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DATA GAPS ANALYSIS REPORT ALBUQUERQUE REACH HABITAT ANALYSIS AND RECOMMENDATIONS STUDY, MIDDLE RIO GRANDE ENDANGERED SPECIES COLLABORATIVE PROGRAM

Prepared for

U.S. ARMY CORPS OF ENGINEERS — ALBUQUERQUE DISTRICT

Prepared by

SWCA ENVIRONMENTAL CONSULTANTS

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Prepared for:

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Table of Contents

List of Tables

INTRODUCTION AND PURPOSE

The purpose of the Data Gaps Analysis Report is two-fold. The first is to review the existing data compiled in Task 3 Existing Information Summary to identify gaps in existing information pertaining to the current conditions with regards to physical habitat criteria for the Rio Grande silvery minnow (*Hybognathus amarus*; silvery minnow) and the Southwestern Willow Flycatcher (*Empidonax traillii extimus*; Flycatcher). This information and data are generally required to assess the existing habitat conditions and will be used in developing habitat restoration recommendations.

The second purpose is to review species biology information and data as they pertains to the Middle Rio Grande (MRG), specifically the Albuquerque Reach. The data gaps analysis for the silvery minnow and the Flycatcher builds upon the existing body of literature and identifies gaps in our knowledge regarding species biology and habitat ecology. The types of information and data discussed could inform and improve management strategies. This information and data could also be used to develop habitat restoration recommendations and will inform the development of evaluation criteria and monitoring methods.

This Data Gaps Analysis Report will: 1) summarize how SWCA Environmental Consultants (SWCA) will obtain or proceed in the absence of the data/information, and 2) provide recommendations for future studies and actions.

GENERAL RESTORATION

The information and data gaps identified in this section are often required for planning and implementing specific habitat restoration projects. Data regarding soil salinity, soil surveys, vegetation surveys, and jetty jack locations should be obtained and analyzed prior to implementing specific habitat restoration projects. General restoration information and data gaps are presented in Table 1.

Table 1. General Restoration Information and Data Gap Analysis

Gap	Comments	Recommended Action
Soil Salinity Data	An absence of comprehensive soil salinity data for the Albuquerque Reach may affect the success of restoration activities. Recent changes to groundwater levels, drought, and the presence of saltcedar are likely to have contributed to elevated salinity levels. Many riparian species, including cottonwood and coyote willow, are intolerant of high salinity levels.	Salinity data could therefore be used to target low salinity areas that would provide the greatest potential for riparian vegetation establishment and long-term survival. Comprehensive soil surveys and salinity mapping should be conducted throughout the MRG bosque.
Soil Surveys	NRCS Soil Survey for Bernalillo County is available. In addition, select site specific data from the installation of monitoring wells and other restoration/ monitoring projects are available throughout the reach. These surveys are useful for identifying general soil types but lack the specificity desired for habitat restoration planning.	A fine-scale soil survey should be conducted in the bosque in the Albuquerque Reach. Sampling should be conducted at discreet locations and tracked as part of a longitudinal study so changes in macro-nutrient content can be tracked.
Albuquerque Drinking Water Project Data	The Drinking Water Project will divert large quantities of water from the Rio Grande between the Alameda Bridge and the Wastewater Treatment Plant off of Rio Bravo Boulevard.	Water quality, river flows, and sediment changes should be monitored between where water is withdrawn and returned in the river.
Vegetation Classification	Knowledge of vegetation consistency, density, and age structure is a critical component of existing and future ecosystem restoration, as well as wildfire planning efforts.	Studies, such as the 2005 Hink and Ohmart analysis and the MRG River Bar Vegetation Map (Milford et al. 2003) should be ground-truthed prior to implementing habitat restoration projects. An Albuquerque Reach-wide vegetation mapping would have utility for future habitat restoration planning. While a significant up-front cost, this will facilitate future restoration initiatives.

Table 1. General Restoration Information and Data Gap Analysis

Gap	Comments	Recommended Action
Vegetation Classification	Knowledge of vegetation consistency, density, and age structure is a critical component of existing and future ecosystem restoration, as well as wildfire planning efforts.	Studies, such as the 2005 Hink and Ohmart analysis and the MRG River Bar Vegetation Map (Milford et al. 2003) should be ground-truthed prior to implementing habitat restoration projects. An Albuquerque Reach-wide vegetation mapping would have utility for future habitat restoration planning. While a significant up-front cost, this will facilitate future restoration initiatives.
Infrastructure Modifications/Maintenance	Various entities, including the MRGCD, USBOR, USACE, and the City of Albuquerque routinely conduct maintenance on infrastructure in and around the bosque. No central depository exists for data showing modifications and impacts to the riparian corridor.	A central depository should be created. This would likely entail compiling reports as well as GIS data.
Identification of Contractor Access and Staging Areas	Large and/or specialized equipment will likely be required for project implementation. Identification of suitable access and staging within the Bosque will be important.	Planning should begin during this phase. Final selection should be initiated during Plans & Specs for project implementation.
Consolidated Information on Location of Remaining Kellner Jetty Jacks	SWCA has in its possession GIS data indicating the location of jetty jacks. USBOR and USACE have mapped jack locations and have removed numerous jacks as part of various restoration efforts.	Databases should be consolidated and remaining jack locations should be field verified. Consolidated shapefiles should be created and maintained.

NRCS = Natural Resources Conservations Service; USGS = U.S. Geological Survey; NMISC = New Mexico Interstate Stream Commission; MRGCD = Middle Rio Grande Conservancy District; USBOR = U.S. Bureau of Reclamation; USACE = U.S. Army Corps of Engineers; GIS = geographic information system

RIO GRANDE SILVERY MINNOW

INFORMATION NEEDS AND FUTURE RESEARCH

Most contemporary investigations of silvery minnow life history are relevant to a limited subset of the environmental conditions that would have likely served as a selective basis for life-history adaptation. This incomplete perspective is largely a consequence of anthropogenic regulation of hydrologic conditions in the MRG, resulting in contemporary measures of central tendency and variation of discharge that deviate from pre-impoundment conditions, along with altered fluvial processes and basin geomorphology. Observations of the silvery minnow under such restrictive conditions can easily lead to misinterpretation of its needs and misidentification of causes for observed phenomena.[1] Knowledge of the habitat conditions under which the silvery minnow would be reasonably expected to maintain viable populations is vital to efforts to manage for a functioning condition that is aligned with fitness characteristics of the species.

Although numerous descriptions of quantitative and qualitative aspects of the flow regime of the MRG have been published, little attention has been paid to the evolutionary linkages of the natural flow regime and the fitness of the silvery minnow to live in this environment. Understanding the links between species' fitness and flow regime is crucial for the effective management and restoration of running water ecosystems. Although the importance of hydrologic dynamics to silvery minnow reproductive biology and resultant population trajectories is now generally acknowledged, the challenge remains to develop a mechanistic understanding of observed effects.

Information deficits presently preclude credible inferences about habitat limitation based on accurate information on the quantity and distribution of different habitats available to the silvery minnow along with direct measures of the consequences (growth, survival, fecundity, reproductive success) of occupying different habitat types. The role of habitat in limiting silvery minnow population abundance and growth can best be understood by considering habitat effects over successive life stages because of differential life stage utilization of available habitats over variable discharge regimes (Halpern et al. 2005). Silvery minnow spawning and recruitment to the juvenile stage tends to vary positively with high-discharge events during spring and summer, especially discharge levels that inundate the floodplain. Recruitment to the adult life stage varies with habitat type, habitat quantity and quality, and the continuity of surface water habitat in time and space. Conditions of drought coupled with extractive use of water frequently results in the loss of multiple expansive segments of running water habitat in the MRG as the principal proximate factor linked to significant silvery minnow mortality. In each instance, life stage dynamics are linked to population consequences of habitat loss or gain. The probability that an individual will survive to reproduce will be the product of a series of stage-specific survival probabilities that depend on habitat conditions experienced by each life stage. Under normal contemporary conditions of environmental variation, successive life cycle stages represent

[1] Some of the more pivotal advancements in elucidating adaptive aspects of the silvery minnow's life history and behavior come from recent observations of the species over successive years of contrasting and extreme hydrologic conditions that are unusual to the contemporary MRG, but nonetheless reflective of an undeveloped MRG. Only under such variable and extreme environmental circumstances can one hope to learn about silvery minnow life history traits and behaviors that appear to be adaptive to hydrologic extremes, such as the occupation or avoidance of various drought- or flood-prone habitats.

unique leverage opportunities for directed management to enhance the long-term probability of species survival.

Research is needed to identify alternate means of creating and maintaining desired discrete habitat features that will serve the needs of different life stages of the silvery minnow over a broad range of hydrologic conditions. Large water impoundments combine with sediment and flood control structures and large-scale extractive use of water to profoundly alter the landscape-level fluvial processes that formerly operated to maintain physical habitat features common to the pre-development MRG. From historic records of fish collections in the MRG (Sublette et al. 1990), we can surmise that pre-development habitat features of the MRG were aligned with fitness characteristics of a diverse native ichthyofauna, including the silvery minnow. Such discrete habitat features will persist only if the processes that generate them are maintained in a broader landscape context. Unfortunately, the practicality of this seems precluded by the contemporary constraints of large-scale water development on geomorphic processes in the basin coupled with water scarcity, a condition exacerbated by frequent recurring conditions of drought.

Planning for the provision of refugial habitats to overcome drought-associated habitat limitations requires that a quantitative relationship between habitat and population size be established for the species, and that sufficient habitat be maintained to meet an established recovery target based on the habitat-population relationship. For silvery minnow, this relationship, although unquantified, is known to vary profoundly by life stage and with varying hydrologic circumstances. As such, habitat-population relationships will be complicated by the necessary consideration of stage-specific estimates of survival (i.e., the fraction of the population that successfully recruits to each life history stage) and separate relationships between habitat and abundance for each life stage over a range of hydrologic conditions.

Several options exist to achieve a desired outcome involving refugia to protect against mortality-causing drought (emphasizing the need to conserve source populations). It seems possible that critical reaches of wetted surface habitat can be maintained over short periods of intermittent flow by strategic utilization of the irrigation infrastructure of the MRG to surgically convey water, ancillary to consumptive needs, to various delivery points along the river. Likewise, strategically placed wells could be used for the same purpose with a heightened assurance of water delivery to meet critical time-and space-dependent needs. These engineered hydrological measures can be coupled with measures to enhance geomorphic processes utilizing flow-deflecting structures (e.g., large woody debris or other revetment structures) that serve to focus pool-scouring water velocity. Experimental design should focus on a variety of refugial habitat designs comprising several spatial configurations. Fundamental aspects of evaluation should include considerations of efficiency and effectiveness, including conditions under which a management alternative will succeed or fail and considerations of longevity of benefits. The best indices of habitat quality are direct measures of the fitness consequences to individuals (growth, survival, fecundity, reproductive success) of using different habitat types, ideally in the absence of competition (i.e., at low density).

PERFORMANCE MONITORING

Programmatic monitoring is necessary to determine whether management actions have placed silvery minnow populations on a trajectory toward agreed-upon desired future conditions.

Assessing management programs also helps to reveal information deficits and technical problems that directed research may be able to rectify. Likewise, program monitoring and evaluation, when focused on problem identification, can reveal limiting factors that underlie fish populations that fail to achieve their full potential. Finally, monitoring and evaluating contemporaneous dynamic variables is required to adapt management practices to new circumstances. Without monitoring, innovation is discouraged, new knowledge is applied too slowly, and inefficiencies persist to the detriment of fisheries resources and the public.

From our initial examination of available silvery minnow data sets, it seems that few data sets exist as a result of evaluations of project performance. Furthermore, where such evaluations have been attempted, it is rarely conducted as a part of a true *designed* experiment (i.e., involving comparison of treatment effects between randomly selected *experimental* and *control* subjects free of confusion with other factors that may seriously influence response).

The vast majority of evaluations of the effects of Middle Rio Grande Endangered Species Collaborative Program (Collaborative Program) projects has involved, and will likely continue to be dominated by, *observational studies*—those in which the experimenter simply *observes* responses from sample members. In an observational study, the experimenter does not control the allocation of treatments between subjects after the sample has been selected (although, the experimenter may have control over a few intervention channel-specific *parts* of a treatment). The data derived from observational studies are often difficult to interpret because there may not be an explicit means of estimating the no-service baseline and where non-treatment effects may lead to errors in causal inference.

Impact analysis consists largely of observing program elements—the problem, management activities, and the outcomes of interest—and relating them to one another. The crux of analysis with respect to a particular outcome is a comparison of what did appear after implementing the program with the "no-service baseline." Although management operations have been defined and funded, the problems associated with individual projects have never been explicitly articulated in terms facilitative of program analysis. Outside of the context of an explicit statement of a management problem, an activity can only have a vague and implied purpose. Even so, failure to consider the problem leads to a fundamentally flawed evaluation—an evaluation without a "problem alleviated" expression of impact.

Evaluation of the Silvery Minnow Habitat Modification Projects

Several habitat evaluation projects, with associated data sets, have been initiated but are ongoing. Presently, there are insufficient data to judge the potential or realized managerial utility of these data sets. An important component of the experimental protocol for assessing the effect of habitat modification projects is the provision of adequate concurrent controls. In the absence of such controls, the data derived from experimental field studies are often difficult to interpret because there may not be an explicit means of estimating the no-service baseline and because non-treatment effects may lead to errors in causal inference, as stated above. Causal inference may be difficult to establish because of the following:

- First, compared sites or times usually differ in a variety of ways, so it is unclear which factors are responsible for any perceived patterns.

- Second, two variables may be correlated because both are related to a third, perhaps unmeasured and incidental, variable.
- Third, relationships between environmental and response variables may only be valid over the range of values of the environmental conditions found in the surveyed sites. If this range of values is small, sampling variation may preclude detection of a relationship between environmental and response variables. More important, it is not clear whether the survey results can be applied to sites or times with environmental values lying outside the surveyed range. Significantly, correlation analysis relies on static measures and is, therefore, poor at elucidating dynamic relationships between factors (e.g., those involving feedbacks and time lags).
- Finally, because surveys often are based on measurements taken over a limited period of time, they may miss important extreme events.

PRIMARY BIOLOGICAL PROCESSES AND VITAL RATES

Demographic parameters for many animal populations vary with the age of individuals in the population. An age or life stage-specific record of survival, mortality, and fecundity is essential for understanding observed patterns of population growth and decline. Likewise, an age- or stage-based record of survival, mortality, and fecundity is essential for predicting the future growth or decline of populations of concern, including management intervention strategies that are expected to alter rates of birth and death. These data are fundamental to understanding past observed *sawtooth* population dynamics, characterized by periods of exponential growth followed by exponential decay.

Cowley et al. (2006) observed five age classes (I–V) of silvery minnows in an 1874 sample from San Ildefonso, New Mexico, based on an examination of scales for annuli. This life span is characteristic of other species of *Hybognathus* (Becker 1983; Lehtinen and Layzer 1988). Nonetheless, length alone is regarded as an imperfect index of silvery minnow age, especially on a regional scale, because growth of fish is known to vary longitudinally with energy inputs and length of the growing season, and because the species' extended spawning season generally does not provide for a clear demarcation of age by size without validation of age founded on known age individuals or from evidence of annual growth that is often discernable on scales and otoliths.

Current understanding of silvery minnow age class strength and contemporary rates of survival and mortality can only be considered provisional; however, based on the chronological record of count-based indices of species status,[2] age class strength and the vital rates of birth and death are thought to be highly variable in time and space, primarily due to hydrologic variability linked either to strong recruitment or death.

The U.S. Fish and Wildlife Service (USFWS 2003) determined that the silvery minnow experiences high levels of mortality after maturation. Seemingly, contemporary impressions of

[2] The referenced chronological record of count-based indices of species status is derived variously from records of the Division of Fishes, Museum of Southwestern Biology, University of New Mexico, and the American Southwest Ichthyological Research Foundation.

silvery minnow mortality and survival rates come from apparent *trends* in silvery minnow density over time. Density estimates result from count data standardized to some unit of area. Traditionally, in the case of the silvery minnow, density is expressed in terms of fish captured per 100 m^2 of surface water sampled. At any given point in time and space, silvery minnow abundance and density is a function of reproduction, recruitment, and age-specific schedules of mortality and growth, along with varying rates of immigration and emigration. Complicating matters, density can have an effect on mortality and survival. Teasing out the partial effects of individual variables that govern productivity is a daunting task. Suffice it to say, fish abundance (or fish density) and survival (or the antithetical concept of mortality), while related, are not equivalent concepts.

Without judging the voracity of the claim that the silvery minnow experiences high levels of mortality after maturation, it is interesting to note that estimates of mortality and survival rates of silvery minnow populations that might be regarded as *baseline* have never actually been quantified. So, while we may be interested in the rates of survival of salvaged silvery minnows in the wild, we actually do not have a meaningful context in which to interpret these rates at the population level of biological organization. This is problematic, because to properly evaluate projects we need to be able to relate their outputs to the amelioration of the problems to which they are relevant.

Table 2 summarizes information and data gaps. The information presented above and in Table 2 will inform the habitat analysis and restoration recommendations while providing the basis for evaluation criteria and monitoring recommendations.

Table 2. Rio Grande Silvery Minnow Information and Data Gap Analysis

Gap	Comments	Recommended Action
Habitat Availability	Although literature exists that documents silvery minnow preferred habitat, little or no literature exists that documents spatial and temporal amounts of spawning, nursery, and adult habitat.	No information exists that documents suitable silvery minnow spawning habitat; therefore, studies should be conducted to define spawning habitat for the species. Studies should be conducted to map the amount of available habitat using habitat preferences defined by Dudley and Platania (1997) spatially and temporally over a range of flow regimes.
Demographics (Longevity of Contemporary Population)	Cowley et al. (2006) documented the presence of five age classes from specimens collected in 1874 from San Ildelfonso, New Mexico. The majority of contemporary spawning silvery minnows are age 1+, with 2+ fish generally making up less than 10 percent of the population. This information is not verified through scale age analysis. The main advantage of age-based stock assessment over more traditional approaches, such as catch per effort as an index of population abundance, is that this assessment can be applied without knowledge of effective sampling effort, catchability, or gear selectivity.	Scales should be collected from silvery minnow recorded during monitoring. Recent collections have documented the presence of multiple age classes of silvery minnow in the Albuquerque Reach; however, researchers were not permitted to collect scales to verify the observations (Hatch and Gonzales 2008). In addition, silvery minnow from the Albuquerque Reach appear to achieve a larger maximum size than fish collected from the Isleta Reach, possibly indicating an older aged population in the Albuquerque Reach. The presence of older aged silvery minnow may be attributable to the reach's perennial flow.
Growth	Little or no information exists that documents growth rates of wild minnows.	Size information (length and weight) should be collected from all silvery minnow collected during monitoring. Studies can then be conducted to determine which occupied habitats are the most suitable for silvery minnow growth.

Table 2. Rio Grande Silvery Minnow Information and Data Gap Analysis

Gap	Comments	Recommended Action
Reproduction (Fecundity)	Currently, one can only speculate about the year class or life-stage–specific reproductive potential of silvery minnows; formal analysis of reproductive potential awaits the accumulation of requisite managerial or research-grade data. This is unfortunate because such information is vital to understanding observed population dynamics and assessing risks associated with a wide array of management alternatives, especially as they relate to the management and administration of limited water resources considering that the reproductive biology and early life history of silvery minnows is so intricately linked to hydrologic dynamics.	Studies should be conducted to document the fecundity for silvery minnow over the range of encountered sizes.
Population Monitoring/Trends	One fundamental problem of trend extrapolation presumes, contrary to experience, that the future will be like the past. Formal assertions of trends through traditional regression analysis of such data sets are dependent on a constant variation in observations (i.e., constant capture probabilities) over time. In the case of count data for the silvery minnow, a schooling species exhibiting uneven distributions and dissimilar capture probabilities, such assumptions cannot be satisfied. It is probable that variance gets larger as density of a schooling species gets smaller. In all likelihood, such data are ill suited for even simple retrospective characterizations of trends based on traditional regression analysis.	Closed population (depletion or mark-recapture) or open population (mark-recapture) studies should be conducted to estimate catchability of the species for commonly used gear types.
Abundance of Spawning Rio Grande Silvery Minnow (“Escapement”)	Estimates of the number of spawning adults would provide managers with an index of population status and expected recruitment. This index would provide managers with information that would allow for annual adaptive management of water in the MRG.	Silvery minnow should be monitored immediately prior to and during spawning. This data can then be used to develop index values of the minimum number of adults necessary for a viable population.

SOUTHWESTERN WILLOW FLYCATCHER

The Flycatcher is a difficult to track species, and much of the information about the species has been derived from studies of the Flycatcher's habitat. As such, many of the identified data gaps in the Albuquerque Reach are related to habitat. Below are the identified data gaps and recommendations to identify suitable habitat locations within the Albuquerque Reach and the greater MRG.

Quantitative studies designed to identify the critical relationships between the presence of and/or proximity to standing water and Flycatcher site/territory occupancy are needed. Although much Flycatcher life history and habitat research has been conducted over the last 10 years, there is paucity of *quantitative* studies focused on the habitat requirements of the species as related to water. Typically, Flycatcher studies incorporating water investigations record hydrological conditions at sites using *qualitative* means, such as general habitat descriptions for entire breeding sites or survey areas. Manipulative experiments at restoration sites that attempt to duplicate hydrological conditions at breeding sites may provide managers information regarding the amount and duration of standing water needed to create and maintain the structural characteristics of vegetation found at occupied Flycatcher habitat. Experiments should include different types of water impoundment structures and materials to identify those that are best suited for riparian ecosystem replication. Examining the critical relationships between the presence of and/or proximity to standing water may help guide habitat restoration and site enhancement efforts for the Flycatcher within the Albuquerque Reach and elsewhere.

Although much funding and effort is currently being focused on creating and restoring riparian habitat along the MRG for the Flycatcher, the degree to which the species uses the river corridor as a migratory flyway and/or prospective existing habitat is unknown and should be investigated. Determining if, how, and where the Flycatcher prospects in existing habitat along the MRG may provide insight as to where restoration and enhancement sites should be located to best facilitate colonization.

Habitat use by unpaired resident and non-territorial floater (including returning juveniles) Flycatchers remains largely unknown, and future studies (e.g., using radio telemetry) should document habitat use for unpaired resident and non-territorial floater Flycatchers. These data may help guide restoration efforts and promote recovery of the species by providing quantitative information regarding how the spatial patterning of habitats within the greater landscape best facilitates Flycatcher immigration and establishment of new populations.

The affinity of breeding Flycatchers with standing water and saturated soil is noted consistently in the literature, and presence of water may be a factor in sustaining particular vegetation features at breeding sites (Paradzick 2005) and providing a more suitable microclimate for raising offspring (Sogge and Marshall 2000; Mcleod et al. 2008). Moreover, the fluctuating availability of surface water at Flycatcher breeding sites is likely one factor influencing residency and breeding at a site in any given year, with Flycatchers breeding in years when sites contain standing water (Weddle et al. 2007, Mcleod et al. 2008). Vegetation studies conducted by Mcleod et al. (2008) found Flycatcher nest sites to be significantly closer to surface water or saturated soil during nesting than at unoccupied sites within the same breeding patches. Assessing potential Flycatcher habitat within the Albuquerque Reach should include examination and mapping of perennial, intermittent, and ephemeral water as well groundwater table data. Areas along the reach that contain high water tables and receive intermittent flows should be considered the most potentially suitable for Flycatchers. Data analysis gap results are summarized in Table 3.

Table 3. Southwestern Willow Flycatcher Information and Data Gap Analysis

Gap	Comments	Recommended Action
Habitat use by unpaired resident and non-territorial floater (including returning juveniles)	Typically, Flycatcher studies incorporating water investigations record hydrological conditions at sites using *qualitative* means, such as general habitat descriptions for entire breeding sites or survey areas.	Delphic process involving avian ecologists, biologists, and landscape ecologists to ensure habitat assessments conducted along the Albuquerque Reach produce data that best facilitate habitat restoration and site enhancement efforts for the Flycatcher.
The degree to which the species uses the river corridor as a migratory flyway and/or prospects in existing habitat is unknown	Determining if, how, and where the Flycatcher prospects in existing habitat along the MRG may provide insight as to where restoration and enhancement sites should be located to best facilitate colonization.	Map perennial, intermittent, and ephemeral water sources in the MRG. Use Light Detection and Ranging (LiDAR) as a method to delineate suitable habitat. Use high-resolution aerial photographs to delineate suitable habitat.
Critical relationships between the presence of and/or proximity to standing water and Flycatcher site/territory occupancy	These data may help guide restoration efforts and promote recovery of the species by providing quantitative information regarding how the spatial patterning of habitats within the greater landscape best facilitates Flycatcher immigration and establishment.	Examine and map perennial, intermittent, and ephemeral water and groundwater table data to assess potential habitat suitability. Future studies (e.g., using radio telemetry) should document habitat use for unpaired resident and non-territorial floater Flycatchers.

HYDROLOGY, HYDRAULICS, AND GEOMORPHOLOGY

Many hydrologic studies have been conducted related to the Rio Grande. Because the river dynamic and geomorphic changes impact hydrology along the Rio Grande's riparian corridor, studies require constant revision and updating. The information and data gaps analysis presented in Table 4 is based on initial information and data gaps for the project. This list focuses on what we believe will be required to advance the recommended restoration projects to final design and ultimately construction. We anticipate that this list will evolve and may expand as we progress with our work. The list does not include data and information known to exist and requested from the federal agencies. We are assuming that this data will be made available.

Table 4. Hydrology Hydraulics and Geomorphology Information and Data Gap Analysis

<table>
<tr><th colspan="4">Subreach Specific Data</th></tr>
<tr><th>Sub-Reach ID</th><th>River Mile Start</th><th>River Mile End</th><th>Description</th></tr>
<tr><td>Reach A</td><td>209.7</td><td>209.2</td><td>Angostura Diversion Dam to North Boundary Santa Ana Pueblo</td></tr>
<tr><th>Gap</th><th colspan="2">Comments</th><th>Recommended Action</th></tr>
<tr><td>Active Channel Cross Section Surveys</td><td colspan="2">No USBOR range lines or other cross sections are known to exist within this reach. Agg/deg only.</td><td>Prior to the next phase of project, establish three lines spaced evenly within the reach from levee to levee and survey.</td></tr>
<tr><td>High Resolution Topographic Data</td><td colspan="2">2-foot contour & DTM data exist (TRM 2000). Produced for USACE/BIA by Thomas R Mann and Associates. Suitable for preliminary design. Final design/P & S will require new ground-based topographic data collection.</td><td>Initiate prior to Plan & Specs. Use survey grade GPS or total station.</td></tr>
<tr><th>Sub-Reach ID</th><th>River Mile Start</th><th>River Mile End</th><th>Description</th></tr>
<tr><td>Reach B</td><td>204</td><td>201.5</td><td>South Boundary Santa Ana Pueblo to North Boundary Sandia Pueblo (Barranca Arroyo)</td></tr>
<tr><th>Gap</th><th colspan="2">Comments</th><th>Recommended Action</th></tr>
<tr><td>Active Channel Cross Section Surveys</td><td colspan="2">Existing sections: BI-296; BB-300, 301, 303–305, 307–320; CO-30. Good coverage, many surveyed in 2004.</td><td>During next phase of project, resurvey existing lines. Verify existing condition hydraulics. Create site specific models with new survey data to support final design of in-channel projects.</td></tr>
<tr><td>High Resolution Topographic Data</td><td colspan="2">2-foot contour & DTM data exist (TRM 2000). Produced for USACE/BIA by Thomas R Mann and Associates. Suitable for preliminary design. Final design/P & S will require new ground-based topographic data collection.</td><td>Initiate prior to Plan & Specs. Use survey grade GPS or total station.</td></tr>
</table>

Table 4. Hydrology Hydraulics and Geomorphology Information and Data Gap Analysis, continued

Subreach Specific Data, continued			
Sub-Reach ID	**River Mile Start**	**River Mile End**	**Description**
Reach 1	201.5	192.2	Barranca Arroyo to Alameda Bridge
Gap	**Comments**		**Recommended Action**
Active Channel Cross Section Surveys	Existing sections: BB-323, 327, 338–342, 345; CR-355, 361, 367, 372, 378, 382, 386, 388, 394, 400, 413; CA-1; CO-31-34. Good coverage. Recent surveys 2004–2006.		During next phase of project, resurvey existing lines. Add cross sections at key locations. Verify existing condition hydraulics. Create site-specific models with new survey data to support final design of in-channel projects.
High Resolution Topographic Data	TRM data exists for Sandoval County. Bernalillo County/AMAFCA/USACE digital mapping project (BHI 2000) provides high resolution LiDAR within levees. Data is suitable for project identification and preliminary design and quantity computation.		Site-specific ground-based data collection (RTK, GPS, or total station) should take place prior to final design/Plans & Specs. Important for bars, banks, and islands that may be modified.
Sub-Reach ID	**River Mile Start**	**River Mile End**	**Description**
Reach 2	192.2	187.9	Alameda Bridge to Montano Bridge
Gap	**Comments**		**Recommended Action**
Active Channel Cross Section Surveys	Existing sections: CR-435, 436, 438, 440, 441, 443, 448, 458, 462; CA-2-13; CO-35 Good coverage. Most surveyed in 2004-2005.		During next phase of project, resurvey existing lines. Verify existing condition hydraulics. Create site specific models with new survey data to support final design of in-channel projects.
High Resolution Topographic Data	Bernalillo County/AMAFCA/USACE digital mapping project (BHI 2000) provides high resolution LiDAR within levees. Data is suitable for project identification and preliminary design and quantity computation.		Site-specific ground-based data collection (RTK, GPS, or total station) should take place prior to final design/Plans & Specs. Important for bars, banks, and islands that may be modified.
Sub-Reach ID	**River Mile Start**	**River Mile End**	**Description**
Reach 3	187.9	183.4	Montano Bridge to Central Bridge
Gap	**Comments**		**Recommended Action**
Active Channel Cross Section Surveys	Existing sections: AQ-467, 472, 476, 480, 487, 488, 503, 507. Limited coverage. Surveyed in 2004.		During next phase of project, resurvey existing lines. Verify existing condition hydraulics. Create site specific models with new survey data to support final design of in-channel projects.
High Resolution Topographic Data	Bernalillo County/AMAFCA/USACE digital mapping project (BHI 2000) provides high resolution LiDAR within levees. Data is suitable for project identification and preliminary design and quantity computation.		Site-specific ground-based data collection (RTK, GPS, or total station) should take place prior to final design/Plans & Specs. Important for bars, banks, and islands that may be modified.

Table 4. Hydrology Hydraulics and Geomorphology Information and Data Gap Analysis, continued

Subreach Specific Data, continued			
Sub-Reach ID	**River Mile Start**	**River Mile End**	**Description**
Reach 4	183.4	177.1	Central Bridge to Tijeras Arroyo
Gap	**Comments**		**Recommended Action**
Active Channel Cross Section Surveys	Existing sections: AQ-521, 526, 531, 535; A-1-9; CO-36, 37. Fair coverage. AQs and COs surveyed in 2004-2005. A lines surveyed in 1999.		During next phase of project, resurvey existing lines. Verify existing condition hydraulics. Create site specific models with new survey data to support final design of in-channel projects.
High Resolution Topographic Data	Bernalillo County/AMAFCA/USACE digital mapping project (BHI 2000) provides high resolution LiDAR within levees. Data is suitable for project identification and preliminary design and quantity computation.		Site-specific ground-based data collection (RTK, GPS, or total station) should take place prior to final design/Plans & Specs. Important for bars, banks, and islands that may be modified.
Sub-Reach ID	**River Mile Start**	**River Mile End**	**Description**
Reach 5	177.1	169.3	Tijeras Arroyo to Isleta Diversion Dam
Gap	**Comments**		**Recommended Action**
Active Channel Cross Section Surveys	Existing sections: AQ-563, 567, 578, 589, 595, 600, 606, 609, 621, 625, 643; CO-38. Limited coverage. Surveyed in 2004.		During next phase of project, resurvey existing lines. Verify existing condition hydraulics. Create site specific models with new survey data to support final design of in-channel projects.
High Resolution Topographic Data	Bernalillo County/AMAFCA/USACE digital mapping project (BHI 2000) provides high resolution LiDAR within levees. Data is suitable for project identification and preliminary design and quantity computation.		Site-specific ground-based data collection (RTK, GPS, or total station) should take place prior to final design/Plans & Specs. Important for bars, banks, and islands that may be modified.

Table 4. Hydrology Hydraulics and Geomorphology Information and Data Gap Analysis, continued

Reach-wide Data		
Gap	**Comments**	**Recommended Action**
Soils Data - Active Channel	NRCS Soil Survey for Bernalillo County is available. In addition, USBOR bed material sediment gradations are available for select cross sections within this reach.	During next phase of project, collect bed material samples at historic locations of sample collection. Compare data; adjust designs or criteria if warranted.
Groundwater Information	Many shallow groundwater monitoring wells and/or piezometers exist within the project (BEMP, RMRS, others) reach but have a limited associated database.	Consolidate databases and continue to monitor water levels. Adjust designs and or criteria if necessary based on most current data.
Groundwater/Surface Water Interaction	The interaction between groundwater and surface water is important in an area managed with a policy of conjunctive management. Groundwater/surface water interactions are important in assessing Flycatcher habitat.	The Collaborative Program has funded recent studies to analyze groundwater and surface water interactions (conducted by the NMISC). The results of these studies are not yet available. The NMISC should be contacted. Additionally, The USGS monitors groundwater levels. The USGS may be contacted to determine if there are any new data or findings.
Detailed Hydraulic Model	Existing 250-foot grid FLO-2D model suitable for project identification and feasibility analysis.	Create site specific HEC-RAS files with most current field surveyed cross sections. Use for final design of restoration projects.
Updated Flow Frequency/Duration Information	Construction contract will require time window for implementation. Care and diversion of water will be critical for successful construction of in-channel projects. Most current data available should be used to estimate flow magnitudes and durations.	During Plans & Specs, update existing analyzes with most current USGS data to provide flow duration information.

USBOR = U.S. Bureau or Reclamation; TRM = Thomas R. Mann and Associates; USACE = U.S. Army Corps of Engineers; BIA = Bureau of Indian Affairs; DTM = digital terrain model; P&S = Plans and Specifications; GPS = global positioning system; RTK = Real Time Kinematic; BHI = Bohannon Huston, Inc.; AMAFCA = Albuquerque Metropolitan Arroyo Flood Control Authority; LiDAR = Light Detection and Ranging; AQ = Albuquerque Range Lines; CO = Cochiti Range Lines; NRCS = Natural Resources Conservation Service; BEMP = Bosque Ecosystem Monitoring Program; RMRS = Rocky Mountain Research Station; USGS = U.S. Geological Survey.

PUEBLO SPECIFIC DATA

The three pueblos within the project area, Santa Ana, Sandia, and Isleta, all have active ongoing resource management programs that improve the riparian and riverine conditions of the MRG that traverses their lands. Some of the work has been completed with Collaborative Program funding and some of the work has been completed with other funding sources. For example, the Pueblo of Santa Ana is completing a river restoration project with the U.S. Army Corps of Engineers (USACE 2008) that builds upon work completed in partnership with the USACE (2003) and the U.S. Bureau of Reclamation (Reclamation 1999). The Pueblo of Sandia is implementing a habitat restoration project funded through the USFWS Management of Exotics for the Recovery of Endangered Species (MERES) grant (SWCA 2008a) and has completed the Pueblo of Sandia Habitat Restoration Analysis and Recommendations Report (SWCA 2008b). Similarly, the Pueblo of Isleta has completed studies and is completing an analysis and recommendations study for the Isleta Reach. All three pueblos have conducted silvery minnow and Flycatcher studies.

While this study will not include the pueblos, studies and habitat restoration projects completed on pueblo lands may help inform this study. Available data and information may be publicly available; however, most of the data is likely to be held and controlled by each pueblo. SWCA will contact each pueblo through the appropriate channels to request data and information of interest. Table 5 summarizes the data and information to be requested from each pueblo. All data and information summarized in Table 5 is unavailable at this time.

It will be important to recognize that the pueblos may consider data and information requested to be sensitive and may therefore be unwilling to release the requested data and information. Examples include any data or information related to hydrology, which may be used against the pueblo(s) in a water-rights adjudication, and culturally sensitive information. While this information may be useful, we will be sensitive to pueblo needs and respect their decisions. We will need to be careful in what we ask for. It may be necessary to initiate government-to-government consultations.

Table 5. Pueblo Information and Data Gaps Analysis

Pueblo of Santa Ana		
Gap	**Comments**	**Recommended Action**
Boundary	Existing boundary shapefiles are inaccurate.	Request boundary shapefile from the Pueblo.
River restoration site locations	Santa Ana Pueblo has implemented a number of river restoration projects, including the Gradient Restoration Facilities (GRFs), bar/island overbank inundation, and the creation of backwater wetlands.	Request shapefiles indicating the location of GRFs, bar/island inundation projects, and restored backwater wetlands.
River restoration design information	Santa Ana Pueblo has conducted hydraulic modeling to determine the inundation depth and duration of discharge for bar/island inundation as a part of the Aquatic Habitat Restoration project (USACE 2008). Some of the data may be in the public domain; however, GIS data showing inundation depths may not be. Acquiring the GIS data would facilitate the representation of current restoration activities in the MRG.	Request GIS data for projects in which information is already available in the public domain.
Rio Grande silvery minnow monitoring	Santa Ana has initiated silvery minnow monitoring in partnership with USFWS.	Request summaries or monitoring reports.
Southwestern Willow Flycatcher monitoring	Santa Ana Pueblo has conducted Flycatcher monitoring for a number of years.	Request summaries or monitoring reports.
Pueblo of Sandia		
Gap	**Comments**	**Recommended Action**
River restoration site locations	Sandia Pueblo has implemented a number of restoration projects, including the MERES project, bosque inundation channel, and management of non-native phreatophytes in the Sandia bosque	Request shapefiles indicating the location of restoration sites.
Pueblo of Sandia Habitat Restoration Analysis and Recommendations Report (Sandia A&R Report)	SWCA has completed the Sandia A&R Report and has in its possession the digital elevation model, hydraulic modeling results, and shapefiles indicating the location of proposed river restoration projects. However, since the A&R Report was completed on behalf of the Pueblo, SWCA does not have permission from the Pueblo to use this information.	Request permission to use information used in the Sandia A&R Report.
Rio Grande silvery minnow monitoring	Sandia has implemented a silvery minnow monitoring program in partnership with USFWS. Additionally, Sandia has cooperated with the USFWS in augmenting silvery minnow populations.	Request summaries or monitoring reports.
Southwestern Willow Flycatcher monitoring	Sandia has conducted Flycatcher monitoring for a number of years.	Request summaries or monitoring reports.

Table 5. Pueblo Information and Data Gaps Analysis, continued

Pueblo of Isleta		
Gap	**Comments**	**Recommended Action**
River restoration site locations	Isleta Pueblo has implemented restoration projects funded through the Collaborative Program.	Request shapefiles indicating the location of restoration sites.
Pueblo of Isleta Habitat Analysis and Recommendations Report (Isleta A&R Report)	Isleta Pueblo is conducting an Analysis and Recommendation Study in the Isleta Subreach.	Request permission to use information used in the Isleta A&R Report.
Rio Grande silvery minnow monitoring	Isleta Pueblo is conducting silvery minnow monitoring.	Request summaries or monitoring reports.
Southwestern Willow Flycatcher monitoring	Isleta has conducted Flycatcher monitoring for a number of years.	Request summaries or monitoring reports.

GEODATABASE

SWCA has amassed a rather sizeable geodatabase that was presented in the Task 3 Existing Information Summary Report. As a part of the Data Gaps Analysis, SWCA has reviewed Bosque Feasibility Study data, Route 66 data, Albuquerque Reach projects data, and the geodatabase and cross-referencing information with the Draft Bibliography for Spatial Analysis of Existing Data compiled as part of the geodatabase mapping project, all provided by the USACE. The data gap summary provided in Table 6 represents data we are actively working to acquire. We anticipate that we will be able to acquire the data identified. Additional data may become available as we proceed with the project, and we anticipate adding to the geodatabase as we progress.

Table 6. Geodatabase Data Gaps Summary

Gap	Comments	Recommended Action
Santa Ana Pueblo Boundary	Existing boundary shapefiles are inaccurate.	Request boundary shapefile from the Pueblo.
Collaborative Program funded projects	We do not as of yet have a complete listing of Collaborative Program funded projects.	Acquire a list from the Collaborative Program.
Hydraulic data compilation	Prepared by S.S. Papadopulos and Associates (SSPA) as a part of the River Eyes project	Acquire GIS data from SSPA or the Collaborative Program.
Riparian and groundwater models for the MRG	We have downloaded the reports from the Collaborative Program website. However, we do not have available GIS data above the Isleta Reach.	Acquire GIS data from NMISC or SSPA.
2008 high flow, moderate flow, and low flow aerial photography	Series of aerial photography acquired in June, July, and August, respectively. U.S. Bureau of Reclamation is managing the project. Deliverables are not due until October through December 2008. The imagery may be very useful in the analysis of existing habitat and developing habitat restoration recommendations.	Acquire imagery when available.
Bosque Feasibility Study	Map documents (.mxd format) provided by the USACE reference feature data sets called "Specific_WP_Designs" and "Baselin_HO_Mapping" within a personal geodatabase called MRGBER.mdb.	Obtain feature data sets or geodatabase from the USACE.

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