Revised Integrated Stocking Plan for Razorback Sucker and Bonytail

by

The Integrated Stocking Plan Revision Committee

of the

Upper Colorado River Endangered Fish Recovery Program

Final

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The Integrated Stocking Plan Revision Committee members were:

Thad Bingham, US Fish and Wildlife Service, Grand Junction, Colorado
Pete Cavalli, Wyoming Game and Fish Department, Pinedale, Wyoming
Harry Crockett, Colorado Parks and Wildlife, Fort Collins, Colorado
Tom Czapla, US Fish and Wildlife Service, Lakewood, Colorado
Scott Durst, US Fish and Wildlife Service, Albuquerque, New Mexico
Matt Fry, US Fish and Wildlife Service, Ouray, Utah
Mike Gross, US Fish and Wildlife Service, Grand Junction, Colorado
Zane Olsen, Utah Division of Wildlife Resources, Big Water, Utah
Brian Scheer, US Fish and Wildlife Service, Grand Junction, Colorado
Dave Schnoor, US Fish and Wildlife Service, Ouray, Utah
Ted Smith, Colorado Parks and Wildlife, Alamosa, Colorado
Krissy Wilson, Utah Division of Wildlife Resources, Salt Lake City, Utah
Koreen Zelasko, Colorado State University, Laramie, Wyoming

Introduction and Purpose

Bonytail (*Gila elegans*) is listed as "endangered" under the Endangered Species Act of 1973 as amended (ESA; 16 U.S.C. 1531 *et seq.*). Although bonytail have been shown to reproduce and survive in managed ponds, no self-sustaining populations of bonytail currently exist in the wild, and very few individuals have been caught. Of the 34 adult bonytail captured in Lake Mohave between 1976 and 1988 (Minckley et al. 1989), 11 were used as the original brood stock (Hamman 1985). Progeny of these fish have been released into several upper basin habitats, but survival rates have been low.

Razorback sucker (*Xyrauchen texanus*) is listed as "endangered" under the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 *et seq.*), under a final rule published on October 23, 1991 (56 FR 54957). In the early 2000s, the largest population of razorback sucker in the Upper Colorado River Basin occurred in low-gradient flat-water reaches of the middle Green River between the Duchesne River and Yampa River (Muth et al. 2000). In the lower Green River at that time, only a few individual adult razorback sucker were being captured and small numbers of larvae and juveniles indicated probable spawning in the vicinity of the San Rafael River confluence (Muth et al. 2000). In the upper Colorado River subbasin, the wild population was considered extirpated from the Gunnison River (Burdick and Bonar 1997) and only a few scattered adults remained in the mainstem of the Colorado River as of 1996. Stocking began in earnest in 1998 and has resulted in increasing numbers of razorback sucker in both the Green and upper Colorado River subbasins.

The Upper Colorado River Endangered Fish Recovery Program (Program) implemented an Integrated Stocking Plan (Nesler et al. 2003) to establish three populations of razorback sucker and three populations of bonytail to meet recovery goal demographic criteria (US Fish and Wildlife Service 2002a, 2002b). The recommended size at stocking was 300 millimeters total length (mm TL) for razorback sucker and 200 mm TL for bonytail. Recent findings regarding survival of stocked fish prompted recommended revisions to the stocking plan for these species. The number and sizes of fish specified for stocking, the timing of stocking, and release locations are being modified with this plan in an effort to increase survival of stocked fish. These changes are based on recommendations from Zelasko et al. (2011) to improve survival of stocked razorback sucker, make the best use of available fish hatchery resources, and address other factors that are believed to be important to the survival of stocked fish. Additional parameters, such as habitat needs, may also need to be addressed to achieve the demographic criteria defined in the recovery goals for both species.

Background

Bonytail.

2002 Recovery Goals Downlist Demographic Criteria (U.S. Fish and Wildlife Service 2002a): "In both the Green River and Colorado River Subbasins, self-sustaining populations are maintained over a 5-year period, starting with the first point estimate acceptable to the Service, such that: 1) the trend in adult [age 4+; ≥250 millimeters total length (mm TL] point estimates does not decline significantly; 2) mean estimated recruitment of age-3 (150–249 mm TL) naturally produced fish equals or exceeds mean annual adult mortality; and 3) each point estimate exceeds 4,400 adults [4,400 adults is the estimated minimum viable population (MVP) number]."

2003 Integrated Stocking Plan: "The Program has two facilities dedicated to the production of bonytail, the Wahweap State Fish Hatchery (Wahweap) and the Mumma Native Aquatic Species Restoration Facility, Alamosa, CO (Mumma). Wahweap will produce all the bonytail destined for Utah waters, a total of 10,660 bonytail >200 mm TL annually for 6 years. Mumma will produce all bonytail destined for Colorado waters, a total of 5,330 bonytail >200 mm TL annually for 6 years." Annual survival rate estimates at the hatcheries were 75% for age-0 to age-1; and 90% from age-1 to release. After release, annual survival rates were estimated at 30%, 50%, and 60% for ages 2, 3, and 4 respectively; age-5 and older fish all had a 70% annual survival estimate rate. Table 1 indicates the priority and locations of river reaches to be stocked.

Table 1. From the Integrated Stocking Plan (Nelser et al. 2003) for bonytail. River reaches were prioritized for each state (C=Colorado; U=Utah; Nesler et al. 2003).

River Reaches	Fish age and Sizes (mm TL)	Season stocked[1]	Numbers of fish stocked per year	Number of years to be stocked
1C: Middle Green–Yampa Rivers: Dinosaur National Monument	Age 2+ 200	1° Fall 2° Spring–Summer	2,665[2]	6
2C: Colorado River: Palisade to Loma	Age 2+ 200	1° Fall 2° Spring–Summer	2,665[3]	6
1U: Middle Green River: (RM 302–249)	Age 2+ 200	1° Fall 2° Spring–Summer	2,665[2]	6
2U: Lower Green River: (RM 249–120)	Age 2+ 200	1° Fall 2° Spring–Summer	5,330[4]	6
3U: Colorado River: (RM 110.5)	Age 2+ 200	1° Fall 2° Spring–Summer	2,665[3]	6

[1] 1° refers to the primary season; 2° refers to secondary season to cull fish and allow smaller individuals to achieve stocking size by the next fall.
[2] Represents one population in the Middle Green River.
[3] Represents one population in the Upper Colorado River.
[4] Represents an additional population in case of a catastrophic event.

Field observations: Limited data have been collected from stocked bonytail. Bestgen et al. (2008) reported bonytail survived for no more than four months after stocking in the Middle Green River from 2002 to 2005. Many recaptured bonytail had *Lernea* or fungal infections, weighed less than when stocked, and attained little or no growth. Few stocked bonytail have been recaptured, most of those shortly after they had been stocked. Remote Passive Integrated Transponder (PIT) antennas detected 16 stocked bonytail in the San Rafael River during 2008–2010 (Bottcher, et al. 2013). One of these was originally stocked at Dewey Bridge on the Colorado River and moved 333 kilometers (km) before being detected. Most other bonytail were stocked at Green River, Utah about 36 km upstream. Ten bonytail were detected (five each in 2009 and 2010) at remote PIT tag antennas placed in a connecting channel between the Green River and the Stirrup floodplain (about 14 miles downstream of the Highway 40 Bridge to Bonanza, Utah; Breen and Keddy 2012). All of those fish had been stocked in the middle Green River. In May and June 2011, the same antennas detected over 1,100 bonytail that had been stocked in the Stirrup floodplain in April 2011 (Breen and Keddy 2012). This accounted for 16% of the bonytail that had been stocked that year in the floodplain. Bonytail movements out of the floodplain occurred when flows in the river were dropping. In 2009, Hedrick detected 42 bonytail that were stocked in Stewart Lake leaving the lake as flows were receding (T. Hedrick, UDWR unpublished data).

More recently, over 100 bonytail stocked in the White River above Bonanza Bridge in the fall of 2013 were detected in the summer of 2014. These fish appeared to be in excellent condition. In Summer 2014, four bonytail were captured during sampling in the Colorado River inflow area of Lake Powell, one had been stocked in 2007, one in 2013, and two were stocked in 2014. The two most recently stocked fish had moved 179.5 miles from the San Rafael River in four days and 186.5 miles from the Dolores River in 6 days.

On the Colorado River, bonytail stocked in Debeque Canyon were detected moving downstream at the Price-Stubb PIT tag antennas. For years 2011 through 2013, 16, 88 and 138 individual bonytail were detected, respectively, at the antennas.

Bonytail survival after stocking appears to be low. Stocking locale, size at stocking, condition, stock time, and/or acclimation (to flow, temperature, and/or predators) before stocking need to be evaluated in order to determine whether any of these factors are responsible for the poor survival rates noted in previous years. Research on other factors, such as habitat preferences and water chemistry, may also need to be evaluated if the parameters listed above are not found to be responsible for poor survival.

Razorback Sucker.

2002 Recovery Goals Downlist Demographic Criteria (U.S. Fish and Wildlife Service 2002b): "In both the Green River and Colorado River Subbasins, self-sustaining populations are maintained over a 5-year period, starting with the first point estimate acceptable to the Service, such that: 1) the trend in adult (age 4+; ≥400 mm TL) point estimates does not decline significantly; 2) mean estimated recruitment of age-3 (300–399 mm TL) naturally produced fish equals or exceeds mean annual adult mortality; and 3) each point estimate exceeds 5,800 adults (5,800 adults is the estimated MVP number)."

2003 Integrated Stocking Plan: "The Program has two facilities dedicated to the production of razorback sucker, Grand Junction Endangered Fish Facility (Grand Junction) and Ouray National Fish Hatchery (Ouray). Grand Junction will produce 14,895 razorback sucker >300 mm TL annually for 6 years (9,930 for Colorado waters and 4,965 for Lower Green River, Utah). Ouray will produce 14,895 razorback sucker >300 mm TL annually for 6 years (9,930 for Middle Green River and 4,965 for Lower Green River). Although, previously it was determined that brood from Ouray would be used to stock the Green River, more recent information of a fish released in the Gunnison River moving downstream to the Colorado River, to the confluence with the Green River, then upstream to Green River, Utah, suggests, as fish are distributed throughout the basin they will eventually mix among the river reaches." Table 2 indicates the priority and locations of river reaches to be stocked.

Table 2. From the Integrated Stocking Plan (Nesler et al. 2003) for razorback sucker. River reaches were prioritized for each state (C=Colorado; U=Utah;).

River Reaches	Fish age and Sizes (mm TL)	Season stocked[1]	Numbers of fish stocked per year	Number of years to be stocked
1C: Colorado River: Rifle to Debeque Canyon	Age 2+ 300	1° Fall 2° Spring–Summer	3,310[2]	6
2C: Gunnison River: Hartland to Redland dams	Age 2+ 300	1° Fall 2° Spring–Summer	3,310[2]	6
3C: Colorado River: Palisade to Stateline	Age 2+ 300	1° Fall 2° Spring–Summer	3,310[2]	6
1U: Middle Green River: (RM 302–249)	Age 2+ 300	1° Fall 2° Spring–Summer	9,930	6
2U: Lower Green River: (RM 249–120)	Age 2+ 300	1° Fall 2° Spring–Summer	9,930[3]	6

[1] 1° refers to the primary season; 2° refers to secondary season to cull fish and allow smaller individuals to achieve stocking size by the next fall.
[2] Represents one population in the Upper Colorado and Gunnison rivers.
[3] Represents an additional population in case of a catastrophic event.

Annual survival rate estimates at the hatcheries were 75% for age-0 to age-1, and 70% from age-1 to release. After release, annual survival rates were estimated at 50% and 60% for ages 2 and 3, respectively; age-4 and older fish all had a 70% annual survival estimate rate.

Field observations: Since implementing the 2003 Integrated Stocking Plan, survival of stocked razorback sucker has been monitored. Stocked-fish survival-rate estimates based on size, method of rearing, season stocked, and year stocked were evaluated (Zelasko et al. 2011) and compared to survival estimates that were used in the original integrated stocking plan (Nesler et al. 2003). For razorback sucker stocked at 350 mm TL, intensively-reared individuals (seasonally using indoor tanks and outdoor ponds) had the highest average first-interval (first year at large) survival estimates (21%) compared to solely pond-reared (15%) and tank-reared (9%). Post first-interval survival rate estimates for stocked razorback sucker were 79% for intensively-reared fish, 92% for pond-reared fish, and 94 % for tank reared fish over three years. Primary recommendations from Zelasko et al. (2011) were:

- Cease stocking of Razorback Sucker during summer months.
- Increase recommended total length at stocking for razorback sucker.
- Conduct a cost-benefit analysis of razorback sucker total length at stocking, season of stocking, rearing method, and associated first-interval survival.
- Collect individual weight data on at least a subsample of every batch of razorback sucker stocked. Resulting length-weight relationships would provide a condition factor that may aid in future predictions of survival and comparisons among treatment groups.
- Investigate reasons for low first-interval survival of stocked razorback sucker (e.g., predation, acclimation, and lack of conditioning).

Several projects (especially Colorado Pikeminnow population-abundance estimates) have captured stocked razorback sucker (Figure 1). Razorback sucker in the entire Upper Colorado River Basin have been acting as one population, as evidenced by fish moving between the Green and Colorado rivers. In addition, at least three fish have moved from the San Juan River to the Colorado River between Moab and the Colorado state line (T. Francis, personal communication). A monitoring plan developed for razorback sucker in the Upper Colorado River Basin produced abundance estimates of stocked individuals in three reaches (totaling 569 miles of river) of the Green River ranging from 474 to 5,153 for the years of 2006–2008 (Bestgen et al. 2012). In addition, spawning aggregations, larval production and possible recruitment (i.e., small [100 mm TL] wild fish) have been observed (Webber 2013; Webber, et al. 2013). Larval abundance has increased since the early 2000s in the middle Green River (Figure 2). During summer sampling in the Colorado River inflow area of Lake Powell, 241 razorback sucker were captured; 20 were without a PIT-tag. There was representation from every year stocked from 2002 to 2013.

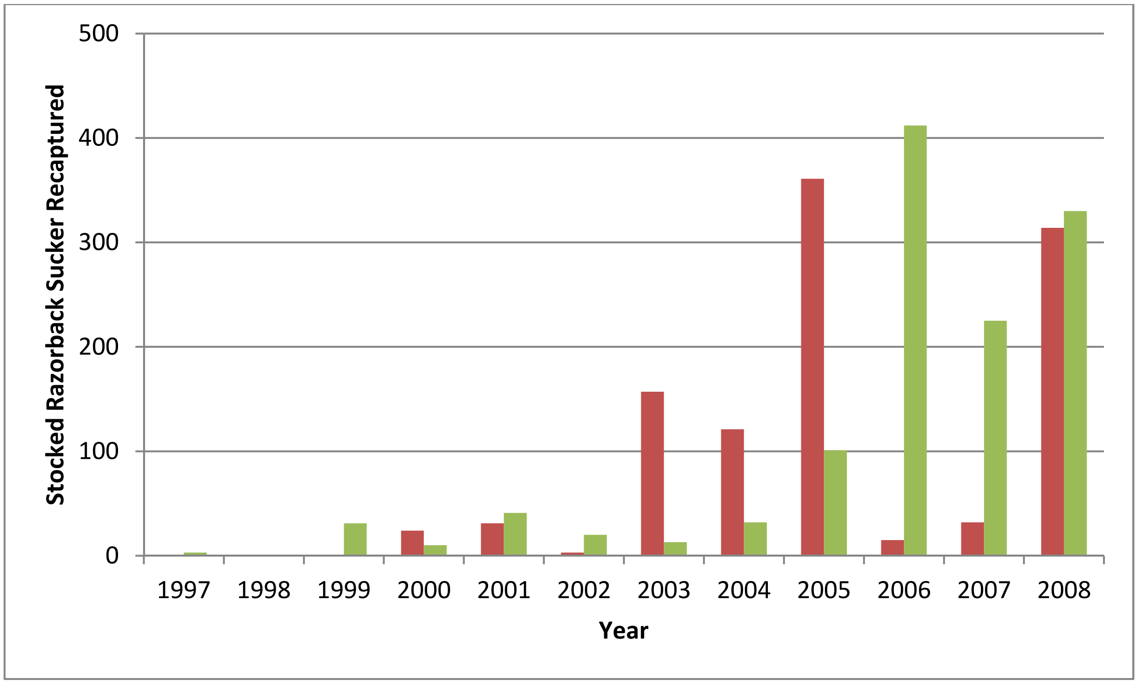

Figure 1. Number of stocked razorback sucker recaptured each year in the Colorado River (red) and the Green River (green) from 1997–2008 (modified from Zelasko et al. 2011). Annual sampling effort varied in both rivers.

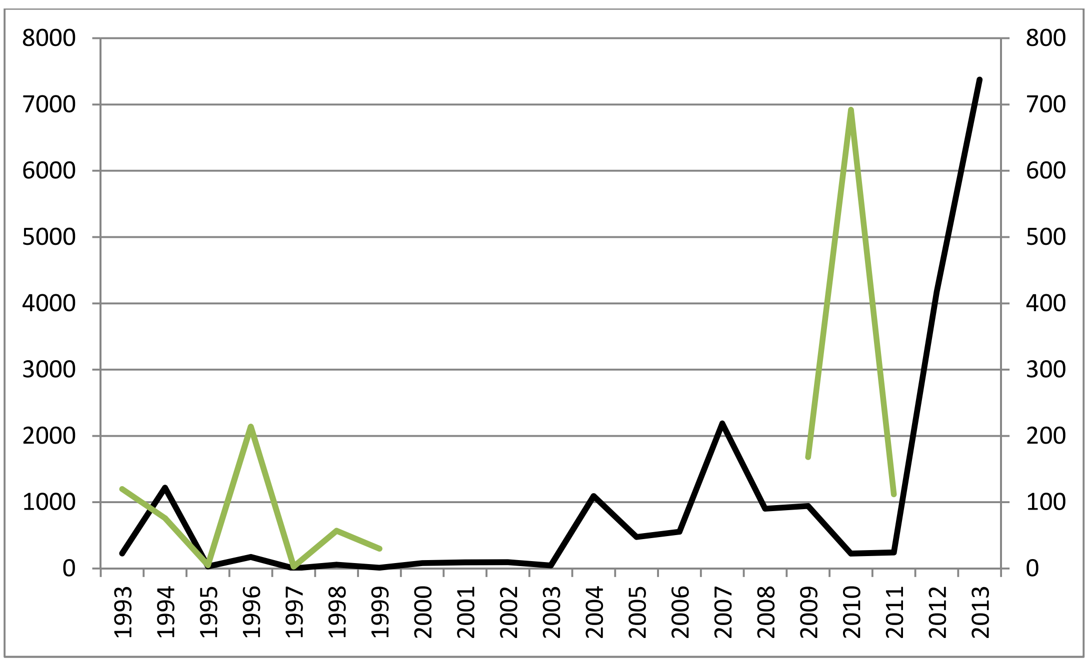

Figure 2. Number of razorback sucker larvae collected annually in the Middle Green River (left axis, black; via light traps) and the Lower Green River (right axis, green; sampling in the lower Green River occurred from 1993–1999 using just seines, and was restarted in 2009; the latest years sampling was done with both light traps and seines).

In 2012, Price-Stubb PIT tag antennas detected razorback sucker stocked in years 2004 through 2010. In 2013, the antennas detected razorback sucker stocked from the year 2000 to 2012. Stationary PIT tag antennas have also detected razorback sucker presence in the San Rafael River (20 fish between 2008 and 2010; Bottcher et al. 2013) and the Price and White rivers (52 and 16 fish in 2012–2013, respectively; Gary Thiede, Utah State University, unpublished data). Additionally, 29 razorback sucker moved upstream in the Gunnison River via the Redlands fish passage from 1996 through 2013 (Francis 2013).

Propagation Methods to Improve Survival of Stocked Fish

Fish Health. Hatcheries are implementing the Health Condition Profile (HCP; Goede and Barton 1990), a systematic, standardized, necropsy-based method of internal and external examinations of fish developed in Utah over 25 years ago. The Health Condition Profile is an empirical autopsy-based system of organ and tissue indices that provides a health profile of the population. Condition indices provide relatively simple and rapid indications of how well fish cope with their environment. They are manifestations of biochemical and physiological alterations expressed at the organism level, and are useful in assessing stress in fish. Normal appearances of vital organs are assumed to indicate that a fish population is in harmony with its environment. Departures from normal growth, bioenergetic state, presence of infectious agents, and general homeostasis, can be detected in the fish. The advantages of this method are that it is simple to use, requires little training, and does not need costly, sophisticated equipment. This assessment will be used to establish a database to evaluate condition of both bonytail and razorback sucker reared in hatcheries, and provide guidance to improve and maximize the health of fish stocked.

Stocking Season/Temperature. Kappenman et al. (2012) studied thermal requirements of bonytail. The predicted temperature for maximum weight gain was 25.9°C, and the predicted temperature for zero weight gain was 14.2°C. At temperatures below 14°C, the specific growth rate was below zero. Temperatures from 14–20°C provided incremental growth, and temperatures up to 26°C allowed for accelerated growth. They hypothesize that propagation temperatures and/or seasonal river temperatures from 22–26°C would maximize growth of juvenile bonytail and might promote higher survival because bonytail would be less vulnerable to predation, have greater energy reserves, and exhibit increased metabolic efficiency.

Stocking temperatures, water chemistry, season, and locations all have great influence on fish survival. Ideally, fish need to be subjected to minimal stress, be in good condition (as measured by HCP), and be as prepared as possible to handle the conditions encountered in the receiving waters. Each species and stocking situation is unique. However it appears from Kappenman et al. (2012) that bonytail have been stocked into waters that are too cold for them to recover from handling and hauling stress. Since bonytail exhibit zero growth at 14.2°C, their metabolism may be too low to heal from handling and hauling stress at or below this temperature.

At their natural spawning temperatures, fish must be able to recover from spawning stresses. Warm water fish tend to spawn in the spring as water temperatures are increasing. At the same time, the fish's metabolism is increasing, as is its ability to deal with stress and injury. Another important aspect of stocking temperature is exposure time to warmer temperatures. Stocking bonytail late in the fall with rapidly decreasing water temperatures can be problematic because they need time to heal. When bonytail are stocked in the fall, water temperatures may decrease rapidly thereafter and fish may not have sufficient exposure time or temperature units to recover from handling and hauling stress.

Stocking bonytail in the spring when temperatures are 15^{o}C or higher and are rising may increase survival. Razorback sucker stocked into cooler waters in the fall are surviving, and showing up in aggregations at spawning bars in the spring. However, razorback sucker spawn at approximately 14°C (before bonytail spawn) and are generally stocked at larger sizes than are bonytail (larger size increases chances of survival).

At temperatures above 24°C many warm water fishes appear to become "soft" (i.e., more susceptible to handling stresses; D. Schnoor, Ouray National Fish Hatchery, personal communication). When holding warm water fish in temperatures at or above 24°C, it is common practice to cool them down to at least 21°C overnight to "harden them" before handling, grading, or stocking. In addition, bonytail should not be handled or hauled long distances at temperatures above 20–21°C (Z. Olsen, Wahweap State Hatchery, personal communication). Schnoor recommends stocking as water is warming and temperatures are around 18°C, since adequate temperature units would be available to allow them to heal/recover from handling and hauling stress. Stocking in the early spring after run off would appear to be ideal if there is space in the hatchery to hold them that long. Addressing the temperature at which bonytail are stocked will help to alleviate one of the stressors imposed upon these fish.

Bonytail raised at Wahweap State Fish Hatchery were stocked in water at or below 14°C on eight of ten occasions, while the remaining events were in water between 14 and 15°C. Eleven of 28 stocking occasions of bonytail from J.W. Mumma Aquatic Species Restoration Facility occurred at or below 14°C, and five stockings occurred between 14.1° and17.9°C. Of the 12 bonytail stockings at 18°C or above, seven were in June or August, while the remaining five were in September. Depending on the year and circumstances, late September stockings could pose a problem with rapidly decreasing water temperatures. As a side note, Butch Craig Pond was the release site for five of the 12 Mumma bonytail stockings that occurred at or above 18°C.

Handling. When raising and stocking live animals, reducing or eliminating stress is very important. Fish should only be handled once a day and then allowed to recover for at least 24 hours before stressing them again (T. Smith, J.W. Mumma Aquatic Species Restoration Facility, personal communication). The standard practice after PIT tagging bonytail and razorback sucker at the hatcheries is to allow them to recover for several days before stocking, and using a salt and/or stress coat solution to help fish recover from handling stress.

Acclimation. Several forms of acclimation should be considered to increase first-interval survival: avian and fish predation [predator avoidance behavior in fish occurs at an early life stage (see review by Le Vaya et al. 2007)], habitat, and flow training.

Avian/mammal predation: Cultured fish are often more susceptible to avian predation than wild fish (Fairchild and Howell 2004). Although fish raised in ponds are exposed to some bird predation, some form of exposure to mimic bird predation should be considered. In a similar way, mimicking mammal predation should be considered since mammals (e.g., river otters), have been a problem at some of our pond facilities.

Fish predation: Smallmouth bass (*Micropterus dolomieu*), northern pike (*Esox lucius*), walleye (*Sander vitreus*), and channel catfish (*Ictulurus punctatus*) are nonnative predators in the Upper Colorado River basin, and smallmouth bass have been shown to consume bonytail (Bestgen et al. 2008). Recent studies indicate that native fish reared in a hatchery environment are "predator naive", thus increasing risk of predation and reducing survival of stocked fish (Mueller et al. 2007, Ward and Figiel 2011). These studies suggest that razorback sucker and bonytail do not inherently recognize predators (catfish and largemouth bass used in experiments) as a threat but can readily learn to associate the sight/scent of a dead conspecific with a novel predator (Ward and Figiel 2011). Ward and Figiel (2011) state: "Recognition of novel predators often occurs through a mechanism known as releaser-induced recognition learning, where alarm cues from the skin of an injured conspecific are paired with the visual and or chemical cues of a predator to elicit an antipredator response. These behaviors include increased group cohesion, increased use of shelter, decreased activity, or rapid escape to avoid". The effects of antipredator conditioning on post-release survival are unknown, but these study results suggest that native fish can be conditioned to recognize novel predators at least for a short period of time (Mueller et al. 2007, Ward and Figiel 2011).

Flow training: Razorback sucker and bonytail are reared in ponds or tanks at Program hatcheries. Studies suggest that fish reared in standing water may experience increased stress, downstream displacement, or high predation mortality when released into lotic environments (Ward and Hilwig 2004, Luke et al 2010). Ward and Hilwig (2004) compared the swimming performance of captive fish held in standing water and captive fish exercised in flowing water to evaluate the effects of exercise conditioning and holding environment on swimming performance. The swimming performance of bonytail and razorback sucker held in standing water increased by 15 and 26%, respectively, after exercise conditioning in flowing water (10–100 cm/s) for as little as 10 days (Ward and Hilwig 2004). Their results indicate that exercise conditioning can increase swimming performance to a level similar to that of wild fish. Avery et al (2010) found that exercised razorback suckers did not move as far downstream from the point of release as the non-exercised razorback sucker and suggest that exercise conditioning may increase overall fitness of pond-reared razorback sucker and thereby increase the effectiveness of augmentation stocking. The above mentioned studies suggest exercise in conjunction with predator recognition trials may be effective in increasing survival of hatchery-reared razorback sucker and bonytail after stocking. The Mumma Hatchery has been flow training bonytail for the past several years in an effort to acclimate pond- and tank-reared bonytail to flowing water conditions.

Habitat: The Natural Rearing Enhancement System (NATURES; Maynard et al. 2003; https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=00000548-1) is a program directed at developing and evaluating rearing strategies for the production of hatchery fish with wild characteristics and increased post-release survival. Habitats are mimicked at the hatchery prior to release or during the entire rearing process with the intention of improving post stocking survival. Although some of the Recovery Program's hatchery pond environments simulate natural, off-channel habitats, hatchery managers should consider incorporating more from the NATURES model in their management strategies. Other habitat features, such as water chemistry and temperature, are usually taken care of at time of stocking by tempering the fish at the site of release.

Stocking Locations:

Bonytail reared at the Wahweap State Hatchery spawn in outdoor ponds. Every year Wahweap produces bonytail in excess of quota due to prolific spawning in the ponds. In 2013, more than 100,000 bonytail, spawned in the ponds and considered excess, were provided to the Lower Colorado River Multispecies Conservation Program and an additional 50,000 were stocked into a pond in Colorado (Olsen 2013). Bonytail are currently stocked directly into the river within designated river reaches (Nesler et al 2003). However, managers are encouraged to experiment with other stocking locations (e.g. reaches upstream of designated Critical Habitat) throughout the Upper Basin that have been approved by the Recovery Program's Biology Committee. In addition to traditional main channel stocking locations, managers should experiment with specific stocking locations that closely mimic hatchery ponds (e.g., slack water habitats, suitable backwaters, off channel ponds) to increase survival of stocked bonytail. Stocking locations will be decided on an annual basis dependent on the water year and available habitats. Attempts to stock bonytail in such locations have begun in recent years and should continue, evidenced by bonytail survival in Stewart Lake and Baeser Bend floodplain wetlands.

The size of razorback sucker being stocked allows them to go into off-channel areas connected to the river. River reaches are identified under the hatchery producing them, below. As with bonytail, managers are encouraged to experiment with other stocking locations (e.g. reaches upstream of designated Critical Habitat) throughout the Upper Basin that have been approved by the Recovery Program's Biology Committee.

Integrated Stocking Plan Revisions

- The size at stocking for bonytail will increase from an average of 200 mm TL to an average of 250 mm TL. The goal is to stock 35,000 bonytail annually for five years; this more than doubles the previous target of 15,000. The various facilities will try to produce these fish over a two year period prior to release in spring or early summer. Biologists will collect a length and weight sample of every batch of bonytail stocked to provide a length-weight relationship. Techniques to improve survival of stocked bonytail will include any acclimation procedures that can be implemented at the hatchery and stocking site. Bonytail that do not undergo flow training should be stocked from May through June (when waters are 15ºC or warmer) into flooded wetlands and/or quiet backwaters, if available. Flow trained fish can be stocked into backwaters of the river.

- In 2012, the hatcheries were directed to reduce production of razorback sucker to accommodate increased production of bonytail. The stocking size of razorback sucker will be increased from an average size of 300 mm TL to 350 mm TL, based on the recommendation of Zelasko et al. (2011). Biologists will collect a length and weight sample of every batch of razorback sucker stocked to provide a length-weight relationship. The larger stocking size of razorback sucker should supplement juvenile to adult recruitment and add to natural production. Razorback sucker will be reared in a combination of outdoor ponds during warmer month and indoor tanks or runs in the winter (to increase growth). Each facility will attempt to produce 6,000 razorback sucker annually. Fish will be released when they get to an average size of 350 mm TL, but not during summer months (June–August).

- Training native fish to recognize introduced predators could be used as a management tool to reduce predation mortality when hatchery-reared fish are stocked into natural systems. Exercise in conjunction with predator-recognition trials may be effective in increasing post-stocking survival of hatchery-reared razorback sucker and bonytail.

- Hatchery Production:

Ouray National Fish Hatchery:

Grand Valley Unit:

Bonytail: Bonytail larvae (20,000) will be produced at the Southwest Native Aquatic Species Restoration Center and sent to the Grand Valley Unit for rearing. Hatchery personnel anticipate they can produce 10,000 bonytail (averaging 250 mm TL) annually. These fish will be stocked in spring or early summer.

Razorback Sucker: It is not known how fish will perform in ponds built in 2012 at Grand Valley . Therefore, the Grand Valley staff is taking a conservative approach with these ponds until they have been used for a full year and their performance can be evaluated. Hatchery personnel are confident that they can produce ≥6,000, razorback sucker (averaging 350 mm TL) and stock them in historical locations or at new sites (approved by the Recovery Program's Biology Committee) in the Colorado River drainage.

Randlett Unit:

Bonytail: Bonytail larvae (20,000) will be produced at the Southwest Native Aquatic Species Restoration Center and sent to the Randlett Unit. Hatchery personnel anticipate they can produce 10,000 bonytail (averaging 250 mm TL) annually. These will be stocked in spring or early summer.

Razorback Sucker: Hatchery personnel are confident that they can produce ≥6,000, 350 mm TL (on average) razorback sucker and stock them in historical locations or at new sites (approved by the Recovery Program's Biology Committee) in the Green River drainage.

J.W. Mumma Aquatic Species Restoration Facility

Bonytail: Continue to produce 5,000 bonytail (averaging 250 mm TL) annually. These will be stocked in spring or early summer. These bonytail will be stocked in historical locations or at new sites (approved by the Recovery Program's Biology Committee) in the Colorado River drainage.

Wahweap State Hatchery

Bonytail: Continue to produce 10,000 bonytail (averaging 250 mm TL) annually. These will be stocked in spring or early summer. These fish will be stocked in historical locations or at new sites (approved by the Recovery Program's Biology Committee) throughout the Colorado and Green rivers drainages.

- Specific Stocking Locations: These will be determined by hatchery managers, state managers, and the Recovery Program Director's Office as the time of stocking approaches and water levels and flows are better understood for that particular water year. Stocking locations should more closely mimic ponds (e.g., slack water habitats, backwaters, floodplain habitats) to increase survival of bonytail, and to better acclimate razorback sucker before encountering strong mainstem flows. The size of razorback sucker being stocked allows them to go into off-channel areas connected to the river.
- Excess Fish Production at Hatcheries: Natural reproduction of bonytail in hatchery ponds (as opposed to selective crosses performed by hatchery staff) allows for continued production of fish into out years. However, those that are in excess of production needs should be available to the Upper Basin Recovery Program to be stocked in locations determined by hatchery managers, state managers and the Recovery Program Director's Office. In light of the difficulty we are having with bonytail survival and absence of wild offspring, the Recovery Program accepts the fact that these fish will be unmarked. When spawning and larval production of bonytail in natural habitats are detected, stocking of unmarked fish will cease. Excess, unmarked razorback sucker are not to be released anywhere in the system, since reproduction by hatchery fish in natural habitats and recruitment to juvenile-sized fish has been documented.
- Stocking Evaluation: The Recovery Program has begun to implement some of the recommendations by Zelasko et al. 2011 (e.g., no more stocking in the summer and stocking larger fish), and we are now capturing many razorback sucker. An evaluation similar to that conducted for razorback sucker should be considered for bonytail after these new stocking recommendations have been followed for five years.

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