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In Reply refer to:
2023-0133893

Memorandum

To: Acting Regional Director, U.S. Fish and Wildlife Service, Albuquerque, New Mexico

Through: Acting Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service Region 2, Albuquerque, New Mexico

From: Field Supervisor, Arizona Ecological Services Field Office, Phoenix, Arizona

HEATHER WHITLAW

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Date: 2025.07.28 15:30:19 -07'00'

Subject: Intra-Service Biological Opinion on the issuance of a 10(a)(1)(A) Enhancement of Survival Permit and Approval of the *Eagle Creek Multi-Species Conservation Benefit Agreement* (CBA) and Biological Opinion on the U.S. Bureau of Reclamation Eagle Creek Barrier Construction and Maintenance

This document transmits the U.S. Fish and Wildlife Service's (Service) intra-Service biological opinion (BO) on the effects of our issuance of an Enhancement of Survival Permit (EOS permit) pursuant to Section 10(a)(1)(A) of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. §§ 1531-1544), and approval of Freeport-McMoRan Morenci, Inc. and the Morenci Water and Electric Company's (Permittee) *Eagle Creek Multi-Species Conservation Benefit Agreement* (CBA). The EOS permit authorizes the incidental take of the federally-listed endangered spikedace (*Meda fulgida*), loach minnow (*Tiaroga cobitis*), Gila chub (*Gila intermedia*), and designated critical habitat for the three species; and the federally-listed threatened narrow-headed gartersnake (*Thamnophis rufipunctatus*). Although the federally-listed threatened western yellow-billed cuckoo (*Coccyzus americanus*) is not a covered species under the CBA, we evaluated the potential affects to the species related to the EOS permit issuance and approval of the CBA and have made a "may affect, not likely to adversely affect" determination for the species. Rationale for our determination is provided in Appendix A.

In addition, this BO addresses the United States Bureau of Reclamation's (Reclamation) proposed fish barrier construction in Eagle Creek on the spikedace, loach minnow, Gila chub, and designated critical habitat for the three species; narrow-headed gartersnake; and western yellow-billed cuckoo pursuant to section 7(a)(2) of the Act. Reclamation's request for formal consultation on spikedace, loach minnow, Gila chub, and narrow-headed gartersnake was received on October 1, 2024, and we initiated consultation on the same day. Reclamation also requested our concurrence that the proposed action is "not likely to adversely affect" the western yellow-billed cuckoo. We concur with that determination for the western yellow-billed cuckoo and provide our rationale in Appendix A.

Barrier construction would be funded by the Permittee and Reclamation. In cooperation with the Permittee, Reclamation has designed and will construct, operate, and maintain the fish barrier in Eagle Creek, Greenlee County, Arizona. The portions of the BO relevant to barrier construction are based on information provided in Reclamation's October 1, 2024, Biological Assessment (BA). Effects of the action relevant to our issuance of an EOS permit and approval of the CBA are based on information in the CBA, and other sources of information and correspondence. Literature cited in this BO is not a complete bibliography of all literature available on the species of concern, and the effects on the species and their critical habitat, or on other subjects considered in this BO. A complete administrative record of this consultation is on file at the Arizona Ecological Services Field Office.

CONSULTATION HISTORY

The following consultation history begins with Reclamation's August 13, 2024, request for initiation of consultation.

- October 1, 2024: We received an email and memo from Reclamation with attachments, including the BA, requesting the initiation of formal consultation for the proposed fish barrier construction project.
- October 1, 2024: We initiated consultation on the proposed project.
- December 20, 2025: We received the Permittee's application for an EOS permit supported by the CBA.
- January 3, 2025: We announced availability of the CBA, EOS permit application, and draft Environmental Assessment for the CBA and fish barrier project for a 30-day public review.
- February 20, 2025: We requested a 60-day extension from Reclamation to complete the biological opinion.
- February 20, 2025: We received an email from Reclamation accepting our request for the 60-day extension.
- June 2, 2025: We provided a draft BO to Reclamation for review.
- June 12, 2025: We received Reclamation's comments on the draft BO.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

Regulations implementing the Act (50 CFR 402.02) define "action" as "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies of the United States or upon the high seas."

Issuance of the EOS Permit and Conservation Benefit Agreement Approval

The Permittee operates the Morenci Mine near the town of Clifton, in Greenlee County Arizona. The Permittee owns land along Eagle Creek and holds associated surface water rights and groundwater rights to facilitate the transport of water in support of its mining operations. These land and water rights are also used for municipal water service and other related uses in the vicinity of the mine.

The Permittee applied for an EOS permit supported by the CBA. The purpose of the CBA is to provide a plan to implement conservation actions to protect and enhance habitat for spikedace, loach minnow, Gila chub, and narrow-headed gartersnake in the upper portion of Eagle Creek and its tributaries. Under the CBA, and in compliance with the Permittee's *Spikedace and Loach Minnow Management Plan: Eagle Creek and San Francisco River, Greenlee and Graham County, Arizona* (October 21, 2011; Management Plan), the Permittee will undertake and fund the conservation actions described below in "Conservation Measures". These conservation actions are intended to protect and enhance habitat on portions of Eagle Creek for aquatic species listed under the Act, thereby aiding in their recovery and providing a net conservation benefit. In addition, the CBA is intended to establish a framework for cooperation and coordination with the Service in connection with resource conservation actions based on adaptive management principles, at a total cost to Permittee of up to $2,100,000, to protect and enhance habitat for the species. Under the CBA, the Permittee will continue to conduct existing activities that support its mining operations as described in "Covered Activities".

Covered Activities

The Permittee's enrolled property covered in the CBA is located along Eagle Creek (Parcels 1 through 10; Figures 2 and 3). These lands collectively represent the Covered Area for purposes of this BO. The barrier will be constructed within Parcel 10. The Permittee does not conduct any activities on this parcel or Parcel 9. A single residence and outbuildings occur within Parcel 8 where ongoing operations and maintenance are permitted to occur. The Mud Springs well field and associated pumps (four total) and water pipeline occur in Parcels 3 through 7. Parcel 2 includes the Bee Canyon well field along with the associated pumps (two total), facilities, and a single residence where ongoing operations and maintenance are permitted to occur. Parcel 1 includes the pumps, water pipeline, and diversion features described in more detail below.

As part of the CBA, the Permittee will continue to divert water from the Black River to Eagle Creek via Willow Creek, with water entering Eagle Creek at approximately river mile 44.2 (71 kilometer [km]). The Permittee will also continue to pump groundwater from the Mud Springs Well Field and divert flows by gravity through a 22-inch (in) (56 centimeters [cm]) diameter pipe approximately five miles (8 km) to a concrete discharge box near Eagle Creek where it is released into Eagle Creek near river mile 43 (69 km), approximately one mile (1.6 km) south of the confluence of Willow Creek and Eagle Creek (Parcels 3 through 7, Figure 2). In addition, the groundwater that is pumped from the Bee Canyon Well Field (Parcel 2, Figure 2) will be discharged into the Bee Canyon channel, which flows into Big Dry Creek, and in turn flows into Eagle Creek near river mile 42.2 (71 km). The ongoing groundwater pumping and water releases further augment stream flow at and below the Willow Creek confluence. The Permittee does not own any property along Eagle Creek at the confluences of Willow Creek or Bee Canyon and the Permittee does not conduct any management activities in these areas.

Maintenance at each well site requires activities such as turning the pump on and off (every few days), oil changes (every 1 to 2 months), gearhead maintenance (every 3 to 4 months), and occasional emergency repairs. The vegetation within 100 ft (30 m) of each well is periodically cleared to minimize wildfire risk. No riparian vegetation will be cleared or cut as part of normal operations. The two wells in Parcel 2 (Figure 2) are decreasing their yields. The Permittees may deepen the existing wells or drill two new ones in the next two to three years. If this occurs, the operations will likely be in the vicinity of the existing wells, but outside of riparian habitat.

The Permittee owns and operates an existing diversion dam at river mile 13.8 (22.2 km) and a land parcel (Parcel 1, Figure 3) at river mile 11.5 (18.5 km) on which they operate a pump station and associated infrastructure. The infrastructure at this site includes a pipeline that conveys water from a settling pond to a storage tank, a storage tank, an overhead pipeline that conveys water from the storage tank over Eagle Creek to pump stations, and an above ground pipeline that returns excess water from the storage tank into Eagle Creek. At present, the Permittee does not conduct any activities other than periodic maintenance and, as needed, repair of the pump station (located inside a building), the diversion dam, pipelines, and other associated infrastructure.

Specific maintenance at this location includes:

1) Removing brush and debris from the tunnel at the diversion dam. This is completed by hand during high flow periods (spring runoff and monsoon season) and can be as frequent as daily during these periods.
2) Draining the settlement basin and flushing out sediment twice a year concurrent with shut down of the Morenci Mill (typically early spring and late fall). The flushing takes a couple of days using mechanized equipment. Routine maintenance also includes periodic clearing of non-riparian ground vegetation around the perimeter of the basin.
3) Limited, selective clearing of small trees and branches annually during winter months to maintain visibility of the pipeline and other infrastructure around the pump station. The clearing does occasionally involve riparian vegetation.
4) Emergency repairs such as replacement of aged facilities, pipelines, or other infrastructure upgrades to ensure adequate operating capacity.

The Permittee intends to continue to pump groundwater and transport and divert water in support of its mining operations as described above for the foreseeable future. It is possible that, in the future, the Permittee may alter the manner in which it diverts and transports water including potentially installing pipelines or other infrastructure to transport water for its operations. However, at this time the Permittee has no proposal to alter its water transportation and diversion facilities and associated infrastructure in the vicinity of Eagle Creek except as may be required to ensure the continued groundwater pumping, diversion, and delivery of water as described above. As noted above, these activities would all occur below the constructed barrier.

<u>Fish Barrier Construction</u>

Reclamation is constructing the Eagle Creek fish barrier project (barrier project) as partial completion of their conservation commitments under the Central Arizona Project biological opinions (USFWS 1994, 2001, 2008). These opinions address the transport and delivery of water through the Central Arizona Project (CAP) and its potential to introduce and spread nonnative aquatic species in the Gila River basin.

Reclamation would construct the proposed barrier project approximately 25 miles (mi) (40 km) north northwest of the town of Morenci in east-central Arizona (Figure 1). The proposed construction site is located on private lands (Parcel 10, Figure 1) owned by the Permittee near river mile 51.5 (83 km), approximately 7.9 mi (12.7 km) upstream of Eagle Creek's confluence with Willow Creek.

Existing roads (United States (U.S.) Highway 191 and Upper Eagle Creek Road) would be used to access the site. A temporary construction easement (TCE) area (29.86 acres [ac]; 12.1 hectares [ha]) is identified in the BA. Within this area, there are two construction and equipment staging areas (contractor use area; 2.09 ac, 0.8 ha) and a fish barrier construction area footprint (0.31 ac; 0.13 ha) located along Eagle Creek (Figure 1). Long-term operation and maintenance of the structure, including routine inspections and maintenance, are also part of the proposed action. Operations and maintenance may occur anywhere within the 10.86 ac (4.4 ha) perpetual, non-exclusive easement (Easement) area (Figure 1).

The proposed barrier project would involve the construction of a reinforced concrete drop structure within upper Eagle Creek to preclude the upstream movement of nonnative fishes from lower Eagle Creek and the Gila River. The barrier project is designed to prevent fish movement during periods of base flow and portions of ascending and descending stages of floods that do not completely inundate the drop structure. At flows associated with peak floods that may submerge the fish barrier's crest at the abutments, high water velocity would be the primary hindrance to the upstream movement of nonnative fishes.

Construction of the proposed barrier project would occur between mid-October and mid-March in either 2026 or 2027. Fall construction is preferable to avoid high river flows that result from snowmelt (February to April) and monsoon storms (June to September).

The proposed barrier project would consist of three key features: (1) a 4-foot-high arched drop structure placed across the 100-foot-wide channel; (2) a sloped concrete apron spanning the width of the drop structure to prevent plunge pool development; and (3) buried upstream and downstream scour walls to help anchor the barrier and prevent scour from undermining the structure. Additionally, the fish barrier would be designed to withstand forces associated with a 100-year frequency flood (e.g., anchored to abutment bedrock with anchor bars and keyed into the channel alluvium to ensure stability) as determined by hydraulic modeling and engineering.

The sequence of construction would consist of site mobilization (delivery of equipment and setup of the staging area); site preparation (excavation of streambed alluvium for construction of the scour walls, dewatering, and stream diversion); construction of the concrete formwork, placement of concrete, and placement of backfill; and demobilization (site restoration and removal of equipment). Stream flow, if present, would be diverted with dikes or piped around the active work areas prior to being returned to the active stream channel below the construction area. Specific dewatering methods would be determined by the contractor. Prior to dewatering, the stream would be surveyed at the project site, and any fish present would be relocated. Increases in sedimentation during active construction would be minimized by diverting stream flow around the construction zone. Alluvial deposits adjacent to the foundation trench would be dewatered with shallow subsurface pumps to keep the excavation free of water during construction. Water from these pumps would be discharged to the channel immediately downstream of the construction area.

Concrete would be placed in several phases to allow for continuous stream diversion. Standard excavation methods would be used to prepare the foundation trench for placement of formwork and concrete. Fluvial material extracted from this trench would be temporarily stockpiled within the fish barrier construction footprint for reuse as backfill once the barrier construction is complete. Batched concrete would be delivered by commercial mixer trucks to the lower contractor use area, where it would be pumped to the fish barrier construction area in a pipe.

Finally, construction crews (consisting of 4 to 5 workers) may also camp within the two contractor use areas. No firewood cutting or gathering of firewood would be permitted, and sanitary services would be provided by the Permittee.

At the end of construction, dewatering pumps would be removed, and diversion berms and any surplus stockpiles of excavated alluvium would be spread to conform to the predominant contours of the ground surface. All unused construction materials would be removed when the barrier project is finished.

Once the barrier project is completed, inspection and maintenance would be transferred to and performed by the Central Arizona Water Conservation District. Operation of the structure would require annual inspections as well as post-major flood event inspections (5-year flood event equivalency or greater). Routine inspection and maintenance of the proposed fish barrier is also part of the proposed action and is commensurate with the current operational authorizations of the CAP. Based on previous CAP actions at other Reclamation fish barriers, maintenance may include activities such as painting or cleaning of graffiti; vegetation and sediment removal; and concrete erosion repair (i.e., installation of non-shrink grout or placement of steel plates). The frequency of operation and maintenance activities is anticipated to include annual inspections and inspections after major flood events (5-year frequency or greater). If any substantial maintenance or repair activities (outside of the scope of Reclamation’s BA and this BO) are required, Reclamation will coordinate with the Permittee, Service, and other appropriate agencies prior to any action.

Conservation Measures

Issuance of the EOS Permit and CBA Approval

The following general and species-specific conservation actions will be implemented by the Permittee as part of the CBA:

- The Permittee will spend up to $2,100,000 to investigate, design, and construct a fish barrier on Eagle Creek that will protect and enhance aquatic habitat for the Covered Species. The fish barrier will prevent nonnative species from moving upstream into the upper portion of the Eagle Creek, protecting the species covered by the permit and their habitat.
- The Permittee will develop and implement a three-year monitoring program to detect the presence of nonnative invasive crayfish within the upper reach of Eagle Creek and investigate the practicability and cost of actions to suppress the populations of these species in the upper segment of Eagle Creek, above the fish barrier site.

- The Permittee will undertake a monitoring program on its land along Eagle Creek. This program will include annual surveys on Eagle Creek for the Gila chub, spikedace, loach minnow, and narrow-headed gartersnake[1] as well as other fish species, which can be used to inform future conservation and management activities and assist in recovery.

Fish Barrier Construction

The following general and species-specific conservation measures will be implemented by Reclamation with the intent to avoid and minimize adverse effects resulting from barrier construction:

Narrow-headed Gartersnake

- Reclamation will make all reasonable efforts to ensure that pollutants do not enter surface waters during any barrier construction and maintenance activities.
- Reclamation will make all reasonable efforts to minimize damage to, or loss of, narrow-headed gartersnake habitat in the project area.
- Reclamation will make reasonable efforts to ensure monitoring for the presence of narrow-headed gartersnakes prior to the beginning of any construction, or operation and maintenance activities.
- Prior to initiation of construction, contractor personnel will be provided with environmental awareness training that provides information on the life history, status, identification, and measures used to prevent or mitigate potential impacts to narrow-headed gartersnakes.
- If a gartersnake is identified during construction, if appropriate, the contractor will photograph suspected narrow-headed gartersnakes for expert identification and confirmation of species presence.
- Examples of reasonable efforts include: stream diversion and dewatering during construction; directing contractors to avoid harming mature riparian trees and minimize vegetation impacts; limit trampling/crushing of vegetation in staging areas; stabilizing disturbed areas with a native seed plant mix post construction; checking under equipment and materials before use/movement to ensure narrow-headed gartersnake are not present; ensuring relocated or redistributed sediment is clear of narrow-headed gartersnakes; and pausing or shifting work to another location if a narrow-headed gartersnake is encountered to allow it to leave the area.

Native Fish and Aquatic Species

- Prior to the initiation of construction, a permitted fish biologist will survey the project area for any temporary pools that may be hosting native fish and gartersnake. Surveys will be conducted with dip nets, fish seines, or other methods necessary to capture native fish or gartersnake and relocate them upstream or downstream of the proposed barrier. Reclamation shall submit a summary report of the project to the Service within 12 weeks

[1] Although not required by the Conservation Benefit Agreement, the Permittee has agreed to allow access, with prior notice, to conduct surveys for narrow-headed gartersnake to enhance knowledge about the species distribution and habitat use within Eagle Creek (U.S. Fish and Wildlife Service 2025).

of project completion that documents the implementation of mitigation measures and any fish or gartersnake encounters.

Western Yellow-billed Cuckoo

- Activities associated with barrier project construction would take place between mid-October to mid-March when the western yellow-billed cuckoo is likely not present in Arizona. If possible, operation and maintenance activities will not occur between May 25 to September 30, to avoid impacts to this species during the period when they are anticipated to be present in the action area.
- As part of Reclamation's Clean Water Act Section 404 permit for activities associated with barrier project construction, all vegetative impacts have been previously mitigated for through the acquisition of a 1,420-ac (575 ha) conservation easement on 3 Links Farm that contains an approximate 300-ac (121 ha) riparian zone. The mitigation property features perennial flows, abundant native streamside vegetation, and an abundance of native aquatic species. Western yellow-billed cuckoos and southwestern willow flycatchers (*Empidonax trailii estimus*) are also detected there annually.

Action Area

The action area is defined at (50 CFR 402.02) as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action. The Service has determined that the action area for this project includes the 29.86 ac (12.1 ha) of TCE, a portion of which includes 0.75 mi (1.22 km) of perennial habitat upstream of the barrier; up to one mile of perennial habitat below the barrier; and Forest Service roads used to access the site. The TCE includes the barrier project footprint, along with the contractor use storage, camping, and staging areas, plus the easement area for future operations and maintenance.

As part of the CBA, the Permittee's property covered in the CBA (Parcels 1 through 10; Figures 2 and 3) is included in the action area. Offsite impacts are anticipated below the Permittee's properties as part of the covered activities; therefore, we are including the downstream portions of Eagle Creek between Parcels 3, 4 and 8; between Parcel 2 and 3; and up to one mi (1.6 km) below Parcel 2 within the action area.

STATUS OF THE SPECIES AND CRITICAL HABITAT

GILA CHUB

Legal Status

The Gila chub was listed as endangered with critical habitat in 2005 (USFWS 2005). Primary threats to Gila chub, such as predation by and competition with nonnative organisms, and secondary threats identified as habitat alteration, destruction, and fragmentation are all factors identified in the final rule that contribute to the consideration that the Gila chub is endangered or likely to become extinct throughout all or a significant portion of its range.

Gila chub was formerly considered a separate taxonomic entity but is now recognized, along with headwater chub and roundtail chub, as a single taxonomic species—the roundtail chub (*Gila robusta*) (USFWS 2017). We intend to reevaluate the status of the Gila chub, which is currently listed as endangered with critical habitat (USFWS 2005). However, until that evaluation is completed and potential proposed and final rules to delist the Gila chub are published, its legal status remains as an endangered species with designated critical habitat. Our effects analysis in this biological opinion reflects this current status.

Background

Gila chub is a member of the roundtail chub (*Gila robusta*) complex that also includes headwater chub (*G. nigra*). The roundtail chub complex has had a turbulent and controversial taxonomic history that includes an assortment of classification schemes. Much of the debate has centered on whether the complex represents a number of nominal species or subspecies of Gila robusta. A nomenclatorial synonymy for Gila chub can be found in Minckley (1973).

Gila chub has long been recognized as distinct. Miller (1945) supported full generic rank for the genus Gila (Baird and Girard 1853) with a "*Gila robusta* complex" that included Gila chub. Miller (1946) considered Gila chub to be an "ecological subspecies" of *G. robusta* (i.e., *G. r. intermedia*) characteristic of the small tributaries they inhabit. Rinne (1969, 1976), using univariate analyses of morphological and meristic characters, argued for recognition of both *G. robusta* and *G. intermedia* as distinct species and against the ecological subspecies concept. This approach was supported by some (e.g., Minckley 1973), but it was not until further evidence was generated by DeMarais (1986, 1995) that the specific status for *G. intermedia* was generally accepted. DeMarais (1995) supported continued recognition of *G. intermedia* based on the following arguments: 1) phenotypic extremes between *G. intermedia* and *G. robusta* are widely divergent and each possesses many morphologically uniform populations; (2) the geographic distributions of both species is an overlapping mosaic, therefore not satisfying traditional geographic criteria; and (3) contiguous populations of *G. intermedia* and *G. robusta* show no evidence of genetic exchange, thus each species maintains its evolutionary independence.

Gila chub is a thick-bodied species, chunky in aspect, whereas roundtail chub is slender and elongate, and headwater chub is intermediate in meristic and morphometric characteristics (Rinne 1969, 1976; Minckley 1973; DeMarais 1986; Minckley and DeMarais 2000; Minckley and Marsh 2009). Females can reach 250 mm (9.8 inches; in) in total length (TL), but males rarely exceed 150 mm (5.9 in) (Minckley 1968, 1973; Rinne and Minckley 1991; Schultz and Bonar 2007). Body coloration is typically dark overall, sometimes black or with diffuse, longitudinal stripes, with a lighter belly speckled with gray. The lateral scales often appear to be darkly outlined, lighter in center. Breeding males, and to a lesser extent females, develop red or orange on lower parts of the head and body and on bases of the pectoral, pelvic and anal fins.

While most reproductive activity by Gila chub occurs during late spring and summer, in some habitats it may extend from late winter through early autumn (Minckley 1973). Schultz and Bonar (2007) data from Bonita and Cienega creeks suggested that multiple spawning attempts per year per individual were likely, with a major spawn in late February to early March followed by a secondary spawn in autumn after monsoon rains. Reproductive activities in Monkey Spring (now extirpated) reportedly occurred for longer periods than in other populations, as breeding appeared to last virtually all season (Minckley 1968, 1973, 1985). Bestgen (1985) concluded that temperature was the most significant environmental factor triggering spawning.

Spawning probably occurs over beds of submerged aquatic vegetation or root wads. Minckley (1973) observed a single female closely followed by several males over a bed of aquatic vegetation in a pond. Nelson (1993) also suspected deep pools with vegetation in Cienega Creek were important sites for spawning but did not witness any associated behavior near submerged vegetation.

Gila chub is considered a habitat generalist (Schultz and Bonar 2007), and commonly inhabits pools in smaller steams, cienegas, and artificial impoundments throughout its range in the Gila River basin at elevations between 609 and 1,676 m (2,000 to 5,500 ft) (Miller 1946; Minckley 1973; Rinne 1975; Weedman et al. 1996). Common riparian plants associated with these populations include willows, tamarisk (*Tamarix* spp.), cottonwoods, seep-willow (*Baccharis glutinosa*), and ash (*Fraxinus* spp.). Typical aquatic vegetation includes watercress (*Nasturtium officinale*), horsetail (*Equisetum* spp.), rushes (*Juncus* spp.), and speedwell (*Veronica anagallis-aquatica*) (USFWS 1983; Weedman et al. 1996).

Gila chub is a highly secretive species, remaining near cover including undercut banks, terrestrial vegetation, boulders, root wads, fallen logs, and thick overhanging or aquatic vegetation in deeper waters, especially pools (Rinne and Minckley 1991; Nelson 1993; Weedman et al. 1996). Recurrent flooding and a natural hydrograph are important in maintaining Gila chub habitats and in helping the species maintain a competitive edge over invading nonnative aquatic species (Propst et al. 1986; Minckley and Meffe 1987). They can survive in larger steam habitats, such as the San Carlos River, and artificial habitats, like the Buckeye Canal (Stout et al. 1970; Rinne 1976; Minckley 1985; Rinne and Minckley 1991), and they interact with spring and small-stream fishes regularly (Meffe 1985).

Young Gila chub are active throughout the day and feed on small invertebrates as well as aquatic vegetation (especially filamentous algae) and organic debris (Bestgen 1985; Griffith and Tiersch 1989; Rinne and Minckley 1991). Adult Gila chub are crepuscular feeders, consuming a variety of terrestrial and aquatic invertebrates, and fishes (Griffith and Tiersch 1989; Rinne and Minckley 1991). Benthic feeding may also occur, as suggested by presence of small gravel particles.

Gila chub evolved in a fish community with low species diversity and where few predators existed, and as a result developed few or no mechanisms to deal with predation (Carlson and Muth 1989). This species is known to be associated with speckled dace (*Rhinichthys osculus*), longfin dace, desert sucker (*Pantosteus clarki*), Sonora sucker (*Catostomus insignis*), Gila topminnow (*Poeciliopsis occidentalis*), desert pupfish (*Cyprinodon macularius*), and Monkey Spring pupfish (*C. arcuatus*). Prior to the widespread introduction of nonnative fishes, Gila chub was probably the most predatory fish within the habitats it occupied. In the presence of the nonnative green sunfish (*Lepomis cyanellus*) in lower Sabino Creek, Arizona, Gila chub failed to recruit young (Dudley and Matter 2000). Direct predation by green sunfish on young Gila chub was the acknowledged cause of this observation.

<u>Status and Distribution</u>

Historically, Gila chub was recorded from nearly 50 rivers, streams and spring-fed tributaries throughout the Gila River basin in southwestern New Mexico, central and southeastern Arizona, and northern Sonora, Mexico (Rinne and Minckley 1970; Minckley 1973; Miller and Lowe 1976; Rinne 1976; DeMarais 1986; Sublette et al. 1990; Weedman et al. 1996); and, occupancy of Gila chub throughout its range was more dense, and currently-occupied sites were likely more expansive in distribution (Hendrickson and Minckley 1984; Minckley 1985; Rinne and Minckley 1991). Gila chub remain occupied in the Agua Fria River, Verde River, Santa Cruz River, San Pedro River, and Upper Gila River Subbasins. For a complete status of Gila chub populations within the five subbasins referenced above, refer to the Species Status Report for the roundtail chub (*Gila robusta*) in the Lower Colorado River Basin (USFWS 2022).

Gila Chub Critical Habitat

Critical habitat for Gila chub is designated for approximately 160.3 miles of stream reaches in Arizona and New Mexico that includes cienegas, headwaters, spring-fed streams, perennial streams, and spring-fed ponds. Critical habitat includes the area of bankfull width plus 300 feet on either side of the banks. The bankfull width is the width of the stream or river at bankfull discharge (i.e., the flow at which water begins to leave the channel and move into the floodplain) (Rosgen 1996; USFWS 2005). Critical habitat is organized into seven areas or river units (USFWS 2005).

There are seven primary constituent elements of critical habitat, which include those habitat features required for the physiological, behavioral, and ecological needs of the species:

1) Perennial pools, areas of higher velocity between pools, and areas of shallow water among plants or eddies all found in headwaters, springs, and cienegas, generally of smaller tributaries;
2) Water temperatures for spawning ranging from 63°F to 75 °F, and seasonally appropriate temperatures for all life stages (varying from about 50°F to 86 °F;
3) Water quality with reduced levels of contaminants, including excessive levels of sediments adverse to Gila chub health, and adequate levels of pH (e.g. ranging from 6.5 to 9.5), dissolved oxygen (i.e., ranging from 3.0 ppm to 10.0 ppm) and conductivity (i.e., 100 mmhos to 1,000 mmhos);
4) Prey base consisting of invertebrates (i.e., aquatic and terrestrial insects) and aquatic plants (i.e., diatoms and filamentous green algae);
5) Sufficient cover consisting of downed logs in the water channel, submerged aquatic vegetation, submerged large tree root wads, undercut banks with sufficient overhanging vegetation, large rocks and boulders with overhangs, a high degree of stream bank stability, and a healthy, intact riparian vegetation community;
6) Habitat devoid of nonnative aquatic species detrimental to Gila chub or habitat in which detrimental nonnative species are kept at a level that allows Gila chub to continue to survive and reproduce; and
7) Streams that maintain a natural flow pattern including periodic flooding.

Consultation History

Our information indicates that, rangewide, more than 50 consultations have been completed or are underway for actions affecting Gila chub. These opinions primarily include the effects of grazing, water developments, fire, species control efforts, recreation, sportfish stocking, native fish restoration efforts, and mining.

SPIKEDACE

Listing

Spikedace was originally listed as a threatened species on July 1, 1986 (U.S. Fish and Wildlife Service 1986) and was reclassified to endangered status on February 23, 2012 (U.S. Fish and

Wildlife Service 2012). The current critical habitat designation was published simultaneously with the reclassification of spikedace to endangered status.

Critical Habitat

When critical habitat for spikedace was designated in 2012, the Service determined the PCEs for spikedace. The spikedace critical habitat designation includes eight units based on river subbasins, including the Verde River, Salt River, San Pedro, Bonita Creek, Eagle Creek, San Francisco River, Blue River, and Gila River subbasins. Occupancy within these units is described in USFWS (2012).

Primary Constituent Elements (PCEs) of Critical Habitat

PCEs include those habitat features required for the physiological, behavioral, and ecological needs of the species. The PCEs describe appropriate flow regimes, velocities, and depths; stream microhabitats; stream gradients; water temperatures; and acceptable pollutant and nonnative species levels (U.S. Fish and Wildlife Service 2012). PCEs for the spikedace include:

• PCE 1: Habitat to support all egg, larval, juvenile, and adult spikedace, which includes: a. Perennial flows with a stream depth generally less than 3.3 ft (1 meter), and with slow to swift flow velocities between 1.9 and 31.5 in/sec (4.8 and 80 cm/sec); b. Appropriate stream microhabitat types including glides, runs, riffles, and the margins of pools and eddies, and backwater components over sand, gravel, and cobble substrates with low or moderate amounts of fine sediment and substrate embeddedness; c. Appropriate stream habitat with a low gradient of less than approximately 1%, at elevations below 6,890 ft (2,100 m); and d. Water temperatures in the general range of 46.4 to 82.4°F (8 to 28°C);

• PCE 2: An abundant aquatic insect food base consisting of mayflies, true flies, black flies, caddisflies, stoneflies, and dragonflies;

• PCE 3: Streams with no or no more than low levels of pollutants;

• PCE 4: Perennial flows, or interrupted stream courses that are periodically dewatered but that serve as connective corridors between occupied or seasonally occupied habitat and through which the species may move when the habitat is wetted;

• PCE 5: No nonnative aquatic species or levels of nonnative aquatic species that are sufficiently low as to allow persistence of spikedace; and

• PCE 6: Streams with a natural, unregulated flow regime that allows for periodic flooding or, if flows are modified or regulated, a flow regime that allows for adequate river functions, such as flows capable of transporting sediments.

Information for subbasins relevant to this consultation are summarized in the table below. See USFWS (2012) for additional detail.

Table 1. Critical habitat designated for spikedace, by subbasin.

Unit	Stream	Total Mi (Km)	Area Designated
Unit 5 – Eagle Creek Subbasin	Eagle Creek	16.5 (26.5)	Eagle Creek from the Freeport-McMoRan diversion dam at Township 4 South, Range 28 East, southwest quarter of the northwest quarter of section 23 upstream to the confluence of East Eagle Creek in Township 2 North, Range 28 East, southwest quarter of section 20. This area does not include portions of Eagle Creek on lands belonging to Freeport-McMoRan, which is excluded from this designation.

Background

Spikedace is a small, silvery fish whose common name alludes to the well-developed spine in the dorsal fin (Minckley 1973). Spikedace are omnivores that feed primarily upon insects transported in stream drift. They have specific preferences, depending on season and location, for members of the families Baetidae (mayflies) and Simulidae (black flies) and/or Chironomidae (midges) and Hydropsychidae (Anderson 1978; Schreiber & Minckley 1981; Barber & Minckley 1983; Propst et al. 1986). There is both spatial and temporal variation associated in their diets due to resource availability.

Taxonomic and genetic work on spikedace indicates there are substantial differences in morphology and genetic makeup between remnant spikedace populations. Remnant populations occupy fragmented stream segments in the Gila River basin and are isolated from each other. Anderson and Hendrickson (1994) found that spikedace from Aravaipa Creek are morphologically distinguishable from spikedace from the Verde River, while spikedace from the upper Gila River and Eagle Creek have intermediate measurements and partially overlap the Aravaipa and Verde populations. Mitochondrial DNA and allozyme analyses have found similar patterns of geographic variation within the species (Tibbets 1992, 1993).

Life History

Spikedace eggs are approximately two mm in diameter upon release and protolarvae are about five mm total length on hatching. After hatching, individuals grow rapidly during the summer, obtaining 35 to 40 mm 1.4 to 1.6 (in) to standard length by November. Spikedace spawns from March through May with some yearly and geographic variation (Barber et al. 1970; Anderson 1978; Propst et al. 1986). Spawning behavior and captive studies indicate eggs are laid over gravel and cobble where they adhere to the substrate.

Spikedace live about two years in the wild, with reproduction occurring primarily in one-year old fish (Barber et al. 1970; Anderson 1978; Propst et al. 1986). They feed primarily on aquatic and terrestrial insects (Schreiber 1978; Barber & Minckley 1983; Marsh et al. 1989). Additional details on habitat preferences are provided in the 2012 critical habitat designation (U.S. Fish and Wildlife Service 2012).

Habitat Use

Spikedace live in flowing water with slow to moderate velocities over sand, gravel, and cobble substrates (Propst et al. 1986; Rinne & Kroeger 1988). Specific habitat for this species consists of shear zones where rapid flow borders slower flow, areas of sheet flow at the upper ends of mid-channel sand/gravel bars, and eddies at the downstream riffle edges (Propst et al. 1986). juveniles are found in quiet areas along pool edges over finer-grained substrate. Specific habitat can vary seasonally, among streams and ontogenetically (Anderson 1978; Rinne 1985, 1991; Propst et al. 1986).

Diet

Spikedace are omnivores that feed primarily upon insects transported in stream drift. They have specific preferences, depending on season and location, for members of the families Baetidae (mayflies) and Simulidae (black flies) and/or Chironomidae (midges) and Hydropsychidae (Anderson 1978; Schreiber & Minckley 1981; Barber & Minckley 1983; Propst et al. 1986). There is both spatial and temporal variation associated in their diets due to resource availability. Other foods, including larval fishes and Culicidae (midge-like flies), are occasionally eaten but are minor components of the diet. Adults and larval individuals are opportunistic with smaller, post-larval spikedace consuming a variety of small, soft-bodied animals and adults feeding primarily on drifting invertebrates.

Current Distribution

Spikedace were once common throughout much of the Gila River basin, including the mainstem Gila River upstream of Phoenix, and the Verde, Agua Fria, Salt, San Pedro, and San Francisco subbasins. Habitat destruction and competition and predation by nonnative aquatic species reduced their range and abundance (Miller 1961; Lachner et al. 1970; Ono et al. 1983; Moyle 1986; Moyle et al. 1986; Propst et al. 1986). Spikedace are now restricted to 10 to 15% of their historical range, and are restricted to:

- portions of the upper Gila River (Grant, Catron, and Hidalgo Counties, New Mexico);
- Aravaipa Creek (Graham and Pinal Counties, Arizona);
- Eagle Creek (Graham and Greenlee Counties, Arizona);
- and the Verde River (Yavapai County, Arizona) (Marsh et al. 1990; Brouder 2002; Stefferud & Reinthal 2005; Paroz et al. 2006; Propst 2007).

Spikedace have recently been translocated to additional streams as part of recovery efforts for the species. Translocation efforts include Hot Springs and Redfield canyons, in Cochise County and Pima counties, Arizona (2007); Fossil Creek in Gila County, Arizona (2007); Bonita Creek in Graham County, Arizona (2008), the upper San Francisco River in Catron County, New Mexico (2011), and the Blue River, Greenlee County (2012). Efforts to establish spikedace in Hot Springs and Redfield canyons were not successful, nor were efforts at Bonita Creek to date. Spikedace have become established in Fossil Creek and the Blue River (Robinson et al. 2014a, 2014b; Hickerson et al. 2021; Shollenberger et al. 2021). Monitoring through traditional means and with the use of eDNA detected spikedace in the San Francisco River in 2017. Spikedace were also detected in 2020 (Shollenberger et al. 2021). Monitoring, and potentially augmentation of spikedace, in the San Francisco River will continue; however, insufficient time has elapsed to determine if the translocation effort will ultimately be successful and result in establishment of a new population of spikedace in the San Francisco River in New Mexico.

Spikedace is now common only in Aravaipa Creek in Arizona (Arizona State University (ASU) 2002; Reinthal 2022) and one section of the Gila River south of Cliff, New Mexico (New Mexico Department of Game and Fish (NMDGF) 2008; Propst et al. 2009). The Verde River is presumed occupied; however, the last captured fish from this river was from a 1999 survey (Brouder 2002). Similarly, Eagle Creek is presumed occupied; however, the last captured spikedace from the Eagle Creek population was in 1989 (Marsh 1996).

Threats

Primary threats to spikedace include habitat alteration and destruction, introduction and spread of nonnative species, wildfire, and drought and environmental change.

Within the historical range of spikedace, groundwater withdrawals, surface water diversions, and construction of impoundments have converted large portions of flowing streams into intermittent streams, large reservoirs, or dewatered channels, and eliminated suitable spikedace habitat in impacted areas (Propst et al. 1986; Tellman et al. 1997). Removal of groundwater in hydrologically connected areas can change the long-term average rates of inflow to and outflow from aquifer systems through time which directly affects the presence of surface water (U.S. Geological Survey 2010, 2013; Barlow & Leake 2012). Groundwater also is important for sustaining streamflow between storms and during drier periods of the year (Barlow & Leake 2012). Water diversions directly affect water availability by removing all or a portion of available streamflow, while almost any dam may prevent movements of fish between populations. Larger dams dramatically alter flow regimes and water quality through water impoundment (Ligon et al. 1995). Maintenance or reconstruction of diversions can result in habitat damages and inputs of sediment into the active channel.

Impacts to spikedace from recreation can occur from movement of people, vehicles, and horses or mules along streambanks, trampling, soil compaction and erosion, loss of vegetation, water quality issues, and increased danger of fire (Northern Arizona University 2005; Monz et al. 2010). In the arid Gila River Basin, recreational impacts are disproportionately distributed along streams as a primary focus for recreation (Briggs 1996). Overuse through camping and other recreational activities can lead to decreased riparian vegetation (U.S. Forest Service (USFS) 2008) and subsequent increases in stream temperatures, as well as soil compaction and vegetation loss, which in turn can lead to increased runoff and sedimentation in waterways (Andereck 1993; Monz et al. 2010).

Livestock grazing has been one of the most widespread and long-term causes of adverse impacts to native fishes and their habitat (Miller 1961; Platts 1990). Improper livestock grazing can destabilize stream channels, disturb riparian ecosystem functions, and contribute to nutrient loading in streams (Platts 1990; Armour et al. 1991; Tellman et al. 1997; Wyman et al. 2006; Brown & Froemke 2012). Excessive grazing can reduce or eliminate riparian vegetation that affects fish habitat by increasing stream temperatures and sedimentation, eroding soils, and degrading water quality (Armour et al. 1991). Effects from livestock grazing have been reduced in the last 20 years due to improved management on Federal lands (U.S. Fish and Wildlife Service 1997) and discontinuation of grazing in many riparian and stream corridors.

In the Gila River basin, introduction of nonnative species is considered the primary factor in the decline of native fish species (Minckley 1985; Williams et al. 1985; Minckley & Deacon 1991; Douglas et al. 1994; Rinne & Stefferud 1997; Rinne 2004; Bonar et al. 2004; Clarkson et al. 2005; Olden & Poff 2005; Minckley & Marsh 2009). Nonnative fishes that co-occur are a major source of concern for spikedace. Ictalurid and Ameiurid catfishes are likely to interact strongly with natives, and there is direct evidence of native fish predation by nonnatives (Propst et al. 1986; Bonar et al. 2004). Channel catfish and yellow bullhead tend to be benthic omnivores, but flathead catfish are piscivorous and have had a major impact via predation throughout the historic range of spikedace (Pilger et al. 2010). Channel catfish of all sizes move onto riffles to feed, often on the same animals most important in the diets of spikedace, and juvenile flathead catfish also feed in riffles at night.

Nonnative channel catfish, flathead catfish, and smallmouth bass all prey on spikedace, as indicated by prey remains of native fishes in the stomachs of these species (Propst et al. 1986, 1988; Bonar et al. 2004). Smallmouth bass are known to co-occur with spikedace and are documented predators of the species (U.S. Fish and Wildlife Service 1991; Paroz et al. 2006). When smallmouth bass densities increased on the East Fork Gila River, densities of native fishes decreased (Stefferud et al. 2011). Green sunfish are also thought to be a predator, likely responsible for replacement of native species like spikedace and loach minnow. While no direct studies have been completed on predation by green sunfish on spikedace or loach minnow, they are a known predator of fish that size, and they occur within areas occupied by these species.

Declines of native fish species appear linked to increases in nonnative fish species. In 1949, for example, 52 spikedace were collected at Red Rock on the Gila River, while channel catfish composed only 1.65% of the 607 fish collected. However, in 1977, only 6 spikedace were located at the same site, and the percentage of channel catfish had risen to 14.5% of 169 fish collected. The decline of spikedace and the increase of channel catfish is likely related (Anderson 1978). Similarly, interactions between native and nonnative fishes were observed in the upper reaches of the East Fork of the Gila River. Prior to the 1983 and 1984 floods in the Gila River system, native fish were limited, with spikedace being rare or absent, while nonnative channel catfish and smallmouth bass were moderately common. After the 1983 flooding, adult nonnative predators were generally absent, and spikedace were collected in moderate numbers in 1985 (Propst et al. 1986).

The majority of areas considered occupied by spikedace have seen a shift from a predominance of native fishes to a predominance of nonnative fishes. For spikedace, this is best demonstrated on the upper Verde River, where native species dominated the total fish community at greater than 80% from 1994 to 1996, before dropping to approximately 20% in 1997 and 19 percent in 2001. At the same time, three nonnative species increased in abundance between 1994 and 2000 (Rinne et al. 2005). Similar changes in the dominance of nonnative fishes have occurred on the Middle Fork Gila River, with a 65% decline of native fishes between 1988 and 2001 (Propst 2002). In other areas, nonnative fishes may not dominate the system, but their abundance has increased, while spikedace abundance has declined, as is the case for the Cliff-Gila Valley area of the Gila River (Propst et al. 1986), the Redrock and Virden valleys on the Gila River (Propst et al. 1986), and the East Fork Gila River (Propst 2005). Nonnative fishes are also considered a management issue in other areas including Eagle Creek, the San Pedro River, West Fork Gila River, and to a lesser extent on the Blue River and Aravaipa Creek. Generally, when the species composition of a community shifts in favor of nonnative fishes, a decline in spikedace abundance occurs (Olden & Poff 2005). The effects of nonnative fishes often occur with, or are exacerbated by, changes in flow regimes or declines in habitat conditions and should be considered against the backdrop of historical habitat degradation that has occurred over time (Minckley & Meffe 1987; Rinne 1991).

Nonnative channel catfish, flathead catfish, and smallmouth bass are present in most spikedace habitats, including the Verde River (Minckley 1993; Jahrke & Clark 1999; Rinne 2004; Bahm & Robinson 2009a; Robinson & Crowder 2009), the Gila River (Propst et al. 1986, 2009; Jakle 1995; Springer 1995); the San Pedro River (Minckley & Meffe 1987; Jakle 1992); the San Francisco River (Papoulias et al. 1989; Propst et al. 2009); the Blue River (Arizona State University (ASU) 1994, 1995; Clarkson et al. 2008); Forks of the Gila River (Paroz et al. 2006; Propst et al. 2009) and Eagle Creek (Marsh et al. 2003; Arizona State University (ASU) 2008; Bahm & Robinson 2009b).

Nonnative fishes known to occur within the historical range of spikedace include channel catfish, flathead catfish, red shiner, fathead minnow, green sunfish, largemouth bass, smallmouth bass, rainbow trout, western mosquitofish, carp, warmouth, bluegill, yellow bullhead, black bullhead, and goldfish (Miller 1961; Nico & Fuller 1999; Clark 2001; Bahm & Robinson 2009b). The aquatic ecosystem of the central Gila River basin has relatively small streams with warmwater and low gradients, and many of the native aquatic species are small. In these areas, small, nonnative fish species pose a threat to spikedace (Deacon et al. 1964). Examples of this are the impacts of mosquitofish and red shiner, which may compete with, or predate upon, native fish in the Gila River basin (Meffe 1985; Douglas et al. 1994).

Negative interactions also occur between small native and large nonnative individuals. On the East and Middle Forks of the Gila River, where large nonnative predators were comparatively common, small native species were uncommon or absent. Conversely, on the West Fork Gila River, when large nonnative predators were rare, most small-bodied and young of large-bodied native fishes persisted (Stefferud et al. 2011). For spikedace and loach minnow, every habitat that has not been renovated or protected by barriers has at least six nonnative fish species present, at varying levels of occupation.

Several of the nonnative species now in spikedace habitat arrived since the species was listed, such as red shiner in Aravaipa Creek (Stefferud & Reinthal 2005). Nonnative red shiners compete with spikedace for suitable habitats, as the two species occupy essentially the same habitat types. The red shiner has an inverse distribution pattern in Arizona to spikedace (Minckley 1973). Where the two species occur together, there is evidence of displacement of spikedace to less suitable habitats than previously occupied (Marsh et al. 1989). As a result, if red shiners are present, suitable habitat for spikedace is reduced. In addition, the introduction of red shiner and the decline of spikedace have occurred simultaneously (Minckley & Deacon 1968; Douglas et al. 1994).

Following 1980, red shiner, fathead minnow, channel catfish, and western mosquitofish are all regularly collected within the range of spikedace. Mosquitofish may negatively affect populations of small fishes through predation and competition (Courtenay & Meffe 1989). Nonnative crayfish have also invaded occupied spikedace habitats (Taylor et al. 1996; Robinson & Crowder 2009; U.S. Geological Survey 2009). Crayfish are known to eat fish eggs, especially those bound to the substrate (Dorn & Mittelbach 2004), as is the case for spikedace. Additionally, crayfish cause decreases in macroinvertebrates, amphibians, and fishes (Hanson et al. 1990; Lodge et al. 2000).

Wildfires affect streams and fish in a variety of ways. The effects of fire are many and can vary. A number of rivers and streams that contain suitable habitat for spikedace originate within or flow through areas that have been affected by recent fires including the Gila, San Francisco, Blue, and Verde Rivers, and Eagle Creek.

Effects of current drought conditions may be more pronounced due to their combination with reduced habitat suitability from other effects, as described above. Drought can eliminate streamflow, or result in lower streamflow, and consequently can elevate water temperatures beyond the species' upper tolerance limits. Drought also can cause crowding as surface waters shrink, which in turn can result in more crowded habitats with higher levels of predation or competition. In other areas, drought reduces flooding that would normally rejuvenate habitat and reduce populations of some nonnative species that are less adapted to the relatively large floods of southwestern streams (Minckley & Meffe 1987; Stefferud & Rinne 1995). Drought conditions may have a more severe impact on spikedace than in the past due to their current fragmented distribution. Small, fragmented populations are less likely to be recolonized from areas that may have provided refugial habitat in the past when the species was more widely distributed. Their ability to rebound from these conditions also may be compromised by other factors such as nonnative species, habitat alteration, or lack of genetic diversity.

Examples of effects of environmental change include warming of the global climate system over recent decades, and substantial increases in precipitation in some regions of the world and decreases in other regions (Intergovernmental Panel on Climate Change (IPCC) 2007a; Solomon et al. 2007). Most of the observed increases in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and very likely is due to observed increases in greenhouse gas concentrations in the atmosphere as a result of human activities, particularly emissions of carbon dioxide from fossil fuel use (Intergovernmental Panel on Climate Change (IPCC) 2007a; Solomon et al. 2007).

While climate scientists are confident that environmental change will continue in the Southwest through the twenty-first century and beyond, they are not equally confident about all aspects of environmental change or variation projections. Their confidence is highest for projections that are consistent among climate models and for those with observed changes. In an assessment of environmental change in the Southwest, Garfin et al. (2014) conclude with high confidence that warming will continue, with longer and hotter heat waves in summer, late season snowpack will continue to decrease; and droughts in parts of the southwest will become hotter, more severe, and more frequent. They predict with medium-high confidence that declines in river flow and soil moisture will continue. Similar results were determined by the Palmer Drought Severity Index and others (Hoerling & Eischeid 2007; Intergovernmental Panel on Climate Change (IPCC) 2007b; Seager et al. 2007).

With respect to effects of environmental change on species, Fleishman et al. (2013) concluded that observed changes in climate are associated strongly with changes in geographic distributions of species, and that the extent of these observed changes in geographic distribution varies considerably. Fleishman et al. (2013) also concluded that observed changes in climate are associated strongly with some observed changes in timing of seasonal events in the life cycles of species, with some variation in the magnitude among species. While no environmental change studies have been completed specific to spikedace, studies on impacts to aquatic species in general conclude that environmental change could lead to changes in flooding and flow patterns, which in turn can affect the timing of fish spawning, increase the probability that embryos will be scoured from gravel nests, and wash away newly emerged fry (Warren et al. 2009; Wenger et al. 2011).

Recovery

The Service completed a spikedace recovery plan in 1991 (U.S. Fish and Wildlife Service 1991). Steps outlined as necessary for recovery included:

- Protection of existing populations of spikedace;
- Monitoring the status of existing populations;
- Identifying the nature and significance of interaction with nonnative fishes;
- Quantifying spikedace habitat needs and the effects of physical habitat modification on life cycle completion;
- Enhancing or restoring habitats occupied by depleted populations;
- Reintroducing populations of spikedace to selected streams within their historic range;
- Determination of qualitative criteria for describing a self-sustaining population;
- Planning and conducting investigations on captive holding, propagation, and rearing; and
- Developing an information and education program.

A recovery plan revision is underway; however, it has not yet been completed.

Previous Related Consultations

Our information indicates that, rangewide, over 1,100 formal, informal, and technical assistance consultations have been completed or are underway for actions potentially affecting spikedace. The majority of these opinions concerned the effects of road and bridge construction and maintenance, grazing, water developments, fire, species control efforts, or recreation. Small numbers of projects occur for timber, land acquisition, agriculture, sportfish stocking, flooding, Habitat Conservation Planning, native fish restoration efforts, alternative energy development, and mining.

LOACH MINNOW

Listing

Loach minnow was listed as a threatened species on October 28, 1986 (U.S. Fish and Wildlife Service 1986) but was reclassified as an endangered species on February 23, 2012 (U.S. Fish and Wildlife Service 2012). The current critical habitat designation was published simultaneously with the reclassification to endangered status.

Critical Habitat

When critical habitat was designated in 2012, the Service determined the PCEs for loach minnow. The loach minnow critical habitat designation includes eight units based on river subbasins, including the Verde River, Salt River, San Pedro River, Bonita Creek, Eagle Creek, San Francisco River, Blue River, and Gila River subbasins. Occupancy within these units and critical habitat within each subbasin is described in the critical habitat designation(U.S. Fish and Wildlife Service 2012).

Primary Constituent Elements of Critical Habitat

When critical habitat was designated in 2012, the Service determined the PCEs for loach minnow. PCEs include those habitat features required for the physiological, behavioral, and ecological needs of the species. The PCEs describe appropriate flow regimes, velocities, and depths; stream microhabitats; stream gradients; water temperatures; and acceptable pollutant and nonnative species levels (U.S. Fish and Wildlife Service 2012). PCEs for the loach minnow include:

• PCE 1: Habitat to support all egg, larval, juvenile, and adult loach minnow which includes:

a. Perennial flows with a stream depth generally less than 3.3 ft (1.0 meter), and with slow to swift flow velocities between 0.0 and 31.5 inches per second (in/sec) (80.1 cm per second [cm/sec]);

b. Appropriate stream microhabitat types including pools, runs, riffles, and rapids over sand, gravel, cobble, and rubble substrates with low or moderate amounts of fine sediment and substrate embeddedness;

c. Appropriate stream habitat with a low gradient of less than approximately 2.5%, at elevations below 8,202 ft (2,500 m); and

d. Water temperatures in the general range of 46.4 to 77°F (8 to 25°C);

• PCE 2: An abundant aquatic insect food base consisting of mayflies, true flies, black flies, caddisflies, stoneflies, and dragonflies;

• PCE 3: Streams with no or no more than low levels of pollutants;

• PCE 4: Perennial flows, or interrupted stream courses that are periodically dewatered but that serve as connective corridors between occupied or seasonally occupied habitat and through which the species may move when the habitat is wetted;

• PCE 5: No nonnative aquatic species or levels of nonnative aquatic species that are sufficiently low as to allow persistence of loach minnow; and

• PCE 6: Streams with a natural, unregulated flow regime that allows for periodic flooding or, if flows are modified or regulated, a flow regime that allows for adequate river functions, such as flows capable of transporting sediments.

The loach minnow critical habitat designation includes eight units based on river subbasins, including the Verde River, Salt River, San Pedro, Bonita Creek, Eagle Creek, San Francisco River, Blue River, and Gila River subbasins. Information for subbasins relevant to this consultation are summarized in Table 2 (See USFWS 2012 for additional detail).

Table 2. Details for designated critical habitat in subbasins within this consultation.

Critical Habitat Unit	**Stream**	**Total Mi (Km)**	**Area Designated**
5 – Eagle Creek Subbasin	Eagle Creek	16.5 (26.5)	Eagle Creek from the Freeport-McMoRan diversion dam at Township 4 South, Range 28 East, southwest quarter of the northwest quarter of section 23 upstream to the confluence of East Eagle

Critical Habitat Unit	Stream	Total Mi (Km)	Area Designated
			Creek in Township 2 North, Range 28 East, southwest quarter of section 20. This area does not include portions of Eagle Creek on lands belonging to Freeport-McMoRan, which is excluded from this designation.

Background

Loach minnow is a small fish from the minnow family Cyprinidae. Loach minnow are olivaceous in color, and highly blotched with darker spots. Whitish spots are present at the front and back edges of the dorsal fin, and on the dorsal and ventral edges of the caudal fin. A black spot is usually present at the base of the caudal fin. Breeding males have bright red-orange coloration at the bases of the paired fins and on the adjacent body, on the base of the caudal lobe, and often on the abdomen. Breeding females are usually yellowish on the fins and lower body (Minckley 1973; U.S. Fish and Wildlife Service 1991).

The limited taxonomic and genetic data available for loach minnow indicate there are substantial differences in morphology and genetic makeup between remnant loach minnow populations. Tibbets (1993) concluded that results from mitochondrial DNA (mtDNA) and allozyme surveys indicate variation for loach minnow follows drainage patterns, suggesting little gene flow among rivers. The levels of divergence present in the data set indicated that populations within rivers are unique and represent evolutionarily independent lineages. The main difference between the mtDNA and allozyme data was that mtDNA suggest that the San Francisco/Blue and Gila groups of loach minnow are separate, while the allozyme data places the Gila group within the San Francisco/Blue group. Tibbets (1993) concluded that the level of divergence in both allozyme and mtDNA data indicated that all three main populations (Aravaipa Creek, Blue/San Francisco Rivers, and Gila River) were historically isolated and represent evolutionarily distinct lineages.

Life History

Loach minnow live two to three years in the wild with reproduction occurring primarily in the second summer of life (Minckley 1973; Sublette et al. 1990). Spawning occurs from March through May (Britt 1982; Propst et al. 1988); however, under certain circumstances loach minnow also spawn in the autumn (Vives & Minckley 1990). Loach minnow eggs are attached to the underside of a rock that forms the roof of a small cavity in the substrate on the downstream side. Limited data indicate that the male loach minnow may guard the nest during incubation (Propst et al. 1988; Vives & Minckley 1990).

Habitat Use

Loach minnow are a bottom-dwelling inhabitant of shallow, swift water over gravel, cobble, and rubble substrates (Rinne 1989; Propst & Bestgen 1991). Loach minnow use the spaces between, and in the lee of, larger substrate for resting and spawning (Propst et al. 1988; Rinne 1989; Propst & Bestgen 1991). They are rare or absent from habitats where fine sediments fill the interstitial spaces (Propst & Bestgen 1991). Some studies have indicated that the presence of filamentous algae may be an important component of loach minnow habitat (Barber & Minckley 1966). Loach minnow feeds exclusively on aquatic insects (Schreiber 1978; Abarca 1987).

Diet

Loach minnow is an opportunistic, benthic insectivore, largely deriving food from riffle-dwelling larval Ephemeropterans (mayflies) and Simuliid and Chironomid dipterans (true flies); larvae of other aquatic insect groups, such as Plecopterans (stoneflies), Trichopterans (caddisflies), and occasionally pupae or emerging adults, may be seasonally important (Britt 1982; Propst et al. 1988; Propst & Bestgen 1991; Pilger et al. 2010). Chironomids (midges, flies) are relatively more important among the few food items utilized by larval and juvenile fish; diversity of food types increases as fish become larger, but the array of foods eaten is usually small compared with other stream fishes (Schreiber & Minckley 1981; Abarca 1987; Marsh et al. 1989). Because loach minnow is not known to swim in turbulent riffles other than for brief periods, it appears that individuals actively seek foods among bottom substrates, rather than pursuing animals entrained in the drift. Feeding habits therefore parallel seasonal changes in relative abundance and thus availability of riffle-inhabiting invertebrates.

Current Distribution

Loach minnow are believed to occupy approximately 15 to 20% of their historical range, and are now restricted to the following:

- portions of the Gila River and its tributaries West Fork, Middle Fork, and East forks of the Gila River and Bear Creek in Grant, Catron, and Hidalgo Counties, New Mexico (Paroz & Propst 2007; Propst 2007; Propst et al. 2009; Johnson et al. 2021; Shollenberger et al. 2021)
- the San Francisco and Tularosa rivers and their tributaries Negrito and Whitewater creeks in Catron County, New Mexico (Propst et al. 1988; Arizona State University (ASU) 2002; Paroz & Propst 2007; Propst 2007; Johnson et al. 2022);
- the Blue River and its tributaries Dry Blue, Campbell Blue, Pace, and Frieborn creeks in Greenlee County, Arizona and Catron County, New Mexico (Miller 1998; Arizona State University (ASU) 2002; Carter 2005, 2008; Clarkson et al. 2008; Robinson 2009; Hickerson et al. 2021; Shollenberger et al. 2021);
- Aravaipa Creek and its tributaries Turkey and Deer creeks (Graham and Pinal Counties, Arizona) (Stefferud & Reinthal 2005);
- Eagle Creek in Graham and Greenlee Counties, Arizona (Knowles 1994; Bagley & Marsh 1997; Marsh et al. 2003; Carter 2007; Carter et al. 2007; Bahm & Robinson 2009; Freeport-McMoRan Corporation 2020);
- East Fork and North Fork East Fork Black River in Apache and Greenlee Counties, Arizona (Leon 1989; Lopez 2000; Gurtin 2004; Carter 2007; Robinson 2009, 2010) and;
- possibly the White River and its tributaries, the East and North Fork White River in Apache, Gila, and Navajo Counties, Arizona.

Loach minnow have been translocated to additional streams as part of the recovery efforts for the species. Translocation efforts include Hot Springs and Redfield canyons in the San Pedro Watershed (2007), Fossil Creek in the Verde River Watershed (2007), and Bonita Creek in the

Gila River Watershed (2008) in Arizona. Of these three efforts, loach minnow are considered established in Hot Springs Canyon (Shollenberger et al. 2021); however, augmentation efforts have been suspended in Redfield Canyon due to drought and a lack of adequate flowing water. Efforts in both Fossil Creek and Bonita Creek are considered unsuccessful at this point, although further attempts may be made at Bonita Creek. In New Mexico, loach minnow were translocated to Saliz Canyon in the San Francisco Watershed (2017), and into Little Creek in the upper Gila Watershed (2014). To date, insufficient time has passed to determine if these translocations will be successful.

Threats

Primary threats to loach minnow include habitat alteration and destruction, introduction and spread of nonnative species, wildfire, and drought and environmental change.

Within the historical range of loach minnow, groundwater withdrawals, surface water diversions, and construction of impoundments have converted large portions of flowing streams into intermittent streams, large reservoirs, or dewatered channels, and eliminated suitable loach minnow habitat in impacted areas (Propst et al. 1988; Tellman et al. 1997). Removal of groundwater in hydrologically connected areas can change the long-term average rates of inflow to and outflow from aquifer systems through time which directly affects the presence of surface water (Leake & Haney 2010; Barlow & Leake 2012; Garner et al. 2013). Groundwater also is important for sustaining streamflow between storms and during drier periods of the year (Barlow & Leake 2012). Water diversions directly affect water availability by removing all or a portion of available streamflow, while almost any dam may prevent movements of fish between populations. Larger dams dramatically alter flow regimes and water quality through water impoundment (Ligon et al. 1995). Maintenance or reconstruction of diversions can result in habitat damages and inputs of sediment into the active channel.

Impacts to loach minnow from recreation can occur from movement of people, vehicles, and horses or mules along streambanks, trampling, soil compaction and erosion, loss of vegetation, water quality issues, and increased danger of fire (Northern Arizona University 2005; Monz et al. 2010). In the arid Gila River Basin, recreational impacts are disproportionately distributed along streams as a primary focus for recreation (Briggs 1996). Overuse through camping and other recreational activities can lead to decreased riparian vegetation (U.S. Forest Service (USFS) 2008) and subsequent increases in stream temperatures, as well as soil compaction and vegetation loss, which in turn can lead to increased runoff and sedimentation in waterways (Andereck 1993; Monz et al. 2010).

Livestock grazing has been one of the most widespread and long-term causes of adverse impacts to native fishes and their habitat (Miller 1961; Platts 1990). Improper livestock grazing can destabilize stream channels, disturb riparian ecosystem functions, and contribute to nutrient loading in streams (Platts 1990; Armour et al. 1991; Tellman et al. 1997; Wyman et al. 2006; Brown & Froemke 2012). Excessive grazing can reduce or eliminate riparian vegetation that affects fish habitat by increasing stream temperatures and sedimentation, eroding soils, and degrading water quality (Armour et al. 1991). Effects from livestock grazing have been reduced in the last 20 years due to improved management on Federal lands (U.S. Fish and Wildlife Service 1997) and discontinuation of grazing in many riparian and stream corridors.

In the Gila River basin, introduction of nonnative species is considered the primary factor in the decline of native fish species (Minckley 1985; Williams et al. 1985; Minckley & Deacon 1991;

Douglas et al. 1994; Rinne & Stefferud 1997; Bonar et al. 2004; Clarkson et al. 2005; Rinne 2005; Olden & Poff 2005; Minckley & Marsh 2009). Nonnative fish affect loach minnow through predation and competition for resources. The final critical habitat and reclassification rule (U.S. Fish and Wildlife Service 2012) provides additional detail on studies completed regarding increases in nonnatives and declines in loach minnow throughout its historical range.

Nonnative channel catfish, flathead catfish, and smallmouth bass all prey on loach minnow, as indicated by stomach content analysis (Propst et al. 1988). Channel catfish move into riffles to feed, preying on the same animals most important to loach minnows, while juvenile flathead catfish prey on loach minnows (Propst et al. 1988). Green sunfish are also thought to be a predator. Nearly all nonnative species that inhabit streams and rivers of the Gila River basin are likely predators on at least some life stages of natives like loach minnow (Schooley et al. 2008). Nonnatives are nearly ubiquitous across the Gila River basin (Arizona State University (ASU) 2002; Minckley & Marsh 2009), and case history demonstrates that natives typically thrive in the absence of nonnatives (Marsh & Pacey 2005). For these and other reasons, nonnative fishes in general appear responsible for declines and replacement of native species like loach minnow (Minckley 1985; Williams et al. 1985; Moyle 1986; Minckley & Deacon 1991; Dudley & Matter 2000; Clarkson et al. 2005, 2012; Marsh & Pacey 2005; Olden et al. 2006; Minckley & Marsh 2009). Red shiner are competitors with loach minnow for food and cover. Studies indicate that red shiner move into voids left when native fishes such as loach minnow are extirpated due to habitat degradation in the area (Bestgen & Propst 1986). Should habitat conditions improve and once again become suitable for loach minnow, presence of red shiner may preclude occupancy of loach minnow, although the specific mechanism of this interaction is not fully understood.

Effects of nonnative fishes often occur with, or are exacerbated by, changes in flow regimes or declines in habitat conditions (see Factor A above) and should be considered against the backdrop of historical habitat degradation that has occurred over time (Minckley & Meffe 1987; Rinne 1991). Propst et al. (2008) examined the interaction of physical modification of stream channels coupled with widespread introduction and establishment of nonnative aquatic species and determined that natural flow alone would be insufficient to conserve native fish assemblages. Propst et al. (2008) conclude that, while native fish assemblages persist through drought, their resistance and resilience are compromised if nonnative predators are present. They also conclude that, while retention of natural hydrologic regimes is crucial for the persistence of native fish assemblages in arid-land streams, removal and preclusion of nonnative predators and competitors are equally important (Propst et al. 2008). Similarly, Marks et al. (2010) concluded that both flow restoration and nonnative fish removal increased native fishes, but that removal of nonnative fish provided a three-fold greater benefit to native fishes than did flow restoration.

Wildfires affect streams and fish in a variety of ways. The fire itself can increase temperatures, resulting in fish kills. Fire suppression efforts often involve use of fire retardants, which can contaminate streams. Following removal of vegetation by a fire, post-fire runoff from damaged watersheds affect water quality due to ash flows and increasing sedimentation. Wildfires have increased in ponderosa pine forests of the Southwest (Swetnam & Betancourt 1990, 1998). Within the range of loach minnow, the Wallow Fire in 2011 and the Whitewater-Baldy Fire in 2013 cumulatively burned approximately 838,000 ac (339,128 ha). Several rivers and streams that contain suitable habitat for loach minnow originate within or flow through areas that have been affected by recent fires including the Gila, San Francisco, Blue, Tularosa, Black, and Verde Rivers, and Eagle Creek. Ash and fine particulate matter created by fire can suffocate fish, fill interstitial spaces between gravel particles, eliminating spawning habitat or, depending on the timing, suffocate embryos that are in the gravel. Ash and debris flows can decimate aquatic invertebrate populations that fish depend on for food (Molles 1985). Increase in fires has led to an increase in the use of fire retardant, some of which can be toxic to aquatic wildlife (Gaikwokski et al. 1996; Poulton et al. 1997; Buhl & Hamilton 1998; Little & Calfee 2002; Calfee & Little 2003; Angeler et al. 2006).

Effects of current drought conditions may be more pronounced due to their combination with reduced habitat suitability from other effects, as described above. Drought can eliminate streamflow, or result in lower streamflow, and consequently can elevate water temperatures beyond the species' upper tolerance limits. Drought also can cause crowding as surface waters shrink, which in turn can result in more crowded habitats with higher levels of predation or competition. In other areas, drought reduces flooding that would normally rejuvenate habitat and reduce populations of some nonnative species that are less adapted to the relatively large floods of southwestern streams (Minckley & Meffe 1987; Stefferud & Rinne 1997). Drought conditions may have a more severe impact on loach minnow than in the past due to their current fragmented distribution. Small, fragmented populations are less likely to be recolonized from areas that may have provided refugia habitat in the past when the species was more widely distributed. Their ability to rebound from these conditions also may be compromised by other factors such as nonnative species, habitat alteration, or lack of genetic diversity.

Examples of effects of environmental change include warming of the global climate system over recent decades, and substantial increases in precipitation in some regions of the world and decreases in other regions (Intergovernmental Panel on Climate Change (IPCC) 2007a; Solomon et al. 2007). Most of the observed increases in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and very likely is due to observed increases in greenhouse gas concentrations in the atmosphere as a result of human activities, particularly emissions of carbon dioxide from fossil fuel use (Solomon et al. 2007, 2007).

While climate scientists are confident that environmental change will continue in the Southwest through the twenty-first century and beyond, they are not equally confident about all aspects of environmental change or variation projections. Their confidence is highest for projections that are consistent among climate models and for those with observed changes. In an assessment of environmental change in the Southwest, Garfin et al. (2014) conclude with high confidence that warming will continue, with longer and hotter heat waves in summer, late season snowpack will continue to decrease; and droughts in parts of the southwest will become hotter, more severe, and more frequent. They predict with medium-high confidence that declines in river flow and soil moisture will continue. Similar results were determined by the Palmer Drought Severity Index and others (Hoerling & Eischeid 2007; Intergovernmental Panel on Climate Change (IPCC) 2007b; Seager et al. 2007).

With respect to effects of environmental change on species, Fleishman et al. (2013) concluded that observed changes in climate are associated strongly with changes in geographic distributions of species, and that the extent of these observed changes in geographic distribution varies considerably. Fleishman et al. (2013) also concluded that observed changes in climate are associated strongly with some observed changes in timing of seasonal events in the life cycles of species, with some variation in the magnitude among species. While no environmental change studies have been completed specific to loach minnow, studies on impacts to aquatic species in general conclude that environmental change could lead to changes in flooding and flow patterns, which in turn can affect the timing of fish spawning, increase the probability that embryos will be scoured from gravel nests, and wash away newly emerged fry (Warren et al. 2009; Wenger et al. 2011).

Recovery

The Service completed a loach minnow recovery plan in 1991 (U.S. Fish and Wildlife Service 1991). Steps outlined as necessary for recovery included:

- Protection of existing populations of loach minnow;
- Monitoring the status of existing populations;
- Identifying the nature and significance of interaction with nonnative fishes;
- Quantifying loach minnow habitat needs and the effects of physical habitat modification on life cycle completion;
- Enhancing or restoring habitats occupied by depleted populations;
- Reintroducing populations of loach minnow to selected streams within their historic range;
- Determination of qualitative criteria for describing a self-sustaining population;
- Considering contingency planning and completing preliminary investigations for captive holding, propagation, and rearing; and
- Developing an information and education program.

A recovery plan revision is underway; however, it has not yet been completed.

Previous Related Consultations

Our information indicates that, rangewide, over 1,500 formal, informal, and technical assistance consultations have been completed or are underway for actions affecting loach minnow. The majority of these opinions concerned the effects of road and bridge construction and maintenance, grazing, water developments, fire, species control efforts, or recreation. Small numbers of projects occur for timber, land acquisition, agriculture, sportfish stocking, flooding, Habitat Conservation Planning, native fish restoration efforts, alternative energy development, and mining.

NARROW-HEADED GARTERSNAKE

This section summarizes best available data about the biology and condition of the narrow-headed gartersnake (*Thamnophis rufipunctatus*) throughout its range that are relevant to formulating an opinion about the effects of the proposed action. The Service published its decision to list the narrow-headed gartersnake as threatened on July 8, 2014 (79 FR 38678).

Species Description and Taxonomy

The narrow-headed gartersnake is a small to medium-sized gartersnake with a maximum total length of 44 in (112 cm) (Painter and Hibbitts 1996). Its eyes are set high on its unusually elongated head, which narrows to the snout, and it lacks striping on the dorsum (top) and sides, which distinguishes its appearance from other gartersnake species with which it could co-occur (Rosen and Schwalbe 1988). The base color is usually tan or grey-brown (but may darken) with conspicuous brown, black, or reddish spots that become indistinct towards the tail (Rosen and Schwalbe 1988; Boundy 1994). The scales are keeled. Degenhardt *et al.* (1996), Rossman *et al.* (1996), Ernst and Ernst (2003), and Holycross *et al*. (2020) further describe the species.

Currently known as *Thamnophis rufipunctatus*, the taxonomic history of the narrow-headed gartersnake is rather complex. Please refer to Holycross *et al*. (2020) for a complete taxonomic history of this species.

Species Life History

Diet

Narrow-headed gartersnakes eat fish (Rosen and Schwalbe 1988; Degenhardt *et al.* 1996; Rossman *et al.* 1996; Nowak and Santana-Bendix 2002; Nowak 2006; Jennings and Christman 2012, p. 16), and are considered specialists in this regard. This species is an underwater ambush hunter, believed to be heavily dependent on visual cues when foraging (de Queiroz 2003; Hibbitts and Fitzgerald 2005). Therefore, sediment and turbidity levels within the water column may affect foraging success. Native fish species considered as prey for the narrow-headed gartersnake include Sonora sucker, desert sucker, speckled dace, roundtail chub (*Gila robusta*), and Gila and Apache trout (*Onchorhynchus gilae, O. apache*) (Rosen and Schwalbe 1988; Degenhardt *et al.* 1996; Holycross *et al*. 2020) but all native fish species of the appropriate size class are expected as prey. Native suckers and chubs were posited by Rosen *et al.* (2012) to be the most beneficial prey items for narrow-headed gartersnakes due to traits such as high fecundity, weak territoriality, and their growth through size classes which provide an optimum food source for a range of size classes of narrow-headed gartersnakes. Dace, also correlated with persistence and abundance of narrow-headed gartersnake populations, reach high densities and may also be integral to gartersnake persistence in high elevation populations (Rosen *et al.* 2012,). While the preponderance of literature and expert opinion find that narrow-headed gartersnakes eat primarily fish, a late-stage Arizona toad (*Anaxyrus microscaphus*) larva was regurgitated from a wild narrow-headed gartersnake in Saliz Creek, New Mexico (Christman *et al*. 2021), the first and only observation of its kind from wild specimens.

Prevalence of native fish species at a given site may be the most predictable variable associated with narrow-headed gartersnake occupancy (Jennings *et al*. 2017, p. 15). However, nonnative predatory fish species in their fingerling size classes are also used as prey by narrow-headed gartersnakes, including brown trout (*Salmo trutta*) (Rosen and Schwalbe 1988; Nowak and Santana-Bendix 2002; Nowak 2006), green sunfish (*Lepomis cyanellus*) (Fleharty 1967), smallmouth bass (*Micropterus dolomieu*) (M. Lopez, 2010, pers. comm.), and rock bass (*Ambloplites rupestris*) (Wilcox 2015). Reports suggest that brown trout are consumed more frequently than smallmouth bass. Nonnative fish with spiny dorsal fins are not generally considered suitable prey items due to the risk of injury to the gartersnake during ingestion and because of where they tend to occur in the water column (Nowak and Santana-Bendix 2002).

Reproduction

Growth rates of wild narrow-headed gartersnakes can be significant; indicating that growth to maturity may be achieved over a relatively short period of time, perhaps as short as 2 years of age (Jennings and Christman 2012). Narrow-headed gartersnakes are viviparous, breeding annually. Females give birth to 4 to 17 offspring from early- to mid-July (Jennings and

Christman 2012) into early August, perhaps earlier at lower elevations (Rosen and Schwalbe 1988).

Native Predators
Native predators of the narrow-headed gartersnake include vertebrates such as birds of prey, including black-hawks (Etzel *et al*. 2014), other snakes such as regal ring-necked snakes (Brennan *et al.* 2009), wading birds, mergansers, belted kingfishers, raccoons (Rosen and Schwalbe 1988), and possibly other generalist mammalian predators. Invertebrates, such as diving beetles have also been documented preying upon gartersnakes (Drummond and Wolfe 1981, entire). Historically, large, highly predatory native fish species such as Colorado pikeminnow may have preyed upon narrow-headed gartersnakes where the species co-occurred. Native chubs (*Gila* spp.) in their adult size class may also prey on neonatal gartersnakes.

Home Range
Home ranges of narrow-headed gartersnakes were recorded using ingested telemetry technology and determined using minimum convex polygons in New Mexico (Jennings and Christman 2012,). The maximum home range calculated was 5.5 ac (2.2 ha) but ingested telemetry techniques significantly limit the tracking duration of individuals, so estimates are likely smaller than actual (Jennings and Christman 2012). Home ranges tended to have their long axis parallel the associated stream (Jennings and Christman 2012). Sixty-seven individual movements of narrow-headed gartersnakes were tracked by Jennings and Christman (2012) who found the average distance of each movement was 52.5 ft (range 2-686 feet) with males moving larger distances than females. It should also be noted that habitat use and seasonal movement patterns can vary significantly within snake species or within neighboring groups of individuals (Gomez *et al.* 2015).

Longevity
Rosen and Schwalbe (1988) suggested that individual gartersnakes may live 10 years in the wild, but they inferred this estimate from size-frequency histograms, not recaptured gartersnakes, and their data did not include narrow-headed gartersnakes older than 4 or 5 years. To date, longevity in wild narrow-headed gartersnakes remains poorly understood, but maximum longevity in captivity was documented at approximately 14 years (Ryan *et al*. 2022). Longevity in wild narrow-headed gartersnakes likely differs from captivity.

Terrestrial Habitat Use
Narrow-headed gartersnakes also use terrestrial, upland habitat and a variety of organic and inorganic cover for their thermoregulatory needs such as for shelter during periods of cold-season dormancy, basking in gestation of young in pregnant females, facilitating digestion, healing from injury or illness, and to escape flood events. Artificial cover is often preferred by snakes when available (Cox *et al*. 2009). Man-made structures such as rock walls, water pipes, rock chimney ruins, foundation or retaining walls, broken concrete slabs, and old bridge pilings are also often used as cover where present (Nowak 2006; Holycross *et al*. 2020).

Rocks and rock structures present excellent thermoregulatory conditions for a wide range of physiological needs and are frequently prioritized by gartersnakes over other types of microhabitat (Huey 1991). Out of 498 unique recorded cover objects from three sites in New Mexico, narrow-headed gartersnakes used rocks the most (56 percent) followed by earthen burrows (9 percent), debris pile (8 percent), stumps/logs (6 percent) and vegetation (3 percent) (Jennings and Christman 2012); the remaining 18 percent of detections were of snakes in the water or on the ground surface. Willows and grasses may be disproportionately used by narrow-headed gartersnakes for basking (Rosen *et al.* 2012; Holycross *et al*. 2020).

Telemetry studies in New Mexico on the Tularosa River, Gila River, and Whitewater Creek found narrow-headed gartersnakes an average of 58.7 ft (17.9 m) from water, with a maximum distance of 285 ft (87 m) across four different sites on the three streams with a sample size of 69 individuals (Jennings and Chirstman 2012). This is the largest study on movement from water sources of the narrow-headed gartersnake to date. Researchers found most snakes within 3.28 ft (1 m) of the water's edge (Jennings and Christman 2012). Narrow-headed gartersnakes were found with lowest average distance of 22.7 ft (6.9 m) during the dry season of 2010, and highest average distance of 88.3 ft (26.9 m) during the wet season in 2010 (Jennings and Chirstman 2012). Accordingly, the snakes seem to generally use terrestrial habitat within 89 ft (27 m) of the active channel of a stream.

<u>Habitat Requirements</u>

The narrow-headed gartersnake, distributed across the Mogollon Rim of Arizona and extreme southwestern New Mexico, is widely considered to be one of the most aquatic of the gartersnakes (Drummond and Marcias Garcia 1983; Rossman *et al.* 1996), as a function of its prey specificity. This species is strongly associated with clear, rocky, often perennial streams with moderate grade and interspersed deep pools and riffles, using predominantly pool and riffle habitat that includes cobbles and boulders (Rosen and Schwalbe 1988; Degenhardt *et al.* 1996; Rossman *et al.* 1996; Nowak and Santana-Bendix 2002; Ernst and Ernst 2003, Holycross *et al*. 2020). Rock structure, particularly large rocks, boulders, and rocky outcrops within and adjacent to streams appears to be important (Holycross *et al*. 2020). Narrow-headed gartersnakes have also been documented using isolated pools within an intermittent flow reach of the Blue River (Cotton et al. 2017). The wetted areas where gartersnakes were detected also had abundant native prey of the narrow-headed gartersnake, indicating that these areas may provide greater foraging opportunities during low flow periods (Cotten *et al.* 2017). Narrow-headed gartersnakes have rarely been observed using reservoir shoreline habitat in New Mexico (Fleharty 1967; Rossman et al. 1996, Hellekson 2012b, pers. comm.). Narrow-headed gartersnakes occur at elevations from approximately 2,300 to 8,200 ft (700 to 2,500 m), with most records occurring at elevations between 4,000-6,200 feet (Holycross *et al*. 2020). Narrow-headed gartersnakes occur within a wide range of biotic communities including Petran Montane Conifer Forest, Great Basin Conifer Woodland, Interior Chaparral, and Arizona Upland Sonoran Desertscrub communities (Rosen and Schwalbe 1988; Brennan and Holycross 2006).

Despite the reputation of being highly aquatic, narrow-headed gartersnakes found in water represented less than 10 percent of total observations according to a multi-year telemetry study in New Mexico, with more females found in water compared to males (Nowak 2006, Jennings and Christman 2012). These data suggest that this species may spend a relatively small percentage of its time in the water but compared to other native gartersnakes of the southwestern U.S., it is still considered the most aquatic. While foraging, narrow-headed gartersnakes use pool and riffle habitats more commonly than glides (or runs) (Rosen *et al.* 2012). Within pools, these gartersnakes often select the portion of the pool adjacent to a riffle (Rosen *et al.* 2012). Narrow-headed gartersnakes prefer boulder and cobble substrates, both within and along streams, and often within near proximity to bedrock (Rosen *et al.* 2012). Crevices within bedrock associated with outcrops and cliffs along suitable streams appear to provide critical microsites for sheltering, and are often used by aggregations of narrow-headed gartersnakes (Rosen *et al.* 2012).

Species Range

The historical distribution of the narrow-headed gartersnake ranged across the Mogollon Rim, particularly the associated perennial streams drainages from central and eastern Arizona, southeast to southwestern New Mexico at elevations ranging from 2,300 to 8,000 ft (700 to 2,430 m) (Rosen and Schwalbe 1988; Rossman *et al.* 1996; Holycross *et al.* 2006). Major subbasins in its historical distribution included the Salt and Verde River subbasins in Arizona, and the San Francisco and Gila River subbasins in New Mexico (Holycross *et al.* 2006). Holycross *et al.* (2006) suspect the species was likely not historically present in the lowest reaches of the Salt, Verde, and Gila Rivers below 2,300 ft, even where perennial flow persisted.

Population Status, Dynamics, and Distribution

To "jeopardize the continued existence of" a species means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and the recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02).

The narrow-headed gartersnake has declined markedly over the past several decades and most populations are thought to occur at low population densities.

In 2011, the remaining streams where the narrow-headed gartersnake could reliably be found were located at: (1) Whitewater Creek (New Mexico; NM), (2) Tularosa River (NM), (3) Diamond Creek (NM), (4) Middle Fork Gila River (NM), and (5) Oak Creek Canyon (Arizona; AZ). However, in 2012, flows containing high amounts of ash and sediment followed the Whitewater-Baldy Complex Fire significantly affected the fish communities of Whitewater Creek and the Middle Fork Gila River which significantly affected the gartersnake's prey base. The narrow-headed gartersnake population in the Middle Fork Gila River appears to be stabilizing with the return of native fish (Jennings *et al*. 2022). From a combination of post-fire effects and a chemical fish renovation project underway (NMDGF 2017), the Whitewater Creek population is now considered extirpated. In 2012, the narrow-headed gartersnake population in Diamond Creek, New Mexico, was considered to be a high-density population based on catch per unit effort (Hellekson 2012a) but growth in the crayfish population through 2021 and effects from the 2022 Black Fire have reduced the population density to a very low level (Christman *et al*. 2023). Survey data from the Tularosa River found crayfish densities to be rising, which is a cause for concern for the resident gartersnake population (Jennings et al. 2019).

In summary, since 2011 two of five populations where the species could be generally, reliably detected, either exist at a very low density (Diamond Creek) or considered extirpated (Whitewater Creek). Currently, most populations over its range are thought to occur at lower population densities. Across its range, many areas where previous records occur are heavily impacted by predatory nonnative species or vulnerable to drought or human water use impacts. Existing sampling data suggest that perhaps only three populations of narrow-headed gartersnakes are considered relatively dense where the species remains somewhat reliably detected: 1) Tularosa River (NM); 2) Middle Fork Gila River (NM); and 3) Oak Creek/ West Fork Oak Creek (AZ).

Occupancy, Surveys, and Detection

Narrow-headed gartersnakes are well-camouflaged, secretive, and very difficult to detect in structurally complex, dense habitat where they could occur at very low population densities, which characterizes most occupied sites (79 FR 38678; July 8, 2014). Narrow-headed gartersnakes were detected in 5 of 16 historical localities in Arizona and New Mexico surveyed by Holycross *et al.* (2006) in 2004 and 2005. Population densities have noticeably declined in many populations, as compared to previous survey efforts (Holycross *et al.* 2006). Holycross *et al.* (2006) compared narrow-headed gartersnake detections based on results from their effort and that of previous efforts in the same locations and found that significantly more effort is required to detect this species in areas where it was formerly robust, such as along Eagle Creek (AZ), the East Verde River (AZ), the San Francisco River (NM), the Black River (AZ), and the Blue River (AZ). Based on our analyses in the rule listing the narrow headed gartersnake (79 FR 38678; July 8, 2014), it is apparent there has been a significant decline in the species over the past 50 years. This decline appeared to accelerate during the two decades immediately before listing occurred. From this observation, we concluded in the listing rule that many areas that were occupied by the species in surveys during the 1980s are likely no longer occupied because those populations have disappeared.

In examining occupancy by reviewing all of the surveys conducted since the 1980s, we determined those surveys included at least the same amount or more search effort than those surveys that detected the species in the 1980s (85 FR 23608; April 28, 2020). Since 1998, researchers have detected the species in many areas where they were found in the 1980s, but also not in other areas. Resurveyed areas with no confirmed detection of narrow-headed gartersnakes since the 1980s include the Gila River Subunit downstream of the Middle Box (Christman and Jennings 2017; Jennings *et al.* 2017; Jennings *et al.* 2018; Jennings and Christman 2019); San Francisco River downstream of confluence with Whitewater Creek (Holycross *et al.* 2006; Hellekson 2012), and Salt River (Holycross *et al.* 2006).

Table 4. Record histories for the narrow-headed gartersnake showing significant gaps in time between records and before first detections in various streams.

Stream	Record	Subsequent Record	Gap in Years	First Record
West Fork Gila River	1958	1984	26	
East Fork Gila River	1949	2006	57	
Snow Lake	1958	2012	54	
Iron Creek	1935	2009	74	
Black Canyon	1967	2009	42	
Negrito Creek	1977	2021	44	
Turkey Creek	1986	2020	34	
Diamond Creek (NM)				2009
Tularosa River	1986	2009	23	
South Fork Negrito Creek				2006
Dry Blue Creek				2010
Campbell Blue Creek				2000
Coleman Creek				1989
Eagle Creek	1934	1983	49	
	1991	2013	22	
East Fork Black River	1988	2004	16	

West Fork Black River	1956	1991	35	
Bear Wallow Creek				2003
North Fork Bear Wallow Creek				2004
Reservation Creek				2016
Canyon Creek	1990	2015	25	
Big Bonito Creek	1957	1986	29	
Houston Creek				2005
Tonto Creek (Salt Subbasin)				1988
Christopher Creek				1993
Verde River				1986

However, falsely declaring a species absent can result in improper conservation decisions or even extirpation of populations due to the lack of appropriate protections (Kery 2002; Halstead *et al.* 2011). Given the imperfect nature of gartersnake surveys and limited inferences that can be made about population status as well as the presence of known stressors to narrow-headed gartersnakes throughout much of their known range, and the ability of gartersnakes to elude detection during protocol surveys, we expect the species remains extant in all historically streams (except for Whitewater Creek within the San Francisco Subbasin). Currently, we expect narrow-headed gartersnakes to generally occur as low-density subpopulations that are spatially isolated along stream courses where habitat retains important characteristics. The history of records from 1980 to present (representing the most-surveyed period of time for this species) throughout all known historically occupied streams portrays the universe of potentially extant populations with imperfect resolution, which demonstrates the need to expand survey effort both in terms of the number of sites sampled within streams and the number and duration of traps and trapping effort across seasons and years.

Threats

Predatory Nonnative Species
The best available commercial and scientific information suggest predatory nonnative species such as bass (*Micropterus* sp.), flathead catfish (*Pylodictis* sp.), channel catfish (*Ictalurus* sp.), bullheads (*Ameiurus* sp.), sunfish (*Lepomis* sp.), crappie (*Pomoxis* sp.), brown trout (*Salmo trutta*), American bullfrogs (*Lithobates catesbeiana*), northern (virile) crayfish (*Orconectes virilis*), and red swamp crayfish (*Procambarus clarkii*) are the most significant threat to narrow-headed gartersnakes and their prey base, and have had a profound role in their rangewide decline. Predatory nonnative fish and bullfrogs affect gartersnake populations via direct and indirect community interactions. Crayfish affect gartersnakes via alteration of physical habitat in addition to via adverse community interactions (Gonçalves Loureiro *et al.* 2015).

Crayfish may impact narrow-headed gartersnakes via direct predation effects (Weaver 2004, entire; Westeen and Martinez-Fonseca 2021, entire), wound infliction, and indirect competition, possibly through exploitative and indirect effects on gartersnake prey populations and interference competition by limiting their ability to forage safely in submerged interstitial spaces (Rosen *et al.* 2012; Holycross *et al*. 2020). Rosen *et al.* (2012) found tail injuries in narrow-headed gartersnakes strongly correlated with crayfish abundance. Crayfish may disproportionately affect dace populations, which indirectly may disproportionately affect the neonatal and small juvenile size classes of narrow-headed gartersnakes (Rosen *et al.* 2012, p. 78). Crayfish can be particularly difficult to eradicate once established. Biological, chemical, mechanical, physical, biocidal, autocidal, and legislative control methods have been used for crayfish control around the world, but each come with environmental costs that can outweigh benefits and no single method has proven both effective and efficient (Stebbing *et al.* 2014; Gonçalves Loureiro *et al.* 2015).

Several researchers have attempted to test several variables to correlate narrow-headed gartersnake detectability, occupancy, or abundance with fish community status, specifically whether the community is predominately native or nonnative (Rosen *et al.* 2021; Jennings *et al*. 2017; Jennings *et al*. 2018). Rosen *et al.* (2021) reviewed fish community data over time and found that invasions of centrarchid and ictalurid fishes destabilized native fish communities in Oak Creek, Black River, San Francisco River, Middle Fork Gila River, and Eagle Creek. Rosen *et al.* (2012) detected statistical relationships between narrow-headed gartersnake abundance and fish community characteristics. Specifically, they found larger native fishes (suckers and chubs) had strong positive, while predatory nonnative fishes in the Centrarchid and Ictalurid families had strong negative statistical associations with narrow-headed gartersnake status (Rosen *et al.* 2012). Between predation and competition as basic effect pathways, they found competitive effects via reduction in prey abundance is the strongest mechanism of impact (Rosen *et al.* 2012). Age structure evenness (the relative proportion of individuals in various age classes within a population) of narrow-headed gartersnakes may also correlate with native fish abundance, and inform gartersnake recruitment, according to research done by Rosen *et al.* (2012). Rosen *et al.* (2012) stated: "In the present study, we are witnessing ongoing, long-term effects of this situation, and others like it, involving profound impacts of introduced predatory fishes across multiple vertebrate classes, species, and in an apparently widening array of localities." Jennings *et al*. (2018) reported results from several surveys within the upper Gila subbasin where they detected narrow-headed gartersnakes at four of nine sites surveyed in 2018. Of the sites where narrow-headed gartersnakes was detected, all had native or nearly native fish communities; the sites where no detections were made generally had nonnative fish communities comprised of spiny-rayed species in the Centrarchidae and Ichtaluridae (Jennings *et al*. 2018). These data suggest prey specificity is the most limiting life history characteristic for narrow-headed gartersnakes, but also represents the most efficient path to their recovery.

The effect of these predatory nonnatives on the native aquatic community is broad and should be treated as a landscape-scale threat to biodiversity. For example, in 2014, Timmons *et al*. (2015) conducted fish surveys at 65 different sites within the Gila River basin. They concluded that at approximately 46 of the sites sampled, nonnative fish were a primary threat to the native fish community; often seconded by drought or crayfish.

In addition to risking physical injury from the dorsal or pectoral spines of predatory nonnative fish while attempting to ingest them (Emmons *et al.* 2016), complex ecological interactions between these predatory nonnative species and the native aquatic community have resulted in 1) direct predation on gartersnakes; 2) shifts in biotic community structure from largely native to largely nonnative; and 3) competition for a diminished gartersnake prey base that can ultimately result in the injury, starvation, or death of individual narrow-headed gartersnakes. These circumstances can result in 1) reduced recruitment within populations; 2) subsequent population declines; and ultimately 3) local and regional extirpations. The native fish communities that serve as the sole prey base for narrow-headed gartersnakes have been severely affected by predatory nonnative species such that native aquatic ecosystems are on the verge of collapse in many regions, as documented by multiple listings under the Endangered Species Act of native fish species of the Southwestern United States and by a large body of literature over several decades (Meffe 1985; Propst *et al.* 1986; 1988; 2009; Rosen and Schwalbe 1988; Douglas *et al.* 1994; Degenhardt *et al.* 1996; Fernandez and Rosen 1996; Richter *et al.* 1997;Inman *et al.* 1998; Rinne *et al.* 1998; Nowak and Santana-Bendix 2002; Propst 2002; Desert Fishes Team (DFT) 2003; 2004; Bonar *et al.* 2004; Rinne 2004; Clarkson *et al.* 2005; Fagan *et al.* 2005; Knapp 2005; Olden and Poff 2005; Turner 2007; Holycross *et al.* 2006; Brennan 2007; Propst *et al.* 2008; Brennan and Rosen 2009; Minckley and Marsh 2009; Pilger *et al.* 2010; Stefferud *et al.* 2011).

Diminishing Surface Water

Activities that reduce flows or dewater habitat, such as dams and diversions (Ligon *et al.* 1995; Turner and List 2007), flood-control projects, and groundwater pumping (Stromberg *et al.* 1996; Rinne *et al.* 1998; Voeltz 2002; Haney *et al.* 2009; USGS 2013), seriously threaten the physical habitat of the gartersnakes and are second only to predatory nonnative species in their scope and magnitude of effect on the narrow-headed gartersnake because fish must have water to survive and without this prey base, narrow-headed gartersnakes will not persist. These structures alter the timing, duration, intensity, and frequency of flood events which favors predatory nonnative species and leads to unfavorable shifts in entire fish communities (Rinne *et al.* 1998; 2005; Propst *et al.* 2008) which compounds their effect on narrow-headed gartersnake populations. Even without these factors, reservoirs promote predatory nonnative fish communities downstream of dams regardless of whether dam construction results in any changes to thermal regimes or downstream flow (Martinez *et al.* 1994). Human population growth has resulted in increased water demands and exacerbated the magnitude and scope of these effects on narrow-headed gartersnake populations.

High Severity Wildfire

Since 2002, within Arizona, approximately 1.564 million ac (632,928 ha) have burned in wildfires in the Gila, Salt, and Verde River basins (Jones *et al.* 2014). High intensity wildfires lead to excessive sedimentation and ash flows which can, in turn, result in sharp declines in fish communities downstream and even complete fish kills. In 2011 and 2022, both Arizona (2011 Wallow Fire) and New Mexico (2022 Black Fire) experienced the largest wildfires in their respective State histories; indicative of recent history that has been punctuated by wildfires of massive proportion. The 2011 Wallow Fire affected (to various degrees) approximately 540,000 ac (218,530 ha) of Apache-Sitgreaves National Forest, White Mountain Apache Indian Tribe, and San Carlos Apache Indian Reservation lands in Apache, Navajo, Graham, and Greenlee counties in Arizona as well as Catron County, New Mexico (InciWeb 2011). The 2011 Wallow Fire impacted 97 percent of perennial streams in the Black River subbasin, 70 percent of perennial streams in the Gila River subbasin, and 78 percent of the San Francisco River subbasin and resulted in confirmed fish kills in each subbasin (Meyer 2011); each of these streams is known to support populations of narrow-headed gartersnakes. In New Mexico, recent wildfires have affected narrow-headed gartersnake populations in the San Francisco and upper Gila watersheds via effects to the fish communities. The 2012 Whitewater-Baldy Complex Fire had serious impacts to fish communities in the San Francisco River watershed (*e.g.,* Middle Fork Gila River, Whitewater Creek). Also in New Mexico, the 2022 Black Fire had similar impacts to fish communities in the upper Gila River watershed (*e.g.*, Black Canyon, Diamond Creek).

Post-fire flooding with significant ash and sediment loads can result in significant declines, or even the collapse, of resident fish communities, which poses significant concern for the persistence of resident gartersnake populations in affected areas. Sedimentation can adversely affect fish populations used as prey by narrow-headed gartersnakes by: (1) Interfering with respiration; (2) reducing the effectiveness of fish's visually based hunting behaviors; and (3) filling in interstitial (spaces between cobbles, etc., on the stream floor) spaces of the substrate, which reduces reproduction and foraging success of fish (Wheeler *et al.* 2005). The presence of adequate interstitial spaces along stream floors may be particularly important for narrow-headed gartersnakes. Hibbitts *et al.* (2009) reported the precipitous decline of narrow-headed gartersnakes in a formerly robust population in the San Francisco River at San Francisco Hot Springs from 1996 to 2004. The exact cause for this decline is uncertain, but the investigators suspected that a reduction in interstitial spaces along the stream floor from an apparent conglomerate, cementation process may have affected the narrow-headed gartersnake's ability to successfully anchor themselves to the stream bottom when seeking refuge or foraging for fish (Hibbitts *et al.* 2009). These circumstances would likely result in low predation success and eventually starvation. While siltation and embeddedness of cobble and boulder substrates within streams is considered problematic for foraging narrow-headed gartersnakes (Hibbitts *et al.* 2009), Rosen *et al.* (2012) did not find a statistical correlation with occupancy in their research of the subject. Siltation of the rocky interstitial spaces along stream bottoms also decreases the dissolved oxygen content where fish lay their eggs, resulting in depressed recruitment of fish and a subsequent reduction in prey abundance for narrow-headed gartersnakes through the loss of prey microhabitat (Nowak and Santana-Bendix 2002). The underwater foraging ability of narrow-headed gartersnakes (de Queiroz 2003) is largely based on vision and is also directly compromised by excessive turbidity caused by sedimentation of water bodies. Suspended sediment in the water column may reduce the narrow-headed gartersnake's visual hunting efficiency from effects to water clarity, based on research conducted by de Queiroz (2003) that concluded the species relied heavily on visual cues during underwater striking behaviors.

Increasing Demand for Water

Human population growth in the southwest has been significant (Gammage *et al*. 2008) and is expected to increase. From 2010-2030, the human population of Arizona and New Mexico are expected to grow by 48 percent and 37 percent, respectively (Thoebald *et al.* 2013). This projected population growth will intensify pressure on the region's water resources (Overpeck 2008), in particular larger perennial or near-perennial streams which are integral to the recovery of the narrow-headed gartersnake. The combination of greater human use of water and environmental change-induced drought, could significantly limit surface water in the Southwest, exacerbate the ecological effect of predatory nonnative species, and therefore the recovery of narrow-headed gartersnakes on a rangewide scale. Human population growth is also expected to increase visitation to aquatic sites which may result in increases in adverse human interactions with snakes and potentially increases in gartersnake mortality due to the public's general fear and dislike of snakes (Fleharty 1967, Rosen and Schwalbe 1988; Green 1997, Nowak and Santana-Bendix 2002, Hibbitts and Fitzgerald 2009).

Environmental Change and Drought

The future of the narrow-headed gartersnake is also intrinsically linked to environmental change. As discussed above, the narrow-headed gartersnake depends on fish populations as prey. Projected environmental change in the southwestern United States includes increasing temperatures, decreasing precipitation, decreasing snowpack, decreasing runoff and stream flow (Cayan *et al*. 2013). Specifically, projections suggest that by year 2100 1) average annual temperatures in the Southwest may increase by 2-9° F; 2) annual runoff could decrease by 10-40 percent; and 3) the severity and length of droughts and soil-moisture depletion could increase substantially (Fleishman *et al*. 2013). Increasing temperature increases the rate of evaporation and transpiration of surface water, further reducing the amount of water for gartersnake prey species.

Environmental change is expected to disproportionately affect the prey base of narrow-headed gartersnakes both through effects to habitat and through community interactions between native and nonnative species. Effects of environmental change in the southwestern United States are predicted to benefit predatory nonnatives over native aquatic species. According to modeling results reported by Jaeger *et al.* (2014) environmental change is expected to affect southwestern streams by increasing the number of zero-flow days, the number of zero-flow periods, and the duration of zero-flow periods which will concentrate fish populations and exacerbate community-level effects of predatory nonnative from increased competition and predation. Rahel and Olden (2008) expect that increases in water temperatures in drier climates such as the southwestern United States will result in periods of prolonged low flows and stream drying. Predatory nonnative fish such as largemouth bass are expected to benefit from prolonged periods of low flow (Propst *et al.* 2008; Rahel and Olden 2008). Other predatory nonnative species such as green sunfish, channel catfish, and bluegill, are expected to increase their distribution by 7.4 percent, 25.2 percent, and 33.3 percent, respectively (Eaton and Scheller 1996). Environmental change is predicted to foster the expansion of predatory nonnative aquatic species into new areas, magnify the effects of existing aquatic nonnative species where they currently occur, increase predation rates from nonnative predators, and heighten the virulence of disease outbreaks in North America (Rahel *et al.* 2008). As annual precipitation amounts lower, base flows weaken, and pools decline in volume and persistence, aquatic vertebrate populations will be forced to occupy smaller aquatic spaces which will increase the frequency of interactions between predatory nonnative species and native species, thus increasing predation and hastening the decline of native aquatic species throughout the southwestern United States.

Genetic Effects
Collectively, threats affecting this species have created isolated populations, which have reduced the genetic connectivity among extant narrow-headed gartersnake populations and resulted in genetic drift and subsequently, the potential for inbreeding and limited adaptive potential to address abiotic and biotic changes over time (Wood 2018). Through genetic analyses, Wood *et al*. (2018) found four major clades representing major basins (Verde, Salt, San Francisco, and Gila Rivers); two samples from Tonto Creek (Gila County, AZ) grouped with the Verde instead of the presumed Salt but the relationship was not strongly supported. In addition, narrow-headed gartersnakes partioned in to six major clusters, including a Verde River cluster (Oak Creek samples), two Salt River clusters (Canyon Creek and Black River samples), two San Francisco River clusters (Blue River and Tularosa River samples), and a Gila River cluster composed of the Middle Fork Gila River, Diamond Creek, and West Fork Gila River samples (Wood *et al*. 2018).

Estimates of effective population size for narrow-headed gartersnakes across sites resulted in values well below (13 - 42) the threshold (≥ 100) to limit inbreeding depression, with effective population sizes being found particularly low at Canyon Creek, Blue River, and Middle Fork Gila River (Wood *et al*. 2018). Wood *et al*. (2018) also detected significant bottlenecks at all sites which suggests loss of genetic diversity has occurred across the range of this species within the last 2–4 generations.

When genetic connectivity among populations is disrupted, a series of deleterious and synergistic genetic effects can occur, including 1) levels and distribution of genetic diversity increasingly erode which can result in increased genetic differentiation between populations and small effective population sizes; 2) lower effective population sizes can create a feedback loop between genetic drift and inbreeding which can lead to decreased fitness of a population (or "inbreeding depression") and increased sensitivity to environmental stressors and demographic changes; and finally 4) these changes can cumulatively drive further population declines, increasing the risk for population extirpations (Wood *et al*. 2018).

Ralls *et al*. (2017) reiterate that small and genetically isolated populations can lose genetic diversity, becoming increasingly inbred with each generation. Wood *et al*. (2018) recommends considering assisted gene flow as a management tool for combatting genetic effects of isolation; specifically suggesting "… management using reciprocal translocations and multiple sources …" to alleviate concerns of further depleting low-density populations through removal of individuals for this purpose. Table 11 in Wood *et al*. (2018) lists genetically vulnerable populations and potential source populations for use in assisted gene flow.

Synergistic Stressors
Many other factors have contributed to the decline of the narrow-headed gartersnake, and in some cases, continue to present a significant threat to low-density populations through synergistic mechanisms, including: environmental change and drought (IPCC 2007; Seager *et al.* 2007; Overpeck 2008); development and recreation within riparian corridors (Briggs 1996, Ernst and Zug 1996, Green 1997, Wheeler *et al.* 2005, Paradzick *et al.* 2006); indirect effects from fisheries management activities (Dawson and Kolar 2003, Carpenter and Terrell 2005, Holycross *et al.* 2006, Finlayson *et al.* 2010); road construction, use, and maintenance (Klauber 1956, Waters 1995, Shine *et al.* 2004, Ouren *et al.* 2007, Breininger *et al.* 2012); adverse human interactions with gartersnakes (Fleharty 1967, Greene 1997, Nowak and Santana-Bendix 2002, Hibbitts and Fitzgerald 2005); environmental contaminants (Hopkins *et al.* 1999, Campbell *et al.* 2005, Rainwater *et al.* 2005, Wylie *et al.* 2009); and mortality from entanglement hazards such as erosion control products (Stuart *et al.* 2001, Barton and Kinkead 2005, Kapfer and Paloski 2011, Barragán-Ramírez and Ascencio-Arrayga 2013, NMDGF 2013).

<u>Recovery</u>

The recovery priority number assigned to the narrow-headed gartersnake is 2C which indicates a high degree of threat, a high recovery potential (rangewide), the listed entity is a species, and conflict exists with respect to economic activity (48 FR 43098). A Recovery Plan for the narrow-headed gartersnake has not been completed. However, the following guidance provides important components to a narrow-headed gartersnake interim recovery strategy that adheres to the long-term needs of this conservation reliant species.

An interim recovery strategy for the narrow-headed gartersnake should create a foundation for aquatic species conservation under the most plausible scenario of future conditions. Conservation experts largely agree the three most significant threats that challenge the recovery of native aquatic ecosystems are 1) predatory nonnative species; 2) regional human population growth and its effect on demand for declining surface/ground water; and 3) regional environmental change and drought (which inherently prioritizes perennial mainstem rivers as critical for native species recovery). Of these three main threats, management-based solutions may only be realistic for addressing predatory nonnative species. However, there are management actions that may improve resiliency, redundancy, and representation of narrow-headed gartersnakes on the landscape to respond to stressors.

Management of Predatory Nonnatives

Several opportunities exist to work with key partners and a coalition of landowners and land managers to revisit historical nonnative aquatics management and look for improved strategies that slow the degradation of native aquatic communities and facilitate the potential reversal of adverse trends. Some examples include 1) garnering public support by developing an outreach campaign to educate the public about why native aquatic ecosystems are unique, valuable, and at risk of disappearing, what is required to mitigate the most significant threats, and how that facilitates multiple-use concepts on public land; 2) only stocking only fish species which are considered minimally predatory (i.e. rainbow trout) regardless of location; 3) concentrating recreational angling opportunities in lentic habitats and in lotic habitats nearest the largest human population centers (i.e. urban lakes, reservoirs, the Verde River below Horseshoe Dam, and the Salt River below Roosevelt Dam) whereby using streams outside of these areas for native-only management; 4) implementing a sustained, mechanical predatory nonnative species suppression and/or eradication program focused on perennial mainstem rivers and their larger tributaries expected to persist under long term drought conditions; and 5) change how the fisheries management programs are funded to increase financial resources and remove long-term conflicts in management objectives.

Native fish, the largest proportion of the narrow-headed gartersnakes prey base (Manjerrez *et al*. 2017), have shown resilience to physical habitat alteration if predatory nonnative fish are absent or at low densities. Marsh and Pacey (2005) predicted that, despite the significant physical alteration of aquatic habitat in the southwestern United States, native fish species could flourish in these altered environments but for the presence of predatory nonnative fish species. This is critically important as it implies both narrow-headed gartersnakes and their prey base could be efficiently and effectively recovered if addressing predatory nonnative species on the landscape becomes a primary recovery objective.

Maintenance of Genetic Connectivity and Diversity on the Landscape

To address concerns about population genetics of the narrow-headed gartersnakes, negative effects of low genetic diversity can be reversed to allay its predatory effects and promote genetic health of populations. This could be accomplished through crossing genetically at-risk populations with genetically distinct ones, as evidenced by a review of 156 relevant datasets, which found such measures were beneficial in 93 percent of the applications (Ralls *et al*. 2017). To combat genetic effects of isolated populations, management actions based on “genetic rescue” or “assisted gene flow” concepts provided in Whitely *et al*. (2015), Ralls *et al*. (2017), and Weeks *et al*. (2017) should be considered for implementation and guided through genetic data collection and expanded genetic research. Specifically, Wood *et al*. (2018) recommends considering assisted gene flow as a management tool for combatting genetic effects of isolation via strategic translocation to alleviate concerns of further depleting low-density populations through removal of individuals for this purpose. Table 12 in Wood *et al*. (2018) list genetically vulnerable populations and potential source populations of narrow-headed gartersnakes for use in assisted gene flow. These direct approaches to improving genetic connectivity among gartersnake populations can be facilitated by indirect methods such as improving habitat quality and connectivity for gartersnake prey species.

Narrow-headed gartersnake Critical Habitat

Critical habitat was proposed on July 10, 2013 (78 FR 41500) and later revised and re-proposed on April 28, 2020 (85 FR 23608). Final critical habitat for the narrow-headed gartersnake was designated on October 21, 2021 (86 FR 58474).

Critical Habitat Description

Critical habitat for the narrow-headed gartersnake was designated in eight units in portions of Arizona and New Mexico, totaling 23,785 ac (9,625 ha). Within these areas, the physical and biological features (PBFs) essential to narrow-headed gartersnake conservation are:

1. Perennial streams or spatially intermittent streams that provide both aquatic and terrestrial habitat that allows for immigration, emigration, and maintenance of population connectivity of narrow-headed gartersnakes and contain:
    - (A) Pools, riffles, and cobble and boulder substrate, with low amount of fine sediment and substrate embeddedness;
    - (B) Organic and natural inorganic structural features (*e.g*., cobble bars, rock piles, large boulders, logs or stumps, aquatic vegetation, vegetated islands, logs, and debris jams) in the stream channel for basking, thermoregulation, shelter, prey base maintenance, and protection from predators;
    - (C) Water quality that meets or exceeds applicable State surface water quality standards; and
    - (D) Terrestrial habitat within 328 ft (100 m) from the active stream channel (water's edge) that includes flood debris, rock piles, and rock walls containing cracks and crevices, small mammal burrows, downed woody debris, and streamside vegetation (*e.g.,* alder, willow, sedges, and shrubs) for thermoregulation, shelter, brumation, and protection from predators throughout the year.
2. Hydrologic processes that maintain aquatic and riparian habitat through:
    - (A) A natural flow regime that allows for periodic flooding, or if flows are modified or regulated, a flow regime that allows for the movement of water, sediment, nutrients, and debris through the stream network, as well as maintenance of native fish populations; and
    - (B) Physical hydrologic and geomorphic connection between the active stream channel and its adjacent terrestrial areas.
3. A combination of native fishes, and soft-rayed, nonnative fish species such that prey availability occurs across seasons and years.
4. An absence of nonnative aquatic predators, such as fish species of the families Centrarchidae and Ictaluridae, American bullfrogs, and/or crayfish, or occurrence of these nonnative species at low enough levels such that recruitment of narrow-headed gartersnakes is not inhibited and maintenance of viable prey populations is still occurring.
5. Elevations of 2,300 to 8,200 ft (700 to 2,500 m).

Table 5: Land ownership and size of narrow-headed gartersnake revised, proposed critical habitat units. [Area estimates reflect all land within critical habitat unit boundaries. County-owned lands are considered as private lands.]

Unit	Subunit	Land Ownership by Type Acres (Hectares)				Size of Unit
		Federal	**State**	**Tribal**	**Private**	
1. Upper Gila River Subbasin	Gila River	1,191 (482)	315 (127)		2,267 (917)	3,773 (1,527)
	West Fork Gila River	615 (249)	228 (92)		21 (8)	864 (350)
	Little Creek	281 (114)	9 (4)			291 (118)
	Middle Fork Gila River	978 (396)				978 (396)
	Iron Creek	111 (45)				111 (45)
	Gilita Creek	376 (152)				376 (152)
	Black Canyon	300 (121)			8 (3)	308 (125)
	Diamond Creek	231 (93)			73 (29)	303 (123)
Unit Total		4,084 (1,144)	553 (224)		2,368 (958)	7,005 (2,835)
2. San Francisco River Subbasin	San Francisco River	2,128 (861)			1,194 (483)	3,322 (1,344)
	Whitewater Creek	254 (103)	3 (1)		125 (51)	382 (155)
	Saliz Creek	194 (78)			68 (27)	261 (106)
	Tularosa River	444 (180)			471 (191)	915 (370)
	Negrito Creek	543 (220)			90 (36)	632 (256)
	South Fork Negrito Creek	362 (147)			20 (8)	382 (155)
Unit Total		3,924 (1,588)	3 (1)		1,967 (796)	5,895 (2,386)
3. Blue River Subbasin	Blue River	2,595 (1,050)			430 (174)	3,025 (1,224)
	Campbell Blue Creek	200 (81)			21 (8)	220 (89)
	Dry Blue Creek	122 (50)				122 (50)
Unit Total		2,918 (1,181)			450 (182)	3,368 (1,363)
4. Eagle Creek		84 (34)			0.4 (0.2)	84 (34)
Unit Total		84 (34)			0.4 (0.2)	84 (34)
	Black River	796 (322)				796 (322)

5. Black River Subbasin	Bear Wallow Creek	183 (74)				183 (74)
	North Fork Bear Wallow Creek	80 (32)				80 (32)
	Reservation Creek	149 (60)				149 (60)
	Fish Creek	135 (55)				135 (55)
	East Fork Black River	436 (176)				436 (176)
Unit Total		1,780 (720)				1,780 (720)
6. Canyon Creek		204 (82)				204 (82)
Unit Total		204 (82)				204 (82)
7. Tonto Creek Subbasin	Tonto Creek	1,673 (677)			91 (37)	1,078 (436)
	Houston Creek	30 (2)			1 (0.4)	18 (7)
	Haigler Creek	473 (191)			26 (10)	294 (119)
Unit Total		2,176 (881)			117 (47)	1,764 (714)
8. Verde River Subbasin	Verde River	1439 (583)			101 (41)	923 (374)
	Oak Creek	634 (256)	109 (44)		422 (171)	1,165 (471)
	West Fork Oak Creek	372 (151)				372 (151)
Unit Total		2,446 (990)	109 (44)		602 (244)	3,156 (1,277)
Total		17,614 (7,128)	665 (269)		5,505 (2,228)	23,785 (9,625)

Note: Area sizes may not sum due to rounding.

Threats

Threats to narrow-headed gartersnake critical habitat PBFs include the continued existence and proliferation of predatory nonnative species, diminishing surface water, increasing human demands for water, and drought associated with environmental change. These factors and their effects to the basic life functions of narrow-headed gartersnakes are described above under the "Threats" subsection for this species.

Conservation Value

The total acreage and number of designated critical habitat units for the narrow-headed gartersnake represent a relatively small land area both collectively and individually. Therefore, actions that adversely affect one or more designated units may have a larger, more pronounced effect on the overall conservation value of designated critical habitat for this species. Actions that may benefit nonnative predatory species or the availability or amount of surface water may have exaggerated effects on critical habitat. For more information on factors that affect the conservation value of designated units, please see the final rule designating critical habitat for this species (86 FR 58474).

Previous Related Consultations

Given the wide range of the narrow-headed gartersnake, several Federal actions affect this species every year. Activities continue to adversely affect the status of the gartersnake and its prey base throughout its range (e.g. predatory aquatic nonnative species, human water uses, environmental change and drought, high severity wildfire, genetic effects, etc.).

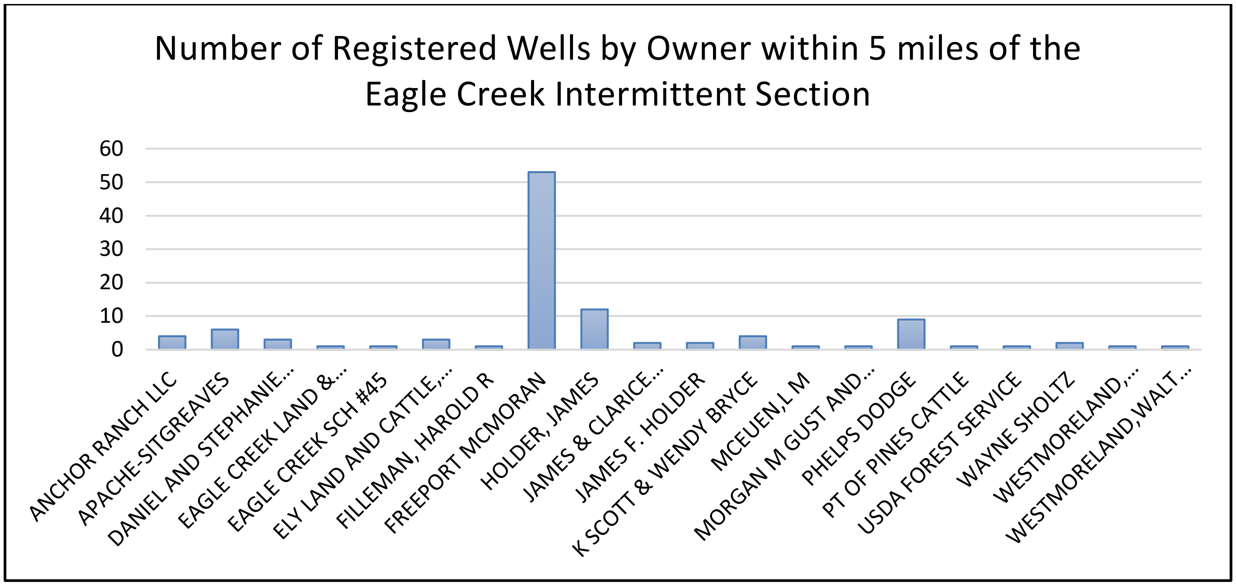
ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

Status of the Species and Critical Habitat within the Action Area

Eagle Creek begins near Robinson Mesa, south of the Mogollon Rim in east-central Arizona, where several smaller streams join East Eagle Creek. Eagle Creek flows south to join the Gila River southwest of Clifton, a distance of approximately 60 miles (mi) (96.6 km). Flow characteristics of Eagle Creek are variable. The upper portion of Eagle Creek is perennial where the stream passes through mountainous terrain and is likely bedrock controlled. Upon entering a broader alluvial valley, which begins near river mile 49, the creek becomes seasonally intermittent until it reaches the Willow Creek confluence. Willow Creek discharges into Eagle Creek near river mile 44, and Eagle Creek is again perennial and remains perennial to its confluence with the Gila River. Within or adjacent to the intermittent/dry reach of Eagle Creek there are numerous groundwater wells in various forms of use or classification (i.e., domestic, stock, irrigation, no water use, mining, industrial, etc.) some even dating backing to 1918 (ADWR 2025; Well Registry 2024 | Arizona Department of Water Resources Open Data). An overview map of the well registry records within the action area (including Covered Area lands) displays the density of registered wells within the vicinity of Eagle Creek from the headwaters to the confluence of Gila River (Figure 4). We highlighted a five-mile buffer from the documented intermittent reach and captured the well registry data within this buffer, which includes the two well fields (Bee Canyon and Mud Creek) described in the CBA proposed action section above. The combination of the number of registered wells within the vicinity of this intermittent reach (Table 6) along with the potential years in use (1918 to current day) may be contributing to this reach being intermittent where the flows between the stream and the underlying aquifer are briefly disconnected, a potential scenario described by Barlow and Leake (2012). Groundwater pumping for extended periods can deplete the aquifer storage levels which is initially the primary water source to a well, but with time, the groundwater contribution declines, and streamflow becomes the primary source of water to a well (Barlow and Leake 2012). In other words, this scenario could explain why this reach is seasonally intermittent.

Table 6. Graph documenting the number of registered wells by owner within the five-mile buffer surrounding the Eagle Creek intermittent section (see Figure 4).



Extensive fish surveys have occurred in Eagle Creek, including annual surveys from 1989 through 2021. Techniques used to sample fish were electrofishing, seine nets, baited minnow traps, dip nets, and hook and line. The portion of Eagle Creek downstream of Willow Creek, including the Sheep Wash area, is dominated by nonnative fish. In particular, three nonnative species – smallmouth bass (*Micropterus dolomieu*), green sunfish (*Lepomis cyanellus*), and channel catfish (*Ictalurus punctatus*) – are common in this stream segment and show an upward trend in numbers collected during recent surveys. Green sunfish, red shiner (*Cyprinella lutrensis*), and mosquito fish (*Gambusia affinis*) are the most abundant species, with channel catfish and yellow bullheads (*Ameiurus natalis*) being the least abundant species.

Conversely, the portion of Eagle Creek upstream of Willow Creek is dominated by native fish. As stated above, there is a broad alluvial valley immediately above the confluence of Willow Creek where Eagle Creek is seasonally intermittent for approximately three miles (4.8 km) before re-appearing where the basin narrows just above the Willow Creek confluence. Above this intermittent stream segment, longfin dace, speckled dace, desert sucker, and Sonoran sucker are common, and Gila chub, spikedace, and loach minnow are rare. The upper reach of Eagle Creek also has several tributaries that likely harbor native fish, including East Eagle Creek, Wet Prong Creek, and Middle Prong Creek.

The intermittent reach of Eagle Creek, located immediately upstream of Willow Creek, appears to limit encroachment of nonnative fish into the upper reach of the creek and its tributaries, at least during drier periods. However, the seasonally intermittent nature of this flow, particularly during wetter periods (e.g., during periods of snow melt and monsoon seasons with above-normal precipitation), could provide nonnatives, especially red shiner, access to the upper reach of the creek.

Between the intermittent reach of Eagle Creek and the proposed fish barrier site, there are approximately 2.5 mi (4.0 km) of perennial flow. Within this area, the Permittee owns two disjunct parcels of land with approximately 600 linear feet (183 m) of stream between the proposed barrier site and the downstream edge of one parcel and 1,050 linear feet (45.7 m) between the lower boundary of the second parcel to the intermittent reach, for a total of approximately 1,650 ft (503 m) of wetted area. The vegetation in this area is characterized by a mix of riparian woodlands and shrublands with cottonwood (*Populus* sp.), oak, and walnut (*Juglans* sp.) species as the dominating overstory community and willow (*Salix* sp.) and alder (*Alnus* sp.) species as the dominating understory community.

Gila Chub

Gila chub have been occasionally collected during annual surveys in upper Eagle Creek. In 1987, and then from 1989 through 1995, no Gila chub were collected in Eagle Creek. Beginning in 1996 and continuing through 2009, Gila chub were occasionally collected during survey efforts, with the most of these collections occurring in the upper portion of the creek and its tributaries. After 2009, Gila chub were not captured during survey efforts in upper Eagle Creek until 2015 and 2016, when AGFD and WestLand captured chub near the Honeymoon Campground, approximately 6 mi (9.7 km) upstream of the proposed fish barrier site (AGFD unpublished data 2015, 2016; WestLand Resources 2016). No Gila chub were captured in 2017 and 2018, but in 2019 a single chub was captured approximately 0.5 mi (0.8 km) below the proposed fish barrier site (Marshall 2020). In 2020, a single Gila chub was captured near Honeymoon Campground (Kesner et al. 2020) and 110 were captured in the same area in November (Hickerson et al. 2021). Gila chub have never been detected in East Eagle or Chitty creeks, which are both tributaries to upper Eagle Creek.

Eagle Creek is considered occupied by Gila chub from the Willow Creek confluence upstream to the confluence of East Eagle Creek. From the fish barrier site downstream to an intermittent area at river mile 49, the Permittee owns approximately 1,650 linear feet (503 m) on which limited management occurs or will occur. At present, Gila chub would likely be found in the upper reach of the creek and its tributaries, such as East Eagle Creek (which has been designated critical habitat for the species), where there are few nonnative fish. From River mile 49 downstream to the Willow Creek confluence, we anticipate that Gila chub could be present, but in low numbers, likely due in part to the seasonally intermittent flows in this area.

There are 22.4 stream miles (36.0 km) of potential Gila chub habitat in upper Eagle Creek above the proposed fish barrier. Currently, upstream migration of nonnative species is precluded only by an intermittent stretch of river near river mile 49, which can be hydrologically connected during periods of flow. Therefore, there is currently no protection of suitable Gila chub habitat and the CBA baseline for Gila chub is 0 stream miles (0 km) of protected habitat.

Spikedace

Early collections by Miller in 1950 did not identify spikedace in Eagle Creek, and no spikedace were collected during surveys in the 1970s and early 1980s (Marsh *et al.* 1990). For a brief period in the 1980s, spikedace were collected. Bestgen (1985 as cited in Marsh *et al.* 1990) reported that 12 juvenile spikedace were caught in Eagle Creek in 1985. In 1987, 398 spikedace were caught from Sheep Wash downstream to the Permittee's diversion dam, and one spikedace was caught below the diversion dam (Marsh *et al.* 1990). No spikedace were captured above Sheep Wash in 1987 (Papoulias *et al.* 1989). In 1989, two spikedace were caught in Eagle Creek. All spikedace detections occurred below the Willow Creek confluence. There are no spikedace records from tributary streams to Eagle Creek. The Arizona Game and Fish Department (AGFD), Service, and Reclamation completed sampling in Eagle Creek for environmental DNA (eDNA) in 2017, 2019, and 2021. Samples were collected at 23 locations between the Eagle

Creek and East Eagle Creek confluence and Knight Canyon. No spikedace were detected in these eDNA sampling efforts. Determining the number of spikedace present in an area is difficult due to limited access to some habitat within Eagle Creek, the low number of spikedace present within the stream, their small body size, and fluctuations in populations for the species from one year to the next.

Since 1989, no spikedace have been captured during annual surveys of Eagle Creek (Biome 2024). The Service believes that spikedace may persist, but in numbers too low for annual survey efforts to detect or in areas where access is limited by landownership. From the fish barrier site downstream to an intermittent area at river mile 49, the Permittee owns approximately 1,650 linear feet (503 m) on which limited management occurs or will occur. From river mile 49 downstream to the Willow Creek confluence, we anticipate that spikedace are not likely to be present as evidenced by the lack of recent detections. This is likely due in part to the seasonally intermittent flows in this area. From the Willow Creek confluence downstream to its confluence with the Gila River, it is unlikely that spikedace regularly occur due to the substantial increase in nonnative species that compete and prey on spikedace during the past two decades and based on the absence of the species in recent surveys.

There are 8.4 stream miles (13.5 km) of suitable spikedace habitat in upper Eagle Creek above the proposed fish barrier. Currently, upstream migration of nonnative species is precluded only by an intermittent stretch of river near river mile 49, which can be hydrologically connected during periods of flow. Therefore, there is currently no protection of suitable spikedace habitat and the CBA baseline for spikedace is 0 stream miles (0 km) of protected habitat.

Loach Minnow

Miller made a single collection of loach minnow in Eagle Creek in 1950, when 12 adults were caught (early collections by Miller in 1950 as cited in Marsh *et al.* 2003). Marsh *et al.* (2003) reported that despite intensive sampling efforts since the 1970s, no loach minnow were collected until the mid-1990s. At that time, Marsh *et al.* (2003) documented four years of occurrence of loach minnow in the upper portion of Eagle Creek, near Honeymoon Campground (near river mile 57), from 1994 to 1997. They found 10 adults in 1994, 12 adults in 1995, three adults in 1996, and two adults in 1997. The AGFD, Service, and Reclamation completed sampling in Eagle Creek for environmental DNA (eDNA) in 2017, 2019, and 2021. Samples were collected at 23 locations between the Eagle Creek and East Eagle Creek confluence and Knight Canyon. No loach minnow were detected in these eDNA sampling efforts. No loach minnow records exist for tributaries to Eagle Creek. Determining the number of loach minnow present in a given area is difficult due to their small size and behavior of hiding under protective cover during daylight (Marsh et al. 2003). Limited access to some habitat within Eagle Creek and the low number of individuals present within the stream also hamper detection efforts. For Eagle Creek, loach minnow went undetected for a 44-year period (1950 to 1994) before being rediscovered (Marsh et al. 2003), which illustrates the difficulty in detecting the species.

Since 1997, no loach minnow have been captured during annual surveys of Eagle Creek (Biome 2024). The Service believes that loach minnow may persist in Eagle Creek, but in numbers too low for annual survey efforts to detect or in areas where access is limited by landownership. At present, loach minnow are likely confined to the upper reach of the Eagle Creek and its tributaries, such as East Eagle Creek, where few nonnative fish species are present to compete with and prey on loach minnow and where the majority of loach minnow detections have occurred in the past. From the fish barrier site downstream to river mile 49, there is one loach minnow record from 1994. The Permittee owns approximately 1,650 linear feet (503 m) in this area, on which limited management occurs or will occur. From river mile 49 downstream to the Willow Creek confluence, we anticipate that loach minnow are not likely to be present as evidenced by the lack of detections in recent and past surveys. This is likely due in part to the seasonally intermittent flows in this area. From the Willow Creek confluence downstream to its confluence with the Gila River, it is unlikely that loach minnow regularly occur due to the substantial increase in nonnative species during the past two decades and based on the absence of the species in recent surveys.

There are 8.4 stream miles (13.5 km) of suitable loach minnow habitat in upper Eagle Creek above the proposed fish barrier. Currently, upstream migration of nonnative species is precluded only by an intermittent stretch of river near river mile 49, which can be hydrologically connected during periods of flow. Therefore, there is currently no protection of suitable loach minnow habitat and the CBA baseline for loach minnow is 0 stream miles (0 km) of protected habitat.

Narrow-headed Gartersnake

The narrow-headed gartersnake is historically known from Eagle Creek based upon observations in 1934 (n=2), 1964 (n=1), 1983 (n=2), 1987 (several), 1988 (n=1), and 1991 (n=1). In 1987, Fernandez and Rosen (1996) conducted a comprehensive survey along a total of 21 stream miles (33.8 km) across lower, middle, and upper Eagle Creek. Rosen observed a total of 29 narrow-headed gartersnakes all located in lower and middle Eagle Creek. Based on these results, Rosen concluded that while an eight-mile (12.9 km) reach of middle Eagle Creek supported a relatively high density of narrow-headed gartersnakes evidenced by one of the highest catch per unit efforts recorded for this species, the species was “rare to absent” in the upper half of Eagle Creek.

In 2004 and 2005, Holycross conducted narrow-headed gartersnake surveys at three sites previously surveyed by Rosen in upper (Honeymoon Campground), middle (P-Bar Ranch), and lower (Morenci pumping station) Eagle Creek. No narrow-headed gartersnakes were detected during a cumulative survey effort of 138 hours of visual encounter surveys and 19,660 trap-hours (Holycross et al. 2006). The only observation of narrow-headed gartersnake along Eagle Creek since 1991 was the incidental detection of a single adult near Sheep Wash in 2013 (Ehlo et al. 2013). There are no records of narrow-headed gartersnake in tributaries to Eagle Creek.

No gartersnakes have been observed during annual fish surveys that have been conducted at multiple sampling sites in lower, middle, and upper Eagle Creek since the 1980s. Narrow-headed gartersnakes are difficult to adequately monitor due to low detection probabilities and because they are generally only observed if surface active. In addition, surveys often occur within limited spatial areas as a sample of larger areas. The difficulty of detecting gartersnakes is also exacerbated when they are present in low numbers. In addition, the history of records for this species includes gaps in records for various streams of over 50 years, with the first species records for some streams occurring in the 2000s. This underscores the species’ demonstrated ability to elude detection for multiple decades particularly in under-sampled streams. Narrow-headed gartersnakes are also difficult to detect due to their tendency to shelter out of sight and to blend into their environment. For Eagle Creek, there is adequate flow in the creek as well as a native prey base to support the species. Combined with detections over time, as well as a lack of gartersnake-specific monitoring, we anticipate that narrow-headed gartersnakes are likely present at Eagle Creek at a very low-density population.

To better determine a baseline for purposes of the CBA, we analyzed the potential number of gartersnake home ranges within the project area by applying results from research that determined gartersnake home range size (Nowak 2006, Jennings and Christman 2012). This research found a maximum home range size of 5.5 ac (2.2 ha). Buffering 8.4 mi (13.5 km) of Eagle Creek above the fish barrier by 100 m (328 ft) to incorporate streamside habitat, we determined that there is a maximum of 682 ac (276 ha) of streamside habitat that would be above the proposed barrier, equating to a maximum of 124 potential home ranges. Not all of this area is on the Permittee's lands, but the barrier would protect the river and associated riparian habitat above the barrier regardless of land ownership. Also, we recognize that not all areas incorporated in the 124 potential home ranges above the barrier are suitable for gartersnakes and that some may be highly suitable and others less so or not suitable. As noted above, we anticipate that gartersnakes are likely present at Eagle Creek as a very low-density population. While we recognize that additional surveys are also needed, we anticipate that habitat suitability also affects population density. In addition, there are approximately 4,060 ac (1,643 ha) below the barrier, with 1,894 ac (766.5 ha) on the Permittee's lands, equating to a potential maximum of 344 home ranges. This area is occupied by multiple nonnative fish species which serve as prey as well as prey on and compete with narrow-headed gartersnakes (Fleharty 1967, M. Lopez, pers. comm. 2010). As with those portions of Eagle Creek above the barrier, we recognize that not all acres of habitat are equally suitable for gartersnakes and that some reaches may be highly suitable and others less so or not suitable.

Based on the information above, there are approximately 468 home ranges along Eagle Creek both above and below the proposed fish barrier. There is currently no protection for gartersnake home ranges along Eagle Creek above the proposed fish barrier; therefore, the CBA baseline for gartersnake is 0 protected home ranges.

EFFECTS OF THE ACTION

In accordance with 50 CFR 402.02, effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of all other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see §402.17).

This BO analyzes the effects of the Service's issuance of an EOS permit and approval of the CBA. In addition, this BO analyzes the effects of the fish barrier construction for Reclamation. Effects resulting from each action will be analyzed separately below.

Gila Chub, Spikedace, and Loach Minnow

Issuance of the EOS Permit and CBA Approval

The effects from the Permittee's Covered Activities to Gila chub, spikedace, and loach minnow on Covered Area lands are ongoing and will continue to occur regardless of our issuance of the EOS permit and CBA approval. These effects are analyzed below. However, our issuance of the EOS permit and CBA approval will provide multiple conservation actions and benefits that protect and enhance habitat for Gila chub, spikedace, and loach minnow, and their critical habitat above the constructed fish barrier. The Permittee's financial commitments related to the investigation, design, and construction of the fish barrier will provide long-term benefits and protections from harmful nonnative fish species below the fish barrier. In addition, the Permittee's commitment to develop and implement a three-year monitoring program (nonnative crayfish study) above the fish barrier and a separate monitoring program on Covered Area lands along Eagle Creek will help inform conservation and management activities to assist in the future recovery of Gila chub, spikedace, and loach minnow. The conservation actions outlined in the CBA will protect 22.4 stream miles (36.0 km) of potential Gila chub habitat, 8.4 stream miles (13.5 km) of suitable spikedace and loach minnow habitat in upper Eagle Creek above the constructed fish barrier. The baseline for all three species is 0 stream miles (0 km) of protected habitat; therefore, the proposed CBA is expected to result in a net conservation benefit for the three species and no take of the three species is anticipated to result from the proposed actions above the fish barrier.

Covered Activities are not conducted on the Covered Area lands in upper Eagle Creek (see Parcel Number 10 and 9, Figure 2). Parcel 8 (Figure 2) is where the single residence and wellfield maintenance manager resides. This area is included in the CBA and is used to store pipes and materials related to the groundwater well operations. No ground-disturbing activities occur on this parcel and only building maintenance or repairs will be conducted when necessary. The Permittee will continue to divert water from the Black River, pump groundwater from two separate well fields (Parcel 2 through 7, Figure 2; where Bee Canyon and Mud Springs occur) and transport the water to Eagle Creek. Only ongoing maintenance and operation of the pumps (Parcels 3, 5, 6, and 7, Figure 2) is identified for these properties. A buried pipeline connects to each well and transports water downstream to Eagle Creek. No actions were identified for the pipeline, but construction, alteration, or maintenance may be included in the future. Parcel 2 includes the Bee Canyon well field along with the associated pumps (two total), facilities, and a single residence where ongoing operations and maintenance are permitted to occur. The Permittee intends to continue to transport and divert water from these locations for the foreseeable future. It is possible that, in the future, the Permittee may alter the manner in which they divert and transport water from either well field including potentially installing pipelines or other infrastructure to transport water for its operations; however, no alterations are proposed at this time.

Ground disturbance (vehicle use, heavy equipment, materials storage, etc.) from the continued operation and facility maintenance at the single residence (Parcel 8, Figure 2) that contributes sediment to Eagle Creek would have the potential to affect Gila chub, spikedace, and loach minnow. However, because the area is already disturbed, currently in use, and no new ground-disturbing activities will occur; the effect from these actions are not likely to contribute a significant amount of sediment that would reduce pool availability for Gila chub and its critical habitat or increase fine sediment and substrate embeddedness for spikedace and loach minnow. Gila chub and its critical habitat do not occur below Parcel 8; therefore, the remaining discussion only refers to the potential effect to spikedace and loach minnow further downstream.

We expect the Covered Activities related to groundwater pumping from the Bee Canyon and Mud Springs well field will contribute to further reductions in the groundwater aquifer. As stated previously, groundwater pumping for extended periods can deplete the aquifer storage levels to the point that streamflow becomes the primary source of water to the well (Barlow and Leake 2012). Although there are no known studies or baseline information related to the conditions that led to the seasonally intermittent section in Eagle Creek, there are numerous studies documenting the link between groundwater pumping, streamflow depletion, and impacts to fish (Barlow and

Leake 2012, Barlow et al. 2018, Gleeson and Richter 2018, Perkins et al. 2017, Ruhi et al. 2016). Based on known studies related to groundwater pumping, we can reasonably assume that within the 50-year timeframe there is potential for these ongoing actions to reduce streamflow or further deplete water within Eagle Creek. Any loss in streamflow or expansion of the intermittent/dry section of Eagle Creek, beyond baseline conditions, could result in a seasonal reduction of available habitat for spikedace and loach minnow. Any fluctuation in streamflow or expansion of the intermittent/dry section is anticipated to occur below Parcel 8 (Figure 2) downstream to the Willow Creek confluence. Spikedace and loach minnow in this area are non-existent or severely reduced in numbers due to their continued exposure to nonnative fish. Therefore, a seasonal reduction in available habitat is not likely to have a meaningful impact to the population. However, if present, these impacts could result in individual spikedace and loach minnow's inability to perform daily life history functions (breeding, feeding, shelter) and or result in increased stress or mortality from the loss of water or isolation in pools. Therefore, the effects of continued groundwater pumping within this area are likely to adversely affect spikedace, and loach minnow. The reductions or loss of water will also adversely affect critical habitat PCEs 1, 4, and 6 for the spikedace and loach minnow in areas beyond the Permittee's Covered Area lands.

Further downstream (between Parcel 2 and 3), the addition of water to Eagle Creek from Black River (via Willow Creek) and the two well fields is not likely to adversely affect spikedace or loach minnow since the water is sourced locally, is not contaminated, and will contribute to the streamflow in Eagle Creek. If the Permittee alters the manner in which it diverts and transports water, including potentially installing pipelines or other infrastructure to transport water for its operations, these actions will occur outside of the stream channel but could contribute sediment into Eagle Creek. We do not know the number or length of pipelines, location, or other types of infrastructure; however, any pipeline installation would require the use of heavy equipment and either use of existing or construction of new roads. We therefore expect that these actions could contribute a measurable amount of sediment to Eagle Creek (up to one mile below Parcel 2), adversely impacting fine sediment and substrate embeddedness for spikedace and loach minnow. As noted immediately above, spikedace and loach minnow in this area are non-existent or severely reduced in numbers due to their continued exposure to nonnative fish. Therefore, increases in sedimentation in this area are not likely to have a meaningful impact to the population, but could adversely affect individuals. Were this to occur, adverse effects could potentially expand downstream and into critical habitat that begins below the Permittee's Covered Areas in Eagle Creek, and also affect spikedace and loach minnow and their critical habitats (PCE 5).

Further downstream, near river mile 11.5 (18.5 km) (Parcel 1, Figure 3), the Permittee operates a pump station and infrastructure that includes a pipeline that conveys water from a settling pond to a storage tank, a storage tank, an overhead pipeline that conveys water from the storage tank over Eagle Creek to pump stations and an above ground pipeline that returns excess water from the storage tank into Eagle Creek. At this time, the Permittee does not conduct any activities other than periodic maintenance and, as needed, repair of the pump station (located inside a building), the diversion dam, pipelines, and other associated infrastructure. In the future, more extensive activities may be required, such as replacement of aged facilities or upgrades to ensure adequate operating capacity. Again, we do not know which facilities or infrastructure and the extent of repairs that may occur; however, any replacement or repair of existing facilities would require the use of heavy equipment and either use of existing or construction of new roads. We therefore expect that these actions could contribute a measurable amount of sediment to Eagle Creek (up to one mile below the affected disturbance area), and adversely affect spikedace and loach minnow from the increase in fine sediment and substrate embeddedness.

<u>Fish Barrier Construction</u>
Construction of the proposed fish barrier would directly affect approximately 2.4 ac (0.9 ha) in Eagle Creek. The actions proposed in this area consist of site mobilization, site preparation, construction of the concrete formwork, concrete placement, backfill, and demobilization. To prepare for the instream work, stream flow (if present), would be diverted with dikes or piped around the work area downstream to the active stream channel. The concrete barrier would permanently impact approximately 0.10 ac (0.04 ha) of the 0.31-ac (0.12 ha) construction footprint, and temporary impacts would be expected on approximately 2.09 ac (0.8 ha) designated as the contractor use areas for material storage, equipment staging and camping. Within the construction zone, approximately 6,286 cubic yards (cy) of alluvium would be excavated to prepare the foundation trench and construct the scour walls and apron. Native materials would be stockpiled in contractor use areas for reuse as backfill (see Figure 1). A combination of backfill and riprap would be placed in the channel above and below the fish barrier to prevent impoundment of surface flows and protect the barrier from blowouts during 100-year flood events. Sedimentation is expected to occur once the fish barrier is completed, and flows are returned to Eagle Creek. Effects to instream habitat in the sedimentation zone (estimated 4.4 ac; 1.8 ha) will occur primarily from lowering the local stream gradient, essentially modifying pool or steep-gradient riffles. The timeframe for construction operations is between mid-October 2025 (or 2026) to mid-March 2026 (or 2027).

There are several actions proposed during the fish barrier construction process including pre-construction preparation, construction, and demobilization (described above) that could result in instream disturbance or ground disturbance that could affect Gila chub, spikedace, and loach minnow. Ground disturbance could occur anywhere within the 2.09 ac (0.8 ha) contractor use areas as well as ground or instream disturbance within the 0.31 ac (0.13 ha) construction area footprint. Prior to construction, stream flow from Eagle Creek will be diverted around the work area downstream to the active stream channel. The process to divert water may include, but is not limited to, cofferdams, channels, flumes, drains, and sumps. However, the preferred method is to use a siphon and a gravity flow diversion system to minimize the length of stream impacted by the operation. Prior to stream diversion activities, a permitted fish biologist will survey the stream for native and aquatic species and relocate any captured individuals up or downstream of the action area.

Direct effects from the initial placement of dikes or pipe into the active stream channel could result in disturbance to Gila chub, spikedace, or loach minnow if they were to avoid capture (by the permitted fish biologist) or move back into the area. However, we expect these activities will take time to construct, providing sufficient opportunities for Gila chub, spikedace, or loach minnow to avoid direct impacts from these instream actions. Because the construction period begins in mid-October, spawning periods for Gila chub (February through March), spikedace, and loach minnow (both March through May) will be avoided, thereby eliminating any effects to eggs. Once the water is diverted around the construction area footprint, the primary excavation, formwork construction, concrete placement, and backfilling will occur in the dewatered area. Direct effects from these actions will not adversely affect Gila chub, spikedace, or loach minnow because they will not have access to the area and streamflow will be diverted downstream of the construction area footprint.

Construction of the fish barrier will occur between mid-October through mid-March to avoid periods of high river flows (monsoon storm and snowmelt). Seasonal low flows in Eagle Creek, combined with the placement of dikes or pipe to divert water around the construction area footprint will prevent any substantial movement of sediment from the pre-construction, construction, and demobilization of the construction area footprint and contractor use areas. Ground disturbance (from vehicles, equipment, etc.) in contractor use areas may contribute small amounts of sediment to Eagle Creek during seasonal rainfall events but these effects are insignificant and likely be difficult to observe given the small disturbance area (2.09 ac; 0.8 ha). However, once flows are returned to Eagle Creek, the demobilization of the area which includes the removal of the dikes or pipe from the stream could lead to short-term sediment transport downstream. We expect sedimentation could impact riffle and pool habitats (essential habitat types for breeding, feeding, and cover) within 1.0 mile (1.6 km) downstream of the construction area footprint, but these impacts are temporary and will likely return to pre-construction conditions between one and five years after construction. And, since the demobilization occurs during the low flow period, the sediment will likely dissipate and have no observable impact greater than one mile (1.6 km) from the construction area footprint.

Permanent loss or modifications to instream habitat is expected to occur in Eagle Creek from the fish barrier footprint (0.10 ac; 0.04 ha) and the sedimentation zone (estimated 4.4 ac; 1.8 ha). Once the fish barrier is in place and flows are returned to Eagle Creek, aquatic habitat above the fish barrier will be modified, essentially forming a sedimentation zone from lowering the stream gradient and restricting the formation of steep-gradient riffles. Decreases in mean sediment size and increases in channel sinuosity and braiding are other possible localized effects associated with a lower gradient. Other impacts such as downstream scour immediately below the barrier could occur; however, Reclamation will select the appropriate design based off previous fish barrier designs/models to minimize these affects.

Gila chub may occur within the fish barrier construction action area, but in low numbers, and the potential for spikedace and loach minnow to occur in this area is also low, as they are more likely absent or present in extremely low numbers. Based on our review of the fish barrier construction activities, adverse effects to Gila chub, spikedace, and loach minnow are anticipated to occur from the permanent loss of available habitat at the fish barrier construction site (0.10 ac; 0.04 ha), the modification of habitat from sediment in the sedimentation zone (4.4 ac; 1.8 ha), and the one to five year modification of pool and riffle habitat immediately below the fish barrier (1 mi, 1.6 km) following demobilization activities. These impacts may cause Gila chub, spikedace, or loach minnow to move further upstream or downstream to more suitable habitat, causing short-term harassment or harm from the disruption in feeding, breeding, and or the ability to find shelter.

Once the fish barrier is in place, the habitat upstream of the barrier will be protected from the natural invasion of nonnative fish species that could compete with or harm Gila chub, spikedace, and loach minnow. Habitat that is devoid of nonnatives will provide more opportunities for population growth or augmentation (if necessary) to the area. As populations grow and expand in location, there is a potential for Gila chub, spikedace, and or loach minnow to be washed downstream below the fish barrier during high flow events. Fish that move below the barrier will be permanently separated from the upstream population and exposed to the existing nonnative population. We anticipate that these fish would likely be preyed on by nonnative species; however, this could also occur at present prior to barrier construction.

Based on our review of the proposed action and effects discussion above, critical habitat for Gila chub, spikedace, and loach minnow is anticipated to be modified or lost at the fish barrier construction site (0.10 ac; 0.04 ha), the sedimentation zone (4.4 ac; 1.8 ha), and the immediate area downstream of the fish barrier (1 mi, 1.6 km). The loss or modifications to critical habitat are likely to impact Gila chub PCE 1, related to perennial pools; and spikedace and loach minnow PCE 1b, related to appropriate stream microhabitat and low amounts of fine sediment and substrate embeddedness. Therefore, the effects from the fish barrier construction may affect, and are likely to adversely affect Gila chub, spikedace, and loach minnow critical habitat. Although adverse effects are anticipated to occur to Gila chub, spikedace, and loach minnow critical habitat, the construction of the fish barrier will also provide protection from nonnative aquatics for all three species and their critical habitat upstream. Therefore, long term beneficial affects to Gila chub (PCE 6) and spikedace and loach minnow (PCE 5), related to habitat devoid of nonnative species, are anticipated to occur from the fish barrier construction.

Fish Barrier Operation and Maintenance

Impacts to Gila chub, spikedace, and loach minnow are not anticipated to occur from the annual and post major flood event inspections. Minor maintenance or repairs such as painting, cleaning graffiti, etc., that do not require heavy equipment are not likely to adversely affect Gila chub, spikedace, and loach minnow or their critical habitats because they do not require any ground or instream disturbances that could result in sedimentation to Eagle Creek. Any maintenance or repair that requires heavy equipment that cannot be carried to the site would follow similar measures and techniques described in the sections above related to barrier construction, staging, and access. We expect the impacts from maintenance and repair (that requires heavy equipment) may cause Gila chub, spikedace, or loach minnow to move further upstream or downstream to more suitable habitat (depending on the action), causing short-term harassment or harm from the disruption in feeding, breeding, and or the ability to find shelter. The effects to Gila chub PCE 1, and spikedace and loach minnow PCE 1b, will also be similarly impacted from the possible influx of sediment during these operations. Therefore, the impacts from the fish barrier maintenance or repairs may affect, and is likely to adversely affect Gila chub, spikedace, and loach minnow and their critical habitat. At this time, we are unable to determine the timing, and/or the level of maintenance that may be required; however, any actions that are outside of the scope of the BA and BO, will require supplemental environmental compliance actions (i.e., NEPA, Section 7, etc.), prior to initiation of maintenance work.

Effects to Recovery (Tipping Point)

In *Wild Fish Conservancy v. Salazar*, 628 F.3d 513 (9th Cir.2010), the Ninth Circuit held that the Service must identify when a species would likely pass the tipping point for recovery and determine whether the proposed action would cause the species to reach that tipping point. We have determined that the fish barrier construction, operations, and maintenance performed by Reclamation, and our issuance of the EOS permit and CBA approval, may affect and is likely to adversely affect the Gila chub, spikedace, and loach minnow. Based on the survey histories summarized above, Gila chub, spikedace, and loach minnow are limited in numbers and detection along Eagle Creek. Once the fish barrier is in place, habitat upstream will be protected from harmful nonnative species, providing opportunities for Gila chub, spikedace, and loach minnow to increase in numbers and improve the recovery potential. Our issuance of the EOS permit and CBA approval will provide a net conservation benefit for Gila chub, spikedace, loach minnow and their habitat above the constructed fish barrier. In addition, the Covered Activities under the CBA are limited in scope and primarily in pre-disturbed areas; therefore, the proposed actions are not expected to preclude recovery for Gila chub, spikedace, and loach minnow.

Narrow-headed Gartersnake

Issuance of the EOS Permit and CBA Approval

The effects from the Permittee's Covered Activities to narrow-headed gartersnake on Covered Area lands are ongoing and will continue to occur regardless of our issuance of the EOS permit and CBA approval. These effects are analyzed below. However, our issuance of the EOS permit and CBA approval will provide multiple conservation actions and benefits that protect and enhance habitat for narrow-headed gartersnake and its habitat above the constructed fish barrier. The Permittee's financial commitments related to the investigation, design, and construction of the fish barrier will provide long-term benefits and protections from harmful nonnative fish species below the fish barrier. In addition, the Permittee's commitment to develop and implement a three-year monitoring program (nonnative crayfish study) above the fish barrier and a separate monitoring program on Covered Area lands along Eagle Creek will help inform conservation and management activities to assist in the future recovery of narrow-headed gartersnake. Conservation actions outlined in the CBA will protect approximately 124 potential narrow-headed gartersnake home ranges in upper Eagle Creek above the constructed fish barrier from nonnative fish that prey on the snakes. The baseline for narrow-headed gartersnake is currently no protection of home ranges along Eagle Creek above the proposed fish barrier; therefore, the proposed CBA is expected to result in a net conservation benefit for the species and no take of narrow-headed gartersnake is anticipated to result from the proposed actions above the fish barrier. Below the proposed fish barrier, there are approximately 344 home ranges on the Permittee's Covered Area lands.

Covered Activities are not conducted on the Covered Area lands in upper Eagle Creek (see Parcel Number 10 and 9, Figure 2). Parcel 8 (Figure 2) is where the single residence and wellfield maintenance manager resides. This area is included in the CBA and is used to store pipes and materials related to the groundwater well operations. No ground-disturbing activities will activities occur on this 5 ac (2 ha) parcel and only building maintenance or repairs will be conducted when necessary. The Permittee will continue to divert water from the Black River, pump groundwater from two separate well fields (Parcel 2 through 7, Figure 2; where Bee Canyon and Mud Springs occur) and transport the water to Eagle Creek. Only ongoing maintenance and operation of the pumps (Parcels 3, 5, 6, and 7, Figure 2) is identified for these properties. A buried pipeline connects to each well and transports water downstream to Eagle Creek. No actions were identified for the pipeline, but construction, alteration, or maintenance may be included in the future. Parcel 2 includes the Bee Canyon well field along with the associated pumps (two total), facilities, and a single residence where ongoing operations and maintenance are permitted to occur. The Permittee intends to continue to transport and divert water from these locations for the foreseeable future. It is possible that, in the future, the Permittee may alter the manner in which they divert and transport water from either well field including potentially installing pipelines or other infrastructure to transport water for its operations. However, no alterations are planned currently.

We expect the Covered Activities related to groundwater pumping from the Bee Canyon and Mud Springs well field will contribute to further reductions in the groundwater aquifer. As stated previously, groundwater pumping for extended periods can deplete the aquifer storage levels to the point that streamflow becomes the primary source of water to the well (Barlow and Leake 2012). Although there are no known studies or baseline information related to the conditions that led to the seasonally intermittent section in Eagle Creek, there are numerous studies documenting the link between groundwater pumping, streamflow depletion, and impacts to fish (Barlow and Leake 2012, Barlow et al. 2018, Gleeson and Richter 2018, Perkins et al. 2017, Ruhi et al. 2016). Based on known studies related to groundwater pumping we can reasonably assume that within the 50-year timeframe there is potential for these ongoing actions to reduce streamflow or further deplete water within Eagle Creek. Any loss in streamflow or expansion of the intermittent/dry section of Eagle Creek, beyond baseline conditions, would result in a reduction of available habitat for narrow-headed gartersnake. Any fluctuation in streamflow or expansion of the intermittent/dry section is anticipated to occur below Parcel 8 (Figure 2) downstream to the Willow Creek confluence. These impacts would result in the species' inability to perform daily life history functions (i.e., feeding) and result in undue stress from the loss of water and prey availability. Therefore, the effects of continued groundwater pumping within this area are likely to adversely affect narrow-headed gartersnake.

The potential effect from the continued operation and facility maintenance within Parcel 8 would occur from any type of ground disturbance (vehicle use, heavy equipment, materials storage, etc.) and potential indirect effects from sediment to Eagle Creek. Narrow-headed gartersnake on the property could be disturbed, trampled, and/or harmed from the continued operations over the life of the CBA (50 years). Because the area is already disturbed, currently in use, and no new ground-disturbing activities will occur; these actions are not likely to contribute a meaningful amount of sediment that could result in a reduction in riffle, pool, and cobble and boulder substrate habitats for narrow-headed gartersnake prey.

Further downstream (between Parcel 2 and 3), the addition of water to Eagle Creek from Black River (via Willow Creek) and the two well fields is not likely to adversely affect narrow-headed gartersnake since the water is sourced locally, is not contaminated, and will contribute to the streamflow in Eagle Creek. If the Permittee decides to alter the manner in which it diverts and transports water, including potentially installing pipelines, repair existing pipelines, or other infrastructure to transport water for its operations, these actions would most likely occur in Parcels 2, 3, and 4. Parcel 2 is approximately 570 ft (174 m) from Eagle Creek (see Parcel 2 Figure 2). Because of the distance away from Eagle Creek, the potential installation of pipelines and other infrastructure is not likely to result in adverse effects to narrow-headed gartersnake or its habitat in Eagle Creek. However, any future actions that occur in Parcels 3 or 4, along with water pipeline repairs or replacement downstream of these two properties could result in adverse effects to narrow-headed gartersnake, were they to occur within occupied habitat adjacent to Eagle Creek. Narrow-headed gartersnake avoidance behaviors may occur from construction, ground vibration, compaction, and heavy equipment digging and operating in the area causing a disruption and possible undue energy expenditure to brumating or active narrow-headed gartersnake. In addition, these actions could contribute a measurable amount of sediment to Eagle Creek (up to one mile below Parcel 2), adversely affecting riffle, pool, and cobble and boulder substrate embeddedness for narrow-headed gartersnake prey.

Further downstream, near river mile term 11.5 (18.5 km) (Parcel 1, Figure 3), the Permittee operates a pump station and infrastructure that includes a pipeline conveying water from a settling pond to a storage tank, an overhead pipeline that conveys water from the storage tank over Eagle Creek to pump stations, and an above ground pipeline that returns excess water from the storage tank into Eagle Creek. At this time, the Permittee does not conduct any activities other than periodic maintenance (including vegetation clearing, drainage and flushing of the settlement, etc.) as needed, repair of the pump station (located inside a building), the diversion dam, pipelines, and other associated infrastructure. In the future, more extensive activities may be required, such as replacement of aged facilities or upgrades to ensure adequate operating capacity. We do not know which facilities or infrastructure and the extent of maintenance or repairs that may occur; however, any replacement or repair of existing facilities would require the use of heavy equipment and either use of existing or construction of new roads. We therefore expect that these actions could result in adverse effects to narrow-headed gartersnake if they occur within occupied habitat adjacent to Eagle Creek. Harm and/or harassment to narrow-headed gartersnake may occur from construction, ground vibration, compaction, and heavy equipment digging and operating in the area causing a disruption and possible undue energy expenditure to brumating or active narrow-headed gartersnake. In addition, these actions along the drainage and flushing of the settlement basin could contribute a measurable amount of sediment to Eagle Creek (up to one mile below the affected disturbance area), adversely affecting riffle, pool, and cobble and boulder substrate embeddedness which are essential habitat elements necessary for narrow-headed gartersnake sheltering and foraging success.

<u>Fish Barrier Construction</u>

There are several actions proposed during the fish barrier construction process including pre-construction preparation, construction, and demobilization (described above) that could result in instream disturbance or ground disturbance that could affect narrow-headed gartersnake. Ground disturbance could occur anywhere within the 2.09 ac (0.8 ha) contractor use areas as well as ground or instream disturbance within the 0.31 ac (0.13 ha) construction area footprint. Prior to construction, stream flow from Eagle Creek will be diverted around the work area downstream to the active stream channel. The process to divert water may include, but is not limited to, cofferdams, channels, flumes, drains, and sumps. However, the preferred method is to use a siphon and a gravity flow diversion system to minimize the length of stream impacted by the operation. Reclamation will make reasonable efforts to ensure monitoring for the presence of narrow-headed gartersnake prior to any construction, operation, or maintenance activity; and if found, the contractor will stop work in that location and coordinate with federal or state wildlife agencies to determine appropriate measures and avoid disturbance.

Direct effects from the initial placement of dikes or pipe into the active stream channel is not likely to adversely affect narrow-headed gartersnake because the construction period occurs mid-October through mid-March, when narrow-headed gartersnake are most likely in brumation (cold season dormancy). During this timeframe, we expect narrow-headed gartersnake will occur in the upland habitat, adjacent to Eagle Creek. Therefore, any construction operations (pre-construction, excavation, formwork, construction, concrete placement, and backfilling) that occur within the active channel is not likely to adversely impact narrow-headed gartersnake. Direct effects from ground disturbance that occurs anywhere within the 2.09 ac (0.8 ha) construction area footprint could result in harm or harassment to narrow-headed gartersnake if they were not detected prior to these operations. Adverse effects may occur from construction, ground vibration, compaction, and heavy equipment digging and operating in the area potentially crushing individuals or causing a disruption and possible undue energy expenditure to brumating narrow-headed gartersnake.

Construction of the fish barrier will occur between mid-October through mid-March to avoid periods of high river flows (monsoon storm and snowmelt). Seasonal low flows in Eagle Creek, combined with the placement of dikes or pipe to divert water around the construction area footprint will prevent any substantial movement of sediment from the pre-construction, construction, and demobilization of the construction area footprint and contractor use areas. Ground disturbance (from vehicles, equipment, etc.) in contractor use areas may contribute small amounts of sediment to Eagle Creek during seasonal rainfall events but these effects are insignificant and likely difficult to observe given the small disturbance area (2.09 ac; 0.8 ha). However, once flows are returned to Eagle Creek, post-project demobilization, which includes the removal of the dikes or pipe from the stream, could lead to short-term sediment transport downstream. We expect sedimentation could impact riffle, pool, and cobble and boulder substrate habitats (essential for shelter and foraging success) within one mile downstream of the construction area footprint, but these impacts are temporary and will likely return to pre-construction conditions between one and five years after construction. And, since the demobilization occurs during the low flow period, the sediment will likely dissipate and have no observable impact greater than one mile from the construction area footprint.

Permanent loss or modifications to instream habitat is expected to occur in Eagle Creek from the fish barrier footprint (0.10 ac; 0.04 ha) and the sedimentation zone (estimated 4.4 ac; 1.8 ha). Once the fish barrier is in place and flows are returned to Eagle Creek, aquatic habitat above the fish barrier will be modified, essentially forming a sedimentation zone from lowering the stream gradient and restricting the formation of steep-gradient riffles. Decreases in mean sediment size and increases in channel sinuosity and braiding are other possible localized effects associated with a lower gradient. Other impacts such as downstream scour, immediately below the barrier, could occur; however, Reclamation will select the appropriate design based off previous fish barrier designs/models to minimize these affects.

Narrow-headed gartersnake may occur within the fish barrier construction action area, but in low numbers. Based on our review of the fish barrier construction activities, adverse effects to narrow-headed gartersnake are anticipated to occur from the loss of available habitat at the fish barrier construction site (0.10 ac; 0.04 ha), disturbance and modification of habitat at the construction area footprint (2.09 ac; 0.8 ha), the modification of habitat from sediment in the sedimentation zone (4.4 ac; 1.8 ha), and the one to five year modification of pool and riffle habitat immediately below the fish barrier once post-construction demobilization occurs. These effects may impact fish community distribution, density, and reproductive output as a prey base for narrow-headed gartersnake, causing them to move further upstream or downstream to more suitable habitat, causing short-term harassment or harm from the disruption in feeding, breeding, and or the ability to find shelter.

Once the fish barrier is in place, the habitat upstream of the barrier will be protected from the natural invasion of nonnative fish species that could compete with or harm narrow-headed gartersnake. Habitat that is devoid of nonnatives will provide more opportunities for population growth above the barrier. As populations grow and expand in location, there is a potential for narrow-headed gartersnake to move or be flushed downstream below the fish barrier. Narrow-headed gartersnake that move below the fish barrier will be exposed to the existing nonnative fish population.

<u>Fish Barrier Operation and Maintenance</u>
Impacts to narrow-headed gartersnake are not anticipated to occur from the annual and post-major flood event inspections. Minor maintenance or repairs such as painting, cleaning graffiti, etc., that do not require heavy equipment are not likely to adversely affect narrow-headed gartersnake because they do not require any ground our instream work that could result in disturbance to individuals or sedimentation to Eagle Creek. Any maintenance or repair that requires heavy equipment that cannot be carried to the site would follow similar measures and techniques described in the sections above related to barrier construction, staging, and access. We expect the impacts from maintenance and repair (that requires heavy equipment) will be the same as described above. Adverse effects from these actions may cause narrow-headed gartersnake to be crushed or killed from construction equipment, and/or move further upstream or downstream to more suitable habitat (depending on the action), causing harm or short-term harassment from the disruption in feeding, breeding, and/or the ability to find shelter. Narrow-headed gartersnake will also be impacted from the possible influx of sediment during these operations, potentially impacting riffle, pool, and cobble and boulder substrate habitats immediately downstream of the construction area footprint. At this time, we are unable to determine the timing, frequency and/or the level of maintenance that may be required; however, any actions that are outside of the scope of the BA and BO, will require supplemental environmental compliance actions (i.e., NEPA, Section 7, etc.), prior to work.

Effects to Recovery (Tipping Point)

In Wild Fish Conservancy v. Salazar, 628 F.3d 513 (9th Cir.2010), the Ninth Circuit held that the Service must identify when a species would likely pass the tipping point for recovery and determine whether the proposed action would cause the species to reach that tipping point. A recovery plan has not yet been developed for the narrow-headed gartersnake; however, we anticipate primary recovery objectives to focus on the leading threats affecting this species such as effects from predatory nonnative species (centrarchid and ictalurid fish, crayfish, and bullfrogs predominantly), as well as surface water concerns including drought and human-based dewatering of streams. We have determined that the fish barrier construction, operations, and maintenance performed by Reclamation, and our issuance of the EOS permit and CBA approval, may affect and is likely to adversely affect the narrow-headed gartersnake. Once the fish barrier is in place, habitat upstream will be protected from harmful nonnative species, providing opportunities for narrow-headed gartersnake to increase in numbers and assist in recovery. Our issuance of the EOS permit and CBA approval will provide a net conservation benefit for narrow-headed gartersnake and its habitat above the constructed fish barrier. In addition, the Covered Activities under the CBA are limited in scope and primarily occur in pre-disturbed areas; therefore, these actions are not expected to preclude achievement of recovery for narrow-headed gartersnake.

CUMULATIVE EFFECTS

Cumulative effects are those "effects of future State or private activities, not involving federal activities, that are reasonably certain to occur within the action area" considered in this Opinion (50 CFR 402.02). A number of future non-federal actions such as livestock grazing, recreation, off-highway vehicle use, hunting, fishing, wildfire, mining, and ground water pumping are expected to continue into the foreseeable future within portions of the action area. These actions, the effects of which are considered cumulative, may result in the alteration or degradation of the available riparian and upland habitat, groundwater, and water clarity potentially affecting Gila chub, spikedace, loach minnow, and narrow-headed gartersnake.

CONCLUSION

Issuance of the EOS Permit and CBA Approval

After reviewing the current status of the Gila chub, spikedace, loach minnow, and narrow-headed gartersnake, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is our biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the Gila chub, spikedace, loach minnow, and narrow-headed gartersnake and is not likely to destroy or adversely modify designated critical habitat. We base this conclusion on the following:

Gila Chub, Spikedace, and Loach Minnow

1. Under the CBA, the Covered Activities conducted below the barrier could affect individual Gila chub, spikedace, and loach minnow if their numbers improve above the barrier and individuals move or are transported downstream. However, we anticipate the number of fish that move downstream is likely to be minimal, that fish that do move downstream are more likely to be preyed up on by nonnative fishes, and that the actions below the fish barrier will not influence the larger populations present in Eagle Creek above the barrier as a whole.
2. Our issuance of the EOS permit and CBA approval will provide financial commitments and multiple conservation actions and benefits that protect and enhance habitat for Gila chub, spikedace, and loach minnow, and their critical habitat above the constructed fish barrier; ultimately proving a net conservation benefit for these species.

Narrow-headed Gartersnake

1. Under the CBA, the Covered Activities conducted below the barrier could affect individual narrow-headed gartersnake currently present downstream. If individual narrow-headed gartersnake numbers improve above the barrier and move downstream they would also be impacted by the Covered Activities on the Permittee’s land. However, we anticipate that, due to protection of areas upstream of the barrier, gartersnakes are more likely to persist in these areas and at higher numbers, so that the actions below the fish barrier will not appreciably influence the Eagle Creek population as a whole.
2. Our issuance of the EOS permit and CBA approval will provide financial commitments and multiple conservation actions and benefits that protect and enhance habitat for the narrow-headed gartersnake and its habitat above the constructed fish barrier; ultimately proving a net conservation benefit to the species.

Fish Barrier Construction Operation and Maintenance

After reviewing the current status of the Gila chub, spikedace, loach minnow, and narrow-headed gartersnake, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is our biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the Gila chub, spikedace, loach minnow, and narrow-headed gartersnake and is not likely to destroy or adversely modify designated critical habitat. We base this conclusion on the following:

Gila Chub, Spikedace, and Loach Minnow

1. The installation of the fish barrier will provide future protections from nonnative fish species and increase recovery potential for the Gila chub, spikedace, and loach minnow.
2. The low numbers of spikedace and loach minnow that may be present in the action area reduces the likelihood that effects will occur to the two species in those areas on which active management is likely to occur (i.e., downstream of the barrier).
3. Conservation measures related to the survey and relocation of Gila chub, spikedace, and loach minnow prior to diverting Eagle Creek around the fish barrier construction area will minimize the impact from these operations.
4. Permanent loss or modification of critical habitat for Gila chub, spikedace, and loach minnow is anticipated at the fish barrier construction site (0.10 ac; 0.04 ha) and the upstream sedimentation zone (4.4 ac; 1.8 ha); however, 22.4 stream miles (36.0 km) Gila chub habitat, and 8.4 stream miles (13.5 km) of spikedace and loach minnow habitat will be protected upstream in perpetuity.

Narrow-headed Gartersnake

1. The installation of the fish barrier will provide future protections from nonnative fish species and increase recovery potential for the narrow-headed gartersnake.
2. Permanent loss or modification of critical habitat for narrow-headed gartersnake is anticipated at the fish barrier construction site (0.10 ac; 0.04 ha) and the upstream sedimentation zone (4.4 ac; 1.8 ha); however, 8.4 stream miles (13.5 km) of narrow-headed gartersnake habitat will be protected upstream in perpetuity.

The conclusions of this biological opinion are based on full implementation of the project as described in the Description of the Proposed Action section of this document, including any conservation measures that were incorporated into the project design.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. “Take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. “Harm” is further defined (50 CFR § 17.3) to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. “Harass” is defined (50 CFR § 17.3) as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. “Incidental take” is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by Reclamation and the Service so that they become binding conditions of any grant or permit issued to any applicant, contractor, or permittee, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activity covered by this incidental take statement. If Reclamation or the Service (1) fails to assume and implement the terms and conditions or (2) fails to require any applicant, contractor, or permittee, as appropriate to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation must report the progress of the action and its impact on the species as specified in the incidental take statement. [50 CFR § 402.14(i)(3)]. Similarly, the Service must ensure adherence to the EOS permit conditions and terms of the CBA, which require annual reporting on action compliance and incidental take by the Permittee.

AMOUNT OR EXTENT OF TAKE

The Service anticipates that issuance of the EOS permit and CBA approval, and the fish barrier project may result in incidental take of Gila chub, spikedace, loach minnow, and narrow-headed gartersnake. We anticipate incidental take will be in the form of harm and harassment as described below. Incidental take attributed to Reclamation's action to construct, operate, and maintain the fish barrier is authorized by this biological opinion, and incidental take attributed to our issuance of the EOS permit and approval of the CBA is authorized solely through the EOS permit.

<u>Issuance of the EOS Permit and CBA Approval</u>

Gila Chub, Spikedace, and Loach Minnow

We anticipate our issuance of the EOS permit and CBA approval will provide protection for 22.4 stream miles (36.0 km) of suitable Gila chub habitat and 8.4 stream miles (13.5 km) of suitable spikedace and loach minnow habitat in upper Eagle Creek above the constructed fish barrier. The CBA baseline for Gila chub, spikedace, and loach minnow is 0 stream miles (0 km) of protected habitat within upper Eagle Creek. Although a CBA allows for "return to baseline", the Permittee has committed to leaving the fish barrier in place, even if they elect to discontinue participation in the CBA and no "return to baseline" is anticipated.

As described in the CBA, no take of Gila chub, spikedace, and/or loach minnow is authorized upstream of the fish barrier. According to results of recent and ongoing surveys, there are very low numbers of Gila chub, and an absence of spikedace and loach minnow, in those portions of Eagle Creek below the fish barrier due to the continued presence and abundance of nonnative species that preclude the recruitment and persistence of the species. Once the fish barrier is in place, 22.4 stream miles (36.0 km) of suitable Gila chub, and 8.4 stream miles (13.5 km) of suitable spikedace and loach minnow habitat will be protected from upstream movement of nonnative species. If Gila chub, spikedace and loach minnow numbers increase above the barrier due to recruitment and/or augmentation, there is the potential that individuals could move or be transported downstream below the barrier. We anticipate the approximately three miles (4.8 km) of stream with seasonally intermittent flows below the barrier, as well as the nonnative species presence, will continue to suppress Gila chub, spikedace and loach minnow numbers to the point where long-term survival and establishment is improbable in the future. However, it is possible that there may be take of individuals resulting from the CBA Covered Activities. We anticipate incidental take of Gila chub, spikedace, and loach minnow will be difficult to detect due to small body sizes, low or irregular species occurrence in the impact area, and nonnative species presence, making detection of dead or impaired individuals unlikely. We anticipate take of all Gila chub, spikedace, and loach minnow below the fish barrier.

Fish Barrier Construction, Operation, and Maintenance

Gila Chub, Spikedace, and Loach Minnow

We anticipate that the proposed actions related to fish barrier construction, operation, and maintenance conducted by Reclamation are reasonably certain to result in incidental take of all Gila chub, spikedace, and loach minnow that may occur within the fish barrier construction site (0.10 ac; 0.04 ha), the upstream sedimentation zone (4.4 ac; 1.8 ha), and the immediate area downstream (1 mi; 1.6 km) of the fish barrier for a period of one to five years. We expect incidental take in the form of harm (disruption in feeding, breeding, and or the ability to find shelter) and harassment to Gila chub, spikedace, and loach minnow from the permanent loss of habitat at the fish barrier construction site, demobilization (downstream sedimentation), sedimentation zone (upstream), and maintenance and repair of the fish barrier. We anticipate incidental take of Gila chub, spikedace, and loach minnow will be difficult to detect due to small body sizes, low or irregular species occurrence in the impact area, and nonnative species presence, making detection of dead or impaired individuals unlikely. We anticipate take of all Gila chub, spikedace, and loach minnow in the fish barrier construction site, upstream sedimentation zone, and the immediate area downstream of the fish barrier.

Issuance of the EOS Permit and CBA Approval

Narrow-headed Gartersnake

We anticipate our issuance of the EOS permit and CBA approval will provide protection for approximately 124 potential narrow-headed gartersnake home ranges in upper Eagle Creek above the constructed fish barrier. The CBA baseline for narrow-headed gartersnake is zero protected home ranges within upper Eagle Creek miles (0 km) of protected habitat within upper Eagle Creek. Although a CBA allows for “return to baseline”, the Permitee has committed to leaving the fish barrier in place, even if they elect to discontinue participation in the CBA and no “return to baseline” is anticipated.

As described in the CBA, no take of narrow-headed gartersnake is authorized upstream of the fish barrier. Monitoring and reporting will be conducted as set forth in the CBA. We anticipate our issuance of the EOS permit and CBA Covered Activities on Permittee-owned lands (Parcel 1 and 8, Figures 3 and 2) below the fish barrier are reasonably certain to result in incidental take of narrow-headed gartersnake. Incidental take is anticipated to occur from the direct harm (e.g. direct injury, fatality, or reduced fitness) or temporary harassment (e.g. avoidance/escape behavior or ground disturbance) of individual gartersnakes to the degree that gartersnakes are lost as viable members of the population and thus “taken”. Incidental take of narrow-headed gartersnake will occur if any of the CBA Covered Activities crush them in their brumation sites (e.g., heavy mechanical equipment, off-site material storage, etc.) or result in the permanent modification of aquatic habitat. The amount or potential for incidental take is related to the ongoing actions in Parcel 8 (5 ac; 2 ha), and the footprint and potential disturbance area associated with the 0.3 ac (0.12 ha) diversion dam and the 18.4 ac (7.4 ha) pump station infrastructure in Parcel 1. In total, the amount of upland and aquatic habitat described here equals 23.7 ac (9.6 ha).

Based on the linear calculation described above, the 23.7 ac (9.6 ha) of the affected narrow-headed gartersnake habitat equates to four of the approximately 344 home ranges within the CBA Plan Area downstream of the fish barrier.

The Service anticipates that incidental take of narrow-headed gartersnake from the proposed actions may be difficult to monitor over the timeframe of this action for the following reasons: 1) narrow-headed gartersnake are small-bodied, secretive, well-camouflaged, and use subsurface retreats and protective cover; therefore, injury or crushing from heavy machinery may go undetected; 2) current survey methodologies are imperfect and require surface activity for detection although narrow-headed gartersnakes are infrequently surface active or easily detectable; and 3) reduced narrow-headed gartersnake prey capture success that results from sedimentation in the stream due to the proposed action cannot be measured or verified.

Because of the challenges of quantifying incidental take, the use of surrogate measures have been adopted to determine when take has been exceeded for the Service associated with the issuance of the EOS permit CBA approval. The surrogate will be the number of acres associated with the CBA Covered Activities that occur in narrow-headed gartersnake habitat. Therefore, we conclude that incidental take for the proposed action will have been exceeded if the acres associated with CBA Covered Activities result in impacts to one additional home range. For example, incidental take is associated with four narrow-headed gartersnake from 23.7 ac (9.6 ha) of affected habitat. If that number increases to five calculated home ranges then take would be considered to have been exceeded.

Fish Barrier Construction, Operation, and Maintenance

Narrow-headed Gartersnake

We anticipate that Reclamation's proposed action of fish barrier construction, operation, and maintenance are reasonably certain to result in incidental take of narrow-headed gartersnake. Incidental take is anticipated to occur from the direct harm (e.g. direct injury, fatality, or reduced fitness) or temporary harassment (e.g. avoidance/escape behavior or ground disturbance) of individual gartersnakes to the degree that gartersnakes are lost as viable members of the population and thus "taken". Incidental take of narrow-headed gartersnake will occur if any of the proposed actions crush them in their brumation sites (e.g., heavy mechanical equipment, off-site material storage, etc.) or result in the permanent modification of aquatic habitat. For the fish barrier construction, the amount or potential for incidental take is related to the disturbance footprint associated with the 2.09 ac (0.8 ha) contractor use areas, the 0.31 ac (0.1 ha) fish barrier construction area, and the 4.4 ac (1.8 ha) upstream sedimentation zone. In total, the amount of upland and aquatic habitat described here equals 6.8 ac (2.75 ha). In addition, operation and maintenance activities may result in impacts to some of the 10.86 ac (4.4 ha) fish barrier operation and maintenance easement area but would not exceed 6.8 ac (2.75 ha) in any five-year period post-construction.

Narrow-headed gartersnake home ranges may vary in size and season. As described in the status of the species section above, data derived from ingested telemetry represents the best-available information, and for purposes of this analysis, we will use 5.5 ac (2.2 ha) as the home range size utilized throughout the active season. To determine the number of potential home ranges and gartersnake affected, we provide a linear calculation, based on the 5.5 ac (2.2 ha) home range. We considered the 328-foot (100 m) streamside suitable habitat buffer, described by Nowak (2006), as the upland extent from the stream and for the linear calculation we stretched the 5.5 ac (2.2 ha), along an axis parallel to the stream, to 732 ft (223 m), as 732 ft x 328 ft squared equates to 5.5 ac (2.2 ha). Based on this linear calculation, the 6.8 ac (2.75 ha) of the affected narrow-headed gartersnake habitat equates to impacts to one home range associated with Reclamation's proposed fish barrier construction. In addition, using the same calculation we anticipate impacts to up to one home range 6.8 ac (2.75 ha) every 5 years throughout the life of the project resulting from operations and maintenance.

The Service anticipates that incidental take of narrow-headed gartersnake from the proposed actions may be difficult to monitor over the timeframe of this action for the following reasons: 1) narrow-headed gartersnake are small-bodied, secretive, well-camouflaged, and use subsurface retreats and protective cover; therefore, injury or crushing from heavy machinery may go undetected; 2) current survey methodologies are imperfect and require surface activity for detection although narrow-headed gartersnakes are infrequently surface active or easily detectable; and 3) reduced narrow-headed gartersnake prey capture success that results from sedimentation in the stream due to the proposed action cannot be measured or verified.

Because of the challenges of quantifying incidental take, we use surrogate measures have to determine when take has been exceeded for Reclamation. The surrogate is the number of acres associated with the fish barrier construction, and operations and maintenance activities that occur in narrow-headed gartersnake habitat. We conclude that incidental take for Reclamation's proposed action will have been exceeded during fish barrier construction if there are impacts to more than 6.8 ac (2.75 ha) of habitat within the identified disturbance area footprint. Separately, we conclude that incidental take for Reclamation's proposed action will have been exceeded if operations and maintenance activities result in combined impacts to more than 6.8 ac (2.75 ha) within the fish barrier operation and maintenance easement area in any five-year period throughout the life of the project, with the first five-year period beginning once the fish barrier is constructed. Monitoring and reporting will be conducted as set forth in the CBA.

EFFECT OF TAKE

Issuance of the EOS Permit and CBA Approval

In the accompanying biological opinion, we have determined that the level of anticipated take is not likely to result in jeopardy to the Gila chub, spikedace, loach minnow, or narrow-headed gartersnake. Although we anticipate some incidental take to occur, the implementation of the conservation measures proposed in the Permittee's CBA should result in a net conservation benefit.

Fish Barrier Construction Operation and Maintenance

In the accompanying biological opinion, we have determined that the level of anticipated take is not likely to result in jeopardy to the Gila chub, spikedace, loach minnow, or narrow-headed gartersnake. Although we anticipate some incidental take to occur, the implementation of the conservation measures proposed by Reclamation should ultimately result in avoidance and minimization of adverse effects.

REASONABLE AND PRUDENT MEASURES AND TERMS AND CONDITIONS

Issuance of the EOS Permit and CBA Approval

All conservation measures in the EOS permit conditions and CBA, including avoidance and minimization measures, biological and compliance monitoring, and reporting measures are incorporated herein by reference as reasonable and prudent measures and terms and conditions for this action. No additional reasonable and prudent measures or terms and conditions were identified during the consultation.

Fish Barrier Construction Operation and Maintenance

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measure is necessary and appropriate to minimize take of Gila chub, spikedace, loach minnow, and narrow-headed gartersnake:

1) Monitor incidental take resulting from Reclamation's proposed action and report to the Service the findings of that monitoring.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. The following Term and Condition implements Reasonable and Prudent Measure Number 1:

To monitor incidental take resulting from the proposed action, Reclamation shall ensure that they or their representative monitor the impacts of the action as they relate to Gila chub, spikedace, loach minnow, and narrow-headed gartersnake and report these to the Service for the life of the project. Reclamation is therefore required to submit a report to the Service at the end of the year (December 31) following the initial completion of fish barrier construction as well as at the end of each year in which maintenance is performed. Reports will be sent to the Service at incomingazcorr@fws.gov and will include a description of the action implemented, including conservation measures and reasonable and prudent measures.

Disposition of Dead or Injured Listed Species

Upon locating a dead, injured, or sick listed species initial notification must be made to the FWS's Law Enforcement Office: Delivan Roper, Resident Agent in Charge; Las Cruces, New

Mexico Investigations Office (575) 382-2177 within three working days of its finding. Written notification must be made within five calendar days and include the date, time, and location of the animal, a photograph if possible, and any other pertinent information. The notification shall be sent to the Law Enforcement Office with a copy to this office. Care must be taken in handling sick or injured animals to ensure effective treatment and care, and in handling dead specimens to preserve the biological material in the best possible state.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. For Reclamation, continue to participate in the implementation of the recovery actions related to Gila chub, spikedace, loach minnow, and narrow-headed gartersnake.

For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations performed by Reclamation.

REINITIATION NOTICE

This concludes formal consultation with Reclamation on the Eagle Creek Barrier Construction and Maintenance project and the Intra-Service BO on the issuance of an EOS permit and approval of the CBA. As provided in 50 CFR §402.16, reinitiation of consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this biological opinion or written concurrence; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Please refer to the consultation number, 2023-0133893 in future correspondence concerning this project. Should you require further assistance or if you have any questions please contact Ryan Gordon (ryan_gordon@fws.gov) or Laura Stewart (laura_r_stewart@fws.gov).

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APPENDIX A - CONCURRENCE

Western Yellow-billed Cuckoo

Issuance of the EOS Permit and CBA Approval

We conclude that the issuance of the EOS permit related to our approval of the CBA may affect, but is not likely to adversely affect, the western yellow-billed cuckoo for the following reasons:

1. Multiple surveys of western yellow-billed cuckoo have occurred along Eagle Creek (Westland Resources 2014, Westland Resources 2015, Westland Resources 2023, BLM 2018, Andreson 2016) with a single survey occurring along Bee Canyon (Westland Resources 2023). Within the Covered Area lands, western yellow-billed cuckoo were documented within Parcel 10 (Figure 2) and Parcel 1 (Figure 3). Within the remaining Covered Area lands (Parcels 2 through 9, Figure 2), there are no records of western yellow-billed cuckoo. The Permittees will not conduct any actions within Parcel 10. In Parcel 1, the Permittees operate a pump station and infrastructure that includes a pipeline that conveys water from a settling pond to a storage tank, a storage tank, an overhead pipeline that conveys water from the storage tank over Eagle Creek to pump stations, and an above ground pipeline that returns excess water from the storage tank into Eagle Creek. The nearest detection of western yellow-billed cuckoo within this property is greater than 0.5 mi (0.8 km) from the pump stations and infrastructure described above. Because western yellow-billed cuckoo have not been detected within the Covered Area lands or are greater than 0.5 mi (0.8 km) from any of the Covered Activities, direct or indirect effects to the species are not anticipated to occur.
2. Designated western yellow-billed cuckoo critical habitat does not occur within any of the Permittee's Covered Area lands.
3. Ongoing maintenance is identified in Parcels 1, 2, 3, 5, 6, and 7 (Figures 2 and 3). This may include the occasional clearing of small trees and branches around the pumps and other infrastructure to the extent that suitable western yellow-billed cuckoo habitat is either not present or unable to reach mid-seral or mature status (necessary for nest placement). All prior maintenance activities within these parcels are considered baseline. Moving forward, any maintenance related to riparian vegetation trimming or removal around the facilities is intended to allow operations to continue for the duration of the 50-year permit. These ongoing maintenance actions are considered insignificant because the continuation of baseline conditions prevent western yellow-billed cuckoo from nesting in these areas in the future.
4. The Permittee intends to continue to transport and divert water from the Bee Canyon and Mud Springs well fields for the foreseeable future. It is possible that, in the future, the Permittee may alter the manner in which they divert and transport water from either well field including potentially installing pipelines or other infrastructure to transport water for its operations. These alterations could influence the amount of water to these areas which could either maintain or reduce the habitat quality in these areas. At this time, western yellow-billed cuckoo are not known to occur within 0.5 mi (0.8 km) of these areas (Parcels 2 through 7, Figure 2); therefore, the effects to the species or its habitat is considered insignificant. Should western yellow-billed cuckoo move into these areas and

adverse effects be considered likely, the Permittee may need to amend the EOS permit and CBA as they are not currently a covered species within the CBA.

5. The Permittee will continue to divert water from the Black River, pump groundwater from two separate well fields (Parcels 2 through 7, Figure 2; where Bee Canyon and Mud Springs occur) and transport the water to Eagle Creek. The continuation of supplemental water from the surface water diversion and groundwater pumping for mining operations has increased the water supply in Eagle Creek and Bee Canyon above typical background conditions, likely promoting the dense riparian vegetation, particularly in Bee Canyon and in Eagle Creek at and below the Willow Creek confluence. The Permittee intends to continue these operations into the foreseeable future; therefore, providing a long-term beneficial effect to western yellow-billed cuckoo habitat.

<u>Fish Barrier Construction, Operation and Maintenance</u>

We concur with Reclamation's determination that the proposed action may affect, but is not likely to adversely affect, the western yellow-billed cuckoo for the following reasons:

1. The fish barrier construction period (mid-October through mid-March) will occur when western yellow-billed cuckoo are not present due to southern migration and will also avoid the nesting season (May 25 through September 30). For this reason, direct affects to the species are not likely to occur from the fish barrier construction.
2. There are several actions proposed during the fish barrier construction process including pre-construction preparation, construction, and demobilization (described above) that may result in vegetation disturbance or removal that could affect the riparian habitat preferred by western yellow-billed cuckoo. During these operations, the contractor will be directed to avoid harming mature riparian trees and minimize impacts to other vegetation, to the extent possible. Vegetation disturbance could occur within the 2.09 ac (0.8 ha) contractor use areas. These areas are primarily bare ground with limited vegetation present; therefore, the potential effects from material and equipment staging in this area is minimal. However, vegetation that occurs within the 0.31 ac (0.13 ha) fish barrier construction footprint could be disturbed or removed. Permanent impacts to vegetation are expected within the 0.1 ac (0.04 ha) from the concrete barrier footprint. Following construction, all other areas are expected to recover through natural regeneration. Although some riparian vegetation potentially utilized by nesting western yellow-billed cuckoo could be disturbed or removed, permanent impacts from the concrete barrier footprint are not likely to have a measurable effect to western yellow-billed cuckoo as they would occur within a riparian area where there is suitable habitat immediately adjacent. For these reasons, the impacts to western yellow-billed cuckoo habitat are insignificant.
3. Designated western yellow-billed cuckoo critical habitat does not occur within the action area of the project.
4. The effects from the fish barrier operations and maintenance would be similar to those described above related to fish barrier construction. Although the specific timing and frequency of these actions are unknown, they would likely not occur during the nesting season (May 25 through September 30). And, if any substantial maintenance or repair

activities (outside of the scope of the BA and BO) are required, supplemental environmental compliance actions (i.e., NEPA, Section 7, etc.) would be conducted as needed by Reclamation, in coordination with Freeport and the Service, prior to work.

5. The construction of Reclamation's fish barriers have been previously mitigated through the acquisition of a 1,420-ac (575 ha) conservation easement on 3 Links Farm that contains an approximate 300-ac (121 ha) riparian zone where western yellow-billed cuckoo are observed annually.

APPENDIX B - FIGURES

Figure 1. Fish barrier construction location and construction features.

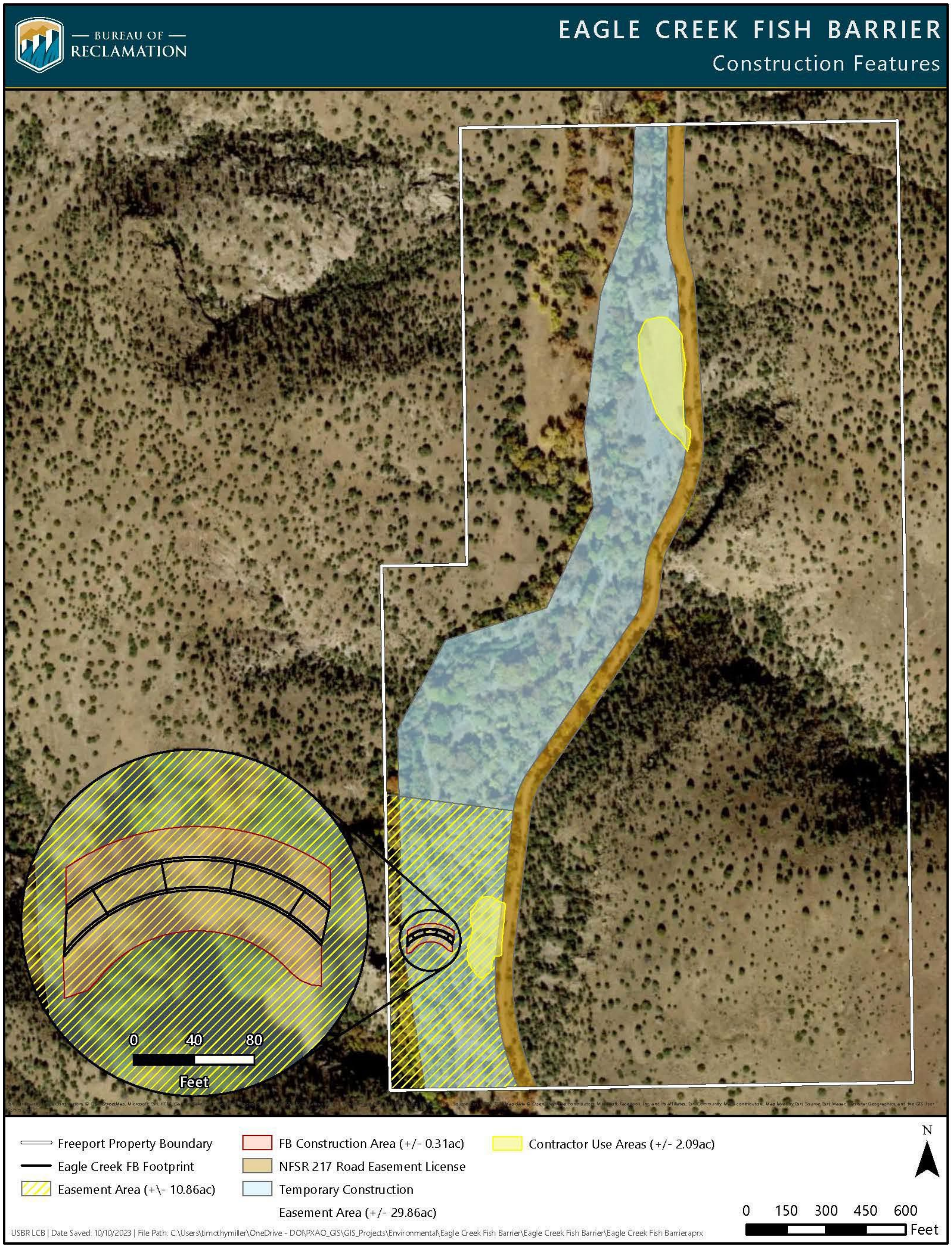

Figure 2. Permittee's Covered Area lands in upper Eagle Creek, Parcels 2 through 10

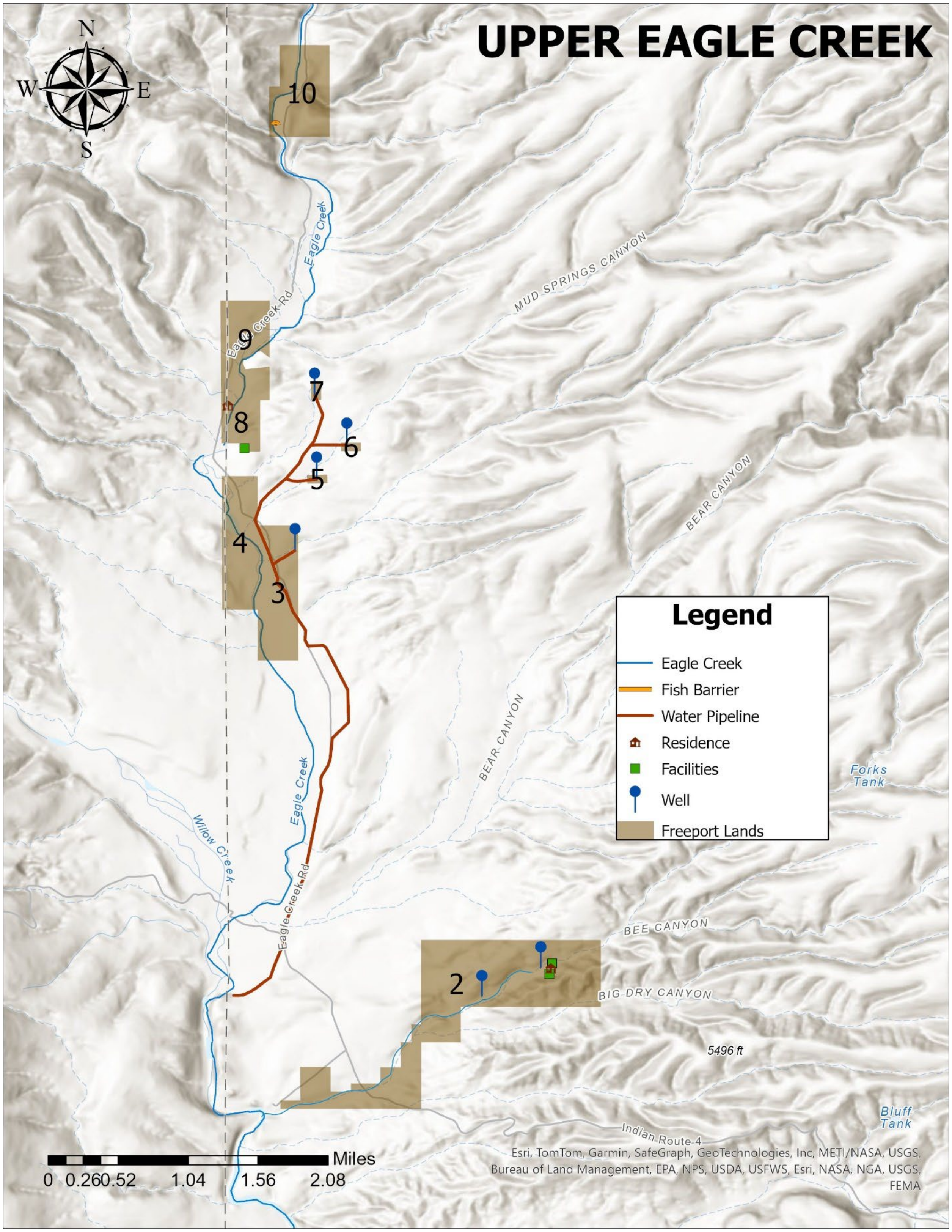

Figure 3. Permittee's Covered Area lands in lower Eagle Creek, Parcel l

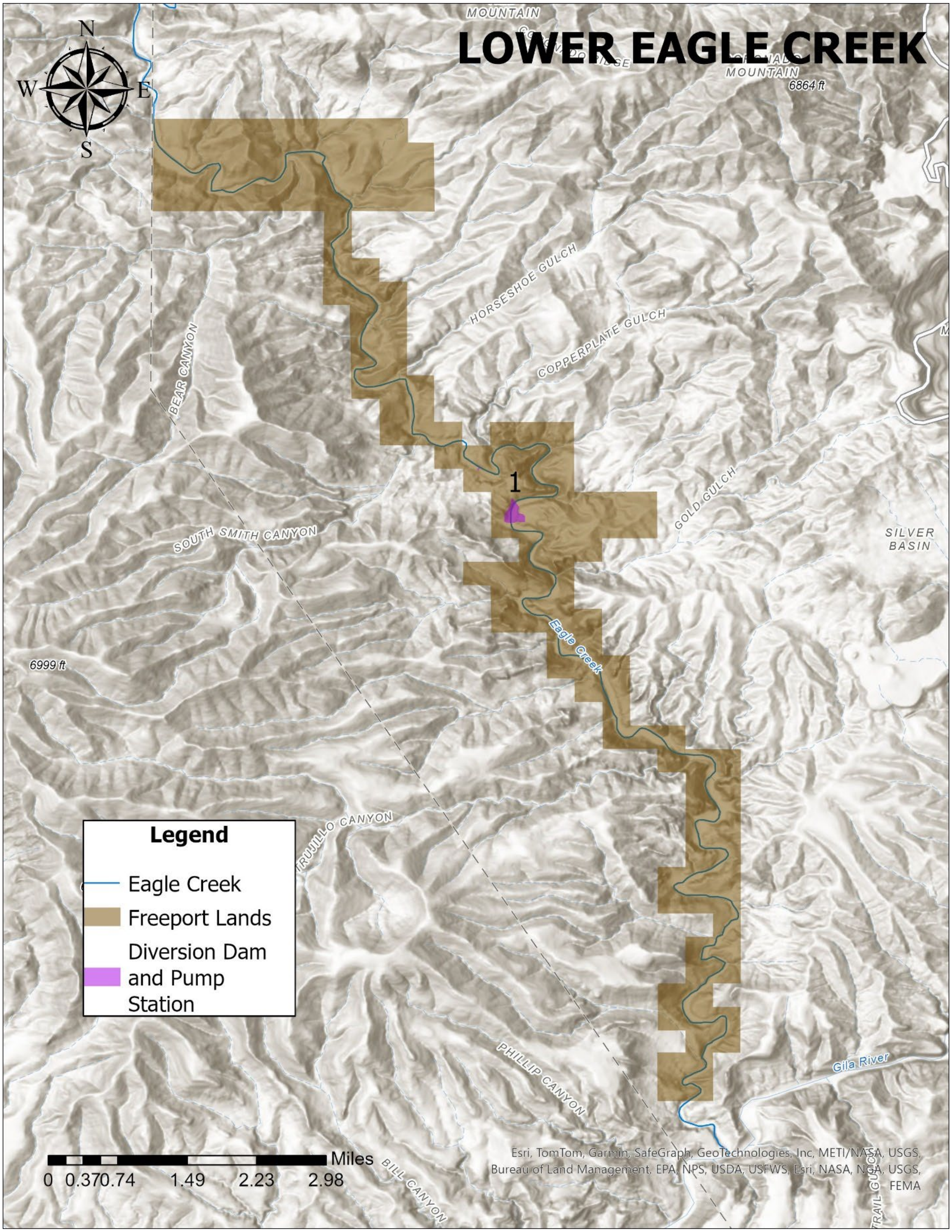

Figure 4. Registered groundwater wells within the action area. This map also highlights the density of wells within and around the Permittee's Covered Area lands in upper Eagle Creek.