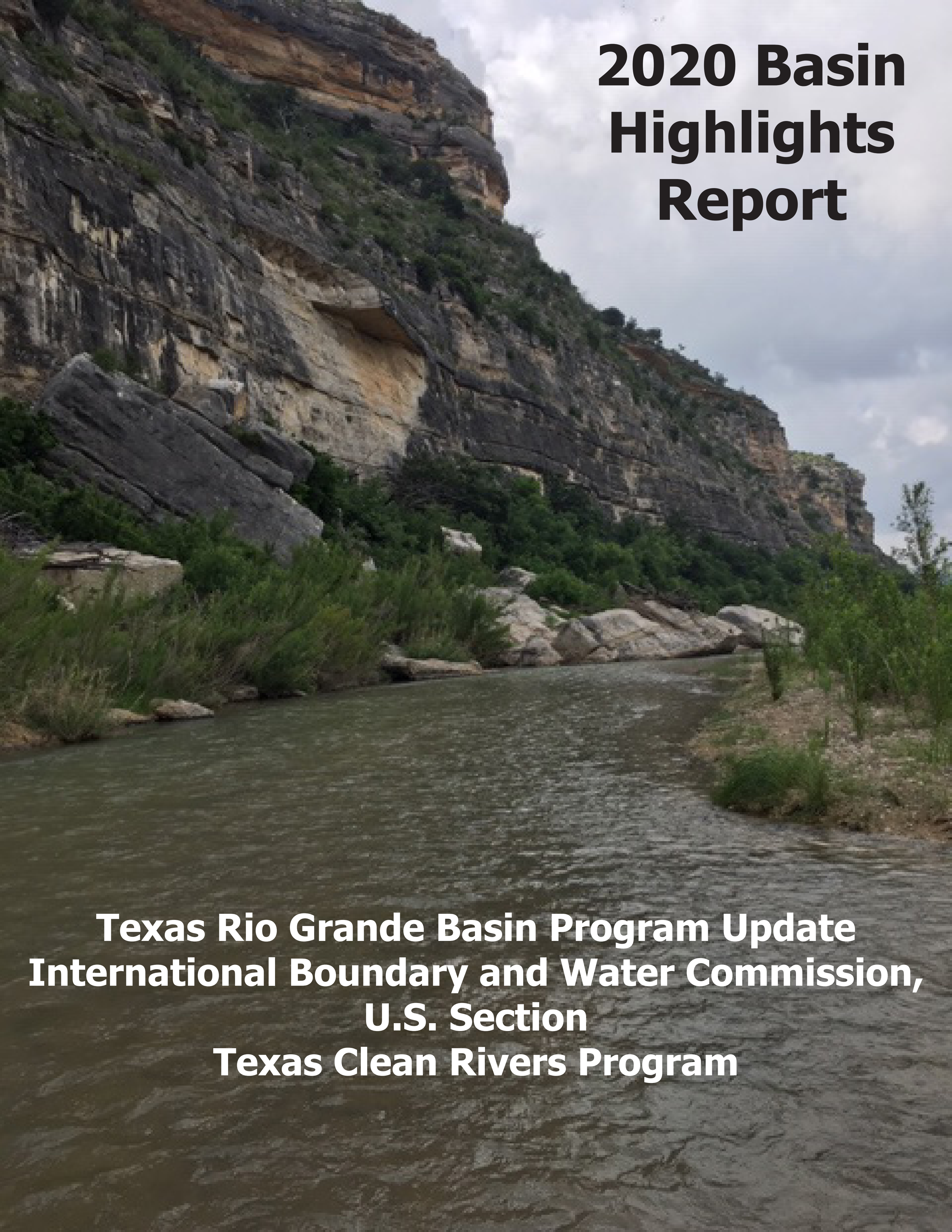

2020 Basin Highlights Report

Texas Rio Grande Basin Program Update
International Boundary and Water Commission, U.S. Section
Texas Clean Rivers Program

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Table of Contents

Pictured on front cover: Pecos River at Station 14163, looking downstream. Photo by L. Grijalva
Pictured on back cover: Pecos River at at Station 14163, looking upstream. Photo by L. Grijalva

Aspects of the Clean Rivers Program

The USIBWC is one of 15 partner agencies that collaborate with TCEQ to administer the Texas Clean Rivers Program in the 23 river and coastal basins in Texas. The main goals of the CRP from the long-term plan include:

- Maintain a basin-wide routine water quality monitoring program and water quality database.
- Provide quality-assured data to TCEQ for use in water quality decision-making.
- Identify and evaluate water quality issues and summarize in reports.
- Promote cooperative watershed planning (such as conducting Coordinated Monitoring Meetings and collaborating on watershed plans and water quality initiatives).
- Inform and engage stakeholders (for example, conducting Basin Advisory meetings, watershed education activities, maintain an updated website, and print our annual reports).
- Maintain an efficient use of public funds.
- Adapt the program to emerging water quality issues.

CRP Long-term plan:
https://www.tceq.texas.gov/assets/public/waterquality/crp/CRP-LongTermPlan06.pdf

Coordinated Monitoring Meetings and Basin Advisory Committee Meetings

The CRP holds several types of meetings, including an important series of annual meetings called Coordinated Monitoring Meetings (CMMs). The purpose of these meetings is to plan and coordinate water quality monitoring efforts among different entities and partners. These meetings allow for more efficient use of agency resources, and take into consideration concerns from the public. They provide an opportunity for the CRP to hear about local water quality interests and problems, and allows attendees to bring up any questions or concerns they may have about their area to CRP staff. Additionally, USIBWC CRP typically hosts trainings for sampling partners in conjunction with these meetings. Basin Advisory Committee (BAC) meetings are held two to three times a year, and usually involve an annual water quality update to the public, as well as updates about important issues in the area. This might include fish kills, water quality concerns, and projects in the area. Basin Advisory Committee meetings are open to anyone interested in the CRP's activities in the Rio Grande and Pecos River Basins. Information on the Coordinated Monitoring Meetings, BAC meetings, minutes and agendas for past meetings can be found at https://ibwc.gov/CRP/Calendar.htm.

Introduction

Life is not sustainable without water; it is essential to every living thing on the planet. Water is a crucial part of our every day lives, from the irrigation fields that grow our food to the water that comes out of our faucets at home. In a time when we are facing water shortages worldwide, the quality of the water we do have is even more important. Water quality can affect aquatic life, ecosystems, and even public health, so water quality monitoring is essential to ensure the safety of our water bodies.

The Rio Grande Basin starts in the San Juan Mountains of Colorado and travels through New Mexico and Texas before emptying into the Gulf of Mexico. As if traveling through three states in the United States didn't provide enough challenges, in the State of Texas the Rio Grande forms the 1,250 mile international border between the United States and Mexico. The binational nature of the Rio Grande within Texas presents many unique challenges to addressing water quality concerns within the watershed.

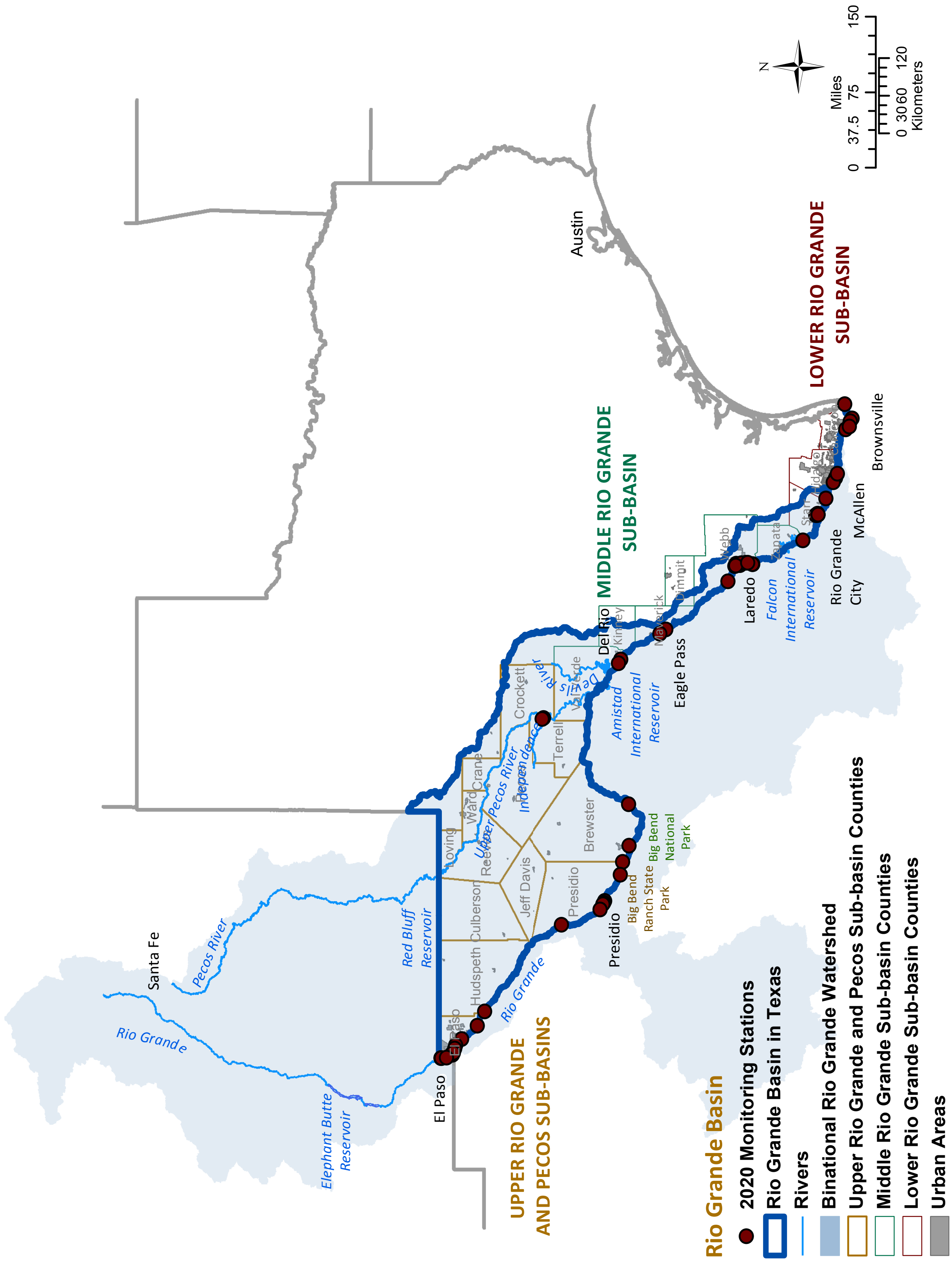
The Texas Clean Rivers Program (CRP), born out of the Texas Clean Rivers Act (Senate Bill 818) passed by the State Legislature in 1991, was created to address water resources in an integrated and systematic manner. The CRP was created specifically to perform water quality monitoring, assessment and public outreach, and aims to improve the quality of water within each river basin in Texas through partnerships with the Texas Commission on Environmental Quality (TCEQ) and participating entities.

In 1998, the State of Texas contracted with the International Boundary and Water Commission, United States Section (USIBWC) to implement the CRP for the Rio Grande Basin, and to monitor and address water quality issues unique to the international water boundary. The USIBWC CRP monitors and assesses the Texas portion of the Rio Grande Basin from the point that it enters the state to its end at the Gulf of Mexico. This action has resulted in better coverage within the basin and more comprehensive information, which is then used to advance the resolution of issues along the border. The USIBWC has expanded the program to include 15 partners and 56 water quality monitoring stations, and provides support for special projects along the border. The partners participate in water quality monitoring, providing advice and suggestions on improving the program and the basin, developing and assisting in special studies, and communicating with and educating the general public.

For the purpose of coordination and planning, the USIBWC CRP has divided the basin in Texas into four sub-regions: the Pecos, Upper, Middle and Lower Rio Grande. This report will focus mainly on the Pecos River Sub-basin, which extends from the New Mexico/Texas state line downstream and emptying into Amistad Reservoir (Segments 2312, 2311, 2310, and 2310A).

This report will provide a more detailed look at water quality data in this section of the basin, the various factors that have an impact on water quality and information on activities performed to improve water quality. The summary statistics presented in the watershed characterization portion of the report are compiled from 10 years of water quality data collected by the TCEQ Midland office and the USIBWC CRP. Where the data and/or information refers to the TCEQ Integrated Report, it will be so stated. If you have questions on the data or information presented in this report, please contact USIBWC CRP staff. Contact information is available on the back cover of this report.

Figure 2. General Map Overview of the Rio Grande Basin in Texas



How is the Water Quality?

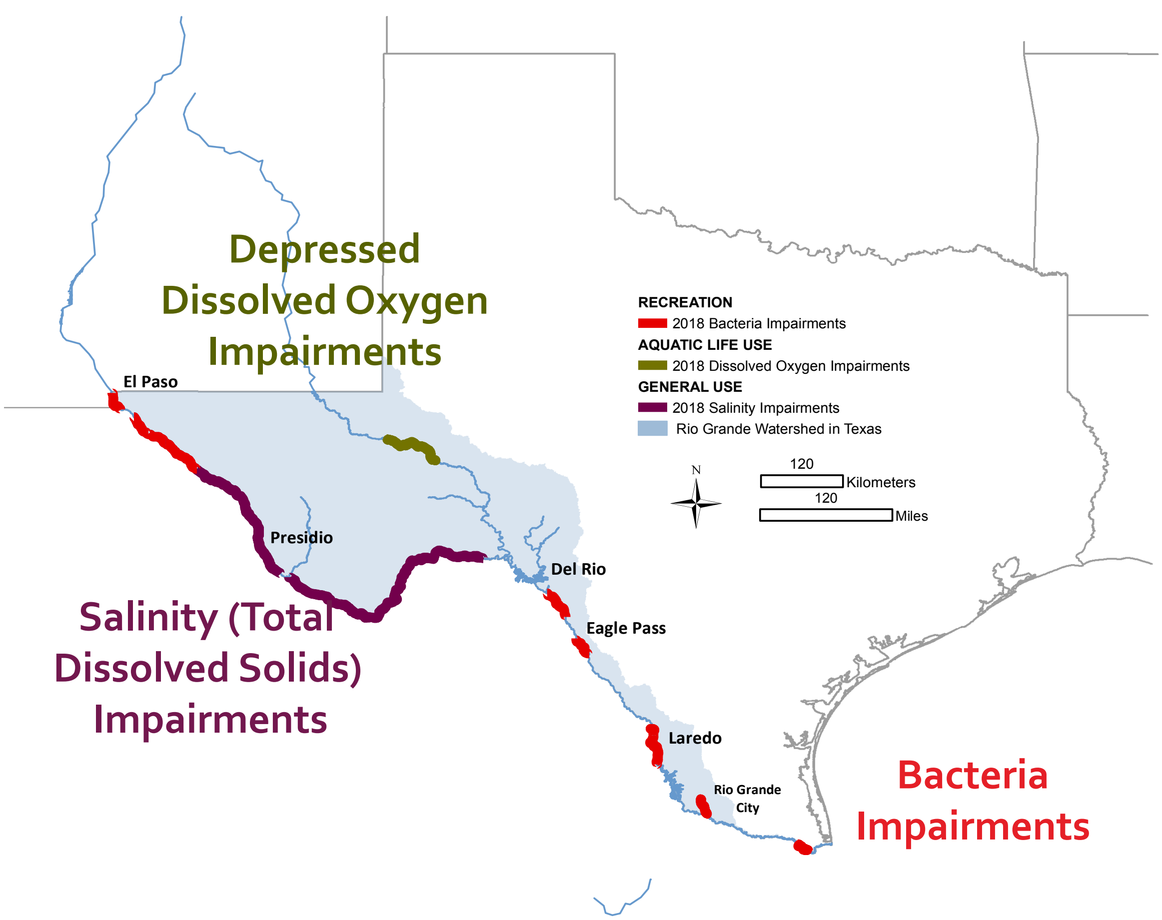
What are Impaired Waters?

The State of Texas publishes the Texas Surface Water Quality Standards (TSWQS) for each river basin. USIBWC Clean Rivers Program water quality data is used to help determine whether stream segments are meeting the standards. Not every parameter of concern in the Rio Grande Basin has standards associated with it; however, screening levels exist for parameters that have historically led to environmental issues in the area. A water body is listed as "impaired" in the Texas Integrated Report if the data shows the standards are not being met. A water body is described as having a concern if it is near non-attainment to the standard (CN) or is not meeting the screening levels (CS). The EPA approved the 2014 TSWQS for the Rio Grande Basin and the 2020 Integrated Report can be found at the following links.

TSWQS **https://www.tceq.texas.gov/waterquality/standards/2014standards.html**

Integrated Report: **https://www.tceq.texas.gov/waterquality/assessment/20twqi/20txir**

Figure 3. Impairments in the Rio Grande Basin



Overview of Water Quality Monitoring

How do we determine water quality?

During the past year, the USIBWC CRP continued to maintain its large network of water quality stations. The CRP and the TCEQ gain an understanding of the conditions of the water quality through routine monitoring, which is performed at fixed locations at regular intervals throughout the year. Table 1 shows the kinds of data that we analyze during routine monitoring and why.

Routine monitoring helps us understand questions about how the river can be used (Table 3), such as:

- Is the Rio Grande Watershed swimmable?
- Is the Rio Grande Watershed drinkable?
- Is the Rio Grande Watershed fishable?
- Is the habitat in the Rio Grande Watershed healthy for aquatic life?

CRP partners throughout the basin collect water quality and sediment samples at about 56 routine monitoring stations. When these samples are collected for laboratory analysis, personnel also make field observations to record conditions at the time the sample was taken. Field observations include things such as weather conditions at the time of collection, recent rain events in the area, water color, and other general notes related to water quality and stream uses. Important field measurements are made using different pieces of equipment. Measurements include: water and air temperature, water depth, Secchi disk, stream flow and how that flow compares to the normal flow for that water body. Field parameters are described in more detail in Table 4.

The routine collection of field parameters together with laboratory parameters, also described in Table 1, allow us to determine the health of the river ecosystem and what potential human and ecological issues we should focus on. Data is compared with Texas Surface Water Quality Standards (TSWQS) criteria and screening levels in Tables 1, 2 and 4; these steps are described in the next sections.

When routine monitoring shows a water quality issue or trend, we begin more intensive monitoring and special studies, which are created to gather information to address a specific water quality issue.

Pictured From Top and Middle: Laredo Community College students sampling with RGISC

Pictured Bottom: TPWD staff at Big Bend Ranch State Park collecting samples

Photos by L. Grijalva

Table 1. Primary Surface Water Quality Standards for the Rio Grande Basin*

2014 Texas Surface Water Quality Standards for the Rio Grande Basin											
SEGMENT		USES			CRITERIA						
Segment	Segment Name	Recreation	Aquatic Life	Domestic Water Supply	Cl^- (mg/l)	$SO4^{2-}$ (mg/l)	TDS (mg/l)	DO (mg/l)	pH range (SU)	Bacteria geomean (#/100ml)	Temperature (deg F)
2301	**Rio Grande Tidal**	PCR1	E	-	-	-	-	5.0	6.5-9.0	35	95
2302	**RG Below Falcon Reservoir**	PCR1	H	PS**	270	350	880	5.0	6.5-9.0	126	90
2303	**Falcon International Reservoir**	PCR1	H	PS**	200	300	1,000	5.0	6.5-9.0	126	93
2304	**RG Below Amistad International Reservoir**	PCR1	H	PS**	200	300	1,000	5.0	6.5-9.0	126	95
2305	**International Amistad Reservoir**	PCR1	H	PS	150	270	800	5.0	6.5-9.0	126	88
2306	**RG Above Amistad International Reservoir**	PCR1	H	PS	200	450	1,400	5.0	6.5-9.0	126	93
2307	**RG Below Riverside Diversion Dam**	PCR1	H	PS	300	550	1,500	5.0	6.5-9.0	126	93
2308	**RG Below International Dam**	NCR	L	-	250	450	1,400	3.0	6.5-9.0	605	95
2309	**Devils River**	PCR1	E	PS	50	50	300	6.0	6.5-9.0	126	90
2310	**Lower Pecos River**	PCR1	H	PS	1,700	1,000	4,000	5.0	6.5-9.0	126	92
2311	**Upper Pecos River**	PCR1	L	-	7,000	3,500	15,000	5.0	6.5-9.0	33	92
2312	**Red Bluff Reservoir**	PCR1	H	-	3,200	2,200	9,400	5.0	6.5-9.0	33	90
2313	**San Felipe Creek**	PCR1	H	PS	50	50	400	5.0	6.5-9.0	126	90
2314	**RG Above International Dam**	PCR1	H	PS	340	600	1,800	5.0	6.5-9.0	126	92
2315+	**Rio Grande Below Rio Conchos**	PCR1	H	-	450	750	2,-100	5.0	6.5-9.0	126	93

PCR - Primary Contact Recreation   ALU - Aquatic Life Use   NCR - Noncontact Recreation   PS - Public Water Supply
E - Exceptional Aquatic Life   L - Limited Aquatic Life   H - High Aquatic Life   TDS - Total Dissolved Solids   geomean - geometric mean Cl^- - chloride $SO4^{2-}$ - sulfate   DO - Dissolved Oxygen

The indicator bacteria for freshwater is *E. coli* and Enterococci for saltwater (2301, 2312, 2311).
The DO criterion in the upper reach of Segment 2307 (Riverside Diversion Dam to the end of the rectified channel below Fort Quitman) is 3.0 mg/L when headwater flow over the Riverside Diversion Dam is less than 35 cfs.
The critical low-flow for Segments 2309 and 2313 is calculated according to §307.8(a)(2)(A) of the TSWQS.
A 24-hr minimum dissolved oxygen criterion of 1.0 mg/L applies to Segment 2311.

* The Standards listed above are the Proposed 2018 Revisions to the Texas Surface Water Quality Standards (TSWQS). The 2018 Standards became effective as a state rule on March 1, 2018. More information on primary standards can be found at TCEQ's TSWQS website (https://www.tceq.texas.gov/waterquality/standards/2018-surface-water-quality-standards)
+The proposed Segment 2315 has not been approved by the EPA at this time.
**Designated in the 2014 TSWQS as a sole-source surface drinking water supply, as provided by the TCEQ Drinking Water Protection Team.

Table 2. 2010 Texas Nutrient Criteria for the Rio Grande Basin			
Segment	Segment Name	Station ID	Chlorophyll-a Criteria (µg/L)
2312	**Red Bluff Reservoir**	13267	25.14***

*** Criteria for chlorophyll-a are attained when they are not exceeded by the median of monitoring data results.
The nutrient criteria has not changed since the 2010 TSWQS.

Designated Uses

The State of Texas assigns designated uses to specific water bodies. Table 3 describes the designated uses for the Rio Grande Basin, and Table 1 lists the uses and standards for each segment. Designated uses and water quality standards are defined in the TSWQS. For more info, see TSWQS website.

Contact recreation (CR) – Fishing, swimming, wading by children, boating, and direct water contact. E. Coli and Enterococci bacteria are used as indicators. The proposed 2014 revisions to the TSWQS created subcategories of Primary (PCR) and Secondary Contact Recreation (SCR). PCR refers to activities such as swimming, and SCR refers to non-immersing recreation activities such as canoeing and fishing.

Public water supply (PS) – As a drinking water source, the primary concern is total dissolved solids (TDS). The TSWQS includes a list of parameters that are screened to ensure safe domestic water supply use.

Aquatic life use (ALU) – This designated use is designed to protect aquatic species including fish and benthic macroinvertebrates (aquatic insects). This designated use has four levels depending on the ability of a water body to support aquatic life (exceptional, high, intermediate, and limited). The primary parameter used to determine the ALU of a waterbody is DO.

Fish consumption (FC) – This applies to all water bodies where citizens may collect and consume fish. The TSWQS includes a list of parameters that are screened to ensure the fish consumption use is met.

General use – To safeguard general water quality rather than for protection of one specific use.

Aquatic life studies evaluate the health and diversity of organisms such as fish and insects that live in the water.

Table 3. Designated Uses for Freshwater

<table>
<tr><th colspan="4">Designated Uses</th></tr>
<tr><th>Designated Use</th><th>Description</th><th>Primary Parameter</th><th>Criteria</th></tr>
<tr><td rowspan="3">Contact Recreation (CR)</td><td rowspan="3">3 levels depending on the use of the water:Fishing, swimming, wading, boating, etc
Note: Secondary contact recreation criteria is not applied in any of the segments in the Rio Grande Basin</td><td rowspan="3">Bacteria: E. Coli
Tidal and saline- Enterococcus (Entero)</td><td>Primary Contact Recreation (significant possibility of water ingestion, i.e. swimming)
Geometric mean:
126 colony forming units (CFU) for E. Coli
35 CFU Entero</td></tr>
<tr><td>Secondary Contact Recreation (limited body contact that poses a less significant risk of ingestion of water, i.e. fishing, boating)
Geometric mean
630 colony forming units (CFU) for E. Coli
175 CFU Entero</td></tr>
<tr><td>Non- Contact Recreation: Unsuitable for contact recreation</td></tr>
<tr><td>Public Water Supply (PS)</td><td>Drinking water source</td><td colspan="2">See full list of Human Health Criteria in Table 2 of the TSWQS</td></tr>
<tr><td rowspan="5">Aquatic Life Use (ALU)</td><td rowspan="4">4 levels depending on the ability of water body to support aquatic life</td><td rowspan="4">DO - average values</td><td>(E) Exceptional 6.0 mg/L</td></tr>
<tr><td>(H) High 5.0 mg/L</td></tr>
<tr><td>(I) Intermediate 4.0 mg/L</td></tr>
<tr><td>(L) Limited 3.0 mg/L</td></tr>
<tr><td>Toxics in Water</td><td colspan="2">See full list of Aquatic Life Criteria in Table 1 of the TSWQS</td></tr>
<tr><td>Fish Consumption (FC)</td><td>Prevent contamination to protect human health</td><td colspan="2">See full list of Human Health Criteria in Table 2 of the TSWQS
Example: Mercury - 0.0122 ug/L in water & fish</td></tr>
<tr><td>General Use (GU)</td><td>General water quality</td><td colspan="2">Water Temp, High pH, Low pH, Dissolved Solids, Nutrients, and Chlorophyll-a. See Tables 2 and 4 in this document.</td></tr>
</table>

Table 4. Water Quality Parameters

Parameter	Description	Effects to Water body
Field Parameters		
pH	Measure of how acidic or basic the water is. The values range from 0 to 14, with 7 being neutral. pH values less than 7 indicate acidity, whereas a pH greater than 7 indicates a base.	Values greater than 9.0 and less than 5.0 can have detrimental affects on the health of aquatic life, wildlife, and humans.
Specific Conductance	Indicator of how well the water conducts electricity. Pure water does not conduct electricity; impurities of water are what allow electricity to pass through the water. These impurities are salts and metals. Since total and dissolved metal values are very low, conductivity primarily measures how much salt is in the water. Most naturally-occurring waters have some level of conductivity.	High conductivity can cause physiological effects in animals and plants. It also has negative implications for TDS. Indirect effects of excess dissolved solids are primarily the elimination of desirable food plants and habitat-forming plant species. Agricultural uses of water for livestock watering are limited by excessive dissolved solids and high dissolved solids can be a problem in water used for irrigation.
Dissolved Oxygen (DO)	Measure of the oxygen in the water.	Low DO values can lead to a reduced abundance and diversity in aquatic communities. Very low levels (<2) can be indicative of higher levels of oxygen-demanding plants that use up DO during the decay process.
Secchi Depth	A measure of the transparency of water - the maximum depth at which a black and white disk is visible.	Higher transparency leads to a more robust aquatic plant life (particles in water block sunlight for photosynthesis). High transparency coupled with high nutrients can lead to negative impacts on DO and aquatic life.
Stream Flow	Volume of water moving over a location over a period of time. Low flow conditions common in the warm summer months create critical conditions for aquatic organisms.	At low flows, the stream has a lower assimilative capacity for waste inputs from point and nonpoint sources.
Conventional Laboratory Parameters		
Parameter	**Description**	**Effects to Water body**
Solids	Total and dissolved materials of any kind (calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates).	High total dissolved solids indicate higher amounts of dissolved salts which can reduce the diversity of aquatic life and can render the water unusable for human consumption, industry and agriculture.
Nutrients	Nutrients include nitrogen compounds, ammonia, and phosphorus.	High levels can cause excessive plant growth, which can lead to reduced dissolved oxygen and fish kills, reduced stream flow and reduced navigability of the waters. Elevated ammonia can also be toxic to aquatic life.
Chlorophyll-a	Chlorophyll-a is used as an indicator of algal growth in water.	High levels for long periods may indicate low water quality and are indicative of excess nutrient levels.
Non-conventional Laboratory Parameters		
Parameter	**Description**	**Effects to Water body**
Metals	Aluminum, arsenic, barium, chromium, copper, lead, mercury, nickel, silver, and zinc. Metals can be tested as total or dissolved metals in water or metals in sediment to determine long-term accumulation.	High concentrations can result in long- and short-term effects on aquatic life and human health.
Organics	Chemicals containing carbon and hydrogen. Organic compounds analyzed are herbicides, pesticides and industrial compounds both in water and in sediment.	Organics can result in long- and short-term effects on aquatic life and human health.
Biological Parameters		
Parameter	**Description**	**Effects to Water body**
Nekton	Fish captured in the river during biological surveys using both electrofishing and seining methods	Using Index of Biologicial Integrity (IBI), Indicate biodiversity and overall health of river.
Benthics	Freshwater macroinvertebrates collected during a five-minute kick net method	Using IBI, this biological aquatic assemblage analysis indicates biodiversity and overall health of river. Healthy macroinvertebrate communities can be excellent indicators of high water quality.

Table 5. Summary of Water Quality Impairments and Concerns in the Rio Grande Basin					
Seg-ment	Segment Name	Parameter (s) Impaired	Year First Listed	Parameter(s) of Concern	Type of Concern
2301	Rio Grande Tidal	No Impairment		Bacteria Chlorophyll-a Nitrate	CN CS CS
2302	RG Below Falcon Reservoir	Bacteria	1996	Ammonia Chlorophyll-a Depressed Dissolved Oxygen	CS CS CS
2302A	Los Olmos Arroyo	Bacteria	2004	Chlorophyll-a	CS
2303	International Falcon Reservoir	No Impairment		Fish Kill in Water Toxicity in Water	CN CN
2304	RG Below Amistad International Reservoir	Bacteria	1996	Toxicity in Water Ammonia	CN CS
2304B	Manadas Creek	No impairment		Bacteria Antimony in Sediment Nitrate Total Phosphorus	CN CS CS CS
2305	International Amistad Reservoir	No impairment		Fish Kill in Water	CN
2306	RG Above Amistad International Reservoir	Sulfate	2010	Chlorophyll-a Fish Kill Report	CS CN
2306A	Alamito Creek	No impairment		No Concern	
2307	RG Below Riverside Diversion Dam	Bacteria Chloride Total Dissolved Solids	2002 1996 1996	Nitrate Total Phosphorus Ammonia Chlorophyll-a	CS CS CS CS
2308	RG Below International Dam	Bacteria	2014	Chlorophyll-a Total Phosphorus Ammonia	CS CS CS
2309	Devils Rivers	No Impairment		No Concern	
2310	Lower Pecos River	Total Dissolved Solids	2020	No Concern	
2310A	Independence Creek	No Impairment		No Concern	
2311	Upper Pecos River	Depressed DO	2006	Bacteria Chlorophyll-a	CN CS
2312	Red Bluff Reservoir	No Impairment		Depressed DO	CS
2313	San Felipe Creek	Bacteria	2014	No Concern	
2314	RG Above International Dam	Bacteria	2002	Chlorophyll-a Ammonia Nitrate Total Phosphorus in Water	CS CS CS CS
2315*	RG Below Rio Conchos*	Not evaluated		Not evaluated	

CN - Concern for near-nonattainment of the Water Quality Standards
CS - Concern for water quality based on screening levels
***New segment in 2014 WQS Revision. This segment was previously a part of Segment 2306. This segment has not been approved by the EPA at this time.**

Note: Each Segment is further subdivided into Assessment Units (AU). The entire segment may not be impaired. The complete list of impairments and AUs can be found at the TCEQ 303(d) website.

How does the program function?

The USIBWC Clean Rivers Program is proud to be partnered with 17 partners: 3 laboratories, five USIBWC field offices, two universities, three municipalities, one non-profit organization, and other state and federal agencies. These partners have volunteered to collect water quality data in addition to their own projects and work goals, and the collaboration helps monitor this large watershed. The large collaboration works by making sure that USIBWC CRP staff keeps in constant contact with all the partners via phone calls, emails, and meetings.

All USIBWC CRP partners are trained by USIBWC CRP staff, and all partners use the sampling methods outlined in TCEQ's Surface Water Quality Monitoring Procedures Manual, Volume 1. The stations monitored are agreed upon at annual meetings. Field sheets and chain of custody records are kept by both the partner and the USIBWC CRP staff, so that the integrity of the data can be traced if needed. All partners use the same standard equipment. The water samples are sent to laboratories accredited by the State of Texas under the National Environmental Laboratory Accreditation Program (NELAP). This is a requirement in order for the data collected by the partners to be accepted by the State of Texas for assessment purposes. The reports are then sent to USIBWC CRP staff.

The USIBWC CRP coordinates all the data received from the partners, in the form of field data, and the laboratories, in the form of lab reports. The staff checks the data against rigorous quality assurance criteria, consolidates all the data into usable reports, and sends the data to the TCEQ to be reviewed. Once the TCEQ reviews these reports, the data is uploaded into the state's database, called SWQMIS (Surface Water Quality Monitoring Information System). All data collected by the CRP partners is available to the public on the USIBWC CRP website.

Coordinated Monitoring Schedule

All entities that monitor the Rio Grande in Texas gather annually to discuss and coordinate monitoring activities. You can see who is collecting water quality data, where, and how often within the Rio Grande watershed on the Coordinated Monitoring Schedule.

http://cms.lcra.org/

Pictured: Pecos River. Photo by L. Grijalva.

Who are the CRP Partners in the Pecos River Sub-basin?

The only CRP partner in the Pecos River Sub-Basin is Midland College. Greg Larson, Biology Professor at Midland College, incorporates the monitoring he does for the program into his curriculum throughout the semester. The students accompany Professor Larson out into the field to collect samples and then analyze the data for the sampling event. The students have presented on their water quality findings at several poster sessions. Midland College is a good example of how we can teach students and show them how their learning objectives have real-world implications.

Pictured: Greg Larson and CRP staff Samantha Stiffler collecting water samples. Photos by L. Grijalva.

The Pecos River Sub-Basin

The Pecos River is the largest U.S. tributary in the Rio Grande Basin. It enters Texas from New Mexico and joins the Rio Grande at the upstream arm of the International Amistad Reservoir. The Pecos River is 926 miles (1,490 km) long and drains approximately 38,300 square miles (99,200 square km). The headwaters originate in the Sangre de Cristo mountains of north-central New Mexico and flow along the western portion of Texas.

The sub-basin lies mostly within the Trans-Pecos region in the western section of the state and is bounded by the Rio Grande to the south and west (International Amistad Reservoir), the New Mexico portion of the basin to the north and the Colorado River and Edwards Plateau to the east. Shortly after crossing the Texas-New Mexico state line, the Pecos River is impounded by Red Bluff Dam, creating Red Bluff Reservoir. Releases from Red Bluff Reservoir are made in accordance with the Pecos River Compact for distribution to several irrigation districts in the basin. The river then flows southeast across Texas for 409 miles (658 km) until it empties into the Rio Grande upstream of the Internaitonal Amistad Dam.

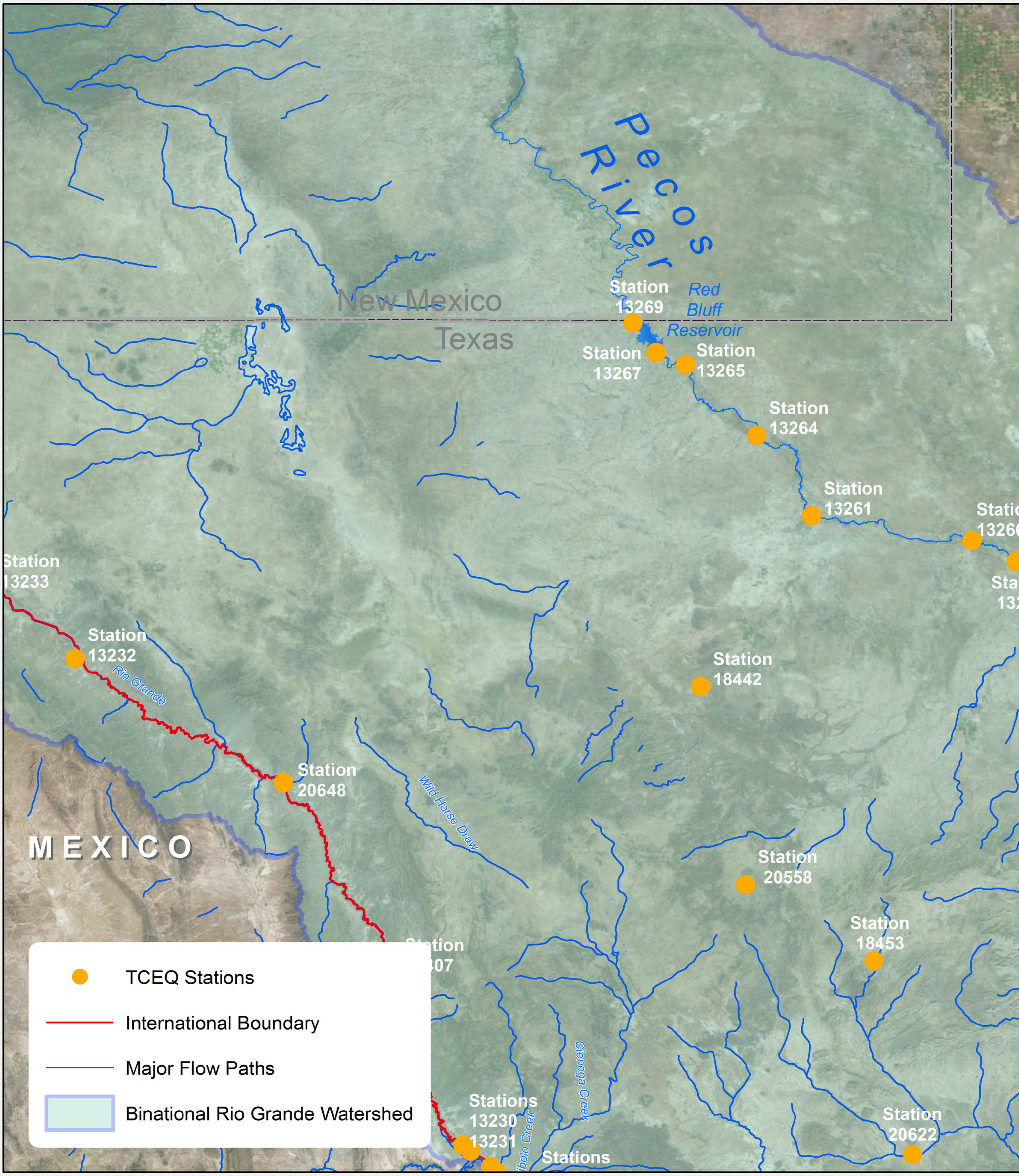
The topography of this sub-basin generally consists of plains with high hills to high mountains. High mountainous terrain surrounds the river along the Permian Basin and empties into the Rio Grande downstream of Big Bend National Park, forming an arm of International Amistad Reservoir. This region relies heavily on groundwater from four major aquifers (Ogallala, Edwards-Trinity {Plateau}, Trinity, and Pecos Valley) and seven minor aquifers to meet water supply needs. Reservoirs, run-of-river supplies, desalination, and wastewater reuse also contribute to the existing supply. Population centers along the Pecos River are relatively few and the entire area has seen a general decline in population over the last ten years. The major economic sectors of this area include healthcare and social assistance, mining, manfucaturing, agriculture, and oil and gas. Irrigation and municipal needs account for the two largest water consumers.

Water in the Pecos River is naturally high in dissolved solids and salt concentrations; it is one of the saltiest rivers in the western U.S. and contributes almost 10 percent of the stream inflow into International Amistad Reservoir and 26 percent of the total salt loading. The high salinity levels are aggravated by low flows and the prevalence of salt cedar, a non-native invasive species that is an enormous water consumer. The introduction of high quality fresh water from natural springs feeding Independence Creek creates significant changes to the aquatic community in the lower Pecos River.

The USIBWC CRP has one partner in the Pecos River Sub-Basin, Midland College. The partner monitors 2 stations, one in Segment 2310 and one in Segment 2311. The TCEQ regional office in Midland monitors eight stations in Segments 2310, 2311 and 2312, providing field, flow, and water quality data to promote the protection, restoration, and wise use of Texas surface-water resources. Each segment will be discussed in more detail.

Pictured: Pecos River at Coyanosa, TX. Photo by L. Grijalva.

TCEQ Monitoring Stati



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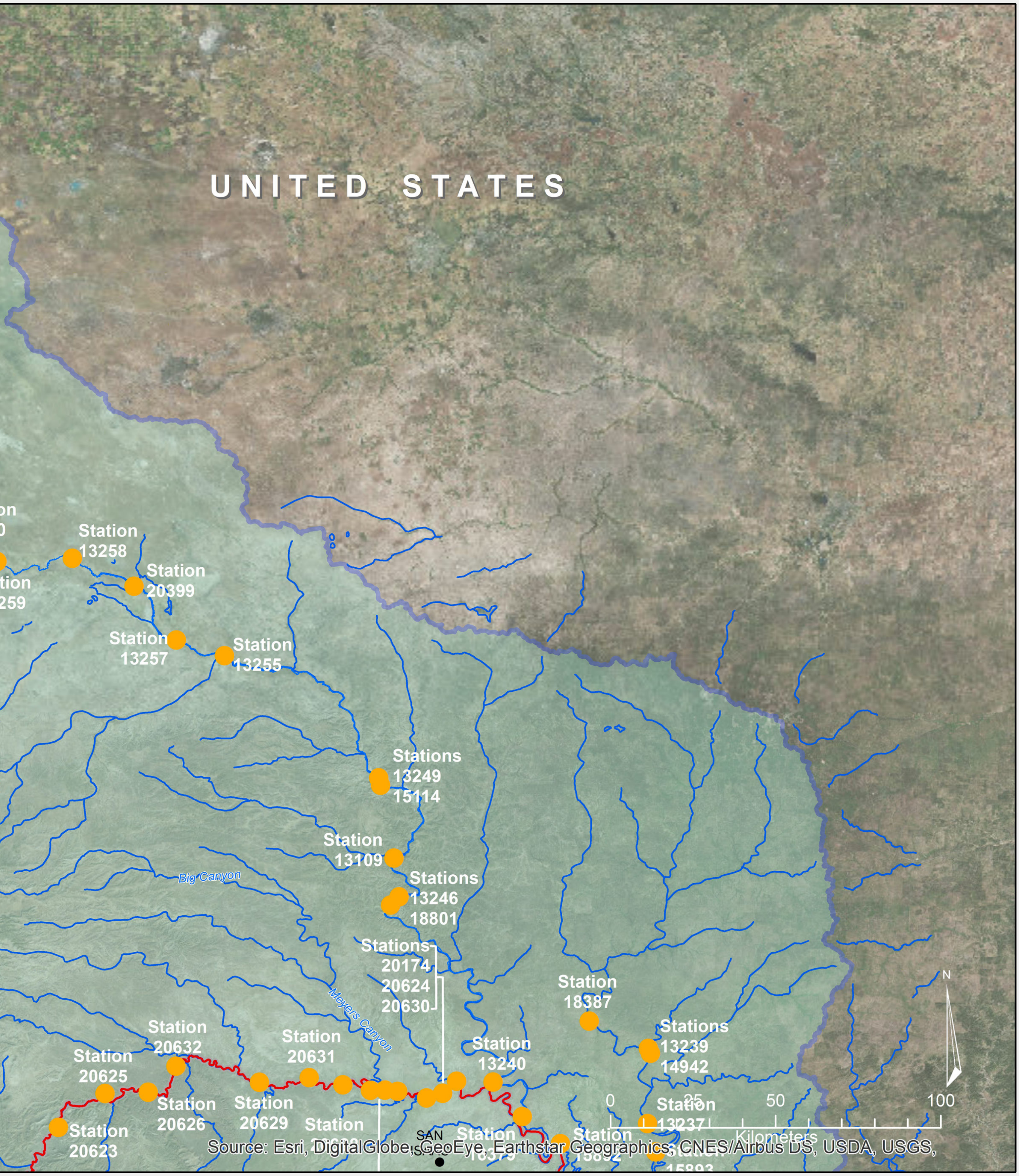

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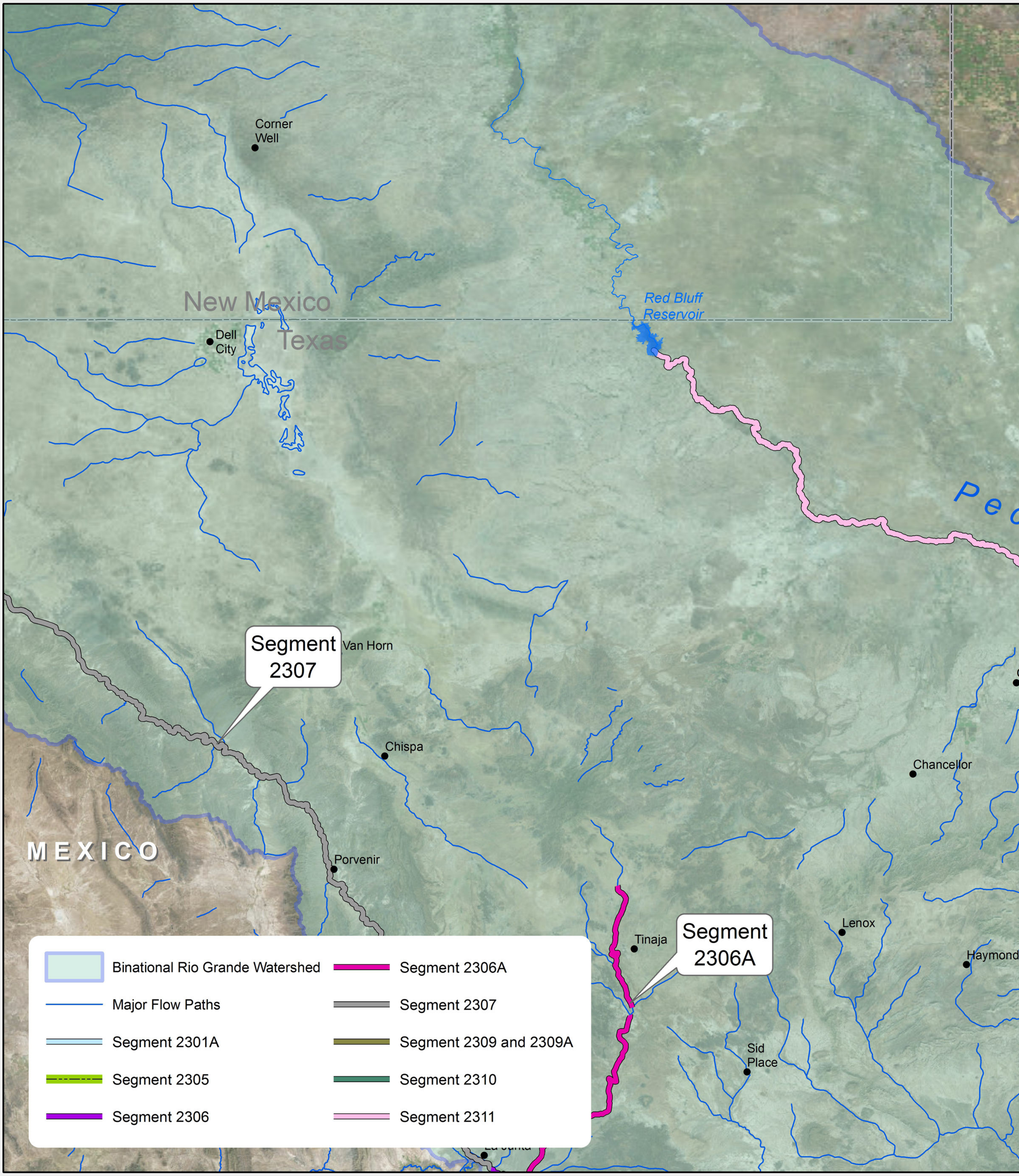

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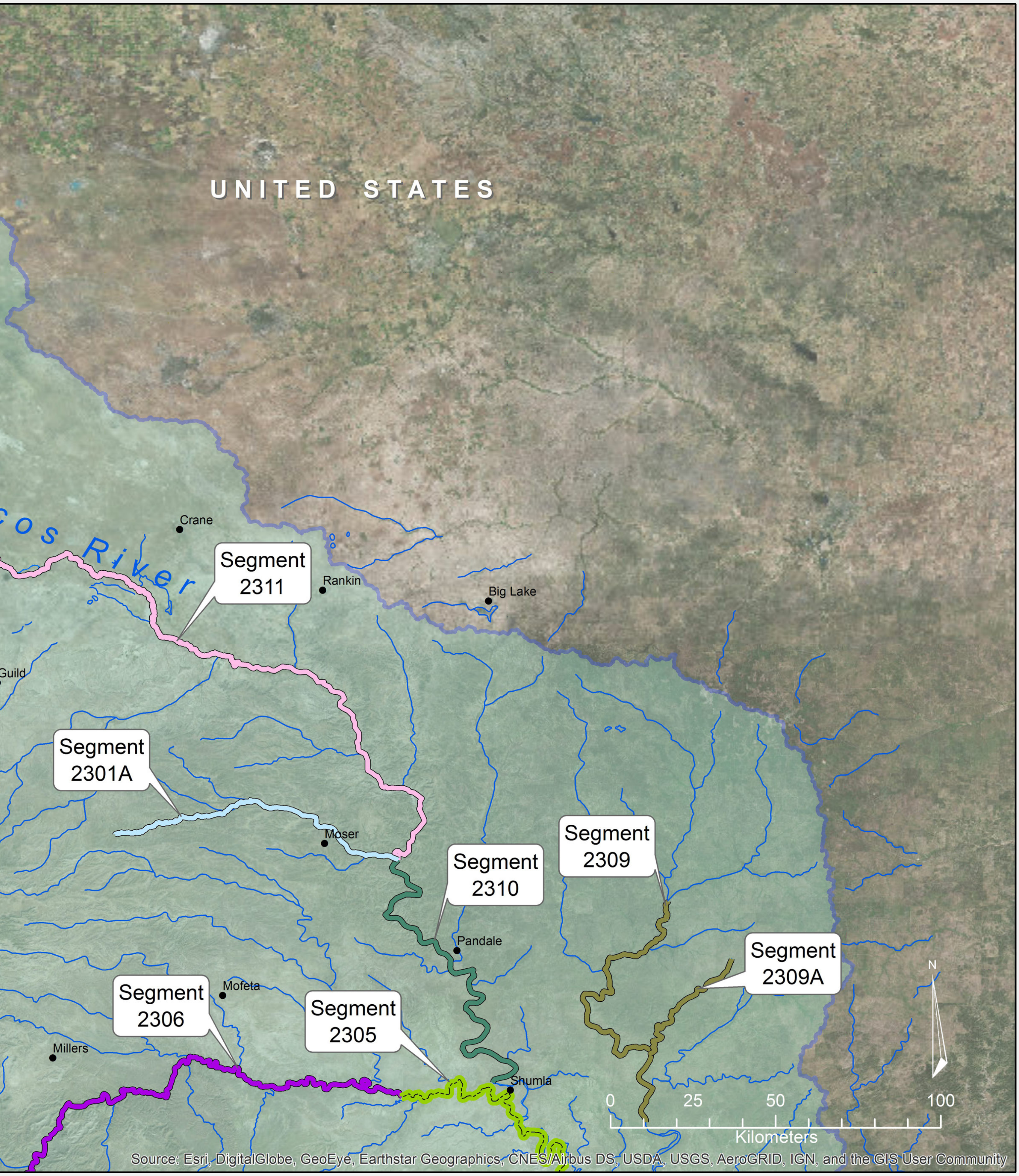

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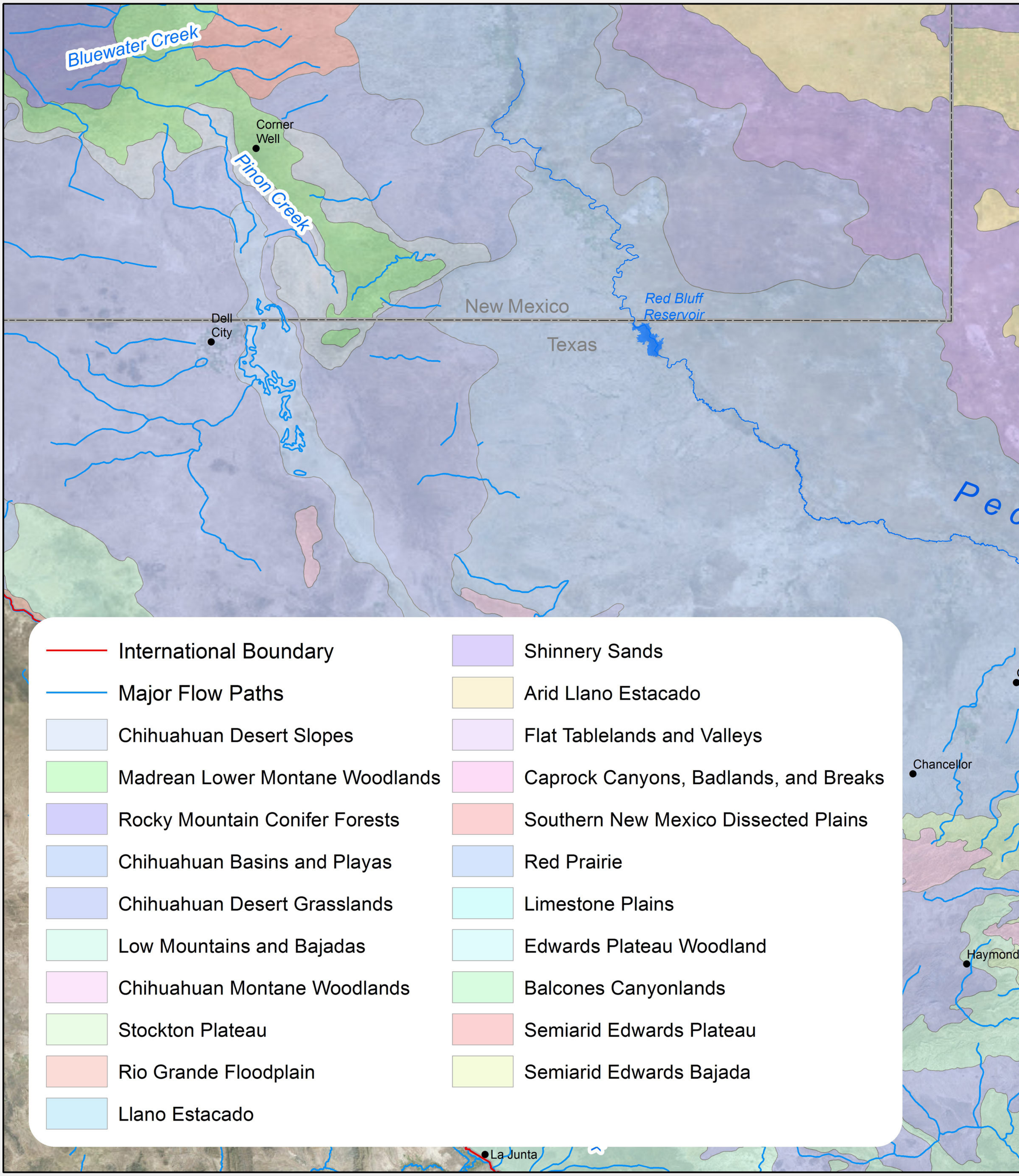

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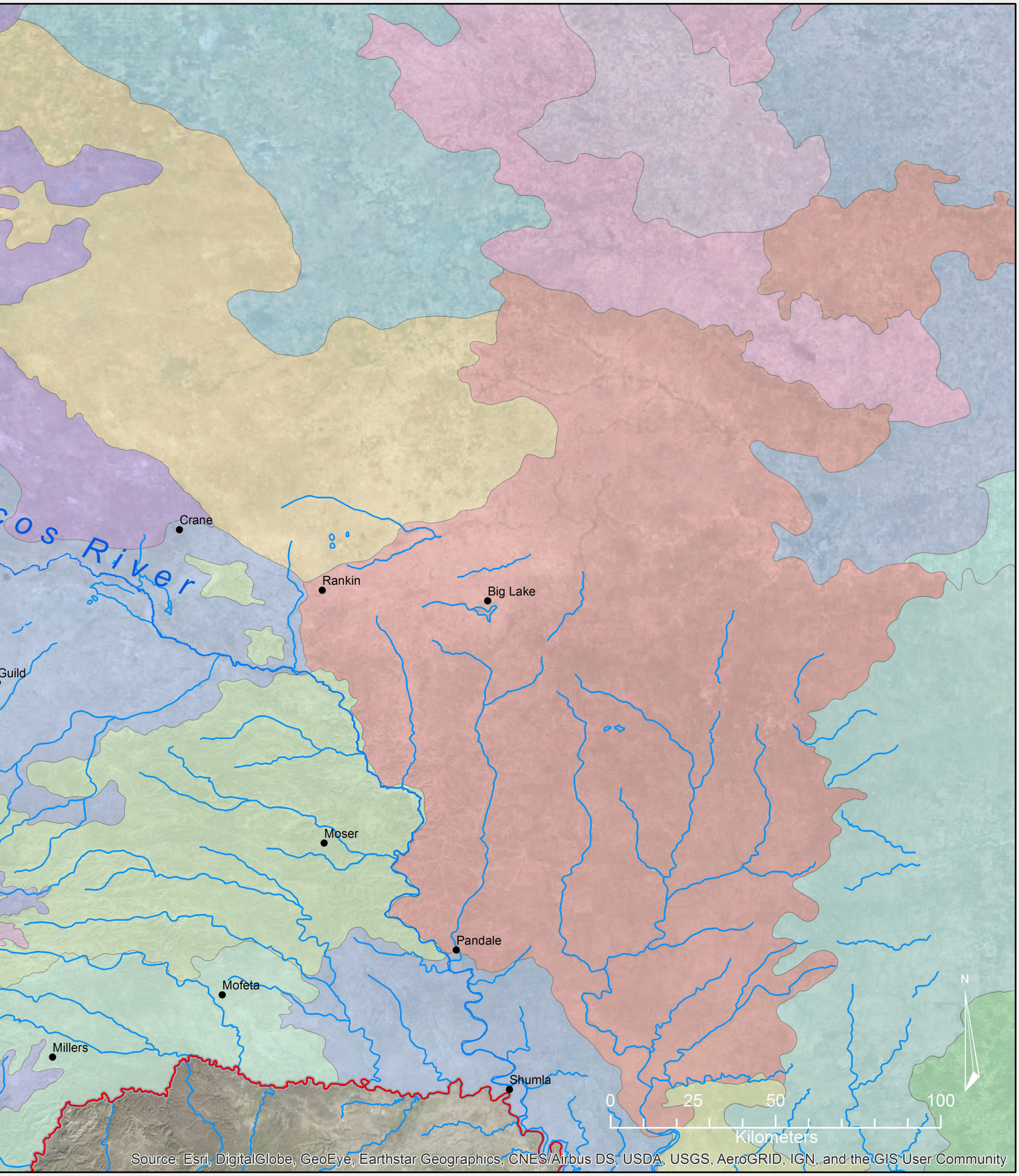

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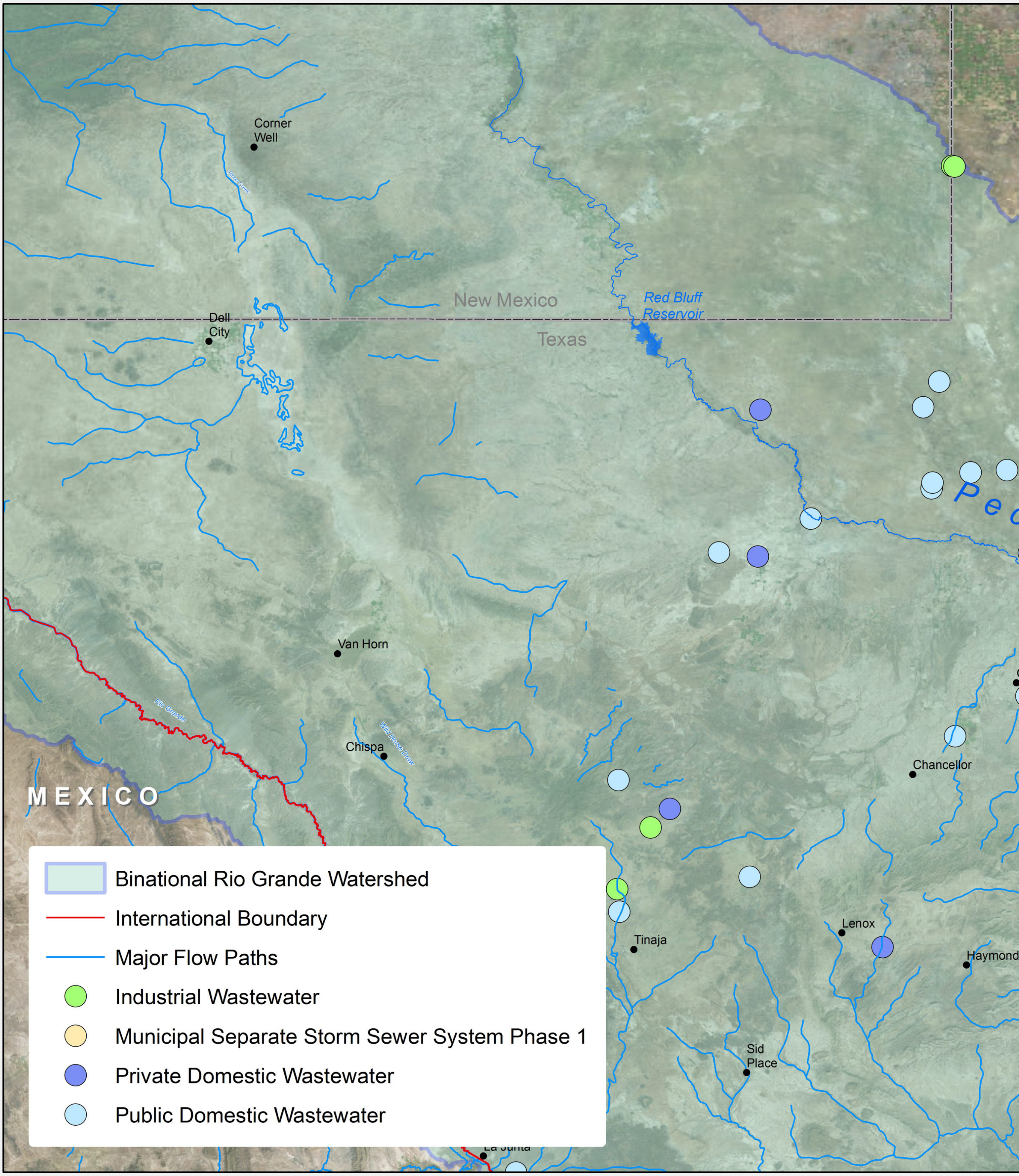

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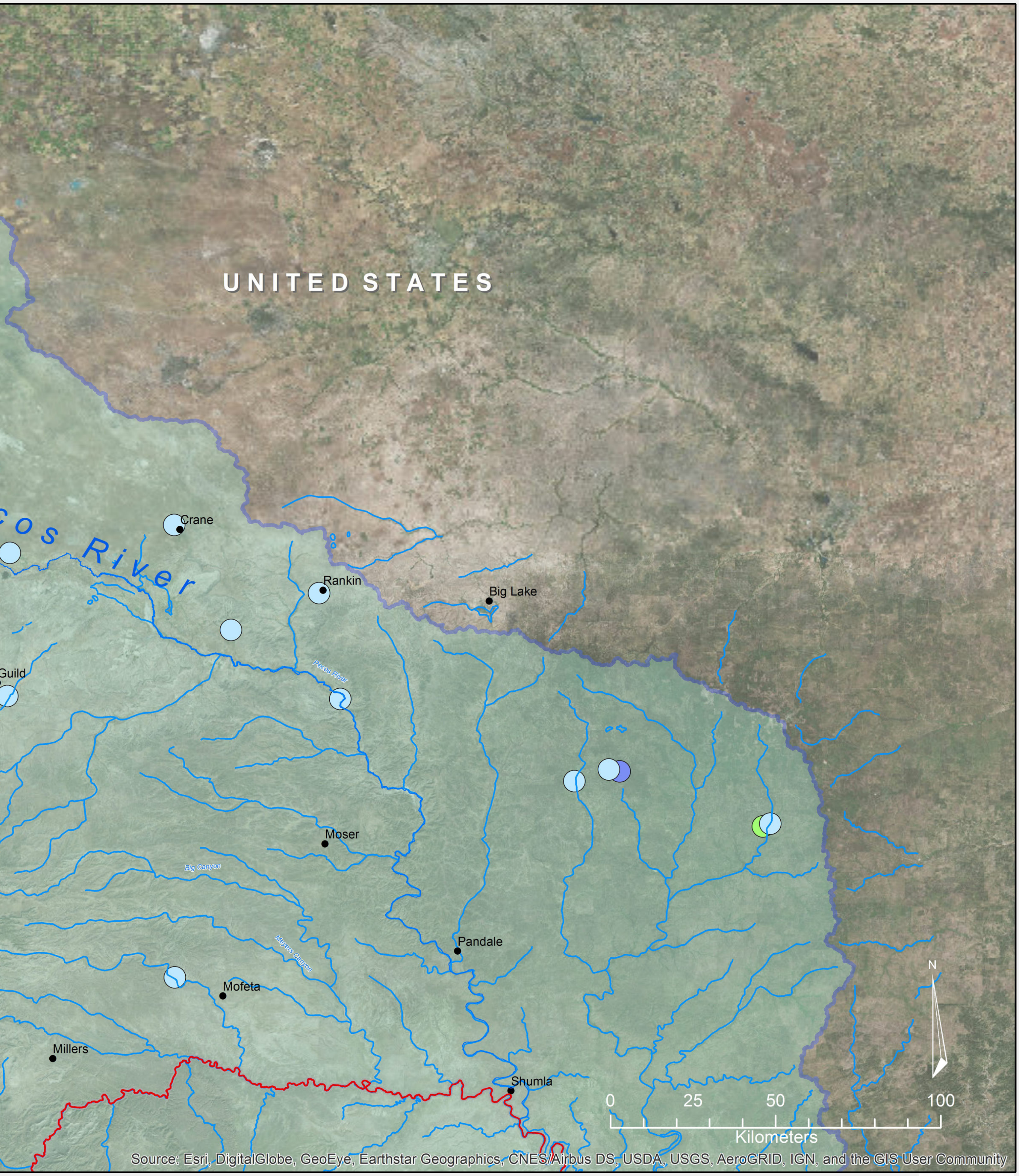

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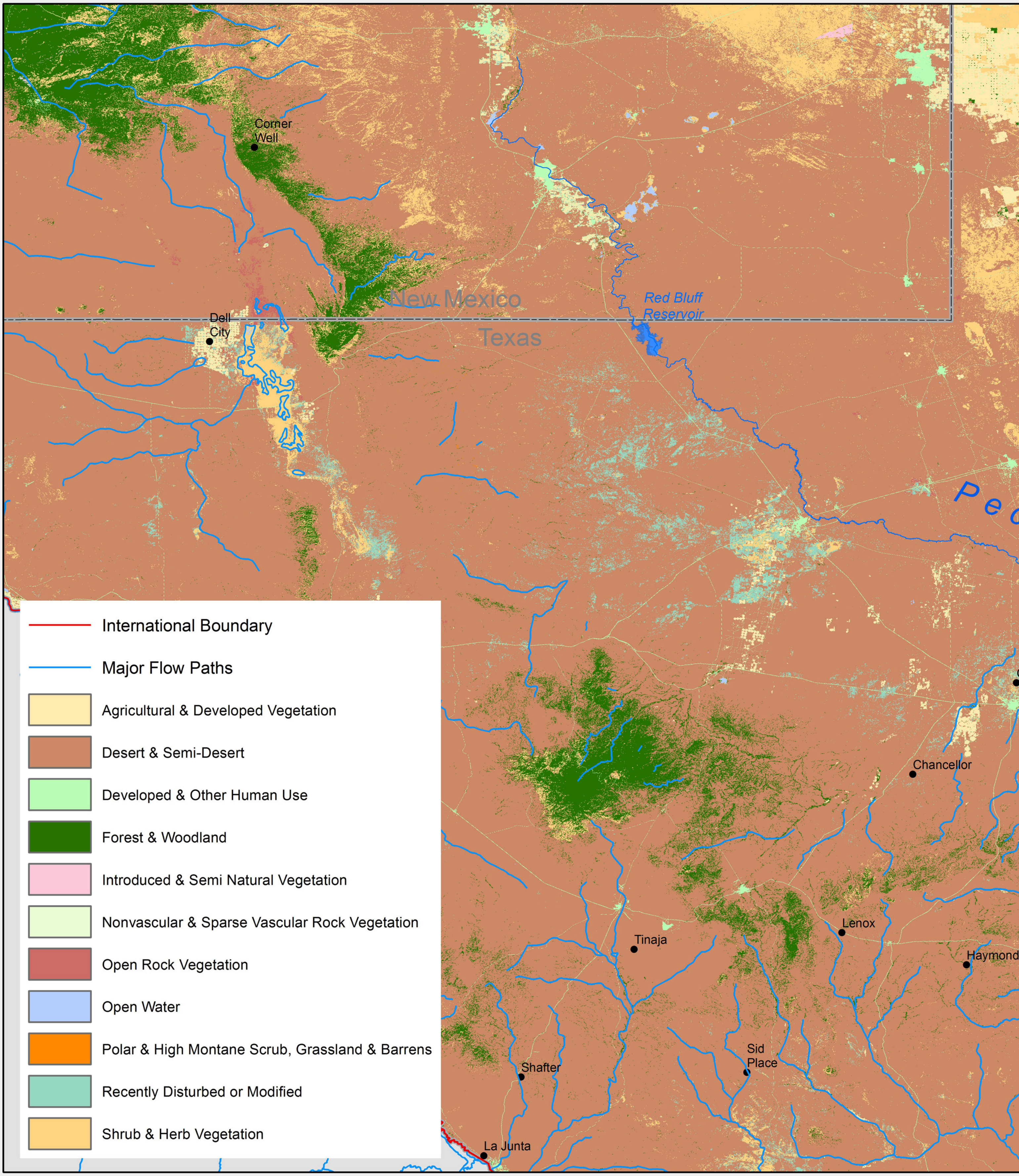

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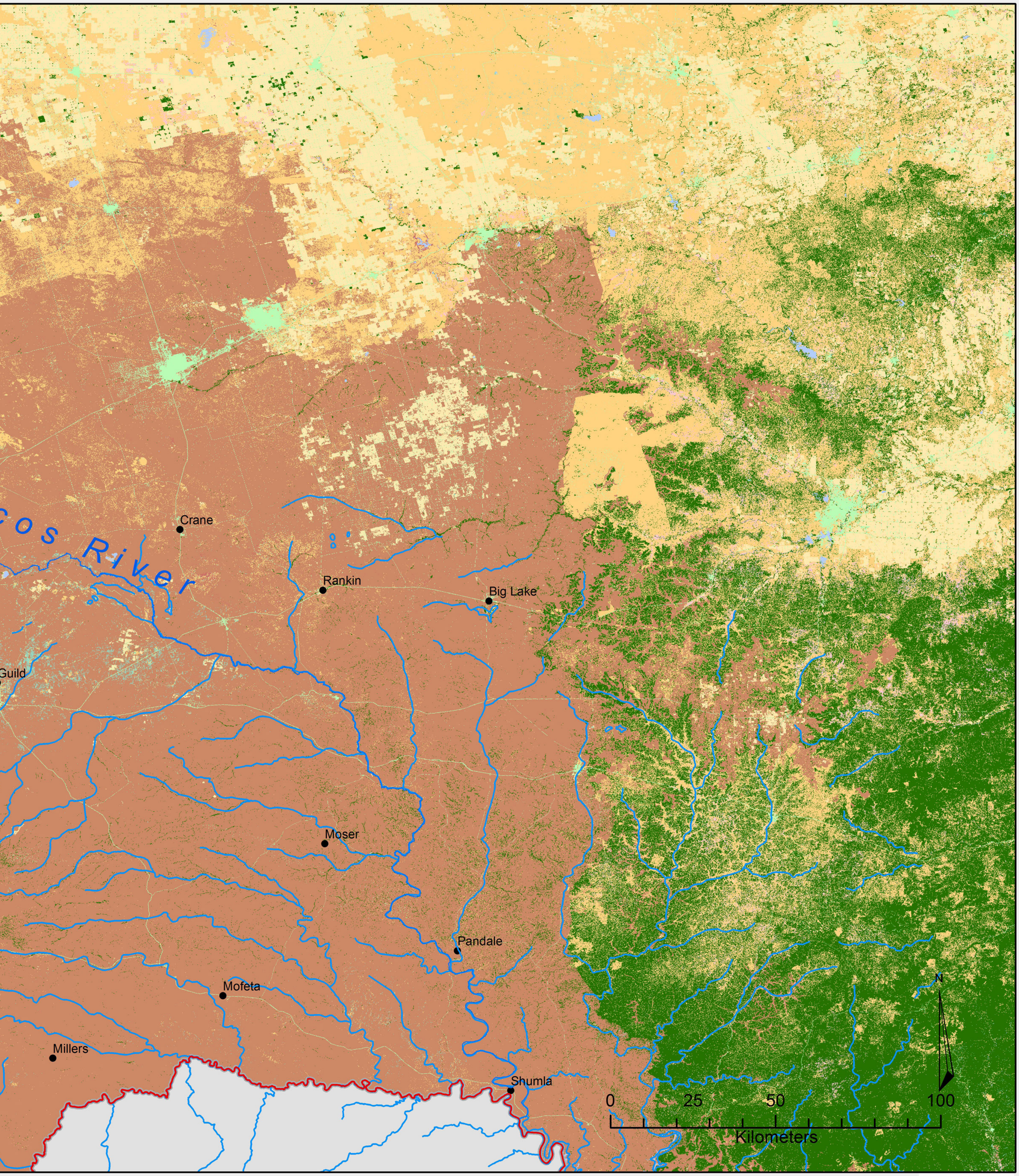

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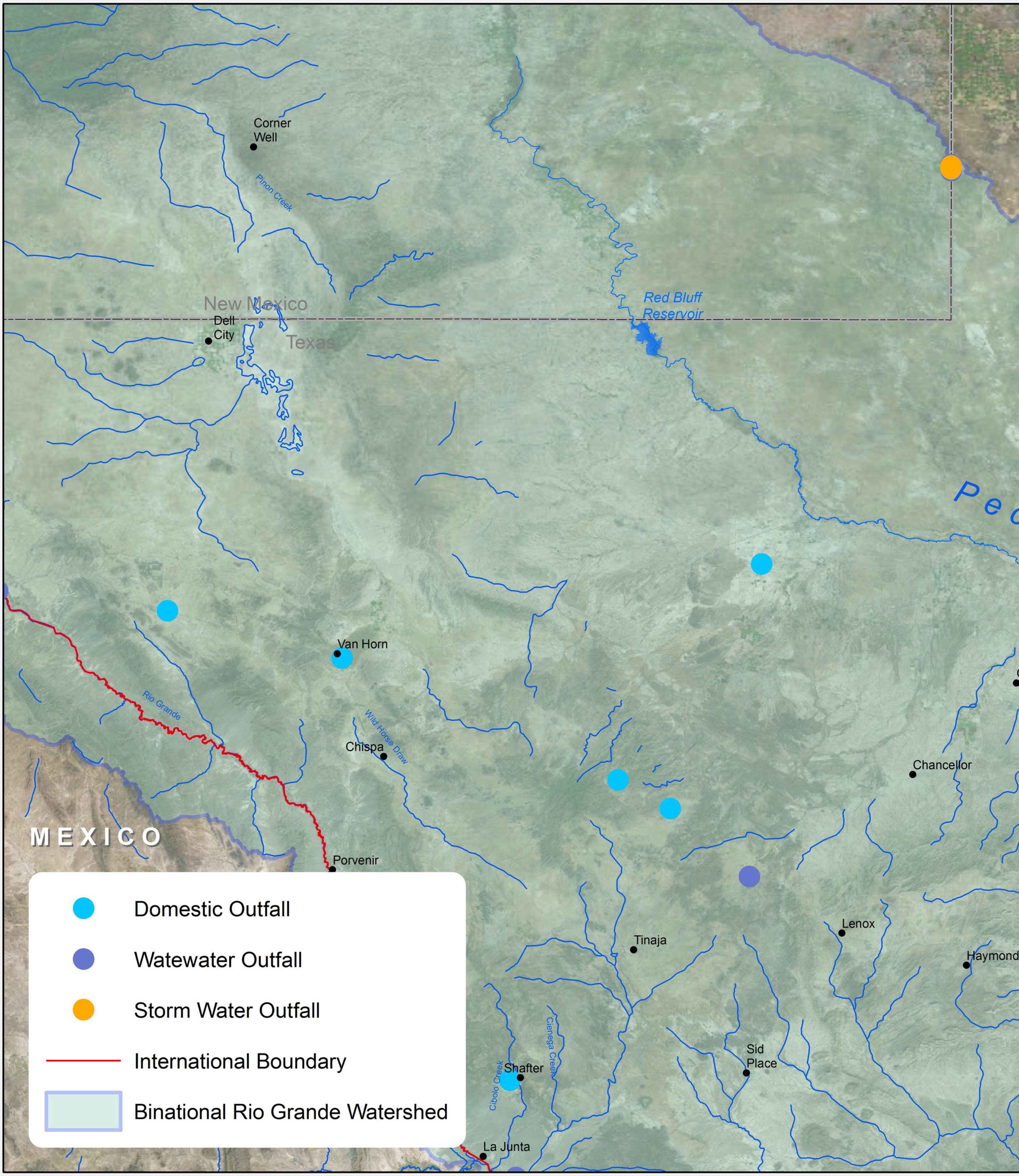

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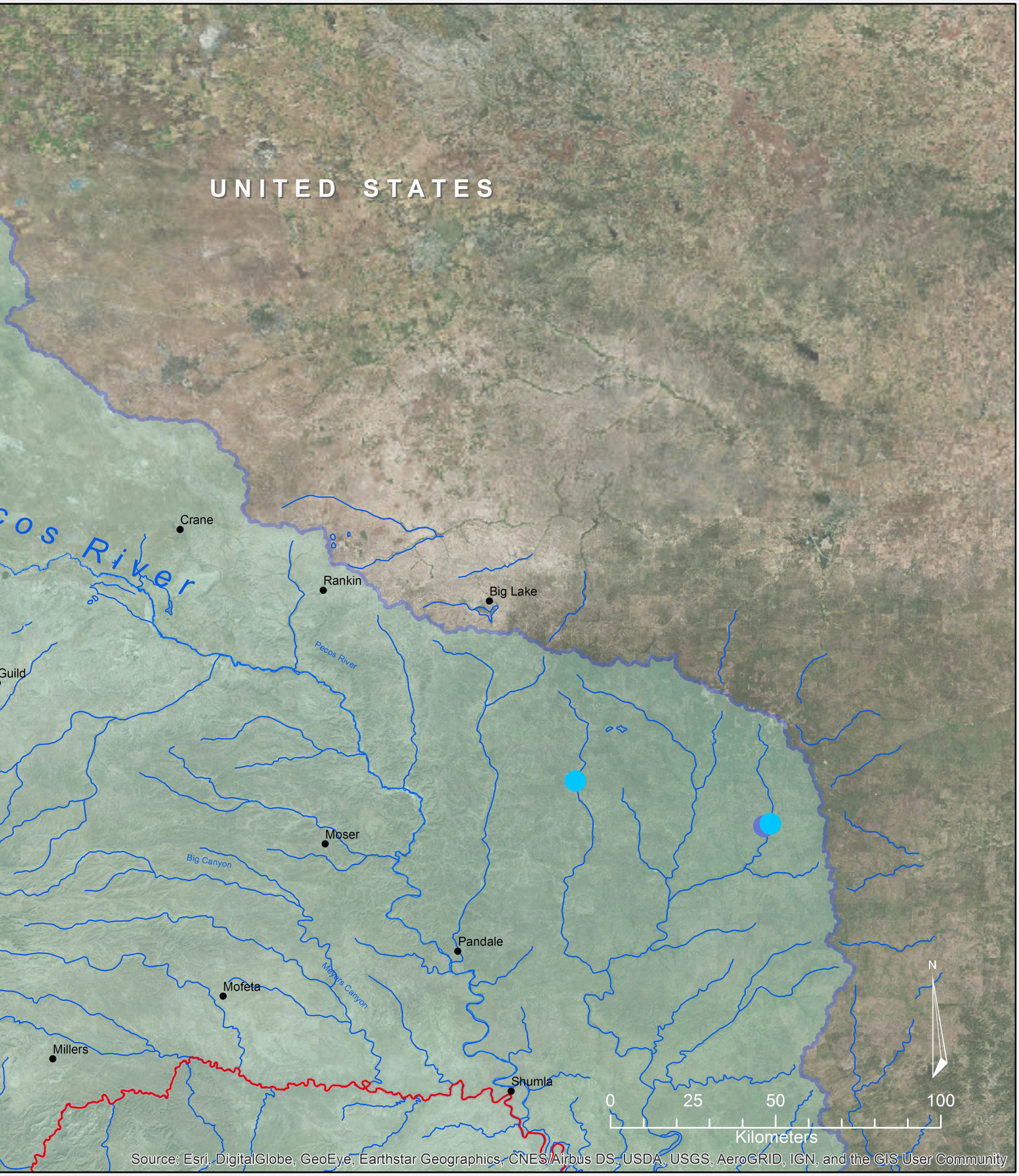

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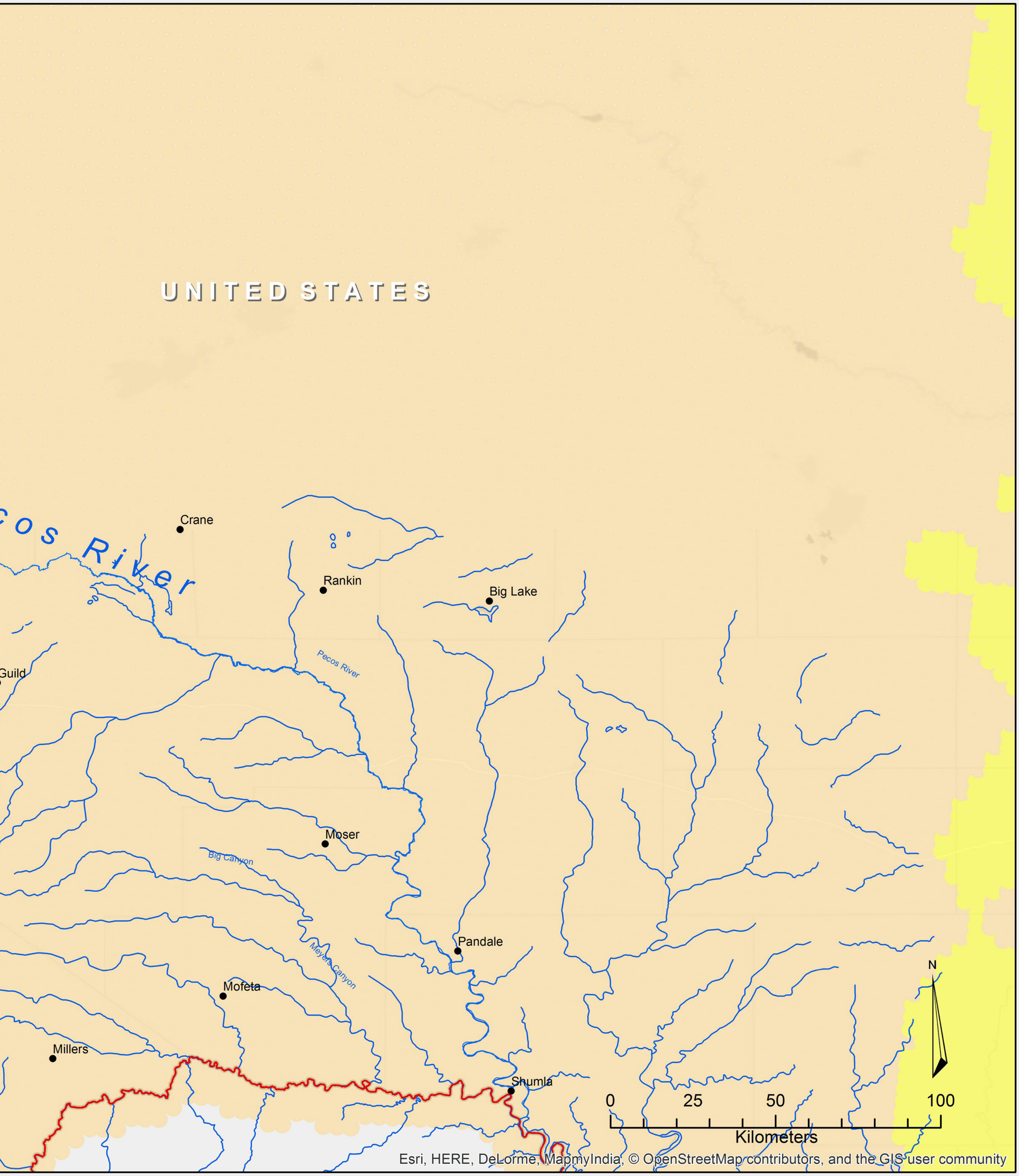

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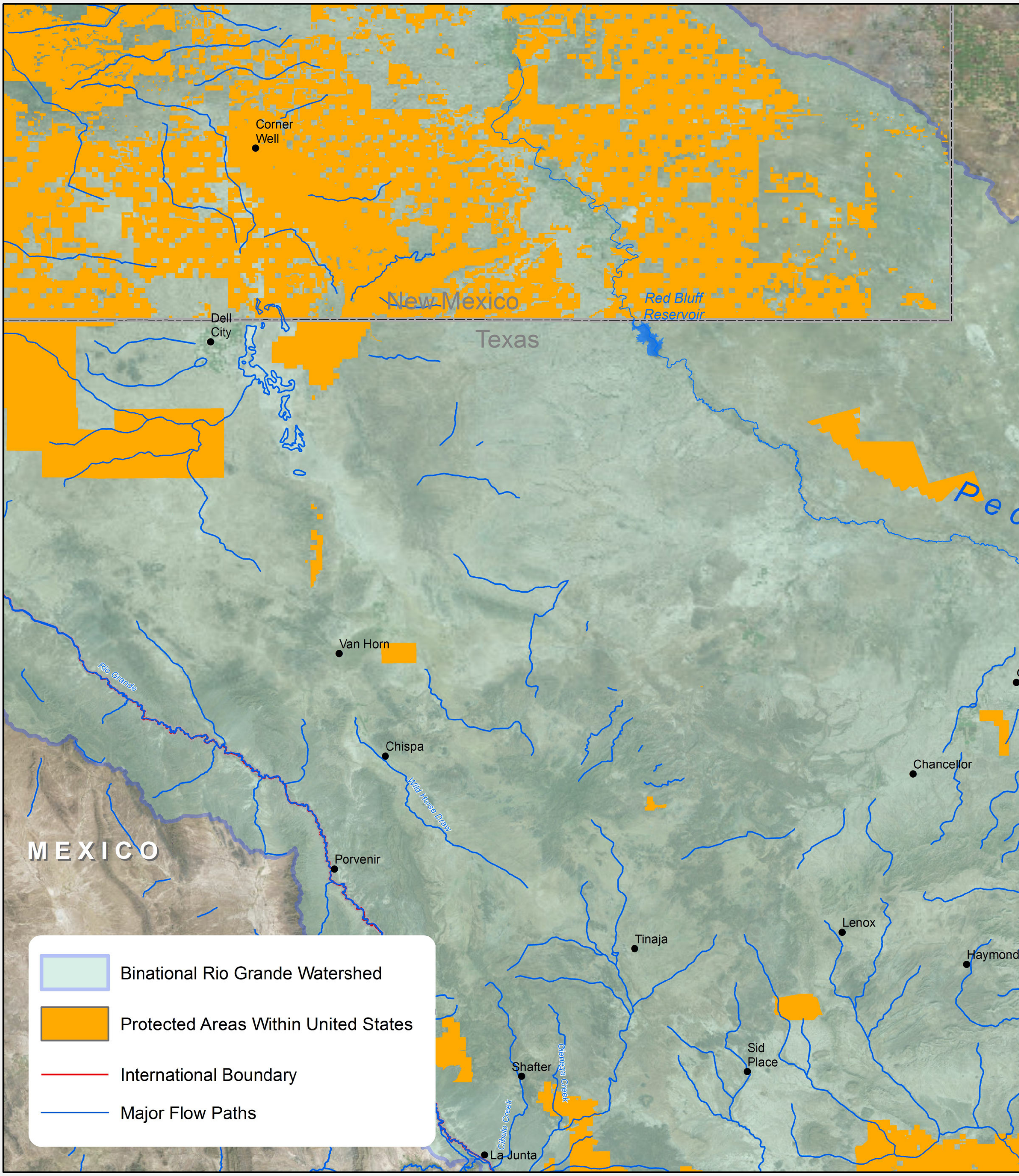

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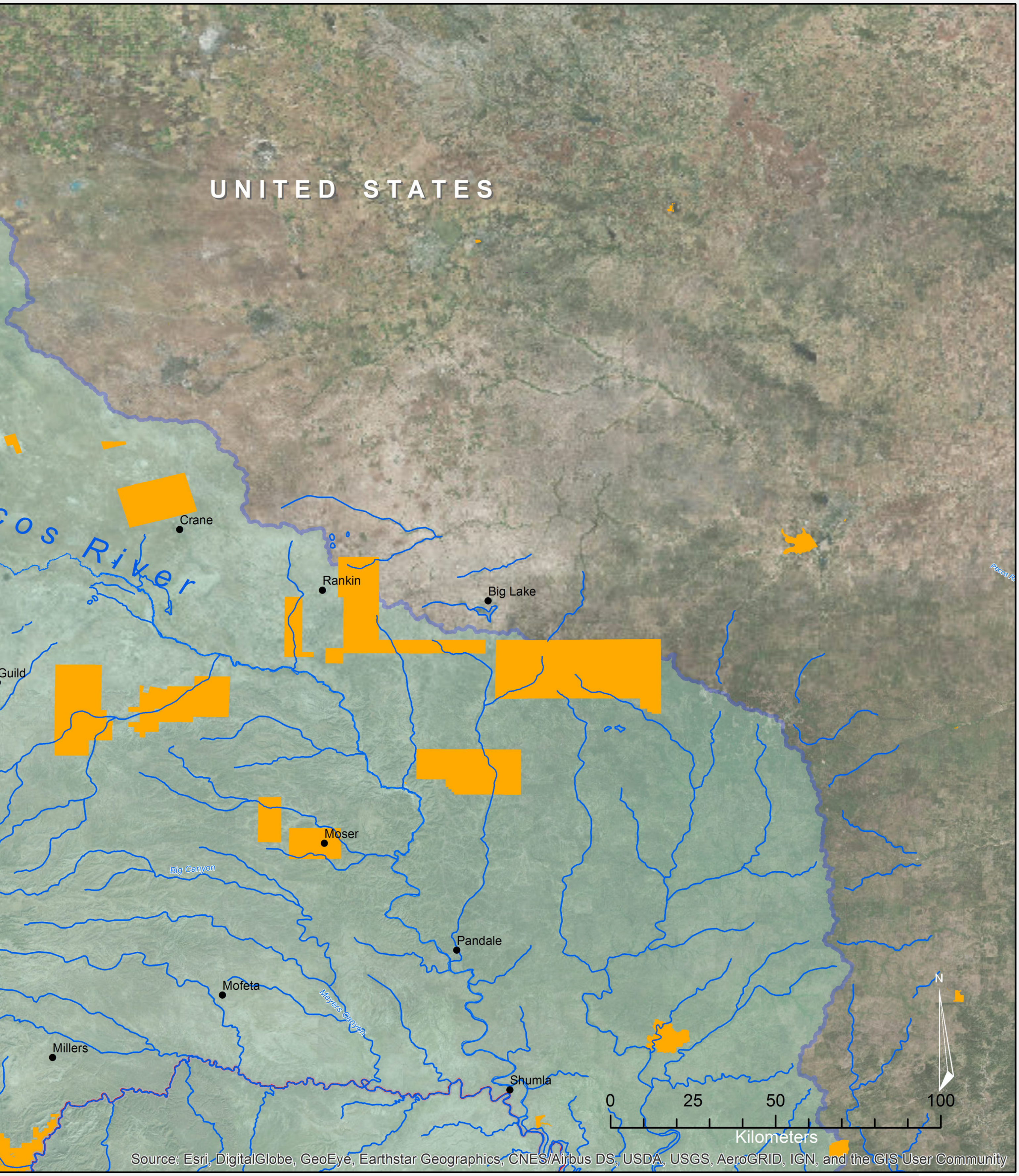

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TCEQ

PECOS RIVER WATER QUALITY UPDATE

As previously stated, due to the size of the Rio Grande Basin, the USIBWC CRP program has split it into four sub-basins. Table 6 characterizes the Pecos River Sub-Basin and the segments associated with it, describes active stations in those segments, and gives water quality information for these segments. For questions about water quality in the Pecos River Sub-Basin, or for information on historical or currently inactive stations, please contact USIBWC CRP staff (contact information located in back cover).

Table 6. Water Quality Review for the Pecos River Sub-Basin

Water Quality Review for the Middle Rio Grande Sub-Basin					
Segment	***Uses**	**Stations**	**Length**	**Segment Characteristics**	**Water Quality Summary**
Red Bluff Reservoir-Segment 2312	PCR1, H	13267, 13269	-	Defined as Red Bluff Dam to the New Mexico state line. Impounds the Pecos River in New Mexico.	This segment has no impairments but has a concern for DO grab from Red Bluff Dam to mid-lake. Red Bluff Dam impounds the Pecos River entering from New Mexico. Naturally occuring salt springs situated upstream of the reservoir in New Mexico contribute to high levels of TDS and chlorides. The high salinity limits its use as a public water supply. The Reservoir has struggled in recent years due to the drought, high evaporation rates and high infiltration rates of the bed and banks of the Pecos River.
Upper Pecos River-Segment 2311	PCR1, L	13248, 13249, 15114, 13257, 13258, 13259, 13260, 20399,	349 mi	Defined as the Pecos River from a point immediately upstream of the confluence of Independence Creek in Crokett/Terrell County to Red Bluff Dam in Loving/Reeves County	A portion of this segment (from US Hwy 67 upstream to the Ward Two Irrigation Turnout) is impaired for 24 hr DO min and has concerns for bacteria and chlorophyll-a. Classified as a freshwater stream extending for 249 miles (562 km). This reach is naturally high in salts due to groundwater passing through salt-bearing geologic formations. Water is not drinkable due to the high salinity. Salinity increases as you move downstream.
Lower Pecos River and Independence Creek-Segments 2310 and 2310A	PCR1, H, PS	13109, 13246, 14163, 18801	89 mi	Independence Creek is described as from the Pecos River confluence northeast of Sanderson in Terrell County to a point approx. 4.1 km (2.5 mi) east of US Hwy 285 in Pecos County. Lower Pecos is From a point 0.7 km (0.4 mi) downstream of the confluence of Painted Canyon in Val Verde County to a point immediately upstream of the confluence of Independence Creek in Crockett/Terrell County	Segments 2310A has no impairments or concerns. Segment 2310 has an impairment for TDS and no concerns. Segment 2310 is classified as a freshwater stream. Waters coming in from Independence Creek in the past have brought TDS values down to drinking water levels, but more recent data shows high levels of chloride, sulfate, and TDS. In the past this segment had concerns for fish kills, especially during stressful drought conditions. Drought conditions also contributed to an increase in nuisance aquatic vegetation, and algae began to develop as nutrient levels increased.

Segment 2312, Red Bluff Reservoir

From Red Bluff Dam in Loving/Reeves County to New Mexico State Line in Loving/Reeves County, up to normal pool elevation 2842 feet (impounds Pecos River). The segment has two assessment units (AU):

Segment 2312, Red Bluff Reservoir

2312_01, From the Red Bluff Dam to mid-lake

2312_02, From mid-lake to the Texas/New Mexico state line

There are 2 active stations within this segment:

13267, Red Bluff Reservoir Upstream Dam North of Orla

13269, Red Bluff Reservoir 1/2 Mile South of Texas- New Mexico Border

In the 2020 Intergrated Report, Segment 2312 has no impairments but has a concern for DO grab from red Bluff Dam to mid-lake. There are two active stations currently monitored by the Texas Commission on Environmental Quality within this segment. The data reported in Tables 9 and 10, which is submitted by the TCEQ Midland field office, has been extracted from the TCEQ Surface Water Quality Information Management Information System (SWQMIS) database.

Table 7. Segment 2312

Segment	Segment Name	Parameter(s) Impaired	Year First Listed	Assessment Category[1]	Parameter (s) of Concern	Level of Concern[2]
2312_01	From Red Bluff Dam in loving/Reeves County to New Mexico State Line in Loving/Reeves County, up to normal pool elevation 2842 feet (impounds Pecos River)	No impairment	-	*5c*	DO	CN

CS- Concern for water quality based on screening levels
CN- Concern for water quality based on non-attainment of water quality standards
NS - Non-supporting

Table 8. Hydrologic Characteristics

Assessment Unit (AU)	Stations	Date Range (mmm yyyy)	Mean Flow (cfs)
AU 2312_01	13267	5/13/2009- 8/5/2019	Flow not taken in reservoirs
AU 2312_02	13269	5/13/2009- 8/5/2019	Flow not taken in reservoirs

Recreational activities are common in the surrounding area, which may have an impact on water quality, currently there are no additional issues besides the concern for DO grab. Previous Integrated Reports had concerns for fish kills and algal blooms, which could be attributed to the severe drought in the area.

Table 9. Data Analysis of Water Quality Issues (mean values, varies by station)

Station	# of data points	Date Range (mmm yyyy)	*Enterococci* (#/100 mL)	DO (mg/L)	pH (standard units)	Chloride (mg/L)	Sulfate (mg/L)
			Std: 33/100 ml	Std: 5.0 mg/L	Std: 6.5-9.0 SU	Std: 3,200 mg/L	Std: 2,200 mg/L
13267	22	5/13/2009- 8/5/2019	-	8.7	8.1	2771	2310
13269	22	5/13/2009- 8/5/2019	-	8.1	8.1	2541	1902

Land Use

Red Bluff Reservoir extends into Loving and Reeves Counties in Texas, and Eddy County in New Mexico. The reservoir is used for irrigation, power generation, flood control and recreational purposes. There are public boat ramps, and the reservoir is located relatively close to Highway 285. There are small businesses around the reservoir, and maps show what may be some small homes around the area as well.

Possible negative impacts on water quality

Nonpoint sources- Runoff from suburban areas of surrounding areas of Texas may be a source of non-point source pollution to the reservoir, particularly the highway, although the reservoir is relativel far from the highway and most highly urbanized areas. The recreational activities from the populace may also be a major contributor of contamination into the reservoir.

Agricultural- Agriculture is extremely important in this area and is one of the main reasons the reservoir was created was for irrigation. Satellite imagery shows what may or may not be remnants of agricultural lands around the reservoir. Runoff may introduce contaminants that are high in nutrients.

Wildlife- Red Bluff reservoir is stocked with fish that are intended to improve the reservoir's use for recreation, fishing and swimming. The warm climate and combination of of mountains and desert make the area very diverse in both wildlife and habitat. There are many species of birds that call this area home, as well as multiple other species. Please see the end of the report for more information on the wildlife.

Urban Runoff- As previously mentioned, the area is not surrounded by areas of high urbanization. The City of Pecos is 40 miles away, and there are no residential areas visible in the immediate surrounding area of the reservoir. The interstate runs along the legnth of the reservoir, but is also relatively far; however, flooding rains could produce enough runoff that in the event of a major flood, the runoff could potentially impact the reservoir.

Influences of Flow - Red Bluff reservoir is heavily influenced by rainfall, some of which is capable of producing flooding. Rainfall is stored in the reservoir until releases are are needed and scheduled, at which time water is released and flows downstream.

Google Maps Red Bluff Reservoir

Imagery ©2020 CNES / Airbus, Landsat / Copernicus, Maxar Technologies, NMRGIS, USDA Farm Service Agency, Map data ©2020 1 mi

Potential Stakeholders

Landowners

US Fish & Wildlife Service

TX Parks and Wildlife

City of Pecos

City of Orla

Red Bluff Water Power Control District

TCEQ Watermaster Office

TCEQ Regional Offices

Red Bluff Recreation Area

Red Bluff Reservoir

Loving and Reeves Counties

Recommendations

The TCEQ should continue their routine monitoring of the segment. Current impacts of agricultural lands and urban runoff are unknown.

Segment 2311, Upper Pecos River

Segment 2311 is defined as from a point immediately upstream of the confluence of Independence Creek in Crockett/Terrell County to Red Bluff Dam in Loving/Reeves County. The segment is 349 river miles (562 km) in length. This reach of the Pecos River has naturally high salinity due to groundwater passing through salt-bearing geologic formations. Due to the high salinity, the water is not suitable for consumption. Salinity increases as the water flows downstream; this is due to a complex inter-relationship of natural processes involving the seasonal nature of precipitation within the region, the exchange of surface water and groundwater, variability of seasonal flow, and evaporation influence changes in TDS, chloride, and sulfate concentrations. The designated uses for this segment are primary contact recreation; it is not listed as a public water supply and is characterized as low for aquatic life use. There are 11 monitoring stations in this segment primarily located within the populated areas along the river. The segment has 8 assessment units, or AUs:

Segment 2311, Upper Pecos River

2311_01, From just upstream of the Independence Creek confluence upstream to US Hwy 290

2311_02, US Hwy 290 upstream to US Hwy 67

2311_03, From US Hwy 67 upstream to the Ward Two Irrigation Turnout

2311_04, From the Ward Two Irrigation Turnout upstream to US Hwy 80 (Bus 20)

2311_05, From US Hwy 80 (Bus 20) upstream to the Barstow Dam

2311_06, From the Barstow Dam upstream to State Hwy 302

2311_07, From State Hwy 302 upstream to FM 652

2311_08, From FM 652 upstream to the Red Bluff Dam

There are 5 active stations within these segments:

Station 13249 – Upper Pecos River at Bridge on SH 290SE of Sheffield CAMS 0735

Station 13257 – Pecos River at US 67 NE of Girvin

Station 13260 – Pecos River at FM 1776 SW of Monahans CAMS 709

Stations 13265 – Pecos River at FM 652 Bridge NE of Orla CAMS 0798

Station 14164 – Pecos River Approx 2.98 KM Upstream of the Confluence with Independence Creek

Segment 2311 is impaired for depressed dissolved oxygen in one assessment unit, which has been listed on the Texas Integrated Report since 2006. There are also concerns for near non-attainment of water quality standards based on screening levels in AUs 2311_03, 2311_04, 2311_07, and 2311_08. The data reported in Tables 12 and 13 are compiled from data collected by the USIBWC CRP and extracted from TCEQ's SWQMIS database.

Table 10. Segment 2311

Segment	Segment Name	Parameter(s) Impaired	Year First Listed	Assessment Category[1]	Parameter (s) of Concern	Level of Concern
2311_01	From just upstream of the Independence Creek Confluence upstream to US Hwy 290	-	-	5c	chlorophyll-a	CS
2311_02	From US Hwy 290 upstream to US Hwy 67	-	-	5c	chlorophyll-a	CS
2311_03	From US Hwy 67 upstream to the Ward Two irrigation Turnout	Depressed Dissolved Oxygen	2006	5c	bacteria	CN
2311_04	From the Ward Two Irrigation Turnout upstream to US Hwy 80 (Bus 20)	-	-	5c	chlorophyll-a	CS
2311_07	From State Hwy 302 upstream to FM 652	-	-	5c	chlorophyll-a	CS
2311_08	From FM 652 up-stream to the Red Bluff Dam	-	--	5c	chlorophyll-a	CS

CS- Concern for water quality based on screening levels
CN- Concern for water quality based on non-attainment of water quality standards
NS - Non-supporting

Table 11. Hydrologic Characteristics

Assessment Unit (AU)	Stations	# of data points	Date Range (mmm yyyy)	Mean Flow (cfs)
AU 2311_01	13248	14	05/15/14- 10/28/16	186.5
	14164	16	10/28/2016- 05/15/2019	33.6
AU 2311_02	13249	51	01/07/09- 10/28/19	36.5
	15114	--	--	--
AU 2311_03	13257	74	01/21/09- 09/23/19	24.7
	13258	--	--	--
	13259	--	--	--
	13260	85	01/20/09- 9/23/19	12.9
	20399	--	--	--
AU 2311_04	No Stations	--	--	--
AU 2311_05	13261	--	--	--
AU 2311_06	No Stations	--	--	--
AU 2311_07	13264	--	--	--
AU 2311_08	13265	41	02/05/09- 07/09/19	50.0

Table 12. Data Analysis of Water Quality Issues (Mean values)

Station	# of data points	Date Range	*E. Coli* (#/100 mL)	Dissolved Oxygen (mg/L)	pH (Standard units)	Chloride (mg/L)	TDS (mg/L)	Sulfate (mg/L)
			Std: 33/100 ml	Std: 5.0 mg/L	Std: 6.5-9.0 SU	Std: 7,000 mg/L	Std: 15,000 mg/L	Std: 3,500 mg/L
13248	14	5/15/14 – 10/28/16	--	7.7	7.9	2383	6158	1325
14164	16	10/28/2016-05/15/19	--	7.6	7.9	2953	7246	1756
13249	51	6/17/93–10/28/19	--	7.8	7.8	7000	--	2099
13257	74	8/9/93-9/23/19	--	7.5	8.0	6125	--	3861
13260	85	01/20/09-9/23/19	--	8.4	7.7	5125	--	3106
13265	41	02/05/09-7/9/19	--	8.1	7.8	3244	--	2527
14164	16	Feb. 2000 – Nov. 16	--	7.6	7.9	2953	7246	1756

Land Use

Segment 2311 stretches from just upstream of Independence Creek to Red Bluff Dam in Loving/Reeves County, which is about 349 miles (562 km) in length. Based on satellite imagery, there are some cities, such as Sheffield, and small towns near the river throughout the length of the segment.

Possible negative impacts on water quality

Nonpoint sources- There is very little research on the subject, but this segment and the segment downstream may be be impacted by the interstate (I-10) and highways that cross or parallel it throughout the segment. This area is very highly trafficked with commercial and private vehicles.

Agricultural- This segment is impacted by agricultural activities. There are agricultural fields adjacent to the Pecos River which may potentially introduce contamination due to the use of fertilizers, pesticides during irrigation. The return flows from irrigation are high in nutrients, which can lead to excess algae growth, and, in turn, lead to decreased DO in the water.

Wildlife- Similar to Segment 2312, the warm climate and combination of of mountains and desert make the area very diverse in both wildlife and habitat. There are many species of birds that call this area home, as well as multiple other species. Satellite imagery shows what appear to be watering holes or ponds located throughout the segment, which could possibly attract wildlife. Please see the end of the report for more information on the wildlife.

Urban Runoff- There are multiple communities along the river in this span of the basin. The communities of Pecos, Sheffield, and Iraan are all located near the Pecos River. Runoff from these communities could make its way into the river during storm events and introduce pollutants.

Influences of Flow - Segment 2311 is heavily influenced by releases from Red Bluff Reservoir. The area is also heavily influenced by strong storms during monsoon season that frequently produce flooding.

Potential Stakeholders

Landowners

US Fish & Wildlife Service

TX Parks and Wildlife

City of Pecos

City of Sheffield

TCEQ Watermaster Office

TCEQ Regional Offices

Red Bluff Recreation Area

Red Bluff Reservoir

City of Iraan

Reeves, Ward, Crane, Pecos, Crokett, and Terrell Counties

Red Bluff Water Power Control District

Recommendations

The USIBWC CRP will continue routine monitoring at Station 14164, and the TCEQ should continue their routine monitoring of the segment as well.. The program will continue to monitor and look at increasing or decreasing trends to identify water quality issues and needs in this area.

Segment 2310 and 2310A, Lower Pecos River and Independence Creek

Segment 2310 is defined as from a point downstream of the confluence of Painted Canyon in Val Verde/County to to a point immediately upstream of the confluence of Independence Creek in Crockett/Terrell County. The segment is 89 river miles (143 km) in length. This reach of the Pecos River is classified as a freshwater stream. The designated uses are high aquatic life use, contract recreation and public water supply. In the past, waters from Independence Creek would enter the Pecos River and dilute the highly saline waters coming from upstream, but more recently there have been high values of chloride, sulfate and TDS in the data. There are 4 monitoring stations in this segment. The Segments 2310 and 2310A both have two assessment units, or AUs:

Segment 2310, Lower Pecos River

2310_01, From the Devils River Arm of Amistad Reservoir confluence upstream to FM 2083 near Pandale

2310_02, From FM 2083 near Pan Dale upstream to just upstream of the Independence Creek confluence

Segment 2310A, Independence Creek

2310A_01, Perennial stream from the confluence with the Pecos River upstream to the mouth of Surveyor Canyon (upstream of FM 2400)

2310A_01, From the mouth of Surveyor Canyon (upstream of FM 2400) to a point approximately 4.1 km (2.5 mi) east of US Hwy 285 in Pecos County

There are 4 active stations within these segments:

Station 13246 – Pecos River 7.52 km Upstream from the Val Verde/Terrell/Crockett County Line Convergence

Station 14163 – Pecos River Approx 355 Meters Dowsntream from the Confluence with Independence Creek

Station 18801 – Lower pecos River West bank 3.56 Km/2.3 mi Upstream of Terrell/Val Verde/ Crockett County Line Convergence CAMS 0729 on Brotherton Ranch

Station 13109 – Independence Creek 0.5 mi Downstream from John Chandler Ranch Hdqrtrs

Segments 2310 has a new impairment for TDS in the 2020 Integrated Report, and no parameters of concern. Segment 2310A currently has no impairments or concerns. The data reported in Tables 12 and 13 are compiled from data collected by the USIBWC CRP and extracted from TCEQ's SWQMIS database.

Table 13. Segment 2310

Segment	Segment Name	Parameter(s) Impaired	Year First Listed	Assessment Category[1]	Parameter (s) of Concern	Level of Concern
2310_01	From the Devils River Arm of Amistad Reservoir confluence upstream to FM 2083 near Pan Dale	Total Dissolved Solids	2020	5c	-	No impairments or concerns
2310_02	From FM 2083 near Pan Dale upstream to just upstream of the Independence Creek confluence	Total Dissolved Solids	2020	5c	-	No impairments or concerns
2310A_01	Perennial stream from the confluence with the Pecos River upstream to the mouth of Surveyor Canyon (upstream of FM 2400)	-	-	5c	-	No impairments or concerns
2310A_02	From the mouth of Surveyor Canyon (upstream of FM 2400) to a point approximately 4.1 km (2.5 mi) east of US Hwy 285 in Pecos County	-	--	5c	-	No impairments or concerns

CS- Concern for water quality based on screening levels
CN- Concern for water quality based on non-attainment of water quality standards
NS - Non-supporting

Table 14. Hydrologic Characteristics

Assessment Unit (AU)	Stations	# of Data Points	Date Range (mmm yyyy)	Mean Flow (cfs)
AU 2310_01	No Stations	--	--	--
AU 2310_02	13246	--	--	--
	14163	29	05/15/14- 05/15/19	128
	18801	48	--	--
AU 2310A_01	13109	86	01/06/2009- 10/28/2019	26.6
AU 2310A_02	No Stations	--	--	--

Table 15. Data Analysis of Water Quality Issues (Mean values)

Station	# of data points	Date Range	*E. Coli* (MPN/100 mL)	Dissolved Oxygen (mg/L)	pH (Standard units)	Chloride (mg/L)	T D S (mg/L)	Sulfate (mg/L)
13246	-	-	-	-	-	-	-	-
14163	29	5/15/14-5/15/19	132	8	7.9	1964	6703	1152
18801	48	11/4/08-8/28/19	52	8.8	8	1322	--	839
13109	86	01/06/09-10/28/19	18	9	8.1	104	--	155

Land Use

Segment 2310 stretches from Amistad International Reservoir to just upstream of Independence Creek, which is about 89 miles (143 km) in length. Based on satellite imagery, there are no major cities or small towns near the river throughout the length of the segment.

Possible negative impacts on water quality

Nonpoint sources- The Pecos River may be be impacted by the major highway (Hwy 90) that crosses it in this segment. There may be commerical and private traffic, but not in the volume seen in the previous segment, so impacts should be minimal.

Agricultural- This segment does not seem to be impacted by agricultural activities. There are no agricultural fields visible in satellite imagery.

Wildlife- Similar to Segment 2311, the warm climate and combination of of mountains and desert make the area very diverse in both wildlife and habitat. Satellite imagery does not show any type of ponds or watering holes in the area. Seminole Canyon State Park is located shortly upstream of the confluence of the Pecos River with the Rio Grande, and there may be areas within the state park that are set up for wildlife. Please see the end of the report for more information on the wildlife.

Urban Runoff- There are no communities along the river in this span of the basin. Urban runoff would not impact the river unless it is coming from upstream.

Influences of Flow - Segment 2310 is also heavily influenced by releases from Red Bluff Reservoir. The area is also heavily influenced by strong storms during monsoon season that frequently produce flooding.

Potential Stakeholders

Landowners

US Fish & Wildlife Service

TX Parks and Wildlife

City of Pecos

Terrell and Val Verde Counties

TCEQ Watermaster Office

TCEQ Regional Offices

Red Bluff Recreation Area

Red Bluff Reservoir

Red Bluff Water Power Control District

Recommendations

The USIBWC CRP will continue routine monitoring at Station 14163 for a full assessment in 2020. The program will continue to monitor and look at increasing or decreasing trends for parameters to identify water quality issues and needs in this area. It is recommended that TCEQ continues its routine monitoring of stations as well.

Statistical Analysis for Segments 2312, 2311, 2310, and 2310A

This table describes analytical means for parameters with established water quality standards. Values in cells represent means or geomeans (bacteria). A green highlighted cell indicates a statistically significant decreasing trend ($p \le 0.1$), a yellow cell indicates a significantly increasing trend ($p \le 0.1$), and a red cell indicates that more than 10% of the data exceeds the standard. Red text indicates the mean of the parameter over the period of record is above the Texas State Water Quality Standard, with the exception of dissolved oxygen, where falling below 5 mg/L would indicate impairment. A leaf indicates that a seasonal trend exists within the data, and a wave indicates that the parameter concentration is related to flow. An asterisk (*) indicates that the station had a sample size (n) for that parameter that is less than the samples size required for trend analysis ($n \ge 19$). The following types of analyses were run for the table below:

1. Mean of Data Exceeding Standard: Permutation Test
2. 10 % Exceedance Levels: Quantile Test
3. Trend Tests
    a. Over time, and over time in combo with flow: Theil-Sen tests
    b. Over time and season, and over Time, season, flow combo: Seasonal Kendall tests
4. Seasonal Variation between means: Wilcox and permutation tests
5. Parameter concentrations correlated to flow: Kendall correlation test

Table 16. Statistical Analysis for Pecos Stations using R Statistical Software

Station	Parameter						
	Water Temperature (°C)	Dissolved Oxygen (mg/L)	pH	Chloride (mg/L)	Sulfate (mg/L)	Total Dissolved Solids (mg/L)	Bacteria (MPN/100ml)
Segment 2312 | Red Bluff Reservoir							
13269	25.6	8.1	8.1	2541	1902	.	.
13267	23.3	7.4	8.1	2771	2310	.	.
Standards	32.2	5	6.5-9	3200	2200	9400	33
Segment 2311 | Upper Pecos River							
13265	17.6	8.1	7.8	3244	2527	.	.
13260	17.4	8.4	7.7	5125	3106	.	.
13257	18	7.6	7.9	6734	4205	.	.
13249	19.4	7.9	7.7	3448	2009	.	.
14164	18.8*	7.6*	7.9*	2953*	1756*	7246*	.
Standards	33.3	5	6.5-9	7000	3500	15000	33
Segment 2310 | Lower Pecos River							
13248	21.4*	7.7*	7.9*	2383*	1325*	6158*	.
13109	20.4	9	8.1	104	155	.	18
14163	21.3	7.9	7.9	1960	1098	6179	132
18801	20.6	8.8	8	1322	839	.	52
16379	22.9	8.6	8.2	513	351	.	54
Standards	33.3	5	6.5-9	1700	1000	4000	126

* = less than 19 observations so values are not actionable

More than 10% of data exceeds standards
decreasing over time in combo with flow
= seasonal effect
flow correlation
increasing over time

Statistical Analysis, continued

Water quality parameters selected for analysis were those with Texas State Water Quality Standards, and include: water temperature, pH, dissolved oxygen, bacteria (E.coli or enterococcus), sulfate, chloride, and total dissolved solids. For each water quality parameter of interest, data analysis consisted of minimums, maximums, medians, means, geomeans (bacteria only), standard deviations, as well as trend, interaction (flow and season), and percent exceedance analysis. Trend analysis allows for the identification of how water quality parameters change over time (increase or decrease), while interaction analysis provides a more detailed examination of how parameter concentrations may differ by time of year and flow conditions. Percent exceedance analysis allows us to determine if the data consistently exceeds standards, which can indicate that a site may need more in depth investigation to determine why standards are repeatedly exceeded. Analyses were not run on stations that had fewer than 10 data points over the period of record (2009-2019).

Continuous Water Quality Monitoring Network

TCEQ continuously monitors water quality parameters in different watersheds within Texas. The Pecos River has ten continuous water quality monitoring gaging stations along the length of the river that monitor water temperature, discharge, specific conductance, dissolved oxygen and pH 24 hours a day. These stations are funded by the TCEQ and are maintained, typically on a monthly basis, by the USGS. Current and historical instantaneous data is available for these stations, although the period of record and data availability varies by station. The data is transmitted via satellite and is available in "near real time." The data are received, processed and validated by staff before it is available to the public on the webpage. In an area where there is limited routine monitoring, these stations provide important water quality data and help establish and maintain a baseline for the area. If you would like to learn more about the CWQM network, please contact CRP staff or you can visit the TCEQ webpage at https://www.tceq.texas.gov/waterquality/monitoring/swqm_realtime.html.

Pictured: Setup of the CWQM station at Langtry by staff with the USGS.

Invasive Species and Biological Control

TPWD considers the Trans-Pecos region one of the most complex because of the diverse habitats and vegetation. The region includes mountains, desert valleys and plateaus, and ranges in elevation from 2,500 feet to more than 8,749 feet at Guadalupe Peak. There are two invasive species that are of concern in this area- saltcedar (*Tamarix spp.)* and giant cane or carrizo cane (*Arundo donax)*. Both are enormous water consumers, placing additional hardships on an area already struggling with low water availability, and both outcompete native vegetation, thereby reducing the local ecosystem's biodiversity. They also increase the risk for flooding due to their rapid, expansive growth into waterways.

Carrizo cane is native to Europe, Asia and Africa and was used for ornamental purposes and for fiber. It was brought to the Americas and other parts of the world for ornament and quickly established itself in the warmer climate areas. It is very invasive in riparian habitats, irrigation canals and drainage ditches. Along the Rio Grande, it also impedes access to the river and uses a substantial amount of water.

Saltcedar is a small shrub or tree that is originally from Europe, Africa and Asia. It was introduced in the early 1900's to reduce flooding and provide erosion control, as well as for ornamental purposes. It has very long roots and is able to tap into the water table at deeper levels. It is highly salt-tolerant, extracting salt from the soil, which collects in the leaves. When the leaves fall and decompose, the salt is released back into the soil, thereby increasing salt concentrations in soil levels, affecting and outcompeting the local plant life. This plant is also fire-adapted, and can bounce back after a fire much quicker than native plantlife. Saltcedar can spread rapidly and cover large amounts of land in a realtively short amount of time and has a negative effect on the local environment. Mechanical and chemical means have been used to try to eraduicate it or curb its spread, but these methods are exensive and can cause damage to native plants.

Recently, both plants have been the subject of studies aimed at reducing their spread through biological control. In 2009 and 2012, two different insects- the arundo wasp (*Tetramesa romana Walker)* and the arundo scale (*Rhizaspidiotus donacis (Leonardi))* were released in Texas and Mexico. These insects only feed on *Arundo donax.* The wasp lays eggs in the arundo cane side shoots, which results in the formation of abnormal plant growths that the larvae feed on. This damages the stems and shoots of the cane, which leads to the death of the stalk. As of 2016, the wasp was responsible for an average decrease by 32% of cane along the Rio Grande. The impact of the release of the arundo scale is still under investigation. Both of these biological controls are still active and are still being investigated, while a third, the arundo leaf miner, has been recently approved for study.

The saltcedar beetle released in the Rio Grande and Trans-Pecos region (subtropical tamarisk beetle, *Diorhabda sublineata)* is one of 4 species of beetles that feed only on saltcedar. It was released into these regions of Texas in 2009. Adult saltcedar beetles and larvae both feed on tender bark and saltcedar leaves; larvae do more damage. The larvae will eat the entire leaf or chew only on the surface tissue of the bark, which will cause the rest of the foliage to die. As the leaves are detroyed, the tree needs to use energy reserves from the extensive root system to regrow leaves, and the cycle repeats itself. Over time, this cycle depletes the plant's energy reserves and the plant starves to death. After five years in one particular area where the beetle was released, Big Springs, TX, it was estimated that the saltcedar canopy was reduced by 85-95 percent and about 20 percent of the trees were dead.

The subject of biological control has always been one of extreme caution- while we can expect a certain result or behavior, we can never be truly sure of what will happen once in the wild. In the case of salt cedar, there were concerns that once the beetle destroyed the salt cedar shrubs, they could turn to a closely related species of athal tree that is used for ornamental purposes in Mexico for survival. While some beetles did start to feed on the athal trees, they kept mainly to the salt cedar and moved on once that plant's foliage was depleted. Ultimately, in these two instances, this method proved much more safe and effective than mechanical or chemical means, although it does take more time to see full results. Research is still ongoing for both insects.

Invasive species and Biological Control

Pictured: Giant Cane (*Arundo donax*)

Pictured: Salt Cedar (*Tamarix spp.*)

Pictured: Arundo wasp, Tetramesa romana Walker

Pictured: subtropical tamarisk beetle, *Diorhabda sublineata*

Federally Listed, State Listed, and Candidate Species in Texas: Nongame and Rare Species Program, Texas Parks and Wildlife Department

The Pecos River Sub-Basin extends along the Rio Grande from Red Bluff Reservoir at the NM-TX state line and proceeds downstream until it empties into Amistad International Reservoir, running through Reeves, Loving, Pecos, Ward, Crane, Crockett, Terrell, and Val Verde counties. This stretch of the river basin is home to a variety of vertebrates, invertebrates, and plant species. Amongst the wildlife that occupy the basin are endangered and threatened species categorized by both state and federal agencies.

Table 17. Amphibians found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Valdina Farms sink-hole salamander	*Eurycea troglodytes*	Amphibian			Val Verde	Isolated, intermittent pools of sub-terranean streams and sinkholes in Nueces, Frio, Guadalupe, and Ped-ernales watersheds within Edwards Aquifer area.
Woodhouse's Toad	*Anaxyrus woodhousii*	Amphibian			Crane, Crockett, Loving, Pecos, Reeves, Terrell	Extremely catholic up to 5000 feet, does very well (except for traffic) in association with man.

Valdina Farms sinkhole salamander

Woodhouse's Toad

Table 18. Birds found in the Pecos River Sub- Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Reddish egret	*Egretta rufescens*	Bird	Near-Threatened	Threatened	Reeves	oak-juniper woodlands with distinctive patchy, two-layered aspect; shrub and tree layer with open, grassy spaces; requires foliage reaching to ground level for nesting cover; return to same territory, or one nearby, year after year; deciduous and broad-leaved shrubs and trees provide insects for feeding; species composition less important than presence of adequate broad-leaved shrubs, foliage to ground level, and required structure; nesting season March-late summer
White-faced ibis	*Plegadis chihi*	Bird	Threatened		Crane, Crockett, Loving, Pecos, Reeves, Terrell, Ward, Val Verde	Prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; currently confined to near-coastal rookeries in so-called hog-wallow prairies. Nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats.
Bald eagle	*Haliaeetus leucocephalus*	Bird			Crane, Crockett, Pecos, Terrell, Ward, Val Verde	Found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds
Common black-hawk	*Buteogallus anthracinus*	Bird	Threatened		Val Verde	Cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas
Zone-tailed hawk	*Buteo albonotatu*	Bird			Crockett, Pecos, Reeves, Terrell, Val Verde	Arid open country, including open deciduous or pine-oak woodland, mesa or mountain county, often near watercourses, and wooded canyons and tree-lined rivers along middle-slopes of desert mountains; nests in various habitats and sites, ranging from small trees in lower desert, giant cottonwoods in riparian areas, to mature conifers in high mountain regions
Gray Hawk	*Buteo plagiatus*	Bird			Val Verde	Locally and irregularly along U.S.-Mexico border; mature riparian woodlands and nearby semiarid mesquite and scrub grasslands; breeding range formerly extended north to southernmost Rio Grande floodplain of Texas
American peregrine falcon	*Falco peregrinus anatum*	Bird	Endangered		Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Table 18. Birds found in the Pecos River Sub- Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Mountain plover	*Charadrius montanus*	Bird	Threatened	Threatened	Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous
Interior least tern	*Sternula antillarum athalassos*	Bird	Endangered		Val Verde	Sand beaches, flats, bays, inlets, lagoons, islands. Subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	Bird		Threatened	Pecos, Reeves, Terrell	Status applies only to western population beyond the Pecos River Drainage; breeds in riparian habitat and associated drainages; springs, developed wells, and earthen ponds supporting mesic vegetation; deciduous woodlands with cottonwoods and willows; dense understory foliage is important for nest site selection; nests in willow, mesquite, cottonwood, and hackberry; forages in similar riparian woodlands; breeding season mid-May-late Sept.
Western burrowing owl	*Athene cunicularia hypugaea*	Bird	Threatened	Threatened	Crane, Crockett, Loving, Reeves, Terrell, Val Verde, Ward	Open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows
Tropical kingbird	*Tyrannus melancholicus*	Bird			Terrell	Habitat description is not available at this time.
Black-capped vireo	*Vireo atricapilla*	Bird	Threatened	Threatened	Crockett, Pecos, Terrell, Val Verde	Oak-juniper woodlands with distinctive patchy, two-layered aspect; shrub and tree layer with open, grassy spaces; requires foliage reaching to ground level for nesting cover; return to same territory, or one nearby, year after year; deciduous and broad-leaved shrubs and trees provide insects for feeding; species composition less important than presence of adequate broad-leaved shrubs, foliage to ground level, and required structure; nesting season March-late summer
Tropical parula	*Setophaga pitiayumi*	Bird			Val Verde	Semi-tropical evergreen woodland along rivers and resacas. Texas ebony, anacua and other trees with epiphytic plants hanging from them. Dense or open woods, undergrowth, brush, and trees along edges of rivers and resacas; breeding April to July.

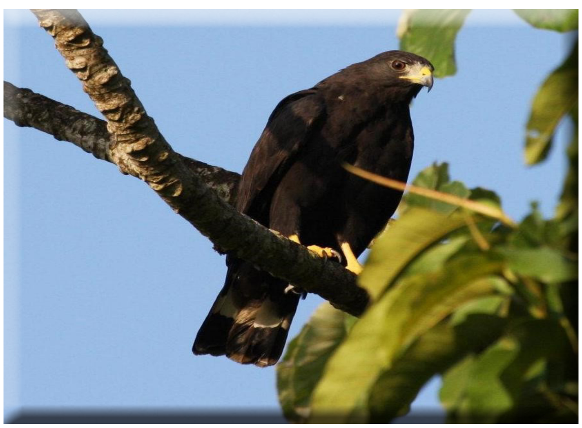
Reddish Egret

White-faced ibis

Bald Eagle

Common Black Hawk

Zone-tailed Hawk



Gray Hawk

Mountain Plover

Interior Least Tern

Western Yellow-Billed Cuckoo

Western Burrowing Owl

Tropical Kingbird

Black Capped Vireo

Tropical parula

Table 19. Fish found in the Pecos River Sub-Basin

Common Name	Scientific Name		State Status	Federal Status	County	Description
Rio Grande cut-throat trout	*Oncorhynchus clarkii virginalis*	Fish	Threatened	Threatened	Pecos	It is thought to have been originally present in at least Limpia and McKittrick creeks in Texas and possibly elsewhere in the Davis Mountains, but is not extirpated. Originally occupied a variety of fluvial habitats, ranging from first-order streams to the Rio Grande mainstem, now restricted to small headwater streams with gravelly substrates.
Devils River minnow	*Dionda diaboli*	Fish	Endangered	Endangered	Val Verde	Devils River, San Felipe and Sycamore creeks in Val Verde County; Las Moras (extirpated) and Pinto creeks in Kinney County. Restricted to clear, spring-fed waters having little temperature variation. Found over gravel-cobble substrate, usually associated with aquatic macrophytes.
Roundnose minnow	*Dionda episcopa*	Fish			Pecos, Reeves	Pecos River and Limpia Creek. Restricted to clear, spring-fed waters having little temperature variation.
Manantial roundnose minnow	*Dionda argentosa*	Fish			Crockett, Pecos, Terrell, Val Verde	Lower Pecos River, Devils River, San Felipe and Sycamore creeks. Val Verde County. Headwaters and runs of spring-influenced waters.
Texas shiner	*Notropis amabilis*	Fish			Crockett, Pecos, Terrell, Val Verde	In Texas, it is found primarily in Edwards Plateau streams from the San Gabriel River in the east to the Pecos River in the west. Typical habitat includes rocky or sandy runs, as well as pools.
Tamaulipas shiner	*Notropis braytoni*	Fish	Threatened		Crockett, Pecos, Terrell, Val Verde	Restricted to the Rio Grande basin in Texas including the lower Pecos River. Typically found in large rivers and creeks associated with a variety of flowng-water habitats such as runs and riffles over gravel, cobble, and sand.
Rio Grande Shiner	*Notropis jemezanus*	Fish	Petitioned	Petitioned	Crockett, Terrell, Val Verde	Rio Grande drainage. Occurs over substrate of rubble, gravel and sand, often overlain with silt
Longnose dace	*Rhinichthys cataractae*	Fish			Terrell, Val Verde	Can only be found in the Big Bend portion of the Rio Grande. Occasionally taken in lakes and clear pools of rivers but prefers clear, flowing water in gravelly riffles.
Proserpine shiner	*Cyprinella proserpina*	Fish	Threatened		Pecos, Terrell, Val Verde	Limited range includes Devils and lower Pecos rivers, Las Moras, Pinto, and San Felipe creeks, and Independence Creek in the Rio Grande watershed in western Texas. Associated with spring-fed tributaries and spring-runs. May be found in flowing pools, swift runs and riffles.
Speckled chub	*Macrhybopsis aestivalis*	Fish			Crockett, Pecos, Reeves, Terrell, Val Verde, Ward	Found throughout the Rio Grande and lower Pecos River but occurs most frequently between the Río Conchos confluence and the Pecos River. Flowing water over coarse sand and fine gravel substrates in streams; typically found in raceways and runs.

Table 19, continued, Fish found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Mexican redhorse	*Moxostoma austrinum*	Fish			Val Verde	Limited/uncertain distribution within the Rio Grande. Rocky runs and riffles of creeks and small to medium rivers; often near boulders in swift water.
Headwater catfish	*Ictalurus lupus*	Fish			Crockett, Pecos, Reeves, Terrell, Val Verde	Originally throughout streams of the Edwards Plateau and the Rio Grande basin, currently limited to Rio Grande drainage, including Pecos River basin; springs, and sandy and rocky riffles, runs, and pools of clear creeks and small rivers.
Chihuahua catfish	*Ictalurus sp. 1*	Fish			Terrell, Val Verde	Native to the Rio Grande and Davis Mountains in west Texas; it inhabits the middle to upper parts of moderate to large rivers and also occurs in small, headwater creeks and springs over gravel, rubble, rocks, boulders and mud substrates.
Leon Springs pupfish	*Cyprinodon bovinus*	Fish	Endangered	Endangered	Val Verde	Leon Creek, a tributary of the Pecos River (Pecos County); Diamond Y Spring. Natural spring-fed marshes, pools, and slow-flowing waters; usually near edges with minimal growth of vegetation.
Comanche Springs pupfish	*Cyprinodon elegans*	Fish	Endangered	Endangered	Pecos, Reeves	Restricted to small series of springs and their outflows, and man-made irrigation canals in the area of Balmorhea, Texas, including Phantom Springs (Jeff Davis County), San Solomon Springs, Giffin Springs and Toyah Creek (Reeves County). Native range: Comanche, Phantom Cave, San Solomon springs (Pecos and Reeves counties). Prefers fast-flowing water. Originally in Comanche Springs, San Solomon, and Phanton Cave, presently restricted to San Solomon and Phantom Cave and associated springs, and downstream irrigation canals; found in constantly discharging springs and in swift-flowing water of canals and earthen ditches
Conchos pupfish	*Cyprinodon eximius*	Fish	Threatened	Threatened	Val Verde	Devils River and Alamito Creek. The Devils River and Alamito Creek populations are morphologically and biochemically distinct from the Rio Conchos (Mexico) populations. Shallow water (<25 cm) on bedrock shelves and in coves, sloughs, and backwaters over soft bottoms, all where current is negligible and bottom generally devoid of aquatic macrophytes.
Pecos pupfish	*Cyprinodon pecosensis*	Fish	Threatened	Near Threatened	Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Originally Pecos River basin, presently restricted to upper basin only; shallow margins of clear, vegetated spring waters high in calcium carbonate, as well as in sinkhole habitats

Table 19. Fish found in the Pecos River Sub-Basin

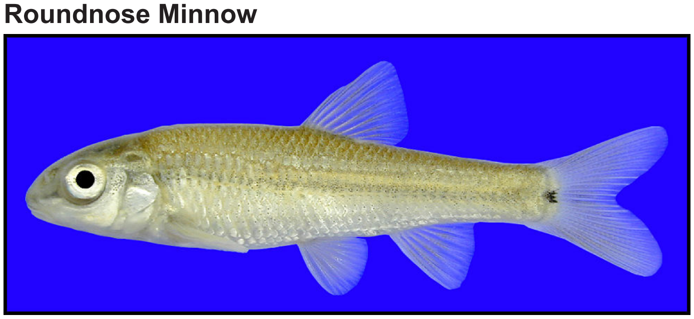
Common Name	Scientific Name	Group	State Status	Federal Status	County	Description
Pecos gambusia	*Gambusia nobilis*	Fish	Endangered	Endangered	Pecos, Reeves	Endemic to the Pecos River basin in southeastern New Mexico and western Texas. Restricted to two locations in Texas (Balmorhea springs complex and Diamond Y Draw). Stenothermal springs, runs, ciénegas and irrigation canals carrying spring waters.
Spotfin gambusia	*Gambusia krumholzi*	Fish	Threatened		Val Verde	Restricted to San Felipe and Sycamore creeks in Texas; also occurs in Mexico. Prefers densely vegetated, edge or quiet water habitats in close association with areas of swift flows.
Rio Grande darter	*Etheostoma grahami*	Fish	Threatened	Near Threatened	Crockett, Terrell, Val Verde	Essentially restricted to the mainstream and spring-fed tributaries of the Rio Grande and the lower Pecos River downstream to the Devils River and Dolan, San Felipe and Sycamore creeks. Gravel and rubble riffles

Rio Grande Cutthroat trout

Devils River Minnow

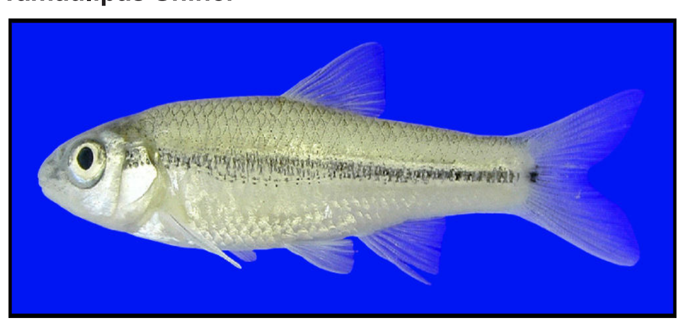
Manantial round-nose minnow

Roundnose Minnow

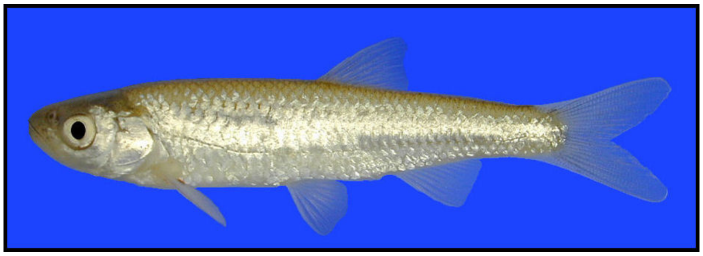


Texas Shiner

Tamaulipas Shiner

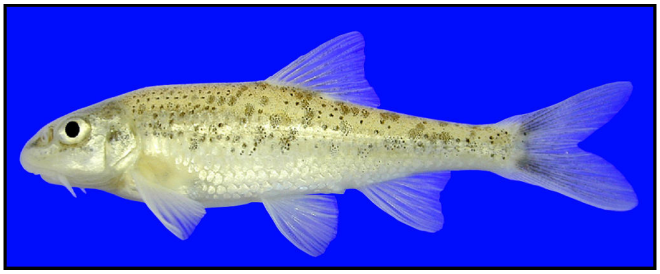


Rio Grande Shiner

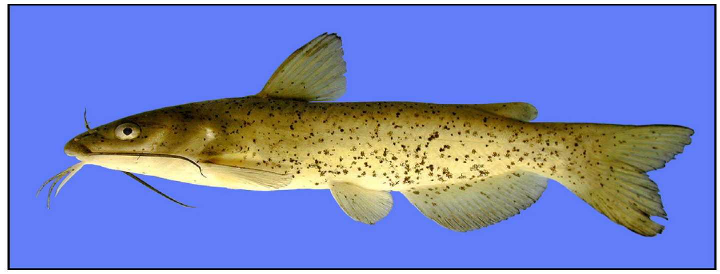


Longnose dace

Speckled Chub



Headwater Catfish



Proserpine Shiner

Devil's River Minnow

Leon Springs Pupfish

Comanche Springs Pupfish

Conchos Pupfish

Pecos Pupfish

Rio Grande Darter

Pecos Gambusia

Table 20. Mammals in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Mexican long-tongued bat	*Choeronycteris mexicana*	Mammal	Near Threatened		Crane	Only Texas record is from riparian forest; in general--neotropical nectivorous species roosting in caves, mines, and large crevices found in deep canyons along the Rio Grande ; also found in buildings and often associated with big-eared bats (Plecotus spp.); single TX record from Santa Ana NWR
Cave myotis bat	*Myotis velifer*	Mammal			Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val verde, Ward	Colonial and cave-dwelling; also roosts in rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (Hirundo pyrrhonota) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum cave of Panhandle during winter; opportunistic insectivore.
Western small-footed myotis bat	*Myotis ciliolabrum*	Mammal			Reeves	Mountainous regions of the Trans-Pecos, usually in wooded areas, also found in grassland and desert scrub habitats; roosts beneath slabs of rock, behind loose tree bark, and in buildings; maternity colonies often small and located in abandoned houses, barns, and other similar structures; apparently occurs in Texas only during spring and summer months; insectivorous
Tricolored bat	*Perimyotis subflavus*	Mammal			Crockett, Pecos, Terrell, Val Verde	Forest, woodland and riparian areas are important. Caves are very important to this species.
Big brown bat	*Eptesicus fuscus*	Mammal			Pecos, Reeves, Terrell	Any wooded areas or woodlands except south Texas. Riparian areas in west Texas.
Eastern red bat	*Lasiurus borealis*	Mammal			Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Found in a variety of habitats in Texas. Usually associated with wooded areas. Found in towns especially during migration.
Hoary bat	*Lasiurus cinereus*	Mammal			Crane, Crockett, Loving, Pecos, Reeves. Terrell, Val Verde, Ward	Known from montane and riparian woodland in Trans-Pecos, forests and woods in east and central Texas.
Western yellow bat	*Lasiurus xanthinus*	Mammal			Terrell, Val Verde	Forages over water both perennial and intermittent sources, found at low elevations (< 6,000 feet), roosts in vegetation (yucca, hackberry, sycamore, cypress, and especially palm); also hibernates in palm; locally common in residential areas landscaped with palms in Tuscon and Phoenix, Arizona; young born in June; insectivore
Townsend's big-eared bat	Corynorhinus townsendii	Mammal			Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Habitat description is not available at this time.
Mexican free-tailed bat	Tadarida brasiliensis	Mammal			Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Roosts in buildings in east Texas. Largest maternity roosts are in limestone caves on the Edwards Plateau. Found in all habitats, forest to desert.

Table 20 continued, Mammals in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Greater western mastiff bat	*Eumops perotis californicus*	Mammal			Crockett, Pecos, Terrell, Val Verde	Arid canyons; roosts in crevices in rock walls of desert canyons, old buildings, hollow trees; roost site must have clearance for a three meter fall by exiting bats; colony size varies from several individuals to several dozen; males and females may remain together throughout the year; single offspring (occasionally twins) born June-July.
Pocketed free-tailed bat	*Nyctinomops femorosaccu*	Mammal			Pecos, Terrell, Val Verde	Semiarid desert grasslands; roosts in caves cliff crevices under building roof tiles; feed on insects; females bear one pup per season Jul - Aug
Big free-tailed bat	*Nyctinomops macrotis*	Mammal			Crane, Crockett, Loving, Pecos, Reeves, Ward	Habitat data sparse but records indicate that species prefers to roost in crevices and cracks in high canyon walls, but will use buildings, as well; reproduction data sparse, gives birth to single offspring late June-early July; females gather in nursery colonies; winter habits undetermined, but may hibernate in the Trans-Pecos; opportunistic insectivore
Davis Mountains cottontail	*Sylvilagus robustus*	Mammal			Reeves	Brushy pastures, brushy edges of cultivated fields, and well-drained streamsides; active mostly at twilight and at night, where they may forage in a variety of habitats, including open pastures, meadows, or even lawns; rest during daytime in thickets or in underground burrows and small culverts; feed on grasses, forbs, twigs and bark; not sociable and seldom seen feeding together
Gray-footed chipmunk	*Tamias canipes*	Mammal			Reeves	High elevation (1800-2500 meters) forest-dwelling chipmunk occurring in dense stands of mixed timber and on brushy hillsides with rock crevices or downed logs along forest edges. Occurs in Texas only in the Sierra Diablo and Guadalupe Mountains in the Trans-Pecos; favorite habitat is downed logs near edges of clearings; also occur in dense stands of mixed timber (oaks, pines, firs) and on brushy hillsides, especially with rock crevices.
Black-tailed prairie dog	*Cynomys ludovicianus*	Mammal			Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Dry, flat, short grasslands with low, relatively sparse vegetation, including areas overgrazed by cattle; live in large family groups
Texas pocket gopher	*Geomys personatus fuscus*	Mammal			Val Verde	Underground burrows of deep, sandy soils; feed mostly on vegetation; reproductive data not well known, but likely breed year round, with no more than two litters per year

Table 20 continued, Mammals in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Rock mouse	*Peromyscus nasutus*	Mammal			Reeves	Rocky areas and talus slopes above 6000 feet. General vegetation associations include madrone, oak, maple, juniper, pinyon and ponderosa pine.
Pecos River muskrat	*Ondatra zibethicus ripensis*	Mammal			Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Creeks, rivers, lakes, drainage ditches, and canals; prefer shallow, fresh water with clumps of marshy vegetation, such as cattails, bulrushes, and sedges; live in dome-shaped lodges constructed of vegetation; diet is mainly vegetation; breed year round.
Swift fox	*Vulpes velox*	Mammal			Crane, Crockett, Pecos	Restricted to current and historic shortgrass prairie. Open deserts or grasslands; sparsely vegetated habitats; western and northern portions of Panhandle.
Kit fox	*Vulpes macrotis*	Mammal			Crane, Crockett, Loving, Reeves, Terrell, Val Verde, Ward	Open desert grassland; avoids rugged, rocky terrain and wooded areas.
Black Bear	*Ursus americanus*	Mammal	Threatened		Crane, Crockett, Pecos, Reeves, Terrell, Val verde, Ward	In Chisos, prefers higher elevations where pinyon-oaks predominate; also occasionally sighted in desert scrub of Trans-Pecos (Black Gap Wildlife Management Area) and Edwards Plateau in juniper-oak habitat. For ssp. luteolus, bottomland hardwoods, floodplain forests, upland hardwoods with mixed pine; marsh. Bottomland hardwoods and large tracts of inaccessible forested areas.
White-nosed coati	*Nasua narica*	Mammal	Threatened		Crockett, Terrell, Val Verde	Woodlands, riparian corridors and canyons.Most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade
Long-tailed weasel	*Mustela frenata*	Mammal			Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Includes brushlands, fence rows, upland woods and bottomland hardwoods, forest edges & rocky desert scrub. Usually live close to water.
American badger	*Taxidea taxus*	Mammal			Crane, Crockett, Loving, Pecos, Reeves,Terrell, Val Verde, Ward	Habitat description is not available at this time.
Western spotted skunk	*Spilogale gracilis*	Mammal			Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Habitat description is not available at this time.
Hooded skunk	*Mephitis macroura*	Mammal			Crane, Loving, Pecos, Reeves, Terrell, Ward	Rocky canyons & riparian corridors at low elevations, rarely to 6000 feet. Avoids man-made habitations.

Table 20 continued, Mammals in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Western hog-nosed skunk	*Conepatus leuconotus*	Mammal			Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Habitats include woodlands, grass-lands & deserts, to 7200 feet, most common in rugged, rocky canyon country; little is known about the habitat of the ssp. telmalestes.
Mountain lion	*Puma concolor*	Mammal			Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Rugged mountains & riparian zones.
Pronghorn	*Antilocapra americana*	Mammal			Crane, Crockett, Loving, Pecos, Reeves, Terrell, Ward	Restricted to current and historic shortgrass prairie. Open deserts or grasslands; sparsely vegetated habitats; western and northern portions of Panhandle.

Mountain Lion

Pronghorn

Mexican long-tongued bat

Big Brown Bat

Davis Mountain Cottontail

Black-tailed Prairie Dog

Rock Mouse

Swift Fox

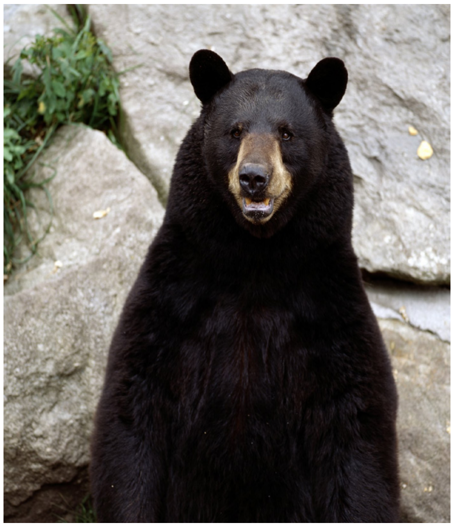
Gray-footed Chipmunk

Texas Pocket Gopher

Pecos River Muskrat

Kit Fox

Black Bear



White-nosed coati

Long-tailed weasel

American Badger

Western Spotted Skunk

Hooded Skunk

Table 21. Reptiles found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Rio Grande river cooter	*Pseudemys gorzugi*	Reptile			Crockett, Reeves, Terrell, Val Verde	Habitat description is not available at this time.
Western box turtle	*Terrapene ornata*	Reptile	Near Threatened		Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Ornate or western box trutles inhabit prairie grassland, pasture, fields, sandhills, and open woodland. They are essentially terrestrial but sometimes enter slow, shallow streams and creek pools. For shelter, they burrow into soil (e.g., under plants such as yucca) (Converse et al. 2002) or enter burrows made by other species; winter burrow depth was 0.5-1.8 meters in Wisconsin (Doroff and Keith 1990), 7-120 cm (average depth 54 cm) in Nebraska (Converse et al. 2002). Eggs are laid in nests dug in soft well-drained soil in open area (Legler 1960, Converse et al. 2002). Very partial to sandy soil.
Big Bend slider	*Trachemys gaigeae*	Reptile			Terrell	Almost exclusively aquatic, sliders (Trachemys spp.) prefer quiet bodies of fresh water with muddy bottoms and abundant aquatic vegetation, which is their main food source; will bask on logs, rocks or banks of water bodies; breeding March-July
Texas Tortoise	*Gopherus berlandieri*	Reptile	Threatened		Val Verde	Open brush with a grass understory is preferred; open grass and bare ground are avoided. Seasonally flooded tidal flats are not utilized. When inactive occupies shallow depressions at base of bush or cactus, sometimes in underground burrows or under objects; longevity greater than 50 years; active March-November; breeds April-November
Reticulate collared lizard	*Crotaphytus reticulatus*	Reptile	Threatened		Crockett, Val Verde	Requires open brush-grasslands; thorn-scrub vegetation, usually on well-drained rolling terrain of shallow gravel, caliche, or sandy soils; often on scattered flat rocks below escarpments or isolated rock outcrops among scattered clumps of prickly pear and mesquite
Spot-tailed earless lizard	*Holbrookia lacerata*	Reptile			Crockett, Val Verde, Ward	Central and southern Texas and adjacent Mexico; moderately open prairie-brushland; fairly flat areas free of vegetation or other obstructions, including disturbed areas; eats small invertebrates; eggs laid underground

Table 21. Reptiles found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Texas horned lizard	*Phrynosoma cornutum*	Reptile	Threatened		Crane, Crockett, Loving, Pecos, Reeves, Terrell, Val Verde, Ward	Occurs to 6000 feet, but largely limited below the pinyon-juniper zone on mountains in the Big Bend area. Open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September.
Dunes sagebrush lizard	*Sceloporus arenicolus*	Reptile			Crane, Ward	Confined to active sand dunes near Monahans; dwarf shin-oak sandhills with sagebrush and yucca; opportunistic insectivore; sit and wait predator; burrows in sand or plant litter to escape enemies
Gray-checkered whiptail	*Aspidoscelis dixoni*	Reptile			Pecos, Reeves	Habitat description is not available at this time.
Indigo snake	*Drymarchon melanurus*	Reptile	Threatened		Val Verde	Thornbush-chaparral woodland of south Texas, in particular dense riparian corridors.Can do well in suburban and irrigated croplands if not molested or indirectly poisoned. Requires moist microhabitats, such as rodent burrows, for shelter; Texas south of the Guadalupe River and Balcones Escarpment.
Texas indigo snake	*Drymarchon melanurus erebennus*	Reptile	Threatened		Val Verde	Thornbush-chaparral woodland of south Texas, in particular dense riparian corridors.Can do well in suburban and irrigated croplands if not molested or indirectly poisoned. Requires moist microhabitats, such as rodent burrows, for shelter; Texas south of the Guadalupe River and Balcones Escarpment.
Western hognose snake	*Heterodon nasicus*	Reptile			Crane, Crockett, Pecos, Reeves, Terrell, Val Verde, Ward	Habitat consists of areas with sandy or gravelly soils, including prairies, sandhills, wide valleys, river floodplains, bajadas, semiagricultural areas (but not intensively cultivated land), and margins of irrigation ditches (Degenhardt et al. 1996, Hammerson 1999, Werler and Dixon 2000, Stebbins 2003). Also thornscrub woodlands and chaparral thickets. Seems to prefer sandy and loamy soils, not necessarily flat. Periods of inactivity are spent burrowed in the soil or in existing burrows. Eggs are laid in nests a few inches below the ground surface (Platt 1969).

Table 21. continued, Reptiles found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Trans-Pecos black-headed snake	*Tantilla cucullata*	Reptile	Threatened		Pecos, Terrell, Val Verde	1300-5000 feet elevation. Small size with a uniform body color and a small, dark head; secretive; fossorial; mostly nocturnal; mesquite-creosote and pinyon-juniper-oak; eggs laid June-August; eat insects, spiders, and other invertebrates.
Western rattlesnake	*Crotalus viridis*	Reptile			Crane, Crockett, Loving, Pecos, Reeves, Terrell, Ward	Grassland, both desert and prairie; shrub desert rocky hillsides; edges of arid and semi-arid river breaks.
Massasauga	*Sistrurus tergeminus*	Reptile			Crane, Crockett, Pecos, Reeves, Ward	Quite common in gently rolling prairie occasionally broken by creek valley or rocky hillside

Rio Grande Cooter

Big Bend Slider

Reticulated Collared Lizard

Western Box Turtle

Texas Tortoise

Texas Horned Lizard

Spot-tailed Earless Lizard

Indigo Snake

Gray-checkered Whiptail

Western Rattlesnake

Texas Indigo Snake

Massasauga

Trans-Pecos Black-Headed Snake

Table 22. Mollusks found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
No accepted common name	*Holospira mesolia*	Mollusks			Pecos, Terrell	Habitat description is not available at this time.
Mexican Fawnsfoot	*Truncilla cognata*	Mollusks	Threatened		Terrell, Val Verde	Largely unknown; possibly intolerant of impoundment; possibly needs flowing streams and rivers with sand or gravel bottoms based on related species needs; Rio Grande basin.
Salina Mucket	*Potamilus metnecktayi*	Mollusks	Threatened		Terrell, Val Verde	Lotic waters; submerged soft sediment (clay and silt) along river bank; other habitat requirements are poorly understood; Rio Grande Basin.
Texas Hornshell	*Popenaias popeii*	Mollusks	Threatened	Threatened	Crane, Crockett, Pecos, Reeves, Terrell, Val Verde, Ward	Both ends of narrow shallow runs over bedrock, in areas where small-grained materials collect in crevices, along river banks, and at the base of boulders; not known from impoundments; Rio Grande Basin and several rivers in Mexico
Stockton Plateau threeband	*Humboldtiana texana*	Mollusks			Pecos, Terrell	Rocky hill country with short grasses and some dwarf oaks on the hills; elevation about 1200-1500 m (3900-5000 ft)
Phantom springsnail	*Pyrgulopsis texana*	Mollusks	Endangered	Endangered	Reeves	Endemic aquatic snail; known only from three spring systems and associated outflows in Jeff Davis and Reeves counties; vulnerable to reduction of springflow resulting from declining levels of groundwater
Caroline Springs pyrg	*Pyrgulopsis ignota*	Mollusks			Terrell	Habitat description is not available at this time.
Striated hydrobe	*Texapyrgus longleyi*	Mollusks			Val Verde	Habitat description is not available at this time.
Phantom tryonia	*Tryonia cheatumi*	Mollusks	Endangered	Endangered	Pecos, Reeves	Endemic aquatic snail; known only from three spring systems and associated outflows in Jeff Davis and Reeves counties; vulnerable to reduction of springflow resulting from declining levels of groundwater
Diamond Y springsnail	Pseudotryonia adamantina	Mollusks	Endangered	Endangered	Pecos	Endemic; aquatic snail only known from a spring system and associated outflows in Pecos County; mud substrates on the margins of small springs and seeps, and marshes in flowing water associated with sedges and cattails; presumed to be fine particle feeders of detritus and periphyton within substrate
Gonzales tryonia	*Tryonia circumstriata*	Mollusks	Endangered	Endangered	Pecos, Terrell	Endemic; aquatic snail only known from a spring system and associated outflows in Pecos County; mud substrates on the margins of small springs and seeps, and marshes in flowing water associated with sedges and cattails; presumed to be fine particle feeders of detritus and periphyton within substrate

Table 22. Continued, Mollusks found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Brune’s tryonia	*Tryonia brunei*	Mollusks			Reeves	Endemic freshwater snail; benthic; currently only found in modified waters Phantom Lake Spring; abundant on firm substratum and in soft mud before modification; vulnerable to declining groundwater resulting in reduction of springflow
No accepted common name	*Elimia comalensis*	Mollusks			Val Verde	Habitat description is not available at this time.
Pecos assiminea snail	*Assiminea pecos*	Mollusks	Endangered	Endangered	Pecos, Reeves	A member of the marine snail family, but represents the most inland snail of the genus; semi-aquatic, usually found on moist ground or beneath emergent plants within a few centimeters of flowing water; only known remaining Texas population at near Fort Stockton, Pecos County; historical to the Pecos River Valley of New Mexico and Texas
No accepted common name	*Phreatodrobia coronae*	Mollusks			Val Verde	Habitat description is not available at this time.

Mexican Fawnsfoot

Texas Hornshell

Salina Mucket

Phantom Springsnail

Table 23. Plants found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Warnock's water-willow	*Justicia warnockii*	Plant			Crockett, Pecos, Terrell	Occurs mostly on xeric limestone uplands and rock outcrops; Perennial; Flowering May-Dec; Fruiting June
Wright's water-willow	*Justicia wrightii*	Plant			Pecos, Terrell, Val Verde	Shortgrass grasslands and/or shrublands; dry gravelly clay soils over limestone on flats and low hills at elevations of 900-1500 m (2950-4900 ft); flowering April-August, or perhaps after periods of sufficient rainfall
Texas shrimp-plant	*Yeatesia platystegia*	Plant			Terrell, Val Verde	Occurs very sparingly in a variety of shrublands and canyon woodlands at widely scattered locations; Perennial; Flowering/Fruiting April-Dec
Hinckley's spreadwing	*Eurytaenia hinckleyi*	Plant			Crane, Reeves, Ward	Loose sandy soils of the Monahans/Kermit Sandhills; Annual; Flowering/Fruiting May-July
Tharp's bluestar	*Amsonia tharpii*	Plant			Pecos	Open areas in midgrass grasslands or shrublands in shallow clay soils over limestone; Bedrock at Pecos County site is mapped as Cretaeous limestone and marl of Washita Group; soils very shallow, well-drained calcareous moderately alkaline, light brownish-gray stony loam of Lozier-Rock outcrop, developed over fractured caliche-coated limestone; New Mexico site differs; Perennial; Flowering April-early May
Plateau milkvine	*Matelea edwardsensis*	Plant			Terrell	Occurs in various types of juniper-oak and oak-juniper woodlands; Perennial; Flowering March-Oct; Fruiting May-June
Arrowleaf milkvine	*Matelea sagittifolia*	Plant			Terrell, Val Verde	Most consistently encountered in thornscrub in South Texas; Perennial; Flowering March-July; Fruiting April-July and Dec?
Gravelbar brickellbush	*Brickellia dentata*	Plant			Val Verde	Essentially restricted to frequently-scoured gravelly alluvial beds in creek and river bottoms; Perennial; Flowering June-Nov; Fruiting June-Oct
Narrowleaf brickellbush	*Brickellia eupatorioides var. gracillima*	Plant			Val Verde	Moist to dry gravelly alluvial soils along riverbanks but also on limestone slopes; Perennial; Flowering/Fruiting April-Nov
Cliff thistle	*Cirsium turneri*	Plant			Terrell, Val Verde	Found mostly in fractures of vertical limestone cliff-faces in canyons along the Rio Grande; Perennial; Flowering April-Dec; Fruiting June-Oct
One-head encelia	*Encelia scaposa*	Plant			Terrell	Occurs on open gravelly clay flats; Perennial; Flowering/Fruiting March-Nov
Neglected sunflower	*Helianthus neglectus*	Plant			Reeves, Ward	Deep sands on rolling hills and dunes of Pleistocene sand sheets, often associated with Havards shin oak dwarf woodlands or mesquite-sand sage woodlands; flowering July-September
Pecos sunflower	*Helianthus paradoxus*	Plant	Threatended	Threatened	Pecos, Reeves	Restricted to saline, calcareous, heavy-textured soils around cienegas; usually most abundant on perennially wet soils of subirrigated terraces just above the wettest sites; flowering August-November

Table 23 continued, Plants found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Sticky tansy aster	*Machaeranthera viscida*	Plant			Loving, Ward	Occurs on calcareous or sandy soils in Chihuahuan Desert shrublands or mesquite grasslands.
Limestone rock-daisy	*Perityle aglossa*	Plant			Terrell	Crevices in limestone outcrops along the Rio Grande in Brewster and Terrell counties; Perennial; Flowering July-Dec; Fruiting Oct-Nov
Rayless rock-daisy	*Perityle angustifolia*	Plant			Crockett, Pecos,Terrell, Val Verde	Crevices of limestone bluffs and cliff-faces; Perennial; Flowering April-Oct; Fruiting April-Sept
Apressed two-bristle rock-daisy	*Perityle bisetosa var. appressa*	Plant			Terrell	Crevices in limestone exposures on bluffs and other rock outcrops; flowering May-September
Two-bristle rock-daisy	*Perityle bisetosa var. bisetosa*	Plant			Pecos, Terrell	Crevices in limestone exposures on bluffs and other rock outcrops; flowering late summer-fall
Grayleaf rock-daisy	*Perityle cinerea*	Plant			Crockett, Pecos, Reeves, Terrell, Ward	Crevices in dry limestone caprock of mesas; flowering spring-fall
Devils River rock-daisy	*Perityle lindheimeri var. halimifolia*	Plant			Crockett, Val Verde	Limestone cliff-faces in Val Verde County eastward to central Texas; Perennial; Flowering April-Sept; Fruiting June-Aug
Leafy rock-daisy	*Perityle rupestris var. rupestris*	Plant			Pecos	Igneous rock outcrops; Perennial; Flowering May-Nov; Fruiting June-Sept
Warnock's rock-daisy	*Perityle warnockii*	Plant			Val Verde	Crevices and solution pits in steep, dry, inaccessible limestone bluffs; flowering spring-fall
Cienega false clappia-bush	*Pseudoclappia arenaria*	Plant			Pecos, Reeves. Ward	Mostly in alkali sacaton (Sporobolus airoides) grasslands on alkaline, gypseous or saline soils of alluvial flats around cienegas, playa lakes and other desert wetlands; Perennial; Flowering spring-summer
Springrun whitehead	*Shinnersia rivularis*	Plant			Val Verde	In shallow, slow-moving water in small, usually spring-fed streams and rivers arising from calcareous outcrops; abandoned river channel fed by a strong perennial stream, rooted in fine-textured sediments, with stems entirely submerged and only the flowering branch tips appearing above water surface; in slowly flowing water up to 0.3-0.4 m deep but appeared to be absent from deeper water, shaded for most of the day; also in water 0.5-1 m deep, rooted in a mucky to gravelly bottom; flowering throughout the year, most reliably March-May
Shinner's brickellbush	*Flyriella parryi*	Plant			Terrell, Val Verde	Dry rocky limestone slopes; Perennial; Flowering/Fruiting April-June
McVaugh's bladderpod	*Physaria mcvaughiana*	Plant			Pecos	Grasslands on rocky limestone uplands at moderate elevations; Stream bed gravels, rocky limestone slopes and hills, canyon bottoms and slopes, limestone rubble, 1200-1600 m elevation; Perennial; Flowering/Fruiting March-Aug
Durango yellow-cress	*Rorippa ramosa*	Plant			Terrell	Moist, fine-textured, alluvial soils on floodplains and in beds of intermittent streams; flowering March-May

Table 23 continued, Plants found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Jones' selenia	*Selenia jonesii*	Plant			Crockett,	Wet clayey soils of stream margins, playa lakes, and roadsides, mostly in the western Edwards Plateau; Annual; Flowering Feb-April; Fruiting March-April
lyreleaf twist-flower	*Streptanthus carinatus ssp. carinatus*	Plant			Reeves	Occurs on igneous and limestone slopes and alluvial fans (Carr 2015).
Broadpod twist-flower	*Streptanthus platycarpus*	Plant			Crockett, Pecos, Terrell, Val Verde	Western Edwards Plateau and the Trans-Pecos, seemingly disjunct in Llano Uplift area, occurring sparingly in various habitats; Biennial Annual; Flowering/Fruiting March-June
Sparsely-flowered jewelflower	*Streptanthus sparsiflorus*	Plant			Crockett, Pecos, Terrell, Val Verde	Shaded areas in gravelly limestone canyons and arroyos, often in dry creek beds at elevations ranging 1,200-1,800 m (3,900-5,900 ft); flowering May-June; populations vary widely in size from year to year depending on rainfall
Bunched cory cactus	*Coryphantha ramillosa ssp. ramillosa*	Plant	Near Threatened	Endangered	Terrell	Rocky slopes, ledges, and flats in the Chihuahuan Desert, most frequently on exposures of Santa Elena or Buda limestones or the Boquillas Formation between 400-1070 m (1300-3500 ft) in elevation; flowering August-November, perhaps as early as April in response to rainfall.
Correll's green pitaya	*Echinocereus viridiflorus var. correllii*	Plant			Pecos	Among grasses on rock crevices on low hills in desert or semi-desert grassland on novaculite or limestone; flowering March-May
Texas claret-cup cactus	*Echinocereus coccineus var. paucispinus*	Plant			Crane, Crockett, Pecos, Reeves, Val Verde, Ward	Habitat description is not available at this time.
Tobusch fish-hook cactus	*Sclerocactus brevihamatus ssp. tobuschii*	Plant	Endangered	Threatened	Val Verde	Shallow, moderately alkaline, stony clay and clay loams over massive fractured limestone; usually on level to slightly sloping hilltops; occasionally on relatively level areas on steeper slopes, and in rocky flood-plains; usually open areas within a mosaic of oak-juniper woodlands, occasionally in pine-oak woodlands, rarely in cenizo shrub-lands or little bluestem grasslands; sites are usually open with only herbaceous cover, although the cactus may be somewhat protected by rocks, grasses, or spikemosses; flowering (late January-) February-March (rarely early April)
Desert night blooming cereus-	*Peniocereus greggii var. greggii*	Plant			Pecos, Reeves, Terrell	Chihuahuan Desert shrublands or shrub invaded grasslands in alluvial or gravelly soils at lower elevations, 1200-1500 m (3900-4900 ft), on slopes, benches, arroyos, flats, and washes; flowering synchronized over a few nights in early May to late June when almost all mature plants bloom, flowers last only one day and open just after dark, may flower as early as April
White column cactus	*Escobaria albicolumnari*	Plant			Pecos, Terrell	Creosote bush or lechuguilla canyon shrublands primarily on nearly level terrain to rolling hills on thin, gravelly soils or limestone bedrock of the Santa Elena, Glen Rose, Boquillas, and Telephone Canyon formations; at lower elevations 550-1370 m (1800-5000 ft) in the Chihuahuan Desert; flowering early March-May

Table 23 continued, Plants found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Dense cory cactus	*Escobaria dasyacantha var. dasyacantha*	Plant			Pecos	Lechuguilla-sotol or creosote bush shrublands, grasslands, and oak-juniper woodlands on gravelly, rocky, and/or loamy soils over igneous or limestone substrates at moderate elevations 750-1800 m (2450-5900 ft) in the Chihuahuan Desert; flowering March-May (-July), fruiting (May-) June-August
Hester's cory cactus	*Escobaria hesteri*	Plant			Pecos, Terrell	Grasslands on novaculite hills or limestone hills and alluvial fans, also in pine-oak-juniper woodlands on igneous substrates; flowering April-early June (-November), also during growing season possibly in response to significant rainfall; fruiting June-August (-January)
Creeping petrogenia	*Bonamia repens*	Plant			Terrell, Val Verde	Occurs mostly in open xeric habitats on limestone (Carr 2015).
Texas greasebush	*Glossopetalon texense*	Plant			Val Verde	Dry limestone ledges, chalk bluffs, and limestone outcrops; one population is on an extremely steep slope, inaccessible to most herbivores; flowering period uncertain, including at least June-December
Tree dodder	*Cuscuta exaltata*	Plant			Val Verde	Parasitic on various Quercus, Juglans, Rhus, Vitis, Ulmus, and Diospyros species as well as Acacia berlandieri and other woody plants; Annual; Flowering May-Oct; Fruiting July-Oct
Alkali spurge	*Euphorbia astyla*	Plant			Pecos	In Pecos County, locally frequent in nearly bare areas within alkali sacaton (Sporobolus airoides) grasslands on alkaline and/or saline silt loam on alluvial flats along a spring-fed desert stream; in Mexico, on windblown gypsum deposits and gypsum flats, Coahuila locally abundant; flowering and fruiting at least March-June and August-September, probably throughout the growing season depending on rainfall
Dwarf broom-spurge	*Euphorbia jejuna*	Plant			Pecos, Terrell, Val Verde	According to specimen collections, found on grama-grass prairie on caliche uplands, also dry caliche slopes, and limestone hills; flowering late March through July
Tall plains spurge	*Euphorbia strictior*	Plant			Crockett	Occurs in shortgrass grasslands on dry rocky or, more commonly, deep sandy sites; Perennial; Flowering/Fruiting June-Sept
Heather leaf-flower	*Phyllanthus ericoides*	Plant			Terrell	Crevices in limestone on dry canyon walls and other rock outcrops; flowering October, and presumably in other months, given sufficient moisture
Gyp locoweed	*Astragalus gypsodes*	Plant			Reeves	Gypsum or stiff gypseous clay soils on low rolling hills, mostly low elevations in the middle Pecos River valley; many of the known locations are on the Castile Formation (Permian); flowering March-June

Table 23 continued, Plants found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Cory's woolly locoweed	*Astragalus mollissimus var. coryi*	Plant			Crockett	Grasslands over limestone on the western Edwards Plateau; Perennial; Flowering March-May
Waterfall's milkvetch	*Astragalus waterfallii*	Plant			Crockett, Terrell	Rocky limestone slopes; Perennial; Flowering Feb-May; Fruiting April- May
Wright's milkvetch	*Astragalus wrightii*	Plant			Val Verde	Habitat description is not available at this time.
Anacacho orchid tree	*Bauhinia lunarioides*	Plant			Val Verde	Shrublands in draws on rocky limestone slopes and on limestone ledges along rivers; Perennial; Flowering March-Dec; Fruiting May-Oct
Broadpod rushpea	*Pomaria brachycarpa*	Plant			Crockett	Grasslands, live oak savannas, and open mesquite woodlands on shallow, stony, clay soils over limestone; most specimens are from ungrazed roadsides, often in shallowest soils on landscape where competition from taller perennial grasses is minimal; flowering April-July, possibly also in November
Cox's dalea	*Dalea bartonii*	Plant			Pecos, Terrell	Semi-desert shortgrass grasslands with scattered pinyon pine and juniper in gravelly soils on limestone hills; probably flowering in late spring, fruiting in late summer-early fall, may flower in response to rainfall
Sabinal prairie clover	*Dalea sabinalis*	Plant			Val Verde	Information sketchy, but probably in rocky soils or on limestone outcrops in sparse grassland openings in juniper-oak woodlands; flowering April-May or May -June
Orcutt's senna	*Senna orcuttii*	Plant			Pecos, Terrell	Gravelly or rocky soil on limestone slopes and in beds of intermittent streams, within various mid- to lower elevation Chihuahuan Desert communities; at least one site is on east- to north-facing slopes; flowering July-August
Rydberg's scurfpea	*Pediomelum humile*	Plant			Val Verde	Shortgrass grasslands or cenizo-guajillo shrublands on shallow, stony to gravelly clay soils on dry, open limestone or yellowish, eroding caliche hills; flowering March-May, however, plants often do not appear above the ground surface if there is not sufficient precipitation, flowering and fruit maturation are also dependent on rainfall
Correll's false dragon-head	*Physostegia correllii*	Plant			Val Verde	Wet, silty clay loams on streamsides, in creek beds, irrigation channels and roadside drainage ditches; or seepy, mucky, sometimes gravelly soils along riverbanks or small islands in the Rio Grande; or underlain by Austin Chalk limestone along gently flowing spring-fed creek in central Texas; flowering May-September
Plateau loosestrife	Lythrum ovalifolium	Plant			Terrell, Val Verde	Banks and gravelly beds of perennial (or strong intermittent) streams on the Edwards Plateau, Llano Uplift and Lampasas Cutplain; Perennial; Flowering/Fruiting April-Nov

Table 23 continued, Plants found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Longstalk heimia	*Nesaea longipes*	Plant			Pecos, Val Verde	Moist or subirrigated alkaline or gypsiferous clayey soils along unshaded margins of cienegas and other wetlands; occurs sparingly on an alkaline, somewhat saline silt loam on terraces of spring-fed streams in grassland; also occurs common in moderately alkaline clay along perennial stream and in subirrigated wetlands atop poorly-defined spring system; also occurs in low, wetland area along highway right-of-way; flowering May-September
Havard trumpets	*Acleisanthes acutifolia*	Plant			Pecos	In xeric limestone or gypseous habitats; Perennial; Flowering July-Sept
Texas trumpets	*Acleisanthes crassifolia*	Plant			Val Verde	Shallow, well-drained, calcareous, gravelly loams over caliche on gentle to moderate slopes, often in sparsely vegetated openings in cenizo (Leucophyllum frutescens) shrublands; known populations occur on Austin Chalk (Cretaceous) or Uvalde Gravel (Pleistocene); Perennial; Flowering March-November; Fruiting April-December
Wright's trumpets	*Acleisanthes wrightii*	Plant			Pecos, Reeves, Terrell, Val Verde	Open semi-desert grasslands and shrublands on shallow stony soils over limestone on low hills and flats; Perennial; Flowering spring-fall, probably also in response to rains
Dune unicorn-plant	*Proboscidea sabulosa*	Plant			Crane, Loving, Ward	Deep, dry to seasonally moist loose sands on sparsely vegetated, unstabilized dunes and in openings in shinneries; in New Mexico, one location found as a secondary successional species in fallow fields; does not germinate in years with inadequate summer rainfall, but may be locally abundant during unusually wet summers; flowering July-August, with fruits maturing in fall
Maravillas milkwort	*Polygala maravillasens*	Plant			Terrell	Crevices of limestone exposed on canyons walls, along the Rio Grande and its tributaries, and in low desert mountains at 450-950 m (1,450-3,100 ft) elevation; appears restricted to the area of the Lower Canyons of the Rio Grande and lower Boquillas Canyon on both sides of the border; flowering May-October
Palmer's milkwort	*Polygala palmeri*	Plant			Val Verde	Limestone slopes; Perennial; Flowering April-July; Fruiting June-Oct
Irion County wild-buckwhea	*Eriogonum nealleyi*	Plant			Pecos	Grasslands and shallow stony soils over limestone and indurated caliche, often collected from ungrazed but sparsely vegetated roadsides, particularly where limestone or caliche is exposed on hilltops; flowering June-September
Bushy wild-buckwheat	*Eriogonum suffruticosum*	Plant			Pecos	Sparsely vegetated rocky limestone slopes, low hills, and clay flats; also on gypseous soils; flowering March-April, in full fruit by May
Turner's hawthorn	*Crataegus turnerorum*	Plant			Crockett, Val Verde	Brush, dwarf oak scrub, stream banks, 300-600 m elevation; Perennial; Flowering April-June; Fruiting April-Sept

Table 23 continued, Plants found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Havard plum	*Prunus havardii*	Plant			Crockett	Local in limestone canyons, on igneous talus slopes and novaculite outcrops; Perennial; Flowering March-July; Fruiting June-Oct
Texas almond	*Prunus minutiflora*	Plant			Val Verde	Wide-ranging but scarce, in a variety of grassland and shrubland situations, mostly on calcareous soils underlain by limestone but occasionally in sandier neutral soils underlain by granite; Perennial; Flowering Feb-May and Oct; Fruiting Feb-Sept
Leoncita false foxglove	*Agalinis calycina*	Plant			Val Verde	Dry, steep or vertical limestone cliff faces of various exposures in Chihuahuan Desert along Rio Grande, Pecos River, and their tributaries, at elevations of 350-500 m (1150-1650 ft), resembles cliff swallow nests that are also found on limestone cliffs; flowering April-November, fruiting May-December
Heller's beard-tongue	*Penstemon triflorus ssp. integrifolius*	Plant			Crockett, Val Verde	Occurs sparingly on rock outcrops and in grasslands associated with juniper-oak woodlands (Carr 2015).
Wright's beard-tongue	*Penstemon wrightii*	Plant			Reeves	Occurs mostly in montane grasslands and woodlands; Perennial; Flowering April-Aug; Fruiting May-Aug
Texas seymeria	*Seymeria texana*	Plant			Val Verde	Found primarily in grassy openings in juniper-oak woodlands on dry rocky slopes but sometimes on rock outcrops in shaded canyons; Annual; Flowering May-Nov; Fruiting July-Nov
Texas snowbells	*Styrax platanifolius ssp. texanus*	Plant	Endangered	Endangered	Val Verde	Limestone bluffs, boulder slopes, cliff faces, and gravelly streambeds, usually along perennial streams or intermittent drainages in canyon bottoms, in full sun or in partial shade of cliffs and/or Sycamore-Little walnut woodlands, oak-juniper woodlands, or mixed oak shrublands; flowering late March-April
Rock grape	*Vitis rupestris*	Plant			Val Verde	Occurs on rocky limestone slopes and in streambeds; Perennial; Flowering March-May; Fruiting May-July
Perennial caltrop	*Kallstroemia perennans*	Plant			Val Verde	Somewhat barren gypseous clays or limestone soils at low elevations in the Chihuahuan Desert; flowering late spring-early fall
Cory's ephedra	*Ephedra coryi*	Plant			Loving, Ward	Dune areas and dry grasslands in the southern Plains Country; Perennial; Flowering April-Sept; Fruiting May-Sept
Chisos agave	*Agave glomeruliflora*	Plant			Pecos	Gravelly or rocky soils in oak-juniper woodlands and mesquite-creosote bush-invaded grasslands at elevations of about 600-1800 m (1950-5900 ft); Perennial; Flowering mid-spring to early fall

Table 23 continued, Plants found in the Pecos River Sub-Basin

Common Name	Scientific Name	Group	State Status	Federal Status	County	Habitat & Phenology
Mexican hesper-aloe	*Hesperaloe funifera*	Plant			Val Verde	Occurs in the Devils River watershed along dry rocky limestone slopes (Carr 2015).
Red yucca	*Hesperaloe parviflora*	Plant			Val Verde	Shrublands on dry limestone slopes; Perennial; Flowering April-May; Fruiting May-June
Dune umbrel-la-sedge	*Cyperus onerosus*	Plant			Loving, Ward	Moist to wet sand in swales and other depressions among active or partially stabilized sand dunes; flowering/fruiting late summer-fall
Warnock's coral-root	*Hexalectris warnockii*	Plant			Terrell	In leaf litter and humus in oak-juniper woodlands on shaded slopes and intermittent, rocky creekbeds in canyons; in the Trans Pecos in oak-pinyon-juniper woodlands in higher mesic canyons (to 2000 m [6550 ft]), primarily on igneous substrates; in Terrell County under Quercus fusiformis mottes on terrraces of spring-fed perennial streams, draining an otherwise rather xeric limestone landscape; on the Callahan Divide (Taylor County), the White Rock Escarpment (Dallas County), and the Edwards Plateau in oak-juniper woodlands on limestone slopes; in Gillespie County on igneous substrates of the Llano Uplift; flowering June-September; individual plants do not usually bloom in successive years
Bigelow's desert grass	*Blepharidachne bigelovii*	Plant			Loving, Pecos, Reeves, Terrell	Restricted to xeric limestone or various gypsum-influenced habitats; Perennial; Flowering March-Dec; Fruiting March-Dec
Mexican mud-plantain	*Heteranthera mexicana*	Plant			Val Verde	Wet clayey soils of resacas and ephemeral wetlands in South Texas and along margins of playas in the Panhandle; flowering June-December, only after sufficient rainfall

Pecos Sunflower

Bunched Cory Cactus

Tobusch Fishhook Cactus

Correll’s Green Pitaya

Texas Snowbells

Texas Seymeria

Texas Almond

Texas Trumpets

CRP Website and References

Watershed Characterization Report

One goal of the USIBWC CRP is to ensure that the public and stakeholders are informed of the water quality related activities occurring in the basin. The intent of the basin reports is to disseminate that information and also demonstrate the effective use of program data. The Watershed Characterization Report is an in-depth look at a river basin. The next basin report from the USIBWC CRP (May 2021) will be in similar format highlighting the Upper Rio Grande Basin. We invite partners, stakeholders and members of the public to submit small summaries of projects occurring in the basin. We seek people/issues/projects that should be highlighted that we could include in these reports, or any other issues pertinent to our river basin. We ask the public to submit pictures of the river, recreational activities, natural scenery and wildlife. Submissions can be made to CRP staff via email no later than by end of November 2020 for inclusion in the 2021 report. Please contact staff with any questions.

The USIBWC CRP maintains a website with a wealth of information for the public:

- **About CRP:** An introduction to the Rio Grande Basin
- **Contact Information:** Contacts for the USIBWC CRP and program information
- **Study Area:** Contains maps of the Rio Grande Basin and of the monitoring locations
- **Monitoring Station Data:** USIBWC CRP and TCEQ water quality data in Excel files by station; information about quality assurance, parameters, and standards.
- **Other Information:** A calendar provides information on upcoming meetings and activities. There are links to studies and publications about the Rio Grande Watershed and the USIBWC Adopt-a-River program. Partner links provide resources for monitoring partners, links to other planning agencies, and links to environmental groups and resources for the Rio Grande.
- **Media Gallery:** Photo albums and videos about monitoring, research, geography, wildlife, and outreach. Our video gallery now includes a number of videos, the most recent being about water quality in the Rio Grande.

Additional Resources and Links:

TSWQS: https://www.tceq.texas.gov/waterquality/standards/2014standards.html

SWQM: http://www.tceq.texas.gov/waterquality/monitoring

2018 Texas Integrated Report: https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/18txir/2018_303d.pdf

Coordinated Monitoring Schedule: http://cms.lcra.org/

EPA Recreational WQ Criteria: http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/

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