

Fishes in the Middle and Lower Rio Grande Irrigation Systems of New Mexico

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INTRODUCTION

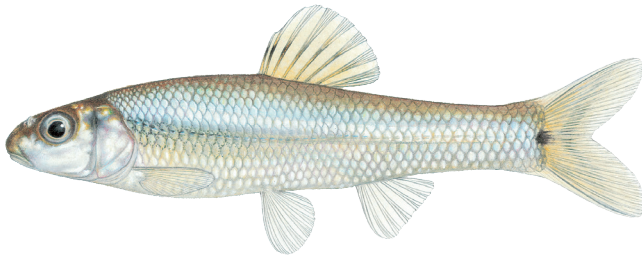
New Mexico and the southwestern United States have been transformed by the construction and widespread development of irrigation systems. Irrigation has allowed agriculture, urban growth, and economic development to flourish

in regions where it would otherwise have been impossible. However, it has also taken a heavy toll on river ecosystems, most of which have been greatly altered and depleted due to dam-flow regulation and water over-extraction. In New Mexico and other arid regions, the water supply in many rivers has been over-allocated for human uses so that, in climatically dry periods, rivers go completely dry while the adjacent irrigation systems may have all the available water.

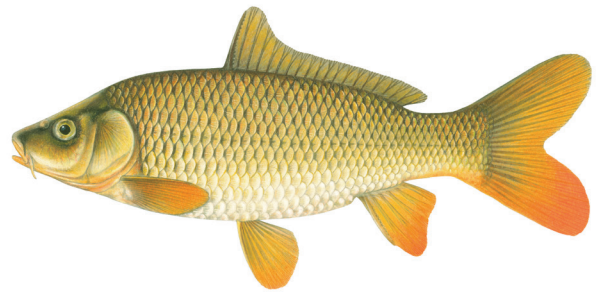
Because the Rio Grande has been highly altered, it has been named as one of the top ten most endangered rivers in the world (Wong et al., 2007). Most of the main river channel has been modified by a series of dams and irrigation diversions, which have altered its flow, discharge, and biodiversity (Sublette et al., 1990; Cowley, 2006; Smith and Fernald, 2006). Irrigation is the primary use of the Rio Grande surface flow throughout the basin. Despite all these modifications to the river, fish continue to persist in the Rio Grande. At least 166 species of fishes have been found in the Rio Grande, of which 86 are freshwater species (Dahm et al., 2005). However, many of the fishes in the Rio Grande today are not native to the river. Many species were introduced purposely for sport fishing by state and federal agencies, or negligently by anglers or aquarium enthusiasts unaware of regulations and of the ecological impacts of their actions. The fishes of the Rio Grande basin were once dominated by a rich minnow assemblage including the federally endangered Rio Grande silvery minnow (see Figure 1). But most of these unique species, along with most of the large-bodied



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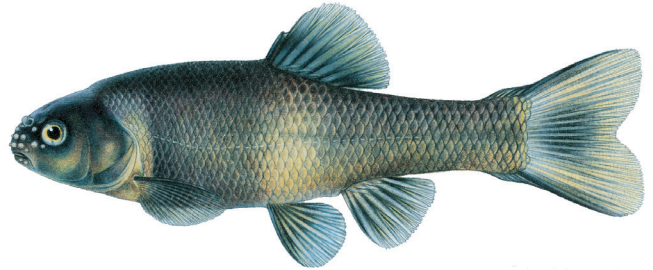
Bullhead minnow



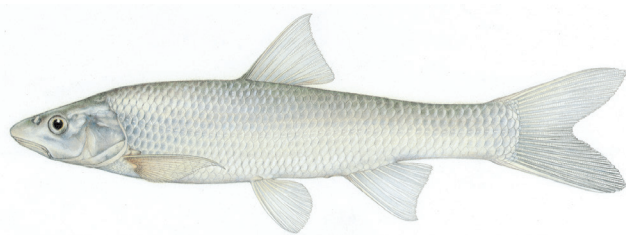
Common carp



Fathead minnow female



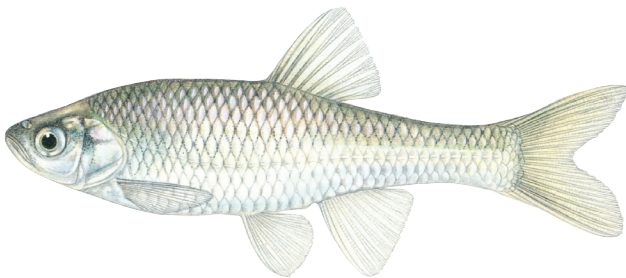
Fathead minnow male



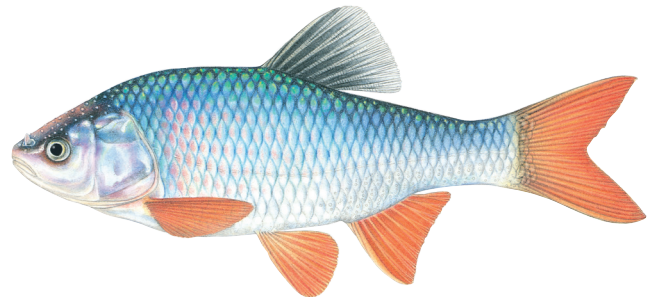
Flathead chub



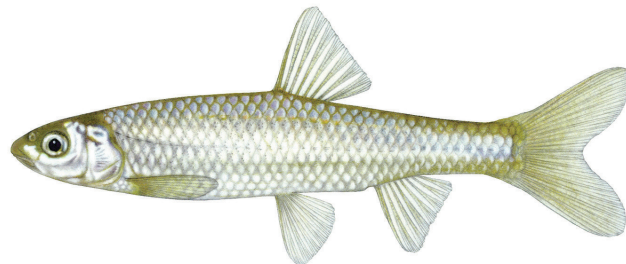
Longnose dace



Red shiner female



Red shiner male



Rio Grande silvery minnow

Figure 1. Native and nonnative minnow species (Cyprinidae) commonly found in the Rio Grande irrigation system. Illustrations provided by Joe Tomelleri (www.americanfishes.com).



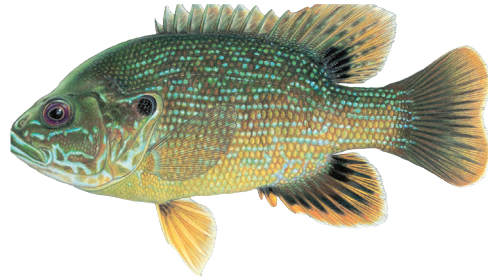
Black crappie



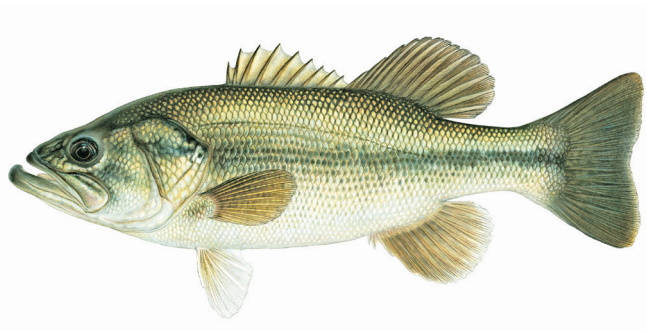
Bluegill



Channel catfish female



Green sunfish



Largemouth bass



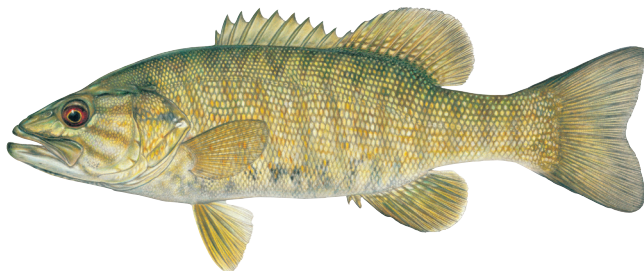
Longear sunfish



Rainbow trout



River carpsucker



Smallmouth bass

Figure 2. Game and other fish species found in the Rio Grande irrigation system. Illustrations provided by Joe Tomelleri (www.americanfishes.com).



Walleye



White crappie male



White sucker



Yellow bullhead

Figure 2 (continued). Game and other fish species found in the Rio Grande irrigation system. Illustrations provided by Joe Tomelleri (www.americanfishes.com).

native fishes, have been eliminated. Of the 27 species of fishes that were historically native to the Rio Grande in New Mexico, only 14 remain (Cowley, 2006). One of the greatest problems for the fishes of the Rio Grande Basin is the dewatering of the river channel, which occurs when the irrigation season coincides with periods of drought. In these circumstances, irrigation canals retain water and can provide refugial habitat for fish during periods when large sections of the river are dry, allowing them to survive until flows are restored to the river.

This circular is the result of fish surveys conducted by the authors. It provides a list of all fish species found in the irrigation canals along the Rio Grande of New Mexico (Figures 1 and 2). The study focused on the lower two-thirds of the river in New Mexico, and divides the area into two regions. The **Middle Rio Grande** lies between Cochiti Dam to the north and Elephant Butte Reservoir to the south. The Middle Rio Grande Conservancy District maintains over 1,200 miles of irrigation ditches and canals (Dumars and Nunn, 1993) that transfer water to and from 70,000 acres of croplands located between Cochiti Dam and the Bosque del Apache National Wildlife Refuge. The

Lower Rio Grande is the segment from Elephant Butte Reservoir to El Paso, Texas. The Lower Rio Grande is largely canalized and serves to deliver irrigation and municipal water from Elephant Butte and Caballo Reservoirs. Elephant Butte Irrigation District is the agency responsible for water deliveries to over 90,000 acres of irrigated land via its extensive network of diversion dams, canals, and drains. The purpose of this circular is to promote a better understanding of how irrigation canals can provide habitat for fishes even when the main river is dewatered. Angling enthusiasts who use these areas for recreational fishing will recognize many of the species mentioned. In addition, the circular suggests ways that irrigation canals could promote conservation of native species while continuing to support municipal and agricultural water uses.

THE IRRIGATION SYSTEMS

The irrigation networks in New Mexico consist of canals with various characteristics. There are many names for these different canal types. A basic nomenclature of canals, consistent with the usage in this guide, along with the purposes of these differ-

Table 1. The Nomenclature of Irrigation Canals in New Mexico		
Canal Type	Other Names in Use	Purpose
Canal	Main canal, lateral, ditch, acequia, acequia madre, conveyance canal	Deliver water from the Rio Grande to water users
Drain canal	Drain, clear ditch	Drain excess water from fields, prevent waterlogging of soils by intercepting shallow groundwater, provide flood protection
Return canal	Wasteway	Return water from the irrigation system to the Rio Grande

ent types of canals, can be seen in Table 1. Some of the names for canals date to Spanish colonial days in New Mexico. Other names, like “wasteway,” convey the commodity nature of water in New Mexico and the lack of social value placed on water in a river ecosystem.

FISHES OF THE RIO GRANDE IRRIGATION SYSTEMS

Fishes of the Middle Rio Grande irrigation system

In 2002, researchers at New Mexico State University, supported by the USDA-funded Rio Grande Basin Initiative, began a survey of fishes in different types of irrigation canals within the Middle Rio Grande Conservancy District, focusing most of the sampling effort on drain canals and return canals (Table 1). These surveys netted a total of 27 fish species, 16 nonnative species and 11 native species (Table 2). The most abundant native species have been fathead minnows (*Pimephales promelas*), red shiners (*Cyprinella lutrensis*), and the endangered Rio Grande silvery minnow (*Hybognathus amurus*). In many individual samples, the Rio Grande silvery minnow has been the most abundant species, making up 35% or more of all fishes. It has been suggested that the Rio Grande silvery minnow is adept at finding irrigation return flows, possibly because water in return canals is cooler than water in the river. The most abundant nonnative species

have been channel catfish (*Ictalurus punctatus*) and largemouth bass (*Micropterus salmoides*)—both fish-eating predators—and white sucker (*Catostomus commersonii*), an invasive species.

The fish assemblage in the canals differs between the irrigation season and the off-season. Native species are in higher abundance during the irrigation season. In contrast, nonnative species, such as largemouth bass, channel catfish, and rainbow trout (*Oncorhynchus mykiss*), are more prevalent during the off-season. The New Mexico Department of Game and Fish stocks rainbow trout frequently during the winter months; their impact on native minnows like the Rio Grande silvery minnow has never been studied.

Fishes of the Lower Rio Grande (Elephant Butte Irrigation District)

The system of ditches and canals making up the Elephant Butte Irrigation District also supports a number of fish species. In a study conducted at NMSU to compare species assemblages between the Lower Rio Grande and its adjacent irrigation system, Carrasco (2010) collected a total of 20 species of fish, of which 9 were native to the Rio Grande and 11 were nonnative. This result is quite remarkable given the annual frequency of drying of large sections of this reach of the Rio Grande during the irrigation off-season. Of the 20 species found, 18 were collected from river sites, 17 were from the drain canals, and 13 were from the canals (Carrasco, 2010; Table 2). The assemblage of fish typical of drain canals included three sunfish species—green sunfish (*Lepomis cyanellus*), longear sunfish (*L. megalotis*), and largemouth bass—along with mosquitofish (*Gambusia affinis*), common carp (*Cyprinus carpio*), and yellow bullhead (*Ameiurus natalis*). The sunfish species were rarely found in the canals or the main river. Carp in particular were found throughout the study area, but appeared in the highest concentrations in drain canals. It should be noted that most of the species inhabiting drain canals are nonnative predatory fish, which is consistent with findings from the Middle Rio Grande irrigation system (Cowley et al., 2007). Carrasco (2010) also found that overall fish diversity was greatest at drain locations closer to the river, and decreased with increasing distance from the Rio Grande.

Table 2. Fishes in Irrigation Systems along the Rio Grande of New Mexico. The Middle Rio Grande (MRG) and the Lower Rio Grande (LRG) are represented. N denotes a native species, X denotes presence. Most sampling in the MRG was in drain and return canals.

Scientific Name	Common Name	Native	MRG	LRG Canals	LRG Dain Canals
Family Clupeidae	Shads				
<i>Dorosoma cepedianum</i>	Gizzard shad	N	X	X	X
<i>Dorosoma petenense</i>	Threadfin shad			X	
Family Cyprinidae	Minnows				
<i>Cyprinella lutrensis</i>	Red shiner	N	X	X	X
<i>Cyprinus carpio</i>	Common carp		X	X	X
<i>Hybognathus amarus</i>	Rio Grande silvery minnow	N	X		
<i>Pimephales promelas</i>	Fathead minnow	N	X	X	X
<i>Pimephales vigilax</i>	Bullhead minnow		X	X	X
<i>Platygobio gracilis</i>	Flathead chub	N	X		
<i>Rhinichthys cataractae</i>	Longnose dace	N	X	X	
Family Catostomidae	Suckers				
<i>Carpiodes carpio</i>	River carpsucker	N	X		X
<i>Catostomus commersonii</i>	White sucker		X		
<i>Catostomus plebeius</i>	Rio Grande sucker	N	X		
Family Ictaluridae	Catfishes				
<i>Ameiurus melas</i>	Black bullhead		X		
<i>Ameiurus natalis</i>	Yellow bullhead			X	X
<i>Ictalurus furcatus</i>	Blue catfish	N	X		
<i>Ictalurus punctatus</i>	Channel catfish		X	X	X
Family Salmonidae	Trouts				
<i>Oncorhynchus mykiss</i>	Rainbow trout		X		
Family Centrarchidae	Sunfishes				
<i>Lepomis macrochirus</i>	Bluegill	N	X		X
<i>Lepomis megalotis</i>	Longear sunfish		X	X	X
<i>Lepomis hybrids</i>	Sunfish hybrids				X
<i>Lepomis cyanellus</i>	Green sunfish		X		X
<i>Micropterus salmoides</i>	Largemouth bass		X		X
<i>Micropterus dolomieu</i>	Smallmouth bass		X		X
<i>Pomoxis annularis</i>	White crappie		X	X	X
<i>Pomoxis nigromaculatus</i>	Black crappie		X		X
Family Percichthyidae	Basses				
<i>Morone chrysops</i>	White bass			X	X
Family Percidae	Perches				
<i>Perca flavescens</i>	Yellow perch		X		
<i>Sander vitreus</i>	Walleye		X	X	X
Family Poeciliidae	Livebearers				
<i>Gambusia affinis</i>	Mosquitofish	N	X	X	X

How can irrigation systems be managed to favor the conservation of native fishes?

Surveys have shown that return canals are significant refuges for fishes during river drying. Studies elsewhere also show that irrigation systems support many aquatic species, including species considered to be “nationally scarce” (Armitage et al., 2003; Poizot et al., 1999; Williams et al., 2004). The Middle Rio Grande Conservancy District has investigated the utility of intentionally “leaking” water out of the irrigation system via the return canals to help provide refugial fish habitat during periods when the river becomes dewatered.

A persistent problem, though, is that nonnative fishes often make up the majority of species present in irrigation canals (May and Brown, 2002; Martin and Saiki, 2005). In the Middle Rio Grande irrigation system, nonnative species such as channel catfish and largemouth bass, along with invasive plants (parrotfeather) and invertebrates (rusty and virile crayfishes), are a serious problem in using drain canals as native fish habitat. Radio telemetry studies of largemouth bass suggest that they are long-term residents of the drain canals (Muldoon, 2007). Native fishes might be favored by allowing smaller fishes to pass through the irrigation system back to the river while using screens to retain larger-sized predators in the irrigation canals. This would have the added benefit of concentrating larger-sized game fishes in these sections of the drain canal and providing focused recreational fishing opportunities. Another potential strategy to favor native fishes would be to limit recreational fish stockings of rainbow trout to areas where fish movement could be controlled. By limiting movement of nonnative predators, native fish species would be given a better chance of surviving their transit through the irrigation system.

Further development of refugial fish habitats at locations where irrigation canals empty into the Rio Grande would also benefit native fishes. The occurrence of Rio Grande silvery minnows in return canals suggests that refugial habitats for this endangered species could be developed at these locations. The Middle Rio Grande Conservancy District developed experimental habitat modifications at three return canal confluences with the Rio Grande (Wesche et al., 2010). Fish sampling at those locations indicated that nonnative fish predators could be a problem in protecting native fishes.

By incorporating strategies to conserve native fishes, water managers could help protect New Mexico’s biodiversity, which has intrinsic as well as economic, cultural, aesthetic, and scientific value. It is hoped that innovative solutions can be found that will protect water users and native fishes, and enable a sustainable coexistence for both in the Rio Grande Valley.

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