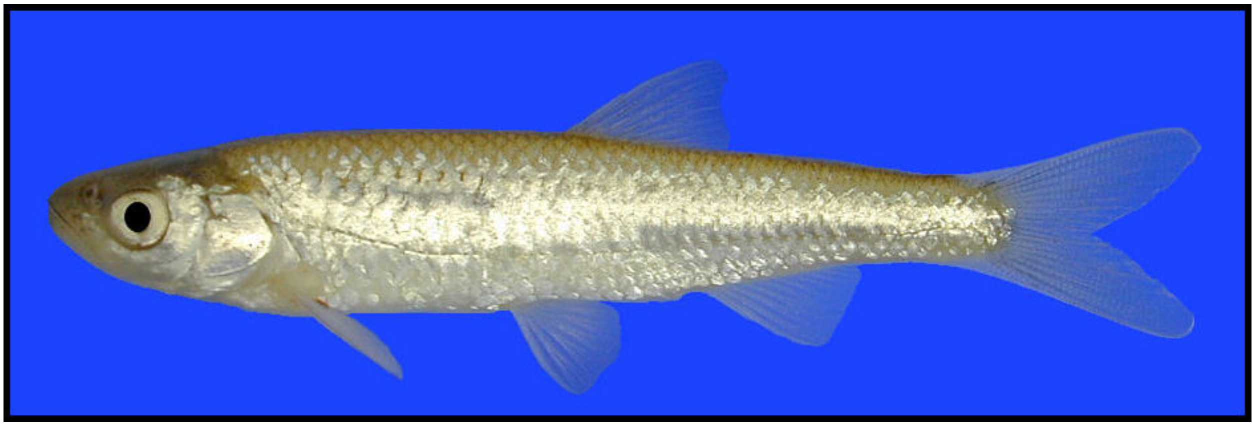
PETITION TO LIST THE
Rio Grande Shiner (*Notropis jemezanus*)
UNDER THE ENDANGERED SPECIES ACT



Rio Grande shiner (*Notropis jemezanus*). Photo: Chad Thomas, Texas State University-San Marcos.

Petition Submitted to the U.S. Secretary of the Interior
Acting through the U.S. Fish and Wildlife Service

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WildEarth
GUARDIANS

INTRODUCTION

WildEarth Guardians (Guardians) respectfully requests that the Secretary of the Interior (Secretary), acting through the U.S. Fish and Wildlife Service (Service) list the Rio Grande shiner (*Notropis jemezanus*) as "threatened" or "endangered" under the U.S. Endangered Species Act (ESA) (16 U.S.C. §§ 1531-1544). Guardians also requests that the Service designate critical habitat for this species and timely develop a recovery plan.

The Rio Grande shiner is a small-bodied freshwater fish endemic to the Rio Grande Basin. The shiner once thrived throughout the Rio Grande and Pecos River in New Mexico, Texas and Mexico, but is now rare. It has been extirpated from much of its range and is imperiled in its few remaining holdouts. For years, the Rio Grande shiner has had a very low population, and population numbers continue to decline. The Rio Grande shiner's habitat and range have been greatly reduced, and based on current and future environmental threats, can be expected to continue shrinking unless the shiner is protected. Habitat loss and degradation are the main reasons the Rio Grande shiner's populations have been and will continue to decline if not protected. Unsustainable water diversions reduce stream flow, dams and diversions alter the historic flow patterns, and dam and levee infrastructure fragment populations. Climate change also exacerbates these threats and further taxes the already-strained rivers.

The heavily altered state of the Rio Grande and Pecos River systems is causing the health of these vital Southwestern rivers to fail. These rivers are no longer able to support the needs of native aquatic species, including the Rio Grande shiner. The shiner is one of six species of pelagic-spawning fish—those that reproduce by releasing eggs and larvae that passively drift downstream for several days until becoming individuals capable of freely navigating the river—that face extreme challenges meeting their basic needs in the ailing Rio Grande and Pecos River.

> The Rio Grande Basin historically supported at least six pelagophils in three genera. Several of these species have declined dramatically throughout their range, resulting in federal protection for Pecos bluntnose shiner, *Notropis simus pecosensis*, (threatened) and Rio Grande silvery minnow, *Hybognathuasm arus*, (endangered). Two additional taxa, phantom shiner, *Notropis orca*, and Rio Grande bluntnose shiner, *Notropis simus simus*, declined in abundance during the 1950s and 1960s and are now extinct (Dudley & Platania 2007, p. 2,083, *internal citations omitted*)

Scientists recommended over a decade ago that "[a]dditional protection may be necessary for other pelagophils within the region in the near future" (Dudley & Platania 2007, p. 2,083). The Rio Grande shiner, like its previously listed pelagic counterparts (the Rio Grande silvery minnow and the Pecos bluntnose shiner), desperately needs the immediate protections of the ESA before the species vanishes forever.

To ensure protection for the Rio Grande shiner, WildEarth Guardians seeks its listing as "endangered" under the ESA. Listing will afford the shiner critical habitat designation, a recovery plan, and the stringent federal protection it needs to survive. As is the intention of the

ESA, designating the Rio Grande shiner as "endangered" would also conserve and provide much needed protections for the aquatic ecosystem upon which the species depends.

ENDANGERED SPECIES ACT AND IMPLEMENTING REGULATIONS

In 1973, Congress enacted the ESA, 16 U.S.C. §§ 1531 et seq., "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such endangered species and threatened species." 16 U.S.C. § 1531(b). The protections of the ESA only apply to species listed as endangered or threatened according to the provisions of the statute. The ESA delegates authority to determine whether a species should be listed as endangered or threatened to the Secretary, who has in turn delegated authority to the Director of the Service. As defined in the ESA, an "endangered" species is one that is "in danger of extinction throughout all or a significant portion of its range." 16 U.S.C. § 1532(6); *see also* 16 U.S.C. § 533(a)(1). A "threatened species" is one that "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." 16 U.S.C. § 1532(20). The Service must evaluate whether a species is threatened or endangered as a result of any of the five listing factors set forth in 16 U.S.C. § 1533(a)(1):

A. The present or threatened destruction, modification, or curtailment of its habitat or range;
B. Overutilization for commercial, recreational, scientific, or educational purposes;
C. Disease or predation;
D. The inadequacy of existing regulatory mechanisms; or
E. Other natural or manmade factors affecting its continued existence.

A taxon need only meet one of the listing criteria outlined in the ESA to qualify for federal listing. 50 C.F.R. § 424.11.

The Service is required to make these listing determinations "*solely* on the basis of the best available scientific and commercial information regarding a species' status." 16 U.S.C. § 1533(b)(1)(A); 50 C.F.R. § 424.11(b). "The obvious purpose of [this requirement] is to ensure that the ESA not be implemented haphazardly, on the basis of speculation or surmise." *Bennett v. Spear*, 117 S.Ct. 1154, 1168 (1997). "Reliance upon the best available scientific data, as opposed to requiring absolute scientific certainty, 'is in keeping with congressional intent' that an agency 'take preventive measures' *before* a species is 'conclusively' headed for extinction." *Ctr. for Biological Diversity v. Lohn*, 296 F.Supp.2d 1223, 1236 (W.D.Wash.2003).

In making a listing determination, the Secretary must give consideration to species which have been "identified as in danger of extinction, or likely to become so within the foreseeable future, by any State agency or by any agency of a foreign nation that is responsible for the conservation of fish or wildlife or plants." 16 U.S.C. § 1533(b)(1)(B)(ii) (*See also* 50 C.F.R. § 424.11(e) stating that the fact that a species has been identified by any State agency as being in danger of extinction may constitute evidence that the species is endangered or threatened). Listing may be done at the initiative of the Secretary or in response to a petition. 16 U.S.C. § 1533(b)(3)(A).

After receiving a petition to list a species, the Secretary is required to determine "whether the petition presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533(b)(3)(A). Such a finding is termed a "90-day finding." A "positive" 90-day finding leads to a status review and a determination whether the species will be listed, to be completed within twelve months. 16 U.S.C. §1533(b)(3)(B). A "negative" initial finding ends the listing process, and the ESA authorizes judicial review of such a finding. 16 U.S.C. § 1533(b)(3)(C)(ii). The applicable regulations define "substantial information," for purposes of consideration of petitions, as "that amount of information that would lead a reasonable person to believe that the measure proposed in the petition may be warranted." 50 C.F.R. § 424.14(b)(1).

The regulations further specify four factors to guide the Service's consideration on whether a particular listing petition provides "substantial" information:

i. Clearly indicates the administrative measure recommended and gives the scientific and any common name of the species involved;
ii. Contains detailed narrative justification for the recommended measure; describing, based on available information, past and present numbers and distribution of the species involved and any threats faced by the species;
iii. Provides information regarding the status of the species over all or significant portion of its range; and
iv. Is accompanied by appropriate supporting documentation in the form of bibliographic references, reprints of pertinent publications, copies of reports or letters from authorities, and maps. 50 C.F.R. § 424.14(b)(2)(i)-(iv).

Both the language of the regulation itself (by setting the "reasonable person" standard for substantial information) and the relevant case law underscore the point that the ESA does not require "conclusive evidence of a high probability of species extinction" in order to support a positive 90-day finding. *Ctr. for Biological Diversity v. Morgenweck*, 351 F.Supp.2d 1137, 1140 (D. Colo. 2004); *see also Moden v. U.S. Fish & Wildlife Serv.*, 281 F.Supp.2d 1193, 1203 (D. Or. 2003) (holding that the substantial information standard is defined in "non-stringent terms"). Rather, the courts have held that the ESA contemplates a "lesser standard by which a petitioner must simply show that the substantial information in the Petition demonstrates that listing of the species *may* be warranted" (emphasis added). *Morgenweck*, 351 F.Supp.2d at 1141 (quoting 16 U.S.C. § 1533(b)(3)(A)); *see also Ctr. for Biological Diversity v. Kempthorne*, No. C 06-04186 WHA, 2007 WL 163244, at *3 (N.D. Cal., Jan. 19, 2007) (holding that in issuing negative 90-day findings for two species of salamander, the Service "once again" erroneously applied "a more stringent standard" than that of the reasonable person).

CLASSIFICATION AND NOMENCLATURE

Common name. The common names for *Notropis jemezanus* are "Rio Grande shiner" or "carpita del bravo" (ITIS 2019, p. 1). We refer to this species as the "Rio Grande shiner" or "shiner" throughout this petition.

Taxonomy. The petitioned species is *Notropis jemezanus*. The full taxonomic classification is shown in Table 1.

Table 1. Taxonomy of *Notropis jemezanus* (ITIS 2019, p. 1).

Kingdom	Animalia
Phylum	Chortata
Class	Actinopterygii
Order	Crypiniformes
Family	Cyprindea
Genus	*Notropis*
Species	*jemezanus*

SPECIES DESCRIPTION

Physical description. The Rio Grande shiner is a small minnow that grows to a maximum length of about 75 mm or 2.95 in (Hendrickson & Cohen 2015, p. 1, *internal citations omitted*). Its coloration has been described as mostly plain silvery, except for a faint dusky band along its sides. More specifically, the shiner's head, back and abdomen are silvery and its sides have a dark lateral stripe with a few dark specks along its abdomen. The shiner's lips may be dusky and the fish may be black around anal fin base and along underside of caudal peduncle. There is also a middorsal stripe behind dorsal fin usually one or two chromatophores wide. The apex of the shiner's chin and narrow anterior portion of its gula are densely covered with melanophores, and its upper jaw is scattered with melanophores (Hendrickson & Cohen 2015, p. 1, *internal citations omitted*).

The shiner is heavier dorsally with a slender body. Its body depth is less than or equal to the head length in adult fish. Its mouth position is terminal and oblique. Its pharyngeal teeth count is as follows: 1-2,4-4,2 or 1-4-4,1 (Hendrickson & Cohen 2015, p. 1, *internal citations omitted*).

Diet. Based on the shiner's simple S-shaped gut, it has a carnivorous-omnivorous diet (Hendrickson & Cohen 2015, p. 3, *internal citations omitted*).

Habitat. The shiner is "characteristic of main channel habitats of wide, open, sand laden rivers with variable flow regimes" (Hoagstrom & Brooks 2005, p. 35, *internal citations omitted*). The shiner inhabits medium and large rivers and only infrequently ascends into small tributaries (*Id., internal citations omitted*).

The Rio Grande shiner is not considered a migratory species (IUCN 2018, p. 5). However, Hoagstrom and Brooks (2005, Table 6) reported low densities of older *N. jemezanus* in downstream river stretches. Because pelagic embryos and larvae displaced downstream, some authors have suggested that adult shiners eventually return upstream to maintain spawning populations, but this hypothesis is untested (Hoagstrom & Brooks 2005, pp. 52-53).

Reproduction. The Rio Grande shiner is a pelagic broadcast spawner (Hoagstrom & Brooks 2005, p. 36; *see also* Hendrickson & Cohen 2015, p. 2). It broadcasts non-adhesive semi-buoyant eggs ranging from 2.9 mm to 3.0 mm (.114-.118 in) in diameter, and spawns in spring and summer (Hendrickson & Cohen 2015, p. 2, *internal citations omitted*). Gravid females have been found from mid-May to late August (NatureServe 2018, p. 4).

After being broadcast, eggs normally hatch within 24 to 48 hours (Hoagstrom & Brooks 2005, p. 36). Early larvae remain pelagic for around 48 to 72 hours, until the swim bladder and fins fully develop (*Id.*). Accordingly, young shiners are highly susceptible to downstream displacement for the 72 to 120 hours post-spawning, a rate that is considered rapid compared to other fishes (*Id.*).

The following spawning patterns were observed in aquaria: a male shiner pursues a single female and nudges her abdominal region, and when the female is ready to spawn, the male wraps himself around her and both eggs and milt are simultaneously expelled (Hendrickson & Cohen 2015, p. 2, *internal citations omitted*). Individual spawning episodes were repeated in aquaria several times during the reproductive process, with at least 10-minute intervals between individual events (*Id.*).

Longevity. In the right conditions, the shiner can live at least two winters (*Id.*, p. 3). Rio Grande shiners, like Rio Grande silvery minnows, have very short lifespans.

Morphologically similar fishes. The emerald shiner (*Notropis atherinoides*) and the sharpnose shiner (*N. oxyryhnchus*), also members of subgenus *Notropis,* occur within closest geographical range of *N. jemezanus*. *N. jemezanus* is similar to *N. atherinoides*, but the Rio Grande shiner has larger, less slanted mouth extending under the eye while *N. atherinoides* has a more slanted mouth reaching to the front of the eye on fairly pointed snout; *N. jemezanus* has smaller eye; deeper snout; and lacks black lips (may be dusky) versus having the front half of lips black in coloration as does *N. atherinoides*; further, *N. jemezanus* has black around the anal fin base and along the underside of the caudle peduncle. Phylogenetic analysis of cytochrome b indicated strong support for sister-group relationship between *N. jemezanus* and the Texas shiner, *N. amabilis*. However, *N. amabilis* differs in having an eye that is distinctly longer than the snout and in having along the sides a dark streak that is separated from the dorsal pigmentation by a clear area (Hendrickson & Cohen 2015, p. 3, *internal citations omitted*).

HABITAT REQUIREMENTS

The Rio Grande shiner is a freshwater fish found only in the Rio Grande drainage (Hoagstrom & Brooks 2005, p. 35). "The Rio Grande drains a bi-national basin that flows through Colorado and New Mexico before reaching Texas at El Paso, from whence it continues south and east to form a 2000-km U.S.–Mexico international border" (Dettinger et al. 2015, p. 2,083). The shiner's habitat includes runs and flowing pools of large open weedless rivers and large creeks with bottoms of rubble, gravel, and sand, often overlain with silt (IUCN 2018, p. 4, *internal citations omitted*). The shiner tends to prefer turbid water (Hendrickson & Cohen 2015, p. 2, *internal citations omitted*).

Studies in the Pecos River, New Mexico, found the shiner primarily selected mesohabitats with low to moderate velocities (backwaters and parallel plunges), in winter selected pools, and in summer selected perpendicular plunge pools. In the Pecos River, studies found age 0-1 fish had highest densities in downstream river stretches (presumably due to displacement of pelagic, semibuoyant embryos and early larvae); density of older fish was low in the same areas, for reasons that have not been determined (*Id.*). As noted above, some scientists have proposed that older fish swim back upstream to populate higher reaches based on this density pattern.

Generally, pelagic broadcast spawning is advantageous in pristine floodplain rivers with unstable substrates because pelagic embryos and larvae have a low risk of burial and are readily distributed throughout habitats of wide, shallow river channels and floodplains (Hoagstrom & Brooks 2005, p. 36). High flows could also be advantageous to broadcast eggs because the habitat area is temporarily increased and flood intolerant animals (potential competitors and predators) are temporarily reduced (*Id.*).

GEOGRAPHIC DISTRIBUTION

The shiner's range included New Mexico, Texas, and Mexico, but it has been extirpated from much of its historic range (IUCN 2018, pp. 3-4, Figures 1 & 2). The Rio Grande shiner is "endemic to the Rio Grande drainage, from just above [the delta] of the main river in Texas and Mexico to [the] headwaters of Rio Grande and Pecos rivers, northern New Mexico; range also includes major tributaries in Mexico: Rio San Juan, Rio Salado and Rio Conchos" (Hendrickson & Cohen 2015, p. 2).

Rio Grande. The shiner's range and abundance has noticeably diminished in the Rio Grande since the 1950s (Hendrickson & Cohen 2015, p. 2, *internal citations omitted*). The shiner has been extirpated from the Rio Grande in New Mexico since the species was first collected there in 1874 (Platania 1991, p. 191), and is absent from large sections of the Rio Grande in western Texas (IUCN 2018, p. 4). The shiner was reported absent from the Rio Grande between El Paso and Presidio, Texas, as early as the 1970s due to local irrigation practices (Hendrickson & Cohen 2015, p. 2, *internal citations omitted*). This portion of the Rio Grande—from Fort Quitman to Presidio, Texas—is nicknamed "the forgotten reach" because it no longer receives high spring flows from the mainstem due to the construction of Elephant Butte Reservoir, other dams, and irrigation for the Rio Grande Project. The reach now only receives intermittent tributary flows due to isolated thunderstorms for the majority of the year, dramatically reducing and changing the timing of flows in this region of the river (USACE 2008, p. 61). The shiner has disappeared from the Rio Grande upstream of the Rio Conches confluence (New Mexico, Texas, and Chihauhua) and the Rio Grande downstream from Falcon Reservoir (Texas and Tamaulipas) (Hoagstrom & Brooks 2005, pp. 48-49, *internal citations omitted*), and as of 2004 had not been collected below Amistad Reservoir in 10 years (Hendrickson & Cohen 2015, p. 2, *internal citations omitted*).

Pecos River. The shiner persists in the Pecos, but has been extirpated from the 89 km (55 mile) reach of the upper Pecos River between Santa Rosa and Sumner Reservoirs in New Mexico (Hendrickson & Cohen 2015, p. 2) (Historically the shiner occurred at least at far north as Santa Rosa (Platania & Altenbach 1998, p. 566)).

In the Pecos River in Texas between Iraan and Amistad Reservoir, the shiner had been relatively abundant prior to a red tide fish kill in 1986-1988, after which the species was virtually absent from the reach (Hendrickson & Cohen 2015, p. 2; *see also* Rhodes & Hubbs 1992). The shiner's last remaining population within the Pecos River basin is found between Fort Sumner Irrigation District Dam and Brantley Reservoir, New Mexico (Hoagstrom & Brooks 2005, p. 52). This is the largest known population of the shiner anywhere (*Id.*). For recent collection data, see the attached databases from New Mexico Natural Heritage (NMNH 2019) and Museum of Southwestern Biology (MSB 2019).

Rio San Juan, Rio Salado, and Rio Conchos. The shiner once occurred in the Rio San Juan, Rio Salado, and Rio Conchos in Mexico (IUCN 2018, p. 4). As of the early 2000s, the shiner still persisted in certain Rio Conchos watershed localities (Hoagstrom & Brooks 2005, p. 49). Its status in the Rio San Juan and Rio Salado is currently unknown (*Id.,* p. 48), although it has been referred to as "rare" in Mexico (Hendrickson & Cohen 2015, p. 2).

Summary of existing populations. The shiner persists in the Rio Grande along the Texas-Mexico border (from Presidio at least as far south as Amistad Reservoir, see Figures 1 & 2); in the Pecos River between Fort Sumner Irrigation District Dam and Brantley Reservoir, New Mexico; and in the Rio Conchos watershed in Mexico. All other occurrences are extirpated or their status is unknown.

Figure 1. U.S. Distribution by watershed of the Rio Grande shiner (NatureServe 2018). The shiner is also extirpated from the stretch of the Rio Grande between El Paso and Presidio, Texas (Hendrickson & Cohen 2015, p. 2), and may be absent below Amistad Reservoir as well (*Id.*).

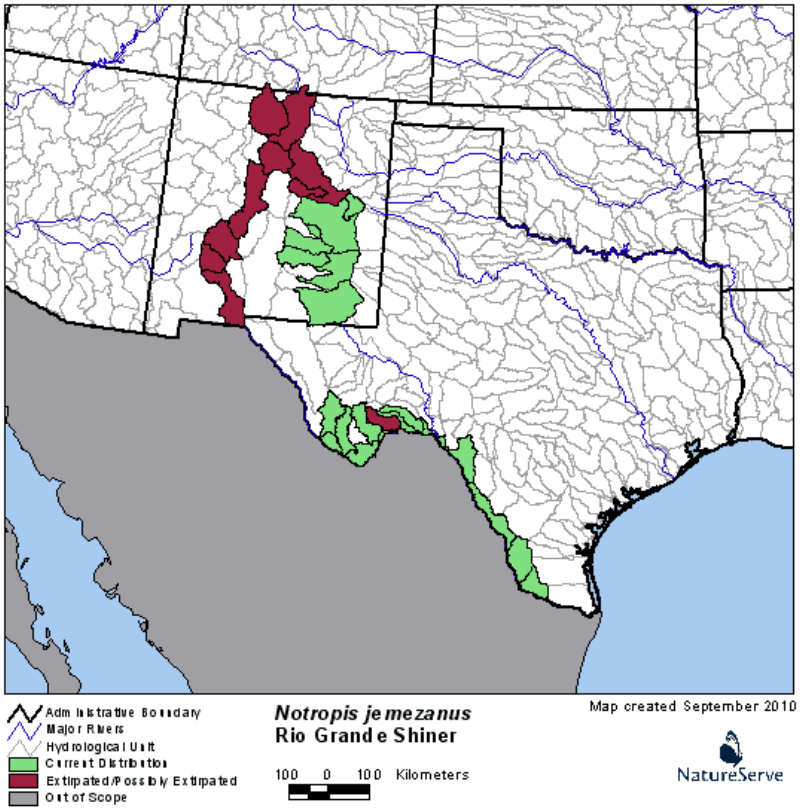


Figure 2. Global distribution of the Rio Grande shiner (IUCN 2018). The shiner is also extirpated from the stretch of the Rio Grande between El Paso and Presidio, Texas (Hendrickson & Cohen 2015, p. 2) and may be absent below Amistad Reservoir as well (*Id.*).

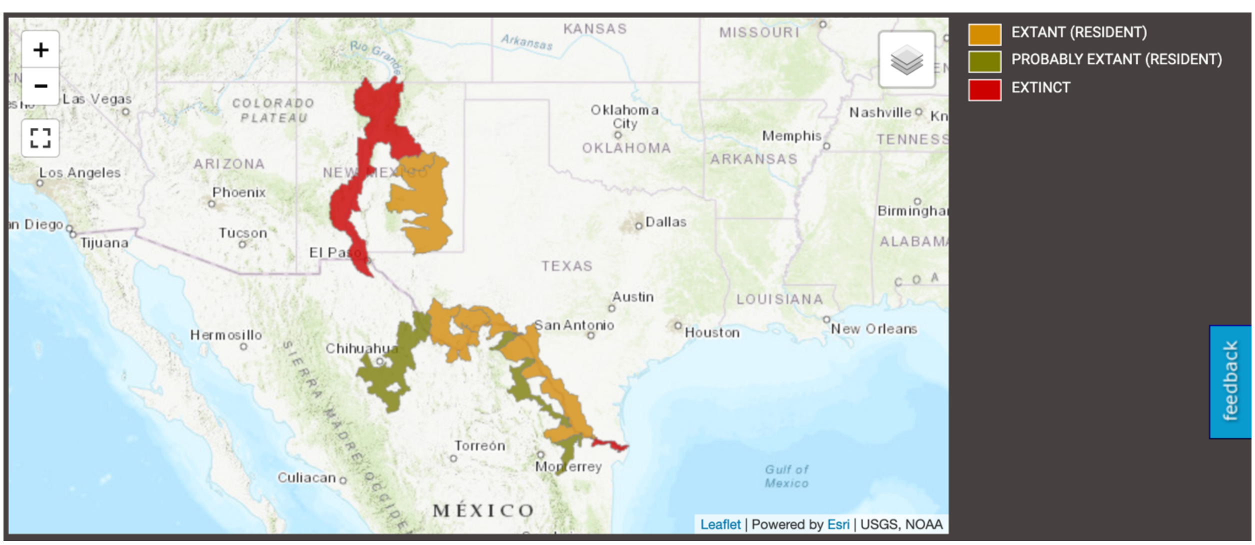


Figure 3. Map of the lower Pecos River, New Mexico and Texas, with three fish faunal segments delineated. Also included are selected reservoirs, tributaries, and cities (Hoagstrom 2003, p. 92)

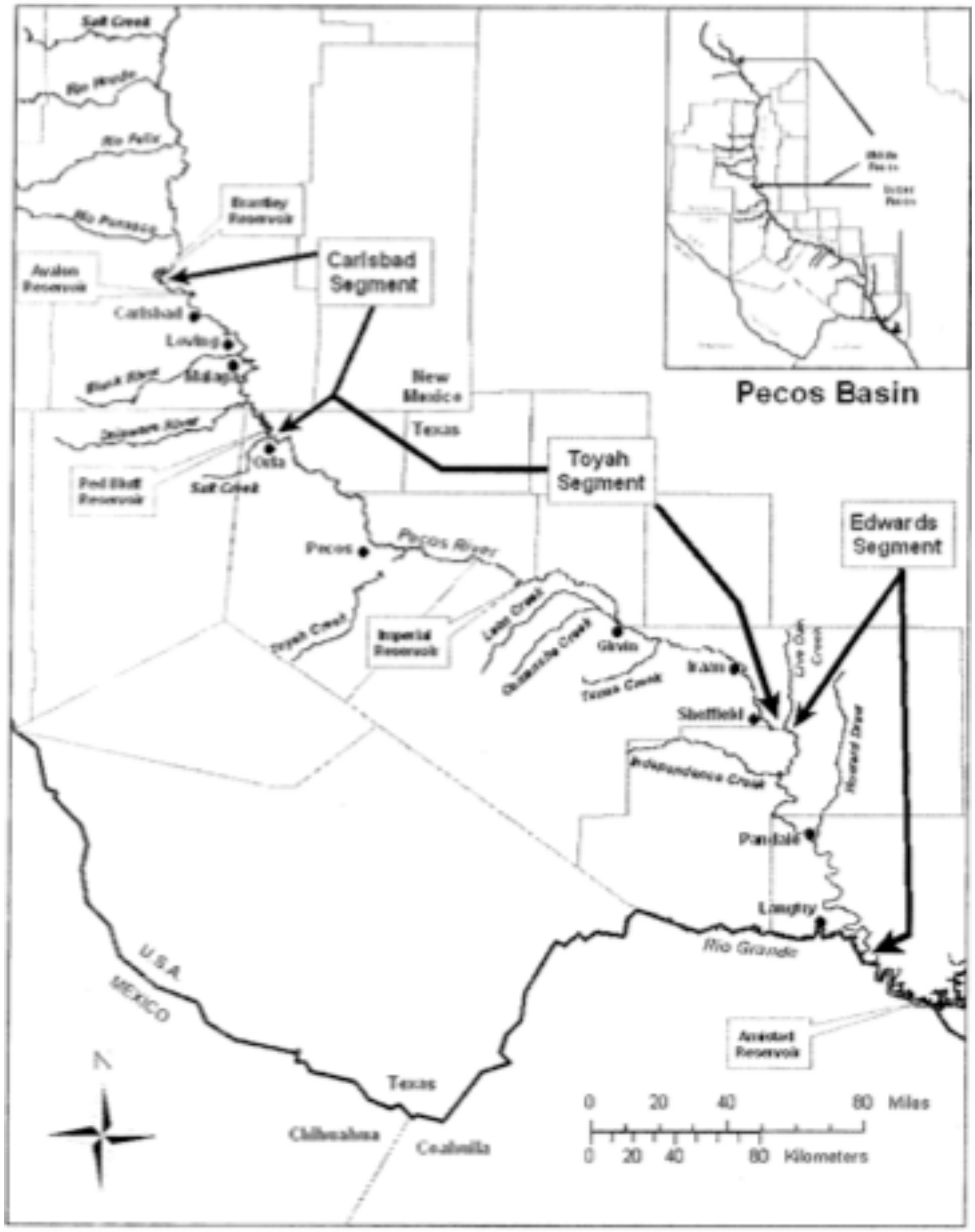
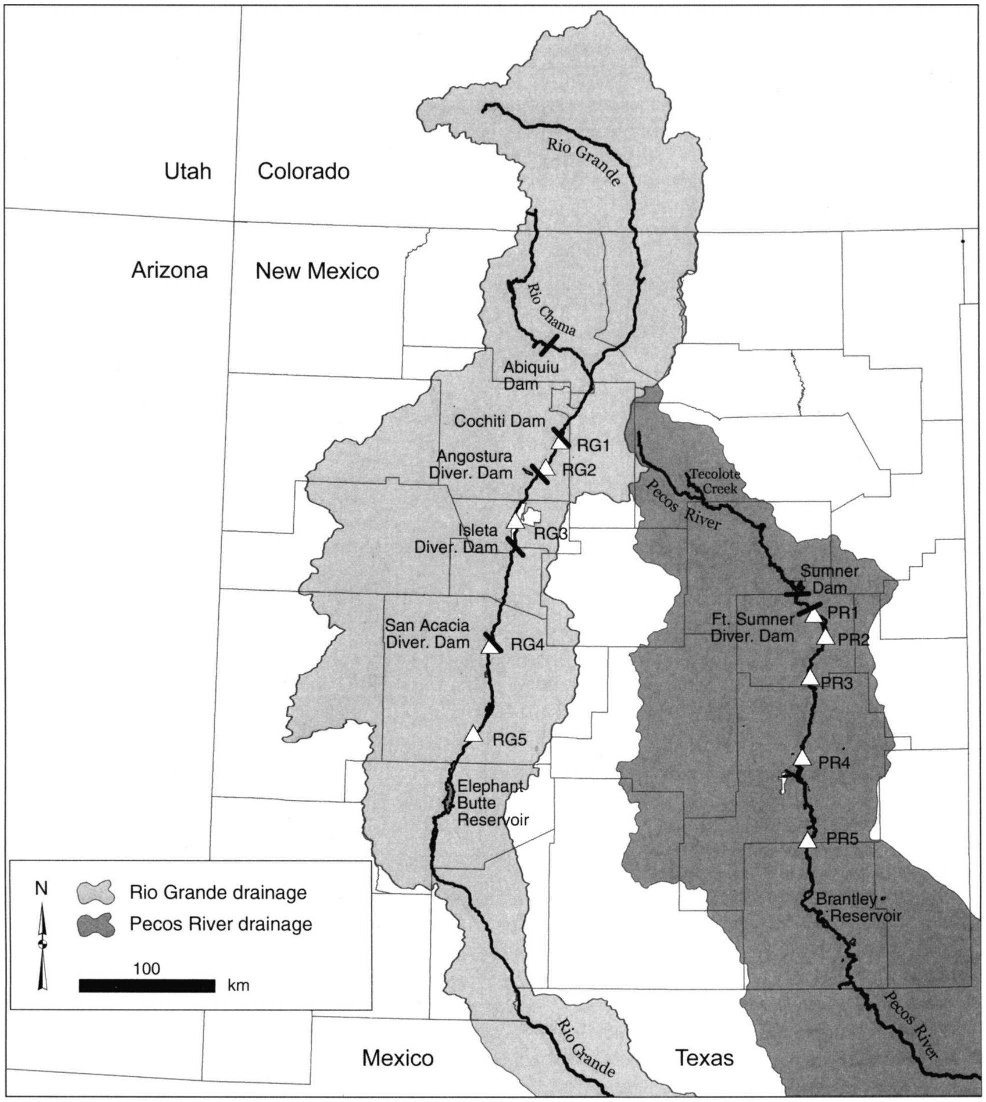


Figure 4. The Pecos River in New Mexico and Texas
(https://en.wikipedia.org/wiki/Pecos_River).

Figure 5. Select dams and diversions along the Rio Grande from Velarde to Elephant Butte Reservoir, New Mexico (Bullard & Wells 1992, p. 1).

Figure 6. Map of the upper Rio Grande and Pecos River drainages, illustrating select dams, reservoirs, and gauging stations (triangles) ((Dudley & Platania 2007, p. 2,077).



POPULATION STATUS: HISTORIC AND CURRENT

In 1997, Texas Natural History Collections mapped 65 collection locations, including 41 in the Rio Grande in Texas, 2 in the Pecos River in Texas, 10 in the Pecos River drainage in New Mexico, 4 in the Rio Grande in New Mexico, 4 in the Rio Conchos, 2 in the Rio Salado, and 2 in the Rio San Juan. However, since then the species has declined and has disappeared from many areas, including the Rio Grande in New Mexico, much of the Rio Grande in Texas, and a portion of the Pecos River above Sumner Lake (NatureServe 2018, p. 2). The species was last collected in the Rio Grande in New Mexico in 1949 (*Id.*). There are currently a relatively small number of Rio Grande shiner occurrences: between 6 and 80 (*Id.*).

Though the exact "[r]ate of decline is unknown," the species is estimated to have a short-term decline of 10-30 percent and a long-term decline of 30-70 percent (*Id.*). Genetic research found that "effective size estimates for *N. jemezanus* are indicative of a declining population" (Osborne 2013, p. 16).

Analysis of Fishes of Texas data provides "strong support for the previously less rigorously conceived consensus that this species is declining, and here it is clear its distribution is shifting and narrowing toward the north and west" in Texas (Cohen et al., 2018, p. 24)

IDENTIFIED THREATS TO THE PETITIONED SPECIES: CRITERIA FOR LISTING

The Service must evaluate whether a species is "threatened" or "endangered" as a result of any of the five listing factors set forth in 16 U.S.C. § 1533(a)(1):

> A. The present or threatened destruction, modification, or curtailment of its habitat or range;
> B. Overutilization for commercial, recreational, scientific, or educational purposes;
> C. Disease or predation;
> D. The inadequacy of existing regulatory mechanisms; or
> E. Other natural or manmade factors affecting its continued existence.

"More than 20 percent of the world's 10,000 freshwater species have become extinct, threatened or endangered in recent decades" (Wong 2007, p. 5, *internal citations omitted*). Ricciardi and Rasmussen (1999, p. 1,221) predicted a future extinction rate of ~4 percent per decade for freshwater fishes, mollusks, crayfish, and amphibians, and a 2.4 percent future extinction rate for freshwater fishes. Almost 40 percent of North American fishes are currently imperiled; of those that were considered imperiled in 1989, most (89 percent) are currently in the same or worse conservation condition (Jelks et al. 2008, p. 372). "In the twentieth century, freshwater fishes had the highest extinction rate worldwide among vertebrates. The modern extinction rate for North American freshwater fishes is conservatively estimated to be 877 times greater than the background extinction rate for freshwater fishes (one extinction every 3 million years). Reasonable estimates project that future increases in extinctions will range from 53 to 86 species by 2050" (Burkhead 2012, p. 798). The loss of biodiversity in freshwater ecosystems is attributed to anthropogenic disturbances to rivers and streams including habitat degradation (Jelks et al. 2008, p. 382), changes in land use, climate change, nitrogen deposition (Sala et al. 2000, p. 1,772), introduction of nonnative species, and introduction of diseases and parasites (Jelks et al. 2008, p. 382).

(Factor A) The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

"Habitat alteration is the single biggest cause of loss of diversity of aquatic life because few aquatic habitats have not been affected either directly or indirectly by human activities" (Moyle & Leidy 1992, p. 145; *see Id.*, p. 145-152 *for a general discussion of causes and impacts of habitat loss in aquatic environments*). Indeed, habitat loss is one of the main drivers of Rio Grande shiner population decline (Jelks *et al*. 2008, p. 391). Dams, dewatering, channelization, and other human interference have changed the nature of the Rio Grande and Pecos rivers such that uninterrupted stretches of river with wide channels and periodic flooding—prime habitat for the shiner—have been replaced with deep, quick-flowing channels, stagnant reservoirs, and dry river beds unsuitable for the shiner's survival. Habitat reduction has resulted in extirpation for other pelagophilic species similar to the Rio Grande shiner: "A high percentage of native pelagophilic species that formerly occupied much of the Rio Grande Basin have been extirpated" (Dudley & Platania 2007, p. 2,080).

Habitat degradation is not a new threat. Early records of fish populations in Colorado noted the following:

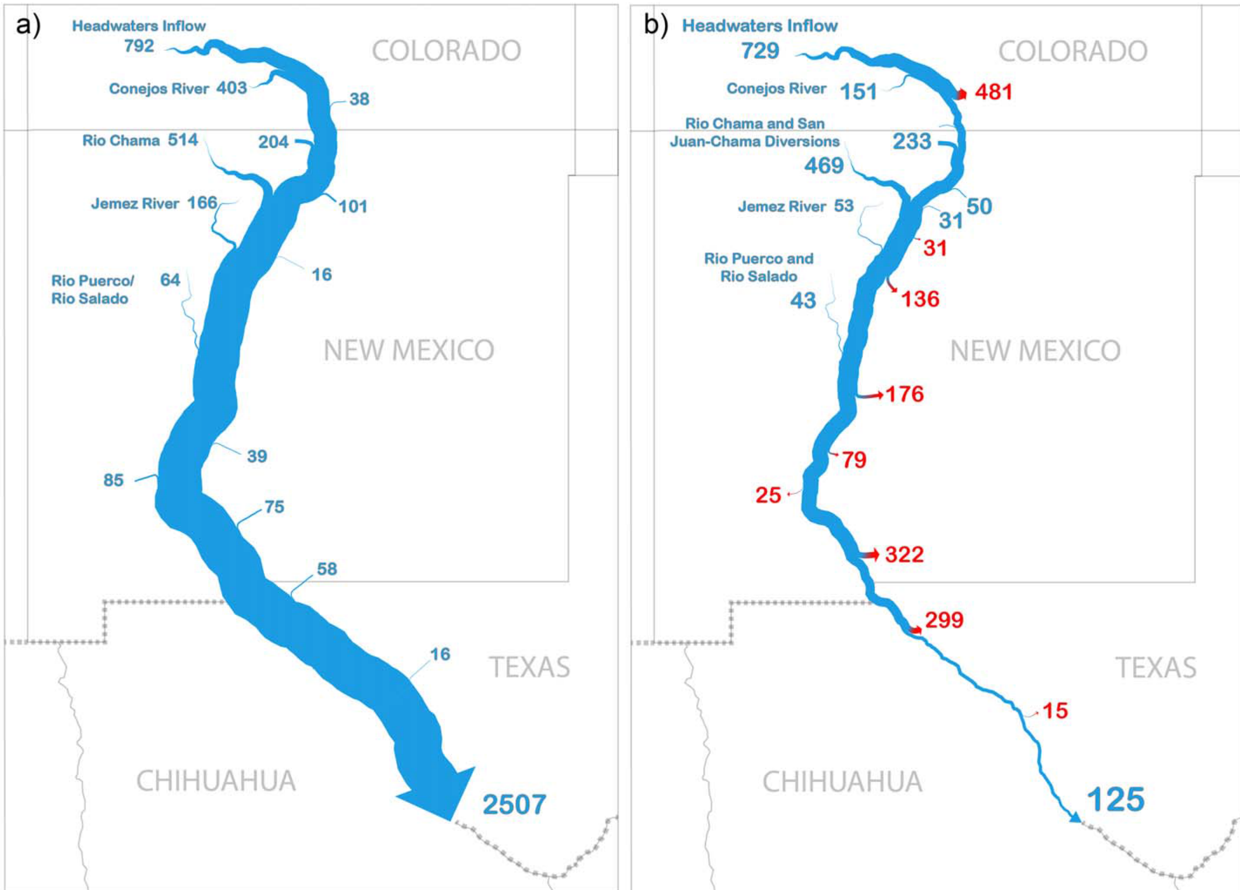
> In the progress of settlement of the valleys of Colorado the streams have become more and more largely used for irrigation. Below the mouth of the cañons dam after dam and ditch after ditch turn off the water. In summer the beds of even large rivers (as the Rio Grande) are left wholly dry, all the water being turned into these ditches. Much of this water is consumed by the arid land and its vegetation; the rest seeps back, turbid arid yellow, into the bed of the stream, to be again intercepted as soon as enough has accumulated to be worth taking. (Jordan 1891, p. 4)

"Unfortunately, pre-development conditions were never quantified… [D]evelopment proceeded rapidly throughout the late 19th century and withdrawals for irrigation largely depleted the Rio Grande by 1900" (Hoagstrom *et al*. 2010, p. 79, *internal citations omitted*). However, a recent study by Blythe & Schmidt (2018) developed a tool for estimating a river's natural flow regime using existing streamflow data. The results "highlight the significant deviation from natural condition that occurred in the 20th century" in the Rio Grande Basin (*Id.*, p. 1,212). The study found:

> "[T]he total annual flow of the northern branch of the Rio Grande at its confluence with the Rio Conchos is 95% less than the estimated natural flow. Where a snowmelt flood once characterized the annual hydrograph, there are only small flash floods from summer and monsoon rains, and a large portion of the watershed, which produced approximately 23% of the annual flow, now contributes virtually no flow to the lower Rio Grande." (*Id.,* pp. 1,233-1,234)

Further, "the magnitude of floods today was more than 60% less than the magnitude of the estimated natural floods. The duration of today's floods was typically 20% shorter, and flood timing was more variable with the annual peak occurring later in in the year." (*Id.,* p. 1,224). This is particularly important given that "native aquatic and riparian ecosystems are adapted to the river's natural flow regime," (*Id.*, p. 1,212, *internal citations omitted*), and that native species evolved under these historic conditions.

Figure 7. Average annual inflows (blue lines) and consumptive losses (red arrows) of Rio Grande in million cubic meters for a) 1900-2010 estimated natural conditions and b) 1950-2010 modern conditions (Blythe & Schmidt 2018, p. 1,224).



Today, the Rio Grande is one of the most endangered rivers in North America (Rinne & Platania 1995, p. 165).

> Both water-quantity and water-quality issues are major concerns… The Rio Grande failed to reach the Gulf of Mexico in much of 2002 and 2003. Water-quality problems include elevated salinity, nutrients, bacteria, metals pesticides, herbicides, and organic solvents. In addition, riparian areas in most parts of the basin are in decline, with nonnative species dominating in many reaches. (Dahm et al. 2005, p. 192)

Dams and diversions. There are 68 dams and 13 reservoirs in the Rio Grande Basin (Rio Grande and Pecos rivers) (Dudley & Platania 2007, p. 2,074; *see* Figures 3, 5, & 6 *for a partial accounting*). These dams and diversions reduce channel complexity and isolate fish populations (*Id*.).

The Rio Grande once served as uninterrupted habitat for the shiner, but now a total of 36 dams and five reservoirs fragment the river (Dudley & Platania 2007, p. 2,080). Between the confluence with the Rio Chama and the river's terminus at the Gulf of Mexico, only five free-flowing reaches remain that exceed 100 km (*Id.*).

The Pecos River from its confluence with Tecolote Creek at Tecolotito, New Mexico, to its confluence with the Rio Grande, in Texas (1,378 km), is fragmented by 22 dams and eight reservoirs. While there are two free-flowing river reaches that are greater than 300 km (186 miles), all other reaches in this section are less than 65 km (40 miles) (Dudley & Platania 2007, p. 2,080). Reservoir habitat now represents 10.8% of the longitudinal distance in the Pecos River study area that was once prime shiner habitat (*Id.*).

"The decline of [the Rio Grande shiner] corresponded with human development of [its] native watersheds. [The shiner] disappeared from river reaches that were dewatered or isolated by dams" (Hoagstrom & Brooks 2005, p. 36). Dams and water diversions affect fish populations, including the Rio Grande shiner, through a variety of mechanisms: dewatering, habitat fragmentation, or changes in stream morphology and flow regime. These factors are discussed in more depth below (*for a general discussion of the impact of dams on southwestern grassland fishes, see* Calamusso 2005, pp. 152-154).

<u>Dewatering.</u> The Rio Grande is threatened by high levels of water extraction for agriculture and domestic use.

> The Bureau of Reclamation constructed four federal projects in the basin. The Rio Grande project was approved in 1905, and its primary reservoir, the 2.5-km^3 Elephant Butte, was completed in 1916 to service project lands in the Paso del Norte region and beyond. Water from this reservoir is delivered by Elephant Butte Irrigation District and El Paso County Water Improvement District #1 to farmers in New Mexico and Texas. The Rio Grande Project services 728 km^2 of U.S. land and another 100 km^2 in Mexico. Major irrigated crops are cotton, alfalfa, pecans, vegetables, and grain. The Bureau of Reclamation's Middle Rio Grande Project was approved in 1950s and involved rehabilitation of an existing regional irrigation system, the Middle Rio Grande Conservancy District. Reclamation channelized the Rio Grande in this river section creating a number of environmental problems. Approximately 400 km^2 are irrigated by the project. Alfalfa, barley, wheat, oats, corn, fruits, and vegetables are the principal crops grown. Still farther upstream, in the San Luis Valley, agriculture and irrigation developed prior to federal involvement. The Closed Basin Project there was completed in the 1970s to provide agriculture with extra supplies not subject to the compact. The fourth Bureau of Reclamation project is the San Juan–Chama built in the 1970s to move Colorado River water into the Rio Grande, thereby providing an additional 0.1 km^3 per year for the Rio Grande. This project provides municipal supplies for Albuquerque and Santa Fe, irrigation supplies for the Middle Rio Grande Conservancy District, and is also used for a federal reserved rights settlement with the Jicaralla Apache Tribe. In recent drought years, this water has been critical for environmental, municipal and irrigation interests. This water, however, is subject to New Mexico's Colorado River Compact allocation and could be curtailed by drought and climate change. (Dettinger et al. 2015, p. 2,084, *internal citations omitted*).

While irrigation accounts for more than 80 percent of all water taken from the river, municipal needs are growing as urban areas expand (Wong et al. 2007, p. 18). Along the Rio Grande mainstem, there are only four major cities, but the urban population is growing at a rapid rate of two to four percent per year (*Id*.).

> The sporadic and cyclic desiccation and re-wetting of the mainstream Rio Grande channel severely impacts habitat availability, life cycles, and population levels of fishes throughout the Middle Rio Grande. During low-flow periods, fish are often trapped in pools where they may more readily fall prey to introduced game fishes. Even in absence of predation, fish trapped in intermittent pools may ultimately succumb due to declining water quality prior to re-connection of sustained flows. Fish appear to have a tendency to move upstream during periods of low-flow thereby concentrating populations below mainstream diversions. Below these areas, there is not only a greater probability of encountering predation, but also increased disease due to stress. Such concentration and crowding at the base of dams potentially increases the probability of the loss of a major portion of the native fish fauna during natural events such as de-oxygenation or human-caused activities such as spills of toxic materials. (Rinne & Platania 1995, pp. 169-170)

Drought and increased water withdrawals post-1950 have periodically dried extensive reaches of the Rio Grande and likely led to elimination of small shiner populations (NatureServe 2018, p. 2; IUCN 2018, p. 5).

<u>Habitat fragmentation.</u> Rio Grande shiners are susceptible to habitat fragmentation from barriers including dams and diversions. “River fragmentation and regulation are thought to have contributed either directly or indirectly to the decline or loss of numerous pelagic-spawning fishes throughout the Great Plains and Southwest United States… Numerous pelagophils in highly regulated river ecosystems are now extirpated from much of their native range, or extinct” (Dudley & Platania 2007, p. 2,075). Nearly all reaches of river less than 100 km (62 miles) no longer retain any pelagic-spawning freshwater fishes (*Id.,* p. 2,080). “[P]opulations of native pelagophils have been extirpated from all river reaches that now provide only reservoir habitat” (*Id.,* pp. 2,080-2,081). Furthermore, flow regulation decreases habitat heterogeneity by increasing channelization, decreasing geomorphic complexity and connectivity between rivers and floodplains (*Id.,* p. 2,081). Collective effects of river regulation, such as direct river channelization, dredging, rock dikes (groynes), shoreline revetment, and levee construction for flood control, increases flow velocity which increases the downstream transport of ichthyoplankton into unsuitable downstream environments such as reservoirs or irrigation networks (*Id.*).

“The Rio Grande Basin historically supported at least six pelagophils in three genera” (Dudley & Platania 2007, p. 2,082). Many of these species have declined significantly due to the declining condition of the Rio Grande Basin. Both the phantom shiner, *Notropis orca*, and the Rio Grande bluntnose shiner, *Notropis simus simus*, are extinct after declining significantly during the 1950s and 1960s (*Id.,* p. 2,083). Both the Pecos bluntnose shiner, *Notropis simus pecosensis*, and the Rio Grande silvery minnow, *Hybognathus amarus*, have become so imperiled that both received federal protections (*Id.*). The Pecos bluntnose shiner has been listed as “threatened,” and the Rio Grande silvery minnow as “endangered” under the ESA (*Id.*). Based on these and other instances, scientists have stated that "[a]dditional protection may be necessary for other pelagophils within the region in the near future" (*Id.*).

The Rio Grande Basin has been made unsuitable for the Rio Grande shiner and similar species because of dams, which fragment the river, creating uninhabitable reservoirs and restricting movement of aquatic species. "Dams prevent subsequent upstream movement of individuals transported over these instream barriers and out of their natal reach" (Dudley & Platania 2007, p. 2,075). "[I]chthyoplankton are also subject to transport into downstream reservoirs, which sustain nonnative piscivorous fishes and lack appropriate habitat for pelagophils" (*Id.*). "The deleterious consequences of downstream transport of reproductive propagules into unsuitable environments, such as reservoirs, are magnified for pelagophils because these short-lived species cannot endure consecutive reproductive failures" (*Id.*). "[R]educed water temperatures (e.g., downstream of hypolimnetic release dams) and prolonged development to the free-swimming phase are thought to increase mortality risk for ichthyoplankton" (*Id.*). In reservoirs, eggs and free embryos fall out of suspension in standing water, where they are subjected to hypoxic conditions and suffocation in bottom sediments (*Id.*, p. 2,082.) Furthermore, "[d]iversion dams reduce upstream populations of pelagophils by preventing the return of any spawned fish that were transported over these instream barriers as propagules. Additional threats to ichthyoplankton imposed by diversion structures include entrainment in irrigation canals and drying of downstream reaches during low-flow periods" (*Id.*).

The Rio Grande and its tributaries once provided huge expanses of uninterrupted habitat, but after being dammed, most of the basin is uninhabitable for the shiner. For example, the Rio Grande was once free-flowing along 2,651 km (1650 miles), but now only five free-flowing reaches exceeding 100 km (62 miles) remain (Dudley & Platania 2007, p. 2,080). A total of 36 dams and five reservoirs fragment the Rio Grande from its confluence with the Rio Chama to its terminus at the Gulf of Mexico (*Id.*). Similarly, the Pecos River, from its confluence with Tecolote Creek at Tecolotito, New Mexico, to its confluence with the Rio Grande in Texas (1,378 km), is fragmented by 22 dams and eight reservoirs. While there are two free-flowing river reaches on the Pecos greater than 300 km (186 miles), all other reaches in this section are less than 65 km (40 miles) (*Id.*).

<u>Changes in stream morphology and flow regimes.</u> Shiner habitat has been damaged by flow regulation. "Pelagic-spawning fishes… are thought to be particularly susceptible to river regulation because their early life stages (ichthyoplankton) drift until becoming free-swimming, although the extent of transport is largely unknown" (Dudley & Platania 2007, p. 2,074).

> Flow regulation causes increased channelization, decreased geomorphic complexity, loss of connectivity between rivers and floodplains, and thus decreased habitat heterogeneity. Direct river channelization, dredging, rock dikes (groynes), and shoreline revetment also increase flow velocity and redirect flow toward the thalweg. Levee construction for flood control reduces channel area during flow pulses, further increasing velocity. These collective effects of river regulation likely increase the downstream transport of ichthyoplankton into unsuitable downstream environments such as reservoirs or irrigation networks (*Id.,* p. 2,081, *internal citations omitted*).

Artificial flow regulation has resulted in a relatively static channel compared to historical conditions. Formerly, high flows from snowmelt and seasonal rains facilitated over-bank flooding and periodically reshaped the channel, creating optimal habitat for the shiner. Nonnative vegetation thrives under non-flooding flow regimes and further contributes to the "narrowing and habitat homogenization of these regulated rivers" (Dudley & Platania 2007, p. 2,081). The suite of native fish in the Rio Grande "would benefit from management to restore historical flow regimes and associated channel maintenance" (Rees *et al.* 2005, p. 17). "Low flows and intermittency seem to be responsible for a large fish kill that occurred [on the Pecos]… this study documented fish kills at two sites associated with low flows and intermittency" (Larson & Propst 2004, p. 26).

On the Pecos, the "completion of Sumner Dam and extensive groundwater pumping in the Pecos River valley have increased the frequency of zero-flow periods" (Larson & Propst 2000, p. 55, *internal citations omitted*). River discharge modifications "occurred via reduction of high snow-melt and storm runoff flows by reservoir capture and flow increased during normally low-discharge periods s a consequence of steady and consistent release from reservoirs for human needs" (Larson & Propst 2003, pp. 1-2).

Human interference has changed spawning timing for the shiner and similar species. Releases of reservoir water now provide spawning stimulus, as opposed to spawning being triggered by the runoff of seasonal rainstorms (Dudley & Platania 2007, p. 2,081). Natural runoff and rainstorms are more variable and generally of shorter duration than reservoir releases (Dudley & Platania 2007, p. 2,081).

Water quality degradation. In the Pecos River, "human activities have… impacted water quality through oil production and agricultural processes in the region. These practices have led to high levels of pesticides, heavy metals, and the primary water quality issue, high salinity levels. Increased salinity along with altered habitat availability has greatly influenced fish community structure in the lower Pecos River resulting in a loss of native fish diversity" (Cheek & Taylor, 2015, p. 1, *internal citations omitted*). The Pecos River experienced a golden algae bloom and resulting fish kill in 1986 from which the Rio Grande shiner never recovered (*Id.,* pp. 8-9). "Declines of… *N. jemezanus* in the downstream sites between 1987 and 2011 were likely due to lack of suitable reproductive conditions exacerbated by stochastic events such as golden algae blooms. …*N. jemezanus* [was] likely extirpated from the upstream reaches of the study area prior to 1987 due to loss of habitat, reduced flow and increased salinity" (*Id.,* p. 9). "The degraded condition of the lower Pecos River[1] in recent decades was evidenced by elevated salinity, toxic algal blooms, and replacement of a native pupfish by a hybrid swarm with a nonnative congener" (Hoagstrom 2003, p. 91, *internal citations omitted*).

<u>(Factor C) Disease or Predation</u>

The habitat degradation and modified flow patterns discussed above (*see* Factor A) are contributing to predation on the Rio Grande shiner by nonnative species. The rivers of the Rio

[1] The lower Pecos River is defined here as the 770 km from 17 km northwest of Carlsbad, New Mexico, to the Rio Grande near Langtry, Texas (Hoagstrom 2003, p. 91).

Grande Basin have been transformed into low-disturbance systems, allowing the invasion of non-native fishes (Dudley & Platania 2007, p. 2,082). These nonnative fishes compete with and prey upon native fishes such as the shiner (*Id.*). Especially in reservoirs and in the cold and clear waters released downstream of dams, nonnative fish prosper to the detriment of native fishes (*Id.*).

> The potential impact on native shiner numbers by [red shiner and mosquitofish] could occur after the spawn, when larval fish produced by members of the broadcast spawning guild (e.g. Pecos bluntnose shiner and Rio Grande shiner) escape the drift and seek lower velocity habitats. These habitats may also be occupied by western mosquitofish and red shiner, and if normal food resources are reduced, or, if habitat alteration has resulted in an overall reduction in low velocity habitats causing these two species to become more concentrated, they may prey heavily on larval fish that are already being depleted by extended reservoir releases (Larson & Propst 2000, p. 53, *internal citations omitted*).

In the Pecos between Sumner Dam and Brantley Reservoir, the "low abundance and small size classes of piscivores in the study area suggests that piscivory on native shiners is not a major cause of mortality under flow condition encountered during the study period, however, the absence of an extended zero-flow period during this study has precluded examination of the effect of predation on prey species in isolated pools" (Larson & Propst 2000, executive summary).

The Service should consider risks from predation by non-native species when determining whether or not to list the shiner.

(Factor D) The Inadequacy of Existing Regulatory Mechanisms

The American Fisheries Society's Endangered Species Committee considered the Rio Grande shiner "endangered" in their 2008 review, meaning it is "a taxon that is in imminent danger of extinction throughout all or extirpation from a significant portion of its range." They noted that it had declined since 1989 (Jelks et. al 2008 at 391). This designation provides no legal protection. The Committee has not made a more recent comment on the status of the species.

Mexico. The species is considered "rare" by CONABIO (Hendrickson & Cohen 2015, p. 2).

Federal. The shiner is not listed as a sensitive species by the Forest Service Region 3[2] or Region 8.[3] The shiner is on the "watch" list of BLM sensitive species in New Mexico.[4]

[2] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_021328.pdf
[3] (Regional Forester 2018)
[4] https://www.blm.gov/sites/blm.gov/files/IB%20NM-2019-002_Attachment%201%20Animal.pdf

State.

New Mexico. The Rio Grande shiner is not listed under the New Mexico state endangered species act.[5] It is not considered a Species of Greatest Conservation Need in the State Wildlife Action Plan (SWAP).[6]

Texas. The shiner has been reported as threatened in Texas since at least the early 1990s (Hendrickson & Cohen 2015, p. 2; "Hubbs et al. (1991) reported *N. jemezanus* as threatened in Texas and Edwards et al. (2002) report collections supporting this designation"). The shiner is not listed under the Texas state endangered species act.[7] It is considered a species of high priority under the Texas Wildlife Action Plan.[8]

Water use regulations. "The [Rio Grande] is governed by a 1906 international treaty and a three-state compact signed in 1939. The compact was designed to protect senior agricultural water rights in both Colorado and near El Paso. Under the compact, the upper two sections have annual (and occasionally year-to-year) delivery requirements to river sections downstream that vary nonlinearly according to input flows" (Dettinger et al. 2015, p. 2,083). State and federal water policy is not adequate to protect flows in the Rio Grande necessary for the conservation and protection of the Rio Grande shiner and other river-dependent species. Western water law—the system of prior appropriation—values the diversion of water from rivers and streams for "beneficial use" at the expense of river flows and the natural environment (Johnson & DuMars, p. 350). Such state policies allocate water for agriculture, municipal and industrial purposes on a "first come, first served" basis. Thus, the oldest water rights have first priority over any subsequently developed water right. Historically, instream flow rights were not recognized because the requisite intent of a "diversion" did not exist (*Id.*). While certain states now recognize instream flow rights, most rights were developed relatively recently and thus are junior to existing consumptive uses such as agriculture. Therefore, the system of modern prior appropriation does not provide an adequate tool for securing river flows to protect river-dependent species.

In Colorado, "water rights are based on the appropriation system which requires the permanent fixing of rights to the use of water at the time of the adjudication, with no provision for the future needs" (C.R.S. § 37-92-101 (2014)). The goal of allocation is for the maximum beneficial use of water from rivers. The Rio Grande shiner does not have known habitat in Colorado, but upstream use of water impacts their habitat in New Mexico and Texas. The Colorado Constitution, Article XVI, Section 6 provides that "[t]he right to divert the unappropriated waters of any natural stream to beneficial uses shall never be denied." Thus, Colorado prioritizes diversion of water from our rivers for traditional domestic, agricultural and industrial uses over more modern values such as instream flows. For example, since the 1890s "the irrigated lands in San Luis Valley used all the available natural flow of [the] Rio Grande and its tributaries in that valley" (NRC 1938, p. 8). Dewatering of the river threatens many species including the Rio Grande shiner (*see* "Factor

[5] http://www.wildlife.state.nm.us/conservation/wildlife-species-information/threatened-and-endangered-species/
[6] http://www.wildlife.state.nm.us/download/conservation/swap/New-Mexico-State-Wildlife-Action-Plan-SWAP-Final-2019.pdf
[7] https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/listed-species/
[8] https://tpwd.texas.gov/publications/pwdpubs/pwd_pl_w7000_1187a/

A," *supra*). Such agricultural diversions from the San Luis Valley of Colorado continue today, consuming nearly all of the headwater's flows (especially in dry years) and leaving only a trickle at the Colorado-New Mexico state line. For example, in 2013, 99 percent of the Rio Grande's flows were consumed between the Del Norte gauge located above the diversions in the San Luis Valley and the Lobatos Gauge near the Colorado-New Mexico state line.

In 1973, Colorado's legislature "recogniz[ed] the need to correlate the activities of mankind with some reasonable preservation of the natural environment" and granted the Colorado Water Conservation Board (CWCB) the authority to file for and hold instream flow water rights in Colorado (C.R.S. § 37-92-102(3)). As of 2012, the CWCB had acquired instream flow rights on 9,120 stream miles in Colorado: 8 percent of the state's total miles and 30 percent of its perennial miles (CWCB 2012; EPA 1998 at Appendix A). However, the instream flow rights held by CWCB remain junior to prior water rights and represent a tiny fraction of the water rights in the state: 0.31 percent of the water consumed for agriculture in 2005 (Gardner-Smith 2014, p. 3). "As a result, streams where the CWCB holds junior rights are often still left shallow or dry after senior water rights for irrigation are exercised" (*Id.*). There are no instream flow reaches on the main stem of the Rio Grande from Del Norte to the Colorado-New Mexico state line.

In New Mexico, all water is subject to appropriation for human use: "[t]he unappropriated water of every natural stream, perennial or torrential, within the state of New Mexico, is hereby declared to belong to the public and to be subject to appropriation for beneficial use, in accordance with the laws of the state" (New Mexico Constitution, Article XVI, Section 2). "[A]ll waters appropriated for irrigation purposes… shall be appurtenant to specified lands owned by the person, firm or corporation having the right to use the water, so long as the water can be beneficially used thereon... Priority in time shall give the better right" (N.M.S. § 72-1-2 (2013)).

Similar to Colorado, New Mexico places a high value on consumptive water uses. As a result, water is diverted from the Rio Grande at a rate that is not sustainable. Dewatering of the river threatens many species, including the Rio Grande shiner (*see* "Factor A," *supra*). Both municipal and agricultural water uses must be reformed and water must be re-allocated to the Rio Grande itself if the river and its inhabitants are to survive and thrive, especially in light of the growing threat of climate change in the Southwest (*see* "Factor E," *infra*).

In Texas, state law "treats surface water and groundwater as separate resources (despite their functional interdependence), with groundwater considered private property. Under this so-called rule of capture law, there is no enforceable legal mandate at the state or local level to maintain minimum aquifer levels (and hence springflow and stream baseflow) needed by endangered species" (Devitt et al. 2018, *internal citations omitted*).

(Factor E) Other Natural or Man-made Factors Affecting its Continued Existence

Climate change. Climate change has and will continue to affect hydrology and ecosystems across the American West. Up to 60 percent of the climate-related trends in river flow, winter air temperature and snow pack between 1950-1999 were influenced by human-induced climate change (Barnett et al. 2008, p. 1,080).

The Rio Grande Basin faces particular threats from climate change. A report prepared for Congress by the U.S. Bureau of Reclamation (BOR) found that warming without precipitation change over the Rio Grande Basin will likely "lead to increased watershed evapotranspiration, decreased spring snowpack and snowmelt, and ultimately reduced water supplies" (BOR 2011, p. 121). The average temperature of the Upper Rio Grande Basin has increased by approximately 1 to 2° F over the course of the 20th century (*Id.*, p. 108). The basin's average temperature increased from the 1910s to the mid-1940s, before declining slightly until the 1970s. Since then, the temperature has increased steadily (*Id.*).

> Over the period 1971 through 2011, average temperatures in the Upper Rio Grande Basin rose at a rate of just under 0.7 degrees Fahrenheit (°F) per decade, a rate approximately double the global rate of temperature rise. Such rates of warming are unprecedented over the last 11,300 years. This rate of warming has the potential to cause significant environmental harm and change the region's hydrology. (BOR 2013a, p. S-iii, *internal citations omitted*)

The basin-average mean-annual temperature in the Upper Rio Grande Basin is expected to increase by roughly 5 to 6° F during the 21st century (BOR 2011, *p.* 111, *see also* BOR 2013, p. S-iii). Additionally, Reclamation projections indicate that overall precipitation will gradually decline over much of the basin during the course of the 21st century (*Id.*). "Climate projections suggest that annual precipitation in the Rio Grande Basin will remain quite variable over the next century, with a decrease of from 2.3 to 2.5 percent by 2050" (BOR 2016, p. 7-5). Although the overall magnitude of precipitation is projected to decrease, the character of precipitation within the Upper Rio Grande basin is expected to change as temperatures increase over time, resulting in more frequent rainfall events and less frequent snowfall events (BOR 2011*,* p. 115). Temperature and precipitation changes are expected to affect hydrology in various ways; warming is expected to diminish the accumulation of snow during the cool season and the availability of snowmelt to sustain runoff to the Upper Rio Grande during the warm season (*Id.*)

Projected climate changes are likely to have an array of interrelated and cascading ecosystem impacts (*Id.*, p. 123). Changes in climate and snowpack within the Upper Rio Grande Basin will alter the availability of natural water supplies, runoff levels, and flood peaks. Throughout the Rio Grande Basin, decade-mean annual runoff is projected to steadily decline through the 21st century as a result of decreasing precipitation and warming (*Id*., p. 115). Total annual runoff could decline as much as 25 percent in some parts of the river (Figure 8). Decreasing minimum runoff and the resulting reduced water flow adversely affects habitats through reduced availability of aquatic habitat and increased water temperatures (*Id*., p. 117). A study of the Upper Rio Grande Basin in 2013; supports these projections: "Supplies of all native [water] sources to the Rio Grande are projected to decrease on average by about one third, while flows in the tributaries that supply the imported water of the San Juan-Chama Project are projected to decrease on average by about one quarter" (BOR 2013, p. S-iv).

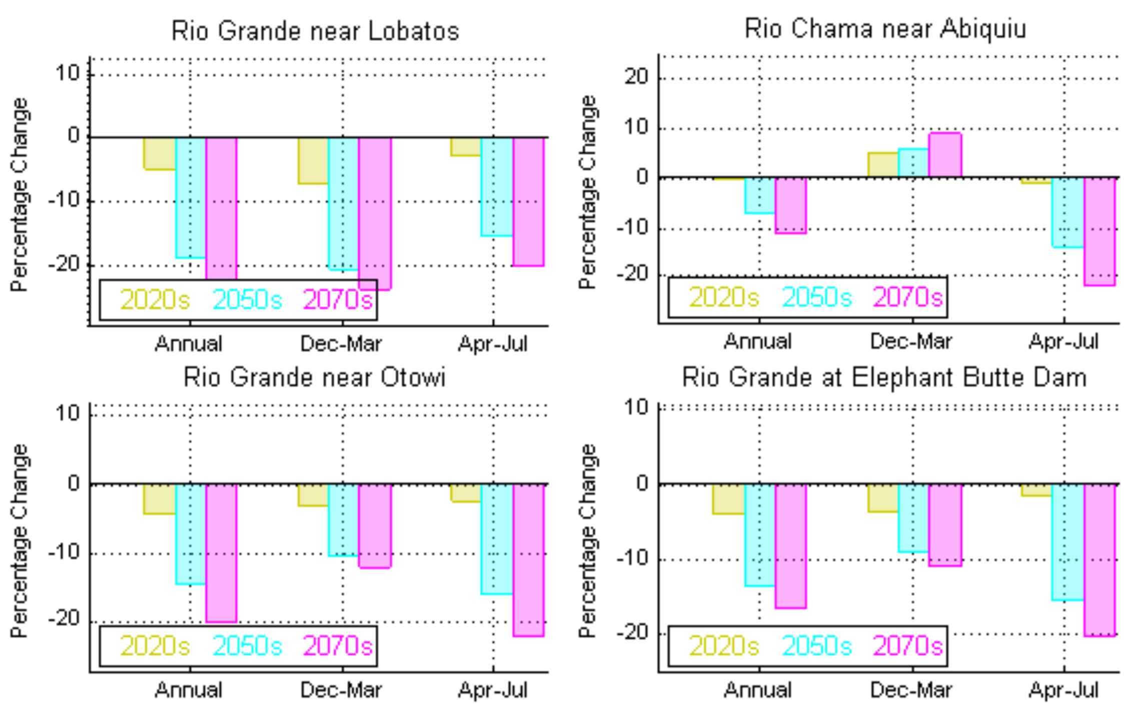
The resulting low flows will likely compound the already-pervasive impacts of dewatering on Rio Grande shiner habitat.

Climate change results in a reduction of water in the Upper Rio Grande system resulting from decreased supplies coupled with increased demands. This reduction in water is expected to make environmental flows in the river more difficult to maintain, and reduce the shallow groundwater available to riparian vegetation. Both of these impacts have implications on the habitat of fish and wildlife in the Upper Rio Grande riparian system. While the inability to meet flow targets is an indirect method to estimate the impact of climate change on riverine habitat, the results of these indicators are not ambiguous: there would be less water in the river, and low flow-related biological requirements would be more difficult to meet (BOR 2013, p. 109).

The Lower Rio Grande Basin in Texas is expected to experience similar climactic shifts:

- Precipitation is expected to increase from the 1990s level during the 2020s and 2050s but decline nominally during the 2070s.
- Temperature shows a persistent increasing trend from the 1990s level.
- April 1 snowpack (Upper Rio Grande Basin) shows a persistent decreasing trend from the 1990s level.
- Annual runoff shows some increase from the 1990s level to the 2020s, but then declines to the 2050s and 2070s. (BOR 2013b, p. 2-32)

Figure 8. Simulated changes in decade-mean runoff for four subbasins in the Rio Grande basin. Each panel shows percentage changes in mean runoff (annual and seasonal) for three future decades (2020s, 2050s, and 2070s) relative to 1990s baseline conditions (BOR 2011, p. 118).



A study conducted primarily in the northern Rio Grande Basin in Colorado and New Mexico detected several trends over a 45-year period which support these projections. The study found significantly increasing trends in mean annual air temperature (Zeigler et al. 2012, p. 1,049), a decrease of 5.3 percent per decade in Snow Water Equivalent (SWE) trends, and a shift in timing of spring snowmelt to 10.7 days earlier (*Id*., p. 1,050). Reduced snowpack, earlier runoff, and higher evaporative demands will affect vegetative cover and species' habitat (Hurd & Coonrod 2007, p. 24). "Increased summer air temperatures could increase dry season aquatic temperatures and affect fisheries habitat" (BOR 2011, p. 123).

> A change in water temperatures is the most likely effect of climate change in most regions, and this change will have secondary effects on water quality parameters (e.g., dissolved oxygen) and biotic processes… Changes in thermal regime pose threats to a broad range of higher level population and community interactions, ranging from direct mortality from acute temperature stress, chronic bioenergetic stresses, and shifts in the balance of interspecies competition as habitat space for some species is reduced. (Meyer et al. 1999, p. 1,378)

Climate warming may also increase competition and hasten the spread of invasive species. "[C]ompetition with surrounding communities (or invasive aliens) appears to accelerate the breakdown of 'islands' of relict vegetation which might otherwise be more resistant to direct climate effects" (Hampe & Petit 2005, pp. 465-466). "The timing, duration, and severity of a specific temperature anomaly may cause undesirable biological organisms (i.e. invasive) to thrive, and strain physical resources such as water and its sources (e.g. snow and glaciers)" (Pedersen et al. 2010, p. 136).

Climate change may particularly impact the pelagic-broadcast spawning guild of which the Rio Grande shiner is a part. "Future climate change might negatively affect [pelagic-broadcast spawning] species as their thermal tolerances are close to maximum summer temperatures. Temperature also alters habitat use, swimming speed, and parasite susceptibility" (Worthington et al., 2018, p. 31*, internal citations omitted*).

Climate change could also result in changed demand for instream flow or reservoir releases to satisfy human needs, such as hydropower generation, municipal and industrial water deliveries, river and reservoir navigation, and agricultural and recreational uses (BOR 2011, p. 125). "[T]he Rio Grande is another western basin that is using its water to the maximum, and even more so than in the Colorado, current projections of climate change suggest that the flows that are currently being disputed and wrangled in the Rio Grande are likely to be less and less available for any use as the century wears on" (Dettinger et al. 2015, p. 2,084).

> [C]ompetition over limited water resources remains a serious stress to aquatic ecosystems… humans currently appropriate [an estimated] 54 percent of runoff that is geographically and temporally accessible to them. This competition is likely to be intensified by climate change. Hence climate-induced changes must be assessed in the context of existing demands for a limited supply of water and massive human-induced changes in water quantity and quality that have resulted from altered patterns of land use, water withdrawal, and species invasions. (Meyer et al. 1999, p. 1,374)

Species and habitats already stressed by water diversion will be less able to cope with climate change (Loarie et al. 2009, p. 1,054). Research suggests that species and ecosystems will need to shift (northward, away from the equator) an average of 0.42 km per year to survive the deleterious effects of increasing temperatures associated with climate change (*Id.* at 1,052). This is not possible for species confined to waterways.

Human population growth. "The ultimate cause of most loss of biodiversity is the exponential expansion of human populations. Until that expansion n and the concomitant rapidly expanding use of natural resources cease, any efforts to protect species from extinction will be short-term 'holding actions'" (Moyle & Leidy 1992, p. 141). As noted in Factor A, *supra*, municipal needs for water are growing as urban areas expand (Wong et al. 2007, p. 18). Along the Rio Grande mainstem, the urban population is growing at a rapid rate of 2 to 4 percent per year (*Id*.). The pressure on the Rio Grande to provide water for municipal and agricultural use will increase with increasing population and will likely be exacerbated as climate change continues to impact the Rio Grande Basin. For example, in the eight-county region of the Lower Rio Grande Basin in south Texas (Cameron, Willacy, Hidalgo, Starr, Zapata, Jim Hogg, Webb, and Maverick counties) the population "is expected to grow from 1.7 million in 2010 to 4.0 million in 2060, resulting in the need for an additional 592,000 ac-ft/yr, or about 35%, of the total water demand... This study determined that climate change may likely increase the shortage by an additional 86,438 ac-ft/yr" (BOR 2013b, p. S-3).

Currently, management of the Rio Grande does not sufficiently protect water for the river itself (*see* "Factor D," *supra*), and therefore as human demand increases, there is no guarantee that natural flows will be maintained.

> The growing imbalance between supply and demand is expected to lead to a greater reliance on non-renewable groundwater resources. Increased reliance on groundwater resources will lead to greater losses from the river into the groundwater system. Additionally, projections suggest a somewhat more reliable supply from the imported San Juan-Chama Project water than from native Rio Grande water. A greater reliability of the imported water supply than the native water supply, which has the most aboriginal and senior water rights holders and users, could have significant socio-economic implications. Finally, all of the changes in water supply that are projected to result from climate change would be compounded by the numerous other changes made to the landscape and to the water supply. (BOR 2016, p. 7-8)

Life history factors. Rio Grande shiners, like Rio Grande silvery minnows, have very short lifespans. A study by Horwitz et al. (2017) points out that these unique life history traits present certain challenges to successful recovery:

> While the rapid development of this species (i.e., from eggs to reproducing adults in ~12 months) can lead to substantial population increases under suitable spawning and recruitment conditions (e.g., elevated and prolonged spring flows), this potential is tempered by its short lifespan, which could dramatically increase

> its risk of population collapse during a series of consecutive drought years. (Horwitz et al. 2017, p. 275, *internal citations omitted*)

The article concludes:

> The absence of adequate conditions for reproduction and survival, even for a single year, has an extremely strong impact on short-lived species, such as the Rio Grande Silvery Minnow, relative to taxa with more numerous and evenly balanced age classes. Whereas poor environmental conditions that continue for several years would typically only have modest effects on longer-lived species, they could pose notable risks to the future persistence of shorter-lived species, particularly considering the impacts of ongoing climate change. (*Id., internal citations omitted*)

The shiner is one of six species of pelagic-spawning fish—those that reproduce by releasing eggs and larvae that passively drift downstream for several days until becoming individuals capable of freely navigating the river—that face extreme challenges meeting their basic needs in the ailing Rio Grande and Pecos River.

> The Rio Grande Basin historically supported at least six pelagophils in three genera. Several of these species have declined dramatically throughout their range, resulting in federal protection for Pecos bluntnose shiner, *Notropis simus pecosensis*, (threatened) and Rio Grande silvery minnow, *Hybognathuasm arus*, (endangered). Two additional taxa, phantom shiner, *Notropis orca*, and Rio Grande bluntnose shiner, *Notropis simus simus*, declined in abundance during the 1950s and 1960s and are now extinct (Dudley & Platania 2007, p. 2,083, *internal citations omitted*)

Scientists recommended over a decade ago that "[a]dditional protection may be necessary for other pelagophils within the region in the near future" (Dudley & Platania 2007, p. 2,083). "Pelagic-spawning fishes… are thought to be particularly susceptible to river regulation because their early life stages (ichthyoplankton) drift until becoming free-swimming, although the extent of transport is largely unknown" (Dudley & Platania 2007, p. 2,074).

> Flow regulation causes increased channelization, decreased geomorphic complexity, loss of connectivity between rivers and floodplains, and thus decreased habitat heterogeneity. Direct river channelization, dredging, rock dikes (groynes), and shoreline revetment also increase flow velocity and redirect flow toward the thalweg. Levee construction for flood control reduces channel area during flow pulses, further increasing velocity. These collective effects of river regulation likely increase the downstream transport of ichthyoplankton into unsuitable downstream environments such as reservoirs or irrigation networks (*Id.,* p. 2,081, *internal citations omitted*).

"Periods of low- or zero-flow may also inhibit reproduction by fish, particularly pelagic broadcast-spawners" (Larson & Propst 2003, p. 2, *internal citations omitted*).

Small, isolated populations. The Service has previously recognized that small population size and small, isolated populations increases the likelihood of extinction.[9] For example, in reference to the Sisi snail (*Ostodes strigatus*), the Service noted that "[e]ven if the threats responsible for the decline of this species were controlled, the persistence of existing populations is hampered by the small number of extant populations and the small geographic range of the known populations." Heightened risk of extinction is "inherent in low numbers," a basic tenet that has been a cornerstone of conservation biology (Caughley, 1994, p. 216). Small, isolated populations such as those of the Rio Grande shiner are particularly vulnerable to: 1) demographic fluctuations, 2) environmental fluctuation in resource or habitat availability, predation, competitive interactions and catastrophes, 3) reduction in cooperative interactions and subsequent decline in fertility and survival, 4) inbreeding depression reducing reproductive fitness, and 5) loss of genetic diversity reducing the ability to evolve and cope with environmental change (Traill et al., 2010, p. 29).

The Service, in their final rule listing the streaked horned lark and Taylor's checkerspot butterfly, considered both species at risk due to small population size or small, isolated populations (USFWS, 2013a, p. 61,489).

> Populations that are small, fragmented, or isolated by habitat loss or modification of naturally patchy habitat, and other human-related factors, are more vulnerable to extirpation by natural, randomly occurring events, to cumulative effects, and to genetic effects that plague small populations, collectively known as small population effects. These effects can include genetic drift (loss of recessive alleles), founder effects (over time, an increasing percentage of the population inheriting a narrow range of traits), and genetic bottlenecks leading to increasingly lower genetic diversity, with consequent negative effects on evolutionary potential. (USFWS, 2013a, p. 61,488)

The Service found similar threats when listing the Florida bonneted bat:

> In general, isolation, whether caused by geographic distance, ecological factors, or reproductive strategy, will likely prevent the influx of new genetic material and can result in low diversity, which may impact viability and fecundity. Distance between subpopulations or colonies, the small sizes of colonies, and the general low number of bats may make recolonization unlikely if any site is extirpated. Isolation of habitat can prevent recolonization from other sites and potentially result in extinction. The probability of extinction increases with decreasing habitat availability. Although changes in the environment may cause populations to fluctuate naturally, small and low-density populations are more likely to fluctuate below a minimum viable population (i.e., the minimum or threshold number of individuals needed in a population to persist in a viable state for a given interval). If populations become fragmented, genetic diversity will be

[9] For examples, see candidate assessment forms for *Ostodes strigatus* (Sisi snail, June 2013), *Porzana tabuensis* (spotless crake, June 2013), *Vagrans egistina* (Mariana wandering butterfly, June 2013), *Gallicolumba stairi* (friendly ground-dove, June 2013), and *Hyla wrightorum* (Arizona treefrog, April 2013) (Available at http://ecos.fws.gov/tess_public/pub/SpeciesReport.do?listingType=C&mapstatus=1)

> lost as smaller populations become more isolated. (USFWS, 2013b, p. 61,037, *internal citations omitted*)

The Rio Grande shiner has small, isolated populations and fragmented habitat, and thus is facing a similar risk of extinction.

Cumulative threats. The Service should consider whether the array of aforementioned threats intersect and act synergistically, therefore increasing the likelihood of extinction or endangerment of the Rio Grande shiner in the foreseeable future. For example, "[c]limate change may act synergistically with other anthropogenic stressors, e.g., reduced base-flows in the spawning season and contaminants, to further impact [pelagic-broadcast spawners] and other Great Plains species" (Worthington et al., 2018, p. 31*, internal citations omitted*).

> Traits such as ecological specialization and low population density act synergistically to elevate extinction risk above that expected from their additive contributions, because rarity itself imparts higher risk and specialization reduces the capacity of a species to adapt to habitat loss by shifting range or changing diet. Similarly, interactions between environmental factors and intrinsic characteristics make large-bodied, long-generation and low-fecundity species particularly predisposed to anthropogenic threats given their lower replacement rates. (Brook et al., 2008, p. 455, *internal citations omitted*)

> [O]nly by treating extinction as a synergistic process will predictions of risk for most species approximate reality, and conservation efforts therefore be effective. However challenging it is, policy to mitigate biodiversity loss must accept the need to manage multiple threatening processes simultaneously over longer terms. Habitat preservation, restoring degraded landscapes, maintaining or creating connectivity, avoiding overharvest, reducing fire risk and cutting carbon emissions have to be planned in unison. Otherwise, conservation actions which only tackle individual threats risk becoming half-measures which end in failure, due to uncontrolled cascading effects. (Brook et al., 2008, p. 459, *internal citations omitted*)

CONCLUSION AND REQUESTED DESIGNATION

Guardians hereby petitions the Service to list the Rio Grande shiner (*Notropis jemezanus)* as an "endangered" species under the Endangered Species Act. Listing is warranted, given the rarity of this species and ongoing and future threats. The Rio Grande shiner is threatened by at least three of the five listing factors under the ESA: (Factor A) The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range; (Factor D) The Inadequacy of Existing Regulatory Mechanisms; and (Factor E) Other Natural or Man-made Factors.

Guardians also requests that critical habitat be designated for the Rio Grande shiner in occupied and unoccupied suitable habitat concurrent with final ESA listing. Designating critical habitat for this species will support its recovery and protect areas crucial to long-term survival of Rio Grande shiner populations. Guardians also requests timely development of a recovery plan.

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