CIBOLA HIGH LEVEE POND
Draft Annual Report for FY-2002

by

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SUMMARY

After 50 years, bonytail and razorback sucker are once again producing young in the lower Colorado River basin! In 1998, biologists discovered both species producing young at Cibola High Levee Pond (CHLP). The fact that these fish, which many consider to be riverine, would produce young in an isolated pond is unprecedented in the basin. Several year classes of young have been produced and the pond supports a self-sustaining native fish community.

CHLP was initially set aside as a grow-out facility for bonytail and razorback sucker. Nearly 58,400 small bonytail and 14,000 razorback sucker were stocked between 1993 and 1996. Fish growth was monitored and as fish reached 30 cm in length they were removed, PIT tagged and stocked elsewhere.

In December 1998, biologists discovered both species had successfully produced young. Fish stocking and removal were both suspended in order to study this phenomena. In 2002, only six years after stocking, the community consists of roughly 6,000 bonytail (>15 cm) and 1,100 razorback sucker. The pond's carrying capacity was measured at 4,350 fish/ha with a biomass of 635 kg/ha.

Both species were observed spawning in 2002. Razorback suckers spawned over gravel substrate and bonytail were found spawning over riprap. Fish eggs were found at both spawning sites but only bonytail larvae were collected. Young fish and eggs appear to be lost to invertebrates, crayfish, and other fish. As with other cyprinids, bonytail are aggressive feeders that are attracted to spawning areas. Regardless, the pond contains tens of thousands of young (<15 cm) bonytail.

This unprecedented native fish community is providing us a unique glimpse of how an oxbow community may have functioned. Two factors are obvious. First, the pond contains few, if any, nonnative fish and second, recruitment can occur in non-flowing habitats. Stream flow is not necessary. The ability of these fish to successfully spawn in non-flowing habitats strongly suggests that oxbow communities were essential in their survival strategy. Unfortunately, this ecological feature has been largely ignored. CHLP is providing us the opportunity to study the early life history of these unique fish in a controlled, semi-natural setting, in addition to providing the fish a refuge for survival.

The following report describes the various sampling techniques, observations, and future plans.

INTRODUCTION

Background

CHLP was initially developed as a grow-out pond for bonytail and razorback sucker. CHLP was chemically renovated in 1993 and stocked until 1996 by Fish and Wildlife Service (FWS). A total of 58,300 juvenile bonytail and 14,000 razorback suckers were stocked (LaBarbara 1999; Marsh 2000). Fish were quite small: razorback suckers averaged 98 mm (57-147 mm) and bonytail averaged 66 mm (61-115 mm) in total length. All the fish were produced at Dexter National Fish Hatchery and Technology Center (22 October 1993, FWS memo).

Fish growth was monitored and as fish reached 30 cm they were PIT tagged and stocked in Lake Havasu or the Colorado River. More than 225 bonytail and 760 razorback suckers were relocated between 1993 and 1998. During a removal effort in the fall of 1998, biologists collected young of both species that were <15 cm. One 25-mm bonytail fry was collected using a floating light and dip net in April of 2000. Observations of this fry and other size classes of fish made it obvious that reproduction had occurred. The fact that one, let-alone both species had produced young stimulated interest into the mechanisms and factors that led to their survival. Fish removal was suspended in December 1998 in hopes of studying this phenomena.

CHLP was sampled again in the fall of 1999 using a combination of electrofishing and netting techniques. Fish were fin clipped and allowed sufficient time to distribute throughout the pond before being resampled. A mark-recapture survey suggested the pond contained about 3,000 razorback sucker, or 1,500 suckers per hectare (Marsh 2000). Recapture rates for bonytail were insufficient to estimate their numbers. This study was initiated in 2001 to direct more effort into describing the community.

Site Description

CHLP is a 2-ha pond that was historically part of the Colorado River channel. The pond is located in the Cibola National Wildlife Refuge, which is approximately 5 miles south of Palo Verde, California. The center of the pond represents the California and Arizona state boundary. It was isolated when the river was straightened by dredge. The pond is approximately 350 m long and 100 m at its widest point. The pond's volume is roughly 25,000 m^3.

The pond is relatively shallow, having a maximum depth of slightly more than three meters and sits between two parallel levees that form its eastern and western banks. The southeastern shore was armored decades ago and the large rock is more prevalent underwater than along shore where it has been covered by soil and vegetated by saltcedar and mesquite. The northwestern shoreline is shallow and vegetated by cattail, saltcedar, and mesquite. Cattails extend 5 m from shore; decaying stumps suggest they extended more than 50 m into the pond at one time.

The pond contains substantial cover in the form of submerged brush, submergent vegetation, and riprap. Riprap covers about 40% of the shoreline and provides fish cavities in which to hide. The southeastern bank is covered with brush and root wads and the northwestern shoreline is dominated by cattails. The pond contains dense stands of submergent vegetation, dominated by spiny naiad (*Najas marina*) and sago pondweed (*Potamogeton pectinatus*). The deeper portion of the pond contains a large windrow of submerged brush that originated from road maintenance.

The pond's elevation fluctuates with the river. The river elevation is generally half a meter higher than the pond. The pond's elevation is generally more than a meter higher than downstream portions of the historic channel.

METHODS

Limnology

Dissolved oxygen, temperature, pH, and conductance measurements were monitored at 0.5-m intervals from the surface to the pond's bottom using a Hydrolab. We also collected a pair of vertical plankton tows from a depth of 2 m. These samples were preserved for later analysis that has not yet been completed.

Fish Sampling

Nine field trips occurred thus far in FY-2002. The pond was electrofished on 7 - 8 November 2001. Net sampling began the week of 29 January 2002 and subsequent trips occurred during the weeks of 20 February, 5 March, 19 March, 2 April, 16 April, 7 May, and 10 June. A typical field trip consisted of three nights and two days of sampling. Light traps, hoop nets, and fyke nets were set Monday afternoon just before dark. Tuesday morning they were checked. The nets were reset and the light traps pulled. Limnological data and zooplankton samples were collected in the afternoon. Hoop nets and fyke nets were checked once again in late afternoon. Trammel nets and light traps were set just before dark; after about 2 hours the trammel nets were pulled and the fish removed. Fish were placed in large live nets and held so they would not be recaptured. Wednesday morning the hoop and fyke nets were again checked and the light traps were pulled. If conditions permitted, we snorkeled the pond. Just before dark the hoop and fyke nets were pulled and trammel nets reset for another 2 hours. All fish were measured and released. Fish larger than 20 cm were PIT tagged and those smaller had their right pectoral fin clipped.

RESULTS

Limnology

Water quality parameters were normal. Temperatures ranged from a low of 10.7°C to a high of 24.9°C (Figure 1). We experienced a cooling trend in early March followed by a significant warming trend. Surface water temperatures jumped from 16 to 23°C in two weeks. The pond was well aerated and no DO concentrations were below 7 mg/L (Figure 2). Conductance averaged 1182 μmhos/cm (1167-1199) and pH averaged 7.9 (7.6-8.1).

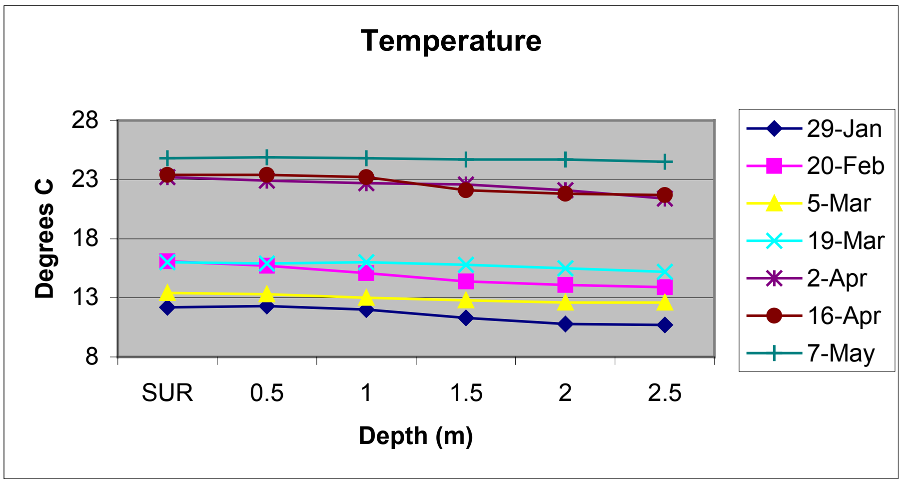


Figure 1. Water temperature profiles taken from the surface to the bottom of CHLP from 29 January 2001 to 7 May 2002.

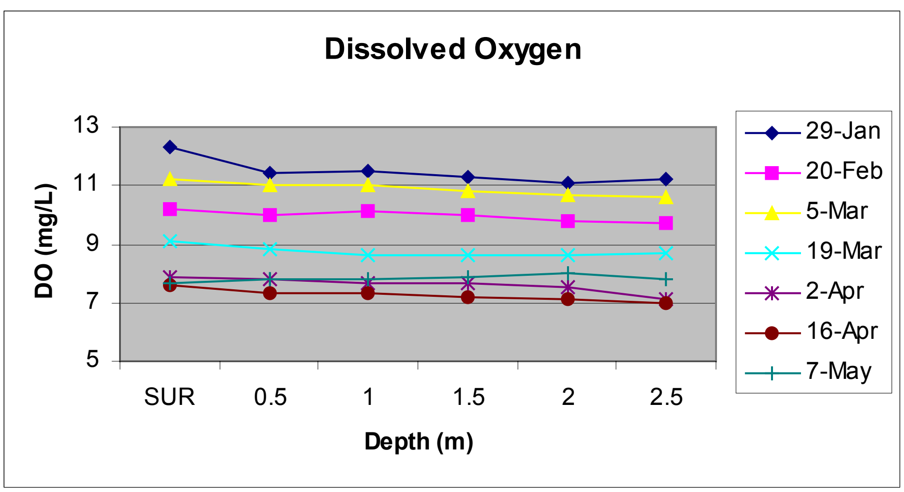


Figure 2. Dissolved oxygen profiles taken from the surface to the bottom of CHLP from 29 January 2001 to 7 May 2002.

Fish Sampling

A variety of sampling methods were used to determine which were the most effective and less stressful to the fish (Table 1). The pond was divided into four quadrants or sampling zones (A, B, C, D) to examine fish distribution (Figure 3). Each zone received a similar amount of sampling effort that included two trammel nets (1.2 and 2.5 cm meshed), two large minnow traps, a fyke net, and a light trap. Later in the season, we experimented with large hoop nets.

More than 4,000 net hours of sampling effort captured nearly 1,300 bonytail and over 180 razorback suckers. Electrofishing collected another 250 fish. We did experience some fish mortality but losses were generally <1%. Fish were lost to crayfish predation, gilling, and stress related to netting or handling. Crayfish were the most prevalent mortality factor.

Table 1. Summary of the number of sets and capture results (CPUE) in CHLP from November 2001 to May 2002.

Technique	Sets	Hours	Razorback	Bonytail	Fish/hr	RZB:BT
Light traps	64	826	0	8	0.01	0
Electrofishing	6	1.58	84	160	101.26	1:2
Fyke nets	20	480	2	35	0.08	1:17
Minnow traps	112	2,688	0	35	0.01	0
Trammel sets	47	112	110	1,170	11.43	1:10
Small meshed hoop[a]	4	96	2	26	0.29	1:13
Large meshed hoop[b]	8	186	72	1	0.39	72:1

[a] 9-mm mesh [b] 25-mm mesh

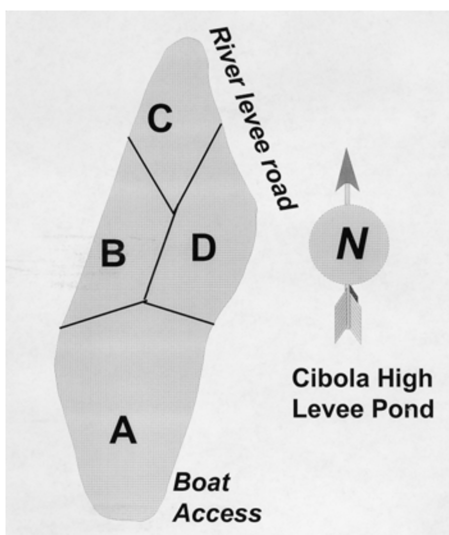


Figure 3. General map of CHLP showing the four sampling zones.

Light Traps

Light traps have been successfully used to capture bonytail and razorback sucker larvae for over a decade (Mueller et al. 1993; Snyder and Meismer 1997). One light trap was set in each of the four quadrants at dusk. Traps were retrieved in the morning and contents examined for larval fish (Figure 4). Sixty-four light trap sets equaled 826 hours of trapping effort. Overnight samples contained hundreds of large aquatic insects; some were known larval fish predators. We started to count (estimate) their numbers and found that traps contained, on average, 1 dragonfly nymph, 11 damselflies, and 300 water boatmen (Table 2). Samples yielded only three fish larvae, all bonytail.

Figure 4. Light trap being emptied.

Table 2. Summary of fish and invertebrates captured in overnight light trap sets in CHLP.

Organism	Total	Mean Count/Set
Razorback sucker	0	0.00
Bonytail	3	0.04
Dragonfly nymphs (Anisoptera)	85	1.25
Mayfly nymphs (Ephemeroptera)	407	5.99
Damselfly nymphs (Zygoptera)	747	10.99
Scuds (Amphipoda)	6,050	88.98
Water boatman (Hemiptera: *Notonectidae*)	20,600	302.94

While snorkeling, we found three areas along the riprap where the substrate had been disturbed. The areas were roughly one square meter, and on closer examination we found fish eggs buried between the rocks. We set light traps near these sites and failed to collect any fish larvae after two nights (8 sets). Usually we did not set light traps during our last evening since we were not returning in the morning. However, the night we found fish eggs, we set the light traps for only two hours while we worked the trammel nets. To our surprise, 3 of the 4 traps produced 5 larvae (0, 1, 1, 3), nearly twice as many as our 826 hours of overnight sets from all previous nights.

This sudden occurrence of larvae in the light traps raised questions. Did we happen to hit a peak hatch or were larvae being preyed upon inside the traps? Odonates are known fish predators and other taxa may be as well (Horn et al. 1994). Next year we will examine this more closely by setting four pairs of light traps. Each pair will consist of one trap fished for two hours and another trap fished overnight. If this trapping schedule indicates that insect predation is significant, we will conduct a series of predation studies using the various categories of insects as potential predators.

Electrofishing

Fall electrofishing occurred on 7-8 November 2001. The effort was divided into three, 15-min (actual) shocking samples performed over two consecutive nights after dark (Table 3). Small trammel nets were set to operate as blocking nets and data for those fish were kept separate. As with netting, fish were held in live cars and released when sampling was completed.

Electrofishing was the most effective method of collecting fish but was selective toward larger fish. A total of 244 fish were captured at a rate of more than 100 fish/hr of actual shocking time. They included 160 bonytail, 84 razorback sucker, and 1 large (10 kg) channel catfish. The channel catfish is the only nonnative fish captured thus far. The capture ratio of bonytail to razorback sucker was 2:1, which reflects the selectivity of the gear to larger suckers.

Table 3. Summary of electrofishing capture rates (fish/hr) at CHLP, November 2001.

Date	Time (min)	Razorback sucker	Bonytail
11/7/01	15	21	35
	15	7	35
	15	9	35
11/8/01	15	17	17
	15	27	22
	15	3	16

Numbers of fish captured in 2000 and 2001 were similar, but juvenile razorback suckers were completely absent in 2001 (Table 4). There were also substantial shifts in mean length and weight from the previous year's sample. Mean bonytail size declined from 192 to 152 mm, suggesting an increase in the number of small fish. The opposite trend occurred for razorback sucker: their average size increased from 389 to 440 mm, suggesting a decrease in number of small fish.

Table 4. Summary of length data collected from electrofishing on 6 December 2000 and 7-8 November 2001.

Date	Number	Total Length, mm		Total Weight, g	
		Mean	Range	Mean	Range
Dec 2000	180	192	150–370	50	20-1056
Nov 2001	178	152	75–480	29	3-757
Dec 2000	126	389	265–578	690	196-1526
Nov 2001	161	440	352–550	842	355-757

Netting. Fish were also collected using fyke nets, minnow traps, trammel nets, and paired hoop nets that shared a common lead. All sampling methods have their own biases but by using a variety of techniques, we were able to capture a broad size range of fish.

Fyke nets. Fyke nets with a 6-mm mesh and a 5-m center lead were set perpendicular to shore for 24 hours and checked every 12 hours. Twenty sets were fished for a total of 480 hours. These nets captured 2 razorback suckers, 35 bonytail, 13 crayfish, and 73 tadpoles. Netting efficiency proved to be only 0.08 fish/hour effort with a 1:17 razorback to bonytail selectivity ratio.

Minnow Traps. Minnow traps were 0.3 m in diameter and 1.3 m long, with two mesh sizes (3-mm and 6-mm). The minnow traps had the greatest amount of netting effort yet the lowest catch rate (Table 1). Poor capture rates induced us to bait half the traps with commercial fish chow in hopes of increasing catch. Bait did not increase the number of fish taken, but it did increase tadpole and crayfish numbers. One hundred and twelve sets produced only 35 fish over 2,688 hours of net effort (0.001 fish/hr). While numbers were pitifully low, the samples included a significant find: several of the smallest bonytail caught (35 to 60 mm).

Trammel Nets. Each trammel net set was comprised of 1.2-cm and 2.5-cm mesh nets that were 1.3 m high and 17 m long. Nets were alternately set from shore or from rope leads 20 m long. This approach allowed us to sample both along and away from shore. Nets were set at dusk and pulled one to two hours later. Sampling duration was dependent on expected catch. As waters warmed, our capture rates dramatically increased, as did crayfish predation. Crayfish would climb the nets and feed on the entangled fish. To minimize losses, we reduced the sampling time to one hour.

A total of 1,280 fish were captured from 47 pairs of net sets that were fished a total of 112 hours. Sampling efficiency proved to be 11 fish/net set/hour. A large percentage (>50%) of bonytail between 12 and 15 cm became gilled in the interpanel. We found fish could be removed more rapidly and with less stress by using a darning hook to lift the net from and around their opercular flap (Figure 5). The capture ratio was 1:10 for razorback suckers versus bonytail (110 razorback suckers and 1,170 bonytail); this was similar to the 1:6 ratio developed from the population estimates (see Table 6).

Hoop Nets. Later in the season (after April) we experimented with small (1 cm) and large (3 cm) mesh hoop net sets. A set consisted of two, 7-hoop nets joined together with a common lead. The large-mesh set was placed in the deeper portion of the pond (zone D) while the small-mesh set was put into shallower areas. The small set produced 2 razorback suckers and 26 bonytail, while the large set produced 72 razorback suckers and 1 bonytail. Capture rates were 0.29 and 0.39 fish/hour effort for the small and large meshed nets, respectively.

Figure 5. Trammel nets were the most effective passive netting technique used to capture fish in CHLP. Here biologists are removing fish from a 1.2-cm mesh net.

Community Description

Location of Capture. Fish distribution appeared fairly uniform and was undoubtedly influenced by the small size of the pond. We did not find any difference in capture rates of traps or nets that were either set along, or 20 m from shore. A comparison of the four zones (A-D) suggests fish were slightly more abundant in the deeper portion of the pond. A summary of fish distribution is provided in Table 5.

More than a third of both species were collected from zone D, the deeper portion of the pond. The second and third most productive areas for razorback suckers were zones A and C, which lie adjacent to D. Most bonytail were taken in zones D and B, which represent the river levee and shallow cattail zone.

Table 5. Percentage of fish captured in each of the four sample zones in CHLP in 2002.

Species	Capture method	Sets	Total Fish	Percent captured in each zone A	B	C	D
Razorback sucker	Fyke nets	20	2	0	50	50	0
	Minnow traps	286	0	0	0	0	0
	Trammel nets	112	110	20	17	27	36
	Weighted Mean (%)			20	18	27	35
Bonytail	Fyke nets	20	35	11	63	3	23
	Minnow traps	286	115	29	39	14	18
	Trammel nets	112	1070	24	23	18	35
	Weighted Mean (%)			24	26	17	33

Population Size. We calculated population size for fish larger than 10 cm. Although the pond contained fish smaller than 10 cm, we did not have an effective method for capturing them.

Population estimates were calculated for two sizes of bonytail (10-20 cm and ≥20 cm). This represented two marking techniques, fin clipping and PIT tagging. Fin regeneration was rapid and by May we found several fish with a fin that had completely regenerated. The only telltale sign was dark pigmentation and a distortion in the fin's ray pattern. Fin clipping can only be considered viable for periods of less than six months. We did not capture any razorback suckers smaller than 20 cm. Recapture rates ranged from 15% for small bonytail to 60% for razorback sucker.

Population size was calculated two ways. One method represents a pooled average and the second is based on individual samples (Table 6). It is estimated that CHLP contained 7,842 (95% Confidence Interval = 5,959-11,635) bonytail and 987 (95% Confidence Interval = 844-1190) razorback sucker.

Table 6. Population estimates for bonytail and razorback sucker in CHLP during the 2002 sampling season.					
Species and size range	Pooled estimate	Range (95%CI)	df	Individual sample estimate	Range (95%CI)
Bonytail 10 - 20 cm	5,979	4,794 - 11,512	6	6,189	4,814 - 8,663
Bonytail ≥20 cm	1,593	860 - 2,542	7	1,653	1,145 - 2,972
Razorback sucker ≥20 cm	1,111	732 - 2,460	9	987	844 - 1190

Standing Crop. CHLP has not had fish stocking nor removal since 1998 and we assume the fish population has reached or is near carrying capacity. Population estimates place native fish densities at approximately 4,350 fish/ha. Numerically, bonytail dominate the community, making up 88.5% of the population; however, razorback sucker constitute 67% of the pond's biomass (Table 7). Currently, the pond supports 635.6 kg of fish/ha larger than 10 cm. Volumetrically, standing crop is 3.5×10^{-4} fish/m^3 and 5.1×10^{-5} kg/m^3.

Incidental Observations. We attempted to observe fish from shore and by snorkeling. Typically, water visibility was less than one to two meters. Razorback suckers were commonly seen during daytime when it was calm. They formed dense schools numbering 50 to 100 fish and swam near the surface with their bodies crowed closely together. Their lips were often fully extended in what appeared to be a feeding posture. They swam in mass, often in large circles. It is believed this school behavior may help the fish "herd" plankton. Otherwise, individuals or small groups were seldom seen. Their absence from the shallower portions of the pond suggests that razorback suckers normally inhabit the deeper portion of the pond when they are not schooling.

Larger bonytail are quite elusive and secretive and are seldom seen from shore, by boat, or by snorkeling. During the day, bonytail were found hiding in the interspaces of the large riprap, in submergent vegetation, or in other forms of cover.

Small bonytail school and were much easier to find. Schools of small fry (<7 cm) were found along the deeper portions of the banks that had overhanging cover. For instance, small fish were prevalent in the underwater tunnels of beaver dens (Figure 6). The combination of cover with depth may be critical in limiting crayfish predation. Large crayfish were always found stalking schools of fish. Their claws were generally open and extended toward the fish. Past studies have shown them to be effective predators of native fish under laboratory conditions (Carpenter 2000).

Table 7. Density and biomass estimates of bonytail and razorback sucker measured from November 2001 to May 2002, based on recapture data.

Standing crop	Fish/ha	(%)	Mean weight (g)	N	Kg/ha	(%)
Bonytail ≥20 cm	800	(18.4)	171.6	125	137.3	(21.6)
Bonytail 10 to 20 cm	3,050	(70.1)	23.6	917	71.8	(11.3)
Razorback sucker ≥20 cm	550	(12.5)	775.4	659	426.5	(67.1)
Total	4,350				635.6	

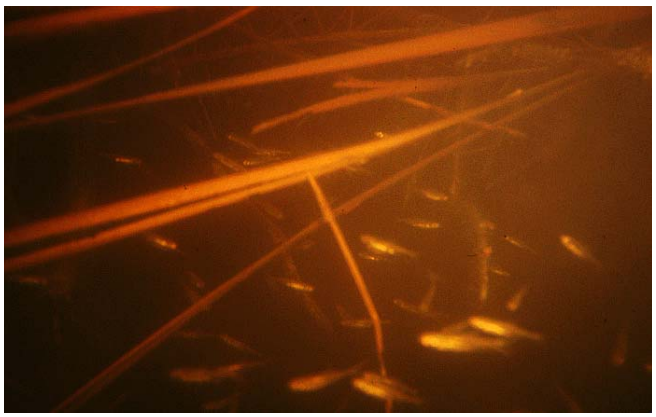


Figure 6. Underwater photograph of small (2-4 cm) bonytail found intermixed with submerged brush next to a beaver den entrance.

Spawning

Location. It was well documented by Marsh (2000) that both species had produced young in CHLP during 1999 and 2000. Mitch Thorson (FWS) was the first to observe bonytail spawning several years ago. Water elevation at that time had flooded a portion of the boat access area and he reported fish spawning over the gravel. Terry Murphy, Bureau of Reclamation (BOR), visited the pond during the winter of 2002 and observed razorback suckers spawning over the same area.

Razorback sucker. We caught ripe male razorback sucker during the entire sampling period (November to May) and ripe females were caught between February and late April. On 2 April we observed a large female sucker flanked by what we assumed to be smaller males in the northern portion of the pond. The fish were found in about one meter of water and it was obvious the substrate had been disturbed. The majority of ripe fish were captured in the deeper end, which suggests the majority of spawning might have occurred out of our sight.

We snorkeled and found a larger area about 50 m further south where the substrate had been disturbed and was relatively free of silt. We found several small pockets (1-2 m^2) of cleaned rock that were perched on the riprap slope. The cleaned areas had much smaller (1-2 cm diameter) substrate than surrounding riprap and were bordered by decaying cattail roots. Both sites probably measured < 10 m^2 each. Several fungused eggs were found in this rocky material.

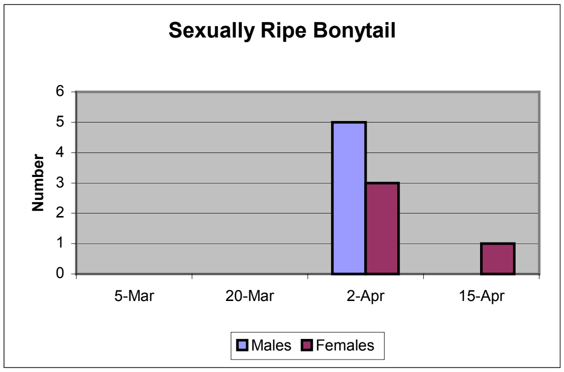
Bonytail. We caught ripe bonytail during the first three weeks of April and observed a school of small bonytail actively working the riprap on 17 April. The school consisted of approximately 100 bonytail that ranged from 10 to 20 cm in length. A stiff breeze made surface observations difficult so we carefully entered the water with mask and snorkel to get a better look. To our surprise, the fish totally ignored our presence.

The activity was centered over a 2 m^2 area of riprap that was composed of small (1-5 cm) rock. It represented the location where a beaver trail entered the pond from the river. The substrate was clean from the shoreline to a depth of approximately one meter. The slope of the area was steep, approximately 45º. The fish were remarkably bold and aggressive, darting back and forth. Frequently, they would drive their head in between the rocks. During these contortions, their silvery sides would flash, which is how we saw them from shore. We attempted to drive them away in order to sample for eggs but this seemed to attract them even more. We did manage to collect about a dozen eggs that had been buried deep in the rock. It was apparent these fish were attempting to feed on deposited eggs.

We set up an underwater video camera in the late afternoon and filmed the activity that continued into the night. We filmed for about three hours; the activity never slowed. We believe fish were primarily feeding on eggs but on one occasion it appeared three fish attempted to spawn. The event was brief but quite different than the feeding behavior. Three fish darted to the bottom and upon reaching it, two flanked and angled their genitalia toward that of the center fish. The event only lasted a few seconds and they all darted off. Although eggs were found at three locations, we were unable to witness other spawning. We suspect the majority of spawning may have occurred after dark, which appeared to be the case in Lake Mohave (Marsh and Mueller 1999).

Spawning Season. Data thus far suggests that bonytail have a much shorter spawning season compared to razorback suckers. We collected 9 ripe bonytail (4 females, 5 males) during the first 3 weeks in April (Figure 8). The base of their fins and operculum covers had orange coloration and they were freely expressing gametes. We did not observe any tuberculation in either sex. Ripe males ranged from 21 to 30 cm TL and ripe females were slightly larger at 29 to 46 cm TL. The two largest females had frayed tailfins; fin abrasion may have been from spawning activity.

We collected 45 sexually ripe razorback suckers (18 females and 27 males; Figure 8). Males were already tuberculate by November and four were actually ripe. We found 13 ripe males during the first week of March. Ripe females were collected from 19 February to 2 April. Ripe males ranged from 37 to 51 cm TL and females were once again slightly larger, at 39 to 52 cm.



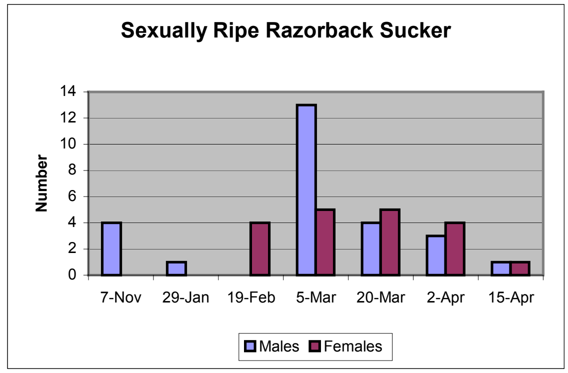


Figure 7. Sexually ripe bonytail and razorback suckers captured in CHLP from November 2001 to May 2002.

Recruitment. Bonytail have produced young in each of the past three years (2000-2002). Larvae were captured in light traps in 2000 and 2002 and juvenile fish (35 to >150 mm) were captured in minnow traps. Snorkeling biologists observed other small fish. Thousands of year class I bonytail were observed near the windrow of tumbleweeds, located in a deeper portion of the pond. Fish were seen schooling throughout the water column with individuals actively darting back and forth (Figure 9). It appeared the fish were chasing and feeding on zooplankton.

Razorback sucker young survived in 1999 (Marsh 2000) but it appears they did not in 2000 or 2001. Reasons for their lack of success in 2001 and 2002 are not yet apparent and there is no evidence to suggest any survival this year.

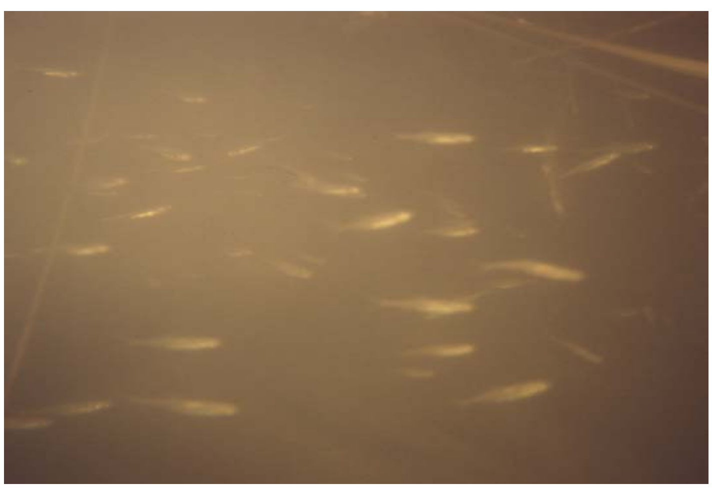


Figure 8. Year class I bonytail schooling in CHLP.

DISCUSSION

We confirmed that bonytail are phototaxic; however, insect predation may be a serious problem with light traps left overnight. Next year we plan to double our light trap sets, setting four traps for two hours while setting a second group overnight.

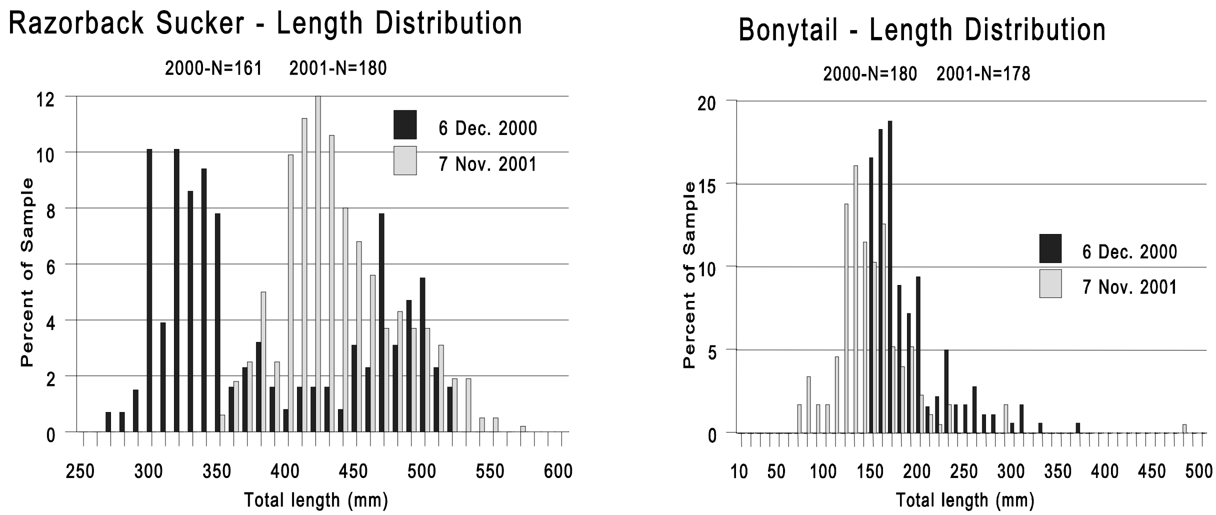
We caught more than 1,700 fish this year. Electrofishing was the most effective capture method, producing nearly 100 fish for each hour of effort. The 1.2 mm trammels had capture rates that exceeded 40 fish for every 100 m^2 of net fished for 2 hours after dark. The majority of the bonytails between 10 and 14 cm in length were found gilled in the net's inner panel. The small size of the fish and twine made their removal extremely difficult. We found that by using darning hooks we could more easily lift the twine from around the fish's gills. Fish were held until all the sampling was finished (<2 days) and mortality losses were <1%.

Although we captured large numbers of fish, sampling techniques are biased toward larger fish (>10 cm). Small fish easily evaded electrofishing and the trammel nets. Our minnow trap effort captured a disappointing 35 fish. We attempted to increase capture rates by baiting traps; however, baiting only increased crayfish and tadpole numbers and the likelihood of crayfish predation. Beginning next year, we plan to use smaller-mouthed metal minnow traps that will prevent larger crayfish from entering. Different types of bait will be used and traps will be set in areas where we have seen schools of small fish. We will also explore other methods for capturing young-of-the-year fish.

We also experimented with setting large hoop nets (1.5 m diameter) joined by a common lead. At times these traps were quite effective and they may work better once fish enter the trap. In one set, we captured 49 adult razorback suckers.

We did not capture any young-of-year razorback suckers this past season. The 15-17 cm cohort found in the 1999 sample was not encountered in either 2001 or 2002, which suggests there was little or no recruitment during those years (Figure 10a). Length distribution for the razorback sucker has narrowed as small fish disappeared and surviving fish matured. Data suggest the 30-35 cm cohort found in the fall 2000 sample grew nearly 10 cm by November 2001.

In terms of the natural history of these fish, the absence of two or three year-classes may be unremarkable. The longevity of these fish suggests spawning success may have been historically intermittent. It is possible the high numbers of small bonytail now present in CHLP are effectively preying on razorback sucker eggs. When comparing fish catches, it is notable that young bonytail were far less numerous and possibly absent when young suckers were caught in 2000 (Figure 10b). Suckers spawn over smaller-sized gravel and their eggs and larvae may be more vulnerable to predation than bonytail that spawn over larger riprap. Undoubtedly, other predators such as crayfish, bullfrogs, and macroinvertebrates may also be influencing recruitment and the benthic nature of razorback suckers may make them more susceptible to these predators than bonytail. Observed behavior by young catostomids in laboratory experiments suggests they may be more vulnerable to predation than young cyprinids (Carpenter 2000).



10a **10b**

Figure 9. Length distribution of razorback sucker and bonytail taken from CHLP by electrofishing in the fall of 2000 and 2001.

WORK PLANNED FOR FY-2002-2003

Some time in late summer or early fall the pond will be surveyed to map bottom type and cover location, and to refine bathymetry. Four sites along shore will be established (bench marked) for use in the telemetry study that is scheduled for next season. Starting in January, our emphasis will shift during the next two years towards studying spawning behavior and factors that limit recruitment for both species. Arizona State University will assist in telemetry studies aimed at identifying specific spawning locations, spawning behavior, and possible nest predation for both species. Ten razorback suckers will be fitted with transmitters and monitored hourly for 8 weeks in 2003. A similar telemetry project will follow for bonytail in FY-2004. Large fish will continue to be sampled prior to, and following, razorback sucker spawning.

Very little has been written regarding the predatory role, if any, of many of the more common nonnative fish. In conjunction with this project, we have initiated a predator-prey study in cooperation with Willow Beach National Fish Hatchery. The adult and subadult life stages of 16 nonnative fishes will be tested for predatory behavior; razorback sucker larvae and fry (<45 mm) will be used as potential prey.

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