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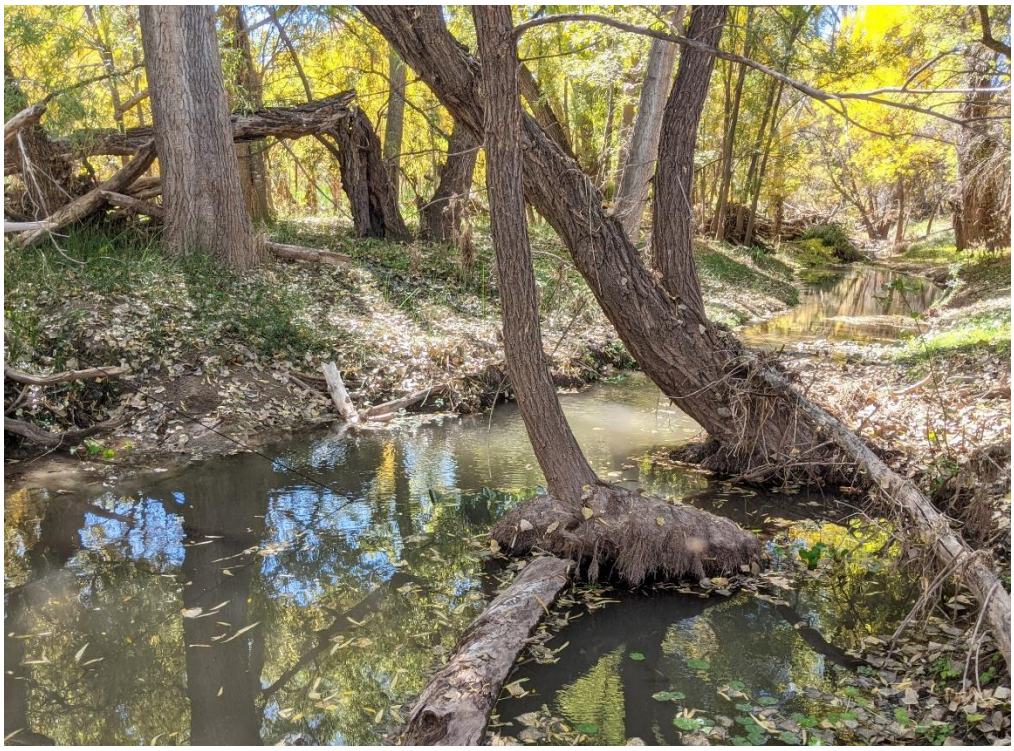
Re-establishment of Beaver (*Castor canadensis*) on the Las Cienegas National Conservation Area
Draft Environmental Assessment



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List of Acronyms

ACEC	areas of critical environmental concern
AO	authorized officer
AGFD	Arizona Game and Fish Department
ASLD	Arizona State Land Department
BDA	beaver dam analogues
BLM	Bureau of Land Management
BMPs	best management practices
CFR	Code of Federal Regulations
DBH	diameter at breast height
EA	environmental assessment
ESA	endangered species act
HDMS	Arizona Heritage Data Management System
HSI	Habitat Suitability Index
IPAC	Information for Planning and Consultation
LCNCA	Las Cienegas National Conservation Area
NHPA	National Historic Preservation Act
NEPA	National Environmental Policy Act
NLCS	National Landscape Conservation System
PFC	proper functioning condition
ROD	record of decision
RMP	Resource Management Plan
SVAPD	Sonoita Valley Acquisition Planning District
T/E	threatened/endangered
USFWS	U.S. Fish and Wildlife Service

1 INTRODUCTION

1.1 Background

The Bureau of Land Management (BLM) is preparing this Environmental Assessment (EA) to analyze the impacts for re-establishing the North American beaver (*Castor canadensis*) as well as the option to add beaver dam analogues (BDA's) in the Las Cienegas National Conservation Area (LCNCA). This EA has been prepared pursuant to the National Environmental Policy Act (NEPA) of 1969 (NEPA; 42 U.S.C. 4321 et seq.), Council of Environmental Quality NEPA regulations (40 CFR 1500-1508), Department of Interior NEPA implementing regulations (43 CFR Part 46), and BLM NEPA Handbook H-1790-1.

Las Cienegas National Conservation Area is comprised of over 45,000 acres, most of which were acquired by the BLM through a land exchange in the late 1980s. In 2000, legislation signed by Congress directed the BLM to conserve, protect, and enhance the unique and nationally important riparian and aquatic ecosystems as well as other values in the LCNCA. Cienega Creek is one of the few riparian areas remaining in southern Arizona and one of the most significant, largely due to the rarity of the vegetative communities along the creek called cienegas (spring fed, desert marshlands). It has perennial springs, streams and wetlands which create conditions that support a high level of biodiversity including native fish and wildlife. The creek is home to natural populations of threatened and endangered species such as the Gila topminnow, Gila chub, Chiricahua leopard frog, Mexican Gartersnake, and Huachuca water umbel; BLM listed species include longfin dace and lowland leopard frog. Additionally, many resident and migratory birds depend on Cienega Creek and associated riparian corridor for habitat and forage. Cienega Creek is considered an ecological treasure in the Southwest, flourishing with native wetland and riparian species while remaining free from aquatic non-natives (Rosen and Caldwell 2004).

Cienega Creek begins and flows north through LCNCA in southern Arizona (Figure 1). Historically, the land within LCNCA was used primarily for grazing large herds of cattle due to the lush grasslands and water resources in the area. Consequently, during the late 1800s and early 1900s Cienega Creek experienced downcutting which caused the stream to become incised (Figure 2) (Dobyns 1981; Hendrickson and Minckley 1984). In the early 1990's, shortly after the land was acquired by BLM, fencing was built to exclude cattle from the riparian area to allow the area to recover naturally. Following the exclusion of livestock from the creek, native trees (cottonwood-willow gallery forest) and native herbaceous plants established, providing stability to stream banks. Cienega Creek and its tributaries are currently separated from their historic floodplain in much of LCNCA. The channel has been widening and the stream has re-established a narrow floodplain within the cutbanks which range from approximately one to five meters high (Bodner and Simms 2008). Additionally, the channel has been slowly aggrading which allows for connection to larger, remnant floodplains along the creek. The area of these floodplains can be over a quarter-mile wide with a potentially significant recharge capacity. Current threats to the aquatic, wetland, and riparian ecosystem include climate change, unsustainable groundwater pumping, future open pit mining, and increasing human occupation of the watershed.

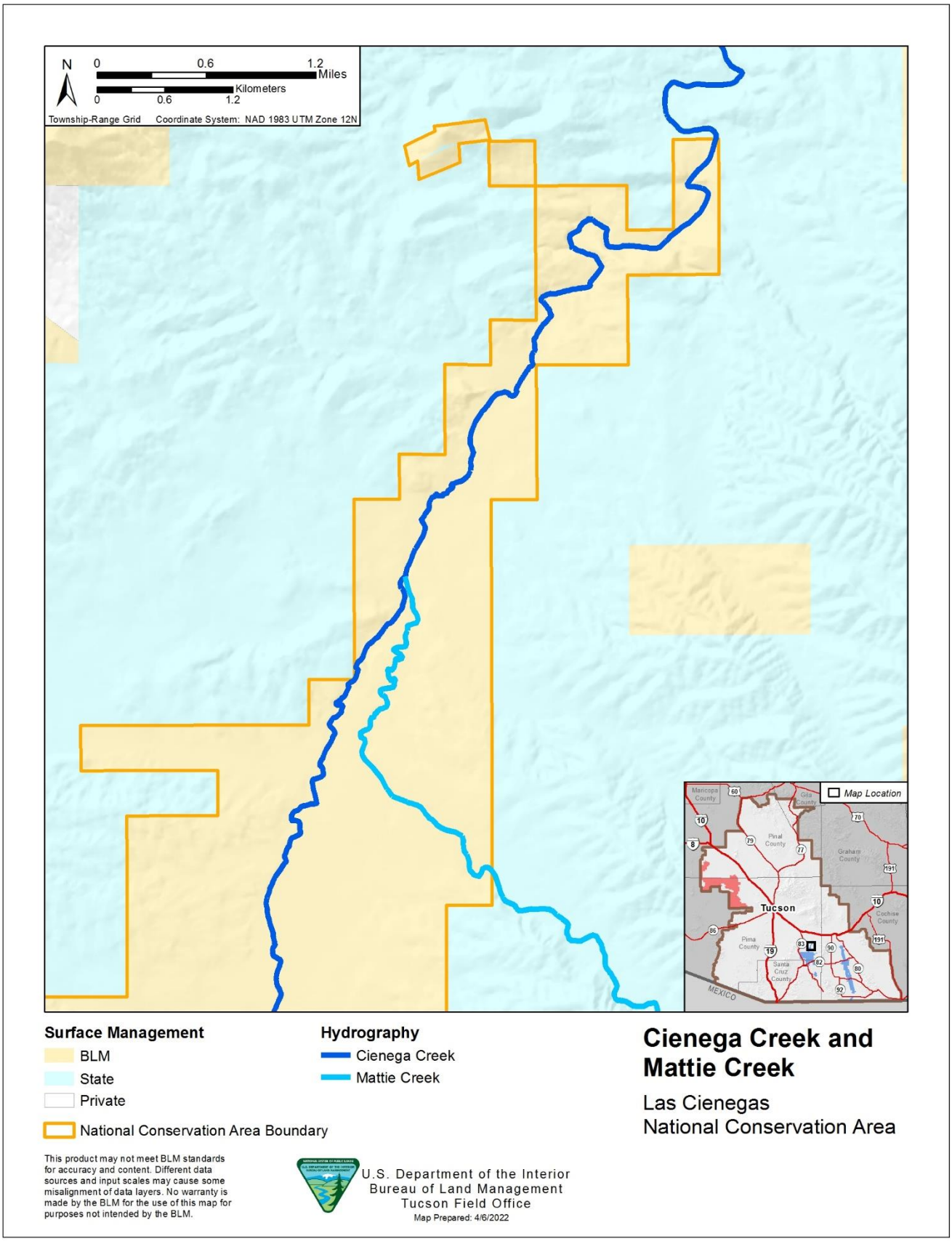

Figure 1. Cienega Creek and Mattie Creek, LCNCA, Pima County.

Figure 2. Two examples of incision resulting in high cut banks observed in 2008 along Cienega Creek, LCNCA, Pima County.

1.2 Purpose and Need for Action

The purpose for this project is twofold: 1) respond to a proposal by Arizona Game and Fish Department (AGFD) to re-establish beaver, an extirpated species, on Cienega Creek and 2) implement the Las Cienegas Resource Management Plan (RMP)/Record of Decision (ROD), which directs such re-establishment actions to occur (Las Cienegas RMP decision Wildlife [WF]01) as well as maintaining an/or improving watershed processes (Las Cienegas RMP decision Watershed [WS]21). The proposed re-establishment would contribute toward population restoration efforts in southern Arizona and range-wide conservation of this keystone species which would improve stream, spring, and wetland resiliency to the ongoing and increasing effects of ground water extraction and climate change.

Recently, there has been emerging interest among land managers to use North American beaver (*Castor canadensis*) for stream restoration, water storage, and water recharge in degraded riparian areas as an alternative to mechanical restoration practices (Gurnell 1998; Rosell et al. 2005; Pollock et al. 2007; Gibson and Olden 2014; Dauwalter and Walrath 2018; Fesenmyer et al. 2018; Nash et al. 2021). Historical records confirm the presence of beaver in the Santa Cruz watershed (Dobyns 1981; Eddy et al. 1983; Betancourt 1990). Beaver were extirpated from southern Arizona watersheds largely due to early European settlers trapping beaver for pelts beginning in the 1700s. Currently, beaver in Arizona are often found in narrow ribbons of riparian habitat along streams and rivers that are dominated by cottonwoods and willows. Bonita Creek, Pinal Creek, and the lower San Pedro River are examples of narrow riparian corridors in southern Arizona that presently contain beaver and are similar to Cienega Creek. The width of riparian habitat where beaver occur along these systems ranges from 37 to 190 meters. The introduction of beaver into Cienega Creek would mitigate the current challenges Cienega Creek is facing and improve habitat conditions for existing native species.

Beaver are ecosystem engineers with the ability to completely alter habitats. By reintroducing beaver into Cienega Creek, the effects of current and future challenges to perpetuate the aquatic-wetland-riparian ecosystem on Cienega Creek could be reduced (Hood and Bayley 2008; Wild 2011; Dittbrenner et al. 2018; Stoll and Westbrook 2020). The benefits of beaver re-establishment on the LCNCA are many and include: (1) improved aquatic ecosystem resilience to climate change and ground water pumping; (2) restoration of incised stream channel through sediment accumulation, thus restoring connection with floodplains; (3) reduction of erosion potential and sediment carrying capacity of the stream; (4) elevation of water tables and increased area of riparian and cienega habitat; (5) increased water storage capacity leading to enhanced stream flow and extent during dryer periods; and (6) maintenance and improvement of favorable habitat conditions for several federally listed species whose distribution is tied to these habitats.

Additionally, BDAs are instream structures that mimic natural beaver dams. BDAs can be placed in preferred locations to achieve desired results to improve watershed function. The placement of the BDAs can act as starter dams for beaver to aid in establishment of beaver colonies within a particular area (Pollock et al. 2015; Charnley 2018). If beaver colonize the BDAs, the dam and surrounding area would be maintained naturally by beaver. Additional documentation can be found in Appendix A.

The proposed action fits the current administrative America the Beautiful priorities: Developing approaches to conserve at least 30% each of our lands and waters by the year 2030. To protect biodiversity, slow extinction rates and help leverage natural climate solutions by conserving 30% of America's lands and waters by 2030. This relies on support for local, state, private, and tribally-led nature conservation and restoration efforts that are underway across America.

1.3 Decision to Be Made

The Authorized Officer (AO) will decide whether or not to allow for the re-establishment of beaver in Cienega Creek by the AGFD.

1.4 Conformance with Applicable Land Use Plan(s)

The proposed action is in conformance with the Approved Las Cienegas RMP/ROD (2003). This proposed action has been reviewed to determine if it conforms with the land use plan terms and conditions as required by 43 CFR 1610.5, BLM MS 1617.3.

Relevant excerpts from Approved Las Cienegas RMP/ROD July 2003 (Pages 12-13 and 35-36):

Manage suitable public land habitats for the recovery or re-establishment of native populations in collaboration with federal and state agencies, user groups, and other interested parties. Provide for the re-establishment of Gila topminnow into suitable habitats in accordance with the existing BLM-AGFD Memorandum of Understanding. In addition, provide for the re-establishment, or supplementation of the following endangered, threatened, candidate and priority species within suitable habitats in accordance with existing regulations, policies and agreements (WF05):

- *Gila chub*
- *Desert pupfish*
- *Southwestern willow-flycatcher*
- *Aplomado falcon*
- *Chiricahua leopard frog*
- *Lowland leopard frog*
- *Black-tailed prairie dog*
- ***Beaver***
- *Pronghorn*
- *Gould's turkey*

AND

Reestablish, extend the distribution within historic ranges of, or supplement populations of the following wildlife species in the Sonoita Valley, where determined to have suitable habitat and be compatible with other management activities (WF18):

- *Aplomado falcon (Falco femoralis)*
- *Gould's turkey (Meleagris gallopavo mexicana)*
- *Gila topminnow (Poeciliopsis occidentalis)*
- *Desert pupfish (Cyprinodon macularius)*
- ***Beaver (Castor canadensis)***
- *Gila chub (Gila intermedia)*
- *Pronghorn antelope (Antilopcapra americana)*
- *Lowland leopard frog (Lithobates yavapaiensis)*
- *Chiricahua leopard frog (Lithobates chiricahuensis)*
- *Black-tailed prairie dog (Cynomys ludovicianus)*

(Other species may be considered as new information or management needs become known.)

Accomplish this action through the following steps:

a. *Determine the population status and resources available (e.g., habitat quality, water availability) to wildlife species proposed for reestablishing or supplementing. (AA07)*
b. *When habitat conditions have been determined to be suitable for the survival of any of the above species, coordinate the suitable action (reestablishing or supplementing) by established procedures with the suitable combination of agencies and landowners: AGFD, USFWS, BLM, ASLD, and affected private landowners. (AA08)*

1.5 Relationship to Statutes, Regulations or Other Plans

The LCNCA and Sonita Valley Acquisition Planning District (SVAPD)were designated by Congress and signed into law by the President on December 6, 2000 (Public Law 106-538). “In order to conserve, protect, and enhance for the benefit and enjoyment of present and future generations the unique and nationally important aquatic, wildlife, vegetative, archaeological, paleontological, scientific, cave, cultural, historical, recreational, educational, scenic, rangeland, and riparian resources and values of the public lands described in subsection (b) while allowing livestock grazing and recreation to continue in appropriate areas, there is hereby established the Las Cienegas National Conservation Area in the State of Arizona. The Secretary shall manage the Conservation Area in a manner that conserves, protects, and enhances its resources and values, including the resources and values specified in the section above, pursuant to the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701 et seq.) and other applicable law, including this Act. The Secretary shall allow only such uses of the Conservation Area as the Secretary finds will further the purposes for which the Conservation Area is established.”

As specified in the Omnibus Public Land Management Act of 2009 (16 U.S.C. 7202) (the Omnibus Act of 2009 or Act), the National Landscape Conservation System (NLCS) was established in order to “conserve, protect, and restore nationally significant landscapes (including NCAs) that have outstanding cultural, ecological, and scientific values for the benefit of current and future generations.” The Act goes on to require that NLCS units be managed “in a manner that protects the values for which the components of the system were designated.” 50 CFR §402.01 directs Federal agencies to carry out conservation programs for listed species under the Endangered Species Act (ESA). Conservation is “...to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures of pursuant to this Act are no longer necessary.” The BLM is responsible for assisting the U.S. Fish and Wildlife Service (USFWS) with actions that support the recovery of threatened and endangered species [Section 7(a) 1].

As water resources become stressed, the BLM must improve the resilience of the aquatic habitats on LCNCA in order to conserve and protect resources as described in Public Law 106-538. Conservation is “...to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures of pursuant to this Act are no longer necessary.” The proposed project is entirely within the LCNCA and SVAPD created by Congress. Enabling legislation for the LCNCA directed the BLM to “conserve, protect and enhance” resources including aquatic habitat, fish and wildlife.

1.6 Scoping and Public Involvement

The project was discussed with a variety of Federal, State, local agencies, and BLM stakeholders at the LCNCA biological planning meeting for outreach purposes on March 31, 2017. Arizona Game and Fish have been involved in the development of this project and provided input on multiple occasions starting in 2013.

The project was scoped with the BLM interdisciplinary team at the NEPA meeting on January 14, 2020. Issues identified from these scoping activities are summarized in the following table.

Resource	Issues Identified related proposed action
Threatened and Endangered Species	-Would federally listed species be impacted by the re-establishment of beaver? -Would bullfrogs reinvade Cienega creek as a result of beavers creating more available habitat?
Fish and Wildlife Resources	-Would the beaver habitat alterations change the food web in some areas from allochthonous (leaf litter) to autochthonous (algae) energy input to aquatic ecosystem? -Would the addition of beaver to the ecosystem influence habitat diversity for many wildlife species including game species? -Would the habitat alteration caused by dam building impact to the avian community?

Resource	Issues Identified related proposed action
	-Would the creation of beaver ponds change habitat availability and suitability for waterfowl and shorebirds?
Floodplains/Surface water	- Would the addition of beaver into the ecosystem mitigate current climatic conditions in relation to drought by creation of ponds (additional water storage)? -Would addition of beaver into the system alter the current hydraulic conditions in Cienega creek and tributaries?
Livestock Grazing	Would livestock crossings be flooded because of damming caused by beaver activity?
Noxious Weeds	None brought forward.
Recreation	None brought forward.
Wetlands/Riparian Zones	- Would beaver alter current riparian plant community from a cottonwood-willow veg dominated to wetland vegetation dominated? - Would the addition of beavers into the ecosystem cause a reduction in canopy cover?
Vegetation	None brought forward for upland vegetation. See wetland/riparian zones above.
Visual Resources	None brought forward.
Cultural Resources	None brought forward.
Other	-Would the released beavers disperse onto private lands with ponds? -Would the released beaver disperse onto the Pima County portion of Cienega creek?

1.7 Issues

1.7.1 Issues Considered, but eliminated from Detailed Analysis

1.7.1.1 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact livestock grazing within LCNCA?

Rationale: Cienega creek has been fenced from year-round livestock use since 1990. Throughout the creek, cattle now use six 50m- to 250m-long crossing lanes for short periods when moving between pastures. Dam building activities by beaver and subsequent water elevation may flood designated cattle crossings but likely not to depths that would prevent use by the livestock operator anywhere in the crossing lanes. Thus, the livestock grazing operation would not be affected by the re-establishment of beaver in Cienega creek and this issue is eliminated from detailed analysis.

1.7.1.2 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact soil resources within LCNCA?

Rationale: Damming activity by beaver causes deposition of more fine silt and sediment increasing the volume of riparian soils. In Minnesota, beaver dams retained 6500 cubic meters of sediment and increased the wetted surface of stream channels (Naiman et al. 1986). Aggradation (recovery from incision resulting from trapped sediment) has been observed where beaver have recolonized streams and built dams (Scheffer 1938; Butler and Malanson 1995; McCullough et al. 2005). Re-establishing beaver back into Cienega creek would aid in recovery of the incised stream channel through the process of aggradation and restoring the ecological, geomorphological, and hydrological processes of the riparian system; and thus, protect and potentially increase the amount of riparian (hydric) soils. Temporary overland access used in

relocation of beavers and installation of BDAs has the potential to cause short term disturbances to soils. This would be mitigated by using the best management practices (BMPs) listed in the proposed action.

1.7.1.3 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact to the spread of noxious weeds within LCNCA?

Rationale: There is the potential for the introduction or spread of invasive and non-native species and introduction of noxious weeds from seeds which are transported on equipment used in project activities under the Proposed Action. To prevent seed transport and minimize risk, all equipment would be washed off prior to use on the project as is the standard operating procedure for projects.

1.7.1.4 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact recreation and visual resources within LCNCA?

Rationale: Re-establishment of beaver would support improvement of riparian areas, increase aquatic habitat diversity, and enhance wildlife viewing opportunities on LCNCA. There are no foreseen adverse effects to recreation from the re-establishment of beaver in Cienega creek, thus this issue is eliminated from detailed analysis.

1.7.1.5 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact wild and scenic rivers within LCNCA?

Rationale: The proposed action should benefit the Cienega creek Wild and Scenic River segments by supporting improvement of riparian areas and surface water flow and extent.

1.7.1.6 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact visual resources within LCNCA?

Rationale: The visual resource management class for the project area is under the Class II Objective. This objective recommends retaining the existing character of the landscape and allowing a low level of change that should not attract the attention of the casual observer. The proposed action would restore landscape to is natural state by restoring incised stream channels, reducing erosion potential and sediment carrying capacity of the stream, and increase water storage capacity leading to enhanced stream flow during dryer periods. Changes to the existing landscape would gradually occur over time and should not attract the immediate attention of the casual observer.

1.7.1.7 Will the re-establishment of beaver and addition of BDA's into Cienega creek impact areas of critical environmental concern (ACEC) listed in the Las Cienegas RMP

Rationale: The proposed action is in conformance with the goals of the Empire-Cienega ACEC (Map 1 in Approved Las Cienegas Resource Management Plan and Record of Decision, July 2003) as re-establishment of beaver would enhance watershed and wildlife resource values of the ACEC. The goals of ACEC are to protect and enhance watershed, grassland, and threatened/endangered wildlife resources emphasizing total ecosystem management on LCNCA. The objectives are: 1. Resolve non-federal land use conflicts; 2. Maintain adequate instream flows to support aquatic and riparian resources; 3. Maintain water quality to support aquatic, riparian and fish and wildlife values; 4. Maintain or improve riparian condition to meet objectives for riparian Proper Functioning Condition (PFC) and threatened and endangered (T/E) fish and wildlife habitat, including but not limited to a combination of maintenance of adequate woody species regeneration, promotion of mixed-aged stands of woody species, promotion of mature cottonwood overstory, and maintenance of cienega habitats; 5. Maintain or improve upland condition to meet objectives for proper functioning condition and desired future conditions of uplands (maintain or improve ecological site similarity to potential natural community); 6. Minimize surface disturbance and erosion through adequate controls on recreational activities, livestock grazing and other human uses; 7. Educate the public regarding riparian and T/E wildlife issues and management needs; 8. Promote the recovery of the Gila Topminnow; 9. Increase stability in the soil piping and headcutting areas; 10. Maintain or improve water quality in the Cienega creek system; 11. Stabilize incised channel banks within these unstable soil areas; 12. Reduce surface

disturbance and vehicle use within these areas of soil piping and headcutting; 13. Increase public safety; 14. Prevent the introduction of and control non-native invasive species in the ACEC.

The proposed action would meet ACEC objectives 2, 3, 4, 7, 8, and 10 by enhancing water quantity and quality in the stream and enhancing riparian condition and wildlife habitat.

1.7.1.8 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact cultural resources in LCNCA?

Rationale: Proposed BDA installation and/or mitigative construction locations would be subject to individual project review to ensure compliance with section 106 of the National Historic Preservation Act (NHPA). Potential inundation of historic properties along stream and riparian embankments would also be considered to determine whether adverse effects are likely and/or warrant mitigation. The BLM's primary and preferred method to protect historic properties is avoidance of impacts through redesign or relocation of proposed activities and/or constructions. Should the BLM identify potential impacts to historic properties, the BLM would develop plans to resolve potential adverse effects in consultation with the State Historic Preservation Office, Tribes, and other potentially affected parties.

1.7.1.9 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact tribal interests within LCNCA?

Rationale: The BLM initiated government-to-government consultation with 10 Native American Tribes who claim cultural affiliation to and/or traditional use of the area. Letters summarizing the current range of alternatives were sent to the Fort Sill Apache Tribe, Hopi Tribe, Mescalero Apache Tribe, Pascua Yaqui Tribe, San Carlos Apache Nation, Tohono O'odham Nation, Tonto Apache Tribe, White Mountain Apache Tribe, Yavapai-Apache Nation, and Zuni Tribe in May 2022.

Currently, there are no known or likely impacts to any culturally significant plants, items, sites, or landscapes. Any new information provided by consulting Tribes could prompt issue(s)-analysis and/or alternatives development. Likewise, the BLM may later apply additional or edited terms and conditions to project implementation or require mitigation to protect or restore culturally significant resource values. The BLM's Tribal consultations will continue throughout the EA process.

1.7.1.10 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact private lands with streams and ponds outside LCNCA?

Rationale: It is possible that released beaver could disperse on private lands and Pima county lands. This issue is addressed in the mitigation section. Arizona Game and Fish will remove any unwanted beaver that stray from the LCNCA.

1.7.2 Issues Identified and Analyzed

1. Would the re-establishment of beaver and addition of BDA's into Cienega creek impact groundwater and streamflow?
2. Would the re-establishment of beaver and addition of BDA's into Cienega creek impact water quality?
3. Would the re-establishment of beaver and addition of BDA's into Cienega creek wetlands, riparian zones (vegetation), floodplain, and stream channel?
4. Would the re-establishment of beaver and addition of BDA's into Cienega creek impact aquatic microhabitats?
5. Would the re-establishment of beaver and addition of BDA's into Cienega creek impact neotropical migratory birds, waterfowl, and shorebirds?
6. Would the re-establishment of beaver and addition of BDA's into Cienega creek impact threatened and endangered species?

7. Would the re-establishment of beaver and addition of BDA's into Cienega creek impact BLM sensitive species?

2 PROPOSED ACTION AND ALTERNATIVE(S)

2.1 Alternative A (Proposed Action): Re-establishment of beaver in LCNCA with option to include Beaver Dam Analogues

Under this alternative beaver would be reintroduced into LCNCA with the option of adding Beaver Dam Analogues (BDAs) before and/or after beaver establishment. Naturally created beaver dams and BDAs aim to achieve similar results such as sediment accumulation to reduce an incised stream channel, increasing sediment carrying capacity, elevating water tables, increasing heterogeneity in habitat types, increasing water storage capacity created by pools, and connecting channel with disconnected floodplains (Hammerson 1994; Pollock et al. 2007; Demmer Beschta 2008; Westbrook et al. 2011: Hafen and Macfarlane 2016; Wheaton et al. 2019). BDAs are an initiation of active restoration, but the success of these structures ultimately depends on colonization by vegetation and beaver (Pollock et al. 2014). These artificial structures have been shown to cause rapid aggradation when used alone, however, beaver vital to maintain and expand on BDAs.

BDAs are instream structures commonly created with organic materials such as wood posts, branches of surrounding trees, grasses, mud, gravel, silt, clay, and cobble (Pollock et al. 2015; Wheaton et al. 2019) and are semiporous, and span all or part of a stream channel (Charnley 2018). Beaver dam analogs would be placed in circled habitat locations in lower Cienega creek (Figure 3) within the LCNCA. Specific areas within these circled habitat locations would be selected based on level of adjacent floodplain development for recharge, adequate spacing between family groups, availability of surface water at base flow, and forage and will be decided at the project implementation level. Additionally, accessibility would be a consideration when choosing sites. Depending on channel geomorphology there would be multiple placements of BDAs over time in order to attract released or dispersing beaver to locations with a high potential for improved recharge and to create patches of suitable habitat (ponding) where none currently exist or is very limited in size and depth. Over the life of the project, up to 15 BDA structures could be installed in the stream channel of Cienega creek and Mattie Creek for the purpose of attracting beaver as the population expands.

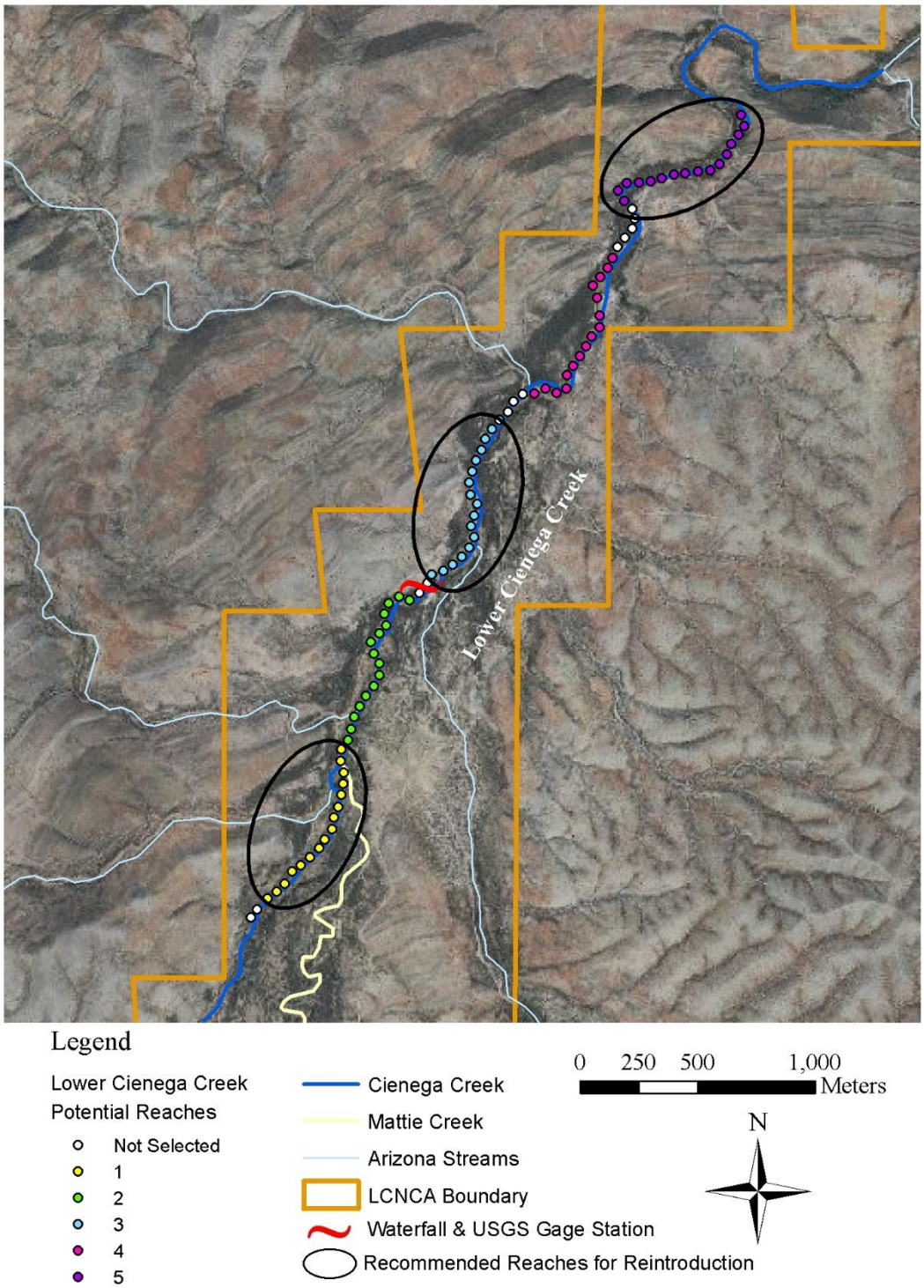

Figure 3. Potential reaches (length = 800m) for beaver re-establishment and BDA's highlighted by color along lower Cienega creek, LCNCA, Pima County. Of the five reaches, it is recommended that only three family groups or pairs be transplanted. Recommended reaches for re-establishment are circled in black. (Map from Habitat Suitability of Cienega creek for Beaver (Castor canadensis), Las Cienegas National Conservation Area, Arizona, 2019)

2.1.1 Construction and Installation of BDAs

Prior to placement of BDAs in a section of stream, the area would be surveyed for the presence of federally listed species. Timing of the project would be coordinated in a manner to avoid construction during breeding of federally listed species. Special attention (staying close to project footprint) would be given when walking in the water to minimize disturbing or injuring federally listed and BLM listed aquatic species. The area would be surveyed for the occurrence of Huachuca water umbel (*Lilaeopsis schaffneriana*), amphibian egg masses, and Mexican gartersnake in selected project areas prior to construction activities. If Huachuca water umbel, egg masses, or Mexican gartersnakes are detected, the location would be flagged and avoided. If the patch of umbel is large, the project footprint would move upstream or downstream of the identified area. Additionally, areas of occupied Arizona eryngo and Arizona giant sedge would be avoided. Biologists would brief personnel in the field using BMPs for avoiding federally listed species prior to project initiation.

Prior to implementation, proposed BDA locations will be subject to cultural resources assessment. Review and compliance procedures will conform with the Arizona BLM Statewide Protocol (executed December 14, 2014) and the NHPA implementing regulations at 36 CFR 800. The potential for nearby inundation of historic properties, if present, would also be evaluated and consulted on as necessary.

The BDAs would be constructed by installing a line of 2.5- 4-inch diameter wooden posts (untreated pine or local slash wood) in the stream channel using a pneumatic post driver, leaving about 40 inches of post above the water surface (Wheaton et al. 2019). The length of the wooden post would depend on the desired depth of the water, as two-thirds of the pole must be underground to remain structurally sound. The number of posts installed depends on the width of the stream in the area and would be placed in staggered rows. The spacing of the posts would be between 20-40 inches apart. Fresh branches from slash left behind by other projects in the uplands would be used to fill in gaps between posts if available, otherwise, a single tree (Gooding's Willow, Velvet Ash, or Fremont Cottonwood) with abundant pliable branches would be used instead. Alternatively, mesquite from upland vegetation treatments could be used as woody plant material in the construction of BDAs when available. Woody material that is purchased or brought in from a treatment area in the uplands would be staged in piles a short distance from the structures, typically just off the nearest access road. Work would be conducted using hydraulic or pneumatic post hammers and hand tools such as hammers and saws. All materials would be hauled on foot where road access is not available.

An upstream face would be constructed using cobble and other large material placed at the upstream base of each dam to prevent underflow and potential scour. Successive layers of vegetation and finer-grained material are placed on top until the structure has achieved the desired level of flow permeability and upstream pool depth (Pollock et al. 2015, Bennet et al 2018). During the layering, branches are interwoven into the mesh to create a downstream apron. This apron aids in reducing the downstream hydraulic drop created by the structure. Additionally, a shorter secondary BDA is often constructed immediately downstream to pool water directly behind the primary BDA to also lessen the force of the hydraulic drop. Planform, profile, and cross-sectional views of BDAs are available in Appendix B. Cobble would be obtained from tributaries and side channels and moved with buckets and wheelbarrows. Finer grained material would be obtained from the steam channel on the upstream side of the BDA. Following the construction of BDAs, beaver would be released at BDA locations.

The BDAs would ideally be maintained by resident beaver. However, if a BDA or set of BDAs do not become occupied by beaver in two or three years, a decision would be made whether to maintain or remove the structures based on level of observed benefit and cost of maintenance.

2.1.2 Proposed Beaver Release Sites

Over the next 10 years, in cooperation with AGFD, the BLM proposes to release a total of three family groups in three reaches of Lower Cienega creek with additional beaver released to replace lost individuals prior to the establishment of a self-sustaining population. Additionally, if deemed necessary, beavers can be supplementally added following the 10- year reintroduction effort to maintain genetic diversity.

In 2008, AGFD used the U.S. Fish and Wildlife Service Habitat Suitability Index (HSI) model along with wet/dry data to select the most favorable reaches to support beaver in LCNCA (Stingelin and Ingraldi 2009; Appendix C) (Figure 3; Figure 4). Methodologies and other details of the HSI study performed by AGFD are described in Appendix C. The model rates habitat quality in riverine habitats based on seven variables related to water permanency and flow (i.e., water level fluctuation, stream gradient) and food availability (i.e., tree canopy closure, stem diameter, shrub crown closure, shrub canopy height, and woody species composition). The model specifies a minimum habitat area of 800m of contiguous stream (i.e., permanent source of water at least 800m in length). The food resources in Mattie Creek and upper and lower Cienega creek were evaluated during this effort. Inventory of the food resources revealed that the riparian area along these creeks are producing a large number of sapling and young ash trees, and the existing stands of cottonwood and willows are getting older and larger with little new recruitment. The availability of food for beaver is abundant and diverse in the lower reaches of Cienega creek.

A total of five 800m reaches were identified along lower Cienega creek on LCNCA for beaver re-establishment. The final HSI values for the identified reaches range from 0.7 – 0.8 (maximum = 1.0) which AGFD considers suitable for beaver re-establishment. Of the five reaches, AGFD recommends transplanting beaver into only three (Figure 3) (Stingelin and Ingraldi 2009). This conservative approach is recommended due to concerns that transplanting beaver into each identified reach along lower Cienega creek may result in overutilization of preferred food species (i.e., cottonwood and willow) from the narrow riparian forest corridor. Studies have shown that beaver tend to exploit some food resources (*Populus* spp.) and waste others by inundation (Hall 1960; Northcott 1971; Gill 1972; Beier and Barrett 1987). As a result, beaver distribution over time is dynamic as family groups often deplete food resources and move to new colony sites (Boyle and Owens 2007). However, food resource overexploitation is less likely in Cienega creek because there is a wide range of vegetative choices for beaver such as herbaceous wetland plants including cattails, bulrush, watercress, water parsnip, and many other plant species. Beaver are unlikely to build lodges for winter storage of food from trees. Researchers with AGFD suggest reserving upper Cienega creek and Mattie Creek as areas open to natural dispersal and colonization rather than transplanting beaver into these areas. Dam building activities along lower Cienega creek and subsequent back flooding would likely increase the amount of suitable habitat (i.e. perennial water) available for colonization along Mattie Creek and the central portion of Cienega creek and provide a more favorable corridor for dispersal between the upper and lower perennial sections of Cienega creek.

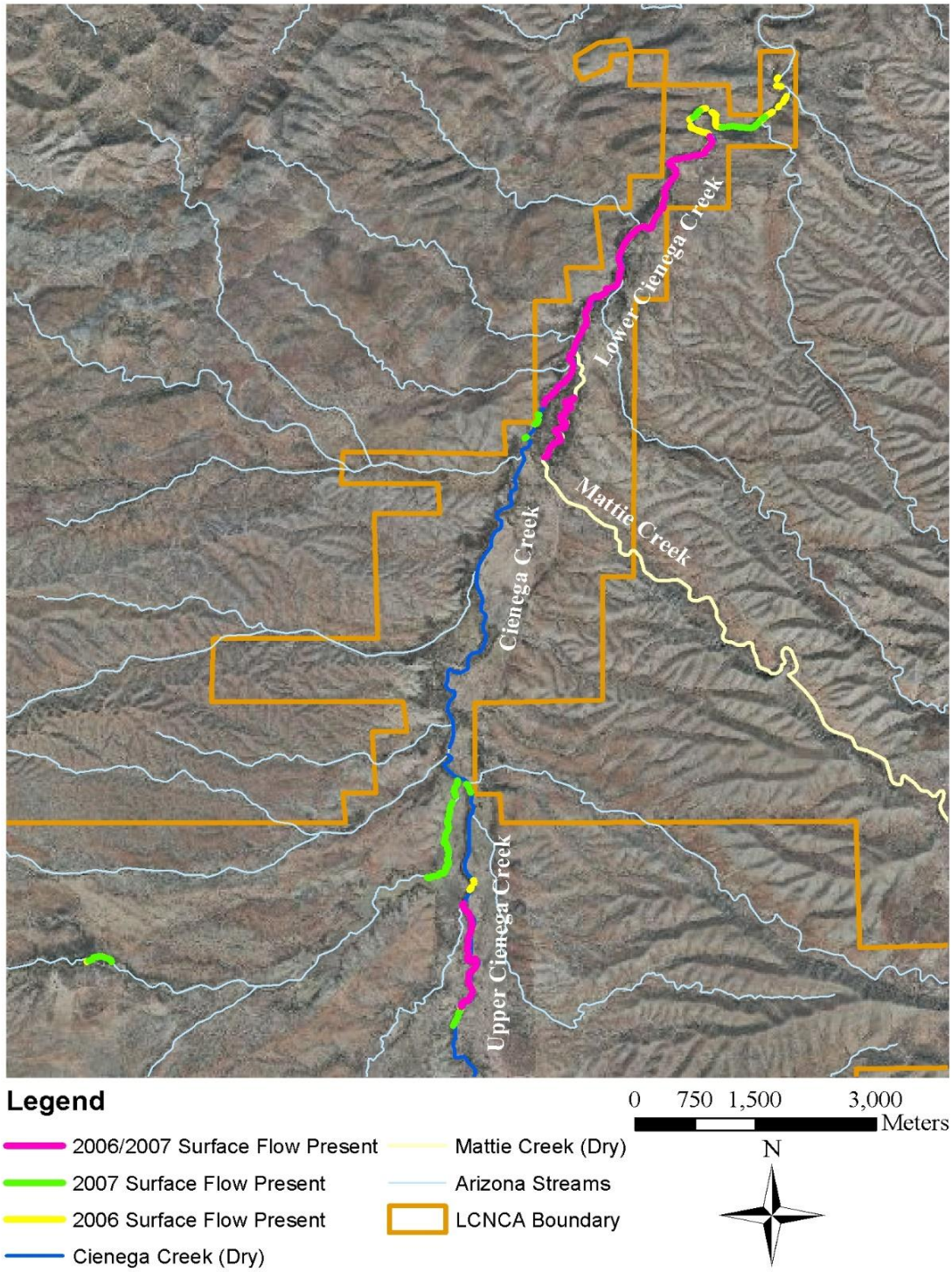

Figure 4. AZGFD Habitat Suitability Study. Wet/dry data collected by BLM in 2006 and 2007 along the Cienega creek riparian corridor, LCNCA, Pima County. Areas highlighted in pink identify reaches where surface water presence overlapped both years. These reaches (i.e., upper and lower Cienega creek, Mattie Creek) were further evaluated for habitat suitability. These reaches still have surface flow, though it varies in extent from year to year. (Map from Habitat Suitability of Cienega creek for Beaver (Castor canadensis), Las Cienegas National Conservation Area, Arizona, 2019)

2.1.3 Translocation of Beaver

Beaver are available from the U.S. Department of Agriculture Animal and Plant Health Inspection Service for transplant into lower Cienega creek. A total of three family groups would be transplanted. Depending on availability, these may be captured all at once or a few at a time over a one to two-year period. If possible, entire family groups or adult pairs would be captured and transplanted to maintain pair bond integrity. High losses from mortality and emigration were reported by McKinstry and Anderson (2002) when groups of unpaired beavers were released to restoration sites in Wyoming. Additional transplant efforts were needed to provide mates for unpaired beavers that established territories. Transplanting beaver into Cienega creek would likely be most successful in the late spring (April/May) when vegetation is highly nutritious and plentiful, and water levels are relatively stable, thus minimizing potential for immediate dispersal. However, capturing beaver in the fall is easiest when family groups are in close association. In addition, the possibility of transplanting pregnant females would be eliminated if transplants are done in the fall. Due to logistic and/or budgetary constraints, it may be necessary to transplant beaver during both seasons.

Beaver would be released into a stretch of lower Cienega creek located between the Mattie Creek confluence and the Narrows. Releases would occur at three different locations spaced approximately 800m apart. If BDA's are installed prior to beaver reintroduction, beavers would be place in a location near the BDA's.

2.1.4 Post-Release Monitoring

Monitoring is an integral component of the proposed action. Only through a carefully designed monitoring plan would participating agencies be able to determine whether the attempt at re-establishment was successful and formulate future plans based on the effort's successes and failures. Extent and duration of monitoring by BLM or AGFD may be limited by availability of funds. Studies on the following resources would be conducted primarily by AGFD and BLM to document beaver population dynamics and the impact of beaver on various aspects of the riparian ecosystem: beaver use and dispersal, riparian vegetation, stream channel morphology, stream water quality, stream flow, riparian photo points, threatened and endangered species, aquatic habitat, amphibians (including bullfrog) and reptiles. Methodologies and other details of these proposed monitoring efforts are described in Appendix D.

Evaluation of monitoring data would occur on an annual basis for the first five years and every five years thereafter. BLM personnel, USFWS, and AZGFD would assess the positive and negative effects of beaver on the riparian ecosystem. AGFD, USFWS, and BLM would be primarily involved in these evaluations with assistance from other agencies and groups as appropriate. The primary factors that be evaluated to make this assessment would include the following: changes in riparian vegetation, stream channel morphology, groundwater elevations, stream flow regime and water quality, responses of threatened and endangered species (individual species and as a group), and other factors. Methodologies and other details of these proposed monitoring efforts are described in Appendix D.

Following the initial establishment of individual family groups at each site, it may be necessary to augment the beaver population to maintain genetic diversity or in the event their numbers are reduced by predation or emigration during drought, flood, and/or disease. If beaver fail to establish at any of the selected sites, the determination as to whether the site is suitable for continuing efforts would be reached jointly by the BLM, USFWS, and AGFD.

If beaver are discovered on private, county, or the property of another federal entity and their presence is detrimental or undesirable to the landowner, they would be removed promptly by AGFD.

In addition, bullfrogs (*Rana catesbeiana*) would continue to be monitored on Cienega creek within LCNCA and the rest of the basin. Bullfrog control in the basin would be ongoing whether or not this project is implemented as it is necessary for the long-term conservation of several federally listed and BLM listed aquatic species in LCNCA.

2.1.5 Mitigation: Conservation Measures for Proposed Action

The following conservation measures would be implemented during installation of BDAs and release of beaver.

- Biologists would consider the seasonal and spatial needs of federally listed species (*e.g.*, avoiding or protecting important use areas or structures and maintaining adequate patches of key habitat components) during project planning and implementation.
- As part of a mandatory briefing held prior to all delegated activities, all support personnel would be briefed and educated by a biologist or designated supervisors about listed species and the importance of minimizing impacts to individuals and their habitats. All personnel would be informed of the conservation measures designed to minimize or eliminate take of the species present.
- Any cultural (historic/prehistoric site or object) or paleontological (fossil remains of plants or animals) resource discovered during implementation shall be immediately reported to the BLM Field Office Archaeologist and protected in place. All activities in the area of the discovery shall cease; activities may not resume until permission is obtained from the BLM Field Office Manager. A qualified archaeologist or paleontologist shall make an evaluation of the discovery to determine appropriate actions to prevent the loss of significant cultural or scientifically important values.
- Any vehicles or equipment used on the project would be washed prior to use on the site to minimize risk of introduction of exotic plant species.
- A sign or signs would be posted notifying visitors of the presence of beaver release sites. The sign(s) would include visitor guidelines emphasizing safety and the protection of the beaver and their habitat. Additional interpretive material may be added as applicable to the site.
- Work would be conducted between October 1 and March 15 to avoid disturbing nesting willow flycatcher and yellow-billed cuckoo and other migratory birds.
- Biologists would scan the area to locate any amphibian egg masses deposited in the work area and flag their location(s). Work crews would be required to work away from flagged areas.
- Biologists would survey the proposed area for BDA construction for the presence of Northern Mexican gartersnakes prior to any construction activities. If snakes are detected the location of the BDA would be moved.
- Materials used for BDA construction will not be taken from within the wetted portions of the creek to protect aquatic microhabitat used by reptiles, amphibians, fishes, invertebrate, and plant species.
- Biologist will locate locations of Huachuca water umbel and flag locations to avoid any disturbance. Work crews would be required to work away from flagged areas.

2.1.6 Mitigation: Installing Pond Leveling Devices

Should a beaver pond interfere with the ecological needs of a federally listed species (e.g., winter thermal conditions for leopard frogs), then pond leveling devices (also called flow devices) could be installed in a beaver dam(s) to allow for drainage of the beaver pond to the desired level. The pond levelers are installed in areas where the benefits of beavers are apparent, and removal may not be effective due to likelihood of recolonization, or where decreased pond size is desired for any reason. This approach is a more feasible solution to managing pond size as compared to the removal of beaver dams.

A pond leveling device consists of a pipe that goes through the dam and a cage around the inlet of the pipe to prevent the beaver from blocking the pipe with debris. Pond levelers would be constructed off-site and transported by foot to site location. The pipe used would be a flexible drainage pipe with a diameter of at least 12 in to ensure adequate drainage. The cage would be constructed using galvanized cattle panel fencing with 4 in x 6 in mesh. Each cylindrical cage has a top and a bottom to ensure that beavers cannot get into the cage to plug the pipe. This mesh should be large enough for fish and other aquatic species to safely pass through.

The leveler would be placed strategically in an area of the dam to achieve desired results. The dam would be notched using hand tools (i.e. rakes, Pulaski, axe) to a height meeting the new depth requirements. The dam would be notched to the height of the desired pond level. It is important to notch the dam gradually. Releasing too much water rapidly can cause problems downstream, create high sediment loads and impact fish in the system. The pipe would be placed in the

notch with the cage at least 10 feet upstream of the dam. The cage and pipe would be secured beneath the water surface with crossed t-posts. The t-posts would be installed using a manual post pounder. Cinder blocks may be used to weigh down the pipe if necessary. The pond levelers would require maintenance and need to be checked periodically for any blockage.

2.2 Alternative B: No Action

Under this alternative, beaver would not be released onto the LCNCA and/or BDAs would not be placed in Cienega creek.

2.3 Alternative C: Beaver re-establishment into LCNCA exclusion of BDAs

See above for methods of Beaver re-establishment, excluding BDA installation.

2.4 Alternatives Considered but Eliminated from Detailed Study

Suggested Alternative(s) that were considered but eliminated were:

1) Thinning of riparian trees using chainsaws to reduce canopy cover. This alternative does not completely achieve the purpose and need and would require constant maintenance which is not economically feasible.

2) Burning small sections of the riparian area to reduce canopy cover. This alternative comes with many issues such as effects of ash on water quality and therefore all aquatic species and would also require constant maintenance which is not economically feasible.

3) Stream restoration to increase ponding. This alternative does not meet the stated purpose and need. However, stream restoration projects can enhance habitats.

4) Beaver dam analogues with the exclusion of beaver to mimic beaver natural pond formation. Trees would have to be manually felled and the area would require constant maintenance in order meet the purpose and need. This alternative is not likely to be economically feasible.

All of these alternatives would not meet the purpose or need for the project which is to respond to a proposal by Arizona Game and Fish Department (AGFD) to re-establish beaver, an extirpated species, on Cienega creek and 2) implement the Las Cienegas RMP/ROD, which directs such re-establishment actions to occur. The proposed re-establishment would contribute toward population restoration efforts in southern Arizona and range-wide conservation of this keystone species which would improve stream, spring, and wetland resiliency to the ongoing and increasing effects of ground water extraction and climate change. Beaver have the ability to naturally create and maintain a mosaic of habitat conditions.

3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact groundwater levels and streamflow?

3.1.1 Affected Environment

The Upper Cienega creek basin is in the southern extent of the basin and range physiographic province, which is comprised of generally north-south trending mountain ranges. Studies indicate that this mountain front recharge is the predominate source of inflow to the aquifer (Tucci 2018; Gray 2018; Eastoe and Wright 2019). Cienega creek is the main drainage feature through the valley. Water presence and absence in Cienega creek is monitored with wet/dry surveys performed annually in June one of the driest parts of the year, with 1.16 miles of perennial flow in Empire Gulch. The percentage of wet reaches has declined by around 14% since monitoring of wet/dry began in 2006 (Allen et al. 2019). Wet-dry data collected since 2006 have shown a decrease in the miles of wetted stream channel since 1990 (Figure 5). As the creek dries, the flow becomes increasingly interrupted in areas resulting in dewatered segments or a series of unconnected pools. The steady decline of surface water presence in Cienega creek during the past two decades has resulted in 40% (on average) or 4 miles of creek becoming ephemeral or intermittent. The availability of surface water base flow depends on the amount of water available in the aquifer.

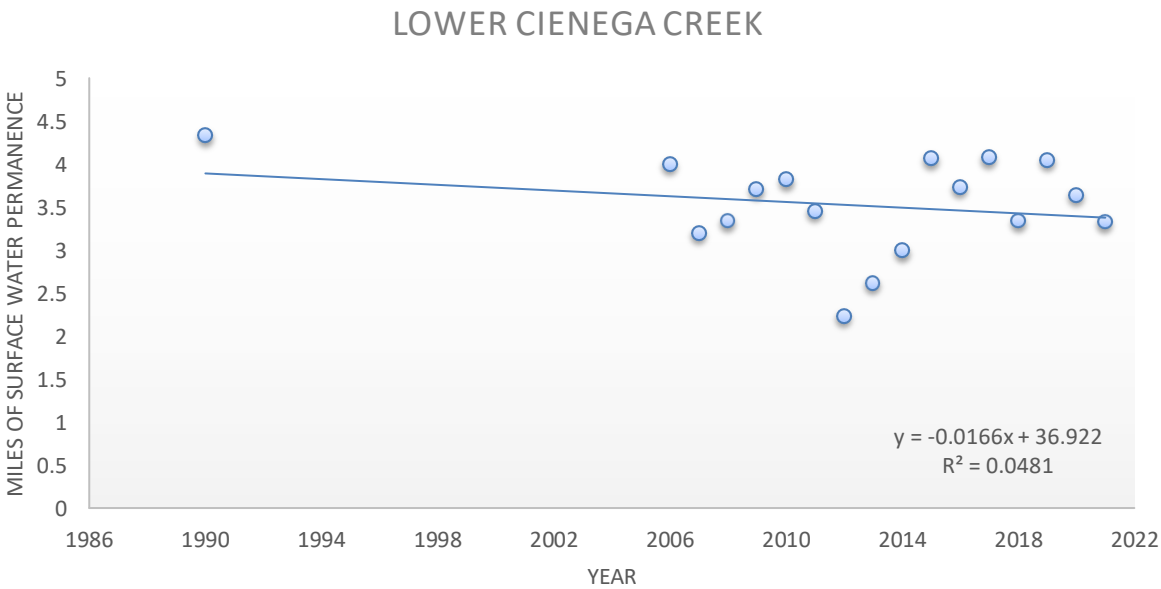

Figure 5. Wet-dry data collected along lower Cienega creek from 2006 to 2021 (data from 1990 is baseline). The data depicts surface water presence in the creek in the summer, typically the hottest time of the year (June).

In the 1980s and early 1990s Cienega creek had perennial flow for 8.3 miles, while its tributaries, Mattie Canyon and Empire Gulch, had perennial flow for 1.1 and 0.9 miles, respectively, for a total of 10.3 miles. Climate change and unregulated groundwater pumping have contributed to decreased surface water presence in Cienega creek. Reduced precipitation and extended drought are anticipated to put heavy pressure on these important wetland and riparian habitats which would likely impact border region biodiversity (Garfin et al. 2013; Udall and Overpeck 2017; Crimmins 2019). Additionally, climate models predict continued temperature increases with longer and hotter summer heat waves (Kunkel et al. 2013; Garfin et al. 2013). Areas in the creek with already minimal summer flows in the 1990s now experience no

flow in the summer. In 2001, a stream gaging station was installed at the site of an old masonry dam on Cienega creek just above the confluence with Wood Canyon. The gage records flow (discharge) in Cienega creek in bedrock substrate in cfs. The 7-day average low flow for the summer season 2002-2019 was computed and depicted in the Figure 6. In 2010, the stream gage computed a streamflow of 0 cfs for part of May and most of June. The gage height at this time was below the minimum recording depth of the stream gage, which highlights that this zero-reading does not indicate the stream was dry, only that the flow had ceased or was so low that it could not be physically monitored by the gage.

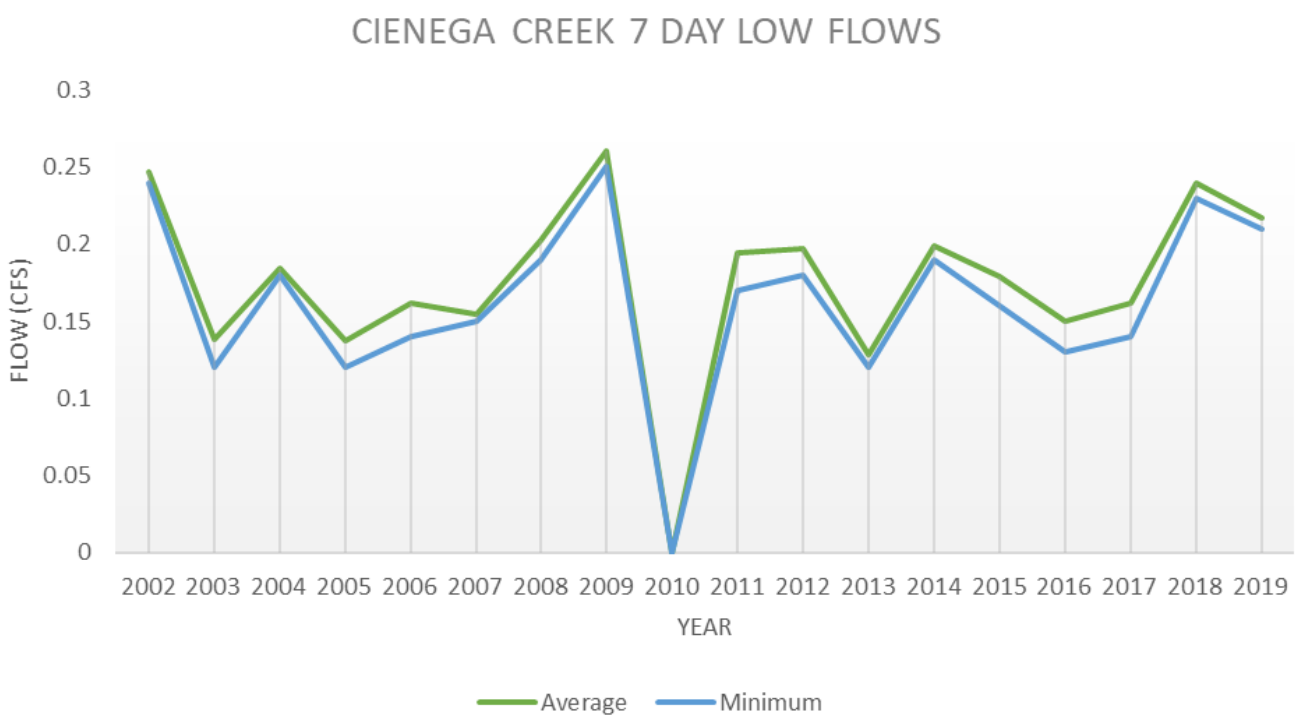

Figure 6. 7-day low flow data for Cienega creek retrieved from USGS gage 09484550 Cienega creek near Sonoita, AZ. Period selected extends from 15 May to end of July. Data available for years 2002-2019. Zero flow in 2010 lasted from May 20- June 19 (31 consecutive days). Note that 0.1 cfs = 45 gpm.

Loss of perennial stream segments were documented in the 1990s. Cienega creek had a loss of surface water from the stream reach delineated by the canal diversion to Spring Water Canyon (0.75 mi.) in the summer of 1997 and a loss of perennial surface water from Apache Canyon to the Narrows (0.5 mi.) in the summer of 1994. Instantaneous discharge measurements have been taken on Cienega creek during the periods of 1975 until 1983 (University of Arizona) and 1988 through 1994 (BLM). At the flow measurement station located near the confluence of Oak Tree Canyon in the reach below Spring Water Canyon, base flows ranged from 0.3 to 0.9 cfs between 1988 and 1992. This reach is now largely dry in the summer prior to the onset of the monsoons. Other reaches dried as well before regular GPS monitoring of summer surface water extent in 2006.

Geomorphically, upper Cienega creek (above the bedrock "narrows") increases in lateral confinement moving downstream. This means that the river's ability to meander and its available floodplain decreases moving north as the creek enters less erodible bedrock. Wet reaches of Cienega creek in the Upper basin are controlled by bedrock outcroppings, in which the less porous bedrock forces the groundwater flowing north to the surface (Roudebush 1996). "The Narrows" is an area where bedrock outcrops on both sides of the Cienega creek channel and divides the lower and upper Cienega creek subareas. As the creek moves from the middle of the basin towards the narrows, the depth to bedrock decreases and the size of the aquifer below the stream also diminishes.

Significant springs in the planning area include Cold Spring, Empire Spring, Apache Spring, Post Canyon, Smitty Spring, Nogales Spring, and Little Nogales Spring. Perennial ponds include Clyne's Pond (Northwest Reservoir) and Cienega Ranch Wetland. There are over 30 acres of wetlands in the project area. The most prominent include: Cienega Ranch

Wetland, Cienguita wetland complex (Egret pond, Crescent Pond, Heart Pond), Spring Water Wetland, and lower Empire Gulch.

Cienega creek is designated as a "Outstanding Arizona Water" and one of the most intact riparian areas in southern Arizona. The proposed mine site in the Santa Rita Mountains is one of the primary drainage areas that recharges the main aquifer that supplies Cienega creek. The development of a mine in the Santa Rita Mountain threatens to deplete groundwater that supports springs, Cienega creek, and wetlands. Historically, copper mines use a large amount of water in the refinement process; one ton of copper from ore requires approximately 380,000 liters of water, more than for any other heavy metal (Lewis and Burraychak 1979).

3.1.2 Impacts from Alternative A (Proposed Action)

Direct and Indirect Impacts

Beaver are known to greatly influence the hydrology of riparian systems and the degree of that influence varies depending on spatial scales. The impact analysis area for these resources is the Cienega creek basin, location where the proposed action will occur and the extent to which the impacts will effect the water resources (Figure 3). At the individual dam scale, there is a higher variability of impacts to stream discharge caused by changes to the active channel (Majerova et al. 2015). At the reach scale, beaver dams and BDA's increase storage in two ways (above and below ground) through the trapping of water in the form of a pond behind the dam and the increased infiltration of surface water into the aquifer (Parker et al. 1985; Hammerson 1994; Baker Hill 2003; Westbrook et al. 2006; Hafen and Macfarlane 2016). Pollock et al. (2003) suggests that of these two ways of storage, the contributions to groundwater is far greater than surface storage behind the dams. Hafen (2017) estimated that groundwater made up two-thirds of the water stored by beaver dams. The amount of water that recharges the near-stream aquifer varies depending on stream reach setting, stream geomorphic confinement, and alluvial aquifer size (Pollock et al. 2003; Brierly and Fryirs 2006).

As noted above, the perennial stream reach of Cienega creek below the USGS gage becomes increasingly confined moving north. At the same time, the stream alluvium that can store water becomes thinner (Roudebush 1996). At this point the stream is considered a gaining reach as it receives discharge contributions from the aquifer. Therefore, it is likely that the capacity for the aquifer to accept increased recharge from beaver dams is consequently reduced. In reaches of Cienega creek where stream confinement is less and aquifer capacity is greater, primarily upstream of the USGS gage, the quantity of potential groundwater storage from the dams is greater. Furthermore, dams can increase floodplain connectivity by aggrading stream channels and increasing channel roughness. This spreads water laterally across floodplains allowing more time for water to infiltrate (Bergstrom 1985; Parker et al. 1985). These upstream reaches in general have a wider available floodplain and thus a greater potential for this effect.

In both cases, streamflow timing will be affected in these reaches of the creek due the pools created by beaver attenuating flood flows and slowing the release of stored water (Parker 1986; Hammerson 1994; Pruss et al. 1999; Neumayer et al. 2020). This will provide more constant flows during low flow periods (i.e., late spring, early summer months) thus maintaining water levels and aquatic habitat for fish and amphibians. Additionally, aquatic habitats are controlled mainly by sediment input and transport which are functions of the volume and pattern of precipitation and runoff. Beaver dams have been shown to reduce stream velocities during floods by spreading water laterally across floodplains allowing more time for water to infiltrate (Bergstrom 1985; Parker et al. 1985). Additionally, studies have shown a shift in reach (750 m in length) discharge from losing to gaining, following beaver colonization (Majerova et al. 2015).

These surface and groundwater storage changes affect the availability of water for plants to use in transpiration and influence the amount of surface evaporation to the atmosphere, together referred to as evapotranspiration (ET). Changes in ET from beaver re-establishment have not been widely researched, although a recent study found an increase in vegetation productivity following beaver dam building compared to a similar riparian area without beaver activity (Fairfax and Small 2018). While the use of riparian trees and vegetation for building of dams may initially reduce the ET demand it is expected that ET will increase as water availability increases, particularly if the riparian area expands laterally (see section 3.3). The extent to which this increase in ET will impact surface water and ground water levels is not entirely clear but is expected to be far less than the increases in storage associated with the dams.

If beaver dams are abandoned and unmaintained, sediment will continue to accumulate and will eventually fill in. Hydrologic impacts from abandoned or inactive dams may persist for several years (Hafen 2017). Field observations of abandoned beaver dams have indicated that even abandoned dams increase channel complexity by creating split channels, islands, or bends downstream of them (Polvi and Wohl 2012). Channel complexity and the reduction of riparian forest density would likely lead to patches of cienega (marsh wetlands) forming over time (see section 3.3). This would create a mosaic of habitats for riparian and aquatic species.

Additionally, BDA's would provide the same overall function of beaver dams therefore the indirect and direct impacts would be similar to those listed above. The installation of BDAs would result in increased turbidity and possible increase in sedimentation limited to the construction time frame.

Cumulative Impacts

In a cumulative impacts analysis, effects are considered for the entire Cienega creek basin, from its headwaters near Sonoita to below the USGS gage at Pantano wash. Forecasts for future climate conditions coupled with groundwater extraction from a current and growing population, and future mining activities (Rosemont Mine), are anticipated to continue to diminish the water table in the basin. Climate change would impact the basin and others in southern Arizona by changing precipitation patterns and thereby reducing mountain front recharge (Meixner et al. 2016) as well as increasing temperatures and the resultant evaporative demand of near-stream vegetation. Modeling of the development of the Rosemont Mine in the Santa Rita Mountains has indicated that the open pit dewatering will likely impact nearby springs and potentially dewater parts of Davidson Canyon and Cienega creek in the long-term (USFS 2011). Past groundwater modeling in the basin has shown the sensitivity of the system to groundwater pumping and continued development of the basin will stress the aquatic and riparian resources that depend on groundwater discharge (Boggs 1980; Bota 1997; Knight 1996). Considering these effects in the long term, sections along Cienega creek that have perennial surface water will shorten and continue to dry within the present century if not mitigated. The long-term effect of all these factors is anticipated to culminate in the drying of Cienega creek and the loss of aquatic wildlife that is reliant on surface water and wildlife that depend on the riparian habitat to survive in an otherwise arid climate. Flow in Cienega creek is highly influenced by unregulated ground water pumping and progressing changes in climate. From the years 1990 to 2009, the basin underwent a 45% increase in the number of wells, totaling 1,886 wells in 2009 (Arizona Department of Water Resources well registration data base). The number of wells are predicted to increase as population increases. As a result, the aquifer in the basin will be further reduced in volume, and discharge from groundwater to Cienega creek will diminish. If the base flows are not sufficient, then creek and wetland habitat will be further reduced and permanently degraded as is the case in the northern-most segment and Agriculture Fields segment of the creek. The fish species that rely on these habitats will experience not only habitat loss, but also stress due to the increase in water temperature and low dissolved oxygen, making them more prone to disease, mortality, and predation. Riparian and wetland plants will experience stress, leading to vegetation reduction and eventual loss, causing an ecosystem collapse in affected stream reaches and cienegas.

The impacts from beaver dams and BDAs may have a countervailing influence on the broad impacts of climate change and development within the watershed described above. Several studies have indicated that this type of restoration has allowed riparian areas to be more resilient to drought (Silverman et al. 2017; Fairfax and Small 2018).

3.1.3 Impacts from the Alternative B

Direct and Indirect Impacts

Under the No Action Alternative, the current conditions of the water table and recharge/discharge and any long-term trends will remain unchanged.

The channel will continue to deepen and erode away in an upstream fashion if groundwater diminishes; these dry conditions will result in the channel becoming further incised from the lack of vegetation and root systems that hold the stream bed and banks. This will further lessen the available floodplain along the creek. When this occurs, floodwaters

reach floodplains less frequently and less floodplain recharge occurs. In a fully functioning unconfined stream ecosystem, most of the flood volume is dispersed across the floodplain which slowly returns to the channel allowing more time for seepage into the ground (e.g. flood attenuation). Currently, the creek receives most of its recharge water from the Santa Rita mountain range with little contribution from floodplain recharge, potentially due to extent of channel incision in certain reaches. If drying of the surface water and concomitant incision of the bed and banks continues at the current rate, it will contribute to further depletion of the aquifer in the basin through lowering of the water table. The lower groundwater elevations will cause the loss of additional riparian vegetation, perennial surface flow, and aquatic habitat.

Cumulative Impacts

Under the No Action Alternative, a long-term effect will be drying of surface water in LCNCA and eventually depletion of the aquifer. This would be mainly attributed to overuse of water resources in the watershed (i.e. population growth, mining, commercial developments) coupled with current and future climate change.

3.1.4 Impacts from Alternative C

Direct and Indirect Impacts

Please refer to direct and indirect impacts from alternative A excluding BDA impacts.

Cumulative Impacts

Please refer to cumulative impacts under alternative A excluding BDA impacts.

3.2 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact water quality?

3.2.1 Affected Environment

Arizona Department of Environmental Quality designated Cienega creek and its tributaries in the Upper Cienega creek for the following uses: aquatic and wildlife (warm water fisheries), full body contact (swimming), and livestock use. Fecal coliform, fecal strep, ammonia, and sulfides have been detected in the upper basin and occasionally exceeded state water quality standards over the monitoring period of 1992 to 1993. The source of fecal contamination was found to be animal (likely cows and other animals). All other water quality parameters have been within acceptable limits.

3.2.2 Impacts from Alternative A (Proposed Action)

Direct and Indirect Impacts

Beaver will create dams that will turn lotic areas into lentic areas and slow the flow of water that will create pools with cascades or riffles occurring below the dams; these features allow for aeration of water, which improves water quality (dissolved oxygen for fish and other aquatic animals). The dams created by beaver filtrate sediment and organic and inorganic particles, reduce turbidity downstream, increase the amount of organic carbon and nitrogen available, and reduce stream acidity (Hammerson 1994; Albert and Trimble 2000; Baker and Hill 2003). These processes improve overall water quality. Additionally, beaver ponds can increase dissolved oxygen concentrations (Smith et al. 1991) which would be beneficial to the three native fish species that occur in Cienega creek.

In some circumstances, however, beaver ponds can decrease water velocity and create anaerobic conditions as the demand for oxygen increases due to the increase in organic matter (Hammerson 1994; Baker Hill 2003; Burchsted et al. 2010).

However, in the event this occurs, it is anticipated that effects would be relatively small or localized and there will still be areas within the creek with a higher water velocity and sufficient dissolved oxygen levels for aquatic wildlife species.

Some studies have found that stream temperatures downstream of beaver dams exhibit a slight increase (Margolis et al. 2001; Andersen et al. 2011). However, contradictory studies demonstrate that there is no consistent relationship between size and number of beaver impoundments and the degree of downstream warming and large ponds may act as thermal buffers that dampen daily fluctuations in water temperatures and only moderately raised downstream temperatures (McRae and Edwards 1994; Talabere 2002). Furthermore, studies suggest that any increase in radiant heating of surface water may be offset by the buffering effect of increased surface water storage or cool water discharge back to stream (Weber et al. 2017).

Additionally, BDA's would provide the same overall function of beaver dams therefore the indirect and direct impacts would be similar to those listed above. The installation of BDAs would result in increased turbidity and possible increase in sedimentation for limited to construction time frame.

Cumulative Impacts

The proposed action could improve water quality within portions of Cienega creek with beaver activity. Nevertheless, continued development of private and Arizona State Land Department (ASLD) lands on the rapidly growing southeast side of Tucson, as well as growth in outlying areas paired with climate change will decrease the quality of water in the long-term. As the stream begins to dry, the quality of water will decrease due to lack of flow. If not mitigated, surface water will eventually be depleted.

The proposed mine site in the Santa Rita Mountains is one of the primary drainage areas that recharge the main aquifer for Davidson Canyon, Empire Gulch, and Cienega creek. Development of a mine in the watershed would likely affect the long-term ground and surface water quality in LCNCA.

3.2.3 Impacts from Alternative B (No Action)

Direct and Indirect Impacts

Under the no-action, the current water quality conditions and long-term trends will remain unchanged.

Cumulative Impacts

Please refer to cumulative of alternative A. Unmitigated by beaver activity, these cumulative impacts would likely lead to severe changes to wetlands, riparian zones, floodplains, and stream channels. See section 3.1.2 Cumulative effects under Effects of the proposed action on groundwater levels and surface flows.

3.2.4 Impacts from Alternative C

Direct and Indirect Impacts

Please refer to direct and indirect impacts under alternative A excluding BDA impacts.

Cumulative Impacts

Please refer to cumulative impacts under alternative A excluding BDA impacts.

3.3 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact wetlands, riparian zones (vegetation), floodplains, and stream channels?

3.3.1 Affected Environment

The riparian vegetation benefits from high water tables and extra water from flooding events. Soils are generally deep and sandy. The stream banks are dominated by deergrass *Muhlenbergia rigens* and the surrounding potential plant community is a southwestern deciduous riparian woodland dominated by Freemont cottonwood *Populus Fremontii* and Goodding willow *Salix gooddingii*. Tree canopy can be as high as 70%. Other woody vegetation present include Velvet ash *Fraxinus pensylvanica*, Arizona walnut *Juglans major*, Netleaf hackberry *Celtis reticulata* and Seep willow *Baccharis glutinosa* a common shrub in the understory.

The proposed re-establishment sites are all within the lower Cienega creek riparian corridor. Much of this reach is characterized by a narrow floodplain located between cut streambanks that range from approximately one to five meters high (Bodner and Simms 2008). Riparian vegetation is dominated by cottonwood-willow forest flanked by mesquite bosque and semi-desert grasslands in upland areas. Other prevalent woody species along the lower riparian corridor include velvet ash, mesquite, netleaf hackberry, and Arizona walnut. Most riparian herbaceous vegetation is native, with Bermuda grass *Cynodon dactylon* and Johnson grass *Sorghum halepense* in some sites. Wetland obligates like rushes and horsetail *Equisetum* sp. dominate banks in areas with perennial water. Deergrass is common in the lower perennial reaches, growing up banks in many areas and in the channel (Bodner and Simms 2008; Stingelin and Ingraldi 2009). Wetland and riparian plants influence the formation of aquatic macrohabitats such as pools, runs, and riffles. These plants also contribute to habitat quality by providing undercut bank, overhanging cover, shade, and escape cover in spaces between plant stems. Pools tend to be permanent only where protected from excess sediment from ephemeral tributaries.

Gradual drying of Cienega creek over the past 20 years has caused the loss of riparian plants including cottonwood-willow gallery allowing large head cuts to develop along the creek. The data obtained from the USGS gage in Cienega creek illustrate the potential beaver dams have to capture flood flows which offer an opportunity for additional recharge (Figure 7). Beaver would hasten the aggradation process, reconnecting the stream to these historic floodplains that only occasionally get overbank flooding from the largest storm events by capturing flood flows in Cienega creek. Currently, the creek receives most of its recharge water from the Santa Rita mountain range with little contribution from floodplain recharge very likely due to extent of channel incision. If drying of the surface water and concomitant incision of the bed and banks continues at the current rate, it will contribute to further depletion of the aquifer in the basin through lowering of the water table. The lower groundwater elevations will cause the loss of additional riparian vegetation, perennial surface flow, and aquatic habitat. This process is taking place currently on Cienega creek in some reaches. Stream segments at or near ecological potential are at risk of being lost and summertime flows reduced; this will result in a loss of not only aquatic habitat but also water quality.

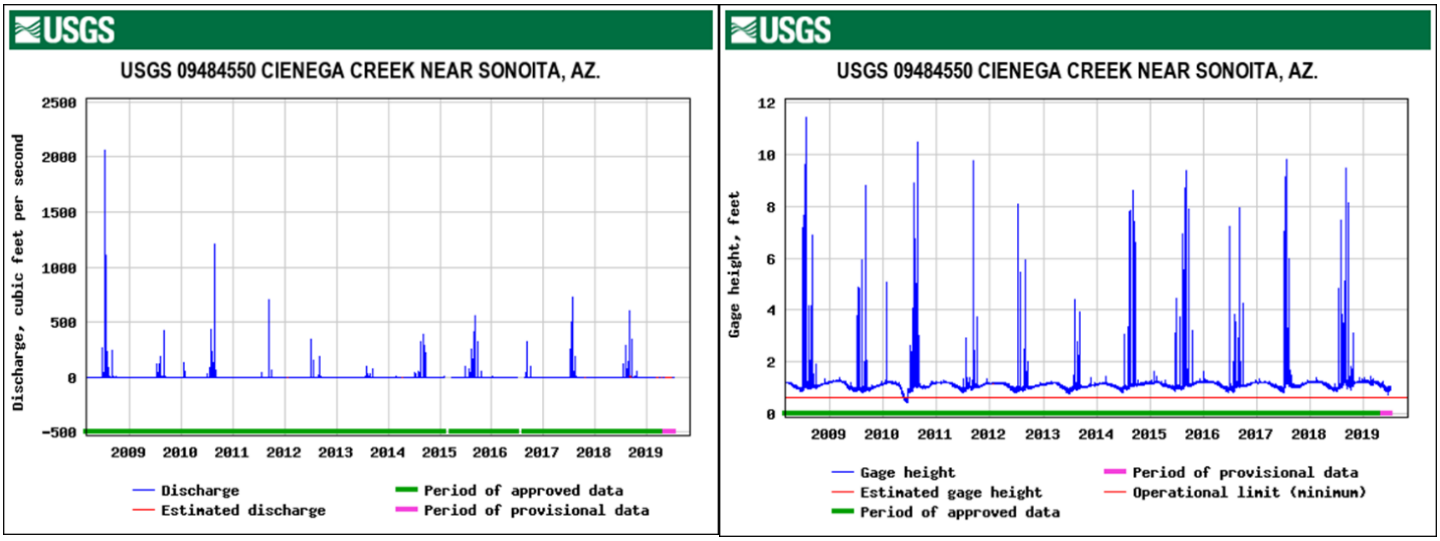

Figure 7. United States Geological Survey (USGS) data on monthly (a) discharge (cfs) peak flood flows and (b) stream gage height (ft.) along Cienega creek, Site Number 09484550 (USGS Water Data for USA 2019).

Extensive sacaton grasslands occupy the stream terraces along Cienega creek south of its confluence with Mattie Canyon. North of the Mattie Canyon confluence, mesquite bosques grow next to the cottonwood-willow dominated riparian woodlands. Several natural, perennial wetland ponds (cienegas) with herbaceous vegetation are also found in the sacaton grasslands on the Cienega creek floodplain.

Riparian areas and associated stream channels constantly undergo change. The riparian area and associated aquatic habitat are exposed to natural external factors, mainly stream flow and sediment transport (Rosgen 1996). Properly functioning riparian areas change gradually and have adequate vegetation, floodplain development, or woody debris to dissipate flood energies.

3.3.2 Impacts from Alternative A (Proposed Action)

Direct and Indirect Impacts

In southern Arizona, preferred beaver habitat is a riparian community with abundant stands of cottonwood and/or willow trees and good reproduction. Beaver have a substantial impact on the structure and productivity of the riparian zone, primarily by cutting trees and shrubs (Jenkins 1980) which reduces vegetation height, alters species biomass and growth form, and increases the amount of light reaching the stream channel and forest floor (Naiman et al. 1988; Parker et al. 2007). Although the benefits of reestablishing beaver in LCNCA are many, concerns exist regarding change in vegetation structure and composition resulting from beaver herbivory. Concerns include the recruitment and replacement of riparian vegetation balance between marsh development and maintenance of deciduous riparian trees within the relatively narrow stream corridor of Cienega and Mattie creeks. When installing BDAs, a short-term effect to the ecosystem would be the loss of a single tree next to a BDA construction site (If other materials are not available). The loss of a single tree creates an opening for young trees and other plants to occupy. There would be increased turbidity and possible increase in sedimentation from the use of equipment at installation sites.

Recruitment of cottonwood and willow may increase which would be opposite of the current trends in the decline and cessation of recruitment in some areas identified by BLM (Bodner and Simms 2008). Beaver dams are known to trap organic material and create carbon sinks resulting in succession of deeply rooted vegetation types such as willows and cottonwoods (U.S. Forest Service 2011). Opening the canopy would allow light to reach areas where seedlings germinate, allowing them to prosper. Because willow readily resprout and grow rapidly, they are tolerant of beaver foraging. Beaver herbivory on willow results in a mutualistic interaction in which beaver cutting stimulates willow growth patterns beneficial to beavers and other browsers, at least in the absence of intense browsing by ungulates (Baker and Hill 2003; Baker et al. 2005). Red-willow trees annually cut by beaver were also found to maintain vigor and growth characteristics like trees with no history of beaver use (Kindschy 1985). Damming activity by beaver and subsequent water table elevation will likely favor growth and spread of Goodding willow along Cienega creek. Goodding willow requires permanently available shallow groundwater (Lite and Stromberg 2005).

Narrowleaf cottonwood *Populus angustifolia* in Utah resprout prolifically after beaver herbivory. This resprout foliage differs in architecture relative to unbrowsed trees and is ontogenetically juvenile (i.e., plants that are not yet reproductive) (Bailey and Whitham 2006). Selective foraging by beaver was also responsible for observed differences in cottonwood *Populus fremontii* growth form along the San Juan River, Utah. Plants near the river's edge exhibited a shrub-like growth form, whereas trees away from the river assumed an upright growth form. Beaver foraging did not kill or reduce the vigor of trees that were most heavily pruned but resulted in the production of dense hedges with delayed reproductive maturity (McGinley and Whitham 1985).

Changes in riparian vegetation have been documented within the San Pedro River NCA following re-establishment of beaver in 2002. Fredlake (2004) compared baseline vegetation data collected pre-release of beaver in 1996 to data collected post-release in 2004 from eight sites selected at random along the river. Canopy cover and tree density (number of trees per hectare) of the three most common species (Fremont cottonwood, Goodding willow, and seep willow) decreased significantly between 1996 and 2004 at the majority of sites. Declines in cover and density were attributable to wildfire, particularly a high-intensity wildfire in 2003 which impacted several of the monitoring sites. Other sites not

substantially impacted by wildfire or beaver herbivory also experienced declines from 1996 to 2004, suggesting that other factors such as groundwater withdrawal, natural fluctuations in precipitation and/or stream flow, competition, or disease were responsible. Declines in canopy cover and tree density were also documented at one active beaver site that was not impacted by wildfire, however, results were not significantly different when compared to sites where beaver activity was low.

Reduction in the overstory canopy by beaver activity may also facilitate shifts in species composition from slower-growing shade tolerant species (e.g., ash) which currently dominate many reaches to early successional species which favor disturbance (e.g., cottonwood). Dense stands of young cottonwood and willow will likely be thinned by beaver activity, helping to transform these wooded swamps into more open areas with herbaceous vegetation characteristic of cienegas. Radke (2010) evaluated effects of beaver herbivory on riparian vegetation within the San Pedro River NCA approximately 10 years post-re-establishment (2000-2010). Active beaver caches (n=6) were monitored to document preferential selection of plants by beaver. Cache size ranged from 0.06 – 0.81 ha (mean = 0.34) and contained 11 to 134 trees (mean = 40.7). Fremont cottonwood was the most common plant with beaver herbivory in four of the caches and was present in all six caches. For two caches, Goodding willow was the most common plant with beaver herbivory. Results showed the mean diameter at breast height (DBH) of standing Fremont cottonwood and Goodding willow was significantly larger than the DBH of downed trees for both species, indicating a preference by beaver for smaller-sized trees. In addition, Fremont cottonwood, once felled, had a higher rate of limb and bark removal by beaver than Goodding willow perhaps indicating a taste preference or suitability for dam building. Like other studies, vegetation close to water was selected by beaver more often than vegetation further from water. No significant differences in foliage density of Fremont cottonwood and Goodding willow were found between control and beaver sites, indicating high variability in tree densities along the river corridor.

Consumption of grasses and forbs by beaver varies with latitude and elevation. Beaver are generalized herbivores; however, they show strong preferences for particular size classes of woody plants (1 to 6 inches DBH) and plant species such as aspen *Populus tremuloides*, willow, cottonwood, and alder *Alnus spp.* (Denney 1952; Jenkins 1975; Collins 1976; Jenkins 1979). The leaves, twigs, and bark of woody plants are eaten, as well as many species of aquatic and terrestrial herbaceous vegetation such as forbs, grasses, and the rhizomes and roots of aquatic vegetation (Allen 1983). Beaver are central place foragers, gathering food and carrying it to a central location in the territory to be consumed (McGinley and Whitham 1985). Most trees are cut within 100m of the water's edge (Allen 1983); however, foraging distances of up to 200m have been reported (Bradt 1938). In southern latitudes where streams are unaffected by ice and growing seasons are extended beaver consume a high percentage of herbaceous vegetation, as much as 84% in summer (Novak 1987). Most riparian areas within LCNCA has been rested from livestock grazing since 1995. Bodner and Simms (2008) noted abundant herbaceous vegetation, especially grasses, rushes, and Equisetum along Cienega creek. As trees are felled by beaver and sunlight reaching the forest floor increases, it is expected that herbaceous material will increase along the riparian corridor (Bodner and Simms 2008). In the absence of livestock competition for food, the overall impact on the riparian forest will be modest as beaver will likely consume a balance of herbaceous plants and woody vegetation; of course, wood will still be required for dam building and maintenance. Some areas that develop permanently saturated soils behind dams would likely support a variety of herbaceous wetland obligates, but only support wetland trees like Gooding willow and, perhaps, velvet ash. When beaver abandon dam sites, sediment will accumulate and these areas will very likely fill in with wetland vegetation (Baker and Hill 2003), leading to the formation of marshes which are a defining characteristic of cienega wetlands.

Though local reduction of trees around active beaver colonies is likely; it is unlikely that beaver will significantly reduce cottonwood and willow along the riparian corridor for the following reasons:

1. Studies along the San Pedro River in southern Arizona indicated that observed changes in riparian vegetation (canopy cover, tree density, foliage density) following beaver re-establishment were more attributable to other factors (e.g., wildfire) than beaver herbivory.

2. Studies of cottonwood and willow in other areas showed that trees are very tolerant of beaver foraging. Herbivory did not kill or reduce tree vigor but resulted in vigorous basal sprouting and the production of shrub-like growth forms.

3. The growth rate for young cottonwood is high, approaching one inch in diameter per year (as measured by BLM forester, Bill Torgersen in BLM 1995).

4. Maximum daily growth of willow shoots following simulated beaver cutting averaged 4.1cm (Kindschy 1989).

5. Competition with livestock has been eliminated within the riparian corridor of the LCNCA.

6. A variety of herbaceous plants provides alternatives to woody vegetation in the beaver's diet.

The re-establishment of beaver into Cienega creek is anticipated to have several other beneficial effects on the riparian ecosystem, floodplain, and stream channel. Sediment deposition behind beaver dams increases the volume of riparian soils and potential for channel aggradation and water storage in the riparian zone (Smith 1983), therefore, beaver can contribute to the overall stabilization of streams systems (Minkley 1991). Streams in Oregon with beaver were associated with increased channel sinuosity, diverse wetland habitats, and pool-riffle complexes resulting from sediment deposition within ponds (Demmer and Beschta 2008). Beaver dams also increase the wetted surface area of stream channels and floodplains providing colonization sites for vegetation and promoting expansion of the riparian forest away from the main channel (DeVaries et al. 2012). Through the process of dam building and subsequent water table elevation, sediment deposition, and riparian plant colonization, beaver re-establishment could promote cienega development, a community type that was once common along many miles of Cienega creek (Hendrickson and Minckley 1984). This could benefit many wildlife species dependent on this habitat, including several federally listed aquatic and wetland species whose current distribution is within LCNCA.

Additionally, BDA's would provide the same overall function of beaver dams therefore the indirect and direct impacts would be similar to those listed above. The installation of BDAs would result in increased turbidity and possible increase in sedimentation for limited to construction time frame.

Cumulative Impacts

The proposed action in combination with the other actions planned in the Las Cienegas RMP should benefit wetland and riparian resources through maintenance and improvement of groundwater and surface water resources and increased diversity of aquatic, wetland, and riparian habitat. However, continued development of private and ASLD lands in the upper watershed poses a major threat to wetland and riparian areas, as well as the floodplain, in the Cienega watershed and surrounding areas. Of particular concern, are impacts to groundwater and surface water that support these wetland and riparian plant communities which in turn support processes that sustain floodplains, and stream channels in a state of dynamic equilibrium (Rosgen 1996) (See 3.1.2 Cumulative effects under Effects of the proposed action on groundwater levels and streamflow).The ongoing Sonoran Desert Conservation Plan should help minimize some of the threats to riparian areas and floodplain from development in Pima County.

3.3.3 Impacts from Alternative B (No Action)

Direct and Indirect Impacts

Under the No Action Alternative, no impacts to wetlands, riparian zones, floodplains, and stream channels will occur.

Cumulative Impacts

Please refer to cumulative of alternative A. Unmitigated by beaver activity, these cumulative impacts would likely lead to severe changes to wetlands, riparian zones, floodplains, and stream channels. See section 3.1.2 Cumulative effects under Effects of the proposed action on groundwater levels and surface flows.

3.3.4 Impacts from Alternative C

Direct and Indirect Impacts

Please refer to direct and indirect impacts under alternative A excluding BDA impacts.

Cumulative Impacts

Please refer to cumulative impacts under alternative A excluding BDA impacts.

3.4 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact aquatic microhabitats?

3.4.1 Affected Environment

The portion of Cienega creek above Gardner Canyon is relatively isolated from large sediment loads and large floods. Thermal conditions along this reach are moderated by incoming groundwater adding to the surface flow (gaining reach). Thermal conditions are more variable along most of the creek except for the head waters and the confluence with Mattie Canyon where incoming ground water moderates temperature fluctuations. A habitat inventory was conducted in 1989 and 1990 which resulted in the classification of 1016 macrohabitats divided into 9 categories: marsh (49.9%), pool (21.1%), glide (13%), riffle (11.6%), run (2.3%), rapid (1%), cascade (<1%), fall (<1%), and chute (<1%). Pool habitats are normally surrounded by shallow marsh and have a high degree of cover including emergent vegetation, submergent vegetation, exposed roots from deer grass and trees, undercut bank, and medium and small woody debris. From 1988 until 1990 floating vegetation (filamentous algae mats) were a common cover type. Changes in riparian vegetation density has resulted in the increase in aquatic macrophytes and a decrease in algae biomass. Although the soils along Cienega creek are highly erodible, increases in deer grass, willow, cottonwood, rushes, horsetail, and other plants have stabilized the banks to the point that even large floods do not affect most bank surfaces. Grazing activities on the creek are limited to winter grazing only below Pump Canyon. Above Pump Canyon grazing is limited to a few watering gaps and crossing lanes that are rotated to minimize any impacts.

Mattie Canyon supports typical pool-riffle habitat types and has recently begun to develop marsh habitat near the headspring. Empire Gulch supports an extensive marsh habitat with a few large, deep pools and scattered cottonwood and willow trees.

Riffles and runs contain armored sediments that are further stabilized by vegetation, especially plant roots, which cover the floodplain and cross runs and riffles. "Nick points" that turn into pools eventually stabilize when they reach bed materials or vegetation thick enough to prevent further erosion. As a result of these processes, Cienega creek contains "slit pools" or "trench pools" over 6 feet deep as well as runs and riffles that average less than 6 inches deep. These pools, runs, and riffles are often surrounded by saturated soil or thin sheets of standing water with thick mats of marshland vegetation and Goodding willow. Further away from marshy conditions, Fremont cottonwood and velvet ash commonly dominate the riparian forest along stream banks.

There are currently three native fish species that occupy Cienega creek and Mattie Canyon: Gila Topminnow (endangered), Gila chub (endangered), and longfin dace (BLM sensitive species). Fish surveys on the creek have been conducted since 1990 and no nonnative fish or crayfish have been detected within Cienega creek or its tributaries within LCNCA.

Also see affected environment under wetland and riparian zones.

3.4.2 Impacts from Alternative A (Proposed Action)

Direct and Indirect Impacts

Stream macrohabitats are likely to benefit from the inclusion of beaver into Cienega creek and its tributaries. In areas where beaver reside, aquatic microhabitats will be drastically different then pre-beaver habitat conditions. Beavers create heterogeneity within the riparian habitat by creating patches of lentic habitat (ponds) within a corridor of lotic habitat (C. Gibson and R. Gibson 2000). Habitat heterogeneity created by beaver dams has been shown to increase species richness and diversity (Wright et al. 2002; Demmer and Bescheta 2008; Billman et al. 2012). The damming activities of beaver create more open water habitat for obligate riparian species and fish. Additionally, the opened canopy will allow more light to reach the water surface to aid in the breakdown of detritus and leaf litter to increase primary productivity in the stream and riparian area.

In the beaver created ponds macroinvertebrates showed a shift from invertebrate taxa that prefer running water to pond taxa (Baker and Hill 2003). The shift favors collectors and predators and, to a lesser extent, scrapers and shredders (Naiman et al. 1988; Hammerson 1994). The aquatic species in LCNCA are not anticipated to be adversely affected by the shift in macroinvertebrate populations.

If beaver abandons a site, sediment will accumulate and the area will fill with aquatic vegetation (Baker and Hill 2003); however, the channel will shift creating new aquatic habitats and new beaver dams would likely occur elsewhere in the system.

As illustrated above, beaver establishment in Cienega creek can create habitat heterogeneity throughout the creek. However, the extent of heterogeneity would depend on the number and location of dams built. Beaver activity creates undercut banks, open water, and more vegetation along the littoral zone where there is an increase in algal and plankton productivity. Like beaver dams, BDAs improve habitat by connecting the stream to the former floodplain, creating important fish-rearing habitat (Pollock et al. 2013; Charnley 2018). BDAs should have similar outcomes as naturally occurring beaver dams. The cover proved by the vegetation would be beneficial for sub-adult and adult fish, as well as leopard frogs. In addition pockets along the shoreline of ponds would create warm, shallow conditions optimal for fry grow out and young of year fish. Beaver dams increase availability of pool habitat and increase the depth of existing pools that would be favorable for existing fish species in Cienega creek, such as Gila topminnow and Gila chub (Stingelin and Ingraldi 2009). Additionally, data from recent fish surveys performed at Bonita Creek at occupied and unoccupied beaver sites suggest that native fish are found in higher abundances than non-native fish, particularly Gila chub (Hiedi Blasius personal communication).

Habitat suitability along Cienega creek for Gila topminnow has decreased as canopy cover has increased. The shaded habitat creates excess detritus that lowers dissolved oxygen levels in the creek. Gila topminnow are very flexible in selecting habitat but tend to avoid areas with even modest currents and often crowd shallow shoreline habitat exposed to direct sunlight. The increased canopy cover has also caused a decrease in habitat suitability for Gila chub. The low oxygen levels have created areas in the upper creek that are anoxic and unable to support Gila chub (BLM monitoring files). Schultz and Bonar (2006) determined that Gila chub show a definite preference for pool habitat. Beaver activity is anticipated to modify channel hydraulics, improve sediment storage and flood recharge, diversify riparian and aquatic habitats, change and reduce canopy cover, in such a way as to increase stream extent, permanence, habitat suitability for topminnow and chub.

Gibson et al. 2015 found that beaver ponds create the ideal habitat for non-native sunfishes and bullfrogs by altering the flow and changing habitats from lotic to lentic; however, this study was conducted in an already non-native dominated system. This may be a concern in other aquatic systems where non-native fish and amphibian currently exist; however, in Cienega creek there currently are no non-native fish species that occupy any area of the stream. Additionally, Simms and Abarca (2005) found in preliminary studies in the San Pedro River that the presence or absence of a beaver dam does not seem to be a factor in determining fish composition. This is likely due to the presence of ponds created by sediment discharged by dry tributaries that result in damming the channel. Invasive fish that may harm native fish populations are not likely to occur due to that closure of fishing on Cienega creek and tributaries by an AGFD Commission Order, which inhibits surreptitious stocking by fishers whose aim is to create new fishing opportunities.

Installation of BDAs may create minor disturbance to the area. BDA installment requires the use of heavy equipment and hauling of materials to and from sites. Personnel will be in the water when installing BDAs and will cause an increase in turbidity, possible bank disturbance, and possible mortality to aquatic species unable to avoid activity in the area of installation. The installation process will last about one day with impacts to fish that are very localized and short-term. Injury or death is only likely for eggs and larval fish if undetected.

For related impacts see the following sections on Impacts to wetland and riparian zones section 3.3; Impacts to water quality section 3.2; Impacts to neotropical migratory birds, waterfowl, and shorebirds section 3.5; Impacts to threatened and endangered species section 3.6; Impacts to BLM special status species section 3.7.

Cumulative Impacts

Climate change, continued development in surrounding areas, and water withdraws are likely to reduce ground water levels resulting in the reduction or elimination of perennial surface water in the foreseeable future. Because these areas are entirely dependent on available surface water, microhabitats and the fish species that occupy them will become limited or lost. BDAs and beaver activity are anticipated to counter these negative impacts on Cienega creek and Mattie creek. See section 3.1.2 Cumulative effects under Effects of the proposed action on groundwater levels and streamflow.

3.4.3 Impacts from Alternative B (No Action)

Direct and Indirect Impacts

Under the no-action alternative, no impacts to aquatic habitat and fish community will occur from BDA construction or beaver activity.

Cumulative Impacts

Please refer to cumulative impacts of alternative A. Unmitigated by beaver activity, these cumulative impacts would likely lead to a severe loss of habitat aquatic habitats and fish community. See section 3.1.2 Cumulative effects under Effects of the proposed action on groundwater levels and streamflow and section 3.3.2 Cumulative effects under Impacts to wetlands, riparian zones, floodplains, and stream channels.

3.4.4 Impacts from Alternative C

Direct and Indirect Impacts

Please refer to direct and indirect impacts in Alternative A excluding BDA impacts.

Cumulative Impacts

Please refer to cumulative impacts in Alternative A excluding BDA impacts.

3.5 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact neotropical migratory birds, waterfowl, and shorebirds?

3.5.1 Affected Environment

More than 230 bird species have been documented in the planning area, including both resident and migratory bird species and such special status species as the Gray hawk, Osprey, Southwestern willow flycatcher, Yellow-bellied cuckoo, Green kingfisher, and Baird's sparrow. Waterfowl use the ponds and pools along the stream and nesting Virginia rails have been

found in the cienega habitat along its banks. The extensive open grasslands of predominately native grasses provide both breeding and wintering habitat for the rare Grasshopper sparrow and Baird's sparrow.

3.5.2 Impacts from Alternative A (Proposed Action)

Direct and Indirect Impacts

In area along the upper San Pedro River in southeastern Arizona and northern Sonora, Mexico, there was a higher bird abundance and richness of bird groups, such as breeding birds, insectivorous birds, and riparian specialists, and higher relative abundance of many individual species including several avian species of conservation concern where beaver had colonized (Johnson 2014). Additionally, one of the many benefits of beaver in the San Pedro River was a documented increase in avian species richness and density (Johnson 2014).

The process of dam building activities such as harvesting of riparian vegetation creates pond and wetland niches for various types of bird communities. It also opens up the canopy allowing for regrowth of grasses and young trees along the stream edges. The regrowth of understory creates continuous habitat for riparian bird species. Species richness of riparian birds has been demonstrated to be positively correlated with an increase in vegetation along pond width (Bulluck and Rowe 2006; Cooke and Zack 2008). In addition, beaver activities can enhance bird foraging efficiency by creating structurally diverse habitats with a diversity of foraging niches (Medin and Clary 1990).

The presence of beaver in a system can greatly benefit waterfowl and shorebirds by increasing the amount of habitat available through the creation of open water habitat (Nummi 1992; Edwards and Otis 1999; McKinstry et al. 2001). These open areas and associated wetlands serve as important breeding, nesting, and foraging areas for waterfowl and shorebirds. In addition, waterfowl use beaver ponds for brood-rearing habitat and as stopover sites during migration (McCall et al. 1996).

In the short-term, bird habitat may be reduced in the process of tree felling, however in the long-term benefits may out way the negatives. The opening of the canopy will allow for regrowth of younger trees aiding in a more continuous habitat for bird species. Additionally, installation of BDAs might create minor disturbance to the area. BDA installment would require the use of heavy equipment (hydraulic or pneumatic post hole pounder) and hauling of materials to and from sites. This would create noise that may affect the presence of migratory or residence bird species. This however would be a very short-term effect and would also be mitigated for by scheduling restoration efforts when certain bird species are not migrating or present in the area.

Cumulative Impacts

Riparian vegetation relies on ground water and surface water support and is vital habitat for migratory birds, waterfowl, and shorebirds. Climate change coupled with groundwater pumping will eventually deplete the aquifer which will lead to the partial or complete loss of surface water in Cienega and Mattie creeks. This will have large and permanent adverse impacts to wetlands and riparian areas vital for these species. See section 3.1.2 Cumulative effects under Effects of the proposed action on groundwater levels and streamflow; section 3.3.2 Cumulative effects under Impacts to wetlands, riparian zones, floodplains, and stream channels; section 3.4.2 Cumulative effects under Aquatic habitats and fish communities.

3.5.3 Impacts from Alternative B (No Action)

Direct and Indirect Impacts

Under the no action alternative populations of neotropical migratory birds, waterfowl, and shorebirds would remain unaffected.

Cumulative Impacts

Please refer to cumulative of alternative A. Unmitigated by beaver activity, these cumulative impacts would likely lead to a severe loss of habitat severe loss of habitat that support populations of neotropical migratory birds, waterfowl, and shorebirds. See section 3.1 Impacts to groundwater and surface flow; section 3.3 Impacts to wetlands, riparian zones, floodplains, and stream channels; and section 3.5 Impacts on aquatic habitats and fish community.

3.5.4 Impacts of Alternative C

Direct and Indirect Impacts

Please refer to direct and indirect impacts under Alternative A excluding BDA impacts.

Cumulative Impacts

Please refer to cumulative impacts under Alternative A excluding BDA impacts.

3.6 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact threatened and endangered species?

3.6.1 Affected Environment

Information for Planning and Consultation (IPAC) (USFWS) and Arizona Heritage Data Management System (HDMS) (AGFD) identified 14 federally listed species and seven designated critical habitats within 3 miles of the project area (Table 1).

Gila topminnow, Gila chub, Chiricahua leopard frog, and northern Mexican gartersnake occur in perennial stream segments of Cienega creek and Mattie Creek as well as four restored wetlands, six wildlife ponds that subsist on well water, and one small reservoir. Desert pupfish were established in three of the restored wetlands, and five of six wildlife ponds but do not currently occur in Cienega creek or its tributaries Mattie Creek and Empire Gulch. In Cienega creek and Mattie creek Gila topminnow inhabit pools, backwaters, seeps, springs, and wetlands. Gila chub co-occur with topminnow but prefer deep pools with overhanging banks/cover. Chiricahua leopard frog are found in stream channel and off channel pools, wetlands with open water, seeps, springs, wetland ponds, cattle tanks and wildlife ponds. Northern Mexican gartersnakes utilize large portions of riparian, wetland and pond habitat in LCNCA that support its food base of fish and frogs.

The southwestern willow flycatcher migrates through Cienega creek and tributaries but has rarely been observed breeding this can be attributed to the narrow riparian forest lacking in dense patches of willow and cottonwood trees. This has resulted in the use of riparian habitat for migratory individuals rather than for nesting. The yellow-billed cuckoo forages and breeds in humid, cottonwood-willow-mesquite riparian areas along Cienega creek, Mattie Creek, and Empire Gulch.

Huachuca water umbel occupies Cienega creek and tributaries with perennial flow, three wetland ponds, and one wildlife pond. This plant is found in wetland plant communities (marsh), in the understory of riparian forests where saturated or nearly saturated soils occur, and the margins of wildlife ponds. Canelo Hills ladies' tresses do not currently occur in LCNCA but are likely to be reintroduced to aid in species recovery in the future. Jaguar, Ocelot, and the Mexican spotted owl are known to occur in the mountains surrounding the Cienega creek basin, but little is known about their potential use of LCNCA. The California Least Turn and Sonoyta mud turtle have not been observed in or near the project area. Arizona Eryngo does not naturally occur in LCNCA, however, was planted in suitable habitat to aid in recovery of the species. It was planted in five wetlands and Empire Gulch 2019-2021.

The affected environment for federally listed species is the rather complex association of biotic and abiotic elements and processes. In addition to the affected environment described here, it is important to understand the affected environment in other sections: 3.1 Impacts to groundwater and surface flow, 3.2 Impacts to water quality, 3.3 Impacts to wetlands,

riparian zones, floodplains, and stream channels; 3.4 Impacts to neotropical migratory birds, waterfowl, and shorebirds and 3.5 Impacts on aquatic habitats and fish community. More information concerning local habitat conditions can be found in the Biological Opinion for this proposed project in Appendix E.

Table 1. Federally listed or proposed species that occur within the LCNCA. FE = Federally listed as endangered; FT = Federally listed as threatened; CH = designated critical habitat; PE = proposed endangered.

Common Name	**Scientific Name**	**Federal Status**	**Present in Project Area? (Y/N/U)**	**Impacted by Project? (proposed action) (Y/N)**
Gila topminnow	*Poeciliopsis occidentalis*	FE	Yes	Yes
Desert pupfish	*Cyprinodon macularius*	FE	Yes. Isolated ponds	Yes
Gila chub	*Gila intermedia*	FE, CH	Yes	Yes
Chiricahua leopard frog	*Lithobates chiricahuensis*	FT, CH	Yes	Yes
Northern Mexican gartersnake	*Thamnophis eques megalops*	FT, CH	Yes	Yes
Sonoyta mud turtle	*Kinosternon sonoriese longifemorale*	FE, CH	No	No
Mexican spotted owl	*Strix occidentalis lucida*	FT	Unknown	No
California Least Tern	*Sterna antillarum browni*	FE	No	No
Southwestern willow flycatcher	*Empidonax traillii extimus*	FE, CH	Yes	Yes
Yellow-billed cuckoo	*Coccyzus americanus*	FT, CH	Yes	Yes
Jaguar	*Panthera onca*	FE, CH	Unknown	No
Ocelot	*Leopardus pardalis*	FE	Unknown	No
Huachuca water umbel	*Liliaeopsis schaffneriana ssp. recurva*	FE	Yes	Yes
Canelo Hills ladies'-tresses	*Spiranthes delitescens*	FE	No	No
Arizona eryngo	*Eryngium sparganophyllum*	PE	Yes, introduced population	Yes

3.6.2 Impacts from Alternative A (Proposed Action)

Direct and Indirect Impacts

Beaver re-establishment could promote cienega development through the processes of dam building, water table elevation, sediment deposition and riparian plant colonization. Cienegas have a high biodiversity and promote key ecological functions (Hendrickson and Minckley 1984; Cole and Cole 2015) that serve many of the threatened and endangered species discussed in this section. The proposed beaver re-establishment sites and likely population expansion areas are within known occupied habitats of seven listed species: Gila topminnow, Gila chub, Chiricahua leopard frog, Southwestern willow flycatcher, Yellow-billed cuckoo, Northern Mexican gartersnake, and Huachuca water umbel. As well as 6 critical habitat designations for the following listed species: Gila chub, Chiricahua leopard frog, northern Mexican gartersnake, Yellow-billed cuckoo, Southwestern willow flycatcher, and Jaguar. Only minor and short-term adverse impacts to the listed species are anticipated from the proposed action. Many of these impacts are addressed in conservation measures in the proposed action. Some short-term adverse effects to critical habitat for Gila chub, Chiricahua leopard frog, and Northern Mexican gartersnake are anticipated from the proposed action. However, the positive impacts of projected outcome outweighs the possible adverse effects. Improved hydrologic function would benefit all the federally listed species and critical habitat, as surface water and shallow ground water is key to maintaining and potentially expanding the habitat these species depend upon.

Beaver dams flood riparian areas and create additional wetlands, or increase the area of existing wetlands, which is key habitat for species like the Gila topminnow, Desert pupfish, Chiricahua leopard frog, Northern Mexican gartersnake, Huachuca water umbel, Canelo Hill's ladies'-tresses, and Arizona eryngo. Beaver dams are anticipated to increase the amount of habitat available for all seven species and designated critical habitats resulting in a net beneficial effect to each.

Effects to Federally listed species are tied to effects in sections preceding this one (3.1 Impacts to groundwater and surface flow; 3.2 Impacts to water quality; 3.3 Impacts to wetlands, riparian zones, floodplains, and stream channels; 3.4 Impacts to neotropical migratory birds, waterfowl, and shorebirds and 3.5 Impacts on aquatic habitats and fish community).

The re-establishment of beaver and construction of BDAs in Cienega creek would have an overall benefit to native and T/E fishes by increasing aquatic habitat area and diversity (Olson and Hubert 1994), improving water quality, and reducing erosion (Collen and Gibson 2000). Short-term adverse impacts from displacement, destruction of eggs and turbidity could occur when BDAs are constructed. Franks and Valencia (pers. comm. in BLM 1995) noted that beaver dams resulted in increased aquatic habitat diversity in Tonto Creek, AZ. Specifically, it was noted that a beaver dam on Tonto Creek caused the stream to split into two channels, one with swift-flowing riffles and the other with quiet, shaded pools. This increased diversity is expected to occur on Cienega creek as well providing specific niches for fish species. Gila Chub is highly pool orientated and shows preference for habitats with 25-50% cover and could benefit from the deep pools and undercut banks created by beaver activity (Schultz and Bonar 2006). Early reports from surveys on Bonita Creek, Arizona, indicated Gila Chub were a rare species found at sample sites; however, following the reestablishment of beaver into the creek, Gila Chub became the most abundantly collected species at sites (personal communication Heidi Blasius 2019). Debris from dams provide fish cover and foraging areas for predatory fish (Collen and Gibson 2000), which may benefit Gila chub foraging opportunities. Sediment deposition behind beaver dams also increases the volume of riparian soils and potential for channel aggradation and water storage in the riparian zone (Smith 1983). The slow release of stored water will provide more constant flows during lower flow periods (i.e., summer months), thus maintaining water levels and habitat for native fish. Gila topminnow prefer warm water habitat with a slow current and abundant vegetation. This fish would benefit from the habitat alterations made by beaver such as local thinning of the tree canopy that will create more open water habitat and the creation of warm, shallow, still edge-waters associated with the littoral zone of beaver ponds (Minckley and Deacon 1991; Forrest 1992). In addition, Gila topminnow would benefit from warm groundwater inputs in the winter that would provide improved over winter survival and year-round reproduction in more areas of creek occupied by beaver.

Studies have demonstrated that beaver dams do not necessarily alter species diversity of amphibian and aquatic reptiles, however relative abundance of these species is much higher in beaver ponds (Russel et al. 1999; Metts et al. 2001; Dalbeck and Campbell-Palmer 2020). The introduction of beaver into the system is likely to increase areas of groundwater discharge into the creek. Increased recharge would improve winter thermal conditions which prevent the

outbreak of chytridiomycosis in leopard frogs. Recent surveys in Cienega creek revealed that areas within the creek that are influenced by inputs of warmer water (springs and groundwater inputs) throughout the cooler months have lower mortality rates of Chiricauha leopard frogs than areas with no input (Hall 2019). Chiricahua leopard frogs require permanent or near-permanent pools for breeding and water characterized by low levels of contaminants and moderate pH (USFWS 2007). Beaver dams have been shown to act as filters for sediment and organic and inorganic particles, reduce turbidity downstream, and increase the amount of organic carbon and nitrogen available (Hammerson 1994; Albert and Trimble 2000; Baker and Hill 2003); these processes improve overall water quality.

The option to place BDA's in the stream could have detrimental impacts on Chiricahua leopard frog during construction processes through short-term displacement and destruction of egg masses, however following mitigation this would not occur. In the proposed action the procedure for construction of BDA's at sites includes egg mass identification and avoidance in sites selected for BDAs. Another adverse impact to aquatic wildlife could occur from the creation of these same beaver ponds. Bullfrogs and nonnative fish could invade and occupy not only the large pools created by sediment from tributaries but also newly created beaver ponds and wetlands. Bullfrogs are highly predacious and pose a threat to a wide variety of species found in riparian and wetland areas (USFWS 2007, USFWS 2014). The presence of beaver dams and large ponds could make their eradication more difficult. However, bullfrogs presently do not occupy Cienega creek or any wetlands or wildlife ponds in LCNCA because they are actively managed to prevent re-establishment. This mitigation for conservation of aquatic wildlife is planned to continue as long as bullfrogs remain a threat.

The Northern Mexican gartersnake tend to be found in streams, rivers, cienegas, and ponds with dense bank vegetation. Presently, this species occurs along perennial stream segments and marshes within the Cienega creek watershed. Emmons and Nowak 2013 surveyed the upper and middle Verde River in Southern Arizona and found this species most commonly in protected backwaters, braided side channels, beaver ponds, isolated pools near the river mainstem, and edges of dense emergent vegetation that offered cover and foraging opportunities. Additionally, movement of the Northern Mexican gartersnake is guided by seasons. The Mexican gartersnake would benefit from beaver establishment in LCNCA. Through the process of dam building and subsequent increases in groundwater elevation, surface water permanence, sediment deposition, and riparian plant colonization, beaver re-establishment could promote cienega development; a community type that was once common along many miles of Cienega creek (Hendrickson and Minckley 1984; (see Section 3.1 Effects of the proposed action on groundwater levels and streamflow). Cienega development would increase foraging opportunities of an expanded prey base of fish and leopard frogs for the gartersnake.

Currently, no nesting southwestern willow flycatchers have been recorded on LCNCA despite annual surveys. A southwestern willow flycatcher habitat inventory in 2000 identified four LCNCA stream miles as suitable habitat and 9.5 miles as potential habitat. However, much of the potential habitat consisted of relatively even-aged stands of willow that had matured to the point that they lacked sufficient density of understory vegetation. An ecological disturbance is needed to open up these areas to new growth and return the areas to suitable habitat, which is an earlier successional stage (BLM 2002). Willow flycatchers are known to nest in riparian areas and near wetlands and lakes where there is dense growth of willow and other riparian species, often with a scattered overstory such as cottonwood (Tibbitts et al. 1994; Albert and Trimble 2000). Establishment of beaver will promote plant succession in some portions of the stream toward herbaceous wetlands and willow shrub thickets. Kindschy (1985) found that beaver foraging seemed to stimulate stem growth in red willow (Salix sp.) in Oregon. Goodding willow may respond in a similar way. This potential development of willow thickets would improve nesting habitat for the willow flycatcher. Medin and Clary (1990) found willow flycatchers present in beaver pond areas but absent in riparian areas lacking beaver. This is further supported by another study which found that the Southwestern willow flycatcher benefited greatly from the establishment of beaver in aquatic systems (Tibbitts et al. 1994). This species requires dense canopy with open water as a foraging area as they are highly insectivorous (USFWS 2002); through the process of dam making the surface area of open water would increase.

The Yellow-billed cuckoo is an obligate resident of mature cottonwood-willow riparian forests in Arizona. Dense understory foliage appears to be an important factor in nest site selection while mature cottonwood trees are important foraging habitat (AGFD 2011). In arid regions, Yellow-billed Cuckoos primarily utilize river bottoms, ponds, swampy areas, and damp thickets with relatively high humidity. They also inhabit uplands occasionally when migrating and foraging. Upland foraging and migration habitat will not be impacted. Most breeding pairs of western Yellow-billed cuckoos have been found nesting in riparian patches within 100 meters of water. Surface water in these cottonwood-

willow groves may help lower the air temperature via evaporative cooling, which provides the optimal microclimatic breeding conditions for Yellow-billed cuckoos (Johnson et. Al. 2010). A survey commissioned by the BLM in 2001 found 23 pairs of Yellow-billed cuckoo along Cienega creek over a distance of 10km (Harris Environmental 2001). In South Carolina, beaver increased structural complexity in riparian areas resulting in high bird species diversity. Seven Yellow-billed cuckoo were recorded at four beaver ponds, indicating that beaver create favorable habitat conditions for this species (Reese and Hair 1976). Direct impacts to individual Yellow-billed cuckoos would be disturbance from BDA construction and potential nest destruction if a beaver were to fall a tree with nesting cuckoos. Yellow-billed cuckoo critical habitat is likely to experience an adverse impact from the presence of beaver and construction of BDAs, due to some loss of mature trees used for nesting and foraging. Beaver re-establishment will likely improve habitat conditions along Cienega creek and its tributaries by increasing the density and complexity of understory vegetation important to nesting Yellow-billed cuckoos, which would compensate for any short-term adverse effects.

Observations by BLM in June 2006 and 2007 have documented Huachuca water umbel along approximately 5km of stream bank, including dense lawn-like patches measuring over 100m long and 10m wide (Bodner and Simms 2008). A survey conducted by BLM in 2011 revealed 100 patches totaling nearly 1/3 of an acre in total surface coverage. The extent of these patches rivals or exceeds that described for any other sites (USFWS 2002). Re-establishment of beaver will likely have a long-term beneficial effect on Huachuca water umbel by increasing available wetted soil along the perimeter of the stream and by reducing competition with other herbaceous plants such as cattail and bulrush through herbivory by beaver. The process of dam making will open the canopy, increasing the amount of sunlight touching the water surface. Titus and Titus (2008) found that the availability of sunlight might be more important than nutrients in determining growth of Huachuca water umbel. It is possible that beaver establishment could adversely impact the species by burying or inundating patches of water umbel through the process of dam construction. The long-term benefits of beaver, in terms of wetland enhancement that supports an overall increase in suitable habitat, will out-weigh the local loss of plant patches due to inundation.

Arizona Eryngo were planted in suitable sites in LCNCA in 2020 and 2021. Arizona eryngo naturally occurs in locations with perennially saturated soils and can survive for long periods as an emergent plant but does poorly when found under canopy cover (Stromberg 2019). The process of dam building would open the canopy, thus increasing the amount of available sunlight reaching wetland habitat that supports this species. Beaver establishment can however adversely impact the species; it is possible that individual patches of eryngo could be buried by beaver dam building and repair activity or inundated by water rising behind a new dam. The long-term benefits of beaver, in terms of wetland enhancement that supports an overall increase in suitable habitat, will out-weigh the potential loss of plants due to inundation.

More information concerning both adverse and beneficial effects for each species can be found in the Biological Opinion for this proposed project in Appendix E.

Cumulative Impacts

The proposed action in combination with the other actions planned in the Las Cienegas RMP, the Coronado National Forest, AGFD, Pima County, and involved private landowners, should benefit threatened and endangered species and their habitats through implementation of recovery plans, concerted efforts to control bullfrogs and nonnative fishes, and watershed improvement. The ongoing Sonoran Desert Conservation Plan should help minimize some of the threats to listed species from development in Pima County.

These partnerships and actions should benefit the aquatic-wetland-riparian ecosystem that support most of these species through maintenance and improvement of groundwater and surface water resources, and increased diversity of aquatic, wetland, and riparian habitat. This will help improve the prospects for maintaining the baseline conditions or recovery of federally listed species.

However, climate change, continued development in surrounding areas, and water withdraws are likely to reduce ground water levels resulting in the reduction or elimination of perennial surface water in the foreseeable future. Aquatic habitat and the species that occupy them will become limited or lost because these areas are entirely dependent on available surface water. Of particular concern are impacts to groundwater and surface water that support ecosystem processes,

function and overall health. See Section 3.1.2 Cumulative effects under Effects of the proposed action on groundwater levels and streamflow.

BDAs and beaver activity are anticipated to counter these cumulative effects on Cienega and Mattie Creeks. See section 3.1.2 Cumulative effects under Effects of the proposed action on groundwater levels and streamflow.

3.6.3 Impacts from Alternative B (No Action)

Direct and Indirect Impacts

Under this alternative, there will be no impacts on threatened and endangered species and their habitats within Las Cienegas.

Cumulative Impacts

Please refer to direct and indirect impacts of alternative A. Unmitigated by beaver activity, these cumulative impacts would likely lead to a severe loss of habitat for federally listed species.

3.6.4 Impacts from Alternative C

Direct and Indirect Impacts

Please refer to direct and indirect impacts under Alternative A excluding BDA impacts.

Cumulative Impacts

Please refer to cumulative impacts under Alternative A excluding BDA impacts.

3.7 Would the re-establishment of beaver and addition of BDA's into Cienega creek impact BLM sensitive species?

3.7.1 Affected Environment

There are five special status species listed by BLM Arizona that occur in the project footprint (Table 2).

Lowland leopard frogs and Sonoran mud turtles inhabit pools and wetlands along Cienega creek, generally north of Pump Canyon where they tend to overlap with Chiricahua leopard frogs. Thermal conditions from ground water inputs allow adult frogs to overwinter without succumbing to the disease chytridiomycosis, which kills frogs once freezing conditions occur in the fall (Hall 2019). Longfin dace are found in pools, runs, and riffles but use shallow, flowing habitats (glides) for reproduction which peaks in the spring. Additionally, dace will spawn during the winter where thermal conditions are warm enough (Perez and Simms 2020). Arizona Giant sedge is found along Cienega creek, Mattie Creek, and Cold Spring in marsh, swamp, and stream banks in sandy to silty soil types. Arizona eryngo has been transplanted in areas to wetlands along Cienega creek, wildlife ponds, and Empire gulch. The plants were transplanted in 2019 and establishment was only successful at few sites. The western red bat is likely to occur along the riparian corridor in broad-leaf deciduous riparian forest and primarily roosts in cottonwood trees. They roost during the day in tree foliage and sometimes in leafy shrubs or herbs (AGFD 2011).

The affected environment for BLM sensitive species is a rather complex association of biotic and abiotic elements and processes. In addition to the affected environment described here, it is important to understand the affected environment in other sections: 3.1 Impacts to groundwater and surface flow; 3.2 Impacts to water quality; 3.3 Impacts to wetlands, riparian zones, floodplains, and stream channels; 3.4 Impacts to neotropical migratory birds, waterfowl, and shorebirds; and 3.5 Impacts on aquatic habitats and fish community.

Table 2. BLM sensitive species within aquatic, riparian, wetland habitats on the LCNCA.

Common Name	Scientific Name	Habitat and Presence on NCA	Present in Project Area? (Y/N)	Impacted by Project? (proposed action) (Y/N)
Sonora mud turtle	*Kinosternon sonoriense sonoriense*	Perennial streams, springs, wetlands within Cienega creek watershed	Yes	Yes
Lowland leopard frog	*Rana yavapaiensis*	Perennial streams, springs, wetlands within Cienega creek watershed	Yes	Yes
Longfin dace	*Agosia chrysogaster*	Perennial streams, springs, and pools within Cienega creek watershed	Yes	Yes
Arizona giant sedge	*Carex spissa (ultra)*	Wetlands within lower Cienega creek watershed Wetlands	Yes	Yes
Western red bat	*Lasirurs blossevillii*	Cottonwood-willow riparian areas along Cienega creek and tributaries.	Yes	Yes

3.7.2 Impacts of Alternative A (Proposed Action)

Direct and Indirect Impacts

Beaver re-establishment could promote cienega development through the processes of dam building, water table elevation, sediment deposition and riparian plant colonization. Cienegas have a high biodiversity and promote key ecological functions (Hendrickson and Minckley 1984; Cole and Cole 2015) that benefit many of the species discussed below. The proposed beaver re-establishment sites and likely population expansion areas are within habitats occupied by six BLM sensitive species (Table 2). Only minor short-term, adverse impacts to these species are anticipated from the proposed action, however are mitigated for as conservation measures in the proposed action. Improved hydrologic function will benefit all of these species as surface water and shallow ground water is key to maintaining and potentially expanding the habitat that these species depend upon. Beaver dams flood riparian areas and create additional wetlands or increase the area of existing wetlands which is prime habitat for five of the six species (Sonora mud turtle, Lowland leopard frog, Arizona giant sedge, and Arizona eryngo). Beaver dams are anticipated to increase the amount of habitat available for all six species.

Beaver dams are anticipated to increase the amount of habitat available for both the Lowland leopard frog and the Sonora mud turtle. Increased recharge would improve winter thermal conditions for leopard frogs and benefit early reproduction in longfin dace. Beaver activity could have both adverse and beneficial effects for longfin dace. Beaver ponds would replace the existing spawning macrohabitat with extensive and nearly lentic habitat with little to no value for longfin dace. However, the species would benefit from improved stream permanence and extended length of downstream flow. In addition, this fish would benefit from the habitat alterations made by beaver such as creation of warm, shallow, still edge-waters used for grow-out of juvenile fish. Warm ground water inputs in the winter will likely provide improved overwinter survival and year-round reproduction in more areas of creek when occupied by beaver.

The increase in wetland habitat would benefit Arizona giant sedge. Arizona eryngo occurs in locations with perennially saturated soils and can survive for long periods as an emergent plant but does poorly when found under canopy cover (Stromberg 2019). The process of dam building will open the canopy, thus increasing the amount of available sunlight reaching wetland habitat that supports both species. Beaver establishment can however adversely impact the species; it is possible that individual patches of eryngo or sedge may be buried by beaver dam building and repair activity or inundated by water rising behind a new dam. The construction of BDAs may result in the loss of some individuals; however, the proposed action includes conservation measure to locate and avoid Arizona eryngo and Arizona giant sedge before

construction. These plant species are large and prominent easily noticed during construction activites. Even so, the long-term benefits of beaver, in terms of wetland enhancement that supports an overall increase in suitable habitat, will out-weigh the potential loss of plants due to inundation.

Western red bats have been observed along Cienega creek (K. Simms personal observation *in* Bodner and Simms 2008). Dam building by beaver results in increased area of open water and is likely to provide additional watering and insect foraging points for the western red bat. However, beaver may reduce the number of mature cottonwood trees around beaver ponds, resulting in a decrease in roosting sites and can affect the local population size. Though, even with beaver activity, the number deciduous riparian trees including cottonwoods is not likely to limit their overall population in LCNCA.

For related impacts see the following sections on Impacts to aquatic habitats and fish communities section 3.4 and Impacts to threatened and endangered species section 3.6.

Cumulative Impacts

The proposed action in combination with the other actions planned in the Las Cienegas RMP, the Coronado National Forest, AGFD, Pima County, and involved private landowners should benefit BLM sensitive species and their habitats through implementation of recovery plans for federally listed species, concerted efforts to control bullfrogs and nonnative fishes, and watershed improvement. The ongoing Sonoran Desert Conservation Plan should help minimize some of the threats to listed species from development in Pima County. These partnerships and actions should benefit the aquatic-wetland-riparian ecosystem that support most of these species through maintenance and improvement of groundwater and surface water resources, and increased diversity of aquatic, wetland, and riparian habitat. This will help decrease the need to list these under the ESA.

However, climate change, continued development in surrounding areas, and water withdraws are likely to reduce ground water levels resulting in the reduction or elimination of perennial surface water in the foreseeable future. Aquatic habitat and the species that occupy them will become limited or lost because these areas are entirely dependent on available surface water. Of particular concern are impacts to groundwater and surface water that support ecosystem processes, function, and overall health. See section 3.1.2 Cumulative effects under Effects of the proposed action on groundwater levels and streamflow.

BDAs and beaver activity are anticipated to counter these cumulative effects on Cienega and Mattie Creeks. See section 3.1.2 Cumulative effects under Effects of the proposed action on groundwater levels and streamflow.

3.7.3 Impacts of Alternative B (No Action)

Direct and Indirect Impacts

There are no anticipated adverse impacts to BLM sensitive species from the no-action alternative.

Cumulative Impacts

Please refer to direct and indirect impacts of alternative A. Unmitigated by beaver activity, these cumulative impacts would likely lead to a severe loss of aquatic habitat for BLM sensitive species.

3.7.4 Impacts of Alternative C

Direct and Indirect Impacts

Please refer to direct and indirect impacts of alternative A excluding BDA impacts.

Cumulative Impacts

Please refer to cumulative impacts under alternative A excluding BDA impacts.

4 SUPPORTING INFORMATION

4.1 Tribes, Individuals, Organizations, or Agencies Consulted

4.1.1 Tribal Consultation

The BLM initiated government-to-government consultation with 10 Native American Tribes who claim cultural affiliation to and/or traditional use of the area. Letters summarizing the current range of alternatives were sent to the Fort Sill Apache Tribe, Hopi Tribe, Mescalero Apache Tribe, Pascua Yaqui Tribe, San Carlos Apache Nation, Tohono O'odham Nation, Tonto Apache Nation, White Mountain Apache Tribe, Yavapai-Apache Nation, and Zuni Tribe in May 2022.

4.1.2 U.S. Fish and Wildlife Service biological opinion

The BLM will consult with the US Fish and Wildlife Service under Section 7(a)(2) of the Endangered Species Act.

4.2 List of Preparers

Name	Title
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