Riparian Functions for River and Lake Water Quality

- Sherman Swanson,
  - Coordinator, Nevada Creeks and Communities Team
Water Quality:
Chemistry, 
Physical habitat, and 
Biology
Floods Happen:
- Exponentially increased sediment
- Channel erosion
- Sediment deposits
- Channel repair
- Nutrient release
- Nutrient uptake
- Saturated soil
- Denitrification
Floods Happen:
- Exponentially increased sediment
- Channel erosion
- Sediment deposits
- Channel repair
- Nutrient release
- Nutrient uptake
- Saturated soil
- Denitrification

What Happens in Floods:
Depends on riparian functions

What Happens between Floods:
Depends on riparian functions
Non-point Source Stressors

Figure from the National Water Quality Inventory: Report to Congress, August, 2009
Non-point Source Stressors

Figure from the National Water Quality Inventory: Report to Congress, August, 2009
PROPER FUNCTIONING CONDITION – DEFINITION

- RIPARIAN-WETLAND areas are functioning properly when adequate vegetation, landform, or large woody debris is present to:
  - Dissipate STREAM ENERGY associated with high flows
  - Filter SEDIMENT and CAPTURE BED LOAD
  - Aid FLOODPLAIN DEVELOPMENT
  - Improve FLOOD WATER RETENTION and GROUNDWATER RECHARGE
  - Stabilize STREAMBANKS
PROPER FUNCTIONING CONDITION

PROVIDES FOR:

- Habitat for **FISH** and **WILDLIFE**
- Improved **WATER QUALITY**
- Improved **FORAGE PRODUCTION**
- Decreased **SOIL EROSION**
- Greater **BIODIVERSITY**
- **ECOSYSTEM SERVICES**
On-The-Ground Condition

Adequate vegetation, land form or large woody material to:

- Dissipate stream energy
- Reduce erosion
- Filter sediment
- Capture bedload
- Aid floodplain development
- Improve floodwater retention and groundwater recharge
- Develop root masses that stabilize stream banks

- Increased water quality and quantity
- Diverse ponding and channel characteristics
- Habitat for fish and wildlife
- Greater biodiversity
- Forage for livestock
FUNCTIONAL AT RISK

- RIPARIAN-WETLAND areas in Functional Condition,

- But, a Soil, Water, or Vegetation attribute makes them SUSCEPTIBLE TO DEGRADATION
NONFUNCTIONAL

- **RIPARIAN-WETLAND** areas that are **CLEARLY NOT PROVIDING** adequate Vegetation, Landform or Large Woody Debris to:
  - Dissipate Stream Energies associated with higher flows
  - Filter Sediment and Capture Bedload
  - Aid in Floodplain Development
  - Improve Floodwater Retention and Groundwater Recharge
  - Stabilize Streambanks
NONFUNCTIONAL

- Areas that are Nonfunctional
  - DO NOT provide quality wildlife habitat
  - DO NOT provide improved Water Quality
  - DO NOT improve Forage Production
  - EXHIBIT INCREASED Soil Erosion
  - EXHIBIT DECREASED Biodiversity
Riparian functions depend on:

- VEGETATION
- SOIL/LANDFORM
- WATER
To assess PFC, consider the potential for each reach. Consider attributes & processes with an interdisciplinary team:

- Soils/Geomorphology
- Botany/Plant Ecology
- Hydrology
- Fish/Wildlife Biology
- Landowner/Permittee
ATTRIBUTES/PROCESS LIST

- HYDROGEOMORPHIC
  - GROUND-WATER DISCHARGE
  - ACTIVE FLOODPLAIN
  - GROUND-WATER RECHARGE
  - FLOODPLAIN STORAGE & RELEASE
  - FLOOD MODIFICATION
  - BANKFULL WIDTH
  - WIDTH/DEPTH RATIO
  - SINUOSITY – HYPORHEIC INTERCHANGE
  - GRADIENT
  - STREAM POWER
  - HYDRAULIC CONTROLS
  - BED ELEVATION
ATTRIBUTES/PROCESS LIST

- VEGETATION
  - COMMUNITY TYPES
  - COMMUNITY TYPE DISTRIBUTION
  - DENSITY
  - CANOPY
- COMMUNITY DYNAMICS & SUCCESSION
- RECRUITMENT/REPRODUCTION
- SURVIVAL
ATTRIBUTES/PROCESS LIST

- EROSION/DEPOSITION
  - BANK STABILITY
  - BED STABILITY
  - DEPOSITIONAL FEATURES
ATTRIBUTES/PROCESS LIST

- SOILS
  - CAPILLARITY
  - ANNUAL PATTERN OF SOIL WATER STATES
  - ERODIBILITY
  - FERTILITY
ATTRIBUTES/PROCESS LIST

- WATER QUALITY
  - TEMPERATURE
  - SALINITY
  - NUTRIENTS – Nutrient Spiral
  - DISSOLVED OXYGEN
  - SEDIMENT
Figure 1. Succession of states for alluvial/nongraded valley-bottom type.
<table>
<thead>
<tr>
<th></th>
<th>NO</th>
<th>NA</th>
<th>YES</th>
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<tbody>
<tr>
<td>1)</td>
<td>Floodplain above bankfull is inundated in “relatively frequent” events</td>
<td></td>
<td><strong>YES</strong></td>
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<td>2)</td>
<td>Where beaver dams are present, they are active and stable</td>
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<td>3)</td>
<td>Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)</td>
<td><strong>XX</strong></td>
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<td>4)</td>
<td>Riparian-wetland area is widening or has achieved potential extent</td>
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<td>5)</td>
<td>Upland watershed is NOT contributing to riparian-wetland degradation</td>
<td><strong>XX</strong></td>
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<td>YES</td>
<td>NO</td>
<td>NA</td>
<td>6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)</td>
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<td>7) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery)</td>
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<td>8) Species present indicate maintenance of riparian-wetland soil moisture characteristics</td>
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<td>9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high-streamflow events</td>
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<td>10) Riparian-wetland plants exhibit high vigor</td>
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<td>11) Adequate riparian-wetland vegetation cover is present to protect banks and dissipate energy during high flows</td>
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<td>12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)</td>
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<td>YES</td>
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Is this riparian area functioning properly?
Do the land uses here allow it to function properly?
Are riparian areas managed so Rivers can be Rivers?
The Flood Memory Half-Life: The Power to Forget

Longitudinal studies* show long-term declines in:

- Threat Preoccupation
- Risk Perception
- Psychological Distress

*Based upon studies of Mississippi River Floods of 1993, Hurricane Opal and Andrew, numerous tornado studies and Three Mile Island.
The Serial Engineering of Rivers & Floodplains

Floodplain Farming

Agricultural Levees

Floodplain Urbanization

Levee and "Multipurpose" Dam Construction

Flooding

Levee and "Multipurpose" Dam Construction

Floodplain Urbanization

Flooding

Flood Memory Half-life

Flood Memory Half-life

Flood Memory Half-life

Flood Memory Half-life
As Bridge Street, Yerington becomes a floodplain dam, what will we do to the Walker River after the next flood?
What evidence of serial engineering?
Where is it pretty to develop?
Which land uses are flood compatible?
What is the future of Our Rivers?

Los Angeles River at Main Street Bridge looking South

Truckee River in Reno & Sparks
When their waters flow,
what will they bring?
PLANNING PROCESS (Adaptive Management)

- 1. EXISTING CONDITION
- 2. POTENTIAL CONDITION
- 3. PFC (what is needed)
- 4. RESOURCE VALUES (what is wanted)
- 5. PRIORITIZE
- 6. MANAGEMENT GOALS and OBJECTIVES
  - Achievable & sustainable
  - Measurable
  - Worthy
- 7. PLANNED ACTIONS
- 8. MONITORING
- 9. FLEXIBILITY to modify management
A Management Chain Reaction

- Floodplain access & proper use management leads to
- At least a four inch stubble height leads to
- An increase in colonizers leads to
- Deposition there of fine sediments leads to
- An increase in stabilizers leads to
- Narrowing a stream leads to
- Increased floodplain access & aquifer recharge leads to
- Improved base flow leads to
- Improved water and habitat quality leads to
- Increased fish populations leads to
- Increased recreationist satisfaction

So, where is the objective?
A Management Chain Reaction

Where is the objective?

- Floodplain access & proper management
- At least a four inch stubble height
- An increase in colonizers
- Deposition there of fine sediments
- An increase in stabilizers
- Leads to narrowing a stream
- Increased floodplain access & aquifer recharge
- Improved base flow etc.
- Improved water and habitat quality
- Increased fish populations
- Increased recreationist satisfaction

Efficiently Monitored
Actions

Efficiently Monitored
Objectives

PFC

Values
**ADAPTIVE MANAGEMENT**

**ANNUAL INDICATORS OF RECOVERY**

1 - 5 YEARS

- End-of-season condition
  - Vegetative
    - Greenline

**5 - 10 YEARS**

- Vegetative/Physical
  - X-section composition
  - Woody recruitment
  - Greenline to Greenline Width
  - Bank Stability

**DECADES**

- Water and Habitat Quality
  - Temp
  - pH

- End-of-season condition
  - Vegetative
  - Bank alteration
  - Residual vegetation
## Adaptive Management

### Annual Indicators of Recovery
- End-of-season condition
  - e.g. ✓ residual vegetation
  - ✓ bank alteration

### 3-5 Years Indicators of Recovery
- Vegetative
  - e.g. ✓ greenline

### 5-10 Years Indicators of Recovery
- Vegetative/Physical
  - e.g. ✓ X-section composition
  - ✓ Woody recruitment
  - ✓ Greenline to Greenline Width
  - ✓ Bank Stability

### Decades Indicators of Recovery
- Water and Habitat Quality
  - e.g. ✓ Temp
  - ✓ pH
ADAPTIVE MANAGEMENT

ANNUAL INDICATORS OF RECOVERY

3 - 5 - YEARS INDICATORS OF RECOVERY

5 - 10 YEARS INDICATORS OF RECOVERY

DECADES INDICATORS OF RECOVERY

= End-of-season condition
  e.g. ✓ residual vegetation
       ✓ bank alteration

= Vegetative
  e.g. ✓ greenline

= Vegetative/Physical
  e.g. ✓ X-section composition
       ✓ Woody recruitment
       ✓ Greenline to Greenline Width
       ✓ Bank Stability

= Water and Habitat Quality
  e.g. ✓ Temps
       ✓ pH
       ✓ Dissolved Oxygen
ADAPTIVE MANAGEMENT

T I M E

ANNUAL INDICATORS OF RECOVERY

3 - 5 - YEARS INDICATORS OF RECOVERY

5 - 10 YEARS INDICATORS OF RECOVERY

DECADERS INDICATORS OF RECOVERY

= End-of-season condition
  e.g. ✓ residual vegetation
       ✓ bank alteration

= Vegetative
  e.g. ✓ greenline

= Vegetative/Physical
  e.g. ✓ X-section composition
        ✓ Woody recruitment
        ✓ Greenline to Greenline Width
        ✓ Bank Stability

= Water and Habitat Quality
  e.g. ✓ Temp
       ✓ pools
Bear Creek 1977

75AUMs June – Aug.
Difference in Air & Water Temperatures

Bear Creek - Central Oregon
1976
19 Years Later

4 x ↑ water storage, 10 x ↑ production, 15 x ↓ erosion, 3 x ↑ riparian area

354 AUMs Late winter early spring
Difference in Air & Water Temperatures

Bear Creek - Central Oregon
1998
INVENTORY ALL STREAMS UTILIZING PFC PROCESS

- FAR w/Downward Trend or Non-Functional
  - Modify Management Strategy
  - Monitor "NOs" From Checklist
    - Static/Downward Trend
      - Modify Management Strategy
    - Upward Trend
      - Continue Management Strategy

- Static/Downward Trend
  - Modify Management Strategy
  - Continue Monitoring (INCLUDE RMOs)
    - Attain PFC

- PFC or FAR w/Upward Trend
  - Continue Management Strategy
  - Monitor RMOS
    - Static/Downward Trend
      - Modify Management Strategy
    - Upward Trend
      - Continue Management Strategy
      - Continue Monitoring RMOS
        - Attain RMOs

- Modify Management Strategy with Upward Trend
  - Continue Management Strategy
  - Continue Monitoring (INCLUDE RMOs)
Desired Future Condition (DFC)

- Does not equal
- Does not replace

- Supports Legal Requirements, e.g., ESA, CWA
PFC Helps

Determine potential and capability
Link reach/watershed processes to habitat/water-quality conditions
Define issues to be addressed
Select appropriate management practices
Determine appropriate monitoring
For Further Information:

- Sherman Swanson (775-784-4057)
- sswanson@cabnr.unr.eu
- National Riparian Service Team – BLM, FS, NRCS, and a network of other agency and NGO people in all western states

- http://www.blm.gov/or/programs/nrst/index.php
Addendum:

- PFC is a qualitative assessment to understand the location and nature of riparian issues & opportunities
- To monitor at-risk reaches or wetlands, use quantitative method(s)
- Riparian monitoring provides excellent experience for developing professionals
- They gain journey-level skills needed for an effective ID Team for qualitative assessment