State of the Lower Mokelumne River

May 2, 2011
EBMUD’s Mokelumne River Fish Restoration Program

- Integrated approach to ecosystem management
- Codified in 1998 Joint Settlement Agreement
- 10-fold increase in dry-year flows from early 1990s
- A portion of newly acquired supplies provided to further increase Mokelumne flows
- Formal collaboration with resource agencies and stakeholders to optimize river management
- $2 million Endowment for habitat improvements
- $12.5 million in improvements to upgrade hatchery
EBMUD’s Mokelumne Water Releases for Fish

Year Type
- Critically Dry
- Dry
- Below Normal
- Wet

Acre-feet
- Before Mid-1990s Flows
- Joint Settlement Agreement Flows
Mokelumne Fish Hatchery
(From Camanche Dam)

- Admin, Freezer, Shop
- Spawning, Egg, Incubation, Rearing
- Adult Holding Ponds
- Raceways (rearing)
- Downstream
- Settling Ponds
- Storage
- Ladder
- Fish Guidance Fence
EBMUD has worked cooperatively with the downstream Woodbridge Irrigation District to improve fish passage in the lower Mokelumne River, helping to increase survival.
O. mykiss Run Timing Past WID Dam

FISH PASSAGE
## Annual Counts of *O. mykiss* at WID Dam

<table>
<thead>
<tr>
<th>Monitoring Period</th>
<th>Run Timing</th>
<th>Number</th>
</tr>
</thead>
</table>
## Gravel Rehabilitation Project

$696,000 AFRP funding  
$247,000 EBMUD funding  
$60,000 CDFG funding  
$22,000 Partnership funding

<table>
<thead>
<tr>
<th>Year</th>
<th>Gravel added (cubic yards)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>1,200</td>
</tr>
<tr>
<td>1999</td>
<td>3,104</td>
</tr>
<tr>
<td>2000</td>
<td>1,155</td>
</tr>
<tr>
<td>2001</td>
<td>721</td>
</tr>
<tr>
<td>2002</td>
<td>2,215</td>
</tr>
<tr>
<td>2003</td>
<td>2,557</td>
</tr>
<tr>
<td>2004</td>
<td>2,394</td>
</tr>
<tr>
<td>2005</td>
<td>4,091</td>
</tr>
<tr>
<td>2006</td>
<td>4,372</td>
</tr>
<tr>
<td>2007</td>
<td>4,850</td>
</tr>
<tr>
<td>2008</td>
<td>4,390</td>
</tr>
<tr>
<td>2009</td>
<td>4,776</td>
</tr>
<tr>
<td>2010</td>
<td>3,361</td>
</tr>
</tbody>
</table>
|      | **39,188**  
|      | SPAWNING GRAVEL  

![Gravel Rehabilitation Project Image](image_url)
Spatial distribution of *O. mykiss* reds through time

1999 - 2003 ($n = 33$)

2007 - 2010 ($n = 33$)
Construction of Restored Side Channel Habitats (2005)

- Creation of >1,900 m² off-channel rearing habitat
- Native organisms, including juvenile salmon, quickly colonize wetted habitat, enhancing food web productivity
- This habitat restoration works!
Results (Floodplain connectivity)

Floodplain Inundation at 400 CFS
- 2006 Edge of Water
- 2010 Edge of Water

Floodplain habitat increased by 2286 m²

SPAWNING GRAVEL & RIPARIAN HABITAT
O. Mykiss redd counts

![Bar chart showing annual redd counts for O. Mykiss with survey years and counts from 1994 to 2010. The chart indicates the number of complete, partial, and unknown surveys.

Reedd Survey Year

1994: 15
1995: 27
1996: 9
1998: 9
1999: 20
2000: 40
2001: 30
2002: 50
2003: 18
2004: 38
2005*: 65
2006: 43
2007: 51
2008: 66
2009: 66
2010: 53

* No survey

Complete survey
Partial survey
Unknown

Spanning Gravel
Broodstock sources for *O. mykiss*

![Bar chart showing number of eggs/fry imported (Thousands) by brood year and source. The sources include Mokelumne River, Nimbus, Feather River, Coleman, and Mok./Nimb. Mix. The chart displays data from 1966 to 2010.]
• Since 1990, EBMUD has tagged and released over 8.7 million hatchery-origin and 320,000 wild-origin Chinook salmon with coded wire tags.

• Constant Fractional Marking program marks and tags at least 25% of hatchery-produced fish – critical to track the success of fish productivity and harvest.

• Tracking devices inserted in Steelhead (natural and hatchery origin), used to track fish migration routes.
Methods – Fish Handling

1-inch incision into the abdominal cavity

implant acoustic transmitter

close the incision with 2-3 stitches using monofilament sutures
Method – Hatchery Steelhead Releases
Method – Natural Production
Steelhead Releases
Hatchery Origin Success to Golden Gate Bridge

- On Site: 20% (N=6)
- New Hope: 4% (N=2)
- Antioch: 5% (N=5)
- San Pablo: 6% (N=2)
- San Pablo (2 year old): 11% (N=4)
- San Pablo (2 year olds): 7% (N=2)
- Moke River: 25% (N=2)
- On Site (Kelts): 33% (N=2)
- New Hope (Kelts): 22% (N=2)
Through Delta Flows to Pumps Impact Mokelumne Fish Passage
Mokelumne River 2010 Chinook salmon returns compared to Partnership initiated pulse flows and DCC closure
Improve Water Supply Quality

WATER QUALITY

Camanche Hypolimnetic Oxygenation Project

Site Plan

Camanche Dam
Mokelumne River
Mokelumne River Fish Facility
Camanche Power Plant
Access Road
Existing Power Supply
Liquid Oxygen Facility
High Level Outlet
Low Level Outlet
O$_3$ and Electrical Feed Lines
Speece Cone Oxygenator
Perisher Wate Discharge Upstream

WATER QUALITY
Water Chiller

- Maintain <14.5 deg. C
- Water supply in early season up to 16 deg. C
### Controlled Flood Flow Releases to Manage Invasive Aquatic Vegetation

#### Aquatic vegetation coverage

<table>
<thead>
<tr>
<th>Year</th>
<th>Peak flow (m³•sec⁻¹)</th>
<th>Site</th>
<th>Before</th>
<th>After</th>
<th>Reduction</th>
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</thead>
<tbody>
<tr>
<td>2009</td>
<td>56.1</td>
<td>1</td>
<td>47.8%</td>
<td>41.0%</td>
<td>6.8%</td>
</tr>
<tr>
<td>2009</td>
<td>56.1</td>
<td>2</td>
<td>60.7%</td>
<td>47.8%</td>
<td><strong>12.9%</strong></td>
</tr>
<tr>
<td>2009</td>
<td>56.1</td>
<td>3</td>
<td>67.8%</td>
<td>40.5%</td>
<td><strong>27.3%</strong></td>
</tr>
<tr>
<td>2006</td>
<td>141.7</td>
<td>3</td>
<td>34.9%</td>
<td>9.2%</td>
<td><strong>25.7%</strong></td>
</tr>
<tr>
<td>2004</td>
<td>42.7</td>
<td>3</td>
<td>40.7%</td>
<td>34.9%</td>
<td>5.8%</td>
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<td>2003</td>
<td>56.1</td>
<td>4</td>
<td>44.1%</td>
<td>47.7%</td>
<td>0.0%</td>
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<tr>
<td>2003</td>
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<td>3</td>
<td>43.2%</td>
<td>42.4%</td>
<td>0.9%</td>
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<tr>
<td>2003</td>
<td>56.1</td>
<td>2</td>
<td>66.8%</td>
<td>46.8%</td>
<td><strong>20.0%</strong></td>
</tr>
<tr>
<td>2003</td>
<td>56.1</td>
<td>1</td>
<td>43.7%</td>
<td>14.6%</td>
<td><strong>29.1%</strong></td>
</tr>
</tbody>
</table>

**Bold** indicates significant reduction

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**Graph:**
- **X-axis:** Months from Jan-03 to Jan-09
- **Y-axis:** Flow (m³•sec⁻¹)
- Circled peaks denote periods of significant flow releases.
Summary

- EBMUD manages the lower Mokelumne River in partnership with CDFG, USFWS, NMFS, and others.
- EBMUD provides flows and habitat to create a hospitable natural environment for fish.
- EBMUD and MRFH continue to refine management of *O. mykiss* populations in the river and hatchery.
- EBMUD continues to work collaboratively with issues related to steelhead management and research.