# COLORADO RIVER DELTA

## pulse flow reunion

March 24-26, 2014

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# COLORADO RIVER DELTA
## PULSE FLOW REUNION

Date: March 24-26, 2015
Location: Mexicali, Baja California, Mexico

### INTRODUCTION

On March 24th, 2015, the Minute 319 Science Team, tasked with monitoring impacts from the pulse flow on the Colorado River Delta, convened at the Hotel Araiza in Mexicali, Baja California, Mexico for three days. They shared and discussed preliminary hydrological and ecological research collected from sites throughout the Delta. Accompanying the scientists to this meeting were representatives from the Environmental Work Group (established by Minute 317), the International Boundary and Water Commission and the Comisíon Internacíonal de Limites y Aguas, and the Lower Basin States' water agencies. The scientists had research results from one year of monitoring - almost exactly one year to the day prior to the reunion - the historic pulse flow that breathed life into the desiccated Colorado River Delta. For the official Reunion agenda, see Appendix C.

### TUESDAY, MARCH 24, DAY ONE OF REUNION

The morning of the first day of the event began with overview presentations by Steve Nelson, an independent scientist, Dale Turner, from The Nature Conservancy, and Pat Shafroth, from the U.S. Geological Survey. In the afternoon, the science advisory team met in breakout groups designed to analyze, compare and integrate the observations made during and after the pulse flow. Each breakout session was charged with answering the questions in the original monitoring plan. Then, the groups reconvened into plenary sessions to share the breakout group discussions with the larger team.

**Presentation I: The Pulse Flow: The view from space - Steve Nelson, Independent Scientist**

Photographs taken by NASA satellites were used to observe the pulse flow at the large landscape level. Figures 1 and 2 show the release of pulse flow water onto the floodplain at the end of Reach 5 pilot channel, near Reach 7, in early May 2014. Figure 2 shows the extent of the area that the water flooded in nine days.

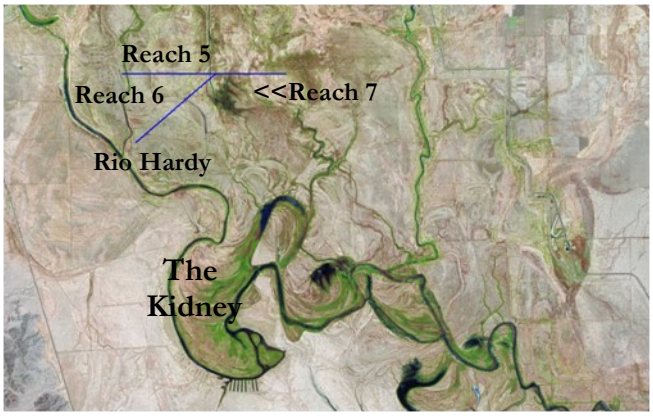



**Figure 1: Upper Reach 7; May 2, 2014**

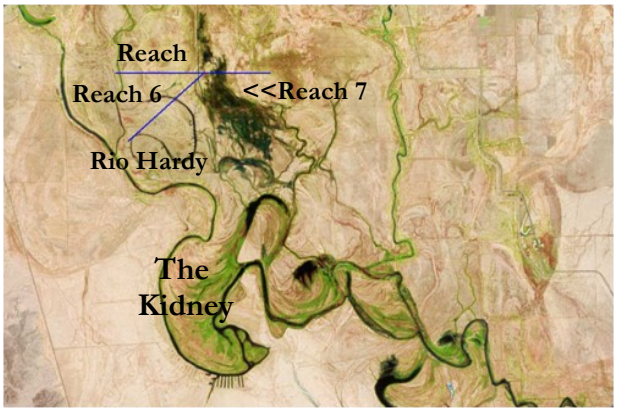



**Figure 2: Upper Reach 7; May 11, 2014**

The slide below, taken from the end of Mr. Nelson's presentation, shows the Colorado River advancing toward the Sea of Cortez in mid-May 2014.

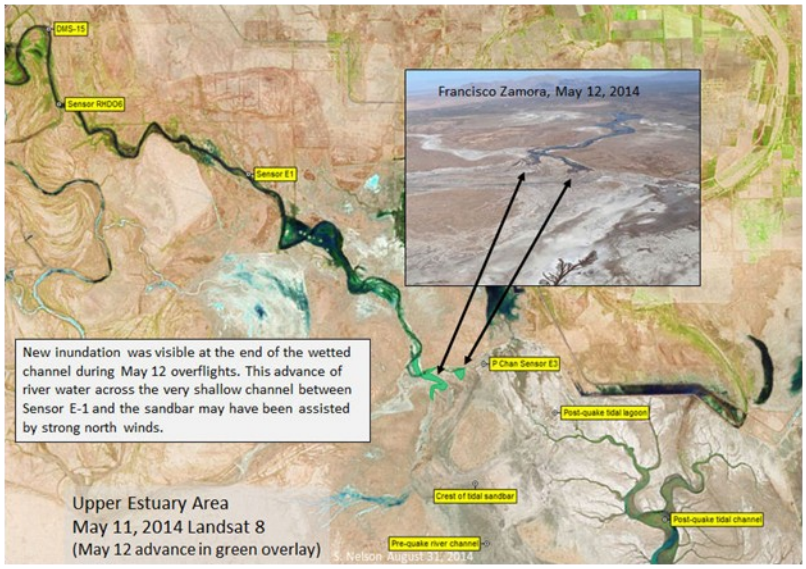



**Figure 3: May 12, 2014**

**Presentation II: The Pulse Flow: Repeat photography - Dale Turner, The Nature Conservancy**


**Figure 4: Repeat Photography**

Repeat photography is commonly used to compare historic photos with recent photos. However, in the case of the pulse flow, researchers did not have the advantage of historic photos for each specific data collection point. Instead, Turner used repeat photography to tell the story of the pulse flow's impacts on vegetation and geography of the Colorado River Delta.

Before the pulse flow in Reach 3, Eloise Kendy of The Nature Conservancy stands by a tamarisk tree to provide observers with a sense of scale.

**Figure 5: Reach 3; March 20, 2014**

The water was about two meters deep in this section during the pulse flow. Eloise in the previous photograph would have been completely submerged.

**Figure 6: Reach 3 During Pulse Flow; March 27, 2014**

By May, the channel in this section was dry, but had been visibly changed by the pulse flow; there was a cut in the bank and the vegetation had greened. Also, roots had been exposed, indicating there had been erosion of the channel.

**Figure 7: Reach 3 After Pulse Flow; May 7, 2014**

Figure 8: Reach 4; March 27, 2014

Figure 9: Reach 4; April 10, 2014

Figure 10: Reach 4; September 29, 2014

Figure 8 shows an active management site in at Laguna Grande on March 27th, before the pulse flow. (See Appendix A for a glossary of terms, including active management site). Figure 9 shows the same location on April 10th, during the pulse flow. Five months later, as shown by Figure 10, a significant amount of water remained in the channel. Native vegetation was growing along its banks.

**Presentation III: Conditions for Establishing New Vegetation – Pat Shafroth (U.S. Geological Survey)**

Pat Shafroth from the U.S. Geological Survey presented an overview of environmental requirements specific to western North America that are necessary for the establishment of "pioneer" woody riparian seedlings. Included in this presentation was a discussion of the relationship between water flows and seedling establishment requirements, and the different management approaches taken to fulfilling seedling requirements throughout the Colorado River Delta restoration sites. He also provided an introduction to the 2014 pulse flow and general seedling responses.

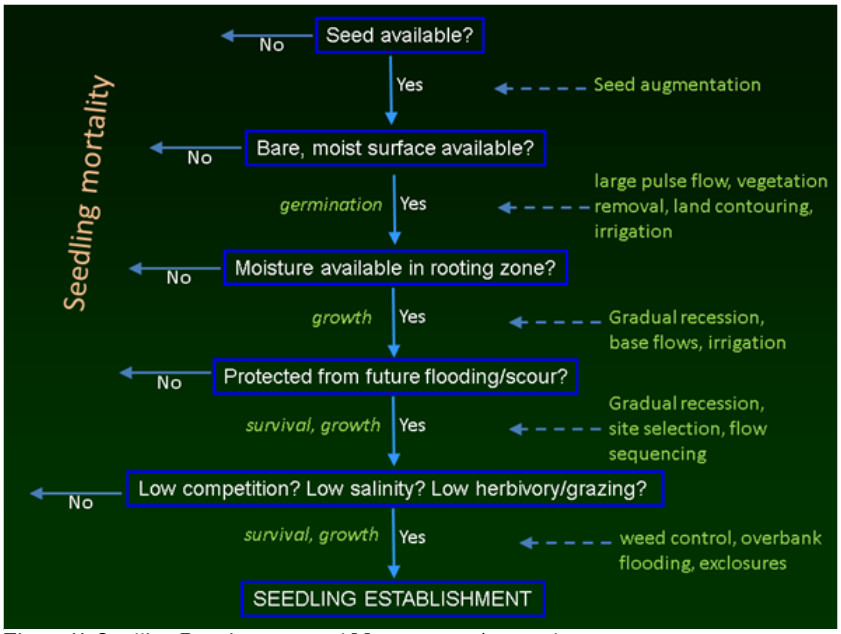



Figure 11: Seedling Requirements and Management Approaches

Figure 11, from Dr. Shafroth's presentation, describes seedling requirements and management approaches to assist establishment.

**Breakout Groups and Plenary Session Two**

In the morning, the convening participants split into three groups to share and integrate specific data. They then regrouped into a plenary, and reported the breakout group discussions to the larger group. The Hydraulic (surface-water) and Geomorphic breakout group discussed the interactions between surface water flows and groundwater along the reaches of Colorado River. The Vegetation breakout group focused on research related to the recruitment of new seedlings in restoration sites. The group largely discussed how the pulse and base flows affected recruitment of new vegetation, whether the pulse flow disturbance created favorable geomorphic and hydrological conditions for native seedling establishment, and whether the availability of seeds affected recruitment. The Social Responses breakout group discussed the surveys that have been conducted over the past three years to estimate local willingness to pay for environmental restoration and recreation sites. They also considered the role that mass and social media play in informing various groups of people on why and how the pulse flow occurred, and in shaping public perception regarding the pulse flow and the longer-term efforts to restore the Delta. Participants reconvened during the plenary session to discuss results and standardization of data.

**Breakout Groups and Plenary Session Three**

In the afternoon participants split into two breakout groups: 1) Groundwater response to pulse and base flows; and 2) Response of existing vegetation and wildlife to pulse and base flows. The Groundwater Response group focused on the degree to which the downstream attenuation of the pulse flow was caused by infiltration losses into the channel bed, and what the volumes and rates of infiltration were into the different reaches of the channel during different time periods of the pulse flow. They also reviewed how the groundwater responded to the pulse flow and enhanced base flows, and how the pulse flow and enhanced base flows affected groundwater salinity. The Vegetation breakout group discussed their research on how the pulse and base flows affected existing native and non-native vegetation and the abundance and diversity of riparian avian communities, and how these changes differed in the active and passive restoration sites.

## WEDNESDAY, MARCH 25TH, DAY TWO OF REUNION

Participants traveled to several study sites in the Limitrophe and in the Laguna Grande area to consider specific data collection methodologies and findings, many of which were discussed the previous day. The field trip also provided an opportunity for attendees to tour the restoration sites and view the range of restoration approaches: passive, managed, and active. The field trip strengthened connections among the attendees, who were able to discuss results between field trip stops.

Figure 12: Talking about Willow Trees

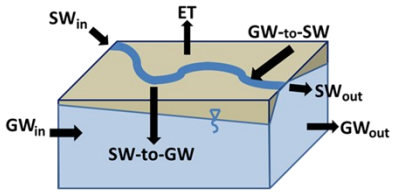
Figure 13: Data Collection

## THURSDAY, MARCH 26TH , DAY THREE OF REUNION

The third day of the meeting provided further opportunity for the participants to discuss and integrate research and to start considering their next steps for data analysis and communication.

### Breakout Groups and Plenary Session Four

During the last breakout session, the group again broke into water and ecological themes. The Water breakout group discussed the components of the water budget for the reaches of the Colorado River Delta that were studied.




Channel: $SW_{in}$ + [GW-to-SW] = $SW_{out}$ + [SW-to-GW]

$SW_{in}$ = pulse flow + base flow + other

Aquifer: $GW_{in}$ +[SW-to-GW] = $GW_{out}$ + [GW-to-SW] + ET

$GW_{in}$ = horizontal underflow + vertical irrigation seepage

$GW_{out}$ = horizontal underflow + pumping for irrigation

Figure 14: Relationships between groundwater and surface water

The Ecological breakout group held an in-depth discussion of ecological and hydrological principles at play during and after the pulse flow and the research timescales of one-year, five-years, and longer term. The discussion focused on vegetative and wildlife response to the pulse flow in the first year. Because different species of vegetation and wildlife will respond at different timeframes to the base and pulse flow, there will be a lag time of several years before the response of some species can be measured in the restoration sites and elsewhere.

**Plenary Session Five**

The ecologists, hydrologists, geologists, and other members of the science team work for various organizations and, while they have separately been monitoring and collecting data throughout the year since the pulse flow, this reunion provided the first opportunity to share, standardize, and integrate their research. The last plenary session was a summary discussion of the reunion and of the lessons learned throughout the past year of data collection. There was consensus that the convening demonstrated the value in face to face meetings for researchers to talk about how they conducted their research and to share insights and suggestions. Regarding the data collection, the researchers pointed to the multi-faceted nature of the responses to the pulse flow. Surprise was expressed at the stunning complexity of the river system. Before wrapping up, attendees emphasized the power of collaboration to strengthen relationships between scientists to facilitate and strengthen high quality science.


Attendees at the end of the reunion.

## APPENDIX A

## GLOSSARY

***Pulse flow:*** A surge of water, measured at Morelos Dam and delivered over the course of eight weeks, designed to simulate spring flooding.

***Seedling establishment or seedling recruitment*:** Growth and survival of seedling for a period of time, typically a minimum of one growing season.

***Active restoration site*:** Site where existing, non-native vegetation was cleared to assist with the natural recruitment processes and/or diverse native vegetation was planted.

***Passive restoration site*:** Site where researchers did not pre-clear non-native species or assist with native vegetation establishment in any way.

## APPENDIX B

## COLORADO RIVER DELTA PULSE FLOW REUNION ATTENDEES

| Last Name | First Name | Organization |
|---|---|---|
| Bernal | Francisco | Comision Internacional de Limites y Aguas |
| Butron | Juan | Pronatura Noroeste |
| Callegary | James | U.S. Geological Survey |
| Caloca | Gabriela | Pronatura Noroeste |
| Calvo Fonseca | Alex | Pronatura Noroeste |
| Cardenas | Robert | International Boundary and Water Commission |
| Carrera | Edgar | Universidad Autonoma de Baja California |
| Carrillo | Yamilett | Delta Water Trust |
| Cohen | Michael | Pacific Institute |
| de la Cerda | Alfredo | Comision Internacional de Limites y Aguas |
| de la Parra | Carlos | Colegio del la Frontera Norte |
| Dimas | Yuliana | Pronatura Noroeste |
| Dodge | Chris | U.S. Bureau of Reclamation |
| Dudley | Tom | UC Santa Barbara |
| Duval | Dari | University of Arizona |
| Flessa | Karl | University of Arizona |
| Flores | Albert | International Boundary and Water Commission |
| Fonseca | Guadelupe | Sonoran Institute |
| Galindo | Daniel | Comision Internacional de Limites y Aguas |
| Glenn | Ed | University of Arizona |
| Gomez-Sapiens | Martha | University of Arizona |
| Grabau | Matt | Geosystems Analysis |

## COLORADO RIVER DELTA PULSE FLOW REUNION ATTENDEES CONTINUED

| Last Name | First Name | Organization |
|---|---|---|
| Hernandez | Itzel | Pronatura Noroeste |
| Hinojosa | Osvel | Pronatura Noroeste |
| Hultline | Kevin | Phoenix Desert Botanical Garden |
| Kartha | Vineetha | Arizona Department of Water Resources |
| Kendy | Eloise | The Nature Conservancy |
| Kennedy | Jeff | U.S. Geological Survey |
| Lomeli | Marcelo | Universidad Autonoma de Baja California |
| Lopez | Jose Luis | CONAGUA - Mexicali |
| Mahoney | Maren | Sonoran Institute |
| Mueller | Erich | U.S. Geological Survey |
| Nagler | Pam | U.S. Geological Survey |
| Nelson | Steve | Freelance scientist |
| Neuwerth | Jessica | Colorado River Board of California |
| Ostler | Don | |
| Pitt | Jennifer | Environmental Defense Fund |
| Pollock | Peter | Lincoln Institute of Land Policy |
| Ramirez | Alberto | Comision Internacional de Limites y Aguas |
| Ramirez | Jorge | Universidad Autonoma de Baja California |
| Resendez | Adriana | Comision Internacional de Limites y Aguas |
| Rivas | Thomas | Sonoran Institute |
| Rodriguez | Adriana | CONAGUA - Mexico City |
| Rodriguez | Eliana | Universidad Autonoma de Baja California |

## COLORADO RIVER DELTA PULSE FLOW REUNION ATTENDEES CONTINUED

| Last Name | First Name | Organization |
|---|---|---|
| Salcedo | Adrian | Universidad Autonoma de Baja California |
| Santiago | Edith | Sonoran Institute |
| Schlatter | Karen | Sonoran Institute |
| Schmidt | Jack | Utah State University |
| Shafroth | Pat | U.S. Geological Survey |
| Shanahan | Seth | Southern Nevada Water Authority |
| Soto | Eduardo | CONANP - Biosphere Reserve |
| Turner | Dale | The Nature Conservancy |
| Vargas | Juan | International Boundary and Water Commission |
| Waters | Summer | Sonoran Institute |
| Zamora | Francisco | Sonoran Institute |
| Zamora | Hector | University of Arizona |

## APPENDIX C

## COLORADO RIVER DELTA PULSE FLOW REUNION AGENDA

**Tuesday, March 24**

6:00-9:00 AM breakfast buffet at the hotel

9:00 AM Plenary Session 1

- Welcome, meeting logistics and objectives - Karl Flessa, Jennifer Pitt, representative from CILA/IBWC
- The pulse flow: the view from space - Steve Nelson
- The pulse flow: Repeat photography - Dale Turner
- Conditions for establishing new vegetation – Pat Shafroth

10:00 Breakout Sessions

*Breakout Session #1 Hydraulic (surface-water) and geomorphic responses to the pulse flow (Concurrent with Sessions #2, "S")*

*Facilitator:* James Callegary;

*Panelists:* Erich Mueller, Hector Zamora, Jack Schmidt, Jorge Ramirez, Steve Nelson, Marcelo Lomeli, Michael Cohen, Eloise Kendy, Adrian Salcedo, Edgar Carrera

- How did the pulse flow magnitude attenuate downstream between Morelos Dam and the upper Gulf of California?
- What were the extent, depth, and duration of inundation of the channel and adjacent areas?
- What effects did the pulse flow have on channel and floodplain geomorphology, and how did effects vary downstream? Determine the magnitude of channel scour and fill during the pulse flow and how these channel processes change downstream, especially in relation to the changing downstream magnitude of the pulse flow.
- [Lower Delta] Surface water hydrology. What was the full geographic extent of the pulse flow? Did the pulse flow extend into the Gulf of California? Did the pulse flow affect salinity in Reaches 6 and 7? Was the pulse flow water in Reach 7 blocked from the Gulf of California by the low-profile sand bar in the lower channel (Nelson et al., 2013b)? If so, did wetland areas increase in depth or areal extent?
- [Lower Delta] River channel and floodplain geomorphology. Was the pulse flow of sufficient magnitude to erode the lower channel sand bar and re-establish a more frequent tidal connection with the Gulf of California?

*Breakout Session #2 Recruitment of new seedlings (Concurrent with Sessions #1, "S")*

*Facilitator:* Karen Schlatter;

*Panelists*: Pat Shafroth, Matt Grabau, Ed Glenn, Martha Gomez-Sapiens; Osvel Hinojosa; Juan Butron, Eliana Rodriguez, Thomas Rivas, Eduardo Soto, Yamilett Carrillo, Alex Calvo Fonseca

- How did the pulse and base flows affect recruitment of new vegetation? Did the pulse flood disturbance create favorable geomorphic and hydrological conditions for native seedling establishment? Did the availability of seeds affect recruitment?
- How did the response of the vegetation differ between active and passive restoration sites?
- Baseflow delivery data

*Breakout Session "S" – Social responses (Concurrent with Sessions #1, #2)*

*Facilitator*: Carlos de la Parra;

*Panelists*: Francisco Zamora, Karl Flessa, Edith Santiago, Itzel Hernandez, Yuliana Dimas

- How did community members and the media react to the pulse flow?
- What questions or suggestions were raised by community members and the media?
- What economic values were articulated by community members and the media?
- What role might the social impact of the pulse flow have on future plans?

12: 00 Plenary Session 2

- Report from Breakout Session #1
- Report from Breakout Session #2
- Report from breakout Session "S"

1:00 PM Lunch at hotel

2:30 PM Breakout Sessions

*Breakout Session #3 – Groundwater response to pulse and base flows (Concurrent with Session #4)*

*Facilitator*: Eloise Kendy

*Panelists*: Jeff Kennedy, James Callegary, Ed Glenn, Edgar Carrera, Eliana Rodriguez, Michael Cohen

- To what degree was downstream attenuation of the pulse flow caused by infiltration losses into the channel bed? What were the volumes and rates of infiltration into different reaches of the channel during different time periods of the pulse flow?
- How did groundwater respond to the pulse flow and enhanced base flows
- How did the pulse flow and enhanced base flows affect groundwater salinity?

*Breakout Session #4 – Response of existing vegetation and wildlife to pulse and base flows (Concurrent with Session #3)*

*Facilitator*: Osvel Hinojosa

*Panelists*: Karen Schlatter, Dale Turner, Pat Shafroth, Jorge Ramirez, Thomas Rivas, Matt Grabau, Ed Glenn (mobile with #3), Martha Gomez-Sapiens, Guadelupe Fonseca, Juan Butron, Yamilett Carrillo, Alexa Calvo Fonseca, Francisco Zamora

- How did pulse and base flows affect the distribution, composition, and cover of existing native and non-native vegetation?
- What were the timing, delivery points, and volumes of baseflows that have been delivered?
- How did the abundance and diversity of the riparian avian community (particularly songbirds and marsh birds) change in response to pulse and base flows during the period of the pilot project? How did changes differ between the active and passive restoration sites?
- Determine species-specific greening response of vegetation in the delta to the pulse flood.

4:30 Plenary Session 3

- Report from Breakout Session #3
- Report from Breakout Session #4

7:00 PM dinner at nearby restaurant

**Wednesday, March 25**

6:00-7:00 AM breakfast buffet at the hotel

7:00 Depart for field trip from hotel parking lot

- Morning
  - Limitrophe Stop # 1 Reach 1 vegetation transect (passive restoration);
  - Stop # 2 Miguel Aleman restoration site (active restoration)
- Afternoon
  - Lunch (provided): Laguna Grande restoration sites
  - Stop # 3 Reach 4 vegetation transect (passive restoration)
  - Stop # 4 Laguna Grande restoration site (active restoration)
  - 5:00 Depart for return to Mexicali
  - 7:00 Return to Hotel Araiza

Dinner at hotel

**Thursday, March 26**

6:00-8:00 AM breakfast buffet at the hotel

8:00 AM Plenary Session #3

- Review of field trip, plans for the day - Karl Flessa
- Lower river and estuary monitoring and restoration – Francisco Zamora

9:30 AM Breakout Sessions

*Breakout Session #5 – Where did the water go? (Water budget by reach) (Concurrent with Session #6)*

*Facilitator:* Eloise Kendy

*Panelists:* Ed Glenn, Jeff Kennedy, James Callegary, Eliana Rodriguez, Adrian Salcedo, Michael Cohen, Jorge Ramirez, Marcelo Lomeli, Matt Grabau, Yamilett Carrillo, Steve Nelson, Edgar Carrera

- Quantify the volumetric water budget by reach, including: surface-water (pulse flow, base flow) inflow and outflow, groundwater inflow and outflow (lateral and pumping), evapotranspiration, and irrigation deliveries.

*Breakout Session #6 - Remaining ecological issues (Concurrent with Session #5)*

*Facilitator:* Karen Schlatter

*Panelists:* Dale Turner, Pat Shafroth, Martha Gomez-Sapiens, Osvel Hinojosa, Edith Santiago, Thomas Rivas, Alex Calvo Fonseca, Juan Butron, Guadelupe Fonseca

12:00 Noon Plenary Session #4

- Report from Breakout Session #5
- Report from Breakout Session #6

1:00 PM Lunch at hotel

2:15 Plenary Session #5 Summary of workshop

- Review of highlights from each breakout session
- What have we learned so far?
- What are our working hypotheses?
- What data are still being collected and analyzed?
- What new data should be collected in the near future?
- Future reports and their deadlines

3:00 PM Adjourn

## APPENDIX D

Sites visited during the field trip: seedlings transects (passive restoration sites) in Reach 1 and 4 and active restoration sites Miguel Aleman in Reach 2 and Laguna Grande and CILA in Reach 4. Imagery sources from years 2005, 2008 and 2010.