

Status of the Lees Ferry Rainbow Trout Fishery

2014 Annual Report

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Status of the Lees Ferry Rainbow Trout Fishery—2014 Annual Report

By David L. Rogowski, Lisa K. Winters, Pilar N. Wolters and Kristy M. Manuell

Abstract

Rainbow trout (*Oncorhynchus mykiss*) were initially stocked in the Colorado River downstream from the recently constructed Glen Canyon Dam in 1964. Consequently, fish management efforts and dam operations (e.g. flow regimes) continually interact to influence the trout fishery. The Arizona Game and Fish Department has consistently monitored the fishery since 1991 using boat electrofishing and creel surveys. In 2014, we conducted three standard electrofishing sampling trips in the spring, summer, and fall. We sampled 115 sites in total, with 36, 39, and 40 sites sampled each season, respectively. Rainbow trout dominated the fish community comprising 98.8% of fish captured. Rainbow trout mean catch-per-unit-effort across seasons was 3.22, 95% CI [2.80, 3.63] fish/minute. During fall sampling average length of rainbow trout captured was 235 mm. In addition, approximately 24% of the trout collected during fall sampling were below 152 mm (6 inches) indicating a strong cohort of fish recruited this year. Mean fall length has been trending upwards since 2010. Rainbow trout relative condition (all samples and size classes) were well below 1.00, the condition of an average Lees Ferry rainbow trout. This is the lowest fish condition recorded since monitoring began in 1991. Fish condition for all three sampling trips and for all size classes of rainbow trout were below average. One night during our summer electrofishing was dedicated to identifying rare nonnative fishes present in the reach. Six walleye (*Sander vitreus*) were captured at the base of the Glen Canyon Dam spillways. At a large backwater area referred to as the slough (river mile -12.0), 68 common carp (*Cyprinus carpio*) were captured along with five native flannelmouth suckers (*Catostomus latipinnis*) and 27 rainbow trout. Carp continue to dominate the fish community in the slough, and this year 56% were recaptures (previously marked individuals).

Angler surveys were conducted on 69 days for the period of 1 January- 31 December 2014. During these surveys a total of 1,651 anglers were interviewed: 1,275 from upriver (boaters) and 376 utilizing the walk-in section. In the upriver section, anglers interviewed reported a total of 19,703 rainbow trout being caught with an average catch rate of 2.07 fish/hr. Harvest rates in the upriver section continue to be extremely low with only 2.3% of the total catch of rainbow trout harvested. In the walk-in section of the fishery 1,155 rainbow trout were caught by anglers interviewed, resulting in an average catch rate of 0.82 fish/hr. Harvest rates in the walk in section were 22.7% of total catch, substantially higher than the 13% harvested in 2013. Overall angler success remains high with 95% and 64% of the anglers in the upriver section and walk-in section, respectively, catching at least one fish. Additionally, fishing satisfaction remains high for both boaters and walk-in anglers averaging 4.55 and 4.25 on a scale of 1 – 5, respectively. Results from our angler preference question revealed that there was a significant statistical difference in preference of catching ten 16" fish, over the alternative of catching two 20" fish ($P < 0.0001$).

Introduction

The Arizona Game and Fish Department (AGFD) has been monitoring and researching the fishery in the Lees Ferry reach of the Colorado River (Figure 1) since the mid 1960's. Rainbow trout were initially stocked in the Colorado River downstream from Glen Canyon Dam in 1964 and fish management efforts, dam operations, and flow regimes interact to influence the fish community (McKinney et al. 2001, Hilwig and Makinster 2010, Cross et al. 2011, 2013). Nonnative rainbow trout in the tailwater provide a popular recreational fishery and coexist with native flannelmouth sucker, nonnative brown trout (*Salmo trutta*), and nonnative common carp. Stocking of rainbow trout ceased in 1998, as the majority of trout in the system were from natural reproduction (McKinney et al. 1999a; 2001).

The Colorado River directly below Glen Canyon Dam is highly managed. Water is discharged from the hypolimnion of Lake Powell, thus, water temperatures are cold throughout the year (mean daily temperature 10.1°C during July 2006-June 2009) and dissolved oxygen can be low. An increase in water temperature within the tailwater below the dam started to occur around 2003, coincident with lower reservoir elevations in Lake Powell (Vernieu 2013). Water is clear most of the year as there are no tributaries or sediment input in this upper segment of river. Habitat consists of cobble/gravel bars, talus/cliff faces, and fine-grained depositional zones (Cross et al. 2011).

Glen Canyon Dam operates to meet downstream water supply requirements. In doing so, the natural state of the Colorado River is altered by decreasing high spring flows, increasing summer and winter flows, eliminating floods, decreasing the sand supply, and virtually eliminating seasonal water temperature variability (Melis et al. 2011). A Modified Low Fluctuating Flow (MLFF) design was implemented in 1995 following completion of an environmental impact statement which reduced variation in flow during dam operation. Since then, controlled floods have been performed in March 1996, November 2004, March 2008, November 2013, and November 2014. Large flows have the potential to bury redds and reduce fish survival rates (Holtby and Healey 1986; Magee et al. 1996), flush fines from interstitial pore spaces and increase survival of early fish life stages (Kondolf et al. 1987; Murlle et al. 2003), increase wetted area and thereby habitat for juvenile fish (Mitro et al. 2003; Lobon-Cervia 2007; Korman et al. 2011b), or displace juvenile fish from preferred habitat due to higher water velocities (Valdez et al. 2001; Einum and Nislow 2005). Additionally, scour due to high water velocities may alter the composition and abundance of invertebrates on the stream bottom and in the drift (Rosi-Marshall et al. 2010; Kennedy et al. 2013). For example, the timing of the 2008 flood likely cleaned rainbow trout redds, increased abundance of age-0 fishes, increased rearing habitat, and increased midges and black flies available for trout consumption, leading to a large cohort of rainbow trout in 2008 and 2009 (Melis et al. 2011; Korman et al. 2012).

Rainbow trout have increased in abundance in Glen and Marble Canyons over the following decade after the MLFF was initiated. Early life stage survival (recruitment) improved substantially with the reduction in hourly variation in flow (Korman et al. 2012). As this response was considered detrimental to the endangered humpback chub population downstream due to increased competition and predation (Yard et al. 2011), flow variation was increased during winter and spring 2003-2005 to suppress rainbow trout recruitment. Low dissolved oxygen levels early in 2005 may have confounded seemingly successful results. Additionally, a removal program targeting rainbow trout and brown trout was conducted from 2003-2006 near the Little Colorado River, successfully shifting the fish community from one dominated by nonnative rainbow trout to one dominated by native species (Coggins et al.

2011). At the same time, however, rainbow trout abundance in Lees Ferry declined steadily during 2002- 2006 (Makinster et al. 2007), and the high flow experiment of fall 2004 may have elevated mortality (Coggins et al. 2011). A major factor was likely that trout are predominantly sight feeders, therefore high turbidity and reduced prey are likely to adversely impact foraging (Yard 2003). Correspondingly, increased water temperature in the mainstem (to 17°C) could have led to increased native fish recruitment even without concurrent nonnative species control efforts (Coggins et al. 2011). An experiment from 2008-2012 was initiated to hold dam releases steady for a short period in May and the entire months of September and October, to try and raise nearshore Colorado River water temperatures in the vicinity of the confluence of the Little Colorado River, to benefit the endangered humpback chub (*Gila cypha*). Further complicating the variation in conditions, 4 months of steady flows during the summer of 2000 resulted in a large recruitment event due to expanded shoreline habitat (Korman and Campana 2009).

From 1991 through 1997, higher mean and less variable releases from Glen Canyon Dam favored high standing stocks of rainbow trout, but size-related changes occurred in relative condition and bioenergetics of fish (McKinney et al. 1999a; McKinney and Speas 2001). Small fish (< 305 mm) were strongly affected by low and variable releases from the dam, but not by biotic variables, which allowed them to meet maintenance energy requirements. In contrast, large fish (\geq 305 mm) were not affected by flow variability but were strongly influenced by biotic factors (i.e., density-dependence) associated with degradation of the aquatic food base. Large fish rarely meet energy requirements for growth (McKinney and Speas 2001). Impacts of regulated flow on rainbow trout in the Lees Ferry tailwater have been a source of interest and debate for resource managers and the public for several decades (McKinney et al. 1999c; McKinney et al. 2001; McKinney and Speas 2001; Cross et al. 2011, 2013). Understanding fish ecology in relation to dam operations is essential to integrate water, power, and fishery management goals.

Arizona Game and Fish Department has been conducting creel surveys at Lees Ferry off and on since about 1977 with various changes to methodology. In some years only certain months were sampled and often only boat anglers were surveyed. Other years both boat and walk-in anglers were surveyed and samples were collected throughout the year. Since 2012, angler surveys have been standardized and recognized as an important tool in monitoring the Lees Ferry rainbow trout fishery. Anglers are interviewed individually, and are asked how long they have been fishing that day, how many and what kind of fish caught, where they are traveling from, as well as satisfaction and preference questions, among others. Consequently, Grand Canyon Monitoring and Research Center (GCMRC) of the U.S. Geological Survey and AGFD have agreed to fund angler surveys with AGFD funding every third year and GCMRC funding the additional years. Currently, AGFD uses a stratified random sampling approach to select sample date (by month and weekday/weekend), and samples both boat and shoreline anglers throughout the year.

The rainbow trout population in the Lees Ferry reach has been monitored on a regular basis by Arizona Game & Fish Department since 1991, as part of a cooperative agreement with the U.S. Geological Survey's Grand Canyon Monitoring and Research Center. For monitoring the Lees Ferry fishery, we use a variety of metrics. Catch-per-unit-effort (CPUE) data, for both angler and electrofishing is the primary metric for tracking long term trends in the fishery. CPUE is calculated as the number of fish caught per minute from our electrofishing boat, or the number of fish caught per hour by an angler. CPUE is an index of relative abundance that provides a means to assess general trends in populations. However, this metric is not the best for comparing year to year variation. Additionally, we

use length-frequency histograms to assess the size structure of the population. Finally, relative fish condition, calculated from the average length-weight relationship of rainbow trout at Lees Ferry, is used to monitor the overall health of the population.

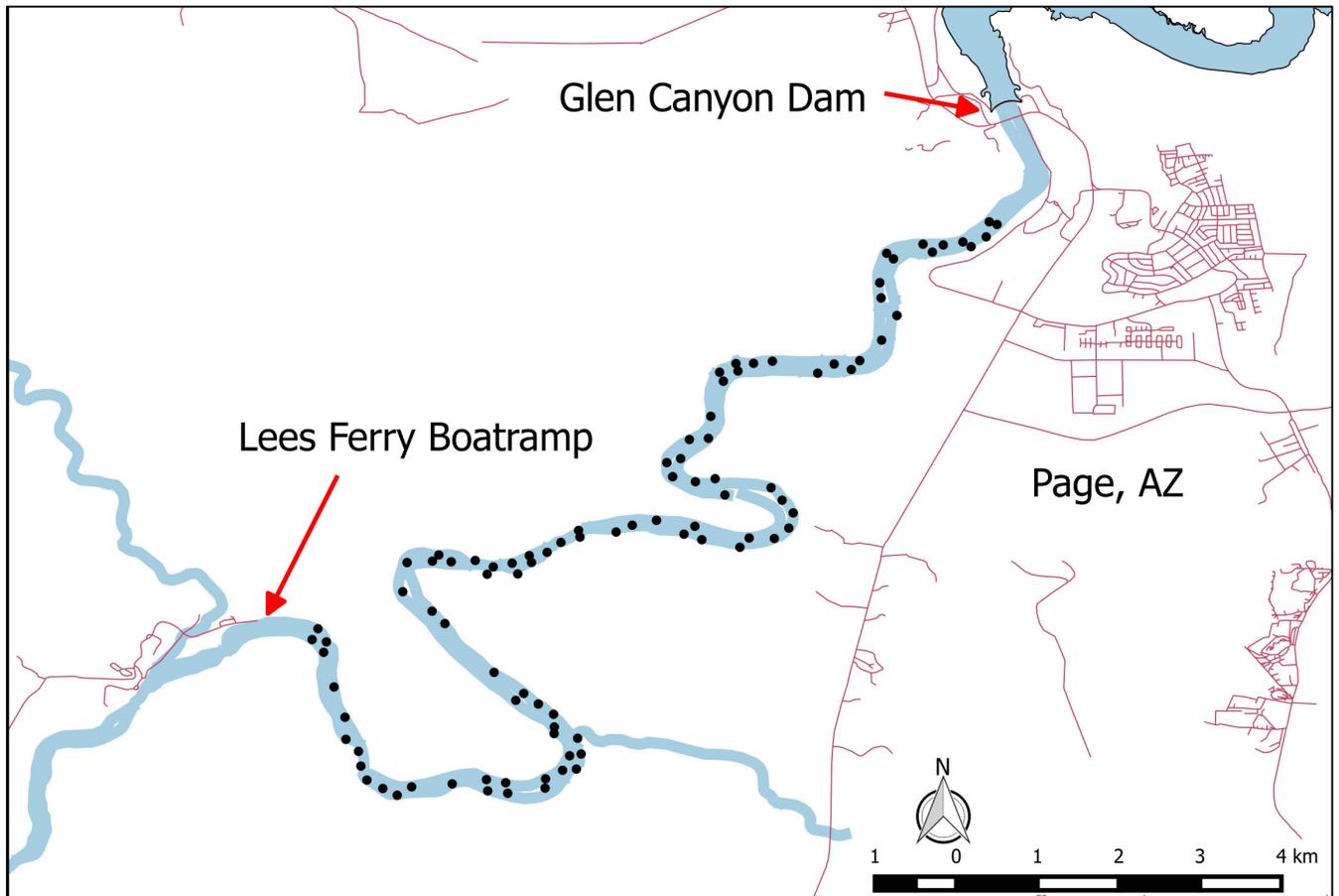


Figure 1. Diagram of the Lees Ferry tailwater reach of the Colorado River from Glen Canyon Dam (RM -15.7) to the historical ferry location (RM 0.0), located near the Arizona-Utah border. 2014 sampling sites within the reach are shaded dark.

Standardized monitoring of the trout fishery using electrofishing (Sharber et al. 1994) at fixed sampling locations was initiated in 1991 and has provided data on response of the rainbow trout population to dam operations (McKinney and Persons 1999; McKinney et al. 1999a, c; McKinney et al. 2001). In 2013, the National Park Service released a Finding of No Significant Impact for the Comprehensive Fisheries Management Plan for the Colorado River below Glen Canyon Dam and for all waters within Grand Canyon National Park. The primary goal is to maintain a quality rainbow trout fishery in Glen Canyon, with certain metrics or trigger points, that if met result in action. In the event that the fishery declines, stocking of sterile (non-spawning) rainbow trout in Lees Ferry is warranted (See Appendix I). Stocking criteria includes:

1. Recruitment is low for multiple years: rainbow trout recruits (fish less than six inches) comprise less than 20% of the fish community during Arizona Game & Fish fall monitoring events for more than three consecutive years, OR

2. Arizona Game and Fish electrofishing estimates of relative abundance (including all sizes of fish) are less than one fish/minute for two consecutive years of fall sampling, OR
3. If angler catch rate in Glen Canyon Reach decline to less than 0.5 rainbow trout/hour and average size is less than 14 inches for two consecutive years.

We present results from fish monitoring activities in the Lees Ferry tailwater during 2014. Our monitoring objectives have not changed since 2002 and include evaluating the status and trends in catch rate, population structure (size composition) and relative condition (K_n) of rainbow trout. We present our results in a format consistent with historical presentation of data as well as in relation to the Comprehensive Fisheries Management Plan for the Glen Canyon reach of the Colorado River below Glen Canyon Dam.

Methods

Long-term monitoring

We conducted standard monitoring surveys in the Lees Ferry tailwater from March 18-21, July 14-18 and 30 September – 3 October, 2014. We used two 16 ft. Achilles inflatable boats outfitted for electrofishing, applying pulsed DC (~410 V, ~12 A; Sharber et al. 1994) to a 35-cm spherical electrode system. Sampling commenced shortly after dusk and persisted 5-7 hours per night for three consecutive nights.

This year (2014) we switched our sampling sites to the 250 m sampling sites that are being used throughout the river by other researchers, to allow for easier comparisons and integration of data collected from different agencies. There are approximately 220 potential sites to select within this reach. During March, July and October monitoring surveys, a minimum of 36 random sites were sampled covering approximately nine kilometers of shoreline area. We utilized a stratified random sample approach to allocate sample sites from sample units found in RM $\bar{15.3} \pm 0.9$. We stratified sample units longitudinally. Longitudinal stratification was by RM; upper (RM $\bar{15.3} \pm 10.8$), middle (RM $\bar{10.8} \pm 4.0$) and lower (RM $\bar{4.0} \pm 0.9$) sub-reaches of the tailwater downstream from Glen Canyon Dam. Longitudinal stratification also allowed randomization while maintaining safety and logistical integrity (i.e., boats visit the same section of the river on each night) as well as among longitudinal gradients in fish density (Speas et al. 2004).

We measured total length (TL, in mm) for all fish captured and weight (g) for most fish >150 mm TL (except for native fish) when conditions permitted accurate weight measurements. Rainbow trout <150 mm TL were not weighed due to scale accuracy concerns and the magnitude of error associated with condition measurements based on inaccurate weight. For rainbow trout captured we measured fork length and TL. Fish were sexed based on manual expression of gametes. Untagged brown trout and native species (i.e. flannelmouth sucker) > 149 mm TL were implanted with 134.2 kHz PIT tags at all sites and brown trout were given an adipose fin clip to monitor tag retention. PIT tags were implanted ventrally into the fish body cavity with the insertion point immediately posterior to the pelvic fin. Common carp were also marked with PIT tags implanted in the dorsal musculature, and the first 1-2 dorsal fin rays were removed to monitor tag retention, and for subsequent aging and growth calculations.

Nonnative fish surveillance

During July 2014, one additional night was spent electrofishing areas not normally sampled as a part of the standardized monitoring. The objective of this sampling was to target nonnative fishes that are not normally encountered during our standardized sampling. Sample sites included Glen Canyon Dam spillways, spring inflows and other unique habitat features including backwaters of various sizes (e.g. slough near RM 12.0) and rock shoreline habitat that are relatively uncommon throughout the remainder of the reach. A total of 15 sites were sampled during this detection effort by boat electrofishing, four of which were inside the slough. Fish were processed using the same processing methods described above; we avoided capturing rainbow trout electrofished outside the slough, but captured all fish inside the slough, regardless of species.

Creel surveys

Arizona Game and Fish Department has been conducting creel surveys at Lees Ferry off and on since about 1977 with various changes to the methods. Prior to 2011 in general only people going upriver utilizing boats were surveyed. Walk-in anglers were only sporadically surveyed prior to 2011. Since 2011 we have been following a standard protocol. Anglers are divided into two categories, those going upriver using boats and those that access the fishery on foot (walk-in anglers). Creel surveys were conducted at Lees Ferry at the beginning of 2014 with samples equally stratified by month and weekday or weekend (6 days per month total). Beginning in August of 2014 sample allocation was changed to four weekend days and two weekdays in a month to decrease variance in yearly estimates of use and other angler statistical measures. Previous surveys revealed greater variation (and greater use) for weekend days than weekdays, thus more effort was targeted towards weekends. Creels were conducted at the boat ramp (point access creel) as well as the walk-in section (roving creel). For statistical analyses most holidays are treated as “weekends” with the exception of Christmas and Thanksgiving days, as very few people fish those holidays and angler use is more like weekdays, than weekends. More detailed methodology of our creel surveys can be found in Appendix III.

While reviewing historically reported creel data (1977-2010) we noticed a number of data entry errors as well as errors in calculating catch per unit effort (CPUE). Previous to 2011, many different data sheet formats were used with a range of fields including hours fished, species, fish caught/harvested, tackle used and angler information about experience and trip details. Inconsistencies in data sheet use, as well as poor data collection in the field, have led to discrepancies in the data entry process. Boat anglers were the main focus of creel in these years but shore anglers were interviewed if they were angling in proximity to the boat ramp. Additionally, previous to 2011, anglers were interviewed in groups, not as individuals.

We have not had time to correct all historical creel data. Years that were corrected include: 1980, 1985, 1991, 1995-2000, 2002, 2003, 2005, and 2010. The original data sheets for each of these years were reviewed and any errors observed corrected within the electronic database. For the other years CPUE was correctly recalculated based on group interviews, and any obvious errors (outliers, typos) were corrected, but not all angler data sheets were reviewed.

Specific errors that were observed in the historical creel data included missing times, missing data sheets and missing state information. Several data sheets were lacking start and end times; however times were somehow entered into the database. This data was corrected and not included in the CPUE calculation. A reoccurring issue was data sheets that were never entered. Data sheets not entered

included interviews with anglers that caught large quantities of fish (over 100); unsuccessful anglers, and/or anglers with missing start and end times. Missing data was entered and included in CPUE calculations when possible. Groups interviewed often consisted of anglers from more than one state, however only one state was recorded in the database spreadsheet regardless of the actual data recorded. For some reason if the state residence field was left blank, previous data recorders entered Arizona as a default residence into the database. State of residence was adjusted to reflect what was actually recorded during the interview. Angler groups interviewed often had state residences recorded but no indication how many individuals were from each state. Therefore some data could not be used in the analysis of angler state residence due to undetermined place of residence. For example, if three anglers were interviewed within a group, but only two states were recorded; two anglers were given a state while the third angler was classified as unknown.

Data Analysis

Long-term monitoring

We computed mean CPUE (fish/minute) using all fish for each site during electrofishing surveys, as well as for the following length categories: <152 mm TL, 151.99-304.99 mm TL, 305-405.99 mm TL and >405.99 mm TL, with CPUE serving as an index of relative abundance. We determined relative condition factor (K_n ; Le Cren 1951) using the equation:

$$K_n = \left[\frac{W}{W'} \right]$$

where W' is the standard weight relationship $10^{[-4.6023 + 2.8193 * \log_{10}(TL)]}$ incorporating Lees Ferry rainbow trout length and weight data collected since 1991 (See Appendix II for K_n derivation). Condition was determined for each of the size classes with TL greater than 152 mm. Condition was not calculated for fish <152 mm TL due to a combination of factors including no weights taken on fish <150 mm, accuracy of scales at measuring small fish, and the magnitude of error in condition factor associated with incorrect weights for small fish. We report mean CPUE and K_n with 95% confidence intervals.

Creel surveys

For creel surveys, mean CPUE was calculated by how many fish an angler catches per hour of angling. Anglers are only interviewed if they have been fishing for at least half an hour. To estimate angler use for the year, we averaged the number of anglers recorded on creel days by weekday and weekend for boat anglers and walk-in anglers to estimate monthly usage, and then summed the totals for the year. Angler use is defined as one angler fishing one day, regardless of the length of time spent that day. Creel surveys from 2002-2010 did not include walk-in anglers. It is also not known whether every boat angler was interviewed or only a subset for the data prior to 2011. To investigate the percent of anglers from in state and out of state we reexamined a subset of creel data for every five years beginning in 1980 till 2010, and the past two years. The original creel data sheets were compared to the electronic database and corrected where necessary. As most of the original data sheets from 1990 were missing we elected to use 1991 data.

Another concern with the historical creel data was the incorrect calculations of angler statistics. Group angler data was entered and then expanded out into individual interviews. Total fish caught was divided among anglers, which does not necessarily represent the actual number of fish caught by any

one angler in that group. Catch per unit effort was calculated from this expanded file of individual anglers and not from the main group effort, thus inflating the sample size and resulting in lower reported standard errors and confidence intervals. If groups are interviewed, angler statistics should be calculated based on group data, not individual data. Consequently, for years prior to 2011 the CPUE was recalculated by multiplying the number of anglers by their effort for the day, then divided by the total number of fish caught. The correct sample size was the number of groups interviewed, not the number of anglers.

Results

Hydrological characteristics

Discharges from Glen Canyon Dam followed the modified low fluctuating flow (MLFF) regime for much of 2014 (Figure 2). On November 10-16, 2014 Bureau of Reclamation initiated the 6th high-flow experiment (HFE) with a maximum release of 1062 m³ (37,500 cfs). This HFE was conducted after all of our electrofishing sampling was completed.

The lowest temperature of 2014 was 7.6 °C occurring on 20 February 2014 and the highest temperature recorded was 15.3°C on 15 November 2014 during the high flow experiment (Figure 2).

Table 1. Summary water quality measurements of the Colorado River measured at the Lees Ferry USGS streamflow gage station (#USGS 09380000) in 2014.

Measurement	Mean	Lower and upper 95 % CI	Minimum	Maximum
Discharge (CFS)	11,142	11,100, 11,186	5,540	38,400
Temperature (°C)	11.2	11.20, 11.24	7.6	15.3
Dissolved oxygen (mg/l)	7.37	7.36, 7.38	5.04	11.2
Turbidity (FNU)	0.833	0.821, 0.846	0.000	33.0
Specific conductance (µS/cm)	825	825, 826	684	960

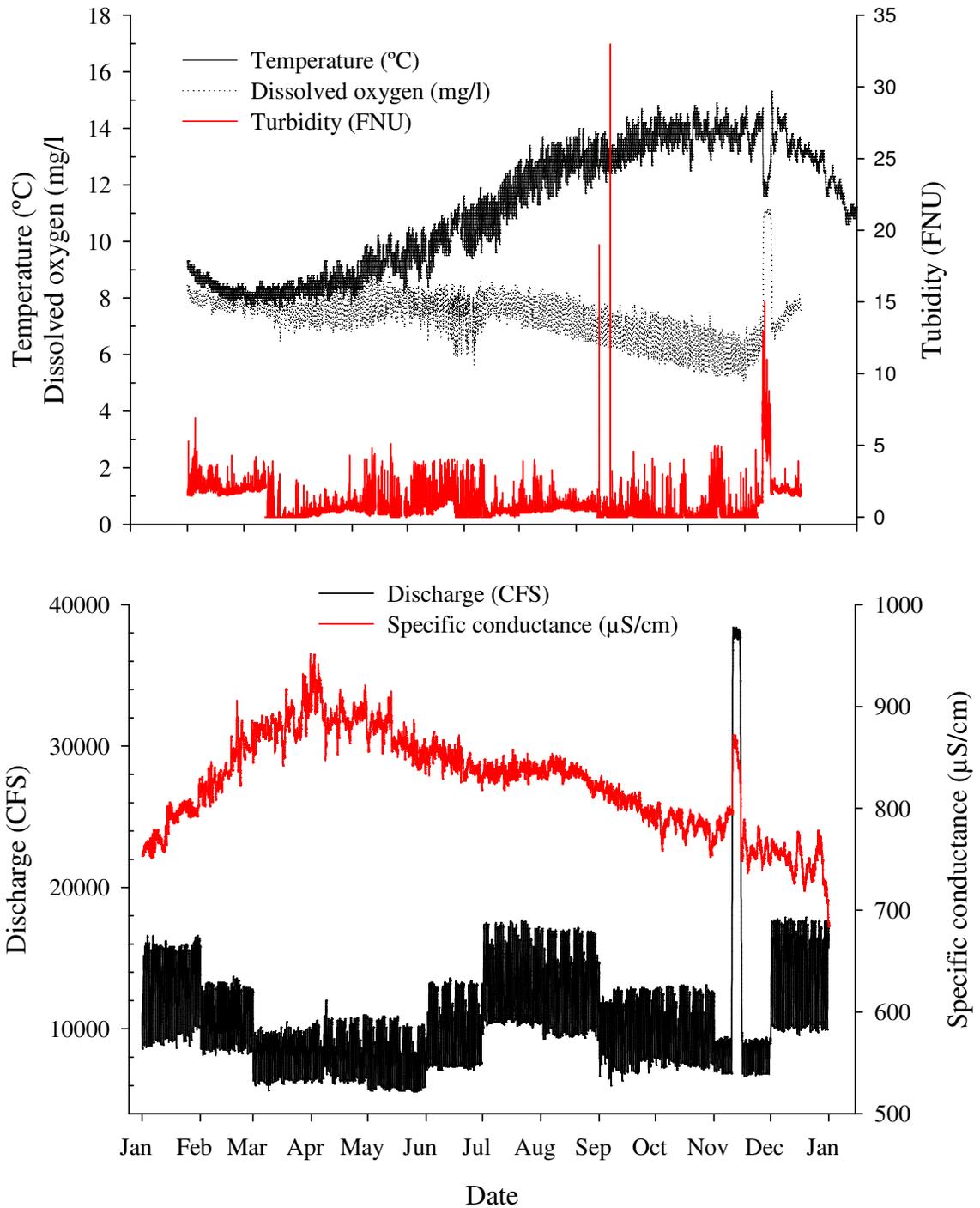


Figure 2. A) Temperature (°C), dissolved oxygen (mg/L), and turbidity (FNU), and B) discharge (m³/s) and specific conductance (µS/cm) of the Colorado River measured at the Lees Ferry USGS streamflow gage station (#USGS 09380000) in 2014.

Long-term monitoring

We sampled 115 sites within the Lees Ferry reach of the Colorado River in 2014, with 36, 39, and 40 sites sampled in spring, summer, and fall respectively. A total of 4,209 fish from five species were captured during long-term monitoring at Lees Ferry in 2014 (Table 2). Rainbow trout were the most prevalent species captured (98.8%) followed distantly by brown trout (0.55%).

Table 2. Species composition within the Lees Ferry reach of the Colorado River during 2014 standard monitoring (boat electrofishing).

Species	Spring March	Summer July	Fall October	Total	Percent
Rainbow trout	945	1412	1803	4160	98.8%
Brown trout	11	10	2	23	0.55%
Carp	8	0	4	12	0.29%
Flannelmouth sucker	1	0	11	12	0.29%

Overall rainbow trout mean CPUE during 2014 was 3.22, 95% CI [2.80, 3.64] fish/min for all sites combined across all three sampling trips (Figure 3). Mean CPUE by size class is presented in Figure 4. Over the past five years there was no significant trend ($R^2=0.0538$, $F_{1,4}=0.171$, $P=0.707$). Summary results for CPUEs for rainbow trout by sampling trip are presented in Tables 3-5.

Table 3. Rainbow trout mean catch-per-unit-effort (CPUE) for March 2014 sampling in the Lees Ferry reach of the Colorado River. 36 sites were sampled.

Size class (mm TL)	CPUE (fish/min)	95 % CI	Number of fish	% Total catch
Total catch	2.46	1.80, 3.12	946*	
<152	0.461	0.269, 0.654	196	20.7%
152-305	1.31	0.912, 1.71	500	52.9%
306-405	0.642	0.433, 0.850	234	24.8%
>405	0.0408	0.0195, 0.0621	15	1.6%

*One fish escaped without obtaining a length measurement, thus the sum does not equal the total catch.

Table 4. Rainbow trout mean catch-per-unit-effort (CPUE) for July 2014 sampling in the Lees Ferry reach. 39 sites were sampled (not including “sampling for nonnatives”).

Size class (mm TL)	CPUE (fish/min)	95 % CI	Number of fish	% Total catch
Total catch	3.54	2.69, 4.40	1412*	
<152	0.242	0.179, 0.304	106	7.5%
152-305	2.03	1.54, 2.52	840	59.7%
306-405	1.22	0.792, 1.64	449	31.9%
>405	0.0397	0.0142, 0.0652	13	1.0%

* Four fish escaped without obtaining a length measurement, thus the sum does not equal the total catch.

Table 5. Rainbow trout mean catch-per-unit-effort (CPUE) for fall (Sept. – Oct.) 2014 sampling in the Lees Ferry reach. 40 sites were sampled.

Size class (mm TL)	CPUE (fish/min)	95 % CI	Number of fish	% Total catch
Total catch	3.59	3.23, 3.94	1803*	
<152	0.797	0.690, 0.905	423	23.5%
152-305	2.17	1.89, 2.46	1077	59.8%
306-405	0.605	0.503, 0.708	298	16.5%
>405	0.00863	0.00697, 0.0156	4	0.22%

*One fish escaped without a length measurement, thus the sum does not equal the total catch.

Length-frequency analysis of the spring and fall sample showed a bimodal length distribution, representing two size classes: young of the year and adults (Figure 5). In the fall sample 23.5 % of the rainbow trout captured were below 152 mm TL (Figure 6). Figure 7 shows historical fall length frequency histograms for comparison.

Mean TL of rainbow trout captured during fall of 2014 was 235.0 mm 95% CI [230.8, 239.2] (Figure 8). There was a significant increase in mean TL over the past five years ($R^2=0.984$, $F_{1,4}=187$, $P=0.000847$). From 1984 to 2014 the median length of ripe female and male rainbow trout has declined (female: $MS=926499$, $F_{1,861}=399$, $P<0.0001$; male: $MS=6158376$, $F_{1,2617}=1479$, $P<0.001$; Figure 9). The same pattern ($MS=719729$, $F_{1,656}=415.9$, $P<0.001$) was also found downstream from river mile three to 61.9 (just upstream of the Little Colorado River confluence). Median total length of ripe male rainbow trout was significantly related to variation in flow during February through July ($MS=282$, $F_{1,28}=13.4$, $P=0.001$; Figure 10).

Overall, rainbow trout condition for 2014 was 0.883 [95% CI: 0.879, 0.888]. Size-stratified rainbow trout mean condition by year is presented in Figure 11. Condition was not estimated for juvenile fish (<152 mm TL) as weight measurements are not routinely taken for fish < 150 mm TL.

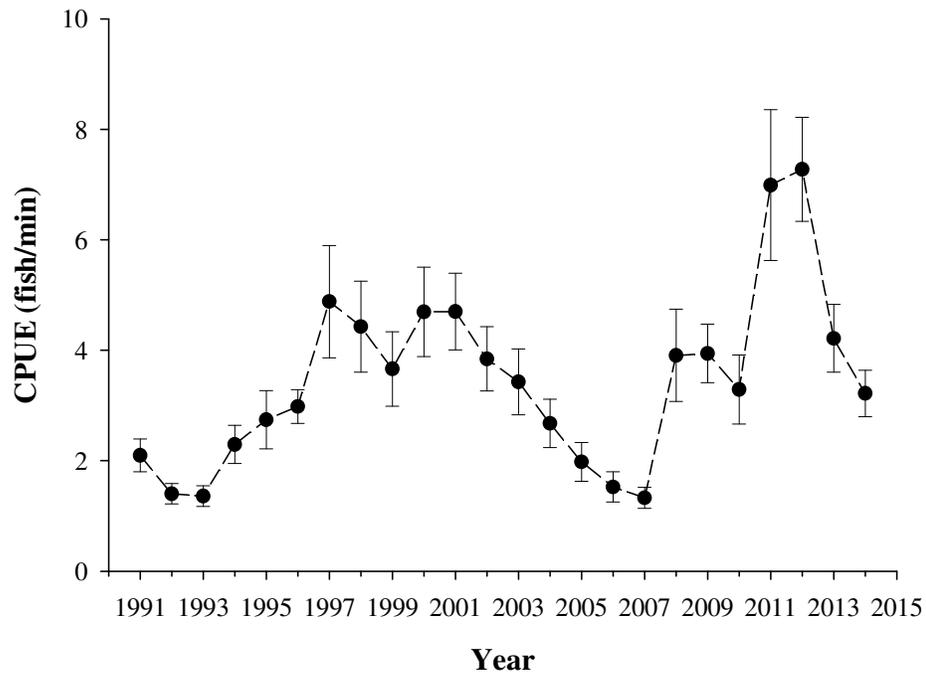


Figure 3. Overall mean rainbow trout CPUE from 1991-2014 from all samples combined (by year) from the Lees Ferry reach of the Colorado River. Error bars represent 95% confidence intervals, prior to 2011 error bars are two times the standard error.

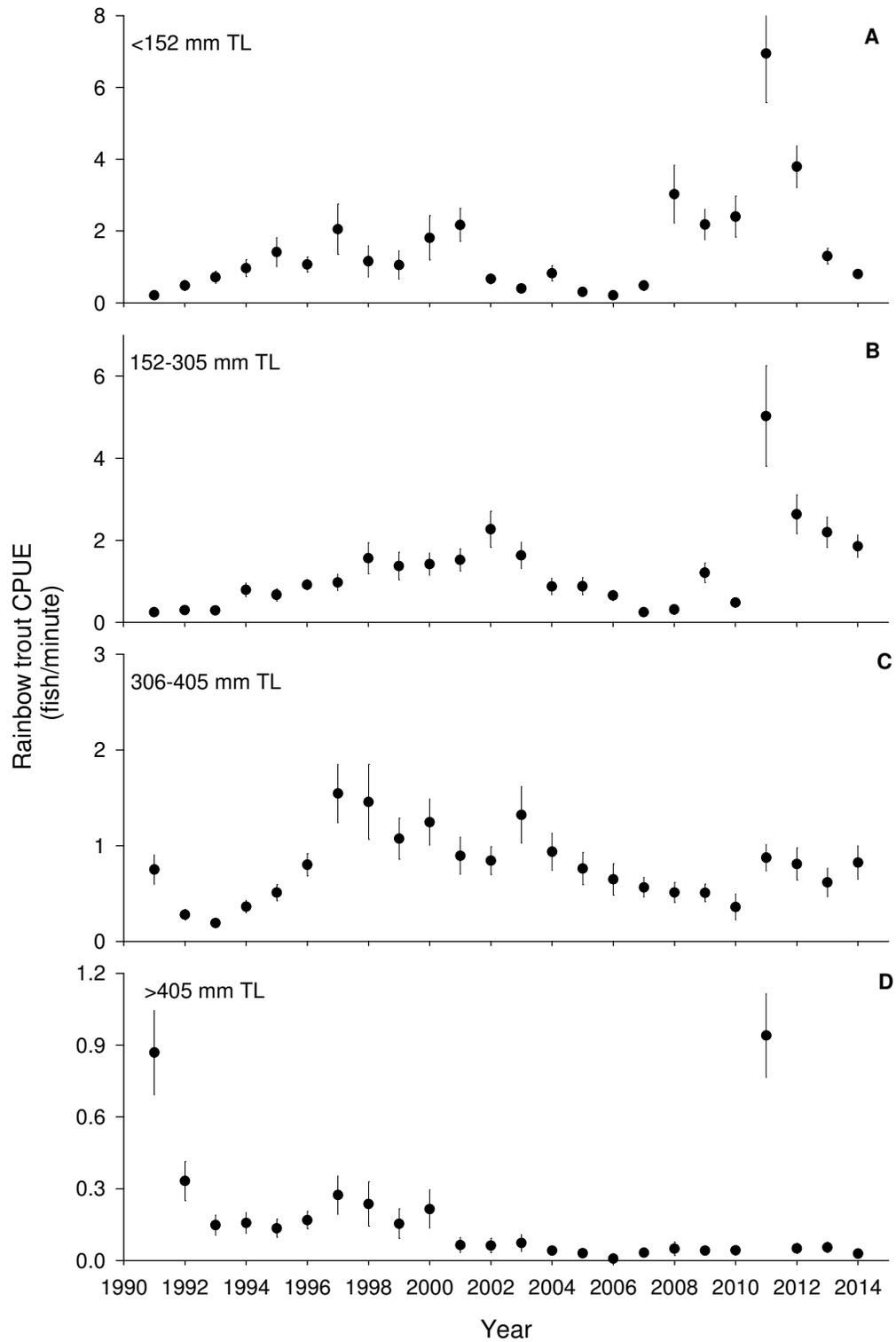


Figure 4. Mean rainbow trout CPUE by size class from 1991-2014 for the Lees Ferry reach of the Colorado River. All three (spring, summer, fall) yearly samples are combined. Error bars represent 95% confidence intervals. Note different scales for the vertical axes.

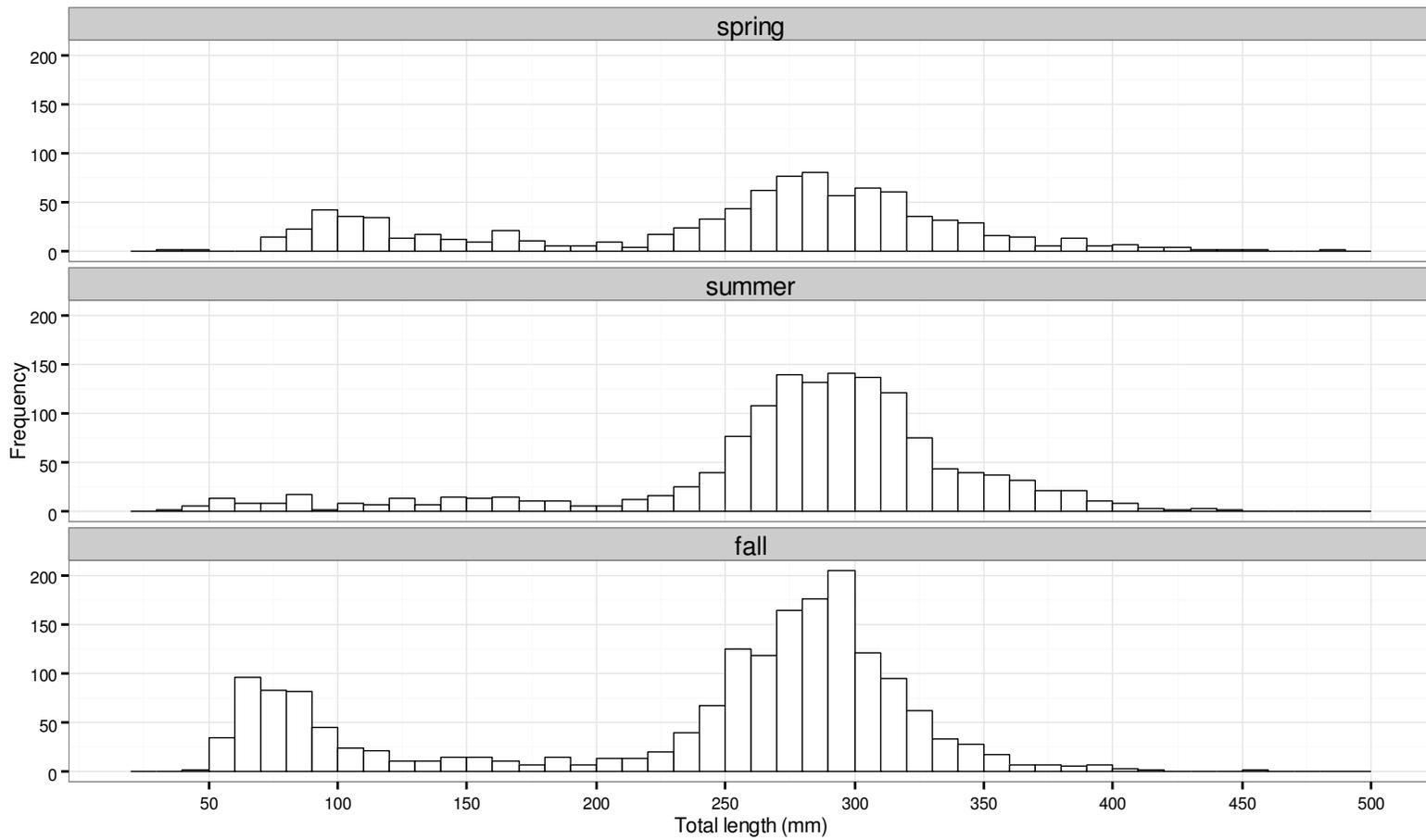


Figure 5. Length frequency histogram of rainbow trout collected in 2014 from the Lees Ferry reach of the Colorado River, for each sampling trip (spring, summer, fall). Bin width equals 10 mm increments.

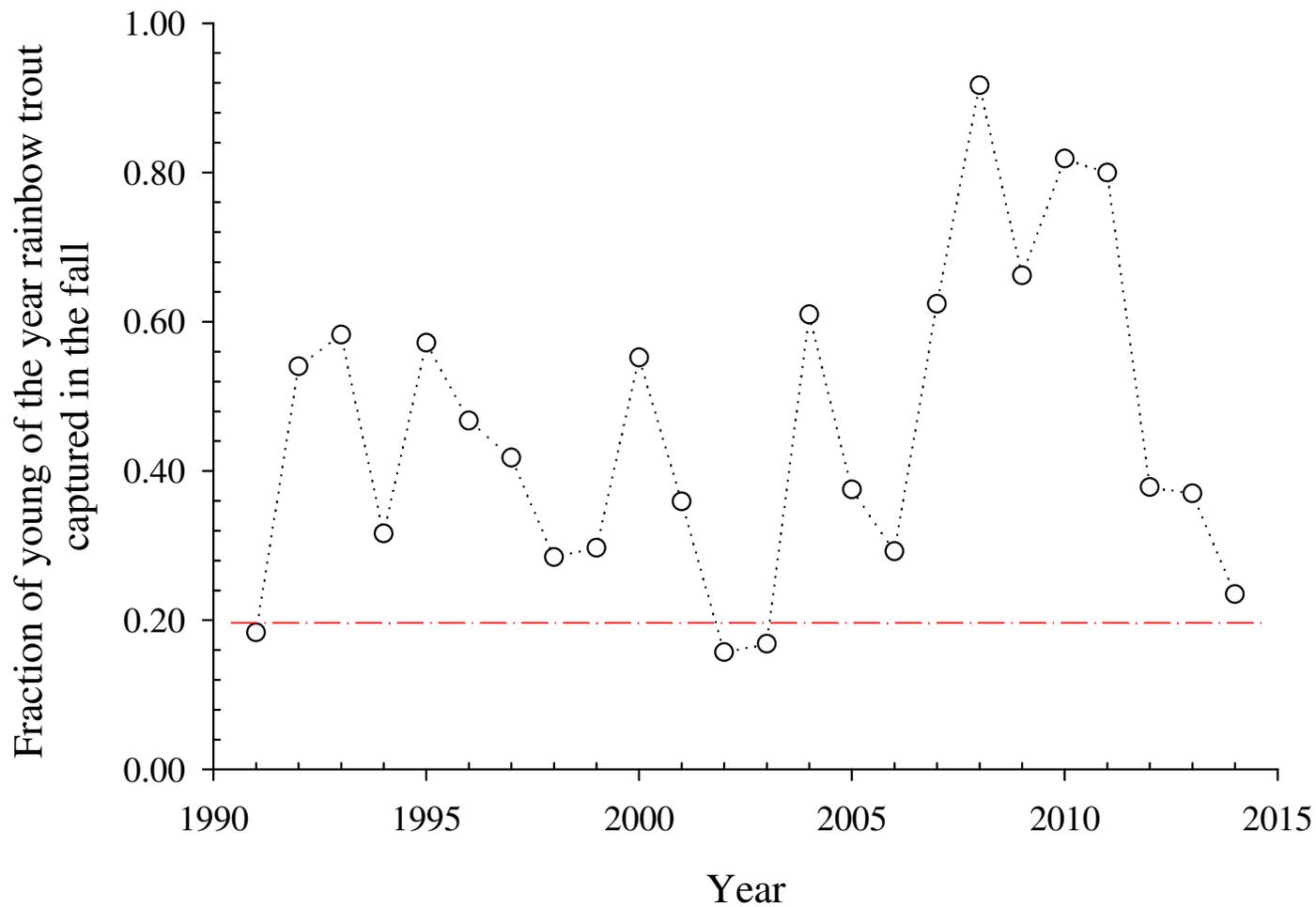


Figure 6. Percent of young of the year (YOY) rainbow trout captured during fall electrofishing sampling by year. Note that in 1994 and 1995 no fall sampling occurred so data is presented for sampling results from December. The red line represents a trigger for management of trout. If percent of YOY is below 20% for at least three years then stocking of triploid trout may be warranted.

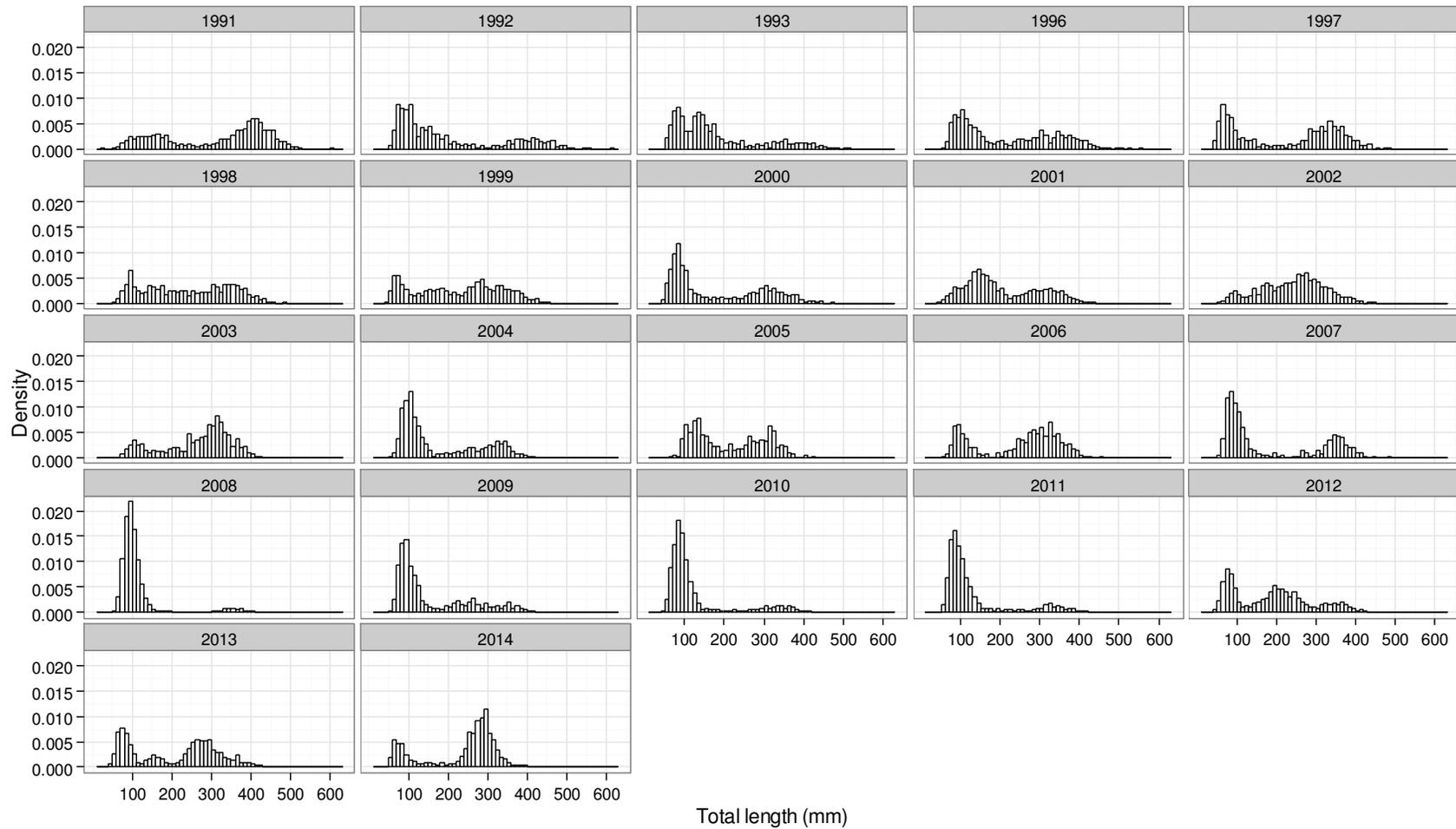


Figure 7. Density histograms of rainbow trout by total length captured during fall from the Lees Ferry reach of the Colorado River. Fall sampling was not always conducted every year of long-term monitoring (e.g. 1994, 1995).

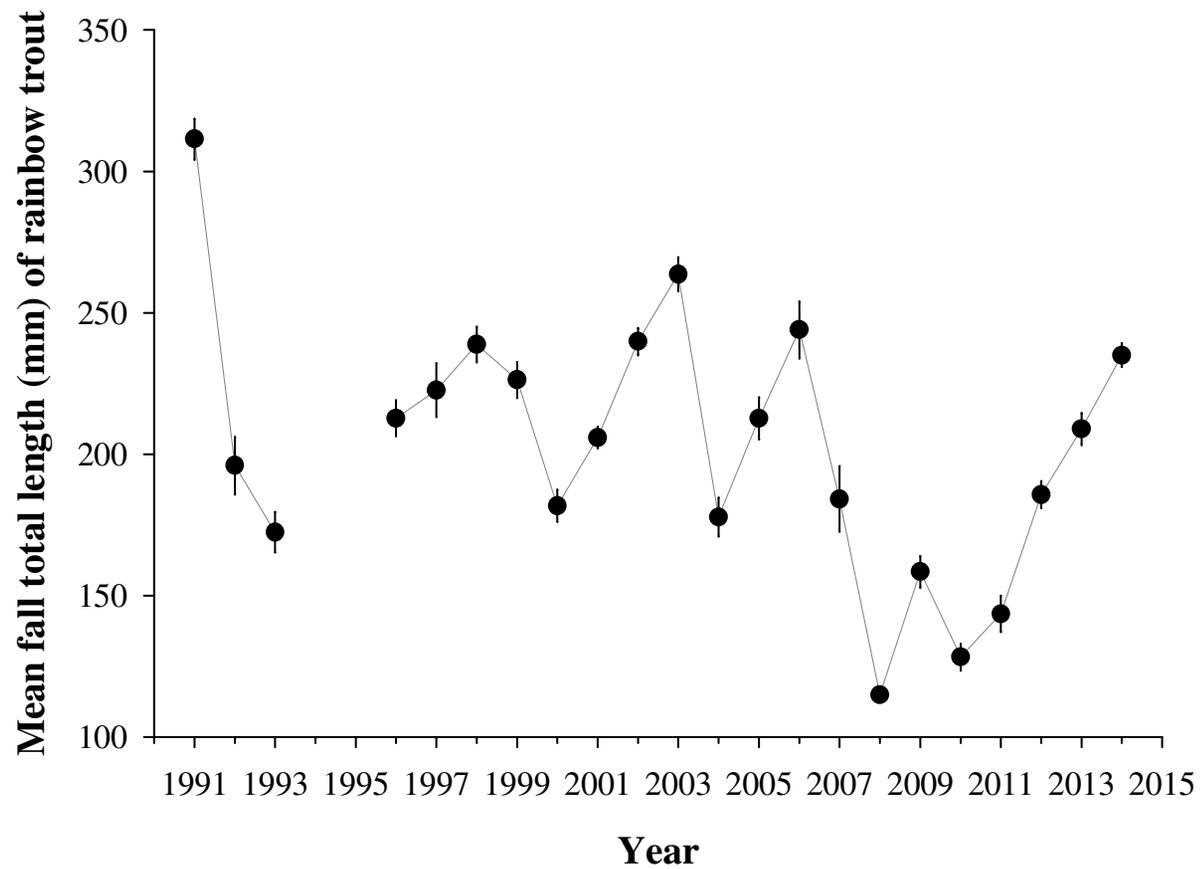


Figure 8. Mean total length of rainbow trout captured during fall electrofishing sampling in the Lees Ferry reach of the Colorado River. No fall sampling occurred in 1994 and 1995. Error bars represent 95% confidence intervals.

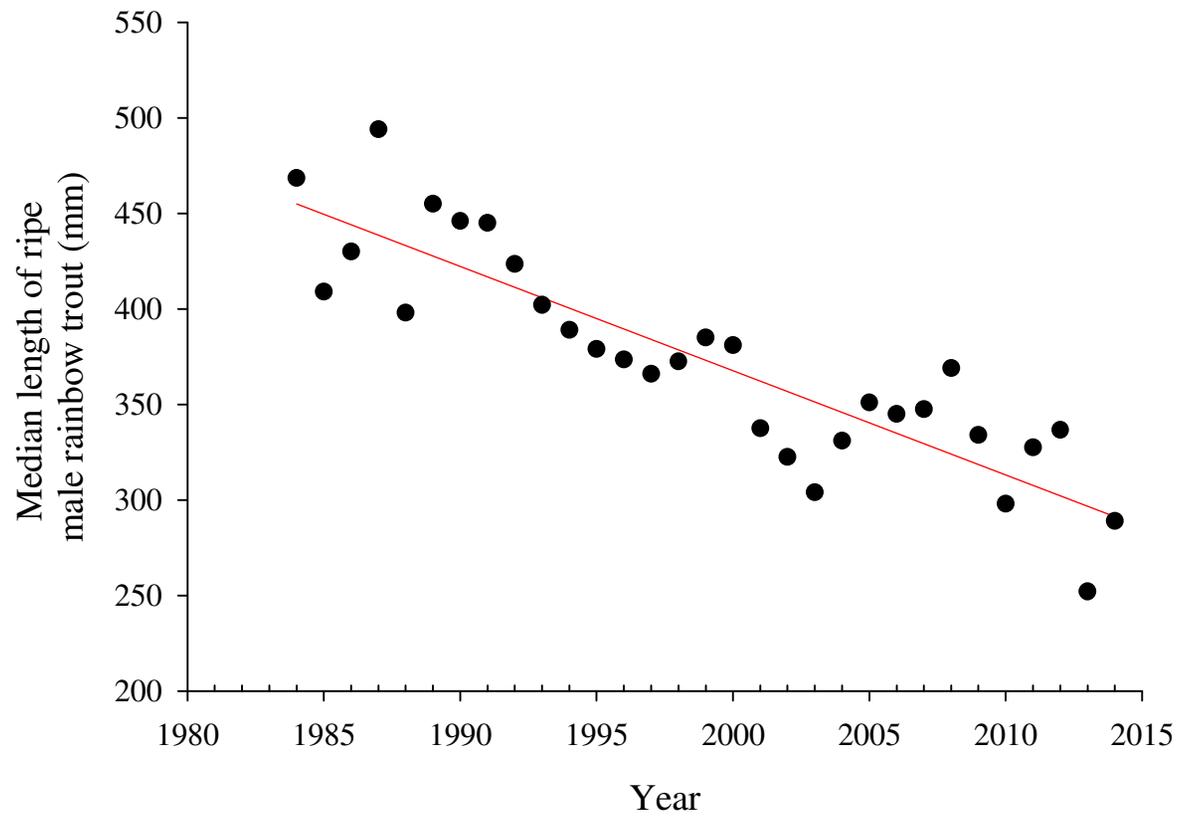


Figure 9. Total median length of ripe (express milt) male rainbow trout in the Lees Ferry reach of the Colorado River by year from 1984 to 2014.

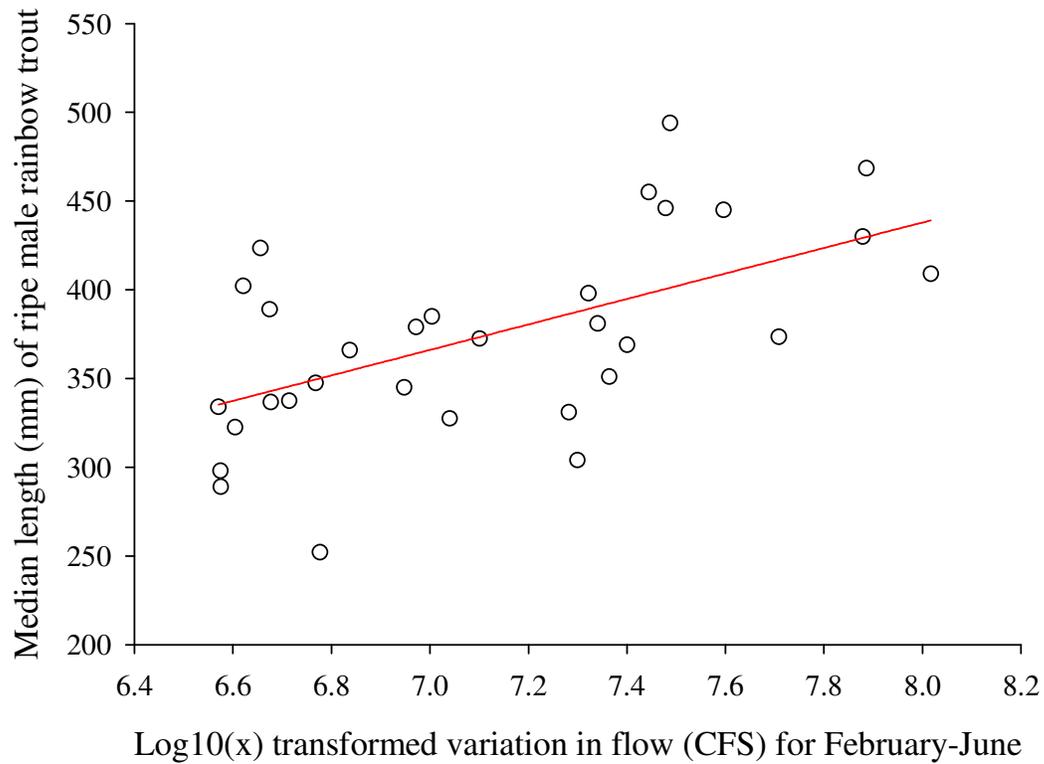


Figure 10. Relationship between median total length of ripe male rainbow trout in the Lees Ferry reach of the Colorado River and variation in flow (CFS).

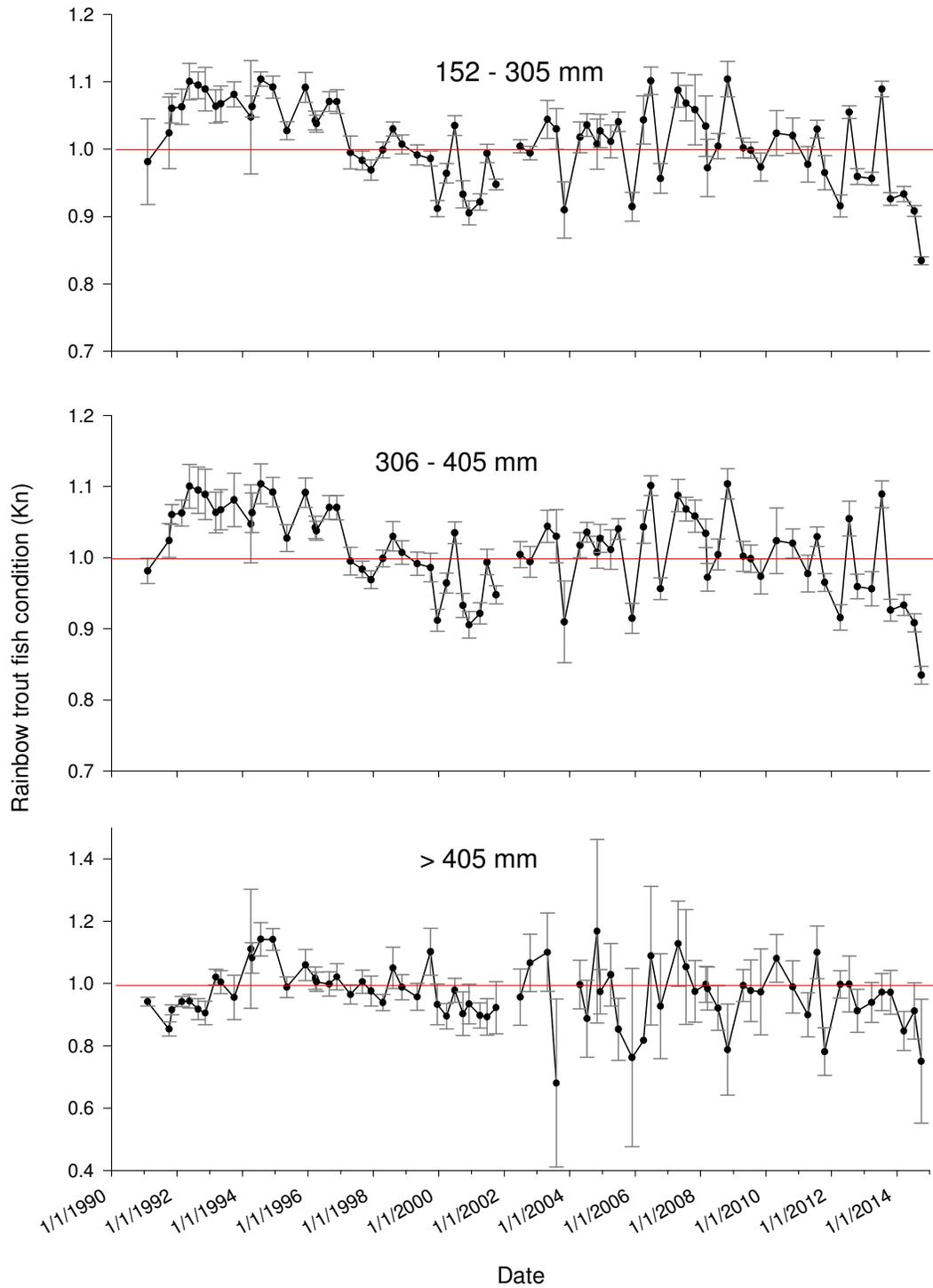


Figure 11. Mean rainbow trout relative condition in the Lees Ferry reach of the Colorado River since 1991 by sample date. Error bars represent 95% confidence intervals. The red line represents the average fish condition ($K_n=1.00$) for rainbow trout in this Lees Ferry reach.

Nonnative fish surveillance

We captured a total of 76 nonnative fish from 2 species while conducting nonnative surveillance during July 2014. A total of 15 sites were sampled, four of which no rare nonnative fish were captured (Table 6). Six large adult walleye (425 ± 43 SD mm TL) were captured in the left and right spillways immediately downstream from Glen Canyon Dam. Common carp were the most abundant species captured with 70 individuals being collected, 68 from the slough and two from a spring inflow, with mean (and SD) total length of 529 ± 124 mm. Evaluation of the length-frequency distribution for common carp indicated the presence of multiple size classes including young of year, sub adult and adult fish. A large school (50-75) of young of year carp were observed outside of electrofishing effort. Of the carp captured, 56% were recaptures (previously marked individuals). We also captured five flannelmouth suckers within the slough with a mean of 498 ± 53 mm TL (SD).

Table 6. Summary results within the Lees Ferry reach of the Colorado River during 2014 rare nonnative surveillance (boat electrofishing).

Site	River side	Effort (seconds)	River mile	Walleye	Carp
Backwater feature	L	411	-1.5	0	0
Warm spring inflow	L	223	-3.32	0	2
Spring inflow	L	108	-13.5	0	0
Below Ferry swale bar	R	406	-11.02	0	0
Spring inflow	R	109	-13.72	0	0
Spillway left	L	1551	-15.78	3	0
Spillway right	R	1968	-15.73	3	0
Slough (-12.05_L)*	L	504	-12.32	0	17
		**	-12.09	0	12
		688	-12.31	0	31
		1366	12.09	0	8

*The slough was sampled with 4 transects

**Effort not provided for site

Creel surveys

Angler surveys were conducted on 69 days for the period of 1 January- 31 December 2014. During these surveys a total of 1,651 anglers were interviewed, 1,275 from upriver (boaters) and 376 utilizing the walk-in section. A total of 10,908 estimated anglers used the fishery in 2014, of which 6,739 were boat anglers (Figure 12) and 4,169 walk-in anglers. Only years with complete creel data are presented. As June was the month most often surveyed and is significantly correlated ($R^2 = 0.811$, $F_{1,8} = 35.4$, $P = 0.000570$) with total yearly boat angler use, it is also presented. Both measures reveal a significant decline (linear regression for June: $R^2 = 0.383$, $F_{1,11} = 6.85$, $P = 0.0240$) in angler use over the years (2002-2014).

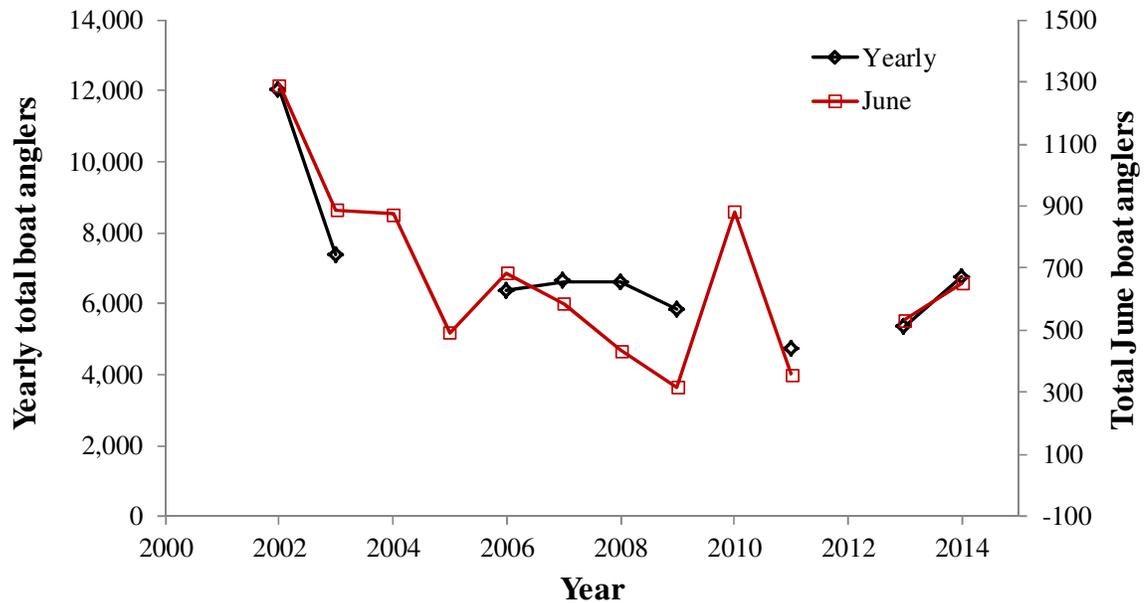


Figure 12. Estimated total boat angler use at Lees Ferry by year and for the month of June. Data based on angler (creel) surveys.

In the upriver section, boat anglers interviewed reported a total of 19,703 rainbow trout caught with an average catch rate of 2.07 fish/hour (Figure 13). Over the last five years there has not been a significant increase in CPUE by boat anglers ($R^2 = 0.698$, $F_{1,4} = 6.95$, $P = 0.0780$). Harvest rates in the upriver section continue to be extremely low with only 2.27% of the total catch of rainbow trout harvested (Figure 14).

In the walk-in section of the fishery, 1,167 rainbow trout were caught by anglers interviewed, resulting in an average catch rate of 0.82 fish/hr. Harvest rates in the walk-in section were 22.5% of total catch, and 28.3% of walk-in anglers harvested fish, compared to 10.7 % of boat anglers harvesting fish (Figure 14).

Overall angler success remains high with 95.2% and 64% of the anglers in the upriver section and walk-in section respectively, catching at least one fish. Angler satisfaction on a scale of one to five remains high for both boaters and walk-in anglers averaging 4.55 and 4.28, respectively. Results from our angler preference question revealed that there was no statistical difference in preference of catching ten 16" fish, over the alternative of catching two 20" fish between boat and walk-in anglers (Fisher's exact test: $p = 0.608$, odds ratio 0.920). Thus, the results from the two types of anglers were combined, with 1,006 out of 1,343 anglers preferring 10 fish (over two fish), and using binomial distribution test there was a significant preference for 10 fish ($P < 0.0001$).

Mean CPUE of the angler surveys (boat and walk-in) is correlated with standard electrofishing (linear regression: $r^2 = 0.513$, $F_{1,22} = 25.2$, $P < 0.0001$; $r^2 = 0.648$, $F_{1,13} = 23.9$, $P < 0.0001$ respectively) (Figure 15).

The percent of anglers over time fishing at Lees Ferry (boat anglers) that were from Arizona has remained fairly stable since creel surveys have been conducted beginning in 1977 (linear regression: $r^2 < 0.000$, $F_{1,8} < 0.000$, $P < 0.0001$). Approximately 72% of anglers were from Arizona (Figure 16).

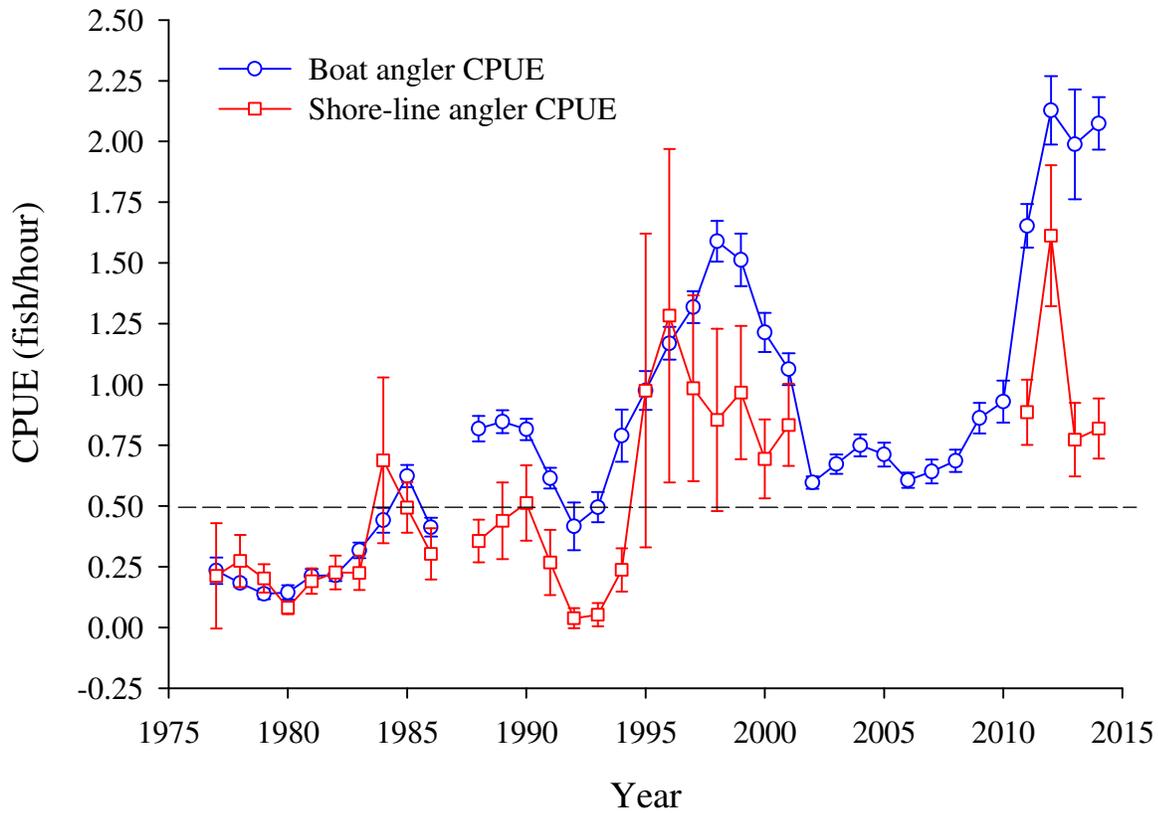


Figure 13. Mean rainbow trout CPUE of both boat anglers (blue) and shore-line anglers (red) from creel surveys at Lees Ferry. Error bars represent 95 % confidence intervals. The dashed line indicates the trigger point (0.5 fish/hour) for potential restocking of rainbow trout (see Appendix I).

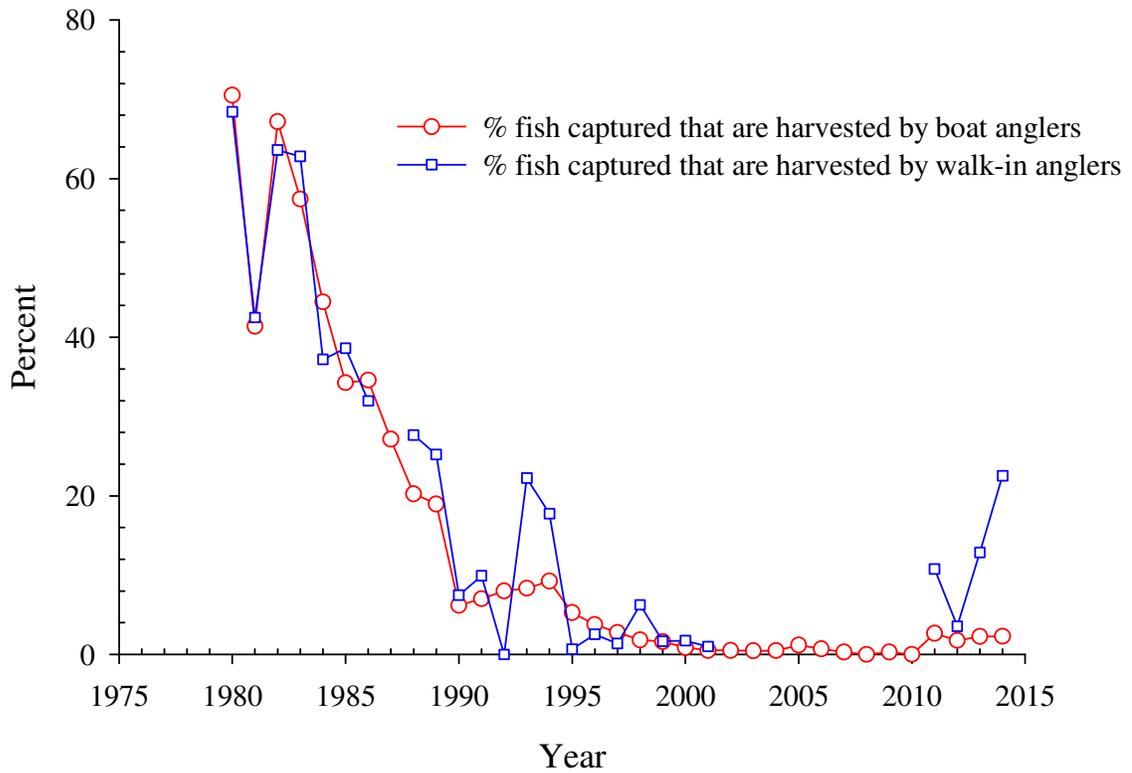


Figure 14. Percent of captured fish that are harvested (primarily rainbow trout) via boat anglers (red) and walk-in anglers (blue), calculated from creel surveys at Lees Ferry by year.

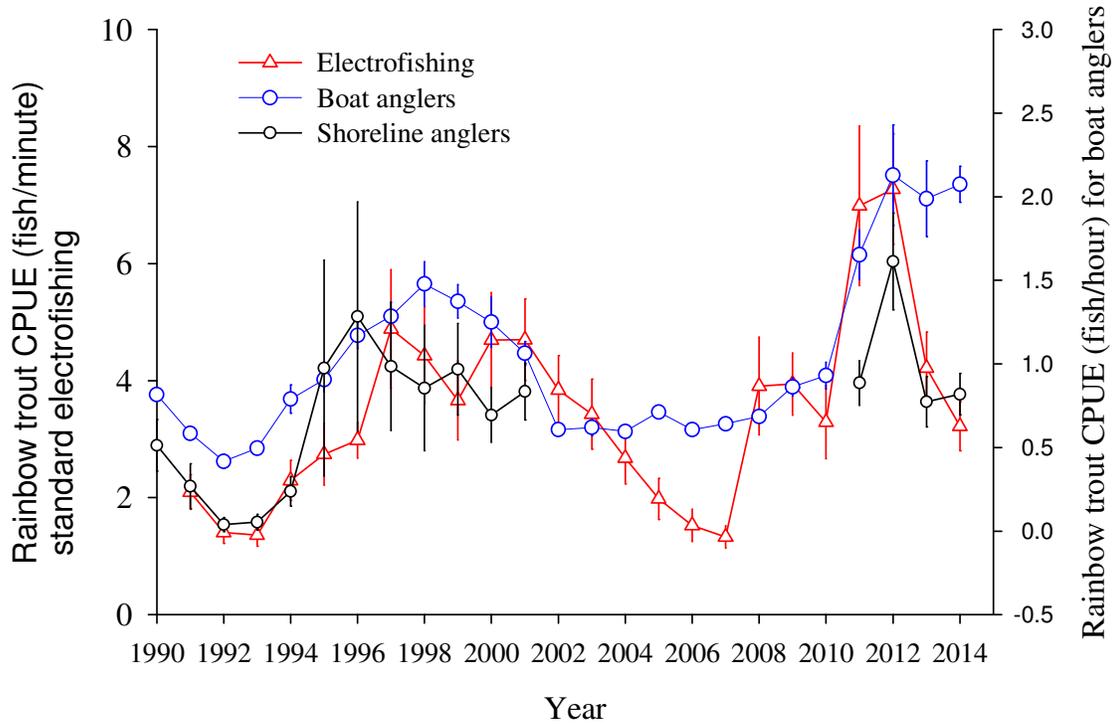


Figure 15. Comparison of mean CPUE of rainbow trout from standard boat electrofishing (black) and surveys of boat (blue) and walk-in anglers (red) at Lees Ferry, Colorado River. Error bars are 95% confidence intervals.

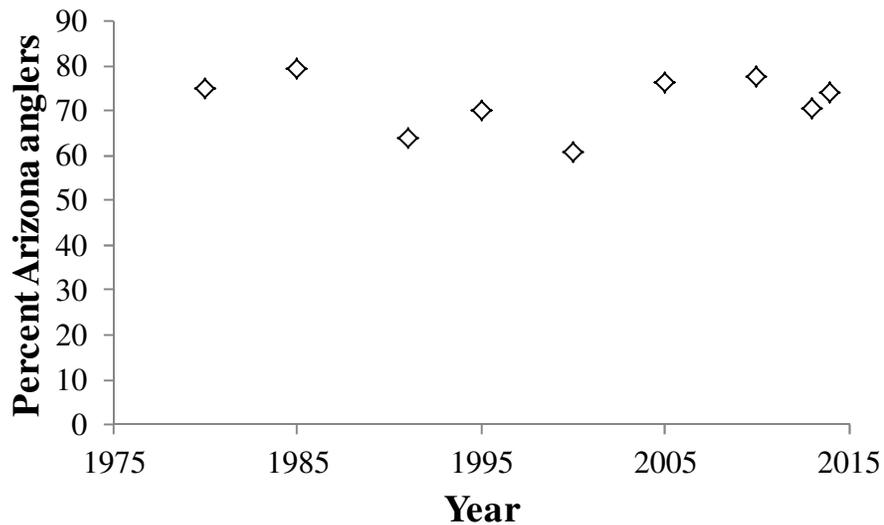


Figure 16. Percent of boat anglers traveling from within Arizona at the Lees Ferry reach of the Colorado River, calculated as an average approximately every five years from 1980 to 2010, and 2013-2014.

Discussion

Long-term monitoring

Results of 2014 sampling indicate most metrics are above pivotal tipping points, indicating a healthy overall status of the fishery. Despite a decrease in mean CPUE for the two smaller size classes compared to the previous two years (2012-2013), the overall mean CPUE in 2014 is consistent with values seen in 2008-2010. We believe this is a result of a combination of the large 2008-2011 cohort aging out and mortality.

The effects of the 2008-2011 cohort are also seen in the increasing fall mean length trends of rainbow trout over the past few years. While there has been a long term decline in mean length of rainbow trout captured in the fall since 1991, mean length has been increasing since 2010. Mean length was lowest in 2008 when there was a record recruitment of fish that year (young of the year comprised 92% of the fall sample in 2008). This recruitment was likely due to the experimental high flow in the spring of 2008 which benefited juvenile fish through increased habitat and drift food.

The mean total length of ripe female trout has been declining since 1983. This would indicate there is selection for fish to reproduce at a smaller size. There are a number of hypotheses that could account for this although the actual reason(s) are not known. Typically in a commercial exploited fishery this occurs as all the larger fish are harvested before they breed, resulting in strong selection pressure for smaller size at maturity (Berkeley et al. 2004). Harvest rates are low at Lees Ferry so this is likely not the case. At Lees Ferry, variation in flow was significantly related to a decrease in size at reproduction. The more variable the flow the greater the median size at reproduction for rainbow trout. It is possible having relatively stable flow volumes could allow for reproduction to occur every year, leading to an evolutionary advantage for reproduction to occur earlier (small size). Additionally, there is evidence that there is not enough food within the system for rainbow trout to grow to a large size and reproduce (energetic demands are too great) for the density of rainbow trout present (McKinney et al. 2001, Kennedy et al. 2013). A high density of fish, low food supply, or a combination of those factors could result in selection for reproducing at a smaller size (Bell 1980). This pattern (reproduction at small size) holds for two reaches of the Colorado River, Lees Ferry where there is recreational fishing pressure, and downstream past the recreational fishing area (RM 3-61.9). As harvest is fairly low in the Lees Ferry reach it is likely that the same factors that account for the declining size at reproduction occur in both sections.

Rainbow trout condition varies within a year, where fish captured in the spring and fall samples typically have lower levels of mean condition compared to fish captured in July samples. However, 2014 rainbow trout fish condition was below average (<1.00) for all three electrofishing sampling trips and all rainbow trout size classes. In the past, low condition was typically only seen for the large size class of rainbow trout, and was thought to be related to available food and competition (density dependence), as there just are not enough large prey items to support large fish (Cross et al. 2013). This may be what is occurring currently for all size classes of rainbow trout, as the large cohort of young of the year fish produced from 2008-2011 are now subadult (152-305 mm TL) and adult size (>305 mm TL) and there isn't enough of a food base to support that large of a population. Rainbow trout in Glen Canyon are sensitive to flow from Glen Canyon Dam. Controlled floods and steadier flows, originally aimed at partially restoring conditions before the dam (greater native fish abundance and larger sandbars), appear to be beneficial to nonnative rainbow trout (Korman et al. 2012), hence the large population increase from 2008-2011. Overall, CPUE from electrofishing was highest in 2011-2012 and has since declined in 2013-2014, and we suspect that it will decline even further in 2015. In the fall of

2014, AGFD received reports of a number of dead fish observed in the Lees Ferry reach and that the trout are the skinniest anglers have seen in a while.

Nonnative fish surveillance

Sampling in 2014 included one night of nonnative fish surveillance in an attempt to monitor areas not normally included in standardized monitoring. Monitoring occurred in July 2014, targeting backwaters, spring inflows and unique habitat features throughout the study reach. Walleye were detected at sites within one river mile of Glen Canyon Dam in low numbers. In recent years, green sunfish, smallmouth bass, and striped bass have also been detected. Continued monitoring at these locations is imperative to understand the distribution and abundance of these species in Lees Ferry, and may allow early detection and subsequent preventative actions to limit further increases in the populations of these other nonnative fishes.

Common carp are occasionally captured during standardized monitoring in the Lees Ferry reach, despite water temperatures being relatively cold for this species. In July 2014, water temperatures in the mainstem ranged from 11.2- 13.7°C, which is not conducive to native fish or carp. Carp generally begin to spawn at temperatures of 17- 27°C (Stuart and Jones 2006). Within the Lees Ferry reach these temperatures are only found within sloughs or backwater areas. At river mile -12.0, a large backwater slough maintains a 4°C higher water temperature than the mainstem during the summer months. Carp are the dominant fish species within the slough, comprising 70-80% of the fish community. We believe carp are utilizing the slough as a thermal refuge and for reproduction, as 52% of the carp sampled in 2014 were reproductively active.

The large portion of recaptures (~56% total catch) of common carp in combination with known movement patterns, suggests that a large portion of common carp in the Lees Ferry reach are resident. Stuart and Jones (2006) found that 85% of the common carp marked and recaptured moved less than 20 km. Additional research has shown mean movement distances of around 30 km, with individual fish exhibiting high site fidelity (Jones and Stuart 2009). This slough is also believed to serve as a refugium for native flannelmouth suckers until they spawn in the nearby Paria River. In 2014, we collected five flannelmouth suckers in the slough. Flannelmouth suckers migrate up to the slough from as far downstream as 234 km (Avery et al. 2011). Carp may be preventing or hindering flannelmouth sucker growth, survival, and reproduction in this rare and important warm water habitat in the Colorado River. In the event that control of common carp in Glen Canyon becomes a management priority, focused removal efforts in the area near RM 12.0 would likely result in a substantial reduction in the population of carp in the Lees Ferry reach.

Creel surveys

Angler use of the fishery has been in decline since 2002, but those anglers present are satisfied with their experience in the Lees Ferry reach. Angler catch rates for the past three years (2012-2014) are at the highest levels that have been recorded since 1977 for boat anglers. Data for walk-in anglers have not been collected as rigorously or as frequently as boat angler data in the past. These missing data are manifested by the relatively large confidence intervals for walk-in CPUE compared to boat angler CPUE. However, the CPUEs for both angler types correlate fairly well, with the exception of the last two years (2012-2014). The CPUE for walk-in anglers is much lower than the boat anglers in recent years, and as such, is more correlated with our standard electrofishing CPUE. We believe that boat angler CPUE remains high as boaters can target preferred rainbow trout habitat that are not accessible to walk-in anglers. These areas will always retain a higher density of trout compared to the overall river, and consequently result in higher CPUE for boat anglers. The percentage of boat anglers that harvest

fish has been stable since 2011 with an average of 11.5 % (SD=0.517) of boat anglers harvesting fish. However, only 2.5% of fish caught are harvested by boat anglers. The percent of shoreline anglers we have interviewed that harvest fish has been fairly variable since we started (in 2011) recording individual harvest data (36, 13, 18, and 28 % for 2011-2014 respectively). We believe these low numbers of harvest have little to no impact on the fishery.

Conclusions

Based on our sampling this year (2014) and in particular the low condition factors for rainbow trout, it appears that rainbow trout in the Lees Ferry reach might not be doing as well as in previous years. As populations are cyclical and experience highs and lows, the fishery may be at a stage of decline. It appears that recent high density of rainbow trout and a depauperate food base has led to low condition in rainbow trout and may ultimately lead to a reduction in trout density over winter. With the low condition factor for all size classes, many rainbow trout may not have enough energy reserves to survive the winter. Despite this scenario, boat angler CPUE for rainbow trout the last three years was at an all-time high, although walk-in anglers and electrofishing CPUE has shown a decline in the last two years, which might be related to a decline in density and survival of rainbow trout in the Lees Ferry reach.

No triggers were met that would warrant management action (stocking rainbow trout) in the Lees Ferry reach. Anglers are happy, and prefer to catch more, smaller rainbow trout than a couple of large rainbow trout.

Acknowledgements

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Appendices

Appendix I. Glen Canyon Rainbow Trout Management (page 12 of the FONSI)

Available at: <http://parkplanning.nps.gov/document.cfm?parkID=65&projectID=35150&documentID=56565>

Glen Canyon Rainbow Trout Management

Sterile Trout Experimental Stocking

NPS 2006 Management Policies (NPS 2006a, Section 4.4.3) allow for exotic species stocking for recreational fishing in altered water bodies when allowed by law, such as in GCNRA's enabling legislation, when the activities will not result in unacceptable impact to park natural resources or processes. Sterile trout would not reproduce, and could be stocked in an experimental context to maintain GCNRA fishing opportunities in the tailwater of the Glen Canyon Dam. Experimental stocking of sterile, triploid rainbow trout (stocking plan to be determined) could be initiated, specifically if one or more elements in Table 7 are met.

Table 7. Glen Canyon Reach Rainbow Trout Experimental Stocking Criteria

<ul style="list-style-type: none">• Recruitment (wild young fish) is low for multiple years: rainbow trout recruits (fish less than six inches) comprise less than 20% of the fish community during AZGFD fall monitoring events for more than three consecutive years; or
<ul style="list-style-type: none">• AZGFD electro-fishing estimates of relative abundance (including all sizes of fish) are less than one fish/minute for two consecutive years of fall sampling; or
<ul style="list-style-type: none">• If angler catch rates in Glen Canyon Reach decline to less than 0.5 rainbow trout/hour and average size is less than 14 inches for two consecutive years.

Sterile rainbow trout stocking will be limited to the Glen Canyon Reach. If triggers are met, stocking would likely continue until electro-fishing relative abundance estimates and/or angler catch rate criteria in Table 7 are met. Relative abundance of all fish caught of any size would be greater than one fish/minute or angler catch rates exceeded 0.5 fish/hour for two consecutive years. Depending on conditions that may lead to a potential decline in the fishery in the future, sterile trout may be stocked for a number of years until the fishery objectives are met, at which time stocking would potentially cease until triggers are met, and stocking would be re-initiated. Stocking could be reinitiated as appropriate, following GCNRA's rainbow trout adaptive management strategy described in the next paragraph.

Adaptive Management

A stocking and monitoring plan including number and size of sterile trout stocked will be developed before sterile trout stocking is implemented. At a minimum, sterile fish released would be marked to assess their performance. Short- and long-term outcomes, monitoring metrics, and an adaptive management framework will be defined and determined. Depending on the final stocking and monitoring plan, additional planning and compliance may be necessary. For example, experimental stocking of triploid rainbow trout will include marking of hatchery fish to monitor multiple metrics including, but not limited to, return to anglers, movement, growth, and survival. If marked fish are not returned/captured by anglers as intended or are found moving out of the stocking-approved area (i.e., into Marble Canyon/Little Colorado River area), stocking will be reassessed. Reassessment could include altering location of stocking, size of fish stocked, timing of stocking, and number of fish stocked. If stocking was deemed sustainable at a given level (i.e., acceptable catch rates, minimal impacts outside the fishery), it would continue. Essentially, the experiment will be considered a success if, through triploid trout stocking, fisheries objectives are maintained and an adequate control of the rainbow trout population is achieved while minimizing impacts on resources outside the fishery. If, through monitoring of stocked fish, there is minimal return to anglers or unacceptable levels of impact on resources outside the fishery, stocking would cease.

Appendix II.

Conversion of fork length to total length for Lees Ferry rainbow trout.

It was necessary to determine the conversion equation for rainbow trout fork length to total length as a result of a recommendation to change our (AGFD) measuring protocols from measuring total length to fork length in 2012. This recommendation was made and followed in 2012 and part of 2013, despite the long historical record of measuring only total length for rainbow trout. For most of July 2013 sampling and since then, both fork length and total length were measured for all rainbow trout captured.

Data for the conversion equation of fork length to total length was obtained by using all rainbow trout captured in Glen Canyon from 1991 through October 2013 with measurements of both total length and fork length. As there are errors in the database, we screened the data first. Since the fish measuring board only goes up to 500 mm, all fish above that were excluded and all fish below 100 mm TL were excluded. We were left with 5,607 rainbow trout to construct our equation (listed below).

$$TL = 1.9557129 + FL * 1.0643074$$

$$R^2 = 0.990563$$

Calculation of rainbow trout relative condition

A subset of all rainbow trout captured in Lees Ferry from 1991 to 2012 was included in the analysis for determining the predicted length-specific weight based on \log_{10} transformed data. All fish less than 150 mm TL and/or those that weighed less than 10 grams were excluded from analysis. Prior to 2013 rainbow trout <100 mm TL and since 2013 fish < 150 mm TL were not weighed due to scale accuracy concerns and the magnitude of error associated with condition measurements based on inaccurate weight. Additionally, errors associated with fish weighing less than 10 grams were a concern as errors of one to two grams (10-20%) are relatively large in comparison to heavier fish, and our scale is not that accurate. The data file was subsequently filtered to remove fish with a TL/weight relationship less than 0.069 or greater than three, as values outside those ranges are likely due to an error in recording, transcribing, measuring or weighing incorrectly. We determined relative condition factor (K_n ; Le Cren 1951) using the equation:

$$K_n = \left[\frac{W}{W'} \right]$$

where W is the individual fish weight, and W' is the standard weight relationship $10^{[-4.6023 + 2.8193 * \log_{10}(TL)]}$ incorporating all Lees Ferry rainbow trout length and weight data collected since 1991.

Appendix III. 2013-2014 Lees Ferry Angler Creel Instructions

The creel day is broken into five distinct periods as follows:

- 1) Roving Creel (12:00p-12:45pm)**
 - 2) Access Creel (12:45p-2:30pm)**
 - 3) Roving Count (2:30 – 2:45pm)**
 - 4) Access Creel (2:45p-5:30pm)**
 - 5) Roving Creel (5:30p-6:15pm)**
- 1) 12:00p-12:45p: 1st Roving Creel**

Starting at the Lees ferry boat ramp record the start time, count any anglers up and downstream who are not fishing from a boat, drive from the boat ramp parking lot to the parking lot below the Paria River confluence. While driving, count any anglers at vehicles or who are walking back to vehicles in the main walk-in section that were not observed from the upper boat ramp. At the Paria River parking lot, walk down to the beach and count any anglers upstream and downstream of the beach (both sides of the river) who were not observed from the upper boat ramp. Record the total number of anglers in the appropriate section of the **Roving Creel** datasheet.

Start interviews with any anglers at the beach below Paria River confluence with the Colorado River and then drive to the walk in area to complete your interviews. The amount of time that you do this survey becomes limiting if there are a large number of anglers fishing the walk-in, so if there are more people in one section or the other start there. Begin with the section that is most populated and accessible, use your best judgment to maximize interviews. Before even starting the interview, you can check the appropriate column for angler age (juvenile; less than 18, adult; 18-55, retired; older than 55; does not have to be exact but be consistent), location (above (APR) or below (BPR) the Paria River), gear type (Fly/Spin/Bait; F/S/B). You will then need to mark whether the angler is continuing to fish after the interview. If they are done fishing record “Y” in the trip complete column of the datasheet, otherwise denote “N”. Ask the angler for their zip code, and if they do not know it, get a city/state. Next, ask what time they started fishing, and record the interview time in the appropriate columns. If they have fished for less than 30 minutes you do not need to conduct the rest of the interview. Next ask how many fish they have landed (most will be rainbow trout, so if they have caught fish ask if they were all rainbow trout), next ask if they have harvested any fish. Ask how many rainbow trout over 18 inches were caught. You will then get angler satisfaction, which is based on a scale of 1-5 with 1 being poor and 5 being excellent. All anglers will also be asked how many trips they take to Lees Ferry in a calendar year. Finally, ask if they have been interviewed in the current calendar year, if they have, the interview is over, if not, you then ask the final opinion question, which is a catch rate vs. size preference question. Anglers have the right to decline an interview, and if they do, keep a tally in the missed/declined section of the datasheet. You will not conduct any interviews after the 45 minute block is over, so it is very important not to get sidetracked during an interview. If an angler has specific questions, provide them with a business card or tell them that you will check into their question and get back to them. Once you have reached the end of the time block, tally up the number of anglers that you were not able to interview and add them to the tally for missed/declined.

1) 12:45pm -2:30pm: 1st Access Creel

After finishing the first roving creel, head back to the main boat ramp and park in the area just behind the dock. Do a count of all trailers in the lot and record in the trailers section of the Access Creel datasheet. Make note of any NPS or other obvious government trailers, as these will not count toward the total. You will then stay at the boat ramp until 2:30 interviewing any anglers that return during this time. During the Access Creel, it is very important to record any anglers who are not interviewed. It is not a huge issue if a few anglers are missed but we need to keep track of how many so that we know the total. You should also keep a tally of the number of boats that you observe returning to the ramp during the Access Creel in the correct location in the datasheet, as well as any new trailers in the lot observed during the survey (don't need to count the new boats launching). Any boats returning to the ramp that were not fishing (i.e. duck hunters, sightseers) should be subtracted from the total number of trailers since we are only keeping track of people who are fishing.

2) Roving Count (2:30 – 2:45pm)

Drive the normal route to conduct a count of the anglers (dock, walk-in, and beach). You only need to do a **count**; you will not interview any anglers.

3) Access Creel (2:45p-5:30pm)

Finish out the creel at the boat ramp. Most of the guide boats will return in the same 30 minutes so there will likely be a really busy time between 3:30 and 5:00 pm.

4) 5:30p-6:15pm: 2nd Roving Creel

This is the last portion of the day, starting just before 5:30 if possible or as soon thereafter if no boats are at the ramp, count the number of anglers you can see from the main dock, as was done in the previous two counts. Then just as in the other roving counts, head toward the Paria parking lot, interviewing any anglers who may be back at their vehicles in the main walk-in lot. Complete your count at the Paria lot and then begin interviewing anglers. Interviews will end either when you have interviewed everyone, or you have reached 6:15 pm.

There are a few occasions that will require some slight adjustments to how the data is recorded.

- 1) In the event that you interview the same angler during both the first and second survey periods, the overall catch rate needs to be recorded, please use the same interview number as previously recorded, see example 1.
- 2) If an angler catches multiple species of fish you will need to record them on separate lines with the same interview number, see example 2.
- 3) Subtract any non-angling boats from the total number of trailers and do not record the boat in the boat section of the data sheet.
- 4) Survey hours may need to be adjusted due to season and changing day length. Any changes must have prior approval from supervisor.

EXAMPLE 1

AZGFD 2013 Lees Ferry Roving Creel Survey

Clerk: Pilar Wolters				1st survey:	Start Time: 12:00		Mid-day Count		2nd Survey:	Start Time: 17:30		Comments: interviewed same fisherman (#1) twice						
Date: 10-07-13					End Time: 12:46		Time:	14:32		End Time: 18:13								
					Total Anglers: 3		Total Anglers:	2		Total Anglers: 1								
Missed/Declined: 1/O		Missed/Declined: 0																
Int #	People Count			Trip complete	Zip Code	Fishing duration		APR BPR	Gear F/S/B	Fish Spp	Total		Catch >18	Satisfaction 1-5	Trips / year	Creel 2013 ?	Preference	
	Juv	Adu	Ret			Start	Int				Catch	Harvest					10@16 "	2@20 "
1		I		N	85658	7:30	12:05	APR	F	RBT	3	0	0	4	3	N		I
2			I	N	86001	9:00	12:23	APR	F	RBT	5	0	0	5	12	Y		
1		I		Y	85658	7:30	17:46	APR	F	RBT	8	0	0	5	3	Y		

EXAMPLE 2

AZGFD 2013 Lees Ferry Access Point Creel Survey

Clerk:		Pilar Wolters			Start Time:	12:47	Trailer Count:		5	Anglers Missed:		0	Comments:					
Date:		10-07-13			End Time:	17:29	Boat Count:		1	Anglers Declined:		0						
Int #	People Count			Guide	Zip Code	Fishing duration		Gear	Fish	Total		Catch	Satisfaction 1-5	Trips/ year	Creel 2013 ?	Size Opinion		
	Juv	Adu	Ret	Y/N		Start	Interview	F/S/B	Spp	Catch	Harvest	>18				10@16 "	2@20 "	
1		I		Y	85282	7:00	15:12	S	RBT	12	4	1	5	2	N	I		
2	I			Y	85282	7:00	15:12	S	RBT	5	4	0	5	2	N		I	
2									BNT	1	0	1						