Fisheries Monitoring Activities in the Little Colorado River within Grand Canyon During 2000

A Final Report

Submitted to the Grand Canyon Monitoring and Research Center

By

Lewis G. Coggins, Jr. and David R. Van Haverbeke

US. Fish and Wildlife Service

Arizona Fishery Resources Office – Flagstaff

December 2001

Document Number: USFWS-AZFRO-FL-01-007

TABLE OF CONTENTS

EXECUTIVE SUMMARY 1

INTRODUCTION 3

Objectives 6

April 6

June 7

October/November 7

APRIL TRIP METHODS 7

Boulder Camp 8

Salt Trail Camp 8

Upper Atomizer Falls Camp 9

Biological and Habitat Sampling 9

APRIL TRIP RESULTS 9

Physical Parameters 9

Fish Captures 10

Gear and CPUE 10

Length Frequencies and Sexual Condition 11

APRIL TRIP DISCUSSION 12

JUNE TRIP METHODS 14

Salt Trail Camp 14

Lower Atomizer Falls Camp 15

Biological and Habitat Sampling 15

Data Analysis 16

JUNE TRIP RESULTS 18

Physical Parameters 18

TABLE OF CONTENTS

Fish Captures 19
Calibration Studies 19
Summarized Data 19
Abundance and Density Estimates 20
CPUE to Density Relationships 21
JUNE TRIP DISCUSSION 22
OCTOBER/NOVEMBER TRIP METHODS 24
Boulder Camp 24
Redbud Canyon Camp 25
Salt Trail Canyon Camp 25
Biological and Habitat Sampling 26
Data Analysis 26
OCTOBER/NOVEMBER TRIP RESULTS 31
Physical Parameters 31
Effort and Catch Composition 31
Population Abundance Estimation 32
OCTOBER/NOVEMBER TRIP DISCUSSION 34
LITERATURE CITED 37
LITERATURE CITED 38
APPENDICIES 68

LIST OF TABLES

Table 1. Summary of fish captured by camp, gear type, and species, Little Colorado River, April, 2000. 39

Table 2. Summary of fishing effort in number of mini-hoop sets, hours, humpback chub (HBC) catch, and HBC catch per unit effort (CPUE; fish/hr) by camp, Little Colorado River, April 2000. 40

Table 3. Summary of mini-hoopnet fishing effort by reach, Little Colorado River, June 2000. 41

Table 4. Summary of fish captured by camp, calibration reach, gear type, and species, Little Colorado River, June 2000. 42

Table 5. Summary of humpback chub (HBC) catch rate (CPUE; fish/hour) during night and day periods, HBC captures, HBC marks, and HBC recaptures by size and haul in the Lower Atomizer Falls reach, Little Colorado River, June 2000. 43

Table 6. Summary of humpback chub (HBC) catch rate (CPUE; fish/hour) during night and day periods, HBC captures, HBC marks, and HBC recaptures by size and haul in the Pyramid Rock and Hell Hole reaches, Little Colorado River, June 2000.....44

Table 7. Humpback chub (HBC) abundance, density, and river-wide abundance by calibration reach and size. 45

Table 8. Estimated catchability coefficient (q) of humpback chub by reach, size, and time of day.....46

Table 9. Summary of fishing effort in number of mini-hoopnet sets and hours by camp and trip in the Little Colorado River, 2000. 47

Table 10. Mini-hoopnet catch by species, camp, and trip in the Little Colorado River, 2000. 48

Table 11. Summary of capture data of humpback chub during two sampling events in the Little Colorado River, 2000. Upper table presents captures of all fish large enough to be PIT tagged. Lower table presents captures of fish within the sampled portion (≥ 135 mm TL) of the population. 49

Table 12. Number of humpback chub recaptured and not recaptured during the recapture event by reach and sub-reach in the Little Colorado River, 2000. 50

LIST OF TABLES

Table 13. Population Estimates for humpback chub ≥ 135 mm TL in the lower 14.2 km of the Little Colorado River, October-November, 2000. ...51

Table 14. Population Estimates for humpback chub ≥ 135 mm TL in the lower 14.2 km of the Little Colorado River stratified by 10 mm length interval, October-November, 2000.....52

Table 15. Estimated abundance of humpback chub during October and November 1991, 1992, and 2000 in the lower Little Colorado River. 53

LIST OF FIGURES

Figure 1. Catch rate (CPUE) of humpback chub (HBC) ≤ 150 mm TL captured at Salt Trail Camp, Little Colorado River, April 1993-1995, 2000. Error Bars represent 95% confidence intervals about the mean. Sampling did not occur during 1996 – 1999. 54

Figure 2. Catch rate (CPUE) of humpback chub (HBC) > 150 mm TL captured at Salt Trail Camp, Little Colorado River, April 1993-1995, 2000. Error Bars represent 95% confidence intervals about the mean. Sampling did not occur during 1996 – 1999. 55

Figure 3. Total length frequency distributions of humpback chub captured at each of the three camps, Little Colorado River, April 2000.....56

Figure 4. Total length frequency distributions of bluehead sucker captured at each of the three camps, Little Colorado River, April 2000.....57

Figure 5 Schematic of trip seine used at Salt Trail Camp, Little Colorado River, June 2000. 58

Figure 6. CPUE of humpback chub (HBC) of all sizes by haul for each of the calibration study reaches, Little Colorado River, June 2000. Hauls alternate between day and night fishing efforts (A, C, E, … = Night and B, D, F, … = Day). 59

Figure 7. Estimated catchability coefficient (q) of humpback chub (HBC) for day and night fishing periods by calibration reach and size (total length (mm)), Little Colorado River, June 2000. 60

Figure 8. Linear relationship between humpback chub (HBC) density and initial CPUE for night and day fishing efforts for fish of all sizes (total length), Little Colorado River, June 2000. 61

Figure 9. Linear relationship between humpback chub (HBC) density and initial CPUE for night and day fishing efforts for fish < 200 mm TL, Little Colorado River, June 2000. 62

Figure 10. Linear relationship between humpback chub (HBC) density and initial CPUE for night and day fishing efforts for fish ≥ 200 mm TL, Little Colorado River, June 2000. 63

Figure 11. Observed turbidity during the October and November trips in the Little Colorado River, 2000. 64

Figure 12. Length distributions of all humpback chub large enough to be PIT tagged captured during the marking and recapture events in the Little Colorado River, 2000. 65

LIST OF FIGURES

Figure 13. Cumulative length distributions of humpback chub captured in the Little Colorado River, 2000. 66

Figure 14. Estimated abundance of humpback chub by 10 mm total length interval in the Little Colorado River, 2000. 67

LIST OF APPENDICIES

Appendix A - 1. Summary of PIT tags from Little Colorado River, April 2000. ...69

Appendix A - 2. Summary of PIT tags from Little Colorado River, June 2000. ..80

Appendix A - 3. Summary of PIT tags from Little Colorado River, October 2000. 87

Appendix A - 4. Summary of PIT tags from Little Colorado River, November 2000. 95

Appendix B - 1. Probability distributions of the initial abundance of humpback chub (HBC) for the mark-recapture method (prob mark), depletion method (prob cpe), and the combined mark-recapture/depletion method (total prob) within the Pyramid Rock reach for three size classes of fish. 99

Appendix B - 2. Probability distributions of the initial abundance of humpback chub (HBC) for the mark-recapture method (prob mark), depletion method (prob cpe), and the combined mark-recapture/depletion method (total prob) within the Hell Hole reach for three size classes of fish. 100

Appendix B - 3. Probability distributions of the initial abundance of humpback chub (HBC) for the mark-recapture method (prob mark), depletion method (prob cpe), and the combined mark-recapture/depletion method (total prob) within the Lower Atomizer Falls reach for three size classes of fish. 101

EXECUTIVE SUMMARY

During 2000, the US Fish and Wildlife Service (USFWS) was contracted to conduct fisheries monitoring activities in the lower Little Colorado River (LCR) by the Grand Canyon Monitoring and Research Center (GCMRC). A total of four monitoring trips were conducted during: (1) April 17-25, (2) May 31 – June 9, (3) October 3-16, and (4) November 9-20. The overall goal of these trips was to provide information useful in characterizing the long-term trends in the abundance and species composition of the LCR fish community. Since the LCR contains the largest and only known successfully reproducing population of the endangered humpback chub (*Gila cypha*; HBC) in Grand Canyon, the monitoring efforts were more heavily weighted to obtain information about this species.

The April trip was a two-pronged effort to continue catch per unit effort (CPUE) abundance indexing of HBC in the Salt Trail reach of the LCR, and to implant passive integrated transponder (PIT) tags in as many native fish as possible. GCMRC staff developed the objectives and methods for this trip. In a sense, the methods employed during this trip were a hybrid of the techniques used by the USFWS and Arizona State University during the early 1990s (Gorman and Stone 1999, Douglas and Marsh 1996). Comparing CPUE data from 2000 with data collected in 1993-95 suggests that while the abundance of adult HBC has remained fairly stable, there is greater variability in the abundance of younger HBC.

The June trip was an evaluation of the use of CPUE depletion and mark-recapture methods to estimate the abundance of HBC in short river reaches. This was the initial effort to investigate the feasibility of using a rigorous CPUE abundance indexing technique to monitor the abundance of LCR HBC. Following this trip we concluded that although this technique was feasible in a theoretical sense, the logistics of implementing this technique were prohibitive.

The final two trips were to conduct a mark-recapture experiment to estimate the abundance of HBC in the lower 14.2 kilometers of the LCR. The results of this effort indicate that there were 1,590 (SE = 297) HBC ≥ 135 mm total length residing in the lower LCR during the fall of 2000.

INTRODUCTION

With the passage of the Grand Canyon Protection Act in 1992, the Glen Canyon Dam Adaptive Management Program was initiated. The heart of the program is the Adaptive Management Work Group (AMWG). The AMWG has the responsibility of defining management objectives associated with downstream resources and making recommendations for the development of a long-term monitoring program to assess those resources. The Grand Canyon Monitoring and Research Center (GCMRC) is responsible for implementing the long-term monitoring program and assuring that it is fulfilling the needs of the AMWG. Of the suite of downstream resources, fishes of the Grand Canyon including humpback chub (*Gila cypha*) are particularly important. This elevated status is due to the humpback chub's status as a federally listed endangered species, and the fact that it is so intimately tied to the operations of Glen Canyon Dam (GCD).

A tremendous amount of research effort has been expended to gain a better understanding of humpback chub in Grand Canyon over the last 20 years (Kaeding and Zimmerman 1983, Valdez and Ryel 1995, Douglas and Marsh 1996, Robinson et al. 1998, Gorman and Stone 1999, Clarkson and Childs 2000). However, the majority of this effort has been to gain a better understanding of the life history and ecology of this species, rather than to precisely evaluate the status and trends of this resource. Therefore, the AMWG is not presently able to effectively assess the impacts of the operation of GCD, or to evaluate whether the management objectives associated with Grand Canyon

fishes are being attained. As a result, GCMRC has identified that long-term monitoring of Grand Canyon fishes will embrace stock assessment methodologies to provide information on the dynamics of fish populations. GCMRC began changing the focus of fisheries work in Grand Canyon during 2000 in an attempt to obtain information useful in assessing fish stocks.

GCMRC contracted the US Fish and Wildlife Service (USFWS) to conduct four fish monitoring trips into the Little Colorado River (LCR) during 2000. The trip dates were: (1) April 17-25, (2) May 31 – June 9, (3) October 3-16, and (4) November 9-20. As above, the overall goal of these trips was to provide information useful in characterizing the long-term trends in the abundance and species composition of the LCR fish community. Since the LCR contains the largest and only known successfully reproducing population of the humpback chub (HBC) in Grand Canyon, the monitoring efforts were more heavily weighted to obtain information about this species. Additionally, GCMRC specified that year 2000 was essentially a transition or interim period preceding the implementation of a long-term monitoring program (GCMRC *unpublished*). During this period, a variety of field operations were implemented to test different techniques that could potentially be incorporated in the long-term monitoring program. Therefore, the objectives and sampling techniques for the April and June trips were different from one another and different from the fall trips.

The April trip was a two-pronged effort to continue catch per unit effort (CPUE) abundance indexing of HBC in the Salt Trail reach of the LCR, and to implant

passive integrated transponder (PIT) tags in as many native fish as possible. GCMRC staff developed the objectives and methods for this trip. In a sense, the methods employed during this trip were a hybrid of the techniques used by the USFWS and Arizona State University during the early 1990s (Gorman and Stone 1999, Douglas and Marsh 1996). GCMRC attempted to retain the best attributes of each of these entities' sampling designs.

The ultimate goal of the June trip was centered on evaluating the use of a long-term monitoring strategy in the LCR that utilized CPUE to estimate the abundance of HBC. This method was proposed during a meeting of fisheries professionals primarily focused on developing objectives and sampling protocols associated with the year 2000 low steady summer flows. However, long-term monitoring strategies for the LCR were also discussed. The conceptual plan for implementing this method involved a stratified sample throughout the lower 14.9 km of river to quantify the relative abundance of fish using mini-hoopnet CPUE estimates. These data were then to be used to estimate mean strata CPUE and finally mean CPUE for the entire lower LCR. In concert with the estimation of CPUE, a number of CPUE to absolute abundance calibration efforts were also to be conducted. These efforts relied on depletion and mark-recapture methods to estimate the absolute abundance of fish in a small calibration area. The results of these calibration efforts were then to be used to expand the strata and system-wide CPUE estimates to absolute abundance estimates. Due to formidable logistical challenges in sampling the entire lower 14.9 km of LCR, we restricted

our attention during the June trip to evaluating methods to conduct the calibration studies.

After the somewhat disappointing results observed attempting to conduct the CPUE to absolute abundance calibration studies in June, USFWS proposed undertaking a mark-recapture experiment to estimate HBC abundance. We proposed a simplistic two-pass mark-recapture experiment to estimate the fall abundance of HBC in the LCR. These trips occurred in October and November 2000.

The organization of this report is chronological in an attempt to reflect the evolving nature of the monitoring efforts in 2000. This document will, in turn, describe the methods and discuss the results for each of these trips in the context of the stated objectives. However, since the methods associated with the April trip were not specifically designed to assess the objectives in a rigorous manner, discussion for this trip is limited. Additionally, data analysis and reporting for the April trip were outside of the contractual agreement between GCMRC and USFWS.

Objectives

April

As in the Interim Fish Monitoring Plan prepared by Grand Canyon Monitoring and Research Center (GCMRC *unpublished*), the objectives for the April trip were as follows.

1) Assess abundance, distribution, growth, and condition/health of native fishes in the LCR.

2) Assess reproductive capacity and success of the native fish in the LCR.

3) Assess year class strength of early life stages and recruitment of native fish in the LCR.

June

As in the Little Colorado River Study Plan prepared by the USFWS (USFWS *unpublished*), the objectives for the June trip were as follows.

1) Evaluate the feasibility of conducting CPUE to absolute abundance calibration studies using mini-hoopnets deployed along fixed ropes spanning the river.

2) Evaluate the feasibility of conducting CPUE to absolute abundance calibration studies using mini-hoopnets deployed along shorelines.

October/November

As in the Humpback Chub Stock Assessment in the Little Colorado River Study Plan (USFWS 2000a), the objective for the October and November trips were as follows.

1) Estimate the abundance of humpback chub ≥ 100 mm total length in the lower 14.2 km of the Little Colorado River during October/November, 2000.

APRIL TRIP METHODS

Three camps were established during the course of this trip: Boulder Camp at 2.0 kilometers upstream from the confluence (rkm 2.0), Salt Trail camp (rkm 10.8), and Upper Atomizer Falls Camp (rkm 14.7).

Boulder Camp

Boulder camp personnel deployed mini-hoopnets (0.5 - 0.6 m diameter, 1.0 m length, 6 mm mesh, single 10 cm throat) throughout the lower 3.0 km of the river. Nets were checked on approximately a 12-hour schedule such that net checks occurred in the morning and evening hours. Nets were deployed non-randomly in areas suspected of yielding good catches of HBC. If after several net checks the catches were poor, the nets were repositioned in alternate sites. Boulder camp personnel also deployed trammel nets in the confluence area in the late afternoon and early evening.

Salt Trail Camp

Personnel at this camp deployed mini-hoopnets along fixed ropes spanning the river. Between 4 and 8 nets were deployed along any given rope depending on the width of the river. These ropes were positioned at an average spacing of approximately 22 m between rkm 10.7 and 11.2, an average spacing of approximately 37 m between rkm 11.4 to 11.7, and an average spacing of approximately 25 m between rkm 11.9 to 12.0. Nets were checked on approximately a 12-hour schedule such that net checks occurred in the morning and evening hours. Additionally, minnow traps were deployed in the outlet of Big Canyon (rkm 11.6) and 4 mini-hoopnets were deployed in a HBC spawning area at rkm 10.6. For a more complete description of this fishing method, see Gorman and Stone (1999).

Upper Atomizer Falls Camp

Upper Atomizer camp personnel deployed mini-hoopnets throughout the reach including rkm 13.9 to 14.7. Nets were checked on approximately a 12-hour schedule as above. Nets were deployed non-randomly in areas suspected of yielding good catches of HBC. If after several net checks the catches were poor, the nets were repositioned in alternate sites.

Biological and Habitat Sampling

Data collected for all captured fish included: fork and total lengths, weight, sex, sexual condition, and sexual characteristics. All native fish ≥ 150 mm total length (TL) were scanned for a PIT tag and if lacking a tag, injected with a PIT tag. All large bodied non-native fish were sacrificed and their stomach contents examined and recorded. Stream habitat characteristics associated with a particular net were recorded including: water depth, substrate, distance to shore, shoreline type, and hydraulic unit. Water quality was measured with a hydro-lab water quality meter set in the LCR near Salt Trail Camp, and daily observations of turbidity were made with a HACH 2100p turbidimeter.

APRIL TRIP RESULTS

Physical Parameters

The LCR ran nearly at base flow throughout this trip (0 – 2.3 cfs above base flow). Turbidity was highest on April 17 at 126 NTU and gradually fell to 16.1 on April 24. The turbidity was due to slight flow input, or to settling of previous

above base flow conditions. Water temperature ranged between 17.0 – 21.7 °C and conductivity ranged between 4354 – 4463 μS/cm.

Fish Captures

A total of 1,653 fish were captured among the three camps. Salt Trail camp captured the largest number of fish (699) followed by Upper Atomizer (693) and Boulder (261). Overall, the most prevalent species captured was HBC with captures at Upper Atomizer, Salt Trail and Boulder numbering 239, 351 and 128, respectively. Speckled dace (SPD) were most prevalent at Upper Atomizer (421), and a relatively high number of bluehead sucker (BHS) were captured at Salt Camp (150;Table 1). A summary of PIT tagging data from this trip is presented in Appendix A-1.

Gear and CPUE

A total of 780 mini-hoopnets were set among all three camps resulting in 8,475 hours of fishing effort. The resulting catch per unit effort (CPUE) for HBC was highest in the Upper Atomizer reach (0.121 fish/hr) and lowest in the Boulder reach (0.052 fish/hr; Table 2). In addition, six trammel nets were set near the confluence for a total of 9.2 hours of fishing effort, and three minnow traps were set in Big Canyon for a total of 152.3 hours of fishing effort.

CPUE for humpback chub captured at Salt Camp transects in April 2000 was compared to Salt Camp transect data from April 1993, 1994 & 1995 (Figures 1 and 2). For HBC < 76 mm TL, annual CPUE was not significantly different during 1994, 1995 and 2000 as evidenced by overlapping 95% confidence intervals

(Figure 1). A marked exception was 1993, when no HBC < 76 mm TL were captured. For HBC between 76 - 150 mm TL, significant differences are seen in CPUE from 1993 – 1995, however 1995 was similar to 2000. Nearly the opposite pattern is seen looking at HBC between 151 - 200 mm TL. Here, no significant differences are observed in CPUE from 1993 – 1995, however, 2000 catch rates were significantly elevated compared to all previous years. Finally, in contrast to all smaller size classes of HBC, no significant differences are seen between any of the years for HBC > 200 mm TL. Overall, there is generally a high amount of variability in CPUE between years for fish < 200 mm TL, while CPUE remains more constant for adult fish (i.e., > 200 mm TL).

Length Frequencies and Sexual Condition

The distribution of HBC size was noticeably disparate among the Upper Atomizer reach and the Salt Trail and Boulder reaches (Figure 3). Most fish in the Upper Atomizer reach had lengths ranging between 200 – 300 mm TL. This mode was markedly absent from Salt and Boulder reaches and was likely due to spawning aggregations of this size class in the Upper Atomizer reach. A high proportion of ripe fish (35%) were captured at Atomizer reach, and 5% of these were ripe females. In contrast, Salt Trail had 7% ripe fish and Boulder had 0% ripe fish.

Salt Camp captured noticeably more bluehead suckers (BHS) than the other two reaches, and a high proportion of fish < 100 mm TL (Figure 4). The high catches of BHS in the Salt Trail reach were possibly magnified by the many offshore nets deployed along ropes spanning the river channel and occasionally fished in riffle-run habitats. However, the dramatic observed differences in both abundance

and size composition of HBC and BHS among the three reaches were likely real phenomena.

APRIL TRIP DISCUSSION

The results of the April trip provided CPUE data that was comparable to historical CPUE data (i.e., 1993 -1995). Highly variable CPUE between years for HBC <76 mm TL and HBC between 76 - 150 mm TL is likely a reflection of variability in spawning and young of year (YOY) emergence timing as well as cohort strength. We suggest that this variability is linked to environmental variability (e.g. annual differences in hydrology). For example, a large flood of 16,400 cfs on 13 Jan 1993 may have strongly contributed to the very low catch rates of HBC 75 - 150 mm TL (and absence of HBC < 75 mm TL) in April 1993. In contrast, the high catch rates of HBC < 150 mm TL in April 1994 was preceded by a year with peak flood events not exceeding 2,410 cfs.

Other research indicates that hydrology is linked to survivorship of small fish. Flooding is known to cause downstream displacement of larval fishes (Harvey 1987). Dispersal of young humpback chub (<75 mm TL) into the mainstem Colorado River was concurrent with summer rain induced floods in the LCR (Valdez and Ryel 1995). Robinson et al. (1998) estimated that over 370,000 native fish larvae drifted out of the LCR into the Colorado River in a 46-day period in 1993. Interestingly, during this time frame (11 May – 26 June, 1993), flows at Cameron gauge station did not exceed 35 cfs, and the large majority of days were base flow conditions for LCR. The potential for a flood event in the

LCR to magnify this drift (or displacement) could be great and is highly variable from year to year.

In contrast to HBC < 200 mm TL, the more consistent catch rates of adult fish (> 200 mm TL) during the spawning season suggests more stability, at least for these four years. Presumably this is because HBC are long lived and periodic successful spawning and rearing events maintain adult numbers. However, this is a chance scenario, dependent upon the variation in the success of each year class, and upon the resulting long-run growth rate of the population, factors still very poorly understood for the species.

Inferring changes in abundance based on changes in CPUE is problematic unless catchability remains constant (Hilborn and Walters 1992). Additionally, the catchability of hoopnets within the LCR appears to be negatively correlated with turbidity (USFWS 2000b, Van Haverbeke 2000). Although flows were generally < 550 cfs above base flow during all sampling years (as measured at Cameron gauge station), there was still enough flow variability to cause large differences in turbidity. For example, above base mean daily flows varied between 0 - 2.3 cfs during 16 - 25 April 2000, while they varied between 268 - 546 cfs during 12 - 20 April 1993. Therefore, it is possible that the highly elevated CPUE for HBC 151 - 200 mm TL observed during 2000 is due more to favorable fishing conditions than to high abundance.

Although some interesting patterns may be gleaned from comparing annual CPUE data, it is apparent that conclusive trend data will need to come from

intensive and strategic mark-recapture methods, such as were initiated in 1990 by Arizona State University, and reinitiated in October 2000 by USFWS.

JUNE TRIP METHODS

Two camps were established during the course of this trip: Salt Trail Camp (rkm 10.8) and Lower Atomizer Falls camp (rkm 14.2).

Salt Trail Camp

Personnel at this camp were responsible for conducting 2 CPUE to abundance calibration studies (calibration studies) using mini-hoopnets deployed along ropes fixed perpendicular to the river channel. The fixed rope transect lines were spaced approximately 20 m apart and between 4 and 9 mini-hoopnets were deployed from each line. Each of the depletion studies lasted 4 days and included 7 net checks occurring during the morning and evening hours (2 net checks per day). The first calibration study was conducted in a reach known as Hell Hole (HH reach) beginning at rkm 11.50 and ending at rkm 11.66. The second calibration study was conducted in Pyramid Rock reach (PR reach) between rkm 11.66 and rkm 11.94.

An additional effort to evaluate the effectiveness of a new kind of capture gear called a baited trip seine was also accomplished. This gear consisted of a 30 feet x 6 feet long (¼ inch mesh) beach seine tied to shore and partially anchored in mid-stream (Figure 5). A bait bag was anchored on the bottom to attract fish

into the mouth of the deployed seine. The seine was retrieved by disconnecting the offshore anchor and hauling the seine to shore.

Lower Atomizer Falls Camp

Lower Atomizer Falls personnel were responsible for conducting 1 calibration study using mini-hoopnets deployed along shorelines. Net set locations were varied throughout the 8-day study in an attempt to maximize catch and thoroughly sample the study reach. Each net was checked twice each day during morning and evening hours. The Lower Atomizer Falls reach (LAF reach) included the reach between rkm 14.05 and rkm 14.24.

Biological and Habitat Sampling

Data collected for all captured fish included: fork and total lengths, weight, sex, sexual condition, and sexual characteristics. All native fish ≥ 120 mm were scanned for a PIT tag and if lacking a tag, injected with a PIT tag. All large bodied non-native fish were sacrificed and their stomach contents examined and recorded. Stream habitat characteristics associated with a particular net were recorded including: water depth, substrate, shoreline type, and hydraulic unit. Water quality was measured with a hydro-lab water quality meter set in the LCR near Salt Trail Camp, and daily observations of turbidity were made with a HACH 2100p turbidimeter.

Because calibration studies involve the use of a depletion estimator (i.e., fish must be depleted or removed from the calibration reach), captured fish must either be removed from the calibration area or marked so that they can be

identified as being previously captured. This is easily accomplished considering fish that are either large enough to be PIT tagged or sacrificed for stomach analysis, but small fish released alive were treated differently. In the HH and PR reaches, small fish were released alive well below the calibration reaches. In the LAF reach, small fish were marked by removing a small portion of their lower caudal fin.

Data Analysis

Conducting the calibration studies in each reach required the estimation of the absolute abundance of HBC within the reach and the CPUE following each net check. Abundance estimates were generated using both a depletion estimator and a mark-recapture estimator (Hilborn and Walters 1992). Additionally, since both the depletion and mark-recapture estimators were cast in a likelihood setting, a combined depletion/mark-recapture estimate was also employed. The abundance estimates were then converted to density estimates. With the density and CPUE estimates in hand, it was then possible to estimate a linear CPUE to abundance calibration relationship. However, since our study included only three trials, only three data points defined this relationship.

The depletion and mark-recapture abundance estimates were computed in a spreadsheet model (Tagrec) developed by Dr. Carl Walters (personal communication, Carl Walters, University of British Columbia). To estimate abundance using the depletion method, the underlying relationships given by the Leslie method (Hilborn and Walters 1992) are:

$$N_t = N_1 - K_{t-1}, \tag{1}$$

$$CPUE_t = qN_t e^{-v_t}, \tag{2}$$

where N_t is the abundance at time *t*, N_1 is the abundance at time *t* = 1, K_{t-1} is the cumulative removals prior to time *t*, $CPUE_t$ is the observed catch rate between time *t* = 1 and time *t*, q is the catchability coefficient, and v_t ~$N(0,\sigma^2)$ observational error. Central to estimating abundance using the depletion method is estimating q. The spreadsheet model Tagrec essentially varies the population abundance to maximize the log-likelihood of q. The q and the log-likelihood of q (Walters and Ludwig 1994) are:

$$Z_t = \ln\left(\frac{CPUE_t}{N_t}\right), \tag{3}$$

$$q = e^{\frac{\sum_{t=1}^{n} Z_t}{n}}, \tag{4}$$

$$\mathcal{L}_q = \left(\sum_{t=1}^{n}\left(Z_t - \ln(q)\right)^2\right)^{\left(\frac{-(n-1)}{2}\right)} \tag{5}$$

where N_t is the abundance at time *t*, *n* is the number of samples, and $\mathcal{L}_q$ is the log-likelihood function of q. Equation (5) is the marginal likelihood for the CPUE data integrated over all possible values of the variance of v_t with a ($1/\sigma^2$) prior distribution. If multiple CPUE indexes are used, a combined likelihood function is constructed as the product of the log-likelihood components of each index.

The spreadsheet program Tagrec also estimates abundance using mark-recapture information in a likelihood setting. The log-likelihood function to estimate absolute abundance relies on fitting observed mark-rate to predicted marked rate assuming a particular total population size. The log-likelihood function (personal communication Carl Walters, University of British Columbia) is given as:

$$\mathcal{L}_{m\text{-}r} = \left((c_t - m_t) \ln\left(1 - \frac{M_{t-1}}{N}\right) + m_t \ln\left(\frac{M_{t-1}}{N}\right)\right), \tag{6}$$

where c_t is the number of fish captured during sample *t*, m_t is the number of marked fish captured in sample *t*, M_{t-1} is the number of marked fish at large just before sample *t*, N is the abundance of fish at the beginning of the experiment, and $\mathcal{L}_{m\text{-}r}$ is the mark-recapture log-likelihood function.

Finally, Tagrec estimates abundance using a joint likelihood function using depletion and mark-recapture information. The log-likelihood maximized in this estimation is simply the product of $\mathcal{L}_q$ and $\mathcal{L}_{m\text{-}r}$.

JUNE TRIP RESULTS

Physical Parameters

The LCR flowed clear during this entire trip with measured turbidity between 6 and 19 NTU. Water temperature ranged between 18.8 and 24.6 °C and conductivity between 4030 and 4544 µS/cm.

Fish Captures

A total of 851 mini-hoopnets sets were conducted resulting in 10,710 hours of fishing effort (Table 3). Additionally, 6 baited trip seine sets were conducted near Salt Trail Camp as a trial evaluation for this gear type. Between the two camps, a total of 1,419 fish were captured (Table 4). The Salt Trail Camp caught the largest number of fish at 917 and the Lower Atomizer Camp captured 502 fish. A total of 428 HBC were captured with Lower Atomizer and Salt Trail Camps contributing 189 and 239, respectively.

Lower Atomizer Camp personnel captured 93 HBC, 1 BHS, and 1 flannelmouth sucker (FMS) large enough to receive a pit tag (>120 mm TL). Of these, both suckers and 57 HBC had not previously been tagged. The Salt Trail Camp personnel captured 183 HBC, 10 BHS, and 5 FMS large enough to be tagged (>120mm TL). Of these, 128 HBC, 1 BHS, and 1 FMS had not been previously tagged. For HBC, these results translate into recapture rates of 39% in the Lower Atomizer Reach, 30% in the Salt Trail Reach, and 33% overall. A summary of the PIT tagging data from this trip is presented in Appendix A-2.

Calibration Studies

Summarized Data

In a typical depletion study, one hopes that CPUE is a decreasing function over time as fish are removed (or tagged) from the study reach. In our study, this idealized pattern was generally not true since CPUE observed during daylight hours was grossly different from night (Figure 6). When looking at the CPUE results for the PR reach, one can see that the daylight hauls (B, D, and F) have

higher CPUE than any of the night hauls (A, C, E, and G). Additionally, the daylight hauls actually increase in catch rate slightly over time. Similar results occur for the other reaches and for CPUE based on subsets of data stratified by HBC total length. We therefore decided to treat day and night CPUE as separate indexes for the purposes of the abundance estimation within the Tagrec model. Tables 5 and 6 present the data necessary to compute the abundance estimates within the Tagrec model. We stratified the data based on HBC total length in order to obtain estimates of all fish < 200 mm TL and all fish ≥ 200 mm TL.

Abundance and Density Estimates

Density estimates for HBC of all sizes ranged from 317 fish/km to 1005 fish/km among all calibration reaches (Table 7). The density estimates of HBC < 200 mm TL displayed even more variability and ranged from 299 fish/km to 2,071 fish/km. Density estimates of HBC ≥ 200 mm TL varied from 19 fish/km to 452 fish/km. The density estimates are predicated on calibration reach abundance that is estimated by the depletion, mark-recapture, or combined depletion and mark-recapture methods. The depletion method failed to converge to an estimate in 3 of 9 trials and displayed an extremely flat solution surface with a very large estimate (582 fish) on another (HBC <200 mm TL PR reach). These results along with the probability distributions of the initial reach abundance for the mark-recapture and combined depletion/mark-recapture methods are presented in Appendices B-1, B-2, and B-3. The abundances estimated with the joint likelihood functions (labeled total in Table 7) are, by definition, a compromise between the information from the depletion method and the mark-

recapture method. In the cases where the depletion estimates do not converge, the estimates from the combined estimator should be viewed skeptically. In addition to the reach abundance and reach density estimates, river-wide estimates are also constructed. These estimates are constructed with the naïve assumption that density is constant throughout the river corridor and should be considered for comparative purposes only.

As mentioned in the methods section, central to using the depletion method is the estimation of the catchability coefficient (q). The estimates of q show some interesting patterns among day versus night sets and among various size classes of HBC. Among all reaches, HBC < 200 mm TL have a higher catchability coefficient during day than at night (Table 8 and Figure 7). Alternatively, HBC ≥ 200 mm TL have higher catchability during night sets.

CPUE to Density Relationships

Despite the overall poor performance of the depletion estimator, the relationship between initial CPUE in a reach and the estimated density from the mark-recapture method was relatively good. Although it is extremely difficult to evaluate these relationships with only 3 data points, in all the calibration curves we see increasing CPUE with increasing density (Figures 8-10).

JUNE TRIP DISCUSSION

The results of this trip provided a great deal of information useful in evaluating whether a HBC monitoring program based on expanding CPUE to absolute abundance estimates was a tenable option in the Little Colorado River. In contrast to the depletion studies conducted in the mainstem Colorado River on rainbow trout using electrofishing gear (personal communication, Dave Speas, Arizona Game and Fish Department), depletion methods performed fairly poorly in the Little Colorado River using mini-hoopnets. Although it was possible to construct initial CPUE to density calibration curves that were positively correlated consistent with theory (Hilborn and Walters 1992), it was difficult to evaluate this relationship given the limited amount of data available from this experiment. Additionally, the LCR is an incredibly dynamic environment with many factors potentially affecting CPUE. Possibly the most important factor is water turbidity which has been shown to be negatively correlated with HBC CPUE (USFWS 2000b, Van Haverbeke 2000). Therefore, it is likely that a robust relationship between density and CPUE would have to account for turbidity and host of other environmental factors.

Stone (1999) found that under clear water conditions, 80% of HBC > 210 mm TL were captured during night fishing efforts. He further found that HBC < 91 mm TL were more likely to be captured during day as opposed to night fishing efforts. The patterns in the catchability coefficients estimated in this study for small and

large HBC among day and night fishing periods are consistent with these previous findings.

Despite the positive aspects of this method, we recommended the initiation of a mark-recapture program to monitor HBC in the LCR (USFWS 2000a). This recommendation was made primarily from logistic concerns. Although it was possible to construct initial CPUE to abundance calibration curves, rigorously estimating HBC CPUE in the entire 14.9 km of the lower LCR is quite another challenge.

With regard to logistics and sampling biases, we offer the following observations. In our opinion, the most reasonable approach to implementing a HBC monitoring program designed to expand observed CPUE to absolute abundance is to staff three camps distributed at approximately equal intervals throughout the lower LCR. Personnel in these camps would be responsible for both estimating CPUE in the area near the camp, and conducting a calibration study in a suitable proximate reach. After evaluating the data collected during this trip, it appears that over 50 hoopnets would be required to estimate CPUE in a short reach of river. This is due mainly to the low catch rate of hoopnets (personal communication, Carl Walters, University of British Columbia). From a practical standpoint this means that on a typical monitoring trip of 10 - 14 days, each camp could only obtain two to four estimates of CPUE in addition to completing the calibration study. Furthermore, due to the difficulty in transporting this amount of fishing gear through the river corridor, CPUE could only be estimated in river reaches near the base camps. Expanding CPUE estimates from as little as 3-km

to the entire 14.9-km of river could potentially bias subsequent abundance estimates to an unknown degree and direction. We can think of only two ways to avoid the issue of biased sampling. The first involves distributing large caches of hoop nets (50) at approximately 1-km intervals throughout the lower LCR. Although this would circumvent the toil and hazards of moving large amounts of gear throughout the river corridor, it would be quite expensive to purchase 750 hoopnets. The second would involve frequent helicopter support to transport nets between sampling stations and would also involve considerable expense. It is for these reasons that we recommended the implementation of a rigorous mark-recapture program in the fall of 2000.

OCTOBER/NOVEMBER TRIP METHODS

During the course of the October 3-16 and November 9-20 trips, three camps were established: Boulder Camp (rkm 2.0), Redbud Canyon Camp (rkm 8.0), and Salt Trail camp (rkm 10.8).

Boulder Camp

Personnel at this camp were responsible for fishing mini-hoopnets throughout the reach from rkm 0.0 to 5.0. Forty-five mini-hoopnets were fished throughout this reach with spacing between nets of approximately 100 – 150 m. Each hoopnet was positioned in favorable habitat suspected of yielding good catches of HBC. Nets were repositioned following check runs if the catch was poor or an alternative site was available. On average, each hoopnet was checked once

every 24 hours. The overall reach was broken down into three sub-reaches: rkm 3.4 to 5.0 (above Powell Canyon to rkm 5.0), rkm 1.6 to 3.4 (above Jump Off Rock to above Powell Canyon), and rkm 0.0 to 1.6 (Confluence to above Jump Off Rock). During the October trip, nets were fished for 3 net checks (3 days) in the upstream most sub-reach, and for 4 net checks (4 days) in the lower 2 sub-reaches. Nets were fished for 4 net checks (4 days) in all sub-reaches during the November trip.

Redbud Canyon Camp

Personnel at this camp were responsible for fishing mini-hoopnets throughout the reach from rkm 5.0 to 10.0. Forty-five mini-hoopnets were fished throughout this reach and set, checked, and reset as above. The overall reach was broken down into three sub-reaches: rkm 8.4 to 10.0 (Redbud Canyon to above House Rock), rkm 6.8 to 8.4 (above White Spot to Redbud Canyon), and rkm 5.0 to 6.8 (rkm 5.0 to above White Spot). As above, nets were fished for 3 net checks (3 days) in the upstream most sub-reach, and for 4 net checks (4 days) in the lower 2 sub-reaches during the October trip. Nets were fished for 4 net checks (4 days) in all sub-reaches during the November trip.

Salt Trail Canyon Camp

Personnel at this camp were responsible for fishing mini-hoopnets throughout the reach from rkm 10.0 to 14.2. Forty-five mini-hoopnets were fished throughout this reach and each hoopnet was set, checked, and reset as above. The overall reach was broken down into three sub-reaches as follows: rkm 12.9 to 14.2 (Triple Drop to Lower Atomizer Falls), rkm 11.6 to 12.9 (Hell Hole to Triple Drop),

and rkm 10.0 to 11.6 (above House Rock to Hell Hole). As above, nets were fished for 3 net checks (3 days) in the upstream most sub-reach, and for 4 net checks (4 days) in the lower 2 sub-reaches during the October trip. Nets were fished for 4 net checks (4 days) in all sub-reaches during the November trip.

Biological and Habitat Sampling

Data collected for all captured fish included: fork and total lengths, weight, sex, sexual condition, and sexual characteristics. All HBC ≥ 100 mm TL were scanned for a PIT tag and if lacking a tag, injected with a PIT tag. All other native fish ≥ 150 mm TL were scanned for a PIT tag and if lacking a tag, injected with a PIT tag. All large bodied non-native fish were sacrificed and their stomach contents examined and recorded. Stream habitat characteristics associated with a particular net included: shoreline type and hydraulic unit. Turbidity was measured with a HACH 2100p turbidimeter at the Boulder Camp site.

Data Analysis

Mark-recapture experiments were used to estimate the abundance of HBC ≥ 100 mm TL in the lower 14.2 km of the Little Colorado River. Capture and sampling of fish occurred throughout the study reach during October 3-16 (marking event) and November 9-20 (recapture event). Fish ≥ 100 mm TL that had not previously been tagged were injected with an individually numbered PIT tag and the number recorded. The tag number of all previously tagged fish was recorded. At the end of the October trip, all HBC that had been either tagged during the October trip or

recaptured with a functioning PIT tag were considered the marked portion of the population.

As stated above, the target population (i.e., the size specific component of the population whose abundance is to be estimated) was all HBC ≥ 100 mm TL. However, frequently the target and sampled population (i.e., the size specific component of the population that is effectively sampled) differ and it is only possible to estimate the abundance of the sampled population. Therefore, we first examined our data to define our sampled population. Following Bernard and Hansen (1992) we defined the lower boundary of the sampled population equal to the length of the smallest recaptured fish. We defined the upper bound of the sampled population based on the size of the largest recaptured fish and the overall numbers of large fish captured in the experiment.

The Chapman modified Peterson two-sample mark-recapture model (Seber 1982) was used to estimate the abundance of the sampled population. Assumptions associated with this estimator are:

1. The population is closed, with no additions or losses between marking and recapture events (through recruitment, immigration, mortality, or emigration).
2. Marking does not affect capture probability during the recapture event.
3. All HBC ≥ 100 TL have an equal probability of capture during the marking event or the recapture event; or marked fish mix completely with unmarked fish prior to the recapture event.
4. Marks (tags) are not lost between the marking and recapture events.
5. All marked fish captured can be recognized from unmarked fish.

The first assumption addressing closure could potentially be violated in this system since HBC in the LCR have free access to the mainstem Colorado River. However, this assumption is likely met in our study given the short time period between the marking and recapture events and because HBC movement is thought to be at a minimum during this time of year (Douglas and Marsh 1996, Valdez and Ryel 1995). We also assumed that growth related recruitment did not occur due to the short hiatus between marking and recapture events. Finally, all fish captured during the study were handled with utmost care to avoid injury or stress related mortality.

If HBC emigrate from the LCR or die between sampling events, it is assumed that both marked and unmarked fish are lost to the experiment at the same rate. The Chapman-Peterson estimator can still be used in this circumstance, but the population estimate will be germane for the population during the marking event. Additionally, if HBC immigrate into the LCR between the two events, then the population estimate will be germane for the population during the recapture event. If both additions and losses occur between the events, there is no possible correction and the abundance estimate is biased high.

It was not possible to directly test the second assumption that addresses whether capture and handling during the first event affected the recapture probability in the second event. However, results of the tests examining violation of the third provided indirect evidence of whether the second assumption was violated. Again, careful handling of the fish throughout the study should have minimized problems of violating this assumption.

The third assumption addresses the notion of equal capture probability of all fish. This assumption can be violated if the capture gear (i.e., mini-hoopnets) is highly size selective. To determine if the probability of capture varied due to fish size, Kologorov-Smirnov tests were applied to the length data collected during both the capture and recapture events. The first test compared the length frequency distributions of fish captured during the recapture event with those captured during the marking event. The second test compared the length frequency distributions of fish marked during the marking event with those recaptured during the recapture event. Capture probability can also differ by location (i.e., along the LCR river corridor). During both capture and recapture events, sampling was equally distributed throughout the entire 14.2 km study area. To validate whether all fish had an equal probability of capture during the marking event regardless of their location, we used a contingency table analysis to test whether recapture rate differed among sampling reaches and sub-reaches. The results of these tests determined if modifications to the Chapman-Peterson estimator were necessary to minimize bias (Bernard and Hansen 1992).

The fourth assumption was not directly tested since an auxiliary mark (e.g. fin clip) was not applied to the fish. However, fish are routinely examined for evidence of an abdominal scar located near the pelvic fins associated with tagging. Though this scar is occasionally not visible on PIT tagged fish and is therefore a poor diagnostic tool for evaluating tag loss, very few, if any, fish displaying this scar were found that did not contain a PIT tag. We therefore conclude that tag loss was negligible during this experiment.

The fifth assumption relates to the ability of field personnel to detect the presence of a tag in a fish. We did not attempt to evaluate this assumption directly. However, our staff is trained in the proper operation of the PIT scanners and is exceedingly careful to ensure that PIT scanners are in good working order.

Abundance estimates were calculated with the formulae presented by Seber (1982) as:

$$N^* = \frac{(M+1)(C+1)}{R+1} - 1, \tag{7}$$

$$V[N^*] = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}, \tag{8}$$

where N^* is the estimated number of fish in the population, $V[N^*]$ is the estimated variance of the number of fish in the population, *M* is the number of fish marked during the marking event (October trip), *C* is the number of fish captured during the recapture event (November trip), and *R* is the number of fish recaptured in the recapture event.

In order to characterize the size distribution of the estimated fall population, the overall estimate of abundance was stratified to different length intervals (i.e., size classes). The appropriate estimation formulae from Seber (1982) are:

$$N_x^* = \frac{M_x + C_x - R_x}{M + C - R} N^*, \tag{9}$$

$$V[N_x^*] = N_x^{*2}\left[\frac{1}{M_x} + \frac{2}{M_x^{\,2}} + \frac{6}{M_x^{\,3}}\right] + \frac{N_x^*(N^* - N_x^*)}{(M+C+1)} \tag{10}$$

where the subscript *x* indicates fish that belong to a particular size class (e.g. 100-125 mm TL).

OCTOBER/NOVEMBER TRIP RESULTS

Physical Parameters

The Hydrolab water quality meter was not deployed during either the October or November trips due to the equipment needing repair. Mid-day water temperatures were approximately 13 °C during the October trip and 10 °C during the November trip. Air temperatures ranged from approximately 5 to 17 °C during the October Trip, and approximately –2 to 13 °C in November. Elevated water turbidity was observed during both trips (Figure 11).

Effort and Catch Composition

A total of 1,038 mini-hoopnet sets were conducted during the October and November trips yielding 24,572 hours of fishing effort (Table 9). The October trip had slightly less effort expended due to logistical concerns not required during the November trip. The distribution of effort was similar among the three reaches with Boulder camp expending slightly more effort during each trip. Fishing effort during these trips produced a catch of 1,319 fish (Table 10). The dominant species in the catch were HBC (673 fish) and fathead minnow (330 fish). The catches among the three camps were similar with the most extreme difference in the October trip between Boulder and Redbud Canyon camps (75 fish), and a 19 fish difference between Boulder and Salt Trail camps during the November trip.

Summaries of PIT tagging data for the October and November trips are presented in Appendices A-3 and A-4.

Population Abundance Estimation

A total of 321 unique HBC ≥ 100 were captured and released with PIT tags during the marking event (Table 11). During the recapture event, a total of 146 HBC ≥ 100 mm TL were captured, 20 of which were recaptures from the marking event. The smallest HBC recaptured had a total length of 136 mm TL and the largest recaptured HBC was 308 mm TL in total length. Although we did not recapture HBC larger than 308 mm TL, given the small number of fish ≥ 310 mm TL that were tagged in the marking event (4 fish) and examined in the recapture event (8 fish), we do not believe that there is sufficient evidence to conclude that we were unable to effectively sample the larger members of the population (Figure 12). As hoopnets have been shown to effectively capture large HBC in previous studies (Gorman and Stone 1999) and the literature suggests that most large individuals reside in the mainstem Colorado River during this time of year (Valdez and Ryel 1995), we believe that the observed low catches of large chub are due to their absence in the system rather than fishing gear selectivity. Based on these results, we chose to define our sampled population to include all HBC ≥ 135 mm TL. The data analyses that follow all use the truncated data sets corresponding to the sampled population.

The truncated data sets revealed that for HBC ≥ 135 mm TL, 262 were marked in the marking event, 126 were examined for marks in the recapture event, and 20

fish captured in the recapture event had been previously captured in the marking event. The variables in equations (7) and (8) were therefore defined as: M = 262, C = 126, and R = 20 (Table 11).

The cumulative length distribution of HBC captured and released during the marking event was not significantly different from HBC captured in the recapture event (n_1 = 262, n_2 = 126, D = 0.125, p = 0.142). Similarly, the cumulative length distribution of HBC recaptured during the recapture event was not significantly different than HBC marked and released in the marking event (n_1 = 262, n_2 = 20, D = 0.205, p = 0.418; Figure 13). We conclude from these tests that that there was no significant size selective gear bias within the sampled population and that our abundance estimator need not be stratified by size (Seber 1982, Bernard and Hansen 1992).

There was no significant difference (χ^2 = 2.80, df = 2, p = 0.246) in the recapture rate among the 3 sampling reaches or among the 9 sampling sub-reaches (χ^2 = 5.69, df = 8, p = 0.682; Table 12). We conclude from these tests that our abundance estimator need not be stratified by location. Based on the above tests, we chose an un-stratified Chapman-Peterson model to estimate the abundance of HBC ≥ 135 mm TL in the lower 14.2 km of the LCR. The estimated abundance was 1,590 (SE = 297) HBC (Table 13). Although there was not a significant difference in the recapture rate among sampling reaches indicating that pooling data across reaches was appropriate, it is informative to know the spatial distribution of HBC within the system. Therefore, we also

constructed area stratified abundance estimates. One can easily see that the majority (81%) of the population is concentrated in the lower and upper sampling reaches with the remaining 19% residing in the middle sampling reach (Table 13). The 95% confidence limits on the abundance estimates assume a poisson distribution appropriate given the ratios of R/C and R/M observed in this experiment (Seber 1982). Using equations (9) and (10), the total abundance estimate was also stratified by 10 mm total length intervals (Table 14, Figure 14). It is apparent that the majority (81%) of the population is smaller than 225 mm TL and that only 3% of the population was larger than 315 mm TL.

OCTOBER/NOVEMBER TRIP DISCUSSION

The abundance estimates obtained in this study agree fairly well with the most recent HBC stock assessment studies conducted in LCR. Douglas and Marsh (1996) reported the abundance of HBC in the lower LCR as 2,038, 1,989, 1,099, and 1,417 during October 1991, November 1991, October 1992, and November 1992, respectively (Table 15). The 95% confidence interval for the 2000 estimate contains the point estimates of all the October/November estimates constructed in the early 90s. Additionally, the average of the four 1991/92 fall estimates (1,636) differs from the year 2000 point estimate by less than 50 fish. However, the early 1991/92 estimates include only fish ≥ 150 mm TL total length while the 2000 estimate includes fish ≥ 135 mm TL. One would expect that if the abundance in 1991/1992 were the same as the abundance during 2000, an estimate including all fish ≥ 135 mm TL should be marked higher than an

estimate including only fish ≥ 150 mm TL. Therefore, although the 1991-1992 and 2000 estimates are not significantly different, there is the suggestion that 2000 abundance has decreased since the early 1990's. Given that the majority of the fish included in these estimates belong to the smaller and younger portion of the population, the implication is that recruitment during the late 1990's may have declined in relation to the late 1980's and early 1990's.

Environmental conditions in the fall of 2000 can be generally characterized as colder and wetter than normal. These conditions affected our field operations and the success of this experiment in a variety of ways. Elevated turbidity in the LCR generally reduced CPUE and contributed to lower than expected catches of HBC (USFWS 2000b, Van Haverbeke 2000). Additionally, a flood peaking at approximately 4000 cfs was observed upstream of our study reach at the USGS Cameron gauge during the hiatus between our marking and recapture events (USGS *unpublished data*). It is possible that there was some emigration between the marking and recapture events associated with this flood. However, our recapture data suggests that movement was not significant. Of the 20 fish recaptured, 13 fish (65%) were recaptured within 250 m of their initial capture location, 6 fish (30%) moved downstream more than 250 m, and 1 fish (5%) moved upstream more than 250 m. The largest movement was a fish that journeyed 2.5 km downstream. It is also possible that there was immigration into the LCR from fish that were in the Colorado River during the marking event. However, two issues suggest that immigration was either minimal or non-existent. The first is that all indications from the literature suggest that nearly all

movement from the Colorado River into the LCR is associated with late-winter or spring spawning migrations (Douglas and Marsh 1996, Valdez and Ryel 1995). Additionally, the fish that are associated with the spawning run are mature fish generally over 200 mm TL. Since our sampling occurred in fall and fish over 200 mm TL made up a fairly small portion of our sampled population, it is likely that immigration during our hiatus was not a problem. Finally, even if some emigration occurred, our abundance estimate is not biased and is germane to the number of fish present during the recapture event (Bernard and Hansen 1992).

LITERATURE CITED

Bernard, D.R. and P.A. Hansen. 1992. Mark-recapture experiments to estimate the abundance of fish. Alaska Department of Fish and Game, Special Publication No. 92-4. Anchorage, Alaska.

Clarkson, R.W. and M.R. Childs. 2000. Temperature effects of hypolimnial-release dams on early life stages of Colorado River Basin big-river fishes. Copeia 2000(2), pp. 402-412.

Douglas, M.E. and P.C. Marsh. 1996. Population estimates/population movements of *Gila cypha*, an endangered Cyprinid fish in the Grand Canyon region of Arizona. Copeia 1996(1), pp. 15-28.

GCMRC. *Unpublished*. Fish interim monitoring plan. Grand Canyon Monitoring and Research Center, Flagstaff, AZ.

Gorman, O.T. and D.M. Stone. 1999. Ecology of spawning humpback chub (*Gila cypha*), in the Little Colorado River near Grand Canyon, Arizona. Environmental Biology of Fishes 55: 115-133.

Harvey, B.C. 1987. Susceptibility of young-of-the-year fishes to downstream displacement by flooding. Transactions of the American Fisheries Society 116:851-855.

Hilborn, R. and C.J. Walters. 1992. Quantitative fisheries stock assessment: choice, dynamics, and uncertainty. Chapman and Hall, New York. 570 pp.

Kaeding L.R. and M.A. Zimmerman. 1983. Life history and ecology of humpback chub in the Little Colorado and Colorado Rivers of the Grand Canyon. Transactions of the American Fisheries Society 112:577-594.

Robinson, A.T., R.W. Clarkson and R. E. Forrest. 1998. Dispersal of larval fishes in a regulated river tributary. Transactions of the American Fisheries Society 127:772-786.

Seber, G.A.F. 1982. The Estimation of Animal Abundance, 2nd edition. Griffin, London. 654 pp.

Stone, D.M. 1999. Ecology of humpback chub (*Gila cypha*) in the Little Colorado River, near Grand Canyon, Arizona. Master's thesis. Northern Arizona University. 141 pp.

USFWS. *Unpublished*. Little Colorado River fish monitoring study plan. US Fish and Wildlife Service, Arizona Fishery Resources Office, Flagstaff, AZ.

LITERATURE CITED

USFWS. 2000a. Humpback chub stock assessment in the Little Colorado River. US Fish and Wildlife Service, Arizona Fishery Resources Office, Pinetop, AZ. Document Number: USFWS-AZFRO-FL-00-002.

USFWS. 2000b. Monitoring of native fishes of the Colorado River ecosystem in Grand Canyon: trip report, Little Colorado River, 3 October – 16 October 2000. US Fish and Wildlife Service, Arizona Fishery Resources Office, Pinetop, AZ. Document Number: USFWS-AZFRO-FL-00-003.

Valdez, R.A. and R.J. Ryel. 1995. Life history and ecology of the humpback chub (Gila cypha) in the Colorado River, Grand Canyon, Arizona. Final Report to Bureau of Reclamation, Salt Lake City, Utah. Contract No. 0-CS-40-09110. BIO/WEST Report No. TR-250-08. 286 pp.

Van Haverbeke, D.R. 2000. Monitoring of native fishes of the Colorado River ecosystem in Grand Canyon: trip report, Little Colorado River, November 9 – 20, 2000. US Fish and Wildlife Service, Arizona Fishery Resources Office, Pinetop, AZ. Document Number: USFWS-AZFRO-FL-00-004.

Walters, C.J. and D. Ludwig. 1994. Calculation of Bayes posterior probability distributions for key population parameters. Can. J. Fish. Aquat. Sci. 51:713-722.

Table 1. Summary of fish captured by camp, gear type, and species, Little Colorado River, April, 2000.

Camp	Gear	Species[a]									
		BHS	CCF	FHM	FMS	HBC	RBT	RSH	SPD	YBH	Total
Boulder	mini hoop net	17	1	4	3	128	2	8	89		252
Salt Trail	mini hoop net	150	5[b]	30	3	351	3	4	90	3	639
Upper Atomizer	mini hoop net	3	1	16		239	1	5	421	7	693
Total	mini hoop net	170	7	50	6	718	6	17	600	10	1584
Salt Trail	minnow trap								60		60
Total	minnow trap	0	0	0	0	0	0	0	60	0	60
Boulder	trammel net				9						9
Total	trammel net	0	0	0	9	0	0	0	0	0	9
Boulder	all gear	17	1	4	12	128	2	8	89	0	261
Salt Trail	all gear	150		30	3	351	3	4	150	3	699
Upper Atomizer	all gear	3	1	16		239	1	5	421	7	693
Grand Total	all gear	170	2	50	15	718	6	17	660	10	1653

[a] BHS = bluehead sucker (*Catostomus discobolus*); CCF = channel catfish (*Ictalurus punctatus*); FHM = fathead minnow (*Pimephales promelas*); FMS = flannelmouth sucker (*Catostomus latipinnis*); HBC = humpback chub (*Gila cypha*); RBT = rainbow trout (*Oncorhynchus mykiss*); RSH = red shiner (*Notropis lutrensis*); SPD = speckled dace (*Rhinichthys osculus*), YBH = yellow bullhead (*Ictalurus natalis*).

[b] 1 channel catfish captured by hand

Table 2. Summary of fishing effort in number of mini-hoop sets, hours, humpback chub (HBC) catch, and HBC catch per unit effort (CPUE; fish/hr) by camp, Little Colorado River, April 2000.

Camp	Effort		HBC	HBC
	Sets	Hours	Catch	CPUE
Boulder	198	2,485	128	0.052
Salt Trail	416	4,022	351	0.087
Upper Atomizer	166	1,969	239	0.121
Total	780	8,475	718	0.08471

Table 3. Summary of mini-hoopnet fishing effort by reach, Little Colorado River, June 2000.

Reach	Effort	
	net sets	hours
Pyramid Rock	308	3,923
Hell Hole	293	3,650
Lower Atomizer	250	3,137
Total	851	10,710

Table 4. Summary of fish captured by camp, calibration reach, gear type, and species, Little Colorado River, June 2000.

Camp	Calibration Reach	Gear	Species [a] BHS	CCF	CCP	CRP	FHM	FMS	HBC	PKF	RBT	SPD	YBH	Total
Salt Trail	Hell Hole	mini-hoopnet	140			6	23	2	65		1	190	2	429
Salt Trail	Pyramid Rock	mini-hoopnet	205			6	1	1	93			53	1	360
Salt Trail	N/A	Trip Seine	14			6		1	81	3		23		128
Lower Atomizer	Lower Atomizer	mini-hoopnet	5	1	2		66	1	189			237	1	502
Grand Total		All	364	1	2	18	90	5	428	3	1	503	4	1419

[a] BHS = bluehead sucker (*Catostomus discobolus*); CCF = channel catfish (*Ictalurus punctatus*); CRP = common carp (*Cyprinus carpio*); FHM = fathead minnow (*Pimephales promelas*); FMS = flannelmouth sucker (*Catostomus latipinnis*); HBC = humpback chub (*Gila cypha*); plains killifish (*Funulus zebrinus*); RBT = rainbow trout (*Oncorhynchus mykiss*); SPD = speckled dace (*Rhinichthys osculus*), YBH = yellow bullhead *(Ictalurus natalis*).

Table 5. Summary of humpback chub (HBC) catch rate (CPUE; fish/hour) during night and day periods, HBC captures, HBC marks, and HBC recaptures by size and haul in the Lower Atomizer Falls reach, Little Colorado River, June 2000.

	HBC all Size Classes					HBC < 200 mm					HBC ≥ 200 mm				
	CPUE					CPUE					CPUE				
Haul	NIGHT	DAY	Captured	Marked	Recaptured	NIGHT	DAY	Captured	Marked	Recaptured	NIGHT	DAY	Captured	Marked	Recaptured
A	8.63E-02		22	22	0	3.90E-02		10	10	0	4.73E-02		12	12	0
B		7.99E-02	12	9	3		7.10E-02	11	8	3		8.89E-03	1	1	0
C	1.97E-02		6	5	1	7.89E-03		3	2	1	1.18E-02		3	3	0
D		7.07E-02	13	10	3		7.07E-02	12	10	2		0.00E+00	1	0	1
E	4.51E-02		15	11	4	9.10E-03		4	2	2	3.60E-02		11	9	2
F		3.50E-02	9	6	3		2.30E-02	4	4	0		1.20E-02	5	2	3
G	8.57E-03		4	2	2	8.57E-03		4	2	2	0.00E+00		0	0	0
H		3.60E-02	41	31	10		3.60E-02	8	6	2		0.00E+00	33	25	8
I	4.02E-03		3	2	1	4.02E-03		3	2	1	0.00E+00		0	0	0
J		3.85E-02	9	4	5		2.74E-02	7	3	4		1.11E-02	2	1	1
K	1.78E-02		12	4	8	0.00E+00		0	0	0	1.78E-02		12	4	8
L		2.40E-02	3	3	0		1.57E-02	2	2	0		8.30E-03	1	1	0
M	8.86E-03		6	2	4	8.86E-03		3	2	1	0.00E+00		3	0	3
N		3.76E-02	16	7	9		2.30E-02	5	3	2		1.45E-02	11	4	7
O	1.35E-02		8	3	5	8.92E-03		3	2	1	4.55E-03		5	1	4
P		1.73E-02	10	5	5		1.73E-02	4	2	2		0.00E+00	6	3	3

Table 6. Summary of humpback chub (HBC) catch rate (CPUE; fish/hour) during night and day periods, HBC captures, HBC marks, and HBC recaptures by size and haul in the Pyramid Rock and Hell Hole reaches, Little Colorado River, June 2000.

Pyramid Rock Reach

	HBC all Size Classes						HBC < 200 mm						HBC ≥ 200 mm					
	CPUE						CPUE						CPUE					
Haul	NIGHT	DAY	Captured	Marked	Recaptured	Removed	NIGHT	DAY	Captured	Marked	Recaptured	Removed	NIGHT	DAY	Captured	Marked	Recaptured	Removed
A	2.82E-02		21	14	0	7	1.91E-02		14	7	0	7	9.13E-03		7	7	0	0
B		3.74E-02	18	5	4	9		3.74E-02	17	5	3	9		0.00E+00	1	0	1	0
C	9.82E-03		9	2	2	5	9.82E-03		9	2	2	5	0.00E+00		0	0	0	0
D		3.92E-02	13	3	1	9		3.17E-02	11	1	1	9		7.51E-03	2	2	0	0
E	5.08E-03		6	2	2	2	3.85E-03		5	1	2	2	1.23E-03		1	1	0	0
F		3.90E-02	19	3	7	9		3.90E-02	17	3	5	9		0.00E+00	2	0	2	0
G	4.20E-03		5	1	2	2	4.20E-03		5	1	2	2	0.00E+00		0	0	0	0

Hell Hole Reach

	HBC all Size Classes						HBC < 200 mm						HBC ≥ 200 mm					
	CPUE						CPUE						CPUE					
Haul	NIGHT	DAY	Captured	Marked	Recaptured	Removed	NIGHT	DAY	Captured	Marked	Recaptured	Removed	NIGHT	DAY	Captured	Marked	Recaptured	Removed
A	1.78E-02		9	6	0	3	1.39E-02		7	4	0	3	3.94E-03		2	2	0	0
B		1.91E-02	8	3	2	3		1.91E-02	7	3	1	3		0.00E+00	1	0	1	0
C	5.80E-03		4	1	0	3	5.80E-03		4	1	0	3	0.00E+00		0	0	0	0
D		3.71E-02	14	2	2	10		3.47E-02	13	1	2	10		2.39E-03	1	1	0	0
E	5.57E-03		6	0	2	4	5.57E-03		5	0	1	4	0.00E+00		1	0	1	0
F		3.59E-02	13	2	1	10		3.59E-02	12	2	0	10		0.00E+00	1	0	1	0
G	1.13E-02		11	3	3	5	9.88E-03		10	2	3	5	1.47E-03		1	1	0	0

Table 7. Humpback chub (HBC) abundance, density, and river-wide abundance by calibration reach and size.

			Abundance (Fish)			Density (Fish/km)			River Wide Expansion (Fish) [a]		
Reach	Length (m)	Size [b]	Deplet. [c]	M-R [d]	Total [e]	Deplet. [c]	M-R [d]	Total [e]	Deplet. [c]	M-R [d]	Total [e]
Pyramid Rock	281	All Fish	89	109	107	317	388	381	4,730	5,780	5,674
Hell Hole	160	All Fish	NC [f]	84	92	NA	525	575	NA	7,823	8,568
Lower Atomizer	197	All Fish	165	198	189	839	1,005	959	12,498	14,976	14,295
Pyramid Rock	281	<200	582	84	84	2,071	299	299	30,860	4,454	4,454
Hell Hole	160	<200	NC [f]	82	95	NA	513	594	NA	7,636	8,847
Lower Atomizer	197	<200	77	112	99	389	569	503	5,794	8,471	7,488
Pyramid Rock	281	≥200	7	16	10	25	57	37	371	848	552
Hell Hole	160	≥200	3	4	5	19	25	31	279	373	466
Lower Atomizer	197	≥200	NC [f]	89	92	NA	452	467	NA	6,731	6,958

[a] Expansion conducted by expanding the density estimate to the lower 14.9 km of the Little Colorado River.

[b] Total Length (mm).

[c] Estimate from depletion methods.

[d] Estimate from mark-recapture methods.

[e] Estimate from joint likelihood of depletion and mark-recapture.

[f] Estimator did not converge.

Table 8. Estimated catchability coefficient (q) of humpback chub by reach, size, and time of day.

Reach	Size [a]	Estimated q	
		Night	Day
Pyramid Rock	All Fish	1.412E-04	5.950E-04
Hell Hole	All Fish	1.351E-04	4.190E-04
Lower Atomizer	All Fish	1.478E-04	3.554E-04
Pyramid Rock	<200	1.603E-04	7.139E-04
Hell Hole	<200	1.139E-04	3.817E-04
Lower Atomizer	<200	1.537E-04	5.189E-04
Pyramid Rock	≥200	8.778E-04	2.545E-52
Hell Hole	≥200	8.258E-04	1.762E-52
Lower Atomizer	≥200	3.002E-04	2.219E-04

[a] Total length (mm)

Table 9. Summary of fishing effort in number of mini-hoopnet sets and hours by camp and trip in the Little Colorado River, 2000.

Trip	Camp	Effort	
		Sets	Hours
October			
	Salt Trail Camp	165	3,809
	Redbud Canyon Camp	165	3,821
	Boulder Camp	165	4,085
	Total	495	11,715
November			
	Salt Trail Camp	180	4,263
	Redbud Canyon Camp	180	4,254
	Boulder Camp	183	4,340
	Total	543	12,857
Grand Total		1,038	24,572

Table 10. Mini-hoopnet catch by species, camp, and trip in the Little Colorado River, 2000.

Trip	Camp	SPECIES [a]											Total
		BBH	BHS	CCF	CRP	FHM	FMS	HBC	RBT	RSH	SPD	YBH	
October													
	Salt Trail Camp	1	2	1	5	132	4	136	1		12	11	305
	Redbud Canyon Camp	2	8	6	29	49	1	158		2	7	8	270
	Boulder Camp		10	6	14	57	38	189	4	1	25	1	345
	Total	3	20	13	48	238	43	483	5	3	44	20	920
November													
	Salt Trail Camp	5		1	5	43	1	71	1		10	3	140
	Redbud Canyon Camp	6		6	9	32	1	63	1	1	7	12	138
	Boulder Camp	10		2	5	17	6	56	7	1	12	5	121
	Total	21		9	19	92	8	190	9	2	29	20	399
Grand Total		24	20	22	67	330	51	673	14	5	73	40	1,319

[a] BBH = black bullhead (*Ictalurus melas*); BHS = bluehead sucker (*Catostomus discobolus*); CCF = channel catfish (*Ictalurus punctatus*); CRP = common carp (*Cyprinus carpio*); FHM = fathead minnow (*Pimephales promelas*); FMS = flannelmouth sucker (*Catostomus latipinnis*); HBC = humpback chub (*Gila cypha*); RBT = rainbow trout (*Oncorhynchus mykiss*); RSH = red shiner (*Notropis lutrensis*); SPD = speckled dace (*Rhinichthys osculus*), YBH = yellow bullhead (*Ictalurus natalis*).

Table 11. Summary of capture data of humpback chub during two sampling events in the Little Colorado River, 2000. Upper table presents captures of all fish large enough to be PIT tagged. Lower table presents captures of fish within the sampled portion (≥ 135 mm TL) of the population.

Fish ≥ 100 mm total length

Event	Date	Marked	Examined for Marks	Recaptures
Marking	10/3-16/00	321		
Recapture	11/9-20/00		146	20

Fish ≥ 135 mm total length

Event	Date	Marked	Examined for Marks	Recaptures
Marking	10/3-16/00	262		
Recapture	11/9-20/00		126	20

Table 12. Number of humpback chub recaptured and not recaptured during the recapture event by reach and sub-reach in the Little Colorado River, 2000.

Reach	Recaptured	Not Recaptured	Recapture Rate
Salt Trail Camp	7	49	13%
Redbud Canyon Camp	9	28	24%
Boulder Camp	4	29	12%
Total	20	106	16%

Ho: Recapture rate among reaches is the same.
Fail to reject null hypothesis (χ^2 =2.80 , p =0.246)

Reach	Sub-reach	Recaptured	Not Recaptured	Recapture Rate
Salt Trail Camp	1	1	14	7%
	2	2	5	29%
	3	4	30	12%
Redbud Canyon Camp	1	2	10	17%
	2	6	14	30%
	3	1	4	20%
Boulder Camp	1	1	6	14%
	2	2	14	13%
	3	1	9	10%
Total		20	106	16%

Ho: Recapture rate among sub-reaches is the same.
Fail to reject null hypothesis (χ^2 =5.69 , p =0.682)

Table 13. Population Estimates for humpback chub ≥ 135 mm TL in the lower 14.2 km of the Little Colorado River, October-November, 2000.

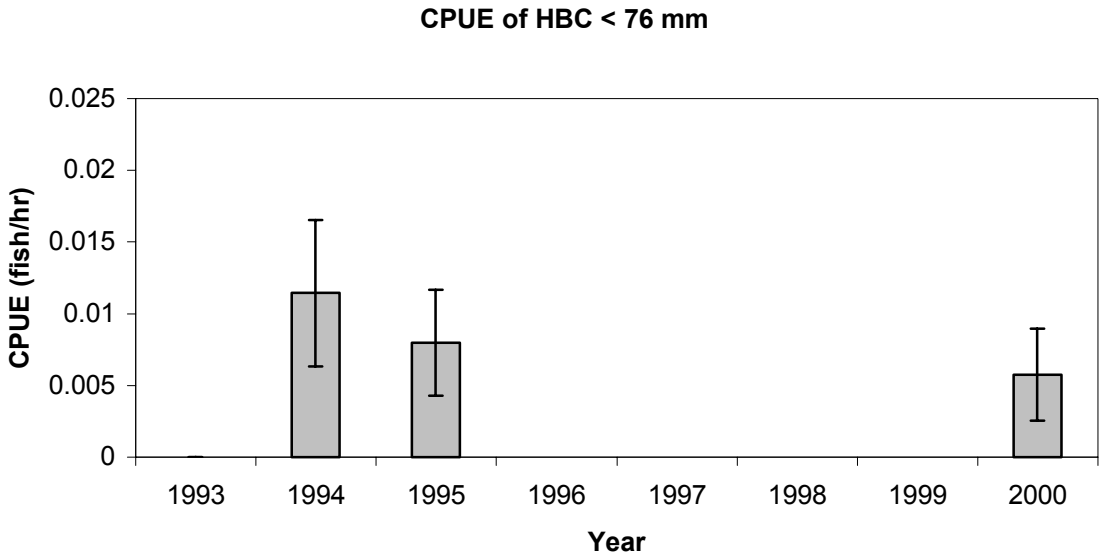
Method	Estimate	N	var(N)	SE(N)	CV(N)	Low 95%	Upp95%
All Pooled	Total Population	1,590	88,312	297	18.7%	992	2,552
Stratified by Reach	Sum of Reaches	1,592	94,368	307	19.3%		
	Salt Trail Camp	733	47,447	218	30%	320	1,765
	Redbud Canyon Camp	303	5,417	74	24%	145	634
	Boulder Camp	557	41,504	204	37%	184	1,973

Table 14. Population Estimates for humpback chub ≥ 135 mm TL in the lower 14.2 km of the Little Colorado River stratified by 10 mm length interval, October-November, 2000.

Total Length interval (mm)	N^*_x	var(N^*_x)	SE(N^*_x)
135-144	130	1422	38
145-154	147	1747	42
155-164	125	1346	37
165-174	160	2011	45
175-184	177	2391	49
185-194	177	2391	49
195-204	173	2293	48
205-214	99	931	31
215-224	99	931	31
225-234	56	397	20
235-244	43	276	17
245-254	39	239	15
255-264	30	172	13
265-274	35	205	14
275-284	13	62	8
285-294	22	113	11
295-304	9	39	6
305-314	4	19	4
315-324	0	0	0
325-334	4	19	4
335-344	4	19	4
345-354	4	19	4
355-364	4	19	4
365-374	9	39	6
375-384	9	39	6
385-394	9	39	6
395-404	4	19	4
405-414	0	0	0
415-425	4	19	4

Table 15. Estimated abundance of humpback chub during October and November 1991, 1992, and 2000 in the lower Little Colorado River.

Date	Abundance Estimate	SE	95 % Confidence Interval Lower	95 % Confidence Interval Upper	Reach (rkm) [a]	Sampled [b] population
October 1991	2,038	518	1,276	3,368	0 - 14.9	≥ 150 mm
November 1991	1,989	489	1,264	3,235	0 - 14.9	≥ 150 mm
October 1992	1,099	60	990	1,224	0 - 14.9	≥ 150 mm
November 1992	1,417	408	839	2,500	0 - 14.9	≥ 150 mm
Average Oct. & Nov. 91-92	1,636					
October/November 2000	1,590	297	992	2,552	0 - 14.2	≥ 135 mm



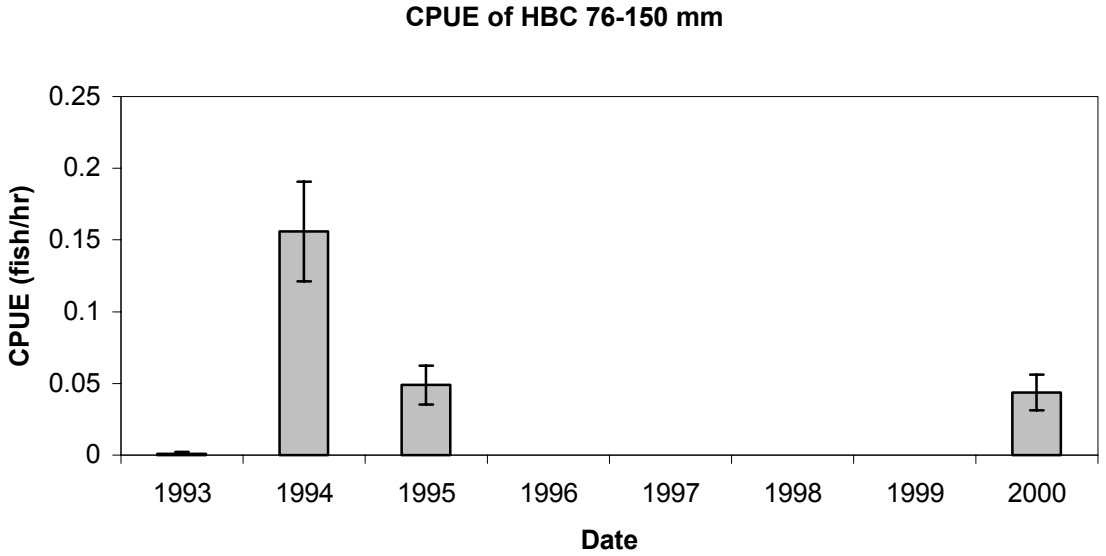


Figure 1. Catch rate (CPUE) of humpback chub (HBC) ≤ 150 mm TL captured at Salt Trail Camp, Little Colorado River, April 1993-1995, 2000. Error Bars represent 95% confidence intervals about the mean. Sampling did not occur during 1996 – 1999.

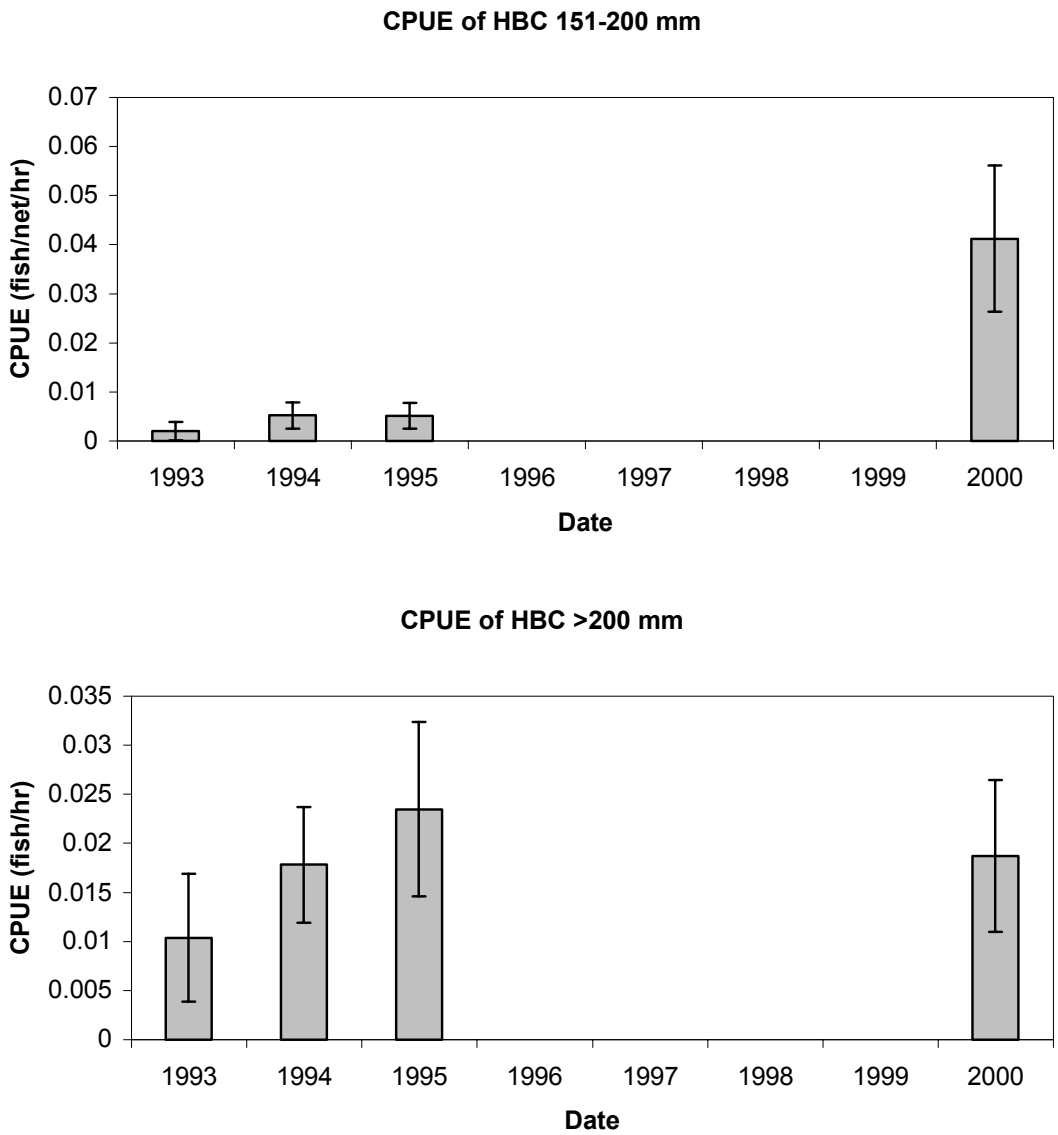


Figure 2. Catch rate (CPUE) of humpback chub (HBC) > 150 mm TL captured at Salt Trail Camp, Little Colorado River, April 1993-1995, 2000. Error Bars represent 95% confidence intervals about the mean. Sampling did not occur during 1996 – 1999.

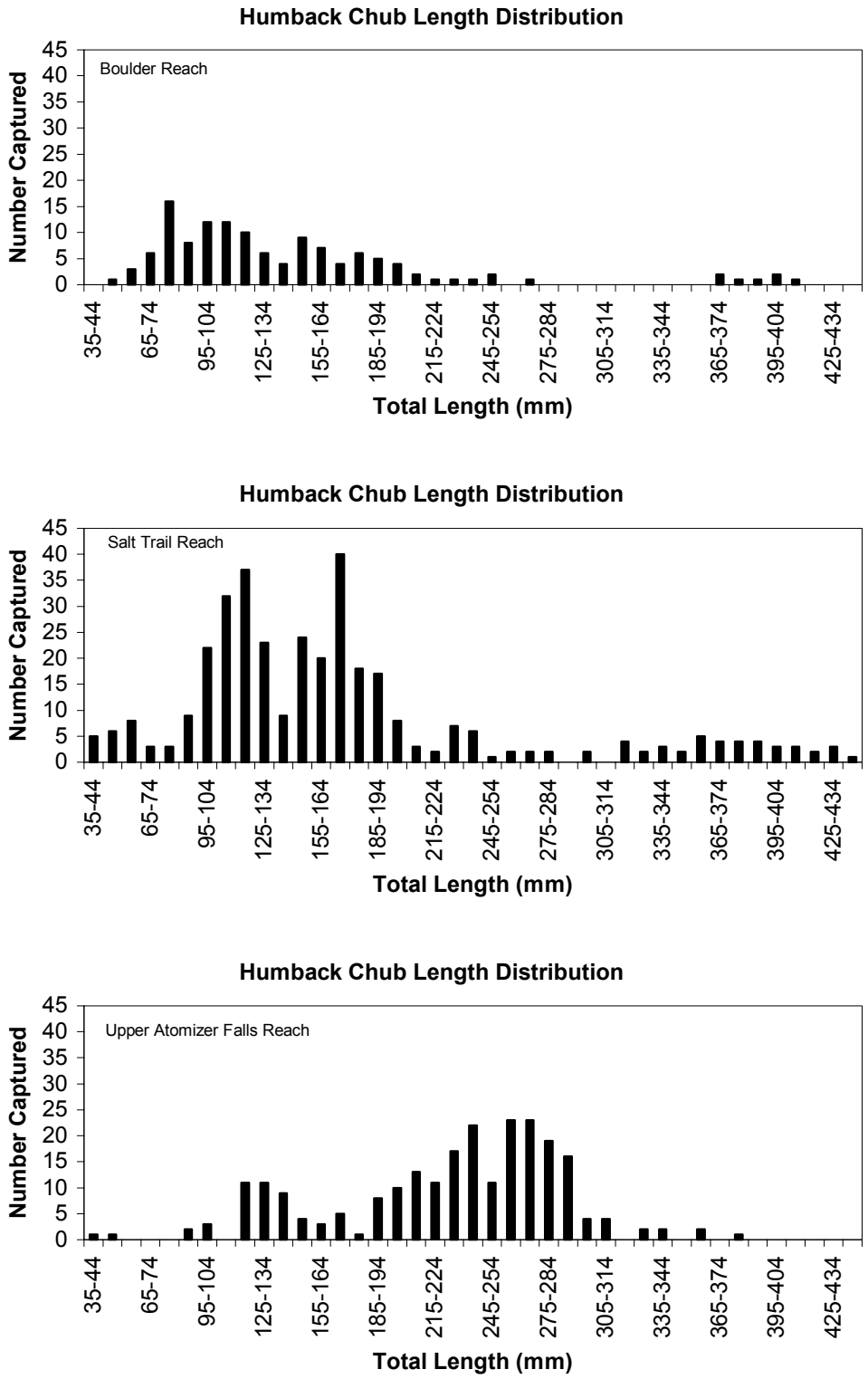


Figure 3. Total length frequency distributions of humpback chub captured at each of the three camps, Little Colorado River, April 2000.

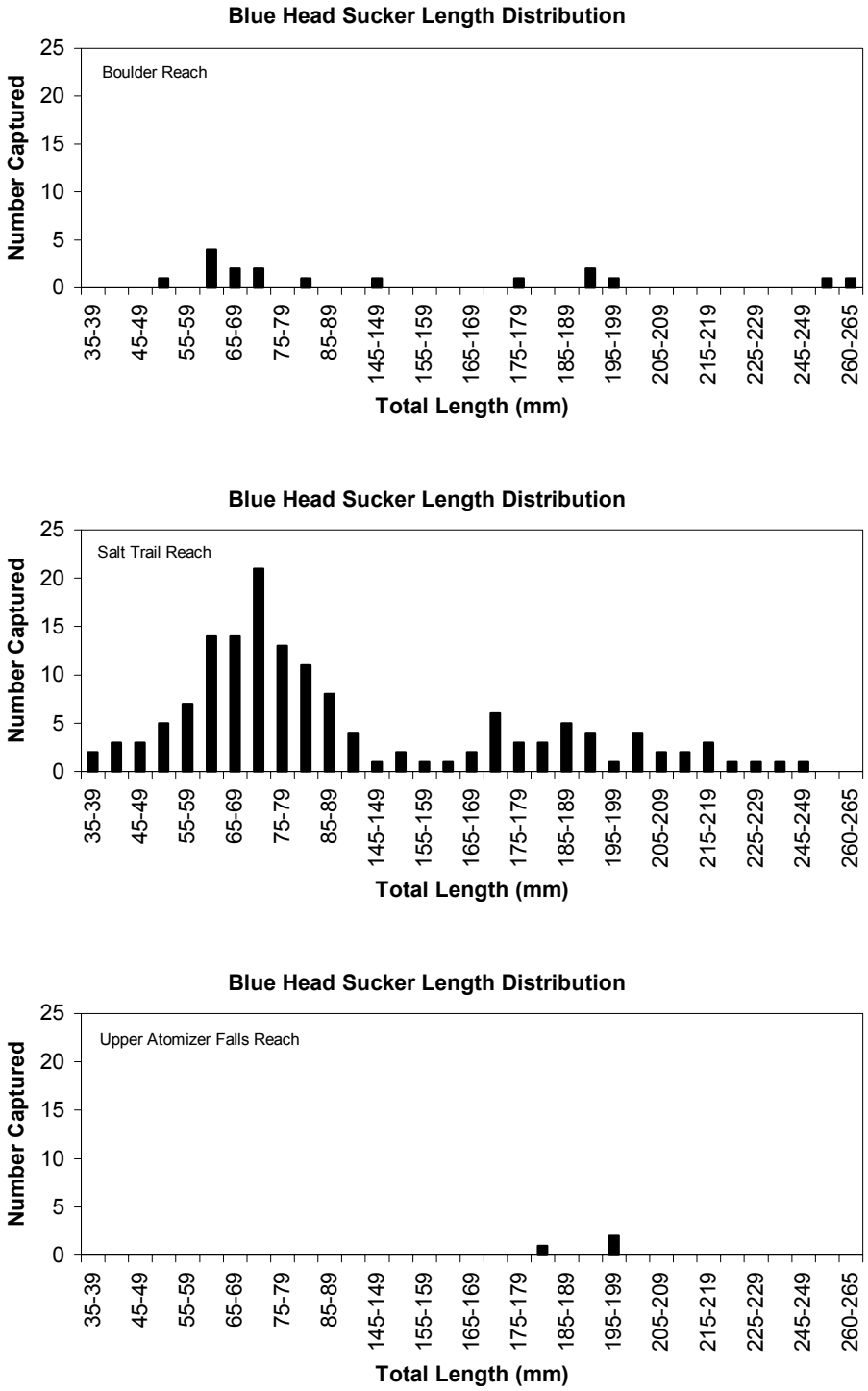


Figure 4. Total length frequency distributions of bluehead sucker captured at each of the three camps, Little Colorado River, April 2000.

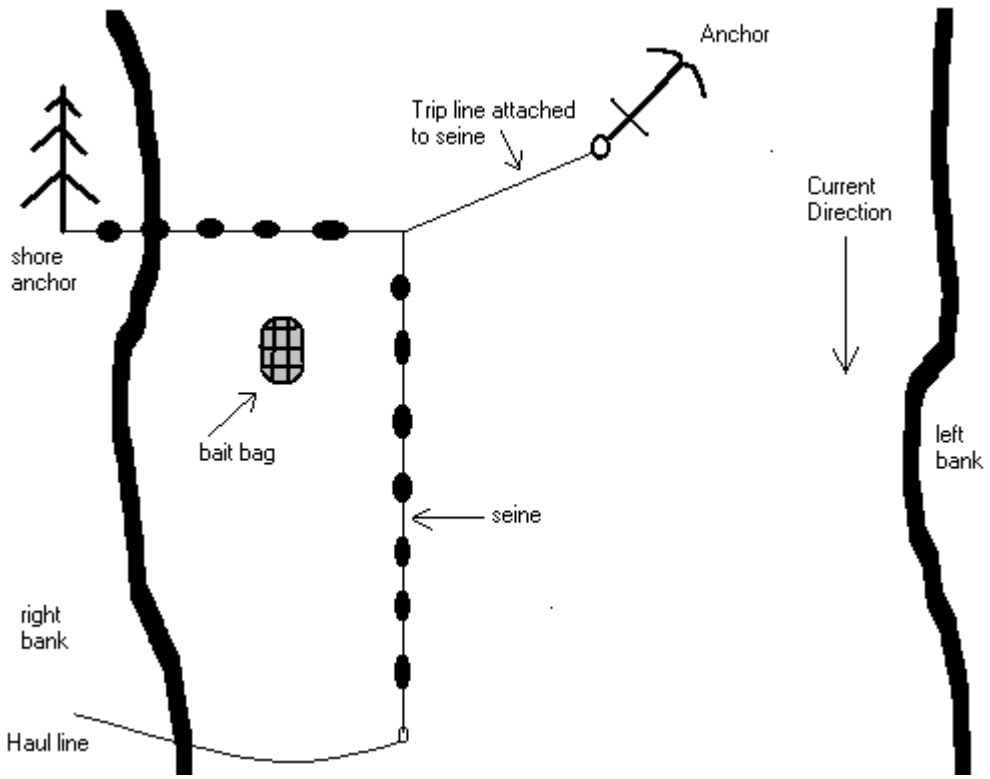


Figure 5 Schematic of trip seine used at Salt Trail Camp, Little Colorado River, June 2000.

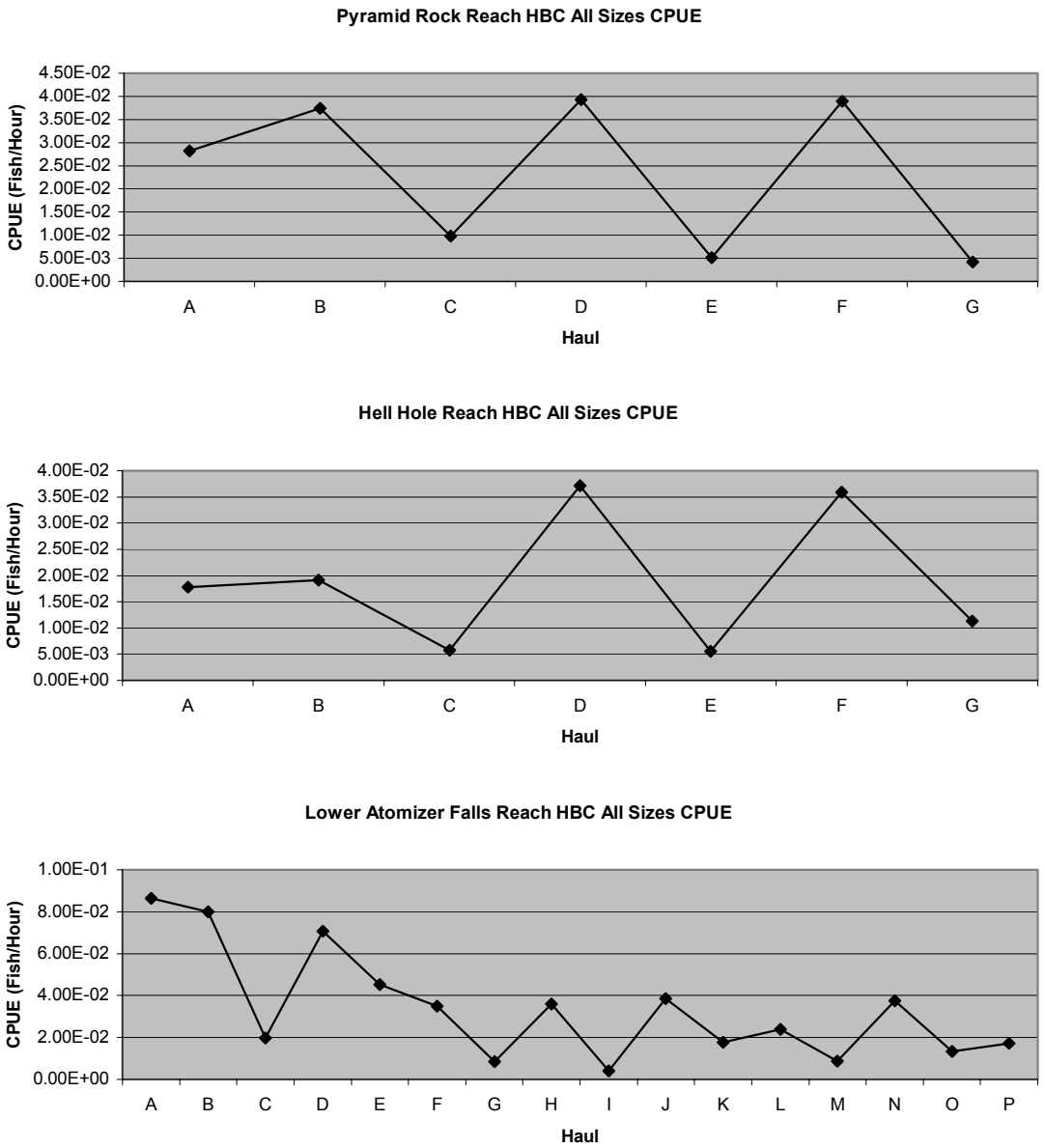


Figure 6. CPUE of humpback chub (HBC) of all sizes by haul for each of the calibration study reaches, Little Colorado River, June 2000. Hauls alternate between day and night fishing efforts (A, C, E, … = Night and B, D, F, … = Day).

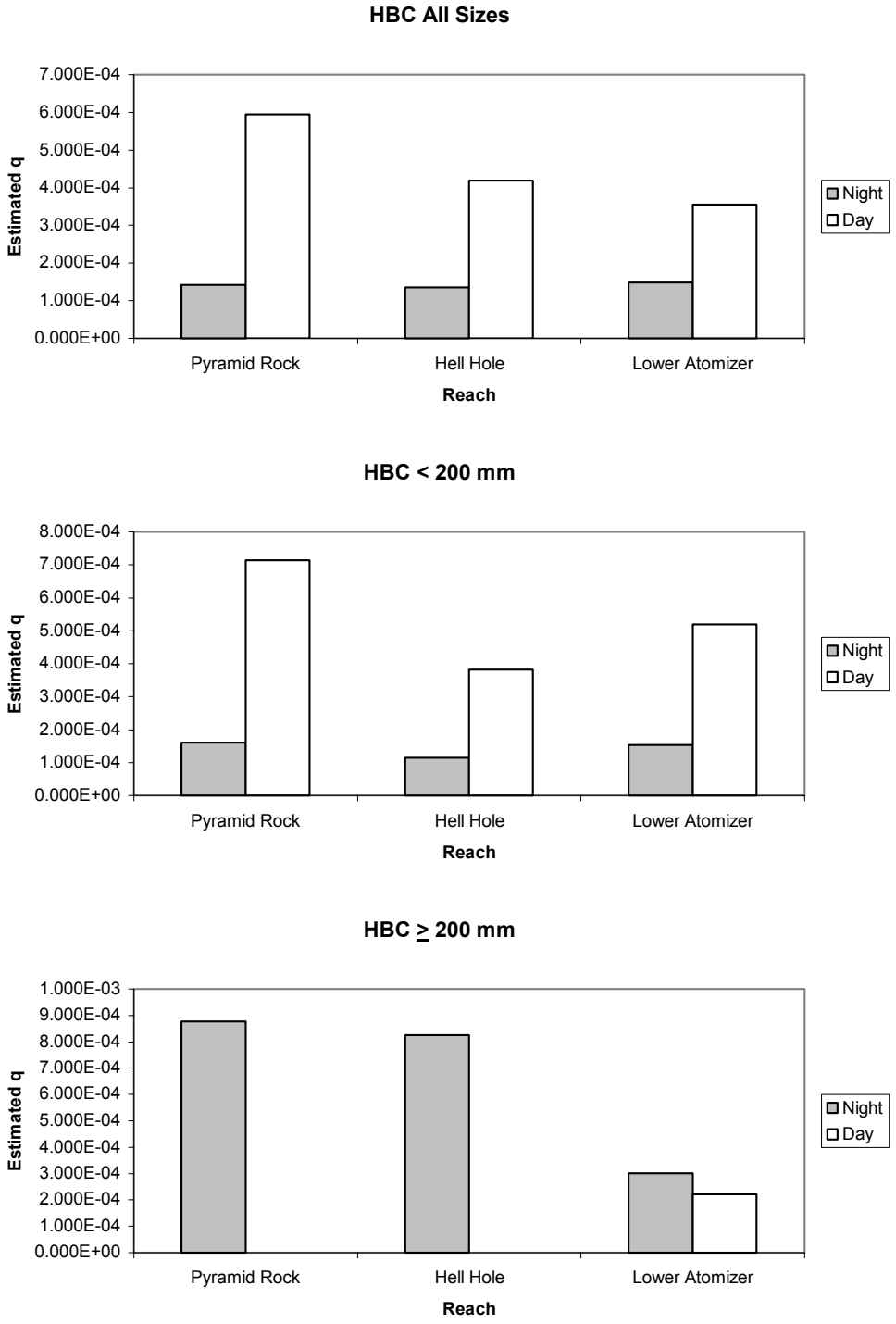


Figure 7. Estimated catchability coefficient (q) of humpback chub (HBC) for day and night fishing periods by calibration reach and size (total length (mm)), Little Colorado River, June 2000.

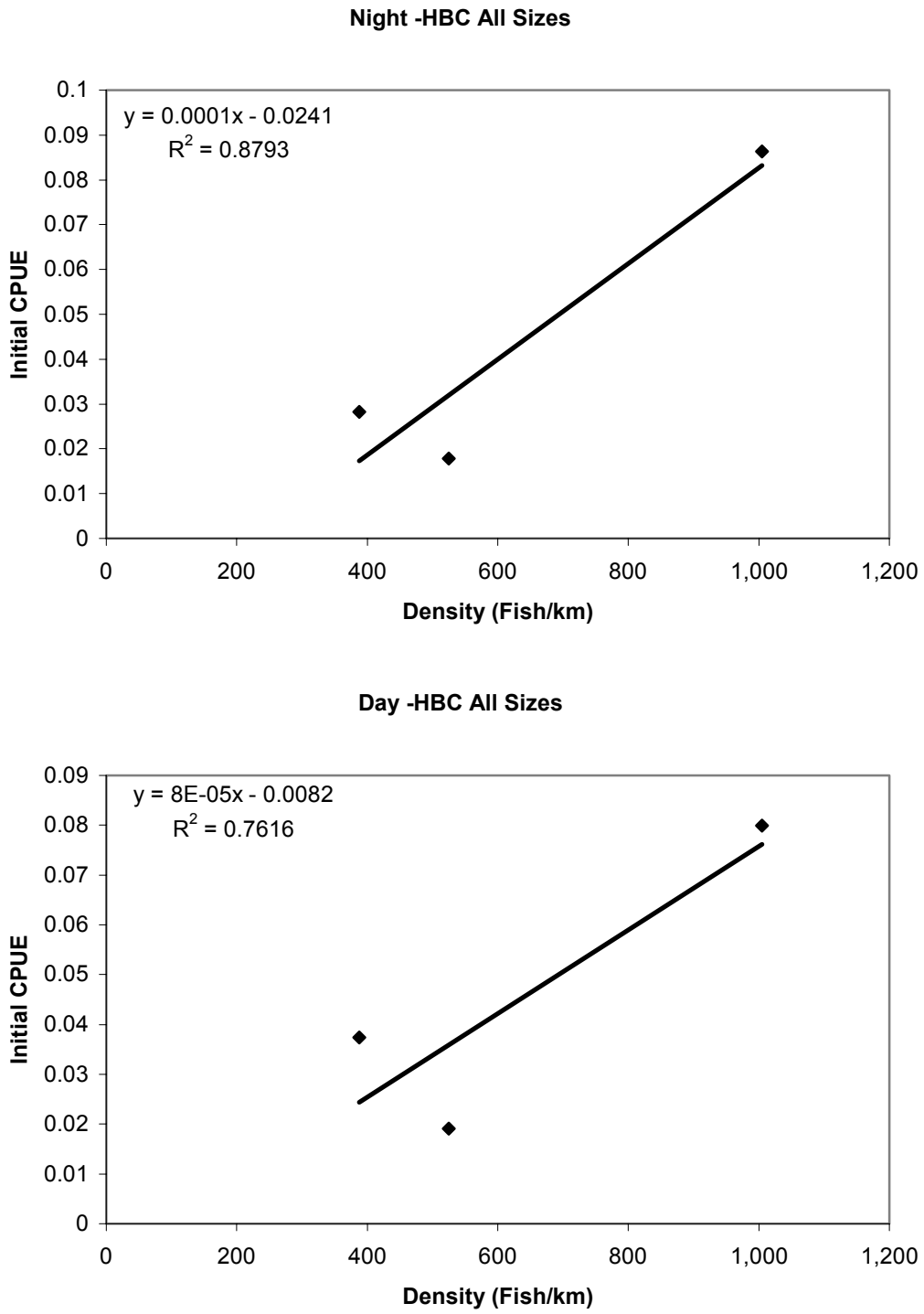


Figure 8. Linear relationship between humpback chub (HBC) density and initial CPUE for night and day fishing efforts for fish of all sizes (total length), Little Colorado River, June 2000.

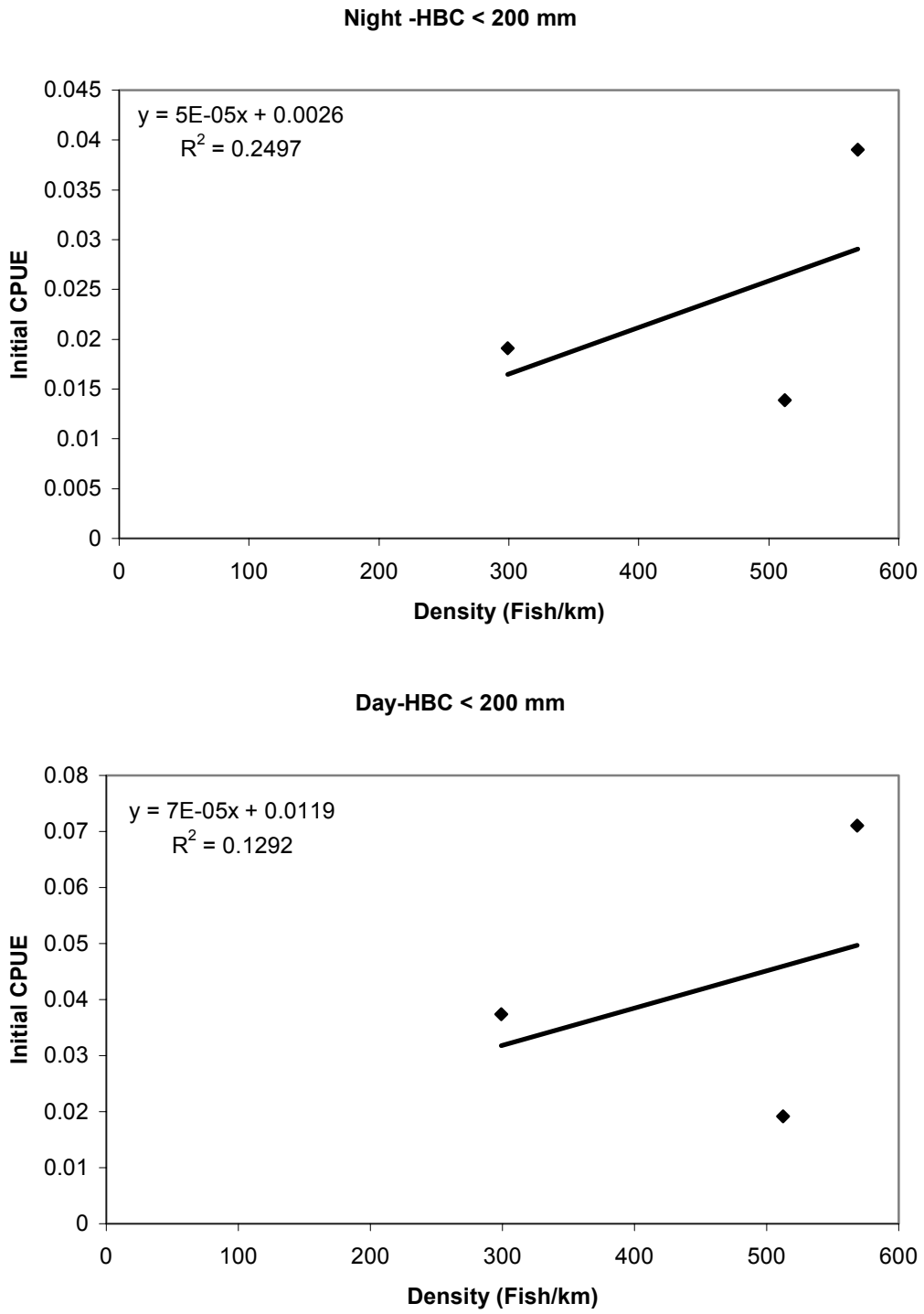


Figure 9. Linear relationship between humpback chub (HBC) density and initial CPUE for night and day fishing efforts for fish < 200 mm TL, Little Colorado River, June 2000.

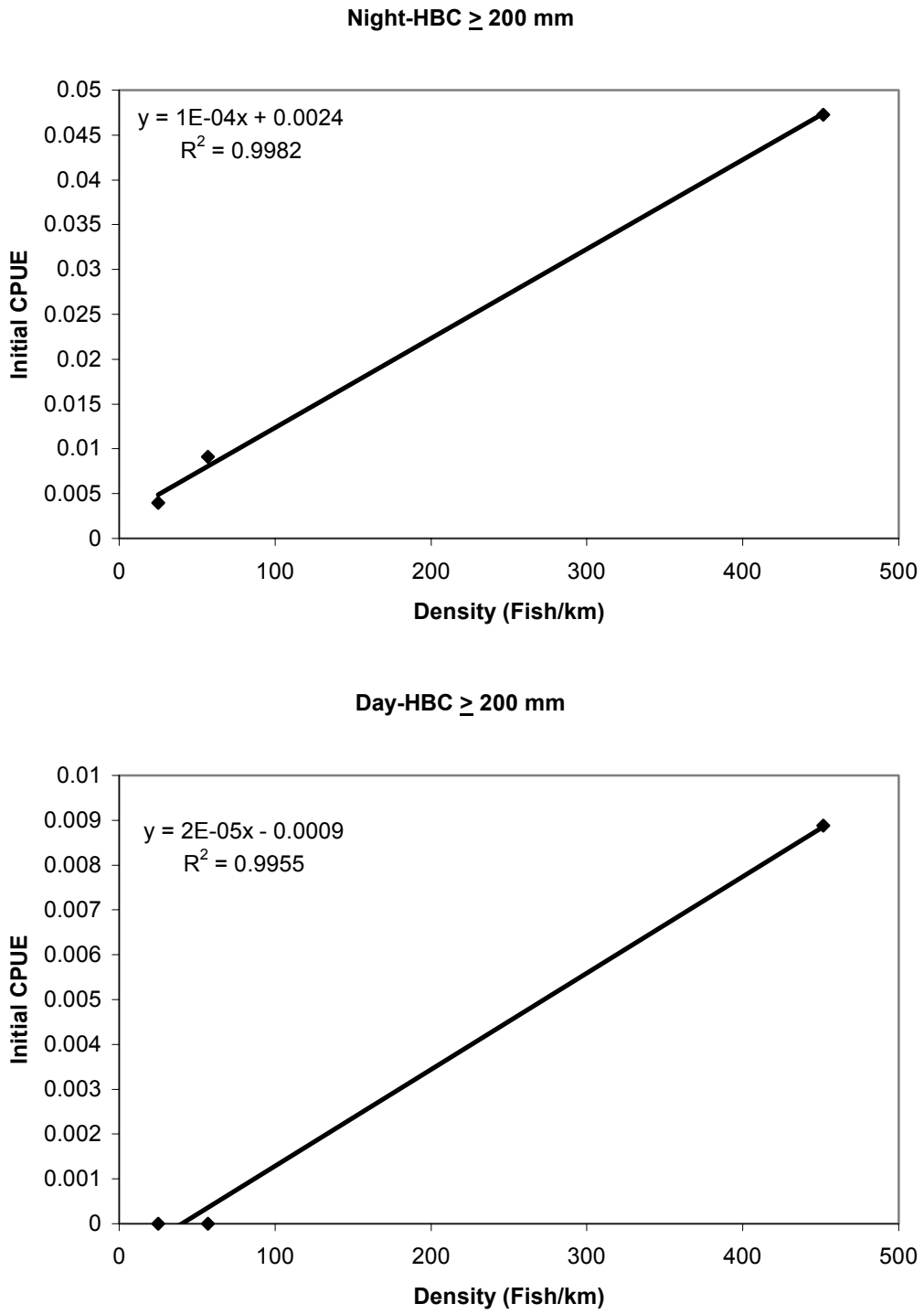


Figure 10. Linear relationship between humpback chub (HBC) density and initial CPUE for night and day fishing efforts for fish ≥ 200 mm TL, Little Colorado River, June 2000.

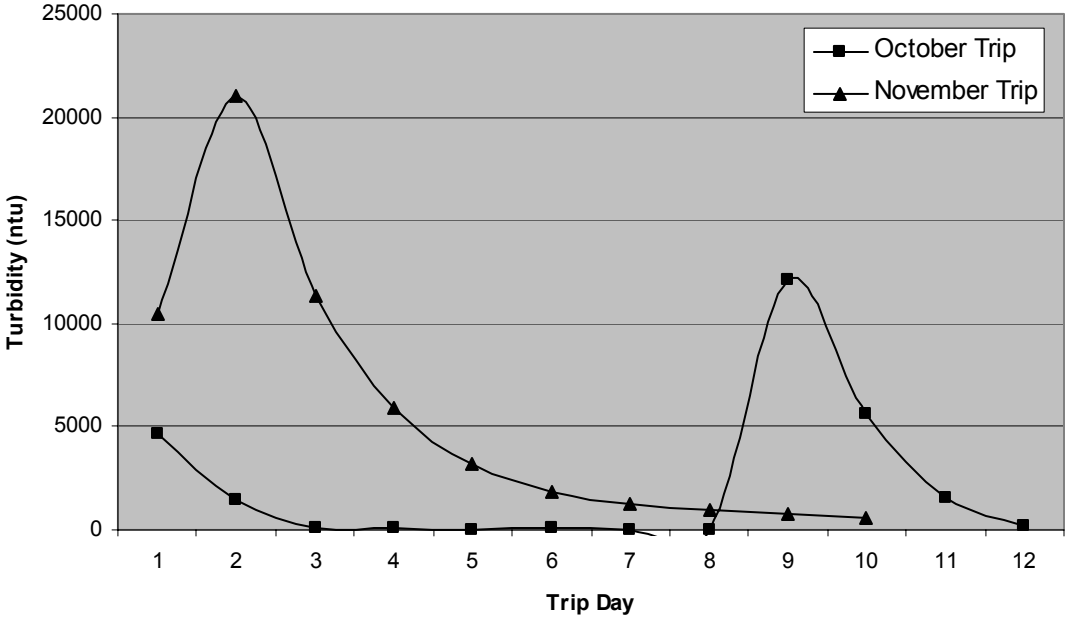


Figure 11. Observed turbidity during the October and November trips in the Little Colorado River, 2000.

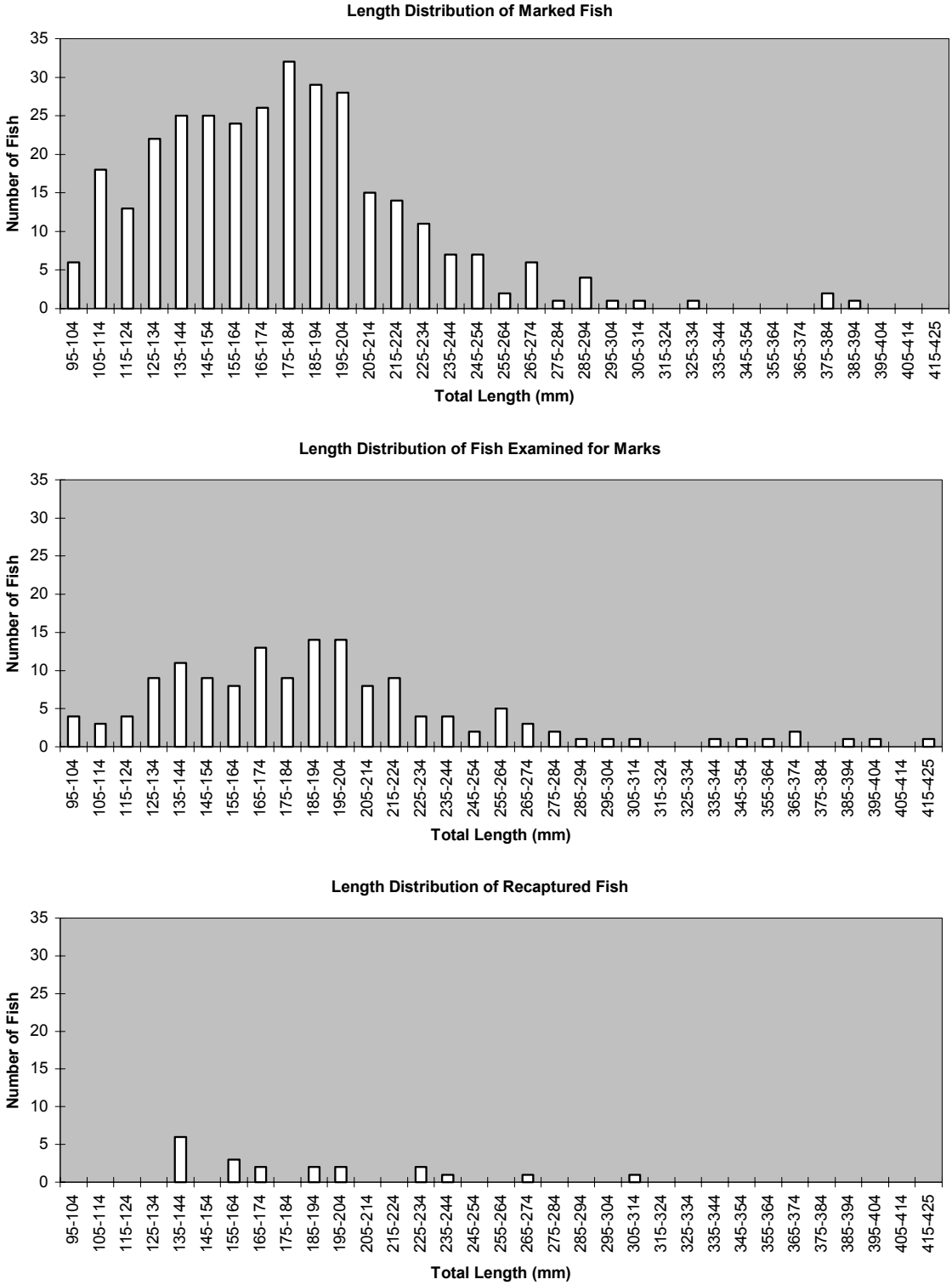
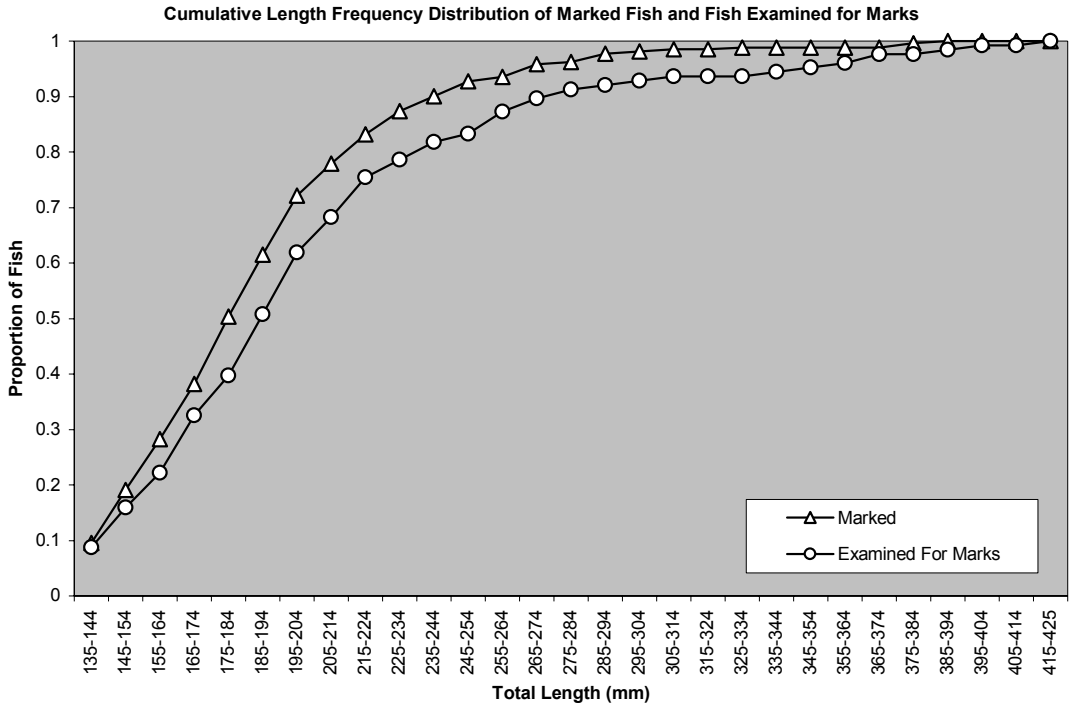


Figure 12. Length distributions of all humpback chub large enough to be PIT tagged captured during the marking and recapture events in the Little Colorado River, 2000.



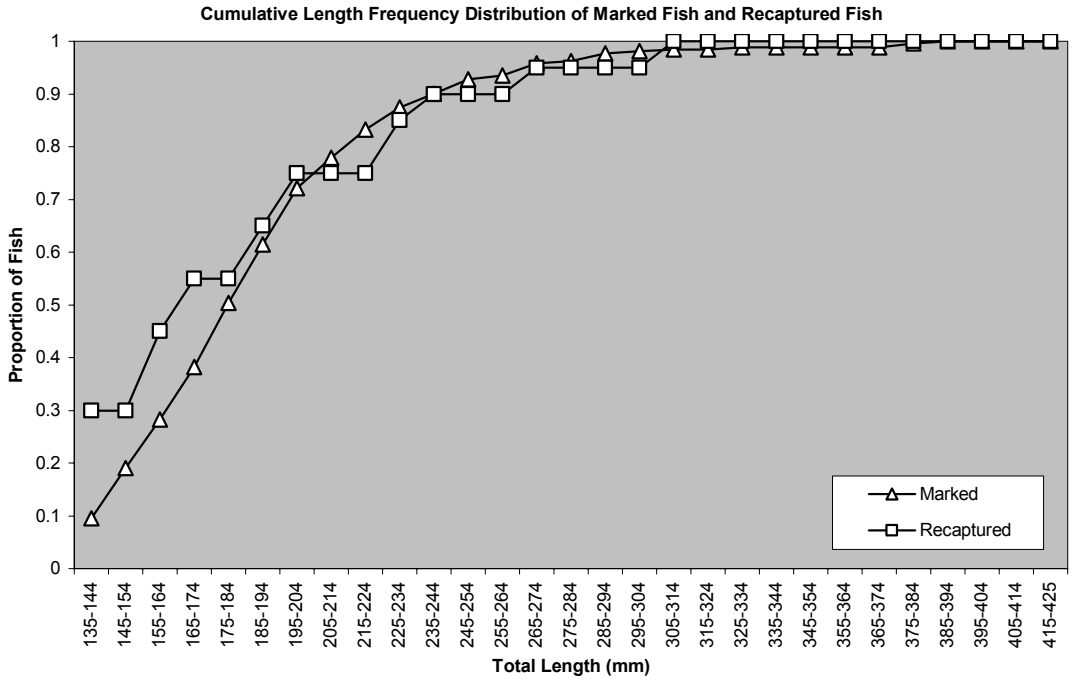
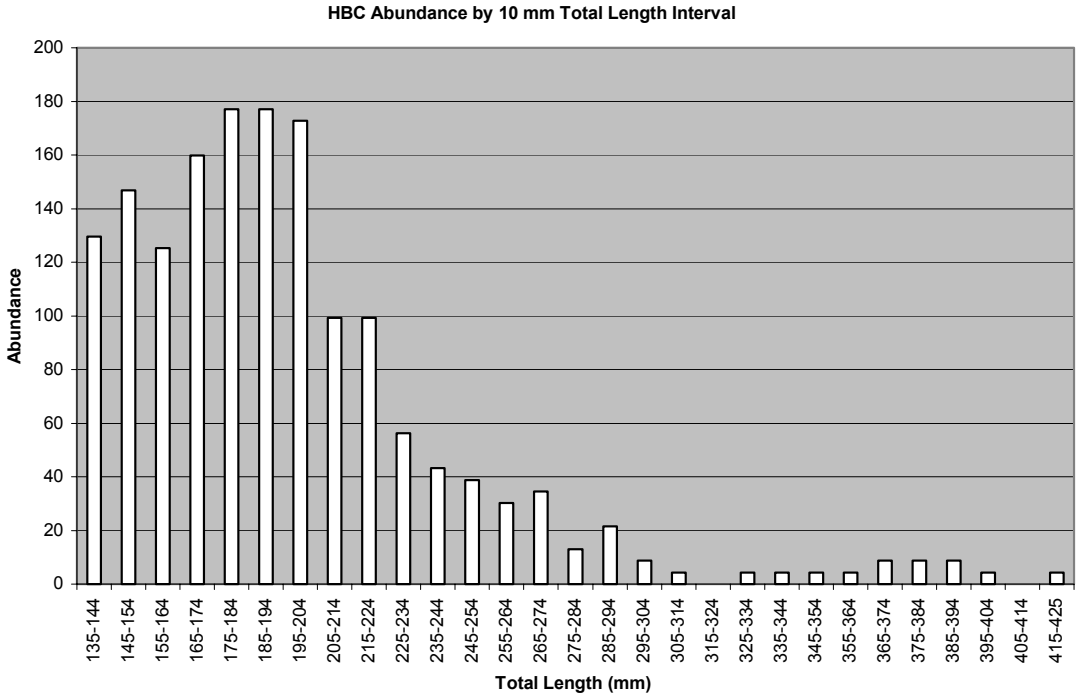


Figure 13. Cumulative length distributions of humpback chub captured in the Little Colorado River, 2000.



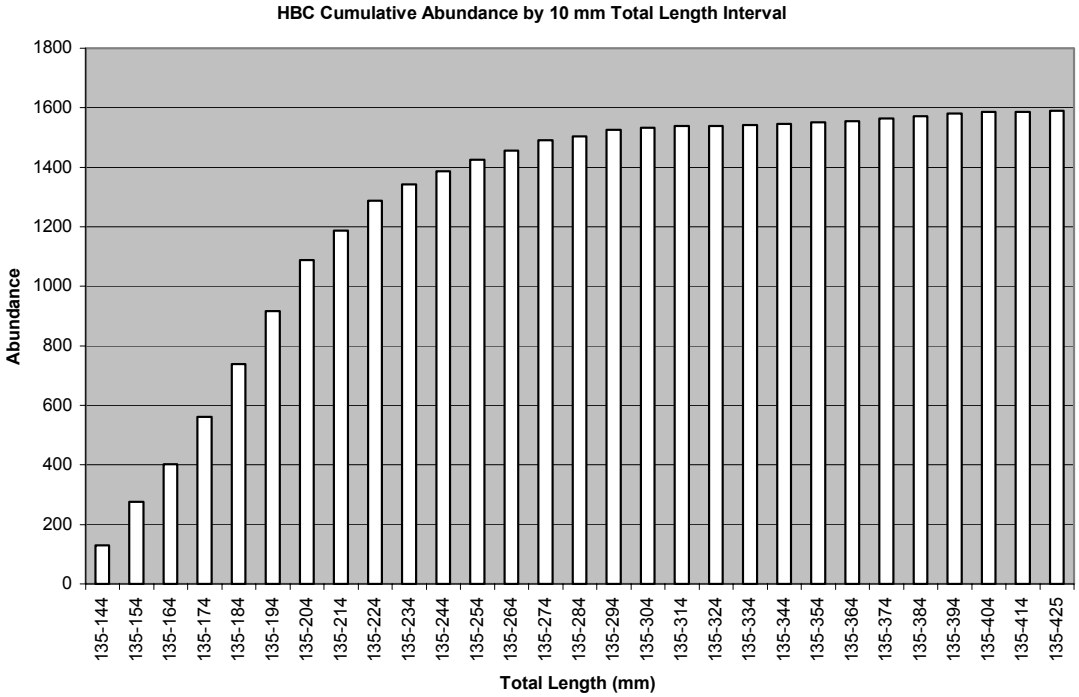


Figure 14. Estimated abundance of humpback chub by 10 mm total length interval in the Little Colorado River, 2000.

APPENDICIES

Appendix A - 1. Summary of PIT tags from Little Colorado River, April 2000.

Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
11.7	23-Apr-00	HBC	319	285	250	Y	1F201C2500	F	
10.8	19-Apr-00	HBC	430	385	643	Y	1F466B0E22	F	
1.2	22-Apr-00	HBC	272	247		Y	1F78095709	M	
11.2	21-Apr-00	HBC	280	255	191	Y	1F78306F4A	M	
11.9	24-Apr-00	HBC	356	315	366	Y	1F7A35763C	M	R
11.7	22-Apr-00	HBC	365	319	384	Y	1F7B03590A	M	
11.7	22-Apr-00	HBC	179	155		Y	41746F117B	M	R
11.2	21-Apr-00	HBC	247	215	97	Y	41753C220B	M	R
14.5	18-Apr-00	HBC	280	241	160	Y	51103E697B	M	R
10.8	18-Apr-00	HBC	231	205	80	Y	5110487E79	M	R
10.8	19-Apr-00	HBC	231	204	78	Y	5110487E79	M	R
14.5	18-Apr-00	HBC	288	251	181	Y	51104A746C	F	
14.5	18-Apr-00	HBC	236	204	91	Y	51104C2C46	M	R
2.3	22-Apr-00	HBC	192	170	51	Y	511052673E	M	
11.7	23-Apr-00	HBC	270	241	134	Y	5110563501	F	
14.7	21-Apr-00	HBC	255	222	108	Y	5114091723	M	R
14.2	24-Apr-00	HBC	253	220	110	Y	5114191723	M	
11.2	20-Apr-00	HBC	261	226	118	Y	511604336E	M	
11.6	23-Apr-00	HBC	240	216	106	Y	511607300A	M	
11.6	22-Apr-00	HBC	200	172	54	Y	5116081D5E	M	R
11.7	22-Apr-00	HBC	200	173	55	Y	5116081D5E	M	R
11.9	23-Apr-00	HBC	175	150	35	Y	5116110C2C	F	
11.9	24-Apr-00	HBC	175	150	34	Y	5116110C2C	F	
10.7	18-Apr-00	HBC	194	167	53	Y	5116124159	M	
14.5	18-Apr-00	HBC	285	247	158	Y	5116645A07	F	
14.5	18-Apr-00	HBC	270	232	150	N	530F053218	F	
14.7	19-Apr-00	HBC	219	189		Y	530F0A362A	M	R
14.7	18-Apr-00	HBC	218	192		N	530F0A362A	M	R
14.7	19-Apr-00	HBC	282	241	159	N	530F0B0477	M	R
11.2	20-Apr-00	HBC	236	208	100	N	530F0B725D	F	
14.2	21-Apr-00	HBC	206	181	59	N	530F0E1A79		
14.4	20-Apr-00	HBC	234	205	87	N	530F124A49	F	
14.4	19-Apr-00	HBC	276	241	145	N	5314341C23	F	
14.3	20-Apr-00	HBC	278	241	148	Y	5314341C23	F	
14.4	18-Apr-00	HBC	244	212		N	53143A2329	F	
14.7	18-Apr-00	HBC	275	240		N	53143C2176	M	R
14.5	18-Apr-00	HBC	244	210	95	N	53143D3F74		
14.5	18-Apr-00	HBC	239	207	99	N	53143D557C	F	
14.4	22-Apr-00	HBC	236	203	92	Y	53143D557C	F	
14.4	20-Apr-00	HBC	254	224	107	Y	53143D6A4A	M	R
14.4	19-Apr-00	HBC	253	223	110	N	53143D6A4A	M	R
14.3	21-Apr-00	HBC	255	223	105	Y	53143D6A4A	M	R
14.8	18-Apr-00	HBC	280	241		N	531442423D	M	R
14.7	18-Apr-00	HBC	200	172		N	5314446376		
14.7	18-Apr-00	HBC	240	209		N	5314453246	M	R
14.5	17-Apr-00	HBC	262	225	147	N	5314463001	M	R

Appendix A - 1. Summary of PIT tags from Little Colorado River, April 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
14.4	19-Apr-00	HBC	228	196	75	N	531447082E	F	
14.5	18-Apr-00	HBC	165	144	40	N	5314475556		
14.4	19-Apr-00	HBC	165	143	36	Y	5314475556		
14.4	19-Apr-00	HBC	240	226	91	N	5314477E04	F	
14.7	18-Apr-00	HBC	265	227		N	531448103E	F	
14.3	20-Apr-00	HBC	207	178	63	N	5314481F75	M	R
14.4	19-Apr-00	HBC	259	225	135	N	5314490812	M	R
14.5	18-Apr-00	HBC	207	180		N	53144A7B72	M	
0.4	18-Apr-00	HBC	166	154	33	N	53144C342B		
14.7	17-Apr-00	HBC	255	220	124	N	53144C6618	F	
14.7	18-Apr-00	HBC	270	238		N	53144E7D50	M	R
14.5	18-Apr-00	HBC	275	240	124	N	53144F4A34	F	
14.4	20-Apr-00	HBC	274	239	115	Y	53144F4A34	F	
14.3	19-Apr-00	HBC	275	239	120	Y	53144F4A34	F	
10.7	18-Apr-00	HBC	169	148	41	N	5320036155		
14.7	18-Apr-00	HBC	285	250		N	53201A617A	M	R
14.2	21-Apr-00	HBC	215	183	69	N	53201F6356	M	
14.1	21-Apr-00	HBC	255	217	120	N	5320241523	M	
14.5	20-Apr-00	HBC	325	278	234	N	532027682B	F	
10.7	17-Apr-00	HBC	169	148	32	Y	5320281275	M	
10.7	18-Apr-00	HBC	162	143	86	Y	5320281275		
14.4	20-Apr-00	HBC	272	237	143	N	532028520C	M	R
14.7	19-Apr-00	HBC	269	235	150	N	53202A4E49	M	
11.5	21-Apr-00	HBC	199	169	48	Y	53207B432F	M	
14.5	18-Apr-00	HBC	277	242	131	N	53207B7C19	M	
14.4	19-Apr-00	HBC	234	204	99	N	53207C0F75	F	
0.4	18-Apr-00	HBC	152	142	36	N	53207C5617		
0.6	20-Apr-00	HBC	155	143	36	Y	53207C5617		
14.8	18-Apr-00	HBC	267	227		N	53207D6A22	M	R
14.8	18-Apr-00	HBC	251	221		N	53207E2C06	F	
14.5	18-Apr-00	HBC	283	245	148	N	53207E4103	F	
14.7	19-Apr-00	HBC	241	205	122	N	53207F3113	M	R
14.7	20-Apr-00	HBC	270	235	120	N	53207F7D36	M	
14.7	18-Apr-00	HBC	292	254		N	5321006C3D	F	
14.7	19-Apr-00	HBC	312	269	213	N	5321042E7C	F	
14.4	19-Apr-00	HBC	275	235	139	N	5321054A08	M	R
14.4	21-Apr-00	HBC	277	237	138	Y	5321054A08	M	R
14.4	19-Apr-00	HBC	243	209	94	N	5321064009		
14.7	19-Apr-00	HBC	235	208	97	N	53210647B8	M	R
14.4	24-Apr-00	HBC	213	184	60	Y	5321066533	F	
14.4	19-Apr-00	HBC	214	184	60	N	5321066533	F	
14.3	19-Apr-00	HBC	214	185	60	Y	5321066533	F	
14.5	18-Apr-00	HBC	325	280	241	N	5321072D18	F	
0.4	18-Apr-00	HBC	369	337	512	N	5321076F55	F	
14.4	19-Apr-00	HBC	263	220	120	N	5321081F79	F	
14.3	19-Apr-00	HBC	263	225	120	Y	5321081F79	F	

Appendix A - 1. Summary of PIT tags from Little Colorado River, April 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
14.8	18-Apr-00	HBC	230	200		N	5321087745	M	
14.7	19-Apr-00	HBC	237	209	103	N	53210A3262	M	R
14.8	18-Apr-00	HBC	285	247		N	53210A467C	F	
14.5	18-Apr-00	HBC	279	242	161	N	53210A4937	M	
14.7	19-Apr-00	HBC	265	226	132	Y	53210B511B	M	R
14.7	18-Apr-00	HBC	265	228		N	53210B511B	M	R
14.8	18-Apr-00	HBC	360	320		N	53210B5616	F	
14.4	19-Apr-00	HBC	313	270		N	53210B5D47	F	R
14.3	19-Apr-00	HBC	313	271	208	Y	53210B5D47	F	R
14.1	21-Apr-00	HBC	215	188	64	N	53210C5922	F	
14.7	19-Apr-00	HBC	272	238	142	N	53210E4818	M	R
14.2	21-Apr-00	HBC	215	196	72	N	53210F104D	M	R
11.2	20-Apr-00	HBC	167	145	33	Y	53210F7871		
14.2	21-Apr-00	HBC	210	182	60	N	5321101704	F	
14.7	18-Apr-00	HBC	245	212		N	5321105153	M	R
1.1	21-Apr-00	HBC	190	172		N	532110754A		
14.5	20-Apr-00	HBC	288	253	167	N	5321111710	F	
14.2	20-Apr-00	HBC	185	159	42	N	5321111A6F		
14.1	24-Apr-00	HBC	186	158		Y	5321111A6F		
14.4	19-Apr-00	HBC	255	224	97	N	5321112F2B	F	
14.7	18-Apr-00	HBC	278	240		N	5321114523	M	R
14.7	22-Apr-00	HBC	200	173	30	Y	532112106E		
14.2	21-Apr-00	HBC	201	173	55	N	532112106E	M	
11.5	21-Apr-00	HBC	243	210	90	Y	5321126F21	M	
14.4	19-Apr-00	HBC	282	247	164	N	5321135B52	F	
14.4	19-Apr-00	HBC	253	214	111	N	532115163F	F	
14.3	21-Apr-00	HBC	256	221	120	Y	532115163F	F	
14.5	18-Apr-00	HBC	255	221	112	N	5321154222	M	R
14.7	19-Apr-00	HBC	299	259	206	N	532117146C	F	
14.8	18-Apr-00	HBC	274	240		N	5321175E67	M	R
14.5	18-Apr-00	HBC	337	285	222	N	5321184B08	F	
14.8	18-Apr-00	HBC	218	189		N	5321187C78	M	R
14.5	18-Apr-00	HBC	285	243	160	N	5321190200	M	R
1.1	22-Apr-00	HBC	159	148		N	53211B6F62		
14.5	17-Apr-00	HBC	259	219	130	N	53211D0616	F	
0.5	20-Apr-00	HBC	201	184	52	N	53211E0168		
14.7	19-Apr-00	HBC	289	251	185	N	53211E1B64	F	
14.5	18-Apr-00	HBC	155	132	26	N	53211F0D20		
14.5	18-Apr-00	HBC	162	141		N	53211F0E37		
14.5	18-Apr-00	HBC	170	149	36	N	5321203837		
10.7	18-Apr-00	HBC	269	238	140	Y	5321215631	M	R
14.3	19-Apr-00	HBC	255	221	118	N	532122371B	M	R
14.8	18-Apr-00	HBC	233	200		N	5321233B53	F	
14.3	19-Apr-00	HBC	274	240	138	N	532123583E	F	
11.9	23-Apr-00	HBC	188	165	51	Y	532123662B	M	
0.4	19-Apr-00	HBC	175	152	62	N	5321242D7C		

Appendix A - 1. Summary of PIT tags from Little Colorado River, April 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
14.7	19-Apr-00	HBC	279	244	141	N	532126397F	F	
14.4	20-Apr-00	HBC	243	209	94	N	5321272B21	M	R
14.4	22-Apr-00	HBC	242	218	91	Y	5321272B21	M	R
14.5	18-Apr-00	HBC	235	204	88	N	532128026F	M	R
14.4	20-Apr-00	HBC	261	225	129	N	5321295745	M	R
14.8	18-Apr-00	HBC	285	248		N	53212A7735	M	R
14.5	17-Apr-00	HBC	284	245	166	N	53212D545E	M	R
14.4	19-Apr-00	HBC	265	234	155	N	53212D5E2C	F	R
14.4	20-Apr-00	HBC	199	174	53	N	5321303F56		
14.4	19-Apr-00	HBC	285	246	164	N	5321335C48	M	R
14.3	21-Apr-00	HBC	285	246	165	Y	5321335C48	M	R
14.7	19-Apr-00	HBC	285	245	149	N	532134714B	M	R
14.7	20-Apr-00	HBC	270	235	143	N	5321350F33	M	
14.5	18-Apr-00	HBC	292	249	160	N	5321351D79	M	R
14.4	21-Apr-00	HBC	292	251	152	Y	5321351D79	M	R
14.4	19-Apr-00	HBC	263	226	132	N	5321367849	F	
14.4	20-Apr-00	HBC	281	243	158	N	5321382951	M	R
11.2	18-Apr-00	HBC	380	340	378	N	53232A4E5A	M	R
11.5	22-Apr-00	HBC	172	147	32	N	5323670251		
11.2	20-Apr-00	HBC	162	141	29	N	5323744003	F	
2.5	23-Apr-00	HBC	177	153	33	N	53237B7810		
11.2	21-Apr-00	HBC	159	130	31	N	53237B7B07		
10.8	18-Apr-00	HBC	152	135	26	N	5324054161		
2.9	23-Apr-00	HBC	163	145	27	N	5324067A3E		
2.9	23-Apr-00	HBC	180	159	37	N	532409755D	F	
11.2	20-Apr-00	HBC	171	148	37	N	53240E355B	F	
11.4	21-Apr-00	HBC	193	171	66	N	53240E3824	M	
2.9	23-Apr-00	HBC	251	231	134	N	53240F4151	M	
11.9	24-Apr-00	HBC	167	143	30	Y	532410030F		
11.9	23-Apr-00	HBC	167	143	30	N	5324117E37	M	
2.3	22-Apr-00	HBC	200	178	66	N	5324126937	F	
11.7	22-Apr-00	HBC	173	151	55	N	5324127C70	M	
11.2	18-Apr-00	HBC	222	187	61	N	532415494B	M	
11.9	23-Apr-00	HBC	167	144	14	Y	532418030F		
11.5	21-Apr-00	HBC	164	139	26	N	5324181A14		
2.2	21-Apr-00	HBC	235	220	111	N	5324274B63	M	
2.5	21-Apr-00	HBC	175	160	39	N	532428185B		
2.5	23-Apr-00	HBC	180	160	40	Y	532428185B		
10.7	17-Apr-00	HBC	170	151	35	N	53242C014C	M	
2.3	22-Apr-00	HBC	187	168	44	N	532430172B		
12.0	24-Apr-00	HBC	155	133	27	Y	532430281D		
12.0	23-Apr-00	HBC	154	135	28	N	532430281D		
11.9	23-Apr-00	HBC	194	166	47	N	5324346E46	M	
2.9	24-Apr-00	HBC	180	158	37	N	5324354A4B		
11.9	23-Apr-00	HBC	151	131	24	N	5324367952		
11.2	20-Apr-00	HBC	172	150	37	N	5324377C7F	M	

Appendix A - 1. Summary of PIT tags from Little Colorado River, April 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
2.8	24-Apr-00	HBC	205	179	57	Y	5324386B24		
2.5	23-Apr-00	HBC	206	179	46	N	5324386B24	F	
2.5	23-Apr-00	HBC	164	145	28	N	532439376B		
11.2	21-Apr-00	HBC	162	145	32	N	53243A0551		
11.2	18-Apr-00	HBC	173	150	26	N	53243B1C5E	M	
11.2	20-Apr-00	HBC	189	157	44	N	5324402041	M	
10.7	18-Apr-00	HBC	171	153	34	N	5324431661		
2.4	21-Apr-00	HBC	167	155	38	N	53250C7402		
12.0	23-Apr-00	HBC	150	131	24	N	53250D2A79		
11.9	24-Apr-00	HBC	151	131	24	Y	53250D2A79		
12.0	23-Apr-00	HBC	191	167	49	N	53250E4E6A		
2.4	20-Apr-00	HBC	166	148	32	N	53250E6C5D		
2.5	23-Apr-00	HBC	166	147		Y	53250E6C5D		
11.2	20-Apr-00	HBC	215	185	61	N	53250E7465	F	
10.7	18-Apr-00	HBC	152	136	24	N	53250F4850		
2.2	21-Apr-00	HBC	160	142	31	N	5325115F73		
2.6	23-Apr-00	HBC	195	178	52	N	5325125C17	F	
11.5	21-Apr-00	HBC	162	141	31	N	5325160660		
11.6	22-Apr-00	HBC	172	153	34	N	5325161A4C	M	
11.2	20-Apr-00	HBC	232	210	87	N	532517333E	F	
11.2	18-Apr-00	HBC	167	142	33	N	5325180A0E		
11.9	23-Apr-00	HBC	193	166	45	N	5325186840	F	
2.5	21-Apr-00	HBC	154	136	21	N	5325186A74		
11.1	21-Apr-00	HBC	150	128	22	N	5325191E7E		
10.8	18-Apr-00	HBC	176	155	38	N	53251B1548	F	
11.5	21-Apr-00	HBC	227	200	79	N	53251B212F	M	
2.3	21-Apr-00	HBC	225	196	85	N	53251C046A		
2.9	24-Apr-00	HBC	185	157	36	N	53251C6624		
11.5	22-Apr-00	HBC	198	171	56	N	53251C6F41	M	
2.5	23-Apr-00	HBC	151	132	18	N	53251D122E		
2.9	23-Apr-00	HBC	155	135	21	N	53251D7143		
2.9	23-Apr-00	HBC	155	135	24	Y	53251D7143		
11.4	22-Apr-00	HBC	150	130	22	N	53251F2846	M	R
11.9	24-Apr-00	HBC	182	155	43	N	53251F5A76	M	
12.0	24-Apr-00	HBC	235	203	77	N	5325207A26	M	
2.5	24-Apr-00	HBC	200	177	52	N	5325250C14	M	
10.7	17-Apr-00	HBC	226	200	77	N	5325255D30	M	
11.0	20-Apr-00	HBC	190	163	44	N	532529482C		
11.9	23-Apr-00	HBC	152	132	24	N	53252B565D		
2.4	22-Apr-00	HBC	187	177	55	N	53252F707C		
11.9	24-Apr-00	HBC	154	132	24	N	532532281E		
11.9	23-Apr-00	HBC	190	165	45	N	532533442C	M	
11.9	23-Apr-00	HBC	172	150	34	N	532534273E	M	R
10.7	18-Apr-00	HBC	169	148	51	N	5325366437		
2.9	23-Apr-00	HBC	152	133	25	N	5325396312	M	
11.9	23-Apr-00	HBC	202	175	52	N	53253D5363	M	

Appendix A - 1. Summary of PIT tags from Little Colorado River, April 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
14.3	21-Apr-00	HBC	213	185	64	N	5325503952	F	
14.2	24-Apr-00	HBC	200	174	51	N	532551372E	M	R
14.7	22-Apr-00	HBC	274	240	142	N	532552344A	F	
14.2	21-Apr-00	HBC	246	211	95	N	5325523569	F	
14.1	21-Apr-00	HBC	205	181	60	N	5325562B73		
14.2	21-Apr-00	HBC	268	230	120	N	5325573452	F	
11.5	21-Apr-00	HBC	179	155	40	N	5325583F2B	F	
11.2	20-Apr-00	HBC	162	119	21	N	532558597F		
14.2	24-Apr-00	HBC	230	203	86	Y	532559154E	M	R
14.1	21-Apr-00	HBC	230	204	88	N	532559154E	M	R
14.7	22-Apr-00	HBC	294	253	172	N	5325594A02	F	
11.2	20-Apr-00	HBC	173	154	39	N	53255B214E	M	
11.4	21-Apr-00	HBC	180	157	39	N	5325603278		
10.8	18-Apr-00	HBC	193	178	61	N	5325614268	F	
14.1	22-Apr-00	HBC	240	213	92	N	5325621F63	F	
11.4	21-Apr-00	HBC	189	165	48	N	532562244F	F	
14.1	21-Apr-00	HBC	192	169	45	N	5325650433		
14.1	21-Apr-00	HBC	208	180	57	N	5325655F65	M	R
14.2	24-Apr-00	HBC	262	232	136	Y	532567280B	F	
14.2	21-Apr-00	HBC	265	233	137	N	532567280B		
11.2	21-Apr-00	HBC	166	148	34	N	53260B2F38	M	
14.4	22-Apr-00	HBC	197	173	53	N	53260C1914	M	
11.4	21-Apr-00	HBC	153	135	24	N	53260F1F49		
10.8	18-Apr-00	HBC	167	149	44	N	5326104E29		
10.8	19-Apr-00	HBC	165	149	39	Y	5326104E29		
14.2	24-Apr-00	HBC	259	221	113	N	5326111814	F	
14.1	21-Apr-00	HBC	290	253	160	N	5326116056	M	R
10.8	19-Apr-00	HBC	159	139	27	N	5326140B65		
11.2	20-Apr-00	HBC	160	139	25	Y	5326140B65		
13.9	22-Apr-00	HBC	230	198	76	N	5326162569	F	
11.2	20-Apr-00	HBC	156	135	28	N	5326175D3F		
10.8	18-Apr-00	HBC	167	152	39	N	5326176C61		
11.2	21-Apr-00	HBC	212	187	77	N	5326187471	M	
14.3	22-Apr-00	HBC	273	238	133	N	53261A1242	F	
13.9	24-Apr-00	HBC	211	182	67	N	53261A7622		
11.9	23-Apr-00	HBC	199	171	49	N	5326200160	M	
14.2	24-Apr-00	HBC	228	201	87	N	5326206039	M	
10.8	19-Apr-00	HBC	404	362	550	N	5326225946	F	
14.1	21-Apr-00	HBC	220	190	66	N	5326232875	M	R
14.1	21-Apr-00	HBC	218	188	64	N	532626444B	M	R
10.8	18-Apr-00	HBC	196	178	48	N	5326272732	M	
10.8	18-Apr-00	HBC	184	162	48	N	53262C6062		
11.2	20-Apr-00	HBC	180	156	39	N	53262C7632	F	
14.1	21-Apr-00	HBC	193	166	50	N	53262C7A6E	F	
10.8	18-Apr-00	HBC	205	180	63	N	53262E2652	F	
11.2	20-Apr-00	HBC	168	148	33	N	53262F537B		

Appendix A - 1. Summary of PIT tags from Little Colorado River, April 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
11.2	20-Apr-00	HBC	169	147	33	N	5326316041		
14.1	21-Apr-00	HBC	240	206	84	N	5326320F03	M	R
14.1	22-Apr-00	HBC	226	195		Y	5326326206	M	R
14.1	21-Apr-00	HBC	226	194	74	N	5326326206	M	R
14.2	24-Apr-00	HBC	270	237	136	N	5326326B63	M	R
14.1	21-Apr-00	HBC	219	186	69	N	5326332566	M	
11.9	24-Apr-00	HBC	244	223	136	N	5326333215	M	
10.8	19-Apr-00	HBC	169	148	39	N	532634543E		
11.5	22-Apr-00	HBC	170	152	39	Y	532634543E	F	
11.6	22-Apr-00	HBC	180	155	40	N	5326347609	M	R
14.2	21-Apr-00	HBC	233	204	92	N	5326350619	F	
14.1	21-Apr-00	HBC	240	211	86	N	5326361C66	M	R
14.1	21-Apr-00	HBC	193	170	55	N	5326362C1B	M	
11.2	19-Apr-00	HBC	201	175	57	N	532638083E	M	R
14.1	22-Apr-00	HBC	233	200	78	N	5326396C4A	F	
14.1	21-Apr-00	HBC	241	209	80	N	53263B0C57	M	R
14.2	21-Apr-00	HBC	241	211	98	N	53263B1D0A	F	
10.8	18-Apr-00	HBC	160	137	41	N	53263B665F		
10.9	20-Apr-00	HBC	159	138	27	Y	53263B665F		
14.2	21-Apr-00	HBC	250	212	101	N	53263B6B20	F	
10.8	19-Apr-00	HBC	181	162	40	N	53263C3413		
14.1	21-Apr-00	HBC	195	167	46	N	53263D4403	M	
11.1	20-Apr-00	HBC	165	145	28	N	53263D4D66		
10.9	19-Apr-00	HBC	152	134	25	N	53263F262A		
10.8	18-Apr-00	HBC	158	138	30	N	53263F4838		
14.7	22-Apr-00	HBC	227	197	67	N	5326403452	F	
14.1	21-Apr-00	HBC	202	173	59	N	532642133B	F	
14.2	24-Apr-00	HBC	298	263	188	Y	532643611F	F	
14.7	22-Apr-00	HBC	298	263	176	N	532643611F	F	
11.7	23-Apr-00	HBC	205	178	56	N	5326445E56	M	R
14.2	22-Apr-00	HBC	230	200	87	N	532644787B	F	
10.8	19-Apr-00	HBC	180	156	42	N	5326447A4F		
11.7	22-Apr-00	HBC	160	139	29	N	5326450437		
14.2	23-Apr-00	HBC	252	217	93	N	5326466862	F	
11.1	19-Apr-00	HBC	181	155	39	N	5326475663		
14.1	21-Apr-00	HBC	219	189	58	N	53264D3C5B	M	R
10.7	18-Apr-00	HBC	190	163	38	N	53264D3F4C	M	
11.7	23-Apr-00	HBC	182	162	46	Y	53264D3F4C	F	
11.7	23-Apr-00	HBC	174	150	35	N	53264D6234	M	R
14.1	21-Apr-00	HBC	255	220	105	N	53264F201E	F	
11.2	21-Apr-00	HBC	167	147	33	N	53264F7637		
14.1	21-Apr-00	HBC	169	149	27	N	532650293F	M	
10.8	18-Apr-00	HBC	190	165	44	N	5326503F6F	M	
14.7	22-Apr-00	HBC	299	256	177	N	5326510279	M	R
11.4	21-Apr-00	HBC	154	133	26	N	532651527E		
10.8	18-Apr-00	HBC	318	274	169	N	5326532F62	M	R

Appendix A - 1. Summary of PIT tags from Little Colorado River, April 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
10.8	19-Apr-00	HBC	316	273	166	Y	5326532F62	M	R
10.9	20-Apr-00	HBC	181	156	39	N	5326534449	M	
11.7	22-Apr-00	HBC	155	132	25	N	532654067B		
11.7	22-Apr-00	HBC	171	153	31	N	5326550807	M	R
10.8	18-Apr-00	HBC	157	136	32	N	5326550B10		
10.9	20-Apr-00	HBC	161	136	25	Y	5326550B10		
14.7	22-Apr-00	HBC	218	191	73	N	5326553E54	F	
14.2	21-Apr-00	HBC	175	150	32	N	532655487E	M	
11.5	21-Apr-00	HBC	174	154	36	N	5326555668	F	
11.5	22-Apr-00	HBC	173	151	40	Y	5326555668		
14.7	21-Apr-00	HBC	262	225	119	N	5326571561	F	
14.2	24-Apr-00	HBC	160	137	28	N	5326575021		
10.9	20-Apr-00	HBC	192	170	47	N	5326582E65	M	
10.9	19-Apr-00	HBC	190	165	45	N	5326583835		
13.9	24-Apr-00	HBC	283	245	187	N	5326584D08	M	R
14.1	21-Apr-00	HBC	190	167	44	N	5326594374	M	R
14.1	21-Apr-00	HBC	185	159	40	N	53265A1017	M	R
10.9	18-Apr-00	HBC	235	210	92	N	53265A1223	M	
11.5	21-Apr-00	HBC	151	134	22	N	53265A2F21		
11.2	19-Apr-00	HBC	162	140	26	N	53265B3965		
14.4	22-Apr-00	HBC	210	181	64	N	53265B3D7F	M	R
14.7	22-Apr-00	HBC	194	166	51	N	53265B670A	M	R
11.2	21-Apr-00	HBC	192	172	47	N	53265B7C25	M	
14.1	21-Apr-00	HBC	270	232	116	N	53265C7D79	M	R
14.2	21-Apr-00	HBC	248	218	114	N	53265E2066	M	R
14.7	22-Apr-00	HBC	242	210	68	N	53265E5D1D	M	R
14.1	21-Apr-00	HBC	240	206	84	N	53265F3701	F	R
11.7	23-Apr-00	HBC	324	290	293	N	53265F4A7A	F	
10.8	18-Apr-00	HBC	260	233	145	N	53265F4B59	M	
11.2	20-Apr-00	HBC	299	268	217	N	53265F4D77	F	
11.6	23-Apr-00	HBC	283	256	188	N	5326600947	M	R
11.2	21-Apr-00	HBC	230	198	76	N	5326602944	M	
14.4	21-Apr-00	HBC	260	222	125	N	5326610618	M	R
14.7	22-Apr-00	HBC	256	226	107	N	5326611A3A	F	
14.1	23-Apr-00	HBC	255	225	108	Y	5326611A3A	F	
11.2	20-Apr-00	HBC	229	206	94	N	532662403C	F	
11.6	22-Apr-00	HBC	166	144	36	Y	5326636214	M	R
11.5	21-Apr-00	HBC	165	145	34	N	532663621F	M	R
14.1	21-Apr-00	HBC	165	144	35	N	532664175D		
14.2	21-Apr-00	HBC	248	215	104	N	5326642C71	M	R
14.1	21-Apr-00	HBC	200	176	48	N	532664367D	M	R
10.8	18-Apr-00	HBC	169	144	33	N	5326643E3B		
2.4	22-Apr-00	HBC	249	228	138	N	5326647C4E	F	
14.7	23-Apr-00	HBC	225	200	82	N	5326654A31	M	R
14.4	21-Apr-00	HBC	265	234	124	N	5326657D41	M	R
10.9	20-Apr-00	HBC	167	146	32	N	532666280C		

Appendix A - 1. Summary of PIT tags from Little Colorado River, April 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
11.2	20-Apr-00	HBC	182	162	43	N	5326662D35	F	
14.2	21-Apr-00	HBC	242	209	92	N	5326667574	M	
14.7	23-Apr-00	HBC	199	174	59	N	5326677754	M	R
11.2	20-Apr-00	HBC	172	154	37	N	5326683C54		
14.2	21-Apr-00	HBC	214	187	66	N	5326685E1A	F	
11.5	21-Apr-00	HBC	155	135	26	N	532669113C		
14.1	21-Apr-00	HBC	230	201	69	N	5326696B4A	M	R
11.2	20-Apr-00	HBC	192	173	49	N	5326697823	M	
10.8	18-Apr-00	HBC	168	145	33	N	53266B2A77	M	
11.9	23-Apr-00	HBC	340	306	296	Y	7F7A1C614C	M	
14.5	20-Apr-00	HBC	384	331	345	Y	7F7B023A76	M	R
0.2	18-Apr-00	HBC	412	365	608	Y	7F7B073B5A		
11.9	24-Apr-00	HBC	425	379	570	Y	7F7B097645	F	
13.9	22-Apr-00	HBC	312	273	244	Y	7F7B18333C	M	R
11.7	22-Apr-00	HBC	385	347	473	Y	7F7D02652D	M	
11.7	22-Apr-00	HBC	342	308	295	Y	7F7D075D72	M	
11.9	24-Apr-00	HBC	405	368	515	Y	7F7D170C79	M	
11.4	22-Apr-00	HBC	358	327	401	Y	7F7D17325E	M	
11.7	22-Apr-00	HBC	362	320	329	Y	7F7D175908	M	R
11.7	22-Apr-00	HBC	368	324	407	Y	7F7D177D74	M	
11.7	23-Apr-00	HBC	343	311	309	Y	7F7D18052C	M	
10.8	19-Apr-00	HBC	389	348	395	Y	7F7D180822	M	
11.5	21-Apr-00	HBC	392	350	455	Y	7F7D180832	M	R
10.7	18-Apr-00	HBC	375	334	431	Y	7F7D181C5C	F	
11.5	22-Apr-00	HBC	405	359	446	Y	7F7D22574C	F	
11.9	23-Apr-00	HBC	423	379	598	Y	7F7D225ADE	M	
10.8	19-Apr-00	HBC	432	392	665	Y	7F7D225D02	F	
10.7	18-Apr-00	HBC	348	332	366	Y	7F7D226755	M	R
10.8	19-Apr-00	HBC	333	294	292	Y	7F7D255137	F	
11.5	22-Apr-00	HBC	440	395	685	Y	7F7D294527	F	
0.4	20-Apr-00	HBC	387	335	480	Y	7F7D2A4C40	F	
11.7	23-Apr-00	HBC	374	338	345	Y	7F7D2B2931	M	R
0.1	18-Apr-00	HBC	400	355		Y	7F7D2C0E2A	M	
11.7	22-Apr-00	HBC	370	335	415	Y	7F7D2C3601	M	
12.0	23-Apr-00	HBC	354	318	346	Y	7F7D300C7D	M	
14.2	21-Apr-00	HBC	363	323	306	Y	7F7E43062F	F	
10.8	19-Apr-00	HBC	420	370	520	Y	7F7E432C01	F	
10.8	19-Apr-00	HBC	364	316	349	Y	7F7F173941	F	
3.0	23-Apr-00	HBC	402	360	456	Y	7F7F182E28	F	
11.1	21-Apr-00	HBC	390	345	531	Y	7F7F256325	F	
11.2	19-Apr-00	HBC	409	365	407	Y	7F7F284840	F	
10.8	19-Apr-00	HBC	377	343	476	Y	7F7F292A70	F	
11.7	22-Apr-00	HBC	362	329	360	Y	7F7F2C0870	M	
0.4	18-Apr-00	HBC	380	343	536	Y	7F7F3C2B56	F	
11.2	21-Apr-00	HBC	395	349	456	Y	7F7F3E272D	M	
11.7	23-Apr-00	HBC	395	346	436	Y	7F7F3E3310	F	

Appendix A - 1. Summary of PIT tags from Little Colorado River, April 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
11.7	22-Apr-00	HBC	375	332	423	Y	7F7F3F4F0A	F	
14.1	21-Apr-00	HBC	340	279	281	Y	7F7F45630E	M	R
1.3	21-Apr-00	HBC	370	333		Y	7F7F48606E	F	
10.7	18-Apr-00	HBC	334	295	282	Y	7F7F7E5C49	M	R
11.2	21-Apr-00	FMS	427	400	584	N	531F05765D	M	
0.2	19-Apr-00	FMS	211		84	N	53202E5344		
-0.1	21-Apr-00	FMS	458			N	532111301E	F	
0.4	18-Apr-00	FMS	291		240	N	5321350462		
0.0	22-Apr-00	FMS	464			N	532427704F		
0.0	22-Apr-00	FMS	502			N	5324386362	F	
0.0	22-Apr-00	FMS	430			N	53243A5F24		
0.0	22-Apr-00	FMS	427			N	53251C5A05		
0.0	22-Apr-00	FMS	425			N	53252B0832		
11.5	22-Apr-00	FMS	354	338	371	N	5325351C06	M	
2.5	23-Apr-00	FMS	421		478	N	53253B7F57		
0.0	22-Apr-00	FMS	525			N	53253D4624		
11.4	21-Apr-00	FMS	181	169	42	N	5326654926	F	
-0.1	21-Apr-00	FMS	505			Y	7F7B197F0B	F	
-0.1	21-Apr-00	FMS	553			Y	7F7B1A0155	F	
11.2	21-Apr-00	BHS	172		36	N	53233A1D26	F	
2.3	20-Apr-00	BHS	192		56	N	53236A086C		
10.8	18-Apr-00	BHS	165		41	N	5323765C46	M	R
10.7	18-Apr-00	BHS	188		25	N	53240B4650		
14.2	22-Apr-00	BHS	180	167	45	N	53240C783A	M	
2.4	20-Apr-00	BHS	196		67	N	5324212217		
2.9	23-Apr-00	BHS	250		151	N	5324276112		
10.7	18-Apr-00	BHS	182	160	40	N	53242B125A	F	R
2.8	24-Apr-00	BHS	175		43	N	5324365F7F		
10.8	18-Apr-00	BHS	187		70	N	532441302B	M	R
11.0	19-Apr-00	BHS	191		71	Y	532441302B	M	R
11.1	21-Apr-00	BHS	171		32	N	5324421675		
10.7	18-Apr-00	BHS	210		91	N	53250A1530		
10.8	18-Apr-00	BHS	195		63	N	53250D0D77	M	R
10.9	19-Apr-00	BHS	193		61	Y	53250D0D77	M	R
10.8	18-Apr-00	BHS	215		76	N	53250D5702	M	R
11.1	20-Apr-00	BHS	173		36	N	5325184005	F	
2.5	21-Apr-00	BHS	262		118	N	53251F3650		
2.9	24-Apr-00	BHS	191		50	N	5325202D2C		
11.7	22-Apr-00	BHS	185		39	N	5325224743	F	
11.2	18-Apr-00	BHS	201			N	532523626D	F	
10.7	18-Apr-00	BHS	219		64	N	532539091A	M	R
10.8	18-Apr-00	BHS	182		61	N	532539524C	F	
11.2	21-Apr-00	BHS	155		26	N	532549613C		
11.2	19-Apr-00	BHS	180		55	N	53254C7774	F	
10.8	19-Apr-00	BHS	170		42	N	5325504110	M	R
11.0	19-Apr-00	BHS	202		54	N	5325522945	M	R

Appendix A - 1. Summary of PIT tags from Little Colorado River, April 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
11.2	19-Apr-00	BHS	200		64	N	532568130F	F	
11.2	19-Apr-00	BHS	170		42	N	5326135D33	F	
10.8	19-Apr-00	BHS	234		122	N	53262D0E64	F	
11.0	19-Apr-00	BHS	151		46	N	5326352200	M	R
11.2	19-Apr-00	BHS	175		46	N	532637194B	F	
10.8	19-Apr-00	BHS	170		41	N	5326394E7D	M	R
11.2	19-Apr-00	BHS	179		61	N	53263C6D71	M	R
10.9	19-Apr-00	BHS	186		51	N	5326400F7E	F	
11.0	19-Apr-00	BHS	191		51	N	5326410F6A	M	
10.8	19-Apr-00	BHS	210		87	N	532646217E	M	R
11.0	19-Apr-00	BHS	218		89	N	5326510F06	F	
10.8	19-Apr-00	BHS	166		36	N	5326582C51	M	R
14.7	22-Apr-00	BHS	195		53	Y	53265C7628	F	
14.2	22-Apr-00	BHS	195		46	N	53265C7628	F	
11.0	19-Apr-00	BHS	203		79	N	5326600A50	M	R
11.0	19-Apr-00	BHS	207		75	N	5326603B0E	F	
10.8	19-Apr-00	BHS	191		62	N	5326610B67	F	
11.0	19-Apr-00	BHS	188		63	Y	5326610B67	M	R
10.8	19-Apr-00	BHS	205		80	N	5326643344	M	R
10.8	19-Apr-00	BHS	227		124	N	53266A4766	F	

Appendix A - 2. Summary of PIT tags from Little Colorado River, June 2000.

Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
14.2	01-Jun-00	HBC	320	275	203	Y	1F3E626160	M	
14.2	04-Jun-00	HBC	321	276	225	Y	1F3E626160	M	
12.0	05-Jun-00	HBC	146	118	12	Y	1F7A25231F	M	
10.8	06-Jun-00	HBC	143	125	22	N	227D2D1725	M	
10.8	07-Jun-00	HBC	119	106	10	N	227D2D5A23		
11.8	05-Jun-00	HBC	120	104	12	N	227D327016		
12.0	05-Jun-00	HBC	122	108	12	Y	227D327016		
11.8	05-Jun-00	HBC	120	105	11	N	227D345369		
12.0	06-Jun-00	HBC	120	105		Y	227D345369		
12.0	07-Jun-00	HBC	214	186	69	N	227D351409	F	
10.8	02-Jun-00	HBC	230	197	77	N	227D3B2937	M	
10.8	07-Jun-00	HBC	228	196	75	Y	227D3B2937	F	
10.8	02-Jun-00	HBC	124	106	13	N	227D3B7E3D		
11.8	07-Jun-00	HBC	216	188	61	Y	227D433D1E	F	
11.9	06-Jun-00	HBC	215	190	65	N	227D433D1E		
10.8	07-Jun-00	HBC	168	147	30	N	227D437F53	F	
10.8	07-Jun-00	HBC	128	109	13	N	227D45112A		
11.5	01-Jun-00	HBC	186	161	41	N	227D454D71		
11.5	01-Jun-00	HBC	184	159		Y	227D454D71	F	
11.7	03-Jun-00	HBC	141	121	18	Y	227D471E06		
11.7	02-Jun-00	HBC	144	123	18	N	227D471E06		
11.5	04-Jun-00	HBC	138	129	18	Y	227D471E06		
10.8	06-Jun-00	HBC	190	164	42	N	227D4A1867	F	
10.8	02-Jun-00	HBC	184	160	44	N	227D4B727B	F	
10.8	06-Jun-00	HBC	174	159	42	Y	227D4B727B	F	
10.8	06-Jun-00	HBC	197	170	54	N	227F0F2266	F	
10.8	07-Jun-00	HBC	196	170	50	Y	227F0F2266	F	
11.5	03-Jun-00	HBC	124	118	12	N	227F102C4A		
11.5	04-Jun-00	HBC	125	106	12	Y	227F102C4A		
11.7	02-Jun-00	HBC	152	133	23	Y	227F11115C	M	
11.7	02-Jun-00	HBC	147	138	21	N	227F11115C		
11.7	01-Jun-00	HBC	158	139	28	N	227F11753C		
11.7	02-Jun-00	HBC	209	179	59	N	227F117D7A	M	
11.5	03-Jun-00	HBC	201	178	52	Y	227F117D7A	M	
11.5	03-Jun-00	HBC	227	180		Y	227F117D7A	M	
11.7	07-Jun-00	HBC	135	120		Y	227F125778		
12.0	07-Jun-00	HBC	138	123	17	Y	227F125778		
12.0	06-Jun-00	HBC	135	118	16	N	227F125778		
10.8	03-Jun-00	HBC	153	138	26	N	227F135F2A		
10.8	07-Jun-00	HBC	143	127	22	Y	227F135F2A	F	
11.6	01-Jun-00	HBC	222	192	67	N	227F140A6B	M	
10.8	06-Jun-00	HBC	158	136	27	N	227F144C3C	M	
10.8	02-Jun-00	HBC	131	114	16	N	227F161D7F		
11.7	08-Jun-00	HBC	122	105		Y	227F18266F	F	
12.0	07-Jun-00	HBC	119	105	11	N	227F18266F		
11.6	04-Jun-00	HBC	215	188	65	N	227F192176		

Appendix A - 2. Summary of PIT tags from Little Colorado River, June 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
10.8	06-Jun-00	HBC	127	112	14	N	227F195F1A		
10.8	02-Jun-00	HBC	123	105	13	N	227F1A6B0E		
10.8	07-Jun-00	HBC	122	107	14	Y	227F1A6B0E	M	
10.8	06-Jun-00	HBC	197	169	50	N	227F1B0112	F	
10.8	07-Jun-00	HBC	170	147	31	N	227F1C5D36	F	
10.8	07-Jun-00	HBC	121	103	14	N	227F1D1D5B		
11.7	04-Jun-00	HBC	155	134	25	N	227F1F0613		
10.8	06-Jun-00	HBC	200	177	56	N	227F1F345A	F	
11.7	03-Jun-00	HBC	134	116	18	N	227F201133		
11.4	04-Jun-00	HBC	132	114	17	Y	227F201133		
11.5	01-Jun-00	HBC	169	148	28	N	227F20525D		
11.5	02-Jun-00	HBC	171	149	29	Y	227F20525D	M	
10.8	07-Jun-00	HBC	123	107	16	N	227F206220	F	
11.7	01-Jun-00	HBC	129	110	14	N	227F272D6D		
10.8	06-Jun-00	HBC	178	155	39	N	227F273909	M	
10.8	07-Jun-00	HBC	178	153	38	Y	227F273909	M	
11.9	07-Jun-00	HBC	124	109	13	N	227F280734		
11.9	07-Jun-00	HBC	158	138	27	Y	227F286160	F	
12.0	07-Jun-00	HBC	155	135	24	N	227F286160	F	
10.8	06-Jun-00	HBC	161	137	24	N	227F296174		
10.8	07-Jun-00	HBC	180	156	39	N	227F2A2A2F	M	
11.7	05-Jun-00	HBC	145	127	20	N	227F2A4D58		
11.8	05-Jun-00	HBC	142	132	22	Y	227F2A4D58		
10.8	07-Jun-00	HBC	123	107	16	N	227F2C7031	M	
10.8	06-Jun-00	HBC	138	121	18	N	227F2D2101	F	
10.8	03-Jun-00	HBC	213	183	77	N	227F2D2438	M	
10.8	06-Jun-00	HBC	158	139	31	N	227F2E775B	F	
11.5	01-Jun-00	HBC	215	185	61	Y	227F2F5356	M	
11.5	01-Jun-00	HBC	213	179	56	N	227F2F5356		
10.8	02-Jun-00	HBC	141	121	20	N	227F304B2A		
11.9	05-Jun-00	HBC	193	167	43	N	227F304C27	M	
11.7	01-Jun-00	HBC	181	157	43	N	227F327E09	M	R
11.7	05-Jun-00	HBC	138	121	19	Y	227F332151	M	
11.8	05-Jun-00	HBC	140	122	21	N	227F332151	M	
11.5	01-Jun-00	HBC	181	159	40	N	227F352B48		
10.8	06-Jun-00	HBC	140	127	21	N	227F356143		
10.8	03-Jun-00	HBC	198	174	59	N	227F367259	M	
10.8	06-Jun-00	HBC	199	173	51	Y	227F367259	M	
11.8	07-Jun-00	HBC	192	171	48	N	227F38244C	M	
11.9	08-Jun-00	HBC	197	170	46	Y	227F38244C		
10.8	06-Jun-00	HBC	133	113	13	N	227F396421		
10.8	06-Jun-00	HBC	163	139	34	N	227F3A242B	M	
11.7	01-Jun-00	HBC	145	128	21	N	227F3C6100		
11.8	08-Jun-00	HBC	178	154	35	Y	41746F117B		
11.7	07-Jun-00	HBC	187	161	42	Y	4174792216	F	
11.9	05-Jun-00	HBC	188	162	45	Y	4174792216	M	

Appendix A - 2. Summary of PIT tags from Little Colorado River, June 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
12.0	07-Jun-00	HBC	189	163	43	Y	4174792216	F	
14.2	08-Jun-00	HBC	253	220	111	Y	5114191723	M	
10.8	06-Jun-00	HBC	183	156	46	Y	5116110C2C	F	
12.0	05-Jun-00	HBC	214	183	67	Y	5116411003	M	
14.2	04-Jun-00	HBC	252	221	112	N	5320052250	F	
14.2	03-Jun-00	HBC	216	185	67	Y	53201F6356	M	
14.2	04-Jun-00	HBC	255	219	126	Y	5320241523	M	
11.7	04-Jun-00	HBC	197	173	54	Y	53207B432F	F	
14.2	06-Jun-00	HBC	271	235	123	Y	53207F7D36	M	
14.2	08-Jun-00	HBC	271	235	132	Y	53207F7D36	M	
14.2	08-Jun-00	HBC	219	191	84	Y	53210C5922	F	
14.2	04-Jun-00	HBC	189	163	48	Y	5321111A6F	F	
14.2	01-Jun-00	HBC	201	172	57	Y	532112106E	M	R
12.0	05-Jun-00	HBC	241	211	95	Y	5321126F21	M	
10.8	06-Jun-00	HBC	193	170	55	Y	532123662B	M	
14.2	08-Jun-00	HBC	128	111	14	N	5323655F4E		
11.9	05-Jun-00	HBC	223	192	63	Y	53237F2A2F		
12.0	07-Jun-00	HBC	223	190	63	Y	53237F2A2F	M	
12.0	05-Jun-00	HBC	225	194	60	N	53237F2A2F	M	
11.8	06-Jun-00	HBC	160	140	29	N	5324071F69	M	
14.2	04-Jun-00	HBC	211	181	60	N	532407460B	M	
14.2	04-Jun-00	HBC	228	198	74	N	5324124265	F	
14.2	07-Jun-00	HBC	230	197	72	Y	5324124265	F	
10.8	02-Jun-00	HBC	219	186	60	Y	532415494B		
14.2	04-Jun-00	HBC	235	200	90	N	5324162C78	M	
11.8	06-Jun-00	HBC	192	166	50	Y	5324206B1F	F	
12.0	05-Jun-00	HBC	195	169	54	N	5324206B1F	F	
14.2	07-Jun-00	HBC	244	215	89	Y	53242C640F	F	
14.2	04-Jun-00	HBC	245	215	90	N	53242C640F	F	
14.2	08-Jun-00	HBC	152	135		N	53242E3E1D		
14.2	07-Jun-00	HBC	229	199	79	N	53242F0979	F	
14.2	04-Jun-00	HBC	263	228	114	N	53242F455C	M	
11.9	06-Jun-00	HBC	182	162	34	N	5324371560	M	
11.9	07-Jun-00	HBC	190	162		Y	5324371560	M	
12.0	07-Jun-00	HBC	191	166	45	Y	5324371560	M	
14.2	06-Jun-00	HBC	159	138	30	N	5324373179	F	
14.2	04-Jun-00	HBC	141	122	19	N	5324375C7C		
14.2	07-Jun-00	HBC	132	120	20	N	5324393E0E		
10.8	03-Jun-00	HBC	177	156	39	Y	5324431661		
14.2	04-Jun-00	HBC	280	246	161	N	53250B401A	M	
14.2	06-Jun-00	HBC	279	245	148	Y	53250B401A	M	
14.2	08-Jun-00	HBC	282	245	143	Y	53250B401A	M	
14.2	04-Jun-00	HBC	208	189	69	N	5325134B70	F	
12.0	05-Jun-00	HBC	245	211	80	N	5325163427	M	
12.0	05-Jun-00	HBC	227	197	79	N	532517121E	M	
12.0	05-Jun-00	HBC	184	157	38	N	5325176434		

Appendix A - 2. Summary of PIT tags from Little Colorado River, June 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
11.7	05-Jun-00	HBC	122	111	14	N	53251B4F3D	M	
11.8	06-Jun-00	HBC	127	110	13	Y	53251B4F3D	M	
12.0	06-Jun-00	HBC	215	186	61	N	53251E125D		
10.8	07-Jun-00	HBC	162	142	25	Y	53251F2846	M	
12.0	05-Jun-00	HBC	123	105	12	N	53251F3C22		
14.1	06-Jun-00	HBC	208	179	65	N	53251F7E6F	F	
14.1	04-Jun-00	HBC	135	116	18	N	5325231D22		
14.2	04-Jun-00	HBC	261	225	111	N	5325252451	F	
14.2	07-Jun-00	HBC	142	123	19	N	53252C3E1E		
14.2	04-Jun-00	HBC	150	134	25	N	53252E6638		
14.1	04-Jun-00	HBC	136	118	18	N	53253B4C3D		
14.2	02-Jun-00	HBC	241	213	87	Y	5325523569	F	
14.1	01-Jun-00	HBC	265	230	112	Y	5325573452	F	
14.2	04-Jun-00	HBC	264	233	121	Y	5325573452	F	
14.2	04-Jun-00	HBC	294	253	177	Y	5325594A02	F	
10.8	06-Jun-00	HBC	212	184	64	Y	5325614268	F	
14.2	04-Jun-00	HBC	261	225	124	Y	5326111814	F	
14.2	04-Jun-00	HBC	231	205	93	Y	5326162569	F	
14.2	07-Jun-00	HBC	233	205	84	Y	5326162569	F	
14.2	08-Jun-00	HBC	218	187	60	Y	5326232875	M	R
14.2	04-Jun-00	HBC	238	205		Y	5326320F03	M	
14.2	06-Jun-00	HBC	239	205	84	Y	5326320F03	M	
14.2	04-Jun-00	HBC	224	193	80	Y	5326326206	M	
14.2	03-Jun-00	HBC	269	237	129	Y	5326326B63	M	
14.2	03-Jun-00	HBC	271	238	129	Y	5326326B63	M	
14.2	07-Jun-00	HBC	270	241	131	Y	5326326B63	M	
14.2	02-Jun-00	HBC	223	192	80	Y	5326332566	M	
14.1	03-Jun-00	HBC	220	189	77	Y	5326332566	M	
10.8	02-Jun-00	HBC	176	152	39	Y	532634543E		
14.2	04-Jun-00	HBC	235	203	97	Y	5326396C4A	F	
14.2	04-Jun-00	HBC	242	210	97	Y	53263B0C57	M	
14.2	07-Jun-00	HBC	243	211	95	Y	53263B0C57	M	
14.2	06-Jun-00	HBC	243	210	88	Y	53263B0C57	M	
14.2	01-Jun-00	HBC	224	198	81	Y	5326403452	M	
14.2	07-Jun-00	HBC	224	198	84	Y	5326403452	M	
14.2	07-Jun-00	HBC	298	264	179	Y	532643611F	F	
14.2	08-Jun-00	HBC	298	264	191	Y	532643611F	F	
14.2	04-Jun-00	HBC	254	219	107	Y	5326466862	F	
14.2	05-Jun-00	HBC	255	220	97	Y	5326466862	M	
11.7	05-Jun-00	HBC	120	106	13	N	5326466941	M	
14.2	04-Jun-00	HBC	253	220	120	Y	53264F201E	F	
14.1	08-Jun-00	HBC	185	165	33	Y	532650293F	M	
14.2	03-Jun-00	HBC	300	257	167	Y	5326510279	M	R
14.2	02-Jun-00	HBC	123	110	14	N	5326532433		
14.1	02-Jun-00	HBC	145	127	21	N	5326540F1E		
14.2	01-Jun-00	HBC	169	147	33	Y	5326575021	F	

Appendix A - 2. Summary of PIT tags from Little Colorado River, June 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
14.2	03-Jun-00	HBC	170	147	33	Y	5326575021	F	
14.2	08-Jun-00	HBC	170	146	30	Y	5326575021	F	
14.2	05-Jun-00	HBC	253	221	98	N	5326592A6B	F	
14.2	03-Jun-00	HBC	197	169	48	Y	5326594374	M	
14.2	04-Jun-00	HBC	194	170	49	Y	5326594374	F	
14.2	03-Jun-00	HBC	232	196	80	N	53265C1D03	F	
14.2	04-Jun-00	HBC	232	196	82	Y	53265C1D03	F	
14.2	06-Jun-00	HBC	269	231	113	Y	53265C7D79	M	
14.2	04-Jun-00	HBC	269	231	135	Y	53265C7D79	M	
14.2	04-Jun-00	HBC	244	211	91	Y	53265E5D1D	M	
14.2	07-Jun-00	HBC	244	212	81	Y	53265E5D1D	M	
14.2	08-Jun-00	HBC	215	189	64	Y	53265F431F		
14.2	02-Jun-00	HBC	220	191	67	N	53265F431F	M	
14.2	02-Jun-00	HBC	220	191	64	Y	53265F431F		
14.2	06-Jun-00	HBC	217	189	65	Y	53265F431F	M	
14.2	01-Jun-00	HBC	254	225	106	Y	5326611A3A	F	
14.2	06-Jun-00	HBC	255	225	105	Y	5326611A3A	F	
14.2	04-Jun-00	HBC	245	215	102	Y	5326642C71	M	
10.8	06-Jun-00	HBC	195	176	59	N	5326662D35	F	
14.2	04-Jun-00	HBC	240	210	96	Y	5326667574	M	
14.2	06-Jun-00	HBC	242	210	92	Y	5326667574	M	
14.2	07-Jun-00	HBC	242	210	84	Y	5326667574	M	
14.2	03-Jun-00	HBC	255	226	117	Y	53266F1C28	M	
14.2	03-Jun-00	HBC	256	224	116	N	53266F1C28	M	
14.2	07-Jun-00	HBC	255	221	112	Y	53266F3360	M	
14.1	01-Jun-00	HBC	257	221		N	53266F3360	M	
14.2	04-Jun-00	HBC	139	121	17	N	5326721679		
14.2	01-Jun-00	HBC	144	126	20	N	5326742578		
14.1	07-Jun-00	HBC	144	126	19	Y	5326742578		
14.2	07-Jun-00	HBC	222	196	83	N	5326751F63	F	
14.2	02-Jun-00	HBC	156	136	28	N	5326752C09	F	
14.1	01-Jun-00	HBC	146	126	22	N	5326761562		
14.1	01-Jun-00	HBC	145	125	23	Y	5326761562		
14.2	05-Jun-00	HBC	140	123	17	Y	5326766566		
14.1	04-Jun-00	HBC	139	121	17	Y	5326766566		
14.2	03-Jun-00	HBC	142	123	18	N	5326766566		
14.2	03-Jun-00	HBC	160	140	26	N	5326773575		
14.2	01-Jun-00	HBC	316	284	206	N	5326781E0F	F	
14.2	03-Jun-00	HBC	221	193	70	N	532679177E	F	
14.2	04-Jun-00	HBC	219	191	74	Y	532679177E	F	
14.2	08-Jun-00	HBC	221	193	69	Y	532679177E	F	
14.2	05-Jun-00	HBC	147	125	20	N	5326791835		
14.2	01-Jun-00	HBC	140	122	19	N	53267A2770		
14.2	08-Jun-00	HBC	337	294	277	N	53267B3B46	F	
14.2	02-Jun-00	HBC	140	121	20	Y	53267C4476		
14.2	01-Jun-00	HBC	139	122	25	N	53267C4476		

Appendix A - 2. Summary of PIT tags from Little Colorado River, June 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
14.1	02-Jun-00	HBC	140	123	20	Y	53267C4476	M	
14.2	01-Jun-00	HBC	290	261	148	N	53267D6158	M	
14.2	03-Jun-00	HBC	302	270	191	N	53267E3621	M	
14.2	04-Jun-00	HBC	306	270	197	Y	53267E3621	M	
14.2	07-Jun-00	HBC	233	199	81	N	53267F185E	F	
14.2	01-Jun-00	HBC	274	242	126	N	53267F7824		
14.2	04-Jun-00	HBC	274	242	128	Y	53267F7824	F	
14.2	08-Jun-00	HBC	275	242	125	Y	53267F7824	M	
14.2	03-Jun-00	HBC	200	174	56	N	5327010210	M	
14.2	03-Jun-00	HBC	222	193	71	N	5327011B0B	M	
14.2	01-Jun-00	HBC	222	190	72	N	532702133E	M	R
14.2	08-Jun-00	HBC	224	192	71	Y	532702133E	M	
14.2	04-Jun-00	HBC	222	191	76	Y	532702133E	M	
14.2	07-Jun-00	HBC	222	191	71	Y	532702133E	M	
14.2	06-Jun-00	HBC	222	192	70	Y	532702133E	M	
14.2	06-Jun-00	HBC	205	177	57	N	5327056171	M	
14.2	01-Jun-00	HBC	210	181	56	N	532707235B	F	
14.2	04-Jun-00	HBC	208	180	55	Y	532707235B	F	
14.2	06-Jun-00	HBC	279	239	134	N	5327095832	M	
14.2	06-Jun-00	HBC	258	225	99	N	532709612A	M	
14.1	03-Jun-00	HBC	205	178	56	N	532754435F	M	
14.1	03-Jun-00	HBC	167	144	32	N	53275A0700		
14.2	04-Jun-00	HBC	166	145	33	Y	53275A0700		
14.1	02-Jun-00	HBC	155	137	25	N	53275B6257		
14.2	08-Jun-00	HBC	153	136	23	Y	53275B6257	F	
14.2	03-Jun-00	HBC	248	215	106	N	53275C1E70	M	R
14.1	07-Jun-00	HBC	106	92	9	Y	532761556C		
14.2	05-Jun-00	HBC	106	92	8	N	532761556C		
14.2	01-Jun-00	HBC	231	200	86	N	53276D596B	M	
14.2	03-Jun-00	HBC	231	200	84	Y	53276D596B	M	
14.2	03-Jun-00	HBC	231	200	83	Y	53276D596B	M	
10.8	03-Jun-00	HBC	395	353	548	Y	7F7D077871	M	
10.8	03-Jun-00	HBC	378	334	333	Y	7F7D1B712A	F	
14.2	01-Jun-00	HBC	334	290	251	Y	7F7D2C050E	M	R
14.2	04-Jun-00	HBC	362	324	354	Y	7F7E43062F	F	
12.0	05-Jun-00	HBC	383	349	358	Y	7F7F26602A	M	
10.8	03-Jun-00	HBC	400	355	467	Y	7F7F27056D		
10.8	03-Jun-00	HBC	359	320	452	Y	7F7F273040	M	
12.0	05-Jun-00	HBC	275	247	153	Y	7F7F331601	M	R
14.2	04-Jun-00	HBC	337	295	274	Y	7F7F45630E	M	
11.5	02-Jun-00	FMS	421			Y	1F783E1F0C		
11.5	03-Jun-00	FMS	474			N	227F110C5D	M	
11.9	06-Jun-00	FMS	252			N	227F362470		
10.8	06-Jun-00	FMS	439			N	227F384218		
14.1	01-Jun-00	FMS	430	411	711	N	5326773456	M	
11.6	01-Jun-00	BHS	179			N	227D2D5E39		

Appendix A - 2. Summary of PIT tags from Little Colorado River, June 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
11.5	01-Jun-00	BHS	170			N	227F0F1338		
11.8	07-Jun-00	BHS	163			N	227F1B042B		
11.6	02-Jun-00	BHS	172			N	227F1B4571	F	
11.7	01-Jun-00	BHS	179			N	227F3A1C10	M	
11.6	02-Jun-00	BHS	227			N	227F3C3333	F	
11.7	02-Jun-00	BHS	229			N	227F3C3333	F	
12.0	05-Jun-00	BHS	183			N	531E204900	F	
12.0	05-Jun-00	BHS	185			N	5325110B6E	M	
11.9	05-Jun-00	BHS	158			Y	5326367A32	F	
14.1	08-Jun-00	BHS	195		54	N	53275B6825	F	

Appendix A - 3. Summary of PIT tags from Little Colorado River, October 2000.

Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
1.0	14-Oct-00	HBC	392	353	576	Y	1F1F726E62	F	
5.8	09-Oct-00	HBC	220	195	62	N	227D273E73	F	
13.1	07-Oct-00	HBC	162		22	N	227D2F7B64		
12.0	07-Oct-00	HBC	145		15	N	227D32271C		
5.2	08-Oct-00	HBC	178	153	31	N	227D333776	F	
5.4	08-Oct-00	HBC	141	119	15	N	227D337C5E	F	
5.5	11-Oct-00	HBC	158	142	22	N	227D351F58	M	
13.1	05-Oct-00	HBC	265		118	N	227D3A195E	M	
7.5	13-Oct-00	HBC	216	189	51	N	227D3A620B	F	
8.8	06-Oct-00	HBC	129	113	12	N	227D3B2B03		
7.7	12-Oct-00	HBC	165	140	20	N	227D3E7574	F	
5.8	08-Oct-00	HBC	157	134	22	N	227D3F3F6B	F	
10.8	11-Oct-00	HBC	117	94	9	N	227D40006F		
12.3	08-Oct-00	HBC	214		56	N	227D404B47	F	
13.6	05-Oct-00	HBC	242		83	N	227D40525C		
12.1	07-Oct-00	HBC	182		36	N	227D426D0D		
10.8	11-Oct-00	HBC	156	139	25	N	227D427238		
3.2	08-Oct-00	HBC	215	190	53	Y	227D433D1E	F	
10.8	11-Oct-00	HBC	129	111		N	227D461159		
10.6	14-Oct-00	HBC	145	120		N	227D46553A		
7.9	15-Oct-00	HBC	134	114	12	N	227D48203B		
1.9	12-Oct-00	HBC	195	167	44	N	227D4A160F		
12.5	07-Oct-00	HBC	170		24	N	227D4B0D34	M	
7.7	12-Oct-00	HBC	185	159	31	N	227D4C3049	F	
11.0	11-Oct-00	HBC	140	131	17	N	227F0E2351		
6.7	11-Oct-00	HBC	101	90	6	N	227F0E4043		
12.3	07-Oct-00	HBC	175		31	N	227F0F0C0D		
7.0	12-Oct-00	HBC	265	230	103	N	227F0F1516	F	
3.6	11-Oct-00	HBC	135	117	15	N	227F0F1B7E		
10.8	11-Oct-00	HBC	201	183	49	Y	227F0F2266	M	
12.8	10-Oct-00	HBC	225	198		N	227F0F3A5E	F	
12.7	08-Oct-00	HBC	264		125	N	227F0F421C	M	
8.0	13-Oct-00	HBC	185	160	43	N	227F102E7E	M	
8.0	15-Oct-00	HBC	183	159	38	Y	227F102E7E	M	
10.8	11-Oct-00	HBC	154	136	18	N	227F104E04		
10.5	12-Oct-00	HBC	160	140	24	N	227F105226		
5.4	08-Oct-00	HBC	161	137	23	N	227F110316	F	
8.0	14-Oct-00	HBC	100	85	7	N	227F11107F		
5.8	09-Oct-00	HBC	156	136	19	Y	227F11115C	M	
11.4	12-Oct-00	HBC	225	198	69	N	227F111368	F	
6.9	12-Oct-00	HBC	144	122	13	N	227F11424C		
10.6	11-Oct-00	HBC	245	212	96	N	227F116655		
2.2	11-Oct-00	HBC	128	111	11	N	227F117843		
9.9	06-Oct-00	HBC	224	194	67	N	227F117C59	F	
8.0	13-Oct-00	HBC	156	133	22	N	227F122B20	M	
10.8	11-Oct-00	HBC	196	170	41	N	227F12312C	M	

Appendix A - 3. Summary of PIT tags from Little Colorado River, October 2000									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
3.1	11-Oct-00	HBC	127	110	11	N	227F126E60		
10.5	12-Oct-00	HBC	197	168		N	227F134F54	M	
2.8	09-Oct-00	HBC	150	131	18	Y	227F135F2A		
11.9	09-Oct-00	HBC	217	185	52	N	227F141067	M	
12.9	05-Oct-00	HBC	195		41	N	227F145F55		
12.0	09-Oct-00	HBC	194	170	38	N	227F150A7F		
5.8	10-Oct-00	HBC	181	155	35	N	227F151835	M	
12.2	10-Oct-00	HBC	212	180		N	227F151B22		
1.9	13-Oct-00	HBC	169	148	28	N	227F154074		
10.8	11-Oct-00	HBC	176	153	33	N	227F161A72		
12.8	10-Oct-00	HBC	327	282	218	N	227F164233	F	
11.7	12-Oct-00	HBC	152	130	18	N	227F164D78		
11.8	09-Oct-00	HBC	214	185	61	N	227F16591C	F	
8.0	13-Oct-00	HBC	248	216	87	N	227F165E11	F	
12.2	08-Oct-00	HBC	172		29	N	227F170A18		
8.0	15-Oct-00	HBC	142	122	19	N	227F17237E	F	
10.8	11-Oct-00	HBC	156	137	25	N	227F174167		
12.1	08-Oct-00	HBC	176		33	N	227F174855	F	
11.0	11-Oct-00	HBC	118	107	10	N	227F176307		
6.2	09-Oct-00	HBC	105	89	7	N	227F181426		
8.8	06-Oct-00	HBC	180	150	32	N	227F19302B	F	
12.0	10-Oct-00	HBC	203	175		N	227F19386D		
10.4	12-Oct-00	HBC	117	103	11	N	227F195E39		
5.8	11-Oct-00	HBC	110	95	9	N	227F19686A		
2.2	11-Oct-00	HBC	101	86	6	N	227F1A3676		
10.8	11-Oct-00	HBC	139	124	15	Y	227F1A6B0E		
5.3	11-Oct-00	HBC	142	121	15	N	227F1A772C	F	
6.4	08-Oct-00	HBC	216	187	57	Y	227F1B0112	M	
12.7	08-Oct-00	HBC	226		72	N	227F1B4D37	F	
12.9	07-Oct-00	HBC	187			N	227F1C4952		
10.4	14-Oct-00	HBC	129	111		N	227F1C535E		
12.7	09-Oct-00	HBC	212		55	N	227F1C5667	F	
10.8	11-Oct-00	HBC	213	188	57	N	227F1C592C	M	
5.5	11-Oct-00	HBC	103	87	7	N	227F1D6D5F		
12.4	09-Oct-00	HBC	247	218	104	N	227F1F0427	F	
2.1	11-Oct-00	HBC	137	119	14	N	227F1F087B		
8.0	14-Oct-00	HBC	113	98	10	N	227F1F0D42		
12.7	08-Oct-00	HBC	252		96	N	227F1F0F76	F	
12.1	10-Oct-00	HBC	171	147		N	227F1F5503		
1.9	12-Oct-00	HBC	181	157	35	N	227F201A62		
5.1	10-Oct-00	HBC	124	109	10	N	227F201B41		
2.0	11-Oct-00	HBC	168	145	27	N	227F205069		
12.4	10-Oct-00	HBC	173	150		N	227F21141E		
12.6	07-Oct-00	HBC	211			N	227F21370A		
12.1	10-Oct-00	HBC	285	245		N	227F216F4B	F	
5.1	10-Oct-00	HBC	194	166	44	N	227F22031E	M	

Appendix A - 3. Summary of PIT tags from Little Colorado River, October 2000.									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
6.5	09-Oct-00	HBC	141	123	16	N	227F22096C	F	
10.8	14-Oct-00	HBC	135	117	15	N	227F227B5C		
11.8	08-Oct-00	HBC	215		53	N	227F23085B	F	
5.5	09-Oct-00	HBC	201	172	57	N	227F231F28	M	
12.6	10-Oct-00	HBC	178	155	36	N	227F23201E		
10.6	12-Oct-00	HBC	187	160	39	N	227F234C38	F	
7.6	15-Oct-00	HBC	179	154	28	N	227F235B4B	F	
11.9	07-Oct-00	HBC	162		23	N	227F236253		
12.6	08-Oct-00	HBC	163			N	227F241406		
12.6	09-Oct-00	HBC	154		22	N	227F246B49		
12.0	09-Oct-00	HBC	202	172	51	N	227F252156	M	
9.0	06-Oct-00	HBC	148	129	20	N	227F255366	F	
5.1	09-Oct-00	HBC	188	175	36	N	227F256B5D		
10.1	06-Oct-00	HBC	165	142	24	N	227F266F34	F	
10.0	07-Oct-00	HBC	163	141		Y	227F266F34	F	
11.2	14-Oct-00	HBC	146	129		Y	227F272D6D		
5.1	10-Oct-00	HBC	145	123	13	N	227F274765	F	
7.3	14-Oct-00	HBC	217	190	54	N	227F28445A	F	
5.5	11-Oct-00	HBC	117	99	8	N	227F285424		
11.0	14-Oct-00	HBC	134	118	13	N	227F28657A		
9.4	06-Oct-00	HBC	131	112	14	N	227F291267		
13.7	05-Oct-00	HBC	202		44	N	227F295F61		
6.7	09-Oct-00	HBC	135	116	17	N	227F297C75		
11.1	11-Oct-00	HBC	134	118	14	N	227F2A3F68		
13.7	07-Oct-00	HBC	225		110	N	227F2A4B76	F	
12.8	09-Oct-00	HBC	226		67	N	227F2B142E		
5.2	11-Oct-00	HBC	141	120	14	N	227F2B3E5F	M	
7.3	15-Oct-00	HBC	167	143	26	N	227F2C1572	M	
9.4	06-Oct-00	HBC	153	132	20	N	227F2C1C17		
7.7	12-Oct-00	HBC	110	95	7	N	227F2C2870		
12.2	07-Oct-00	HBC	244		91	N	227F2C6455	F	
1.1	13-Oct-00	HBC	142	125	16	N	227F2D7025		
10.1	06-Oct-00	HBC	171	146	29	N	227F2E075F	F	
1.3	14-Oct-00	HBC	155	135	14	N	227F2E310C		
1.8	12-Oct-00	HBC	192	167	39	N	227F2E4F60		
7.5	14-Oct-00	HBC	155	133	19	N	227F2F5E29	F	
12.3	07-Oct-00	HBC	176		38	N	227F30115F		
12.6	07-Oct-00	HBC	113			N	227F301F37		
5.5	11-Oct-00	HBC	163	133	22	N	227F302235	M	
1.8	12-Oct-00	HBC	137	116	12	N	227F305005		
11.9	07-Oct-00	HBC	175		31	N	227F30683E		
2.8	11-Oct-00	HBC	210	180	48	N	227F316642	M	
10.8	11-Oct-00	HBC	170	147	28	N	227F31771F		
3.0	11-Oct-00	HBC	153	134	20	N	227F323715		
9.9	06-Oct-00	HBC	170	144	25	N	227F32385E		
12.6	09-Oct-00	HBC	195		46	N	227F326712		

Appendix A - 3. Summary of PIT tags from Little Colorado River, October 2000.									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
12.1	09-Oct-00	HBC	193	167	42	N	227F326859		
5.5	11-Oct-00	HBC	132	113	12	N	227F332E1A		
5.5	11-Oct-00	HBC	146	125	16	N	227F33384A		
11.4	14-Oct-00	HBC	154	132	20	N	227F336625		
10.6	12-Oct-00	HBC	180	155	31	N	227F337362	M	
5.8	11-Oct-00	HBC	111	95	8	N	227F340414		
12.2	10-Oct-00	HBC	236	217		N	227F343E1B		
5.5	09-Oct-00	HBC	111	97	15	N	227F344077		
8.0	14-Oct-00	HBC	164	142	25	N	227F356D1F	M	
10.8	11-Oct-00	HBC	172	149	30	N	227F366227		
3.0	11-Oct-00	HBC	174	152	28	N	227F366409		
2.9	10-Oct-00	HBC	157	136	19	N	227F366855		
11.1	12-Oct-00	HBC	210	185	58	Y	227F367259	F	
9.0	06-Oct-00	HBC	223	191	60	N	227F367C31	F	
5.8	10-Oct-00	HBC	181	156	30	N	227F372001	F	
12.9	07-Oct-00	HBC	254		123	N	227F372464	M	
13.0	07-Oct-00	HBC	269		132	N	227F37507A	M	
8.0	13-Oct-00	HBC	187	158	38	N	227F376310	M	
11.5	11-Oct-00	HBC	304	265	195	N	227F37670A	F	
6.4	08-Oct-00	HBC	169	148	28	N	227F381E43		
7.1	15-Oct-00	HBC	177	157	29	N	227F382678		
7.7	12-Oct-00	HBC	139	117	17	N	227F384B7D		
13.6	05-Oct-00	HBC	229		56	N	227F385345	M	
7.5	14-Oct-00	HBC	204	173	53	N	227F385A20	F	
2.4	11-Oct-00	HBC	170	145	29	N	227F387817		
12.0	07-Oct-00	HBC	180		29	N	227F387D2E		
6.7	09-Oct-00	HBC	212	182	50	N	227F3A1741	M	
3.0	11-Oct-00	HBC	150	131	18	N	227F3A1929		
5.3	09-Oct-00	HBC	145	125	18	N	227F3A261F	F	
5.4	08-Oct-00	HBC	182	157	33	N	227F3A5201	M	
8.0	14-Oct-00	HBC	102	89	9	N	227F3A7202		
12.2	10-Oct-00	HBC	180	156		N	227F3A7618		
13.1	07-Oct-00	HBC	198		40	N	227F3B0331	F	
12.1	09-Oct-00	HBC	149	127	17	N	227F3B2C79		
12.3	07-Oct-00	HBC	185		36	N	227F3B2D5A		
0.9	13-Oct-00	HBC	196	168	33	N	227F3B543B		
12.1	10-Oct-00	HBC	201	175		N	227F3B572C	F	
6.9	15-Oct-00	HBC	141	120	12	N	227F3B7A50		
11.5	11-Oct-00	HBC	153	131	21	N	227F3C2440		
5.1	08-Oct-00	HBC	142	123	16	N	227F3C3941	F	
2.0	08-Oct-00	HBC	160	139	22	N	41524F2D15		
1.9	12-Oct-00	HBC	160	139	27	Y	41524F2D15		
2.1	08-Oct-00	HBC	152	135	23	N	415301386B		
3.1	10-Oct-00	HBC	145	135	22	Y	41530E670F		
3.0	08-Oct-00	HBC	145	135	22	N	41530E670F		
2.1	08-Oct-00	HBC	142	122	17	N	41530F761		

Appendix A - 3. Summary of PIT tags from Little Colorado River, October 2000.									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
8.3	05-Oct-00	HBC	142	122	17	N	4153105C73	F	
8.1	06-Oct-00	HBC	243	234	85	N	4153276056	M	
9.8	05-Oct-00	HBC	286	245	152	N	41675F0F23	F	
3.1	08-Oct-00	HBC	130	110	16	N	41680E1D35		
10.0	07-Oct-00	HBC	112	98		N	4169013C59		
2.4	08-Oct-00	HBC	185	158	33	N	416922213C		
2.1	08-Oct-00	HBC	130	111	12	N	416A030A7E		
2.1	09-Oct-00	HBC	130	111	12	Y	416A030A7E		
8.1	06-Oct-00	HBC	106	96	6	N	416A19767A		
8.1	06-Oct-00	HBC	105	97	7	N	416A20282D		
2.1	08-Oct-00	HBC	115	100	8	N	416A27190C		
8.1	06-Oct-00	HBC	161	151	26	N	416A595D49	F	
2.0	08-Oct-00	HBC	106	92	8	N	416A665768		
10.1	06-Oct-00	HBC	234	207	81	N	416A763247	M	
2.8	08-Oct-00	HBC	173	150	32	N	416A7E143D		
2.1	10-Oct-00	HBC	175	155	29	Y	416A7E143D		
8.8	06-Oct-00	HBC	120	104	8	N	416B017128		
2.0	08-Oct-00	HBC	200	172	47	N	416B026125		
2.1	08-Oct-00	HBC	128	109	11	N	416B026628		
2.1	11-Oct-00	HBC	128	109	11	Y	416B026628		
2.4	09-Oct-00	HBC	144	124	14	N	416B062C2F		
10.0	05-Oct-00	HBC	200	170	42	N	416B0D3433	F	
9.8	06-Oct-00	HBC	214	182	52	N	416B0D556A	M	
8.1	06-Oct-00	HBC	143	135	17	N	416B0E243E		
9.8	07-Oct-00	HBC	183	157	39	N	416B117649	M	
2.0	09-Oct-00	HBC	175	153	30	N	416B12414A		
3.6	09-Oct-00	HBC	175	154	27	N	416B140D04		
2.0	08-Oct-00	HBC	179	154	33	N	416B146E69		
2.1	09-Oct-00	HBC	150	128	18	N	416B153D6D		
3.0	08-Oct-00	HBC	130	113	11	N	416B165A69		
2.6	08-Oct-00	HBC	205	176	49	N	416B177F47		
9.6	05-Oct-00	HBC	150	127	18	N	416B194B1C	F	
2.8	09-Oct-00	HBC	200	174	51	N	416B1B4430		
2.1	08-Oct-00	HBC	135	116	13	N	416B1C0B7D		
8.5	06-Oct-00	HBC	232	202	78	N	416B1F0445	F	
2.2	09-Oct-00	HBC	191	160	42	N	416B1F1F6A		
3.1	10-Oct-00	HBC	172	149	27	N	416B1F2672		
9.7	07-Oct-00	HBC	125	108	11	N	416B226D6E		
3.6	09-Oct-00	HBC	180	154	30	N	416B266633		
3.1	08-Oct-00	HBC	120	104	11	N	416B28660F		
2.0	08-Oct-00	HBC	132	115	14	N	416B2A166C		
2.1	08-Oct-00	HBC	139	121	15	N	416B2A3C1D		
3.6	07-Oct-00	HBC	190	162	37	N	416B2A4271		
2.0	09-Oct-00	HBC	185	159	36	N	416B2F1563		
3.6	09-Oct-00	HBC	224	195	59	N	416B2F3443		
3.0	11-Oct-00	HBC	220	194	61	Y	416B2F3443		

Appendix A - 3. Summary of PIT tags from Little Colorado River, October 2000.									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
2.1	09-Oct-00	HBC	172	148	13	N	416B306400		
3.1	09-Oct-00	HBC	152	132	20	N	416B347765		
2.0	08-Oct-00	HBC	162	138	20	N	416B351311		
3.1	08-Oct-00	HBC	126	109	12	N	416B3B387F		
8.5	05-Oct-00	HBC	193	163	37	N	416B3C2501	M	
10.1	06-Oct-00	HBC	209	181	51	N	416B3E0C00	M	
7.9	12-Oct-00	HBC	224	189	63	Y	416B48167D	M	
9.8	05-Oct-00	HBC	225	191	67	N	416B48167D	M	
3.6	09-Oct-00	HBC	190	160	38	N	416B4C7A57		
9.8	05-Oct-00	HBC	207	177	49	N	416B53255F	F	
12.7	09-Oct-00	HBC	257		116	Y	41745C0A5C	F	
8.9	06-Oct-00	HBC	184	153	33	Y	4174746A66	M	
8.4	07-Oct-00	HBC	196	170		N	423D210C79	F	
6.5	08-Oct-00	HBC	195	166	47	N	423D2A0122	F	
9.0	07-Oct-00	HBC	131	113		N	423D391C3C		
6.7	08-Oct-00	HBC	175	152	32	N	423D3A6300	F	
8.8	07-Oct-00	HBC	195	168		N	423D48482F		
8.8	07-Oct-00	HBC	106	91		N	423D520F07		
1.8	15-Oct-00	HBC	184	158	31	N	4240273968		
1.7	15-Oct-00	HBC	120	108	9	N	4240280442		
1.7	15-Oct-00	HBC	111	95	8	N	42403D710B		
1.7	15-Oct-00	HBC	172	148	24	N	42404C3E37		
1.7	15-Oct-00	HBC	165	143	22	N	4240525C29		
1.8	15-Oct-00	HBC	186	167	33	N	4240525D0A		
1.8	15-Oct-00	HBC	178	159	46	N	42410F5053		
1.9	15-Oct-00	HBC	243	211	92	N	51097B121F	F	
6.5	08-Oct-00	HBC	294	256	179	N	510A7D221A	F	
12.0	10-Oct-00	HBC	179	153		Y	51104A6F43		
2.0	10-Oct-00	HBC	196	170	36	Y	511052673E		
1.0	15-Oct-00	HBC	194	167	39	N	511236387F		
11.1	12-Oct-00	HBC	267	235	124	Y	511604336E	F	
8.4	07-Oct-00	HBC	167	144		N	51570F3254	F	
10.1	07-Oct-00	HBC	202	174		N	5158440A6F	M	
9.9	07-Oct-00	HBC	272	235		N	5158454070		
1.8	15-Oct-00	HBC	176	151	31	N	5158550E0D		
1.0	13-Oct-00	HBC	215	186	62	Y	530F0C114F		
14.0	07-Oct-00	HBC	224		73	Y	530F0E1A79	F	
4.4	07-Oct-00	HBC	107	95	6	N	5314344462		
3.9	07-Oct-00	HBC	112	98	8	N	53143E116C		
4.4	06-Oct-00	HBC	125	109	9	N	531440682B		
4.2	07-Oct-00	HBC	137	120	15	N	531441615A		
5.1	07-Oct-00	HBC	121	104	10	N	531445700B		
4.2	07-Oct-00	HBC	132	126	17	N	53144B404A		
3.9	05-Oct-00	HBC	188	164	36	N	53207B074C		
3.9	07-Oct-00	HBC	116	102	7	N	53207B0E29		
3.6	05-Oct-00	HBC	129	111	14	N	53207E2E32		

Appendix A - 3. Summary of PIT tags from Little Colorado River, October 2000.									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
1.9	15-Oct-00	HBC	131	115	13	Y	53207E2E32		
5.1	06-Oct-00	HBC	182	158	34	N	53207E6C7F		
3.9	07-Oct-00	HBC	105	90	6	N	53207F6203		
3.6	06-Oct-00	HBC	141	122	17	N	53207F7744		
4.4	07-Oct-00	HBC	171	146	21	N	5321012535		
3.9	06-Oct-00	HBC	162	137	21	N	5321016778		
4.2	07-Oct-00	HBC	147	128	19	N	5321052539		
10.8	11-Oct-00	HBC	196	171	47	Y	5321074F56		
4.4	06-Oct-00	HBC	155	136	18	N	5321110D1C		
3.9	07-Oct-00	HBC	169	149	27	N	5321112A12		
4.0	07-Oct-00	HBC	123	106	11	N	5321141D7A		
3.9	07-Oct-00	HBC	99	84	6	N	5321153408		
3.6	06-Oct-00	HBC	225	195	64	N	5321156970	F	
3.8	07-Oct-00	HBC	131	115	14	N	532117023C		
3.8	07-Oct-00	HBC	105	94	7	N	532117346F		
4.4	07-Oct-00	HBC	154	133	22	N	53211C1937		
3.8	07-Oct-00	HBC	186	161	41	N	53211E1E5D		
4.4	06-Oct-00	HBC	166	147	27	N	5321212C47		
4.9	07-Oct-00	HBC	210	181	45	N	5321281D5A		
4.5	07-Oct-00	HBC	145	127	15	N	5321287752		
3.0	08-Oct-00	HBC	191	163	33	Y	53212F1563		
4.4	06-Oct-00	HBC	190	163	47	N	5321305253	F	
3.9	07-Oct-00	HBC	119	102	9	N	532135091D		
2.0	08-Oct-00	HBC	187	160	36	Y	5321371E09		
3.9	07-Oct-00	HBC	111	96	8	N	5321374371		
4.4	06-Oct-00	HBC	195	173	53	N	5321376A17	F	
4.8	07-Oct-00	HBC	175	149	27	N	53216D405B		
10.1	07-Oct-00	HBC	225	192		Y	532415494B	F	
2.0	08-Oct-00	HBC	205	178	52	Y	532430172B		
2.9	11-Oct-00	HBC	191	166	38	Y	5324354A4B		
11.0	12-Oct-00	HBC	253	218	93	Y	5325163427	F	
13.6	07-Oct-00	HBC	220		60	Y	53251F7E7F	F	
8.3	06-Oct-00	HBC	157	145	19	Y	532532281E	F	
3.9	07-Oct-00	HBC	187	162	41	Y	532534273E	M	
13.0	06-Oct-00	HBC	240			N	5325585D65	F	
14.0	07-Oct-00	HBC	289		152	Y	5326116056	M	
10.8	11-Oct-00	HBC	175	153	33	Y	5326140B65	F	
10.8	12-Oct-00	HBC	197	172		Y	5326176C61	F	
14.0	06-Oct-00	HBC	222			Y	532626444B		
4.2	07-Oct-00	HBC	200	177	51	Y	53262C6062	M	
10.8	11-Oct-00	HBC	187	160	43	Y	532634543E		
10.8	14-Oct-00	HBC	185	162	44	Y	532634543E		
5.1	07-Oct-00	HBC	192	166	41	Y	5326534449		
10.8	11-Oct-00	HBC	244	222	99	N	53265A1223	F	
10.6	11-Oct-00	HBC	192	164	40	Y	53265B3965		
13.6	07-Oct-00	HBC	200		41	Y	532664367D	M	

Appendix A - 3. Summary of PIT tags from Little Colorado River, October 2000.									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
10.8	11-Oct-00	HBC	202	175	52	Y	5326662D35	F	
13.8	07-Oct-00	HBC	169		24	N	5326717F15		
13.8	06-Oct-00	HBC	142			N	5326740A30		
14.0	07-Oct-00	HBC	268		124	N	53267E0072	M	
13.1	07-Oct-00	HBC	282		122	Y	5327095832	M	
13.8	07-Oct-00	HBC	246		90	N	53270B4477	F	
14.0	05-Oct-00	HBC	158		22	N	5327526B71		
13.7	06-Oct-00	HBC	162			N	5327566515		
12.8	10-Oct-00	HBC	308	268		Y	7F7B1A000A	F	
3.6	05-Oct-00	HBC	378	337	471	Y	7F7F206B49	M	
5.2	08-Oct-00	HBC	381	340	476	Y	7F7F391F33	M	R
3.1	11-Oct-00	FMS	116	107	11	N	227F18695D		
3.1	11-Oct-00	FMS	167	152	34	N	227F1B0508		
0.1	12-Oct-00	FMS	448	430	914	N	227F1D143E	M	
1.3	12-Oct-00	FMS	156	147	28	N	227F1D160A		
0.2	15-Oct-00	FMS	485	463	1069	N	227F20663A	M	
0.2	15-Oct-00	FMS	497	443	1115	N	227F2A4C7B	M	
2.0	11-Oct-00	FMS	117	109	12	N	227F353821		
2.8	08-Oct-00	FMS	150	136	23	N	41684F1B6E		
3.6	08-Oct-00	FMS	145	139	24	N	4168745403	F	
3.1	08-Oct-00	FMS	154	140	25	N	416939044E		
3.1	08-Oct-00	FMS	155	148	28	N	416B062A01	F	
3.3	10-Oct-00	FMS	147	130	24	N	416B0C432E		
3.1	08-Oct-00	FMS	286	264	174	N	416B166F2D	F	
2.0	09-Oct-00	FMS	124	112	14	N	416B190200		
3.1	10-Oct-00	FMS	164	148	28	N	416B195B62	F	
3.1	08-Oct-00	FMS	141	127	21	N	416B1C5726	F	
3.6	08-Oct-00	FMS	184	178	44	N	416B1F5B09		
3.6	08-Oct-00	FMS	129	119	71	N	416B3D7C77		
3.6	08-Oct-00	FMS	124	112	15	N	416B4B5E31		
1.7	15-Oct-00	FMS	145	138	21	N	42402A457F	F	
1.9	15-Oct-00	FMS	102	98	9	N	5158492B00		
3.8	07-Oct-00	FMS	160	146	28	N	5314366711	F	
4.5	07-Oct-00	FMS	138	127	20	N	531439735D		
4.0	06-Oct-00	FMS	152	140	26	N	532102641C	F	
4.2	07-Oct-00	FMS	141	139	21	N	5321040223		
3.9	07-Oct-00	FMS	143	132	23	N	5321082E27		
0.2	14-Oct-00	BHS	196	185	71	N	227F1A2860	F	
5.5	11-Oct-00	BHS	170			N	227F300D7D		
6.2	09-Oct-00	BHS	194			N	227F323A6A		
2.0	11-Oct-00	BHS	191	180	62	N	227F387A23	M	R
3.1	09-Oct-00	BHS	205	192	81	N	416A723B2E	M	R
3.6	07-Oct-00	BHS	106	99	8	N	416B0A7F64	F	
1.3	15-Oct-00	BHS	193	180	55	N	42402B2E40	F	
1.3	15-Oct-00	BHS	205	193	77	N	424055465A	M	
4.2	06-Oct-00	BHS	233	222	114	N	5314372914	M	R

Appendix A - 4. Summary of PIT tags from Little Colorado River, November 2000.

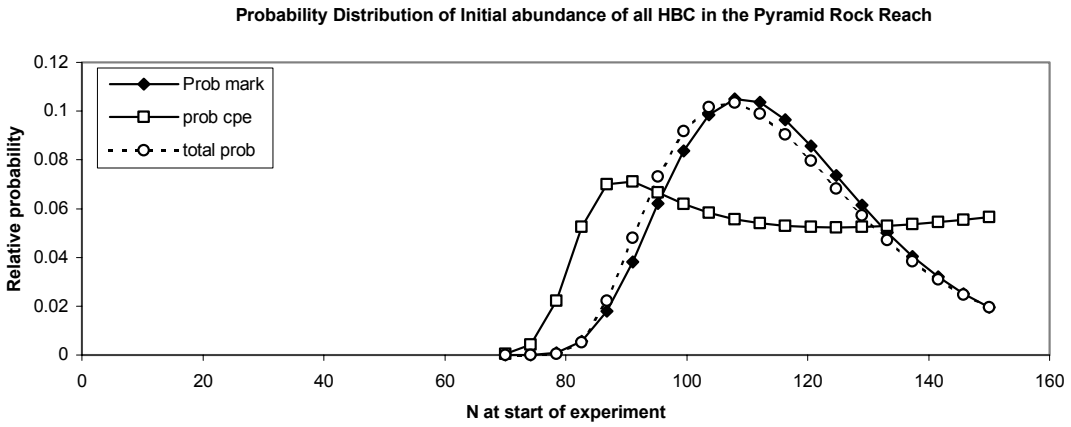
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
2.0	18-Nov-00	HBC	403	365	613	Y	1F46661223	F	
2.0	18-Nov-00	HBC	422	374	713	Y	1F7A3B2D7F	F	
5.1	13-Nov-00	HBC	111	95	8	N	227D260D0D		
13.5	12-Nov-00	HBC	264	228	124	N	227D2E6566	F	
13.1	10-Nov-00	HBC	161	138	24	Y	227D2F7B64		
13.1	10-Nov-00	HBC	212	179	56	N	227D33383D	F	
9.9	10-Nov-00	HBC	139	122	18	Y	227D345369		
8.0	11-Nov-00	HBC	195	171	40	N	227D356639	M	
7.8	16-Nov-00	HBC	161	139	19	Y	227D3E7574		
8.0	16-Nov-00	HBC	214	185	64	N	227D42284D	M	
10.6	19-Nov-00	HBC	140	121	19	Y	227D46553A		
1.9	19-Nov-00	HBC	198	172	60	Y	227D4A160F	F	
8.0	10-Nov-00	HBC	197	174	41	N	227D4B473F	F	
7.0	16-Nov-00	HBC	146	119	19	N	227F0E2668	F	
13.4	10-Nov-00	HBC	257	223	108	N	227F0E3F73	F	
6.4	16-Nov-00	HBC	119	107	10	N	227F105C4E		
10.2	16-Nov-00	HBC	227	195	72	Y	227F117C59		
12.9	13-Nov-00	HBC	226	194	75	N	227F117E6D	F	
9.2	12-Nov-00	HBC	223	194	66	N	227F122C2D	M	
14.2	11-Nov-00	HBC	175	150	34	N	227F130D19		
6.9	16-Nov-00	HBC	132	113	14	N	227F144A12	M	
13.1	13-Nov-00	HBC	284	246	158	N	227F155B5B	F	
7.6	18-Nov-00	HBC	144	122	17	Y	227F17237E		
13.6	12-Nov-00	HBC	176	151	32	N	227F176B41	F	
6.8	16-Nov-00	HBC	134	114	13	N	227F185F0E		
10.8	19-Nov-00	HBC	218	188	71	Y	227F192176	F	
5.4	16-Nov-00	HBC	141	123	18	N	227F1C5049	F	
12.8	15-Nov-00	HBC	285	248	174	N	227F1C5453	M	
7.9	18-Nov-00	HBC	171	143	31	N	227F1E6B02	F	
5.1	16-Nov-00	HBC	200	176	53	N	227F1E6E3B	M	
12.0	14-Nov-00	HBC	161	139		Y	227F1F5503		
7.9	18-Nov-00	HBC	189	160	49	N	227F1F5A48	F	
11.0	16-Nov-00	HBC	148	126	20	Y	227F201133		
5.8	15-Nov-00	HBC	123	106	11	N	227F201529		
12.7	15-Nov-00	HBC	197	170	48	N	227F204C4B	F	
6.5	14-Nov-00	HBC	207	179	44	N	227F213841	M	
12.9	12-Nov-00	HBC	220	191	70	N	227F23155A	F	
4.4	10-Nov-00	HBC	199	173	50	Y	227F231F28	M	
7.2	16-Nov-00	HBC	185	160	35	N	227F234D1B	F	
7.9	18-Nov-00	HBC	180	155	40	Y	227F273909	F	
13.1	12-Nov-00	HBC	284	246	147	N	227F27763B	M	
7.6	16-Nov-00	HBC	187	161	36	N	227F297E41	F	
7.0	17-Nov-00	HBC	113	96	10	N	227F2A7440		
6.9	19-Nov-00	HBC	113	98	9	Y	227F2A7440		
12.4	14-Nov-00	HBC	265	233		N	227F2B0664	F	
8.0	16-Nov-00	HBC	122	108	11	N	227F2B6113		

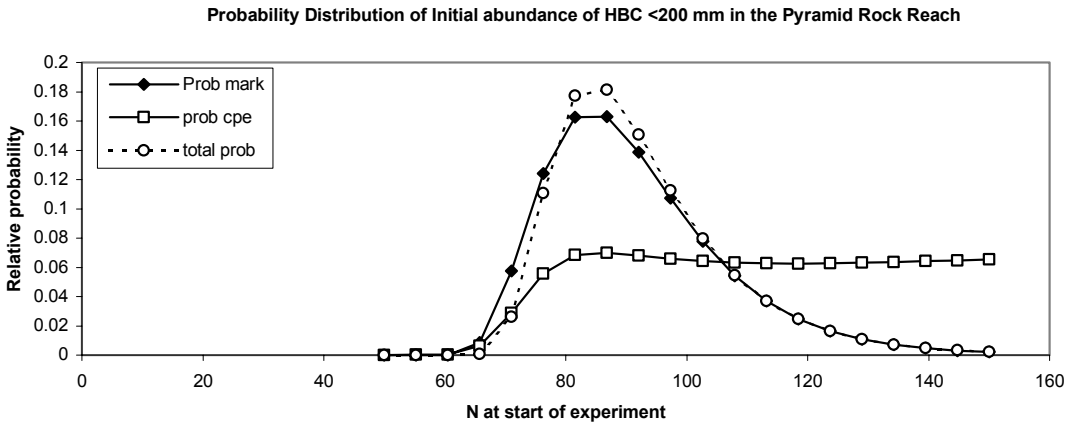
Appendix A - 4. Summary of PIT tags from Little Colorado River, November 2000.									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
6.9	16-Nov-00	HBC	174	153	33	N	227F2C7112	F	
8.0	10-Nov-00	HBC	239	206	78	N	227F2D3939	M	
14.2	11-Nov-00	HBC	237	208	87	N	227F2D7E4D	M	
9.9	10-Nov-00	HBC	170	145	30	Y	227F2E075F	F	
12.2	13-Nov-00	HBC	102	92	8	N	227F2E4108		
8.9	11-Nov-00	HBC	223	192	71	N	227F2F0800	M	
9.0	11-Nov-00	HBC	131	114	14	N	227F2F411C		
14.1	12-Nov-00	HBC	220	194	56	N	227F2F5578		
7.0	18-Nov-00	HBC	161	138	23	N	227F316761	F	
11.4	17-Nov-00	HBC	205	177	53	Y	227F327E09		
7.6	16-Nov-00	HBC	246	212	92	N	227F363719	M	
8.0	18-Nov-00	HBC	185	158	35	Y	227F376310	M	
10.9	19-Nov-00	HBC	308	265	186	Y	227F37670A	F	
7.8	19-Nov-00	HBC	139	121	15	Y	227F384B7D	F	
7.7	16-Nov-00	HBC	139	118	14	Y	227F384B7D		
7.9	18-Nov-00	HBC	183	161	41	N	227F3A2326	F	
6.9	16-Nov-00	HBC	144	123	13	Y	227F3B7A50		
5.1	13-Nov-00	HBC	143	122	18	Y	227F3C3941	F	
6.0	15-Nov-00	HBC	302	275	229	Y	4127677F52	F	
7.9	18-Nov-00	HBC	171	154	39	N	41531D3139	M	
7.9	19-Nov-00	HBC	164	142	25	N	41681A5936	M	
7.9	19-Nov-00	HBC	149	128	20	N	4169782022	F	
2.0	19-Nov-00	HBC	136	118	18	Y	416B2A166C		
7.7	18-Nov-00	HBC	227	193	69	Y	416B48167D		
2.0	17-Nov-00	HBC	131	111	14	N	423D1F6B49		
1.8	17-Nov-00	HBC	131	113	13	N	423D25594B		
1.2	19-Nov-00	HBC	218	188	58	N	423D257603		
10.8	18-Nov-00	HBC	174	152	35	N	423D275A3B		
2.2	15-Nov-00	HBC	174	149	31	N	423D276872		
3.2	15-Nov-00	HBC	200	172	47	N	423D285827		
1.7	16-Nov-00	HBC	186	161	33	N	423D293B5E		
2.8	13-Nov-00	HBC	193	166	41	N	423D2B5F59		
3.2	16-Nov-00	HBC	204	178	48	N	423D2E5E62		
10.2	18-Nov-00	HBC	133	117	15	N	423D2F0019		
2.8	14-Nov-00	HBC	224	193	68	N	423D30534D		
1.9	19-Nov-00	HBC	243	213	115	N	423D316207	F	
4.4	12-Nov-00	HBC	171	149	31	N	423D34386A		
2.1	16-Nov-00	HBC	174	151	31	N	423D36392E		
4.7	13-Nov-00	HBC	180	155	42	N	423D37772B		
3.4	13-Nov-00	HBC	209	176	48	N	423D39097B	F	
10.6	17-Nov-00	HBC	147	124	20	N	423D391826		
11.1	17-Nov-00	HBC	149	125	21	N	423D3A2F25		
2.8	15-Nov-00	HBC	104	86	6	N	423D3C4A0D		
1.8	19-Nov-00	HBC	123	106	10	N	423D3C615F		
10.6	16-Nov-00	HBC	150	127	19	N	423D420337		
4.4	12-Nov-00	HBC	181	155	26	N	423D426F11		

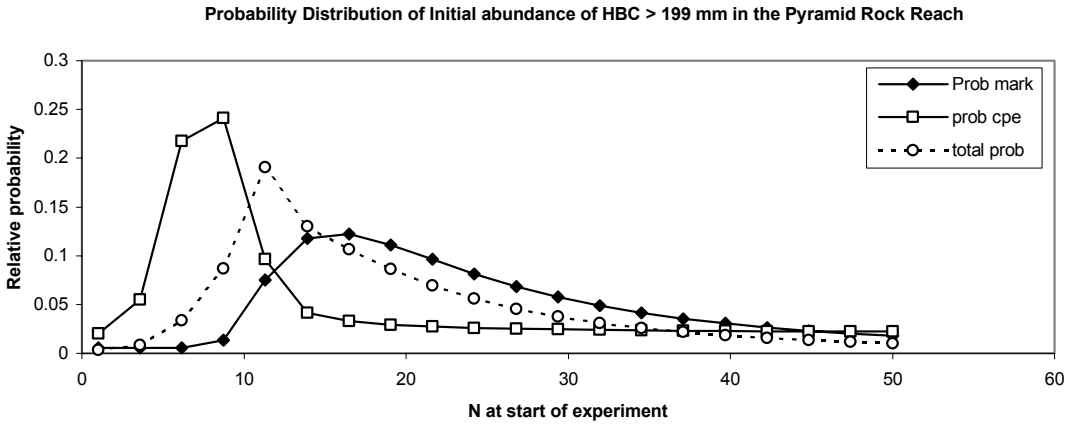
Appendix A - 4. Summary of PIT tags from Little Colorado River, November 2000.									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
2.0	13-Nov-00	HBC	136	115	9	N	423D456940		
1.8	18-Nov-00	HBC	169	148	28	N	423D47466F		
11.6	18-Nov-00	HBC	149	126	19	N	423D4C0525		
2.2	15-Nov-00	HBC	96	84	4	N	423D4E236F		
0.7	18-Nov-00	HBC	175	150	31	N	423D4E4002		
1.8	18-Nov-00	HBC	195	168	56	N	423D512A4E		
2.8	16-Nov-00	HBC	133	112	12	N	423D537939		
11.7	17-Nov-00	HBC	201	172	52	N	423D56620E		
10.8	19-Nov-00	HBC	146	123	21	N	423D5C5154		
1.9	16-Nov-00	HBC	169	144	27	N	423D5D4C41		
2.0	15-Nov-00	HBC	175	150	37	N	423D5D6713		
1.8	16-Nov-00	HBC	174	149	34	Y	423D5D6713		
3.2	16-Nov-00	HBC	130	110	13	N	42403B0A35		
10.8	19-Nov-00	HBC	159	138	25	N	4240463641		
3.8	10-Nov-00	HBC	186	162	47	N	42404F5C0A	F	
10.8	19-Nov-00	HBC	126	116	11	N	42405F174E		
12.1	15-Nov-00	HBC	100	87	6	N	4240782175		
10.8	19-Nov-00	HBC	153	133	20	N	4241001002		
10.2	17-Nov-00	HBC	255	217	103	N	4241084171	F	
10.9	16-Nov-00	HBC	189	163	27	N	51090B6873		
11.7	16-Nov-00	HBC	157	135	24	N	51090D181C		
11.7	17-Nov-00	HBC	157	133	22	Y	51090D181C		
11.1	18-Nov-00	HBC	137	116	16	N	5109160B3D		
11.5	17-Nov-00	HBC	212	183	61	N	510A7E1D5F		
10.8	19-Nov-00	HBC	212	183	57	N	510B0B703C	M	
11.1	16-Nov-00	HBC	271	232	137	N	511604336E	F	
8.0	10-Nov-00	HBC	256	221	96	Y	5116134379	F	
10.9	18-Nov-00	HBC	201	179	50	Y	51164A017A	F	
10.8	18-Nov-00	HBC	195	170	41	N	51570E3A06	F	
4.7	10-Nov-00	HBC	230	199	63	N	51576C513C	M	
12.7	15-Nov-00	HBC	166	141	26	N	51584D1D5F		
10.8	16-Nov-00	HBC	198	171	40	N	5158510764		
10.4	17-Nov-00	HBC	144	124	18	N	5158736479		
11.4	19-Nov-00	HBC	217	184	60	N	51587F7A34	F	
10.6	18-Nov-00	HBC	185	161	41	N	51590B3740	M	
12.2	16-Nov-00	HBC	114	97	8	N	5159531971		
10.2	17-Nov-00	HBC	185	156	35	N	5159560072		
11.0	18-Nov-00	HBC	260	224	118	Y	530F0B725D	F	
10.8	17-Nov-00	HBC	219	193	71	Y	5321005F57	F	
9.0	10-Nov-00	HBC	189	166	48	Y	5321203914	M	
3.2	14-Nov-00	HBC	174	149	29	Y	53216D405B		
2.2	16-Nov-00	HBC	194	169	39	N	532428185B		
13.8	11-Nov-00	HBC	191	160	40	Y	5324373179		
10.8	19-Nov-00	HBC	210	181	61	Y	53250E4E6A	F	
11.9	16-Nov-00	HBC	253	218	87	Y	5325207A26	F	
12.7	13-Nov-00	HBC	238	207	73	Y	5325585D65		

Appendix A - 4. Summary of PIT tags from Little Colorado River, November 2000.									
Km	Date	Species	TL	FL	Weight	Recap	PIT tag	Sex	Ripe
10.8	18-Nov-00	HBC	185	161	48	Y	532634543E	F	
10.8	18-Nov-00	HBC	175	152	34	Y	53263F262A		
10.8	19-Nov-00	HBC	173	147	33	Y	53263F4838	F	
10.8	18-Nov-00	HBC	204	176	48	Y	5326503F6F	F	
14.2	10-Nov-00	HBC	154	137	21	Y	5326532433		
14.2	13-Nov-00	HBC	155	133	18	Y	5326532433		
14.2	13-Nov-00	HBC	267	234	124	Y	5326657D41	M	
1.1	16-Nov-00	HBC	342	309	407	Y	7F7B022202		
2.0	19-Nov-00	HBC	391	346	585	Y	7F7D3C512D	F	
2.6	16-Nov-00	HBC	373	335	449	Y	7F7F27287D		
10.5	18-Nov-00	HBC	361	333	400	Y	7F7F291538	F	
5.1	11-Nov-00	HBC	349	312	249	Y	7F7F39585E	M	
0.5	17-Nov-00	HBC	373	338	476	Y	7F7F3F4E04		
0.1	18-Nov-00	FMS	498	488	1042	Y	1F3E5D6066	F	
6.9	16-Nov-00	FMS	244			N	227F1D2754	M	
0.5	18-Nov-00	FMS	474	453	953	Y	4174691A41	M	
11.4	19-Nov-00	FMS	437		600	Y	4174704D64	M	R
1.1	16-Nov-00	FMS	112	104	10	N	423D4D3075		
4.4	11-Nov-00	FMS	172	153	24	N	51570B2854		
8.0	17-Nov-00	BHS	182			N	227F1B3A3E		
6.9	16-Nov-00	BHS	167			N	227F242061	F	
5.3	15-Nov-00	BHS	154			N	227F266368	F	
6.9	16-Nov-00	BHS	156			N	227F2C2202	F	
1.5	16-Nov-00	BHS	135	113	12	N	227F327904	F	
1.5	18-Nov-00	BHS	192	182	59	N	423D1F5768		
2.0	16-Nov-00	BHS	266	256	199	N	423D211675	F	
4.2	10-Nov-00	BHS	149	134	24	N	423D327A4C	M	R
2.0	13-Nov-00	BHS	276	259	158	N	423D3F696A	F	
1.5	17-Nov-00	BHS	228	216	117	N	423D42072D	M	
1.5	19-Nov-00	BHS	132	119	17	N	423D59737B	F	
2.1	14-Nov-00	BHS	285	270	207	N	423D5A6904	F	
1.5	17-Nov-00	BHS	219	208	81	N	42401C5511	F	R
11.2	18-Nov-00	BHS	166		40	N	424051636C	M	R
4.1	12-Nov-00	BHS	111	101	6	N	424131271D	F	
11.4	19-Nov-00	BHS	188		41	N	510A7B3B6A	F	

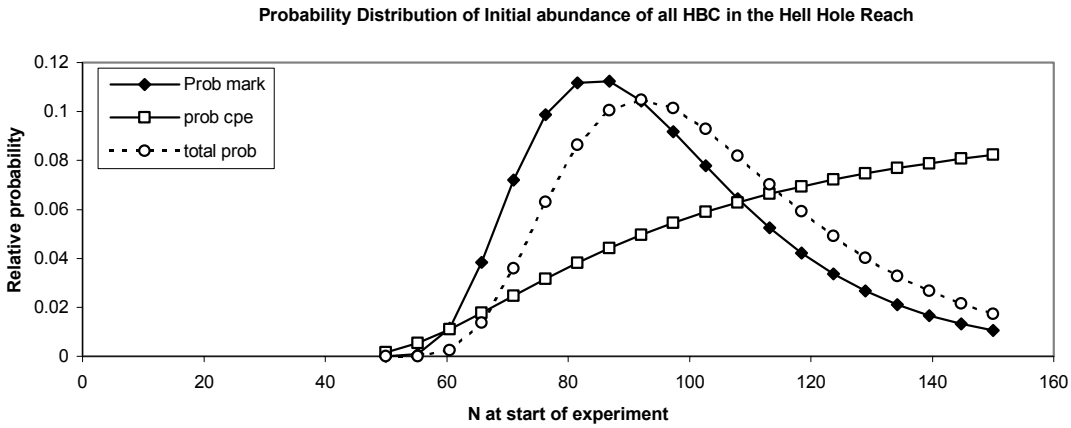
Appendix B - 1. Probability distributions of the initial abundance of humpback chub (HBC) for the mark-recapture method (prob mark), depletion method (prob cpe), and the combined mark-recapture/depletion method (total prob) within the Pyramid Rock reach for three size classes of fish.

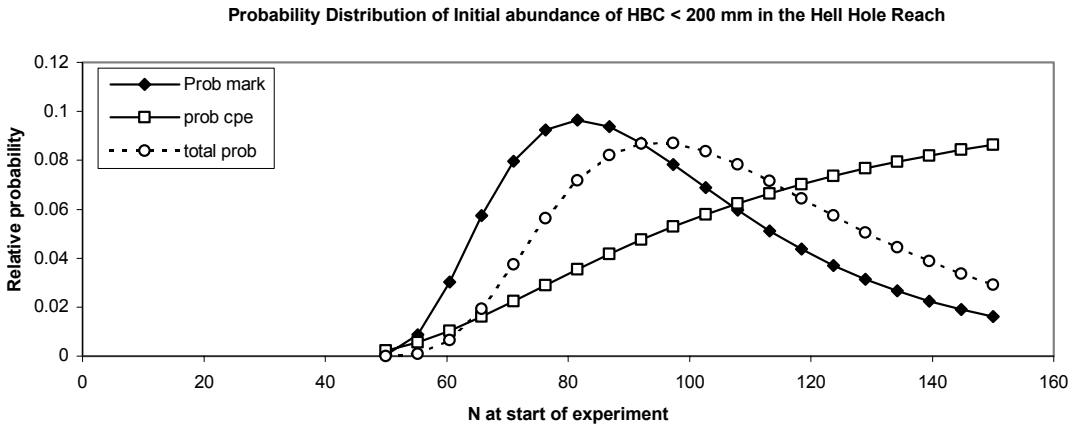


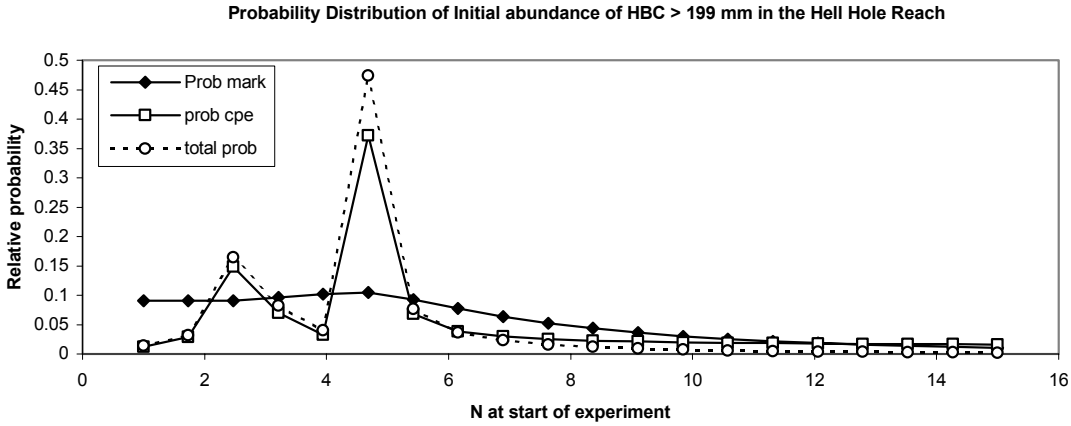
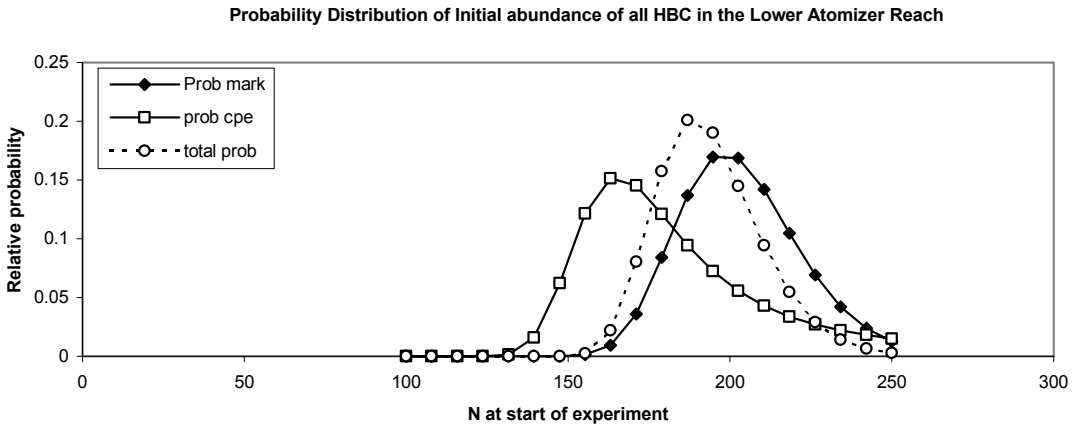
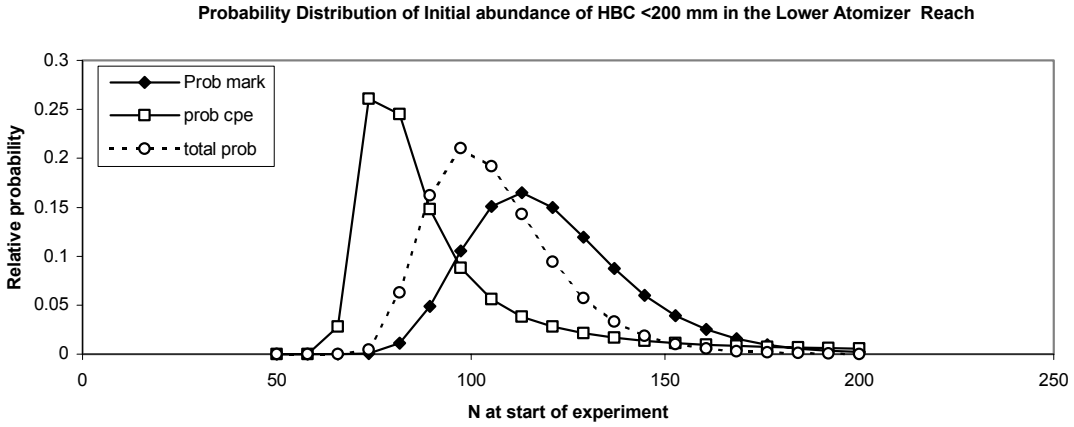
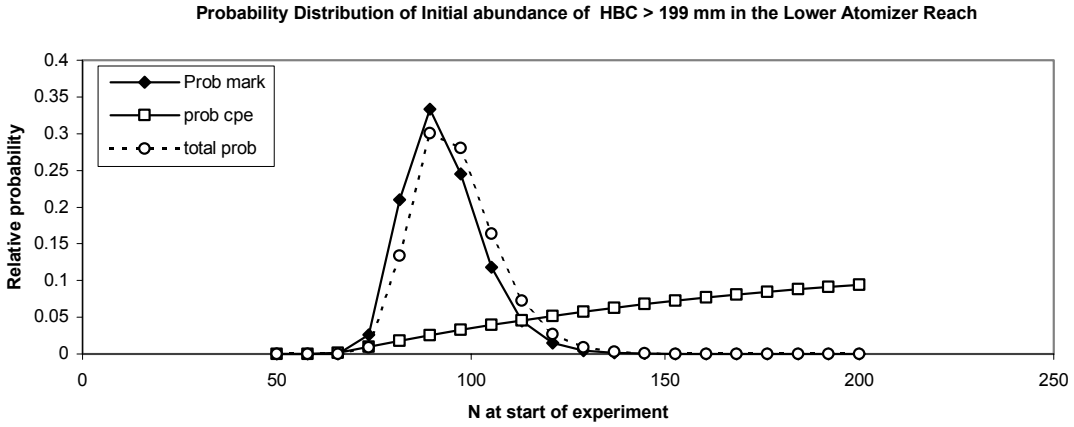




Appendix B - 2. Probability distributions of the initial abundance of humpback chub (HBC) for the mark-recapture method (prob mark), depletion method (prob cpe), and the combined mark-recapture/depletion method (total prob) within the Hell Hole reach for three size classes of fish.







Appendix B - 3. Probability distributions of the initial abundance of humpback chub (HBC) for the mark-recapture method (prob mark), depletion method (prob cpe), and the combined mark-recapture/depletion method (total prob) within the Lower Atomizer Falls reach for three size classes of fish.