LOS ANGELES RIVER WQ & RESTORATION

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HOGUE HYDROLOGY GROUP

SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT
Applying next-generation science to aquatic ecosystems management
A PUBLIC AGENCY

University of Portland
SHILEY SCHOOL OF ENGINEERING

Agenda

1. Introductions and meeting goals – 1:00 – 1:10

2. General updates and project status – 1:10 - 1:30

3. Water quality effects analysis – 1:30 – 2:00

   (5 min break)

4. Restoration analysis – 2:00 – 2:45

5. Wrap up and next steps – 2:45 – 3:00

Meeting Objectives

1. Discuss availability of final products

2. Present results of water quality analysis

3. Discuss preliminary results of restoration analysis

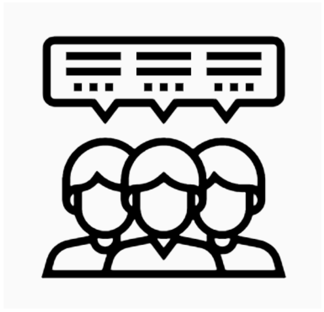
Outcomes of LA River Flows

- Developed tools that can be used to inform decisions about establishing flow management targets

- Tools can easily be used to evaluate potential effects of a broad range of potential management scenarios on in-river flows

- Tools are highly flexible and transferable

- Broad agreement among stakeholders on the application and utility of these tools
  - ➢ Several projects have already begun using the tools



SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT

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Los Angeles River Environmental Flows Project

SCCWRP is working with the State Water Resources Control Board and the Los Angeles Regional Water Quality Control Board, in cooperation with local municipalities (including City of LA Bureau of Sanitation, City of LA Department of Water and Power, LA County Department of Public Works, and LA County Sanitation Districts), to conduct the Los Angeles River Environmental Flows Project (Project). The goals of the project are to develop a process for establishing flow criteria, to apply the process to provide recommendations for flow criteria in the LA River, and to produce tools and approaches to evaluate management scenarios necessary to achieve recommended flow criteria. The project also serves as an important pilot application of the California Environmental Flows Framework (CEFF) by demonstrating how CEFF can be applied in a highly urbanized watershed where flow alteration is primarily caused by wastewater and stormwater discharges. The outcomes of this project may also serve as a model for assessing similar situations in other river systems.

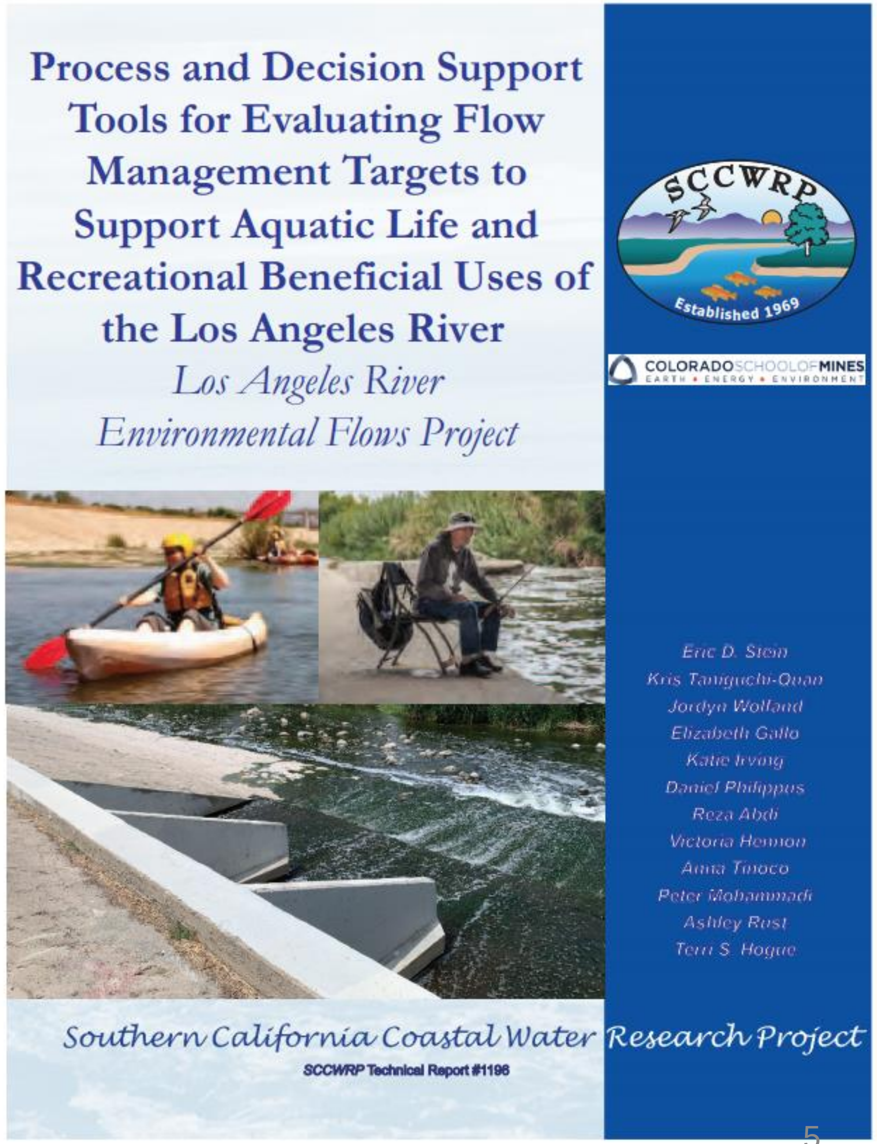
For more information about this project, go to the Background and History of the Los Angeles River Flows Project on the State Water Board's website.

Related Pages

Ecohydrology Research Plan

Ecohydrology

- Progress reports
- Technical reports
- Outreach materials
- TAC meeting materials
- Stakeholder meeting materials
- Data and dashboard



https://www.sccwrp.org/about/research-areas/ecohydrology/los-angeles-river-flows-project/

LA River Environmental Flows Dashboard

Overview | Flow Range Determination | Sensitivity Curves | Flow Range Heat Map | Flow Depth Visualizer

Welcome to the Los Angeles (LA) River Environmental Flows Dashboard!

COLORADO SCHOOL OF MINES
EARTH • ENERGY • ENVIRONMENT

SCCWRP Established 1969

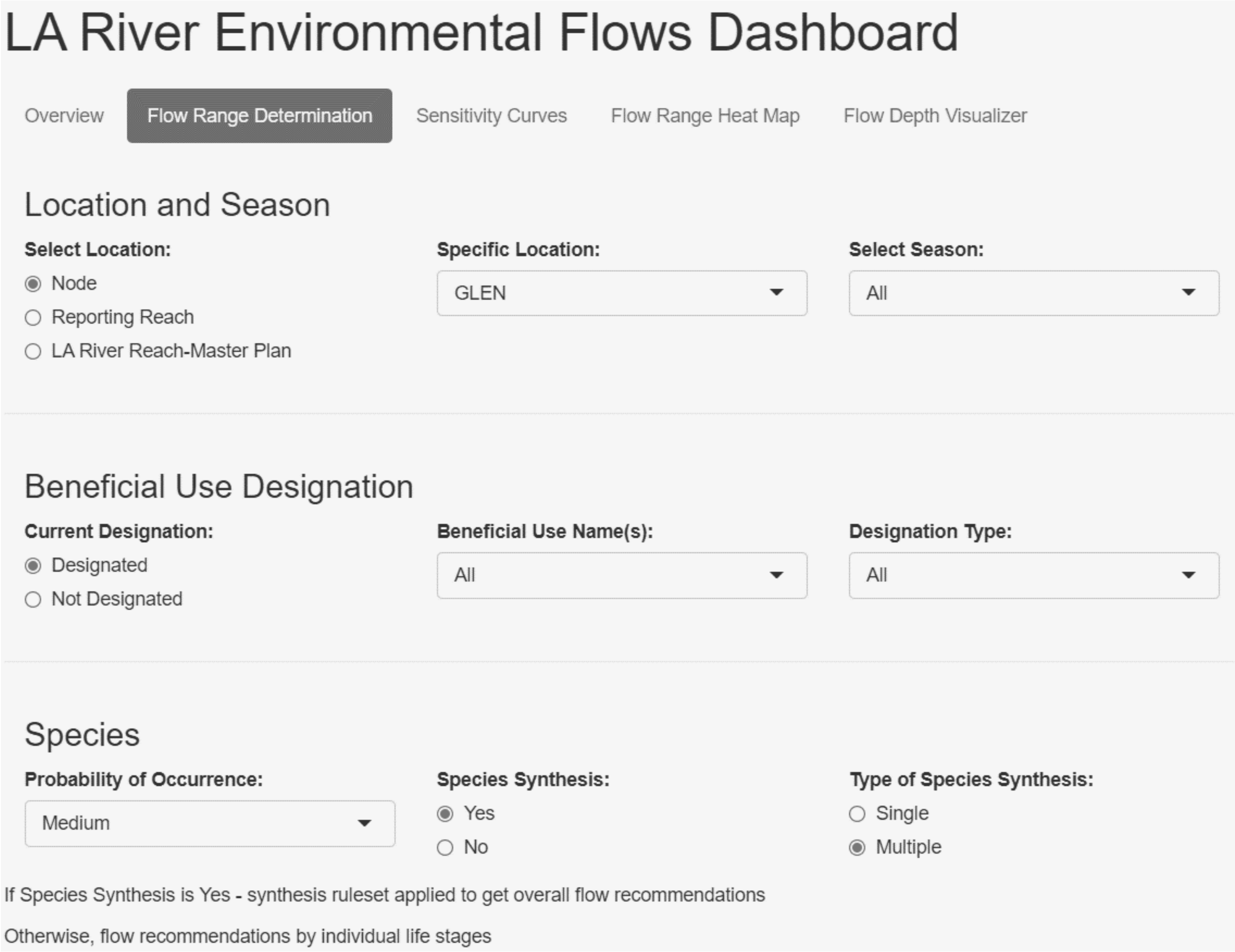
CALIFORNIA Water Boards

Council for Watershed Health

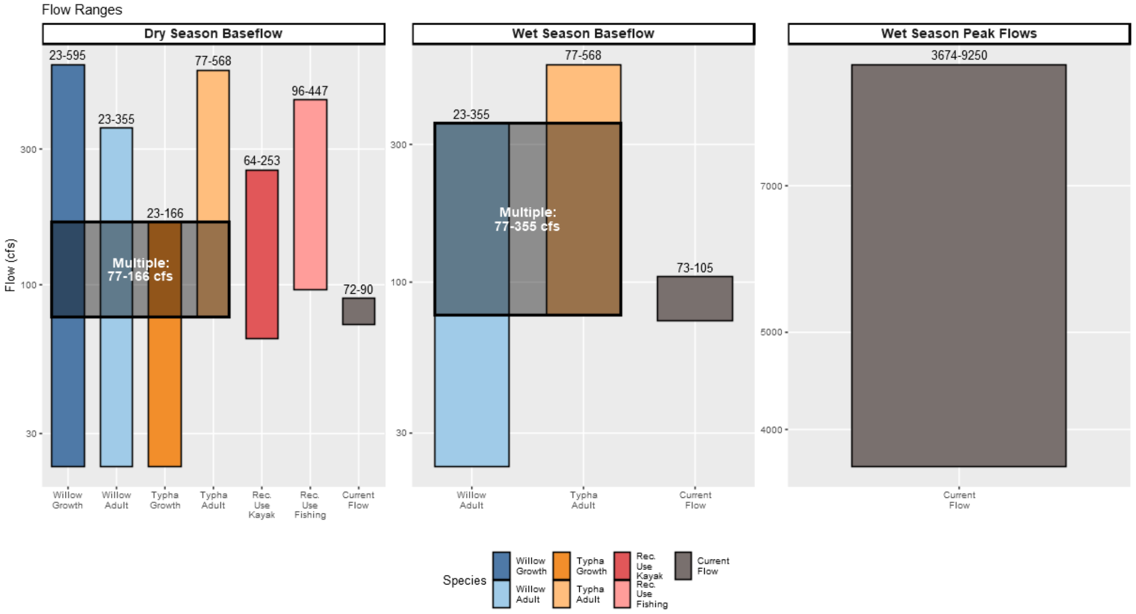
This interactive web page will allow you to explore flow ranges associated with beneficial uses of the LA River (**Flow Range Determination**) and **Sensitivity Curves**, evaluate the relative effects of various WRP discharges on multiple locations of the river (**Flow Range Heat Map**), and visualize flow at multiple cross sections (**Flow Depth Visualizer**). Start by using the menu sections on the top.

https://sccwrp.shinyapps.io/lar_eflows_shinyapp/

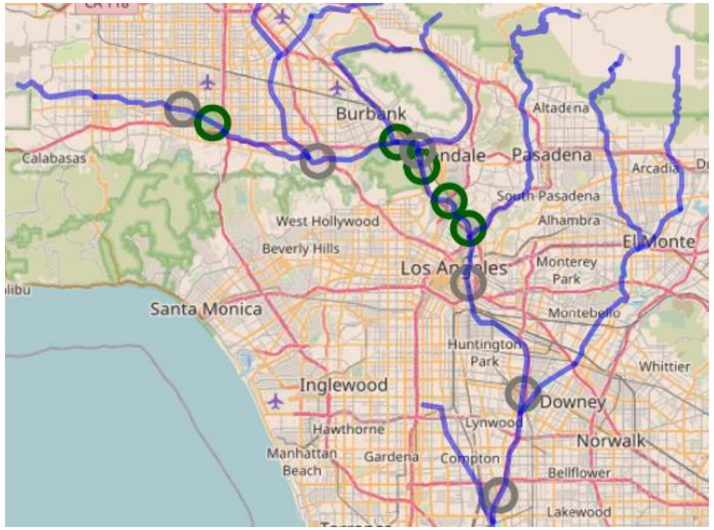
Dashboard Functionality



Visualize Flow Targets



Evaluate Scenarios Spatially



Additional Analysis

- Effects of changes in WRP discharge or stormwater capture/diversion on in-stream water quality
  - Temperature
  - Solids and metals
  - Contaminants of emerging concern (CECs)

- Relationship between changing flows and restoration design considerations
  - Low flow channel configuration (width and depth)
  - Overbank flow area (width and depth)

What We Have Learned So Far

- Restoration actions can improve stream temperature conditions for cold water fish

- Reduced WRP discharge may reduce contaminant loading, but have the potential to increase concentrations

- Restoration designs will have tradeoffs depending on objectives:
  - Low flow channel width is more important for fish habitat
  - Low flow channel depth is more important for willow habitat
  - “optimum” amount of WRP reuse varies based on location in the river and priority species

WATER QUALITY ANALYSIS

Temperature

Solids/Metals

Contaminants of Emerging Concern (CECs)

Temperature Modeling

- *How might different restoration options affect stream temperature in Compton Creek and on the mainstem?*
- *What are the implications for fish?*

Steelhead trout

Santa Ana sucker

Arroyo chub

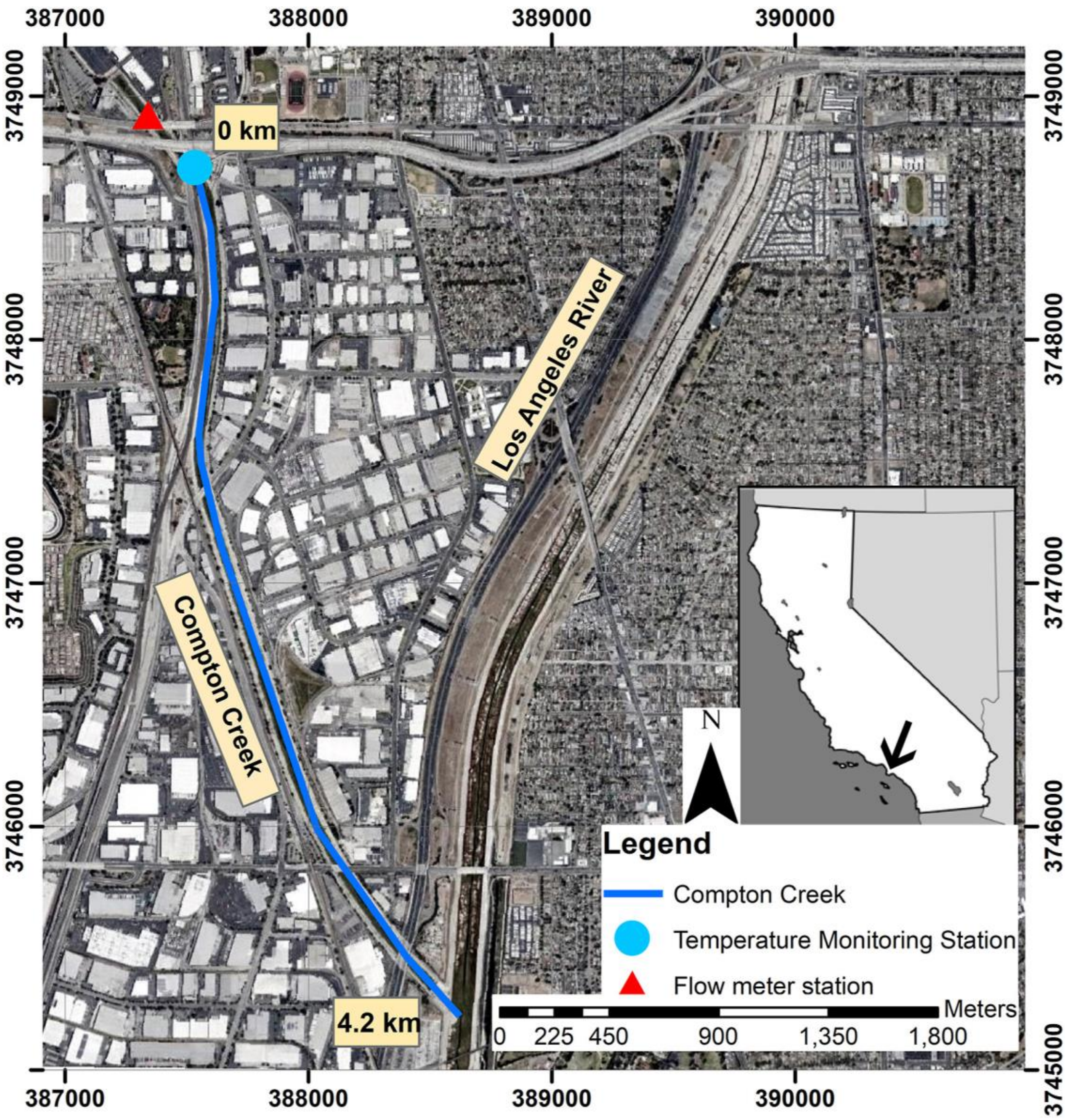
Three-spined stickleback

(1) Abdi, R. et al. (2021). Simulating the thermal impact of substrate temperature on ecological restoration in shallow urban rivers. In Journal of Environmental Management

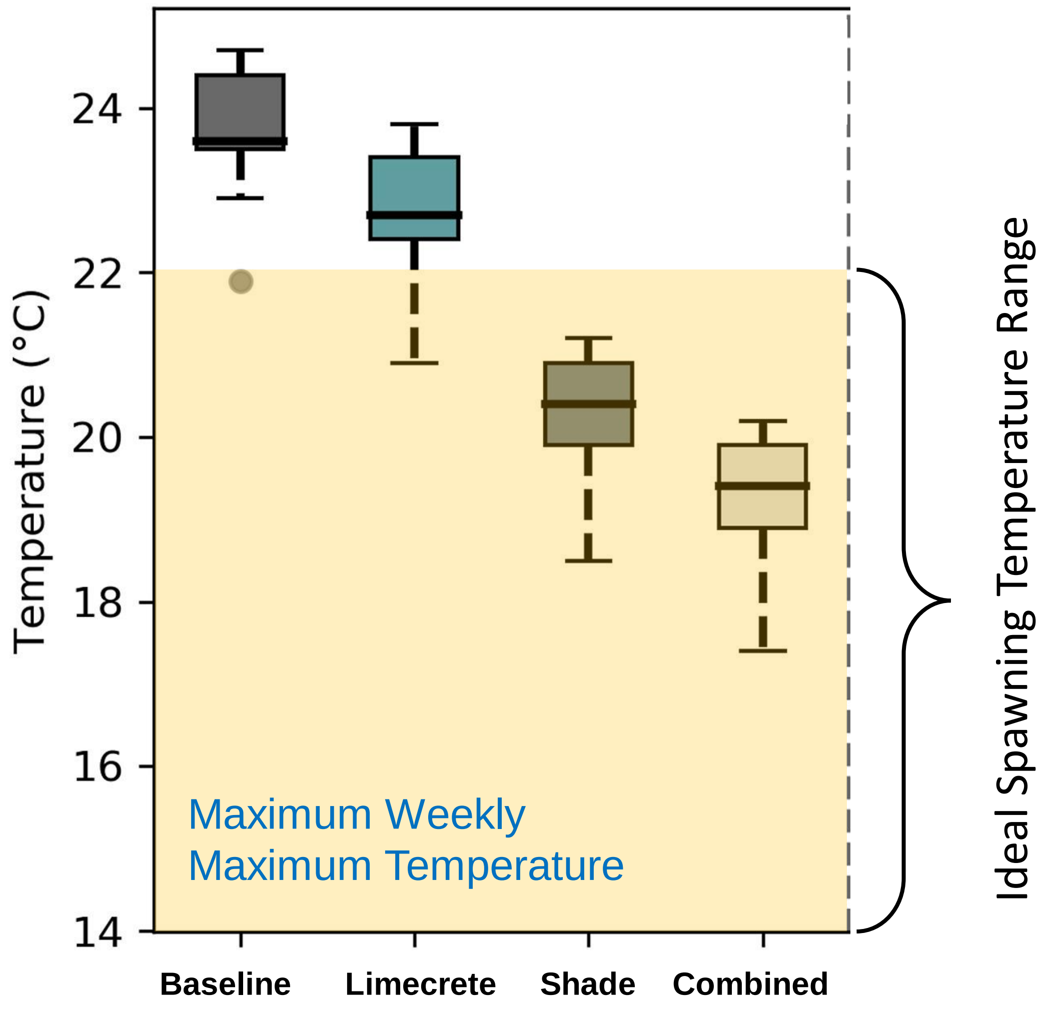
(2) Abdi, R. et al. (2022). Thermal Suitability of the Los Angeles River for Cold Water Resident and Migrating Fish Under Physical Restoration Alternatives. In Frontiers in Environmental Science.

Temperature Modeling – Compton Creek

- Coupled HEC-RAS model with i-TreeCool River
- Assessed three cooling scenarios
    1. Streambed material limecrete
    2. Tree planting in riparian areas
    3. Combined impacts
- Endpoints: arroyo chub and unarmored threespine stickleback



Temperature not a limiting factor for re-introduction of species in Compton Creek



Simulated June 5 to September 5, 2016

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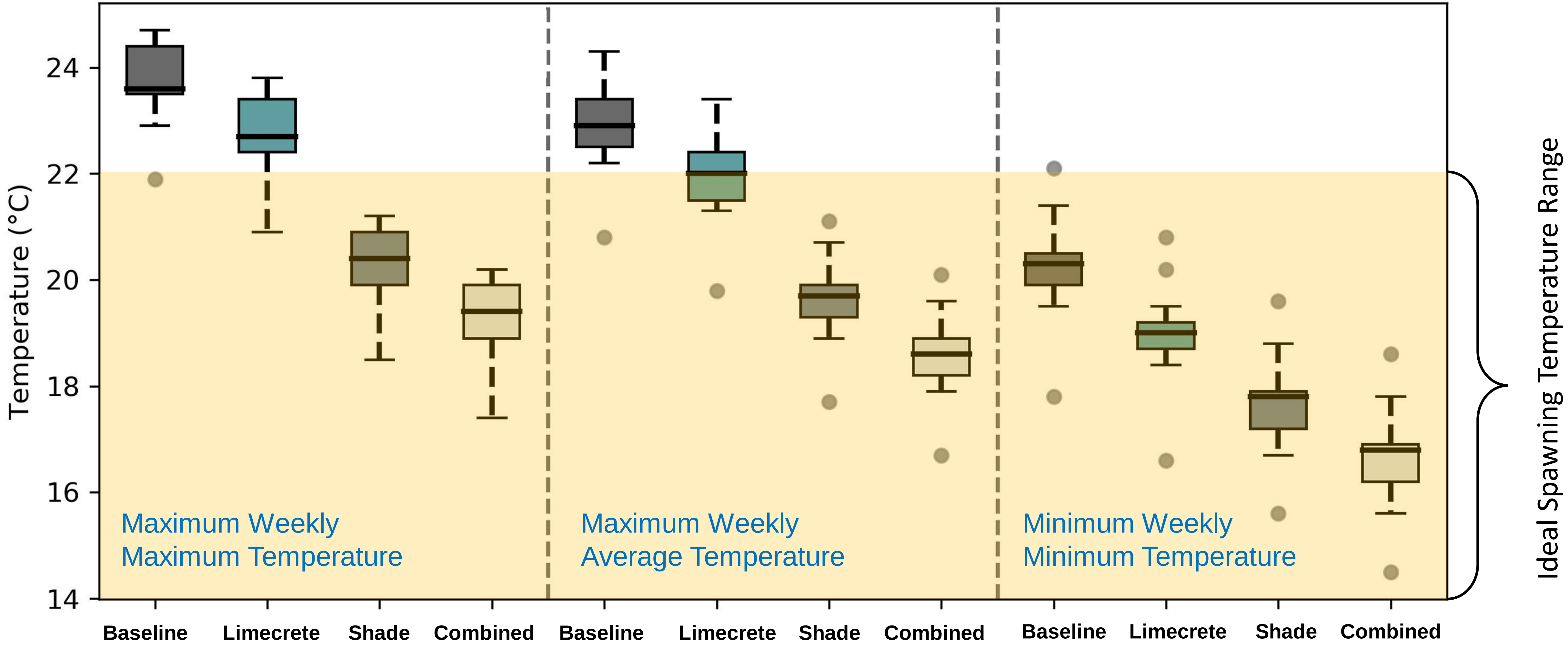
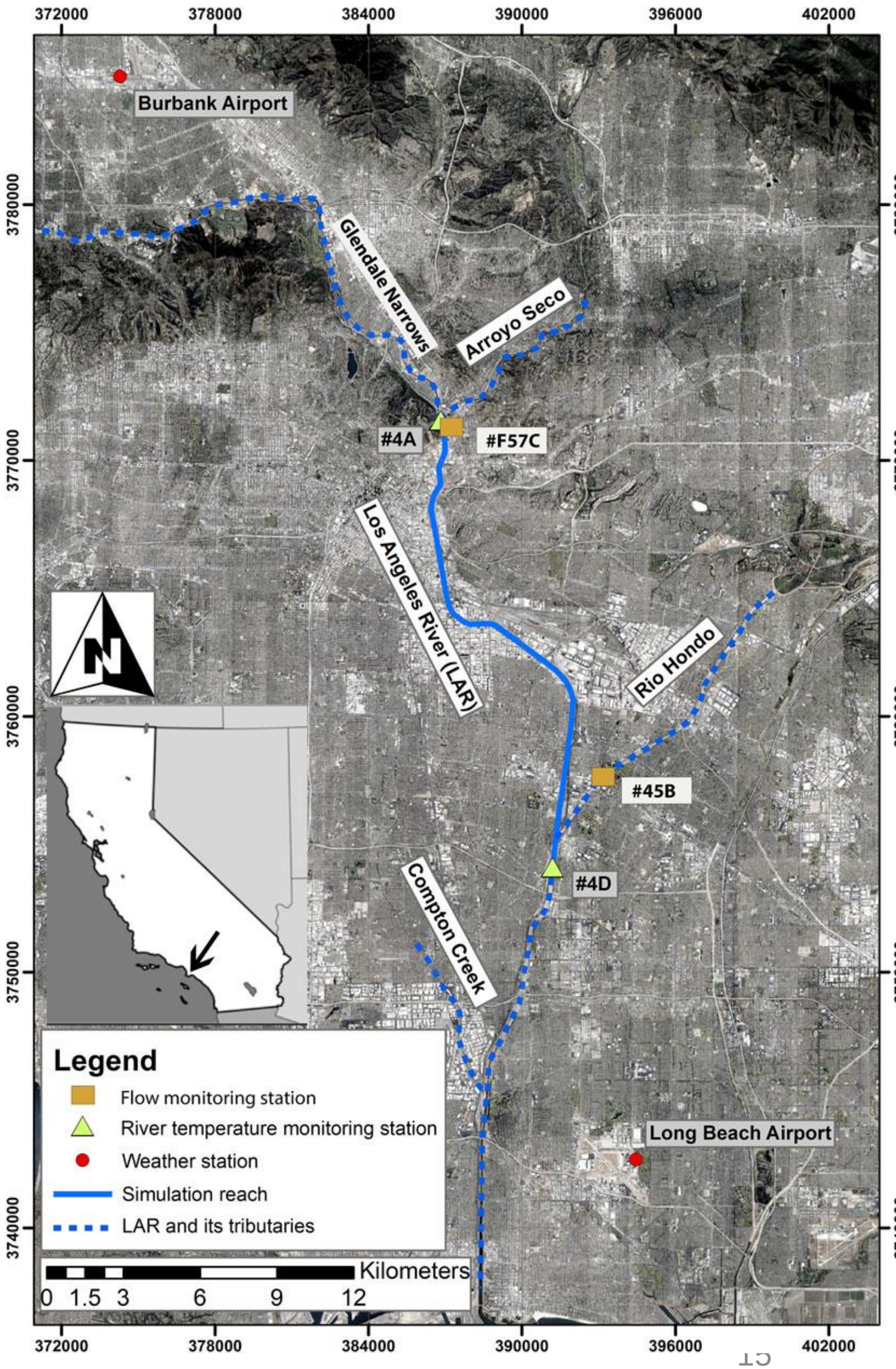


Simulated June 5 to September 5, 2016

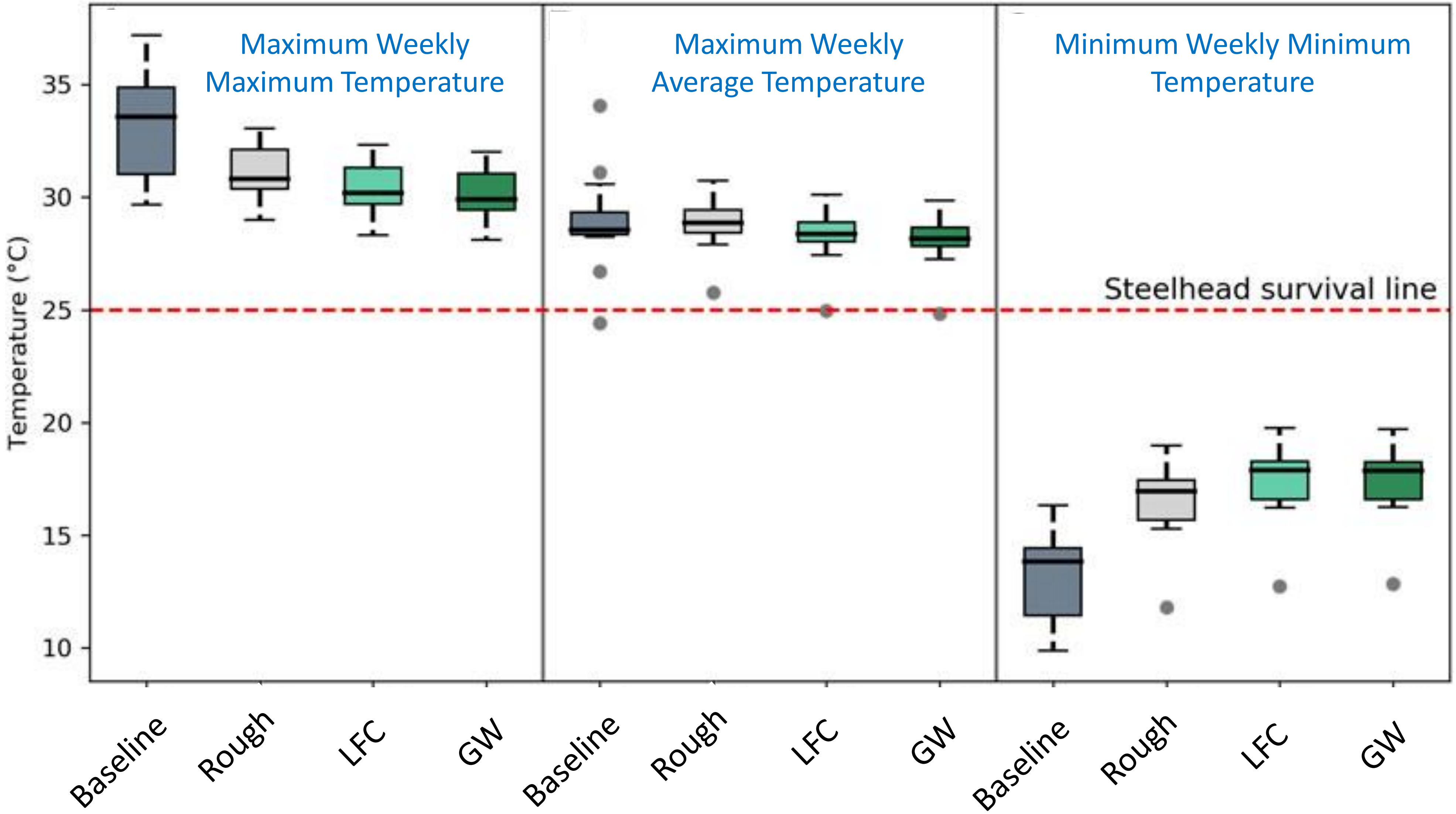
Temperature Modeling – Mainstem

- Coupled HEC-RAS model with i-TreeCool River
- Assessed three cooling scenarios
    1. increasing roughness of the low-flow channel
    2. increasing the depth and width of the low-flow channel
    3. allowing subsurface inflow to the river at a soft bottom reach in the LA downtown area (hyporheic exchange)
- Endpoints: steelhead trout and Santa Ana sucker



Scenarios improved temperature but not enough for cold water fish migration in mainstem

Simulated Feb. 1 – May 31, 2016



Scenarios:

1. Increased roughness ("roughness")
2. Increased depth and width of low-flow channel ("LFC")
3. Increase groundwater exchange ("GW)

Implications of Temperature Analysis

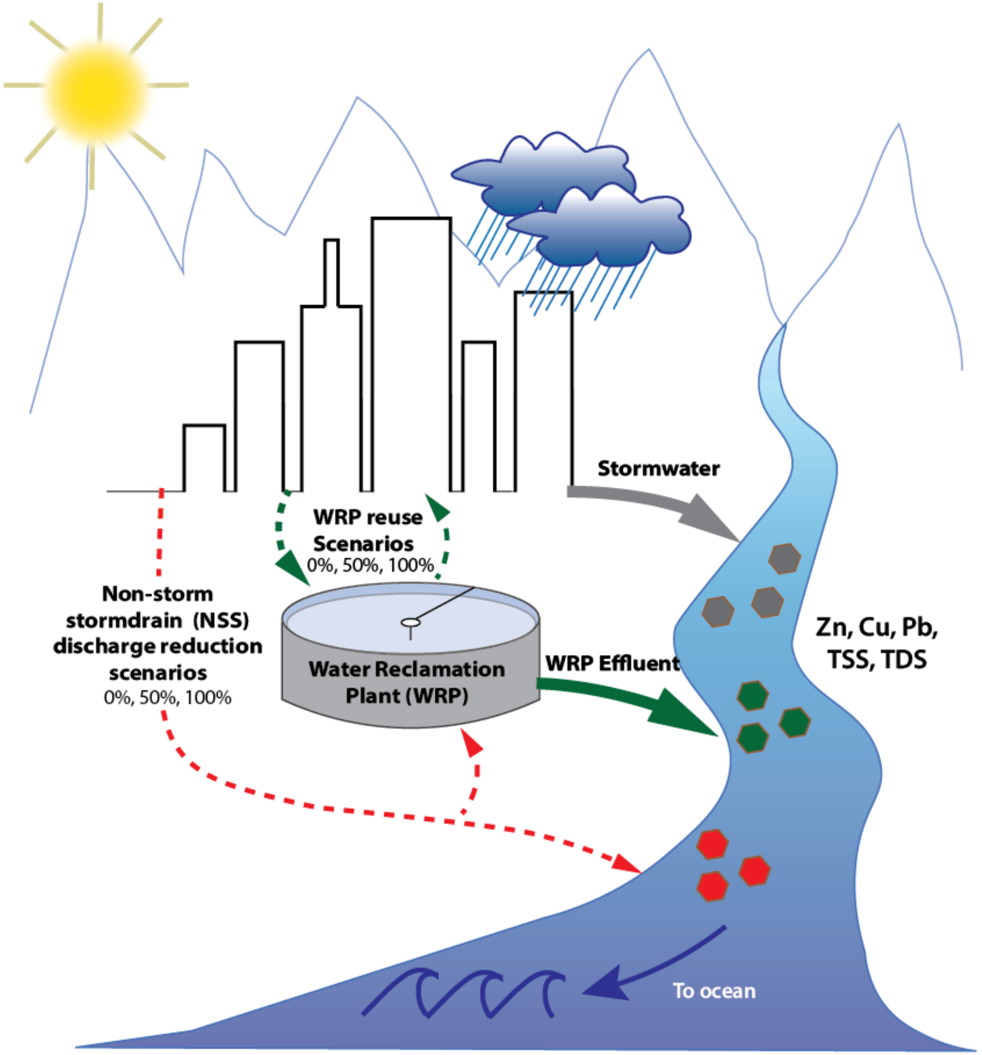
- Temperature not a limiting factor for re-introduction of species in Compton Creek
  - Hydraulics are limiting: low flows in this reach

- Scenarios improved temperature but not enough for cold water fish migration in mainstem
  - Riparian shading could further reduce temperature (but not modeled)
  - Hydraulics are also limiting: high flows in the mainstem
  - Reduced WRP discharge could provide additional cooling

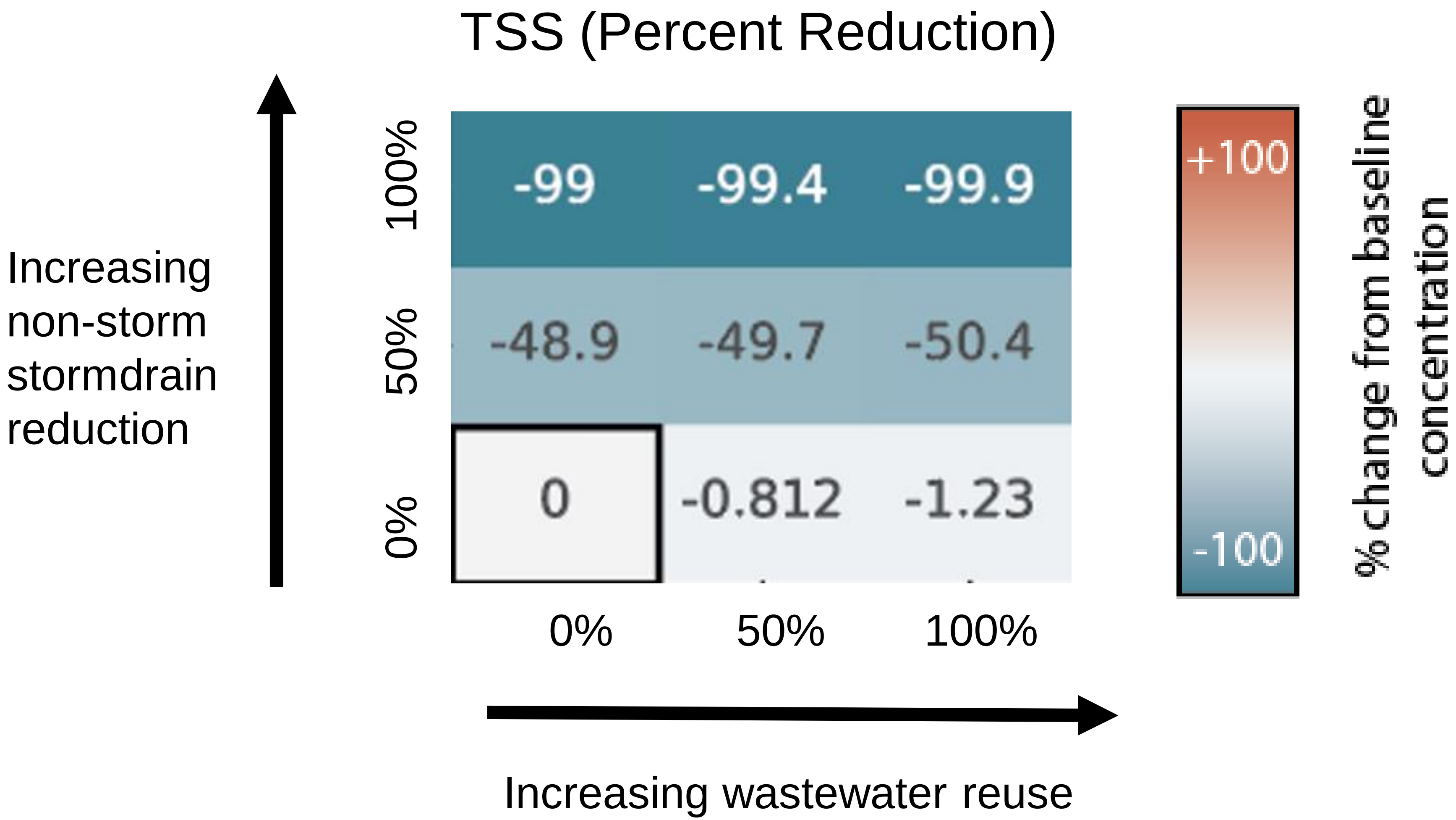
Water Quality Modeling – Suspended Solids & Metals

How might changes in flow affect water quality?

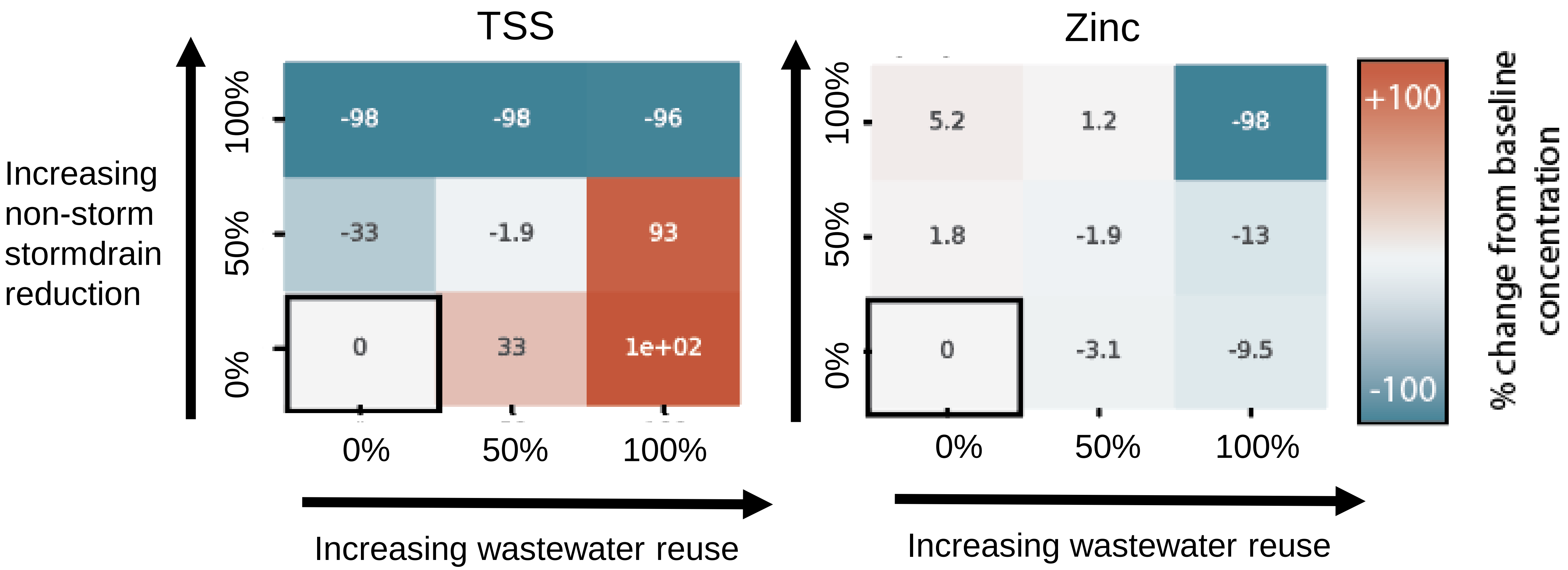
- SWMM model of mainstem
- Pollutants:
  - TSS
  - TDS
  - Copper, Zinc, Lead
- Assessed scenarios:
  - 0%, 50%, 100% WRP reuse
  - 0%, 50%, 100% non-storm stormdrain reduction (nSR)
  - *all combinations thereof*



Loads decrease across all scenarios & pollutants



Impact on concentrations vary



Water Quality Modeling – Contaminants of Emerging Concern

How might changes in flow affect concentrations of CECs in the mainstem?

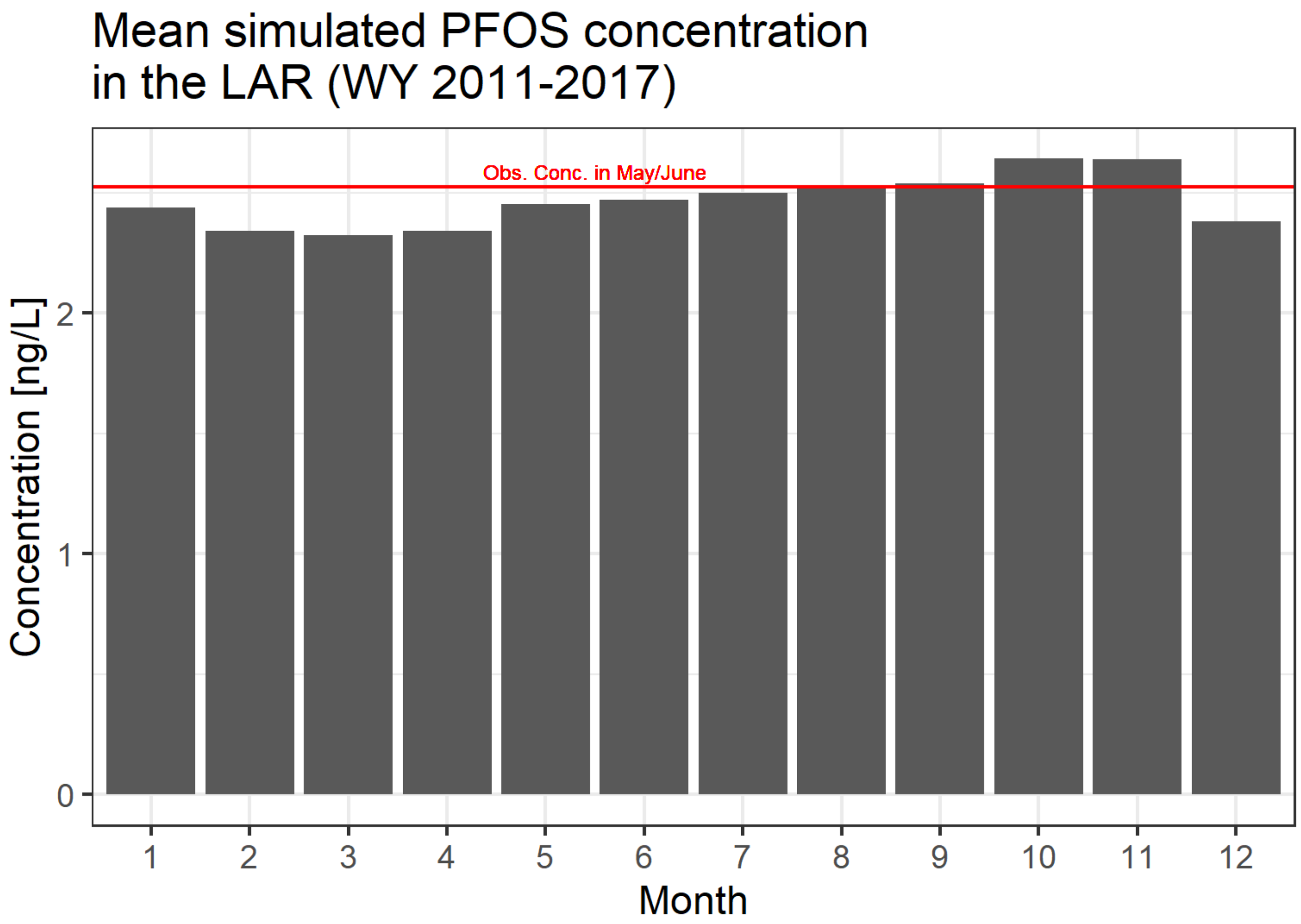
Water Quality Modeling – Contaminants of Emerging Concern

- SWMM model
- Contaminants of concern:
  - Carbamazepine: pharmaceutical
  - Diclofenac: pharmaceutical
  - Galaxolide: fragrance
  - Gemfibrozil: pharmaceutical
  - PFOS: fluorosurfactant
- Assess WRP reuse scenarios (10%, 50%, 90% reuse)

Table 3. Summary of all CEC data averages of effluents of DCTWRP, HTP, TIWRP, and LAGWRP in 2014.

CEC Parameter, ng/L	HTP	TIWRP	DCTWRP	LAG
BDE-209	ND	ND	ND	ND
Fipronil	58	21	68	52
Galaxolide	860	1100	2600	2100
N,N-Dlethyl-m-toluamide (DEET)	560	300	420	220
TCPP	2600	3200	2200	2600
TDCPP	690	1100	720	550
4-tert-Octylphenol	ND	ND	28	ND
Diclofenac	120	ND	76	85
Ibuprofen	ND	ND	ND	ND
Perfluoro octanesulfonate-PFOS	11	19	3.5	5.6
BDE-100	ND	ND	ND	ND
BDE-154	ND	ND	ND	ND
BDE-183	ND	ND	ND	ND
4-Nonylphenol	ND	ND	ND	ND
Gemfibrozil	1100	21	270	220
Amoxicillin	ND	ND	ND	19
Chlorpyrifos	ND	ND	ND	ND
Carbamazepine	130	150	140	140

Model calibration – ongoing!



Next steps for CEC analysis:

- Finish model calibration
- Assess WRP scenarios
- Evaluate longitudinal concentrations along river, compare to recommended action levels

Implications of Water Quality Analysis

- WRP and non-storm flow reduction uniformly reduces loads
- Impact on concentrations vary depending on pollutant source
- CEC model development is ongoing
  - Patterns likely vary based on compound type
  - Future work will evaluate longitudinal profile of pollutants across reuse scenarios
  - Additional data gaps necessary to better understand behavior of some compounds (e.g., role of sediment concentrations)

BREAK

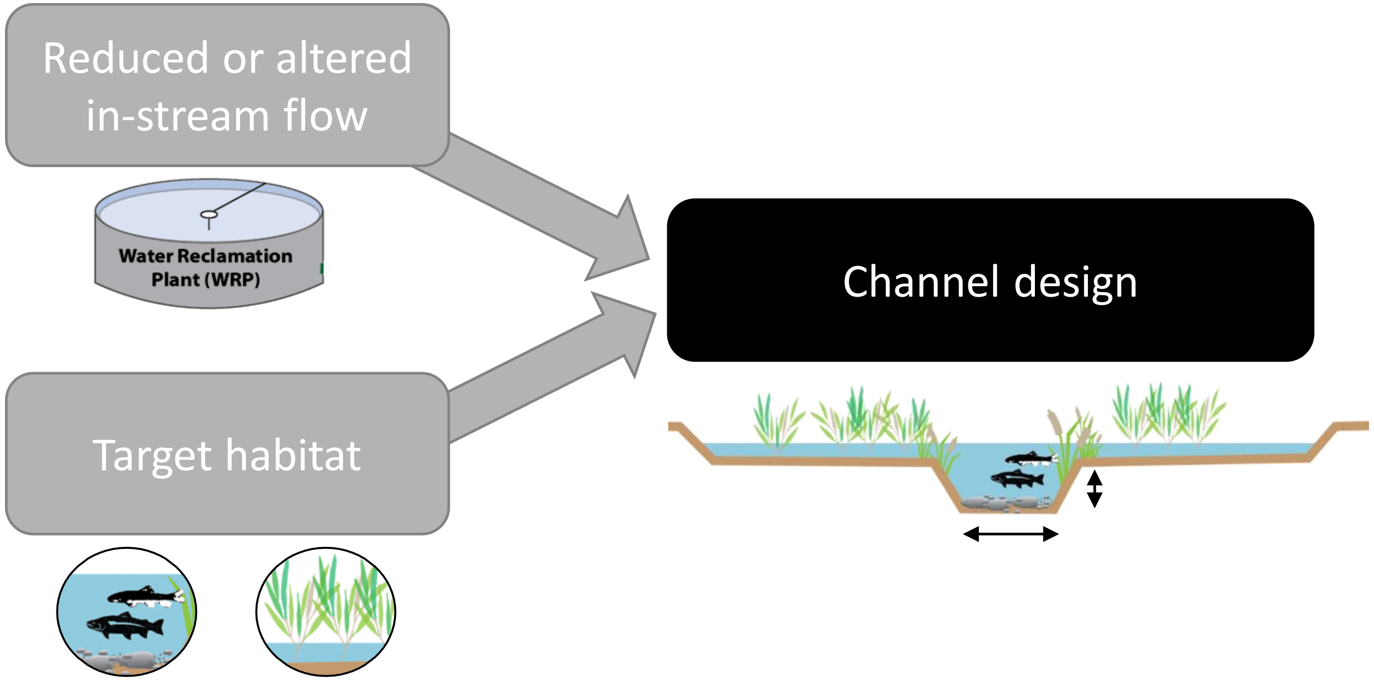
RESTORATION ANALYSIS

Preliminary results

Ongoing coordination

CENTRAL QUESTION

How can channels be designed to meet target flows for specific habitats in consideration of potential future flow changes?

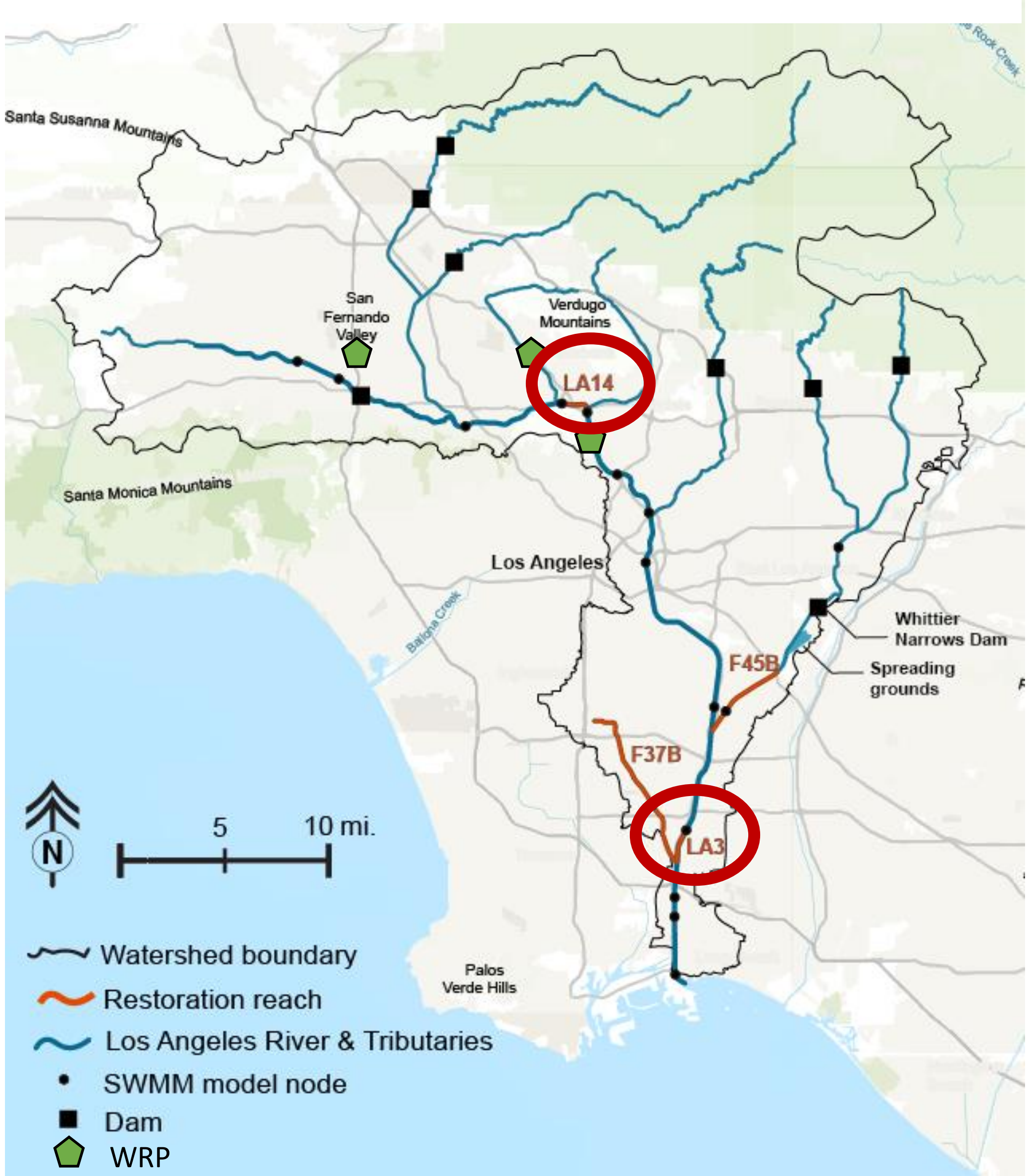


RESTORATION REACHES

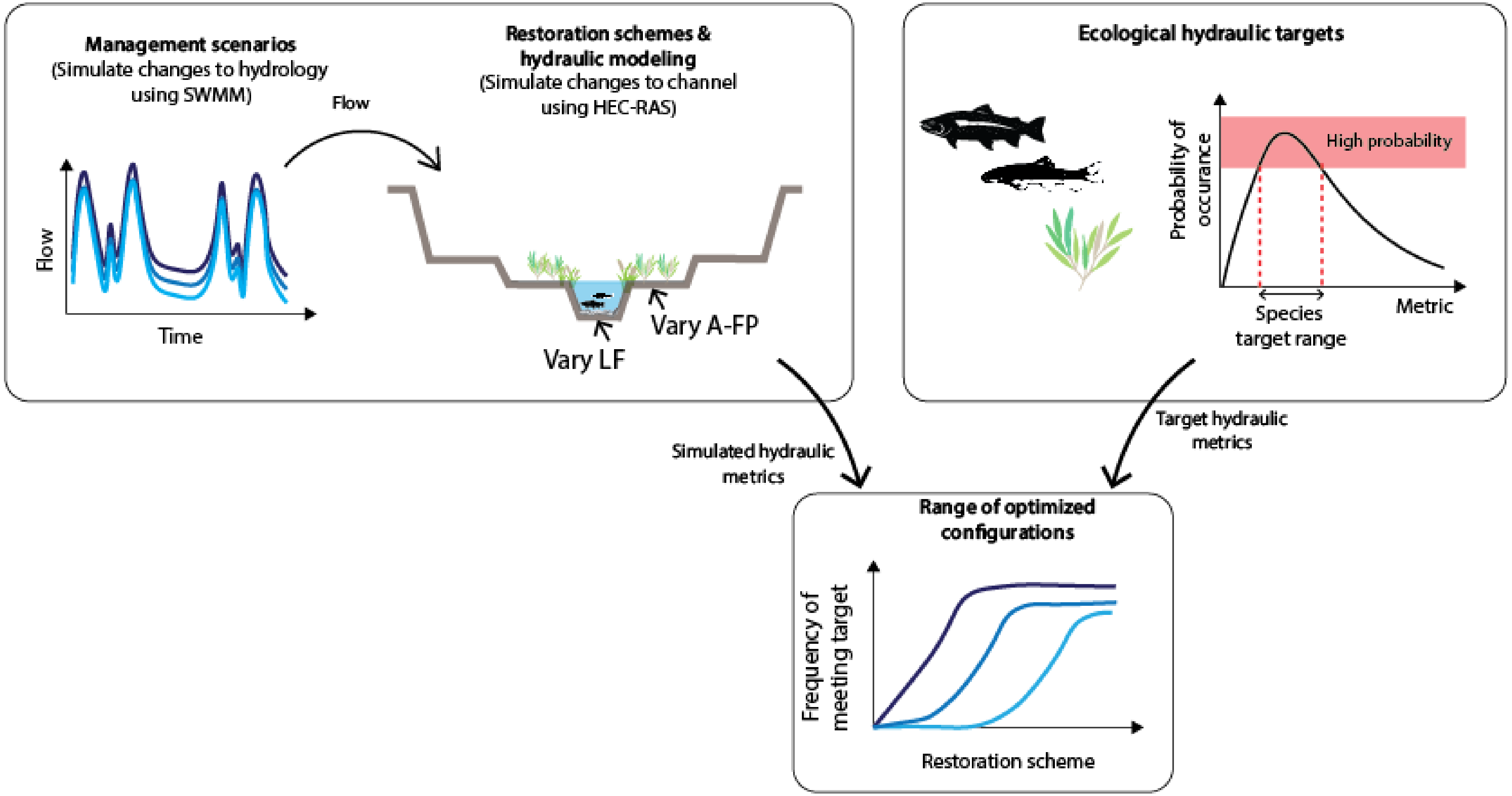
- Evaluated restoration options in four reaches
  - Two on main stem (LA14, LA3)
  - One on Rio Hondo (F45B)
  - One on Compton Creek (F37B)

- Included consideration of reduced WRP and stormdrain discharges

- TODAY: Focus on main stem reaches (LA14 and LA3), and impact of water reclamation plant reuse (WRP %)



GENERAL APPROACH



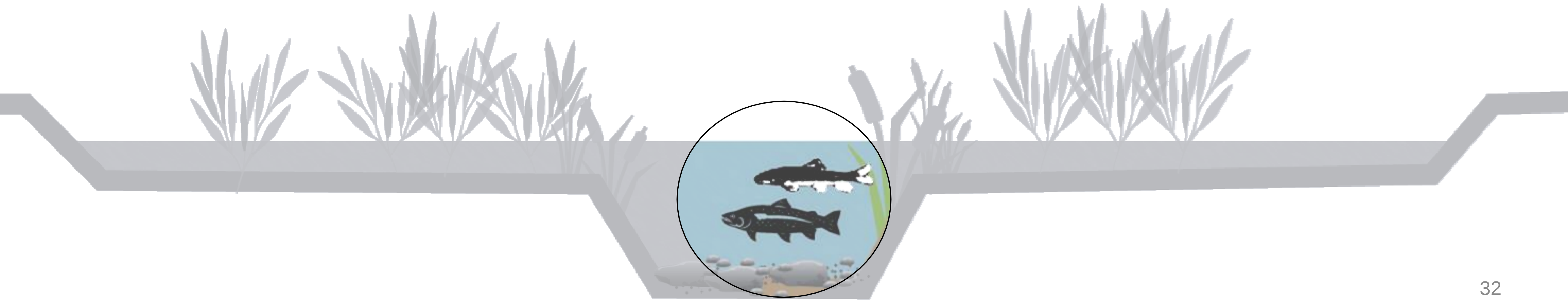
TARGET SPECIES AND RANGES

Cold water and migration habitat species

- Santa Ana Sucker
- Steelhead

Target hydraulic metrics

- Depth: 30 – 48 cm
- Velocity: 0.01 – 2 m/s



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- Santa Ana Sucker
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- Depth: 30 – 48 cm
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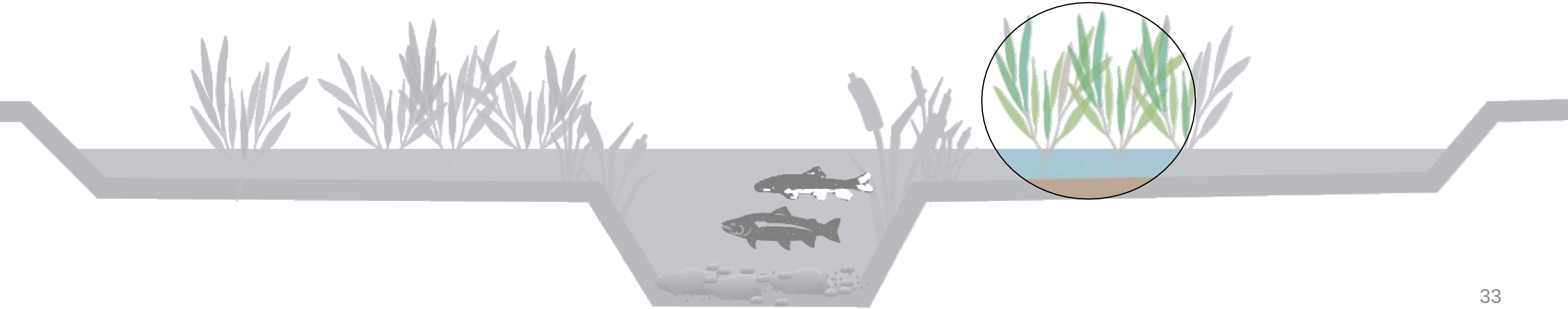
Riparian species

- Goodding's Black Willow (*Salix gooddingii*)

Target hydraulic metrics

- Depth: 0 – 18.4 cm
- Shear stress: 0 – 0.53 Pa
- Inundation: 85 – 280 days/ yr



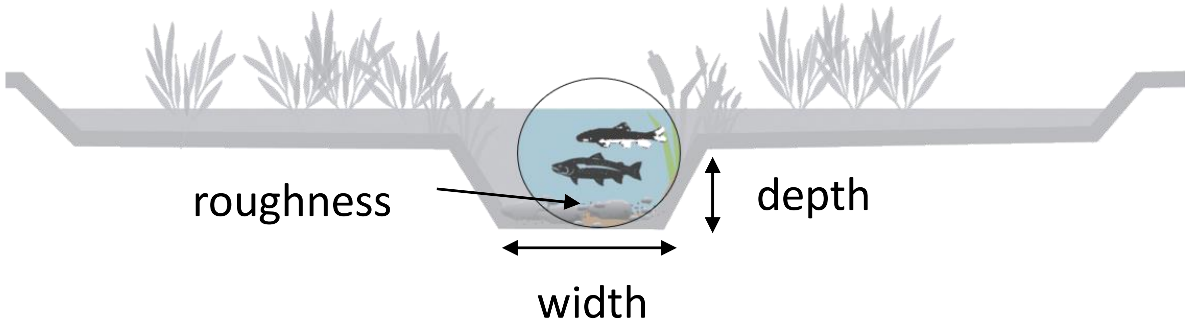
HEC-RAS SIMULATIONS

Low flow channel optimization

Target species: Santa Ana Sucker and Steelhead
HEC-RAS simulations:

- low flow channel bottom widths 1 – 8m
- low flow channel depth 0.3 – 0.5 m
- low flow channel roughness = 0.035

Final optimal low flow channel width for each depth

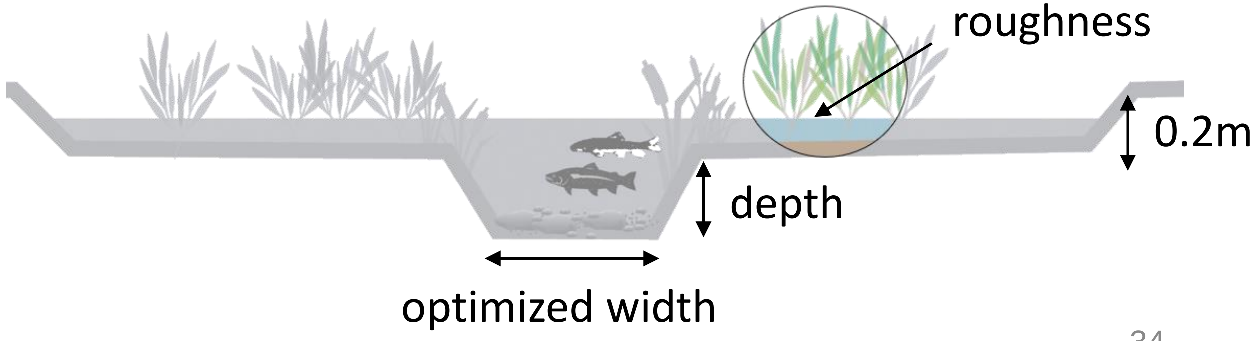


Optimal low flow channels + active floodplain optimization

Target species: Willow
HEC-RAS simulations:

- Optimal low flow channel width
- Low flow channel depth 0.3 – 0.5 m
- Active floodplain depth 0.2m
- Active floodplain roughness = 0.15

Find optimal low flow channel width and depth



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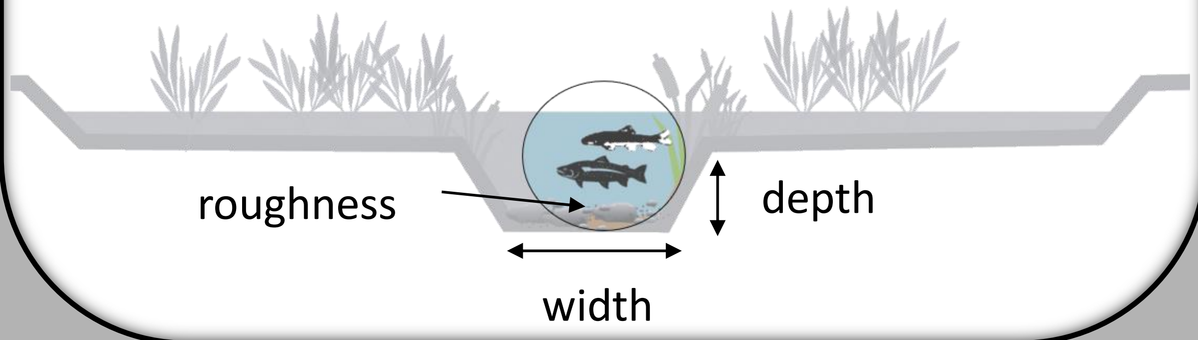

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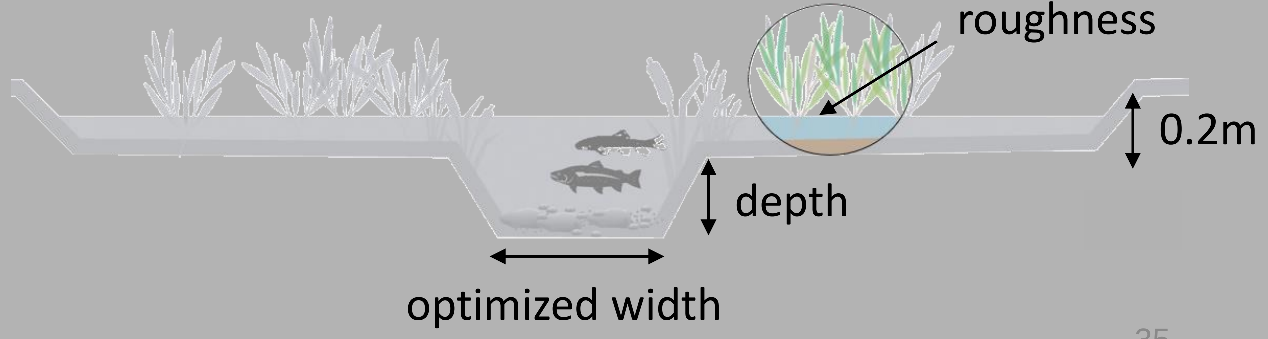
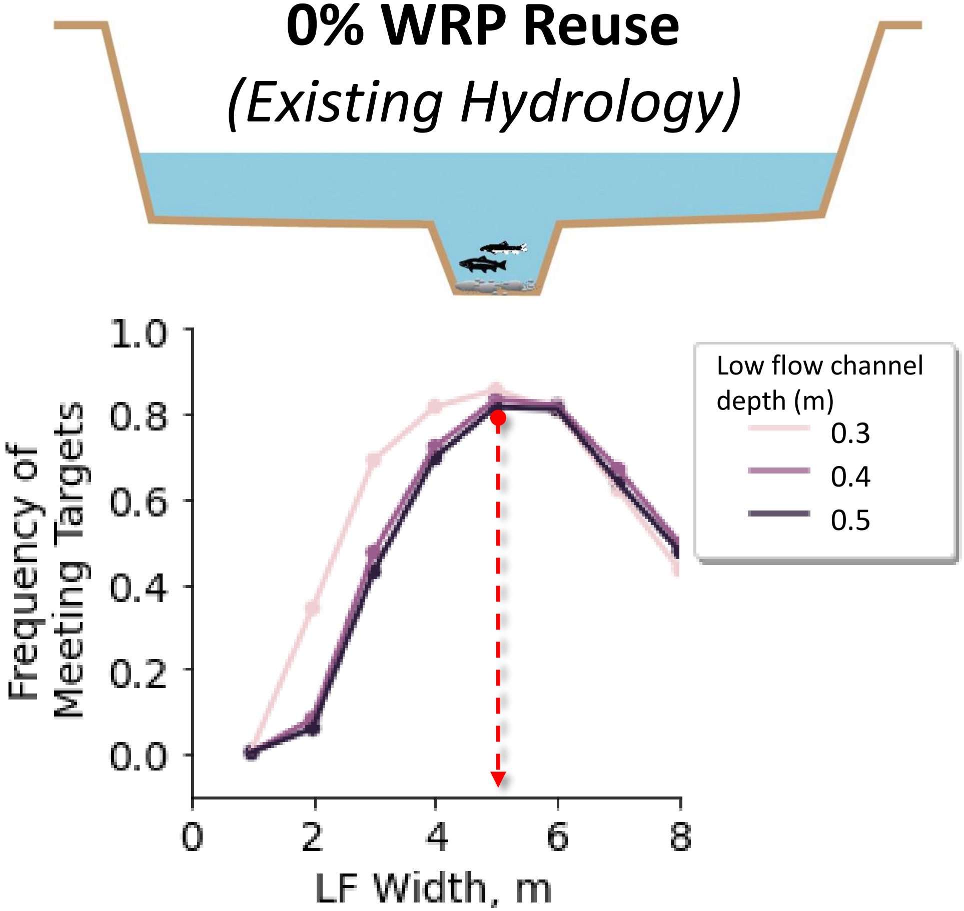


LOW FLOW CHANNEL RESULTS

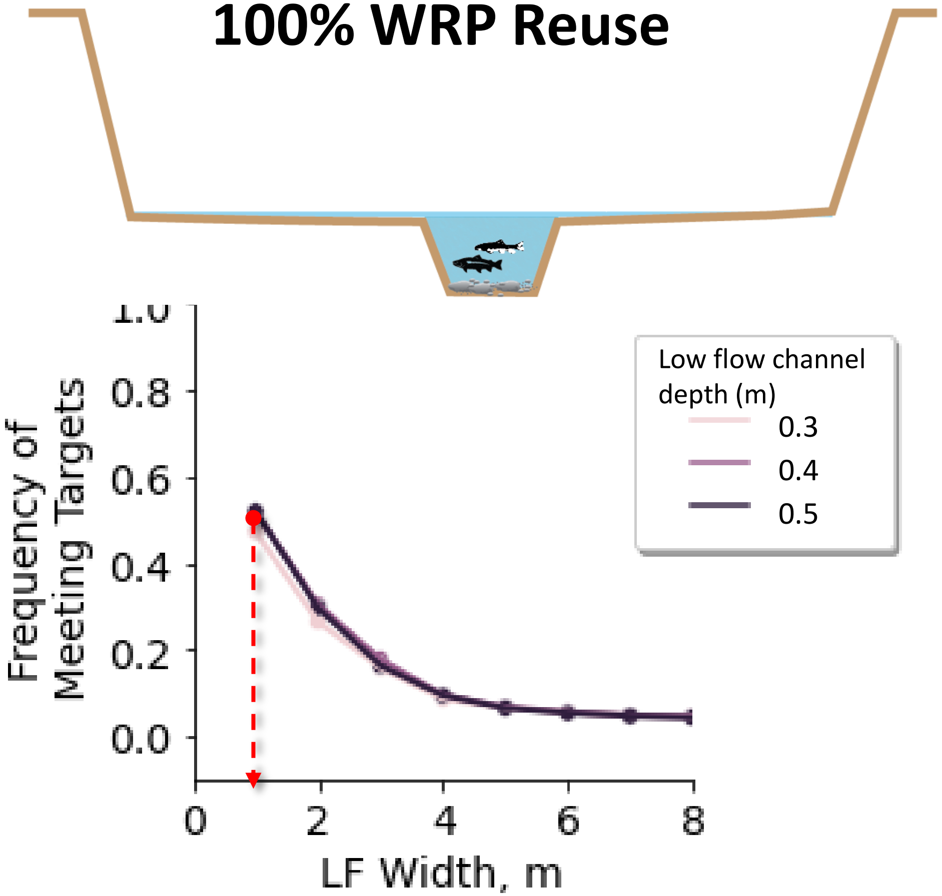
Frequency of meeting targets = <u># of days that meet low flow channel targets per year</u>
 # days per year (365)

Low flow channel target:
- *Depth: 30 – 48 cm*
- *Velocity: 0.01 – 2 m/s*

LA14
0% WRP Reuse
(Existing Hydrology)



LA 14
100% WRP Reuse



LOW FLOW CHANNEL RESULTS

Frequency of meeting targets = <u># of days that meet low flow channel target per year</u> / # days per year (365)

Low flow channel target:
- *Depth: 30 – 48 cm*
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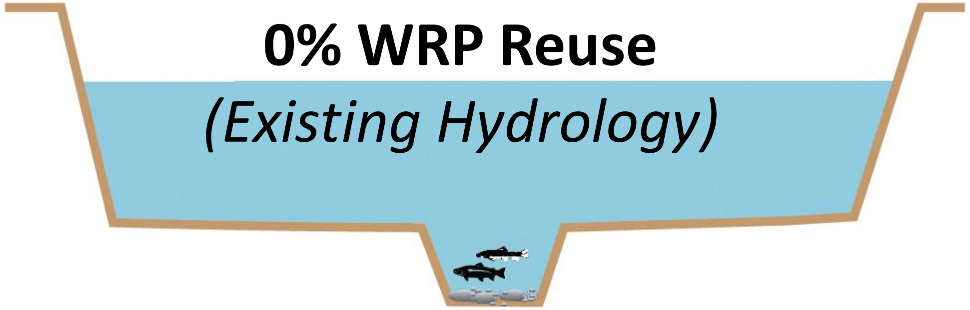
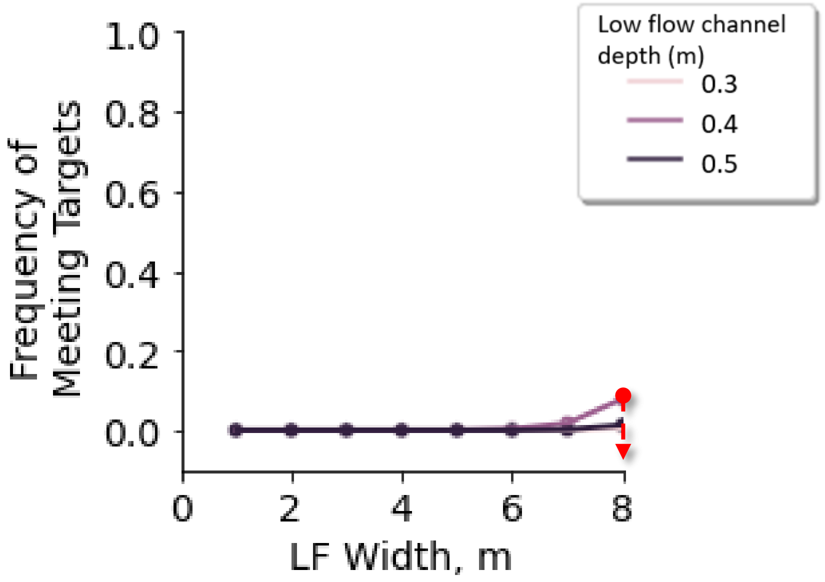
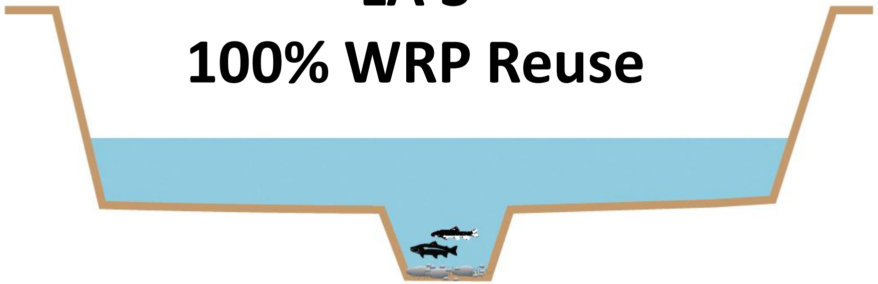
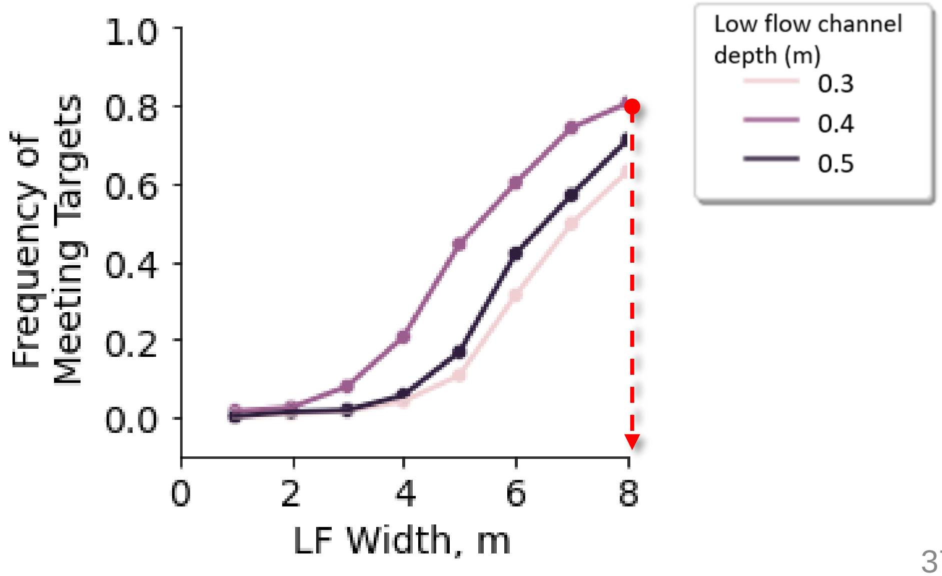
LA3
0% WRP Reuse
(Existing Hydrology)





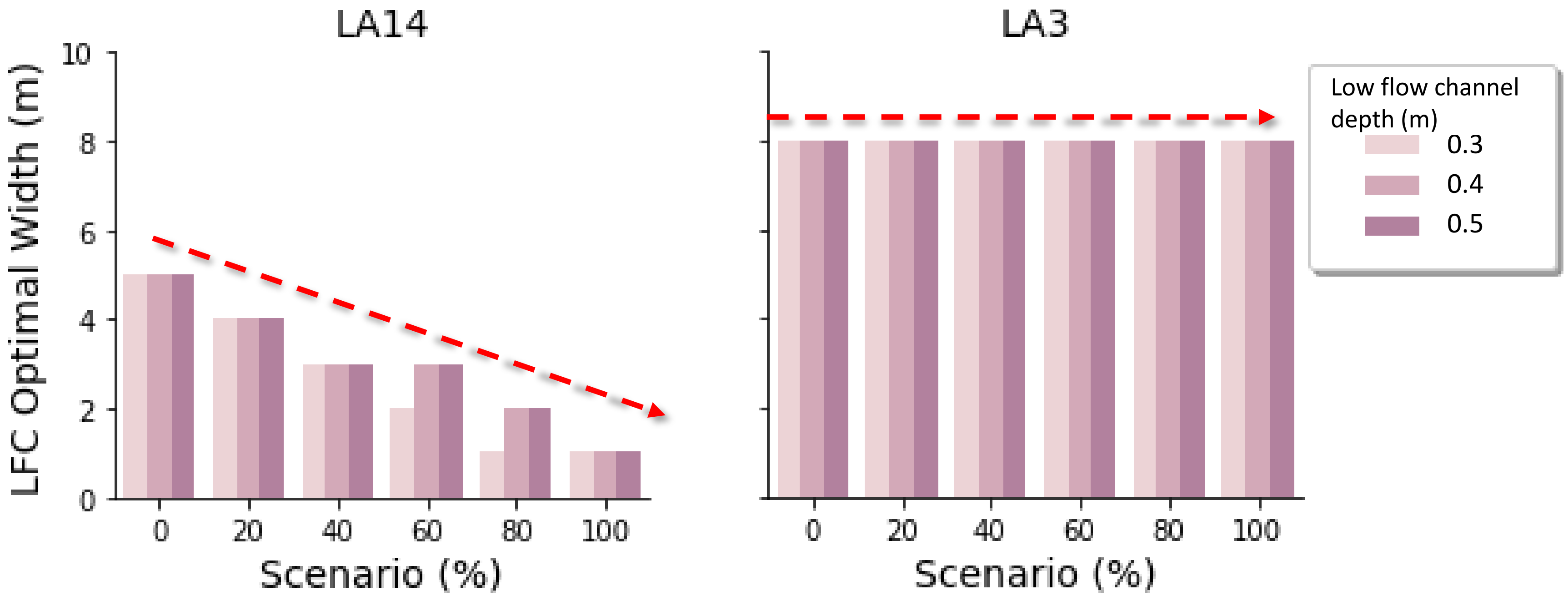
LA 3
100% WRP Reuse





LOW FLOW CHANNEL SENSITIVE TO WIDTH

- Low flow channel targets are **sensitive to low flow channel width**
- LA 14 – optimal width depends on reuse
  - Wider low flow channel needed for smaller reuse scenarios (more flow)
  - Narrower low flow channel needed for higher reuse scenarios (less flow)
- LA 3 – optimal width is 8m across all scenarios (high flows here)



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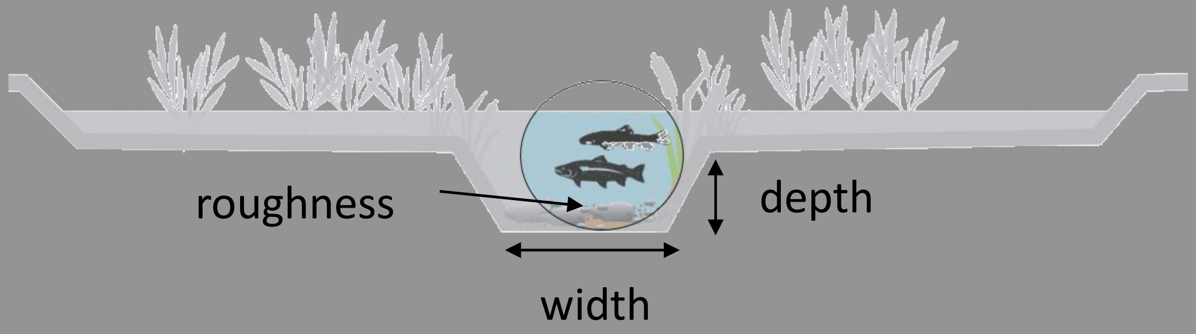

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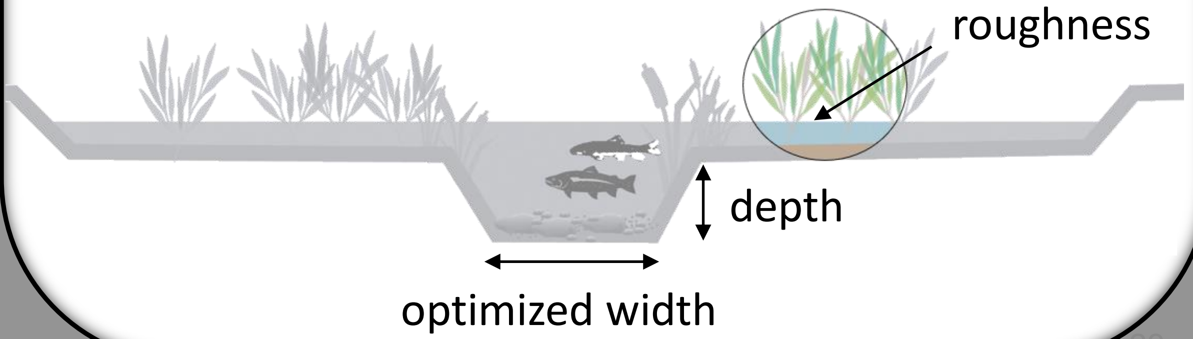
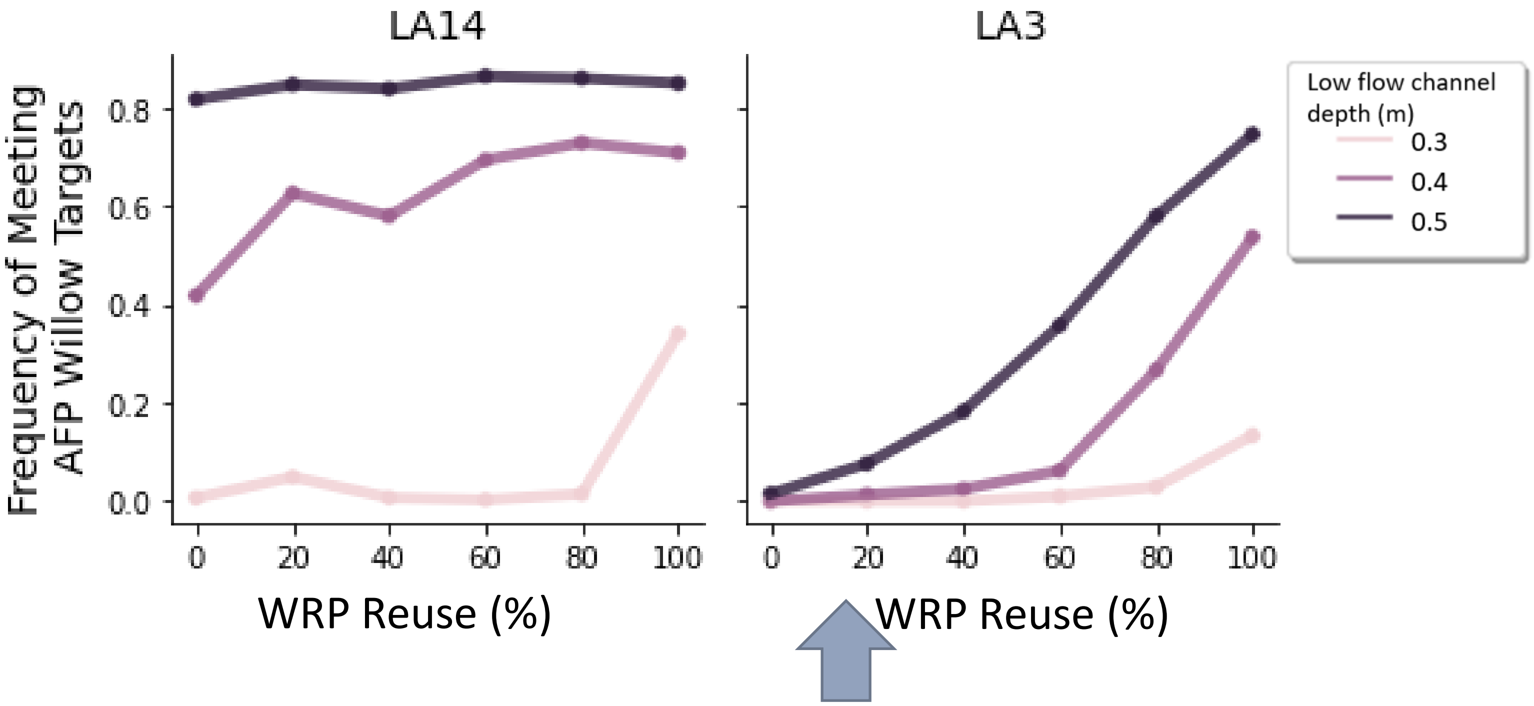


ACTIVE FLOODPLAIN SENSITIVE TO CHANNEL DEPTH

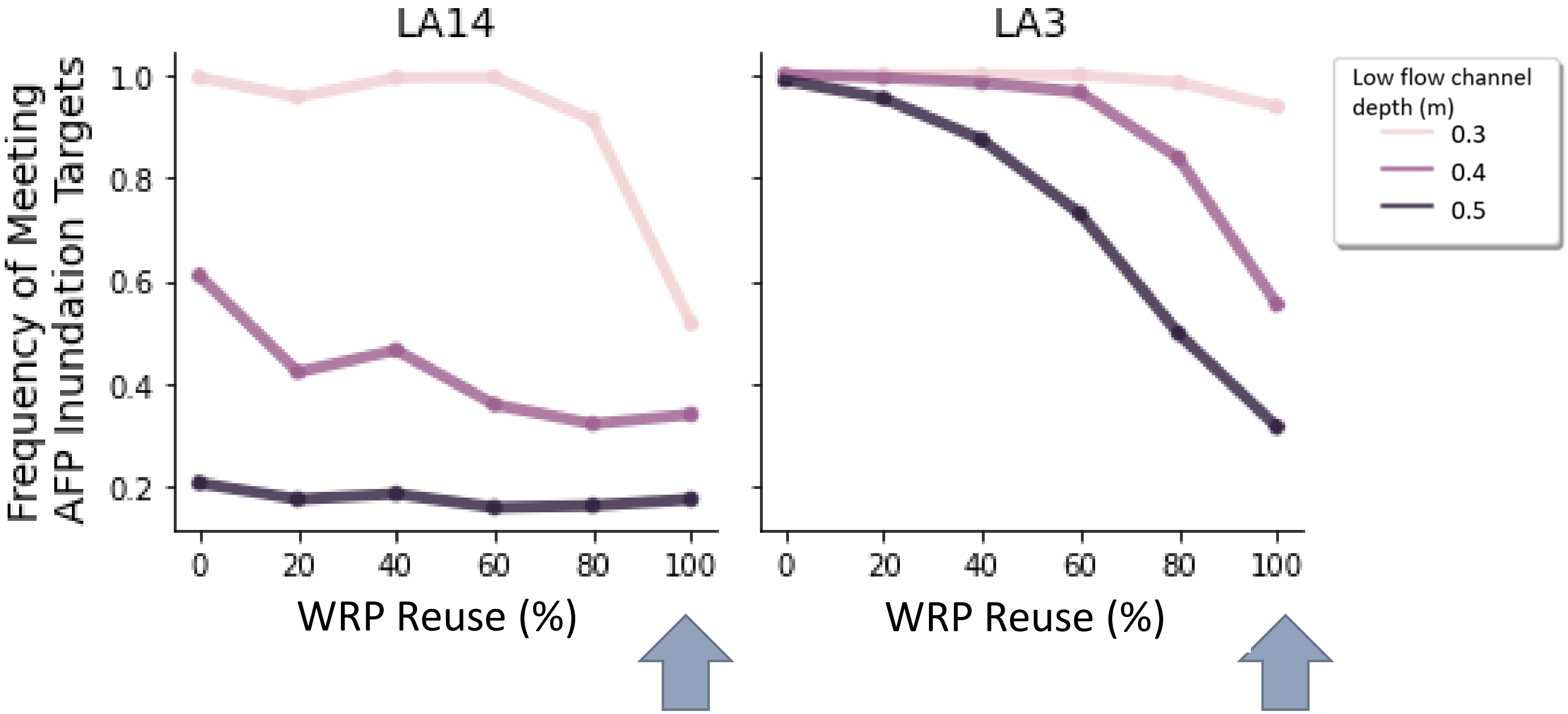
Deeper LF channel meets **Willow depth and shear** targets more frequently for both LA14 and LA3



Not possible to meet active floodplain targets at LA3 under low reuse scenarios – flow too high

ACTIVE FLOODPLAIN SENSITIVE TO LF CHANNEL DEPTH

...But **shallower low flow channel** meets **inundation targets** more frequently for both LA14 and LA3

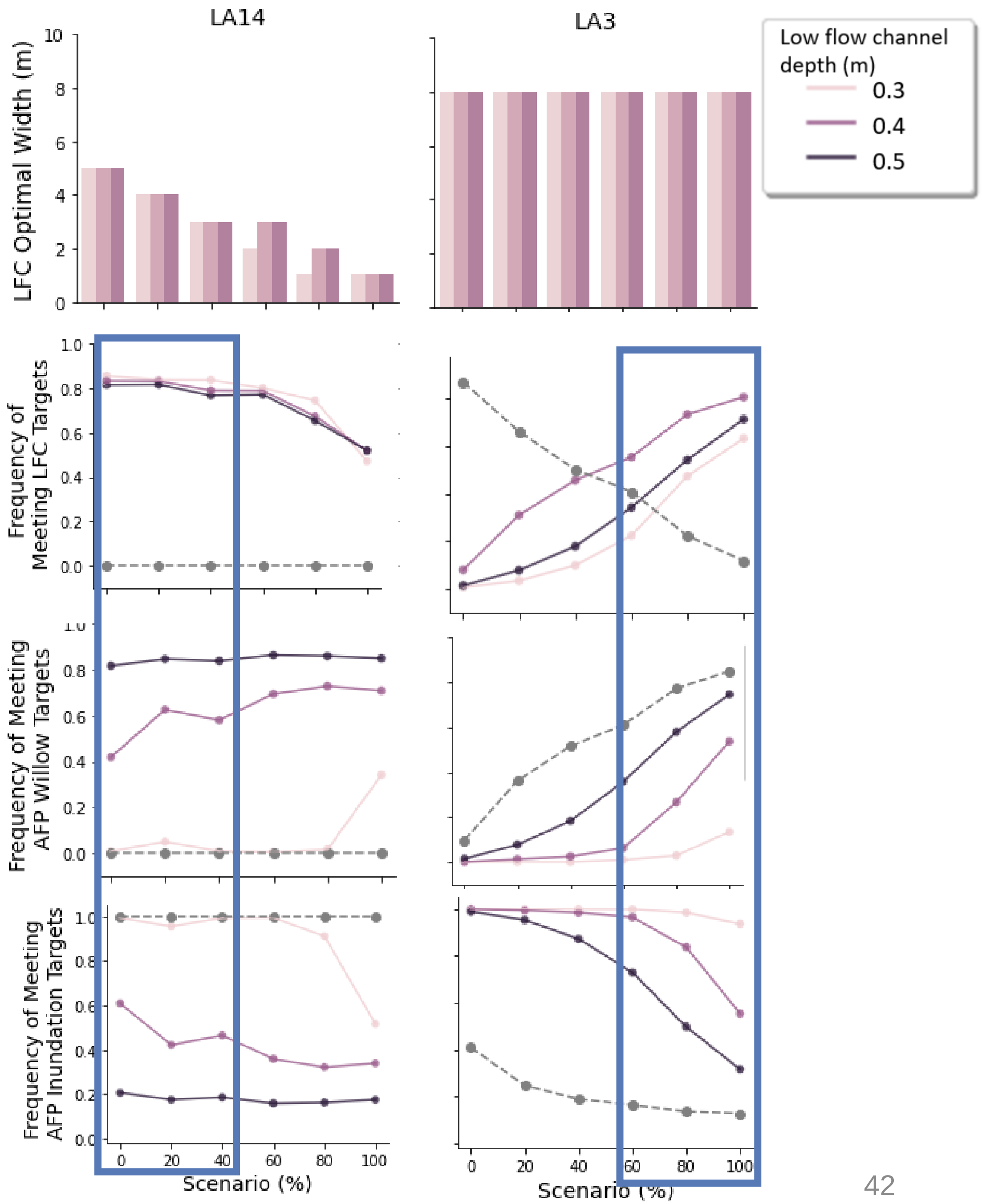


Lower chance of meeting targets with high reuse – not enough flow to inundate floodplain

TRADEOFFS

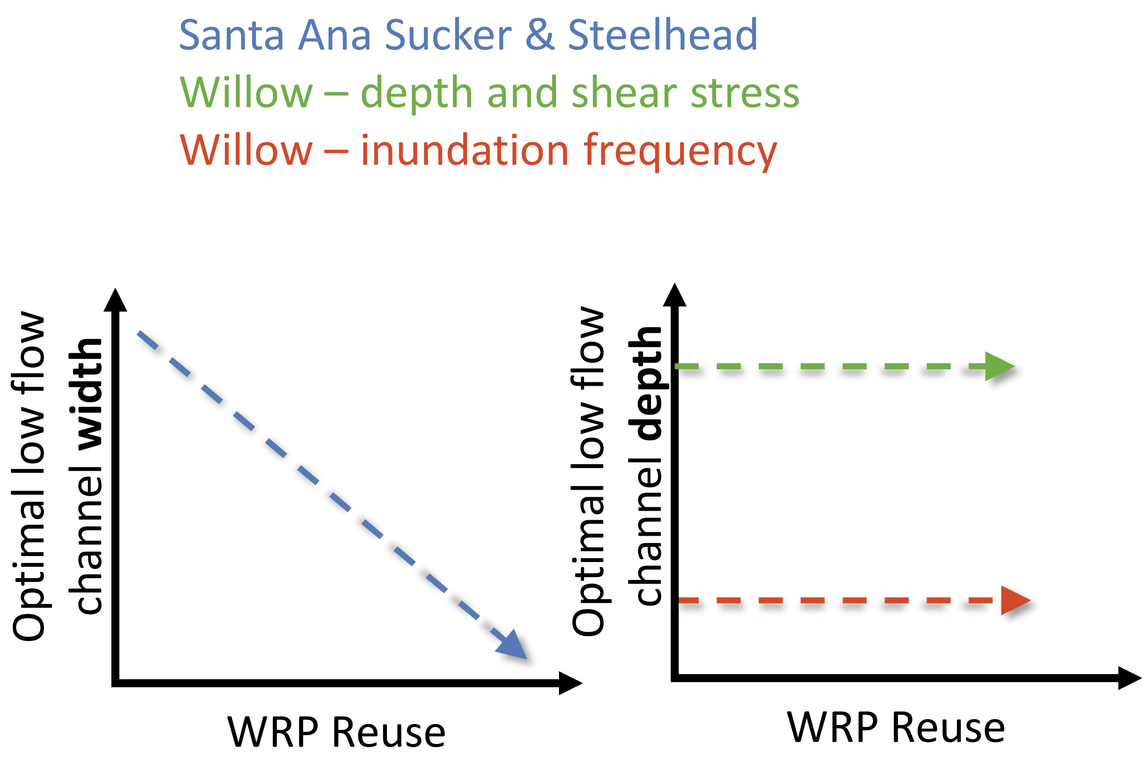
- Tradeoffs in terms of optimal WRP reuse: 0-40% WRP reuse is optimal for LA14, while 60-100% WRP reuse is better for LA3
  - Opportunity for higher % reuse at Glendale (downstream of LA14 and upstream of LA3)

- Tradeoffs in terms of meeting Willow targets: deeper low flow channel better for mean shear stress and depth targetsm but shallow low flow channel better for annual inundation



IMPLICATIONS FOR RESTORATION DESIGN

1. Optimization will vary based on where you are in the river (i.e. more flow further downstream) and WRP reuse scenario
2. Width of low flow channel is important for Santa Ana Sucker and Steelhead.
   - Wider low flow channel needed for smaller WRP reuse scenarios (more flow).
3. Depth of low flow is important for Willows on the active floodplain.
   - Moderate depth (~ 0.4m) may provide needed inundation frequency while minimizing shear stress on the active floodplain.
4. Off-channel storage or high flow bypass for flood control will vary depending on reuse scenario, reach, and channel design – will look at this next



COORDINATION WITH OTHER EFFORTS

Lots of ongoing efforts

- Stillwater steelhead migration
- Bureau of Reclamation steelhead study
- LA River revitalization planning
- NMFS Steelhead recovery planning

We need all the tools in the toolbox

- These are complex problems
- Efforts are complementary

We will continue to coordinate

What We Have Learned So Far

- Restoration actions can improve stream temperature conditions for cold water fish

- Reduced WRP discharge may reduce contaminant loading, but have the potential to increase concentrations

- Restoration designs will have tradeoffs depending on objectives:
  - Low flow channel width is more important for fish habitat
  - Low flow channel depth is more important for willow habitat
  - “optimum” amount of WRP reuse varies based on location in the river and priority species

Status and Products

- Temperature
  - Work is completed
  - Published in Journal of Environmental Management (2021) and Frontiers in Environmental Science (2022)
- Water quality
  - Metals and solids research
    - Work is completed
    - In review at Environmental Science and Technology – Water (Jan 2022) (available upon request)
  - CECs
    - Work is on-going
- Restoration
  - Work is wrapping up
  - Draft report targeted for May 2022

Future Actions

- We have developed a framework for analyzing restoration alternatives in light of changing flows
  - Framework can be applied to other locations along the LAR and its tributaries
  - Framework could be applied to similar local watersheds (e.g., San Gabriel River)

- Draft reports will be shared with the TAC once they are ready

- Need to develop a strategy for post project monitoring
  - Validate results of the relationships between flow modification and restoration
  - Refine modeling approach

- Desire to build stronger connections with community groups
  - Implications of restoration scenarios for local communities
  - Partnership on monitoring and assessment

Questions

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PW Public Works LOS ANGELES COUNTY

environment LA SANITATION CITY OF LOS ANGELES zero waste • zero wasted water

Watershed Conservation Authority

LA DWP Los Angeles Department of Water & Power

CALIFORNIA Water Boards STATE WATER RESOURCES CONTROL BOARD REGIONAL WATER QUALITY CONTROL BOARDS

MRCA Mountains Recreation & Conservation Authority

SANITATION DISTRICTS OF LOS ANGELES COUNTY

Our contribution to today's conversation:

- **Current Stillwater work on fish passage in the LA River**
- **Integration of Flows Project tools into project designs**
- **Additional considerations for managing LA River flows**
- **Recognized need for "larger evaluation" to set flow criteria**

Stillwater Sciences

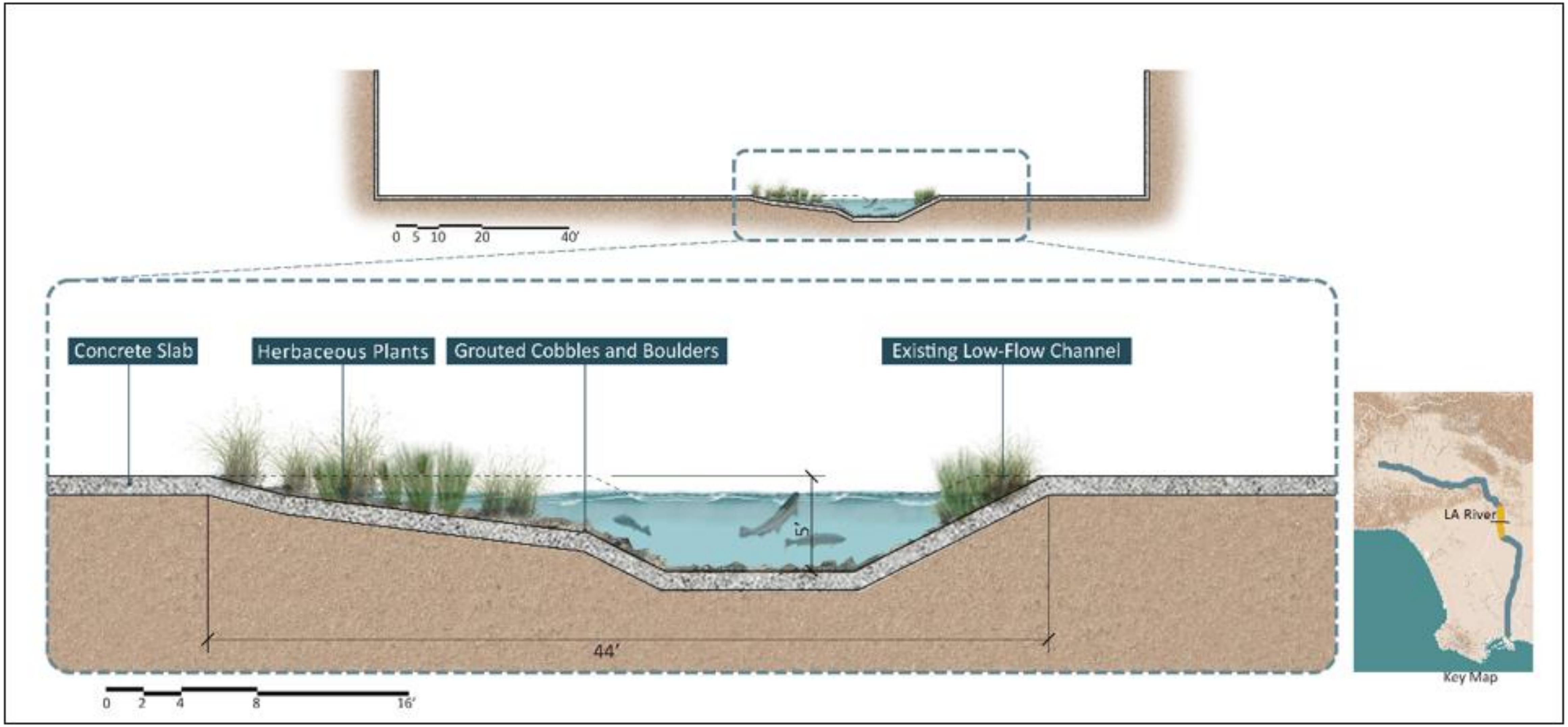
Our work supported by:

- Mountains Recreation & Conservation Authority
- Council for Watershed Health
- Wildlife Conservation Board
- Santa Monica Mountains Conservancy

Current Stillwater work on fish passage in the LA River

Designs to support fish passage:

“***Concept A***”: Asymmetric low-flow channel modification with a 44-ft top width and 5-ft total depth



Current Stillwater work on fish passage in the LA River

Evaluating effects of varying discharge on passable zones (alternative channel designs, 2D hydraulic modeling):

50% exceedance (annual)

5% exceedance (annual)

Current Stillwater work on fish passage in the LA River

Under some conditions, fish need to "rest" during upstream migration: "Textbook"-based design of resting pockets

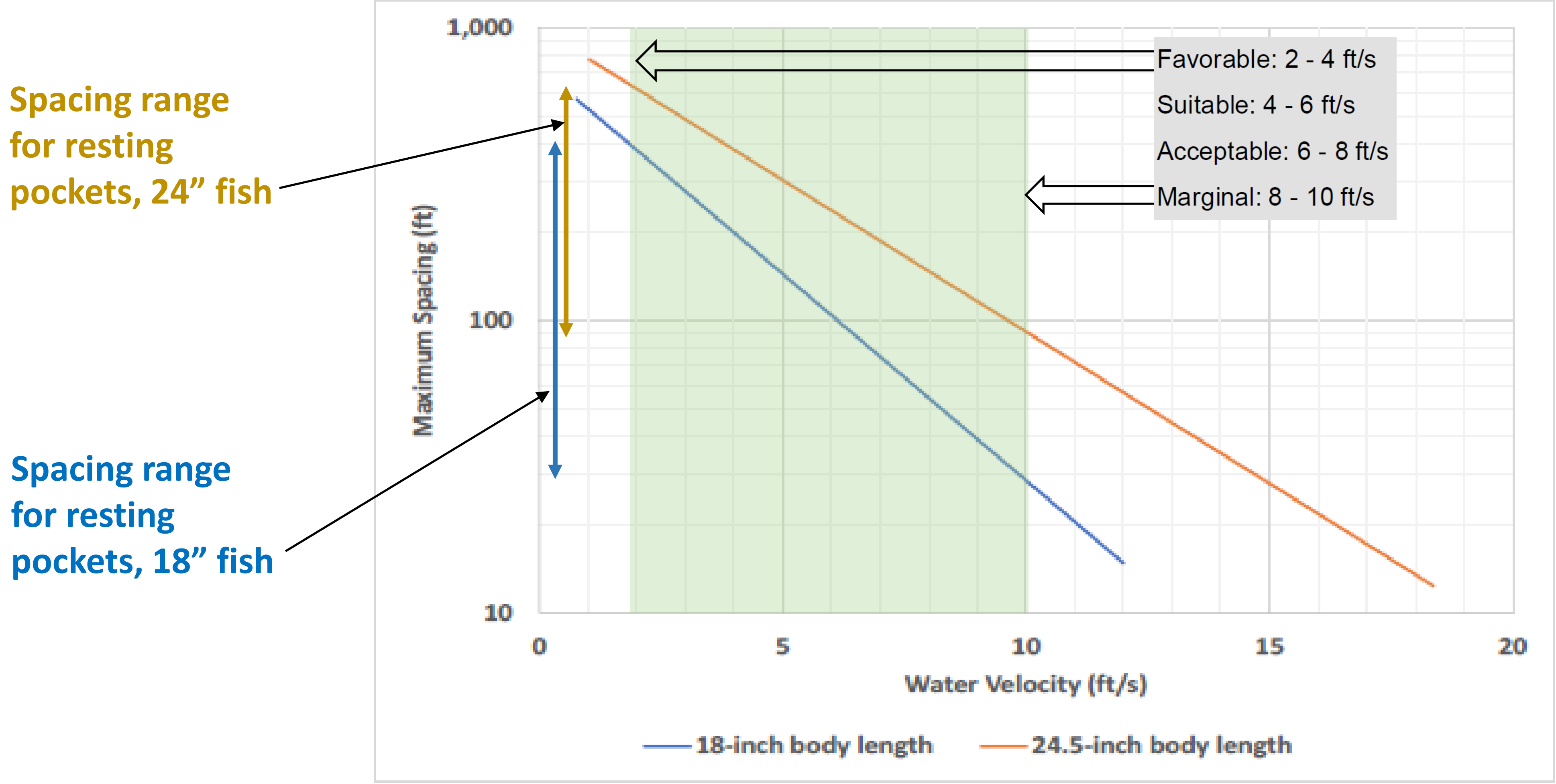
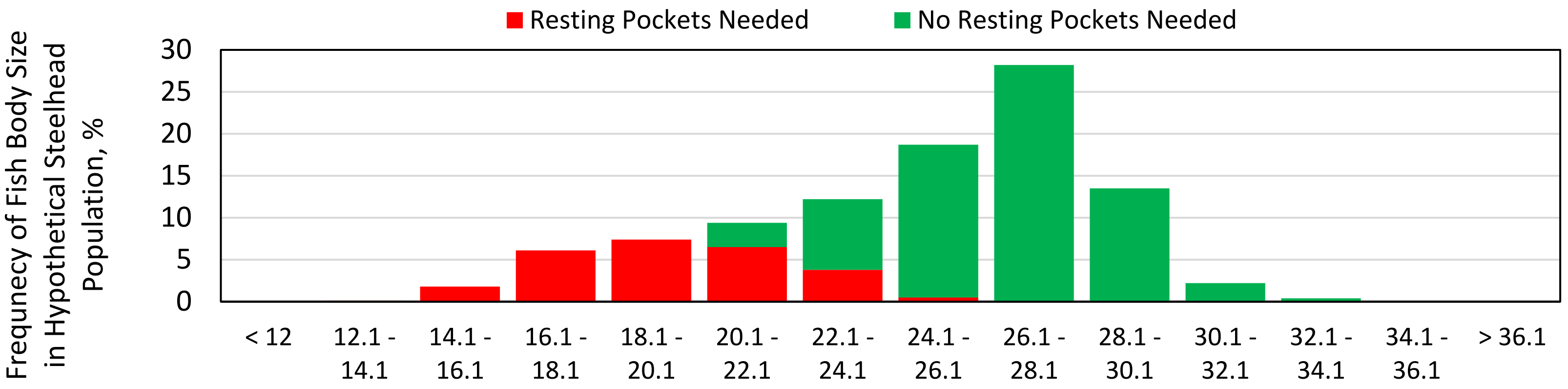


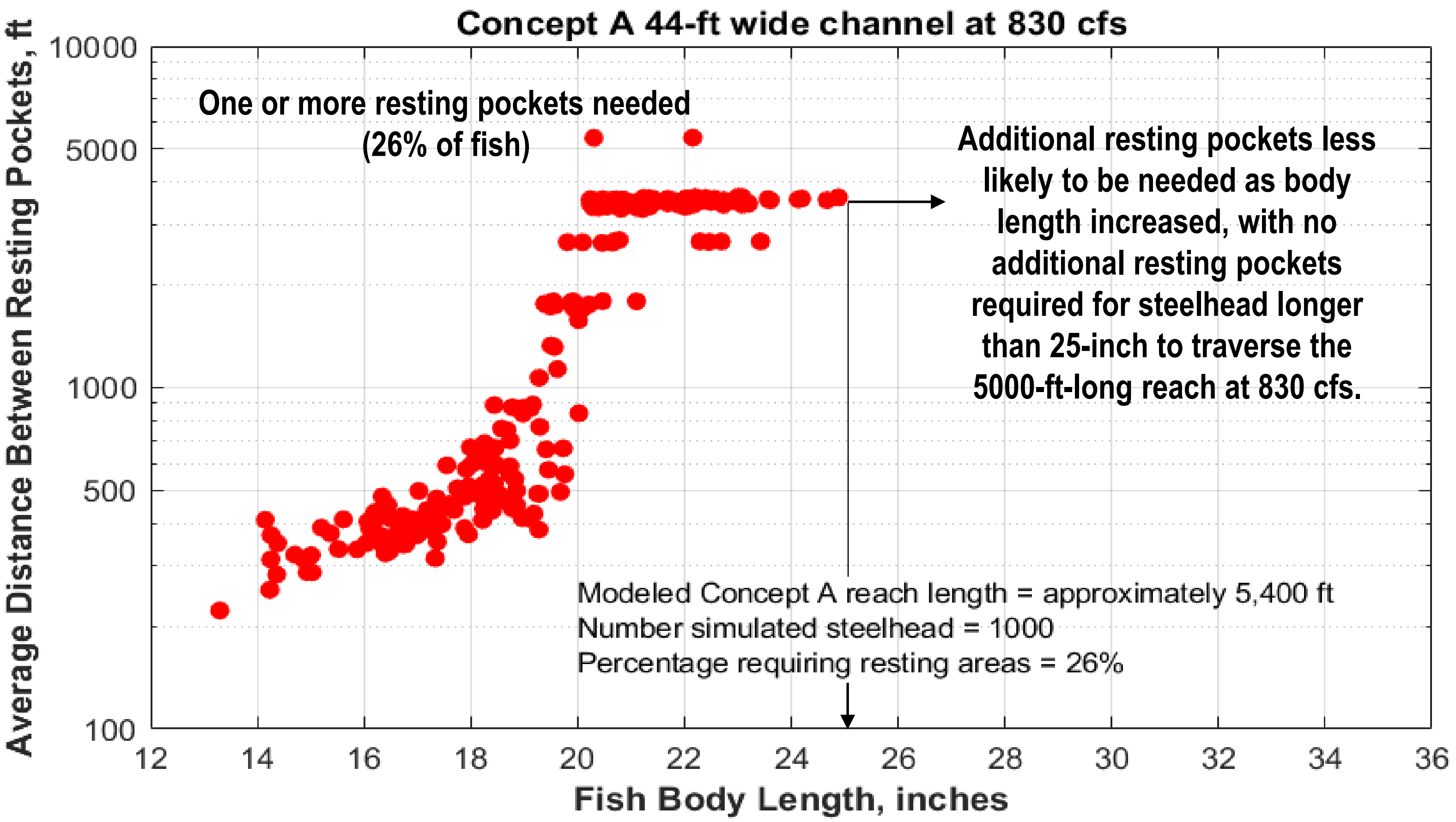
Figure 7-1. Maximum resting pocket spacing for fish swimming in prolonged mode at a constant, optimum ground speed.

Graph from Stillwater Sciences (2022); equations from Michael Love and Associates (2007)

Current Stillwater work on fish passage in the LA River

Next-generation (work in progress) migration fatigue modeling, recognizing variety of fish lengths and initial fitness:

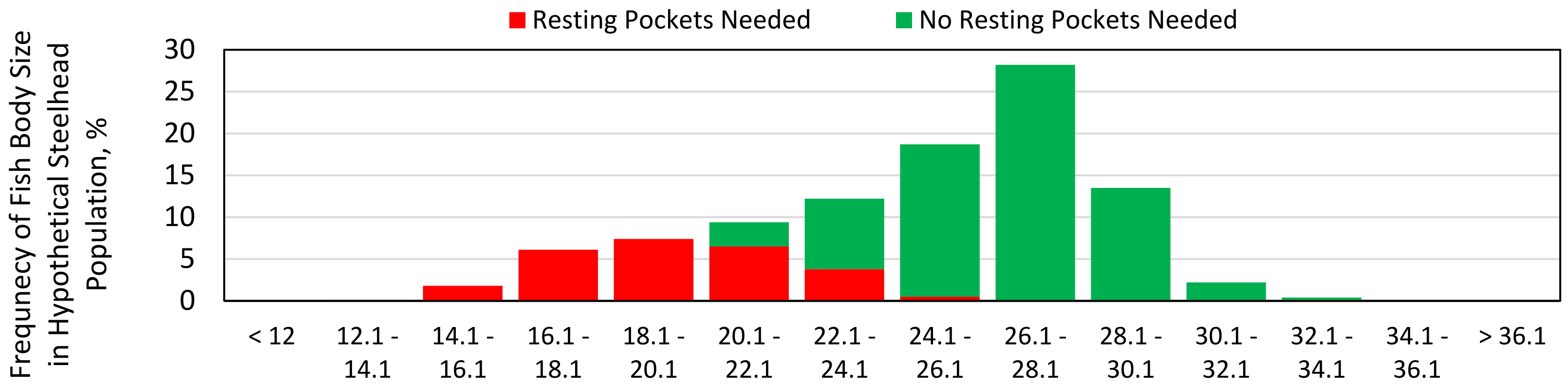


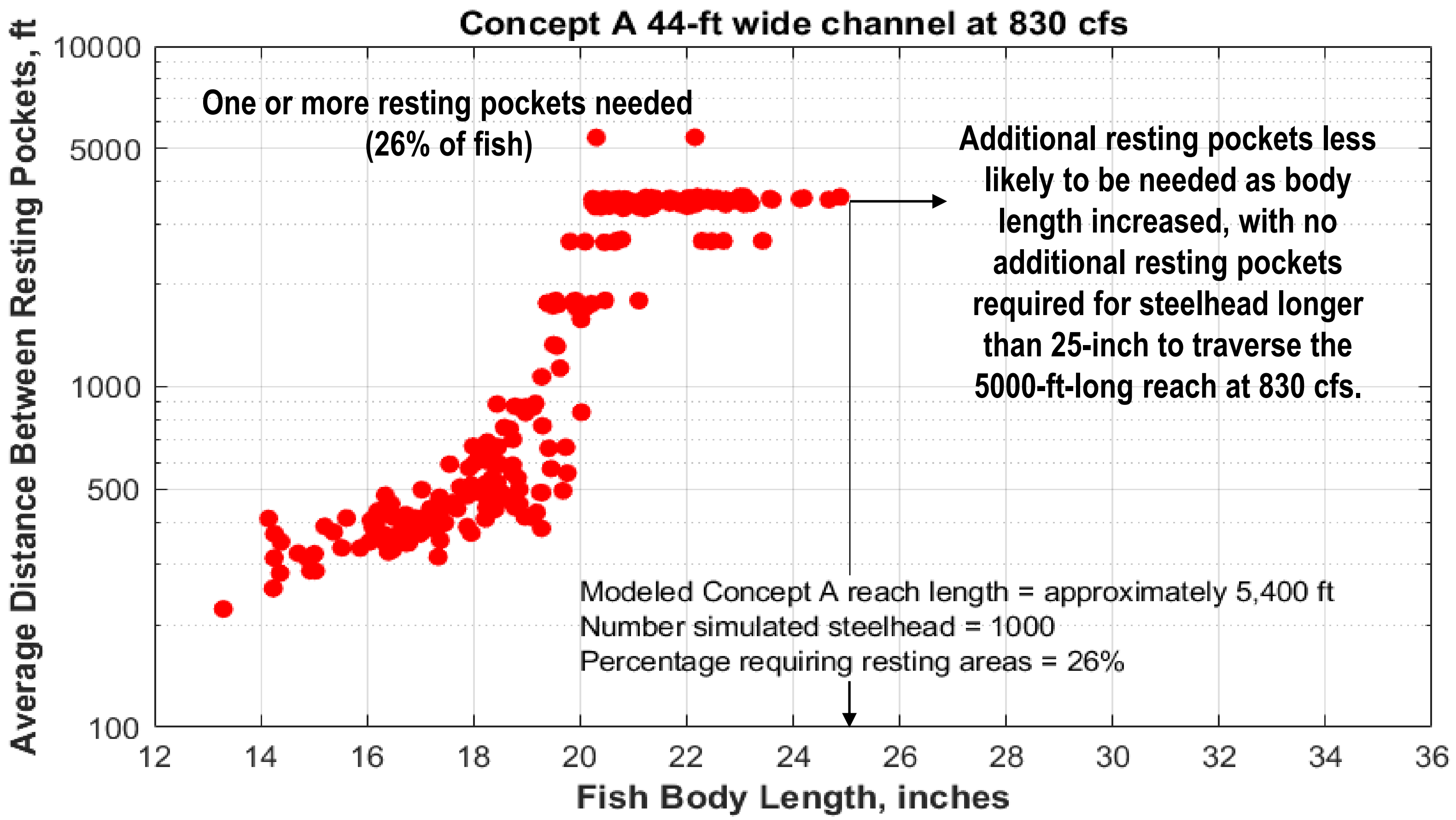


Current Stillwater work on fish passage in the LA River

Next-generation (work in progress) migration fatigue modeling, recognizing variety of fish lengths and initial fitness:

→Fish at or longer than the median length (25”, from other studies) do not require resting pockets over this 1-mile reach at this discharge (5% annual exceedance).

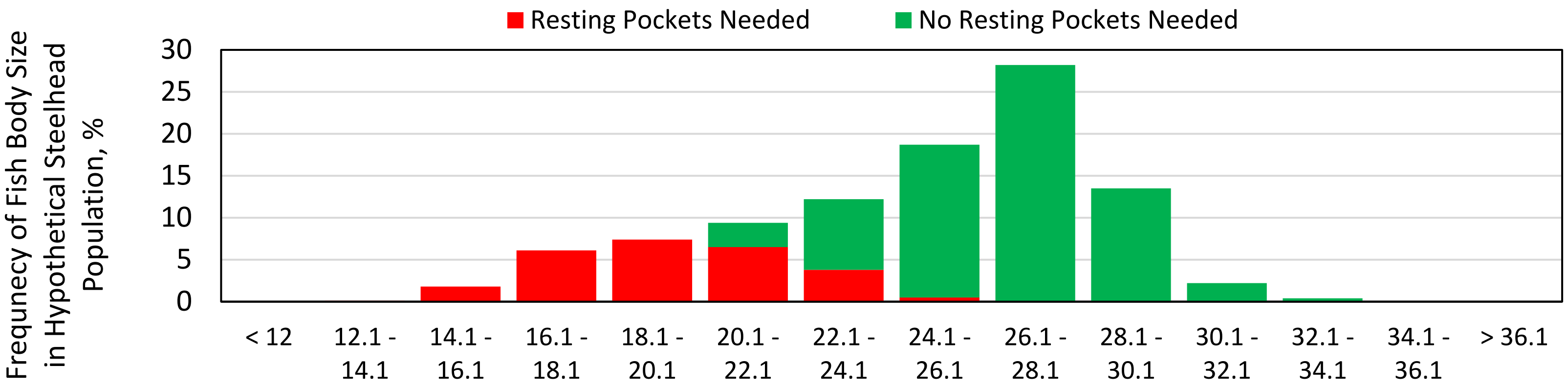


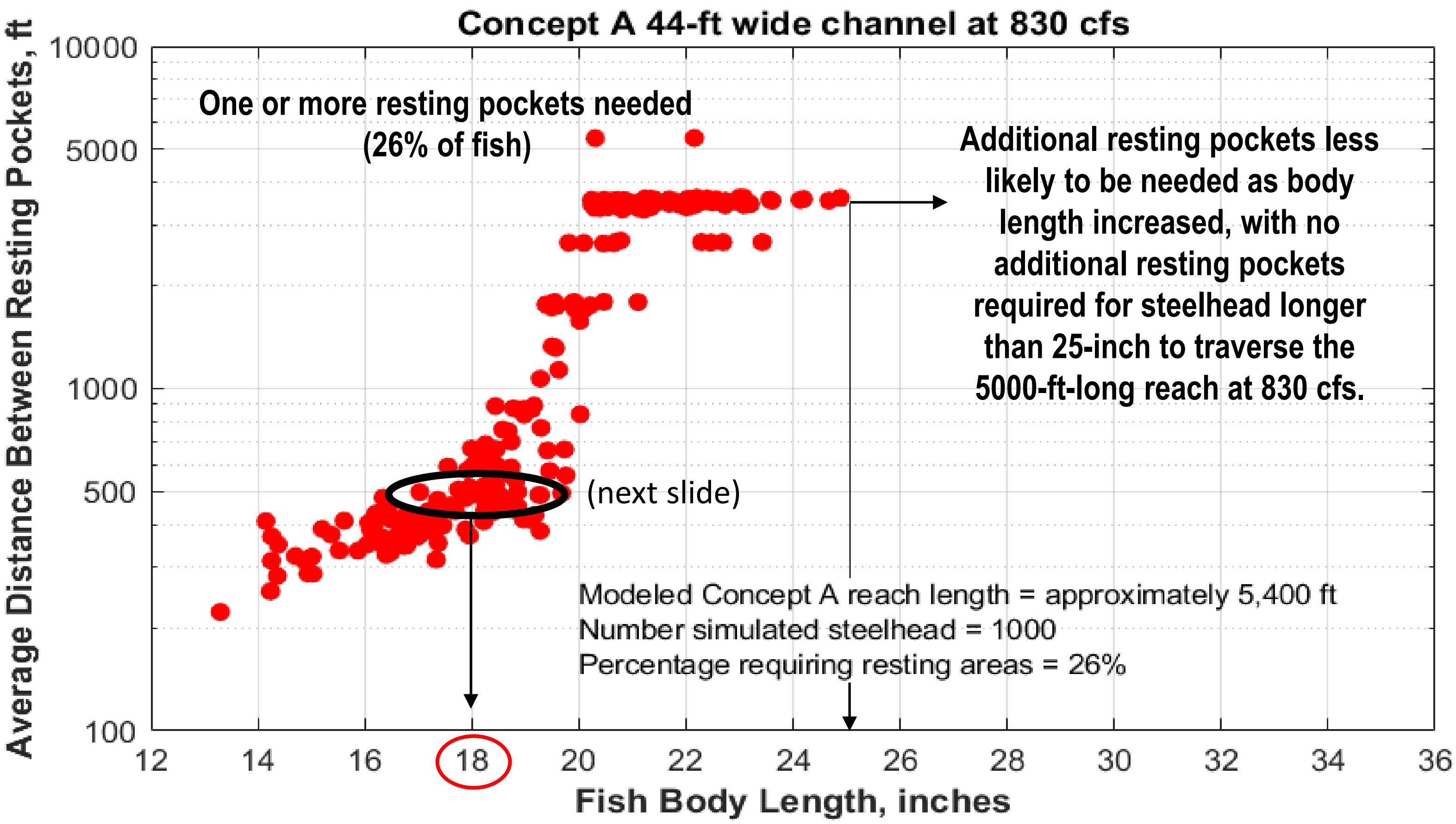


Current Stillwater work on fish passage in the LA River

Next-generation (work in progress) migration fatigue modeling, recognizing variety of fish lengths and initial fitness:

→Shorter fish (e.g., 18”) require multiple resting pockets over this 1-mile reach (at this discharge).

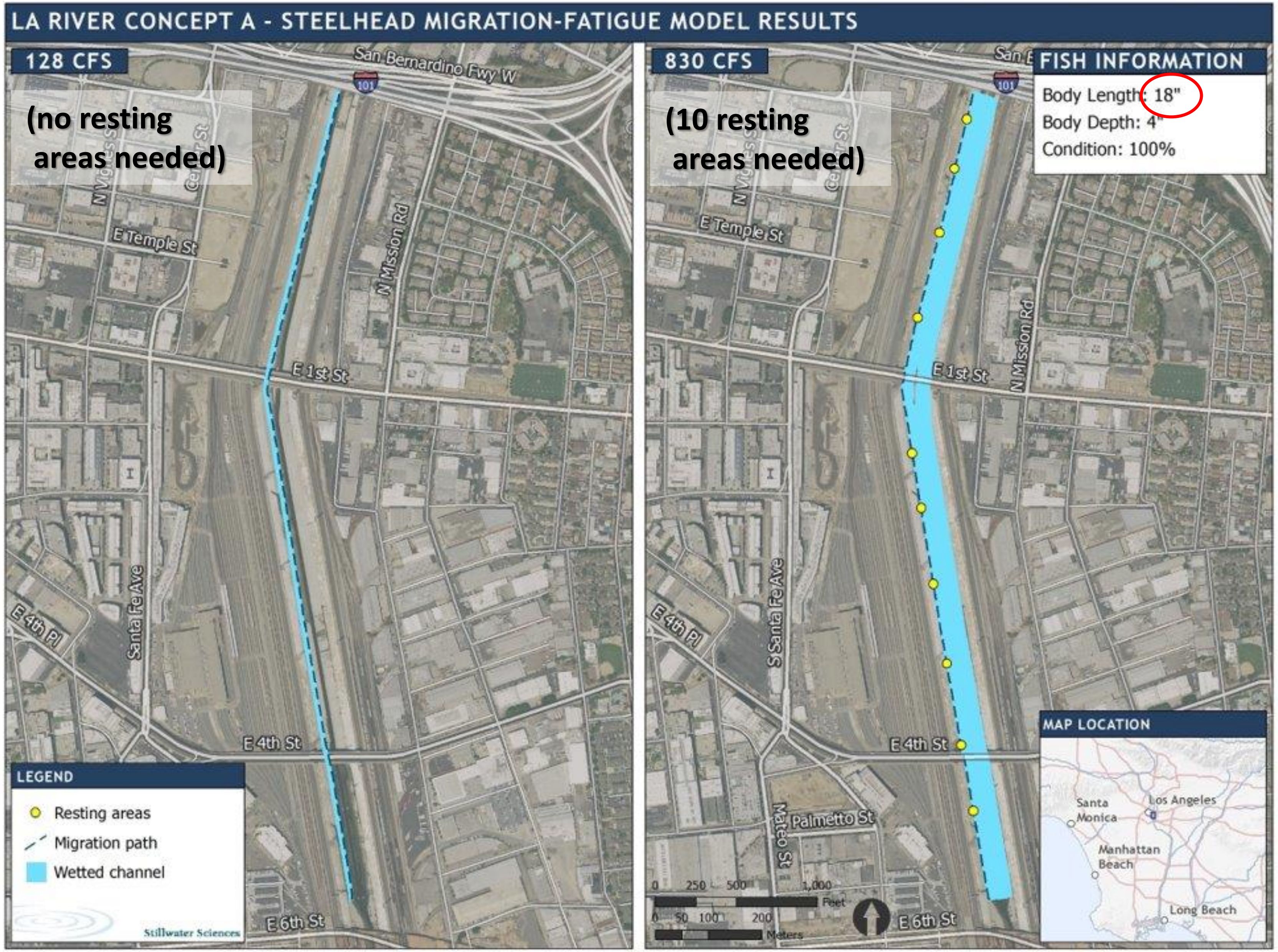




Current Stillwater work on fish passage in the LA River

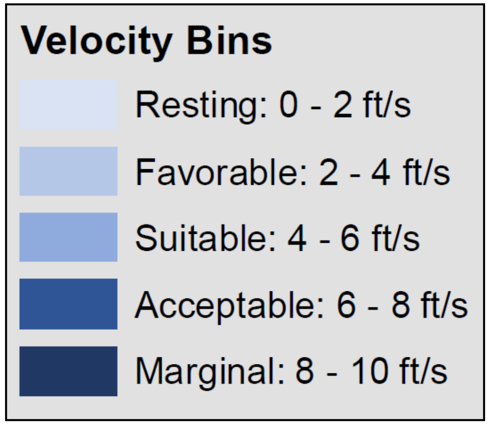
Example application of the stochastic migration fatigue model ("small" fish, varying discharges).

Significant design implications!

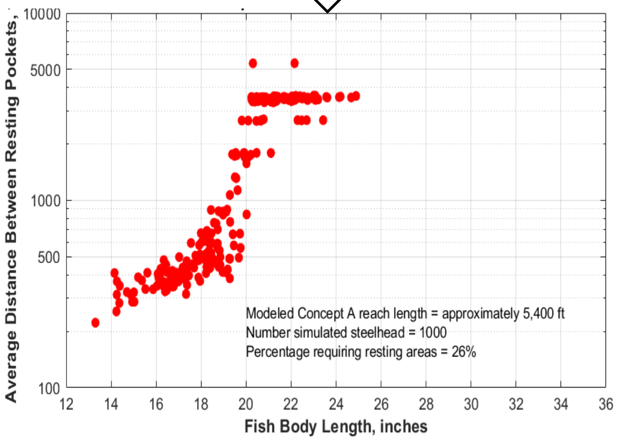


Example future integration with Flows Project tools: integration of complementary model types

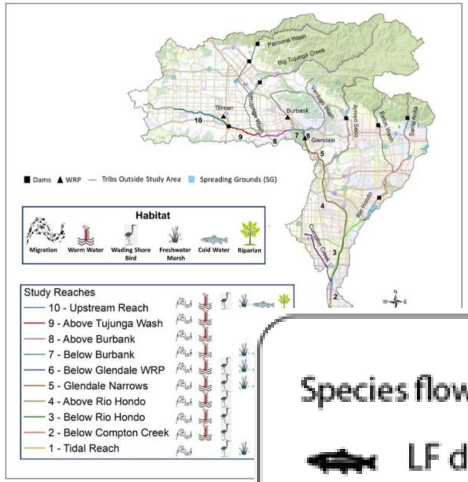
Existing approach to channel design to evaluate fish passage (requires 2D hydraulics for adequate design):

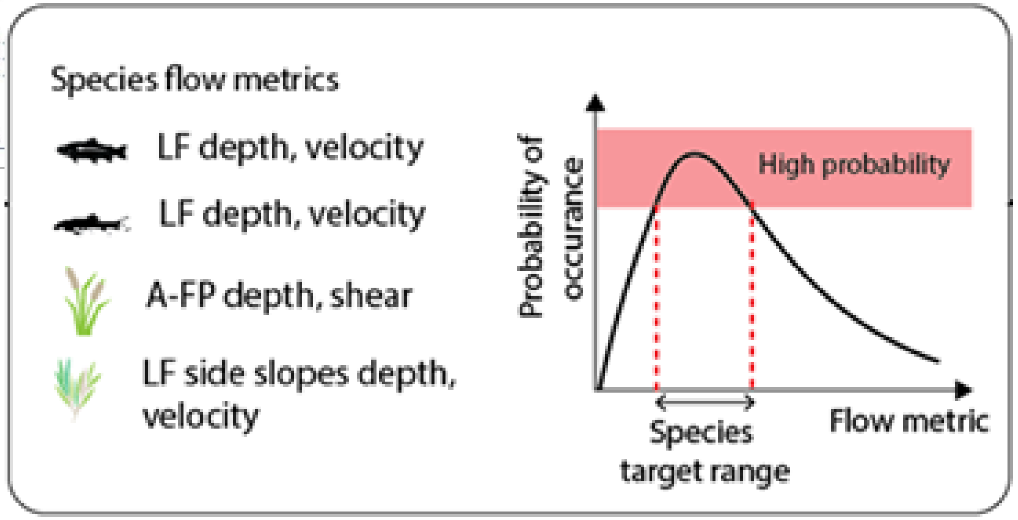


Upcoming improvement for most efficient & effective passage design:



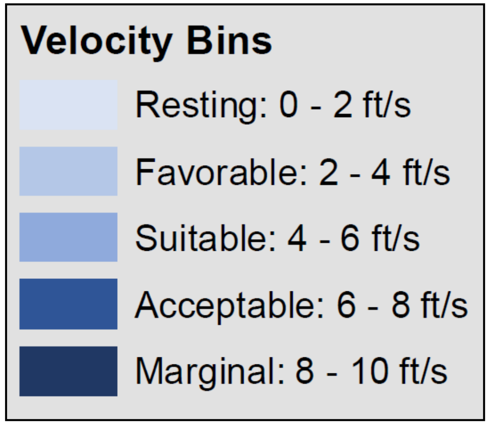
Upcoming tools to accommodate other species and hydraulic parameters:

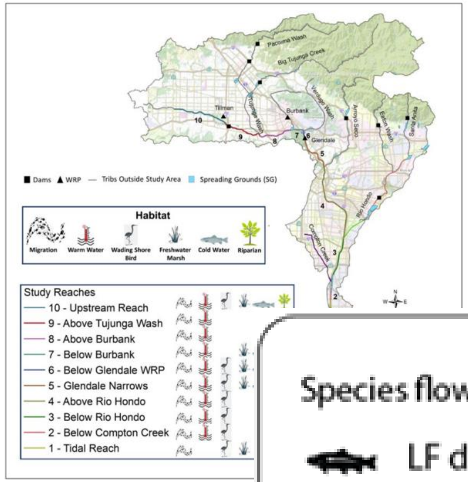




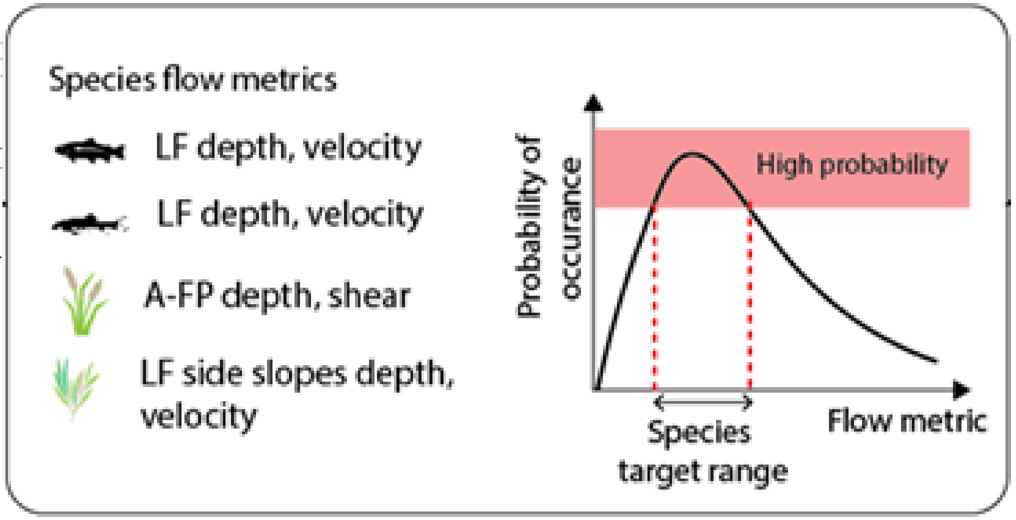
Example future integration with Flows Project tools: integration of complementary model types

Existing approach to channel design to evaluate fish passage (requires 2D hydraulics for adequate design):



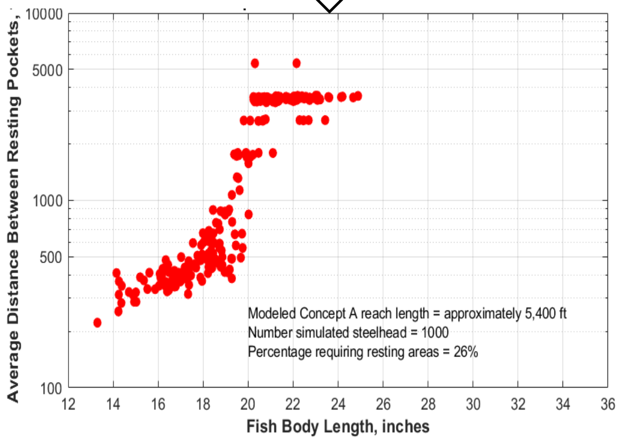


Upcoming tools to accommodate other species and hydraulic parameters:



Obvious opportunities for integration

Upcoming improvement for most efficient & effective passage design:



Example future integration with Flows Project tools: validation of model predictions with field data

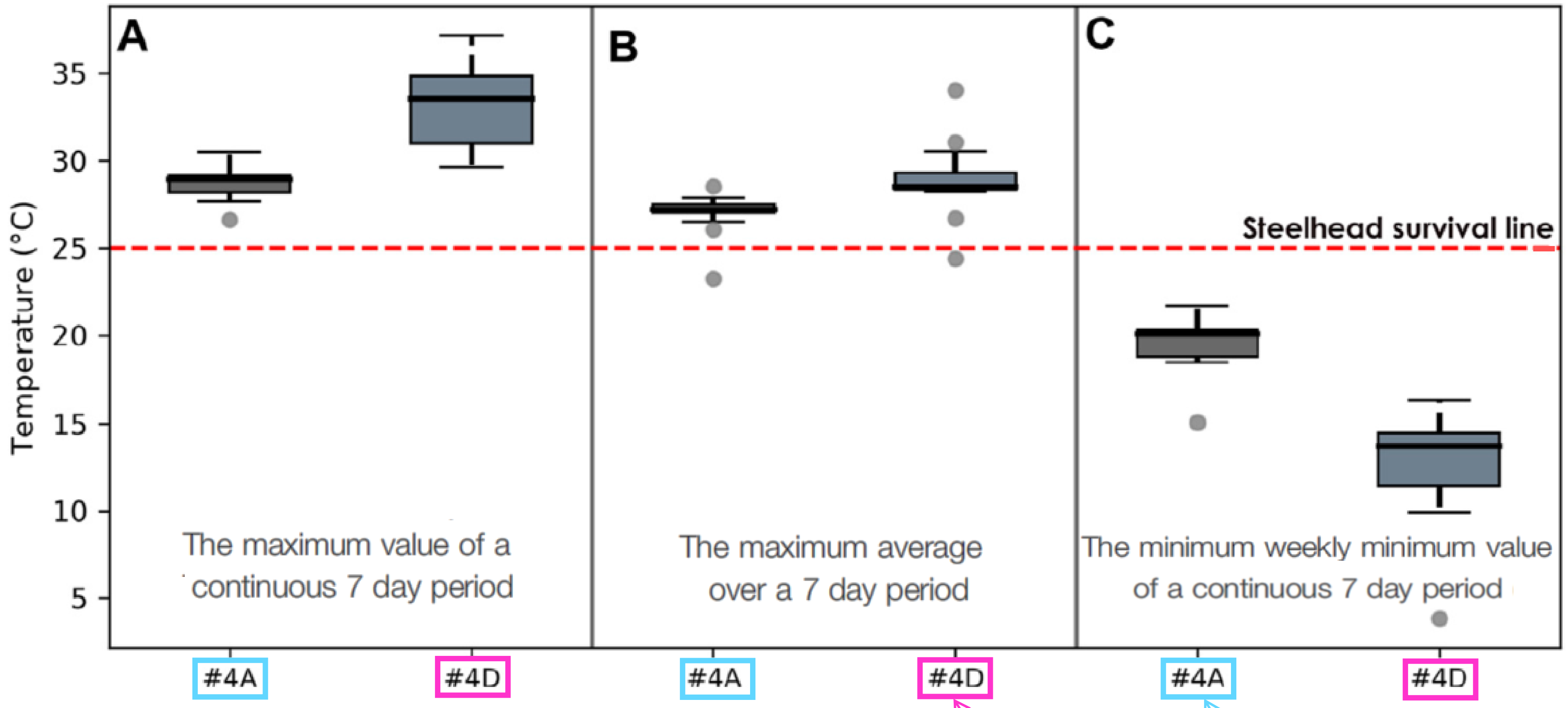
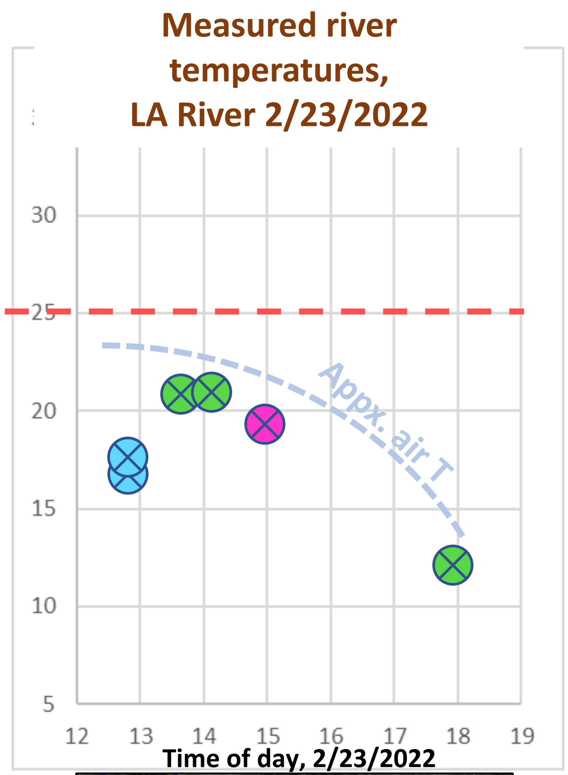
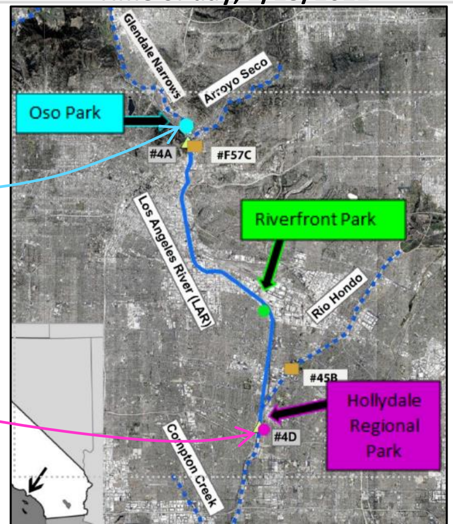


Figure 2 from Abdi et al. (2022)



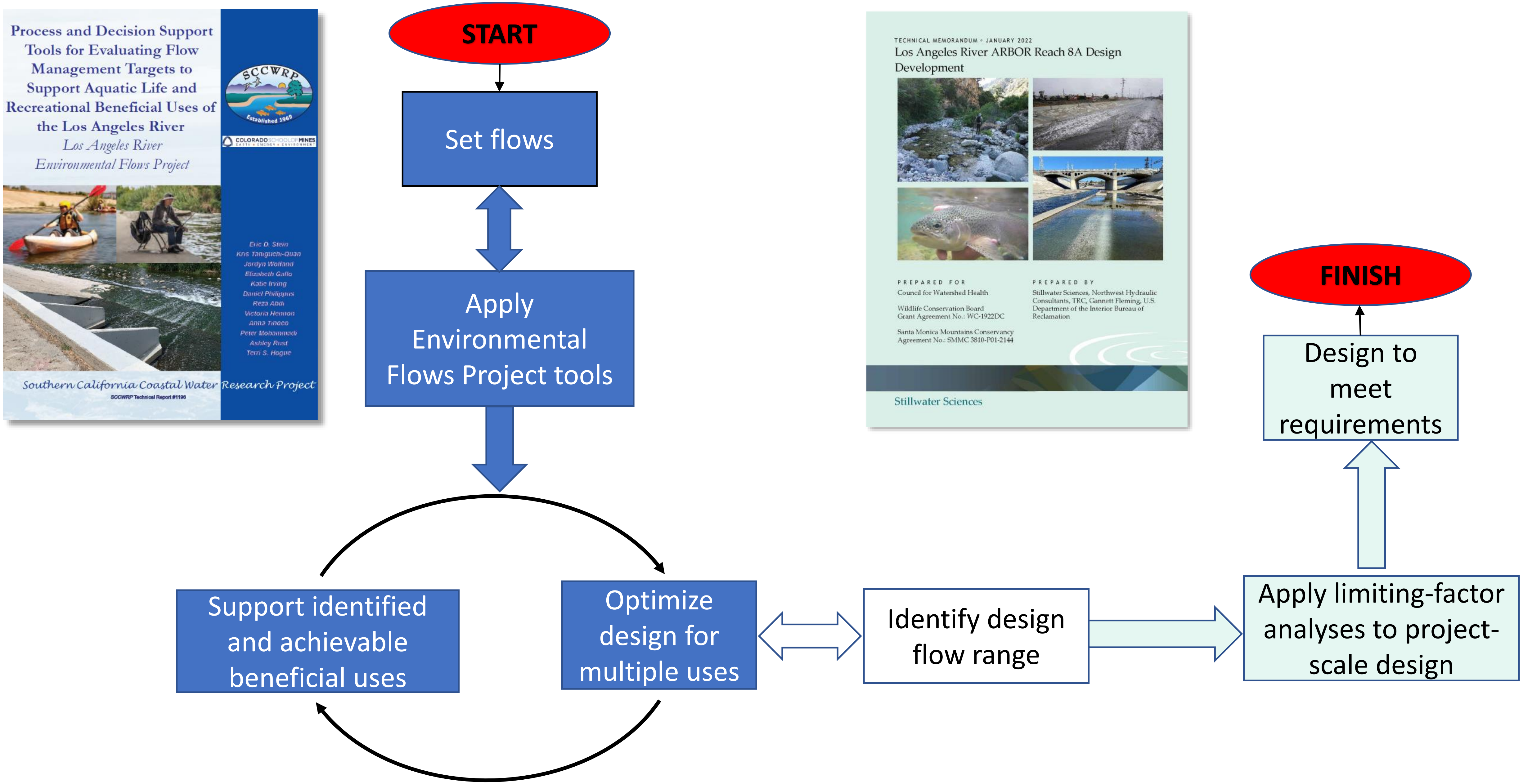


But—there are additional considerations for management of LA River flows

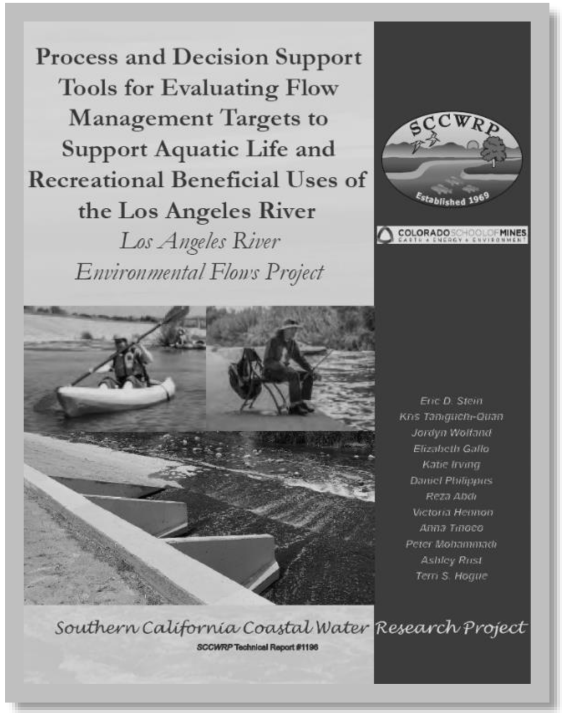
What are those “additional considerations”?

SOURCES OF GUIDANCE→ USES and VALUES ↓	Environmental Flows Project tools	Formal plans and other documents	Regulatory requirements	Other articulated policies	Future restoration plans/projects
1. Beneficial uses	Subset addressed at specified nodes, current channel	Varied	Varied	Varied	Varied (project-specific)
2. Recreational activities	Subset analyzed as feasible, with available data	Yes	No	Yes	Varied
3. Environmental equity	Not included	Yes	Yes	Yes	Varied
4. Ecological integrity	Not included	Varied	Yes	Varied	Varied
5. Water conservation and reuse	Implicit	Yes	No	Yes	Varied
Examples:		LARWQCB Basin Plan	EWMP, TMDL, ESA	LA River Revitalization Plan, City of LA One Water	LA ARBOR

Current framework for flow management in the LA River:



But--what work still remains to incorporate those "additional considerations"?


Process and Decision Support Tools for Evaluating Flow Management Targets to Support Aquatic Life and Recreational Beneficial Uses of the Los Angeles River

Los Angeles River Environmental Flows Project

SCCWRP Established 1969

COLORADO SCHOOL OF MINES

Eric D. Stein
Kris Taniguchi-Quan
Jordyn Wolfand
Elizabeth Gallo
Katie Irving
Daniel Philippus
Reza Abdi
Victoria Hennon
Anna Tinoco
Peter Mohammadi
Ashley Rust
Terri S. Hogue

Southern California Coastal Water Research Project

SCCWRP Technical Report #1196

START

Set flows

Apply Environmental Flows Project tools

Support identified and achievable beneficial uses

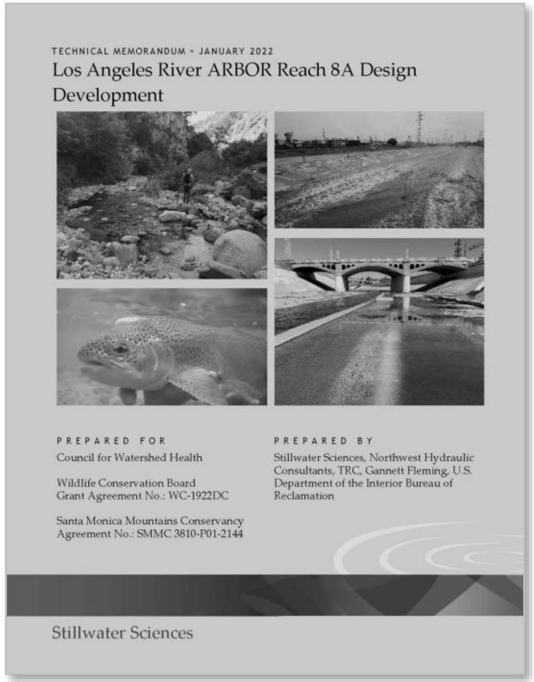
Optimize design for multiple uses

Identify design flow range

Apply limiting-factor analyses to project-scale design

Design to meet requirements

FINISH


TECHNICAL MEMORANDUM • JANUARY 2022

Los Angeles River ARBOR Reach 8A Design Development

PREPARED FOR

Council for Watershed Health

Wildlife Conservation Board
Grant Agreement No.: WC-1922DC

Santa Monica Mountains Conservancy
Agreement No.: SMMC 3810-P01-2144

PREPARED BY

Stillwater Sciences, Northwest Hydraulic Consultants, TRC, Gannett Fleming, U.S. Department of the Interior Bureau of Reclamation

Stillwater Sciences

A "larger evaluation considering all aspects of a proposed project that would ultimately set flow criteria in consideration of multiple management objectives for the LA River" (SCCWRP 2021, p. 39).

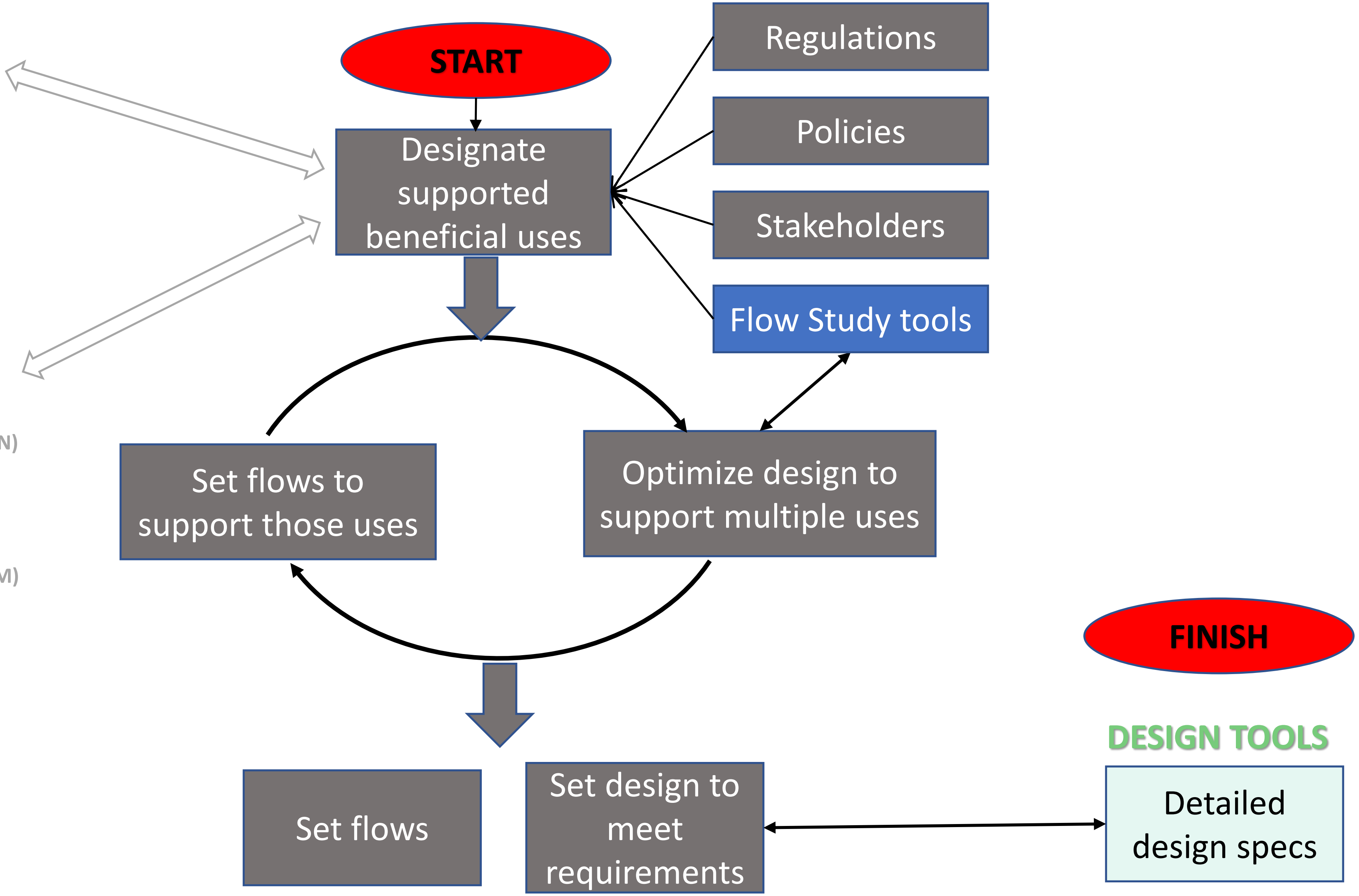
A “larger evaluation considering all aspects of a proposed project that would ultimately set flow criteria in consideration of multiple management objectives for the LA River” (SCCWRP 2021, p. 39).

INCLUDED IN FLOWS TOOL

- Wildlife Habitat (WILD)
- Rare, Threatened, or Endangered Species (RARE)
- Migration of Aquatic Organisms (MIGR)
- Spawning, Reproduction, Early Development (SPWN)
- Cold Freshwater Habitat (COLD)

OTHER LAR BENEFICIAL USES:

- Other Recreation (REC1 & 2)
- Municipal and Domestic Supply (MUN)
- Industrial Service Supply (IND)
- Industrial Service Supply (PROC)
- Ground Water Recharge (GWR)
- Navigation (NAV)
- Commercial and Sport Fishing (COMM)
- Estuarine Habitat (EST)
- Marine Habitat (MAR)
- Shellfish Harvesting (SHELL)
- Wetland Habitat (WET)



This “larger evaluation…”—still needs to be done.