Distribution and status of native fishes in the Colorado River Basin, Colorado

Dr. Kevin R. Bestgen (P.I.): T: 970-491-1848; F: 970-491-5091;
E: kbestgen@lamar.colostate.edu

and Koreen A. Zelasko

Larval Fish Laboratory, Department of Fishery and Wildlife Biology,
Colorado State University, Fort Collins, CO 80523

Final Report

Submitted to

Mr. Tom Nesler
Colorado Division of Wildlife
317 West Prospect
Fort Collins, Colorado 80525

20 August 2004

Larval Fish Laboratory Contribution 141

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Assessing the response of Colorado River Basin fishes to habitat alteration and effects of non-indigenous fishes is facilitated by comparison of historical and recent distribution patterns. Information describing temporal changes in distributions will assist fishery managers in the State of Colorado to assess status of fishes in the Colorado River Basin, Colorado. We gathered distribution records for fishes native to the Colorado River Basin, Colorado, from primary and secondary literature sources and museums and assembled them in a database. We found a total of 33, 548 records for 13 native fishes. The most records were available for speckled dace *Rhinichthys osculus* (n = 8,103) and bluehead sucker *Catostomus discobolus* (n = 7,828). Fewest records found were for mountain sucker *Catostomus platyrhynchus* (n = 27), bonytail *Gila elegans* (n = 36), and Paiute sculpin *Cottus beldingi* (n = 42).

Best-documented distribution patterns were for Colorado pikeminnow *Ptychocheilus lucius*, bonytail, humpback chub *Gila cypha*, and razorback sucker *Xyrauchen texanus*, species which are federally listed as endangered. Distribution and status of those warm water species is relatively well understood because of the extensive research conducted on them since about 1980. Distribution of flannelmouth sucker *Catostomus latipinnis*, bluehead sucker, roundtail chub *Gila robusta,* and speckled dace was relatively well understood in warm water reaches where endangered fishes occurred. However, in upstream cool water reaches where less sampling has occurred, distribution of those species was less well understood. Distribution patterns for fishes that occur exclusively in cool or cold water reaches of Colorado streams were relatively poorly known because little historical or recent sampling that targeted those taxa has been conducted. Poorly known species in those reaches included speckled dace, mountain sucker, mountain whitefish *Prosopium williamsoni*, mottled sculpin *Cottus bairdi*, and Paiute

sculpin. A cold water species whose distribution is relatively well known is Colorado River cutthroat trout *Salmo clarki pleuriticus*.

The recent distribution of most native fishes has declined compared to historical patterns. This has been reasonably well-documented for Colorado pikeminnow, bonytail, humpback chub, razorback sucker, and cutthroat trout. Distribution of flannelmouth and bluehead suckers and roundtail chub has declined throughout the Colorado River Basin. Colorado populations of those taxa have declined in areas associated with reservoirs and in reaches where large populations of introduced predators exist. Changes in distribution and status of the remaining native fishes is less certain because of poor historical and recent sampling coverage.

Additional survey sampling is needed to make distribution and status assessments for stream fishes in the Colorado River Basin, particularly in cool and cold water reaches. Such information would allow managers to identify populations in need of research or management actions and would also allow identification of strong populations that should receive priority for protection. Survey data coupled with collection of environmental data would allow studies of relationships between fish distribution and physico-chemical factors that may limit their abundance. Such information may also permit identification of factors that influence hybridization rates of native suckers and introduced white sucker *Catostomus commersoni*. Continued study of effects of introduced fish predators will assist managers in focusing efforts to conserve native fishes. Studies to understand the distribution and systematics of sculpins in Colorado should also be considered. Finally, additional data sources regarding fish distributions in Colorado likely exist. These may include undiscovered reports or museum records, and unpublished field survey data from files of fish managers in Colorado. As with any fish distribution records, the accuracy of taxonomic identifications of difficult-to identify taxa should be considered.

List of Tables

List of Figures

INTRODUCTION

Effects of habitat modifications and the introduction of non-indigenous fishes has radically changed the composition of native fish communities in the Colorado River Basin (Carlson and Muth 1989). The most radical changes have occurred to fish communities downstream of mainstem dams. There, reservoir water releases are cold and native fishes have been replaced by non-native cold water species. Changes in flow regimes and floodplain vegetation have also altered habitat in reaches where warmwater fish still exist. Non-indigenous fishes have reduced the distribution and abundance of many native fishes in the Colorado River Basin, mostly through negative effects of competition, predation, hybridization, and disease introduction.

Assessing the response of Colorado River Basin fishes to effects of habitat alterations and non-indigenous fishes requires comparison of historical and present patterns of distribution and abundance. The status of endangered Colorado pikeminnow *Ptychocheilus lucius*, humpback chub *Gila cypha*, bonytail *Gila elegans*, and razorback sucker *Xyrauchen texanus* are reasonably well understood as a result of efforts of the Recovery Program for Endangered Fishes in the Upper Colorado River Basin. Those mostly mainstem species have been much reduced in distribution and abundance, especially in the lower Colorado River Basin.

Distribution and status information for all native fishes, including non-endangered ones, is of interest to managers in Colorado, who wish to assess conservation needs. Of particular concern are flannelmouth sucker *Catostomus latipinnis*, bluehead sucker *Catostomus discobolus*, and roundtail chub *Gila robusta* (Bezzerdies and Bestgen 2002). These taxa occupy much of the same habitat where endangered fishes once occurred and their distribution and abundance in Colorado and throughout the Colorado River Basin has been reduced (Minckley 1973, Holden

and Crist 1981, Bestgen and Propst 1989, Platania et al. 1991, Bezzerides and Bestgen 2002). Additional species that are potentially of concern include cool or cold-water fishes whose distribution and status is uncertain. An example is sculpins in the genus *Cottus*. Two forms are known from Colorado, but few studies have been conducted that distinguish between mottled sculpin *Cottus bairdi* and presumptive Paiute sculpin *Cottus beldingi*. Taxonomic status of the latter form is uncertain because the Colorado population is disjunct from the main concentration of this species in the Pacific Northwest and because this form has previously been referred to as the Eagle sculpin *Cottus annae*.

Therefore, the purpose of this report is to describe the historic and present distribution and status of the 13 native fishes in the Colorado River Basin, Colorado. Results of status assessments may be useful for planning conservation strategies for native fishes in the State of Colorado.

STUDY AREA

The study area for this investigation is the Colorado River Basin, Colorado.

METHODS

Literature and collections records have been used to assess changes in the historical distribution and abundance patterns and status of native fishes in the Colorado River Basin (Minckley 1973, Bestgen 1990, Platania et al. 1991, Bezzerides and Bestgen 2002). We used primary and secondary literature sources (Appendix I), museum collection records (Appendix II), and other unpublished collection records to make distribution and abundance assessments for fishes native to the western slope of Colorado in the Colorado River Basin. Records were assembled into an electronic database (Access) for easy retrieval and manipulation. Distribution

maps were prepared with ArcView and records are plotted as distinct points or river reaches, depending on how locality data was recorded by the original investigator. Because some river reaches span the border of Colorado, some reach records will extend into downstream river reaches in other states. Because all overlapping point data are plotted in ArcView, localities where point records were numerous result in the appearance of distribution lines that are heavier than those for single reach records.

Some differences may be noted between the distribution maps for flannelmouth and bluehead suckers and roundtail chubs in Bezzerides and Bestgen (2002) and this document. In that document, they combined present and past distribution records to describe historical (pre-1980) distribution of those taxa. The assumption was that absence of a species in a stream reach in the pre-1980 period was likely a result of poor sampling coverage if it existed there in the more recent, post-1979 period. While that assumption is not unreasonable, in this report we opted instead to show only records for each time period so the reader had a perspective for the levels of historical and recent sampling. An exception to the above assumption might be in regulated stream reaches (e.g., Green River upstream of the Yampa River) where fish communities have been severely altered; those exceptions are discussed.

A narrative summary and accompanying distribution maps were prepared that discusses changes in distribution and status of the species over time. Notes on the biology of species were a compendium taken from accounts in a variety of state fish books, the literature, and our observations. We also provide information on gaps in knowledge and recommend additional studies needed to make more complete assessments of the status of native fishes of the Colorado River Basin, Colorado.

RESULTS

A total of 33,548 records were found among all data sources (Table 1), 29,049 (86.6%) of which were mappable records. Unmappable records consisted of species records for which collection locality was uncertain. The majority of the records were from the collection at the Larval Fish Laboratory; literature records and records from other museums were another primary source of information. Records were found for the 13 fishes known native to the Colorado River Basin, Colorado. Records were also located for seven hybrid combinations.

Species accounts

Salmonidae

Colorado River cutthroat trout *Salmo clarki pleuriticus*

Federal Listing Status: none

State Listing Status: Special concern

Records: A total of 1,359 records for cutthroat trout were found.

Distribution: Historical distribution of Colorado River cutthroat trout includes all cold, high-elevation streams downstream of barriers in all major systems of the Colorado River Basin, Colorado, including the San Juan, Dolores, Gunnison, Colorado, White, Yampa, and Green rivers and their tributaries. Present-day populations are much reduced and the few non-hybridized populations that remain typically occur upstream of barriers in small streams isolated from immigration by other downstream salmonids. Relatively more post-1979 records exist for cutthroat trout than before perhaps due to enhanced collecting efforts. Efforts to conserve and

expand remaining pure genetic stocks continue.

Status: Perhaps stable but precarious due to small number of populations that support few individuals. Remaining pure populations under continued threat of contamination from non-native salmonids and whirling disease.

Notes on Biology: Occupies lakes and streams but requires moving water to reproduce. Adults in lakes grow to relatively large size (50-cm TL), but most individuals in small streams are 30-cm TL or less. Reproduction is in spring when redds are excavated in stream spawning gravel. Eggs incubate for 45 to 90 days depending on water temperature. All life stages of cutthroat trout consume macroinvertebrates including plankton and insects, and also some fish. Adults occupy pools, runs, and riffles in streams; young occur in lower velocity channel margin areas.

Limiting Factors: Reasons for decline of native cutthroat trout in the western United States have been chronicled extensively (Behnke and Benson 1983, Behnke 1992). Main factors responsible for reduction in distribution and abundance of cutthroat trout have been habitat loss and negative interactions with non-native salmonids. Habitat loss is due mainly to changes in water quality, dewatering, overgrazing, logging, and excessive siltation. Negative effects of non-native salmonids can be grouped into two main areas: hybridization and biotic interactions. Cutthroat trout hybridize readily with other subspecies of cutthroat trout as well rainbow trout *Oncorhynchus mykiss*. Pure cutthroat trout populations are rare and generally support few individuals due to small size of isolated and often cold, high elevation streams. Isolated populations remain susceptible to extirpation due to effects of accidental or deliberate introduction of non-native salmonids. Negative effects of biotic interactions may result from competition with or predation by brook trout *Salvelinus fontinalis*, brown *Salmo trutta*, or rainbow trout. In lentic situations, introduced lake trout *Salvelinus namaycush* may also prey

upon cutthroat trout. A relatively new threat to native cutthroat trout is a parasite (*Myxobolus cerebralis*) that causes whirling disease in many salmonid fishes.

Notes: We included all records of *Salmo clarki* found in museums in order to be complete, recognizing that some populations may no longer exist or that they may be considered hybridized to some extent. Most records are from the Monte Bean Museum of Natural History, Brigham Young University, Provo, Utah, and represent specimens donated by Dr. Robert J. Behnke. The large number of records from that museum is because they have large holdings and because each specimen was given a catalog number. Most museums catalog a single lot of specimens of one species as a single number.

mountain whitefish *Prosopium williamsoni*

Federal Listing Status: none

State Listing Status: none

Records: A total of 133 records were found for mountain whitefish in Colorado.

Distribution: Mountain whitefish are found in cool or cold water sections of the Green, Yampa, and Colorado River Basin streams, mostly in relatively large stream reaches. Mountain whitefish are uncommon in streams so warm that few brown trout or other salmonids occur. In the Yampa River downstream of Hayden, Colorado, mountain whitefish were rare from 2000 to 2004 (F. Pfeifer, J. Hawkins, pers. obs.). Distribution of mountain whitefish in the Colorado River downstream of the Gunnison River has apparently declined. Distribution and abundance in the Green River downstream of Flaming Gorge Dam, a reach where warm water fishes historically occurred, was likely enhanced because of cold water releases. An introduced population of mountain whitefish also occurs in the Poudre River, South Platte River Basin.

Status: Perhaps stable but poorly known. Perhaps declining in the lower Yampa and Colorado rivers based on rarity of specimens during recent intensive sampling. Mountain whitefish were likely rare in those reaches historically because of high water temperatures.

Notes on Biology: Adults up to 57.2-cm TL, most 40-cm TL or less. Individuals up to 17 years old documented. Matures at age 3 or 4. Spawns in late autumn or winter (October to February) over gravel or rubble in streams and does not excavate a redd. Eggs average 3.7 mm in diameter, 17,065 eggs per kg of female body mass, up to 24,143 for a 43-cm individual. Embryos hatch in March or April. All life stages feed mostly on benthic macroinvertebrates, including insects, and other invertebrates. Typically found in cool to cold lakes and streams, but during drought in summer 2002, mountain whitefish were found in deep pools in the Yampa River at water temperatures of 21°C. In streams, adults occupy mostly deep pools and runs. Larvae and juveniles found in slow to moderate velocity runs or backwaters over sand substrate. Larvae and small juveniles were present in the Green River from near Swinging Bridge in Browns Park, Colorado, downstream into Island and Rainbow parks, Utah, in spring 2003, presumably from downstream dispersal of just-hatched individuals from upstream reaches. None persisted in reaches downstream of the confluence of the Yampa River in summer.

Limiting Factors: Factors limiting mountain whitefish are not specifically known and the ecology and status of this species is poorly understood. In general, it is likely that many of the same habitat loss factors that limit distribution of cutthroat trout also limit mountain whitefish. Similar to brown trout, mountain whitefish is more tolerant of warmer water than cutthroat and rainbow trout and brook trout. Introduced northern pike *Esox lucius* captured in the Green River in Lodore Canyon regurgitated mountain whitefish, suggesting introduced predaceous fishes may limit their abundance when their ranges overlap.

Cyprinidae

bonytail *Gila elegans*

Federal Listing Status: Endangered

State Listing Status: Endangered

Records: A total of 36 records were found for bonytail in Colorado.

Distribution: Historically known from warm water sections of large, turbid, main stem river reaches including the Yampa, Green, Gunnison, and Colorado rivers. Last-known records for wild-caught individuals in Colorado were in Dinosaur National Monument in the Green and Yampa rivers (Vanicek et al. 1970) and the Colorado River near Black Rocks (Kaeding et al. 1985). Most pre-1980 records in the Colorado River upstream of the Gunnison River were from Kidd (1977). About 10,000 hatchery-reared bonytail 25 to 30-cm TL were released into the Green River at the head of Lodore Canyon in each of 2001 and 2002 (need to check dates, size, and numbers). Subsequent downstream sampling in the Green River associated with a fish community investigation in Lodore and Whirlpool canyons, Colorado and Utah, failed to detect a single individual, despite intensive sampling with electrofishing and trammel-netting gear.

Status: Extirpated as wild populations throughout the Colorado River Basin. Repatriated individuals are apparently surviving in some reaches of the Green and Colorado rivers, Utah.

Notes on Biology: Little known. Occupied main stem reaches of warm water rivers. Vanicek and Kramer (1969) did not distinguish earlier life stages so differences in diet, growth, and

habitat use between roundtail chub and bonytail are unknown. Diet presumably similar to other chubs, consuming mostly aquatic and terrestrial invertebrates. Reproduction occurred in late winter and spring in ponds at Dexter National Fish Hatchery and in ponds adjacent to the lower Colorado River in Arizona.

Limiting Factors: Factors limiting bonytail are unknown because populations were depleted before scientific investigations were conducted to understand their ecology and life history. Once widespread and abundant, bonytail disappeared from the main stem Colorado River and tributaries after large, main stem dams were constructed (Behnke and Benson 1983).

Notes: Most records available for bonytail were from the literature. The few specimens available from museums were not examined. Most records for *Gila*, including those for bonytail, should be viewed cautiously because of morphological variation and the consequent confused historical taxonomy of chubs in the genus *Gila* (Douglas et al. 1989, Douglas et al. 1998).

Colorado pikeminnow *Ptychocheilus lucius*

Federal Listing Status: Endangered

State Listing Status: Threatened

Records: A total of 1,883 records were found for Colorado pikeminnow in Colorado.

Distribution: Large, warm water streams and rivers including the lower portions of the San Juan, Dolores, Gunnison, Yampa, White, and Little Snake rivers and the main stem Colorado and Green rivers.

Status: Perhaps stable or declining. Abundance estimates for Colorado pikeminnow in the Colorado River were similar over the period 1992 to 2000. Ongoing abundance estimates there will provide updated information by 2006. Abundance stable to slightly lower in the Yampa

River over the period 2000 to 2003, and lower in the White River in the same period (McAda 2002, Bestgen et al. 2004). Colorado pikeminnow use of the Little Snake River is thought occasional and often linked with higher flows (Marsh et al. 1991, Wick et al. 1991, Hawkins et al. 2001) in that small system. Records for recent captures of Colorado pikeminnow in the Dolores River were not discovered. Abundance of Colorado pikeminnow appears to be increasing at least seasonally in Lodore Canyon, perhaps as a result of re-operation of Flaming Gore Dam and recent years of low warm summer flows (Bestgen and Crist 2000, Kitcheyan and Montagne 2004).

Notes on Biology: Ecology of this species is perhaps among the best-known for cyprinids. Adult size historically was to 180-cm TL; recent specimens > 100-cm TL are very rare. Adults mature at age 5 (males) to 7 (females) at lengths of 45 to 55-cm TL. In the Green River Basin, adults migrate up to 745 km round-trip to spawn at two spawning areas, one in the lower Yampa River in Yampa Canyon, Dinosaur National Monument, Colorado, and the other in the lower Green River, Gray Canyon, Utah (Irving and Modde 2000). Only local movements to spawning areas are known for Colorado pikeminnow in the Colorado and Gunnison rivers, Colorado. Spawning is in late spring or early summer (from early June through July) when peak spring flows are declining and water temperatures reach or exceed about 16 to 22°C. Spawning in the lower Yampa River occurs over complex cobble bars that are re-created each year by high spring runoff events. Embryos deposited in cobbles hatch in 4 to 7 days depending on water temperature, and are transported downstream when 4 to 8 days post-hatch to near-shore low-velocity areas to rear through the summer. Growth and survival of year-classes of Colorado pikeminnow may be positively related to timing of spawning, water temperatures during the summer growing season, and negatively related to abundance of fish predators in backwaters and stream flow levels. Juveniles are thought to rear mostly in downstream reaches of the Colorado

and Green rivers and subsequently recruit to upstream reaches of those rivers and their tributaries later in life. Capture-recapture sampling to estimate abundance of Colorado pikeminnow is underway in most major river reaches of the Yampa, White, and Colorado rivers, in Colorado. The populations in the San Juan River, a small portion of which enters southwestern Colorado, is small and thought to consist of fewer than 100 wild adults.

Adults occupy relatively large, cool to warm water streams, but are rarely found where summer water temperatures do not exceed 18°C or more. Most adults occur in pools or runs, over a variety of substrate types. In spring, adults may move into relatively warm flood plain areas where other fish prey may be concentrated. In summer, adults may move to smaller and cooler tributaries where prey fish are abundant (Kitcheyan and Montagne 2004). Juveniles and larvae occupy warm, shallow, low velocity areas such as backwaters and shorelines (Haines and Tyus 1990, Haines et al. 1998).

Adults are carnivorous and consume a wide variety of prey including fishes, birds, small mammals, and aquatic and terrestrial insects. Juveniles and larvae are similarly carnivorous, switching from a mostly invertebrate-dominated diet as larvae to fish when about 5-cm TL.

Limiting Factors: Strong year-classes are thought positively related to the amount of backwater habitat available when water temperatures are warm and allow for high growth rates in summer in the lower Green and Colorado rivers. Year-class strength may also be inversely related to abundance of small predators such as red shiners in backwaters. Strong year-classes typically occur when summer flows are low to moderate, although recent year-classes in low-flow drought years in the middle Green River have been very weak. Juvenile and adult Colorado pikeminnow up to 54-cm TL are susceptible to predation by introduced predaceous fishes such as northern pike.

humpback chub *Gila cypha*

Federal Listing Status: Endangered

State Listing Status: Threatened

Records: A total of 97 records were found for humpback chub in Colorado.

Distribution: Main stem warm water reaches of the Colorado, Green, and Yampa rivers, including the Little Snake River, Colorado. Distribution shown in the Colorado River upstream of the Gunnison River is from specimens collected by Kidd (1977) and Valdez et al. (1982a and b). Most were collected in DeBeque Canyon and were morphologically intermediate between humpback and roundtail chub *Gila robusta*. Yampa River records are from Yampa Canyon. Humpback chub are also known intermittently from the Little Snake River, Colorado (Wick et al. 1991, Hawkins et al. 2001), with one radio-tagged individual moving from the Little Snake River downstream to Yampa Canyon. Post-1979 records in the Colorado River are mostly from Black Rocks Canyon, near the Colorado-Utah border.

Status: Uncertain, likely declining. Recent abundance estimates and catch per unit effort statistics for humpback chub in Black Rocks have declined since 1999. Humpback chubs in Yampa Canyon are also rare compared to historical collections (Tyus 1998), with only six captured in three years of sampling from 1998 to 2000 (Haines and Modde 2002). Ongoing sampling suggests humpback chubs are rare in Yampa Canyon, and non-existent in Lodore Canyon. Fish community sampling in Whirlpool Canyon revealed presence of several humpback chubs in 2002 and 2003 (unpublished data, K. R. Bestgen). Humpback chub use of the Little Snake River may be transitory based on the few records and radio-telemetry data (above, Wick et al 1991, Hawkins et al. 2001).

Notes on Biology: Adults of moderate size, to about 40-cm TL; maximum life span thought to

be 20 years or more. May reproduce when 25-cm TL or larger. Reproduction is in spring or early summer when water temperatures exceed 16 to 20°C (Muth et al. 2000) and when high spring flows are declining. Fecundity is unknown, but likely similar to same-sized roundtail chub. Egg size 2.0 to 2.5 mm. Embryos hatch in 5 to 8 days at 18°C. Larvae described and illustrated in Snyder (1981) and Muth (1990). Adults occupy deep eddies and pools, often near large boulders, debris-fans, or sheer cliff faces. Often found with roundtail chubs, and can be captured with a baited hook or small spinners. Juveniles and early life stages presumably occupy near shore channel margin backwaters and pools (unpublished collections records, Converse et al. 1998). Humpback chub diet is general, feeding on aquatic and terrestrial invertebrates, detritus, and algae.

Limiting Factors: Distribution and abundance of humpback chubs may be reduced due to habitat alteration caused by river regulation and predation by non-native fishes (Marsh and Douglas 1997). Effects of proliferation of predaceous fishes in warm water reaches of the Yampa, Green, and Colorado rivers in Colorado where humpback chub occur is unknown but evidence from other stream reaches such as in Grand Canyon suggests that larger populations of predaceous fishes will negatively impact humpback chub. Evidence from the Colorado River in Grand Canyon suggested that predation by introduced predaceous fishes was a major factor affecting recruitment of humpback chubs. It has also been hypothesized that river regulation may promote hybridization between roundtail and humpback chubs, where they co-occur.

roundtail chub *Gila robusta*

Federal Listing Status: None

State Listing Status: Special concern

Records: A total of 2,764 records were found for roundtail chub in Colorado.

Distribution: Historical distribution likely included the main stem and tributary reaches of warm and cool-water streams in all drainages of the Colorado River Basin, Colorado, including the San Juan, Dolores, Colorado, Gunnison, White, Yampa and Green rivers and their tributaries, occasionally ascending streams that are cool enough to support brown trout. Although not depicted with sampling records, present-day distribution and knowledge of their habitat requirements suggested that historical distribution of roundtail chub likely included all cool or warm water reaches of the San Juan, Dolores, and White river drainages. Post-1979 records show reduced distribution in the San Juan, Dolores, and Gunnison River basins. Roundtail chub are very rare throughout most of the San Juan River drainage (Platania et al. 1991). Present-day abundance of roundtail chub is very low in the Yampa River drainage upstream of Craig where chubs used to be common (F. Pfeifer pers comm., KRB, unpublished data), and the Green River in Lodore Canyon (Bestgen and Crist 2000). Roundtail chub may be more widely distributed in the Little Snake River, a tributary of the Yampa River, than records suggest, although recent sampling has not been conducted to confirm that. Additional sampling may also reveal extant populations in locations where roundtail chubs appear absent.

Status: Declining in the Colorado River Basin (Bestgen and Bezzerides 2002), and likely declining in Colorado. Strong populations remain in portions of the main stems of the Colorado and Gunnison rivers (Burdick 1995, Anderson 1997).

Notes on Biology: Adults of moderate size, to about 45-cm TL. Individuals as small as 20-cm TL are reproductive in the lower Colorado River Basin (Bestgen 1985). Reproduce in spring or early summer when water temperatures exceed 16 to 20°C (Vanicek and Kramer 1969, Bestgen 1985, Bestgen and Propst 1989). Fecundity up to 45,000 eggs for females as large as 40-cm TL,

length:fecundity relationship presented in Bestgen (1985). Egg size 2.0 to 2.7 mm in diameter. Embryos hatch in 5 to 7 days at 18°C and often drift downstream in main stem environments (Carter et al. 1986, KRB, pers. obs.). Larvae described and illustrated in Snyder (1981) and Muth (1990). Adults occupy deep pools and runs, often with cover, and can be readily captured with baited hooks or small spinners. Juveniles and early life stages usually occupy backwaters and near shore pools (Bestgen and Propst 1989, Haines and Tyus 1990). Roundtail chub diet is general, feeding on aquatic and terrestrial invertebrates, plankton, detritus, and algae, with adults adding fish and other vertebrates.

Limiting Factors: Roundtail chubs are not typically found in stream reaches with vast expanses of sand, instead preferring a mix of substrate types including gravel and cobble in river reaches where water is seasonally clear. Roundtail chubs may also be sensitive to heavy metals in some reaches of the Dolores River drainage. Roundtail chubs are rare or do not persist where predators such as smallmouth bass *Micropterus dolomieui* are present (Bestgen 1985). Roundtail chubs are increasingly rare in certain reaches of the upper Colorado River Basin such as the Yampa River, where northern pike and smallmouth bass exist. Alternatively, roundtail chub were very common in the upper Colorado River main stem upstream of Grand Junction, where such predators were rare (Anderson 1997). Limiting factors for roundtail chub in Lodore Canyon, where they are more rare than endangered Colorado pikeminnow, may include effects of river regulation and an abundant population of predaceous brown trout (Bestgen and Crist 2000). Ongoing studies in the Yampa River may offer insights into effects of predator removal on populations of native fishes such as roundtail chub.

speckled dace *Rhinichthys osculus*

Federal Listing Status: None

State Listing Status: None

Records: A total of 8,103 records were found for speckled dace in Colorado.

Distribution: This is the most widespread native fish in the Colorado River Basin, Colorado. Speckled dace are widespread because of broad thermal tolerances, occurring in warm, cool, and downstream portions of cold-water streams including large main stem areas and smaller tributaries in all western Colorado River streams. Those include the San Juan, Dolores, Gunnison, Colorado, White, Yampa, and Green River basins. Speckled dace collected near Hot Sulfur Springs, Colorado, in the Colorado River in 1938 indicate occasional presence in cold water reaches of large main stem rivers. It is not known if those upstream populations persist. Early gaps in collections likely represent lack of collecting effort in some reaches (e.g., the lower White River, upper Gunnison River Basin, many tributaries). Similarly, post-1980 gaps in distribution in many reaches of Colorado River Basin streams and tributaries, particularly upstream, likely reflects lack of collecting effort there or lack of data recording when the species was detected.

Status: Perhaps stable but largely undocumented.

Notes on Biology: Despite its wide western distribution, relatively little is known of the biology of speckled dace. Adult size is relatively small, up to about 12 to 14-cm TL but typically < 8-cm TL. Adults to age 4 are known and may live longer in some situations. Individuals as small as 4-cm TL are reproductive, both sexes spawn at age 1 or 2. Widely variable in morphology and coloration, this species likely also has variable biology. In large river environments, this species can attain relatively larger body size and has adaptions for a big river environment, including embedded and small scales, and relatively large and falcate fins. In the Gila River Basin, New Mexico, populations reproduced in March through April. In the lower Yampa River, Colorado,

speckled dace spawn when water temperatures are 15 to 22°C during the post- spring run off period. Eggs 2.0 to 2.5 mm in diameter; fecundity is unknown. Larvae described and illustrated in Snyder (1981) and Snyder et al. (in prep) and are about 6 to 8-mm TL at hatching. In riverine habitat, larvae drift downstream to backwaters where they rear. Adults typically occupy riffles and runs, younger life stages occur in lower velocity areas. Larvae rear in backwaters or near-shore channel margins. All life stages consume small aquatic macroinvertbrates. Adults in the Gila River Basin observed in mid-water, often downstream of larger catostomids, feeding on dislodged benthic macroinvertebrates.

Limiting Factors: Ecology and life history of speckled dace is poorly known, so factors affecting their distribution and abundance are not known. Speckled dace were very rare in the Green River upstream of the Yampa River until water releases from Flaming Gorge Dam were warmed (Holden and Crist 1981). Speckled dace are very rare in reaches of the Yampa River where populations of predaceous non-native fishes such as smallmouth bass are common (Anderson and Stewart 2000, KRB pers. obs.).

Catostomidae

bluehead sucker *Catostomus discobolus*

Federal Listing Status: None

State Listing Status: Special concern

Records: A total of 7,828 records were found for bluehead sucker in Colorado.

Distribution: Warm and cool water reaches of most main stem and large tributaries in all

western Colorado River Basin rivers including the San Juan, Dolores, Gunnison, Colorado, White, Yampa (including the Little Snake River), and Green River basins. Bluehead suckers collected near Hot Sulfur Springs, Colorado, in the Colorado River in 1938 indicate occasional presence in cold water reaches of large main stem rivers. It is not known if those upstream populations persist. Were historically present in upstream reaches of the Gunnison River and throughout the lower portions of the White River and tributaries as well. Present distribution or abundance reduced in some reaches including the upper Gunnison and Yampa rivers. Patchy distribution in the Dolores River Basin may indicate lack of historical and present-day sampling. Hybridization noted in recent years in the Yampa River downstream of Hayden, Colorado (Prewitt 1977, Douglas and Douglas 2003), where few bluehead suckers were found from 2000 to 2003 (F. Pfeifer, J. Hawkins, pers. comm.). Hybrids also common in the Green River in Lodore Canyon.

Status: Declining in the Colorado River Basin (Bezzerides and Bestgen 2002), likely declining in Colorado although strong populations remain. Declining in the upper Yampa and upper Gunnison River basins, abundant in the upper Colorado River (Anderson 1997) and the lower Gunnison River (Burdick 1995). Reduced post-1979 distribution in the San Juan River Basin may be due to lack of recent collecting, or actual decline.

Notes on Biology: Adults to 48-cm TL, typically 40-cm TL or less. Size at maturity varies throughout the range of bluehead sucker (Smith 1966). Fish from small tributaries mature at smaller sizes than those occupying large rivers (McAda and Wydoski 1983). Sexual maturation of bluehead sucker in the San Juan River and Little Colorado River drainages was observed at lengths of 9 to 20-cm SL (Smith 1966). Most individuals in Colorado likely reproduce at age 4 to 6 years old and when > 20-cm TL. Bluehead suckers typically spawn in spring and early summer at lower elevations and latitudes, where water warms earlier in the season, and in May

and June in higher elevation or higher latitude streams. Water temperatures during spawning generally range from 15 to 25°C (Bezzerides and Bestgen 2002). Similar to flannelmouth suckers, bluehead suckers may have a protracted spawning season lasting into late summer or early fall (Smith 1966, Maddux and Kepner 1988, Tyus and Karp 1990, Robinson et al. 1998, Douglas and Douglas 2000). Sublette et al. (1990) noted spawning typically occurs in gravel riffles of streams, with two males normally (one to four) attending each female that enters the spawning area (Maddux and Kepner 1988, Sublette et al. 1990). Carlson et al. (1979) reported incubation times of 7 to 8 days at 15.6 to 17.7°C under laboratory conditions. Size at hatching was 10 to 11-mm TL. Carter et al. (1986) and Robinson et al. (1998) captured bluehead sucker larvae drifting in the Colorado and Little Colorado rivers, respectively. Bluehead sucker larvae occupy backwaters where they feed on dipteran larvae, diatoms, and zooplankton (Muth and Snyder 1995, Bezzerides and Bestgen 2002). Juvenile and adult bluehead suckers are commonly reported as benthic algivores, using the chisel-like ridges inside each lip to scrape algae, organic and inorganic debris, and smaller aquatic insects from rocks and boulders (Bezzerides and Bestgen 2002). Bluehead sucker adults are almost always found in areas with moderate to fast current such as riffles or runs with rocky substrates (Bezzerides and Bestgen 2002). Large adults live in water as deep as two or three meters, and commonly seek out pools, deep coves, or undercut banks that provide cover (Sigler and Miller 1963, Gorman et al. 1994, Beyers et al. 2001). With few exceptions (e.g., Simon 1951), bluehead sucker appears to be an obligate lotic species. Preference appears to be for large, cool streams of 20°C or less, but bluehead suckers also flourish in warm, small creeks, tolerating water temperatures as high as 29°C (Smith 1966, Sigler and Sigler 1996). Bluehead sucker larvae and juveniles use shallower, low-velocity shoreline and backwater areas (Sigler and Miller 1963, Haines and Tyus 1990, Hoffnagle et al. 1994, Robinson et al. 1998).

Limiting Factors: Bluehead suckers are not typically found in stream reaches with vast expanses of sand, instead preferring a mix of substrate types including gravel and cobble in river reaches where water is seasonally clear. Widespread hybridization with introduced and expanding populations of white sucker *Catostomus commersoni* or longnose sucker *Catostomus catostomus* appears to be a primary threat (Hubbs et al. 1943, Hubbs and Hubbs 1947, Hubbs and Miller 1953, Hubbs 1955). Hybridization of bluehead and white sucker in the Yampa River was noted as early 1967 (Holden and Stalnaker 1975b) and continues at present (Prewitt 1977, Douglas and Douglas 2003), but was not as widespread or frequent as white and flannelmouth sucker hybridization. Wiltzius (1978) blamed decline of native catostomids, including bluehead sucker, in the upper Gunnison River on proliferation of white and longnose suckers. Hybrids of white and bluehead suckers (and others) were also noted in the Green River in Lodore Canyon, but the incidence was relatively low at < 10% (Bestgen and Crist 2000). Similar to flannelmouth suckers, expanding populations of non-native predaceous fishes may also limit bluehead suckers in some reaches.

flannelmouth sucker *Catostomus latipinnis*

Federal Listing Status: None

State Listing Status: Special concern

Records: A total of 5,576 records were found for flannelmouth sucker in Colorado.

Distribution: Warm and cool water reaches of most main stem rivers and large tributaries in all Colorado River Basin systems in Colorado including those in the San Juan, Dolores, Gunnison, Colorado, White, Yampa (including the Little Snake River), and Green River basins. Flannelmouth suckers collected near Hot Sulfur Springs, Colorado, in the Colorado River in

1938 indicates occasional presence in cold water reaches of large main stem rivers. It is not known if those upstream populations persist today. Were likely historically present in upstream reaches of the Gunnison River and throughout the lower portions of the White River and tributaries as well, based on habitat preferences and recent distribution. Recent distribution reduced in some reaches including the upper Gunnison and Yampa rivers. Patchy distribution in the Dolores River Basin may indicate lack of historical and present-day sampling. High incidence of hybridization noted in recent years in the Yampa River downstream of Hayden, Colorado, where few pure flannelmouth suckers were found from 2000 to 2003 (F. Pfeifer, J. Hawkins, pers. comm.).

Status: Declining in the Colorado River Basin (Bezzerides and Bestgen 2002), likely declining in Colorado although strong populations remain. Declining in the upper Yampa and Gunnison River basins, abundant in the upper Colorado River (Anderson 1997) and the lower Gunnison River (Burdick 1995). Reduced post-1979 distribution in the San Juan River Basin may be due to lack of recent collecting, or actual decline.

Notes on Biology: Adults to 70-cm TL, typically 60-cm TL or less. Most individuals reproduce at age 4 to 6 and when > 40-cm TL, individuals may live 15 years or more (Scoppetone 1988, McAda 1977, McAda and Wydoski 1985, Douglas and Marsh 1998). Flannelmouth sucker may migrate to spawning areas depending on habitat availability and homing behaviors (Snyder and Muth 1990, Weiss et al. 1998, McKinney et al. 1999). In Grand Canyon, flannelmouth sucker apparently spawn at only a limited number of locations and fish may move considerable distances to access spawning sites (Douglas and Marsh 1998, Weiss et al. 1998, Douglas and Douglas 2000). In the Upper Colorado River Basin, widespread distribution of spawning adults and subsequent early life-history stages suggests that spawning sites are more widely available than in the Grand Canyon (Holden and Stalnaker 1975a). Flannelmouth sucker typically spawn

in March and April in the Lower Colorado River Basin and in May and June in the Upper Colorado River Basin (Holden 1973, Suttkus and Clemmer 1979, McAda and Wydoski 1985, Weiss et al. 1998). Several authors have observed extended or late spawning seasons (Tyus and Karp 1990, Weiss et al. 1998, Douglas and Douglas 2000). Reproduction is usually when water temperatures are 6 to 18.5°C (Bezzerides and Bestgen 2002). Females are typically larger than males (McAda and Wydoski 1985, Weiss et al. 1998), and sex ratios appear to be about equal (Weiss et al. 1998). Reproduction in the Green River is typically when spring peak flows are rising or have peaked. The adhesive, demersal eggs, which are largest of all catostomids in the Colorado River Basin (Snyder and Muth 1990, Weiss 1993), are usually deposited over gravel bars in shallow water (Lanigan and Berry 1981, McAda and Wydoski 1985, Snyder and Muth 1990). Nest excavation did not occur during spawning activities observed by Weiss et al. (1998) in the Paria River. Eggs are 3.0 to 3.7 mm in diameter. Carlson et al. (1979) reported incubation times of 6 to 7 days at 15.5 to 17.8°C for flannelmouth sucker embryos, and large larvae at hatching (11 to 12-mm TL). Larvae are known to drift with the current after emergence from spawning substrate (Carter et al. 1986, KRB, unpublished data) and several studies have noted that larvae occur in backwaters and shorelines (Haines and Tyus 1990, Muth and Snyder 1995, Childs et al. 1998, Robinson et al. 1998). Flannelmouth sucker are omnivorous (Sigler and Miller 1963, Minckley 1973, Sigler and Sigler 1996). Larvae eat chironomids, copepods, phytoplankton, and organic detritus, and juvenile and adult fish consume a wider variety of items including terrestrial seeds and plant debris, algae, aquatic invertebrates, phytoplankton, and organic detritus (Bezzerides and Bestgen 2002). Flannelmouth suckers typically inhabit pools and deeper runs in larger rivers, but are also found in small streams and occasionally in lakes (McAda et al. 1980, Minckley and Holden 1980, Baxter and Stone 1995). Although several authors note their abundance, flannelmouth suckers do not persist in impoundments (Minckley

1973, Wiley 1978, Chart 1987, Chart and Bergersen 1992, Martinez et al. 1994, Berg et al. 1995). Sublette et al. (1990) reported flannelmouth sucker in the Virgin River, Utah, to prefer temperatures ranging from 10 to 27°C, and to be most common at 25.9°C. Substrate preferences vary from mud and silt to cobble and gravel (Sigler and Miller 1963, McAda and Wydoski 1985). Adults are often more abundant over hard substrates, rather than sand or silt (Holden and Stalnaker 1975a). Young fish utilize lower velocity habitats than adults and are frequently found in backwaters, eddies, side channels, and shallow riffles (Bezzerides and Bestgen 2002).

Limiting Factors: Flannelmouth suckers are not typically found in stream reaches with vast expanses of sand, instead preferring a mix of substrate types including gravel and cobble in river reaches where water is seasonally clear. Widespread hybridization with introduced and expanding populations of white sucker *Catostomus commersoni* or longnose sucker *Catostomus catostomus* appears to be a primary threat. Widespread hybridization of flannelmouth and white sucker in the Yampa River was noted as early 1967 (Holden and Stalnaker 1975b) and continues at present (Prewitt 1977, Douglas and Douglas 2003). Wiltzius (1978) blamed decline of native catostomids in the upper Gunnison River on proliferation of white and longnose suckers. Hybrids of white and flannelmouth suckers (and others) were also noted in the Green River in Lodore Canyon, but the incidence was relatively low at < 10% (Bestgen and Crist 2000). Expanding populations of non-native predaceous fishes may also limit flannelmouth suckers in some reaches. Individuals as large as 35-cm TL have been removed from the digestive tract of northern pike in the Green River in Lodore Canyon and in the Yampa River, and smallmouth bass up to 35-cm TL were noted to consume smaller flannelmouth suckers in the Green River.

mountain sucker *Catostomus platyrhynchus*

Federal Listing Status: None

State Listing Status: Special concern

Records: A total of 27 records were found for mountain sucker in Colorado.

Distribution: Mountain sucker records were from the Gunnison, White, Yampa, and Green River basins, but specimens and records are relatively rare (Smith 1966). No mountain suckers have been detected in the San Juan River Basin; the single recent record of mountain sucker from the Gunnison River drainage in Muddy Creek (U. S. National Museum 356920, 1994, n = 50) has not been verified. Specimens reported by Woodling (1985) from the Colorado River were not mapped. Mountain suckers are typically from smaller, colder, and higher elevation streams than bluehead suckers. The range of the two species historically overlapped in the Green and Yampa rivers in Dinosaur National Monument; recent specimens of mountain sucker are not known from there. We suspect that mountain suckers from larger main stem rivers are sometimes mis-identified as the more commonly expected bluehead sucker.

Status: Perhaps stable but largely unknown. Historical distribution and abundance information limited. Mountain sucker collections deposited in museums prior to 1980 are more common than after that, reflecting more active collecting and museum deposition of specimens. Recent sampling indicates that few mountain suckers exist in the Yampa or Green rivers in Dinosaur National Monument, which may indicate a decline (Bestgen and Crist 2000, KRB pers. obs.), even though Holden and Crist (1981) collected them in the Green River, Lodore Canyon, as recently as 1980. Sampling in the relatively cool and small streams likely to support mountain suckers has been limited.

Notes on Biology: Adult size relatively small for catostomids, to about 25-cm TL. Individuals as small as 10-cm TL are reproductive. Reproduce in spring and perhaps autumn, if have patterns

similar to related Rio Grande sucker *Catostomus plebeius* (Koster 1957, KRB, pers. obs.) and bluehead sucker (Douglas and Douglas 2002). Fecundity unknown. Egg size 2.3 to 2.7 mm in diameter. Larvae were described and illustrated in Snyder and Muth (1988). Similar to bluehead suckers, mountain suckers feed on benthos, scraping primarily algae, detritus, and some invertebrates from rocks. Habitat includes small to large streams that support warm or cool water fish communities. Adults are known to inhabit pools, riffles, and runs in streams, early life stages have been observed in low velocity channel margins of streams.

Limiting Factors: Limiting factors are unknown, ecology and life history of this species is poorly understood. Hauser (1969) described aspects of life history of mountain sucker in Montana.

Notes: Uncataloged collections of mountain sucker in the LFL collection exist from tributaries in the upper Yampa River drainage.

razorback sucker *Xyrauchen texanus*

Federal Listing Status: Endangered

State Listing Status: Endangered

Records: A total of 332 records were found for razorback sucker in Colorado.

Distribution: Historically occupied large, warm water streams and rivers including the lower portions of the San Juan, Gunnison, Yampa, and White rivers and the main stem Colorado and Green rivers in Colorado and were abundant (Jordan 1891, Ellis 1914, McAda and Wydoski 1980, Platania et al. 1991). This species is presently very rare. In the upper Colorado River Basin, relatively large numbers of adults are found only in the middle Green River, Utah. In Colorado, adults were formerly relatively common in the Colorado River, near Grand Junction,

Colorado, but few wild individuals remain there or in the Yampa and Green rivers, Colorado. Stocking of adults in historical habitat has occurred. A few larvae are occasionally captured in drift-net or light trap sampling in or just below the lower Yampa River, in Dinosaur National Monument, Colorado; records for adults in the upper Green River Basin, Colorado, including the Yampa, White or Green rivers, are relatively rare. Few were collected during the post-rotenone treatment monitoring in the Green River, Colorado, in Dinosaur National Monument (Banks 1964). Although distribution maps depict a relatively widespread post-1979 population, records for most river reaches are represented by only single or a few individuals captured early in that period.

Status: Rare, wild populations continue to decline. Repatriated animals are surviving in portions of the Green River Basin, Utah, but are not yet known to reproduce.

Notes on Biology: Adult size relatively large for catostomids, to nearly 100-cm TL. Individuals as small as 30-cm TL are reproductive, females at age 4, and males at age 3, when juvenile growth rates are high. Reproduce in January through March in Lake Mohave Reservoir, Arizona and Nevada, and April through June in the Green River, Utah (Bozek et al. 1990, Bestgen 1990, Muth et al. 2000). Fecundity is about 50,000 eggs per kg of female body mass. Spawning usually occurs when water temperatures are 10 to 20°C; reproduction occurs in the lower Green River, Utah, prior to or during spring peak runoff, and in the middle Green River, during or just after spring peak run off. Eggs are 2.5 to 3.0 mm in diameter. Larvae described and illustrated in Snyder (1981) and Snyder and Muth (1990) and are 8 to 9-mm TL at hatch. In riverine habitat, larvae drift downstream to flood plain areas if available. Warm, food-rich flood plain habitat thought necessary for fast growth which may enhance recruitment. In lentic situations, larvae occupy near-shore habitat and can be readily captured using lights at night. Regardless of habitat, recruitment failure limits most populations as few juveniles are found in the wild

(Minckley 1983, Bestgen 1990, Gutermuth et al. 1994, Modde et al. 1996, Bestgen et al. 2002). Juveniles were recently discovered in Lake Mead, Arizona and Nevada (Holden et al. 2001). Wild adults are typically very old, in some situations exceeding 40 to 50 years (McCarthy and Minckley 1987). Adults make limited movements to spawning areas in the middle Green River, Utah (Tyus and Karp 1990). Adults are known to inhabit pools, riffles, and runs in streams, early life stages have been observed in low velocity channel margins of streams or in flood plain areas.

Limiting Factors: A main limiting factor for razorback suckers is recruitment failure due to reduced habitat availability for early life stages and predation by non-native fishes. Habitat reduction is due to reduced spring peak flows in regulated river reaches, and to levees constructed to prevent river meandering and flood plain inundation during high flow events. A number of non-native taxa prey upon early life stages of razorback sucker, including fishes, crayfish, and amphibian larvae. Northern pike in the middle Green River, Utah, have consumed razorback suckers that exceeded 25-cm TL (pers. comm. K. Christopherson, Utah Division of Wildlife Resources, Vernal, Utah).

Cottidae

mottled sculpin *Cottus bairdi*

Federal Listing Status: None

State Listing Status: None

Records: A total of 482 records were available for mottled sculpin in Colorado streams.

Distribution: Cold and cool water streams in the upper Colorado River Basin including the San

Juan, Dolores, Gunnison, Colorado, White, Yampa, and Green River drainages. Distribution of mottled sculpin in the Green River downstream of Flaming Gorge Dam, where warm water fishes historically occurred, was likely enhanced because of cold water releases. Reduced post-1979 distribution in the San Juan River Basin may be due to limited collecting efforts or actual decline. More widespread pre-1980 distribution in Colorado may be due to higher sampling effort in cold water streams rather than to a real decline in distribution. No recent specimens of mottled sculpin have been observed in the Yampa River downstream of Hayden, Colorado (F. Pfeifer, J. Hawkins, pers. comm.). Distribution overlaps with Paiute sculpin *Cottus beldingi* in the upper Colorado River drainage in the Colorado and Roaring Fork rivers and Sheephorn and Blacktail creeks.

Status: Perhaps stable, but poorly known. Studies that emphasize distribution and status of cool or cold water fishes such as sculpins have not been conducted. Further, few studies have been conducted that differentiate the two species of sculpins known to occupy Colorado streams.

Notes on Biology: Up to 13.7-cm TL. Spawning occurs from February to June at water temperatures of 7 to 14°C. Adults mature at 5 to 6-cm TL and at age 2. Spawning nest of gravel or cobble constructed by the male usually a cavern, and adhesive eggs are attached to the roof. Up to 354 eggs per nest, which are attended by the male (sometimes a female as well). Fecundity up to 6,219 per female. Eggs 1.5 to 2.1 mm diameter; embryos hatch in 30 days at 10°C. Larvae are 5.9-mm TL at hatching, emerge from substrate 14 d later at 6.7-mm TL to disperse. Occupies lakes and streams. In streams, occupies mostly swift riffles and runs over gravel to boulder-sized substrate. Tolerates relatively warmer water than Paiute sculpin. Sculpins are ambush predators in stream riffles and runs, often supporting themselves on the substrate with their pectoral fins like darters. Consumes mostly aquatic insects, and some fish, including other sculpins, and a few fish eggs.

Limiting Factors: Ecology and life history of this species is poorly understood in Colorado. In general, sculpins prefer and may require relatively clear, cool or cold, and silt-free water in order to spawn successfully. Thus, distribution and abundance of mottled sculpin may be limited by many of the same factors that affect habitat of cutthroat trout including logging, clear-cutting, and other factors that promote excess siltation of streams. Several streams in the Eagle River drainage are impacted by high levels of heavy metals from mine drainage that have reduced or eliminated aquatic life, including sculpins. Salmonids in most streams prey upon sculpins; in the Green River in Lodore Canyon, individual channel catfish have regurgitated up to three mottled sculpins.

Paiute sculpin *Cottus beldingi*

Federal Listing Status: None

State Listing Status: None

Records: A total of 42 records were found for Paiute sculpin.

Distribution: Cold water streams in the upper Colorado River Basin including the Colorado, Frasier, Roaring Fork, and Eagle River drainages. Distribution overlaps with mottled sculpin in the upper Colorado River drainage in the Colorado and Roaring Fork rivers and Sheephorn and Blacktail creeks. A single literature record and a single museum record is available for Paiute sculpin in the Gunnison River Basin (Wiltzius 1978), but the specimens were not examined. Post-1979 records from Bear Creek in the upper Dolores River drainage (U. S. National Museum) and Wolf Creek in the upper San Juan River drainage need to be verified. The first author has examined several specimens from the Eagle River drainage. These are not part of the database presented here because they have not been cataloged into the LFL museum holdings.

Few other post-1979 specimens were available for Paiute sculpin; specimens recorded in the upper Dolores and San Juan River drainages are of questionable identity and should be examined.

Status: Perhaps stable but poorly known. Studies that emphasize distribution and status of cool or cold water species such as sculpins have not been emphasized in the past. Further, few studies have been conducted that differentiate the two species of sculpins known to occupy Colorado streams.

Notes on Biology: Adults small, to 12 or 13-cm TL. Individuals 5 to 6-cm TL mature at age 2. Spawns in May or June; eggs deposited in a nest constructed and defended by the male. Fecundity low at 11 to 387; 100 to 200 eggs found per nest. Larvae drift at night. Found in both lakes and streams; common in Lake Tahoe and at great depths. Found in cold, clear mountain streams in riffle habitat with cobble and gravel substrate; not found in warm streams. In streams, sculpins occupy benthic positions where it is an ambush predator. Consumes immature stages of aquatic insects, other invertebrates, and sometimes small fishes and fish eggs. Is a primary food of lake trout in Lake Tahoe and trout in streams. Sometimes very abundant, exceeding $6/m^2$ in streams.

Limiting Factors: Ecology and life history of this species in Colorado is poorly studied. Sculpins prefer and may require relatively clear, cool, silt-free water in order to spawn successfully. Thus, distribution and abundance of Paiute sculpin may be limited by many of the same factors that affect habitat of cutthroat trout including logging, clear-cutting, and other factors that promote excess siltation of streams. Several streams in the Eagle River drainage are impacted by high levels of heavy metals from mine drainage that have reduced or eliminated or aquatic life. Most salmonid fishes are known to prey upon Paiute sculpins where they co-occur.

Notes: Putative Paiute sculpin specimens examined from Colorado appear consistent with the original description and taxonomic characteristics of known Paiute sculpin. Identifying characteristics include the presence of a single pre-opercular spine and a complete lateral line, and absence of palatine teeth. Specimens considered Paiute sculpin from the upper Colorado River Basin, Colorado, were originally described as Eagle River sculpin *Cottus annae* (Jordan 1891). Bailey and Bond (1963) synonomized *C. annae* with *C. beldingi* without comment, apparently based on similarity of taxonomic characteristics of the two taxa. The next nearest population of Paiute sculpin occurs in the upper Snake River drainage, Wyoming, and none have been reported from intervening drainages in the Colorado River Basin such as the Green River drainage (Green, Yampa, and White rivers and their tributaries). The disjunct distribution of this species and lack of a broad-based comparative study of *C. beldingi* suggest that morphological and genetic research to verify the taxonomic status of Paiute sculpins in Colorado may be warranted. A status survey to determine the distribution and abundance of this species in Colorado may also be warranted.

DISCUSSION AND RECOMMENDATIONS

Efforts undertaken here to determine status of native fishes in Colorado River Basin, Colorado, met with mixed success. Distribution and status of federally listed Colorado pikeminnow, bonytail, humpback chub, and razorback sucker are understood reasonably well and management plans for their conservation have been formulated under the inter-agency efforts of the Upper Colorado River Endangered Fishes Recovery Program (USFWS 2002). Status of native Colorado River cutthroat trout in Colorado is also relatively well-understood and

plans have been formulated for their management. Thus, no recommendations for further research are presented for those species.

Distribution and status of the eight remaining native fishes in the Colorado River Basin, Colorado, are less well understood. The ability of this analysis to detect trends in status for some of those species was limited for two reasons. First, historical and recent records for many fishes are simply too few to make more than speculative statements about changes in distribution. A second and correlated reason is that recent changes in habitat quality or introduction of non-native fishes may be effecting changes in distribution of fishes at a rate that renders information about species distributions available since 1980 (most prior to 1990) mostly obsolete. These factors are especially pertinent in upstream cool and cold water reaches, where large areas of apparently suitable habitat have been poorly surveyed. Unfortunately, it appears that in some reaches where historical and recent distribution patterns were known, reductions in native fishes have already occurred. Examples include reductions in roundtail chub, flannelmouth sucker, and bluehead sucker in the upper portions of the Gunnison and Green River basins (Bezzerides and Bestgen 2002).

Research associated with federally listed species has provided some level of information for non-listed native fishes, but only in warm water reaches where most of that sampling is conducted. Furthermore, recent research on federally listed taxa has become more specialized such that broader fish community sampling is not usually conducted. As a result, research on endangered fishes may not provide as much information on other native species in the future. Therefore, it seems important to systematically assess distribution patterns and present status of native fishes in all west slope streams, including warm, cool, and cold water reaches, by conducting widespread and comprehensive survey sampling in the near future. More

contemporary distribution and status information would allow managers to identify populations or species in need of conservation actions, and would also identify strong populations in reaches that should receive priority for protection.

Collection of key environmental data associated with broad survey sampling would also allow managers to understand factors that may limit distribution of native fishes. For example, understanding upstream or downstream distributional limits of some species related to seasonal temperature patterns would allow a greater understanding of available habitat. Correlation of environmental data with distribution patterns of species such as native flannelmouth sucker and introduced white sucker, may offer clues to the potential negative effects of the latter species.

Reductions in distribution of some native taxa seem associated with specific factors and suggest future research and management activities that may be useful for conservation. For example, reductions in the distribution of native bluehead and flannelmouth suckers in Colorado seem closely linked with proliferation of introduced white sucker. This is apparently an issue in Wyoming as well, as many populations of native suckers are being replaced by white suckers (Bezzerides and Bestgen 2002). The exact mechanism for replacement by white suckers is uncertain, but hybridization seems to have played a major role in some reaches. Determining the extent of hybridization in existing populations and associated environmental factors may aid managers in understanding the future extent of hybridization. For example, warmer downstream reaches of Lodore Canyon seem to support fewer white suckers, and fewer white sucker hybrids, than cooler upstream reaches. Perhaps the thermal gradient limits abundance of white suckers in downstream areas. A similar pattern may exist in the Yampa River (Holden and Stalnaker 1975b, Prewitt 1977, Douglas and Douglas 2003), because white suckers and their hybrids have been common for many years in relatively cool upstream reaches but are more rare in warmer downstream reaches where flannelmouth suckers can still be found (Anderson and Stewart

2000). It would also be useful to understand if certain flow or habitat conditions are more conducive to hybridization among native suckers and white sucker than others.

Reduced distribution and abundance of flannelmouth and bluehead suckers, roundtail chub, and speckled dace in some river reaches is also associated with increased abundance of predaceous non-native fishes (Anderson and Stewart 2000). Ongoing research to assess effects of removal of non-native predators in the Yampa River should receive continued support. Response of native fishes to expanding populations of smallmouth bass in the Colorado River should also be assessed. A reasonable first step would be to obtain detailed distribution and abundance information for native fishes in that system so effects could be monitored. If negative effects were demonstrated over time, then support for programs to reduce distribution and abundance of smallmouth bass or other predators would be easier to obtain.

Specific limiting factors research for mountain sucker and the two sculpin species is difficult to recommend because so little is known about their distribution, ecology, and life history. Therefore, a first task may be relatively simple but well-designed distribution and status surveys. Collection of some associated water quality data may be important to understand distribution patterns because some cold, high-elevation streams are adversely impacted by heavy metals and other pollutants.

Associated with distribution surveys should be a study to ensure that what is presently called Paiute sculpin in the state of Colorado is in fact that species. This should be first accomplished with a comparative morphological study with Paiute sculpins across their range and in Colorado. Understanding morphological variation of the species would be useful for future biologists who study the distribution, ecology, and status of sculpins in Colorado. A morphological study could be followed with a genetics assessment if ambiguity remains. Other

interesting research could also be conducted on habitat use and comparative life history of the two sculpin species where they co-exist. Such research may have management implications if putative Paiute sculpin is rare and changes in environmental factors favor expanded distribution of the more widespread mottled sculpin.

Finally, additional data sources regarding fish distributions in Colorado likely exist. These may include undiscovered reports or museum records, and unpublished field survey data from files of fish managers in Colorado. As with any fish distribution records, the accuracy of taxonomic identifications of difficult-to identify taxa should be considered. To this end, surveys conducted should preserve voucher specimens so the veracity of species identifications can be established. Similarly, museum specimens of questionable identity should be verified.

ACKNOWLEDGMENTS

The Colorado Division of Wildlife (CDOW) supported this research through contract CSU-740-01. We thank T. Nesler (CDOW) for his primary organizational and administrative role and his patience. J. Nusbaum, J. Sholts, C. Morales, and R. Robinette of Colorado State University (CSU) provided administrative support. R. Compton of CSU and N. Bezzerides assisted with laboratory work. We also recognize previous investigators whose work set an important baseline of information upon which status determinations were made. This is Larval Fish Laboratory Contribution 141.

LITERATURE CITED

Anderson, R. M. 1997. An evaluation of fish community structure and habitat potential for Colorado squawfish and razorback sucker in the unoccupied reach (Palisade to Rifle) of the Colorado River, 1993-1995. Final Report to the Colorado River Recovery Implementation Program. Project No. 18. Colorado Division of Wildlife, Fort Collins, Colorado. 73p.

Anderson, R., and G. Stewart. 2000. Riverine fish flow investigations. Federal Aid Project F-289-R3. Colorado Division of Wildlife, Fort Collins, CO. 96p.

Bailey, R. M., and C. E. Bond. 1963. Four new species of freshwater sculpins, genus *Cottus*, from western North America. Occasional Papers of the Museum of Zoology, University of Michigan 634:1-27.

Banks, J. L. 1964. Fish species distribution in Dinosaur National Monument during 1961 and 1962. Master's thesis, Colorado State University, Ft. Collins, Colorado. 99p.

Baxter, G. T.,and M. D. Stone. 1995. Fishes of Wyoming. Wyoming Fish and Game Department. 290p.

Behnke, R. J. 1992. Native trout of western North America. Monograph 6, American Fisheries Society, Bethesda, Maryland.

Behnke, R. J., and D. E. Benson. 1983. Endangered and threatened fishes of the upper Colorado River basin. Colorado State University Cooperative Extension Service Bulletin 503A.

Berg, L. N., A. W. Gustaveson, and D. L. Archer. 1995. Fish population trends at Lake Powell determined by annual gill netting and electrofishing during the 1990-1994 period. Sport Fish Restoration Act Project, F-46-R, Publication No. 95-23, Utah Department of Natural Resources. 45p.

Bestgen, K. R. 1985. Distribution, biology and status of the roundtail chub, *Gila robusta*, in the Gila River Basin, New Mexico. M.S. Thesis, Colorado State University, Ft. Collins, Colorado. 104p.

Bestgen, K. R. 1990. Status review of the razorback sucker, *Xyrauchen texanus*. Contribution 44, Colorado State University Larval Fish Lab, Fort Collins, Colorado. 92p.

Bestgen, K. R., and D. L. Propst. 1989. Distribution, status, and notes on the ecology of *Gila robusta* (Cyprinidae) in the Gila River drainage, New Mexico. *The Southwestern Naturalist*, 34(3):402-412.

Bestgen, K. R., and L. W. Crist. 2000. Response of the Green River fish community to construction and re-regulation of Flaming Gorge Dam, 1962-1996. Final Report to Colorado River Recovery Implementation Program, Project Number 40, Larval Fish Laboratory Contribution 109. 74p.

Bestgen, K. R., G. B. Haines, R. Brunson, T. Chart, M. Trammell, G. Birchell, and K. Christopherson. 2002. Status of wild razorback sucker in the Green River Basin, Utah and Colorado, determined from basinwide monitoring and other sampling programs. Final Report submitted to the Recovery Implementation Program for Endangered Fishes in the Upper Colorado River Basin. Larval Fish Laboratory Contribution 126.

Bestgen K. R., and others. 2004 draft. Status of Colorado pikeminnow in the Green River Basin, Utah and Colorado. Draft report to the Upper Colorado River Recovery Program for Endangered Fishes.

Beyers, D. W., C. Sodergren, J. M. Bundy, and K. R. Bestgen. 2001. Habitat use of bluehead sucker, flannelmouth sucker, and roundtail chub in the Colorado River. Contribution 121, Larval Fish Laboratory, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, Colorado. 32p.

Bezzerides, N. and K. R. Bestgen. 2002. Status review of roundtail chub *Gila robustsa*, flannelmouth sucker *Catostomus latipinnis*, and bluehead sucker *Catostomus discobolus* in the Colorado River Basin. Final report submitted to the U. S. Bureau of Reclamation, Salt Lake City, Utah. Larval Fish Laboratory Contribution 118.

Bozek, M. A., L. J. Paulson, and G. R. Wilde. 1990. Effects of ambient Lake Mohave temperatures on development, oxygen consumption, and hatching success of the razorback sucker. *Environmental Biology of Fishes* 27:255–263.

Burdick, B. D. 1995. Ichthyofaunal studies of the Gunnison River, Colorado, 1992-1994. Aspinall Unit Umbrella Studies Recovery Program Project Number 42. Prepared for the Recovery Implementation Program for Endangered Fishes in the Upper Colorado River Basin. U.S. Fish and Wildlife Service, Colorado River Fishery Project, Grand Junction, Colorado. 60p. + appendices.

Carlson, C. A., and R. T. Muth. 1989. Colorado River: lifeline of the American southwest. Pages 220-239 *In:* Proceedings of the international large rivers symposium. D. P. Dodge, editor. Special Publication 106. Canadian Fisheries Aquatic Sciences, Ottawa, Ontario, Canada.

Carlson, C. A., C. G. Prewitt, D. E. Snyder, and E. J. Wick. 1979. Fishes and macroinvertebrates of the White and Yampa Rivers, Colorado. U.S. Bureau of Land Management, *Biological Science Series*, 1:1-276.

Carter, J. G., V. A. Lamarra, and R. J. Ryel. 1986. Drift of larval fishes in the upper Colorado River. *Journal of Freshwater Ecology*, 3(4):567-577.

Chart, T. E. 1987. The initial effect of impoundment on the fish community of the White River, Colorado. Master's thesis, Colorado State University, Ft. Collins, Colorado. 112p.

Chart, T. E., and E. P. Bergersen. 1992. Impact of mainstream impoundment on the distribution and movements of the resident flannelmouth sucker (Catostomidae: *Catostomus latipinnis*) population in the White River, Colorado. *The Southwestern Naturalist*, 37(1):9-15.

Childs, M. R., R. W. Clarkson, and A. T. Robinson. 1998. Resource use by larval and early juvenile native fishes in the Little Colorado River, Grand Canyon, Arizona. *Transactions of the American Fisheries Society*, 127:620-629.

Converse, Y. K, C. P. Hawkins, and R. A. Valdez. 1998a. Habitat relationships of subadult humpback chub in the Colorado River through Grand Canyon: spatial variability and implications of flow regulation. Regulated Rivers 14:267–284.

Douglas, M. R., and M. E. Douglas. 2000. Late season reproduction by big-river catostomidae in Grand Canyon. *Copeia*, 2000(1):238-244.

Douglas, M. R., and M. E. Douglas. 2002. The Little Colorado River sucker: description and comparison. Final Report to Arizona Game and Fish Department, Phoenix, Arizona. Heritage Project: I-98-010.

Douglas, M. R., and M. E. Douglas. 2003. Yampa River hybrid sucker genetic assessment. Unpublished report to the Colorado Division of Wildlife, Fort Collins, Colorado.

Douglas, M. E., and P. C. Marsh. 1998. Population and survival estimates of *Catostomus latipinnis* in Northern Grand Canyon, with distribution and abundance of hybrids with X*rauchen texanus*. *Copeia*, 1998(4):915-925.

Douglas, M. E., W. L. Minckley, and H. M. Tyus. 1989. Qualitative characters, identification of Colorado River chubs (Cyprinidae: Genus *Gila*) and the "Art of Seeing Well". *Copeia*, 1989(3):653-652.

Douglas, M. E., R. R. Miller, and W. L. Minckley. 1998. Multivariate discrimination of Colorado Plateau *Gila* spp.: the "Art of Seeing Well" revisited. *Transactions of the American Fisheries Society*, 127(2):163-173.

Ellis, M. M. 1914. Fishes of Colorado. University of Colorado, Boulder, Colorado. 136p.

Evermann, B. W., and C. Rutter. 1895. The fishes of the Colorado Basin. *U.S. Fish Commision Bulletin*, 14:473-486.

Gorman, O. T., S. C. Leon, and J. M. Seals. 1994. Habitat use by native fishes in the Little Colorado River in the vicinity of the Grand Canyon. Page 15 *In:* Proceedings of the Desert Fishes Council, Volume XXV, 1993 Annual Symposium, 10 to 14 November, Monterrey, Nuevo Leon, Mexico. Dean A. Hendrickson, editor. Desert Fishes Council, Bishop, California.

Gutermuth, F. B., L. D. Lentsch, and K. R. Bestgen. 1994. Collection of age-0 razorback suckers (*Xyrauchen texanus*) in the lower Green River, Utah. *The Southwestern Naturalist* 39:389–391.

Haines, G. B., and H. M. Tyus. 1990. Fish associations and environmental variables in age-0 Colorado squawfish habitats, Green River, Utah. *Journal of Freshwater Ecology*, 5:427-435.

Haines, G. B., D. W. Beyers, and T. Modde. 1998. Estimation of winter survival, movement and dispersal of young Colorado squawfish in the Green River, Utah. Recovery Program Project 36. Contribution 96 of the Larval Fish Laboratory, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, Colorado. 46p.

Haines, G. B., and T. Modde. 2002. Humpback chub monitoring in Yampa Canyon, 1998-2000. Final report to the Upper Colorado River Fish Recovery Program, Project 22a4. U. S. Fish and Wildlife Service, Vernal, Utah.

Hauser, W. J. 1969. Life history of the mountain sucker, *Catostomus platyrhynchus*, in Montana. Transactions of the American Fisheries Society 98:209-215.

Hawkins, J. A., T. Modde, J. E. Bundy. 2001. Ichthyofauna of the Little Snake River, 1995 with notes on movements of humpback chub. Unpublished report to the Recovery Program for Endangered Fish Species in the Upper Colorado River Basin. Colorado State University, Fort Collins. Larval Fish Laboratory Contribution 125.

Hoffnagle, T. L., W. R. Persons, and G. Doster. 1994. Use of backwater areas by juvenile native fishes in the Colorado River, Grand Canyon. Page 33 *In:* Proceedings of the Desert Fishes Council, Volume XXV, 1993 Annual Symposium 10 to 14 November, Universidad Autonoma de Nuevo Leon, Facultad de Ciencias, Monterrey, Nuevo Leon, Mexioc. Edited by Dean Hendrickson. Desert Fishes Council, Bishop, California.

Holden, P. B. 1973. Distribution, abundance and life history of the fishes of the Upper Colorado River Basin. Ph.D. Dissertation, Utah State University, Logan, Utah. 59p.

Holden, P. B., and L. W. Crist. 1981. Documentation of changes in the macroinvertebrate and fish populations in the Green River due to inlet modification of Flaming Gorge Dam. Contract No. 0-07-40-S1357 for Water and Power Resources Service. Bio/West, Inc., Logan, Utah. 128p.

Holden, P. B., and C. B. Stalnaker. 1975a. Distribution and abundance of mainstream fishes of the Middle and Upper Colorado River Basins, 1967-1973. *Transactions of the American Fisheries Society*, 104(2):217-231.

Holden, P. B., and C. B. Stalnaker. 1975b. Distribution of fishes in the Dolores and Yampa River systems of the upper Colorado River basin. *The Southwestern Naturalist*, 19(4):403-412.

Holden, P. B., P. D. Abate, and T. L. Welker. 2001. Razorback sucker studies on Lake Mead, Nevada, 2000-2001 annual report. PR-578-5. Unpublished report by BIOWEST, Inc., Logan Utah.

Hubbs, C. L. 1955. Hybridization between fish species in nature. *Systematic Zoology*, 4:1-20.

Hubbs, C. L., and L. C. Hubbs. 1947. Natural hybrids between two species of *Catostomid* fishes. *Papers of the Michigan Academy of Science, Arts, and Letters*, 31:147- 167.

Hubbs, C. L., and R. R. Miller. 1953. Hybridization in nature between the fish genera *Catostomus* and *Xyrauchen*. *Papers of the Michigan Academy of Science, Arts and Letters*, 38:207-233.

Hubbs, C. L., L. C. Hubbs, and R. E. Johnson. 1943. Hybridization in nature between species of catostomid fishes. *Contr. Lab. Verte. Biology.*, University of Michigan, 22:1-76.

Irving, D. B., and T. Modde. 2000. Home-range fidelity and use of historic habitat by adult Colorado pikeminnow (*Ptychocheilus lucius*) in the White River, Colorado and Utah. *Western North American Naturalist*, 60(1):16-25.

Jordan, D. S. 1891. Report of explorations in Utah and Colorado during the summer of 1889, with an account of fishes found in each of the river basins examined. *Bulletin of the U.S. Fish Commission*, 9:1–40.

Kaeding, L. R., B. D. Burdick, P. A. Shrader, and W. R. Noonan. 1986. Recent capture of a bonytail (*Gila elegans*) and observations on this nearly extinct cyprinid from the Colorado River. *Copeia*, 1986:1021-1023.

Karp, C. A., and H. M. Tyus. 1990. Humpback chub (*Gila cypha*) in the Yampa and Green Rivers, Dinosaur National Monument, with observations on roundtail chub (*Gila robusta*) and other sympatric fishes. *Great Basin Naturalist*, 50(3):257-264.

Kidd, G. 1977. An investigation of endangered and threatened fish species in the Upper Colorado River as related to Bureau of Reclamation projects. Final Report, January 1977, Northwest Fisheries Research, Clifton, Colorado. 37p+appendices.

Kitcheyan, C., and M. Montagne. 2004 draft report. Evaluation of movement, migration, and habitat use by Colorado pikeminnow (*Ptychocheilus lucius*) in a regulated river below Flaming Gorge Dam, Utah. Draft report submitted to the U. S. Park Service, Dinosaur National Monument, Dinosaur, CO, and Central Utah Project. U. S. Fish and Wildlife Service, Vernal, Utah.

Koster, W. J. 1957. Guide to the fishes of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 116p.

Lanigan, S. H., and C. R. Berry, Jr. 1981. Distribution of fishes in the White River, Utah. *The Southwestern Naturalist*, 26(4):389-393.

Maddux, H. R., and W. G. Kepner. 1988. Spawning of bluehead sucker in Kanab Creek, Arizona (Pisces: Catostomidae). *The Southwestern Naturalist*, 33(5):364-365.

Marsh, P. C., and M. E. Douglas. 1997. Predation by introduced fishes on endangered humpback chub and other native species in the Little Colorado River, Arizona. *Transactions of the American Fisheries Society*, 126:343-346.

Marsh, P. C., M. E. Douglas, W. L. Minckley, and R. J. Timmons. 1991. Rediscovery of Colorado squawfish, *Ptychocheilus lucius* (Cyprinidae) in Wyoming. *Copeia* 1991:1091–1092.

Martinez, P. J., T. E. Chart, M. A. Trammel, J. G. Wullschleger, and E. P. Bergersen. 1994. Fish species composition before and after construction of a main stem reservoir on the White River, Colorado. *Environmental Biology of Fishes*, 40:227-239.

McAda, C. W. 1977. Aspects of the life history of three Castostomids native to the Upper Colorado River Basin. Master's thesis, Utah State University, Logan, Utah. 104p.

McAda, C. W. 2002. Subadult and adult Colorado pikeminnow monitoring: summary of results, 1986-2000. Final Report submitted to the Recovery Implementation Program for Endangered Fishes in the Upper Colorado River Basin. U. S. Fish and Wildlife Service, Grand Junction, CO.

McAda, C. W., and R. S. Wydoski. 1980. The razorback sucker, *Xyrauchen texanus*, in the Upper Colorado River Basin, 1974-76. U.S. Fish and Wildlife Service, Department of the Interior, Washington D.C. 15p.

McAda, C. W., and R. S. Wydoski. 1983. Maturity and fecundity of the bluehead sucker, *Catostomus discobolus* (Catostomidae), in the Upper Colorado River Basin, 1975-76. *The Southwestern Naturalist*, 28(1):120-123.

McAda, C. W., and R. S. Wydoski. 1985. Growth and reproduction of the flannelmouth sucker, *Catostomus latipinnis*, in the upper Colorado River basin, 1975-76. *Great Basin Naturalist*, 45:281-286.

McAda, C. W., C. R. Berry, Jr., and C. E. Phillips. 1980. Distribution of fishes in the San Rafael River system of the Upper Colorado River Basin. *The Southwestern Naturalist*, 25(1):41-50.

McCarthy, M. S., and W. L. Minckley. 1987. Age estimation for razorback sucker (Pisces: Catostomidae) from Lake Mohave, Arizona and Nevada. *Journal of the Arizona-Nevada Academy of Sciences* 21:87–97.

McKinney, T., W. R. Persons, and R. S. Rogers. 1999. Ecology of flannelmouth sucker in the Lee's Ferry tailwater, Colorado River, Arizona. *Great Basin Naturalist*, 59(3):259-265.

Minckley, W. L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix, Arizona.

Minckley, W. L. 1983. Status of the razorback sucker, *Xyrauchen texanus* (Abbott), in the lower Colorado River basin. *The Southwestern Naturalist* 28:165–187.

Minckley, W. L., and P. B. Holden. 1980. *Catostomus latipinnis* Baird and Girard, flannelmouth sucker. Page 381 *In:* Atlas of North American Freshwater Fishes. David S. Lee, Carter R. Gilbert. Charles H. Hocutt, Robert E. Jenkins, Don E. McAllister, and Jay R. Stauffer, Jr., editors. 1981. North Carolina State Museum of Natural History. 867p.

Minckley, W. L., and B. D. DeMarais. 2000. Taxonomy of chubs (Teleostei, Cyprinidae, Genus *Gila*) in the American Southwest with comments on conservation. *Copeia*, 2000(1):251-256.

Modde, T., K. P. Burnham, and E. J. Wick. 1996. Population status of the razorback sucker in the middle Green River. *Conservation Biology* 10:110–119.

Muth, R. T. 1990. Ontogeny and taxonomy of humpback chub, bonytail, and roundtail chub larvae and early juveniles. Doctoral Dissertation. Colorado State University, Fort Collins.

Muth, R. T., and D. E. Snyder. 1995. Diets of young Colorado squawfish and other small fish in backwaters of the Green River, Colorado and Utah. *Great Basin Naturalist* 55(2):95-104.

Muth, R. T., L. W. Crist, K. E. LaGory, J. W. Hayse, K. R. Bestgen, T. P. Ryan, J. K. Lyons, R. A. Valdez. 2000. Flow and temperature recommendations for endangered fishes in the Green River downstream of Flaming Gorge Dam. Upper Colorado River Recovery Program Project FG-53.

Platania, S. P., K. R. Bestgen, M. M. Moretti, J. E. Brooks, and D. L. Propst. 1991. Status of Colorado squawfish and razorback sucker in the San Juan River, Colorado New Mexico, and Utah. *The Southwestern Naturalist* 36:147-150.

Prewitt, C. G. 1977. Catostomid fishes of the Yampa and White rivers, Colorado. Masters thesis, Colorado State University, Fort Collins.

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

Scoppettone, G. G. 1988. Growth and longevity of the cui-ui and longevity of other catostomids and cyprinids in western North America. *Transactions of the American Fisheries Society* 117:301-307.

Sigler, W. F., and R. R. Miller. 1963. Fishes of Utah. Utah State Department of Fish and Game, Salt Lake City, Utah. 203p.

Sigler, W. F., and J. W. Sigler. 1996. Fishes of Utah; a natural history. University of Utah Press, Salt Lake City, Utah. 375p.

Simon, J. R. 1951. Wyoming fishes. Wyoming Game and Fish Department Bulletin 4:1–129.

Smith, G. R. 1966. Distribution and evolution of the North American catostomid fishes of the subgenus *Pantosteus*, Genus *Catostomus*. Miscellaneous Publications of the Museum of Zoology, University of Michigan, No. 129. Museum of Zoology, University of Michigan, Ann Arbor, Michigan. 132p.

Snyder, D. E. 1981. Contributions to a guide to the cypriniform fish larvae of the Upper Colorado River system in Colorado. U.S. Bureau of Land Management Biological Sciences Series 3, Denver, Colorado. 81p.

Snyder, D. E., and R. T. Muth. 1988. Description and identification of June, Utah, and mountain sucker larvae and early juveniles. Report to Utah Division of Wildlife Resources, 88-8. Larval Fish Laboratory Contribution 38, Colorado State University, Fort Collins.

Snyder, D. E., and R. T. Muth. 1990. Descriptions and identification of razorback, flannelmouth, white, Utah, bluehead, and mountain sucker larvae and early juveniles. Technical Publication No. 38, Colorado Division of Wildlife. 152p.

Sublette, J. E., M. D. Hatch, and M. Sublette. 1990. The fishes of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 393p.

Suttkus, R. D., and G. H. Clemmer. 1979. Fishes of the Colorado River in Grand Canyon National Park. Pages 599-604 *In:* Proceedings of the First Conference on Scientific Research in the National Parks. Volume II. U.S. Department of the Interior, National Park Service Transactions and Proceedings Series, Number Five.

Tyus, H. M. 1998. Early records of the endangered fish *Gila cypha* Miller from the Yampa River of Colorado with notes on its decline. *Copeia*, 1:190-193.

Tyus, H. M.. 1990. Potadromy and reproduction of Colorado squawfish in the Green River Basin, Utah and Colorado. *Transactions of the American Fisheries Society*, 119:1035-1047.

Tyus, H. M., and C. A. Karp. 1990. Spawning and movement of razorback sucker, *Xrauchen texanus*, in the Green River basin of Colorado and Utah. *The Southwestern Naturalist*, 35(4):427-433.

Valdez, R., P. Mangan, M. McInerny, and R. P. Smith. 1982a. Tributary report: fishery investigations of the Gunnison and Dolores Rivers. Report 2 *In:* Part 2, Colorado River Fishery Project Final Report, Field Investigations, U.S. Fish and WildlifeService, Salt Lake City, Utah.

Valdez, R., P. Mangan, R. Smith, and B. Nilson. 1982b. Upper Colorado River investigation (Rifle, Colorado, to Lake Powell, Utah). Report 4 *In:* Part 2, Colorado River Fishery Project Final Report, Field Investigations, U.S. Fish and Wildlife Service, Salt Lake City, Utah.

Vanicek, C. D., and R. H. Kramer. 1969. Life history of the Colorado Squawfish, *Ptychocheilus lucius*, and the Colorado chub, *Gila robusta*, in the Green River in Dinosaur National Monument, 1964-1966. *Transactions of the American Fisheries Society*, 98(2):193-208.

Vanicek, C. D., R. H. Kramer, and the late D. R. Franklin. 1970. Distribution of Green River fishes in Utah and Colorado following closure of Flaming Gorge Dam. *The Southwestern Naturalist*, 14(3):297-315.

Weiss, S. J. 1993. Spawning, movement and population structure of flannelmouth sucker in the Paria River. M.S. Thesis, University of Arizona, Tucson, Arizona. 153p.

Weiss, S. J., E. O. Otis, and O. E. Maughan. 1998. Spawning ecology of flannelmouth sucker, *Catostomus latipinnis* (Catostomidae), in two small tributaries of the lower Colorado River. *Environmental Biology of Fishes*, 52:419-433.

Wick, E. J., J. A. Hawkins, and T. P. Nesler. 1991. Occurrence of two endangered fishes in the Little Snake River, Colorado. *The Southwestern Naturalist*, 36(2):251-254.

Wiley, R. W. 1978. Trends in fish population, 1963 through 1976- 14 years of gillnetting, Flaming Gorge Reservoir. Fishery Research Report Monograph Series, Wyoming Game and Fish Department, 1:17-29.

Wiltzius, W. J. 1978. Some factors historically affecting the distribution and abundance of fishes in the Gunnison River. Final Report for Fisheries Investigations of the Lower Gunnison River Drainage. Colorado Department of Natural Resources, Division of Wildlife, Ft. Collins, Colorado. 215p.

Woodling, J. 1985. Colorado's little fish. Colorado Division of Wildlife. Denver, CO.

Table 1. Origin and time period of locality records for Colorado River Basin, Colorado, fish records used in this study. The ? symbol indicates records for which the time period was uncertain. A list of museum contacts is in Appendix I.

		Literature			Other museums			Larval Fish Laboratory			TOTAL
common name	scientific name	<1980	=>1980	?	<1980	=>1980	?	<1980	=>1980	?	
Colorado River cutthroat trout	*Oncorhynchus clarki*	0	0	0	99	1217	43	0	0	0	1359
mountain whitefish	*Prosopium williamsoni*	78	37	0	3	0	2	2	11	0	133
humpback chub	*Gila cypha*	47	15	1	4	0	1	2	27	0	97
humpback X roundtail chub	*Gila cypha X Gila robusta*	0	3	0	0	0	0	1	1	0	5
bonytail	*Gila elegans*	31	1	0	3	0	1	0	0	0	36
roundtail chub	*Gila robusta*	199	301	5	64	251	8	232	1703	1	2764
Gila sp.	*Gila* sp.	13	75	2	1	0	0	0	4462	1	4554
Colorado pikeminnow	*Ptychocheilus lucius*	99	115	1	10	0	3	6	1649	0	1883
speckled dace	*Rhinichthys osculus*	179	270	1	54	781	8	215	6595	0	8103
bluehead sucker	*Catostomus discobolus*	236	739	0	52	335	10	440	6016	0	7828
bluehead X white sucker		41	37	0	5	1	0	0	3	0	87
bluehead X flannelmouth sucker		23	54	0	3	0	0	0	8	0	88
bluehead X mountain sucker		0	0	0	2	0	0	0	0	0	2
bluehead X ? sucker		0	0	0	0	0	0	0	1	0	1
flannelmouth sucker	*Catostomus latipinnis*	210	1239	1	77	278	1	464	3306	0	5576
flannelmouth X white sucker		49	58	0	2	0	0	1	6	0	116
flannelmouth X razorback sucker		16	16	0	1	0	0	0	0	0	33
mountain sucker	*Catostomus platyrhynchus*	6	3	0	13	1	3	0	1	0	27
razorback sucker	*Xyrauchen texanus*	63	22	0	14	1	0	0	232	0	332
mottled sculpin	*Cottus bairdi*	57	42	0	77	202	0	50	54	0	482
Paiute sculpin	*Cottus beldingi*	0	0	0	12	29	1	0	0	0	42

Total 33,548

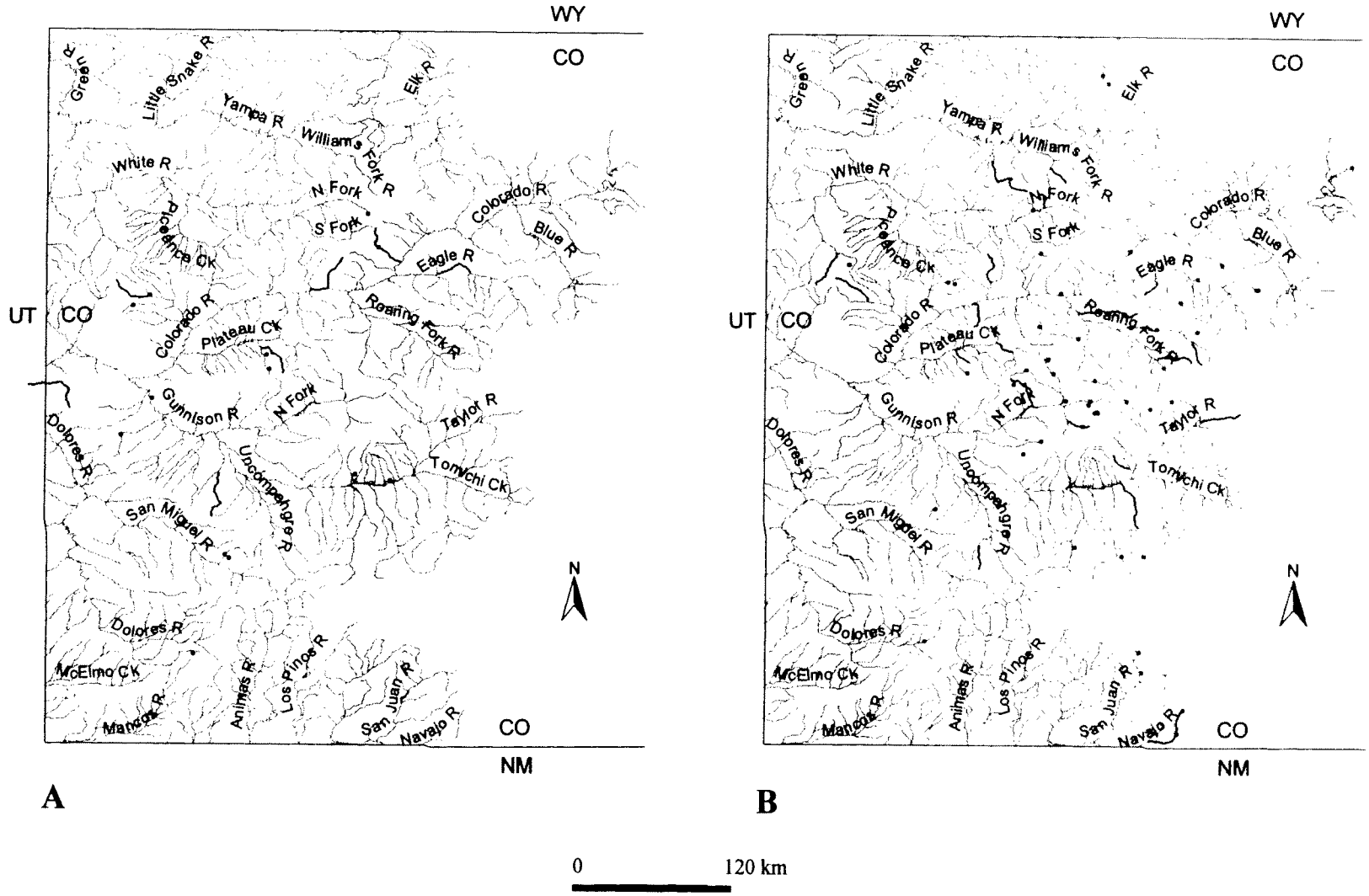

Figure 1. Historical (before 1980, A) and recent (1980 and after, B) distribution of Colorado River cutthroat trout in the Colorado River Basin, Colorado, based on museum and literature records. Heavier distribution lines indicate areas where multiple records exist.

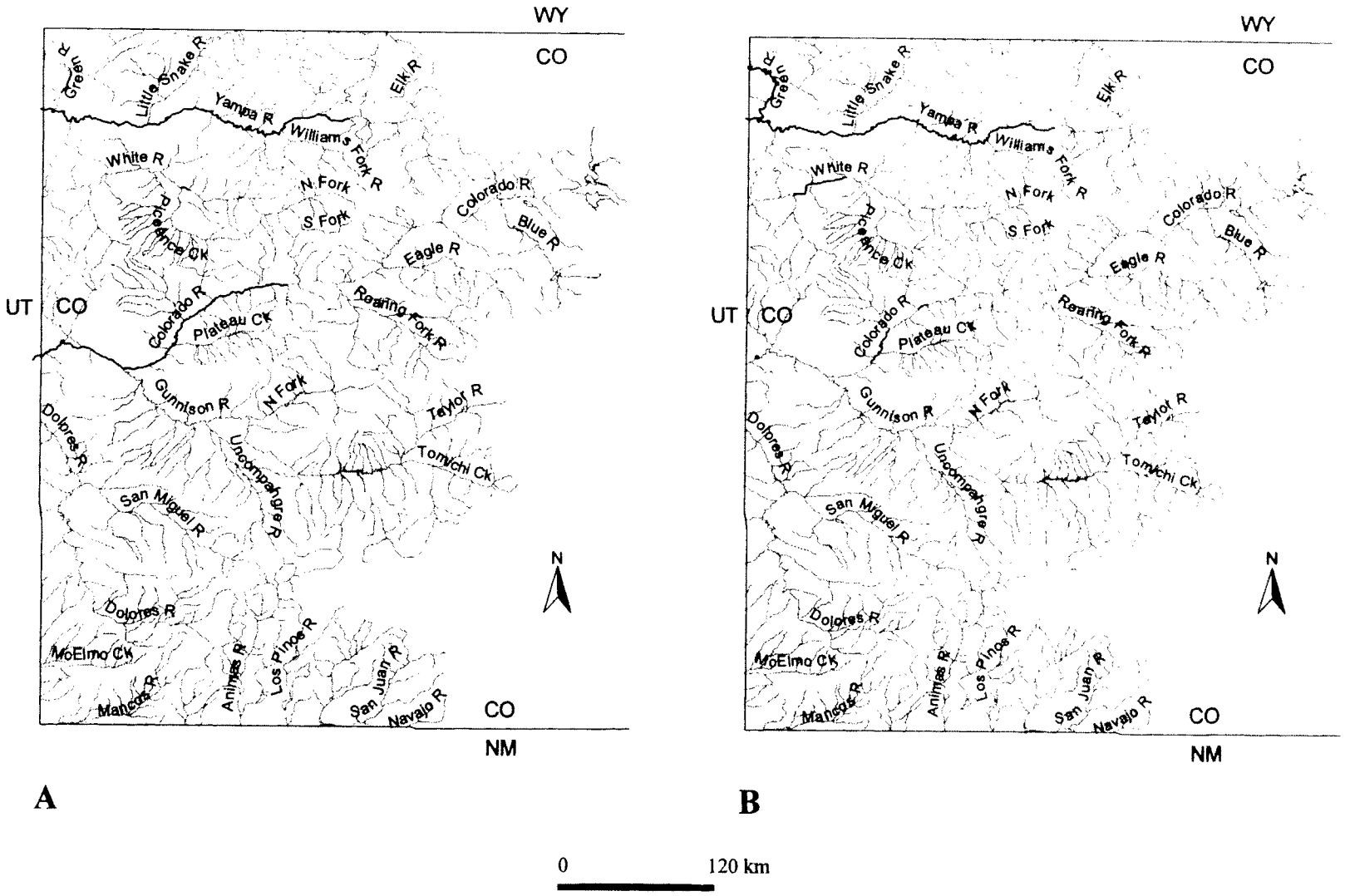

Figure 2. Historical (before 1980, A) and recent (1980 and after, B) distribution of mountain whitefish in the Colorado River Basin, Colorado, based on museum and literature records. Heavier distribution lines indicate areas where multiple records exist.

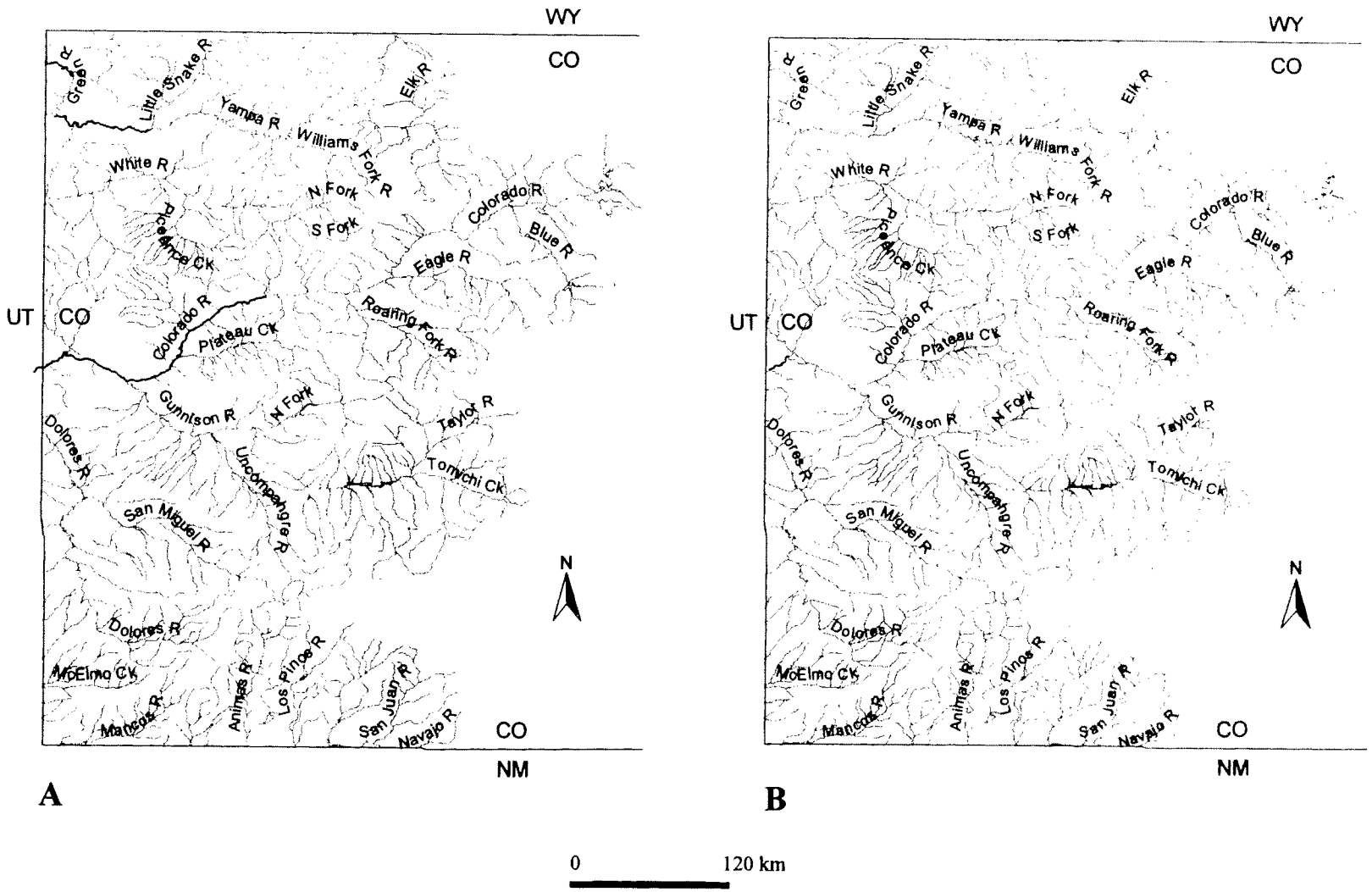

Figure 3. Historical (before 1980, A) and recent (1980 and after, B) distribution of bonytail in the Colorado River Basin, Colorado, based on museum and literature records. Heavier distribution lines indicate areas where multiple records exist.

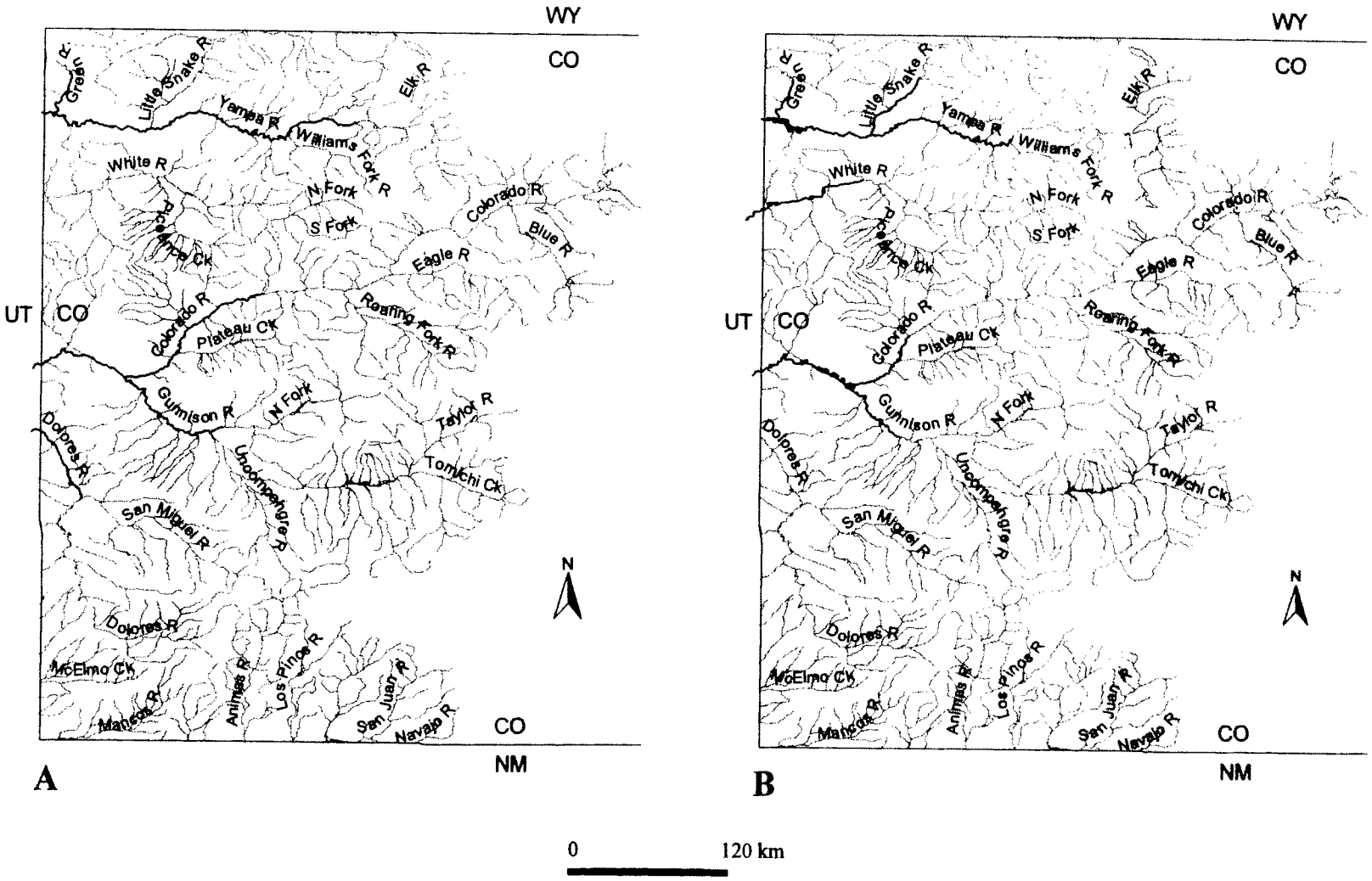

Figure 4. Historical (before 1980, A) and recent (1980 and after, B) distribution of Colorado pikeminnow in the Colorado River Basin, Colorado, based on museum and literature records. Heavier distribution lines indicate areas where multiple records exist.

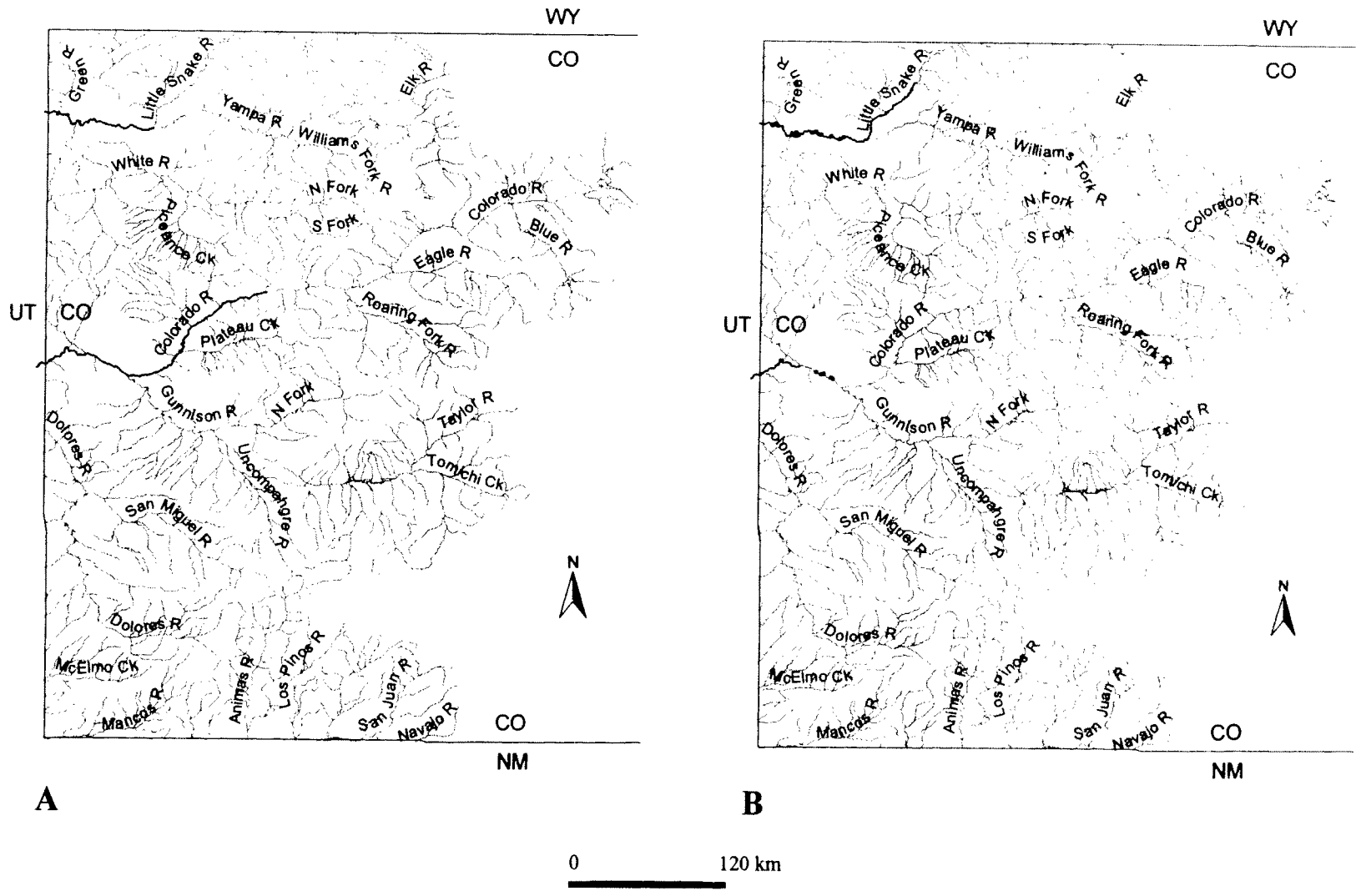

Figure 5. Historical (before 1980, A) and recent (1980 and after, B) distribution of humpback chub in the Colorado River Basin, Colorado, based on museum and literature records. Heavier distribution lines indicate areas where multiple records exist.

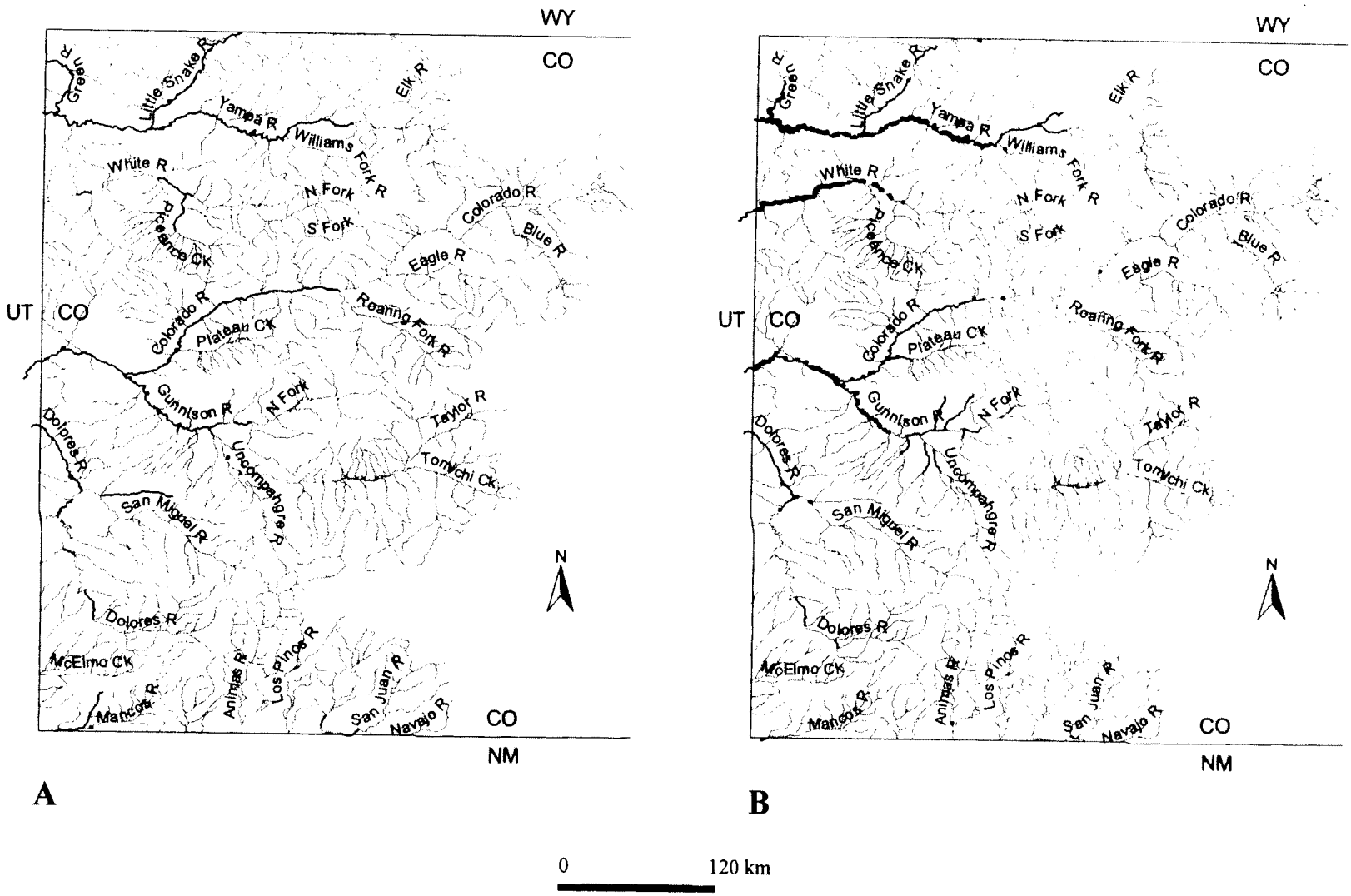

Figure 6. Historical (before 1980, A) and recent (1980 and after, B) distribution of roundtail chub in the Colorado River Basin, Colorado, based on museum and literature records. Heavier distribution lines indicate areas where multiple records exist.

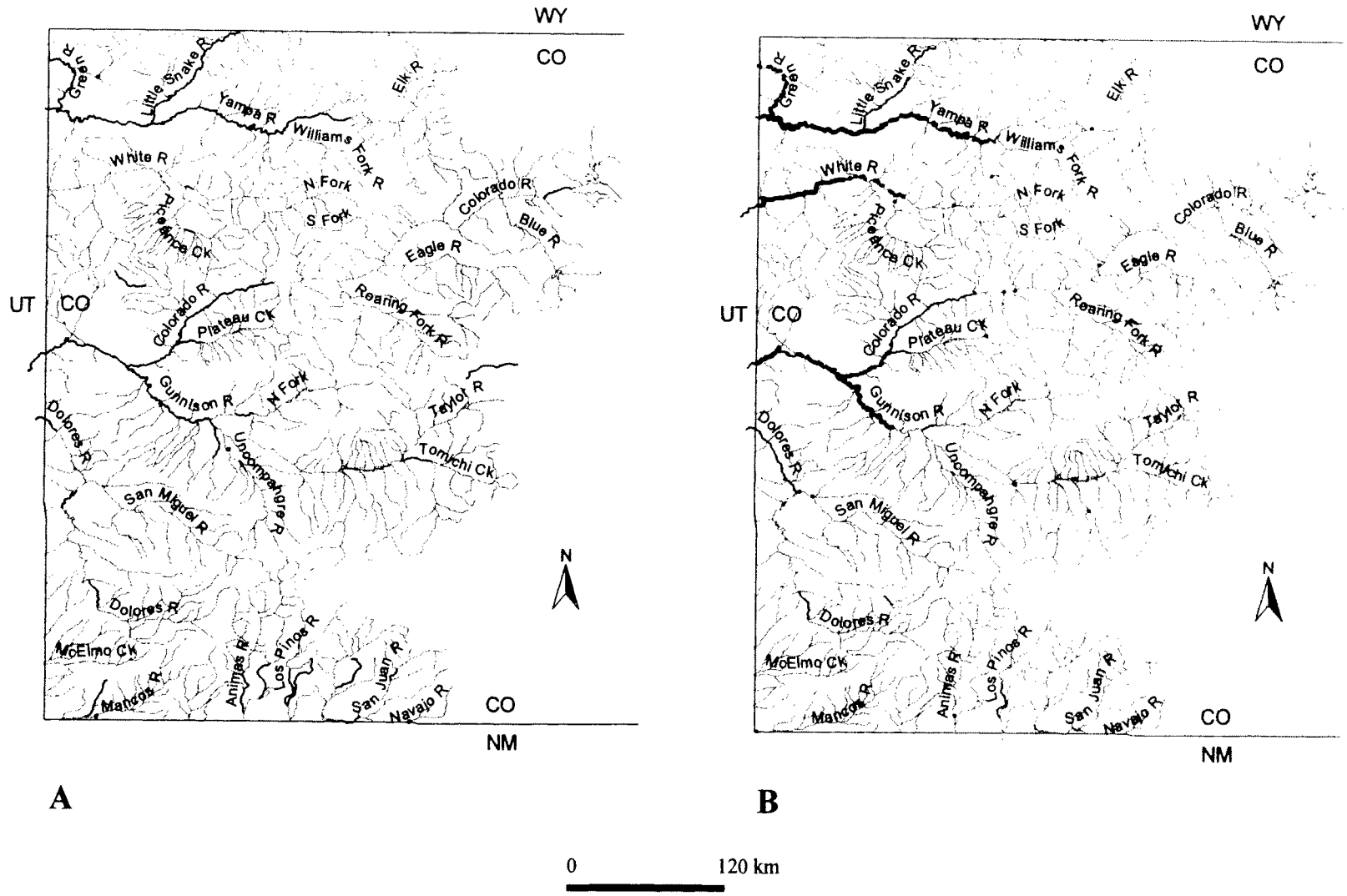

Figure 7. Historical (before 1980, A) and recent (1980 and after, B) distribution of speckled dace in the Colorado River Basin, Colorado, based on museum and literature records. Heavier distribution lines indicate areas where multiple records exist.

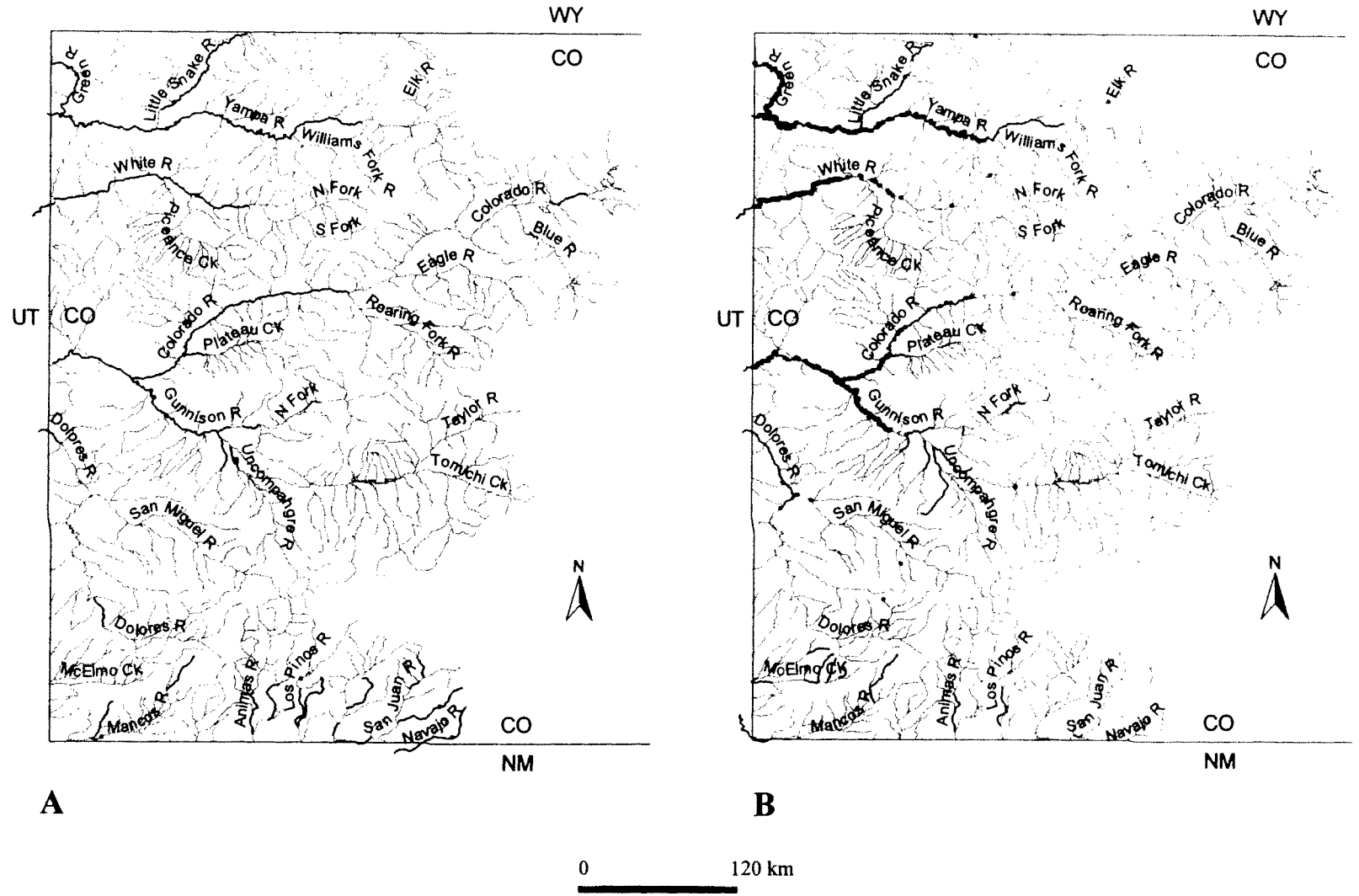

Figure 8. Historical (before 1980, A) and recent (1980 and after, B) distribution of bluehead sucker in the Colorado River Basin, Colorado, based on museum and literature records. Heavier distribution lines indicate areas where multiple records exist.

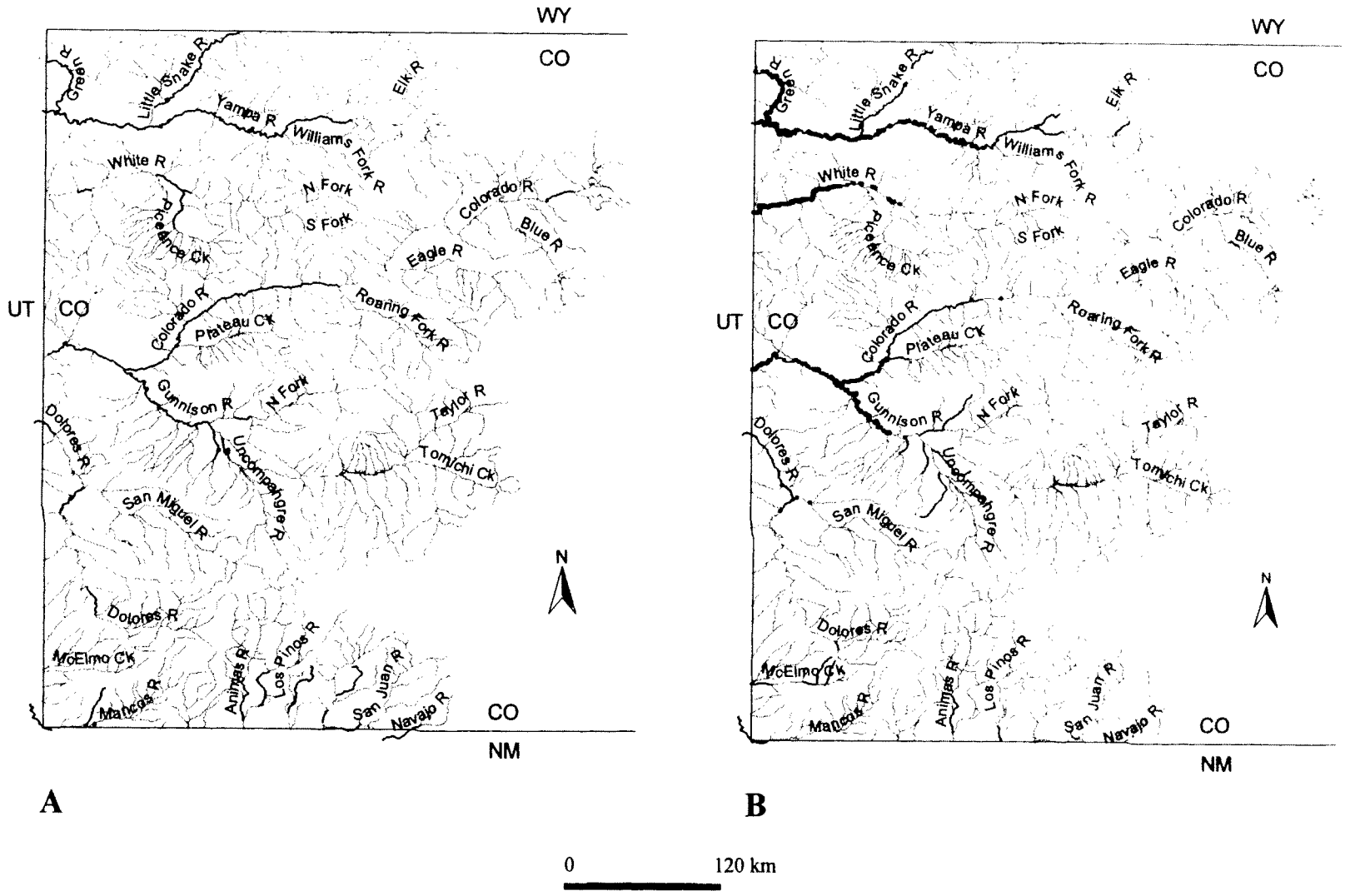

Figure 9. Historical (before 1980, A) and recent (1980 and after, B) distribution of flannelmouth sucker in the Colorado River Basin, Colorado, based on museum and literature records. Heavier distribution lines indicate areas where multiple records exist.

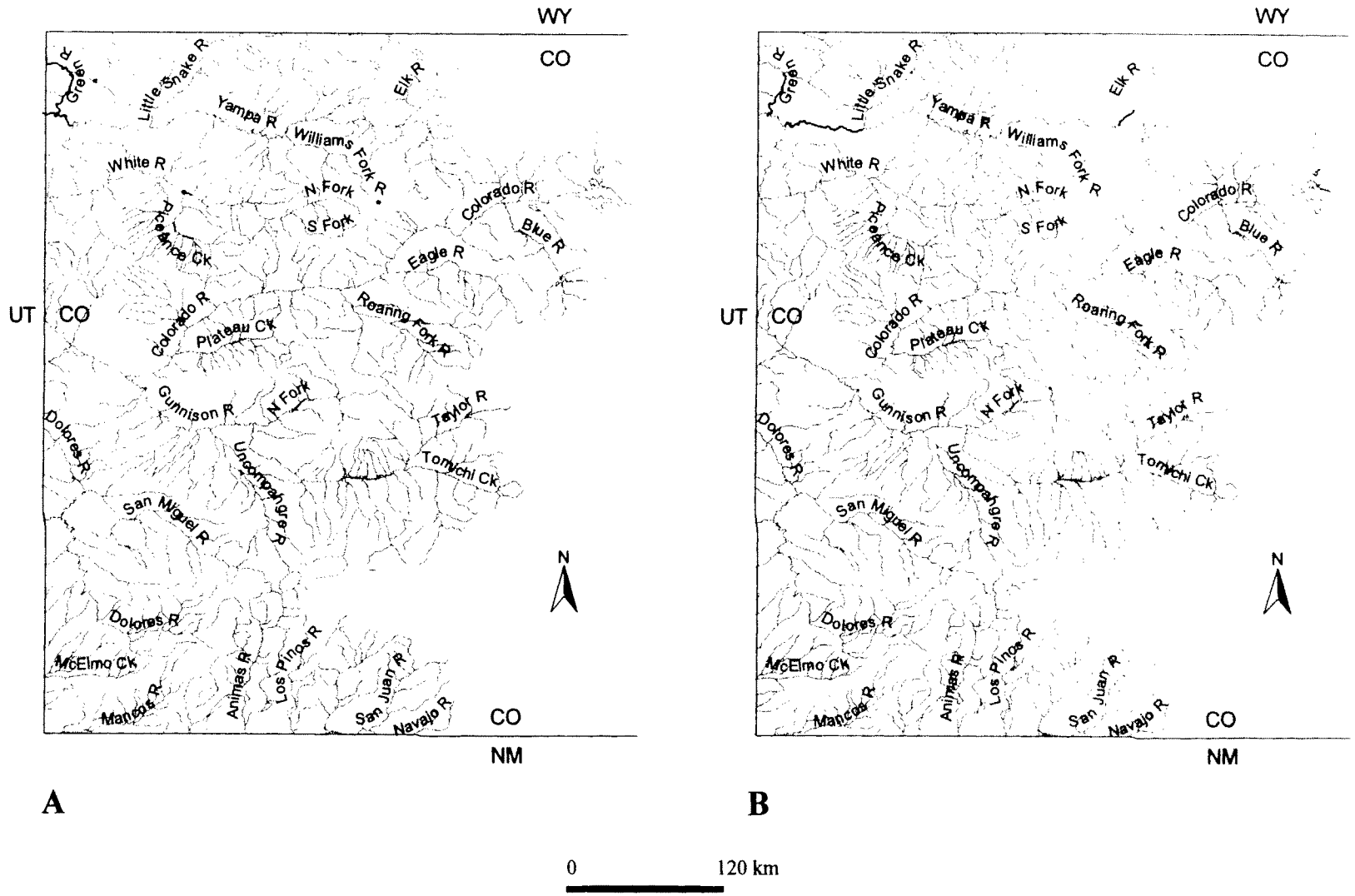

Figure 10. Historical (before 1980, A) and recent (1980 and after, B) distribution of mountain sucker in the Colorado River Basin, Colorado, based on museum and literature records. Heavier distribution lines indicate areas where multiple records exist.

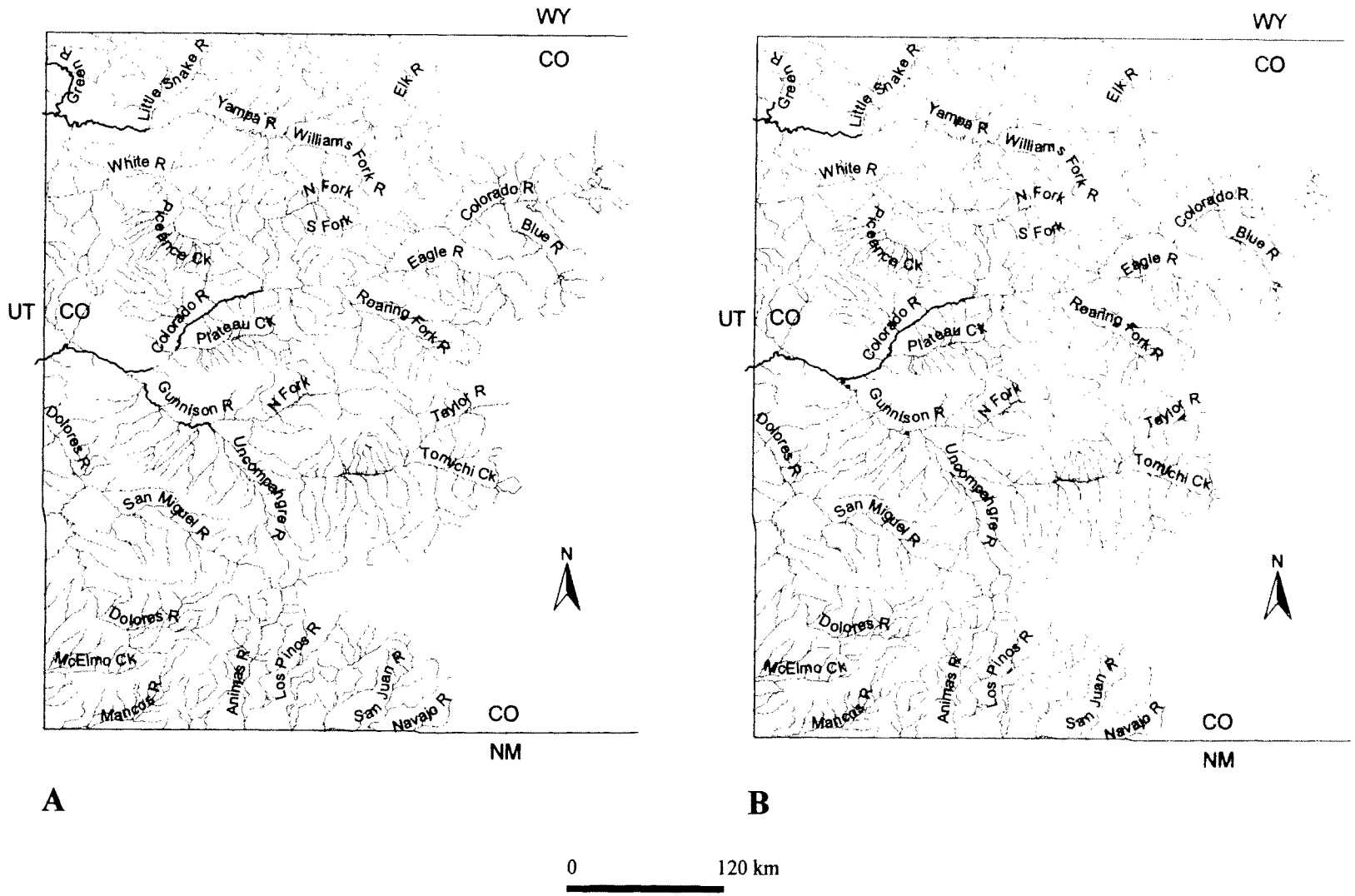

Figure 11. Historical (before 1980, A) and recent (1980 and after, B) distribution of razorback sucker in the Colorado River Basin, Colorado, based on museum and literature records. Heavier distribution lines indicate areas where multiple records exist.

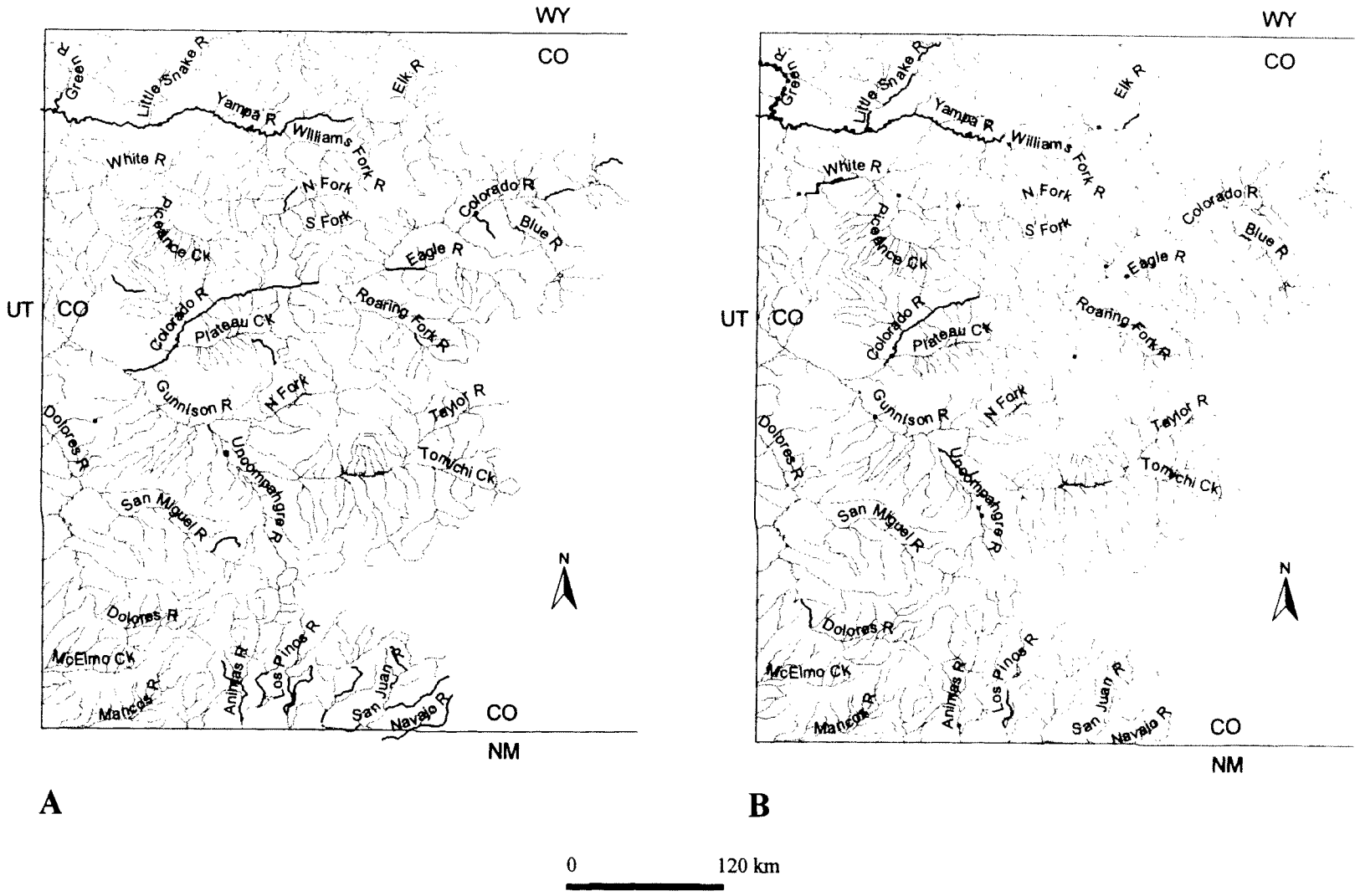

Figure 12. Historical (before 1980, A) and recent (1980 and after, B) distribution of mottled sculpin in the Colorado River Basin, Colorado, based on museum and literature records. Heavier distribution lines indicate areas where multiple records exist.

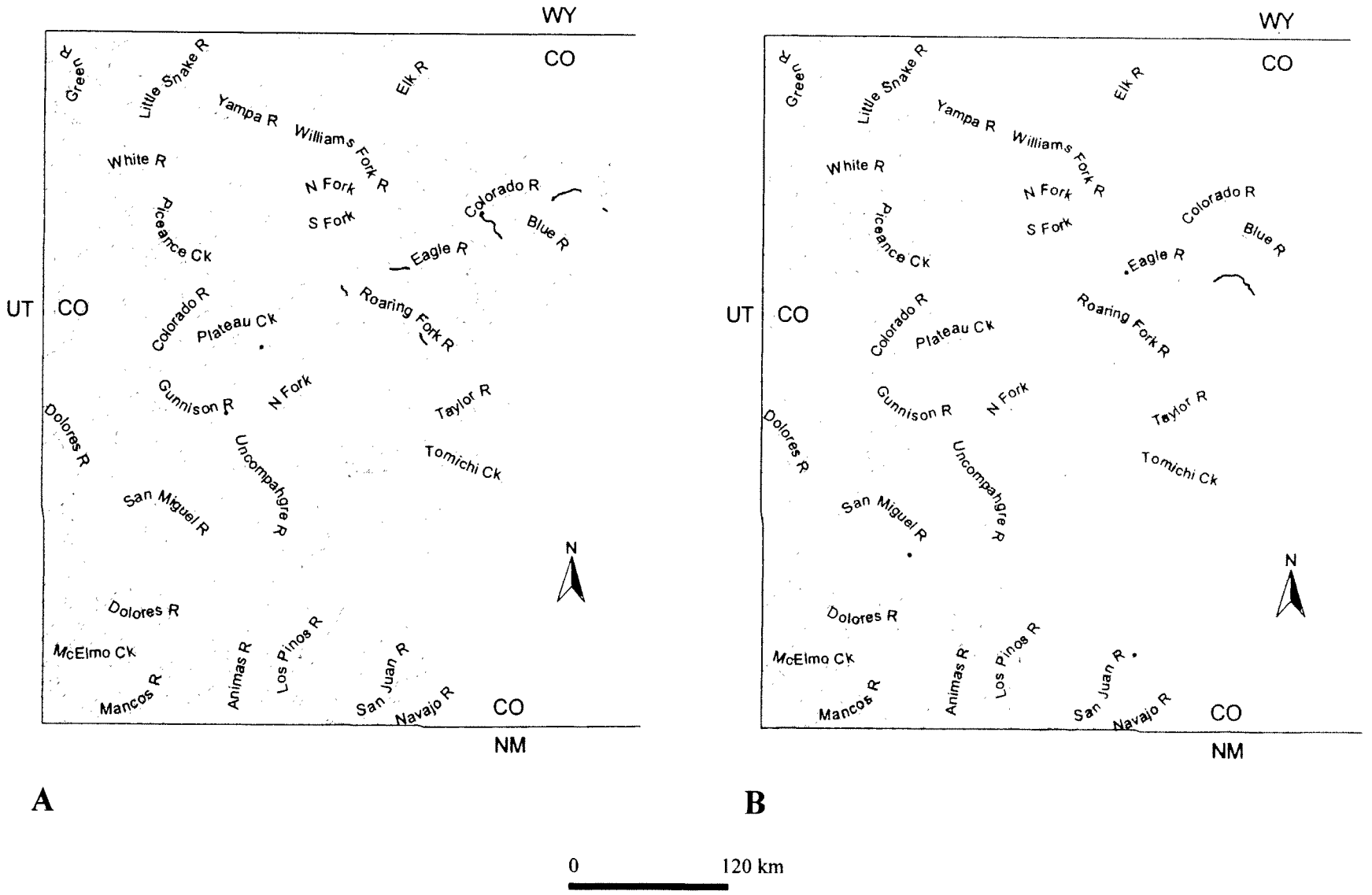

Figure 13. Historical (before 1980, A) and recent (1980 and after, B) distribution of Paiute sculpin in the Colorado River Basin, Colorado, based on museum and literature records. Heavier distribution lines indicate areas where multiple records exist.

APPENDIX I. Museum Contacts

Academy of Natural Sciences, Philadelphia
Mark Sabaj, Collection Manager: sabaj@acnatsci.org

Alabama Museum of Natural History
Bernard R. Kuhajda: bkuhajda@bama.ua.edu

American Museum of Natural History, NYC
Barbara Brown: bbrown@amnh.org

Auburn University Natural History Museum and Learning Center
Jonathan W. Armbruster, Ph.D.: armbrjw@mail.auburn.edu

Bell Museum of Natural History, University of Minnesota
Jay T. Hatch: hatch001@tc.umn.edu

California Academy of Sciences
Jon D. Fong, Senior Collection Manager: jfong@calacademy.org

Conner Museum, Washington State University
Kevin Pullen: connermuseum@wsu.edu

Cornell University Museum of Vertebrates
frogfish@cornell.edu

Dallas Museum of Natural History
Britney Hager: bhager@dmnhnet.org

Eastern New Mexico University
Dr. Marvin M.F. Lutnesky: marv.lutnesky@enmu.edu

Field Museum of Natural History, Chicago
Barry Chernoff, Ph.D. - Associate Curator and Head, Fishes
Mark W. Westneat, Ph.D. - Associate Curator, Fishes
Zoology: (312) 665-7721/ 7754

Florida Museum of Natural History, University of Florida, Gainesville
Rob Robins: rhrobins@flmnh.ufl.edu

Fort Hays State University, Sternberg Museum of Natural History
Mark Eberle: meberle@fhsu.edu

Harvard University, Museum of Comparative Zoology
Karel F. Liem: csouza@oeb.harvard.edu

Appendix I cont.

Humboldt State University
Prof. Ronald A. Fritzsche: raf1@axe.humboldt.edu

Illinois Natural History Survey Fish Collection
Michael Retzer: mretzer@mail.inhs.uiuc.edu

Kansas University, Museum of Natural History
http://nhm.ku.edu/fishes/

Michigan State University Museum
Laura Abraczinskas, abraczi1@msu.edu

Milwaukee Public Museum
Dr. Randy Mooi, Curator: mooi@mpm.edu

Monte L. Bean Life Science Museum, BYU
Shiozawa, Dennis: Dennis_Shiozawa@byu.edu

Museum of Life Sciences, Louisiana State University
Amanda Crnkovic: acrnkov@softdisk.com

Museum of Southwestern Biology, University of New Mexico
Alexandra M. Snyder: amsnyder@unm.edu

National Museum of Natural History, Smithsonian Institution
Jeffrey T. Williams: williams.jeff@nmnh.si.edu

Natural History Museum of LA County
Richard Feeney, collection mgr: rfeeney@nhm.org

New York State Museum, Albany
Robert A. Daniels: rdaniels@mail.nysed.gov

North Carolina Museum of Natural Sciences
Wayne Starnes: Wayne.Starnes@ncmail.net

Ohio State Museum of Biological Diversity
Ted Cavender: cavender.1@osu.edu

Oklahoma Museum of Natural History
William J. Matthews: wmatthews@ou.edu

Sam Houston State University - Vertebrate Collections
Dr. Jerald L. Cook: bio_jlc@shsu.edu

Appendix I cont.

Santa Barbara Museum of Natural History
Paul W. Collins, Senior Associate Curator: pcollins@sbnature2.org

Southern Illinois University at Crbondale, Zoology Collection
Jeffrey Stewart: jstewart@siu.edu

Tulane University Museum of Natural History
Nelson E. Rios: nelson@museum.tulane.edu

University of Arizona, Department of Ecology and Evolutionary Biology
Dr. Peter N. Reinthal: pnr@u.arizona.edu

University of California, Davis
Andrew Engilis, Jr: aengilisjr@ucdavis.edu

University of Colorado Museum, Boulder
Rosanne Humphrey: humphrey@spot.colorado.edu

University of Georgia Museum of Natural History
Freeman, B. J.(Dr.) bud@ttrout.ecology.uga.edu

University of Massachusetts, Museum of Natural History
William E. Bemis: wbemis@bio.umass.edu

University of Michigan, Museum of Zoology
Doug Nelson, collection manager: dwnelson@umich.edu

University of Nebraska State Museum
Patricia W. Freeman: pfreeman1@unl.edu

University of Texas, Texas Natural History Collections
http://chameleon.tnhc.utexas.edu/fish/search.asp

Virginia Institute of Marine Science
Melanie Harbin: mmiller@vims.edu

Yale University, Peabody Museum
http://www.peabody.yale.edu/collections/ich/

Appendix I cont.

Contacts with no fish collection

Mesa SW Museum, AZ
Oakland Museum of CA
Orange Cty NHM
San Diego NHM
Connecticut State MNH
Utah MNH, Salt Lake
MNH and Science, Cincinnati
University of Oregon MNH
MNH Providence
Virginia Tech MNH
Burke MNH and Culture, UW, Seattle
Museum of Vertebrate Zoology, UC Berkeley
Las Cruces MNH
Carnegie MNH, Pittsburgh
James R. Slater MNH, University of Puget Sound
Delaware MNH
University of Iowa Research Collections
Houston Museum of Natural Science