Grand Canyon Long-term Non-native Fish Monitoring, 2002 Annual Report

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Introduction

Robust long-term monitoring of aquatic populations is important to adaptive management programs because it characterizes a "baseline" or antecedent context in which response of biota to changing management policies or experiments can be interpreted (Walters and Holling1990; Thomas 1996; Walters 1997). In the Colorado River below Glen Canyon Dam (GCD), Arizona, long-term monitoring of fishery resources is an essential component of the Glen Canyon Dam Adaptive Management Program in ensuring that GCD is operated in a manner consistent with the pertinent sections of Grand Canyon Protection Act of 1992 [Grand Canyon Monitoring and Research Center (GCMRC) 2001a]. In particular, the non-native salmonids rainbow (*Oncorhynchus mykiss, RBT*) and brown trout (*Salmo trutta, BNT*) have displayed increased abundance, likely because changes in operation of GCD since the early 1990s in the Colorado River in Glen and Grand Canyons(GCMRC 2001a, McKinney et al. 1999, 2001). Minckley (1991), Marsh and Douglas (1997), Coggins (unpublished data), and U.S. Department of Interior (2002) have suggested predation by salmonids as a factor limiting recruitment of native fishes in the Colorado River in Grand Canyon. As a result of these findings, the GCMRC Protocol Evaluation Program has advocated long-term monitoring of non-native fish posing risks of predation to Colorado River native fishes in Grand Canyon (GCMRC 2001b).

Working under cooperative agreement with GCMRC, Arizona Game and Fish Department (AGFD) conducted studies of salmonid catchability using electrofishing and population size as well as relative abundance, distribution, and sampling requirements for long-term monitoring of RBT, BNT, and common carp (*Cyprinus carpio*, CRP) in Grand

Canyon during 2000 - 2001 (AGFD 2001; Speas et al. 2002). In this paper, we report results from non-native fish monitoring activities in the mainstem Colorado River in Grand Canyon during 2002. Specific objectives during 2002 were to:

1. Estimate salmonid and carp relative density and distribution, and estimate salmonid abundance and evaluate trends in abundance during 2000 – 2002.
2. Reevaluate required annual sample sizes and sample allocation for long-term monitoring of salmonids and carp in Grand Canyon.
3. Assist with collections of salmonid genetic materials in the mainchannel Colorado River and select tributaries.

The Illinois Natural History Survey (INHS) instigated objective (3) as part of a study designed to identify salmonid origins (i.e., hatchery-reared or wild-spawned, tributary- or mainchannel-spawned, and genetic strain) in Grand Canyon. However, we present cursory findings regarding fish distribution. Completion reports from INHS are were due Feb 2002.

Methods

We collected electrofishing (EF) samples during February 14 – March 4 and from April 4-21, 2002 between river mile (RM) 12 and RM 218 on the Colorado River in Grand Canyon National Park. Daily river discharge at GCD ranged from ca. 7,500 to 13,500 cubic feet per second during both river trips. All data were collected at night with two 16´ Achilles inflatable sport boats outfitted for electrofishing with a Coeffelt CPS unit, with two netters and one driver per boat. On average these boats fish using 350 volts and 15 amps. With the exception of one night on the April trip, the same drivers drove the boats on both river trips. Sampling was conducted for an average of 5 hours per night beginning at about 7 pm.

In 2002 we used the sample power program Sampling.exe (Walters, unpublished) to determine appropriate sample sizes and distribution of effort for RBT, BNT, and CRP. Using variance estimates (coefficient of variation, CV) from existing Grand Canyon fisheries data (2000-2002), we used Sampling.exe to estimates catch per unit effort (CPUE) (fish per 10/hrs) sample precision as a function of sample size and spatial stratification. The program utilizes a Monte Carlo procedure to estimate the probabilities of detecting a true temporal population trend given a range of sample sizes. We selected the design in the present study based on its projected level of sampling precision, CV $\leq$ 0.10, whereby the power to detect 20% changes in annual salmonid relative abundance is 0.80 (Gerrodette 1987).

We used single-pass electrofishing to estimate relative density (CPUE) and longitudinal distribution of salmonids and carp in Grand Canyon. Each sample consisted of a single, 300-s electrofishing pass along shoreline transects. The sample universe (RM 0-225) consisted of 11 geomorphic reaches identified by Schmidt and Graff (1990). Each geomorphic reach was then divided into fishable sub-reaches. Fishable (e.g. where electrofishing was possible) sub-reaches were defined by campsite availability and location of impassable navigational hazards such as rapids (Table 1). Fishable sub-reaches were randomly selected within geomorphic reaches. The number of fishable sub-reaches sampled within a geomorphic reach was determined by the number of nights necessary within a given geomorphic reach to meet the sample required by Sampling.exe. Start miles on river left and right were randomly generated within fishable sub-reaches.

With few exceptions, shoreline transects were contiguous. Transect start and stop coordinates were recorded with a Garmin III GPS unit and estimated from aerial photographs.

We recorded maximum total length (MTL mm) of each captured fish (Ward 2002). Unless the fish were sacrificed for genetic samples, we implanted all brown trout >120mm MTL with passive integrated transponder (PIT) tags (Prentice et al. 1990) and clipped their adipose fins. The purpose of this marking program is to gather data on system-wide movements of BNT, which are currently lacking from the Grand Canyon fish community database. The adipose clip was used as a secondary mark to evaluate tag loss. We recorded MTL, fork length, and weights (when environmental conditions were favorable) of native fish. We implanted native fish with PIT tags if none were found on capture. All PIT tag numbers were recorded on data sheets and also stored electronically.

We sampled tributaries of the Colorado River with dip nets and backpack electrofishing to identify presence or absence of age-0 trout and to collect specimens for genetic analysis by INHS. We sampled the lowermost 0.5 RM of 12 major tributaries. During the April 2002 trip, we opportunistically collected genetic samples (fin clips) from older trout in mainchannel Colorado River by angling in the vicinity of campsites.

Flannelmouth suckers were also captured during opportunistic sampling at the mouth of Havasu Creek, a tributary to the Colorado River, Grand Canyon. These fish had aggregated for spawning making them easy to catch in the shallow tributary mouth. The mouth of the tributary was shocked for 863 seconds with 450 volts and 5 amps. This effort resulted in 53 adult Flannelmouth suckers being caught with 42 recaptures and 11 new fish being tagged (Appendix 2).

We calculated population estimates for RBT and BNT by scaling CPUE values to estimates of local fish abundance using catchability coefficients (BNT = 0.22, RBT = 0.56) from depletion electrofishing conducted during 2000 (AGFD 2001) and 2001 (Speas et al. 2002). We then extrapolated local estimates to system-wide estimates using river area, estimated effective electrofishing area (Speas et al. 2002), and estimated transect length from aerial photos. We plotted abundance estimates (fish/RM) predicted from observed CPUE values against river miles and fitted the data with a third order polynomial regression line, which provided the best fit. We then integrated the curve to produce system-wide population estimates. 95% confidence intervals were estimated from the variance of the regression line. To make present results comparable to 2000 and 2001, we limited estimates of population size during 2002 to river miles sampled during the previous years (RM 39 – 196).

We investigated BNT growth and movement for data from 2000 to 2002. Yearly growth rates for 2000-2002 (total length at recapture - total length at mark / [days at large / 365]) and distance moved by days at large were calculated for all recaptured BNT at large for at least 45 days. We also calculated mean CPUEs for each of two boat drivers that have been on all of our trips between 2000-2002 to estimate the impact of differing boat drivers on CPUE mean and overall CPUE variance. Each boat driver shocked during similar times and locations over the course of these four trips. We plotted percent of captures by length, year and species (RBT and BNT) for 2000-2002 to examine cohort strength among years.

We cross-validated predictions of Sampling.exe by bootstrapping trip CVs and 95% confidence intervals from the entire 2000- 2002 data set over a range of sample sizes (N=100-1,000) using Resampling Stats 2.0 for MS Excel. We inspected the bootstrapped confidence intervals to approximate minimum detectable yearly changes in salmonid and carp abundance river wide and for areas and species of special concern (RBT at the Little Colorado River reach [LCR, RM 56-66], and BNT at Bright Angel Creek reach [BAC, RM 79 -92]). Minimum yearly detectable linear changes over 5-year periods were investigated using boot strapped CVs and Trends shareware (http://swfsc.nmfs.noaa.gov/prd/software , Gerrodette 1987).

Results

In February - March 2002, 428 samples were collected averaging 310 seconds each over 19 nights with a total of 1748 fish captured from 11 species (Table 2). In April, 390 samples were collected averaging 315 seconds each over 17 nights with a total of 2026 fish captured including 10 species (Table 3). Densities of rainbow trout, brown trout, and common carp were similar from 2000-2002 with densities of rainbow trout being highest near Marble Canyon (Fig. 1), densities of brown trout highest near Bright Angel Creek (Fig. 2), and densities of common carp highest downriver of Bright Angel Creek. Young-of-the-year trout were collected for genetic analysis from 8 out of 12 tributaries (Table 4).

Estimated population size of RBT from RM 39 – 196 in 2002 was 264,000 fish (95% CI = 137,000 – 382,000), slightly lower than estimates from 2000 (400,000) and 2001(380,000) (Figure 4). However, confidence intervals from the 2002 RBT estimate overlapped considerably with those from the 2000 and 2001 estimates (Figure 4). Estimated population size of BNT was 116,000 fish (95% CI = 82,000 – 150,000), which was similar to estimates from 2000 (90,000) and 2001 (85,000). Confidence intervals from the 2002 BNT estimate overlapped considerably with those from 2000 and 2001. (Figure 5).

Mean CPUE of RBT on boat A (43.84/hr) was 7.8 fish/hr higher (15 %) higher than the mean CPUE of RBT on Boat B (51.59/hr) in 2002 (two-sample t – test, P = 0.014, Figure 6). Sampling sites were assigned randomly throughout the canyon to eliminate bias, and each boat driver shocked similar environments. Mean CPUE of RBT in the LCR reach (Figure 7) and BNT in the BAC reach (Figure 8) reach were similar between 2000-2002.

Only 41 of 85 BNT recaptured between 2000-2002 spent over 45 days at large (Range = 1-671). Growth rates (2000-2002) for BNT with over 45 days at large did not change over time (Figure 9). One recaptured BNT moved further than 1 mile from its original mark location. The furthest distance traveled was 3 miles (Figure 10).

Analyses of BNT catch by year revealed a strong mode of adult fish between 250 mm and 350 mm and modes of possible age 0, age 1 and age 2 fish for the years 2000, 2001 and 2002, respectively (Figure 11). Analyses of RBT catch by year revealed a strong mode between 200 mm and 375 mm and modes of age 0 and age 1 fish for the years 2000 and 2001, respectively (Figure 11).

Bootstrapped CVs (N=850) for RBT, BNT, and CRP from the 2000-2002 data set were 0.04, 0.07, and 0.09 respectively (Table 5). Yearly estimated minimum detectable changes in abundance based on bootstrapped 95% confidence intervals were 20%-30% for RBT, 30%-40% for BNT, and 40%-50% for CRP (Table 5). Minimum yearly and overall detectable changes in abundance over a 5-year period of linear change were as follows: 6% yearly and 24% overall for RBT, 9% yearly and 34% overall for BNT, 12% yearly and 47% overall for CRP (Table 5.). Yearly and overall detectable changes for areas and species of special concern were 14 % yearly and 56% overall change over a five year period for RBT in the LCR reach, and 14% yearly and 65% overall change over a five year period for BNT in the BAC reach (Table 6).

Discussion

The sampling conducted in 2002 represents what we now believe is necessary for long-term monitoring of salmonids and carp in the Grand Canyon (N= 818). Although the impetus for large-scale monitoring came in the spring of 2000, much of our time was spent calibrating CPUE to BNT and RBT densities for population estimates. The number of samples taken in 2000 (N= 413) and 2001 (N= 234) were inadequate to capture status and trends of the non-native fish in question.

Bootstrapping indicated that changes in salmonid relative abundance (CPUE) of 20%-30% and 30%-40% for RBT and BNT, respectively, are detectable between consecutive years with the current stratified random sample design, provided we complete between 800-900 samples per year. Long term (5-year) analysis of the same data yields a much more sensitive monitoring tool for 5-year linear changes in CPUE. Confidence intervals of the regression line used to model population size are much wider than those obtained for CPUE, which likely precludes detection of similar changes in absolute abundance. However, no changes in CPUE or absolute abundance of RBT, BNT and CRP are detectible with the most recent three years of data (2000-2002).

We did not expect or observe much movement of BNT over the past three years. Most movement of BNT occurs in fish less than 15 months old and with adults during the spawning season (Solomon and Templeton 1976). Almost all fish that we mark are older than 15 months, and our long term monitoring does not occur during the spawning season (Nov – Jan). The experimental weir placed in Bright Angel Creek in 2002 by the Park Service has captured at least two BNT that have traveled over 50 RM (Personal communication, Melissa Trammell, SWCA Environmental Consultants, Flagstaff). It is our recommendation that tagging of BNT continue only as long as the use of a weir at Bright Angel Creek is maintained.

The analyses of lengths by trip for BNT and RBT suggest that the low summer steady flows of 2000 resulted in relatively strong recruitment of both RBT and BNT. The modes observed in the RBT data match length-at-age calculated for age 0 and age1 RBT from Lees Ferry. We have attempted to compute length-at-age for BNT by utilizing mark-recapture data from this monitoring program. Attempts to date have been unsuccessful because BNT tagging began in 2000 and few fish have grown between mark and recapture events. Future monitoring may provide data necessary for estimated growth rates. Future analysis of BNT otoliths may also provide length-at-age estimates.

The sampling design used in 2002 was established to detect river-wide population trends. Evaluating localized management actions, such as mechanical removal of RBT in the LCR reach, requires more intensive sampling than long-term monitoring would allocate. In 2000 and 2001, insufficient samples (N=41 in 2000, and N=47 in 2001) were taken in the LCR reach, and in 2001 inadequate sampling was done in the BAC reach (N = 38) to detect yearly or short-term trends as is evidenced by extremely wide confidence intervals. The extensive sampling that took place in the BAC (N=197) and LCR (N= 147) reaches in 2002 is indicative of the effort that will be necessary to detect localized trends.

There is an apparent difference in the CPUE between elecrofishing boats. Variation in catch between boats may be caused by the individual boat driver or the physical electronic equipment on the boat (Hardin and Connor 1992). Regardless of the source of this variation there are apparent differences between boats that account for a large portion (15%) of the variability within the dataset. Small differences in catchability can have large effects on population estimates derived using CPUE (Bayley and Austen 2002; Speas et al. in review). When CPUE data are used to evaluate population trends, the assumption is made that catchability remains constant over time. This assumption may not be met because of variations in discharge, turbidity, boat driver, or netters between and among trips. All of these factors have the potential to effect catchability (McInery and Cross 2000; Bayley and Austen 2002; Speas et al. in review). Attempts to minimize changes in these factors are made by sampling during the same months each year and attempting to keep crews consistent (Hardin and Connor 1992). All of our sampling has used the same two boat drivers, but future changes in boat driver may increase variance in the dataset potentially confounding CPUE trends. We strongly recommend any new boat drivers receive training prior to monitoring trips. We also recommend that information on the specific electronic units (CPS units) used on each boat along with the name of the boat driver must be recorded so that differences in catch can be evaluated further.

The logistically stratified-random design used in 2002 appears to be working well, and the level of effort appears to be appropriate for monitoring of RBT, BNT, and CRP in Grand Canyon. In 2003, some of the effort will be re-allocated to ensure adequate sampling of areas around the LCR and Bright Angel creek and to increase effort in lower portions of the river near Diamond Creek. The additional effort will increase ability to track population trends in these specific areas of interest. It is critical that monitoring programs remain consistent over time. If monitoring designs are compromised to answer short-term questions, the effectiveness of the monitoring program may be lost. Localized questions or questions on a time scale finer than 5 years will require additional, separate effort beyond that outlined for long-term monitoring. Consistent, long-term monitoring will be essential to the success of the adaptive management program by allowing the effects of management actions to be measured.

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Table 1. Sample universe of the Colorado River, Grand Canyon, divided into geomorphic reaches and subdivided into logistically reaches (fishable sub-reaches). Some logistic reaches are listed more than once to indicate alternate camp sights. Logistic reaches and start miles within logistic reaches were randomly selected. Reaches highlighted in yellow were not sampled because river morphology made them unsafe for electrofishing.

Geomorphic reach	Logistic Reach	Miles Available	Camp RM	Camp	Start Mile	Start name	End Mile	End name
1	1.1	6.8	2.8	Cathedral	1.0	Paria riffle	7.8	Badger
1	1.1	6.8	5.8	6 mile wash	1.0	Paria riffle	7.8	Badger
1	1.2	3.2	8.0	Jackass	8.0	Badger	11.2	Soap
1	1.2	3.2	11.2	Soap	8.0	Badger	11.2	Soap
1	1.3	5.5	11.2	Soap	11.3	Soap	16.8	House Rock
1	1.3	5.5	12.2		11.3	Soap	16.8	House Rock
1	1.3	5.5	16.5	Hot Na Na	11.3	Soap	16.8	House Rock
1	1.4	3.5	17.0	Below House Rock	17.0	Below House Rock	20.5	North
1	1.4	3.5	18.0	18 Mile Wash	17.0	Below House Rock	20.5	North
1	1.4	3.5	19.0	19 mile canyon	17.0	Below House Rock	20.5	North
1	1.4	3.5	20.0	20 Mile	17.0	Below House Rock	20.5	North
1	1.4	3.5	20.7	North	17.0	Below House Rock	20.5	North
1	1.5	2.4	21.9	21.9 Mile	20.8	Below North	23.2	Indian Dick
1	1.5	2.4	23.0	23 Mile	20.8	Below North	23.2	Indian Dick
1	1.5	1.3	24.5	Above 24.5 Mile	23.2	Indian Dick	24.5	Above 24.5
1	1.5	3.6	26.5	Above Tiger Wash	25.5	Below 25.5	29.1	Silver Grotto
1	1.5	3.6	29.1	Silver grotto	25.5	Below 25.5	29.1	Silver Grotto
2	2.1	6.9	29.1	Silver grotto	29.1	Silver Grotto	36.0	36 Mile
2	2.1	6.9	30.2		29.1		36.0	
2	2.1	6.9	31.6	South	29.1		36.0	
2	2.1	6.9	33.8		29.1		36.0	
2	2.1	6.9	34.9	Nautiloid	29.1		36.0	
2	2.2	7.7	37.3	Tatahatso	36.0		43.7	Harding
2	2.2	7.7	38.4		36.0		43.7	Harding
2	2.2	7.7	41.0	Buck Farm	36.0		43.7	Harding
2	2.2	7.7	43.2	Above Harding	36.0		43.7	Harding
2	2.3	8.3	43.7	Below Harding	43.7	Harding	52.0	Nankoweap
2	2.3	8.3	44.7		43.7	Harding	52.0	Nankoweap
2	2.3	8.3	44.8		43.7	Harding	52.0	Nankoweap
2	2.3	8.3	46.2		43.7	Harding	52.0	Nankoweap
2	2.3	8.3	46.4		43.7	Harding	52.0	Nankoweap
2	2.3	8.3	47.0	Saddle	43.7	Harding	52.0	Nankoweap
2	2.3	8.3	47.5		43.7	Harding	52.0	Nankoweap
2	2.3	8.3	48.3		43.7	Harding	52.0	Nankoweap
2	2.3	8.3	48.8		43.7	Harding	52.0	Nankoweap
2	2.3	8.3	50.0		43.7	Harding	52.0	Nankoweap
2	2.3	8.3	50.2		43.7	Harding	52.0	Nankoweap
2	2.3	8.3	51.7	Little Nankoweap	43.7	Harding	52.0	Nankoweap
2	2.3	8.3	52.5	Nankoweap	43.7	Harding	52.0	Nankoweap
2	2.4	4.0	53.0	Below Nanko	52.0	Nankoweap	56.0	Kwagunt
3	3.1	9.5	56.1	Below Kwagunt	56.0	Kwagunt	65.5	Lava Chuar
3	3.1	9.5	56.5		56.0	Kwagunt	65.5	Lava Chuar
3	3.1	9.5	58.0	Awatubi	56.0	Kwagunt	65.5	Lava Chuar
3	3.1	9.5	58.5		56.0	Kwagunt	65.5	Lava Chuar
3	3.1	9.5	58.7		56.0	Kwagunt	65.5	Lava Chuar
3	3.1	9.5	61.0	LCR Point	56.0	Kwagunt	65.5	Lava Chuar
3	3.1	9.5	62.5	Crash	56.0	Kwagunt	65.5	Lava Chuar
3	3.1	9.5	64.8	Carbon	56.0	Kwagunt	65.5	Lava Chuar
3	3.1	9.5	65.4	Above Lava Chuar	56.0	Kwagunt	65.5	Lava Chuar
3	3.2	3.0	65.6	Below Lava Chuar	65.6	Below Lava Chuar	68.6	Above Tanner
3	3.2	3.0	68.5	Above Tanner	65.6	Below Lava Chuar	68.6	Above Tanner
4	4.1	3.8	69.1	Below Tanner	68.7	Below Tanner	72.5	Above Unkar

Table1. Continued

Geomorphic reach	Logistic Reach	Miles Available	Camp RM	Camp	Start Mile	Start name	End Mile	End name
4	4.1	3.8	69.2		68.7	Below Tanner	72.5	Above Unkar
4	4.1	3.8	71.1	Cardenas	68.7	Below Tanner	72.5	Above Unkar
4	4.1	3.8	72.0	Above Unkar	68.7	Below Tanner	72.5	Above Unkar
4	4.2	2.9	74.3	Above Nevills	72.6	Below Unkar	75.5	Above Nevills
4	4.2	2.9	75.7	Above Nevills	72.6	Below Unkar	75.5	Above Nevills
4	4.3	1.2	76.7	Above Hance	75.5	Below Nevills	76.7	Above Hance
5	5.1	2.4	81.2	Grapevine	78.8	Sock	81.2	Above Grapevine
5	5.2	2.9	84.0	Clear Ck	81.6	Grapevine	84.5	Zoraster
5	5.2	2.9	84.2	Clear Ck	81.6	Grapevine	84.5	Zoraster
5	5.3	3.8	87.0	Cremation	85.0	85 Mile	88.8	Pipe Creek
5	5.4	3.3	91.5	Trinity Ck	90.2	Below Horn	93.5	Granite
5	5.4	3.3	93.4	Above Granite	90.2	Below Horn	93.5	Granite
5	5.5	1.2	94.0	94 mile	93.6	Below Granite	94.8	Above Hermit
5	5.5	1.2	94.9	Above Hermit	93.6	Below Granite	94.8	Above Hermit
5	5.6	2.9	96.0	Below Hermit	95.1	Below Hermit	98.0	Crystal
5	5.6	2.9	96.8	Boucher	95.1	Below Hermit	98.0	Crystal
5	5.7	2.5	103.0	103R	102.0	Turquoise	104.5	Ruby
5	5.7	2.5	107.7	Upper Bass	106.0	Serpentine	108.5	Shinumo
5	5.7	2.5	108.1	Bass	106.0	Serpentine	108.5	Shinumo
5	5.7	2.5	108.5	Shinumo	106.0	Serpentine	108.5	Shinumo
6	6.1	3.7	109.3		108.6	Below Shinumo	112.3	Waltenberg
6	6.2	4.1	114.0	Garnet	112.4	Waltenberg	116.5	Elves
6	6.2	4.1	116.0		112.4	Waltenberg	116.5	Elves
6	6.3	6.2	116.5	Elves	116.5	Elves	122.7	Forster
6	6.3	6.2	118.2		116.5	Elves	122.7	Forster
6	6.3	6.2	119.0		116.5	Elves	122.7	Forster
6	6.3	6.2	120.0	Blacktail	116.5	Elves	122.7	Forster
6	6.3	6.2	122.2	122 Mile	116.5	Elves	122.7	Forster
6	6.3	6.2	122.8	Forster	116.5	Elves	122.7	Forster
6	6.4	2.3	124.0	124 Mile	122.7	Forster	125.0	Fossil
6	6.5	2.0	125.4	Below Fossil	125.0	Fossil	127.0	127 Mile
6	6.5	2.0	126.3	Randys Rock	125.0	Fossil	127.0	127 Mile
6	6.6	2.0	128.0	128 Mile	127.0	127 Mile	129.0	Specter
7	7.1	1.3	131.8	Above Deubendorff	130.5	Bedrock	131.8	Above Dubendorff
7	7.2	1.8	132.0	Stone Creek	131.9	Below Dooby	133.7	Tapeats
7	7.2	1.8	133.0		131.9	Below Dooby	133.7	Tapeats
7	7.2	1.8	133.7	Above Tapeats	131.9	Below Dooby	133.7	Tapeats
7	7.3	2.2	133.8	Below Tapeats	133.8	Below Tapeats	136.0	Deer Creek
7	7.4	3.7	134.3	134 Mile	134.0	134 Mile	137.7	Doris
7	7.4	3.7	134.6		134.0	134 Mile	137.7	Doris
7	7.4	3.7	136.0	Across Deer Ck	134.0	134 Mile	137.7	Doris
7	7.4	3.7	136.5		134.0	134 Mile	137.7	Doris
7	7.4	3.7	136.6		134.0	134 Mile	137.7	Doris
7	7.5	1.3	137.9	Below Doris	137.8	Doris	139.1	Fishtail
7	7.5	1.3	138.4		137.8	Doris	139.1	Fishtail
7	7.5	1.3	138.5		137.8	Doris	139.1	Fishtail
7	7.5	1.3	138.9	Fishtail	137.8	Doris	139.1	Fishtail
7	7.6	4.4	139.8		139.1	Fishtail	143.5	Kanab
7	7.6	4.4	143.3	Kanab	139.1	Fishtail	143.5	Kanab
7	7.7	6.2	145.7	Olo	143.5	Below Kanab	149.7	Upset
7	7.8	7.1	150.2	Below Upset	149.8	Below Upset	156.9	Havasu
7	7.8	7.1	151.5		149.8	Below Upset	156.9	Havasu
7	7.8	7.1	155.5		149.8	Below Upset	156.9	Havasu
7	7.8	7.1	156.0		149.8	Below Upset	156.9	Havasu
7	7.8	7.1	156.7	Last chance	149.8	Below Upset	156.9	Havasu

Table 1. continued

Geomorphic reach	Logistic Reach	Miles Available	Camp RM	Camp	Start Mile	Start name	End Mile	End name
7	7.9	9.6	157.7	Below Havasu	157.0	Havasu	166.6	National
7	7.9	9.6	158.5		157.0	Havasu	166.6	National
7	7.9	9.6	159.9		157.0	Havasu	166.6	National
7	7.9	9.6	160.9		157.0	Havasu	166.6	National
7	7.9	9.6	164.5	Tuckup	157.0	Havasu	166.6	National
8	8.1	12.9	166.6	National	166.6	National	179.5	Lava Falls
8	8.1	12.9	167.3		166.6	National	179.5	Lava Falls
8	8.1	12.9	168.0	Fern Glen	166.6	National	179.5	Lava Falls
8	8.1	12.9	171.0	Stairway	166.6	National	179.5	Lava Falls
8	8.1	12.9	171.5	Mohawk	166.6	National	179.5	Lava Falls
8	8.1	12.9	173.0		166.6	National	179.5	Lava Falls
8	8.1	12.9	174.2	Cove	166.6	National	179.5	Lava Falls
8	8.1	12.9	177.0	Honga Spring	166.6	National	179.5	Lava Falls
8	8.1	12.9	177.8		166.6	National	179.5	Lava Falls
8	8.1	12.9	179.0	Above Lava Falls	166.6	National	179.5	Lava Falls
9	9.1	10.2	179.8	Below Lower Lava	179.8	Below Lava Falls	190.0	
9	9.1	10.2	180.8		179.8	Below Lower Lava	190.0	
9	9.1	10.2	182.8		179.8	Below Lower Lava	190.0	
9	9.1	10.2	186.2		179.8	Below Lower Lava	190.0	
9	9.1	10.2	188.0	Whitmore	179.8	Below Lower Lava	190.0	
9	9.1	10.2	190.0		179.8	Below Lower Lava	190.0	
9	9.2	10	190.9		190.0		200.0	
9	9.2	10	191.8	192 Mile Canyon	190.0		200.0	
9	9.2	10	192.2		190.0		200.0	
9	9.2	10	193.1		190.0		200.0	
9	9.2	10	194.2	Common 194 Mi	190.0		200.0	
9	9.2	10	194.6	194 Mi Can	190.0		200.0	
9	9.2	10	196.0		190.0		200.0	
9	9.2	10	198.6	Parashant	190.0		200.0	
10	10.1	5.6	204.5		200.0		205.6	205 Mile Rapid
10	10.2	3.2	208.0		205.7	Below 205 Mi	208.9	Above Granite Pk
10	10.2	3.2	208.9	Granite Park	205.7	Below 205 Mi	208.9	Above Granite Pk
10	10.3	10.8	209.8		209.2	Below Granite Pk	220.0	220 Mile
10	10.3	10.8	211.5	Fall Cnyn	209.2	Below Granite Pk	220.0	220 Mile
10	10.3	10.8	212.8	Pumpkin	209.2	Below Granite Pk	220.0	220 Mile
10	10.3	10.8	214.0		209.2	Below Granite Pk	220.0	220 Mile
10	10.3	10.8	215.5	Three Springs	209.2	Below Granite Pk	220.0	220 Mile
10	10.3	10.8	219.2	Trail Cnyon	209.2	Below Granite Pk	220.0	220 Mile
11	11.1	5	220.0	220 Mile	220.0		225.0	
11	11.1	5	222.0		220.0		225.0	
11	11.1	5	222.3		220.0		225.0	
11	11.1	5	224.5		220.0		225.0	
11	11.1	5	225.0	Diamond	220.0		225.0	Above Diamond

Table 2. Number of runs, start mile(ST Mile), average seconds, and species captured by each boat (Arizona Game and Fish Department, trip 1, FEB-MAR 2002). Names and abbreviations of species listed are located in Appendix 3.

DATE	BOAT	# RUNS	ST RM	SEC	AVG SEC	RBT	BNT	CRP	HBC	FMS	BHS	SPD	FHM	BBH	RSH	CCF
2/14/2002	A	12	26.8	3721	310	126		2								
2/14/2002	B	12	26	3690	308	116	2									
2/15/2002	A	12	34.8	3750	313	93	1			1						
2/15/2002	B	12	34.3	4278	357	195										
2/16/2002	A	12	50.4	3615	301	47										
2/16/2002	B	12	46.3	3689	307	134	1			1						
2/17/2002	A	12	61.2	3673	306	39	1	7	3	4	3			1		
2/17/2002	B	12	61.3	3691	308	65	1			1						
2/18/2002	A	12	62.9	3676	306	23		1		1						1
2/18/2002	B	12	62.7	3672	306	29	2	1		2						
2/19/2002	A	12	64	3691	308	22	3	2		2						
2/19/2002	B	12	64.1	3768	314	29	2	5	1	3						
2/20/2002	A	12	75	3650	304	39	7		2				3			
2/20/2002	B	12	73.8	3702	309	38	1	3	1	1			1		1	
2/21/2002	A	12	83.5	3734	311	20	13									
2/21/2002	B	12	82.7	3639	303	32	16									
2/22/2002	A	12	87.4	3698	308	42	61	4		4	1	1				
2/22/2002	B	12	87.2	3709	309	21	33			1						
2/23/2002	A	12	95.8	3826	319	2	19	13								
2/23/2002	B	12	95.8	3658	305	8	7	8								
2/24/2002	A	12	106.7	3703	309	4	8	6		1						
2/24/2002	B	13	106.7	4051	312	12	7	6		1						
2/25/2002	A	12	108.3	3773	314	13	6	34		1						
2/25/2002	B	12	108.2	3624	302	12	2	20		1						
2/26/2002	A	12	117.4	3787	316	6	7	10								
2/26/2002	B	12	116.6	3667	306	14	7	4		1						
2/27/2002	A	12	117.6	3743	312	8	13	6		1						
2/27/2002	B	12	120.7	3696	308	19	1	3		3						
2/28/2002	A	12	163.6	3778	315	3	2	14		3		3				
2/28/2002	B	12	163	3677	306	4	0	4		2						
3/1/2002	A	12	172	3817	318	7	5	11		2						
3/1/2002	B	12	175.5	3641	303	2	6	4		2						
3/2/2002	A	12	194.6	3835	320	4	3	17		2		3				
3/2/2002	B	12	197.7	3680	307	0	1	8		3		2	2			
3/3/2002	A	9	216.7	2789	310	0	0	3								
3/3/2002	B	10	217.7	3066	307	0	0	10				1	2			
Total		**428**		**132857**	**310**	**1228**	**238**	**206**	**7**	**44**	**4**	**10**	**8**	**1**	**1**	**1**

Table 3. Number of runs, start mile, average seconds, and species captured by each boat (Arizona Game and Fish Department, Trip 2, April 2002). Names and abbreviations of species listed are located in Appendix 3.

DATE	BOAT	# RUNS	ST RM	SEC	AVG SEC	RBT	BNT	CRP	HBC	FMS	SPD	FHM	RSH	CCF	STB
4/4/2002	A	12	14.6	3727	311	102									
4/4/2002	B	12	15	3803	317	69									
4/5/2002	A	12	30.9	3849	321	81		3							
4/5/2002	B	12	32.4	3707	309	135	2								
4/6/2002	A	12	48.1	3845	320	113									
4/6/2002	B	12	44.2	3767	314	126	3								
4/7/2002	A	12	56.6	3929	327	118	4			1					
4/7/2002	B	12	56.9	3787	316	209									
4/8/2002	A	12	58.2	3815	318	82	3			3					
4/8/2002	B	12	58.3	3752	313	92	1			2					
4/9/2002	A	12	59.4	4010	334	58	1	3	1	5		1			
4/9/2002	B	12	59.1	3746	312	64	5								
4/10/2002	A	12	66.1	3730	311	33		5				1	1		
4/10/2002	B	12	67.5	3779	315	54	2	3		3					
4/11/2002	A	12	79.8	3904	325	18	9	2							
4/11/2002	B	12	78.5	3749	312	33	7								
4/12/2002	A	12	85	3769	314	2	49	1							1
4/12/2002	B	12	85	3751	313	21	50	1							
4/13/2002	A	9	86.5	2756	306	5	23	5							
4/13/2002	B	10	86.1	3155	316	9	23	1							
4/14/2002	A	13	90.8	4104	316	10	34	13							
4/14/2002	B	12	92	3773	314	6	40	5							
4/15/2002	A	6	103.3	1860	310	5	12	1							
4/15/2002	B	7	103.2	2255	322	11	9	1							
4/16/2002	A	9	110.3	2826	314	13	11	1							
4/16/2002	B	12	110.3	3729	311	38	13	12							
4/17/2002	A	12	141	3705	309	11	4	9		2					
4/17/2002	B	12	140.1	3843	320	30	7	4							
4/18/2002	A	12	167.8	3748	312	5	3	5		7					
4/18/2002	B	12	169.6	3818	318	2	6	6		2	2				
4/19/2002	A	12	193.2	3817	318	1		16			1			1	
4/19/2002	B	12	195.1	3754	313	2	3	4		1					
4/20/2002	A	12	213.1	3722	310			3		1					
4/20/2002	B	12	216	3723	310			4							
TOTAL		**390**		**123007**		**1558**	**324**	**108**	**1**	**27**	**3**	**2**	**1**	**1**	**1**

Table 4. Date, water temperature, and presence or absence of young of year trout at tributaries sampled during each sampling trip.

Tributary	Date	RM	Water temp (°C)	Present (y/n)
Nankoweap	2/7/2002	52	9	N
Clear	2/21/2002	84	12	N
Bright Angel	2/22/2002	88	10	Y
Pipe	2/23/2002	89	9	N
Hermit	2/24/2002	95	12	N
Crystal	2/24/2002	98	9	N
Shinamo	2/25/2002	108	12	Y
Tapeats	2/28/2002	134	10	Y
Dear	2/28/2002	136	13	Y
Kanab	2/28/2002	143	9	N
Havasu	2/28/2002	157	14	Y
Diamond	3/3/2002	225	9	N
Nankoweap	4/7/2002	52		N
Clear	4/13/2002	84		Y
Bright Angel	4/12/2002	88	18.4	Y
Pipe	4/14/2002	89		Y
Hermit	4/15/2002	94	16.2	N
Crystal	4/15/2002	98	18.2	Y
Shinumo	4/16/2002	108	14.7	Y
Tapeats	4/17/2002	134	18.6	Y
Deer	4/17/2002	136	16.5	Y
Kanab	4/18/2002	143	17.9	Y
Havasu	4/18/2002	157		N
Diamond	4/21/2002	225		N

Table 5. Yearly minimum detectable and overall minimum detectable changes in catch per unit effort for rainbow trout (RBT), brown trout (BNT), and Carp (CRP) in the Colorado River, Grand Canyon. Minimum detectable yearly and overall changes in TRENDS analyses are based on 5-year linear trends. All analyses are based on bootstrapped (N= 850) coefficient of variations from the 2000-2002 electroshocking data set.

	Bootstrapped N = 800-900 sample per year		TRENDS N = 800-900 samples per year	
Species	Coefficient of variation	Minimum detectable yearly rate of change **(95%conf)**	Minimum detectable yearly rate of change over 5 years **(5 years linear)(95% conf)**	Minimum detectable overall change in 5 years **(5 years linear)(95%conf)**
RBT	0.04	20%-30%	6%	24%
BNT	0.07	30%-40%	9%	34%
CRP	0.09	40%-50%	12%	47%

Table 6. Yearly minimum detectable and overall minimum detectable changes in catch per unit effort for rainbow trout (RBT) brown trout (BNT) in areas of special concern (RBT at the Little Colorado River reach [RM 56-66], LCR, and BNT at Bright Angel Creek reach [RM 79 -92], BAC). Minimum detectable yearly and overall changes in TRENDS analyses are based on 5-year linear trends. All analyses are based on bootstrapped (N=120 for RBT in LCR, N=168 for BNT in BAC) coefficient of variations from the 2000-2002 electroshocking data set.

	Bootstrapped		TRENDS	
Species	Coefficient of variation	Minimum detectable yearly rate of change **(95%conf)**	Minimum detectable yearly rate of change **(5 years linear)(95% conf)**	Minimum detectable overall change **(5 years linear)(95%conf)**
RBT (LCR) N=120	0.08	30%-40%	14%	56%
BNT (BAC) N=168	0.08	30%-40%	14%	65%

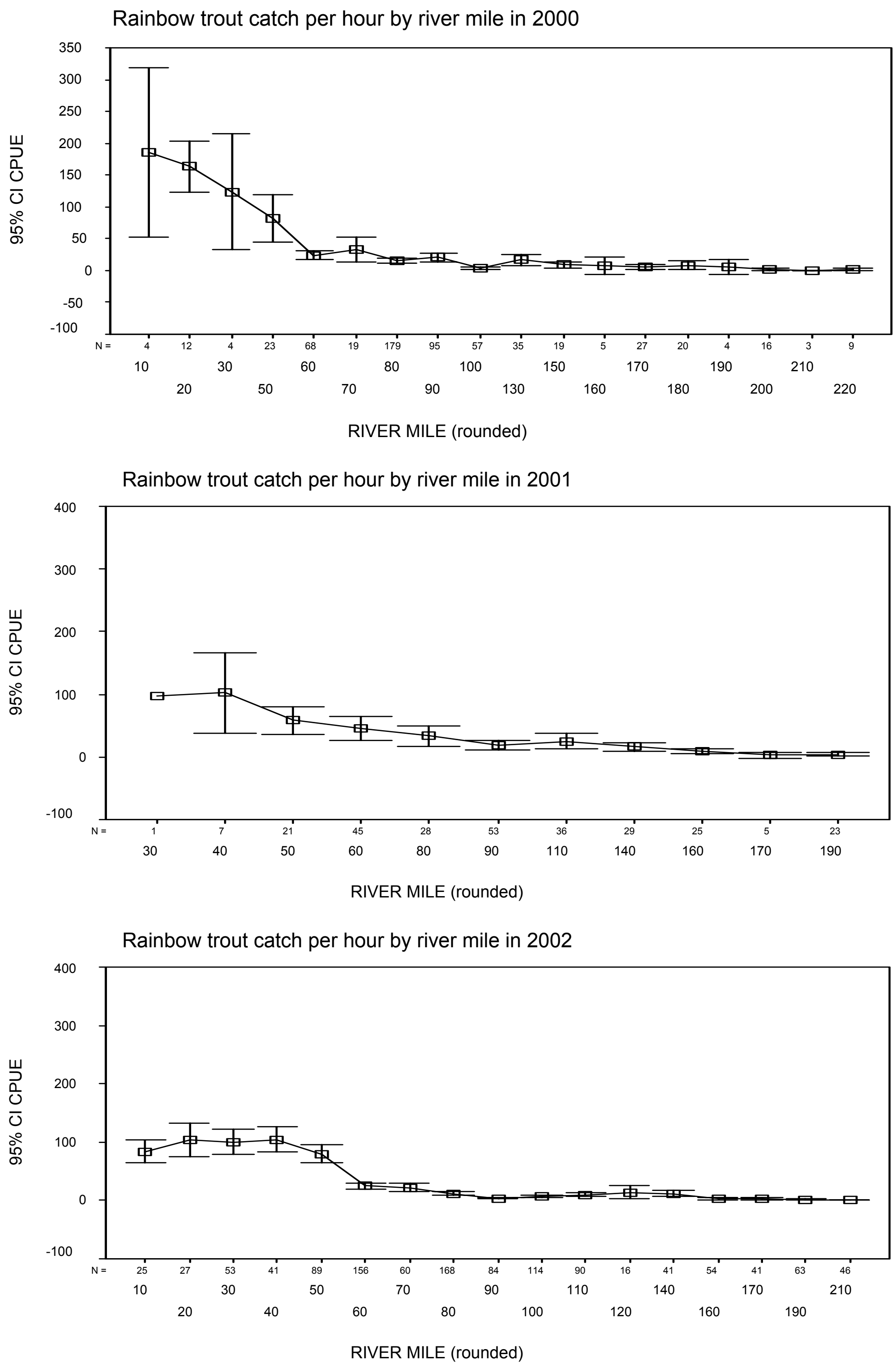


Figure 1. Rainbow trout catch per unit effort by river mile/10 during 2000-2002 (Colorado River, Grand Canyon). N = number of 300 sec electrofishing samples taken.

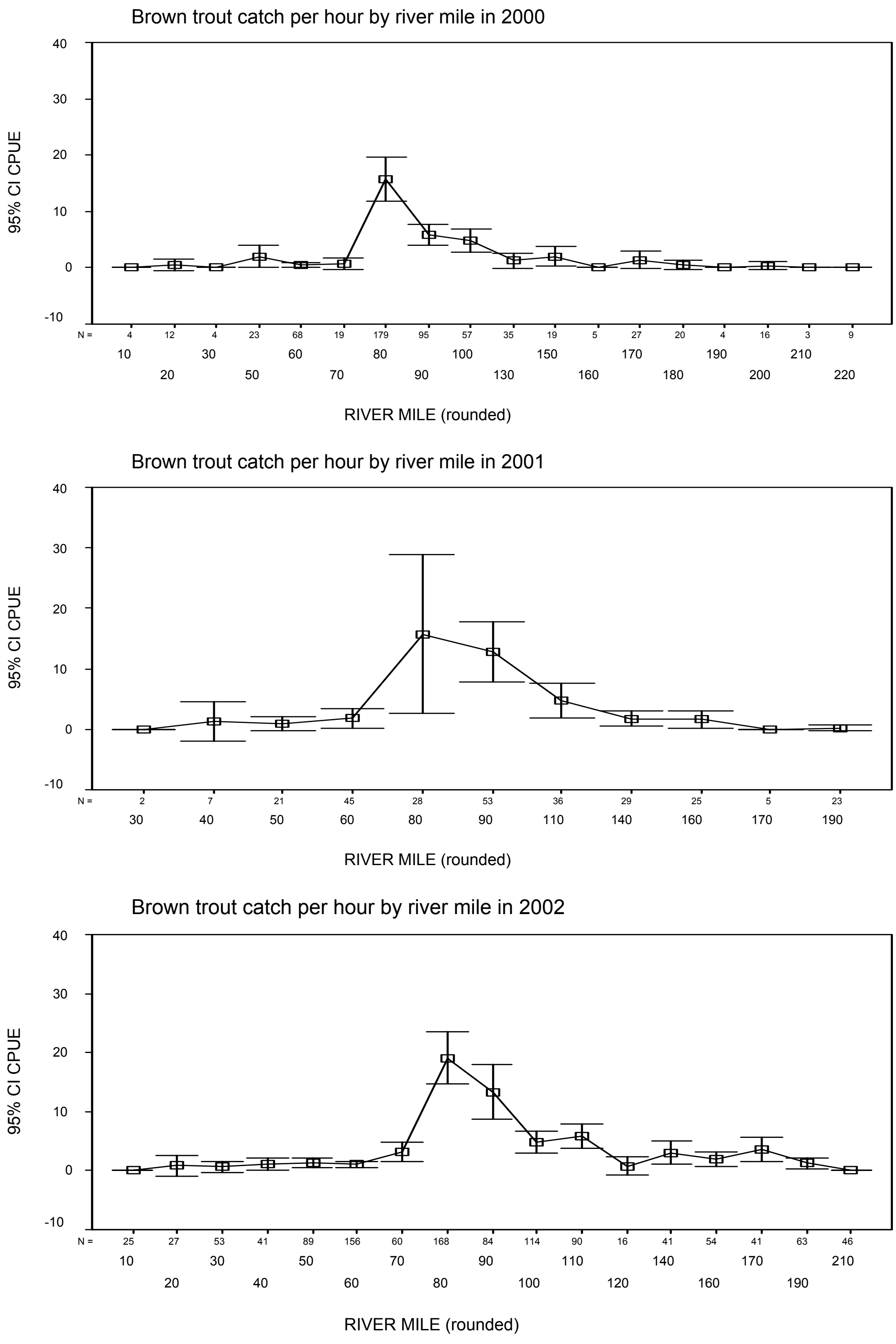


Figure 2. Brown trout catch per unit effort by river mile/10 during 2000-2002 (Colorado River, Grand Canyon). N = number of 300 sec electrofishing samples taken.

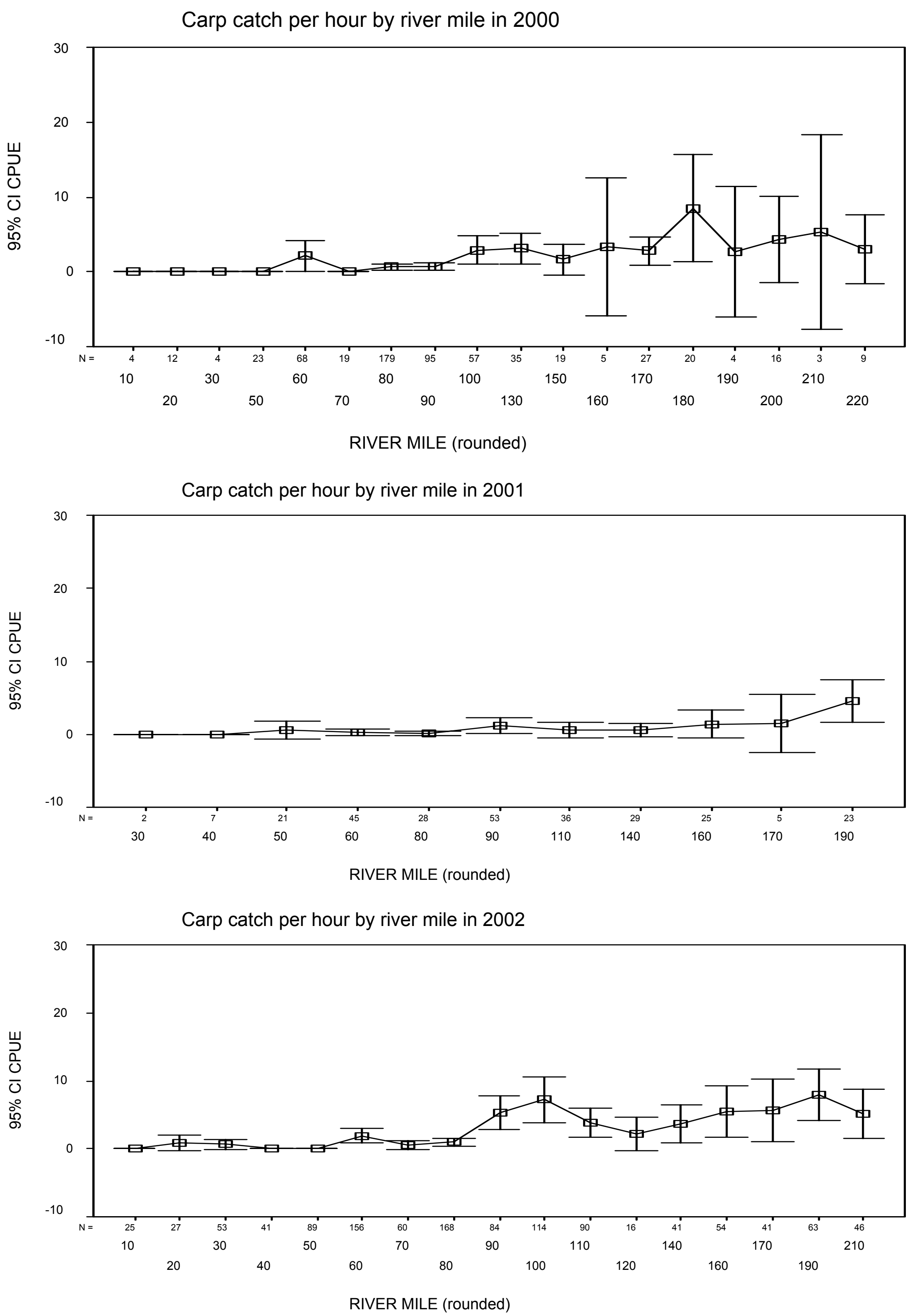


Figure 3. Carp catch per unit effort by river mile/10 during 2000-2002 (Colorado River, Grand Canyon). N = number of 300 sec electrofishing samples taken.

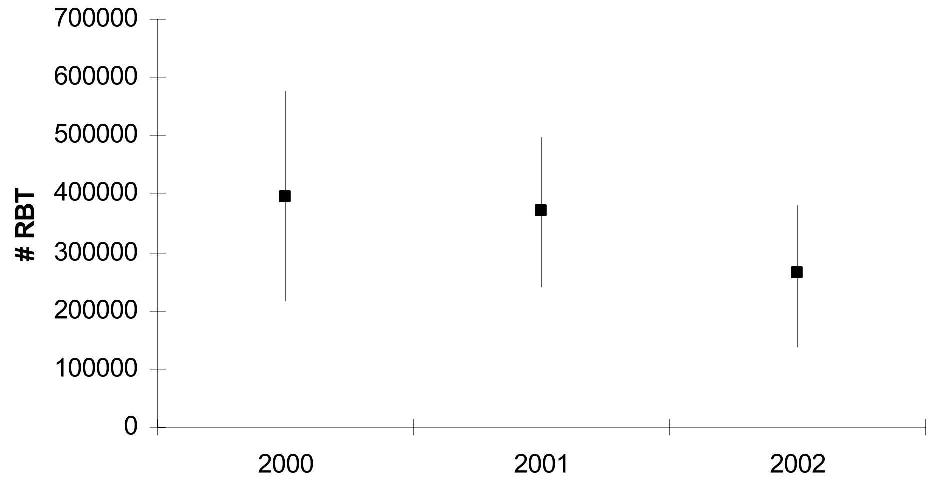


Figure 4. Estimated population size of rainbow trout in the Colorado River in Grand Canyon (RM 39 to 196) during 2000 – 2002. Bars represent 95% confidence intervals of the mean.

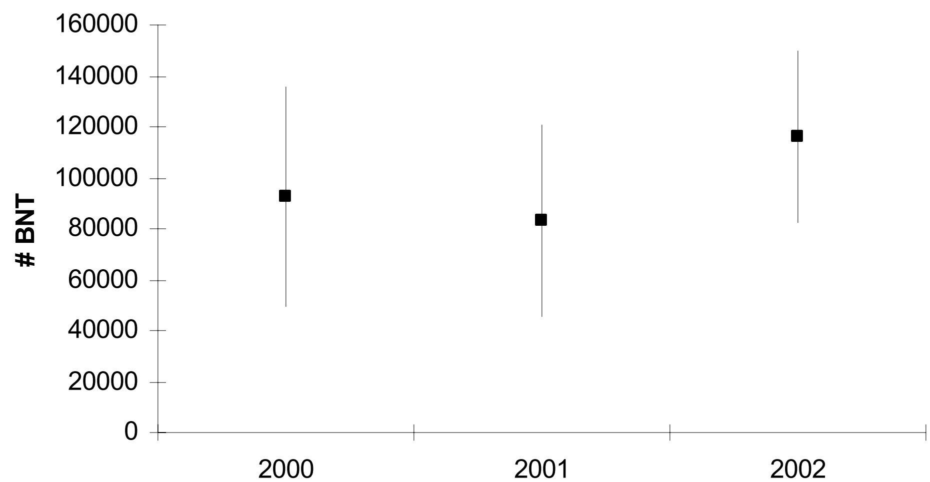


Figure 5. Estimated population size of brown trout in the Colorado River in Grand Canyon (RM 39 to 196) during 2000 – 2002. Bars represent 95% confidence intervals of the mean

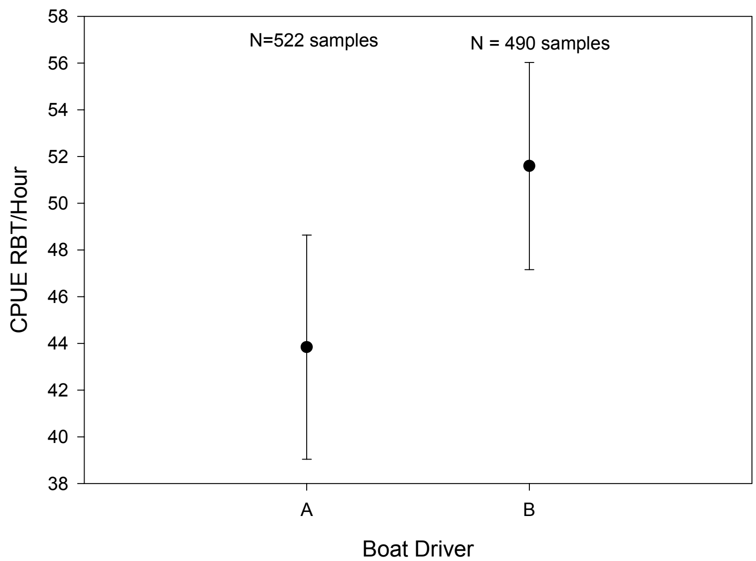


Figure 6. Catch per unit effort for boat A and boat B during 2000-2002. Samples were taken randomly throughout the canyon (RM 15- 220). Bars represent 95% confidence intervals of the mean.

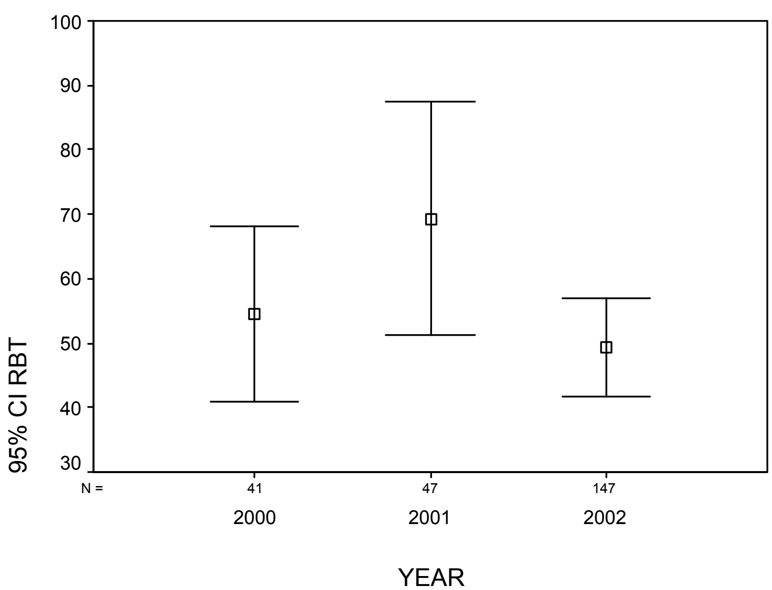


Figure 7. Catch per unit effort for rainbow trout during 2000-2002, near the Little Colorado River (LCR reach RM 56-69), tributary to the Colorado River.

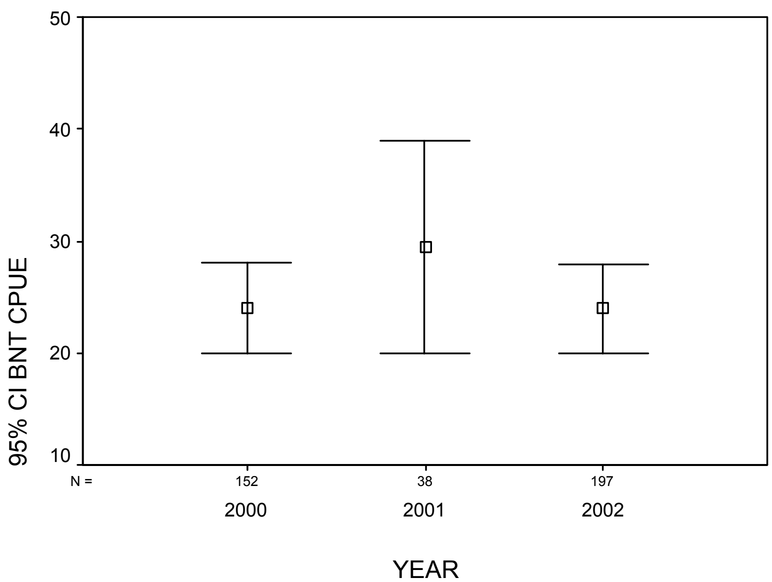


Figure 8. Catch per unit effort for brown trout during 2000 –2002, near Bright Angel Creek (BAC reach RM 85-93), tributary to the Colorado River.

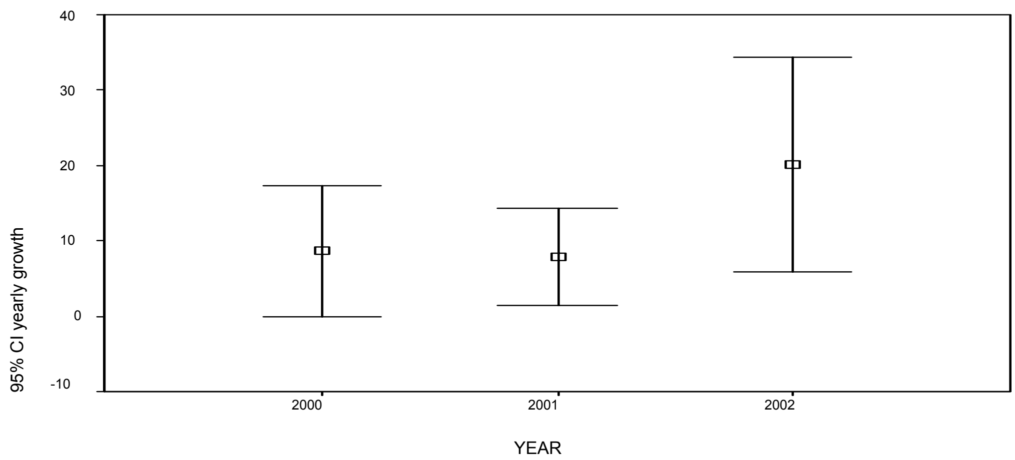


Figure 9. Mean yearly growth rates (mm) for brown trout first marked in the years 2000-2002 in the Colorado River, Grand Canyon.

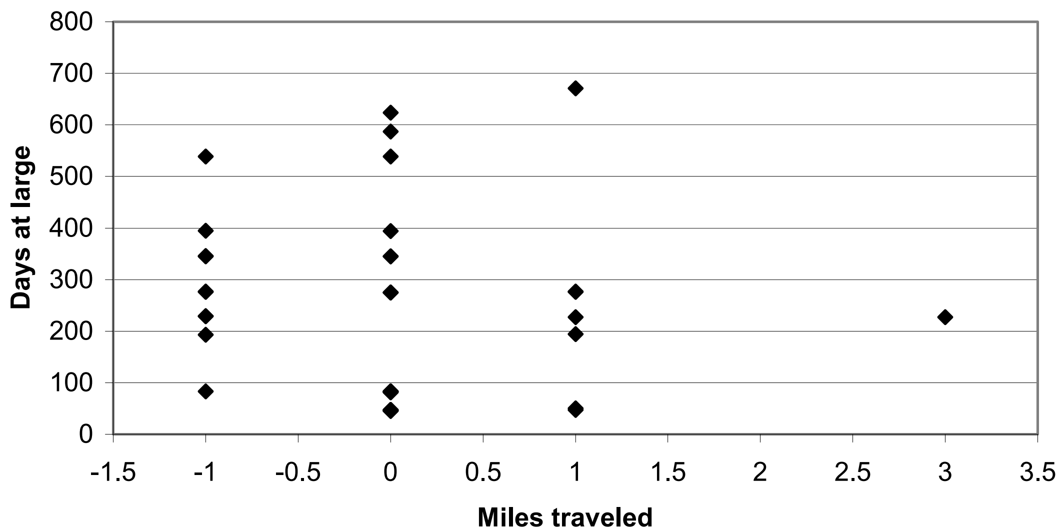
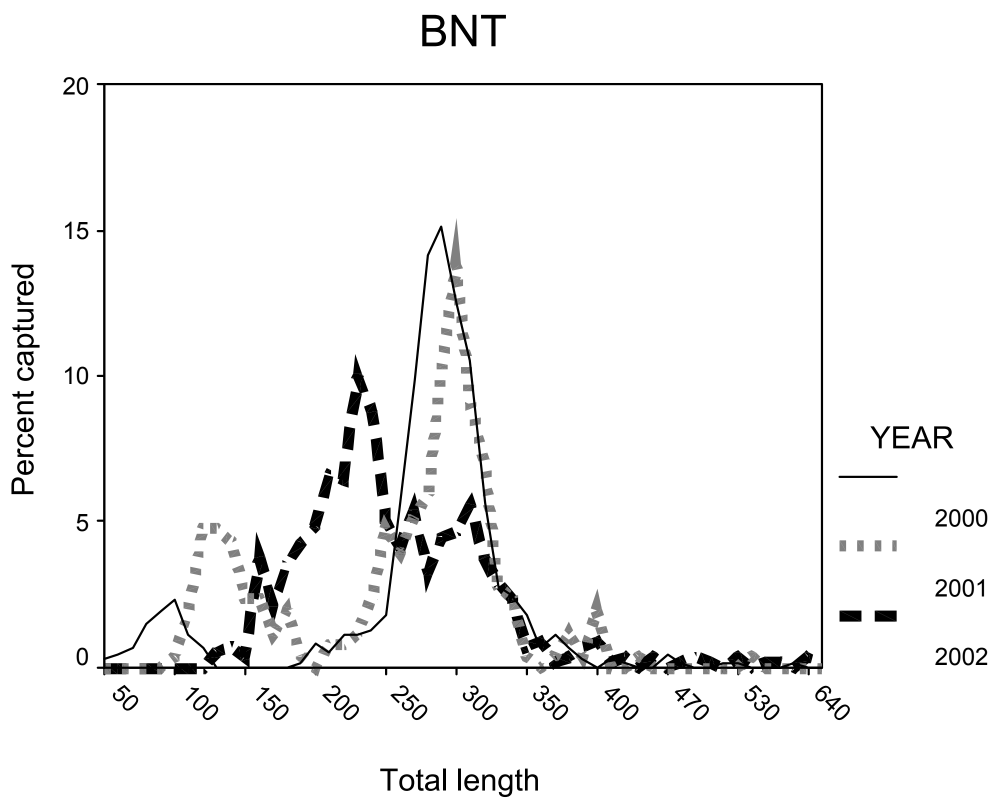


Figure 10. Distance traveled by days at large for brown trout recaptured in the Colorado River, Grand Canyon. Negative miles indicated movement downstream.



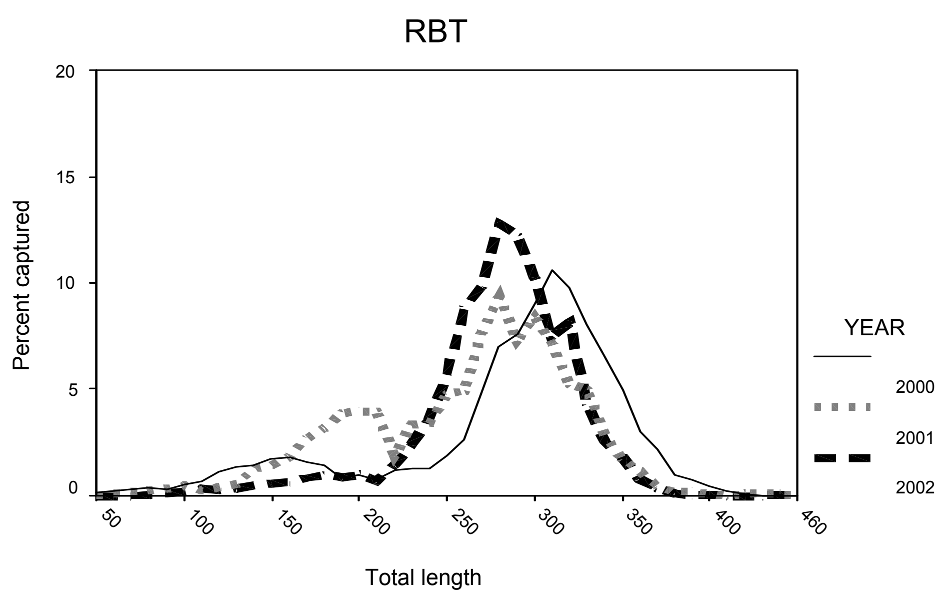


Figure 11. Percent of brown trout (BNT) and rainbow trout (RBT) captured by length for monitoring done in the Colorado River, Grand Canyon (2000-2002).

Appendices

Appendix 1. All native fish captured in regular electroshocking monitoring during 2002.

Date	RIVER	RM	SPECIES	TL	FL	PIT_RECAP	PITTAG
2/17/2002	COR	61.7	HBC	335	302	Y	4174654F24
2/17/2002	COR	61.7	HBC	380	339	Y	7F7D180574
2/17/2002	COR	61.7	HBC	359	326	Y	7F7F477F06
2/19/2002	COR	64.2	HBC	413	368	Y	1F465B053B
2/20/2002	COR	74.6	HBC	45			
2/20/2002	COR	74.6	HBC	43			
2/20/2002	COR	74.8	HBC	122	115		
4/9/2002	COR	60.4	HBC	195	176	N	43473D0845
2/15/2002	COR	34.8	FMS	487	468	Y	51166A0C12
2/16/2002	COR	46.8	FMS	80			
2/17/2002	COR	61.2	FMS	211	196	N	426A4B5054
2/17/2002	COR	61.2	FMS	185	169	N	426D2E4A79
2/17/2002	COR	61.2	FMS	192		N	426D533B0B
2/17/2002	COR	61.6	FMS	157	145	N	426E0C5016
2/17/2002	COR	62.4	FMS	218	202	N	426B5C4269
2/18/2002	COR	63.4	FMS	279		N	426D6B1C29
2/18/2002	COR	62.8	FMS	262	247	N	426A2C0563
2/18/2002	COR	62.9	FMS	465	444	Y	53241D7D7B
2/19/2002	COR	64.6	FMS	135	125		
2/19/2002	COR	65	FMS	225	208	N	425A4D3856
2/19/2002	COR	64.2	FMS	139	133		
2/19/2002	COR	64.3	FMS	226	214	N	426B5D6573
2/19/2002	COR	64.3	FMS	232	218	Y	423E734863
2/20/2002	COR	74.2	FMS	232	220	N	426A6C7A4D
2/22/2002	COR	87.4	FMS	553	531	Y	1F7A761061
2/22/2002	COR	87.6	FMS	498	476	N	426C6F7E0F
2/22/2002	COR	87.6	FMS	535	509	N	425A722A4F
2/22/2002	COR	88.1	FMS	148	139	N	
2/22/2002	COR	88.4	FMS	455		N	426A480B71
2/24/2002	COR	107.3	FMS	262	247	N	426A5E6564
2/24/2002	COR	107.7	FMS	161	152	N	426C2A3B36
2/25/2002	COR	109.1	FMS	470	454		
2/25/2002	COR	108.8	FMS	465	445	Y	1F0F743A24
2/26/2002	COR	117.2	FMS	155	145	N	426A6A7E3C
2/27/2002	COR	118.4	FMS	205	198	N	434745650D
2/27/2002	COR	121.8	FMS	175	168		
2/27/2002	COR	121.8	FMS	169	159		
2/27/2002	COR	121.8	FMS	193	186		
2/28/2002	COR	164.2	FMS	204	193	N	434735402D
2/28/2002	COR	164.2	FMS	203	191	N	4347274331

Appendix 1. continued

Date	RIVER	RM	SPECIES	TL	FL	PIT_RECAP	PITTAG
2/28/2002	COR	163	FMS	161		N	4269270477
2/28/2002	COR	163.6	FMS	137	129	N	
3/1/2002	COR	172	FMS	222	212	N	434737542E
3/1/2002	COR	172.2	FMS	73	69	N	
3/1/2002	COR	175.6	FMS	141	136	N	
3/1/2002	COR	176.6	FMS	63	59		
3/2/2002	COR	194.7	FMS	83	78		
3/2/2002	COR	195.2	FMS	176	166	N	4347085E0F
3/2/2002	COR	197.9	FMS	184	175	N	426B7F7B15
3/2/2002	COR	198	FMS	140	131		
3/2/2002	COR	199.2	FMS	204	192	N	43473D4777
4/7/2002	COR	57.7	FMS	439		Y	53212C302A
4/8/2002	COR	58.7	FMS	464	440	N	43472A3A1F
4/8/2002	COR	58.7	FMS	502	471	N	430F74696D
4/8/2002	COR	59.1	FMS	81	74		
4/8/2002	COR	58.7	FMS	77			
4/8/2002	COR	58.7	FMS	86			
4/9/2002	COR	59.5	FMS	73	68		
4/9/2002	COR	59.9	FMS	470	445	Y	1F3C13682A
4/9/2002	COR	60.4	FMS	93	88		
4/9/2002	COR	60.5	FMS	475	455	Y	7F7A121A5B
4/9/2002	COR	60.8	FMS	220	205	Y	4347281F42
4/10/2002	COR	68	FMS	505	480	Y	7F7F3E5206
4/10/2002	COR	68.4	FMS	305	285	N	4347342D3C
4/10/2002	COR	68.4	FMS	142	136		
4/17/2002	COR	141.5	FMS	170	160	N	426E057B07
4/17/2002	COR	141.5	FMS	170	159	N	426E2A006D
4/18/2002	COR	167.9	FMS	524	495	N	43472D2476
4/18/2002	COR	168	FMS	133	124		
4/18/2002	COR	168	FMS	186	170	N	430F643906
4/18/2002	COR	168.1	FMS	161	154	N	43470C1408
4/18/2002	COR	168.1	FMS	160	152	N	4347371574
4/18/2002	COR	168.6	FMS	166	158	N	4347254924
4/18/2002	COR	168.8	FMS	169	160	N	43472F346F
4/18/2002	COR	170.2	FMS	165	154	N	41746E5950
4/18/2002	COR	170.2	FMS	473	447	Y	51103F5831
4/19/2002	COR	195.5	FMS	201	193	N	423D58370C
4/20/2002	COR	213.1	FMS	172	163	N	430F524F3C
2/17/2002	COR	61.6	BHS	199	180	N	426E154922
2/17/2002	COR	61.6	BHS	241	229	N	42690F1815
2/22/2002	COR	87.4	BHS	232	219	N	426A226979

Appendix 2. Fish captured during an opportunistic sampling of spawning flannelmouth suckers at the mouth of Havasu Creek, a tributary to the Colorado River, Grand Canyon. The mouth of the tributary was shocked for 863 seconds with 450 volts 15 amps output from the shocking boat.

DATE	RIVER	RM	SPECIES	TL	FL	PIT_RECAP	PITTAG
2/28/2002	HAV	157	RBT	31			
2/28/2002	HAV	157	FMS	487	461	N	426B7E7A22
2/28/2002	HAV	157	FMS	542	521	Y	7F7B144B29
2/28/2002	HAV	157	FMS	490	472	N	426C4A0B3D
2/28/2002	HAV	157	FMS	445	429	Y	1F7A260839
2/28/2002	HAV	157	FMS	480	457	N	426C684900
2/28/2002	HAV	157	FMS	436	413	N	426B596D39
2/28/2002	HAV	157	FMS	510	485	N	426E326D53
2/28/2002	HAV	157	FMS	502	473	N	426B016228
2/28/2002	HAV	157	FMS	394	373	N	426E046C60
2/28/2002	HAV	157	FMS	486	461	N	426C611867
2/28/2002	HAV	157	FMS	514	496	N	425A376504
2/28/2002	HAV	157	FMS	469	451	N	426B77614E
2/28/2002	HAV	157	FMS	534	511	N	426D5D1E0D
2/28/2002	HAV	157	FMS	482	459	Y	7F7F3E5E1C
2/28/2002	HAV	157	FMS	517	494	N	426E155E51
2/28/2002	HAV	157	FMS	536	509	N	426B70090D
2/28/2002	HAV	157	FMS	473	452	N	426D585F4F
3/1/2002	HAV	157	FMS	463	444	N	426B3D2166
3/1/2002	HAV	157	FMS	480	457	N	426B596C1A
3/1/2002	HAV	157	FMS	493	474	N	4268712909
3/1/2002	HAV	157	FMS	489	466	Y	5325130755
3/1/2002	HAV	157	FMS	424	404	Y	4128072E45
3/1/2002	HAV	157	FMS	483	459	N	426C6B6A67
3/1/2002	HAV	157	FMS	426	408	N	426B58444B
3/1/2002	HAV	157	FMS	474	453	Y	5321255855
3/1/2002	HAV	157	FMS	426	411	N	426E2C391E
3/1/2002	HAV	157	FMS	470	444	N	426A37771B
3/1/2002	HAV	157	FMS	435	414	N	426E06426C
3/1/2002	HAV	157	FMS	470	446	N	426E3B0970
3/1/2002	HAV	157	FMS	523	496	Y	1F78101247
3/1/2002	HAV	157	FMS	454	437	Y	416B293A40
3/1/2002	HAV	157	FMS	504	483	N	426E0E2075
3/1/2002	HAV	157	FMS	454	437	N	426B68267E
3/1/2002	HAV	157	FMS	441	429	N	426B462A09
3/1/2002	HAV	157	FMS	455	432	N	426D757819
3/1/2002	HAV	157	FMS	478	456	N	426E155D46

Appendix 2. continued

DATE	RIVER	RM	SPECIES	TL	FL	PIT_RECAP	PITTAG
3/1/2002	HAV	157	FMS	468	449	Y	1F3E693E7C
3/1/2002	HAV	157	FMS	537	508	N	4269263A76
3/1/2002	HAV	157	FMS	488	463	N	426E093157
3/1/2002	HAV	157	FMS	464	441	N	426E304571
3/1/2002	HAV	157	FMS	480	453	N	426B78287A
3/3/2002	HAV	157	FMS	450	428	Y	5110420A57
3/3/2002	HAV	157	FMS	543	519	N	426B51371B
3/3/2002	HAV	157	FMS	470	448	N	426D245D3A
3/3/2002	HAV	157	FMS	437	405	N	42690F0A5F
3/3/2002	HAV	157	FMS	454	436	N	426E330A30
3/3/2002	HAV	157	FMS	442	424	Y	1F7B153E13
3/3/2002	HAV	157	FMS	455	434	N	426A34330B
3/3/2002	HAV	157	FMS	459	438	N	426A62262A
3/3/2002	HAV	157	FMS	478	438	N	426A7A203F
3/3/2002	HAV	157	RBT	287			
3/3/2002	HAV	157	FMS	473	455	N	426C466A3F

Appendix 3. Common and scientific names as well as three-letter abbreviations of species listed in this report.

Scientific Name	**Common Name**	**Abbreviation**
Oncorhynchus mykis	Rainbow trout	RBT
Salmo trutta	Brown trout	BNT
Cyprinus carpio	Common carp	CRP
Gila cypha	Humpback chub	HBC
Rhinichthys osculus	Speckled dace	SPD
Pimephales promelas	Fathead minnow	FHM
Cyprinella lutrensis	Red shiner	RSH
Catostomus latipinnis	Flannelmouth sucker	FMS
Catostomus discobolus	Bluehead sucker	BHS
Ictalurus punctatus	Channel catfish	CCF
Ictalurus melas	Black bullhead	BBH
Morone saxatilis	Striped bass	STB