Caspar Creek Fishways

Labyrinth Spillway Gates, Removable Weirs, Subterranean View Ports and More…

South Fork Caspar Creek

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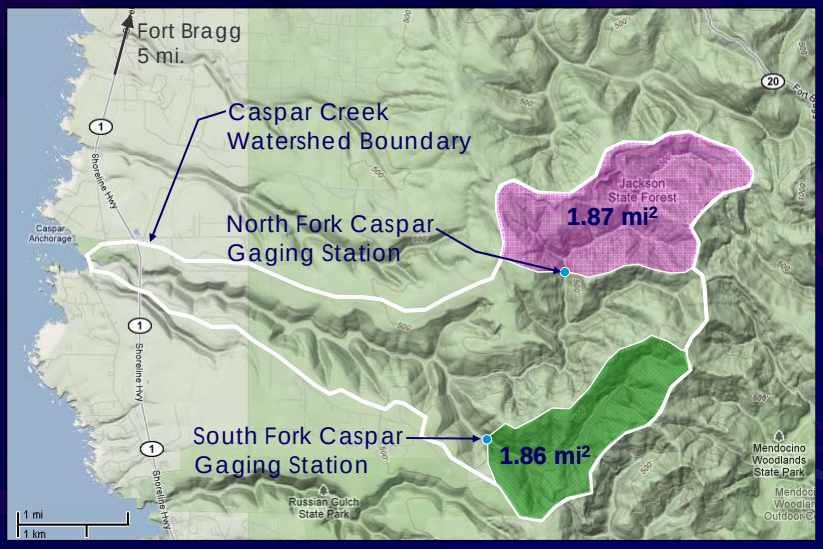
Caspar Creek Experimental Watershed

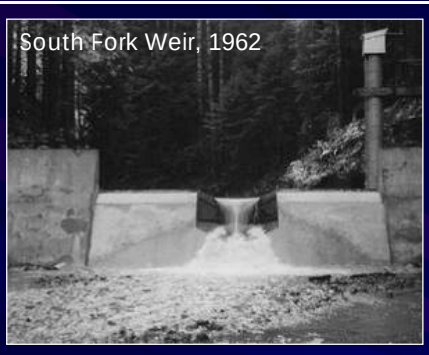
- Located in Jackson State Forest
- Cooperatively Operated by CalFire and USFS PSW Research Station
- Paired watershed study of Cumulative Effects of Forest Management
- Continuous since 1962

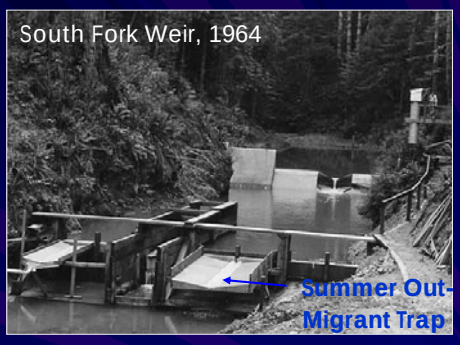
Presented at the Joint Salmonid Restoration Federation and California-Nevada Chapter of the American Fisheries Society 2010 Conference

Caspar Creek Experimental Watershed



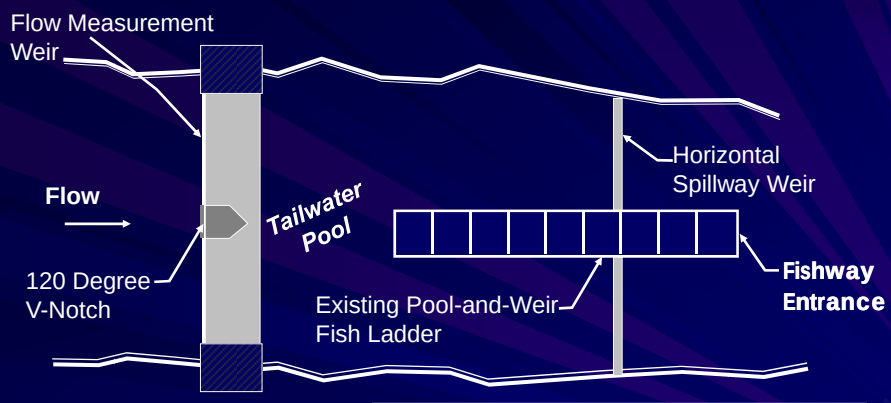
Measurement Weirs & Sediment Basins



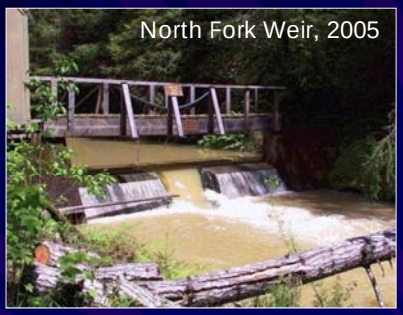


- **Concrete dam at outlet of North & South Fork**
  - Forms upstream sediment basin
  - Equipped with precise flow measurement weir
- **Wooden pool & weir fishway with spillway**
  - For passage of adult coho and steelhead
  - Avoids backwatering v-notch weir at high flows

Measurement Weir & Fishway Layout



Problematic Fish Passage



- **Wooden fishway performance**
  - Leaky (impinging juveniles)
  - Excessive turbulence
  - Drop at entrance
- **Passage over weir**
  - ~3 ft water surface drop at low and high flows
  - Nappe impacts dam face at lower flows

Desire for a New Fish Passage Facility

- NMFS BO for facility O&M required upstream passage for juvenile salmonids
- 2003 CalFire & PSW agreed to build a new fish passage facility
- Collaborative Effort Ensued between CalFire, PSW, 5 Counties SCP, NMFS, DFG
- W-K and MLA joined project in 2005

Project Objectives & Constraints

- Upstream adult salmonid passage (November – April)
- Upstream juvenile salmonid passage (June – October)
- **No change in flow measurement accuracy/consistency:**
  - Tailwater remain min. 0.2 ft below weir crest up to ~20 year peak flow (280 cfs)
  - At higher flows, weir submergence no greater than existing conditions (consistent with historic flow record)

Fish Passage Design Flows

Adult Coho & Steelhead (using NMFS & DFG criteria)

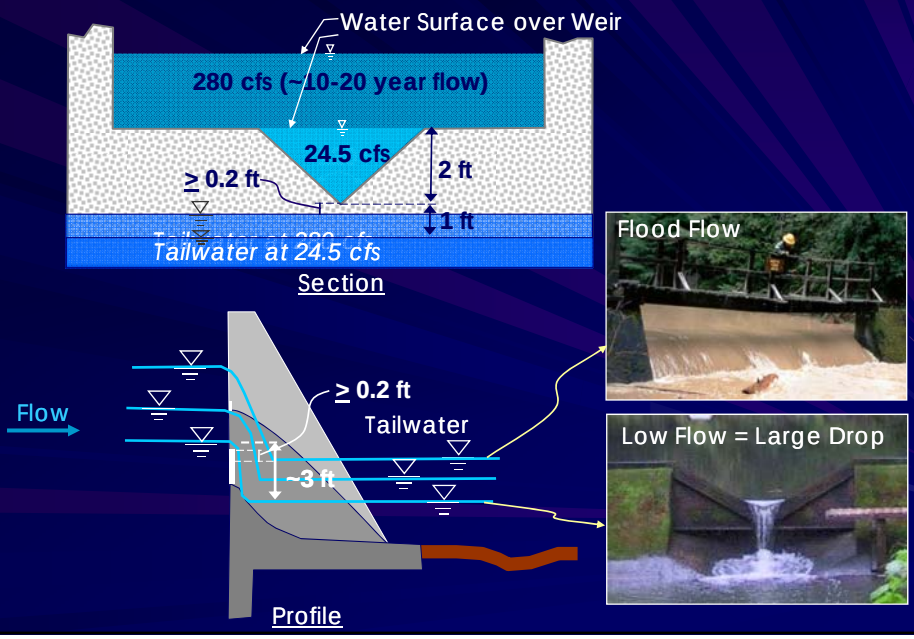
- Low Passage Design Flow = **3 cfs**
- High Passage Design Flow
  (1% Annual Exceedance Flow)
  - **North Fork = 47.6 cfs**
  - **South Fork = 44.3 cfs**

Juvenile Coho & Steelhead (Passage June – October)

- High Passage Design Flow = **1.0 cfs**
  (~1% Exceedance Flow for the period)
- Low Passage Design Flow = **0.05 cfs**
  (~95% Exceedance Flow for the period)

Avoiding Submergence of the Measurement Weir

Pre-Project Conditions



Design Challenge:

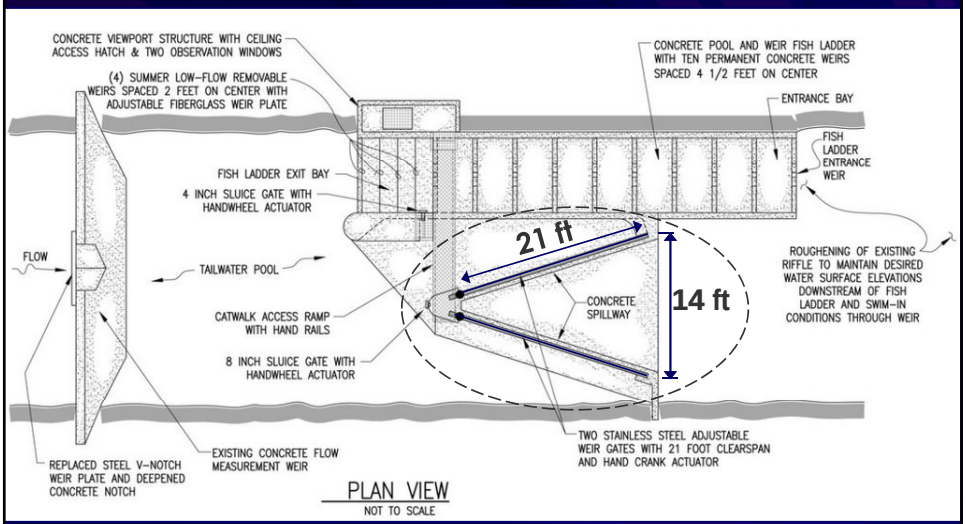
- Minimize tailwater fluctuations with changes in flow to minimize water surface drop (leap height)

Solution:

- **Labyrinth Weir Spillway**, designed based on Falvey (2003) *Hydraulic Design of Labyrinth Weir.*

3-Cycle Labyrinth Weir, San Antonio, Texas

The Final Fishway Design



Labyrinth Weir Spillway Length = 42 feet

Adjustable Labyrinth Weir Spillway

- Effective spillway length of 42 feet
- Adjusted to convey min 20% of total flow in fishway at high passage design flow (47 cfs)

Design Challenge:

- Minimize drop/leap for juvenile salmonid passage (June – October)

Conditions:

- Persistent baseflow during period (minimal precipitation)

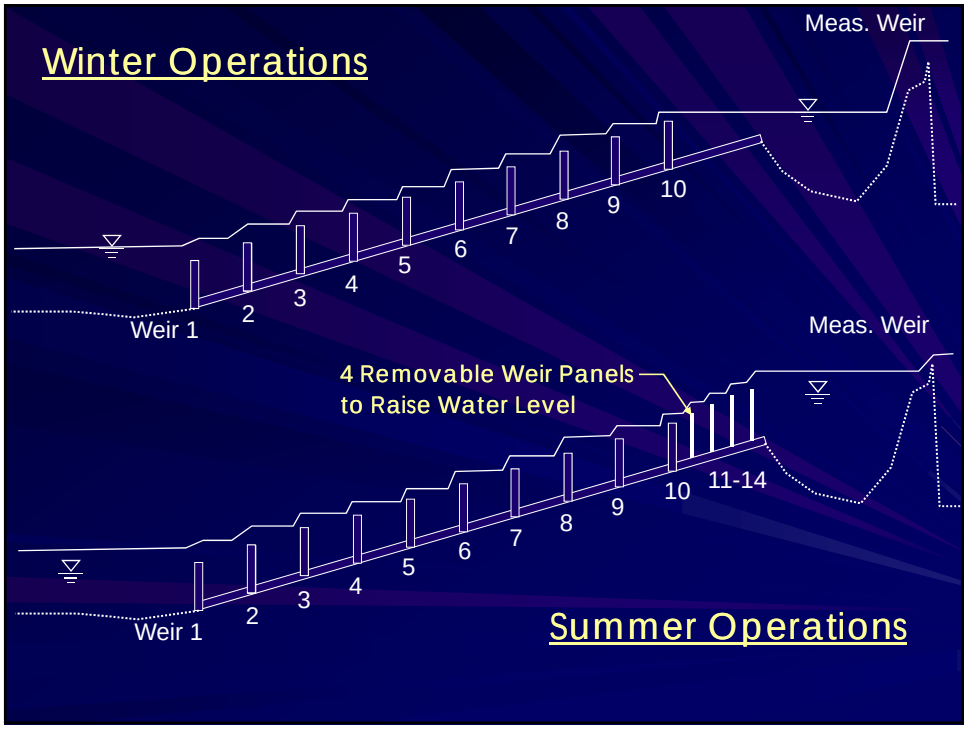
Solution:

- Removable summer weirs added to fishway exit
- Adjustable labyrinth spillway weir (raise & lower)

  Operations in early June:

  – install removable fishway weirs

  – raise spillway weir to 0.3 feet below measurement weir crest


Winter Operations
Meas. Weir
Weir 1
2
3
4
5
6
7
8
9
10
4 Removable Weir Panels
to Raise Water Level
Meas. Weir
Weir 1
2
3
4
5
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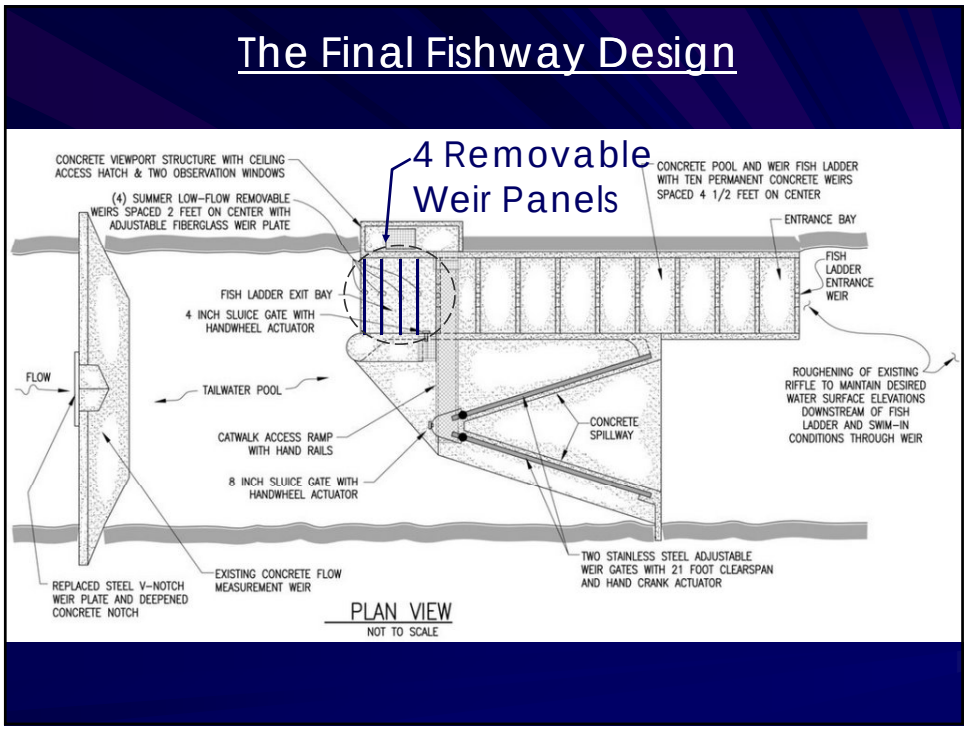
10
11-14
Summer Operations


The Final Fishway Design
4 Removable Weir Panels
CONCRETE VIEWPORT STRUCTURE WITH CEILING ACCESS HATCH & TWO OBSERVATION WINDOWS
(4) SUMMER LOW-FLOW REMOVABLE WEIRS SPACED 2 FEET ON CENTER WITH ADJUSTABLE FIBERGLASS WEIR PLATE
CONCRETE POOL AND WEIR FISH LADDER WITH TEN PERMANENT CONCRETE WEIRS SPACED 4 1/2 FEET ON CENTER
ENTRANCE BAY
FISH LADDER ENTRANCE WEIR
FISH LADDER EXIT BAY
4 INCH SLUICE GATE WITH HANDWHEEL ACTUATOR
FLOW
TAILWATER POOL
CATWALK ACCESS RAMP WITH HAND RAILS
8 INCH SLUICE GATE WITH HANDWHEEL ACTUATOR
CONCRETE SPILLWAY
ROUGHENING OF EXISTING RIFFLE TO MAINTAIN DESIRED WATER SURFACE ELEVATIONS DOWNSTREAM OF FISH LADDER AND SWIM-IN CONDITIONS THROUGH WEIR
REPLACED STEEL V-NOTCH WEIR PLATE AND DEEPENED CONCRETE NOTCH
EXISTING CONCRETE FLOW MEASUREMENT WEIR
TWO STAINLESS STEEL ADJUSTABLE WEIR GATES WITH 21 FOOT CLEARSPAN AND HAND CRANK ACTUATOR
PLAN VIEW
NOT TO SCALE

Removable Weirs Panels

Summer Operations

Before Installation

After Installation

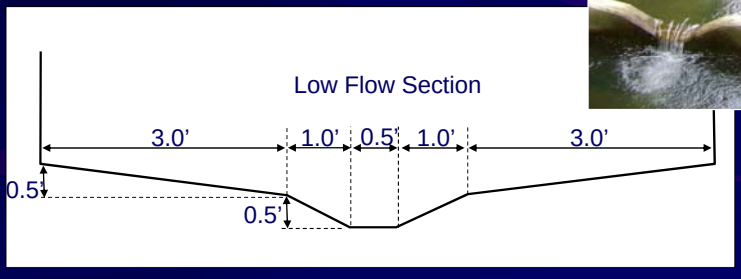
6 inch water surface drop
Tailwater 0.2 feet below weir crest

Hydraulics of Removable Summer Weirs

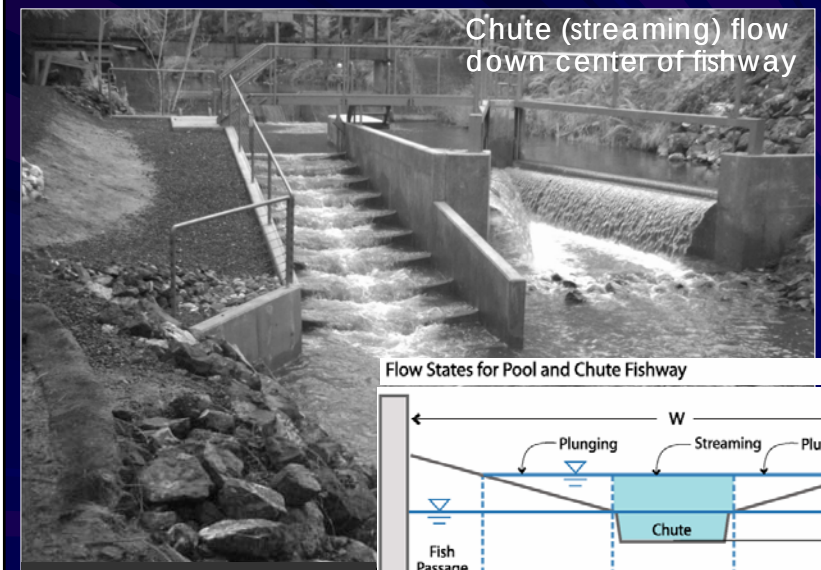
- Nearly level crest limits upstream water surface fluctuations
- Crest elevation is adjustable for fine-tuning

Fishway Weirs Shaped for Plunging & Streaming

- 10 Concrete Weirs, 6” Drops
- Low flow notch (full @ 1.4 cfs)
  - Supports Juvenile Passage
  - Creates Streaming Flow
- Gently Sloped Crest
  - Provides Thin Nappe on Edges
  - Maintains Calm Water along Edges

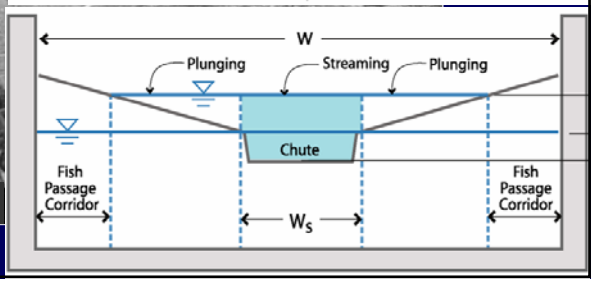


High Fish Passage Flows



Flow = 45.3 cfs

Flow States for Pool and Chute Fishway



Fish Guidance and Attraction

- Minimum fishway Flow is 20% of Streamflow
- Entrance located near spillway
- Concrete slab and riprap make spillway flow unattractive (shallow & sheeting)

Roughened Riffle below Fishway

Roughened Riffle with Engineered Streambed Material Stabilizes Channel below Fishway

Modified Measurement Weir Notch

Modified concrete to eliminate nappe impacting dam face

Future Monitoring and Monitoring Facilities

- View Ports
- PIT Tag Antenna Array
- Time-Lapse Camera

Juvenile Steelhead Ascend Ladder

In Summary

- Labyrinth weir spillways provides excellent flow control
- Including operational flexibility into the design ensures hydraulic objectives can be satisfied
- More to learn from future evaluations