Española Valley, Rio Grande and Tributaries, New Mexico Study

Appendix C

Environmental Resources

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1 - Existing Conditions - Environmental Resources

1.1 Historic Conditions

The Rio Grande and the Rio Chama previously supported substantial bosque (Spanish for woodland) areas of cottonwood gallery forest, with willows, New Mexico olives, shrubs, and wetlands along the southwestern streams and rivers (Scurlock 1998). The Rio Grande is the 5th largest river in North America and one of the top ten endangered rivers in the world (Wong et al. 2007).

1.1.1 Importance of Riparian Habitat

The importance of the Rio Grande bosque, a type of riverine riparian zone only found in the arid Southwest, as a wildlife habitat and cultural resource in the region and nation, as well as the impact on the bosque of earlier interventions by Federal agencies, indicates there is a Federal interest in restoration. The term "bosque" originates from 16th century Spanish settlers, and traditionally used in the southwest to describe to the riparian woodlands that have existed along the Rio Grande through recent history (Scurlock 1998). The bosque areas along the Rio Grande are internally defined by the three Pueblos with a landscape perspective. Many of the riparian areas are associated "with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community. The New Mexico State Wildlife Action Plan (SWAP) team has identified riparian habitat as important habitat for wildlife conservation.

Channelization activities, gravel mining and non-engineered spoilbanks have modified the hydrology thereby changing the composition of native bosque plant species and associated wildlife habitats. Surface/groundwater interactions and sedimentation dynamics that are important for sustaining and regenerating bosque vegetation have been negatively affected by changes in river hydrology. These altered processes will eventually result in complete dominance of the plant communities by non-native plant species including saltcedar, Russian olive, Siberian elm, and tree of heaven. Eventual conversion of the bosque to a non-native-plant-dominated ecosystem uninfluenced by hydrologic processes would diminish habitat suitability and quality for many native animal species. The sponsors' goal is returning the river and bosque to pre-flood control conditions.

1.1.2 *Affected Environment

The Rio Grande bosque consists of undeveloped cottonwood and willow riparian habitat. Flooding and scour are the basic processes that created a patchwork of variable age class forest stands on the floodplain (Crawford et al. 1993; Scurlock 1998). Riparian corridors comprise less than one percent of New Mexico's landscape (USEPA and NMED 1998), yet they are the most important ecosystems in the state (Roelle and Hagenbuck 1995; Marshall et al 2000; American Bird Conservation 2007). The surface area of wet meadows, marshes, and ponds has decreased by 73% along 250 miles of the Rio Grande floodplain from Española to Elephant Butte Lake in New Mexico.

The primary ecosystem problem is the severe degradation and loss of riparian habitat along the Rio Grande and its tributaries. Channelization, levee construction, and jetty jack installation along the river, along with sediment retention in reservoirs and flow regulation have created a fixed channel plan form and a narrower floodplain that is disconnected from the hydrograph. The use of surface and groundwater for agriculture, along with dam construction has transformed the Rio Grande and Rio Chama into highly incised rivers that no longer flood the riparian areas during spring runoff. Gravel extraction (1980s) downstream of Ohkay Owingeh has further increased channel incision, reducing water availability for riparian vegetation (Appendix I).

Scurlock (1998) has summarized trends for historic Rio Grande riparian communities over the last 150 years. The reach through the project area is one of the most extensive cottonwood bosques in New Mexico. The riparian ecosystem has changed with the decline of cottonwood gallery forest, encroachment of upland junipers, and invasion of saltcedar (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*). The loss of riparian habitat is an important conservation issue in the arid Southwest due to its rarity. The bosque ecosystem supports 276 vertebrate species, including birds (167), mammals (54), fish (31), amphibians (8 species), and reptiles (14 species) (BISON-M, accessed August 2009).

Table 1-1 – Study area habitat trends based on National Wetland Inventory vegetation classification.

	Acres			**Percent Change**	
Overall	**1935**	**1989**	**2002**	**1935-2002**	**1989-2002**
Emergent Persistent	949.9	272.7	349.3	-63.2%	28.1%
Forest Broad-Leaved Deciduous	536.4	1174.2	374.3	-30.2%	-68.1%
Scrub-Shrub Broad-Leaved Deciduous	614.5	116.9	408.1	-33.6%	249.1%
Riparian Forest	627.9	869.4	1838.4	192.8%	111.4%
Riparian Scrub-Shrub	830.2	40.5	680.0	-18.1%	1579.6%
Total Acres	3558.9	2473.8	3650.2		

There are three Federally listed species identified by the U.S. Fish and Wildlife Service (Consultation code 02ENNM00-2014-SLI-0436, 12 Jan 2015) that either occur in the action area and/or have proposed critical habitat in the action area. These species are the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (flycatcher), the Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) (cuckoo), and the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) (mouse). The other species of interest identified by the U.S. Fish and Wildlife Service (Consultation code 02ENNM00-2014-SLI-0436, 12 Jan 2015) do not meet the criteria for further analysis because there is no critical habitat in the action area, the lack of suitable habitat (based on primary constituent elements (PCEs)) for the species, or the species is unlikely to occur in the action area.

1.2 Fish and Wildlife

The U.S. Fish and Wildlife Service provided their Coordination Act Report on July 13, 2015. Draft versions of the report were sent to the New Mexico Department of Game and Fish, and the Forestry Division of the New Mexico Energy, Minerals, and Natural Resources Department. The report was also sent to the Pueblos of Ohkay Owingeh, San Ildefonso, and Santa Clara.

1.2.1 Fish and Wildlife Coordination Act Report

The project shall incorporate the following FWCA recommendations including the use of CHAP analysis for evaluating habitat value, avoiding construction during the migratory bird nesting season, use clean backfill materials, use local native plants for re-vegetation, protect cottonwood trees from damage, and develop an adaptive management and monitoring plan.

United States Department of the Interior

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July 13, 2015

Consultation No. 02ENNM00-2012-CPA-0052

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Dear Ms. Alcon:

This is the U.S. Fish and Wildlife Service (Service) response to your request for review of the U.S. Army Corps of Engineers (USACE) feasibility study for the Española Valley Rio Grande and Tributaries, New Mexico Project (Project) under the Fish and Wildlife Coordination Act (16 USC 661-667e). Please consider this letter our 2(b) report for the Project.

Introduction

The purpose of the Project is to identify ecosystem restoration and flood risk management alternatives that are technically feasible, economically practicable, sound with respect to environmental considerations, and publicly acceptable within the Project area (USACE 2009). Previous work in this area includes review of flood protection for the City of Española (Service 1969), improve existing levees along Rio Grande in the City of Española and flood protection along Arroyo Guachupangue (Service 1991); and a Coordination Act Report on the Española Flood Control Project (Service 1995).

Project Description

The Project area is located in southern Rio Arriba County and includes a small portion of northern Santa Fe County. Study area boundaries extends 1.6 kilometers (km) (1 mile (mi)) east and west of the centerline of both the Rio Chama and Rio Grande from the northern border of Ohkay Owingeh tribal lands (latitude 36.0918, longitude –106.0660), and the Santa Clara Pueblo lands to the southern border of San Ildefonso Pueblo lands (latitude 35.8538, Longitude –106.1567). The tributaries, Santa Cruz River, Arroyo Guachupangue, Santa Clara Creek, and the Rio Pojoaque, are also included in the Project area (Figure 1).

The pueblos of Ohkay Owingeh, Santa Clara and San Ildefonso, in partnership with USACE, conducted this feasibility study to identify and define environmental degradation, flood risk management, and related land and water resource problems and to develop solutions to rehabilitate the riparian environment. The primary problem is the severe degradation and loss of riparian habitat along the Rio Grande and its tributaries. As a result of these changes, stands of healthy native riparian habitat, including wetlands, are rare and scattered in the Project area (USACE 2009).

As a direct consequence of the extent of the lost or degraded riparian habitat, the area has experienced a major reduction in species diversity and in the populations of remaining species. In addition, destruction of native riparian habitat facilitates an increase in invasive plant species that are more tolerant of disturbed conditions (USACE 2009).

Habitat restoration has the potential to increase wetland and riparian habitat acreage and quality, thereby expanding wildlife diversity and quantity, controlling invasive plant species, and providing an ecological resource that is historically and culturally significant and valuable to the tribes and the region. In addition to restoration efforts, opportunities exist to improve passive recreation opportunities associated with the restored floodplain.

The second issue of local concern the potential of flood damages caused by high flows in the Rio Grande, especially on Santa Clara Pueblo lands. Floodplain mapping shows that the areas of highest concern are the confluences of the Rio Grande and its tributaries, the Santa Cruz River and the Guachupangue Arroyo.

The Rio Grande in the Project area has been described as low sinuosity, single channel increasing in width below the Rio Chama confluence and becoming sandier and less cobbly (Bureau of Reclamation (BOR) 2007a). Proposed river maintenance activities include widening the riparian corridor, monitor bends, and discourage gravel mining (BOR 2007a). Waters within the Project area have reported impairments of Polychlorinated biphenyls in fish tissue and turbidity (Environmental Protection Agency 2015).

From the Rio Grande Canyon to Rio Chama confluence the formation of a significant floodplain is absent (Massong et al. 2007). The channel has a slightly sinuous, single channel pattern. The bed is composed of gravel and small cobbles with a pool-riffle morphology, however, the pools tend to be small in size compared to the riffles (glides). This channel morphology has not changed significantly in the recent past and appears relatively stable (Massong et al. 2007).

From the Rio Chama confluence to White Rock Canyon there is a relatively, large floodplain throughout most of this reach. The channel is a combination of slightly sinuous single channel with sections with migrating bends and double channels (Massong et al. 2007). Other than the active bends, the bankline throughout this reach appear stable (Massong et al. 2007). There has been active gravel mining within this reach, with associated headcutting and bed lowering events (Massong et al. 2007).

On the San Ildefonso Pueblo a detailed geomorphic trends assessment was completed in 2005 (Massong and AuBuchon 2005). The review in this area showed a 64 percent reduction in active channel width since 1935. Current channel characteristics convey the 5-year return flows without significant overbanking and only minor amounts of bed incision are expected in the future.

Sensitive Species and Habitat

Riparian corridors comprise less than 1 percent of New Mexico's landscape (Deason 1998), yet they are one of the most important ecosystems in the Southwest (Roelle and Hagenbuck 1995). Most of the Project area can be classified as deciduous riparian woodland, interspersed with open areas of grass and forb cover and sparsely vegetated gravel bars (USACE 2009). The native cottonwood-and-willow Bosque has been heavily invaded by nonnative species, including Russian olive (*Elaeagnus angustifolia*), salt cedar (*Tamarix* spp.), and Siberian elm (*Ulmus pumila*). New Mexico olive (*Foresteria neomexicana*) and coyote willow (*Salix exigua*) are components of the shrub community (La Calandria Associates 2007). Hink and Ohmart (1984) include in their study the Bosque up to Española but did not differentiate vegetation by reach. Plant species within the study area have been summarized in vegetation surveys (USACE 2009, Appendix G).

Ohkay Owingeh

Approximately 809 hectares (ha) (2,000 acres) of Bosque exist within Ohkay Owingeh, along 10.5 km (6.5 mi) of the Rio Grande and over 6.4 km (4 mi) of the Rio Chama. Ohkay Owingeh has treated approximately 369 ha (912 acres) since 1999 for Russian olive, Siberian elm, and salt cedar, resulting in a more native mix of riparian species. Purple loosestrife (*Lythrum salicaria*) is a persistent invader into Ohkay Owingeh wetlands requiring continual control measures (La Calandria Associates 2007).

Ohkay Owingeh wetlands have been drastically affected by channelization (since the 1950s) and sand and gravel mining (after 1980) that occurred along the river in the area of the tribal lakes near the southern end of the Pueblo (La Calandria Associates 2007). Mining and channelization had the effect of downcutting the Rio Grande, and head cutting on the Rio Chama (La Calandria 2007). The Rio Grande is currently confined to a much straighter channel and no longer inundates its former floodplain within the Project area.

National Wetlands Inventory (NWI) data mapping indicates a total of approximately 270 ha (669 acres) of wetland at the time of mapping (Service 2015).

Santa Clara Pueblo

Santa Clara Pueblo contains about 714 ha (1,764 acres) of Bosque, located along the Rio Grande and Santa Clara Creek. Grazing, erosion caused by roads, and exotic species invasion along Santa Clara Creek are affecting native riparian plant communities. Ecological restoration is ongoing, and most of the Bosque is scheduled for treatment (Warren 2005).

NWI data mapping indicates 44 ha (109 acres) of freshwater emergent vegetation and 88 ha (217 acres) of freshwater forested/shrub wetlands, for a total of 132 ha (326 acres) (Service 2015) and identified by location and functionality by Warren (2000).

San Ildefonso Pueblo

Aerial photos and field surveys show the floodplain at San Ildefonso Pueblo is dominated by cottonwood (*Populus deltoides* spp.), Russian olive, New Mexico olive, and one seed juniper (*Juniperus monosperma*). Cottonwood recruitment is sparse or nonexistent. Russian olive and juniper trees compete with cottonwoods for water and provide ladder fuels in the event of wildfire. Salt cedar was present in relatively low numbers but not widely distributed.

Downcutting along the Rio Grande and Los Alamos Creek at the Otowi Bridge (NM Highway 502) has left the historical Bosque disconnected from the main channel. Loss of Bosque habitat along Los Alamos Creek has been identified as an issue of concern.

NWI data indicates a total of 103 ha (254 acres) of wetlands on San Ildefonso Pueblo (Service 2015).

San Ildefonso Pueblo withdrew from the Project in 2010.

Fishes

McGarvey (2011) identified this area's fish fauna as belonging to the upper portion of the Middle Zone from Abiquiu Dam to Elephant Butte Dam. Platania (1991) examined the longitudinal distribution of fishes along the upper Rio Grande including the Project area. Data from Platania and Clemmer (1986) were incorporated in Platania (1991). At the three sampling locations within the Project area he found 13 fish species including four native species (Table 1). Platania (1993) found three additional species including one native species in the Project area. Plateau Ecosystems Consulting (2001) summarized fish data collected by BOR from 1995–1999 in the Project area, and found an additional two species. Buntjer and Remshardt (2005) sampled the Project area with both seine and electrofishing gears. They added two additional species to the fish fauna including the white bass (*Morone chrysops*) not previously reported from the upper Middle Rio Grande (Table 1). Based in these studies 20 species are known from the Rio Chama and Rio Grande in the Project area. The Rio Grande bluntnose shiner (*Notropis simus simus*) was known from the Project area but is now believed extinct (Chernoff et al. 1982). There is no state or federally listed fish in the Project area. Two species, Rio Grande chub (*Gila pandora*) and Rio Grande sucker (*Catostomus plebeius*), have been petitioned for listing (Wildearth Guardians 2013, 2014).

Birds

The Project area is part of the Upper Rio Grande Corridor avian concentration area (New Mexico Avian Protection 2009). Thompson et al. (1994) reported 59 bird species from the Project area (Table 2) and Hink and Ohmart (1984) made incidental observations on an additional seven species. Of these 65 species, 54 percent (35) are riparian dependent (Waur 1977; Cartron et al. 1999). The Bosque provides a riparian migratory corridor essential for Neotropical migratory birds (Skagen et al. 2005).

The federally listed southwestern willow flycatcher (*Empidonax traillii extimus*) and yellow-billed cuckoo (*Coccyzus americanus*) are reported from the Project area and designated critical habitat for the southwestern willow flycatcher and proposed critical habitat for the yellow-billed cuckoo are found in the Project area (Service 2013a, Service 2014a). Section 7 consultation under the Endangered Species Act (ESA) will be necessary for these species.

Mammals

Twenty-three mammal species are reported from the Project area (Table 3) by Findley et al. (1975) and Hink and Ohmart (1984). The New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) (jumping mouse) is the only listed mammal in the area. The jumping mouse is listed as endangered by the Service (2014b) and there is proposed critical habitat in the Project area (Service 2013b). Section 7 consultation under the ESA will be necessary for this species.

Amphibians and Reptiles

There are nine amphibians and reptiles reported from the Project area (Hink and Ohmart 1984, Degenhardt et al. 1996) (Table 4). None are state or federally listed.

Discussion

There is substantial riparian and wetland habitat within the Project area separated by White Rock Canyon from the Middle Rio Grande Bosque. This makes it a somewhat self-contained, highly valuable wildlife and cultural resource to the area. With further restoration this area could be the second largest Bosque on the Rio Grande and a significant resource of the region (Apogee Research 1997). Restoration and habitat improvement with the dedicated efforts of the Pueblos should result a long-term habitat improvement.

<u>With and without the project</u>

The primary focus of the Project activities is habitat restoration. No Flood Risk Measures (flood control structures) were included in the tentatively selected Plan. Of the proposed structures the in-channel features (grade control structures, bendaway weirs, and j-hook vanes) have the most risk of further degrading the system if improperly sited and installed. Grade control structures are of the greatest concern to us as they have been found to fragment fish populations in other areas (Livitan et al. 2008, Thomas et al. 2011). Improper design of grade control structures with fish passages can exacerbate the problem of fish population fragmentation (Baigun et al. 2012). The rivers in the Project area connect headwater streams that harbor native species, such as Rio Grande chub and Rio Grande sucker, which have been petitioned for listing (Wildearth Guardians 2013, 2014). These species occur in headwater streams of the Jemez River (below the Project area) and Rio Chama and Rio Grande (above the Project area) though they are now uncommon in the main stems of the rivers at and below the Project area (Platania 1991; Calamusso et al. 2002; Bestgen et al. 2003). Rock structure in sand/cobble dominated rivers can attract nonnative predators (Davenport et al. 2003). Grade control structures should allow passage of the native fish fauna while limiting habitat for nonnative species. The goal of these structures should be to help recreate the braided stream morphology of the old floodway (USACE 2004). USACE proposed Grade Restoration Facilities at six sites (USACE 2015a). These are designed to stabilize the channel bed and allow fish passage.

Northwest Habitat Institute (NWHI) analyzed the 50-year future without the Project for USACE and project proponents (NWHI 2012) and implemented the Combined Habitat Assessment Protocols (CHAP) analysis (USACE 2015b). This report identifies species that might be lost over time including the southwestern willow flycatcher.

Over the next 50 years without the Project there is a projected 49 percent decline in habitat value. The most significant decrease in floodplain area would occur downstream from the confluence with the Rio Chama due to continuing degradation from the channel headcut (USACE 2015b). The headcut is anticipated to move up the Rio Chama, reducing flooding between the confluence with the Rio Grande and the Chamita/Hernandez diversion structure (USACE 2015b). This would likely be catastrophic for the riparian-floodplain ecological function (Knopf et al. 1988).

In planning restoration efforts a comprehensive assessment and spatial explicit model would be essential for identifying the areas to be restored, type of restoration, and long-term management. This comprehensive assessment should include all proposed (La Calandria Associates 2007, USACE 2009, Appendix G) and previous restoration efforts, for example, Bureau of Reclamation Collaborative Program habitat rehabilitation projects (BOR 2007b), Forest Service Collaborative Forest Restoration Program (Forest Service 2013), Alcalde-Velarde Valley Restoration (Johnston 2011), and mitigation areas for past projects (e.g., NM 74 bridge replacement). The CHAP analysis identified a target mosaic for the restoration and estimated habitat value increase after restoration but we did not see where the analysis prioritized restoration efforts that would help make most efficient use of resources (USACE 2015b). Restoration projects could be prioritized by the change in habitat value with the highest positive change being the highest priority.

Recommendations

Use the CHAP analysis to prioritize restoration efforts.

Prepare a GIS based restoration overview of all proposed and past restoration efforts in the Project area to guide future restoration efforts. The area for this overview should be Rio Grande Canyon to White Rock Canyon as activities outside the Project area may affect projects within the area.

Include the City of Española in restoration plan as there are areas that could be restored within the city. Española still has substantial flood risks. Improvements in other areas should reduce flood risks and need to be considered under Española Flood Control Project (Service 1995).

Prepare a detailed geomorphic analysis of the Project area to identify channel incision areas that are impacting groundwater levels of the riparian zone. Identify areas to reestablish the hydrologic connection to the historical floodplain.

Reevaluate the acquisition of flood easements. Based on our 1991 assessment the most environmentally friendly alternative would be for USACE acquisition of flood easements on or fee title of the l00-year flood plain in and around Española, relocation of the residents of this area, and conversion of the acquired land into riparian habitat that could also be used as an urban park. This would maximize flood protection for the City of Española and would cause minimal environmental damage (Service 1991). The omission of the City of Española from this Project makes comprehensive restoration planning difficult.

Removal of remaining jetty jacks would facilitate a more active floodplain and help restore riparian habitat (Grassel 2002).

Where possible, avoid construction during the migratory bird nesting season of April through August. Where that is not possible, vegetated areas slated for clearing should be surveyed for the presence of nesting birds prior to construction. Avoid disturbing nesting areas until young have fledged.

Any use of backfill should be uncontaminated soils suitable for revegetation with native plant species.

Scarify compacted soils or replace topsoil and revegetate all disturbed sites with suitable mixture of native grasses, forbs, and woody shrubs.

Protect mature cottonwood trees from damage during clearing of nonnative species, other construction activities, and beavers using fencing, or other appropriate materials.

Use local genetic stock wherever possible in the native plant species establishment throughout the riparian area.

Develop a monitoring plan to examine the effectiveness of the restoration activities including wildlife, vegetation, and groundwater levels.

We appreciate the opportunity to provide these recommendations and look forward to working with you on the restoration implementation.

Sincerely,

Wally "J" Murphy
Field Supervisor

cc:
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Governor, Ohkay Owingeh, San Juan Pueblo, New Mexico
Governor, Pueblo of Santa Clara, Española, New Mexico
Governor, Pueblo of San Ildefonso, Santa Fe, New Mexico

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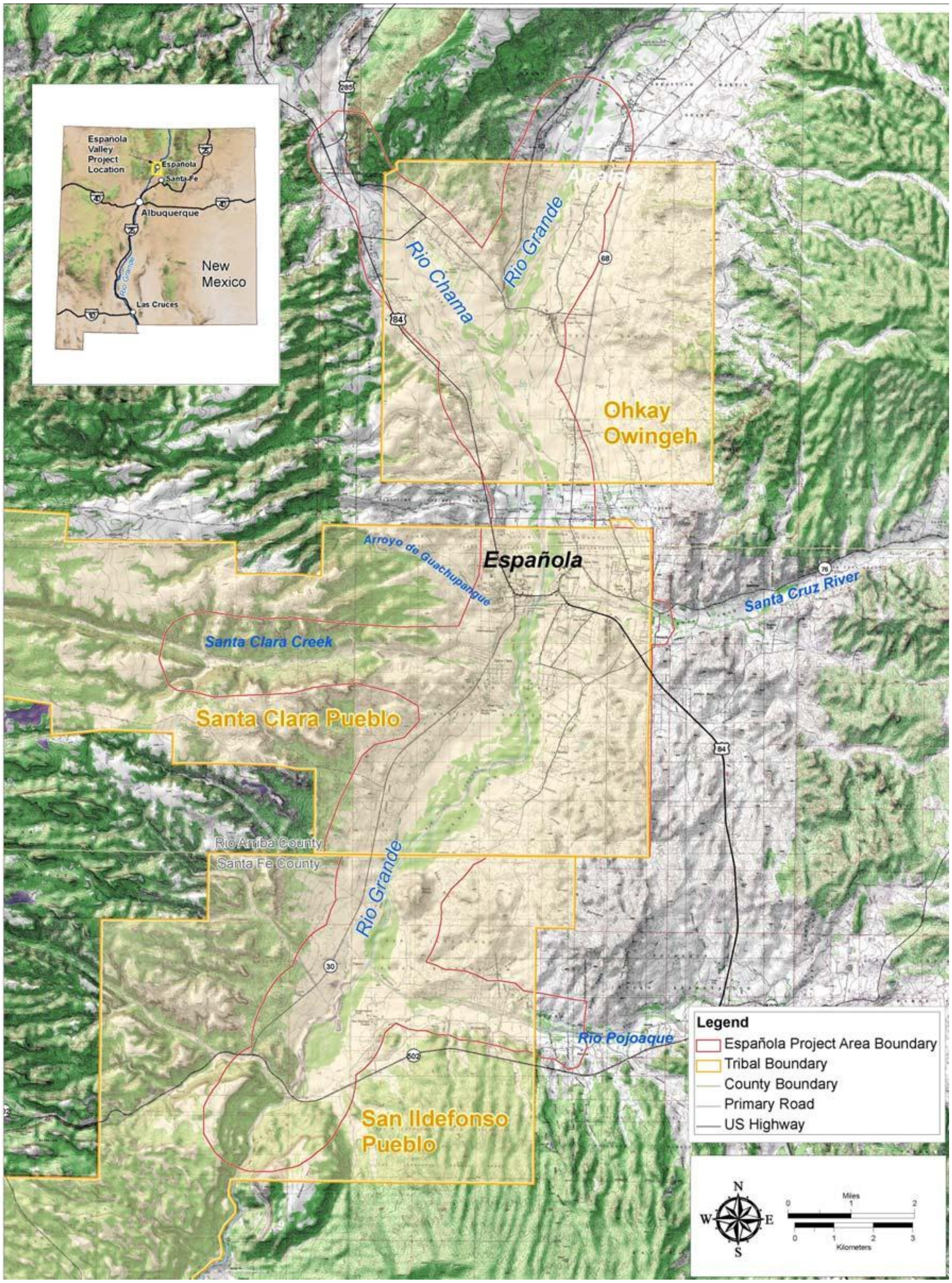

Figure 1. The Española Valley Rio Grande and Tributaries, New Mexico Project area (from USACE 2009).

Table 1. Fish species reported from the Española Valley Rio Grande and Tributaries, New Mexico Project Area.

Common Name	Species [1]	Status	Platania and Clemmer 1986	Platania 1991	Platania 1993	Platania et al. 1996	PEC 2001	Buntjer and Remshardt 2005
black bullhead	*Ameiurus melas*	Introduced		X			X	X
bluegill	*Lepomis macrochirus*	Native						X
brown trout	*Salmo trutta*	Introduced					X	X
channel catfish	*Ictalurus punctatus*	Introduced		X			X	X
common carp	*Cyprinus carpio*	Introduced	X	X			X	X
fathead minnow	*Pimephales promelas*	Native	X	X	X	X	X	X
flathead chub	*Platygobio gracilis*	Native	X	X		X		X
gizzard shad	*Dorosoma cepedianum*	Introduced			X			
green sunfish	*Lepomis cyanellus*	Introduced	X	X	X			
largemouth bass	*Micropterus salmoides*	Introduced	X	X			X	X
longnose dace	*Rhinichthys cataractae*	Native	X	X	X	X	X	X
rainbow trout	*Oncorhynchus mykiss*	Introduced					X	X
red shiner	*Cyprinella lutrensis*	Introduced	X	X	X		X	X
Rio Grande chub	*Gila pandora*	Native	X	X	X	X	X	X
Rio Grande sucker	*Catostomus plebeius*	Native			X	X		
river carpsucker	*Carpiodes carpio*	Native	X	X			X	X
smallmouth bass	*Micropterus dolomieu*	Introduced						X
western mosquitofish	*Gambusia affinis*	Introduced	X	X	X	X		X
white bass	*Morone chrysops*	Introduced						X
white crappie	*Pomoxis annularis*	Introduced			X			
white sucker	*Catostomus commersoni*	Introduced	X	X	X	X	X	X
		No Species	10	12	9	6	11	17

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Platania 1993, stations 3, 4, 5; Platania et al. (1996) Rio Chama Hwy 285 Station.
Buntjer and Remshardt 2005, Rio Chama Hwy 285, Alcalde, Española, Buckman Wash.

Table 2. Mammal species reported from the Española Valley Rio Grande and Tributaries, New Mexico Project Area.

Common Name	**Scientific Name**	**Source**	**Locality**
Abert's Squirrel	*Sciurus aberti*	Findley et al. 1975	Española
Bobcat	*Lynx rufus*	Findley et al. 1975	San Ildefonso Pueblo
Botta's Pocket Gopher	*Thomomys bottae*	Findley et al. 1975	Española; Santa Clara Pueblo; San Ildefonso Pueblo
Brush mouse	*Peromyscus boylii*	Findley et al. 1975	San Ildefonso Pueblo
Colorado chipmunk	*Neotamias quadrivittatus*	Hink and Ohmart 1984	
Coyote	*Canis latrans*	Findley et al. 1975	Española
Deer mouse	*Peromyscus maniculatus*	Findley et al. 1975; Hink and Ohmart 1984	San Ildefonso Pueblo
Gunnison's Prairie Dog	*Cynomys gunnisoni*	Findley et al. 1975	Española
House Mouse	*Mus musculus*	Findley et al. 1975	San Ildefonso Pueblo
Mexican Woodrat	*Neotoma mexicana*	Findley et al. 1975	San Ildefonso Pueblo
Northern Grasshopper Mouse	*Onychomys leucogaster*	Findley et al. 1975	Española
Ord's Kangaroo Rat	*Dipodomys ordii*	Findley et al. 1975	Española
Pinon Mouse	*Peromyscus truei*	Findley et al. 1975	Española
Plains Pocket Mouse	*Perognathus flavescens*	Findley et al. 1975	Española
Red squirrel	*Tamiasciurus hudsonicus*	Findley et al. 1975; Hink and Ohmart 1984	
Rock mouse	*Peromyscus difficilis*	Findley et al. 1975	San Ildefonso Pueblo
Rock Squirrel	*Spermophilus variegatus*	Findley et al. 1975	San Ildefonso Pueblo
Silky Pocket Mouse	*Perognathus flavus*	Findley et al. 1975	San Ildefonso Pueblo
Spotted Ground Squirrel	*Spermophilus spilosoma*	Findley et al. 1975	Española; San Ildefonso Pueblo
Western Harvest Mouse	*Reithrodontomys megalotis*	Findley et al. 1975	Española
New Mexico meadow jumping mouse	*Zapus hudsonius luteus*	Findley et al. 1975; Frey 2004	Española
White-footed mouse	*Peromyscus leucopus*	Findley et al. 1975	Española; San Juan Pueblo
White-throated Woodrat	*Neotoma albigula*	Findley et al. 1975	Española; San Juan Pueblo

Table 3. Bird species reported from the Española Valley Rio Grande and Tributaries, New Mexico Project Area.

Common Name	**Scientific Name**	**Riparian nester[1]**	**TOTAL**	**Rank**	**Source**
American crow	*Corvus brachyrhynchos*		8	28	Thompson et al. 1994
American Robin	*Turdus migratorius*	X	65	3	Thompson et al. 1994
Ash-throated Flycatcher	*Myiarchus cinerascens*	X	7	29	Thompson et al. 1994
bald eagle	*Haliaeetus leucocephalus*				Hink and Ohmart 1984
Barn Owl	*Tyto alba*		1	50	Thompson et al. 1994
Barn Swallow	*Hirundo rustica*		1	50	Thompson et al. 1994
Bewick's Wren	*Thryomanes bewickii*	X	57	5	Hink and Ohmart 1984
Black-and-White Warbler	*Mniotilta varia*		1	50	Thompson et al. 1994
Black-billed Magpie	*Pica hudsonia*	X	15	22	Hink and Ohmart 1984
Black-capped Chickadee	*Poecile atricapillus*	X	107	1	Thompson et al. 1994
Black-chinned Hummingbird	*Archilochus alexandri*	X	24	15	Thompson et al. 1994
Black-headed Grosbeak	*Pheucticus melanocephalus*	X	28	11	Thompson et al. 1994
Blue Grosbeak	*Passerina caerulea*	X	20	18	Thompson et al. 1994
Blue-gray Gnatcatcher	*Polioptila caerulea*	X	4	34	Thompson et al. 1994
Brewer's Sparrow	*Spizella breweri*		3	37	Thompson et al. 1994
Broad-tailed Hummingbird	*Selasphorus platycercus*		2	39	Thompson et al. 1994
Brown-headed Cowbird	*Molothrus ater*	X	16	21	Thompson et al. 1994
Bullock's Oriole	*Icterus bullockii*	X	11	25	Thompson et al. 1994
Cedar Waxwing	*Bombycilla cedrorum*		2	39	Thompson et al. 1994
Chipping Sparrow	*Spizella passerina*		51	7	Thompson et al. 1994
Cliff Swallow	*Petrochelidon pyrrhonota*		1	50	Thompson et al. 1994
Common grackle	*Quiscalus quiscula*				Hink and Ohmart 1984
Common Raven	*Corvus corax*		2	39	Thompson et al. 1994
Cooper's Hawk	*Accipiter cooperii*	X	7	29	Thompson et al. 1994
Cordilleran Flycatcher	*Empidonax occidentalis*		2	39	Thompson et al. 1994
Downy Woodpecker	*Picoides pubescens*	X	20	18	Thompson et al. 1994

Table 3. Continued.

Common Name	**Scientific Name**	**Riparian nester[1]**	**TOTAL**	**Rank**	**Source**
Eastern Phoebe	*Sayornis phoebe*				Hink and Ohmart 1984
European Starling	*Sturnus vulgaris*	X	2	39	Thompson et al. 1994
Gray Catbird	*Dumetella carolinensis*	X	7	29	Thompson et al. 1994
Greater Roadrunner	*Geococcyx californianus*	X			Hink and Ohmart 1984
Great-tailed Grackle	*Quiscalus mexicanus*	X			Hink and Ohmart 1984
Green-tailed Towhee	*Pipilo chlorurus*		2	39	Thompson et al. 1994
Hairy Woodpecker	*Picoides villosus*	X	3	37	Thompson et al. 1994
House Finch	*Carpodacus mexicanus*	X	26	13	Thompson et al. 1994
House Wren	*Troglodytes aedon*	X	5	33	Thompson et al. 1994
Indigo Bunting	*Passerina cyanea*	X	2	39	Thompson et al. 1994
Juniper Titmouse	*Baeolophus ridgwayi*		10	27	Thompson et al. 1994
Lazuli Bunting	*Passerina amoena*	X	28	11	Thompson et al. 1994
Lesser Goldfinch	*Spinus psaltria*	X	47	8	Thompson et al. 1994
Lewis's Woodpecker	*Melanerpes lewis*	X	1	50	Thompson et al. 1994
Magnolia Warbler	*Dendroica magnolia*		7	29	Thompson et al. 1994
Mourning Dove	*Zenaida macroura*	X	18	20	Thompson et al. 1994
Northern Flicker	*Colaptes auratus*	X	36	9	Thompson et al. 1994
Orange-crowned Warbler	*Vermivora celata*		11	25	Thompson et al. 1994
Pine Sisken	*Spinus pinus*		1	50	Thompson et al. 1994
Plain Titmouse	*Parus inornatus*				Hink and Ohmart 1984
Plumbeous Vireo	*Vireo plumbeus*		2	39	Thompson et al. 1994
Red-naped Sapsucker	*Sphyrapicus nuchalis*		2	39	Thompson et al. 1994
Rose-breasted Grosbeak	*Pheucticus ludovicianus*		1	50	Thompson et al. 1994
Ruby-crowned Kinglet	*Regulus calendula*		1	50	Thompson et al. 1994
Spotted Towhee	*Pipilo maculatus*		89	2	Thompson et al. 1994
Stellar's Jay	*Cyanocitta stelleri*		1	50	Thompson et al. 1994

Table 3. Continued.

Common Name	**Scientific Name**	**Riparian nester[1]**	**TOTAL**	**Rank**	**Source**
Summer Tanager	*Piranga rubra*	X			Hink and Ohmart 1984
Townsend's Warbler	*Dendroica townsendi*		2	39	Thompson et al. 1994
Virginia's Warbler	*Vermivora virginiae*		14	23	Thompson et al. 1994
Warbling Vireo	*Vireo gilvus*	X	4	34	Thompson et al. 1994
Western Bluebird	*Sialia mexicana*	X	4	34	Thompson et al. 1994
Western Tanager	*Piranga ludoviciana*		55	6	Thompson et al. 1994
Western Wood-pewee	*Contopus sordidulus*	X	24	15	Thompson et al. 1994
White-breasted Nuthatch	*Sitta carolinensis*	X	31	10	Thompson et al. 1994
Williamson's Sapsucker	*Sphyrapicus thyroideus*		1	50	Hink and Ohmart 1984
Willow Flycatcher	*Empidonax traillii*	X	2	39	Thompson et al. 1994
Wilson's Warbler	*Wilsonia pusilla*		25	14	Thompson et al. 1994
Yellow Warbler	*Dendroica petechia*	X	24	15	Hink and Ohmart 1984
Yellow-breasted Chat	*Icteria virens*	X	63	4	Thompson et al. 1994
Yellow-rumped Warbler	*Dendroica coronata*	X	13	24	Thompson et al. 1994
	No. Species	35	59		

[1]after Waur 1977.

Table 3. Amphibian and reptile species reported from the Española Valley Rio Grande and Tributaries, New Mexico Project Area.

Common Name	**Scientific Name**	**Source**
Bullfrog	*Lithobates catesbeianus*	Hink and Ohmart 1984
Common lesser earless lizard	*Holbrookia maculata*	Hink and Ohmart 1984
Eastern fence lizard	*Sceloporus undulatus*	Hink and Ohmart 1984
Little striped whiptail	*Aspidoscelis inornata*	Hink and Ohmart 1984
New Mexico Whiptail	*Aspidoscelis neomexicana*	Hink and Ohmart 1984; Degenhardt et al 1996
Painted Turtle	*Chrysemys picta*	Degenhardt et al 1996
Plateau Striped Whiptail	*Aspidoscelis velox*	Degenhardt et al 1996
Roundtail Horned Lizard	*Phrynosoma modestum*	Degenhardt et al 1996
Striped plateau whiptail	*Sceloporus virgatus*	Hink and Ohmart 1984

1.3 Endangered Fish and Wildlife Consultation

1.3.1 Draft Biological Assessment for the Española Valley Rio Grande and Tributaries, Rio Arriba County, New Mexico

USACE initiated consultation with the U.S. Fish and Wildlife Service on March 13, 2015.

FINAL BIOLOGICAL ASSESSMENT

for the

ESPAÑOLA VALLEY

RIO GRANDE AND TRIBUTARIES,

NEW MEXICO STUDY

U.S. Army Corps of Engineers
Albuquerque District
4101 Jefferson Plaza Northeast
Albuquerque, New Mexico 87109

March 2015

CONVERSION FACTORS

	From	Multiplier	To
Distance:	inches (in)	25.4	millimeters (mm)
	feet (ft)	0.3048	meters (m)
	miles (mi)	1.6093	kilometers (km)
Area:	acres (ac)	0.0407	hectares (ha)
	square miles (mi^2)	2.590	square kilometers (km^2)
Volume:	cubic yards (CY)	0.7646	cubic meters (m^2)
	acre-feet (ac-ft)	1,233.5	cubic meters (m^2)
	acre-feet (ac-ft)	325,851	gallons (gal)
Discharge:	cubic feet/second (cfs)	0.0283	cubic meters/second (cms)
Mass (weight) :	tons [short]	0.9072	metric tons [long]
Velocity:	feet/second (fps)	0.3048	meters/second (cms)
Salinity:	µSiemens/cm or µmhos/cm	0.32379	parts/million NaCl or mg/liter NaCl
Temperature:	° Fahrenheit (°F)	(°F-32)/1.8	° Celsius (°C)

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1 - Introduction

1.1 Scope of the Biological Assessment

The U.S. Army Corps of Engineers (USACE) is submitting this Biological Assessment (BA) to the U.S. Fish and Wildlife Service (Service) pursuant to Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (Act) and its implementing regulations (50 CFR, Part 402, "Interagency Cooperation"). The purpose of this BA is to evaluate potential effects of the proposed action on Federally listed species, and designated critical habitat of the USACE proposed Española Valley, Rio Grande and Tributaries, New Mexico Study (Study). Because the duration of the anticipated habitat measures construction is approximately 10 years, this consultation is being conducted programmatically. During the construction period, changes in design, construction methods, or the condition of ecological resources could alter the determinations of effects made by the Corps or Service at the present time. Should there be a change in the determination of effects, or in the suitability of stipulations of the Biological Opinion or Incidental Take Statement, the Corps would provide to the Service a supplemental BA tiered to this Programmatic BA. The Corps also will provide annual reports on progress to the Service during the construction period.

When determining the proposed action for this consultation, the Corps carefully considered the activities of non-Federal and other Federal entities in the action area. Activities appropriate for inclusion as a proposed action are those that are discretionarily authorized, permitted, funded, or implemented by the Corps. Additionally, activities that are interdependent or interrelated (as defined in 50 CFR §402.02) with our primary actions could be included as a proposed action in this BA. None of the activities of other entities met these criteria for inclusion. Therefore, the proposed action in this Section 7 consultation includes construction and maintenance of habitat restoration measures for the Española Valley Study. If information is developed by the Corps during ongoing planning and design studies that would add to a further understanding of project effects, it would be provided to the Service during consultation.

This BA considers the effects of the USACE proposed action (Chapter 2) on Federally listed species and their designated critical habitat occurring on tribal lands along the Rio Chama and Rio Grande from the upstream boundary of Ohkay Owingeh Pueblo to the downstream boundary of Santa Clara Pueblo, including the lower reaches of the Rio Santa Cruz. This BA is based on the best scientific and commercial data available and includes all information necessary and available to initiate formal consultation and determine the potential effects of the proposed project on listed species and proposed critical habitat in the proposed action area. The proposed measures have been developed by the sponsors to support their respective habitat management objectives. These measures support the partnerships between the sponsors and the U.S. Fish and Wildlife Service (Service 2013). A detailed description of the action area is provided in Section 2.1 of this document.

This BA focuses on the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (flycatcher), the Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) (cuckoo), and the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) (mouse) based on their potential occurrence and habitat in the action area.

Chapter 1 summarizes the general location, description of the project authorization, and purpose and need for the action. Chapter 2 includes a detailed description of the proposed action. Chapter 3 describes detailed information regarding the status of listed species. Chapter 4 includes the analysis of proposed action. Table 4-1 summarizes the USACE determination of effects.

The three threatened and endangered species considered for analysis of effects in this document (Table 1-1) either occur in the action area and/or have proposed critical habitat in the action area. The other species of interest identified by the U.S. Fish and Wildlife Service (Consultation code 02ENNM00-2014-SLI-0436, 12 Jan 2015) do not meet the criteria for further analysis because there is no critical habitat in the action area, the lack of suitable habitat for the species or primary constituent elements (PCEs), or the species is unlikely to occur in the action area.

Table 1-1. List of Federally threatened and endangered species considered for analysis.

Project name: Española Valley Study Threatened and Endangered Species for effects analysis Consultation code 02ENNM00-2014-SLI-0436			
Name Common	 Species	Critical Habitat	Occurrence
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	Final	Yes
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	Proposed	Yes
New Mexico Meadow Jumping Mouse	*Zapus hudsonius luteus*	Proposed	No
Other species of interest eliminated from consideration			
Name Common	 Species	Critical Habitat	Suitable Habitat
Interior Least Tern	*Sterna antillarum athalassos*	Outside	None
Jemez Mountains Salamander	*Plethodon neomexicanus*	Outside	None
Mexican Spotted Owl	*Strix occidentalis lucida*	Outside	None

1.2 Background Information

The initial, multiple purposes of the Española Valley, Rio Grande and Tributaries, New Mexico Study (Figure 1-1) were to identify ecosystem restoration and flood risk management alternatives that are technically feasible, economically practicable, sound with respect to environmental considerations and publicly acceptable. Prior to dam construction in the early 1900s, the Rio Grande and the Rio Chama supported substantial areas of cottonwood, willow, New Mexico olive, and various species of shrub and wetlands (Scurlock, 1998). This suite of vegetation is considered to be representative of the natural "climax community" of species that would be found in an undisturbed riparian corridor along the Rio Grande. Stabilization of the channel through rectification and channelization supported development of extensive areas of cottonwood gallery forest in the 1940's through 60's, which is now reaching senescence.

The Nature Conservancy lists desert riparian woodland as a very rare although significantly important cover type and describes restoration of wetland and riparian systems as critical (USACE 2011). This combination of riparian, wetland, and fringe habitat is extremely valuable due to its rarity. The primary problem is the severe degradation and loss of riparian habitat along the Rio Grande and its tributaries. The importance of the Rio Grande bosque (a type of floodplain riparian zone only found in the arid southwest) as a wildlife habitat and cultural resource in the region and nation, as well as the impact on the bosque of earlier interventions by Federal agencies, indicates there is a Federal interest in restoration.

Channelization activities, gravel mining and non-engineered spoil banks, coupled with climate and water management have modified the hydrology of the Rio Grande, resulting in changes to the composition of native bosque plant species and associated wildlife habitats. Consequently, the river channel through the project area has become incised. The decreasing groundwater table beneath the river has reduced soil moisture in the adjacent riparian areas, significantly reducing nutrient cycling, and microbial and biochemical processes. This has directly contributed to the rapid decline and loss of the native cottonwoods, willows, and riparian ecosystems of the Rio Grande Basin. Channel incision has created 'drought' conditions on the adjacent floodplain, with patches of native riparian vegetation interspersed among larger areas of saltcedar and weedy upland vegetation.

Long-term isolation of riparian vegetation in the study area from the fluvial geomorphic processes on which it depends will eventually result in complete dominance of the plant communities by non-native upland plant species including saltcedar, Russian olive, Siberian elm, and tree of heaven. This eventual conversion of the bosque floodplain community (hydrologically driven) to an upland vegetation community with fire as the major disturbance mechanism would diminish habitat suitability and quality for many native animal species.

Current vegetation management techniques by Pueblo staff, including understory clearing and planting of native species, may temporarily reset patches of bosque to more natural structural states, but gradual replacement by non-native species could continue to occur unless the function of the bosque ecosystem and structure of the dynamic mosaic is restored.

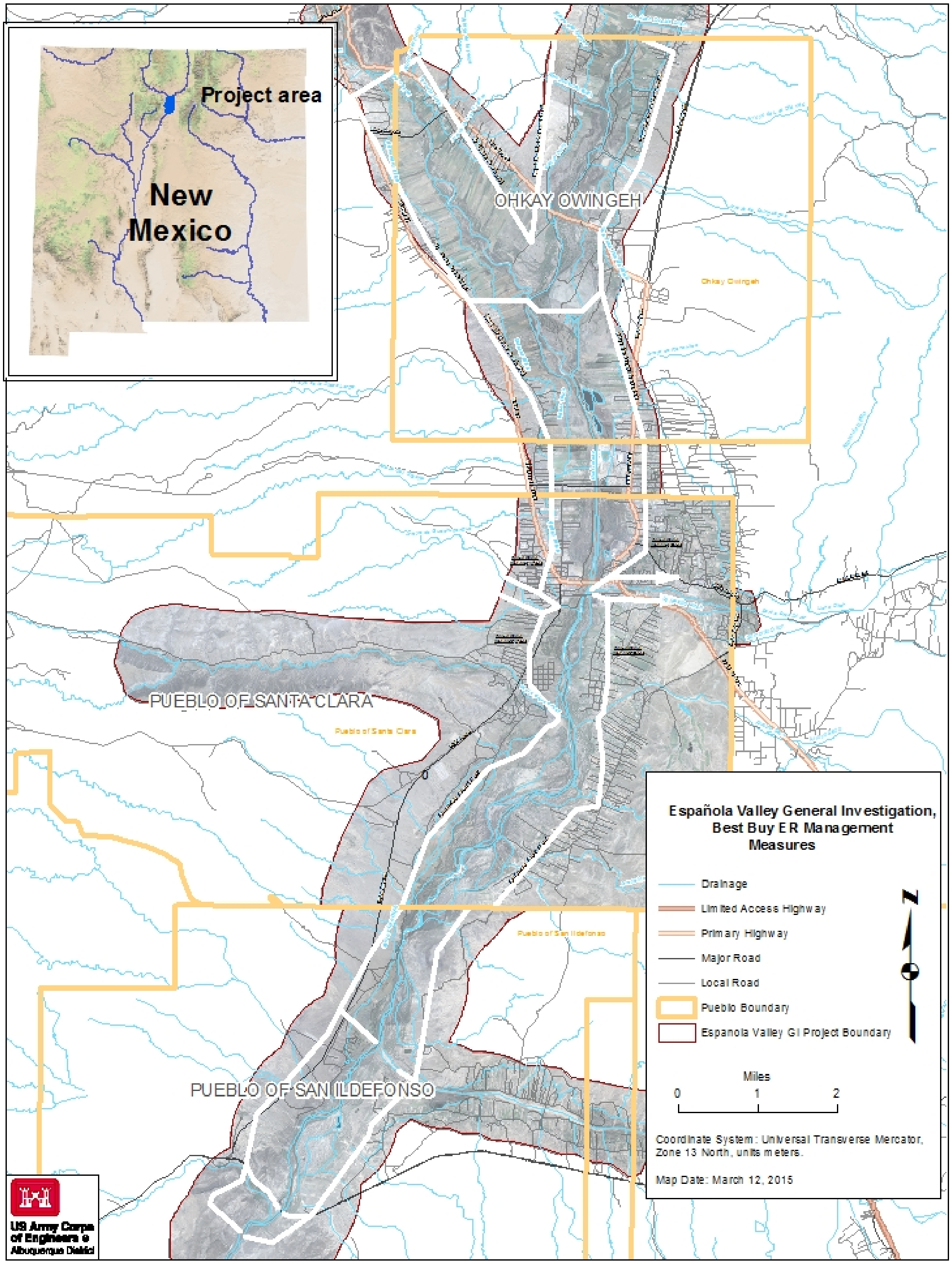


Figure 1-1 Española Valley, Rio Grande and Tributaries, New Mexico Study vicinity map.

1.3 Description of the Authorized Project

The Española Valley, Rio Grande and Tributaries, New Mexico Study (Study) was conducted by the USACE, Albuquerque District, and the Pueblos of Ohkay Owingeh (formerly San Juan Pueblo), Santa Clara, and San Ildefonso. Specifically, the study evaluated whether there was a Federal interest in the implementation of a project in the Rio Grande and Rio Chama floodplains within the study area. The study focused on ecosystem restoration, flood risk management and incidental recreation alternatives that are technically feasible, economically practicable, sound with respect to environmental considerations, and publicly acceptable. Although the Pueblo of San Ildefonso has suspended their participation in the project, leaving Ohkay Owingeh and Santa Clara Pueblos as the non-Federal sponsors, San Ildefonso supports the proposed project purpose to provide ecosystem restoration and passive recreation.

The proposed measures support long-term riparian habitat management on Ohkay Owingeh and Santa Clara Pueblos to benefit all species using a holistic approach (Service 2013a). The Service has excluded the pueblos from flycatcher critical habitat designation to support habitat management through continuing partnerships (Service 2013a).

Tribal sponsors have identified lands available for future projects. As long as this condition remains unchanged, there are opportunities to accomplish significant restoration within the study area. Restoration options have the potential to increase wetland and riparian habitat acreage and quality, thereby expanding wildlife diversity and quantity, controlling invasive plant species, reducing the risk of wildfires, and providing an ecological resource that is historically and culturally significant and valuable to the tribes and the region.

2 - Description of the Proposed Action

2.1 Action Area

The Pueblos of Ohkay Owingeh, Santa Clara and San Ildefonso are the non-Federal sponsors for this study. The study area for the proposed action extends approximately 21 miles along the Rio Grande and Rio Chama between 5,653 and 5,488 feet elevation (above NGVD29), and is roughly 5,300 acres in size (see Figure 2-1). The bosque in the proposed action area was historically one of the largest cottonwood riparian galleries in the southwestern United States. The proposed action area was classified into reaches based on sponsor ownership and watershed.

An interagency habitat team was convened with representatives from the Service, U.S. Bureau of Reclamation (Reclamation), New Mexico Department of Game and Fish (Game and Fish), the U.S. Forest Service (Forest), and the U.S. Bureau of Indian Affairs (Bureau), La Calandria Consultants, and the Audubon Society. The habitat team provided input to sponsors and the USACE on habitat quantification and restoration measures for the project.

The proposed action consists of ecosystem restoration measures to restore 271.9 acres of the bosque (Table 2-1) within the study area. The measures are designed for (1) improving hydrologic connectivity with the floodplain by constructing grade restoration facilities (GRFs), high-flow channels, terrace lowering, willow swales and wetlands, and (2) restoring native vegetation and habitat by exotic species reduction, and riparian forest revegetation with native plant species. The restoration measures proposed by the habitat team were refined by the sponsors prior to incremental cost analysis (Figure 2-1). Each of these proposed measure types will be discussed below. Work would be phased over seven to ten years with an initial construction phase potentially in the fall of 2017.

Table 2-1 Summary of proposed ecosystem restoration measures.

Ohkay Owingeh Pueblo	94.0 total acres
Grade restoration facilities (4 essential GRFs)	12.2
Grade restoration facilities (2 optional GRFs)	4.5
High-flow channels	1.8
Swales / wetlands	19.2
Terrace lowering	37.6
Vegetation management	18.7
Santa Clara Pueblo	177.9 total acres
High-flow channels	20.4
Swales	47.7
Swales / wetlands	17.0
Terrace lowering	7.7
Vegetation management	85.1

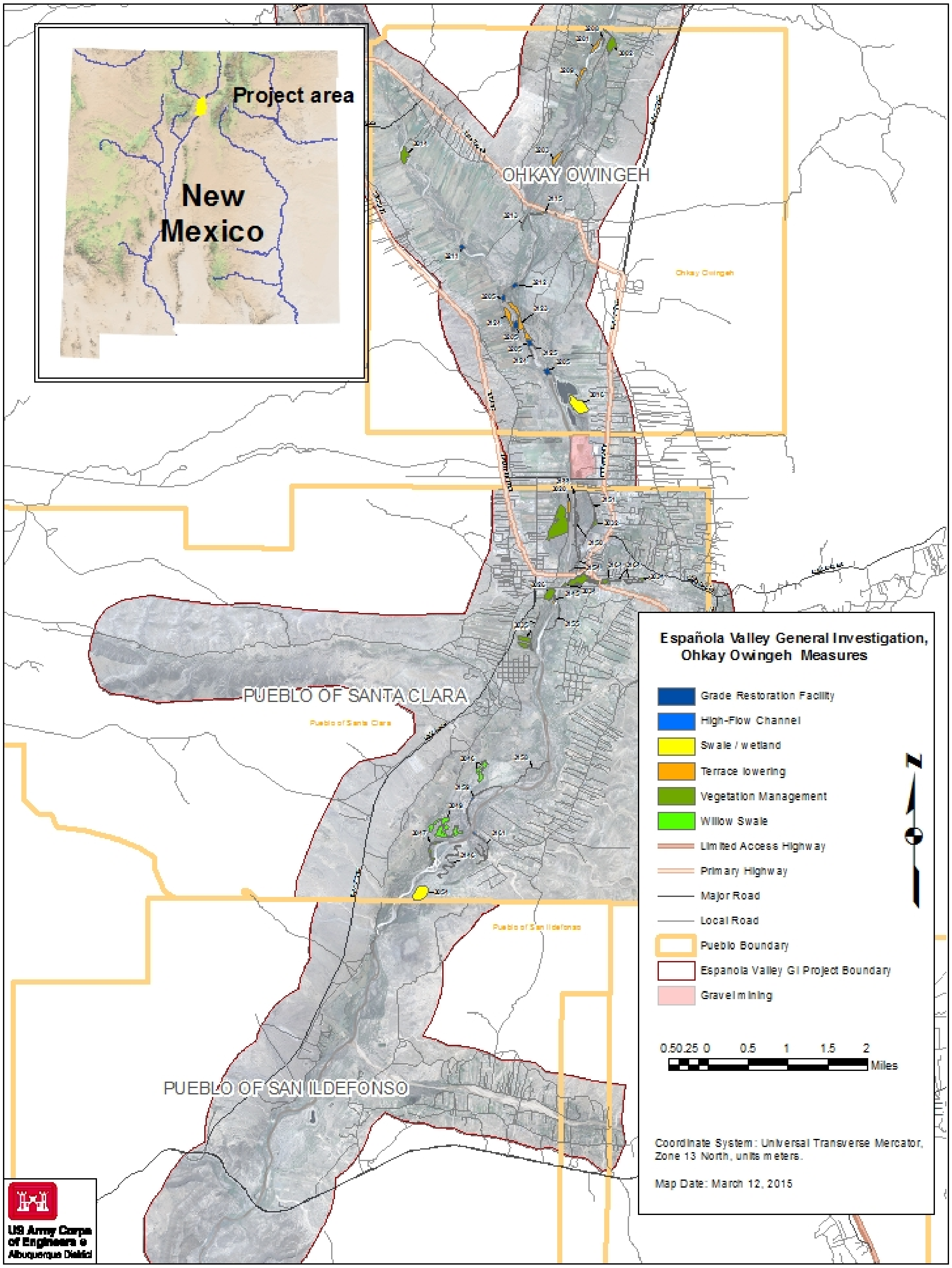
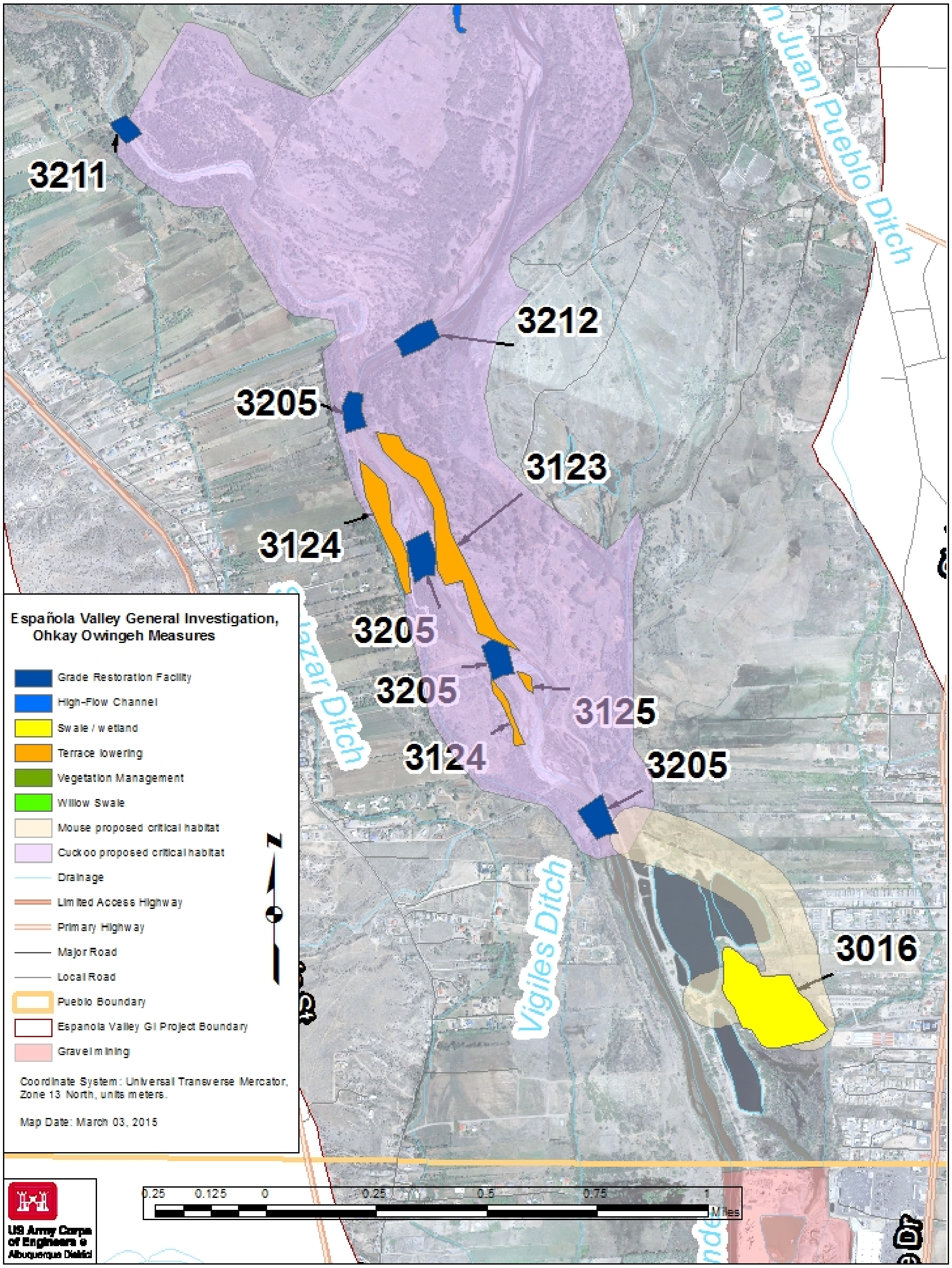


Figure 2-1 Location of proposed ecosystem restoration measures.

2.1.1 Grade Restoration Facilities

Grade restoration facilities (GRFs) are proposed to stabilize the channel bed and reduce the gradient of the river channel on Ohkay Owingeh Pueblo for two purposes. The GRFs are proposed to halt channel head-cutting and reconnect the floodplain. This is accomplished by replacing the hydraulic drop of the head-cut with a stable structure of equal or greater hydraulic drop (Figure 2-2). If the stable structure has a higher hydraulic drop, then some degree of restoration of previous conditions is possible. GRFs are also used to mitigate for the adverse results associated with channel incision. Constructing a stable structure raises the hydraulic grade line of the upstream channel until normal riparian function can be restored to the adjacent floodplain. Four GRFs are proposed to halt upstream migration of head-cuts (incised channels) from recent gravel mining operations (measure 3205 in Figure 2-3). The two upstream GRFs are proposed to provide additional floodplain connectivity (measures 3211 and 3212 in Figure 2-3). The approximate 12.2 acres of GRFs constructed on Ohkay Owingeh Pueblo would improve floodplain connectivity for up to 80 acres adjacent to the measures.

Figure 2-2. Example of a constructed grade restoration facilities at Santa Ana Pueblo.



2.1.2

Figure 2-3 Location of grade restoration facilities (GRFs) on Ohkay Owingeh Pueblo.

2.1.3 High-flow Channels

High-flow channels are proposed to improve floodplain connectivity on Ohkay Owingeh Pueblo (2 acres, Figure 2-5) and Santa Clara Pueblo (20 acres,). Under historic flood flow regimes, high-flow channels were once an integral part of the river form and function. There is evidence of former channels present in many locations within the proposed action area. The objective of this measure is to re-establish the connections between the river and the bosque by constructing channels across the floodplain that would become inundated at flows between 1,500 – 3,000 cfs. This measure typically includes excavating the sediment out of the upstream and downstream portions of the remnant high-flow channels in order to re-establish the bosque-river connection, clearing out debris and non-native plants, and revegetating with native plants to increase the habitat quality within the bosque. High-flow channels would transport much-needed water to bosque vegetation. Embayments may be constructed as part of the high-flow channels when possible to creates area for native recruitment of cottonwoods and willows. The Rio Grande Nature Center Habitat Restoration Project is an example of a recent high-flow channel measure (Figure 2-4).

Figure 2-4 South end of Rio Grande Nature Center high flow channel exiting to river.

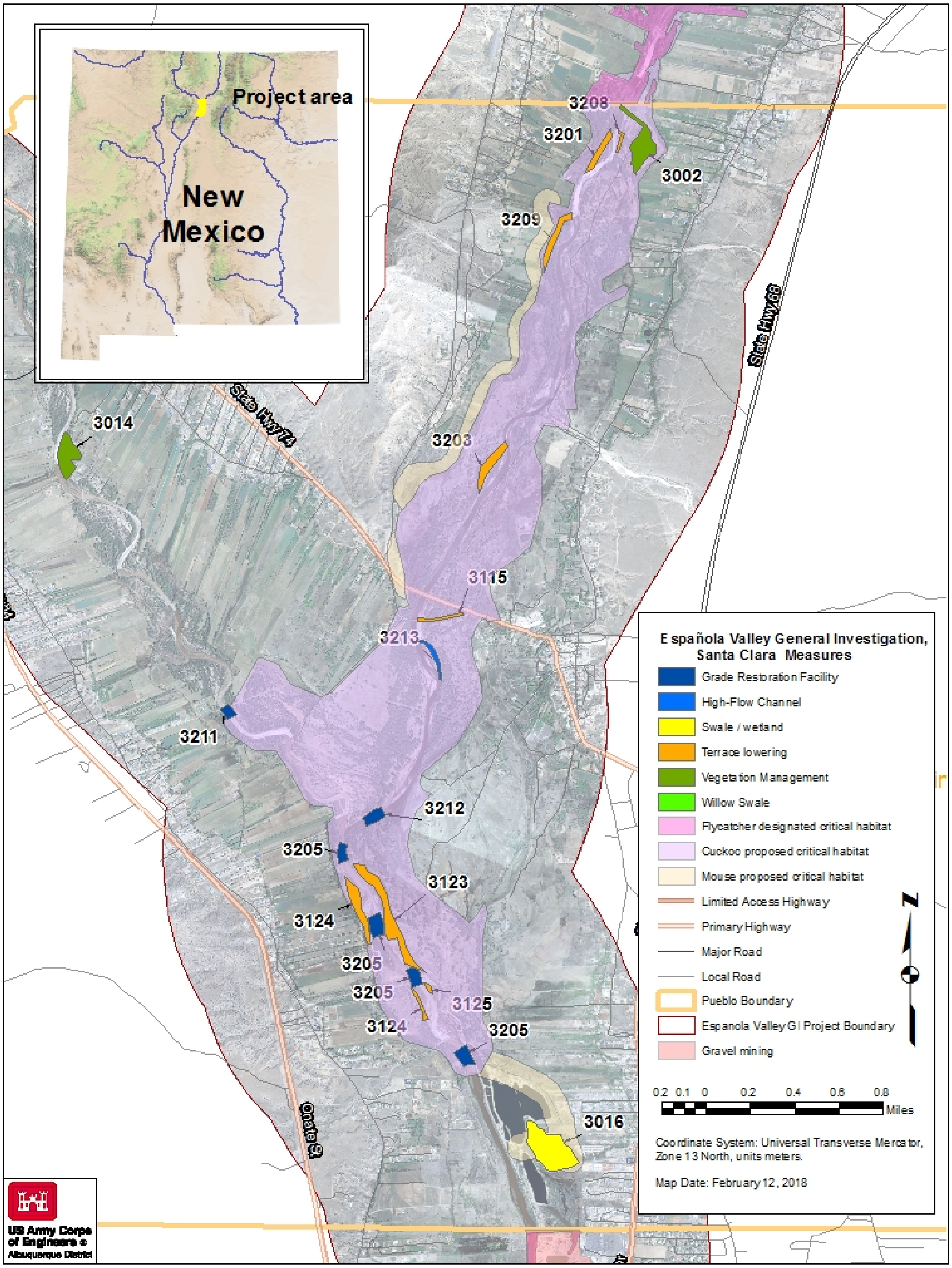


Figure 2-5 Location of ecosystem measures on Ohkay Owingeh Pueblo.

2.1.4 Swales

Approximately 48 acres of willow swales are proposed on Santa Clara Pueblo (Figure 2-8). Willow swales are depressions constructed by removal of vegetation, dumped debris and soil to provide microenvironments in which native plants can thrive due to the decreased depth to the water table and moist soils. In certain areas of the bosque, the depth-to-water table is minimal and even slight excavations expose water. Willow swales also help create vegetative habitat where establishment of native plants or seed would otherwise be challenging due to soil type or depth to groundwater. Depending upon the location, there could be a series of willow swales that become progressively drier with increasing distance from the river or water table. Once established, native plants would thrive in these depressions. Figure 2-6 shows a swale that was constructed at the Brown Burn, after its initial construction, and post-project (Figure 2-7).

2.1.5 Wetland Restoration

Wetland measures (17 acres, Figure 2-8) are proposed on Santa Clara Pueblo. Wetland restoration measures focus on development of open water wetlands, marsh wetlands, or wet meadows. An open water wetland would be similar to that constructed at the Albuquerque Biological Park Wetland (Figure 2-9). Such wetlands provide open water habitat for migrating and local waterfowl and aquatic habitat for numerous species. A marsh wetland would have fluctuating water levels (usually 1-5 feet) and various vegetative species. These areas can be created by lowering the ground surface level below the local water table.

A wet meadow habitat is similar to a marsh wetland, but has much shallower standing water, and is created by allowing flow from a deeper wetland area (such as an open water wetland) to flow out into an existing dry area or by lowering an area to the shallow groundwater table. This creates marshy or moist soil habitat, usually only about 6 inches deep with water.

Figure 2-6 Willow swale at the Brown Burn, South of Rio Bravo Blvd., in Albuquerque, NM.

Figure 2-7 Willow swale at the Brown Burn three years construction.

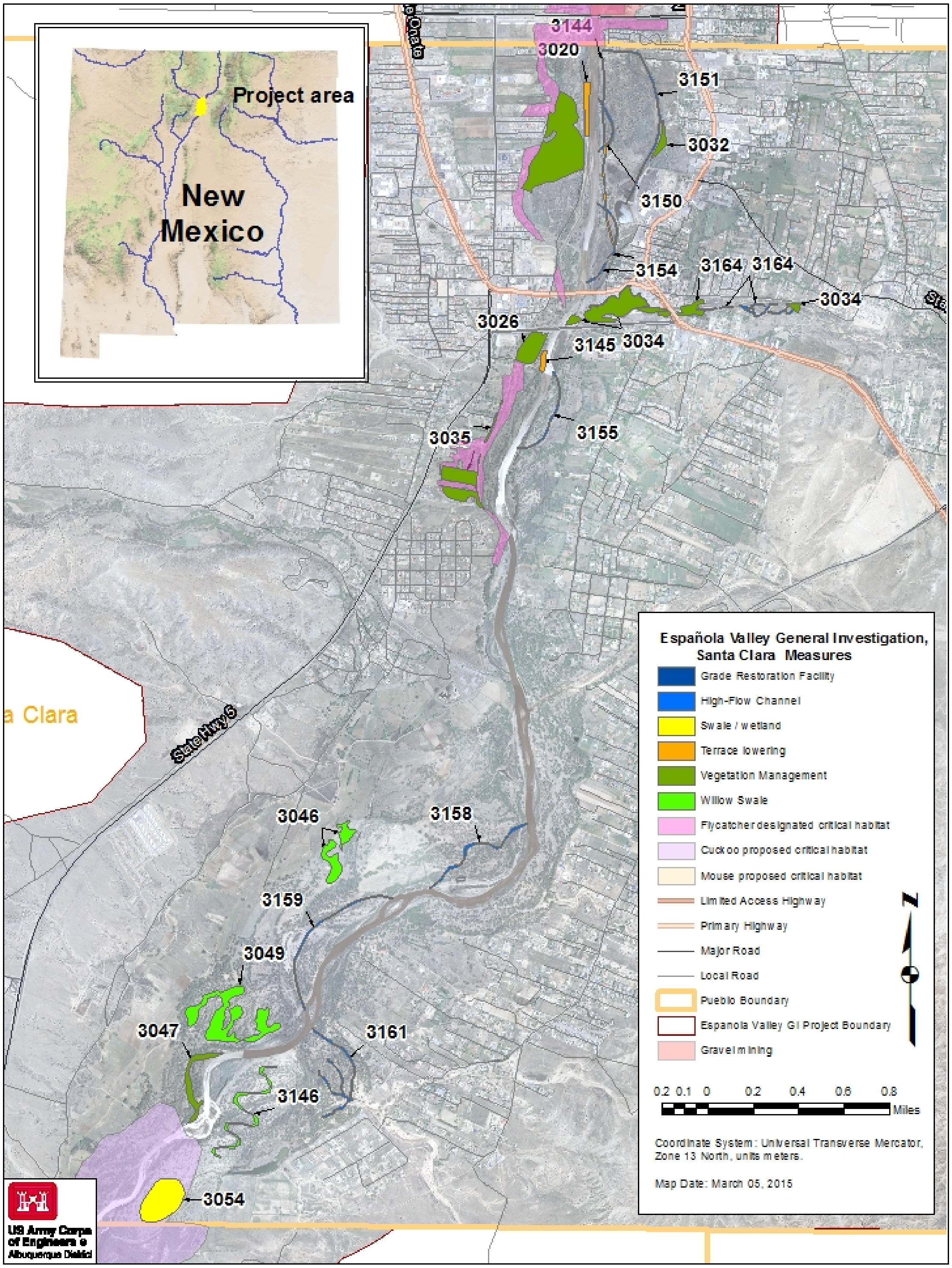


Figure 2-8 Location of ecosystem measures on Santa Clara Pueblo.

Figure 2-9 Albuquerque Biological Park Wetlands, May 2007.

Figure 2-10 Bottomless Lakes State Park wetlands, August 2008.

2.1.6 Terrace Lowering

Terrace lowering is proposed to improve floodplain connectivity on Ohkay Owingeh Pueblo (57 acres, Figure 2-5) and Santa Clara Pueblo (8 acres, Figure 2-8). Terrace lowering involves the removal of vegetation and excavation of soils adjacent to the main channel to enhance the potential for overbank flooding (Tetra Tech, 2004). Terrace lowering has been used extensively in the Albuquerque area (Figure 2-11). This technique (Figure 2-12) has been utilized in various locations of the Middle Rio Grande for creation of potential flycatcher habitat by the Middle Rio Grande Endangered Species Collaborative Program (MRGESCP). As the banks are excavated, it creates a greater connection with the river. As the river moves through these areas, it both scours and creates moist soil for vegetation. In many cases, coyote willow will fill in these areas creating riparian shrub habitat that provides habitat for birds, small mammals and herpetofauna. The opportunity to lower the bankline terraces and revegetate with native riparian vegetation would restore this habitat, facilitate overbank flows, and provide sediment for the natural geomorphic system.

Figure 2-11 Terrace lowering at Tingley Bar.

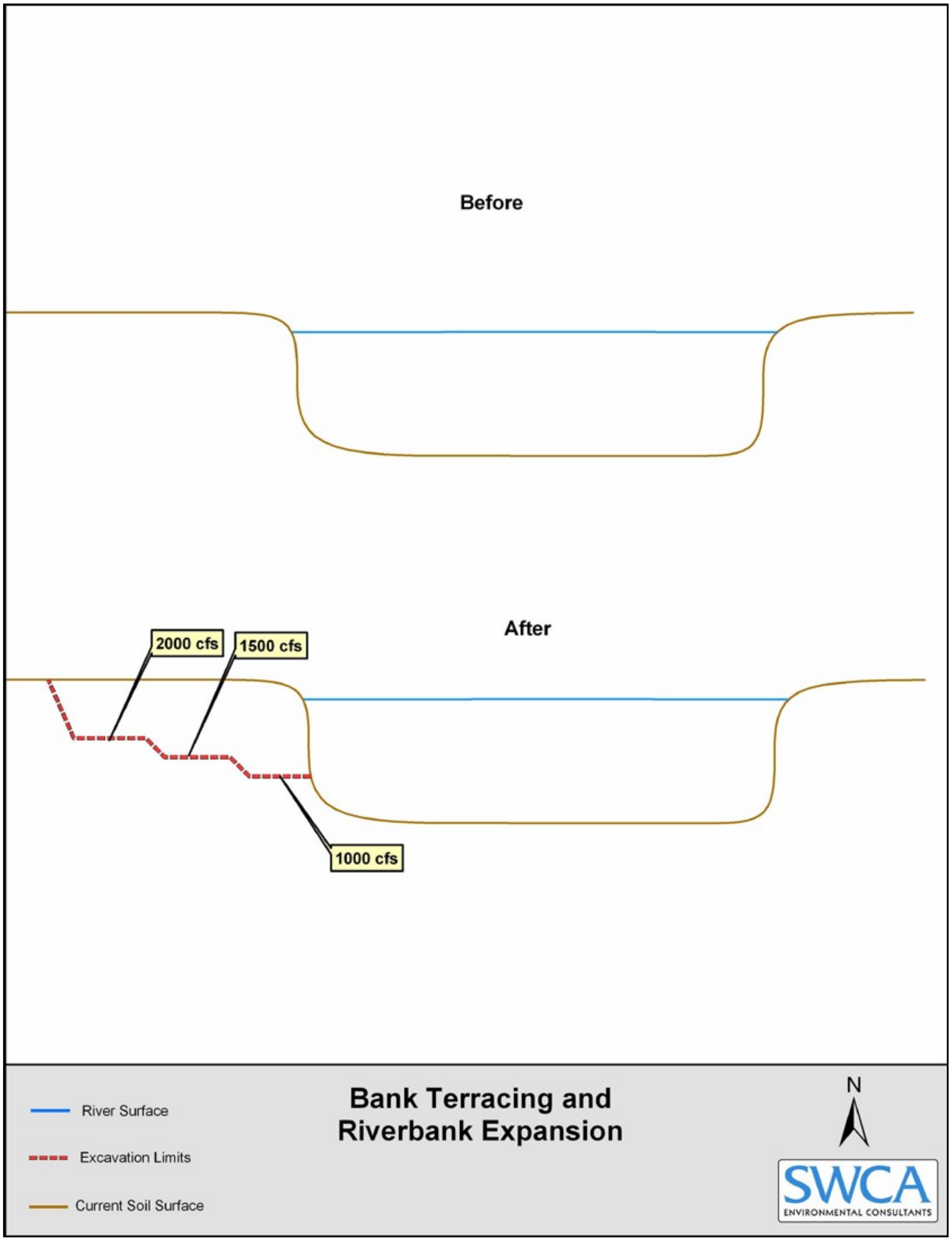


Figure 2-12. Schematic of terrace lowering (USACE 2011).

2.1.7 Vegetation Management

The vegetation management measure consists of two treatment phases: partial to complete removal of invasive plants and subsequent revegetation with native plant species. Vegetation management is proposed as standalone measures on Ohkay Owingeh Pueblo (19 acres,) and Santa Clara Pueblo (85 acres). Vegetation removal is the initial step for excavation measures, which are followed by revegetation with native plant species.

Selective invasive (non-native) plant removal as a primary treatment facilitates restoration efforts by eliminating the chief competition to native trees, shrubs, forbs and grasses. Invasive plant removal also reduces the fire hazard, while enhancing aesthetic and recreational aspects of the bosque. In many areas, continued maintenance and repeated treatment of invasive plant species for stump sprouting, and removal of juvenile volunteer non-natives, would be necessary. This would be provided for under the operations and maintenance portion of the project.

2.1.7.1 Vegetation Removal Treatments

A number of protocols for reducing fuel loads and treating non-native vegetation have been, and are being, utilized in the Middle Rio Grande and throughout the Southwest. These methods include both manual and mechanical treatment methods (described below). Follow-up treatment with herbicides, or root ripping (raking approximately 6-12 inches into the ground in order to remove roots), are also options. Removal of non-native vegetative species would take place between August 15 and April 15 of each year in order to avoid bird nesting seasons and requirements, notably, under the Migratory Bird Act, which severely constrain activities with the potential to impact nesting birds.

Manual treatment - Using this method, dead material would be piled up and/or processed by cutting into small pieces using a chain saw. Large material would be hauled off, with some resources for use as fire wood. Smaller material would be chipped on site using a chipper. Chips would either be tilled into the ground prior to revegetation or hauled off, depending on their density. No more than 2 inches of chipped material would be left on site. The stump of any live non-native trees that is cut would be treated immediately with herbicide, if not entirely removed. This method would be used in areas where the bosque is not very wide and equipment would not fit, or areas where there are a large number of native trees and shrubs to protect.

Mechanical treatment - Mechanical control entails the removal of aerial portions of the tree (trunk and stems) by large machinery such as a tree shear or large mulching equipment. Both dead material and live non-native trees would be treated mechanically. Where possible, trees would be removed with the root-ball intact. Otherwise, the stump would be treated immediately with herbicide. Material would be processed as stated above: large material would be hauled off and smaller material would be chipped.

Combination treatment - The most efficient approach for treatment of dead material and non-native vegetation (and the most frequently used in the Middle Rio Grande where a fair amount of native species are mixed in with non-native) is a combination of manual treatment, mechanical treatment and use of herbicide. Some areas may be very dense, and the use of manual methods allows them to be opened up for machinery access. Mechanical equipment can then take over while hand crews move ahead of machinery to keep areas open enough to work in without damaging native vegetation to remain. The procedure to be implemented at each location would be evaluated on a site-by-site basis.

Re-sprout treatment - Following the initial removal of non-native plant species, re-sprouting from the root systems commonly occurs. These re-sprouts would be treated with either herbicide or by root-ripping prior to revegetating the area with native species. Thinning and removal of non-native vegetation under this proposed action would include herbicide treatment in many locations. Herbicide application would be used where root ripping is not an option. Herbicide would be immediately applied to the plant using a backpack sprayer, hand application with a brush, or other equipment that allows direct application.

2.1.7.2 Revegetation Treatments

The overall restoration strategy for the Española Valley Study measures is to revegetate all areas within the proposed action areas utilizing native species. Each sponsor will review and update the proposed seed and plant lists for measures in their areas. Revegetating the bosque with shrubs and juvenile trees to re-create the lost native understory in the bosque forest woodland areas, and the lost native shrub thickets in open areas. At the same time, gaps are to be left in between the revegetated areas to create edge habitat, the richest type of habitat, and to create firebreaks to limit the potential for catastrophic fire. Maintenance and adaptive management would be important to the long-term success of the revegetated areas. Ongoing removal of non-native stump sprouts and volunteers would be necessary in all planted areas.

Different planting strategies would be combined in order to create the target mosaic mixture of different ecosystem types (bosque forest, grass meadow, wetlands). Planting strategies to target a riparian gallery forest mosaic would include the following revegetation treatments:

Grasses and forbs - Seeding with native grasses and forbs, such as Indian rice grass (*Oryzopsis hymenoides*), galleta grass (*Hilaria jamesii*), side oats grama (*Bouteloua curtipendula*), blue grama (*Bouteloua gracilis*), sand dropseed (*Sporobolus cryptandrus*), and sunflower (*Helianthus annulus*) and in wetter areas, yerba mansa (*Anemopsis californicus*), emory sedge (*Carex emoryi*), and salt grass (*Distichlis stricta*). Seeding involves sowing seed via methods such as broadcasting, crimp and drill, or hydro-mulching. Other than the gel in the hydro mulch, no irrigation would be applied. Timing of seeding would be critical to the establishment of the vegetative cover. Late summer is usually the best time. Wood debris, such as large logs that remain after thinning, would be placed strategically to provide additional habitat once seeding is completed.

Shrubs - Bare root or container planting with native shrubs, such as New Mexico olive (*Forestiera neomexicana*), four wing saltbush (*Atriplex canescens*), chamisa (*Chrysothamnus nauseosus*), false indigo (*Amorpha fruticosa*), golden currant (*Ribes aureum*), three leaf sumac (*Rhus trilobata*), wolfberry (*Lycium pallidum*), and in wetter areas, coyote willow (*Salix exigua*), black willow (*Salix nigra var. gooddingii*), and seep willow (*Baccharis salicifolia*) would be an important strategy for establishing woody plants. Bare root planting refers to planting a plant directly in the ground without a rootball. Most of the native shrubs listed above are grown in tall pots, which provide a longer and more established root system, and have been found to support excellent seedling survival (USDA NRCS PMC, 2001). Container planting refers to planting small plants in small containers. Plants would be watered through the first summer. Coyote willows can be planted directly in wet areas as live sticks. Shrubs would be planted at various densities depending on what is currently at the location. If no native understory vegetation exists at a location, then shrub planting density would be higher (500 stems per acre or more). If there is existing native vegetation, then a lower density of native shrubs would be installed (100-500 stems per acre as needed). Shrubs would be planted in the fall and trees would be planted in the winter.

Trees - Pole planting of native trees, such as the Rio Grande cottonwood (*Populus fremontii var. wislizenii*), and black willow. Pole planting is the technique most frequently used for restoration of riparian areas. Many of the pilot projects in the bosque have utilized pole planting, and according to OSD, they have a 90 percent success rate (Tony Barron, pers. comm., 2002). Branches of cottonwoods and willows, 10 feet to 15 feet in length, are slipped into holes that have been augered through the soil to the water table. Little maintenance is required beyond taking precautions to protect the young trees from beavers. Trees would be planted at a fairly low density since cottonwoods exist throughout the proposed action area. They would be supplemented in some areas as needed but at a very low density (10-50 stem per acre). Willow trees are lacking in some areas of the proposed action area and would be planted at a higher density in those areas (25-75 stems per acre).

Planting strategies would not include planting larger plants, such as balled and burlapped or container trees, because they would not be successful in the proposed action area without significant irrigation. Seeding would be applied wherever restoration occurs. Wetland plants - Plug planting would be used to plant wetland and other moist soil plants within created water features. Species that could be provided as plugs include yerba mansa (*Anemopsis californicus*), native sedge (*Carex* spp.), native rush (*Scirpus* spp.), and saltgrass (*Distichlis stricta*). Plug planting refers to insertion of small seedlings with the soil or growth medium attached. Plugs are planted directly into moist soils on the edge of water features (wetlands, high-flow channels, etc.).

2.1.8 Recreational Features

Recreation features are proposed for the Santa Clara Wetlands and Gutierrez Pond area on the east side of the Rio Grande. The recreational features include a combination walking and biking trail, other gravel trails, informational kiosk and shade structures, hardened crossings to traverse the conveyance channel, and trail shelters. Gravel trails would follow existing trails, levees or access road alignments. Kiosks and benches would be placed at strategic locations along improved trails. Picnic areas are proposed along the trail where the Bosque vegetation would provide natural shade, along with river overlooks and a boardwalk to traverse wetland areas.

Construction activities would be coordinated with the sponsors to avoid effects on tribal activities within the proposed action area. All work zones would be designated and signed with appropriate cautionary information.

2.2 Project Implementation

Due to the scope of the project and anticipated availability of funding, it is estimated that implementation of the proposed action would take place over a period of seven to ten years. The first phase could potentially begin in 2017. The proposed action would be phased to make the most efficient use of available funds, and to phase tasks that require sequential implementation.

Whereas channel stabilization, terrace lowering and high-flow channel building at any one proposed action area can be accomplished in a relatively short time (a few months). Contractors shall use best management practices (BMPs) to minimize bankline disturbance and sediment entering the river during excavation. Swales and wetland measures are excavated away from the river with no effects on water quality. Removal of invasive plant species and revegetation with native plants is, generally, a multiple year effort. Once initial removal takes place, follow-up treatment is required 6 months to a year later to eliminate trees that re-sprout from roots or stumps. Planting of native species is not prudent until such follow-up treatments have been performed. In some areas, removal of non-native species and jetty jacks would also be required to allow access to construct other measures.

Construction of all measures would be scheduled during the typical low flow seasons on the Rio Grande (fall and winter). Invasive species removal would take place first, followed by construction of ecosystem measures. Recreation features would come last. Ecosystem measures would be constructed within the bosque, and only later connected to the river to reduce sediment inputs into the river. If active flows continue adjacent to the inlet/outlet of given ecosystem measures (for example the high flow channels), said active flows may need to be diverted with a port-a-dam or similar device, as described in Section 2.3.1. Excess material excavated by the construction of the ecosystem measures would be transported to appropriate spoil areas on sponsor lands.

2.2.1 Construction Sequence of Ecosystem Restoration Measures

Sequencing of the construction of ecosystem measures (channel stabilization, high flow channels and/or terrace lowering) is proposed to reduce the amount of potential sediment moving into the river and reduce impacts to the river bank edge.

The high-flow channels would be constructed so that the middle of the channel is excavated first, then the opening at the downstream end, and the opening at the upstream end would be excavated last (similar to previous USACE restoration projects at the Rio Grande Nature Center and Route 66 projects). Flows in the river during construction of these high flow channels are anticipated to be about 400-1000 cfs. The exact device used to divert the flow of water during construction, if needed, would be at the discretion of the construction contractor and approved by the USACE. If flows are low enough, it is preferred that the contractor leave the edge of the berm for each end of the channel in place during construction until opening the channel at the very end. The berm could serve as the ‘dam’ itself. Therefore, a coffer dam or silt curtain may not be needed (Figure 2-13). If one is needed, the silt curtain or coffer dam would be placed along the bank line and then pushed out into the channel to expand the bankline, under the supervision of USACE Biologists, in order to minimize disturbance to the flows.

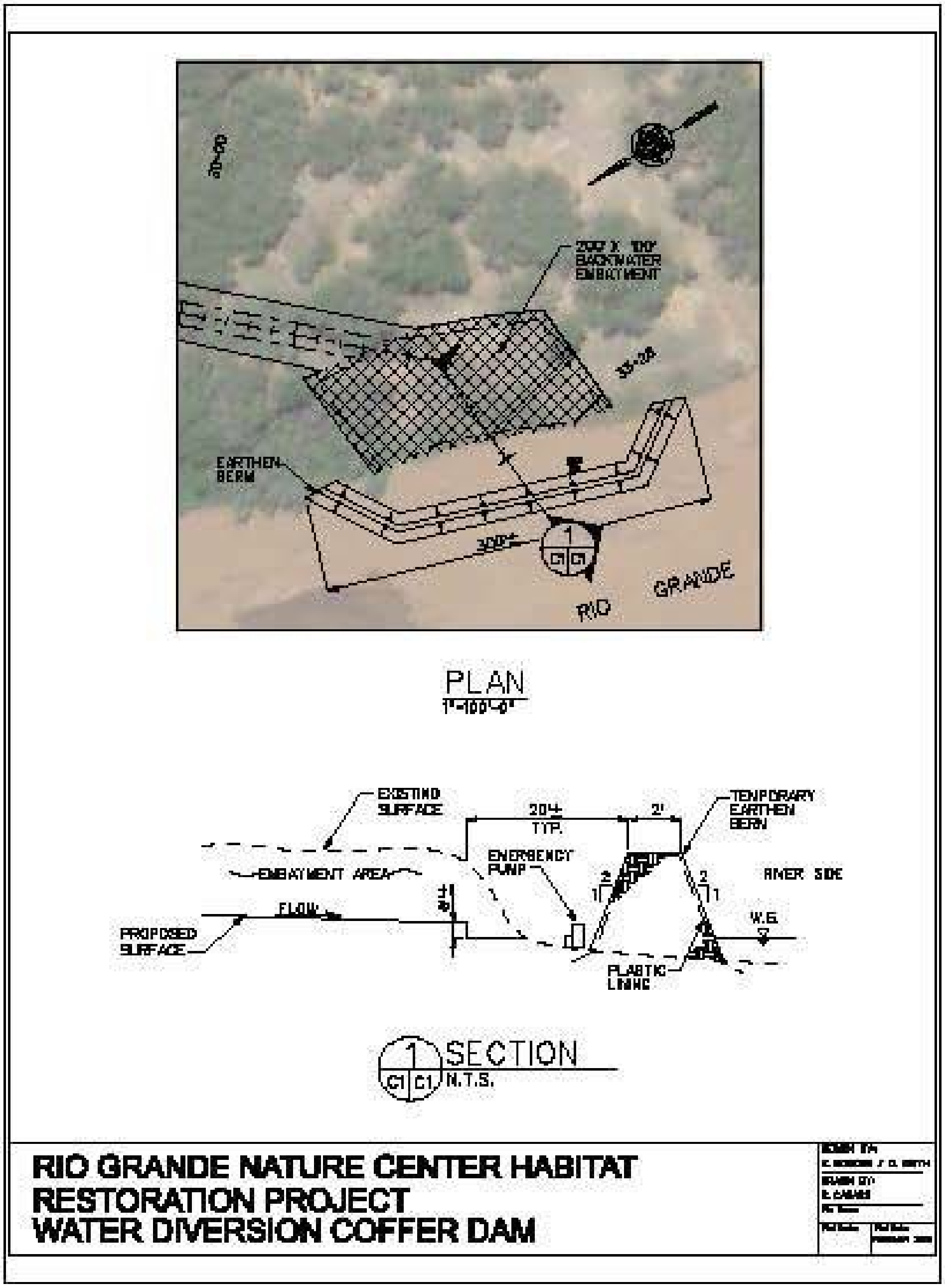


Figure 2-13. Example of potential coffer dam and/or silt curtain for use during construction of channel openings.

2.2.2 Access and Staging

All proposed measures are in proximity to the river channel. Access through the riparian forest to the river edge is available. A temporary access road from the nearest existing road would be constructed to access proposed construction areas. These temporary access roads would be removed and reseeded once construction is complete unless requested to be left by the sponsor.

Any additional disturbance caused by equipment accessing the site would be reseeded with native vegetation and mulched once complete.

Access to all work areas would occur along existing roads, and staging would occur in adjacent open areas made available by the sponsor. Equipment would access proposed construction areas from the nearest road. Daily temporary staging could also take place within the bosque if other areas are not available. Additional access and subsidiary staging areas required to facilitate construction activities would be coordinated with the sponsors.

2.2.3 Monitoring, Adaptive Management and Maintenance

Due to the relatively recent emergence of restoration science and inherent uncertainty in some aspects of ecosystem restoration theory, planning and methods, success can vary based on a variety of technical and site-specific factors. Recognizing this uncertainty, it is prudent to allow for contingencies to address potential problems in meeting restoration goals that may arise during or after project implementation. Recent USACE guidance *Implementation Guidance for Section 2039 of the Water Resources Development Act of 2007 – Monitoring Ecosystem Restoration* requires that a plan be developed for monitoring the success of the ecosystem restoration. This monitoring plan shall include "1) a description of the monitoring activities to be carried out, the criteria for ecosystem restoration, and the estimated costs and duration of the monitoring; and 2) specify that the monitoring shall continue until such time as the Secretary determines that the criteria for ecosystem restoration success will be met." An adaptive management plan should also be included.

Post-project monitoring is a crucial requisite of the adaptive management process, as performance feedback may generate new insights on ecosystem response and provides a basis for determining the necessity or feasibility of subsequent design or operational modifications. Success should be measured by comparing post-project conditions to the restoration project purpose and needs and to pre-project conditions.

Monitoring also provides the feedback needed to establish protocols and make adjustments where and when necessary to achieve the desired results. Monitoring of the USACE Bosque Wildfire, Albuquerque Biological Park Wetlands, Rt. 66 Ecosystem Restoration, and Middle Rio Grande Restoration projects have provided information that has been useful in developing goals and alternatives for this project. Monitoring from those projects would also aid in design. Monitoring of this project would be essential to the success of not only the Española Valley Study, but other USACE studies as well. Therefore, baseline data will be collected so that results can be quantified and compared. Monitoring of project performance and success would be conducted for at least five consecutive years following construction. Wetland and bosque monitoring would include vegetation mortality, wildlife and vegetation species, groundwater and other environmental indicators. Project monitoring would be coordinated with each sponsor and incorporated with ongoing efforts to reduce duplicate effort. These efforts would continue post-construction to show project benefits and changes in use before and after construction. Wildlife use by ecosystem measures may also be conducted. All data would be shared and necessary adjustments to restoration activities would be made by consensus of the habitat team.

Part of this monitoring may provide information on design that may require changes. Depending on how the project measures function (i.e., high flows move through the channel and there is potential for maintenance items such as scouring and/or build up of sediment could occur), adaptive management would be enlisted to make changes in the field if it is determined to be needed once the proposed action measures are in use.

3 - Species Information

Under Section 7(a)(2) of the ESA, when considering the effects of an action on Federally listed species, agencies are required to take into consideration the environmental baseline. Regulations implementing the ESA (50 CFR 402) define the environmental baseline as the past and present impacts of all Federal, State, Tribal, or private actions and other human activities in the action area; the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early Section 7 consultation; and the impacts of State and private actions that are contemporaneous with the consultation in progress. For each species, the environmental baseline describes its current status and its habitat in the action area as a point of comparison to assess the effects of the action now under consultation.

3.1 Southwestern Willow Flycatcher

3.1.1 Status and Distribution

A final rule was published in the February 27, 1995, Federal Register to list the southwestern U.S. population of the Willow Flycatcher as an endangered species under the ESA with proposed critical habitat. The range of the listed subspecies includes southern California, Arizona, New Mexico, southern portions of Nevada and Utah, and southwestern Colorado (Service 1995). The species is likely extirpated from west Texas (Durst *et al*. 2007). A recovery plan for the flycatcher was completed in 2002 (Service 2002).

3.1.1.1 Critical Habitat

The original final rule designating critical habitat for the species range-wide (Service 1997) did not include the Rio Grande. A proposal to re-designate critical habitat was published in October 2004, and final designation was published October 19, 2005 (Service 2005), which did include portions of the action area in the Middle Rio Grande. In 2011, the Service again proposed to revise critical habitat for the flycatcher, and final designation was published on January 3, 2013 (Service 2013a). Within the action area, critical habitat has been designated from the southern boundary of Ohkay Owingeh Pueblo downstream through Santa Clara Pueblo. Flycatcher critical habitat on Santa Clara Pueblo consists of riparian vegetation adjacent to the floodway in the action area (Figure 2-8, Service 2013a).

3.1.1.2 Status and Distribution in the Middle Rio Grande

In New Mexico, the flycatcher has been observed along the Rio Grande, Rio Chama, Zuni River, San Francisco River, and Gila River. Because observations were not consistent or extensive prior to the listing of this species, a comparison of historic numbers to current status is not possible; however, the available native riparian habitat along the Rio Grande has declined, and it is assumed populations may have declined from historic numbers as well (Service 1995).

Since the initial surveys of the Rio Grande valley in the 1990s, breeding pairs have been found in scattered locations from Elephant Butte Reservoir upstream to the vicinity of Española. Several locations along the Rio Grande have consistently harbored breeding flycatchers. These areas have one or more flycatcher pairs that have established a territory in an attempt to breed. In some locations, these local populations appear to be expanding with increasing numbers of territories being detected. Some local populations have remained small (10 territories or fewer) but stable; other sites have been abandoned and no longer contain territorial flycatchers.

In the Middle Rio Grande, surveys for flycatchers in selected areas have been conducted during environmental compliance activities for various projects throughout the riparian corridor of the Middle Rio Grande. Presence/absence surveys and nest monitoring in selected areas of the Rio Grande between Velarde and Elephant Butte Reservoir have been conducted from 1993 to 2014. With expanded or increased survey efforts throughout this 22-year period, several sites have been located where flycatcher territories have consistently occurred. Once located, these core breeding areas have been monitored annually. The summaries of flycatcher surveys and nest monitoring in the Middle Rio Grande from 2003 to 2013, previous consultations, surveys conducted during the 2014 breeding season, and other pertinent data are considered the environmental baseline for breeding flycatchers in within the action area. These data are further discussed below.

Since 1993, flycatchers have been reported from 19 sites within the Rio Grande basin; however, several of these sites no longer support flycatchers. The majority of sites within the Rio Grande basin support isolated populations of fewer than six territories. Elephant Butte Reservoir has consistently supported the largest subpopulation of birds.

Table 3-1 summarizes the locations of known territories (that is, occupied by a male or pair of flycatchers) in the Upper and Middle Rio Grande Management Units from 2003 through 2013. Excluding Tribal lands, most suitable habitat has been regularly surveyed within the main stem of the Middle Rio Grande. It is highly unlikely that any large concentrations of flycatchers have gone undetected; however, sites supporting a few undetected territories may exist in some isolated patches of habitat throughout the basin. Occupied territories are more abundant in the southern half of the Middle Rio Grande (from the Sevilleta NWR south) than in the northern half. In the 2013 breeding season, 333 flycatcher territories were found within the Middle Rio Grande (Moore and Ahlers 2014). Occupied sites were scattered from White Rock Canyon upstream from Cochiti Dam downstream to Elephant Butte Reservoir (approximately 200 river-miles).

Table 3-1 Known Southwestern Willow Flycatcher territories[a] along the Rio Grande, New Mexico, 2003-2013.

River Reach	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
UPPER RIO GRANDE MANAGEMENT UNIT											
Rio Chama – Otowi Bridge	NS[b]	0	0	0	0	0	0	0	0	0	0
Otowi Bridge – Cochiti Dam	NS	NS	NS	NS	NS	0	0	NS	2	0	1
MIDDLE RIO GRANDE MANAGEMENT UNIT											
Cochiti Dam – Isleta Diversion Dam[c]	0	0	0	0	0	0	0	0	0	0	0
Isleta Diversion Dam – San Acacia Diversion Dam	23	26	27	30	33	44	21	19	18	20	27
San Acacia Diversion Dam - RM 62	37	17	3	21	18	20	26	43	61	75	39
Total	60	43	40[d]	51	51	64	47	62	81	95	67

[a] "Territories" = pair or single male present in June and July surveys.
[b] NS = Not surveyed.
[c] Protocol surveys were performed only in limited areas. Anecdotal information supports its absence throughout the reach.
[d] High flows hampered access during surveys throughout the Middle Rio Grande.

3.1.2 Life History and Ecology

Flycatcher Breeding Chronology

The flycatcher is a late spring/summer breeder that builds nests and lays eggs in late May and early June, and fledges young in late June or early July (Sogge *et al*. 1993, 2010; Tibbitts *et al*. 1994). When re-nesting or second broods occur, young will fledge into mid-August (Service 2002). Based on data from flycatcher surveys and nest monitoring along the Middle Rio Grande, particularly in the San Marcial reach, flycatchers have been found in the area as early as May 6; however, actual nest initiation has been documented to occur later in May (Moore and Ahlers 2014).

A generalized Southwestern Willow Flycatcher breeding chronology is presented in Figure 3-1 and is based on Unitt (1987), Brown (1988), Whitfield (1990), Maynard (1995), Sogge (1995), Skaggs (1996), Sferra *et al*. (1997), and Sogge *et al*. (2010). Extreme dates for any given stage of the breeding cycle may vary as much as a week from the dates presented. Egg laying begins as early as late May but more often starts in early to mid-June. Young can be present in nests from mid-June through early August. Young typically fledge from nests from late June through mid-August but remain in the natal area 14 to 15 days. Adults depart from breeding territories as early as mid-August, but may stay until mid-September in later nesting efforts. Fledglings probably leave the breeding areas a week or two after adults.

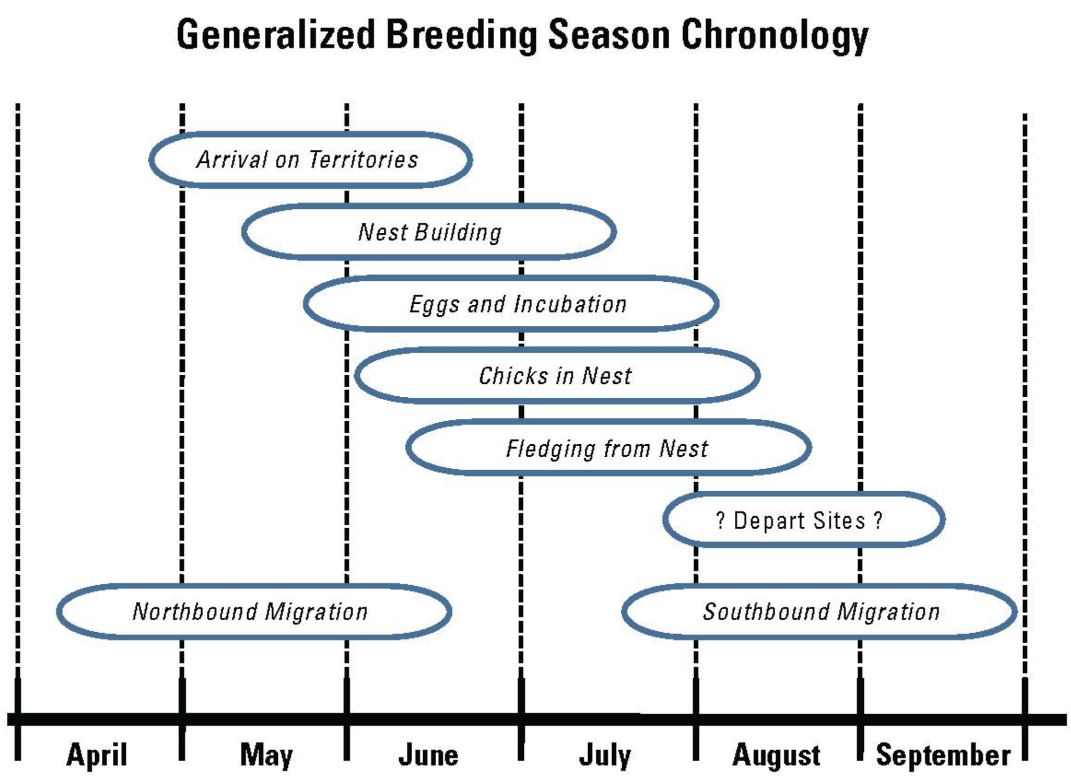


Figure 3-1. Generalized breeding chronology of the Southwestern Willow Flycatcher (from Sogge *et al*. 2010).

Each stage of the breeding cycle represents a greater energy investment in the nesting effort by the flycatcher pair and may influence their fidelity to the nest site or their susceptibility to abandon if the conditions in the selected breeding habitat become adverse.

3.1.2.1 Southwestern Willow Flycatcher Habitat Characteristics

The Primary Constituent Elements (PCEs) of flycatcher critical habitat (Service 2013a) are:

1. Primary Constituent Element 1— Riparian vegetation. Riparian habitat along a dynamic river or lakeside, natural or manmade successional environment (for nesting, foraging, migration, dispersal, and shelter) that is comprised of trees and shrubs [that can include Goodding's willow, coyote willow, boxelder, tamarisk, Russian olive, buttonbush, cottonwood, stinging nettle, alder, seep willow, rose, false indigo, and Siberian elm[1]] and some combination of:
    a. Dense riparian vegetation with thickets of trees and shrubs that can range in height from about 2 m to 30 m (about 6 to 98 ft). Lower-stature thickets (2 to 4 m or 6 to 13 ft tall) are found at higher elevation riparian forests and tall-stature thickets are found at middle- and lower-elevation riparian forests; and/or
    b. Areas of dense riparian foliage at least from the ground level up to approximately 4 m (13 ft) above ground or dense foliage only at the shrub or tree level as a low, dense canopy; and/or
    c. Sites for nesting that contain a dense (about 50 percent to 100 percent) tree or shrub (or both) canopy (the amount of cover provided by tree and shrub branches measured from the ground);
    d. Dense patches of riparian forests that are interspersed with small openings of open water or marsh or areas with shorter and sparser vegetation that creates a variety of habitat that is not uniformly dense. Patch size may be as small as 0.1 ha (0.25 ac) or as large as 70 ha (175 ac); and
2. Primary Constituent Element 2— Insect prey populations. A variety of insect prey populations found within or adjacent to riparian floodplains or moist environments, which can include: flying ants, wasps, and bees (Hymenoptera); dragonflies (Odonata); flies (Diptera); true bugs (Hemiptera); beetles (Coleoptera); butterflies, moths, and caterpillars (Lepidoptera); and spittlebugs (Homoptera).

The flycatcher is an obligate riparian species occurring in habitats adjacent to rivers, streams, or other wetlands characterized by dense patches of willows (*Salix* spp.), seep-willow (*Baccharis* sp.), arrowweed (*Pluchea* sp.), saltcedar (*Tamarix* spp.), or other species (Sogge *et al*. 2010). A critical component for suitable nesting conditions is the presence of saturated soil or surface water at or near the nest site, usually provided by overbank flooding or some other hydrologic source.

[1] Only tree and shrub species likely to occur in the action area for this consultation were included in this list.

Habitat patches comprised of native vegetation accounted for approximately 44% of 209 nests monitored in the Middle Rio Grande during 2013 (Moore and Ahlers 2014). Approximately 27% of these nests occurred in patches dominated by exotic shrubs and 29% were in mixed native-exotic stands. In many cases, exotics are contributing significantly to the habitat structure by providing the dense lower-strata vegetation that flycatchers prefer. Nests located at the Sevilleta NWR and La Joya State Wildlife Management Area (WMA) have been established in areas dominated by saltcedar and Russian olive; however, the overall vegetation type of most of the flycatcher territories established in the Middle Rio Grande is dominated by native species and not saltcedar (Moore and Ahlers 2005, 2008).

Many flycatcher breeding sites are composed of spatially complex habitat mosaics, often including both exotic and native vegetation. Within a site, flycatchers often use only a part of the patch, with territories frequently clumped or distributed near the patch edge. Therefore, the vegetation composition of individual territories may differ from the overall composition of the patch (Sogge *et al*. 2002).

The shrub species selected as the substrate to support the nest varies widely by site; however, species composition appears less important than plant and twig structure (Sogge *et al*. 2010), as slender stems and twigs are important for nest attachment. Data collected and analyzed on nest substrate and surrounding habitat patch communities in the Middle Rio Grande (specifically in the Sevilleta NWR/La Joya State WMA, and San Marcial river reaches) indicate that flycatchers may key in on areas dominated by native vegetation, but often select an exotic shrub, particularly saltcedar, as a nest substrate. Saltcedar may actually be the flycatchers' substrate of choice due to its dense and vertical twig structure. From 1999-2002, approximately 49% of 156 nests located in these river reaches were on exotic Russian olive and saltcedar (Moore and Ahlers 2008).

Nest height is highly variable and depends on the available plant structure; nests have been observed at heights ranging from 2 to 66 feet (Sogge *et al*. 2010). Along the Middle Rio Grande, breeding territories have been found in young and mid-age riparian vegetation dominated by dense growths of willows at least 15 feet high, as well as in mixed native and exotic stands dominated by Russian olive and saltcedar (Moore and Ahlers 2007).

Flycatchers usually breed in areas that are saturated or are inundated by surface water for some portion of the growing season. If saturation or inundation in such suitable habitat decreases, the growth of substrate plants may be adversely affected and habitat quality may decline. The presence of surface water at or near the nest site may also affect nesting success and food availability. In some instances — *e.g.*, recent breeding sites at Sevilleta NWR — flycatchers may select areas lacking saturation or inundation, but choose areas located relatively close to surface water.

Along the Rio Grande, 95% of all flycatcher nests in the Reclamation-surveyed areas were located within 328 ft (100 m) of surface water, and 91% occurred within 164 ft (50 m; Moore and Ahlers 2008). The presence of surface water at the onset of nest site selection and nest initiation is likely critical, though not absolutely necessary.

In New Mexico, the flycatcher has been observed in the Rio Grande, Rio Chama, Zuni River, San Francisco River, and Gila River drainages. Flycatchers were first reported at Elephant Butte

State Park in the 1970s, although the exact locations of the sightings were not documented (Hubbard 1987). Because surveys were not consistent or extensive prior to the listing of this species, a comparison of historic numbers to current status is not possible; however, the available native riparian habitat overall along the Rio Grande has declined, and it is assumed populations may have declined from historic numbers as well.

The Upper Rio Grande Management Unit, New Mexico, extends from the Taos Junction Bridge (State Route 520) downstream to the northern boundary of the Ohkay Ohwingeh Pueblo, and includes a 1.1 km (0.4 mi) segment of the Rio Grande between the Ohkay Ohwingeh and Santa Clara Pueblos (Service 2013a). The Ohkay Ohwingeh, Santa Clara, and San Ildefonso Pueblos (approximately 17 miles of river) are essentially excluded from the final flycatcher critical habitat designation due to their conservation efforts on the Rio Grande (Service 2013a). The Middle Rio Grande Management Unit, New Mexico, was designated as critical habitat as a 180.4-km (112.1-mi) segment of the Rio Grande from Isleta Pueblo downstream and to the upper part of Elephant Butte Reservoir (Service 2013a).

The Service discussed the benefits of excluding the pueblos of San Ildefonso, Ohkay Owingeh and Santa Clara from designated flycatcher critical habitat (Service 2013a). All three pueblos have shown that by managing their resources to meet their traditional and cultural needs, they also address the conservation needs for the flycatcher and other species that may be listed. The pueblos employ tribal members who work on holistic habitat improvement and management, including endangered species and their habitat (Service 2013a).

In the Upper and Middle Rio Grande Management Units, surveys for flycatchers in selected areas have been conducted during environmental compliance activities for various projects. Flycatcher surveys in the project area are conducted by the sponsors, in partnership with the Service. Although a systematic survey effort throughout the entire riparian corridor of the Middle Rio Grande has not occurred, reaches of the river with the most suitable habitat for flycatchers have been surveyed fairly thoroughly. Presence/absence surveys and nest monitoring along selected areas of the Rio Grande have been conducted from 1993 to 2008. With expanded or increased survey efforts during this 12-year period, several sites have been located where flycatcher territories have consistently been established. Once located, most of these core breeding areas have been monitored annually.

Five general locations of flycatcher populations have been established throughout the Middle Rio Grande (Figure 3-2). These areas have consistently held several territories; however, the number of territories, pairs, nest attempts, and successful nests has varied through the years.

Figure 3-2. Location of flycatcher populations along the Middle Rio Grande in New Mexico.

The status of the flycatcher has been closely followed in conjunction with water operations (Service 2003). Ongoing surveys at selected sites along the Rio Grande from Velarde, New Mexico, to the delta of Elephant Butte Reservoir establish the environmental baseline for the current flycatcher population in the Middle Rio Grande for this Biological Assessment. Table 3-1 summarizes the locations of known territories (that is, occupied by a male or pair of flycatchers) in the Upper and Middle Rio Grande Management Units during 2003 through 2013.

3.1.3 Reasons for Flycatcher Decline

During the last two centuries, human-induced hydrological, geomorphological, and ecological changes have strongly influenced the composition and extent of riparian vegetation along the Middle Rio Grande (Bullard and Wells 1992; Dick-Peddie 1993; Crawford *et al.* 1993). The invasion of exotic shrub species, such as saltcedar and Russian olive, has decreased the availability of dense willows and associated desirable vegetation and habitat important to flycatchers. In addition, the rapid rate of deforestation in tropical areas has been cited as a possible reason for population declines in forest-dwelling migrant land birds (Lovejoy 1983; Robbins *et al*. 1989, Rappole and McDonald 1994), such as the flycatcher.

Brood parasitism by Brown-headed Cowbirds (*Molothrus ater*) has been implicated in the decline of songbirds, including those found in the western riparian habitats (Gaines 1974, 1977; Goldwasser *et al*. 1980; Laymon 1987). Brown-headed Cowbirds have increased their range with the clearing of forests and the spread of intensive grazing and agriculture. Flycatchers are particularly susceptible to Brown-headed Cowbird nest parasitism because of the ease of egg laying in the flycatcher’s open-cup nest design. Habitat fragmentation and forest openings allow cowbirds easy access to host nests located near these edges. Nest parasitism, combined with declining populations and habitat loss, has placed the flycatcher in a precarious situation (Mayfield 1977; Rothstein *et al*. 1980; Brittingham and Temple 1983; Laymon 1987).

In the Middle Rio Grande, past and present Federal, State, and private activities that potentially may affect the flycatcher include urban and agricultural development, river maintenance, flood control, dam operation, water storage and diversion, and downstream Rio Grande Compact deliveries. The Rio Grande and associated riparian areas are a dynamic system in constant change. Sediment deposition, scouring flows, inundation, base flows, and channel and river realignment are processes that help to maintain and restore the riparian community diversity. Without these dynamic processes, the riparian community will likely decrease in diversity and productivity.

3.2 Western Yellow-billed Cuckoo

3.2.1 Status and Distribution

The Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis;* cuckoo) was listed as a threatened species on October 3, 2014 (Service 2014c). The listing included information on the cuckoo's biology, range, and population trends, including: habitat requirements for feeding, breeding, and sheltering; genetics and taxonomy; historical and current range including distribution patterns; population levels; conservation measures; and population and breeding season data.

Two factors were considered to be the threats to the species (Service 2013e). The first factor includes threats from habitat destruction, modification, and degradation from dam construction and operations; water diversions; riverflow management; stream channelization and stabilization; floodplain conversion to agricultural uses, such as crops and livestock grazing; urban and transportation infrastructure; and increased incidence of wildfire. These factors also contribute to fragmentation and promote conversion to nonnative plant species, particularly saltcedar. The threats affecting cuckoo habitat are ongoing. Such a loss of riparian habitat leads not only to a direct reduction in cuckoo numbers but also leaves a highly fragmented landscape, which can reduce breeding success through increased predation rates and barriers to dispersal by juvenile and adult cuckoos (Reclamation 2013; Service 2013e).

The second factor includes habitat rarity and the small size and isolated nature of populations of the western yellow-billed cuckoo, which cause the remaining populations in western North America to be increasingly susceptible to further declines through lack of immigration, chance weather events, fluctuating availability of prey populations, pesticides, collisions with tall vertical structures during migration, spread of the introduced tamarisk leaf beetle as a biocontrol agent in the Southwest, and climate change. The ongoing threat of small overall population size leads to an increased chance of local extinctions through random events (Service 2013e).

The distinct population segment (DPS) for the cuckoo is generally west of the Continental Divide (crest of the Rocky Mountains based on watershed boundaries), but in New Mexico the watershed divide between the Rio Grande and Pecos River is the eastern limit. The area under consideration is aligned with the traditionally-defined range of the western yellow-billed cuckoo subspecies (Service 2014c). The analysis by the Service is based solely on the range during the breeding season because the migration route and winter range of western yellow-billed cuckoos are poorly known.

3.2.1.1 Population Trends 2009-2012

Prior to 2006, Reclamation collected incidental cuckoo data within the Middle Rio Grande while conducting flycatcher surveys (Reclamation 2013). In 2006, Reclamation initiated formal presence/absence surveys (Halterman et al 2000) to more accurately determine cuckoo distribution and abundance. The Reclamation study area in the Middle Rio Grande currently extends from Highway 60 downstream to Elephant Butte Reservoir. The number of cuckoo detections and territories show marked variability from 2009 through 2012 (Reclamation 2013). Other bird surveys in the Middle Rio Grande also record the presence of cuckoos.

3.2.1.2 Critical Habitat

Critical habitat for the cuckoo has been proposed along the Upper (Unit 50: NM-6) and Middle Rio Grande (Unit 51: NM-7) in New Mexico (Service 2014b). The proposed critical habitat unit 50 consists of a 10-mi (1,830 ac) segment of the Rio Grande upstream from the fishing lakes on Ohkay Owingeh Pueblo. The proposed critical habitat unit 51 consists of a 6-mi (1,173 ac) segment of the Rio Grande upstream of Highway 502 Bridge. The proposed critical habitat units 50 and 51 in the project area are on lands owned by Ohkay Owingeh, San Ildefonso and Santa Clara Pueblos. These units are occupied by cuckoos, and provide a corridor for cuckoos moving north. Saltcedar reduces the habitat’s value, is a major component of habitat in this unit.

The Primary Constituent Elements (PCEs) of cuckoo critical habitat are:

1. Riparian woodlands. Riparian woodlands with mixed willow and cottonwood vegetation that contain habitat for nesting and foraging in contiguous or nearly contiguous patches that are greater than 325 ft (100 m) in width and 200 ac (81 ha) or more in extent. These habitat patches contain one or more nesting groves, which are generally willow dominated, have above average canopy closure (greater than 70 percent), and have a cooler, more humid environment than the surrounding riparian and upland habitats.
2. Adequate prey base. Presence of a prey base consisting of large insect fauna (including cicadas, caterpillars, katydids, grasshoppers, large beetles, and dragonflies) and tree frogs for adults and young in breeding areas during the nesting season and in post-breeding dispersal areas.
3. Dynamic riverine processes. River systems that are dynamic and provide hydrologic processes that encourage sediment movement and deposits that allow seedling germination and promote plant growth, maintenance, health, and vigor (e.g., lower gradient streams and broad floodplains, elevated subsurface groundwater table, and perennial rivers and streams). This allows habitat to regenerate at regular intervals, leading to riparian vegetation with variously-aged patches from young to old.

The Service is participating in government-to-government discussions with Pueblos on New Mexico cuckoo conservation actions and management plans for potential exclusion from the final designation of critical habitat. The Pueblos conduct a variety of voluntary measures, restoration projects, and management actions to conserve riparian vegetation and protect riparian habitat (Service 2014b). The Pueblos may propose amendments to their management plan for other endangered species, which will contribute to the conservation of the cuckoo (Service 2014b). The Service may exclude Pueblo lands from the final designation of Western Yellow-billed Cuckoo critical habitat under section 4(b)(2) of the ESA.

3.2.2 <u>Life History and Ecology</u>

The cuckoo is a Neotropical migrant that feeds primarily on large insects (Reclamation 2013). Adult cuckoos are a medium-sized bird (length 30 cm, weight 60 g) with moderate to heavy bills, somewhat elongated bodies, and a narrow yellow ring of colored bare skin around the eye (Service 2013e). The bird has a slender, long-tailed profile, with a fairly stout and slightly downcurved bill, which is blue-black with yellow on the basal half of the lower mandible (Service 2013e). The body is grayish-brown above, white below, with boldly patterned tail feathers and short bluish-gray legs. Males have a smaller body size, smaller bill, and the white portions of the tail tend to form distinct oval spots. Females have less distinct white spots that tend to be connected (Service 2013e). Mated cuckoos have a distinctive ‘‘kowlp’’ call, which is a loud, nonmusical series of notes that slows down and slurs toward the end. Unmated cuckoos advertise for a mate using a series of soft ‘‘cooing’’ notes. Both members of a pair use the ‘‘knocker’’ call, a series of soft notes given as a contact or warning call near the nest (Service 2013e).

In New Mexico, they nest in larger patches of riparian vegetation with a cottonwood (*Populus deltoides*) / Goodding’s willow (*Salix gooddingii*) overstory (Ehrlich et al. 1988) with a dense understory that may include saltcedar (*Tamarix* spp.), Russian olive (*Elaeagnus angustifolia*) or native vegetation (e.g. *Salix* spp.) (Reclamation 2013; Sechrist et al. 2009). Territories range in size from 4 to 40 ha (Halterman 2001), with an average home range size of 82 ha (Sechrist et al. 2009). The cuckoo prefers patch dimensions larger than 100 × 300 m, and exceeding 80 ha in area (Service 2014c).

Nest heights range from 1.3 to 13 m with a rapid breeding cycle at each nest; from egg laying to fledging takes approximately 17 days (Halterman 2001). Cuckoos exhibit a variety of reproductive strategies that are thought to increase population (Service 2013e). Both parents build an open cup nest, incubate the eggs, and tend the young. Clutch size varies from two to five eggs. The incubation and nestling periods are short, with the eggs hatching asynchronously in 11–12 days and young fledging in 5–7 days.

3.2.3 Reasons for Cuckoo Decline

It is commonly recognized that one of the primary causes for the decline of Neotropical migrants, along with numerous other terrestrial species, is the decrease in the abundance of riparian vegetation over the past hundred years. The reason for this decline in riparian vegetation is due to the removal of the dynamic components of river systems.

The Rio Grande and associated riparian areas have historically been a dynamic system in constant change and, without this change, the plant diversity and productivity has decreased. Sediment deposition, scouring flows, inundation, and irregular flows are natural dynamic processes that occurred frequently enough in concert to shape the characteristics of the Rio Grande channel and floodplain. Through the development of dams, irrigation systems, and controlled flows, the dynamics of the river system have been significantly reduced except at localized areas such as the reservoirs where water storage levels frequently change with releases and inflows.

3.3 New Mexico Meadow Jumping Mouse

3.3.1 Status and Distribution

A final rule was published in the June 10, 2014 Federal Register (Service 2014a) to list the New Mexico Meadow Jumping Mouse. Critical habitat for the New Mexico Jumping Mouse (*Zapus* *hudsonius luteus*; mouse) was proposed on June 20, 2013 (Service 2013b), with a final designation expected later.

The New Mexico meadow jumping mouse is a morphologically and generically distinctive subspecies that occupies a more isolated and extreme environment in the arid American Southwest (Frey and Malaney 2009). The species is found in the San Juan, Sangre de Cristo, Jemez and Sacramento Mountains, as well as potentially in Catron County adjacent to the White Mountains in Arizona, and along the Rio Grande and Rio Chama drainages (Pierce 2008). Historically the meadow jumping mouse is best documented in the Jemez and Sacramento mountains (Frey and Malaney 2009). The meadow jumping mouse is a riparian obligate, prefers dense vegetation, particularly sedges, with damp to wet soils. Nesting sites are upland and adjacent to dense herbaceous riparian vegetation.

3.3.1.1 Critical Habitat

Proposed critical habitat for the mouse in the general project area is identified as Subunit 6–B, which consists of 51 ha (125 ac) along 4.8 km (3.0 mi) marshes on lands owned by Ohkay Owingeh Pueblo (Service 2013b). There are two segments within subunit 6-B. One segment is upstream of Highway 291west of the Rio Grande along the edge of the floodway. The second segment is in the vicinity of the Ohkay Owingeh Pueblo fishing lakes (Figure 2-3). The second segment overlaps with a proposed swale wetland measure.

Much of the habitat was historically occupied with individuals detected as recently as 1988 (Morrison 1988, pp. 22–27; Frey 2006c, entire); however, no New Mexico meadow jumping mouse surveys have been conducted recently in the project area. The entire subunit within the project area is considered unoccupied at the time of listing.

The Primary Constituent Elements (PCEs) of mouse critical habitat are:

1. Riparian communities along rivers and streams, springs and wetlands, or canals and ditches characterized by one of two wetland vegetation community types:
    a. Persistent emergent herbaceous wetlands dominated by beaked sedge (*Carex rostrata*) or reed canarygrass (*Phalaris arundinacea*) alliances; or
    b. Scrub-shrub riparian areas that are dominated by willows (*Salix* spp.) or alders (*Alnus* spp.); and
2. Flowing water that provides saturated soils throughout the New Mexico meadow jumping mouse’s active season that supports tall (average stubble height of herbaceous vegetation of at least 69 cm (27 inches) and dense herbaceous riparian vegetation (cover averaging at least 61 vertical cm (24 inches) composed primarily of sedges (*Carex* spp. or *Schoenoplectus pungens*) and forbs; and
3. Sufficient areas of 9 to 24 km (5.6 to 15 mi) along a stream, ditch, or canal that contain suitable or restorable habitat to support movements of individual New Mexico meadow jumping mice; and
4. Include adjacent floodplain and upland areas extending approximately 100 m (330 ft) outward from the water’s edge (as defined by the bankfull stage of streams).

The Service is participating in government–to-government discussions with Ohkay Owingeh Pueblo on mouse conservation actions and management plans for potential exclusion from the final designation of critical habitat. The Pueblo has conducted a variety of voluntary measures, restoration projects, and management actions to conserve riparian vegetation and protect riparian habitat (Service 2014a). The Pueblo may propose amendments to their management plan for other endangered species which will contribute to the conservation of the New Mexico meadow jumping mouse (Service 2014a). The Service may exclude Ohkay Owingeh Pueblo lands from the final designation of New Mexico meadow jumping mouse critical habitat under section 4(b)(2) of the Act.

3.3.2 Life History and Ecology

The New Mexico meadow jumping mouse life span is three years or less. Reproduction is poorly understood (Pierce 2008). Typically females have a litter annually with 4 to 7 young, which are born naked. Gestation is 17 to 21 days and weaning 28 to 30 days (Pierce 2008). Nesting sites are typically upland and adjacent to riparian wetlands. Nests or burrows are used to give birth in the summer and to hibernate over the winter (U.S. Fish and Wildlife Service 2013). The species hibernate about 8 or 9 months out of the year, and is therefore only active for 3 or 4 months during the summer (Service 2013b). During active periods, it must breed, birth, raise young and store sufficient fat reserves for upcoming hibernation.

3.3.2.1 Behavior

The meadow jumping mouse is primarily nocturnal, and typically crawls over or moves through high vegetation. When threatened the species is capable of leaping and may alter course in mid-flight using its long tail as a rudder (Pierce 2008). The species are also good swimmers, climbers and diggers. In a population studied at Fenton Lake in 1986, active periods were from mid-June to early October, and females typically emerged from hibernation later than males (Pierce 2008). It was noted that the population was more active on cooler, wetter days. Typically two weeks prior to hibernation time is spent building up fat reserves. The meadow jumping mouse doesn’t cache food for the winter (Pierce 2008). Although the meadow jumping mouse is solitary and docile, the species will make chirping and clucking noises, and will drum their tails when excited (Pierce 2008).

3.3.2.2 Habitat requirements

The meadow jumping mouse habitat requirements are exceptionally specific. The habitat requirements to support life-history needs are characterized by tall (averaging at least 61 cm or 24 in), dense herbaceous riparian vegetation composed primarily of sedges and forbs (Service 2013b). This dense herbaceous riparian vegetation provides cover and protection from predators, building materials for nests, and vital food sources (insects and seeds). These types of wetland vegetation reach full growth with perennial flowing water. The Service estimates that resilient populations need at least 27.5 to 73.2 ha of suitable habitat along with 9 to 24 km of flowing streams, ditches, or canals (Service 2013b).

3.3.2.3 Food Habits

Seeds and insects are the primary food sources for this species. Examination of stomach contents of over seven hundred specimens taken in New York reveled that a variety of foods were taken (Pierce 2008). Immediately after hibernation, insects are the main food source and limited amount of seeds are consumed. As the season progresses and more seeds become available, insects are consumed at lower rates. Particular grass seeds consumed are *Phleum, Anthoxanthum, Poa, Creastium, Rumex, Dacylus, Ptentilla, Oxalis, Echinochloa, Ulmus* and *Asclepias* spp (Service 2013). Snails, fruits, millipedes and fungi are consumed when a more preferred food source is unavailable.

3.3.3 Reasons for Mouse Decline

3.3.3.1 Factors Affecting Habitat

It is estimated that one third of the wetlands (including riparian ecosystems) that once existed in New Mexico have been lost (Pierce 2008). Loss of habitat can result from but is not limited to, water diversion and withdrawal, drought, invasive species, improper restoration efforts, grazing, fire, flood, recreation, and development. Declines in populations of meadow jumping mouse have been due to an almost utter lack of habitat (Frey 2005). Many historic localities are uninhibited due to lack of water or pressure from other species (cattle and elk). In Frey's 2005 and 2006 survey of historical sites, the species and its habitat were not present in 73% of historical localities surveyed in the Jemez Mountains and not present in 94% of historical localities surveyed in the Sacramento Mountains. Loss of habitat was attributed to livestock grazing as well as the loss of the American beaver. The Service recommends that special management procedures be implemented to determine direct and indirect loss of habitat for the meadow jumping mouse. Special considerations include water development, recreational use, livestock grazing, road reconstruction, the loss of beaver ponds, and vegetation mowing.

3.4 Other Threatened and Endangered Rio Grande Species

The Jemez Mountains salamander *(Plethodon neomexicanus),* Interior Least Tern (*Sternula antillarum athalassos*), and Mexican Spotted owl *(Strix occidentalis lucida)* are federally Endangered or Threatened species of concern found near (Service 2015), but are unlikely to occur within, the proposed action area. Nesting by the Interior Least Tern (*Sternula antillarum athalassos*) in the Rio Grande drainage has only been at constructed reservoirs (Lott 2006). Their presence may represent opportunistic range expansion (Service 2013c). The proposed project area is a riverine and riparian ecosystem that is unlikely to be utilized by terns.

The primary constituent elements for salamander critical habitat include coniferous forest at elevations between 6,988 to 11,254 feet (Service 2013), while the primary constituent elements for the owl critical habitat include mixed-conifer forest at elevations above 6,000 feet (Service 2004). The proposed project area does not have the appropriate the vegetation for either species with an elevation less than 5,653 feet (NGVD29, Chamita Gage, USGS 2014).

4 - Analysis of Effects of Proposed Actions

This chapter provides an analysis of the effects of the USACE proposed actions on listed species and their designated and proposed critical habitat. The phrase "effects of proposed actions" refers to the direct and indirect effects of the proposed action on listed species or critical habitat together with the effects of other activities that are interrelated or interdependent with that action.

4.1 Southwestern Willow Flycatcher

There is designated critical habitat for flycatchers on Santa Clara Pueblo adjacent to vegetation management measures (Figure 2-8) that remove invasive plant species and increase the density of native riparian trees in the proposed action area. Other proposed measures have been located away from recently occupied flycatcher habitat based on recommendations by the sponsors. Some measures may temporarily affect marginally-suitable riparian habitat, but will provide conditions for creating potential suitable flycatcher habitat.

The proposed project would create habitat that would potentially benefit the flycatcher. Creation of willow swales in the proposed action would provide potential habitat for the flycatcher. Terrace lowering and high-flow channels should create natural willow and cottonwood stands. Over time, these cottonwood and willow stands would develop the preferred density and stature for flycatcher nesting.

Based on the surveys conducted by the sponsors within the proposed action area, flycatchers are likely to be present in the project area during the ten year construction period (2017 through 2027 or beyond). Surveys would be scheduled during each year of construction to verify presence or absence during the period of project implementation. It is very possible that migrants would be present in the project area in summer and fall. Surveys at the locations where migrants have been detected would continue each year as they have in the past. If nesting flycatchers are detected then consultation with the Service would be reinitiated. Any nesting territories discovered would be avoided.

Therefore, the USACE has determined that the proposed work may affect, but is not likely to adversely affect, the Southwestern Willow Flycatcher. The proposed ecosystem restoration measures may affect, but are not likely to adversely modify designated or proposed critical habitat for the Southwestern Willow Flycatcher. Construction of the measures described in the proposed action may provide beneficial habitat for the flycatcher.

4.2 Western Yellow-billed Cuckoo

There is proposed critical habitat for cuckoos on Ohkay Owingeh and Santa Clara Pueblos that overlap many of the proposed measures (Figure 2-5, Figure 2-8) in the proposed action area. The proposed measures are designed to increase floodplain connectivity (GRFs, high-flow channels, and terrace lowering), with other measures to improve groundwater connectivity for wetlands and willow swales. These measures may temporarily affect marginally-suitable riparian habitat, but would create habitat that would potentially benefit the cuckoo.

The occurrence of the cuckoo in the proposed action area needs better documentation via avian surveys. Cuckoos are likely to be present in the project area during the ten year construction period (2017 through 2027 or beyond). Disturbance of vegetation for the construction of measures would be outside the breeding season, avoiding effects to the cuckoo. It is likely that migrants would be present in the project area in summer and fall. Surveys at the locations where migrants have been detected would continue each year as they have in the past. If nesting cuckoos are detected then consultation with the Service would be reinitiated. Any nesting territories discovered would be avoided.

Therefore, the USACE has determined that the proposed work may affect, but is not likely to adversely affect, the Western Yellow-billed Cuckoo. The proposed ecosystem restoration measures may affect, but are not likely to adversely modify designated or proposed critical habitat for the Yellow-billed Cuckoo. Construction of the measures described in the proposed action may provide beneficial habitat for the cuckoo.

4.3 New Mexico Meadow Jumping Mouse

The proposed mouse critical habitat 6-B Subunit is considered unoccupied at the time of listing (Service 2013). Monitoring by Ohkay Owingeh Pueblo also indicates that the mouse no longer occurs in the proposed action area. The proposed critical habitat for the mouse on Ohkay Owingeh Pueblo overlaps the proposed wetland / swale measure (Figure 2-5) in the proposed action area. The proposed measure would improve groundwater connectivity for the wetland, and may create habitat that would potentially benefit the mouse. The remaining proposed measures are located away from previously occupied areas based on recommendations by the Pueblo.

Trapping surveys for the mouse in the proposed action area would confirm whether the proposed action area remains unoccupied during the ten year construction period (2017 through 2027 or beyond). The partnership between the Pueblo and the Service should discuss monitoring strategies prior to construction in possible mouse habitat.

Therefore, the USACE has determined that the proposed work may affect, but is not likely to adversely affect, the New Mexico Meadow Jumping Mouse. The proposed ecosystem restoration measures may affect, but are not likely to adversely modify designated or proposed critical habitat critical habitat for the New Mexico Meadow Jumping Mouse. Construction of the measures described in the proposed action may provide beneficial habitat for the mouse.

4.4 Other Species

The proposed project area lacks the critical habitat primary constituent elements for the Interior Least Tern (Service 2013c), the Jemez Mountains salamander (Service 2013d,e), or the Mexican Spotted Owl (Service 2004). These three species are not likely to occur within the proposed action area. Based on the best available information, the proposed actions would have no effect on the tern, salamander or owl.

4.5 Environmental Commitments

Best management practices (BMPs) would be employed throughout the project to protect natural and cultural resources, as follows:

1) Stormwater controls will be installed and maintained during excavation activities as appropriate for the NPDES Construction General Permit and Stormwater Pollution Prevention Plan. Silt fence will be installed adjacent to the riverbank where needed for stormwater control.

2) Cofferdams, dikes, straw bales or other suitable erosion control measures would be used during construction of bank line measures (high flow channel inlets and outlets).

3) Cleaning of all equipment to prevent the spread of invasive species is required prior to entering the project area (National Invasive Species Council 2008).

4) Equipment operators will be required to carry an oil spill kit or spill blanket at all times and must be knowledgeable in the use of spill containment equipment. The contractor will develop a spill contingency plan prior to initiation of construction. The plan will identify where storage and dispensing fuels, lubricants, hydraulic fluids, and other petrochemicals will be located outside the 100-year floodplain. The contractor will inspect construction equipment daily for petrochemical leaks. All spills will be contained immediately and all contaminated media will be disposed of following the Resource Conservation and Recovery Act. If a reportable quantity is released, the contractor will notify NMED and U.S. EPA as soon as possible after learning of a discharge, but in no event more than twenty-four (24) hours thereafter. The staging areas will be located outside the 100-year floodplain. The construction equipment will be parked outside the 100-year floodplain during periods of inactivity for an extended period or based on weather conditions. The equipment operators will place drip-pans underneath vehicles at the end of each work day.

5) All work and staging areas will be limited to the minimum amount of area required. Existing roads and right-of-ways and staging areas will be used to the greatest extent practicable to transport equipment and construction materials to the project site, and described in the USACE's project description. Designated areas for vehicle turn around will be provided and maneuvering conducted so as to protect riparian areas from unnecessary damage.

6) Mature cottonwood trees will be protected from damage during clearing of non-native species or other construction activities using fencing, or other appropriate materials.

7) Local genetic stock will be used wherever possible in the native plant species establishment throughout the riparian area.

8) Work inside of the bosque will not occur during migratory bird breeding season (approximately April 15 to August 15). Surveys will be conducted for the presence/absence of Southwestern Willow Flycatchers during their breeding season in areas surrounding proposed measures prior to construction.

4.6 Summary of Effects

Table 4-1 summarizes USACE determination of the effects for all of the proposed actions. In consideration of all direct, indirect, and cumulative effects, the USACE discretionary proposed actions would:

- Would have no effect on the Interior Least Tern, the Jemez Mountains salamander, and the Mexican Spotted Owl;
- May affect, but not likely to adversely affect, the Southwestern Willow Flycatcher;
- May affect, but not likely to adversely modify designated or proposed critical habitat for the Southwestern Willow Flycatcher;
- May affect, but not likely to adversely affect, the Yellow-billed Cuckoo;
- May affect, but not likely to adversely modify designated or proposed critical habitat for the Yellow-billed Cuckoo;
- May affect, but not likely to adversely affect, the New Mexico Meadow Jumping Mouse; and
- May affect, but not likely to adversely modify designated or proposed critical habitat for the New Mexico Meadow Jumping Mouse.

Table 4-1 Summary of determined effects to listed species and proposed or designated critical habitat.

Name	Effects Analysis	
Common (Species)	Species	Critical Habitat
Southwestern Willow Flycatcher	May be present	Critical habitat designated in action area
(Empidonax traillii extimus)	May affect, not likely to adversely affect	May affect, not likely to adversely to modify or affect
Western Yellow-billed Cuckoo	Species may be present in action area	Critical habitat proposed in action area
(*Coccyzus americanus occidentalis)*	May affect, not likely to adversely affect	May affect, not likely to adversely to modify or affect
New Mexico Meadow Jumping Mouse	Species not considered present in action area	Critical habitat proposed in action area
(*Zapus hudsonius luteus)*	May affect, not likely to adversely affect	May affect, not likely to adversely to modify or affect

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1.3.2 Final Biological Opinion for the Española Valley, Rio Grande and Tributaries, New Mexico Study

The U.S. Fish and Wildlife Service concluded consultation and provided the final Biological Opinion on October 5, 2017.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

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October 7, 2016

Cons. #02ENNM00-2014-F-0436

Lynette Giesen, Acting Chief Environmental Resources Section
U.S. Army Corps of Engineers, Albuquerque District
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Dear Ms. Giesen:

We (U.S. Fish and Wildlife Service) (Service) received your (U.S. Army Corps of Engineers) (USACE) March 13, 2015, letter and Biological Assessment (BA) requesting the initiation of formal consultation on the Española Valley, Rio Grande and Tributaries, New Mexico Study (Española HR Study). We requested additional species specific information in a letter dated April 28, 2015 pertaining to the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (flycatcher) and Yellow-billed Cuckoo (*Coccyzus americanus*) (cuckoo), and that data was provided in clarity on December 28, 2015 and a subsequent letter was sent January 25, 2016. Correspondence has been ongoing since your original request for initiation of formal consultation.

Your Española HR Study BA includes the following determinations:

- No effect on the Interior Least Tern (*Sternula antillarun athalassos*), Jemez Mountains salamander (*Plethodon neomexicanus*), and Mexican Spotted Owl (*Strix occidentalis lucida*), or their respective proposed or designated critical habitats.

We concur with your determinations for the following species and/or critical habitat based on your BA and the logic provided indicating that the effects are likely either beneficial, or insignificant and discountable:

- May affect, but is not likely to adversely affect the cuckoo and New Mexico Meadow Jumping Mouse (*Zapus hudsonius luteus*) (jumping mouse).
- May affect, but is not likely to adversely affect flycatcher critical habitat
- May affect, but is not likely to adversely modify proposed critical habitat for cuckoo and jumping mouse.

The Service does not provide concurrence for "no effect" determinations, but we will instead commend your consideration of the species within your BA for the Interior Least Tern (*Sternula antillarun athalassos*), Jemez Mountains salamander (*Plethodon neomexicanus*), and Mexican

Spotted Owl (*Strix occidentalis lucida*), or their respective proposed or designated critical habitats.

As indicated in previous meetings and letters, we believe your Española HR Study "may affect, and is likely to adversely affect the flycatcher" is correct. This is because there are proposed construction sites within the overall action area that would remove or modify habitat historically occupied by flycatchers. Ultimately, these same constructed features may benefit the flycatcher by increasing opportunities for overbank flooding, decreasing depth to groundwater, and/or decreasing non-native species present over the long term. Attached, below this memorandum, is the Biological Opinion (Opinion) on the effects of the proposed action in regard to the flycatcher. This Opinion will be considered final within a 30 day period.

Please reference consultation number 02ENNM00-2014-F-0436 and contact Ms. Vicky Ryan, Fish and Wildlife Biologist, at 505-761-4738 or vicky_ryan@fws.gov with any questions.

Sincerely,

WALLY MURPHY

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Date: 2016.10.05 13:52:51 -06'00'

Wally Murphy
Field Supervisor

cc:
Director, Division of Natural Resources, Ohkay Owingeh, San Juan Pueblo, New Mexico
Director, Office of Environmental Affairs, Santa Clara Pueblo, Espanola, New Mexico

BIOLOGICAL OPINION

I. DESCRIPTION OF PROPOSED ACTION

The following description of the proposed action summarizes relevant material from the Española HR Study, as it pertains to this consultation. For additional detail on the proposed action see the USACE March 13, 2015 Española HR Study BA (USACE 2015).

Purpose and Objective

The purpose of the Española HR Study is to apply ecosystem restoration and flood risk management techniques in an effort to repair problems associated with river channel degradation and loss of riparian habitat that was identified within the project area.

Prior to construction of multiple irrigation and flood control dams in the early 1900s, the Rio Grande and the Rio Chama supported substantial areas of cottonwood (*Populus fremontii*), willow (*Salix* spp.), New Mexico olive (*Forestiera neomexicana),* and various species of shrub and wetlands (Scurlock, 1998). Stabilization of the channel through rectification and channelization supported development of extensive areas of cottonwood gallery forest in the 1940's through 60's, which is now reaching senescence (USACE 2015).

As stated in the Española HR Study BA, "Channelization activities, gravel mining and non-engineered spoil banks, coupled with climate and water management have modified the hydrology of the Rio Grande, resulting in changes to the composition of native bosque plant species and associated wildlife habitats. Consequently, the river channel through the project area has become incised. The decreasing groundwater table beneath the river has reduced soil moisture in the adjacent riparian areas, significantly reducing nutrient cycling and microbial and biochemical processes. This has directly contributed to the rapid decline and loss of the native cottonwoods, willows, and riparian ecosystems of the Rio Grande Basin. Channel incision has created 'drought' conditions on the adjacent floodplain, with patches of native riparian vegetation interspersed among larger areas of saltcedar and weedy upland vegetation." (USACE 2015)

The proposed measures associated with the Española HR Study are to support long-term riparian habitat management on Ohkay Owingeh and Santa Clara Pueblo to benefit all species using a holistic approach (78 FR 343). The restoration options proposed have the potential to reverse the impacts associated with channel degradation and loss of habitat that Ohkay Owingeh and Santa Clara Pueblo have been experiencing.

Project Locations

The Española HR Study is located in Rio Arriba County, New Mexico. This consultation covers the action area being approximately 271.9 acres of restored habitat along the Rio Grande and Rio Chama from the north boundary of Ohkay Owingeh to the south boundary of the Pueblo of Santa Clara (Figure 1).

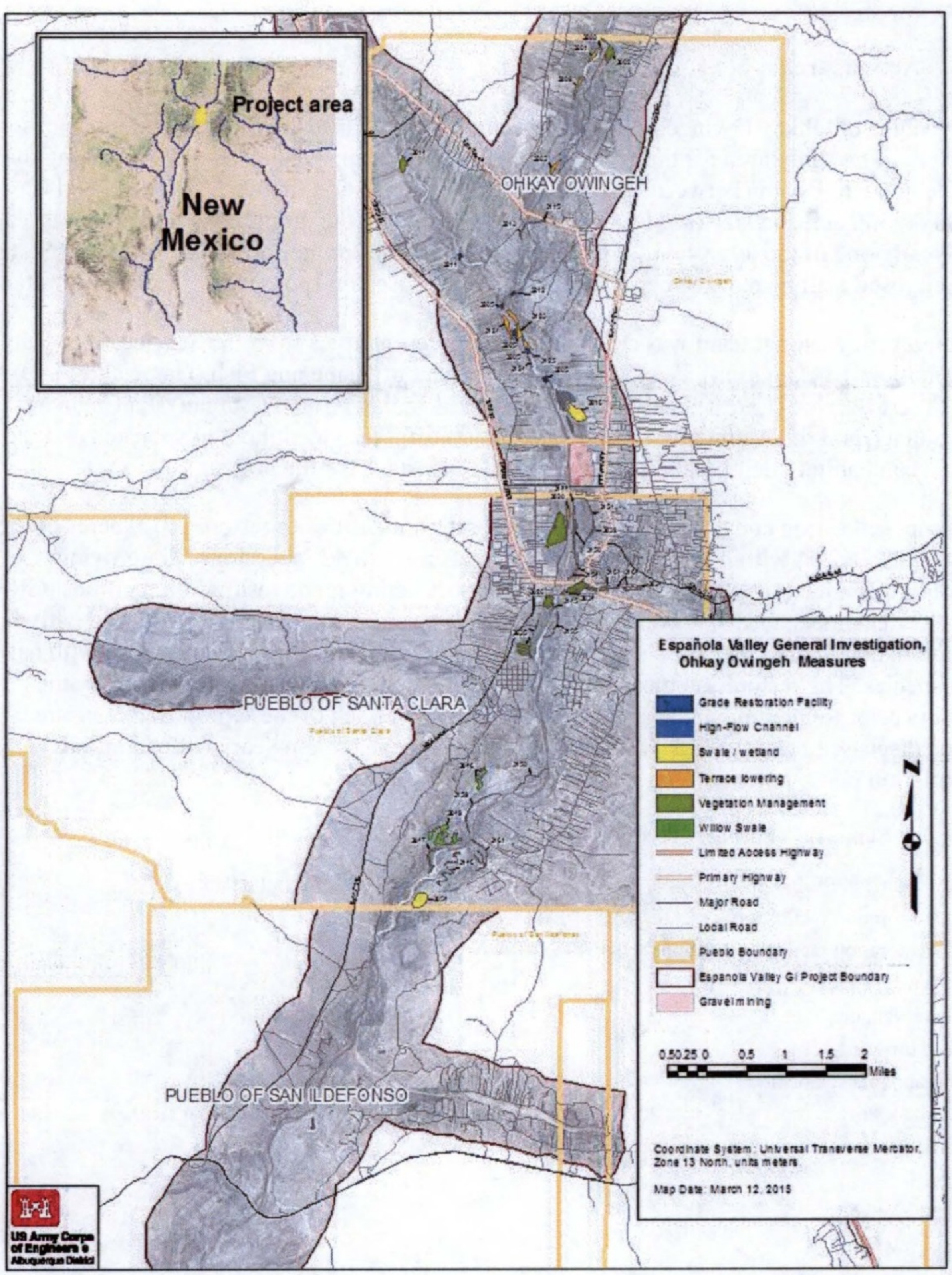

Figure 1. Location of proposed ecosystem restoration measures (USACE 2015).

Proposed Action

The proposed action consists of ecosystem restoration measures to restore 271.9 acres of the bosque (Table 1) within the study area. The measures are designed for (1) improving hydrologic connectivity with the floodplain by constructing grade restoration facilities (GRFs), high-flow channels, terrace lowering, willow swales and wetlands, and (2) restoring native vegetation and habitat by exotic species reduction, and riparian forest revegetation with native plant species. The proposed measure types and acreage are summarized below, and further details can be found within the Española HR Study BA (USACE 2015). Work is anticipated to be phased over seven to ten years with an initial construction phase in the fall of 2017.

Table 1. Summary of proposed ecosystem restoration measures.

Ecosystem Measure	Acres
Grade Restoration Facilities - Essential	12.2
Grade Restoration Facilities - Optional	4.5
High-Flow Channels	22.2
Swales/Wetlands	83.9
Terrace Lowering	45.3
Vegetation Management	103.8
Total	***271.9***

Grade Restoration Facilities

Grade restoration facilities (GRFs) are proposed to halt channel head-cutting and reconnect the floodplain on Ohkay Owingeh. Four GRFs are proposed to halt upstream migration of head-cuts (incised channels) from recent gravel mining operations. Two upstream GRFs are proposed to provide additional floodplain connectivity. The approximate 12.2 acres of GRFs constructed on Ohkay Owingeh would improve floodplain connectivity for up to 80 acres adjacent to the measures.

High-flow Channels

High-flow channels are proposed to improve floodplain connectivity on Ohkay Owingeh (2 acres) and Santa Clara Pueblo (20 acres). The objective of this measure is to re-establish the connections between the river and the bosque by constructing channels across the floodplain that would become inundated at flows between 1,500-3,000 cubic feet per second. This measure would entail the excavation of sediment out of the upstream and downstream portions of the remnant high-flow channels in order to re-establish the bosque-river connection, clearing out debris and non-native plants, and revegetating with native plants. High-flow channels would be intended to transport water to bosque vegetation. Embayments may be constructed as part of the high-flow channels when possible to create areas for native recruitment of cottonwoods and willows.

Swales

Approximately 48 acres of willow swales are proposed on Santa Clara Pueblo. Willow swales are defined as being depressions constructed by the removal of vegetation, dumped debris and soil and created with the intention to provide microenvironments in which native plants can thrive due to the decreased depth to the water table and moist soils. Depending upon the location, there could be a series of willow swales that become progressively drier with increasing distance from the river or water table.

Wetland Restoration

Wetland measures (17 acres) are proposed on Santa Clara Pueblo. Wetland restoration measures are defined as being open water wetlands, marsh wetlands, or wet meadows. A marsh wetland would have fluctuating water levels (usually 1-5 feet) and various vegetative species. These areas will be created by lowering the ground surface level below the local water table.

A wet meadow habitat is similar to a marsh wetland, but has much shallower standing water, and will be created by allowing flow from a deeper wetland area (such as an open water wetland) to flow out into an existing dry area or by lowering an area to the shallow groundwater table. This creates marshy or moist soil habitat about 6 inches deep with water.

Terrace Lowering

Terrace lowering is proposed to improve floodplain connectivity on Ohkay Owingeh (57 acres) and Santa Clara Pueblo (8 acres). Terrace lowering involves the removal of vegetation and excavation of soils adjacent to the main channel to enhance the potential for overbank flooding (USACE 2015).

Vegetation Management

The vegetation management restoration feature consists of two treatment phases: partial to complete removal of invasive plants and subsequent revegetation with native plant species. Vegetation management is proposed on Ohkay Owingeh (19 acres) and Santa Clara Pueblo (85 acres).

In many areas, continued maintenance and repeated treatment of invasive plant species for stump sprouting, and removal of juvenile volunteer non-natives is proposed and described in the operations and maintenance portion of the Española HR Study BA (USACE 2015).

Vegetation Removal Treatments

For both manual and mechanical treatment methods (described below), follow-up treatment with herbicides, or root ripping (raking approximately 6-12 inches into the ground in order to remove roots), may occur. Removal of non-native vegetative species would take place between August 15 and April 15 of each year in order to avoid bird nesting seasons and requirements, notably, under the Migratory Bird Act, which severely constrain activities with the potential to impact nesting birds.

Manual treatment - Using this method, dead material would be piled up and/or processed by cutting into small pieces using a chain saw. Large material would be hauled off, with some resources for use as fire wood. Smaller material would be chipped on site using a chipper. Chips would either be tilled into the ground prior to revegetation or hauled off, depending on their density. No more than 2 inches of chipped material would be left on site. The stump of any live non-native trees that is cut would be treated immediately with herbicide, if not entirely removed. This method would be used in areas where the bosque is not very wide and equipment would not fit, or areas where there are a large number of native trees and shrubs to protect.

Mechanical treatment - Mechanical control entails the removal of aerial portions of the tree (trunk and stems) by large machinery such as a tree shear or large mulching equipment. Both dead material and live non-native trees would be treated mechanically, and the stumps would be treated immediately with herbicide. Material would be processed as stated above: large material would be hauled off and smaller material would be chipped.

Combination treatment - A combination of manual treatment, mechanical treatment and use of herbicide. Some areas may be very dense, and the use of manual methods allows them to be opened up for machinery access. Mechanical equipment can then take over while hand crews move ahead of machinery to keep areas open enough to work in without damaging native vegetation to remain. The procedure to be implemented at each location would be evaluated on a site-by-site basis.

Re-sprout treatment - Following the initial removal of non-native plant species, re-sprouting from the root systems commonly occurs. These re-sprouts would be treated with either herbicide or by root-ripping prior to revegetating the area with native species. Thinning and removal of non-native vegetation under this proposed action would include herbicide treatment in many locations. Herbicide application would be used where root ripping is not an option. Herbicide would be immediately applied to the plant using a backpack sprayer, hand application with a brush, or other equipment that allows direct application.

Revegetation Treatments

The overall restoration strategy for the Española Valley Study is to revegetate all areas within the proposed action areas utilizing native species. Each sponsor will review and update the proposed seed and plant lists for measures in their areas. Maintenance and adaptive management would be important to the long-term success of the revegetated areas. Ongoing removal of non-native stump sprouts and volunteers would be necessary in all planted areas.

Different planting strategies would be combined in order to create the target mosaic mixture of different ecosystem types (bosque forest, grass meadow, wetlands). Planting strategies to target a riparian gallery forest mosaic would include the following revegetation treatments:

Grasses and forbs - Seeding with native and certified "weed free" grasses and forbs, such as Indian rice grass *(Oryzopsis hymenoides),* galleta grass *(Hilaria jamesii),* side oats grama *(Bouteloua curtipendida),* blue grama *{Bouteloua gracilis),* sand dropseed *(Sporobolus cryptandrus),* and sunflower *(Helianthus annulus)* and in wetter areas, yerba mansa *(Anemopsis californicus),* emory sedge *(Carex emoryi),* and salt grass *(Distichlis stricta).* Seeding involves sowing seed via methods such as broadcasting, crimp and drill, or hydro-mulching. Other than the gel in the hydro mulch, no irrigation would be applied. Timing of seeding would typically be in late summer. Wood debris, such as large logs that remain after thinning, would be placed strategically to provide additional habitat once seeding is completed.

Shrubs - Bare root or container planting with native shrubs, such as New Mexico olive, four wing saltbush *(Atriplex canescens),* chamisa *(Chrysothamnus nauseosus),* false indigo *(Amorpha fruticosa),* golden currant *(Ribes aureum),* three leaf sumac *(Rhus trilobata),* wolfberry *(Lycium pallidum),* and in wetter areas, coyote willow (*Salix exigua*), black willow *(Salix nigra var. gooddingii),* and seep willow *(Baccharis salicifolia)* would be an important strategy for establishing woody plants. Bare root planting refers to planting a plant directly in the ground without a rootball. Most of the native shrubs listed above would be grown in tall pots. Container planting refers to planting small plants in small containers. Plants would be watered through the first summer. Coyote willows can be planted directly in wet areas as live sticks. Shrubs would be planted at various densities depending on what is currently at the location. If no native understory vegetation exists at a location, then shrub planting density would be higher (500 stems per acre or more). If there is existing native vegetation, then a lower density of native shrubs would be installed (100-500 stems per acre as needed). Shrubs would be planted in the fall and trees would be planted in the winter.

Trees - Pole planting of native trees, such as the Rio Grande cottonwood *(Populus fremontii var. wislizenii),* and black willow. Branches of cottonwoods and willows, 10 feet to 15 feet in length, will be slipped into holes that have been augered through the soil to the water table. Little maintenance will be required beyond taking precautions to protect the young trees from beavers and monitoring groundwater levels. Trees will be planted at a fairly low density since cottonwoods exist throughout the proposed action area. They would be supplemented in some areas as needed but at a very low density (10-50 stem per acre). Willow trees are lacking in some areas of the proposed action area and would be planted at a higher density in those areas (25-75 stems per acre).

Wetland plants - Plug planting would be used to plant wetland and other moist soil plants within created water features. Species that could be provided as plugs include yerba mansa *(Anemopsis californicus),* native sedge *(Carex* spp.), native rush *(Scirpus* spp.), and saltgrass *(Distichlis stricta).* Plug planting refers to insertion of small seedlings with the soil or growth medium attached. Plugs are planted directly into moist soils on the edge of water features (wetlands, high-flow channels, etc.).

Recreational Features

Recreation features are proposed for the Santa Clara Wetlands and Gutierrez Pond area on the east side of the Rio Grande. The recreational features include a combination walking and biking trail, other gravel trails, informational kiosk and shade structures, hardened crossings to traverse the conveyance channel, and trail shelters. Gravel trails would follow existing trails, levees or access road alignments. Kiosks and benches would be placed at strategic locations along improved trails. Picnic areas are proposed along the trail where the Bosque vegetation would provide natural shade, along with river overlooks and a boardwalk to traverse wetland areas.

Construction activities would be coordinated with the sponsors to avoid effects on tribal activities within the proposed action area. All work zones would be designated and signed with appropriate cautionary information.

Action Area

The Action Area includes the area where the ecosystem restoration features are located, from the north boundary of Ohkay Owingeh to the south boundary of Santa Clara Pueblo and the entire width of the 100 year Rio Grande floodplain within that reach.

II. STATUS OF THE SPECIES

Throughout this document the terms territory and site are used to help describe flycatcher population biology. A territory is the area occupied or defended by a single male or pair of flycatchers throughout the breeding season. Territories are the unit of measurement used by the Service in determining population status and trends. Flycatchers tend to cluster their territories. A flycatcher site may include a single territory or a cluster of territories. Migratory habitat is described for flycatcher long-distance migration and stopover habitat. The term ‘suitable or moderately suitable habitat’ refers to a patch of habitat with the adequate structure, density, and vegetation composition to accommodate flycatcher breeding, nesting, egg and fledgling rearing activity.

Species and Habitat Description

The flycatcher is a small grayish-green passerine bird (Family Tyrannidae) measuring approximately 5.75 inches in length. It has a grayish-green back and wings, whitish throat, light gray-olive breast, and pale yellowish belly. Two white wingbars are visible (juveniles have buffy wingbars). The eye ring is faint or absent. The upper mandible is dark, and the lower is light yellow grading to black at the tip. The song is a sneezy “fitz-bew” and the call is a repeated “whitt” (Sogge *et al.* 2010).

The flycatcher is one of four currently recognized willow flycatcher subspecies (Unitt 1987; Paxton 2000; Paxton *et al.* 2008). It is a neotropical migrant that breeds in the southwestern U.S. and migrates to Central and South America during the non-breeding season (Service 2002). The historic breeding range of the flycatcher included southern California, Arizona, New Mexico, western Texas, southwestern Colorado, southern Utah, extreme southern Nevada, and extreme northwestern Mexico (Sonora and Baja) (Unitt 1987; Browning 1993; Sogge *et al.* 2010).

The flycatcher breeds in dense riparian vegetation from sea level in California to approximately 8,500 feet in Arizona and southwestern Colorado. Flycatchers primarily nest in dense riparian patches of vegetation composed of Goodding’s willow (*Salix gooddingii*), coyote willow, Geyer’s willow (*Salix geyeriana*), arroyo willow (*Salix lasiolepis*), red willow (*Salix laevigata*), yewleaf willow (*Salix taxifolia*), boxelder (*Acer negundo*), tamarisk (also known as saltcedar, *Tamarix ramosissima*), and Russian olive (*Elaeagnus angustifolia*). While there are exceptions, generally flycatchers are not found nesting in areas without willows, tamarisk, or both (78 FR 343). Nesting activity typically begins in early June along the Middle Rio Grande (Moore and Ahlers 2015). Nests typically contain between three and four eggs (Sogge *et al.* 2010).

Flycatchers have higher site fidelity than nest fidelity and can move among breeding sites within and between drainages (Kenwood and Paxton 2001). Flycatchers will typically colonize in a large population (metapopulation) and disperse within 18-25 miles to form smaller populations (Paxton *et al.* 2007, 76 FR 50542). The median patch size of a flycatcher is roughly 4.5 acres (1.8 hectares) and minimum width is 33 feet (Service 2002). In the Middle Rio Grande, at least 50% canopy cover over 3 meters in height was documented for occupied flycatcher habitat and occupied patches consisted of a tree stem density of 2,840 stems per hectare (Moore 2007).

Saltcedar is an important component of nesting and foraging habitat in throughout the species range. For example, during 2014 and along the Middle Rio Grande, 162 of the 257 (63 percent) known flycatcher nests (in 364 territories) were in saltcedar (Moore and Ahlers 2015). Three habitat types have been described for the flycatcher including: native broadleaf, monotypic exotic, and mixed native/exotic (Sogge *et al.* 2010).

Flycatcher suitable habitat is dynamic and can change rapidly; historically occupied sites can mature beyond suitable habitat for nesting, suitable saltcedar or willow habitat can develop in three to five years, heavy runoff can reduce/remove suitable habitat in a day, or river characteristics may change (McLeod *et al.* 2005, Siegle et al. 2013). Flycatcher use of riparian vegetation in different successional stages may also be dynamic. For example, over-mature or young riparian vegetation not suitable for nest placement can be occupied and used for foraging and shelter by migrating, breeding, dispersing, or non-territorial individuals (McLeod *et al.* 2005). That same habitat may subsequently grow or cycle into habitat used for nest placement. Flycatcher habitat can quickly change and vary in suitability, location, use, and occupancy over time (Finch and Stoleson 2000).

Listing and Critical Habitat

The final rule listing the flycatcher as endangered was published on February 27, 1995 and designation of critical habitat was deferred (60 FR 10694). Flycatcher critical habitat was designated on July 22, 1997 in the Federal Register (62 FR 39129). In May 2001, citing a faulty economic analysis, the 10th Circuit Court of Appeals vacated the designation of critical habitat and instructed the Service to issue a new flycatcher critical habitat designation. On October 19, 2005, the Service again designated critical habitat for the flycatcher in approximately 120,824 acres or 737 miles within Arizona, California, Nevada, New Mexico and Utah. On July 13, 2010, the Service agreed to revise critical habitat for the flycatcher; while the 2005 critical habitat designation remained in place.

A proposal for the designation of flycatcher critical habitat was published in the Federal Register on October 12, 2004 (69 FR 60706), with a final rule published October 19, 2005 (70 FR 60886). A total of 737 river miles in southern California, Arizona, New Mexico, southern Nevada, and southern Utah were included in the final designation. The lateral extent of critical habitat included areas within the 100-year floodplain.

As a result of a suit filed by the Center for Biological Diversity over the critical habitat designation in 2005, a revision for critical habitat was proposed on August 15, 2011 (76 FR 50542). The final rule published January 3, 2013 (78 FR 343). The new designation includes a total of 1,227 river miles within the same states listed in the 2005 designation. Within the project area, critical habitat was designated from the southern boundary of Ohkay Owingeh downstream through Santa Clara Pueblo. The primary constituent elements (PCEs) of critical habitat include riparian plant species in a successional riverine environment (for nesting, foraging, migration, dispersal, and shelter), specific structure of this vegetation, and insect populations for food. A variety of river features such as broad floodplains, water, saturated soil, hydrologic regimes, elevated groundwater, fine sediments, etc. help develop and maintain these PCEs (78 FR 343).

Primary Constituent Elements of Critical Habitat
The PCEs listed in the 2013 final rule for the flycatcher are:
(1) *Riparian vegetation.* Riparian habitat along a dynamic river or lakeside, in a natural or manmade successional environment (for nesting, foraging, migration, dispersal, and shelter) that is comprised of trees and shrubs (that can include Goodding's willow, coyote willow, Geyers willow, arroyo willow, red willow, yewleaf willow, pacific willow (*S. lasiandra*), boxelder, tamarisk, Russian olive, buttonbush (*Cephalanthus occidentalis*), cottonwood (*Populus fremontii*), stinging nettle (*Urtica dioica*), alder (*Alnus rhombifolia, A. oblongifolia, A. tenuifolia*), velvet ash (*Fraxinus velutina*), poison hemlock (*Conium maculatum*), blackberry (*Rubus ursinus*), seep willow (*Baccharis salicifolia, B. glutinosa*), oak (*Quercus agrifolia, Q. chrysolepis*), rose (*Rosa californica, R. arizonica, R. multiflora*), sycamore (*Platinus wrightii*), false indigo (*Amorpha californica*), Pacific poison ivy (*Toxicodendron diversilobum*), grape (*Vitis arizonica*), Virginia creeper (*Parthenocissus quinquefolia*), Siberian elm (*Ulmus pumila*), and walnut (*Juglans hindsii*)) and some combination of:

- (a) Dense riparian vegetation with thickets of trees and shrubs that can range in height from about 2 to 30 meters (about 6 to 98 feet). Lower-stature thickets (2 to 4 meters or 6 to 13 feet tall) are found at higher elevation riparian forests and tall-stature thickets are found at middle and lower-elevation riparian forests;
- (b) Areas of dense riparian foliage at least from the ground level up to approximately 4 meters (13 feet) above ground or dense foliage only at the shrub or tree level as a low, dense canopy;
- (c) Sites for nesting that contain a dense (about 50 percent to 100 percent) tree or shrub (or both) canopy (the amount of cover provided by tree and shrub branches measured from the ground);
- (d) Dense patches of riparian forests that are interspersed with small openings of open water or marsh or areas with shorter and sparser vegetation that creates a variety of habitat that is not uniformly dense. Patch size may be as small as 0.1 hectare (0.25 acre) or as large as 70 hectares (175 acres).

(2) *Insect prey populations.* A variety of insect prey populations found within or adjacent to riparian floodplains or moist environments, which can include: flying ants, wasps, and bees (Hymenoptera); dragonflies (Odonata); flies (Diptera); true bugs (Hemiptera); beetles (Coleoptera); butterflies, moths, and caterpillars (Lepidoptera); and spittlebugs (Homoptera).

It is important to recognize that the PCEs, (PCE 1a and 2), are present throughout the river segments selected, but the specific quality of riparian habitat for nesting (PCE 1b, 1c, 1d, 1e), migration (PCE 1), foraging (PCE 1 and 2), and shelter (PCE 1) will not remain constant in their condition or location over time due to succession (i.e., plant germination and growth) and the dynamic environment in which they exist (78 FR 343).

Flycatcher Recovery

The Service published a final flycatcher Recovery Plan in 2002 (Service 2002). The Recovery Plan (Service 2002) identified several key strategies tied to flycatcher conservation such as: (1) populations should be distributed close enough to each other to allow for movement; (2) maintaining/augmenting existing populations is a greater priority than establishing new populations; and (3) a population's increase improves the potential to disperse and colonize. Breeding habitat objectives are incorporated into the delisting criteria because of the importance of providing replacement habitat for dispersing flycatchers after natural stochastic destruction of existing breeding habitat, and suitable habitat for future population growth. Essential to the survival and recovery of the flycatcher is a minimum size, distribution and spatial proximity of habitat patches that promotes metapopulation stability. The current size of occupied breeding habitat patches is skewed heavily toward small patches and small population sizes; this situation inhibits recovery. Recovery will be enhanced by increasing the number of larger populations and by having populations distributed close enough to increase the probability of successful immigration by dispersing flycatchers. The Recovery Plan further describes the reasons for endangerment, current status of the flycatcher, addresses important recovery actions, includes detailed issue papers on management issues, and identifies the goals for recovery.

Flycatcher recovery is defined by reaching numerical and habitat related goals for each specific management unit established throughout the subspecies range and establishing long-term conservation plans (Service 2002). Because the breeding range of the flycatcher encompasses a broad geographic area with much site variation, management of its recovery is approached in the Recovery Plan by dividing the flycatcher's range into six Recovery Units, each of which are further subdivided into Management Units (Service 2002). This provides an organizational strategy to "characterize flycatcher populations, structure recovery goals, and facilitate effective recovery actions that should closely parallel the physical, biological, and logistical realities on the ground" (Service 2002). Recovery goals are recommended for most Management Units. Recovery Units are defined based on large watershed and hydrologic units.

Within each Recovery Unit, Management Units are based on watershed or major drainage boundaries at the Hydrologic Unit Code Cataloging Unit level. Flycatcher habitat within Recovery and Management Units is expected to expand, contract, or change as a result of flooding, drought, inundation, and changes in floodplains and river channels (Service 2002) that result from natural occurrences and water or land management choices. The Recovery Plan (Service 2002) provides recommendations to recover the flycatcher and provides two alternatives, either of which can be met, in order to consider downlisting the species to threatened status. The proposed action will occur in the Upper Rio Grande Management Unit of the Rio Grande Recovery Unit for the flycatcher (77 FR 41147). The Recovery Plan identified a goal of 75 flycatcher territories in the Upper Rio Grande Management Unit to contribute towards recovery.

Rangewide Distribution and Abundance of Flycatchers

There are currently 288 known flycatcher breeding sites in California, Nevada, Arizona, Utah, New Mexico, and Colorado (all sites where a resident flycatcher has been detected as of the 2007 breeding season) holding an estimated 1,299 territories (Durst *et al*. 2008) (table 2). Currently, rangewide population stability is believed to be largely dependent on the presence of large populations in the Gila River, Rio Grande, and San Pedro River drainages where approximately 60 percent of the 1,299 territories exist as of the breeding season of 2007. Therefore, the result of catastrophic events or losses of significant populations either in size or location could greatly change the status and survival of the species. Conversely, expansion into new habitats or discovery of other populations will improve the known stability and status of the flycatcher.

Since listing in 1995, at least 155 Federal agency actions have undergone (or are currently under) formal section 7 consultation to address effects to the species. Many activities continue to adversely affect the distribution and extent of all stages of flycatcher habitat throughout its range (development, urbanization, grazing, recreation, native and non-native habitat removal, dam operations, river crossings, ground and surface water extraction, etc.). Stochastic events also continue to change the distribution, quality, and extent of flycatcher suitable habitat.

Table 2. Number of flycatcher breeding sites and territories by state, as of 2007. (There is no recent survey data or other records to know the current status and distribution within the state of Texas.) (Durst *et al.* 2008).

State	Number of sites with flycatcher territories As of 2007	Percentage of sites with flycatcher territories as of 2007	Number of flycatcher territories as of 2007	Percentage of total flycatcher territories as of 2007
Arizona	124	43.1 %	459	35.3 %
California	96	33.3 %	172	13.2 %
Colorado	11	3.8 %	66	5.1 %
Nevada	13	4.5 %	76	5.9 %
New Mexico	41	14.2 %	519	40.0 %
Utah	3	1.0 %	7	0.5%
Total	***288***	***100 %***	***1299***	***100 %***

Distribution and Abundance in New Mexico and the Action Area

Unitt (1987) considered New Mexico as the state with the greatest number of flycatchers remaining. After reviewing the historic status of the flycatcher and its riparian habitat in New Mexico, Hubbard (1987) concluded, “[it] is virtually inescapable that a decrease has occurred in the population of breeding flycatchers in New Mexico over historic time. This is based on the fact that wooded sloughs and similar habitats have been widely eliminated along streams in New Mexico, largely as a result of the activities of man in the area.” Unitt (1987), Hubbard (1987), and more recent survey efforts have documented very small numbers and/or extirpation in New Mexico on the San Juan River (San Juan County), near Zuni (McKinley County), Blue Water Creek (Cibola County), and the Rio Grande (Doña Ana County and Socorro County).

In New Mexico, surveys and monitoring in 2007 documented approximately 519 flycatcher territories (Durst *et al.* 2008). During the 2003 survey season two new sites were detected in New Mexico, both were in the upper reaches of the Canadian River drainage, one in Colfax County and one in Mora County. Two more new sites were detected during the 2005 survey season, one in Mora County and one near the Mimbres River in Grant County. In 2007 a new site was found on the San Francisco River in Catron County. In 2008 a new nesting site was found on the Black River in Eddy County. Flycatchers have been observed at a total of 42 sites in New Mexico along the Rio Grande, Chama, Canadian, Gila, San Francisco, San Juan, Pecos, and Zuni drainages.

In the Upper Rio Grande Management Unit of the Rio Grande Recovery Unit for the flycatcher, there is estimated to be approximately 20-30 flycatcher territories (Service 2002, Durst *et al.* 2008) (Figure 2).

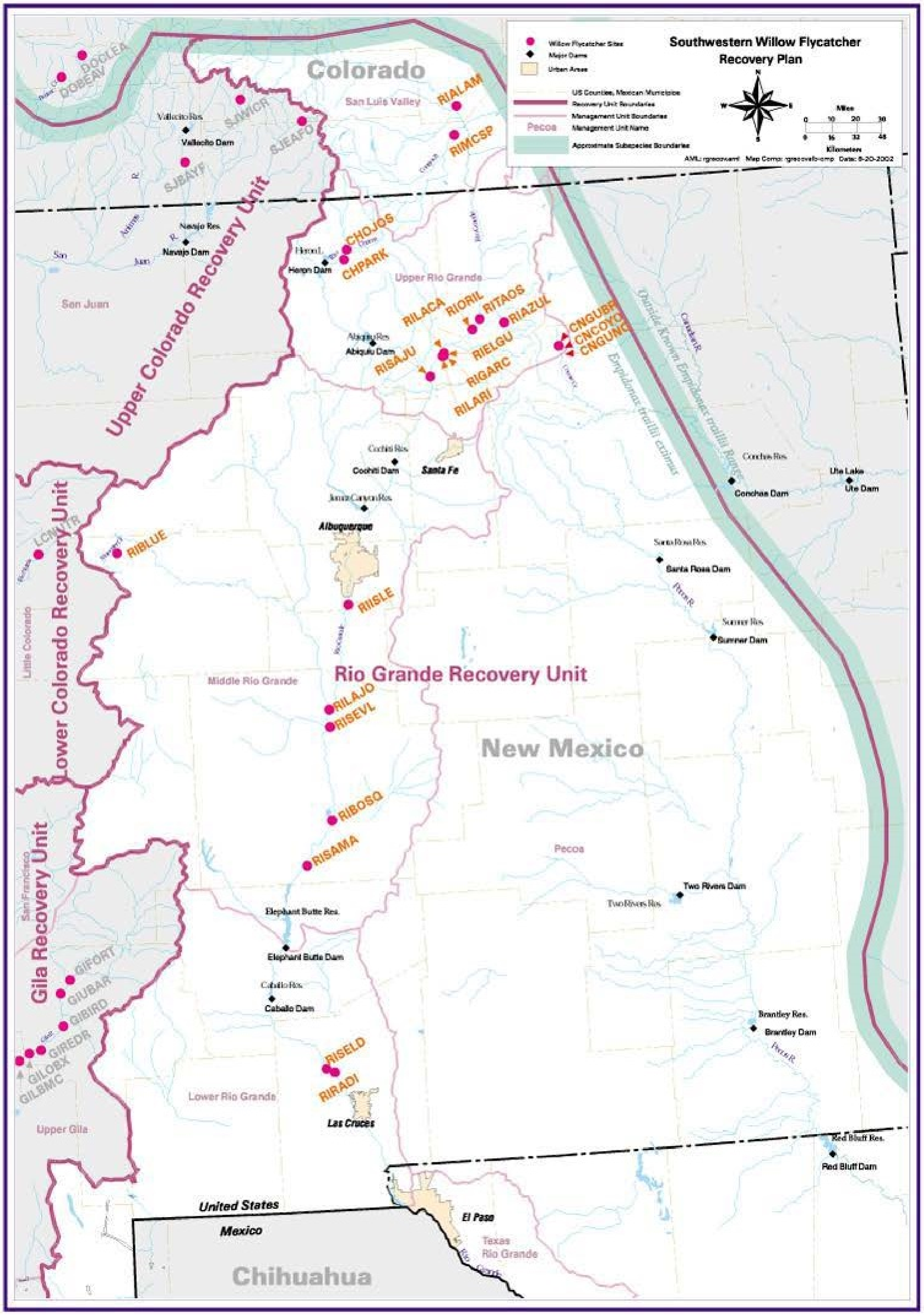

Figure 2. Flycatcher Recovery Plan Rio Grande Recovery Unit and the Upper Rio Grande Management Unit (Service 2002).

III. ENVIRONMENTAL BASELINE

Under section 7(a)(2) of the ESA, when considering the effects of the action on federally listed species, the Service is required to take into consideration the environmental baseline. Regulations implementing the ESA (50 CFR 402.02) define environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area; the anticipated impacts of all proposed Federal actions in the action area that have already undergone formal or early section 7 consultation; and the impact of State and private actions that are contemporaneous with the consultation in process.

Habitat Characteristics

Habitat characteristics within the project area range from areas with dense mature cottonwoods and willows to areas with sparse upland vegetation or exotic vegetation (USACE 2015). Patches of suitable or marginally suitable habitat are present within the action area and several restoration projects sponsored by the Middle Rio Grande Endangered Species Collaborative Program have historically taken place within the action area (La Calandria 2012).

As described in the Española HR Study BA, in the early 1900's, the action area supported substantial areas of cottonwood, willow, New Mexico olive, and various species of shrub and wetlands (Scurlock 1998). Since then, the area has changed due to dam construction, channelization activities, gravel mining, non-engineered spoil banks, water management and climate change (USACE 2015). The river in the action area is now incised and the groundwater table has decreased, directly contributing to the decline and loss of native riparian vegetation and transition to large expanses of exotic and upland vegetation (USACE 2015). The non-native vegetation consists of saltcedar, Russian olive, Siberian elm, and tree of heaven (USACE 2015).

Saltcedar Leaf Beetle (*Diorhabda* spp.)

The saltcedar leaf beetle was released in 2001 (DeLoach *et al*. 2003) to control saltcedar. The saltcedar leaf beetle controls saltcedar by repeated leaf defoliation which typically occurs during flycatcher breeding season (Tamarisk Coalition). In 2015, saltcedar leaf beetle presence was observed along the Middle Rio Grande north of Albuquerque (Tamarisk Coalition 2015). The saltcedar leaf beetle has now been observed along the Rio Grande throughout the majority of New Mexico (Tamarisk Coalition 2015). Recent drought, channel incision and senescence of native vegetation have provided conditions for saltcedar to become more dominant within the action area (USACE 2015).

Historic Consultations

Along the Rio Grande, the following past and present federal, state, private, and other human activities, in addition to those discussed above, have affected the flycatcher and its critical habitat within the action area:

1. <u>Programmatic Biological Opinion on the Effects of Actions Associated with the U. S. Bureau of Reclamation's, U.S. Army Corps of Engineers', and non-federal Entities' Discretionary Actions Related to Water Management on the Middle Rio Grande</u>: The Service completed this biological opinion on 17 March 2003, determining the effects of water management by the applicants on the silvery minnow and flycatcher. This

biological opinion had one Reasonable and Prudent Alternative (RPA) with several elements. These elements set forth a flow regime in the Middle Rio Grande and described habitat improvements necessary to alleviate jeopardy to both the silvery minnow and flycatcher.

2. Joint Biological Assessment U.S. Bureau of Reclamation, Bureau of Indian Affairs, and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico Middle Rio Grande Project, San Juan-Chama Project, and Upper Colorado Region: Bureau of Reclamation submitted this BA on August 31, 2015. This consultation includes effects analysis for the silvery minnow, flycatcher, cuckoo, New Mexico Meadow Jumping Mouse (mouse), Pecos Sunflower, and Interior Least Tern as related to Middle Rio Grande water operations and maintenance.
3. Biological Assessment Middle Rio Grande Endangered Species Collaborative Program Restoring Loosestrife Pond – Expanding Flycatcher Habitat and Controlling Invasive Plants along a Backwater of the Rio Grande at Ohkay Owingeh: Habitat restoration project geared towards expanding pre-existing flycatcher habitat and removal of invasive species. Concurrence was provided to this informal consultation dated March 29, 2012.
4. Biological Assessment Ohkay Owingeh Two Rivers and Three Falls Flycatcher Habitat Expansion – Middle Rio Grande Endangered Species Collaborative Program: Bureau of Reclamation submitted this informal consultation in September 2009 and the project involved expanding flycatcher habitat by excavating a filled-in secondary river channel to reconnect it to the Rio Grande.
5. Intra-Service Section 7 Biological Evaluation – Ohkay Owingeh (San Juan Pueblo), 8 acres of Riparian and Riverine Habitat Restoration: The Service submitted this informal consultation on August 8, 2006. This was a habitat restoration project by the Partners for Fish and Wildlife Program with the goal of removing non-native species, treating re-sprouts, and wetland restoration. This project added to the 745 acres of riparian habitat that had previously been treated for non-native vegetation removal.

Importance of the Action Area to the Survival and Recovery of the Species

The flycatcher Recovery Plan identifies five Recovery Units, the Basin and Mojave, Lower Colorado River, Upper Colorado River, Gila River, and Rio Grande. Flycatcher populations are not distributed evenly throughout these Recovery Units, with the majority of individuals found in the Coastal California, Lower Colorado, Gila, and Rio Grande Recovery Units (Service 2002).

The Rio Grande Recovery Unit contains the eastern most population of flycatchers, and currently has approximately 24 percent of known territories (Durst *et al*. 2008). The Rio Grande Recovery Unit covers a major portion of the flycatcher’s previous range. In order to be well protected against disease and catastrophe, the species should be well distributed geographically. The survival and recovery of the flycatcher is dependent on healthy, self-sustaining populations of birds, which are able to exchange genetic information on occasion, and act as a source population should one area suffer significant losses (Soule *et al.* 1986). The loss or reduction of a major population within a Recovery Unit could have potentially significant effects to the surrounding Recovery Units if genetic information is lost or if a source population which has been supporting other sites is significantly reduced.

Summary

The action area was historically a naturally dynamic riparian system with native vegetation and areas with overbank flows. Since the early 1900's, the action area has now become an area with an incised river, mature native vegetation, and exotic vegetation encroachment. Several restoration projects have taken place in the last decade in an effort to reconnect the floodplain, remove exotic vegetation, enhance wetlands, re-establish native vegetation and expand on flycatcher suitable habitat. The flycatcher population in the Upper Rio Grande Management Unit (as part of the Rio Grande Recovery Unit) is an important source population. Re-establishing a dynamic hydrological system is critical in the action area in order to increase or maintain plant health and foliage cover, promote natural regeneration, and scour and deposit nutrients in the soil.

IV. EFFECTS OF THE ACTION

Effects of the action refer to the direct and indirect effects of an action on the species or designated critical habitat, together with the effects of other activities that are interrelated and interdependent with that action, which will be added to the environmental baseline. Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. The following section describes the effects on flycatcher and its critical habitat, and on cuckoo and its proposed critical habitat a resulting from the proposed action.

The overall goal of this project is to improve floodplain conditions which, in turn, would increase the potential for flycatcher habitat creation. However, the construction associated with this proposed action will likely overlap with historically occupied flycatcher territories. Because flycatchers typically exhibit a strong site fidelity to successful breeding locations, the construction activities would likely indirectly impact flycatchers by removing habitat, and thus, creating the need for flycatchers to relocate upon arrival to their breeding ground. We consider this a form of harm and/or harassment due to their displacement caused by the removal of habitat. The construction activities that would overlap with historically occupied areas include terrace lowering, vegetation management, excavation of a high-flow channel. All of these construction methods would either remove vegetation completely or alter the vegetation composition to the point where the habitat may no longer be suitable.

Based on correspondence between the USACE, the Service, and Ohkay Owingeh, we believe the following construction activities associated with various ecosystem measures would displace up to 6 flycatcher territories:

Table 3. Summary of construction activity intersecting with flycatcher habitat.

Ecosystem Measure Type	Ecosystem Measure Identification	Acreage
Terrace Lowering	3201, 3203, 3208, 3209	13.32
Vegetation Management	3002	10.23
High-flow Channel	3213	1.83

The features listed in Table 3 also have the potential to increase flycatcher habitat availability over time. Terrace lowering and high-flow channels will increase frequency or potential for overbank flows, resulting in moist soils and decreased depth to groundwater and, thus, increasing the chance of natural regeneration of dense riparian vegetation flycatchers depend on. The removal of exotic vegetation via the vegetation management proposed action would decrease the overall amount of vegetative cover initially, but the subsequent native species planting will ensure replacement by more desirable species. The removal of exotic vegetation and replacement of native species would also decrease the possibility of flycatchers being impacted by saltcedar leaf beetle defoliation.

Overall, 25.38 acres of habitat used by flycatchers would be negatively impacted by the construction activities associated with the proposed action. The ultimate goal of the project is to enhance habitat in at least 271.9 acres of the floodplain over time. It is estimated that habitat availability would not be a limiting factor for the displaced flycatchers because there are areas with suitable or moderately suitable habitat within 25 miles of the project location.

In summary, the proposed action construction activities are estimated to displace up to 6 flycatcher territories. Though there would be short term losses in the form of harassment, displacement, and habitat loss; over the long term, the overall benefit of the proposed action would be positive for the flycatcher population and habitat located in this area.

Effect to Designated Critical Habitat

The vegetation management ecosystem restoration measure proposed is located within 9.5 acres of designated critical habitat boundaries. The 9.5 acres where this will occur currently has either sparse vegetation or an abundance of exotic vegetation and would be replanted with more desirable species at a greater density than what is currently present. No known flycatcher territories are located in these areas. We concur with USACEs' determination that the Española HR Study is not likely to adversely affect flycatcher designated critical habitat.

Cumulative Effects

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur in the action area considered in this draft biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the Act. Cumulative effects include:

- Increases in development and urbanization in the historic floodplain that result in reduced peak flows because of the flooding threat. Development in the floodplain makes it more difficult, if not impossible, to transport large quantities of water that will overbank and create low velocity habitats for flycatchers.

- Increased urban use of water, including municipal and private uses. Further use of surface water from the Rio Grande will reduce river flow and decrease available habitat for flycatchers.

- Human activities that may adversely impact the flycatcher by decreasing the amount and suitability of habitat include dewatering the river for irrigation; increased water pollution from non-point sources; habitat disturbance from grazing activities and/or recreational use.

- Wildfires and wildfire suppression in the riparian areas along the Rio Grande may have an adverse effect on flycatchers. Wildfires are a fairly common occurrence in the bosque (riparian area) along the Rio Grande. The increase in wildfires has been attributed to increasingly dry, fine fuels and ignition sources. The spread of the highly flammable plant, saltcedar, and drying of river areas due to river flow regulation, water diversion, lowering of groundwater tables, and other land practices is largely responsible for these fuels. Wildfires have the potential to destroy flycatcher habitat.

- The removal of non-native vegetation (i.e. saltcedar or Russian olive) through mechanical or biological control (i.e. saltcedar leaf beetle (*Diorhabda sp.*)), can adversely affect the amount of available flycatcher habitat. In areas where non-native trees are removed and replaced with native vegetation as part of a restoration project, habitat may be created. Where phreatophyte removal is not followed by restoration, habitat for the flycatcher is lost.

- The effect global warming may have on the flycatcher is still unpredictable. However, mean annual temperature in Arizona increased by 1 degree per decade beginning in 1970 and 0.6 degrees per decade in New Mexico (Lenart 2005). In both New Mexico and Arizona the warming is greatest in the spring (Lenart 2005). Higher temperatures lead to higher evaporation rates which may reduce the amount of runoff, groundwater recharge, and lateral extent of rivers such as the Rio Grande. Increased temperatures may also increase the extent of area influenced by drought (Lenart 2003).

The Service anticipates that these conditions and types of activities will continue to threaten the survival and recovery of the flycatcher by reducing the quantity and quality of habitat through the continuation and expansion of habitat degrading actions.

V. CONCLUSION

After reviewing the current status of the flycatcher, designated critical habitat, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects; it is Service's biological opinion that the Española HR Study is not likely to jeopardize the continued existence of the flycatcher or result in adverse modification of designated critical habitat. Population numbers and habitat availability would be expected to decrease in the Upper Rio Grande Management Unit by up to 6 territories in the short term prior to establishment or replacement of vegetation as a result of the proposed action. However, it would be anticipated that for the long term, the ecological restoration features associated with this proposed action will enhance the dynamic environment in the project area that is critical for flycatchers. We also conclude that the primary constituent elements of flycatcher designated critical habitat adjacent to the action area will serve the intended conservation role for the species with implementation of the proposed action while vegetation becomes re-established within the 25.38 acres of historically occupied habitat.

INCIDENTAL TAKE STATEMENT

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

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

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The Service developed the following incidental take statement based on the proposed actions associated with the Española HR Study.

Take would be expected in the form of harassment and displacement in the areas where terrace lowering, high-flow channel and vegetation management would take place in flycatcher historically occupied locations. It is estimated that up to 6 flycatcher territories would be taken as the result of the removal of 25.38 acres of historically occupied flycatcher habitat.

EFFECT OF TAKE

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the flycatcher, because the number that may be taken would not impair flycatcher recovery goals for the Rio Grande Recovery Unit.

Conservation measures in the Española HR Study BA were also taken into consideration for the effect of take and include the following actions:

1. Stormwater controls will be installed and maintained during excavation activities as appropriate for the NPDES Construction General Permit and Stormwater Pollution Prevention Plan. Silt fence will be installed adjacent to the riverbank where needed for stormwater control.

2. Cofferdams, dikes, straw bales or other suitable erosion control measures would be used during construction of bank line measures (high-flow channel inlets and outlets).

3. Cleaning of all equipment to prevent the spread of invasive species is required prior to entering the project area (National Invasive Species Council 2008).

4. Equipment operators will be required to carry an oil spill kit or spill blanket at all times and must be knowledgeable in the use of spill containment equipment. The contractor will develop a spill contingency plan prior to initiation of construction. The plan will identify where storage and dispensing fuels, lubricants, hydraulic fluids, and other petrochemicals will be located outside the 100-year floodplain. The contractor will inspect construction equipment daily for petrochemical leaks. All spills will be contained immediately and all contaminated media will be disposed of following the Resource Conservation and Recovery Act. If a reportable quantity is released, the contractor will notify NMED and U.S. EPA as soon as possible after learning of a discharge, but in no event more than twenty-four hours thereafter. The staging areas will be located outside the 100-year floodplain. The construction equipment will be parked outside the 100-year floodplain during periods of inactivity for an extended period or based on weather conditions. The equipment operators will place drip-pans underneath vehicles at the end of each work day.

5. All work and staging area will be limited to the minimum amount of area required. Existing roads and right-of-ways and staging areas will be used to the greatest extent practicable to transport equipment and construction materials to the project site, and described in the USACE’s project description. Designated areas for vehicle turn around will be provided and maneuvering conducted so as to protect riparian area from unnecessary damage.

6. Mature cottonwood trees will be protected from damage during clearing of non-native species or other construction activities using fencing, or other appropriate materials.

7. Local genetic stock will be used wherever possible in the native plant species establishment throughout the riparian area.

8. Work inside the bosque will not occur during migratory bird breeding season (April 15 to August 15). Surveys will be conducted for the presence/absence of flycatchers during their breeding season in areas surrounding proposed measures prior to construction.

Reasonable and Prudent Measure

The Service believes the following Reasonable and Prudent Measure (RPM) is necessary and appropriate to minimize impacts of incidental take of the flycatcher due to activities associated with the proposed project.

1. Minimize take of flycatchers in the form of loss of habitat due to construction activities.

Terms and Conditions

Compliance with the following terms and conditions must be achieved in order to be exempt from the prohibitions of section 9 of the ESA. These terms and conditions implement the proposed action described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

To implement RPM 1, USACE shall:

1.1 Conduct flycatcher protocol presence/absence surveys within the proposed action area, or coordinate with Ohkay Owingeh and/or the Pueblo of Santa Clara if flycatcher surveys already take place, in order to determine the most accurate and up to date flycatcher territory locations. To the extent possible, adjust access or other construction activities to avoid the territory and minimize fragmentation of the occupied habitat patch.

1.2 Ensure that habitat within 0.25 miles of a historic flycatcher territory (within 2 years prior to construction) lost to construction activities is restored to the same amount (estimated 25.38 acres) of suitable habitat within 3-4 years of the proposed action. In the event habitat does not naturally regenerate with native species, active planting or restoration in the density required to accommodate nesting activity must take place and be available to the flycatcher by year 2030 (3 years after construction is complete). Suitable habitat is considered a patch at least 33 feet wide and 4.5 acres in size with canopy cover being 50% (or more) and woody stem density of approximately 2800 stems per hectare (1133 stems per acre).

For the RPM, USACE shall monitor the implementation as set forth in this terms and conditions section. An annual report of the progress made in construction activities, updates of how many flycatchers were impacted, as well as how many acres were taken or replaced (via natural recruitment or active planting) must be submitted to the Service's NMESFO. Any measures the USACE took to minimize disturbance to historic territories should also be noted at this time annually. These reports should reference consultation #02ENNM00-2014-F-0436 and should be sent to the email address nmesfo@fws.gov or by mail to the New Mexico Ecological Services Field Office, 2105 Osuna Road NE, Albuquerque, New Mexico 87113.

CONSERVATION RECOMMENDATIONS

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

1. Monitor, maintain, and expand habitat restoration areas.
2. Restore channel function, form, and processes.
3. Maintain the bosque and re-establish native vegetation regeneration.
4. Create wetlands and marshes within the floodplain.
5. Investigate opportunities to enrich habitat for jumping mouse, cuckoo, and/or other sensitive species.
6. Update the riparian and wetland plant and seeding specifications during the design phase with input from the sponsors.

RE-INITIATION NOTICE

This concludes formal consultation on the action(s) described in the USACE Española HR Study BA. As provided in 50 CFR § 402.16, re-initiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) The amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or designated critical habitat in a manner or to an extent not considered in this biological opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or designated critical habitat not considered in this biological opinion; (4) adaptive management that includes additional earth work is needed to repair or maintain the project after the initial construction phase; or (5) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.

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APPLICATION OF THE COMBINED HABITAT ASSESSMENT PROTOCOLS (CHAP) TO ESTIMATE HABITAT UNIT VALUES FOR THE ESPAÑOLA VALLEY, RIO GRANDE AND TRIBUTARIES, NEW MEXICO STUDY

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Table 6. Summarized habitat values from the project area by vegetation type. ... 29

1 - Introduction

The Española Valley, Rio Grande and Tributaries, New Mexico Study (Study) is being conducted to identify ecosystem restoration and flood risk management alternatives. The Pueblos of Ohkay Owingeh (formerly San Juan Pueblo), Santa Clara, and San Ildefonso (project sponsors) defined the boundaries as the riparian corridor extending one mile east and west of the centerline of both the Rio Chama and Rio Grande from the northern border of Ohkay Owingeh Pueblo, through the Santa Clara Pueblo lands and to the southern border of San Ildefonso. The Rio Grande tributaries Santa Cruz River, Arroyo Guachupangue, Santa Clara Creek, and the Rio Pojoaque are also considered in the study area (USACE 2009). The Pueblo of San Ildefonso was a sponsor at the time of modeling was initiated. The study reports include data on hydrology, fluvial geomorphology, substrate conditions, and principle stressors for the ecosystem.

The primary project delivery team (sponsors and USACE staff) participated in a one-day workshop (Sept 2009) to compare the Bosque Riparian Community Index Model for the Middle Rio Grande Bosque Ecosystem Restoration (MRGBER) study (Burkes-Cope 2009) with Combined Habitat Assessment Protocols (CHAP; Northwest Habitat Institute). To evaluate the most current conditions in order to project potential alternative habitat units, the Habitat Team considered two approaches for quantifying habitat. The Habitat Evaluation Assessment Tool (HEAT) is a model that combines the Habitat Evaluation Procedure (HEP) with some hydrological components to estimate habitat units for comparison of proposed measures. CHAP is an ecosystem accounting and appraisal methodology based on habitat, species, and functions (O'Neil *et al.*, 2005) in cooperation with 34 organizations. CHAP combines a field inventory approach with species database to estimate habitat values. HEAT was used by the Middle Rio Grande Bosque Project, while CHAP had been used for the Aliso Creek and Los Angeles River Projects (USACE) in California. The Habitat Team decided to utilize an inventory modeling approach.

The selection of CHAP as the habitat evaluation approach eliminates the time-consuming process of determining an ecosystem-specific model (see the MRGBER model, Burkes-Cope 2009). CHAP uses an inventory approach that is implicitly based on increasing habitat complexity (ecological components) and species diversity (ecological functions) as factors for calculating performance measures (i.e., success criteria). CHAP is not constrained by either a species- or guild-based index model approach for estimating habitat units. The CHAP inventory approach is a comprehensive community index based on direct (field) and indirect (database) information The 2002 GIS vegetation data for the Upper Rio Grande Water Operations FEIS (USACE 2007) was used for the 2010 inventory of ecological components (for CHAP), incorporating vertebrate species information from Biota Information System of New Mexico (BISON-M, 2010).

The basic site characterization, historical data on landscape-scale habitat conditions, land-use characteristics, and ownership patterns were described using GIS in concert with historical records (USACE 2009). CHAP provides a structured (yet flexible) sampling protocol based on vegetation mapping with comprehensive documentation.

2 - Significance of Resources – Why is the Rio Grande important?

The Rio Grande and the Rio Chama previously supported substantial bosque areas of cottonwood gallery forest, with willows, New Mexico olives, shrubs, and wetlands along the southwestern streams and rivers.

The Rio Grande is the 5th largest river in North America and one of the top ten endangered rivers in the world (Wong *et al.* 2007). The Rio Grande contains patches of undeveloped floodplain called 'bosque', consisting of cottonwood and willow riparian habitat. The Nature Conservancy lists desert riparian woodland as a very rare although significantly important cover type and describes restoration of wetland and riparian systems as critical (Marshall et al 2000). These fragmented riparian ecosystems are among the most threatened bird habitats (American Bird Conservation 2007). Riparian corridors comprise less than one percent of New Mexico's landscape (USEPA and NMED 1998), yet they are the most important ecosystems in the state (Roelle and Hagenbuck 1995). The surface area of wet meadows, marshes, and ponds has decreased by 73% along 250 miles of the Rio Grande floodplain from Española to Elephant Butte Lake in New Mexico.

The primary ecosystem problem is the severe degradation and loss of riparian habitat along the Rio Grande and its tributaries. These rivers supported early irrigation projects through spring runoff and monsoon season. Full appropriation of surface water and groundwater for agriculture, with construction of water and sediment retention projects, has transformed the Rio Grande and Rio Chama into highly incised rivers that no longer flood the riparian areas during spring runoff.

As a result of these changes, stands of healthy native riparian habitat, including wetlands, are rare and scattered in the study area. Loss of riparian habitat is extremely significant in the arid Southwest. Riparian habitat comprised approximately 720,000 acres in the 1780s of what would later become the State of New Mexico (only 0.9 percent of New Mexico). As of 1998, approximately 33 percent of the riparian habitat had already been lost in New Mexico (USEPA and NMED 1998). This combination of riparian, wetland, and fringe habitat is extremely valuable due to its rarity.

Channelization, levee construction, jetty jack installation, sediment retention in reservoirs, and flow regulation reversed the processes of river aggradation and channel widening in the region. Active channel width has been reduced by approximately 80% since 1935, creating a fixed channel plan form and a narrower floodplain that is less frequently inundated or is disconnected entirely from the river. The abandoned channels have become vegetated, shifting the distribution of riparian habitat within the project area. Reductions in peak flows and stable banks have limited the lateral migration of the Rio Grande. These factors have eliminated natural restoration of the river and its floodplain, and allowed non-native invasive plant species to become established. The result has been disruption or termination of major processes depicted in the dynamics of a naturally functioning bosque ecosystem. System manipulation will be required to restore lateral connectivity between the river and the adjacent floodplain.

Flooding and scour are the basic processes that created a patchwork of variable age class forest stands on the floodplain (Crawford *et al.* 1993; Scurlock 1998). A major change in vegetation dynamics in the bosque ecosystem has been loss of meander cut-off, meander migration, and flood scour processes, when channelization of the river for flood control (1950s) created a relatively straight channel. These processes were a driving force in the dynamics of the naturally functioning system, which removed existing vegetation and created new sites for establishment of plant communities. The higher water velocities in the deep, trapezoidal channel increased sediment transport leading to incision. Gravel extraction (1980s) downstream of Ohkay Owingeh has further increased channel incision, reducing water availability for riparian vegetation (Mussetter 2008; USACE 2009).

The geomorphology assessment (Mussetter Engineering, Inc.) identified changes in the floodplain connectivity for the Rio Grande, Rio Chama, and the major tributaries within the project boundaries. Flood-control activities (channelization, straightening, and levees) with gravel mining has caused significant incision along the river (up to 10 feet). Channel incision and reduced peak flows have reduced lateral connectivity of the river with the floodplains.

There has been no significant overbank flow along this reach of the Rio Grande to support germination of native bosque vegetation, particularly cottonwoods, since channelization. The decreasing lateral and groundwater connectivity necessary for regeneration of native riparian plants, and the concurrent increasing abundance of non-native species were identified in river systems throughout the western U.S. beginning in the mid-1970s. Mainstem impoundments are typically identified as the primary factor driving alteration of ecosystem structure and function (Fenner *et al.*, 1985; Howe and Knopf, 1991). Impoundments alter the hydrograph and reduce sediment supply in downstream reaches and cause channel incision and narrowing of the floodplain (Williams and Wolman, 1984).

These bosque plant communities are adapted to a dynamic, moist, floodplain environment on a sand-gravel substratum with standing surface water, and shallow ground water. Hink and Ohmart (1984) developed riparian vegetation designations for the Middle Rio Grande that have been used in later studies (Sivinski *et al.* 1990). They defined six structure types based on the height and density of canopy trees, and the understory vegetation. This system indirectly incorporates the temporal dynamics of a riverine system that is continually scouring patches of vegetation, while new patches form on newly created bars. Floods created a gradient of channels, sandbars, wetlands, and scattered bosques of varying-age valley cottonwood (*Populus deltoids* ssp. *wislizeni*), willow (*Salix* sp.), and salt grass dominated understory (Scurlock 1998; Reichenbacher 1984). Invasive saltcedar (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*) have become common components of riparian plant communities with changing hydrologic conditions (Van Cleave, 1935).

Soil moisture levels and depth to ground water on floodplain sites are influenced primarily by surface topography, the variation of which is created through fluvial geomorphic processes (Malanson, 1993). The limits of riparian vegetation are controlled by depth to the water table (Hughes, 1990). Soil moisture has a major influence (Dawson and Ehleringer, 1991) on seed germination and seedling survival of cottonwood (Moss, 1938; Bradley and Smith, 1986) and willow (Taylor *et al.*, 1999; Dixon, 2003). Most of the existing cottonwood stands are over fifty years old.

Emergent persistent wetland habitats (National Wetlands Inventory, 1994) comprise approximately ten percent of the floodplain of the Rio Grande and Rio Chama in the project area. The emergent persistent wetland habitats support many of the rarer plants species like Baltic rush, sedges, and cattails. Cattails, sedges, rush, reed grass, and yerba mansa grew around wetlands, ponds, marshes, and swampy sites Scurlock (1998). These areas were classified as wet meadows by Van Cleave (1935) and were dominated by sedge (*Carex* sp.), spikerush (*Eleocharis* sp.), bulrush (*Schoenoplectus [Juncus]* sp.), inland saltgrass (*Distichlis spicata*), and yerba mansa (*Anemopsis californica*). However, by the mid-1930s much of the floodplain wetland plant community had been eliminated by drainage and lowering of the water table (Van Cleave, 1935).

The naturally functioning bosque ecosystem was structured largely by fluvial geomorphic processes (cf. Déscamps *et al.*, 1988), while changes by impoundments and channel modifications have created a riparian ecosystem organized by plant succession, invasion by non-native plant species, and fire. Decline of natural riparian structure and function in the bosque ecosystem was recognized in the 1980s as a major ecological change in the Middle Rio Grande Valley (Hink and Ohmart, 1984; Howe and Knopf, 1991). The current cottonwood population is 50 - 60 years of age, and can be expected to begin dying out within the next 20+ years unless action is taken to restore the riparian zone. Upland vegetation like junipers have become established as the soil moisture decreases and the canopy opens.

Changes to channel morphology have reduced overbank flooding and floodplain connectivity, limiting regeneration of riparian habitat. The scarcity of suitable riparian nesting and nursery habitat has contributed to the decrease in Southwestern Willow Flycatcher (*Empidonax traillii extimus*, flycatcher) and Rio Grande silvery minnow (*Hybognathus amarus*) populations. At least 80 percent of vertebrate wildlife occurring in New Mexico use riparian areas at some stage of their lives and 50 percent are riparian obligates (NMDGF 2004). Birds (167 species) comprise 60 percent of the 274 vertebrate species, with the balance of species including fish (31 species), amphibians (8 species), reptiles (14 species), and mammals (54 species) in the project area based on a query of the Biota Information System of New Mexico (BISON-M, accessed August 2009).

Riparian areas support a greater diversity of breeding birds than all other habitats in the state combined. Hink and Ohmart (1984) recorded 277 species of birds in the bosque ecosystem. Higher bird densities and species diversity were found in edge habitat vegetation with a cottonwood overstory and an understory of Russian olive (Hink and Ohmart 1984). The Middle Rio Grande is a major migratory flyway for avian species (Yong and Finch, 2002). Emergent marsh and other wetland habitats also had relatively high bird density and species richness. Higher bird densities appear to relate to the structure of the habitat rather than species of plant making up that component.

Amphibian and reptile abundance and diversity within the bosque is generally greater in habitats that lacked dense canopy cover and that were characterized by sandy soils and sparse ground cover (Hink and Ohmart 1984). Hink and Ohmart (1984) described a distinct assemblage of amphibian and reptile species associated with denser vegetation cover in mesic or hydric habitats. Small mammals like shrews and jumping mice were found to be more abundant in moister, densely vegetated habitat, and habitats with dense coyote willow than at drier sites (Hink and Ohmart 1984). Dominant species differed between various habitat types however, so that a variety of habitats increases the diversity of small mammals in the study area.

3 - Project Purpose

A primary goal of the project is riparian habitat restoration along the Rio Grande and its tributaries resulting from the severe channel degradation caused by channelization, sediment retention by Abiquiu Dam, and gravel mining (USACE 2009). The Rio Grande and Rio Chama have become highly incised in the project area and no longer flood the riparian areas during spring runoff. Approximately 33 percent of the riparian habitat has already been lost in New Mexico (USACE 2009). A secondary goal is reducing potential flood damage, specifically on Santa Clara Pueblo lands, caused by high flows in the Rio Grande and Santa Clara Creek following the Las Conchas fire.

3.1 Goals

One goal of the study is to contribute to National Ecosystem Restoration (NER) through increasing the net quality and/or quantity of desired ecosystem resources. Specifically, restore significant bosque ecosystem heterogeneity, function and habitat value in multiple locations throughout the study area for the life of the project.

3.2 Objectives

- Extend and enhance the native bosque communities while creating greater stand diversity in terms of stand age, size and composition within the bosque.
- Promote bosque habitat heterogeneity by recreating pockets of new cottonwood and willow throughout project area where root zones reach the shallow water table.
- Implement measures to reestablish fluvial processes in the bosque, including bank improvements, promote overbank flooding and high-flow channel creation.
- Create new wetland habitat while extending and enhancing quality aquatic habitat in existing wetlands.

- Recreate hydraulic connections between the bosque and the river consistent with operational constraints.
- Develop and implement a long-term operations and maintenance plan, which incorporates long-term monitoring of proposed restoration features. A maintenance plan would be prepared prior to any construction and would be amended annually based on success of previous efforts.
- Coordinate and integrate project implementation and monitoring with other, ongoing restoration efforts in the bosque before and during implementation.

3.3 Alternative Development Rationale

Alternatives are formulated to address a comprehensive Federal project for ecosystem restoration in order to:

- Ensure that a wide variety of possible solutions were considered and took into account public and stakeholder concerns, the highest cost benefit output feasible, and the least negative impact on the human environment.
- Provide decision-makers, both Federal and local, with information that may be utilized to help determine the balance between construction costs and social issues and concerns.
- Comply with National Environmental Policy Act (NEPA) and other environmental laws and regulations.
- Restore a diversity of riparian and associated floodplain habitats to a more natural state.
- Maintain or enhance existing conveyance of peak discharges and ensure that project implementation would not increase flood flows or worsen flooding conditions downstream in existing developed areas.
- Blend existing and proposed improvements where possible, to take advantage of local improvements and to be consistent with the future master planning by the sponsors.
- Produce NER benefits while positively contributing to the NED Account, the regional economic development account and the other social effects account.
- Provide a framework for responding to future urban development in the floodplain consistent with Executive Order 11988.

The Española Valley, Rio Grande and Tributaries, New Mexico Study process involves successive iterations of alternative solutions to the defined ecosystem degradation problem. These solutions are based upon the study objectives and constraints, and address problems and opportunities that have been previously defined.

The general approach to accomplish these criteria was to formulate alternatives that 1) mimic historic, natural conditions that exhibited gently sloping banks with backwater areas, overbank flooding, and off-channel wetlands; 2) facilitate water infiltration; 3) provide for native plant regeneration and nutrient cycling in the bosque; and 4) reconnect the river channel to the floodplain. Existing vegetation communities would be enhanced with supplemental plantings, invasive species control, and the creation of scarce wetland habitats. Near shore and riparian aquatic habitats would be restored. With the restoration, habitat structure should be improved and promote an increase in the number and diversity of wildlife species in the area. This approach to restoration focuses on the restoration of community functions and processes via the rehabilitation of geomorphological processes and vegetation structure. This redirects future trends to a more natural, sustainable system that will uphold or increase in habitat value.

3.4 Inventory and Forecasting Conditions

To develop plans for a community or region, it becomes necessary to predict both the short-term and long-term future conditions of the environment (USACE 2000). Forecasting is undertaken to identify patterns in natural systems and human behavior, and to discover relationships among variables and systems, so that the timing, nature and magnitude of change in future conditions can be estimated. A judgment-based method, supported by the scientific and professional expertise of the evaluation team, is often relied upon to forecast the trends in habitat value for the study area if no project were to take place. Then the same method is used to evaluate the effectiveness of proposed restoration plans, rate project performance, and determine many other important aspects of both future without-project (WOP) and future with-project (WP) conditions.

3.5 Quantifying Wildlife Habitat

Most Federal agencies use annualization as a means to display benefits and costs, and ecosystem restoration analyses should provide data that can be directly compared to the traditional benefit:cost analysis. Since habitat value is difficult to express in monetary terms the cost effectiveness of project features are measured in habitat units (HU). HU's are the product of the amount and value of the habitat. For instance, one acre of a particular habitat with a value that is determined to be 2.5 is equal to 2.5 HU's. Initial evaluation of proposed measures will compare anticipated HU's WP and WOP at the 25 and 50 year intervals.

For a more detailed analysis, HUs can be annualized by summing HUs across all years in the period of analysis and dividing the total (cumulative HUs) by the number of years in the life of the project. The results of this calculation are referred to as average annual habitat units (AAHUs), and can be expressed mathematically. Using HU's as a metric, the WP and WOP conditions can be compared over time based on the forecast conditions. In this way it is possible to quantify a change in habitat by implementing the project and if that change is cost effective.

3.6 Generating a Target Mosaic

The nature of the bosque and the mosaic of habitats patches has changed dramatically since the 17th Century (Pittenger 2003, Scurlock 1998). Changes in land use have altered the size and composition of habitat patches within the bosque (Scurlock 1998). The existence in recent decades of a continuous bosque forest between the river and the levee appears to be unprecedented. Many bosque researchers and commentators now believe that historically the bosque was a dynamic mosaic of riparian wetlands, channels, woodlands, shrub thickets and periodically wet meadows (Najmi *et al.* 2005; Pittenger 2003; Crawford *et al.* 1998). The frequency and area of flooding, water table elevation, and the type of sediment substrate were and continue to be important determining factors of patch type and structure.

Although all bosque patch types contribute to the overall habitat value of the bosque, key types of patches support a larger number of species and individuals, including wetlands and patches with thicker vegetation (Hink and Ohmart 1984; Pittenger 2003; Najmi *et al.* 2005). The latter would include bosque forest or woodland areas with denser understories and shrub thickets. Hink and Ohmart's survey and subsequent research suggests that the edges of these patches–especially where they meet channels, open meadows or wetlands–are of particular importance for wildlife. Therefore, an overall mosaic that includes both "open" and "dense" patches as well as wet areas is the key to maximizing restoration opportunities. This 'reorganization' of bosque, shrub, and wetland patches can occur within the confined floodplain to provide quality habitat (Najmi *et al.* 2005).

Because of the importance of the mosaic to the goal of wildlife restoration, it was determined that the basis for the planning process should be a target mosaic consisting of various types of habitat, including bosque patches, shrub patches, grass meadow, and wet features (high-flow channels, backwater channels, willow swales) should be a basis for the planning process. The target mosaic needed to be based on accounts or descriptions of the bosque prior to major flood control measures, yet no such accounts exist prior to the 20th Century. Information on the composition of the bosque was recorded beginning in the early 20th Century. Starting in 1918, there are surveys of the vegetation types and communities along the Middle Rio Grande (MRG) (Pittenger 2003). Aerial photographs were taken in 1935 and subsequently have been interpreted to generate vegetation cover maps. Beginning with the work done by Hink and Ohmart, vegetation in the MRG has been surveyed and classified by community type and structure on a decennial basis.

The target mosaic was developed with the assumption that most of the key existing habitat would have been removed with the clearing and removal of existing non-native vegetation. Other than river channel, the remaining patch types would be almost entirely open areas in the very early stages of succession, or would be woodland/savannah areas with mature cottonwoods and almost no understory. The key to successful restoration would be 1) replanting of the native understory in the mature cottonwood areas, and 2) the establishment of shrub thickets and water-related features into other open areas.

In the past, the riparian ecosystem of the study area was much larger and functioned very differently than it does now. Periodic flood events maintained a dynamic bosque with a mosaic of patches diverse in size, age and species composition. Abiquiu Dam controls peak flow on the Rio Chama for flood control. Channelization and sediment retention have resulted in channel incision on Ohkay Owingeh and Santa Clara Pueblos. Gravel mining downstream of Ohkay Owingeh Pueblo has resulted in a headcut moving upstream though the pueblo, amplifying the incision effect. The Habitat Team proposed measures to stabilize the river channel bed elevation and increase floodplain connectivity for dynamic topographic interaction with the river. Managing for native plant species combined with river inundation of the floodplain will create an appropriate habitat mosaic.

3.7 Alternative Evaluation Process.

To evaluate the ecological benefits of proposed ecosystem restoration plans, the USACE and its stakeholders needed an assessment methodology that could capture the complex ecosystem process and patterns operating at both the local and landscape levels across multiple habitat types. The USACE guidance on ecosystem restoration requires that benefits from the project meet the objectives listed in Engineer Regulation 1105-2-100, specifically, "The objective of ecosystem restoration is to restore degraded ecosystem structure, function and dynamic processes to a less degraded, more natural condition. Restored ecosystems should mimic, as closely as possible, conditions which would occur in the absence of human changes to the landscape and hydrology".

4 - Using Combined Habitat Assessment Protocols to Estimate Habitat Value

CHAP is a habitat-based approach to assess ecosystems and provide a mechanism for quantifying changes in habitat quality and quantity over time under proposed alternative scenarios. CHAP provides an objective, quantifiable, reliable and well-documented process to generate environmental outputs for all levels of proposed projects and monitoring operations in the natural resources arena. CHAP provides an impartial look at environmental effects, and delivers measurable products to the decision-maker for comparative analysis. CHAP was developed in the Pacific Northwest to estimate habitat impacts for mitigation.

4.1 Components for Estimating Habitat Value

In the CHAP Key Environmental Correlates (KEC) values are tabulated from the field inventory data for each polygon. Field data forms support consistent identification and recording of all potential functions present for each polygon. This approach reduces errors associated with incorrect sampling or measurements. The field inventory supports cover type validation and revision when appropriate. Data quality assurance is inherent in the collection and management of KEC data.

CHAP can be transferred to other regions with similar species databases for generating the Key Ecological Functions (KEFs). The KEFs are the number of interactions between vertebrate species, their habitat, and functions as a component of calculating habitat units. These interactions have been tabulated in the Interactive Habitat and Biodiversity Information System (IBIS). IBIS is a peer-review database of Northwest fish, wildlife, and their habitats managed by the Northwest Habitat Institute (www.nwhi.org). The large overlap of species between the databases supports transfer (cross-walk) of species KEF values from IBIS into BISON-M. The KEF values for two species were based on closely related species in IBIS. Peer review of both the BISON-M and IBIS databases provides ongoing data assurance of the KEF data.

The CHAP system tabulates the KEC values using the baseline field inventory and the KEF values using the BISON-M database species list for each polygon (Table 2). The relative polygon values are multiplied by the baseline acreages to generate habitat units for additional analyses. Calculating the relative habitat value based on KECs (field inventory) and KEFs (database) provides an estimate based on observed habitat complexity and how species utilize the area.

4.2 Vegetative Communities of Concern

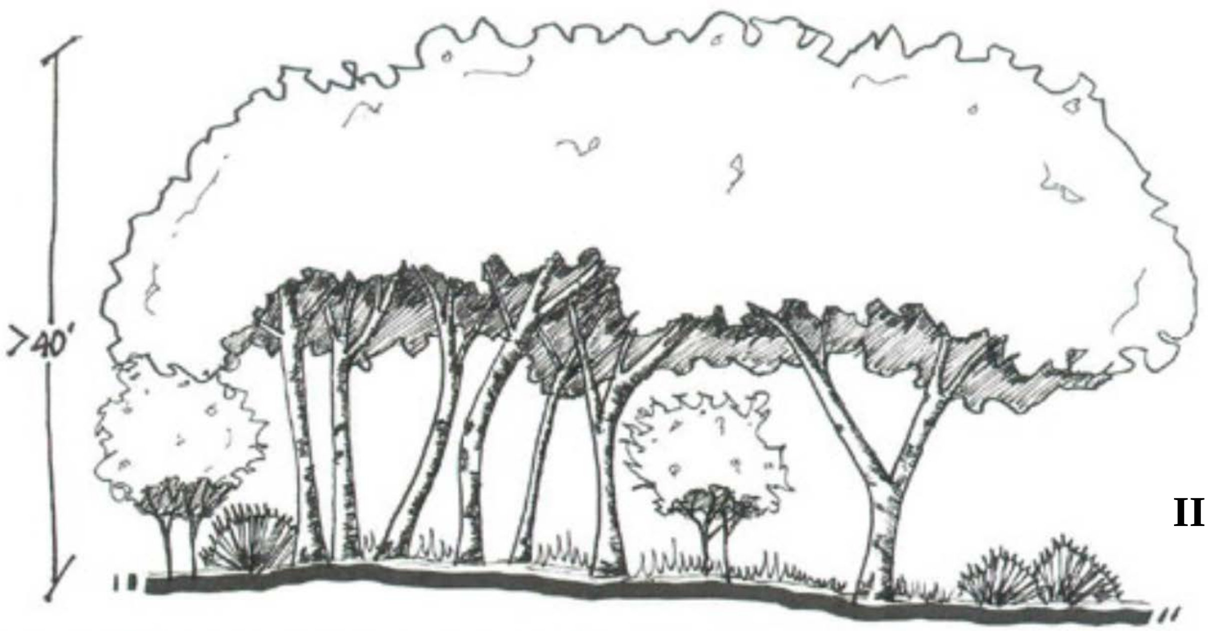
To obtain a value of the existing habitat in the study area and ultimately forecast the improvement in value resulting from any restoration measures, an existing inventory of the habitats within the study area was used. The Middle Rio Grande Biological Survey completed by Hink and Ohmart in 1984 described the plant communities within the study area's riparian zone and provided detailed information on species composition and the structure of cover types. Six general plant vegetation categories were developed by Hink and Ohmart (1984), based on several parameters including height and density of the vegetation, and the makeup of the mid- and understory or lower layers. The habitat structure types used in the analysis and forecasting of the study area are listed in Table 1.

Table 1. Hink and Ohmart Vegetation Classification.

1	**2**	**3**	**4**	**5**	**6**	**OP/OW**
Mature forest		Intermediate forest		Riparian shrubs	Meadows marshes	Open

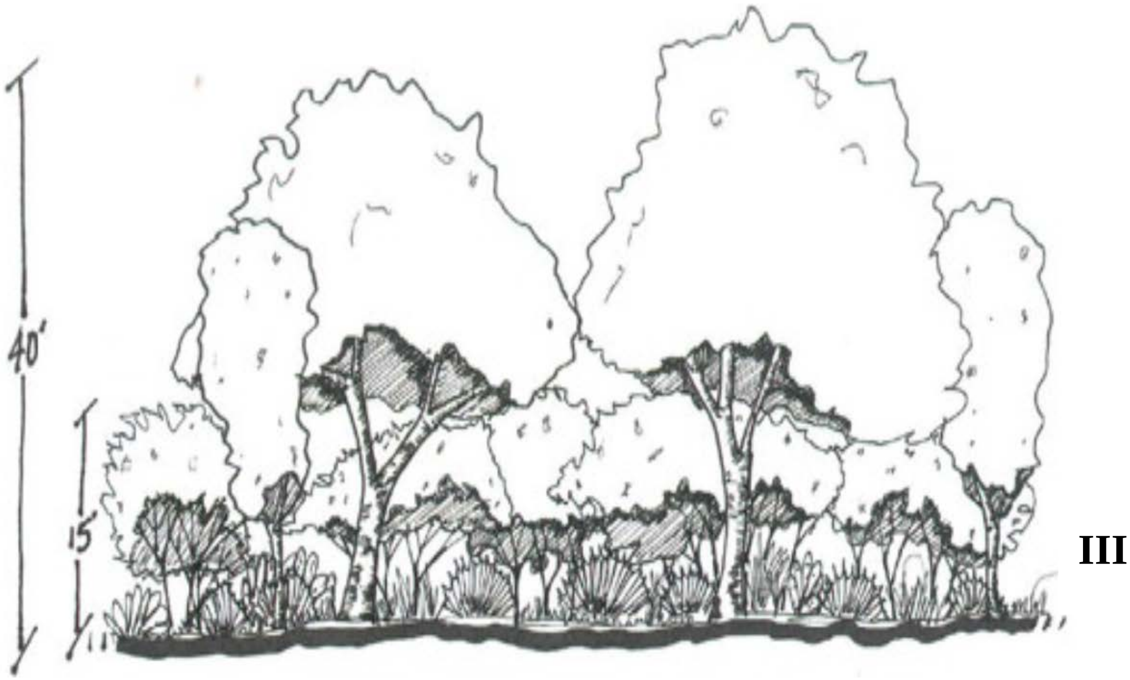
Rio Grande riparian vegetation in the Study Area uses plant community designations developed by Hink and Ohmart (1984) and mapping by Sivinski and others (1990). Hink and Ohmart (1984: 37-39) defined six structure types based on vertical foliage density. Structure Type I consists of tall trees – at least 50 ft (15.2 m) with a relatively dense understory of saplings and shrubs (I). Type II structure is also composed of tall trees but with little or no sapling and shrub understory (II). Type III structure consists of mid-size trees (less than 30 ft [9.1 m]) and dense understory vegetation (III). Type IV structure is characterized by open stands of mid-sized trees with widely scattered shrubs and sparse herbaceous growth (IV). Type V structure is dense, short-stature trees and saplings, to about 15 ft (4.6 m) height, often with dense herbaceous growth (V). Type VI structure is scattered plant growth with foliage not exceeding about 5 ft (1.5 m) in height above the ground (VI).

Hink and Ohmart Type I Vegetation - – Mature Riparian Forest with trees 50-60 ft; closed canopy, established understory

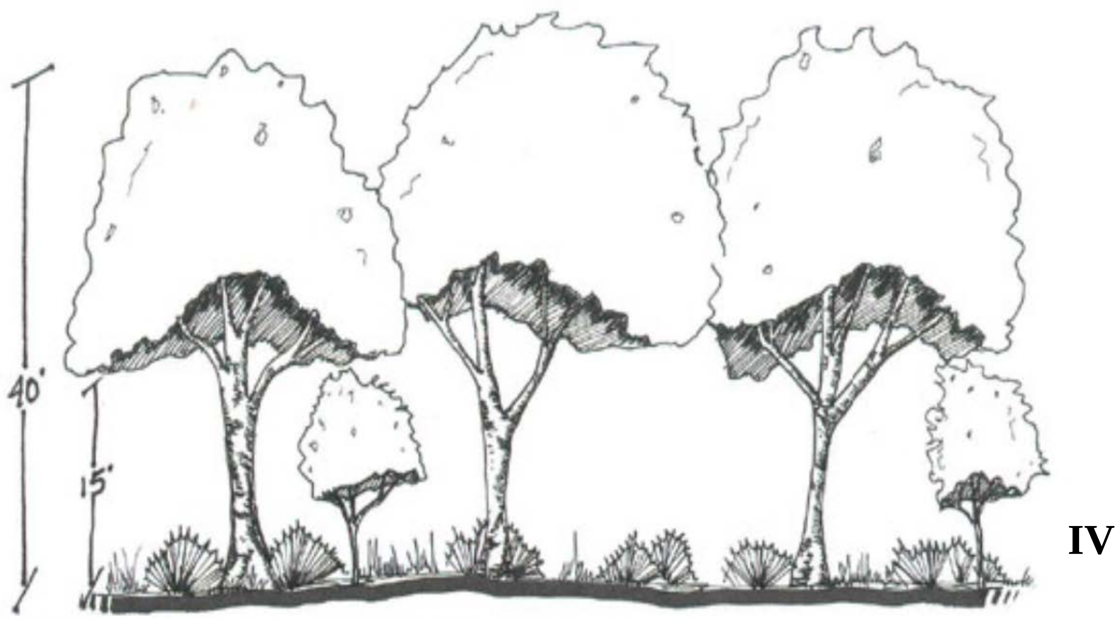


Hink and Ohmart Type II Vegetation – Mature Riparian Forest with trees over 40 ft; nearly closed canopy, limited understory

Figure 1 Hink and Ohmart vegetation classes I and II.

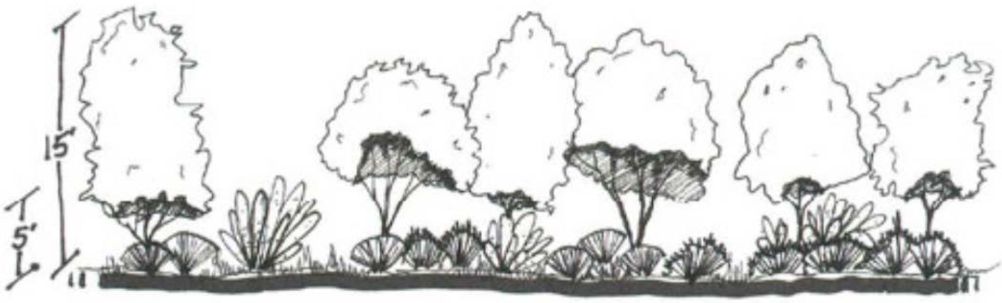


Hink and Ohmart Type III Vegetation - Intermediate aged riparian woodland; closed canopy; dense understory



Hink and Ohmart Type IV Vegetation - Intermediate aged riparian woodland/savannah; broken canopy; mostly grass understory

Figure 2 Hink and Ohmart vegetation classes III and IV.



V

Hink and Ohmart Type V Vegetation – Riparian Shrub up to 15 ft; dense vegetation but no tall trees

VI

Hink and Ohmart Type VI Vegetation - Sparse vegetation with short shrubs, seedlings and grasses; open areas

Figure 3 Hink and Ohmart vegetation classes V and VI.

Table 2 Summary of baseline habitat and affected vegetation in the proposed project.

Native vegetation	Existing acres	
C/CW1 (Cottonwood/Coyote willow)	71.0	
C/CW2	70.5	
C/CW3	196.8	
C/CW4	92.2	
C/CW5 (shrub)	250.9	
C/NMO5 (shrub with New Mexico olive)	527.9	
C/CW6 (meadow with Tree willow)	231.0	
Marsh (6)	369.7	
Native vegetation subtotal	1810.1	49.7%
Mixed gallery forest / shrubs (1-5)	**Existing acres**	
C/CW with Russian Olive	234.5	
C/CW with Salt Cedar	131.8	
Mixed invasive forest	938.9	
Russian Olive dominated forest	131.9	
Salt Cedar dominated forest	31.5	
Mixed gallery forest subtotal	1468.5	40.3%
Other land classifications	**Existing acres**	
Unclassified open area	365.1	10.0%
Total Area	3643.0	

4.3 Calculating Habitat Values

The three primary components of CHAP for estimating the habitat values (per acre) of proposed measures are the species function matrix (KEF), habitat function matrix (KEC), and the invasive species factor (Table 2a). The species function matrix provides a conservative, long-term estimate of habitat use by vertebrates in the project area. The KEF value from the species function matrix are projected to decline over 50 years as half of the uncommon species disappear from the project area during each 25 year interval. Ecological drivers, including hydrology, climate, and land management practices, may have specific effects on species that can be modeled using BISON-M within CHAP.

CHAP provides a site-specific, standard methodology for quantifying areas (polygons) based on a field inventory of ecological functions (KEC). The inventory approach relies on observable differences in habitat for tabulating ecological components. The polygons with a greater number of observed functions (higher KEC values) identify the suite of functions that produce greater habitat complexity and value. The high KEC value polygons can be used as reference sites (Burks-Copes *et al.* 2007; Burks-Copes and Webb 2009) representing possible target conditions for restoration. Measures that increase habitat complexity are anticipated to increase the KEC values in the habitat function matrix, and overall habitat value.

The Invasive Species Factor (ISF) is a value between 0.0 and 1.0 that adjusts overall habitat values as a function of the coverage of invasive plants (Table 2a). The CHAP field inventory estimates the vegetative cover for invasive herbaceous, shrubs, and trees. Table 2a has the conversion from percent cover to factor value (×) for each cover type. High ISF values indicate low invasive species cover, and low ISF values indicate high invasive species cover. Vegetation management measures to remove invasive plants and support native species would increase the ISF, producing a higher corrected per acre value.

GIS mapping shows individual habitat patch values across the landscape in relation to hydrology, topography, land management, and other factors. This allowed the habitat team to identify areas to protect and maintain the ecosystem, and other areas that would benefit from specific measures.

4.4 Projecting Future Conditions

The site-specific CHAP methodology is projected into the future through several variables. First, anticipated trends for invasive plant coverage (herbs, shrubs, and trees) are estimated for recalculation of the ISF (Table 2b). Invasive plant species would increase the percent coverage under the no management scenario, reducing the ISF which decreases the corrected per acre value (decreased coverage of native species).

Second, the KEFs are recalculated based on removal of a percentage of the uncommon species at the 25 and 50 year time horizons. CHAP randomly removes half of the uncommon species (Table 3) at the 25 and 50 year milestones to evaluate the effects of changing habitat for KEFs. Removing a species during these time period(s) has the effect of changing the functional profile and resiliency of the system because they no longer contribute their ecological functions. These functions are removed from the 25 and 50 year runs because these species are not expected to have viable populations within the project boundary. The removal of species at the 25 and 50 year intervals affects the calculations for these time periods (Table 2b). Calculation of habitat units using the adjusted values for ISF and KEFs (see Table 2b) results in a decrease in habitat value and units for the temporal milestones.

Table 3. Española Valley Study Example Calculation.

a. Baseline HAB Calculation Worksheet Format:

Polygon Identification	Acres	Invasive Herbaceous Plants	Invasive Shrubs	Invasive Trees	Invasive Species Factor (ISF)	Species-Function Matrix (KEFs)	Habitat-Function Matrix (KECs)	Uncorrected Per Acre Value	Corrected Per Acre Value	Habitat Units (HUs)
SC_009	2.1	0.3	1	1	0.67	14.90	6.90	21.80	14.59	30.64
From CHAP mapping and GIS										

Invasive species cover	X
From observations in the field for each polygon	
0-10%	1
11-35%	0.9
36-65%	0.7
66-90%	0.5
>90%	0.3

Column	Explanation
Invasive Species Factor (ISF)	GEOMEAN accounts for a structural layer not being present within a polygon (e.g., no shrub layer in polygon)
Species-Function Matrix (KEFs)	Equals the sum of the species-function table divided by the number of functions (species-function table)
Habitat-Function Matrix (KECs)	Equals the sum of the habitat-function table divided by the number of functions (habitat-function table)
Uncorrected Per Acre Value	Equals the sum of the two matrices
Corrected Per Acre Value	Equals the uncorrected per acre value multiplied by the invasive species factor
Habitat Units (HUs)	Equals the corrected per acre value of the polygon multiplied by the area of the polygon (acres)

b. Calculated habitat units for future without-project condition at the 25 and 50 year milestones.

Polygon Identification	Acres	Invasive Herbaceous Plants	Invasive Shrubs	Invasive Trees	Invasive Species Factor	Species-Function Matrix (KEFs)	Habitat-Function Matrix (KECs)	Uncorrected Per Acre Value	Corrected Per Acre Value	Habitat Units (HUs)
SC_009 @ 25 years	2.1	*0.1*	*0.75*	*0.75*	*0.38*	13.23	6.90	20.15	*7.72*	*16.22*
SC_009 @ 50 years	2.1	*0.1*	*0.65*	*0.65*	*0.35*	11.80	6.90	18.70	*6.51*	*13.69*

Table 4. Uncommon species removed during the two 25 year periods for the without project analysis.

0-25 years	26-50 years
Common Name	**Common Name**
Bullhead, Black	Duck, Teal, Blue-winged
Frog, Chorus, Western	Duck, Teal, Cinnamon
Lizard, Earless, Lesser	Duck, Teal, Green-winged
Rattlesnake, Western	Duck, Bufflehead
Snake, Hognose, Western	Duck, Merganser, Common
Duck, Wigeon, American	Falcon, Peregrine
Duck, Canvasback	Coot, American
Duck, Merganser, Hooded	Gull, Ring-billed
Osprey	Gull, California
Hawk, Rough-legged	Dove, Mourning
Avocet, American	Chickadee, Mountain
Swift, White-throated	Sparrow, Lincoln's
Flycatcher, Willow	Blackbird, Brewer's
Vireo, Solitary	Shrew, Masked
Swallow, Tree	Shrew, Water
Swallow, Barn	Shrew, Dwarf
Bluebird, Eastern	Bat, Silver-haired
Thrush, Hermit	Bat, Pipistrelle, Western
Tanager, Hepatic	Bat, Big-eared, Townsend's, Pale
Blackbird, Yellow-headed	Mouse, Pocket, Plains
Grackle, Common	Mouse, Grasshopper, N.
Shrew, Dusky	Rat, Wood, Stephen's
Myotis, Small-footed, Western	Vole, Long-tailed
Myotis, Long-eared	Badger, American
Bat, Spotted	Skunk, Spotted, Western
Mouse, Brush	
Rat, Wood, Bushy-tailed	
Vole, Montane	
Weasel, Ermine	

Example species' (Hognose snake) functions removed from the KEF calculations

Hognose Snake Functions
1.1.2.1 – invertebrate eater
1.1.2.3 – egg eater
1.2.1 – prey for primary and
3.11.2 – creates small burrows
3.12 – uses burrows dug by
1.1.3.3 – amphibian eater
1.1.3.4 – bird eater
1.1.3.5 – mammal eater
1.1.3.6 – reptile eater

5 - Expected Future Without-Project Condition

The future without-project condition is defined as that condition expected to exist in the absence of any action taken (by the federal government) to solve the stated problems. This condition is vitally important to the evaluation and comparison of alternative plans and the identification of impacts (both beneficial and adverse) attributable to proposed Federal actions. The future without-project condition assumes no additional habitat management by the sponsors. The future without-project condition forecast provides a description of anticipated actions external to the project and the anticipated consequences of these actions.

5.1 Hydrology

Future hydrology was reviewed for predictable physical changes within the watershed that would affect flood frequency, such as urbanization and land use. The Española Valley has been an agriculture-based community since before the Spanish arrival in the 1500s. The future land use surrounding the city and within each Pueblo is expected to remain similar to current conditions; as such, the hydrologic conditions are expected to remain constant.

In support of sediment transport modeling, a continuous hydrograph for the Rio Grande and each tributary was created (located in Appendix A-Sediment Transport Reports). These hydrographs reflect the flows from the last 26-years of record, 1980-2005. This period recorded high and low volume floods but did not record any high peak floods. The last flood of record was 1942. Since that time, no large flood events have occurred due to climate variations; storms used to be larger precipitation events. In more recent times precipitation events have been more moderate in size (Molnar and Ramirez, 2006).

5.2 Hydraulic Conditions

Expected future without-project hydraulic conditions are: continued channel bed degradation upstream of the old gravel mining operation upstream of the City of Española as the existing headcut migrates upstream; continued disconnection between the river channel and its floodplains during the smaller flood events, which are vital for ecosystem health; and, precipitation events above the 4% chance continue to flow into urban areas located within the floodplains.

The future conditions hydraulic modeling focused on how the floodplains change due to the modeled changes to the river corridor based on the sediment transport modeling results. As with the current conditions hydraulic modeling, Mussetter Engineering, Inc., prepared the future conditions hydraulic models as well as the sediment transport models. Using the HEC-RAS 4.0 (mobile boundary) application, the hydraulic models that mapped out current condition floodplains were adjusted to include sediment transport. The 26-year histographs were used to estimate future flows in the HEC-RAS 4.0 mobile boundary model, which predicted aggradation or degradation throughout the study area. After the mobile boundary simulation was complete, the final adjusted cross section data were used to estimate the future conditions water surface profiles and floodplain maps.

General sediment transport models found that generally little to no change in channel bed elevation is expected except in the immediate vicinity of bridge/culvert crossings and tributary confluences. However, two locations along the Rio Grande had notable trends: the Rio Grande upstream from the Ohkay Owingeh Pueblo's southern boundary, and upstream and downstream from the Rio Pojoaque confluence.

In the southern end of Ohkay Owingeh Pueblo, gravel mining within the river channel occurred 20-30 years ago; the massive extraction of river sediments significantly decreased the channel bed elevation and the floodplain elevation, a feature that is still visible on the 2007 longitudinal profile (Appendix A - Rio Grande sediment transport model report). The modeled future sediment trends indicated that (1) the old mining scar will continue to fill over the next 26 years, and (2) significant degradation will occur upstream from the mining scar, as the 'headcut' migrates upstream slowly. The affects on the floodplain delineation is a slight improvement of river-floodplain connection in the old mining area, but a slight decrease in connection in the upstream area where degradation is predicted.

Downstream from the Rio Pojoaque confluence, the Rio Grande is predicted to aggrade at a relatively slow rate, approximately 2 feet over the next 26 years. Here, a large number of tributaries, the Rio Pojoaque being the largest, are delivering large quantities of sediment (excessive supply) to the Rio Grande's channel. Although the channel bed is now aggrading, this section of the Rio Grande is slightly incised at present such that the 50% chance event does not access the floodplain. This aggradation is expected to increase flooding during the 50% chance event.

5.3 Floodplains

The future conditions floodplain assessment was completed by incorporating the results of the sediment transport models into the hydraulic models to estimate the future floodplains. The general procedure consisted of running the sediment transport model for the 26-year simulation period, incorporating the final channel geometry of the sediment transport models into the floodplain-hydraulic models, rerunning the eight frequency flows, and then defining the floodplain boundaries from the updated (future) water surface elevations. This method was employed for each reach of rivers and tributaries in the study. Detailed information on these methods and the results is in Appendix A. The main product for the future conditions floodplains (without project) are a series of floodplain maps (Appendix A: Maps FDM.1 Sheet 1-7, FDM.2 Sheet 1-2, FDT.1-FDT.4).

In general, this analysis showed only minor differences in the floodplains between current, existing conditions and future conditions. The most significant differences throughout the study reach occurred during the smaller, high frequency floods (less than the 4% chance event). These changes are typically due to localized aggradation or degradation that cause or eliminate localized flow breakouts and overbank flooding.

In the Rio Grande, the most significant decrease in flood area occurs downstream from the confluence with the Rio Chama due to predicted degradation in this area, while the most significant increase in flood area occurs upstream from the Rio Pojoaque as a result of aggradation associated with sediment loading from this tributary. Relatively little change in flooding conditions is predicted for the majority of the reach in the vicinity of the City of Española. In the Rio Chama, aggradation upstream from the Chamita/ Hernandez Diversion Structure causes a relatively significant increase in flooding at flows less than the 10% chance event, while a reduction in flooding occurs in the majority of the remainder of the reach.

In the Santa Cruz River, the largest increase in flooding occurs at the 2% chance event due to localized aggradation that results in significant shallow flooding under future conditions. An increase in flooding is expected in this tributary at all discharges exceeding the channel capacity, which is slightly greater than the 50% chance peak flow. The predicted degradation in the Arroyo Guachupangue results in an overall decrease in flood area under future conditions, with the largest decrease indicated at the 50% chance event due to an increase in channel capacity.

These results also show a significant reduction in flooding at the 50% and 20% chance events in Santa Clara Creek for similar reasons to those found in Arroyo Guachupangue, but relatively little change is indicated at the higher magnitude flows. In the Rio Pojoaque, the flood area increases at flows greater than the 10% chance event due to the predicted aggradation in the vicinity of the bridges and the associated effect on the hydraulic conditions through the bridge openings.

5.4 Vegetation

The mature bosque forest is anticipated to have decreasing habitat value as cottonwood trees senesce and die resulting in the gallery forest thinning out (Figures 1-3). As the gallery canopy opens up, invasive plants (especially trees) are projected to become established. The increase in invasive plants species coverage is captured in the Invasive Species Factor (Table 2) as a decreasing value.

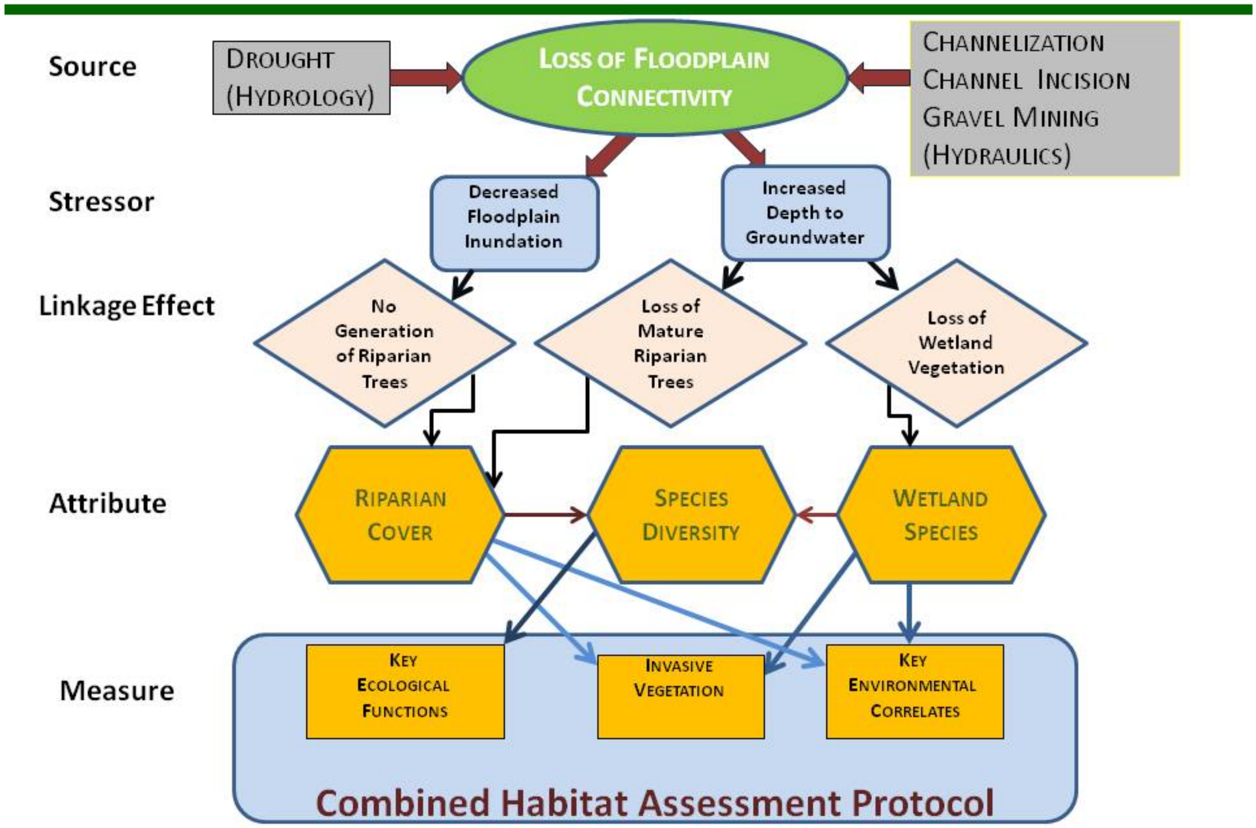


Figure 4. Conceptual model of future riparian habitat from decreased floodplain connectivity.

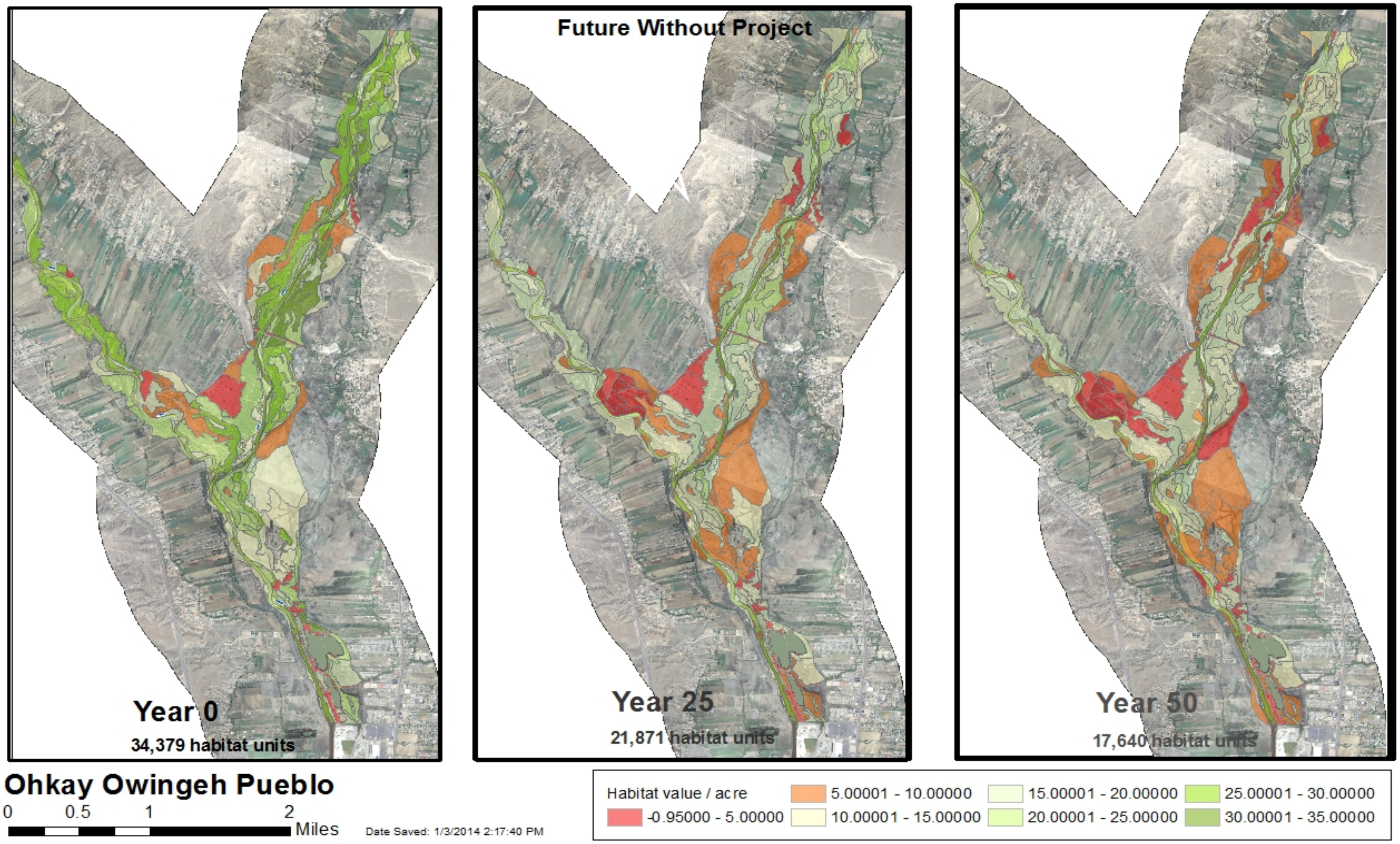


Figure 5. Change in habitat unit values per acre on Ohkay Owingeh Pueblo calculated using CHAP.

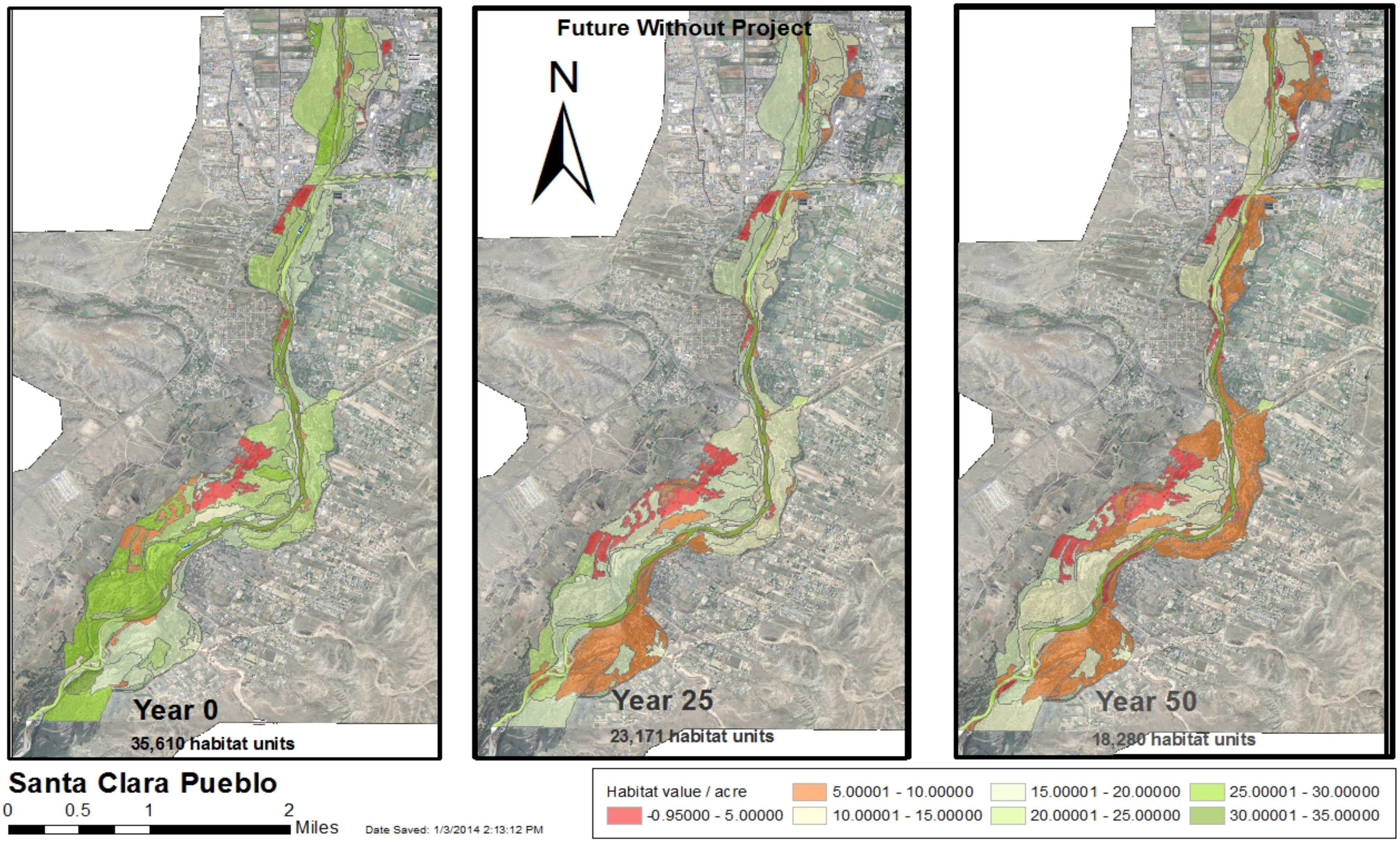


Figure 6. Change in habitat unit values per acre on Santa Clara Pueblo calculated using CHAP.

6 - Expected Future With-Project Conditions

The future with-project summarizes proposed measures for addressing ecosystem restoration objectives. The Habitat Team considered a variety of solutions that focused on restoring a diversity of riparian and floodplain habitats. The team recognized the potential benefits stabilizing the channel bed to support other measures for broadening the hydraulic connectivity of the river with the bosque. Additional measures to reestablish fluvial processes in the bosque include terrace lowering, high-flow channel excavation, vegetation management to remove invasive plants, and increases in native plants to create an interconnected mosaic of vegetation types.

6.1 Formulation of Habitat Restoration Measures

The Habitat Team completed several iterations of the ecosystem restoration formulation process for Ohkay Owingeh and Santa Clara Pueblos (Table 4). The team has reviewed the proposed measures for completeness and anticipated increases in habitat units.

The Habitat Team recognizes the proposed measures will require variable implementation to support development of a habitat mosaic. First, the boundary between proposed measures and existing habitat types creates a preliminary habitat mosaic. Vegetation management can create habitat patches through selective removal of exotic plant species, using a larger number of native plant species, and planting native species in distinct clusters or patches. Excavated measures should implement a variable fine-scale local topography through the constructed footprint to support natural progression of re-vegetation as an element of the overall habitat mosaic.

6.2 Hydraulic Conditions

Sediment transport modeling generally found little change in channel bed elevation through most of the study area. The future sediment trends for Ohkay Owingeh Pueblo indicated that: (1) the old mining scar will continue to fill over the next 26 years, and (2) significant degradation will occur upstream from the mining scar, as the headcut moves slowly upstream. The measures proposed to address the headcut migration include grade control structures and in-channel rock weirs. These measures would stabilize the channel bed upstream of the old gravel mining operation and limit upstream effects of the headcut. Measures that stabilize the channel bed provide a foundation for constructed features to increase floodplain connectivity on Ohkay Owingeh Pueblo.

The current and future floodplain layers were processed using ArcGIS (Figure 4) to estimate the area of floodplain loss due to projected changes in channel bed elevation. The resulting disappearing floodplain layer is subsequently used to evaluate the effects of proposed channel stabilization and terrace lowering measures.

Table 5. Proposed types of habitat restoration measures and their effect on vegetation.

Description	**Action**	**Effect**
Grade control	Excavate/harden channel	Prevent loss of floodplain connectivity Increase cottonwood / willow density
In-channel rock weirs	Excavate/harden channel	Prevent loss of floodplain connectivity Increase cottonwood / willow density
High-flow channel	Excavate, revegetate	Increase seasonal water connectivity Increase cottonwood / willow density
Moist meadow	Excavate , revegetate	Increase groundwater connectivity Increase moist meadow vegetation
Pond	Excavate	Increase aquatic habitat
Vegetation management	Remove exotic vegetation Revegetate with native species	Increase cottonwood / willow / native tree density
Swale	Excavate , revegetate	Increase groundwater connectivity Increase cottonwood / willow density
Terrace	Excavate , revegetate	Increase groundwater connectivity Increase cottonwood / willow density
Wetland	Excavate , revegetate	Increase groundwater connectivity Increase wetland vegetation

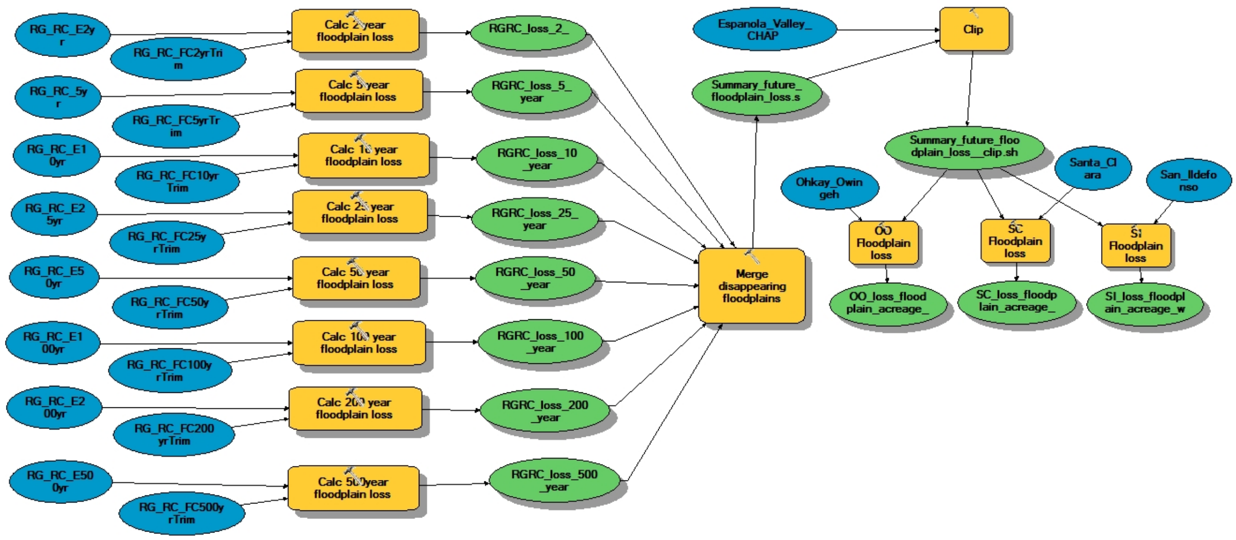


Figure 7. ArcGIS Model for calculating the loss of floodplain area by frequency. Output layers are produced for each sponsor.

6.3 Floodplain Connectivity

Estimating the increased floodplain connectivity (area) from implementation of the proposed measures is the next step. The Rio Grande in the study area, the most significant decrease in floodplain area occurs downstream from the confluence with the Rio Chama due to continuing degradation from the channel headcut. The headcut is anticipated to move up the Rio Chama, reducing flooding between the confluence (with the Rio Grande) and the Chamita/ Hernandez Diversion Structure on the Rio Chama.

Proposed measures (Table 4) for increasing floodplain connectivity (and floodway capacity) consist of high-flow channels and terrace lowering (including swales). High-flow channels consist of channels that can be inundated by higher river flow during spring runoff or storm events. These channels are typically adjacent to the main river, cut into the floodplain, bars, and islands. Terrace lowering consists of excavation of islands, bars, or adjacent areas to lower the ground surface elevation to create habitat features (terraces, swales). The lower surfaces increase floodplain inundation during spring runoff or storm events, and support vegetation requiring increased groundwater connectivity (swales).

The future floodplain connectivity created by implementing the proposed terrace lowering and high-flow channel measures is calculated using ArcGIS (Figure 5. ArcGIS Model for calculating the change of floodplain inundation area by frequency for proposed terrace lowering and high-flow channel measures.Figure 5). The effective area was calculated as the changes in the frequency of inundation resulting from terrace lowering and high-flow channel features. The anticipated changes in flood frequency from the proposed measures are summarized in Table 5.

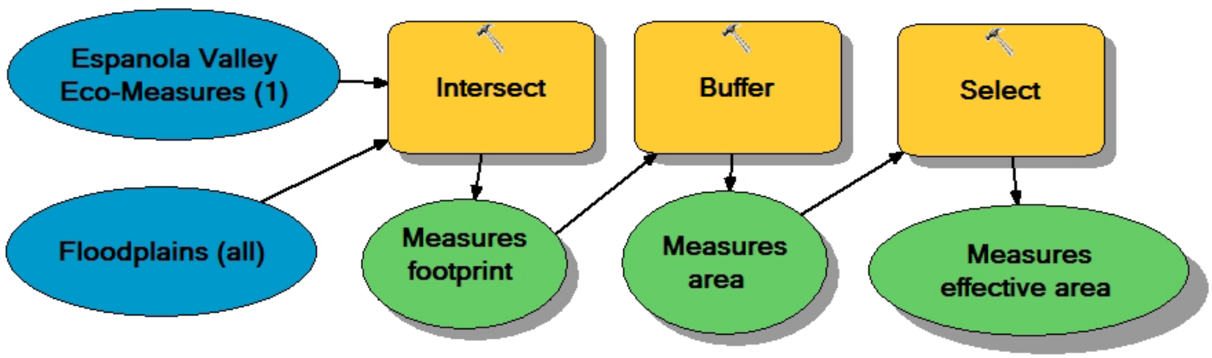


Figure 8. ArcGIS Model for calculating the change of floodplain inundation area by frequency for proposed terrace lowering and high-flow channel measures.

The proposed measures were designed to increase floodplain connectivity during the more frequent return flows. There would be no change in flood damages to buildings or infrastructure associated with the proposed measures. The increased inundation frequency of floodplain area would support existing and natural recruitment of native riparian vegetation.

Table 6. The increased inundation frequency as a resulting from proposed habitat restoration measures.

Inundation Frequency (years)		
Current Floodplain	Future Floodplain	Effective Area (acres)
2	2	93.3
5	2	216.7
10	2	172.3
25	2	110.5
50	2	85.8
100	2	34.8
200	2	19.8
500	2	15.2
Total acres:		748.3

6.4 Vegetation Management

Vegetation management consists of two phases: the selective removal of invasive, non-native plants species, and replanting with native plant species. Estimating vegetation trends with the project assumes that invasive species management will be funded by the sponsors for the project life. All proposed measures for floodplain connectivity include vegetation management within the excavated footprint. Other areas are identified for vegetation management.

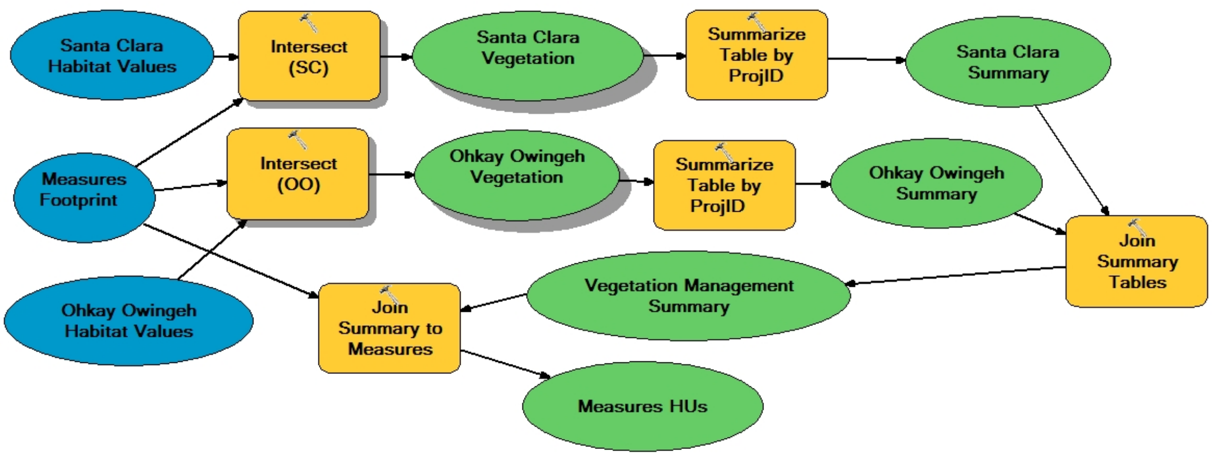


Figure 9. ArcGIS Model for calculating habitat units (HUs) based on vegetation management in combination with other proposed measures, or as stand-alone proposed measures.

The future without-project habitat value in CHAP is estimated based on change in invasive plant cover and the projected loss of species. The future without-project vegetation is estimated using the invasive plant coverage (ISF) to incrementally reduce the habitat value over time. In addition, the uncommon animal species are randomly removed from the species list at 25 and 50 years to simulate decreased habitat suitability. The reduction in animal species, in turn, reduces the KEF component of the habitat unit values.

Estimation of the future with-project vegetation in CHAP is initiated by resetting the anticipated future flood frequency for the proposed measures polygons (Figure 6). A cottonwood / coyote willow (C/CW) community is the replanted primary vegetation. The average and maximum values for existing vegetation communities (reference sites) in the project area are summarized in Table 6. Existing polygons serve as reference sites to project anticipated future habitat values for restoration measures, which should provide realistic target values for analysis. These habitat values assume retention of the uncommon species present during current conditions. The number of species is projected to remain the same with a higher habitat unit value over the projected future without project. The summary provides a foundation for improving the vegetation values by planting additional native species.

Table 7. Summarized habitat values from the project area by vegetation type.

Hink and Ohmart vegetation type[a]	Key Environmental Correlates (KECs)		Initial Polygon Values (uncorrelated)	
	Mean	Maximum	Mean	Maximum
C/CW1	5.31	13.42	11.60	21.70
C/CW2	11.13	20.14	17.21	30.03
C/CW3	14.10	17.39	23.19	24.74
C/CW4	9.76	14.64	18.23	24.45
C/CW5	6.76	11.78	17.66	20.44
C/CW6	19.65	19.65	25.56	25.56
C/NMO1	16.38	21.97	19.73	31.60
C/NMO2	8.76	17.10	17.58	28.41
C/NMO3	15.36	21.99	26.47	32.75
C/NMO4	12.29	18.53	20.54	23.55
C/NMO6	4.66	4.66	19.56	19.56

a. C – cottonwood, CW – coyote willow, NMO – New Mexico Olive
See Table 1 for structure descriptions 1-6

The location and footprint of proposed measures for Ohkay Owingeh and Santa Clara Pueblos are shown in Figures 7 and 8. Preliminary habitat (per acre) values for proposed measures on Ohkay Owingeh and Santa Clara Pueblos are illustrated using GIS (Figures 9 and 10). The left panels show the current (baseline) habitat unit values (7,148 units total) for the footprint of the proposed measures. The other panels show the habitat unit values for the proposed measures at 25 years (middle; 10,514 units total) and 50 years (right; 11,810 units total). The uplift in habitat value for the entire project area will be calculated based on discussions with the Habitat Team and Agency Technical Review Team.

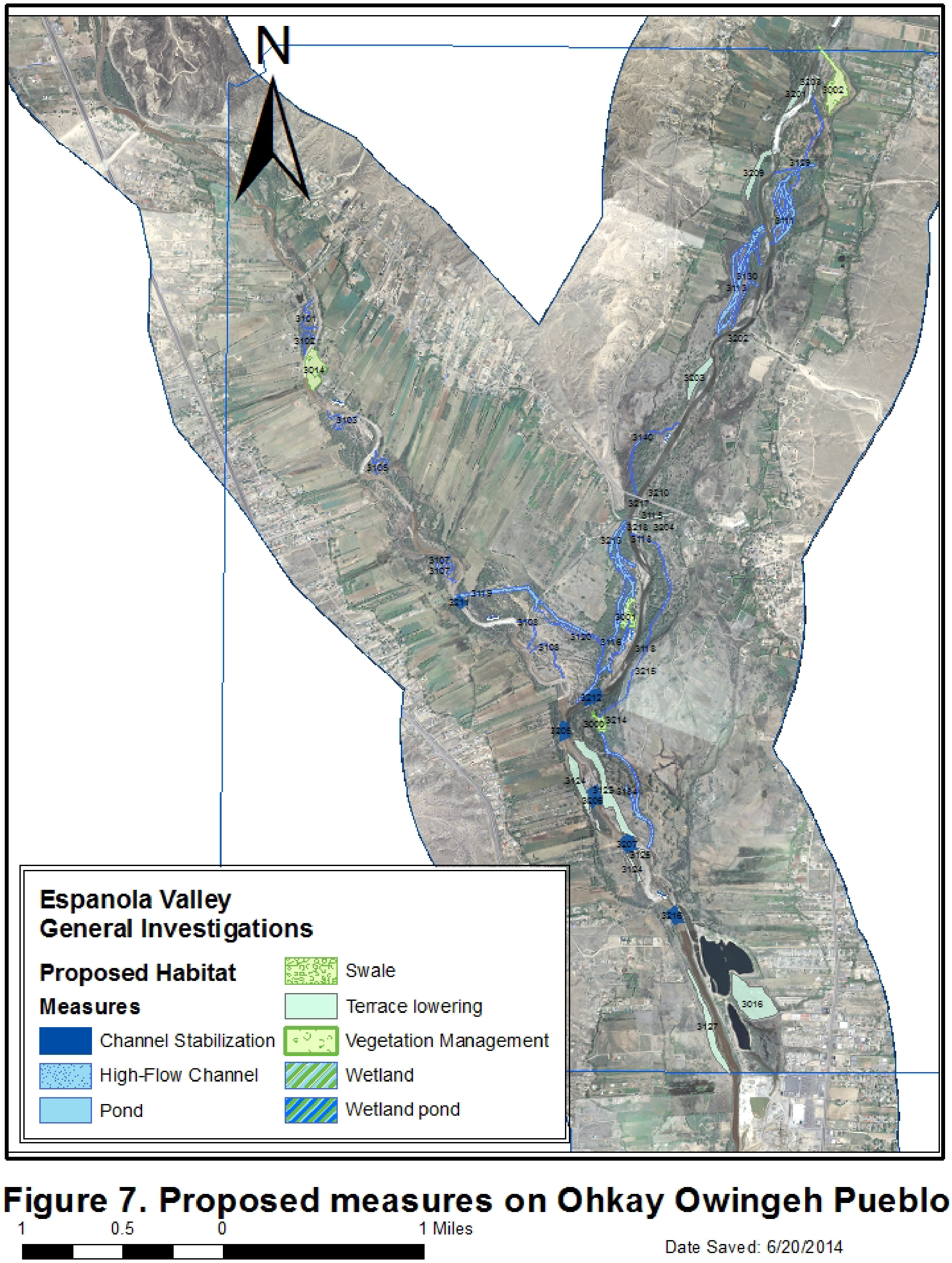


Figure 10. Proposed measures on Ohkay Owingeh Pueblo.

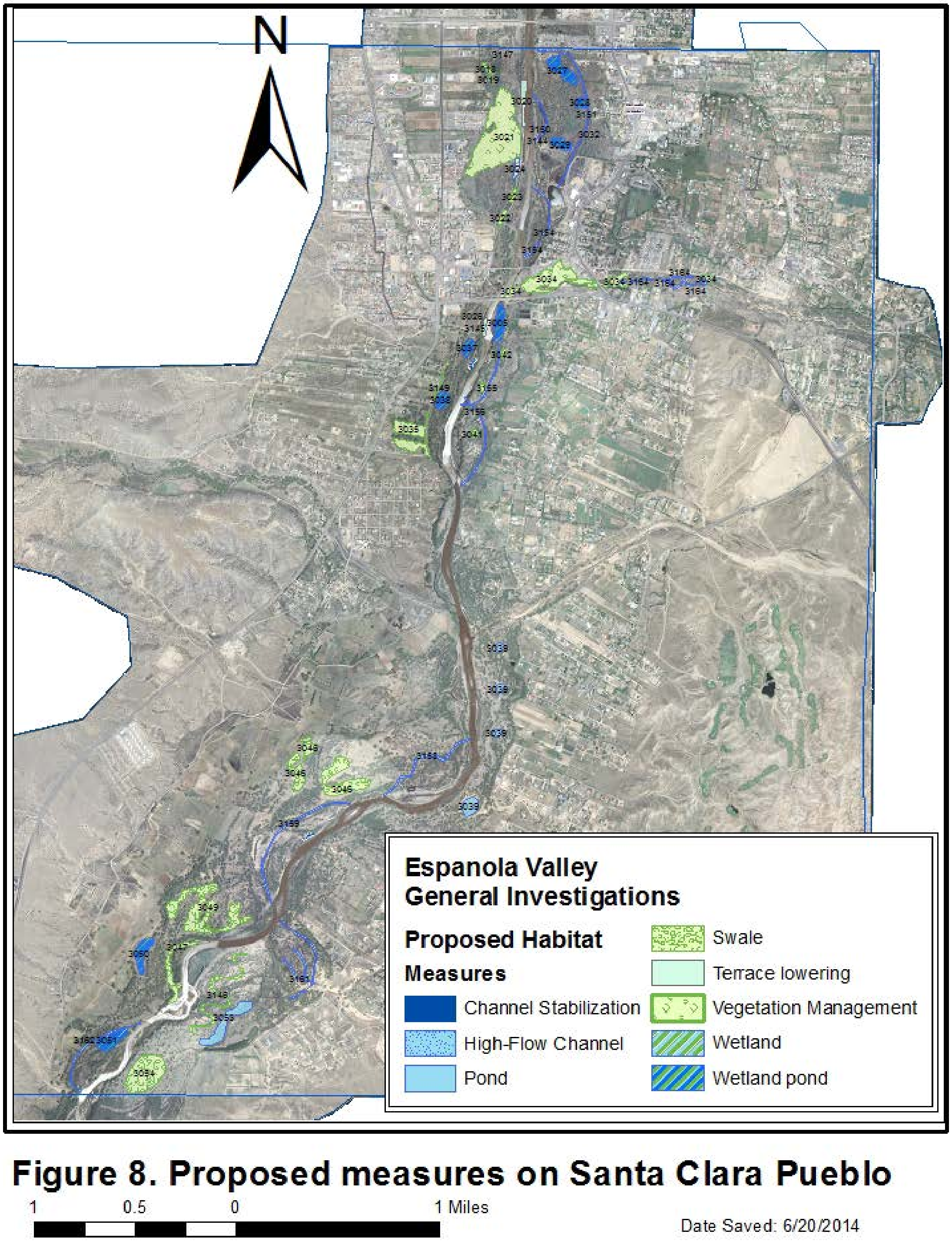


Figure 11. Proposed measures on Santa Clara Pueblo.

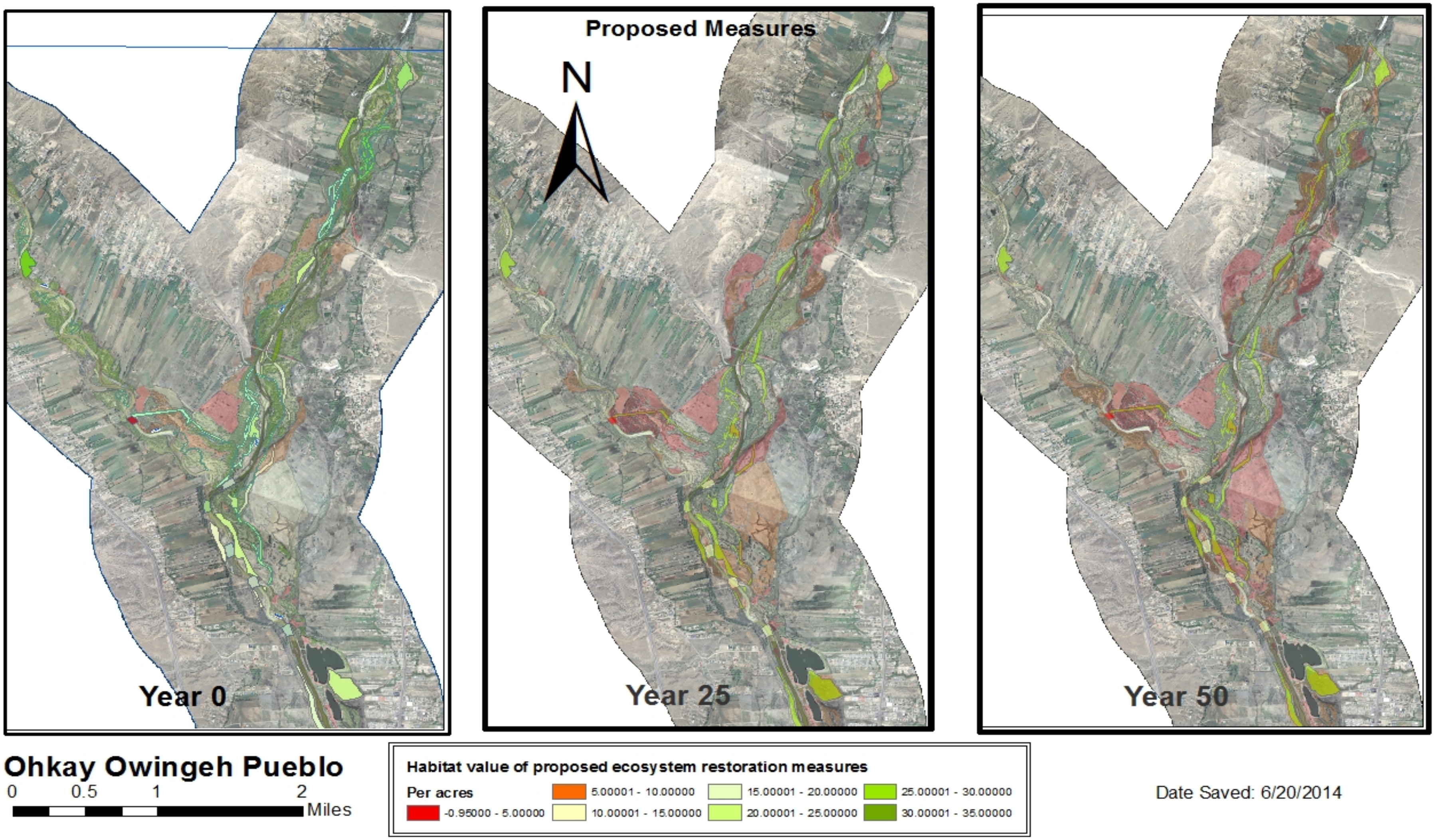


Figure 12. Habitat values for proposed measures on Ohkay Owingeh Pueblo.

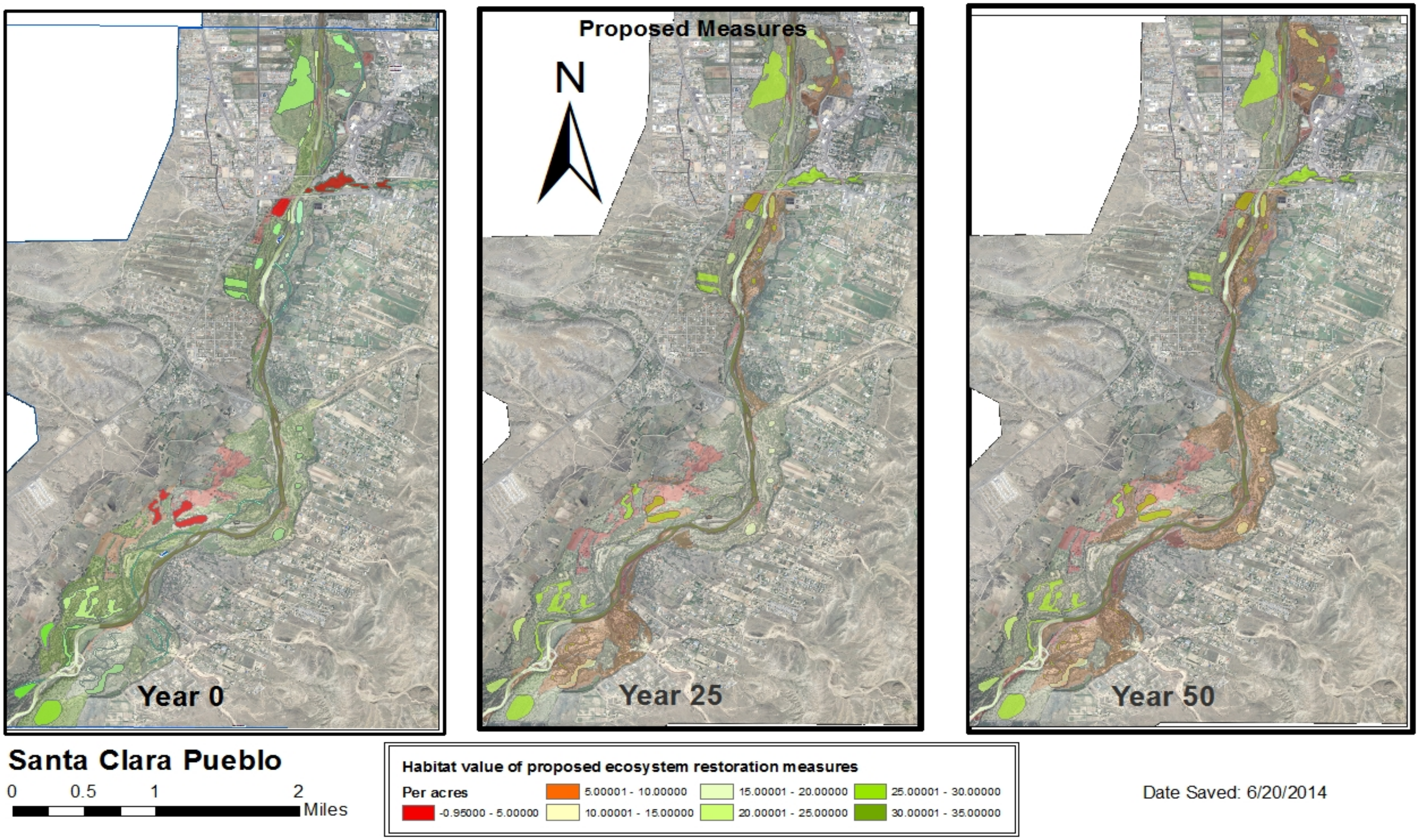


Figure 13. Habitat values for proposed measures on Santa Clara Pueblo.

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1.5 Current Wildlife Habitat Conditions

Wildlife habitat assessments were conducted on the Pueblos of Ohkay Owingeh and Santa Clara Pueblos in 2010-2011. The study area encompasses 3824 acres (1548 ha) composed of 418 Hink and Ohmart (1984) vegetation polygons (USACE 2007) along 12.6 miles of the Rio Grande, 3.9 miles of the Rio Chama, and 1.9 miles of the Santa Cruz River. The CHAP wildlife habitat values (Northwest Habitat Institute 2011) were provided to the habitat team in the form of GIS polygons, information summarized in spreadsheets, and the baseline condition report. CHAP estimated 69,989 annual average habitat units for the project area.

1.5.1 Espanola Wildlife Habitat Assessment Baseline Condition Report

Espanola Wildlife Habitat Assessment
Baseline Condition Report

for
U.S. Army Corp of Engineers
New Mexico District

by
Northwest Habitat Institute

December 8, 2011

HAB Value
Patent No. U.S. 7,681,531 B2

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Espanola Wildlife Habitat Assessment

1 - Introduction:

Throughout the United States there is a move towards assessing restoration and other conservation activities at the ecosystem level. Under current US Army Corps of Engineers (Corps) authority, the objective of Civil Works ecosystem restoration is to restore degraded significant ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. However, partial restoration may be possible, with significant and valuable improvements made to degraded ecological resources. The needs for improving or re-establishing both the structural components and the functions of the natural area should be examined. Restored ecosystems should mimic, as closely as possible, conditions which would occur in the area in the absence of human changes to the landscape and hydrology. Indicators of success would include the presence of a large variety of native plants and animals, the ability of the area to sustain larger numbers of certain indicator species or more biologically desirable species, and the ability of the restored area to continue to function and produce the desired outputs with a minimum of continuing human intervention. Those restoration opportunities that are associated with wetlands, riparian and other floodplain and aquatic systems are most appropriate for Corps involvement. Currently, an ecosystem based habitat evaluation framework exists and is known as CHAP – Combined Habitat Assessment Protocols and it is an accounting and appraisal methodology. This approach involves a triad assessment of habitat, species, and functions (O'Neil et al., 2005), and can provide assessments at multiple scales.

The CHAP method generates habitat units (HUs) based on an assessment of multiple species, habitat features, and functions by habitat type. The information used in formulating, evaluating and selecting ecosystem restoration alternatives includes both quantitative and qualitative information about outputs, costs, significance, acceptability, completeness, effectiveness, and reasonableness of costs. Within the Corps ecosystem restoration policy, *"An ecosystem restoration proposal must be justified on the basis of its contribution to restoring the structure or function, or both, of a degraded ecosystem, when considering the cost of the proposal. Ecosystem restoration projects are justified through a determination that the combined monetary and non-monetary benefits of the project are greater than its monetary and non-monetary costs. As such, plan selection is not based on economic justification in terms of a traditional monetary benefit to cost analysis, since the majority of benefits associated with the primary outputs of ecosystem restoration can rarely be quantified in dollars. Therefore, ecosystem restoration proposals need not have either a benefit-cost ratio greater than 1.0, or positive net economic benefits. However, any monetary incidental benefits which are anticipated from proposed ecosystem restoration projects, and relevant to the particular circumstances associated with the study, should be displayed to aide in decision making"* (Corps, EP 1165-2-502, 1999). Habitat Units (HUs) are the currency the Corps currently uses to rate and compare the value of one project restoration scenario to another.

The overall goal of the Espanola assessment was to rate baseline habitat conditions at a fine level of resolution within an ecosystem context. An ecosystem context is more holistic than assessing just a few individual species (Perkins, 2002), especially with federal or stated listed taxa; it calls for a multiple species framework that includes an evaluation of ecological functions. Additionally, the Corps would like to assess alternative scenarios; hence a realistic depiction of actual habitat site conditions at a fine scale level was needed. The approach reported here depicts the wildlife habitat baseline conditions at a fine resolution or site level-scale; uses multiple species and their habitat functions in its evaluation; and accounts for actual habitat types, structural conditions and key environmental correlates (within the Espanola assessment boundary) based on a field inventory of these habitat components at the site.

Evaluating habitat quality is the approach most often taken because habitat is thought of as a surrogate for ecosystems because it is the setting where plants and animals live, interact, and reproduce. Habitat is frequently viewed in conjunction with species information to gain insight to various uses, structures, and functions existing within a landscape or site. Determining habitat structure and functional integrity of an area is supportive of an ecosystem management approach.

2 - Study Site

The Northwest Habitat Institute (NHI) conducted a wildlife habitat assessment within the Espanola, New Mexico project boundary that included portions of the Rio Grande and Rio Chama in April 2011. The assessment was conducted at the site level scale. A habitat evaluation team (Habitat Team) was established to provide input and consisted of representatives from the Ohkay Owingeh and Santa Clara Pueblos, Corps, U.S. Fish and Wildlife Service (FWS), New Mexico Department of Game and Fish, Bureau of Reclamation, Audubon Society, and several consulting firms. A fine level assessment scale was done over a study area along the Rio Grande that extends 12.6 miles (20.3 km). This distance is split into two sections: the “Ohkay Owingeh” section includes the entire river distance within the Ohkay Owingeh reservation including 3.9 miles (6.3 km) of the Rio Chama, and the “Santa Clara” section includes the section within Rio Arriba county within the Santa Clara reservation and 1.9 miles (3.0 km) of the Santa Cruz River within the Santa Clara reservation. The study area encompasses 3824 acres (1548 ha). 418 polygons were identified within the project boundary [Fig. 1]. These polygons were determined by Hink and Ohmart vegetation classification delineating what occurs within the project area.

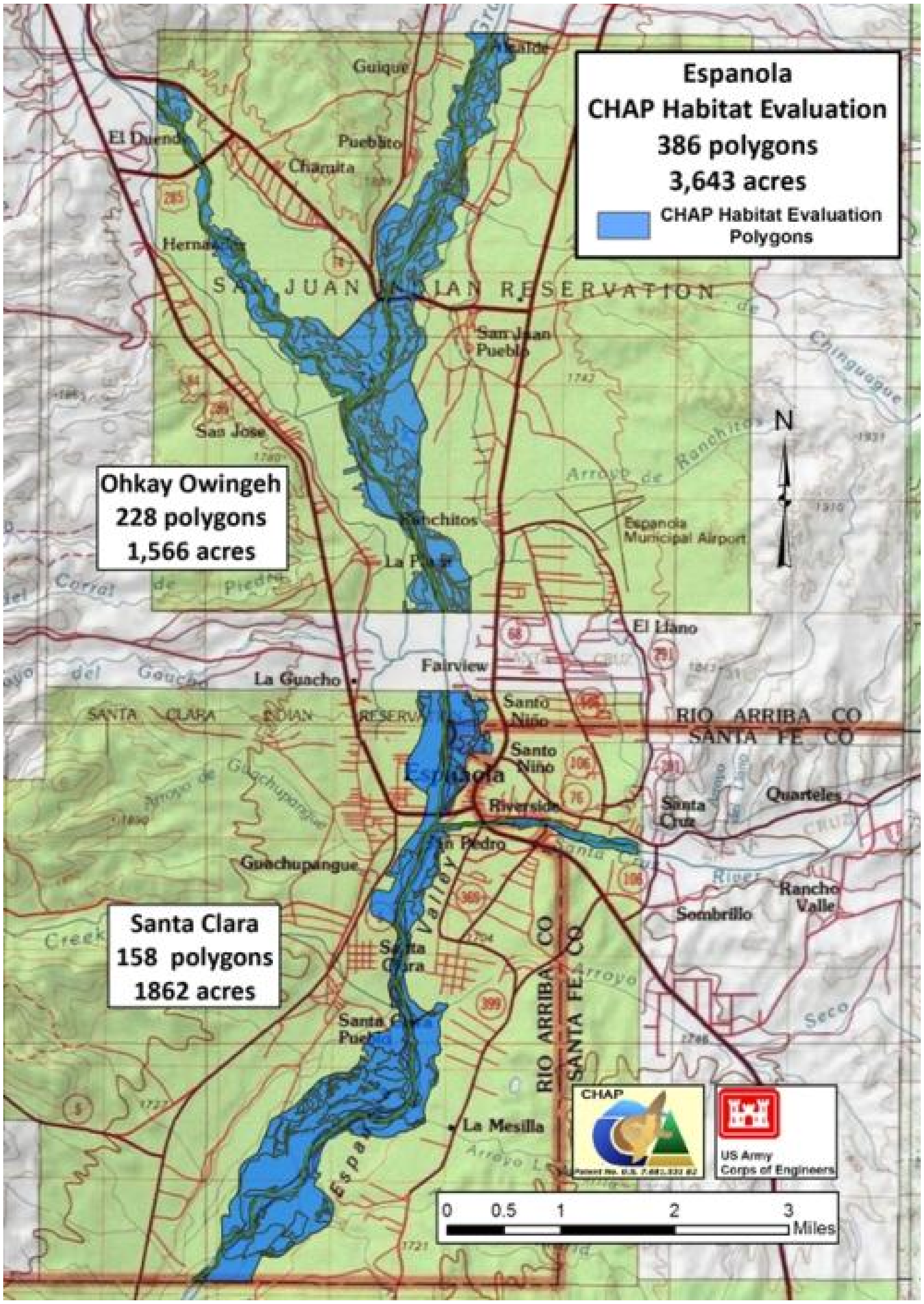

Figure 2-1 Espanola project area divided into 386 polygons classified into the regional GAP Types and Hink and Ohmart vegetation types.

3 - Methods

CHAP is visually based because it develops maps that identify all wildlife habitat types by polygon located within the project boundary. The habitat type classifications used for the Espanola project were determined from taking Hink and Ohmart vegetation classes observed in the field and cross-walking with the Biota Information System of New Mexico (BISON-M) database. Wildlife species associated with these habitat types are then linked to NHI's IBIS data system[1] (Johnson and O'Neil 2001) in order to establish the key environmental correlates (KECs) and key ecological functions (KEFs) for each species (for species list see Appendix A). KECs represent habitat elements (physical and biological) that are thought to most influence a species distribution, abundance, fitness, and viability. While KEFs refers to the principal set of ecological roles performed by each species in its ecosystem. KEFs refer to the main ways organisms use, influence, and alter their biotic and abotic environments. The KECs and KEFs are key components in determining the wildlife habitat unit values. KECs for each polygon were accounted during the site visit.

A site level-scale approach is used to refine the habitat value calculations for the Espanola polygons. CHAP involves four components: 1) preliminary mapping, 2) field inventory, 3) data compilation and analysis, and 4) GIS maps, spreadsheets and report.

1. Preliminary mapping: The Espanola study site is refined by identifying and delineating polygons with homogenous habitat types based on visual interpretation of photography or imagery. Unique to this project, Hink and Ohmart polygons were provided by the Corps and it was determined that this should be the starting base polygon layer.

2. Field inventory: There are two parts to this inventory – one is an ocular survey that a) confirms the polygon delineations, b) identifies and records habitat type, structural conditions, and key environmental correlates (KECs) within each polygon, and c) notes the amount of non-native plant species at the grass/forb, shrub and tree layers. The second part of the inventory, which in the case of this project was contracted separately to SWCA consulting, is to conduct verification transects that are stratified random samples of the vegetation. The purpose of these transects is to measure and substantiate site variables including percent cover/species of trees, shrubs, herbaceous and invasive vegetation and to serve as a double sampling technique to confirm the ocular inventory done in part one.

3. Data compilation and analysis: Field data is used to generate a habitat value for each polygon of the study site. For this project a species list was created from the local Biota Information System of New Mexico database. The database, developed by The New Mexico Department of Game and Fish, is a

[1] The IBIS data system is a peer expert system that contains current ecological information on more than 1,000 fish and wildlife species.

state informational data system known as BISON-M. The development of this data was done in collaboration with Bureau of Land Management, USDA Forest Service, Bureau of Reclamation, Corps, New Mexico State Land Office, New Mexico Natural Heritage Program, and the Conservation Management Institute. The BISON-M was used as the initial data set to rely on wildlife species information for the Espanola project. Querying the dataset is a function of the site, and an initial list of species was generated by habitat type for the project. The list was then circulated to members of the Habitat team for their comment and review. Once the species list was agreed to then a relational tie to the IBIS data was established (see Appendix A for complete species list). This tie allowed for cross-walking IBIS information to the New Mexico project species. Specifically, Key Environmental Correlates (KECs) and Key Ecological Functions (KEFs) from the IBIS data sets were joined to each project species. For species that were not currently residing in IBIS a literature review was done and the KECs and KEFs were identified. The species list is then reviewed by the habitat team and is sorted by its association with the BISON-M habitat types. Additionally, the list of taxa are merged with the KEC and KEF fields within the IBIS data sets so to allow the creation of two matrices: species-functions and habitat-functions.

4. GIS maps, spreadsheets, and report: GIS maps (Appendix C) are generated that depict the habitat values (HUs) of each polygon. Supporting maps illustrate: a) project or area boundaries, b) polygon numbering, c) corrected habitat value per acre, d) habitat units, and e) amounts of non-native plant species by polygon. Spreadsheets are developed which contain the polygon calculations of the species-functions and habitat-functions matrices, along with giving an overall site or area habitat value.

3.1 Determining the Habitat Unit Value

To establish a habitat unit value two matrices are developed. The first matrix determines the mean functional redundancies (MFRI) of species that could be potentially present at the Espanola study site. The MFRI is part one of the computation in determining the baseline habitat values [see Appendix B -Matrix Relationships, Matrix 1]. The MFRI of each habitat type present within the study area was calculated using the list of taxa that occur at the study site. The second matrix is based on what was recorded during the field inventory of the site. Specifically, a list of KECs[2] that were observed at the Espanola Valley study site is generated for each polygon. Additionally, a KEC function matrix is created [see Appendix B -Matrix Relationships, Matrix 2] that represents the habitat components which characterize potential functions within each polygon at the site. Per acre baseline values were then computed for each polygon using the species-functional redundancy (MFRI) value for each habitat type added to the KEC-functional redundancy value. Thus, these two values are summed to give a per acre value for each polygon. To determine a site's baseline habitat unit (HU) value, each polygon's per acre value is

[2] See Appendix B – Matrix 2.

multiplied by its acreage and then these values are summed across all polygons to obtain the site value.

Subsequently, each polygon is assigned an invasive plant value for each of three structural layers (grass/herbaceous, shrub, and tree) based on the occurrence of invasive species in that layer. If a layer is not present, it is left blank and that layer does not calculate into the invasive factor. The per acre values were then discounted for the presence of invasive plants using the values in Table 1 to arrive at a corrected per acre value for each polygon. Figure 2 depicts how the calculated tabular values correspond to mapped polygons. The acreage is calculated for each polygon and the multiplied by the per acre value to derive the Habitat Units. The complete table for each study area is located in Appendix D.

The per acre value is good indicator of wildlife habitat quality because it represents the intrinsic worth to animal taxa determined by accounting for species, habitats, and their functions because the influence of polygon size (acres) is removed from consideration.

Table 3-1 Invasive species adjustment factors.

Invasive species cover	*x*
0-10%	1.0
11-35%	0.9
36-65%	0.7
66-90%	0.5
>90%	0.3

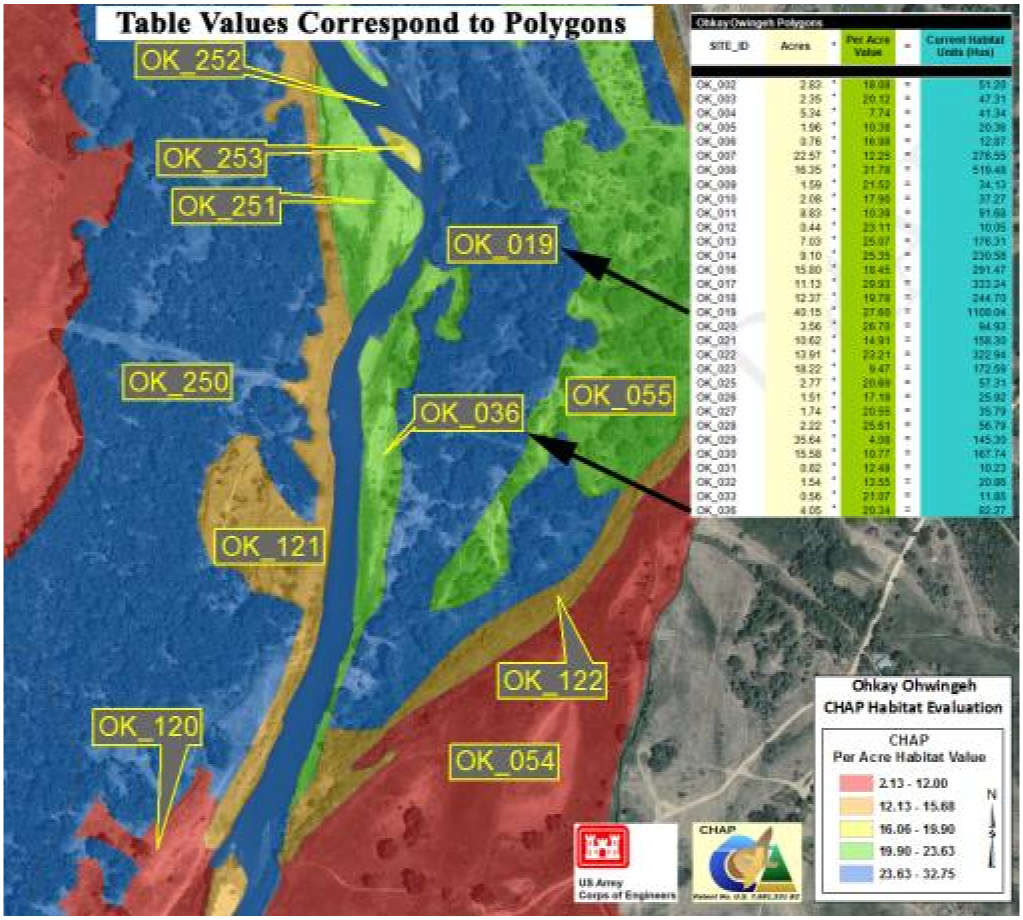

Figure 3-1 Table Values Correspond to Polygons

4 - Results

The habitat assessment of the Ohkay Owingeh study area shows 228 polygons made up of nine BISON-M Gap Types that cover 1780acres (720 ha). The Santa Clara habitat assessment shows 158 polygons made up of the same nine BISON-M Gap Types that cover 1863 acres (754 ha). The proportion and acreage of the habitat types of both study areas are depicted in Tables 2 and 3. The baseline condition assessment shows that the Ohkay Owingeh and Santa Clara study areas have a total values of 34,379 and 38,359 HU's respectively.

Table 4-1 Ohkay Owingeh Study Area breakout of acreage, proportion of total acreage

GAP Code	Habitat Type	Acres	% of Total Acreage	Habitat Units
10	AQUATIC	1.36	0.08%	28.10
12	GRASS	232.35	13.05%	2207.88
21	MARSH rush/bulrush/sedge/cattail	66.24	3.72%	1054.34
22	BARREN LAND	17.71	0.99%	188.83
28	AGRICULTURAL	13.45	0.76%	28.24
33	SCRUB	250.92	14.10%	3446.63
52	LOWLAND RIPARIAN cottonwood/sycamore	994.46	55.87%	22881.54
54	URBAN	28.70	1.61%	85.51
55	AQUATIC: RIVERINE/LACUSTRINE	174.72	9.82%	4457.49
	Total:	**1779.91**		**34378.56**

Table 4-2 Santa Clara Study Area breakout of acreage, proportion of total acreage

GAP Code	Habitat Type	Acres	% of Total Acreage	Habitat Units
10	AQUATIC	4.95	0.27%	85.36
12	GRASS	142.61	7.65%	949.24
21	MARSH rush/bulrush/sedge/cattail	64.60	3.47%	988.45
22	BARREN LAND	37.74	2.03%	551.28
28	AGRICULTURAL	3.80	0.20%	16.16
33	SCRUB	203.74	10.94%	4022.32
52	LOWLAND RIPARIAN cottonwood/sycamore	1263.89	67.84%	27968.75
54	URBAN	6.08	0.33%	18.58
55	AQUATIC: RIVERINE/LACUSTRINE	135.71	7.28%	3759.09
	Total:	**1863.12**		**38359.23**

Using CHAP, we calculated current baseline habitat value for the river and all of the restoration project area polygons (Appendix D).

4.1 Functional Redundancy

A functional redundancy profile can also be determined by counting the number of functions that can be contributed to fish and wildlife species. Figure 3 illustrates the top 15 functions that have the most functional redundancy while Figure 4 depicts the functions with the smallest amount of functional redundancy being performed by wildlife species within the Espanola project area. A complete look at the number of species performing functions at Espanola can be found in Appendix E.

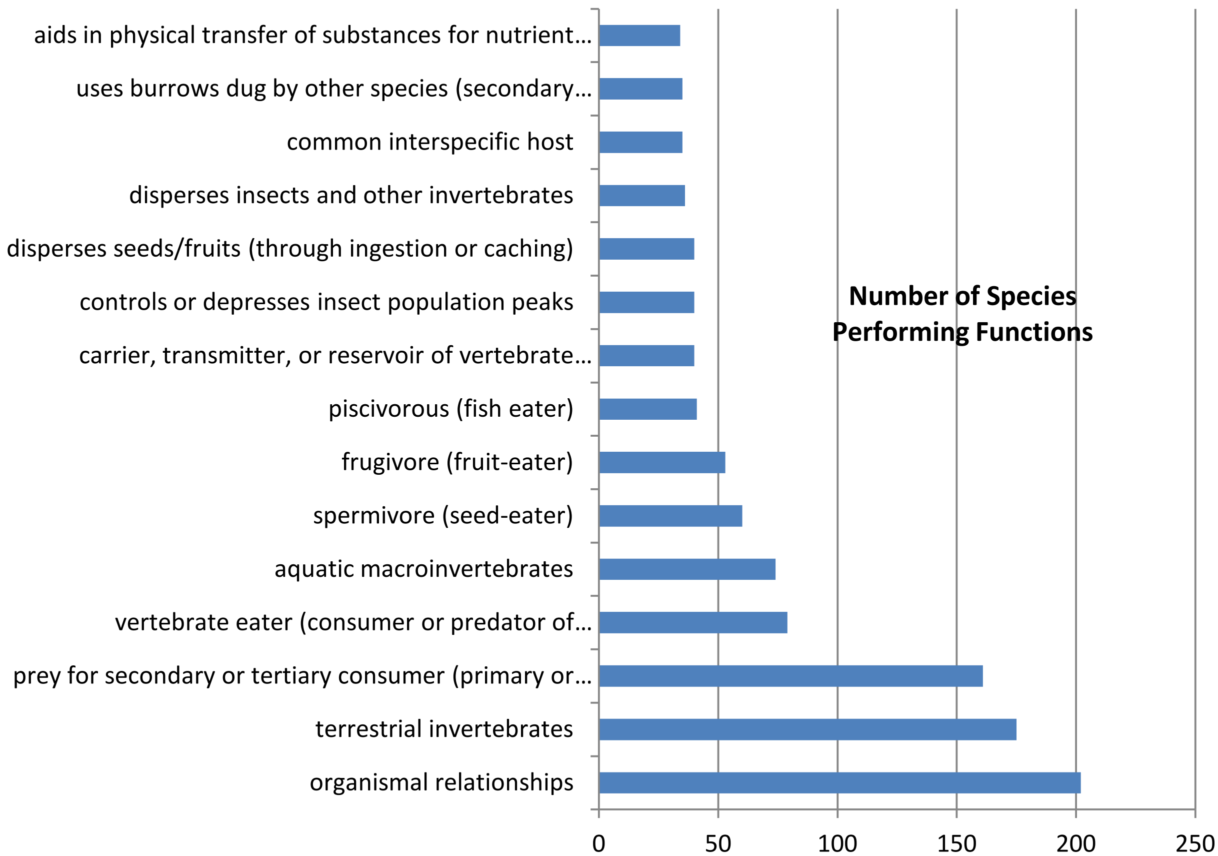

Figure 4-1 15 functions with the most functional redundancy

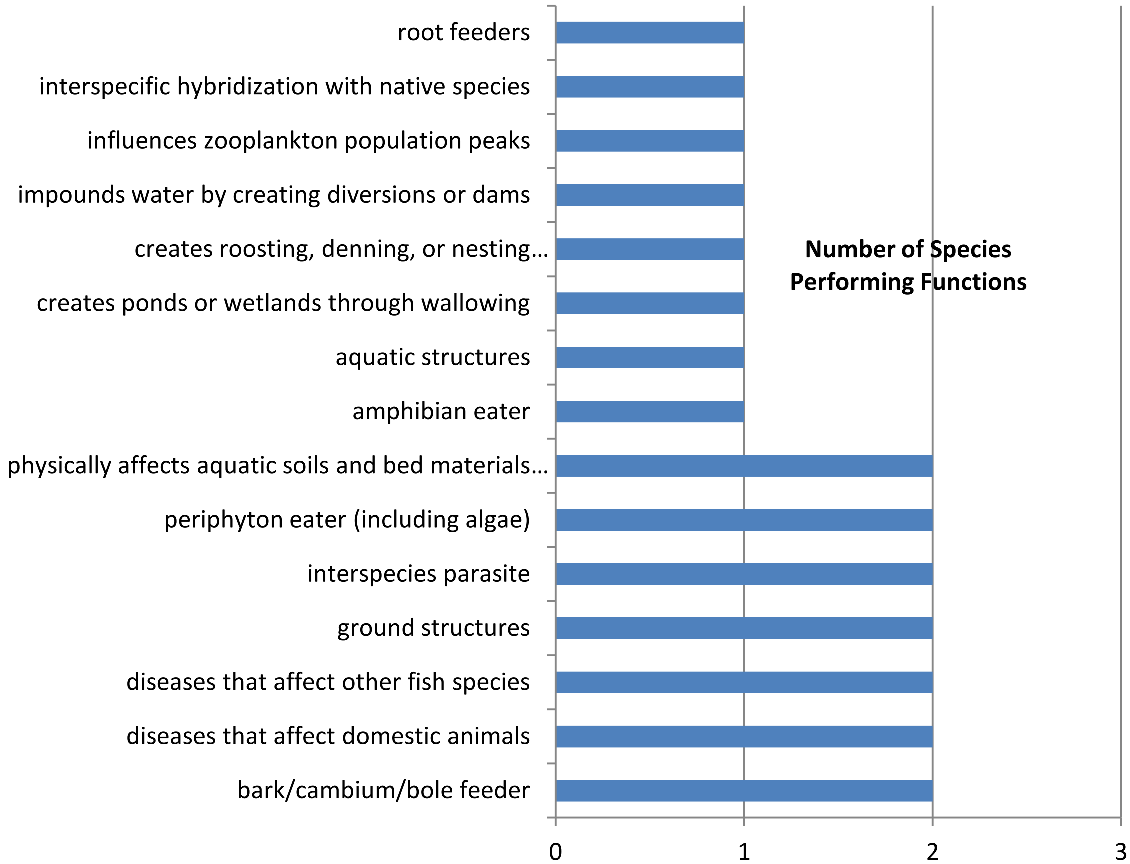

Figure 4-2 15 functions with the least functional redundancy

Lastly, because there are a large number of polygons for the Espanola Project area, a series of maps at a closer zoom level has been developed (Appendix C). The Ohkay Owingeh and Santa Clara areas are divided (Ohkay Owingeh polygon #s OK_XXX, Figs. 5A-5I. Santa Clara polygon #s SC_XXX, Figs. 6A-6G). Other maps produced include: Per Acre Habitat Value (Figs. 7 and 8), Grass/Forb Invasive Species (Figs. 9 and 10), Shrub Invasive Species (Figs. 11 and 12), and Tree Invasive Species (Figs. 13 and 14). Digital images (JPEGs) of zoomed levels of all of these maps plus Structural Conditions and Habitat Units are companion to this report.

4.2 Evaluating Proposed Alternatives

The CHAP process of determining Habitat Units within the study area provides a depiction of the current baseline condition(s) from which to evaluate proposed projects. By using the CHAP method, the calculated Habitat Units represent an accounting of wildlife species, habitat types, structural conditions, KEC and functions (KEFs) for each polygon within the study area. The CHAP approach uses a biological accounting system and standard mapping protocols, hence it is repeatable as well as allows evaluation of various management actions and comparisons to other projects and locations. Because the baseline condition(s) includes a without project scenario, this is akin to a no-action alternative. Thus, alternative project proposals can be formulated that can include various management actions and evaluated. These proposed projects allow resource managers to compare the effects of converting wildlife habitats to other habitat types and structural conditions or to examine the enhancement or alteration of Key Environmental Correlates (KECs) in selected polygons. Because CHAP incorporates a spatial component, the proposed alternative actions can be developed and overlaid in a GIS to recalculate Habitat Units giving comparison between baseline conditions and any proposed actions. So the CHAP approach captures the effects of habitat manipulation or a change in the expected species list and reflects these modifications in the Habitat Unit values.

For instance, the effects of a large flood event on wildlife habitat could be calculated using this method. The flood event can be simulated using a GIS and high resolution digital elevation maps to determine the maximum extent of flooding within the study area. The simulated flood map can then be overlaid onto the baseline condition polygon previously developed using CHAP. The overlay process will show which polygons or partial polygons will be inundated and the changes depicted from this simulated flooding event.   Once the affected areas are identified, then the Habitat Units can be recalculated given the positive or negative changes that have occurred to habitat types, structural conditions and KECs. This process can be extended to any number of simulated scenarios that involve changes to the landscape such as habitat restoration, climate change effects on vegetation, land development impacts, improvement or degradation of KECs, or loss of wildlife species.

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6 - Appendix A: Peer-reviewed Potential Species List for Espanola

Espanola Valley Species List		
Spp. ID	**Scientific Name**	**Common Name**
10023	Cyprinella lutrensis	Shiner, Red
10025	Rhinichthys cataractae	Dace, Longnose
10036	Catostomus plebeius	Sucker, Rio Grande
10068	Gila pandora	Chub, Rio Grande
10109	Micropterus salmoides salmoides	Bass, Largemouth
10113	Micropterus dolomieui	Bass, Smallmouth
10129	Ameiurus melas	Bullhead, Black
10149	Cyprinus carpio	Carp, Common
10157	Ictalurus punctatus	Catfish, Channel
10185	Pimephales promelas	Minnow, Fathead
10189	Gambusia affinis	Western mosquitofish
10205	Esox lucius	Pike, Northern
10257	Lepomis macrochirus	Bluegill
10261	Lepomis cyanellus	Sunfish, Green
10289	Salmo trutta	Trout, Brown
10297	Oncorhynchus mykiss	Trout, Rainbow
11265	Morone chrysops	Bass, White
11309	Carpiodes carpio carpio	Carpsucker, River
11329	Catostomus commersoni	Sucker, White
11341	Platygobio gracilis	Chub, Flathead
20010	Ambystoma tigrinum mavortium ;nebulosum	Salamander, Tiger
20233	Spea multiplicata	Spadefoot, New Mexico
20242	Bufo cognatus	Toad, Great Plains
20250	Bufo woodhousii woodhousii ;australis	Toad, Woodhouse's
20255	Pseudacris triseriata triseriata; maculata	Frog, Chorus, Western
20330	Rana catesbeiana	Bullfrog
30020	Chrysemys picta bellii	Turtle, Painted, Western
30025	Terrapene ornata luteola	Turtle, Box, Ornate
30040	Trachemys scripta elegans (NM)	Slider, Red-eared
30165	Sceloporus undulatus consobrinus ;erythrocheilus; elongatus; garmani; tedbrowni; tristichus	Lizard, Fence, Eastern
30170	Uta stansburiana stejnegeri; uniformis	Lizard, Side-blotched
30177	Holbrookia maculata approximans ;maculata ;elegans; bunkeri	Lizard, Earless, Lesser
30185	Eumeces multivirgatus epipleurotus	Skink, Many-lined
30280	Masticophis taeniatus taeniatus	Whipsnake, Striped, Desert
30320	Thamnophis elegans arizonae; vagrans	Snake, Garter, Wandering
30346	Thamnophis cyrtopsis cyrtopsis	Snake, Garter, Blackneck, W.
30350	Crotalus viridis cerberus; nuntius; viridus ;abyssus	Rattlesnake, Western
30360	Masticophis flagellum testaceus ;piceus	Coachwhip
30380	Heterodon nasicus nasicus ;kennerlyi	Snake, Hognose, W.
40050	Podilymbus podiceps podiceps	Grebe, Pied-billed
40060	Podiceps auritus cornutus	Grebe, Horned
40080	Podiceps nigricollis californicus	Grebe, Eared
40320	Pelecanus erythrorhynchos	Pelican, White, American

Spp. ID	Scientific Name	Common Name
40350	Phalacrocorax auritus auritus; albociliatus	Cormorant, Double-crested
40380	Botaurus lentiginosus	Bittern, American
40390	Ixobrychus exilis exilis	Bittern, Least
40400	Ardea herodias herodias; tregansai	Heron, Blue, Great
40420	Egretta thula brewsteri	Egret, Snowy
40470	Nycticorax nycticorax hoactli	Night-Heron, Black-crowned
40490	Plegadis chihi	Ibis, White-faced
40500	Cathartes aura septentrionalis; teter	Vulture, Turkey
40571	Branta canadensis moffitti; parvipes; hutchinsii; interior	Goose, Canada
40630	Aix sponsa	Duck, Wood
40640	Anas strepera	Duck, Gadwall
40670	Anas americana	Duck, Wigeon, American
40690	Anas platyrhynchos platyrynchos; diazi	Duck, Mallard
40700	Anas discors discors	Duck, Teal, Blue-winged
40710	Anas cyanoptera septentrionalium	Duck, Teal, Cinnamon
40720	Anas clypeata	Duck, Shoveler, Northern
40730	Anas acuta	Duck, Pintail, Northern
40760	Anas crecca carolinensis	Duck, Teal, Green-winged
40770	Aythya valisineria	Duck, Canvasback
40780	Aythya americana	Duck, Redhead
40790	Aythya collaris	Duck, Ring-necked
40820	Aythya affinis	Duck, Scaup, Lesser
40900	Bucephala albeola	Duck, Bufflehead
40910	Bucephala clangula americana	Duck, Goldeneye, Common
40940	Lophodytes cucullatus	Duck, Merganser, Hooded
40950	Mergus merganser americanus	Duck, Merganser, Common
40970	Oxyura jamaicensis rubida	Duck, Ruddy
40980	Pandion haliaetus carolinensis	Osprey
41000	Haliaeetus leucocephalus alascanus	Eagle, Bald
41040	Accipiter gentilis atricapillus; apache	Goshawk, Northern
41080	Buteo jamaicensis calurus; harlani; fuertesi	Hawk, Red-tailed
41100	Buteo lagopus johannis	Hawk, Rough-legged
41120	Falco sparverius sparverius	Kestrel, American
41151	Falco peregrinus anatum	Falcon, Peregrine
41152	Falco peregrinus tundrius	Falcon, Peregrine, Arctic
41260	Meleagris gallopavo merriami (NM,AZ);intermedia (NM);silvestris (NM)	Turkey, Wild
41320	Rallus limicola limicola	Rail, Virginia
41330	Porzana carolina	Sora
41350	Fulica americana americana	Coot, American
41360	Grus canadensis canadensis; tabida; rowani	Crane, Sandhill
41440	Charadrius vociferus vociferus	Killdeer
41490	Recurvirostra americana	Avocet, American
41570	Actitis macularia	Sandpiper, Spotted
41580	Bartramia longicauda	Sandpiper, Upland
41720	Calidris mauri	Sandpiper, Western
41760	Calidris minutilla	Sandpiper, Least
41890	Gallinago gallinago delicata	Snipe, Common
41900	Phalaropus tricolor	Phalarope, Wilson's
42010	Larus philadelphia	Gull, Bonaparte's
42040	Larus delawarensis	Gull, Ring-billed

Spp. ID	Scientific Name	Common Name
42050	Larus californicus	Gull, California
42230	Sterna antillarum athalassos	Tern, Least
42240	Chlidonias niger surinamensis	Tern, Black
42410	Zenaida macroura marginella; carolinensis	Dove, Mourning
42470	Bubo virginianus pallescens; occidentalis	Owl, Horned, Great
42500	Glaucidium gnoma californicum	Owl, Pygmy, Northern
42610	Cypseloides niger borealis	Swift, Black
42630	Aeronautes saxatalis saxatalis	Swift, White-throated
42640	Archilochus alexandri	Hummingbird, Black-chinned
42680	Selasphorus platycercus platycercus	Hummingbird, Broad-tailed
42690	Selasphorus rufus	Hummingbird, Rufous
42710	Ceryle alcyon caurina; alcyon	Kingfisher, Belted
42720	Melanerpes lewis	Woodpecker, Lewis's
42725	Melanerpes erythrocephalus caurinus	Woodpecker, Red-headed
42800	Picoides villosus monticolus; leucothorectis; icastus	Woodpecker, Hairy
42835	Picoides scalaris cactophilus; symplectus	Woodpecker, Ladder-backed
42840	Colaptes auratus borealis; collaris	Flicker, Northern
42860	Contopus cooperi	Flycatcher, Olive-sided
42870	Contopus sordidulus veliei; saturatus	Pewee, Wood, Western
42890	Empidonax traillii extimus	Flycatcher, Willow, SW.
42910	Empidonax hammondii	Flycatcher, Hammond's
42930	Empidonax oberholseri	Flycatcher, Dusky
42950	Empidonax occidentalis	Flycatcher, Cordilleran
42960	Sayornis nigricans semiatra	Phoebe, Black
42970	Sayornis phoebe	Phoebe, Eastern
42980	Sayornis saya saya; yukonensis	Phoebe, Say's
43000	Myiarchus cinerascens cinerascens	Flycatcher, Ash-throated
43020	Tyrannus verticalis	Kingbird, Western
43030	Tyrannus tyrannus	Kingbird, Eastern
43060	Lanius ludovicianus excubitorides; sonoriensis; gambeli	Shrike, Loggerhead
43110	Vireo plumbeus	Vireo, Plumbeous
43120	Vireo cassinii	Vireo, Cassin's
43140	Vireo gilvus swainsonii	Vireo, Warbling
43160	Vireo olivaceus olivaceus	Vireo, Red-eyed
43230	Pica hudsonia	Magpie, Black-billed
43240	Corvus brachyrhynchos hesperis; hargravei	Crow, American
43260	Corvus corax sinuatus	Raven, Common
43300	Tachycineta bicolor	Swallow, Tree
43310	Tachycineta thalassina lepida	Swallow, Violet-green
43320	Stelgidopteryx serripennis serripennis; psammochrous	Swallow, Rough-winged, N.
43330	Riparia riparia riparia	Swallow, Bank
43340	Petrochelidon pyrrhonota tachina; minima	Swallow, Cliff
43350	Hirundo rustica erythrogaster	Swallow, Barn
43360	Poecile atricapilla septentrionalis; garrinus	Chickadee, Black-capped
43370	Poecile gambeli gambeli	Chickadee, Mountain
43410	Baeolophus ridgwayi	Titmouse, Juniper
43440	Sitta carolinensis nelsoni	Nuthatch, White-breasted
43490	Thryomanes bewickii eremophilus; cryptus	Wren, Bewick's
43500	Troglodytes aedon parkmannii	Wren, House
43520	Cistothorus palustris iliacus; plesius	Wren, Marsh

Spp. ID	Scientific Name	Common Name
43530	Cinclus mexicanus unicolor	Dipper, American
43540	Regulus satrapa amoenus; apache	Kinglet, Golden-crowned
43550	Regulus calendula calendula	Kinglet, Ruby-crowned
43560	Polioptila caerulea amoenissima	Gnatcatcher, Blue-gray
43580	Sialia mexicana bairdi	Bluebird, Western
43585	Sialia sialis sialis; fulva	Bluebird, Eastern
43590	Sialia currucoides	Bluebird, Mountain
43600	Myadestes townsendi townsendi	Solitaire, Townsend's
43630	Catharus ustulatus ustulatus; swainsoni	Thrush, Swainson's
43640	Catharus guttatus guttatus; nanus; sequoiensis; auduboni; slevini	Thrush, Hermit
43660	Turdus migratorius migratorius; propinquus	Robin, American
43690	Dumetella carolinensis ruficrissa	Catbird, Gray
43700	Mimus polyglottos leucopterus	Mockingbird, Northern
43720	Toxostoma rufum longicauda	Thrasher, Brown
43740	Sturnus vulgaris	Starling, European
43800	Anthus rubescens pacificus; alticola; rubescens	Pipit, American
43870	Vermivora celata celata; orestera; lutescens	Warbler, Orange-crowned
43890	Vermivora virginiae	Warbler, Virginia's
43920	Dendroica petechia sonorana; morcomi; amnicola; rubiginosa	Warbler, Yellow
43970	Dendroica coronata coronata; auduboni	Warbler, Yellow-rumped
43980	Dendroica nigrescens	Warbler, Gray, Black-throated
43990	Dendroica virens virens	Warbler, Green, Black-throated
44035	Dendroica graciae graciae	Warbler, Grace's
44060	Dendroica palmarum palmarum; hypochrysea	Warbler, Palm
44130	Seiurus aurocapillus cinereus	Ovenbird
44140	Seiurus noveboracensis	Waterthrush, Northern
44170	Oporornis tolmiei tolmiei; monticola	Warbler, Macgillivray's
44180	Geothlypis trichas campicola; occidentalis; chryseola	Yellowthroat, Common
44190	Wilsonia citrina	Warbler, Hooded
44200	Wilsonia pusilla pusilla; pileolata; chryseola	Warbler, Wilson's
44220	Icteria virens auricollis	Chat, Yellow-breasted
44230	Piranga rubra rubra; cooperi	Tanager, Summer
44245	Piranga flava dextra; hepatica	Tanager, Hepatic
44250	Piranga ludoviciana	Tanager, Western
44260	Pipilo chlorurus	Towhee, Green-tailed
44270	Pipilo maculatus	Towhee, Spotted
44300	Spizella passerina arizonae	Sparrow, Chipping
44390	Passerculus sandwichensis nevadensis; anthinus	Sparrow, Savannah
44440	Melospiza melodia juddi; montana; fallax	Sparrow, Song
44450	Melospiza lincolnii lincolnii; alticola	Sparrow, Lincoln's
44460	Melospiza georgiana ericrypta	Sparrow, Swamp
44490	Zonotrichia leucophrys oriantha; gambelii	Sparrow, White-crowned
44510	Junco hyemalis hyemalis; aikeni; cismontanus; montanus; mearnsi; oreganus; shufeldti; thurberi; caniceps; dorsalis	Junco, Dark-eyed
44590	Pheucticus melanocephalus melanocephalus; maculatus	Grosbeak, Black-headed
44600	P. caerulea interfusa	Grosbeak, Blue
44620	Passerina cyanea	Bunting, Indigo
44660	Agelaius phoeniceus nevadensis; fortis; arctolegus; sonoriensis	Blackbird, Red-winged
44690	Xanthocephalus xanthocephalus	Blackbird, Yellow-headed
44710	Euphagus cyanocephalus	Blackbird, Brewer's

Spp. ID	Scientific Name	Common Name
44720	Quiscalus quiscula versicolor	Grackle, Common
44730	Quiscalus mexicanus prosopidicola; monsoni	Grackle, Great-tailed
44740	Molothrus ater obscurus; artemisiae	Cowbird, Brown-headed
44780	Icterus galbula	Oriole, Baltimore
44790	Icterus bullockii	Oriole, Bullock's
44930	Carduelis psaltria psaltria; hesperophilus	Goldfinch, Lesser
44950	Carduelis tristis pallidus	Goldfinch, American
44960	Coccothraustes vespertinus montanus; brooksi; vespertinus	Grosbeak, Evening
50020	Sorex cinereus cinereus	Shrew, Masked
50050	Sorex monticolus monticolus; obscurus	Shrew, Dusky
50090	Sorex palustris navigator	Shrew, Water
50125	Sorex nanus	Shrew, Dwarf
50190	Myotis ciliolabrum melanorhinus	Bat, Myotis, Small-footed, W.
50200	Myotis yumanensis yumanensis	Bat, Myotis, Yuma
50220	Myotis volans interior	Bat, Myotis, Long-legged
50230	Myotis thysanodes thysanodes	Bat, Myotis, Fringed
50250	Myotis evotis evotis	Bat, Myotis, Long-eared
50260	Lasionycteris noctivagans	Bat, Silver-haired
50270	Pipistrellus hesperus hesperus; maximus	Bat, Pipistrelle, Western
50280	Eptesicus fuscus pallidus	Bat, Brown, Big
50290	Lasiurus cinereus cinereus	Bat, Hoary
50300	Euderma maculatum	Bat, Spotted
50312	Corynorhinus townsendii pallescens	Bat, Big-eared, Townsend's, Pale
50320	Antrozous pallidus pallidus	Bat, Pallid
50330	Tadarida brasiliensis mexicana	Bat, Free-tailed, Brazilian
50440	Neotamias minimus operarius; chuskaensis	Chipmunk, Least
50635	Spermophilus variegatus grammurus	Squirrel, Rock
50755	Perognathus flavus flavus; hopiensis	Mouse, Pocket, Silky
50765	Perognathus flavescens copei; melanotis; relictus	Mouse, Pocket, Plains
50767	Peromyscus boylii rowleyi	Mouse, Brush
50780	Dipodomys ordii longipes; medius; montanus; ordii; richardsoni	Rat, Kangaroo, Ord's
50810	Castor canadensis frondator; mexicanus; concisor; missouriensis	Beaver, American
50820	Reithrodontomys megalotis megalotis; aztecus	Mouse, Harvest, Western
50866	Peromyscus leucopus arizonae; tornillo	Mouse, White-footed
50870	Onychomys leucogaster arcticeps; pallescens; ruidosae	Mouse, Grasshopper, N.
50885	Neotoma stephensi stephensi; relicta	Rat, Wood, Stephen's
50900	Neotoma cinerea arizonae; orolestes; acraia	Rat, Wood, Bushy-tailed
50905	Neotoma albigula albigula; laplataensis; warreni; mernsi; venusta	Rat, Wood, White-throated
50970	Microtus montanus fusus	Vole, Montane
51010	Microtus longicaudus longicaudus; alticola; baileyi; mordax	Vole, Long-tailed
51050	Ondatra zibethicus pallidus; osoyooensis; cinnamominus	Muskrat, Common
51090	Mus musculus	Mouse, House
51100	Zapus princeps princeps	Mouse, Jumping, Western
51115	Zapus hudsonius luteus	Mouse, Jumping, Meadow
51120	Erethizon dorsatum couesi; epixanthum	Porcupine, Common
51140	Canis latrans lestes; mearnsi; texensis	Coyote
51160	Vulpes vulpes fulva; macroura	Fox, Red
51170	Vulpes macrotis neomexicanus; macrotis	Fox, Kit
51180	Urocyon cinereoargenteus scottii	Fox, Gray, Common
51210	Bassariscus astutus arizonensis; flavus; yumanensis; nevadensis	Ringtail

Spp. ID	Scientific Name	Common Name
51220	Procyon lotor hirtus; mexicanus; pallidus	Raccoon, Common
51250	Mustela erminea muricus	Weasel, Ermine
51260	Mustela frenata arizonensis; neomexicana; nevadensis	Weasel, Long-tailed
51290	Taxidea taxus berlandieri	Badger, American
51300	Spilogale gracilis	Skunk, Spotted, Western
51310	Mephitis mephitis estor; hudsonica; varians	Skunk, Striped
51320	Lontra canadensis sonora (NM,AZ)	Otter, River, Southwestern
51350	Lynx rufus baileyi	Bobcat
51395	Cervus elaphus nelsoni	Elk
51405	Odocoileus hemionus hemionus; crooki	Deer, Mule

7 - Appendix B Relationship Matrix Descriptions

MATRIX 1: Potential Species by Function Matrix

The potential species list generated by IBIS (see Appendix A) is aligned with Key Ecological Functions (KEFs) that could potentially be performed in the habitat type and structural condition represented by the polygon. For example, if the polygon represents a "shrub-steppe" habitat type, the KEFs thought to be performed in that habitat type by the potential species are included in the relationship matrix. This information is acquired from IBIS. The result of this matrix is the number of potential species performing key functions in that habitat type. Example follows:

Lowland Mixed Conifer Habitat Type *Species Value (Potential)*	**Function 1** ***Secondary Consumer***	**Function 2** ***Breaks up Down Wood***	**Function 3** ***Primary Excavator***	**Function 4** ***Eats Terrestrial Insects***
Downey Woodpecker	**0**	**1**	**1 (tree)**	**1**
Bobcat	**1**	**0**	**0**	**0**
Belted Kingfisher	**1**	**0**	**1 (burrows)**	**1**
Great Blue Heron	**1**	**0**	**0**	**1**

MATRIX 2: Actual KEC by Function Matrix

In this matrix, the functions, or KEFs, are again related to Key Environmental Correlates (KECs), but this time the KECs are those actually present at the site (based on field data inventory). Because this is an actual account, those KEFs not correlated to an actual KEC are then removed. The result of this matrix is the number of KEFs characterized by KECs specific to that polygon. Example follows:

Lowland Mixed Conifer Habitat Type *KEC Value (Potential)*	**Function 1** ***Creates Snags***	**Function 2** ***Breaks up Down Wood***	**Function 3** ***Primary Excavator***	**Function 4** ***Eats Terrestrial Insects***
KEC 1 down wood	**0**	**1**	**0**	**1**
KEC 2 snags	**1**	**0**	**1**	**1**
KEC 3 tree cavities	**1**	**1**	**1**	**1**
KEC 4 hollow living trees	**0**	**1**	**0**	**1**

8 - Appendix C: Habitat Evaluation Maps

Figure 8-1 Ohkay Owingeh Polygon Identification

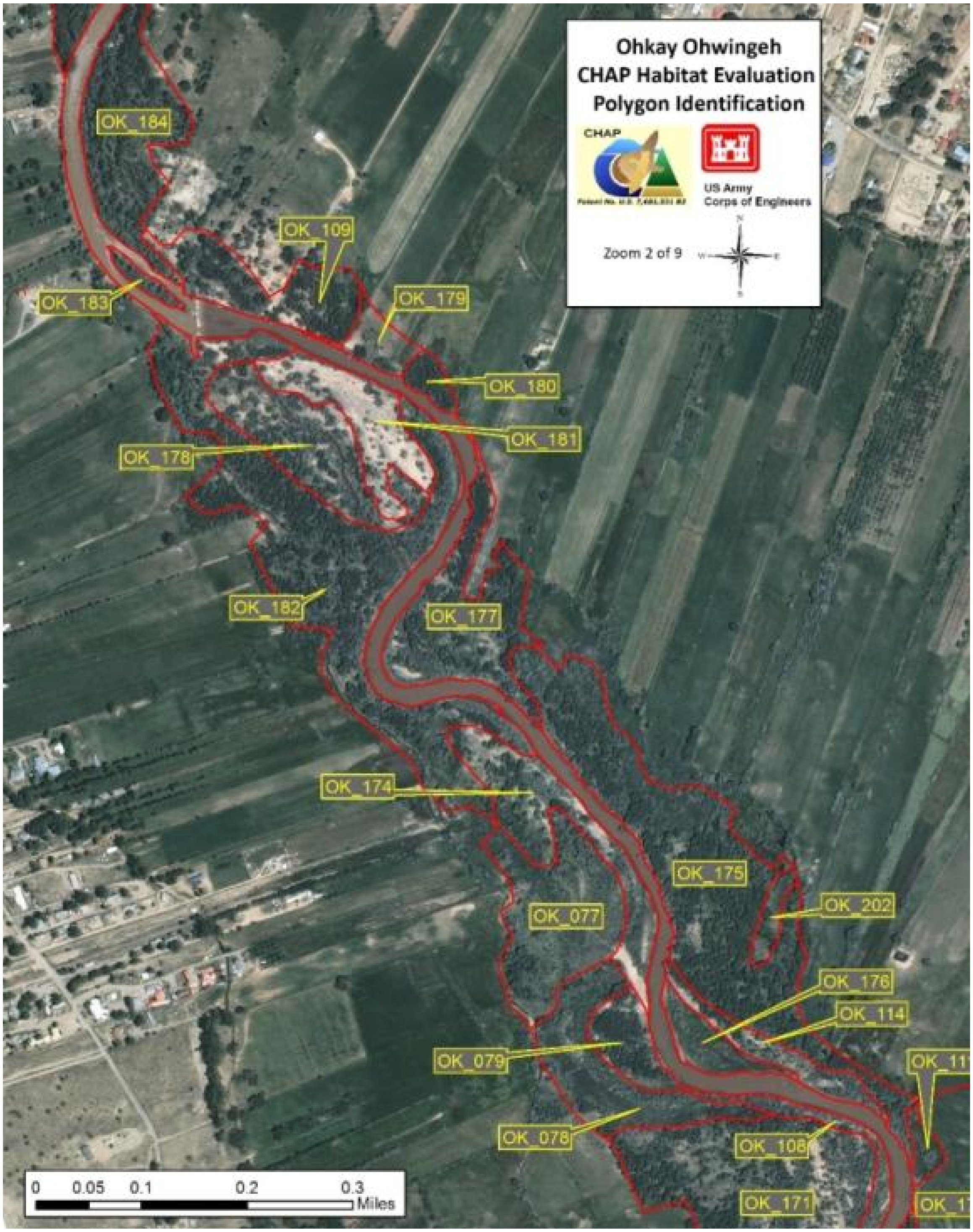

Figure 8-2 Ohkay Owingeh Polygon Identification

Figure 8-3 Ohkay Owingeh Polygon Identification

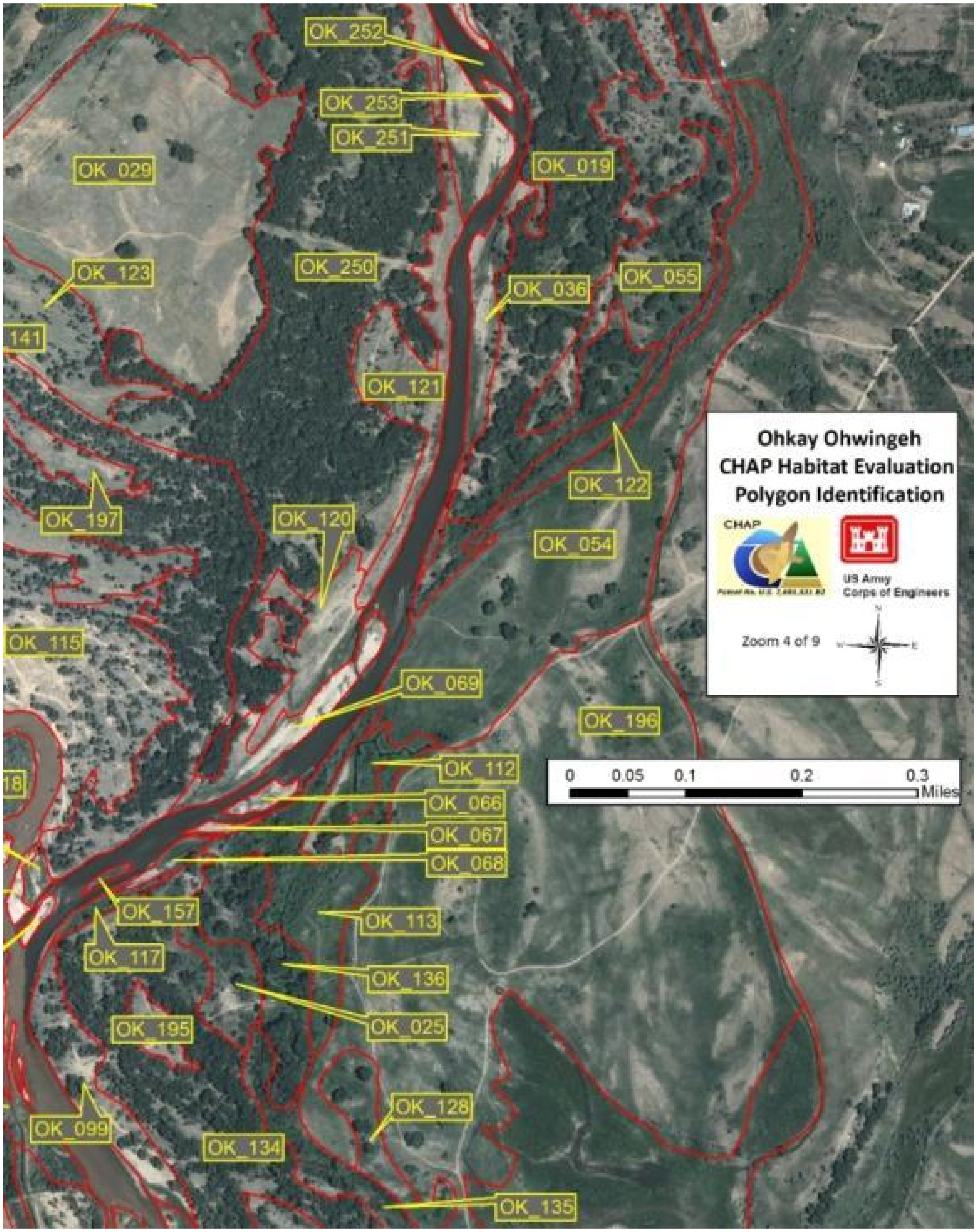

Figure 8-4 Ohkay Owingeh Polygon Identification

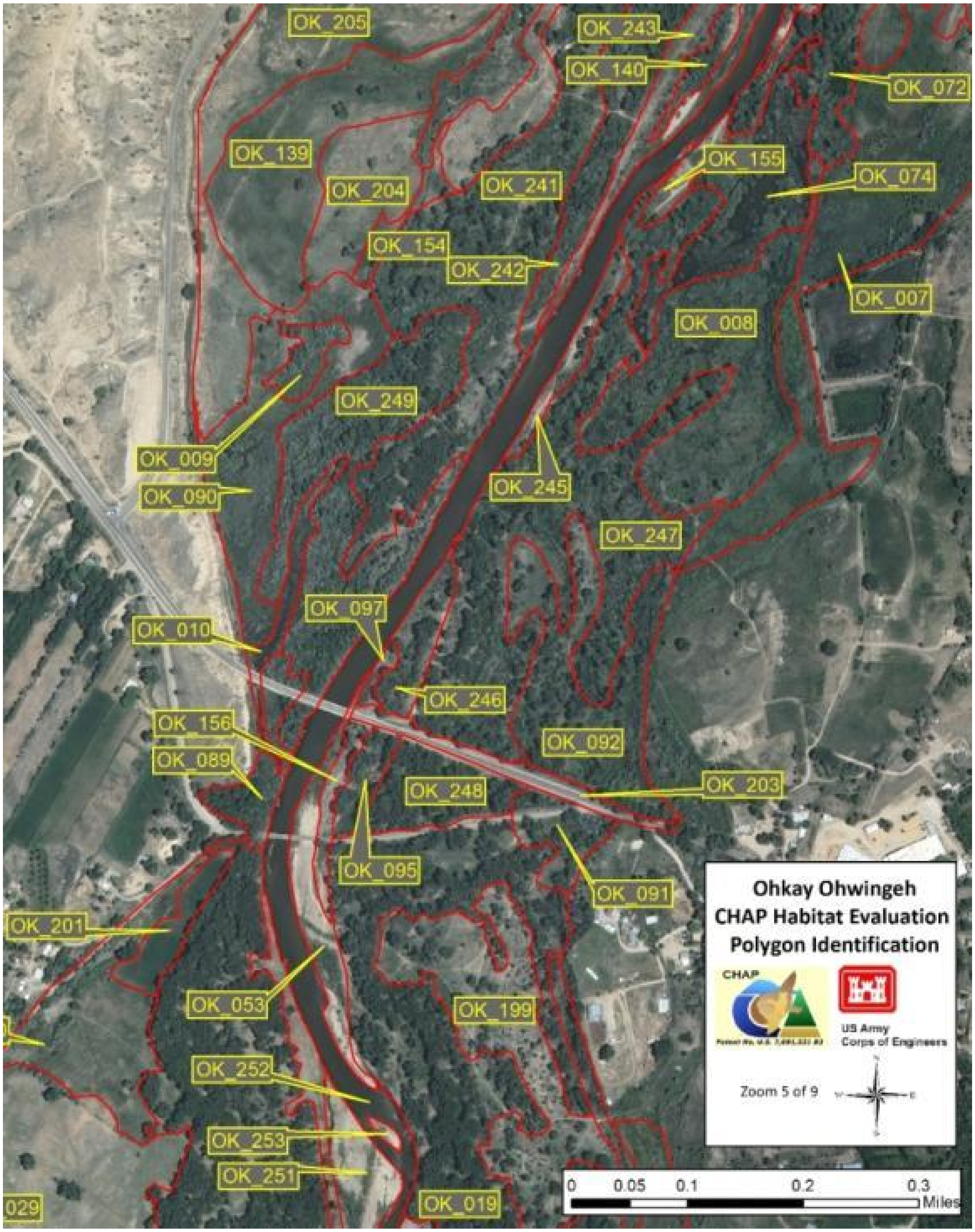

Figure 8-5. Ohkay Owingeh Polygon Identification

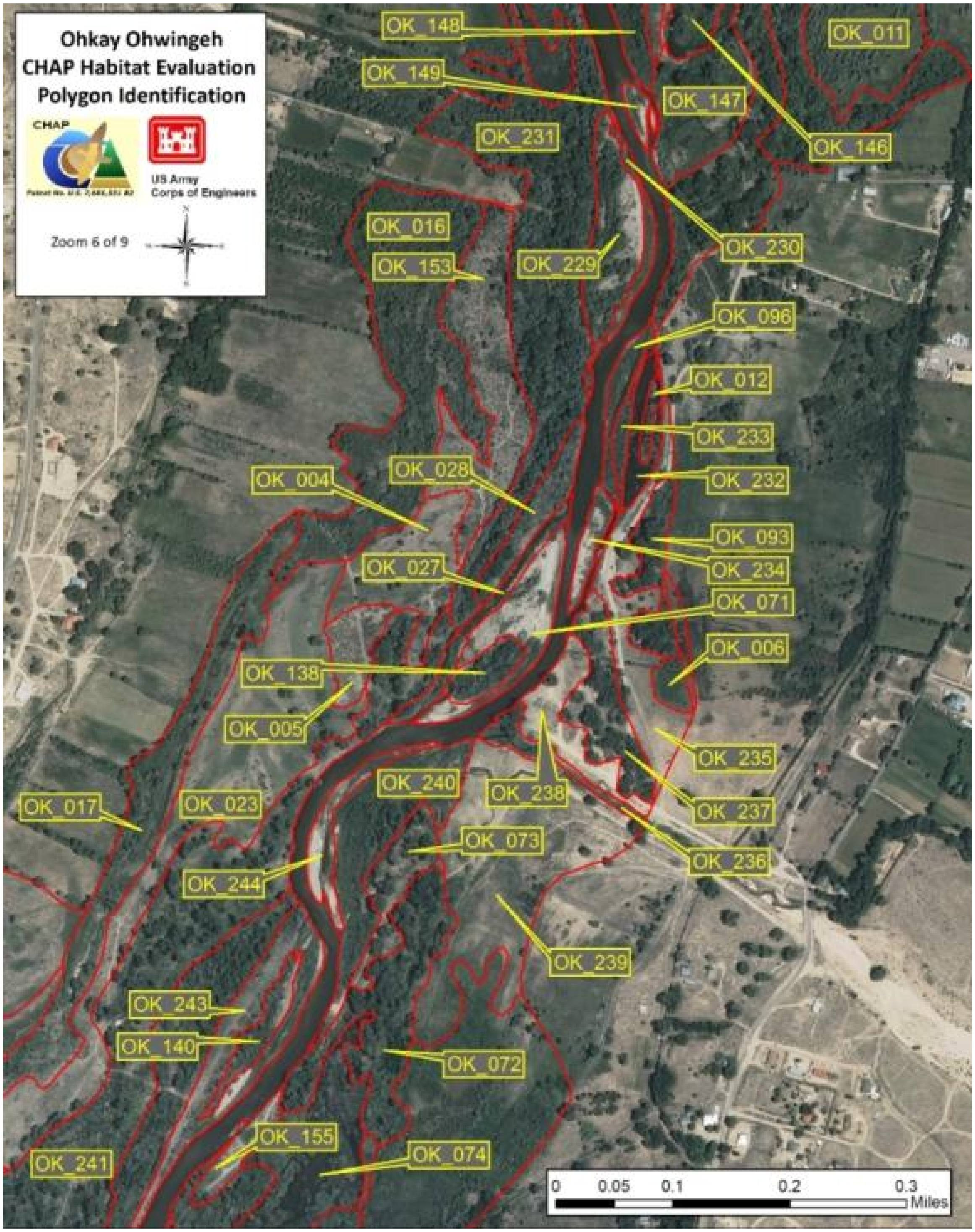

Figure 8-6 Ohkay Owingeh Polygon Identification

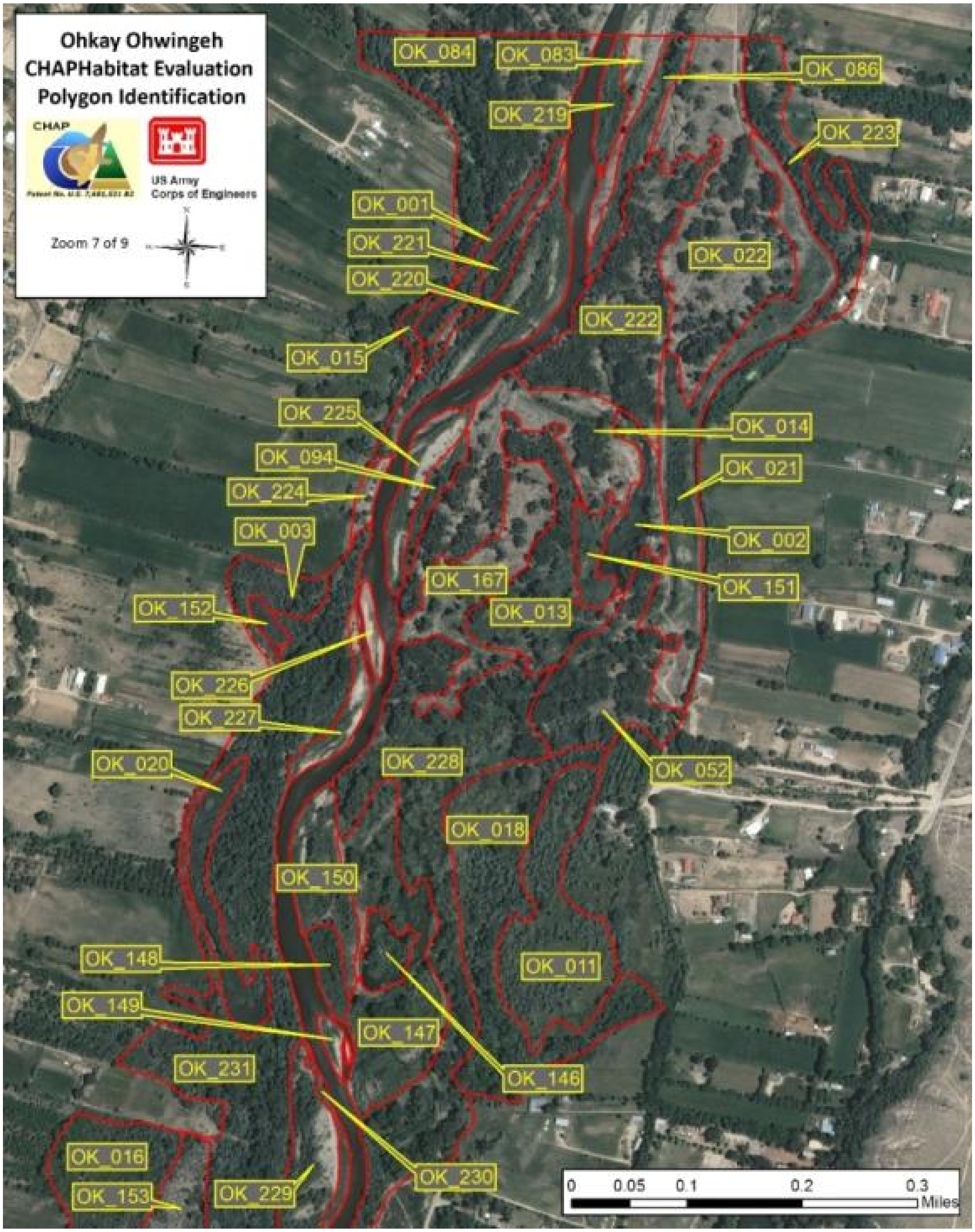

Figure 8-7 Ohkay Owingeh Polygon Identification

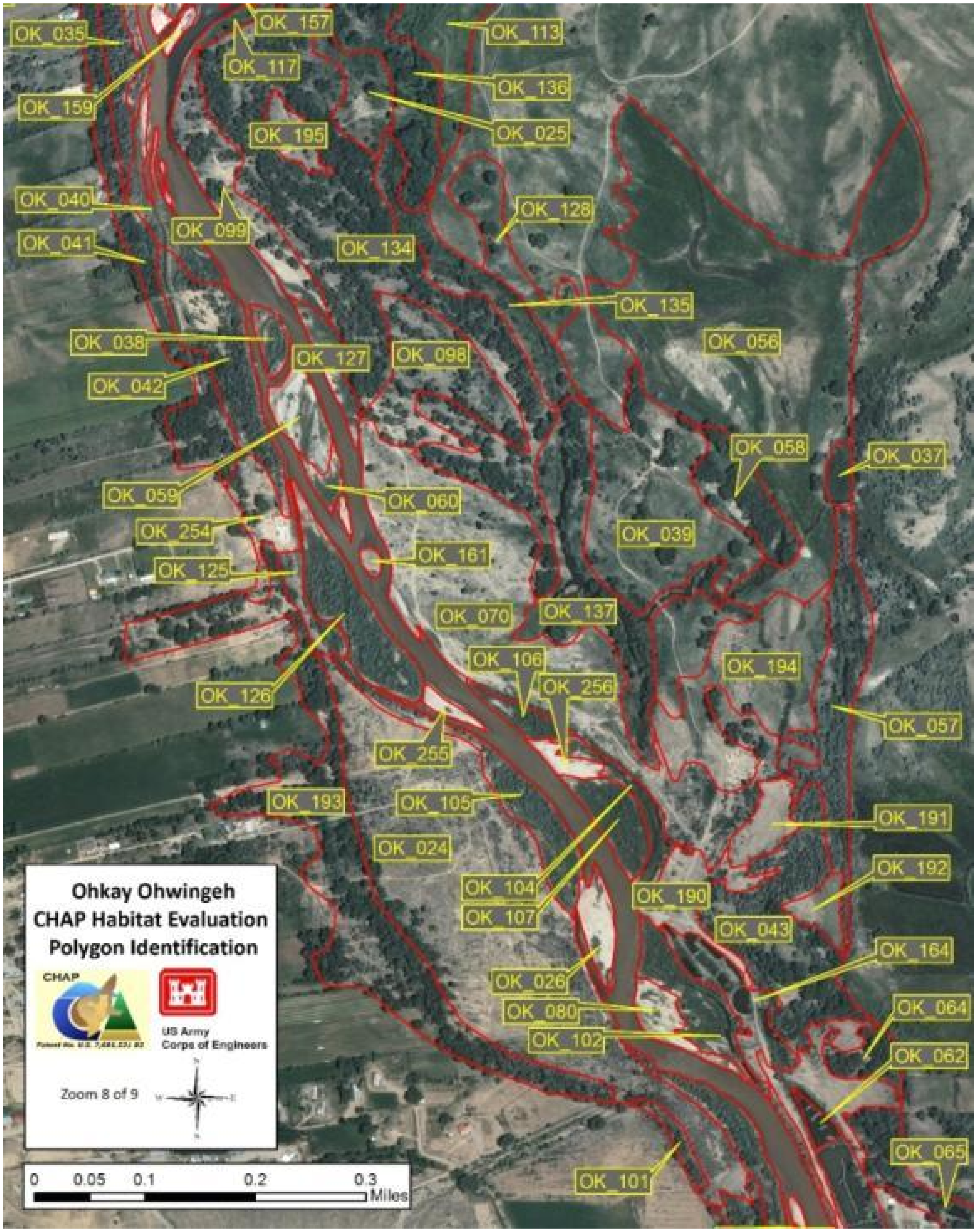

Figure 8-8 Ohkay Owingeh Polygon Identification

Figure 8-9 Ohkay Owingeh Polygon Identification

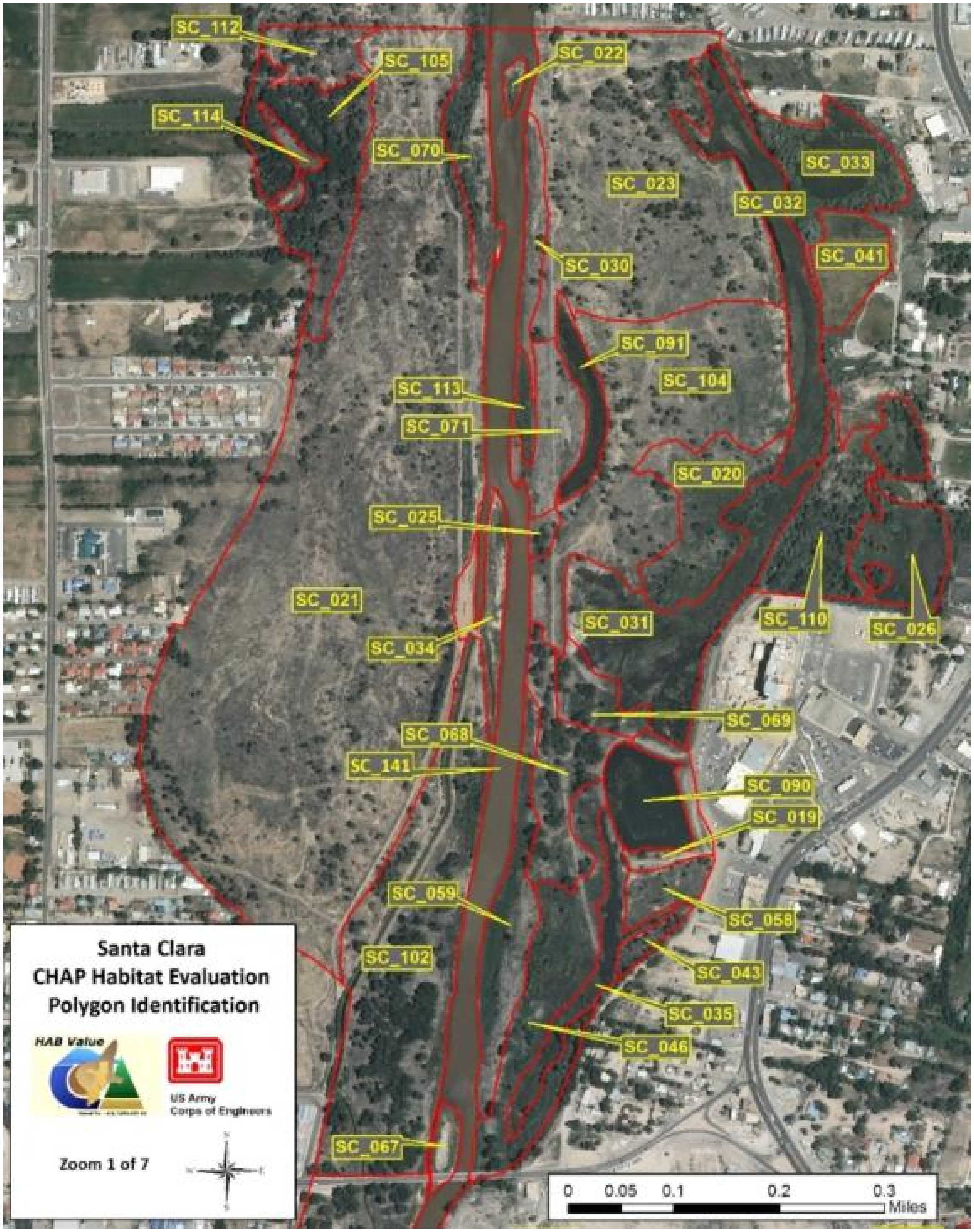

Figure 8-10 Santa Clara Polygon Identification

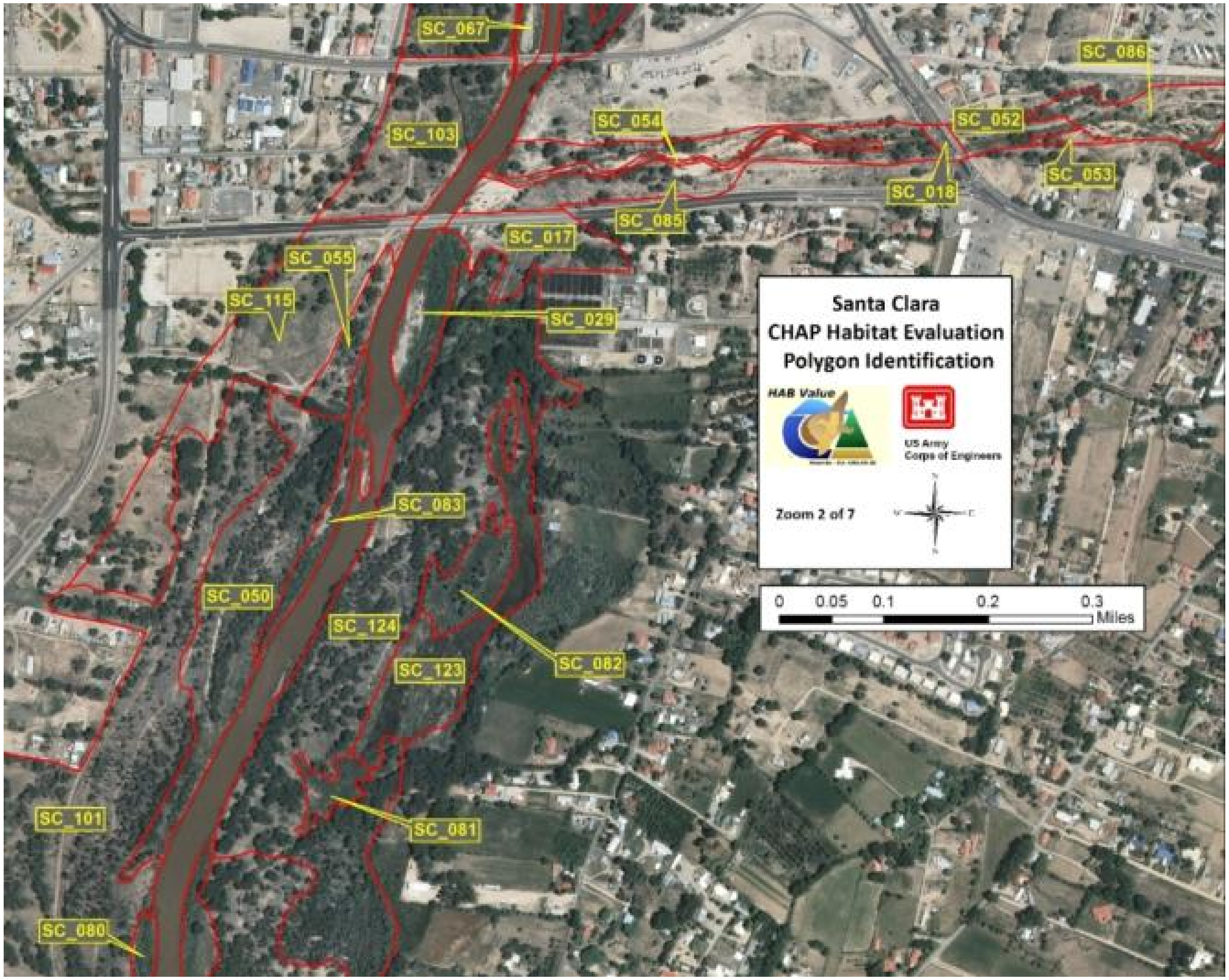

Figure 8-11 Santa Clara Polygon Identification

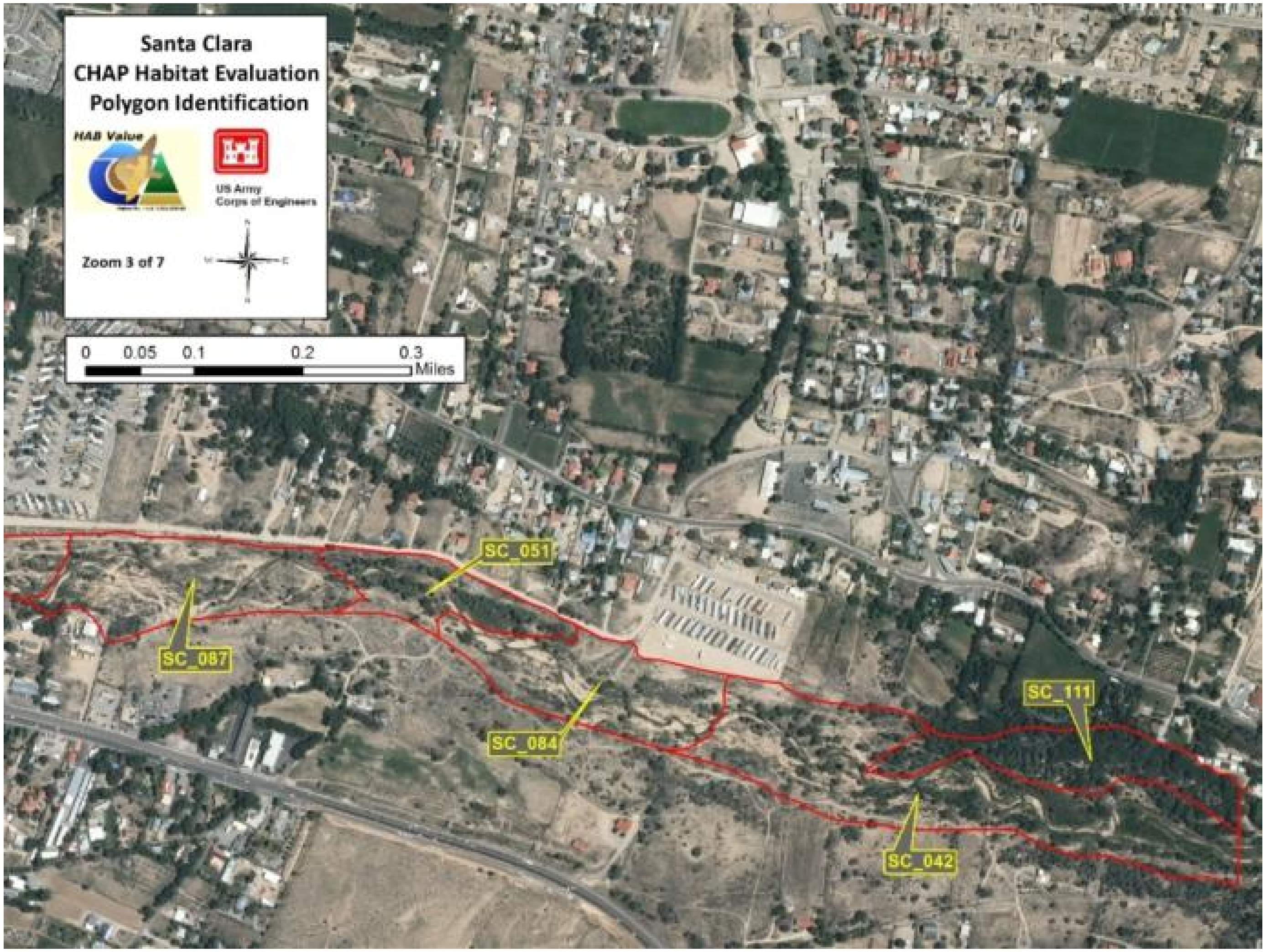

Figure 8-12 Santa Clara Polygon Identification

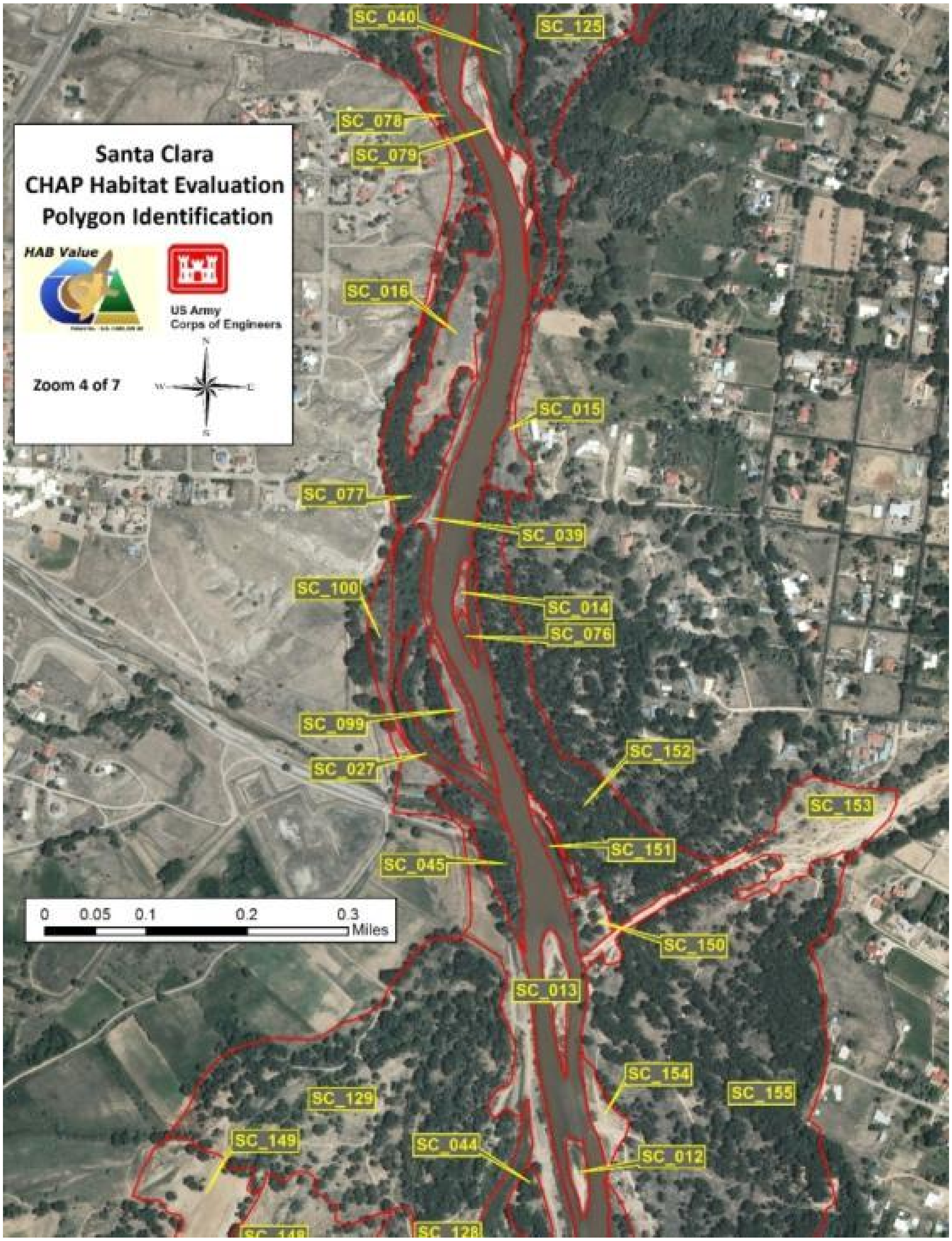

Figure 8-13 Santa Clara Polygon Identification

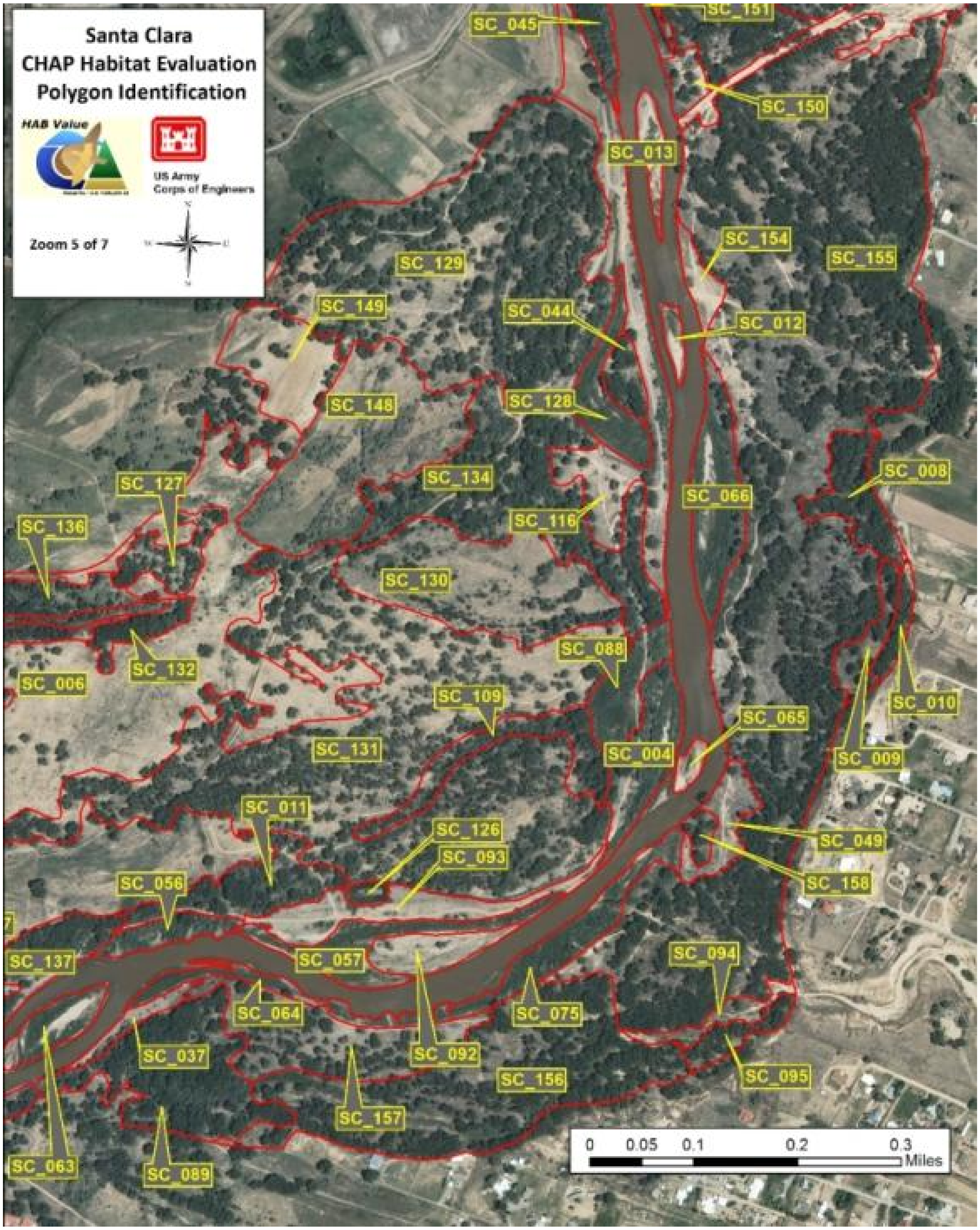

Figure 8-14 Santa Clara Polygon Identification

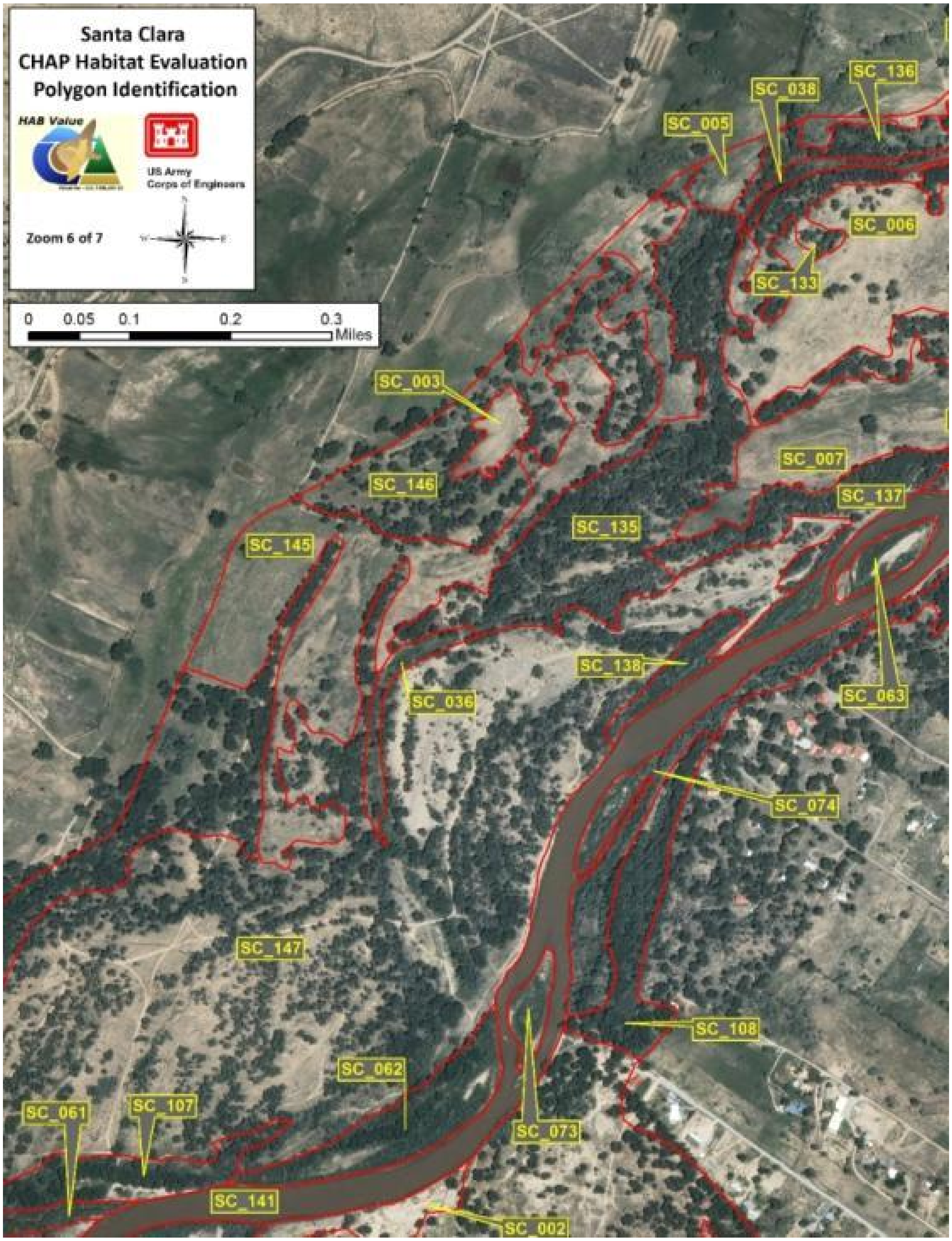

Figure 8-15 Santa Clara Polygon Identification

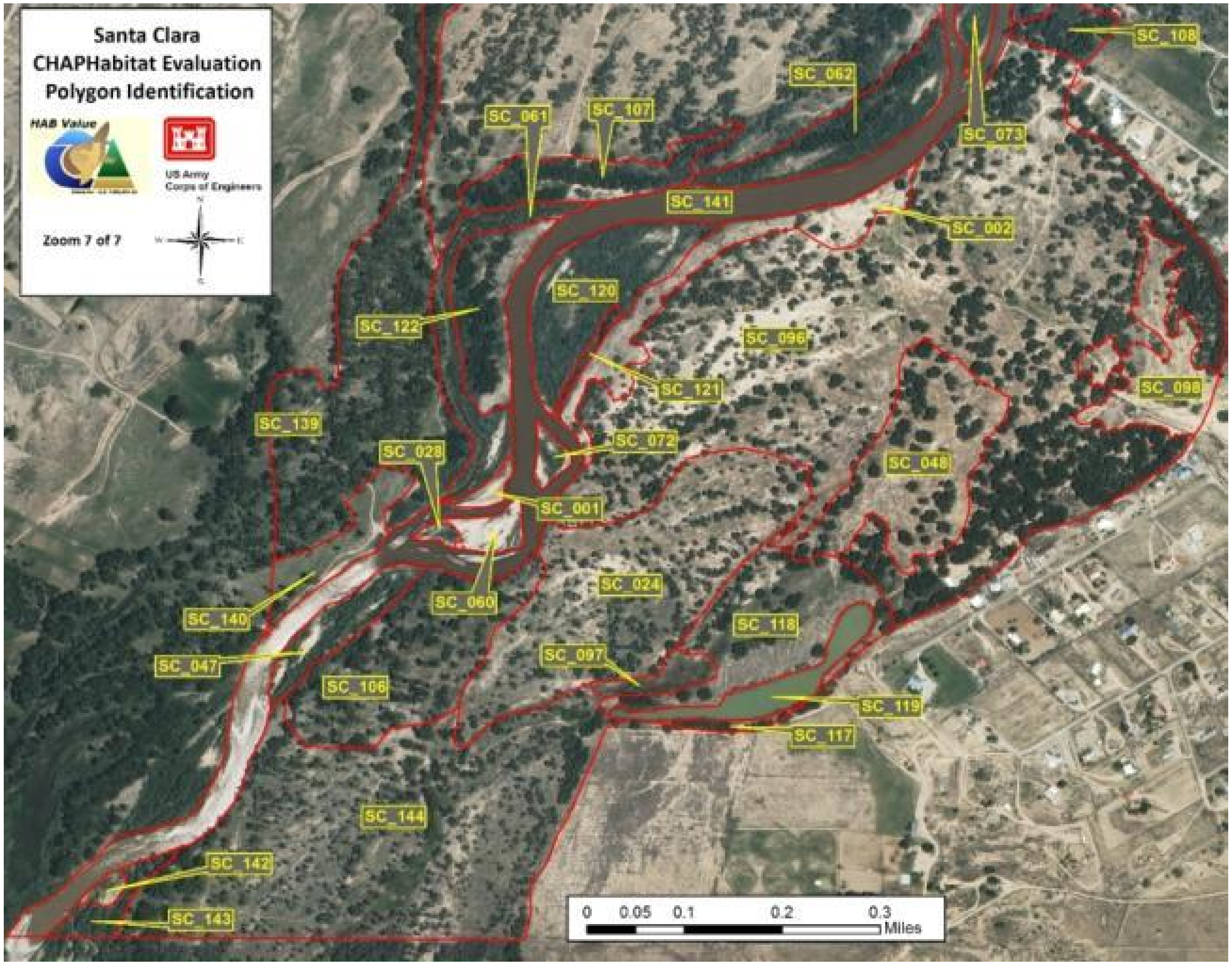

Figure 8-16 Santa Clara Polygon Identification

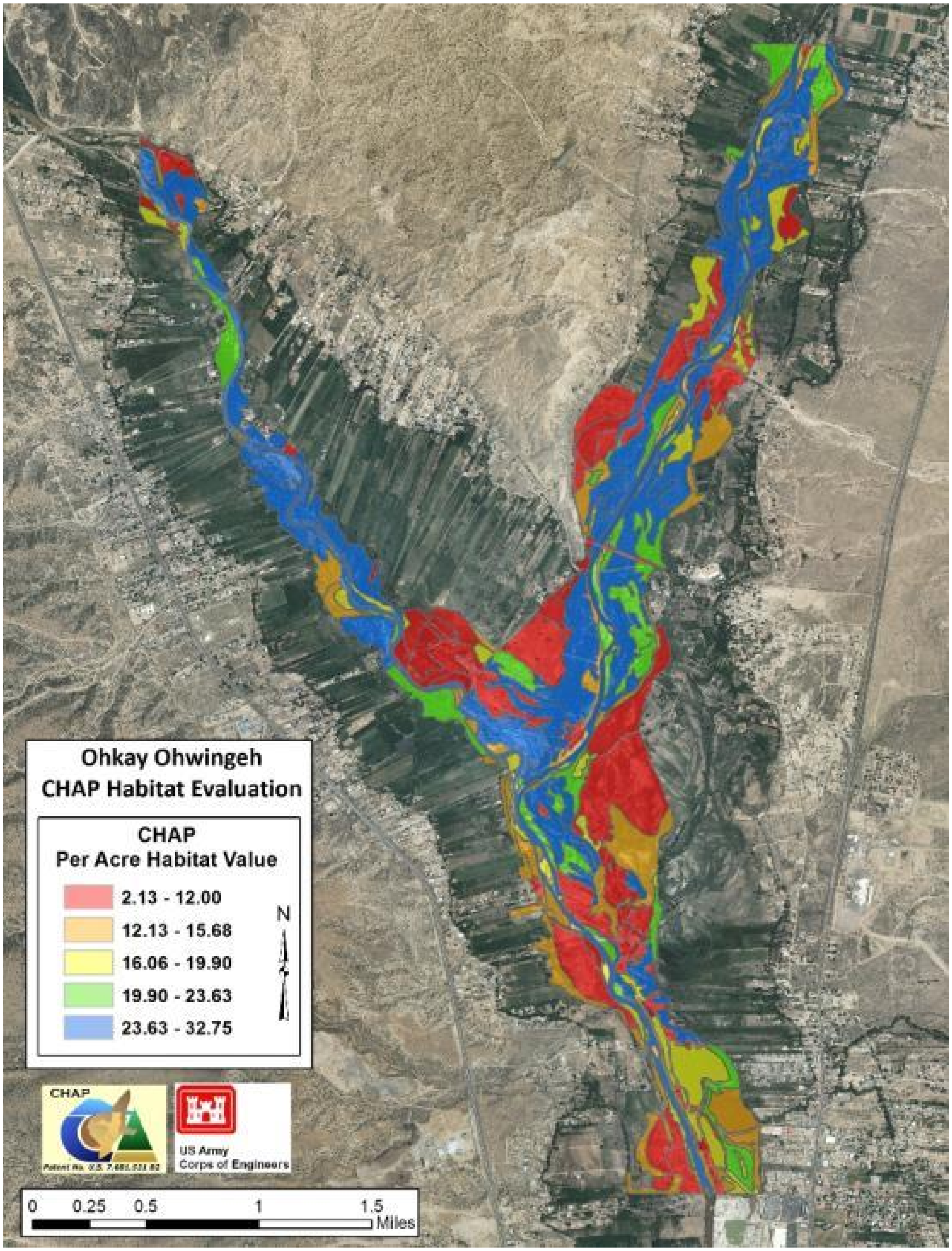

Figure 8-17 Corrected Per Acre Values for Ohkay Ohwingeh. Per acre baseline values were computed for each polygon using the species-functional redundancy for each habitat type added to the observed KEC value.

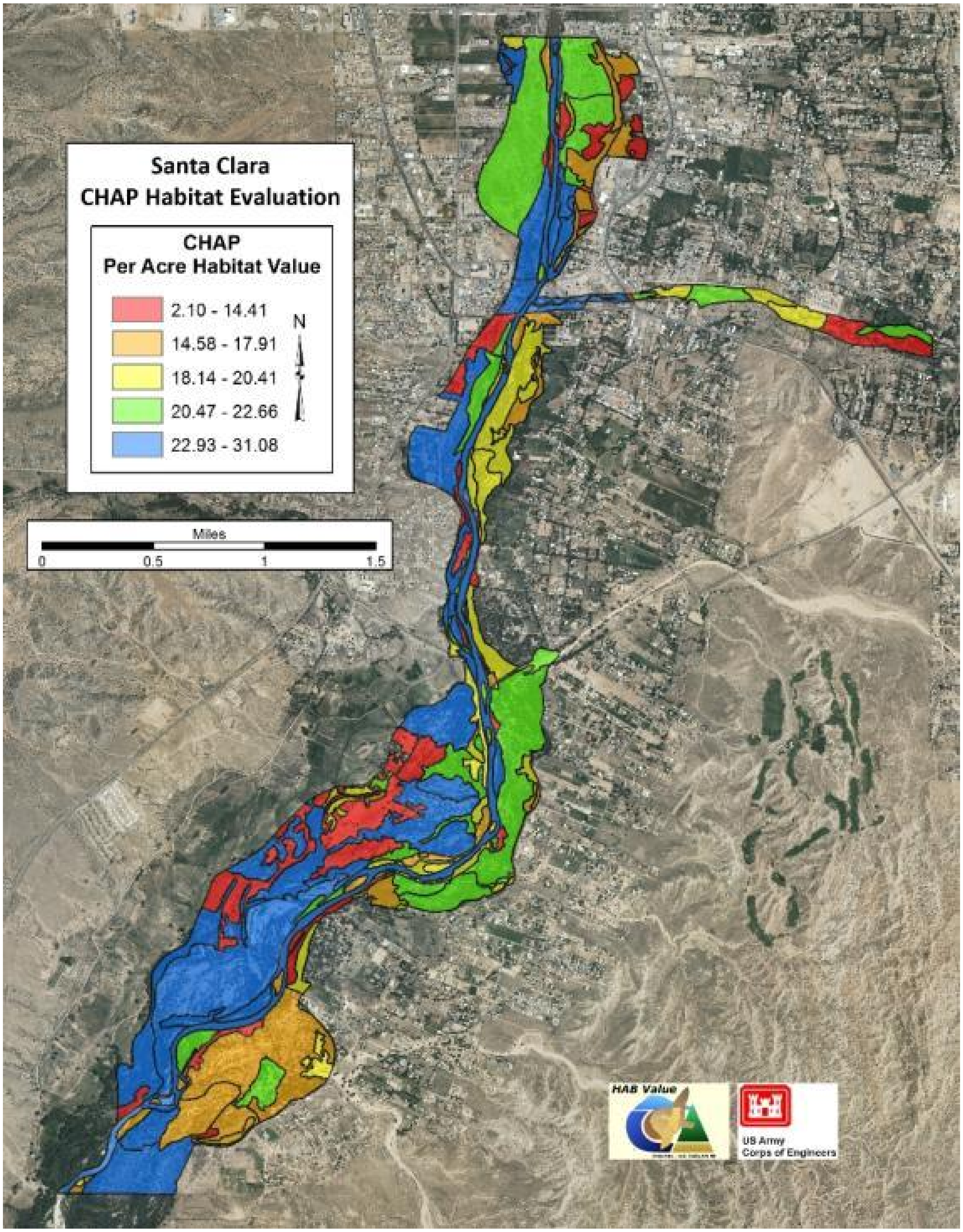

Figure 8-18 Corrected Per Acre Values for Santa Clara. Per acre baseline values were computed for each polygon using the species-functional redundancy for each habitat type added to the observed KEC value.

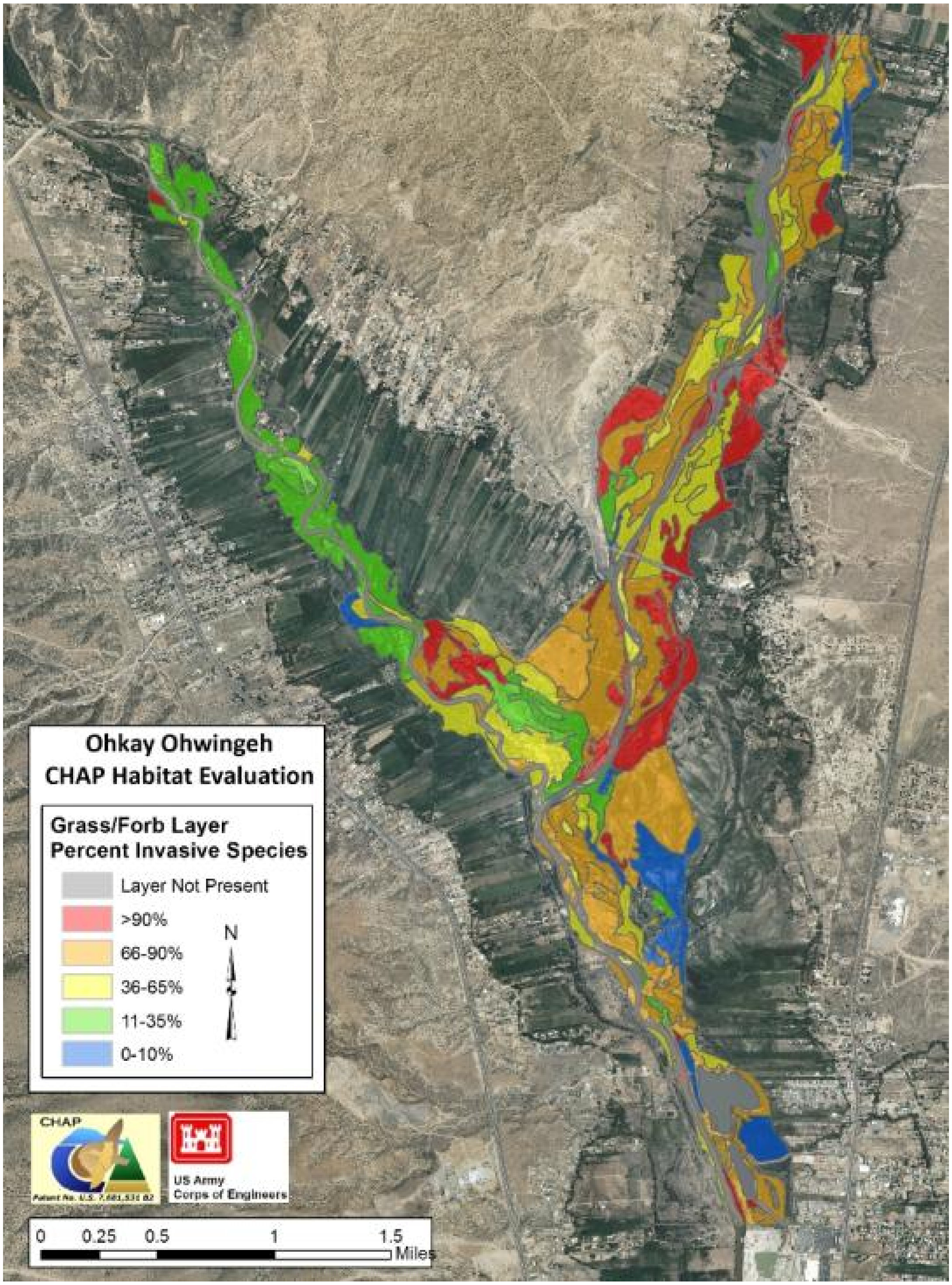

Figure 8-19 Ohkay Ohwingeh habitat assessment area grass/forb layer percent invasive species.

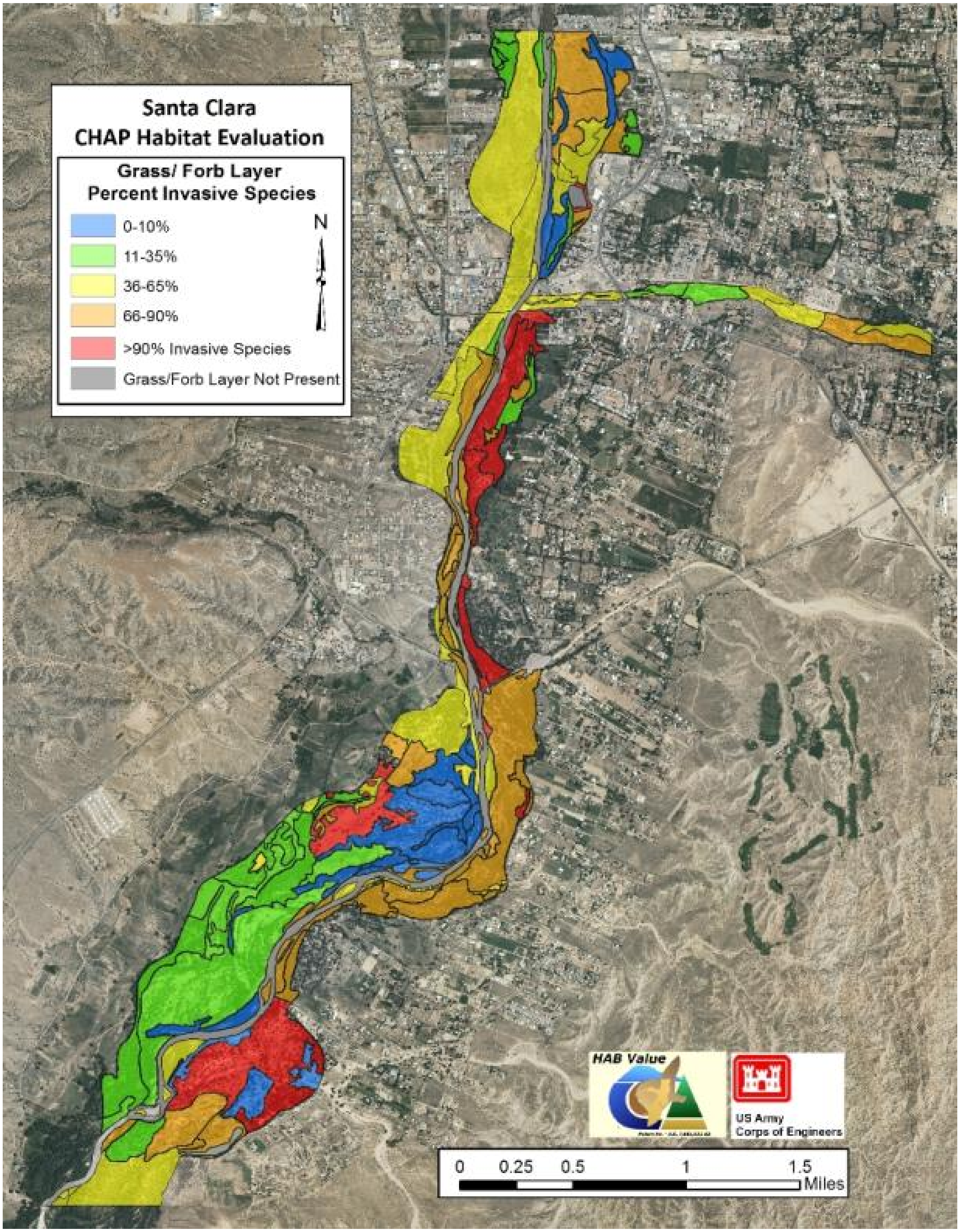

Figure 8-20 Santa Clara habitat assessment area grass/forb layer percent invasive species.

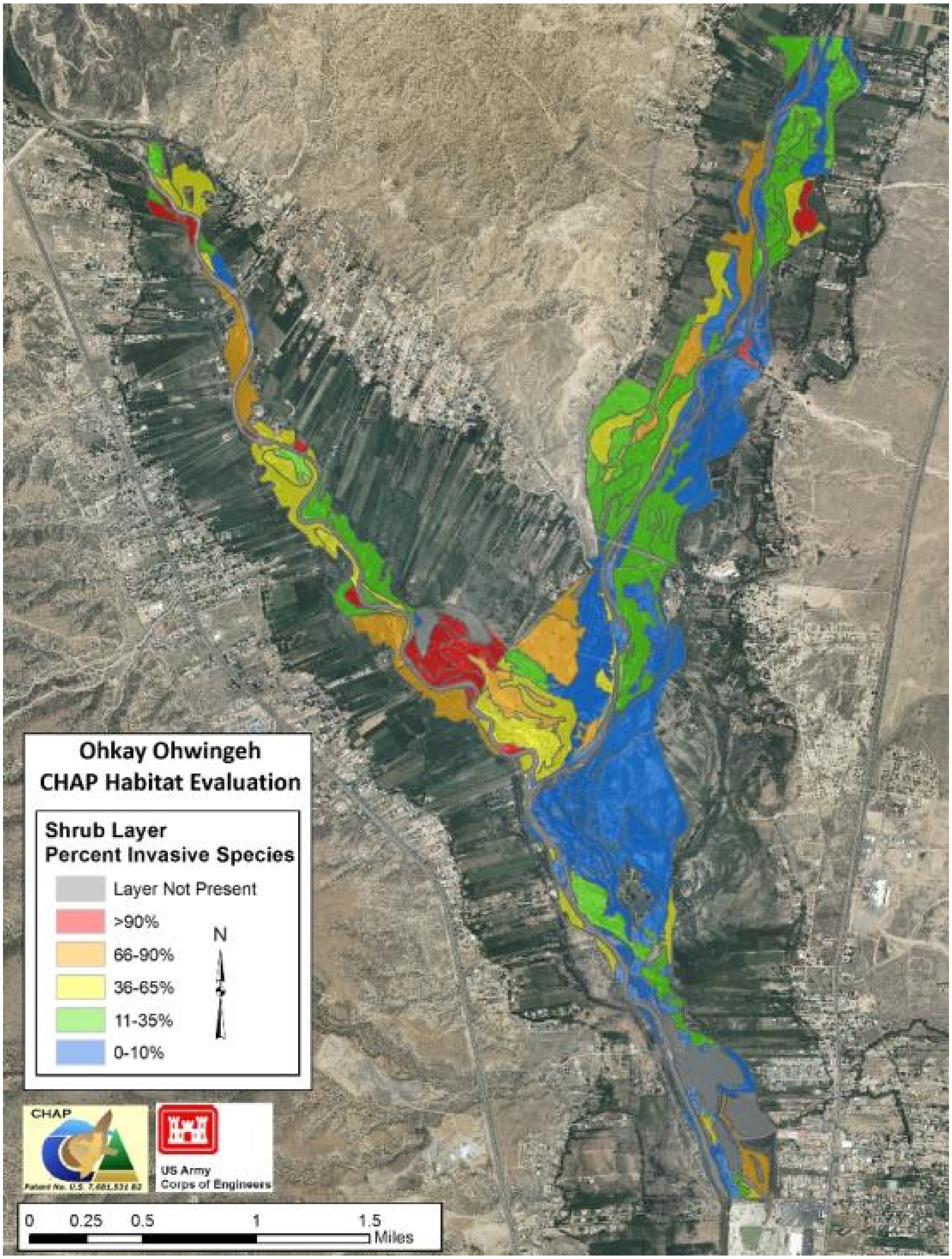

Figure 8-21 Ohkay Owingeh habitat assessment area shrub layer percent invasive species.

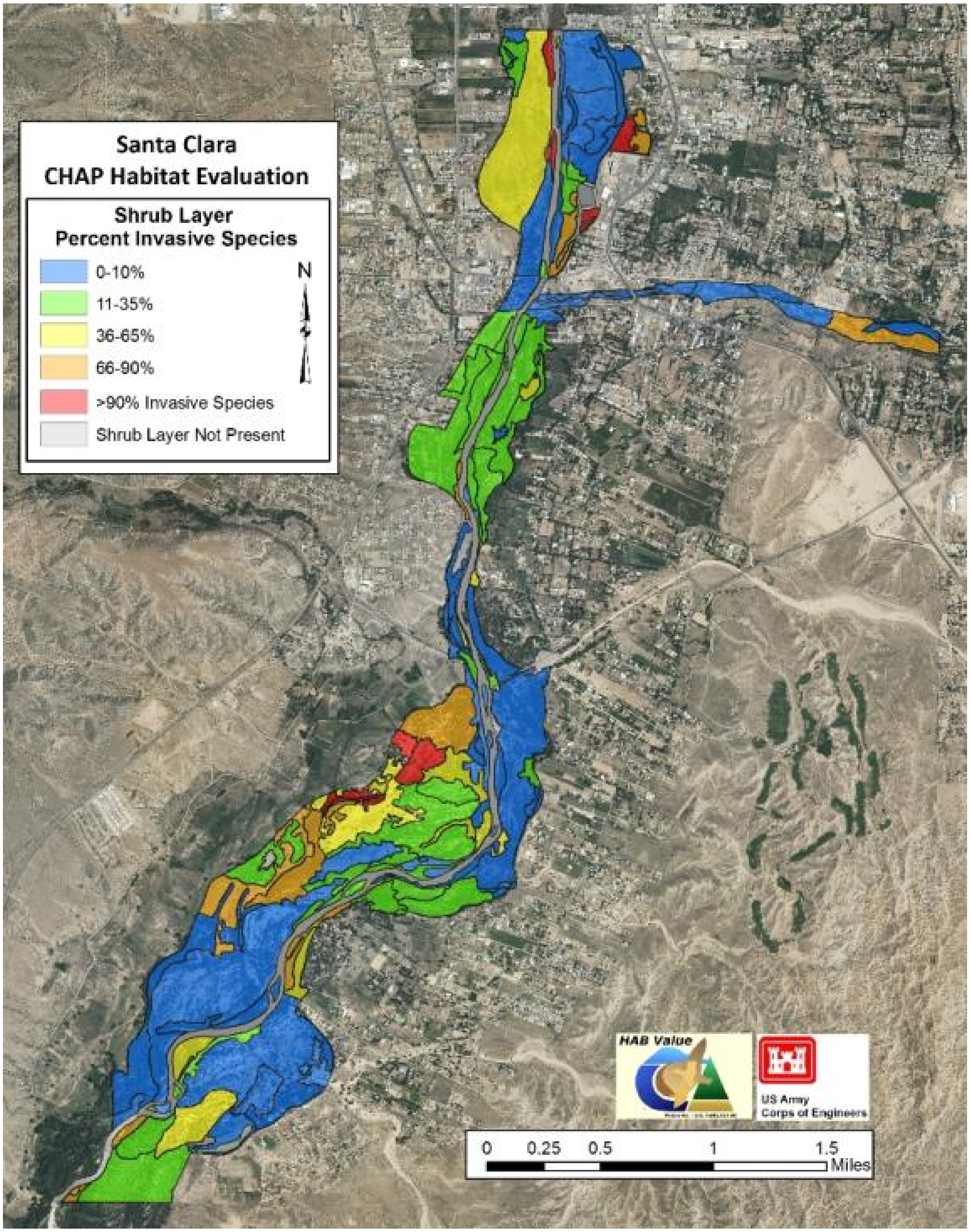

Figure 8-22 Santa Clara habitat assessment area shrub layer percent invasive species.

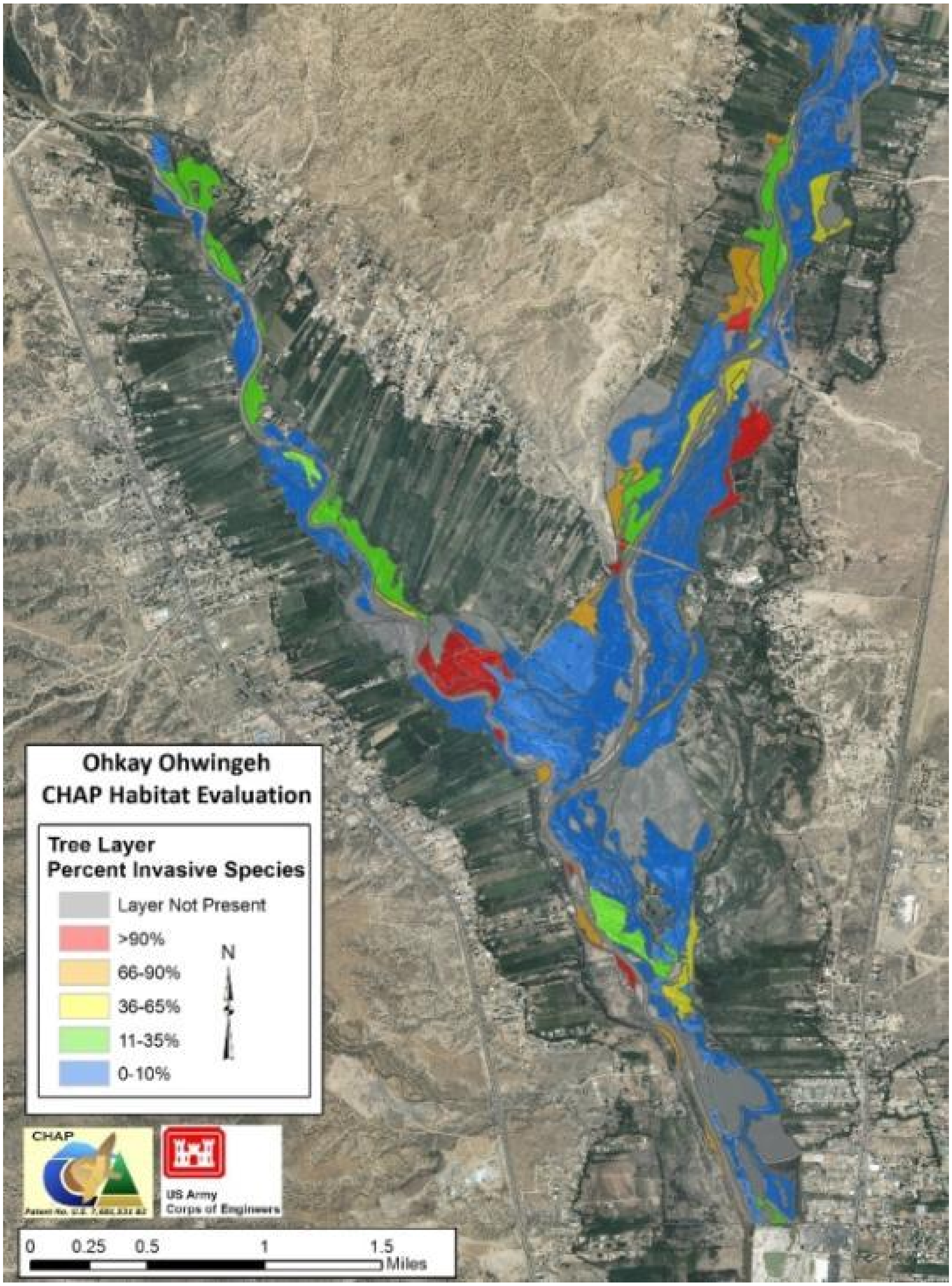

Figure 8-23 Ohkay Owingeh habitat assessment area Tree layer percent invasive species.

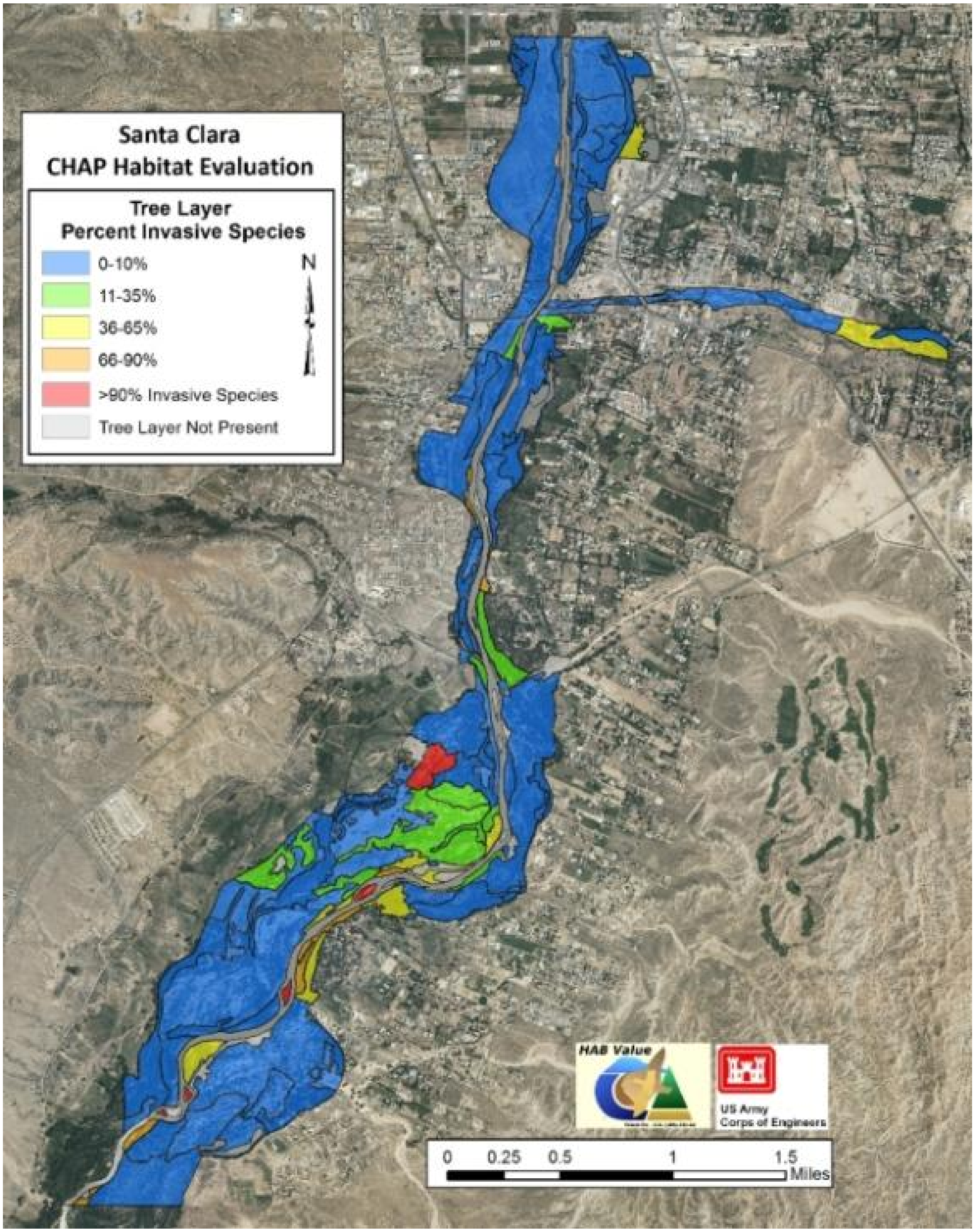

Figure 8-24 Santa Clara habitat assessment area Tree layer percent invasive species.

9 - Appendix D: Polygon Area, Per Acres Habitat Value and Baseline Habitat Units

Ohkay Owingeh number of habitat units by polygon.

Ohkay Owingeh CHAP Polygons					
NHI_ID	**Acres**	*****	**Per Acre Value**	**=**	**Habitat Units**
OK_002	2.83	*	18.08	=	51.20
OK_003	2.35	*	15.97	=	37.55
OK_004	5.34	*	7.74	=	41.34
OK_005	1.96	*	10.20	=	20.01
OK_006	0.76	*	15.13	=	11.47
OK_007	22.57	*	12.25	=	276.55
OK_008	16.35	*	31.78	=	519.48
OK_009	1.59	*	21.52	=	34.13
OK_010	2.08	*	17.90	=	37.27
OK_011	8.83	*	6.95	=	61.37
OK_012	0.44	*	23.11	=	10.05
OK_013	7.03	*	25.07	=	176.31
OK_014	9.10	*	25.35	=	230.58
OK_016	15.80	*	18.45	=	291.47
OK_017	11.13	*	29.93	=	333.24
OK_018	12.37	*	19.78	=	244.70
OK_019	40.15	*	27.60	=	1108.04
OK_020	3.56	*	26.23	=	93.28
OK_021	10.62	*	14.65	=	155.55
OK_022	13.91	*	23.21	=	322.94
OK_023	18.22	*	9.47	=	172.59
OK_025	2.77	*	19.50	=	54.01
OK_026	1.51	*	15.32	=	23.10
OK_027	1.74	*	20.20	=	35.17
OK_028	2.22	*	25.61	=	56.79
OK_029	35.64	*	4.08	=	145.30
OK_030	15.58	*	10.77	=	167.74
OK_031	0.82	*	9.10	=	7.46
OK_032	1.54	*	13.55	=	20.86

Ohkay Owingeh CHAP Polygons					
NHI_ID	Acres	*	Per Acre Value	=	Habitat Units
OK_033	0.56	*	20.71	=	11.65
OK_036	4.05	*	17.80	=	72.02
OK_037	0.75	*	16.75	=	12.63
OK_038	0.90	*	12.15	=	10.97
OK_040	2.64	*	15.80	=	41.76
OK_043	9.65	*	23.76	=	229.30
OK_044	6.98	*	18.06	=	126.04
OK_045	0.81	*	20.81	=	16.77
OK_046	1.06	*	18.06	=	19.09
OK_047	2.95	*	18.29	=	53.88
OK_048	7.92	*	16.84	=	133.43
OK_049	8.58	*	23.12	=	198.48
OK_052	7.19	*	23.86	=	171.54
OK_053	3.91	*	21.06	=	82.45
OK_054	32.76	*	8.99	=	294.70
OK_055	8.69	*	22.33	=	194.01
OK_056	37.33	*	14.57	=	543.81
OK_057	6.91	*	23.42	=	161.77
OK_058	3.62	*	27.05	=	97.83
OK_059	2.12	*	15.35	=	32.55
OK_060	0.84	*	15.65	=	13.22
OK_061	5.45	*	19.61	=	106.77
OK_062	0.59	*	4.93	=	2.92
OK_063	28.12	*	16.84	=	473.44
OK_064	1.70	*	25.89	=	44.07
OK_065	5.82	*	30.03	=	174.91
OK_066	0.59	*	16.05	=	9.40
OK_067	0.26	*	16.05	=	4.19
OK_068	0.73	*	19.29	=	14.10
OK_069	3.60	*	12.38	=	44.56
OK_070	25.72	*	10.96	=	281.77
OK_071	3.60	*	24.69	=	88.91
OK_072	7.43	*	32.75	=	243.37
OK_073	2.74	*	9.36	=	25.60
OK_074	8.50	*	16.06	=	136.52
OK_076	4.73	*	29.51	=	139.63
OK_078	7.53	*	13.22	=	99.56
OK_079	2.89	*	17.37	=	50.29
OK_080	1.56	*	18.14	=	28.23

Ohkay Owingeh CHAP Polygons					
NHI_ID	Acres	*	Per Acre Value	=	Habitat Units
OK_081	10.91	*	20.02	=	218.55
OK_082	2.29	*	20.02	=	45.86
OK_083	1.74	*	7.39	=	12.89
OK_084	12.46	*	19.90	=	248.04
OK_086	2.68	*	17.53	=	47.06
OK_087	2.16	*	16.54	=	35.67
OK_088	2.10	*	19.67	=	41.37
OK_089	3.08	*	8.16	=	25.12
OK_090	10.87	*	12.96	=	140.84
OK_091	2.89	*	20.00	=	57.84
OK_092	12.36	*	20.00	=	247.18
OK_093	2.57	*	18.13	=	46.51
OK_094	1.10	*	23.71	=	26.04
OK_095	1.73	*	22.73	=	39.24
OK_096	1.25	*	25.17	=	31.50
OK_097	0.46	*	7.56	=	3.45
OK_098	6.92	*	23.36	=	161.65
OK_099	5.02	*	21.02	=	105.47
OK_102	3.32	*	24.28	=	80.59
OK_103	3.50	*	20.10	=	70.44
OK_104	1.82	*	29.68	=	54.04
OK_105	4.26	*	12.00	=	51.14
OK_106	1.04	*	21.83	=	22.61
OK_107	2.30	*	21.83	=	50.15
OK_108	2.32	*	19.21	=	44.51
OK_109	6.31	*	28.11	=	177.33
OK_111	0.95	*	15.48	=	14.72
OK_112	3.09	*	18.50	=	57.14
OK_113	9.02	*	22.12	=	199.47
OK_114	2.94	*	19.54	=	57.43
OK_115	31.44	*	23.63	=	742.94
OK_116	4.86	*	10.49	=	50.93
OK_118	3.47	*	16.98	=	58.91
OK_119	2.35	*	8.85	=	20.80
OK_120	4.78	*	8.34	=	39.87
OK_121	9.03	*	11.10	=	100.23
OK_122	6.89	*	14.14	=	97.40
OK_123	11.15	*	22.61	=	252.03
OK_124	1.15	*	15.37	=	17.61

Ohkay Owingeh CHAP Polygons					
NHI_ID	Acres	*	Per Acre Value	=	Habitat Units
OK_126	4.78	*	14.15	=	67.69
OK_127	1.57	*	18.87	=	29.67
OK_128	3.52	*	17.98	=	63.26
OK_131	2.93	*	12.59	=	36.88
OK_132	10.63	*	9.26	=	98.45
OK_133	4.59	*	8.23	=	37.77
OK_134	28.57	*	24.79	=	708.39
OK_135	5.03	*	27.78	=	139.82
OK_136	6.20	*	29.02	=	179.98
OK_137	9.72	*	13.26	=	128.96
OK_138	1.31	*	18.22	=	23.96
OK_139	13.68	*	11.66	=	159.43
OK_140	1.50	*	18.79	=	28.09
OK_141	28.13	*	25.75	=	724.17
OK_142	2.98	*	17.05	=	50.79
OK_145	18.52	*	15.59	=	288.67
OK_146	1.52	*	15.18	=	23.11
OK_147	9.17	*	31.13	=	285.37
OK_148	1.17	*	22.00	=	25.85
OK_149	0.54	*	22.00	=	11.95
OK_150	3.69	*	27.95	=	103.07
OK_151	1.58	*	16.76	=	26.53
OK_152	0.49	*	18.84	=	9.22
OK_153	8.38	*	6.77	=	56.71
OK_154	1.38	*	20.56	=	28.31
OK_155	1.44	*	18.27	=	26.27
OK_156	1.49	*	7.56	=	11.29
OK_157	0.22	*	17.14	=	3.84
OK_158	0.44	*	20.78	=	9.22
OK_159	0.32	*	20.78	=	6.58
OK_160	0.30	*	18.19	=	5.42
OK_161	0.25	*	18.76	=	4.76
OK_162	0.21	*	6.42	=	1.38
OK_163	0.62	*	6.42	=	3.95
OK_164	3.21	*	19.02	=	61.08
OK_165	1.50	*	19.16	=	28.80
OK_166	1.12	*	14.41	=	16.15
OK_167	6.29	*	24.74	=	155.69
OK_168	1.32	*	11.16	=	14.69

Ohkay Owingeh CHAP Polygons					
NHI_ID	Acres	*	Per Acre Value	=	Habitat Units
OK_169	21.37	*	9.17	=	195.91
OK_170	21.93	*	21.73	=	476.68
OK_171	19.63	*	20.86	=	409.37
OK_172	0.16	*	17.36	=	2.75
OK_173	8.74	*	1.88	=	16.46
OK_174	7.74	*	26.22	=	202.95
OK_175	23.37	*	28.80	=	673.14
OK_176	2.44	*	24.26	=	59.30
OK_177	9.73	*	26.29	=	255.74
OK_178	8.09	*	27.37	=	221.55
OK_179	1.92	*	4.53	=	8.69
OK_180	1.09	*	25.69	=	27.88
OK_181	5.82	*	25.50	=	148.33
OK_182	26.25	*	25.47	=	668.37
OK_183	0.71	*	12.22	=	8.63
OK_184	10.25	*	25.56	=	262.01
OK_185	0.55	*	22.30	=	12.33
OK_186	1.51	*	31.58	=	47.76
OK_187	18.46	*	23.18	=	427.97
OK_188	1.33	*	4.98	=	6.65
OK_189	21.99	*	2.77	=	60.89
OK_190	2.94	*	2.77	=	8.14
OK_191	1.81	*	2.68	=	4.85
OK_192	1.22	*	4.51	=	5.51
OK_194	10.34	*	11.03	=	114.05
OK_195	1.30	*	8.13	=	10.59
OK_196	83.24	*	9.61	=	800.00
OK_197	2.35	*	10.67	=	25.06
OK_198	20.92	*	9.55	=	199.84
OK_199	14.68	*	22.16	=	325.29
OK_200	9.29	*	6.68	=	62.05
OK_201	2.29	*	1.88	=	4.30
OK_203	2.44	*	4.03	=	9.83
OK_204	6.08	*	7.44	=	45.19
OK_205	24.64	*	7.44	=	183.20
OK_206	1.79	*	23.04	=	41.32
OK_207	2.64	*	31.27	=	82.71
OK_208	16.87	*	29.07	=	490.26
OK_209	3.00	*	19.90	=	59.80

Ohkay Owingeh CHAP Polygons					
NHI_ID	Acres	*	Per Acre Value	=	Habitat Units
OK_210	5.80	*	16.47	=	95.48
OK_211	2.42	*	3.09	=	7.48
OK_213	4.83	*	27.65	=	133.57
OK_214	5.59	*	26.45	=	147.88
OK_219	1.34	*	14.25	=	19.03
OK_220	6.00	*	29.01	=	174.08
OK_222	10.53	*	28.41	=	299.25
OK_223	5.08	*	25.58	=	129.92
OK_224	0.65	*	21.91	=	14.30
OK_225	2.46	*	16.25	=	39.90
OK_226	0.63	*	21.16	=	13.30
OK_227	1.57	*	13.97	=	21.88
OK_228	19.83	*	25.08	=	497.35
OK_229	4.01	*	28.20	=	113.15
OK_230	1.14	*	20.27	=	23.04
OK_231	30.97	*	22.06	=	683.14
OK_232	1.36	*	20.60	=	28.10
OK_233	0.76	*	27.58	=	20.94
OK_234	1.00	*	13.37	=	13.43
OK_235	5.73	*	2.94	=	16.83
OK_236	1.26	*	12.74	=	16.02
OK_237	3.78	*	18.04	=	68.13
OK_238	2.90	*	5.63	=	16.35
OK_239	14.13	*	7.22	=	102.06
OK_240	6.38	*	26.05	=	166.12
OK_241	33.73	*	29.01	=	978.48
OK_242	8.11	*	23.63	=	191.57
OK_243	5.69	*	12.22	=	69.51
OK_244	1.82	*	11.59	=	21.04
OK_245	2.01	*	25.98	=	52.20
OK_246	2.73	*	22.73	=	62.13
OK_247	27.71	*	31.60	=	875.60
OK_248	4.62	*	31.60	=	145.92
OK_249	17.49	*	29.03	=	507.87
OK_250	57.51	*	24.70	=	1420.38
OK_251	3.37	*	21.75	=	73.25
OK_252	129.57	*	28.40	=	3679.38
OK_253	0.22	*	16.65	=	3.65
OK_255	0.46	*	18.76	=	8.63

Ohkay Owingeh CHAP Polygons					
NHI_ID	Acres	*	Per Acre Value	=	Habitat Units
OK_256	0.75	*	19.20	=	14.41
OK_257	0.32	*	18.13	=	5.74
OK_259	2.15	*	14.67	=	31.59
OK_260	1.11	*	5.06	=	5.61

Santa Clara number of habitat units by polygon:

Santa Clara CHAP Polygons					
NHI_ID	Acres	*	Per Acre Value	=	Habitat Units
SC_001	0.81	*	23.31	=	18.79
SC_002	8.12	*	9.38	=	76.15
SC_003	2.11	*	5.54	=	11.67
SC_004	4.65	*	15.77	=	73.35
SC_005	2.25	*	5.35	=	12.03
SC_006	40.65	*	3.71	=	150.93
SC_007	17.95	*	11.54	=	207.11
SC_008	3.63	*	19.85	=	72.02
SC_009	2.10	*	14.58	=	30.66
SC_010	1.22	*	17.63	=	21.49
SC_011	5.22	*	20.90	=	109.19
SC_012	0.71	*	21.63	=	15.32
SC_013	1.39	*	21.63	=	29.97
SC_014	0.37	*	18.32	=	6.78
SC_015	2.01	*	12.56	=	25.27
SC_016	6.30	*	4.26	=	26.81
SC_017	5.13	*	15.06	=	77.24
SC_018	0.52	*	3.68	=	1.91
SC_019	2.19	*	2.10	=	4.59
SC_020	7.74	*	14.41	=	111.55
SC_021	101.14	*	22.66	=	2291.59
SC_022	0.51	*	25.94	=	13.16
SC_023	31.88	*	20.60	=	656.63
SC_024	30.09	*	16.46	=	495.26
SC_025	0.65	*	26.43	=	17.11

Santa Clara CHAP Polygons					
NHI_ID	Acres	*	Per Acre Value	=	Habitat Units
SC_026	6.90	*	12.02	=	82.91
SC_027	1.96	*	20.87	=	40.81
SC_028	0.52	*	16.30	=	8.42
SC_029	3.90	*	15.78	=	61.60
SC_030	2.69	*	23.46	=	63.12
SC_031	12.86	*	14.77	=	189.89
SC_032	8.56	*	14.94	=	127.93
SC_033	7.94	*	16.63	=	132.06
SC_034	3.36	*	3.59	=	12.07
SC_035	4.21	*	15.15	=	63.82
SC_036	2.65	*	27.12	=	71.82
SC_037	1.12	*	14.38	=	16.10
SC_038	1.99	*	10.14	=	20.21
SC_039	3.03	*	22.10	=	67.07
SC_040	6.20	*	19.86	=	123.12
SC_041	3.80	*	4.26	=	16.16
SC_042	23.62	*	12.69	=	299.82
SC_043	0.95	*	15.37	=	14.64
SC_044	1.50	*	21.70	=	32.47
SC_045	2.91	*	23.57	=	68.66
SC_046	10.82	*	22.94	=	248.17
SC_047	4.30	*	15.54	=	66.87
SC_048	15.64	*	21.05	=	329.14
SC_049	2.45	*	8.03	=	19.69
SC_050	15.94	*	21.67	=	345.53
SC_051	6.40	*	20.15	=	128.91
SC_052	1.60	*	22.33	=	35.77
SC_053	0.45	*	17.00	=	7.63
SC_054	1.54	*	21.14	=	32.65
SC_055	2.92	*	20.82	=	60.89
SC_056	1.94	*	19.56	=	37.91
SC_057	4.38	*	20.06	=	87.76
SC_058	2.18	*	13.66	=	29.79
SC_059	6.62	*	26.28	=	173.99
SC_060	1.73	*	23.31	=	40.24
SC_061	6.64	*	21.70	=	144.03
SC_062	8.48	*	25.92	=	219.76
SC_063	2.37	*	16.94	=	40.07
SC_064	2.64	*	19.10	=	50.34

Santa Clara CHAP Polygons					
NHI_ID	Acres	*	Per Acre Value	=	Habitat Units
SC_065	0.63	*	19.52	=	12.34
SC_066	5.67	*	24.25	=	137.50
SC_067	1.14	*	20.47	=	23.40
SC_068	6.59	*	24.83	=	163.63
SC_069	2.81	*	21.14	=	59.48
SC_070	4.56	*	14.68	=	66.95
SC_071	4.33	*	8.79	=	38.07
SC_072	0.97	*	16.30	=	15.86
SC_073	1.90	*	15.04	=	28.58
SC_074	10.06	*	12.54	=	126.07
SC_075	4.23	*	20.41	=	86.28
SC_076	0.29	*	18.70	=	5.48
SC_077	12.08	*	25.84	=	312.08
SC_078	1.77	*	13.69	=	24.27
SC_079	1.85	*	31.08	=	57.42
SC_080	1.02	*	13.69	=	13.99
SC_081	1.67	*	18.19	=	30.37
SC_082	3.70	*	18.14	=	67.05
SC_083	3.32	*	18.79	=	62.46
SC_084	11.22	*	19.92	=	223.43
SC_085	11.96	*	23.04	=	275.48
SC_086	5.05	*	19.46	=	98.36
SC_087	12.30	*	20.63	=	253.73
SC_088	3.22	*	18.36	=	59.07
SC_089	10.77	*	15.71	=	169.19
SC_090	4.13	*	17.91	=	73.87
SC_091	2.57	*	18.65	=	47.90
SC_092	2.52	*	19.20	=	48.32
SC_093	4.76	*	16.79	=	79.89
SC_094	1.54	*	21.33	=	32.80
SC_095	1.70	*	19.07	=	32.39
SC_096	110.56	*	16.93	=	1871.92
SC_097	1.94	*	9.48	=	18.38
SC_098	8.65	*	19.55	=	169.17
SC_099	1.18	*	9.74	=	11.53
SC_100	1.85	*	23.29	=	43.04
SC_101	52.75	*	24.42	=	1288.32
SC_102	26.01	*	27.69	=	720.30
SC_103	10.23	*	22.93	=	234.69

Santa Clara CHAP Polygons					
NHI_ID	Acres	*	Per Acre Value	=	Habitat Units
SC_104	23.12	*	20.71	=	478.82
SC_105	10.65	*	25.25	=	269.01
SC_106	16.71	*	30.62	=	511.63
SC_107	6.53	*	23.12	=	150.89
SC_108	8.30	*	18.69	=	155.24
SC_109	4.45	*	22.41	=	99.69
SC_110	7.42	*	15.42	=	114.43
SC_111	8.45	*	21.66	=	183.15
SC_112	3.14	*	19.96	=	62.62
SC_113	1.05	*	20.27	=	21.25
SC_114	1.00	*	11.54	=	11.55
SC_115	17.72	*	4.60	=	81.43
SC_116	14.23	*	19.41	=	276.19
SC_117	0.86	*	17.23	=	14.76
SC_118	13.72	*	17.01	=	233.32
SC_119	4.28	*	17.49	=	74.82
SC_120	10.36	*	21.40	=	221.61
SC_121	0.67	*	15.75	=	10.54
SC_122	6.86	*	22.61	=	155.19
SC_123	9.87	*	17.37	=	171.36
SC_124	44.02	*	19.13	=	841.95
SC_125	15.69	*	19.62	=	307.94
SC_126	0.54	*	15.57	=	8.37
SC_127	2.74	*	22.28	=	61.00
SC_128	3.43	*	20.39	=	69.90
SC_129	38.67	*	23.49	=	908.36
SC_130	13.28	*	27.82	=	369.33
SC_131	59.15	*	24.08	=	1424.23
SC_132	1.71	*	16.64	=	28.49
SC_133	4.76	*	18.86	=	89.81
SC_134	16.42	*	21.68	=	355.99
SC_135	27.73	*	23.89	=	662.55
SC_136	4.29	*	18.17	=	77.88
SC_137	8.37	*	25.23	=	211.10
SC_138	4.28	*	21.13	=	90.45
SC_139	49.02	*	29.30	=	1436.04
SC_140	4.82	*	12.03	=	57.99
SC_141	124.41	*	28.40	=	3532.82
SC_142	0.65	*	18.63	=	12.13

Santa Clara CHAP Polygons					
NHI_ID	Acres	*	Per Acre Value	=	Habitat Units
SC_143	2.09	*	14.99	=	31.30
SC_144	52.90	*	26.96	=	1426.28
SC_145	38.57	*	6.03	=	232.56
SC_146	21.03	*	27.11	=	570.18
SC_147	149.90	*	25.19	=	3776.40
SC_148	14.93	*	3.74	=	55.81
SC_149	5.54	*	3.32	=	18.40
SC_150	1.67	*	17.81	=	29.82
SC_151	0.67	*	5.32	=	3.55
SC_152	15.56	*	19.58	=	304.60
SC_153	7.02	*	20.52	=	144.15
SC_154	1.35	*	8.72	=	11.80
SC_155	92.87	*	21.00	=	1950.11
SC_156	23.19	*	21.51	=	498.73
SC_157	9.16	*	21.16	=	193.89
SC_158	0.78	*	21.00	=	16.33

10 - Appendix E: Espanola's Species Functional Redundancy

Key Ecological Function (KEF) Description	Species Count
organismal relationships	202
terrestrial invertebrates	175
prey for secondary or tertiary consumer (primary or secondary predator)	161
vertebrate eater (consumer or predator of herbivorous vertebrates)	79
aquatic macroinvertebrates	74
spermivore (seed-eater)	60
frugivore (fruit-eater)	53
piscivorous (fish eater)	41
carrier, transmitter, or reservoir of vertebrate diseases	40
controls or depresses insect population peaks	40
disperses seeds/fruits (through ingestion or caching)	40
disperses insects and other invertebrates	36
common interspecific host	35
uses burrows dug by other species (secondary burrow user)	35
aids in physical transfer of substances for nutrient cycling (C,N,P, etc.)	34
disperses vascular plants	34
diseases that affect other wildlife species	30
aquatic herbivore	29
ovivorous (egg eater)	29
diseases that affect humans	25
secondary cavity user	25
soil relationships	22
carrion feeder	21
foliovore (leaf-eater)	21
physically affects (improves) soil structure, aeration (typically by digging)	20
creates small burrows (less than rabbit-sized)	19
fish prey for secondary or tertiary consumer (primary or secondary predator)	18
controls terrestrial vertebrate populations (through predation or displacement)	16
freshwater or marine zooplankton	16
tertiary consumer (secondary predator or secondary carnivore)	16
significant carrier of nutrients	14
uses runways created by other species)	14
within aquatic system	14

KEF Description	Species Count
aerial structures	11
cannibalistic	11
grazer (grass, forb eater)	10
aquatic structures	9
creates large burrows (rabbit-sized or larger)	9
interspecific hybridization	9
creates runways (possibly used by other species)	8
physically fragments down wood	8
wood structure relationships (either living or dead wood)	8
feeds in water on decomposing benthic substrate	7
phytoplankton eater (including algae)	7
pirates food from other species	7
pollination vector	7
ground structures	6
browser (leaf, stem eater)	5
creates feeding opportunities (other than direct prey relations)	5
flower/bud/catkin feeder	5
fungivore (fungus feeder)	5
physically fragments standing wood	5
primary cavity excavator (in aquatic and/or terrestrial systems)	5
disperses fungi	4
influences aquatic invertebrate population peaks	4
nectivore (nectar feeder)	4
sap feeder	4
significant carrier of heavy metals	4
within aquatic systems	4
aerial structures	3
bird eater	3
creates standing dead trees (snags)	3
herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)	3
herbivory on trees or shrubs that may alter vegetation structure and composition (browsers)	3
mammal eater	3
reptile eater	3
bark/cambium/bole feeder	2
diseases that affect domestic animals	2
diseases that affect other fish species	2
ground structures	2
interspecies parasite	2
periphyton eater (including algae)	2

KEF Description	Species Count
physically affects aquatic soils and bed materials (typically by digging or spawning actions)	2
amphibian eater	1
aquatic structures	1
creates ponds or wetlands through wallowing	1
creates roosting, denning, or nesting opportunities	1
impounds water by creating diversions or dams	1
influences zooplankton population peaks	1
interspecific hybridization with native species	1
root feeders	1

2 - Expected Future Without-Project Conditions

2.1 Future Wildlife Habitat Conditions

The future wildlife habitat values were based recommendations by the habitat team that projected a decrease in annual floodplain inundation, increasing the loss of the dominant canopy vegetation from senescence and an increase in presence of invasive plant species, leading to a decrease in the number of fish and wildlife species.

The 25 and 50-year future analysis are built upon the current baseline conditions (Northwest Habitat Institute 2011) by modifying the species-habitat-functions information. The future conditions were projected for 25 and 50 years from the baseline condition to evaluation changes in wildlife habitat values. The habitat team discussed how to estimate the loss of species over the 50 year simulation of future conditions. The Without Project Analysis accounts for the loss wildlife species from the project area in calculating the future wildlife habitat value (25 and 50 years). Habitat units are projected to decrease to 44,905 units in 25 years and 35,920 units in 50 years.

2.1.1 Final Espanola Habitat Assessment 50-year Future without Project

Final
Espanola Habitat Assessment
50-year Future without Project

U.S. Army Corp of Engineers
Albuquerque District

by

Northwest Habitat Institute

April 16, 2012

HAB Value

Patent No. U.S. 7,681,531 B2

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Final
Espanola Habitat Assessment
50-year Future without Project

1 - Introduction:

A 50-year habitat evaluation assessment was conducted for the Espanola project area as part of the baseline ecosystem restoration feasibility assessment. The purpose of this study was to approximate the conditions of the Espanola project area without the implementation of a federal restoration and flood control project. This assessment would be equivalent to a "no action" alternative. The baseline assessment was done using 2009 imagery to depict 2011 baseline conditions, and the 50-year timeframe assesses several future time periods; one at 25 years (2036) and the other at 50-years (2061).

To help characterize the potential influence over this 50-year time period, we rely on a recent report, *Potential Effects of Climate Change on New Mexico*, develop by the State of New Mexico's Agency Technical Work Group (2005). To follow is their summarization of some of their future predictions:

Climate models project substantial changes in New Mexico's climate over the next 50 to 100 years, if no measures are taken to reduce global greenhouse gas emissions. Projected climate changes by mid- to late-21st century include: air temperatures warmer by 6-12°F on average, but more in winter, at night, and at high elevations; more episodes of extreme heat, fewer episodes of extreme cold, and a longer frost- free season; more intense storm events and flash floods; and winter precipitation falling more often as rain, less often as snow. Some climate models project that average precipitation will increase, while others predict a decrease. However, recurrence of a severe multi-year drought like that of the 1950s is likely some time during this century, regardless of human-caused climate change. When such a drought does recur, higher evaporation rates because of warmer temperatures will exacerbate effects of drought, and will at least partially offset the effect of any increase in precipitation that might occur due to climate change.

1.1 Water Resources in General

Warmer temperatures will reduce mountain snowpacks, and peak spring runoff from snowmelt will shift to earlier in the season. A longer and hotter warm season will likely result in longer periods of extremely low flow and lower minimum flows in late summer. Water supply systems which have no storage (e.g., many acequia systems) or limited storage (e.g., small municipal reservoirs) may suffer seasonal shortages in summer. Large reservoir systems may also suffer shortages from a reduction in average runoff. Recurrence of a multi-year severe drought like that of the 1950s would have greater impacts on the water resources and the economy of the state than in the 1950s because of the warmer temperatures, as well as the great increases in population and demand for water since the 1950s.

1.2 Agriculture in General

Climate change impacts on agriculture are highly dependent on whether precipitation increases or decreases. Increases in precipitation would increase yields of rain-fed and irrigated crops and would tend to improve forage availability on rangelands. Warmer temperatures will lengthen the frost-free growing season. Severe drought coupled with warmer temperatures would adversely affect crop and rangeland production. Higher atmospheric carbon dioxide concentrations will tend to increase yields of some crops, if water and nutrients are not limiting. On rangelands, however, higher carbon dioxide levels may favor woody plants over grasses, which would reduce grazing capacity. Major uncertainties are the impacts of intense rainfall events, pests, weeds, and pathogens. Warmer conditions may affect pest populations, requiring new strategies for pest control. Farmers can use a number of adaptation strategies to lessen potential yield losses.

1.3 Natural Systems in General

Climate change is likely to have significant impacts on the ecosystems of New Mexico's forests, grasslands, deserts, lakes and streams. Predicting the specific impacts is difficult because of the complexity of natural systems, with each species responding in its own way to the physical environment and with multiple interactions among species. As each species responds individually to its changed environment, existing plant or animal communities will likely change as new assemblages of species form. Changes in ecosystem structure and functioning will often be abrupt rather than continuous and gradual.

Aquatic systems are particularly vulnerable to climate change because they will be impacted not only by warmer temperatures but also by changes in the timing and amount of water. Climate change is expected to result in a significant loss of aquatic habitat. Habitat suitable for coldwater fish (e.g., trout) is expected to shrink, with replacement by warm water fish species. Extinction rates of many endemic species of the eastern plains are expected to increase. Riparian ecosystems are expected to experience losses and decline, with a reduction in species diversity.

Change in terrestrial ecosystems will include shifts in the timing of seasonal life history events such as breeding of birds, insects or amphibians, and flowering of plants. Geographic ranges are expected to shift to the north and to higher elevations. Some species trapped on isolated mountain ranges could become locally extinct if the mountain is not high enough to provide suitable alternative habitat and the species cannot disperse across intervening deserts to other mountaintops. Invasions of non-native species are likely, but species diversity may be reduced. Shrubs such as mesquite and creosote bush are likely to further invade grasslands. Forests are likely to experience more catastrophic wildfires, and more massive dieback due to drought stress and insect outbreaks. Alpine meadows may largely disappear from New Mexico.

1.4 Specific Project Assessment

To undertake this assessment several projections were made to assess habitats over the 50-year time period. These projections are based on the locale's current condition and trends.

Specifically, it is seems reasonable to conceive, based on the general assessments above, that there will be: 1) an increase in presence of invasive plant species, 2) a reduction in the number of fish and wildlife taxa present within the study area over time, 3) hydrological increased likelihood of longer periods of extremely low flow and lower minimum flows in late summer, and 4) increasing senescence and decadence of dominant canopy vegetation leading to a higher fuel loading, 5) a greater potential for an increase in wildfire due to the potential for drought conditions in the bosque along , 6) which will yield a projected likelihood for at least one occurrence of a wildfire within the 50-year period. Other points and rationale will be discussed subsequently.

The existing conditions habitat assessment of the Espanola study area was performed using NHI's Combined Habitat Assessment Protocols (CHAP) accounting and appraisal method that utilizes species-habitat-functions to derive current habitat values. To determine a change in these values over time, the above projections were used to alter either the species, habitat, or function, parameters. Appling these changes over several time periods, requires some conjecture to deduce the amount of influence that might be expected during each time period. Nonetheless, to display the future condition outcomes the habitat changes are applied to the fine scale habitat map while the species and function changes are applied to their respective data sets to help visualize these changes over time.

2 - Methods:

Because some speculation is required to forecast the 50-years time frame, the outcomes that are illustrated may generate further discussions with the *Espanola Ecosystem Restoration Habitat Evaluation Team.* The goal of this assessment is to reach a consensus approach to the future without project conditions assessment. Reasonable predictions were made so that plausible scenarios for evaluating change over the next 50-year period within the study area could be accomplished.

The potential influences to New Mexico as a whole, based on *climate change,* are described as: the current distribution, abundance, and vitality of species and habitats are strongly dependent on climatic (and microclimatic) conditions. Climate change is expected to result in warmer temperatures year-round, accompanied by potentially wetter winters.

The 25 and 50-year future analysis are built upon the current baseline conditions analysis that illustrates the Hink and Ohmart classification types by polygon (Hink and Ohmart 1984). By modifying the species-habitat-functions information based on the perceived future projections for the area, a comparative time series look for 3 time periods (2011, 2037, and 2061) over the 50-year period is generated and assessed.

The rationales for making projections over the 50-years within the study area were the following criteria:

1. **Potential non-viable wildlife populations** – two taxa that now occur in the project area may no longer occur given the current projections for their breeding and impacts from development, they

are: Southwestern willow flycatcher (*Empidonax traillii extimus)* and the solitary vireo *(Vireo solitaries)*. These species are thought to have the potential for having non-viable populations within the project area over the next 50 years. For the willow flycatcher, it is because there are currently less than 100 breeding pair in the state and their breeding is thought to be in decline statewide (BisonM species account). For the solitary vireo it is because they winter in the tropics where an increase in human activity and development may affect these wintering area, resulting in a potential for decline in the future within the project area (BisonM species account) .

Additionally, the Habitat Evaluation Team had some discussion on the fate of other species, especially those listed as uncommon within the project area. Because the without project 50 year assessment is a simulation of a potential future conditions, removing all species designated as uncommon for the project area was predicted, though the exact likelihood of this occurrence cannot be known.

So the Without Project Analysis takes into account the loss of these wildlife species from the project area and the diversity they provide when calculating the future years 25 and 50 habitat value. Without knowledge of which species would disappear and which would continue to survive, a random selection of half of the 61 species classified as uncommon were removed for the year 25 analyses with the remaining uncommon species being removed in year 50. Below in Tables 1 and 2 are the lists of species that were removed in each time period.

3 - Conclusions:

3.1 Year 2011-2036 species removed from within project area:

Table 3-1 Uncommon species removed during the first 25 year period for without project analysis.

SppID	Common Name	Scientific Name
10129	Bullhead, Black	Ameiurus melas
20255	Frog, Chorus, Western	Pseudacris triseriata triseriata; maculata
30177	Lizard, Earless, Lesser	Holbrookia maculata approximans ;maculata ;
30350	Rattlesnake, Western	Crotalus viridis cerberus; nuntius; viridus ;abyssus
30380	Snake, Hognose, W.	Heterodon nasicus nasicus ;kennerlyi
40670	Duck, Wigeon, American	Anas americana
40770	Duck, Canvasback	Aythya valisineria
40940	Duck, Merganser, Hooded	Lophodytes cucullatus
40980	Osprey	Pandion haliaetus carolinensis
41100	Hawk, Rough-legged	Buteo lagopus johannis
41490	Avocet, American	Recurvirostra americana
42630	Swift, White-throated	Aeronautes saxatalis saxatalis
42890	Flycatcher, Willow	Empidonax traillii extimus,
43110	Vireo, Solitary	Vireo solitarius
43300	Swallow, Tree	Tachycineta bicolor

43350	Swallow, Barn	Hirundo rustica erythrogaster
43585	Bluebird, Eastern	Sialia sialis sialis; fulva
43640	Thrush, Hermit	Catharus guttatus guttatus; nanus; sequoiensis; auduboni; slevini
44245	Tanager, Hepatic	Piranga flava dextra; hepatica
44690	Blackbird, Yellow-headed	Xanthocephalus xanthocephalus
44720	Grackle, Common	Quiscalus quiscula versicolor
50050	Shrew, Dusky	Sorex monticolus monticolus; obscurus
50190	Myotis, Small-footed, W.	Myotis ciliolabrum melanorhinus
50250	Myotis, Long-eared	Myotis evotis evotis
50300	Bat, Spotted	Euderma maculatum
50767	Mouse, Brush	Peromyscus boylii rowleyi
50900	Rat, Wood, Bushy-tailed	Neotoma cinerea arizonae; orolestes; acraia
50970	Vole, Montane	Microtus montanus fusus
51250	Weasel, Ermine	Mustela erminea muricus

3.2 Year 2037-2062 species removed from within project area:

Table 3-2 Uncommon species removed during the second 25 year period for without project analysis.

SppID	Common Name	Scientific Name
40700	Duck, Teal, Blue-winged	Anas discors discors
40710	Duck, Teal, Cinnamon	Anas cyanoptera septentrionalium
40760	Duck, Teal, Green-winged	Anas crecca carolinensis
40900	Duck, Bufflehead	Bucephala albeola
40950	Duck, Merganser, Common	Mergus merganser americanus
41151	Falcon, Peregrine	Falco peregrinus anatum
41350	Coot, American	Fulica americana americana
42040	Gull, Ring-billed	Larus delawarensis
42050	Gull, California	Larus californicus
42410	Dove, Mourning	Zenaida macroura marginella; carolinensis
43370	Chickadee, Mountain	Poecile gambeli gambeli
44450	Sparrow, Lincoln's	Melospiza lincolnii lincolnii; alticola
44710	Blackbird, Brewer's	Euphagus cyanocephalus
50020	Shrew, Masked	Sorex cinereus cinereus
50090	Shrew, Water	Sorex palustris navigator
50125	Shrew, Dwarf	Sorex nanus
50260	Bat, Silver-haired	Lasionycteris noctivagans
50270	Bat, Pipistrelle, Western	Pipistrellus hesperus hesperus; maximus
50312	Bat, Big-eared, Townsend's, Pale	Corynorhinus townsendii pallescens
50765	Mouse, Pocket, Plains	Perognathus flavescens copei; melanotis; relictus

50870	Mouse, Grasshopper, N.	Onychomys leucogaster arcticeps; pallescens; ruidosae
50885	Rat, Wood, Stephen's	Neotoma stephensi stephensi; relicta
51010	Vole, Long-tailed	Microtus longicaudus longicaudus;
51290	Badger, American	Taxidea taxus berlandieri
51300	Skunk, Spotted, Western	Spilogale gracilis

2. **Flood inundation effects on native vegetation –** The Habitat Evaluation Team also considered the effects of 8 intervals of floodplain extents within the project area. A floodplain inundation raster file was provided by the Corps to simulate the effect of the amount of floodplain inundation on the potential increase of non-native plants in years 25 and 50. The flood inundation raster was classed into several categories representing delineations at 2, 5, 10, 25, 50, 100, 200, and 500 flood events. These categories were then assigned multipliers for invasive plant species for years 25 and 50. These values are shown in Table 3 below.

Table 3-3 . Espanola Valley vegetation trends without project or continued invasive species management.

FP	Invasive Current or Year 0	Invasive in 25 Years	Invasive in 50 Years
2	1	2	3.5
5	1	3	4.0
10	1	3	4.0
25	1	2.5	3.5
50	1	2.5	3.5
100	1	2.5	3.5
200	1	2.5	3.5
500	1	2.5	3.5

Since the values for invasive plant had similar multiplier for several floodplain periods, three categories emerged: (1) 2-year, (2) 5-10 year and (3) 25 -500 year floodplains. Using ArcGIS Spatial Analyst Extension's Tabulate Area tool, the proportion of each floodplain category with each CHAP polygon was assessed. Each polygon was then assigned its category based upon having over 50% of its area belonging to that category. Polygons containing a mix of floodplain categories, with no category having 50% or greater coverage were determined by selecting the category that had the highest representation within the polygon. Those polygons which did not intersect the floodplain map retained the invasive values from the baseline survey.

Those polygons that were assigned a floodplain category then used values derived from Table 3 to influence the invasive plant values in time periods 25 and 50 years. The derived values from Table 3 were generated by dividing the table values by a factor of 10 to better reflect the classes that CHAP uses to classify the invasive plant layers. CHAP evaluations apply a fractional multiplier based on invasive species coverage that reduces overall habitat value of a site. For example, a polygon with 66-90% invasive cover in each layer would have its' per acre habitat value multiplied by .5, reducing the overall habitat value by half. Thus, if the tabular value in table three was a 2, it was applied as a 0.2 reduction in a given invasive plant layer (herbaceous/forb, shrub, or tree). A 3.5 in the table would result in a .35 reduction and so on.

The Habitat Evaluation Team also wanted to simulate the potential effects that might occur to riparian and wetland habitat within the project boundary. Table 4 depicts the multipliers developed by the Habitat Evaluation Team to illustrate the decrease of these native habitats if a no management scenario were to occur.

Table 3-4 Espanola Valley vegetation trends without project for riparian and wetland habitats.

FP	Riparian_0	Riparian_25	Riparian_50	Wetland_0	Wetland_25	Wetland_50
2	1	0.5	0.3	1	0.5	0.5
5	1	0.6	0.3	1	0.5	0.5
10	1	0.6	0.3	1	0.5	0.5
25	1	0.7	0.4	1	0.5	0.5
50	1	0.7	0.4	1	0.5	0.5
100	1	0.7	0.4	1	0.5	0.5
200	1	0.7	0.4	1	0.5	0.5
500	1	0.7	0.4	1	0.5	0.5

3. **Fire history interval –** The fire regime in and around the Espanola valley has been historically and geographically varied. Historically, fire frequency and intensity have been linked to periods of drought like the one currently affecting the Southwest (Margolis, E. and J. Balmat. 2009. Fire history and fire–climate relationships along a fire regime gradient in the Santa Fe Municipal Watershed, NM, Forest Ecol Manag 258: 2416–30). From a landscape perspective, certain areas have proven far more susceptible to fire than others. Spruce stands, for example, burn very rarely but when they do, often undergo stand replacing fires. The last major fires of this kind in the area burned in 1685 and 1842. Mixed conifer and aspen stands, however, have been shown to burn far more frequently but usually in a mosaic pattern, scarring ~20% of trees. Margolis & Balmat showed that these fires have a mean interval of 15-25 years, with smaller fires occurring even more frequently. This mosaic pattern often results in stand replacing fires of less than 250 ac directly adjacent to areas with little mortality. However areas in which mixed conifers infill between existing stands greatly increase fire connectivity and fire intensity.

   We expect to see an increase in the potential of fire over the next 50-years due to climate change, potential vegetation types becoming older, more senescence, and the increasing prevalence of fire prone species like Juniper and Russian olive encroaching into the site. We chose to simulate such a fire in the 25 year without project as conditions seem favorable for a small to medium mosaic burn in the time period. Based on past fire behavior the ignition point would likely occur in the hills outside the Espanola valley. If this were to take place to the West it could be driven down through relatively dense Juniper stands towards town by prevailing South West winds. If the fire was not stopped at Hwy 84, it could spread quickly through low shrub and grasslands into the project area before likely being stopped at the river.

   To follow are two views of a 1,435 acre fire that was simulated in the Rio Chama drainage. We want to emphasis here that this fire is only a simulation and is not a certainty. The simulation is to only give the reader a general idea of the potential of a fire to occur within the next 50 years based on the areas current fire history. Acreage of the fire is extrapolated from the fire history and is only an estimate.

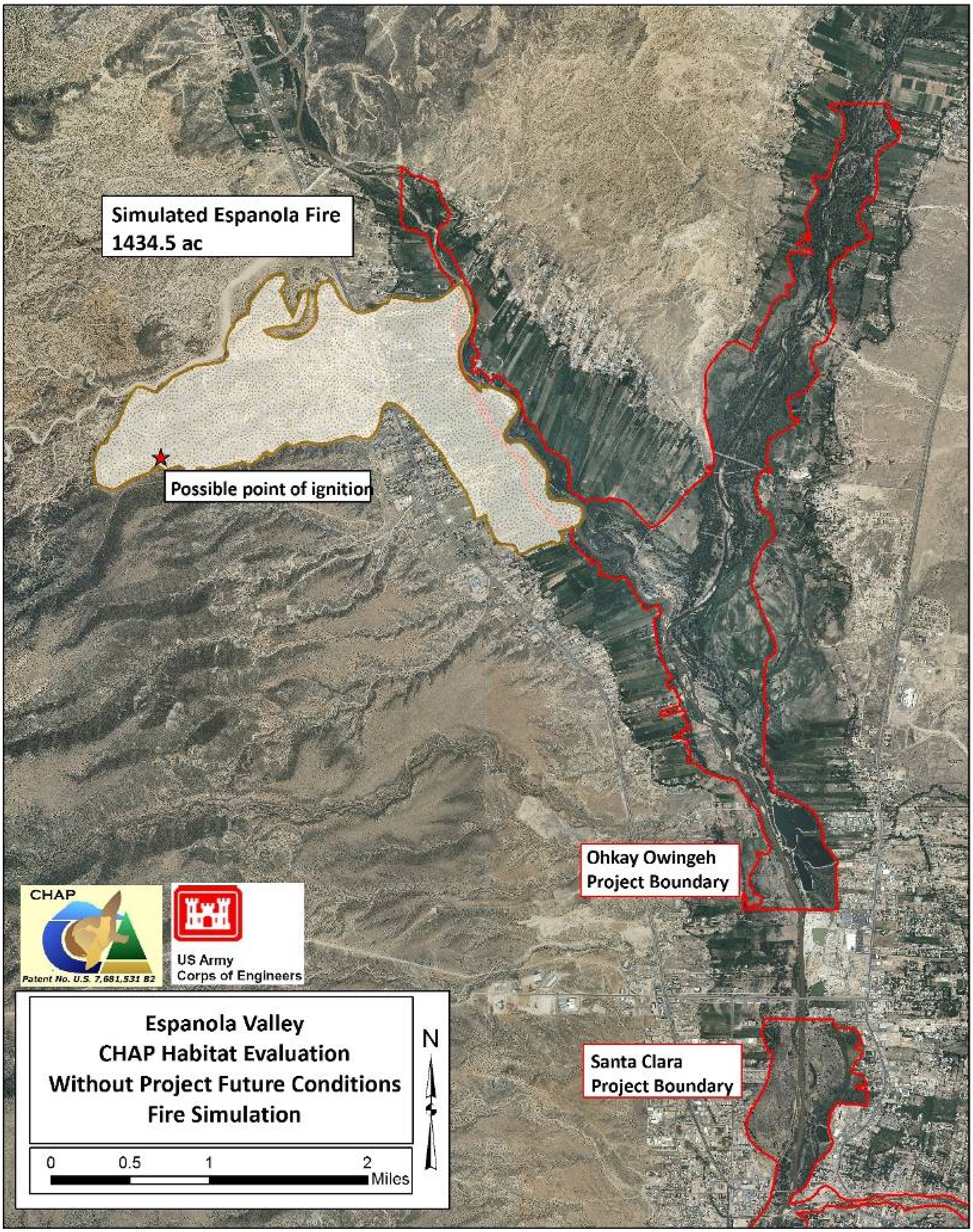

Figure 3-1 A general perspective of a simulated fire that could occur and encroach into the project area within the next 50 years.

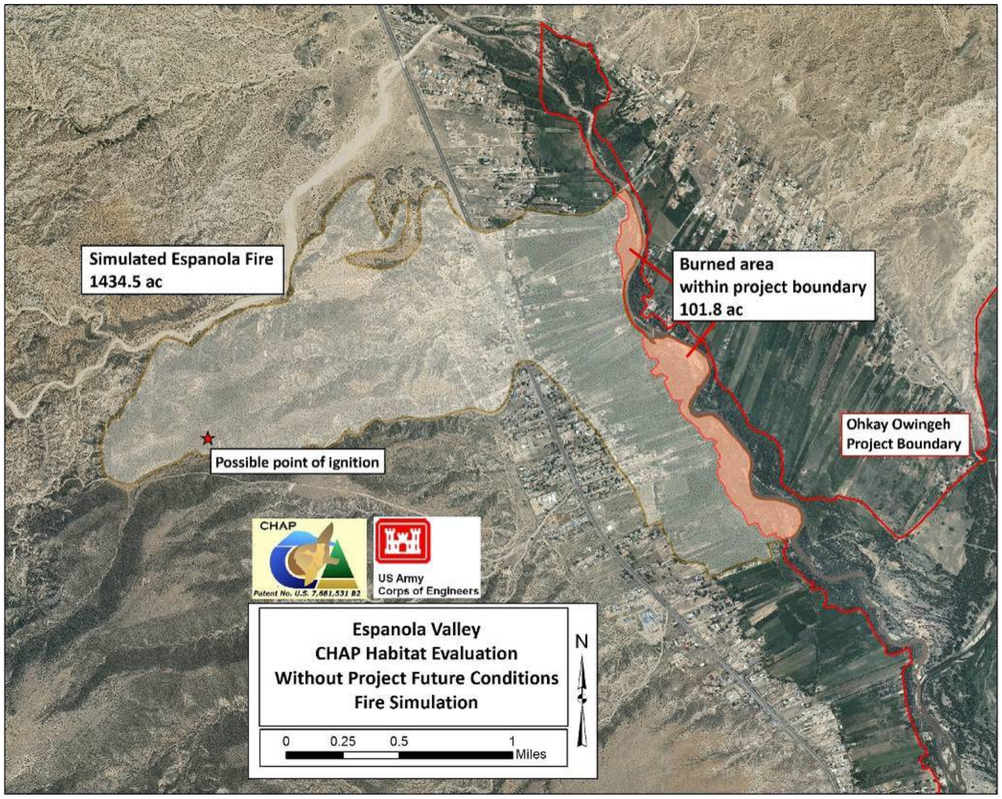

Figure 3-2 A close-up of a simulated fire that could occur and encroach into the project area.

4. **<u>Connectivity</u> -** Given the location of the project area to other large tracts that include mountain ranges, national forest, and wilderness areas, along with lack of development predicted for the area that would impede movement; the habitat evaluation team did not feel connectivity would be an issues for the next 50 years. No species were expected to be lost within the project area over the next 50 years due to barriers in habitat connectivity. To show the project area's juxtaposition to these large tracts of land along with distance between them, please see Table 5 and Figure 3.

Table 5. Distances between the project area and other large wild areas.

Espanola Habitat Connectivity Table	Miles from Project Boundary
San Pedro Mountains	15
Nacimiento Mountains	16
Sangre De Cristo Mountains	20

Pecos Wilderness	22
Santa Fe National Forest	25
San Juan Mountains	27

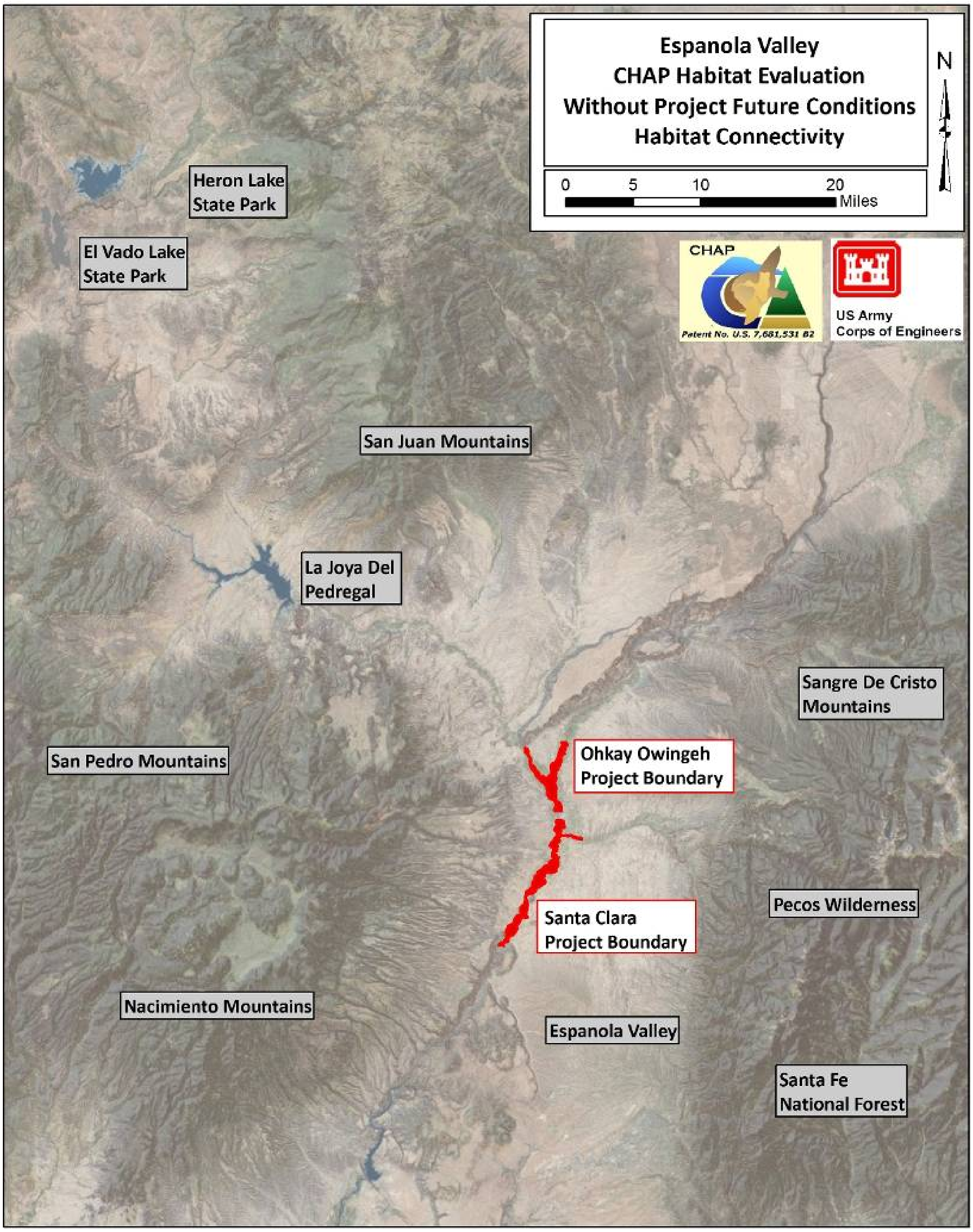

Figure 3-3 Landscape view of the juxtaposition of Espanola project area to other large wild areas.

5. **<u>Habitat Conversion -</u>** Based on the location of the project area in a riparian setting, certain habitat types are expected to shift in the next 50 years, in some cases dramatically. Riparian ecosystems are naturally very dynamic areas with rapid cyclical succession patterns. Within the next 50 years, disturbances like flooding and fire will likely reset certain areas from mature riparian woodlands to an early successional grassland or scrubland. It is likely that in the 25 year period there would be an increase in these habitat types. However there would simultaneously be maturation and colonization in existing grasslands and scrublands resulting in new riparian woodlands. For this reason it is difficult to estimate a net effect on habitat type conversion over the next 50 years.

Figure 4 attempts to illustrate the potential shift in habitat types for the confluence of the Rio Chama and Rio Grande, which is thought to be the area that may be the most dynamic over the 50-years due to flooding and fire. This figure was created by overlaying the Army Corps Inundation Raster on top of the CHAP delineated habitat types. These floodplains were grouped into the three categories that were created to model inundation effects on invasive species (See description of methodology above): (1) 2-year, (2) 5-10 year and (3) 25 -500 year floodplains. These potential floods are displayed below as a conversion from their existing habitat to Grassland habitat, but depending on duration and intensity of flooding it is likely that large areas could resist habitat conversion. Not enough is known about future conditions to model the actual amount of habitat conversion, but looking at the figure it is easy to see there is a high potential that habitat types will be dynamic in the next 50 years.

4 - CHAP Without Project Results:

The 50-year analysis without project illustrates a general trend of declining habitat values given the applied projections that result in a loss in the overall ecological integrity of the area. This is shown in the graph below (Figure 5). Figures 6 and 7 illustrate the expected Habitat Units (HUs) in each time period. Finally, Appendix A shows the existing and without project habitat values for the three time periods for Ohkay Owingeh and Santa Clara.

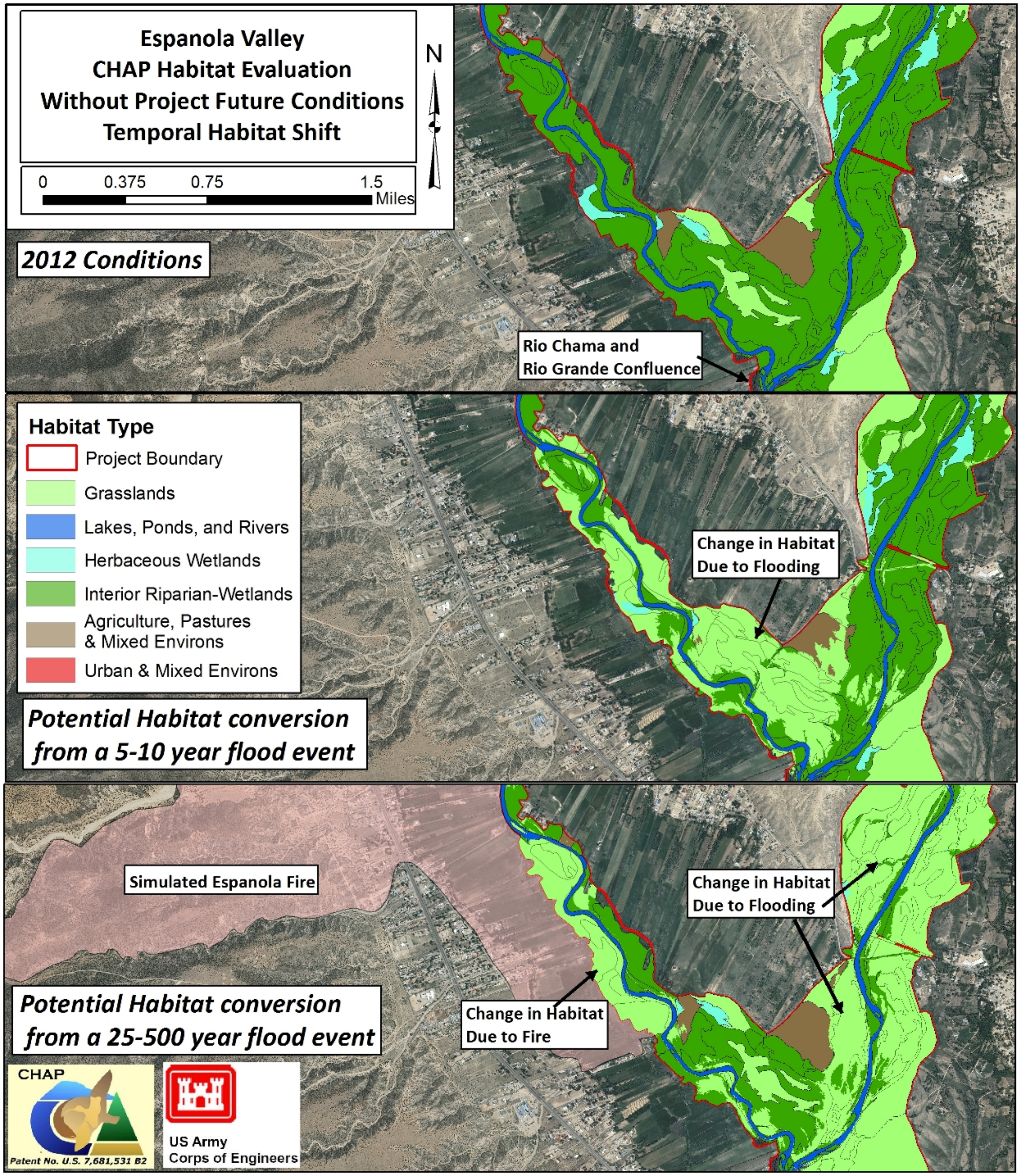

Figure 4-1 Visual depiction of the potential shift in Habitat Types over the 50-year period focused on the Rio Grande and Rio Chama confluence.

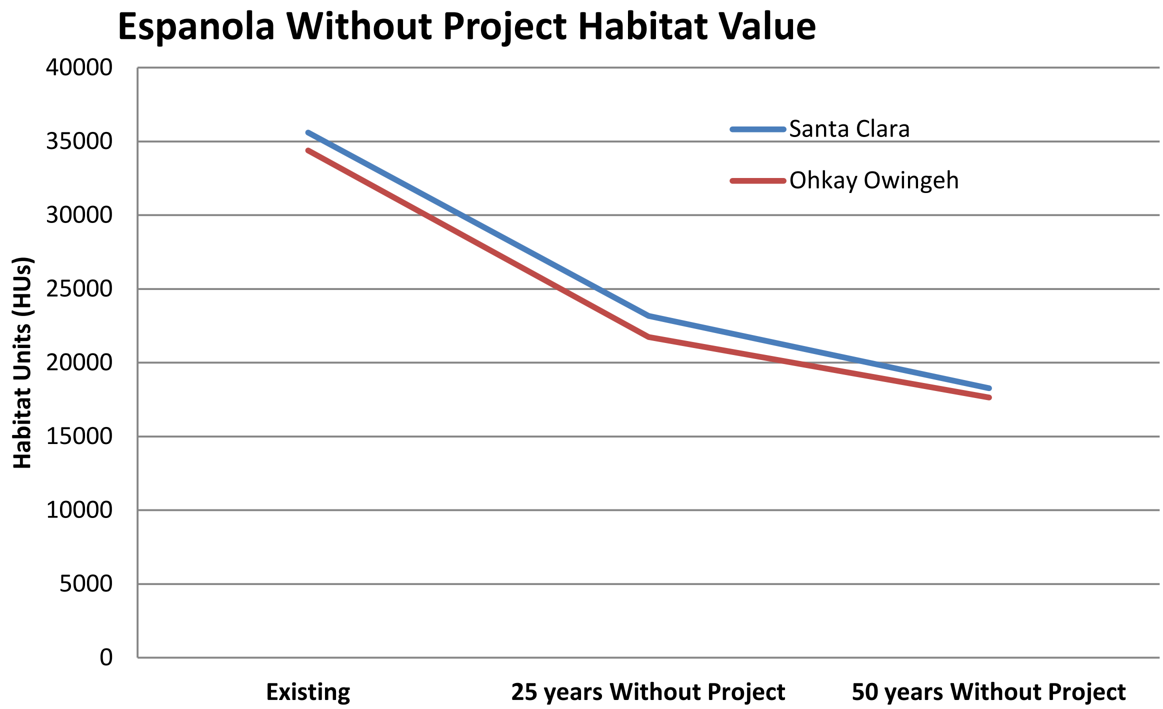

Figure 4-2 Decline in Wildlife Habitat Value over 50-years at

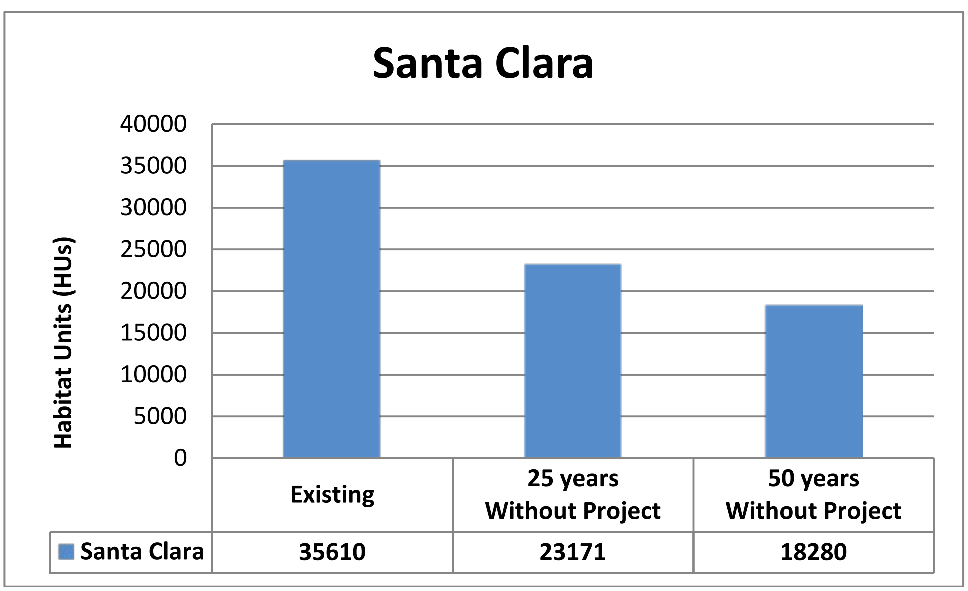

Figure 4-3 Change in Santa Clara project HUs over 50-year time period.

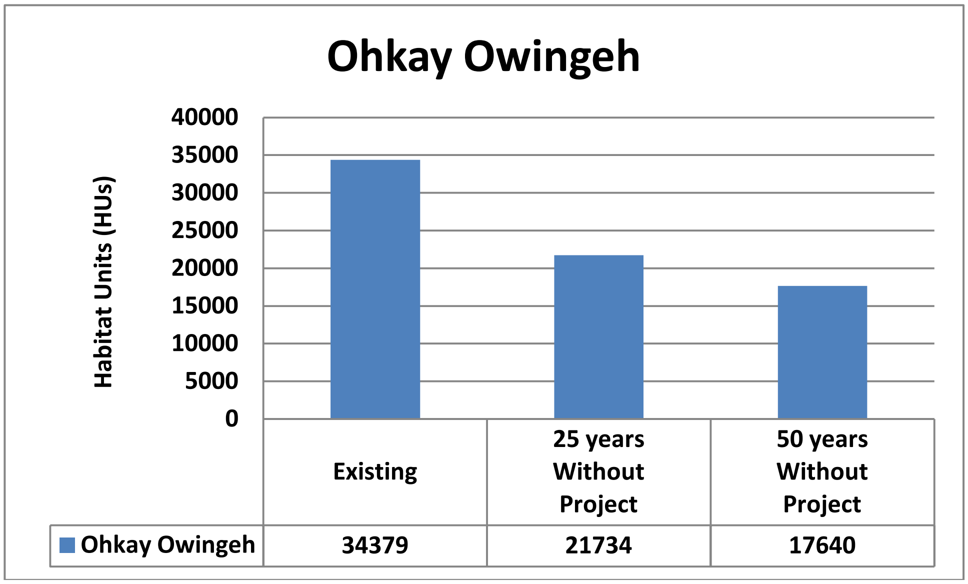

Figure 4-4 Change in Ohkay Owingeh project HUs over 50-year time period.

5 - Citations

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6 - Appendix A: Espanola Without Project Habitat Values by CHAP Polygon

Ohkay Owingeh CHAP Polygon Without Project Habitat Units (HUs):

Ohkay Owingeh				
NHI_ID	Acres	Existing Habitat Units (HUs)	25yr Without Project HUs	50yr Without Project HUs
OK_002	2.83	51.20	34.68	27.17
OK_003	2.35	37.55	17.80	10.17
OK_004	5.34	41.34	18.60	15.17
OK_005	1.96	20.01	13.67	10.44
OK_006	0.76	11.47	6.48	4.33
OK_007	22.57	276.55	113.45	102.11
OK_008	16.35	519.48	352.90	282.59
OK_009	1.59	34.13	19.87	13.88
OK_010	2.08	37.27	25.21	19.73
OK_011	8.83	61.37	18.99	17.72
OK_012	0.44	10.05	6.59	4.51
OK_013	7.03	176.31	108.28	78.54
OK_014	9.10	230.58	141.69	102.83
OK_016	15.80	291.47	162.60	109.99
OK_017	11.13	333.24	206.42	150.97
OK_018	12.37	244.70	137.06	93.08
OK_019	40.15	1108.04	683.80	498.32
OK_020	3.56	93.28	64.53	52.20
OK_021	10.62	155.55	94.19	76.93
OK_022	13.91	322.94	197.47	142.65
OK_023	18.22	172.59	95.01	61.71
OK_025	2.77	54.01	34.82	26.69
OK_026	1.51	23.10	13.82	8.74
OK_027	1.74	35.17	23.67	18.60
OK_028	2.22	56.79	35.01	30.18
OK_029	35.64	145.30	65.77	48.45
OK_030	15.58	167.74	56.15	48.46
OK_031	0.82	7.46	2.83	2.05

Ohkay Owingeh				
NHI_ID	Acres	Existing Habitat Units (HUs)	25yr Without Project HUs	50yr Without Project HUs
OK_032	1.54	20.86	10.03	8.01
OK_033	0.56	11.65	7.94	6.30
OK_036	4.05	72.02	42.69	27.23
OK_037	0.75	12.63	7.91	6.58
OK_038	0.90	10.97	4.98	3.56
OK_040	2.64	41.76	25.05	15.88
OK_043	9.65	229.30	116.64	94.21
OK_044	6.98	126.04	78.90	50.99
OK_045	0.81	16.77	11.07	8.37
OK_046	1.06	19.09	11.95	7.72
OK_047	2.95	53.88	27.38	21.84
OK_048	7.92	133.43	118.59	106.26
OK_049	8.58	198.48	108.71	89.09
OK_052	7.19	171.54	105.28	90.38
OK_053	3.91	82.45	54.45	41.21
OK_054	32.76	294.70	149.19	119.08
OK_055	8.69	194.01	105.51	91.56
OK_056	37.33	543.81	340.10	280.67
OK_057	6.91	161.77	93.37	79.07
OK_058	3.62	97.83	63.38	55.40
OK_059	2.12	32.55	19.48	12.32
OK_060	0.84	13.22	7.93	5.02
OK_061	5.45	106.77	72.43	57.27
OK_062	0.59	2.92	0.87	0.78
OK_063	28.12	473.44	420.78	377.05
OK_064	1.70	44.07	23.95	19.70
OK_065	5.82	174.91	107.24	93.02
OK_066	0.59	9.40	6.22	4.06
OK_067	0.26	4.19	2.78	1.81
OK_068	0.73	14.10	9.25	6.96
OK_069	3.60	44.56	20.64	17.90
OK_070	25.72	281.77	141.82	108.31
OK_071	3.60	88.91	61.60	47.05
OK_072	7.43	243.37	165.57	132.76
OK_073	2.74	25.60	12.52	9.63
OK_074	8.50	136.52	87.83	66.37

Ohkay Owingeh				
NHI_ID	Acres	Existing Habitat Units (HUs)	25yr Without Project HUs	50yr Without Project HUs
OK_076	4.73	139.63	89.64	78.57
OK_078	7.53	99.56	59.46	47.79
OK_079	2.89	50.29	24.23	21.43
OK_080	1.56	28.23	17.11	10.96
OK_081	10.91	218.55	99.84	76.57
OK_082	2.29	45.86	20.95	16.06
OK_083	1.74	12.89	7.75	4.59
OK_084	12.46	248.04	132.62	113.69
OK_086	2.68	47.06	30.08	22.86
OK_087	2.16	35.67	31.63	28.28
OK_088	2.10	41.37	20.83	16.65
OK_089	3.08	25.12	10.78	9.26
OK_090	10.87	140.84	80.98	55.02
OK_091	2.89	57.84	30.93	26.53
OK_092	12.36	247.18	132.20	113.36
OK_093	2.57	46.51	24.99	21.43
OK_094	1.10	26.04	18.12	14.71
OK_095	1.73	39.24	24.22	17.58
OK_096	1.25	31.50	21.79	17.53
OK_097	0.46	3.45	1.07	1.01
OK_098	6.92	161.65	88.59	72.65
OK_099	5.02	105.47	64.76	46.78
OK_102	3.32	80.59	52.98	36.38
OK_103	3.50	70.44	42.98	27.71
OK_104	1.82	54.04	38.75	30.94
OK_105	4.26	51.14	23.20	16.55
OK_106	1.04	22.61	15.63	12.61
OK_107	2.30	50.15	34.67	27.96
OK_108	2.32	44.51	28.24	21.45
OK_109	6.31	177.33	108.35	93.68
OK_111	0.95	14.72	9.42	6.89
OK_112	3.09	57.14	38.79	30.47
OK_113	9.02	199.47	136.34	109.00
OK_114	2.94	57.43	30.86	25.52
OK_115	31.44	742.94	429.05	363.49
OK_116	4.86	50.93	19.04	17.15

Ohkay Owingeh				
NHI_ID	Acres	Existing Habitat Units (HUs)	25yr Without Project HUs	50yr Without Project HUs
OK_118	3.47	58.91	34.60	22.01
OK_119	2.35	20.80	7.87	5.69
OK_120	4.78	39.87	15.02	10.79
OK_121	9.03	100.23	43.21	35.68
OK_122	6.89	97.40	45.66	34.60
OK_123	11.15	252.03	152.00	129.76
OK_124	1.15	17.61	8.30	6.32
OK_126	4.78	67.69	39.24	24.63
OK_127	1.57	29.67	19.43	14.59
OK_128	3.52	63.26	32.44	29.11
OK_131	2.93	36.88	16.53	14.85
OK_132	10.63	98.45	49.65	38.05
OK_133	4.59	37.77	15.19	11.93
OK_134	28.57	708.39	389.59	320.53
OK_135	5.03	139.82	98.59	80.74
OK_136	6.20	179.98	121.70	97.02
OK_137	9.72	128.96	74.46	59.72
OK_138	1.31	23.96	15.00	9.70
OK_139	13.68	159.43	89.25	59.63
OK_140	1.50	28.09	14.65	12.08
OK_141	28.13	724.17	440.31	378.90
OK_142	2.98	50.79	24.44	21.60
OK_145	18.52	288.67	179.33	147.63
OK_146	1.52	23.11	12.95	10.55
OK_147	9.17	285.37	191.58	152.29
OK_148	1.17	25.85	16.89	11.53
OK_149	0.54	11.95	7.81	5.33
OK_150	3.69	103.07	71.93	55.34
OK_151	1.58	26.53	14.88	9.95
OK_152	0.49	9.22	6.23	4.90
OK_153	8.38	56.71	32.46	18.23
OK_154	1.38	28.31	17.17	12.66
OK_155	1.44	26.27	15.05	10.21
OK_156	1.49	11.29	3.52	3.30
OK_157	0.22	3.84	2.32	1.48
OK_158	0.44	9.22	8.48	7.85

Ohkay Owingeh				
NHI_ID	Acres	Existing Habitat Units (HUs)	25yr Without Project HUs	50yr Without Project HUs
OK_159	0.32	6.58	6.05	5.60
OK_160	0.30	5.42	3.46	2.56
OK_161	0.25	4.76	4.34	3.98
OK_162	0.21	1.38	0.42	0.39
OK_163	0.62	3.95	1.21	1.13
OK_164	3.21	61.08	38.32	32.33
OK_165	1.50	28.80	25.98	23.64
OK_166	1.12	16.15	8.37	6.98
OK_167	6.29	155.69	95.54	69.26
OK_168	1.32	14.69	7.90	5.03
OK_169	21.37	195.91	61.75	58.68
OK_170	21.93	476.68	244.83	197.34
OK_171	19.63	409.37	200.09	157.80
OK_172	0.16	2.75	1.96	1.41
OK_173	8.74	16.46	5.14	4.69
OK_174	7.74	202.95	123.53	106.41
OK_175	23.37	673.14	425.45	371.51
OK_176	2.44	59.30	40.06	32.07
OK_177	9.73	255.74	174.19	139.70
OK_178	8.09	221.55	147.75	116.71
OK_179	1.92	8.69	4.21	3.64
OK_180	1.09	27.88	18.66	14.58
OK_181	5.82	148.33	100.84	80.73
OK_182	26.25	668.37	406.13	349.26
OK_183	0.71	8.63	3.93	3.38
OK_184	10.25	262.01	155.42	114.98
OK_185	0.55	12.33	7.26	5.33
OK_186	1.51	47.76	34.10	27.07
OK_187	18.46	427.97	231.14	189.02
OK_188	1.33	6.65	6.65	6.65
OK_189	21.99	60.89	35.37	30.59
OK_190	2.94	8.14	4.73	4.09
OK_191	1.81	4.85	4.49	8.04
OK_192	1.22	5.51	2.98	2.32
OK_194	10.34	114.05	79.84	61.72
OK_195	1.30	10.59	7.36	4.89

Ohkay Owingeh				
NHI_ID	Acres	Existing Habitat Units (HUs)	25yr Without Project HUs	50yr Without Project HUs
OK_196	83.24	800.00	433.93	275.27
OK_197	2.35	25.06	12.72	9.67
OK_198	20.92	199.84	99.98	74.66
OK_199	14.68	325.29	176.83	153.39
OK_200	9.29	62.05	21.94	14.43
OK_201	2.29	4.30	1.34	1.23
OK_203	2.44	9.83	9.83	9.83
OK_204	6.08	45.19	19.77	16.12
OK_205	24.64	183.20	76.99	65.34
OK_206	1.79	41.32	24.60	20.99
OK_207	2.64	82.71	52.50	46.04
OK_208	16.87	490.26	295.77	255.48
OK_209	3.00	59.80	30.42	27.41
OK_210	5.80	95.48	48.00	42.75
OK_211	2.42	7.48	3.29	2.86
OK_213	4.83	133.57	88.18	69.26
OK_214	5.59	147.88	94.33	82.17
OK_219	1.34	19.03	8.61	7.80
OK_220	6.00	174.08	121.74	93.84
OK_222	10.53	299.25	202.12	160.96
OK_223	5.08	129.92	80.73	58.98
OK_224	0.65	14.30	8.29	7.02
OK_225	2.46	39.90	21.24	18.11
OK_226	0.63	13.30	8.58	7.38
OK_227	1.57	21.88	12.99	8.15
OK_228	19.83	497.35	305.44	221.56
OK_229	4.01	113.15	79.16	62.31
OK_230	1.14	23.04	14.80	12.69
OK_231	30.97	683.14	389.76	264.93
OK_232	1.36	28.10	20.44	15.23
OK_233	0.76	20.94	14.95	11.88
OK_234	1.00	13.43	6.05	5.46
OK_235	5.73	16.83	7.79	6.50
OK_236	1.26	16.02	7.44	6.46
OK_237	3.78	68.13	36.59	31.37
OK_238	2.90	16.35	6.12	5.18

Ohkay Owingeh				
NHI_ID	Acres	Existing Habitat Units (HUs)	25yr Without Project HUs	50yr Without Project HUs
OK_239	14.13	102.06	43.49	36.70
OK_240	6.38	166.12	111.19	85.27
OK_241	33.73	978.48	605.26	442.07
OK_242	8.11	191.57	108.27	74.15
OK_243	5.69	69.51	31.08	27.86
OK_244	1.82	21.04	9.37	8.36
OK_245	2.01	52.20	32.47	23.74
OK_246	2.73	62.13	40.69	27.83
OK_247	27.71	875.60	588.23	467.90
OK_248	4.62	145.92	98.03	77.98
OK_249	17.49	507.87	336.11	264.63
OK_250	57.51	1420.38	880.88	642.40
OK_251	3.37	73.25	48.48	36.78
OK_252	129.57	3679.38	3436.69	3235.13
OK_253	0.22	3.65	2.20	1.40
OK_255	0.46	8.63	5.51	4.69
OK_256	0.75	14.41	9.45	7.11
OK_257	0.32	5.74	3.55	2.29
OK_259	2.15	31.59	13.47	11.28
OK_260	1.11	5.61	2.45	1.91

Santa Clara CHAP Polygon Without Project Habitat Units (HUs):

Santa Clara				
NHI_ID	Acres	Existing Habitat Units (HUs)	25yr Without Project HUs	50yr Without Project HUs
SC_001	0.81	18.83	13.99	10.61
SC_002	8.12	74.83	51.12	34.98
SC_003	2.11	9.20	4.93	3.37
SC_004	4.65	73.39	49.92	33.84
SC_005	2.25	10.68	5.75	3.96

Santa Clara				
NHI_ID	Acres	Existing Habitat Units (HUs)	25yr Without Project HUs	50yr Without Project HUs
SC_006	40.65	150.93	72.24	56.82
SC_007	17.95	207.11	124.11	90.70
SC_008	3.63	72.29	38.67	25.82
SC_009	2.10	30.68	16.22	13.69
SC_010	1.22	21.52	13.04	9.30
SC_011	5.22	109.44	65.65	49.95
SC_012	0.71	13.65	8.88	5.34
SC_013	1.39	26.70	17.37	10.45
SC_014	0.37	4.27	2.38	1.11
SC_015	2.01	25.33	10.07	6.84
SC_016	6.30	23.89	15.33	8.75
SC_017	5.13	77.34	38.63	32.24
SC_018	0.52	1.92	1.92	1.92
SC_019	2.19	2.06	0.69	0.69
SC_020	7.74	111.55	70.88	52.83
SC_021	101.14	2294.28	1462.94	1117.09
SC_022	0.51	12.73	9.31	6.91
SC_023	31.88	657.64	403.31	290.94
SC_024	30.09	495.84	250.05	159.95
SC_025	0.65	17.13	12.84	9.83
SC_026	6.90	72.58	38.74	24.49
SC_027	1.96	38.46	27.02	19.03
SC_028	0.52	8.44	4.53	3.51
SC_029	3.90	61.60	33.98	27.41
SC_030	2.69	63.24	46.70	35.14
SC_031	12.86	189.89	121.02	90.49
SC_032	8.56	127.93	84.68	64.66
SC_033	7.94	132.06	88.60	68.68
SC_034	3.36	5.41	1.67	1.50
SC_035	4.21	62.71	43.94	31.15
SC_036	2.65	72.04	47.35	38.30
SC_037	1.12	12.81	7.13	3.32
SC_038	1.99	20.21	9.65	7.66
SC_039	3.03	67.18	45.92	30.00
SC_040	6.20	107.97	69.03	40.71
SC_041	3.80	10.18	4.72	2.53

Santa Clara				
NHI_ID	Acres	Existing Habitat Units (HUs)	25yr Without Project HUs	50yr Without Project HUs
SC_042	23.62	299.97	278.00	259.01
SC_043	0.95	14.66	6.27	4.48
SC_044	1.50	32.49	21.00	16.71
SC_045	2.91	68.83	46.54	29.96
SC_046	10.82	248.77	170.44	111.59
SC_047	4.30	66.99	38.05	18.10
SC_048	15.64	329.57	227.68	182.71
SC_049	2.45	16.53	7.90	4.05
SC_050	15.94	345.95	234.48	151.60
SC_051	6.40	128.97	119.53	111.36
SC_052	1.60	35.81	33.24	31.02
SC_053	0.45	7.63	6.97	6.39
SC_054	1.54	32.53	29.64	27.24
SC_055	2.92	60.96	37.72	29.33
SC_056	1.94	37.99	25.58	16.43
SC_057	4.38	87.94	57.54	35.49
SC_058	2.18	29.83	12.66	8.97
SC_059	6.62	174.30	130.63	99.95
SC_060	1.73	40.32	29.96	22.73
SC_061	6.64	144.01	105.27	78.82
SC_062	8.48	219.96	164.69	125.89
SC_063	2.37	40.14	21.59	16.78
SC_064	2.64	47.44	33.09	23.15
SC_065	0.63	10.99	7.10	4.24
SC_066	5.67	137.74	99.66	72.74
SC_067	1.14	21.70	15.05	10.44
SC_068	6.59	163.82	99.40	76.48
SC_069	2.81	59.62	39.12	30.42
SC_070	4.56	67.12	36.83	29.55
SC_071	4.33	38.07	24.94	15.93
SC_072	0.97	15.89	8.53	6.61
SC_073	1.90	28.62	14.63	10.25
SC_074	10.06	126.39	47.21	22.16
SC_075	4.23	86.43	58.36	37.59
SC_076	0.29	5.48	3.70	2.39
SC_077	12.08	312.30	215.41	141.95

Santa Clara				
NHI_ID	Acres	Existing Habitat Units (HUs)	25yr Without Project HUs	50yr Without Project HUs
SC_078	1.77	24.32	13.71	6.47
SC_079	1.85	32.23	20.82	12.44
SC_080	1.02	14.02	7.90	3.73
SC_081	1.67	30.43	16.40	10.95
SC_082	3.70	56.39	25.22	14.52
SC_083	3.32	62.49	41.95	26.87
SC_084	11.22	223.57	207.01	192.69
SC_085	11.96	275.72	183.86	144.61
SC_086	5.05	98.36	90.25	83.23
SC_087	12.30	253.87	234.12	217.05
SC_088	3.22	59.07	42.73	31.49
SC_089	10.77	169.37	83.96	53.16
SC_090	4.13	73.74	66.02	59.60
SC_091	2.57	47.76	32.21	25.32
SC_092	2.52	48.32	30.90	24.31
SC_093	4.76	79.89	50.39	39.08
SC_094	1.54	32.81	21.76	17.02
SC_095	1.70	32.40	30.16	28.22
SC_096	110.56	1873.64	956.92	810.99
SC_097	1.94	11.58	4.03	1.73
SC_098	8.65	169.27	154.89	142.44
SC_099	1.18	11.53	6.82	4.76
SC_100	1.85	43.09	26.41	20.38
SC_101	52.75	1289.86	781.83	600.99
SC_102	26.01	722.18	447.34	348.93
SC_103	10.23	235.11	156.74	123.25
SC_104	23.12	479.46	294.15	212.27
SC_105	10.65	269.42	184.97	148.86
SC_106	16.71	512.88	382.34	289.82
SC_107	6.53	151.12	112.21	85.07
SC_108	8.30	155.42	74.47	46.31
SC_109	4.45	99.85	60.19	46.02
SC_110	7.42	114.71	51.72	38.26
SC_111	8.45	183.33	170.85	160.06
SC_112	3.14	62.70	42.70	33.94
SC_113	1.05	21.25	15.51	11.53

Santa Clara				
NHI_ID	Acres	Existing Habitat Units (HUs)	25yr Without Project HUs	50yr Without Project HUs
SC_114	1.00	11.55	7.44	5.51
SC_115	17.72	81.43	53.08	39.42
SC_116	14.23	276.49	167.14	127.29
SC_117	0.86	14.78	8.94	6.37
SC_118	13.72	233.47	125.10	83.09
SC_119	4.28	74.65	66.64	59.98
SC_120	10.36	222.03	149.99	99.78
SC_121	0.67	9.94	6.77	4.61
SC_122	6.86	155.40	111.13	80.02
SC_123	9.87	165.65	100.05	75.63
SC_124	44.02	842.90	427.88	362.82
SC_125	15.69	308.29	156.73	133.10
SC_126	0.54	8.37	5.15	3.92
SC_127	2.74	61.06	35.14	26.07
SC_128	3.43	70.10	45.08	35.68
SC_129	38.67	910.87	469.89	307.31
SC_130	13.28	369.83	236.65	188.93
SC_131	59.15	1426.49	904.46	715.65
SC_132	1.71	28.52	13.71	11.18
SC_133	4.76	90.09	41.02	23.30
SC_134	16.42	356.40	217.30	166.91
SC_135	27.73	664.22	359.41	242.61
SC_136	4.29	77.99	39.47	33.37
SC_137	8.37	211.31	134.40	106.67
SC_138	4.28	90.62	59.48	36.79
SC_139	49.02	1437.91	936.11	755.09
SC_140	4.82	57.99	40.23	28.03
SC_141	124.41	3547.00	3313.97	3120.44
SC_142	0.65	10.20	6.26	3.49
SC_143	2.09	31.36	18.71	9.87
SC_144	52.90	1430.20	872.03	674.16
SC_145	38.57	232.92	126.45	83.50
SC_146	21.03	571.49	360.01	284.90
SC_147	44.03	1110.13	715.88	572.14
SC_148	14.93	55.81	19.77	12.93
SC_149	5.54	13.41	4.59	2.96

Santa Clara				
NHI_ID	Acres	Existing Habitat Units (HUs)	25yr Without Project HUs	50yr Without Project HUs
SC_150	1.67	25.48	12.73	10.64
SC_151	0.67	2.60	1.16	0.98
SC_152	15.56	305.43	155.27	131.85
SC_153	7.02	144.15	132.47	122.38
SC_154	1.35	5.29	1.55	1.36
SC_155	92.87	1953.06	1063.30	717.44
SC_156	23.19	499.44	268.55	180.18
SC_157	9.16	194.17	104.30	69.91
SC_158	0.78	16.36	8.90	6.01

3 - Proposed Ecosystem Management Measures for the Española Valley, Rio Grande and Tributaries, New Mexico, Detailed Feasibility Study

3 - PROPOSED ECOSYSTEM MANAGEMENT MEASURES FOR THE ESPAÑOLA VALLEY, RIO GRANDE AND TRIBUTARIES, NEW MEXICO STUDY

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1 - Introduction

The habitat team identified appropriate inputs for estimating habitat units and possible measures for achieving ecosystem restoration objectives. This report provides an overview of the baseline information for estimating habitat units, and the proposed ecosystem management measures to reconnect the Rio Grande with its floodplains, and increase the area, diversity and quality of the boque on Ohkay Owingeh and Santa Clara Pueblos.

The habitat team followed a process similar to the US Fish and Wildlife Service's (USFWS) Ecological Service Manual series on HEP (USFWS 1980a-c), and the USACE Habitat Evaluation and Assessment Tools (HEAT) protocols developed by ERDC-EL (Brinson 1993; Smith et al. 1995). The general steps involved in assessing an environmental restoration project are described in Burks-Copes et al. 2007.

2 - Rio Grande Riparian Ecosystem

2.1 Hink and Ohmart Vegetation Classification

The cottonwood bosque is the most extensive remaining gallery cottonwood forest in the Southwest, having survived the impacts of development. Over the past decade the value of riparian habitats to wildlife in this arid region has been widely recognized (Hubbard 1971, Carothers et al. 1974, Johnson and Jones 1977, Brown 1982, Ohmart and Anderson 1982). The Hink and Ohmart (1984) study characterized the major types of riparian habitat, vegetation and terrestrial vertebrate communities along the Rio Grande. The major communities were composed of combinations of cottonwood, coyote willow, juniper, Russian olive, saltcedar, and cattail marsh. Six vegetation structure types were defined based on the overall height of the vegetation and the amount of vegetation in the lower layers. The riparian community supports a rich assemblage of vertebrate species, particularly birds. The highest wildlife densities and diversities were found in mature cottonwood/Russian olive stands and the intermediate-aged cottonwood/coyote willow stands. Areas with sparser vegetation had lower densities and numbers of vertebrate species.

The Española Valley Project Habitat Team decided to use the 2002 Hink and Ohmart (Burks-Copes et al. 2007, USACE 2007) habitat mapping for establishing study site conditions. The map layers divided the area into manageable classified homogenous sections for field surveys and analysis in GIS. The Hink and Ohmart (1984) classification delineated distinct vegetation based on species and structure. The use of the recent mapping (USACE 2007) accelerated the inventory of ecological functions for CHAP, and integrated the project into ongoing river management efforts.

Riparian woodlands have a canopy of Rio Grande cottonwood (*Populus fremontii var. wislizenii*), and, less extensively, Goodding's willow (*Salix nigra var. gooddingii*) (Parametrix, 2008), with an understory of native shrub species composed primarily of coyote willow (*Salix* *exigua*) and seep-willow (*Baccharis salicifolia*). The majority of bosque has an understory dominated by saltcedar (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*). Saltcedar is an invasive species of exposed soil sites in the riparian zone (Smith, et al. 2002). Cottonwood seedlings have a competitive advantage during the spring (1.5 months) under ideal soil moisture conditions (Horton, et al. 1960; Sher, et al. 2000). This competitive effect is lost under conditions of water stress (Segelquist, et al. 1993) or elevated salinity (Busch and Smith, 1993). Saltcedar produces seed for several months beginning in late spring (Ware and Penfound, 1949; Horton, et al. 1960), allowing it to colonize bare, moist-soil sites throughout the summer. The longer period of seed production allows saltcedar seedlings to establish on and dominate open sites wetted by runoff, rainfall, or river flows during the summer. Saltcedar can also become established in the understory of mature cottonwood stands in the project area where there is sufficient light (Crawford, et al. 1996).

The studies by Hink and Ohmart (1984) and Thompson et al. (1994) have characterized wildlife use of the various plant associations in the riparian ecosystem. These studies conclude that the riparian community supports a rich assemblage of vertebrate species, particularly birds. Generally, wildlife was higher in marshes, cottonwood gallery forest with a dense understory, and Russian olive shrub stands. Open areas, early growth stands, saltcedar, and river bars support lower wildlife diversity and abundance.

Breeding bird abundance increases with the complexity and density of vegetation structure, because of the increased food, cover, and nest substrate it provides (Crawford, et al. 1996). Cottonwood stands with a well developed shrub understory have a bird abundance that is approximately four times greater along the riverward and landward edges of the bosque than in the interior of the stand (Hink and Ohmart, 1984; Hoffman 1990; Thompson et al. 1994; Stahlecker and Cox, 1997), while bosque stands with a sparse understory generally support fewer breeding birds. The Rio Grande is a major migratory corridor for songbirds (Yong and Finch, 2002), waterfowl, and shorebirds. At various times of the year, riparian areas support the highest bird densities and species numbers in the Middle Rio Grande. Agricultural fields and grassy areas with little woody vegetation are important food sources for sparrows and other songbirds during migration and winter.

In the Hink and Ohmart study, herptile abundance and diversity was greatest in habitats that lacked dense canopy cover and that were characterized by sandy soils and sparse ground cover (Hink and Ohmart 1984). Small mammals were abundant in more moist and densely vegetated habitats and those with dense coyote willow than at drier sites (Hink and Ohmart 1984).

2.2 Habitat Inventory

The habitat inventory using the Reclamation (2002) vegetation mapping was conducted at Ohkay Owingeh and Santa Clara Pueblos by SWCA Environmental Consultants and Northwest Habitat Institute in 2010 and 2011. The data were compiled into a database and linked to the Hink and Ohmart GIS shapefiles for processing. The field inventory approach relies on identifying percent coverage for canopy and understory vegetation, tree and shrub species, biotic, abiotic, anthropogenic, and other identifiable habitat components (NHI 2010; O'Neil et al. 2012). The number of components for each habitat patch (polygon) reduces the weight value for any single factor in calculating the unit value, while the field datasheets produce consistent results across the study area (and among projects). The inventory design supports a more detailed evaluation of habitat patches (particularly small patches) with rapid data acquisition.

2.3 Biota Information System of New Mexico (BISON-M)

The Biota Information System of New Mexico (BISON-M) is an online database by a consortium of state, federal and academic organizations. The BISON-M contains data for all vertebrate wildlife occurring in New Mexico (including all threatened, endangered and sensitive species). BISON-M was developed as a wildlife information database to assist State fish and wildlife agencies by the New Mexico Department of Game and Fish, and the Fish and Wildlife Information Exchange (FWIE; now the Conservation Management Institute, Virginia Tech University, Blacksburg, VA). Other agencies cooperating with BISON-M include the Natural Heritage New Mexico (University of New Mexico's Museum of Southwestern Biology), US Army Corps of Engineers, US Bureau of Land Management, US Bureau of Reclamation, US Fish and Wildlife Service, US Forest Service, and New Mexico State Land Office.

BISON-M supports data queries by taxonomic groups, counties, habitat, vegetation types and land use (BISON-M 2013). The database was queried to provide the initial vertebrate species list for the Española Valley project. The list was reviewed by the habitat team to focus on species likely to occur within the project area boundaries. The majority of species in the BISON-M list were also represented in the IBIS database (O'Neil et al. 2005). This correspondence across species databases supported the use of the Combined Habitat Analysis Protocol.

2.4 Combined Habitat Assessment Protocols (CHAP)

The Combined Habitat Assessment Protocol (CHAP) is an accounting and appraisal methodology based on a habitat evaluation framework. CHAP uses an inventory of habitat, species, and functions (O'Neil et al. 2005) to assess habitat values at multiple scales. The CHAP method calculates habitat units (HUs) using an assessment of multiple species, habitat features, and functions by habitat type (NWHI 2013a, b).

The inventory and accounting approach reduces errors associated with incorrect sampling or measurements by identifying multiple factors for estimating habitat values. The CHAP approach does not rely on reference sites for any habitat type or precision measurement of variables for calculations in deterministic habitat suitability models. The use of key ecological functions (KEFs) from the BISON-M database adds a broader perspective for integrating the habitat patches in the riparian zone.

Burks-Copes et al. (2007) describes Habitat Suitability Indices (HSIs) as "simple mathematical expressions for calculating each unit-less index of habitat quality as a function of one or more environmental variables that define habitat for a particular species or life history stage." HSI models use suitability indices (a 0-1 scale) to represent habitat quality for a species stage over the range of possible environmental conditions (vegetative cover, patch size, or hydrologic regime). The habitat-defining indices are combined in an algorithm to yield a composite HSI value (between 0.0 and 1.0). The HSI index values can then be used to compute habitat gains and losses from proposed measures.

Basic problems with the HEP/HSI approach are expanding reference site parameters to the spatial extent of the project area, and linking species presence or relative abundance with the spatial distribution of habitat parameters (VanHorne and Wiens 1991, Burks-Copes et al. 2007). The interpretation of the CHAP GIS-based inventory is similar to the normalized HSI values (Table 1). Comparisons of adjacent forest and grassland habitats using both approaches would illustrate the strengths and weaknesses of the habitat scales (CHAP:summation versus HSI:normalized).

Table 2-1.A comparison of descriptive HEP habitat per unit values (Burks-Copes et al. 2007) with CHAP (Northwest Habitat Institute 2013a, b).

HSI / HEP Value / acre	Interpretation	CHAP Value / acre
0.8 - 0.99	Mature habitat structure with excellent functionality High key environmental correlates	35
0.6 - 0.79	High or good functional capacity	30
0.5 – 0.59	Moderately high functional capacity	25
0.4 – 0.49	Moderately functioning ecosystem	20
0.3 -0.39	Fair to moderate functioning capacity	15
0.2 – 0.29	Low or poorly functioning system with good potential for rehabilitation or restoration	10
0.0 - 0.19	Extremely low or very poorly functioning system. The ecosystem processes and/or functions are unlikely to recover through natural processes	5

2.5 Riparian Habitat Value using CHAP

Using the most recent Hink and Ohmart classification system for initial identification of coherent vegetation patches (polygons) supports conducting a more precise field inventory of key environmental correlates (KECs) for CHAP. Patch size based on the 2002 Hink and Ohmart vegetation survey ranges from 0.15 to 150 acres, with an average size of 9.4 acres. The habitat value per acre by polygon represents the local conditions of the habitat mosaic in the riparian cottonwood forest. The inventory approach allows the habitat team to use CHAP for focusing on restoration measures at a broader range of scales. Table 2 shows the range of habitat values (per acre) for the Hink and Ohmart structural components.

Table 2-2. The distribution of maximum, average, and minimum existing conditions habitat values per acre by Hink and Ohmart vegetation type for Ohkay Owingeh and Santa Clara Pueblos.

Ohkay Owingeh Pueblo

Value / acre	Hink and Ohmart Vegetation Classification						
	1	2	3	4	5	6	OP/OW
	Mature forest		Intermediate forest		Riparian shrubs	Meadows marshes	Open
35	32.8	31.6	31.8				
30				29.5	27.6		28.4
25	25.0	22.8	22.3			24.7	
20				20.1	17.7		
15			12.2			14.2	13.3
10	10.8	9.2		9.6	6.6		
5						2.8	3.8

Santa Clara Pueblo

Value / acre	Hink and Ohmart Vegetation Classification						
	1	2	3	4	5	6	OP/OW
	Mature forest		Intermediate forest		Riparian shrubs	Meadows marshes	Open
35						31.1	
30		30.6		27.8	27.7		28.4
25	23.9	24.3	25.9				
20	20.4		19.3	20.3	17.7	17.1	
15	15.4	15.4	12.5				11.5
10							
5				4.6	3.7	3.3	2.1

Row colors correspond to the habitat unit intervals used for the project maps.

The field inventory support consistent identification of environmental functions based on changes in vegetative cover by type (tree, shrub, and forb, etc…) and species. These details are compiled into larger habitat values and form the basis for calculating future conditions for each polygon. The habitat values per acre are summarized further using GIS (O'Neil et al. 2008) to identify general trends for existing conditions and the future conditions without implementation of proposed management measures.

3 - Proposed Ecosystem Management Measures

3.1 River Restoration and Floodplain Re-connection

Ecological management strategies are based on a variety of techniques depending on local river conditions, project goals, and environmental effects. The applicable methods for the Española Valley are based on the U.S. Bureau of Reclamation (USBR) *Middle Rio Grande River Maintenance Program Comprehensive Plan and Guide Appendix A: Middle Rio Grande Maintenance and Restoration Methods* (2012). These methods are organized into categories with similar features and objectives. Methods can be combined at project locations to improve the benefits for riparian habitat restoration. The suitability and effectiveness for a suite of methods at a site are a function of the inherent properties of the method and the physical characteristics of each reach and/or site. Each method was rated with a level of confidence (I, II, III) for achieving the desired geomorphic, and habitat effects (USBR 2012). The methods have been adapted here for local conditions in the Española Valley Project area.

The key to long-term success for Española Valley Project riparian restoration is to reconnect rivers and their floodplains. The most cost-effective way to get additional water into the interior portions of the bosque, and to restore the sediment movement and river meandering needed for long-term sustainability, is reconnecting the river to former channels that were cut off when the river was channelized in the 1950s. However, water levels in the Rio Grande at all but peak flows are now lower than the bottom elevations in the former channels at the points where they approach the river. A combination of two techniques may be implemented to improve floodplain connectivity. First, construct structures to raise water surface elevations at select locations in the river and arrest further down-cutting to raise the water surface elevation in the river channel. Second, excavate variable length channels from the river to allow surface flows from the river back into former river channels within the bosque. Improving floodplain connectivity would increase the area and quality of wetland and native riparian habitat in the bosque, and allow some degree of point bar deposition and soil scour so that new vegetation could become established.

3.2 Channel Management with River Spanning Features

Structures like boulder weirs, riffles, or grade restoration facilities (GRFs) are intended to manage channel incision while raising the riverbed level in relation to the surrounding floodplain to reduce the elevation difference between the river in its current channel and the abandoned channels in the bosque (USBR 2012). The objective of river spanning features is to control the channel bed elevation or grade, improve or maintain current flood plain connectivity, and stabilize ground water elevations.

GRFs are engineered structures that are designed to control river channel grade while maintaining the river perpetually in its current location. Weirs or riffles are designed to encourage river flow into the former channels that over time may allow the river to avulse entirely into former channels, eventually leaving the boulder weir behind.

3.2.1 Deformable Riffles

Deformable riffles are a recent (and untested) method to establish a channel with a stable grade, allow some vertical channel bed movement, and supplement the bed material load (USBR 2012). Deformable riffles consist of a trench excavated across the channel and filled with rock that would be stable during most flows. The length of a deformable riffle in the downstream direction should approximate the length and slope of typical stable riffles. Local natural riffles may be used to determine the appropriate shape and rock size based on information about the flow range for bed mobilization.

Multiple riffles could be constructed in series along the river about five to seven river widths apart. Riffles would contain a supply of rock to be mobilized during subsequent 5- to 10-year flow events, while allowing some erosion of the riffles to occur.

3.2.2 Rock Sills

Rock sills involve placing large stones directly on the streambed that resist erosion in an incising river zone (USBR 2012). Rock sills are constructed of larger, less mobile rocks, while deformable riffles have smaller rock that are differentially transported during high-flow events. The rock sill would deform as the channel establishes small pools and scour between each sill.

3.2.3 Riprap Grade Control

Rock grade control structures are constructed by excavating a trench across the streambed which is filled with large rock, with the top elevation being the river bed (USBR 2012). As the channel degrades and downstream scour occurs, a portion of the variably sized rock in the trench will be transported downstream.

3.2.4 Grade Restoration Facility

Grade restoration facilities (GRF) are engineered structures that are designed to control river channel grade while maintaining the river perpetually in its current location. This method raises the river bed about 1-2 feet, and has a long low slope downstream apron to dissipate water velocity. GRFs consist of an upstream sheet pile wall, with a variably sized rock section, and a downstream sheet pile wall. Scour protection is often added to protect the downstream sheet pile wall. GRFs are designed to replicate long, low slope riffles and to raise the river bed up to improve flood plain connectivity. These low structures can raise the water surface during low flows and do not generally raise the water surface during higher flows.

3.2.5 Low Head Stone Weirs

Low head stone weirs are used to protect banks, stabilize the bed of incising channels, activate side channels, reconnect flood plains, and create in-channel habitat (USBR 2012). The structures are constructed across the river with individual stone (or smaller variably sized rock) placed in lines forming “U,” “A,” “V,” or “W” shapes. During low flows, the water surface elevation changes through the structures. Stone weirs can be oriented to direct flow toward the center of the channel, creating a pool while limiting bank erosion.

3.3 Habitat Management with Channel Perimeter Features

Channel perimeter modifications can be used to manage the river channel for floodplain restoration (USBR 2012). Connecting remnant channels, historic irrigation channels, and natural depressions with river flows can create a variety of diverse floodplain and wetland conditions. More opportunities for new vegetation establishment occur in deep former river channels that can reactivate the geomorphological disturbance environment needed for a healthy and sustainable riparian ecosystem in the floodplain. Shallow ponds, wet meadows, backwaters, and saturated soil will develop all around and between these flowing channels as essential components of a healthy floodplain ecosystem.

3.3.1 Terrace Lowering

Terrace lowering consists of excavation of islands, bars, or adjacent areas to lower the ground surface elevation to create habitat features (terraces, swales). The lower surfaces increase floodplain inundation during spring runoff or storm events, and support vegetation requiring increased groundwater connectivity (swales). Willows and cottonwoods are commonly planted in the excavated terraces and swales. Excavated materials can be placed for downstream sediment transport (sediment enrichment) or to manage flow across islands and bars for habitat diversity.

3.3.1.1 Swales

Willow swales are depressions constructed by removal of vegetation, dumped debris and soil to provide microenvironments in which native plants can thrive due to the decreased depth to the water table and moist soils (USACE 2011). In certain areas of the bosque, the depth-to-water table is minimal and even slight excavations expose water. Willow swales also help create vegetative habitat where establishment of native plants or seed would otherwise be challenging due to soil type or depth to groundwater. Depending upon the location, there could be a series of willow swales that become progressively drier with increasing distance from the river or water table. Once established, native plants would thrive in these depressions.

3.3.1.2 Wetland Restoration

Wetland restoration measures focus on development of open water wetlands, marsh wetlands, or wet meadows (USACE 2011). Such wetlands provide open water habitat for migrating and local waterfowl and aquatic habitat for numerous species. A marsh wetland would have fluctuating water levels (usually 1-5 feet) and various vegetative species. These areas can be created by lowering the ground surface level below the local water table.

A wet meadow habitat is similar to a marsh wetland, but has much shallower standing water, and is created by allowing flow from a deeper wetland area (such as an open water wetland) to flow out into an existing dry area or by lowering an area to the shallow groundwater table. This creates marshy or moist soil habitat, usually only about 6 inches deep with water.

3.3.2 Side Channels (High-flow, Perennial, and Oxbow Re-establishment)

Side channels consist of channels that can be inundated by higher river flow during spring runoff or storm events, which are adjacent to the main river in the flood plain, bars, and islands. Excavation can consist of creating completely new side channels or enlarging natural topographic low areas on bars or abandoned flood plains when the channel has incised. Side channels can be created by excavating the entire feature or reconnecting abandoned river channels or topographic low areas. Side channels in combination with a boulder weir or similar structure that controls channel incision would increase the effectiveness of the technique.

3.3.3 Bank Line Embayment

Bank line embayments (including shelves, scallops, inlets, and backwater areas) may be excavated into bank lines at various elevations to create slackwater habitat during spring runoff and summer thunderstorms. The features are designed with sufficient width and distance to created areas of very low water velocity habitat, while allowing flow through the feature. These features provide fish habitat when inundated and are suitable for natural recruitment of willow and cottonwood seedlings on the descending hydrograph.

3.3.4 Transverse Features or Flow Deflection Techniques

Transverse features are structures that extend into the river channel to redirect flow away from the bank line to reduce erosion (USBR 2012). These features can be constructed using boulder groupings, rootwads, large woody debris or bioengineering techniques. Flow deflection structures also include vanes, baffles, or j-hook weirs extending out into the river from one bank. These structures can also raise the water level to direct flow into a reconnected side channel, and towards the opposite bank for the formation of meander bends. Channel meandering encourages natural erosion and deposition, which benefits the bosque and wetland ecological communities. As deposition occurs, vegetation begins to establish, stabilizing the newly formed point bar.

3.3.5 Bendway Weirs

Bendway weirs are rock features that are designed to be angled upstream from the bank line into the flow in order to direct flow away from the bank line, thereby reducing bank erosion and creating slackwater habitat (USBR 2012). During low river discharges, the flow is directed to the center of the channel, while at high flows, secondary currents reduce water velocity near the bank. They also re-align or relocate the river thalweg through the weir field and downstream.

3.3.6 Boulder Groupings

Boulder groupings are designed to increase or restore structural complexity and variable depth and velocity habitat (USBR 2012). Boulder groupings can be constructed to improve aquatic habitat diversity. High-flow events interacting with boulder groupings create and maintain downstream scour pools and provide bed sorting.

3.3.7 Bioengineering, Large Woody Debris and Rootwads

Bioengineering treatments may be constructed to replace "hardened" rock features revetments with more esthetically pleasing and wildlife-friendly designs (USBR 2012). Techniques include piles of woody materials, rootwads, brush mattresses, vertical bundles, and brush or tree revetments that use live and/or dead plant materials in combination with support materials. Bioengineering treatments can be as durable and protective as simple rip-rap while providing soil improvement, water shading, cover for fish, and habitat for birds.

Large woody debris (LWD) structures are constructed from cut trees to redirect, deflect, or dissipate erosive flows (USBR 2012). LWD can be used in combination with other features to enhance the effectiveness and mitigate the impacts of channel spanning or transverse features. Downstream scour can create perennial pools and variable depth and velocity habitat conditions. Rootwads are LWD features embedded into the banks or bed of the channel to redirect flow, especially when placed close together (USBR 2012). Engineered logjams are larger LWD structures constructed for sediment deposition onto in-channel bars (NRCS 2007; Shields et al. 2004). All woody structures provide additional habitat value as substrate for many aquatic insects, scour perennial pools, sort gravel substrate, and create variable velocity habitat.

Planting willows and cottonwood poles, willow bundles and/or willow mats / along the bank line can reduce erosion there. Vegetation has low erosion resistance, with plantings requiring time to establish (USBR 2012). Biodegradable fabrics, wattles, mats, Bio-D Blocks, etc., may be used to assist with plant growth and bank stability until vegetation becomes well established (Fischenich 2000). The use of living vegetation as a bank protection material is generally limited to the bank elevations above a base flow where natural vegetation grows in the river system. Most bioengineering methods include some longitudinal toe protection component.

3.4 Change in Sediment Supply

Sediment supply and transport vary within a river system as a function of discharge over time and space. The sediment supply in the project area has been reduced by Abiquiu Dam (USACE 2007) and gravel mining. The result has been channel incision, narrowing, and deepening. Sediment augmentation (adding sediment) to the river may reduce the effects of channel incision. Sediment from excavation of other project features (bank/bar/island clearing, terrace lowering, floodplain channels, and etc.…) can be used to augment sediment in the river. Construction of downstream LWD features to capture sediment would increase the habitat value of both project features.

3.5 Riparian Vegetation Management

Successful riparian vegetation management relies on creating the appropriate hydrology conditions, effective long-term control of invasive plants and the presence of thriving native plants. The previously discussed river restoration and floodplain reconnection techniques should provide the foundation hydrological and groundwater conditions for successful revegetation using native plants.

3.5.1 Invasive species control

Managing invasive plant species is an essential element for successful Southwestern riparian ecological restoration. Russian olive, saltcedar and Siberian elm are the most common woody invasive plants that have become established in the bosque. There are many herbaceous species that should receive substantial control effort. The key to invasive plant species control is using multiple strategies to both remove the species and create an environment where native plants can thrive. This includes replanting areas with native species, in concert with re-establishing (where possible), the preferred soil, hydrology and groundwater conditions to support competition by native species against non-native invaders.

3.5.2 Trees and shrubs

Invasive tree species include Russian olive, saltcedar, Siberian elm, and tree-of-heaven. These species may predominate in large, dense monocultures that can be effectively cleared using cutter-mulchers. Other situations require hand-clearing with chain saws, followed immediately by herbicide application (using a hand-operated sprayer) to the cut stump. Resprouts are cut by hand using machetes, hatchets, powered weed cutters or chainsaws if there is significant new growth, and the cut faces of the sprouts immediately treated with herbicide. Successful herbicide control of resprouts usually requires two to three additional growing seasons after the initial treatment is completed.

3.5.3 Herbaceous weeds

Invasive (noxious) herbaceous weed species are an increasing threat to Southwestern riparian ecosystems. Many of these species become established in disturbed areas such as newly excavated or bladed areas, spoil piles or where invasive trees have been removed. Revegetation activities should include a systematic invasive weed survey, with appropriate control efforts to prevent the spread of invasive weeds. Table 3 lists the most commonly encountered invasive herbaceous weed species and control methods for each.

3.5.4 Riparian Vegetation Reestablishment

Whether planting native vegetation may occur following excavation or invasive plant species control, or as an independent management action, success depends on providing vigorous native plant revegetation. Many areas will naturally revegetate on their own from the soil seed bank or nearby seed sources. Planting container plants, locally harvested transplants, seeds or other plant parts (poles) will accelerate the revegetation process and suppress undesirable invasive species at the restoration site.

3.5.5 Types of plant material

Native plants can be propagated either through stem cuttings (willows and cottonwoods especially), root wads (willows and many wetland grasses and sedges), seeds (most species), and whole plants. Often local plant materials are better. Transplanting local, dormant or semi-dormant willow root wads or herbaceous wetland species has several advantages: 1) It guarantees that the plants will be adapted to the area; 2) It prevents accidental introduction of new, undesirable species to the bosque; 3) It maintains and promotes the local genetic composition of the species; 4) Generally the survivorship following transplant is better; and 5) The costs are generally lower than commercially available material. Seed can also be collected seasonally from the bosque, but can be difficult and time consuming.

Species lists of appropriate bosque plants for the study area are available from the New Mexico Natural Heritage Program. A plant list has been developed that includes a total of 57 species recommended for transplant into restoration sites (Tables 4 and 5). The gallery forest still has sufficient Rio Grande cottonwoods for seed production every spring that with barren, saturated soil in full sunlight, abundant seedlings will sprout.

In addition to transplanted material, reseeding an area with a vigorous and competitive mix of native grasses and forbs is commonly used to accelerate revegetation of disturbed areas (excavated) and provide a long-term control strategy to restrain the colonization of non-native plants. A typical seed mix for dryer or more “upland” areas (Table 6) is a starting point for post-treatment revegetation in order to prevent a quick reinvasion of undesirable species. Revegetation of wetland areas should use rooted plant material for transplant instead of seeds.

Table 3-1. Common herbaceous invasive weed species and control techniques.

Common Name	Scientific Name	Control Methods*	Herbicide
Russian knapweed	*Acroptilon repens*	H	Aminopyralid (Milestone)
Spotted and diffuse knapweeds	*Centaurea stoebe* and *C. diffusa*	M/H	Aminopyralid (Milestone)
Purple loosestrife	*Lythrum salicaria*	H	Triclopyr (Garlon 3A)
Canada thistle	*Cirsium arvense*	H/B	Aminopyralid (Milestone)
Bull thistle	*Cirsium vulgare*	M/H	Aminopyralid, Glyphosate (Milestone, Roundup)
Hoary cress whitetop	*Cardaria draba*	H	Imazapyr, Metsulfuron (Habitat, Escort)
Perennial pepperweed	*Lepidium latifolium*	H	Imazapyr, Metsulfuron (Habitat, Escort)
Cheatgrass	*Bromus tectorum*	M/H/G	Impazapic, Glyphosate (Plateau, RoundUp)
Dalmatian and yellow toadflax	*Linaria dalmatica* and *L. vulgaris*	H	Impazapic, Chlorsulfuron (Plateau, Telar)
Leafy spurge	*Euphorbia esula*	H/B	Picloram+2-4D, Imazapic (Tordon, Plateau)

*H= Herbicide, M= Manual (cutting or pulling), B= Biological Control, G= Grazing.

3.6 Vegetation Management for Dynamic Island and Bank Formation

A reciprocal technique to bar and island destabilization to improve floodplain connectivity, is combining native plant revegetation with engineered logjams or channel management techniques. The combination of engineered features with plants would increase sediment retention from the river to creating bars and islands, and raising the channel bed elevation.

Table 3-2. Recommended herbaceous species for restoration sites.

Common Name	Scientific Name	Preferred Water depth	Preferred Hydrology					Wetland Status
Herbaceous species			S	M	OD	OM	X	
Water sedge	*Carex aquatilis*	Moist soil to 3”	S	M				OBL
Nebraska sedge	*Carex nebrascensis*	Seasonal flooding	S	M				OBL
Beaked sedge	*Carex utriculata (rostrata)*	Moist soil to 6”	S	M				OBL
Fox sedge	*Carex vulpinoidea*	Seasonal flooding	S	M	OD			OBL
Creeping spike rush	*Eleocharis palustris*	Moist soil to 4”	S	M	OD			OBL
Desert spikerush	*Eleocharis parishii*	Moist soil to 4"	S	M	OD			OBL
Spiny rush	*Juncus acutus*	Seasonal flooding	S	M				
Baltic (wire) rush	*Juncus balticus*	Seasonal flooding	S	M	OD			OBL/ FACW
Colorado rush	*Juncus confusus*	Seasonal flooding	S	M				FACW
Inland rush	*Juncus interior*	Seasonal flooding	S	M	OD			
Knotted rush	*Juncus nodosus*	Seasonal flooding	S	M				OBL
Torry's rush	*Juncus torreyi*	Seasonal flooding	S	M				FACW/
Hardstem bulrush	*Scirpus acutus*	Moist soil to 36”	S	M				OBL
Saltmarsh bulrush	*Scirpus maritimus*	Moist soil to 12”	S	M	OD			OBL
Small fruited bulrush	*Scirpus microcarpus*	Moist soil to 3”	S	M				OBL
Olney's threesquare	*Scirpus olneyi*	Moist soil to 12”	S	M	OD			OBL
Cloaked bulrush	*Scirpus pallidus*	Moist soil to 3”	S	M				OBL
Three square rush	*Scirpus pungens*	Moist soil to 6”	S	M				OBL
Softstem bulrush	*Scirpus validus*	Moist soil to 12”	S	M				OBL
Tufted hair grass	*Deschampsia caespitosa*	Seasonal flood	S	M				FACW
Saltgrass	*Disticilis stricta (spicata)*	Seasonal flood	S	M	OD			FACW
Fowl manna grass	*Glyceria striata*	Seasonal flood	S	M				OBL
Scratchgrass muhly	*Muhlenbergia asperifolia*	Seasonal flood	S	M	OD	OM		
Nuttall's alkali grass	*Puccinellia nuttalliana*	Seasonal flood	S	M	OD			FAC-OBL
Alkali sacaton	*Sporobolus airoides*	Seasonal flood	S	M	OD	OM		FAC
Giant sacaton	*Sporobolus wrightii*	Seasonal flood	S	M	OD			
Yerba mansa	*Anemopsis californicus*	Seasonal flood	S	M	OD			
Marsh sunflower	*Helianthus nuttallii*	Seasonal flood	S	M	OD			FACW
Big blue lobelia	*Lobelia siphilitica*	Seasonal flood	S	M	OD			
Yellow monkey flower	*Mimulus guttatus*	Moist soil to 3”	S	M				OBL/ FACW
Riparian primrose	*Oenothera elata*	Seasonal flood	S	M	OD			
Slender cinquefoil	*Potentilla gracilis*	Seasonal flood	S	M	OD			FAC/ FACW
Sago pondweed	*Potamogeton pectinatus*	Open water 30-60”	S					OBL
Marsh buttercup	*Ranunculus cymbalaria*	Moist soil to 2”	S	M	OD			OBL/ FACW
Buttercup	*Ranunculus pennsylvanicus*	Seasonal flood	S	M				
Arrowhead, duck potato	*Sagittaria latifolia*	Saturated to 36”	S	M				OBL
Riparian vervain	*Verbena hastata*			M	OD	OM		FACW
Preferred hydrology: S ; M ; OD ; OM ; X								
Wetland status: OBL – obligate; FACW – facultative wetland ; FACU – facultative upland ; FAC+ -								

Table 3-3. Recommended woody species for restoration sites.

Common Name	Scientific Name	Preferred Water depth	Preferred Hydrology					Wetland Status
Woody species			S	M	OD	OM	X	
Box elder	*Acer negundo*	Seasonal flood	S	M	OD			FAC/ FACW
Thinleaf alder	*Alnus tenuifolia*	Seasonal flood	S	M				FACW
False indigo bush	*Amorpha fruiticosa*	Seasonal flood	S	M				OBL/ FACW
Netleaf hackberry	*Celtis reticulata*	Upland			OD	OM	X	
Apache plume	*Fallugia paradoxa*	Upland				OM	X	—
New Mexico olive	*Forestiera neomexicana*	Seasonal flood		M	OD	OM		
Narrowleaf cottonwood	*Populus augustifolia*	Seasonal flood	S	M	OD			FAC/FAC+
Rio Grande cottonwood	*Populus deltoides var.*	Seasonal flood	S	M	OD			FAC/FAC+
Native plum	*Prunus americana*	Upland		M	OD	OM		UPL/FACU
Chokecherry	*Prunus virginiana*	Seasonal flood		M	OD			UPL/FACU
Three leaf sumac	*Rhus trilobata*	Upland		M	OD	OM	X	UPL/FACU
Golden currant	*Ribes aureum*	Upland		M	OD	OM		FACW
Wood's rose	*Rosa woodsii*	Upland		M	OD	OM		FACU/FAC
Peachleaf willow	*Salix amygdaloides*	Seasonal flood	S	M	OD			FACW
Coyote willow	*Salix exigua*	Seasonal flood	S	M	OD			FACW/OBL
Gooding's willow	*Salix goodingii*	Seasonal flood	S	M	OD			
Silver buffaloberry	*Shepherdia argentea*	Upland				OM	X	UPL

Table 3-4. Upland seed mix for seeding disturbed areas. Prices reflect 2010 quote.

Common Name	Percent of mix	Bulk lbs/acre	Price per lb.	Price per acre
Sand dropseed	28%	4	$5.50	$22
Blue grama	30%	12	$8.00	$96
Side oats grama	20%	10	$5.50	$55
Needle-and-thread	2%	3	$50.00	$150
Indian ricegrass	20%	9	$17.00	$153
Total	100%	38		$476

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4 - *Effects Analysis

4.1 Environmental Quality

The effects of the proposed action were evaluated based on comparison of the existing (baseline) and future without project (No Action) conditions for the floodplain and riparian zone. The No-Action and proposed action alternatives would not adversely affect geology and soils, sponsor agricultural lands and practices, water quality, cultural and socioeconomic resources, environmental justice, Indian Trust Assets, or recreation. The proposed action would increase floodplain connectivity, benefitting the riparian habitat and associated wildlife.

4.2 National Ecosystem Restoration Analysis

The Feasibility Study for the Española Valley Ecosystem Restoration Project followed the USACE six-step planning process specified in Engineering Regulation (ER) 1105-2-100. This process is used to identify and respond to problems and opportunities associated with the Federal objective and specific State and local stakeholder concerns. The process provides a framework for problem solving and sound decision making. A number of alternatives were considered and rejected, including: 1) the No Action Alternative; and 2) alternatives with recreational and interpretive features.

4.2.1 <u>Description and Evaluation of Alternatives</u>

4.2.1.1 No Action Alternative Summary

Without-project future conditions were projected using CHAP for comparison of restoration benefits. The Rio Grande Valley, the river, floodplain, and the associated fish and wildlife populations would be expected to continue to experience adverse effects from channel incision, invasive plant species, and Federal, State, and private water resource development projects. The local sponsors would continue removal of non-native vegetation as they are able, but the proposed measures for increasing floodplain connectivity would not be constructed.

4.2.1.2 Tentatively Selected Plan Summary

The Tentatively Selected Plan is based on Best Buy Plan #37 (Appendix B of the main report) generated by the Incremental Cost Analysis (CE/ICA). The Tentatively Selected Plan represents the most cost-effective aggregation of restoration features that best meet the objectives of the restoration project. Implementation of the Tentatively Selected Plan would restore approximately 272 acres of the project area by improving hydrologic connectivity with the floodplain and supporting native vegetation. In addition, recreational use of the bosque would be improved by creating designated trails with benches, signs and other interpretive features.

4.2.1.3 Selected Alternative

The Tentatively Selected Plan consists of ecosystem restoration measures to restore 272 acres of the bosque (Table 4-1) within the Study Area. The measures are designed to (1) improve hydrologic connectivity with the floodplain by constructing grade restoration facilities (GRFs), high-flow channels, terrace lowering, willow swales and wetlands, and (2) restore native vegetation and habitat by reduction of exotic species, and riparian forest revegetation with native plant species. The restoration measures proposed by the habitat team were refined by the sponsors prior to incremental cost analysis. The proposed ecosystem measures would result in a net increase of 6,271 habitat units at year 25, and 8,258 habitat units at year 50. Work would be phased over seven to ten years with an initial construction phase potentially in the fall of 2017.

Table 4-1 Summary of proposed ecosystem restoration measures.

Ohkay Owingeh	94.0 total acres
Grade Restoration Facilities (4 essential GRFs)	12.2
Grade Restoration Facilities (2 optional GRFs)	4.5
High-flow channel	1.8
Swale / wetland	19.2
Terrace lowering	37.6
Vegetation Management	18.7
Santa Clara Pueblo	177.9 total acres
High-flow channel	20.4
Swale	47.7
Swale / wetland	17.0
Terrace lowering	7.7
Vegetation Management	85.1

4.2.1.4 Access and Staging

All proposed measures are in proximity to the river channel. Access through the riparian forest to the river edge is available. A temporary access road from the nearest existing road would be constructed to access proposed construction areas. These temporary access roads would be removed and reseeded once construction is complete unless requested by the sponsor. Any additional disturbance caused by equipment accessing the site would be reseeded with native vegetation and mulched once complete.

Access to all work areas would occur along existing roads, and staging would occur in adjacent open areas made available by the sponsor. Equipment would access proposed construction areas from the nearest road. Staging could also take place within the bosque if other areas are not available. Additional access and subsidiary staging areas required to facilitate construction activities would be coordinated with the sponsors.

Table 4-2 Measures organized by sponsor and identification number.

Santa Clara Ecosystem Restoration Management Measures		
3054	Swale (wetland/marsh/wet meadow)	
3047	Vegetation Removal	
3146	Swale	
3049	Swale	
3159	High Flow Channel	
3161	High Flow Channel	
3046	Willow Swale	
3158	High Flow Channel	
3035	Vegetation Removal	
3155	High Flow Channel	
3145	Bank Destabilization	
3026	Vegetation Removal	
3034	Vegetation Removal	
3164	High Flow Channel	
3154	High Flow Channel	
3144	Bankline Lowering	
3021	Vegetation Removal	
3020	Bankline Lowering	
3032	Vegetation Removal	
3150	High Flow Channel	
Ohkay Owingeh Ecosystem Restoration Management Measures		
3016	Bankline Lowering	
3205	Gradient Restoration Facility	
3124	Terrace Lowering	
3125	Terrace Lowering	
3123	Terrace Lowering	
3212	Gradient Restoration Facility	
3211	Gradient Restoration Facility	
3014	Vegetation Removal	
3213	High Flow Channel	
3115	Terrace Lowering	
3203	Terrace Lowering	
3209	Terrace Lowering	
3201	Terrace Lowering	
3208	Terrace Lowering	
3002	Vegetation Removal	

4.2.2 404 (B) (1) Analysis - Española Valley, Rio Grande and Tributaries, New Mexico Study

I. Project Description

The Proposed Action would include 272 acres of the bosque that would be restored by enhancing hydrologic function (by constructing wet features such as grade restoration facilities, high-flow channels, willow swales, and wetlands) and restoring native vegetation and habitat by removing exotic tree species, and riparian gallery forest restoration. The Proposed Action Area is approximately 20 miles in length along the river and roughly 3,650 acres in size.

a. Location

The Proposed Action Area includes the bosque between state highways 74 -582 (north) and 502 (south) in Rio Arriba and Santa Fe Counties, New Mexico. The Proposed Action Area includes the bosque within the Pueblo of Ohkay Owingeh and the Pueblo of Santa Clara lands, and those lands are managed by the respective Pueblos.

The Northern border for the Pueblo of Ohkay Owingeh forms the north boundary of the Proposed Action Area. The west boundary of the Proposed Action Area on Ohkay Owingeh Pueblo is defined as the western edge of the Rio Chama and Rio Grande floodway up to the boundaries with private landowners. The east boundary of the Proposed Action Area on Ohkay Owingeh Pueblo is defined as the eastern extent of the Rio Grande floodplain within the pueblo which includes irrigation canals and drains. The Southern border for the Pueblo of Santa Clara forms the south boundary of the Proposed Action Area. The east and west boundaries of the Proposed Action Area on Santa Clara Pueblo is defined by the extent of riparian forest and floodplain on both sides of the Rio Grande floodway.

b. General Description See above.

c. Authority and Purpose

Authorization

The U.S. Army Corps of Engineers, Albuquerque District (Corps), in cooperation with Ohkay Owingeh and Santa Clara Pueblos as the local sponsors and other stakeholders, is proposing an ecosystem restoration project in the Middle Rio Grande Bosque (bosque) within the Espanola reach, specifically from the north boundary Pueblo of Ohkay Owingeh to the south boundary of Santa Clara Pueblo. "Bosque" is a Spanish word that is used traditionally in the southwest to refer to a wooded riparian area.

The authority for this Proposed Action was derived from a series of Congressional actions authorizing projects on the Rio Grande, particularly in the Middle Rio Grande (MRG). These authorizations began with the basic flood control authorization for the Middle Rio Grande Public Law No. 228, 77th Congress, 1st Session, H.R. 4911 dated 18 August 1941. House of Representatives Resolution, dated 11 April 1974 requested a study of environmental enhancement on the Rio Grande. On 10 December 2009, the U.S. Senate Committee on Environment and Public Works of the 111th Congress, 1st Session, directed the Secretary of the Army to review the report of the Chief of Engineers on the Rio Grande and Tributaries transmitted to Congress on 27 June 1949 and related reports to determine whether additional projects were necessary in the Española Valley to meet Federal flood risk management, ecosystem restoration and allied goals.

The area is maintained as a part of the Middle Rio Grande Flood Control Acts of 1941 and 1950 and is within the *Facilities of the Middle Rio Grande Floodway Project* which resulted in the construction of additional levees and dams between Espanola and San Marcial, NM (USACE 2002, 2003a, 2007, 2008a,b).

In 1991 and 1992, USACE conducted an initial reconnaissance study to evaluate the federal interest in pursuing a flood risk management study in the Española Valley of northern New Mexico. The study was terminated in September 1996 with the completion of a draft feasibility report.

After the termination of the feasibility phase in 1996, there was significant interest among the public, tribes, and agencies in resuming the evaluation of potential projects in the Española Valley.

Significant interest in evaluating a valley wide, multi-purpose, river restoration, recreation, and flood risk management project by the general the public and tribes encouraged USACE to revisit the study. As a result, a 905(b) analysis to rescope the 1996 study reconfirmed the federal interest in continuing into a new feasibility phase in December 2004. On December 21, 2005, the Pueblos of Santa Clara, San Ildefonso, and Ohkay Owingeh signed a Feasibility Cost Sharing Agreement with USACE which marked the beginning of the feasibility study, known as the Española Valley, Rio Grande and Tributaries, New Mexico, Detailed Feasibility Study. Each Pueblo agreed to share equally in the sponsorship of the project and formed individual Project Delivery Teams (PDTs) consisting of technical experts, legal counsel, and project managers (PMs).

Purpose and Need

On a regional scale, estimates of riparian habitat loss in the Southwest range from 40% to 90% (Dahl 1990), and desert riparian habitats are considered to be one of this region's most endangered ecosystems (Minckley and Brown 1994, Noss et al. 1995). Decline of natural riparian structure and function of the bosque ecosystem was recognized in the 1980s as a major ecological change in the MRG (Hink and Ohmart 1984; Howe and Knopf, 1991). In ecological terms, the cumulative effects of agriculture, urban development and flood protection measures have resulted in a disruption of the original hydrologic (hydraulic) regime along the Española reach of the Rio Grande and the ultimate degradation of the bosque ecosystem.

This regime is key to sustaining and regenerating a variety of ecological components that make up the bosque, and the wildlife that it supports. Whereas it is not possible to return the Rio Grande to its pre-flood protection state, there are abundant opportunities to restore function and habitat value within the constraints of climate change and current water use restrictions without imposing flood damages.

The mosaic or patchy distribution of habitats that once made up the bosque has changed dramatically since the 17th Century (Pittenger 2003, Scurlock 1998). With changes in land use and settlement, the size and composition of various patches within the bosque have also changed (Scurlock 1998). The existence in recent decades of a continuous bosque forest between the river and the levee appears to be unprecedented. Many bosque researchers and commentators now believe that historically the bosque was a dynamic mosaic of riparian wetlands, channels, woodlands, shrub thickets and periodically wet meadows (Pittenger 2003, Crawford et al. 1998). Frequency of flooding, water table elevation and the type of sediment substrate were and continue to be important determining factors of patch type and structure. Though the manmade flood control structures that now regulate the river and bosque, for the most part, must stay in place, one of the main goals of this Proposed Action is to look for alternatives to reconnect the bosque and river floodplain.

Another problem that is now in existence is the presence (and in many cases dominance) by non-native vegetation. It is most likely not possible to totally eradicate all non-native vegetation within the 20 miles/3,650 acres of the bosque. Therefore, another purpose for this Proposed Action is to look at integrating the non-native with native species to an acceptable level.

The hydrologic cycle in the Rio Grande and Rio Chama is critical to the function of the bosque cottonwood riparian communities and wetlands. It follows a pattern of high flows during spring snowmelt runoff and low flows during the fall and winter months. Additional high flows of short duration result from thunderstorms that occur in the late summer months. The high flows across the floodplain facilitated nutrient cycling, seed dispersal and seed establishment. The inundation and high water table recharged wetlands and provided for seasonal growth and nurturing of existing plant communities.

Much of this inundation has been reduced by the disconnection between the river and floodplain due to channel straightening, decreased sediment supply, and channel head-cutting from gravel mining. This also created the loss of high- flow and side channels in the system. This 'reconnection of function' can be obtained, however, through restoration features such as the development of high flow channels, backwater channels and other features that connect the bosque and the main channel.

These potential features will be further discussed below.

Based on the hydrologic and ecological problems discussed above, a number of key purpose and needs of the Proposed Action were developed and include:

1. Implement measures to reestablish fluvial processes in the bosque, including grade restoration facilities (GRFs), terrace lowering, promote overbank flooding and high-flow/side channel creation.
2. Improve habitat quality and increase the amount of native bosque communities while creating greater stand diversity in terms of stand age, size and composition within the bosque (a mosaic).
3. Promote bosque habitat heterogeneity by recreating pockets of new cottonwood, willow and other native species throughout Proposed Action Area where root zones reach the shallow water table.
4. Create new wetland habitat while extending and enhancing quality aquatic habitat in existing wetlands.
5. Recreate hydraulic connections between the bosque and the river consistent with operational constraints.
7. Protect, extend and enhance areas of potential habitat for listed species within the existing bosque.
8. Develop and implement a long-term operations and maintenance plan, which incorporates long-term monitoring of proposed restoration features.
9. Coordinate and integrate project implementation and monitoring with other,

ongoing restoration and research efforts in the bosque.

10. Create opportunities for educational or interpretive features, while integrating recreational features that are compatible with ecosystem integrity.
11. Continue to engage the public in the restoration of the bosque ecosystem by garnering input and involvement.

d. General Description of Dredged or Fill Material

During construction of the proposed grade restoration facilities, a temporary diversion structure will need to be extended from the bank of the Rio Grande, which is a water of the United States. During construction of the proposed high flow channels, a temporary diversion structure may need to be placed at the bank of the Rio Grande, which is a water of the United States.

(1) General Characteristics of Material (grain size, soil type)

Soils along the bank of the river are fine-grained alluvial silts, sands, and gravels. Soils derived from these deposits in the Study Area are Torrifluvents, Calciorthids and Torriorthents (Soil Conservation Service 1974). Grain size is therefore very small.

(2) Quantity of Material (cubic yards, CY)

The approximate quantity of material to be removed is approximately 132,286 CY from the overbank and channel cut for the grade restoration facilities. This material would be removed and used within the site to build up berms along the channel or other features (such as the outfall channel habitat) but some of this dredged material would be hauled off site. The quantity of backfill for the grade restoration facilities overbank and channel is approximately 87,900 CY. Cobble backfill would be 14,857 CY, sand and gravel backfill would be 11,276 CY, and the gravel filter would be 16,912 CY. Total riprap would be 45,104 CY, with an additional 2,264 3-foot boulders.

The approximate quantities of material to be removed from the high-flow channels (87,100 CY), swales (308,100 CY), swale/wetlands (109,800 CY), and terrace lowering (234,100 CY). This material would be removed and used within the site to build up berms along the channel or other features (such as the outfall channel habitat) but some of this dredged material would be hauled off site.

(3) Source of Material

Riprap and clean sediment excavated from the channel and adjacent overbank area would be placed during the construction of the grade restoration facilities for this project. No material would be placed during the construction of other features for this project.

e. Description of the Proposed Discharge Site(s)

No material would be discharged during construction of this project.

(1) Location (map)
(2) Size (acres)
(3) Type of Site (confined, unconfined, open water)
(4) Type(s) of Habitat
(5) Timing and Duration of Discharge

f. Description of Disposal Method (hydraulic, drag line, etc.)

Some of the excavated material (87,900 CY) would be placed for construction of the GRFs. The balance of material (783,500 CY) would be removed and used within the site to build up berms along the channel or other features (such as the outfall channel habitat) but none of this dredged material would be placed. If excess material exists, it would be hauled off site and deposited at an approved location.

II. Factual Determination

A coffer dam would be placed at the bank edge and pushed out into the water to create a 'work zone' during construction of each grade restoration facility. Sediment within this area would be graded, with additional clean sediment from the adjacent overbank, and rock placed in the river for the GRF as described in Section d(2). Therefore, there would be short term effects on waters of the US from the temporary placement and removal of the coffer dam during construction.

If needed, a coffer dam would be placed at the bank edge and pushed out into the water to create a 'work zone' during construction of the inlet and outlet of the high-flow channels. Sediment dredged within this area would be removed as described in Section f and would not be allowed to discharge or be placed in the river.

Installation of structures would occur between August and March. Rio Grande discharge is normally lowest during this portion of the year. At each structure, coffer dams placed near the channel centerline would divert flow to one side of the channel to facilitate construction of half of the structure at a time. Coffer dams would consist of on-site earthen material or steel frames covered with geotextile fabric, and would be installed and removed following best management guidelines. Pumps would be utilized to keep the active work area dry.

Coffer dams would extend at least 500 feet upstream from each GRF. Excavated waste soil would be deposited within this dry area to fill the upstream space created by the bed elevation rise of the GRF, and, following reintroduction of flow, would provide sediment to fill the voids within the GRFs' riprap aprons. A total of about 65,700 CY of material would be placed within dry portions of the channel during construction of GRFs. A total of about 22,200 CY of material would be placed in the adjacent overbank area during construction of GRFs. Therefore, there would be long term, positive effects on waters of the US from the construction of the GRFs.

Construction of the GRFs and downstream bed sill entails the placement of fill in areas classified as Waters of the United States under Section 404 of the Clean Water Act. An individual Section 404 permit would be obtained from the Regulatory Branch of the Albuquerque District prior to the start of construction activities. Section 401 Water Quality Certification has been obtained from each Pueblo. Therefore, the placement of clean fill for construction of the GRFs would result in permanent, beneficial effects on waters of the US by rasing the channel bed elevation relative to the surrounding floodplain.

The initial reintroduction of flow to previously coffer dammed areas would increase turbidity slightly immediately downstream from the GRFs. Bed material within the channel is primarily coarse sand and gravel with only a small percentage of suspended fine particles; therefore, increased turbidity should extend no more than one mile downstream from a structure. The temporary elevated turbidity would be similar to levels occurring annually in the Rio Grande during the spring runoff period and would not pose a threat to aquatic life. Therefore, there would be short term effects on waters of the US from the use of the coffer dams to create an in-channel workzone.

a. Physical Substrate Determinations

(1) Substrate Elevation and Slope – Substrate elevation is in line with the bank of the river and a steep slope exists. This would be modified to allow a connection of the existing high flow channel to the river.

(2) Sediment Type – Sediments are those described in d.(1) as well as in river sediments consisting of organic and inorganic solid materials.

(3) Dredged/Fill Material Movement - Movement of dredged material would be limited by the methodology of removal as well as the installation of the coffer dam where needed. Material from the grade restoration facilities would be removed by an excavator and processed for placement back in the river and adjacent overbank area. Excess material would be placed directly into a dump truck to be used on site (outside of the river) or hauled off site.

(4) Physical Effects on Benthos (burial, changes in sediment type, etc.) – Benthos would be affected during dredging of the material at the bank and in the channel of the river. Placement of previously dredged material would not affect benthos within the work zone created by the coffer dam. Benthos is expected to re-colonize the GRF surface substrate following removal of the coffer dam.

(5) Other Effects – Fish may also be affected by the dredging. The installation of the coffer dam will assist in minimizing effects to fish. The placement of cobble and riprap for the GRFs will have a positive effect on fish habitat.

(6) Actions Taken to Minimize Impacts –

- If a disposal site is needed (other than on site outside of the river), a site that has been previously used for dredged material would be utilized.
- As described above, a coffer dam would be placed in the river and dewatered in order to create a work zone for the GRFs.
- As described above, a coffer dam would be placed in the river and dewatered (if needed) in order to create a work zone for floodplain features.
- Work area would be monitored for fish or invertebrates present. If any are found, they would be placed back into the river.
- Construction of the diversion structures (coffer dam or other) would be performed during low-flow conditions outside of the spring runoff and summer thunderstorm seasons.
- Sediment and erosion controls would be used to prevent bank and streambed erosion if storm evens occur during the construction period and before stream banks are permanently stabilized.

b. Water Circulation, Fluctuation and Salinity Determinations

The coffer dam would be installed at the edge of the bank for the work zone to minimize impacts to water quality in the main channel of the river.

(1) Water – There would minimal, short-term effects to water quality during the installation and removal of the coffer dam for high-flow channel construction and grade restoration facilities. Water quality would be monitored before, during and after installation and removal of coffer dams in order to determine any major changes in the following:

(a) Salinity – No change in salinity is expected.
(b) Water Chemistry (pH, etc.) – pH and dissolved oxygen may change slightly due to this action.
(c) Clarity – Clarity would be affected during and after installation and removal of the coffer dam.
(d) Color – Color would be affected during and after installation and removal of the coffer dam.
(e) Odor – There may be an additional odor due to the excavation of river and/or wetland sediments.
(f) Taste – Taste of water may be more silty due to this action.
(g) Dissolved Gas Levels – DO levels may drop during and after installation and removal of the coffer dam.
(h) Nutrients – Nutrient levels may change during and after installation and removal of the coffer dam.
(i) Eutrophication – Eutrophication may be affected during and after installation and removal of the coffer dam.
(j) Others as Appropriate

(2) Current Patterns and Circulation - Current patterns of flow and circulation would not be affected by the constructed GRFs, but would be affected during and after installation and removal of the coffer dam as follows:
(a) Current Patterns and Flow – Patterns and flow at the bank edge would be disturbed during and after installation and removal of the coffer dam.
(b) Velocity – Velocity would be slightly affected during and after installation and removal of the coffer dam. Since the coffer dam would be fairly small in size, water would be diverted around it.
(c) Stratification – Stratification may be affected as the water column is stirred up during and after installation and removal of the coffer dam.
(d) Hydrologic Regime – Hydrologic regime would be fairly unaffected.
(3) Normal Water Level Fluctuations (tides, river stage, etc.) - Normal water level would not be affected.
(4) Salinity Gradients – NA.

(5) Actions That Will be taken to minimize impacts:
- Water quality would be monitored before, during and after construction in order to determine any major changes in water chemistry.
- Care would be taken to minimize effects on water quality and flow during installation of the coffer dam by pushing the water column out from the edge of the bank slowly.

- Construction of the diversion structures (coffer dam or other) would be performed during low-flow conditions outside of the spring runoff and summer thunderstorm seasons.
- Sediment and erosion controls would be used to prevent bank and streambed erosion if storm evens occur during the construction period and before stream banks are permanently stabilized.

c. Suspended Particulate/Turbidity Determinations

(1) Expected changes in suspended particulates and turbidity levels in vicinity of disposal site – Suspended particulates and turbidity levels would increase during and after installation and removal of the coffer dam.
(2) Effects – There would be minimal short-term effects to suspended particulates and turbidity during and after installation and removal of the coffer dam.
(a) Light Penetration – Light penetration would be affected for a short period of time during and after installation and removal of the coffer dam.
(b) Dissolved Oxygen – Dissolved oxygen (DO) may drop during and after installation and removal of the coffer dam. DO would be monitored during and after installation and removal of the coffer dam.
(c) Toxic Metals and Organics – Toxic metals and organics are not anticipated to occur due to construction.
(d) Pathogens – Pathogens are not anticipated to be found due to construction.
(e) Aesthetics – Aesthetics would be altered for a short time during construction.
(f) Others as Appropriate

(3) Effects on Biota – Macroinvertebrates, microinvertebrates, amphibious and/or fish species may be affected by these short term impacts to water quality based on suspended particulates and/or turbidity. Since this impact would be limited to a short period of time during and after installation and removal of the coffer dam, the following factors should not be affected:
(a) Primary Production, Photosynthesis
(b) Suspension/Filter Feeders
(c) Sight Feeders

(4) Actions taken to minimize impacts:
- Care would be taken to minimize effects on suspended particulates and turbidity in the water during installation of the coffer dam by pushing the water column out from the edge of the bank slowly.
- This area would be monitored for amphibians, fish or invertebrates present. If any are found, they would be placed back into the river.
- Construction of the diversion structures (coffer dam or other) would be performed during low-flow conditions outside of the spring runoff and summer thunderstorm seasons.
- Sediment and erosion controls would be used to prevent bank and streambed erosion if storm evens occur during the construction period and before stream banks are permanently stabilized.

d. Contaminant Determinations - Contaminants would not be increased due to construction of this project. Therefore, the required determinations pertaining to the presence and effects of contaminants can be made without testing.

e. Aquatic Ecosystem and Organism Determinations - Since there is no anticipated addition of contaminants due to construction, the following would not be affected by construction of the project due to contaminants.

(1) Effects on Plankton
(2) Effects on Benthos
(3) Effects on Nekton
(4) Effects on Aquatic Food Web
(5) Effects on Special Aquatic Sites

(a) Sanctuaries and Refuges – Not applicable.
(b) Wetlands – Wetlands would be avoided during construction of the high-flow channels. There is no wetland habitat adjacent to the channel where excavation to connect the channel to the river would take place. Dredging along the bank of the river would occur and therefore, this analysis concludes that activities would be covered under Nationwide Permit #33. Construction of the restoration features adjacent to the bank of the river would be covered under Nationwide Permit #27, Aquatic Habitat Restoration, Establishment and Enhancement Activities.
(c) Mud Flats – Not applicable.
(d) Vegetated Shallows - Not applicable.
(e) Coral Reefs – Not applicable.
(f) Riffle and Pool Complexes – Construction of the grade restoration facilities may have a short-term effect on riffle and pool complexes during construction only. Installation of the coffer dam to excavate the high-flow channel may have a short-term effect on riffle and pool complexes during construction only.

(6) Threatened and Endangered Species - Refer to Section 4.4.5 and Appendix C (including the BA and BO) of the integrated report.
(7) Other Wildlife – Refer to Section 4.11 of the DEA.
(8) Actions to Minimize Impacts – Actions to minimize impacts as described in the Biological Assessment and Biological Opinion would be implemented including the following:
    - All conditions for Nationwide Permits 33 and 27 would be adhered to during construction.
    - BMPS's discussed in reference to fish would be implemented as follows:
    - The use of silt fences adjacent to the riverbank to prevent erosion to the river.
    - Work zones to the river would be blocked when constructing the High- Flow Channels.
    - Fueling of vehicles would not take place inside the 100 year floodplain,
    - Storage of equipment and vehicles would not occur in the bosque.
    - The proposed work would occur during the winter, which is when Bald Eagles may be in or near the Proposed Action Area. In order to minimize the potential for disturbing Bald Eagles utilizing adjacent habitat, the following guidelines would be employed. If a Bald Eagle is present within 0.25 mile upstream or downstream of the active construction site in the morning before activity starts,

or is present following breaks in project activity, the contractor would be required to suspend all activity until the bird leaves of its own volition; or an USACE biologist, in consultation with the USFWS, would determine that the potential for harassment is minimal. However, if a Bald Eagle arrives during construction activities or if an eagle is greater than 0.25 mile away, construction need not be interrupted.

- Conduct flycatcher protocol presence/absence surveys within the proposed action area, or coordinate with Ohkay Owingeh and/or the Pueblo of Santa Clara if flycatcher surveys already take place, in order to determine the most accurate and up to date flycatcher territory locations. To the extent possible, adjust access or other construction activities to avoid the territory and minimize fragmentation of the occupied habitat patch.
- Ensure that habitat within 0.25 miles of a historic flycatcher territory (within 2 years prior to construction) lost to construction activities is restored to the same amount (estimated 25.38 acres) of suitable habitat within 3-4 years of the proposed action. In the event habitat does not naturally regenerate with native species, active planting or restoration in the density required to accommodate nesting activity must take place and be available to the flycatcher by year 2030 (3 years after construction is complete). Suitable habitat is considered a patch at least 33 feet wide and 4.5 acres in size with canopy cover being 50% (or more) and woody stem density of approximately 2800 stems per hectare (1133 stems per acre).

f. <u>Proposed Disposal Site Determinations</u> – Any excess excavated material would be hauled to an approved site.

(1) Mixing Zone Determination – Not applicable.

(2) Determination of compliance with applicable water quality standards – All standards listed in the Nationwide Permits 33 and 27, 401 water quality certification, and Section 402 (p) of the CWA would be adhered to during construction.

(3) Potential effects on human use characteristic – Human use would not be affected by the proposed project.

(a) Municipal and Private water supply – The proposed project is not within or adjacent to municipal or private water supplies.

(b) Recreational and commercial fisheries - Not applicable.

(c) Water related recreation – No recreational resources would be affected by the proposed project.

(d) Aesthetics – As discussed above, water quality would be affected during construction. Turbidity would be increased for a short duration.

(e) Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and similar preserves – The proposed project is within the Rio Grande Valley State Park. All rules and regulations of the Park would be adhered to during construction.

g. <u>Determination of Cumulative Effects on the Aquatic Ecosystem –</u> There are numerous high-flow channels proposed within the project. They are located within the 20 miles project area. Implementation of the Proposed Action would likely take place over five to ten years. Construction of water features (GRFs and high- flow channels) would be phased in order to minimize impacts to water quality. All actions to minimize impacts as described above would be implemented in order to reduce this cumulative effect as much as possible. Also, each channel would be constructed from the downstream end to the upstream end so that no sediment loosened by the construction would outflow into the river. It would all be removed before the upstream end is excavated and the coffer dam removed.

h. Determination of Secondary Effects on the Aquatic Ecosystem – The placement of fill proposed for the GRFs within this project would increase the channel bed elevation within the current channel width. The riprap would increase channel roughness, decreasing water velocity along the channel bed. Therefore, the no secondary effects on the aquatic ecosystem are anticipated to be beneficial.

III. Findings of Compliance or Non-Compliance with the restrictions on discharge

a. Adaptation of the Section 404(b) (1) Guidelines to this Evaluation – Not applicable.

b. Evaluation of Availability of Practicable Alternatives to the Proposed Discharge site which would have less adverse impact on the aquatic ecosystem
There is no discharge site proposed within the project.

c. Compliance with applicable state and tribal water quality standards
The proposed action is in compliance with applicable state water quality standards. Concurrence (and a 401 water quality certificate, if required) from each pueblo.

d. Compliance with applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act
Not applicable.

e. Compliance with Endangered Species Act of 1973

The proposed project is in compliance with the Endangered Species Act of 1973. Effects on listed species have been determined and are discussed in Section 5.3.4 of the combined report. A Biological Assessment requesting concurrence was submitted to the U.S. Fish and Wildlife Service, as required.

f. Compliance with specified protection measures for marine sanctuaries designated by the Marine Protection, Research and Sanctuaries Act of 1972
Not applicable.

g. Evaluation of Extent of Degradation of the Waters of the United States

(1) Significant adverse effects on human health and welfare – No significant adverse effects on human health or welfare would occur due to the proposed project.
(a) Municipal and private water supplies – No effect to municipal or private water supplies would occur from the proposed project.
(b) Recreation and commercial fisheries – No effect to recreation or commercial fisheries would occur from the proposed project.
(c) Plankton – Plankton would not be affected by the proposed project.

(d) Fish - Fish species may be affected by these short term impacts to water quality based on suspended particulates and/or turbidity.
(e) Shellfish – Shellfish would not be affected by the proposed project.
(f) Wildlife – Wildlife would not be affected by the proposed project.
(g) Special Aquatic sites – No applicable.

(2) Significant adverse effects on life stages of aquatic life and other wildlife dependent on aquatic ecosystems – There would not be significant adverse effects on life stages of aquatic life and other wildlife dependent on aquatic ecosystems.
(3) Significant adverse effects on aquatic ecosystem diversity, productivity and stability - There would not be significant adverse effects on aquatic ecosystem diversity, productivity and stability.
(4) Significant adverse effects on recreational, aesthetic, and economic values - There would not be significant adverse effects on recreational, aesthetic, and economic values.

h. Appropriate and practicable steps taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem – All of the actions to minimize potential adverse impacts of the proposed project as listed above include:

- If a disposal site is needed (other than on site outside of the river), a site that has been previously used for dredged material would be utilized.
- As described above, a coffer dam would be placed in the river and dewatered (if needed) in order to create a work zone.
- This area would be monitored for fish or invertebrates present. If any are found, they would be placed back into the river proper.
- Construction of the diversion structures (coffer dam or other) would be performed during low-flow conditions outside of the spring runoff and summer thunderstorm seasons.
- Sediment and erosion controls would be used to prevent bank and streambed erosion if storm evens occur during the construction period and before stream banks are permanently stabilized.
- Water quality would be monitored during construction in order to determine any major changes in water chemistry.
- Care would be taken to minimize effects on water quality and flow during construction.
- Care would be taken to minimize effects on suspended particulates and turbidity in the water during installation of the coffer dam by pushing the water column out from the edge of the bank slowly .
- This area would be monitored for amphibians, fish or invertebrates present. If any are found, they would be placed back into the river proper.
- All conditions for the Nationwide Permits 33 and 27 would be adhered to during construction.
- The use of silt fences adjacent to the riverbank to prevent erosion to the river.
- Work zones to the river would be blocked when constructing the High- Flow Channels.

- Fueling of vehicles would not take place inside the levees,
- Storage of equipment and vehicles would not occur in the bosque.
- The proposed work would occur during the winter, which is when Bald Eagles may be in or near the Study Area. In order to minimize the potential for disturbing Bald Eagles utilizing adjacent habitat, the following guidelines would be employed. If a Bald Eagle is present within 0.25 mile upstream or downstream of the active construction site in the morning before activity starts, or is present following breaks in project activity, the contractor would be required to suspend all activity until the bird leaves of its own volition; or an USACE biologist, in consultation with the USFWS, would determine that the potential for harassment is minimal. However, if a Bald Eagle arrives during construction activities or if an eagle is greater than 0.25 mile away, construction need not be interrupted.

i. <u>On the basis of the guidelines, the proposed disposal site(s) for the discharge of dredged or fill material</u>

(1) Specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem.

4.2.3 Letters for Tribal Water Quality Certification

DEPARTMENT OF THE ARMY
ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS
4101 JEFFERSON PLAZA NE
ALBUQUERQUE NM 87109-3435

August 4, 2017

Planning, Project and Program Management Division
Planning Branch
Environmental Resources Section

Ms. Naomi Archuleta
Ohkay Owingeh
Environment Department
P.O. Box 717
San Juan, NM 87566

Dear Ms. Archuleta:

The U.S. Army Corps of Engineers (Corps) has been working with our sponsors, Ohkay Owingeh and Santa Clara Pueblo on ecosystem restoration in the Española Valley, Rio Grande and Tributaries, New Mexico Project. The Corps is hereby requesting Water Quality Certification pursuant to Section 401 of the Clean Water Act for activities associated with the Española Valley Project.

A notice of availability of the draft integrated feasibility report and Draft Environmental Assessment document was available electronically on the Albuquerque District website in October through December 2015 for public comment. In addition, the Corps published notices of availability in local newspapers (Santa Fe New Mexican) starting on October 12, 2015.

Pueblo staff have reviewed the proposed project and provided input throughout the planning process.

As is the case for the Corp's construction projects, the inclusion of 404(b)(l) Guidelines Evaluation in decision documents fulfills the Section 404 process (that is, the Corps does not issue Section 404 permits to itself). Enclosed is an updated 404(b)(1) Guidelines Evaluation (enclosure 1) and Environmental Commitments (enclosure 2) which shall be included in the final decision document. We are requesting Tribal Water Quality Certification for the proposed project.

Because the duration of construction for the project may be as long as 10 years, please be sure to inform us of any requirements for reapplication for certification in the future.

If you have any questions relating to this project, please contact Dr. Michael D. Porter of my staff, at 505-342-3264 or e-mail at Michael.D.Porter@usace.army.mil.

Sincerely,

George H. MacDonell
Chief, Environmental Resources Section

Enclosures:

DEPARTMENT OF THE ARMY
ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS
4101 JEFFERSON PLAZA NE
ALBUQUERQUE NM 87109-3435

August 4, 2017

Planning, Project and Program Management Division
Planning Branch
Environmental Resources Section

Ms. Shawn Cato
Pueblo of Santa Clara
Office of Environmental Affairs
P.O. Box 580,
Espanola, NM 87532

Dear Ms. Cato:

The U.S. Army Corps of Engineers (Corps) has been working with our sponsors, Ohkay Owingeh and Santa Clara Pueblo on ecosystem restoration in the Española Valley, Rio Grande and Tributaries, New Mexico Project. The Corps is hereby requesting Water Quality Certification pursuant to Section 401 of the Clean Water Act for activities associated with the Española Valley Project.

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Sincerely,

George H. MacDonell
Chief, Environmental Resources
Section

Enclosures:

Office of Environmental Affairs

P.O. Box 717
Ohkay Owingeh, New Mexico 87566
Phone (505) 852-4212 • Fax (505) 852-1432

August 16, 2017

Mr. George H. MacDonell
Department of the Army
Albuquerque, District, Corps of Engineers
Planning, Project & Program Management Division
Environmental Resource Section
4101 Jefferson Plaza NE
Albuquerque, NM 87109-3435

RE: 401 Permit for ARMY CORPS OF ENGINEERS ESPANOLA VALLEY PROJECT

Dear Mr. MacDonell:

The Army Corps of Engineers Planning, Project and Program Management Division has requested a final position on Section 401 Water Quality Certification for the Espanola Valley Project which includes both Ohkay Owingeh and Santa Clara Pueblos. The project is located within the Trust Lands of Ohkay Owingeh. The request is to determine if the project will impact Ohkay Owingeh's Water Quality Standards.

Based on my review of the above mentioned project, the Ohkay Owingeh Office of Environmental Affairs in accordance with Section 106 of the Clean Water Act Part 401 ***hereby issues the 401 Water Quality Certification for activities authorized by the Nationwide Permits (NWP's). The permit will be valid for two years (2) and reapplication for certification will be necessary upon expiration.*** Permitted activities will be conducted in a manner which will not violate the Pueblo's Water Quality Standards and provisions of the Clean Water Act. Due to the proximity of the project directly located in a known waterway (Rio Grande/Rio Chama), the certification is issued under the *conditions* the tribe submitted to the Army Corps of Engineers, dated January 24, 2017, Nationwide Permit Issuance, CWA Section 401 Water Quality Certification.

If you have any questions concerning this 401 Water Quality Certification please feel free to contact me at 505-852-4212.

Sincerely,

Naomi L. Archuleta
Environmental Programs Manager
Office of Environmental Affairs

Xc: File
Water Quality Program

5 - Monitoring, Adaptive Management and Maintenance

5.1 Introduction

Due to the relatively recent emergence of restoration science and inherent uncertainty in some aspects of ecosystem restoration theory, planning and methods, success can vary based on a variety of technical and site-specific factors. Recognizing this uncertainty, it is prudent to allow for contingencies to address potential problems in meeting restoration goals that may arise during or after project implementation. Recent USACE guidance (*Implementation Guidance for Section 2039 of the Water Resources Development Act of 2007 – Monitoring Ecosystem Restoration*) requires that a plan be developed for monitoring the success of the ecosystem restoration.

The use of restoration measures with demonstrated success in the Middle Rio Grande focuses monitoring on project-level implementation. Implementation of adaptive management at the design and construction phases of the ecosystem restoration project will minimize post-construction changes to project features. A review of previous Rio Grande restoration features for best design and management processes (lessons learned) should be the initial step for implementation of adaptive management at the design stage. Cross-section survey data should be verified, particularly for the grade restoration facilities to ensure the best available elevation data is used for construction. Post-construction monitoring is an important component of the adaptive management process, as performance feedback may generate new insights on ecosystem response and provides a basis for determining the necessity or feasibility of subsequent design or operational modifications (GeoSystems Analysis 2014). Success should be measured by comparing post-project conditions to the restoration project purpose and pre-project conditions.

Monitoring also provides the feedback needed to establish protocols and make adjustments where and when necessary to achieve the desired results. Monitoring of other Rio Grande restoration projects by the USACE and other stakeholders in the Middle Rio Grande Endangered Species Collaborative Program provides information that has been useful in developing goals and alternatives for this project.

Monitoring of project performance and success would be conducted for at least five consecutive years following construction. Wetland and bosque monitoring would include vegetation survival and mortality, wildlife and vegetation species inventories, floodplain inundation monitoring, and other environmental indicators of project level success for the ecosystem restoration measures. Project monitoring would be coordinated with each sponsor and incorporated with ongoing efforts to reduce duplicate effort. These efforts would continue post-construction to show project benefits and changes in use before and after construction. Wildlife use by ecosystem measures may also be conducted to document parameters inputs for CHAP.

An effective monitoring program is necessary to assess the status and trends of ecological health and biota richness and abundance on a per project basis, as well as to report on regional program success within the United States. Assessing status and trends includes both spatial and temporal variations. Gathered information under this monitoring plan will provide insights into the effectiveness of current restoration projects and adaptive management strategies, and indicate where goals have been met, if actions should continue, and/or whether more aggressive management is warranted.

This monitoring plan shall include “1) a description of the monitoring activities to be carried out, the criteria for ecosystem restoration, and the estimated costs and duration of the monitoring; and 2) specify that the monitoring shall continue until such time as the Secretary determines that the criteria for ecosystem restoration success will be met.” Therefore, Section 2039 also directs that a Contingency Plan (Adaptive Management Plan) be developed for all ecosystem restoration projects.

5.2 Authority and Purpose

Section 2039 of WRDA 2007 Monitoring Ecosystem Restoration

1. In General - In conducting a feasibility study for a project (or a component of a project) for ecosystem restoration, the Secretary shall ensure that the recommended project includes, as an integral part of the project, a plan for monitoring the success of the ecosystem restoration.
2. Monitoring Plan - The monitoring plan shall--
    a. include a description of the monitoring activities to be carried out, the criteria for ecosystem restoration success, and the estimated cost and duration of the monitoring; and
    b. specify that the monitoring shall continue until such time as the Secretary determines that the criteria for ecosystem restoration success will be met.
3. Cost Share - For a period of 10 years from completion of construction of a project (or a component of a project) for ecosystem restoration, the Secretary shall consider the cost of carrying out the monitoring as a project cost. If the monitoring plan under subsection (b) requires monitoring beyond the 10-year period, the cost of monitoring shall be a non-Federal responsibility.

5.2.1 <u>Guidance</u>

The following documents provide distinct USACE policy and guidance that are pertinent to the formulation of the project and developing this monitoring and adaptive management plan:

(a) USACE. 2009. Planning Memorandum. Implementation Guidance for Section 2039 of the Water Resources Development Act of 2007 (WRDA 2007) - Monitoring Ecosystem Restoration

(b) USACE. 2000. ER 1105-2-100, Guidance for Conducting Civil Works Planning Studies. Washington D.C.

(c) USACE. 2003a. ER 1105-2-404. Planning Civil Work Projects under the Environmental Operating Principles. Washington, D.C.

5.3 Project Area Description

The study area (Figure 1) is described in Chapter 1 of the main report. Historically, the Rio Grande and the Rio Chama supported substantial growths of cottonwoods, willows, New Mexico olives, shrubs, and wetlands (locally, these riparian communities are termed *bosque*). Riparian habitat comprised approximately 720,000 acres in the 1780s of what would later become the State of New Mexico (only 0.9 percent of New Mexico). This combination of riparian, wetland, and fringe habitat is extremely valuable due to its rarity.

Scurlock (1998) has summarized trends for historic Rio Grande riparian communities over the last 150 years. The Rio Grande and its tributaries have suffered severe channel degradation and no longer regularly inundates the riparian areas, resulting in the loss of riparian habitat. The bosque of the Española Valley study area is an ideal location for restoration because of its unique quality and critical value as wildlife habitat and its importance on a local, regional, national, and international scale.

5.4 Habitat Trends Triggering Restoration

The project proposes measures to reverse the trends of riparian habitat degradation. Important trends include:

- Channel incision from gravel mining and channel straightening
- Reduced floodplain connectivity
- Senescence of the cottonwood gallery forest
- Reduced coverage of native riparian vegetation
- Increased coverage of non-native, invasive vegetation
- Does not contribute habitat to the Rio Grande Flyway

5.4.1 Key Uncertainties.

Future declines in habitat value caused by future channel incision along the Rio Grande and Rio Chama will be variable. The rate of progress for upstream migration of the existing head cuts were estimated over the 50 year period of analysis and described as a linear function, that is, a constant rate of migration.

Changes in the channel bed elevation prior to Grade Restoration Facility construction may require increasing construction material quantities. Specifically, the amount of fill material and rock to stabilize the channel bed and halt the headcut may be increased to achieve the target water surface elevations to inundate adjacent floodplain. Likewise, excavation of terraces, swales, and high-flow channels may require removal of additional materials to produce suitable elevations for floodplain and groundwater connectivity for establishment of riparian vegetation. A high survival rate (low mortality) for vegetation plantings is an important uncertainty that has significant impacts on project costs.

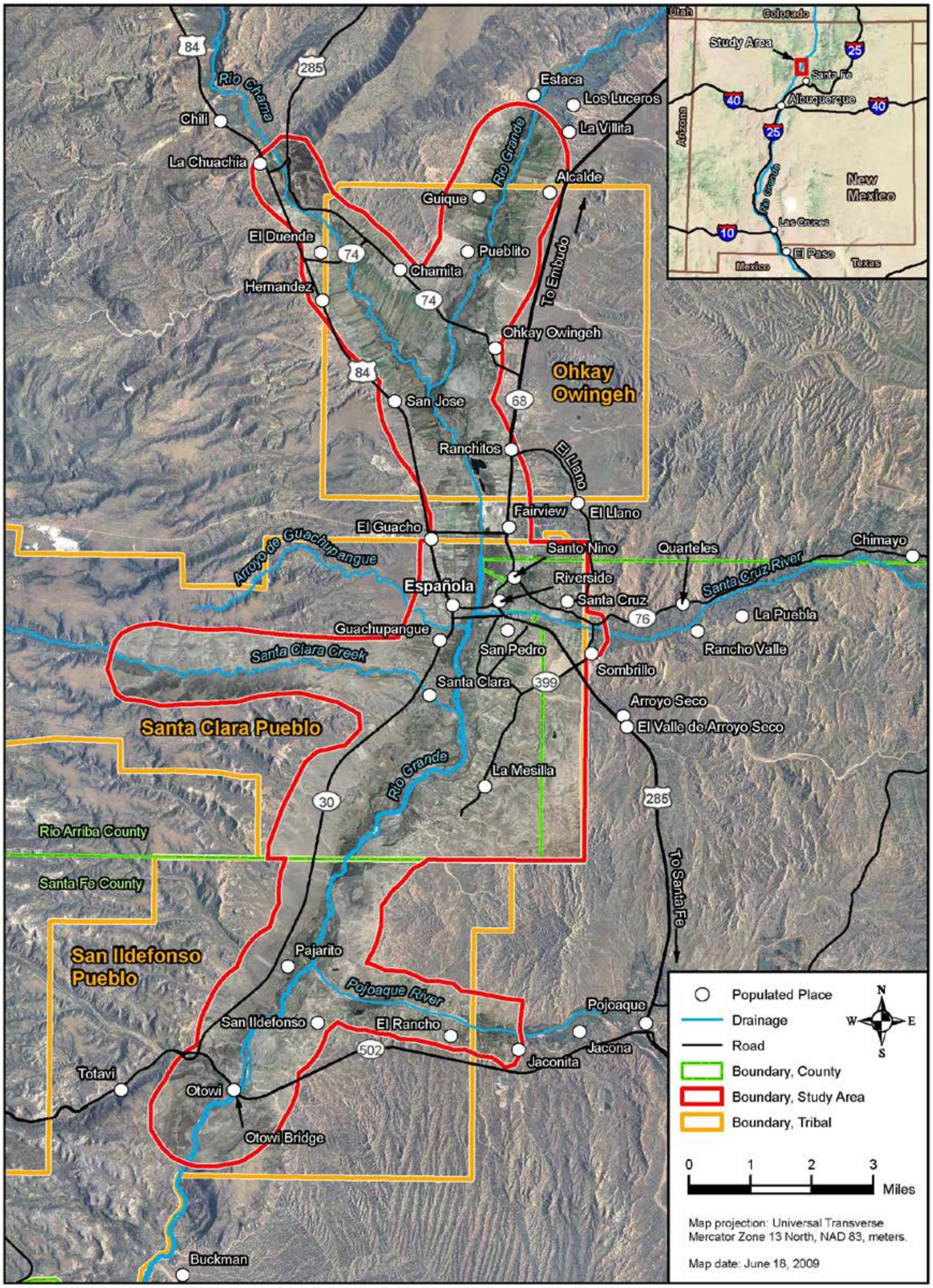

Figure 1 Española Valley study area.

5.4.2 Restoration Design Overview

Implementation of the Habitat Diversity Mosaic Alternative provides a relatively even distribution of habitat restoration measures across the study area. The measures would reconnect the Rio Grande and its tributaries to their floodplain, and increase the amount, quality and diversity of riparian habitat. The recommended plan maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, is selected and identified as the National Ecosystem Restoration (NER) Plan for the Española Valley Project. Habitat measures include 1) Grade Restoration Facilities, 2) terrace lowering, 3) willow swales, and 4) side channels to increase floodplain connectivity and decrease the depth to the water table to support native riparian forest. Vegetation management measures consist of 1) removal of invasive plant species (Russian olive, saltcedar, Siberian elm, and herbaceous species), and 2) planting with native vegetation to re-establish the riparian forest.

5.5 General Monitoring Objectives

Monitoring will be aimed at evaluating project success and guiding adaptive management actions by determining if the project has met ‘performance standards’. Validation monitoring will involve various degrees of quantitative monitoring aimed at verifying that restoration objectives have been achieved for both biological and physical resources. Effectiveness monitoring will be implemented to confirm that project construction elements perform as designed. Monitoring will be carried out until the project has been determined to be successful (performance standards have been met), as required by Section 2039 of WRDA 2007, as noted in paragraph 3.c of the implementation guidance.

The following are general project monitoring objectives:

- To determine and prioritize needs for ecosystem restoration
- To support adaptive management of implemented projects
- To assess and justify adaptive management expenditures
- To minimize costs and maximize benefits of future restoration projects
- To determine “ecological success”, document, and communicate it
- To advance the state of ecosystem restoration practice

The objectives provide direction for monitoring plans and help establish project specific objectives. Additional information is located in the Monitoring Goals of the Project.

5.5.1 Monitoring Components

Pre-construction, during construction and post construction monitoring shall be conducted by the Corps. After that time, monitoring would continue and be the responsibility of the local sponsor. Adaptive management monitoring should be budgeted at 2 percent of the total project costs (approximately $1.3 million). Pre-construction monitoring provides important baseline information. Quantification of habitat value (AAHU) will be more relevant for implementation and evaluating results within an adaptive management framework.

Post-construction monitoring is an important component of the adaptive management process, as performance feedback may generate new insights on ecosystem response and provides a basis for determining the necessity or feasibility of subsequent design or operational modifications (GeoSystems Analysis 2014). Success should be measured by comparing post-project conditions to the restoration project purpose and pre-project conditions.

Monitoring will be carried out until the project has been determined to be successful (performance standards have been met), as required by Section 2039 of WRDA 2007, as noted in paragraph 3.c of the implementation guidance. Monitoring of vegetation establishment would be conducted for at least five consecutive years following construction. Wetland and bosque monitoring would include vegetation mortality, wildlife and vegetation species inventories, floodplain inundation monitoring, and other environmental indicators. Project monitoring would be coordinated with the sponsors and incorporated with ongoing efforts to reduce duplicate effort.

5.6 Planning Objectives

The primary goal of the Española Valley project is to restore riparian floodplain habitat along the Rio Grande and Rio Chama. The monitoring plan would document the success of the habitat measures for meeting this goal. The study planning objectives are:

1. Reconnect the Rio Grande and its tributaries to their floodplains within the study area for the through the period of analysis and beyond.
2. Increase the amount and quality of valuable Bosque habitat in the study area through the period of analysis and beyond.
3. Increase the diversity of riparian habitat types in the study area through the period of analysis and beyond.

5.7 Monitoring Goals of the Project

Monitoring will be aimed at evaluating project success and guiding adaptive management actions by determining if the project has met ‘performance standards’. Validation monitoring will involve various degrees of quantitative monitoring aimed at verifying that restoration objectives have been achieved for both biological and physical resources. Effectiveness monitoring will be implemented to confirm that project construction elements perform as designed. Periodic CHAP field inventories should be conducted every 5 years during construction to document changes in habitat value as required by Section 2039 of WRDA 2007, as noted in paragraph 3.c of the implementation guidance.

The first step in designing an evaluation program for the Española Valley Restoration Project is to define the goals and objectives of the project. As stated in the U.S. Army Corps of Engineers (Corps) Feasibility Report (August 2015), they are as follows:

- Reconnect the Rio Grande and its tributaries to their floodplains within the study area for the life of the project.
- Increase the amount and quality of valuable bosque habitat in the study area for the life of the project.
- Increase the diversity of riparian habitat types in the study area for the life of the project.
- Provide recreational opportunities to the public in the study area for the life of the project.

Goals for a Monitoring and Adaptive Management Plan for the project should measure whether these objectives have been met or not. Some general items to keep in mind when developing specific monitoring components to measure include:

- Provide a thorough understanding of the ecosystem with and without restoration.
- Show direct cause-effect relationships between restoration measures and ecological responses.
- Include quantifiable biological responses.
- Document changes that are of social and scientific importance. (USACE, 1992).

There are also some constraints to implementation of the restoration project that should be kept in mind when developing specific monitoring components to measure. Some of these are:

1. The Rio Grande is a multi-jurisdictional, multi-boundary natural resource that is extremely human managed and manipulated due to this multi-jurisdictional setting.

2. There are legal obligations in the form of water rights in the State of New Mexico and especially on the Rio Grande.

3. With the exception of some jetty jacks (not all), river channelization and manipulation structures will remain in place.

These are some of the constraints of not only the evaluation of restoration, but of the restoration components themselves. These are the constraints, challenges, and potential benefits (when trying to approach this optimistically) that must be operated within in this large scale restoration effort.

5.8 Habitat Quality Evaluation

5.8.1.1 Vegetation Monitoring

Monitor success of invasive plant species management by mapping locations of re-sprouts and seedling establishment for additional measures. Map areal cover of invasive tree species and other noxious plants in measure footprints.

Map the establishment of native plantings. Map areal cover of native tree and plant species. For woody plantings (trees and shrubs), the performance standard will require at least 85% survival of planted material at the end of the third growing season following planting. If survival is less than this criterion, the contractor will install additional plantings to assure at least 85% living trees or shrubs.

Construction contracts will include warranties or performance standards for the establishment of vegetation. For seeding, the requirements will specify that planted areas will exhibit vigorous growth after a one-year establishment period. Requirements typically will include stem density or percent cover measures which the Contracting Officer Representative will use to verify that the performance standards have been, or have not been, met. Any additional planting activities to meet the performance standard will be performed at the contractor’s expense. The stem density or percent cover criteria included in each contract will vary depending on location-specific soil and moisture conditions, as well as the specified seed mix.

Update the Hink and Ohmart vegetation mapping for the project area five years following completion of restoration measures.

5.8.1.2 Habitat Analysis and Performance Screening

Evaluating the ecological benefits of proposed ecosystem restoration plans requires an assessment methodology that captures the complex ecosystem processes and patterns operating at both the local and landscape levels across multiple habitat types. USACE guidance on ecosystem restoration requires that benefits from the project meet the objectives listed in Engineer Regulation 1105-2-100, specifically, “The objective of ecosystem restoration is to restore degraded ecosystem structure, function and dynamic processes to a less degraded, more natural condition. Restored ecosystems should mimic, as closely as possible, conditions which would occur in the absence of human changes to the landscape and hydrology”. The proposed ecosystem measures measures were evaluated for cost effectiveness and incremental benefits during the formulation process. The preliminary recommended measures plan provides a reasonable approach to habitat benefits relative to the costs.

5.8.1.3 Combined Habitat Assessment Protocol Application

The Combined Habitat Assessment Protocols (CHAP) using the Hink and Ohmart vegetation mapping (Siegle et al. 2013) is proposed for estimating habitat unit values for measures (USACE 2016). CHAP relies on GIS for visualizing individual habitat patch values across the landscape. CHAP is a habitat-based approach for quantifying changes in habitat quality and quantity over time that uses an inventory of habitat correlates and species functions (O’Neil et al. 2005) to assess habitat values at multiple scales. CHAP provides an objective, quantifiable, reliable and well-documented process to generate environmental outputs for all levels of proposed projects and monitoring operations in the natural resources arena. CHAP provides an impartial look at environmental effects, and delivers measurable products to the decision-maker for comparative analysis. The CHAP method calculates habitat units (HUs) by combining using an assessment of correlates by habitat type and multiple vertebrate species functions (NWHI 2013a, b).

CHAP provides a site-specific, standard methodology for quantifying areas (polygons) based on observable differences in habitat by tabulating ecological functions. The primary components of CHAP for estimating the habitat values (per acre) of proposed measures are the species function matrix and habitat function matrix. An invasive species factor based on vegetation changes (effect) was developed for the Española Valley Ecosystem Restoration Project (USACE 2015).

The Biota Information System of New Mexico (BISON-M) is an online database for all vertebrate wildlife occurring in New Mexico (including all threatened, endangered and sensitive species). This database provides the vertebrate species list for the Bernalillo to Belen Levee project. With the majority of species in the BISON-M list represented in the Integrated Habitat and Biodiversity Information System (IBIS; O'Neil et al. 2005), CHAP was able to use existing Key Ecological Functions (KEFs). The KEFs are the number of interactions between vertebrate species, their habitat, and functions as a component of calculating habitat units that have been tabulated in the IBIS database.

The Key Environmental Correlates (KEC) represent the range of ecosystem functions that may occur within different habitat types. These KECs link habitat type to species use to enable assessment of the impact to species of change in habitat availability across multiple habitat types. The values would be tabulated from the field inventory data for each vegetation polygon. The field inventory identifies the percent coverage for canopy and understory vegetation, tree and shrub species, biotic, abiotic, anthropogenic, and other identifiable habitat components (NHI 2010; O'Neil et al. 2012). The inventory design supports a more detailed evaluation of habitat patches with rapid data acquisition. The polygons with a greater number of observed functions (higher KEC values) identify the suite of functions that produce greater habitat complexity and value. The high KEC value polygons can be used as reference sites (Burks-Copes *et al.* 2007; Burks-Copes and Webb 2009) representing possible target conditions for measures.

The Invasive Species Factor (ISF) is a value between 0.0 and 1.0 that adjusts overall habitat values as a function of the coverage of invasive plants. The CHAP field inventory can estimate the vegetative cover for invasive herbaceous, shrubs, and trees. High ISF values indicate low invasive species cover, and low ISF values indicate high invasive species cover. Vegetation management measures to remove invasive plants and support native species would increase the ISF, producing a higher corrected per acre value.

5.8.1.4 River-Floodplain Connectivity

Hydrology: Flood frequency, flood duration, depth, velocity, wetted area and groundwater depth will be evaluated for constructed high-flow channels, bank terracing, willow swales and other wetland features. Results will inform need for adaptive management actions and will inform future restoration designs.

Flood frequency relates the magnitude of discharge to the probability of occurrence or exceedance. Discharge or flow rate is typically given in cubic feet per second (cfs). Flood duration defines the amount of time that a specific flood frequency will meet or exceed a given discharge or flow rate. Flood duration is typically defined in either hours or days.

Flood duration, frequency, depth and velocity would be measured using a FlowTrakker Acoustic Doppler Velocimeter (ADV). This meter samples velocity measurement over a given length of time (seconds) and averages velocity at a given point in the water column. The meter computes discharge, after transects are made, according to USGS standards.

Wetted area can be measured by measuring surface water area. This is done by using the top width of the feature (high flow channel, terrace and/or willow swale) and the duration of flow from the hydrograph. Some areas may be mapped by hand using a GPS to get the overall surface area of wetted area.

Seasonal depth to groundwater will be monitored utilizing existing instrumented shallow groundwater piezometers. Data will be used to evaluate floodplain-channel connectivity and to allow comparisons to vegetation growth parameters.

The overall Performance Standard is to increase flood frequency and duration into bosque by 10% and increase wetted area in bosque by 15%. As features potentially get filled with sediment, they will need to be cleaned out. In order to help reduce the maintenance need, an increase in interconnection between features is proposed. This will also potentially enhance wetted area habitat diversity and function in order to meet the Performance Standard. If this is occurring, adaptive management in form of the maintenance above and/or reviewing the original design would be implemented.

5.9 Endangered Species Monitoring

The Southwestern Willow Flycatcher is an obligate riparian species and nests in thickets associated with rivers, streams and wetlands with dense growth of willow, buttonbush, boxelder, Russian olive, salt cedar, or other plants. This species may occupy a portion of the study area. To avoid direct impacts to breeding Southwestern Willow Flycatchers, the following monitoring activities have been included as conservation measures in the Biological Assessment (USACE 2011):

Beginning with the breeding season prior to the initiation of proposed construction, USACE will perform or fund annual protocol surveys (5 visits per season) within the floodway from South Diversion Channel to Highway 346. Annual surveys will continue until the completion of construction and will continue for five years following the phased construction of each levee segment.

Flycatcher surveys for each anticipated segment of construction will be conducted in the anticipated construction area one season prior to the anticipated construction.

Construction contracts will include warranties or performance standards for the establishment of vegetation. For seeding, the requirements will specify that planted areas will exhibit vigorous growth after a one-year establishment period. Requirements typically will include stem density or percent cover measures which the Contracting Officer will use to verify that the performance standards have been, or have not been, met. Any additional planting activities to meet the performance standard will be performed at the contractor’s expense. The stem density or percent cover criteria included in each contract will vary depending on location-specific soil and moisture conditions, as well as the specified seed mix. For woody plantings (trees and shrubs), the performance standard will require at least 85% survival of planted material at the end of the third growing season following planting. If survival is less than this criterion, the contractor will install additional plantings to assure at least 85% living trees or shrubs.

The success of re-vegetation measures measures will be based on the acceptable development of vegetation and its likelihood of continued development into a mature stand. Monitoring will be conducted by USACE once each year during the summer growing season for five years following planting. Monitoring requirements beyond five years (to be determined during ongoing consultation and coordination) would be conducted by the project sponsor.

5.10 Monitoring Responsibilities

Pre-construction, during construction and post construction monitoring shall be conducted by the Corps. After that time, monitoring would continue and be the responsibility of the local sponsor. Adaptive management monitoring is described in Table 1 with tasks and costs provided in Table 2 (approximately $1.3 million).

Monitoring will be aimed at evaluating project success and guiding adaptive management actions by determining if the project has met ‘performance standards’. Validation monitoring will involve various degrees of quantitative monitoring aimed at verifying that habitat ecosystems objectives have been achieved for native riparian vegetation. Effectiveness monitoring will be implemented to confirm that project measures perform as designed. Monitoring will be carried out until the project has been determined to be successful (performance standards have been met), as required by Section 2039 of WRDA 2007, as noted in paragraph 3.c of the implementation guidance.

The overall Performance Standard is to mitigate the loss of native riparian habitat by removing non-native vegetation and planting with target riparian tree species. If this is occurring, adaptive management in form of the maintenance above and/or reviewing the original design would be implemented.

5.10.1 Reporting

The Corps and/or their agents will prepare annual reports that include specific information pertaining to each of the monitoring elements. These reports will include information about all equipment and techniques used for monitoring purposes.

Annual reports will be submitted to the Pueblos of Ohkay Owingeh and Santa Clara, U.S. Fish and Wildlife Service (USFWS), and U.S. Bureau of Reclamation (Reclamation), and other interested parties by December 31 of each monitoring year.

5.11 Adaptive Management

Adaptive management measures (Table 2) are not the same as typical operation and maintenance activities described in the following section. These measures are technically response actions to changes that adversely affect how the system was predicted to respond. In so being adaptive, there are no absolute measures that can be defined prior to the issue arising. However, general concerns and examples of adaptive management processes can be identified at this stage. The primary concerns for this project are stability of the GRFs, river-floodplain connectivity, effective invasive vegetation management, and successful establishment of native vegetation. Descriptions of adaptive managements below are brief and will be further detailed once a complete set of plans and specifications are drafted. This is necessary since the adaptive management measures will need to be based upon contracting bid items, final feature designs and predicted adverse responses. It is also noted that these measures have relatively low costs to regain lasting benefits.

Table 2 Adaptive Management monitoring for Española Valley ecosystem restoration measures.

Goal #	Goal	Objective	Monitoring Metric	Performance Standard/ Adaptive Management Trigger	General Approach	Schedule	Link to Other Goals/Objectives
1	Improve Habitat Quality	#1: Reduce cover of non- native vegetation	Non-native plant cover	Areal cover of Russian olive and white mulberry <25% in any map unit.	Hink & Ohmart mapping for woody species; pedestrian surveys for herbaceous species	Annually for first 5 years then re-assess	Goal 1, Objectives 3&4; Goal 3, Objective 1
				Areal cover by Siberian elm and/or saltcedar shall not exceed			
				Areal cover by Class A and B noxious weeds shall not exceed			
				Areal cover by kochia and/or Russian thistle shall not exceed			
		#2: Increase native plant species richness and cover	Survival and growth of planted tree and shrub species	>50% survival in first year following cessation of supplemental irrigation; Planted spp. contribute at least 50% of relative shrub cover in planted areas after 10 years.	Sub-sample of species planted at each project site; record live vs. dead; tag live individuals and record canopy radius.	Measure survival and canopy development late summer year 1; and repeat every five years	Goal 1, Objectives 3&4; Goal 3, Objective 1
			Natural plant recruitment in constructed restoration features	Natural recruitment dominated (>80%) by native spp.	Plant census in all "wet" habitat features	Initiate in late summer 2014. repeat in five year intervals	
		#3: Increase structural diversity of floodplain vegetation communities	Areal proportion (% area) of Hink & Ohmart structure types in each project reach.	Increase habitat functions (see CHAP inventory)	Hink & Ohmart mapping; complete standard H&O and CHAP field inventory forms	Initiate in summer Year 1, repeat at five year intervals	Goal 1, Objective 1&4; Goal 3, Objective 1
		#4: Increase avian diversity	Direct measures of avian spp richness and abundance	Increase above baseline	Walking transects; assess differences in avian diversity between stands with different H&O structure types	Seasonal monitoring performed annually	Goal 1, Objective 3
2	Improve River-Floodplain Connectivity	#1: Increase floodplain acreage inundated under range of flow discharges.	Inundated floodplain acreage at different discharge levels.	At least partial inundation of constructed restoration features when flows exceed 1,500 cfs.	Use high-resolution GPS to map extent of flood inundation at different discharge levels. Record data on inundation depth, flow velocity and approximate inundation duration.	Opportunistic data collection at different discharge levels.	Goal 3, Objective 1; Goal 4, Objectives 1-4
		#2: Create and maintain shallow groundwater & moist soil conditions in constructed restoration features.	Groundwater levels in constructed restoration features.	Maximum DTW in constructed features do not exceed 3 ft bgs.	Establish piezometer network adjacent to GRFs and high-flow features. Collect data prior to construction. Use data to develop riparian groundwater model for project reach.	Continue on-going groundwater monitoring.	Goal 1, Objectives 2,3,4; Goal 3, Objective 1
			Moist soil conditions in constructed habitat features.	Soil moisture remains above wilting point through plant growing season.	Install soil moisture sensors in bore holes within representative restoration features.	Initiate soil moisture monitoring program in Year 1.	
3	Protect, Extend and Enhance Areas of Potential Habitat for Listed Species	#1: Create willow stands considered "highly-suitable" for breeding SWFL's.	Habitat attribute scores for breeding SWFL's	Achieve and maintain a minimum raw score of 75% for individual willow swales within 3 years following restoration	Score sites/willow swales using methods described in GeoSystems Analysis 2014. Incorporate data collected from Goal 2, Objectives 1&2.	Initiate in summer Year 1, and repeat at three year intervals.	Goal 2, Objectives 1&2; Goal 4, Objective 2
		#2: Maintain / increase number of migrating and breeding SWFL using the EV Project area.	SWFL detections	Increase number of SWFL detections in EV Project area above baseline (pre-restoration)	Follow standardized survey protocols per Sogge et al. 2010. Increase number of survey areas to include as many constructed willow swales as budget allows	Annual surveys.	Goal 2, Objectives 1&2; Goal 4, Objective 1

Table 3 Proposed Monitoring and Adaptive Management (AM) tasks and costs for Española Valley ecosystem restoration measures. Estimated cost is $1,300,000.

Goal #	Goal	Objective	Monitoring Metric	Pre-construction	Phases 3	Phases 6	Phases 8	Phases 10	Phase 10 +3 years	Phase 10 +5 years	Schedule
1	Improve Habitat Quality	#1: Reduce cover of non- native vegetation	Non-native plant cover			Treat invasive plants with herbicide as appropriate during growing season	Treat invasive plants with herbicide as appropriate during growing season	Treat invasive plants with herbicide as appropriate during growing season	Treat invasive plants with herbicide as appropriate during growing season	Treat invasive plants with herbicide as appropriate during growing season	Annually for first 5 years then re-assess
		#2: Increase native plant species richness and cover	Survival and growth of planted tree and shrub species					Monitor feature native plant re-vegetation success for 80% survival	Monitor feature native plant re-vegetation success for 80% survival	**Replant native trees as needed (AM)**	Measure survival and canopy development late summer year 1;
			Natural plant recruitment in constructed restoration features					Map feature native plant recruitment as percent area of polygon	Map feature native plants as percent area of polygon and conduct CHAP inventory		Initiate in late summer 2014. repeat in five year intervals
		#3: Increase structural diversity of floodplain vegetation communities	Areal proportion (% area) of Hink & Ohmart structure types in each project reach.			Map initial feature riparian vegetation for comparison with adjacent polygons	Map initial feature riparian vegetation for comparison with adjacent polygons	Map feature riparian vegetation for comparison with adjacent polygons and conduct CHAP inventory	Map initial feature riparian vegetation for comparison with adjacent polygons	Map initial feature riparian vegetation for comparison with adjacent polygons	Initiate in summer Year 1, repeat at five year intervals
		#4: Increase avian diversity	Direct measures of avian spp richness and abundance	Conduct avian monitoring surveys on proposed features and adjacent habitat patches		Conduct avian monitoring surveys on proposed features and adjacent habitat patches	Conduct avian monitoring surveys on proposed features and adjacent habitat patches	Conduct avian monitoring surveys on proposed features and adjacent habitat patches	Conduct avian monitoring surveys on proposed features and adjacent habitat patches	Conduct avian monitoring surveys on proposed features and adjacent habitat patches	Seasonal monitoring performed annually
2	Improve River-Floodplain Connectivity	#1: Increase floodplain acreage inundated under range of flow discharges.	Inundated floodplain acreage at different discharge levels.	Survey river cross sections at all grade restoration facility locations and subset of locations for other restoration features	Resurvey river cross sections at all grade restoration facility locations post-construction. Map inundated features at appropriate flows	**Supplemental rock to raise grade restoration facilities (AM)**	Map inundated features at appropriate flows	Resurvey river cross sections at all locations post-construction Map inundated features at appropriate flows	Map inundated features at appropriate flows	Map inundated features at appropriate flows	Opportunistic data collection at different discharge levels.
		#2: Create and maintain shallow groundwater & moist soil conditions in constructed restoration features.	Groundwater levels in constructed restoration features.	Install groundwater monitoring wells and record pre-construction groundwater elevations	Conduct groundwater monitoring at establish wells	Conduct groundwater monitoring at establish wells	Conduct groundwater monitoring at establish wells	Conduct groundwater monitoring at establish wells	Conduct groundwater monitoring at establish wells **Supplemental excavation (AM)**	Conduct groundwater monitoring at establish wells	Continue on-going groundwater monitoring.
			Moist soil conditions in constructed habitat features.	Survey soil moisture condition for spring / summer / fall		Conduct Survey soil moisture condition for spring / summer / fall	Conduct Survey soil moisture condition for spring / summer / fall	Conduct Survey soil moisture condition for spring / summer / fall	Conduct Survey soil moisture condition for spring / summer / fall	Conduct Survey soil moisture condition for spring / summer / fall	Initiate soil moisture monitoring program in Year 1.
3	Protect, Extend and Enhance Areas of Potential Habitat for Listed Species	Willow swales considered "highly-suitable" for breeding SWFL's.	Habitat attribute scores for breeding SWFL's			Evaluate establishment of riparian vegetation using vegetation mapping			Evaluate establishment of riparian vegetation using vegetation mapping		Initiate in summer Year 1, and repeat at three year intervals.
		Increase number of SWFL using Project area.	SWFL detections					Evaluate potential for SWFL use based on vegetation mapping and avian surveys			Annual surveys.
					$118,000 + $31,000	$266,000 + $69,000	$189,000 + $49,000	$1,070,000 + $278,000		**Total First Cost**	$2,070,000

5.12 Operations and Maintenance

The O&M costs of the project are estimated to an average annual cost of $2,500 with a 3.75% interest rate over 50 years. A detailed O&M Manual containing all the duties will be provided to the non-Federal sponsor after construction is closed out. The O&M for ecosystem projects are practical and should be minimal due to use of established restoration measures, project design efforts and design targets for sustainability. The primary O&M activities are the same type of activities that occur during feature construction. The O&M measures described here are a subset of the Adaptive Management measures described in the previous section.

The estimated cost for mapping inundated habitat would be approximately $1,000/year after the 5-year monitoring period. Mapping will support tracking the effectiveness of the river connectivity restoration measures. Monitoring of native planting would be approximately $500/year, and would support effective establishment of riparian species.

The estimated cost for invasive plant species control would be approximately $1,000/year after the 5-year monitoring period. This would provide for spot herbicide application of the entire site as well as replanting roughly 5% of the original total of trees and shrubs. Management of the native riparian plants will also be required to maintain species richness, abundance and structure of the restored riparian habitat. This work would occur after the establishment period is over.

The best operational measure to quickly identify and rectify external stressors is vigilance. Routine inspections by sponsors' environmental staff are imperative to notice adverse change quickly. The long term monitoring plan provided above will not identify sudden change in the site as would routine inspection the sponsors.

Table 4 Estimated annual operation and maintenance costs for the sponsors.

OMRR&R Activity	Estimated Annual Cost ($/year)
Map inundated features at appropriate	$1,000
Monitor feature native plant re-vegetation	$500
Treat invasive plants with herbicide flows	$1,000
OMRR&R Total	$2,500

ESPAÑOLA VALLEY RESTORATION PROJECT REPORT
PERIODIC SITE ASSESSMENT FORM
Sample Format for Periodic Site Assessment Form

Site:

Date:

Location of site (include map:

Personnel:

Item No.	Description	Response	
		Yes	No
1	Erosion observed in revegetation areas? If yes, describe location(s) and provide a map of affected area(s).		
2	Erosion control blankets, geotextile mats, and underlying soil on low berm in good condition?		
3	Flood damage to vegetation or other site features?		
4	Wind damage to vegetation or other site features?		
5	Herbicide damage to desired vegetation?		
6	Wildlife damage to desired vegetation?		
7	Vandalism to desired vegetation?		
8	Vandalism to other site features (e.g., signs)?		
9	Debris or refuse present?		
10	Access roads maintained as specified?		
11	Access gates, barriers and locks in good working order?		
12	Volunteer establishment of desired species observed?		
13	Portions of revegetation areas currently flooded? If yes, describe extent of flooding and provide a map of affected area(s).		
14	Other items?		
Comments:			