Welcome to the Conservation Lecture Series

https://www.wildlife.ca.gov/Conservation/Lectures

Questions? Contact Margaret.Mantor@wildlife.ca.gov
CDFW Conservation Lecture Series

The Conservation Lecture Series is organized by CDFW's Habitat Conservation Planning Branch. The lecture series is designed to deliver the most current scientific information about species that are of conservation concern.

Below is a list of lectures and speakers for the Conservation Lecture Series. Lectures are open to anyone who is interested in participating. Participants may attend in-person or remotely via webinar. Please be sure to register for each class. Lectures are recorded and posted for those unable to attend the day of the event. Visit the archive page to see recordings of past lectures.

Subscribe to receive email updates and invitations to upcoming lectures.

Upcoming Lectures

Coming Soon

American Badgers - August 6, 2015, 1:00-3:00 pm. Presented by Dr. Jessie Quinn

The American badger (*Taxidea taxus*) is a Species of Special Concern in California. Funded by a grant from the CDFW Resource Assessment Program (RAP), Dr. Jessie Quinn studied the population distribution, movement behavior, and pathogen and rodenticide exposure in collaboration with the UC Davis Wildlife Health Center with support from the OSPR Marine Wildlife Veterinary Care and Research Center. She completed a Species Status Report for the American badger for CDFW in 2009, and more recently completed a book chapter on pathogens and parasites in American badgers that will be included in the upcoming text *Badgers of the World*. Dr. Quinn's lecture will discuss the natural history of the species in California, potential threats to populations, and results of her research.

Location: Natural Resources Building, First Floor Auditorium
Process-based Restoration to Help Farmers and Fish-
Why California Needs 10,000 More (Ecologically Functional) Dams

Michael M. Pollock  NOAA Fisheries-Northwest Fisheries Science Center, Seattle Washington
Brian Cluer  NOAA Fisheries Western Regional Office, Santa Rosa, California
Topics

- Why dam channels to restore them?
  - Answer: To create stage zero channels
  - Definitions
    - Ecologically Functional Dams
    - Stage Zero Channels or Fluvial Systems

- Stage zero channels
  - Attributes
  - Occurrence on the landscape
  - Ecological Importance
  - Process-based principles for restoring zero order channels and the role of EFDs
  - Examples at multiple scales
Ecologically Functional Dams

- Natural, semi-permeable instream structures (or their human analogues), which slow transport rates of sediment and water and help to create, restore or maintain stage zero channels.
- Consist of natural materials such as wood and other organic matter, live vegetation, rock, and mud.
- Examples: wood jams, beaver dams, rock slides, debris jams, standing live trees and shrubs, emergent vegetation.

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Stage Zero Channels

- A dynamically meta-stable network of anabranched channels with vegetated islands, which creates physically and biologically complex habitat that provides high levels of ecological goods and services. Occur across a wide range of stream sizes.
- Typical characteristic include: well connected floodplains with elevated water tables, multithreaded channels, spatially variable hydrologic regimes and structurally complex aquatic and riparian habitat.
Floods diffused over the full width of the floodplain so flood peaks are maximally attenuated. Flood pulses diffused and subdued. High water table and close connection between stream flow and ground water ensures reliable base flows and continuous hyporhesis, though flow in smaller anabranches may be ephemeral.
Hydraulics and Substrate

- Multiple channels provide maximum in-channel hydraulic diversity through partition of discharge between branches that widens range of in-channel depth/velocity combinations. Anabranches create multiple slow water margins and channels. Wide range of substrate grain sizes arranged into numerous, well-sorted bed patches.
Multiple anabranche, islands and side channels. Morphological features abound in-channel and on the extensive and fully connected floodplain, providing a high capacity to store sediment and wood and supporting diverse wetlands and aquatic habitats. Bank heights are low with stability enhanced by riparian margins, but some unvegetated banks are generated by localized erosion. Network and floodplain are highly resilient to disturbance, buffering the system.
Frequent, small channel adjustments and high, reliable water table create ubiquitous settings for proliferation and succession of aquatic, emergent, riparian and floodplain plants. Wet woodlands on islands and floodplain supply and retain wood, and widespread vegetation proximal to channels produces abundant leaf litter. When present, beaver use vegetation to build dams and lodges. Biogenic obstructions such as large wood, beaver dams and live vegetation help to create and retain an anabranching channel pattern.
Where Do Stage Zero Channels Occur?

**Sediment supply zone:**
Weathering and erosion of steep slopes. Multiple tributaries collect sediment and supply it to the mainstem. Forced settings have single thread channels. Intermittent mountain meadows and valleys have Stage 0-1 channels where undisturbed.

**Alluvial fan zone:**
Depositional fans accumulate coarse sediment, buffering transfers downstream. Frequent avulsions in multiple Stage 0-1 channels, if undisturbed.

**Deposition zone:**
Fine sediment is naturally deposited on floodplain/coastal plain or as a delta. Domain of Stage 0-1 channels if undisturbed.

**Transfer zone:**
Main stream receives and exchanges coarse sediment loads with floodplain, buffering downstream transfer. Domain of Stage 0-1 channels if undisturbed.

From Cluer and Thorne 2014
Stage Zero Examples

Salmon River, Idaho
Stage Zero Examples

Lemhi River, Idaho
Stage Zero Examples

Peel River, Canada
Stage Zero Examples

- Wenaha River Tributary, Eastern Oregon
The Stage Zero Channel as a Recovery Goal

From Cluer and Thorne 2014
See also Walter and Merritts 2008

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## Habitat and Ecosystem Benefits Table

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<td>Temperature amelioration (shade and hyporheic flow)</td>
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<td>Biodiversity (species richness and trophic diversity)</td>
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<td>Proportion of Native Biota</td>
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From Cluer and Thorne 2014
Natural Recovery Rates Can be Long

From Pollock et al. 2014

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Degraded streams have limited ecological function.
The scale of restoration needs to be commensurate with the scale of the actions that caused the degradation.
Meaningful restoration needs to occur on a time frame relevant to recovery time frames for target species (e.g. salmon) so as to avoid extinction.
Principles for building Stage Zero System

From Pollock et al. 2014
Increased Flow Resistance is Essential

From Pollock et al. 2014

\[ nQ_s d_{50} \propto D_w S \]
Factors Controlling Stage Zero Channel Formation

Valley confinement

Sediment supply,
Sediment size

Discharge

Channel slope

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Factors Controlling Stage Zero Channel Formation

- Sediment supply, Sediment size
- Vegetation
- Herbivores
- Valley confinement
- Predators
- Bank material
- Channel slope
- Discharge
- Beaver

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Beaver Dams

- Can reduce recovery times from Stage 1 to Stage 7-8/0 systems by 1-2 orders of magnitude (year to decades instead of decades to centuries)

From Pollock et al. 2014
Beaver dams create complex habitat that provide many benefits

- Groundwater Recharge
- Expanded Riparian Vegetation
- Floodplain reconnection
- Juvenile Rearing & Overwintering
- Holding Pool
- Fish Passage
- Cool Water Upwelling / Spawning
- Hyporheic flowpaths
Beaver and BDAs creating a zero order “channel”
Since 2009, a combination of BDAs and beaver turned a narrow single thread channel with an infrequently inundated floodplain into a multi-threaded channel with water levels close to the floodplain surface most of the year.
Survival of *O. mykiss* in Bridge and Murderers (trt and cntrl)

Analysis by Mary Conner

*O. mykiss* survival season

- **Bridge (trt)**
- **Murderers (cntrl)**
Average Groundwater Elevation

Time (2006-2012)

Discharge (CFS)

Alluvial Groundwater Analysis by Jason Hall
Plan view of a beaver dam showing cooling effect of hyporheic flow paths

Incoming Stream Temperature
= 70-80 Degrees

Beaver Dam

General Direction of Hydraulic Gradient

Ground Temperature
= 54 degrees

Longer subsurface flow paths allow for more cooling

Substantial hyporheic exchange can cool the entire stream

Cool Water Refugia
= 55-65 Degrees

Some hyporheic flowpaths may be very long

Daily Maximum Temperature (°C)

Pollock et al. 2007
Wood Jams
Wood Jams

Hunter Ck – First flows 2014

Post 5-yr RI flood WY15

Courtesy of Rocco Fiori
Wood-based Stage Zero Restoration Tools

Log Steps (USFS-many locales, T. McKee-Mattole R., CA)
Wood Jams (Many locales, e.g. Rocco Fiori, Klamath River, CA)
Gravel Dams (Campbell Ranch-Silvies R., OR, CDA Tr., ID)
Meander Dams (Quivira Coalition, NM)
Constriction Dams (N. Bouwes-Asotin R., WA)
Choke Dams (P. Devries-Idaho)
Process-based restoration restores processes, not specific habitat types
What types of structures are appropriate?

<table>
<thead>
<tr>
<th>Location</th>
<th>Off-channel ponds</th>
<th>Beaver Pond steps, Overflow</th>
<th>Log steps, Underflow</th>
<th>Bank Input Debris</th>
<th>Valley Jams</th>
<th>Flow Deflection Jams</th>
<th>Unstable Logs</th>
<th>Apex Jams</th>
<th>Mean-der Jams</th>
<th>Log Rafts</th>
<th>Debris Flow Jams</th>
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### What are your goals? (coho as an example)

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<tbody>
<tr>
<td>&lt;50m BFW, &lt;500m VW</td>
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<td>S (&lt; 10 m)</td>
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#### Geomorphology
- Floodplain reconnectivity: X
- Bedrock to alluvium conversion: X
- Increased planform complexity: X
- Increased spawning gravel mobility: X
- Multichannel formation: *
- Sediment storage/aggradation: X

#### Hydrology/Hydraulics
- Extensive slow-water habitat: XX
- Increased streamflow/GW recharge: X
- Hyporheic exchange: X
- Thermal refugia: X
- Upstream backwater pool: X
- Downstream scour pool: X
- Under or lateral scour pool: ?

#### Biology/Other
- Increase riparian vegetation: X
- Improved food production: X
- Cover: X
- Wetland formation: X
Types of “Dams” that Build Stage Zero Channels/Valleys-Scaling Up

- Beaver Dams
- Live Vegetation
- Large Wood
- Levee Setbacks
- Landslides
- Alluvial Fans
- Sea Level (Rise)
- Tectonics

Key Functions:
- Increase flow resistance,
- Lower slope
- Reduce stream power/unit width

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Levee Removal

- Can (re)create stage zero systems if channel is at grade or perched
- In incised systems, flow/sediment obstructions can accelerate habitat recovery

Eel River, California

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Landslides-Naches River, WA (Nile Valley)
Controls on valley width in mountainous landscapes: The role of landsliding and implications for salmonid habitat

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²Department of Geological Sciences, University of Oregon, Eugene, Oregon 97403, USA
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⁴U.S. Forest Service Pacific Northwest Research Station, Corvallis, Oregon 97331, USA

ABSTRACT

A fundamental yet unresolved question in fluvial geomorphology is what controls the width of valleys in mountainous terrain. Establishing a predictive relation for valley floor width is critical for realizing links between aquatic ecology and geomorphology because the most productive riverine habitats often occur in low-gradient streams with broad floodplains. Working in the Oregon Coast Range (western United States), we used airborne lidar to explore controls on valley width, and couple these findings with models of salmon habitat potential. We defined how valley floor width varies with drainage area in a catchment that exhibits relatively uniform ridge-and-valley topography sculpted by shallow landslides and debris flows. In drainage areas >0.1 km², valley width increases as a power law function of drainage area with an exponent of ~0.6. Consequently, valley width increases more rapidly downstream than channel width (exponent of ~0.4), as derived by local hydraulic geometry. We used this baseline valley width–drainage area function to determine how ancient deep-seated landslides in a nearby catchment influence valley width. Anomalously wide valleys tend to occur upstream of, and adjacent to, large landslides, while downstream valley segments are narrower than predicted from our baseline relation. According to coho salmon habitat-potential models, broad valley segments associated with deep-seated landsliding resulted in a greater proportion of the channel network hosting productive habitat. Because large landslides in this area are structurally controlled, our findings indicate a strong link between geologic properties and aquatic habitat.

sediment by providing space for the formation of debris flow fans. In addition, low-gradient broad valleys with old-growth forest store the great majority of above-ground and below-ground carbon in mountain streams (Wohl et al., 2012). Understanding the links between hillslope processes and riverine habitat is particularly important for Pacific salmon (Oncorhynchus spp.) because these fish are intricately tied to Pacific Rim topography (Montgomery, 2000; Waples et al., 2008).

The goals of this paper are twofold. First, we seek to define an empirical relation between valley width and drainage area (akin to hydraulic geometry for river channels) in a setting with negligible influence from variable rock properties and deep-seated landslide activity. Our approach uses high-resolution topography generated from airborne lidar to define this baseline relation of valley width in a mountainous catch-
Sea level - the ultimate dam

Taku River (southeast) Alaska

Kuskokwim River, Alaska
MacKenzie River, Canada
Yukon River, Alaska
Sacramento-San Joaquin Rivers-150 ybp
150 years ago, 5% of California was "wetlands", mostly in the Central Valley, really more of a wetland-river complex.
A Tectonic “Dam”-Scott River, Klamath Basin
Okavango River, Botswana
If all the ice melts, >200 ft
tsea level rise
- 1-3 m rise predicted by 2100, but predicted rates keep increasing.
- Circa 5000 yrs for 200 foot rise (big error bars), but on the scale of the rise and fall of civilizations
- Need sediment to counteract rising seas.
Really Big Low Head
Dams as Tide Barriers-
- St Petersburg-16 mi
Venice-1.5 mi (3 openings)
Carquinez Strait? -1 mi
Current Water Management Paradigms are Causing Substantial Long-term Problems

-Is this a map of the past or a blueprint for the future?

-A 150 Year Restoration Plan? (Delta is currently sinking)

-No farms, no food, and…
No water no farms,
No sediment, no farmland

-Floods are inconvenient but droughts destroy civilizations
Sediment is a resource
- No sediment = no alluvial valleys
- Base flow water elevation is key design feature

Three components to stream restoration
- Sediment, Water and Biota

These processes play out at multiple spatio-temporal scales to:
- Lower stream and valley slopes
- Lower stream power per unit width
- Increase retention rates of both sediment and water
- Benefit Fish, Benefit Farmers

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Degraded streams have limited ecological function

The scale of restoration needs to be commensurate with the scale of the actions that caused the degradation

Restoration needs to occur on a time frame relevant to recovery time frames for target species (e.g. 100 years for salmon) so as to avoid extinction
Regulatory Issues

- In terms of adverse effects-spatial and temporal scales of effects needs to be reconsidered
  - Short-term v. long-term
  - Fine-scale v. coarse scale
  - Individual v. population
Regulatory Scenarios- BDs/BDAs

1. Unknown what is in pond above BD nonC/ESA adult Chinook in pool below, no “human visible” fish passage

2. C/ESA juvenile coho in pond above BD C/ESA adult coho in pool below, no “human visible” fish passage.

3. C/ESA juvenile coho abundant in pond above BD C/ESA juvenile coho in pool below, no “human visible” fish passage.

4. Scenario 3 but below BDA, stream is drying up, and the last remaining wet reach is just below the beaver dam.
Regulatory Scenarios-BDs/BDAs

1. C/ESA juvenile coho in pond above BDA nonC/ESA adult Chinook in pool below, no “human visible” fish passage.
2. C/ESA juvenile coho in pond above BDA C/ESA adult coho in pool below, no “human visible” fish passage.
3. C/ESA juvenile coho abundant in pond above BDA C/ESA juvenile coho in pool below, no “human visible” fish passage.
4. Scenario 3 but below BD, stream is drying up, and the last remaining wet reach is just below the beaver dam.
5. BD increases total amount of good habitat, but also increases total habitat that is less good (e.g. temp, DO issues)

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Stage Zero Restoration:
= Process **discontinuity management**
= habitat management,
Does not = continuity management

- Sediment = Essential ingredient
  - Deposition and sorting
  - Aggradation
  - Erosion and avulsions
  - Sediment = a resource
  - No Sediment = No Valley floor

- Water
  - Flow diffusion
  - Groundwater recharge
  - Hyporheic exchange
  - Long inundation periods
  - Less distinction between wetlands and channels and floodplains
Stage Zero Attributes or Tendencies

- Multi-threaded or no definable channels (vegetation)
- Common in unconfined, low-gradient valleys
- Low stream power/unit width
- Wide range of hydrologic conditions
- Abundant off-channel habitat w/long inundation periods
- Elevated water tables
- Wide range of Velocity/Depth combinations
- Blurred line between wetlands and channels
- Biological flow resistance in channels, on banks and on stream adjacent surfaces (e.g. floodplains and mid-channel islands)
  - Aquatic vegetation
  - Emergent vegetation
  - Live trees and shrubs
  - Dead trees
  - Beaver dams-dead trees and shrubs (N. Hemisphere)
Continuity of Sediment Transport or Habitat Formation?
Restoration “Toolkit” for Building Stage Zero Channels/Valleys

- Beaver Dams
- Live Vegetation
- Large Wood
- Levee Setbacks
- Landslides
- Alluvial Fans
- Sea Level Rise
- Tectonics

Increasing Time Scales

These Tools:
- Increase Flow Resistance,
- Lower Slopes
- Reduce Stream Power/Unit Width

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BDAs work together

Primary Dam
- Pond creation
- River right flow dispersal

Secondary Dam
- Pond extension
- Dissipate gradient

Secondary Dam
- Pond extension
- Return flow capture

Constriction Dams
1) Erode exposed cutbank for gravel recruitment, increased sinuosity and channel lengthening
2) Scour pool formation
3) Bar formation
4) Incorporate existing features to force flow against or to anchor to.
* structure spacing not shown to scale

Primary Dam
5) Dam-forced ponding
6) High-flow dispersal over floodplain and high bench
7) Captures material recruited from constriction dams and other US sediment sources causing aggradation

* structure spacing not shown to scale
Historical data helpful: e.g. extensive wetlands and beaver dams in Scott Valley
Beaver and riparian vegetation have been part of stream ecosystems for a long-time, so we are currently in a somewhat unique situation.
Where are you in the network?

Reach

BFW < 8 m *

Slope < 0.015

Pool-riffle

Slope < 0.03

Plane-bed

Slope < 0.065

Step-pool

Cascade

Confined

Prediction Model *

Braided

Island-braided

Meandering

Straight

Small “Mountain” Channels
Montgomery and Buffington (1997)

Large Unconfined Channels
Beechie and Imaki (in review)

* Support Vector Machine