2D HYDRODYNAMIC-BASED LOGIC MODELING TOOL FOR RIVER RESTORATION DECISION ANALYSIS

A QUANTITATIVE APPROACH TO PROJECT PRIORITIZATION

River Restoration NW, Feb. 5, 2014
Hydraulic Model +
Habitat Analysis +
Prioritization Rules =

A tool to decide what parts of the river need work the most.
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The Trinity River, Northern California
Trinity and Lewiston Dams completed in 1964, part of the Central Valley Project

70 – 90% of the inflow to Trinity Lake diverted to the CVP from 1964 to 2000
Post-Dam Reduction of Discharge

Peak discharge is a fraction of what it once was.
Effects on Fish Populations

<table>
<thead>
<tr>
<th>Species</th>
<th>% Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinook</td>
<td>67%</td>
</tr>
<tr>
<td>Coho</td>
<td>96%</td>
</tr>
<tr>
<td>Steelhead</td>
<td>53%</td>
</tr>
</tbody>
</table>

Decrease from Pre-Dam Population

- Less spawning in coarse bed material
- Inaccessible upstream habitat
- Altered thermal regime
- Lack of juvenile rearing habitat
Trinity River Restoration Program (TRRP est. 2000)

The goal is to create fish habitat and recover salmonid populations

Rescale the river for the new flow regime

Rivers adjust to the 1-2 year flood
40 Miles of River to Restore

Lewiston Dam to the North Fork

- Restore dynamic fluvial processes
- Increase flows
- Add transportable gravel
- Lower floodplains
- Remove barriers to channel migration
47 Sites Selected For Rehabilitation

About half are already constructed.

What remaining sites on the river are highest priority?

A need for quantitative prioritization and prediction capabilities.
Rehabilitation Project Prioritization

2D Hydraulic Model [Flow Scenarios]

Habitat Module: Evaluation Metrics

Logic Model: Statistical Analysis

Project Prioritization/Ranking
Sedimentation and River Hydraulics Model (SRH-2D)

Solves the St. Venant equations

Model mesh represents terrain

Boundary conditions: dam release, tributary inputs, outlet WSE

Calibrated by tuning roughness to observed water surface elevations
Digital Terrain Model (DTM)

Airborne LiDAR
(+/- 0.3 ft RMSE)

Sonar bathymetry
(+/- 0.7 ft RMSE)

Field check:
40 measured XS’s
849 RTK GPS points
Model Calibration

Tune roughness to match observed WSE

Some observations were inconsistent with bathymetry (WSE < BedZ).

WSE collected during bathymetric survey was most appropriate.

<table>
<thead>
<tr>
<th>Calibration Discharge (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
</tr>
<tr>
<td>1200</td>
</tr>
<tr>
<td>1300</td>
</tr>
<tr>
<td>1600</td>
</tr>
<tr>
<td>2000</td>
</tr>
<tr>
<td>2500</td>
</tr>
<tr>
<td>4500</td>
</tr>
</tbody>
</table>
Model WSE Misfit at Calibration Flows

Misfit = Model Z – Observed Z

CDF

Long Profile
Model Outputs (Hydraulic + Habitat)

Spatial
- WSE
- Depth
- Velocity
- Froude number
- Shear stress (and divergence)
- Vorticity
- Distance to cover
- Habitat category

Panel
- Total area in each habitat category
- Mean and std. deviation of spatial parameters over the panel

Cross section
Mean width, depth, velocity, elevation, slope, width to depth ratio, wetted area
The Logic Model

“a statistical prioritization tool that helps identify the most desirable locations for channel rehabilitation actions”
(Muraskas, 2014)

Combines hydraulic and habitat data with geospatial data (property ownership, infrastructure) and user-defined rules to rank potential restoration sites.
1st Application: 2016 Site Selection

Juvenile Rearing Habitat Metrics

Weighted Useable Area (WUA) at winter baseflow and a low spring flow

Proximity to upstream spawning areas (# of redds within 800 m)

River complexity
  - std. dev. of bed elevation
  - std. deviation of unit stream power at a gravel transporting flow
WUA based on Habitat Suitability Curves

Averaged, weighted by element area, and summed over a panel to yield Weighted Useable Area (WUA).
Metric Weighting

<table>
<thead>
<tr>
<th>Metric</th>
<th>Weight</th>
<th>Relative influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>WUA at 300 cfs + tribs</td>
<td>1.50</td>
<td>0.333</td>
</tr>
<tr>
<td>WUA at 1500 cfs</td>
<td>1.00</td>
<td>0.222</td>
</tr>
<tr>
<td>Upstream redds (2011 – 2013)</td>
<td>1.00</td>
<td>0.222</td>
</tr>
<tr>
<td>SD of bed elevation (m)</td>
<td>0.50</td>
<td>0.111</td>
</tr>
<tr>
<td>SD of unit stream power at 8,500 cfs</td>
<td>0.50</td>
<td>0.111</td>
</tr>
</tbody>
</table>

**Low WUA, High Connectivity, Low Complexity = Needs Work**

A spatial clustering algorithm identifies proximal areas with similar scores (Aldstadt and Getis, 2006).
Professional judgment: the crucial final step
Dutch Creek
Questions?

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