Channel Morphologic Changes Associated with Invasive Vegetation Removal

Celeste Wieting\textsuperscript{1}, Sara Rathburn\textsuperscript{2}, Lindsay Reynolds\textsuperscript{3}, Jonathan Friedman\textsuperscript{4}, Derek Schook\textsuperscript{5}

\textsuperscript{1}Colorado State University \hspace{1cm} \textsuperscript{2}Colorado State University \hspace{1cm} \textsuperscript{3}Bureau of Land Management \hspace{1cm} \textsuperscript{4}United States Geological Survey \hspace{1cm} \textsuperscript{5}Water Resources Division, NPS

Canyon de Chelly, AZ, Nov. 2019
A Removal Database

As part of my research, I intend to compile site-specific data on vegetation removal projects.

Please email me if you would like to contribute to the database:

Celeste.Wieting@colostate.edu
Outline

How will the river respond?
• Post-removal monitoring usually overlooked

Invasive vegetation control methods

My research
i) A literature review of post-removal channel morphologic changes
ii) Ongoing reach- to segment-scale field monitoring – CACH
iii) Geomorphic-vegetation interactions through sediment dynamics – BIBE (In development)
A shift in the geomorphic nature.
Erosion

\[ \tau_o > \tau_c \]

Remove Vegetation

\[ \uparrow \tau_o \]

Introduce Vegetation

\[ \downarrow \tau_o \]

Channel Narrowing

Increased bank stability
Potential Response to Invasive Vegetation

Morphologic changes

Channel narrowing
- Graf, 1978 (*GSA Bulletin*
- Friedman et al., 1996b (*Geomorphology*)
- Cadol et al., 2011 (*River Res Appl.*)
- Dean and Schmidt, 2011 (*Geomorphology*)
- Scott et al., 2018 (*Ecohydrology*)

Channel incision
- Simon and Rinaldi, 2006 (*Geomorphology*)

Scott et al., 2018 (*Ecohydrology*)
Control methods

Mechanical (Whole Plant), Cut-Stump, Chemical, Biological, Grazing, Fire, Flooding.

MC, CSC, CC, BC, GC, FC, FlC
Removal of invasive vegetation: What happens next?

“Long-term monitoring and follow-up treatment are necessary”
– USGS Saltcedar and Russian Olive Control Demonstration Act Science Assessment
Drivers of post-removal channel change

Is there a flood?

How large was the flood?

How long after?
Aerial images of channel widening within the sprayed reach at Rio Puerco

Average channel width
= 15.7 m

Average channel width
= 35.7 m

October 1996 NAPP photograph

Nov. 2006 satellite image (DigitalGlobe)

content: J. Friedman
Removal of riparian vegetation: What happens next?

What we are seeing at Canyon de Chelly NM...

Native vegetation loss

Bank Slumping

Channel Widening

Incision
### i) Literature Review

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Contributing Drainage Area (km²)</th>
<th>Primary Invasive Vegetation Type</th>
<th>Removal Control Method</th>
<th>Amount of Vegetation Controlled</th>
<th>Control Method Timing</th>
<th>Post-removal Channel Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canyon de Chelly</td>
<td>1,500</td>
<td>RO, tamarisk</td>
<td>MC, CSC</td>
<td>Four 1.1-km reaches</td>
<td>2005</td>
<td>I, W</td>
</tr>
<tr>
<td>Rio Puerco</td>
<td>4,000</td>
<td>Tamarisk</td>
<td>CC</td>
<td>12-km reach</td>
<td>2003</td>
<td>W</td>
</tr>
<tr>
<td>Escalante</td>
<td>5,200</td>
<td>RO</td>
<td>CSC</td>
<td>50-km reach</td>
<td>2000-2018</td>
<td>?</td>
</tr>
<tr>
<td>Rio Grande</td>
<td>471,400</td>
<td>Tamarisk, Giant cane, RO (NM)</td>
<td>BC,FC, CC</td>
<td>150-km reach (NM)</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Dolores</td>
<td>11,800</td>
<td>Tamarisk</td>
<td>BC,CSC</td>
<td>280-km</td>
<td>2009</td>
<td>?</td>
</tr>
<tr>
<td>Gila</td>
<td>150,700</td>
<td>Tamarisk</td>
<td>FC,BC</td>
<td>25 acres</td>
<td>2015?</td>
<td>?</td>
</tr>
<tr>
<td>Verde</td>
<td>17,100</td>
<td>Tamarisk, RO, Giant cane, Tree of heaven</td>
<td>?</td>
<td>?</td>
<td>2012</td>
<td>?</td>
</tr>
<tr>
<td>Colorado</td>
<td>637,100</td>
<td>Tamarisk, RO</td>
<td>CSC,CC, BC</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

*W=widening, N=narrowing, I=incising*
ii) Ongoing monitoring

What are the fundamental controls that govern the suite of probable channel responses following invasive vegetation removal?

How do different removal methods compare in terms of resulting stream morphologic changes?

Does mechanically removing the whole plant lead to the greatest channel morphologic response?
CACH XS and UAS Survey Sites

Whole plant removal, cut-stump, and control areas at each site.
CACH Aerial Imagery

Follow-up to Cadol et al., 2011
(River Res. Applic.)

Sources of imagery:
Google Earth, NAIP, NPS
LWH Whole Plant – Channel Planform Delineations

LEGEND
JUNE 2017
APRIL 2014
SEPTEMBER 2013
SEPTEMBER 2010
JANUARY 2008
JUNE 2007
OCTOBER 1997

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
CACH – SPR – Nov 2019

1.77 km

1.8 km

1.83 km

1.77 km

50 100 Meters
iii) Geomorphic-Vegetation Interactions

Building on Dave Dean’s research

- Dean and Schmidt, 2011
- Dean et al, 2011
- Dean and Schmidt, 2013

Dean and Schmidt, 2011 (Geomorphology)
Big Bend National Park (BIBE)

Which type of vegetation imparts the greatest fluid drag, promoting deposition and channel narrowing?

Inform future vegetation management to:
- Increase sediment conveyance
- Limit channel narrowing
Giant cane (*Arundo Donax*)
“Seepwillow” (*Baccharis salicifolia*)

Common Reed (*Phragmites australis*)
Desert Willow
*(Chilopsis linearis)*
Summary

Understanding post-removal channel morphologic response is valuable to future river restoration.

A database of removal projects will be created to help interpret future channel response associated with invasive species removal.

Celeste.Wieting@colostate.edu

Future work in CACH will link flow characteristics to channel response, analyzing differences in control methods used on Elaeagnus angustifolia L. (Russian olive).

Future work in BIBE to investigate vegetation characteristics to flow and sediment transport dynamics among abundant plant types in Boquillas Canyon.

• Also, how has giant cane removal efforts affected channel morphology?
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