Middle Rio Grande Endangered Species Collaborative Program

Fiscal Year 2018 Annual Report

PROGRAM WEBSITE:
https://webapps.usgs.gov/MRGESCP

Middle Rio Grande Endangered Species Collaborative Program Fiscal Year 2018 Annual Report

Prepared by:

Western EcoSystems Technology, Inc.
Environmental & Statistical Consultants
8500 Menaul Northeast Suite B-342
Albuquerque, New Mexico 87112

On behalf of:

The Middle Rio Grande Endangered Species Collaborative Program

Table of Contents

Acronyms & Abbreviations

Acronym/Abbreviation	Definition
ACF	Aquatic Conservation Facility
ABCWUA	Albuquerque Bernalillo County Water Utility Authority
AM	Adaptive Management
APA	Assessment Payers Association of the Middle Rio Grande Conservancy District
ARRC	Southwest Native Aquatic Resource and Recovery Center
ASIR	American Southwest Icthyological Researchers, L.L.C.
BEMP	Bosque Ecosystem Monitoring Program
BioPark	Albuquerque BioPark
BO	Biological Opinion
CoA	City of Albuquerque
CPUE	catch per unit effort
DPM	Dynamic Patch Mosaic
EC	Executive Committee
ESA	Endangered Species Act
FY	Fiscal Year
LiDAR	Light Detection and Ranging
LLSMR	Los Lunas Silvery Minnow Refugium
MAT	Minnow Action Team
MOA	Memorandum of Agreement
MRG	Middle Rio Grande
MRGCD	Middle Rio Grande Conservancy District
MRGESCP	Middle Rio Grande Endangered Species Collaborative Program
mtDNA	Mitochondrial DNA
NMISC	New Mexico Interstate Stream Commission
NWR	National Wildlife Refuge
NMT	New Mexico Institute of Mining and Technology
Program	Middle Rio Grande Endangered Species Collaborative Program
Reclamation	U.S. Bureau of Reclamation
RGSM	Rio Grande silvery minnow
SWFL	Southwestern willow flycatcher
UNM	University of New Mexico
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WEST	Western EcoSystems Technology, Inc.
YBCU	Yellow-billed cuckoo
2016 MRG BO	Final Biological and Conference Opinion for Bureau of Reclamation, Bureau of Indian Affairs, and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico

Executive Summary

The Middle Rio Grande Endangered Species Collaborative Program (MRGESCP or Program) is a partnership of several federal, state, tribal, and local signatory agencies and organizations working together to address concerns within the Middle Rio Grande (MRG) related to endangered species, while simultaneously protecting current and future water uses. The Program primarily focuses on three listed species in the MRG: the Rio Grande silvery minnow, the Southwestern willow flycatcher, and the yellow-billed cuckoo.

This report describes the MRGESCP's background, organization, accomplishments, and ongoing and completed activities through fiscal year 2018 (FY18). One of the Program's overarching accomplishments over the past 18 years includes bringing diverse participants together in working toward the recovery of the MRG's endangered species while meeting the region's other water needs in compliance with federal and state laws. MRGESCP signatories continue working together to use the best available science to create practicable approaches to achieve the Program mission.

Image: Fall Views of the Sandia Mountains over the Middle Rio Grande Bosque
Image Credit: Mike Marcus

1 Middle Rio Grande Endangered Species Collaborative Program

1.1 Background

The Middle Rio Grande Endangered Species Collaborative Program (MRGESCP or Program) is a diverse collaborative partnership of federal, state, tribal, and local signatory agencies and organizations working together to address concerns within the MRG related to endangered species.

The Rio Grande silvery minnow (*Hybognathus amarus*; RGSM) and the southwestern willow flycatcher (*Empidonax traillii extimus*; SWFL) were listed as federally endangered in 1994 and 1995, respectively. As a result of these listings, drought conditions in 1996, and related litigation in 1999, stakeholder work groups formed to collaborate around species recovery in the MRG. Stakeholders included organizations with interest in resolving conflict and alleviating issues through collaboration as listed in Section 1.4. In 2014, two other species were listed in the MRG: the yellow-billed cuckoo (*Coccyzus americanus*; threatened; YBCU), and the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*; endangered; NMMJM).

The Endangered Species Act (ESA) Workgroup was formed in 2000 with the intent of developing the MRGESCP. The Program was formally established in 2002 with the signing of a Memorandum of Understanding. In 2008, Program signatories re-affirmed their collaborative commitment to achieve the Program mission with a Memorandum of Agreement (MOA). The MRGESCP's mission is multi-faceted:

1. To prevent extinction, preserve reproductive integrity, improve habitat, support scientific analysis, and promote recovery of the listed species within the Program area in a manner that benefits the ecological integrity, where feasible, of the MRG riverine and riparian habitat.
2. To exercise creative and flexible options so that existing water uses continue and future water development proceeds in compliance with applicable federal and state laws.

MRGESCP signatories continue to provide support by collaborating on numerous projects and programs benefitting the listed species in the MRG.

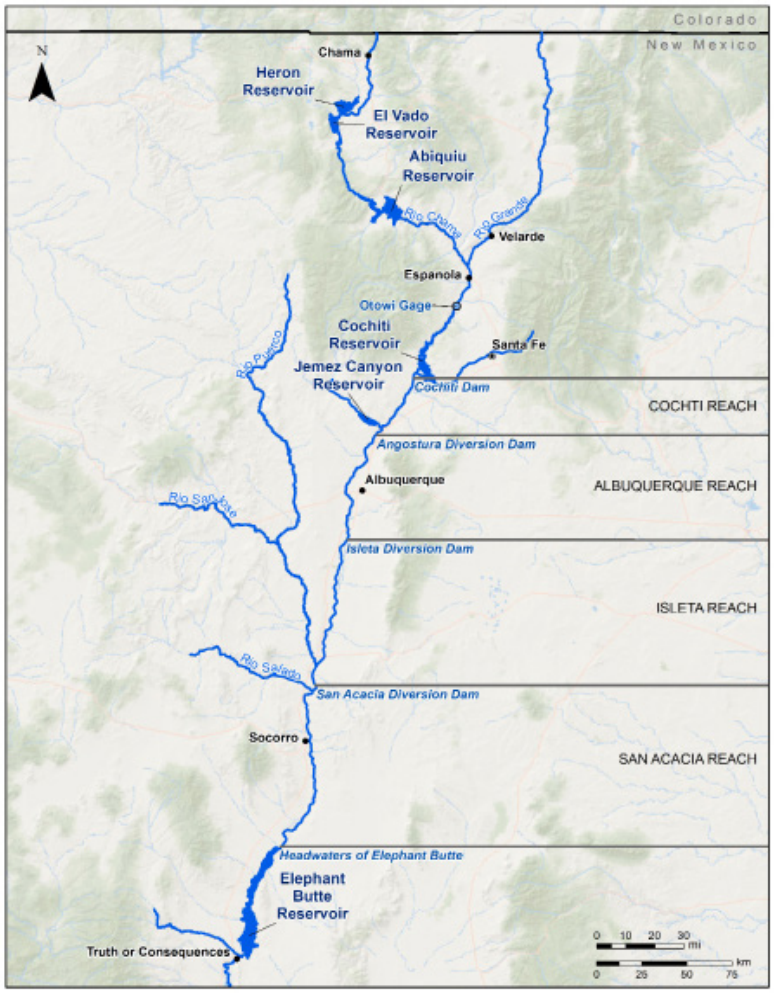


Figure 1. Program Area Map

The Program area stretches from the headwaters of the Rio Chama watershed and the Rio Grande, including tributaries, from the New Mexico/Colorado border, downstream to the elevation of the spillway crest of the Elephant Butte Reservoir at 4,450 feet above mean sea level, excluding the land reserved for the full pool of the Elephant Butte Reservoir (Figure 1). Four reaches are delineated within the MRG: the Cochiti Reach, the Angostura Reach, the Isleta Reach, and the San Acacia Reach (Figure 1). Depending on their jurisdiction and authority, signatories may support activities within one or all four reaches, as well as north of the Cochiti Reach to the New Mexico-Colorado border.

1.2 FY18 Overview

Through FY18, MRGESCP signatory representatives provided technical expertise and collaborative support for several mission-relevant activities. These activities included restoration management and monitoring, population augmentation and management of RGSM, SWFL and YBCU monitoring, coordination around water

releases and flows to benefit riparian habitat for listed species, and performing research to better understand the needs of the listed species.

The Program also formed an Adaptive Management Work Group with the intention of developing an Adaptive Management (AM) Program. In transitioning toward an AM framework, and in continued support of Program science activities, the Program worked to establish and refine processes and guidelines, worked toward a new organizational structure, and explored options for transitioning to an AM Program.

1.3 Governance

Adopted in 2008, the Program's by-laws describe the governance structure, the decision-making processes, and the roles and responsibilities of the signatories. The by-laws have been amended over the years to accommodate Program development. Documents relating to governance including by-laws, authorities, and charters, are maintained on the Program Portal, which can be accessed at https://webapps.usgs.gov/MRGESCP/.

1.4 Organization and Structure

In FY18, the following signatories were party to the 2008 MOA:

- Albuquerque Bernalillo County Water Utility Authority (ABCWUA)
- Assessment Payers Association of the Middle Rio Grande Conservancy District (APA)
- Bosque Ecosystem Monitoring Program (BEMP)
- City of Albuquerque (CoA) Open Space
- Middle Rio Grande Conservancy District (MRGCD)
- New Mexico Attorney General's Office
- New Mexico Department of Game and Fish
- New Mexico Interstate Stream Commission (NMISC)
- Pueblo of Isleta
- Pueblo of Sandia
- Pueblo of Santa Ana
- U.S. Army Corps of Engineers (USACE)
- U.S. Bureau of Reclamation (Reclamation)
- U.S. Fish and Wildlife Service (USFWS)
- University of New Mexico (UNM)

Continuous collaborative support of scientific studies, monitoring and operations, and MRGESCP administration have advanced the goals of contributing to the protection and recovery of federally listed species, while also protecting current and future water uses. This report describes the MRGESCP's background and organization, summarizes MRGESCP-related expenditures by Program signatories, and highlights Program activities and accomplishments during FY18.

In FY18, the MRGESCP's organizational structure consisted of the Executive Committee (EC), technical workgroups, and a third-party Program Support Team (PST). The following outlines the FY18 active committees and workgroups. More information, including meeting-related documents, can be found on the Program Portal.

Image: Executive Committee Members
Image Credit: WEST Staff

Executive Committee

Federal Co-Chair: Brent Esplin, Reclamation
Non-Federal Co-Chair: Janet Jarratt, APA

The EC is the MRGESCP's governing body and consists of one representative from each signatory organization. This committee establishes and provides leadership and oversight to the Program's work groups and ad hoc groups, and coordinates Program recommendations to signatory agencies.

Work Groups

Work groups established by the EC include MRGESCP signatory staff and other parties with expertise related to the group's directive. Work groups provide focused assistance and expertise, technical review and oversight, and coordination to address Program directives and activities. Work groups meet regularly and provide a forum for coordinating on Program matters and technical planning efforts. The following work groups met during FY18:

- Adaptive Management Work Group
- Population Monitoring Work Group
- Science and Habitat Restoration Work Group

Ad Hoc Groups and Subgroups

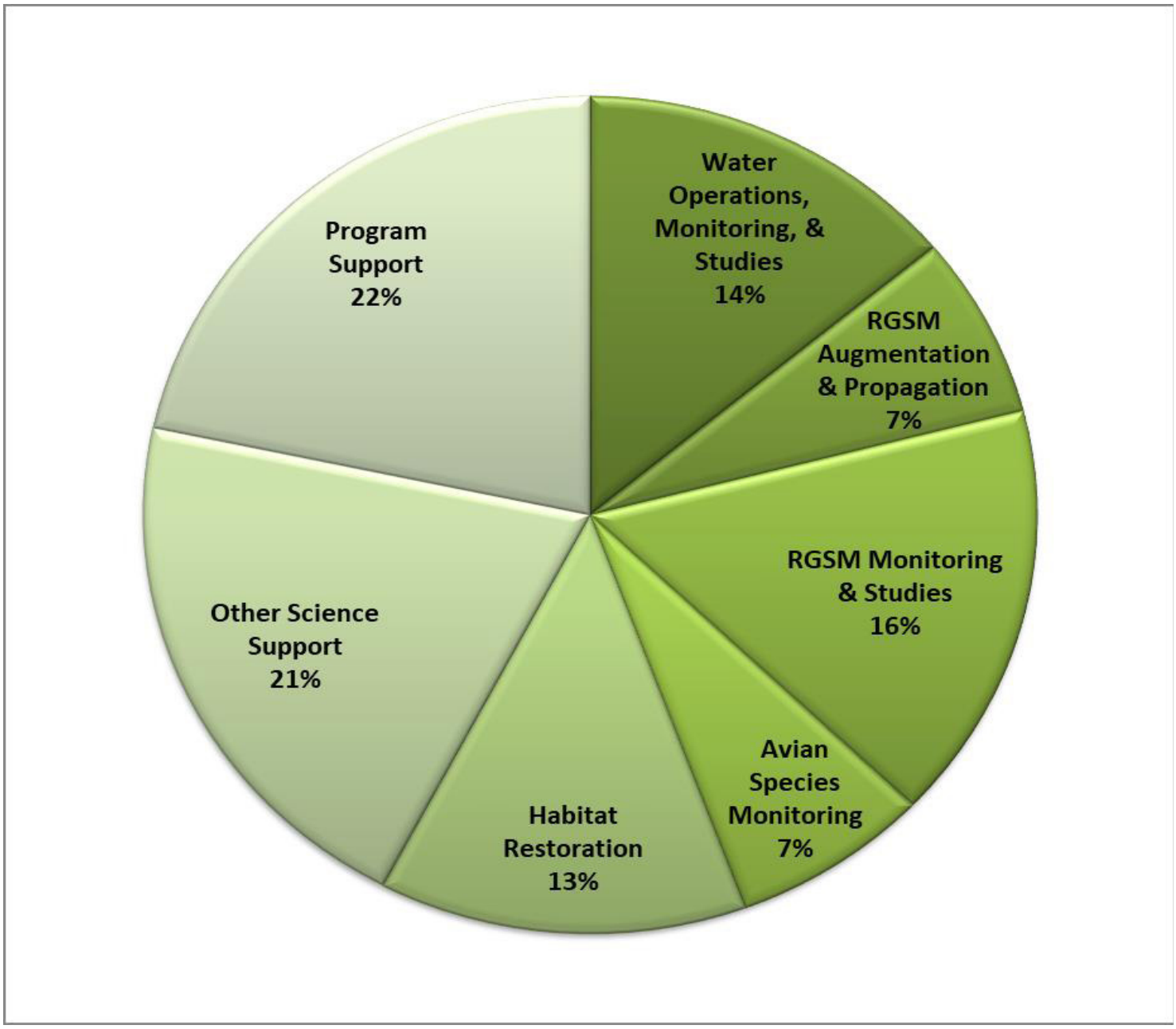
Temporary ad hoc groups occasionally tier from Program committees and work groups to advance individual projects or tasks. Ad hoc groups report to the primary committee or work group, and typically consist of individuals with expertise or interest in the specialized assignment. These groups disband once predetermined objectives have been completed.

2 Financial Summary

In FY18, MRGESCP signatories provided financial contributions and in-kind services toward Program-related activities. Reclamation and USACE administered funding appropriated through the Congressional Energy and Water Development Appropriations, and ABCWUA, CoA, MRGCD, and NMISC expended local and state money for work completed within the Program area (Figure 1). All Program signatories contributed personnel time, technical expertise, and a variety of other resources in support of Program initiatives.

Figure 2 illustrates how the combined signatory's contributions were distributed in FY18. Through federal and state appropriations, local monies, and cost-share contributions, Program signatories expended approximately $8,185,294 toward the categories covered in this report.

Figure 2. FY18 Signatory Contributions per Category



3 Program Activities and Accomplishments

Throughout FY18, the MRGESCP signatories continued to promote the recovery of listed species in the MRG by restoring habitat, conducting studies and monitoring, propagating and augmenting RGSM populations, supporting scientific analysis and adaptive management, and providing support for program management.

3.1 Avian Species

During FY18, signatories conducted activities as part of long-term efforts to monitor SWFL and YBCU population trends, and to better understand the distribution of these species in the region. The data collected enables managers to determine the impacts of specific actions on the species and to adjust management actions as necessary. Table 1 lists avian species-related projects that occurred in FY18, the duration of each project, and signatories that contributed resources.

Table 1. Avian Species Activities List

Project Name	Begin	End	Contributing Signatories
Avian Monitoring	FY14	FY19	USACE
Southwestern Willow Flycatcher Surveys	FY95	Ongoing	Reclamation
Southwestern Willow Flycatcher Surveys on the Rio Grande in the Albuquerque Reach	FY14	FY19	USACE
Yellow-billed Cuckoo Surveys	FY06	Ongoing	Reclamation

Avian Monitoring

The decline of some avian populations has been attributed to inadequate habitat throughout their distribution, including within the MRG. Annual avian community surveys have occurred in the MRG since December 2013 to sample avian abundance and species richness relative to vegetation community and structure types. In FY18, established transects within the MRG were surveyed during both the breeding and non-breeding seasons. Nest searches and monitoring were completed for raptors, songbirds, and the SWFL and YBCU. Collected information included nest success, brood parasitism, predation, abandonment, and productivity.

An additional objective established in 2017 focused on changes in the bosque since the 1984 Middle Rio Grande Biological Survey. The following changes will be documented in the final report in 2019:

1. Provide a 20-plus year comparison of change in avian abundance and species richness;
2. Provide a 20-plus year comparison of change in community and structure types; and
3. Determine community and structure types present 20-plus years ago, versus changes based upon construction of the MRG restoration sites.

The results of this monitoring contribute to baseline population data, monitoring of population trends, and the determination of the current distribution of SWFL and YBCU in the region. Additionally, this project aids in tracking avian activity and assists in determining usable avian habitat within the MRG.

Image: Southwestern Willow Flycatcher
Image Credit: Shannon Caruso, UNM

Image: Southwest Willow Flycatcher Chicks
Image Credit: Vicky Ryan, USFWS

Southwestern Willow Flycatcher Surveys

Program signatory biologists have conducted SWFL surveys and studies at sites from Bandelier National Monument to Elephant Butte Reservoir since 1995. The studies were originally designed to provide insight into potential threats to SWFL populations and their habitats, and they currently focus on completing presence and absence surveys and nest monitoring. The results help determine the distribution, abundance, and productivity of breeding SWFL. This work is required to achieve compliance with the ESA, and support requirements in the Final Biological and Conference Opinion for Bureau of Reclamation, Bureau of Indian Affairs, and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico (2016 MRG BO).

In FY18, as part of USACE's MRG Restoration Project, USACE funded surveys in the Albuquerque bosque during the breeding season to determine presence or absence of SWFL. Additionally, SWFL surveys and nest monitoring were conducted within eight subreaches along approximately 205 miles of the Rio Grande. Results of the 2016, 2017 and 2018 surveys are shown in Table 2.

Table 2. Reach-by-reach summary of SWFL territories, pairs and nests recorded from 2016 - 2018 within the MRG

	Territories			Pairs			Nests		
Reach	2016	2017	2018	2016	2017	2018	2016	2017	2018
Frijoles	0	0	0	0	0	0	0	0	0
Belen	20	17	20	13	16	17	21	27	17
Sevilleta	5	4	12	4	3	7	1	1	3
San Acacia	0	0	0	0	0	0	0	0	0
Escondida	5	8	4	4	6	4	0	9	4
Bosque del Apache	17	16	24	13	11	21	1	16	22
Tiffany	5	0	0	2	0	0	0	0	0
San Marcial	303	257	277	209	223	240	256	298	315
Totals	355	302	337	245	359	289	279	351	361

Image: Southwest Willow Flycatcher Nest
Image Credit: Dave Moore, Reclamation

Image: Southwest Willow Flycatcher Chicks
Image Credit: Darrell Ahlers, Reclamation

Southwestern Willow Flycatcher Surveys on the Rio Grande in the Albuquerque Reach

Through Civil Works authorities, USACE completes habitat restoration in the Rio Grande bosque within the Albuquerque area. USACE has contracted with Hawks Aloft, Inc. to conduct annual SWFL surveys at five bosque sites: Brown Burn, Durand Outfall, Montano Southwest, Rio Bravo Northeast, and South Corrales. At Montano Southwest (formerly known as the Graham Property), annual SWFL surveys have been conducted since 2004. SWFL surveys were initiated at Brown Burn and Rio Bravo Northeast in 2010, and at Durand Outfall and South Corrales in 2011. The results of the surveys assist in determining available SWFL habitat, and in tracking their activity within the MRG.

Image: Southwest Willow Flycatcher
Image Credit: Shannon Caruso, UNM

Yellow-billed Cuckoo Surveys

MRGESCP signatory agencies have conducted YBCU protocol surveys within the MRG basin since 2006. These surveys were designed to track YBCU population trends and to provide insight into habitat use through presence and absence surveys. Survey results are used to determine the distribution and abundance of breeding YBCUs within a specific study area. Additionally, the current surveys achieve ESA compliance for Reclamation projects, and support requirements detailed in the 2016 MRG BO.

Surveys are conducted within seven reaches along approximately 130 miles of the Rio Grande. A reach-by-reach breakdown of YBCU detections and territories between 2016 and 2018 is presented in Table 3. Additionally, in 2018 Reclamation conducted the second year of a radio telemetry study aimed at determining habitat requirements and movement patterns of breeding YBCUs. This project provides data that are considered indicators of status of the present population, population trends, and the current distribution of YBCUs in the region. These data enable managers to determine impacts to the species from specific actions, and to adjust management actions as needed.

Table 3. Reach-by-reach breakdown of YBCU survey results within the MRG from 2016 - 2018

	2016		2017		2018	
Reach	Detections	Territories	Detections	Territories	Detections	Territories
Belen	54	12	34	4	41	10
Sevilleta/La Joya	32	10	12	4	41	10
San Acacia	23	8	50	13	47	14
Escondida	58	16	44	11	55	10
Bosque del Apache	32	11	43	10	46	13
Tiffany	9	0	2	0	0	0
San Marcial	22	59	227	56	193	49
Totals	428	116	412	98	423	106

3.2 Rio Grande Silvery Minnow

In FY18, MRGESCP signatories worked to support long-term RGSM population monitoring efforts, captive breeding programs, augmentation efforts, and several RGSM-related studies. Long-term monitoring of the RGSM population is intended to provide the foundation needed to assess changes in the MRG fish community over time, determine population trends in response to water management practices, record variability in the population between different water years, and assess the impacts of activities on the river. Propagation of RGSM in hatchery facilities, and subsequent augmentation into the river, are intended to aid in reestablishing, stabilizing, and enhancing populations of the RGSM within its historic range in the Rio Grande Basin. Additionally, monitoring of RGSM genetics in hatchery facilities and within the MRG is intended to assure that genetic heterogeneity is maintained in both wild and hatchery-raised populations through time. Resource managers use the collected data to inform and adjust management actions into the future as necessary. Table 4 lists RGSM-related projects that occurred through FY18, the project duration, and signatories that contributed.

Table 4. Rio Grande Silvery Minnow Activites List

Project Name	Begin	End	Contributing Signatores
Assessment and Monitoring of Rio Grande Silvery Minnow Genetics	FY03	Ongoing	Reclamation
City of Albuquerque Aquatic Conservation Facility Rearing and Breeding Operations and Maintenance	FY07 FY18	Ongoing FY18	ABCWUA; Reclamation
Los Lunas Silvery Minnow Refugium Operations and Maintenance	FY07	Ongoing	NMISC; Reclamation
Drain Outfall Sampling	FY15	FY19	MRGCD
Evaluation of Rio Grande Silvery Minnow Population Model Alternatives	FY15	Ongoing	USACE
Fish Community Surveys	Ongoing	Ongoing	Pueblo of Santa Ana
Investigation of Rio Grande Silvery Minnow Mesohabitat Preferences	FY15	Ongoing	USACE
Rio Grande Silvery Minnow Spawning Habitat Study	FY17	Ongoing	ABCWUA; NMISC
Otolith Age Comparison by Reach	FY18	FY18	ABCWUA
Otolith Validation Study	FY18	FY19	ABCWUA
Rio Grande Silvery Minnow Population Management	FY18 FY01	FY18 FY22	MRGCD; Reclamation
Rio Grande Silvery Minnow Population Monitoring	FY93	Ongoing	Reclamation
Rio Grande Silvery Minnow Spawning Monitoring	FY99	Ongoing	Reclamation
San Acacia Diversion Dam Fish Passage Pilot Study	FY17	Ongoing	MRGCD; NMISC; Reclamation

Assessment and Monitoring of Rio Grande Silvery Minnow Genetics

UNM monitored the genetics of the RGSM population from 1999 through 2012, and again during the period 2014 through 2018. This work included monitoring RGSM bred or reared in captivity and released to the MRG since 2002 when the augmentation program began. In 2018, this project also began to genotype all broodstock to produce fish for release in the fall in the Southwestern Native Aquatic Resources and Recovery Center (ARRC) and Albuquerque BioPark (BioPark).

Under this contract UNM also examined changes in levels of genetic variability in the wild RGSM population and how these changes potentially impacted population viability, and the potential impacts of captive propagation and augmentation on the genetics of RGSM wild stock. The RGSM genetics database developed by the project was used to develop, parameterize, and evaluate models designed to assist in predicting genetic

effects of captive propagation on wild stocks of RGSM (under various scenarios) to inform captive propagation and augmentation strategies aimed at species recovery.

Monitoring in 2018 was based on genotyping 443 'wild' RGSM collected in the three occupied reaches of the MRG, as well as broodstock and offspring (n=449) of captive stocks from Southwest Native ARRC, the Los Lunas Silvery Minnow Refugium (LLSRM), and the BioPark. An allele is one of the possible forms of a gene and the the number of times an allele occurs in a genetic sample of a population is often used to monitor changes in various population parameters over time. The average number of alleles declined in 2017, but rebounded in 2018 and was above the benchmark level for this metric. Notwithstanding, the microsatellite gene diversity and heterozygosity in 2018 were essentially unchanged from 2017 values. This is likely a result in part from strong recruitment in fall 2017.

Metrics indicating the diversity of mitochondrial DNA (mtDNA) in 2018 increased in all river reaches from values in 2017. Variance genetic effective size using the temporal comparison from 2017 to 2018 declined; however, mtDNA for female variance effective population size for 2017 to 2018 showed a slight increase, which indicated an increase in the number of females making a reproductive contribution.

In 2018, UNM continued genotyping all broodstock used to produce fish for release in the fall of 2018 from Southwest Native ARRC and the BioPark. Microsatellite diversity metrics for broodstock in 2018 fell within the range seen in wild samples in 2018, and were higher compared to broodstock used in 2017. Haplotype diversity (calculated from mtDNA) was lower in the broodstock from the BioPark compared to those from Southwest Native ARRC, likely because the Southwestern Native ARRC spawned more individuals. In 2018, UNM also conducted a parentage analysis for fish released the prior fall of 2017.

Image: Rio Grande Silvery Minnow
Image Credit: CoA ACF Staff

City of Albuquerque Aquatic Conservation Facility Rearing and Breeding Operations and Maintenance

The CoA Aquatic Conservation Facility (ACF) works to promote the recovery of the RGSM in the wild through captive propagation and augmentation. Funding for the ACF comes from several sources including ABCWUA and Reclamation. The ACF is a breeding, rearing, and research center that includes indoor and outdoor culture systems and a naturalized refugium. The indoor systems are used for quarantine, breeding, egg hatching, and rearing larvae. The outdoor systems are used for raising larvae to sub-adult age and for holding large numbers of broodstock. The outdoor naturalized refugium is a river-like environment with controllable flow, variable depth, variable habitat, and natural substrate.

In 2017, ACF staff collected approximately 3,000 RGSM larvae and transferred them to Southwestern Native ARRC for grow out and potential use as broodstock. During the 2018 spawning season, additional RGSM eggs were collected by American Southwest Ichthyological Researchers (ASIR) staff, resulting in approximately 72,209 RGSM eggs being delivered to the ACF. In 2017 and 2018, a significant amount of natural RGSM spawning was expected, and operations at the ACF were adjusted accordingly. ACF staff collected approximately 93,128 naturally-spawned RGSM eggs for monitoring and returned them to the BioPark. Approximately 46,200 eggs and approximately 25,000 to 35,000 RGSM larvae were transferred to the Southwestern Native ARRC in 2017 and 2018. Captive spawning at the ACF in 2018 produced approximately 78,279 viable RGSM eggs.

Image: Los Lunas Silvery Mnnow Refugium
Image Credit: WEST Staff

Los Lunas Silvery Minnow Refugium Operations and Maintenance

The LLSMR was built by NMISC with federal financial assistance, and is designed for the propagation and culture of RGSM. The facility began operation in 2009 and is located on State of New Mexico property in the Village of Los Lunas, about 20 miles south of Albuquerque. The LLSMR includes an outdoor refugium that has a stream, ponds, islands, and overbank areas to mimic the Rio Grande's habitats, and an indoor hatchery, quarantine building, outdoor tanks, and office building. The facility has a permanent staff of two aquaculturists and one technician, and NMISC works with the Program's Science and Habitat Restoration Workgroup and USFWS's Genetics and Captive Propagation Workgroup to accomplish the facility's goals and objectives. In FY18, the LLSMR was jointly funded by NMISC and Reclamation. The facility is permitted by USFWS.

The NMISC operates the LLSMR to propagate RGSM for augmentation into the MRG. During 2018, a total of 3,282 RGSM were reared and provided to the USFWS for augmentation efforts. The fish produced for augmentation are intended to help support a reproducing population of RGSM in the MRG, especially in years with low population numbers. In addition, the LLSMR is holding fish for a fish movement study being conducted by NMISC and their contractor. To support this study, 4-year-old RGSM are injected with Passive Integrated Transponder (PIT) tags and held on station.

Drain Outfall Sampling

Throughout the 2018 irrigation season, small volumes of water were consistently discharged from multiple MRGCD outfall locations within the Isleta Reach of the MRG where river channel drying is common in summer months. The fish populations in three outfalls were sampled at monthly intervals in the late summer and early fall of 2018 to determine the degree to which RGSM utilize them as refugia during periods of adjacent river channel drying. Much of the water discharged from the outfalls has been supplied from other agencies that have coordinated with the MRGCD to convey the water through the MRGCD system.

RGSM may use MRGCD outfall locations as refugial habitat during periods of drying. The sampling conducted in the drains will be used to inform future water management decisions, help determine the most economical use of water when supplies are limited, and aid in the formation and refinement of future studies and monitoring projects.

Evaluation of Rio Grande Silvery Minnow Population Model Alternatives

This project includes testing the potential for using a simulation model to evaluate the impact of environmental factors on the Rio Grande that have measurable effects on RGSM populations. This initial simulation model uses R software to establish RGSM population parameters (fecundity, survival). Subsequent models will accommodate parameters for spatial and temporal aspects of habitat availability and quality, including environmental flows (magnitude, duration, and timing) for RGSM spawning and recruitment. A comparative model approach will be used to evaluate river drying with perennial flow to demonstrate the effect of drying on the population trajectories. Subsequent versions of the model will evaluate possible management actions for population effects.

Image: Gravid RGSM Female
Image Credit: LLSMR Staff

This information will be useful for management decisions regarding river flow, water deliveries, aquatic and riparian habitat restoration, endangered species protection, and the public use of sensitive areas. Management decisions may be made that result in appropriate river flow levels that support improved environmental conditions and ecosystems for species that rely on riparian and aquatic habitats.

Fish Community Surveys

The Pueblo of Santa Ana completed spring, summer, and fall 2018 fish community surveys in conjunction with USFWS staff. Surveying fish communities was intended to provide management-relevant information on RGSM, including trends in fish abundance in response to habitat restoration projects.

The Pueblo monitored nine sites in the Santa Ana stretch of the Rio Grande during all three seasons, and four sites in the Rio Jemez during the spring and summer events. There were 162 seine hauls during the spring event, 150 hauls during the summer event, and 120 hauls during the fall event. The USFWS stocked 20,000 minnows into Santa Ana's reach of the Rio Grande. Subsequently, the Pueblo collected data on the stocking recapture and provided the data to USFWS.

Figure 3. Santa Ana Fish Community 2018 Survey Data

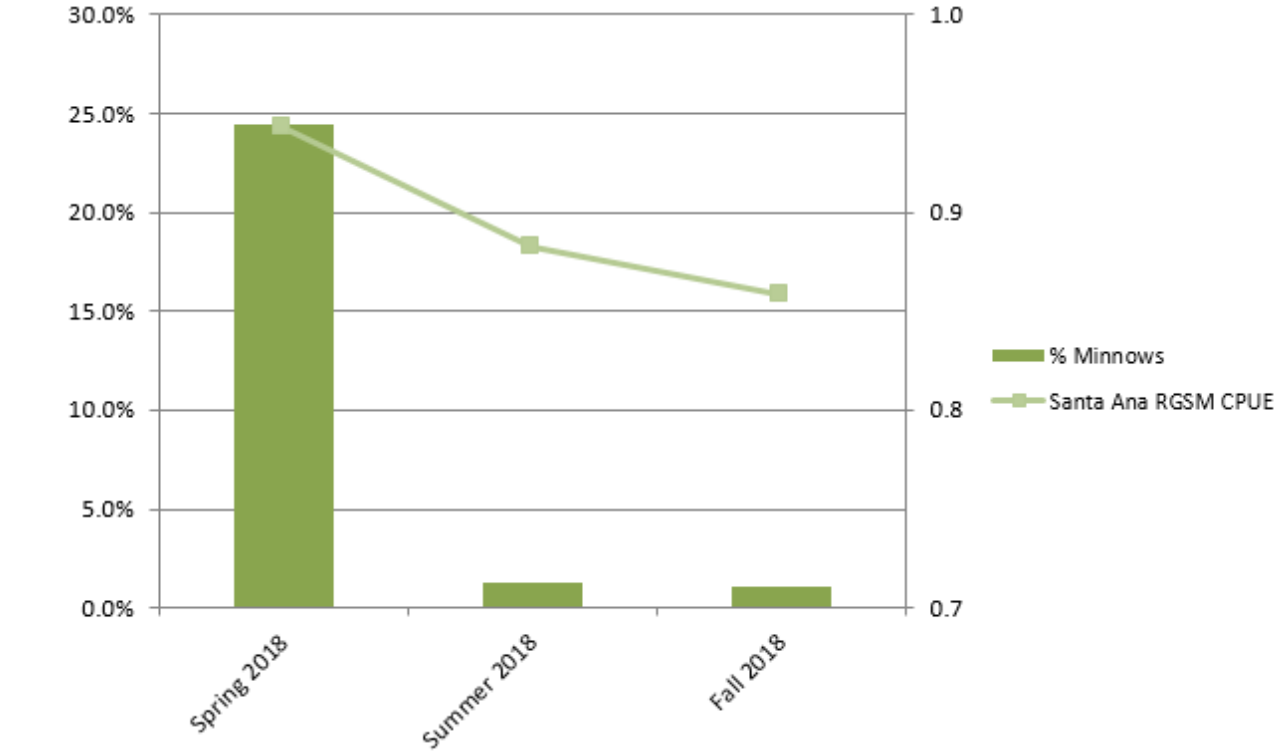


Figure 3 shows percentage of RGSM caught compared to the entire species list numbers, and catch per unit effort as RGSM/100m^2

Investigation of Rio Grande Silvery Minnow Mesohabitat Preferences

USACE funded a project through FY18 that studied mesohabitat types and fish behavior under various levels of water velocity and depth at fifteen sites on the MRG. The U.S. Geological Survey (USGS) mapped the spatial extents and physical characteristics of fish habitat, evaluating them at moderate and low stream flows. The goal of collecting this information is to better understand RGSM mesohabitat preferences and modeling of fish movement, which may be necessary to maintain viable fish populations. It also lends to understanding mesohabitat usage by RGSM to help develop tools for river management.

Rio Grande Silvery Minnow Spawning Habitat Study

The NMISC and the ABCWUA have collaborated to support a study investigating the occurrence and use of inundated floodplain habitat by RGSM larvae and adults on both restored and unrestored sites in the Angostura, Isleta, and San Acacia Reaches. Monitoring began in FY17 and is ongoing. The objective of the study is to determine when and how long adult and larval RGSM occur in floodplain habitats in spring, as well as examining the utilization of floodplain habitat restoration sites by RGSM larvae and adults. Two supplemental studies have been initiated to accurately age larval RGSM to help determine when larvae were hatched and how many dats post-hatch larvae remain in floodplain habitat. The first is an otolith age validation study and the second is to evaluate the ages of larval RGSM collected from all three reaches using otoliths.

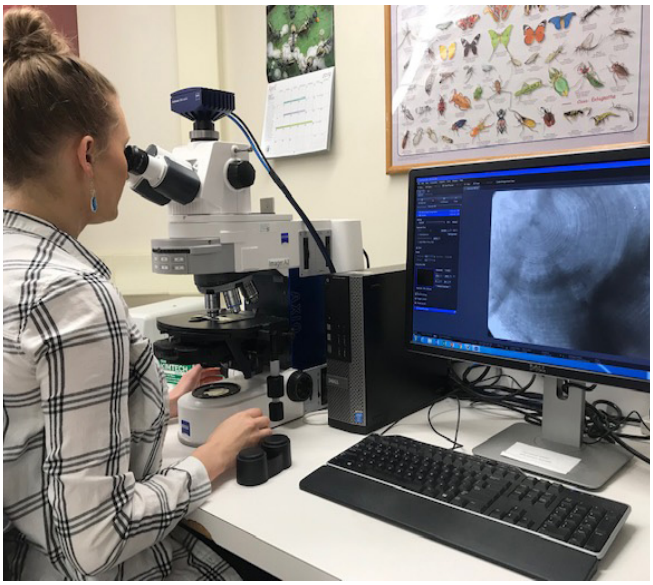


Image: Otolith Study
Image Credit: Steve Zipper, SWCA

Otolith Validation Study

To date, there is insufficient evidence that RGSM larvae can be accurately aged to days post-hatch using otoliths. The objective of the otolith validation study is to determine if RGSM larvae deposit a single daily increment on lapillar and sagittal otoliths. Larval RGSM were hatched and grown to thirty days, then a double-blind aging method was used to assess daily deposits on the otoliths. Initial findings show that larvae deposit a daily increment on sagittal and lapillar otoliths. These deposits are critical to determine the age of larval RGSM, and a better understanding of otolith development is expected to result in more accurate aging of RGSM.

Otolith Age Comparison by Reach

The RGSM Spawning Habitat Study collected larval RGSM from the Angostura, Isleta, and San Acacia Reaches. Physical and chemical conditions can vary among the three reaches, which could potentially impact when RGSM larvae occur on the floodplain and for how long. To determine how differences between reaches may affect RGSM spawning, an age comparison study of larval RGSM was initiated in FY18. Aging larval RGSM will help determine when they were hatched and how long they occur in the floodplains. Additionally, this study may provide insight into how the timing of different environmental cues, such as hydrologic peaks and temperature impact RGSM spawning and larval development among the three reaches.

Rio Grande Silvery Minnow Population Management

The RGSM is restricted to a portion of the Rio Grande in New Mexico, ranging approximately 150 river miles from the vicinity of Bernalillo, downstream to the headwaters of Elephant Butte Reservoir. The objectives of this project include continued propagation of RGSM, continued monitoring and augmentation of wild RGSM with hatchery-raised fish, and rescue and transport of stranded RGSM during intermittent flow periods in the MRG.

The MRG rescue and salvage program seeks to recover RGSM from intermittent reaches of the Rio Grande between the Isleta Diversion Dam and Elephant Butte Reservoir that would likely result in substantial RGSM mortality without management intervention. The RGSM are rescued from isolated pools, and then transported and released alive at locations that are perennially wet.

During FY18, ABCWUA, MRGCD and Reclamation provided resources to USFWS for fish rescue and salvage activities. Between April 2018 and September

2018, rescue activities were conducted on 40.4 miles of the MRG's main channel that became intermittent; four miles in the Isleta Reach and 36.4 miles in the San Acacia Reach. In total, 70,797 live RGSM were rescued, and of these, only 27 were young-of-year RGSM, while 342 were hatchery-reared RGSM. The remainder of RGSM rescued alive were naturally-spawned adults. These were the highest numbers of adult RGSM rescued in any year since the standard protocol was implemented in 2007. In addition to rescued RGSM, USFWS found 23,102 dead RGSM during river intermittency, and all but three individuals were from the San Acacia Reach.

This project also evaluated the effectiveness of RGSM population augmentation in the MRG, and monitors the temporal and spatial movements of released RGSM. A total of 187,000 RGSM were stocked within nine locations of the MRG during fall 2018. Over 2,580,000 hatchery-raised RGSM have been released in the MRG since 2002. All released fish were supplied by hatchery operations with guidance from the RGSM Genetics Management and Propagation Plan.

In 2018, USFWS initiated a rescued fish survival pilot study. The study is intended to determine how drying and the resulting rescue efforts affect RGSM survival. The USFWS Fish and Wildlife Conservation Office brought RGSM into controlled laboratory conditions to monitor survival rates both prior to river drying and from isolated pools during drying. Survival rates were variable but were highest in RGSM that were collected prior to drying and spawning.

Image:s USFWS Releasing RGSM into the Rio Grande
Image Credit: USFWS Conservation Office Staff

Rio Grande Silvery Minnow Population Monitoring

Systematic population monitoring of the RGSM and associated MRG fish community began in 1993 at multiple sites from Algodones to Elephant Butte Reservoir. Monitoring was refined to standardized sites prior to MRGESCP involvement in FY02, and has evloved with Program review and recommendations over time. This long-term monitoring program documents the number of fish captured per unit of effort, which is used to calculate the Catch Per Unit Effort (CPUE) density metric. A comparison of CPUE over time is considered and used to describe the long-term trends and overall status of the RGSM population in the MRG. The monitoring also supplies required information for the 2016 MRG BO.

Monitoring occurs up to nine months of the year at 20 locations in the MRG. In 2017 and 2018, the sampling design was modified to include a total of 30 sites during the key months of April and October. A consistent monitoring protocol is expected to yield a long-term ecological data set to accomplish the following:

- Determine long-term (multi-year) and short-term (seasonal) trends in MRG fish populations using statistical approaches that discern spatiotemporal differences in the abundance of native and non-native fish, with a focus on the RGSM
- Evaluate the influence of water discharge timing, magnitude, and duration on population fluctuations of both native and non-native fish species in the MRG over time and space, with a focus on the RGSM
- Compare changes in RGSM rank abundance to that of other native and non-native fish species
- Determine site-specific sampling variation
- Examine spatial correlation of RGSM population dynamics over time

Image: Seining in the MRG
Image Credit: Robert Dudley, ASIR LLC

The estimated densities (CPUE as E(x)) of RGSM in October are used as an annual index for long-term trends across years and were notably lower from 2010 to 2014 as compared to the 2007 to 2009 period. Estimated densities improved in October 2015 (E(x) = 0.16), and again in 2016 (E(x) = 7.20). Catch rates dramatically increased in October 2017 (E(x) = 23.17); and then dramatically decreased in 2018 following an extreme low water year (CPUE calculation = 0.1 with three age classes detected).

Rio Grande Silvery Minnow Spawning Monitoring

Each spring, daily RGSM spawning activity has been monitored at sites in the Angostura, Isleta, and San Acacia Reaches since 1999. The resulting spawning data are used to estimate the in-river passage rates for RGSM eggs produced during major spawning events and over the duration of the principal spawning season (late April through June). Spawning data are also used in correlation analyses with hydrograph and water quality data to identify detailed spatial spawning patterns, and to assess spawning over time.

From 2003 to 2016, Reclamation funded monitoring in main canals associated with diversion dams to document RGSM entrainment during the RGSM spawning period (May 1 to May 31). To minimize take as a result of diversions, egg catch rates in irrigation canals were used to determine the extent of the transport of eggs into the irrigation system at both the Isleta and San Acacia Diversion Dams. Daily reports informed management decisions during the spring runoff, and indicated very low to no entrainment of eggs was occurring.

Images: RGSM Spawning Monitoring in the Rio Grande
Image Credit: Robert Dudley, ASIR LLC

Image: RGSM Spawning Monitoring Equipment in the Rio Grande
Image Credit: Robert Dudley, ASIR LLC

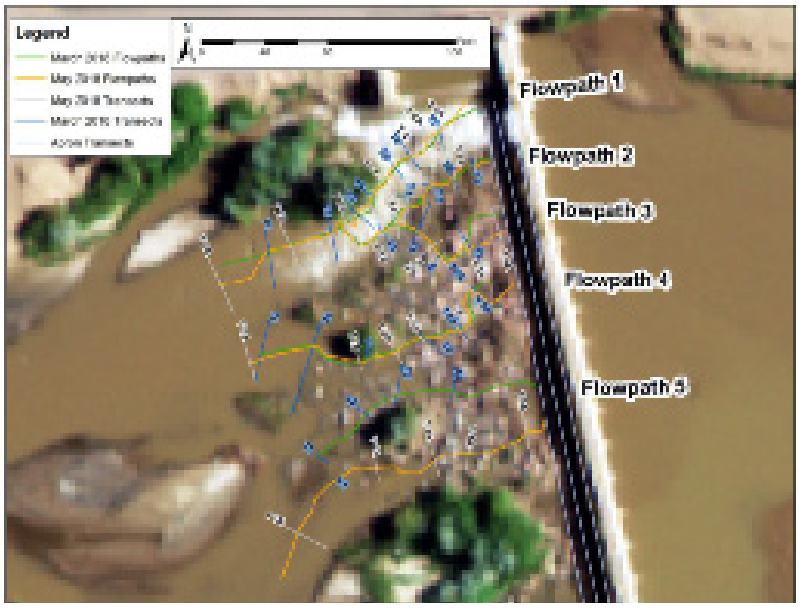
Egg monitoring from April 22, 2018 through June 10, 2018 detected a total of 104,259 RGSM eggs. The estimated number of eggs transported downstream was 2,198,794 at the lower Albuquerque site, and 43,425,850 at the Sevilleta NWR site. In 2018, flathead chub (*Platygobio gracilis*) eggs were detected for the first time during this reproductive monitoring project (positively identified from hatched larvae).

San Acacia Diversion Dam Fish Passage Pilot Study

As a 2016 MRG BO obligation, the NMISC, in cooperation with MRGCD, Reclamation, and USFWS, is conducting a pilot fish passage study at the San Acacia Diversion Dam. The Diversion Dam is located on the Rio Grande between Belen and Socorro (Figure 4). Planning began in early 2017 to evaluate existing conditions at the Dam to evaluate the potential for in-channel fish passage options through operational changes and small modifications to the existing infrastructure that would create hydraulic connection at the location. The NMISC contracted for hydraulics evaluation of the Diversion Dam, and planned a fish movement study to evaluate the physical and hydrologic barriers that might require modification. Pilot projects below the Dam were planned; however, an evaluation of the dam structure by Reclamation indicated that stabilization was needed prior to allowing pilot study construction. As a result, the NMISC was able to conduct only limited studies for fish movement and engineering evaluations in 2017 and 2018, and plans to continue work in 2019. Results indicate that RGSM can be successfully detected using PIT tags in and around the San Acacia Diversion Dam, and that further field and modeling efforts are needed to determine the best option for river connectivity and fish passage (Figure 5).

Figure 4. San Acacia Diversion Dam

Figure 5. Location of flow paths and collected data



3.3 Habitat Restoration

In FY18, the MRGESCP supported habitat restoration projects that provided RGSM spawning habitat, RGSM larval nursery habitat, and SWFL and YBCU nesting habitats. Habitat restoration projects are intended to provide sustainable habitat features for listed species in the MRG. Table 5 provides a list of habitat restoration activities that were ongoing through FY18, the duration of the projects, and the contributing signatories.

Table 5. Habitat Restoration Activities List

Project Name	Begin	End	Contributing Signatores
Bosque and Riverine Restoration Project, and Fish Passage at Isleta Diversion Dam	FY17	Ongoing	MRGCD; Pueblo of Isleta; Reclamation; USFWS
Candelaria Nature Preserve Hydrology and Soils	FY18	FY18	CoA
Candelaria Nature Preserve Wildlife Inventory	FY18	FY19	CoA
Habitat Restoration in the Isleta and San Acacia Reaches	FY16	Ongoing	NMISC; Reclamation; USWFS
Habitat Restoration Site Surveying	FY17	Ongoing	USACE
Identifying Restoration Priorities for Threatened Tamarisk Dominated Habitat to Benefit Future Habitat for Southwestern Willow Flycatcher	FY18	FY19	USACE
Los Lunas Habitat Restoration Project Monitoring	FY00	Ongoing	USACE

Image: Middle Rio Grande
Image Credit: Robert Dudley, ASIR LLC

Bosque and Riverine Restoration Project, and Isleta Diversion Dam Fish Passage

The Pueblo of Isleta continued to develop the Pueblo's Bosque and Riverine Implementation Report, which identifies specific treatment types for the entire 2000-acre Isleta bosque. The project is intended to complete bosque and riverine improvements along Isleta's eight-mile stretch of the bosque. The project goals include exotic species removal, fuels reduction, revegetation with native plants, wildlife habitat improvement, and Kellner Jetty Jack removal. In addition to bosque and riverine improvements, and in coordination with Reclamation and MRGCD, modifications to Isleta Diversion Dam are proposed, that will modify the Diversion Dam's irrigation infrastructure for sediment management, and will incorporate a fish passage structure.

The decline in RGSM populations has been attributed to several factors, including decreased and interrupted stream flow caused by impoundments and permanent water diversion structures. The Isleta Diversion Dam is one of three diversion dams dividing the remaining RGSM population, and a fish passage will provide connectivity between the Isleta and Angostura Reaches of the MRG. Once the project is constructed, the bosque and riparian restoration will enhance current habitat and provide new habitat for listed species.

Image: Rio Grande Cottonwood
Image Credit: Mike Marcus

Candelaria Nature Preserve Hydrology and Soils

In July 2018, the CoA Open Space Division contracted GeoSystems Analysis, Inc. to assess soil conditions at the Candelaria Farm Nature Preserve project area. Boreholes were dug to a depth of eight feet or to the water table, whichever was encountered first, and soils from each borehole were extracted and evaluated. Soil texture was recorded for each depth increment where there was a distinct color break and/or textural change. Soil samples from the boreholes were sent for chemical analysis, including particle size distribution, salinity, and sodium absorption ratio.

Candelaria Nature Preserve Wildlife Inventory

The CoA Open Space Division funded a project to conduct wildlife inventory surveys at the Candelaria Farm Nature Preserve in April 2018. The effort spanned eighteen landscape crop units, wildlife ponds, and associated riparian woodland corridors. Wildlife trap cameras and real-time observations by biologists documented native vertebrate animal species, non-native domestic animals, and recreational use of habitat patches. All field and camera recorded wildlife observations will be digitized and submitted with an annual project report that summarizes the findings by season and habitat patch type over the sampling year. Work will continue through March 2019.

Habitat Restoration in the Isleta and San Acacia Reaches

In 2018, NMISC collaborated with Sevilleta National Wildlife Refuge (NWR) and Reclamation to select, design, and construct habitat restoration projects to improve RGSM, SWFL, and YBCU habitats. Cooperation with these agencies allowed projects to be constructed using Reclamation and Sevilleta NWR field crews, which resulted in timely and cost-effective environmental compliance, design, and construction. The project is focused on characterizing hydrologic and geomorphic conditions in the lower Isleta Reach and upper San Acacia Reach, selecting potential restoration sites, modeling channel and overbank flows, and designing these projects.

During FY18, one 16-acre overbank and backwater project was constructed on the Sevilleta NWR, and five off-channel projects, ranging from 1 to 10 acres, were constructed south of the San Acacia Diversion Dam. These projects provide habitat diversity and increase floodplain inundation during spring runoff when several native fish species spawn.

Image: Rio Grande Nature Center
Image Credit: Mike Marcus

Image: Coyote with Racoon at Candelaria Nature Preserve
Image Credit: SWCA Wildlife Camera

Image: Candelaria Nature Preserve Wildlife Camera Observation
Image Credit: SWCA Wildlife Camera

Habitat Restoration Site Surveying

USACE conducted habitat restoration in the Rio Grande bosque in the Albuquerque area. Surveying of these project sites involved assessing morphological adjustments and sediment aggradation and erosion in a variety of hydrological features such as high-flow channels and embayments, terraced or scalloped banklines, oxbows, and other features installed at various USACE habitat restoration sites within the Albuquerque Reach.

This monitoring collected data on stream flow through the various channels and inundation of other habitat restoration features during spring runoff, which helps biologists understand whether, and for how long, flow conditions in this channel may be suitable for RGSM spawning and recruitment. Additionally, the amount and duration of flows affect growth of native shrub species that provide essential SWFL habitat.

Information from this project will provide insight into the development of general design guidance for increased sustainability of restoration features for desirable RGSM habitat; assessing what design assumptions and conditions worked and which would require tweaking in future designs. This effort will also help estimate expected life expectancy for the various features.

Image: Bank Views of the Middle Rio Grande
Image Credit: Mike Marcus

Identifying Restoration Priorities for Threatened Tamarisk Dominated Habitat to Benefit Future Habitat for the Southwestern Willow Flycatcher

In FY18, USACE contracted with Tetra Tech on a study to provide site-specific verification and final priority rankings for the top 15 of the 103 tamarisk-dominated SWFL restoration sites identified in the report Tetra Tech completed in January 2015. The project included ground-truthing the sites to verify continued appropriateness for restoration goals including assessing site access opportunities, vegetation community validation, proximity to recent SWFL nesting sites, and hydrology and stage-discharge relationships, floodplain connection, and groundwater dynamics.

Currently, SWFL nest site numbers and population size exceed recovery goals for the MRG. Loss of quality nesting habitat for this species could result in decreases in nesting success, reducing future population sizes to levels potentially below recovery goals. Timely efforts to restore at-risk tamarisk-dominated habitat near SWFL nesting sites would help SWFL population numbers remain above minimum recovery requirements.

Image: Middle Rio Grande Bosque
Image Credit: Mike Marcus

Los Lunas Habitat Restoration Project Monitoring

Following a fire in April 2000, the Los Lunas restoration site was selected as the first restoration area under the 2003 "Biological and Conference Opinions on the Effects of Actions Associated with the Programmatic Biological Assessment of Bureau of Reclamation's Water and River Maintenance Operations, Army Corps of Engineers' Flood Control Operation, and Related Non-Federal Actions on the Middle Rio Grande, New Mexico". Reclamation and USACE acted as joint lead federal agencies on this 40-acre project, with MRGCD as the primary non-federal cooperator. This was the first habitat restoration project supported by the MRGESCP.

The project included removing non-native vegetation to promote native willow and cottonwood establishment and growth, excavating high-flow channels and terrace lowering to provide RGSM nursery habitat, and excavating a groundwater pond/wetland for other wildlife. Ongoing monitoring of the site will record the availability and effectiveness of restored habitat, including physical elements related to habitat characteristics (hydrology, geomorphology, and vegetation), and the presence of RGSM and SWFL. The FY19 project will include a summary of the past 20+years of monitoring as well as provide recommendations for where best to focus future monitoring efforts.

3.4 Science Support

The MRGESCP supports the use of the best available science to make management decisions for the benefit of the listed species. Science support funding provides planning and technical assistance, such as data collection, monitoring projects, and literature reviews, needed for signatories to design and create resilient habitat for listed species in the MRG. Table 6 lists science support-related activities, their duration, and contributing signatories.

Table 6. Science Support Acitivites

Project Name	Begin	End	Contributing Signatores
Adaptive Management Framework	FY16	FY18	USACE
Assessment and Quantification of Sediment and Discharge at Arroyo de los Piños	FY17	Ongoing	Reclamation; USACE
Bosque Ecosystem Monitoring Program Site Monitoring	FY18 FY14	FY19 Ongoing	MRGCD; USACE
Bosque School Bosque Ecosystem Monitoring Program After-School Program	FY18	FY18	CoA
Collaborative Aerial Data Collection and Analysis	FY16	FY18	USACE
Drought Plan Efficiency Study	FY16	FY19	MRGCD
Literature Review of Techniques for Creating Channel Bars for Instream Rio Grande Silvery Minnow Habitat	FY15	FY18	USACE
Monitoring Climate Change in the Middle Rio Grande	FY12	Ongoing	USACE
Rio Grande Sediment Gages: Rio Puerco, San Acacia, San Marcial	FY10	Ongoing	USACE
Rio Grande and Tributaries Geomorphic Characterization Study	FY11	FY17	USACE
Tamarisk Leaf Beetle Monitoring	FY13	FY19	USACE
Update and Analysis of Corrales Bosque Preserve Hink and Ohmart Map	FY18	FY18	MRGCD

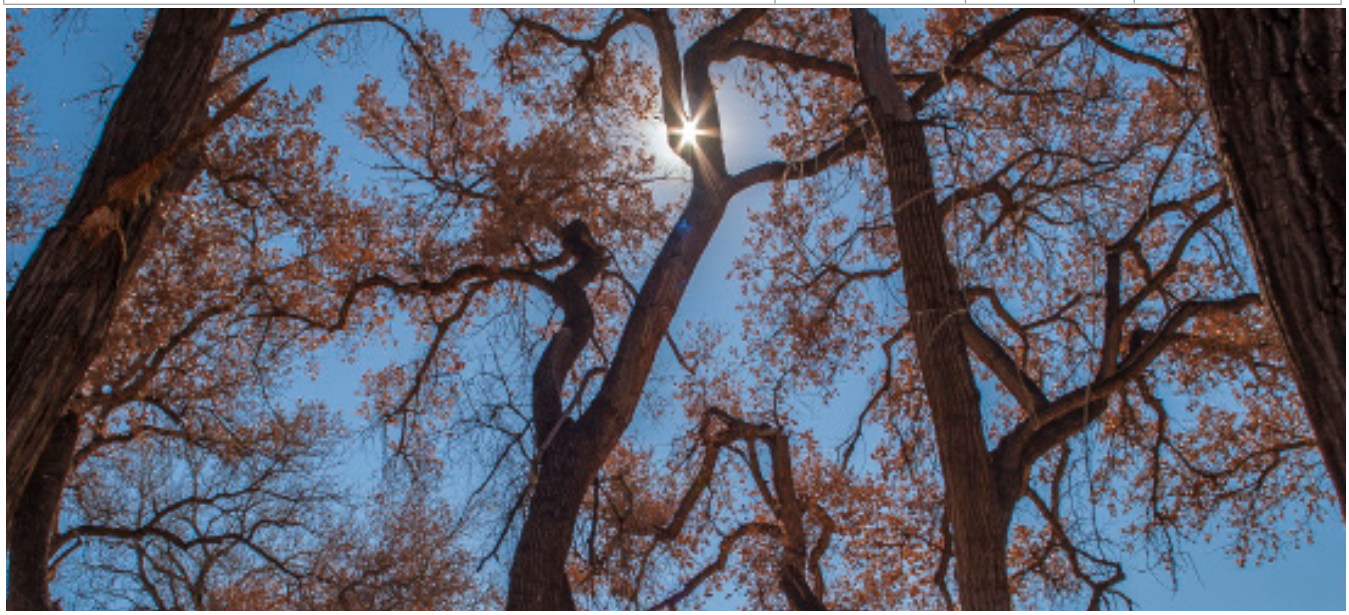


Image: Bosque Cottonwood Cover
Image Credit: Mike Marcus

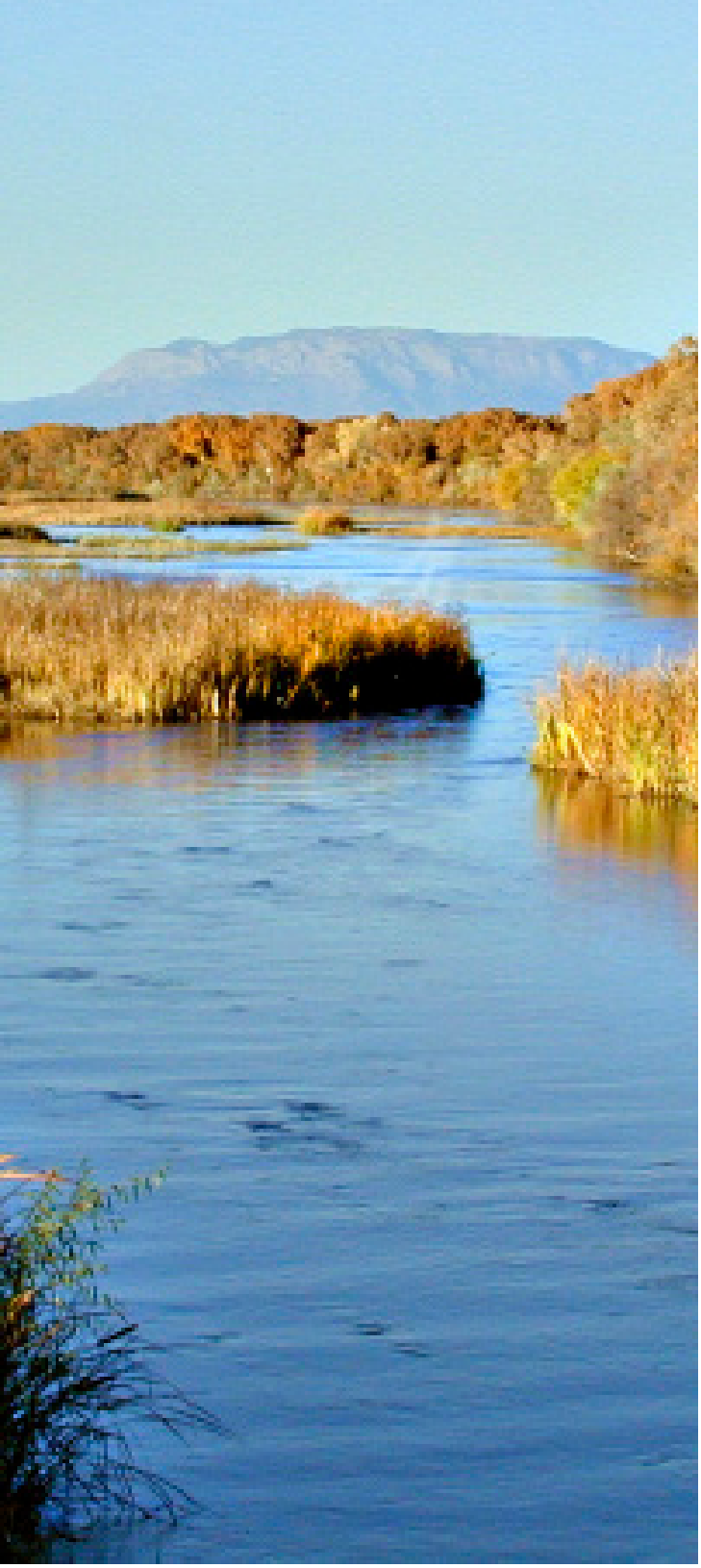


Image: Middle Rio Grande Views
Image Credit: Mike Marcus

Adaptive Management Framework

In FY18, USACE funded a project through GeoSystems Analysis concluding in a final report, "Middle Rio Grande Adaptive Management Framework: Identifying Critical Scientific Uncertainties." The framework identified critical scientific uncertainties and recommended associated studies for the RGSM, SWFL, YBCU, and the New Mexico Meadow Jumping Mouse. The report was submitted to the MRGESCP EC in May 2018 after extensive review by technical staff.

Assessment and Quantification of Sediment and Discharge at Arroyo de los Piños

Reclamation, USACE, the New Mexico Institute of Mining and Technology (NMT), USGS, UNM, and Ben Gurion University of the Negev have partnered to better understand the tributary sediment loading at Arroyo de los Piños, a tributary to the MRG. The MRG is a dynamic and complex fluvial system where flow and sediment transported from the upper Rio Grande and MRG tributaries influence the observed form of the river. This flux of water and sediment (magnitude, duration, and frequency) is tempered by bank and bed stability, base level changes, floodplain lateral confinement, and floodplain connectivity, which in turn influence how much, when, and where water and sediment are eroded, transported, or stored within and through the fluvial system. The Arroyo de los Piños is one of several ephemeral tributaries on the east side of the MRG between San Acacia and San Antonio. The smaller drainage basin of this arroyo, coupled with a constriction in the flow channel at the Escondida Drain, provides an ideal opportunity to construct a direct bed load collection system.

How sediment moves through the MRG is an important planning question as it addresses a wide range of concerns including flood control and river rehabilitation. Too much or too little sediment may impair the riverine ecosystem, which is important to species such as the RGSM, SWFL, and the YBCU. Knowing how the sediment supply moves within and through the MRG is a key component in designing river rehabilitation projects that work with the complex interplay of the natural processes on the MRG.

Bosque School Bosque Ecosystem Monitoring Program Site Monitoring

BEMP is a collaborative ecological monitoring program between UNM and the Bosque School. Monitoring, outreach, and other BEMP activities are funded, in part, by USACE and MRGCD. BEMP uses volunteers and students to conduct regular and systematic monitoring of habitats on the historic floodplain while promoting education and awareness of the bosque's overall condition. BEMP collects long-term data at a total of 33 research sites along 350 miles of the Rio Grande including weather data, shallow groundwater table depth, monthly precipitation, surface arthropod activity, and forest production measurements (leaf litter biomass, tree diameter, growth rates, and plant distribution). BEMP provides long-term data collection, promotes public outreach, and furthers preservation of species habitat. These data are shared with Program signatories and other land and natural resource managers.

Bosque Ecosystem Monitoring Program After-School Program

In FY18, the CoA Open Space Division began funding BEMP to provide after school opportunities for students in Albuquerque to gain experience with scientific research in the field and the lab. Students research projects in ecology, wildlife, and conservation, and make presentations at community events and to science and conservation professionals each year. The after school program incorporates field experiences in their local parks or school yards, study trips in the bosque, and science, technology, engineering, art, and math activities that tie concepts together. Activity themes include phenology, entomology, and storm water runoff, and students work with BEMP staff to develop research projects they can carry out in the bosque or around Albuquerque. In this program, students are supported in designing, carrying out, and presenting original research at community and professional events to teach their peers with the support of BEMP educators.

Collaborative Aerial Data Collection and Analysis

Movement of sediment in the southwestern United States tends to be initiated by flash flood events resulting from monsoon events. These events are short-term and occur under monsoonal weather conditions, which make it difficult to accurately measure sediment volumes and movement using common terrain mapping technologies such as aerial Light Detection and Ranging (LiDAR). The major impediments to using these methods include the short notice to activate flight missions, and the inability to rapidly develop maps. This project develops tools to facilitate the rapid production of sediment-related measurements.

USACE has collaborated with the UNM GIScience for Environmental Management Lab, the U.S. Air Force Civil Air Patrol, and Bureau of Land Management to implement the sensor array and conduct aerial data collection. The Albuquerque Metropolitan Arroyo Flood Control Authority and Southern Sandoval County Arroyo Flood Control Authority have also collaborated on arroyo data collection and ground control for aerial flights. Initial flights have been conducted with promising provisional results, and work is being done to produce additional tools for ongoing monitoring.

In 2018, this project conducted multiple flights along the MRG, including the full Arroyo de los Piños watershed. Data collected during peak spring runoff included floodplain habitat and levee inundation. The Arroyo de los Piños research site in Socorro, NM is the focus of extensive, ground-based, instrumented sediment monitoring developed by Reclamation, USGS, and NMT. The imagery from these flights will be used for high resolution geomorphic and vegetation analysis.

Drought Plan Efficiency Study

The MRGCD was awarded a grant by Reclamation to develop a Drought Contingency Plan. The overall goal of the Plan is to increase the MRGCD's resilience to water shortages. The Plan enables MRGCD to continue providing a reliable supply of water for their constituents, while also meeting obligations set forth in the Rio Grande Compact and 2016 MRG BO.

The Drought Contingency Plan is an administrative framework that includes an index for monitoring drought and corresponding triggers for drought severity. It identifies current and future vulnerabilities, proposes long-term mitigation actions and drought response actions. Implementation could enable the MRGCD to operate more efficiently, which would potentially increase the available water for listed species.

Image: Low-flow Conveyance Channel
Image Credit: Mike Marcus

Literature Review of Techniques for Creating Channel Bars for Instream Rio Grande Silvery Minnow Habitat

Sand bars and similar geomorphic features are important for river ecosystems because they provide nesting and foraging habitat for birds (including endangered species) and important shallow water habitat for numerous aquatic species. However, most rivers that are managed to prevent flooding lack sufficient sediment to maintain channel bars, which causes these features to erode and disappear. In channels that are being eroded and that lack floodplain connectivity, instream habitat is even more important. This project intends to identify effective techniques for creating these features.

The techniques, guidance, and models described in this literature review provide planning support for USACE and other agencies to develop in-channel habitat restoration projects that better utilize river flows, structural modifications, and available sediment to create quality habitats.

Monitoring Climate Change in the Middle Rio Grande

Most model projects of future climate in the Rio Grande basin are characterized by persistent drought. Recent drought has highlighted the vulnerability of regional water supplies to persistent drought, and the potential impacts of drought on habitat and species conservation efforts. This project helps decision-makers understand and plan for climate change impacts to listed species and their designated or proposed critical habitat by creating and maintaining an ongoing summary and analysis of current trends in climate and resulting hydrologic changes in the Rio Grande basin above Elephant Butte Reservoir. In addition, this project supports active participation in the following regional climate change planning efforts:

- Reclamation and MRGCD WaterSMART climate change projects, including the Rio Grande-New Mexico Basin Study and the Drought Framework Planning Study
- Rio Grande basin representation on the South Central Climate Science Center Rio Grande Coordinating Call and to the Southern Rockies Landscape Conservation Cooperative
- Information sharing with federal agencies through the Watershed Futures initiative
- Collaboration with Reclamation and the National Corporation for Atmospheric Research on a project modeling how future changes in climate extremes may affect stream flows in the Upper and MRG basin

Rio Grande Sediment Gages: Rio Puerco, San Acacia, San Marcial

This data collection effort provides information with which to assess the relative contributions of dams and secondary influences on the geomorphology of the Rio Grande. The geomorphology of the Rio Grande within the middle valley has been affected by flood control and irrigation projects, with secondary influences, such as dams, channel rectification measures, and sediment delivery from contributing drainage areas, altering the geomorphology of the channel. Accurate sediment gage data are critical to understanding these effects, and this project supports data collection at three gages essential to this effort. Collection efforts aid in the understanding of how USACE project activities affect species' environments, and support operational and strategic decision-making.

Rio Grande and Tributaries Geomorhpic Characterization Study

This study assessed the relative contributions of dams and additional influences on the geomorphology of the Rio Grande through a combination of quantifying influences and numerical sedimentation modeling. USACE contracted with Tetra Tech to develop and apply a numerical sediment routing model on the MRG between Cochiti Dam and the Elephant Butte Reservoir. The purpose of the model was to provide a better understanding of geomorphic changes on the MRG related to sediment transport. The developed model is a one-dimensional, numerical hydraulic model with a mobile bed boundary. The study is intended to investigate influences of mainstem dams,

Image: Bosque del Apache National Wildlife Refuge
Image Credit: Mike Marcus

tributary loadings, reduced snowpack, Elephant Butte reservoir levels, and a river realignment that Reclamation is proposing at Bosque del Apache NWR on the sediment supply and transport within the MRG.

This is one of a series of studies being conducted to better understand the impacts of USACE dams on the geomorphology and sedimentation of the mainstem Rio Grande. The geomorphology of the MRG has been influenced by flood control and irrigation structures, and secondary influences have altered the geomorphology of the channel. This understanding will aid in the stewardship of vital resources along the MRG that are important for species recovery.

Tamarisk Leaf Beetle Monitoring

Tamarisk leaf beetle (*Diorhabda carinulata*) monitoring results revealed the spread of beetle and subsequent defoliation of tamarisk within the Rio Grande watershed. The spread of the tamarisk leaf beetle from the north and potential spread of other species of tamarisk leaf beetle (e.g., *Diorhabda elongata*) from Texas will ultimately affect riparian forests in central and southern New Mexico. *Diorhabda carinulata* has already spread further south, and the spread of the Texas beetle species is expected to continue range expansion into New Mexico watersheds. These areas provide suitable habitat for the endangered SWFL and are important to many other riparian birds, reptiles, and amphibians.

The survey methods for tamarisk leaf beetle are based on those established by the Tamarisk Coalition, with some modification. Field data sheets are compiled and entered into a database, the spatial data for the beetle numbers present in each sampling location are used to create a GIS map, and findings that identify what beetle species are present in New Mexico watersheds are recorded. This work is used to coordinate and compile tamarisk leaf beetle monitoring datasets with the Tamarisk Coalition.

Suitable habitat for SWFL and other riparian birds, reptiles, and amphibians exists in the MRG, and the spread of the tamarisk leaf beetle will ultimately impact riparian forests in central and southern New Mexico. This project provides valuable information to managers for habitat restoration and other projects in riparian forests along the MRG.

Update and Analysis of Corrales Bosque Preserve Hink and Ohmart Map

This project included updating vegetation mapping of the Corrales Bosque Preserve using Hink and Ohmart community and structure survey protocol and vegetation classifications. Vegetation composition was analyzed and compared to the MRG Conservation Action Plan rating criteria for Dynamic Patch Mosaic (DPM) vegetation. The DPM attribute indicates the mix of vegetation community types (i.e. the vegetation mosaic) that facilitates the best outcome for ecosystem resilience and biodiversity in the bosque.

The updated vegetation community and structure types were used to classify general vegetation types per the MRG Conservation Action Plan. The analysis conducted found that woodland was the most common type (433.7 acres; 71.16%), followed by shrubland (169.5 acres; 27.81%), meadow (6.2 acres; 1.01%), and marsh (0.1 acre; 0.02%).

A status assessment of DPM riparian and wetland vegetation was completed based on the results of the vegetation analysis. The Corrales bosque received an overall rating of "fair" for the DPM attribute. Based on these results, recommendations were made on how to reach the future desirable status of wetland and riparian DPM vegetation according to the MRG Conservation Action Plan.

Densely vegetated woodlands and shrublands are increasing in the Corrales bosque, while meadows are decreasing, and wetlands remain extremely scarce. Young and emergent vegetation is rare, resulting from the lack of regenerative processes caused by altered river hydrology because young and emergent vegetation mostly occurs in dry or seasonally flooding river channels. Wildfire in the Corrales bosque is a perennial and increasing risk, and without intervention, the area could become increasingly overgrown and prone to wildfire. Aging vegetation communities will continue to perish, and without young and emergent classes of native vegetation to replace them, ecological quality will diminish.

3.5 Water Monitoring and Coordination

In FY18, Program signatories collaborated on water releases and species activity, and conducted hydrologic monitoring in the MRG. Data collection and monitoring projects aid resource managers in determining the appropriate action to take for the benefit of the MRG species. Table 7 provides an overview of water coordination activities, monitoring, and studies; the project duration; and contributing signatories.

Table 7. Water Monitoring and Coordination Activites List

Project Name	Begin	End	Contributing Signatores
Minnow Action Team	FY12	Ongoing	ABCWUA; MRGCD; NMISC; Reclamation; USFWS
Continuous Water Temperature Monitoring of the Middle Rio Grande Basin	FY13	Ongoing	USACE
Environmental Compliance Monitoring Associated with the San Juan-Chama Drinking Water Project	FY04	Ongoing	ABCWUA
Los Chavez Gate Installation	FY18	FY19	MRGCD
Middle Rio Grande Groundwater Monitoring	FY18	FY20	USACE
Rio Grande Nature Center High Flow Channel Gage Monitoring	FY10	Ongoing	USACE
Socorro South Distrubution Hub	FY16	FY19	MRGCD

Image: San Acacia Diversion Dam
Image Credit: Mike Marcus

Minnow Action Team

The Minnow Action Team (MAT) began in 2012 as an ad hoc work group to provide an adaptive management focus to MRG water and species activities. As a result of reports of low RGSM numbers in the MRG resulting from the prolonged drought in that year, the MAT was formed to determine if any management actions could be proposed to the Program's EC.

The MAT assists water and resource management entities and the Program with annual coordination, evaluation, and recommendations on water operations and species management to meet 2016 MRG BO and recovery goals for the RGSM. It does this by assimilating hydrologic, biological, and ecological information on an annual basis; and providing recommendations that could be used to reduce endangered species threats, and to enhance spawning, recruitment, and survival conditions for RGSM.

Hydrologic forecasts for 2018 were extremely poor due to near record low snow accumulation in Colorado and northern New Mexico. Flows in the mainstem of the Rio Grande were insufficient to meet irrigation needs in the middle valley and releases from storage began in March. The MAT prepared recommendations to assist in egg collections during the spring period to stock as refuge populations in the hatchery system, collect adult fish early in the season and move to areas that had a higher likelihood of remaining wetted, and distribute supplemental water throughout the MRG to keep as much of the river wet as possible. These recommendations were agreed upon by the EC, and results were tangible with almost 100,000 eggs collected, 93,607 fish rescued, and 40.6 miles of unique river drying. Program signatories volunteered personnel and equipment to MRG drought response efforts.

Figure 6. Bi-Weekly Discharge at Otowi Bridge from March to June 2018

Continuous Water Temperature Monitoring of the Middle Rio Grande Basin

USACE, UNM, and USGS have partnered since FY13 to collect water temperature data at fixed stations year-round and periodically during periods important to the life history of the RGSM (i.e. snowmelt pulse, flow reduction, flow alteration). The thermal regime of rivers is a key factor that determines the overall health of aquatic ecosystems. It influences the habitat suitability, distribution, and growth rates for most aquatic organisms. Water temperature affects the solubility of gasses such as dissolved oxygen, which are crucial for the health of aquatic organisms and ecosystem process.

Water temperature in the MRG fluctuates naturally (i.e. daily, seasonally, annually), and as of result of anthropogenic influenced distresses such as dam releases from reservoirs, flow reduction, and flow alteration. The RGSM evolved in a highly variable ecosystem, and is likely more tolerant of elevated temperatures and low dissolved oxygen concentrations for short periods. Despite this tolerance, degraded water quality can significantly affect the RGSM directly by reaching lethal and non-lethal limits, or indirectly by affecting physiological processes and increasing stress levels, which may ultimately lead to impairment or death.

The water temperature monitoring project data are used by scientists and engineers to assess how water temperature influences RGSM hatch periodicity, growth rates, survival, and population trends. In addition, these data are used to assess how naturally occurring and anthropogenic processes impact the thermal regime of the MRG, which also influences RGSM life history.

Image: Middle Rio Grande
Image Credit: Robert Dudley, ASIR LLC

Environmental Compliance Monitoring Associated with the San Juan-Chama Drinking Water Project

The purpose of this environmental monitoring project is to comply with select elements of the Reasonable and Prudent Measures and Terms and Conditions specified in ABCWUA's 2004 BO. The environmental monitoring for FY18 investigated the 2018 RGSM spawning event near the Alameda diversion structure, and larval RGSM-use of habitat restoration sites. Additionally, ABCWUA contracted with SWCA to monitor for RGSM eggs during the experimental "jiggle" of the diversion dams in the Angostura and Isleta Reaches that helped create a pulse flow to encourage RGSM spawning.

Although RGSM egg monitoring is required under ABCWUA's 2004 BO, collection of field measurements of egg production can also inform management actions, such as controlled water releases. Additionally, monitoring larval RGSM-use of habitat restoration sites helps inform managers regarding the success of habitat restoration measures.

Los Chavez Gate Installation

At the Los Chavez Wasteway in the Isleta reach of the Rio Grande, the MRGCD discharges small, consistent amounts of water into the river to provide thermal refugia for RGSM when conditions in the adjacent river channel are not suitable. The MRGCD installed two Langemann Gates, which are devices used to control and measure water in the Riverside Feeder Canal, from which water is discharged into the Los Chavez Wasteway. The two gates installed at these locations enable the MRGCD to reliably meet the desired flow into the outfall through control of both the upstream water level and the rate of flow to the river, and to create refugia in the Wasteway, which may be used by RGSM.

Middle Rio Grande Groundwater Monitoring

Monitoring data from this project provide information regarding how long designed groundwater depths are sustained following repeated flood inundation. Moist surface soils are important for establishment and growth of riparian-wetland plant species, and for organic soil development, nutrient cycling, invertebrate diversity, and other ecological processes. Long-term monitoring will help determine if depth thresholds are exceeded after restoration features become repeatedly inundated. In addition, monitoring of groundwater levels is needed to evaluate if, and to what degree, soil moisture retention improves with time as restoration features become repeatedly inundated. These data are valuable for evaluating differences in soil moisture availability on vegetation growth attributes in the constructed willow restoration features. This is particularly important for informing future design of SWFL habitat restoration projects. The data are also valuable for evaluating differences in primary biological productivity between restoration features with and without a direct river connection. In FY18, the following tasks were added to the project:

- Review of existing groundwater wells to determine if any of the existing wells can be retired from the monitoring network;
- Development of a groundwater database; and
- Review of riparian groundwater models to determine whether or not this data can be integrated into a spatially explicit, USACE-developed riparian groundwater model for the MRG.

This project will aid in the understanding of impacts to species' environments, support operational strategy decision-making, and contribute to maintaining healthy and suitable species habitat.

Image: Middle Rio Grande
Image Credit: Mike Marcus

Rio Grande Nature Center High Flow Channel Gage Monitoring

This monitoring project funded by USACE collected data on stream flow through the Rio Grande Nature Center high flow channel during spring runoff. The information helps biologists understand whether, and for how long, flow conditions in the channel are suitable for RGSM spawning and recruitment. The amount and duration of flows also affect growth of native shrub species that provide suitable SWFL habitat. This project informs the reestablishment of a hydrological connection between the river and channel, which benefits RGSM and SWFL in the Albuquerque portion of the Angostura Reach.

Image: Views of the Middle Rio Grande near Alameda
Image Credit: Mike Marcus

Soccorro South Distribution Hub

The Socorro Main South Distribution Hub uses an existing check structure and a newly constructed check structure in the Socorro Riverside Drain to supply water to a new pump station. In turn, this provides water to three separate discharge locations; two of the three locations discharge into the MRGCD conveyance system, enabling the MRGCD to access water in the drains for delivery to irrigators. The third discharge location is through the levee. Existing infrastructure can then be used to discharge the pumped water into the river channel to augment flows for threatened and endangered species needs.

The Socorro Hub provides the MRGCD the ability to use water from the Socorro Riverside Drain and effectively minimizes the amount of water diverted directly from the Rio Grande River. In addition, the pump station will be able to augment flows in the river channel for the RGSM below the San Acacia Diversion Dam.

Water Quality Monitoring of Aquatic Refugia in the Middle Rio Grande

River intermittency, or drying of stretches of the river so there is not continuous flow, will continue to become more common because of climate change, especially in the southwestern U.S. On the MRG, significant river intermittency is now considered the norm, and will become more frequent and widespread given water scarcity predictions.

Aquatic wildlife experience habitat loss as drying occurs along stretches of the MRG. Remaining aquatic habitat, such as irrigation outfalls, areas below irrigation outfalls, and isolated pools, may provide temporary refuge for aquatic wildlife during periods of river intermittency. These spaces are known as aquatic refugia, and may become increasingly important as drying trends continue in the Rio Grande basin. Water quality factors within aquatic refugia including pH, nutrient content, temperature, and oxygen have been identified as potentially inhibiting the use of these spaces by endangered species such as the RGSM.

Continuous and discrete measurements of water quality within aquatic refugia provide insight into factors that may influence fish survival, and more specifically, survival of the RGSM. Moreover, the evaluation of these aquatic refugia can lead to a greater understanding of stream fish ecology and future challenges facing the MRG. These results may be used to inform management decisions.

Quantifying and evaluating the water quality and biogeochemistry, in combination with overlapping physical habitat and fish community assessments of MRG aquatic refugia help water managers determine how to manage water or other factors to support refugia for RGSM and the greater MRG fish community.

3.6 Program Support

The MRGESCP requires administrative support to accomplish its goals and objectives. Signatories provide staff to complete tasks including contract development and administration, coordination of activities across projects and work groups, and support of Program planning and activities such as meeting coordination, website administration, and outreach activities.

During FY18, the MRGESCP worked to develop a new website and Program Portal, and provide contract and signatory staff and resources toward achieving Program goals. Program support is essential to the continuous forward movement of the MRGESCP in providing science support and coordination of activities within the MRG for the benefit of the listed species. Table 8 lists Program support activities, project dates, and the signatories that contributed resources.

Table 8. Program Support Activities List

Project Name	Begin	End	Contributing Signatores
Program and Science Support Contract	FY16	FY21	Reclamation
Program Portal	FY17 FY18	FY18 Ongoing	ABCWUA; USACE
U.S. Fish and Wildlife Service Management and Support	FY02	FY22	Reclamation

Program and Science Support Contract

In FY18, Reclamation continued to contract with Western Ecosystems Technology, Inc. (WEST) to provide third-party program and science support services to the MRGESCP. The WEST team includes a Program Manager, a Science Coordinator, and support staff. WEST is responsible for facilitating the achievement of Program goals by providing meeting administration and support, and disseminating information about Program activities and initiatives. Science coordination services include support for the Program's science activities, and coordination with Program scientists and technical experts to develop plans, processes, and other documents to support MRGESCP signatories.

Contracting MRGESCP support services helps with Program operations and aids in implementing Program activities. Coordination around research and monitoring allows for Program-supported science and other activities to better inform management decisions on the MRG related to listed species.

Program Portal

In FY18, ABCWUA provided funding to maintain the former database management system while USACE contracted with USGS to develop a new "Program Portal." The Program Portal will be designed to be more user-friendly and adaptable to meet the MRGESCP's current and growing program and science support needs. In FY18, USGS worked with the Program signatories to review needs, and developed a beta site to test functionality. The Program Portal will include a public-facing informational website with a calendar, mapping features, document storage, and a data module. The site can be accessed at https://webapps.usgs.gov/mrgescp/.

U.S. Fish and Wildlife Service Management and Support

In FY18, Reclamation provided funding to USFWS for personnel to support MRGESCP management activities and to facilitate ESA compliance. USFWS assisted in the coordination, planning, and management of work groups staffed by Program participants. Specific ESA compliance tasks included facilitating Section 7 consultations for the Program's federal partners, and managing Section 10 permits for other Program signatories.

As a signatory, USFWS also independently provides program management and on-the-ground support for activities that advance the recovery of listed species, including the facilitation of ESA compliance to minimize adverse effects of actions in the MRG on threatened and endangered species and their proposed and designated critical habitat.

Images: Mike Marcus

Middle Rio Grande Endangered Species Collaborative Program

FY18 Annual Report