NEVADA DEPARTMENT OF WILDLIFE
STATEWIDE FISHERIES MANAGEMENT

FEDERAL AID JOB PROGRESS REPORT

Desert Terminal Lakes 84240-6-J
and
Sport Fish Restoration F-20-48
2012

WALKER LAKE
WESTERN REGION

NEVADA DEPARTMENT OF WILDLIFE, FISHERIES DIVISION
ANNUAL PROJECT REPORT

Table of Contents

Contents Page

SUMMARY 1

BACKGROUND 2

OBJECTIVES 3

PROCEDURES 4

Assistance from the Walker Basin Biologist 4

Water Quantity and Quality 4

Angler Use and Success 5

Stocking 5

Fish Population Monitoring 5

Zooplankton Monitoring 8

FINDINGS 9

Assistance from the Walker Basin Biologist 9

Water Quantity and Quality 9

Angler Use and Success 14

Fish Stocking 15

Tui Chub Population Monitoring 15

Zooplankton Monitoring 20

PROJECT REVIEW 23

RECOMMENDATIONS 25

REFERENCES 26

NEVADA DEPARTMENT OF WILDLIFE, FISHERIES DIVISION
ANNUAL PROJECT REPORT

List of Figures

Number	Title	Page
1	Walker Lake Elevation 2007-2012	10
2	2007-2012 Flow at Lateral 2-A Siphon	10
3	Average Yearly Secchi Depths	11
4	2012 Walker Lake Temperature Profiles	12
5	2012 Walker Lake Dissolved Oxygen Profiles	13
6	2012 Lake Elevation vs. TDS	14
7	2002-2011 Expanded Harvest from Mail-in Angler Questionnaire Surveys	15
8	2007-2012 Percent Tui Chub Egg Deterioration and Increasing TDS	17
9	Survivability of Tui Chub in Increasing TDS	18
10	Dissolved Oxygen in Tanks 1 through 3 During Acclimation	19
11	Temperature in Tanks 1 through 3 During Acclimation	20
12	Periodic Lake-wide Zooplankton Averages	22
13	2007-2012 Combined Zooplankton Average Number/L	22
14	2012 Average Monthly Zooplankton Densities	23
15	2007-2012 Zooplankton Average Number/L by Species	24

NEVADA DEPARTMENT OF WILDLIFE, FISHERIES DIVISION
ANNUAL PROJECT REPORT

List of Tables

Number	Title	Page
1	2002-2012 Lake Elevation History (meters above MSL)	9
2	Various Years' Secchi Depths (meters)	12
3	Mail-In, Angler Questionnaire Survey History	14
4	2007-2012 Stage of Development of Tui Chub Eggs	16
5	2012 Average Monthly Zooplankton Densities	24

List of Attachments

Number	Title	Page
1	GPS Sampling Site Map	28
1	GPS Sampling Site Locations	29
2	2012 Mid-Lake Water Quality Profiles	30
3	Histopathology Report	31
4	Walker Lake South Marsh Refuge Habitat and Amphibian Surveys	34

NEVADA DEPARTMENT OF WILDLIFE, FISHERIES DIVISION
ANNUAL PROJECT REPORT

State: *Nevada*
Project Title: *Statewide Fisheries Program*
Job Title: *Walker Lake*
Period Covered: *January 1, 2012 through December 31, 2012*

SUMMARY

Total loss in lake elevation for Walker Lake in 2012 was 1.2 m (3.9 ft). A new all time low lake level prohibited launching from October through December, so quarterly sample collection for total dissolved solids (TDS) was not possible during this time. TDS level for July was 19,223 mg/L. Lake elevation descended another 0.7 m (2.3 ft) from July through the end of 2012, which raised the TDS level to an unknown amount. Based on empirical evidence from past lake level/TDS relationships, TDS was estimated to approach 20,000 mg/L by the end of 2012.

Average snow-water equivalent for the Walker Basin was 43% of average on April 1, 2012 according to the Natural Resource Conservation Service SNOTEL sites. Approximately 5,614 cfs (11,118 AF) flowed through the Lateral 2-A Siphon. All water entering the lake was a result of warm winter temperatures causing in early runoff prior to April.

No Lahontan cutthroat trout (LCT, *Oncorhynchus clarki henshawi*) were observed or reported in 2012. Water quality conditions in Walker Lake have exceeded limitations for LCT existence and this is the third year that LCT were not stocked. A restocking effort will not be considered until conditions improve.

In June and July, Lahontan tui chub (tui chub, *Siphateles bicolor pectinifer and S.b. obesa*) (Vigg, 1982) spawning and egg deposition were documented through visual surveys. Nearly all eggs collected and observed for embryo development exhibited very high rates of deterioration and no advanced development. No tui chub under 285 mm were observed in 2012. Last year's lake elevation increase gave tui chub a brief reprieve from the harsh conditions; however, mortality and stress was observed again concurrent to the 2012 lake elevation decline.

The Rose Creek Reservoir tui chub refugia population was augmented again with 27 adult tui chub from Walker Lake. An experiment was conducted utilizing pond born tui chub collected from the reservoir and re-acclimated to Walker Lake water to determine if they maintain their ability to tolerate the high TDS.

Samples of tui chub collected from Walker Lake were sent to Washington Animal Disease Diagnostic Laboratory (WADDL) for an official diagnosis regarding clinical signs of physiological stress observed.

The inability to launch a boat from October through December prohibited all sampling efforts during that time, including water quality and zooplankton collection. In addition, fall gill netting was not conducted.

BACKGROUND

Lake Lahontan, a large inland, freshwater sea, once covered much of northern Nevada. Dry periods, resulting from severe climatic changes, caused Lake Lahontan to desiccate several times. Walker Lake is one remnant of Lake Lahontan, which last went dry about 2,100 years ago.

LCT have had a long historical connection to the Lahontan basin as the dominant, predatory fish and in Walker Lake have grown to over 13.6 kg (30 lbs). When explorers discovered the lake in the 1840's, its elevation was 1,244 m (4,080 ft) above mean sea level (MSL) and LCT were able to access the Walker River to propagate naturally. Shortly after, much of the river was diverted for agricultural and ranching use. The lack of a permanent flowing river resulting from irrigation diversions and the construction of barriers has prevented upstream spawning migrations since the early 1900's. The consequence of a declining lake is an increasing TDS concentration, which shortens the life span of LCT.

Since the early 1950's, the LCT fishery in Walker Lake has been maintained by stocking and managed by NDOW as a quality coldwater fishery. Historically, several strains have been planted with good results, but as TDS levels increased, LCT stocking survival decreased. Elevated TDS levels (mostly bicarbonate, sodium, sulfate, and chloride) negatively affect gill and kidney function resulting in decreased survivorship and size of fishes. High TDS levels (approaching 20,000 mg/L in 2011) have reduced stocking survival of stocked trout; fish die quickly when stocked directly from fresh water into Walker Lake. NDOW and United States Fish and Wildlife Service (USFWS) experimented with stocking LCT into the Walker River in 2006 through 2008, allowing LCT to self acclimate in the plume of mixed water at the inflow of the lake. Since 2009, conditions within the lake have not been conducive to LCT survival, precluding stocking efforts.

Decreasing lake levels leading to increasingly toxic lake conditions have resulted in a depauperate fishery. The current TDS levels have severely diminished tui chub egg viability, affected tui chub survival, exceeded tolerance levels for LCT, altered zooplankton composition and abundance, and degraded water quality. Other native fish species once existed in Walker Lake, but the tui chub is the last remaining species. The tui chub population is under a great deal of physiological stress. Sub-adult cohorts are absent and the remaining adults are approaching the upper limits of survivability in Walker Lake.

OBJECTIVES

WSFR General Management Objective:

- Assist with trammel netting, angler surveys, water quality monitoring, or other activities as requested by the Walker Lake Fisheries Improvement Team.

Desert Terminal Lakes Grant Objective: To collect and analyze water quality seasonally from Walker Lake to document changes as lake levels fluctuate.

Approaches:

- To monitor lake elevation and river discharge.
- To conduct water quality monitoring every other week from April through October and once a month from November through March.

Desert Terminal Lakes Grant Objective: Determine survival, both initial and long-term, of LCT stocked into Walker Lake (if lake conditions are suitable for trout stocking).

Approaches:

- To report mail-in survey.
- To maintain angler survey boxes and an angler information center.
- Conduct opportunistic creel until fishery is recovering and then return to conducting creel census for a minimum of eight days a month from October through May.
- To tag/acclimate/bioassay LCT for stocking into Walker Lake if TDS and flows permit.

Desert Terminal Lakes Grant Objective: To collect information on Lahontan tui chub life history and abundance and document spawning success or failure as lake levels fluctuate and water quality changes, and to work toward successful establishment of tui chub refuge.

Approaches:

- Examine spawning behavior by conducting daytime and nighttime shorezone snorkeling on four occasions in August. Nighttime snorkeling utilizes light emitting diode (LED) flashlights to look for larval chub.
- Collect eggs from gravel at six sites (one site in each grid around lake) and place into jars to determine viability.
- Set fall gill nets for tui chub in order to examine changes in relative abundance, age class and form.
- Conduct trap netting in order to observe population composition of tui chub and augment Rose Creek Reservoir's refuge population of Walker Lake tui chub.
- To conduct acclimation of pond-born tui chub in Rose Creek Reservoir to Walker Lake water.
- Continue searching for additional refuge sites for Walker Lake tui chub within the south marsh of Walker Lake, and on Mt. Grant.

- Floy tag Rose Creek Reservoir tui chub for identification of cohorts and determine population size using capture/mark/recapture methods.

Desert Terminal Lakes Grant Objective: To conduct monthly zooplankton collection and document changes in abundance and composition.

Approaches:

- Collect zooplankton monthly at ten historic collection sites utilizing a Nitex net with a 30 cm mouth opening. One vertical net pull is collected at each site.

PROCEDURES

Assistance from Walker Basin Biologist

Assist with trammel netting, angler surveys, water quality monitoring, or other activities as requested by the Walker Lake Fisheries Improvement Team: No assistance was given in 2012.

Water Quantity and Quality

To monitor lake elevation and river discharge: Walker Lake elevation (USGS gage No. 10288500) and Walker River discharge (Lateral 2-A siphon, USGS gage No. 10302002, about 16.1 km [10 mi] upstream from Walker Lake) were obtained from the USGS real-time data web interface system.

Because the surface area of Walker Lake has declined since the last bathymetric analysis was conducted, a new estimation of surface area was conducted. NDOW personnel recalculated the surface acreage by creating a new polygon using ArcGIS data from the Economic and Social Research Institute ESRI imagery website from December, 2012.

Conduct water quality monitoring every other week from April through October and monthly from November through March: Water quality was checked at three sites for temperature, dissolved oxygen (DO), pH, and conductivity using a YSI 600 XL water quality analyzer. Water quality parameters were analyzed monthly from January through March and biweekly from April through September at three stations (WL2C, WL3C, and WL4C [Attachment 1]). The YSI was calibrated on site for parameters including DO, pH, conductivity and depth prior to data collection to ensure proper readings and accounts for the variation in barometric pressure.

Sampling by Nevada Division of Environmental Protection (NDEP) occurred at the same sites for the same parameters, using a Hydrolab Data Sonde 4a water quality analyzer in March, May, and July. Only the center site for each sampling date is reported here. Concurrent to profiles, NDEP also collected water at three depths from each site to analytically measure TDS. In this report, TDS concentrations were

averaged at depths above the hypolimnion during summer and throughout the water column in winter.

Secchi depths were recorded at ten stations (WLN, WL2, WL2E, WL2W, WL3, WL3E, WL3W, WL4, WL4E, WL4W [Attachment 1]) on each of the sampling dates. Secchi depths from WL3C on each of the dates sampled in 2012 are reported here.

Angler Use and Success

To report Mail-In Angler Questionnaire Survey: NDOW mailed out angler surveys to 10 percent of anglers that purchased a Nevada fishing license in 2011 for summarization of their angling activities and success. Data was expanded to estimate total anglers, total angler days, and total fish caught for Walker Lake.

To maintain angler survey boxes and an angler information center: Drop-boxes at Sportsman's Beach boat ramp, State Parks boat ramp, the road leading to the North Cliff parking area, 20-Mile Beach, and Ski Beach were kept stocked with surveys. Anglers were asked to report their total hours fished, type of fishing conducted, number of fish caught, number of fish kept, size of fish, and angling satisfaction. Anglers were also asked to supply tag data from tagged fish that were caught. Satisfaction was ranked from +2 (highly satisfied) to –2 (dissatisfied).

The angler information center was located at Sportsman's Beach boat ramp and provided the most current boating, angling, and water data information for Walker Lake to the public.

To collect angler use information eight days a month from October to May if LCT are still present: Roving creel surveys were not conducted in 2012.

Stocking

To tag/acclimate/bioassay LCT for stocking into Walker Lake if TDS levels and flows permit: LCT stocking was not conducted in 2012.

Fish Population Monitoring

To check for spawning and recruitment in April through July through visual and boat surveys conducted next to shore: Tui chub spawning activity and egg deposition were examined on five days during the spawning season. This was completed by observing shorelines from adequate vantage points or slowly boating parallel to the shore with one or two persons visually observing for shoaling fish.

To determine tui chub egg viability by collecting eggs from gravel and examining for stage of development: Eggs were collected by kicking up rocks and sediment that the eggs were clinging to, then a small mesh dip net was used to capture

the eggs that were suspended in the water column. Egg collection was conducted in May, June, and July at WLE4 through WLE6 (Attachment 1). The eggs were stored in jars for no more than one day and then observed for embryo development. Deterioration of eggs was documented as well, and was indicated by a cloudy appearance resulting in the inability to determine any stage of development.

Stages of egg development were based on J. Cooper (1982) and include:

Stage A. Directly after fertilization the perivitelline space becomes separated from the zygote and swelling occurs.

Stage B. Blastodermal cap forms at animal pole and covers one-fourth of the circumference of the yolk.

Stage C. Late gastrulation, when the embryo becomes recognizable around the yolk.

Stage D. Embryo length is two-thirds of the way around the yolk circumference and the head region is discernible from the tail.

Stage E. Embryo has 6–8 somites and optic vesicles are easily discernible and the yolk sac is very large.

Stage F. Embryo begins to squirm in egg case heart and notochord and flowing blood is visible.

Stage G. Egg hatches and larva body is curved. There is slight pigmentation, swim bladder is visible and larva swims periodically and sinks to the bottom.

Stage H. Larvae is 8–10 mm long, pectoral fins forming, four-gill chambers and arches are easily discernible posterior to the eyes, and melanophors cover more than half of the body. Swimming action increases, but is not yet consistent. Yolk sac is small and no feeding is observed.

To conduct larval tui chub snorkeling surveys in summer: Larval tui chub snorkel surveys were discontinued.

To set fall gill nets for YOY tui chub in order to examine changes in relative abundance: Inability to launch a boat after September precluded fall gill netting efforts.

To conduct trap netting in order to observe population composition of tui chub and augment Rose Creek Reservoir's refuge population of Walker Lake tui chub: Trap netting was conducted on July 10 through 13, during the active spawn and concurrent with inflow from the Walker River in order to facilitate an effective netting

effort. Three trap nets were set, retrieved, and reset at a different location every 24 hours. Locations of net sets were WLGN 4-6, TNI, TNS, TNN, and WLE 4-6 (Attachment 1). Fish netted each day were measured, weighed and released. On the final day of netting, all tui chub captured were transferred to a 2.27 m^3 (500 gal) tank on a fish truck and transplanted to Rose Creek Reservoir. A visual observation of the refuge was conducted concurrent to the transplant.

To continue searching for additional refuge sites for Walker Lake tui chub on Mt. Grant: Coordinate field trip and transplant efforts with Hawthorne Army Depot (HAD) personnel to observe potential new refuge locations and determine their suitability.

To conduct acclimation of pond-born tui chub in Rose Creek Reservoir to Walker Lake water: One trawl with a nylon mesh beach seine was used to collect small tui chub (5-10 cm [2-4 in]) from Rose Creek Reservoir. The seine had 6.35 mm (1/4 in) mesh, was 15.24 m (50ft) long and 1.83 m (6 ft) tall, and the purse was 1.83 m (6 ft) X 1.83 m (6 ft). Tui chub were placed in a fish transport tank and relocated to the study site.

Tui chub were divided into three sample groups of 50 individuals each and placed into three 0.23 m^3 (50 gallon) fish tanks (T1, T2, and T3) that were filled with fresh water. Lake water was exchanged with tank water in T1 and T2 every day to increase conductivity by 3,000-4,000 µs/cm during each exchange, until 100 percent lake water concentrations were achieved. The same quantity of fresh water was exchanged in the control (T3) at the same intervals.

Dissolved oxygen, temperature, conductivity, and pH were recorded using an YSI 600 XL two times per day from initial placement of fish into the tank. Mortalities were enumerated concurrent to water profile collection.

During the weekend, the mortalities were enumerated by hatchery personnel and water levels were adjusted to account for evaporation.

TDS was derived from electrical conductivity (EC) as described in Tracy, 2004 as follows:

$$\text{TDS (mg/L)} = 0.8446 \text{ X EC } (\mu\text{s/cm @ } 25.0°\text{C}) - 1{,}470.4$$

Statistical significance of results was determined by evaluation the *F* ratios and *P-value* using a one way ANOVA.

To Floy tag Rose Creek Reservoir tui chub for identification of cohorts and determine adult population size using capture/mark/recapture methods: Coordinate with HAD to conduct a capture/mark/recapture effort using Floy tags in order to estimate the adult tui chub population in Rose Creek Reservoir. Also, Floy tag 100 pond-born tui chub concurrent to adult tagging effort.

To send samples of stressed Walker Lake tui chub to WADDL for diagnosis: Because of ongoing stress and mortality observed among the tui chub at Walker Lake, some tui chub were collected for observation of clinical signs of stress.

One frame net was set on June 20, near the State Parks boat launch in order to capture samples of stressed tui chub to send to WADDL. Five fish were captured, transported live back to the laboratory, and necropsied. All organs were preserved in 10% formalin and shipped overnight to WADDL.

Zooplankton Monitoring

To collect and analyze zooplankton: Zooplankton were collected concurrent to water quality analysis at 10 sites (WLN, WL2, WL2E, WL2W, WL3, WL3E, WL3W, WL4, WL4E, WL4N [Attachment 1]). Samples were collected using an 80 μm (3.15×10^{-3} in) mesh Nitex net with a mouth opening of 30 cm (12 in) and a length of 172.7 cm (68 in). Vertical plankton tows were conducted from approximately one meter from the bottom to the surface at a rate of 1 m x sec^{-1} and plankton were preserved in a 4% formaldehyde/sugar mixture. Zooplankton from three 1 mL (2.64×10^{-4} gal) sub-samples were enumerated and identified by using an optical Fisher microscope (4, 10, 40, and 100 X magnification capability), and then the lake-wide density was averaged from all sites using:

$$\text{Number per liter} = \frac{X \times V}{K \times Z} \div 1000$$

Where X = mean number of organisms per mL in sample, V = total volume of sample (mL), Z = depth (m) of vertical tow, and K (surface area of net opening) = 7.068×10^{-2} m^2.

FINDINGS

Assistance from Walker Basin Biologist

No assistance was provided in 2012.

Water Quantity and Quality

To monitor lake elevation and river discharge: The Walker Basin received 43% of average snow-water equivalent as recorded on April 1, 2012. The lowest lake elevation in recent history occurred in 2012 at 1,195.4 m (3922.1ft). The highest lake elevation for 2012 was recorded on February 2, at 1,196.6 m (3926.0 ft).

Horne et al., (1994) estimated yearly vertical losses at 1.25 m (4.1 ft) and evaporative losses at 1.73×10^8 m^3 (140,000 AF), at that time the surface area was estimated at 1.41×10^8 m^3 (35,000 acres). Lopes (2007) reported losses were actually

closer to 1.8 m (6.0 ft) per year, but subtracted ground water contributions to the lake to show overall evaporative losses. For simplicity and from here on volumetric loss = evaporative loss + groundwater inflow. In 2005, yearly vertical loss was 1.2 m (4.0 ft) and volumetric loss was 1.59 x 10^8 m^3 (128,760 AF), at that time the lake surface area was estimated to be 1.30 x 10^8 m^3 (32,190 acres) (Lopes, 2007).

Estimates of vertical and volumetric losses through time are still comparable to Lopes (2007) even though the lake's surface area has decreased. A reduction in evaporative losses due to a smaller surface area is expected, but the bathymetry of Walker Lake and groundwater inflow are variables that are not measurable. The changing slopes of the lake bed create differences in yearly evaporative losses and these combined factors contribute to an unpredictable vertical loss.

The December 2012 surface area was approximately 1.23 x 10^8 m^3 (30,500 acres) (Herrick T., NDOW GIS Department, email comm., 2012). With the addition of the river inflow, net vertical loss in 2012 was 1.2 m (3.9 ft) (Table 1 and Figure 1), yielding a net volumetric loss of approximately 1.37 x 10^8 (118,950 AF). The amount of lake elevation loss since 2007 is 3.6 m (11.8 ft) (Table 1 and Figure 1).

Table 1

2002-2012 Lake Elevation History (meters above MSL)

	2008	2009	2010	2011	2012
Jan	1199.0	1197.9	1196.8	1196.0	1196.6
Feb	1199.0	1197.9	1196.9	1195.9	1196.6
Mar	1199.0	1197.9	1196.9	1196.2	1196.6
Apr	1198.9	1197.7	1196.8	1196.2	1196.6
May	1198.8	1197.7	1196.8	1196.3	1196.5
Jun	1198.8	1197.6	1196.7	1196.7	1196.4
Jul	1198.7	1197.4	1196.6	1197.1	1196.2
Aug	1198.5	1197.2	1196.5	1197.0	1196.0
Sep	1198.4	1197.1	1196.3	1196.8	1195.9
Oct	1198.2	1197.0	1196.1	1196.7	1195.8
Nov	1198.0	1196.9	1196.0	1196.6	1195.6
Dec	1197.9	1196.8	1196.0	1196.6	1195.4
Change*	-1.0	-1.06	-0.8	0.6	-1.2

* Net change from beginning to end of year.

Since 2007, flow through Lateral 2A Siphon has been dismal, with the exception of 2011 (Figure 2). In 2012, a mild winter caused an early runoff in the Walker Basin and all of the flow, 1.37 x 10^7 m^3 (11,116 AF) was received before April (Figure 2).

Figure 1

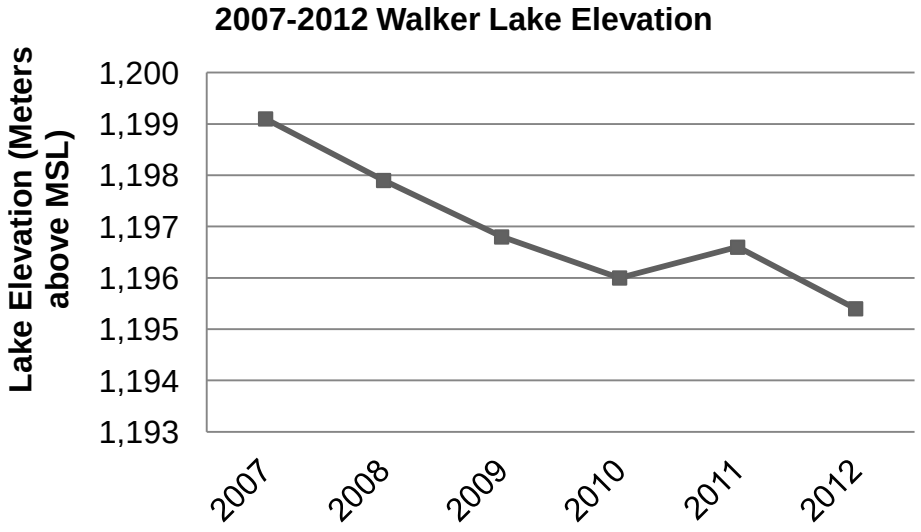
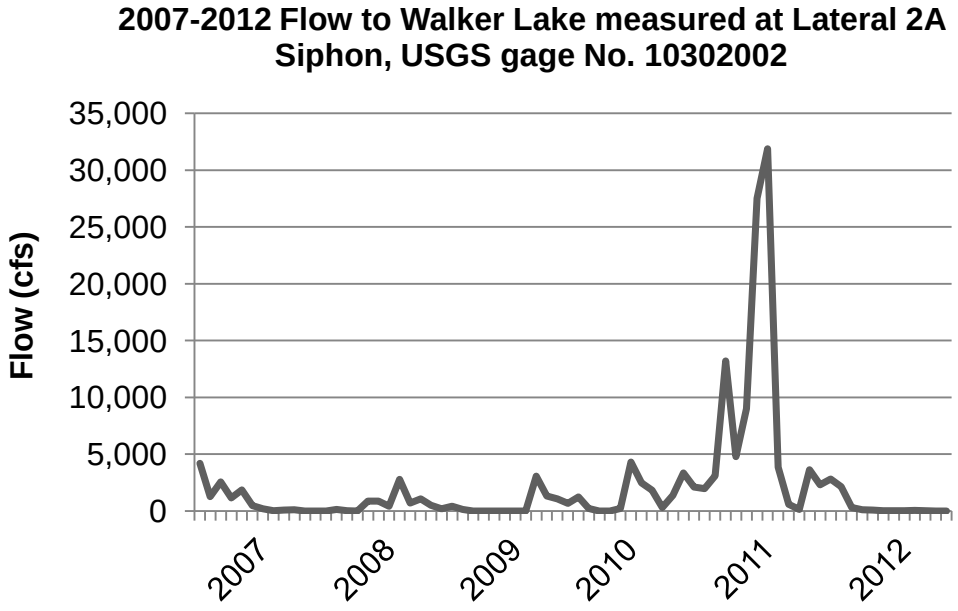


Figure 2



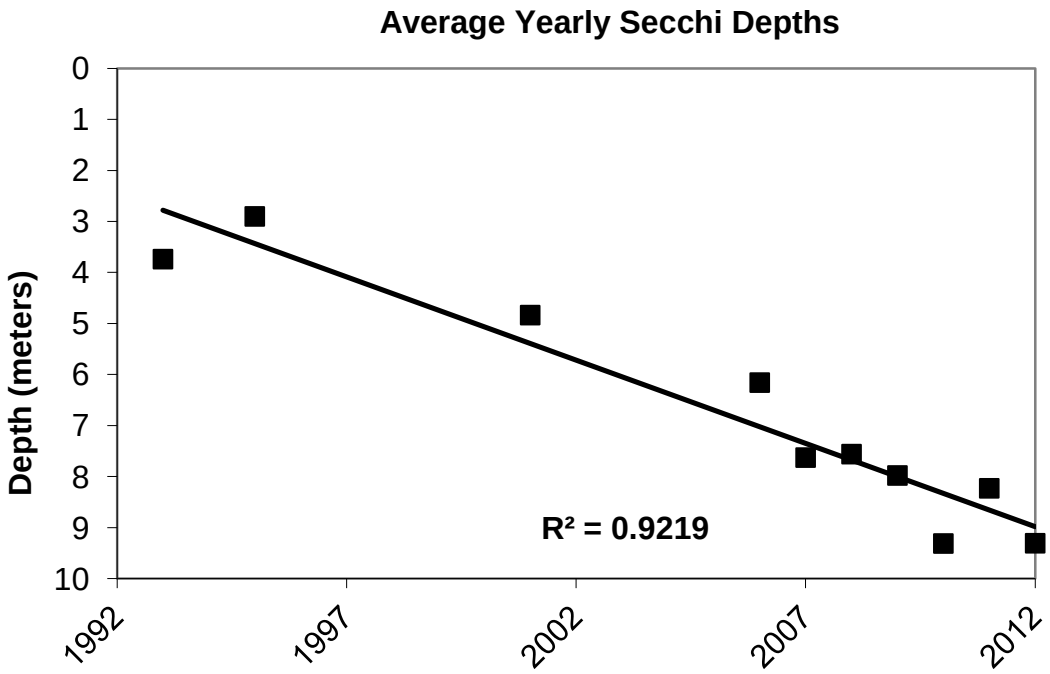
Conduct water quality monitoring every other week from April through October and monthly from November through March: Water clarity has improved at Walker Lake despite a diminishing water quality as it pertains to fish life. Large phytoplankton blooms of *Nodularia spumigena* typically began in March or April and then peaked in June through August.

Low water clarity indicates a highly modified, eutrophied system. Walker Lake is at the high end of hypereutrophic classification (Chandra and Sada, 2009). The reason for the improved water clarity is not yet known. It is possible that the shifting food chain

or slight changes in phosphorus or nitrogen are affecting the clarity (Robert Jellison, pers. com.).

Consecutive monthly Secchi depths were obtained in 1993, 1995, 2001, and 2006-2012 (Figure 3). An increase in water clarity through time is apparent (Figure 3, Table 2). In 2012, Secchi depth increased again, thereby increasing the significance of the regression (R^2 = 0.9219) from last year. If data was collected during October through December 2012, Secchi depths could have exceeded all prior years. For all months that Secchi depths were collected in 2012, they were deeper than those from any other year (Table 2).

Figure 3



Temperature and DO profiles are presented in Figures 4 and 5 and Attachment 2. A temperature gradient formed in April 2012. The first sign of the summer thermocline occurred on July 17 at 12 m (39.4 ft). The thermocline descended to 17 m (55.8 ft) on August 23 and then to 19 m (62.3 ft) by September 19. Deep thermoclines in the summer of 2012 occurred because of the influence of warm temperatures on the decreased lake volume. Mixing was not documented due to the inability to launch from October through December. Maximum surface temperature reached 25.0 Cº (77.1 Fº) by late August. Dissolved oxygen readings were incorrect during several months due to probe malfunction, so dissolved oxygen is reported from NDEP profile data for January, April and July. The DO probe was back on line for August and September. Dissolved oxygen showed a typical clinograde profile during warmer months. The bottom of the lake was anoxic in August and September.

Table 2

Various Years' Secchi Depths (meters)

	1993	1995	2001	2006	2007	2008	2009	2010	2011	2012
Mar				9.0		5.8	10.2	33.3	6.9	11.5
Apr		8.3				10.2	10.2			15.7
May		5.8	8.3	7.4	13.1	10.2	13.1		20.0	33.1
Jun	9.5	6.4	10.0		26.6	27.9	32.8	23.8	29.5	39.4
Jul				14.5		34.5	28.5			37.6
Jul	6.5	6.6	10.0		19.7	35.1	35.8	23.8	24.6	
Aug	11.0	15.4		28.2	33.5	31.5	37.7	33.3	35.4	37.7
Sep						26.6	30.5	33.3		38.7
Sep	14.3	14.6	26.0		21.3	27.2	34.1		35.8	
Oct				31.1		27.9	30.0	40.3		
Oct	20.0	9.5			36.4	30.6			33.8	
Nov						30.2	25.0	35.0	30.0	
Dec			25.0	31.0	24.6					

Figure 4

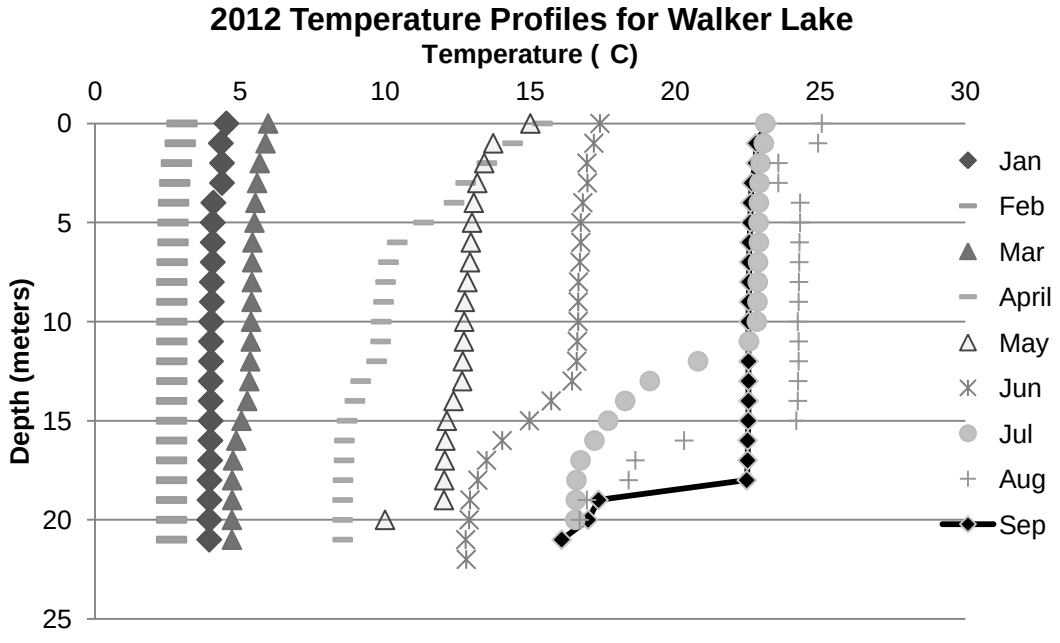
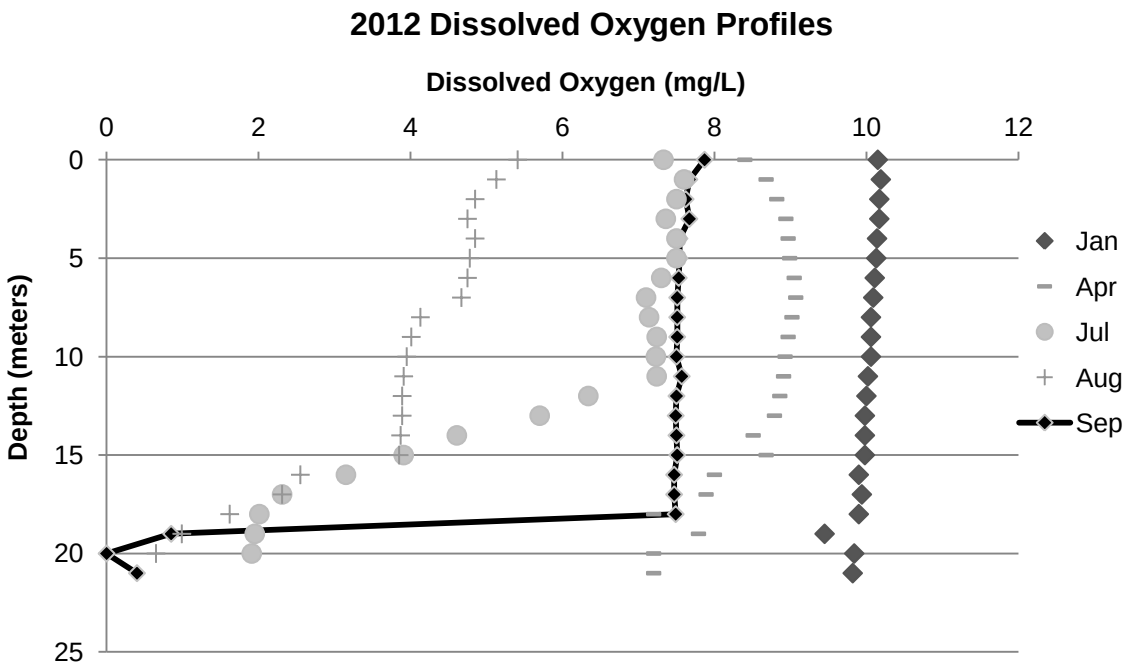


Figure 5

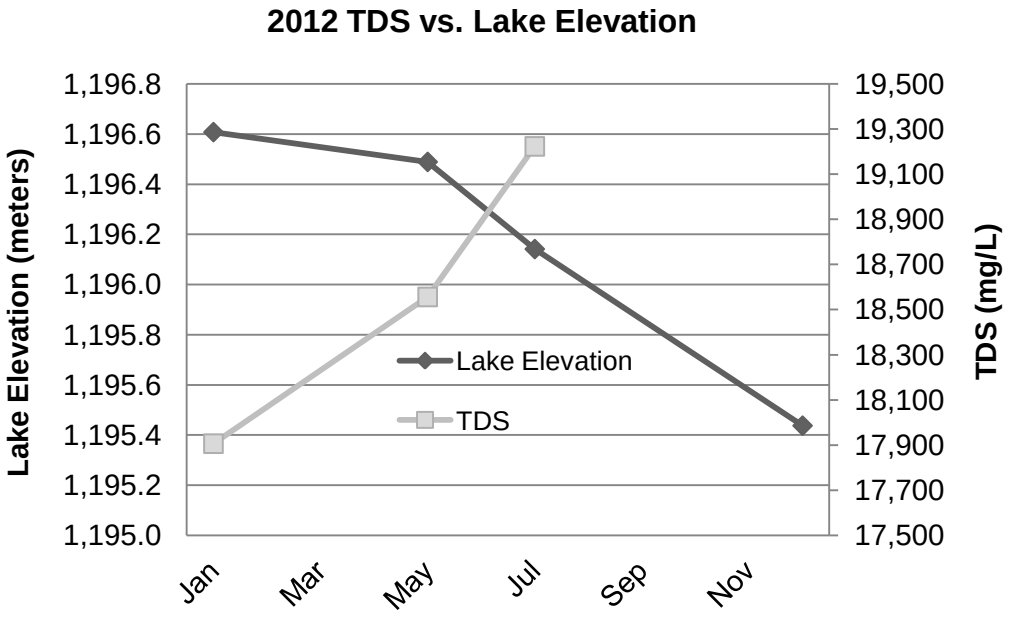


A temperature/dissolved oxygen "squeeze" that typically limits fish habitat and causes physiological stress for salmonids, was extreme in Walker Lake during August. The August temperature profile showed 24.18 Cº (75.52 Fº) at 15 m (49.2 ft), with a DO at the corresponding depth was 3.8 mg/L. These conditions would likely create extreme stress in remaining LCT and certainly contribute to the stress observed among tui chub this year.

Stress created from the amount of time fish spend within their upper temperature and low DO tolerance limits, combined with physiological stress (such as spawning stress), very high TDS, and high pH would have created a negative synergistic effect. Increased TDS levels negatively affects gill and kidney function (Dickerson and Vinyard, 1999). In addition to the synergistic effect created by the above environmental and physiological stressors, ammonia concentrations in the hypolimnion during the summer (mean of 2.47 µM) and throughout the water column during mixing events (high of 6.44 µM) (Jellison and Herbst, 2009) would add another stressor to all fish life.

TDS level shows a negative relationship with lake elevation. By July 2012, TDS ascended to 19,223 mg/L (Simpson, email comm., 2012) (Figure 6). TDS level for the rest of 2012 is unknown due to prohibitive boat launching conditions, but it is estimated to have neared 20,000 mg/L. There was no other way to extrapolate TDS levels, either from conductivity, as no sampling was conducted, or by comparing to historic levels, as a new low lake level was realized.

Figure 6



Angler Use and Success

To report Mail-in, Angler Questionnaire Survey: For the first time, the Mail-in Angler Questionnaire Survey data (Table 3, Figure 7) reported no fish being caught. Mail-in questionnaires reported that 23 anglers spent 54 days and caught 0 fish at Walker Lake in 2011.

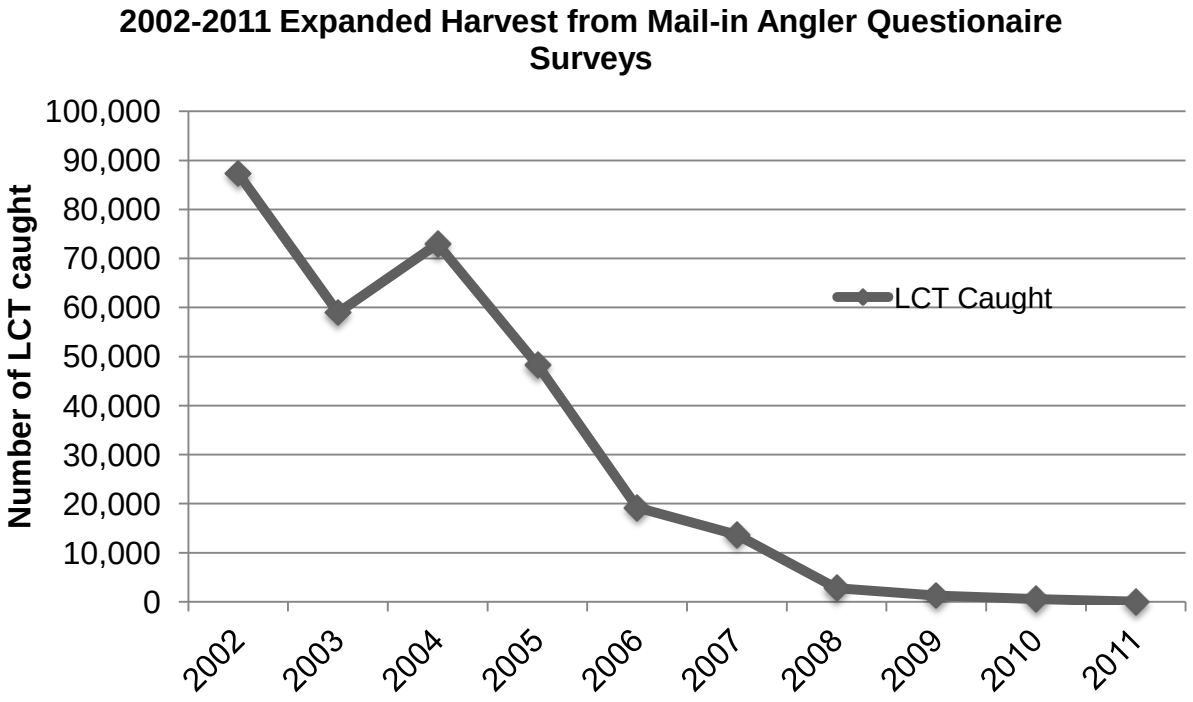
Table 3

Mail-In, Angler Questionnaire Survey History

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
No. of Anglers	4,657	4,376	3,844	3,745	2,141	2,214	955	510	368	23
Anglers Days	27,257	17,098	18,898	16,247	9,120	7,537	2,902	1,392	964	54
LCT Caught	87,339	58,944	72,957	48,282	19,177	13,670	2,766	1,282	548	0
Fish/Angler/Day	3.2	3.5	3.9	2.9	2.0	1.8	1.0	0.9	0.6	0

Maintain angler survey boxes and report data, maintain angler information center: The angler information center was updated in January and maintenance was conducted as necessary. No drop-box forms were filled out in 2012.

Figure 7



To collect angler use information eight days a month from October to May if LCT are still present: Routine creel surveys were not conducted in 2012. No opportunistic creel data was collected as no anglers were observed.

Fish Stocking

To tag/acclimate/bioassay LCT for stocking into Walker Lake if TDS levels and flows permit: LCT stocking has been suspended since 2009 due to high TDS levels and a lack of flow in the Walker River. No fish will be stocked until TDS levels come down to a more habitable level. The Team will determine future restocking efforts based on TDS levels as well as current and potential inflow to the lake once the elevation starts to ascend.

Tui Chub Population Monitoring

Overview

All tui chub perished in the Carson Sink when TDS concentration reached 20,000 mg/L (Rowe and Hoffman, 1987). As the TDS concentration in Walker Lake lingered near 20,000 mg/L in 2012, mortality was documented. Mortality appeared insignificant as in recent years when TDS levels neared 20,000 mg/L. However, we now know that the tui chub population has been seriously affected by the increased TDS level.

To check for spawning and recruitment April through July through visual boat surveys conducted next to shore: Tui chub spawning surveys were conducted on June 12, 15, 16, 29, and July 10. Many adult tui chub were observed shoaling offshore and within rocky substrate on each day of observation.

To determine tui chub egg viability by collecting eggs from gravel and examining for stage of development: Egg collection was achieved but with greater effort than in years past. The observation of less abundant eggs could be attributed to: 1) timing of the spawn occurring sooner than collection was attempted, 2) fewer adult tui chub present in the lake, or 3) tui chub are not expelling eggs due to stress.

Collection was conducted on June 12, 15, 16, 29, and July 10 at three sites (WLE4-WLE6 [Attachment 1]). Eggs were then transported to the lab and observed for stage of development. Stage of development of eggs collected since 2007 is summarized in Table 4. Since 2009, advanced development was absent in most of the observed samples and no recently hatched tui chub were observed.

Table 4

2007-2012 Stage of Development of Tui Chub Eggs

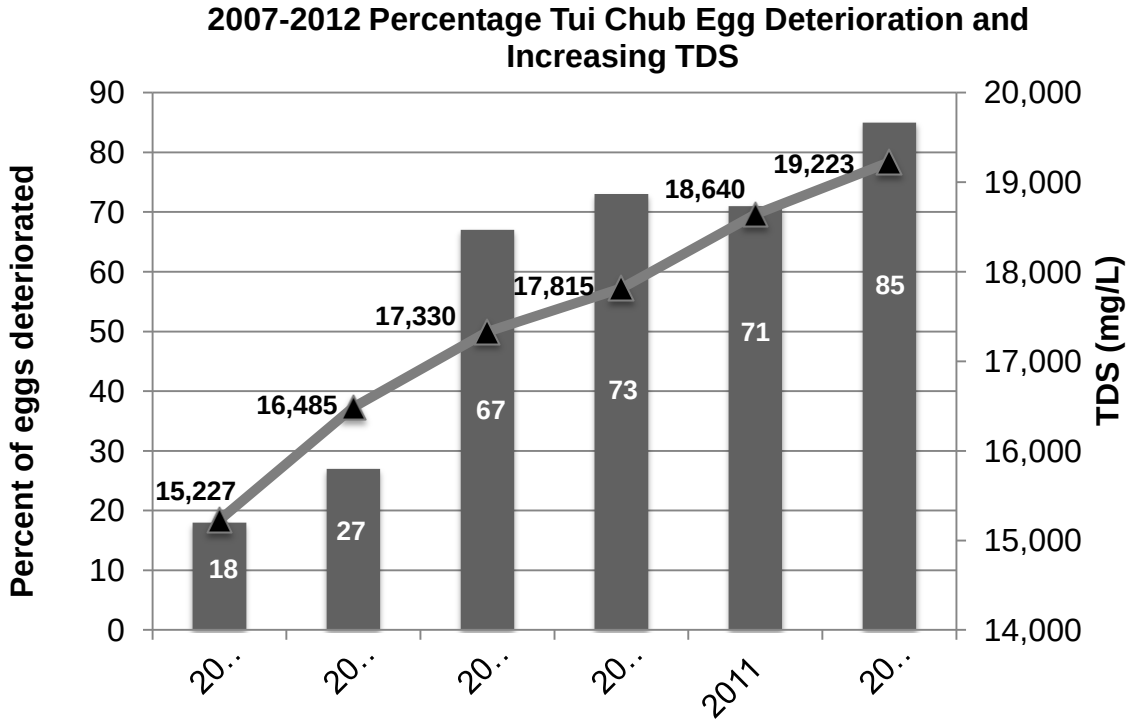
	2007	2008	2009	2010	2011	2012
Number Observed	824	384	841	793	767	812
Percent Deteriorated	18	29	67	73	71	85.09
Percent Stage A	7	27	12	25	12.999	3.336
Percent Stage B	69	29	8	1.9	9	4.187
Percent Stage C	5.99	12	6	0.05	7	4.187
Percent Stage D	0.005	3	7	0.05	0	1.60
Percent Stage E	0.006	0	0	0	0.001	1.60
Percent Stage F	0	0	0	0	0	0
Percent Stage G	0	0	0	0	0	0
Percent Stage H	0	0	0	0	0	0

Since first detected in 2007, deterioration rates rose from 18 percent in 2007, to 85 percent in 2012 (Figure 8). Increasing TDS levels were significantly related to egg deterioration ($R^2 = 0.934$, $P = 0.0001$) (Figure 8).

To conduct day and evening larval tui chub snorkeling surveys in summer: Snorkeling surveys were discontinued in 2012 as no sub-adult chub have been observed for several years now.

To set fall gill nets for YOY chubs in order to examine changes in relative abundance: Launching a boat became impossible after October 2012, so fall gill netting was not conducted.

Figure 8



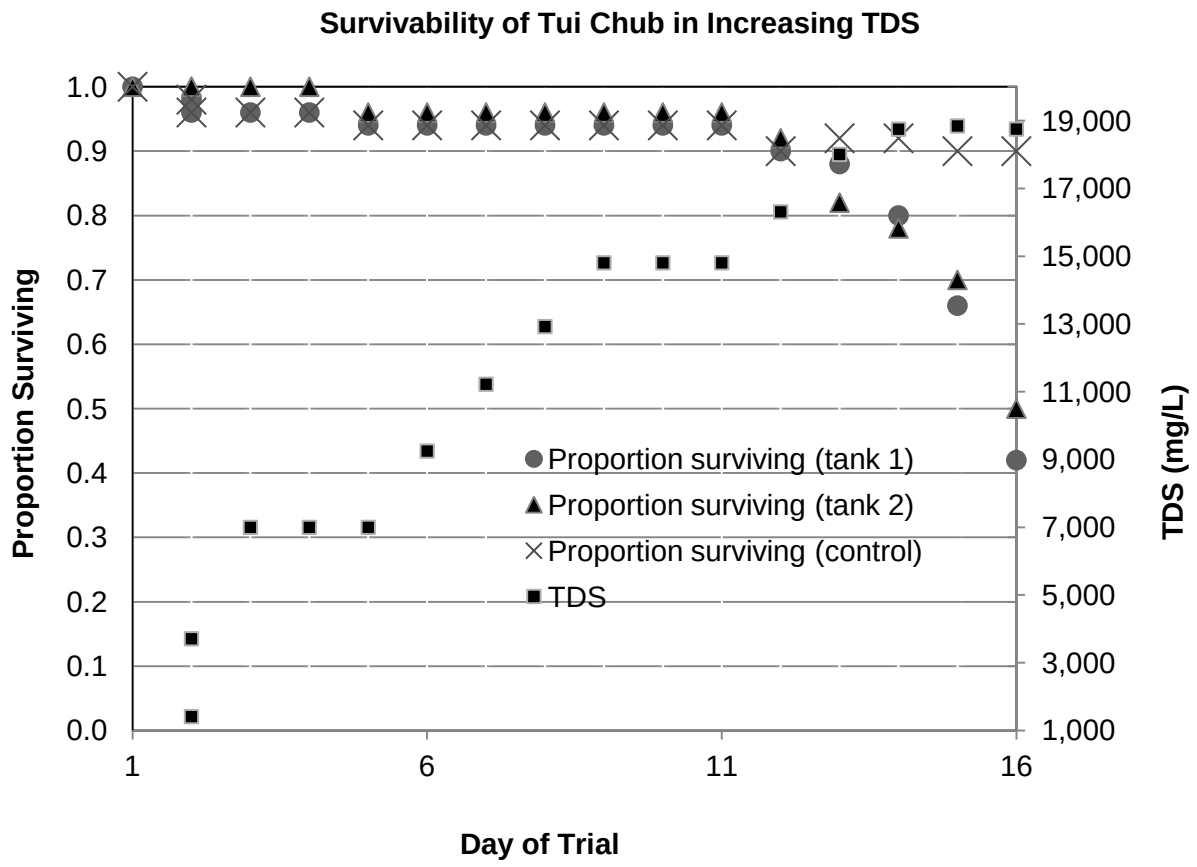
To conduct trap netting in order to observe population composition of tui chub and augment Rose Creek Reservoir's refuge population of Walker Lake tui chub: In 2011, a conflict of data occurred between cooperating Team members regarding the possibility of the existence of small tui chub in Walker Lake. This year, an effort was made to confirm the lack of small (<age 5) tui chub in Walker Lake. The goal of capturing 1,000 tui chub was agreed upon by Team members in order to provide an abundant data set on the size composition of tui chub at Walker Lake.

Over 600 adult tui chub were captured, none less than 285 mm. The results of the netting effort provided more evidence that there are no more small chub in Walker Lake. Based on combined observations, it is unlikely that tui chub under 8 to 10 years old exist in Walker Lake.

After coordinating with HAD, a date for transplant to Rose Creek Reservoir was set for the final day of Walker Lake netting. It was hypothesized that if chub were transplanted on the last day of netting, that the best net set locations would be known and provide the best chance of netting a large quantity of tui chub. On that date, only 27 tui chub were netted. While they will help augment the genetic pool in the reservoir, many more adults are desired to reach the effective population size of 500. Right now the adult population is estimated to be approximately 200. However, visual observation of Rose Creek Reservoir indicated the presence of adults and several pond-born age classes.

To conduct acclimation of pond-born tui chub in Rose Creek Reservoir to Walker Lake water: A one way analysis of variance test for significance of percent survivability of tui chub in increasing TDS levels reveled significant differences from the control, $F(2,48) = 4.95$, *p-value* = 0.011. Proportion of tui chub survival in increasing TDS is shown in Figure 9.

Figure 9

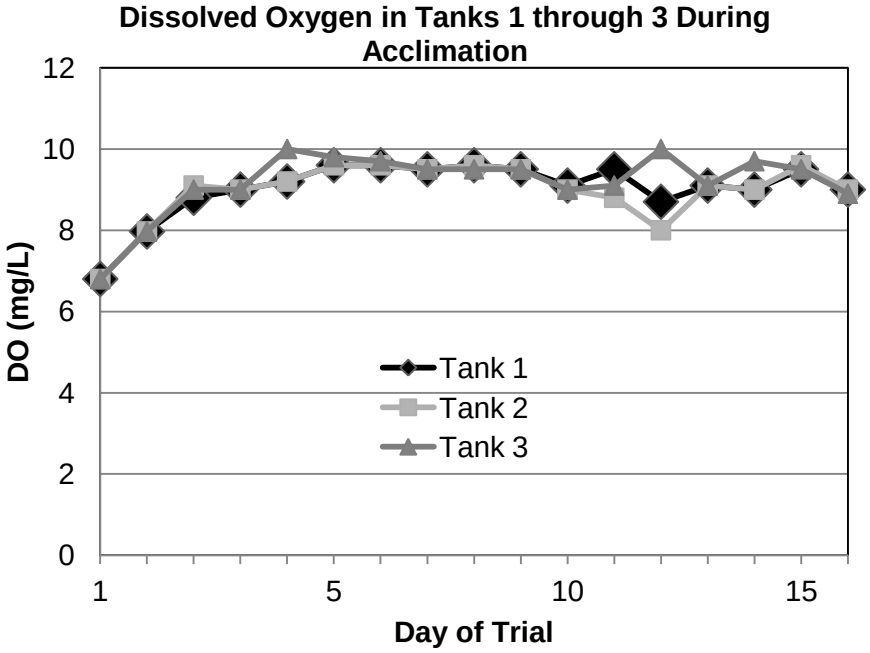


This study showed that smaller tui chub (5-10 cm) survival was negatively impacted by increasing TDS, compared to the control. According to the results of the study, tui chub slowly acclimated to increasing TDS levels survived almost entirely, until the TDS level reached 16,000-17,000 mg/L. At that point, mortality was observed among both sample groups. Once TDS reached 19,000 mg/L, no more water exchanges were made; within a period of four days, 40 percent of the tui chub had expired.

Individuals surviving to the end of the 17 days appeared to be in good condition with the exception of hemorrhaging on the lips. Survivors exhibited normal behavior in the tank and showed no other signs of stress.

Stable and adequate DO and temperatures were present in tanks 1 through 3 throughout the study (Figures 10 and 11). Temperature in Tank 1 averaged one degree higher than the other two tanks throughout the study. It is unknown why this occurred.

Figure 10



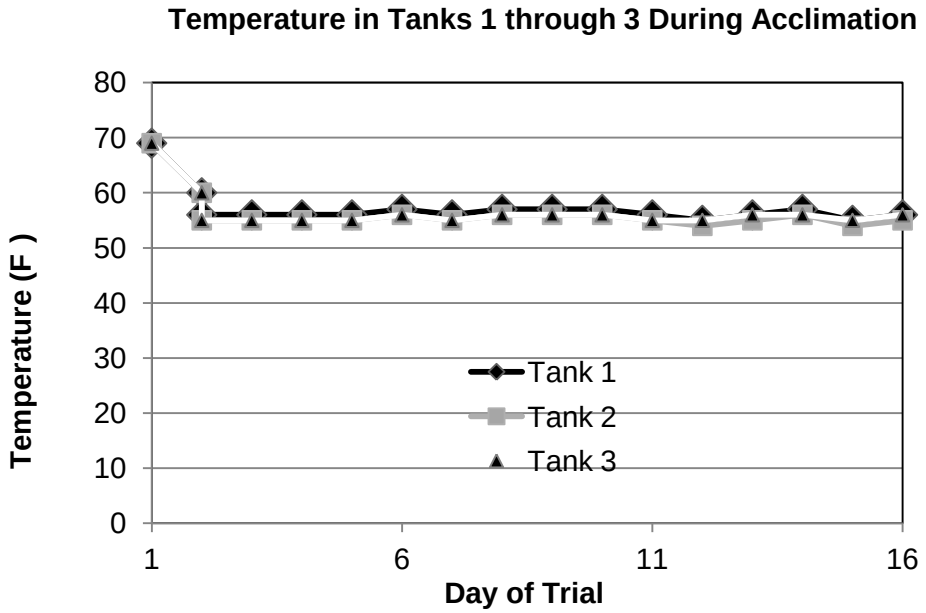
Due to unavoidable circumstances, the study had to be concluded before all of the tui chub expired. It would be beneficial to carry out the study at such a time that it could be carried out to completion.

Most importantly, it was hypothesized that the pond-born tui chub would rapidly adapt to their new environment and their ability to tolerate the high TDS may be lost with rapid genetic evolution in the very different environment. It is therefore noteworthy that the pond-born tui chub re-acclimated to the Walker Lake water successfully and results mirrored life history results of resident Walker Lake tui chub. Results of the re-acclimation indicate that if refuge tui chub do not bottleneck, those pond-born individuals will be candidates for reintroduction into Walker Lake as TDS declines.

To continue searching for additional refuge sites for Walker Lake tui chub on Mt. Grant: The south marsh area of Walker Lake was surveyed as a potential refuge for tui chub and those findings are provided as Attachment 4. Potential refuge sites on Mt. Grant have been identified; however, coordinating a field trip and subsequent transplant was unsuccessful.

To Floy tag Rose Creek Reservoir tui chub for identification of cohorts and determine population size using capture/mark/recapture methods: Coordinating the effort to conduct a capture/mark/recapture effort in order to determine adult population size at Rose Creek Reservoir was unsuccessful.

Figure 11



To send samples of stressed tui chub to WADDL for official diagnosis: Hemorrhaging on mouth, fins and stomach; tumors, lesions, flaking skin, pale skin, and erratic swimming patterns were observed and documented in stressed fish. When animals were dissected, internal organs exhibited a green color and mushy consistency. Some individuals appeared to have an accumulation of fluid in the body cavity.

The specimens collected for diagnosis by WADDL did not exhibit the extreme clinical signs mentioned above. They had minimal hemorrhaging and discoloration; the organs appeared normal. Those tui chub were diagnosed by WADDL to be suffering from extreme spawning stress that was compounded by the high TDS level in Walker Lake. They were essentially starving to death and had a large build up of bile from a lack of digestion. The green colored organs seen during initial dissection were most likely a buildup of bile.

The histopathology report also indicated stress induced resorption of the eggs. Tui chub have been actively shoaling and spawning in recent years, with an observed decrease in egg viability. However, these results indicate that perhaps the next stage of stress will result in the resorption rather than expelling of eggs. A copy of the histology report is provided as Attachment 3.

Zooplankton Monitoring

Overview

Cladocerans and copepods dominated the zooplankton community during the 1977-79 work of Cooper and Koch (1984). Low numbers of the crustacean *Acanthocyclops vernalis* were present. Average lake-wide zooplankton densities were

high during early spring and mid-summer. *Leptodiaptomus sicilis* dominated populations from November to June, while *Moina hutchinsoni* became abundant in August and September.

Cladocerans and copepods also dominated in 1992-94 (Horne and Goldman, 1994) along with a new rotifer, *Hexarthra fennica*. The crustacean *A. vernalis* was absent. Average lake-wide zooplankton densities were similar to those found in 1977-79 (Horne and Goldman, 1994). *L. sicilis,* the dominant species in 1977-79, declined to one-third to one-half of its population (Horne and Goldman, 1994). *M*. *hutchinsoni* remained relatively unchanged. *H. fennica* was the most numerous of all species. Harpacticoid copepods, ostracods, and *Alona guttata* were rare (Horne and Goldman, 1994).

NDOW began monitoring zooplankton in 2002. The population composition since that time has included primarily *L. sicilis, M*. *hutchinsoni*, and *H. fennica. Brachionus plicatilis*, *Alona* sp., and *Lecane* (Monostyla) were also found, but their occurrences were rare.

Average lake-wide *z*ooplankton densities were compared for the three study periods (1977-79, 1992-95, and 2007-12) (Figure 12). Overall densities have increased and changes in composition abundance are present through time (Figure 13).

To collect and analyze zooplankton: In 2012, cladocerans, copepods and rotifers dominated the zooplankton community. Average lake-wide zooplankton densities were high in the spring (Figure 14), which was due primarily to an abundance of *H. fennica* and to a lesser degree, *L. sicilis. M*. *hutchinsoni* showed its highest densities in summer (Figure 14 and Table 6).

From 2007 to 2011, *H. fennica* was dominant for four or five months of the year and prior to that, even less. The species assemblages were notably different this year. For the first time, in seven months out of the eight months sampled, *H. fennica* was the dominant species. Average *H. fennica* density in April was a record 424.2/L (Figure 14 and Table 6).

M. *hutchinsoni* has exhibited slight year to year variations since 2007 and a slight but steady decline since 2009 (Figure 15). *L. sicilis* exhibited the largest overall decline in average density for all of the species after peaking at over 50/L in 2008 and then declining to 26/L in 2011 (Figure 15). It then showed an increase in 2012, rising to 36/L. More time is needed to determine if *M*. *hutchinsoni* and *L. sicilis* population declines/fluctuations are cyclical, or if conditions are becoming more than they can tolerate.

Figure 12

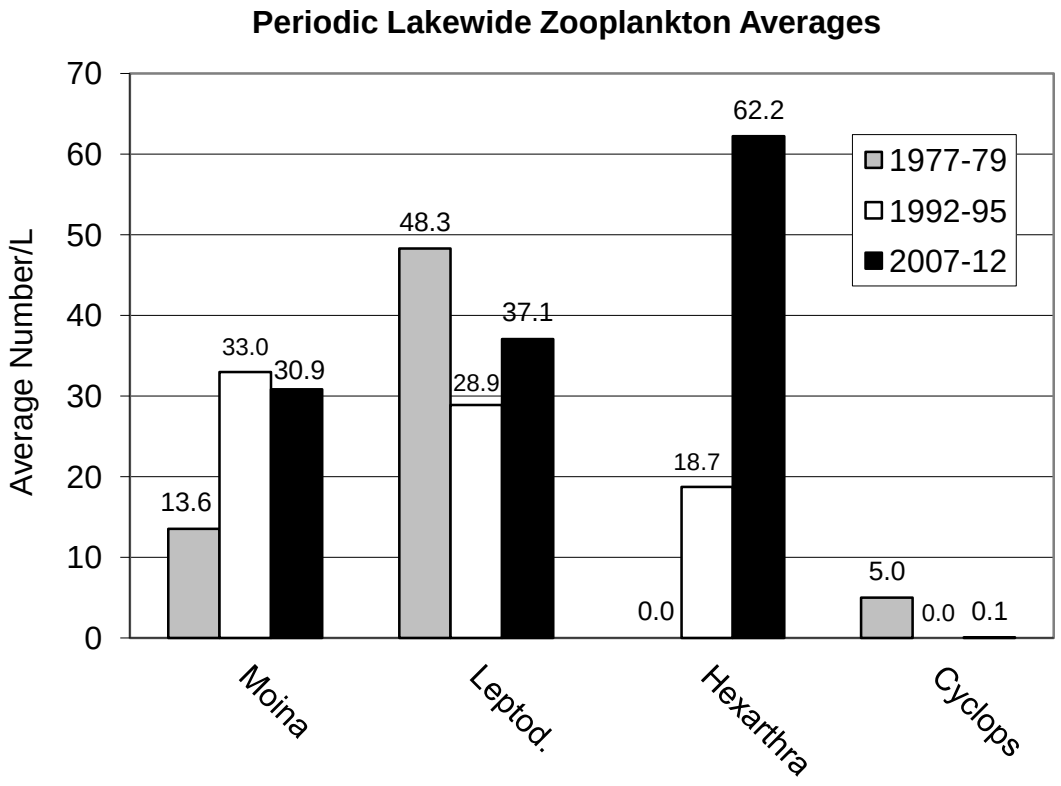


Figure 13

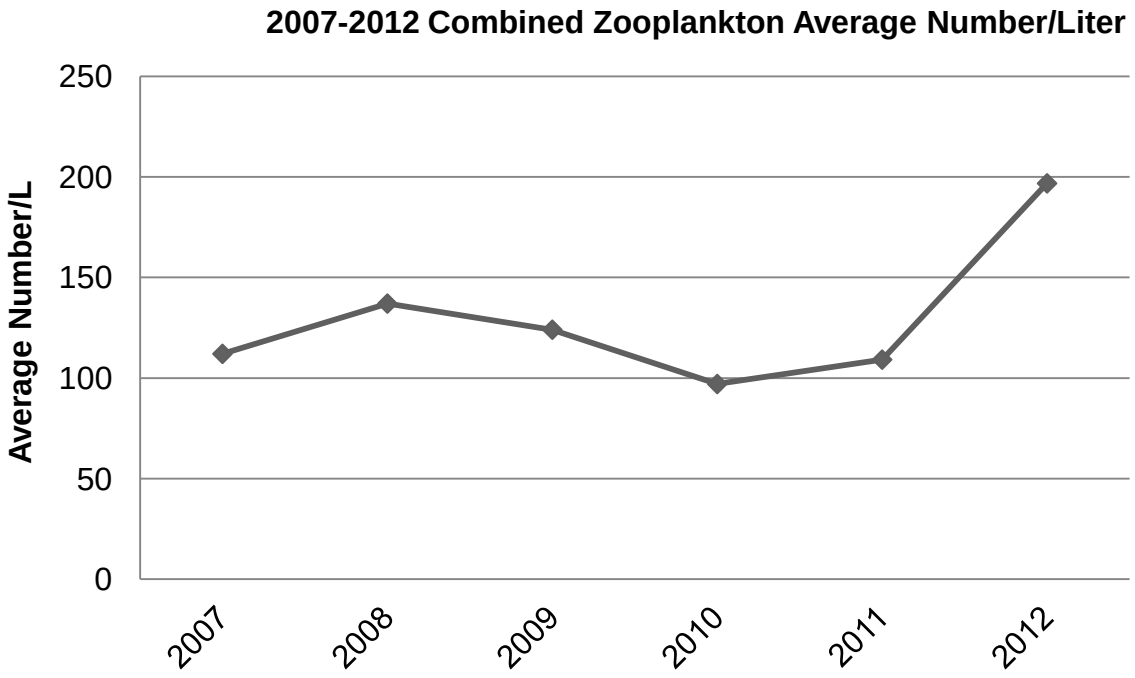
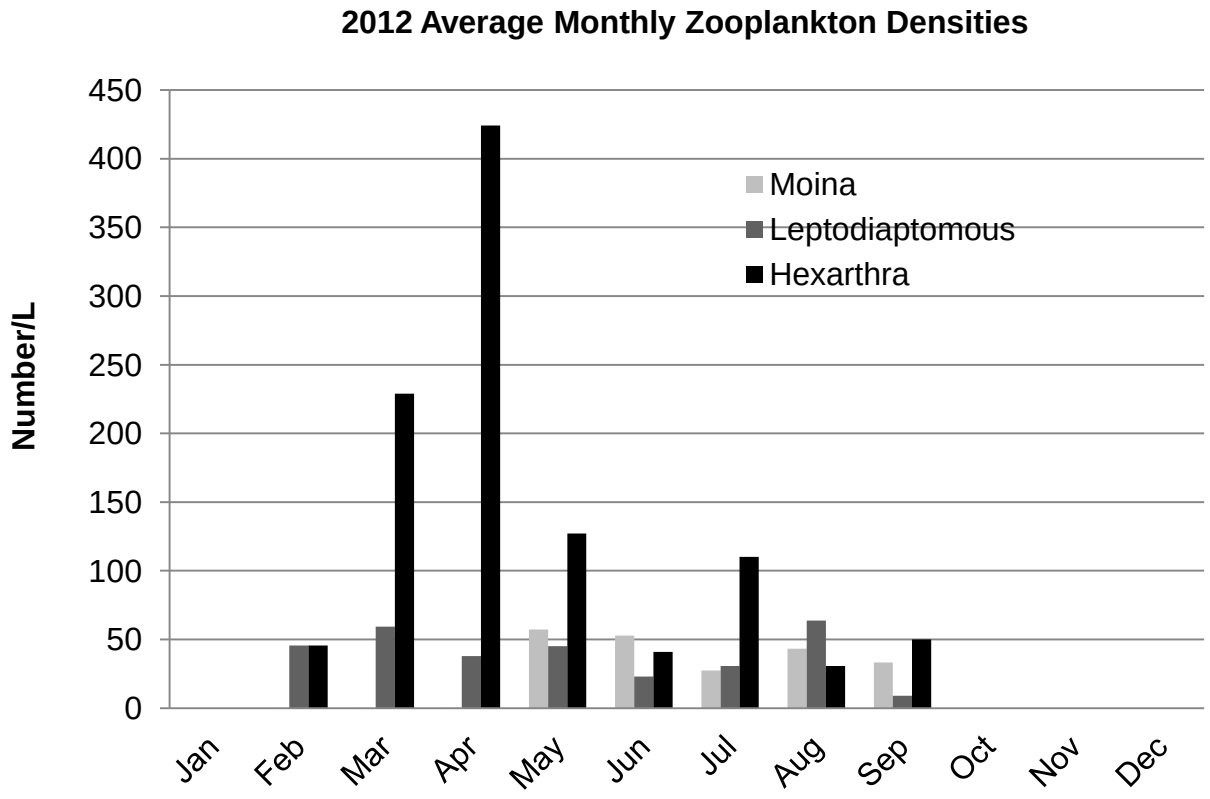


Figure 14



H. fennica exhibited a notable increase in overall density in 2012. Zooplankton was not collected in April of 2010 and 2011, possibly lowering the averages for those years. Even with April zooplankton data excluded, 2012 *H. fennica* averages were higher than ever observed. April winds make zooplankton collection difficult; however, more effort should be directed at achieving this effort. *H. fennica* shows an increase from 2007 to 2008, a steady decrease from 2008 to 2010, and increase again in 2011, and then it booms in 2012 (Figure 15).

PROJECT REVIEW

Federal grant agreement objectives were met through September in 2012. The inability to launch the survey boat from October through December precluded fall gill netting efforts, water profile collection, and zooplankton collection.

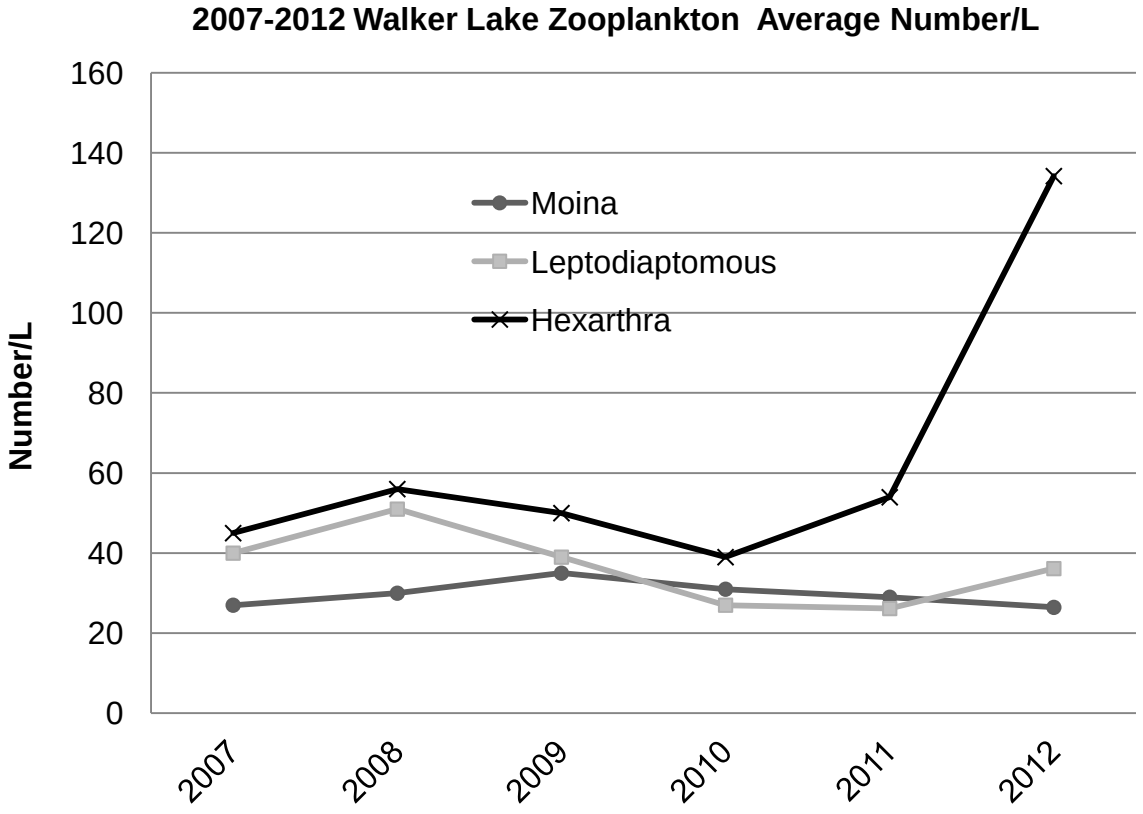
The 2012 water year was below average and did not provide any relief from the toxic environment. Water acquisitions from Desert Terminal Lakes funding proceeded slowly, and no water was received from acquisitions in 2012. TDS levels neared 20,000 mg/L by the end of 2012. Regular TDS monitoring was precluded from October through December due to boat launch status, so exact yearend TDS level is unknown.

Table 5

2012 Average Monthly Zooplankton Densities

	No./L Moina	No./L Leptodiaptomous	No./L Hexarthra	No./L Total
Jan	no data	no data	no data	no data
Feb	0.1	45.6	45.6	91.3
Mar	0.3	59.2	228.9	288.4
Apr	0.1	37.9	424.2	462.3
May	57.2	45.2	127.2	229.6
Jun	52.9	22.9	40.9	116.8
Jul	27.5	30.6	110.0	168.1
Aug	43.2	63.7	30.8	64.5
Sep	33.2	8.9	50.0	92.1
Oct	no data	no data	no data	no data
Nov	no data	no data	no data	no data
Dec	no data	no data	no data	no data

Figure 15



The Team made the decision in September 2010, to collect creel opportunistically due to a lack of pressure and harvest. One LCT was documented in each of 2009 and 2010. No LCT were documented for the last two years by any method and this is the first year that expanded mail-in angler questionnaire data from the prior year showed zero harvest. Conditions at Walker Lake have exceeded limitations for LCT existence. This was the third year that LCT stocking was suspended at Walker Lake.

While no fall gill netting was conducted, spring trap netting was conducted in order to confirm the lack of small chub at Walker Lake and also to transplant as many adult chub as possible to augment the refuge in Rose Creek Reservoir. Efforts produced over 600 tui chub; none were less than 280 mm in length. Data collected in spring nets confirmed NDOWs prior findings.

Effort to transplant tui chub to Rose Creek Reservoir did not meet objectives. Only 27 tui chub were netted on the day of transport. Further attempts to net tui chub were unsuccessful as the spawning effort and inflow ceased. A greater effort must be made next year to coordinate timing of multiple efforts for transplant and monitoring with the tribe, hatchery, and HAD if the refuge is to be a success.

Egg collection was more difficult this year than in years past. Eggs collected for observation of stage of development showed very high rates of deterioration and little advanced development for the fourth year in a row. A complete lack of sub-adult tui chub in Walker Lake suggests that even if some tui chub eggs hatch, survival of larval tui chub would be unlikely.

More samples of tui chub should be collected and sent to WADDL as soon as they can be collected. Individuals exhibiting more extreme clinical signs of stress should be targeted.

The zooplankton, *L. sicilis* appears to be declining and *M*. *hutchinsoni* may be declining as well. More years of data will be helpful to determine if those species are actually declining, or if it is just part of a cyclic pattern. The *H. fennica* experienced a population explosion, more than doubling in abundance.

The State Parks boat launch became unusable during the last three months of 2012. An effort was made to seek out a new launch site, but there is no safe launch site at this time. Snowpack at the end of 2012 is fair, but not enough that a prediction can be made as to future launch status.

RECOMMENDATIONS

- To conduct water quality monitoring every other week from April through October and once a month from January through March and then November through December.

- To monitor lake elevation and river discharge.

- To tag/acclimate/bioassay LCT for stocking into Walker Lake if TDS levels and flows permit.

- To collect angler use information opportunistically when conditions improve.

- To maintain angler survey boxes and angler information center.

- To report mail-in survey data.

- To set spring trap nets to examine changes in tui chub abundance and population composition.

- To set fall gill nets in order to examine changes in tui chub abundance and population composition.

- To send more samples to WADDL for evaluation and diagnosis of physiological stress.

- To determine tui chub egg viability by collecting eggs from gravel and examining for stage of development.

- To check for spawning and recruitment April through July through visual boat surveys conducted next to shore.

- To collect zooplankton monthly at ten stations.

- To monitor and augment Rose Creek Reservoir's refuge population of Walker Lake

- To determine tui chub adult population using capture/mark/recapture methods.

- To GPS perimeter of south marsh area of Walker Lake and conduct amphibian surveys.

- To Floy tag at least 100 pond born tui chub within Rose Creek Reservoir.

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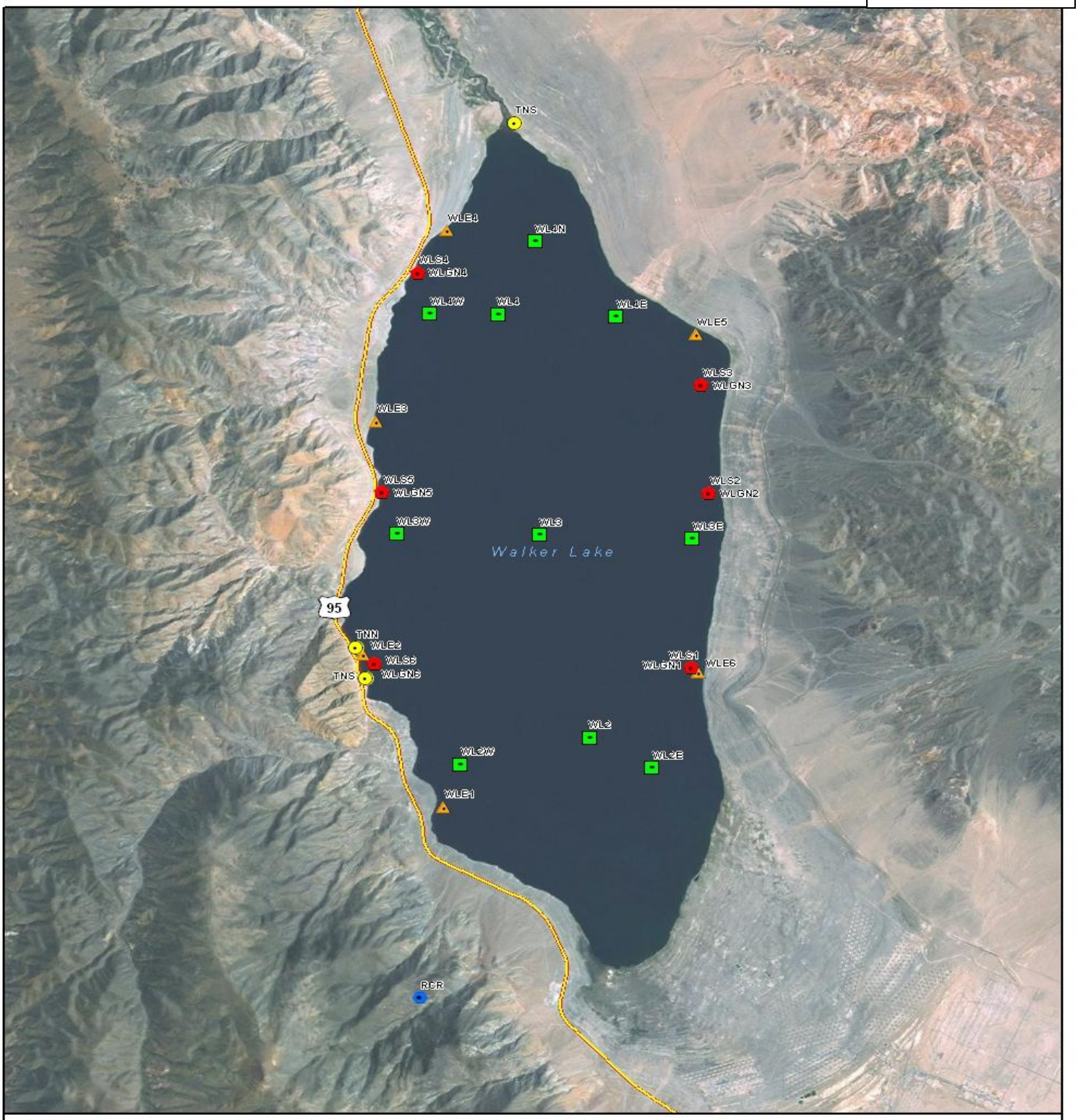
Prepared by: Karie Wright
Fisheries Biologist
Western Region

Date: February 2012

Attachment 1



Walker Lake GPS Sample Sites

Sample Sites
- RCR
- TN
- WL
- WLE
- WLGN/WLS

No warranty is made by the Nevada Department of Wildlife as to the accuracy, reliability, or completeness of the data for individual use or aggregate use with other data.

0 1 2 3 Miles

Projection: UTM Zone 11 North, NAD83

3/3/2011

Attachment 1 cont.

Walker Lake GPS Sample Site Locations

Site	UTM UPS, WGS 84
WLE1	11 S 349086 4276357
WL2	11 S 351857 4279467
WL2E	11 S 353361 4278668
WL2W	11 S 348709 4278755
WL3	11 S 350645 4284886
WL3E	11 S 354343 4284781
WL3W	11 S 347171 4284915
WL4	11 S 349630 4290770
WL4E	11 S 352496 4290704
WL4N	11 S 350529 4292721
WL4W	11 S 347982 4290789
WLE4	11 S 348401 4293009
WLE5	11 S 355103 4291168
WLE6	11 S 355067 4281203
WLS1	11 S 354355 4281337
WLS2	11 S 354770 4285998
WLS3	11 S 354594 4288876
WLS4	11 S 347694 4291881
WLS5	11 S 346839 4286019
WLS6	11 S 346636 4281456
WLGN4	11 S 347694 4291881
WLGN5	11 S 346839 4286019
WLGN6	11 S 346636 4281456
TNS	11 S 346435 4281050
TNI	11 S 350068 4295875
RCR	11 S 350354 4276625

Attachment 2

2012 Mid-Lake Water Quality Profiles

	30-Jan		21-Feb	28-Mar	24-Apr		29-May	17-Jul		24-Aug		19-Sep	
Depth (m)	T (°C)	DO (mg/L)	T (°C)	T (°C)	T (°C)	DO (mg/L)	T (°C)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)	T (°C)	DO (mg/L)
0	4.53	10.15	3.00	5.97	15.43	8.40	15.01	23.11	7.33	25.06	5.41	23.17	7.87
1	4.34	10.19	2.94	5.88	14.40	8.68	13.73	23.06	7.60	24.93	5.13	22.79	7.67
2	4.38	10.17	2.81	5.68	13.51	8.82	13.42	22.95	7.50	23.56	4.85	22.78	7.62
3	4.38	10.17	2.75	5.59	12.78	8.94	13.18	22.91	7.36	23.56	4.75	22.64	7.67
4	4.08	10.14	2.71	5.53	12.38	8.97	13.06	22.89	7.50	24.31	4.85	22.60	7.54
5	4.06	10.13	2.69	5.50	11.33	8.99	13.00	22.88	7.50	24.31	4.78	22.59	7.54
6	4.06	10.11	2.69	5.43	10.42	9.05	12.96	22.89	7.30	24.29	4.75	22.56	7.53
7	4.06	10.09	2.66	5.42	10.12	9.07	12.93	22.86	7.10	24.28	4.67	22.55	7.51
8	4.03	10.06	2.65	5.41	10.02	9.02	12.84	22.85	7.14	24.27	4.13	22.55	7.51
9	4.03	10.06	2.65	5.40	9.95	8.97	12.75	22.84	7.24	24.26	4.01	22.54	7.51
10	4.01	10.06	2.65	5.38	9.87	8.93	12.73	22.82	7.23	24.23	3.95	22.53	7.50
11	4.00	10.02	2.65	5.37	9.85	8.91	12.72	22.55	7.24	24.26	3.91	22.53	7.57
12	4.00	10.00	2.65	5.35	9.71	8.86	12.68	20.79	6.34	24.26	3.89	22.53	7.50
13	3.99	9.98	2.65	5.32	9.16	8.79	12.66	19.13	5.70	24.24	3.89	22.53	7.49
14	3.99	9.98	2.64	5.25	8.96	8.51	12.36	18.28	4.61	24.23	3.87	22.53	7.50
15	3.99	9.98	2.64	5.05	8.69	8.68	12.13	17.69	3.91	24.18	3.85	22.52	7.51
16	3.98	9.90	2.64	4.87	8.60	8.00	12.08	17.22	3.15	20.31	2.55	22.50	7.47
17	3.97	9.94	2.64	4.76	8.59	7.89	12.06	16.74	2.31	18.63	2.31	22.50	7.47
18	3.95	9.90	2.64	4.73	8.55	7.20	12.04	16.60	2.01	18.40	1.62	22.47	7.49
19	3.95	9.45	2.64	4.73	8.54	7.79	12.03	16.58	1.95	16.96	0.99	17.36	0.85
20	3.94	9.84	2.64	4.72	8.54	7.20	10.00	16.56	1.91	16.71	0.65	17.00	0.00
21	3.94	9.82	2.64	4.72	8.54	7.20							
Avg. TDS (NDEP)	**17,906 mg/L**				**18,556 mg/L**			**19,223 mg/L**					

***Water quality was collected using NDEP equipment and samples were collected for TDS analysis**

Attachment 3

WASHINGTON ANIMAL DISEASE DIAGNOSTIC LABORATORY

P.O. Box 647034
Pullman, WA 99164-7034
Phone: (509) 335-9696
Fax: (509) 335-7424

Veterinarian:	Karie Wright	Owner:	Nevada Dept of Wildlife
Clinic:	Nevada Dept of Wildlife	Animal:	
Address:	1100 Valley Road	Species:	Fish sp.
		Breed:	
	Reno, NV 89512	Age:	
Phone:	(775) 857-7622	Sex:	Not Reported

HISTOPATHOLOGY REPORT **12/03/12** **WADDL #2012-7375**
Report authorized by: Kevin Snekvik, Senior Pathologist **Received: 06/25/12**

Two containers of formalin fixed tissues from multiple *Siphateles bicolor pectinifer* are submitted and grossly representative sections from each of the tissues are processed and evaluated. Changes are similar and will be described together with differences between fish note below.

Eye: In multiple fish, the interstitium of the rete mirabile and choroid gland along with the loose connective tissue internal to the sclera posterior to these vascular structures are infiltrated by moderate to large numbers of eosinophilic granular cells. The loose connective tissue is additionally expanded by abundant amounts of eosinophilic granular proteinaceous edema fluid. In one fish the above inflammatory infiltrates and edema fluid radiate into the retrobulbar adipose tissue

Ovary: In all samples, there are eggs in multiple phases of development with a predominance of vitellogenic follicles. However, many of these follicles have a corrugated membrane, peripheral band of granular palely eosinophilic yolk material with highly variable yolk granule size (early atretic follicles). In one sample, the interstitium of the ovary is multifocally infiltrated by low numbers of macrophages that are occasionally clustered. The serosal surface of the ovary is lined by innumerable fibrovascular strands that interconnect with the mesentery.

Liver: Subjectively, throughout multiple lobes the hepatocytes are moderately reduced in size ranging from 5-7 um in diameter with the cytoplasm approximately equaling the area of the nucleus (presumptive hepatocellular atrophy). Scattered individual hepatocytes contain intracytoplasmic accumulations of bright yellow to light brown pigment with individual to moderately sized clusters of macrophages which contain similar intracytoplasmic pigment.

Heart: In multiple samples, the epicardium, spanning regions of the ventricle, atrium and bulbous arteriosus, is infiltrated by low to infrequently moderate numbers of loosely scattered macrophages and fewer lymphocytes. In one sample the myocardium of the ventricle is multifocally disrupted by occasional densely packed clusters of lymphocytes and rare macrophages. The most severe of these myocardial

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lesions have concurrent aggregates of lymphocytes along the endocardium and extending into the ventricular lumen.

Mesentery/ serosa: The serosal surfaces of the mesentery and visceral organs is diffusely lined and interconnected by a web of innumerable, delicate fibrovascular strands that lack inflammatory infiltrates.

In one fish, embedded within the mesenteric adipose tissue are frequent encysted cestodes. The cestodes are partially coiled, vary moderately in size, and are characterized by a brightly eosinophilic tegument and a parenchymous filled body that lacks a digestive tract and contains calcareous corpuscles. The cestodes are surrounded by a variably thick mantle of epithelioid macrophages in turn bordered scant to moderate amounts of fibrosis with scant to occasionally moderate numbers of lymphocytes and macrophages. In the same fish, rare small nematodes are also encysted within the mesenteric adipose tissue. The nematodes are approximately 175-210um in diameter and are characterized by a smooth cuticle and a pseudocoelom lined by platymyarian musculature, paired lateral cords and containing a digestive tract lined by multiple tall cuboidal epithelial cells.

The mesentery is infiltrated by loosely scattered to multifocal clusters of densely packed plump reactive macrophages. The macrophages often contain light golden tan globular pigment (lipofuscin) and scant amounts of dark brown, granular pigment (melanin). In addition to the histiocytic inflammation are occasional small granulomas that contain a central core of cellular debris surrounded by plump reactive to epithelioid macrophages in turn encompassed by scant amounts of fibrous tissue. Some granulomas are centered on remnant of cestodes and nematode worms in the fish described above.

Pancreas: Occasional lobules of pancreatic acini are surrounded and separated by moderately increased amounts of well-organized fibrous connective tissue infiltrated by low to moderate numbers of lymphocytes and macrophages.

Spleen: The red pulp has multifocal 35-75um diameter aggregates of plump densely packed macrophages that contain abundant intracytoplasmic accumulations of lipofuscin and scant melanin pigment (lipogranulomas).

Gill: In one fish, very rare secondary lamellae are shrunken and lined by piled hypertrophied epithelial cells.

The following tissues are normal: head kidney, stomach, intestine, posterior kidney and gall bladder,

HISTOLOGIC DIAGNOSES:

1. Choroiditis, granulocytic, focally extensive (multiple fish) with granulocytic retrobulbar steatitis (one fish)
2. Follicular atresia, acute, moderate to severe, multiple fish
3. Hepatocellular atrophy, diffuse, moderate to severe with minimal to moderate bile stasis, multiple fish
4. Epicarditis, lymphocytic, chronic, multifocal, mild (multiple fish) with mild, multifocal, lymphocytic myocarditis (one fish)
5. Trematodiasis and cestodiasis, moderate, one fish

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HISTOPATHOLOGY REPORT **12/03/12** **WADDL #2012-7375**

COMMENTS: A primary infectious agent is not evident that would explain the hemorrhages noted clinically in this group of fish. There are lesions of septicemia, specifically choroiditis in the eyes and epicarditis and myocarditis. Given that the heart lesions are mild, no organisms are noted on histopathology in any lesions and no additional lesions are noted in organs such as the spleen and kidney these changes would be most consistent with an acute septicemia and are interpreted as secondary to debilitation from stress. The ovaries have large numbers of vitellogenic follicles, which is compatible with fish close to spawning. However, many of the follicles are in early atresia, beginning to degenerate before spawn and supportive of stress induced resorption. Given all this information along with the environmental conditions noted in the history (high total dissolved solids, increased water temperatures), the clinical signs and mortalities noted in this group of fish is attributed to a combination of environmental and spawning stress with early secondary bacterial infection.

WORK PENDING: None

Dr. Kevin Snekvik/KRS/krs/phy
9042

Attachment 4

FIELD TRIP REPORT

DATE: May 5, 2012

TITLE: Walker Lake South Marsh Refuge Habitat and Amphibian Surveys

FIELD PARTY: Karie Wright (NDOW), John Peterson (Hawthorne Army Depot)

PREPARED BY: Karie Wright
Date: 9-18-2012

Objective

To conduct a survey of the south marsh area of Walker Lake in order to determine if suitable habitat exists for Walker Lake Lahontan tui chub (*Gila bicolor pectinifer and G.b. obesa*).

Concurrent to habitat survey, amphibian presence/absence will be documented.

Background

Tui Chub- Tui chub have been the only fish observed in Walker Lake since 2009. Historically, tui chub contributed to the food base of large (>380 mm, 15 in) Lahontan cutthroat trout (LCT, *Oncorhynchus clarki henshawi*) and substantially to the food base of piscivorous birds (Koch et al. 1979). Tui chub recruitment has been nominal and infrequent since regular monitoring began in 2002.

Upstream water diversions, resulting in a decrease in lake volume, are the primary threat to tui chub persistence in Walker Lake. As lake volume decreases, total dissolved solids (TDS) concentration increases. TDS (mostly sodium and chloride) in Walker Lake peaked at 19,200 mg/L in 2011, and is currently near that level once again. It is unknown what level of TDS concentration will extirpate tui chub from Walker Lake. In the Carson Sink, Nevada, nearly 7 million fish (mostly tui chub) died when the TDS increased to 20,000 mg/L (Rowe and Hoffman, 1987).

The Walker Lake Fisheries Improvement Team (Team) consisting of biologists from USFWS, NDOW, and Walker River Paiute Tribe (WRPT) was established in 2006 to develop a cooperative, extensive monitoring effort on Walker Lake. The primary goal of the team was to determine the effects of increasing TDS level on the ecosystem.

Results of a genetic study conducted on Walker basin tui chub by UC Davis showed substantial differentiation (based on pairwise Fst values) (Finger and May 2010). Walker Lake tui chub had the most private alleles (17), and the highest heterozygosity (0.83). Walker Lake tui chub grouped most closely with the Pyramid Lake tui chub, Stillwater and Topaz tui chub grouped next closely. Preserving a refuge population of the Walker Lake tui chub was recommended, if adequate precautions are taken to preserve genetic fitness (Finger and May 2010).

In 2008, the NDOW biologist began investigating the possibility of creating a refuge for the Walker Lake tui chub (Wright, 2008). In September, 2009, Rose Creek Reservoir was toured by three biologists from NDOW and USGS who deemed the reservoir suitable for tui chub inhabitance (Wright, 2009). In October 2009, the first transplant of tui chub from Walker Lake to Rose Creek Reservoir was conducted (Wright, 2009). Augmentation of the refuge population in Rose Creek Reservoir was conducted in spring of 2010 (Wright, 2010) and 2011(Wright, 2011). Attempts to augment the population in 2012 were not successful (only 30 fish transplanted) because of the inability to coordinate access to the refuge with the Hawthorne Army Depot (HAD) personnel during the tui chub spawn.

Multiple refugia are desired for optimal preservation of valuable genetic material.

Amphibians- No written records could be found regarding amphibians at the south marsh of Walker Lake. A preceding biologist captured western toads (*Bufo boreas*) at Navy Beach over 10 years ago (Sevon, pers. comm.). Hawthorne Army Depot personnel reported observing both western toads and an unknown frog species (Peterson, pers. comm.)

Procedure

Tui chub- The survey was conducted by wading throughout the marsh, documenting and photographing suitable tui chub habitat. Temperature, DO, and pH were recorded.

Amphibians- The survey was conducted by wading throughout the marsh, documenting and photographing amphibians. Several tadpoles were collected and reared to the juvenile life stage in order to facilitate accurate identification. Temperatures were recorded where tadpoles were found.

Findings and Analysis

Tui chub- Cursory observations indicated a presence of adequate tui chub habitat within the south marsh ponds. Surface temperature in the largest pond was 17.2°C, pH was 8.4, and DO was 8.5. The ponds were heavily choked with

emergent vegetation (cattail). Removal and maintenance of cattail may be necessary for success of a tui chub refuge. Ponds were approximately 0.3 m to 1 m deep. One pond was estimated to be 40-50 m long and 5 m wide, another pond was approximately 5-7 m long by 5-7 m wide. Mosquito fish (*Gambusia affinis)* are present in abundance throughout the entire area.

Amphibians- Thousands of western toad tadpoles were observed throughout the south marsh area in the very shallow (<10 cm), warm water (26.6°C). The tadpole samples that were collected morphed into western toads. Approximately 100 toads were observed in the dense riparian vegetation. Of the 100 observed, 32 were captured, photographed and measured. Total length of toads ranged from 25 mm to 89 mm.

Photographs taken on the field trip were accidently destroyed.

Conclusions and Recommendations

Tui chub- While suitable habitat currently exists for the Walker Lake tui chub within the south marsh area of Walker Lake, conditions are declining and the longevity of a potential refuge is in question.

Historical data does not exist for the south marsh and baseline conditions have not been established so it is difficult to quantify a decline. Google Map images (Figures 1 and 2) show the apparent decline in total area and health of the south marsh in recent years.

Figure 1

2006 Satellite Image of South Marsh Walker Lake

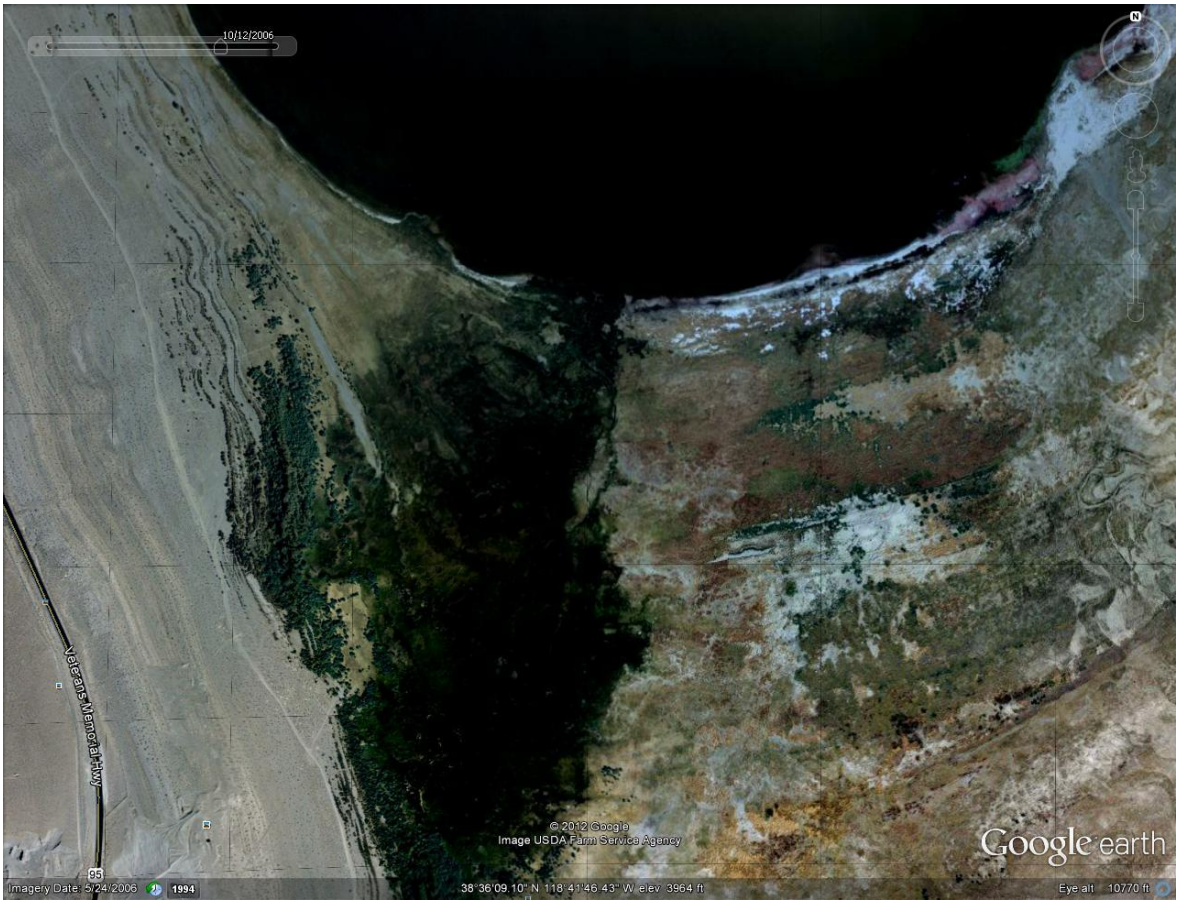

Figure 2

2010 Satellite Image of South Marsh Walker Lake

The establishment of a long-lived refuge is desired for the Walker Lake tui chub. The uncertainly of the stability of the south marsh, combined with the difficult access and potential maintenance does not make it an ideal refuge.

Amphibians- As a result of the amphibian surveys, western toads have been added to the NDOW species records database. A springtime presence/absence survey for amphibians in the south marsh is recommended. Efforts should also include establishing an outer perimeter of the marsh using GPS in order to document marsh shrinkage. A more in depth look at satellite imagery may also be useful in the analysis. HAD personnel will be contacted in regards to results and ongoing monitoring proposals. There are no foreseen problems with cooperation.

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