EXHIBIT 91

Walker Lake Fishery Improvement Program
Final Report

March 15, 2011

Completed by: NEVADA DEPARTMENT OF WILDLIFE

In Compliance with FWS
Cooperative Agreement No. 84240-6-J

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WALKER LAKE
FINAL PROJECT REPORT

State: *Nevada*
Project Title: *Desert Terminal Lake Program*
Job Title: *Walker Lake Fishery Improvement Program*
Period Covered: *January 1, 2007 through December 31, 2010*

Summary

In 2005, Congress appropriated money to research desert terminal lakes; in 2007, Nevada Department of Wildlife (NDOW) received part of that money to increase study efforts at Walker Lake. In 2010, the fishery improvement plan (FIP) was implemented for the fourth full year. FIP outlines a collaborative effort between NDOW, United States Fish and Wildlife Service (USFWS), and Walker River Paiute Tribe (WRPT) to monitor stocking survival of Lahontan cutthroat trout (LCT, *Oncorhynchus clarki henshawi*) and document the ecosystems response to increasing total dissolved solids (TDS).

NDOW's monitoring program included: new methodologies applied in analysis of creel data to expand harvest, extensive efforts to increase probability of contact with tui chub YOY, research and location of Lahontan tui chub (tui chub, *Siphateles bicolor pectinifer and S. b. obesa*) refugia, measuring changes in zooplankton composition and abundance, and documentation of changes in water quality and quantity. Study results will aid in providing a timeline for re-establishment of the fishery when water is secured for Walker Lake, drought ends, or both. Work presented here comprises data collected from 2007-2010. Studying effects of increasing TDS on Walker Lake will aid other managers in decision making for similar scenarios.

Acknowledgements

NDOW's monitoring program was accomplished with assistance from USFWS, NDOW, SNARL, WRPT, and NDEP personnel. Pat Sollberger (NDOW) and Robert Jellison (SNARL) provided input into the development and continued improvement of the monitoring program. Steve Parmenter (California Fish and Game) provided technical advice for tui chub sampling, refugia, and was the catalyst to acquiring adequate numbers of fin clips for genetic analysis. Thanks to Stephanie Byers (USFWS) for providing numerous personnel and equipment to aid in completion of program goals. Thanks to Gerry Emm and David Schildt (WRPT) for providing logistical support and assistance in the field. John Heggeness and Dave Simpson (NDEP) collected valuable TDS readings quarterly throughout the study period. Kris Urquhart (NDOW) assisted with data and sample collection when needed.

Chapter 1
Introduction

Background

Lake Lahontan, a large inland freshwater sea, once covered much of northern Nevada. Severe climatic changes caused droughts and desiccation of Lake Lahontan several times. Walker Lake, a desert terminal lake, is remnant of Pleistocene Lake Lahontan which last went dry about 2,100 years ago. Walker Lake is fed by Walker River, running from east of Sierra Nevada through miles of farming community before terminating at Walker Lake.

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

Since diversions were constructed, an approximately 150 foot drop in lake elevation has occurred. Decreasing lake levels, leading to increasingly toxic lake conditions, have resulted in a depauperate fishery. High TDS (mostly bicarbonate, sodium, sulfate, and chloride) affect gill and kidney functions that impact survivorship and size of fishes. Since the early 1950s, LCT in Walker Lake have been maintained through stocking. Several strains have been planted with good results but as TDS increases, LCT stocking survival decreases. High TDS (over 19,000 mg/L in 2010) has reduced survival of stocked LCT. While other native species once existed in Walker Lake, tui chub may be the last remaining species. Rising TDS has decreased LCT catchability, decreased survivorship and growth of LCT, severely diminished tui chub egg viability, altered zooplankton composition and abundance, and degraded water quality.

Goals, Objectives, and Approaches

Goal: The goal for the Walker Lake Fishery Improvement Plan (FIP) is to improve survival of LCT in Walker Lake and lower Walker River and to study the Walker Lake ecosystem's response to changing TDS levels.

- Objective: To collect and analyze water quality seasonally from Walker Lake to document changes as lake levels vary.

  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.

- Objective: Determine survival, both initial and long-term, of LCT stocked into Walker Lake.

  Approaches:
  - To report data from the Mail-in, Angler Questionnaire Survey.
  - To maintain angler survey boxes and an angler information center.
  - To collect angler use information eight days a month from October to May if LCT are still present.
  - To tag/acclimate/bioassay LCT for stocking into Walker Lake if TDS and flows permit.

- Objective: To collect information on the Lahontan tui chub life history and abundance, and document spawning success or failure as lake levels fluctuate and water quality changes.

  Approaches:
  - To check for spawning and recruitment April through July through visual boat surveys conducted next to shore.
  - To determine tui chub egg viability by collecting eggs from gravel and examining for stage of development.
  - To conduct day and evening larval tui chub snorkeling surveys in summer.
  - To set fall gill nets for YOY chubs in order to examine changes in relative chub abundance.
  - To set minnow traps in order to increase encounter probability for YOY.
  - To monitor Rose Creek Reservoir's refuge population of Walker Lake tui chub.

- Objective: To conduct monthly zooplankton collection and document changes in abundance and composition.

  Approaches:
  - To collect and analyze zooplankton populations.

Additional FIP objectives that were not part of the regular work program included collection of fin clips, for genetic analysis and the construction of an acclimation facility.

Chapter 2
Water Quality Monitoring

Methods

Water Quantity

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

Water Quantity

Water quality was checked at three sites for temperature, dissolved oxygen (DO), pH, and conductivity using an YSI 600 XL water quality analyzer. Water quality parameters were analyzed monthly from November through March, and biweekly from April through October, at three stations (WL2C, WL3C, and WL4C [Attachment 1]). The YSI was calibrated for all parameters including DO, pH, conductivity and depth on site prior to data collection to ensure proper readings and account for variations in barometric pressure.

Additionally, quarterly sampling occurred with Nevada Division of Environmental Protection (NDEP) at the same sites for the same parameters, using a Hydrolab Data Sonde 4a water quality analyzer. Only the center site for each sampling date is reported here. Concurrent to quarterly sampling, NDEP also collected water at three depths from each site to determine TDS concentrations. In this report, TDS were averaged at depths above the hypolimnion during summer and throughout the water column in winter.

Secci depth was recorded at ten stations (WLN, WL2, WL2E, WL2W, WL3, WL3E, WL3W, WL4, WL4E, WL4W [Attachment 1]) on each sampling date. Secci depths from center stations on each date sampled during this study period are reported here.

Results

Water Quantity

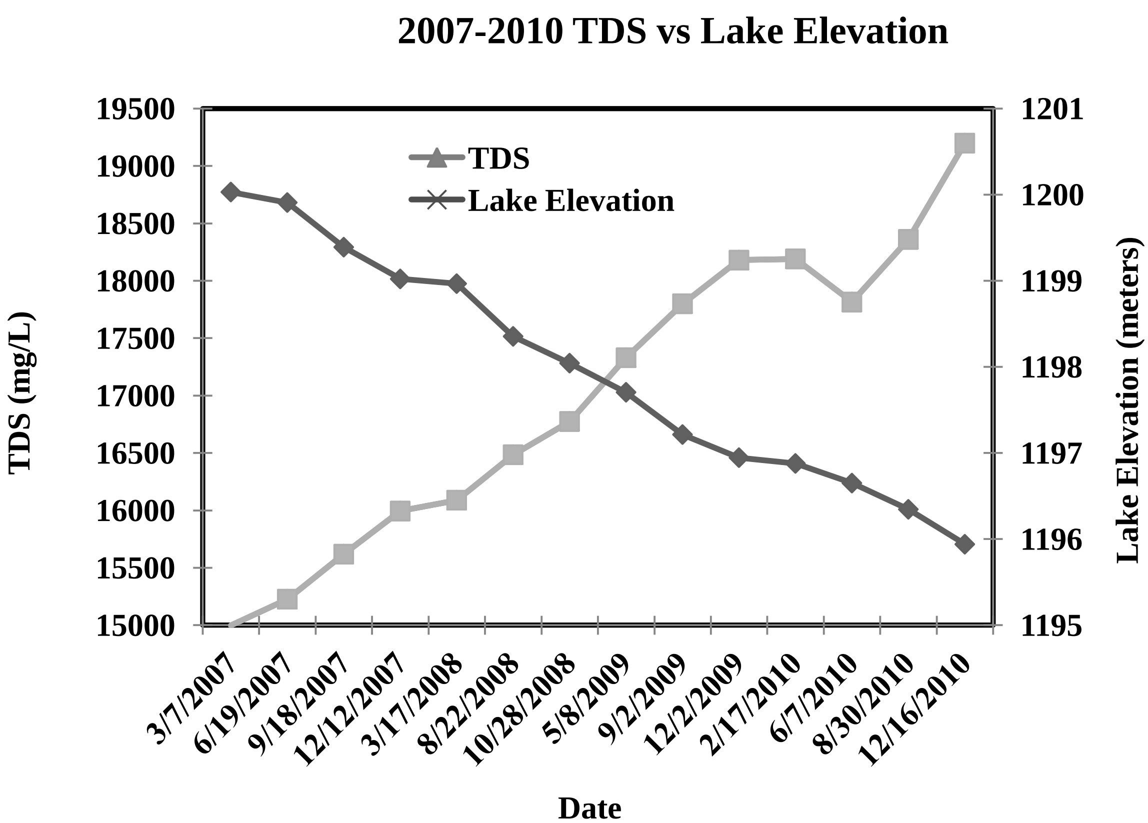
Based on mountain data from Natural Resource Conservation Service SNOTEL sites in Walker Basin, average snow water equivalent for Walker Basin on April 1 of each year from 2007-2010 was 41, 93, 84, and 91 percent, respectively. A general rule is that if Walker Basin does not receive about 120 percent of average snow water equivalent in one year, it is possible for no water to be received at Walker Lake. Exceptions to this are when water comes too quickly as runoff and it cannot be held, or if water is sent to Walker Lake as part of fallowing programs.

Yearly evaporative losses have been estimated at 1.73 x 10^8 m^3 (140,000 AF) (Horne et al., 1994). Walker River contributed an estimated 2.37 x 10^7 m^3 (19,284.3 AF) of water to Walker Lake in 2007, 2.1 x 10^7 m^3 (17,209.05 AF) in 2008, 1.6 x 10^7 m^3 (12,953.52 AF) in 2009, and 4.23 x 10^7 m^3 (34,260 acre-ft) in 2010. Lake level dropped in each year of this study (Figure

1). Losses were 1 m (3.3 ft), 1.15 m (3.78 ft), 1.06 m (3.5 ft), and 0.87 m (2.84 ft) in 2007 to 2010, respectively. During this study period, high lake elevation occurred on March 26, 2007 at 1,200.1 m (3,937.3 ft) and low lake elevation occurred on December 12, 2010 at 1,196.0 m (3,923.90 ft).

TDS have a negative relationship with lake elevation, as lake levels descended to all time documented low levels in 2010, TDS ascended to 19,200 mg/L (Figure 1) (Simpson, 2010).

Figure 1



Water Quantity

In 2007, water temperature began warming up in May with maximum surface temperature occurring in early August at 24ºC (75.2ºF). Thermal stratification first developed in early May with no distinct thermocline occurring until July at 13 m (42.6 ft). The thermocline descended to 15 m (49.2 ft) in August and 20 m (65.6 ft) in September (Figures 2 and 3, Attachment 2).

Figure 2

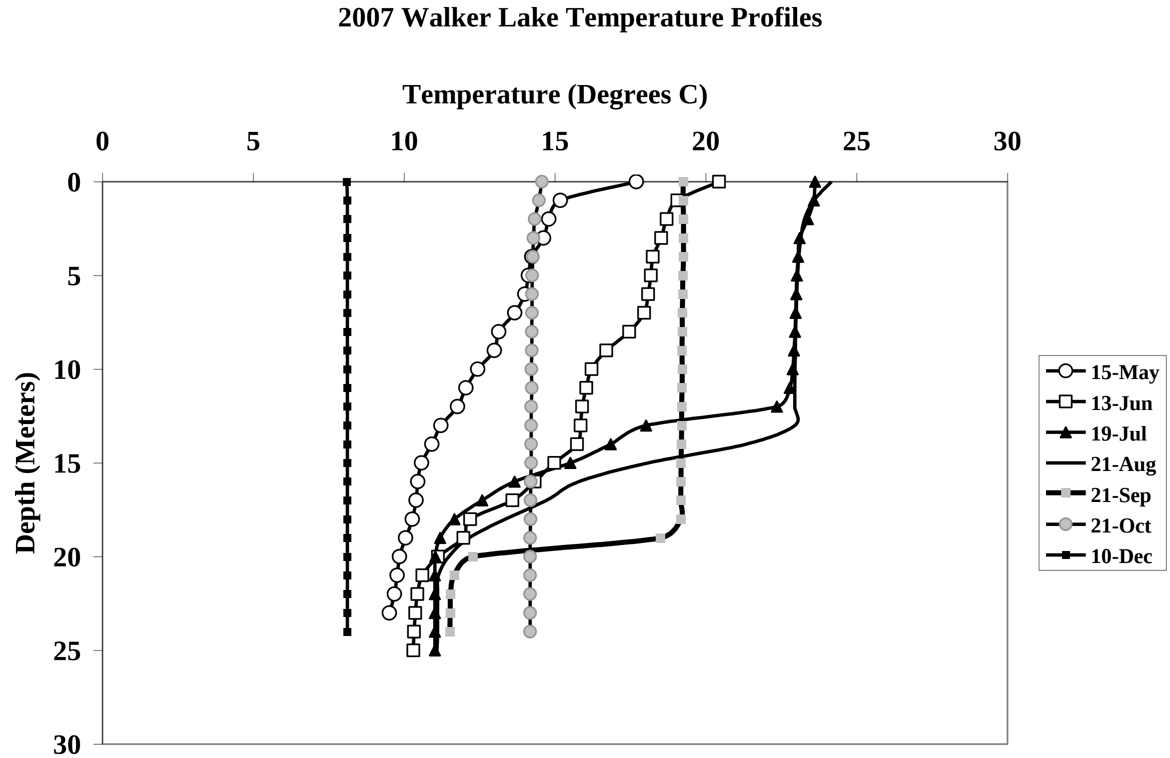
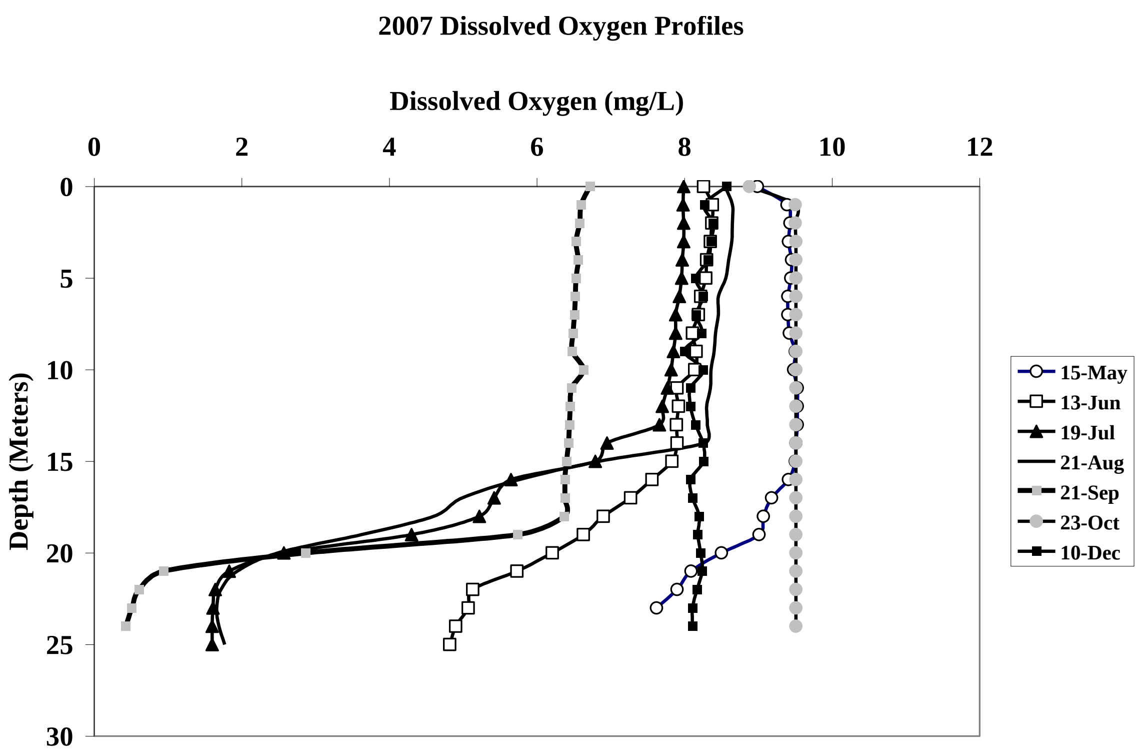


Figure 3



In 2008, a temperature gradient formed in May, however due to cool early summer temperatures and frequent wind, a summer thermocline was not observed until June 23 at a depth of 13 m (42.6 ft). The thermocline ascended to 10 m (32.8 ft) in July due to cool and breezy weather, and then descended to 15 m (49.2 ft) in August and even deeper 18 m (59.05 ft) in September. Maximum surface temperature reached 25.46º C (77.82º F) by late August (Figures 4 and 5, Attachment2).

Figure 4

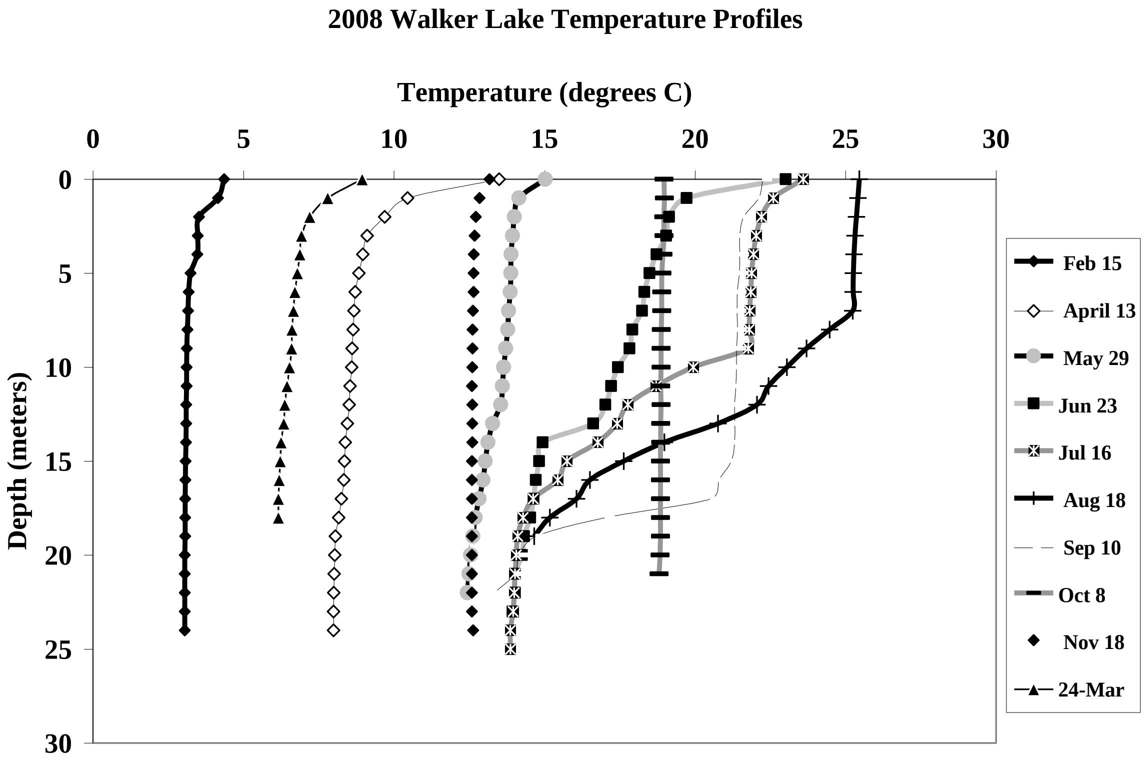
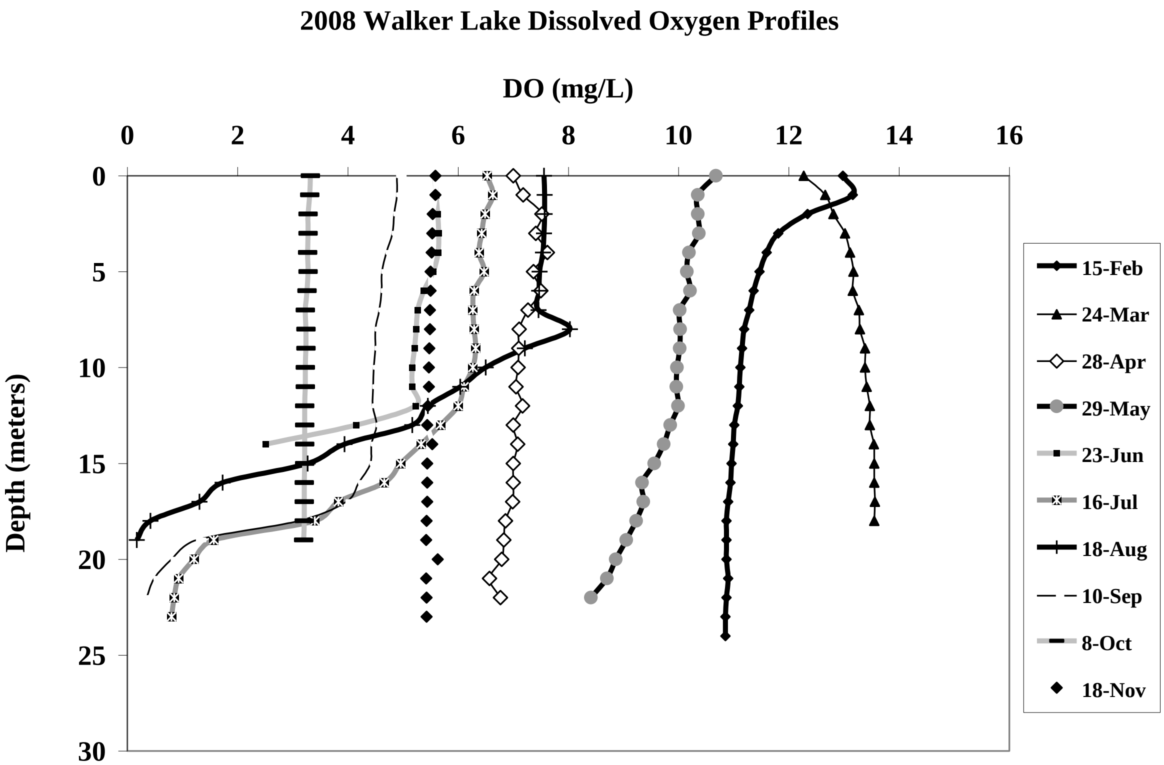


Figure 5



In 2009, a temperature gradient formed in April, and a thermocline was observed on May 20 at a depth of 10 m (32.8 ft). The thermocline descended to 17 m (55.76 ft) by June 25 due to warm weather. The thermocline remained at 17 m (55.76 ft) in August and then descended to 21 m (68.88 ft) in September just before mixing occurred. Maximum surface temperature reached 24.78º C (76.6º F) by late July (Figures 6 and 7, Attachment 2).

Figure 6

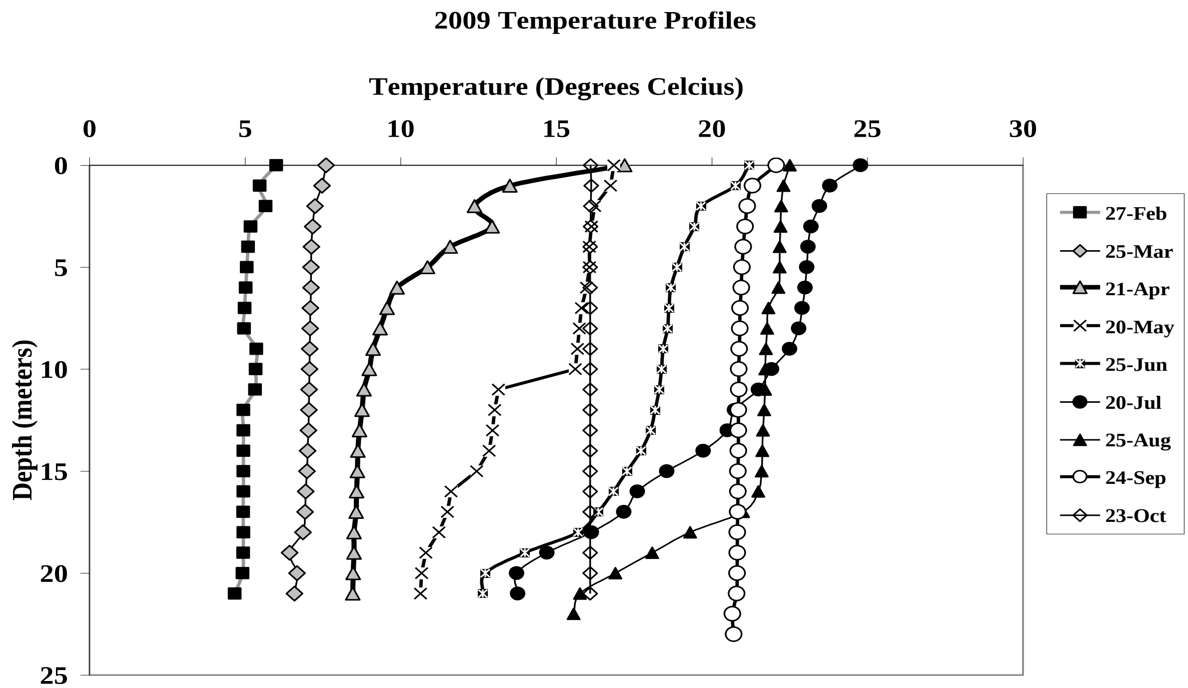
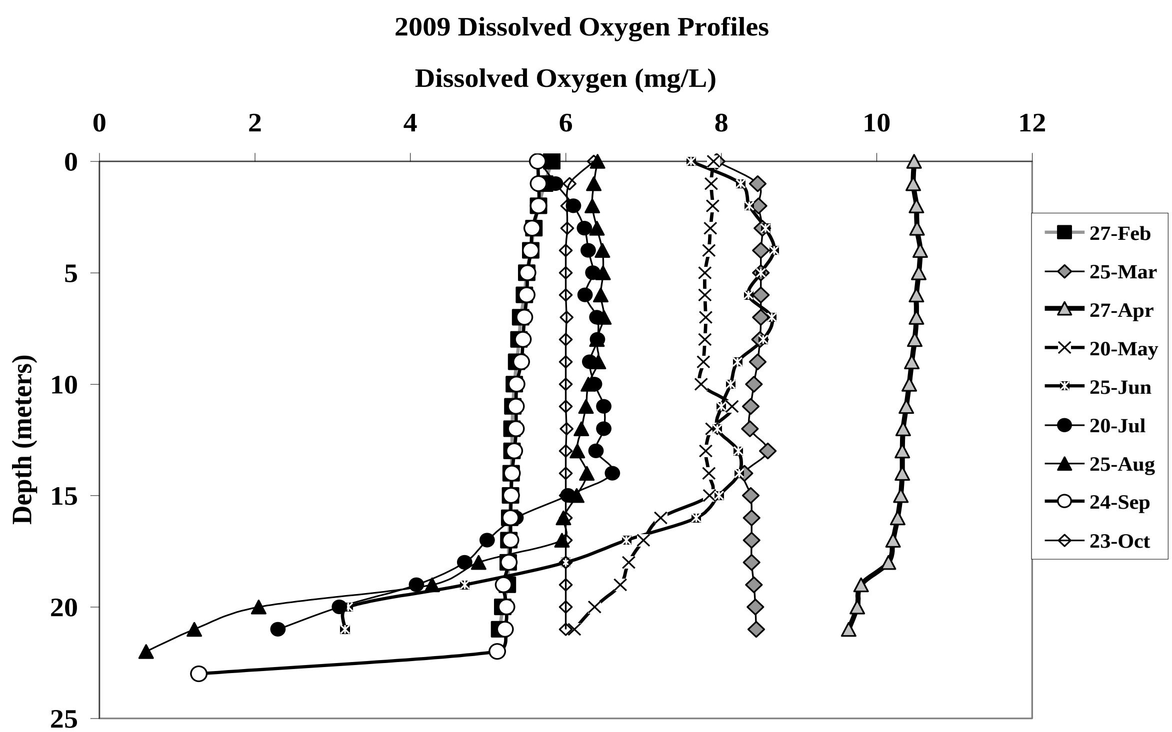


Figure 7



In 2010, a temperature gradient did not form until early June. A summer thermocline was not observed until June 29 at a depth of 15 m (49.2 ft). The thermocline steepened and ascended to 13 m (42.65 ft) in July, then descended to 16 m (54.5 ft) in August, and was on the lake bottom at 21 m (68.9 ft) in September just before mixing occurred. Maximum surface temperature reached 23.94º C (75.1º F) by late July. Dissolved oxygen showed a typical clinograde profile during warmer months. The lake bottom was completely anoxic in August and nearly anoxic in September (Figures 8 and 9, Attachment 2).

Figure 8

2010 Temperature Profiles

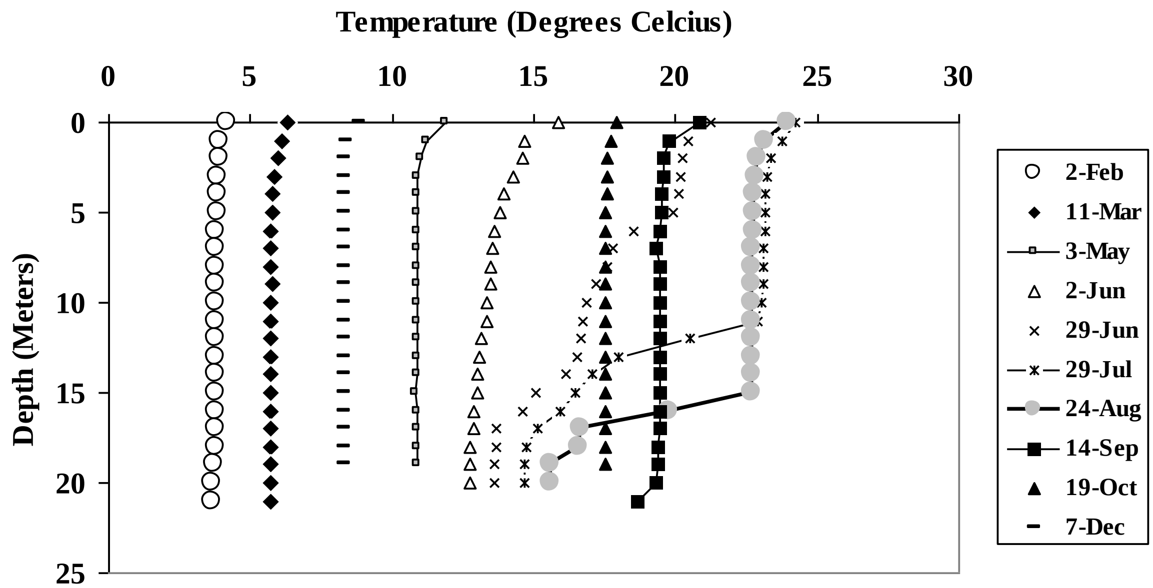
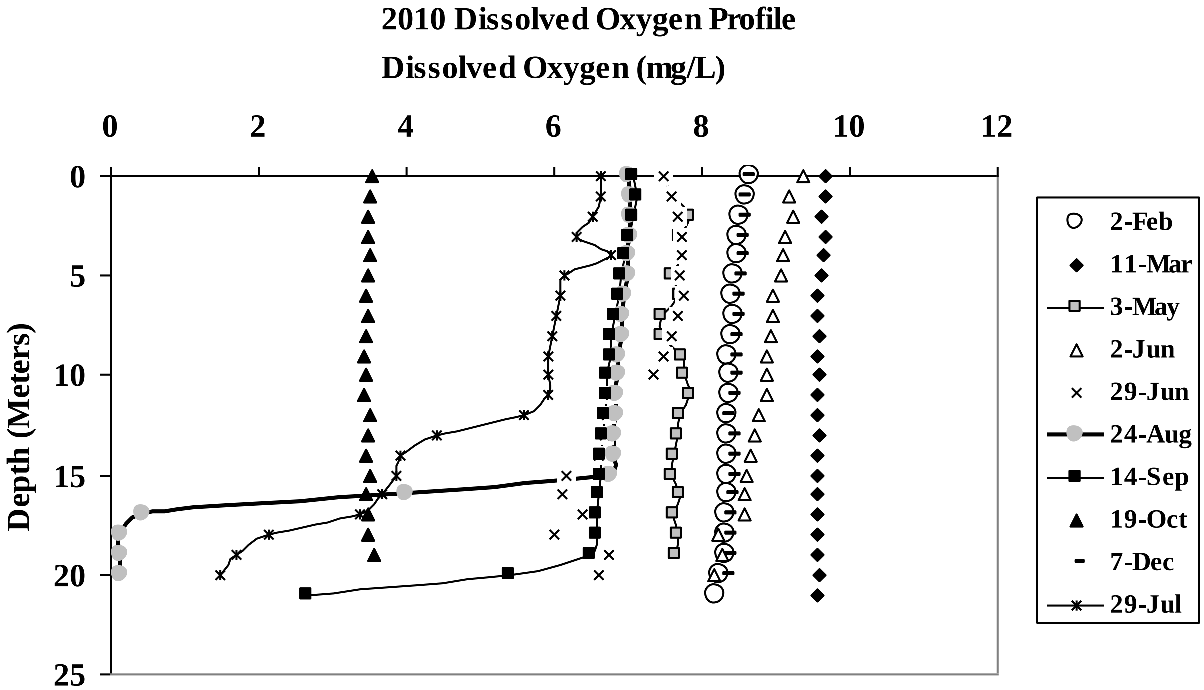


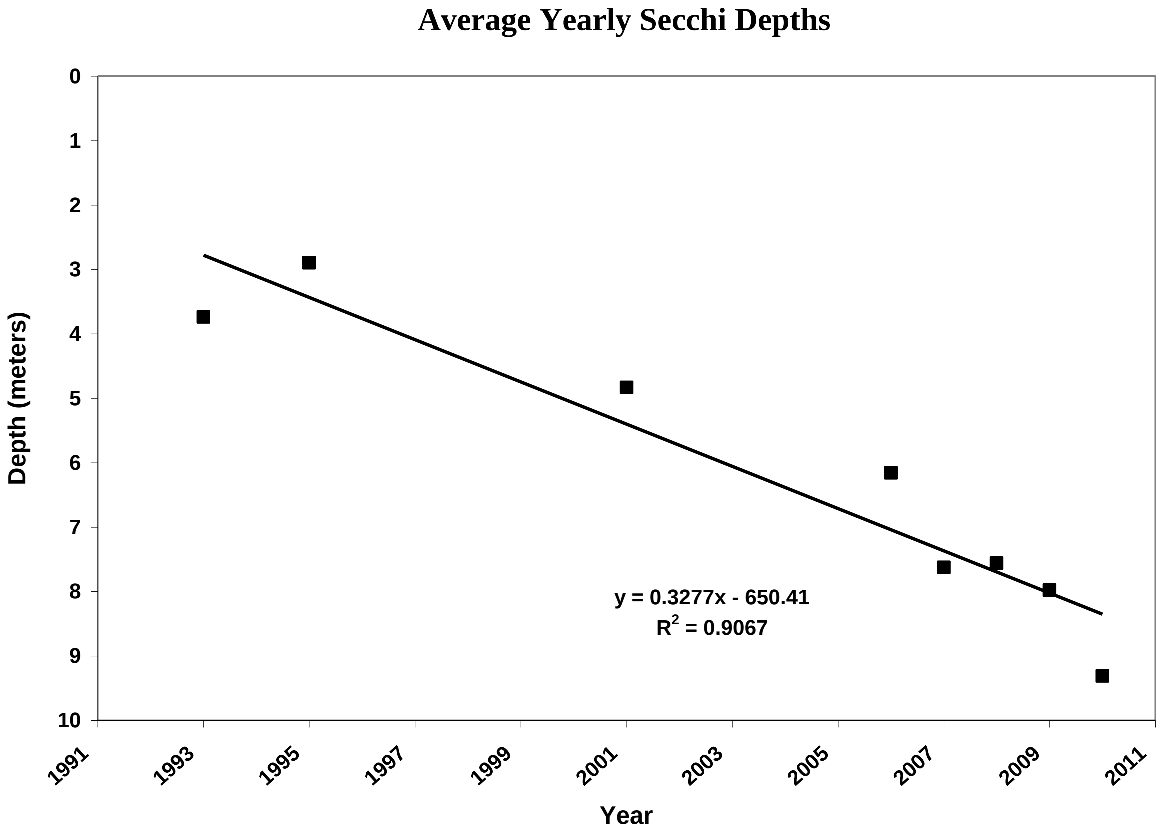
Figure 9



While TDS concentration (19,200 mg/L on December 14, 2010), pH (average 9.49 from center stations 2007-2010), and chemical composition of salts (sodium sulfate, sodium chloride, and sodium carbonate) (Koch et al., 1977) increases, Walker Lake's ability to sustain fish life declines. Increasing TDS negatively affects gill and kidney function of fishes (Dickerson and Vinyard, 1999).

Water clarity has improved at Walker Lake, despite decreasing water quality as it pertains to fish life. Large phytoplankton blooms of *Nodularia spumigena* typically begin in March or April and then peak in June through August. This year's Secchi depths were compared to previous year's Secchi depths. Many years presented (1993, 1995, 2001, 2006-2010) had consecutive monthly Secchi depth documentation, hence, they were chosen for comparison. Secchi depths from these varying years are presented in Figure 10. An increase in Secchi depth through time is apparent R^2=0.9067 (Figure 10). Visual observation indicates that while *Nodularia* blooms are present, and even possibly increasing, they are clearly not singularly influencing water clarity.

Figure 10



Low water clarity is suggestive of a highly modified, eutrophied system. Walker Lake is considered to be at the high end of hypereutrophic classification (Chandra and Sada, 2009). Increasing water clarity is not understood. It is possible that shifting food chains or slight changes in phosphorus or nitrogen are affecting clarity (Robert Jellison, pers. com.).

Discussion

During this study period, Walker Lake elevation decreased to its all time documented low, while TDS increased to the all time documented high. Water acquisitions from Desert Terminal Lakes funding are proceeding slowly, but it appears that Walker Lake may start to receive some of that water in 2011. The fallowing program at Schurz will be suspended in 2011 due to the WRPT's concern with the arid conditions that the lack of water is creating.

FIT objectives were met for Water Quality Monitoring for all years of the study.

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Chapter 3
LCT Monitoring

Methods

Mail-In Angler Questionnaire Survey

NDOW mailed out angler surveys early in each year of the study to 10 percent of fishing license holders for summarization of their prior years angling activities. Data was expanded to estimate total anglers, total angler days, and total fish caught for Walker Lake.

Drop boxes

Drop boxes at Sportsman's Beach boat ramp, State Parks boat ramp, North Cliffs road, 20-Mile Beach, and Ski Beach were used to collect angler information. 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 they caught. Satisfaction was ranked from +2 (highly satisfied) to –2 (dissatisfied). Floy tag information was provided to USFWS monthly.

Angler information center

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

Roving creel

Roving creel surveys were conducted on eight days in each month, four of which were weekend days, from January to May and from October to December from January, 2007 through May, 2010. Due to a lack of anglers (9) and complete lack of fish during the first part of the fishing season in 2010, roving creel was collected opportunistically during the second part of the season (October through December). Similar information was gathered as in drop box surveys, except angler satisfaction ratings. Fish were measured (TL and FL), weighed, and noted for adipose fin clips and Floy tags. Floy tag information was provided to USFWS monthly. Stomachs were collected when possible for examination of contents. Indices of well being were determined using Fulton-type condition factor or K-factor as follows:

$$K = \frac{W \text{ X } 100}{L^3}$$

where K is condition factor or coefficient of condition, W=weight of fish (g), L=length of fish (cm).

Roving creel data was expanded to estimate total pressure and harvest at Walker Lake in 2007-2009. Due to month to month variation, weekend and weekday pressure variation, and boating and shore harvest differences, creel results were broken down respectively to more accurately represent pressure and harvest. The following assumptions were made:

- a proportionate number of anglers were assumed to be missed as were seen, when creel census was only conducted for a portion of a day
- an equal proportion of anglers fished on weekends/weekdays when no creel was conducted as had fished on a given number of weekend/weekdays when creel was conducted
- contacted anglers that had not completed fishing would complete average number of hours for that month, and catch fish at catch rate for that month
- missed anglers would complete average number of hours for that month, and catch fish at catch rate for that month

Results

Mail-in, Angler Questionnaire Survey

According to Mail-in Angler Questionnaire survey data from 2006 through 2009 (one year lag in data here because of timing of mail-in surveys), angler effort and success declined with each successive year. Without exception, each consecutive year documented that fewer anglers expended fewer days fishing and caught fewer fish each year from 2006 through 2009 (Table 1).

Table 1

Mail-In, Angler Questionnaire Survey History

	2006	2007	2008	2009
No. of Anglers	2,141	2,214	955	510
Anglers Days	9,120	7,537	2,902	1,392
Fish Caught	19,177	13,670	2,766	1,282
Fish/Angler/Day	2.0	1.8	1.0	0.9

Drop Boxes

According to drop box forms that were completed from 2007-2010, catch rates also declined (Table 2, Figure 1 and 2). Anglers caught 0.93 fish/angler/rod in 2007, 1.50 fish/angler/rod in 2008, 0.56 fish/angler/rod in 2009 and no fish were reported in 2010.

Table 2

Lakeside Drop-Box, Angler Survey History

	2007	**2008**	**2009**	**2010**
No. of rods	118	143	35	0
Hours Fished	354.0	335.0	78.0	0
LCT Caught	141	162	22	0
No. Fish/Hour	0.36	0.50	0.23	0
No. Fish rod	0.93	1.50	0.56	0

Boating angler surveys comprised most drop-box data prior to 2008 (41 percent in 2008, 71 percent in 2007, 72 percent in 2006, and even higher percentages in prior year's surveys) (NDOW, 2002-2006). In 2009, drop-box data indicated that only 13 percent of forms were completed by boat anglers. Only four forms were completed in 2010 and those forms indicated shore use. Cause of declining boater surveys is due to a complete lack of captured LCT combined with poor launching conditions.

Figure 1 presents drop box catch rates since 2001 in order to show what has been happening to the LCT fishery since 2001 (NDOW, 2001-2006). Figure 2 illustrates what has happened to the fishery over the course of this study.

Figure 1

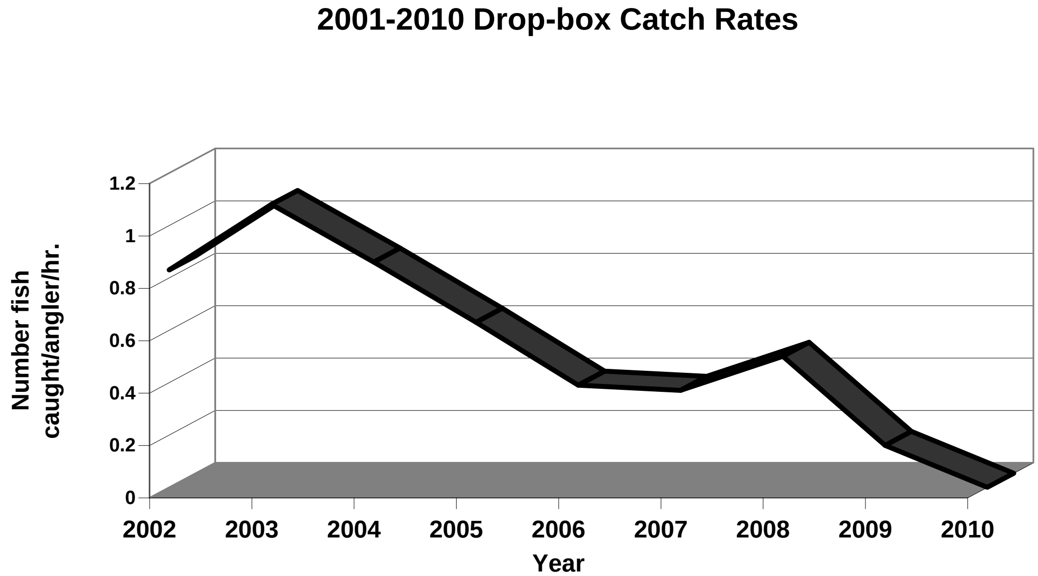
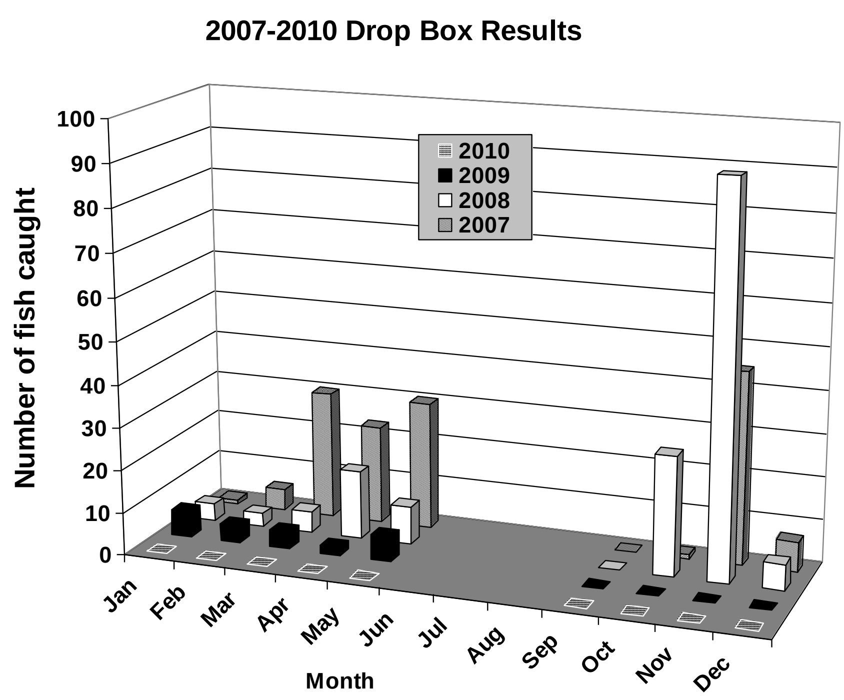


Figure 2



Drop box surveys also reported a decline in angler satisfaction. Anglers were asked to rate their angling experience at Walker Lake from a -2 to +2 in regard to their experience, size of LCT and number of LCT. In 2007, angler satisfaction was 0.27, -0.13, and -0.73, in 2008 angler satisfaction was -0.13, 0.04, and 0.04, and in 2009 angler satisfaction was -0.73, -0.47, and -0.47, and no satisfaction (or lack of satisfaction) was reported in 2010, respective to above mentioned parameters.

Angler information center

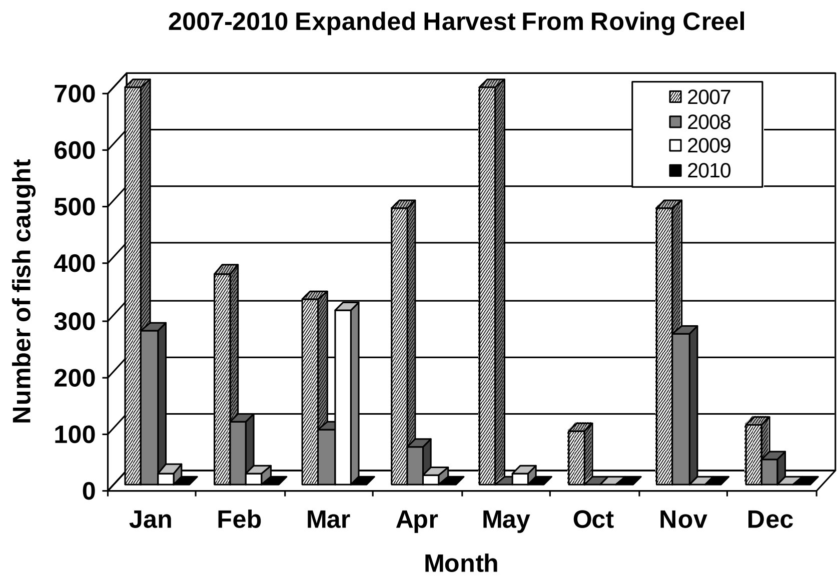
The angler information center was updated once a year to display the prior year's data for the public.

Roving Creel

Roving creel that was collected was used to expand pressure and harvest at Walker Lake. Expanded roving creel pressure and harvest data indicated severe changes in Walker Lake fishing success from 2007 to 2010.

Expanded roving creel pressure and harvest data indicated severe changes since 2007. Figures 3 and 4 provide pressure and harvest comparisons between 2007 through 2010. Far fewer fish were caught each year from 2007 to 2009 (Figure 3). After expanding data, it was found that 4,302 LCT were caught in 2007, 854 were caught in 2008, and 386 in January through May 2009. Since May 2009, few anglers were seen during creel surveys and no fish were either seen during surveys or reported by anglers.

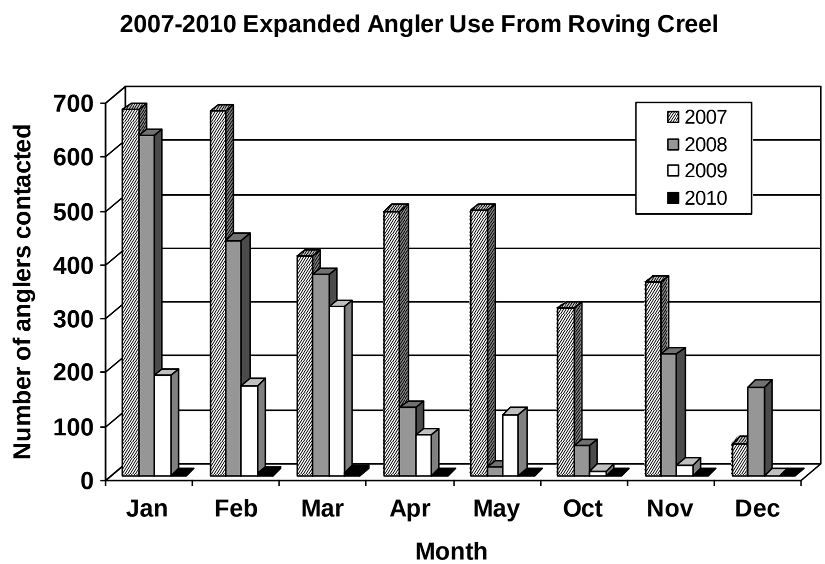
Figure 3



In 2010, roving creel was collected during the first part of the fishing season (January through April) and opportunistically during the second part of the fishing season (September through December). The decision to collect creel data opportunistically, rather than as a regular part of the monitoring program was made by the Team due to the complete lack of fish and very low pressure during the first part of the fishing season.

Expanded roving creel indicated that 3,470 anglers fished at Walker Lake in 2007, 2,026 anglers fished in 2008, and 855 anglers fished at in 2009 (Figure 4). Not enough data was available to expand fishing pressure data in 2010.

Figure 4



Catch rates from roving creel in 2007 were 0.14 fish per hour or 1.03 fish per rod day, in 2008 were 0.07 fish per hour or 0.45 fish per rod day, and in 2009 were 0.05 fish per hour or 0.18 fish per rod day. No LCT were captured by any method since May, 2009.

Fish Stocking

From 2007 through 2008, approximately 70,000 Floy tagged LCT were stocked per year into Walker Lake. No LCT were stocked in 2009 or 2010 due to high TDS and a lack of flow in Walker River. River flows may assist LCT with self-acclimation in the lake. It is likely that even with flow in the Walker River that no fish will be stocked until TDS comes down to a more habitable level. The Team will determine this level once lake elevation begins to ascend.

The success of 2006-2008 stocking efforts is part of a current study being conducted by USFWS and UNR. The use of Floy tags has provided information about stocking success (survival) and life history of LCT in Walker Lake, this information will be valuable regarding the re-stocking effort of LCT once conditions improve.

Discussion

Measurable parameters of fishing at Walker Lake, according to all survey methods, declined during this study from meager to absent. Declining pressure and harvest was due to increasingly poor catch rates created by increasingly toxic conditions (Tables 1 and 2, Figures 2 and 3). No LCT have been seen or reported since May, 2009. While a nearly complete lack of pressure may account for the apparent absence of LCT, it is possible that the conditions at Walker Lake have exceeded limitations for LCT existence.

This is the second year that no LCT were stocked due to a lack of flow in the Walker River and very high TDS.

Launching a boat has been a continual problem at Walker Lake since 2007. In 2008, Mineral County employees constructed a primitive boat launch next to the old State Park launch. During the summer of 2009, State Parks placed the launch facilities at Walker Lake on caretaker status, however Mineral County periodically conducts repairs. The launch has been washed out and repaired several times since its construction, including the most recent repair in July, 2010. Currently, the State Parks launch is barely usable and with any more receding of the lake, it is possible that it will be unusable and a new launch site will need to be established.

Federal grant agreement objectives were met in 2007 with regards to LCT.

Federal grant agreement objectives were met in 2008 for LCT monitoring with the exception of roving creel for three days in April and two days May, due to a miscommunication. In addition, spring gill nets to assess survival of stocked fish were not set in 2008. Loss of LCT by gill nets was not a desired outcome of the Walker Lake Fisheries Improvement Team so NDOW agreed to discontinue the spring gill netting until the tagging program is complete.

Federal grant agreement objectives were met in 2009 for LCT monitoring with the exception of roving creel. The months of January and October fell short by two and three days, respectively. This was due to the work load during those months necessitating the adjustment of priorities to other activities.

Federal grant agreement objectives were met in 2010 for LCT monitoring with the exception of roving creel. The Team made the decision in September, 2010, to collect creel opportunistically, due to the very few anglers and complete lack of fish reported fish during the first part of the fishing season.

One of the goals of FIT was to build an acclimation facility on the Northwest shoreline of Walker Lake. Construction was put on hold indefinitely due to unresolved permitting issues between the Nevada Division of Water Resources and WRPT. The construction has not been pursued by the FIT because of the state of the fishery.

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Chapter 4
Tui Chub Monitoring

Methods

Tui Chub Spawn Success

Tui chub spawning activity and egg deposition were examined 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 observing for shoaling fish.

Collection of eggs was attempted at six sites (WLE1- WLE6 [Attachment 1]), however, eggs were collected from only three of those sites (WLE4 through WLE6), due to lack of spawning habitat at WLE1 through WLE3. Eggs in all surveys were collected, preserved and then observed for stage of development within 24 hours.

Spawning surveys and egg collection were conducted on May 14 and 16 and June 11, 12, and 26, 2007, on June 9 and 11, 2008, on May 15, 16 and 17, June 3 and 4, July 9 and 19, 2009, on June 1, 8, 10, and 14, 2010 at WLE1 through WLE6 (Attachment 1). Sites were selected according to the six established trap netting grids used by USFWS. Eggs were collected by kicking up rocks and sediment and then by using a small mesh dip net to capture the eggs that were suspended in the water column. The eggs were stored in jars for no more than one day and then observed for embryo development using standards developed by J. Cooper (1982).

Snorkeling

Larval tui chub surveys were conducted four times (two days and two nights) in July and August through snorkel surveys. Location of sites were WLS1 through WLS6 (Attachment 1) and were 400 m (1,312 ft) in length. Transects were selected according to the six established trap netting grids used by USFWS. One transect in each grid was observed by boat and then snorkeled for 30 minutes each during night and day. Snorkeling occurred parallel to shore throughout dense aquatic vegetation to observe for YOY tui chub. Nighttime snorkeling surveys utilized a light emitting diode (LED). The presence or absence of tui chub was documented at each site as well as the lake and weather conditions.

Gill netting

Gill nets were set at WLGN1 through WLGN6 (Attachment 1) and fished overnight to assess presence of YOY tui chub and population abundance. One net was set in each of the six established trap netting grids used by USFWS. All tui chub caught were measured, weighed, and opercles were removed to examine age class composition.

Nets had a variety of mesh sizes ranging from 12.7 mm to 64 mm (0.5 to 2.5 in), and were 42.42 m (140 ft) long and 1.82 m (6 ft) tall.

Small Mesh Gill Net and Minnow Trapping

In an attempt to increase the probability of capturing YOY tui chub, minnow traps and one small mesh gill net were added to the capture methodologies in Walker Lake in 2008. Six strings of five plastic coated minnow traps were set perpendicular to shore, on the lake bottom, at six sites (WLGN1 through WLGN6 [Attachment 1]). One set of traps was set in each of the six grids established for USFWS trap netting and fished overnight. Minnow traps had plastic coating, were 17.5 in (44 cm) long, 8.5 in (21.5 cm) wide, and had a 1.5 inch (3.81 cm) opening. Traps were baited with white bread and cat food. One small mesh gill net with 0.25 in (6.35 mm) mesh, and dimensions of 10 ft (3.15 m) by 20 ft (6.09 m) long, was set concurrent to minnow trapping at WLN1 and WLN2 (Attachment 1).

Due to its inability to capture any fish at Walker Lake in 2008, the small mesh gill net was tested at Topaz Lake where a known presence of YOY tui chub exists. At Topaz Lake, the shoreline was observed by boat until schooling chub were located. The net was set in the midst of ample tui chub, then observed for 0.5 hours and left to fish overnight.

Minnow traps (8) were also set at Topaz Lake to determine their efficacy. Traps were placed at varying depths, some traps were baited with white bread and cat food and some traps were left empty, some traps were placed among ample tui chub and some were placed were no chub were observed. Traps were left to fish overnight.

Refuge augmentation and monitoring

In 2008, the NDOW biologist began researching tui chub refuge locations in order to determine what qualities a refuge of this type must possess to be successful. Three sites were observed in Bishop, California (see 2008 FTR, Observations of Owens tui chub refugia in Bishop, CA for details).

In September, 2009, three biologists toured Rose Creek Reservoir in order to determine its suitability as a tui chub refuge. The Hawthorne Army Depot representative provided access and was interviewed about his knowledge of the history of Rose Creek Reservoir. In order to determine the presence/absence of a food source for the tui chub, a plankton net was towed horizontally through the water column at two to three feet in depth for approximately ten seconds (see 2009 FTR, Observations of potential Lahontan tui chub refugia for details).

In order to capture tui chub for the refuge and to conduct an experimental acclimation of the tui chub to fresh water, trap nets were set during two weeks in October, 2009, targeting areas where high numbers of tui chub had been previously netted. During the first week of netting, tui chub were collected for the experimental acclimation study of the Walker Lake chub to fresh water. On the second week of trap netting, tui chub were collected for relocation to Rose Creek Reservoir (see 2009 FTR, Transplant of Lahontan tui chub from Walker Lake to Rose Creek Reservoir for details).

Two trap nets were set in June, 2010 at three sites (IGN, NGN, SGN [Attachment 1]) during the active spawn. Tui chub were captured, placed into a fish truck with a 50/50 mixture of fresh/lake water, and then held overnight in an attempt to acclimate them to fresh water. Temperature and dissolved oxygen were monitored. No continuous power source was available to allow for constant aeration, so aerators were activated using the truck battery every two hours for ten minutes (see 2010 FTR, Augmentation of Walker Lake Lahontan tui chub refuge population in Rose Creek Reservoir for details).

Due to failure of the first attempt in June, 2010, netting efforts were duplicated the following week. However, due to lack of time available for acclimation, the tui chub were immediately transported with no acclimation to Rose Creek Reservoir (Attachment 1), given a left ventral fin clip and then planted (see 2010 FTR, Augmentation of Walker Lake Lahontan tui chub refuge population in Rose Creek Reservoir for details).

In July, a trap net was set in Rose Creek Reservoir and fished for 48 hours. Captured adults were measured (fork length and total length), noted for absence of right or left a ventral fin clip, and then given a partial clip on their anal fin. In addition, a visual survey was conducted by walking the shoreline and looking for schooling tui chub fry (see 2010 FTR, Augmentation of Walker Lake Lahontan tui chub refuge population in Rose Creek Reservoir for details).

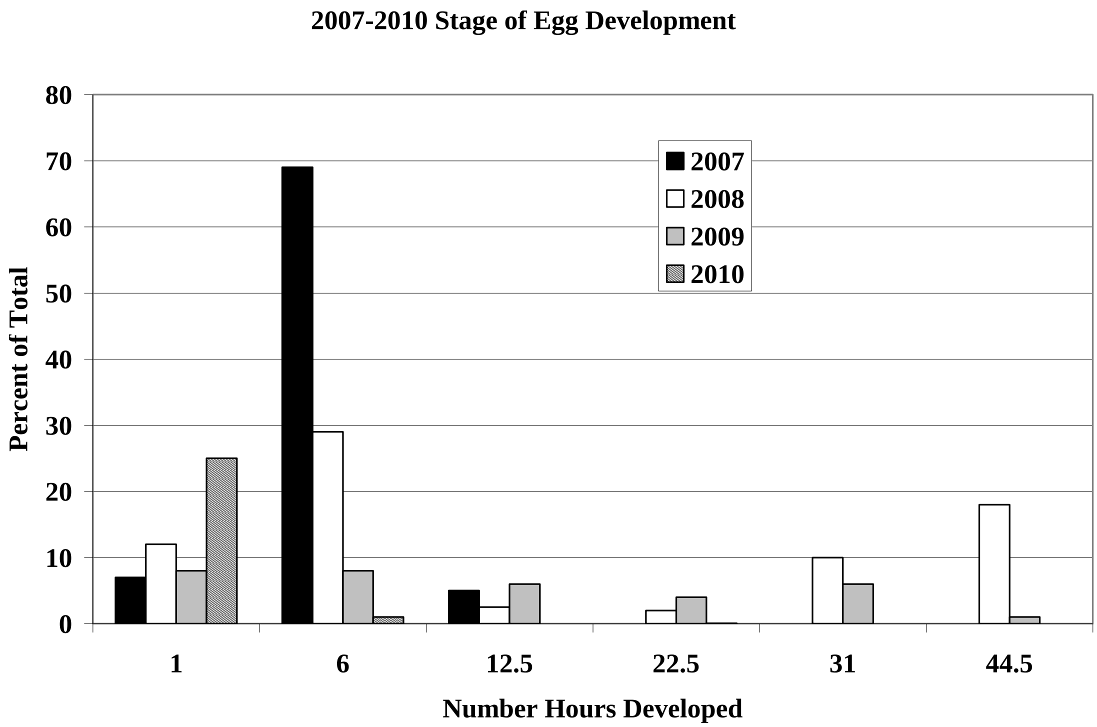
Results

Tui Chub Spawn Success

Eggs collected throughout spawning seasons exhibited very similar stages of development and deterioration, so development of eggs is presented grouped by year. Collection of eggs was attempted at six sites (WLE1- WLE6 [Attachment 1]), however, eggs were collected from only three of those sites (WLE4 through WLE6), due to lack of spawning habitat at WLE1 through WLE3. Eggs in all surveys were collected, preserved and then observed for stage of development within 24 hours.

During 2007 surveys, adults were observed spawning around shorelines. Of eggs (824) observed, 18 percent showed either no development or deterioration, 7 percent developed to 1 hour, 69 percent developed to 6 hours, 5 percent developed to 12.5 hours, 4 eggs developed to 22.5 hours, and 5 eggs developed to 31 hours (Figure 1).

Figure 1



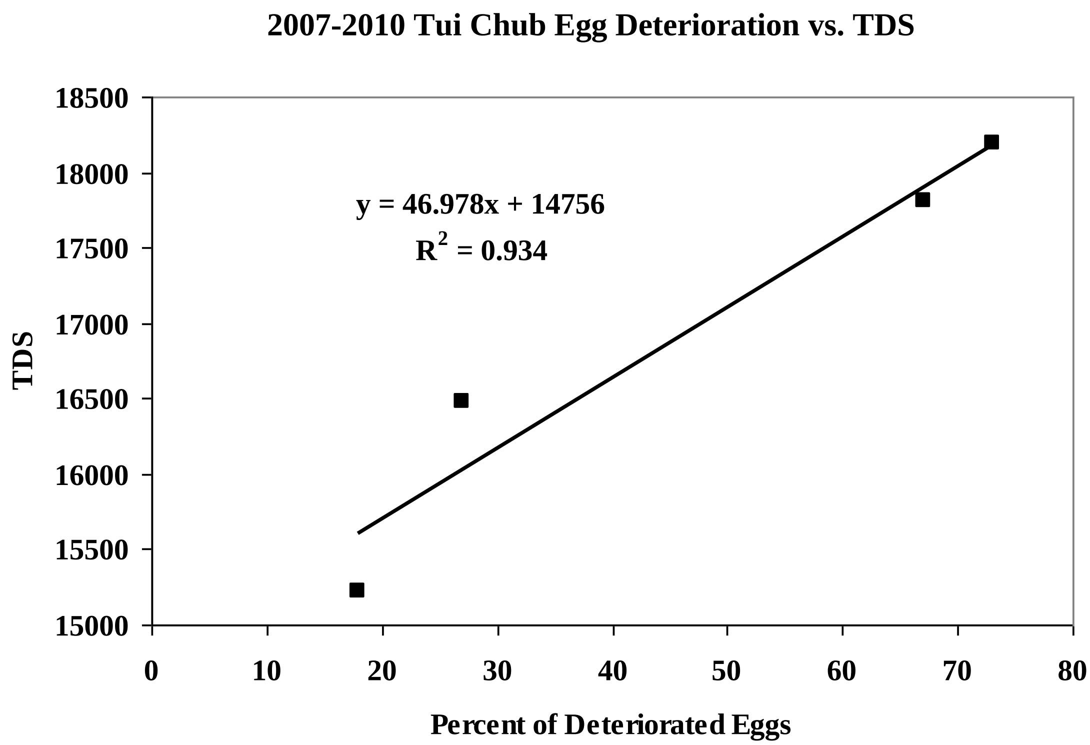
During 2008 surveys, adults were observed spawning around shorelines. A total of 384 eggs was observed of which 27 percent showed either no development or deterioration, 12 percent developed to one hour, 29 percent developed to six hours, 2.5 percent developed to 12.5 hours, two percent developed to 22.5 hours, 10 percent developed to 31 hours, and 18 percent developed to 44.5 hours. No recently hatched tui chub were observed.

During 2009 surveys, adults were observed spawning around shorelines. Fewer spawning adults were seen in June than in May and none were observed in July. Heavy rain in June and early July cooled water temperatures and stalled spawning activity. A total of 841 eggs was observed of which 67 percent showed either no development or deterioration, eight percent developed to one hour, eight percent developed to six hours, four percent developed to 12.5 hours, four percent developed to 22.5 hour stage, six percent developed to 31 hours, and less than one percent developed 44.5 hours.

During 2010 surveys, adults were observed spawning around shorelines. A total of 793 eggs was observed of which 73 percent showed either no development or deterioration, 25 percent had developed to one hour stage, one percent had developed to six hour stage, <1 percent had developed to 12.5 hour stage, <1 percent had developed to 22.5 hour stage.

Eggs in 2010 had a higher rate of deterioration (73 percent) than previous years' (67 percent in 2009, 27 percent in 2008, and 18 percent in 2007) (Figure 1). Any advanced stage of development was absent in 2010 samples and no recently hatched chub were observed. TDS levels strongly correlated to deterioration (R^2 = 0.934) (Figure 2). When looking at correlation between hour of development and TDS, no relationships formed.

Figure 2



Snorkeling

Snorkeling surveys occurred in July and August from 2007-2010. Many adult tui chub were observed during both nighttime and daytime snorkeling surveys but no YOY tui chub were observed in any snorkeling sites. Adults were observed at WLS6 (Attachment 1) in 2007-2010 and appeared within the water column as well as on lake bottom. One school of tui chub was observed at WLS4 (Attachment 1) during 2007 snorkeling surveys. The school was made up of approximately 100 to 150 sub-adult chub, and most likely part of age 2 or 3 cohorts.

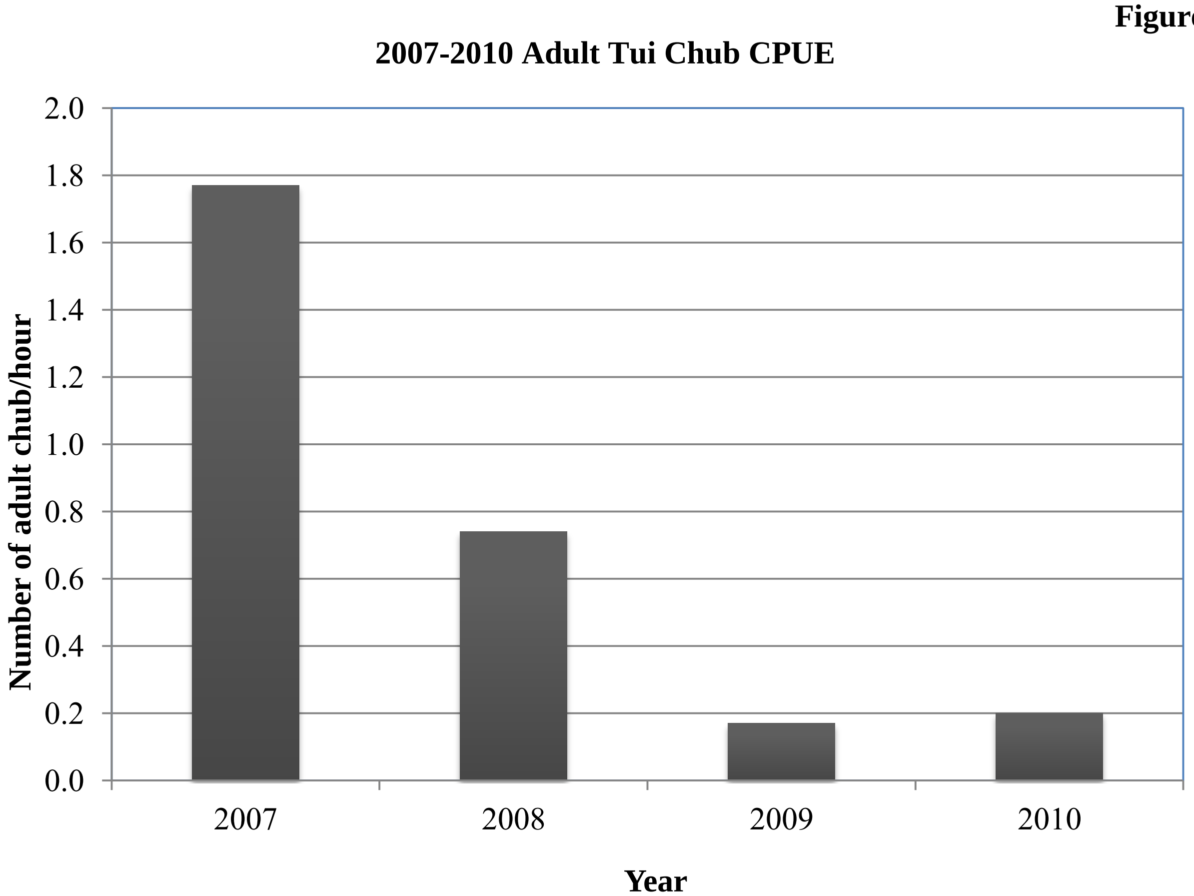
Gill netting

Gill net CPUE from 2002 through 2006 averaged 2.3 ± 0.2 in all but one year (2005 was 1.5) (NDOW 2002-2006).

CPUE on October 18, 2007 was 4.1 (Figure 3). Catch was mainly comprised of age one and two cohorts with four YOY representing the age class. The age three cohort was also present, but not as abundant. Adults, 11 to 22 years old were captured (Figure 4).

Gill nets set on October 23, 2008 captured fewer immature chub than 2007 nets (Figure 3). CPUE in 2008 declined to 0.73 (Figure 3). Age two through age four cohorts were present, although not in abundance, and no YOY or age one chub were observed. Adults, 10 to 23 years old were captured (Figure 4).

Figure 3



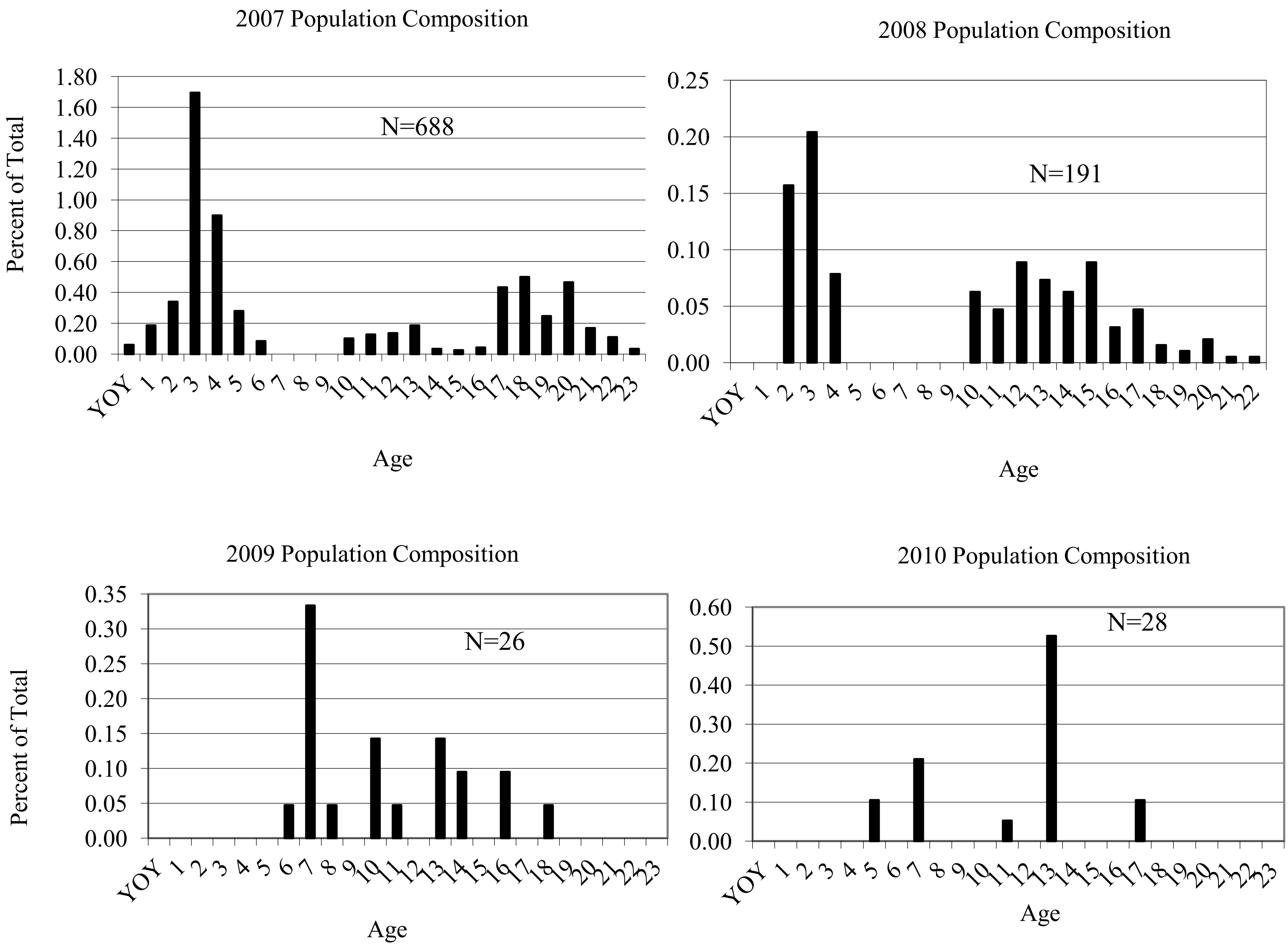
Gill nets set on November 16, 2009 captured no YOY through age six individuals, and a lack of very old tui chub was apparent (Figure 4). CPUE dropped dramatically to 0.17 (Figure 3).

Gill nets set on November 16 and 18, 2010 captured no YOY through age four individuals, and a lack of very old tui chub was apparent (Figure 4). CPUE remained similar to 2009 at 0.2 (Figure 3).

Tui chub gill net results in 2009 and 2010 were based on a very small sample size (2009, N=26, 2010, N=28). Historical documentation of tui chub until 2007 showed a typical cohort distribution (NDOW 2002-2006). Young fish have been increasingly sparse since 2008 (Figure 4).

Figure 4

2007-2010 Tui Chub Ages by Opercles



Post spawn netting efforts in 2009 and 2010 captured chub in very poor condition. Larger fish were in the poorest condition. Pale skin color and peeling skin, or sores, were primary indicators of poor condition. K-Factor of tui chub was 1.66 in 2007 (N=688), 1.92 in 2008 (N=191), no weight collected in 2009 due to equipment malfunction, and 1.86 in 2010 (N=28).

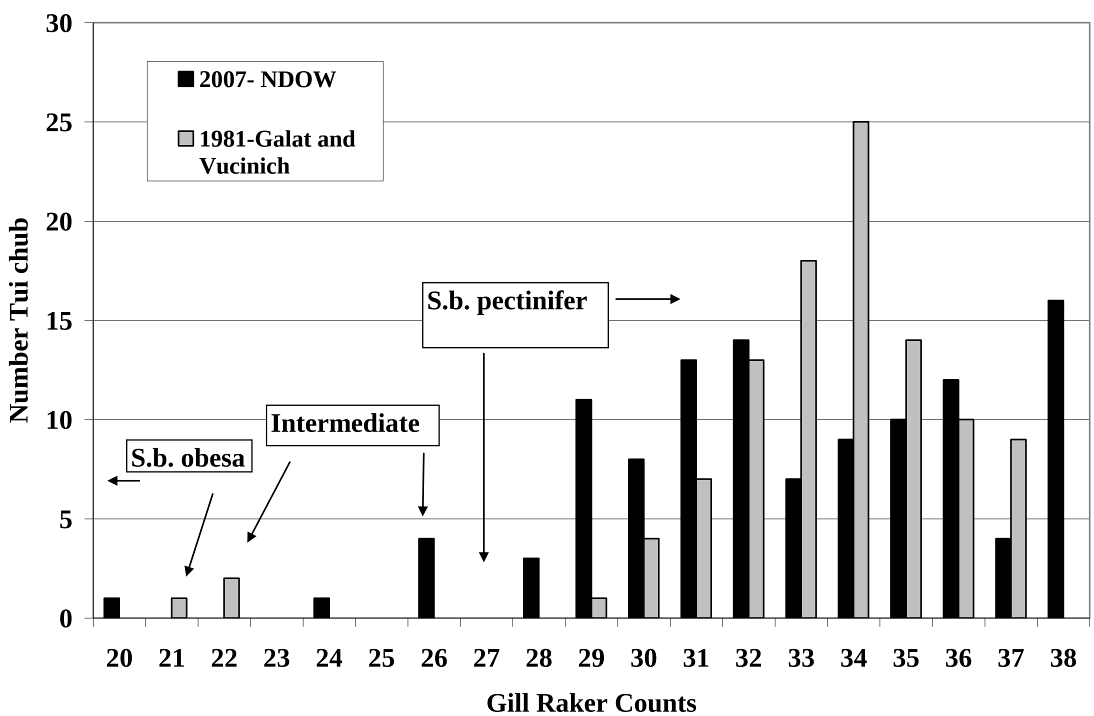
K-Factor of tui chub in Walker Lake from 2002-2006 (NDOW) was 1.86 and when compared to this study's data, no relationship between body condition and increasing TDS is apparent (R^2=0.4).

Gillraker counts were used to determine form of Walker Lake tui chub. In lab experiments, Hunt et al. (1982) found *S.b. pectinifer* (previously *G.b. pectinifer*) eggs were more resistant to TDS and lived longer than *S.b. obesa* (previously *G.b. obesa*) eggs at similar high concentrations. According to species form identification defined in Vigg, 1982, using gillraker counts, greater than 95 percent of tui chub found in Walker Lake are *S. b. pectinifer,* about one percent is *S.b. obesa*, and less than 4.5 percent are an intermediate form.

Composition of tui chub form according to this study is similar to composition of form found in 1981 work by Galat and Vucinich. Because N=104 sampled in 2007 is similar to N=112 in 1981, those data are presented below (Figure 5).

Figure 5

1981 and 2007 Tui Chub Gill Raker Counts



Small Mesh Gill Net and Minnow Trapping

Minnow traps were set on July 31 and September 4, 2008, and fished overnight. No tui chub were captured in any of the traps. It was theorized that perhaps because of the pelagic nature of *S.b. pectinifer,* that the minnow traps should have been suspended in the water column, rather than placed on the lake bottom.

Concurrent to July 31 and September 4, 2008 minnow trapping, an experimental small mesh gill net 0.25 in (6.35 mm) was fished over night. No tui chub were caught. The net was constructed of large monofilament and may not be ideal for trapping tui chub as they may be able to avoid it.

The small mesh gill net set at Topaz Reservoir on August 19, 2009 captured no YOY, proving the theory that the monofilament was detectable by the tui chub. During the period of visual observation, thousands of tui chub were seen schooling in direct proximity of the net and it was apparent that they could avoid it. Due to findings at Topaz, the small mesh gill net was not used at Walker Lake post 2008.

Minnow traps yielded varying results at Topaz Lake depending on quantity of tui chub in proximity of trap and location of trap in the water column. Traps suspended mid-column in the presence of large numbers of YOY chub captured few YOY. Presence/absence of bait in traps did not appear to increase probability of capturing YOY chub. Traps set in areas where chub were present in low abundance did not capture any chub, nor did any traps placed on the bottom of the lake (Table 1).

Table 1

Minnow Trapping Results from Topaz Lake

Trap number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Water Depth (meters)	3	1	4	4	2	2	3	3
Trap Depth (meters)	1.5	0.5	2	2	1	2	3	2
Baited Y/N	N	N	Y	N	Y	Y	Y	N
Chub present Y/N	N	Y	Y	Y	N	Y	Y	N
Chub captured	0	2	1	2	0	0	0	0

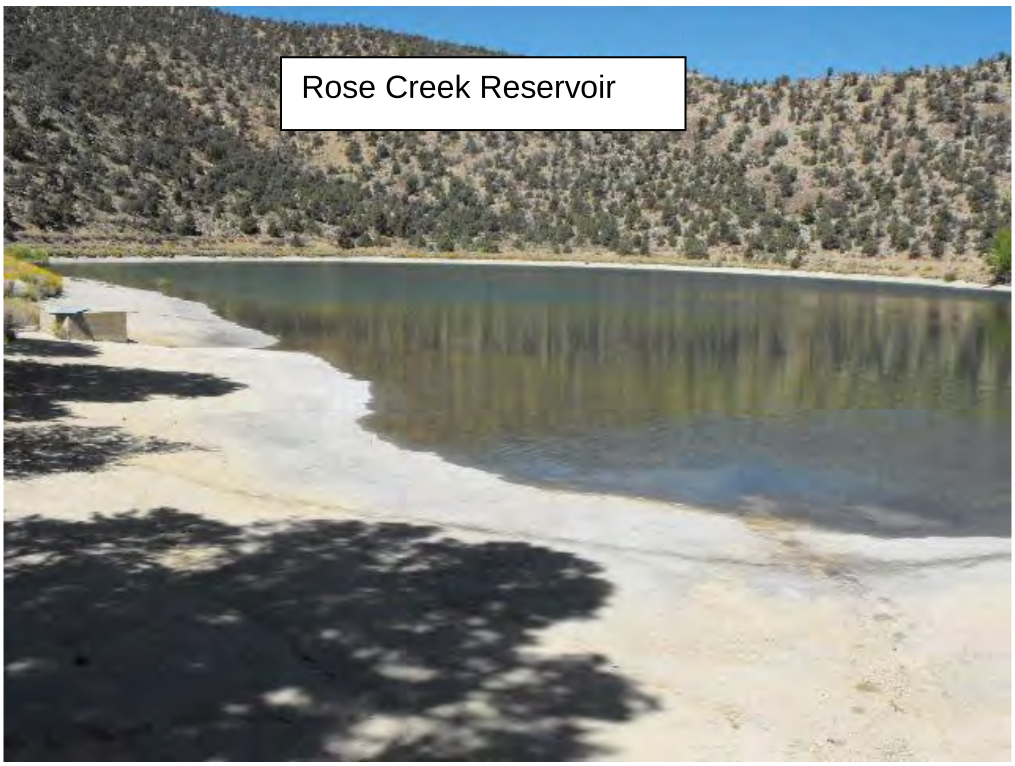
Minnow traps were set on September 9 and 14, 2009 and fished overnight at Walker Lake. No tui chub were captured in any of the traps. This has been a common result of minnow trapping tui chub in Walker Lake (NDOW, 2002). While the minnow trapping at Topaz confirm the theory about suspending the traps in the water column, no chub were caught using these methods at Walker Lake.

No minnow traps were set in Walker Lake in 2010 because priorities were adjusted to focus on minnow trapping at Rose Creek Reservoir.

Refuge augmentation and monitoring

After researching tui chub refugia criteria and determining Rose Creek Reservoir's suitability as a refuge, Walker Lake tui chub were transplanted. Initial transplant of tui chub may not have been successful due to environmental stressors at time of transplant (see 2008 FTR, Observations of Owens tui chub refugia in Bishop, CA 2009, and 2009 FTR, Transplant of Lahontan tui chub from Walker Lake to Rose Creek Reservoir for details).

The second attempt to relocate tui chub from Walker Lake to Rose Creek Reservoir began on June 23, 2010. On June 24, while attempting to acclimate Walker Lake tui chub to fresh water, they were unintentionally killed when the aerators were activated. Ammonia that accumulated on the bottom of the fish tank was dispersed into the water column during aeration, creating a fatal mixture. Due to the total loss in the first effort, nets were re-set the following week. Tui chub (170) were captured on July 1, 2010 and due to time constraints, the chub were transplanted to Rose Creek Reservoir with no acclimation (see 2010 FTR, Augmentation of Walker Lake Lahontan tui chub refuge population in Rose Creek Reservoir for details).



Augmentation of the reservoir in 2010 was successful. Not only was reproduction observed, but frame nets captured adult chub that survived the transplant.

Discussion

All tui chub perished in Carson Sink when TDS concentration reached 20,000 mg/L (Rowe and Hoffman, 1987). As TDS rapidly approaches 20,000 mg/L in Walker Lake, mortality has been observed among the tui chub population. In summer 2009 and during most months in 2010, tui chub mortality was observed. A random distribution of dead chub of indiscriminant age and body condition was documented on several occasions. A protocol was implemented in August 2009 for counting the mortalities. Although the number of dead chub on the lake appeared insignificant (between 10 and 100 individuals at a given time), fall gill net CPUE of tui chub was very low in both of the last two years of the study, indicating that mortality may have been more significant than it appeared (Figure 3). In addition, most of the largest adult fish captured in USFWS trap nets in 2009 and 2010 were observed to be in very poor condition.

Population estimates of tui chub in Walker Lake by hydroacoustic surveys were conducted in 2007-2009 by Sierra Nevada Aquatic Research Laboratory (SNARL). The most recent 2009 estimates were 4.9 million or 385 fish/ha (Jellison and Herbst, 2009). No hydroacoustic surveys have been conducted since the observed mortality and are scheduled for spring 2011. Once completed, the surveys will help determine chub abundance.

A contract between the Team and the University of California, Davis, to determine the genetic differentiation between Walker Basin tui chub, was completed in 2010. The findings of this study showed that Walker Lake tui chub have great genetic fitness and diversity. It would be desirable to utilize the original Walker Lake tui chub population in reestablishing Walker Lake with chub if the original population is lost, under restrictive conditions. First, if repopulating individuals were the original adults and there were an adequate number of them. Second, if the population within the refuge was large enough to maintain diversity and not evolve too rapidly within their new environment (Finger and May 2010, Parmenter, pers. com.). Rapid genetic adaptations often occur in such different environments (Finger and May, 2010, Parmenter, pers. com.). Multiple refuges would also be preferred and should be sought out. If those goals cannot be accomplished, it is recommended that Pyramid Lake tui chub (the closest in relation to Walker Lake chub) be used in re-establishing the Walker Lake population of tui chub.

Because the Walker Lake population is the desired population for reestablishment in Walker Lake if criteria are met, tui chub should be transplanted from Walker Lake into Rose Creek Reservoir for as long as possible. Genetic analysis may be necessary to determine if the recruits to Rose Creek Reservoir are suitable for reintroduction to Walker Lake. The primary goal at Rose Creek Reservoir has been to establish a large adult population of Walker Lake tui chub that would be returned to Walker Lake if needed. Recruits hopefully maintain the fitness of the Walker Lake population and have the ability to acclimate to Walker Lake water.

The refuge will be monitored as necessary and augmented with as many new adults in spring of 2011 as can be transplanted. It may be necessary to conduct genetic evaluations of the daughter population, if they are needed to reestablish the chub in Walker Lake. In the spring of 2011, some one year old tui chub from Rose Creek Reservoir will be sacrificed for aging purposes while others will be given a Floy tag in order to track the cohort for determination of age using opercals. The Floy tags will aid in determining the most desirable individuals for reestablishment to Walker Lake as the oldest recruits may be the closest in evolutionary proximity to the original adults.

FIT objectives were met with regard to tui chub monitoring with the exception of collection of desired numbers of basin wide and neighboring basin samples of tui chub for genetic analysis 2007, but enough clips were obtained throughout the study to complete the data. In addition, minnow trapping was not conducted in Walker Lake in 2010.

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Chapter 5
Zooplankton Monitoring

Methods

Zooplankton were collected concurrent to water quality analysis at 10 sites (WLN, WL2, WL2E, WL2W, WL3, WL3E, WL3W, WL4, WL4E, WL4W [Attachment 1]). Samples were collected using a 80µm (3.15×10^{-3} in) mesh Nitex net with a mouth opening of 30cm (12 in) and a length of 172.7cm (68 in). Vertical plankton tows were conducted from approximately one meter from bottom to surface at a rate of 1 m x sec^{-1} (39.4 in x sec^{-1}) and plankton were preserved in a four percent formaldehyde/sugar mixture. Zooplankton from three 1mL (2.64×10^{-4} gal) sub-samples was enumerated and identified using an optical Fisher Microscope (4, 10, 40, and 100 times magnification capability), and then lake-wide density was averaged from all sites using:

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

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

Results

Zooplankton Analysis

Large seasonal variation in abundance and composition of zooplankton is common (Cooper and Koch 1984, Horne and Goldman, 1994). Figure 1 shows large seasonal variation of abundance of zooplankton from 2007 to 2010. Overall densities appear fairly stable but when looking closer at the same data (Figure 2), a decrease in densities is present. From 2009-2010, in every month that zooplankton was collected, densities decline, with the exception of August.

Figure 1

2007-2010 Average (Lake-Wide) Zooplankton Density

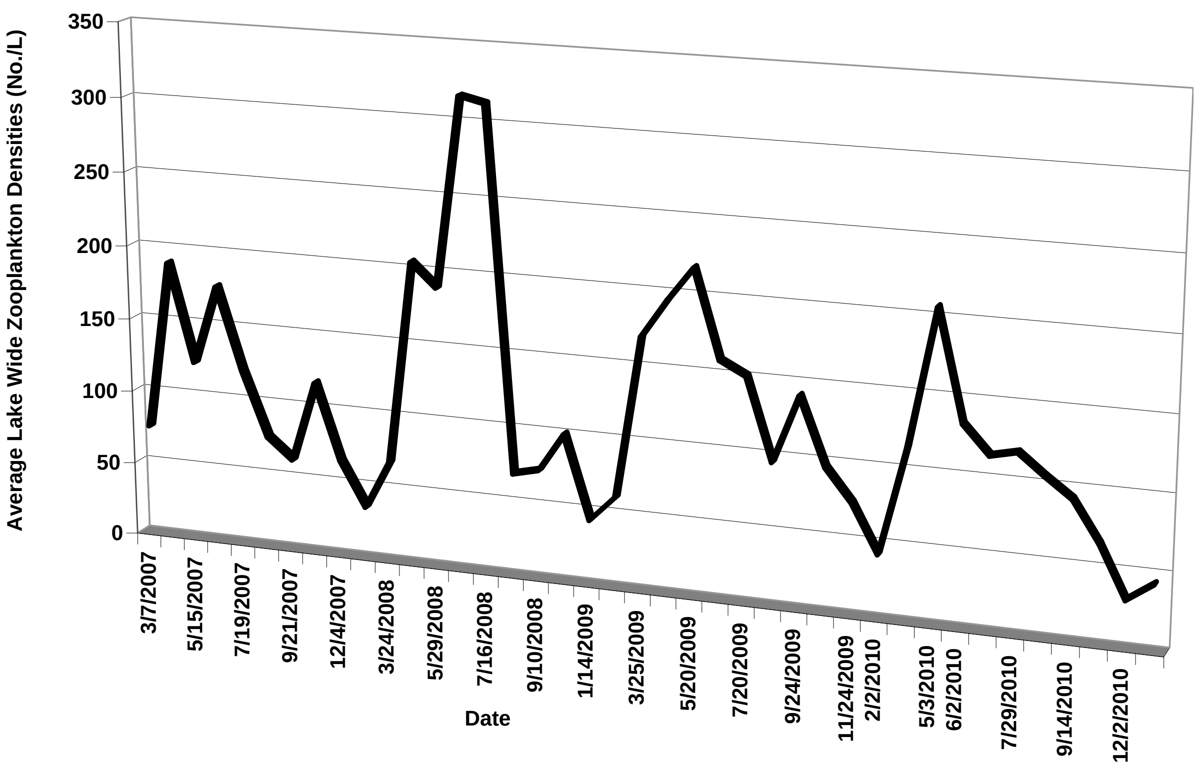
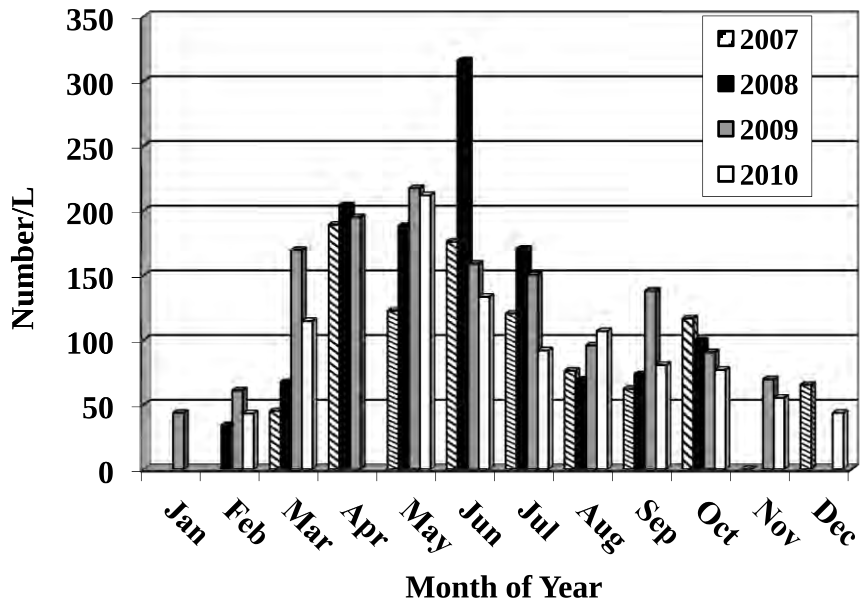


Figure 2

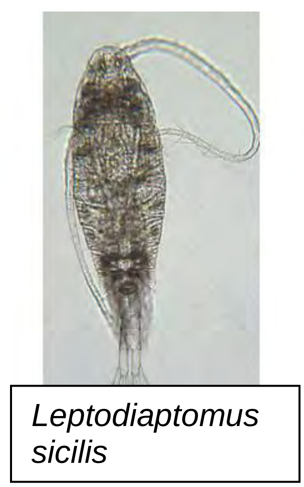
2007-2010 Total Zooplankton Densities



Zooplankton average population has declined since 2007 of NDOW's monitoring program. *Leptodiaptomus sicilis, Moina hutchinsoni*, and *Hexarthra fennica* densities from 2007-2010 are presented in Figures 3, 4, and 5.

Moina hutchinsoni

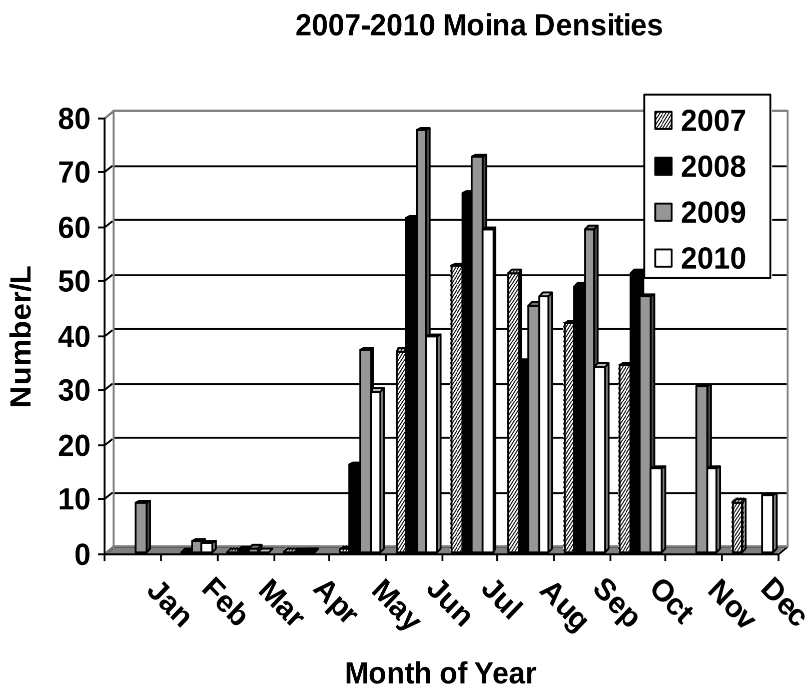
Hexarthra fennica



Leptodiaptomus sicilis

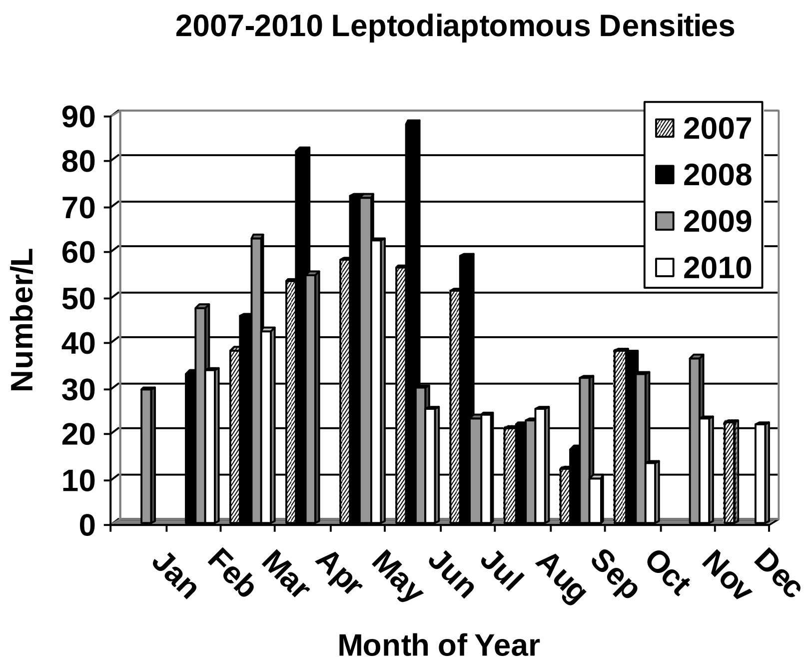
M. hutchinsoni, Figure 3, shows an increase in number/L in most months from 2007 to 2009, and then a decrease in numbers/L in most months from 2009 to 2010. *M. hutchinsoni* went from an average number/L of 27.80 in 2007 to 31.28 in 2010.

Figure 3



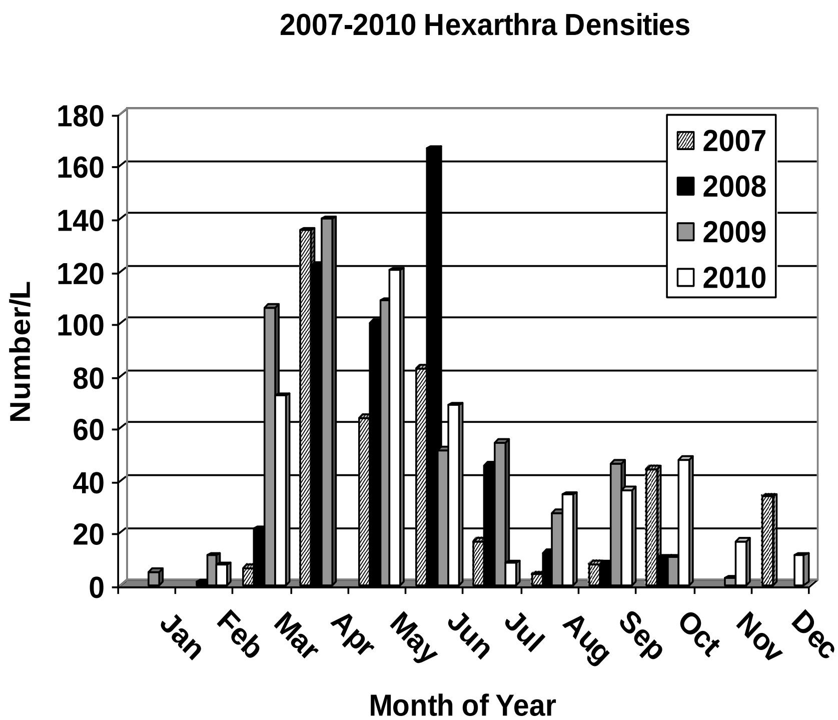
L. sicilis, Figure 4, shows numbers increasing from 2007 to 2009, however, from 2009-2010 densities decrease in every month except for July and August, where they increase slightly. *L. sicilis* exhibited the largest overall decline in average number/L, going from 40.07 in 2007 to 27.48 in 2010.

Figure 4



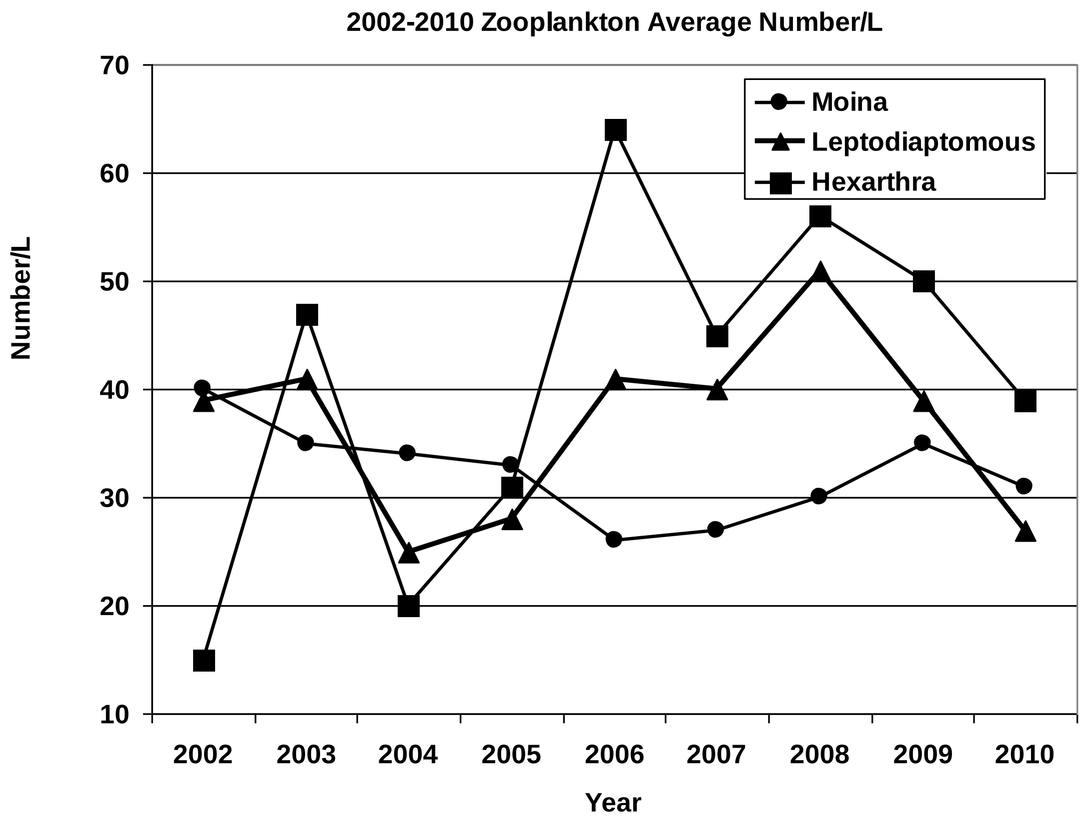
H. fennica, Figure 5, is the least discernable of the three, however average densities of *H. fennica* decreased from 2007-2010. *H. fennica* went from an average number/L of 45.37 in 2007 to 39.55 in 2010.

Figure 5



L. sicilis, M. hutchinsoni, and *H. fennica* average densities from 2002-2010 are presented in Figure 6. *M. hutchinsoni* exhibits an overall steady decline in average numbers/L from 2002 to 2007, and then begins to increase until 2009 when it then drops off slightly through 2010. *L. sicilis* appears to be increasing until 2008, but then appears to decline. *H. fennica* appears to be increasing very rapidly until 2008, and then a decrease in number/L is observed. Further investigation will be required to determine whether or not observed phenomena is part of a cyclical pattern, possibly due to the parthenogenic nature of some of these zooplankton species, or if we are seeing the beginning of the decline of zooplankton in Walker Lake due to changing conditions.

Figure 6



Discussion

Cladocerans and copepods dominated zooplankton communities during the 1977-79 work of Cooper and Koch (1984). Additionally, low numbers of crustacean *Acanthocyclops vernalis* were present. Average lake-wide zooplankton densities were high during early spring and mid-summer (Cooper and Koch, 1984). *Leptodiaptomus sicilis* dominated populations from November to June while *Moina hutchinsoni* became abundant in August and September.

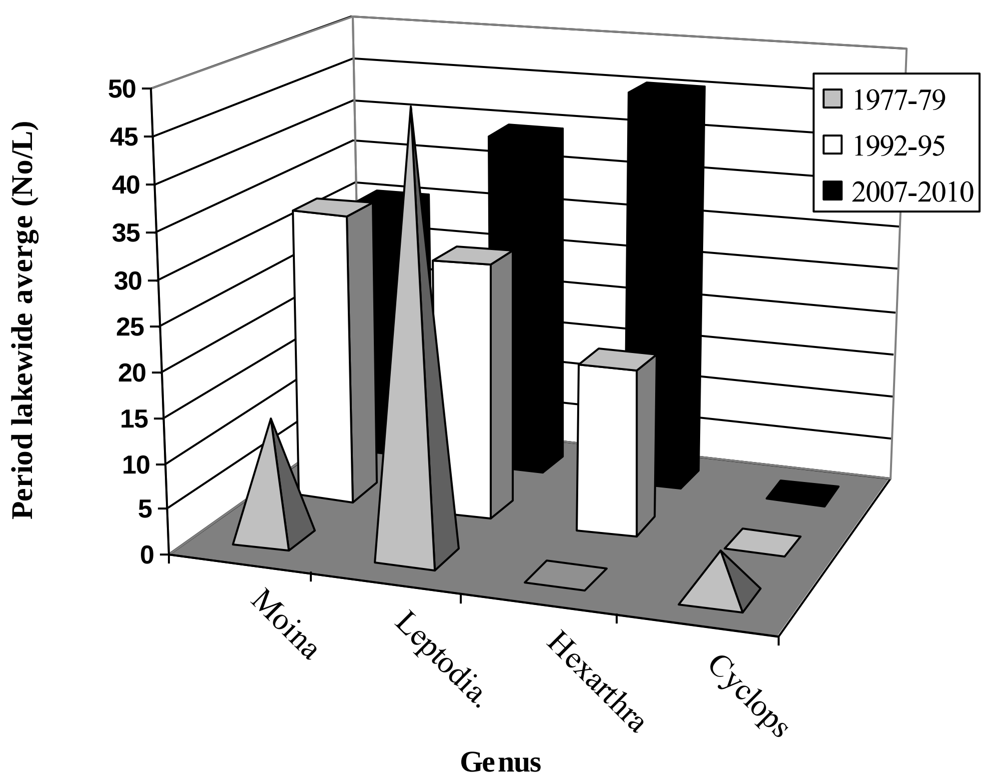
Cladocerans and copepods also dominated in 1992-94 (Horne and Goldman, 1994) along with a new rotifer, *Hexarthra fennica*. Crustacean *A. vernalis* was absent. Seasonally, average lake-wide zooplankton densities were similar to those found in 1977-79 (Horne and Goldman, 1994). *L. sicilis,* dominant 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 most numerous of all species. Harpacticoid copepods, ostracods and *Alona guttata* were rare (Horne and Goldman, 1994).

NDOW began monitoring zooplankton in 2002. 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.

Figure 7 shows zooplankton lake-wide average densities for three study periods (1977-79, 1992-95, and 2007-10). Changes in composition abundance are present through time. Most notably, since their discovery in 1992, *H. fennica* has become the most numerous species.

Figure 7

Periodic Average Zooplankton Species Composition Comparison



One hypothesis for the increase in water clarity is the changing food web, i.e., a decrease in number of fish leads to an increase in number of zooplankton, a decrease in phytoplankton leads to an increase in water clarity. If this preliminary decrease in zooplankton continues, the hypotheses will be eliminated as a possibility.

Zooplankton samples collected on June 2, 2010 contained two samples that had such dense algae that it was impossible to determine zooplankton quantities accurately. This was the first time that this phenomenon has been documented. Zooplankton numbers decreased in 2010 and water clarity continued to increase.

FIT objectives were met for all years of the study with the exception of April, 2010 zooplankton collection. The biologist was on leave till mid-April and then inclement weather ensued for the duration of the month.

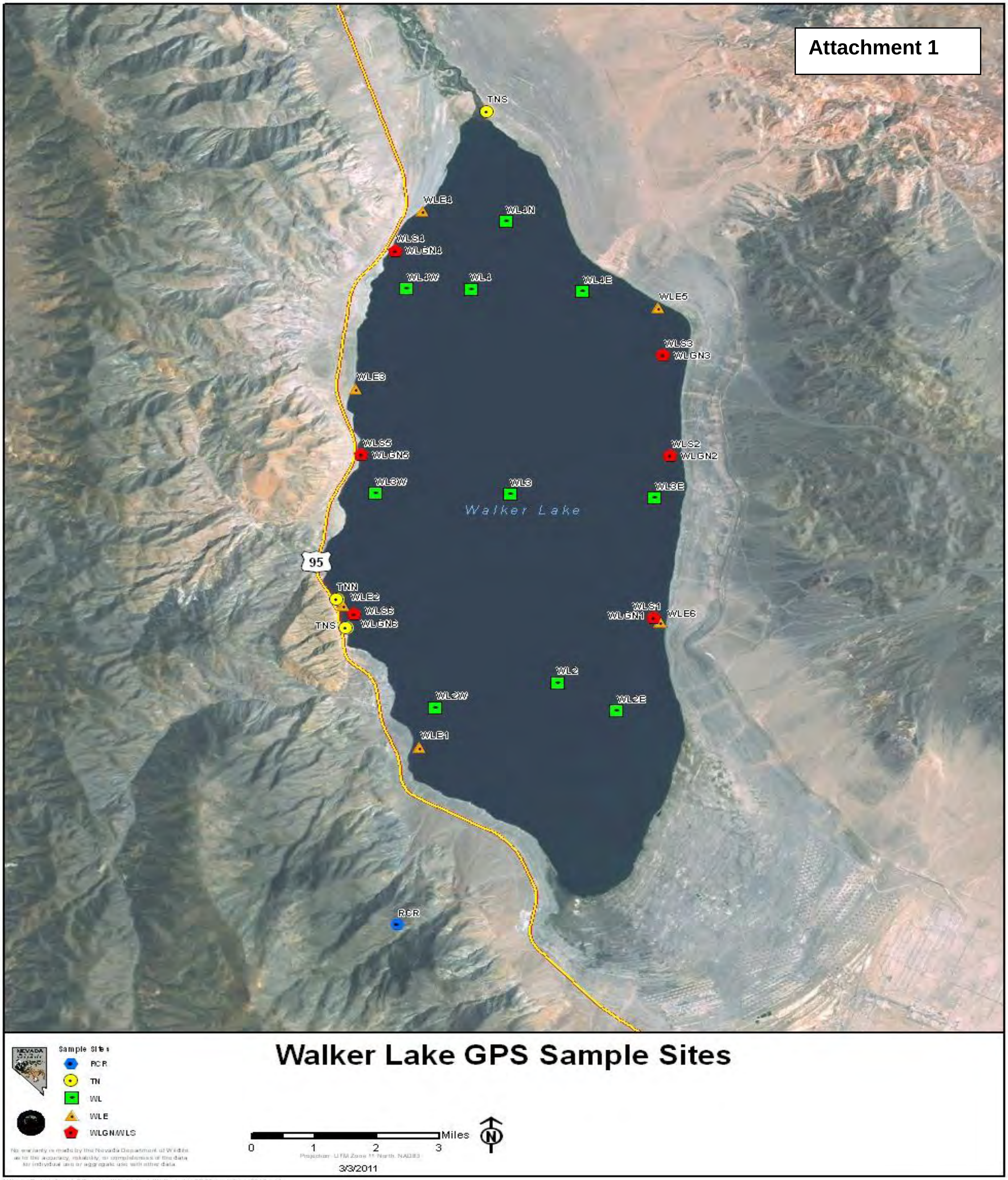
References

Cooper, J.J, D.L. Koch. 1984. Limnology of a Desert Terminal Lake, Walker Lake, Nevada, U.S.A. Hydrobiologia 118:275-292.

Horne, A. J. and C. R. Goldman. 1994. Limnology. New York, McGraw-Hill, Inc. 576p

Prepared by: Karie Wright
Fisheries Biologist

Date: April, 2011


Attachment 1
TNS
WLE4
WL4N
WLS4
WLGN4
WL4W
WL4
WL4E
WLE5
WLS3
WLGN3
WLE3
WLS5
WLGN5
WLS2
WLGN2
WL3W
WL3
WL3E
Walker Lake
95
TNN
WLE2
WLS6
TNS
WLGN6
WLS1
WLGN1
WLE6
WL2
WL2W
WL2E
WLE1
RCR
Sample Sites
RCR
TN
WL
WLE
WLGN/WLS
Walker Lake GPS Sample Sites
Miles
0
1
2
3
N
3/3/2011

Walker Lake GPS Sample Site Locations

Site	UTM UPS, WGS 84
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
WLE1	11 S 348322 4277621
WLE2	11 S 346346 4281677
WLE3	11 S 346683 4287919
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
WLGN1	11 S 354355 4281337
WLGN2	11 S 354770 4285998
WLGN3	11 S 354594 4288876
WLGN4	11 S 347694 4291881
WLGN5	11 S 346839 4286019
WLGN6	11 S 346636 4281456
TNN	11S 346196 4281885
TNS	11S 346435 4281050
TNI	11S 350068 4295875
RCR	11S 350354 4276625

Attachment 2

2007 Mid-Lake Water Quality Profiles

	May 5 (NDOW)		June13 (NDOW)		Jul 19 (NDOW)		Aug 21 (NDOW)		Sep 21 (NDOW)		Oct 23 (NDOW)		Dec 10 (NDEP)	
Depth (m)	T (°C)	DO mg/L	T (°C)	DO mg/L	T (°C)	DO mg/L	T (°C)	DO mg/L	T (°C)	DO mg/L	T (°C)	DO mg/L	T (°C)	DO mg/L
0	17.70	8.99	20.44	8.26	23.62	7.99	24.16	8.55	19.25	6.72	14.57	8.88	8.10	8.57
1	15.18	9.39	19.06	8.38	23.58	7.98	23.58	8.65	19.25	6.60	14.47	9.50	8.12	8.27
2	14.80	9.43	18.70	8.37	23.38	7.99	23.27	8.65	19.26	6.58	14.33	9.50	8.12	8.39
3	14.62	9.41	18.52	8.35	23.11	7.99	23.15	8.64	19.26	6.53	14.29	9.51	8.12	8.36
4	14.23	9.45	18.24	8.30	23.06	7.97	23.08	8.60	19.26	6.56	14.27	9.51	8.12	8.32
5	14.12	9.44	18.18	8.29	23.02	7.96	23.04	8.56	19.24	6.53	14.25	9.51	8.12	8.15
6	14.00	9.40	18.09	8.22	23.00	7.93	23.01	8.46	19.23	6.52	14.24	9.51	8.12	8.25
7	13.67	9.40	17.96	8.19	22.98	7.88	23.00	8.46	19.22	6.51	14.24	9.51	8.12	8.16
8	13.14	9.42	17.46	8.11	22.96	7.88	22.98	8.42	19.22	6.49	14.23	9.51	8.12	8.23
9	12.99	9.50	16.70	8.16	22.92	7.85	22.97	8.40	19.21	6.48	14.23	9.51	8.12	8.00
10	12.44	9.48	16.21	8.14	22.88	7.82	22.96	8.36	19.22	6.63	14.22	9.51	8.12	8.25
11	12.05	9.53	16.04	7.90	22.78	7.77	22.95	8.35	19.21	6.47	14.23	9.51	8.12	8.08
12	11.77	9.53	15.90	7.92	22.36	7.70	22.95	8.30	19.20	6.45	14.21	9.51	8.12	8.08
13	11.22	9.53	15.85	7.89	18.02	7.66	22.95	8.31	19.20	6.44	14.21	9.51	8.12	8.15
14	10.92	9.51	15.73	7.90	16.85	6.95	21.33	8.27	19.19	6.43	14.21	9.51	8.12	8.25
15	10.58	9.50	14.98	7.83	15.51	6.79	18.09	6.84	19.18	6.40	14.21	9.51	8.12	8.26
16	10.45	9.41	14.33	7.56	13.66	5.65	15.79	5.76	19.18	6.38	14.20	9.51	8.12	8.08
17	10.40	9.18	13.59	7.27	12.59	5.42	14.72	4.99	19.17	6.38	14.19	9.51	8.12	8.11
18	10.27	9.07	12.19	6.90	11.67	5.22	13.35	4.60	19.17	6.37	14.19	9.51	8.12	8.20
19	10.05	9.01	11.97	6.63	11.19	4.30	12.15	3.62	18.50	5.74	14.18	9.51	8.12	8.18
20	9.85	8.50	11.12	6.21	11.03	2.57	11.48	2.49	12.28	2.87	14.18	9.51	8.12	8.22
21	9.77	8.09	10.61	5.73	11.02	1.83	11.14	1.94	11.66	0.94	14.18	9.51	8.12	8.24
22	9.68	7.90	10.44	5.13	11.02	1.64	11.11	1.72	11.54	0.61	14.18	9.51	8.12	8.17
23	9.51	7.62	10.37	5.07	11.02	1.61	11.11	1.66	11.53	0.51	14.18	9.51	8.12	8.11
24	0.00	0.00	10.33	4.90	11.02	1.60	11.11	1.69	11.51	0.43	14.18	9.51	8.12	8.11
25	0	0	10.31	4.82	11.02	1.6	11.09	1.77	0	0	0	0	0	0
Avg. TDS (NDEP)			15,277 mg/L		15,227 mg/L				15,619 mg/L				16,008 mg/L	

Attachment 2 cont.

2008 Mid-Lake Water Quality Profiles

	Feb 15		4-Mar		**24-Mar		13-Apr		28-Apr		29-May		12-Jun		23-Jun		7-Jul	
Depth(m)	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**
0	4.36	12.98	6.56	10.11	8.94	12.27	13.49		13.16	7.00	15.03	10.68	17.86	5.58	23.01	7.41	23.59	6.95
1	4.15	13.16	5.95	11.26	7.80	12.66	10.45		12.17	7.18	14.15	10.35	17.86	5.60	19.72	8.05	22.60	7.90
2	3.52	12.34	5.70	10.29	7.20	12.81	9.69		11.66	7.52	14.00	10.35	17.84	5.63	19.14	7.71	22.21	7.19
3	3.48	11.81	5.61	10.29	6.93	13.02	9.11		11.14	7.41	13.94	10.37	17.73	5.65	19.04	7.67	22.03	7.19
4	3.47	11.60	5.35	10.25	6.87	13.11	8.96		10.82	7.62	13.89	10.19	16.65	5.64	18.72	7.61	21.94	7.20
5	3.24	11.47	5.13	10.20	6.79	13.17	8.83		10.51	7.37	13.88	10.15	17.25	5.55	18.49	7.41	21.88	7.20
6	3.18	11.36	4.94	10.10	6.71	13.16	8.71		10.31	7.50	13.86	10.21	16.82	5.38	18.32	7.36	21.85	7.18
7	3.16	11.28	4.80	10.08	6.66	13.27	8.67		10.18	7.27	13.81	10.02	16.70	5.27	18.24	7.25	21.82	7.15
8	3.14	11.19	4.67	10.03	6.61	13.29	8.64		10.13	7.11	13.78	10.03	16.67	5.24	17.92	7.23	21.80	7.12
9	3.12	11.15	4.65	9.97	6.60	13.38	8.61		10.10	7.10	13.71	10.02	16.60	5.21	17.82	7.18	21.77	7.10
10	3.11	11.12	4.65	8.78	6.53	13.38	8.59		10.01	7.09	13.64	9.97	16.61	5.17	17.44	6.82	19.94	7.22
11	3.11	11.10	4.60	9.90	6.45	13.41	8.54		9.96	7.05	13.60	9.96	16.59	5.17	17.21	6.93	18.71	7.12
12	3.10	11.07	4.51	9.84	6.37	13.47	8.51		9.80	7.17	13.55	9.99	16.53	5.23	17.02	6.83	17.77	6.82
13	3.10	11.01	4.40	9.80	6.34	13.47	8.45		9.61	7.00	13.28	9.85	16.53	4.15	16.62	6.97	17.41	6.65
14	3.09	10.99	4.48	9.78	6.25	13.54	8.38		9.49	7.08	13.12	9.73	16.56	2.51	14.94	6.07	16.77	6.56
15	3.08	10.96	4.47	9.83	6.22	13.55	8.35		9.40	7.00	13.03	9.56			14.82	6.92	15.75	6.46
16	3.07	10.94	4.46	9.83	6.19	13.55	8.33		9.36	7.00	12.96	9.34			14.71	6.79	15.44	6.08
17	3.06	10.90	4.43	9.73	6.16	13.56	8.25		9.34	6.99	12.83	9.36			14.64	6.62	14.62	5.91
18	3.06	10.87	4.43	9.38	6.16	13.55	8.16		9.32	6.86	12.70	9.23			14.53	6.36	14.29	5.15
19	3.06	10.87					8.05		9.31	6.83	12.62	9.05			14.32	6.19	14.11	3.95
20	3.05	10.87					8.03		9.31	6.79	12.55	8.86			14.25	4.50	14.06	3.16
21	3.05	10.90					8.01		9.31	6.57	12.49	8.70			14.02	4.21	14.02	2.66
22	3.05	10.87					8.00		9.31	6.77	12.44	8.41			14.02	3.94	13.99	2.24
23	3.05	10.85					7.99								13.94	2.27	13.96	1.92
24	3.05	10.85					7.99										13.86	1.72
25																	13.87	1.43
Avg. TDS (NDEP)					16,089 mg/L													

2008 Mid-Lake Water Quality Profiles Continued

	16-Jul		7-Aug		**18-Aug		10-Sep		8-Oct		**28-Oct		18-Nov	
Depth (m)	T (°C)	DO mg/L	T (°C)	DO mg/L	T (°C)	DO mg/L	T (°C)	DO mg/L	T (°C)	DO mg/L	T (°C)	DO mg/L	T (°C)	DO mg/L
0	24.27	6.53	24.57	6.51	25.46	7.56	22.25	4.89	18.97	3.32	15.46	7.74	13.17	5.59
1	23.75	6.63	24.32	6.49	25.41	7.57	22.11	4.89	18.98	3.31	15.48	7.65	12.84	5.59
2	23.64	6.49	24.27	6.45	25.36	7.57	21.61	4.84	18.96	3.28	15.47	7.57	12.72	5.54
3	23.57	6.43	24.22	6.41	25.31	7.56	21.48	4.81	18.97	3.28	15.48	7.57	12.68	5.53
4	23.53	6.38	24.20	6.38	25.28	7.54	21.48	4.70	18.93	3.27	15.45	7.56	12.65	5.52
5	23.49	6.47	24.12	6.37	25.26	7.48	21.47	4.62	18.90	3.28	15.45	7.53	12.64	5.50
6	23.48	6.29	24.10	6.35	25.25	7.47	21.40	4.61	18.89	3.26	15.44	7.51	12.64	5.50
7	23.44	6.27	23.89	6.31	25.24	7.46	21.39	4.57	18.89	3.23	15.44	7.45	12.62	5.49
8	23.06	6.29	23.05	6.26	24.47	8.03	21.41	4.50	18.88	3.24	15.44	7.48	12.61	5.49
9	22.24	6.32	20.87	6.35	23.70	7.21	21.38	4.50	18.87	3.24	15.44	7.45	12.61	5.48
10	20.33	6.27	19.21	5.48	23.05	6.50	21.37	4.47	18.87	3.23	15.44	7.46	12.60	5.47
11	19.05	6.11	18.49	4.54	22.44	6.04	21.35	4.46	18.86	3.23	15.43	7.45	12.59	5.47
12	18.09	6.00	17.81	4.35	22.06	5.45	21.31	4.45	18.87	3.22	15.43	7.43	12.60	5.45
13	17.24	5.68	17.45	4.16	20.76	5.17	21.32	4.52	18.86	3.22	15.43	7.40	12.60	5.44
14	16.56	5.33	16.87	3.99	18.98	3.94	21.31	4.43	18.86	3.22	15.43	7.43	12.60	5.53
15	15.73	4.96	16.27	3.75	17.63	3.27	21.20	4.41	18.85	3.22	15.43	7.40	12.59	5.44
16	15.11	4.66	15.40	3.46	16.51	1.73	20.79	4.20	18.85	3.21	15.43	7.36	12.59	5.44
17	14.51	3.83	15.33	1.78	16.06	1.31	20.52	3.97	18.85	3.21	15.43	7.36	12.59	5.44
18	14.22	3.40	15.39	0.88	15.18	0.42	17.02	3.11	18.85	3.21	15.43	7.36	12.59	5.43
19	14.06	1.57	15.41	0.39	14.66	0.17	14.72	1.26	18.85	3.20	15.43	7.37	12.59	5.42
20	14.02	1.21					14.16	0.80	18.84	3.20			12.59	5.63
21	14.01	0.93					14.01	0.49	18.80	3.19			12.59	5.42
22	14.01	0.85					13.33	0.35					12.59	5.43
23	14.01	0.80											12.59	5.43
24													12.63	4.53
Avg. TDS (NDEP)					16,485 mg/L						16,775 mg/L			

Attachment 2 cont.

2009 Mid-Lake Water Quality Profiles

	27-Feb		25-Mar		21-Apr		27-Apr		9-May**		20-May		7-Jun		25-Jun		12-Jul	
Depth (m)	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**
0	6.00	5.82	7.60	7.94	17.20	11.13	11.87	10.48	15.65	8.58	16.85	7.90	19.02	8.40	21.20	7.61	23.00	5.64
1	5.47	5.73	7.47	8.47	13.51	11.96	11.52	10.47	13.74	8.89	16.74	7.87	17.32	8.80	20.76	8.25	21.85	5.99
2	5.66	5.65	7.25	8.48	12.37	11.88	11.12	10.51	13.42	8.90	16.23	7.89	17.05	8.58	19.65	8.36	21.66	5.85
3	5.18	5.59	7.17	8.53	12.94	11.82	10.96	10.52	13.30	8.86	16.13	7.86	16.98	8.52	19.44	8.57	21.60	5.84
4	5.10	5.55	7.13	8.51	11.59	11.64	10.87	10.56	13.24	8.83	16.06	7.84	16.91	8.48	19.12	8.68	21.49	6.12
5	5.06	5.50	7.12	8.51	10.86	11.60	10.78	10.54	13.19	8.81	16.07	7.79	16.88	8.45	18.88	8.51	21.42	6.00
6	5.02	5.47	7.12	8.51	9.88	11.68	10.69	10.51	13.12	8.79	15.97	7.79	16.85	8.43	18.68	8.35	21.44	6.06
7	4.99	5.42	7.10	8.51	9.56	11.70	10.57	10.51	13.09	8.78	15.81	7.80	16.84	8.41	18.62	8.65	21.44	5.89
8	4.97	5.40	7.09	8.50	9.34	11.49	10.51	10.49	13.05	8.78	15.74	7.79	16.83	8.36	18.57	8.54	21.42	5.97
9	5.36	5.37	7.08	8.47	9.11	11.45	10.46	10.45	13.02	8.77	15.68	7.77	16.81	8.31	18.44	8.21	21.41	6.02
10	5.34	5.34	7.07	8.42	8.99	11.39	10.44	10.42	12.95	8.76	15.61	7.74	16.78	8.29	18.38	8.12	21.38	6.00
11	5.32	5.32	7.06	8.38	8.82	11.33	10.44	10.38	12.84	8.76	13.14	8.14	16.73	8.27	18.31	8.00	21.39	5.82
12	4.95	5.31	7.05	8.37	8.76	11.04	10.39	10.34	12.60	8.77	13.02	7.88	16.63	8.27	18.18	7.95	21.33	6.01
13	4.95	5.31	7.04	8.60	8.68	10.68	10.34	10.33	12.30	8.81	12.95	7.80	16.51	8.26	18.03	8.22	20.29	5.96
14	4.95	5.30	7.01	8.30	8.62	10.57	10.23	10.33	12.05	8.84	12.84	7.84	16.45	8.21	17.72	8.23	19.01	5.75
15	4.95	5.29	6.99	8.38	8.61	10.35	10.08	10.31	12.00	8.73	12.44	7.85	16.39	8.19	17.27	7.97	18.26	5.50
16	4.95	5.28	6.95	8.39	8.58	10.30	9.97	10.27	11.95	8.61	11.62	7.22	16.38	8.20	16.84	7.68	17.66	5.55
17	4.94	5.27	6.93	8.39	8.57	10.41	9.93	10.21	11.80	8.57	11.50	7.00	15.00	8.32	16.35	6.78	16.09	5.39
18	4.95	5.26	6.86	8.39	8.50	10.03	9.88	10.15	10.86	8.61	11.23	6.81	13.38	7.81	15.70	6.00	14.85	4.27
19	4.94	5.25	6.43	8.42	8.50	9.97	9.54	9.80	10.27	8.09	10.81	6.70	11.93	6.98	13.99	4.70	13.97	2.86
20	4.92	5.19	6.67	8.44	8.47	9.83	9.42	9.75	10.12	7.81	10.67	6.37	11.68	5.72	12.72	3.20	13.61	1.97
21	4.67	5.15	6.59	8.45	8.46	9.80	9.39	9.64	10.02	7.43	10.64	6.11	11.63	5.02	12.64	3.16		
Avg. TDS (NDEP)									17,330 mg/L									

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

Attachment 2 cont.

2009 Mid-Lake Water Quality Profiles Continued

	20-Jul		18-Aug**		25-Aug		17-Sep		24-Sep		23-Oct		23-Nov**	
Depth (m)	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T T(°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**	**T (°C)**	**DO mg/L**
0	24.78	5.66	22.80	7.20	22.51	6.41	22.96	7.30	22.07	5.64	16.10	6.36	10.57	8.98
1	23.79	5.87	22.62	7.17	22.30	6.36	21.82	7.36	21.31	5.65	16.12	6.05	10.74	8.55
2	23.46	6.10	22.51	7.15	22.23	6.34	21.59	7.33	21.14	5.65	16.11	6.02	10.73	8.43
3	23.19	6.24	22.38	7.18	22.21	6.40	21.50	7.32	21.07	5.57	16.10	6.02	10.72	8.42
4	23.09	6.29	22.36	7.15	22.18	6.47	21.44	7.32	21.01	5.55	16.09	6.00	10.71	8.40
5	23.05	6.35	22.29	7.12	22.18	6.48	21.38	7.23	20.97	5.51	16.09	6.00	10.71	8.37
6	23.00	6.25	22.22	7.08	22.14	6.45	21.45	7.21	20.95	5.50	16.09	6.00	10.70	8.38
7	22.90	6.40	22.21	7.09	21.82	6.49	21.40	7.21	20.91	5.47	16.09	6.01	10.70	8.35
8	22.79	6.41	22.20	7.11	21.78	6.40	21.38	7.18	20.90	5.45	16.09	6.00	10.70	8.33
9	22.50	6.31	22.14	7.11	21.74	6.42	21.37	7.17	20.88	5.43	16.09	6.00	10.69	8.30
10	21.92	6.37	22.12	7.09	21.72	6.29	21.35	7.15	20.87	5.37	16.09	6.00	10.69	8.30
11	21.50	6.49	22.09	7.09	21.71	6.26	21.36	7.12	20.87	5.36	16.09	6.00	10.69	8.30
12	20.73	6.49	22.05	7.08	21.68	6.20	21.36	7.09	20.85	5.36	16.09	6.01	10.70	8.30
13	20.50	6.39	22.04	7.03	21.64	6.15	21.37	7.06	20.85	5.34	16.09	6.00	10.69	8.28
14	19.72	6.60	21.99	7.07	21.62	6.27	21.38	7.04	20.85	5.31	16.09	6.00	10.68	8.25
15	18.55	6.03	21.73	6.74	21.60	6.14	21.37	7.01	20.84	5.30	16.09	6.00	10.68	8.24
16	17.61	5.36	20.86	5.87	21.49	5.97	21.35	7.01	20.84	5.29	16.09	6.00	10.68	8.22
17	17.17	4.99	20.36	4.55	21.00	5.95	21.36	6.98	20.83	5.29	16.09	6.00	10.68	8.24
18	16.13	4.70	18.80	3.45	19.30	4.88	21.31	6.98	20.82	5.27	16.09	6.00	10.68	8.22
19	14.70	4.08	17.91	2.91	18.08	4.28	21.23	6.98	20.82	5.20	16.09	6.00	10.68	8.19
20	13.73	3.09	17.91	2.91	16.90	2.05	20.82	6.58	20.81	5.24	16.09	6.00	10.68	8.18
21	13.76	2.30	15.66	0.40	15.76	1.22	17.53	1.62	20.80	5.22	16.09	6.00	10.68	8.13
22			15.61	0.48	15.56	0.60	17.41	1.04	20.66	5.12				
Avg. TDS (NDEP)			17,811 mg/L						18,180 mg/L					

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

2010 Mid-Lake Water Quality Profiles

	2-Feb		**17- Feb		11-Mar		**2-Jun		29-Jun		29-Jul	
Depth (m)	**T (°C)**	**DO (mg/L)**	**T (°C)**	**DO (mg/L)****	**T (°C)**	**DO (mg/L)**	**T (°C)**	**DO (mg/L)**	**T (°C)**	**DO (mg/L)**	**T (°C)**	**DO (mg/L)**
0	4.15	8.66	7.93	-	6.33	9.67	15.85	9.37	21.21	7.49	24.20	6.63
1	3.94	8.61	6.15	-	6.11	9.66	14.68	9.19	20.44	7.58	23.79	6.64
2	3.89	8.53	5.96	-	5.99	9.62	14.59	9.23	20.26	7.67	23.36	6.52
3	3.85	8.50	5.88	-	5.85	9.66	14.27	9.13	20.18	7.72	23.24	6.29
4	3.84	8.50	5.84	-	5.79	9.65	13.94	9.10	20.10	7.73	23.19	6.77
5	3.83	8.45	5.79	-	5.75	9.62	13.79	9.08	19.90	7.71	23.17	6.13
6	3.81	8.41	5.76	-	5.73	9.56	13.60	8.95	18.53	7.76	23.14	6.07
7	3.81	8.43	5.72	-	5.72	9.57	13.53	8.95	17.81	7.68	23.13	6.03
8	3.80	8.40	5.63	-	5.72	9.58	13.48	8.92	17.56	7.59	23.11	5.96
9	3.80	8.36	5.50	-	5.75	9.57	13.45	8.89	17.18	7.47	23.11	5.91
10	3.80	8.38	5.45	-	5.71	9.59	13.32	8.89	16.87	7.34	23.05	5.93
11	3.79	8.37	4.96	-	5.71	9.57	13.31	8.87	16.74	6.76	22.87	5.91
12	3.79	8.36	4.75	-	5.71	9.57	13.12	8.77	16.63	6.70	20.53	5.58
13	3.79	8.35	4.64	-	5.71	9.58	13.06	8.70	16.55	6.68	18.01	4.42
14	3.79	8.35	4.58	-	5.71	9.57	13.01	8.66	16.10	6.59	17.09	3.92
15	3.79	8.35	4.49	-	5.70	9.55	13.00	8.60	15.08	6.16	16.48	3.87
16	3.78	8.36	4.45	-	5.70	9.55	12.90	8.57	14.59	6.12	15.90	3.66
17	3.78	8.33	4.45	-	5.70	9.56	12.87	8.57	13.68	6.37	15.11	3.36
18	3.75	8.33	4.44	-	5.70	9.57	12.75	8.21	13.65	6.00	14.75	2.15
19	3.70	8.32	4.44	-	5.70	9.57	12.74	8.27	13.63	6.73	14.68	1.69
20	3.68	8.24	4.44	-	5.70	9.58	12.72	8.17	13.63	6.61	14.64	1.47
21	3.68	8.20	-	-	5.70	9.55	-	-	-	-	-	-
Avg. TDS (NDEP)			18,191				17,815					

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

2010 Mid-Lake Water Quality Profiles Continued

	****24-Aug**		**14-Sep**		**19-Oct**		****7-Dec**	
Depth (m)	**T (°C)**	**DO (mg/L)**	**T (°C)**	**DO (mg/L)****	**T (°C)**	**DO (mg/L)**	**T (°C)**	**DO (mg/L)**
0	23.94	7.00	20.81	7.08	17.92	3.53	8.84	8.57
1	23.17	7.05	19.77	7.13	17.70	3.51	8.36	8.53
2	22.92	7.05	19.60	7.06	17.60	3.48	8.32	8.51
3	22.81	7.03	19.55	7.01	17.58	3.49	8.31	8.49
4	22.79	7.02	19.52	6.95	17.56	3.52	8.30	8.48
5	22.76	7.01	19.49	6.91	17.54	3.47	8.29	8.47
6	22.74	6.95	19.47	6.87	17.53	3.45	8.29	8.44
7	22.73	6.92	19.34	6.82	17.53	3.49	8.29	8.43
8	22.73	6.93	19.44	6.78	17.53	3.45	8.29	8.42
9	22.72	6.89	19.43	6.78	17.53	3.42	8.29	8.42
10	22.71	6.89	19.43	6.72	17.51	3.45	8.29	8.41
11	22.70	6.85	19.43	6.70	17.52	3.43	8.29	8.39
12	22.70	6.84	19.43	6.68	17.52	3.50	8.29	8.29
13	22.69	6.82	19.43	6.67	17.52	3.47	8.29	8.39
14	22.68	6.82	19.42	6.64	17.51	3.46	8.28	8.39
15	22.67	6.77	19.42	6.62	17.51	3.5	8.28	8.39
16	19.81	3.99	19.42	6.61	17.50	3.45	8.28	8.35
17	16.69	0.45	19.42	6.58	17.51	3.49	8.29	8.34
18	16.62	0.14	19.40	6.57	17.51	3.48	8.27	8.32
19	15.59	0.15	19.40	6.50	17.50	3.57	8.28	8.32
20	15.57	0.14	19.34	5.40	-	-	8.29	8.31
21	-	-	18.63	2.65	-	-	-	-
Avg. TDS mg/L (NDEP)	18,361						19,199	

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