BAYWORK Training Buffet, November 2023

System-wide tools for managing water and ecosystems

Content

1. Introduction
2. Biological evaluation framework
3. Outputs
4. Key insights

Introduction

Location:

Santa Clara Valley Water District (SCVWD): San Jose, California

History:

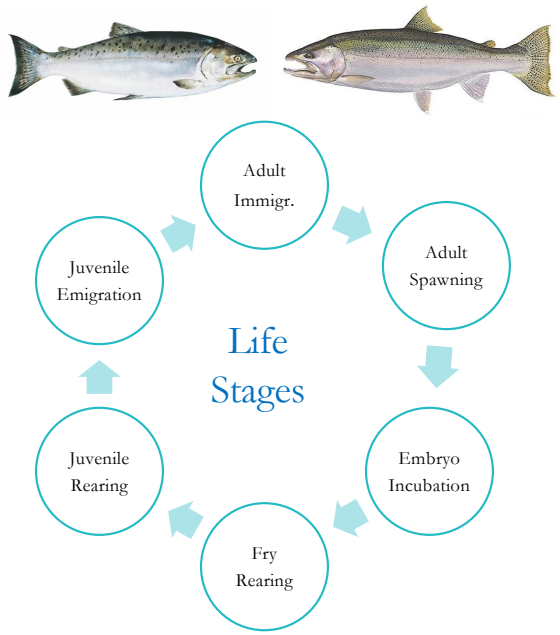
1996: Guadalupe Creek Resource Conservation District (GCRCD) files complaint against the SCVWD alleging that the district's use of its water rights degraded fish, wildlife, and water quality.

1996-2003: Negotiations and investigations lead to settlement agreement: "Fish and Aquatic Habitat Collaborative Effort" (FAHCE) to develop new operating rules for 7 SCVWD reservoirs

2017-2019: SCVWD to file CEQA report

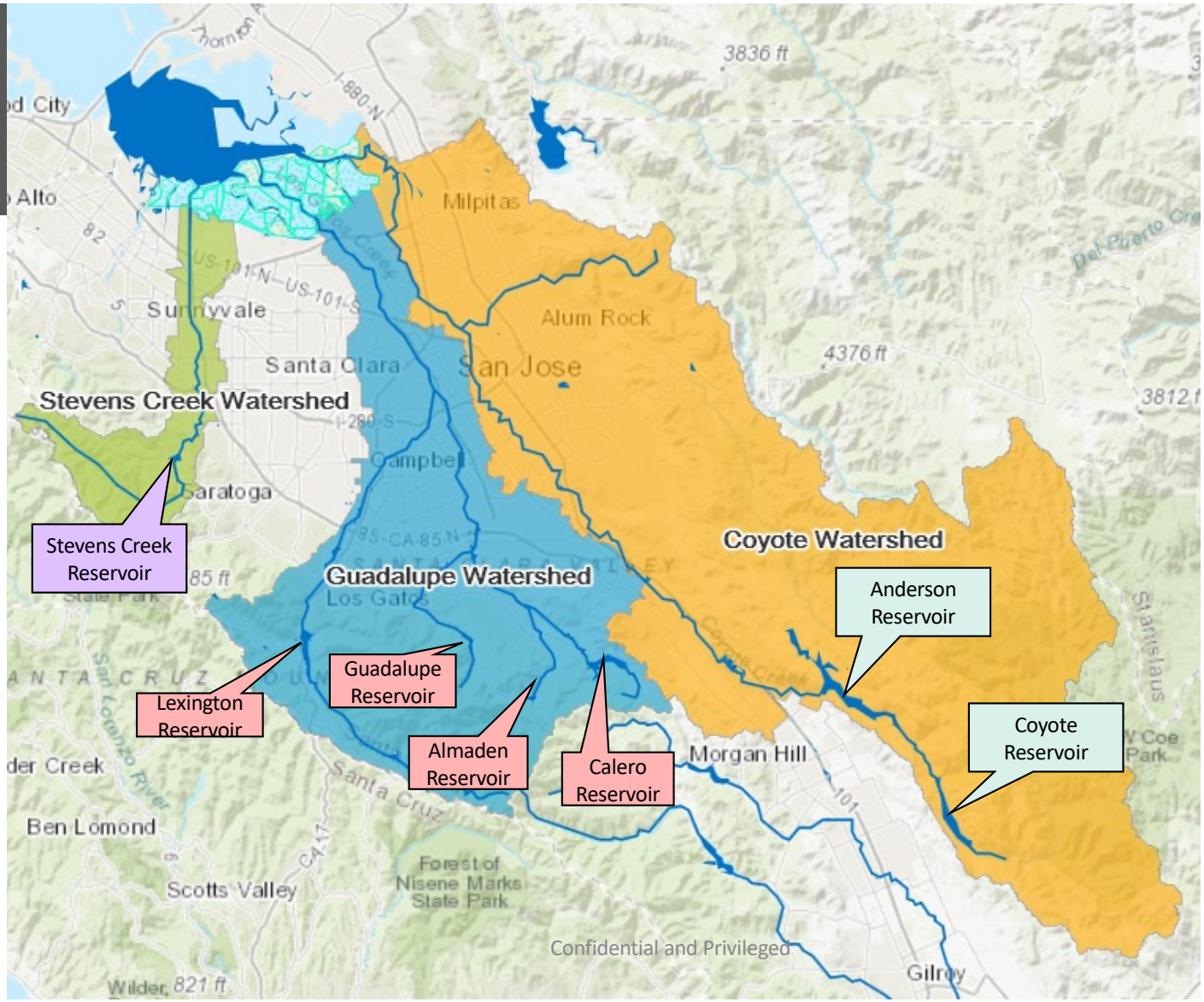
Goal:

Improved habitat conditions for steelhead trout and chinook salmon.



The System

3 Watersheds
8 Creeks
7 reservoirs
71 miles of streams
500 Square Miles



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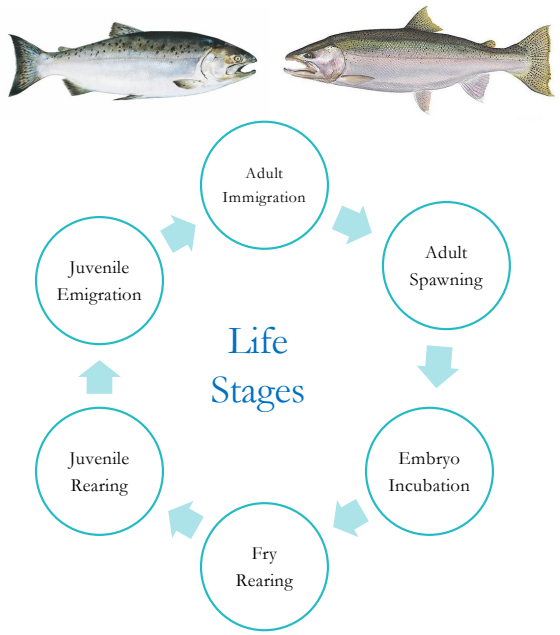
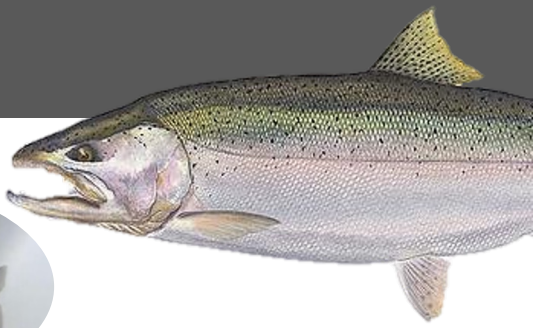
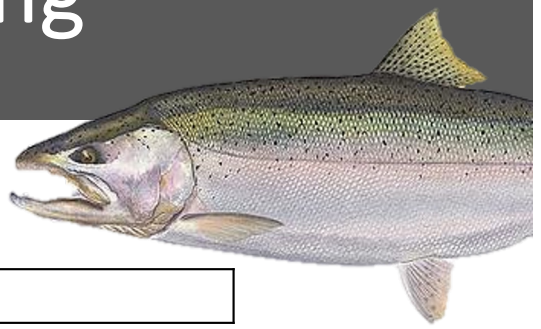


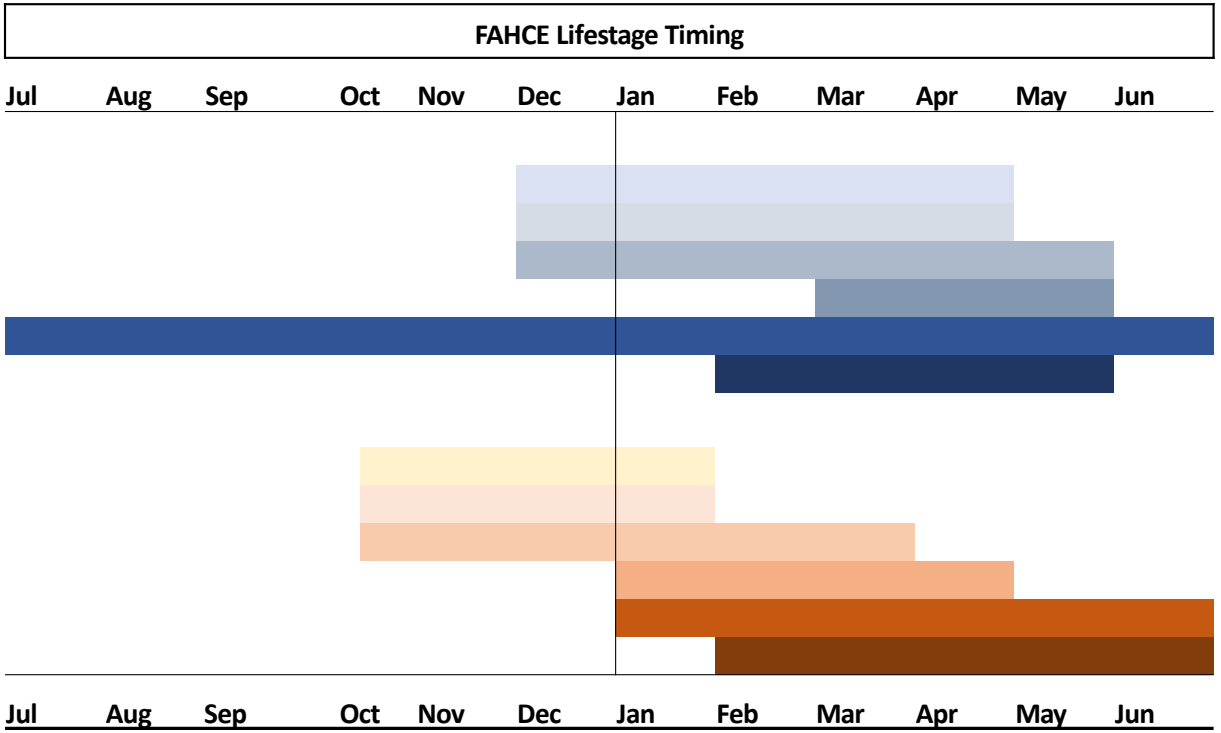
Salmonid Life History



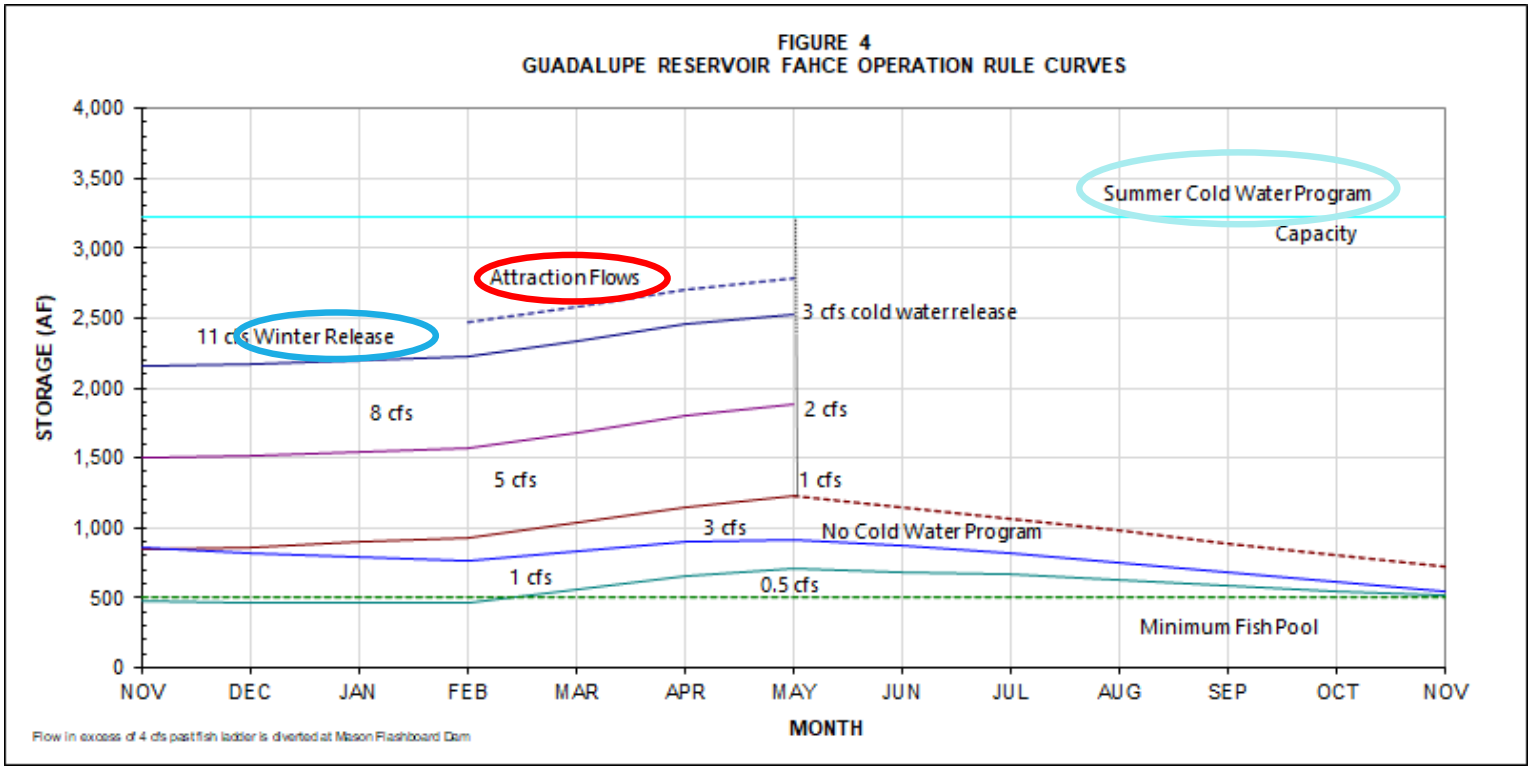
- Adults Spawn in Freshwater
- Eggs hatch and rear in freshwater
- Juveniles emigrate to the ocean
- Adults mature in the ocean and return to freshwater to spawn.

Salmonid Life History - Timing

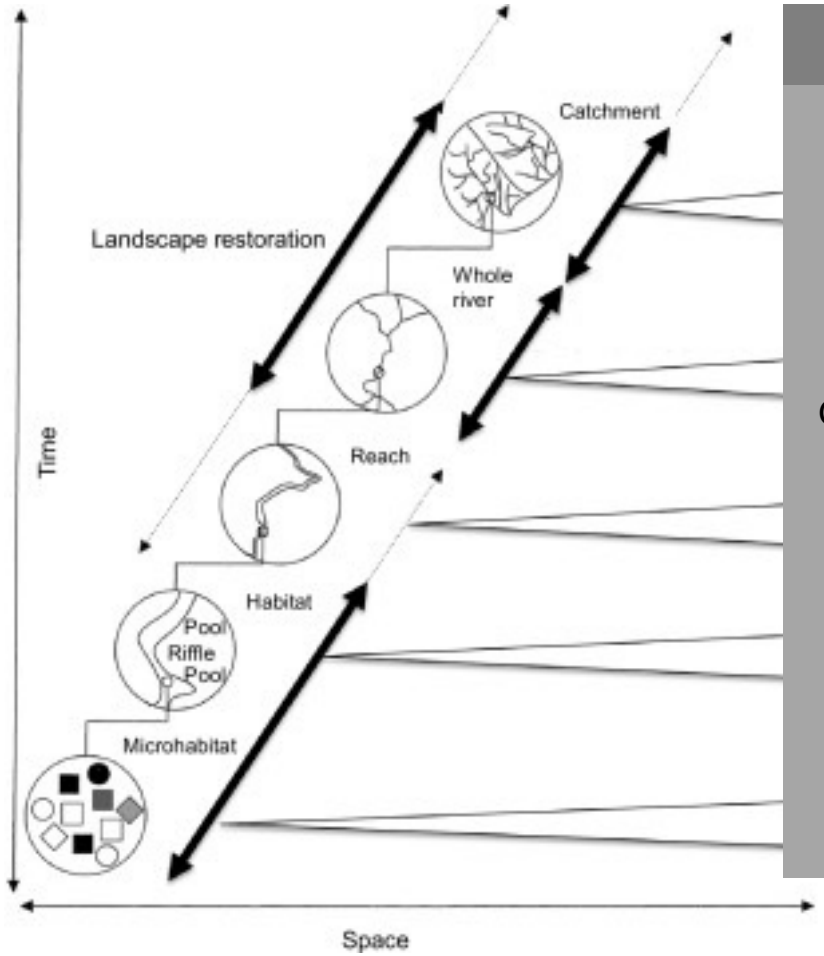




FAHCE



- Attraction Flows to promote migration
- Winter Base flows to support spawning, incubation, and winter rearing
- Summer Flows to support summer rearing



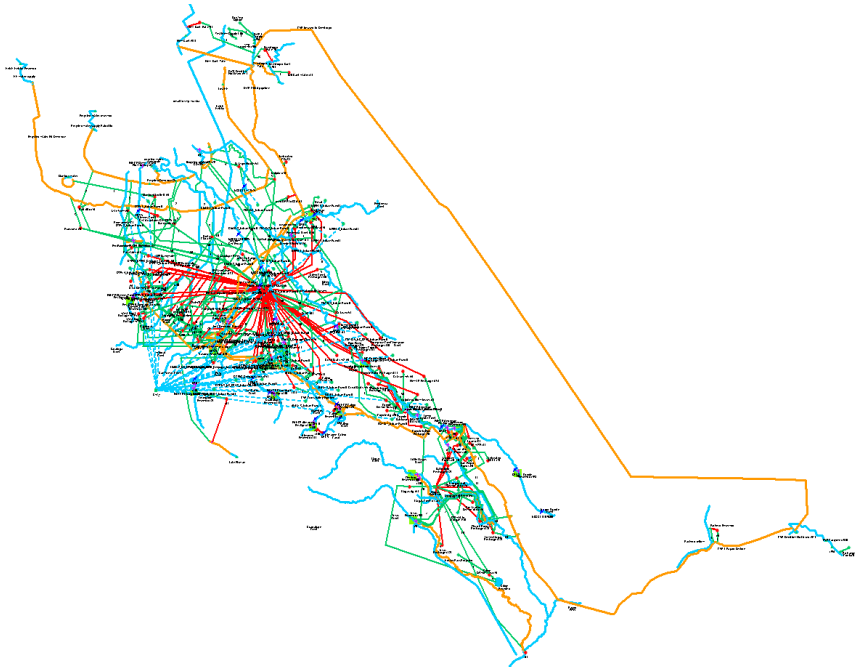
Adapted from: N. Friberg et al, Chapter Eleven - Effective River Restoration in the 21st Century: From Trial and Error to Novel Evidence-Based Approaches, Editor(s): Alex J. Dumbrell, Rebecca L. Kordas, Guy Woodward, Advances in Ecological Research, Academic Press, 2016

Process	Habitat metrics	Tool	Key uncertainty
Hydrologic and Landscape	Flow, re and ts	WEAP	Climate
Hydrologic and Fluvial Geomorphology	con	P/HEC-RAS	Geomorphic response to climate
Hydraulic	Depth, velocity, width		Simplified 1D flow conditions
Physical habitat units	Habitat unit suitability		tability Curves
Ecological functions	Substrate heterogeneity	Not considered	Fish response to habitat conditions

How to reconcile the river system and the habitat scale? What are the key uncertainties?

WEAP model

Converted to daily from existing monthly model



Operations and response strategies

- Current Operations to supply demands
- Set of scenarios

Relationships between variables in model

WEAP

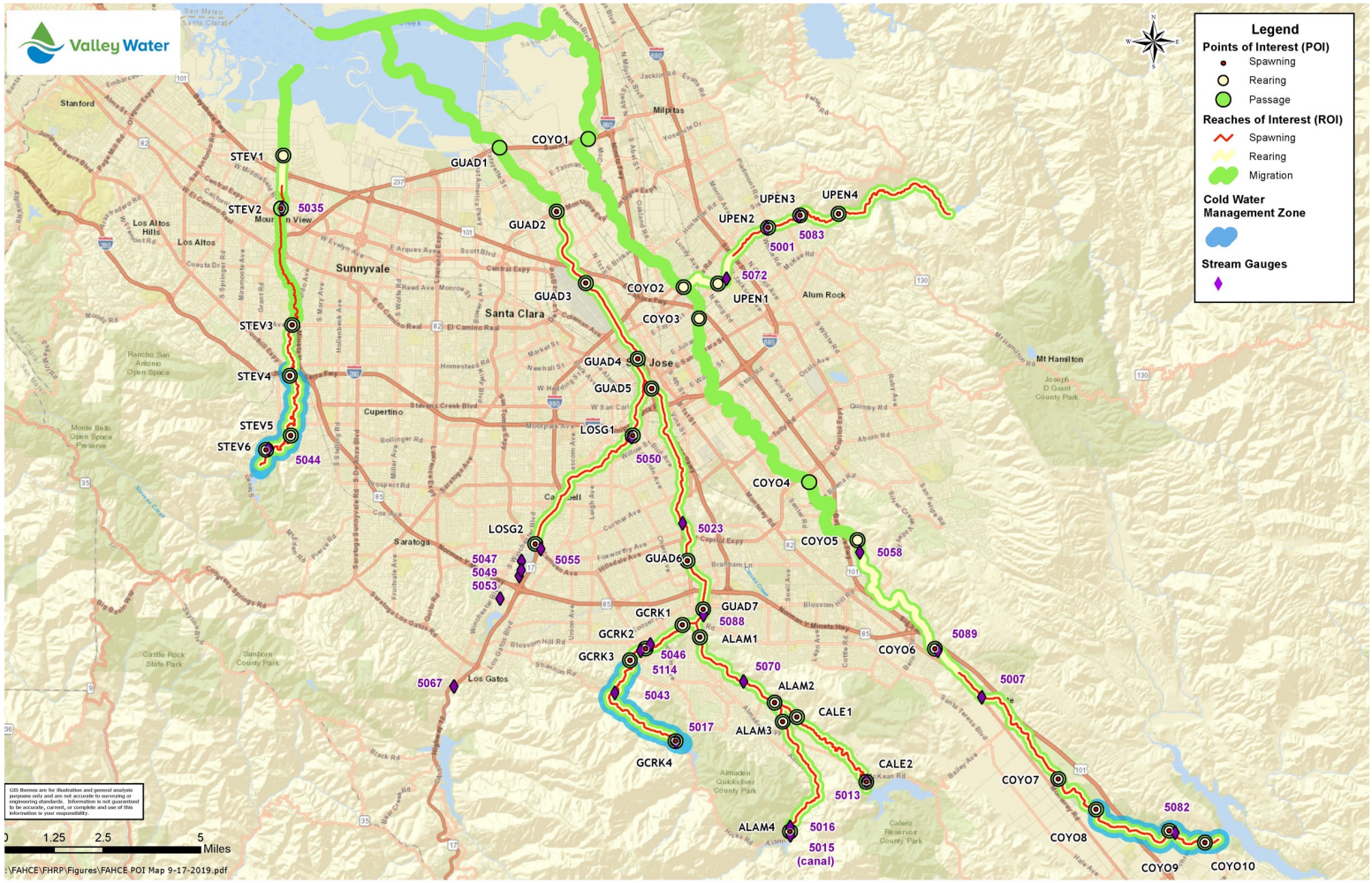
- Import Water Allocations from CalSim
- Monthly Local Demands
- Monthly Local Supplies
- Seismic Restrictions
- LSAA Bypass Flow Requirement
- Daily Inflows to Reservoirs
  Urban catchments
  Habitat/flow relationships

Metrics of performance

Reliability and coverage
Delivery reliability
Unmet demands
Groundwater & surface water storage

Habitat metrics: flow, temperature, suitability

WEAP model – Points of Interest

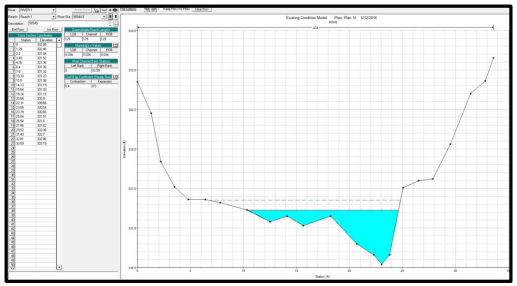


HEC-RAS models

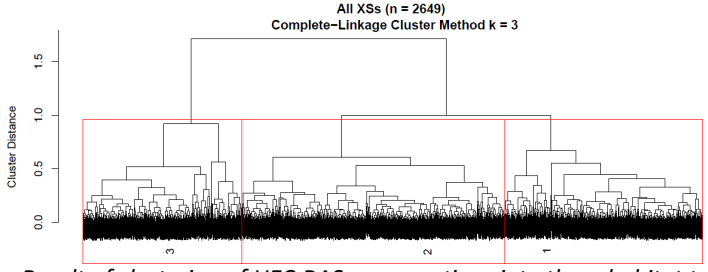
Cross-sections in HEC-RAS relate streamflow to velocity and depth

Cluster cross-sections into three habitat types (riffle, flatwater pool) based on channel geomorphology

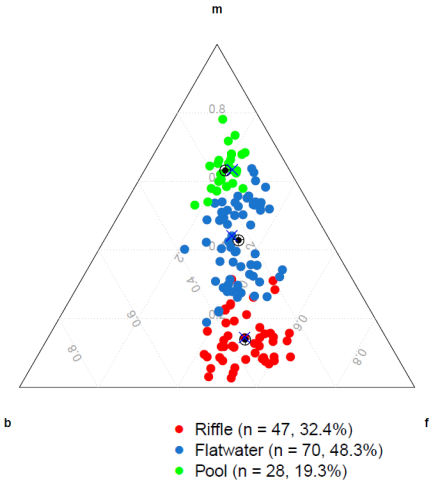
Select “representative” cross-section for the three habitat types in each stream reach



New critical riffle transect at representative cross section

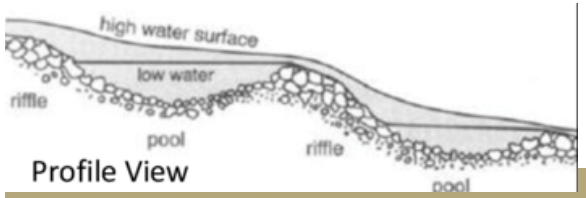


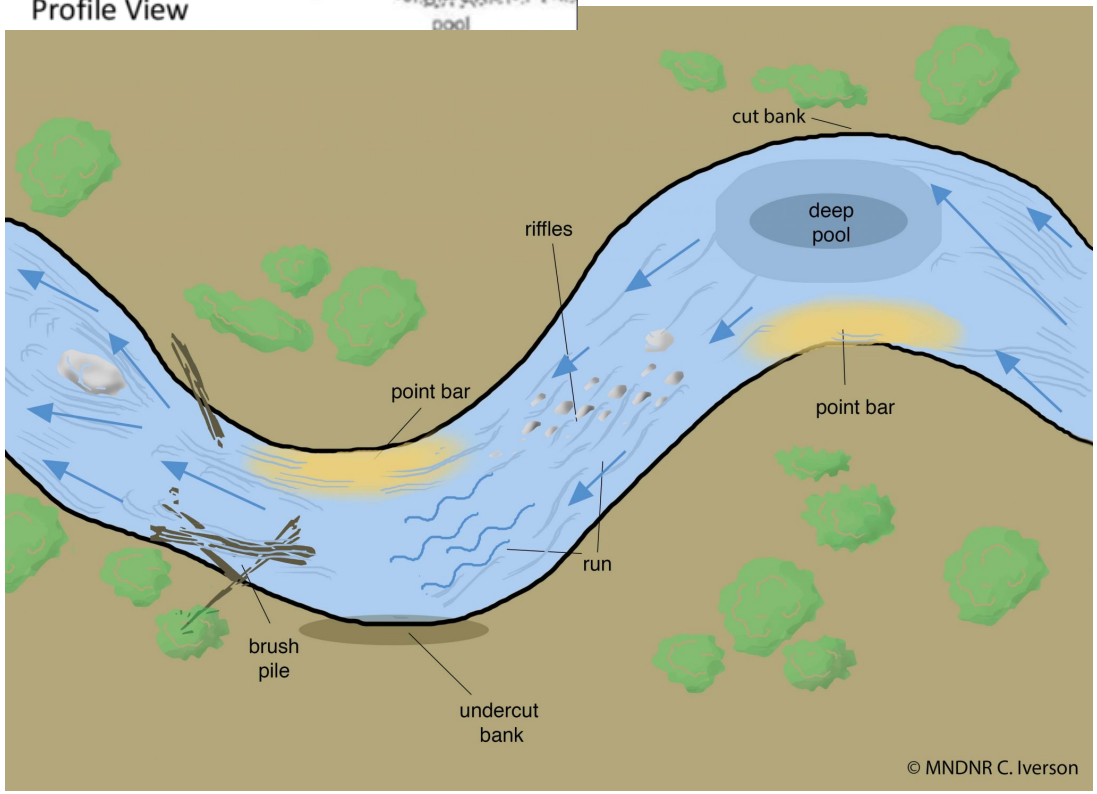
Result of clustering of HEC-RAS cross-sections into three habitat types



Ternary plot showing HEC-RAS cross-sections in river reach

Habitat Types





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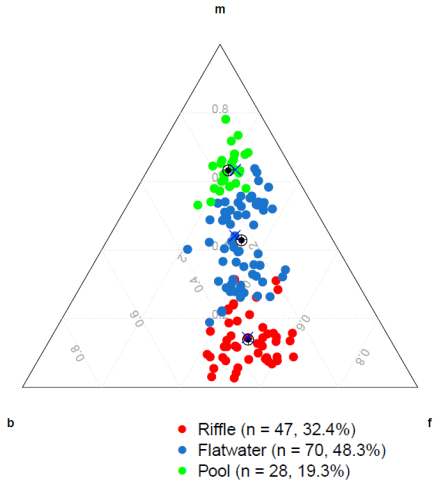
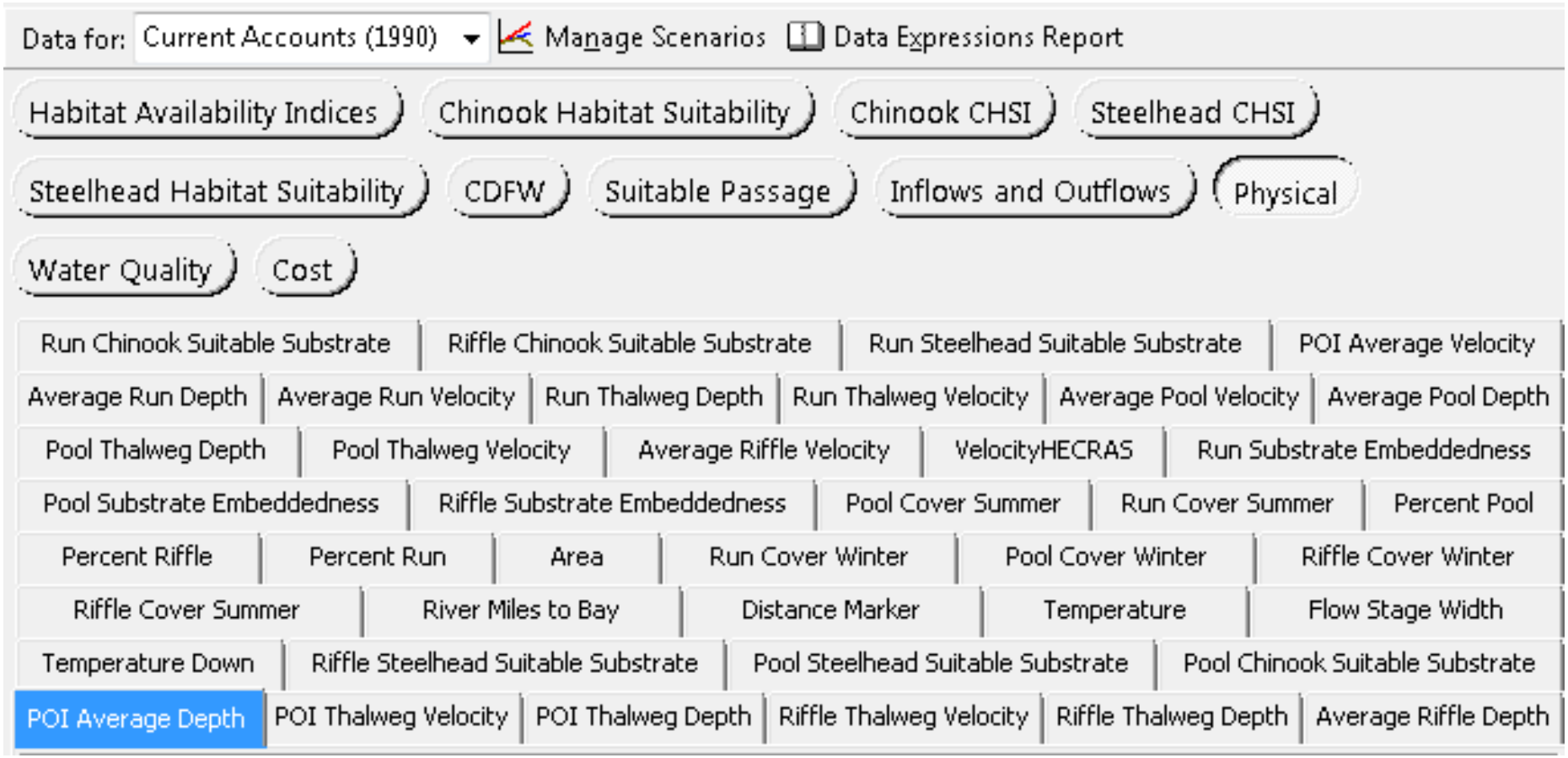


Ternary plot showing HEC-RAS cross-sections in river reach


Data for: Current Accounts (1990)
Manage Scenarios
Data Expressions Report
Habitat Availability Indices
Chinook Habitat Suitability
Chinook CHSI
Steelhead CHSI
Steelhead Habitat Suitability
CDFW
Suitable Passage
Inflows and Outflows
Physical
Water Quality
Cost
Run Chinook Suitable Substrate
Riffle Chinook Suitable Substrate
Run Steelhead Suitable Substrate
POI Average Velocity
Average Run Depth
Average Run Velocity
Run Thalweg Depth
Run Thalweg Velocity
Average Pool Velocity
Average Pool Depth
Pool Thalweg Depth
Pool Thalweg Velocity
Average Riffle Velocity
VelocityHECRAS
Run Substrate Embeddedness
Pool Substrate Embeddedness
Riffle Substrate Embeddedness
Pool Cover Summer
Run Cover Summer
Percent Pool
Percent Riffle
Percent Run
Area
Run Cover Winter
Pool Cover Winter
Riffle Cover Winter
Riffle Cover Summer
River Miles to Bay
Distance Marker
Temperature
Flow Stage Width
Temperature Down
Riffle Steelhead Suitable Substrate
Pool Steelhead Suitable Substrate
Pool Chinook Suitable Substrate
POI Average Depth
POI Thalweg Velocity
POI Thalweg Depth
Riffle Thalweg Velocity
Riffle Thalweg Depth
Average Riffle Depth

Biological Evaluation Framework

Adaptive management

Point of Interest 1

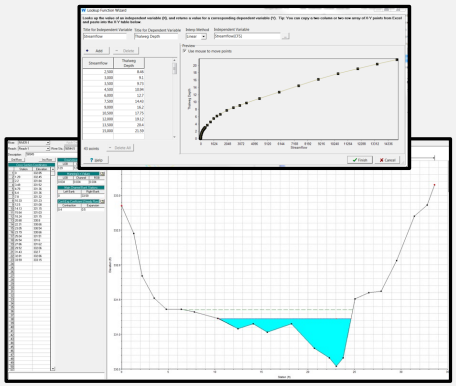
WEAP

Flow

Temperature

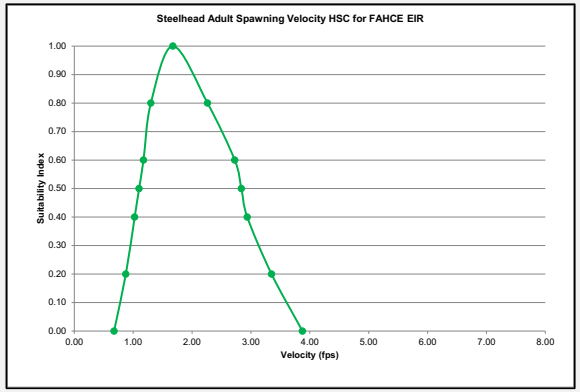
Substrate Cover

Hydraulic modeling with HEC-RAS to define flow-depth and flow-velocity relationships



Depth
Velocity

Suitability curves and thresholds (by life stage and species)

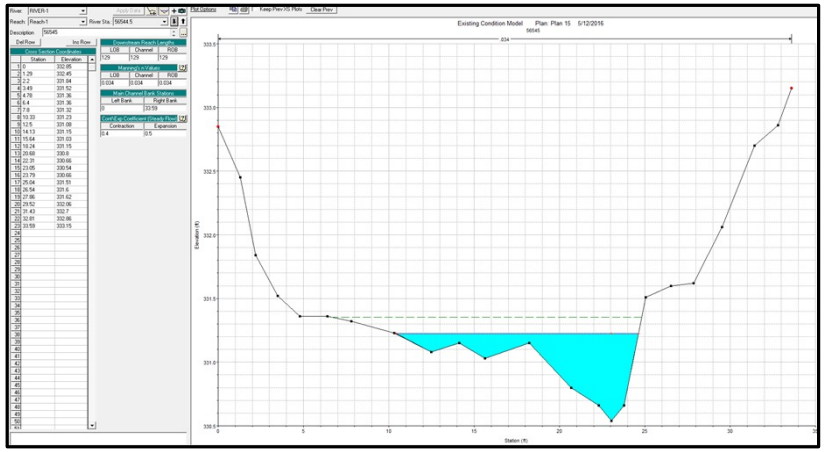


Habitat

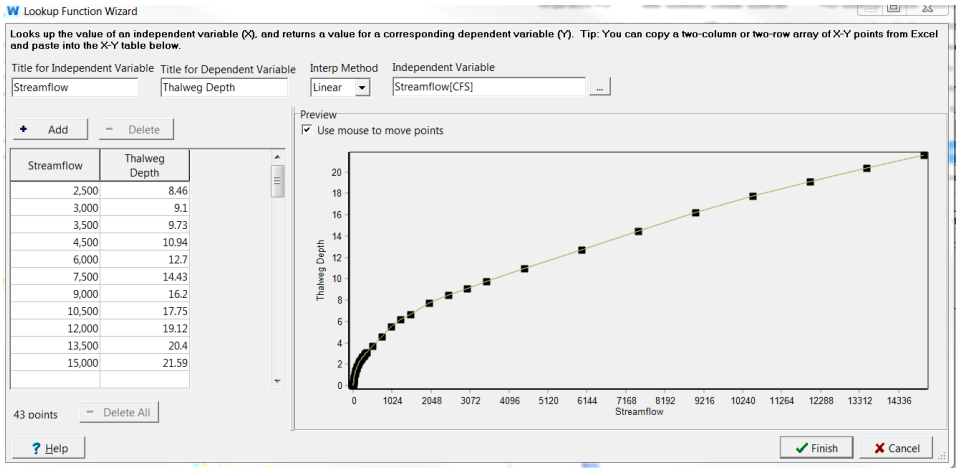
Summary of habitat metric variables in WEAP

At each stream reach:

- Thalweg & average depth and velocity
- Depth threshold achievement
- Daily average temperature
- Area of each habitat type
- Other variables (cover, substrate, etc.)

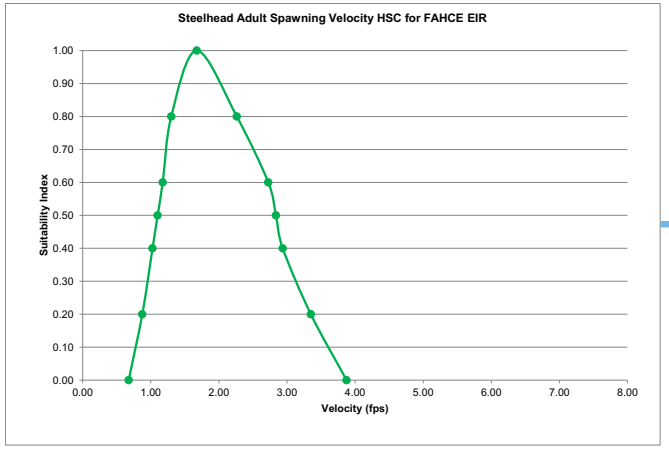


Example: Flow -> Thalweg Depth

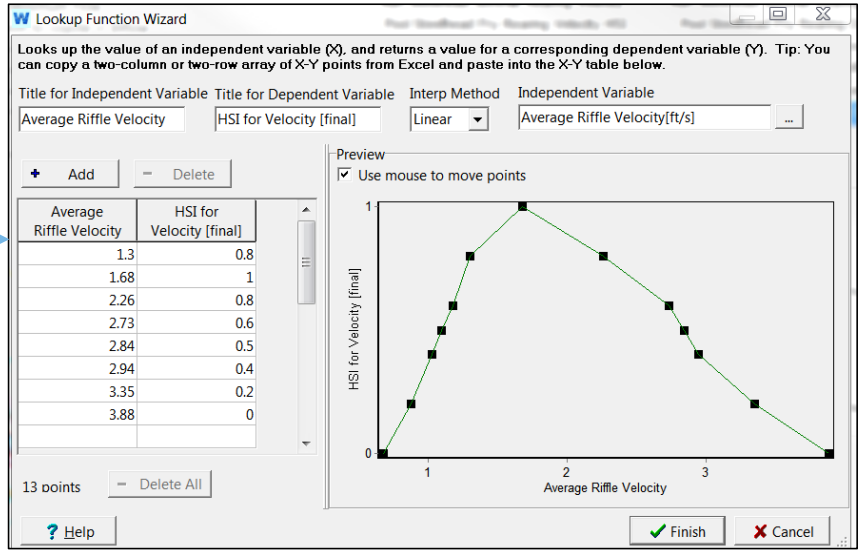


Habitat suitability index, composite and availability

At each stream reach, per habitat type, per fish life stage, per fish species:



Habitat suitability curves from "Fisheries Habitat Availability Estimation Methodology" technical memo



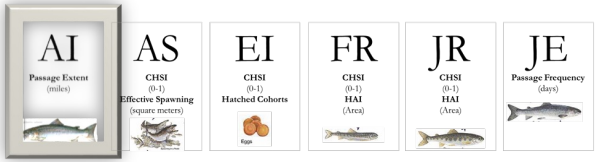
Habitat Suitability Index: For depth, velocity, temperature, cover, substrate embeddedness in relevant life stage

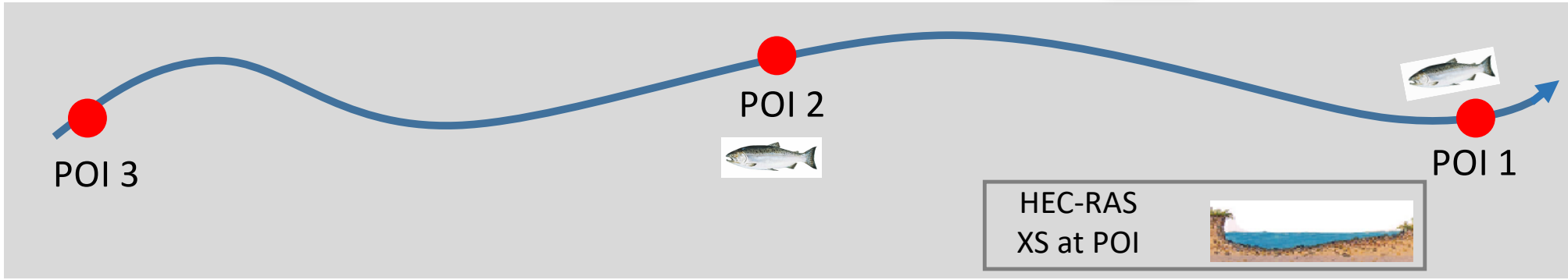
Composite Habitat Suitability Index (CHSI) = Geometric mean of relevant habitat suitability indices, in relevant months for life stage

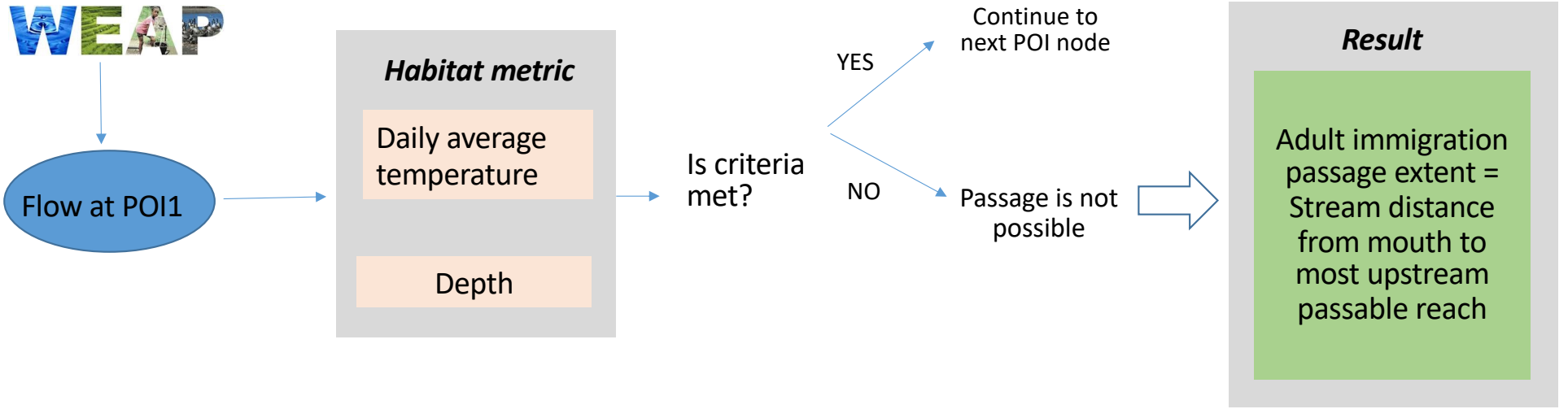
Habitat Availability Index (**HAI)** = CHSI * area of reach* % habitat type in reach

Passage extent and frequency: upstream passable length for immigration and emigration

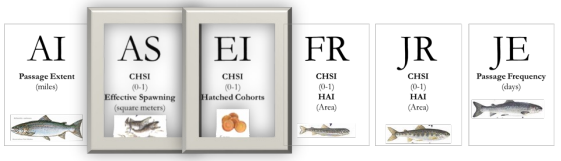
Adult Immigration Passage Extent

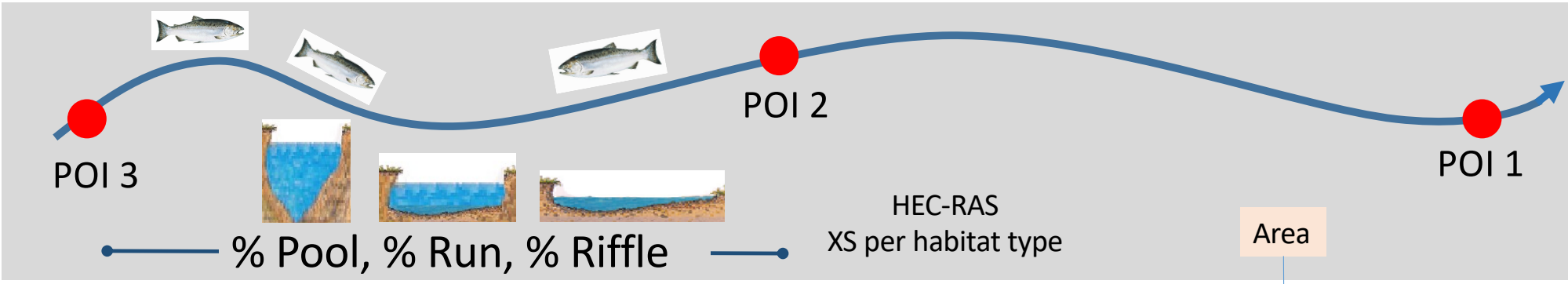






Spawning and Incubation Habitat Suitability and Availability





Area

Depth

Daily average temperature

Incubation CHSI

Incubation conditions must be met for entire incubation duration (defined by ATU) for each daily cohort

WEAP

Flow at reach

Habitat metric

Riffle, Run, Pool

Depth

Velocity

Substrate

Depth Spawning HSI

Velocity Spawning HSI

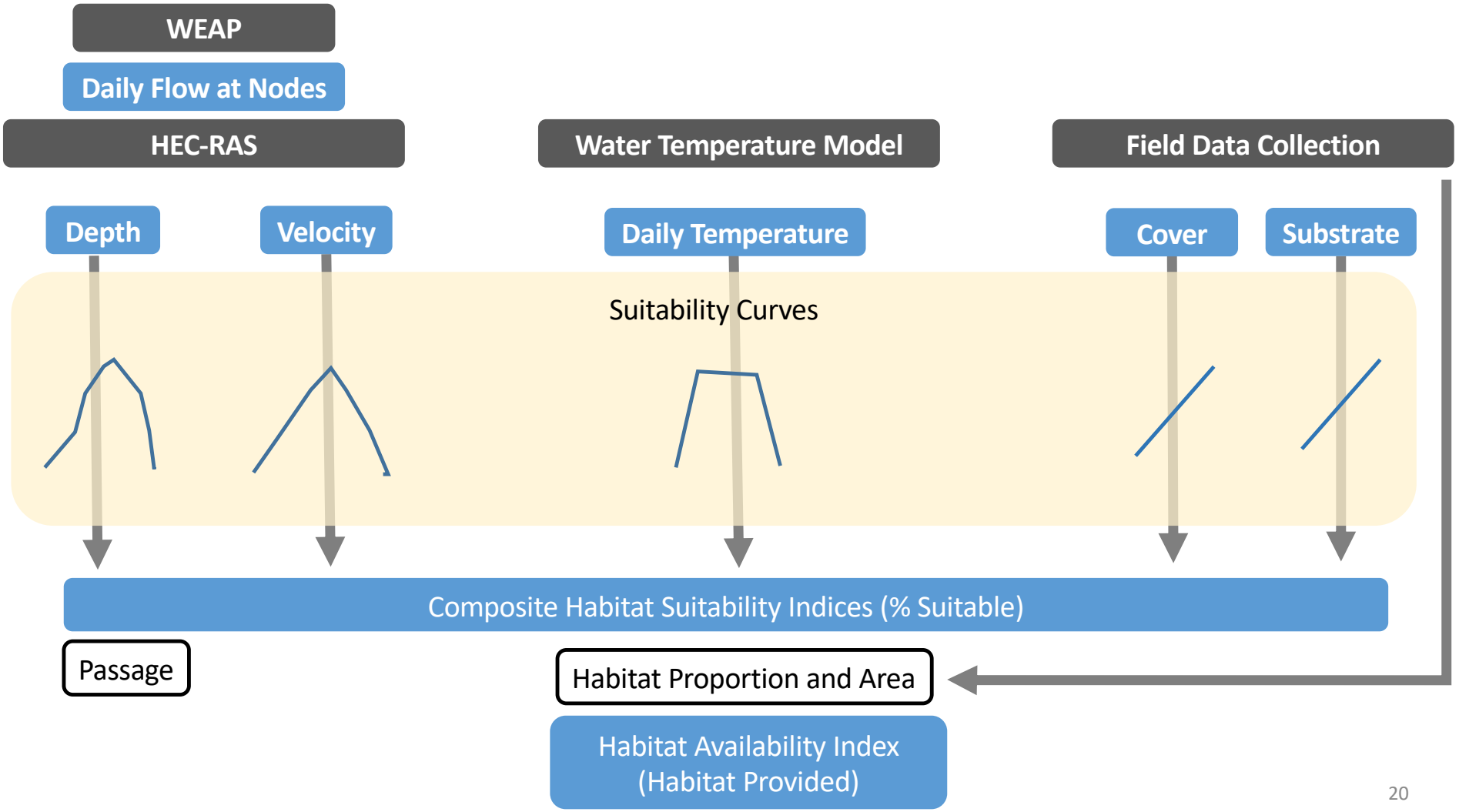
Substrate Spawning HSI

Result

Effective Spawning CHSI*

Habitat availability index

*0 when a single day in the incubation period fails the criteria


WEAP
Daily Flow at Nodes
HEC-RAS
Water Temperature Model
Field Data Collection
Depth
Velocity
Daily Temperature
Cover
Substrate
Suitability Curves
Composite Habitat Suitability Indices (% Suitable)
Passage
Habitat Proportion and Area
Habitat Availability Index
(Habitat Provided)

Scenario Development

Foundation

Hydrology

Hydraulics

WEAP PLATFORM

Levers to Pull

Reservoir Releases

Management Objectives

Groundwater Recharge

Juvenile Rearing

Adult Passage

Changes Through Time

Water Supply Demand

Infrastructure Improvements

Present

Future

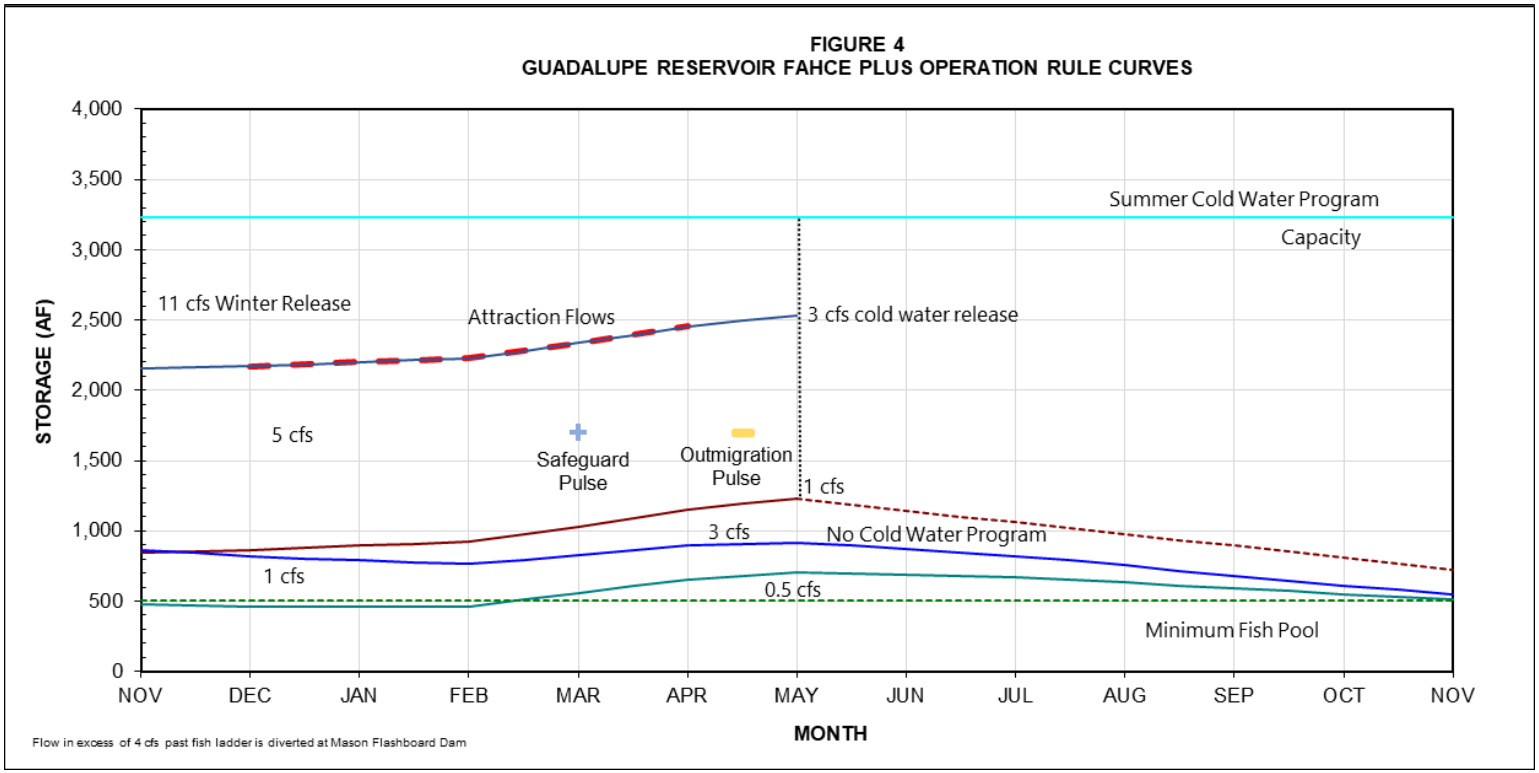
P

F

P

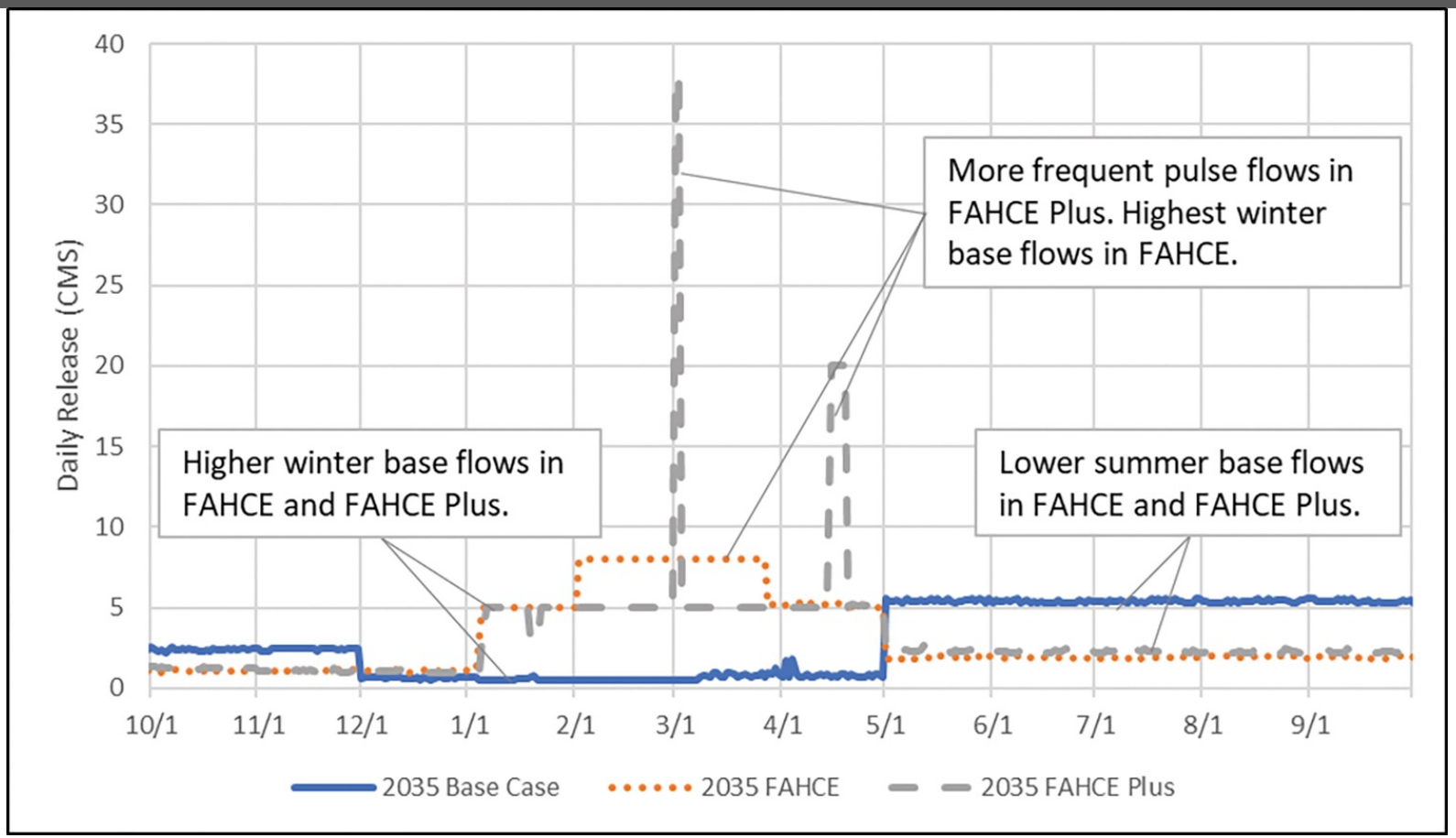
F

FAHCE Plus

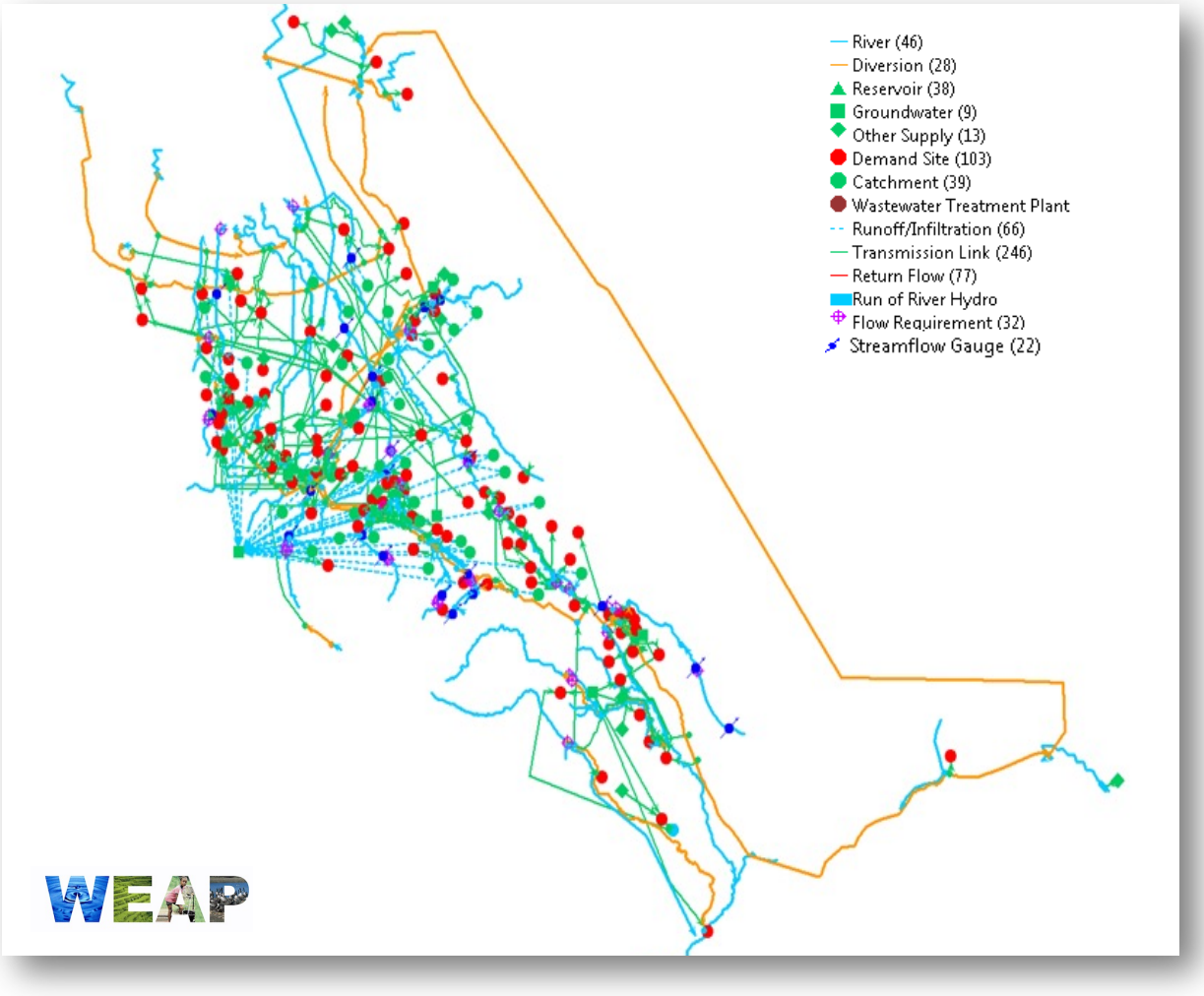


- Lowered Attraction Pulse and extended back through December
- Removed one of the winter base flow tiers to increase pulse flows
- Added Safeguard pulse
- Added outmigration pulse
- Modified Cold Pool thresholds

FAHCE Plus


Daily Release (CMS)
40
35
30
25
20
15
10
5
0
10/1
11/1
12/1
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
More frequent pulse flows in FAHCE Plus. Highest winter base flows in FAHCE.
Higher winter base flows in FAHCE and FAHCE Plus.
Lower summer base flows in FAHCE and FAHCE Plus.
2035 Base Case
2035 FAHCE
2035 FAHCE Plus

WEAP by the Numbers



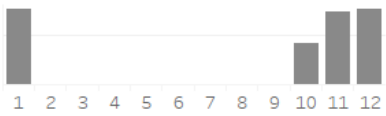
39 points and reaches of ecological interest

4,602 result variables about habitat suitability and availability (118 variables x 39 POIs)

37,023,090 result values per scenario

Outputs

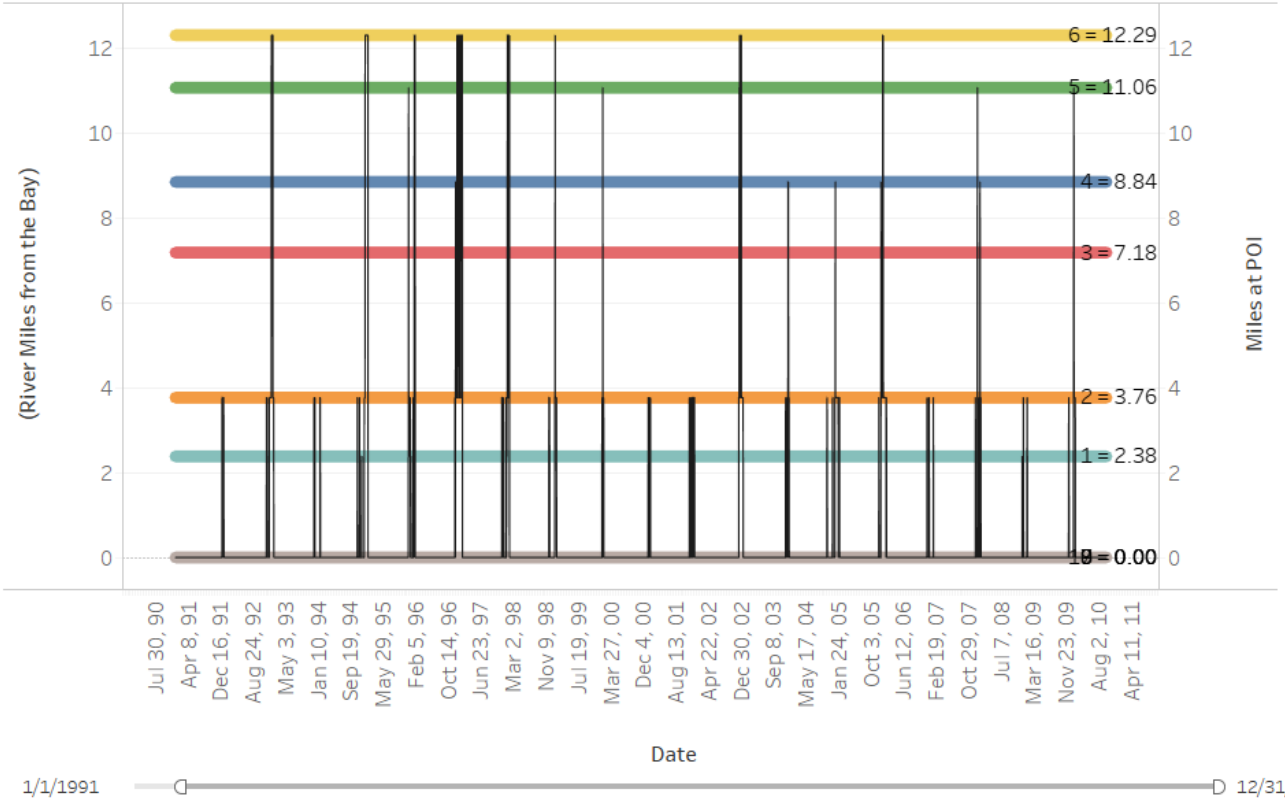
Fish Adult Immigration in River Miles



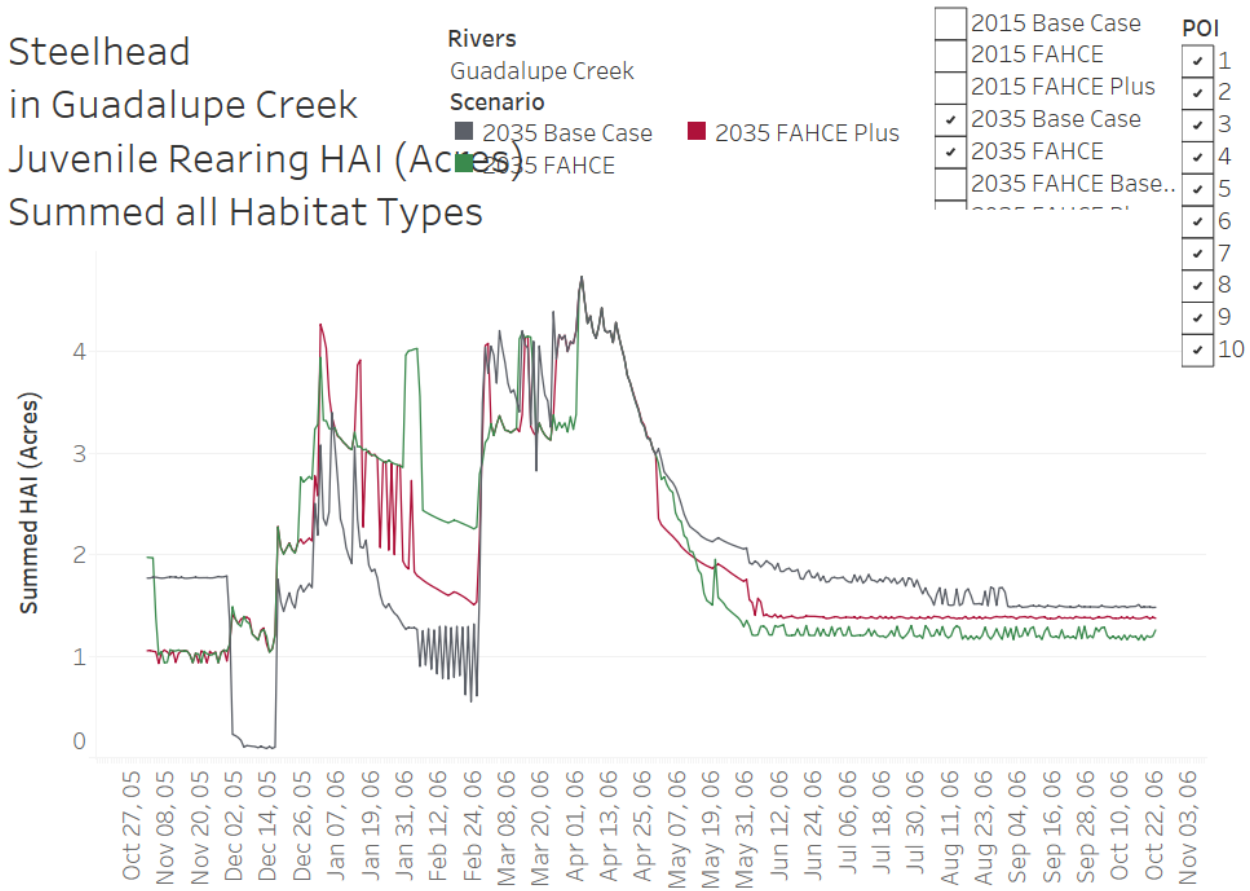
River
California River

Scenario
Scenario 1

POI
10
9
8
7
6
5
4
3
2
1



1/1/1991 — 12/31/2010



Date 11/2/2005 to 10/23/2006

PRIVILEGED/CONFIDENTIAL COMMUNICATION
PURSUANT TO CALIFORNIA EVIDENCE CODE SECTION 1152
PRELIMINARY RESULTS SOLELY FOR USE IN SETTLEMENT NEGOTIATIONS

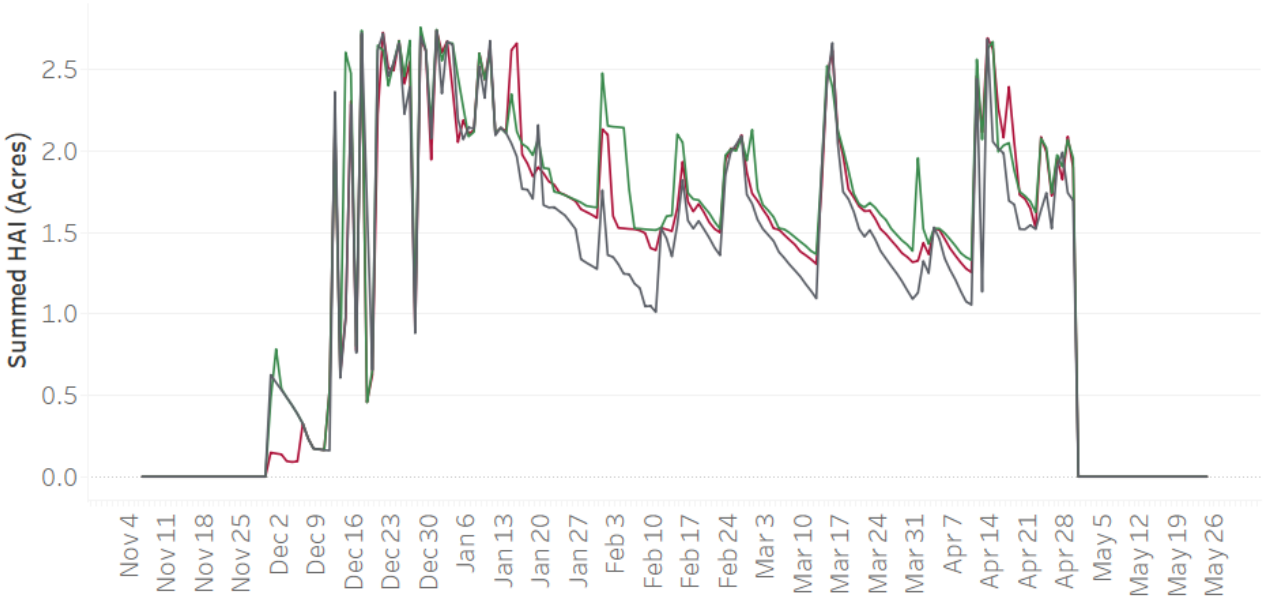
Steelhead Spawnin
Summed HAI
for all Habitat types
in Guadalupe

Rivers
Guadalupe

Scenario
2035 Base Case
2035 FAHCE
2035 FAHCE Plus

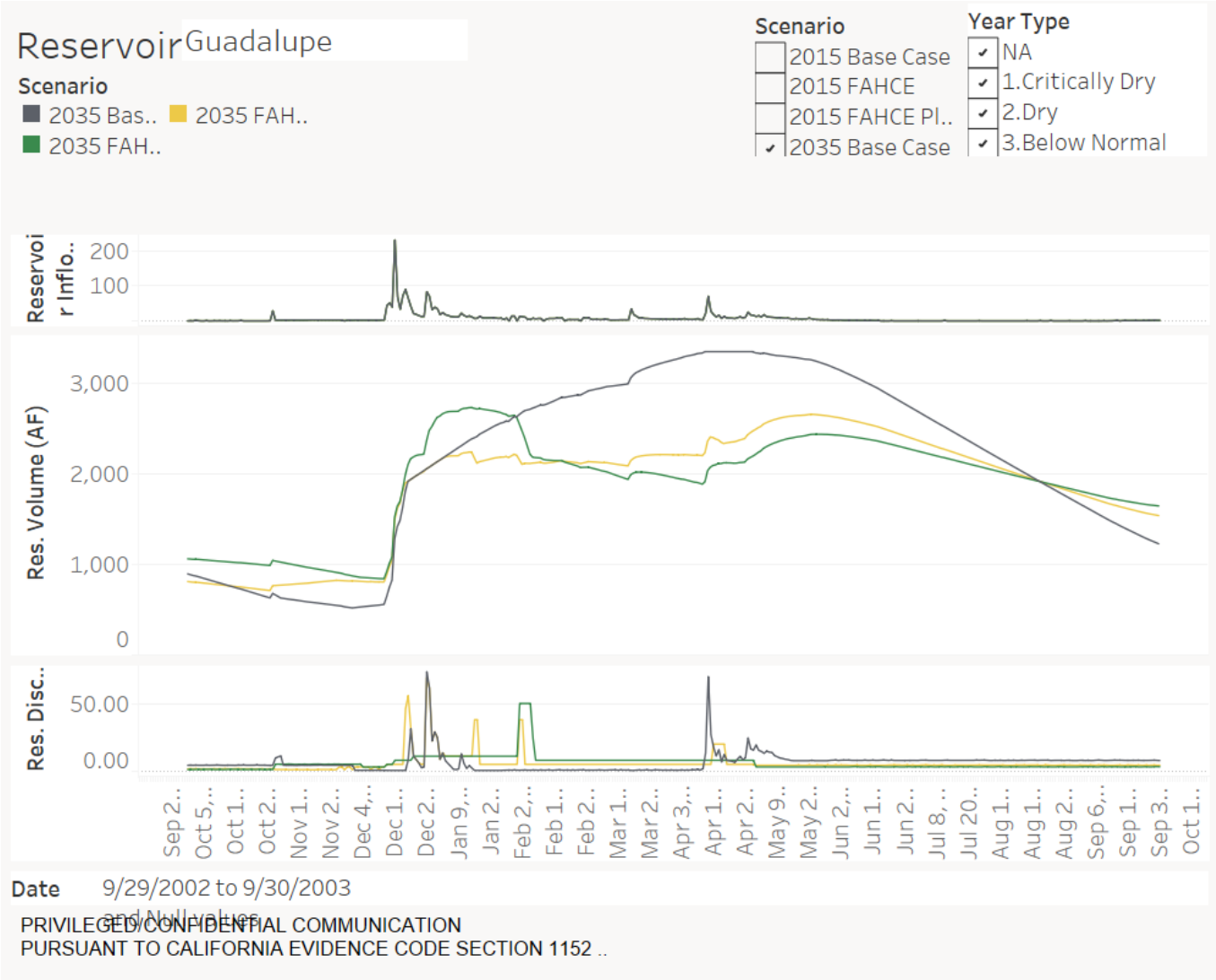
Scenario
- [ ] 2015 Base Case
- [ ] 2015 FAHCE
- [ ] 2015 FAHCE Plus
- [x] 2035 Base Case
- [x] 2035 FAHCE
- [ ] 2035 FAHCE Baseline O..
- [x] 2035 FAHCE Plus

POI
- [x] 1
- [x] 2
- [x] 3
- [x] 4
- [x] 5
- [ ] 6



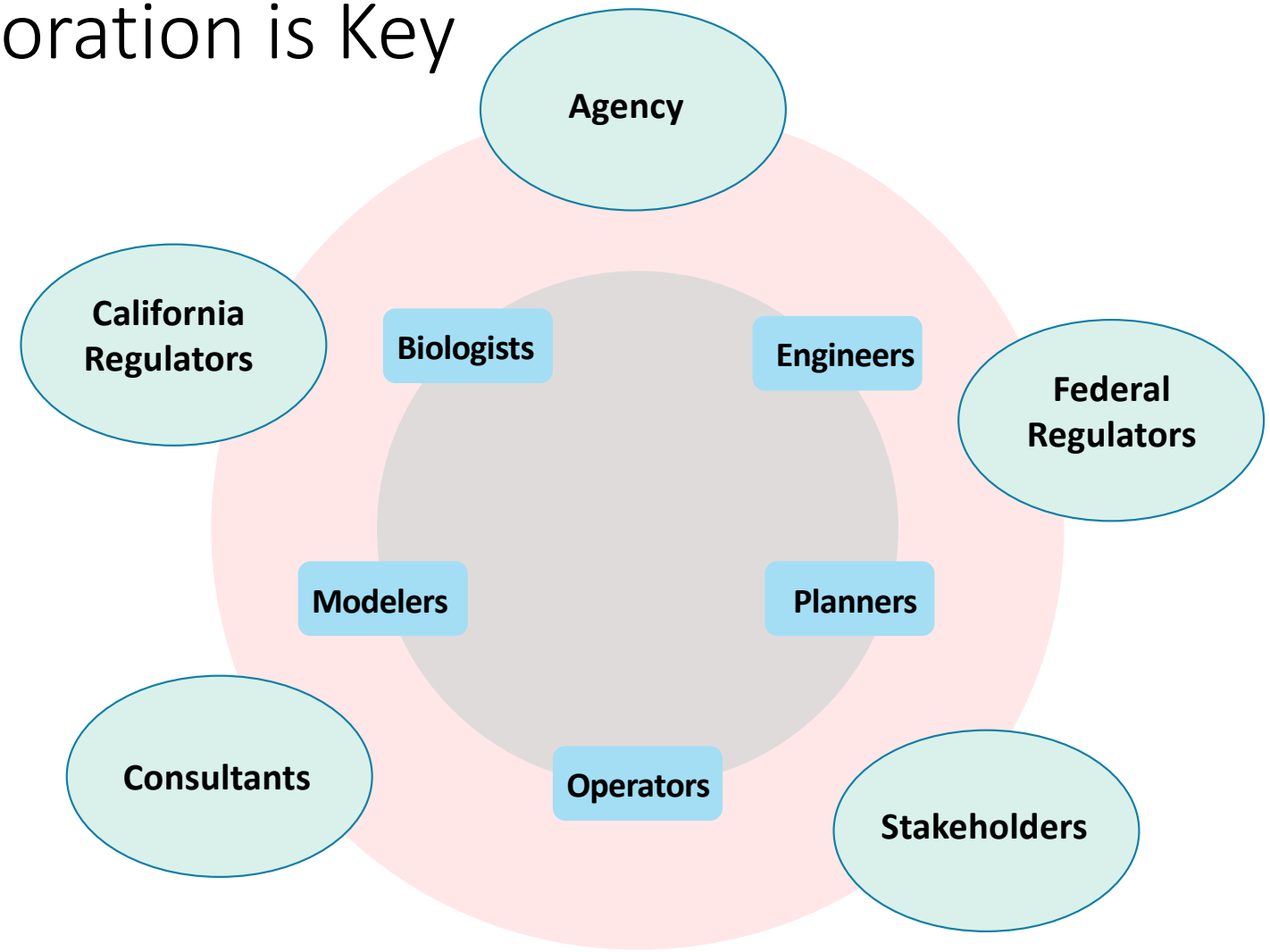
Date November 7, 2002 to May 25, 2003
and Null values

PRIVILEGED/CONFIDENTIAL COMMUNICATION
PURSUANT TO CALIFORNIA EVIDENCE CODE SECTION 1152
PRELIMINARY RESULTS SOLELY FOR USE IN SETTLEMENT NEGOTIATIONS



PRIVILEGED/CONFIDENTIAL COMMUNICATION
PURSUANT TO CALIFORNIA EVIDENCE CODE SECTION 1152 ..

Collaboration is Key



Key insights

From the process

A **collaborative environment** is important to discuss technical approaches, balanced with a focus on production.

Flow management is an entry point for habitat improvements in systems with storage and conveyance infrastructure.

Defining **realistic operation rules** is required for integrating reservoir management as an habitat restoration measure.

From the outputs

Scenarios that focus on habitat create challenges to achieve other water delivery **objectives**.

At least a **daily timestep** is needed to model scenarios of reservoir storage and release.

From the modeling tools

This work demonstrates a **novel tool** for integrated water resources planning giving ecosystems a seat at the table and providing water managers the context they need to weigh trade-offs.

Integrating modeling approaches, such as WEAP, hydraulic metrics and habitat assessment, can help in resolving **complex water management challenges.**

Questions?

For more information:

- Chalmers D, Escobar M, Forni LG, Nishijima J, Layng L (2023) **Application of watershed-scale habitat modeling and decision-support tools for reservoir reoperations in coastal northern California.** PLOS Water 2(6): e0000069. https://doi.org/10.1371/journal.pwat.0000069
- Stockholm Environmental Institute (SEI)

SEI Stockholm Environment Institute