LITTLE COLORADO RIVER
LOWER 1200 M HOOP NET MONITORING

2008 ANNUAL REPORT

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INTRODUCTION

In 1987, the Arizona Game and Fish Department (AGFD) began monitoring of fishes in the lower 1200 meters of the Little Colorado River (LCR) to assess population trends and status of the endangered humpback chub (*Gila cypha* (HBC); Robinson and Clarkson 1992). Annual standardized hoop net sampling is conducted for 20 – 30 days each spring to capture humpback chub and other fishes during the spring spawning period (Table 1). Catch-per-unit-effort (CPUE) indices derived from this monitoring program are useful as independent validation for the age structured mark-recapture (ASMR) population models of humpback chub developed by Coggins *et al*. (2006). In addition, the hoop nets are effective at capturing all native fishes in the LCR. AGFD was not responsible for LCR lower 1200 m monitoring from 2000-2001. With the exception of 2000-2001, the lower 1200 meter sampling represents one of the most consistent, long-term sampling methods for Grand Canyon fishes.

STUDY SITE

The study site is the lower section of the LCR, from its confluence with the Colorado River to 1200 m upstream. The LCR in the study area is a deeply entrenched channel located in a vertical-walled canyon that, in places, narrows to less than 50 m. The LCR channel contains runs, riffles, deep pools and small rapids. Substrates are primarily silt and sand with scattered large boulders and travertine dams. The LCR is the primary spawning site for the endangered HBC in Grand Canyon and is the only known HBC aggregate in the Colorado River Ecosystem from which fish are known to recruit into the adult population (Valdez and Ryel 1995; Coggins et al. 2006). Other native fishes, bluehead sucker (*Catostomus discobolus*), flannelmouth sucker (*Catostomus latipinnis*), and speckled dace (*Rhinichthys osculus*) spawn in the LCR (Robinson *et al*. 1998) as do nonnative species including channel catfish (*Ictalurus punctatus*), fathead minnow (*Pimephales promelas*), red shiner (*Cyprinella lutrensis*), common carp (*Cyprinus carpio*), black bullhead (*Ameiurus melas*) and plains killifish (*Fundulus zebrinus*).

METHODS

We fished thirteen standardized AGFD hoop nets from April 11 through May 5, 2008, checking nets once daily. Due to time constraints and personnel illness there were a few occasions where the nets were not checked daily (Clark 2008). Hoop nets measured 5 m long and 1 m diameter with 6.3 mm mesh, 7 hoops and two throats. Nets were set at 100, 119, 137, 165, 420, 480, 500, 577, 675, 1045, 1110, 1160, and 1195 m upstream from the confluence. Net locations were set as close as possible to those used in previous sampling efforts (Brouder and Hoffnagle 1998).

All fish captured were handled following protocols in Ward (2002). All fish collected were identified to species and measured for total length (TL; nearest mm). Fork length was also measured for humpback chub, flannelmouth sucker, and bluehead sucker. Weights were not measured in an effort to reduce handling time and because high winds common during the study period do not allow accurate weight measurements. Analysis of previous weight data from this monitoring program also indicates these weights are not useful as an index of fish condition because sexual condition and tapeworm loads can confound weight data. Native fish were sexed when possible based on external sexual characteristics or manual expulsion of gametes and sexual condition (not ripe, ripe) was recorded. Examination of sexual characteristics (none, color, tuberculate) was also noted. Number and type of external parasites were recorded. Native fishes ≥ 150 mm TL were scanned for the presence of a Passive Integrated Transponder (PIT) tag with both a 134.2 kHz tag reader and an 400 kHz tag reader to verify that no tags were missed. If a tag was not found and the fish was ≥ 150 mm TL, a 134.2 kHz PIT tag was inserted into the abdominal cavity. Also, if captured native fish ≥ 150 mm TL possessed an old 400 kHz PIT tag, they were given a new 134.2 kHz PIT tag. Tag presence or absence and PIT tag number (old and new) were recorded. Fish were also checked for fin clips. PIT tag information was downloaded electronically and checked for errors. Catch-per-unit-effort was calculated as number of fish captured per hour.

Turbidity (NTU) and temperature (C) data were collected during the monitoring period using a Hach 2100P Turbidimeter and a Cooper MODEL DPP400W thermometer. The turbidity and temperature data was collected each morning at Boulders camp (RKM 2.1), prior to daily hoop

net checks. Flow data was acquired from the USGS Real-Time Water Data for USGS 09402300 LITTLE COLORADO RIVER ABV MOUTH NR DESERT VIEW, AZ, which is located within the 1200 m monitoring site.

RESULTS

Flows were greater than 600 cubic feet per second (cfs) during start of the 2008 monitoring period and decreased to base flow (238 cfs) at the end of the 25 day period (Figure 1). Turbidity during the sampling period ranged from 928 to 6 NTU (Figure 2). Water temperature ranged from 10.5 to 19 ºC during the sampling period (Figure 3).

A total of 3,044 fish representing eight species were captured during standardized monitoring in 2008 (Table 2). Native species dominated the catch and comprised approximately 97 % of fish caught. Speckled dace (SPD), humpback chub (HBC), bluehead sucker (BHS), and flannelmouth sucker (FMS) were the predominant species caught. Native fishes have comprised over 80 % of the total catch since 1987, with the exception of 1997 and 2006 when fathead minnows dominated the catches (Figure 4).

Native species

Humpback chub

During the 2008 monitoring period, a total of 507 humpback chub were collected in standardized hoop net sets. Humpback chub captured in 2008 had a mean TL of 152 mm and ranged in size from 57 mm to 432 mm total length.

We examined 203 humpback chub ≥ 150 mm TL for presence of a PIT tag and 65 (32 %) were PIT tag recaptures (Table 3). Sixty seven percent of 137 PIT tagged HBC were 200-300 mm TL and nine new tags were inserted into humpback chub ≥ 301 mm TL (Figure 5). Catch per unit effort of HBC < 150 mm TL has been highly variable over the last five years. The mean CPUE of humpback chub ≥ 150 mm TL declined from 1987 to 1994 and remained relatively stable from 1994 to 2002. Mean CPUE of HBC ≥ 150 mm TL since 2003 has been variable at levels

similar to the early 1990's monitoring period. In 2008, the mean CPUE of HBC ≥ 200 mm TL was the highest observed since 1991 (Figure 6). Eight ripe male HBC were observed in 2008. Three of the eight ripe males were turberculate and ranged in size from 200-239 mm total length. Seventeen humpback chub were captured that were infected with 1-3 *Lernaea* each during 2008 whereas in 2007, *Lernaea* were not detected on humpback chub. (Figure 7).

Flannelmouth sucker

Flannelmouth sucker were the second most abundant native species captured in 2008 (N= 596; 21%) (Table 2). Flannelmouth sucker captured in 2008 had a mean TL of 288 mm and ranged in size from 67 mm to 513 mm (Figure 8). A total of 527 flannelmouth sucker greater than 150 mm TL were caught and 152 (29 %) were recaptures (Table 3). Flannelmouth sucker CPUE was the highest observed since the monitoring project began in 1987 (Figure 9). Flannelmouth sucker CPUE has been highly variable during the last 4 years but still indicates an increasing overall trend since 2002 (Figure 9). Eleven of the 596 FMS were ripe, of which 6 were male and 5 female. Three FMS were captured that were infected with one *Lernaea* each.

Bluehead sucker

Bluehead sucker were the third most abundant native species captured (N= 568). BHS captured in 2008 had a mean TL of 227 mm and ranged in size from 41 to 351 mm TL (Figure 10). A total of 530 bluehead sucker were scanned for presence of a PIT tag, with 33 recaptures (6.2 %) (Table 3). CPUE of bluehead sucker ≥ 150 mm TL increased from 2006 levels and total catch of bluehead sucker in 2008 was the highest recorded since 1987 (Table 4). Of the 568 BHS captured ninety two were ripe, of which 72 were male (78%) and 20 were female. None of the BHS were observed to be infected with *Lernaea*.

Speckled dace

Speckled dace was the most abundant species observed in 2008 with 1,288 individuals captured (Table 3). Speckled dace CPUE has been highly variable among years (Figure 9). One hundred and eighty SPD were observed to be ripe. One hundred and sixteen were males and sixty four were female. None of the SPD were observed to be infected with *Lernaea*.

Nonnative species

Nonnative species made up less than 3 % of the total catch in 2008 with fathead minnow (FHM) the most abundant nonnative species caught (N= 62; Table 2). Catch rates of channel catfish have been relatively low over the last five years. Catch of common carp (CRP) was low and was similar to 2005 (Figure 11). The catch of black bullheads (BBH) was the highest recorded since AGFD monitoring began in 1987 and has shown a general pattern of increase since 2002 (Table 4). BBH captured in 2008 had a mean TL of 126 mm and ranged in size from 82 to 255 mm TL (Table 5).

DISCUSSION

Native species

Catch rates of native fishes in 2008 were generally greater than in 2007, with the exception of FMS and SPD. The LCR was above baseflow conditions during the first half of the sampling period with decreasing levels of turbidity. Recent investigations of the effects of turbidity on hoop net catch rates have revealed that catch rates increase significantly at turbidities < 180 NTU (Stone 2004). In general, catch rates of native fishes show an overall increasing trend since 2002.

Humpback chub

A large cohort of juvenile (likely Age 1) HBC was observed in 2008. The 2008 length frequency histogram suggests that young humpback chub are transitioning into larger adult fish.

Flannelmouth sucker

All size classes of FMS were collected in 2008. Over the last four years, flannelmouth sucker catch rate has shown an increasing trend. Length frequency distributions of FMS from 2006-2008 indicate that juvenile and sub-adult flannelmouth suckers are recruiting to the adult population. Flannelmouth suckers have also been more abundant in electrofishing samples from the mainstem Colorado River in recent years (unpublished data).

Bluehead sucker

Juvenile and adult bluehead sucker were observed in 2008. Warmer mainstem water temperatures caused by drought conditions and lowered water levels in Lake Powell (Susan Hueftle, USGS unpublished data) may have led to increased survival of both flannelmouth and bluehead suckers (Rogers et al. 2008). The removal of predatory nonnative species around the confluence of the Little Colorado River may also be partly responsible for the increased catch of suckers within the Little Colorado River. Separating the effects of warmer water and fewer predators may take several more years of investigation. The overall effect appears to have been beneficial to sucker populations. Thirty-three bluehead suckers were recaptured in 2008, twice as many recaptures as in 2007.

A few BHS were observed with fungus near the posterior end of the body. A few of these fish were caught in hoop nets and other BHS were found dead along the shoreline upstream of the lower 1200 meter monitoring site. These fish were not tagged due to severe tissue damage in the region where the fungus was located. A BHS specimen was preserved and photos were taken of two fish found dead. Researchers with the USFWS that were monitoring fish also observed BHS mortalities several kilometers upstream of the AGFD lower 1200 meter study site. None of the BHS mortalities encountered during the monitoring period were PIT tag recaptures. Therefore, it is highly unlikely that the mortalities were a direct result of handling or PIT tagging injuries. Due to the increased number of reproductive adult BHS currently in the LCR, the fungal infections were probably due to primary stress related to reproduction.

Speckled dace

Catches of speckled dace were highly variable among years. Warmer mainstem water temperatures and fewer introduced predators are expected to benefit speckled dace populations, as well as humpback chub and sucker populations.

Nonnative species

Nonnative fishes in the Little Colorado River remains at low levels (< 3%). The catch rate of red shiner has been low over the last two years possibly due to spring runoff flows disadvantaging small-bodied nonnative fishes by displacement into the mainstem Colorado River.

The increase in BBH may be attributed to immigration from within the LCR watershed (Stone et al. 2007), local reproduction and warmer mainstem Colorado River temperatures. Diet analysis of ten sacrificed BBH in 2008 found only two individuals with fish remains in their stomach, possibly due to predation while confined in the hoop nets. The remains of the partially digested fish appeared to be speckled dace. Stomach contents also included terrestrial insects and aquatic vegetation. Two of the sacrificed BBH were mature females. Also, with the possibility of additional remote PIT tag detection capabilities, it may be beneficial to PIT tag nonnative species of concern (i.e.: CRP, CCF, and BBH).

No trends are evident in catch rates of channel catfish and common carp, although large numbers of adult carp are visually observed throughout the LCR and channel catfish are commonly captured by angling. Both species are not very vulnerable to capture in hoop nets during clear water periods within the Little Colorado River so hoop net catch rate trends are not good indices of the adult carp or channel catfish populations.

The pattern of nonnative fish abundance in the Little Colorado River is not typical of most southwestern streams. Typically, once small-bodied, introduced species such as fathead minnow or red shiner appear they gradually increase in abundance over time until they numerically dominate a fish assemblage (Marsh and Pacey 2005). The extreme flood regime, high turbidity and high salinity of the Little Colorado River during the spring and late summer may prevent these nonnative species that are adapted for more stable systems from becoming established (Minckley and Meffe 1987, Ward et al. 2003).

Strengths and weaknesses of lower 1200 meter monitoring

The lower 1200 meter hoopnet monitoring represents one of the longest ongoing, standardized trend indices for Grand Canyon fishes. The real strength of this data set is the length of time over which the data has been collected in a consistent manner. Catch-per-unit-effort indices derived from the lower 1200 meter monitoring show dramatic declines in relative abundance of adult humpback chub and validate open population estimates (Coggins et al. 2006). The lower 1200 meter standardized hoop net monitoring will be assessed by the 2009 Protocol Evaluation Panel

PIT Tag Antennas

Recent technological advances including 134.2 kHz PIT tags allow new possibilities for detection of fish, which may help address questions of fish movement and population closure within the Little Colorado River. We have been evaluating the potential of detecting PIT tags in fishes using stationary PIT tag antennas.

Three 24-inch diameter square antennas were deployed from April 4 - Oct. 21, 2008. Antennas were placed perpendicular to the shoreline in a swim through, window type configuration. The antennas were attached to shore using rope and secured in place in the river with rocks attached to the bottom of the antennas. Tag readers (Biomark FS-2001, "cheese block readers") were connected to each antenna and powered with 12 volt batteries charged by solar panels. Tag readers continually record PIT tags within approximately 12 inches of the antenna. Each tag detected was recorded by the FS-2001 reader along with a date and time stamp. The antennas were downloaded when possible during the period of deployment.

One antenna was located approximately 20 meters downstream of Boulders camp on tributary left at the location known as Cattail (Cat : RKM) 1.85L. The Cattail antenna was relocated on July 2nd downstream on river right due to signal interference. The new location is known as Amazon Island (AI) at RKM 1.35R. The second antenna was deployed upstream at RKM 5.02R at the camp formerly known as Old Coyote (OC). The third antenna was deployed upstream of OC at RKM 9.05R at the USFWS camp known as New Coyote (NC).

The antennas detected a total of 1171 unique tags during 2008. For comparison, 1154 unique PIT tags were recaptured from the thirteen standard monitoring nets. Sixty-two fishes were caught in standardized lower 1200 monitoring nets and also detected by an antenna. Forty-six fishes were detected in multiple antennas. The majority of fishes detected were HBC and BHS, also six common carp (CRP) were detected. Further data analysis is ongoing.

This year was our first attempt to operate the remote antennas beyond the scheduled LCR lower 1200 m monitoring period. A special trip was conducted in June to download and check systems prior to the anticipated beginning of the monsoon season. Two of the three antennas were not adversely affected by the summer high flows (> 3000 cfs). The antenna at NC had moved from its original position and the data cable had unplugged from the antenna when it was checked in September.

The equipment worked well with a few exceptions. As mentioned previously, the Cattail antenna was moved to a new location due to signal interference. This antenna performed well except for continued signal interference most likely due to the solar hardware. The only other issue was with one of the FS-2001 yellow scanners. AGFD personnel were not able to download the OC scanner in October. This scanner was sent back to Biomark for replacement of a defective memory chip but approximately 10 days of data were lost. We will attach CF card readers to the scanners to continuously download data and to provide a backup should a scanner fail. We also plan to install a variety of noise filters to the systems to reduce signal interference.

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TABLES

Table 1. Standardized lower 1200 m LCR hoop net sampling information, 1987 - 2008.

Year	Start Date	End Date	GCMRC Trip ID	Days Sampled	Effort (Hours)	Average duration of net sets (hours)	Number of net sets per year
1987	9-May	30-May	LC19870509	21	1428	11.52	124
1988	3-May	29-May	LC19880503	26	3668	11.15	329
1989	3-May	28-May	LC19890503	25	4920	24.00	205
1990	17-Apr	14-May	LC19900417	27	4479	23.70	189
1991	3-May	30-Jun	LC19910503	58	7773	14.56	534
1992	5-May	28-May	LC19920505	23	6038	18.93	319
1993	30-Apr	31-May	LC19930430	31	9116	12.25[a/]	744[a/]
1994	19-Apr	21-May	LC19940419	32	9987	12.27[a/]	814[a/]
1995	20-Apr	20-May	LC19950420	30	9449	12.01[a/]	787[a/]
1996	18-Apr	18-May	LC19960418	30	9175	12.25[a/]	750[a/]
1997	13-Apr	14-May	LC19970413	31	9076	12.05[a/]	753[a/]
1998	5-Apr	26-Apr	LC19980405	21	7060	16.38	431
1999	7-Apr	1-May	*GC19990406	24	9373	18.86	497
2002	19-Apr	19-May	LC20020419	30	3138	24.14	130
2003	11-Apr	9-May	LC20030411	28	3415	24.75	138
2004	9-Apr	3-May	LC20040409	24	7190	24.05	299
2005	8-Apr	6-May	LC20050408	26	6333	23.99	264
2006	7-Apr	5-May	LC20060407	24	7417	24.44	312
2007	15-Apr	7-May	LC20070414	21	6695	25.75	260
2008	11-Apr	5-May	LC20080411	23	6919	24.80	279

* 1999 has a GC extension because it was submitted with USFWS Grand Canyon data.
[a/] From1993 to 1997 nets were often checked twice daily which led to a higher number of net sets.

Table 2. Species composition of standardized hoop net catches, Little Colorado River, April 11 - May 5, 2008.

Species	Number	%
Bluehead sucker (BHS)	568	18.7
Flannelmouth sucker (FMS)	596	19.6
Humpback chub (HBC)	507	16.7
Speckled dace (SPD)	1288	42.3
Total Native	2959	97.3
Black bullhead (BBH)	19	0.60
Channel catfish (CCF)	3	0.09
Common carp (CRP)	1	0.03
Fathead minnow (FHM)	62	2.04
Plains killifish (PKF)	0	0.00
Rainbow trout (RBT)	0	0.00
Red shiner (RSH)	0	0.00
Total Non-native	85	2.7
Total	3044	100

Table 3. Number of fishes scanned, tagged, and recaptured by species, standardized lower 1200 m LCR hoop net sampling April 11 – May 5, 2008.

Species	Number Scanned	Number Tagged	Number Recaptured
HBC	203	137	65 (32%)
FMS	527	373	152 (29%)
BHS	530	477	33 (6.2%)

Table 4. Total catch by species and year standardized lower 1200 m LCR hoop net sampling 1987 – 2008.

	Species												
Year	BBH	BHS	CCF	CRP	FHM	FMS	GSF	HBC	PKF	RBT	RSH	SPD	SUC
1987	0	39	5	2	1	81	1	396	0	0	0	132	0
1988	0	65	8	1	12	91	0	596	0	0	0	192	0
1989	0	72	41	0	17	28	0	548	0	1	2	204	0
1990	0	25	2	0	10	30	0	418	0	0	0	90	3
1991	0	106	4	0	3	106	0	316	0	1	0	1003	0
1992	0	19	8	0	1	25	0	199	0	0	0	110	0
1993	0	44	0	0	1	50	0	431	0	2	0	455	1
1994	0	64	5	0	265	88	0	657	0	0	0	1022	0
1995	1	32	1	1	19	65	0	243	0	1	0	488	0
1996	0	413	1	8	237	237	0	359	0	8	14	741	2
1997	1	45	12	60	726	97	0	123	97	1	74	417	0
1998	1	27	5	0	52	6	0	132	1	4	8	106	0
1999	0	61	10	5	14	21	0	156	0	6	70	187	0
2002	0	122	1	0	46	79	0	130	1	3	3	115	0
2003	3	93	3	7	42	256	0	157	0	0	13	116	0
2004	5	154	7	7	91	357	0	743	52	5	65	1918	0
2005	4	347	3	1	0	192	0	344	0	1	0	445	0
2006	12	395	13	19	1286	483	0	587	9	1	44	3173	0
2007	9	304	3	13	17	644	0	266	12	0	8	1644	0
2008	19	568	3	1	62	596	0	507	0	0	0	1288	0

Table 5. Length frequency distributions of fish collected during standardized lower 1200 m LCR hoop net sampling, April 11 – May 5, 2008.

	Species										
Length	BBH	BHS	CCF	CRP	FHM	FMS	HBC	PKF	RBT	RSH	SPD
20 – 29											
30 - 39					4						
40 - 49		3			16						4
50 - 59		1			25		1				108
60 - 69		8			13	1	7				368
70 - 79		10			3	4	23				335
80 - 89	3	4	2		1	6	73				266
90 - 99	2	3				10	118				142
100 - 109	9	4				17	43				48
110 - 119						9	21				11
120 - 129		1				5	6				6
130 - 139		2				9	8				
140 - 149		2				8	4				
150 - 159		2				1	6				
160 - 169	1	6				13	5				
170 - 179	1	8				12	15				
180 - 189		8				24	8				
190 - 199		29				13	15				
200 - 209	1	47				21	22				
210 - 219	1	45				17	15				
220 - 229		74				10	23				
230 - 239		76	1			23	17				
240 - 249		64		1		11	19				
250 - 259	1	51				14	15				
260 - 269		34				11	9				
270 - 279		35				9	4				
280 - 289		19				12	5				
290 - 299		20				17	3				
300 - 309		8				11	1				
310 - 319		2				13	2				
320 - 329		1				25	1				
330 - 339						39	1				
340 - 349						32	1				
350 - 359		1				32	1				
360 - 369						26	2				
370 - 379						38					
380 - 389						26	2				
390 - 399						18	1				
400 - 409						16					
410 - 419						10	5				
420 - 429						13	4				

Length	Species BBH	BHS	CCF	CRP	FHM	FMS	HBC	PKF	RBT	RSH	SPD
430 - 439						4	1				
440 - 449						3					
450 - 459						3					
460 - 469						2					
470 - 479						2					
480 - 489						5					
490 - 499											
500 - 509											
510 - 519						1					

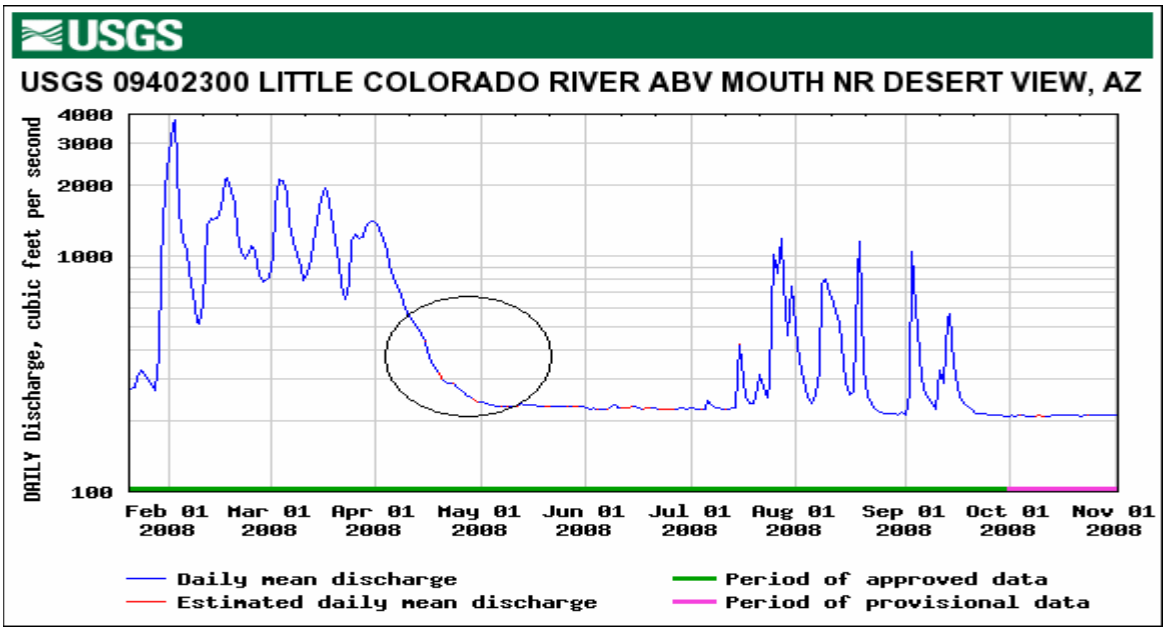

Figure 1. Mean daily discharge, Little Colorado River February - November 2008. The lower 1200 m monitoring period is circled. Gauge is located above confluence with the Colorado River.

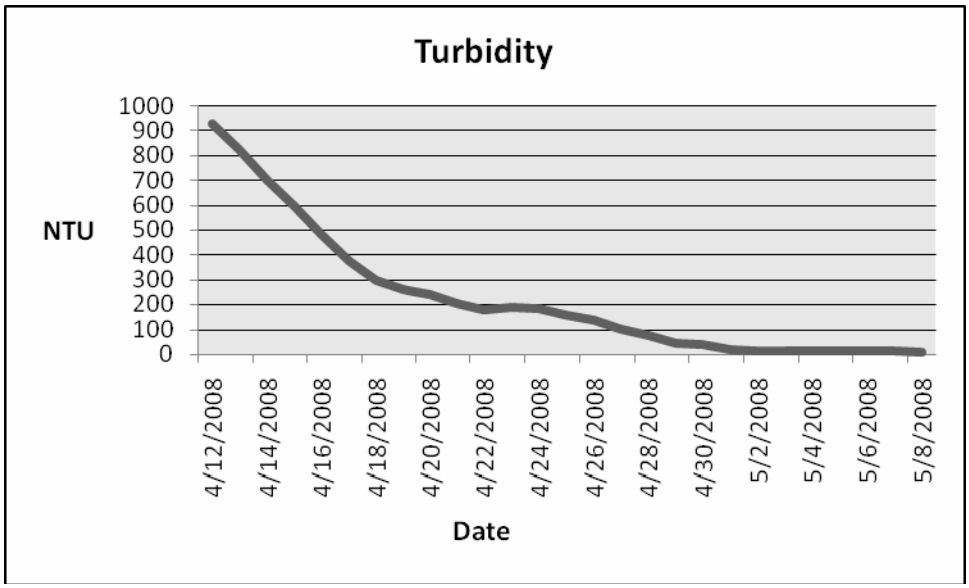

Figure 2. Daily turbidity (NTU's), Little Colorado River April 11 – May 8, 2008.

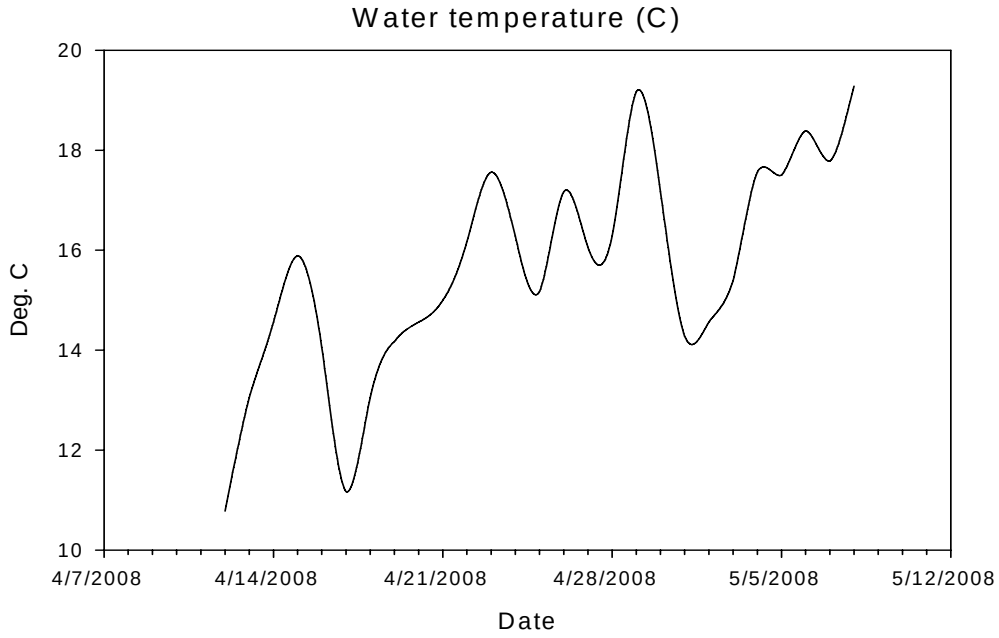

Figure 3. Daily water temperature, Little Colorado River, April 11- May 8, 2008.

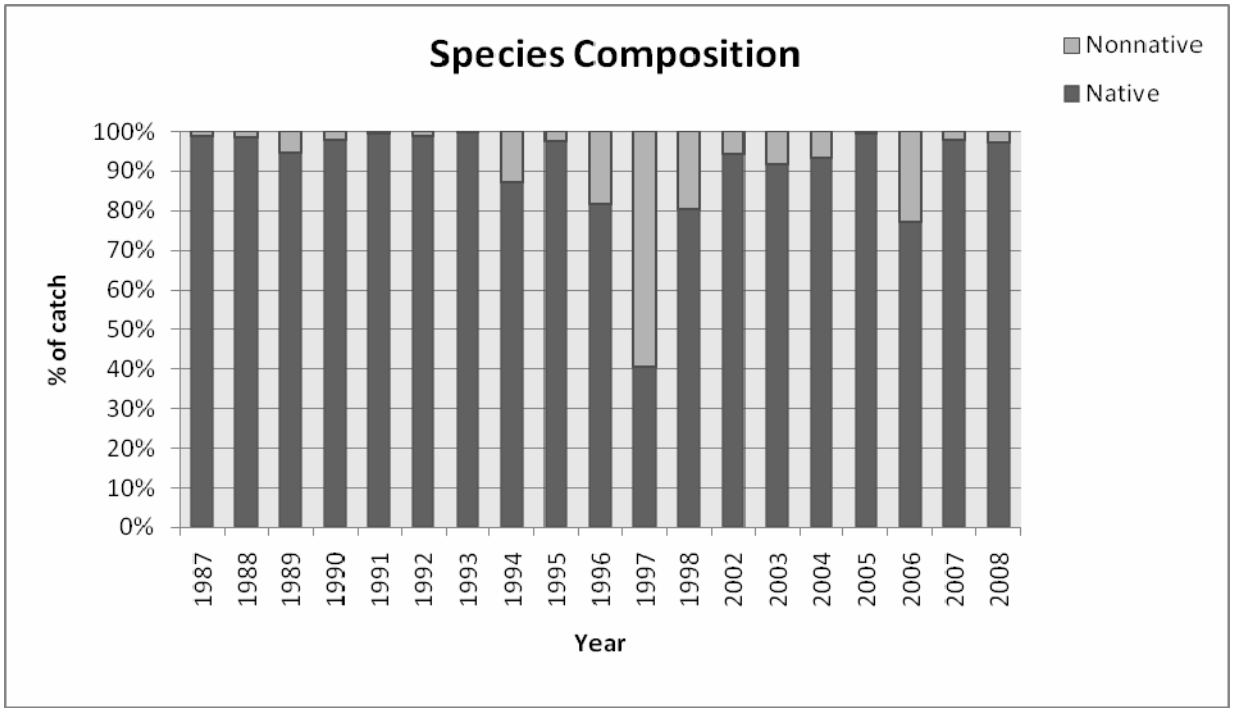

Figure 4. Species composition of standardized lower LCR hoop net catches, Little Colorado River, 1987 - 2008.

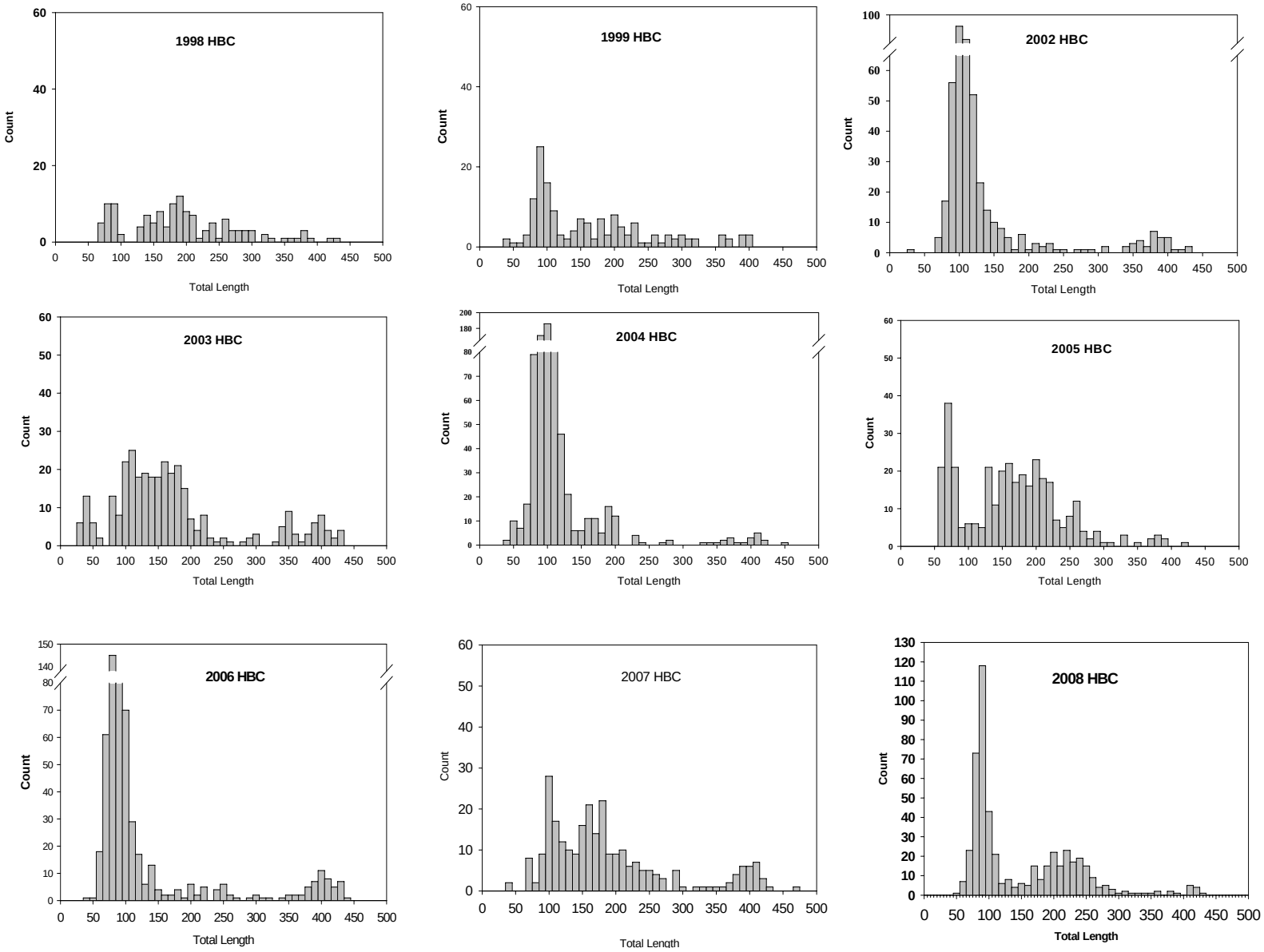

Figure 5. Length frequency distributions for humpback chub (HBC), caught in the Little Colorado River during AGFD lower 1200 m monitoring, 1998-2008. Note the difference in the y-axis scale among all histograms.

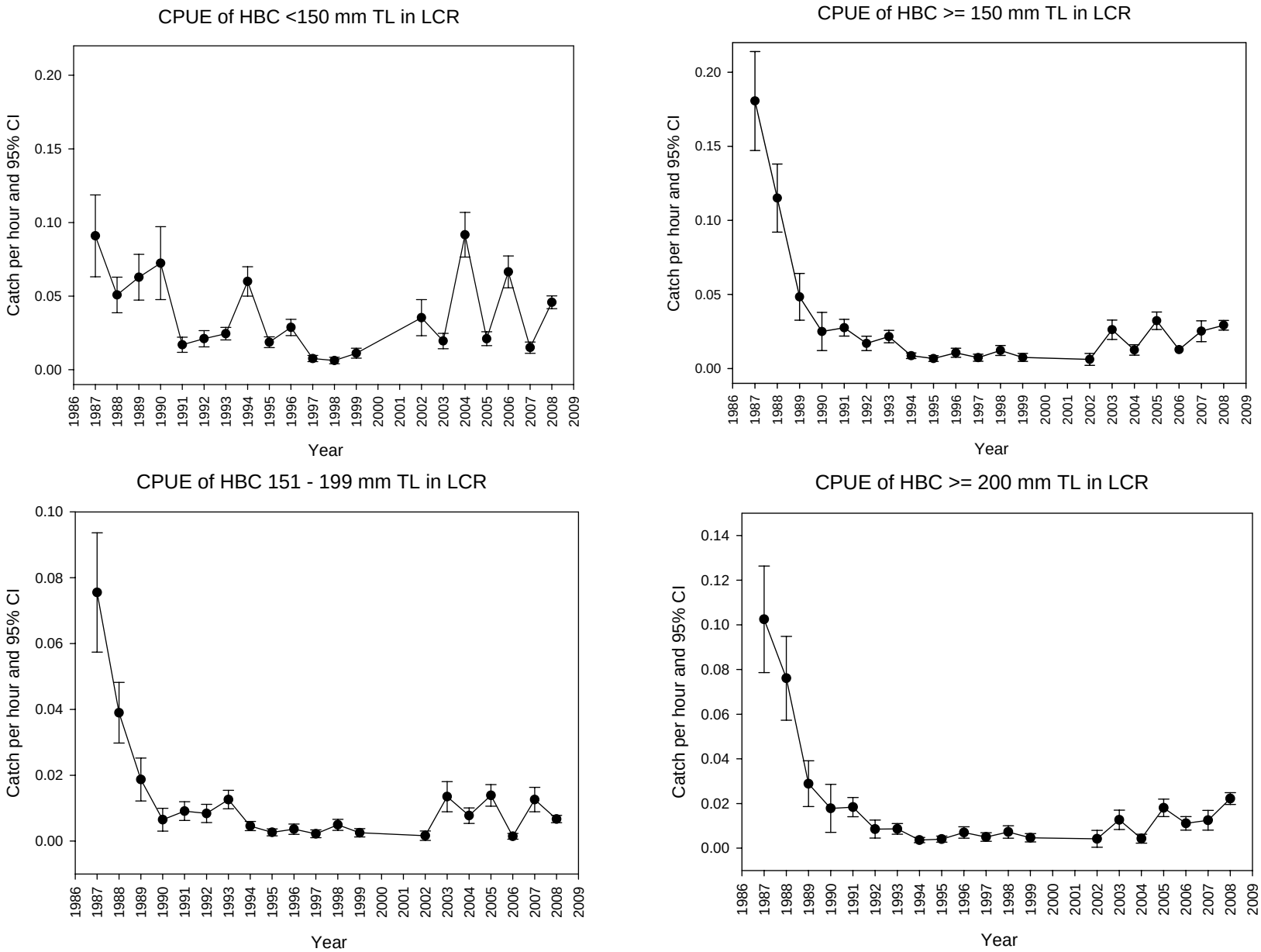

Figure 6. Mean catch per hour (CPUE) for 4 size groups of humpback chub in the LCR during AGFD lower 1200 m monitoring, 1987 – 2008.Bars represent 95% confidence intervals of the mean.

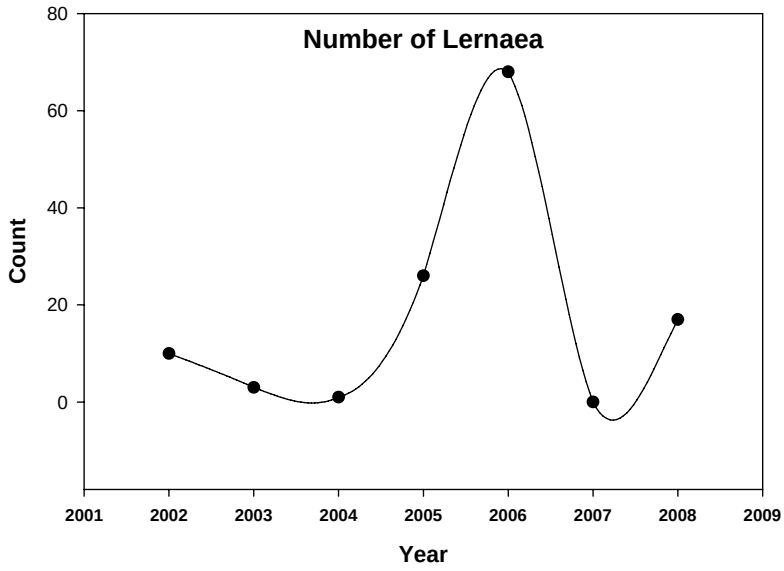

Figure 7. Total count of *Lernaea* observed in humpback chub during AGFD lower 1200 m monitoring, 2002 -2008.

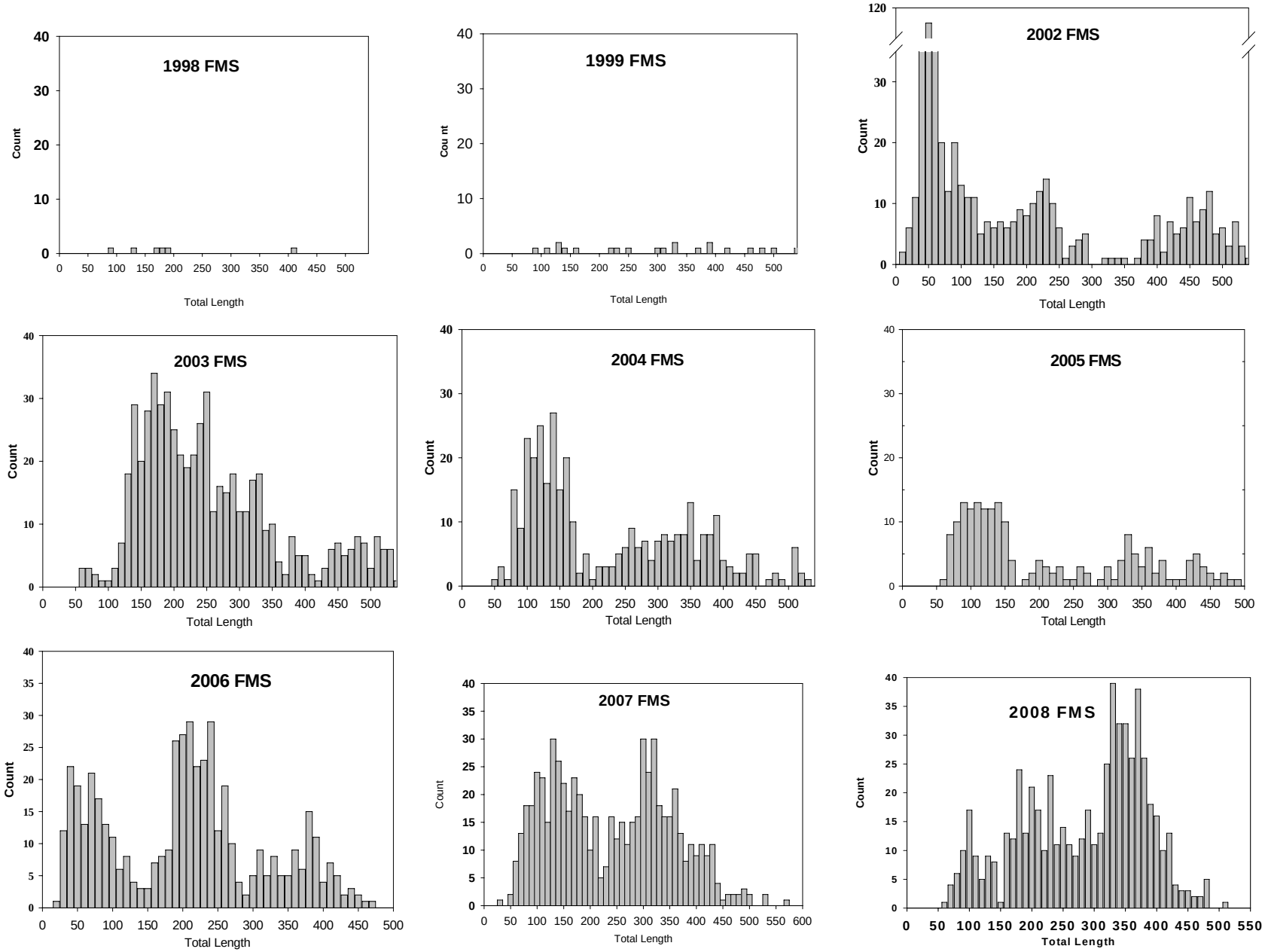

Figure 8. Length frequency distributions of flannelmouth sucker (FMS), caught in the Little Colorado River during AGFD lower 1200 m monitoring, 1998-2008. Note the difference in the y-axis scale among histograms.

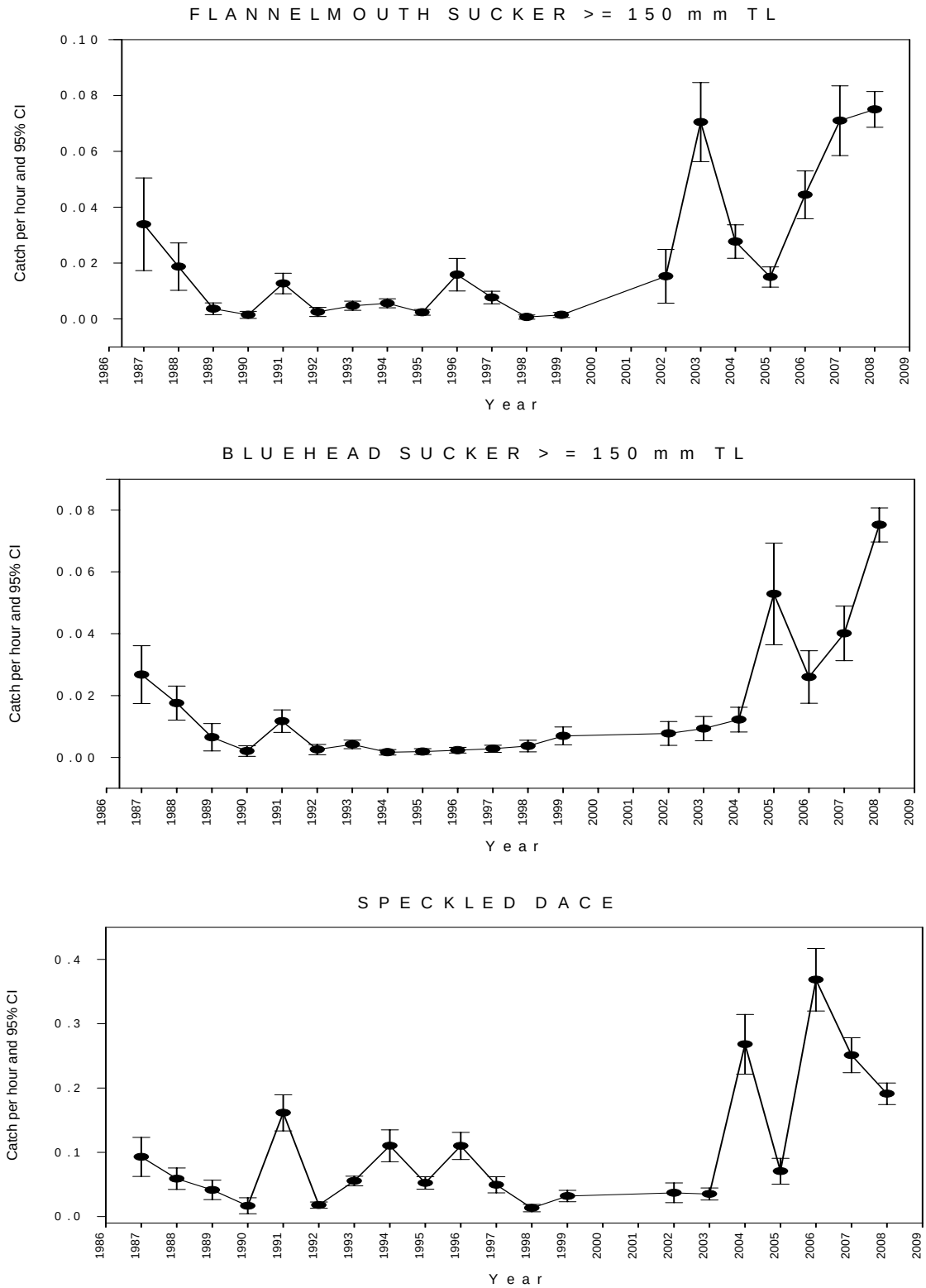

Figure 9. Mean catch per hour of flannelmouth sucker >149 mm TL, bluehead sucker > 149 mm TL and all sizes of speckled dace in the LCR during lower 1200 m monitoring, 1987 – 2008. Bars represent 95% confidence intervals of the mean.

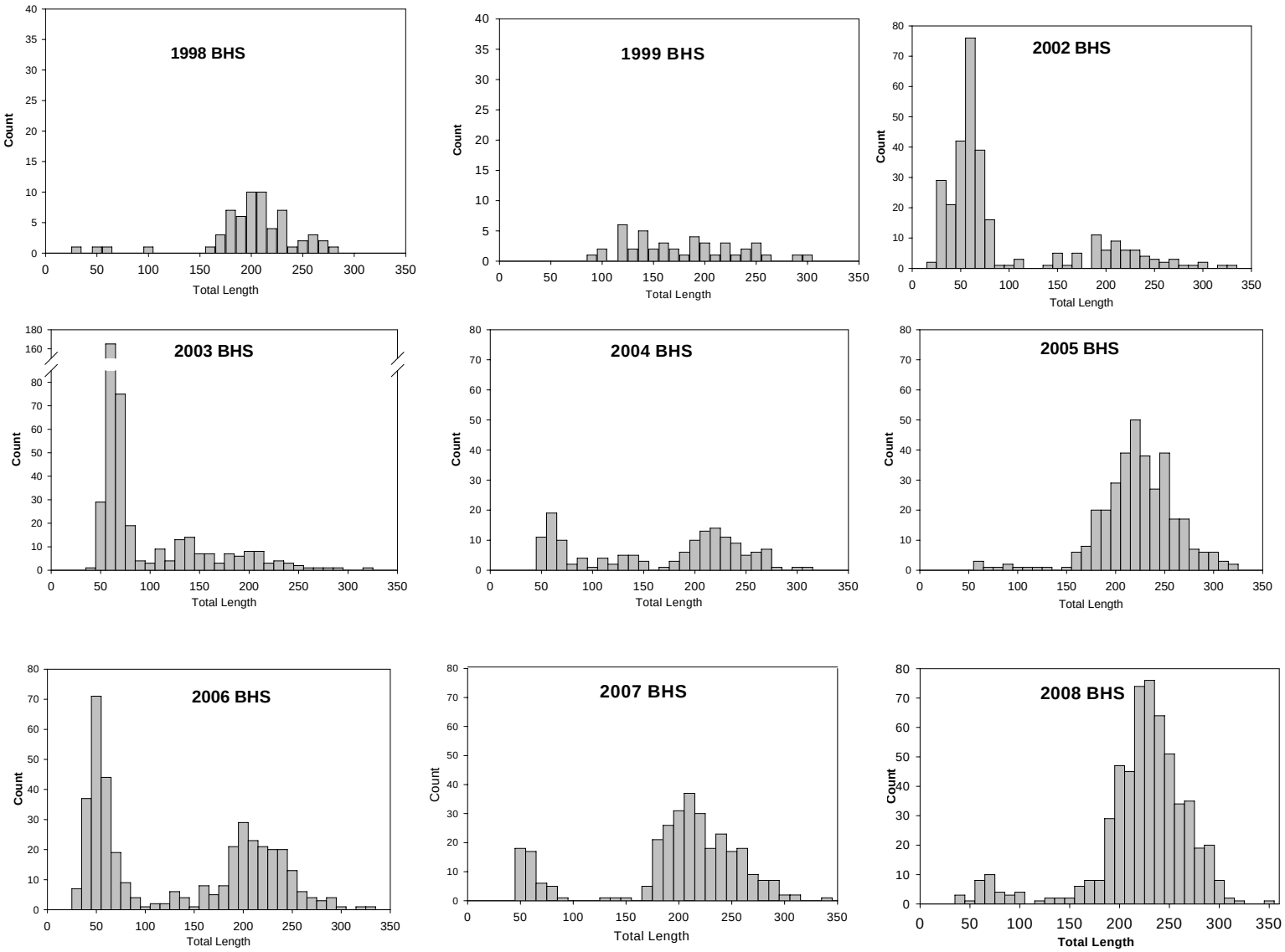

Figure 10. Length frequency distributions of bluehead sucker (BHS), caught in the Little Colorado River during AGFD lower 1200 m monitoring, 1998-2008. Note the difference in y-axis scale among histograms.

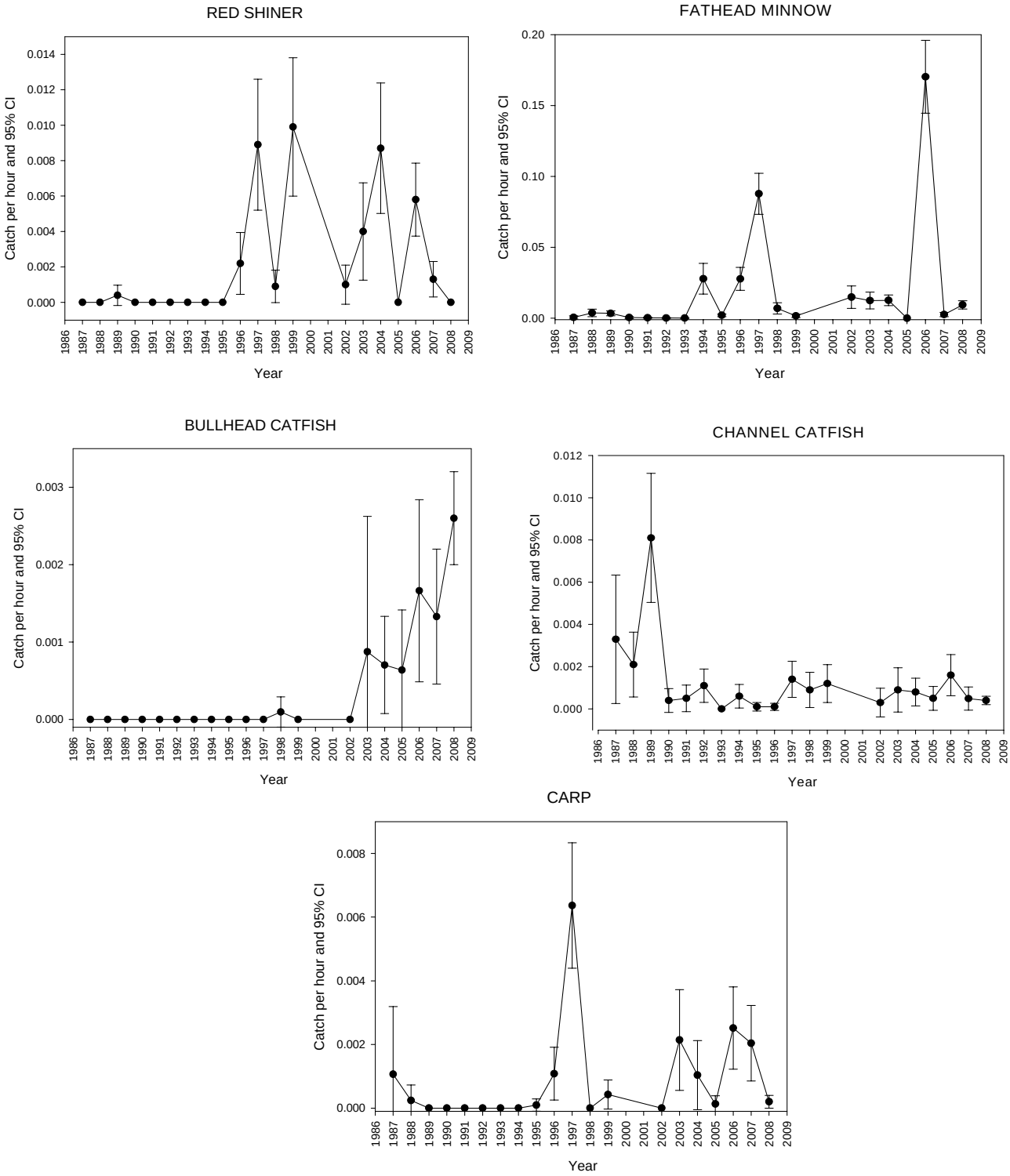

Figure 11. Mean catch per hour of nonnative fishes in the LCR during AGFD lower 1200 m monitoring, 1987-2008. Bars represent 95% confidence intervals of the mean.