Assessing the Effects of Water Rights Purchases on Dissolved Oxygen, Stream Temperature, and Fish Habitat

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Background

• Human impacts from land and water development have degraded water quality and altered the physical, chemical and biological integrity of Nevada’s Walker River (Figure 1).
• High daily stream temperatures and low nightly dissolved oxygen concentrations affect native fish populations (Figure 2).
• Water rights purchases are being considered to maintain instream flows, improve water quality and enhance habitat for native fish species, such as Lahontan cutthroat trout.
• Stream temperatures and dissolved oxygen concentrations are proxies for trout habitat.

Objectives

• Monitor the extent and seasonality of high stream temperatures and low dissolved oxygen concentrations (Figure 3).
• Simulate thermal and dissolved oxygen changes from increased streamflow to prioritize the time periods and locations that water rights purchases most enhance native trout habitat.

Methods

• Established a dissolved oxygen sensor network.
• Ten PME MiniDOts deployed collecting hourly temperature and dissolved oxygen data.
• DO: Accuracy = ±0.1 mg/L; Resolution = ±0.05 mg/L
• Temp: Accuracy = ±0.10°C; Resolution = 0.01°C

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Preliminary Results: Mean Daily Temperature & DO

Figure 1. Walker River Basin showing East, West and Mainstem Walker River flowing into terminal Walker Lake. Stream Color indicates lowest mean daily dissolved oxygen content, in mg/L, monitored by DO sensor. Black arrows indicate agricultural canal outflows with size corresponding to average canal flow volume. Spotted arrows represent inflows (either natural streams or agriculture-return canals).

Minimum Mean Daily DO (mg/L)

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Level of Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 3.1</td>
<td>No Production Impairment</td>
</tr>
<tr>
<td>0.1 - 1.0</td>
<td>Slight Production Impairment</td>
</tr>
<tr>
<td>1.1 - 1.5</td>
<td>Moderate Production Impairment</td>
</tr>
<tr>
<td>1.6 - 2.0</td>
<td>Severe Production Impairment</td>
</tr>
<tr>
<td>2.1 - 2.5</td>
<td>Extreme Production Impairment</td>
</tr>
<tr>
<td>2.6 - 3.0</td>
<td>Limit to Avoid</td>
</tr>
</tbody>
</table>

Figure 2. Level of water quality impairments to adult trout. Colored boxes correspond to stream shade colors. Red to black gradient matches shading in Figure 3.

Water Quality Impairments to Trout

Figure 3. Mean daily stream temperature and dissolved oxygen recorded at monitoring sites, as well as daily stream flow from associated USGS gaging stations. Red to black gradients indicate impairment zones and degree of impairment. Top-left numbers indicate site locations.

Work in Progress

• Modeling using Tennessee Valley Authority’s River Modeling System (RMSv4) for two years: Water Year 2014 and Water Year 2015.
• A one-dimensional, hourly, physically-based hydrodynamic and water quality model.
• Simulate water rights purchases to quantify affects to stream temperature and DO.

References: