WHAT PROCESSES ARE BROKEN IN RIPARIAN AREAS?
CONDITION ASSESSMENT

Joe Wheaton
RIPARIAN AREA DEGRADATION

- Numerous riparian zones throughout sage grouse range are threatened or impaired by altered flow patterns, invasion by non-native plant species, loss of riparian vegetation, anthropogenic confinement, and land use conversions
QUESTION OF CONDITION, SIMILAR TO PRINCIPLES WE COVERED EARLIER

1. Is valley bottom anthropogenically confined?
2. Is land use and herbivory limiting riparian vegetation?
3. Have key physical processes shaping riparian areas (climatic, hydrologic, hydraulic & geomorphic) been altered?
4. Are the building blocks (structural elements and geomorphic units) we expect still present?
5. One simple way to pull together with available data
RECALL MARGINS

A border or edge between distinct regions used to define a riverscape’s setting.

From: Wheaton et al. (2015) – Geomorphology; DOI: 10.1016/j.geomorph.2015.07.010

Fig. 1. Tiered fluvial margins classification framework.
ANTHROPOGENIC MARGINS

From: Fryirs et al. (2015) – ESPL; DOI: 10.1002/esp.3893

• Most anthropogenic margins are engineered not to be adjustable
• Most are intended to keep river/stream & its floodwaters on the ‘right’ side of margin
• Many deflect flow energy and erosion ‘problems’ to opposite and downstream banks/floodplains
• Plausible limits on what adjustments are possible

• Add an anthropogenic margin and what is its impact?

From Brierley & Fryirs (2005)
RIPARIAN CONDITION: FRAGMENTATION

- Disconnected areas that are inaccessible due to:
  - Major roads
  - Railroads
  - Levees
  - Building pad fill
STARTING WITH VALLEY BOTTOMS...

1. Start with valley bottom
2. Map anthropogenic margins
3. Look at extent of anthropogenic confinement
4. Only consider areas left as accessible for riparian management
1. Is valley bottom anthropogenically confined?

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WE ALL KNOW WHERE FINGER GETS POINTED USUALLY

- The park ‘em and forget ‘em mentality does not work

- However many forms of progressive grazing management and best practices for riparian areas exist
  - Riparian fencing
  - Active rotation schemes
  - Mixed (don’t do same thing every year)
  - Riders
THERE ARE MANY OTHER CULPRITS

- Other culprits
  - Logging, mining, urban development, transportation infrastructure, utility infrastructure, agricultural development, invasive species invasions, extirpation of keystone species, water diversions... to name a few
I HAVEN’T MADE THE MAP... BUT

- A HUGE % of riparian areas intersect grazing lands
- It makes sense to partner with ranchers

Grazing Lands*

BLM – 25 Million Acres
USFS – 7.7 Millions Acres
SITLA – 4 Million Acres
Private Range – 8 Million Acres

*Not all grazing lands are currently in use for grazing.

WE DON’T HAVE A MAP OF INCISED STREAMS IN WEST

• Back to Utah, we have a lot of:
At one level, it looks great, but it's hard to judge without some sort of reference condition or analogue (e.g. historic)
RIPARIAN VEGETATION DEPARTURE

Departure is based on the percent deviation from the pre-settlement condition.

- A dimensionless ratio of 0-1 was calculated: \(1 - \frac{\text{mean EVT vegetation value}}{\text{mean BpS vegetation value}}\).
  - Values closer to 0 represent good condition
  - Values near 1 represent degraded condition
  - Negative Values represent intact condition

- Site specific studies can be performed to assess existing vegetation and estimate historic more accurately....
- But, LANDFIRE provides a starting point in absence of other information
• Riparian vegetation departure calculated for every 30 m pixel within valley bottom

• Then.. summed up by reaches... for display at broader scales...

- Large Departure: > 66%
- Significant Departure: 33% to 66%
- Minor Departure: 10% to 33%
- Negligible Departure: < 10%
APPLYING CONCEPT @ REGIONAL SCALES

Riparian Vegetation Departure (RVD)

From: Macfarlane et al. (Revisions in Review) – Journal of Environmental Management
BUT WHAT IS THE CAUSE OF DEPARTURE?

Riparian Vegetation Conversion Type (RVCT)
RIPARIAN CONVERSION TYPE – e.g. UTAH
• Riparian Vegetation Departure and Riparian Conversion Type only model departure from estimated historic...

• What else is limiting?
RIPARIAN CONDITION: LAND USE INTENSITY

- Informs riparian condition
- Considered within valley bottom
QUESTION OF CONDITION, SIMILAR TO PRINCIPLES

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3. **Have key physical processes shaping riparian areas (climatic, hydrologic, hydraulic & geomorphic) been altered?**

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WHAT OF THESE MIGHT BE ALTERED?

- **Climate**
  - Spatio-temporal patterns of:
    - Precipitation
    - Temperature

- **Hydrology**
  - Flow regime (timing, frequency & magnitude)
  - Other fluxes (precip, ET, infiltration, GW)
  - Depth to water table

- **Hydraulics**
  - Patterns of velocity and depth
  - GW (gaining or loosing)
  - Flow patterns
    - Uniform
    - Convergent
    - Divergent

- **Geomorphology**
  - Landforms & Processes that shape them:
    - Erosion, Transport, Deposition & Storage of sediment
    - Caliber of sediment
INCISING vs. INCISED? – DISCONNECTED FLOODPLAIN

Figure from Nick Weber
QUESTION OF CONDITION, SIMILAR TO PRINCIPLES

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**WHAT STRUCTURAL ELEMENTS ARE MISSING?**

<table>
<thead>
<tr>
<th>Tier 1</th>
<th>Tier 2</th>
<th>Tier 3</th>
<th>Key attributes to differentiate specific structural elements</th>
<th>Geometry</th>
<th>SE orientation</th>
<th>SE position</th>
<th>Nature of flow impact</th>
<th>SE obstruction type</th>
<th>Stages influenced</th>
<th>Shear zone type</th>
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<td>L.</td>
<td>Bank revetment</td>
<td>Renovated, Gabions, detrior rip rap, boulder rip rap, erosion control blanket</td>
<td>Streamwise</td>
<td>Bank-attached</td>
<td>Roughness</td>
<td>Varies</td>
<td>DS eddy</td>
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<td>Primary dam, secondary dam, reinforced existing dam</td>
<td>Channel-spanning</td>
<td>Porous barrier</td>
<td>All</td>
<td>US backwater</td>
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<td>L.</td>
<td>Culvert</td>
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</table>
ARE THE PROCESSES PRESENT TO MAINTAIN?

- If geomorphic units are missing, can it be attributed to specific processes that have been altered?

Figures from: Brierley and Fryirs (2005)
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MANY WAYS TO MAKE ASSESSMENTS

- Principles can be applied without a tool at local site
- Effective riparian area management requires accurate & comprehensive riparian zone maps.
- Other methods exist, but one approach is RCA, that attempts to map riparian zone extent, condition and recovery potential maps across entire regions
WHAT GOES INTO RIPARIAN CONDITION?

- **RVD – Vegetation departure**
  - Existing departure from Historic

- **Accessibility or connectivity of floodplain**
  - Areas within valley bottom no longer accessible (due to roads, railroads, etc.) should be scored lower

- **Land use intensity**
  - Areas with urban, industrial and intensive agriculture should be scored lower
EXAMPLE RCA OUTPUTS

Riparian Condition Assessment (RCA) for State of Utah
TOOL DEVELOPMENT

A. Riparian Condition Assessment (RCA)

Inputs
- Segmented Stream Network
- Valley Bottom
- Existing Vegetation
- Historic Vegetation
- Transportation Infrastructure

Processing
- Calculate RVD
- Derive Land Use Intensity
- Fragment valley bottom using transportation infrastructure

Rule Table

<table>
<thead>
<tr>
<th>RVD</th>
<th>LUI</th>
<th>Connect</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>High</td>
<td>Low</td>
<td>Poor</td>
</tr>
<tr>
<td>Negligible</td>
<td>Low</td>
<td>High</td>
<td>Intact</td>
</tr>
</tbody>
</table>

Combine in a fuzzy inference system

Output

Riparian Condition Assessment
- Poor: <= 0.4
- Moderate: 0.4 - 0.5
- Good: 0.55 - 0.85
- Intact: > 0.85

Floodplain Connectivity
- Connected
- 0
- 1

More info at [http://etal.joewheaton.org/rcat](http://etal.joewheaton.org/rcat)
TOOL DEVELOPMENT

• The tools have all been automated and are available in an ArcGIS toolbox (see https://bitbucket.org/jtgilbert/riparian-condition-assessment-tools)
EXAMPLE ESTIMATE OF RIPARIAN RECOVERY POTENTIAL

Riparian Recovery Potential (RRP) for State of Utah
Collaborators

- Wally Macfarlane
- Joe Wheaton
- Elijah Portugal
- Pete McHugh
- Josh Gilbert
- Chalese Hafen
- Shane Hill
- Martha Jensen
- Nate Hough-Snee
- Russell Norvell
- Christopher Keleher
- Justin Jimenez
- Jeremy Jarneck
- Frank Howe
- Jimi Gragg

Learn more and download the data at:
https://bitbucket.org/jtgilbert/riparian-condition-assessment-tools