Park: Big Bend National Park (BIBE)
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Salinity and source of nutrients in the Rio Grande/Rio Bravo between Presidio and Amistad Reservoir.

Description:

Upstream control of flows in the Rio Grande/Rio Bravo (RGRB) and its tributaries present a special problem for Big Bend National Park, the Rio Grande Wild and Scenic River Area, Amistad National Recreation Area, and the protected areas in the neighboring states of Coahuila and Chihuahua, Mexico (fig. 1). Flows in the RGRB have diminished to such an extent that the resources of the area have been severely impacted and are threatened even further. Lower flows have resulted in elevated water temperatures and higher total dissolved solids concentrations. For the first time in 40 years, the RGRB recently stopped flowing completely in Mariscal Canyon during the summer of 2003. The elevated salinities may be responsible, in part, for the occurrence of *Prymnesium parvum*, a toxic golden alga. Information is needed to determine the spatial distribution of salinity, the source and concentration of nutrients in the region, and the relationship of these to flows.

Justification:

The lack of flows in the RGRB is an international, national, and regional concern. Little water remains after withdrawals of water from the river by upstream users. Long term drought throughout northern Mexico, the desert southwest and the southern Rockies in the United States has put pressure on an already over-appropriated basin. The Mexican government currently (2003) is not making treaty-obligated releases from reservoirs in the Rio Conchos basin and has a 1.4 million acre-foot debt. Rapid and extensive development in the region means that very little water flows past El Paso and that all the water that does flow downstream is lost in the Forgotten River reach, a reach choked with the invasive plant tamarisk (Schmidt et al., 2003). This reach lacks a recognizable river channel and there are reports of upstream releases that did not flow through.

The lucrative recreation industry that has developed in the region to take advantage of world class white-water flows is threatened. Portions of this reach of the RGRB famous for its canyons are now aggrading and the river channel has narrowed. Bankfull, channel forming, and channel maintaining flows are now an infrequent occurrence. Cobble bars are choked with silt and anoxic conditions regularly occur across many different channel environments. River terraces deposited by higher flows are now left high and dry, and in some cases, badly eroded. The changes in the riparian corridor, fluvial deposits and aquatic habitat are extreme.

Because of decreasing freshwater inflows from the Rio Conchos, increasing salinity in the river is a concern for the indigenous plant and animal species. Additionally, elevated levels of *E. coli* above the maximum contaminant level (MCL) have been measured during high flow events. These higher

flows also are commonly followed by fish die offs and the development of algal blooms. Most of these events have been documented in observations and reports by resource staff, rangers, boatmen, and visitors. Concerns have been raised regarding the potential for elevated concentrations of nutrients that will adversely impact the water quality and habitat of the RGRB. Additional information is needed regarding the spatial distribution, constituent concentration, and possible source of nutrients in the region. This information then can be used to develop a relation between discharge and salinity/nutrient loads.

The Lower Canyons historically have always had more flow than in the upstream reaches, but the exact locations of the gaining and losing reaches is unknown. One of the big picture questions is how much flow do the springs in BBNP and the intervening reach to Amistad Reservoir contribute to the RGRB and is that flow sufficient to sustain restoration efforts and to support threatened aquatic species? The Lower Canyons in Big Bend National Park currently are being considered for repatriation of the Rio Grande silvery minnow. Seven of the 36 native fish in the region have been extirpated and eight species have been listed as species of concern. A recent mussel survey found only dead shells of three of five species that are believed to exist in the area. Other researchers have reported that the lack of flows is contributing to the success of the invasive red eared slider and its hybridization and displacement of the Big Bend slider. The information gathered by this study will help wildlife resource managers prioritize and focus their efforts.

The absence of scouring flows has allowed several invasive plant species, including tamarisk and Giant Cane, to proliferate, thus contributing to the alteration of bank stability and morphology. The RGRB river corridor is the current target of a binational tamarisk eradication team. The team consists of personnel from the Texas Parks and Wildlife Department (TPWD), the National Park Service (NPS), the International Boundary and Water Commission (IBWC), the Comision Internacional de Limites y Aquas (CILA), Comisión Nacional de Áreas Naturales Protegidas, the World Wildlife Fund, and the Rio Grande Institute. Revegetation efforts by the team will be undermined without improved knowledge of the hydrology of the river and how persistent low flows might impact revegetation projects. An analysis of flow magnitude/frequency and channel response will allow resource managers to develop successful revegetation strategies and to set reasonable restoration targets.

Long-term flow data have been collected by park staff in the form of daily stage readings at Castolon and Rio Grande Village, stations located inside the park. No analyses of these data have been performed because historically the data has been collected primarily for river recreational activities. These data are stored in several different places in BBNP and have not been collated or analyzed. There are continuous record discharge stations maintained by the International Boundary and Water Commission (IBWC) on the RGRB below the confluence of the Rio Conchos (IBWC 08-374200), Alamito Creek near Presidio (RM 949.8), at Johnson Ranch (RM 862.4) and also at Terlingua Creek (RM 885.2). Water chemistry data from the USGS's National Stream Quality Accounting Network Program (NASQAN) is available for the Presidio site (IBWC 08-374200), the Rio Grande at Foster Ranch (IBWC 08-377200), the Pecos River near Langtry (IBWC 08-447410), and the Rio Grande below Amistad Dam (IBWC 08-450900). The Wild and Scenic River reach is not gauged and currently lacks any long-term monitoring plan. A baseline assessment of riparian biological resources was recently completed by the USGS (Moring, 2002). Water quality and biological investigations have been conducted, but tend to be more site specific – not regional in nature. This study will bring together these distinct data sets.

Problem:

Flows in the RGRB have diminished to such an extent that the biological, cultural, and geological resources of the area have been severely impacted and are threatened even further by impacted water quality. The spatial distribution of gaining/losing reaches of fresh water and saline water throughout the region is poorly documented. Regions of freshwater springs from BBNP downstream to Amistad National Recreation Area been noted, but have not been clearly mapped or quantified on a regional scale. Higher salinities and the occurrence and distribution of nutrients in the RGRB have been indirectly implicated in the development of toxic algal blooms. The presence of the toxic alga may negatively impact the repatriation of endangered or threatened species to the RGRB. An assessment of flow throughout the region tied in with measurements of the salinity and nutrients are needed by resource managers to predict if natural resources are likely to be threatened. These background data also are needed by resource managers tasked with developing restoration strategies and selecting restoration targets.

Objectives:

1. Quantify flow and identify gaining and losing reaches of the RGRB from Lajitas to Amistad Reservoir (includes Big Bend National Park, Rio Grande Wild and Scenic River, and Amistad National Recreation Area).
2. Characterize the salinity and concentrations of nutrients as related to flow magnitude in these reaches.
3. Determine probable source(s) of nutrient loading to the river.
4. Develop recommendations for long-term monitoring of the RGRB from Big Bend National Park downstream to Amistad National Recreation Area.

Scope:

The scope of the project includes the RGRB downstream from the confluence of the Rio Conchos (Mexico) in Presidio County to the Amistad Reservoir. This area has been designated by the Texas Commission on Environmental Quality (TCEQ) as Texas Surface-Water Quality Segments 2306 and 2305. The project area includes Big Bend National Park, the Rio Grande Wild and Scenic River Area, and the Amistad National Recreational Area in the United States. The project also includes the Maderas del Carmen Protected Area and the Canon de Santa Elena Protected Area in Mexico.

Approach:

The two-year study will include multiple tasks designed to meet project objectives (1-3). These tasks include a field reconnaissance, review of historical water quantity and water-quality data, a gain/loss flow survey, a salinity survey, and collection of water-quality samples. A field reconnaissance will be conducted by USGS, NPS, and other cooperating agency personnel to determine project logistics and to locate sites for the gain/loss and salinity surveys. Historical flow and water-quality data will be reviewed to determine areas of interest for the surveys. Geographical information system (GIS) coverages will be created to show spatial locations of potential gain/loss survey and salinity survey points.

Historical river stage and weather data has been collected on a daily basis at the Castolon and Rio Grande Village sites (Objective 1). These data currently are stored in the Visitor Protection Office

and in the Science and Resource Management Library. An analysis of historical flow data would be useful to park personnel in determining the range in flows within the park and also to determine the change in flow through time. Numerous springs discharging to the RGRB between the Castolon and Rio Grande Village sites have been noted by Park personnel and visitors. The water from many of these springs is fresh, thus providing an additional source of freshwater in the RGRB. These springs often do not discharge from a single orifice, but contribute flow along seepage faces into the river. Because of the widespread area of discharge, measurements of flow at specific sites may not give a good estimate of the total flow contributed by the springs. Measurement of flow from the Rio Grande Village site can be subtracted from flow at the upper Castalon site to obtain an estimate of discharge from the springs above Rio Grande Village into the RGRB in Big Bend National Park.

To analyze the change in flow between the Castalon and Rio Grande Village sites, the historical stage data needs to be converted to a flow volume for analysis and compared to weather data. The river at these sites is predominantly a sand and gravel channel that carries a high sediment load during runoff events. Although there are problems associated with estimating historical discharge in stream channels with a shifting channel geometry, attempts will be made to convert the stage data into a flow (volume) data. This conversion of stage data will require the establishment of a stage-discharge relation at each of the two sites. If possible, theoretical stage-discharge curves (rating curves) will be developed for each of these sites. Several different methods can be used to develop the stage-discharge curve, including using Water-Surface PROfile (WSPRO), a computer model that develops a stage-discharge relation using standard step-backward computational techniques (Shearman, 1990).

If a stage-discharge relation can be developed for each of these sites, historical discharge then can be estimated and low-flow frequency statistical analyses can be completed. The low flow frequency analysis is important to park personnel tasked with maintaining and restoring natural habitat and may provide information on how flows have changed over time and the frequency of low flows that can be expected in the future. If time permits, low flow and statistical analyses also could be conducted for the IBWC continuous record sites in the study area. To complement the historical dataset, continuous record surface-water gaging sites will be established at both Castolon and Rio Grande Village to measure stage in the river. Each site will be equipped with instrumentation designed to measure and store stage data and will include a bubbler/pressure transducer connected to a data collection platform/recorder. NPS personnel will make discharge measurements at these sites to update and maintain the stage-discharge rating curve. Each time a discharge measurement is made instantaneous measurements of dissolved oxygen, pH, conductivity, and temperature will be made with a four parameter water quality probe. The stage record will be processed and reviewed by the USGS and stored in the USGS's ADAPS database. Daily mean discharge will be computed for both sites during the investigation. Contribution of intervening flow to the RGRB in Big Bend National Park will be computed during the investigation. Water levels in nearby wells at Castalon and Rio Grande Village also will be monitored by park personnel on a regular basis to try to determine the relation between ground water and surface water in these areas of the park.

To quantify flow in the region (Objective 1), gain/loss surveys will be conducted at selected sites from Presidio downstream to Amistad National Recreation Area in areas that are currently ungaged to locate gaining or losing reaches of the RGRB. The selection of gain/loss survey sites will be based on the distribution of current gaging sites operated by the IBWC. Geographical Information System (GIS) feature datasets will be created showing the distribution of bedrock lithology, structural features, streams/rivers, and springs in the study area. These datasets also will be used to help select the gain/loss survey locations. An Acoustic Doppler Velocimeter (ADV) will be used to measure the water velocities and calculate the discharge in the ungaged reaches. The ADV is especially useful in

this type of an application because the equipment can be used to measure discharge in water depths as shallow as 1 inch (2 cm) and to measure velocities as lows as 0.003 ft/sec (0.001m/s). The ADV technology should allow for measurements with higher resolution and accuracy than can be obtained using conventional surface-water velocity meters.

Concurrent with the gain/loss surveys, a salinity survey will be conducted along the RGRB from Presidio to Amistad Reservoir (Objective 2). The purpose of the salinity survey is to map salinity zones along the river and to try to match those zones with the gaining and losing reaches. The scope of the salinity survey is that portion of the RGRB from Presidio downstream to Amistad Reservoir, including Big Bend National Park, Rio Grande Wild and Scenic River Area, and Amistad National Recreation Area (Texas Surface Water Segments 2305 and 2306) (Texas Commission on Environmental Quality, 2000). A four parameter water-quality monitor will be used to measure pH, conductance, temperature, and dissolved oxygen at multiple sites. The surveys will be conducted during lower flow conditions on the RGRB so that springflow can be better quantified without interference from runoff in the region. Information from the salinity survey then will be used along with the gain/loss survey results to determine areas where there are freshwater and/or saline-water inflows from springs, and also to determine areas of higher salinity. The GIS feature datasets created for this project and additional unpublished maps of spring locations and other hydrologic information will be used to determine the water-quality sampling sites (International Boundary and Water Commission, 1967). These areas of higher salinity may include regions where there is discharge of saline water from local aquifers and in areas with a high prevalence of tamarisk vegetation.

Algal blooms and fish kills in portions of the RGRB in Big Bend National Park are suspected to be the result of, in part, of higher concentrations of nutrients and increased biological oxygen demand in the water and sediment. The concentration, spatial distribution, relation to flow and source of these nutrients is not well documented. Some possible sources of nutrients include undertreated sewage from the Presidio/Ojinaga area and border villages, livestock grazing in riparian areas, and agricultural runoff (Blackston and others, 1998). Further downstream in the Rio Grande Wild and Scenic Area, little information is available as to the general water-quality conditions of the river. Several water-quality analyses exist that can be used to fingerprint the source of the nutrients (Objective 3). A combination of nitrogen isotope ($^{15}N/^{14}N$) and oxygen ($^{18}O/^{16}O$) isotope ratios in the nitrate ion, NO_3-, and other carbon species can be used to determine sources of nitrate in surface water and groundwater. Both nitrate and ammonium are found in detectable concentrations in the study area. Nitrogen isotopes ($^{15}N/^{14}N$) of both nitrate and ammonium will be analyzed as a means of determining potential source of nutrients in the RGRB. Information on the source of nutrients in the region is needed prior to revegetation and repatriation of threatened and endangered species. Water samples will be collected from both selected river sites in the study area and from shallow wells located near or adjacent to the river in Big Bend National Park and possibly the Mexican Protected Areas. Samples will be analyzed for major ions, trace metals, nutrient and carbon species (including NH_3, NO_3, NO_2, P, PO_4, DOC, SOC, and TOC), and nitrogen and oxygen isotopes ($^{15}N/^{14}N$ and $^{18}O/^{16}O$). If sufficient data can be collected, flow-weighted average constituent concentrations will be calculated.

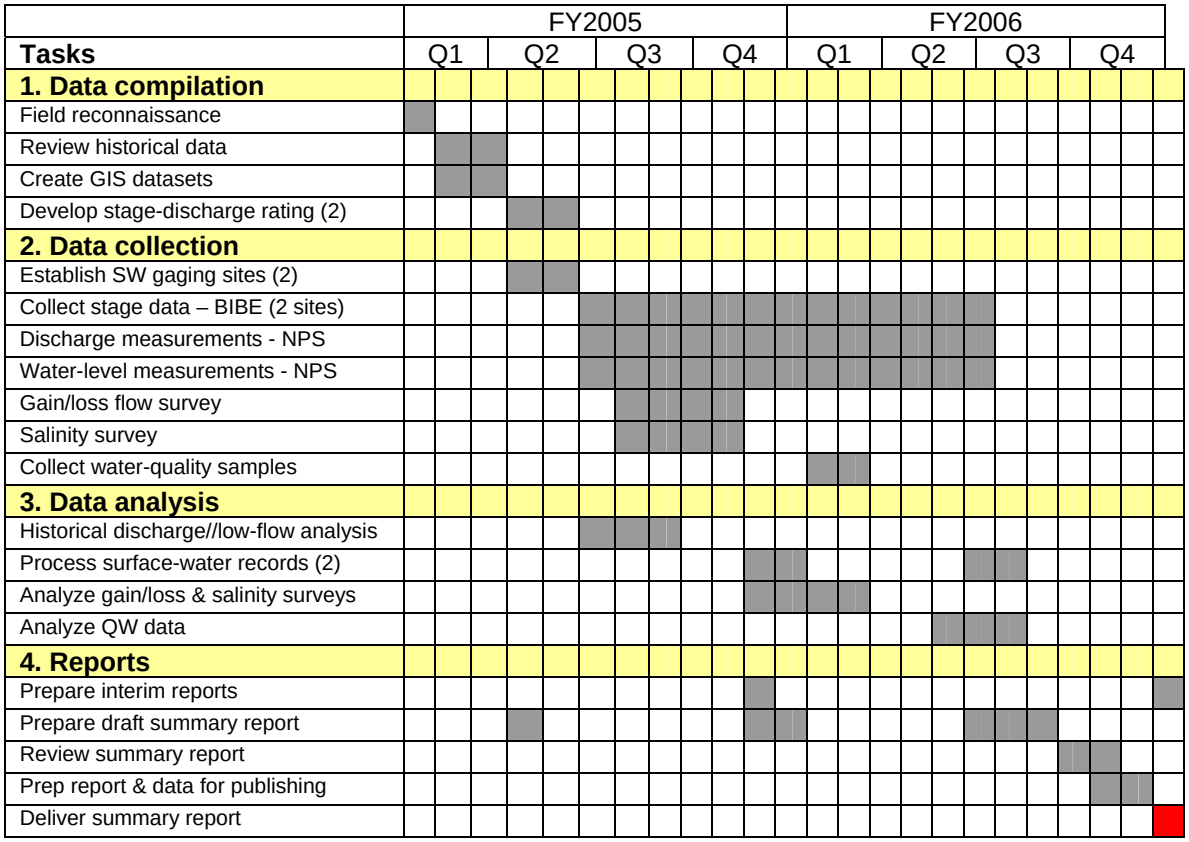
Recommendations as to future monitoring needs will be addressed and based on the analysis of the gain/loss and salinity surveys and the water-quality results (Objective 4). The goal of the project is to provide resource managers with a more precise definition of gaining and losing reaches within the study area and to delineate areas where freshwater and saline water occur. A secondary goal of the project is to look at the association of nutrient concentrations with flow and to determine the probable sources of these contaminants. This information is needed by resource managers tasked with

maintaining and restoring aquatic habitats as well as state agencies tasked with ensuring thos reaches meet the current water quality standards. Information from this study may be used by the TCEQ to revise the existing surface-water quality standards for Segments 2306 and 2305.

Quality Assurance Plan:

The Texas District's Quality Assurance Plan (QAP) for surface water and water quality will be followed to ensure the quality, precision, accuracy, and completeness of the data generated during the study. The QAP describes the methods and procedures used by the USGS in Texas to collect hydrologic and water-quality data. The QAP will cover project activities including data collection, data management, and data interpretation. Sample collection and field analyses will be done in conformance with standard USGS guidelines/protocols, including the USGS's Techniques of Water-Resources Investigations. A minimum of 10 percent of all samples collected will be for quality-control purposes. If needed, supplemental sections to the QAP will be prepared to describe the non-routine collection, management, and interpretation of hydrologic data.

Work plan/Timeline:



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Measurable Results:

Results from the study will provide valuable information on the distribution of flow and the quality of water in the RGRB in the region from Presidio to Amistad Reservoir. Interim progress reports summarizing project activities will be prepared at the end of each fiscal year. The completed project will be summarized into a USGS water-resources investigation report that will be prepared in a Factsheet format and published in both English and Spanish. The IBWC may be able to provide translation services for the report. GIS registered feature datasets will be created showing the distribution of geology, streams/rivers, and sampling sites. These datasets along with the project data will be published and made available to the cooperators and the general public. The data will be published in the USGS's annual data report and posted along with other data on the Texas District's Web Page.

Funding Components:

FY05

Item	Description	Qty	Unit	Unit Cost	Item Cost
Personnel Costs	Salaries & benefits			varies	$47,400
Travel and Transportation Costs	Travel, vehicles, gas			Varies	$7,400
Supplies and Equipment Costs	Supplies, equipment			Varies	$7,275
Contractor and Cooperator Costs	Printing, commun.			Varies	$410

Other Costs					
Overhead Costs	Building rent, support staff; etc.			Varies	$36,475
TOTAL					$98,960

FY06

Item	Description	Qty	Unit	Unit Cost	Item Cost
Personnel Costs	Salaries & benefits			Varies	$35,200
Travel and Transportation Costs	Travel, vehicles, gas			Varies	$2,370
Supplies and Equipment Costs	Supplies, equipment			Varies	$2,500
Contractor and Cooperator Costs	Printing, commun.; publication of report			Varies	$4,860
Other Costs	Shipping			Varies	$300
Other Costs	Lab analyses			Varies	$24,540
Overhead Costs	Building rent; support staff, etc.			Varies	$31,110
TOTAL					$100,880

Natural Resource Project Ranking Criteria

1. Significance of the Resource or Issue to the Park

Four main environmental areas of concern affect residents and wildlife on the border. These concerns are water quantity, water quality, waste management, and air quality (Texas Commission on Environmental Quality, 2002). Of these concerns, water quantity, water quality, and air quality are probably most critical to the region. Degrading water quality of the Rio Grande, along with degrading air quality, are the two top resource issues in the region, and are the primary reasons why the BIBE was recently declared second on the list of the 10 most endangered parks by National Parks Conservation Association (NPCA). The Rio Grande aquatic habitat is the only riverine ecosystem in the Chihuahua Desert. The Lower Canyons in Big Bend National Park currently are being considered for repatriation of the Rio Grande Silvery Minnow. Seven of the 36 native fish have been extirpated and eight species have been listed as species of concern. A recent mussel survey found only dead shells of three of five species that are believed to exist in the area. Other researchers have reported that the lack of flows is contributing to the success of the invasive red eared slider and its hybridization and displacement of the Big Bend Slider. No other aquatic habitat in the park or in the region hosts such diversity and abundance of aquatic species as does the Rio Grande. Salinity and nutrients are two of the primary causes suspected of water quality degradation in this section of the Rio Grande. This study will determine the regions where freshwater and saline water occur from Big Bend National Park downstream to Amistad National Recreation Area and will quantify the constituents contributing to salinity and nutrients. The Rio Grande provides abundant habitat for the wildlife in the region and information on the quality of water and sediment in the river are of the utmost concern to NPS managers.

2. Severity of Resource Threat, Problem, or Need(s):

Over the past 10-15 years, a combination of factors has resulted in a water shortage in parts of the Rio Grande watershed. These factors include groundwater depletion, ongoing drought, Mexico's huge backlog of water owed to the United States under an international treaty, and aquatic plants (invasive species) absorbing water and thus blocking stream flow (Texas Commission on Environmental Quality, 2002). Additionally, urban populations are growing rapidly in the border region, exceeding growth rates throughout the rest of Texas and much of the nation. The rapid population growth also has negatively impacted both the surface-water and ground-water supplies. Flows in the RGRB have diminished to such an extent that the natural, cultural, and geologic resources in the area have been severely impacted and are threatened even further. Lower flows have resulted in elevated temperatures and total dissolved solids (TDS) concentrations. For the first time in 40 years, the RGRB recently stopped flowing completely in Mariscal Canyon during the summer of 2003. Despite an early and productive monsoon during the latter part of 2003, the RGRB threatens to cease flowing again. The once wide and broad channel is now choked with tamarisk and giant cane. Recent legislation in Texas has opened the door for the use of the Rio Grande as a conveyance for delivering groundwater to south Texas. The ability of the channel to deliver water is in doubt and the probability of steady flows contributing to the tamarisk infestation is great. The decrease in the quantity of water negatively impacts the remaining water quality in the Rio Grande. The less water that is available, the more concentrated pollutants can become in the river, and the less suitable the water becomes for human and wildlife uses.

3. Problem definition and information base

In 1994, the U.S. Department of the Interior (DOI) chartered the U.S.-Mexico Border Field Coordinating Committee for the purpose of promoting and facilitating coordination among the DOI bureaus on environmental issues of Departmental interest along the U.S.-Mexico border (Blackston and others, 1998). The U.S.-Mexico Border Field Coordinating Committee has state that "water resources are critical to the health of the communities and the environment along each side of the border within the Rio Grande." One of the suggested actions recommended by the U.S.-Mexico Border Field Coordinating Committee is to "ensure that sufficient current water-quantity, water-quality, and aquatic-biological data are readily available to assess water-resources status and trends" (Blackston and others, 1998). In September, 2002, U.S. Senator Jeff Bingaman (New Mexico), Chairman of the Senate Energy and Natural Resources Committee called on the Federal Government to support a binational effort to thoroughly study water availability in the border region.

Numerous studies have been conducted by the U.S. Geological Survey, the International Boundary and Water Commission, the National Park Service, the Texas Commission on Environmental Quality, and other agencies that describe the general water quality of the river as well as documenting the distribution of heavy metals, nutrients, pesticides, and other organic compounds. Long-term water-quality monitoring on a regional basis at selected sites in the study area is done cooperatively by the Texas Commission on Environmental Quality and the International Boundary and Water Commission as part of the Texas Clean Rivers Program, and by the U.S. Geological Survey through the National Stream Quality Accounting Network Program (NASQAN). Available databases also contain samples with elevated densities of fecal coliform bacteria and elevated salinities. The TCEQ has identified a toxic golden alga related to toxicity problems for zooplankton in Santa Elena Canyon on the west boundary of the park. It is suspected that toxicity is impacted in part by the salinity. Salinity has been linked to the hydrology of the river in the upper Rio Grande by the USGS. Freshwater inflows, agricultural return flows, and flow magnitude all impact the water quality and have not been documented for this portion of the RGRB. Climate data also are available for the gages at Rio Grande Village and Castolon and will be used in the historical data analysis. The resulting datasets

are designed to supplement data in the existing databases and will provide researchers and NPS managers with a comparable dataset of water-quality data that can be compared across the region and through time.

4. Technical Soundness

The remoteness, the great areal extent, and the varying climatic conditions in the BBNP area can create logistical challenges to collecting accurate and precise environmental datasets. NPS personnel will be responsible for collecting streamflow and water-level data and maintaining the gaging equipment at the Castalon and Rio Grande Village sites. The USGS will provide assistance in installation of the gages and training of NPS personnel to operate the gages. The USGS-Texas District's Quality Assurance Plan (QAP) for collection of hydrologic data (surface water, ground water, and water quality data) will be followed to ensure the quality, precision, accuracy, and completeness of the data generated during the study. The USGS currently has personnel in the San Antonio Subdistrict and the San Angelo Field Office that are collecting surface-water and water-quality data in both Big Bend National Park and Amistad National Recreation Area as part of the NASQAN program. These personnel are familiar with the hydrology and the water quality of the study area and can provide technical assistance to park personnel. The river will be accessed by both canoe/boat and by road to achieve the objectives of the study. BIBE park personnel are familiar with the river and will be providing logistical assistance to complete the project. The International Boundary and Water Commission (IBWC) which maintains control and access to the river because it is an international boundary will assist in providing access to the river and providing continous record discharge information. Water-quality samples will be collected using parts-per-billion (ppb) protocols that have been developed for the USGS's NASQAN and National Water-Quality Assessment (NAWQA) programs. The samples will be analyzed at the USGS's National Water-Quality Laboratory (NWQL) in Denver, Colorado and Reston, Virginia. The analytical procedures used to determine the constituent concentrations and the nitrogen isotopic ratios are well documented by the NWQL and USGS researchers.

5. Problem resolution

This study will provide park personnel with better locations of gaining and losing reaches along the RGRB and will tie in water quality with those reaches. The TCEQ is interested in better defining these reaches with regard to surface-water quality standards. This information will provide park personnel with the information needed to advise visitor safety as related to water quality issues and to assess habitat degradation and species restoration projects.. This study will also provide the data needed to prioritize, design and implement restoration projects with maximum benefit and efficiency. Several restoration projects are ongoing and we have several other proposed. This data will inform proper placement and design of these projects.

6. Transferability

This study will provide information to resource managers in Big Bend National Park, the Rio Grande Wild and Scenic River, the Mexican protected areas of Canýon de Santa Elena and Maderas del Carmen, and the Amistad National Recreation Area about the occurrence and distribution of salinity and nutrients in the Rio Grande. Because salinity and nutrients are a concern for all of the Rio Grande in Texas and Mexico, information gathered as part of this project will be used by cooperating agencies in Texas and Mexico to make informed decisions regarding the salinity and nutrient

problems downstream of Amistad National Recreation Area. A binational tamarisk eradication team was recently formed at a meeting of stakeholders in Big Bend National Park. Members include resource managers from BIBE, Texas Parks and Wildlife, Canyon de Santa Elena, Madera and representatives of the World Wildlife Fund and the Rio Grande Institute. Water quality and quantity data gathered in this project will inform restoration strategies and targets for resource managers in the National Park Service as well as those in state agencies and across the river. Additionally, information obtained from this study also can be applied to other areas of the United States and Mexico that are located in arid, desert-like environments.

7. Cost effectiveness

This study addresses two water-quality issues in the study area – salinity and nutrients. The study is designed to maximize the opportunities for sample collection in a region with intermittent flows and logistical challenges because of the remoteness of the location. Cooperation among Federal, State, and local agencies limits duplication efforts that might occur if each agency attempted to do this type of project on a smaller scale. Several agencies besides the USGS and the NPS have offered funding or services, or are considering the project for funding. The Texas Commission on Environmental Quality (TCEQ) also is doing a similar type of project on the Pecos River, a tributary to the Rio Grande upstream from Amistad Reservoir. The laboratory analyses that will be done on the water-quality samples will use the same analytical schedules that are currently being used for the USGS's NASQAN program. The goal of this effort is to provide additional data that can be compared with the USGS's long-term monitoring network. The project budget is well researched and commensurate with the work and analysis to be performed.

8. Project Support:

By request of the Texas Commission on Environmental Quality a proposal has been submitted to the TCEQ Clean Rivers Program. Funding cycles for TCEQ do not coincide with NPS schedules and the level of commitment is not known at this time. The International Boundary Waters Commission has expressed an interest in the project and is looking at providing additional assistance. Water-quality data is collected by the USGS's NASQAN program at 4 sites in the study area approximately 6-10 times per year. This data will be used during the analysis of the project data. In addition to the requested funding, the NPS, IBWS, and Friends of Big Bend will provide in-kind support for supplemental backcountry personnel, technical assistance, data, water quality equipment, and logistical assistance. Dollar amounts are totaled in the table below. A detailed description follows.

Source	FY05	FY06	Total
NPS	$22,298.5	$22,298.5	$44,597
Friends of Big Bend	$2500	0	$2500
IBWC	$40,000	$40,000	$80,000
		Total	$127,097
		Total as % of project	126%

The NPS will provide $8400 of in-kind support for supplemental backcountry personnel and logistical assistance. Friends of Big Bend has donated water quality equipment that will be used in this project ($2,500) and the International Boundary and Water Commission (IBWC) will provide an additional $80,000 of in-kind support ($10,000 per year per gauge) for FY2005 and FY2006 for the project to cover the costs associated with collecting discharge information at 4 IBWC gauges

downstream of Presidio, TX. In addition, BIBE will provide NPS personnel as follows; BIBE GS-11 Physical Scientist, 4 pp per year, 2 years = $19,997, BIBE, GS-11 GIS Specialist, 1 pp per year, 2 years = $3600, BIBE, GS-07 Physical Science Technician, 2 pp per year, 2 years = $7600. BIBE existing field equipment, incl. water chemistry supplies, backcountry safety equipment = $2000, BIBE volunteer employee office space, computer, internet, etc. $3000.

9. Scientific Merit:

Data collected by the USGS, the Texas Commission on Environmental Quality, and the Texas Parks and Wildlife Department have shown that elevated concentrations of nutrients and salinity may be related to the toxic effects of alga blooms in this area. There are probably multiple sources for the nutrients in the RGRB. Recent advances in the science of isotope geochemistry have provided a means of differentiating between certain sources of nutrients using nitrogen ($^{15}N/^{14}N$) isotopes of nitrate and ammonia. This study will provide a field example for isotope researchers and biologists studying nutrients in arid environments. Information collected from this study also can be used by researchers and biologists to look at the role of nutrients in biological uptake, and the impact that elevated concentrations of nutrients may have on the continued viability of threatened and endangered species in an arid environment. This information is critical to Park managers who are tasked with ensuring the health of humans and other wildlife, and to researchers who are working on restoration projects along the river.

Cooperating Partners:

U.S. Geological Survey (USGS)
U.S. National Park Service (NPS) – Big Bend National Park, Rio Grande Wild and Scenic Area, and the Amistad National Recreation Area
International Boundary and Water Commission (United States; TX Clean Rivers Program)
Texas Commission on Environmental Quality (TCEQ)
Comision Internacional de Limites y Aguas (IBWC – Mexican counterparts)
Maderas Del Carmen Mexican Protected Area
Canon de Santa Elena Mexican Protected Area