Stand Age & Forest Evapotranspiration: Implications for Forest Management, Streamflow and Salmonid Recovery

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Outline

- Hydrologic Model Development & Objectives
- Evaluation of Streamflow Enhancement Strategies
- Stand Age, Evapotranspiration, Wildfire and Fuel Management Effects on Streamflow

Hydrologic Model Development & Objectives

- Streamflow is a limiting factor for Central Coast coho salmon
- Investigated seasonal and spatial variations in flow for restoration prioritization with a physically-based, spatially-distributed hydrologic model (MIKE-SHE)
- 2012-2021 modeled 4 Russian R. tributaries in collaboration with Gold Ridge and Sonoma RCD's, TU, CA Sea Grant & Coho Partnership
- Grant funding from FRGP & WCB

Hydrologic Models

Watershed	Drainage Area (sq mi)	Geology
Dutch Bill Creek	12	Franciscan
Green Valley & Atascadero Creek	39	Wilson Grove sandstone & Franciscan
Mark West Creek	40	Sonoma Volcanics & Franciscan
Mill Creek	23	Franciscan

Modeled Watersheds



Modeling Approach Overview

- Numerical Hydrologic Model ≈ Management Tool
- Quantify watershed water balance with variation over time and space
- Describe stream flow in relation to critical fish habitat
 - Stream connectivity as indicator of over-summer survival
 - Flow depth across riffles as indicator of smolt escapement
- Alternative model scenarios to estimate effects of:
 - Watershed management strategies
 - Human use of water
 - Drought
 - Climate change

Model Overview

Natural Processes Precipitation Evapotranspiration Runoff Soil Moisture Groundwater Streams



Man-made Influences Irrigation Wells Ponds Diversions

MIKE SHE

an Integrated Hydrological Modelling System



Model Development



Mill Creek Hydrogeology



Streamflow Calibration

Mill Creek Above Wallace 2,500 ME = -1.7 cfs 2,000 RMSE = 67.4 cfsNSME = 0.70 Volume Error = -6.4% Simulated Discharge (cfs) 1,500 Observed 1,000 500 0 Oct-17 Jan-18 Apr-18 Jul-18 Oct-18 Jan-19 Apr-19 Jul-19 Oct-19

Mill Creek At Bear's Flat 6 5 Simulated -Observed 4 Discharge (cfs) 3 2 1 0 Jul-10 Aug-10 May-10 Jun-10 Sep-10 Oct-10

Groundwater Calibration



Existing Hydrology Mean Annual <u>Watershed</u> Water Balance





Existing Hydrology Discharges

Discharge (cfs)		
٠	< 0.1	
٠	0.1 - 0.5	
٠	0.5 - 1.0	
٠	1.0 - 2.5	
٠	2.5 - 5.0	
٠	5.0 - 10	
•	10 - 15	
٠	15 - 20	
٠	20 - 25	
٠	25 - 30	



Existing Hydrology Discharges

Discharge (cfs)		
٠	< 0.01	
٠	0.01 - 0.1	
٠	0.1 - 0.2	
•	0.2 - 0.3	
•	0.3 - 0.4	
•	0.4 - 0.5	
•	0.5 - 0.6	
•	0.6 - 0.7	
•	0.7 - 0.8	
٠	0.8 - 1.0	



Existing Hydrology <u>Riffle</u> <u>Depths</u>

Riffle Depth (ft)

- Disconnected >14 days
- Disconnected <14 days
- <0.05
- 0.05 0.10
- 0.10 0.15
- 0.15 0.20
- 0.20 0.30
- 0.30 0.40

Existing Hydrology – Spring Outmigration



Aug

Oct

Sep

Scenario Analysis

- Water Use Scenarios
 - no diversions, no groundwater pumping, no water use (unimpaired)
- Flow Releases
 - spring outmigration releases, summer baseflow releases
- Recycled Water
 - Re-use of treated wastewater for irrigation & recharge/streamflow enhancement
- Combined
 - Summer flow enhancement & spring flow enhancement
- Climate Change

Existing Water Use

Total Annual Water Use – 257 ac-ft/yr 11.3 ac-ft/mi²

Water Use Categories



Water Use Sources



Scenario Analysis – Water Use



Mean Changes in Summer Flow: No Human Use



Short-term Changes in Summer Flow: No Human Use



Mean Changes in Flow: Forest Management



Scenario Results Mean Summer Streamflow



Scenario Results Mean Spring Streamflow



Scenario Results Duration of Flow for Spring Outmigration



Scenario Results-Return on Investment (\$25,000 project typicals)



Pond Release Scenario Hydrographs



Water Balance Changes



Watershed Evapotranspiration v. Human Use



Paired Watershed Experiments Flow Trends Over Time



HJ Andrews Watershed Experiments

Summer streamflow in clear-cut watersheds relative to unharvested control watersheds



Mill Creek Forest Stand Conditions



Mill Creek-Walbridge Fire Burn Severity



Mill Creek-Hypothetical Effect of Walbridge Fire on Streamflow



Mill Creek-Forecast Streamflow 2021

