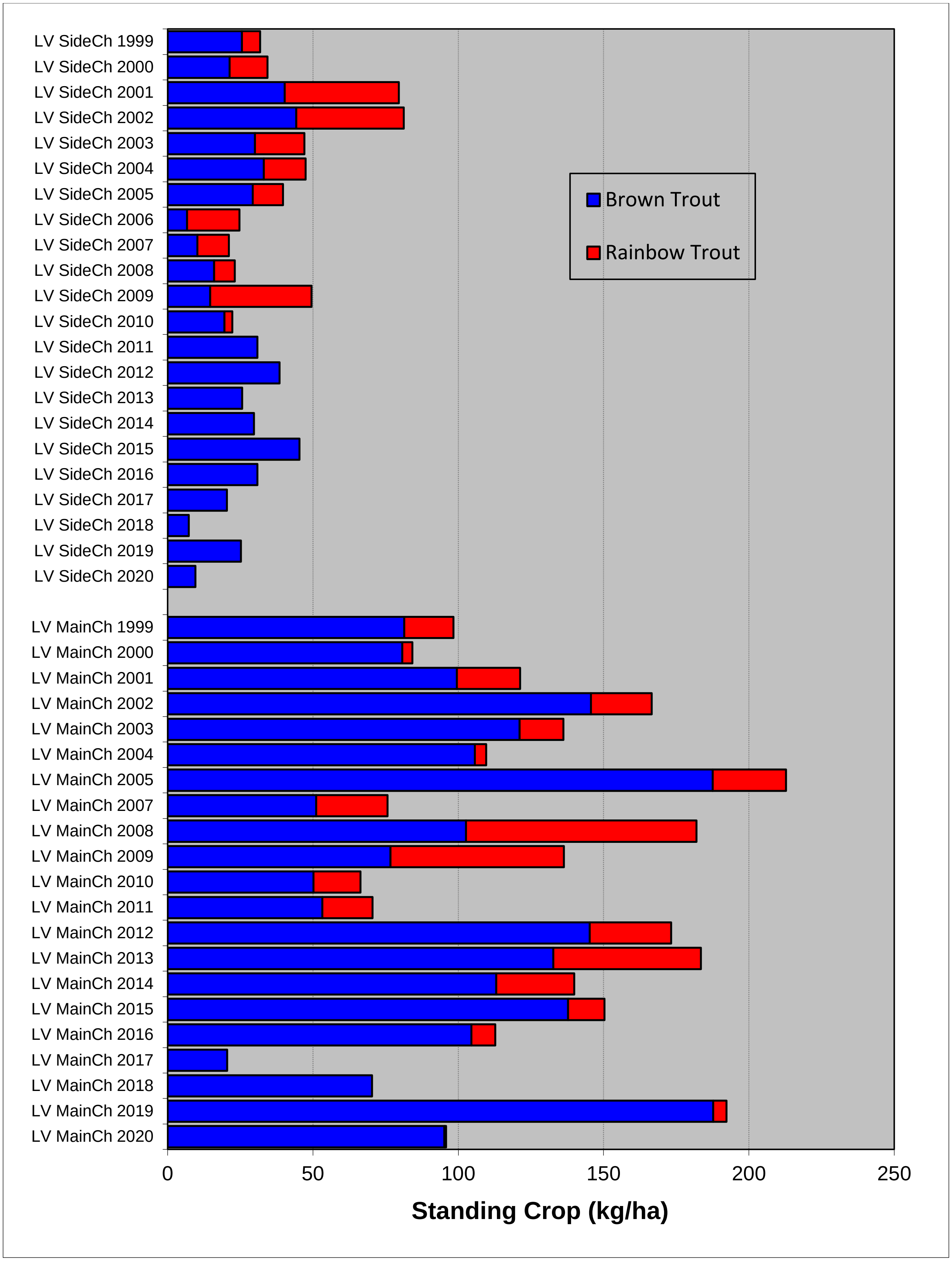


Figure 20. Estimated total standing crop (kilograms per hectare) of Brown Trout and Rainbow Trout (red) in Lee Vining Creek sample sections from 1999 to 2020.

Relative Stock Density (RSD) for Rush and Lee Vining Creeks

In the Upper Rush section, the RSD-225 equaled 13 for 2020, the third straight year of large drops from the record RSD-255 value of 78 for 2017 (Table 15). The 2020 RSD-225 value was most likely influenced by greater numbers of fish smaller than 225 mm which comprised 87% of the trout ≥150 mm (Table 15). The RSD-300 value was 1 in 2020, compared to 2 in 2019 and 9 in 2018 (Table 15). This continued drop in RSD-300 value was influenced by a continued decrease in the numbers of Brown Trout >300 mm captured in 2019 and 2020 (Table 15). Over 21 sampling years, a total of 149 Brown Trout ≥300 mm were captured in the Upper Rush Creek section, an average of 7.1 fish ≥300 mm per year (Table 15).

In the Bottomlands section of Rush Creek, the RSD-225 for 2020 equaled 9, a small increase from the 2019 value of 8 (Table 15). As in the Upper Rush section, the Bottomlands 2020 RSD-225 value was most likely influenced by the large numbers of fish smaller than 225 mm which comprised 91% of the trout ≥150 mm. The RSD-300 value was 0 in 2020 because no Brown Trout ≥300 mm were captured in the Bottomlands section (Table 15). Over the 13 sampling years, a total of 26 Brown Trout ≥300 mm were captured in the Bottomlands section, an average of 2.0 fish ≥300 mm per year (Table 15).

In the MGORD, the RSD-225 value increased slightly from 47 in 2019 to 48 in 2020 (Table 15). In 2020, the RSD-300 value was 13, a small increase from the 2019 RSD-300 value of 10 (Table 15). The RSD-375 value increased from 1 in 2019 to 2 in 2020; the second lowest RSD-375 value recorded in the MGORD (Table 15). The single-pass catch of Brown Trout ≥150 mm in the MGORD during the 2020 season was 322 fish, which included 43 fish ≥300 mm in length and six of these fish were ≥375 mm in length (Table 15). For sampling conducted between 2001 and 2012, the annual average catch of Brown Trout ≥300 mm equaled 180 fish/year; then for the past eight sampling years the annual average catch of Brown Trout ≥300 mm equaled 33 fish/year (Table 15). This 82% decline in larger Brown Trout coincided with the five years of drier RY's and poor summer thermal regimes within the MGORD in 2012-2016; however in the four seasons following the drought, the recruitment of larger, older fish appears to be a relatively slow process (Table 15).

RSD values in Lee Vining Creek were generated for the main channel only (Table 16). The RSD-225 value for main channel decreased from 18 in 2019 to 14 in 2020, most likely influenced by larger numbers of trout <225 mm in length that were captured; which comprised 86% of the fish ≥150 mm (Table 16). In 2020, no Brown Trout greater than 300 mm in length were captured in Lee Vining Creek main channel, thus the RSD-300 value was 0 (Table 16).

Table 15. RSD values for Brown Trout in Rush Creek sections from 2000 to 2020.

Sampling Location Rush Creek	Sample Year	Number of Trout ≥150 mm	Number of Trout 150-224 mm	Number of Trout 225-299 mm	Number of Trout 300-374 mm	Number of Trout ≥375 mm	RSD-225	RSD-300	RSD-375
Upper Rush	**2020**	**148**	**129**	**18**	**1**	**0**	**13**	**1**	**0**
Upper Rush	2019	503	406	85	11	1	19	2	0
Upper Rush	2018	254	155	75	24	0	39	9	0
Upper Rush	2017	130	28	82	19	1	78	15	1
Upper Rush	2016	103	74	26	1	2	28	3	2
Upper Rush	2015	289	246	41	0	2	15	1	1
Upper Rush	2014	366	331	31	4	0	10	1	0
Upper Rush	2013	336	288	45	3	0	14	1	0
Upper Rush	2012	354	284	66	3	1	20	1	0
Upper Rush	2011	498	381	110	6	1	23	1	0
Upper Rush	2010	308	202	97	7	2	34	3	1
Upper Rush	2009	372	322	43	5	2	13	2	1
Upper Rush	2008	227	189	31	6	1	17	3	0
Upper Rush	2007	282	210	61	9	2	26	4	1
Upper Rush	2006	233	154	69	10	0	34	4	0
Upper Rush	2005	202	139	56	5	2	31	3	1
Upper Rush	2004	179	112	64	2	1	37	2	1
Upper Rush	2003	264	216	45	2	1	18	1	0
Upper Rush	2002	220	181	35	1	2	18	2	1
Upper Rush	2001	223	190	27	6	0	15	3	0
Upper Rush	2000	182	158	22	2	0	13	1	0
Bottomlands	**2020**	**128**	**117**	**11**	**0**	**0**	**9**	**0**	**0**
Bottomlands	2019	220	202	17	1	0	8	0	0
Bottomlands	2018	140	90	41	9	0	36	6	0
Bottomlands	2017	82	29	49	4	0	65	5	0
Bottomlands	2016	66	52	11	1	2	21	5	3
Bottomlands	2015	115	88	26	0	1	23	1	1
Bottomlands	2014	154	152	1	0	1	1	1	1
Bottomlands	2013	128	123	5	0	0	4	0	0
Bottomlands	2012	325	290	34	1	0	11	0	0
Bottomlands	2011	267	218	46	3	0	18	1	0
Bottomlands	2010	307	225	81	1	0	27	0	0
Bottomlands	2009	379	321	56	1	1	15	1	0
Bottomlands	2008	160	141	19	0	0	12	0	0

Table 15 (continued).

Sampling Location Rush Creek	Sample Year	Number of Trout ≥150 mm	Number of Trout 150-224 mm	Number of Trout 225-299 mm	Number of Trout 300-374 mm	Number of Trout ≥375 mm	RSD-225	RSD-300	RSD-375
MGORD	**2020**	**322**	**167**	**112**	**37**	**6**	**48**	**13**	**2**
MGORD	2019	275	145	102	24	4	47	10	1
MGORD	2018	326	98	162	51	15	70	20	5
MGORD	2017	104	12	64	17	11	88	27	11
MGORD	2016	179	46	95	18	20	74	21	11
MGORD	2015	116	33	54	20	9	72	25	8
MGORD	2014	388	184	175	19	10	53	7	3
MGORD	2013	411	237	118	41	15	42	14	4
MGORD	2012	694	176	319	173	26	75	29	4
MGORD	2011	216	36	117	55	8	83	29	4
MGORD	2010	694	252	292	115	35	64	22	5
MGORD	2009	643	156	338	123	26	76	23	4
MGORD	2008	856	415	301	118	22	52	16	3
MGORD	2007	621	144	191	259	27	77	46	4
MGORD	2006	567	60	200	280	27	89	54	5
MGORD	2004	424	130	197	64	33	69	23	8
MGORD	2001	774	330	217	119	108	57	29	14

Table 16. RSD values for Brown Trout in the Lee Vining Creek main channel section from 2000-2020.

Sampling Location Rush Creek	Sample Year	Number of Trout ≥150 mm	Number of Trout 150-224 mm	Number of Trout 225-299 mm	Number of Trout 300-374 mm	Number of Trout ≥375 mm	RSD-225	RSD-300
Main Channel	**2020**	**80**	**69**	**11**	**0**	**0**	**14**	**0**
Main Channel	2019	131	107	22	2	0	18	2
Main Channel	2018	51	39	10	2	0	24	4
Main Channel	2017	23	17	5	1	0	26	4
Main Channel	2016	169	145	24	0	0	14	0
Main Channel	2015	210	192	18	0	0	9	0
Main Channel	2014	200	173	27	0	0	14	0
Main Channel	2013	325	308	16	1	0	5	0
Main Channel	2012	111	72	37	2	0	35	2
Main Channel	2011	60	31	23	5	1	48	10
Main Channel	2010	62	28	32	2	0	55	3
Main Channel	2009	137	106	30	1	0	23	1
Main Channel	2008	149	138	11	0	0	7	0
Main Channel	2007	29	24	5	0	0	17	0
Main Channel	2006	Not sampled in 2006 due to unsafe high flows						

Table 16 (continued).

Main Channel	2005	60	37	20	2	1	38	5
Main Channel	2004	70	60	8	2	0	14	3
Main Channel	2003	52	27	23	2	0	48	4
Main Channel	2002	100	74	23	3	0	26	3
Main Channel	2001	90	71	16	3	0	21	3
Main Channel	2000	51	32	18	1	0	37	2

PIT Tag Recaptures

PIT Tags Implanted between 2009 and 2020

Between 2009 and 2020, a total of 9,808 PIT tags were implanted in Brown Trout and Rainbow Trout within the annually sampled sections of Rush, Lee Vining and Walker Creeks (Appendix B). All PIT tagged fish received adipose fin clips. The numbers of PIT tags implanted each year varied according to fish availability and inventory of PIT tags, with year-specific information tabulated in Appendix B.

In 2020, a total of 749 trout received PIT tags and adipose fin clips in Rush and Lee Vining creeks (Table 17). In addition, seven recaptured adipose fin-clipped fish had shed their original tags and were re-tagged, thus a total of 756 PIT tags were implanted during the 2020 fisheries sampling (Table 17). Of the 756 trout tagged, 581 were age-0 Brown Trout and 139 were age-1 and older Brown Trout (Table 17). For Rainbow Trout, 29 age-0 fish and seven older fish were tagged (Table 17). One hundred thirty-two of the age-1+ Brown Trout tagged in the MGORD section were ≤250 mm in total length and were presumed to be age-1 fish (Table 17). The 80 age-0 Brown Trout tagged in the MGORD were the most age-0 fish tagged in a single season within this section (Table 17). Tagged and recaptured fish provided empirical information to estimate fish growth, tag retention, fish movements, and apparent survival rates.

Table 17. Total numbers of trout implanted with PIT tags during the 2020 sampling season, by stream, sample section, age-class and species.

Stream	Sample Section	Number of Age-0 Brown Trout (<125 mm)	Number of Age-1 and older Brown Trout	Number of Age-0 Rainbow Trout (<125 mm)	Number of Age-1 and older Rainbow Trout	Section Totals
Rush Creek	Upper Rush	242	1*	27	0	**270 Trout**
	Bottomlands	65	0	0	0	**65 Trout**
	MGORD	80	132** 1*	2	7	**222 Trout**
Lee Vining Creek	Main Channel	102	1*	0	0	**103 Trout**
	Side Channel	0	0	0	0	**0 Trout**
Walker Creek	Above old 395	92	4*	0	0	**96 Trout**
Age Class Sub-totals:		**581**	**139**	**29**	**7**	**Total Trout: 756**

*shed tag/new tag implanted **≤250 mm in total length

In September of 2020, a total of 123 previously tagged trout (that retained their tags) were recaptured in the Rush Creek watershed (Appendix C). Twenty-seven of the recaptures occurred in the Upper Rush section (all Brown Trout), followed by 10 recaptures in the Bottomlands section, 73 recaptures in Walker Creek and 13 recaptures in the MGORD (Appendix C). In September of 2020, a total of 29 previously tagged Brown Trout (that retained their tags) were recaptured in the Lee Vining Creek main channel section (Appendix C). During the 2020 sampling, no previously tagged Rainbow Trout were recaptured, thus no growth rate information was available for Rainbow Trout in either Rush Creek or Lee Vining Creek.

In the following text, growth between 2019 and 2020 will be referred to as 2020 growth rates. A 2020 trout refers to a fish recaptured in September of 2020. An age of a PIT tagged trout reflects its age during the sampling year. For instance, an age-1 trout in 2020 indicates that a trout was tagged in September 2019 at age-0 and its length and weight were measured in September 2020 when it was recaptured.

Growth of Age-1 Brown Trout between 2019 and 2020

In 2020, a total of 115 known age-1 Brown Trout were recaptured that were tagged as age-0 fish in 2019, for an overall recapture rate of 14.7% (115/784 age-0 fish tagged in 2019). Of the 115 age-1 recaptures; 30 of these fish were from Rush Creek sections, 61 fish were from Walker Creek and 24 fish were from the Lee Vining Creek main channel section. Thus, by creek, the age-1 recapture rates for 2020 were 14% in Lee Vining Creek (23% in 2019, 29% in 2018 and 2% in 2017), 6% in Rush Creek (7% in 2019, 14% in 2018, 19% in 2017 and 5% in 2016), and 45% in Walker Creek (19% in 2019). These recapture rates suggest survival between age-0 and age-1 in Rush Creek in 2020 remained somewhat comparable to the previous year, increased in Walker Creek and that survival rates in Lee Vining Creek in 2020 decreased from the previous year.

In the Upper Rush section, 21 age-1 Brown Trout were recaptured in 2020 and the average growth rates of these trout were 55 mm and 21 g (Table 18). Compared to 2019 rates, the average growth rates of the 25 age-1 Brown Trout were lower by 22 mm and 22 g (Table 18). Growth rates of age-1 Brown Trout in the Upper Rush section had generally declined annually from 2010 to 2014, but the 2015-2017 growth rates increased each year, with the 2017 growth rates the largest recorded for this section (Table 18). After the 2017 season, growth rates of age-1 Brown Trout in Upper Rush have declined for three consecutive years. The 2020 average growth rates for age-1 Brown Trout in Upper Rush were the lowest recorded for the 11 years of available data (Table 18).

In the Bottomlands section of Rush Creek, seven age-1 Brown Trout were recaptured in 2020 and the average growth rates of these trout were 64 mm and 29 g (Table 18). Compared to 2019 rates, the growth rates of the seven age-1 Brown Trout were lower by 10 mm and 9 g (Table 18). After the 2017 season, growth rates of age-1 Brown Trout in the Bottomlands section have declined for three consecutive years (Table 18). The 2020 average growth rates for age-1 Brown Trout in the Bottomlands were the lowest recorded in this section since the 2013 season (Table 18).

In Walker Creek, 61 age-1 Brown Trout were captured in 2020 and the average growth rates of these 61 trout were 54 mm and 24 g; decreases of 4 mm and 4 g from the 2019 average growth rates (Table 18). The growth rates of age-1 Brown Trout in Walker Creek have typically been lower than the rates documented in Rush and Lee Vining creeks (Table 18).

In Lee Vining Creek, 24 age-1 Brown Trout were recaptured in 2020 and the average growth rates of these trout were 71 mm and 41 g (Table 18). Compared to 2019 rates, the growth rates of the 24 age-1 Brown Trout were greater by 1 mm in length and lower by 12 g (Table 18). Growth rates (in weight) of age-1 Brown Trout in Lee Vining Creek have decreased for three straight years after the record high rates documented in 2017 (Table 18).

Growth of Age-2 Brown Trout between 2019 and 2020

In 2020, a total of 12 known age-2 Brown Trout were recaptured that were tagged as age-0 fish in 2018, for a recapture rate of 1.6% (12/732 age-0 fish tagged in 2018). Eight of these fish were recaptured in Rush Creek and Walker Creek, and four fish were captured in Lee Vining Creek. In addition, within the MGORD section of Rush Creek, five Brown Trout were captured in 2020 that were tagged as presumed age-1 fish in 2019 and these presumed age-2 fish had a recapture rate of 3.0% (5/167 age-1 fish tagged in 2019).

Within the Upper section of Rush Creek, three age-2 fish were recaptured in 2020 that had been tagged as age-0 fish in 2018 (Table 18). Between age-1 and age-2, the average growth rates of these three Brown Trout were 44 mm and 55 g (Table 18). Compared to 2019 rates, the growth rates of the three age-2 Brown Trout were lower by 4 mm and by 16 g (Table 18). The 2020 average growth rate (in weight) of age-2 Brown Trout in Upper Rush was the lowest recorded for the past seven years (Table 18).

In the Bottomlands section of Rush Creek, no previously tagged age-2 Brown Trout were recaptured in 2020.

In Walker Creek, five age-2 fish were recaptured in 2020 that had been tagged as age-0 fish in 2018 (Table 18). Between age-1 and age-2, the average growth rates of these five Brown Trout were 36 mm and 30 g (Table 18). The 2020 average growth rates of age-2 Brown Trout in Walker Creek were the lowest recorded for the past seven years (Table 18).

In the Lee Vining Creek main channel section, four age-2 Brown Trout were recaptured in 2020 that had been tagged as age-0 fish in 2018. Between age-1 and age-2, the growth rates of these four Brown Trout were 70 mm and 81 g (Table 18). One of these four fish exhibited tremendous growth (90 mm and 148 g) and boosted the overall average growth rates.

Growth of Age-3 Brown Trout between 2019 and 2020

In 2020, one known age-3 Brown Trout was recaptured in the Upper Rush Creek section that was tagged as an age-0 fish in 2017. Between 2019 and 2020, this age-3 Brown Trout grew by 41 mm and 49 g (Table 18).

In 2020, one known age-3 Brown Trout was recaptured in the Bottomlands section that was tagged as an age-0 fish in 2017. Between 2019 and 2020, this age-3 Brown Trout grew by 21 mm and 20 g (Table 18).

Table 18. Average growth (length and weight) of all Brown Trout recaptured from 2009 through 2020 by age. Note: *denotes only one PIT tagged fish recaptured. •denotes one fish that moved from Upper Rush to the MGORD.

Stream and Reach	Cohort	Average Annual Growth in Length and Weight (mm/g)											
		2008 - 2009	2009 - 2010	2010 - 2011	2011 - 2012	2012 - 2013	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020
Upper Rush Creek	Age 1	89/51	81/50	83/48	72/33	67/35		90/55	105/77	132/129	83/56	77/43	55/21
	Age 2		58/70	54/73	43/42	41/42		64/69	99/176•	108/239	39/66	48/71	44/55
	Age 3				14/29		24/41				11/40*	15/27*	41/49*
	Age 4					12/-22							
	Age-5												
Rush Creek Bottom-lands	Age 1	84/43	77/40	71/35	58/25	56/24		84/41	94/62	118/96	72/42	74/38	64/29
	Age 2		50/54	35/32	30/28	27/22	32/29*	62/62			39/55	36/44*	
	Age 3			13/14	17/16	11/9	35/31						21/20*
	Age 4				4/-11		18/20						
	Age-5												
LV Main Channel Brown Trout	Age 1		80/42*	72/37	99/52	61/27		73/33	74/40	110/92*	103/77	71/41	72/29
	Age 2		66/95		77/110	33/34	35/29	47/40	47/49	77/128*		60/91*	70/81
	Age 3			34/92		23/48*	16/20*	27/32	42/75				
	Age 4				21/41*				25/47*				
	Age-5												
LV Main Channel RB Trout	Age 1					78/47		80/35				80/43*	
	Age 2						40/48*	52/50	62/74*				
	Age 3								38/82*				
	Age 4												
	Age-5												
Walker Creek Above Old 395	Age 1	68/27	51/20	71/34	68/36	59/23		58/24	72/36	66/33		55/28	54/24
	Age 2		31/26	60/56	40/33	27/21	39/35		47/44	37/37	42/52		36/30
	Age 3			28/44	18/12	9/2	20/36	27/29		42/59*	25/37	25/37	
	Age 4				7/2	2/-16*		28/45*			27/37*		8/-5
	Age-5						0/-10*						

In Walker Creek, no age-0 Brown Trout were tagged during the 2017 sampling, thus no tagged age-3 fish were available for recapture during the 2020 sampling.

Growth of Age-4 Brown Trout between 2019 and 2020

In 2020, two known age-4 Brown Trout were recaptured in Walker Creek that were tagged as age-0 fish in 2016 (Table 18). Both of these age-4 Brown Trout grew by 8 mm in length between 2019 and 2020; and both of these fish lost weight between age-3 and age-4 (-2 g and -8 g).

Growth of MGORD Brown Trout between 2019 and 2020

Starting in September of 2017, PIT tagging of Brown Trout in the MGORD section of Rush Creek has been focused on age-0 and presumed age-1 fish. Based on past years' length-frequency histograms and growth rates of know age-1 fish (from recaptures of previously tagged age-0 fish), a cut-off of 250 mm total length was made to define the probable upper limit for age-1 Brown Trout in the MGORD. Thus moving forward, most recaptures of previously tagged fish within the MGORD will allow us to compute annual growth rates of known age fish.

In 2020, two age-1 Brown Trout were captured in the MGORD that were tagged at age-0 in 2019; both of these fish were tagged in the Upper Rush section. Between 2019 and 2020, the average growth rates of these two fish were 82 mm and 35 g. At age-1, these fish had total lengths of 155 mm and 162 mm.

In 2020, five Brown Trout were recaptured in the MGORD that were PIT tagged in the MGORD as presumed age-1 fish in 2019. Between age-1 and age-2, the average growth rates of these five Brown Trout were 49 mm and 68 g. For comparison, in 2019 seven presumed age-2 fish had average growth rates of 56 mm and 98 g. The five age-2 fish recaptured in 2020 ranged from 239 mm to 257 mm in FL, suggesting lower growth rates than previously documented in the MGORD.

In 2020, two Brown Trout were recaptured in the MGORD that had been PIT tagged in the MGORD as presumed age-1 fish in 2018 and were also recaptured as presumed age-2 fish in the MGORD in 2019. Between age-2 and age-3, the average growth rates of these two fish were 35 mm and 70 g.

Growth of MGORD Brown Trout from non-consecutive years

Two age-2 Brown Trout were captured in the MGORD in 2020 that were tagged as age-0 fish in 2018; one of these fish was tagged at age-0 in the MGORD and the other was tagged at age-0 in the Upper Rush section. The fish residing within the MGORD grew by 174 mm and 186 g between age-0 and age-2. The fish tagged in Upper Rush at age-0 and recaptured in the MGORD, grew by 129 mm and 117 g between age-0 and age-2.

The other non-consecutive year recaptures within the MGORD in 2020 were of two large Brown Trout that were 500 mm and 540 mm in length when caught on 9/10/20. The 500 mm fish was first captured and PIT tagged in 2016 and was 405 mm and 725 g. Its first recapture occurred in 2018 and it had grown by 42 mm and 240 g during this two-year time span. This fish was then recaptured in 2020 and grew by 53 mm and 407 g between 2018 and 2020. The 540 mm Brown Trout was originally tagged in 2011 and was 348 mm in length and weighed 410 g. Its first recapture occurred the following year in 2012 and the one-year growth between 2011 and 2012 was 3 mm and 70 g. Its second recapture was in 2017 and five-year growth between 2102 and 2017 was 199 mm and 1,550 g. Its third recapture was in 2020 and in the three years since its previous capture, this fish had lost 10 mm in length and lost 80 g in weight. This likely age-11 or age-12 Brown Trout was 540 mm in total length and weighed 1,930 g with a condition factor of 1.24 when recaptured on 9/10/20.

Movement of PIT Tagged Trout between Sections

From 2009 to 2020 nearly 10,000 PIT tags were surgically implanted in Brown Trout and Rainbow Trout in the following annually sampled sections: Upper Rush, County Road, Bottomlands, MGORD, and Walker Creek. Most recaptures have occurred in the same sections where fish were originally tagged. In many cases, fish were recaptured within the same sub-section as they were initially tagged. Between 2010 and 2020, 42 Brown Trout were recaptured in stream reaches other than where they were initially tagged. The majority of movement between sections has occurred from the Upper Rush section upstream into the MGORD, and from the MGORD downstream into the Upper Rush section. We also documented some limited movement between the Bottomlands and County Road sections. From 2009 to 2013, no movement between other sections was documented. However in 2014, a large Brown Trout initially tagged in the MGORD was recaptured in the Bottomlands section.

In 2020, three Brown Trout recaptured in the MGORD had been tagged in the Upper Rush section in 2018 or 2019. Two of these fish made the upstream migration between age-0 and age-1; however the timing of this upstream movement was unknown. A PIT tag antenna array and receiver at the lower end of the MGORD would provide better knowledge of the timing or magnitude of movement of Brown Trout between the Upper Rush and MGORD sections.

PIT Tag Shed Rate of Trout Recaptured in 2020

In 2020, a total of 132 trout with adipose fin clips were recaptured and nine of these fish failed to produce a PIT tag number when scanned with the tag reader (four shed tags were from Walker Creek, two were from the MGORD, two were from Lee Vining Creek main channel and one was from Upper Rush recaptures). Assuming that all these fish were previously PIT tagged, the 2020 calculated shed rate was 6.8% (9 shed tags/132 clipped fish recaptured). This rate was much lower than the 2019 shed rate of 20%. Retention rates tend to be higher in juvenile fish because adult salmonids are known to shed tags during spawning (Bateman et al. 2009). Also, tag retention rates have also been linked tagger’s experience and crew turnover rates, with less experienced taggers resulting in higher shed rates (Dare 2003). For the past eight years, our crew members implanting tags has remained relatively stable.

Comparison of Length-at Age amongst Sample Sections

During the September 2020 sampling, three age-classes of PIT tagged Brown Trout were recaptured within four fisheries monitoring sections in Rush, Walker and Lee Vining creeks (Tables 19 and 20). Along with providing age-specific length information for each section, these data also allowed comparisons of length-at-age between sample sections and also between the years 2013-2020 (Tables 19 and 20).

In Upper Rush, the average length-at-age-1 in 2020 was 145 mm, 28 mm lower than the average length-at-age-1 in 2019 and third consectutive decrease since 2017's average length-at-age-1 of 243 mm (Table 19). Unlike the four previous years, in 2020, age-1 Brown Trout in Upper Rush were smaller than age-1 fish in the Bottomlands section (Table 19). In the Bottomlands section, the average length-at-age-1 in 2020 was 155 mm, 13 mm less than the 2019 average length-at-age-1 and the lowest average value for the past six years (Table 19).

In Upper Rush, the average length-at-age-2 in 2020 of three age-2 Brown Trout was 221 mm, 16 mm less than the average length-at-age-2 in 2019 and 92 mm lower than in 2017 (Table 19). In 2020, no age-2 PIT tagged Brown Trout were recaptured in the Bottomlands section.

In 2020, a single PIT tagged age-3 Brown Trout was recaptured in the Upper Rush sampling section and at 287 mm in length this fish was 24 mm longer than the one age-3 Brown Trout recaptured in 2019 (Table 19). In 2020, a single PIT tagged age-3 Brown Trout was recaptured in the Bottomlands section and this fish was 240 mm in length and was the first age-3 recapture in this section since 2014 (Table 19).

In 2020, no age-4 or age-5 fish with PIT tags were captured in the Upper or Bottomlands sections of Rush Creek. The 2014 sampling season was the last time PIT tagged age-4 Brown Trout were recaptured in Upper Rush or the Bottomlands section (Table 19).

For Walker Creek in 2020, 61 age-1 Brown Trout were recaptured and the average length-at-age-1 was 151 mm, 8 mm less than the average length-at-age-1 in 2019 (Table 19). In 2020, five age-2 Brown Trout were recaptured in Walker Creek and the average length-at-age-2 was 194 mm (Table 19). In 2020, no age-3 Brown Trout were available for recapture in Walker Creek. In 2020, two age-4 Brown Trout were recaptured in Walker Creek and their average length-at-age-4 was 234 mm (Table 19).

For the Lee Vining Creek main channel in 2020, 24 age-1 Brown Trout were recaptured and the average length-at-age-1 for these Brown was 155 mm, 19 mm less than in 2019 (Table 20). In 2020, four previously tagged age-2 Brown Trout were recaptured and the average length-at-age-2 equalled 232 mm, 15 mm less than in 2019 (Table 20). In 2020, no age-3 or age-4 Brown Trout were recaptured. In 2020, no age-1 Rainbow Trout were recaptured.

These findings of average lengths by age-class appear to support the previous conclusions by the Stream Scientist that very few Brown Trout reach age-4 or older on Rush Creek or Lee Vining Creek. However, the growth rates that Brown Trout exhibited in 2017 and 2018 confirmed that some age-2 and age-3 fish were near or just above lengths of 300 mm, the size class approaching the metrics of the pre-1941 fishery. These growth rates appeared to be a function of relatively low fish densities and mostly favorable summer water temperature conditions in 2017 and 2018. However, increasing densities of trout during the past several years since 2017 may have influenced the decline in growth rates observed between these three years. The relatively small length-at-age values documented in 2020 were most likely influenced by both fish densities and less than favorable summer water temperatures.

Table 19. Size range of PIT tagged fish recaptured in 2013-2020 by age class for Brown Trout at three electrofishing sections on Rush and Walker Creeks. NOTE: years omitted if no fish were caught.

Section	Cohort	Size Range (mm)	Average Length (mm)
Upper Rush	Age-1	**2020** = 124-167 **2019** = 128-202 **2018** = 158-232 **2017** = 224-264 **2016** = 192-237 **2015** = 169-203	**2020** = 145 **2019** = 173 **2018** = 193 **2017** = 243 **2016** = 208 **2015** = 187
	Age-2	**2020** = 209-235 **2019** =203-251 **2018** = 236-305 **2017** = 284-337 **2016** = 289* **2015** = 205-242	**2020** = 221 **2019** = 237 **2018** = 274 **2017** = 313 **2016** = 289* **2015** = 217
	Age-3	**2020** = 287 **2019** = 251 **2018** = 295 **2014** = 226-236 **2013** = 227-263	**2020** = 287 **2019** = 251 **2018** = 295 **2014** = 231 **2013** = 245
	Age-4	**2014** = 288 **2013** = 252-255	**2014** = 288 **2013** = 254
	Age-5	**2014** = 298	**2014** = 298
Bottomlands	Age-1	**2020** = 141-187 **2019** = 133-196 **2018** = 166-199 **2017** = 189-246 **2016** = 172-217 **2015** = 150-181	**2020** = 155 **2019** = 168 **2018** = 181 **2017** = 221 **2016** = 197 **2015** = 169
	Age-2	**2019** = 219 **2018** = 251-287 **2015** = 197-239 **2014** = 192 **2013** = 156-196	**2019** = 219 **2018** = 267 **2015** = 219 **2014** = 192 **2013** = 178
	Age-3	**2020** = 240 **2014** = 194 **2013** = 194-227	**2020** = 240 **2014** = 194 **2013** = 204
	Age-4	**2014** = 215-219	**2014** = 216
	Age-5	**2016** = 318	**2016** = 318
Walker Creek	Age-1	**2020** = 132-170 **2019** = 141-168 **2017** = 151-179 **2016** = 145-187 **2015** = 133-177	**2020** = 151 **2019** = 159 **2017** = 166 **2016** = 167 **2015** = 154
	Age-2	**2020** = 190-196 **2018** = 191-221 **2017** = 180-224 **2016** = 180-226 **2014** = 168-200 **2013** = 181-208	**2020** = 194 **2018** = 210 **2017** = 202 **2016** = 201 **2014** = 186 **2013** = 197
	Age-3	**2019** = 215-235 **2018** = 204-245 **2017** = 238 **2015** = 211-231 **2014** = 207-222 **2013** = 219-221	**2019** = 220 **2018** = 228 **2017** = 238 **2015** = 219 **2014** = 217 **2013** = 220
	Age-4	**2020** = 224-243 **2018** = 265 **2015** = 249 **2014** = 211 **2013** = 219	**2020** = 234 **2018** = 265 **2015** = 249 **2014** = 211 **2013** = 219
	Age-5	**2014** = 220	**2014** = 220

*Fish was tagged in Upper Rush, but moved to MGORD between age-1 and age-2.

Table 20. Size range of PIT tagged fish recaptured in 2013-2020 by age class for Brown Trout and Rainbow Trout on Lee Vining Creek. NOTE: years omitted if no fish were caught.

Section	Cohort	Size Range (mm)	Average Length (mm)
Brown Trout in Lee Vining Main Channel	Age-1	**2020** = 125-185 **2019** = 142-209 **2018** = 170 -194 **2017** = 210 **2016** = 147-186 **2015** = 149-190	**2020** = 155 **2019** = 174 **2018** = 183 **2017** = 210 **2016** = 171 **2015** = 166
	Age-2	**2020** = 212-270 **2019** = 222-274 **2017** = 247 **2016** = 205-217 **2015** = 176-214 **2014** = 174-195 **2013** = 206-225	**2020** = 232 **2019** = 247 **2017** = 247 **2016** = 211 **2015** = 197 **2014** = 188 **2013** = 215
	Age-3	**2017** = 280-305 **2016** = 210-256 **2015** = 188-228 **2014** = 234-241 **2013** = 238-271	**2017** = 293 **2016** = 240 **2015** = 215 **2014** = 238 **2013** = 253
	Age-4	**2016** = 237	**2016** = 237
	Age-5	None captured in past seven years	
Rainbow Trout in Lee Vining Main Channel	Age-1	**2019** = 165 **2015** = 140-177	**2019** = 165 **2015** = 157
	Age-2	**2016** = 232 **2015** = 195-216 **2014** = 201-229	**2016** = 232 **2015** = 204 **2014** = 215
	Age-3	**2016** = 242	**2016** = 242
	Age-4	None captured in past seven years	
	Age-5	None captured in past seven years	

Summer Water Temperature

During the past nine years, the Mono basin has experienced a five-year drought (2012-2016), a record Extreme-wet RY (2017), a Normal RY with a full GLR (2018), a Wet RY (2019) and in 2020 a Dry-normal 1 RY. These RY types have resulted in a range of summer water temperatures in Rush Creek, from moderate-to-severe stressful conditions in drier RYs to thermal regimes mostly condusive to fair-to-good growth conditions in wetter RYs.

In 2020, a Dry-normal 1 RY with GLR storage levels at least 20 feet above the Synthesis Report recommended minimum summer storage threshold of 7,100 feet in July-September resulted in mostly unfavorable summer thermal conditions, with peak water temperatures above 70°F in five of the seven Rush Creek monitoring locations (Table 21). Daily mean temperatures, average daily minimum temperatures, average daily maximum temperatures and maximum diurnal temperature fluctuations were the highest at all Rush Creek temperature monitoring locations in 2020 since the drought years of 2012-2016 (Table 21).

Similar to the 2013-2019 annual reports, 2020 Rush Creek summer average daily water temperature data were classified based on its predicted influence on growth of Brown Trout as either: 1) good potential growth days, 2) fair potential growth days, 3) poor potential growth days (daily averages within one degree or less of a "bad thermal day"), or 4) bad thermal days (Table 22). Development of these growth criteria were fully described in previous annual reports (Taylor 2013 and 2014). Using these growth prediction metrics, good potential growth days in 2020 varied from four to 42 days in Rush Creek out of the 92-day period from July 1 to September 30 (Table 22). The range of the number of good thermal days in 2020 was less than the 62 to 76 good thermal days recorded in 2019 (Table 22). For all Rush Creek monitoring locations, the number of days classified as “fair” potential growth days ranged from 41 to 53 days (Table 22). In 2020, the number of days classified as “poor” potential growth days and bad thermal days increased substainially from 2019’s four poor growth days at Top of MGORD and two poor growth days at Bottom of MGORD (Table 22). In 2020, poor potential growth days and bad thermal days ranged from three days at Rush below Narrows to 38 days at Bottom of MGORD (Table 22). Interestingly, the number of poor growth and bad thermal days in Rush Creek decreased in a downstream direction due to night-time cooling, which resulted in lower daily average temperatures (Table 22). However, these downstream temperature monitoring locations experienced more days with peak temperatures >70^{o}F and much higher diurnal fluctuations, including extended periods of likely stressful diurnal fluctuations.

As was done with the 2013 - 2019 data, the diurnal temperature fluctuations for July, August and September 2020 were characterized by the one-day maximum fluctuation that occurred each month and by monthly averages (Table 23). Also, for each temperature monitoring location, the highest average diurnal fluctuations over consecutive 21-day durations were determined (Table 23). The diurnal fluctuations throughout the summer of 2020 were relatively low at the Top of MGORD and Bottom of MGORD temperature monitoring locations, but diurnal fluctuations increased at the downstream monitoring locations, most likely due to effects of daily warming and nightly cooling of air temperatures (Table 23). Over the 21-day durations, these larger diurnal fluctuations were above the threshold of 12.6^{o}F considered detrimental to trout growth (Werley et al. 2007) during the summer of 2020 as recorded at the Above Parker, Below Narrows and County Road temperature monitoring locations (Table 23).

The thermal window bounded by 66.2-71.6^{o}F where Brown Trout may be physiologically stressed and living at the edge of their survival tolerance as defined by Bell (2006) was quantified for each Rush Creek temperature monitoring location in 2013 through 2020. The hourly temperature data for the 92-day (or 2,208-hour) summer period were sorted from low to high and the number of hours where temperatures exceeded 66.2^{o}F were summed by month and entire summer period (Table 24). The values from 2013 - 2019 were also included to better illustrate the variability that occurred at all the temperature monitoring locations (Table 24). The 2020 data show that all the temperature monitoring locations downstream of GLR experienced increased number of hours bounded by the 66.2-71.6^{o}F thermal window, with levels approaching those experienced during the recent five-year drought (Table 24). At the Bottom of MGORD, hourly water temperatures exceeded 66.2^{o}F 5% of the time and at the three downstream monitoring locations, hourly water temperatures of 66.2^{o}F were exceeded 16% to 22% of the 92-day period (Table 24). In 2020, the Rush Creek County Road location had the most hours (477 hours) within the thermal window bounded by 66.2-71.6^{o}F (Table 24). In 2020 for the temperature monitoring locations from the Bottom of MGORD to County Road, the month of August had the highest number of hours where temperatures exceeded 66.2^{o}F (Table 24). For August, temperatures exceeding 66.2^{o}F occurred for 27% to 35% of the month. Late July into mid August was also when these temperature monitoring locations experienced their highest 21-day diurnal fluctuations, including levels detrimental to trout growth (Werley et al. 2007).

In 2020, the water temperature monitoring locations Above Parker and Below Narrows continued to document cooler water accretions from Parker and Walker Creeks having a slight, yet positive, effect on Rush Creek's summer thermal regime, including a 60% decrease in the number of days with temperatures exceeding 70°F and 50% more good growth thermal days immediately downstream of the tributaries' accretions (Tables 21-24). However, the cooling effects of the Parker and Walker accretions were nonexistent at the County Road temperature monitoring location, where unfavorable summer water temperature metrics of the number of days >70°F and large diurnal fluctuations were documented. Conversely, the At Damsite water temperature monitoring location continued to provide data documenting the thermal loading in Rush Creek as flow passes through GLR and the MGORD (Tables 21-24). This thermal loading during the summer of 2020 included a 3.4°F increase in daily mean temperature and a 6.8°F increase in average daily maximum temperature (Table 21).

Summer water temperatures in Lee Vining Creek were all within the range of good growth potential during 2020. Regardless of water-year type, excessively warm water has not been an issue in Lee Vining Creek, thus detailed analyses were not performed with the 2020 data.

Table 21. Summary of water temperature data during the summer of RY 2020 (July to September). Averages were calculated for daily mean, daily minimum, and daily maximum temperatures between July 1st and September 30th. All temperature data are presented in °F. When available, values for 2013-2019 are provided for comparison.

Temperature Monitoring Location	Daily Mean (°F)	Ave Daily Minimum (°F)	Ave Daily Maximum (°F)	No. Days > 70°F	Max Diurnal Fluctuation (°F)	Date of Max. Fluct.
Rush Ck. – At Damsite	2016 = 58.9 2017 = 58.1 2018 = 59.7 2019 = 57.8 **2020 = 59.8**	2016 = 58.3 2017 = 57.5 2018 = 58.9 2019 = 57.4 **2020 = 59.0**	2016 = 59.5 2017 = 58.7 2018 = 60.4 2019 = 58.5 **2020 = 60.7**	2016 = 0 2017 = 0 2018 = 0 2019 = 0 **2020 = 0**	2016 = 3.2 2017 = 2.1 2018 = 2.4 2019 = 2.3 **2020 = 4.7**	8/11/16 9/07/17 8/22/18 8/21/19 **7/10/20**
Rush Ck. – Top of MGORD	2013 = 63.1 2014 = 64.8 2015 = 64.4 2016 = 63.8 2017 = 57.0 2018 = 60.7 2019 = 58.5 **2020 = 63.2**	2013 = 62.7 2014 = 64.6 2015 = 64.1 2016 = 63.0 2017 = 56.5 2018 = 59.6 2019 = 57.2 **2020 = 62.1**	2013 = 63.7 2014 = 65.0 2015 = 64.8 2016 = 64.7 2017 = 58.1 2018 = 61.9 2019 = 59.9 **2020 = 64.4**	2013 = 0 2014 = 0 2015 = 0 2016 = 0 2017 = 0 2018 = 0 2019 = 0 **2020 = 0**	2013 = 3.4 2014 = 3.9 2015 = 2.1 2016 = 6.5 2017 = 5.4 2018 = 6.7 2019 = 8.2 **2020 = 6.4**	7/09/13 8/13/14 7/03/15 7/07/16 9/07/17 8/20/18 8/10/19 **7/02/20**
Rush Ck. – Bottom MGORD	2013 = 63.2 2014 = 64.8 2015 = 64.4 2016 = 63.8 2017 = 57.1 2018 = 61.0 2019 = 58.7 **2020 = 63.2**	2013 = 60.9 2014 = 62.9 2015 = 62.3 2016 = 61.8 2017 = 56.5 2018 =58.9 2019 = 56.6 **2020 = 60.5**	2013 = 67.1 2014 = 68.5 2015 = 68.0 2016 = 66.9 2017 = 58.5 2018 = 63.9 2019 = 61.3 **2020 = 67.5**	2013 = 1 2014 = 20 2015 = 20 2016 = 1 2017 = 0 2018 = 0 2019 = 0 **2020 = 17**	2013 = 9.0 2014 = 8.3 2015 = 8.4 2016 = 8.0 2017 = 6.4 2018 = 8.7 2019 = 8.1 **2020 = 10.0**	7/09/13 7/13/14 7/06/15 7/04/16 9/07/17 7/05/18 8/10/19 **8/03/20**

Table 21 (continued).

Temperature Monitoring Location	Daily Mean (°F)	Ave Daily Minimum (°F)	Ave Daily Maximum (°F)	No. Days > 70°F	Max Diurnal Fluctuation (°F)	Date of Max. Fluct.
Rush Ck. – Old Highway 395 Bridge/Upper Rush section	2013 = 62.6 2014 = 64.0 2015 = N/A 2016 = 63.5 2017 = 59.0 2018 = 60.9 2019 = 58.7 **2020 = 62.6**	2013 = 58.8 2014 = 60.5 2015 = N/A 2016 = 60.1 2017 = 57.5 2018 = 58.0 2019 = 56.1 **2020 = 58.5**	2013 = 68.7 2014 = 69.8 2015 = N/A 2016 = 68.8 2017 = 61.0 2018 = 65.3 2019 = 62.3 **2020 = 68.4**	2013 = 40 2014 = 51 2015 = N/A 2016 = 47 2017 = 0 2018 = 0 2019 = 0 **2020 = 30**	2013 = 13.5 2014 = 13.3 2015 = N/A 2016 = 12.5 2017 = 7.6 2018 = 10.9 2019 = 10.7 **2020 = 14.0**	7/09/13 7/13/14 N/A 7/11/16 9/07/17 7/10/18 9/14/19 **8/03/20**
Rush Ck. – Above Parker	2016 = 63.2 2017 = 59.0 2018 = 60.9 2019 = 58.4 **2020 = 62.2**	2016 = 58.8 2017 = 57.2 2018 = 57.2 2019 = 55.5 **2020 = 57.1**	2016 = 69.4 2017 = 61.9 2018 = 66.3 2019 = 62.3 **2020 = 68.6**	2016 = 55 2017 = 0 2018 = 0 2019 = 0 **2020 = 40**	2016 = 13.7 2017 = 8.6 2018 = 13.4 2019 = 11.8 **2020 = 16.1**	7/11/16 9/08/17 7/10/18 9/14/19 **8/03/20**
Rush Ck. – below Narrows	2013 = 61.2 2014 = 63.2 2015 = 62.3 2016 = 61.7 2017 = 58.4 2018 = 60.0 2019 = 57.8 **2020 = 61.0**	2013 = 56.2 2014 = 57.1 2015 = 58.8 2016 = 56.9 2017 = 56.3 2018 = 56.0 2019 = 54.4 **2020 = 55.5**	2013 = 67.6 2014 = 69.4 2015 = 66.1 2016 = 68.3 2017 = 61.3 2018 = 65.4 2019 = 62.2 **2020 = 67.5**	2013 = 24 2014 = 46 2015 = 0 2016 = 34 2017 = 0 2018 =0 2019 = 0 **2020 = 16**	2013 = 16.3 2014 = 17.3 2015 = 11.5 2016 = 14.3 2017 = 8.2 2018 = 12.4 2019 = 12.7 **2020 = 15.7**	7/19/13 7/26/14 9/23/15 7/13/16 9/07/17 7/10/18 9/22/19 **8/03/20**
Rush Ck. – County Road	2013 = 61.4 2014 = 62.0 2015 = 62.1 2016 = 61.6 2017 = N/A 2018 = N/A 2019 = 58.2 **2020 = 61.0**	2013 = 56.5 2014 = 56.7 2015 = 59.1 2016 = 56.0 2017 = N/A 2018 = N/A 2019 = 54.0 **2020 = 54.5**	2013 = 66.6 2014 = 67.8 2015 = 65.5 2016 = 68.3 2017 = N/A 2018 = N/A 2019 = 63.6 **2020 = 68.5**	2013 = 7 2014 = 24 2015 = 2 2016 = 32 2017 = N/A 2018 = N/A 2019 = 0 **2020 = 42**	2013 = 14.7 2014 = 17.6 2015 = 9.2 2016 = 16.1 2017 = N/A 2018 = N/A 2019 = 13.5 **2020 = 18.2**	8/02/13 7/26/14 7/28/15 7/11/16 N/A N/A 9/13/19 **8/03/20**

Table 22. Classification of 2013-2020 summer water temperature data into good growth days, fair growth days, poor growth days and bad thermal days based on daily average temperatures (92-day period from July 1 to September 30). The percent (%) designates each thermal day-type's occurrence for the 92-day summer period.

Temperature Monitoring Location	No. of Days for Good Growth Potential – Daily Ave. ≤60.5°F	No. of Days for Fair Growth Potential – Daily Ave. 60.6° – 63.9°F	No. of Days of Poor Growth Potential – Daily Ave. 64.0° - 64.9°F	No. of Bad Thermal Days - Daily Ave. ≥65°F
Rush Ck. – At Damsite	2016 = 69 (75%) 2017 = 88 (96%) 2018 = 53 (58%) 2019 = 76 (83%) **2020 = 42 (46%)**	2016 = 23 (25%) 2017 = 4 (4%) 2018 = 39 (42%) 2019 = 16 (17%) **2020 = 50 (54%)**	2016 = 0 2017 = 0 2018 = 0 2019 = 0 **2020 = 0**	2016 = 0 2017 = 0 2018 = 0 2019 = 0 **2020 = 0**

Table 22 (continued).

Temperature Monitoring Location	No. of Days for Good Growth Potential – Daily Ave. ≤60.5°F	No. of Days for Fair Growth Potential – Daily Ave. 60.6° – 63.9°F	No. of Days of Poor Growth Potential – Daily Ave. 64.0° - 64.9°F	No. of Bad Thermal Days - Daily Ave. ≥65°F
Rush Ck. – Top of MGORD	2013 = 14 (15%) 2014 = 5 (6%) 2015 = 7 (8%) 2016 = 10 (11%) 2017 = 66 (71%) 2018 = 47 (51%) 2019 = 65 (71%) **2020 = 6 (6%)**	2013 = 43 (47%) 2014 = 14 (15%) 2015 = 20 (22%) 2016 = 32 (35%) 2017 = 26 (29%) 2018 = 42 (46%) 2019 = 23 (25%) **2020 = 50 (54%)**	2013 = 17 (18%) 2014 = 25 (27%) 2015 = 5 (5%) 2016 = 17 (18%) 2017 = 0 2018 = 3 (3%) 2019 = 4 (4%) **2020 = 12 (13%)**	2013 = 18 (20%) 2014 = 48 (52%) 2015 = 60 (65%) 2016 = 33 (36%) 2017 = 0 2018 = 0 2019 = 0 **2020 = 24 (26%)**
Rush Ck. – Bottom MGORD	2013 = 11 (12%) 2014 = 6 (6%) 2015 = 8 (9%) 2016 = 9 (10%) 2017 = 67 (73%) 2018 = 48 (52%) 2019 = 62 (68%) **2020 = 4 (4%)**	2013 = 38 (41%) 2014 = 11 (12%) 2015 = 20 (22%) 2016 = 31 (34%) 2017 = 25 (27%) 2018 = 42 (46%) 2019 = 28 (30%) **2020 = 50 (54%)**	2013 = 20 (22%) 2014 = 21 (23%) 2015 = 5 (6%) 2016 = 16 (17%) 2017 = 0 2018 = 2 (2%) 2019 = 2 (2%) **2020 = 18 (20%)**	2013 = 23 (25%) 2014 = 54 (59%) 2015 = 59 (64%) 2016 = 36 (39%) 2017 = 0 2018 = 0 2019 = 0 **2020 = 20 (22%)**
Rush Ck. – Old Highway 395 Bridge/Upper Rush section	2013 = 14 (15%) 2014 = 7 (8%) 2015 = N/A 2016 = 16 (17%) 2017 = 75 (82%) 2018 = 36 (39%) 2019 = 64 (70%) **2020 = 17 (18%)**	2013 = 41 (45%) 2014 = 25 (27%) 2015 = N/A 2016 = 24 (26%) 2017 = 17 (18%) 2018 = 56 (61%) 2019 = 28 (30%) **2020 = 48 (52%)**	2013 = 33 (36%) 2014 = 27 (29%) 2015 = N/A 2016 = 19 (21%) 2017 = 0 2018 = 0 2019 = 0 **2020 = 17 (18%)**	2013 = 4 (4%) 2014 = 33 (36%) 2015 = N/A 2016 = 33 (36%) 2017 = 0 2018 = 0 2019 = 0 **2020 = 10 (11%)**
Rush Ck. – Above Parker Ck.	2016 = 17 (18%) 2017 = 65 (71%) 2018 = 28 (30%) 2019 = 67 (73%) **2020 = 24 (26%)**	2016 = 26 (28%) 2017 = 27 (29%) 2018 = 64 (70%) 2019 = 25 (27%) **2020 = 41 (45%)**	2016 = 24 (26%) 2017 = 0 2018 = 0 2019 = 0 **2020 = 21 (23%)**	2016 = 25 (27%) 2017 = 0 2018 = 0 2019 = 0 **2020 = 10 (11%)**
Rush Ck. – Below Narrows	2013 = 17 (18%) 2014 = 13 (14%) 2015 = 24 (26%) 2016 = 22 (24%) 2017 = 75 (82%) 2018 = 46 (50%) 2019 = 74 (80%) **2020 = 36 (39%)**	2013 = 69 (75%) 2014 = 58 (63%) 2015 = 44 (48%) 2016 = 52 (57%) 2017 = 17 (18%) 2018 = 46 (50%) 2019 = 18 (20%) **2020 = 53 (58%)**	2013 = 6 (7%) 2014 = 18 (20%) 2015 = 22 (24%) 2016 = 16 (17%) 2017 = 0 2018 = 0 2019 = 0 **2020 = 2 (2%)**	2013 = 0 2014 = 3 (3%) 2015 =2 (2%) 2016 = 2 (2%) 2017 = 0 2018 = 0 2019 = 0 **2020 = 1 (1%)**
Rush Ck. – County Road	2013 = 17 (18%) 2014 = 17 (18%) 2015 = 25 (27%) 2016 = 24 (26%) 2017 = N/A 2018 = N/A 2019 = 71 (77%) **2020 = 31 (34%)**	2013 = 64 (70%) 2014 = 59 (65%) 2015 = 39 (42%) 2016 = 50 (54%) 2017 = N/A 2018 = N/A 2019 = 21 (23%) **2020 = 50 (54%)**	2013 = 8 (9%) 2014 = 14 (15%) 2015 =23 (25%) 2016 = 13 (14%) 2017 = N/A 2018 = N/A 2019 = 0 **2020 = 10 (11%)**	2013 = 3 (3%) 2014 = 2 (2%) 2015 = 5 (6%) 2016 = 5 (6%) 2017 = N/A 2018 = N/A 2019 = 0 **2020 = 1 (1%)**

Table 23. Diurnal temperature fluctuations in Rush Creek for 2020: maximum daily for month, daily average for month, and highest average for consecutive 21-day duration (92-day period from July 1 to September 30). NOTE: 2019 values in ( ) for comparison.

Temperature Monitoring Location	Maximum and Average Daily Diurnal Fluctuation for July	Maximum and Average Daily Diurnal Fluctuation for August	Maximum and Average Daily Diurnal Fluctuation for September	Highest Average Diurnal Fluctuation for a Consecutive 21-Day Duration
Rush Ck. – At Damsite	Max = 4.7°F (1.1) Ave = 1.8°F (0.3)	Max = 2.6°F (2.3) Ave = 1.9°F (1.6)	Max = 3.0°F (1.9) Ave = 1.4°F (1.3)	1.9 °F (1.9) July 1 – 21
Rush Ck. – Top of MGORD	Max = 6.4°F (5.5) Ave = 3.3°F (2.3)	Max = 4.5°F (8.2) Ave = 2.7°F (3.8)	Max = 2.5°F (6.2) Ave = 0.8°F (2.1)	3.4°F (4.1) July 1 – 21
Rush Ck. – Bottom MGORD	Max = 9.7°F (6.4) Ave = 6.9°F (3.4)	Max = 10.0°F (8.1) Ave = 7.6°F (5.0)	Max = 9.2°F (7.9) Ave = 6.3°F (6.3)	8.2°F (6.1) July 21 – Aug 10
Rush Ck. – Old Highway 395 Bridge	Max = 13.3°F (6.7) Ave = 10.1°F (4.0)	Max = 14.0°F (8.2) Ave = 10.4°F (6.3)	Max = 12.6°F (10.7) Ave = 9.1°F (8.4)	11.6°F (8.7) July 21 – Aug 10
Rush Ck. – Above Parker Ck.	Max = 14.2°F (7.0) Ave = 12.0°F (4.4)	Max = 16.1°F (9.7) Ave = 11.9°F (7.0)	Max = 14.2°F (11.8) Ave = 10.3°F (9.1)	13.1°F (9.7) July 21 – Aug 10
Rush Ck. – below Narrows	Max = 14.5°F (7.6) Ave = 12.3°F (9.6)	Max = 15.7°F (10.4) Ave = 12.2°F (7.9)	Max = 15.1°F (12.7) Ave = 11.6°F (10.2)	13.2°F (10.8) July 21 – Aug 10
Rush Ck. – County Road	Max = 17.5°F (9.3) Ave = 14.9°F (7.4)	Max = 18.2°F (13.2) Ave = 14.4°F (10.3)	Max = 17.5°F (13.5) Ave = 12.8°F (11.0)	15.5°F (11.7) July 24 – Aug 13

Table 24. Number of hours (percent of hours in parentheses) that temperature exceeded 66.2°F in Rush Creek: by month and for 92-day period from July 1 to September 30, 2013 - 2020. The total number of hours within each month is shown in parentheses in the column headings.

Temperature Monitoring Location	Number of Hours Temperature exceeded 66.2°F in July (744 hours)	Number of Hours Temperature exceeded 66.2°F in August (744 hours)	Number of Hours Temperature exceeded 66.2°F in Sept. (720 hours)	Number of Hours Temperature exceeded 66.2°F in 92-day period
Rush Ck. – At Damsite	2016 = 0 hrs 2017 = 0 hrs 2018 = 0 hrs 2019 = 0 hrs **2020 = 0 hrs**	2016 = 0 hrs 2017 = 0 hrs 2018 = 0 hrs 2019 = 0 hrs **2020 = 0 hrs**	2016 = 0 hrs 2017 = 0 hrs 2018 = 0 hrs 2019 = 0 hrs **2020 = 0 hrs**	2016 = 0 hrs 2017 = 0 hrs 2018 = 0 hrs 2019 = 0 hrs **2020 = 0 hrs**

Table 24 (continued).

Temperature Monitoring Location	Number of Hours Temperature exceeded 66.2°F in July (744 hours)	Number of Hours Temperature exceeded 66.2°F in August (744 hours)	Number of Hours Temperature exceeded 66.2°F in Sept. (720 hours)	Number of Hours Temperature exceeded 66.2°F in 92-day period
Rush Ck. – Top of MGORD	2013 = 4 hrs (0.5%) 2014 = 315 hrs (42%) 2015 = 140 hrs (19%) 2016 = 42 hrs (6%) 2017 = 0 hrs 2018 = 0 hrs 2019 = 0 hrs **2020 = 0 hrs**	2013 = 4 hrs (0.5%) 2014 = 96 hrs (13%) 2015 = 205 hrs (28%) 2016 = 127 hrs (17%) 2017 = 0 hrs 2018 = 6 hrs 2019 = 0 hrs **2020 = 71 hours (10%)**	2013 = 0 hrs 2014 = 0 hrs 2015 = 0 hrs 2016 = 0 hrs 2017 = 0 hrs 2018 = 0 hrs 2019 = 13 hrs **2020 = 47 hrs (7%)**	2013 = 8 hrs (0.4%) 2014 = 411 hrs (19%) 2015 = 345 hrs (16%) 2016 = 169 hrs (8%) 2017 = 0 hrs 2018 = 6 hrs (0.3%) 2019 = 13 hrs (0.6%) **2020 = 118 hrs (5%)**
Rush Ck. – Bottom MGORD	2013 = 121 hrs (16%) 2014 = 282 hrs (38%) 2015 = 305 hrs (41%) 2016 = 142 hrs (19%) 2017 = 0 hrs 2018 = 0 hrs 2019 = 0 hrs **2020 = 49 hrs (6%)**	2013 = 229 hrs (31%) 2014 = 248 hrs (33%) 2015 =282 hrs (38%) 2016 = 268 hrs (36%) 2017 = 0 hrs 2018 = 1 hr (0.01%) 2019 = 0 hrs **2020 = 234 hrs (31%)**	2013 = 61 hrs (9%) 2014 = 115 hrs (16%) 2015 = 17 hrs (2%) 2016 = 38 hrs (5%) 2017 = 2 hrs (0.3%) 2018 = 1 hr (0.01%) 2019 = 46 hrs (6%) **2020 = 101 hrs (14%)**	2013 = 411 hrs (19%) 2014 = 645 hrs (29%) 2015 = 604 hrs (27%) 2016 = 448 hrs (20%) 2017 = 2 hrs (0.09%) 2018 = 2 hrs (0.09%) 2019 = 46 hrs (2%) **2020 = 335 hrs (15%)**
Rush Ck. – Old 395 Bridge/Upper Rush	2013 = 181 hrs (24%) 2014 = 287 hrs (39%) 2016 = 216 hrs (29%) 2017 = 0 hrs 2018 = 17 hrs (2%) 2019 = 0 hrs **2020 = 113 hrs (15%)**	2013 = 228 hrs (31%) 2014 = 248 hrs (33%) 2016 = 263 hrs (35%) 2017 = 0 hrs 2018 = 32 hrs (4%) 2019 = 4 hrs (0.5%) **2020 = 241 hrs (32%)**	2013 = 73 hrs (10%) 2014 = 117 hrs (16%) 2016 = 53 hrs (7%) 2017 = 3 hrs (0.4%) 2018 = 33 hrs (5%) 2019 = 41 hrs (6%) **2020 = 87 hrs (12%)**	2013 = 482 hrs (22%) 2014 = 639 hrs (29%) 2016 = 532 hrs (24%) 2017 = 3 hrs = (0.1%) 2018 = 82 hrs (4%) 2019 = 45 hrs (2%) **2020 = 441 hrs (20%)**
Rush Ck. – Above Parker Creek	2016 = 240 hrs (32%) 2017 = 0 hrs 2018 = 70 hrs (9%) 2019 = 0 hrs **2020 = 146 hrs (20%)**	2016 = 269 hrs (36%) 2017 = 0 hrs 2018 = 68 hrs (9%) 2019 = 11 hrs (2%) **2020 = 257 hrs (35%)**	2016 = 65 hrs (9%) 2017 = 14 hrs (2%) 2018 = 44 hrs (6%) 2019 = 27 hrs (4%) **2020 = 73 hrs (10%)**	2016 = 574 hrs (26%) 2017 = 14 hrs (0.6%) 2018 = 182 hrs (8%) 2019 = 38 hrs (2%) **2020 = 476 hrs (22%)**
Rush Ck. – below Narrows	2013 = 158 hrs (21%) 2014 = 244 hrs (33%) 2015 = 129 hrs (17%) 2016 = 167 hrs (22%) 2017 = 0 hrs 2018 = 36 hrs (5%) 2019 = 0 hrs **2020 = 109 (15%)**	2013 = 192 hrs (26%) 2014 = 193 hrs (26%) 2015 = 189 hrs (25%) 2016 = 222 hrs (30%) 2017 = 0 hrs 2018 = 42 hrs (6%) 2019 = 13 hrs (2%) **2020 = 204 hrs (27%)**	2013 = 55 hrs (7%) 2014 = 105 hrs (15%) 2015 = 0 hrs (0%) 2016 = 49 hrs (7%) 2017 = 0 hrs 2018 = 36 hrs (5%) 2019 = 8 hrs (1%) **2020 = 43 hrs (6%)**	2013 = 405 hrs (18%) 2014 = 542 hrs (25%) 2015 = 318 hrs (14%) 2016 = 438 hrs (20%) 2017 = 0 hrs 2018 = 114 hrs (5%) 2019 = 21 hrs (1%) **2020 = 356 hrs (16%)**
Rush Ck. – County Road	2013 = 197 hrs (27%) 2014 = 222 hrs (30%) 2015 = 174 hrs (23%) 2016 = 212 hrs (28%) 2017 = N/A 2018 = N/A 2019 = 0 hrs **2020 = 195 hrs (26%)**	2013 = 172 hrs (23%) 2014 = 195 hrs (26%) 2015 = 119 hrs (16%) 2016 = 233 hrs (31%) 2017 = N/A 2018 = N/A 2019 = 76 hrs (10%) **2020 = 241 (32%)**	2013 = 42 hrs (6%) 2014 = 79 hrs (11%) 2015 = 0 hrs (0%) 2016 = 42 hrs (6%) 2017 = N/A 2018 = N/A 2019 = 10 hrs (1%) **2020 = 41 hrs (6%)**	2013 = 411 hrs (19%) 2014 = 496 hrs (23%) 2015 = 293 hrs (13%) 2016 = 487 hrs (22%) 2017 = N/A 2018 = N/A 2019 = 86 hrs (4%) **2020 = 477 (22%)**

Discussion

The 2020 sampling year documented fish populations responding with low growth rates and poor condition factors in Rush Creek to the Dry Normal 1 RY and thermally challenging water temperature conditions during the summer months. The 2020 sampling was also marked by wildfires and poor-to-hazardous air quality conditions that prevented us from completing the capture-run electrofishing. For the first time, population estimates were generated using average capture efficiencies from past data collections.

Thus, this report's Discussion is focused on the trout populations' response to the Dry-Normal 1 RY2020, the unfavorable summer water temperatures and the resulting low growth rates and poor condition factors of fish. An examination of Lee Vining air temperature is also made, in context of how air temperatures influence water temperatures.

2020 Summer Water Temperature, Fish Densities and Trout Growth Rates

The 2020 Brown Trout growth, as measured by weight gains of PIT tagged fish, between age-0 and age-1 in the Upper Rush and Bottomlands sampling sections were extremely low (Table 25). In the Upper Rush section, the weight gain of age-1 fish was 21 g in 2020, the lowest average weight gain recorded for this section and 31 g less than the 13-year long-term average (Table 25). Similarly, in the Bottomlands section, the 2020 weight gain of age-1 Brown Trout was 29 g, 14.4 g lower than the long-term average and the lowest value recorded since the first two years of the five-year drought period (Table 25).

The Upper Rush section's age-2 recaptures gained an average of 55 g between 2019 and 2020; a growth rate 35 g lower than the average growth rate (90.3 g) for the 11 years of available tag return data (Table 26). The 2020 average growth rate of age-2 recaptures in Upper Rush was the lowest value recorded for this section since the first two years of the five-year drought period. No PIT-tagged age-2 Brown Trout were recaptured in the Bottomlands section of Rush Creek in 2020 (Table 26).

The poor average growth rates documented in 2020 suggest that a combination of increasing densities of fish was an important factor, in combination with less than favorable summer water temperatures. We also know growth rates were extremely low in the Upper Rush section from the PIT tag recaptures of age-1 fish that were 124 mm, 127 mm in length and three fish of 132 mm in length. In addition, a total of 106 presumed age-1 Brown Trout caught in Upper Rush in 2020 were between 125 and 135 mm in length. Similarly, a total of 34 Brown Trout caught in the Bottomlands section in 2020 were between 125 and 135 mm in length.

Studies have determined that trout growth in streams is a complex interaction of population density, water temperature and food availability (Baerum et al. 2013). Conditions in Rush Creek during 2017 were favorable for the record growth we documented with respect to multiple variables, especially extremely low fish densities and cool summer water temperatures. Then in

2018 growth rates dropped with mostly favorable summer water temperatures, but Brown Trout densities increased in all monitoring sections. In 2019, the wet-year runoff resulted in more favorable summer water temperatures than 2018, yet growth rates continued to drop as fish densities increased. Density-dependent growth in stream-dwelling salmonids is well researched and there's broad support for the hypothesis that density-dependent growth occurs at low population densities, probably due to exploitive completion (Grant and Imre 2005). One study used controlled reaches of a small stream and determined that population density affected growth in trout parr (yearlings and older) and that competition and population regulation was not just limited to early life-stages, as suggested by other researchers (Bohlin et al. 2002). Another analysis used data collected from 19 trout populations (six species and 16 different studies) and determined that 15 of the 19 populations showed evidence of decreased growth rates with increasing densities (Grant and Imre 2005). This analysis was focused primarily on age-0 trout (Grant and Imre 2005). For Upper Rush, 15 years (2006-2020) of age-0 Brown Trout and total Brown Trout population estimates were plotted versus the average weights of age-0 Brown Trout from those sample years (Figure 21). Trend lines through each of the population estimates strongly suggest that density-dependent growth of age-0 fish does occur in the Upper Rush section (Figure 21). In the past four years, average weights of age-0 Brown Trout sampled from the Upper Rush section dropped from 12.3 g in 2017 to 8.6 g in 2018 to 6.3 g in 2019 to 6.9 g in 2020. Similarly, in the Bottomlands section average weights of age-0 Brown Trout dropped from 13.7 g in 2017 to 6.8 g in 2018; a 50% decrease in average weights when densities of age-0 fish increased tenfold. In 2020, the average weight of age-0 Brown Trout in the Bottomlands section equaled 6.3 g.

Table 25. Annual growth rate (g) for PIT tagged or fin-clipped age-0 to age-1 Brown Trout in two sections of Rush Creek by year. N/A = not available

Age Class	Growth Years	Upper Rush Growth (g)	Bottomlands Growth (g)	Fin clip or PIT Tag
Age-0 to Age-1	2006-2007	32	N/A	Ad Clip
	2008-2009	51	43	Ad Clip
	2009-2010	48	40	PIT Tag
	2010-2011	48	36	PIT Tag
	2011-2012	33	25	PIT Tag
	2012-2013	35	25	PIT Tag
	2013-2014	N/A	N/A	N/A
	2014-2015	55	41	PIT Tag
	2015-2016	77	62	PIT Tag
	2016-2017	129	96	PIT Tag
	2017-2018	56	42	PIT Tag
	2018-2019	39	38	PIT Tag
	2019-2020	**21**	**29**	PIT Tag
	Long-term Ave.	*52.0*	*43.4*	

Table 26. Annual growth rate (g) for PIT tagged or fin-clipped age-1 to age-2 Brown Trout in two sections of Rush Creek by year. N/A = not available

Age Class	Growth Years	Upper Rush Growth (g)	Bottomlands Growth (g)	Fin clip or PIT Tag
Age-1 to Age-2	2008-2009	N/A	N/A	Ad Clip
	2009-2010	70	54	PIT Tag
	2010-2011	73	32	PIT Tag
	2011-2012	42	28	PIT Tag
	2012-2013	42	22	PIT Tag
	2013-2014	N/A	29	PIT Tag
	2014-2015	69	62	PIT Tag
	2015-2016	176	N/A	PIT Tag
	2016-2017	239	N/A	PIT Tag
	2017-2018	66	55	PIT Tag
	2018-2019	71	44	PIT Tag
	2019-2020	**55**	**N/A**	PIT Tag
	Long-term Ave.	*90.3*	*40.8*	

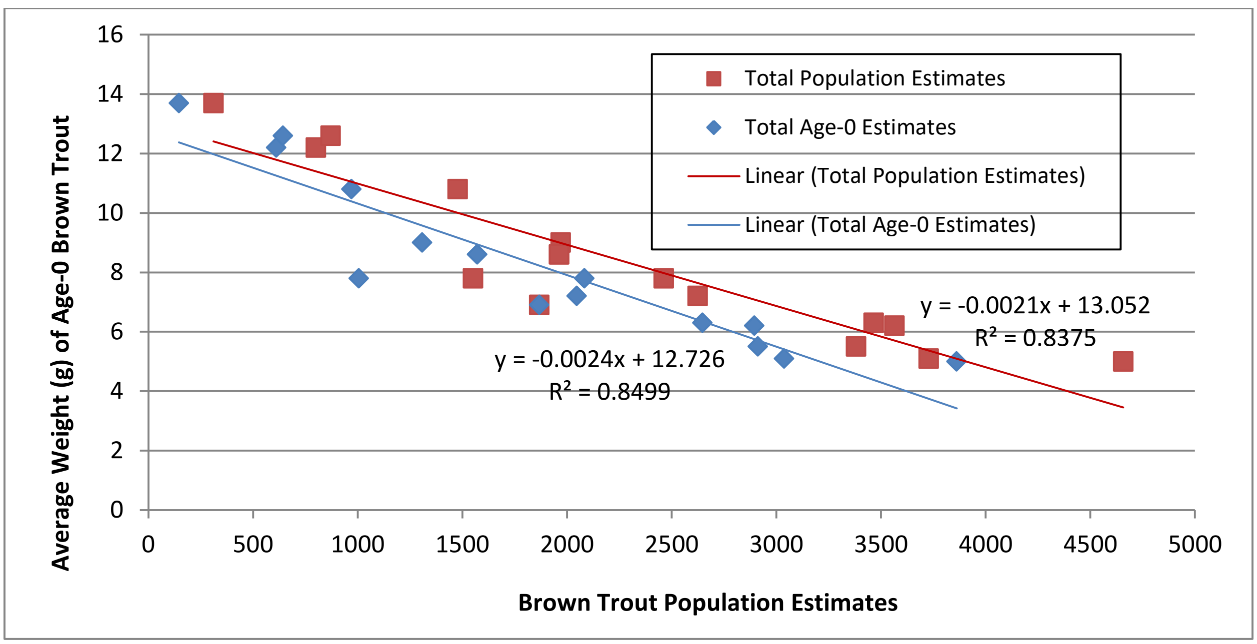


Figure 21. Relationship between average weights of age-0 brown trout and population estimates (age-0 and all trout) in the Upper Rush sampling section, 2006-2020.

Water temperature metrics are varied and papers exist that summarize studies performed to evaluate thermal effects on Brown Trout (Armour 1997; Bell 2006). Diurnal fluctuations previously cited as detrimental and/or stressful to trout (Werley et al. 2007) have been supported by additional research. For example, Rainbow Trout physiological changes such as increased ventilatory rates and stroke rate in response to increases in water temperature have been reported (Henry 1978). This research also documented trout acclimated to 64.5°F water and subjected to 7.2°F diurnal fluctuations exhibited signs of ventilatory and cardiovascular distress, problems commonly associated with low circulating levels of oxygen in the blood (Henry 1978). It appears these trout were unable to fully meet their oxygen requirements associated with cycling temperatures above 64.5°F. When trout are unable to fully meet their oxygen requirements, stress levels elevate and fish may become more susceptible to parasites and other disease vectors. For example, studies of riverine wild Brown Trout populations in Switzerland and proliferative kidney disease (PKD) caused by a myxozoan parasite reported that parasite prelevance and intensity on trout were most strongly correlated to daily mean water temperature during summer months (Ruben et al. 2019). This study concluded that parasite infection prelevance increased by nearly 6% for every one degree (Celsius) increase of daily mean summer water temperature above 15^{o}C (Ruben et al 2019). The authors speculated that the prelevance and intensity of PKD in Brown Trout will increase with ongoing climate change and continued warming of Switzerland's trout-bearing rivers.

As previously described, the 2020 water temperatures in Rush Creek downstream of GLR were unfavorable at all temperature monitoring locations for some periods of the summer, defined as the months of July, August and September. These conditions occurred when GLR's storage elevation was 20.0 to 21.6 feet above the 7,100 foot elevation recommended in the Synthesis Report as a minimum storage level to avoid the release of warmer water to Rush Creek below GLR (McB&T and RTA 2010). This minimum recommended summer storage level was derived from previous GLR temperature modeling conducted in 1991 and 1992, where at reservoir storage levels below 7,100 feet an inflection point occurred where water temperatures released to the MGORD increased (Cullen and Railsback 1993).

The fact that GLR's 2020 summer storage levels were ≥20 feet higher than 7,100 feet, but still resulted in unfavorable thermal conditions for Brown Trout in Rush Creek begs asking the following questions. Why isn't this recommendation producing adequate summer thermal conditions for good trout growth rates and condition factors? Has GLR continued to fill with sediment and its actual storage volume is significantly less than 47,000 acre-feet, thus the 1993 modeled predictions of storage level versus water temperature are inaccurate or no longer valid? Is changing climate leading to hotter summer air temperatures in the Mono basin, and if so, do these air temperatures exert more thermal loading to streamflow as it travels down Rush Creek?

In regards to the question of changing climate; yes, summer air temperatures in the Mono basin have steadily increased over the past 31 years (Table 27). Broken down by decades (1990's, 2000's and 2010's), the metrics of average maximum, average minimum, average average and number of days with peak temperatures ≥90^{o}F have all increased (Table 27). The number of days with peak air temperatures ≥90^{o}F appears to have recently experienced the biggest increase; in the first 25 years there were four years (1994, 2002, 2007 and 2012) where at least 10 days had maximum temperatures ≥90^{o}F versus in the most recent five years (2016-2020) four years experienced at least 10 days with maximum temperatures ≥90^{o}F (Table 27).

Periods of drought will most likely continue to negatively impact the Rush Creek Brown Trout fishery in terms of population size, growth rates and condition factors. However, after the recent five-year drought, the fishery exhibited resiliency and bounced back quickly in the numbers of fish, their growth rates and condition factors. Thus, changing climate and variable snowpack conditions in the eastern Sierras will most likely dictate the long-term fate and viability of Rush Creek's Brown Trout fishery.

Table 27. Thirty-one years of summer (July-September) air temperature data for Lee Vining, CA. Data are from Western Regional Climate Center and National Weather Service/Reno.

YEAR	Ave Max Temp (°F)	Ave Min Temp (°F)	Ave Ave Temp (°F)	Number of Days ≥90°F
1990	80.2	49.8	65.0	1
1991	81.3	51.3	66.3	4
1992	79.9	49.7	64.9	0
1993	N/A	N/A	N/A	N/A
1994	82.7	51.3	67.0	12
1995	80.8	49.9	65.3	0
1996	80.7	50.3	65.4	3
1997	79.1	49.1	64.2	0
1998	79.4	51.2	65.4	7
1999	79.4	49.6	64.5	4
1990's Averages	**80.4**	**50.2**	**65.3**	**3.4**
2000	80.6	49.4	65.0	2
2001	81.9	51.8	66.9	4
2002	81.9	51.1	66.5	14
2003	82.3	51.6	66.9	5
2004	80.6	48.3	64.5	1
2005	79.8	50.3	65.0	6
2006	80.6	50.3	65.4	7
2007	81.7	52.0	66.8	12
2008	83.3	51.5	67.4	6
2009	82.1	50.7	66.4	5
2000's Averages	**81.5**	**50.7**	**66.1**	**6.2**
2010	81.9	49.7	65.8	4
2011	81.7	51.8	66.8	1
2012	84.4	52.6	68.5	12
2013	81.3	50.4	65.9	8
2014	81.5	51.6	66.6	6
2015	80.9	50.9	65.9	5
2016	83.3	49.1	66.2	16
2017	81.4	51.3	66.4	10
2018	83.6	51.8	67.7	13
2019	81.4	50.2	65.8	2
2020	83.5	50.1	67.2	17
2010's Averages	**82.3**	**50.9**	**66.6**	**8.5**

Apparent Survival Rates

Apparent survival rates of age-1 Brown Trout were calculated with the following equation: [# age-1 recaps in 2020/capture probability of age-1 fish] ÷ [# age-0 tagged in 2019 - # shed tags]. For mark-recapture sections, capture probabilities were derived from the recapture run data: # of recaptures/# of captures. Compared to the 2019 survival rates; the 2020 apparent survival rates increased by 4.8% in Upper Rush Creek and decreased by 2.2% in the Bottomlands section of Rush Creek (Table 28). Between 2019 and 2020, the age-1 Brown Trout apparent survival rate decreased by 12.6% in the Lee Vining Creek main channel section (Table 28). Walker Creek's apparent survival rate more than doubled between 2019 and 2020; with the 2020 rate of 46.5% the highest documented for this sampling section (Table 28).

Table 25. Apparent survival rates of age-1 Brown Trout in Rush, Walker and Lee Vining creeks in 2020. Previous years' values are in parentheses for comparisons.

Creek and Section	Capture Probability	No. Age-1 Recaps in 2020	No. Age-0 Tagged in 2019	No. Shed Tags	Apparent Survival Rate
Rush – Upper	0.37	21	257	1	2016 = 22.7% 2017 = 106% 2018 = 50.2% 2019 = 17.4% **2020 = 22.2%**
Rush - Bottomlands	0.47	7	152	0	2016 = 9.7% 2017 = 72.3% 2018 = 66.8% 2019 = 12.0% **2020 = 9.8%**
Walker Creek	0.98	61	137	3	2016 = 37.8% 2017 = 7.0% 2018 = N/A 2019 = 19.8% **2020 = 46.5%**
Lee Vining Creek	0.51	24	174	2	2016 = 46.3% 2017 = 4.8% 2018 = 70.6% 2019 = 40.0% **2020 = 27.4%**

Methods Evaluation

In 2020, the Camp Fire and hazardous air quality prevented us from making mark-recapture population estimates. The use of previous years' capture efficiencies to generate estimates was seen as an acceptable alternate for 2020. This use was supported by peer-reviewed literature that had found in certain situations, population estimates derived from capture efficiencies were appropriate surrogates to more intensive mark-recapture generated population estimates (Peterson and Dunham 2003; Price and Peterson 2010). In the future, we may rely on this method of deriving population estimates, especially since the post-settlement monitoring program will alternate between two-pass sampling years and single-pass sampling years.

As in previous years, small variations in wetted channel widths were measured, which resulted in changes to sample section areas. Thus, it is recommended that channel lengths and widths are re-measured annually.

The PIT tagging program was continued during the September 2020 sampling and tags were implanted primarily in age-0 fish and presumed age-1 fish in the MGORD. The PIT tagging program allowed us to continue to document annual growth rates of trout, calculate apparent survival rates, and assess the ability of fish to reach or exceed lengths of 300 mm (or 12 inches). Continuation of the PIT tagging program is recommended as the fisheries monitoring program moves towards its post-settlement phase.

Trout size classes (0-124, 125-199, and ≥200 mm) developed and discussed during the 2008 annual report should continue to be used for calculations of population estimates (Hunter et al. 2008). Using these size classes provides for long-term consistency as well as year to year consistency with the annual fisheries data sets.

To ensure that electrofishing sampling can be conducted safely and efficiently, flow in Rush Creek should not exceed **40 cfs** and flow in Lee Vining Creek should not exceed **30 cfs** during the annual sampling period. Allowances for flow variances to allow for safe wading conditions and effective sampling were included in the new Terms of Settlement.

As of early February 2021, the eastern Sierras had experienced a below normal winter and the snow pack near Mammoth was approximately 45% to 68% of normal. If RY 2021 remains below average (by April 1st) then Rush Creek below GLR will likely experience less than favorable summer water temperature conditions, which could translate into another year of poor growth rates and condition factors. LADWP hosted a conference call on 2/16/2021 to discuss the 2021 operations plan under another TUCP and the 2021 RY forecast; the RY types in the TUCP ranged from a Dry RY to a Normal RY, with a Dry to Dry-Normal 1 or 2 as the most likely scenario. An extremely wet March would be required to achieve a Normal RY designation.

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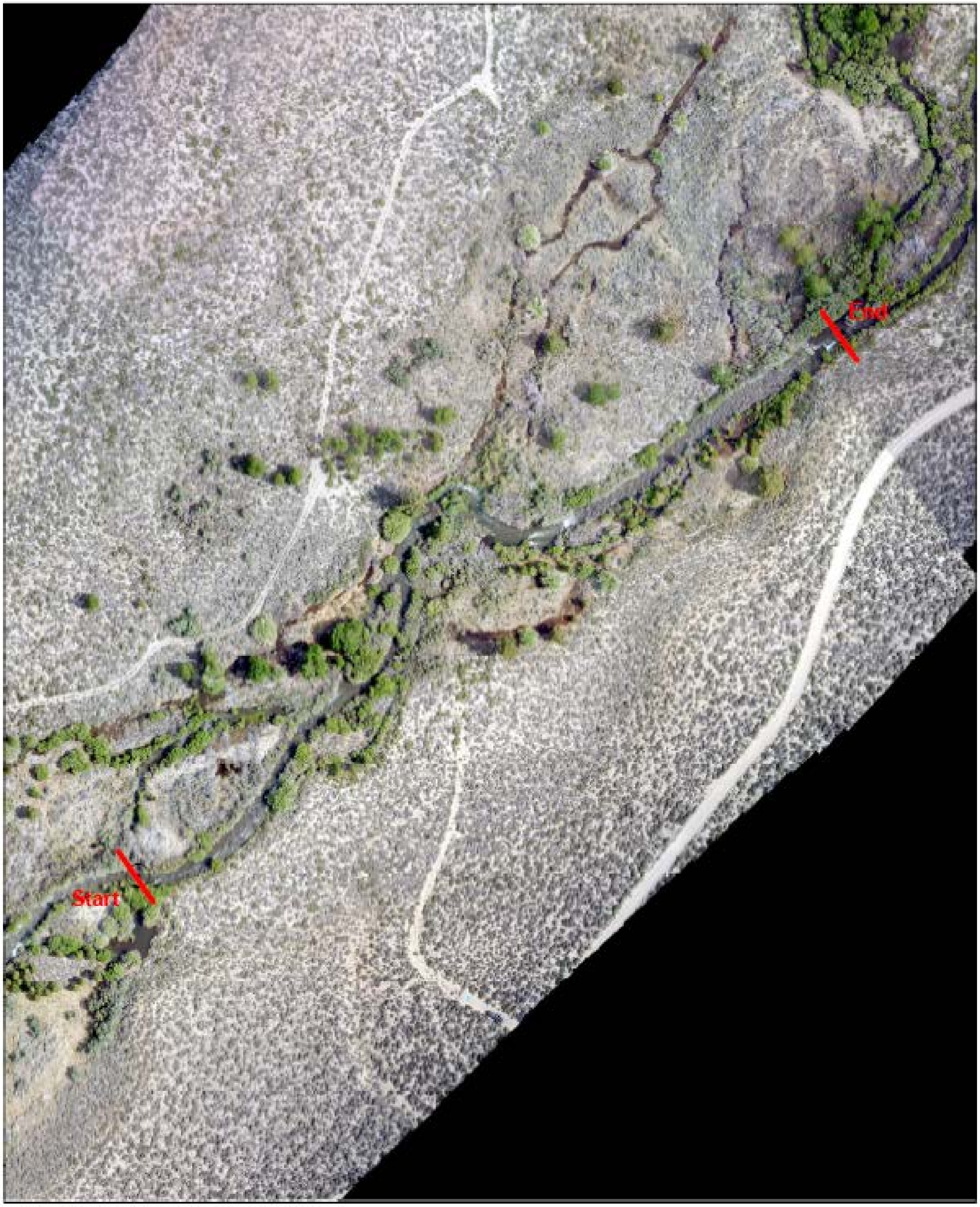
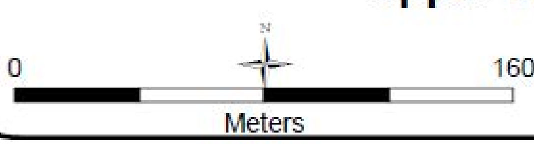
Appendices for the 2020 Mono Basin Annual Fisheries Report

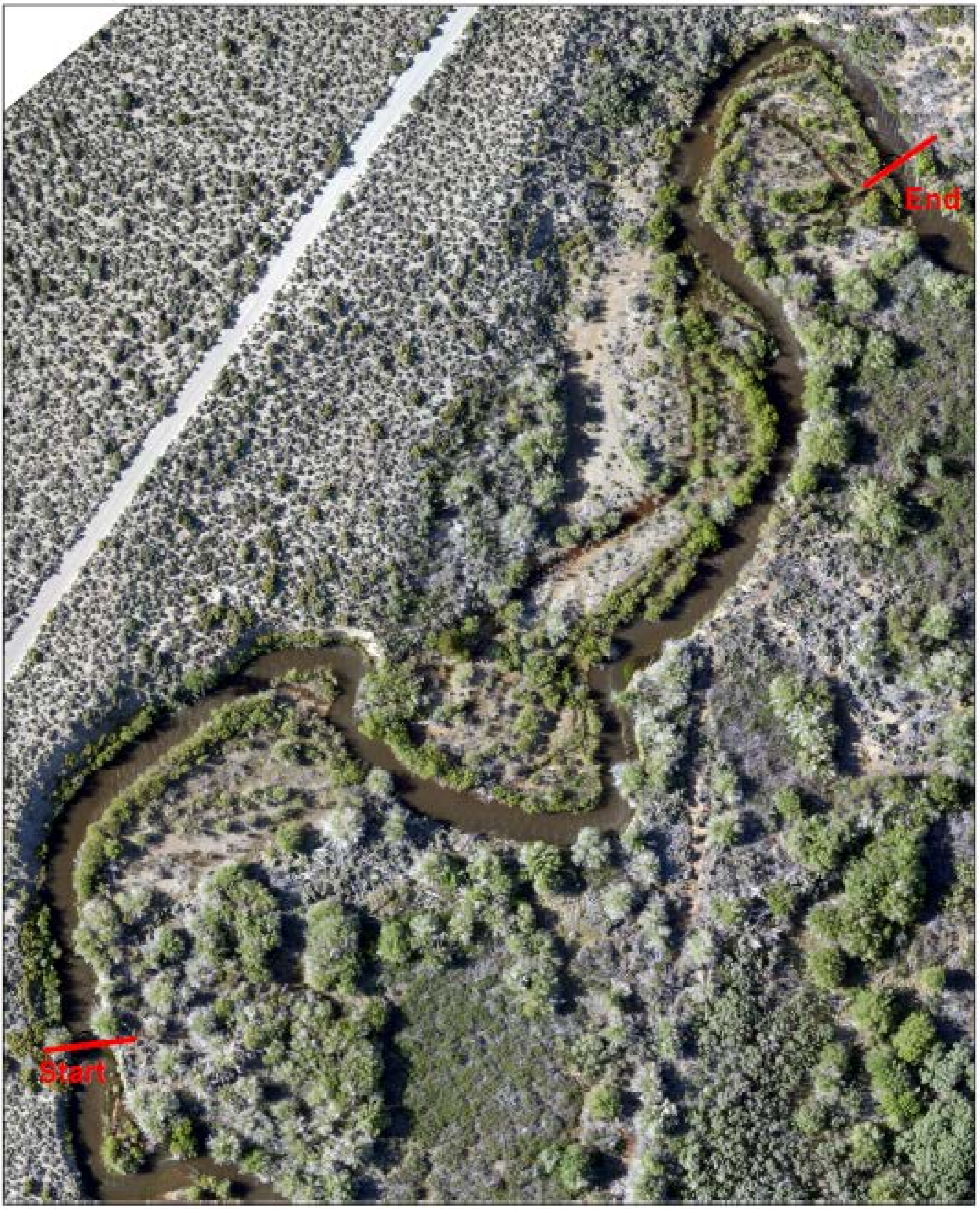
Appendix A: Aerial Photographs of Annual Sample Sites on Rush, Walker and Lee Vining Creeks



Upper Rush Creek



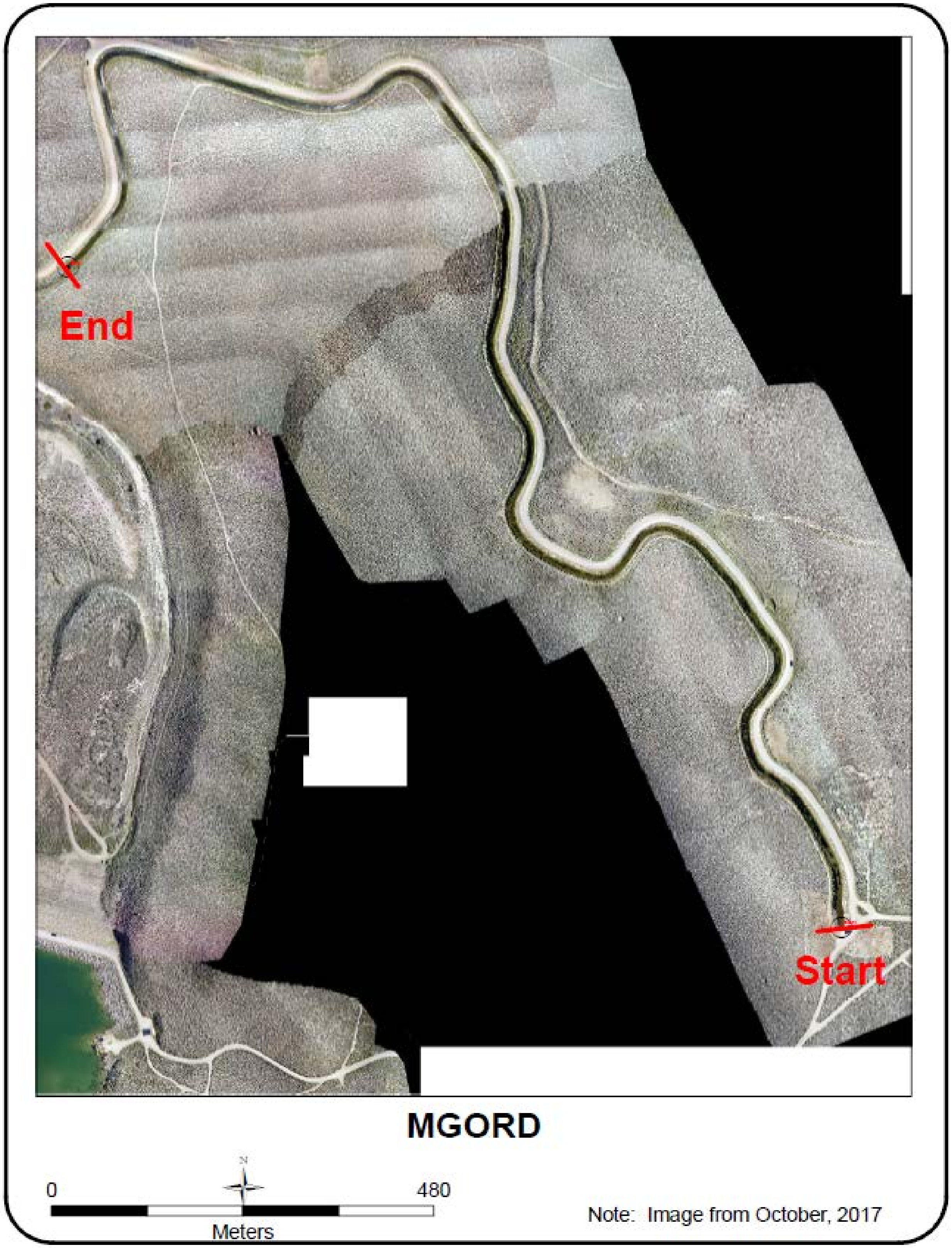
Note: Image from October, 2017



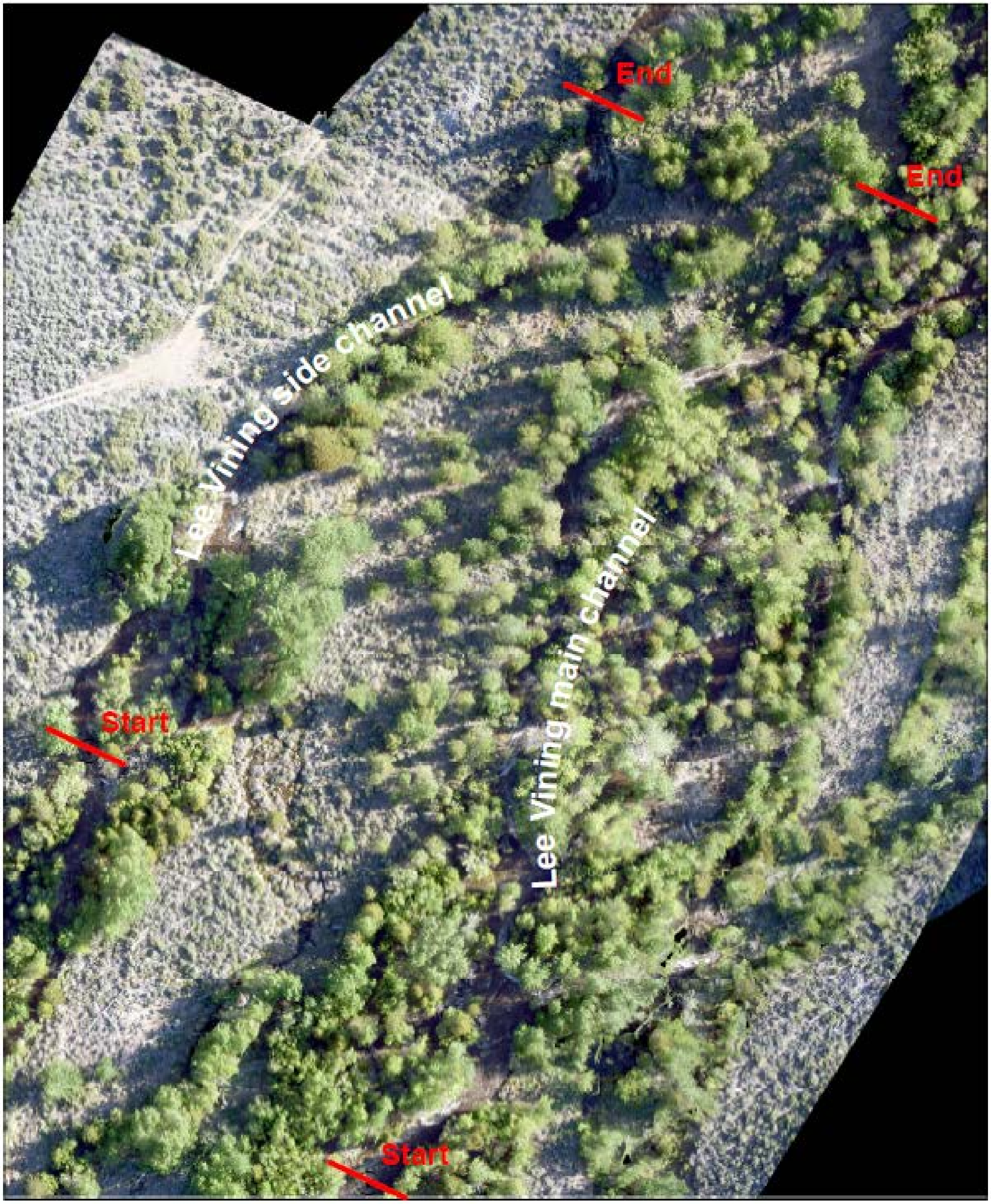
Rush Bottomlands

0 100
Meters

Note: Image from October, 2017


End
Start
MGORD
0
480
Meters
N
Note: Image from October, 2017


End
Start
Walker Creek
0
N
100
Meters
Note: Image from October, 2017



Lee Vining Creek Main and B-1 Side Channels

Note: Image from October, 2017

Appendix B: Tables of Numbers of Brown Trout and Rainbow Trout Implanted with PIT Tags (by sampling section) between 2009 and 2019

Table B-1. Total numbers of trout implanted with PIT tags during the 2009 sampling season, by stream, sample section, age-class and species.

Stream	Sample Section	Number of Age-0 Brown Trout	Number of Age-1 Brown Trout	Number of Age-0 Rainbow Trout	Number of Age-1 Rainbow Trout	Reach Totals
Rush Creek	Upper Rush	256	26	15	1	**298 Trout**
	Bottomlands	164	68	0	0	**232 Trout**
	County Road	108	29	0	0	**137 Trout**
	MGORD	54	642*	0	0	**696 Trout**
Lee Vining Creek	Main Channel	10	45	4	3	**62 Trout**
	Side Channel	5	0	0	1	**6 Trout**
Walker Creek	Above old 395	114	51	0	0	**165 Trout**
Totals:		**711**	**861**	**19**	**5**	**Total Trout: 1,596**

*Many of these MGORD trout were >age-1.

Table B-2. Total numbers of trout implanted with PIT tags during the 2010 sampling season, by stream, sample section, age-class and species.

Stream	Sample Section	Number of Age-0 Brown Trout (<125 mm)	Number of Age-1 and older Brown Trout	Number of Age-0 Rainbow Trout (<125 mm)	Number of Age-1 and older Rainbow Trout	Reach Totals
Rush Creek	Upper Rush	242	11	4	0	**257 Trout**
	Bottomlands	284	3	0	0	**287 Trout**
	County Road	210	7	0	0	**217 Trout**
	MGORD	1	359*	0	12	**372 Trout**
Lee Vining Creek	Main Channel	24	8	0	1	**33 Trout**
	Side Channel	13	0	0	0	**13 Trout**
Walker Creek	Above old 395	81	14	0	0	**95 Trout**
Totals:		**855**	**402**	**4**	**13**	**Total Trout: 1,274**

*Many of these MGORD trout were >age-1.

Table B-3. Total numbers of trout implanted with PIT tags during the 2011 sampling season, by stream, sample section, age-class and species.

Stream	Sample Section	Number of Age-0 Brown Trout (<125 mm)	Number of Age-1 and older Brown Trout	Number of Age-0 Rainbow Trout (<125 mm)	Number of Age-1 and older Rainbow Trout	Reach Totals
Rush Creek	Upper Rush	393	3	30	0	**426 Trout**
	Bottomlands	178	1	11	0	**190 Trout**
	County Road	196	1	6	0	**203 Trout**
	MGORD	8	142*	3	3	**156 Trout**
Lee Vining Creek	Main Channel	24	0	0	0	**24 Trout**
	Side Channel	11	14	0	0	**25 Trout**
Walker Creek	Above old 395	41	0	0	0	**41 Trout**
Totals:		**851**	**161**	**50**	**3**	**Total Trout: 1,065**

*Many of these MGORD trout were >age-1.

Table B-4. Total numbers of trout implanted with PIT tags during the 2012 sampling season, by stream, sample section, age-class and species.

Stream	Sample Section	Number of Age-0 Brown Trout (<125 mm)	Number of Age-1 and older Brown Trout	Number of Age-0 Rainbow Trout (<125 mm)	Number of Age-1 and older Rainbow Trout	Reach Totals
Rush Creek	Upper Rush	117	1	2	0	**120 Trout**
	Bottomlands	110	1	6	0	**117 Trout**
	County Road	0	2	0	0	**2 Trout**
	MGORD	0	0	0	0	**0 Trout**
Lee Vining Creek	Main Channel	125	0	72	0	**197 Trout**
	Side Channel	0	0	0	0	**0 Trout**
Walker Creek	Above old 395	60	0	0	0	**60 Trout**
Age Class Sub-totals:		**412**	**4**	**80**	**0**	**Total Trout: 496**

Table B-5 Total numbers of trout implanted with PIT tags during the 2014 sampling season, by stream, sample section, age-class and species.

Stream	Sample Section	Number of Age-0 Brown Trout (<125 mm)	Number of Age-1 Brown Trout (125-170 mm)	Number of Age-0 Rainbow Trout (<125 mm)	Number of Age-1 Rainbow Trout (125-170 mm)	Section Totals
Rush Creek	Upper Rush	243	86	1	0	**330 Trout**
	Bottomlands	34	43	0	0	**77 Trout**
	MGORD	13	125-199 mm = 60 Brown Trout ≥200 mm = 185 Brown Trout			**258 Trout**
Lee Vining Creek	Main Channel	127	103	5	22	**257 Trout**
	Side Channel	0	0	0	0	**0 Trout**
Walker Creek	Above old 395	42	0	0	0	**42 Trout**
Age Class Sub-totals:		**459**	**232***	**6**	**22**	**Total Trout: 964**

*this sub-total excludes age-1 and older MGORD fish

Table B-6. Total numbers of trout implanted with PIT tags during the 2015 sampling season, by stream, sample section, age-class and species.

Stream	Sample Section	Number of Age-0 Brown Trout (<125 mm)	Number of Age-1 and older Brown Trout	Number of Age-0 Rainbow Trout (<125 mm)	Number of Age-1 and older Rainbow Trout	Section Totals
Rush Creek	Upper Rush	234	2*	7	0	**243 Trout**
	Bottomlands	167	3*	0	0	**170 Trout**
	MGORD	29	125-199 mm = 37 Brown Trout ≥200 mm = 83 Brown Trout (2 shed/new)			**149 Trout**
Lee Vining Creek	Main Channel	195	1*	0	0	**196 Trout**
	Side Channel	0	0	0	0	**0 Trout**
Walker Creek	Above old 395	113	0	0	0	**113 Trout**
Age Class Sub-totals:		**738**	**6****	**7**	**0**	**Total Trout: 871**

*shed tag/new tag implanted **this sub-total excludes age-1 and older MGORD fish

Table B-7. Total numbers of trout implanted with PIT tags during the 2016 sampling season, by stream, sample section, age-class and species.

Stream	Sample Section	Number of Age-0 Brown Trout (<125 mm)	Number of Age-1 and older Brown Trout	Number of Age-0 Rainbow Trout (<125 mm)	Number of Age-1 and older Rainbow Trout	Section Totals
Rush Creek	Upper Rush	36	0	1	0	**37 Trout**
	Bottomlands	79	1*	0	0	**80 Trout**
	MGORD	4 BNT 1 RBT	125-199 mm = 9 BNT ≥200 mm = 154** BNT and 7 RBT			**175 Trout**
Lee Vining Creek	Main Channel	46	1*	0	0	**47 Trout**
	Side Channel	1	0	0	0	**1 Trout**
Walker Creek	Above old 395	228	1*	0	0	**229 Trout**
Age Class Sub-totals:		**394**	**166**	**2**	**7**	**Total Trout: 569**

*shed tag/new tag implanted **two of these BNT = shed tag/new tag implanted

Table B-8. Total numbers of trout implanted with PIT tags during the 2017 sampling season, by stream, sample section, age-class and species.

Stream	Sample Section	Number of Age-0 Brown Trout (<125 mm)	Number of Age-1 and older Brown Trout	Number of Age-0 Rainbow Trout (<125 mm)	Number of Age-1 and older Rainbow Trout	Section Totals
Rush Creek	Upper Rush	192	2*	14	0	**208 Trout**
	Bottomlands	34	0	0	0	**34 Trout**
	MGORD	38	0	2	0	**40 Trout**
Lee Vining Creek	Main Channel	31	0	0	0	**31 Trout**
	Side Channel	5	0	0	0	**5 Trout**
Walker Creek	Above old 395	0	0	0	0	**0 Trout**
Age Class Sub-totals:		**300**	**2**	**16**	**0**	**Total Trout: 318**

*shed tag/new tag implanted

Table B-9. Total numbers of trout implanted with PIT tags during the 2018 sampling season, by stream, sample section, age-class and species.

Stream	Sample Section	Number of Age-0 Brown Trout (<125 mm)	Number of Age-1 and older Brown Trout	Number of Age-0 Rainbow Trout (<125 mm)	Number of Age-1 and older Rainbow Trout	Section Totals
Rush Creek	Upper Rush	314	3*	72	1*	**390 Trout**
	Bottomlands	288	0	0	0	**288 Trout**
	MGORD	25	148**	1	7	**181 Trout**
Lee Vining Creek	Main Channel	87	0	8	0	**95 Trout**
	Side Channel	0	0	0	0	**0 Trout**
Walker Creek	Above old 395	43	2*	0	0	**45 Trout**
Age Class Sub-totals:		**757**	**153**	**81**	**8**	**Total Trout: 999**

*shed tag/new tag implanted **≤250 mm in total length

Table B-10. Total numbers of trout implanted with PIT tags during the 2019 sampling season, by stream, sample section, age-class and species.

Stream	Sample Section	Number of Age-0 Brown Trout (<125 mm)	Number of Age-1 and older Brown Trout	Number of Age-0 Rainbow Trout (<125 mm)	Number of Age-1 and older Rainbow Trout	Section Totals
Rush Creek	Upper Rush	257	3*	28	0	**288 Trout**
	Bottomlands	152	3*	0	0	**155 Trout**
	MGORD	64	167** 8*	1	5	**245 Trout**
Lee Vining Creek	Main Channel	174	0	0	0	**174 Trout**
	Side Channel	0	0	0	0	**0 Trout**
Walker Creek	Above old 395	137	1*	0	0	**138 Trout**
Age Class Sub-totals:		**784**	**182**	**29**	**5**	**Total Trout: 1,000**

*shed tag/new tag implanted **≤250 mm in total length

Appendix C: Table of PIT-tagged Fish Recaptured during September 2020 Sampling

Date of Recapture	Species	Length (mm)	Weight (g)	PIT Tag Number 98-	Location of 2020 Recapture	Location of Initial Capture and Tagging	Comments
9/11/2020	BNT	212	76	~~9001028114777~~	LV Main	LV Main	MORT, tag pulled
9/11/2020	BNT	185	55	~~9001031372126~~	LV Main	LV Main	MORT, tag pulled
9/11/2020	BNT	157	33	~~9001031372149~~	LV Main	LV Main	MORT, tag pulled
9/11/2020	BNT	160	38	9001031372149	LV Main	LV Main	Shed tag, new tag implanted
9/10/2020	BNT	211	95	9001038116788	MGORD	MGORD	Shed tag, new tag implanted
9/19/2019	BNT	139	28	9001038116743	UpperRush	Upper Rush	Shed tag, new tag implanted
9/12/2020	BNT	154	39	9001038117260	Walker Ck	Walker Creek	Shed tag, new tag implanted
9/12/2020	BNT	168	46	9001038117265	Walker Ck	Walker Creek	Shed tag, new tag implanted
9/12/2020	BNT	155	34	9001038117308	Walker Ck	Walker Creek	Shed tag, new tag implanted
9/12/2020	BNT	225	104	9001038117319	Walker Ck	Walker Creek	Shed tag, new tag implanted
9/9/2020	BNT	287	194	9001006111571	UpperRush	Upper Rush	
9/9/2020	BNT	235	140	9001028113863	UpperRush	Upper Rush	
9/9/2020	BNT	198	80	9001028113952	UpperRush	Upper Rush	
9/9/2020	BNT	214	81	9001028114021	UpperRush	Upper Rush	
9/9/2020	BNT	219	99	9001028114542	UpperRush	Upper Rush	
9/9/2020	BNT	209	93	9001028114712	UpperRush	Upper Rush	
9/9/2020	BNT	132	24	9001031371563	UpperRush	Upper Rush	
9/9/2020	BNT	154	30	9001031371568	UpperRush	Upper Rush	
9/9/2020	BNT	132	21	9001031371569	UpperRush	Upper Rush	
9/9/2020	BNT	132	19	9001031371570	UpperRush	Upper Rush	
9/9/2020	BNT	167	40	9001031371584	UpperRush	Upper Rush	
9/9/2020	BNT	142	25	9001031371589	UpperRush	Upper Rush	
9/9/2020	BNT	151	31	9001031371634	UpperRush	Upper Rush	
9/9/2020	BNT	156	33	9001031371636	UpperRush	Upper Rush	
9/9/2020	BNT	132	21	9001031371655	UpperRush	Upper Rush	
9/9/2020	BNT	157	36	9001031371763	UpperRush	Upper Rush	
9/9/2020	BNT	161	41	9001031371767	UpperRush	Upper Rush	
9/9/2020	BNT	162	40	9001031371783	UpperRush	Upper Rush	
9/9/2020	BNT	159	45	9001031371787	UpperRush	Upper Rush	

Date of Recapture	Species	Length (mm)	Weight (g)	PIT Tag Number 98-	Location of 2020 Recapture	Location of Initial Capture and Tagging	Comments
9/9/2020	BNT	137	25	9001031371816	UpperRush	Upper Rush	
9/9/2020	BNT	157	35	9001031372260	UpperRush	Upper Rush	
9/9/2020	BNT	140	24	9001031372274	UpperRush	Upper Rush	
9/9/2020	BNT	137	25	9001031372277	UpperRush	Upper Rush	
9/9/2020	BNT	138	25	9001031372287	UpperRush	Upper Rush	
9/9/2020	BNT	124	17	9001031372320	UpperRush	Upper Rush	
9/9/2020	BNT	127	19	9001031372322	UpperRush	Upper Rush	
9/9/2020	BNT	141	27	9001031372324	UpperRush	Upper Rush	
9/12/2020	BNT	240	129	9001006111449	Bottomlands	Bottomlands	
9/12/2020	BNT	191	76	9001028114118	Bottomlands	Bottomlands	
9/12/2020	BNT	186	56	9001028114314	Bottomlands	Bottomlands	
9/12/2020	BNT	147	33	9001031371510	Bottomlands	Bottomlands	
9/12/2020	BNT	146	29	9001031371512	Bottomlands	Bottomlands	
9/12/2020	BNT	187	57	9001031371515	Bottomlands	Bottomlands	
9/12/2020	BNT	148	31	9001031371543	Bottomlands	Bottomlands	
9/12/2020	BNT	151	31	9001031371544	Bottomlands	Bottomlands	
9/12/2020	BNT	141	28	9001031371988	Bottomlands	Bottomlands	
9/12/2020	BNT	164	45	9001031372007	Bottomlands	Bottomlands	
9/11/2020	BNT	270	209	9001028114355	LV Main	LV Main	
9/11/2020	BNT	216	104	9001028114728	LV Main	LV Main	
9/11/2020	BNT	229	105	9001028114774	LV Main	LV Main	
9/11/2020	BNT	226	114	9001028114817	LV Main	LV Main	
9/11/2020	BNT	165	41	9001031371958	LV Main	LV Main	
9/11/2020	BNT	160	38	9001031371966	LV Main	LV Main	
9/11/2020	BNT	164	40	9001031371971	LV Main	LV Main	
9/11/2020	BNT	191	61	9001031371975	LV Main	LV Main	
9/11/2020	BNT	153	30	9001031371978	LV Main	LV Main	
9/11/2020	BNT	125	17	9001031372020	LV Main	LV Main	
9/11/2020	BNT	137	24	9001031372024	LV Main	LV Main	

Date of Recapture	Species	Length (mm)	Weight (g)	PIT Tag Number 98-	Location of 2020 Recapture	Location of Initial Capture and Tagging	Comments
9/11/2020	BNT	146	30	9001031372031	LV Main	LV Main	
9/11/2020	BNT	155	33	9001031372038	LV Main	LV Main	
9/11/2020	BNT	145	32	9001031372054	LV Main	LV Main	
9/11/2020	BNT	151	37	9001031372056	LV Main	LV Main	
9/11/2020	BNT	148	26	9001031372065	LV Main	LV Main	
9/11/2020	BNT	143	26	9001031372074	LV Main	LV Main	
9/11/2020	BNT	158	38	9001031372090	LV Main	LV Main	
9/11/2020	BNT	157	35	9001031372099	LV Main	LV Main	
9/11/2020	BNT	135	22	9001031372100	LV Main	LV Main	
9/11/2020	BNT	158	38	9001031372101	LV Main	LV Main	
9/11/2020	BNT	166	42	9001031372116	LV Main	LV Main	
9/11/2020	BNT	162	37	9001031372117	LV Main	LV Main	
9/11/2020	BNT	147	29	9001031372122	LV Main	LV Main	
9/11/2020	BNT	141	26	9001031372129	LV Main	LV Main	
9/11/2020	BNT	175	47	9001031372130	LV Main	LV Main	
9/10/2020	BNT	540	1950	5121021867358	MGORD	MGORD	
9/10/2020	BNT	500	1372	9001004581314	MGORD	MGORD	
9/10/2020	BNT	291	200	9001028114412	MGORD	MGORD	
9/10/2020	BNT	249	134	9001028114666	MGORD	**Upper Rush**	
9/10/2020	BNT	316	287	9001028114788	MGORD	MGORD	
9/10/2020	BNT	345	262	9001028114826	MGORD	MGORD	
9/10/2020	BNT	251	168	9001031371732	MGORD	MGORD	
9/10/2020	BNT	257	176	9001031371743	MGORD	MGORD	
9/10/2020	BNT	255	158	9001031371751	MGORD	MGORD	
9/10/2020	BNT	155	35	9001031371853	MGORD	**Upper Rush**	
9/10/2020	BNT	249	156	9001031371866	MGORD	MGORD	
9/10/2020	BNT	239	123	9001031372250	MGORD	MGORD	
9/10/2020	BNT	162	45	9001031372301	MGORD	**Upper Rush**	
9/12/2020	BNT	224	103	9001006111045	Walker Ck	Walker Creek	

Date of Recapture	Species	Length (mm)	Weight (g)	PIT Tag Number 98-	Location of 2020 Recapture	Location of Initial Capture and Tagging	Comments
9/12/2020	BNT	243	130	9001006111064	Walker Ck	Walker Creek	
9/12/2020	BNT	215	98	9001006111139	Walker Ck	Walker Creek	
9/12/2020	BNT	195	69	9001028114134	Walker Ck	Walker Creek	
9/12/2020	BNT	190	68	9001028114139	Walker Ck	Walker Creek	
9/12/2020	BNT	191	69	9001028114162	Walker Ck	Walker Creek	
9/12/2020	BNT	205	88	9001028114163	Walker Ck	Walker Creek	
9/12/2020	BNT	195	69	9001028114179	Walker Ck	Walker Creek	
9/12/2020	BNT	199	68	9001028114180	Walker Ck	Walker Creek	
9/12/2020	BNT	196	68	9001028114187	Walker Ck	Walker Creek	
9/12/2020	BNT	191	63	9001028114194	Walker Ck	Walker Creek	
9/12/2020	BNT	190	69	9001028114224	Walker Ck	Walker Creek	
9/12/2020	BNT	154	36	9001031371657	Walker Ck	Walker Creek	
9/12/2020	BNT	137	21	9001031371658	Walker Ck	Walker Creek	
9/12/2020	BNT	147	28	9001031371659	Walker Ck	Walker Creek	
9/12/2020	BNT	166	40	9001031371665	Walker Ck	Walker Creek	
9/12/2020	BNT	165	44	9001031371666	Walker Ck	Walker Creek	
9/12/2020	BNT	151	39	9001031371667	Walker Ck	Walker Creek	
9/12/2020	BNT	140	29	9001031371668	Walker Ck	Walker Creek	
9/12/2020	BNT	145	25	9001031371669	Walker Ck	Walker Creek	
9/12/2020	BNT	144	28	9001031371675	Walker Ck	Walker Creek	
9/12/2020	BNT	136	21	9001031371678	Walker Ck	Walker Creek	
9/12/2020	BNT	170	38	9001031371685	Walker Ck	Walker Creek	
9/12/2020	BNT	150	30	9001031371694	Walker Ck	Walker Creek	
9/12/2020	BNT	151	32	9001031371698	Walker Ck	Walker Creek	
9/12/2020	BNT	152	33	9001031371707	Walker Ck	Walker Creek	
9/12/2020	BNT	153	33	9001031371725	Walker Ck	Walker Creek	
9/12/2020	BNT	152	34	9001031371727	Walker Ck	Walker Creek	
9/12/2020	BNT	135	24	9001031371734	Walker Ck	Walker Creek	
9/12/2020	BNT	145	31	9001031371742	Walker Ck	Walker Creek	

Date of Recapture	Species	Length (mm)	Weight (g)	PIT Tag Number 98-	Location of 2020 Recapture	Location of Initial Capture and Tagging	Comments
9/12/2020	BNT	160	38	9001031372360	Walker Ck	Walker Creek	
9/12/2020	BNT	155	35	9001031372365	Walker Ck	Walker Creek	
9/12/2020	BNT	151	33	9001031372366	Walker Ck	Walker Creek	
9/12/2020	BNT	153	33	9001031372367	Walker Ck	Walker Creek	
9/12/2020	BNT	138	23	9001031372369	Walker Ck	Walker Creek	
9/12/2020	BNT	159	38	9001031372373	Walker Ck	Walker Creek	
9/12/2020	BNT	161	42	9001031372374	Walker Ck	Walker Creek	
9/12/2020	BNT	150	32	9001031372378	Walker Ck	Walker Creek	
9/12/2020	BNT	141	29	9001031372380	Walker Ck	Walker Creek	
9/12/2020	BNT	166	43	9001031372382	Walker Ck	Walker Creek	
9/12/2020	BNT	161	37	9001031372383	Walker Ck	Walker Creek	
9/12/2020	BNT	143	28	9001031372387	Walker Ck	Walker Creek	
9/12/2020	BNT	135	25	9001031372388	Walker Ck	Walker Creek	
9/12/2020	BNT	154	36	9001031372390	Walker Ck	Walker Creek	
9/12/2020	BNT	139	26	9001031372391	Walker Ck	Walker Creek	
9/12/2020	BNT	134	21	9001031372395	Walker Ck	Walker Creek	
9/12/2020	BNT	148	31	9001031372397	Walker Ck	Walker Creek	
9/12/2020	BNT	138	25	9001031372399	Walker Ck	Walker Creek	
9/12/2020	BNT	151	29	9001031372402	Walker Ck	Walker Creek	
9/12/2020	BNT	148	32	9001031372406	Walker Ck	Walker Creek	
9/12/2020	BNT	153	33	9001031372407	Walker Ck	Walker Creek	
9/12/2020	BNT	140	28	9001031372409	Walker Ck	Walker Creek	
9/12/2020	BNT	162	41	9001031372410	Walker Ck	Walker Creek	
9/12/2020	BNT	139	26	9001031372414	Walker Ck	Walker Creek	
9/12/2020	BNT	135	22	9001031372417	Walker Ck	Walker Creek	
9/12/2020	BNT	164	40	9001031372425	Walker Ck	Walker Creek	
9/12/2020	BNT	153	32	9001031372426	Walker Ck	Walker Creek	
9/12/2020	BNT	160	43	9001031372428	Walker Ck	Walker Creek	
9/12/2020	BNT	165	42	9001031372429	Walker Ck	Walker Creek	

Date of Recapture	Species	Length (mm)	Weight (g)	PIT Tag Number 98-	Location of 2020 Recapture	Location of Initial Capture and Tagging	Comments
9/12/2020	BNT	148	27	9001031372430	Walker Ck	Walker Creek	
9/12/2020	BNT	170	45	9001031372431	Walker Ck	Walker Creek	
9/12/2020	BNT	137	24	9001031372432	Walker Ck	Walker Creek	
9/12/2020	BNT	165	42	9001031372433	Walker Ck	Walker Creek	
9/12/2020	BNT	169	46	9001031372434	Walker Ck	Walker Creek	
9/12/2020	BNT	150	36	9001031372435	Walker Ck	Walker Creek	
9/12/2020	BNT	155	37	9001031372440	Walker Ck	Walker Creek	
9/12/2020	BNT	168	41	9001031372442	Walker Ck	Walker Creek	
9/12/2020	BNT	142	30	9001031372449	Walker Ck	Walker Creek	
9/12/2020	BNT	160	37	9001031372450	Walker Ck	Walker Creek	
9/12/2020	BNT	141	30	9001031372454	Walker Ck	Walker Creek	
9/12/2020	BNT	166	47	9001031372455	Walker Ck	Walker Creek	
9/12/2020	BNT	132	23	9001031372457	Walker Ck	Walker Creek	
9/12/2020	BNT	144	27	9001031372458	Walker Ck	Walker Creek	

Section 4

RY 2019 Mono Basin Stream Monitoring Report

Memo

Date: April 2, 2021

To: Paul Pau, Engineer
LADWP
111 N. Hope Street
Los Angeles, CA 90012

From: William Trush, HSU River Institute Co-Director
Humboldt State University
Dept. Environmental Science and Management
Arcata, CA 95521

HSU field monitoring in Rush and Lee Vining creeks was curtailed for the RY2020 Season due to the COVID 19 pandemic risk and very poor air quality from extensive local fires. Therefore, I have no new monitoring data to report for RY2020. An extension was requested, and approved by LADWP, to apply project funding to field monitoring activities and report write-up for the RY2021 Season. Looking forward to getting out on both creeks this summer/early-autumn.

William J. Trush

Section 5

Mono Basin Waterfowl Habitat Restoration Program 2019 Monitoring Report with Recommendations by Ms. Debbie House, Interim Mono Basin Waterfowl Monitoring Program Director

Mono Basin Waterfowl Habitat Restoration Program

Statement of Compliance and Summary of 2020 Monitoring

Prepared for the State Water Resources Control Board

The Los Angeles Department of Water and Power (LADWP) conducts monitoring in compliance with the 1996 Mono Basin Waterfowl Habitat Restoration Plan and the 1998 State Water Resources Control Board Order WR 98-05. LADWP completed the following monitoring tasks in 2020:

Hydrology:

- Monthly Mono Lake elevation readings
- Daily stream flows in Rush, Lee Vining, Parker and Walker Creeks

Limnology:

- Meteorological, physical/chemical, phytoplankton, and brine shrimp population monitoring

Vegetation Status in Lake-fringing Wetlands:

- Still-image photography of waterfowl habitats at Mono Lake, Bridgeport Reservoir and Crowley Reservoir

Saltcedar Eradication

- Coordinated with California State Parks to report saltcedar eradication results

Waterfowl Populations:

- Summer ground surveys and documentation of habitat use
- Fall surveys at Mono Lake, Bridgeport Reservoir and Crowley Reservoir

The *Mono Basin Waterfowl Habitat Restoration Program 2020 Monitoring Report* included herein provides detailed discussion of monitoring methods, results, and discussion for each component. Below are brief summaries of the results of the 2020 monitoring year.

Hydrology

Runoff during the 2019-2020 Water Year was 55,452 acre-feet, or 46% of the long-term average. Mono Lake experienced an overall decrease in lake level as compared to 2019. The peak lake level in 2020 of 6,382.3 feet occurred early in spring from March through May as is typical for a dry year. In December 2020, Mono Lake was at 6380.7 feet, or 1.4 feet lower than in December 2019.

Limnology

The 2020 monitoring year marked the end of the most recent meromictic event as Mono Lake completely turned over at the end of the year. The combined effects of low inputs and the breakdown of meromixis contributed to decreased transparency in 2020, which remained below 1 m throughout the year.

The *Artemia* population decreased slightly as compared to 2019 to 12,991 m^{-2} and remained below the long-term average of 18,518 m^{-2}. There has been a temporal shift in peak abundance of *Artemia* instars and adults, however the centroid remained above 210 days for the fifth year in row. Peak monthly instar and adult *Artemia* population abundance occurred in April and June, respectively, following the trend of earlier occurrence of population peaks. Warmer hypolimnetic water temperature in spring may have favored earlier instar peak. Since 2008, instar abundance during later months has been considerably lower than that of the earlier months suggesting an absence or reduced second or/and third generations.

Vegetation Status in Lake-fringing Wetlands

Slight increases in the amount of exposed playa were evident in all shoreline areas due to the decreasing lake level in 2020. Small scale but notable changes to waterfowl habitat conditions were observed in Lee Vining Creek, Rush Creek, Simons Spring, South Shore Lagoons, and Warm Springs. Heavy grazing by feral horses, particularly in the Warm Springs area is continuing, resulting in severe reductions in vegetative cover and increases in bare ground.

Saltcedar Eradication

This year we addressed a need identified in the *Periodic Overview Report* (LADWP 2018) regarding the saltcedar eradication program, working with California State Parks, to compile information regarding the status of tamarisk in the Mono Basin. The State Parks saltcedar program has been very effective at controlling this species as the number of sites treated has dropped from a high of 151 in 2016 to 1 in 2020.

Waterfowl Populations

Breeding waterfowl activity at Mono Lake in 2020 was good, with above-average brood numbers. A total of 950 waterfowl and 56 broods were seen on the two summer surveys. Breeding activity was concentrated at Wilson Creek, South Shore Lagoons and Simons Spring. Most dabbling duck activity occurred in freshwater and brackish ponds, and secondarily freshwater outflow areas around the lake (=”ria”). Only two ponds held water at the Restoration Ponds, and waterfowl breeding activity was well below the long-term mean.

Waterfowl use at Mono Lake in fall 2020 showed another slight increase as compared to 2019, potentially indicating continued recovery from the extended drought ending in 2017. Spatial distribution patterns indicate that fall migratory waterfowl at Mono Lake respond to local conditions, including good foraging opportunities at Wilson Creek and Warm Springs.

In 2020, waterfowl use of Bridgeport Reservoir did not differ significantly from the long-term mean. Totals at Crowley Reservoir were slightly above the mean and Mono Lake slightly below the long-term mean.

Recommendations

I recommend that the second year of the waterfowl time budget study, as required by Order 98-05, be completed by the end of 2021. In addition, I recommend interested parties consider the feasibility of implementing a seasonal flooding program at the Restoration Ponds to improve the productivity for waterfowl.

Debbie House

Debbie House

Mono Basin Waterfowl Monitoring Program Director

April 13, 2021

Mono Basin Waterfowl Habitat Restoration Program 2020 Monitoring Report

Prepared by:
Deborah House, Mono Basin Waterfowl Program Director
Motoshi Honda, Watershed Resources Specialist
Los Angeles Department of Water and Power
Bishop, CA 93514

Prepared for the State Water Resources Control Board
and Los Angeles Department of Water and Power
April 2021

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EXECUTIVE SUMMARY

In 1983, National Audubon Society v. Superior Court resulted in the California State Water Resources Control Board (SWRCB) reevaluating the effect of water diversions by the City of Los Angeles (City) on the public trust values of Mono Lake. SWRCB Decision 1631, signed in 1994, amended the City's water rights, establishing instream flow requirements for the Mono Basin creeks and placing limitations on water exports from the Mono Basin. Order WR 98-05 (SWRCB 1998) directed the Los Angeles Department of Water and Power (LADWP) to implement waterfowl habitat restoration measures and monitoring to mitigate the loss of waterfowl habitat in the Mono Basin from diversions. This report summarizes the results of monitoring conducted in 2020 under the Mono Basin Waterfowl Habitat Restoration Plan (Plan) (LADWP 1996a), as required by Order 98-05.

Mono Lake experienced an overall decrease in lake level in 2020 as compared to 2019. The peak lake level in 2020 of 6,382.3 feet occurred early in spring from March through May, following by a continuous decline through the remainder of the year. At the final lake level read in December 2020 (6380.7 feet), Mono Lake was 1.4 feet lower than in December 2019. Runoff during the 2019-2020 Water Year was 55,452 acre-feet, or 46% of the long-term average. Input from the two major tributaries (Rush and Lee Vining Creeks) in 2020 was 61,587 acre-feet. This combined input was 64% of the long-term average, and was insufficient to maintain the lake level.

The winter of 2019-20 exhibited a similar weather pattern as compared to previous years: below-normal maximum average temperature combined with above-normal minimum average temperature. It was the seventh year in row that the minimum winter temperature was above the long-term average.

The 2020 monitoring year marked the end of the most recent meromictic event that had started in 2017. The weakening chemocline finally broke, and as a result, ammonium which had accumulated in the hypolimnion was released to the epilimnion as Mono Lake completely turned over at the end of 2020. The ammonium level at the deepest monitored depth (35m) decreased from 136.6 µM in February 2020 to 11.1 µM in December after mixing. Chlorophyll *a* levels were higher than normal for most of the year in both epilimnion and hypolimnion. The combined effects of low inputs and the breakdown of meromixis contributed to decreased transparency in 2020, which remained below 1 m throughout the year.

The *Artemia* population decreased slightly as compared to 2019 to 12,991 m^{-2} and remained below the long-term average of 18,518 m^{-2}. There has been a clear temporal shift in peak abundance of *Artemia* instars and adults which are reflected on a strong linear negative trend of centroid days with respect to monitoring years up to 2015. The centroid, however, remained above 210 days for the fifth year in row. Peak monthly instar and adult *Artemia* population abundance occurred in April and June, respectively, following the trend of earlier occurrence of population peaks. Warmer hypolimnetic water temperature in spring may have favored earlier instar peak in 2020, and in general, instar averages have been trending higher earlier in the year, and lower later in the year. Later month abundance of *Artemia* is mostly driven by the second or/and third generations, and thus lower adult population abundance between August and November suggests smaller second and third generations. Since 2008, instar abundance during later months has been considerably lower than that of the earlier months suggesting an absence or reduced second or/and third generations.

Future limnological condition of Mono Lake will largely depend on future runoff conditions. A lack of prolonged meromixis leads to smaller *Artemia* peaks and lower abundance during subsequent monomixis. Since the end of the second meromixis (1995-2002), the longest duration of a wet period has been two years (2005 to 2006) which resulted in three years of meromixis. The most recent meromixis (2017 to 2020) developed due to the second highest runoff in Mono Basin on record. Preceding salinity levels are very important to explain varying strength of chemocline, and the sudden and large influx of freshwater in 2017 combined with high preceding salinity resulted in the shallower and stronger chemocline, which, in turn, enabled continuous accumulation of hypolimnetic ammonium. In contrast the chemocline developed at much deeper depths between 2005 and 2007, allowing upward movement of nutrients earlier, which in turn, prevented continuous accumulation of ammonium. The ammonium accumulation level between 2017 and 2020 was higher than that between 2005 and 2007, but fell far shorter than the level observed between 1995 and 2002.

As a terminal lake, it is inevitable for salinity to increase over time. Prolonged wet periods have been able to arrest this inevitability, but only temporarily. Mono Lake is saltier now than at equivalent lake levels between 1990s and 2010s. It is not clear what is causing this shift in the salinity-lake level relationship; but lake level could drop further with drier and warmer climate forecasted for much of California in the future.

The *Artemia* population is strongly influenced by strength and duration of meromixis. Historically the *Artemia* population has demonstrated resiliency. However, further decline in the lake level could result in much higher salinity, which could approach the species tolerance level. Opportunity for *Artemia* population recovery, prolonged meromixis, and large reductions in salinity may become scarcer in the future. Lower salinity certainly would result in a weaker salinity gradient or chemocline, such that Mono Lake could become holomictic much more easily than the current state. Without a strong and long-lasting chemocline, ammonium accumulation would be lower, which would result in a lower *Artemia* population peak. A higher Mono Lake elevation, therefore, may have very limited impact on the lake's *Artemia* population; however, lower salinity associated with a higher Mono Lake level could lead to "*invasions by predators or competitors of the brine shrimp, which could reduce productivity of the brine shrimp population*" (Jones and Stokes Associates, 1994). At the same time a more diverse invertebrate fauna could lead to increased food sources for shorebird and waterfowl populations.

At Mono Lake, slight increases in the amount of exposed playa were evident in all shoreline areas due to the decreasing lake level in 2020. The most notable changes to waterfowl habitat conditions as compared to 2019 were observed in Lee Vining Creek, Rush Creek, Simons Spring, South Shore Lagoons, and Warm Springs. The deltas of both Lee Vining Creek and Rush Creek deltas were less flooded, reducing potential wind and wave-protected feeding areas for waterfowl. The heavy grazing by feral horses combined with very wet conditions in the Warm Springs area resulted in the creation of multiple ponds and increased feeding areas for fall migratory waterfowl. Small scale, but potentially significant changes were observed to waterfowl habitat conditions at Goose Springs in the South Shore Lagoons area as vegetation encroachment has resulted in a redirection of spring flow from shoreline ponds in the South Shore Lagoons area to the Simons Spring shoreline area.

The dry year resulted in similar decreased water levels at Bridgeport and Crowley Reservoirs.

This year we addressed a need identified in the *Periodic Overview Report* (LADWP 2018) regarding the saltcedar eradication program. Working with California State Parks, we summarized information regarding tamarisk control efforts in the Mono Basin to present in this annual report. Since 2016, a tamarisk surveillance and treatment program has been implemented by California State Parks. The saltcedar program has been very effective at controlling this species in the Mono Basin. The number of sites treated has dropped from a high of 151 in 2016 to 1 in 2020.

Breeding waterfowl activity at Mono Lake in 2020 was good, with above-average brood numbers, despite fewer surveys. Breeding conditions were good at Wilson Creek and Simons Spring, but showed some deterioration in in the South Shore Lagoons area due to small scale habitat changes. A total of 950 waterfowl and 56 broods were seen on the two summer surveys. In 2020, breeding activity was concentrated at Wilson Creek, South Shore Lagoons and Simons Spring. Most dabbling duck activity was concentrated in and around nearshore water features, primarily freshwater and brackish ponds, and secondarily freshwater outflow areas around the lake (=”ria”). Only two ponds held water at the Restoration Ponds, and waterfowl breeding activity was well below the long-term mean, likely due to poor habitat conditions due to failing infrastructure and water delivery problems.

Waterfowl use at Mono Lake in fall 2020 showed another slight increase as compared to last year, potentially indicating continued recovery from the extended drought ending in 2017, however totals were still slightly below the long-term average. A slight seasonal shift in use was observed in 2020 as late fall use was above the long-term average but early season use in September was less than average. Spatial distribution patterns indicate that fall migratory waterfowl at Mono Lake respond to local conditions, including good foraging opportunities at Wilson Creek and Warm Springs.

Monitoring of Mono Lake, Bridgeport and Crowley Reservoirs has shown that waterfowl numbers are highest at Crowley, and lowest at Mono Lake. In 2020, waterfowl use of Bridgeport Reservoir did not differ significantly from the long-term mean. Totals at Crowley Reservoir were slightly above the mean and Mono Lake slightly below the long-term mean.

With the exception of the Ruddy Duck, most waterfowl use at Mono Lake occurs in lake-fringing ponds, or very near to shore. The near shore areas used by waterfowl are generally shallow, have gentle offshore gradients, and freshwater spring, creek, or brackish water input. Mono Lake is deep, highly saline, with limited shallow shoreline areas. These features limit the habitat quality for waterfowl, and may ultimately limit recovery of waterfowl populations.

We recommend that the second year of the waterfowl time budget study, as required by Order 98-05, be completed by the end of 2021. We also recommend interested parties work with the Mono Basin Waterfowl Director in evaluating the feasibility of implementing a seasonal flooding program at the Restoration Ponds to improve the productivity for waterfowl.

1.0 INTRODUCTION

Mono Lake is a large terminal saline lake at the western edge of the Great Basin in Mono County, California. The largest lake in Mono County, Mono Lake has an east-west dimension of 13 miles, a north-south dimension of over nine miles (Raumann et al. 2002), and a circumference of approximately 40 miles. With an average depth of over 60 feet and a maximum depth of approximately 150 feet (Russell 1889), Mono Lake is a large, moderately deep terminal saline lake (Jellison and Melack 1993, Melack 1983). The deepest portions of the lake are found south and east of Paoha Island in the Johnson and Putnam Basins, respectively (Raumann et al. 2002). Shallower water and a gently sloping shoreline are more typical of the north and east shores (Vorster 1985, Raumann et al. 2002).

Mono Lake is widely known for its value to migratory waterbirds, supporting up to 30% percent of the North American Eared Grebe (*Podiceps nigricollis*) population, the largest nesting population of California Gull (*Larus californicus*) in California (Winkler 1996), and up to 140,000 Wilson's (*Phalaropus tricolor*) and Red-necked Phalaropes (*P. lobatus*) during fall migration (Jehl 1986, Jehl 1988).

Saline lakes are highly productive ecological systems (Jellison et al. 1998), however productivity is influenced by factors such as salinity, water depth, temperature, and water influx and evaporation on a seasonal, annual, and inter-annual basis. Saline lakes often respond rapidly to environmental changes, and alterations to the hydrological budget (Jehl 1988, Williams 2002). Water demands for agriculture, human development and recreation, as well as changes in climate are impacting saline lakes globally (Wurtsbaugh et al. 2017).

In 1941, the City of Los Angeles (City) began diverting water from Lee Vining Creek, Rush Creek, Walker Creek, and Parker Creek for municipal water supply. From 1941-1970, when the City was exporting an annual average of 56,000 acre-feet, the elevation of Mono Lake dropped over 29 feet. In 1970, the completion of the second aqueduct in Owens Valley expanded the capacity of the Los Angeles Aqueduct system, resulting in increased diversions, frequent full diversion of flows from Lee Vining, Walker, Parker and Rush Creek and a drying of the creek channels (SWRCB 1994). From 1970 to 1989, Mono Lake dropped another 12.6 feet as yearly exports averaged 82,000 acre-feet, with a peak export of 140,756 acre-feet in 1979. The elevation of Mono Lake dropped to a record low of 6,372.0 feet above mean sea level in 1982. In 1979, the National Audubon Society filed suit with the Superior Court of California against the City (National Audubon Society v. Superior Court), arguing that the diversions in the Mono Basin were resulting in environmental damage and were a violation of the Public Trust Doctrine.

After a series of lawsuits and extended court hearings, the State Water Resources Control Board (SWRCB) amended the City's water rights with the Mono Lake Basin Water Right Decision 1631 (Decision 1631) (SWRCB 1994). Decision 1631 established instream flow requirements for the Mono Basin creeks for fishery protection, and placed limitations on water exports from the basin until the surface elevation of Mono Lake reached 6,391 feet. In addition to diversion reductions, Decision 1631 required LADWP to conduct restoration and monitoring of Mono Lake ecological resources.

SWRCB Order 98-05, adopted on September 2, 1998, defined waterfowl restoration measures and elements of a waterfowl habitat monitoring program for Mono Lake. The Mono Basin Waterfowl Habitat Monitoring Plan has been implemented continuously since. In 2017, LADWP conducted a comprehensive analysis of restoration actions taken under Order 98-05 since its inception. The *Mono Basin Waterfowl Habitat Restoration Program Periodic Overview Report* (LADWP 2018) summarized the results of this analysis and included recommendations to increase effectiveness of various monitoring tasks, and to reduce the cost of the monitoring project while continuing to provide indices to track restoration progress. This current report summarizes the results of waterfowl habitat restoration monitoring conducted in 2020.

2.0 WATERFOWL HABITAT RESTORATION MEASURES

The SWRCB issued Order 98-05 in 1998, defining waterfowl restoration habitat restoration measures and associated monitoring to be conducted in compliance with Decision 1631. The export criteria of Decision 1631 were developed to result in an eventual long-term average water elevation of Mono Lake of 6,392 feet (SWRCB 1996). In determining the most appropriate water level for the protection of public trust resources at Mono Lake, the SWRCB recognized that there was no single lake elevation that would maximize protection of, and accessibility to, all public trust resources. Decision 1631 stated that maximum restoration of waterfowl habitat would require a lake elevation of 6,405 feet. Raising the lake elevation to 6,405 feet however, would have precluded use of any water from the Mono Basin by the City for municipal needs, and inhibited public access to South Tufa, the most frequently visited tufa site. Furthermore, it was determined that a lower target lake elevation of 6,390 feet would accomplish some waterfowl habitat restoration, and that there were opportunities to restore additional habitat, mitigating the overall loss as a result the target being set below 6,405 feet. A target level of 6,392 feet was ultimately established as this level would restore some waterfowl habitat, allow continued access to South Tufa, and ensure compliance with federal air quality standards.

As noted in Order 98-05, and recognized in the restoration plans, the most important waterfowl habitat restoration measures were maintaining an average lake elevation of 6,392 feet, and restoring perennial flow to streams tributary to Mono Lake. In addition to lake level recovery, and stream restoration, Order 98-05 included the following measures to be undertaken by LADWP:

1. reopen distributaries in the Rush Creek bottomlands,
2. provide financial assistance for the restoration of waterfowl habitat at the County Ponds and Black Point or other lake-fringing wetland area,
3. participate in a prescribed burn program subject to applicable permitting and environmental review requirements;
4. participate in exotic species control efforts if an interagency program is established in the Mono Basin; and
5. develop a comprehensive waterfowl and waterfowl habitat monitoring program.

Table 2-1 describes each restoration measure required under Order 98-05, providing a brief discussion on LADWP's progress to date and the current status. Some of these projects have been completed, some are ongoing, and others have been determined by the stakeholders to be unfeasible. More details regarding these restoration measures can be found in the *Periodic Overview Report* (LADWP 2018).

Table 2-1. Mono Basin Waterfowl Habitat Restoration Activities

Mono Basin Waterfowl Habitat Restoration Activities *(as described in SWRCB Order 98-05 and the Mono Basin Waterfowl Habitat Restoration Plan dated February 29, 1996, where relevant)*				
Activity	**Goal**	**Description**	**Progress to Date**	**Status**
Rewatering Distributary Channels to Rush Creek (below the Narrows)	To restore waterfowl and riparian habitat in the Rush Creek bottomlands.	Rewater the Channel 4bii complex	Rewatering of side channels was evaluated in 2002 by the State Appointed Stream Scientists and LADWP. At that time, rewatering of Channel 4bii was deferred because natural revegetation of riparian and wetland species was occurring. The area was reevaluated in 2007 and rewatering was completed in March 2007.	Complete
		Rewater the Channel 8 complex, unplugged lower section	In 2002, the sediment plug was removed and the Channel 8 complex widened at the upstream end. In contrast to rewatering for constant flow, the final design called for flows overtopping the bank and flowing into Channel 8 at approximately 250 cfs and above. Woody debris was spread and willows were transplanted along new banks following excavation. Further rewatering of Rush Creek Channel 8 complex was deferred by the Stream Scientists. Final review was conducted by McBain and Trush (2010). After presentation of the final review, LADWP followed the recommendations of the Stream Scientists and SWRCB approved the plan. Channel 8 was rewatered in March 2007.	Complete
		Rewater the Channel 10 complex	Rewatering of side channels was evaluated in 2002 by the State Appointed Stream Scientists and LADWP. This evaluation concluded that rewatering the Channel 10 complex would result in detrimental impacts to reestablished fishery and riparian habitats. Therefore, there have been no further actions taken to rewater this channel. Project considered complete.	Complete

Mono Basin Waterfowl Habitat Restoration Activities, cont. *(as described in SWRCB Order 98-05 and the Mono Basin Waterfowl Habitat Restoration Plan dated February 29, 1996, where relevant)*				
Activity	**Goal**	**Description**	**Progress to Date**	**Status**
Rewatering Distributary Channels to Rush Creek (below the Narrows)	To restore waterfowl and riparian habitat in the Rush Creek bottomlands.	Rewater Channel 11, unplugged lower portion	Rewatering of side channels was evaluated in 2002 by the State Appointed Stream Scientists and LADWP. At that time, it was determined that there would be little benefit to unplugging Channel 11 compared to the impacts to reestablished riparian vegetation from mechanical intrusion. Further evaluation was conducted by the Stream Scientists. After presentation of the final review, LADWP followed the recommendations of the Stream Scientists not to rewater the channel. This item is now approved by SWRCB and was therefore considered complete in 2008.	Complete
		Rewater the Channel 13 complex	Rewatering of side channels was evaluated in 2002 by the State Appointed Stream Scientists and LADWP. At that time, it was determined that Channel 13 would not be stable or persist in the long term and riparian vegetation was already rapidly regenerating in this reach. Therefore, there have been no further actions taken to rewater Channel 13. Project is considered complete.	Complete

Mono Basin Waterfowl Habitat Restoration Activities, cont. *(as described in SWRCB Order 98-05 and the Mono Basin Waterfowl Habitat Restoration Plan dated February 29, 1996, where relevant)*				
Activity	**Goal**	**Description**	**Progress to Date**	**Status**
Financial Assistance to United States Forest Service (USFS) for Waterfowl Habitat Improvement Projects at County Ponds and Black Point areas	To support repairs and improvement of infrastructure on USFS land in the County Ponds area.	Upon request of the USFS, Licensee (LADWP) shall provide financial assistance in an amount up to $250,000 for repairs and improvements to surface water diversion and distribution facilities and related work to restore or improve waterfowl habitat on USFS land in the County Ponds area.	LADWP was to make available a total of $275,000 for waterfowl restoration activities in the Mono Basin per Order 98-05. This money was to be used by the USFS if they requested the funds by December 31, 2004. Afterwards, any remaining funds are to be made available to any party wishing to do waterfowl restoration in the Mono Basin after SWRCB review. USFS has requested funds for a project estimated at $100,000. MLC has requested that the remainder of the funds be applied toward the total cost of the Mill Creek Return Ditch upgrade which would provide benefits for waterfowl habitat. These funds will continue to be budgeted by LADWP until such a time that they have been utilized. Currently, this money has tentatively been included in the 2013 Settlement Agreement as part of Administrative Monitoring Accounts to be administered by a Monitoring Administration Team (MAT).	In Progress
	To support waterfowl habitat improvement projects on USFS land in the Black Point area.	Upon request of the USFS, Licensee (LADWP) shall provide financial assistance in an amount up to $25,000 for waterfowl habitat improvements on USFS land in the Black Point area.		

Mono Basin Waterfowl Habitat Restoration Activities, cont. *(as described in SWRCB Order 98-05 and the Mono Basin Waterfowl Habitat Restoration Plan dated February 29, 1996, where relevant)*				
Activity	**Goal**	**Description**	**Progress to Date**	**Status**
Prescribed Burn Program	To enhance lake-fringing marsh and seasonal wet meadow habitats for waterfowl	The licensee shall proceed with obtaining the necessary permits and approval for the prescribed burning program described in the Mono Basin Waterfowl Habitat Restoration Plan dated February 29, 1996 and provide the SWRCB a copy of any environmental documentation for the program. Following review of the environmental documentation, the SWRCB may direct Los Angeles to proceed with implementation of the prescribed burning program pursuant to D1631 and Order 98-05, or modify the program.	LADWP began a prescribed burn program with limited success. LADWP requested to remove this item from the requirements in 2002 and the SWRCB instead ruled that the prescribed burn program will be deferred until Mono Lake reaches the target elevation. Once Mono Lake reaches the target elevation, LADWP will reassess the prescribed burn program. Based on results from the assessment, LADWP will either reinstate the program or request relief from the SWRCB from this requirement.	Deferred
Saltcedar Eradication Program	To control non-native vegetation in the Mono Basin	In the event that an interagency program is established for the control or elimination of saltcedar or other non-native vegetation deemed harmful to waterfowl habitat in the Mono Basin, Licensee (LADWP) shall participate in that program and report any work it undertakes to control saltcedar or other non-native vegetation.	LADWP continues treatment of saltcedar as needed. Progress of the salt cedar eradication efforts is reported in the annual reports following the vegetation monitoring efforts. This item will continue until notice from SWRCB is received that LADWP's obligation for this in the Mono Basin is complete.	Ongoing

3.0 WATERFOWL HABITAT RESTORATION MONITORING PROGRAM

The Plan and SWRCB Order WR 98-05 directed LADWP to conduct monitoring to assess the success of waterfowl habitat restoration efforts, evaluate the effects of changes in the Mono Lake area, and plan for future restoration activities. Components of the Mono Basin Waterfowl Habitat Monitoring Program (Program) include hydrology, limnology, the vegetation status of riparian and lake-fringing wetlands, and waterfowl population surveys. Table 3-1 provides a brief description of the monitoring components, their required frequency under the Plan and Order 98-05, and the dates that each monitoring task has been performed.

In 2020, monitoring conducted under the Program included lake elevation, stream flows, lake limnology and secondary producers, saltcedar eradication, aerial photography of waterfowl habitats, and waterfowl population surveys. The remainder of this report provides a summary and discussion on the 2020 data collected under the Program.

Table 3-1. Mono Basin Habitat Restoration Monitoring Program

Mono Basin Habitat Restoration Monitoring Program *(as described in SWRCB Order 98-05 and the Waterfowl Habitat Restoration Plan dated February 29, 1996)*			
Monitoring Component	**Description**	**Required Frequency**	**Dates Monitoring Performed**
Hydrology	Lake Elevation	Weekly through one complete wet/dry cycle after the lake level has stabilized.	Monthly data collected 1936-present; ongoing
	Stream Flows	Daily through one complete wet/dry cycle after the lake level has stabilized.	Daily data collected 1935-present; ongoing
	Spring Surveys	Five-year intervals (August) through one complete wet/dry cycle after the lake level has stabilized.	1999, 2004, 2009, 2014, 2019; ongoing
Lake Limnology and Secondary Producers	Meteorological data, data on physical and chemical environment of the lake, phytoplankton, and brine shrimp population levels.	Annually (monthly February-December) until the lake reaches a relatively stable level. LADWP will evaluate monitoring at that time and make a recommendation to the SWRCB whether or not to continue.	1987-present; ongoing
Vegetation Status in Riparian and Lake Fringing Wetland Habitats	Establishment and monitoring of vegetation transects and permanent photopoints in lake fringing wetlands	Five-year intervals or after extremely wet year events (whichever comes first) until 2014. LADWP will evaluate the need to continue this program in 2014 and present findings to SWRCB.	2000, 2005, 2010, 2015; ongoing
	Aerial photographs of lake fringing wetlands and Mono Lake tributaries	Five-year intervals until target lake elevation of 6,392 feet is achieved.	1999, 2005, 2009, 2014; ongoing

Mono Basin Habitat Restoration Monitoring Program *(as described in SWRCB Order 98-05 and the Waterfowl Habitat Restoration Plan dated February 29, 1996)*			
Monitoring Component	**Description**	**Required Frequency**	**Dates Monitoring Performed**
Waterfowl Population Surveys and Studies	Fall aerial counts	Two counts conducted every other year October 15- November 15. All waterfowl population survey work will continue until 2014, through one complete wet/dry cycle after the target lake elevation of 6,392 feet is achieved. Since 2002, six fall counts have been conducted annually at Mono Lake, Bridgeport Reservoir and Crowley Reservoir. Ground and boat counts were conducted in 2020 due to lack of flight services.	Annually; ongoing
	Aerial photography of waterfowl habitats	Conducted during or following one fall aerial count.	Annually; ongoing
	Ground counts	Total of eight ground counts annually (two in summer, six in fall). All waterfowl population survey work will continue until 2014, or through one complete wet/dry cycle after the target lake elevation of 6,392 feet is achieved. Since 2002, three summer ground counts have been conducted. Fall ground counts were replaced with six aerial counts.	Annually; ongoing
	Waterfowl time activity budget study	To be conducted during each of the first two fall migration periods after restoration plans are approved, and then again when the lake is at or near the target elevation.	Conducted one of two fall migration periods in 2000; completion of second study is recommended

3.1 Hydrology

Lake Level

Mono Lake is hydrographically closed and as such, all surface and groundwater drains towards Mono Lake. Lake elevation, salinity, and water chemistry are influenced by inputs via surface water, springs, precipitation, and subsequent evaporative losses (Vorster 1985). The Mono Basin receives drainage and runoff from several nearby mountains and ranges including the Sierra Nevada, Cowtrack Mountain, the Excelsior Mountains, and others.

Climate has influenced the Mono Lake environment over geologic and historic time. Mono Lake is the saline and alkaline remnant of the much larger Lake Russell, present in the Pleistocene. At its highest, Lake Russell stood at 7,480 feet above sea level, and was once hydrologically connected to the Lahontan and Owens-Death Valley systems (Reheis, Stine and Sarna-Wojcicki 2002). Starting in the late Pleistocene, climatic variation resulted in the contraction of Lake Russell, and hydrologic isolation of Mono Lake. These climatic variations resulted in the level of Mono Lake fluctuating from an extreme high stand of 7,200 feet, to an extreme low of an approximately 6,368-foot lake elevation (Scholl et al. 1967 in Vorster 1985). Since 1941, lake level and salinity have been influenced by water exports by the City, and more recently, climate change may be becoming more influential.

In April of 1941, the City began exporting water from the Mono Basin by diverting Lee Vining Creek, Rush Creek, Walker Creek, and Parker Creek. The prediversion elevation of Mono Lake in April of 1941 was 6,416.9 feet. From 1941-1970, annual exports averaged 56,000 acre-feet, and the surface elevation of Mono Lake dropped over 29 feet during this same time period. In 1970, the completion of the second aqueduct in the Owens Valley expanded the capacity of the system, resulting in an increase in diversions, frequent full diversion of flows from Lee Vining, Walker, Parker and Rush Creek and a drying of the creek channels (SWRCB 1994). From 1970 to 1989, Mono Lake dropped another 12.6 feet as yearly exports averaged 82,000 acre-feet, with a peak export of 140,756 acre-feet in 1979. The lake level dropped to a record low of 6,371.0 feet in 1982, representing a cumulative 45-foot vertical drop in lake elevation as compared to the prediversion level. Decision 1631 amended the City's water rights license in order to support reaching a long-term average lake elevation of 6,392 feet.

Stream Flow

There are seven perennial creeks tributary to Mono Lake, all of which originate on the east slope of the Sierra Nevada. The perennial creeks are primarily snow-melt fed systems, with peak flows typically occurring in June or July, especially in normal-to-wet years. Peak flows may occur in April or May in dry years or on the smaller creeks (Beschta 1994). Rush Creek is the largest tributary, accounting for approximately 50% of stream-flow contributions to Mono Lake. Parker and Walker Creeks are small creeks tributary to Rush Creek. Rush Creek was permanently re-watered in 1982, however Parker Creek and Walker Creek, were not re-watered until 1990. Mono Lake's second largest tributary, Lee Vining Creek, was re-watered in 1986. Along the west shore is Log Cabin Creek, a small tributary monitored as part of the spring monitoring program. Flows in DeChambeau Creek along the northwest shore are intermittent, and do not consistently reach the lakeshore. Mill and Wilson Creeks are along the northwest shore of Mono Lake. Mill Creek is the third largest tributary to Mono Lake.

3.1.1 Hydrologic Monitoring Methodologies

Mono Lake Elevation

LADWP hydrographers record the elevation of Mono Lake monthly using a staff gauge installed at the boat dock on the west shore. The staff gauge is demarcated in tenths and hundredths of a foot. The Mono Lake Committee (MLC) also measures lake level, and since 1979, lake level data reported by the MLC has averaged 0.3 feet higher than LADWP data. Lake elevation is used to evaluate progress in meeting the target lake level, and for determining the annual allowable export. Lake elevation data is also used to evaluate the response of biological indicators including secondary producers, vegetation, and waterfowl.

Stream Flow

LADWP is required to monitor stream flow in the four Mono Lake tributaries from which the City diverts water for export - Rush Creek, Lee Vining Creek, Parker Creek and Walker Creek. Decision 1631 and Order 98-05 dictate the instream flows (base flows) and channel maintenance flows (peak flows) for these four tributaries, based on "Runoff Year" type. Runoff Year is the period from April 1-March 31. Runoff year type (Table 3-2) is based on a comparison of the total acre-feet of predicted runoff to the 1941-1990 average runoff of 122,124 acre-feet. Runoff predictions are based on the results of snow course surveys conducted along drainages contributing to Mono Basin runoff. The runoff year type assigned to any one year is based on the LADWP April 1 Mono Basin runoff forecast, although adjustments may be made on May 1. Runoff year type is used to determine the required annual restoration flows for Rush and Lee Vining Creeks. Instream and channel maintenance flows for other Mono Lake tributaries were not specified by the Order.

Table 3-2. Runoff Year Types per SWRCB Order 98-05

Runoff Year Type	April 1 Runoff Forecast
Dry	<68.5% of average runoff*
Dry/Normal	between 68.5% and 82.5% of average runoff
Normal	between 82.5% and 107% of average runoff
Wet/Normal	between 107% and 136.5% of average runoff
Wet	between 136.5% and 160% of average runoff
Extreme Wet	> 160% of average runoff

*average runoff based on 1941-1990 average runoff of 122,124 acre-feet

LADWP hydrographers collect flow data using continuous instream data recorders that measure flow at 15-minute intervals. The measuring stations used to determine Rush Creek flows are Mono Gate One Return Ditch (STAID 5007) and Grant Lake Spill (STAID5078). Lee Vining Creek flows are measured at Lee Vining Creek below Conduit (STAID5009). The stations for Parker (Parker Creek below Conduit -STAID5003) and Walker Creek (Walker Creek below Conduit - STAID5002) are located just downstream of the diversion point into the Mono Crater Tunnel. Stream flow data are used to determine compliance with the Mono Basin Stream and Stream Channel Restoration Plan (LADWP 1996b), and to provide environmental data to evaluate the response of biological indicators under the Mono Basin Waterfowl Habitat Restoration Plan (LADWP 1996a).

In order to provide a more complete record of annual stream flow contributions to Mono Lake, we also report on flows for DeChambeau Creek, and the estimated inputs of Mill Creek and Wilson Creek. LADWP maintains a continuous instream data recorder station on DeChambeau Creek west of Highway 395 (Dechambeau Creek above Diversion -STAID5049). LADWP does not maintain flow measuring stations on Mill or Wilson Creeks, however flow data was obtained from USGS National Water Information System (waterdata.usgs.gov) for Mill Creek below Lundy Lake (10287069) and Lundy Power Plant Tailrace (10287195). Mill Creek below Lundy Lake measures flow in Mill Creek downstream of the diversion to the Lundy Powerhouse. The Lundy Power Plant Tailrace measures flows downstream of the Lundy Powerhouse. Water downstream of the Lundy Powerhouse is split between return flows to Mill Creek, a diversion to Conway Ranch, and a diversion to Wilson Creek. Further downstream on Wilson Creek, water is diverted off of Wilson Creek for use in the Restoration Ponds.

3.1.2 Hydrology Data Summary and Analysis

Lake Elevation

Monthly LADWP Mono Lake elevation data were summarized for 2020, and for the time period 1990-2020. This time series represents the period during which a preliminary injunction was in place that halted exports until the lake level recovered to 6,377 feet, and the implementation of Decision 1631, beginning in September 1994. Patterns of lake elevation change were evaluated on a yearly and long-term basis.

Although Runoff Year type is used for determining yearly prescribed stream flows, hydrologic data were summarized by "Water Year", or the period from October 1-September 30 of each year. This is the preferred approach for biological analysis as the Water Year will encompass winter precipitation contributing to ecological conditions and processes the following year.

Stream Flow

The real-time station flow data were converted into daily flow, which was used to calculate monthly and annual inflow into Mono Lake. Inflow from Rush Creek is estimated by summing Mono Gate One Return Ditch (STAID 5007), Grant Lake Spill (STAID5078), Parker Creek below Conduit (STAID5003) and Walker Creek below Conduit (STAID5002). Lee Vining Creek below Conduit (STAID5009) and Dechambeau Creek above Diversion (STAID5049) are used to estimate inflow from Lee Vining and Dechambeau Creeks, respectively.

The contribution of Mill and Wilson Creek into Mono Lake cannot be precisely determined due to a lack of direct measure, and therefore the input amounts we report should be considered estimates. The estimated combined contribution of Mill Creek and Wilson Creek was calculated by summing USGS Stations Mill Creek below Lundy Lake (10287069) and Lundy Power Plant Tailrace (10287195). This calculation will overestimate flows to Mono Lake as diversions to Conway Ranch and the Restoration Ponds have not been subtracted.

3.1.3 Hydrology Results

Lake Elevation

In 2020, Mono Lake experienced a period of decreasing lake level (Figure 3-1). Lake level was fairly constant through May, showing only a minimal 0.1-foot rise in level during spring runoff. The lake was at its highest level in 2020 of 6,382.3 feet in early spring (March through May). Lake level steadily decreased thereafter, reaching a low of 6380.7 feet in December, for a total decline in lake elevation in calendar year 2020 of 1.6 feet.

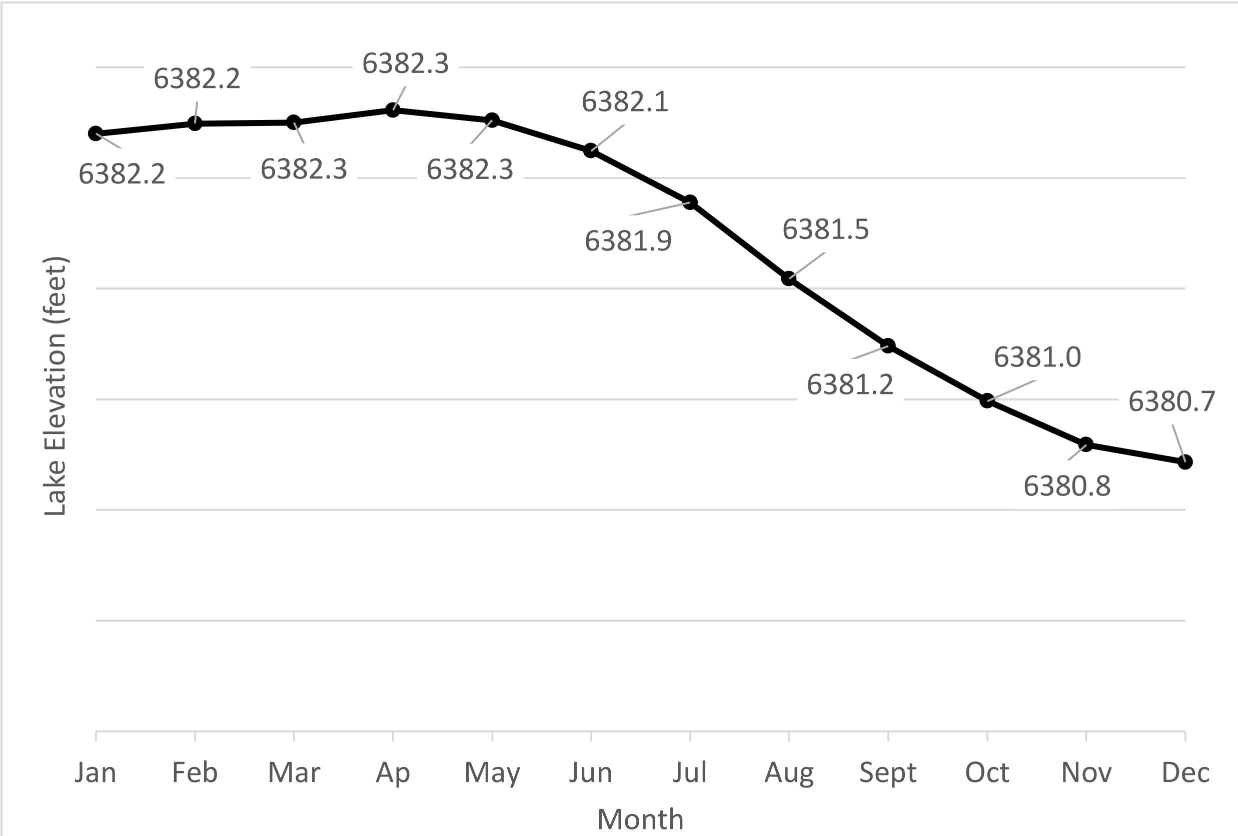

Figure 3-1. Mono Lake Monthly Elevation - 2020

Runoff during the 2019-2020 Water Year was 55,452 acre-feet, or 46% of the long-term average. Since Decision 1631, there have been three distinct wet periods, however though the magnitude and duration of the wet periods has decreased progressively. The first wet period lasted from 1995 to 1998 and averaged 146% of normal; the second wet period only lasted two years (2005 to 2006) and averaged 153% of normal; the third wet period also lasted two years (2010 to 2011) and averaged 130% of Normal. Following this third wet period was an extended drought that resulted in the driest 5-year period on record. The year 2017 marked the end of this extended dry period, and was the second wettest on record with 195% of normal, or an "Extreme Wet year".

The implementation of Decision 1631 appears to have resulted in a stabilization of Mono Lake elevation (Figure 3-2). From 1994 to 2019, Mono Lake has experienced four periods of increasing elevation, and three subsequent decreases, through a total elevation range of 8.0 feet (Figure 3-2). Since export amounts are now regulated, and greatly reduced as compared to historic export amount prior to Decision 1631, variations in lake level are largely driven by climate and runoff. The highest elevation the lake has achieved since 1994 has been 6,384.7 feet, which occurred in July 1999. During a period of extended drought from 2012-2016, the lake elevation dropped almost 7 feet to a low of 6,376.8 feet in October 2016, the lowest level since implementation of the Order. Following the "Extreme Wet" runoff year of 2016-2017, followed by a "Normal" and then "Wet Normal" year, the lake level has shown some recovery from the extreme low point of 2016 (Figure 3-2).

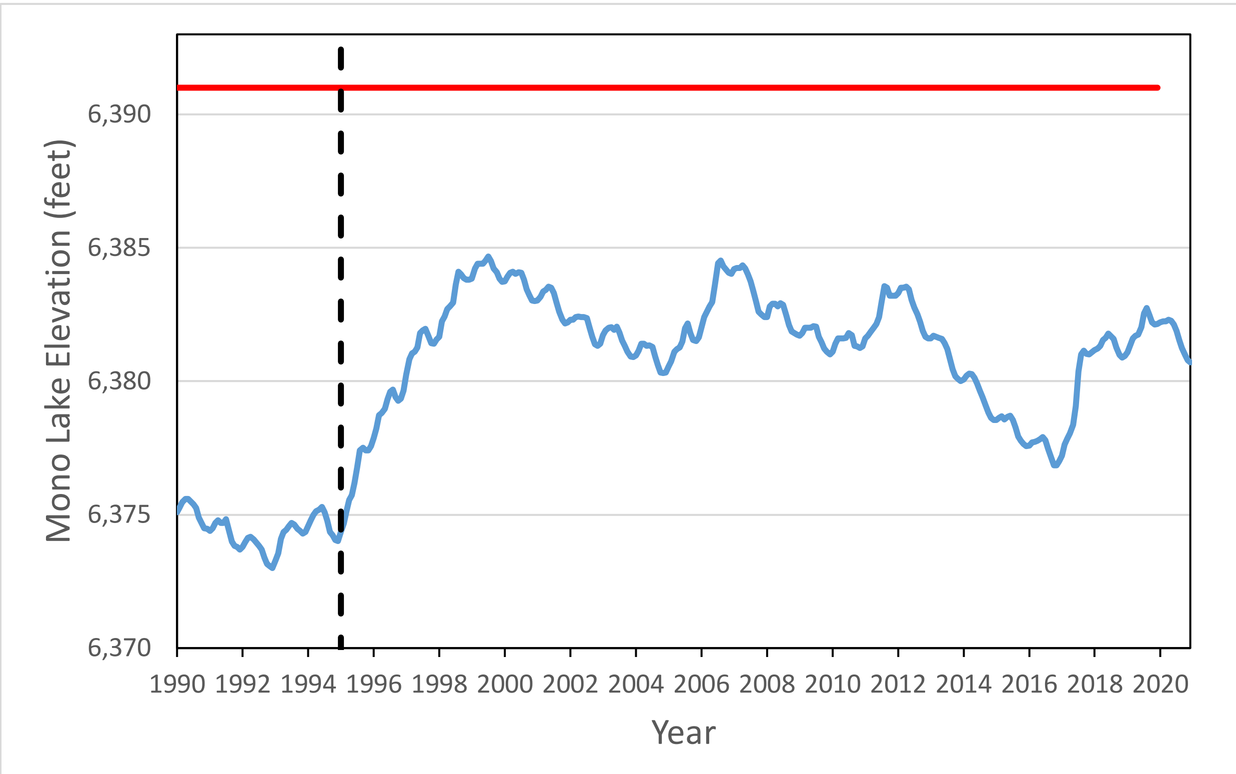

Figure 3-2. Mono Lake Elevation Between 1990 and 2020

Since Decision 1631, there have been four periods of lake level increase associated with above- average runoff.

Stream Flows

In 2020, the input from Rush Creek was 41,437 acre-feet or less than 50% of the 2019 runoff, and approximately 30% less than the long-term average (Table 3-3). Since 1990, Rush Creek has provided the largest inputs to Mono Lake averaging 62,383-acre-foot discharge, with a peak discharge in 2017 of 145,349. Lee Vining Creek input in 2020 was 20,150 acre-feet, or approximately 40% below the long-term average of 38,974 acre-foot, with a peak discharge of 91,133 acre-feet in 2017. Input from the two major tributaries (Rush and Lee Vining Creeks) in

2020 was 61,587 acre-feet, or 64% of the long-term average since re-watering in 1982. The input from Dechambeau Creek in 2020 was 747 acre-feet, slightly below the long-term mean. DeChambeau Creek has averaged 769 acre-feet since 1944 and has contributed less than 1% of total annual input since 1990. The estimated contribution of Mill Creek and Wilson Creek combined in 2020 was 11,344 acre-feet, or 39% less than the long-term average. The combined flow of Mill and Wilson Creek has contributed approximately 15% of annual Mono Lake inputs since 1990.

Table 3-3. Annual Flow Volume in Acre-Feet of Five Mono Lake Tributaries Based on Water Year

Year	Rush Creek	Lee Vining Creek	Dechambeau Creek	Mill/Wilson Creeks
1990	71,047	18,644	326	9,115
1991	35,714	20,562	265	8,726
1992	44,632	20,799	179	10,590
1993	77,461	42,279	440	18,711
1994	56,776	29,377	451	11,118
1995	94,596	66,443	911	31,899
1996	91,842	56,284	1,244	25,558
1997	82,424	66,317	1,486	30,913
1998	93,178	62,335	1,326	27,114
1999	58,047	46,204	1,151	19,473
2000	50,497	40,432	750	16,370
2001	49,357	31,034	576	13,272
2002	45,900	36,599	406	12,708
2003	49,028	30,778	530	15,199
2004	47,644	31,872	550	15,116
2005	72,766	55,367	995	26,640
2006	108,899	75,861	1,460	32,149
2007	38,428	24,091	998	10,173
2008	45,159	25,632	588	13,265
2009	36,570	30,654	586	15,769
2010	57,622	34,776	672	19,330
2011	96,433	65,454	1,151	29,997
2012	46,535	19,487	927	11,272
2013	34,776	18,320	476	10,416
2014	31,893	20,048	340	8,540
2015	32,754	16,525	273	8,485
2016	44,242	28,421	276	15,232
2017	145,349	91,133	1,433	45,411
2018	63,397	33,625	1,211	21,721
2019	89,466	48,687	1,096	27,762
2020	41,437	20,150	747	11,344

3.1.4 Hydrology Discussion

Lake Elevation

Mono Lake experienced an overall decrease in lake level as compared to 2019. At the final lake level read in December (6380.7 feet), Mono Lake was 1.4 feet lower than in December 2019. As is typical of dry years (LADWP 2018), maximum lake level occurred early in spring.

Climatic factors may be influencing Mono Lake and lake level recovery. Mono Lake has not yet reached the target lake elevation, although the implementation of Decision 1631 has stabilized the lake level. Decision 1631 now regulates export amounts and lake level appears to be largely driven by climate and runoff.

Stream Flows

The 2020 runoff resulted in below-average total stream discharge into Mono Lake from the five primary tributaries. The decreased stream discharge contributed to the decrease in lake level observed in 2020. Runoff in the Mono Basin is typified by dry periods interrupted by short wet periods, except in the late 1930s to early 1940s, the late 1970s to 1980s, and the late 1990s when wet periods were found to last longer than the more recent wet periods (LADWP 2018).

3.2 Limnology

Mono Lake supports a relatively simple yet productive aquatic ecosystem. Planktonic and benthic algae form the foundation of the food chain in the lake. The phytoplankton community is primarily composed of coccoid chlorophytes (*Picosystis* spp.), coccoid cyanobacteria, and several diatoms (primarily *Nitzschia* spp.) (Jellison and Melack 1993). Filamentous blue-green algae (*Oscillatoria* spp.) and filamentous green algae (*Ctenocladus circinnatus*) and the diatom *Nitzchia frustulum* dominant the benthic algal community.

Secondary producers in Mono Lake consist of invertebrate species. The most abundant secondary producer in the pelagic zone is the Mono Lake brine shrimp (*Artemia monica*). In the littoral zone, secondary producers including the alkali fly (*Ephydra hians*), long-legged fly (*Hydrophorus plumbeus*), biting midges (*Cuciloides occidentalis*), and deer fly (*Chrysops* spp.) graze on benthic algae (Jones and Stokes Associates, Inc 1993).

Within the hydrographically closed basin, the particular water chemistry of Mono Lake is influenced by climate, water inputs, evaporative losses, and the chemical composition of the surrounding soils and rocks. The waters are saline and alkaline, and contain high levels of sulfates, chlorides, and carbonates. For the period 1938-1950, the salinity of Mono Lake was approximately 50 g/L, and by 1964 salinity had increased to 75 g/L, and up to 100 g/L by 1982 (Vorster 1985). Since implementation of Decision 1631, the salinity has varied from 72.4 to 97.8 g/L, which is approximately two to three times as salty as ocean water. The lake water is also highly alkaline, with a pH of approximately 10, due to the high levels of carbonates dissolved in the water.

The limnological monitoring program at Mono Lake is one component of the Plan and is required under SWRCB Order No. 98-05. The purpose of the limnological monitoring program as it relates to waterfowl is to assess limnological and biological factors that may influence waterfowl use of lake habitat (LADWP 1996a). The limnological monitoring program has four components: meteorology, physical/chemical analysis, chlorophyll *a*, and brine shrimp population monitoring.

An intensive limnological monitoring program at Mono Lake has been funded by LADWP since 1982. The Marine Science Institute (MSI), University of California, Santa Barbara served as the principle investigator, and Sierra Nevada Aquatic Research Laboratory (SNARL) provided field sampling and laboratory analysis technicians until July 2012. After receiving training in limnological sampling and laboratory analysis methods from the scientists and staff at MSI and SNARL, LADWP Watershed Resources staff assumed responsibility for the program, and have been conducting the limnological monitoring program at Mono Lake since July 2012.

Laboratory support including the analysis of ammonium and chlorophyll *a* has been provided by Environmental Science Associates (ESA), Davis, California since 2012.

This report summarizes the results of monthly limnological field sampling conducted in 2019, and discusses the results in the context of the entire period of record. In addition, past findings are summarized to evaluate long term trends in water chemistry parameters and *Artemia* population dynamics.

3.2.1 Limnological Monitoring Methodologies

Methodologies for both the field sampling and the laboratory analysis followed those specified in *Field and Laboratory Protocols for Mono Lake Limnological Monitoring* (*Field and Laboratory Protocols*) (Jellison 2011). The methods described in *Field and Laboratory Protocols* are specific to the chemical and physical properties of Mono Lake and therefore may vary from standard limnological methods (e.g. Strickland and Parsons 1972). The methods and equipment used by LADWP to conduct limnological monitoring were consistent and follow those identified in *Field and Laboratory Protocols* except where noted.

Meteorology

One meteorological station on Paoha Island provided the majority of the weather data. The Paoha Island measuring station is located approximately 30 m from shore on the southern tip of the island. The base of the station is at 1,948 m (6,391 feet) above sea level, several meters above the current surface elevation of the lake. Sensor readings are made every second and stored as either ten-minute averages or hourly values in a Campbell Scientific CR 1000 datalogger. Data were downloaded on March 16, 2021. During the visit, however, LADWP staff found the anemometer missing and the casing with the radiation shield dislodged. A review of the data suggests the strong wind event on November 17, 2020 (maximum wind speed of 18.6m/s) knocked down the anemometer, and the datalogger only recorded a value of zero for wind speed and direction afterward. While temperature readings appear normal, relative humidity readings appear erratic with many zero values and sudden decreases below 25(%).

At the Paoha Island station, wind speed and direction were measured by a RM Young wind monitor sensors at a height of 3 m above the surface of the island and were averaged over a 10-minute interval. During the 10-minute interval, maximum wind speed is also recorded. Using wind speed and direction measurements, the 10-minute wind vector magnitude and wind vector direction were calculated. Ten-minute averages of relative humidity and air temperature (Vaisalia HMP35C), and total rainfall (Campbell Scientific TE525MM-L tipping bucket) are also stored. The minimum detection limit for the tipping bucket gage is 1 mm of water. The tipping bucket is not heated; therefore, the instrument is less accurate during periods of freezing due to the sublimation of ice and snow. The daily mean wind speed, maximum mean wind speed, and relative humidity were calculated from 10-minute averaged data from the Paoha Island site. Due to the inconsistent precipitation readings of the Paoha Island weather station, daily precipitation recorded at LADWP Cain Ranch station is reported.

In addition to the Paoha Island station, monthly total precipitation record was obtained from LADWP Cain Ranch weather station which was established in May 1931, and monthly average maximum and minimum temperatures dating from October 1950 were obtained from the Western Regional Climate Center (www.wrcc.dri.edu) and analyzed to gain better insight into climatic trends. Winter temperature was calculated by averaging the monthly average maximum (or minimum) temperature from December of the previous year and January and February of the subsequent year. For example, the monthly average from December 2018 was combined with the monthly average from January and February 2019 to obtain the winter average for 2019. Summer temperature was calculated as the average monthly temperature between June and August.

Field Sampling and Laboratory Procedures

Sampling of the physical, chemical, and biological properties of the water including the *Artemia* community was conducted at 12 buoyed stations at Mono Lake (Figure 3-3) on the dates listed in Table 3-4. The water depth at each station at a lake elevation of 6384.5 feet (1,946 m) is indicated on Figure 3-3. Stations 1-6 are considered western sector stations, and stations 7-12 are eastern sector stations. There are gaps in data due to COVID-19 imposed restrictions, boat motor failure, and malfunctioning of the dissolved oxygen meter. No sampling was conducted in April at Stations 3 to 6. No DO reading was taken in May and June. Chlorophyll and ammonium samples were not taken in May. Monitoring was generally conducted on two separate days: 1) the first day for dissolved oxygen, ammonium, and chlorophyll *a* sampling, and 2) the second day for *Artemia* sampling, CTD casting, and Secchi readings. Surveys were generally conducted around the 15th of each month.

Table 3-4. Mono Lake Limnology Sampling Dates for 2020

Month	Sampling Dates	
	DO, NH4, CHLA	Artemia, CDT, Secchi
Feb	2/12/2020	2/13/2020
Mar	3/20/2020	3/21/2020
Apr	-	4/23/2020
May	5/20/2020	5/20/2020
Jun	6/23/2020	6/24/2020
Jul	7/22/2020	7/23/2020
Aug	8/13/2020	8/12/2020
Sep	9/22/2020	9/23/2020
Oct	10/21/2020	10/22/2020
Nov	11/19/2020	11/19/2020
Dec	12/16/2020	12/16/2020

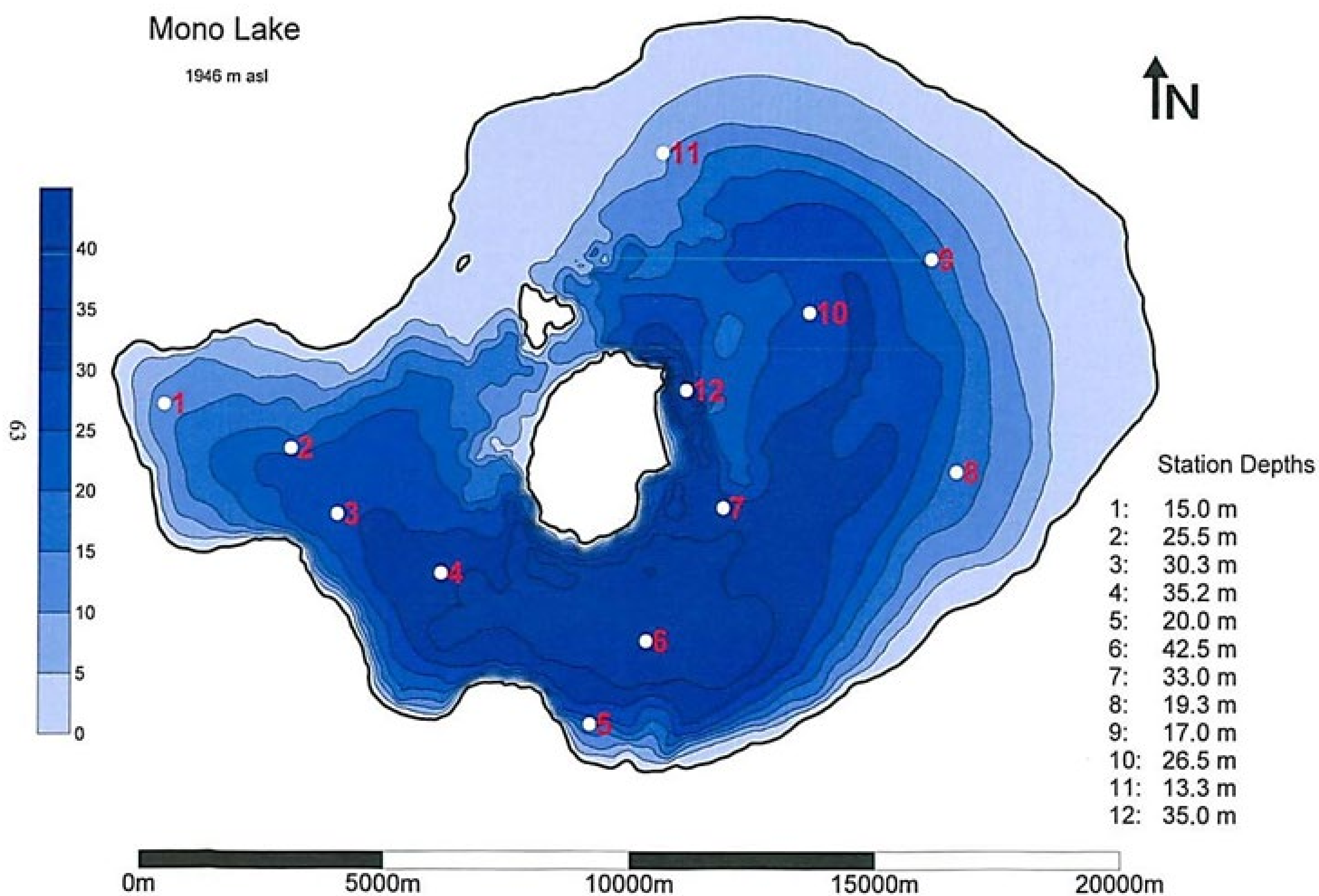

Figure 3-3. Sampling Stations at Mono Lake and Associated Station Depths

Physical and Chemical

Transparency

Lake transparency was measured at all 12 stations using a Secchi disk each month.

Temperature, Conductivity, and Salinity

A Sea-Bird high-precision conductivity temperature-depth (CTD) profiler was used to record conductivity at 9 stations (2, 3, 4, 5, 6, 7, 8, 10 and 12) on a monthly basis. The Sea-Bird CTD is programmed to collect data at 250 millisecond intervals. During sampling, the CTD was initially lowered just below the surface of the water for 40 seconds during the pump delay time. The CTD was then lowered at a rate of approximately 0.5 meter/second with data collected at approximately 12.5-centimeter depth intervals. In situ, conductivity measurements at Station 6 are corrected for temperature (25˚C). Conductivity and temperature readings at the depth closest to a whole number are assigned to that depth and reported at one-meter intervals beginning at one meter in depth down to the lake bottom. Salinity expressed in g/L was calculated based on the equation presented by Jellison in past compliance reports (LADWP 2004).

Dissolved Oxygen

Dissolved oxygen is measured at one centrally-located station (Station 6) with a Yellow Springs Instruments Rapid Pulse Dissolved Oxygen Sensor (YSI model 6562). Readings were taken at one-meter intervals and at 0.5-meter intervals in the vicinity of the oxycline and other regions of rapid change. Data are reported for one-meter intervals only.

Ammonium Sampling

Monitoring of ammonium in the epilimnion was conducted using a 9-m integrated sampler at stations 1, 2, 5, 6, 7, 8, and 11. Ammonium was sampled at eight discrete depths (2, 8, 12, 16, 20, 24, 28, and 35 meters) at Station 6 using a vertical Van Dorn sampler. Samples for ammonium analyses were filtered through Gelman A/E glass-fiber filters, and following collection, immediately placed onto dry ice and frozen in order to stabilize the ammonium content (Marvin and Proctor 1965). Ammonium samples were transported on dry ice back to the laboratory transfer station. The ammonium samples were stored frozen until delivered to the University of California Davis Analytical Laboratory (UCDAL) located in Davis, California and kept frozen until analysis.

Starting in August 2012, the methodology used for ammonium testing changed due to a change in laboratory. In July 2012, the flow injection analysis used by UCDAL for ammonium testing was tested on high salinity Mono Lake water and found to give results comparable to previous years, although this method has a detection limit of approximately 2.8 µM. Immediately prior to analysis, frozen samples are allowed to thaw and equilibrate to room temperature, and are shaken briefly to homogenize. Samples are heated with salicylate and hypochlorite in an alkaline phosphate buffer (APHA 1998a, APHA 1998b, Hofer 2003, Knepel 2003). EDTA (Ethylenediaminetetraacetic acid) is added in order to prevent precipitation of calcium and magnesium, and sodium nitroprusside is added in order to enhance sensitivity. Absorbance of the reaction product is measured at 660 nm using a Lachat Flow Injection Analyzer (FIA), QuikChem 8000, equipped with a heater module. Absorbance at 660 nm is directly proportional to the original concentration of ammonium, and ammonium concentrations are calculated based on absorbance in relation to a standard solution.

<u>Chlorophyll a Sampling</u>

Monitoring of chlorophyll *a* in the epilimnion was conducted using a 9-m integrated sampler at stations 1, 2, 5, 6, 7, 8, and 11. Chlorophyll was sampled at Station 6 at seven discrete depths (2, 8, 12, 16, 20, 24, and 28 meters) using a vertical Van Dorn sampler. Water samples were filtered into opaque bottles through a 120 µm sieve to remove all life stages of *Artemia*. Chlorophyll *a* samples were kept cold and transported on ice back to the laboratory transfer station located in Sacramento, CA. The determination of chlorophyll *a* was conducted through fluorometric analysis following acetone extraction. Fluorometry was chosen, as opposed to spectrophotometry, due to higher sensitivity of the fluorometric analysis, and because data on chlorophyll *b* and other chlorophyll pigments were not needed.

At the laboratory transfer station in Sacramento, water samples (200 mL) were filtered onto Whatman GF/F glass fiber filters (nominal pore size of 0.7 µm) under vacuum. Filter pads were then stored frozen until they could be mailed overnight in dry ice to the University of Maryland Center for Environmental Science Chesapeake Biological Laboratory (CBL), located in Solomons, Maryland. Sample filter pads were extracted in 90% acetone and then refrigerated in the dark for 2 to 24 hours. Following refrigeration, the samples were allowed to warm to room temperature, and then centrifuged to separate the sample material from the extract. The extract for each sample was then analyzed on a fluorometer. Chlorophyll *a* concentrations were calculated based on output from the fluorometer. Throughout the process, exposure of the samples to light and heat was avoided.

The fluorometer used in support of this analysis is a Turner Designs TD700 fluorometer equipped with a daylight white lamp, 340-500 nm excitation filter and >665 nm emission filter, and a Turner Designs Trilogy fluorometer equipped with either the non-acid or the acid optical module.

Artemia *Population Sampling*

Artemia *Population*

The *Artemia* population was sampled by one vertical net tow at each of the 12 stations (Figure 3-3). Samples were taken with a plankton net (0.91 m x 0.30 m diameter, 118 µm Nitex mesh) towed vertically through the water column. Samples were preserved with 5% formalin in Mono Lake water.

An 8x to 32x stereo microscope was used for all *Artemia* analyses. Depending on the density of shrimp, counts were made of the entire sample or of a subsample made with a Folsom plankton splitter. When shrimp densities in the net tows were high, samples were split so that approximately 100-200 individuals were subsampled. Shrimp were classified as nauplii (instars 1-7), juveniles (instars 8-11), or adults (instars >12), according to Heath (1924). Adults were sexed and the reproductive status of adult females determined. Non-reproductive (non-ovigerous) females were classified as empty. Ovigerous females were classified as undifferentiated (eggs in early stage of development), oviparous (carrying cysts) or ovoviviparous (naupliar eggs present).

An instar analysis was completed for seven of the twelve stations (Stations 1, 2, 5, 6, 7, 8, and 11). Nauplii at these seven stations were further classified as to specific instar stage (1-7). Biomass was determined from the dried weight of the shrimp tows at each station. After counting, samples were rinsed with tap water and dried in aluminum tins at 50°C for at least 48 hours. Samples were weighed on an analytical balance immediately upon removal from the oven.

Calculation of long-term *Artemia* population statistics followed the method proposed by Jellison and Rose (2011). Daily values of adult *Artemia* between sampling dates were linearly interpolated using the R package *zoo*. The mean, median, peak and centroid day (calculated center of abundance of adults) was then calculated for the time period May 1 through November 30, during which adult *Artemia* population is most abundant. Long-term statistics were determined by calculating the mean, minimum, and maximum values for the time period 1979-2019.

Artemia Fecundity

When mature females were present, an additional net tow was taken from four western sector stations (1, 2, 5 and 6) and three eastern sector stations (7, 8 and 11) to collect adult females for fecundity analysis including body length and brood size. Live females collected for fecundity analysis were kept cool and in low densities during transport to the LADWP laboratory in Bishop, CA.

Immediately upon return to the laboratory, ten females from each sampled station were randomly selected, isolated into individual vials, and preserved with 5% formalin. Female length was measured using 8x magnification from the tip of the head to the end of the caudal furca (setae not included). Egg type was noted as undifferentiated, cyst, or naupliar. Undifferentiated egg mass samples were discarded. Brood size was determined by counting the number of eggs in the ovisac and any eggs dropped in the vial. Egg shape was noted as round or indented.

3.2.2 Limnology Data Analysis

Salinity and Mono Lake Elevation

The salinity of Mono Lake is directly influenced by water inputs and lake elevation due to the hydrographically-closed nature of the basin. Salinity is a key parameter influencing the structure of aquatic algal and invertebrate communities of closed lake systems (Herbst and Blinn 1998, Verschuren et al. 2000). High salinity has been shown to negatively affect the survival, growth, reproduction, and cyst hatching of *Artemia* in Mono Lake (Starrett and Perry 1985, Dana and Lenz 1986). Negative effects are accentuated when salinity approaches the tolerance level, which ranges from 159 g/L to 179 g/L (Dana and Lenz 1986). As of December 2020, salinity ranged between 85.4 g/L and 89.0 g/L at Station 6 at lake level at 6,380.7 feet. Long-term relationships between lake levels and salinity at three different depths (between 0 and 10 m, between 11 and 20 m, and deeper than 21 m) were examined in this section. Lake elevation data collected as part of the hydrologic monitoring program (Section 3.1.1) was used for this analysis.

<u>Artemia</u> Population Peak

Meromixis has been demonstrated to affect the *Artemia* population in Mono Lake as stratification prevents the release of hypolimnetic ammonium during meromixis. During periods of meromixis, ammonium accumulates in the hypolimnion. With a weakening chemocline, ammonium supply to the epilimnion or mixolimnion increases. This process also allows oxygenation of the hypolimnion, which remains suboxic to anoxic during meromixis. Usually one year after the breakdown of meromixis, the *Artemia* population booms. The salinity gradient as determined by the preceding salinity, and lake input are important aspects affecting the strength and duration of a chemocline, which, in turn, dictate the magnitude of ammonium accumulation. Meromictic events were characterized by salinity gradient and ammonium (NH4) accumulation, in order to evaluate post meromictic *Artemia* population peaks.

A Temporal Shift in Monthly Artemia Population

A temporal shift in peak *Artemia* population or centroid has been noted by Jellison in previous years' compliance reports. LADWP also has reported a continuation of this trend in the *Artemia* instar population (LADWP 2017). Two water parameters - chlorophyll *a* and temperature - have been demonstrated to affect development of *Artemia*. For instance, spring generation *Artemia* raised at high food densities develop more quickly and begin reproducing earlier. In addition, the abundance of algae may likely affect year-to-year changes in *Artemia* abundance (Jellison and Melack 1993). Cysts of Mono Lake brine shrimp require three months of dormancy in cold (<5°C) water to hatch (Dana 1981, Thun and Starrett 1986) and the summer generation of *Artemia* grows much more quickly than the spring counterpart because of warmer epilimnetic water temperature. For adult development, summer epilimnetic water temperature could affect *Artemia* abundance even though other factors such as food availability confounds growth rate (Jones and Stokes Associates 1994).

In this section, monthly *Artemia* abundance (adult and instar) was quantitatively and qualitatively compared to monthly readings of chlorophyll *a* and temperature in order to understand the mechanisms associated with the temporal shifts in *Artemia* population abundance. All analyses were performed using the statistical software, R (The R Project for Statistical Computing).

3.2.3 Limnology Results

Meteorology

Wind Speed and Direction

Mean daily wind-speed from January 1 to December 31, 2020 varied from 0.21 to 12.34 m/sec with an overall mean for this time period of 2.48 m/sec (Figure 3-4). The daily maximum 10-min averaged wind speed (4.14 m/sec) on Paoha Island averaged almost twice as much as the mean daily wind speed. The maximum recorded 10-min reading of 18.56 m/sec occurred on November 17th. Winds were predominantly from the south but slightly eastward unlike previous years (mean 146.3 degrees).

Air Temperature

Hourly average air temperature recorded at Paoha Island in 2020 ranged from a low of -13.7°C on February 4 to a high of 34.46°C on August 1 (Figure 3-5). Daily average temperature ranged from -7.57°C to 23.25°C. Daily average winter temperature (January through February) ranged from -7.57°C to 6.37°C with an average maximum daily winter temperature of 4.78°C. The average maximum daily summer temperature (June through August) was 28.0°C while the average minimum daily summer temperature was 11.32°C.

Relative Humidity

As mentioned previously, relative humidity readings were erratic with many zero values and sudden decreases below 25(%). Therefore, relative humidity data will not be presented in this report.

Precipitation

The total precipitation between January 1 and December 31 measured at LADWP Cain Ranch was 4.5 inches. Precipitation events were more frequent in March and April in 2020 and the largest single day total precipitation of 0.58 inch was recorded on April 9 (Figure 3-6). In January and February, only 0.15 inches of precipitation was recorded, but spring months produced 2.29 inches of precipitation, higher than the long-term average of 1.84 inches. Precipitation was below 1 inch in summer, and no precipitation was recorded in September and October. November precipitation was only 0.41 inch while December precipitation was 0.58 inch. The greatest frequency of days with precipitation (10) occurred in March and April.

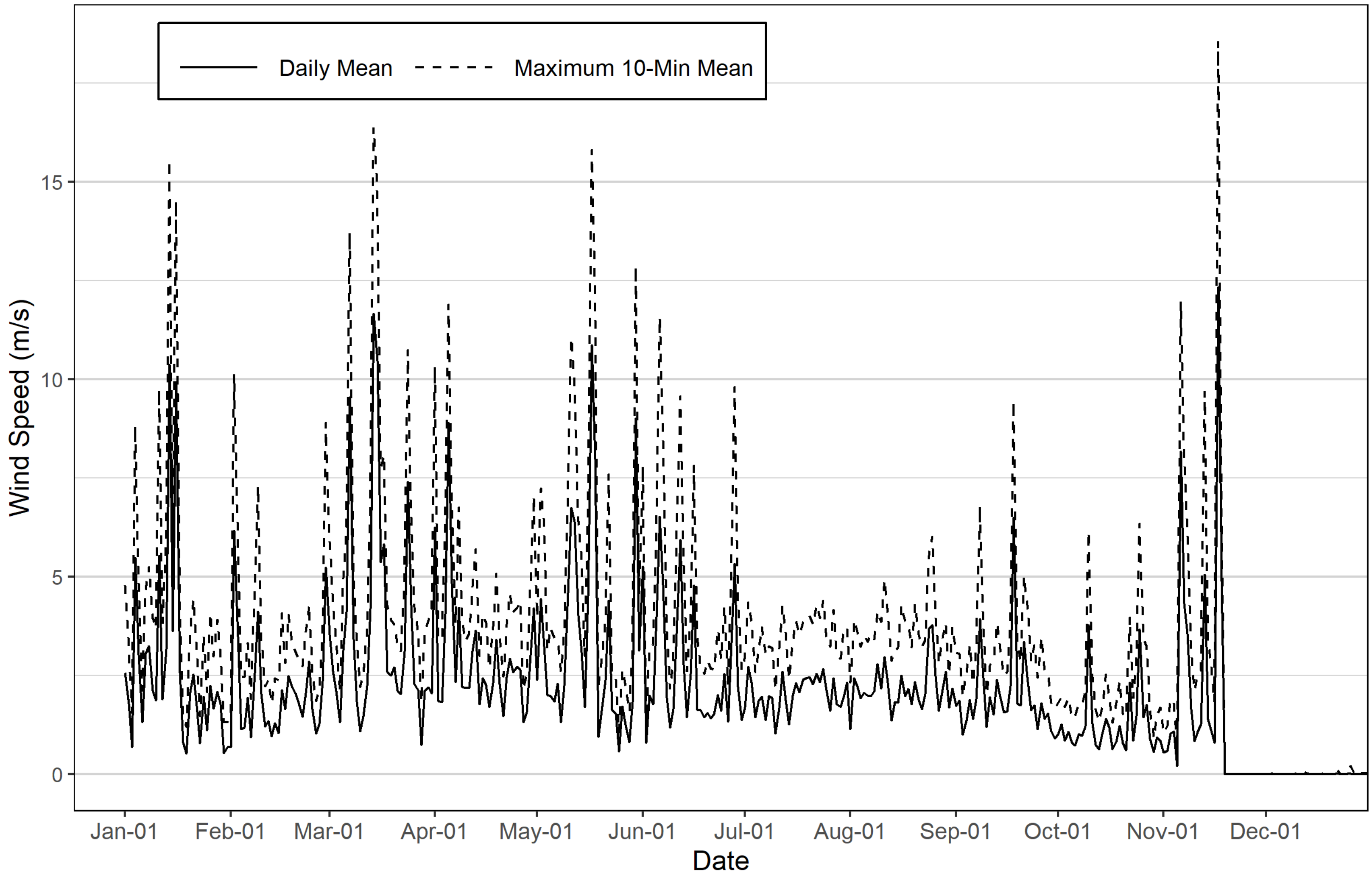

Figure 3-4. Daily Mean and Mean Maximum 10-Minute Wind Speed

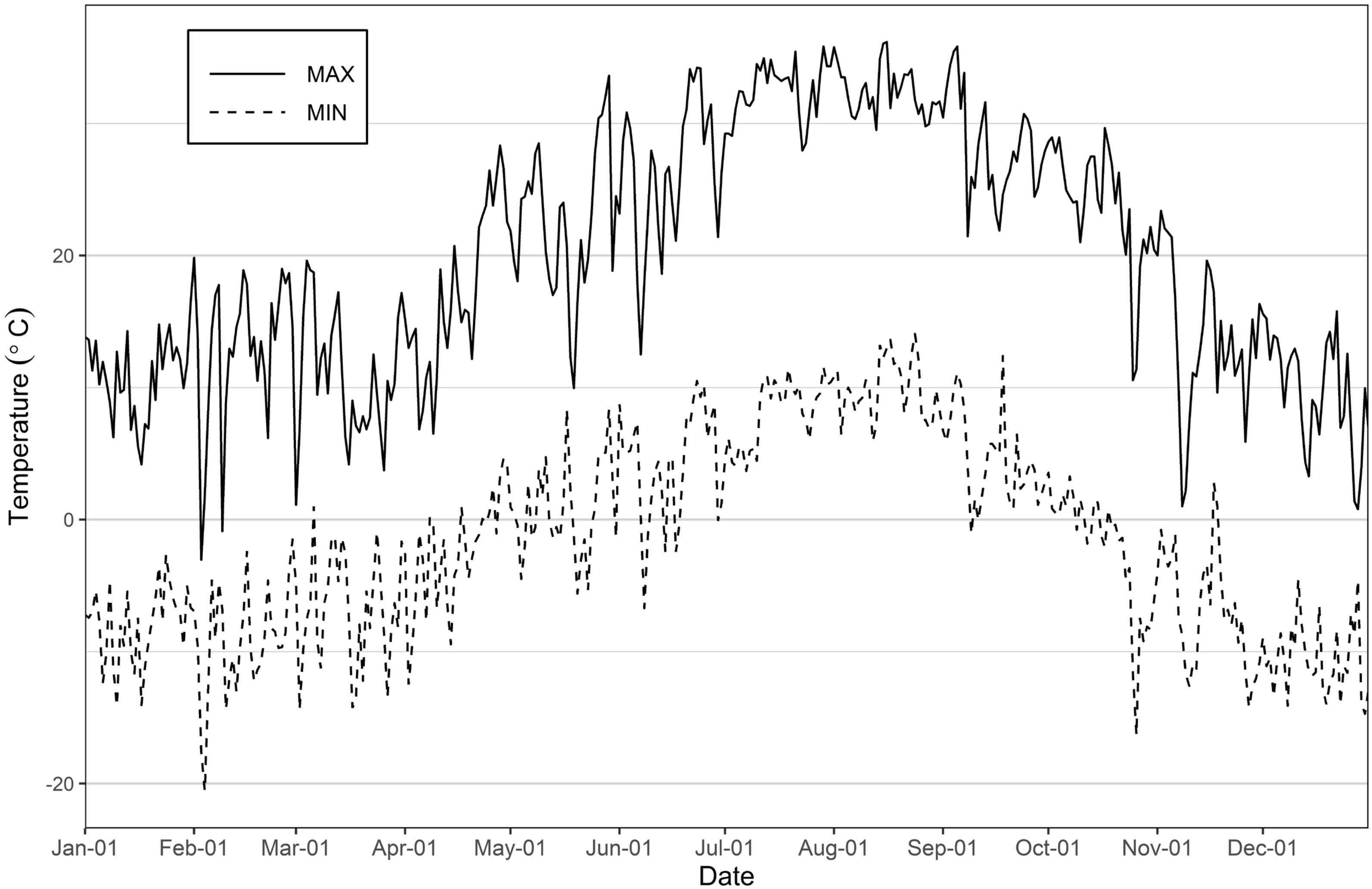

Figure 3-5. Minimum and Maximum Daily Air Temperature (°C)

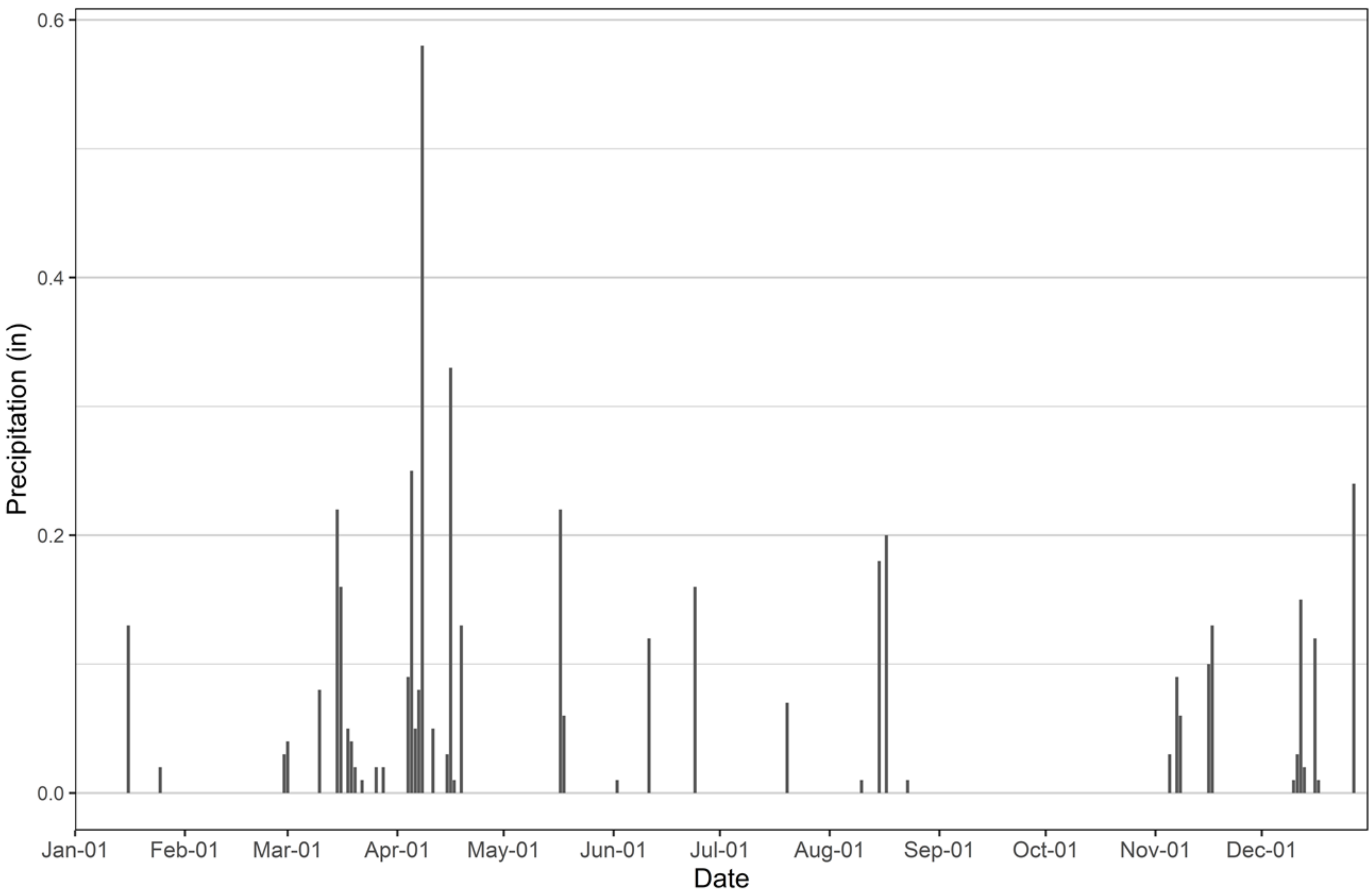

Figure 3-6. Total Daily Precipitation (mm)

Long Term Trends in Temperature and Precipitation

The year 2020 started with a warmer January and February followed by colder March (Figure 3-7). For the rest of the year, monthly average temperature mostly remained above normal. Between July and October, monthly average temperatures were more than 1°C higher than the long-term average (LTA) of each respective month. May and September were particularly warm as monthly average temperature was 1.6°C and 1.7°C above normal, respectively. The winter of 2019-20 exhibited a similar pattern as compared to previous years: below normal maximum average temperature combined with above normal minimum average temperature (Figure 3-8). It was the seventh year in row that the minimum winter temperature was above the long-term average. The summer of 2020 was similar to the summer of 2019, cooler than summers between 2016 and 2018 but warmer than LTA (Figure 3-9). Winter precipitation in 2019-20 (1.26 in) was ranked 84th in 89 years and 26% of normal while summer precipitation was ranked 55th in 90 years and 71% of normal (Figure 3-10, Figure 3-11). There is no clear long-term trend for average summer and winter temperatures since 1960 except for increasing average summer minimum temperatures ($r=0.68$, $p<0.0001$). This trend has been much stronger since 1973 ($r=0.79$, $p<0.0001$) indicating there has been a very strong warming trend in summer minimum temperature from the beginning of the limnology monitoring in 1979. A similar short-term warming trend was observed for summer maximum and winter minimum temperatures, but starting in 1982 ($r=0.49$, $p= 0.0012$) and 1982 ($r=0.50$, $p=0.0012$) respectively.

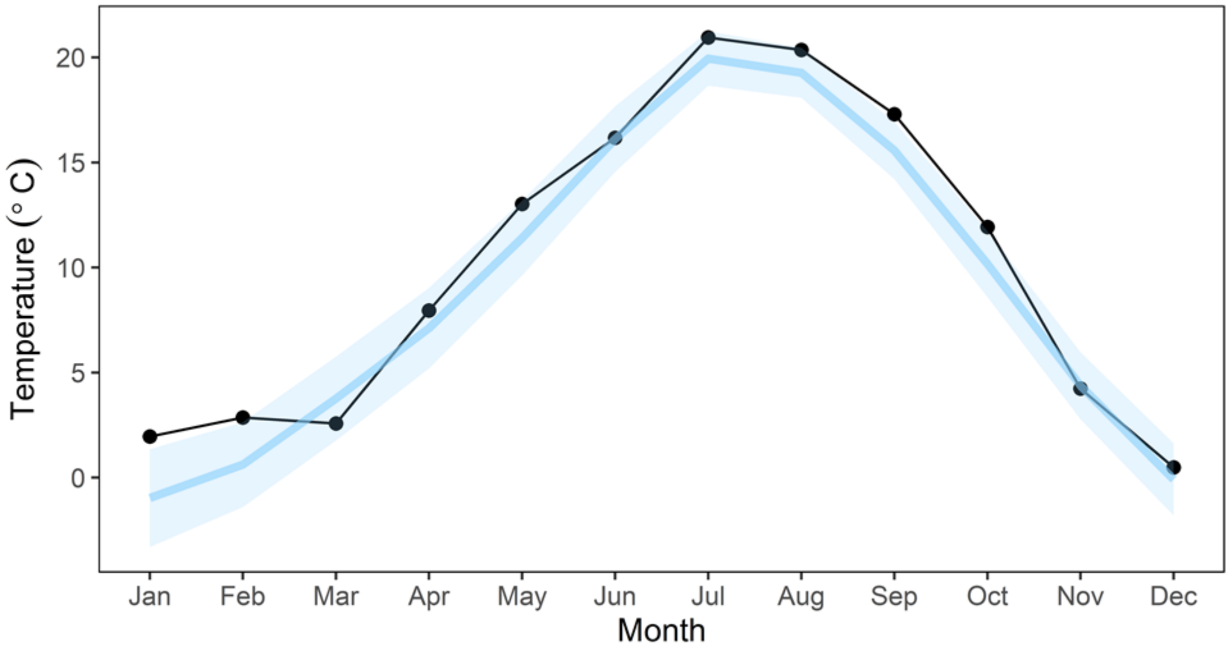

Figure 3-7. Monthly Temperature in 2020 Compared to the Long-term Averages

Long term average monthly temperature was calculated using records at Mono Lake (Station Number 045779-3) between 1951 and 1988, and Lee Vining (Station Number 044881) since 1989; data obtained from Western Regional Climate Center. A blue line indicates the long-term average monthly temperature and the shaded area indicates the standard errors of the respective months.

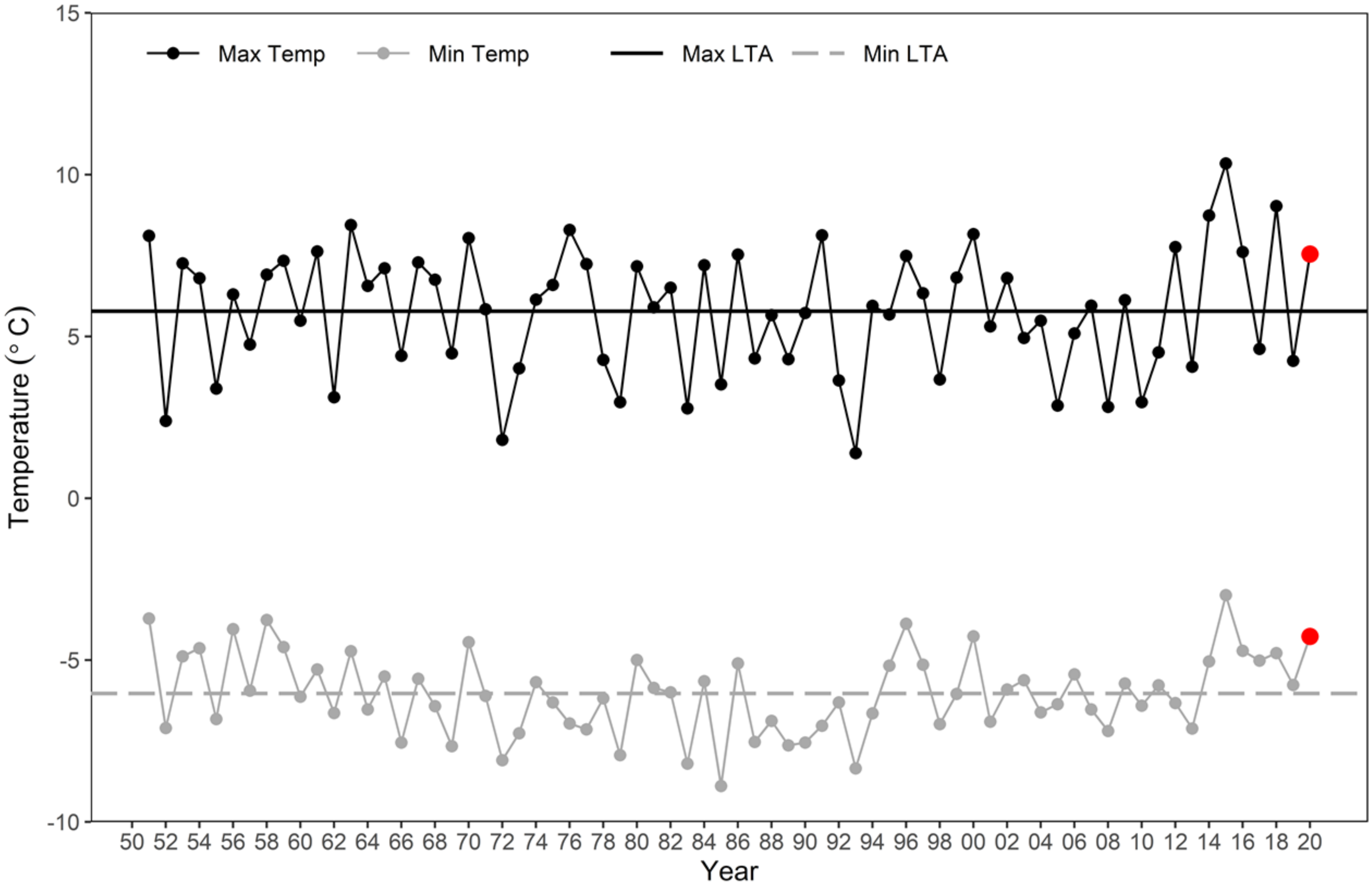

Figure 3-8. Average Temperature during Winter Months (December through February)

Temperature was recorded at Mono Lake (Station Number 045779-3 obtained) between 1951 and 1988 and at Lee Vining (Station Number 044881) since 1989; data obtained from Western Regional Climate Center.

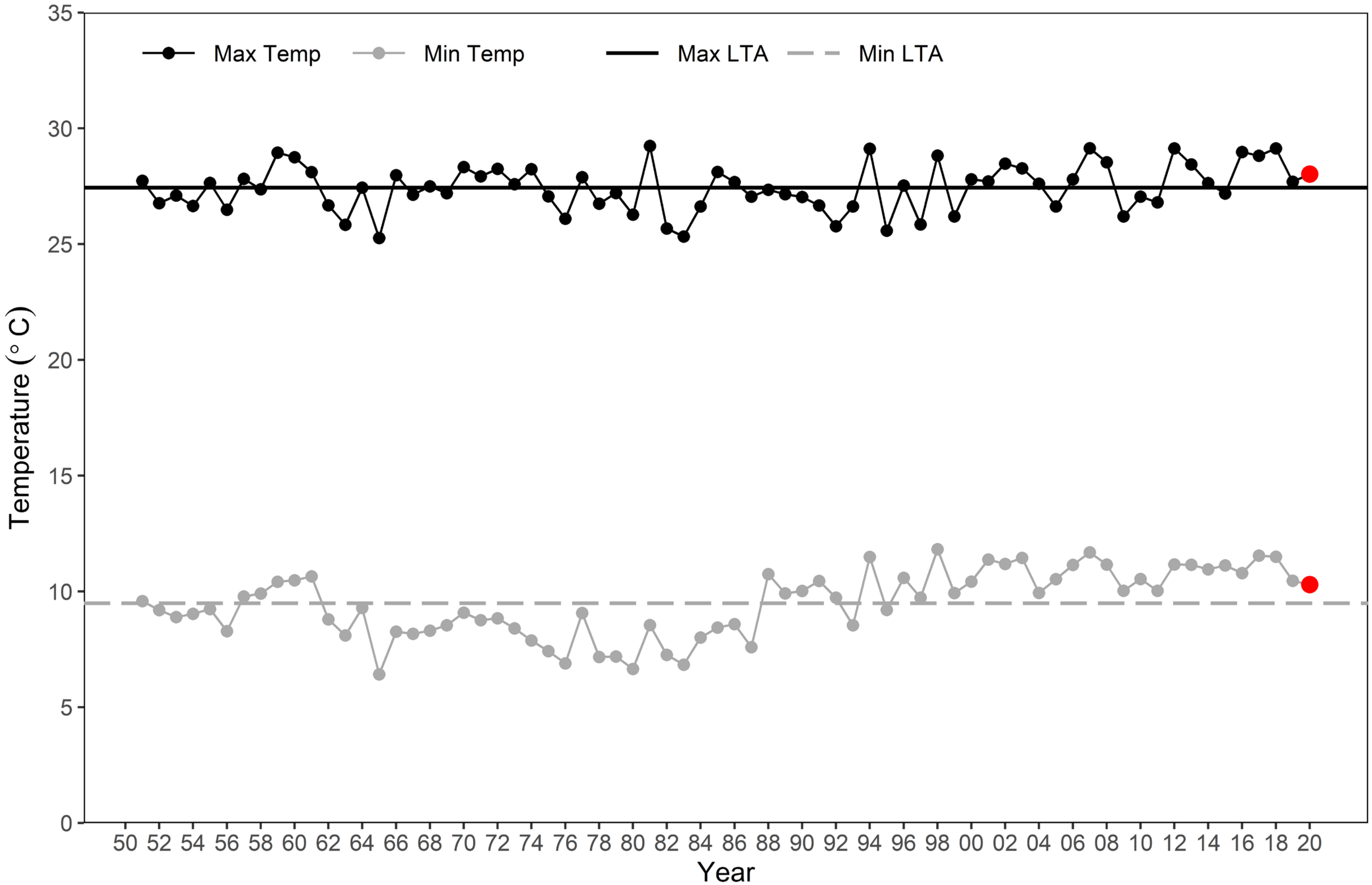

Figure 3-9. Average Temperature during Summer Months (June through August)

Temperature was recorded at Mono Lake (Station Number 045779-3) between 1951 and 1988 and at Lee Vining (Station Number 044881) since 1989; data obtained from Western Regional Climate Center.

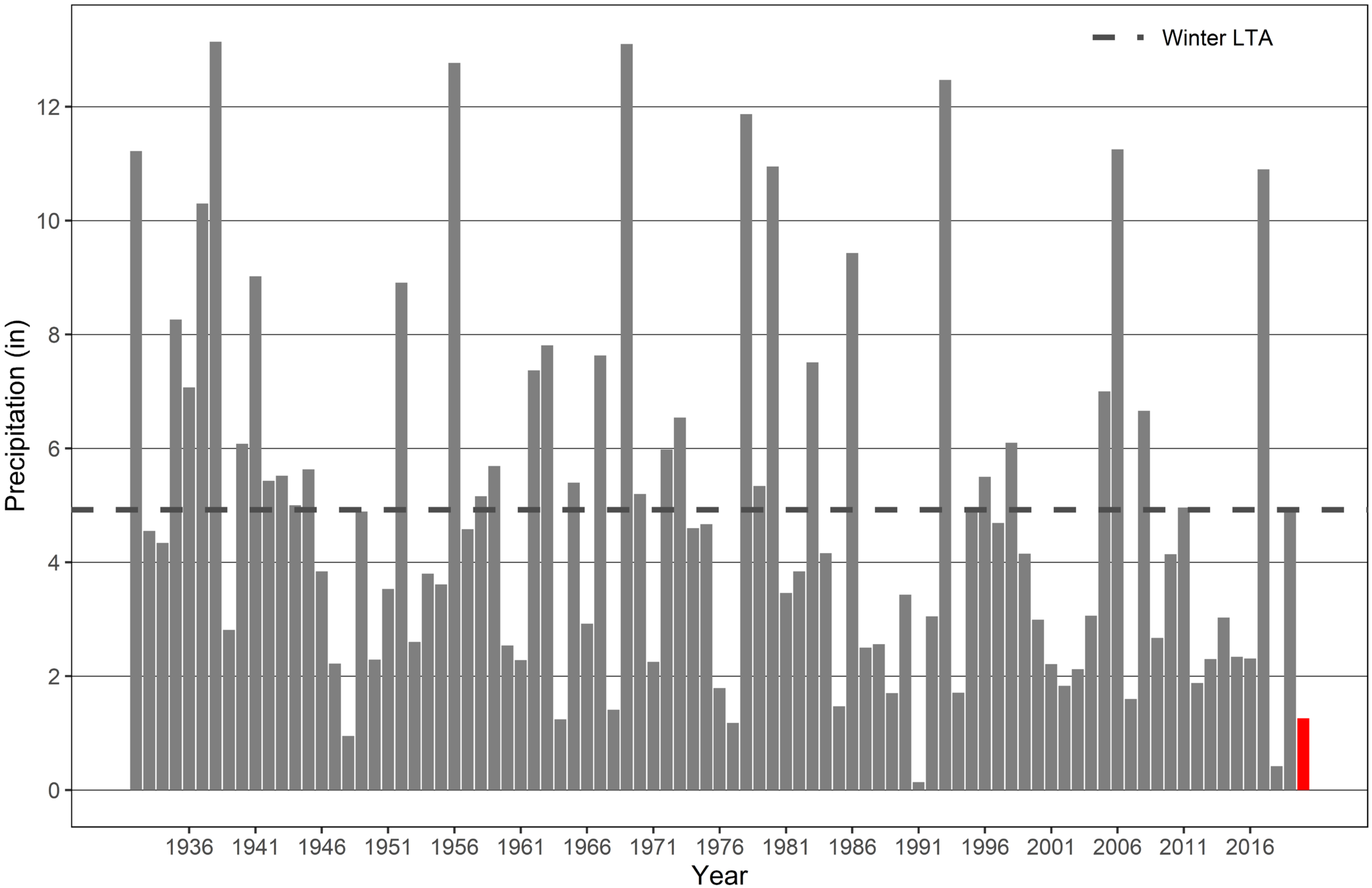

Figure 3-10. Total Winter Precipitation (December through February)

Precipitation recorded at LADWP Cain Ranch since 1932.

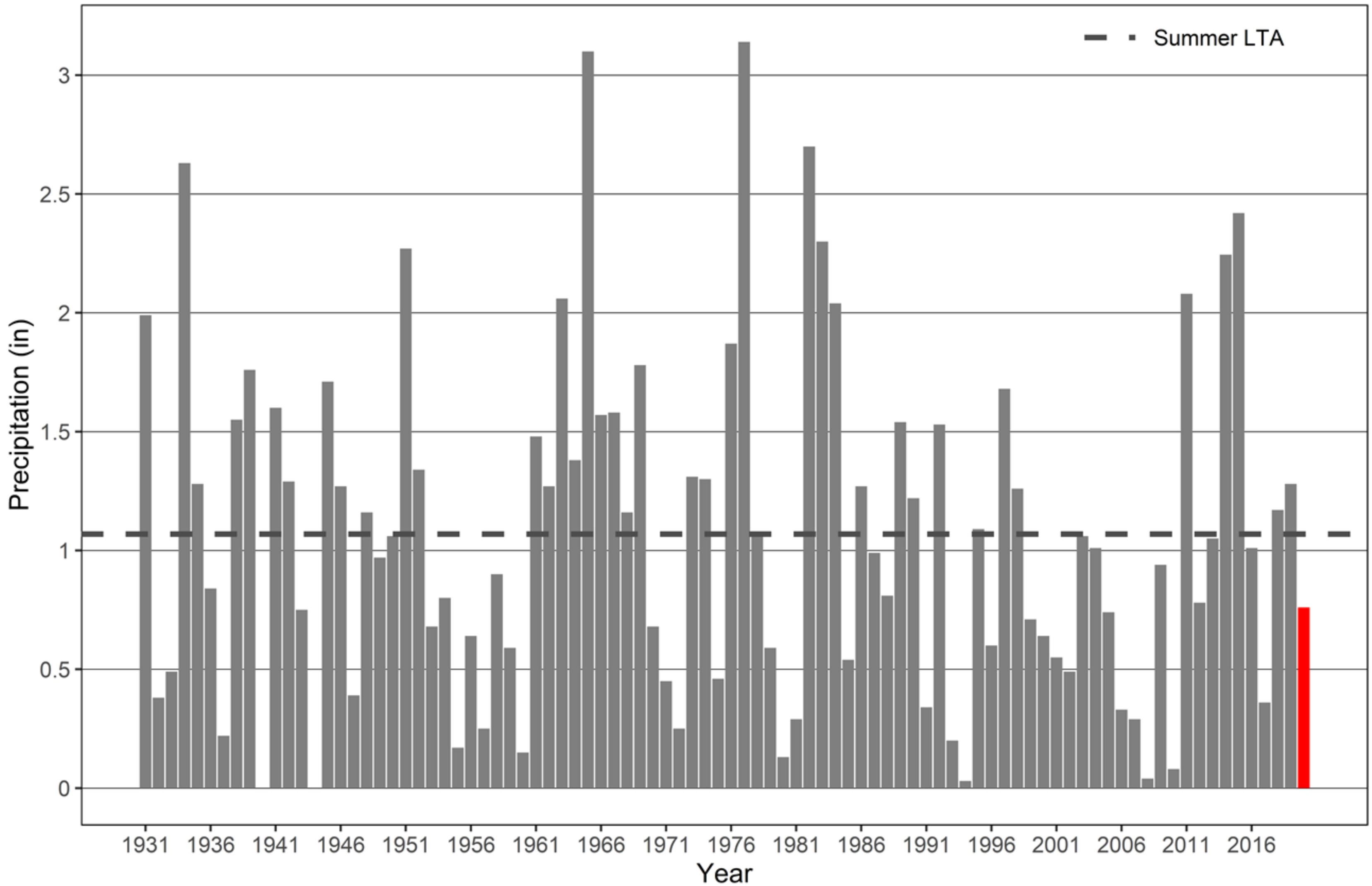

Figure 3-11. Total Summer Precipitation (June through August)

Precipitation recorded at LADWP Cain Ranch since 1932.

Physical and Chemical

Mono Lake Surface Elevation

The average monthly surface elevation of Mono Lake in January 2020 was 6382.2 feet - one foot higher than the January lake elevation in 2018 and 2019 (Figure 3-12). Water Year 2019-20 produced 63,492 acre-feet of runoff in Mono Basin, 52% of the long-term average and ranked 82nd since 1935. Input from the two major tributaries (Rush and Lee Vining Creeks) was 61,587 acre-feet, or 64% of the long-term average since re-watering in 1982. The lake level dropped 1.5 feet to 6380.7 feet during 2020. The input of 64% of normal was insufficient to maintain the lake level at 6382 feet.

Transparency

Average lake-wide transparency remained below 1 m except two readings throughout 2020, and the maximum single station reading was 1.0 m (Table 3-5, Figure 3-13). Transparency of Mono Lake during the summer improved from 0.43 m in May to only 0.88 m in August even though *Artemia* grazing reduced midsummer phytoplankton. Year-round transparency below 1 m was last observed in 2015 and 2016, the last two years of the driest five-year period on record.

Beginning in 2014, maximum transparency has progressively worsened each year; 1.5 m in 2014, 0.9 m in 2015 and 0.6 m in 2016; however, this trend was finally reversed in 2017 even though it still lagged behind historical values (Figure 3-14, Figure 3-15). Transparency degraded again in 2020 and returned to the levels observed in 2015 and 2016. In 2020, the input flow of Rush and Lee Vining Creeks combined peaked on May 19 with estimated combined flow of 270 cfs, which corresponded to an approximate 0.84 exceeding probability and 1.2-year recurrence interval based on daily flow data available since 1991. A peak inflow below 270 cfs has been observed only three times (2013 to 2015) since 1991. The influx of freshwater combined with lake stratification helped transparency to improve considerably in 2017. In 2020 however, the combined effects of low inputs and the breakdown of meromixis contributed to decreased transparency in 2020.

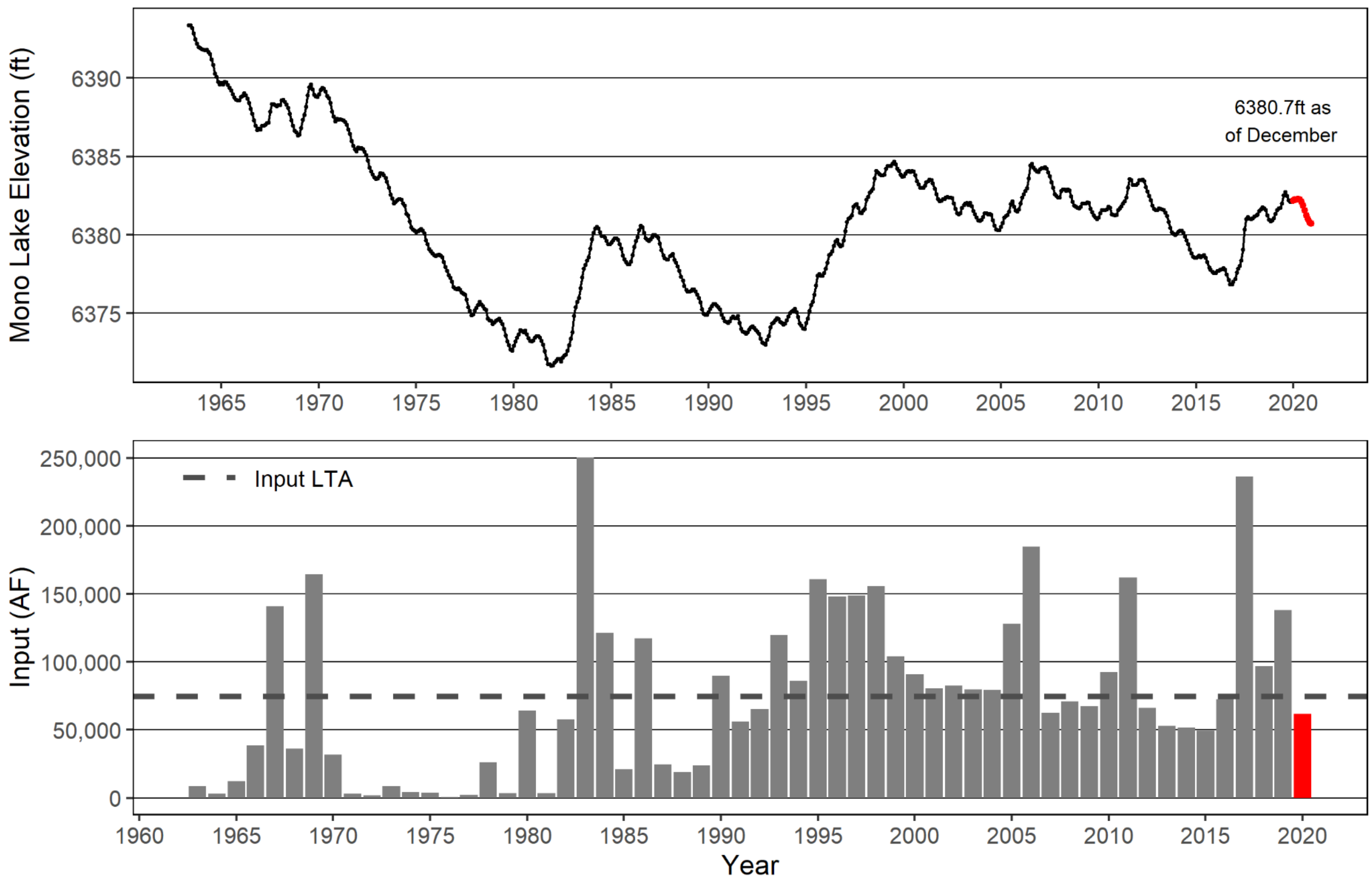

Figure 3-12. Mono Lake Surface Elevation (top) and Combined Inflow of Rush and Lee Vining Creeks (bottom)

Mono Lake elevation and input data are monthly average and total, respectively. Input is monthly flow volume of all tributaries to Rush Creek since 1963. The long-term average (LTA) is based values between 1982 and 2020.

Table 3-5. Secchi Depths (m) between February and December in 2020

	Sampling Month										
Station	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Western Sector											
1	0.3	0.45	0.5	0.4	0.6	1	0.85	0.9	0.5	0.35	0.3
2	0.3	0.5	0.4	0.4	0.5	0.65	0.9	0.8	0.5	0.45	0.3
3	0.6	0.4		0.4	0.5	0.8	0.7	0.7	0.5	0.3	0.3
4	0.6	0.4		0.4	0.7	0.65	0.8	0.8	0.4	0.4	0.4
5	0.5	0.35		0.4	0.8	0.8	0.9	0.7	0.5	0.4	0.4
6	0.5	0.4		0.4	0.6	0.7	0.9	0.8	0.5	0.4	0.3
AVG	0.47	0.42	0.45	0.40	0.62	0.77	0.84	0.78	0.48	0.38	0.33
SE	0.14	0.05	0.07	0.00	0.12	0.13	0.08	0.08	0.04	0.05	0.05
Eastern Sector											
7	0.4	0.5	0.2	0.4	0.5	0.7	0.95	0.8	0.5	0.5	0.3
8	0.6	0.5	0.4	0.4	0.6	0.9	0.9	0.9	0.5	0.45	0.3
9	0.5	0.45	0.3	0.6	0.6	0.85	0.95	0.9	0.6	0.4	0.3
10	0.4	0.5	0.2	0.4	1	0.8	0.8	0.9	0.5	0.5	0.4
11	0.6	0.5	0.5	0.5	0.5	0.9	0.95	0.8	0.6	0.45	0.4
12	0.5	0.4	0.4	0.5	0.7	0.85	0.95	0.9	0.5	0.5	0.4
AVG	0.50	0.48	0.33	0.47	0.65	0.83	0.92	0.87	0.53	0.47	0.35
SE	0.09	0.04	0.12	0.08	0.19	0.08	0.06	0.05	0.05	0.04	0.05
Total Lakewide											
AVG	0.48	0.45	0.36	0.43	0.63	0.80	0.88	0.83	0.51	0.43	0.34
SE	0.48	0.45	0.36	0.43	0.63	0.80	0.88	0.83	0.51	0.43	0.34

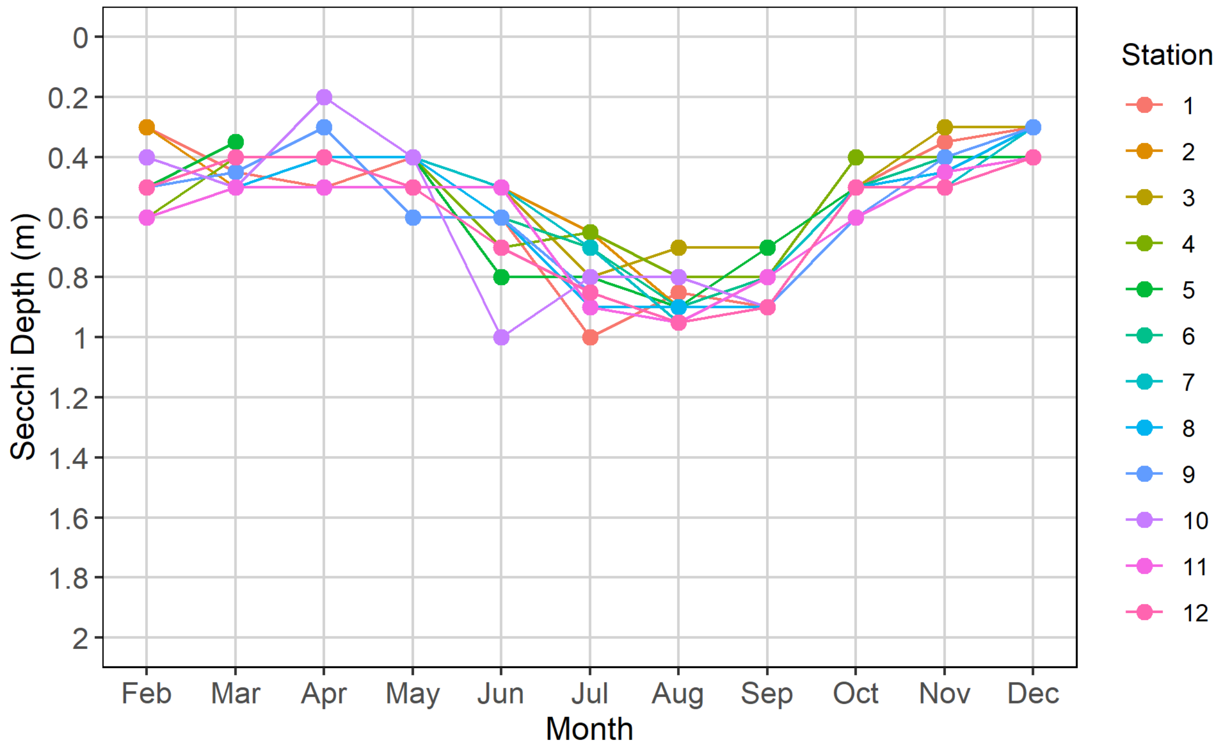

Figure 3-13. Lake-wide Secchi Depths in 2020 by Station

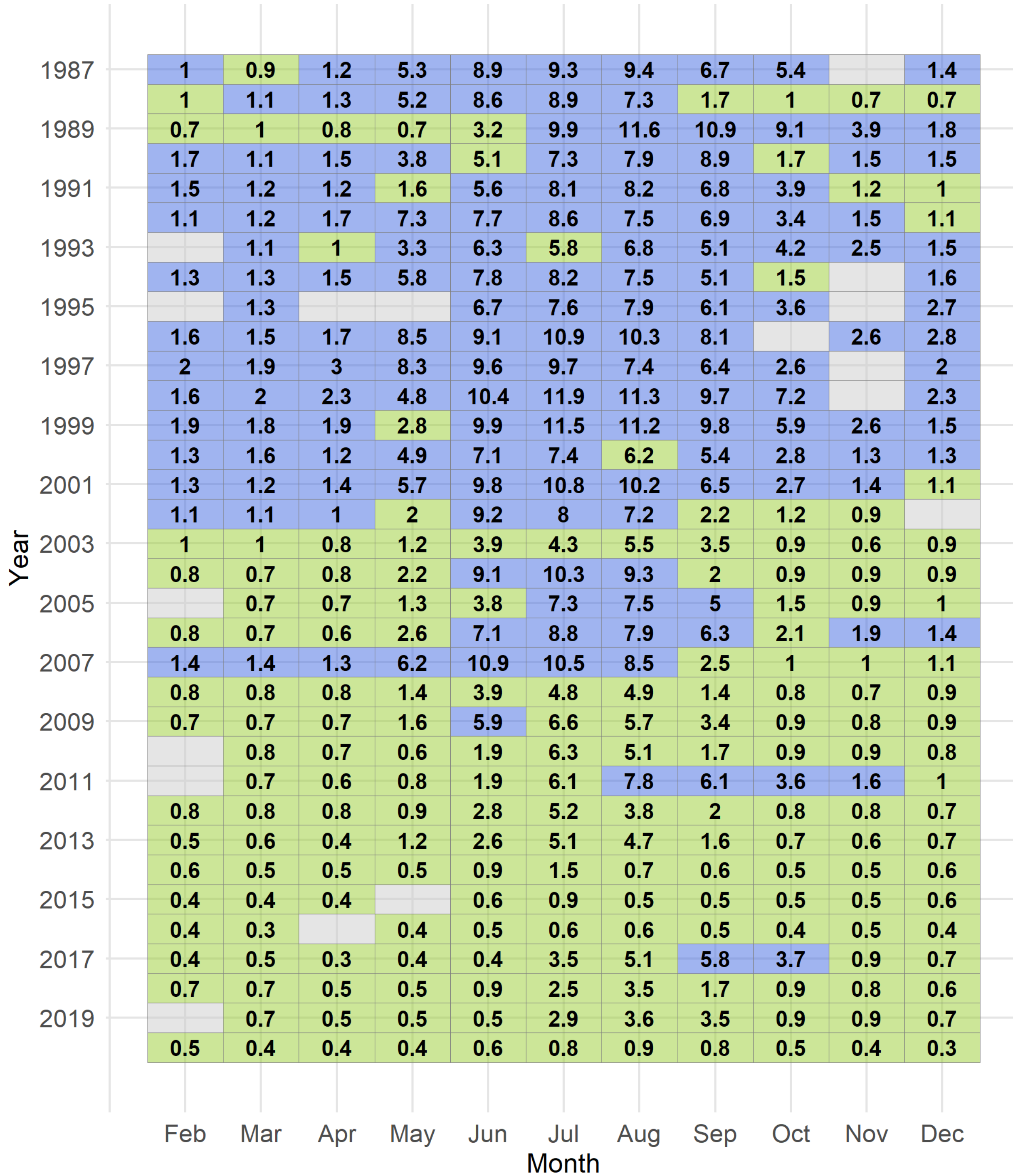

Figure 3-14. Long-term Lake-wide Average Secchi Depths (m)

Blue-colored cells indicate above the long-term average of the respective month while green-colored cells indicate below the long-term average of the respective month.

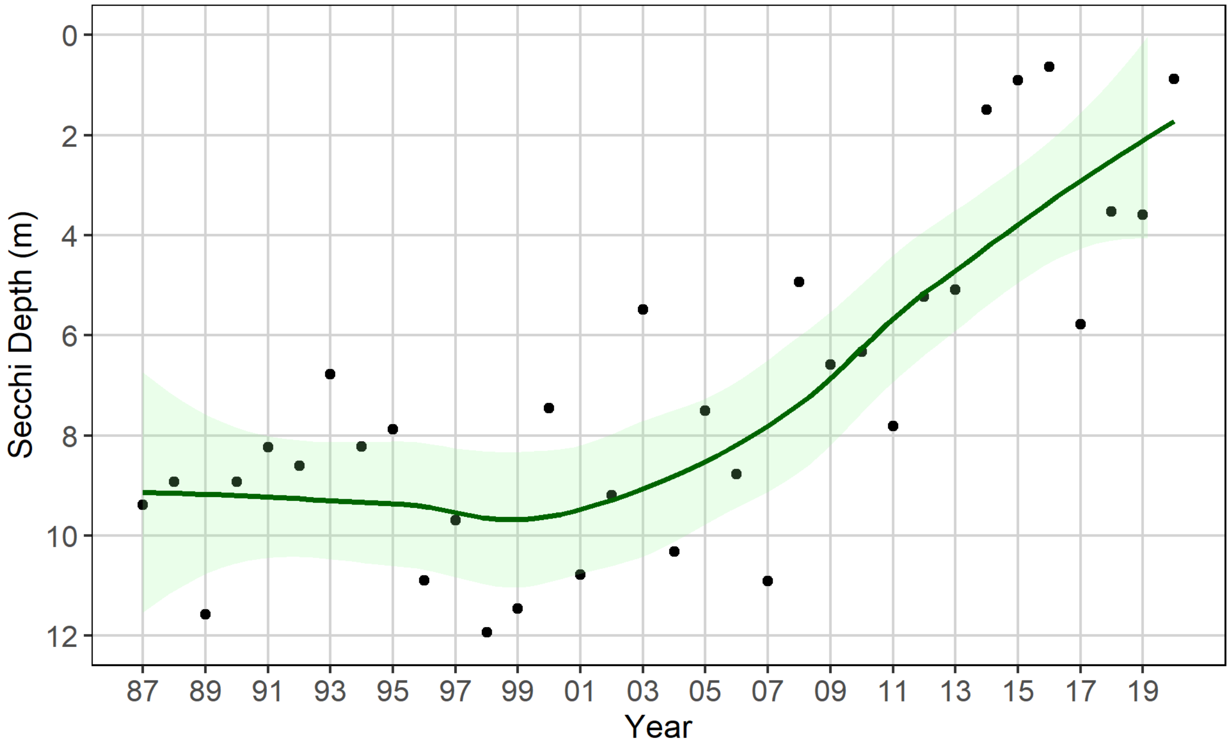

Figure 3-15. Trend in Annual Maximum Secchi Depth Readings (m)

Water Temperature

Water temperature data from Station 6 indicate that meromixis, which had initiated in 2017, remained in place into February since the deepest water depths were warmest (Table 3-6, Figure 3-16). As ambient temperature started to rise in spring, the lake became thermally stratified, and a thermocline (as indicated by the greater than 1°C change per meter depth) formed at 10 to 11 m by May. The thermocline slowly migrated downward throughout the year and reached 15 m in October before disappearing. Thermal stratification weakened in November and the lake was isothermal in December.

Average water temperature in the epilimnion and hypolimnion remained mostly below normal throughout 2020 except in October, in spite of a warmer than normal spring to early fall (Figure 3-17, Figure 3-18). Higher than normal epilimnion water temperature in October is most likely due to warmer conditions that prevailed from spring through fall. Hypolimnion water temperature started to rise in June until November and became warmer than normal in December.

Conductivity

Epilimnetic specific conductivity began to decrease in February and reached its lowest point in June with snowmelt driven runoff (Table 3-7, Figure 3-19). The epilimnetic specific conductivity started to rise in September as a consequence of low inputs. Gradient in conductivity develops as the lake stratifies during meromixis and summer months when influx of freshwater resulting from snowmelt creates a chemocline temporally. The largest vertical range in specific conductivity of 8.4 mS/cm in July and August, which was smaller than that observed in 2019 of 12.8 mS/cm. The vertical range in February was 1.8 mS/cm, indicating continued weakening of the chemocline. The vertical range decreased to 2.5 mS/cm in November and essentially 0 mS/cm in December.

Table 3-6. Water Temperature (°C) Depth Profile at Station 6 in 2020

Depth (m)	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.6	4.2	-	11.6	20.2	20.5	21.9	16.7	14.5	8.6	5.4
2	2.2	4.2	-	11.2	18.4	20.5	21.9	16.7	14.5	8.5	5.5
3	2.1	4.1	-	11.2	17.8	20.5	21.9	16.8	14.6	8.5	5.6
4	2.2	4.1	-	11.1	15.7	20.5	21.9	16.7	14.6	8.5	5.6
5	2.2	4.0	-	11.0	15.1	20.1	21.9	16.7	14.7	8.5	5.6
6	2.2	3.9	-	11.0	13.7	17.8	21.6	16.8	14.7	8.5	5.6
7	2.1	3.8	-	10.8	13.3	15.8	20.1	16.8	14.7	8.5	5.6
8	2.1	3.7	-	10.5	13.0	15.1	18.3	16.9	14.8	8.5	5.6
9	2.0	3.9	-	9.5	12.5	14.1	15.5	17.0	14.9	8.5	5.6
10	2.0	4.0	-	9.1	10.4	12.9	13.2	17.0	14.9	8.5	5.6
11	2.0	4.0	-	7.0	9.9	11.4	12.3	17.0	14.9	8.5	5.6
12	1.9	3.9	-	6.1	8.7	10.6	10.1	16.6	14.6	8.5	5.6
13	1.9	3.9	-	5.8	7.9	9.3	8.9	11.4	14.2	8.5	5.6
14	1.9	3.8	-	5.2	7.1	8.1	8.1	10.2	13.3	8.5	5.6
15	2.0	3.5	-	4.7	6.4	7.0	7.3	8.9	11.6	8.5	5.6
16	2.0	3.4	-	4.5	6.1	6.5	6.8	7.6	10.3	8.5	5.6
17	2.2	3.1	-	4.4	5.6	5.8	6.2	6.5	8.4	8.5	5.6
18	3.0	3.2	-	4.4	5.4	5.5	5.6	5.7	6.9	8.5	5.6
19	3.6	3.2	-	4.2	5.1	5.3	5.3	5.3	6.1	8.5	5.6
20	3.9	3.5	-	4.2	4.9	5.0	5.0	5.1	5.3	8.5	5.6
21	4.1	3.8	-	4.2	4.8	4.8	4.9	5.0	5.1	8.5	5.6
22	4.2	4.2	-	4.2	4.6	4.8	4.9	4.9	4.9	8.5	5.6
23	4.3	4.3	-	4.3	4.5	4.7	4.8	4.8	4.8	8.5	5.6
24	4.5	4.4	-	4.3	4.5	4.7	4.8	4.8	4.8	8.5	5.6
25	4.5	4.4	-	4.3	4.5	4.6	4.7	4.7	4.7	7.7	5.6
26	4.6	4.5	-	4.3	4.5	4.6	4.6	4.7	4.7	7.2	5.6
27	4.6	4.5	-	4.4	4.5	4.6	4.6	4.7	4.7	6.5	5.6
28	4.6	4.6	-	4.4	4.4	4.5	4.6	4.7	4.7	5.8	5.6
29	4.7	4.6	-	4.4	4.4	4.5	4.5	4.6	4.6	5.5	5.6
30	4.7	4.6	-	4.4	4.4	4.5	4.5	4.6	4.6	5.4	5.6
31	4.7	4.6	-	4.4	4.4	4.5	4.5	4.6	4.6	5.3	5.5
32	4.7	4.7	-	4.4	4.4	4.5	4.5	4.6	4.6	5.2	5.5
33	4.7	4.7	-	4.5	4.4	4.5	4.5	4.6	4.6	5.1	5.5
34	4.7	4.7	-	4.5	4.4	4.5	4.5	4.6	4.6	5.0	5.5
35	4.7	4.7	-	4.5	4.4	4.5	4.5	4.6	4.6	5.0	5.5
36	4.7	4.7	-	4.5	4.4	4.5	4.5	4.6	4.6	4.9	5.5
37	4.8	4.7	-	4.5	4.4	4.5	4.5	4.6	4.6	4.9	5.5
38	4.8	4.7	-	-	4.4	4.5	4.5	4.6	4.6	4.8	5.5
39	4.8	4.7	-	-	4.4	4.5	4.5	4.6	4.6	4.8	5.5
40	4.8	4.7	-	-	-	-	-	-	-	-	5.5

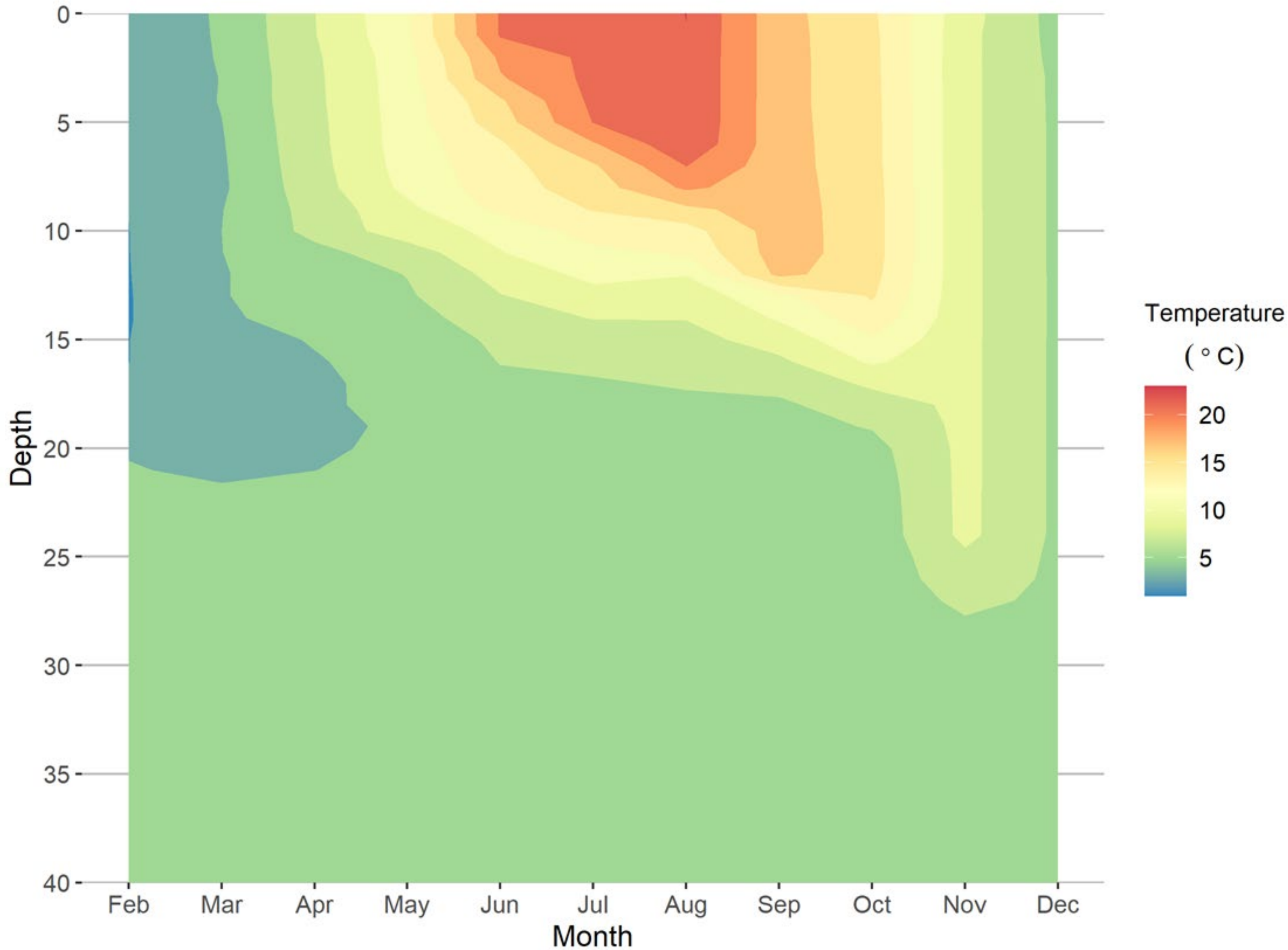

Figure 3-16. Water Temperature (°C) Depth Profile at Station 6 in 2020

April values were interpolated using March and May values. Missing values near the bottom were substituted with closest non-missing value above.

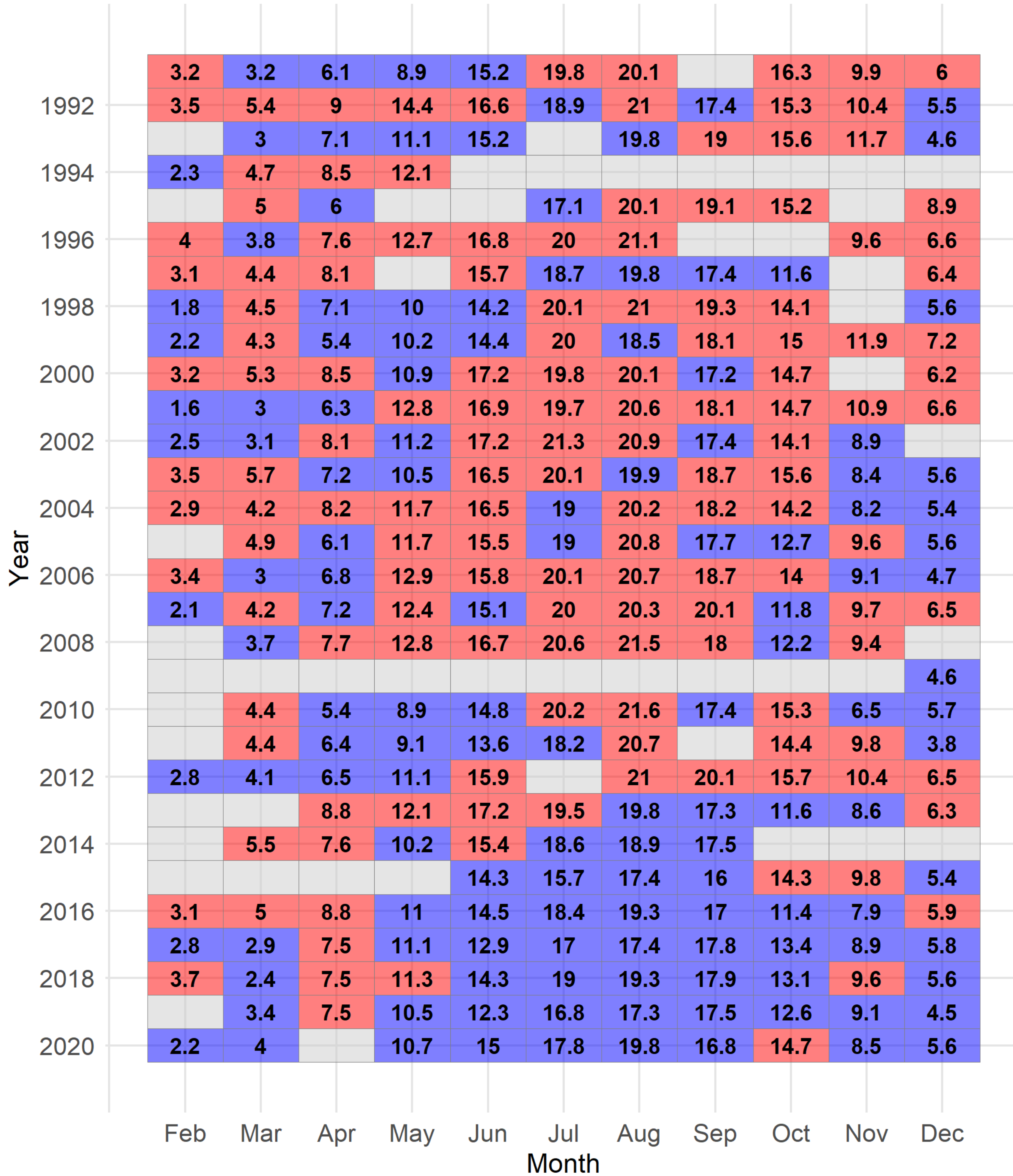

Figure 3-17. Average Water Temperature (°C) between 1 and 10 m at Station 6

Red-colored cells indicate above the long-term average of the respective month while blue-colored cells indicate below the long-term average of the respective month.

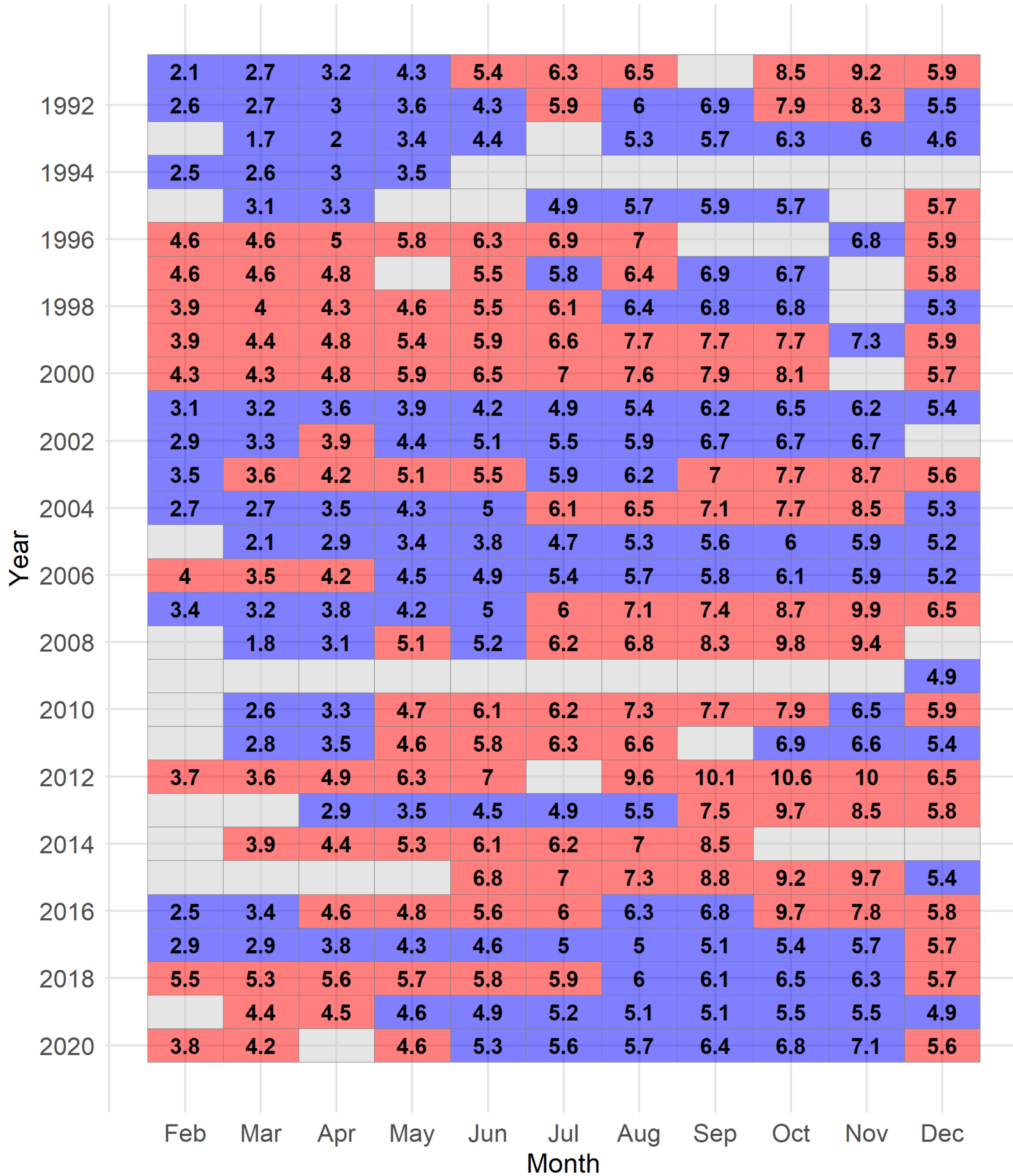

Figure 3-18. Average Water Temperature (°C) between 11 and 38 m at Station 6

Red-colored cells indicate above the long-term average of the respective month while blue-colored cells indicate below the long-term average of the respective month.

Table 3-7. Conductivity (mS/cm at 25°C) Depth Profile at Station 6 in 2020

Depth (m)	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	87.6	85.7	-	82.8	80.9	81.0	81.6	82.5	82.9	85.8	86.2
2	87.7	86.0	-	82.5	81.3	81.1	81.8	82.7	83.1	85.8	87.7
3	87.9	86.1	-	82.5	81.1	81.2	81.8	82.7	82.9	85.8	87.5
4	87.8	86.2	-	82.5	81.7	81.1	81.8	82.7	83.1	85.8	87.5
5	87.8	86.2	-	82.6	81.4	81.0	81.8	82.7	83.4	85.8	87.5
6	87.8	86.2	-	82.5	81.9	80.1	80.3	82.8	83.4	85.8	87.5
7	87.8	86.4	-	82.5	82.0	81.6	81.0	82.9	83.4	85.8	87.5
8	87.9	86.4	-	82.2	82.0	81.3	80.5	82.9	83.4	85.8	87.5
9	88.0	86.5	-	82.9	81.9	81.5	80.0	82.9	83.4	85.8	87.5
10	88.1	86.3	-	83.0	82.8	81.7	82.2	82.9	83.5	85.8	87.5
11	88.1	86.2	-	83.7	82.8	82.5	81.7	82.6	83.5	85.8	87.5
12	88.1	86.4	-	84.9	83.6	82.3	82.2	81.7	83.3	85.8	87.5
13	88.2	86.4	-	84.9	83.9	83.1	83.4	83.4	83.3	85.8	87.5
14	88.3	86.2	-	85.4	84.4	83.8	83.7	83.8	82.6	85.8	87.5
15	88.1	86.7	-	86.1	85.2	84.9	84.4	84.0	84.0	85.8	87.5
16	88.1	86.9	-	86.4	85.5	85.1	84.8	84.6	83.0	85.8	87.5
17	89.0	87.2	-	86.5	85.9	86.2	85.3	85.2	84.6	85.8	87.5
18	88.8	87.5	-	86.6	86.2	86.5	86.4	86.3	85.3	85.8	87.5
19	88.4	88.1	-	87.3	86.6	86.9	86.8	87.0	85.9	85.8	87.5
20	88.7	88.7	-	88.0	87.0	87.4	87.4	87.3	87.0	85.8	87.5
21	88.8	89.2	-	88.2	87.2	87.7	87.5	87.5	87.3	85.8	87.5
22	88.9	89.1	-	88.3	87.7	87.9	87.7	87.6	87.6	85.8	87.5
23	89.0	89.0	-	88.5	88.2	88.0	87.8	87.7	87.8	85.8	87.5
24	89.1	89.1	-	88.6	88.3	88.0	87.9	87.8	87.9	85.8	87.5
25	89.1	89.1	-	88.7	88.4	88.2	88.0	87.9	88.0	85.5	87.5
26	89.1	89.1	-	88.8	88.4	88.2	88.1	87.9	88.0	86.2	87.5
27	89.2	89.2	-	88.8	88.5	88.2	88.2	88.0	88.1	85.9	87.5
28	89.2	89.1	-	88.9	88.6	88.3	88.3	88.1	88.1	86.8	87.5
29	89.2	89.2	-	88.9	88.6	88.4	88.3	88.1	88.1	87.4	87.5
30	89.3	89.2	-	88.9	88.6	88.4	88.4	88.2	88.2	87.4	87.6
31	89.3	89.2	-	89.0	88.7	88.4	88.4	88.2	88.2	87.5	87.6
32	89.3	89.2	-	89.0	88.7	88.4	88.4	88.2	88.2	87.6	87.6
33	89.3	89.2	-	89.0	88.7	88.5	88.4	88.3	88.2	87.7	87.6
34	89.3	89.2	-	89.0	88.7	88.5	88.4	88.3	88.2	87.7	87.6
35	89.3	89.2	-	89.0	88.7	88.5	88.4	88.3	88.2	87.8	87.6
36	89.3	89.3	-	89.0	88.7	88.5	88.4	88.3	88.2	87.8	87.6
37	89.4	89.3	-	89.0	88.7	88.5	88.4	88.3	88.2	87.9	87.6
38	89.3	89.3	-	-	88.8	88.5	88.4	88.3	88.2	88.0	87.6
39	89.4	89.3	-	-	88.8	88.5	88.5	88.3	88.2	88.0	87.6
40	89.3	89.3	-	-	-	-	-	-	-	-	-

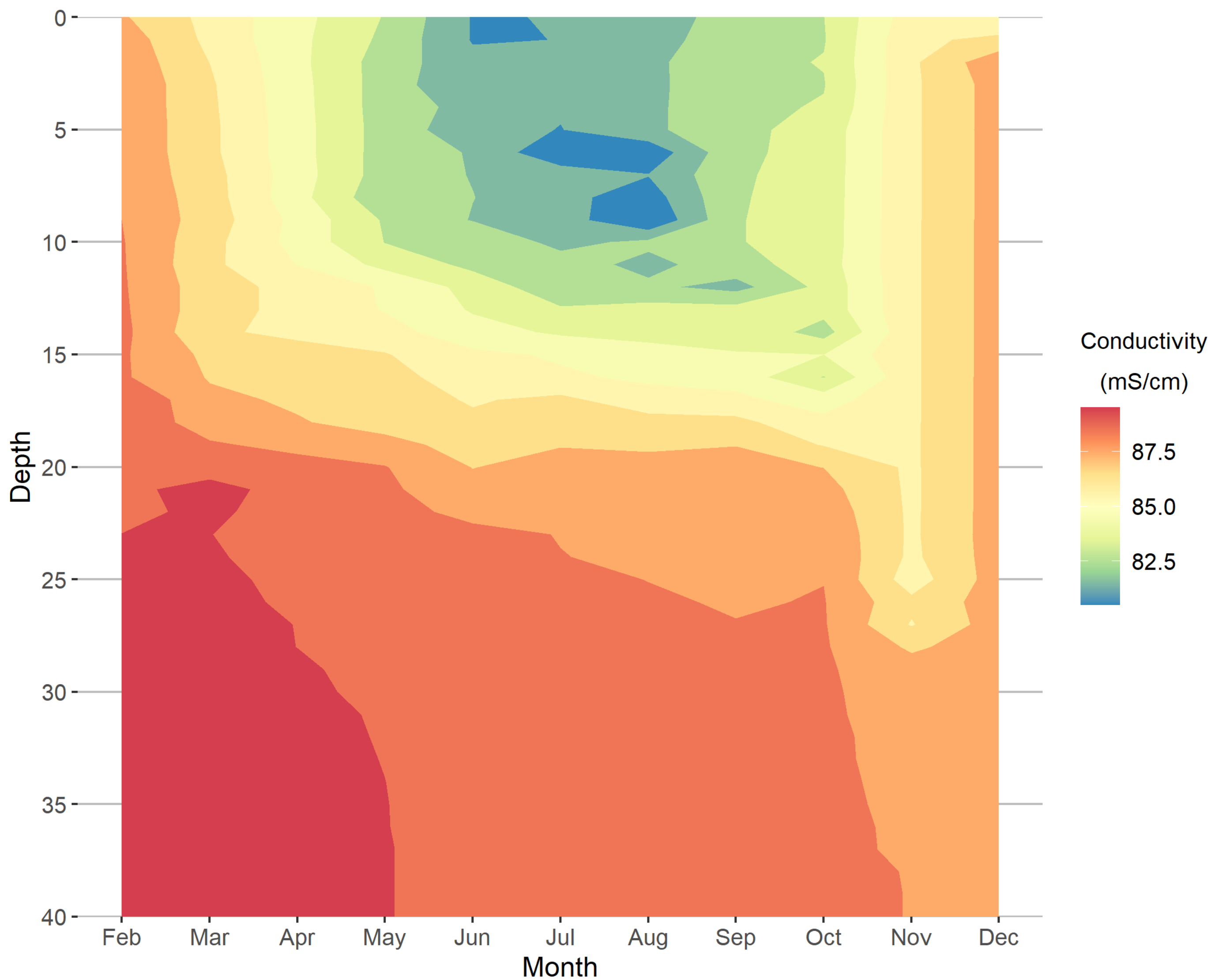

Figure 3-19. Conductivity (mS/cm) Depth Profile at Station 6 in 2020

Salinity

Salinity expressed in g/L at two different depth classes (between 1 and 10 m and below 10 m) is presented in Figure 3-20 and Figure 3-21. Salinity in the epilimnion in March was slightly lower than what was observed in 2019 due to a continued weakening of the chemocline. Salinity started to climb in August however, as a consequence of the 64% normal of Mono Lake input from the two major tributaries and was above normal by September. The year ended with 88.5 g/L in December - the highest in last 4 years. Salinity in the hypolimnion remained higher than normal throughout 2020, but lower than levels observed between 2017 and 2019 with increased mixing of the lake. The difference between epilimnetic and hypolimnetic salinity declined to 0.2 g/L in December, indicating the end of the chemocline.

Mono Lake water started to become more saline at shallower depths in 2020, and with 64% of normal Mono Lake input from two major tributaries, the lake turned over again. Due to the extremely dry condition that persisted between 2012 and 2015 the lake level dropped from 6,383.5 feet in May 2012 to 6,377.0 feet in December 2016. During the same period, the salinity level increased from 75.7 g/L (August 2012) to 96.7 g/L (January 2017) in the epilimnion and from 79.0 g/L (June 2012) to 97. g/L (January 2017) in the hypolimnion. The salinity of 88.5 g/L in the epilimnion and 88.7 g/L in hypolimnion in December of 2020, was much higher than that observed in the last month of the previous three meromictic events.

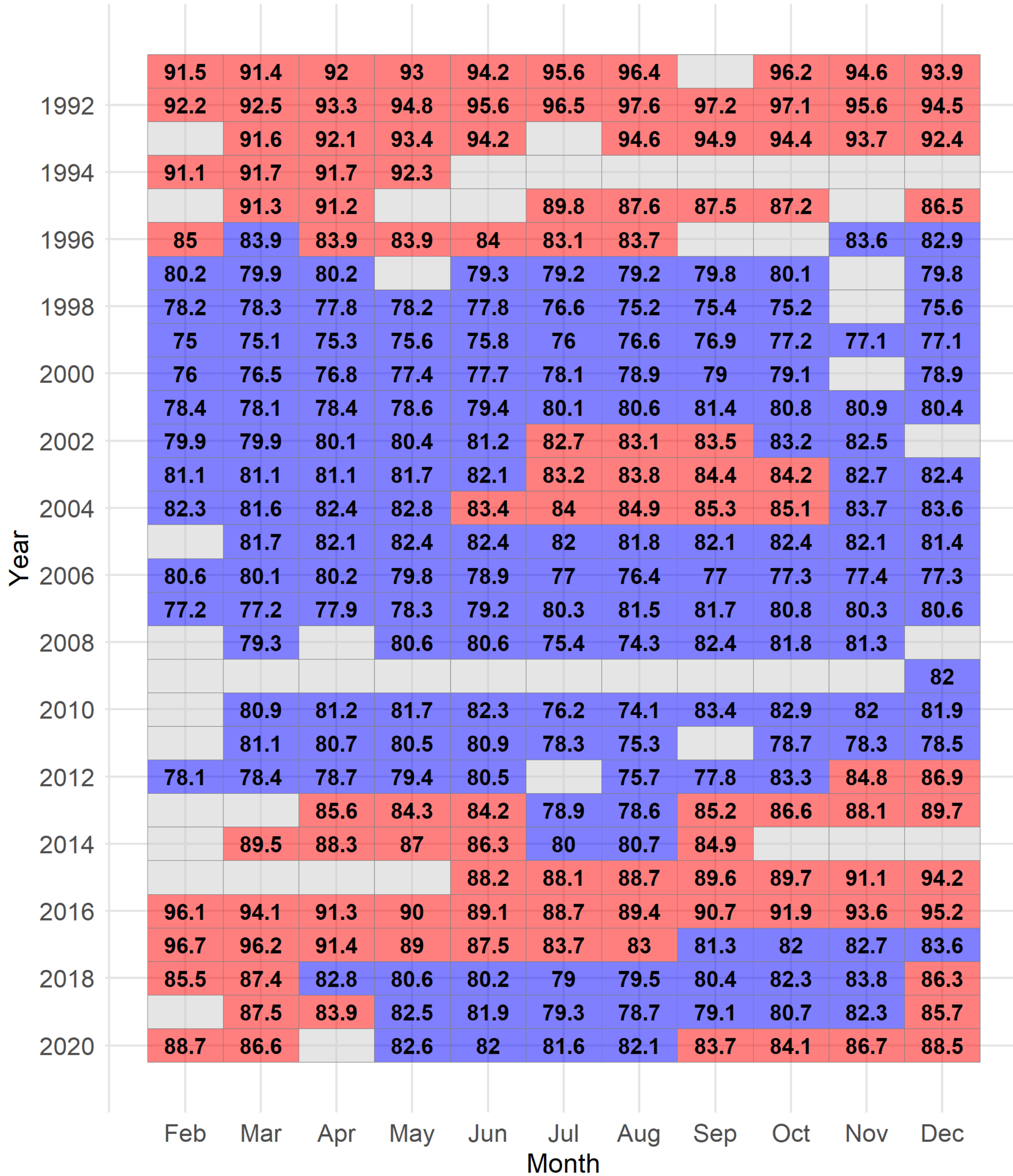

Figure 3-20. Average Salinity (g/L) between 1 and 10 m at Station 6

Red-colored cells indicate above the long-term average of the respective month while blue-colored cells indicate below the long-term average of the respective month.

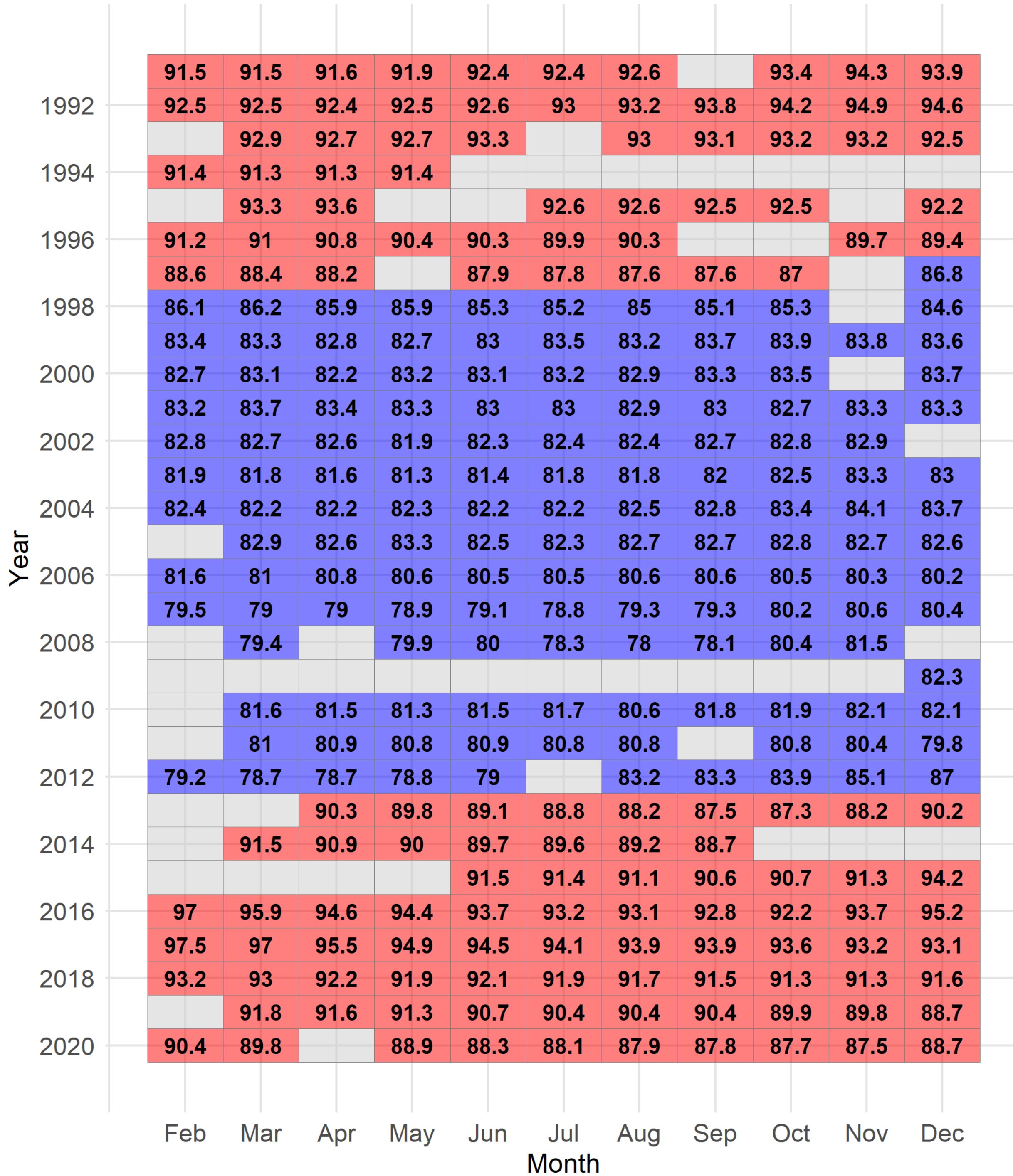

Figure 3-21. Average Salinity (g/L) between 11 and 38 m at Station 6

Red-colored cells indicate above the long-term average of the respective month while blue-colored cells indicate below the long-term average of the respective month.

Dissolved Oxygen

Dissolved oxygen (DO) concentrations in the upper mixed layer (< 15 m) started around 9.0 mg/L in February and declined steadily throughout the year becoming anoxic in November (Table 3-8, Figure 3-22). A steady decline of DO levels from spring through fall due to *Artemia* grazing pressure on phytoplankton populations is usually followed by DO level recovery in winter with disappearance of *Artemia*. In 2020, however, the recovery of DO levels was not observed in December and remained anoxic from November to the end of the year. The vertical difference in DO values became less than 4 g/L in July and less than 2 g/L in September.

Average DO concentrations in the upper mixing layer in 2020 were below LTA beginning in July (except October) (Figure 3-23). The December DO value of 0.2 g/L was lowest on record. Below the upper layer average DO concentrations remained either slightly above suboxic, suboxic or anoxic throughout 2020, and the 2020 hypolimnetic average was the lowest since 1994 (Figure 3-24).

Table 3-8. Dissolved Oxygen* (mg/L) Depth Profile at Station 6 in 2020

Depth (m)	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	9.0	8.6	-	9.9	-	3.9	3.5	1.9	5.2	1.1	0.4
1	9.2	8.7	-	11.6	-	4.0	3.5	1.8	5.2	1.0	0.3
2	9.3	8.8	-	9.5	-	4.0	3.5	1.8	5.2	0.9	0.2
3	9.4	8.8	-	7.9	-	4.0	3.5	1.8	5.0	0.3	0.2
4	9.4	8.8	-	7.5	-	3.9	3.5	1.7	5.0	0.2	0.2
5	9.4	8.6	-	7.3	-	3.9	3.4	1.8	4.9	0.2	0.2
6	9.5	8.2	-	7.2	-	3.8	3.3	1.6	4.8	0.2	0.2
7	9.5	7.7	-	7.1	-	3.7	3.1	1.7	4.8	0.2	0.2
8	9.1	7.6	-	7.0	-	2.3	1.4	1.4	4.6	0.2	0.2
9	8.9	7.5	-	6.8	-	0.9	0.2	1.0	3.8	0.1	0.2
10	8.7	7.5	-	6.5	-	0.2	0.1	1.0	4.0	0.1	0.2
11	8.8	8.4	-	6.1	-	0.2	0.2	0.9	4.0	0.1	0.2
12	8.8	8.5	-	4.1	-	0.0	0.2	0.8	4.1	0.1	0.1
13	8.9	8.6	-	2.4	-	0.2	0.3	0.8	3.3	0.1	0.1
14	9.1	8.4	-	1.3	-	0.1	0.2	0.7	1.7	0.1	0.1
15	9.3	7.7	-	0.3	-	0.0	0.2	0.3	0.8	0.2	0.1
16	9.5	4.3	-	0.2	-	0.0	0.2	0.2	0.2	0.3	0.1
17	7.1	2.7	-	0.1	-	0.0	0.1	0.1	0.1	0.3	0.1
18	0.9	0.8	-	0.1	-	0.1	0.0	0.2	0.1	0.3	0.1
19	0.5	0.5	-	0.1	-	0.1	-0.2	0.1	0.1	0.3	0.1
20	0.4	0.4	-	0.0	-	0.0	-0.8	0.1	0.1	0.3	0.1
21	0.4	0.4	-	0.0	-	0.1	-1.6	0.1	0.1	0.3	0.1
22	0.4	0.3	-	0.0	-	0.1	-2.2	0.0	0.1	0.3	0.1
23	0.4	0.3	-	0.0	-	0.0	-1.8	-0.1	0.1	0.3	0.1
24	0.4	0.3	-	0.0	-	0.0	-1.7	-0.1	0.1	0.3	0.1
25	0.4	0.3	-	0.0	-	0.0	-1.7	-0.1	0.1	0.3	0.1
26	0.4	0.3	-	0.1	-	0.1	-1.1	-0.1	0.1	0.1	0.1
27	0.4	0.3	-	0.0	-	0.0	-0.6	-0.1	0.1	0.1	0.1
28	0.4	0.3	-	0.0	-	0.0	-0.4	-0.1	0.1	0.1	0.1
29	0.4	0.3	-	0.0	-	0.0	-0.3	-0.1	0.1	0.1	0.1
30	0.4	0.3	-	0.0	-	0.0	-0.2	-0.1	0.1	0.1	0.1
31	0.4	0.3	-	0.0	-	0.0	-0.1	-0.1	0.1	0.1	0.1
32	0.4	0.3	-	0.0	-	0.0	0.0	-0.1	0.1	0.1	0.1
33	0.4	0.3	-	0.0	-	0.0	0.1	-0.1	0.1	0.1	0.1
34	0.4	0.3	-	0.0	-	0.0	0.2	-0.1	0.1	0.1	0.1
35	0.4	0.3	-	-	-	-0.1	0.2	-0.1	0.1	0.1	0.1
36	0.4	0.3	-	-	-	0.1	0.3	-0.1	-	0.1	0.1
37	0.4	0.3	-	-	-	0.1	0.3	-0.1	-	0.1	0.1
38	0.4	0.3	-	-	-	0.0	0.3	-0.1	-	0.1	0.1
39	0.4	0.3	-	-	-	0.0	0.4	-0.1	-	0.1	0.1
40	0.5	0.3	-	-	-	0.0	1.6	-0.1	-	0.1	0.1

*YSI probe error (+/- 0.2 mg/L).

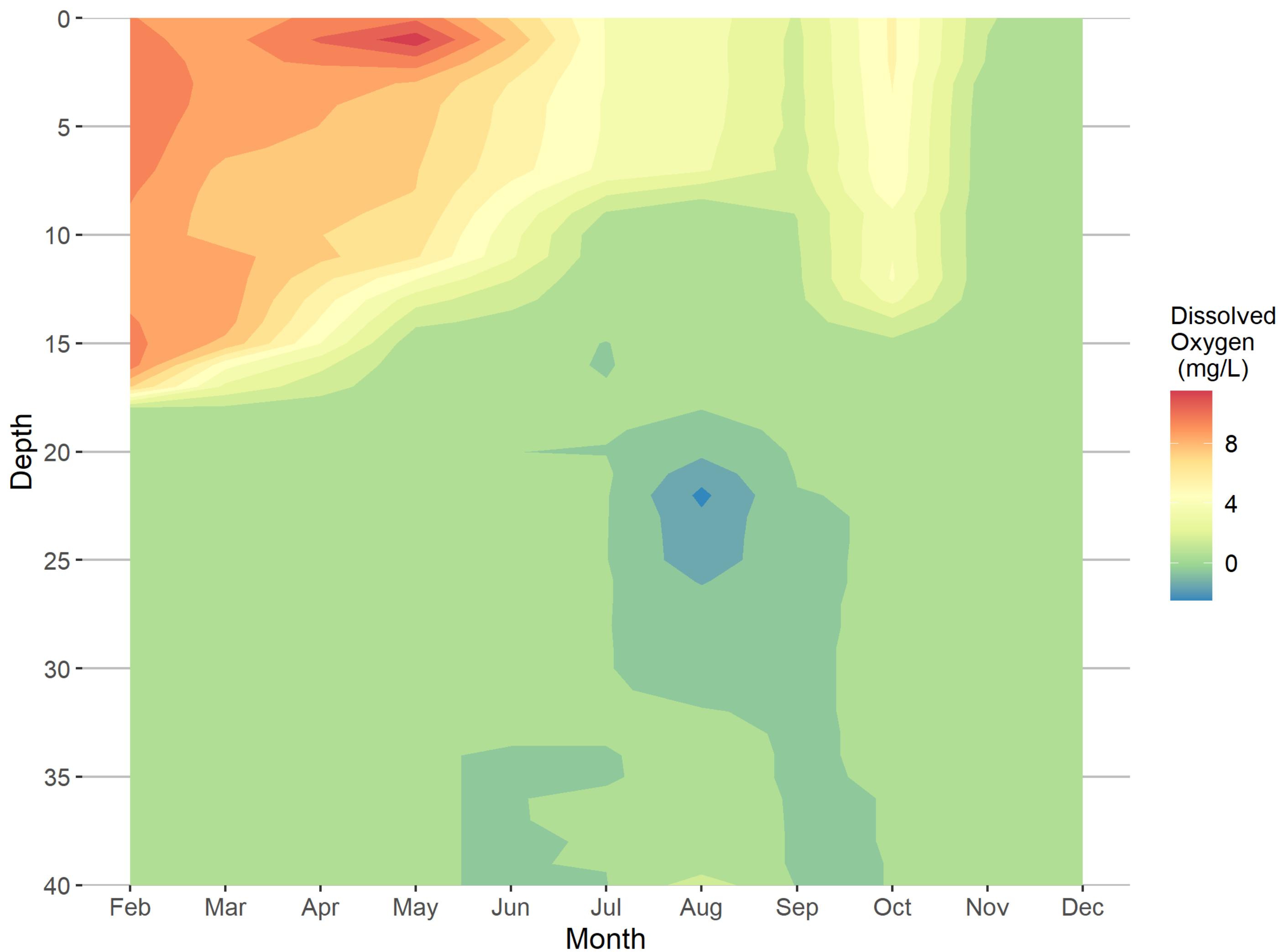

Figure 3-22. Dissolved Oxygen (mg/L) Depth Profiles at Station 6 in 2020

Year	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994					2.5	3.1	3.3	3.1	6.1		4
		6.4			3.6	3.3	4	3.7	4.2		3.5
1996	5.4	4.8	5.1	4.1	4.6	4	4.1	4		5.8	5.4
	7.5	5.5	5.2	5	4.6	5	4.9		5.5		5.3
1998	6.6	7.5	6.8	5.5	4.8	5	4.9	4.9	4.6		5.4
	5.7	6.8	6.2	5.7	4.8	4.8	4.6	4.4	4.9		4.9
2000		6.3	6.2	4.9	4.7	4.5	4.5	4.8	5.6	4.9	5.6
	6.1	7.1	8.2	4.4	5.3	3.8	3.9	4.3	4.3	4.4	2.6
2002	5.6	5.4	4.9	4.1	2.3	3.5	3.1	3.3	3.1	3.1	
	3.9	4.3	3.6	5.6	3.7	4	3.5	3.8	3.6	0.3	1.8
2004	6.8	6.6	4.7	3.3	1.6	2.7	3.4	3.9	3.7	2.6	3.5
		6	5.5	4	3.5	3	3.8	4.8	4.8	4.6	4.9
2006	6.4	4.6	5.5	4.3	3	2.9	3	3.7	3.7	3.8	4.6
	5.2	5.7	5.2	4.7	3	3	3.5		1.6	2.2	4
2008		6.6	6.2	3.8	3.5	3.7	3.7	3.9	2.7	3.1	
	5	5.9	5.7	4.1	2.5	2.9	3.7	3.4	2.9	2.5	5.1
2010		6.5	5.4	5.9	4.4	3	4.3	4.2	4.3	3	4
		5.8	5.7	4.2	4.2	3.4	4.7	4.3			3.8
2012			6.1	5.4		4.8	5.1	3.6	4.2	2.3	5.3
	9.9	9	9.7	10	4.2	5.3	6	7.2	2.5	0.9	0.6
2014	2.3	0.9	2	4.9	0.5	0.8	0.3	1.9	1.9	9.3	4
	3.2	5.6	3.4	1.7	4.2	4.8	3.2	3.9	2.2	1.7	1.9
2016	5.1	4.2	5.3	2.4	4.1	2.2	2.8	2.2	3.1	3.9	1.5
	3.4	3.5	3.4	3.4	2.5	2.8	2.3	2.3	5		5
2018	6.8	7.3	5.8	5.5	4	4	4.1	4	5.2	6.7	3.4
		8.9	5.4	5.6	5.6	4.5	3.7	4.6	5.3	6.2	8.8
2020	9.1	8.2		6.2		2.1	1.8	1.3	4.1	0.3	0.2

Month

Figure 3-23. Average Dissolved Oxygen (mg/L) at Station 6 between 1 and 15 m

Orange-colored cells indicate above the long-term average of the respective month while green-colored cells indicate below the long-term average of the respective month.

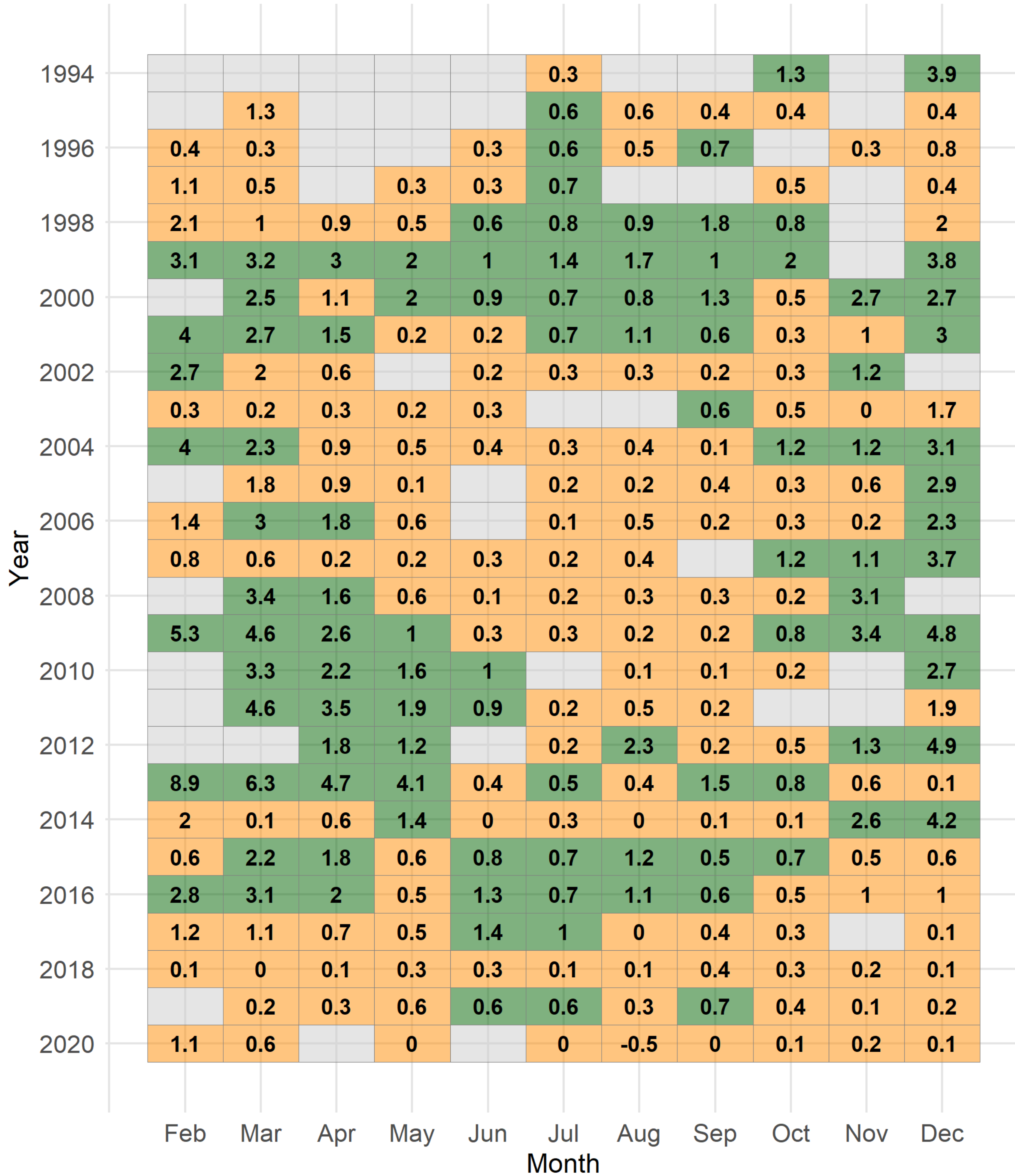

Figure 3-24. Average Dissolved Oxygen (mg/L) at Station 6 between 16 and 38 m

Orange-colored cells indicate above the long-term average of the respective month while green-colored cells indicate below the long-term average of the respective month.

Ammonium

Ammonium levels remained low (<2.8 µM) in the epilimnion through October while accumulated ammonium in the hypolimnion slowly decreased until November when the lake started to mix. In December the lake completely turned over and the hypolimnetic ammonium became available throughout the water column (Table 3-9, Table 3-10, Figure 3-25). In this section, hypolimnion is referred to as depths below 20 m in order to clearly demonstrate continuous accumulation of ammonium at the depths below 20 m. The epilimnetic ammonium became detectable (>2.8m) for the first time since 2016 in November. The peak ammonium accumulation of 134.7 µM at 35m was in March, and then the ammonium level slowly declined until December when the ammonium level suddenly dropped to 11.1 µM. The peak accumulation of 134.7 µM, however, was lower than the peak accumulation of 158.6 µM found in December 2019.

The minimum detectable level of 2.8 µM makes a historical comparison difficult especially for the epilimnion, since an arbitrary value (2 µM) has been substituted for <2.8 µM, which may not reflect actual values. Historically, average ammonium values less than 1 µM have been recorded. In 2019, above normal epilimnetic ammonium levels were found in November and December when the lake completely turned over (Figure 3-26). November and December values were much higher than 2009 and 2013 levels prior to and during the post meromictic *Artemia* population peak, but lower than 2003, prior to the post meromictic *Artemia* peak (30.1 µM in November 2003).

Hypolimnetic ammonium levels appeared to peak in November 2019 at 135.1 µM although hypolimnetic ammonium levels remained mostly above 100 µM throughout 2020 until November (Figure 3-27). As mentioned previously, hypolimnetic ammonium levels were higher than levels observed during and after the previous two meromictic events; however, these levels remained much lower than the levels recorded during and after the second meromixis (1995-2002). The peak hypolimnetic accumulation level during the most recent meromixis (2017-2020) was 135.1 µM, exceeding the levels during two brief meromixis events in 2005-2007 and 2011 (80.6 µM in November 2007 and 83 µM in November 2011, respectively). During the second meromixis, hypolimnetic ammonium levels rose from 50.4 µM in September 1995, to 613.5 µM in August 2001, and remained above 100 µM for a total of almost 8 years (1996 and 2003).

Table 3-9. Ammonium (µM) at Station 6 in 2020

Depth (m)	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	-	-	-	-	-	-
2	<2.8	<2.8	-	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	5.5437	13.305
3	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	<2.8	<2.8	-	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	4.9893	12.751
9	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-
12	<2.8	<2.8	-	<2.8	<2.8	<2.8	8.8699	<2.8	<2.8	5.5437	12.196
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-
16	<2.8	<2.8	-	4.9893	19.957	22.175	21.066	22.729	<2.8	6.6525	12.751
17	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-
20	52.111	35.48	-	29.936	59.872	65.416	77.058	76.503	29.382	4.435	12.196
21	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-
24	66.525	110.32	-	101.45	100.9	98.678	102.56	106.99	94.797	7.2068	12.751
25	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-
28	110.32	129.72	-	115.86	116.97	114.2	114.2	-	103.11	64.307	12.196
29	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-
35	133.6	134.71	-	129.17	122.52	125.84	126.95	128.61	116.42	104.22	11.087

Laboratory detection limit of 2.8µm.

No ammonium depth profile was taken in April. Ammonium sample at 28m from September was not reported as <2.8µM, which was not in accordance with readings above and below.

Table 3-10. 9-meter Integrated Values for Ammonium (µm) in 2020

Station	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	<2.8	<2.8	<2.8	NA	<2.8	<2.8	<2.8	<2.8	<2.8	15.0	13.9
2	<2.8	<2.8	<2.8	NA	<2.8	<2.8	<2.8	<2.8	<2.8	12.2	13.9
5	<2.8	<2.8	NA	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	13.9	23.3
6	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	6.1	13.3
7	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	2.8	8.3
8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	2.8	20.5
11	<2.8	<2.8	<2.8	NA	<2.8	<2.8	<2.8	<2.8	<2.8	4.4	<2.8
Mean	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	8.2	15.5
SE	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.02	2.22

Laboratory detection limit of 2.8µm.

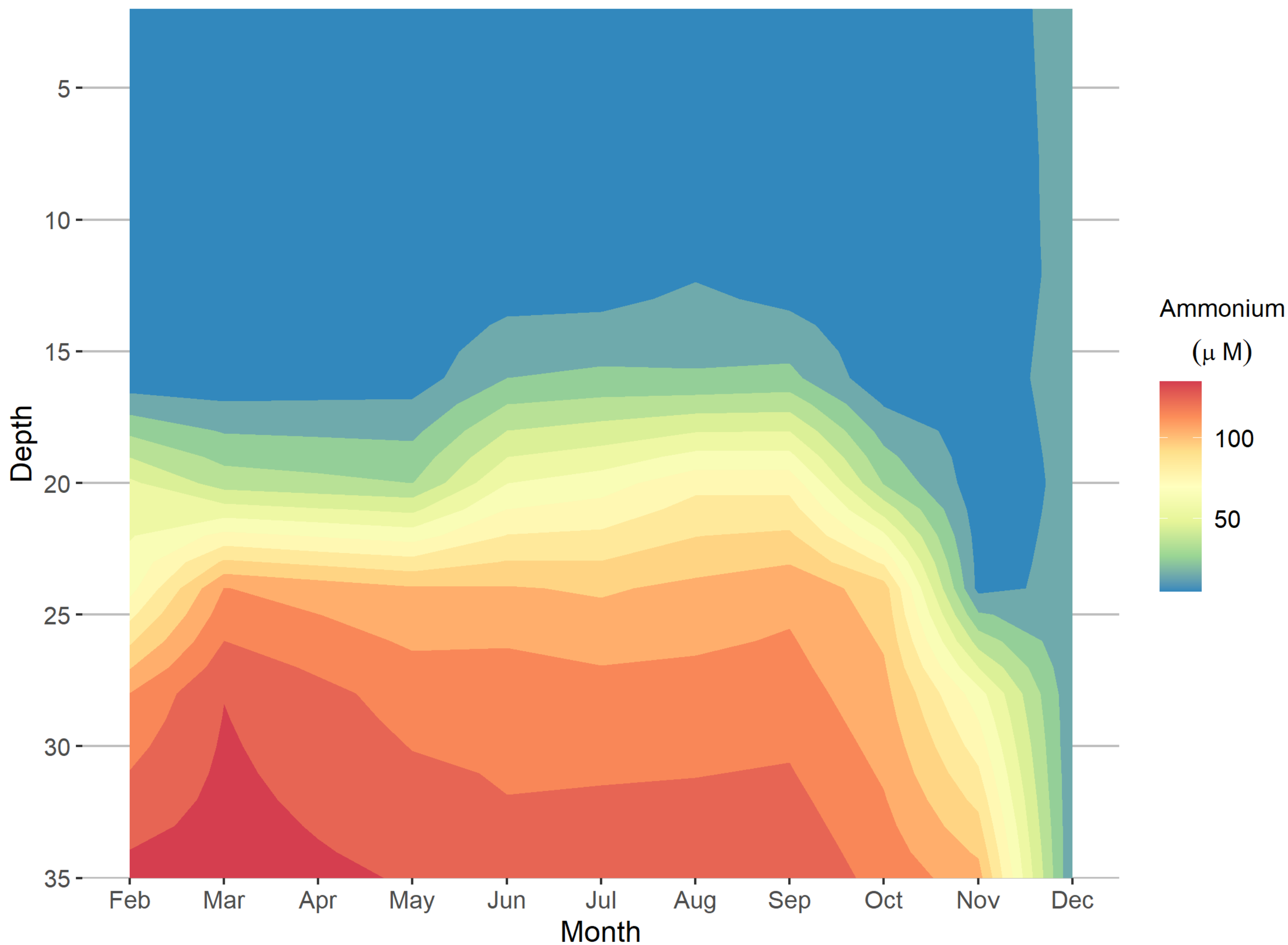

Figure 3-25. Ammonium (μm) Depth Profile at Station 6 in 2020

April values were interpolated using March and May values. Missing values near the bottom were substituted with closest non-missing value above.

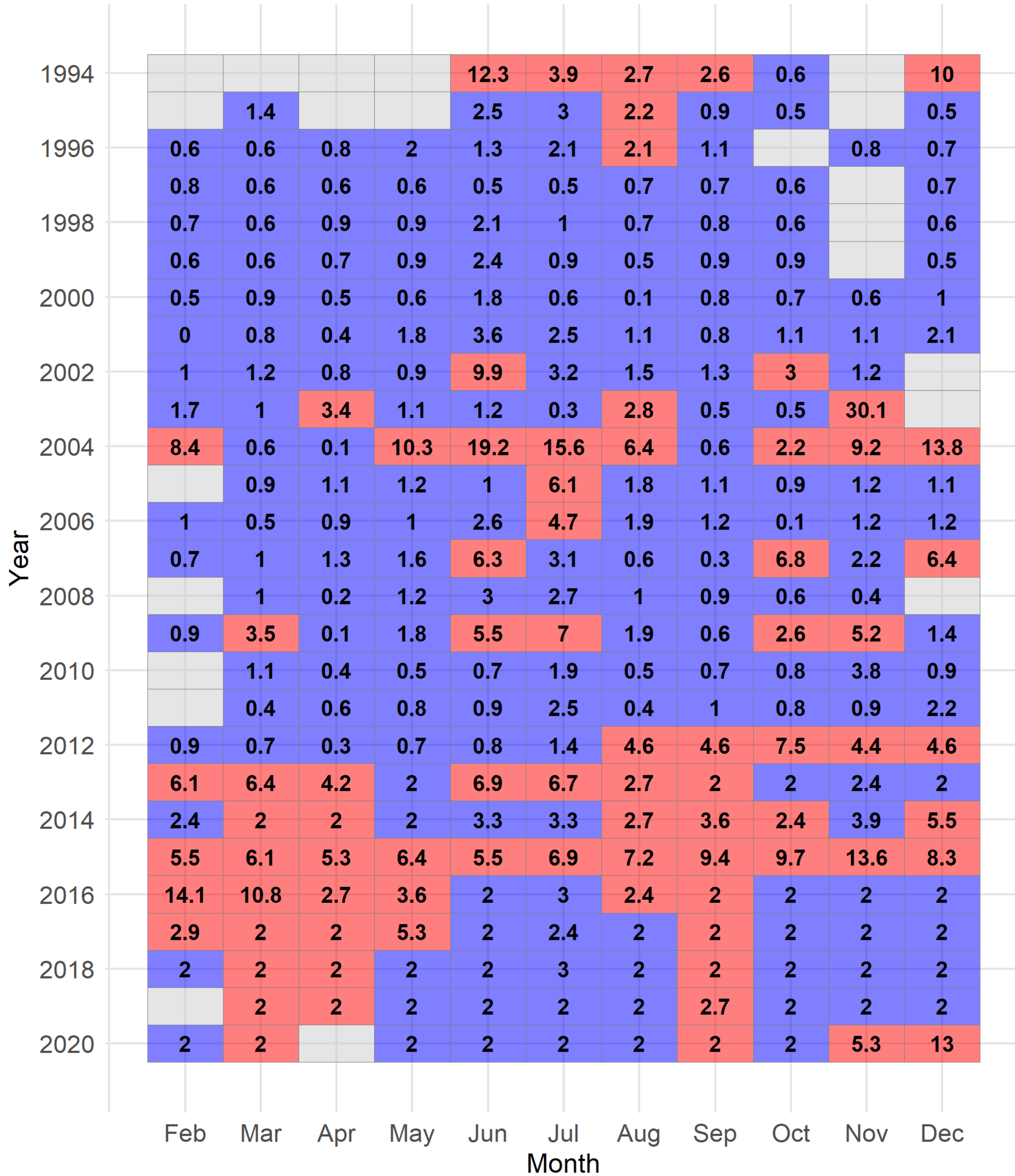

Figure 3-26. Average Ammonium (µm) at Station 6 at 2 and 8 m

An arbitrary value of 2 was used for values below the laboratory detection limit of 2.8µm. Red-colored cells indicate above the long-term average of the respective month while blue-colored cells indicate below the long-term average of the respective month.

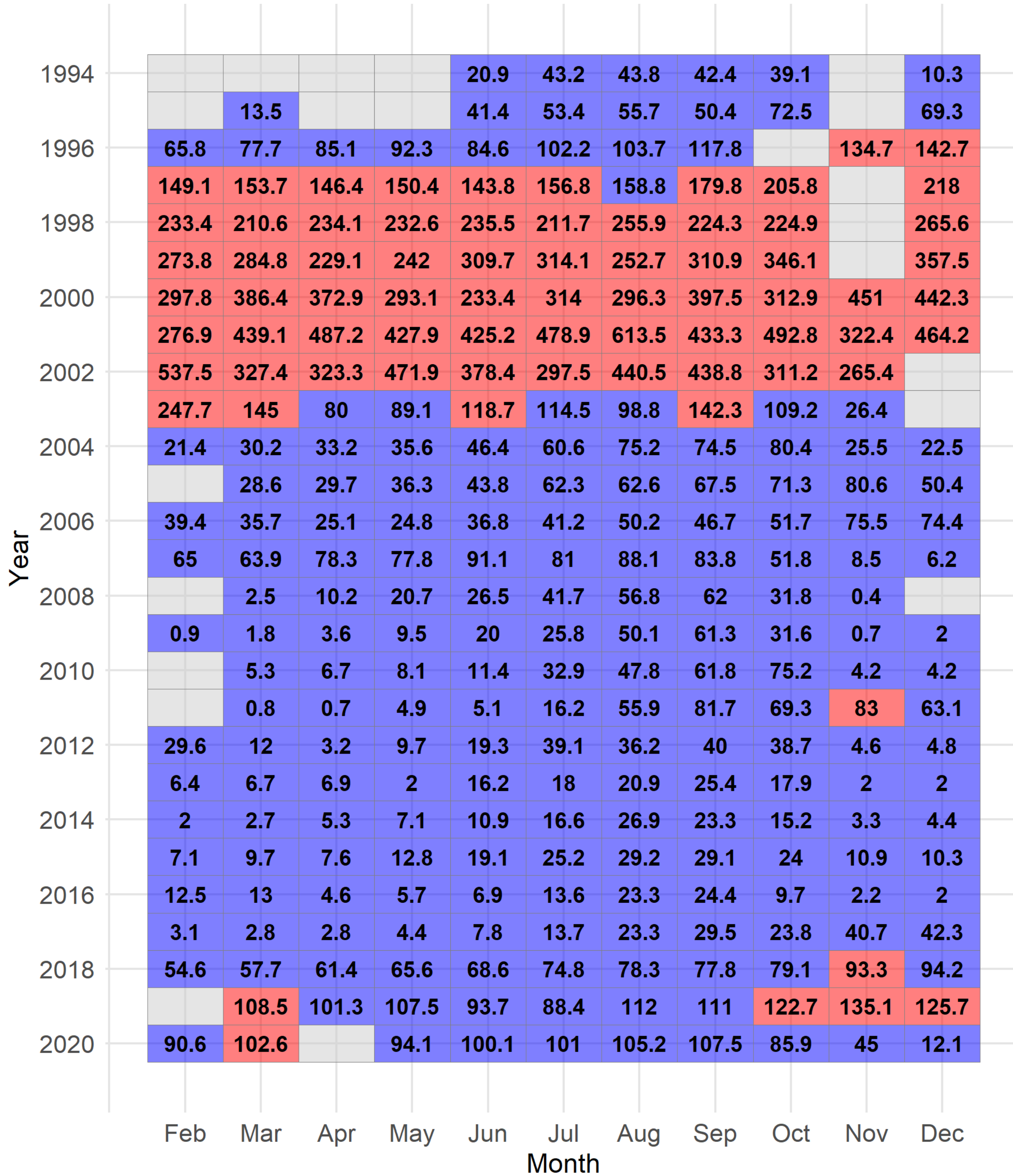

Figure 3-27. Average Ammonium (µm) at Station 6 at and below 20 m

An arbitrary value of 2 was used for values below the laboratory detection limit of 2.8µm. Red-colored cells indicate above the long-term average of the respective month while blue-colored cells indicate below the long-term average of the respective month. An arbitrary value of 2 was used for values below the laboratory detection limit of 2.8µm.

Phytoplankton

Seasonal changes were noted in the phytoplankton community in the epilimnion, as measured by chlorophyll *a* concentration (Table 3-11, Table 3-12, and Figure 3-28). At Station 6, chlorophyll *a* level started to increase with warming temperatures, most likely reaching the initial peaks in May in the epilimnion, but declined through June, reaching the lowest level in July. The epilimnetic chlorophyll level started to increase in August through November due to declining *Artemia* activity in summer to winter. Below 12 m chlorophyll levels were higher than those observed in the epilimnion, but the seasonal changes varied at different depths. The epilimnetic chlorophyll *a* level (between 2 and 8 m) was highest in November (92.7 µg/L) and lowest in August (23. 3 µg/L). Both readings were much higher than the highest readings from 2019 (34.8 µg/L and 2.3 µg/L, respectively). The hypolimnetic chlorophyll *a* level (≤12 m) was highest in August (94.3 µg/L) and lowest in February (58.8 µg/L). The highest reading in 2020 was much higher than the reading from 2019 (59.2 µg/L) (Figure 3-29).

The lake-wide mean chlorophyll *a* level based on the 9-m integrated samples decreased throughout the spring and reached the lowest level at 12.3 µg/L lake-wide in July as *Artemia* grazing intensified. The annual minimum reading of 12.3 µg/L was the fourth highest on record following 2015 to 2017 (Figure 3-30). Chlorophyll *a* level in the epilimnion generally decreases to under 5 µg/L in summer; however, this seasonal change did not occur during the severe drought between 2012 and 2016 as the minimum level remained above 15 µg/L (except 2018 and 2019- the second and third year of the most recent meromixis). The 2020 minimum was lower than levels between 2015 and 2017 but much higher than the long-term minimum level. Chlorophyll levels tend to be lower during meromixis and higher during monomixis, particularly in spring and winter months based on the 9-m integrated samples (Figure 3-30). Higher than normal chlorophyll in spring and winter in 2020 is another indication of the end of the most current meromixis.

Hypolimnetic chlorophyll *a* levels in 2020 were much higher than previous four years, comparable to levels observed during the drought between 2012 and 2016, and readings from August and November were highest on record (Figure 3-31). Hypolimnetic chlorophyll levels tend to decrease during meromictic events; however, these levels remained higher than normal during the most recent meromixis.

Table 3-11. Chlorophyll a (µg /L) Depth Profile at Station 6 in 2020

Depth (m)	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	-	-	-	-	-	-
2	46.443	50.446	-	-	29.545	13.531	22.958	41.407	57.685	89.904	-
3	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-
8	34.77	29.193	-	-	30.114	33.028	30.817	41.875	60.127	95.405	-
9	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-
12	43.165	36.838	-	-	38.235	66.303	82.421	40.507	53.56	93.758	-
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-
16	40.299	54.412	-	-	72.799	81.341	96.379	69.541	60.642	95.403	-
17	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-
20	59.986	64.876	-	-	69.28	86.458	95.564	95.291	74.893	92.039	-
21	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-
24	68.986	77.577	-	-	90.69	85.723	97.55	71.294	94.598	86.448	-
25	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-
28	81.316	75.098	-	-	90.145	94.428	99.74	46.715	88.204	96.736	-

Chlorophyll *a* was not sampled in April and May. Chlorophyll *a* in December was not processed in the lab.

Table 3-12. 9-meter Integrated Values for Chlorophyll a (µg/L) in 2020

Station	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	54.8	45.4	-	-	35.2	18.3	22.8	36.2	56.3	88.3	-
2	60.5	46.8	-	-	30.6	13.5	22.8	37.3	42.4	87.1	-
5	46.7	50.0	-	-	36.9	14.5	20.7	45.5	62.1	83.1	-
6	46.4	49.8	-	-	11.3	8.2	18.1	37.7	56.7	96.4	-
7	51.7	48.6	-	-	22.3	12.1	18.4	43.3	51.8	101.6	-
8	52.5	52.1	-	-	19.2	9.9	16.1	44.4	54.1	101.3	-
11	52.0	46.1	-	-	22.4	9.8	11.7	42.3	53.8	96.9	-
Mean	52.1	48.4	-	-	25.4	12.3	18.7	41.0	53.9	93.5	-
SE	1.8	0.9	-	-	3.5	1.3	1.5	1.4	2.3	2.8	-

Chlorophyll a was not sampled in April and May. Chlorophyll a in December was not was not processed in the lab.

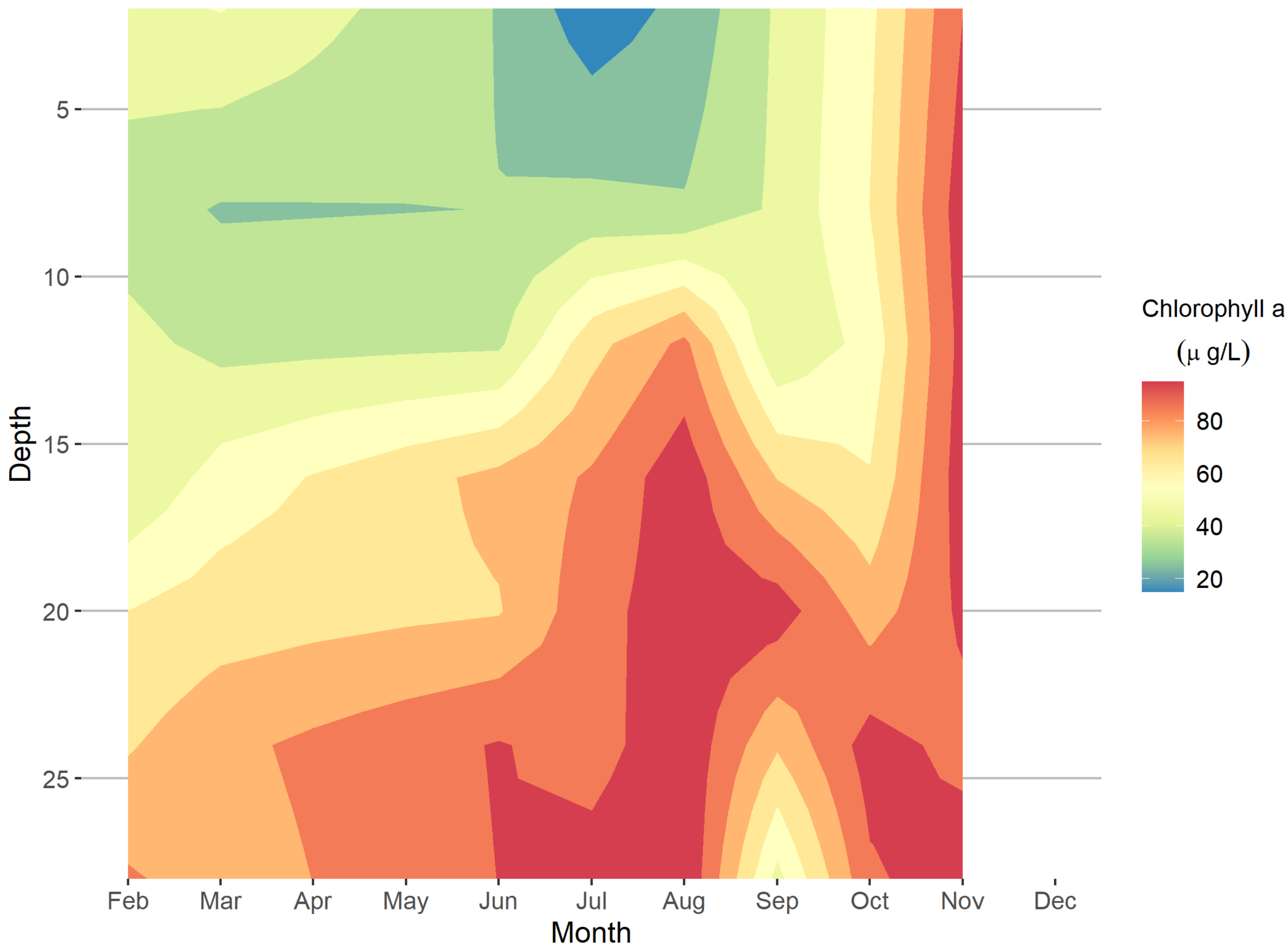

Figure 3-28. Chlorophyll a (µg/L) Depth Profile at Station 6 in 2020

Chlorophyll readings in April and May were estimated based on March and June readings at respective depths.

Year	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994					0.4	2.4	2.2	1.7	49		30
		55.7			1.1	0.7	1.3	0.9	5.3		6.1
1996	17	13.1	6.3	0.7	0.8	0.9	1.9	1.7		11.2	7.7
	25.2	7.8	2.8	0.8	1.5	0.7	0.5	1.4	26.7		8.1
1998	16.9	12	4.8	2.4	0.6	1.3	1.1	1.6	1.6		7.8
	12.2	16.7	14.4	4.4	1.1	1.4	2.1	1.4	3.5		25.8
2000	17.2	10.6	19.8	4.4	2.1	1.8	1.5	4.7	6.9	46.5	53.7
	37.7	34.2	13.5	4.4	3.1	0.7	1.5	2.2	4.8	28.4	50.5
2002	62.3	58.4	29.3	18.4	0.8	1.7	2.4	7.3	33.5	80.2	
	64.8	49.4	73.9	71	9.3	7.3	3.5	17.8	49.4	55.9	57.2
2004	98.1	92.1	57.3	7.3	0.6	2	3.2	2.8	50.3	61.1	70.3
		59.4	74.5	17.2	5.3	1.1	2	2.3	17.8	40.4	63.4
2006	67.7	60.8	52.1	25.9	2.4	2.1	1.7	3.3	8.5	11.4	29.2
	23.6	21.1	20.3	2.7	1.1	1.5	3	12	45.4	73	57.3
2008		56.8	37.1	9	4	3.2	4.2	16.9	49.1	92	
	88.4	85.2	76	43.3	3.1	2.1	4.9	11.1	51.6	79.1	88.5
2010		67.3	65.1	65.9	9.2	2.9	2.3	15	31.4	65.8	78.1
		77.8	72	64	25.4	1.8	2.3	3.9	5	15.2	41
2012	56.2	66.5	67.5	53.8	8.2	3.3	3.5	4.8	45.4	48.8	41.7
	47	40.7	38	22.8	3.2	1.8	3.9	18.1	39.9	50.5	52.3
2014	53.7	55.3	57.2	30.9	13.1	9.3	28.1	52.1	72.9	92.2	93.5
	80.7	63.7	56.7	34.8	34	32.8	34.8	61.1	73.8	85	97.7
2016	59.5	49.7	40.9	36.8	28	18.1	16.8	32.7	53.9	69.5	77.8
	42.2	47.3	51.2	29.2	22.7	40.5	27.6	1.8	1.9	21.3	26
2018	19.8	13.2	26.9	22.6	14.6	4.9	1.7	5.8	16.3	19.3	26.8
		30.8	30.5	33.3	22.5	10.3	4.4	2.3	12.5	17.5	34.8
2020	40.6	39.8			29.8	23.3	26.9	41.6	58.9	92.7	

Month

Figure 3-29. Average Chlorophyll a (µg/L) at Station 6 at 2 and 8 m

Red-colored cells indicate above the long-term average of the respective month while blue-colored cells indicate below the long-term average of the respective month.

Year	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1987				0.7	1.1	0.9	1	2.3	3.9	19.2	29.7
	24.7	55.2	33.2	7.4	0.5	3.4	9.8	33.7	48.1	44.6	40.8
1989	35.9	34.7	68.6	59.6	23.4	0.7	0.4	0.5	1.2	13.4	46.2
	51.2	78.7	41.4	11.5	3.6	1.1	1.5	1.6	41.2	21.7	32.5
1991	65.5	57.8	48.9	27.6	2.9	1.7	3.1	2	7.2	55.7	72.4
	93.8	62	29.2	0.4	1.5	1.4	1.8	2.9	16.5	38.1	49
1993		103.7	86.7	18.2	0.7	2.5	2.7	3.3	6.4	14.1	18
	65.4	79.2	39	2.9	0.7	1.5	2.3	6.3	48.9		28.5
1995		65.5			0.5	0.5	1.3	1.2	14.9		6.4
	16.2	11.7	7.3	0.6	0.9	1.2	1.4	2.4		12.3	7.8
1997	20.6	7.1	3.2	0.7	1.1	0.5	0.6	1.7	48.3		42.1
	15.8	11.8	0.9	1.9	0.7	0.9	1	2.3	2.2		7.4
1999	11.5	18	13.2	4.9	1.2	1.1	1.6	1.8	3.7		25.5
	16.5	12.2	20.4	4	1.6	1.3	1.5	3.1	7.2	43.7	50.2
2001		23.9	13.5	2.3	1.3	1.1	1.3	3.5	6.6	31.5	53
	72.5	57.2	22.3	10.3	0.7	1.1	4.2	11.3	36.8	76.3	
2003	69.4	48.4	67.6	58	6.9	4.6	4	12.5	41.6	56.5	53.5
	101.4	97.5	60.8	14.7	0.4	1.4	2.1	12.8	48.9	63.3	69.9
2005		62	73.5	18.8	4.1	1	2.2	3.5	18.1	40.7	
	61.1	63.6	53.6	26.8	1.9	2	2.1	3.2	8.3	11.3	25.8
2007	21.8	18.7	18.1	1.8	0.9	1.1	2.4	11.9	45.3	71.1	
		49.1	40.5	20.1	6.8	3.6	3.2	17.7	48.5	91.5	
2009	86.3	84.1	69.8	35.2	2.9	1.9	4.7	9.7	54	78.7	
		70.1	66.8	64.2	13	2.5	3.6	13.8	28.3	67.1	79.1
2011		77.2	71.3	58.5	29.1	1.6	1.9	3.2	4.8	14.6	40.1
	58.2	63.5	69.7	40.6	8.8	2.3	3.2	6.6	39.6	48	47.1
2013	47.4	34.8	39.2	18.1	3.3	1.6	3.1	14.4	42.6	51.1	55.5
	57.7	52.8	54.4	31.3	13.7	8.5	24.2	50.9	64.7	86.6	97.7
2015	72.4	71.4	56.6	28.7	18.4	15.4	30.5	65.1	71.1	98.2	97.1
	55.4	55.1	45	36.5	29.1	15.4	17	33.2	68.5	79.5	68.2
2017	44.5	43.9	45.9	31.2	21.9	18.3	10.6	4.4	3.7	19.2	24.8
	15	13.3	27.3	19.7	6.6	2.6	1.4	5.4	18.8	17.7	28.5
2019		36.1	29.6	26.4	17.1	6	3.1	3.4	13.2	18.9	37.9
	52.1	48.4			25.4	12.3	18.7	41	53.9	93.5	

Month

Figure 3-30. Average Lake-wide 9m Integrated Chlorophyll a (µg/L)

Red-colored cells indicate above the long-term average of the respective month while blue-colored cells indicate below the long-term average of the respective month.

Year	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994					35.2	26.8	37.2	25.8	39.9		31.3
		49.1			28.4	16.6	21.8	31.2	37.9		32.2
1996	29.2	34.9	27.6	30.9	30.6	22.3	23.4	29.2		37.6	29.8
	48	44	30	26.9	33.8	28.6	25	17.5	23.5		25.6
1998	30.1	33.2	35.6	45.5	24.3	21.8	24.9	27.9	29.3		28.4
	25.1	25.3	26.7	21.8	36	25.6	18.8	26	15.9		27.4
2000	23.9	27.7	35.3	33.3	22.2	20.3	23.8	25.7	19.9	38	49.3
	40.3	36.6	33.5	33.9	16.4	15.1	10.5	17.3	17.4	25.2	46.3
2002	65.9	53	54.9	29.7	18.9	26	19.8	24.5	25.2	62.9	
	50.6	41.6	40.7	58.5	52.4		44.3	34.5	36.1	60.6	48.8
2004	64.7	59.8	62.1	59.2	42.3	26.7	29.4	33.8	40.6	54.8	58.5
		55.1	62.1	54.5	48.7	37	38.2	41.8	37.6	41.2	51.5
2006	51.8	59.6	59.3	55.1	46.4	34.7	33.3	45.7	42.7	41.3	38.3
	37.3	34.1	38.3	38.8	24.6	21.8	25.2	24.1	40.7	58.2	64.2
2008		86.5	50.8	44.1	42	38.1	45	35.2	45.5	83	
	85.1	91.5	83.1	77.9	75.4	70.6	62.1	56.6	57.9	78.4	82.7
2010		69.6	68.6	73.2	67	65.5	57.4	58.4	53.8	66.5	77.1
		81.3	75.1	74.3	68.7	57.2	60.3	61.5	58.2	67	50.3
2012	50.7	60.4	69.8	52.4	49.6	45.7	20.6	20.3	35.5	48.8	47
	46.9	39.7	37.7	37.9	37	36.7	43	39.5	43.1	50.9	57.5
2014	63.5	55.8	60.5	43.7	55.8	69.3	78.8	70	69.3	87.9	96.7
	72.2	79.1	60.2	60.4	66.9	91.8	88.6	90.3	98.3	90.4	99.7
2016	60.9	47.9	45.5	44.8	61.6	51.8	56.6	55.5	56.1	81.9	63.6
	40.2	45.9	51.6	41.6	51.1	58	71.5	41.5	38.2	72.4	69.1
2018	37.5	41.5	63	68.6	54.1	52.2	58.1	62.1	61.2	50.8	47.6
		47.5	30.3	51.5	46.2	53	59.2	55.5	52.6	48.9	50.1
2020	58.8	61.8			72.2	82.9	94.3	64.7	74.4	92.9	

Month

Figure 3-31. Average Chlorophyll a (µg/L) at Station 6 between 12 and 28 m

Red-colored cells indicate above the long-term average of the respective month while blue-colored cells indicate below the long-term average of the respective month.

Artemia Population and Biomass

Artemia population data are presented in Table 3-13 through Table 3-15 with lake-wide means, sector means, associated standard errors and percentage of population by age class. As discussed in previous reports (Jellison and Rose 2011), zooplankton populations can exhibit a high degree of spatial and temporal variability. In addition, when sampling, local convergences of water masses may concentrate shrimp potentially affecting overall means. For these reasons, Jellison and Rose (2011) have cautioned that the use of a single level of significant figures in presenting data is inappropriate, and that the reader should always consider the standard error associated with *Artemia* counts when making inferences from the data.

Artemia Population

Hatching of overwintering cysts started slowly in February, and was not evident until March. All instars in mid-March were instar age classes 1 and 2. Instar abundance increased through spring to a peak of 113,491 +/- 64,324 m^{-2} in April. Adult *Artemia* were absent between February and April except five adults recorded at Stations 10 and 12 in February. The instar peak observed in April was the total *Artemia* population peak in 2020. A proportion of adults increased from 34% in May to 98% in August. The instar analysis indicated a diverse age structure of instars 1-7 and juveniles (instars 8-11) between May and June, and the abundance of each age class started to decline in July even though all age classes existed. In May, females with cysts were first recorded. Females with cyst abundance peaked at 8,722 +/- 1,014 m^{-2} in August and started to decline afterward. By July, hatching and growth decreased significantly, with instars and juveniles comprising only 12% of the population as compared to 66% in May. The highest adult *Artemia* abundance occurred in June (24,353 +/- 3,178 m^{-2}) and dropped below 10,000 m^{-2} in October, 5,000 m^{-2} in November, and almost to 0 m^{-2} in December.

Table 3-13. *Artemia* Lake-wide and Sector Population Means (per m^2 or m^{-2}) in 2020

	Instars		Adult	Adult	Adult Female	Ad Female Ovigery Classification				Total
	1-7	8-11	Total	Males	Total	empty	undif	cysts	naup	*Artemia*
Lake-wide										
Feb	6,633	22	13	5	8	8	0	0	0	6,667
Mar	22,376	0	0	0	0	0	0	0	0	22,376
Apr	113,491	0	0	0	0	0	0	0	0	113,491
May	939	20,684	11,093	11,066	27	0	0	27	0	32,716
Jun	2,175	9,510	24,353	17,049	7,304	1,710	892	4,380	322	36,038
Jul	246	2,458	19,359	9,276	10,083	895	265	8,722	202	22,063
Aug	195	277	19,094	11,784	7,310	895	145	6,069	202	19,567
Sep	474	244	10,833	6,316	4,517	332	162	3,932	90	11,551
Oct	1,435	235	6,559	3,997	2,562	54	65	2,379	65	8,229
Nov	1,374	359	1,015	629	386	30	2	329	25	2,748
Dec	69	8	3	3	0	0	0	0	0	80
Western Sector										
Feb	2,852	41	0	0	0	0	0	0	0	2,893
Mar	17,862	0	0	0	0	0	0	0	0	17,862
Apr	5,191	0	0	0	0	0	0	0	0	5,191
May	848	18,967	9,631	9,577	54	0	0	54	0	29,447
Jun	2,136	6,761	18,632	12,019	6,613	1,891	657	3,662	402	27,529
Jul	265	3,831	23,241	11,999	11,242	958	353	9,780	151	27,337
Aug	199	302	18,074	11,419	6,655	832	126	5,546	151	18,575
Sep	425	79	2,193	1,749	444	22	22	397	3	2,697
Oct	829	79	2,190	1,427	763	19	16	725	3	3,097
Nov	410	82	123	82	41	9	0	28	3	614
Dec	0	0	0	0	0	0	0	0	0	0
Eastern Sector										
Feb	10,414	3	25	9	16	16	0	0	0	10,442
Mar	26,890	0	0	0	0	0	0	0	0	26,890
Apr	149,591	0	0	0	0	0	0	0	0	149,591
May	1,030	22,401	12,555	12,555	0	0	0	0	0	35,986
Jun	2,213	12,260	30,074	22,079	7,995	1,529	1,127	5,097	241	44,547
Jul	227	1,084	15,477	6,554	8,923	832	176	7,663	252	16,788
Aug	192	252	20,115	12,150	7,965	958	164	6,592	252	20,560
Sep	523	410	19,473	10,883	8,589	643	302	7,468	176	20,405
Oct	2,042	391	10,927	6,566	4,361	88	113	4,033	126	13,360
Nov	2,338	636	1,906	1,175	731	50	3	630	47	4,881
Dec	139	16	6	6	0	0	0	0	0	161

Table 3-14. Standard Errors (SE) of *Artemia* Sector Population Means (per m^2 or m^{-2}) from Table 3-13 in 2020

	Instars		Adult	Adult	Adult Female	Ad Female Ovigery Classification				Total
	1-7	8-11	Total	Males	Total	empty	undif	cysts	naup	*Artemia*
Lake-wide										
Feb	1,659	20	8	5	6	6	0	0	0	1,658
Mar	4,100	0	0	0	0	0	0	0	0	4,100
Apr	64,324	0	0	0	0	0	0	0	0	64,324
May	98	3,078	1,855	1,864	27	0	0	27	0	4,713
Jun	594	1,280	3,178	2,413	951	320	256	665	91	4,126
Jul	36	513	3,342	2,397	1,200	217	109	1,014	75	3,406
Aug	43	81	1,973	1,121	948	161	27	750	56	1,957
Sep	63	81	4,290	2,356	1,952	273	59	1,666	30	4,345
Oct	292	103	1,574	951	677	23	26	634	22	1,816
Nov	472	133	394	235	161	14	2	140	13	966
Dec	66	6	3	3	0	0	0	0	0	70
Western Sector										
Feb	1,721	41	0	0	0	0	0	0	0	1,715
Mar	4,631	0	0	0	0	0	0	0	0	4,631
Apr	241	0	0	0	0	0	0	0	0	241
May	81	5,406	2,799	2,818	54	0	0	54	0	7,882
Jun	690	1,032	3,630	2,575	1,386	604	234	814	142	4,140
Jul	38	608	5,063	3,689	1,731	286	198	1,565	103	4,862
Aug	65	130	1,321	842	932	150	25	776	78	1,406
Sep	97	6	508	433	152	11	19	129	3	563
Oct	302	29	1,040	633	428	13	12	407	3	1,341
Nov	342	75	112	75	37	9	0	25	3	528
Dec	0	0	0	0	0	0	0	0	0	0
Eastern Sector										
Feb	1,852	3	16	9	12	12	0	0	0	1,858
Mar	6,662	0	0	0	0	0	0	0	0	6,662
Apr	81,737	0	0	0	0	0	0	0	0	81,737
May	181	3,360	2,540	2,540	0	0	0	0	0	5,597
Jun	1,038	1,767	4,263	2,977	1,367	269	461	1,036	116	5,367
Jul	64	185	4,179	2,951	1,675	351	99	1,274	115	4,036
Aug	63	110	3,869	2,183	1,707	300	49	1,328	82	3,805
Sep	84	135	7,131	3,987	3,180	538	85	2,682	32	7,170
Oct	370	190	1,480	967	733	41	43	713	25	1,478
Nov	702	202	593	345	254	25	3	221	24	1,417
Dec	131	12	6	6	0	0	0	0	0	139

Table 3-15. Percentage in Different Classes of *Artemia* Population Means from Table 3-13 in 2020

	Instars		Instar	Adult	Adult	Adult Female	Ad Female Ovigery Classification				Ovigerous
	1-7	8-11	%	Total	Males	Total	empty	undif	cysts	naup	Female%
Lake-wide											
Feb	99	0.3	100	0.2	0.1	0.1	100	0	0	0	0
Mar	100	0	100	0	0	0	0	0	0	0	0
Apr	100	0	100	0	0	0	0	0	0	0	0
May	3	63	66	34	34	0.1	0	0	100	0	100
Jun	6	26	32	68	47	20	23	16	78	6	77
Jul	1	11	12	88	42	46	9	3	95	2	91
Aug	1	1	2	98	60	37	12	2	95	3	88
Sep	4	2	6	94	55	39	7	4	94	2	93
Oct	17	3	20	80	49	31	2	3	95	3	98
Nov	50	13	63	37	23	14	8	0.4	92	7	92
Dec	86	10	96	4	4	0	0	0	0	0	0
Western Sector											
Feb	99	1	100	0	0	0	0	0	0	0	0
Mar	100	0	100	0	0	0	0	0	0	0	0
Apr	100	0	100	0	0	0	0	0	0	0	0
May	3	64	67	33	33	0.2	0	0	100	0	100
Jun	8	25	32	68	44	24	29	14	78	9	71
Jul	1	14	15	85	44	41	9	3	95	1	91
Aug	1	2	3	97	61	36	13	2	95	3	88
Sep	16	3	19	81	65	16	5	5	94	1	95
Oct	27	3	29	71	46	25	2	2	97	0.4	98
Nov	67	13	80	20	13	7	23	0	90	10	77
Dec	0	0	0	0	0	0	0	0	0	0	0
Eastern Sector											
Feb	100	0.03	100	0.2	0.1	0.2	100	0	0	0	0
Mar	100	0	100	0	0	0	0	0	0	0	0
Apr	100	0	100	0	0	0	0	0	0	0	0
May	3	62	65	35	35	0	0	0	0	0	0
Jun	5	28	32	68	50	18	19	17	79	4	81
Jul	1	6	8	92	39	53	9	2	95	3	91
Aug	1	1	2	98	59	39	12	2	94	4	88
Sep	3	2	5	95	53	42	7	4	94	2	93
Oct	15	3	18	82	49	33	2	3	94	3	98
Nov	48	13	61	39	24	15	7	0.5	93	7	93
Dec	86	10	96	4	4	0	0	0	0	0	0

<u>Instar Analysis</u>

The instar analysis, shows patterns similar to those of the lake-wide and sector analysis, but provide more insight into *Artemia* reproductive cycles occurring at the lake (Figure 3-32). Instars 1 were proportionally more abundant than Instars 2 in February and March. By May all age classes (1 through 7) of instars and juveniles were present and comprised approximately 66% of the *Artemia* population while adults comprised the remainder (34%). The proportion of instars and juveniles combined fell precipitously beginning in June, and proportions remained low until October.

The presence of late-stage instars and juveniles throughout the monitoring year indicate continuous maturing and breeding. Instar abundance peaked in April and immediately began to decline recording the lowest abundance in October. Abundance of Instars 1 and 2 started to rise in November coinciding slight increase in in females with naupliar eggs (ovoviviparous) in October, suggesting hatching of nauplii rather than cysts could have been responsible for the increase in Instars 1 and 2 during these months. In December, no instar was found in the western sector of the lake.

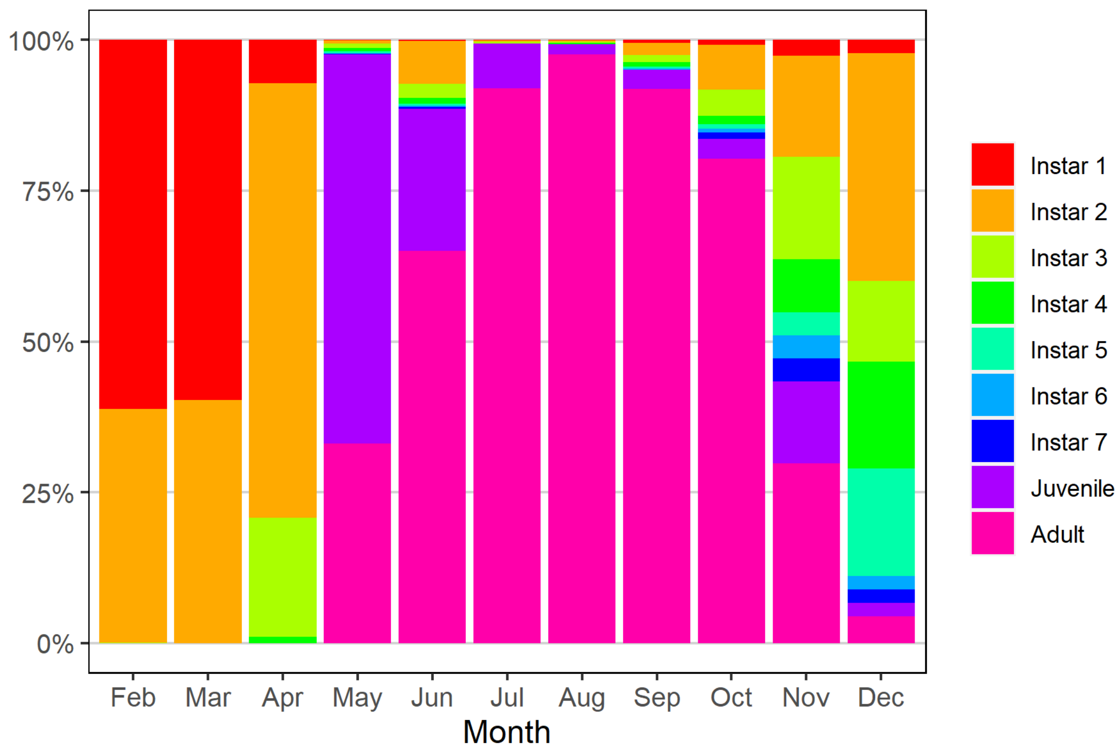

Figure 3-32. Compositional Changes of *Artemia* Instars and Adults in 2020

Biomass

Mean lake-wide *Artemia* biomass exceeded 10 g/m^2 between June and August peaking at 19.0 g/m^2 in June (Table 3-16). Mean biomass was below 10 g/m^2 in September (9.12 g/m^2), declined to 1.09 g/m^2 by November, and reached the yearly low of 0.03 g/m^2 in December. Timing of peak biomass differed between Western and Eastern sectors as the biomass peaked in July (19.6 g/m^2) in the western sector, while the biomass in the eastern sector peaked in June (22.1 g/m^2). Peak mean biomass was higher in the eastern sector than in the western sector, contrary to the pattern observed in 2018 and 2019.

Table 3-16. *Artemia* Mean Biomass (g/m^2) in 2020

Month	Lake-wide	Western Sector	Eastern Sector
Feb	0.33	0.30	0.36
Mar	0.46	0.47	0.45
Apr	3.70	0.22	4.87
May	4.45	4.15	4.74
Jun	19.0	15.9	22.1
Jul	16.8	19.6	14.0
Aug	12.3	11.7	12.9
Sep	9.12	1.92	16.3
Oct	6.41	2.23	10.6
Nov	1.09	0.16	2.01
Dec	0.03	0.00	0.06

Reproductive Parameters and Fecundity Analysis

By June, fecund females were plentiful enough to conduct a fecundity analysis. In mid-June, approximately 20% of females were ovigerous, with 78% oviparous (cyst-bearing), 6% ovoviviparous (naupliar eggs) and 16% undifferentiated eggs (Table 3-13, Table 3-17, Figure 3-33). From July through November, over 90% of females were ovigerous with the majority (88 to 98%) oviparous. The percent of ovigerous female was 100% in May due to one individual female carrying cysts recorded at Station 1.

The lake-wide mean fecundity declined through the summer, and then started to increase in September. The lake-wide mean fecundity was initially 37.0 +/- 1.6 egg per brood in June, decreased to 23.3 +/- 1.0 eggs per brood by August, and rebounded to 46.2 +/- 2.1 in October. The majority of fecund females were oviparous between July and October. The peak in the western section occurred in September, and in October in the eastern section. Typically, mean female lengths are positively correlated with mean eggs per brood, and 2020 followed this pattern.

Table 3-17. *Artemia* Fecundity Summary in 2020

	# of Eggs/Brood				Female Length (mm)		
Month	Mean	SE	% Cyst	% Indented	Mean	SE	n
Lakewide							
Jun	37.0	1.6	98.6	57.1	9.4	0.1	7
Jul	25.8	1.1	98.6	53.5	9.2	0.1	7
Aug	23.3	1.0	97.2	59.2	9.0	0.1	7
Sep	38.1	2.4	96.8	62.9	9.4	0.1	7
Oct	46.2	2.1	100	56.0	9.6	0.1	5
Western Sector							
Jun	39.6	2.4	100	55.0	9.6	0.1	4
Jul	27.2	1.6	100	50.0	9.2	0.1	4
Aug	23.2	1.4	95.1	63.4	9.0	0.1	4
Sep	41.7	3.7	96.8	51.6	9.1	0.2	4
Oct	40.5	2.8	100	60.0	9.2	0.3	2
Eastern Sector							
Jun	33.5	1.8	96.7	60.0	9.1	0.1	3
Jul	23.9	1.3	96.8	58.1	9.1	0.1	3
Aug	23.5	1.2	100	53.3	9.1	0.1	3
Sep	34.5	3.1	96.8	74.2	9.7	0.1	3
Oct	50.1	2.7	100	53.3	9.8	0.1	3

“n” represents number of stations sampled. 10 individuals were sampled at each station.

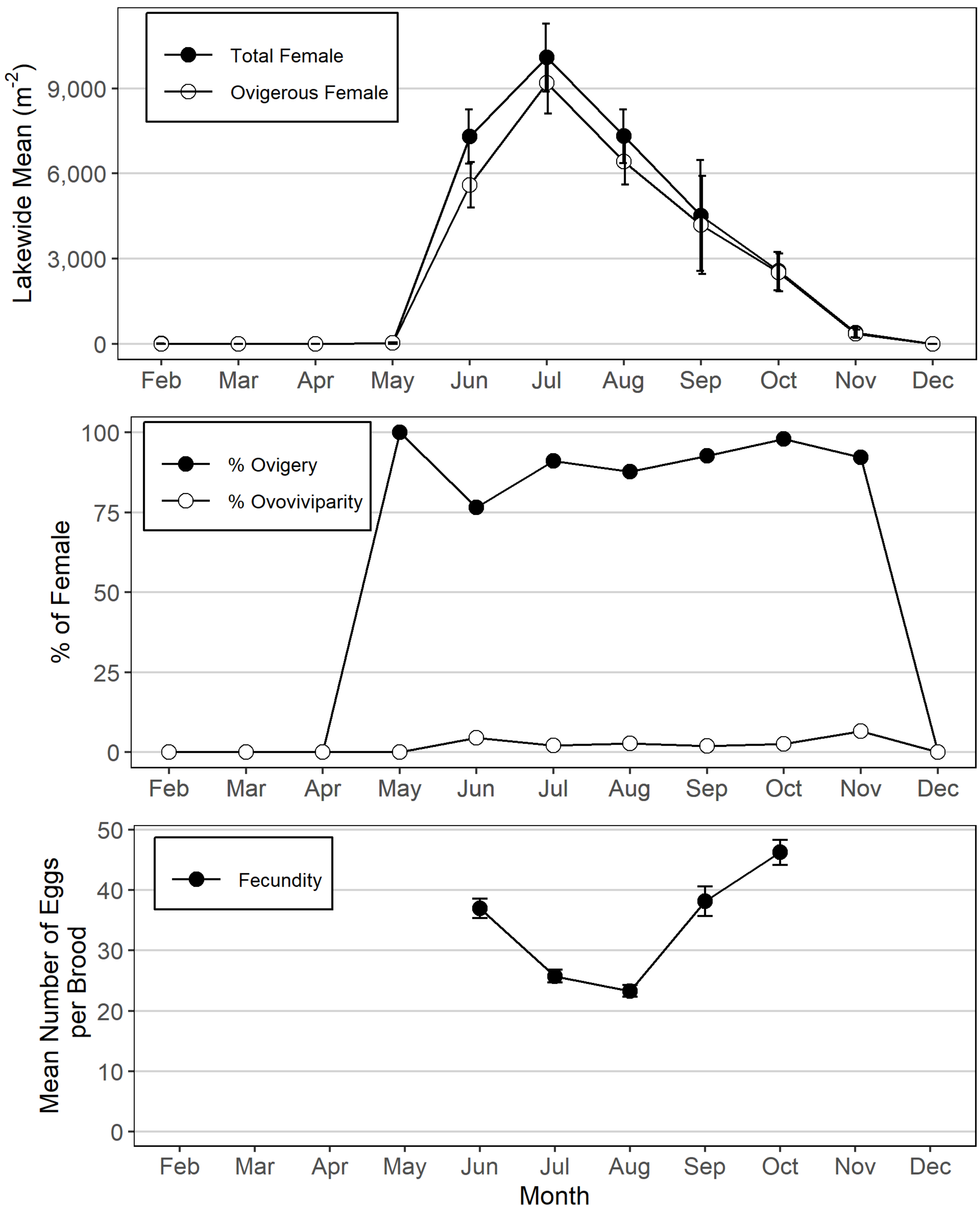

Figure 3-33. *Artemia* Reproductive Parameters and Fecundity between June and October in 2020

Artemia Population Statistics

The annual mean adult *Artemia* population decreased slightly from 13,541 m^{-2} in 2019 to 12,991 m^{-2} in 2020, and remained much lower than LTA of 18,518 m^{-2} (Table 3-18). The centroid decreased to 209 days (June 20th) from 221 days in 2019 but remained above 220 days since 2016, once again breaking the previously observed declining trend (Figure 3-34). The 2020 population peak was below the long-term average, and remained below the long-term average curve throughout 2020 (Figure 3-35).

In 2020, the peak monthly average adult abundance in June remained below LTA (Figure 3-36). The monthly averages in October and November were below LTA unlike the previous 3 years. The monthly average instar abundance peaked in April, and the 2020 peak was highest for April and the fifth highest monthly reading on record (Figure 3-37). A sharp decline in May instead of a continuously-elevated instars population might have contributed to a less broad adult population peak and also to the earlier centroid occurrence in 2020.

Table 3-18. Summary Statistics of Adult *Artemia* Abundance between May 1 and November 30

Year	Mean	Median	Peak	Centroid
1979	14,118	12,286	31,700	216
1980	14,643	10,202	40,420	236
1981	32,010	21,103	101,670	238
1982	36,643	31,457	105,245	252
1983	17,812	16,314	39,917	247
1984	17,001	19,261	40,204	212
1985	18,514	20,231	33,089	218
1986	14,667	17,305	32,977	190
1987	23,952	22,621	54,278	226
1988	27,639	25,505	71,630	207
1989	36,359	28,962	92,491	249
1990	20,005	16,775	34,930	230
1991	18,129	19,319	34,565	226
1992	19,019	19,595	34,648	215
1993	15,025	16,684	26,906	217
1994	16,602	18,816	29,408	212
1995	15,584	17,215	24,402	210
1996	17,734	17,842	34,616	216
1997	14,389	16,372	27,312	204
1998	19,429	21,235	33,968	226
1999	20,221	21,547	38,439	225
2000	10,550	9,080	22,384	210
2001	20,031	20,037	38,035	209
2002	11,569	9,955	25,533	200
2003	13,778	12,313	29,142	203
2004	32,044	36,909	75,466	180
2005	17,888	15,824	45,419	192
2006	21,518	20,316	55,748	186
2007	18,826	17,652	41,751	186
2008	11,823	12,524	27,606	189
2009	25,970	17,919	72,086	181
2010	14,921	7,447	46,237	191
2011	21,343	16,893	48,918	194
2012	16,324	11,302	53,813	179
2013	26,033	31,275	54,347	196
2014	13,467	7,602	42,298	194
2015	7,676	5,786	18,699	185
2016	10,687	10,347	18,498	220
2017	15,158	15,536	26,064	221
2018	12,120	12,024	21,836	216
2019	13,541	12,590	26,531	221
2020	12,991	13,427	24,353	209
Mean	18,518	17,319	42,323	210
Min	7,676	5,786	18,498	179
Max	36,643	36,909	105,245	252

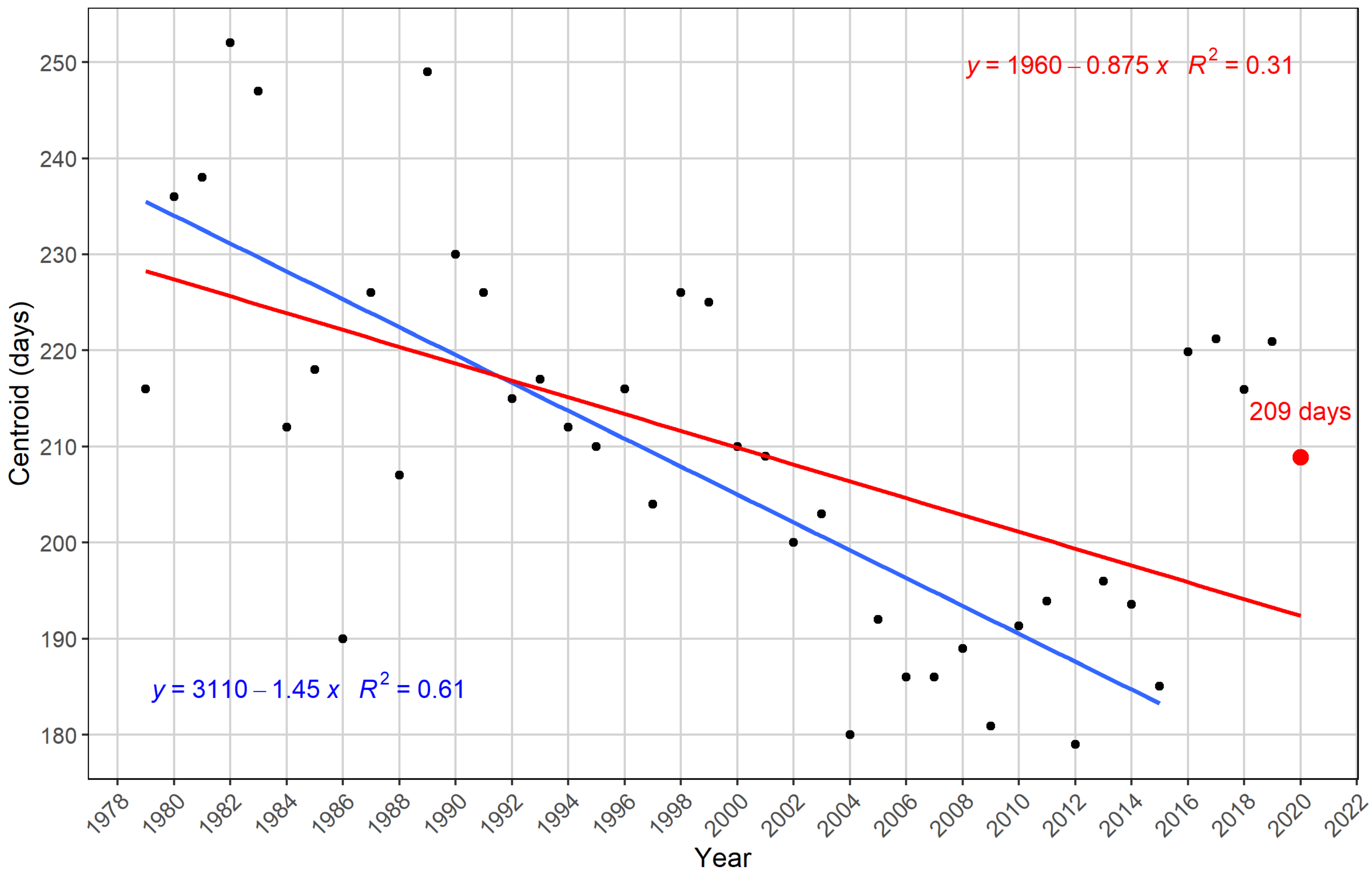

Figure 3-34. Adult *Artemia* Population Centroid

A red dot indicates a value in 2020. The blue line indicates the linear trend between 1979 and 2015 while the red line indicates the linear trend for all monitoring years.

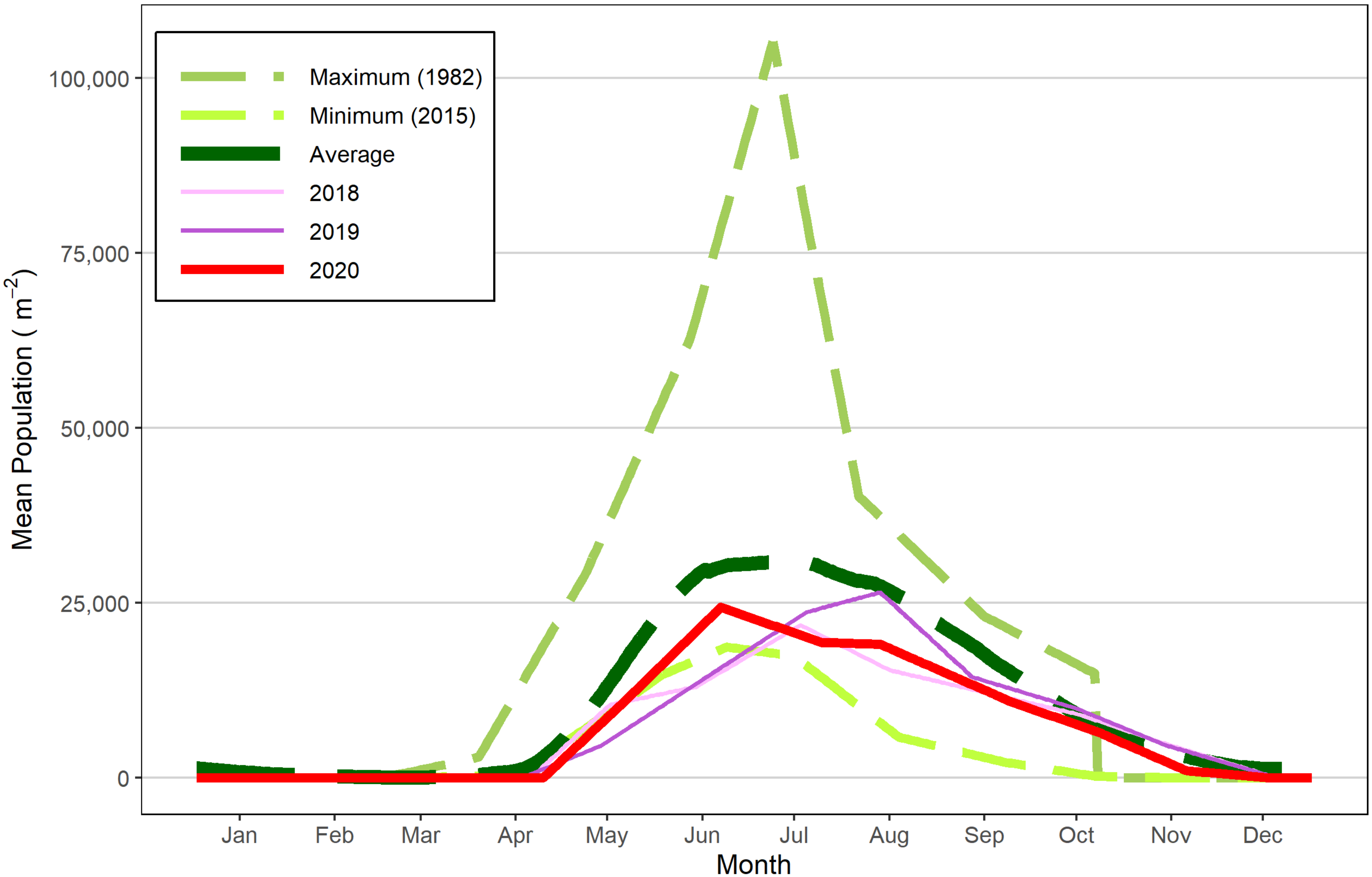

Figure 3-35. Mean lake-wide Adult *Artemia* Population (m^{-2}) since 1987

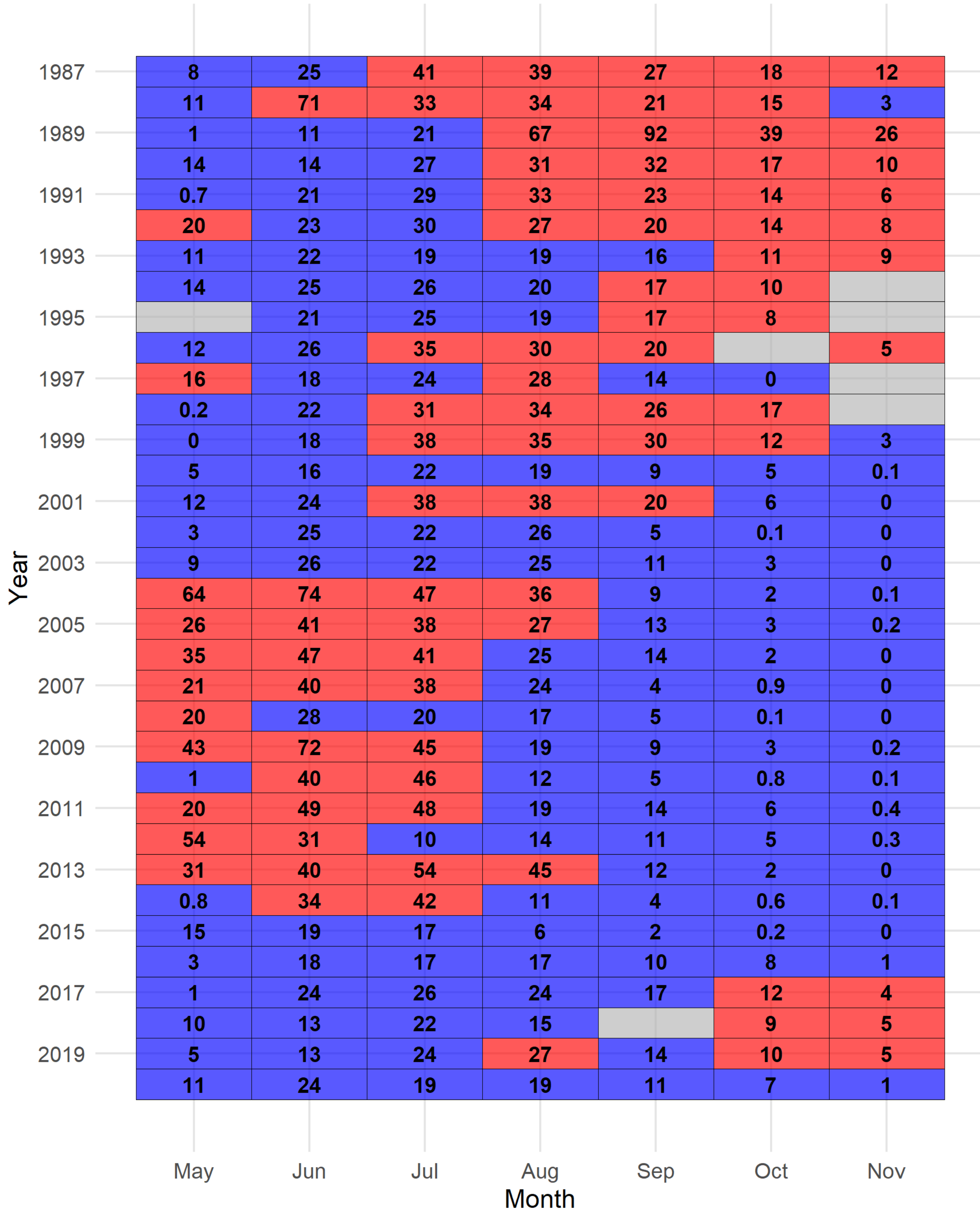

Figure 3-36. Monthly Average Adult *Artemia* Abundance of 12 Stations

Values are in m^{-2} divided by a thousand (e.g. 7.9 = 7,900). Red-colored cells indicate above the long-term average of the respective month while blue-colored cells indicate below the long-term average of the respective month.

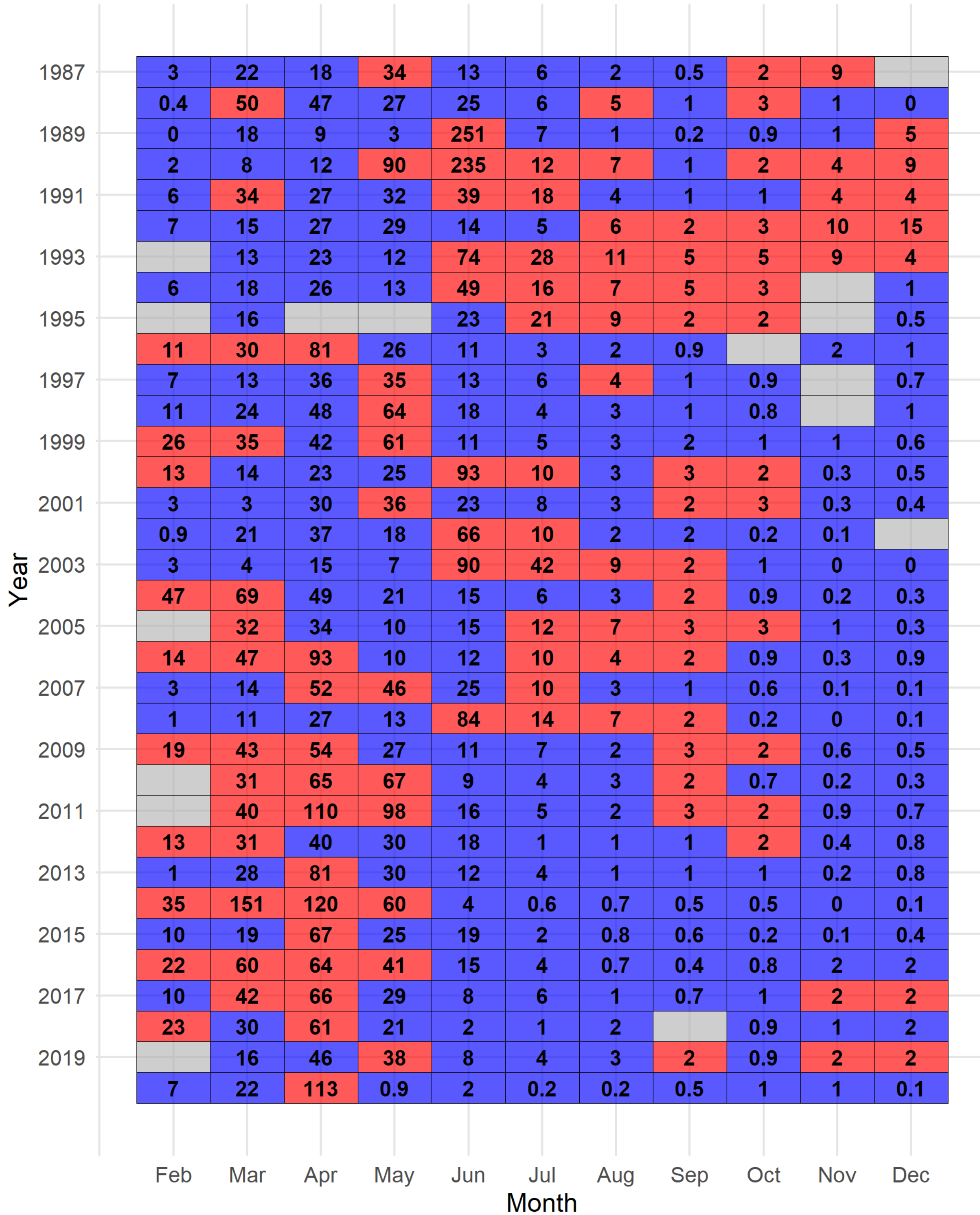

Figure 3-37. Monthly Average Instar *Artemia* Abundance of 12 Stations

Values are in m^{-2} divided by a thousand (e.g. 7.9 = 7,900). Red-colored cells indicate above the long-term average of the respective month while blue-colored cells indicate below the long-term average of the respective month.

Analysis of Long-Term Trends

Salinity and Mono Lake Elevation

The salinity of Mono Lake was closely associated with lake elevation across all monitoring stations, and relationships were much stronger for salinity measured at shallower depths (Table 3-19). The strongest correlation was found at Station 6 (r = -0.921, corresponding to a coefficient of determination (r^2) of 0.85). Further analysis revealed that this relationship had begun to shift in 2008 (Figure 3-38). The relationship was much stronger before 2008 (r^2 = 0.95) compared to r^2 = 0.7 since 2008. Variability is much higher and the slope steeper since 2008. The latter results in both higher and lower salinity values appear to correspond to lower lake levels. Increasing variability is more clearly demonstrated in Figure 3-39. Beginning in 2008 the annual range of salinity between 0 and 10 m has exceeded 5 g/L every year regardless of the lake mixing regime. In 2017, a range of salinity exceeded 15 g/L at all stations. At Station 6 salinity started at 96.6 g/L in February reaching the lowest level in September at 80.9 g/L, resulting in an annual range of 15.7 g/L. The annual range in 2020 was 6.94 g/L., lowest since 2011, most likely due to complete turnover.

Table 3-19. Relationships between Salinity and Lake Elevation for 3 Different Depth Classes

	Depth		
Station	1 to 10m	11 to 20m	21to38m
2	-0.92	-0.86	-
3	-0.88	-0.85	-
4	-0.89	-0.85	-0.60
5	-0.87	-0.85	-
6	-0.92	-0.85	-0.62
7	-0.92	-0.85	-
8	-0.87	-0.80	-
10	-0.86	-0.81	-
12	-0.85	-0.84	-0.62

Monthly average lake elevations were used. Stations 1 and 9 were not included due to a lack of long-term data, and Station 11 was not included because of its shallow depth.

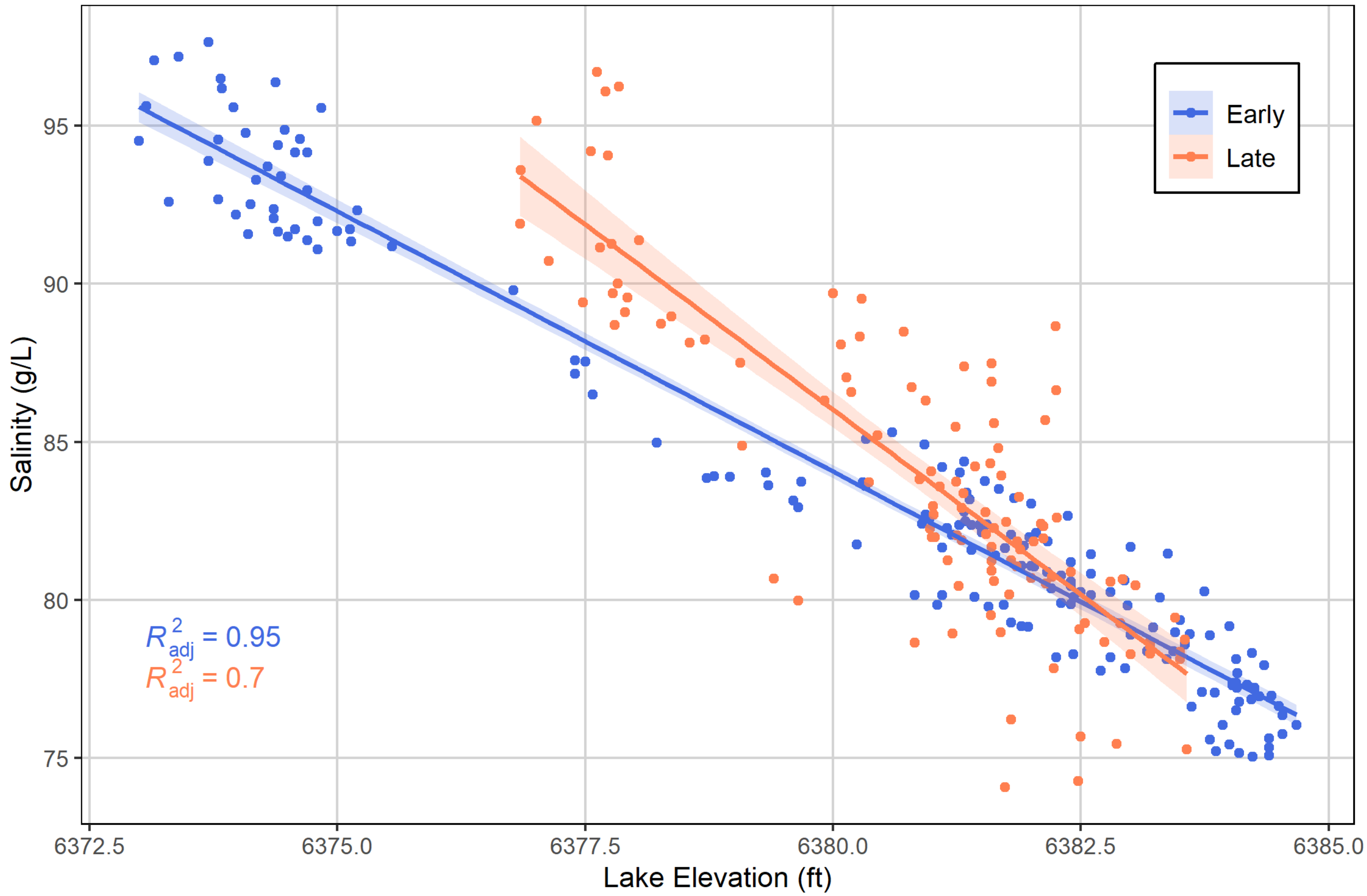

Figure 3-38. Difference in Slopes between Two Periods of Monitoring Years: Earlier (1991-2007) and Later (2008-2020) based on Salinity (g/L) Measured between 1 and 10 m of Depth at Station 6

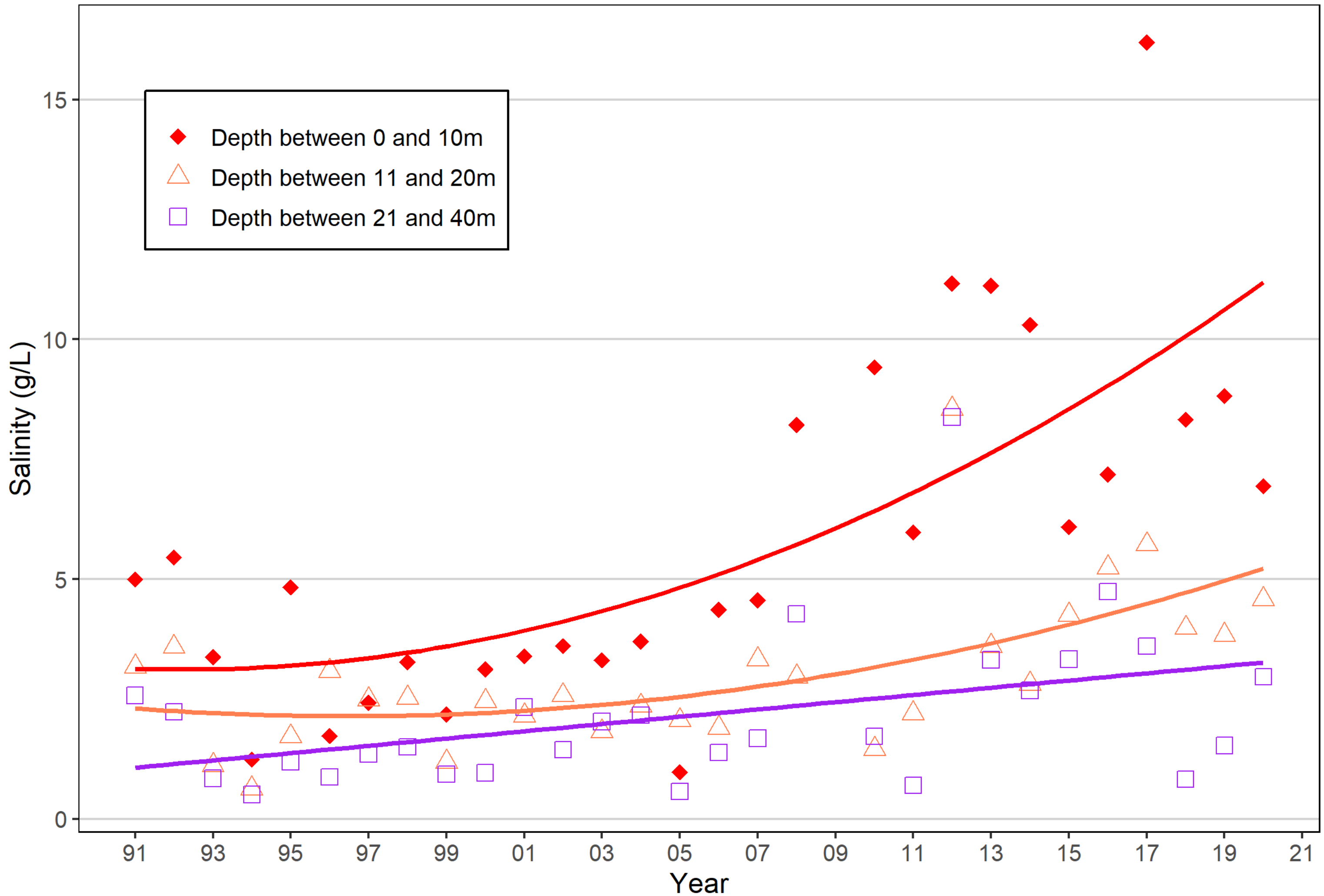

Figure 3-39. Inter-Annual Range of Monthly Salinity Readings (g/L) at Station 6

<u>*Artemia* Population Peak</u>

Post meromictic *Artemia* population peaks have been recorded in 1989, 2004, 2009, and 2013. It is likely for another peak to occur in 2022 as the meromixis, which initiated in 2017, ended in 2020. *Artemia* abundance and ammonium accumulation during each meromictic event are summarized in Table 3-20. The lake-wide mean *Artemia* populations have shown peaks in 1989, 2004, 2009, and 2013, followed by subsequent declining numbers, with an average decline of approximately 500 m^{-2} per year. According to this relationship, the *Artemia* population would be approximately 22,860 m^{-2} in 2021. This predicted peak would be indistinguishable from other monomictic years, which have ranged from 7,676 m^{-2} to 27,639 m^{-2}.

Ammonium (NH4)

Ammonium levels recorded at the two deepest monitoring depths (28 and 35 m) show trends similar to *Artemia* population peaks. Peak monthly accumulation of ammonium prior to the post meromictic *Artemia* population peak during the second meromixis was 1,131 µM in August 2001 with the average rate of accumulation being 124 µM/year (Table 3-20, Figure 3-40). For successive peaks, ammonium accumulation dropped to 107 µM in 2007 and 105 µM in 2011. The lowered *Artemia* population peaks during the same period indicates the importance of nutrient build-up. Nutrient buildup appears to be proportional to the duration of meromixis. The other factor affecting ammonium accumulation is an initial depth of a chemocline. Jellison reported that the deep chemocline resulted in mixing at 23 to 24 m of depth allowing upward fluxes of ammonia in early 2006, resulting disruption of continuous ammonia accumulation and a lower peak than what could have occurred if ammonium were allowed accumulate continuously for three years (LADWP 2006). The maximum accumulation during the most recent meromixis (2017-2020) was 149 µM. This value is almost one magnitude smaller than the peak during the second meromixis, but higher than the peak accumulation during the previous two meromictic events.

When meromixis breaks down, accumulated ammonium become available throughout the water column. A nutrient boost above 10 m of depth was apparent in 2004 but only slightly in 2009 and 2013 (Figure 3-41). Fluctuation in ammonium availability above 10 m, however, does not follow the clear pattern of hypolimnetic ammonium accumulation as more ammonium was available in 2016 (14.1 µM in February) than in 2009 and 2013. The year 2016 was a monomictic year which did not immediately follow a meromixis event; thus, elevated epilimnetic ammonium was not expected. Lower epilimnetic ammonium availability during the third and fourth meromixis may explain reduced post-meromictic *Artemia* peaks. In December 2020 the epilimnetic ammonium level was 13.0 µM, lower than the 2016 February level. The

Artemia peak after this most recent meromixis may be comparable or slightly higher than ones observed in 2009 and 2013, but much lower than the 2004 peak.

Table 3-20. *Artemia* Population Summary during Meromixis and Monomixis

		Peak				
Meromixis	Duration	Year	Artemia abundance (m^{-3})	Average *Artemia* between peaks (m^{-3})	Reduction following a peak	NH_4 accumulation during meromixis (µM)*
1983-1987	5	1989	36,359		45%	NA
				16,576		
1995-2002	8	2004	32,044		44%	1,131
				17,514		
2005-2007	3	2009	25,970		43%	107
				17,529		
2011	1	2013	26,033		48%	105
				12,108		
2017-2020	4					149
Average			30,102	15,828	45%	

* Maximum monthly NH_4 reading during a meromictic event recorded at depths of 28 and 35m at Station 6.

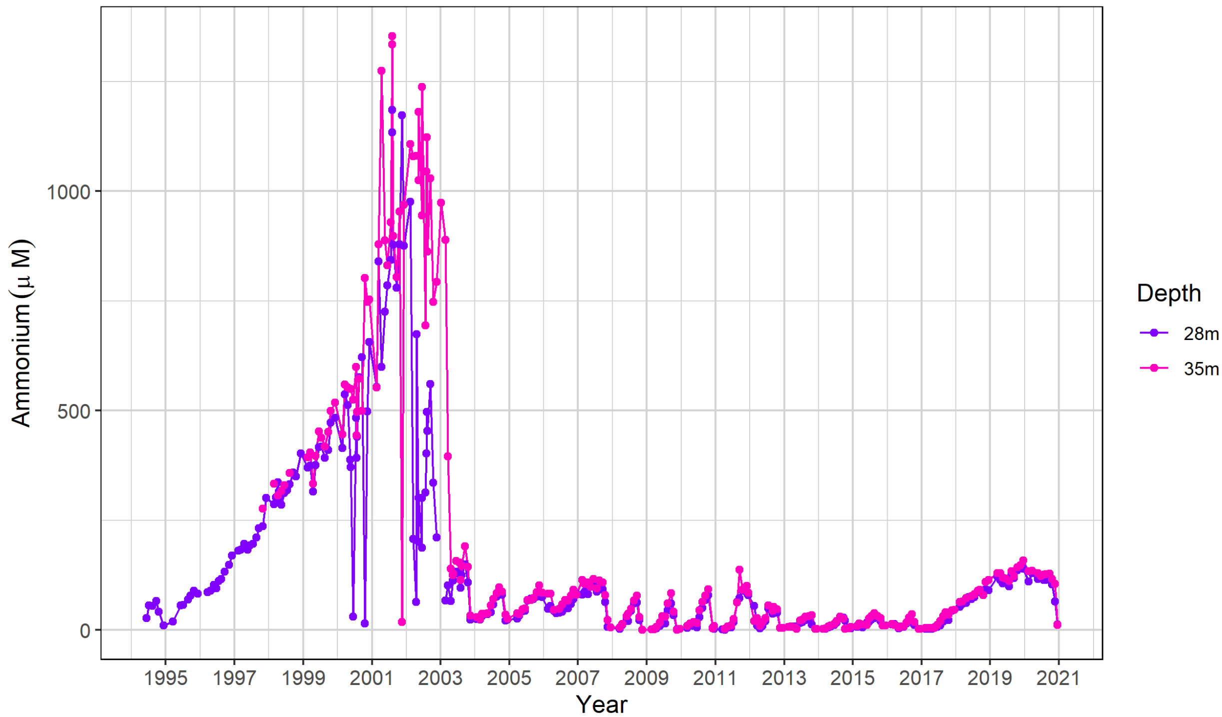

Figure 3-40. Ammonium Accumulation at 28 and 35 m of Depths at Station 6

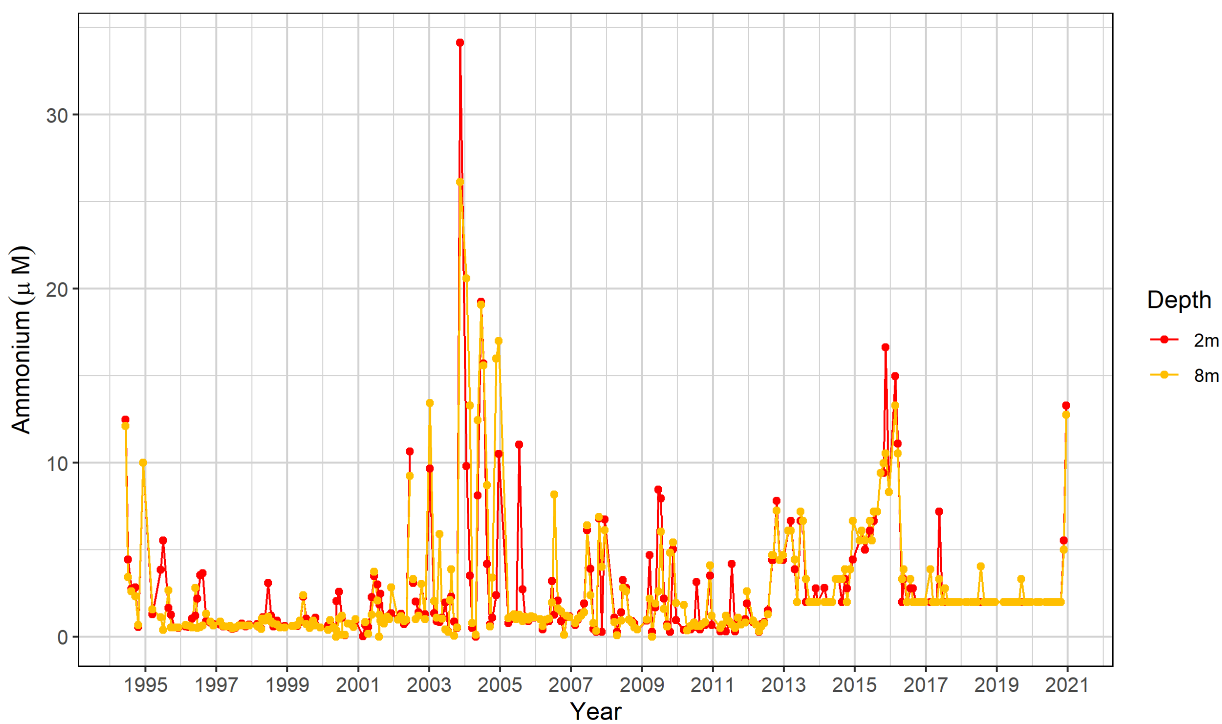

Figure 3-41. Ammonium Accumulation at 2 and 8 m of Depths at Station 6

Salinity

With a large influx of freshwater, epilimnetic salinity declines. During the second meromixis, the salinity gradient slowly developed with the onset of meromixis peaking at 16.2 g/L in August 1998 and disappearing in 2003, a year before the *Artemia* population peak (Figure 3-42). During the third meromixis (2005-2007), however, the salinity gradient did not continuously grow. The salinity gradient weakened at the end of 2005 and re-established in 2006 due to a deeper chemocline, resulting in a much weaker chemocline at the end of meromixis in 2007. The meromixis in 2011 failed to create a salinity gradient distinguishable from monomictic years, and the peak gradient only reached 8.3 g/L, and quickly disappeared. During the latest meromixis (2017-2020), the gradient was near 0 g/L at the beginning of 2017 due to complete turnover at the end of 2016. Mono Lake quickly stratified reaching the maximum gradient of 22.9 g/L in September thanks to the second largest inflow of freshwater on record. The gradient in 2018 and 2019 exceeded 15 g/L annually, but dropped below 7 g/L during winter months. In 2020, the peak range exceeded 10 g/L, but the gradient decreased to 3.5 g/L by December. Consequently, the gradient shows a saw-tooth like pattern instead of a broader continuous pattern observed during the second meromixis.

What has caused different salinity gradient patterns among meromictic events? Between 1995 and 2005, starting salinity levels were very different (Figure 3-20, Figure 3-21). In March 1995, epilimnetic and hypolimnetic salinity readings were 91.3 g/L and 93.3 g/L, respectively, while same readings in March 2005 were 81.7 g/L and 82.9 g/L. It is highly plausible that lower salinity at the beginning of meromixis has led to weaker and less continuous salinity gradient even though the average lake input between 2005 and 2006 was higher than the average between 1995 and 1999 (156,000 acre-feet compared to 144,000 acre-feet). Slightly lower initial epilimnetic and hypolimnetic salinity levels were found in 2011, 81.1 g/L and 81.0 g/L, respectively, than in 2005. Contrary to the third and fourth meromictic event, initial salinity levels in 2017 were much higher than even the 1995 levels (96.2 g/L and 97 g/L in epilimnion and hypolimnion, respectively), resulting in stronger chemocline during the latest meromixis than the previous two events. Almost record-breaking runoff helped to develop this strong chemocline. Preceding salinity levels are very important to explain varying strength of chemocline.

A large influx of freshwater is a requisite for meromixis; however, higher initial salinity levels are also essential for strong salinity gradient. The second and most recent meromictic events started at very high salinity level and the salinity gradients developed very differently. The gradient slowly but continuously developed during the second meromixis while the gradient developed suddenly in 2017 and started to decline afterward. As mentioned previously, the salinity gradient throughout the water column has been not only increasing but also following a sawtooth pattern since 2008 regardless of the lake mixing regime, and the meromixis between 2017 and 2020 was no exception. It is not clear if the temporal variability of the salinity gradient has any effect on ammonium accumulation or *Artemia* population abundance.

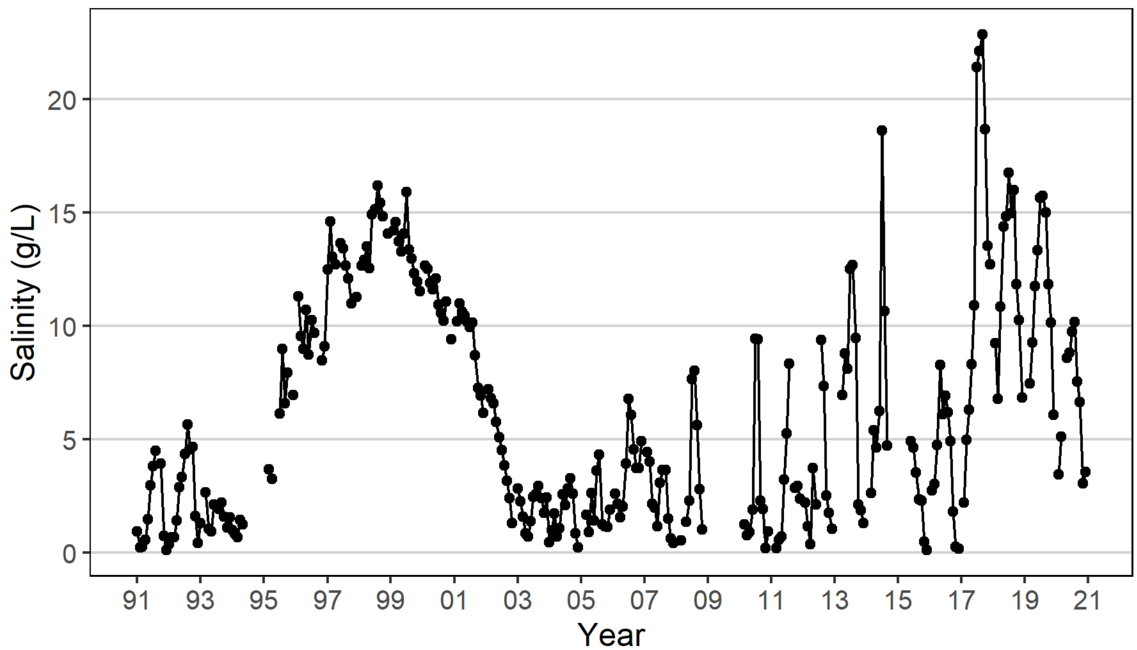

Figure 3-42. A Range of Salinity through Water Column at Station 6

A Temporal Shift in Monthly Artemia Abundance

Figure 3-36 and Figure 3-37 demonstrate a temporal shift in monthly *Artemia* abundance for adults and instars. Figure 3-36 can be broken down into four distinct periods: 1) between 1987 and 1994 (the period representing the end of the first recorded meromixis between 1983 and 1987, the breakdown of meromixis between 1988 and 1989, and after the breakdown), 2) between 1995 and 2003 (the period representing the second recorded meromixis between 1995 and 2002 and the first year of the breakdown in 2003), 3) 2004 to 2016 (mostly monomictic state with two short periods of meromixis), 4) 2017 to present (the most recent meromixis). The last period, however, may have ended in 2019 as the adult monthly peak shifted earlier to June in 2020 instead of July or August. Instar monthly abundance follows the pattern observed for adult (Figure 3-37) except the above average monthly instar abundance was still occurring between February and May during the fourth period. The 2020 monthly instar peak was observed in April.

These two trends are more clearly demonstrated in Figure 3-43 and Figure 3-44. Adult population abundance between May to July (summer) and August to November (fall) were similar throughout the 1990s and started to diverge greatly after 2003, but started to converge again in 2016. Convergence is mainly due to decline of earlier abundance rather than increase of later abundance. Instar population, on the other hand, maintains the divergence as the early months average (between February and May) continue to rise while the later month averages (between June and December) continue to fall. After 2008, instar abundance during later months has been considerably lower than that of the earlier months. These two trends indicate absence or much smaller second or/and third generations.

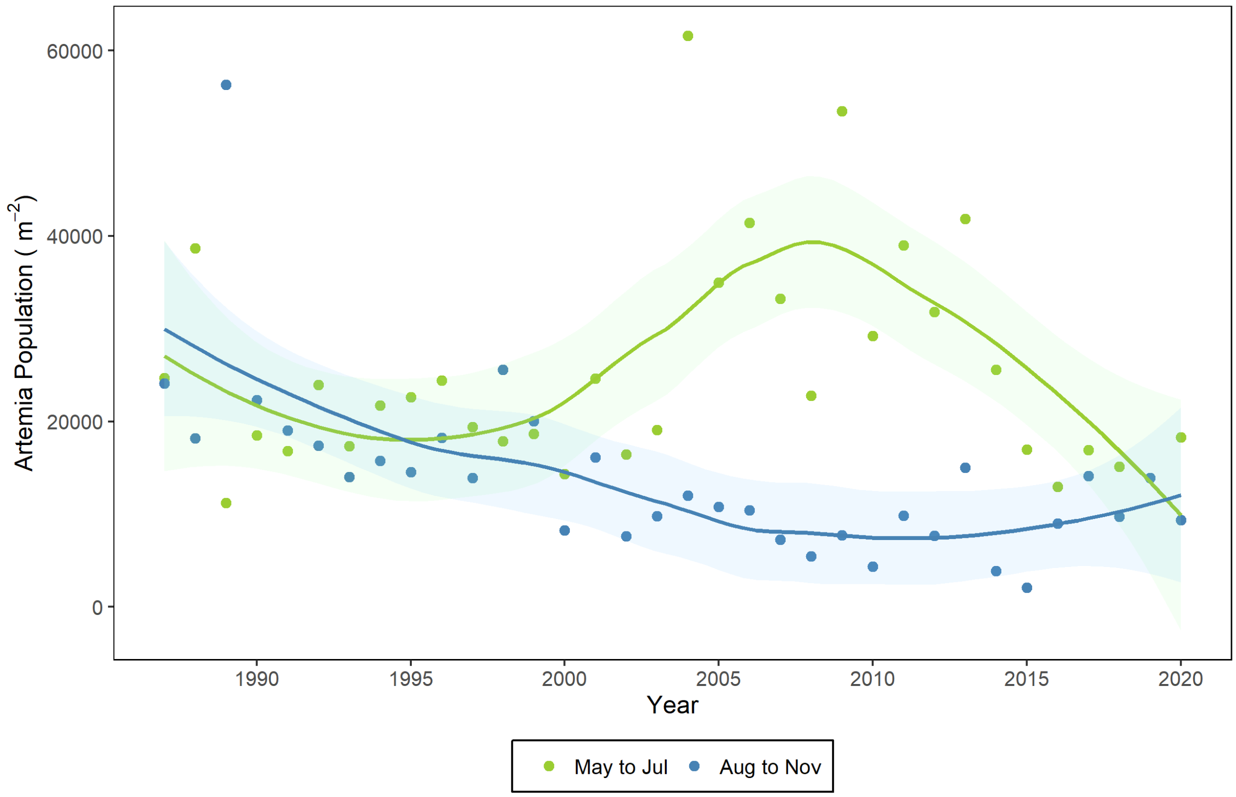

Figure 3-43. Comparison of Mean Lake-wide Adult *Artemia* Population (per m^2) between Earlier and Later Months

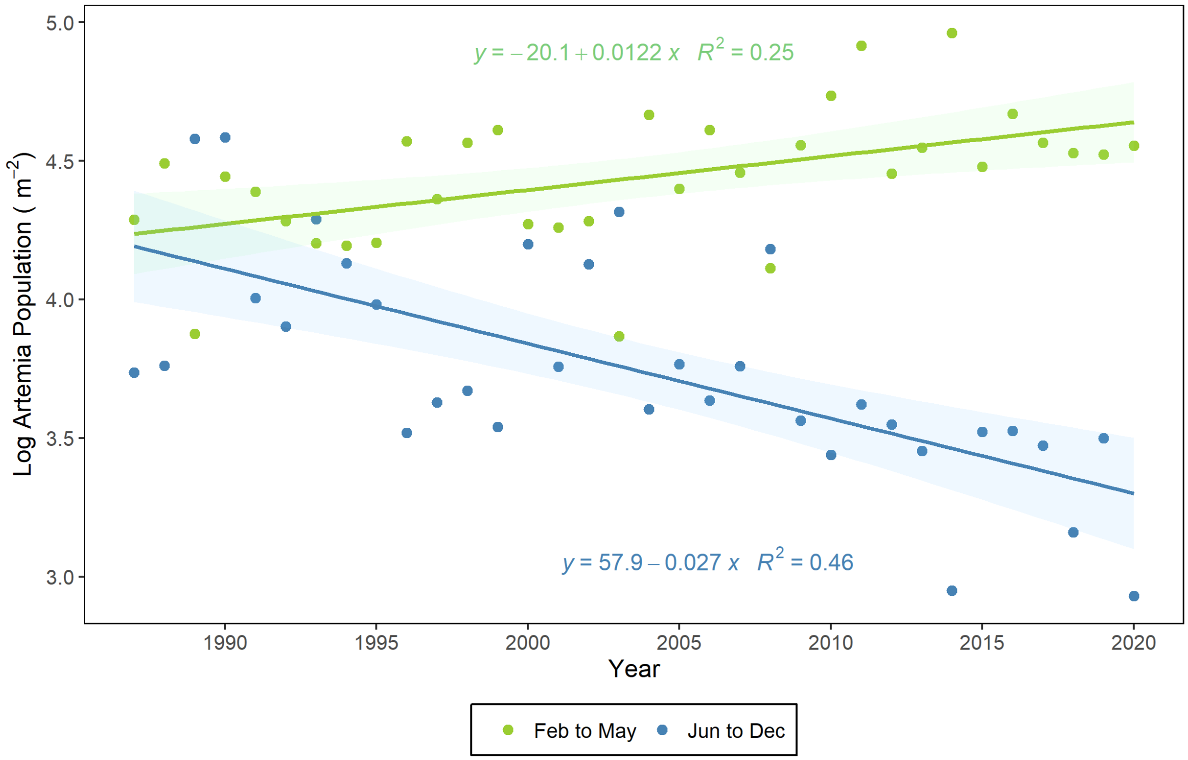

Figure 3-44. Comparison of Mean Lake-wide Instar *Artemia* Population (per m²) between Earlier and Later Months

Chlorophyll a

Increasing food abundance in earlier months (spring to early summer) could facilitate higher growth rates of *Artemia*. Annual fluctuations of chlorophyll *a* during spring months show a positive trend at deeper depths throughout the year and at shallower depths in late spring to summer (Figure 3-29, Figure 3-31, and Figure 3-45). The positive trend has been reversed during the last three years as a fluctuation of chlorophyll *a* levels shows a cyclic pattern following the lake stratification regime as lower chlorophyll levels are found during meromictic years while higher levels are found during monomictic years. Data prior to 1995 are not available for the analysis; thus, it is not possible to assess whether a positive trend has existed including data prior to 1995. Chlorophyll levels should have been higher during the monomixis in the early 90's; and this coincided with earlier monthly population peaks between 1992 and 1995. The positive trend, therefore, may be the artifact of duration of the data; however, increasing trends of chlorophyll *a* in spring until 2017 coincide with earlier peaks of *Artemia* population.

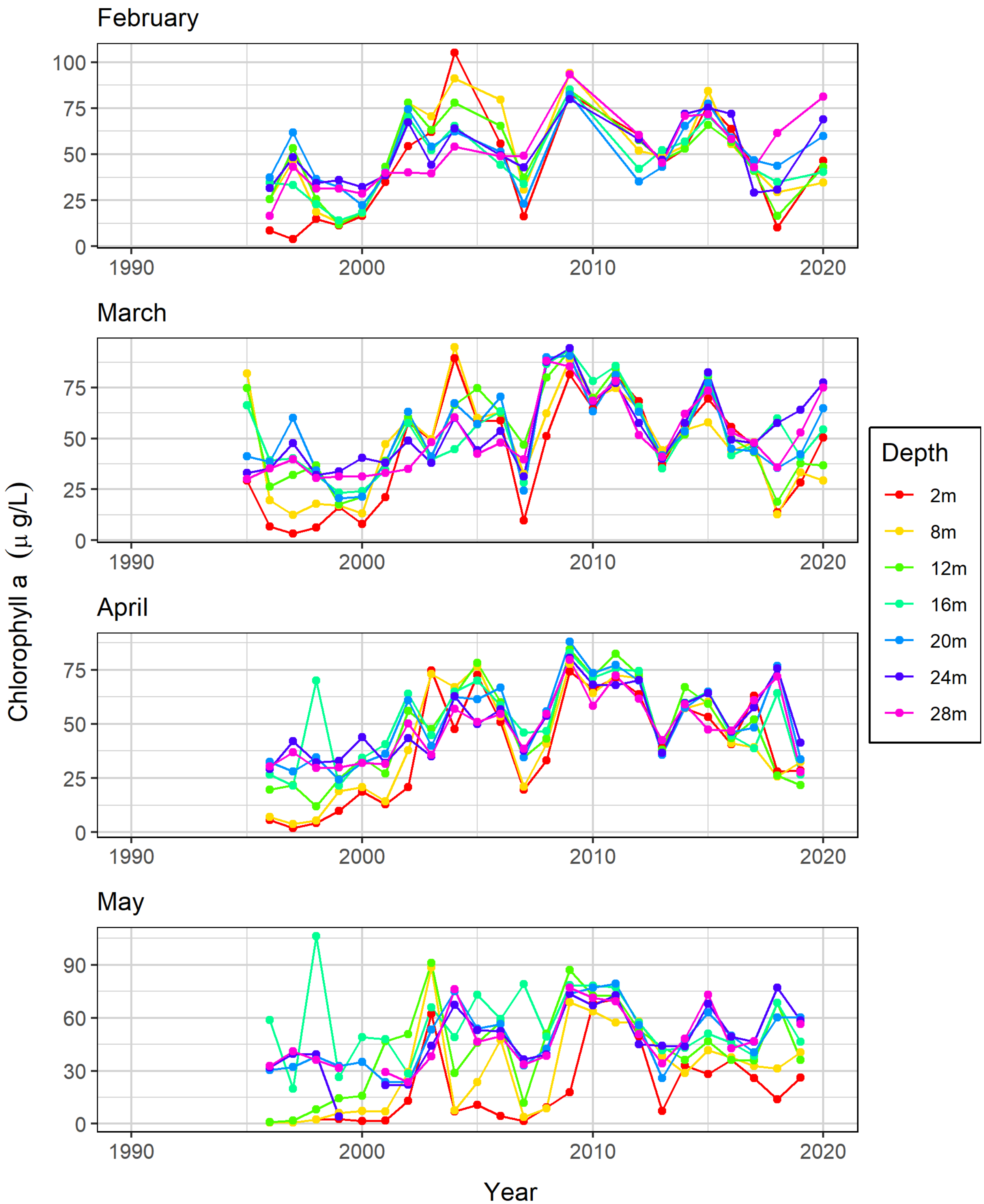

Figure 3-45. Chlorophyll *a* Level over Time at All Depths at Station 6 between February and May

Water Temperature

Following an obligate period of dormancy, warmer water temperatures during spring hatch periods are found to lead to shorter hatching times (Dana et al. 1988). Hypolimnetic water temperature remains relatively high during meromixis, reducing convection across the chemocline, and resulting in relatively warm and stable water temperature conditions in the hypolimnion. High intra-annual variability in water temperature due to complete turnover during monomictic years obscures a long-term trend; however, the stable water temperature during meromixis provides an inference into a temporal trend. Hypolimnetic water temperature during the latest meromixis (2017-2020) was higher by approximately 0.6°C than the second meromixis (1995-2002) (Figure 3-46). The long-term trend, however, became more evident when seasonally summarized data were used especially for summer months (Figure 3-47). Winter and spring hypolimnetic water temperature is highly influenced by the annual and long-term mixing regime; however, there is an increasing trend in water temperature after 2008. Summer hypolimnetic water temperature shows a much stronger positive linear trend for the entire period. Between 1 and 10 m of depth, however, a trend for summer months is reversed while winter and spring months show no trend (Figure 3-48). In the hypolimnion, water temperature appears to be rising especially after the second meromixis meanwhile water temperature in the epilimnion shows a falling trend in summer. Rising hypolimnion water temperature favors earlier *Artemia* instar monthly peaks, but lower epilimnetic water temperature may slow adult development over summer, resulting in much smaller second or third generations.

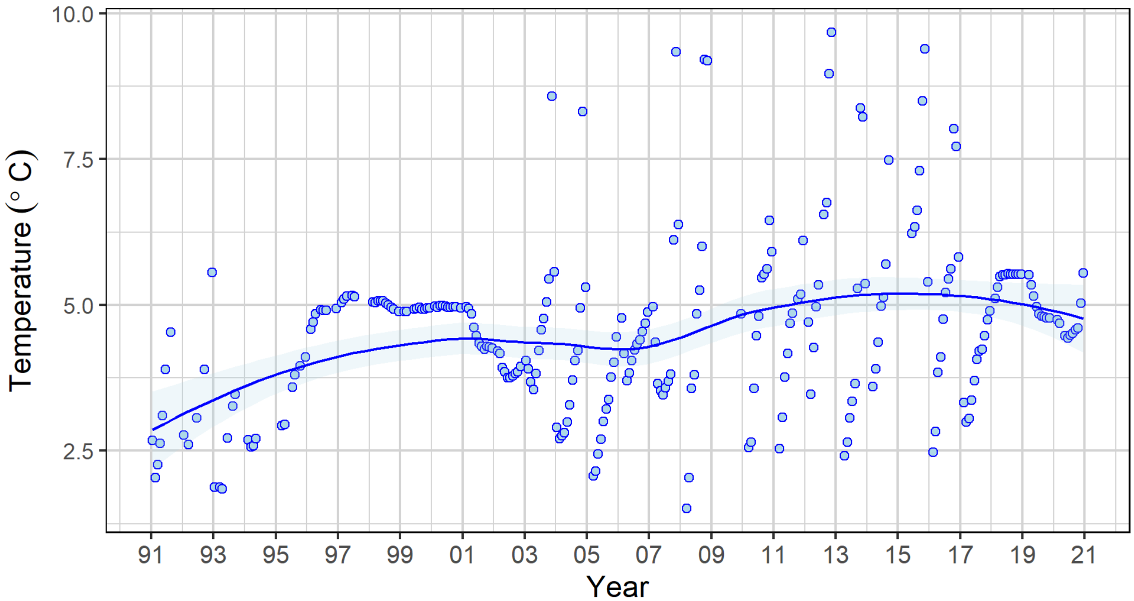

Figure 3-46. Average Water Temperature between 30 and 40 m of Depths at Station 6

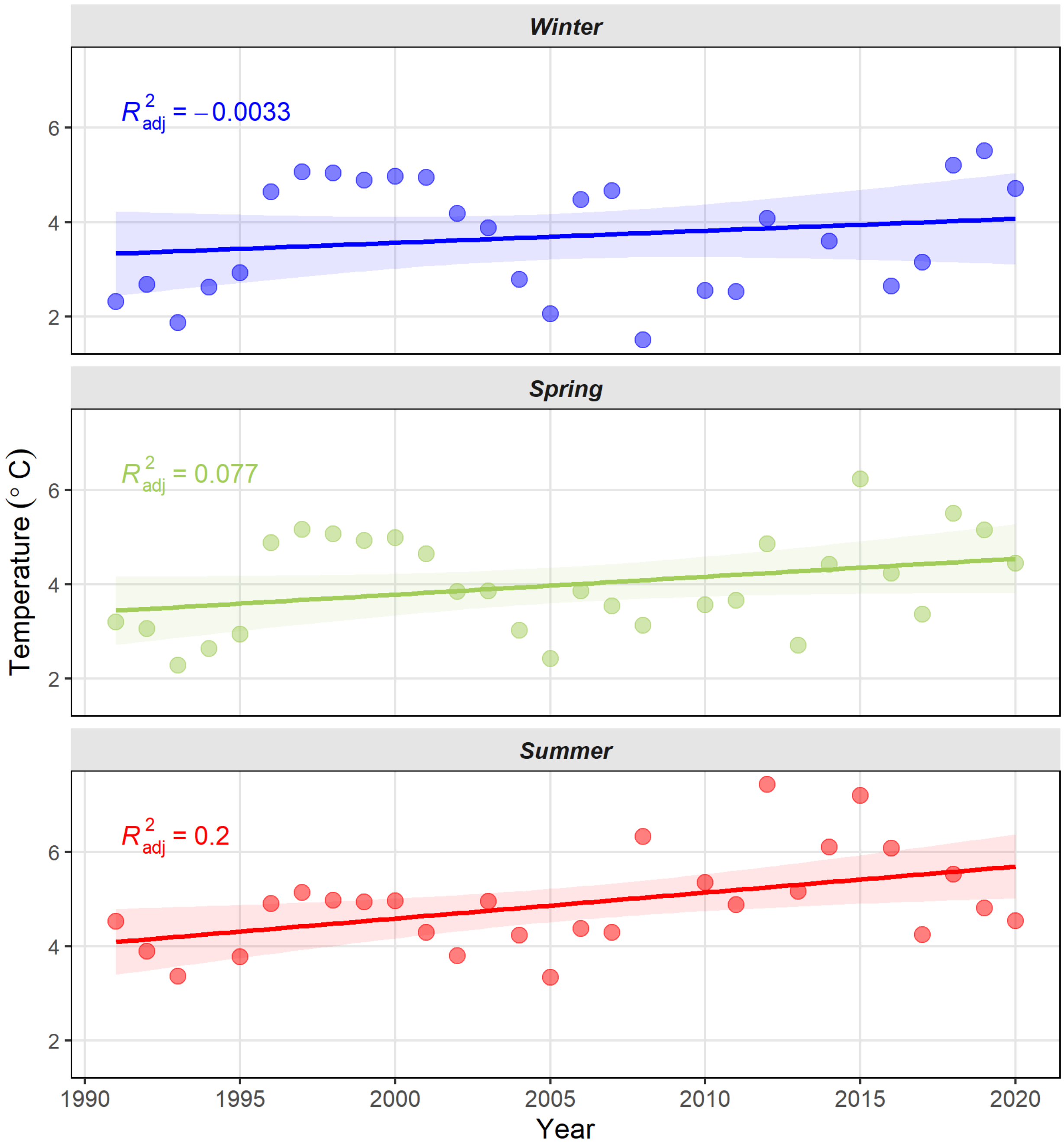

Figure 3-47. Average Water Temperature between 30 and 40 m of Depth during Winter (January to March), Spring (April to June), and Summer (July to October) Months at Station 6

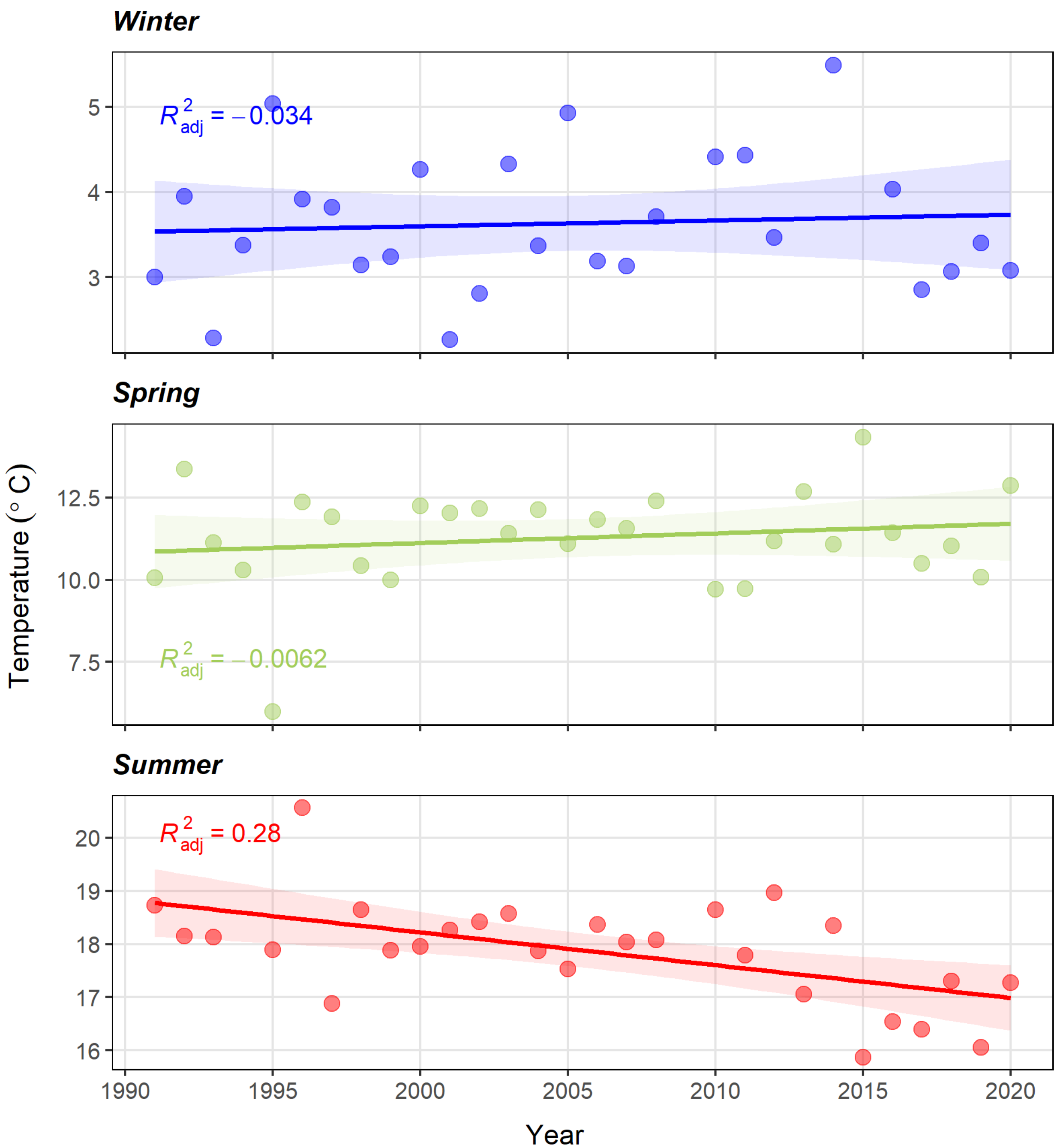

Figure 3-48. Average Water Temperature between 1 and 10 m of Depth during Winter (January to March), Spring (April to June), and Summer (July to October) Months at Station 6

3.2.4 Limnology Discussion

2020 Condition

The 2020 monitoring year marked the end of the most recent meromictic event that had started in 2017. The weakening chemocline finally broke, and as a result, ammonium which had accumulated in the hypolimnion was released to the epilimnion as the Mono Lake completely turned over at the end of 2020. The *Artemia* population decreased slightly from 13,541 m^{-2} in 2019 to 12,991 m^{-2} in 2020 and remained below the long-term average of 18,518 m^{-2}.

Since the first recorded meromixis in 1986, *Artemia* populations have shown an approximate 45% decline the year following post meromictic population peaks. Between 2013 and 2014 the abundance dropped from 26,033 m^{-2} to 13,467 m^{-2} (48%); thus, the 2020 abundance of 12,991 m^{-2} falls within the range of non-peak year mean based on the 2013 peak. The five-year drought also helped to suppress the *Artemia* population. Clarity of the lake continued to degrade in 2020 and remained below 1 m throughout the year for the first time since 2016. The centroid remained above 210 days for the fifth year in row. Peak monthly instar and adult *Artemia* population abundance occurred in April and June, respectively, following the trend of earlier occurrence of population peaks. Chlorophyll *a* levels were higher than normal for most of the year in both epilimnion and hypolimnion. The ammonium level at the deepest monitored depth (35m) decreased from 136.6 µM in February 2020 to 11.1 µM in December as Mono Lake completely turned over to release hypolimnetic ammonium to epilimnion. Epilimnetic ammonium increased from the minimum detectable level to 13 µM in December. Hypolimnetic water temperature during spring months was approximately 4°C in 2020, slightly higher than during the second meromixis. Warmer hypolimnetic water temperature in spring may have favored earlier instar peak in 2020, and the adult peak followed in June.

Long-Term Trend

There has been a clear temporal shift in peak abundance of *Artemia* instars and adults, which are reflected on a strong linear negative trend of centroid days with respect to monitoring years up to 2015. Elevated centroid days since 2015 could be attributable lower abundance of the *Artemia* adult population. During this period, the *Artemia* adult population averaged 12,029 m^{-2}, the lowest 6-year average on record. Further, annual population peak was smaller and broader. Under these scenarios even slight increases in later months could pull centroid days toward a later date.

A temporal shift for adult monthly population is also evident. Adult population was very similar between earlier (May to July) and later (August to November) months prior to and during the second meromixis (1995-2002) and started to diverge after the meromixis. The later month averages decreased up to around 2008 and plateaued while earlier month averages diverged and peaked around 2009 before converging to the later month averages in 2015 in midst of the drought. *Artemia* adult population suffered a major decline during the drought recording the lowest mean value on record at 7,767 m^{-2} in 2015 and remained suppressed since then. A decline of later month averages is more or less steady over time, and stabilized after the population peak in 2004 following the second meromixis (1995-2002). Later month abundance is mostly driven by the second or/and third generations, and lower adult population abundance between August and November indicates smaller second and third generations since 2004.

There has been a steady decline of later month instar averages over time meanwhile earlier month instar averages has been increasing slowly over time. At the very bottom of the lake (>30m) water temperature appears to be rising, which may facilitate earlier hatching meanwhile at the shallower depth (<10m) water temperature appears to be falling in summer, which could slow down the growth. Salinity, on the other hand, does not show any linear changes over time as salinity levels tend to follow the lake mixing regime. It is somewhat puzzling, however, that salinity levels in recent years, especially since 2015, are not as high as levels seen in the early 1990s; yet both adult and instar *Artemia* populations abundance has been smaller than the early 1990s. As mentioned previously the drought between 2012 and 2016 appeared to affect *Artemia* population even though water temperature and salinity did not drastically change during the drought.

Future Condition

Future limnological condition of Mono Lake will largely depend on future runoff conditions. A lack of prolonged meromixis leads to smaller *Artemia* peaks and lower abundance during subsequent monomixis. Since the end of the second meromixis (1995-2002), the longest duration of wet periods has been two years (2005 to 2006) which resulted in three years of meromixis. The most recent meromixis (2017 to 2020) developed due to the second highest runoff in Mono Basin on record. The sudden and large influx of freshwater combined with high preceding salinity resulted in the shallower and stronger chemocline, which, in turn, enabled continuous accumulation of hypolimnetic ammonium. In contrast, the chemocline developed at much deeper depths between 2005 and 2007, allowing upward movement of nutrients earlier, which in turn, prevented continuous accumulation of ammonium. The ammonium accumulation level between 2017 and 2020 was higher than that between 2005 and 2007, but fell far short of the level observed between 1995 and 2002. An *Artemia* population peak (which would mostly likely to occur in 2021) should be lower than the one observed in 2003 but higher than the ones observed in 2008 and 2013.

As a terminal lake, it is inevitable for salinity to increase over time. Prolonged wet periods have been able to arrest this inevitability, but only temporarily. Mono Lake is saltier now than at equivalent lake levels between 1990s and 2010s. At 6,377 feet, salinity was 96.6 g/L in 2017 while at equivalent lake elevation salinity was 85.1 g/L in August 1995. It is not clear what is causing this shift in the salinity-lake level relationship; but lake level could further drop with drier and warmer climate forecasted for much of California in future (Ficklin et al. 2013). *Artemia* population appears to be able to survive and thrive in the salinity levels during monitoring years. However, further decline in the lake level could result in much higher salinity, which could approach the tolerance level (Dana and Lenz 1986). Salinity affects survival, growth, reproduction, and cyst hatching of *Artemia* (Starrett and Perry 1985, Dana and Lenz 1986).

The *Artemia* population declined to the lowest abundance on record in 2015 in response to the driest year on record; however, it has rebounded since then, showing the resiliency of the *Artemia* population in Mono Lake. Historically the *Artemia* population also has demonstrated resiliency. The *Artemia* population has rebounded in spite of the lake level declining to the lowest level of the past century at 6,371.6 feet in December 1981, due to increased inputs as a result of Decision 1631 and some wet years. The *Artemia* population responded positively to a large influx of freshwater in 2017 by increasing from 7,676 m^{-2} in 2015 to 15,158 m^{-2} in 2017. Higher inputs helped the *Artemia* population to rebound in 2017, but an exceeding probability of such an event is 2% and an exceeding probability of such an event occurring in two or more years consecutively is even smaller. Opportunity of the *Artemia* population recovery, prolonged meromixis, and a large reduction in salinity may become scarcer in the future.

The *Artemia* population is strongly influenced by strength and duration of meromixis. Lower salinity certainly will result in a weaker salinity gradient or chemocline, such that Mono Lake could become holomictic much more easily than the current state. Without a strong and long-lasting chemocline, ammonium accumulation would be lower, which would result in a lower *Artemia* population peak. A higher Mono Lake elevation, therefore, may have very limited impact on the lake's *Artemia* population; however, lower salinity associated with a higher Mono Lake level could lead to "*invasions by predators or competitors of the brine shrimp, which could reduce productivity of the brine shrimp population*" (Jones and Stokes Associates, 1994). At the same time more diverse invertebrate fauna could lead to increased food sources for shorebird and waterfowl populations.

3.3 Vegetation Status in Lake-Fringing Wetlands

3.3.1 Lake-fringing Wetland Monitoring Methodologies

The shoreline configuration of Mono Lake is dynamic, with seasonal and annual changes in lake level, shoreline exposure, pond presence and other features important to waterfowl. Due to the dynamic nature of the Mono Lake shoreline, the aerial or satellite imagery studies and subsequent mapping performed at five-year intervals do not adequately capture annual changes that may influence waterfowl use. In order to document annual changes, aerial photographs are taken yearly in fall, in order to provide more complete information to assess shoreline changes at Mono Lake.

In 2020, digital photographs were taken from a helicopter in order to document shoreline conditions. Photos of all three waterfowl survey areas: Mono Lake, Bridgeport Reservoir and Crowley Reservoir, are generally taken the same day, however in 2020, heavy smoke conditions from regional wildfires delayed photography of Crowley Reservoir. Thus, still photos of lake-fringing habitats were taken October 22 at Mono Lake and Bridgeport Reservoir, and November 6 at Crowley Reservoir. For reference, the elevation of Mono Lake in October 2020 was 6,381.0 feet. This work was conducted by Deborah House, Mono Basin Waterfowl Program Director.

At each waterfowl survey area, representative photos were taken of each shoreline subarea established for use in evaluating the spatial distribution of waterfowl. At Mono Lake, the 15 shoreline subareas (Figure 3-49) followed those established in Jehl (2002), except for minor adjustments made in order to provide the observer with obvious landmarks that are easily seen during aerial waterfowl surveys. Bridgeport Reservoir has three shoreline survey areas (Figure 3-50) and Crowley Reservoir seven (Figure 3-51).

3.3.2 Lake-fringing Wetland Photo Compilation

The annual photographs of waterfowl habitats at Mono Lake, Bridgeport Reservoir and Crowley Reservoir were reviewed and compiled. Representative photos from each shoreline subarea were selected. The annual photos, combined with field notes, were used to evaluate and subjectively describe shoreline conditions in 2020.

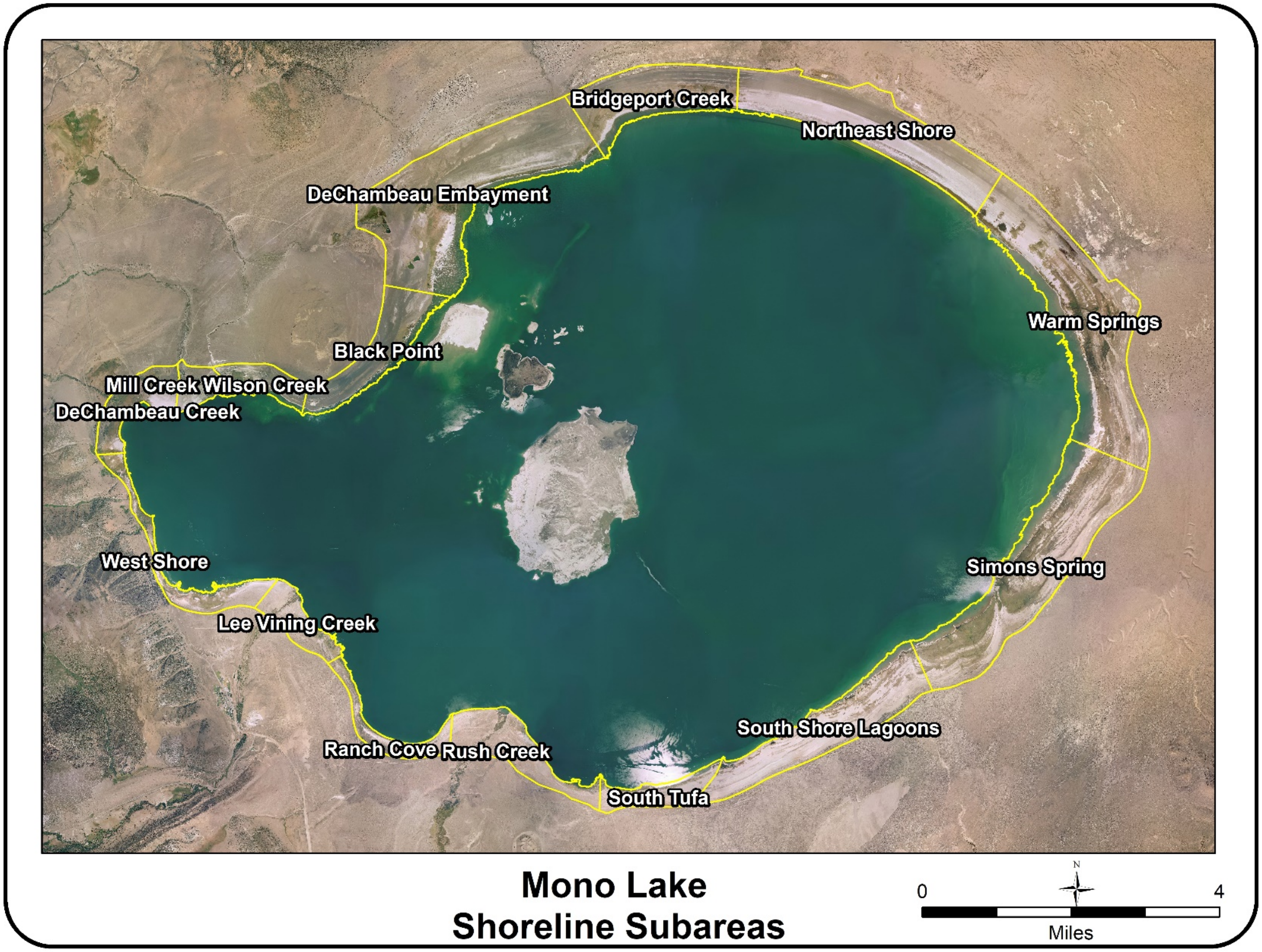

Figure 3-49. Mono Lake Shoreline Subareas

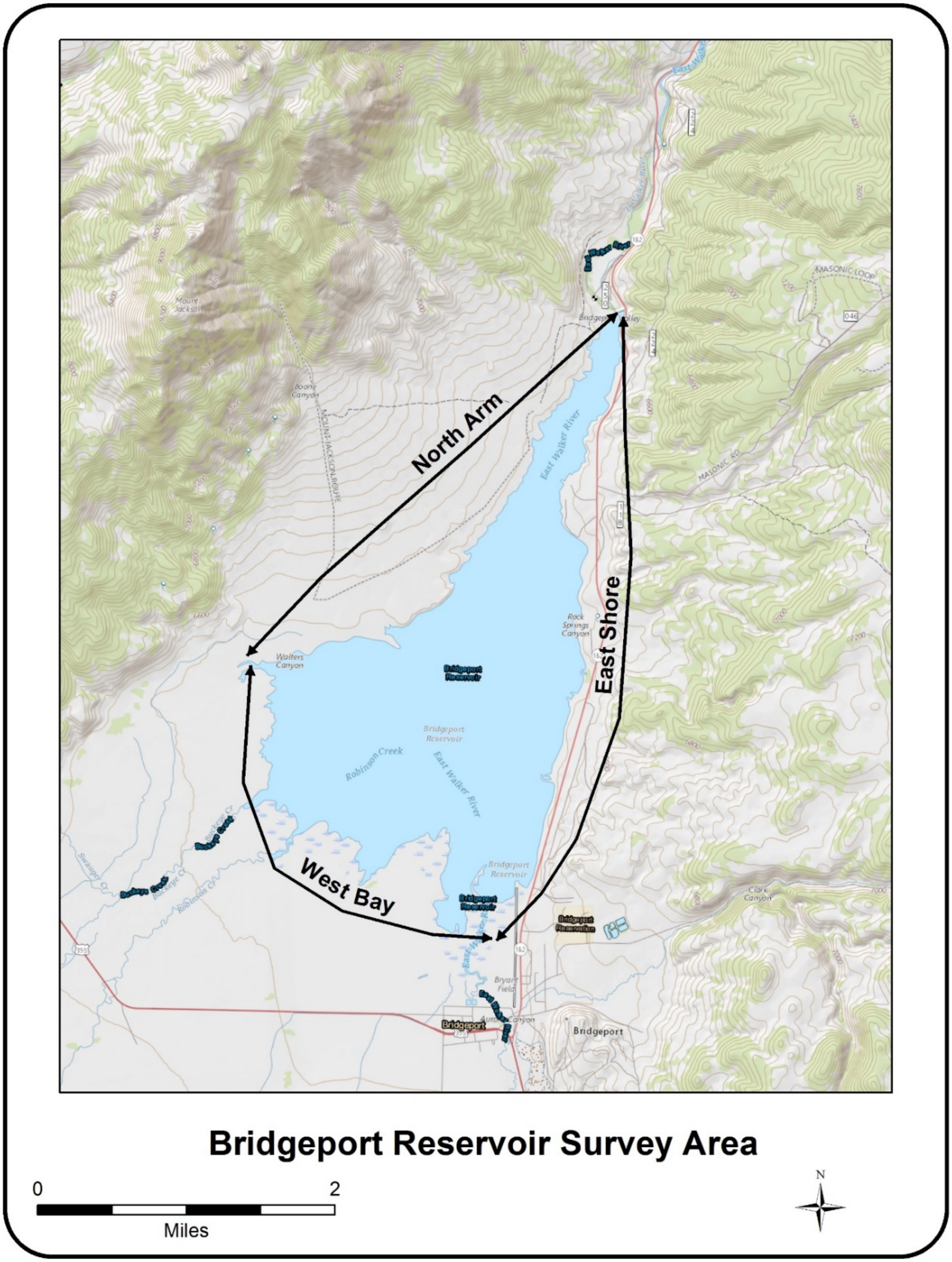

Figure 3-50. Bridgeport Reservoir Shoreline Subareas

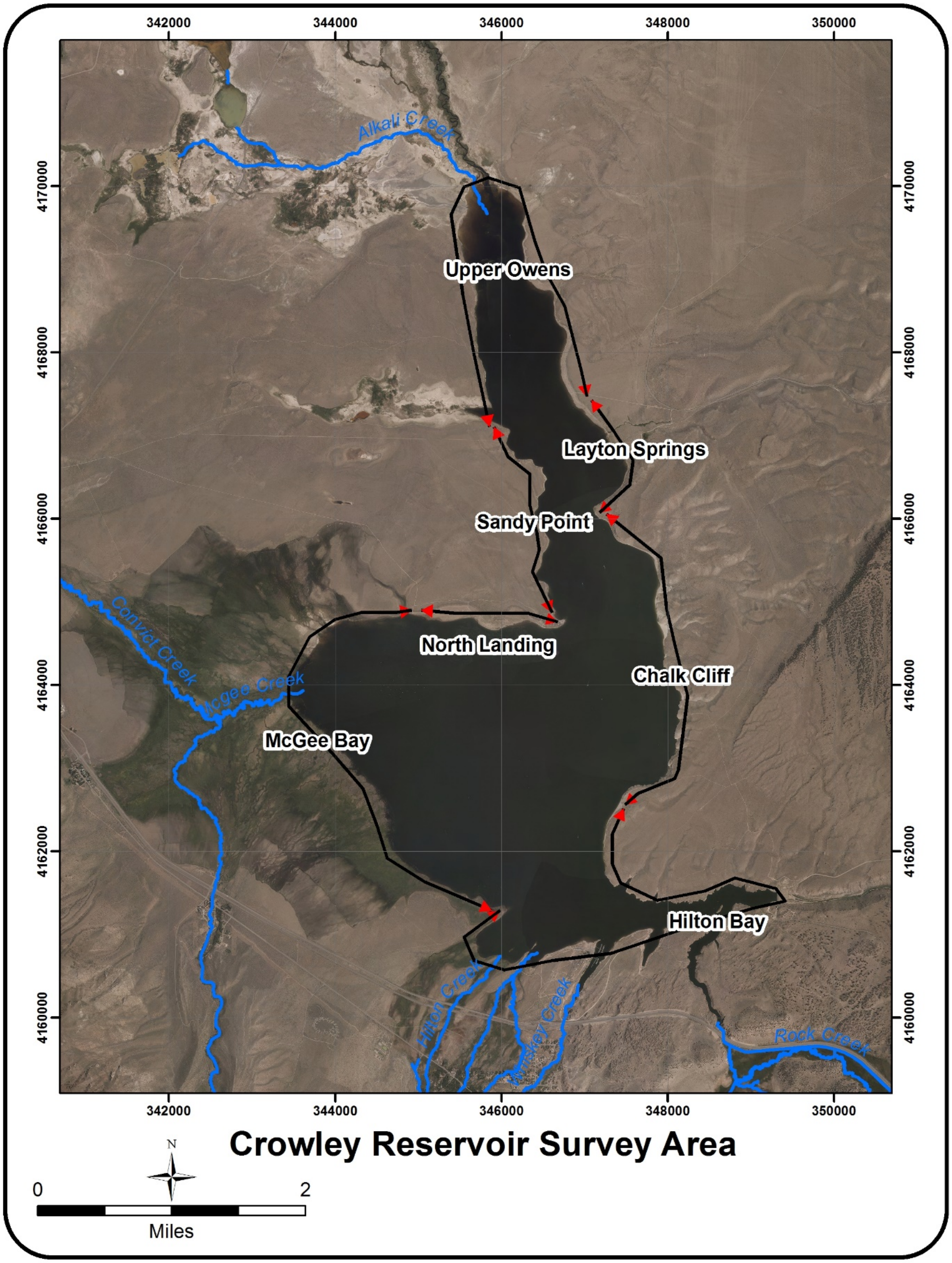

Figure 3-51. Crowley Reservoir Shoreline Subareas

3.3.3 Lake-fringing Wetland Survey Area Conditions

Mono Lake Shoreline Subareas

<u>Black Point (BLPO)</u>

The Black Point (BLPO) shoreline area lies at the base of a volcanic hill on the northwest shore of Mono Lake (see Figure 3-49). The shoreline in this area is composed of fairly dry, loose volcanic soils. At lower lake elevations, barren shoreline and alkali meadow predominate. In the western portion of BLPO, dry alkali meadow exists as a linear strip paralleling the shoreline. In the eastern portion of the shoreline area, unmapped springs exist, and alkali meadow generally extends to the shoreline creating improved foraging habitat for waterfowl. Based on a review of annual photos, brackish ponds become more numerous in the BLPO area at lake elevations above 6,382 feet, but relatively absent at lake elevations below this level. In 2020, the western portion of the Black Point shoreline area was barren and dry (Figure 3-52), while the eastern half supported a few small brackish ponds (Figure 3-53). The decrease in lake level in 2020 resulted in fewer shoreline ponds as compared to 2019.

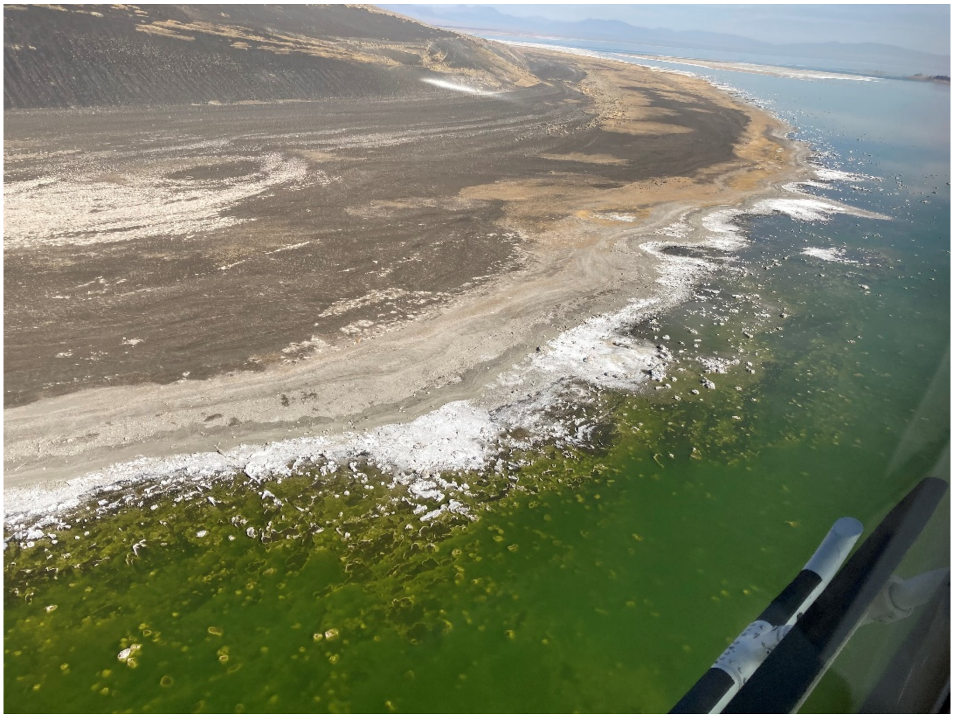

Figure 3-52. Black Point Shoreline Area, Western Half

Figure 3-53. Black Point Shoreline Area, Eastern Half

Bridgeport Creek (BRCR)

This shoreline area is at the terminus of the Bridgeport Creek (BRCR) drainage, however there is no surface flow of water in the creek near the lakeshore. There are several springs in this area, most of which are slightly brackish and support small brackish ponds. The other wetland resources in the Bridgeport Creek shoreline area include alkaline wet meadow and small amounts of wet meadow and marsh. Waterbird use is often most concentrated at the western end of this area, where spring flow has consistently reached the shoreline at all elevations observed. At higher lake elevations, brackish ponds develop along much of the length of this shoreline area. With decreasing lake elevations, barren lake bed increases substantially without a subsequent expansion of vegetation, and brackish ponds disappear. In 2020, the eastern portion supported primarily meadow vegetation with a small pond present upgradient (Figure 3-54). The western portion of BRCR was fairly dry in 2020 however a small stand of marsh and seepage to the lake existed at “Seeping Springs” spring (Figure 3-55).

Figure 3-54. Bridgeport Creek Shoreline Area, Eastern Portion

Figure 3-55. Bridgeport Creek Shoreline Area, Western Portion

"Seeping Springs" located just right of center in this photo, supported a small stand of marsh and seepage of spring water to the lake

DeChambeau Creek (DECR)

The DeChambeau Creek (DECR) shoreline area is along the northwest shore of Mono Lake (see Figure 3-49). Flow in DeChambeau Creek is intermittent, and does not consistently reach the lakeshore. The DECR shoreline area has abundant freshwater resources due to the presence of numerous springs that provide direct flow to the lake.

The freshwater springs at DeChambeau Creek support lush wet meadow and riparian scrub habitats. When the lake elevation is such that shoreline is exposed in this area, the extensive springflow creates freshwater mudflats. During periods of declining lake levels, wet meadow vegetation has been observed to expand onto exposed mudflats due to the abundance of freshwater spring flow. Increases in barren lake bed area with declining lake elevation have been much less apparent in the DECR area as compared to other shoreline subareas due to the slope of the shoreline and the vegetation expansion that occurs. During periods of subsequent increasing lake elevations, this wet meadow vegetation, mudflats, and playa has been subsequently inundated, leaving little exposed shoreline.

In 2020, wetland vegetation extended to the shoreline in the western half, while a narrow, dry beach was present east of the boardwalk (Figure 3-56). A small beaver dam near shore was first noted in this area in 2014. Beaver activity has since resulted in the die off of coyote willow and the creation of small ponds just off shore (Figure 3-57).

Figure 3-56. The DeChambeau Creek Area, Looking North

Figure 3-57. The DeChambeau Creek Area, Looking Southwest
In the center of the photo there is an area of dead, gray *Salix exigua* due to beaver activity.

DeChambeau Embayment (DEEM)

The DeChambeau Embayment (DEEM) area lies just east of the DeChambeau Ranch, and the DeChambeau and County restoration ponds (see Figure 3-49). Historically, Wilson Creek discharged to the lake in the DeChambeau Embayment area, although there was extensive upstream diversion for irrigation of the DeChambeau Ranch. Past diversions altered the discharge point to almost 5 miles west along the shoreline, near the Mill Creek delta.

The wetland resources in DeChambeau embayment include alkaline wet meadow, small amounts of marsh, and several small brackish ponds. There are fresh, slightly brackish and moderately brackish springs in this area, the largest of which - Perseverance Spring - is slightly brackish. Spring flow has reached the lake at all elevations observed.

The bathymetry of the shoreline and offshore area is more complex than other subareas. Very shallow sloping topography exists nearshore in the southern portion of the subarea, with a deeper bay just offshore. Pumice blocks litter the entire subarea, and are most often visible in the southern portion of this area due to the topography and shallow nearshore waters (Figure 3-58). At the higher lake elevations observed, the pumice blocks become partially to completely submerged and the shallow nearshore areas expand. As the lake level drops, this shoreline area experiences rapid increases in the acreage of barren lake bed and a land bridge forms with an offshore island, as was last seen in 2015. At more extreme low lake levels, such as those observed in 2016, the geographic extent of the pumice blocks in the eastern portion of the subarea were revealed (LADWP 2018). The eastern portion of the shoreline in this subarea has a gradually sloping shoreline which extends offshore.

In 2020, only small, isolated brackish ponds were present, primarily along the eastern extent of the shoreline (Figure 3-59).

Figure 3-58. DeChambeau Embayment, Western Extent

The western extent of this shoreline area, looking northeast.

Figure 3-59. DeChambeau Embayment, Eastern Extent

The eastern extent of this shoreline area, looking northeast.

Lee Vining Creek (LVCR)

Lee Vining Creek (LVCR), the second largest stream in the Mono Basin, has primarily a snowmelt-driven hydrologic regime, with peak stream flows occurring during the spring snowmelt season, and reduced flows during the remainder of the year. Peak flows typically occur in June or July in any given year, but may occur in April or May, particularly in dry years. Water diversion by LADWP began in 1941, resulting in a dry channel in the lower reaches of the creek in some years. Most of the impacts to the creek, as a result of LADWP diversions, occurred downstream of Highway 395 (SWRCB 1994). Under Decision 1631, LADWP was required to develop a stream restoration plan and undertake projects to rehabilitate Lee Vining Creek (LADWP 1996b). Channel maintenance and flushing flows, referred to as "stream restoration flows" were established in order to mimic seasonal snowmelt runoff, with the magnitude of the flow based on the hydrological conditions for the year (SWRCB 1994).

Lee Vining Creek is a woody riparian system. The lower reaches of Lee Vining Creek and its delta support small patches of wet meadow vegetation. The creek supplies abundant freshwater year-round, which remains confined to the main channel under low flow conditions, but inundates the lower floodplain under high flow conditions. At higher lake levels, the delta becomes flooded with lake water, inundating the willows and wet meadows close to shore, resulting in some dieback of willows and freshwater emergent vegetation from salt water stress. During periods of descending lake elevations, freshwater ponds may form behind littoral bars. At the most recent extreme low lake elevation observed in 2016, extensive drying of the delta meadows occurred. Ria extends offshore beyond the mapping boundary of Lee Vining Creek subarea, due to flows from Lee Vining Creek, however this waterfowl resource is not captured by landtype mapping (LADWP 2018).

Bathymetry of the area indicates limited shallow water areas near shore. Shallow sloping areas of water are limited to the delta and near the tufa grove, but depths rapidly increase lake-ward (LADWP 2018).

The decline in lake level as compared to 2019 resulted in changes to waterfowl resources in the Lee Vining Creek delta (Figure 3-60). In the northern portion of the delta, a fresh shoreline pond that had been present the last several years was no longer present due to channelization of flow and a draining of the pond. Willows were colonizing the former ponded area. In the southern portion of the delta, flows were also more confined to the channel than in 2019, resulting in less flooding of the delta. Willows were also observed to be colonizing areas no longer inundated.

Figure 3-60. Lee Vining Creek Delta

Mill Creek (MICR)

Mill Creek (MICR) is Mono Lake's third largest tributary, and originates in Lundy Canyon. The Mill Creek delta is dominated by dense stands of shrub willow (Figure 3-61). Beaver activity in the delta since at least 2012 has resulted in fresh water ponds in amongst the willows. No springs have been identified in this area, however freshwater often enters the lake at several points in the delta due to seepage through the loose volcanic soils. Previous bathymetry studies have indicated the creek mouth constitutes the only shallow areas in the Mill Creek delta area.

In 2020, new beaver dams were seen, creating additional fresh water ponds in the delta. In addition, the presence of a long sandbar resulted in most of the flow entering the lake on the east side of the bay.

Figure 3-61. Mill Creek Delta

Northeast Shore (NESH)

In the Northeast Shore (NESH) area, extensive areas of barren playa dominate at most lake elevations as saline groundwater prevents the growth of vegetation. Barren playa comprises 99% of the Northeast Shore area, and only small amounts of alkali meadow are present.

At the higher lake elevations, extensive ponds have formed along the length of the shoreline segment. Although there are no known mapped springs in this reach, some are evident (D. House, pers. obs.) (Figure 3-62). Ephemeral ponds observed along Northeast Shore at elevated lake elevations are presumed to be brackish as flow from springs in adjacent subareas are likely contributing to creation of these ponds. Salinity of these ephemeral ponds may also be influenced by groundwater input. Historically, large perennial brackish ponds were present along the northeast shore. These historic ponds persisted in depressional areas above the high water mark and above the target lake level for Mono Lake. In contrast to the perennial nature of these historic ponds, the ponds observed along the northeast shore in recent times have been more temporary in nature, persisting often a single season. Bathymetry studies indicates a very gradual sloped shoreline in this subarea. In 2020, the Northeast Shore area consisted primarily of dry playa, as is typical (Figure 3-63).

Figure 3-62. An Unnamed Spring Along Northeast Shore

Figure 3-63 Northeast Shore, Looking North

The salinity of the groundwater in this area prevents vegetative growth.

Ranch Cove (RACO)

The Ranch Cove (RACO) shoreline area is a relatively small area located between Rush Creek and Lee Vining Creek. The shoreline area is narrow and generally dry, supporting primarily coyote willow (*Salix exigua*), rabbitbrush, upland scrub, and barren playa. This shoreline area has not shown significant changes with lake elevation. Waterfowl resources are limited in this area, and there is no direct spring flow evident.

Bathymetry shows essentially no shallow area in this shoreline subarea, and a steeply sloped shoreline. As is typical, in 2020 Ranch Cove showed a dry beach lacking onshore ponds or direct spring input (Figure 3-64).

Figure 3-64. Ranch Cove Shoreline Area, Looking Southwest.

Rush Creek (RUCR)

Rush Creek (RUCR), the largest stream in the Mono Basin, has primarily a snowmelt-driven hydrologic regime with peak stream flows occurring during the spring snowmelt season, and reduced flows the remainder of the year. Peak flows typically occur in June or July in any one year, but may also occur in April or May, particularly in dry years (Beschta 1994). There is a long history dating back to the 1860s of diversion of Rush Creek flows for irrigation. Water diversion by LADWP for export began in 1941, resulting in a dry channel in the lower reaches of the creek in some years. Notable large runoff events occurring in 1967, 1969, and the early 1980s, caused substantial incision and scouring due to an absence of riparian vegetation to protect the banks and stabilize the soils. Floodplain incision then drained shallow groundwater tables and left former side channels stranded above the newly incised main stream channel (SWRCB 1994). Under Decision 1631, LADWP developed a stream restoration plan and has undertaken projects to rehabilitate Rush Creek (LADWP 1996b). Channel maintenance and flushing flows, referred to as “stream restoration flows” were established in order to mimic seasonal snowmelt runoff, with the magnitude based on the hydrological conditions for the year (SWRCB 1994).

The wetland resources available at Rush Creek are primarily meadow and woody riparian vegetation (*Salix* spp.) and the creek supplies abundant freshwater year-round. Just upstream of the delta, the floodplain is a broad meadow supporting scattered shrub willows. At higher lake levels or high creek flows, flooding has extended across the delta mouth. During periods of lake elevation recession, much channel braiding exists in the delta. From 2002 through 2014, side channels distributed water through the lower floodplain, creating saturated conditions, fresh water channels, and a stable fresh water pond along the eastern edge. In 2014, headcutting along the mainstem resulted in channel erosion, and side channel abandonment. By the following summer of 2015, pond and channels used by breeding waterfowl in the delta area disappeared as the lower floodplain experienced significant drying. Rush Creek flows create an area of ria that is expected to extend well beyond the delta.

By October 2020, the decline in lake level resulted in less flooding of the delta area, and increased expose of sandbars as compared to 2019 (Figure 3-65). The long glide of lower velocity, nonturbulent flow just upstream of the delta was still present and quite deep, and continued to attract waterfowl.

Figure 3-65. Rush Creek Delta

Features of Rush Creek delta in 2020 include fresh water ponds and a deep section of glide along the channel.

<u>Simons Spring (SASP)</u>

The Simons Spring subarea (SASP) includes the southeastern portion of the lakeshore (see Figure 3-49). Located centrally in the subarea is the Simons Spring faultline, a conspicuous feature on the landscape. Several large springs arise from the fault, conducting groundwater to the surface (Rogers et al. 1992). Being subject to the action of longshore currents, shoreline features of Simons Spring are dynamic, particularly west of Simons Spring faultline. Due to the shoreline gradient, small changes in lake elevation result in large changes in the degree of shoreline flooding.

Open fresh water ponds are a prominent feature of the Simons Spring area, however their presence tends to be ephemeral, especially west of Simons Spring fault. Over the years, longshore currents have resulted in the development of several parallel littoral bars west of the Simons Springs faultline. These littoral bars retain upgradient spring flow and support the creation of ponds, wet meadow, and marsh behind the sandbars. During periods of increasing lake level, lake water inundates areas supporting wetland vegetation upgradient of littoral bars. The vegetation dies back due to salt stress, opening up areas previously grown over with marsh or meadow. During subsequent decreases in lake level, open fresh water ponds have developed, supported by inflow from up gradient springs. Many of the freshwater springs in this area reach the lakeshore through breaks in littoral bars, creating extensive mudflats on exposed playa. Although there may be a physical connection between the mudflats and lake water, the very shallow ponds formed on shore are fresh due to the high spring flow, and are colonized within 1-2 years by wet meadow vegetation.

Just east of the Simons Spring faultline, permanent to semi-permanent brackish water ponds are generally present year-round. The remainder of the subarea to the east lacks spring flow to the lake and supports alkali wet meadow up gradient and barren playa on shore.

Although not mapped as a landtype in this area, ria likely occurs due to the multiple areas of spring flow that reach the lake shore. The bathymetry indicates a more gradual offshore slope in the western half of the subarea, a steep offshore slope where the tufa towers of the faultline reach shore, and an increasing shallow slope to the east (LADWP 2018).

In 2020, waterfowl habitat conditions were fairly good. Numerous fresh and brackish ponds were present, although they appeared to be slightly reduced in size as compared to 2019 due to a combination of vegetation encroachment and lowered lake level. The most significant change observed occurred at the far western end, as flow from Goose Springs was now entering the lake within the confines of the Simons Spring shoreline area, instead of the adjacent South Shore Lagoons area. This shift is believed to be a consequence, at least in part, of the encroachment of cattails into the fresh water pond complex surrounding Goose Springs. This vegetation encroachment has been ongoing over several years, resulting in subtle shifts in water flow patterns and vegetation development around the springs (Figure 3-66).

A large feral horse herd of up to 500 animals was seen several times in the east part of the lake, including the Simons Spring area. Heavy grazing is occurring, potentially accompanied by soil compaction, especially around some springs and other water sources. In 2020, narrow shoreline freshwater ponds were present west of the Faultline (Figure 3-66) and brackish ponds were present east of the fault line Figure 3-67).

Figure 3-66. Simon's Spring, West of the Faultline

Figure 3-67. Simon's Spring, East of the Faultline

South Shore Lagoons (SSLA)

The South Shore Lagoons is a broad stretch of shoreline with scattered waterfowl habitat features. Waterfowl habitat features include permanent freshwater ponds supported by springs, seasonal to semi-permanent ponds supported by groundwater, and ephemeral brackish ponds. Like Simons Spring, the shoreline configuration in the South Shore Lagoons subarea is influenced by longshore currents.

At the western border of the subarea, a pond exists along a southwest-northeast trending faultline. The presence of this semi-permanent pond has been a function of lake elevation. At the higher lake elevations observed (approximately 6,383 feet), the pond has been full. Below approximately 6282.5 feet, the pond experiences notable contraction in size and, at elevations below 6,381.9 feet, has been absent.

Sandflat Spring is an isolated freshwater spring supporting two small freshwater ponds- an upper pond, and a lower pond, both partly surrounded by coyote willow. These were open water ponds until 2014, when water speedwell (*Veronica anagallis-aquatica*) and cattails (*Typha* sp.) encroached and enclosed the open water.

At the east end of the subarea is the Goose Springs complex. Goose Springs is a large spring complex that forms a series of interconnected freshwater ponds surrounded by wet meadow and marsh. In some years, the development of a littoral bar downgradient has captured spring flow, creating large onshore ponds that can be either fresh or brackish.

Away from the immediate shoreline in this subarea, the terrain is sandy hummocks with numerous small, depressions supporting alkali meadow in most years. Groundwater levels in this area have been found to be responsive to lake elevation changes (Rodgers et al. 1992) due to the high topographic gradient and very permeable soils. In 2006 and 2007 when the lake elevation was at its highest observed (above 6,385 feet), these scattered wetlands filled with groundwater, creating a series of scattered fresh water ponds in the South Shore Lagoons subarea.

At the beginning of summer in 2020, several of the uphill depressions held small amounts of water, but not enough to create open water areas for waterfowl. The semi-permanent pond at the western extent of the subarea was fairly flooded in June, but experienced significant drying by October (Figure 3-68). At Sand Flat Spring, there was very little open water habitat, and no direct connection between spring flow and the open water (Figure 3-69).

The most significant change to the South Shore Lagoons area was in the vicinity of Goose Springs. As discussed above, shoreline ponds in the Goose Springs area were cut off from spring flow as flow was directed to the east, and exiting to the lake in the Simons Spring shoreline area. This reduction of flow into the pond has resulted in algal cover and some cattail encroachment (Figure 3-70). If this trend continues, the quality of waterfowl habitat in the Goose Springs area will be severely affected. At the extreme eastern edge of the shoreline area, a brackish pond was present on shore in 2020 that supported many waterfowl broods, and additional use by waterfowl in fall (Figure 3-71).

Feral horse activity continues to increase along the south shoreline of Mono Lake. Horse droppings were seen throughout the area, west to South Tufa. In the Goose Springs area of South Shore Lagoons, grazing by feral horses of wetland vegetation around the ponds was evident for the first time.

Figure 3-68. South Shore Lagoons, West

Although fairly full in June 2020, this pond at the western extent of the subarea was drying by October when this photo was taken.

Figure 3-69. Sand Flat Spring

In 2020, there was no direct connection between spring flow from Sand Flat Spring and lake waters.

Figure 3-70. Overview of the Goose Springs Area

In 2020, water flow to the large freshwater pond near shore was cut off, resulting in the growth of algae and further encroachment by cattails.

Figure 3-71. Goose Springs

This brackish pond on shore at the extreme eastern end of the South Shore Lagoons area supported multiple waterfowl broods in 2020.

South Tufa (SOTU)

The South Tufa area (SOTU) is the primary visitor access point to the Mono Lake shoreline, notable for its large display of tufa towers. The western portion of the survey area, just east of the main tufa tower stand differs notably in terms of waterbird habitat from the eastern portion, just east of a small tufa prominence onshore between the South Tufa access point and Navy Beach. In the western portion, the shoreline is narrow, the offshore topography steep, and the brackish springs create wet mudflat conditions under most lake levels observed. East of the prominence, the shoreline is very gradually sloped onshore as well as offshore. The eastern portion supports an ephemeral brackish pond whose presence has varied as a function of lake elevation and season. At somewhat intermediate lake elevations, the shoreline pond in the eastern section has persisted from summer through fall. In periods of lower lake elevation, the brackish pond has been present in summer, but generally dried by fall.

The South Tufa area was impacted by the “Beach Fire” in August 2020, which burned to the shoreline in the western portion of the shoreline area. By October, the meadow vegetation on shore was recovering and greening up (Figure 3-72). During the summer surveys, a small narrow brackish pond was present in the eastern portion, but had dried by fall (Figure 3-73).

Figure 3-72. South Tufa

The western portion of the South Tufa shoreline area was burned in the Beach Fire in August 2020, and showed some post-fire green-up by October.

Figure 3-73. South Tufa, Eastern Extent

Warm Springs (WASP)

The Warm Springs area is located on the eastern shore of Mono Lake. The main feature of the Warm Springs area is a permanent brackish pond fed by the outflow of Pebble and Twin Warm Springs (referred to as "north pond"). These and other springs in the area support extensive wet meadow, alkali meadow, and marsh vegetation, primarily around the pond and springheads. The springs in the Warm Springs area are slightly to moderately brackish.

The north pond has been present at all lake elevations observed. Some expansion and contraction have occurred, with the pond at its largest extent in 2006. This pond is the only place in the Warm Springs subarea where waterfowl are consistently encountered.

Due to the very gradual sloping shoreline in this area, small changes in lake elevation result in large differences in the amount of exposed playa on shore. Longshore action has also shaped this shoreline as evidenced by the prominent littoral bars creating the north pond and ponds downgradient. During periods of declining lake elevation, seepage of water from the north pond through the loose sandy soil results in the development of ephemeral brackish ponds downgradient of the north pond as was noted in 2010 (LADWP 2018).

Feral horse activity at Mono Lake continues to be highest in the Warm Springs area. On most visits from summer through fall, between 200 and 500 animals were seen in the area. Warm Springs was severely grazed this year, as all of emergent vegetation along the spring channels and around the ponds had been consumed, and the meadows were grazed down to almost zero stubble, and bare patches of soil were appearing.

The intense grazing by the feral horses has had some interesting effects, at least in the short-term, on the conditions at Warm Springs, and the dynamics of waterbird use. Prior to the arrival of the horses to Mono Lake, the wetlands at Warm Springs supported extremely dense alkali meadow vegetation. The heavy grazing has removed much of the cover in the vicinity of the springs (at least this was the case in 2020). In 2020, the area was very wet, creating multiple shallow, open water ponds (Figure 3-74). Whether the flooding is a result of vegetation removal or changes in spring flow, is unknown. The openings and shallow flooding of the meadow has attracted waterbirds to feed and shorebirds to attempt nesting in places previously unavailable because of dense cover. California Gulls and waterfowl were seen away from the shore and feeding uphill in grazed flooded areas. In addition, a large slightly brackish pond on shore, and being fed by outflow from the North Pond, attracted large numbers of waterfowl (Figure 3-75).

Figure 3-74. Overview of Warm Springs

Heavy grazing by feral horses and an increase in flooding resulted in multiple shallow ponds in the Warm Springs area in 2020.

Figure 3-75. Warm Springs, North Pond, Looking West.

This large unvegetated pond on shore was only slightly brackish, being fed by outflow from the North Pond

West Shore (WESH)

The majority of the West Shore subarea (WESH) is located immediately east of Highway 395, along a steep fault scarp. While some shallow gradient areas exist along the southern boundary, most of this shoreline area is steeply sloping lakeward. Several fractured rock gravity springs (LADWP 1987) and two small drainages, Log Cabin Creek and Andy Thom Creek provide fresh water resources along the length of this shoreline subarea, although ponds are lacking. A very narrow beach exists along much of the length and becomes inundated at higher lake elevations. Significant changes have not been noted in the configuration of this shoreline subarea with lake elevation changes. The area supports lush wetland resources, but waterfowl use is limited (Figure 3-76).

Figure 3-76. Overview of the West Shore, Looking North/Northwest

Wilson Creek (WICR)

Wilson Creek is along the northwest shore (see Figure 3-49) and one of the best and most important waterfowl habitat areas at Mono Lake. Wilson Creek supports a large expanse of wet meadow, multiple fresh water springs, and mudflats. The Wilson Creek subarea has the second highest median spring flow of the monitored springs (LADWP 2018). Due to the shoreline configuration and presence of large tufa towers, this subarea also has two protected bays. Submerged pumice blocks are present throughout the shallows of the eastern portion of the subarea. The bathymetry indicates a very gentle sloping topography throughout the protected bays and all along the shoreline. Due to the shelter, spring flow, and shallow waters near shore, the hypopycnal layer may be extensive in this area. The spring flow and shallow waters also lend toward the formation of mudflats, which have been present at most lake elevations observed. At the lowest elevation observed (2016), the retreat of shoreline resulted in some loss of the protection of the bays, however, mudflats were still prominent due to the high spring flow. The extreme low lake elevation observed in 2016 allowed an opportunity to visualize the near shore topography and the significance of spring flow to Wilson Creek bay (LADWP 2018). The topography is very gently sloping throughout the entire bay, extending out beyond the mouth of the bay and east of Tufa Mound spring. The high spring flow in this area combined with the sheltered nature of the bay is conducive to creating hypopycnal conditions. Even at higher lake elevations, such as in 2012, hypopycnal conditions would likely occur across the bay except under windy conditions, due to the high spring flow and contribution from Wilson Creek to the west in 2012. The shallow areas in the bay would make food more accessible to waterfowl. The high spring flow conditions combined with the sheltering of the bay and shallow waters support ideal feeding and loafing conditions for waterfowl at Mono Lake.

In 2020, the Wilson Creek area supported a fresh water pond along the west shore of the bay that supported multiple waterfowl broods (Figure 3-77). The Wilson Creek area supplied a mix of fresh water ponds, mudflats, meadows, and spring flow in 2020 (Figure 3-78). On at least one occasion in June (June 12), the Wilson Creek channel was dry at the Cinder Pit Road (Forest Road 02N41) crossing.

Figure 3-77. Wilson Creek Bay, as Viewed From the Southeast

The freshwater pond on the west side of the bay supported multiple waterfowl broods.

Figure 3-78. Wilson Creek Bay, as Viewed From the East

Bridgeport Reservoir Shoreline

All three shoreline segments at Bridgeport Reservoir: North Arm, West Bay, and East Shore are shown in Figure 3-79. The North Arm seen at the far end of the photo is in the narrowest part of the reservoir and includes primarily sandy beaches bordered by upland vegetation. The West Bay receives fresh water inflows from Buckeye and Robinson Creeks and the East Walker River, creating extensive mudflat areas adjacent to these creek inflow areas, especially when the water level in the reservoir is higher. The West Bay also receives extensive seepage and runoff from the adjacent irrigated pastures. The East Shore includes some mudflat and meadow areas in the vicinity of the East Walker River, but the majority of the East Shore area is bordered by Great Basin scrub or exposed reservoir bottom. In 2020, some reduction in flooded acreage was noted as compared to fall of 2019, when the reservoir was higher.

Figure 3-79. Bridgeport Reservoir, Looking Northwest

Crowley Reservoir Shoreline Subareas

The major source of fresh water input to Crowley Reservoir is the Owens River. Other fresh water input includes flows from McGee and Convict Creeks, Layton Springs, and subsurface flow from other springs along the west shore. Vegetation communities immediately surrounding Crowley Reservoir include irrigated pasture, wet meadow, Great Basin scrub, alkali meadow, and mudflats.

Chalk Cliffs (CHCL)

The Chalk Cliffs subarea lacks fresh water inflow areas and wetland habitats, and is dominated by sandy beaches adjacent to steep, sagebrush-covered slopes (Figure 3-80).

Figure 3-80. Chalk Cliffs

Hilton Bay (HIBA)

Hilton Bay includes Big Hilton Bay to the north and Little Hilton Bay to the south (Figure 3-81). The Hilton Bay area, surrounded by meadow and sagebrush habitat, receives small amounts of fresh water input from Hilton Creek, Whiskey Creek, and area springs.

Figure 3-81. Hilton Bay

Layton Springs (LASP)

The Layton Springs shoreline area is bordered by upland vegetation and a sandy beach. Layton Springs provides fresh water input at the southern border of this lakeshore segment. Reservoir level was very low in late fall of 2020, exposing a large amount of barren reservoir bottom in the Layton Springs area (Figure 3-82)

Figure 3-82. Layton Springs

McGee Bay (MCBA)

The McGee Bay shoreline area supports mudflat areas immediately adjacent to wet meadow habitats. McGee Creek and Convict Creek are tributaries to Crowley Reservoir in this shoreline area. Vast mudflats and wetlands occur along the west shore of Crowley Reservoir, as this area receives inflow from springs and subsurface flow from up-gradient irrigation. In late fall of 2020, a low reservoir level resulted a large expanse of mudflat and exposed reservoir bottom in the McGee Creek area (Figure 3-83Figure 3-84).

Figure 3-83. McGee Bay Shoreline South of McGee and Convict Creek Outflow

Figure 3-84. Southern Portion of the McGee Creek Shoreline Area

North Landing (NOLA)

The North Landing area is influenced by subsurface flows and supports meadow, wet meadow and mudflat habitats (Figure 3-85). The low reservoir level in late fall 2020 resulted in the development of extensive mudflats in the North Landing area.

Figure 3-85. North Landing

Sandy Point (SAPO)

Most of the length of Sandy Point area is bordered by cliffs or upland vegetation. Small areas of meadow habitat occur in this area, and limited freshwater input occurs at Green Banks Bay. A low reservoir level in late fall of 2020 created a large sandy beach in this area (Figure 3-86).

Figure 3-86. Sandy Point

<u>Upper Owens River (UPOW)</u>

The Upper Owens River receives direct flow from the Owens River, the largest source of fresh water to Crowley Reservoir. In 2020, this subarea included a large area of exposed reservoir bottom due to the low reservoir level (Figure 3-87).

Figure 3-87. Upper Owens Delta

3.3.4 Lake-fringing Wetland Condition Discussion

In fall of 2020 when photographs of lake-fringing wetlands were taken, the level of Mono Lake was 6381.0 feet, or 1.5 feet lower than in fall of 2019. Slight increases in the amount of exposed playa were evident in all shoreline areas. Grazing by feral horses was particularly heavy in the Warm Springs and Simons Spring areas. The most notable changes to waterfowl habitat conditions as compared to 2019 were observed in Lee Vining Creek, Rush Creek, Simons Spring, South Shore Lagoons, and Warm Springs.

The decline in lake level resulted in a reduction in the flooding of both Lee Vining Creek and Rush Creek deltas, and therefore of potential wind and wave-protected feeding areas for waterfowl. The low velocity waters of the long glide along Rush Creek just upstream of the bay continued to attract waterfowl.

Waterfowl conditions were fairly good in Simons Spring due to the presence of numerous fresh and brackish ponds, although slightly reduced in size as compared to 2019. Small scale, but potentially significant changes were observed in the Goose Springs area that enhanced the Simons Spring subarea. The shoreline ponds in the Goose Springs area of the South Shore Lagoons were cut off from direct spring flow as the flow was now exiting into the Simons Spring shoreline area. This reduction of flow into some of the Goose Springs ponds has resulted in the growth of algae and some cattail encroachment. If this trend continues, the quality of waterfowl habitat in the Goose Springs area, a key waterfowl breeding site, will be severely affected.

The intense grazing by the feral horses has had some interesting effects, at least in the short-term, on the conditions at Warm Springs, and the dynamics of waterbird use. The heavy grazing has removed much of the dense cover previously in this area. In 2020, the Warm Springs area was very wet, creating multiple shallow, open water ponds, attracting waterbirds to feed and shorebirds to attempt nesting in places previously unavailable because of dense cover. A large slightly brackish pond on shore, attracted large numbers of waterfowl.

A decrease in reservoir level at Bridgeport Reservoir resulted in a reduction in the aerial extent of flooding of feeding areas near the deltas of the East Walker River, Robinson and Buckeye Creeks.

The amount of barren shoreline increased notably at Crowley Reservoir as compared to 2019, due to a reduction in reservoir level. Heavy algal growth was not seen in early fall of 2020, as has occurred in previous years.

3.4 Saltcedar Eradication

3.4.1 Overview of Saltcedar Eradication

Saltcedar (*Tamarix* spp.) is a fast-growing, highly prolific invasive, widely-distributed nonnative large shrub to shrubby tree that can be found in the Mono Basin. The California Invasive Plant Council (Cal-IPC) considers saltcedar as a plant with the potential to have severe impacts to ecological systems including physical processes and biological communities (Cal-IPC 2006). Saltcedar can influence native plant communities by increasing soil salinities, displacing native vegetation, or increasing fire frequency and intensity (University of California 2010).

The control of saltcedar and other invasive weeds in the Mono Basin has been a cooperative effort conducted largely by California State Parks and the Mono Lake Committee. LADWP staff have informed State Parks personnel of new noxious weed populations, and have undertaken tamarisk removal. Although multiple entities have contributed to weed control, these efforts have largely remained undocumented in the annual Mono Basin reports.

A recommendation put forth in the 2018 Periodic Overview Report was improve the sharing of information between LADWP and California State Parks regarding tamarisk locations and treatment efforts so that efforts are not duplicated, and to assist in assessing the progress toward eradication efforts (LADWP 2018).

3.4.2 Saltcedar Eradication Methodologies

Since 2016, a tamarisk surveillance and treatment program has been implemented by California State Parks, with the work conducted primarily by a contractor. In 2021, the Waterfowl Director contacted California State Parks regarding their tamarisk control program in order to provide documentation to the California State Water Resources Control Board regarding the status of tamarisk control efforts, and increase coordination between agencies. California State Parks provided a brief overview of their program, and a Calflora website link of their observations (https://www.calflora.org/entry/observ.html#srch=t&taxon=Tamarix&cols=b&inma=t&y=38.0065&x=-118.9794&z=11). Locations of all tamarisk on the Calflora website since 2016 were downloaded and displayed in ArcGIS. Tamarisk locations were associated with a shoreline location using the waterfowl survey lakeshore segment boundaries. Tamarisk treatment sites were summed by year and shoreline segment.

3.4.3 Saltcedar Eradication Results

Total tamarisk treatment sites represent the number of sites treated per year, and may include plants found previous years (Table 3-21). Most of the tamarisk has been found in the western basin, including Mill Creek, Ranch Cove, and Rush Creek. The total number of saltcedar treatment sites was highest in 2016 (151), when Mono Lake was at its most recent low point. Since 2016, the number of sites decreased dramatically, and only one site was treated in 2020.

Table 3-21. Total Tamarisk Treatment Sites by Year and Shoreline Segment Area

	Year					Total Treated per Shoreline Area 2016-2020
Shoreline Area	2016	2017	2018	2019	2020*	
Bridgeport Creek	2		1	1		4
Lee Vining Creek	8	2	2	1		13
Mill Creek	62	7	8	6		83
Ranch Cove	30	9	6	5		50
Rush Creek	23	8	10	6		47
South Shore Lagoons	6	5	4	4		19
South Tufa	2			8		10
West Shore	8	4	4	5	1	21
Wilson Creek	10					10
Yearly Total Treated	151	35	35	36	1	257

*Surveys were not conducted in the southern portion of the Mono Basin due to a wildfire closure.

3.4.4 Saltcedar Eradication Discussion

The saltcedar eradication program conducted by California State Parks over the past five years has been very effective. The high number of treatment sites in 2016 occurred during a time of reduced lake level, and a high level of recruitment was observed (D. House, pers. obs.) This flush of new recruitment was effectively controlled as only 35 sites were located in 2017. Although not all areas of the shoreline were surveyed in 2020, no new plants were located (Joe Woods, pers. comm.) and only one plant required retreatment.

3.5 Waterfowl Population Surveys

Overview of Waterfowl Population Monitoring

Waterfowl population monitoring in 2020 included summer ground counts at Mono Lake and fall surveys at Mono Lake, Bridgeport Reservoir and Crowley Reservoir. LADWP Watershed Resources staff have conducted waterfowl population monitoring annually at these three sites 2002-2020. Mono Lake, Bridgeport Reservoir, and Crowley Reservoir are the main areas of waterfowl concentration in Mono County, and combined, support the overwhelming majority of waterfowl numbers in the county (D. House, pers. obs.). Thus, these data not only provide local site data, but serve as an index to regional waterfowl populations level.

Mono Lake is almost centrally located in Mono County and lies just east of the town of Lee Vining (Figure 3-88). Bridgeport Reservoir is approximately 22 miles northwest of Mono Lake near the town of Bridgeport. Crowley Reservoir is approximately 31 miles southeast of Mono Lake, and 12 miles southeast of the town of Mammoth Lakes.

Mono Lake Summer Ground Surveys

Of the three survey areas, waterfowl population monitoring has been most intensive at Mono Lake, including summer ground surveys for breeding waterfowl. Summer ground surveys were conducted in the Mono Basin along the shoreline of Mono Lake and at the DeChambeau and County Pond complexes. Although the summer use of Mono Lake by waterfowl is small as compared to use by fall migrants, limited historical information was available during Plan development. The Plan provided no specific guidance regarding the objectives of summer monitoring, however Drewien et al. (1996) recommended summer counts to record numbers and species composition of waterfowl and other waterbirds. The implied intent of summer surveys was to fill in gaps in knowledge regarding summer use by waterfowl.

Fall Surveys

Fall waterfowl surveys were conducted at Mono Lake, Bridgeport Reservoir and Crowley Reservoir. From 2002-2019, aerial surveys were conducted for fall counts. In 2020, a combination of ground and boat surveys were used. Mono Lake is a migratory stopover location for waterfowl, and use by waterfowl is expected to be highest during the fall migratory period. The response of fall waterfowl populations to restoration will be evaluated using this survey data. Waterfowl population response will be evaluated relative to conditions at Mono Lake, but also on a regional scale using waterfowl survey data from Bridgeport and Crowley Reservoirs.

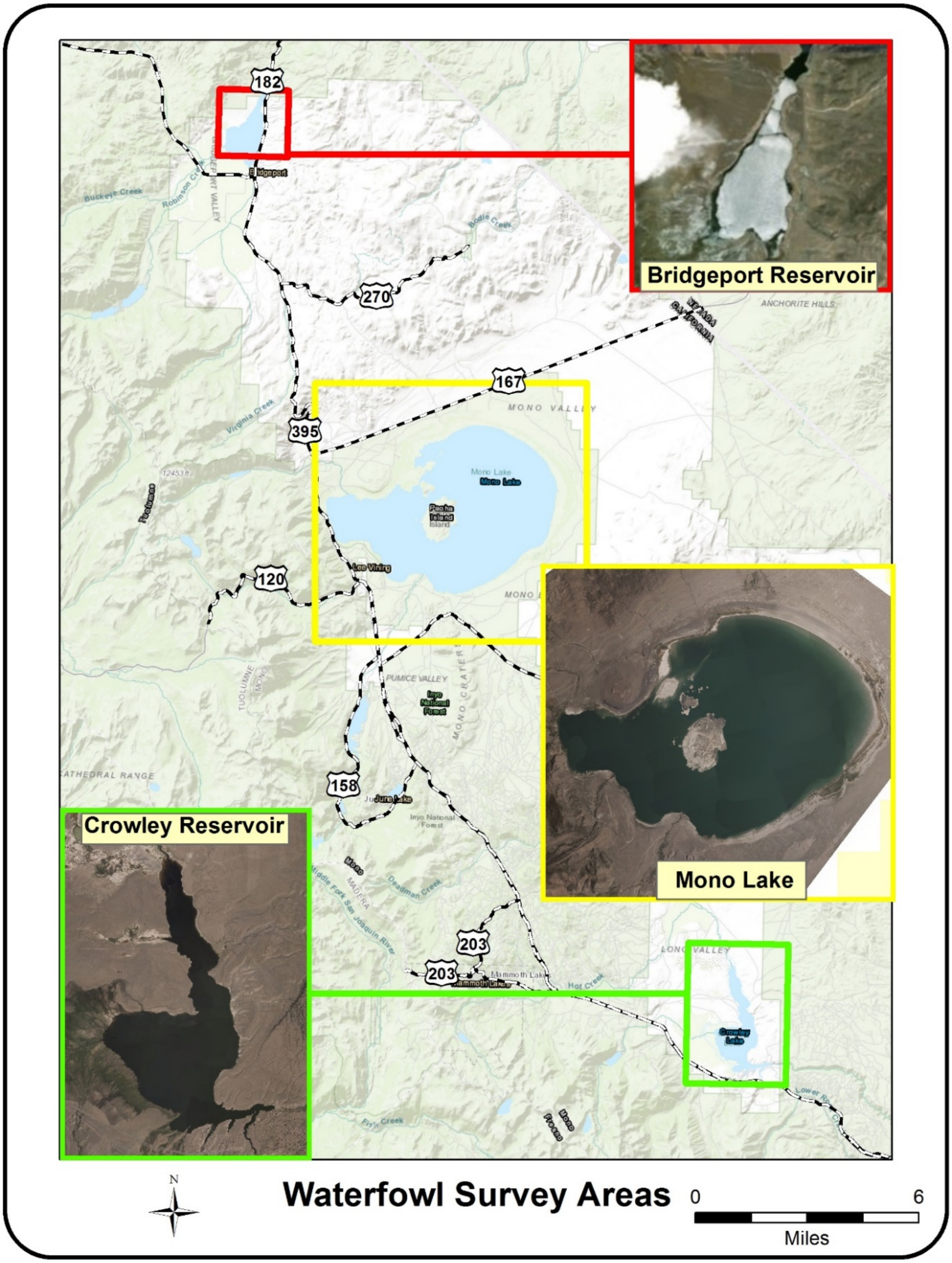

Figure 3-88. Waterfowl Population Monitoring Survey Sites

3.5.1 Waterfowl Population Monitoring Methodologies

Summer Ground Surveys

Mono Lake Shoreline Surveys

Summer ground counts were conducted along the shoreline of Mono Lake to determine summer waterfowl population size and species composition, document broods, record waterfowl habitat use, and habitat conditions. Summer ground counts have been conducted annually since 2002. Summer survey areas include nine shoreline subareas totaling approximately 14 miles of shoreline (Figure 3-89). The shoreline subareas are as follows: DeChambeau Creek (DECR), lower Lee Vining Creek and delta (LVCR), Mill Creek (MICR), lower Rush Creek and Rush Creek Delta (RUCR), Simons Spring (aka “Sammanns”) (SASP), South Tufa (SOTU), South Shore Lagoons (SSLA), Warm Springs (WASP), and Wilson Creek (WICR). In 2020, all surveys were conducted by Deborah House. Additional observers included Bill Deane, LADWP Watershed Resources Specialist.

Each shoreline subarea was visited twice in 2020 with surveys occurring at three-week intervals beginning in early June (Table 3-22). Survey 3 in mid-July was not completed in 2020 because of a family emergency. Surveys were conducted by walking at an average rate of approximately 1 mile/hour - depending on conditions - and recording waterfowl as they were encountered. Surveys started within one hour of sunrise, and all shoreline areas were surveyed over a 4-5-day period. Shoreline subarea visitation was varied in order to minimize the effect of time-of-day on survey results. For each waterfowl observation, the following was recorded: time of the observation; species, total number, and habitat use. Habitat use was recorded by documenting both behavior and landtype waterfowl were occupying. Behavior types recorded include resting, foraging, flying over, nesting, brooding, sleeping, swimming, or calling. In addition to the landtypes used for mapping, two additional habitat types: open water near shore (within 50 meters of shore), and open water offshore (>50 meters offshore), were added to the existing classification system in order to more completely represent areas used by waterfowl.

Table 3-22. 2020 Summer Waterfowl Survey Number and Dates by Subarea

	2020 Survey Number and Date	
Subarea	**Survey 1**	**Survey 2**
DECR	9-Jun	30-Jun
LVCR	9-Jun	30-Jun
MICR	12-Jun	30-Jun
RUCR	12-Jun	1-Jul
SASP	11-Jun	1-Jul
SOTU	10-Jun	29-Jun
SSLA	8-Jun	29-Jun
WASP	10-Jun	8-Jul
WICR	12-Jun	30-Jun
COPO	9-Jun	30-Jun
DEPO	9-Jun	30-Jun

Waterfowl broods were actively searched for while conducting summer ground counts at Mono Lake. Because waterfowl flush readily in response to disturbance, and females with broods are especially wary, observers frequently scanned the shoreline ahead in order to increase brood detection. Brooding females at Mono Lake generally respond in one of two ways to disturbance. Gadwall typically take their young out onto the open water of Mono Lake, where they can be more difficult to age. Other species will retreat to cover onshore, where they can be difficult to observe. Careful scanning of the shoreline and planned approaches to waterfowl use areas has been needed to consistently find broods. The following is recorded for each brood: species, brood size, GPS coordinates (UTM, NAD 83, Zone 11, CONUS), habitat use, and age.

Broods were aged based on plumage and body size (Gollop and Marshall 1954). Since summer surveys were conducted at three-week intervals, any brood assigned to Class I, using the Gollop and Marshall age classification scheme (which includes subclasses Ia, Ib, and Ic), would be a brood that had hatched since the previous survey, and therefore not previously tallied. Assigning an age class to broods allows for a determination of the minimum number of “unique broods” using the Mono Lake wetland and shoreline habitats, and minimize the double-counting of broods when determining annual brood totals.

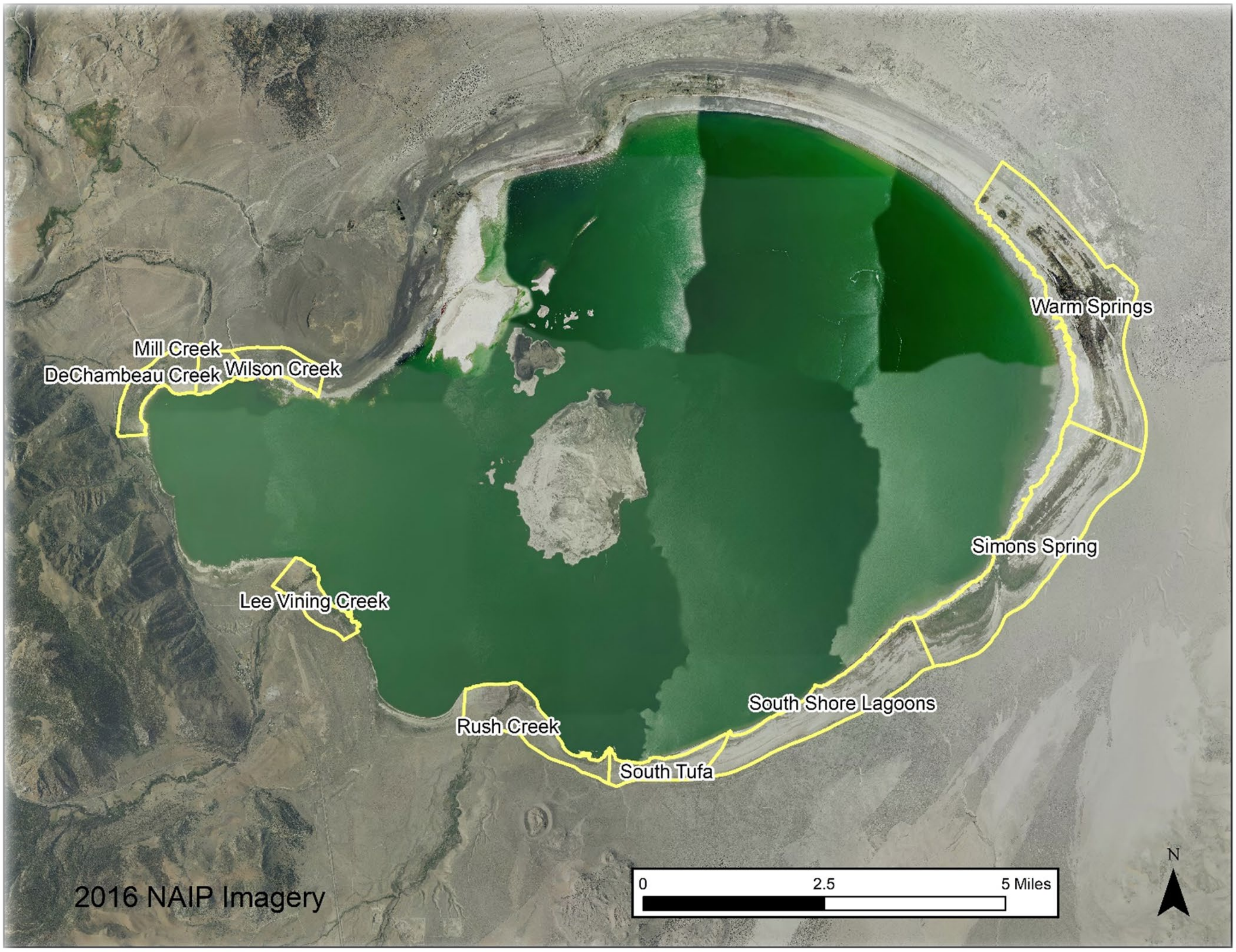

Figure 3-89. Summer Ground Count Shoreline Subareas - 2002-2020

Salinity measurements of lake-fringing ponds were taken using an Extech EC400 Conductivity/TDS/Salinity probe in order to aid in the classification of fresh versus brackish ponds when recording habitat use. Ponds with a salinity of less than 500 ppm were classified as fresh. Ponds with vegetation present and a salinity of greater than 500 ppm were classified as brackish. Ponds with a measured salinity greater than 10 ppt (the maximum range of the probe) and lacking vegetation and subsurface or surface freshwater inflow were classified as hypersaline.

Restoration Ponds

Two summer ground counts were also conducted at the DeChambeau and County Pond complexes north of the Mono Lake shoreline.

The DeChambeau Ponds are a complex of five artificial ponds of varying size (Figure 3-90**Error! Reference source not found.**). There are two water sources currently supplying water to the DeChambeau Ponds. The primary water source is Wilson Creek. Delivery of water from Wilson Creek to the DeChambeau ponds is via an underground pipe, and has averaged 1-2 cfs in recent years (N. Carle, pers. com.). The underground piping moves water from pond 1 to pond 5. The second source is water from a hot spring adjacent to DEPO_4. The hot spring water is typically delivered to each of the five ponds through piping, however a leak developed around 2008 or 2009 in the pipe supplying the ponds (N. Carle, pers. com.). Since the development of the leak, hot spring water can only be delivered to DEPO_4. In summer of 2020, only DEPO_2 and DEPO_4 held water.

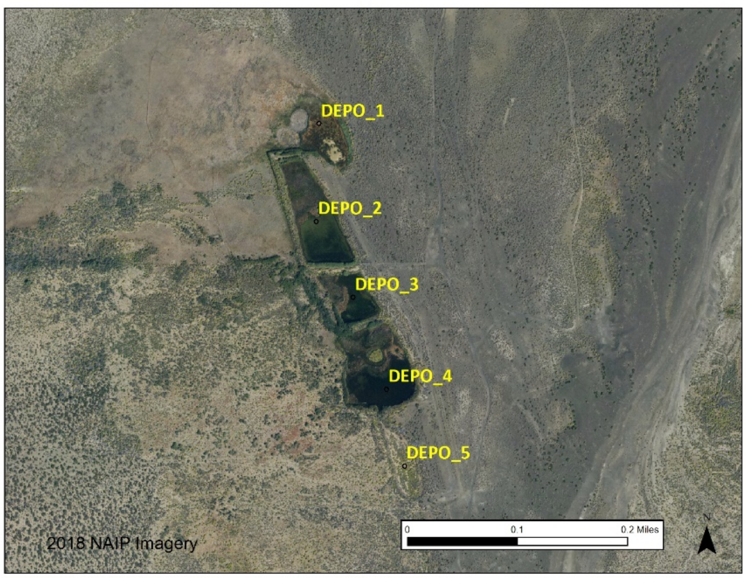

Figure 3-90. DeChambeau Ponds

2018 Imagery courtesy of National Agriculture Imagery Program (NAIP).

The two County Ponds lie in a natural basin and former lagoon that experienced drying as the lake level dropped below 6,405 feet in the 1950's. The County Pond complex consists of two ponds – County Pond East (COPO_E) and County Pond West (COPO_W) (Figure 3-91). Water is delivered to the County Ponds via a pipe from the DeChambeau Ponds. A diversion box exists at the County Ponds to allow some control over water releases to the individual ponds. According to the U.S. Forest Service, County Pond West has been difficult to dry out, and has been subject to cattail overgrowth. In 2020, COPO_W was dry and had a solid cover of dead and dry cattails. COPO_E was also dry in summer. COPO_E has recently also been affected by vegetation encroachment and in 2020, approximately 75% of the pond footprint was covered by dried emergent vegetation.

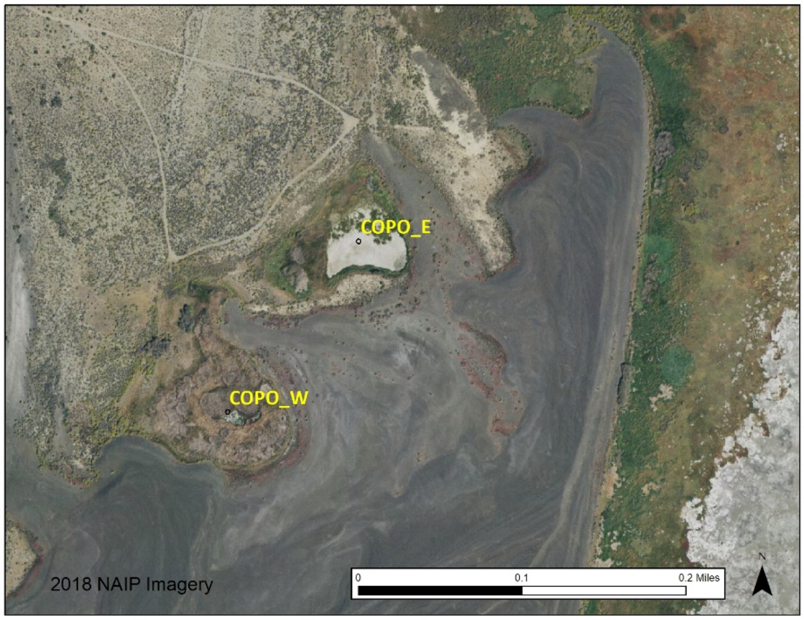

Figure 3-91. County Ponds

2018 Imagery courtesy of National Agriculture Imagery Program (NAIP).

Fall Surveys

In 2020, fall ground and boat surveys were conducted at Mono Lake, Bridgeport Reservoir, and Crowley Reservoir. Surveys were conducted biweekly between August 31 and November 12 (Table 3-23). Although six surveys were scheduled for 2020, the mid-September survey (Survey 2) could not be completed due to persistent hazardous air quality conditions from wildfire smoke. Three to four days were required to complete the surveys at all three sites. Each of the three study sites was divided into shoreline and/or open-water segment areas in order to document the spatial distribution of waterfowl.

Table 3-23. Fall 2020 Survey Dates

Survey Number	Mono Lake	Bridgeport	Crowley
Survey 1	31-Aug-1-Sept	31-Aug	2-Sep
Survey 2	No Survey	No Survey	No Survey
Survey 3	29-Sep	28-Sep	30-Sep
Survey 4	13-14 Oct	13-Oct	14 and 16 Oct
Survey 5	27-28 Oct	26-Oct	26-27 Oct
Survey 6	9-10 Nov	9-Nov	12-Nov

In 2020 fall waterfowl surveys were conducted by the Mono Basin Waterfowl Program Director Deborah House and LADWP Watershed Resources Specialists Bill Deane and Erin Nordin.

<u>Mono Lake</u>

In 2020, fall waterfowl surveys of Mono Lake were conducted primarily by boat, however some areas required a ground survey for adequate coverage. We used a 17-foot Boston Whaler and paralleled the shoreline as closely as was possible given water depths or the presence of submerged objects including tufa or pumice blocks. A speed of approximately 8-10 knots was maintained during most of the shoreline survey. Slower speeds were used when waterfowl flocks were encountered, or when shallow conditions and/or the presence of submerged objects required reduced speeds for safety. On occasion, we stopped on the open water to prevent flushing, or to allow observers improved viewing of waterfowl.

The main area requiring a ground visit in 2020 was Warm Springs. Due to the very gently sloping topography of the east shore, the offshore areas of Warm Springs were too shallow to allow us to approach the shoreline close enough to survey this area by boat. In 2020, the Warm Springs area supported large ponds on shore that were not only not visible from the open water, but were being heavily used by waterfowl. Although other areas such as the Northeast Shore and Bridgeport Creek also have shallow offshore areas, monitoring data has shown these areas support few waterfowl, and mostly Ruddy Ducks, which can be surveyed by boat.

Waterfowl spatial distribution during surveys was recorded using a combination of shoreline subareas and cross-lake transect zones (Figure 3-92). The shoreline was divided into 15 shoreline segments, and waterfowl species and numbers recorded by area. During surveys, the beginning and ending points for each shoreline area were determined using both landscape features and the mobile mapping program Avenza®. Waterfowl not identifiable to species were recorded as the next identifiable taxa higher (e.g. *Aythya* spp.) Waterfowl encountered on the open water were assigned to the appropriate cross-lake transect, however boat surveys did not cover all cross-lake transects surveyed in previous years (LADWP 2018). Cross-lake transects surveyed were those closest to shore, which is also the area where the most Ruddy Ducks have been observed (LADWP, unpublished data).

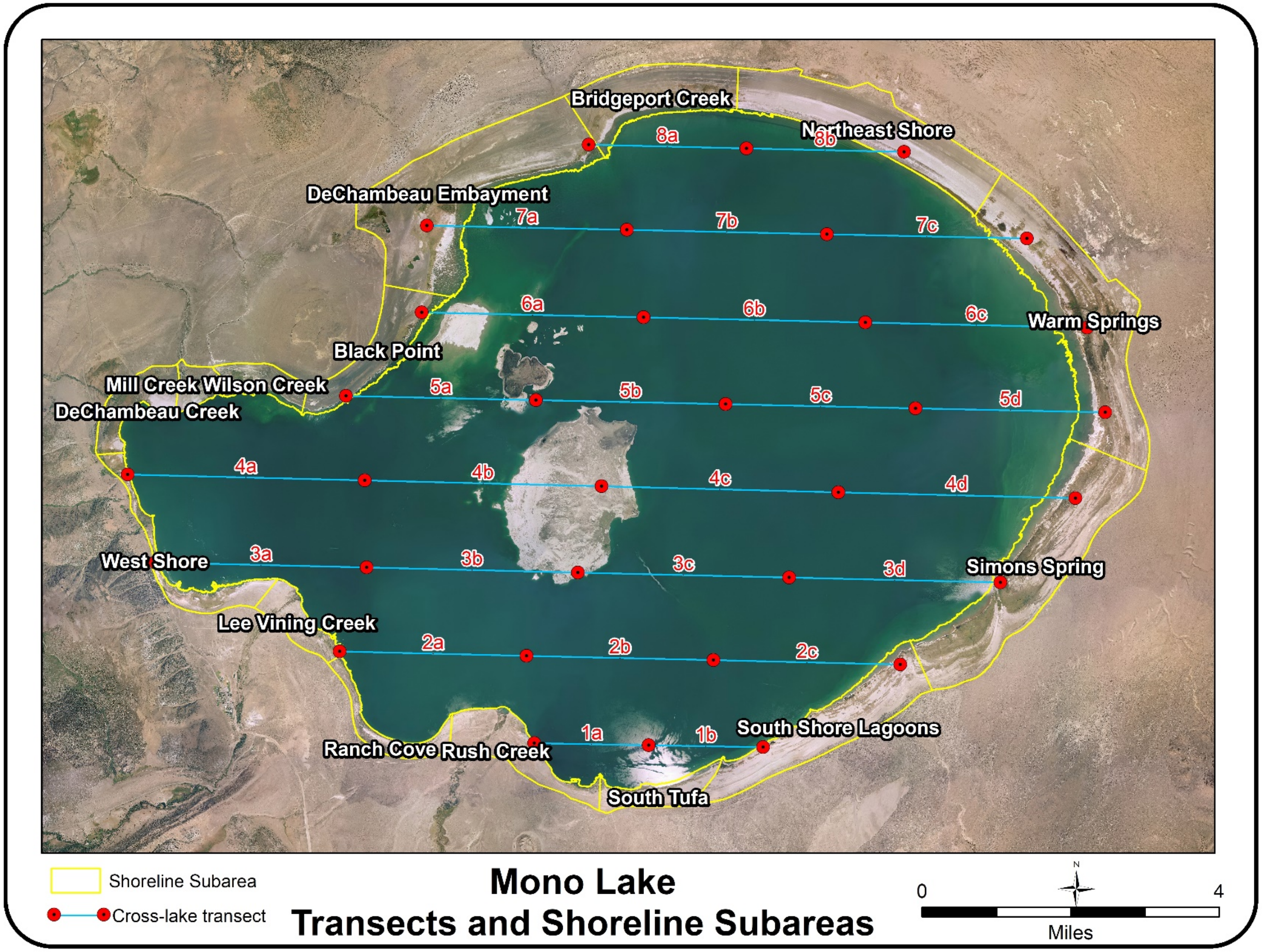

Figure 3-92. Mono Lake Shoreline Subareas and Cross-lake Transects

In 2020, boat surveys covered all shoreline subareas, and those cross-lake transect segments closest to shore.

Restoration Ponds

Four ground surveys were conducted at the DeChambeau and County Restoration Pond complexes. Survey 2 was not conducted due to hazardous wildfire smoke conditions, and Survey 5 due to staffing issues. Waterfowl observations were recorded by pond.

Bridgeport Reservoir

Bridgeport Reservoir is located in Bridgeport Valley in northern Mono County, California, at an elevation of 6,460 feet. Bridgeport Valley has an arid continental climate (Zellmer 1977) and experiences relatively cool, mild summers and cold, snowy winters. The average July temperate is 63°F (17°C), and the maximum July temperature is in the low 90's F. Winters are cold as the average minimum January temperature is 9.1°F, and the average maximum is 42.5°F. Precipitation averages 10 inches (25 cm), most in the form of snow, and Bridgeport averages only 65 frost-free days a year. Bridgeport Reservoir typically freezes over in the winter for varying lengths of time. The mid-November flights are generally ice-free, however in some years, a thin layer of ice is present in some areas of the reservoir.

Bridgeport is part of the hydrologically-closed Walker River Basin, which spans the California/Nevada border. Bridgeport Reservoir, completed in 1923, provides irrigation water to Smith and Mason Valleys in Nevada (Sharpe et al. 2007). Numerous creeks originating from the east slope of the Sierra Nevada drain toward Bridgeport Reservoir. These tributaries are used for upslope irrigation of Bridgeport Valley to support the primary land use of cattle grazing. The creeks directly tributary to the reservoir are the East Walker River, Robinson Creek and Buckeye Creek. Downstream of Bridgeport Reservoir Dam, the East Walker River continues flowing into Nevada, joining the West Walker River, ultimately discharging into the terminal Walker Lake, Nevada. In Nevada, the Walker River system supports extensive agricultural operations.

Bridgeport Reservoir is a small to moderately-sized reservoir with a surface area of approximately 7.4 square miles and a storage capacity of 42,600 acre-feet. The reservoir is rather shallow with a mean depth of 15 feet and a maximum depth of 43 feet (Horne 2003). Irrigated pastures border the south and southwestern portion of the reservoir, while Great Basin scrub is dominant along the north arm and east shore.

Bridgeport Reservoir is eutrophic and experiences summer blooms of blue-green algae of the following genera: *Aphanizomenon*, *Anabaena*, *Microcystis*, and *Gloeotrichia* (Horne 2003). In shallow areas near the deltas, submergent aquatic vegetation is abundant and dominated by water smartweed (*Persicaria amphibia stipulacea*).

In September 2020, Bridgeport Reservoir held 8,631 acre-feet (http://cdec.water.ca.gov/cgi-progs/queryMonthly?s=BDP&d=today). The September 2020 storage level was approximately 50% lower than September of 2019.

Ground surveys were completed using spotting scopes and binoculars at stationary viewing locations accessed from Highway 182, paralleling the east shoreline. Because much of Bridgeport Reservoir is surrounded by private property, ground access is somewhat limited, particularly along the southwestern shoreline where large numbers of waterfowl congregate in fall. Although Bridgeport Reservoir is only moderately-sized, the viewing distance from the east shore to waterfowl in the southwest limited the identification of waterfowl to species on some surveys.

Crowley Reservoir

Crowley Reservoir is located in Long Valley, at an elevation of 6,780 feet. Created by the construction of the Long Valley Dam in 1941, Crowley Reservoir is the second largest lake in Mono County, and the largest reservoir in the county, averaging 13.2 square miles. The primary source of fresh water input to Crowley Reservoir is the Owens River. Other fresh water input includes flows from McGee Creek, Convict Creek, Hilton Creek, and Crooked Creek. Crowley Reservoir also receives spring flow from Layton Springs along the northeast shoreline, and unnamed springs and subsurface flow along the west shore. Crowley is much deeper than Bridgeport Reservoir, with a mean depth of 35 feet and a maximum depth of 125 feet (Corvallis Environmental Research Laboratory and Environmental Monitoring Support Laboratory 1978). Crowley Reservoir is moderately-sized with a storage capacity of 183,465 acre-feet. In September 2020, Crowley Reservoir held 91,182 acre-feet (http://cdec.water.ca.gov/cgi-progs/queryMonthly?s=crw&d=today). The September 2020 storage level was 54% lower than September of 2019.

Crowley Reservoir is eutrophic and experiences summer blooms of the nitrogen-fixing cyanobacteria *Gloeotrichia* in summer, and late-summer and fall season blooms of the cynaobacteria *Aphanizomenon* (Jellison et al. 2003). In shallow areas near the deltas, submergent aquatic vegetation is abundant. Crowley Reservoir is known for supporting a healthy population of midges (Chironomidae).

Ground surveys were completed using spotting scopes and binoculars along shoreline transects or at stationary viewing locations along the shoreline. All seven shoreline areas were surveyed during ground surveys. Ground access is good at most locations of Crowley, but limited in the area of highest waterfowl use in the McGee Bay area. The McGee Bay area was surveyed by walking the shoreline between the McGee/Convict Creek delta and Pelican Point.

3.5.2 Waterfowl Data Summary and Analysis

Summer Ground Surveys

Summer Waterfowl Community

The summer waterfowl community data summary includes all waterfowl breeding, migrant, and non-breeding/oversummering species observed in 2020. Waterfowl species were classified as breeding or nonbreeding based on whether a territorial pair, nest, or brood has been observed over the length of the study. The 2020 summer waterfowl survey data were summarized by survey number. Waterfowl totals by survey (Survey 1 and Survey 2) were compared to the long-term 2002-2020 means +/-SE.

Brood totals for shoreline surveys will be used as an estimate of waterfowl breeding productivity. Brood number totals were determined by eliminating broods potentially double-counted over the season. Brood species, age, size and location were used to determine which broods to eliminate from the total. The calculation of brood parameters included all nesting species except Canada Goose. Canada Goose initiates nesting earlier than the other waterfowl species and family groups can be difficult to approach closely on foot except in areas where they have become habituated to humans. These factors combined with the tendency of this species to be highly mobile has made ageing broods accurately and determining the minimum number of Canada Goose broods difficult. Waterfowl brood totals by survey (Survey 1 and Survey 2) were compared to the long-term 2002-2020 means +/-SE.

The spatial distribution of breeding waterfowl was evaluated by calculating the total number of broods observed on Surveys 1 and Surveys 2 for each shoreline area in 2020.

Habitat Use

Habitat use data were summarized for each breeding species by both modeled and mapped vegetation types (LADWP 2018).

<u>Restoration Ponds</u>

Waterfowl numbers for each pond were summed by survey. The 2020 waterfowl use and total brood results were compared to long-term means for Surveys 1 and 2 for the period 2002-2020.

Fall Surveys

Fall Waterfowl Population Size and Species Composition

Waterfowl species totals were summed by site and survey. Survey totals were compared for each of the five surveys by site.

Spatial distribution

The spatial distribution was evaluated by summing the total waterfowl by site and shoreline area.

Comparison with Reference Data

Waterfowl use of Mono Lake was compared to the reference sites by first calculating annual means +/- SE. For this year, totals excluded Survey 2 to allow comparison with results.

Restoration Ponds

Waterfowl were summed by species across the three annual surveys. Mean annual waterfowl use was calculated for 2002-2019.

3.5.3 Waterfowl Population Survey Results

3.5.3.1 Summer Ground Counts - Mono Lake Shoreline

Summer waterfowl community

In 2020, 950 waterfowl and 13 waterfowl species were observed over the two summer shoreline surveys (Table 3-24) including six breeding and seven non-breeding species. The lingering Blue-winged Teal into July suggests the possibility of breeding, but this was not confirmed. Breeding waterfowl comprised the overwhelming majority of waterfowl present in June (929 of 950). Waterfowl were over twice as abundant in early June as compared to late-June. Of the breeding species, Gadwall was most abundant, comprising 64% of breeding waterfowl at Mono Lake in 2020.

Table 3-24. Summer Ground Count Waterfowl Detections in 2020.

Mono Lake breeding waterfowl species are in bold type.

Species	Survey 1 June 8-12	Survey 2 June 29-July 8	Total Detections
Canada Goose	61	77	138
Blue-winged Teal	5	1	6
Cinnamon Teal	22	11	33
Northern Shoveler	3		3
Gadwall	424	171	595
American Wigeon	1		1
Mallard	99	36	135
Northern Pintail	3		3
Green-winged Teal	13	12	25
Redhead	4		4
Bufflehead	2	2	4
Common Merganser		2	2
Red-breasted Merganser	1		1
Total waterfowl by survey	638	312	950

The total number of breeding waterfowl present on Survey 1 in 2020 was well above the long-term mean. By late-June, numbers had dropped such that totals did not differ from the average long-term mean. Elevated numbers for Survey 1 were due largely to high numbers of Gadwall present (Table 3-25). Canada Goose, Cinnamon Teal, and Mallard numbers were slightly above the mean.

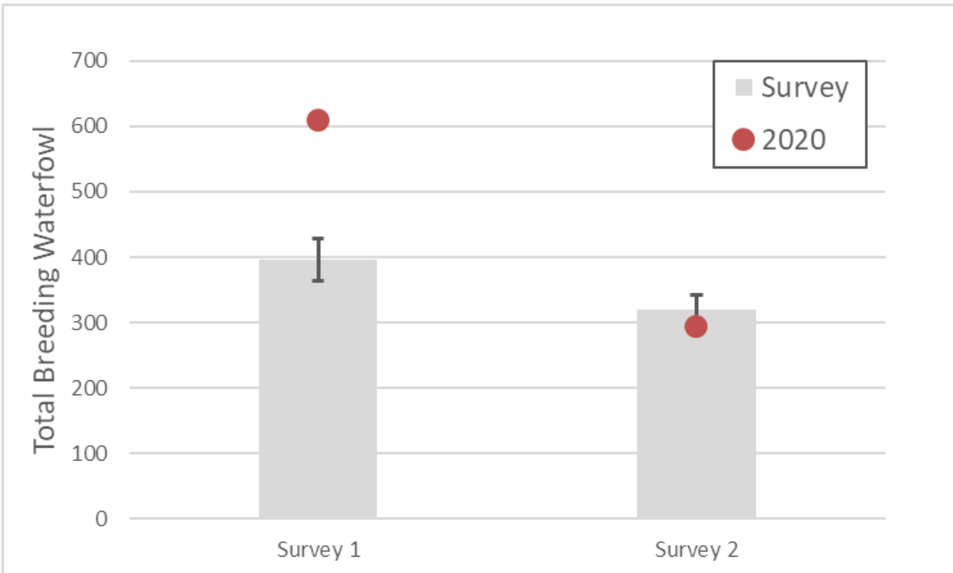

Figure 3-93. 2020 Breeding Waterfowl Population vs. Long-term Mean of Survey 1 and 2

Table 3-25. Breeding waterfowl species totals – 2002-2020 mean +/- SE, and 2020 values

Breeding Species	Survey 1	2020	Survey 2	2020
Canada Goose	49.2 +/- 6.3	61	45 +/- 4.9	77
Cinnamon Teal	14.3 +/- 2.8	22	9.8 +/- 2	11
Gadwall	263 +/- 26.1	424	203.3 +/- 16.7	171
Green-winged Teal	15.4 +/- 1.5	13	14.3 +/- 4.3	12
Mallard	73.2 +/- 6.7	99	40.5 +/- 6.9	36
Northern Pintail	7.4 +/- 2.1	3	4.8 +/- 2.9	0
Ruddy Duck	1.9 +/- 0.6	0	2.4 +/- 0.7	0

A total of 56 waterfowl broods were found on the two surveys conducted in 2020, including three Canada Goose and 53 dabbling duck broods. Breeding was confirmed for five species, with brood numbers highest for Gadwall (Table 3-26). In 2020, broods were found at all shoreline areas, except Warm Springs. Most broods (16; 28%) were found at Wilson Creek. Other areas supporting a large proportion of the broods were South Shore Lagoons, Simons Spring, and Rush Creek.

Table 3-26. Waterfowl Broods by Shoreline Area, 2020

Breeding Waterfowl Species	DECR	LVCR	MICR	RUCR	SASP	SOTU	SSLA	WASP	WICR	Total 2020 Broods (Survey 1 and 2 only)
Canada Goose	3									**3**
Cinnamon Teal							1		1	**2**
Gadwall	1	1	1	4	10	1	10		10	**38**
Green-winged Teal			1						3	**4**
Mallard			1	3	1		2		2	**9**
Total broods per shoreline area	**4**	**1**	**3**	**7**	**11**	**1**	**13**	**0**	**16**	**56**

The total number of dabbling duck broods found on Survey 1 and 2 of 2020 (53) was greater than long-term average of 47.3 +/- 3.7 of all three surveys combined. The number of broods seen on both Survey 1 and Survey 2 in 2020 were the highest over the entire 2002-2020 study period. The number seen on Survey 1 (8) was slightly above the long-term mean, while the number on Survey 2 was well above the long-term mean (Figure 3-94). While conducting Survey 2, an additional 13 potential breeding females and/or pairs of waterfowl were also seen without broods. It is estimated that as many as 13 additional broods may have been produced at Mono Lake in 2020, beyond that detected on Surveys 1 and 2.

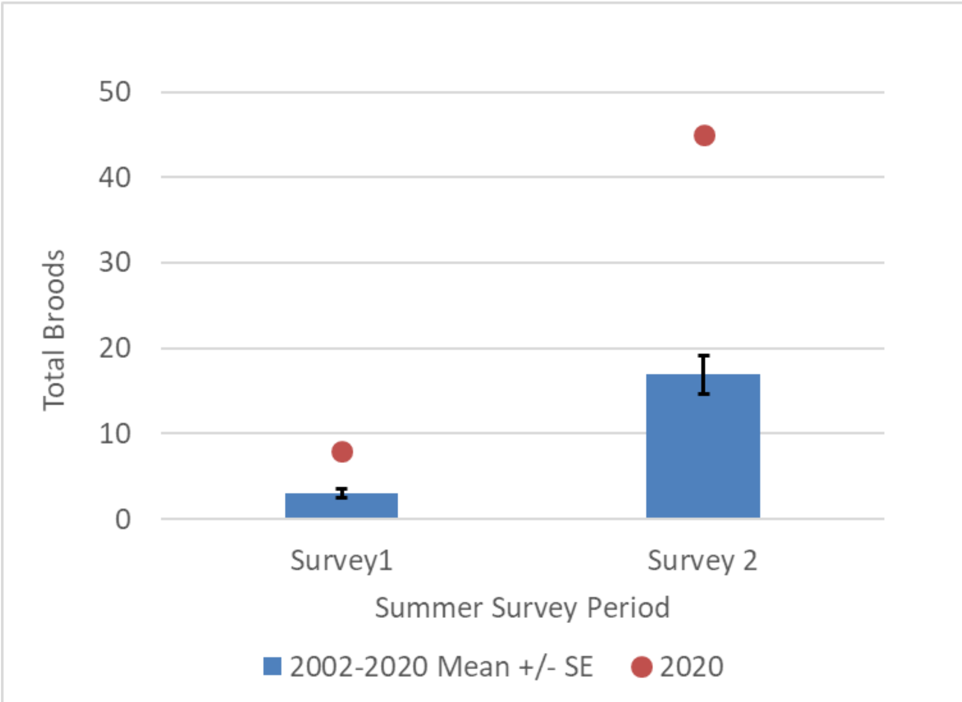

Figure 3-94. Dabbling duck broods seen during each survey period in 2020 as compared to 2002-2020 mean +/- SE.

3.5.3.2 Habitat Use

Most dabbling duck activity was concentrated in and around nearshore water features, primarily freshwater and brackish ponds (Table 3-27). Secondarily, ria was used frequently by Cinnamon Teal, Gadwall and Green-winged Teal, but much less frequently by Mallard. The habitat use patterns of Canada Goose differed from the dabbling duck species in their greater reliance on meadow/marsh landtypes and the open water areas of Mono Lake. Dabbling duck species with broods were seen most frequently in freshwater and brackish ponds, whereas Canada Geese with broods used alkaline wet meadow and brackish ponds. Dabbling ducks fed most often in brackish ponds. Gadwall was the only dabbling duck species that used ria for foraging to any extent in 2020.

Table 3-27. Proportional Habitat use by Breeding Waterfowl Species, 2020

Landtypes		Breeding Waterfowl Species				
Modeled	Mapped	Canada Goose	Cinnamon Teal	Gadwall	Green-winged Teal	Mallard
Meadow Marsh		23%	0%	4%	4%	0%
	Marsh	*0%*	*0%*	*0%*	*0%*	*0%*
	Wet Meadow	*5%*	*0%*	*4%*	*4%*	*0%*
	Alkaline Wet Meadow	*18%*	*0%*	*0%*	*0%*	*0%*
	Dry Meadow/Forb	*0%*	*0%*	*0%*	*0%*	*0%*
Water		20%	79%	66%	72%	91%
	Freshwater Stream	*0%*	*0%*	*2%*	*0%*	*6%*
	Freshwater Pond	*0%*	*59%*	*20%*	*52%*	*62%*
	Brackish Pond	*20%*	*21%*	*44%*	*20%*	*23%*
	Hypersaline Pond	*0%*	*0%*	*0%*	*0%*	*0%*
	Mudflat	*0%*	*0%*	*0%*	*0%*	*0%*
Upland		0%	0%	0%	0%	0%
Ria		2%	21%	18%	20%	5%
Riparian		0%	0%	0%	0%	0%
Barren Lake Bed		29%	0%	11%	4%	3%
Open Water		27%	0%	1%	0%	1%

Summer Ground Counts - Restoration Ponds

In 2020, only two species of waterfowl were seen at the Restoration Ponds, Gadwall and Ruddy Duck (Table 3-28). A total of 17 waterfowl were recorded on the two surveys, and most all use was observed in DEPO_04. The number of waterfowl observed on Survey 1 and Survey 2 in 2020 were well below the long-term 2002-2020 average (Figure 3-95). Two Gadwall and two Ruddy Duck broods were seen in DEPO_04. Two additional Gadwall without broods were at DEPO_04 on Survey 2. It is possible these were breeding ducks and up to two more broods may have been produced at the ponds.

Table 3-28. Total Waterfowl by Species, Pond and Survey Number

		Pond						
	Species	DEPO_01	DEPO_02	DEPO_03	DEPO_04	DEPO_05	COPO_W	COPO_E
Survey 1	Gadwall				1			
	Ruddy Duck		4		3			
Survey 2	Gadwall				4			
	Ruddy Duck				5			

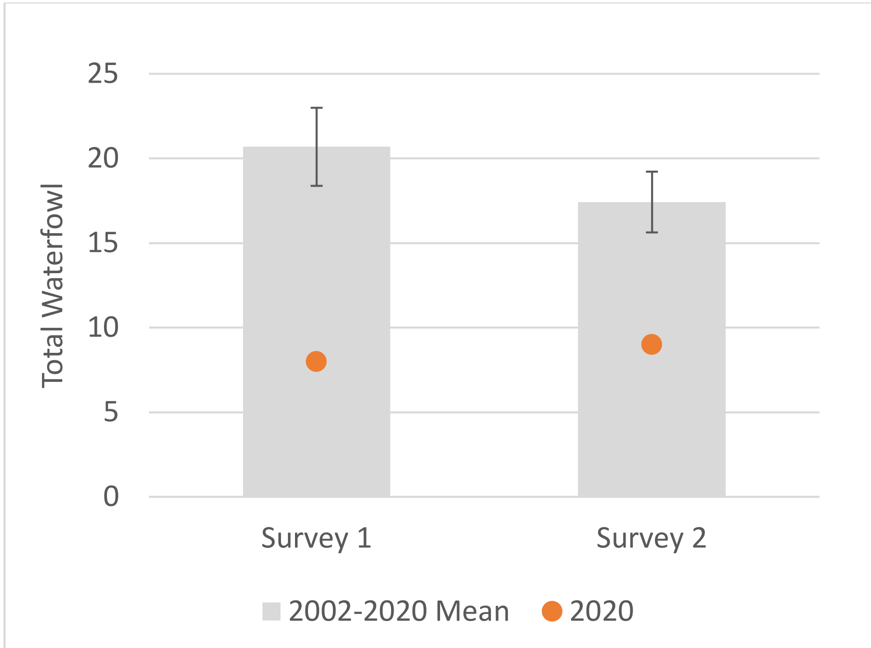

Figure 3-95. Restoration Pond Waterfowl Totals on Survey 1 and 2 in 2020

The 2002-2020 Long-term mean +/- standard error (SE) is shown for reference.

3.5.3.3 Mono Lake Fall Surveys

Fall Waterfowl Population Size and Species Composition

A total 21 waterfowl species and 14,274 individuals were detected during the five 2020 Mono Lake fall surveys (Table 3-29**Error! Reference source not found.**). Northern Shoveler and Ruddy Duck were the most abundant species, and combined, comprised 88% of all waterfowl. Northern Shoveler have typically shown a seasonal peak in numbers on the Early- or Mid-September survey, followed by a dramatic decline through the remainder of the season. In 2020, numbers were highest at the end of September as well, however a significant second pulse of birds arrived at Mono Lake in mid-November. Ruddy Duck numbers typically show a seasonal peak the end of September through the end of October, and in 2020, peak numbers were observed on the End-of-October survey.

Table 3-29. Species Totals, 2020 Mono Lake Fall Waterfowl Surveys

Species	Early Sept	Mid-Sept	End Sept	Mid-Oct	End Oct	Mid-Nov	Species Totals
Snow Goose	0	No Survey Due To Wildfire Smoke	0	0	11	4	15
Ross's Goose	0		0	0	0	1	1
Greater White-fronted Goose	0		1	0	0	0	1
Canada Goose	0		2	0	24	58	84
Tundra Swan	0		0	0	2	2	4
Blue-winged Teal	0		0	0	2	0	2
Cinnamon Teal	32		15	0	0	3	50
Northern Shoveler	1295		2842	84	79	1189	5489
Gadwall	164		18	5	20	10	217
American Wigeon	0		8	19	0	8	35
Mallard	62		49	41	68	23	243
Northern Pintail	1		8	1	0	5	15
Green-winged Teal	68		135	64	249	161	677
Unidentified Teal	5		100	163	0	1	269
Redhead	0		0	0	0	1	1
Ring-necked Duck	0		3	0	0	0	3
Lesser Scaup	0		0	20	9	0	29
Bufflehead	0		0	1	4	26	31
Hooded Merganser	0		0	0	0	3	3
Common Merganser	1		0	0	0	0	1
Red-breasted Merganser	0		0	0	1	2	3
Ruddy Duck	17		1533	1511	2797	1228	7086
Unidentified Diving Duck	0		0	15	0	0	15
Total	**1645**		**4714**	**1924**	**3266**	**2725**	**14274**

Total waterfowl use has varied temporally at Mono Lake, with use highest during the month of September (Figure 3-96). In 2020, waterfowl totals were significantly below the long-term means early in the season (Early September through mid-October) and above the long-term mean late in the season (End of October and mid-November). This early season peak has been largely due to the abundance of Northern Shovelers in September. After the end of September, waterfowl numbers at Mono Lake usually decline substantially, again driven largely by Northern Shoveler abundance and the departure of most shovelers from the Mono Basin.

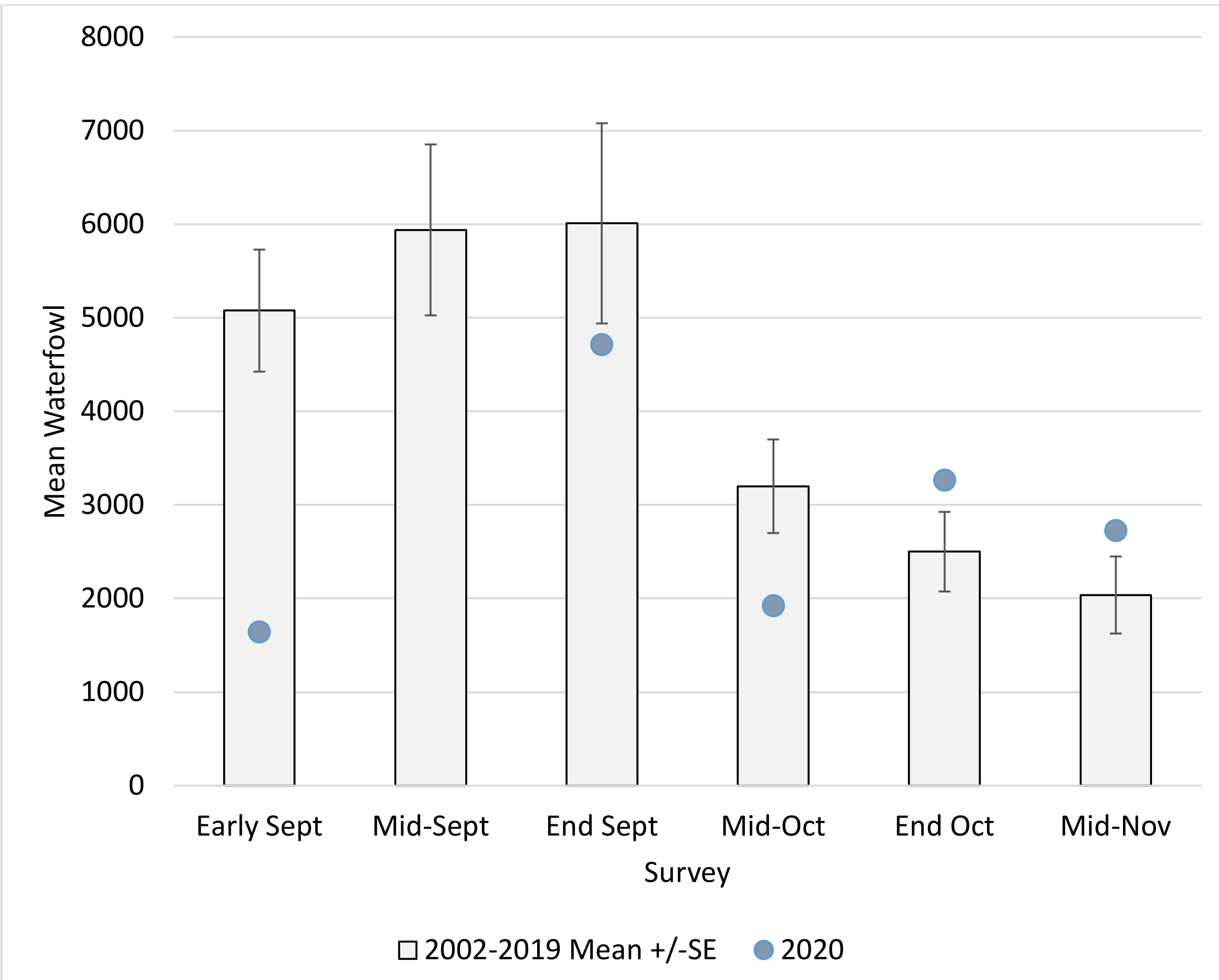

Figure 3-96. 2020 Mono Fall Waterfowl Survey Totals and 2002-2020 Means

Spatial Distribution

At Mono Lake, the majority of waterfowl in fall were seen in the Wilson Creek area or offshore, primarily in the eastern part of the lake (Figure 3-97). Wilson Creek is typically the main staging area for Northern Shoveler in fall, and often the only location where large numbers are seen (1,000s). Offshore use was almost entirely by Ruddy Ducks, and large numbers were congregating in the eastern portion of the lake in 2020. The above-average use of the shoreline areas in the eastern portion of the lake, including BRCR, DEEM, NESH and WASP was due largely to the presence of Ruddy Duck flocks close to shore in these areas as well as off-shore. Waterfowl use by species other than Ruddy Duck was high in the Warm Springs area where heavy grazing by feral horses has opened up areas previously covered in dense mats of alkali meadow vegetation. In addition, the presence of a large brackish pond on shore from summer through fall, created excellent foraging conditions for waterfowl and shorebirds.

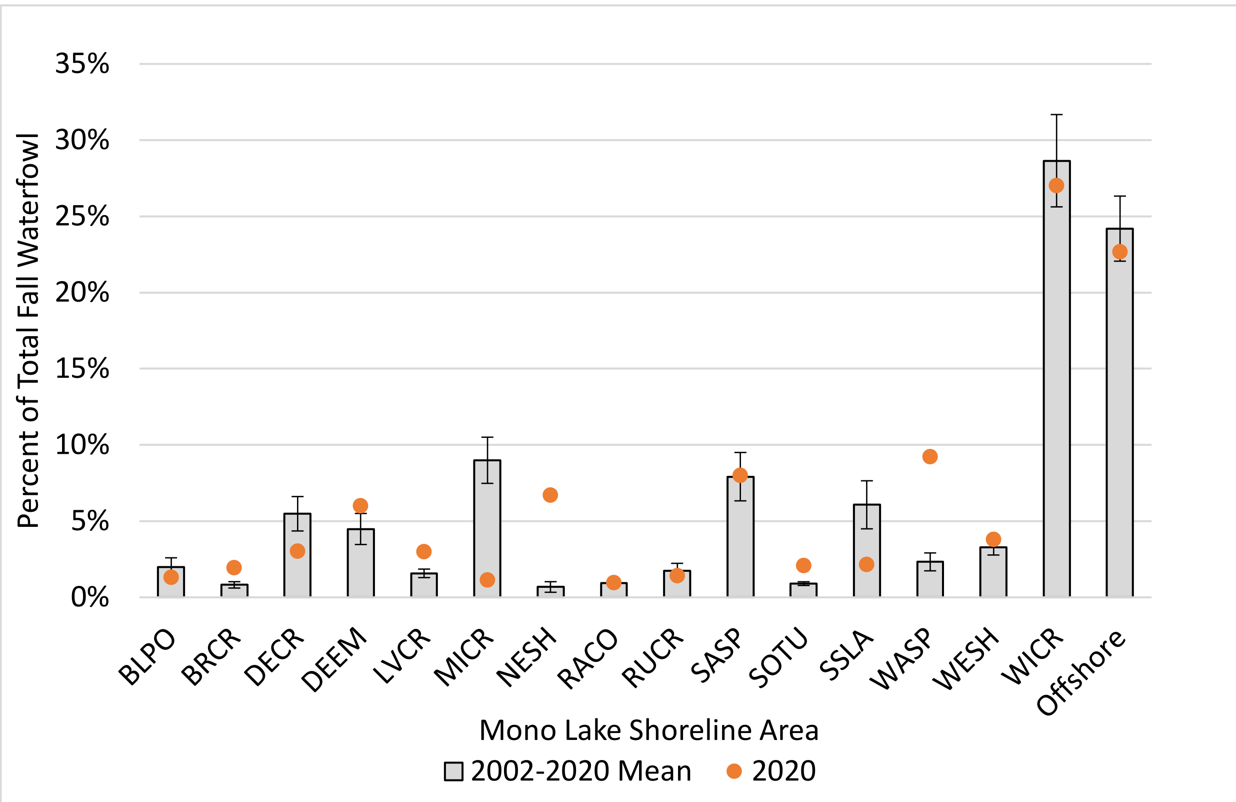

Figure 3-97. Fall Spatial Distribution of Waterfowl at Mono Lake, 2020

Bridgeport Reservoir

Fall Waterfowl Totals and Species Composition

A total of 20 waterfowl species and 27,346 individuals were recorded at Bridgeport Reservoir over the five fall surveys in 2020 (Table 3-30). Geese and swans comprised approximately 10% of all waterfowl, and of this group, only Canada Goose was abundant and present on all surveys. Dabbling ducks totaled 67% of all waterfowl, and of the seven dabbling duck species identified, Northern Shoveler and Green-winged Teal were most abundant. Up to one-third of all dabbling ducks were not identified to species, due to the observation distance – the majority in the month of September. The most species-rich group was diving ducks, with nine species detected and divers as a whole comprised approximately 21% of all waterfowl.

Table 3-30. Species Totals, 2020 Bridgeport Reservoir Fall Waterfowl Surveys

Species	Early Sept	Mid-Sept	End Sept	Mid-Oct	End Oct	Mid-Nov	Species Totals
Snow Goose	-	No Survey Due To Wildfire Smoke	-	-	1	-	1
Greater White-fronted Goose	-		2	-	-	-	2
Canada Goose	430		612	771	702	410	2,925
Tundra Swan	-		-	-	-	15	15
Cinnamon Teal	15		-	-	-	-	15
Northern Shoveler	2,582		402	1,306	-	-	4,290
Gadwall	30		50	55	31	1	167
American Wigeon	1		10	-	-	-	11
Mallard	20		81	404	52	160	717
Northern Pintail	21		100	20	140	61	342
Green-winged Teal	630		560	813	287	895	3,185
Unidentified teal	4,030		4,304	650	400	438	9,822
Canvasback	-		-	4	30	-	34
Redhead	-		4	-	10	-	14
Ring-necked Duck	-		2	-	2	-	4
Lesser Scaup	-		-	-	28	7	35
Bufflehead	-		-	6	81	18	105
Common Goldeneye	-		-	-	-	10	10
Hooded Merganser	-		-	-	8	1	9
Common Merganser	21		40	45	7	3	116
Ruddy Duck	1		571	2,812	1,602	541	5,527
Total	7,781		6,738	6,886	3,381	2,560	27,346

Spatial distribution

Of the three subareas at Bridgeport Reservoir, waterfowl numbers were highest in the West Bay throughout the season (Table 3-31**Error! Reference source not found.**). Waterfowl were found throughout the West Bay and among the several deltas and inlets created where Buckeye Creek, Robinson Creek, and the East Walker River enter the West Bay. Geese were most often found out on the meadows in this area away from the water's edge. Waterfowl use in the East shore subarea occurred primarily in the southern half of this segment area, in proximity to inflow from the East Walker River and shallow water feeding areas and mudflats. In the North Arm, waterfowl tended to be few in number and scattered along the immediate shoreline area.

Table 3-31. Bridgeport Reservoir, Spatial Distribution by Survey, 2020

Survey	EASH	NOAR	WEBA
Early September	859	21	6,901
Mid-September	No Survey		
End of September	811	50	5,877
Mid-October	1,516	45	5,325
End of October	385	12	2,984
Mid-November	271	403	1,886
Total waterfowl by shoreline segment	**3,842**	**531**	**22,973**

3.5.3.4 Crowley Reservoir

Fall Waterfowl Totals and Species Composition

A total of 19 waterfowl species and 51,194 individuals were recorded at Crowley Reservoir over the five fall surveys in 2020 **(**Table 3-32). Geese and swans comprised only 1.3% of all waterfowl. Dabbling ducks totaled 64% of all waterfowl, and of the seven dabbling duck species identified, Northern Shoveler, Mallard, and Green-winged Teal were most abundant. Seven species of diving ducks were observed and divers as a whole comprised approximately 35% of all waterfowl. Ruddy Duck was overwhelmingly the most abundant of the divers.

Table 3-32. Species Totals, 2020 Crowley Reservoir Fall Waterfowl Survey

Species	Early Sept	Mid-Sept	End Sept	Mid-Oct	End Oct	Mid-Nov	Species Totals
Snow Goose	-	No Survey Due To Wildfire Smoke	-	2	25	24	51
Ross's Goose	-		-	-	1	-	1
Cackling Goose	-		-	3	12	-	15
Canada Goose	54		144	73	50	9	330
Tundra Swan	-		-	-	149	106	255
Cinnamon Teal	196		5	-	-	-	201
Northern Shoveler	4634		2690	272	143	39	7778
Gadwall	1354		291	211	96	82	2034
American Wigeon	16		110	220	57	291	694
Mallard	1255		2108	1040	323	1201	5927
Northern Pintail	173		801	233	31	29	1267
Green-winged Teal	69		962	2982	1808	1289	7110
Unidentified Teal	-		3570	-	150	4055	7775
Canvasback	-		-	33	35	7	75
Redhead	8		20	27	9	-	64
Ring-necked Duck	12		10	8	14	90	134
Lesser Scaup	-		-	81	97	13	191
Surf Scoter	-		-	1	1	-	2
Bufflehead	-		10	43	284	144	481
Ruddy Duck	41		2784	6383	4082	3519	16809
Total	7812		13505	11612	7367	10898	51194

Spatial Distribution

During the 2020 surveys, the largest waterfowl concentrations at Crowley Reservoir were in McGee Bay and the delta of the Owens River (Table 3-33**Error! Reference source not found.**), with more than twice as many in McGee Bay. Waterfowl in McGee Bay used the entire shoreline area, although higher densities were observed near the McGee Creek delta and spring outflow areas. The other area of waterfowl concentration was the Upper Owens River delta where flows from the Owens River enter the reservoir. Except at very high reservoir levels, this area has extensive mudflats for loafing, shallow feeding areas, and quiet backwater bays. Due to a low reservoir level in late fall at Crowley, the Upper Owens shoreline segment area appeared to be reduced in extent as compared to most years. During early season surveys, waterfowl generally avoid the Chalk Cliffs area as there are limited feeding opportunities due the deep water and lack of fresh water inflow. Waterfowl continued to show a pattern, however, of late-season use of the Chalk Cliffs area when significant numbers of dabbling ducks are then seen offshore or loafing along the narrow, dry beach. Yearly, increased use of Chalk Cliffs area has coincided with the opening of waterfowl hunting season, and waterfowl may be seeking refuge in this area of more difficult access. Hilton Bay has good waterfowl habitat with adjacent meadows, some fresh water inflow, and shallow waters, but the area is small in size, and supports fewer numbers of waterfowl than areas of comparable quality, likely because of the size difference. Waterfowl use of the Layton Spring subarea is usually concentrated near the spring inflow. Birds may also be scattered in smaller numbers along the mudflats or nearshore throughout the remainder of the subarea which is primarily sandy beach. North Landing is another shoreline area with no direct fresh water inflow, and limited shallow water areas near shore and typically supports lower waterfowl use. The Sandy Point subarea is also an area of limited use by waterfowl due to a lack of freshwater input and limited shallow feeding areas.

Table 3-33. Crowley Reservoir, Spatial Distribution by Survey, 2020

Survey	CHCL	HIBA	LASP	MCBA	NOLA	SAPO	UPOW
Early September	-	106	20	6,225	48	14	1,399
Mid-September	No Survey						
End of September	6	114	127	7,439	12	10	5,797
Mid-October	33	491	133	9,204	6	21	1,724
End of October	290	610	409	3,894	382	320	1,462
Mid-November	761	384	451	5,830	352	524	2,596
Total waterfowl by shoreline segment	1,090	1,705	1,140	32,592	800	889	12,978

Comparison to Reference Sites

Annual waterfowl totals from 2003-2020, excluding Survey 2 have differed among sites (Figure 3-98). Waterfowl numbers have been significantly higher at Crowley Reservoir than the other two sites. Totals for Bridgeport Reservoir have been significantly higher than Mono Lake. In 2020, waterfowl use of Bridgeport Reservoir did not differ significantly from the long-term mean. Totals at Crowley Reservoir were slightly above the mean and Mono Lake slightly below the long-term mean.

The species composition of the waterfowl community at Mono Lake also differs notably from the other two survey areas in that it is dominated primarily by two species typically associated with saline lakes – Northern Shoveler and Ruddy Duck. In contrast, the waterfowl communities of Bridgeport and Crowley Reservoirs are more diverse, and have numerous codominant species as is typical of fresh water systems.

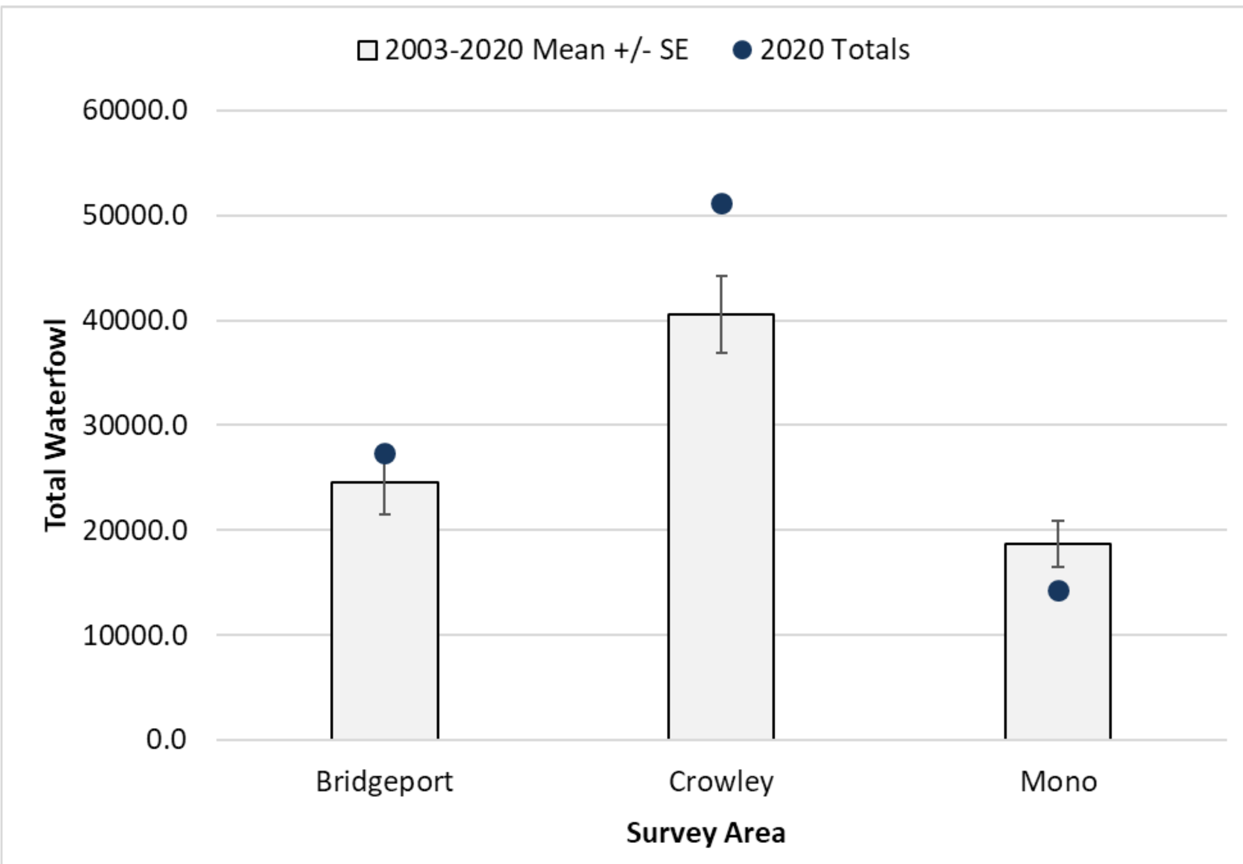

Figure 3-98. Comparison of Mean Fall Waterfowl at each of the Three Surveys Areas, 2003-2020

The totals compared here are excluding numbers from Survey 2 in order to present comparable data.

3.5.3.5 Restoration Ponds

Through October, the only ponds with water were DEPO_2 and DEPO_4. On the November 9 survey, water was also present in DEPO_3 and COPOE, however these ponds were frozen over, along with DEPO_2. The only two ponds supporting waterfowl in fall were DEPO_2 and DEPO_4, with the majority of birds in DEPO_4 (Table 3-34). Gadwall and Green-winged Teal were most abundant. The 2020 total of 66 waterfowl over the four surveys was significantly below the 2002-2020 mean of 181.9 +/-72.

Table 3-34. Results of Four Restoration Ponds Fall Waterfowl Surveys, 2020

	Restoration Pond							
Waterfowl Species	COPOE	COPOW	DEPO_1	DEPO_2	DEPO_3	DEPO_4	DEPO_5	**Total**
Bufflehead						1		1
Gadwall				3		32		35
Green-winged Teal						24		24
Ruddy Duck				4		1		5
Unidentified Teal						1		1
Pond totals	Dry/Frozen	Dry	Dry	7	Dry/Frozen	59	Dry	66

3.5.4 Waterfowl Survey Discussion

3.5.4.1 Summer Ground Surveys – Mono Lake Shoreline

Breeding Population Size and Composition

Breeding waterfowl activity was good at Mono Lake in 2020 with above-average brood numbers, despite missing Survey 3. Since 2002, new brood numbers have been highest on Survey 3 every year except one (2015). Above-average brood numbers on Survey 1 and Survey 2, with few broodless hens or pairs remaining, strongly suggests earlier than normal breeding in 2020.

Spatial distribution

Breeding waterfowl are concentrated into highly localized areas around the shoreline of Mono Lake, where fresh water resources occur for young ducklings. In 2020, breeding conditions were good at Wilson Creek and Simons Spring. In addition to South Shore Lagoons, Wilson Creek has been one of main waterfowl breeding areas. The Wilson Creek delta has abundant spring flow, a shallow sheltered bay which may enhance fresh water resources into the bay, and in 2020, a fresh water pond along the west side of the bay. The fresh water pond attracted significant breeding waterfowl use and brooding. Wilson Creek below the Pumice Mine Road was periodically dewatered in 2020 (D. House, pers. obs.), and the effect this may have on waterfowl habitat in Wilson Creek not clear, although conditions remained good in 2020.

Conditions at Simons Spring were enhanced by the presence of numerous small fresh water ponds along shore, and the shift in the outflow of Goose Springs from the South Shore Lagoons shoreline area, into the Simons Spring shoreline area, creating good feeding conditions. Conditions in the vicinity of Goose Springs have been slowly deteriorating over the last several years, and this change in water flow may accelerate the deterioration and it will virtually eliminate fresh water flow into onshore ponds. The fresh water ponds may be further encroached by emergent vegetation, and onshore brackish ponds may dry.

Habitat Use

Many studies have shown that waterfowl breeding productivity is linked to the abundance and quality of open water wetlands and ponds supporting high densities of aquatic invertebrates (Cox et al. 1998, Pietz et al. 2003, Kaminski and Prince 1981, Krapu et al. 1983). In addition, the abundance and availability of aquatic invertebrates limits the number of breeding waterfowl and waterfowl brood survival (Sjoberg et al. 2000). Habitat use patterns of the breeding waterfowl community at Mono Lake suggest that freshwater ponds, brackish ponds and ria are key habitat features that support the breeding waterfowl community at Mono Lake.

Young ducklings require fresh water in order to survive and gain weight (Swanson et al. 1984), and thus freshwater resources are a necessary component of the habitat of the breeding waterfowl community at Mono Lake. Freshwater resources at Mono Lake include freshwater ponds, freshwater streams, spring outflow and deltas, where a fresh water lens might occur depending on weather conditions, flow, and shoreline topography.

In 2020, breeding dabbling duck activity was concentrated in and around freshwater and brackish ponds, while Canada Goose used meadows areas. Freshwater ponds are an important component of the breeding waterfowl habitat at Mono Lake that was used by all dabbling ducks species, but not Canada Goose. Freshwater outflow areas of creeks and springs (=”ria”) were used primarily by Gadwall for feeding, suggesting a use of *Artemia*. Brackish ponds at Mono Lake were used heavily by all waterfowl for feeding, including hens with broods. Although not studied, the use of brackish ponds by waterbirds at Mono Lake (D. House, pers. obs.) suggests they can be highly productive systems. The presence of brackish ponds, particularly when associated with or near freshwater ponds enhances habitat productivity and available feeding opportunities for breeding waterfowl at Mono Lake. The only species that regularly used meadow habitats was Canada Goose, which was often seen feeding with broods in alkaline wet meadow habitats near or on shore. Canada Goose is almost exclusively herbivorous feeding on roots, leaves, and tubers of emergent wetland plants and submerged aquatic plants. Mono Lake lacks submerged aquatic plants due to the salinity of the lake, and thus the sedges, grasses, and other herbaceous vegetation in shoreline meadow habitats at Mono Lake are the prime feeding areas for this species.

3.5.4.2 Summer Ground Surveys - Restoration Ponds

Waterfowl habitat at the Restoration Ponds continues to be impacted by ageing infrastructure and water delivery problems. Over the last several years, most breeding waterfowl and broods have been at DEPO_04 and COPO_E. During the summer ground count period in 2020, however, only DEPO_2 and DEPO_4 were flooded. Breeding waterfowl use was confined primarily to DEPO_4 and the resulting use was well below the long-term mean.

3.5.4.3 Fall Aerial Counts

Mono Lake - Population Size and Species Composition

Waterfowl use at Mono Lake in fall 2020 showed another slight increase as compared to last year, potentially indicating continued recovery from the extended drought ending in 2017, however totals were still slightly below the long-term average. A slight seasonal shift in use was observed in 2020. Past monitoring has shown that waterfowl totals at Mono Lake have been highest during the month of September, with a significantly reduced numbers mid-October through mid-November. In 2020, the seasonal peak at Mono Lake was in late-September, however all counts through September were below the long-term mean. A second pulse of Northern Shoveler arrived at the end of October, however, resulting above-average counts on the late fall counts. It is possible that early season Northern Shoveler flocks at Mono Lake may be originating from a different source population than those arriving later in fall. The second pulse of birds may also be due to seasonal change in weather conditions on the breeding grounds or along migration corridors, pushing birds farther south. Seasonal shifts such as this could also be an indication of waterfowl response to climate change. Waterfowl migration patterns have been observed to change over time (Lehikoinen and Jaatinen 2012, Reese and Weterings 2018), and the timing of waterfowl use may be useful for assessing waterfowl response to regional or local changes in conditions including those induced by climate change.

Waterfowl at Mono Lake appear to respond to local conditions, as spatial distribution patterns would indicate. The spatial distribution of waterfowl at shoreline sites in fall also suggests that waterfowl habitat at Mono Lake is highly localized. Although the Wilson Creek area makes up <2% of the entire shoreline area, it supported 27% of all dabbling ducks in 2020. The combination of abundant spring flow, extensive wet meadow habitat upgradient, and shallow offshore gradient in the Wilson Creek bay contribute to creating a favorable shallow water feeding and loafing area for fall migrant waterfowl. Waterfowl also responded favorably to improved foraging conditions in the Warm Springs area, where wet conditions and heavy grazing by feral horses has opened up areas previously covered in dense mats of alkali meadow vegetation. In addition, the large brackish pond on shore from summer through fall, created excellent foraging conditions for waterfowl and shorebirds and contributed to the increased numbers of waterfowl in the Warm Springs area. Use of Mill Creek in 2020, was very low, although this area has on average, supported approximately 10% of all fall waterfowl. Use of the South Shore Lagoons shoreline area was also low, possibly due to small scale habitat changes noted earlier that affect the quality and quantity of fresh and brackish ponds onshore.

A time budget study of waterfowl use of shoreline areas and habitats during fall migration would document how fall migratory waterfowl use different shoreline subareas and habitats for feeding, drinking, roosting, or bathing. An understanding of how waterfowl use each subarea and habitat in fall, would provide a greater understanding of the specific resources available for waterfowl around the lake, and how they support migratory waterfowl populations.

Waterfowl at Bridgeport and Crowley Reservoirs were similarly concentrated in around areas of fresh water inflow. Several creeks and potentially subsurface inputs from adjacent irrigated pastures exist along the West Bay portion of Bridgeport Reservoir where waterfowl congregate. These delta areas also provide shallow feeding areas and protected bays ideal for dabbling ducks. At Crowley Reservoir, waterfowl concentrated in the McGee Bay and Upper Owens River delta areas. The McGee Bay subarea receives inflow from Convict and McGee Creeks, and spring flow and subsurface flows from irrigation upgradient. Wetland vegetation often extends to the shoreline, with small areas of mudflats present at all except the highest reservoir levels. The other area of waterfowl concentration is the Upper Owens River delta where flows from the Owens River enter the reservoir. Except at very high reservoir levels, this area has extensive mudflats for loafing, shallow feeding areas, and quiet backwater bays.

Waterfowl populations at Mono Lake are relatively small compared to Bridgeport and Crowley, likely due to a combination of salinity and water depth which limits feeding opportunities. Salinity and water depth influence not only the types and abundance of food items, but also accessibility. Mono Lake is deep, highly saline, with limited shallow shoreline areas. Despite the productivity of Mono Lake, access of these food resources to dabbling duck species like Northern Shoveler is somewhat limited. The topography and bathymetry are such that shallow-water feeding areas, especially those near springs, are widely spaced and not extensive. The range of water depths for optimal foraging by dabbling ducks is 2-10 inches. Prey will generally be less accessible in water depths greater than about 10 inches, and thus foraging efficiency will decrease. At Mono Lake, dabbling ducks have been observed to feed almost exclusively near shore, and more specifically, where the bathymetry data suggests a greater extent of shallow water than areas where waterfowl use is lower or absent.

The highly saline water of Mono Lake currently only support *Artemia* and *Ephydra*, however other species may have occurred historically when the lake was no more than 50 gm/L salinity. The highly saline water also limits the availability of vegetable food sources favored by many dabbling duck species in fall, to isolated fresh water and brackish ponds since the salinity of the lake is above the tolerance of wetland plants.

These features limit the habitat quality for waterfowl and may ultimately limit recovery of waterfowl populations. In order for waterfowl to meet their energetic demands, food resources need to be accessible, abundant, and of sufficient quality.

4.0 SUMMARY AND RECOMMENDATIONS

The Mono Basin Waterfowl Habitat Restoration Program was developed to evaluate the effect of changes in the Mono Lake area relative to the restoration objectives, and to provide information to guide future restoration activities. The program has included a number of restoration projects, objectives, and monitoring projects. Restoration has included establishing a target lake elevation, reestablishing perennial flow in tributaries, channel openings, providing financial assistance for the restoration of waterfowl habitat, and exotic species control. Ecological conditions in the Mono Basin have improved considerably as a result of the restoration program.

The implementation of Decision 1631 appears to have resulted in the lake level stabilization, although Mono Lake is still well below the target lake level 27 years later. Climatic factors may be influencing Mono Lake and its recovery. Current trends indicate seasonal increases in salinity and water temperature, a finding aligned with regional climatic trends. Based on our analysis, without sustained high freshwater input, the trend of increasing salinity cannot be reversed. The recent pattern of shortened wet periods affects freshwater input, and future limnological conditions of Mono Lake will largely depend on runoff conditions.

Within the range of lake elevations observed since 2002, shoreline waterfowl habitat in general shows improvement at higher lake level. These improvements include increased shoreline pond acreage and increased connectivity of shoreline ponds with the shoreline and spring outflow areas. Breeding waterfowl have been very responsive to lake level increases, however fall migratory populations have not.

Mono Lake is deep, highly saline, with limited shallow shoreline areas. These features limit the habitat quality for waterfowl and may ultimately limit recovery of waterfowl populations. In order for waterfowl to meet their energetic demands, food resources need to be accessible, abundant, and of sufficient quality. The current trends seen in the data with regard to salinity and water temperature, if continued, will also influence waterfowl habitat conditions at Mono Lake.

1) **Waterfowl time budget study -** Order 98-05 required a time budget study to be conducted during each of the first two fall migration periods after the plan was approved, and again when Mono Lake reaches its target lake elevation. A single time budget study of Ruddy Ducks was completed in fall of 2000 by Jehl. We recommend the Mono Basin Waterfowl Program Director develop a study plan for the second required time budget study focusing on shoreline use by waterfowl. Although originally

scheduled for 2020, situations beyond our control necessitated rescheduling to fall of 2021. A time budget study allows for the determination of the relative importance of different shoreline sites for migratory waterfowl, and would provide insight into the importance of hypopycnal areas for feeding, resting, or drinking.

2) **Restoration Pond Management** - Order 98-05 provided for funds to be set aside for waterfowl habitat restoration in the Mono Basin. The Restoration Ponds represent a potential location in the Mono Basin for waterfowl habitat enhancement. Waterfowl habitat at the Restoration Ponds would benefit from upgrades to the existing water delivery system to allow for more flexibility in water delivery to individual ponds. The system is also in need of repair, as recent failures in the water delivery infrastructure have affected pond habitat, and at the time of writing, some infrastructure repairs have been made. We also recommend that Restoration Ponds managers consider implementing a system of rotational seasonal flooding of the ponds to improve pond productivity and waterfowl use. Seasonal flooding is a waterfowl habitat management technique used at most waterfowl management areas and wildlife refuges in California to manage waterfowl habitat. Continuous inundation of wetlands will lead to decreased productivity of waterfowl forage plants and invertebrates supported by them. Seasonal flooding programs can also be used to control emergent vegetation and maintain open water habitats. Seasonal manipulation of water delivery should be considered as a tool to aid in long-term management of emergent vegetative growth impacting waterfowl habitat at the Restoration Ponds. Thus, moving away from continual year-round inundation of ponds to seasonal or rotational flooding is encouraged and recommended.

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