Mapping Available Habitat of the Endangered Rio Grande Silvery Minnow (*Hybognathus amarus*) at Different River Flows in the Big Bend Reach of the Rio Grande

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U.S. Geological Survey

Overview

- Background on USFWS's Rio Grande silvery minnow introduction effort in the Big Bend reach.
- Biology of the species.
- Approach to river mapping, habitat characterization, and fish assemblage surveys at the *mesohabitat* scale.
- Plans going forward.

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Project Support

Funding

USGS Science Support Partnership with U.S. Fish and Wildlife Service (USFWS)

Middle Rio Grande Endangered Species Collaborative Program (administered by Bureau of Reclamation)

USGS

Project Support

Others Involved

- Aimee Roberson, Project Lead, USFWS, Alpine, TX

- Jason Remshardt and staff, USFWS, Albuquerque, NM

- Rio Grande Silvery Minnow Technical Advisory Team

- Big Bend National Park

- USGS Texas Water Science Center (TWSC) staff including Erin Sewell, Daniel Pearson, Chris Braun, John Rosendale, Alec MacDonald, Monica Langhorst, and Justin McInnis

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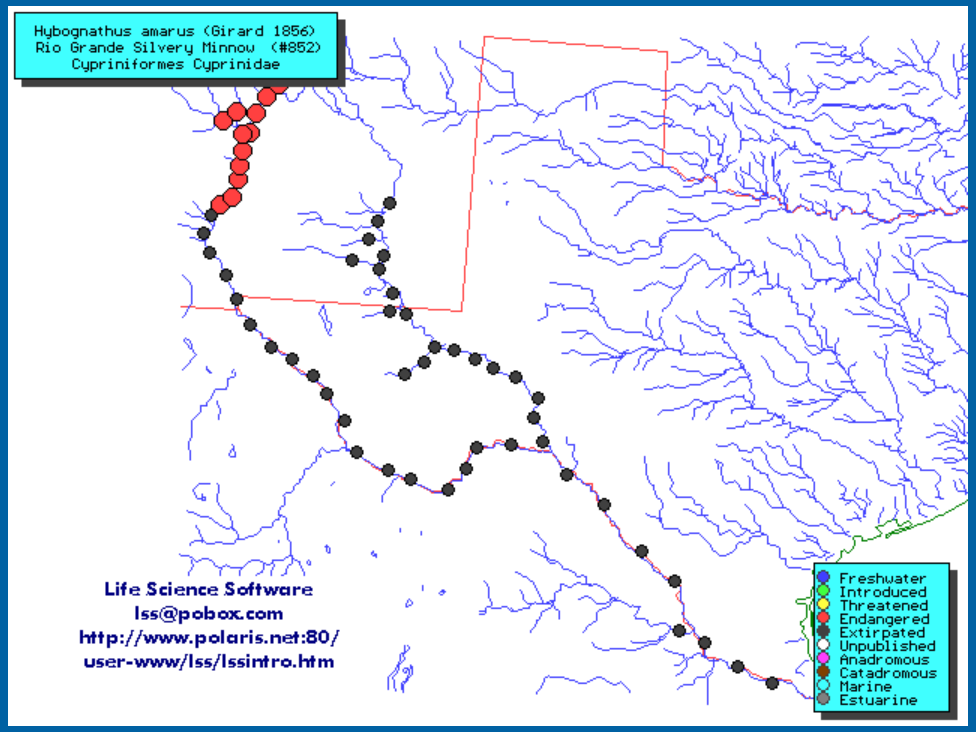
Introduction of the Rio Grande silvery minnow in the Big Bend Reach of the Rio Grande



Current and historical distribution of the Rio Grande silvery minnow.

- Listed as federally endangered in 1994 and critical habitat designated in 2003.

- Occurrence limited to 280 km reach of Rio Grande in New Mexico and small section of Jemez River (5 – 7 percent of former range!).

- Historical distribution included the Rio Grande downstream to almost the Gulf of Mexico and the Pecos in New Mexico and Texas.

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Introduction of the Rio Grande silvery minnow in the Big Bend Reach of the Rio Grande, cont. …

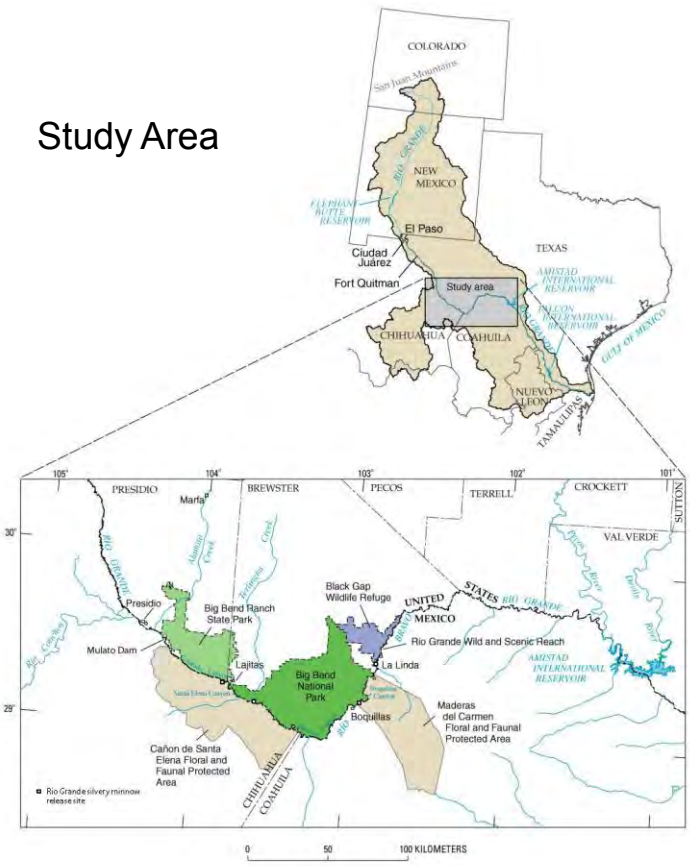


Figure 1. Study area including the Big Bend reach where the reintroduction of Rio Grande silvery minnow will take place.

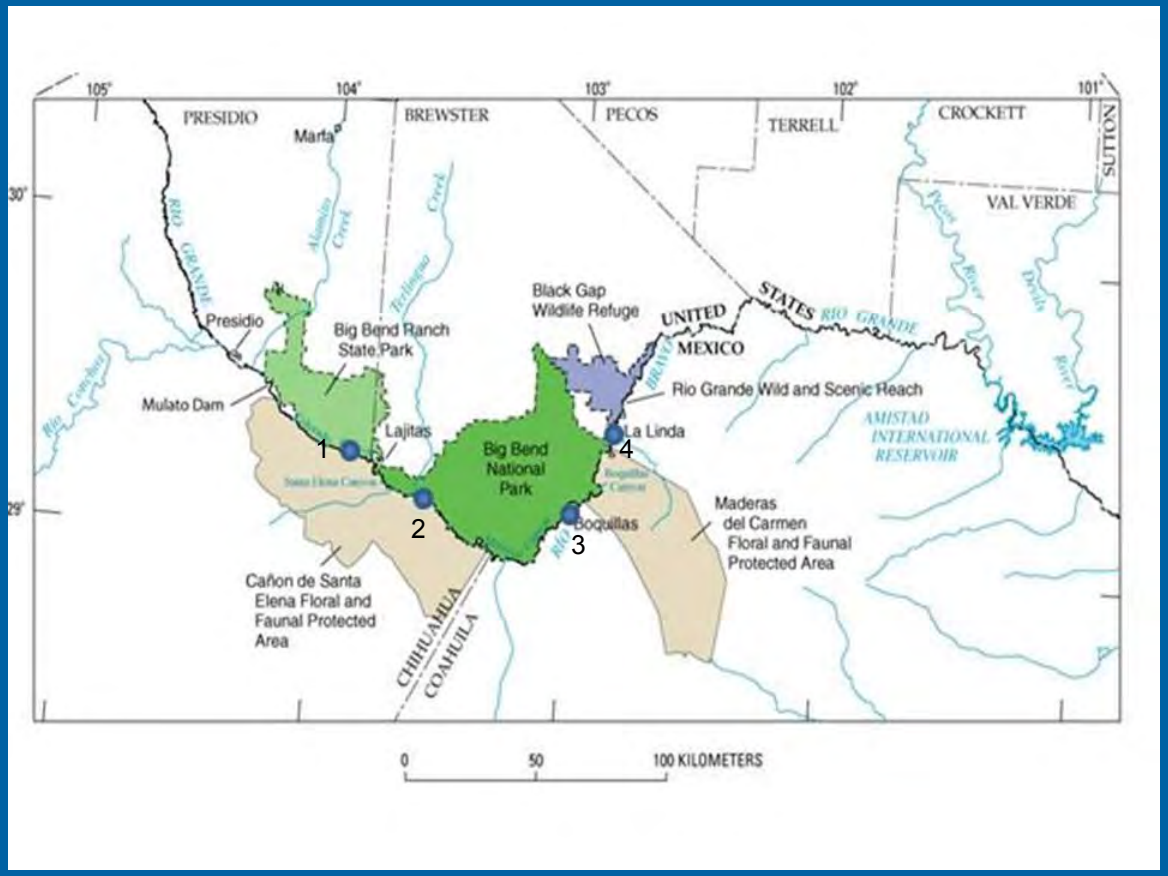
- In December 2008, silvery minnows were introduced in the Rio Grande as a nonessential, experimental population under section 10(j) of the Endangered Species Act.

-Goals of this nonessential introduction include:

1. Self-sustaining population of 500K for a minimum of 5 yrs without augmentation (continued stocking).

2. Population must consist of at least two age age classes.

Introduction of the Rio Grande Silvery Minnow in the Big Bend Reach of the Rio Grande, cont. …



Rio Grande silvery minnow release sites

- Big Bend reach extends from Mulato Dam downstream to the IBWC gaging station just below the Terrell/Val Verde County line.

-Four release sites
  - Rio Grande at Contrabando Ck (1).
  - Rio Grande at Terlingua Ck in Big Bend NP (2).
  - Rio Grande at Rio Grande Village in Big Bend NP (3)
  - Rio Grande at Stillwell Crossing near La Linda (4)

-1.43 million minnows released to date with 3 releases (2008,-09, and -10) completed and 2 releases to go (2011 and 2012).

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Introduction of the Rio Grande Silvery Minnow in the Big Bend Reach of the Rio Grande, cont. …

Transferring minnows from a tank truck to holding nets in Rio Grande.

Goals of this experimental introduction of the Rio Grande silvery minnow in the Big Bend reach.

1. Self-sustaining population of 500K minnows.
2. Augmentation (stocking) not required.
3. Population consists of at least two age classes.

Overall goals of the Rio Grande Silvery Minnow Recovery Plan

1. Change status from federally endangered to threatened (downlisting)

2. Remove the minnow from federal listing (delisting)

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Biology of *Hybognathus amarus*

Member of the Family Cyprinidae
(largest family of freshwater fishes)

- One of seven species in the genus *Hybognathus sp.*

- Adults reach about 125 mm in total length, and are heavy-bodied with relatively small eyes.

- Display little to no sexual dimorphism.

- Adults are greenish-yellow dorsally and light cream to white ventrally.

USGS

Biology of *Hybognathus amarus*

One of several silvery minnow eggs collected in spring of 2010.

- Pelagic spawners producing large numbers of semi-buoyant eggs.

- Prefer low-velocity habitat with sandy or silty substrates.

- Preferred habitats including side channels, backwaters, and oxbows associated with a meandering channel.

- Algal feeders (“graze” on periphyton)

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Overall Project Objectives

- Determine the area of inundation and physical characteristics of riverine habitats over a range of flows that are important for various life stages of the Rio Grande silvery minnow.

- Characterize the fish assemblage in the riverine habitats and determine how the assemblage varies in composition and distribution between low to within-bank river flows.

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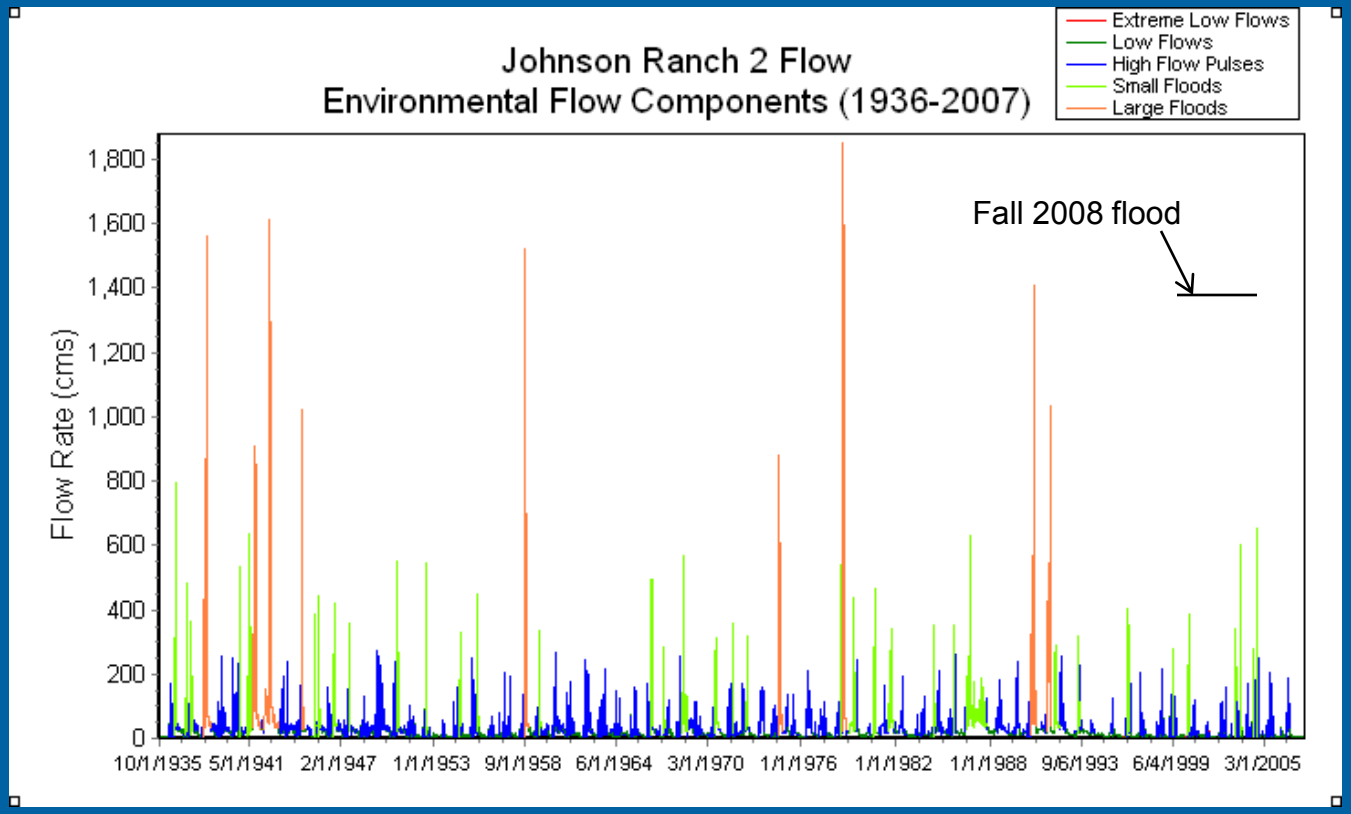
Approach

Selecting River Flows for Mapping



- Flow components of hydrograph of daily mean discharge for 60 years of record from gaging station that is mid reach in Big Bend National Park and the Big Bend reach.
- Output from Index of Hydrologic Alteration (IHA) software (The Nature Conservancy)

USGS

Approach

Selecting River Flows for Mapping, cont. …

- Winter to spring low-flow target = 200 – 400 cfs
- With-bank high pulse = 1500 – 3000 cfs
- Overbank flooding flow = using fall 2008 event

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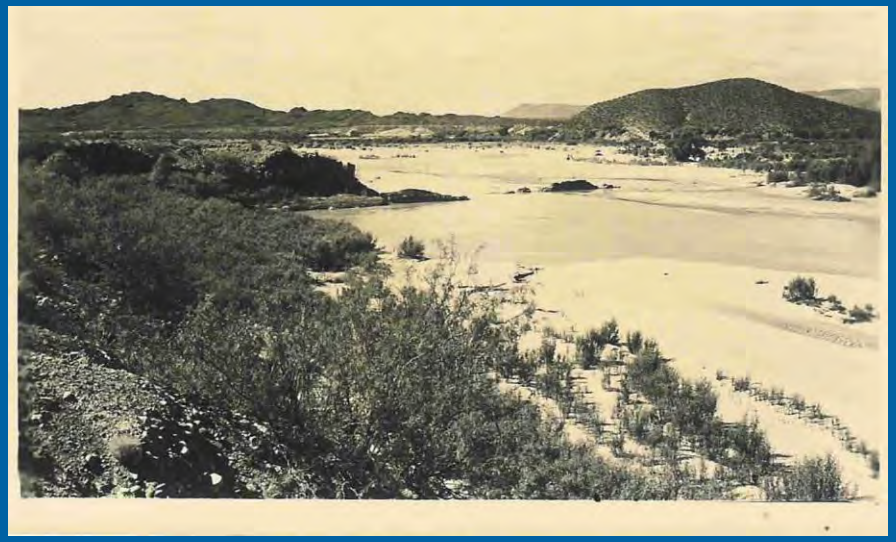
Historical Changes to the Rio Grande in the Big Bend Reach

Near Black Dike in Big Bend NP



1937

Drivers

-Altered flows and sediment transport.

-Invasives such as salt cedar and exotic rive cane.

-

2007

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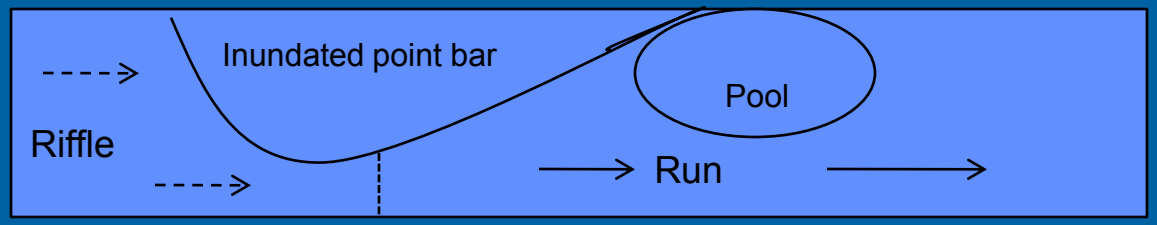
Approach

Mesohabitats

Mesohabitat Scheme = Classification of hydro-morphological units biased towards including more backwater and slack-water habitats important for *H. amarus* and similar species.



Examples of Mesohabitats used in this study:
backwater, (forewater), glide, embayment, rapid, riffle, run, pool, isolated pool, channel bar, and point bar.

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GIS to the Rescue: Saving the Rio Grande Silvery Minnow

1) Identify flows including a seasonal (base) low flow, a within bank high-pulse flow, and an over-bank flow that are important to support various life stages of the minnow
2) Determine the area of inundation and physical characteristics of these habitats over the range of proposed flows
3) Characterize the fish assemblage by mesohabitat type at the low flow and within-bank high-pulse flows

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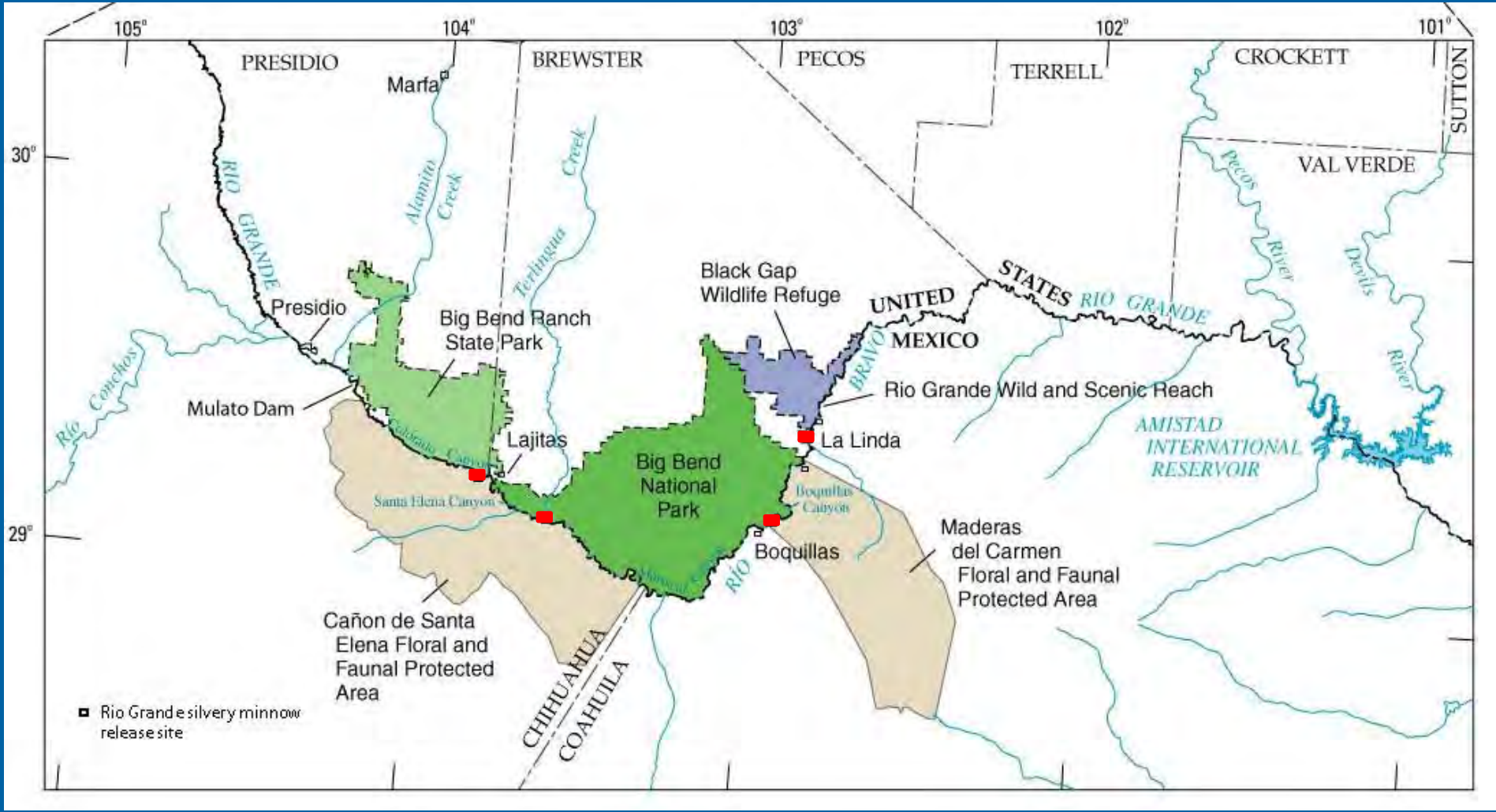
Study Area



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Methods

- Map and characterize instream habitat (mesohabitat-scale approach)
  - low-flow (200cfs)
  - high-pulse flows (1500-3000cfs)
- Create a detailed reach map at each targeted flows using high-performance GPS receiver in conjunction with high-resolution remotely sensed imagery

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Methods cont'd

- Water's edge on both banks was mapped first creating a boundary for each site
- Next, each mesohabitat was mapped by delineating its perimeter with the GPS receiver mounted in a boat or in a backpack by wading
- Each mesohabitat (e.g., rapid, riffle, run, pool, glide, embayment, backwater) edited and stored on a field laptop as geo-referenced polygons using ArcGIS

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Materials

- Trimble® DSM™ 232 modular GPS receiver
  - Omnistar Subcription - offers GPS correction services that improves the accuracy of a GPS receiver, allows sub-foot realtime positioning
- Panasonic Toughbook CF-19
- Hi Capacity External Laptop Battery

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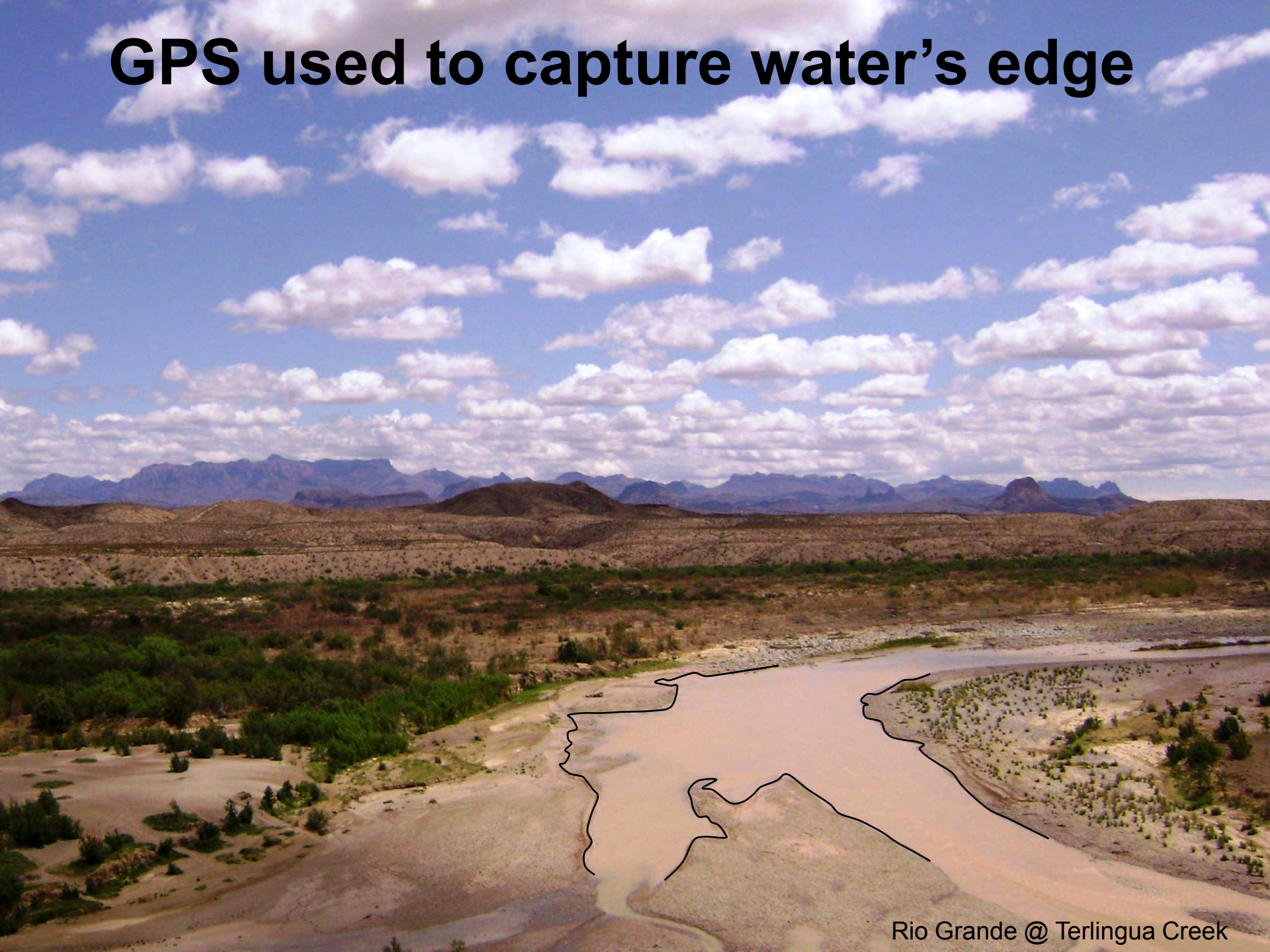
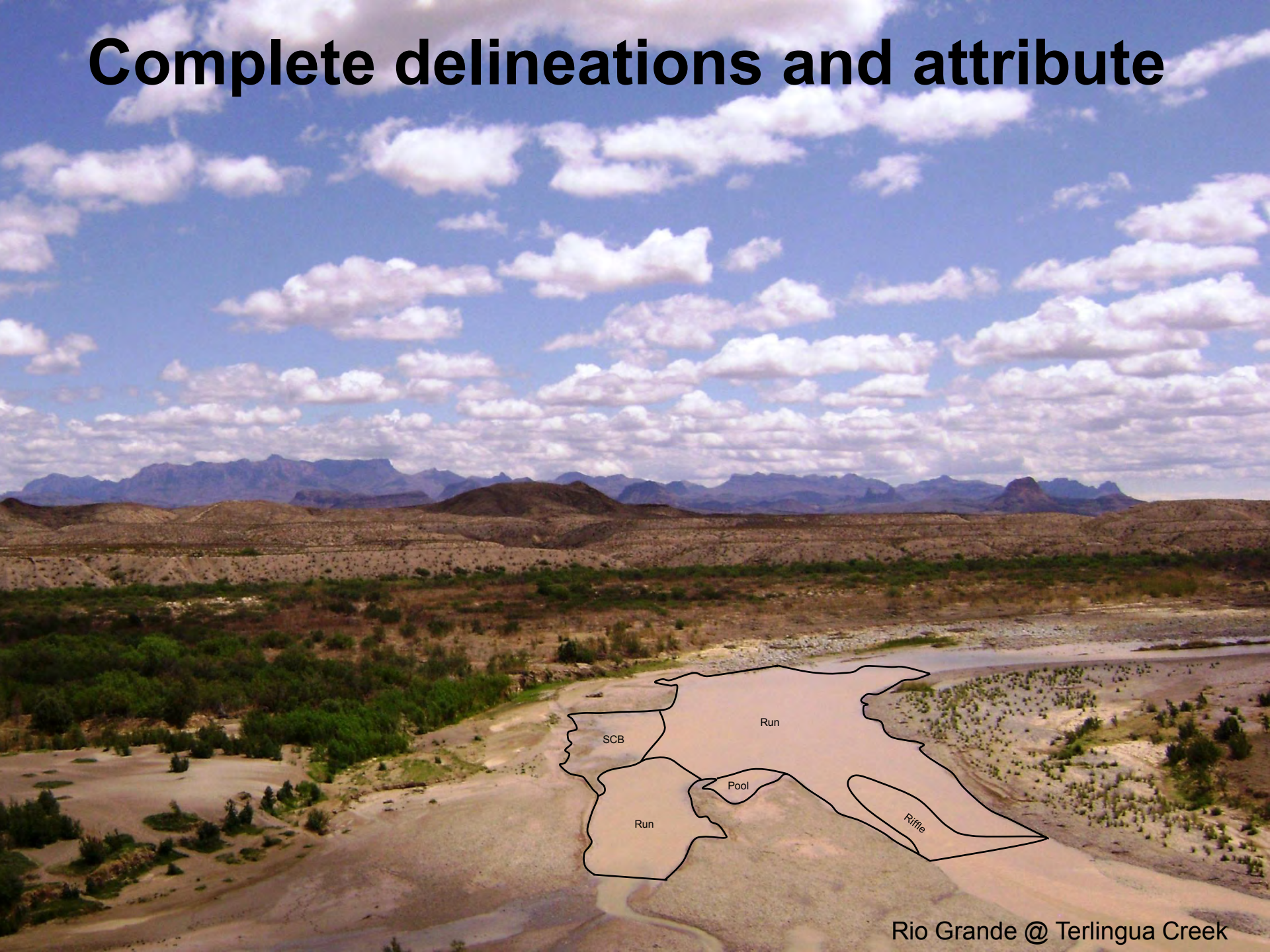
GPS used to capture water's edge

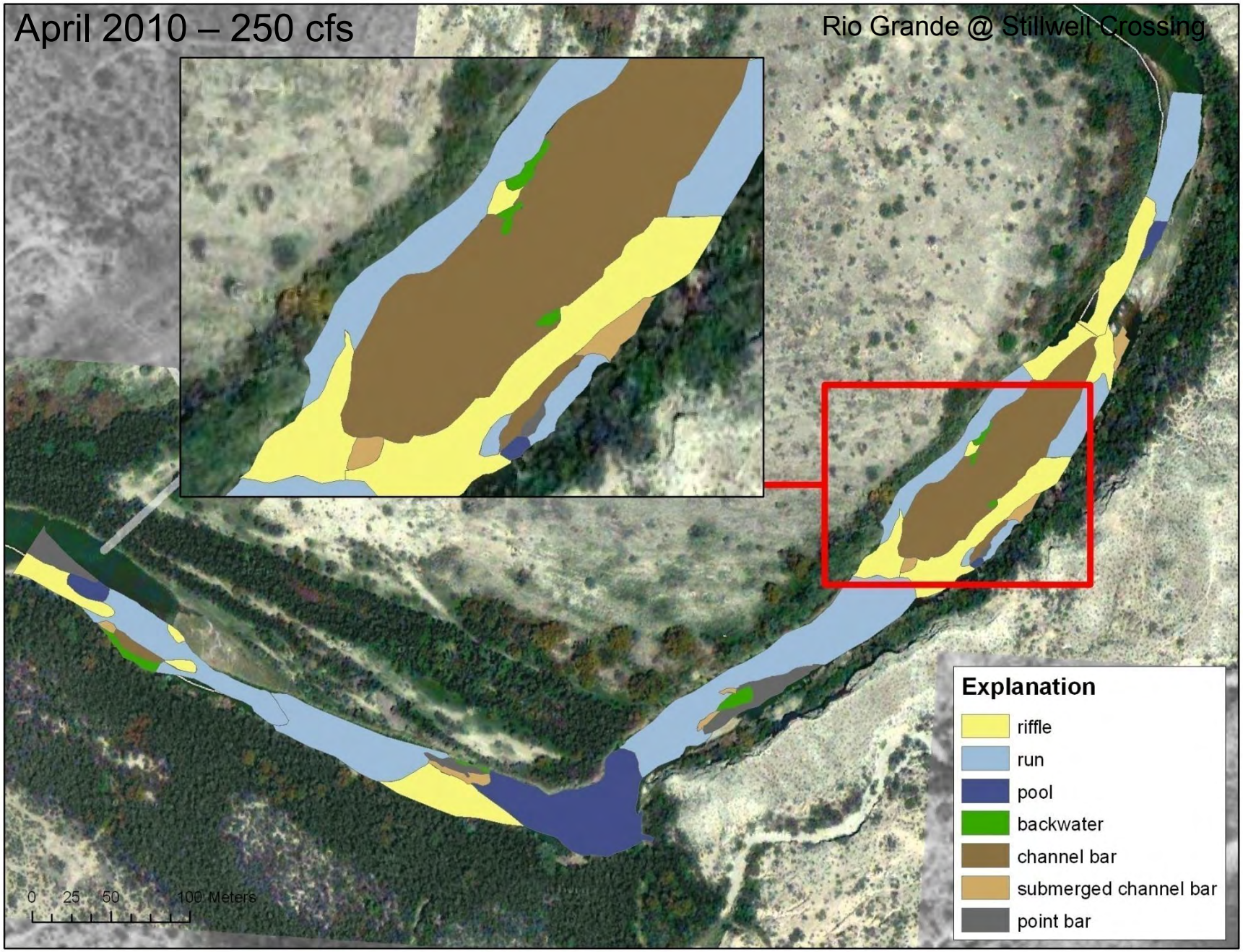


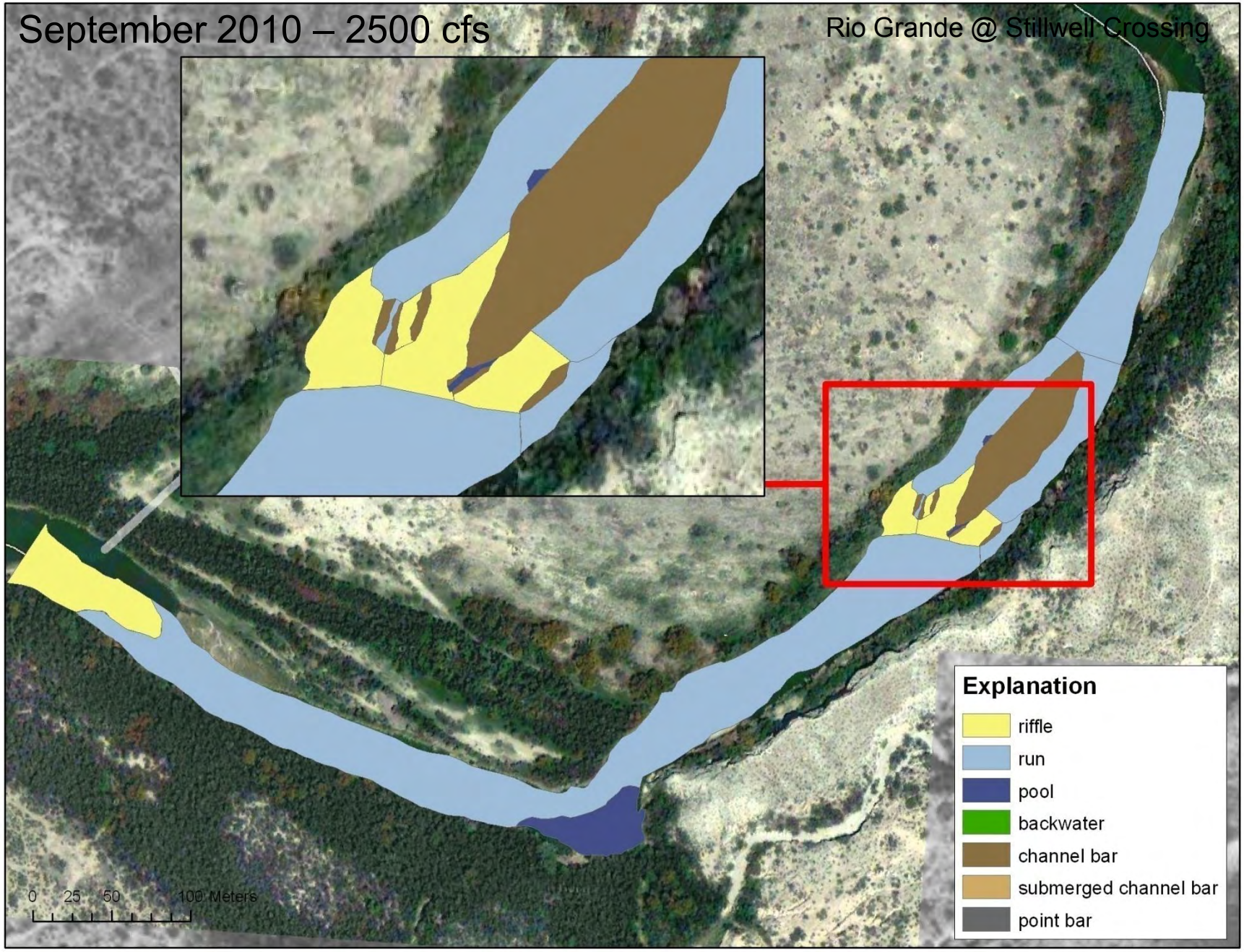
Rio Grande @ Terlingua Creek

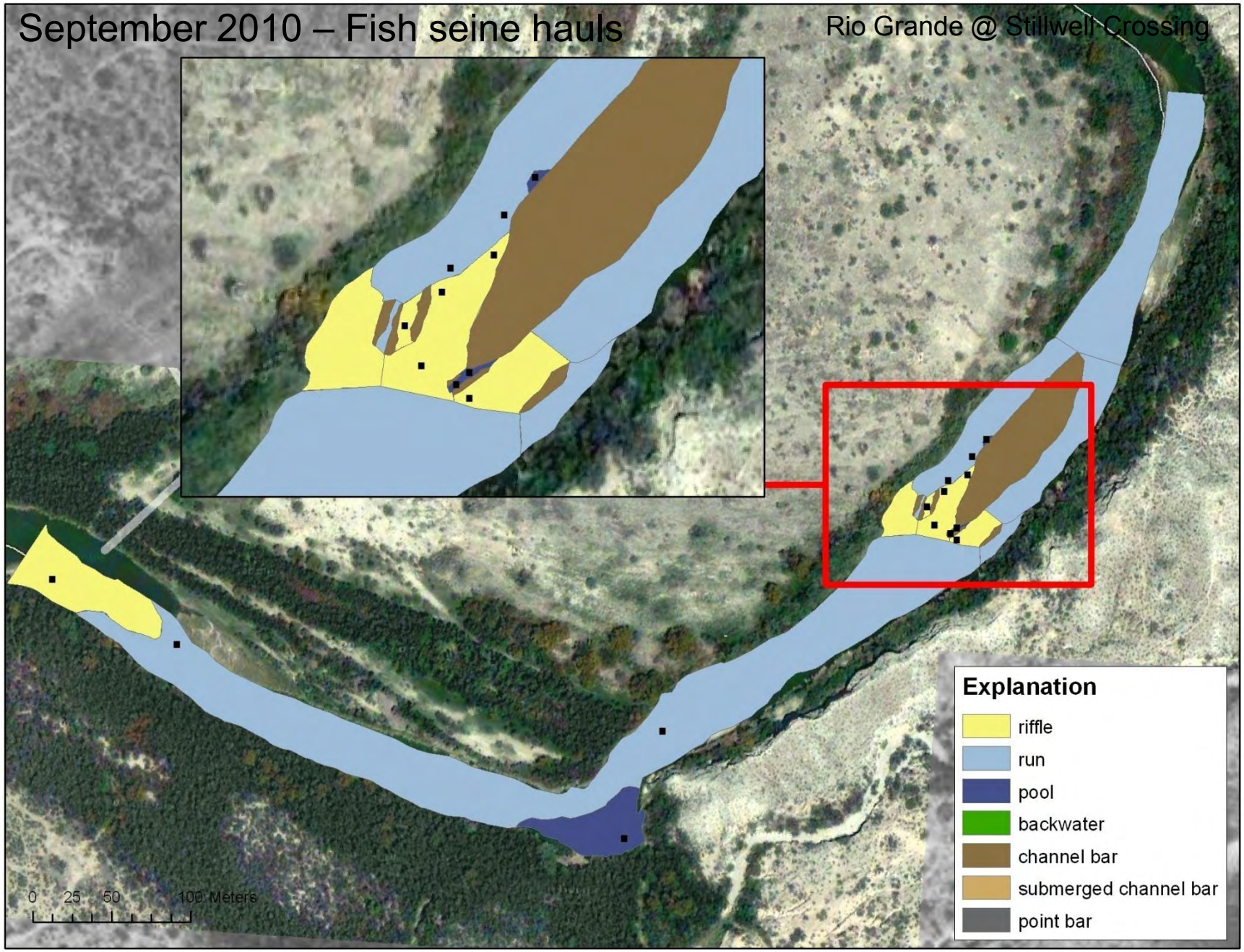
Complete delineations and attribute

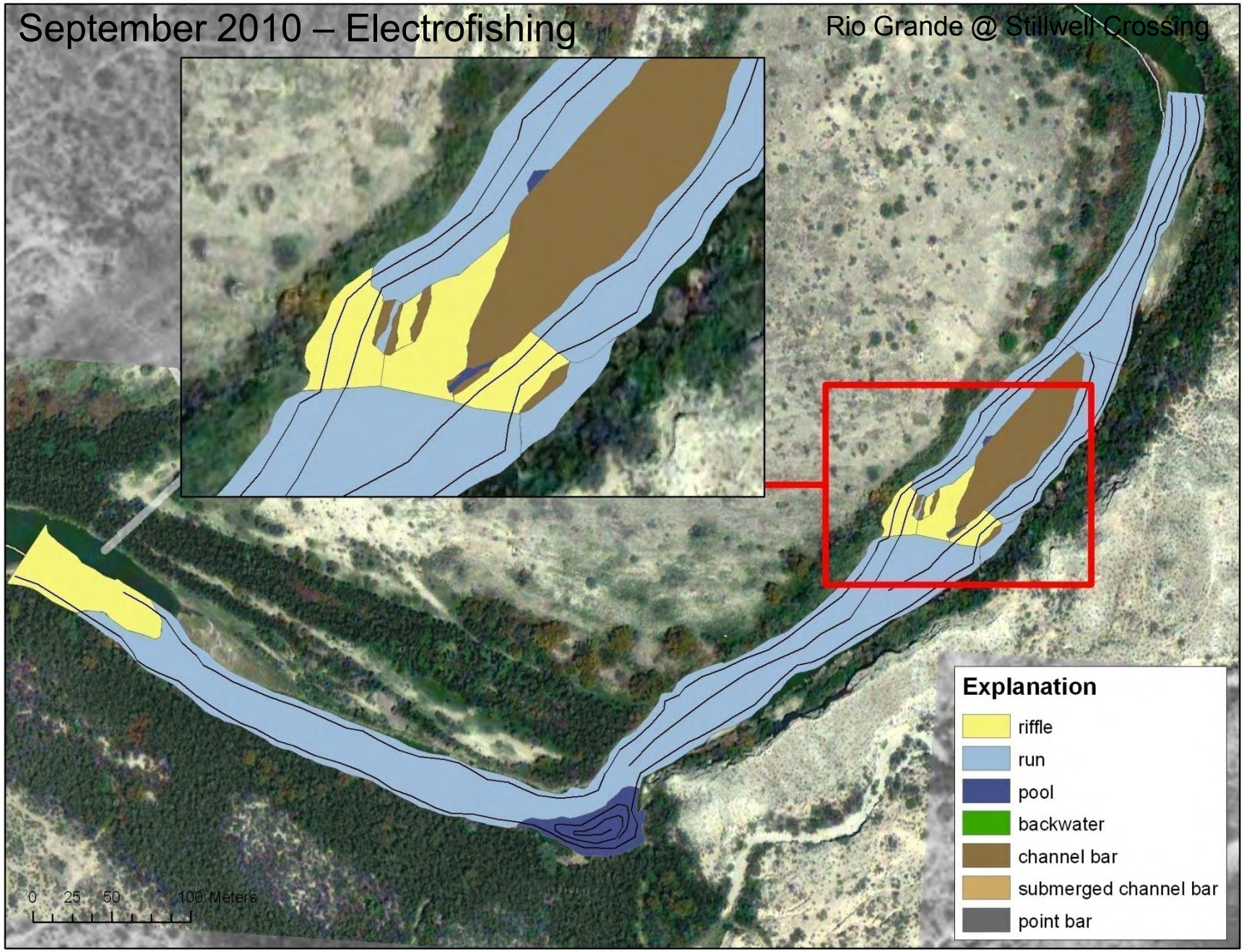


Rio Grande @ Terlingua Creek


April 2010 – 250 cfs
Rio Grande @ Stillwell Crossing
Explanation
riffle
run
pool
backwater
channel bar
submerged channel bar
point bar
0 25 50 100 Meters


September 2010 – 2500 cfs
Rio Grande @ Stillwell Crossing
Explanation
riffle
run
pool
backwater
channel bar
submerged channel bar
point bar
0 25 50 100 Meters


September 2010 – Fish seine hauls
Rio Grande @ Stillwell Crossing
Explanation
riffle
run
pool
backwater
channel bar
submerged channel bar
point bar
0 25 50 100 Meters


September 2010 – Electrofishing
Rio Grande @ Stillwell Crossing
Explanation
riffle
run
pool
backwater
channel bar
submerged channel bar
point bar
0 25 50 100 Meters

Electrofishing – 2500 cfs

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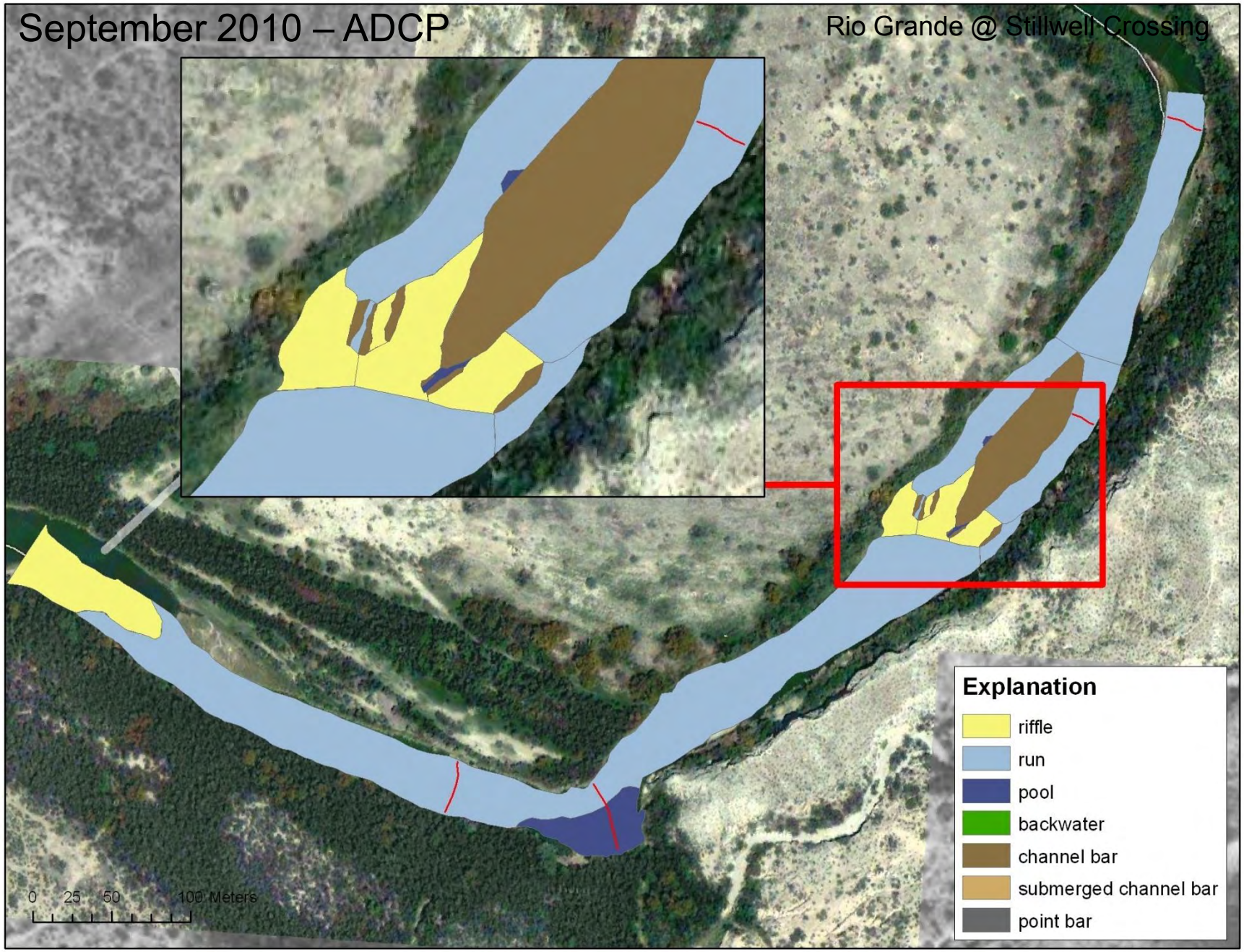
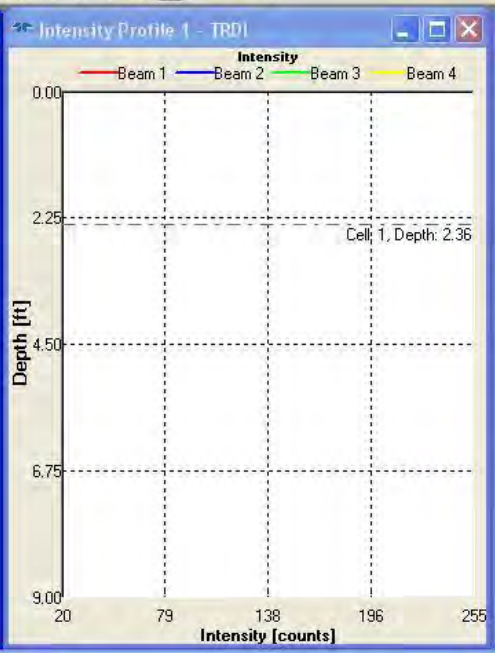

September 2010 – ADCP
Rio Grande @ Stillwell Crossing
Explanation
riffle
run
pool
backwater
channel bar
submerged channel bar
point bar
0 25 50 100 Meters

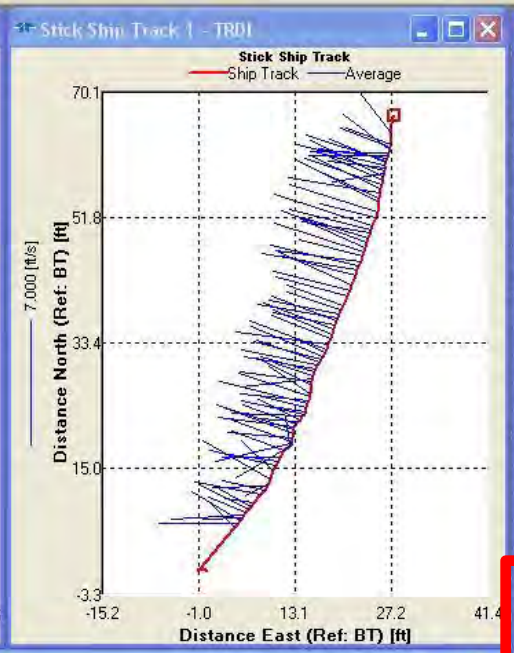
Rio Grande @ Stillwell Crossing

WinRiver II - Teledyne RD Instruments - [Playback]C:\Documents and Settings\amacdona\Desktop\Alec's pics and data\Adam's ranch\rio@admrnch#1_0\rio@admrnch#1_0_

File Configure View Acquire Playback Window Help

MeasurementCt...
- rio@admrnch#1_0.mmt
  - Site Information
  - Site Discharge
    - Transect 001
    - Transect 002
    - Transect 003
    - Transect 004
    - Discharge Summary
  - QA/QC
    - ADCP Test
    - Compass Calibration
    - Moving Bed Test
      - Loop
  - Collect Data

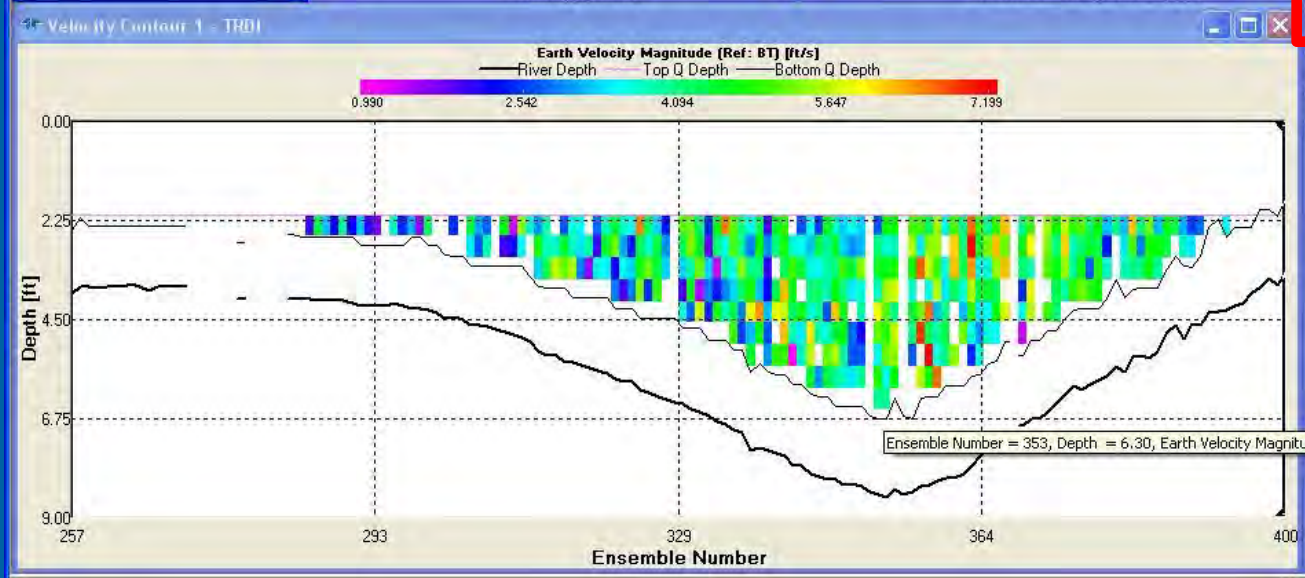




Detailed Discharge Tabular 1 - TRDI

Discharge (Ref: BT) Left to Right

Nmb. of Ens.	144	
Start Time	15:18:21	
Duration	59.75	[s]
Total Q	1667.97	[ft³/s]
Top Q	597.53	[ft³/s]
Measured Q	556.59	[ft³/s]
Bottom Q	400.08	[ft³/s]
(T+M+B) Q	1554.20	[ft³/s]
Left Dist.	12.00	[ft]
Left Vel.	2.802	[ft/s]
Left Depth	4.11	[ft]
Left Area	24.66	[ft²]
Left Q	48.85	[ft³/s]
Right Dist.	10.00	[ft]
Right Vel.	3.739	[ft/s]
Right Depth	4.91	[ft]
Right Area	24.56	[ft²]
Right Q	64.03	[ft³/s]
Width	97.33	[ft]
Total Area	491.32	[ft²]
Q/Area	3.39	[ft/s]
Flow Dir.	285.85	[°]
Course MG	22.33	[°]
Avg Boat Spd	1.285	[ft/s]
Beg Ens Nmb	257	
End Ens Nmb	400	



Rio Grande Creek @Contrabando

- April 2010
- 200 cfs
- Completed full assessment
  - Mapping
  - Habitat measures
    - Substrate, fish cover, periphyton, others
  - Fish Sampling
    - Successful recapture of *Hybognathus amarus*

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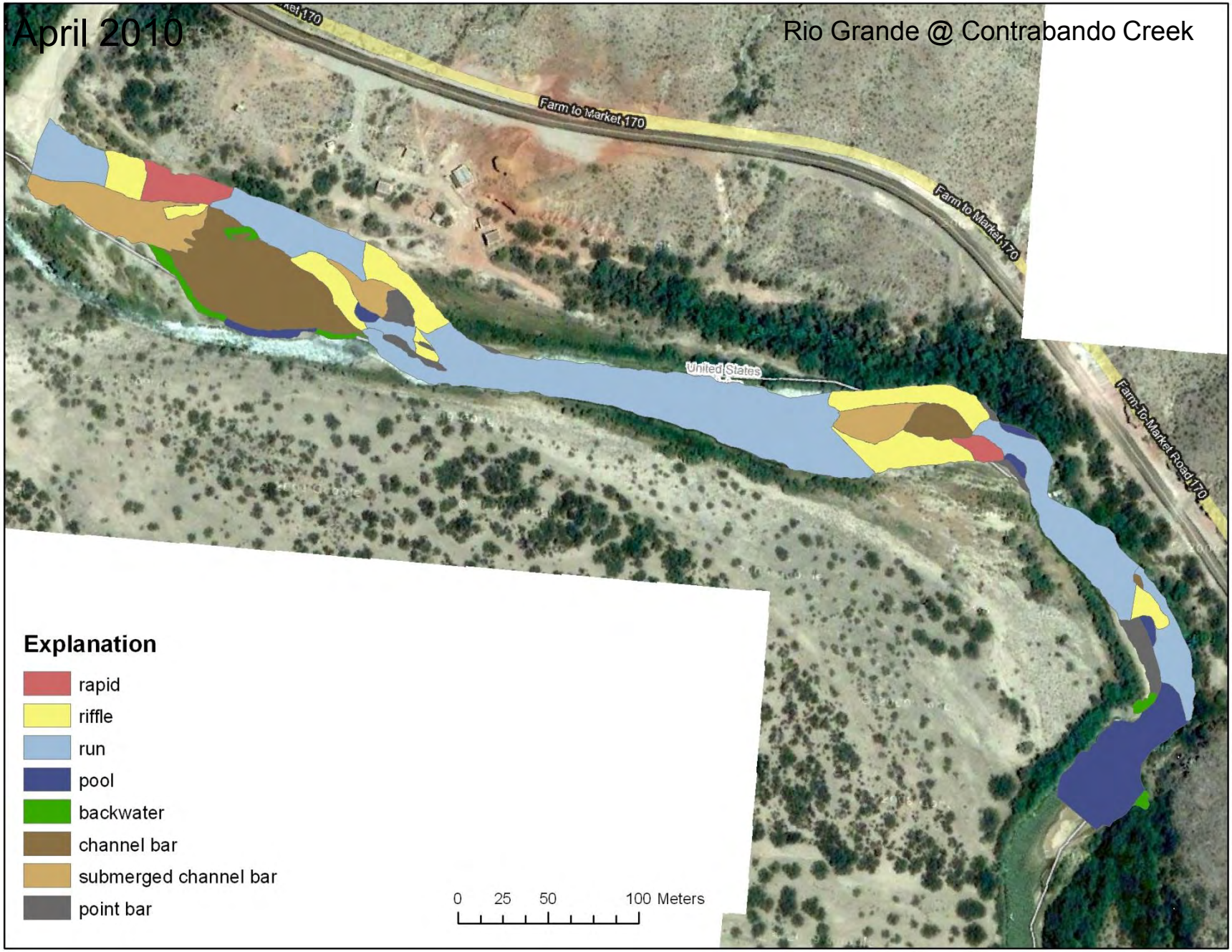
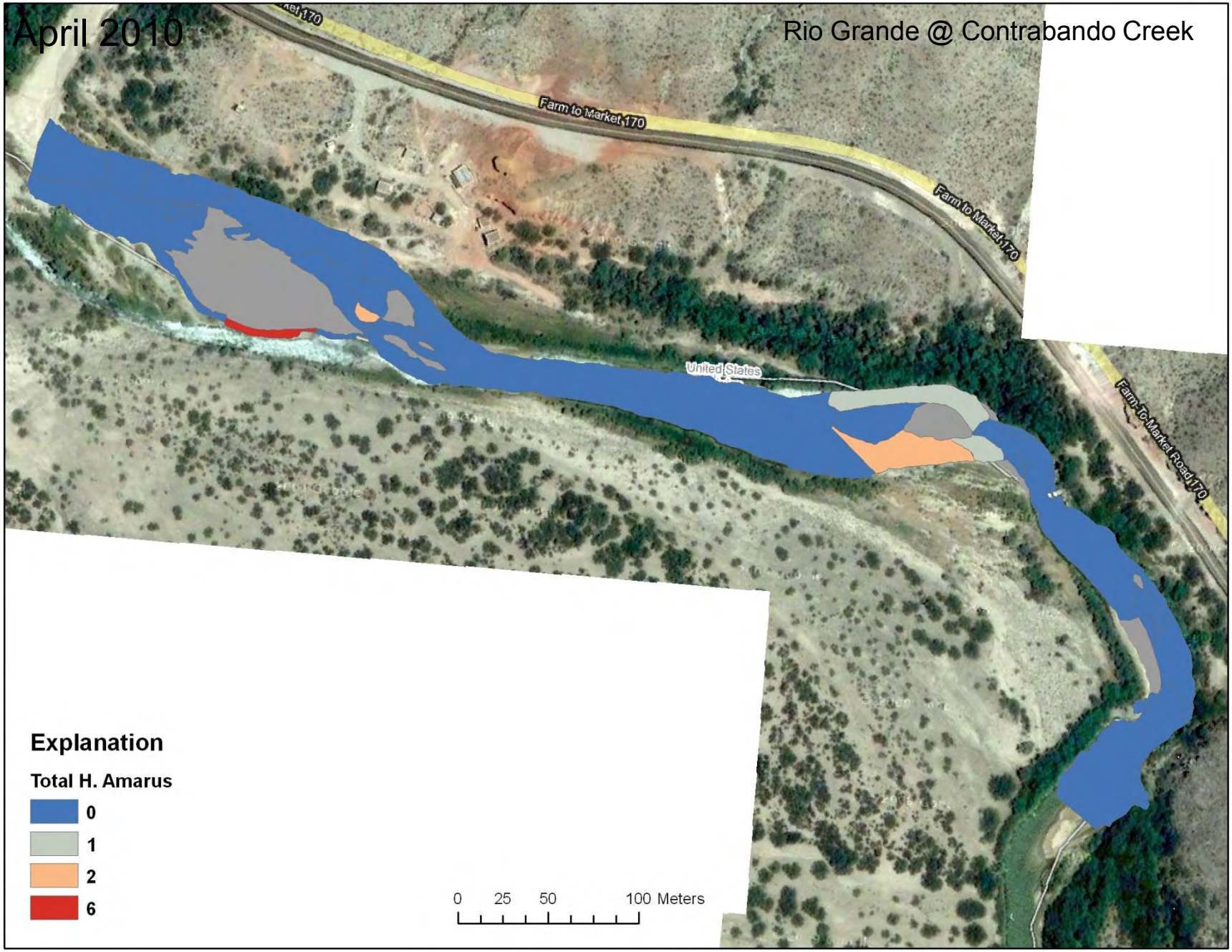
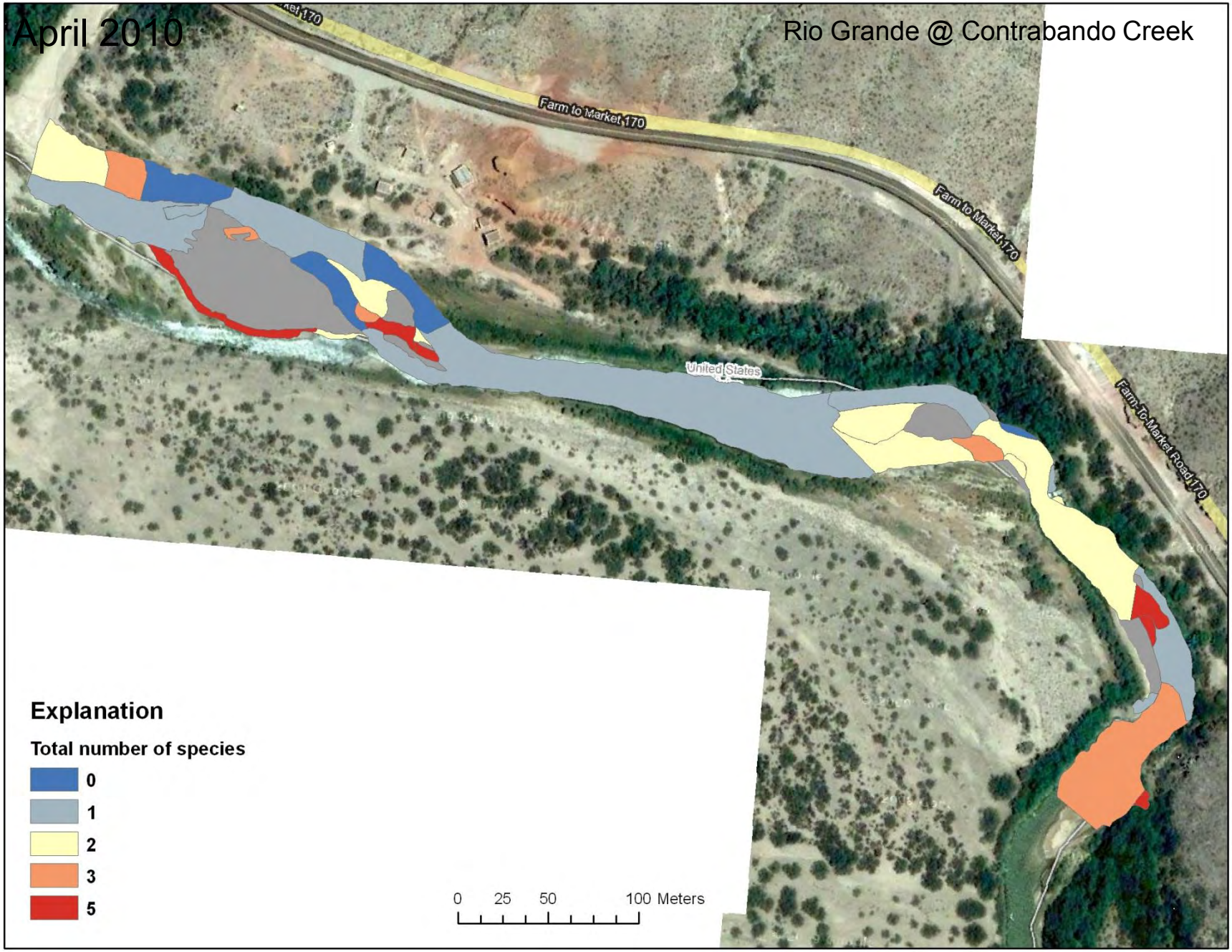
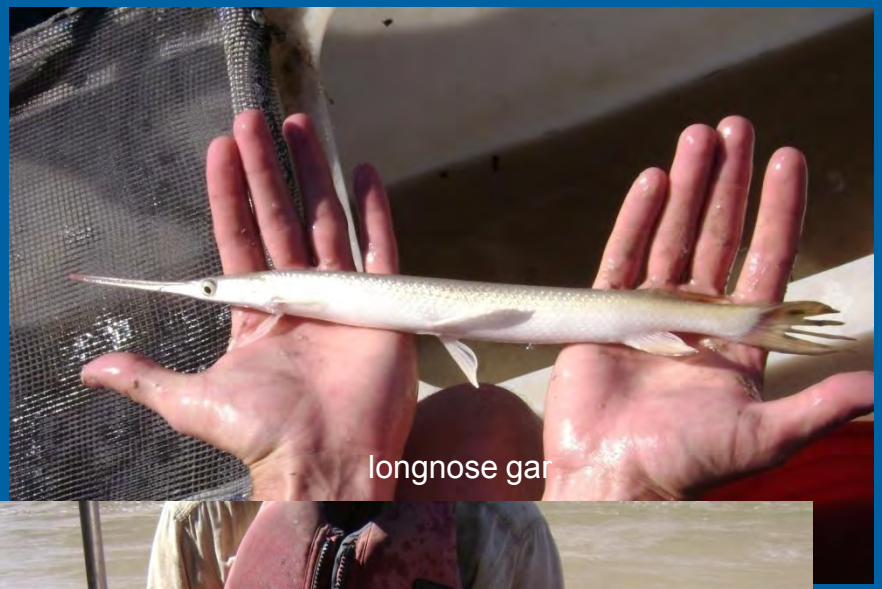

April 2010
Rio Grande @ Contrabando Creek
Farm to Market 170
Farm to Market 170
United States
Farm To Market Road 170
Explanation
rapid
riffle
run
pool
backwater
channel bar
submerged channel bar
point bar
0 25 50 100 Meters


April 2010
Rio Grande @ Contrabando Creek
Farm to Market 170
Farm to Market 170
United States
Farm To Market Road 170
Explanation
Total H. Amarus
0
1
2
6
0 25 50 100 Meters


April 2010
Rio Grande @ Contrabando Creek
Farm to Market 170
Farm to Market 170
United States
Farm To Market Road 170
Explanation
Total number of species
0
1
2
3
5
0 25 50 100 Meters


longnose gar

flathead catfish

smallmouth buffalo

blue sucker

Blue catfish

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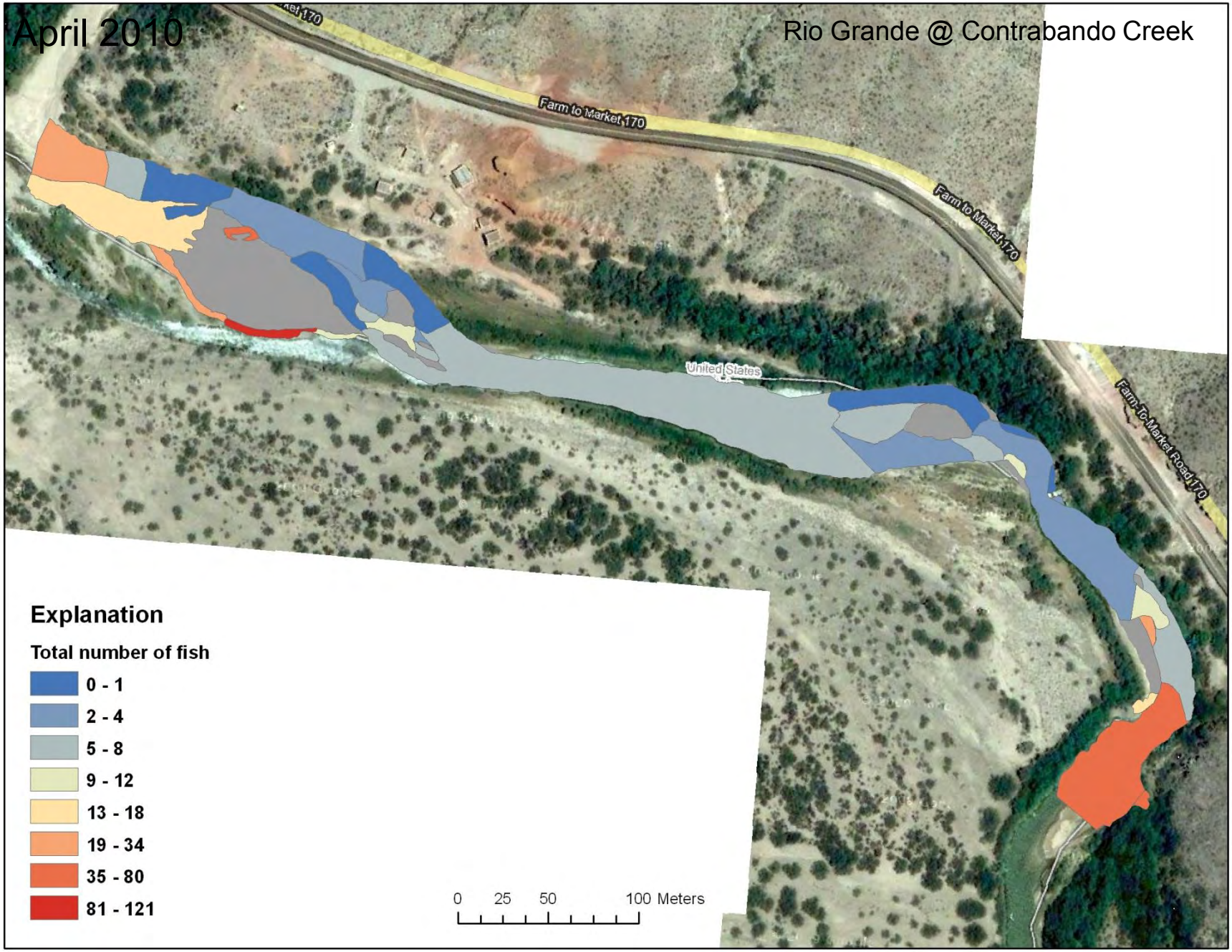
April 2010
Rio Grande @ Contrabando Creek
Farm to Market 170
Farm to Market 170
United States
Farm To Market Road 170
Explanation
Total number of fish
0 - 1
2 - 4
5 - 8
9 - 12
13 - 18
19 - 34
35 - 80
81 - 121
0 25 50 100 Meters

Benefits

- Portable
- Toughbook - Larger screen size compared to PDA
- No post-processing
- Minimal setup time
- Water-resistant

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Realities…

- Water-resistant, not waterproof
- Cable-free roving antenna would have been ideal
- Mapping (Data collection) at higher flows presented challenges
- Geodatabase schema developed

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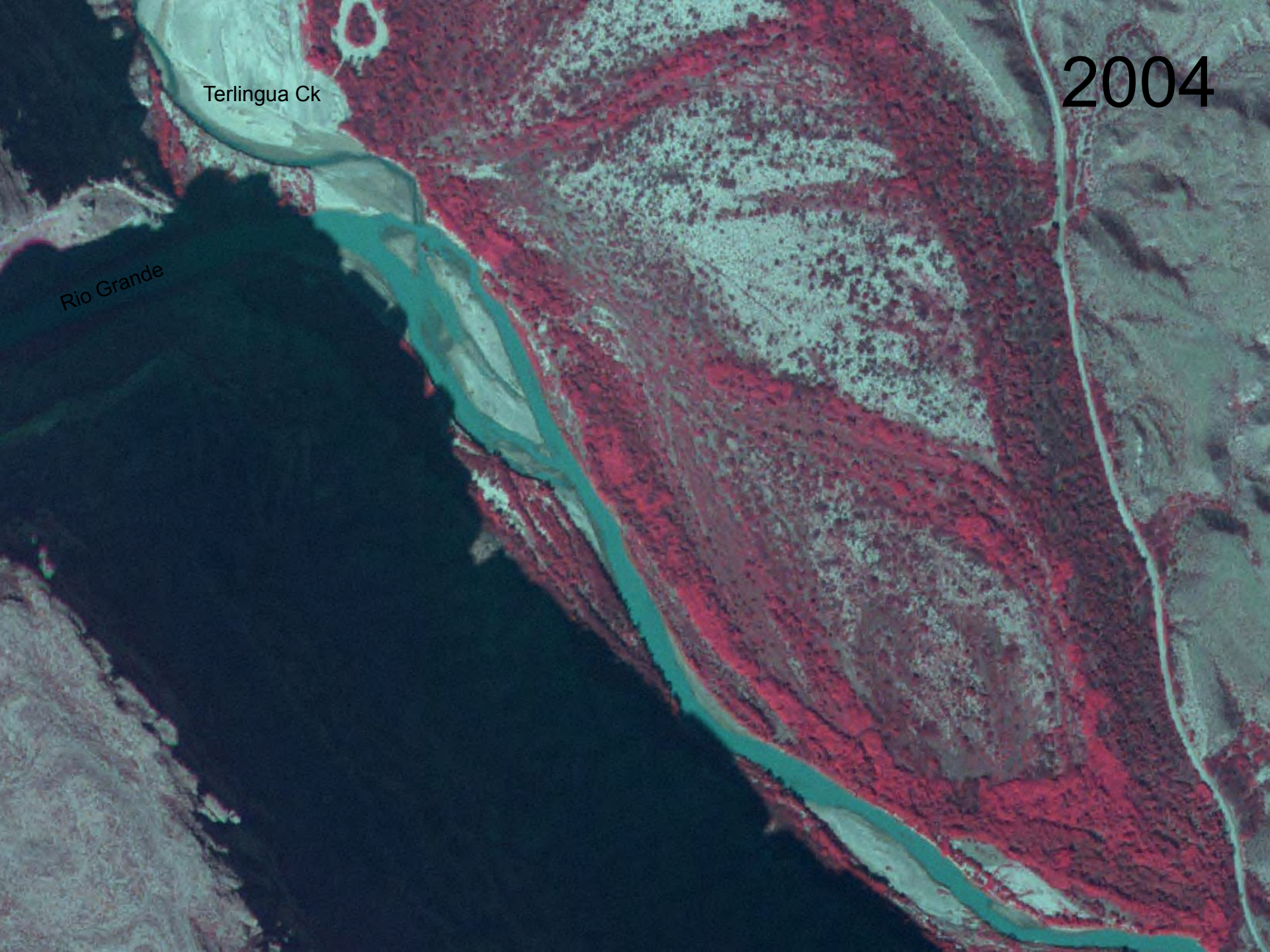
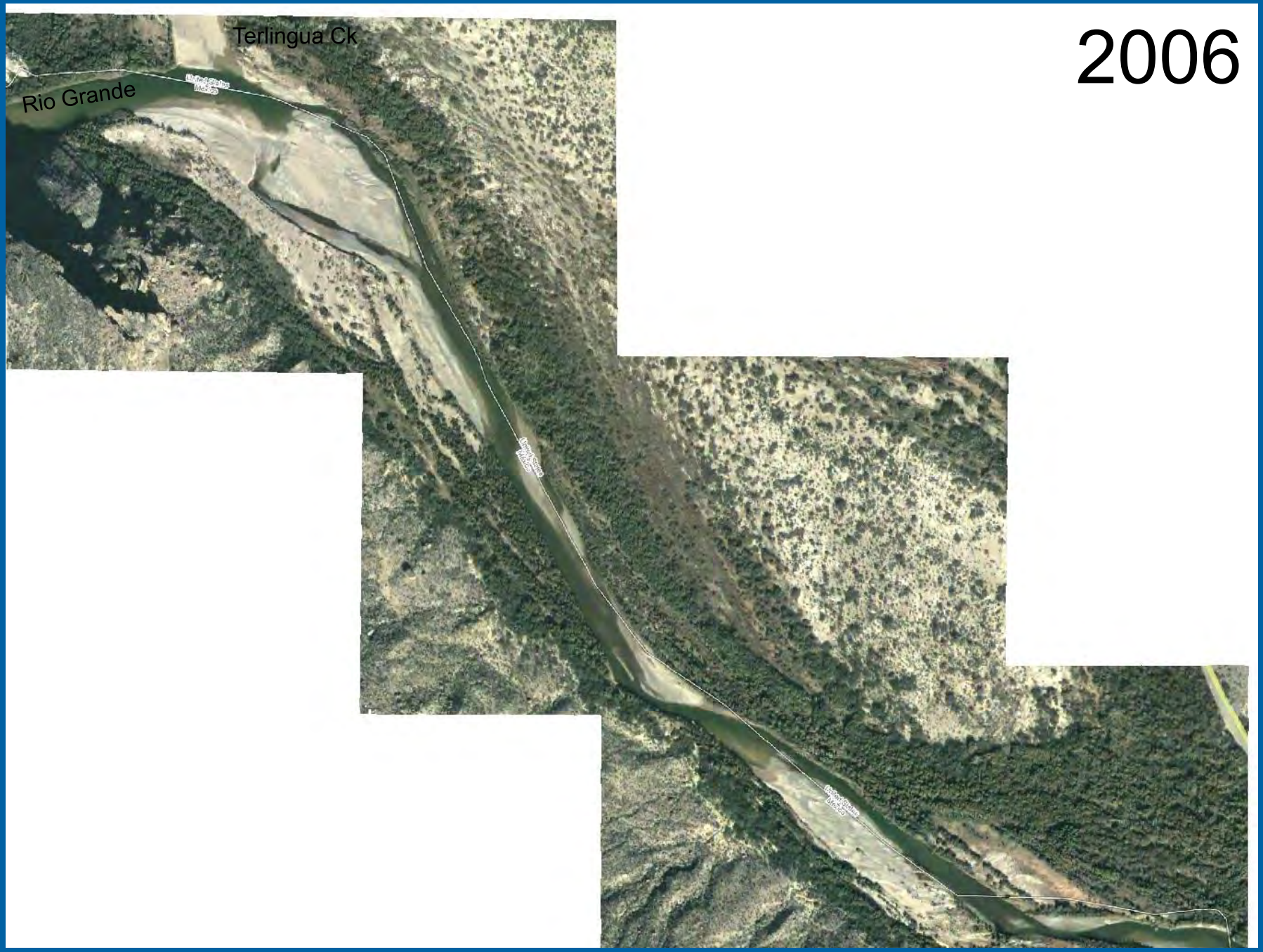

2004
Terlingua Ck
Rio Grande


Terlingua Ck
Rio Grande
2006

2008
Terlingua Ck
Rio Grande

Next Steps: FY 2011-12

- Inundation of the over-bank floodplain habitat will be classified using remotely sensed aerial imagery captured during the September 2008 flood
- Preliminary results will be validated with field verification to enhance the final landcover model
- Visual products: mapped extents of each riparian landcover class

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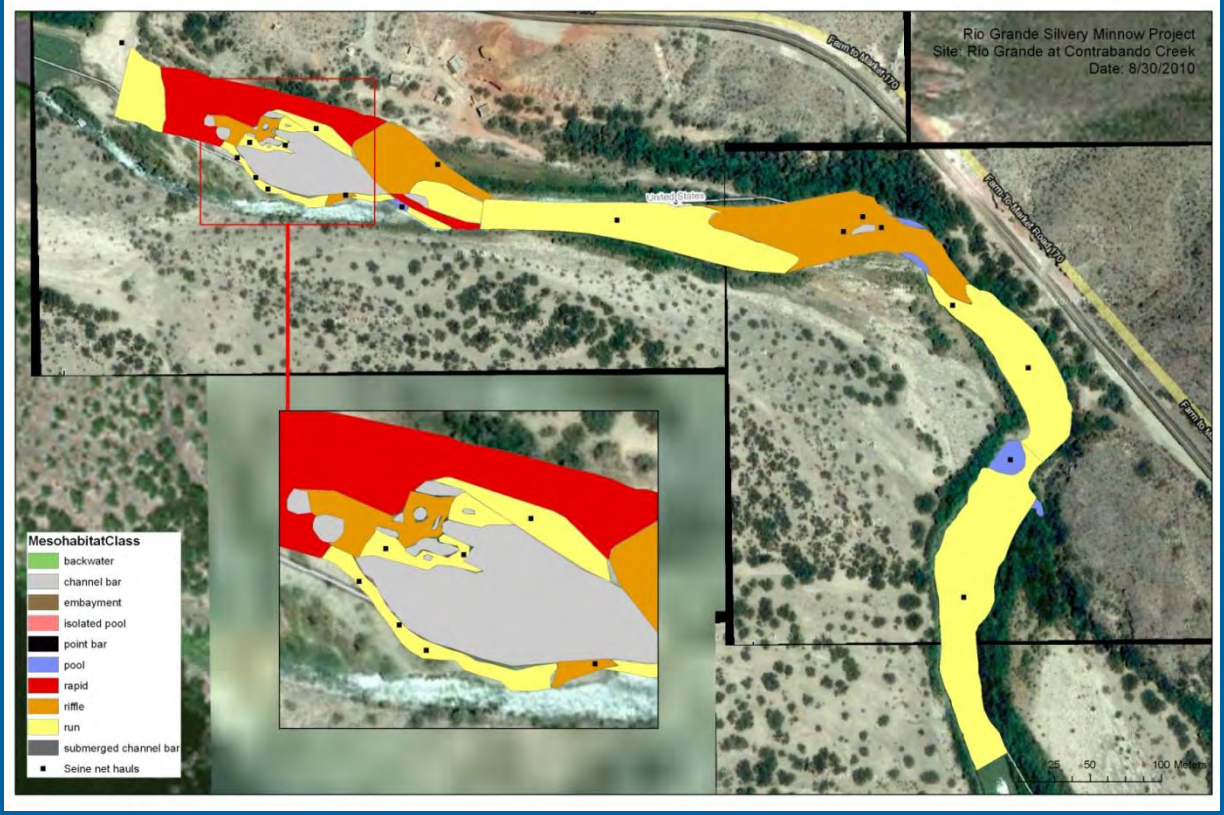
Mesohabitats

Rio Grande at Contrabando Creek during within-bank pulse (1500 cfs)

Mapped and measured physical characteristics in 1 km reach immediately downstream of each release site.



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Mesohabitats

Physical Characterization (Done at low-flow and within-bank pulse flow)

Wadeable Mesohabitats

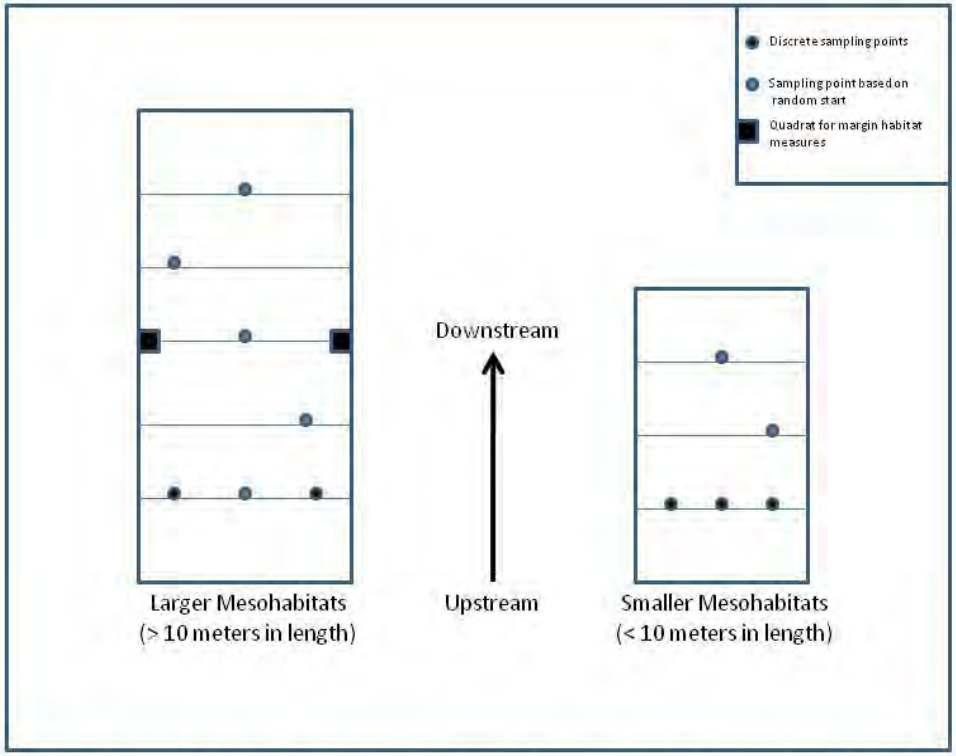

Figure 3. Diagram indicating type and location of sampling points in each mapped mesohabitat.

Depth, velocity, substrate, and at 3 to 5 points in each mesohabitat.

Fish cover along 1-meter wide bank-to-bank transect at each point.

Random start for location of first point moving downstream in order from right to left bank.

Margin or near-shore habitat at mid point evaluated for percent periphyton cover and dominant substrate using .25 m^2 quadrat

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Mesohabitats

Physical Characterization (non-wadeable habitats)

Boat-mounted ADCP on the Rio Grande

ADCP (acoustic doppler current profiler) to collect depth and velocity profiles in deeper mesohabitats (1 to 3 profiles per mesohabitat).

Also used to collect and a discharge measurement at each site during higher flows.

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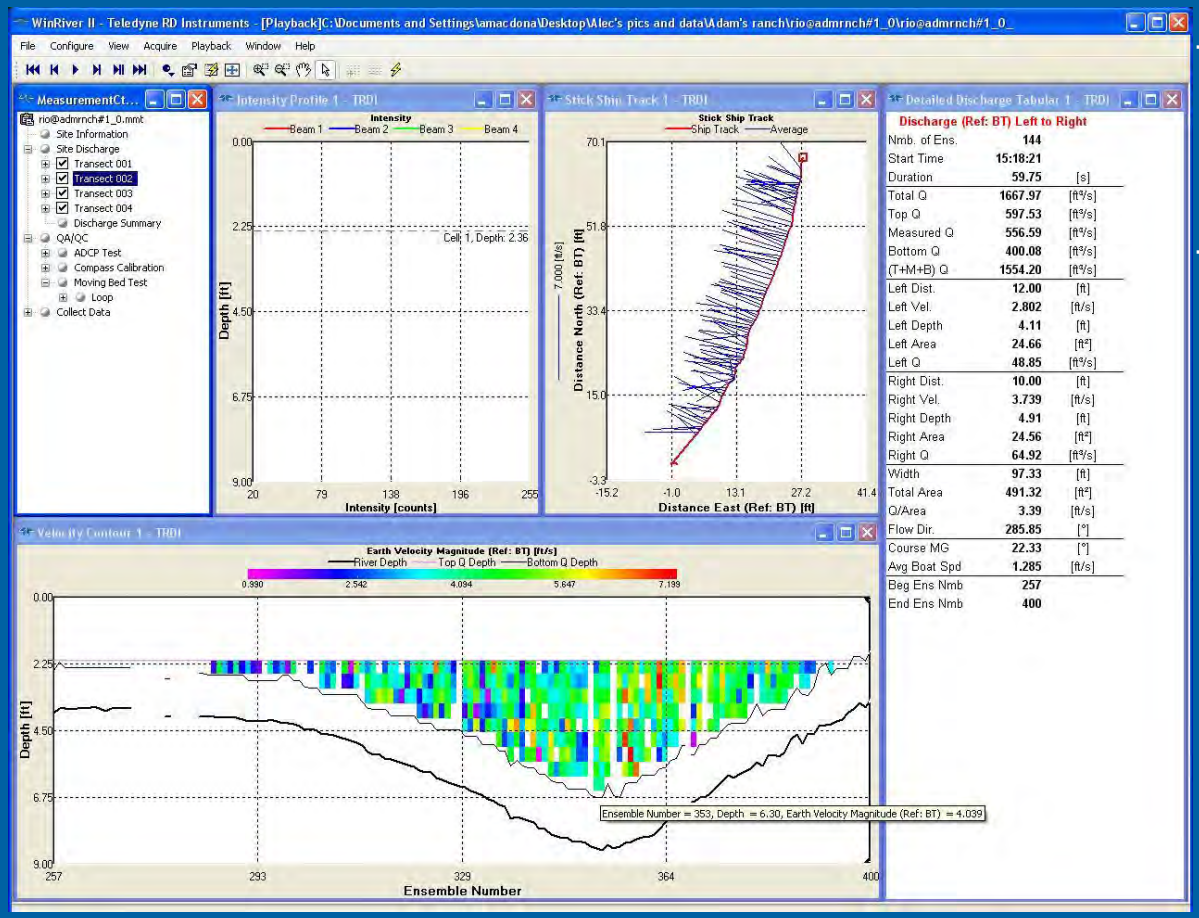
Mesohabitats

ADCP and Depth and Velocity Profiles



-Mean and point velocities and depths per profile/transect.

-Channel profile or section for comparison of width/depth ratios at high pulse flow.

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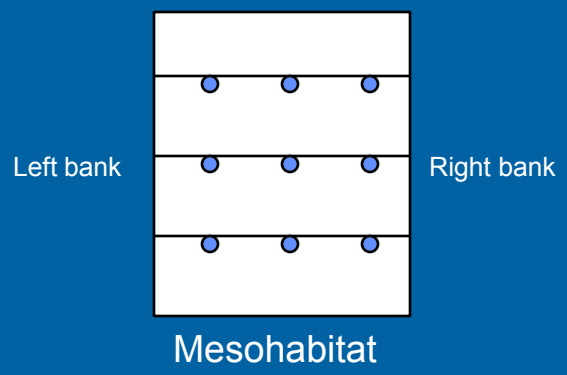
Mesohabitats

Fish Assemblage

Wadeable Mesohabitats



- One seine haul per mesohabitat randomly selected from nine possible locations.

-Two or more seine hauls in some very large runs.

-Per seine haul
Length, depth and velocity (center point), dominant substrate, and counts per species recorded.

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Mesohabitats

Fish Assemblage

Non-wadeable mesohabitats

Boat-electrofishing to sample large pools and deeper and more swift mesohabitat.

Single pass through each non-wadeable mesohabitat

Counts per species.

USGS

Fish Assemblage from Spring 2010 Low-Flow Sampling

Species ranked by relative abundance Upstream → Downstream

Scientific Name	Common Name	Contrabando	Terlingua	Rio Grande Village	Stillwell Crossing
Lepisosteus osseus	longnose gar			**6**	**6**
Hyboganthus amarus	Rio Grande silvery minnow	**6**	**6**	9	
Macrhybopsis aestavalis	speckled chub	7	4	5	7
Notropis braytoni	Tamaulipas shiner	**4**	**4**	2	2
Cyprinus carpio	common carp			7	
Rhinichthys cataractae	longnose dace	9	5	8	4
Cyprinella lutrensis	red shiner	**1**	**1**	**1**	**1**
Carpiodes carpio	River carpsucker	**8**	**8**	3	5
Cycleptus elongatus	blue sucker	2	3		
Astyanax mexicanus	Mexican tetra			**9**	**9**
Ictalurus punctatus	channel catfish				9
Ictalurus furcatus	blue catfish	5	7		
Pylodictis olivaris	flathead catfish	9	8	11	
Fundulus zebrinus	plains killifish			10	
Gambusia affinis	western mosquitofish	3	8	4	3
Lepomis megalotis	longear sunfish	9	7		8

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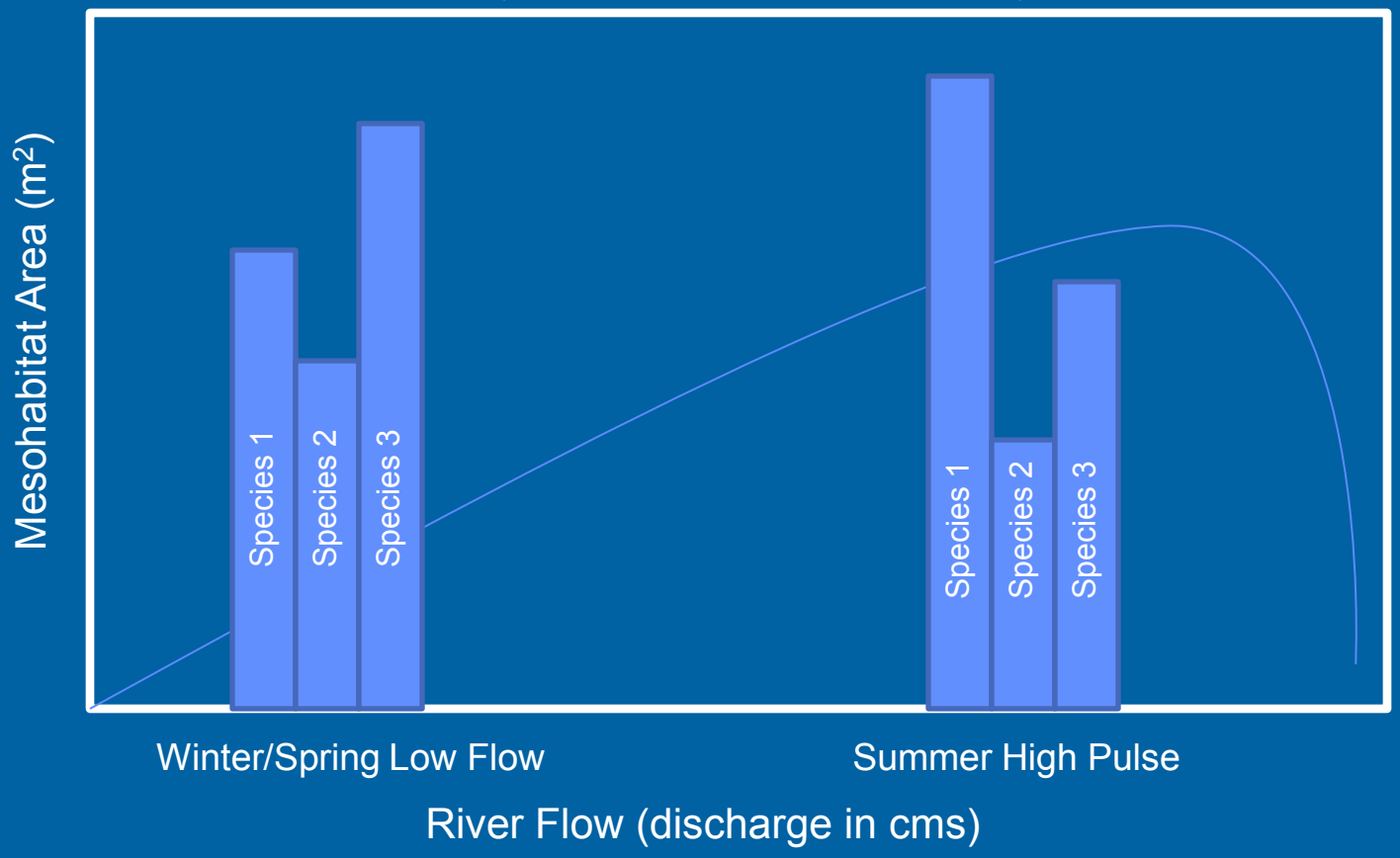
Data Analysis

- Compare mesohabitat areas and physical characteristics among reaches and over range of flows (low flow and high pulse).
- Compare area of over-bank inundation (using 2008 flood) among river reaches (reach = release site to release site)
- Abundance, distribution, and species richness of fish among sites and between low and high-pulse river flows (largely map based!).
- Estimate of available habitat for *H. amarus* and other species at low and high-pulse flows.

USGS

Data Analysis

Estimating available habitat by extrapolating from where fish are collected using presence absence and physical measures such as velocity and depth.



USGS

FY 2011-12

- Project Webpage will serve as the portal for the project geodatabase and web mapping application (available in fall 2011).

- USGS Scientific Investigations Report documenting project methods and results (available in late 2012).

- Discussions with Rio Grande Silvery Minnow Tech. Team on options to expand mapping (at reduced effort) downstream.

USGS

Highlights

- April 2010 sampling trip – Experienced significant rain event
  - Rio Grande rose from 200cfs to 10,000cfs
- Pulse flows are trigger for spawn
- USFWS collected eggs in spring and a juvenile in Aug 2010 within the study area to evaluate if species is spawning.
- Consistently recapturing adults at most release sites.
- USFWS Press Release
  - http://www.nps.gov/bibe/parknews/rio-grande-silvery-minnow-release.htm

USGS

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TWSC home page

http://tx.usgs.gov

Texas GIS Projects Web Site:

http://tx.usgs.gov/GIS/

Questions?