Establishing Environmental Flows for the Los Angeles River

Technical Advisory Committee Meeting #4 – March 11, 2020

SCCWRP
Established 1969

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

Council for Watershed Health

COLORADO SCHOOL OF MINES
EARTH • ENERGY • ENVIRONMENT

Central Question

What are the potential impacts (+ or -) to existing and potential future instream beneficial uses in the Los Angeles River caused by reductions of wastewater treatment plant discharges and/or stormwater capture?

Meeting Objectives and Agenda

Meeting Objectives:

- Discuss habitat modeling approach and thresholds of response
- Modeling update (hydrologic, hydraulic, temperature)
- Review water quality data compilation
- Discuss approach for flow management scenarios and management scenario analysis

AGENDA

1. Introductions and meeting goals– 10:00-10:15
2. Recap from last meeting – 10:15-10:30
3. Discuss habitat modeling – 10:30 – 12:00
4. Lunch – 12:00 – 1:00
5. Update on hydrologic and hydraulic modeling – 1:00 – 1:30
6. Update on temperature modeling – 1:30 – 2:00
7. Water quality data compilation – 2:00 – 2:15
8. Scenario evaluation – 2:15 – 3:15
9. Wrap-up, action items and next steps – 3:15 – 3:30

Los Angeles River Environmental Flows Project Goals

1. Develop technical tools that quantify the relationship between various alternative flow regimes and the extent to which aquatic life and non-aquatic life beneficial uses are achieved

2. Evaluate various flow management scenarios in terms of their effect on uses in the LA River

3. Engage multiple affected parties to reach consensus about appropriate flow needs and optimal allocation of flow reduction allowances from multiple WRPs in consideration of other proposed flow management actions

Assessing Environmental Flows for LAR

Activity 1: Stakeholder Coordination

Activity 2: Non-aquatic life use assessment

Activity 3: Aquatic life use assessment

Activity 4: Asses effects of flow modification/management

Activity 5: Monitoring and Adaptive Management

WRP Water Reuse

Options for Other Scenarios

- Stormwater
- Groundwater
- Conservation
- Environmental restoration

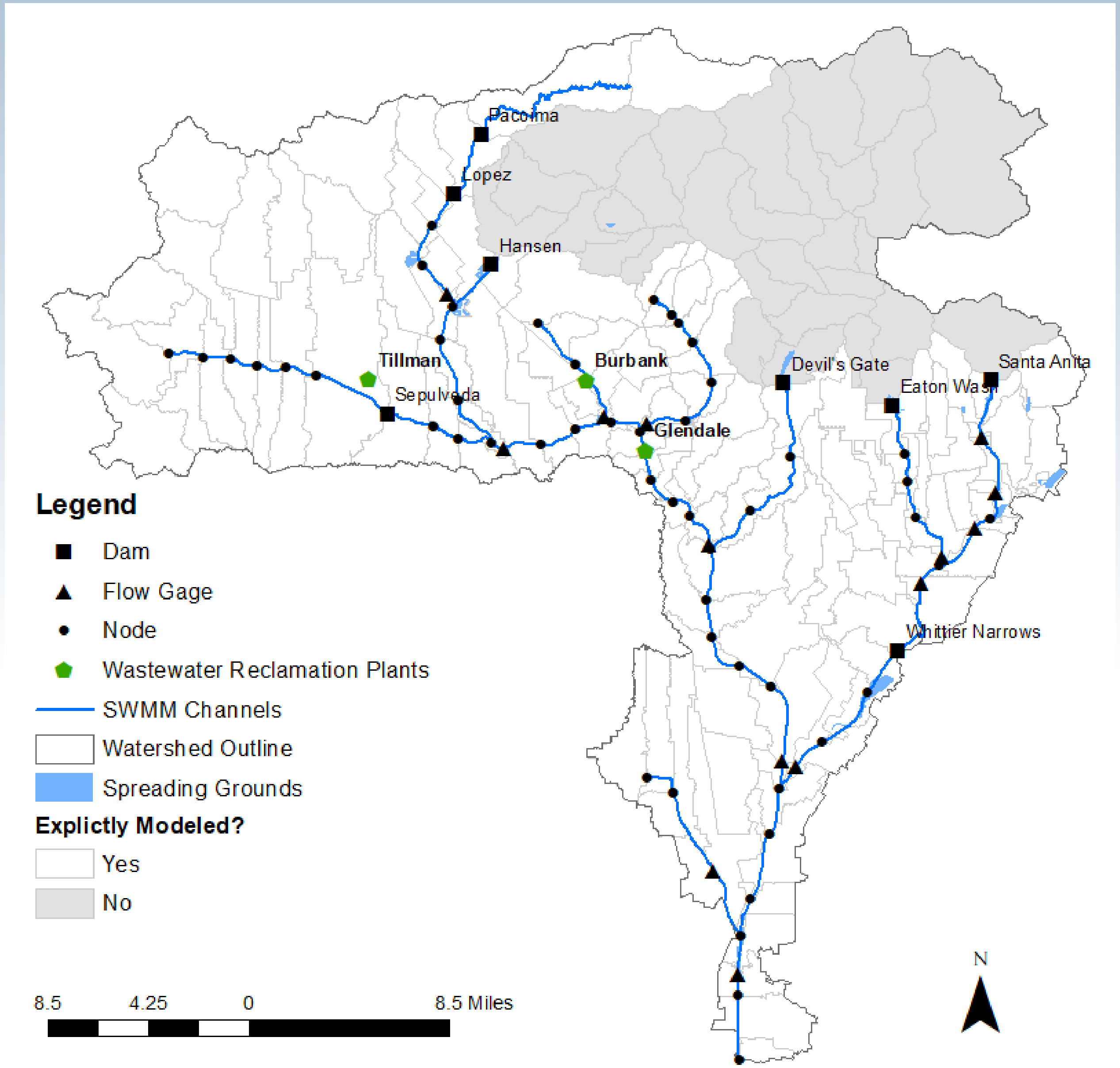
Schedule

Activity / Sub-Tasks	2018 Q4	2019 Q1	2019 Q2	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4
Activity 1 - Stakeholder coordination									
Activity 2 - Non-aquatic Life Use Assessment									
Activity 3 - Aquatic Life Beneficial Use Assessment									
Activity 4 - Apply Environmental Flows/Evaluate Scenarios									
Activity 5 - Monitoring and Adaptive Mangement Plan									
Activity 6 - Summary of results/reporting									

Stakeholder Meetings

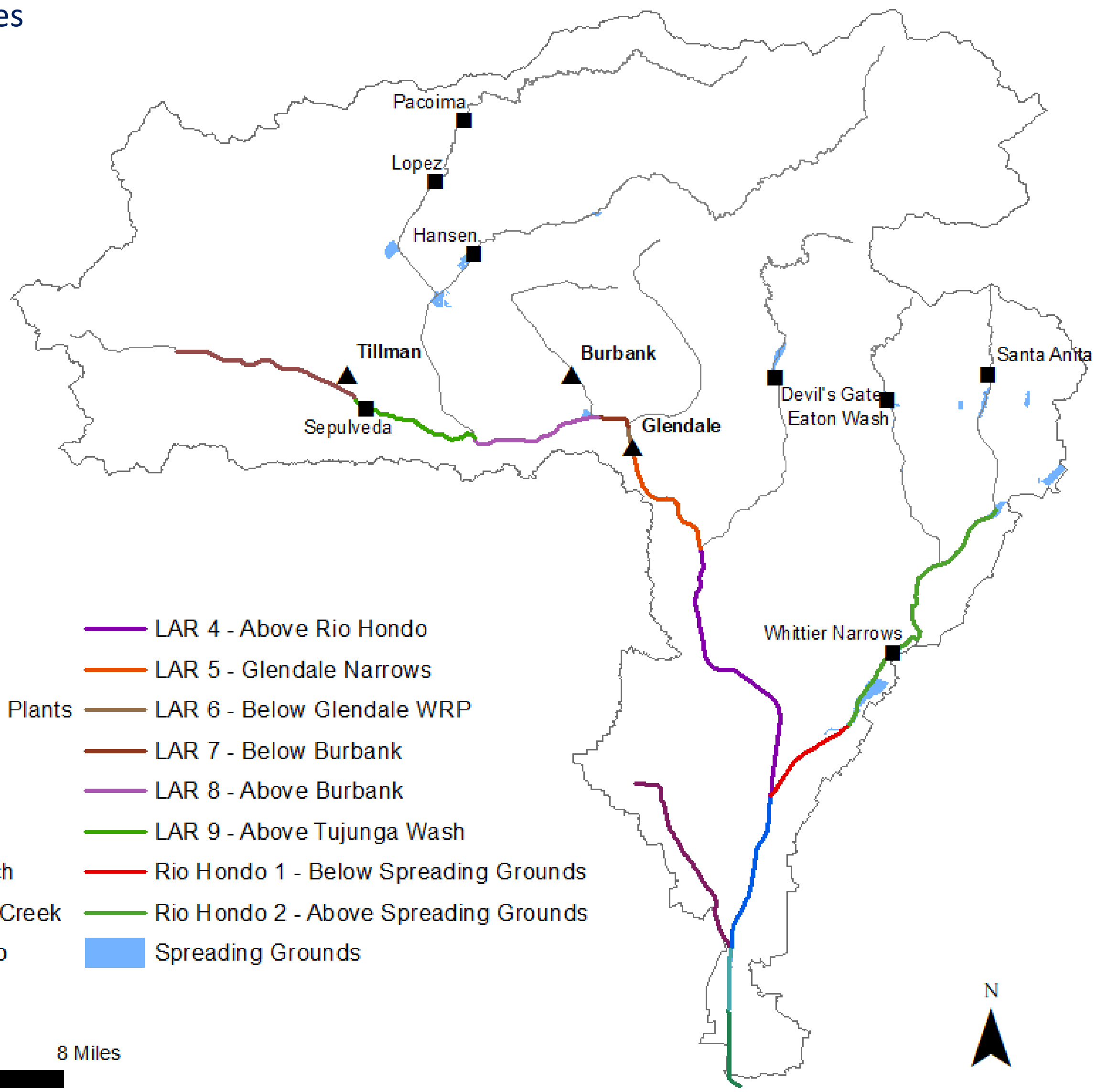
TAC Meetings

Model Domain



Analysis Reaches

LAR Mainstem: 10 reaches
Rio Hondo: 2 reaches
Compton Creek: 1 reach



Study Focus


Cypress Park
Within the banks of the the LA River mainstem
Google Earth
800 m
N
© 2018 Google

TAC Meeting #3: September 16, 2019

RECAP FROM LAST MEETING

Summary from Last Meeting

- Discussed habitat modeling approach and thresholds of response
- Modeling update (hydrologic, hydraulic, temperature)
- Review water quality data compilation
- Discuss approach for flow management scenarios and management scenario analysis

Decisions Made:

- Prob curves, co-dependencies, conceptual approach etc

Summary from Last Meeting and Webinar

Key Recommendations:

- Keep all 5 habitat groups:
  - Add migration habitat: overlays with other habitats
  - Keep coldwater fish habitat → already modeling temperature
  - Incorporate edgewater/pools within some of the reaches where this habitat can occur
  - Choose 1-2 representative species per habitat group
    - Multiple species chosen to bracket range of conditions expected to occur within that habitat
  - Approach species tolerances as ranges that reflect level of confidence in those tolerances

Last Meeting: Action Items

- ✓ Share technical report for non-aquatic life use study
- ✓ Send out compiled list of 5 habitat types, alliance and species data, preliminary end members and rationale
- ✓ Set up a follow up Zoom meeting: habitat characterization
- ✓ Follow up action items on data needs:
  - Burbank plant discharge, temperature, and salinity data
- ✓ Summary set of recommendations from the scenario discussion:
  - Scenario analysis and using sensitivity curves and circling back to heat maps and interpreting sensitivities of the model outputs
- ✓ Share PowerPoint presentations from meeting

Work to Date

- ✓ Data compilation (recreational uses, species, habitats, environmental conditions)
- ✓ Mapping of aquatic life and recreational uses by reach
- ✓ Completed non-aquatic life use assessment
- ✓ Further defined list of focal habitats and key species
- ✓ Characterized habitat needs and tolerance ranges
- ✓ Developed initial habitat modeling approach, conceptual models, and thresholds of response for two habitat types
- ✓ Set up and calibrated hydrologic and hydraulic models
- ✓ Compiled water quality data and identified data gaps
- ✓ Developed initial temperature modeling approach
- ✓ Held three TAC and two Stakeholder Working Group meetings and one TAC webinar
    - **Next stakeholder meeting:** March 26th 9am-2pm (LA Regional Water Board Office)

Today's Meeting

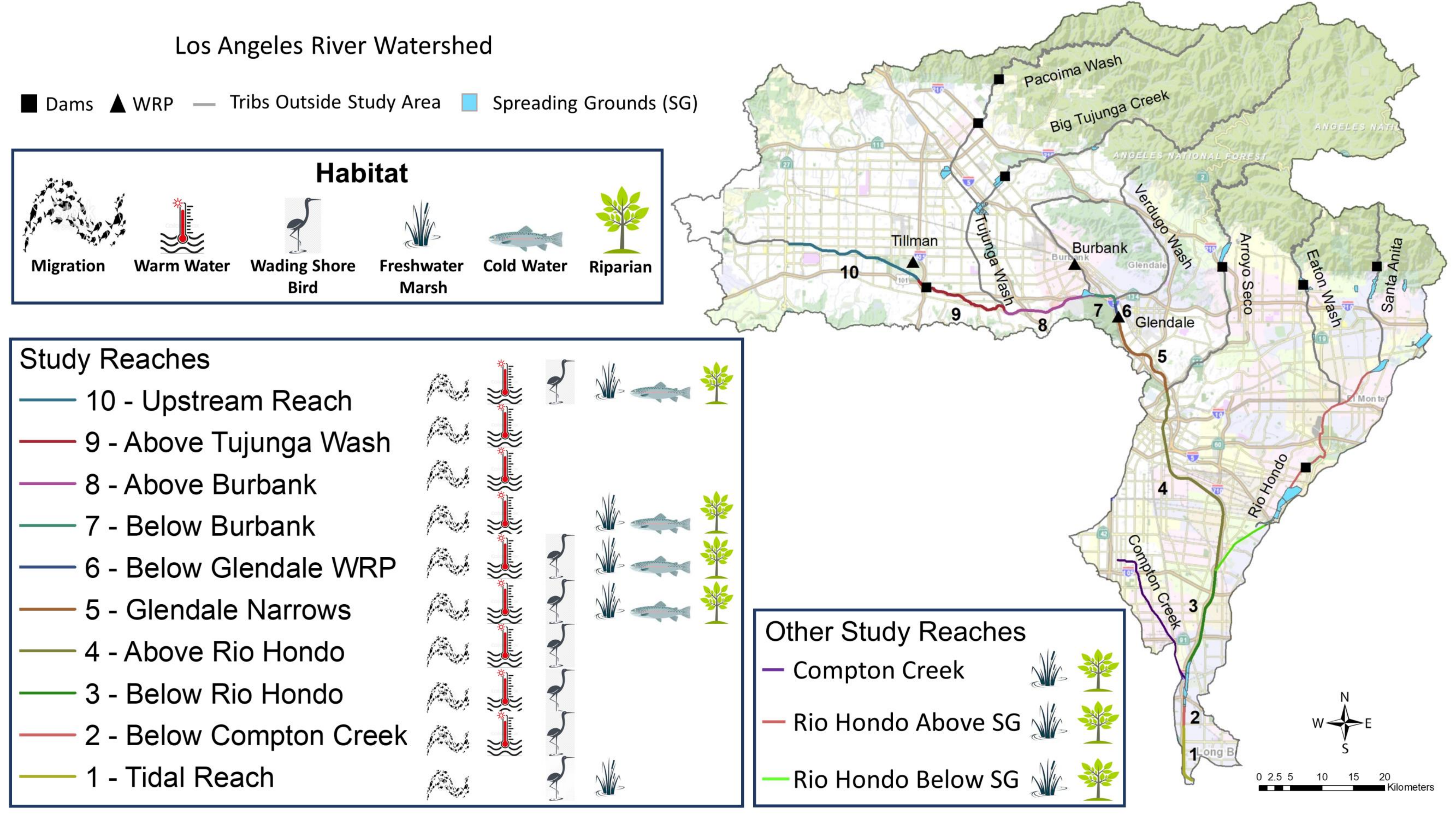
- Discuss habitat modeling approach and thresholds of response
- Modeling update (hydrologic, hydraulics, temperature)
- Review water quality data compilation
- Discuss approach for flow management scenarios and management scenario analysis

Modeling Approach and Thresholds of Response

HABITAT MODELING

Focal Habitats and Species

- **Cold water habitat -** Unarmored threespine stickleback and Santa Ana sucker
  - *Not currently present, but could potentially be in the future*
- **Migration habitat –** Steelhead/Rainbow trout
  - *Overlays with other habitats*
- **Wading shorebird habitat –** Green algae - *Cladophora* spp.
- **Freshwater marsh habitat –** Cattails and Duckweed
- **Riparian habitat –** Sandbar willow and black willow
- **Warm water habitat –** African clawed frog and Mosquitofish
  - *Surrogate for invasive spp. habitat*



Los Angeles River Watershed
Dams
WRP
Tribs Outside Study Area
Spreading Grounds (SG)
Habitat
Migration
Warm Water
Wading Shore Bird
Freshwater Marsh
Cold Water
Riparian
Study Reaches
10 - Upstream Reach
9 - Above Tujunga Wash
8 - Above Burbank
7 - Below Burbank
6 - Below Glendale WRP
5 - Glendale Narrows
4 - Above Rio Hondo
3 - Below Rio Hondo
2 - Below Compton Creek
1 - Tidal Reach
Other Study Reaches
Compton Creek
Rio Hondo Above SG
Rio Hondo Below SG
Pacoima Wash
Big Tujunga Creek
ANGELES NATIONAL FOREST
Tillman
Burbank
Glendale
Tujunga Wash
Verdugo Wash
Arroyo Seco
Eaton Wash
Santa Anita
Rio Hondo
Compton Creek
El Monte
Long B
N
W
E
S
0 2.5 5 10 15 20
Kilometers

Habitat Modeling

Focused on 2 habitats:

Cold water habitat

- Santa Ana Sucker – modeling in progress
- Unarmored Threespine Stickleback – data collection

Riparian habitat

- Goodding's Black Willow – modeling in progress
- Sandbar Willow

Main topics

Overview of the conceptual modeling approach

1. Comments from TAC

Hydraulic variable thresholds for each life stage

1. Agreement/disagreement in values
2. Missing key data?
3. Spatial data limitations

Habitat suitability

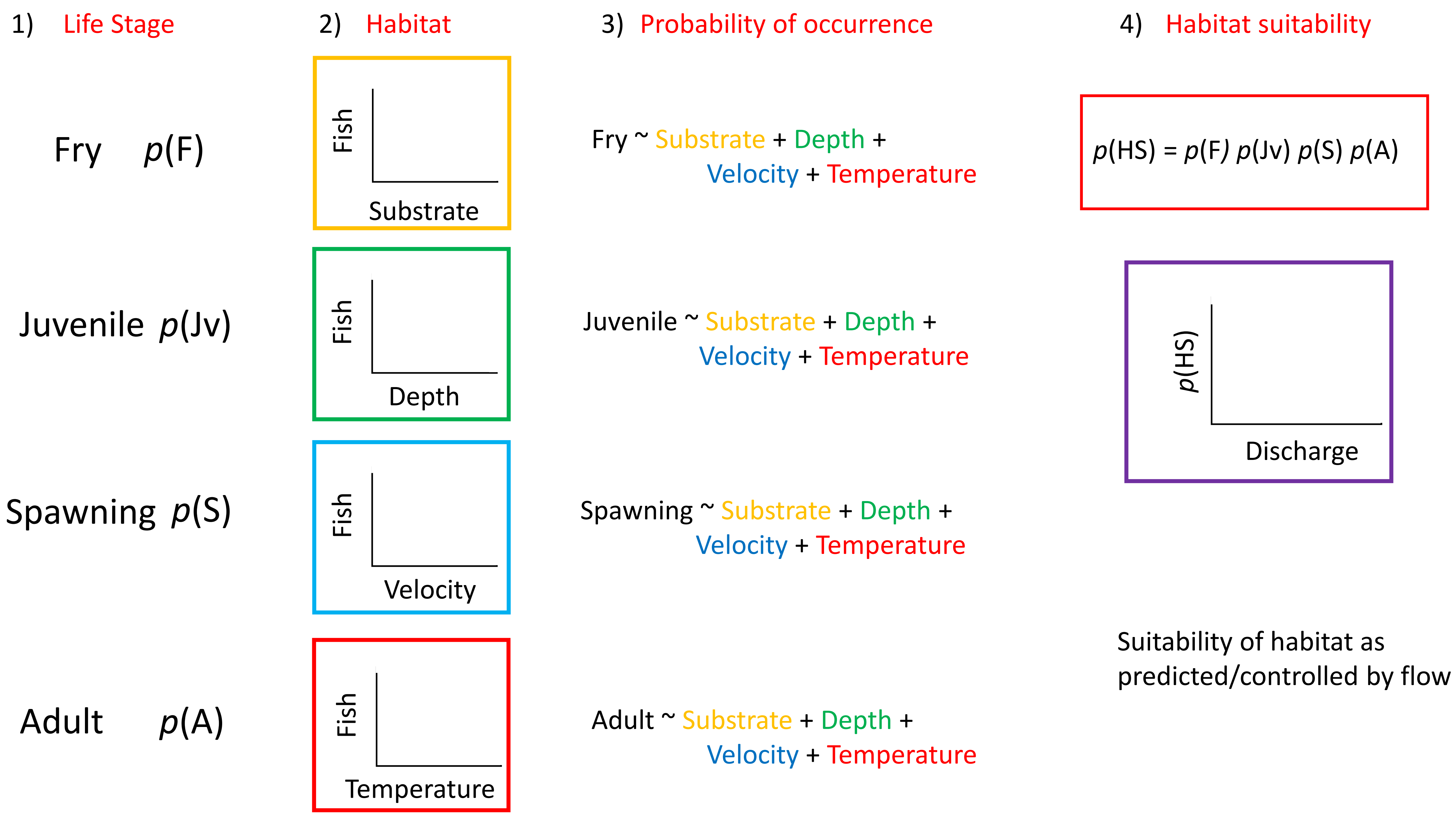
1. Discussion on most appropriate approach

Modeling approach

- Each life history phase is associated with a time, duration, and a series of ideal and critical thresholds.
- E.g. Spawning (March – July)
  - Over gravel/coarse substrate
  - In deep pools
  - “Cold water” temperatures
  - Slow flowing water
- We need to translate this information into thresholds of unsuitable – suitable habitat

Modeling approach

Fry p(F)


1) Life Stage
2) Habitat
3) Probability of occurrence
4) Habitat suitability
Fry p(F)
Juvenile p(Jv)
Spawning p(S)
Adult p(A)
Fish
Substrate
Fish
Depth
Fish
Velocity
Fish
Temperature
Fry ~ Substrate + Depth + Velocity + Temperature
Juvenile ~ Substrate + Depth + Velocity + Temperature
Spawning ~ Substrate + Depth + Velocity + Temperature
Adult ~ Substrate + Depth + Velocity + Temperature
p(HS) = p(F) p(Jv) p(S) p(A)
p(HS)
Discharge
Suitability of habitat as predicted/controlled by flow

Main topics

Overview of the conceptual modeling approach

1. Comments from TAG

Hydraulic variable thresholds for each life stage

1. Agreement/disagreement in values
2. Missing key data?
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Habitat suitability

1. Discussion on most appropriate approach

Main topics

Overview of the conceptual modeling approach

1. Comments from TAG

Hydraulic variable thresholds for each life stage

1. Agreement/disagreement in values
2. Missing key data?
3. Spatial data limitations

Habitat suitability

1. Discussion on most appropriate approach

Key questions for TAC

- Key life history phases represented and dates appropriate?
  - How many years should the life phases last?
- Key hydraulic variables considered?
- Is data used to set thresholds appropriate?
  - Multiple data sources with different thresholds?
    - liberal or conservative with our requirements
  - Prioritizing data compiled for similar species or local places
  - Are there any data sources we are missing that could fill in gaps?
  - What to do if there is no data?
- Think about what ‘success’ would look like:
  - How many years with recruitment constitutes success?

Thresholds: Set up

	Unsuitable	Intermediate	Suitable
Fry			
Juvenile			
Spawning			
Adult			
Buffer			

Thresholds?

Number of categories?

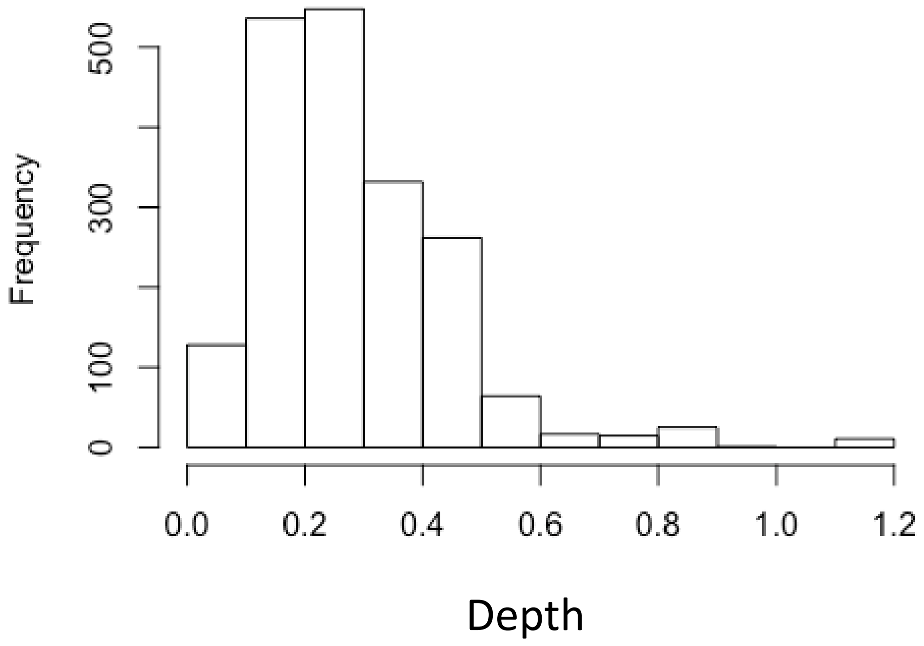
Buffer between categories?

Critical time period?

- March-July or May-June

Challenges with specific variables

Thresholds: Process for decision (e.g. Depth)



Examples from literature

1. Adults prefer 40cm
2. Juveniles prefer 25-45cm
3. Spawning in deep pools 100-150cm
4. Fry prefer 5-10cm

Feeney & Swift 2008
Haglund *et al* 2010
Fish & Wildlife Service 2010

Thresholds: Depth

Depth (cm)	Unsuitable	Intermediate	Suitable
Fry[6,1]	>20	11 to 20	1 to 10
Juvenile[2,7]	<1	1 to 24 or >46	25-45
Spawning[1]	<3	4 to 100	100-150
Adult[1,2,7,8,9]	<3	3 to 29	>30
Buffer			

Thresholds?

Number of categories?

Critical time period?

Buffer between categories?

Thresholds: Temperature

Temperature (°C)	Unsuitable	Intermediate	Suitable
Fry[1]	< 10 & >29	10-17 & 25-28	18-24
Juvenile[1]	<10 & >29	10-14 & 23-28	15-22
Spawning[2]	<10 & >26	10-21, >26	22-25
Adult[2,3,4,5]	>28	22-28	<22
Buffer			

Thresholds?

Number of categories?

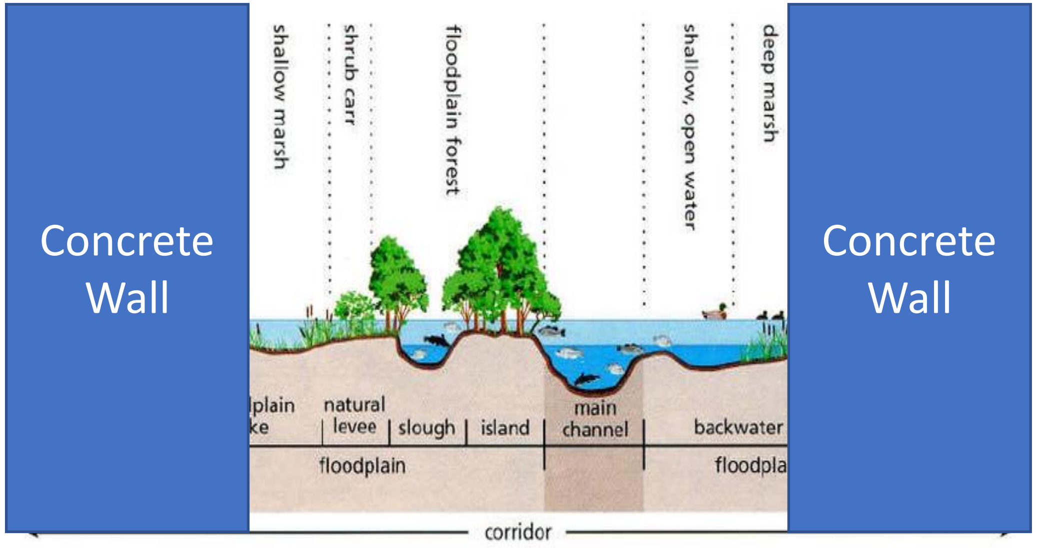
Critical time period?

Buffer between categories?

Thresholds: Velocity

Velocity (m/s)	Unsuitable	Intermediate	Suitable
Fry[1]			next to fast flowing
Juvenile			
Spawning			slow flowing
Adult[7,8,9]	<0.03 or >1.6		0.34-0.64
Buffer			

Spatial cross sections



Each node has a cross section

Different life history phases of fish use different portions of the cross section

- Microhabitats

Depth values available at several points over cross section

Velocity is one value averaged across the channel

E.g. Fry habitat – can measure specific depth but not velocity

Options:

1. Apply the model with uniform velocity
2. Use critical limits – e.g. high flow velocity that eliminates fish from the channel
3. Remove from model

Thresholds: Substrate

Substrate (predominant > 50%)	Unsuitable	Intermediate	Suitable
Fry	concrete	Gravel or cobble or mix	Sand
Juvenile	concrete	Cobble or silt or mix	Gravel or Gravel/Sand mix
Spawning	concrete	Sand or cobble/gravel mix	Gravel or Gravel/Sand mix
Adult	concrete	Sand or cobble or mix	Gravel or Gravel/Sand mix
Buffer			

Thresholds?

Number of categories?

Predominant > 50%)?

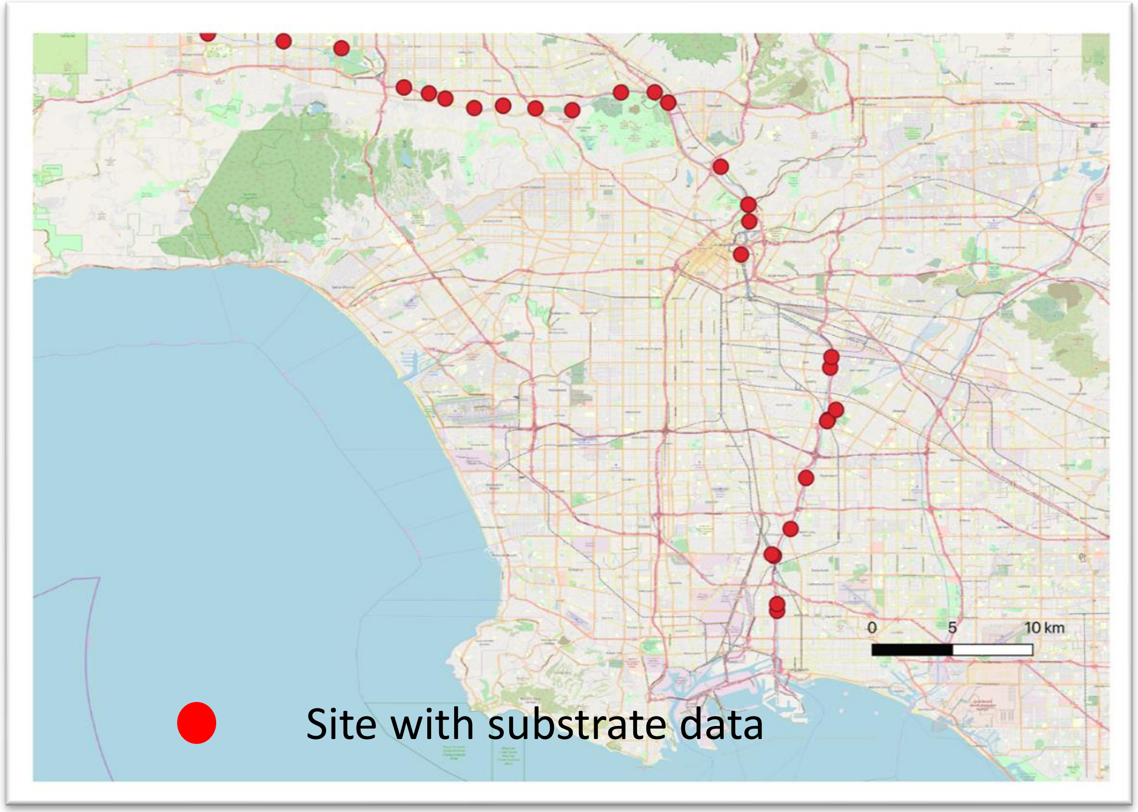
Critical time period?

Substrate type?

What percentage is classed as predominant?

Haglund *et al* 2010

Substrate sites



Source: SMC Database

Substrate highly important for Santa Ana Sucker habitat

We don't have output data for substrate from the HEC-RAS model

BUT

We do have current substrate conditions in the study area

Options:

1. Assume substrate static i.e. between nodes, under different management scenarios
2. Relate to surrogate, e.g. velocity
3. Remove from model

References

1. Feeney, R. F. & Swift, C. C. Description and ecology of larvae and juveniles of three native cypriniforms of coastal southern California. *Ichthyol. Res.* **55**, 65–77 (2008).
2. Haglund, T. R., Baskin, J. N., & Even, T. J. (2010). Results of the Year 9 (2009-2010) Implementation of the Santa Ana Sucker Conservation Program for the Santa Ana River. San Marino Environmental Associates, 9.
3. Moyle, P.B. (2002) *Inland Fishes of California*. Berkeley, CA: University of California Press
4. Greenfield, D. W., Ross, S. T. & Deckert, G. D. Greenfield, Ross & Deckert (1970).pdf. *Fish Game* **56**, 166–179 (1970).
5. Habitat variability and distribution of the Santa Ana sucker , Catostomus santaanae , in the Santa Ana River from the confluence of the Rialto channel to the Prado Basin. Santa Ana Water Project Authority (SAWPA) (2014).
6. Endangered and Threatened Wildlife and Plants; Revised Critical Habitat for Santa Ana Sucker; Final Rule. *Fish Wildl. Serv.* (2010).
7. Saiki, M. K. Water quality and other environmental variables associated with variations of the Santa Ana Sucker. *Natl. Fish Wildl. Found.* (2000).
8. Thompson, A. R., Baskin, J. N., Swift, C. C., Haglund, T. R. & Nagel, R. J. Influence of habitat dynamics on the distribution and abundance of the federally threatened Santa Ana Sucker, Catostomus santaanae, in the Santa Ana River. *Environ. Biol. Fishes* **87**, 321–332 (2010).
9. Wulff, M., Brown, L., May, J. & Gusto, E. Native Fish Population and Habitat Study, Santa Ana River, California, 2017: U.S. Geological Survey data release,. *U.S. Geol. Surv. data release* https://www.sciencebase.gov/catalog/item/5a837189e (2018). doi:https://doi.org/10.5066/F7CJ8CR0.

Habitat Suitability Discussion

- General feedback on the overall modeling concept
- Are thresholds reasonable?
  - Substrate not modeled but can we assume conditions remain the same from current state?
  - Velocity not available laterally over cross section , i.e. it is an average value– how do we account for lateral velocity requirements of different life stages?
  - Are we missing any key data?
- What outcome do we want? We use a categorical approach due to data limitations
  - Should we, or is it somehow possible to apply a continuous approach? Other options?
  - What buffers should be in place for the thresholds? To incorporate uncertainty
  - Time dependency for life stages i.e. Juvenile & Adult, Spawning & Fry

Black Willow Model

Key questions for TAC

- Key life history phases represented and dates appropriate?
  - How many years should the life phases last?

- Key hydraulic variables considered?

- Is data used to set thresholds appropriate?
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    - liberal or conservative with our requirements
  - Prioritizing data compiled for similar species or local places
  - Are there any data sources we are missing that could fill in gaps?
  - What to do if there is no data?

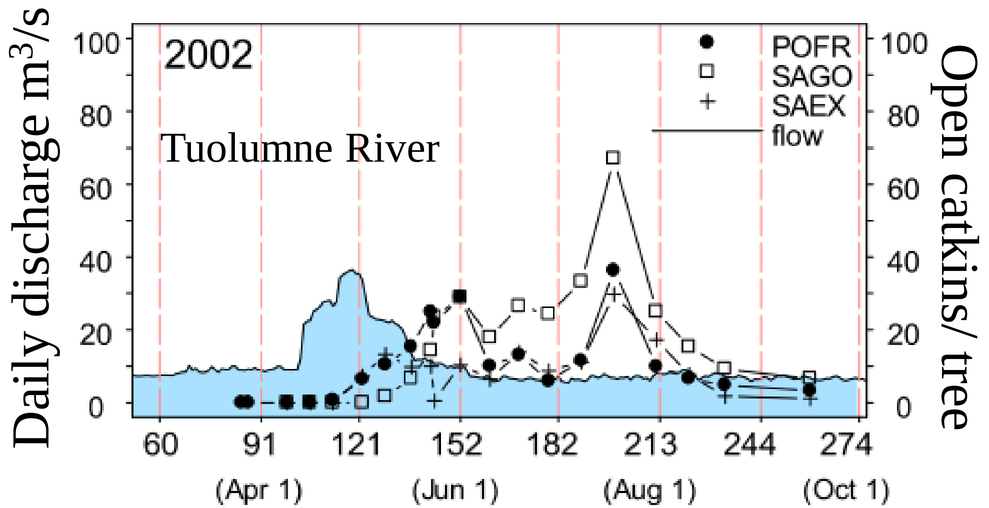
- Think about what ‘success’ would look like:
  - How many years with recruitment constitutes success?

Riparian Vegetation

- Provides habitat to nesting and foraging birds, dense insect populations
- Supports connectivity to other natural areas in the Los Angeles Region
- Canopy covers provides shade to lower water temperatures and protects fish from aerial predators
- Supports all the non-quantifiable benefits of nature (recreation, green space, biodiversity, happiness, etc)
- Example species along the LAR:
  - willow (*salix* spp.), mulefat (*Baccharis salicifolia*), cottonwood (*Populus fremontii*), western sycamore (*Platanus racemosa*)

Salix gooddingii – Goodding's black willow:

Process	Winter	Spring	Summer	Fall
Hydraulic / hydrology / geomorphic	• Large flow • Sediment moves • Surface is wetted • Water table rises • Floodplain cleared	• Final winter storm • Flows are high • Recession of flow • Water table lowers	• Floodplain dries • Baseflow or no flow returns	• Baseflow or dry conditions • First flush events
Biological	• Scour/burial of last years germinates • Preps sediment for germination	• (with HDD) catkins mature and release • Germination	• Seedlings and saplings • Roots need water table contact	• Shoot and root growth



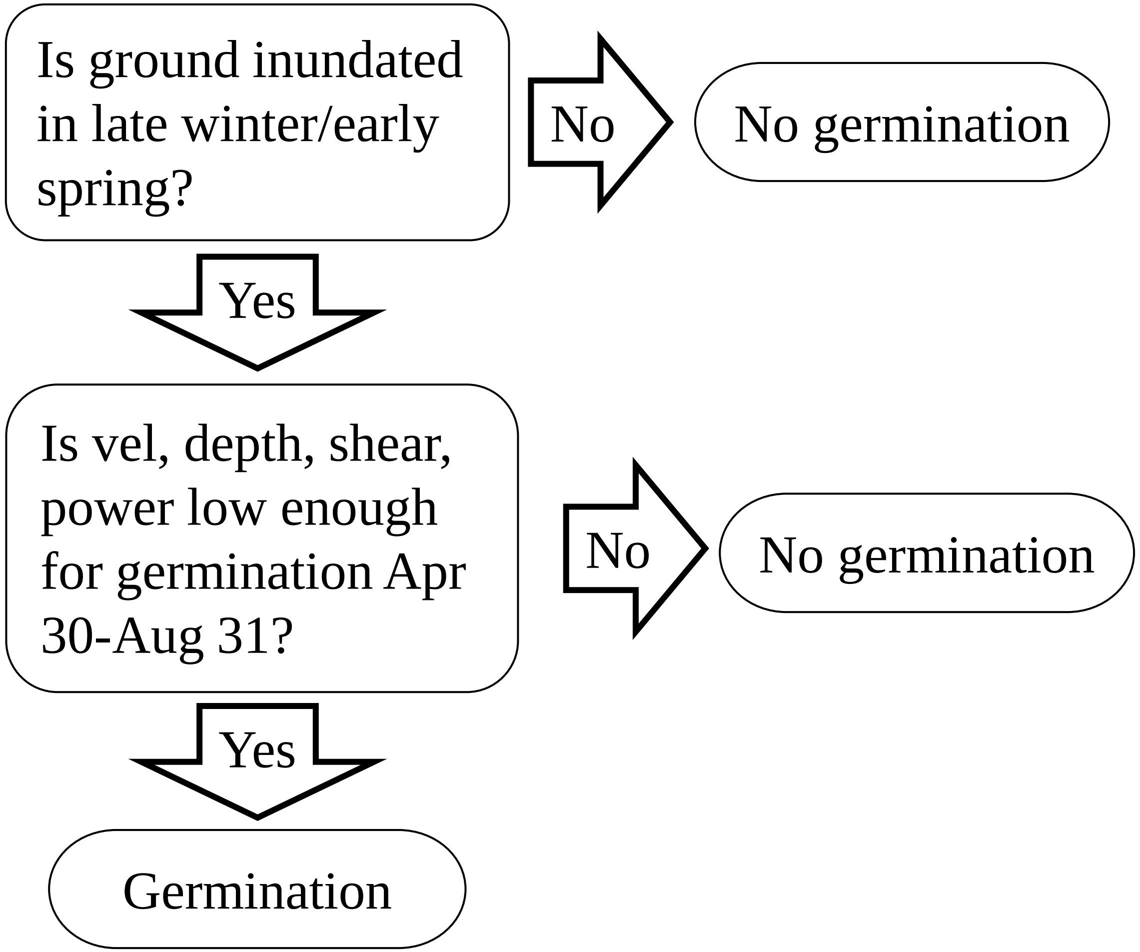
Conditions today:

- Adults black willows dominant spp in upper canopy
- Few willows in the understory – i.e. an aging population of willows
    - Flows suitable for germination and seedlings need to maintain the vegetation community

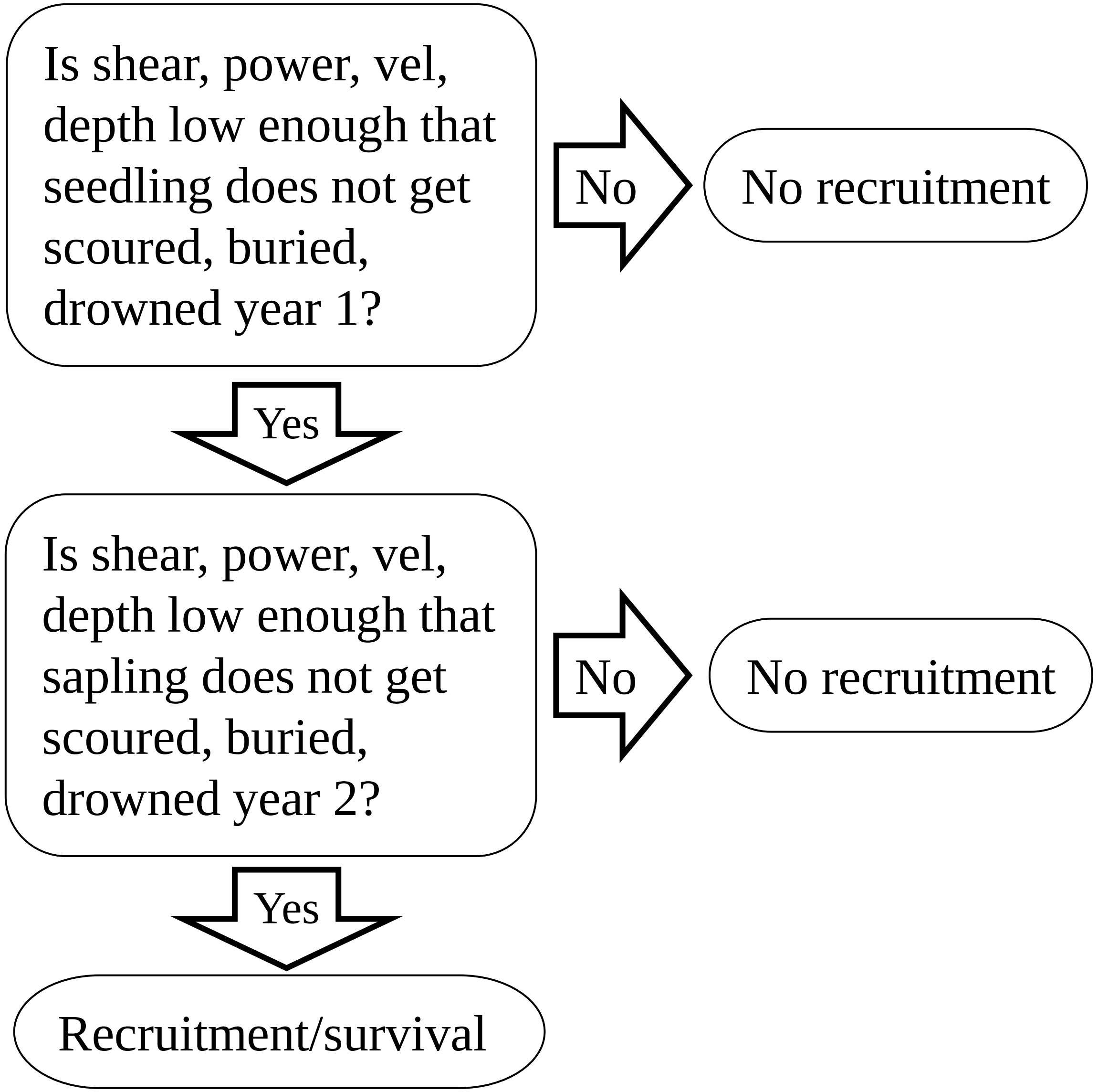
Stella, J. C., Battles, J., & McBride, J. (2006). Restoring recruitment processes for riparian cottonwoods and willows: a field-calibrated predictive model for the lower San Joaquin Basin.

Flow Chart

Germination



Recruitment



Suitable vs Not-Suitable

Life History Phase and duration	Flow (m^3/s)	Velocity (m/s)	Stream power (W/m^2)	Shear (Pa)	Depth (cm)
Pre-germination					
Germination					
Seedling/sapling					
Adult					

Suitable vs Not-Suitable

Life History Phase and duration	Flow (m^3/s)	Velocity (m/s)	Stream power (W/m^2)	Shear (Pa)	Depth (cm)
Pre-germination • April 1 – April 30					
Germination • April 30 – Aug 31					
Seedling/sapling • Oct 1 – Sept 30 (entire water year)					
Adult • Oct 1 – Sept 30 (entire water year)					

Suitable vs Not-Suitable

Life History Phase and duration	Flow (m^3/s)	Velocity (m/s)	Stream power (W/m^2)	Shear (Pa)	Depth (cm)
Pre-germination • April 1 – April 30					
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Seedling/sapling • Oct 1 – Sept 30 (entire water year)					
Adult • Oct 1 – Sept 30 (entire water year)					

Represent the potential for scour/burial/uprooting.

Suitable vs Not-Suitable

Life History Phase and duration	Flow (m^3/s)	Velocity (m/s)	Stream power (W/m^2)	Shear (Pa)	Depth (cm)
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Adult • Oct 1 – Sept 30 (entire water year)					

Represent the potential for scour/burial/uprooting.

Suitable vs Not-Suitable

Life History Phase and duration	Flow (m^3/s)	Velocity (m/s)	Stream power (W/m^2)	Shear (Pa)	Depth (cm)
Pre-germination • April 1 – April 30					X
Germination • April 30 – Aug 31		X	X	X	X
Seedling/sapling • Oct 1 – Sept 30 (entire water year)		X	X	X	X
Adult • Oct 1 – Sept 30 (entire water year)		X	X	X	

Pre-Germination

- Germination requires that the ground is damp
  - Use depth as a proxy for soil moisture?
  - Requirement of depth during early spring (April 1- April 30) of greater than 3cm?

	Atmospheres tension									
Hours	0	0.5	2	4	6	8	10	12	14	16
	Percentage germination of cottonwood seeds at successive time intervals									
15	91.7 (a)	81.7 (ab)	66.7 (bc)	61.7 (bc)	48.3 (c)	25.0 (d)	15.0 (d)	0.0 (e)	1.7 (e)	0.0 (e)
25	93.3 (a)	85.0 (a)	83.3 (a)	75.0 (a)	76.7 (a)	48.7 (a)	26.7 (c)	5.0 (d)	5.0 (d)	1.7 (d)
38	95.0 (a)	88.3 (ab)	86.7 (ab)	81.7 (ab)	78.3 (b)	55.0 (c)	41.7 (c)	16.7 (d)	11.7 (d)	1.7 (e)
47	96.7 (a)	90.0 (b)	86.7 (b)	88.3 (b)	86.7 (b)	66.7 (c)	58.3 (c)	26.7 (d)	15.0 (d)	5.0 (e)
86	96.7 (a)	90.0 (ab)	88.3 (ab)	90.0 (ab)	91.7 (a)	75.0 (bc)	63.3 (c)	26.7 (d)	16.7 (d)	5.0 (e)
110	96.7 (a)	90.0 (ab)	88.3 (ab)	90.0 (ab)	91.7 (ab)	78.3 (bc)	65.0 (c)	30.0 (d)	16.7 (de)	5.0 (e)
134	96.7 (ab)	90.0 (ab)	90.0 (ab)	90.0 (ab)	93.3 (ab)	78.3 (bc)	65.0 (c)	36.7 (d)	16.7 (e)	8.3 (e)

**Populus fremontii* seeds

Fenner, P., Brady, W. W., & Patton, D. R. (1984). Observations on seeds and seedlings of Fremont cottonwood. *Journal of Desert Plants*, *6*, 55–58.

**I'll come back to germination at the end

Suitable vs Not-Suitable

Life History Phase and duration	Flow (m^3/s)	Velocity (m/s)	Stream power (W/m^2)	Shear (Pa)	Depth (cm)
Pre-germination • April 1 – April 30					X
Germination • April 30 – Aug 31		X	X	X	X
Seedling/sapling • Oct 1 – Sept 30 (entire water year)		X	X	X	X
Adult • Oct 1 – Sept 30 (entire water year)		X	X	X	

Proposed mortality thresholds for seedlings

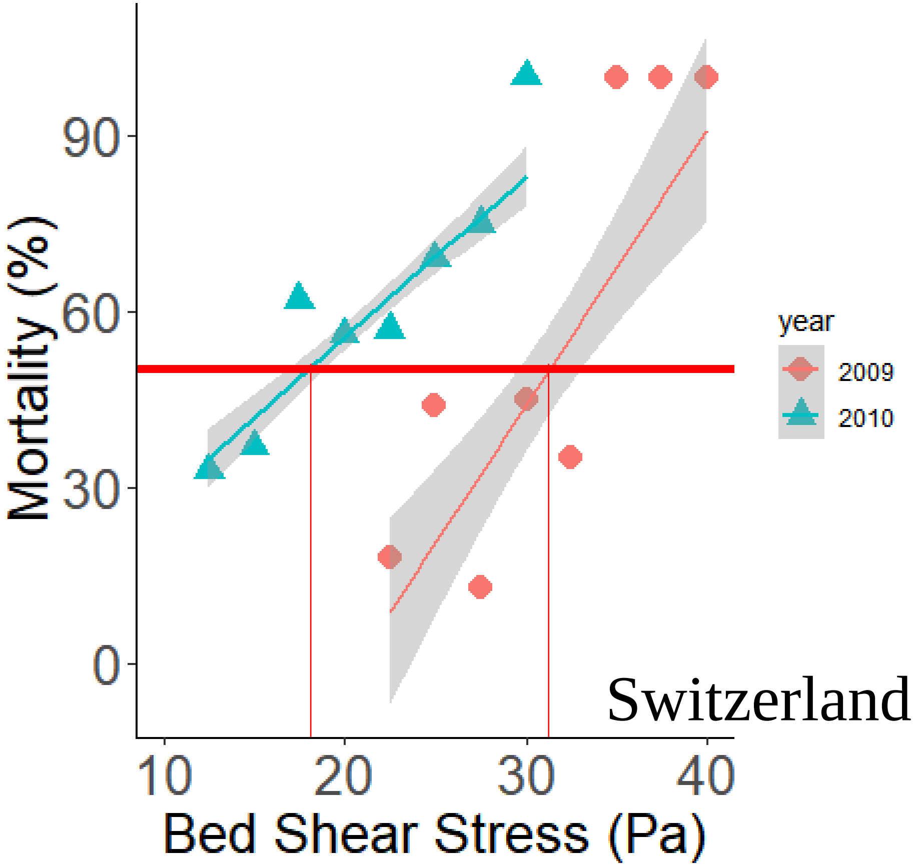
- Shear stress: 25Pa
- Depth: 81 days of submergence at greater than 20cm
- These values will be walked back to the flow requirements that maintain them

➢ In the next slides I'll discuss how I got these and the other options

All S. goodingii cuttings

Seedling: Oct 1 – Sept 30

➢ Shear



➢ Options

- Some shear stress value related to 50% mortality (100% mortality)
- Use the relationship

Pasquale, N., Perona, P., Francis, R., & Burlando, P. (2014). Above-ground and below-ground Salix dynamics in response to river processes. Hydrological Processes, 28(20), 5189–5203.

**All S. gooddingii* cuttings

Seedling: Oct 1 – Sept 30

➢ Options

- Midway = 81 days of inundation at 20cm (similar to the 85 day threshold for box elder)
- Conservative: 58 days inundation at 5cm
- Liberal: 105 days at 35 cm

➢ Depth

- 1 month after root growth - Nevada

Inundation (cm)	105 day Mortality (%)
35 (flooded)	82.5
0 (saturated)	10
-20 (dry)	50

- 2 months after planting - Tucson
  - Survived 58 days of submergence at 5cm above soil level (no sign of stress)
- 85 days of inundation found to be threshold for mortality of *Acer negundo* - Colorado

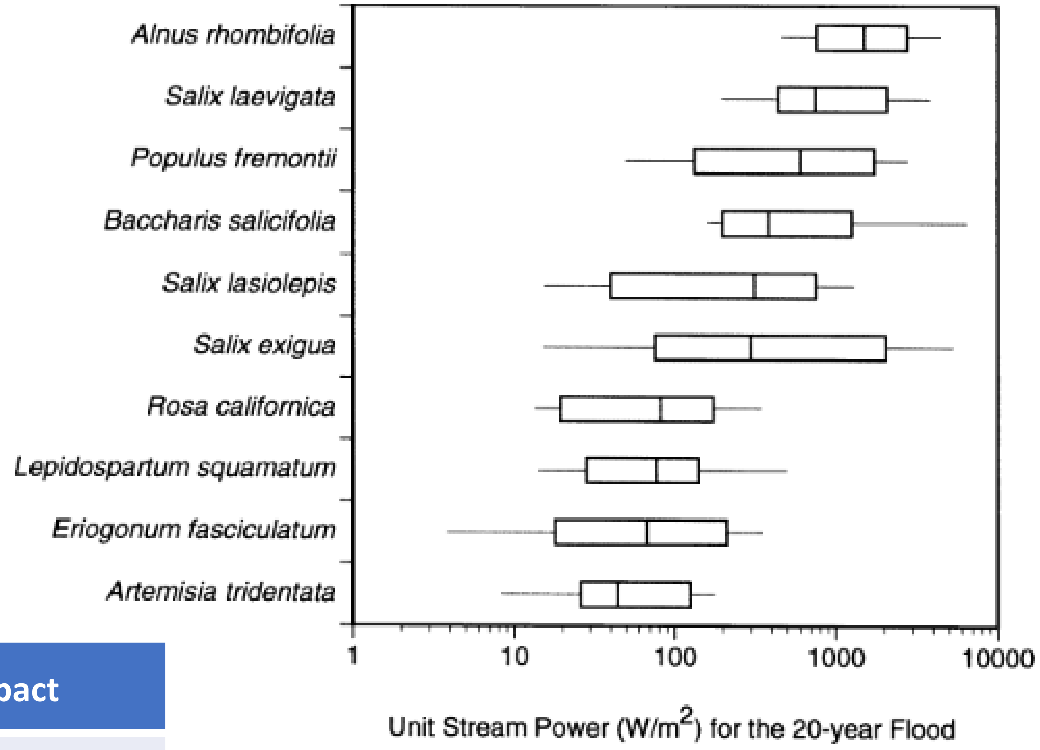
Tallent-Halsell, N. G., & Walker, L. R. (2002). RESPONSES OF SALIX GOODDINGII AND TAMARIX RAMOSISSIMA TO FLOODING. *Wetlands*, *22*(4), 776–785.
Vandersande, M. W., Glenn, E. P., & Walworth, J. L. (2001). Tolerance of five riparian plants from the lower Colorado River to salinity drought and inundation. *J. of Arid Environments*, *49*(1), 147–159.
Friedman, J. M., & Auble, G. T. (1999). Mortality of riparian box elder from sediment mobilization and extended inundation. Regulated Rivers: Research and Management, 15(5), 463–476.

Suitable vs Not-Suitable

Life History Phase and duration	Flow (m^3/s)	Velocity (m/s)	Stream power (W/m^2)	Shear (Pa)	Depth (cm)
Pre-germination • April 1 – April 30					X
Germination • April 30 – Aug 31		X	X	X	X
Seedling/sapling • Oct 1 – Sept 30 (entire water year)		X	X	X	X
Adult • Oct 1 – Sept 30 (entire water year)		X	X	X	

Adult

- ➢ Stream power (W/m2)
  - Observed ranges (Santa Clara River)
    - *S. laevigata* (200-3500)
    - *S. lasiolepis* (15-1500)
    - *S. exigua* (15-4000)
    - *P. Fremontii* (50-3000)
- ➢ Shear Stress (N/m^2)
  - Harm thresholds (SE Spain)



Velocity (m/s)	Shear stress (N/m^2)	Unit stream power (W/m^2)	Species	Form	Impact
2-2.6	133-192	225	*Dodonaea viscosa*	shrub	swept away
3.8	60	186	*D. viscosa*	shrub	swept away
0.3-3.2	28-161	100-155	*D. viscosa*	shrub	died
1.4-2	64-80	94-155	*D. viscosa*	shrub	battering
1.7	390-525	762	*Tamarix canariensis*	shrub/tree	swept away
0.8	135-308	417	*T. canariensis*	shrub/tree	swept away
0.9	133-192	225	*T. canariensis*	shrub/tree	battering

Bendix, J. (1999). Stream power influence on southern Californian riparian vegetation. Journal of Vegetation Science, 10(2), 243–252.

Sandercock, P. J., & Hooke, J. M. (2010). Assessment of vegetation effects on hydraulics and of feedbacks on plant survival and zonation in ephemeral channels. *Hydrolog Processes*, *24*(6), 695–713.

** Back to germination

Suitable vs Not-Suitable

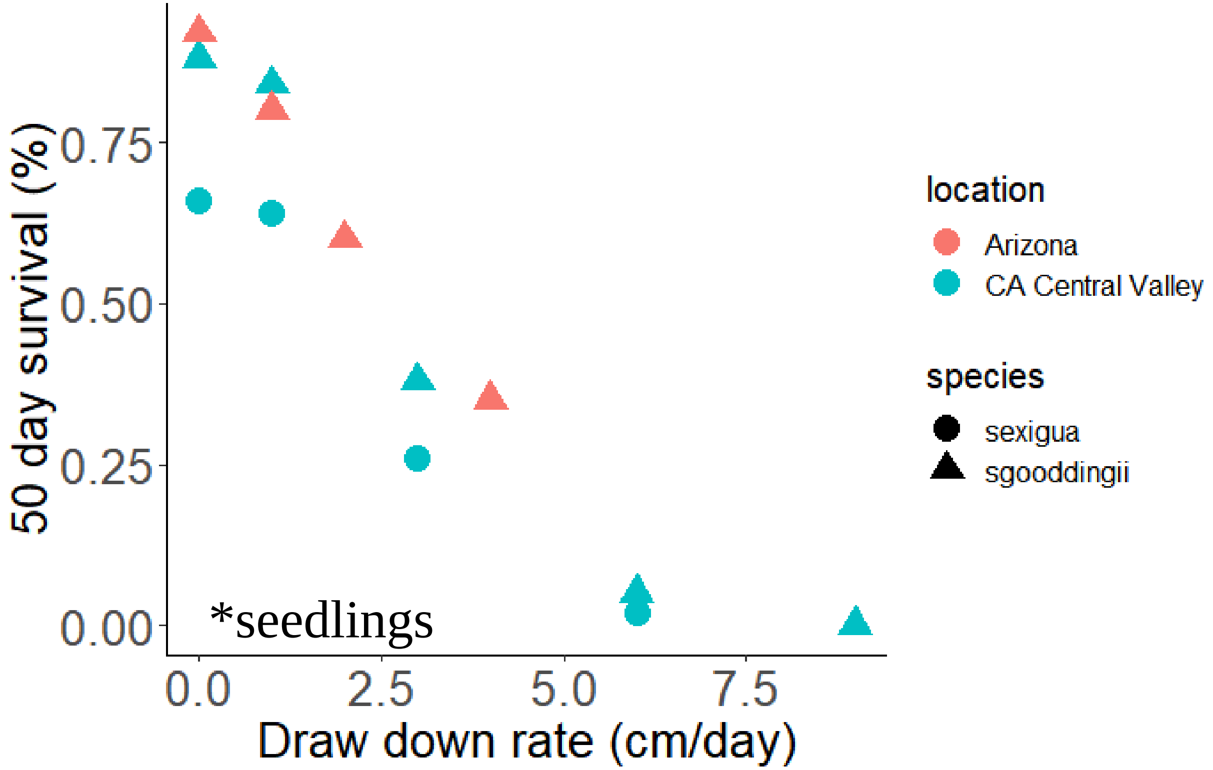
Life History Phase and duration	Flow (m^3/s)	Velocity (m/s)	Stream power (W/m^2)	Shear (Pa)	Depth (cm)
Pre-germination • April 1 – April 30					X
Germination • April 30 – Aug 31		X	X	X	X
Seedling/sapling • Oct 1 – Sept 30 (entire water year)		X	X	X	X
Adult • Oct 1 – Sept 30 (entire water year)		X	X	X	

Germination

- ➢ Nothing here yet!
- ➢ Most papers discuss the seedling stage after a few weeks of establishment.
- ➢ Options:
  - Include germination in the seedling stage (i.e. increase duration of the seedling stage to include germination)?
  - Include germination in the 'pre-germination' stage (i.e. consider only depth to be important. Not ideal because scour variables are detrimental during germination and should be considered)

Water Table

- Many studies document:
  - Relationship between water table decline and seedling establishment
  - Depth to water table for adult survival
- But…We are not modeling ground water dynamics in this study
- *Assumption: In the soft bottomed regions, groundwater is in “root reach” of both seedlings and adults*



Species (adults)	Water table depth (m)
P. fremontii–S. gooddingii	<2.6
S. gooddingii	2
S. exigua	1.5

Horton, J. L., & Clark, J. L. (2001). Water table decline alters growth and survival of Salix gooddingii and Tamarix chinensis seedlings. Forest Ecology and Management, 140(2–3), 239–247.
Stella, J. C., Battles, J., & McBride, J. (2006). Restoring recruitment processes for riparian cottonwoods and willows: a field-calibrated predictive model for the lower San Joaquin Basin.
Stromberg, J. C., & Merritt, D. M. (2016). Riparian plant guilds of ephemeral, intermittent and perennial rivers. Freshwater Biology, 61(8), 1259–1275. https://doi.org/10.1111/fwb.12686
Lite, S. J., & Stromberg, J. C. (2005). Surface water and ground-water thresholds for maintaining Populus-Salix forests, San Pedro River, Arizona. Biological Conservation, 125(2), 153–167.

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Key questions for TAC

- Key life history phases represented and dates appropriate?
  - How many years should the seedling/sapling phase last?
- Key hydraulic variables considered?
- Is data used to set thresholds appropriate?
  - Multiple data sources with different thresholds?
    - liberal or conservative with our requirements
  - Prioritizing data compiled for similar species or local places
  - Are there any data sources we are missing that could fill in gaps?
  - What to do if there is no data?
- Think about what ‘success’ would look like:
  - In our 7 years of model runs, is a single year with appropriate germination/recruitment successful?

Rules moving forward with threshold setting

General TAC preference toward…

1. Data sources with different thresholds
   - liberal or conservative with our requirements
   - Use an averaged value
   - Prioritize values based on region or species

2. What to do if there is no data (willow-germination or sucker-velocity)
   - Exclude life history phase or variable
   - Lump into a different life history phase

Biological Modeling: Next steps

- Final model development
  - Finalize algorithms for each life stage based on TAC feedback
  - Use model to assess biological suitability with hydraulic and temperature data from Colorado School of Mines
  - Aggregation of life stage suitability to determine overall habitat suitability
  - Validation of results
- Scale up to other ‘endmember’ to represent additional habitats
- Apply model under management scenarios to compare ecological impacts

Hydrologic, Hydraulics, and Temperature Modeling

MODELING UPDATE

Key Modeling Questions for TAC

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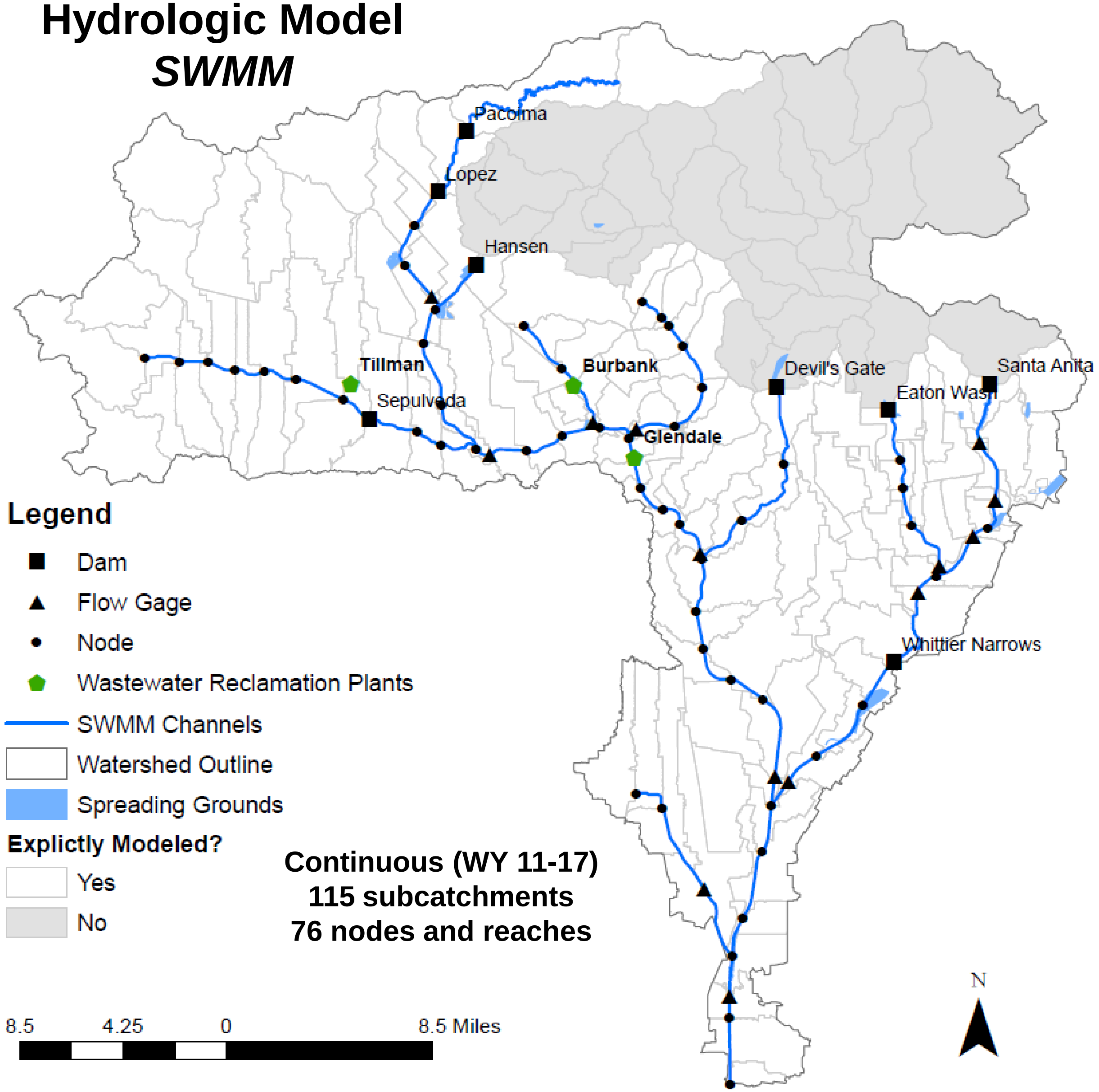
- HEC-RAS and SWMM Scenarios:
  - Do we have any cross-sectional data for the soft bottom area within Sepulveda basin?
  - Is there someone we can talk to who is very familiar with the stormwater capture master plan as we develop our scenarios?

- Temperature, TSS, metals, and specific conductance data for:
  - WRP discharges
  - Mass emissions data for S10 at Wardlow pre-2006
  - MS4 pre-2015
  - What else?

- Stream Temperature Data Needs/Options:
  - Need observed temperature data for calibration/validation in urban areas
  - Collect observed data in summertime using ibuttons?
  - Use air temperature to adjust the temperature for the water?

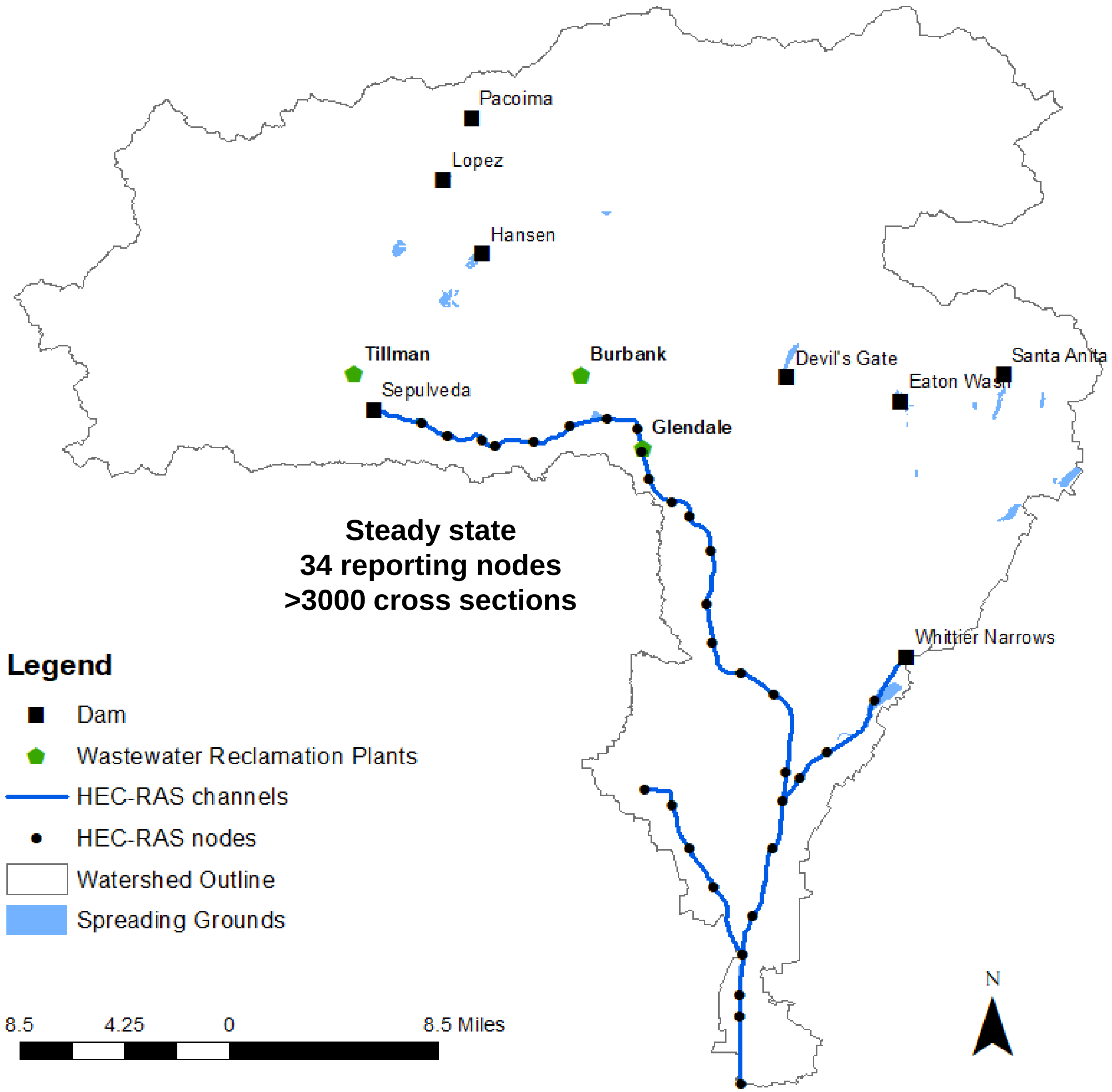
Coupled SWMM & HEC-RAS Model

Hydrologic Model
SWMM



Continuous (WY 11-17)
115 subcatchments
76 nodes and reaches

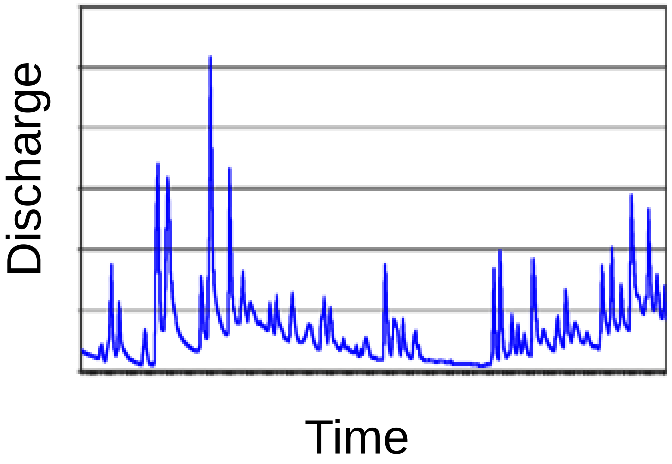
Hydraulic Model
HEC-RAS



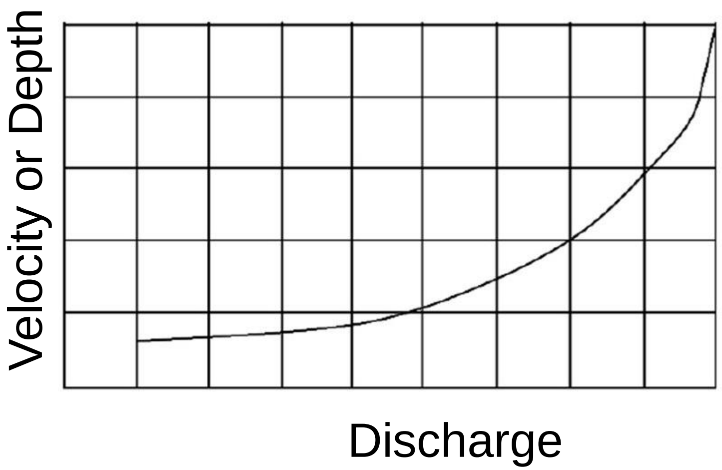
Steady state
34 reporting nodes
>3000 cross sections

Coupled SWMM & HEC-RAS Model

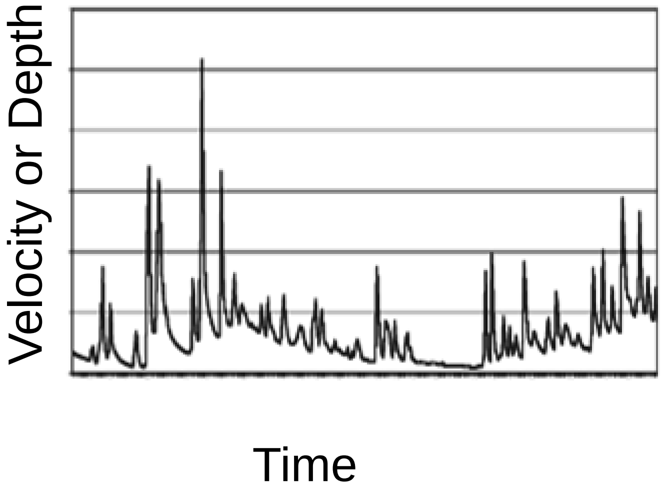
<u>Hydrology Model</u>
SWMM
Unsteady (WY 2011 to 2017, hourly timestep)



<u>Hydraulic Model</u>
HEC-RAS
Steady state to create rating curves

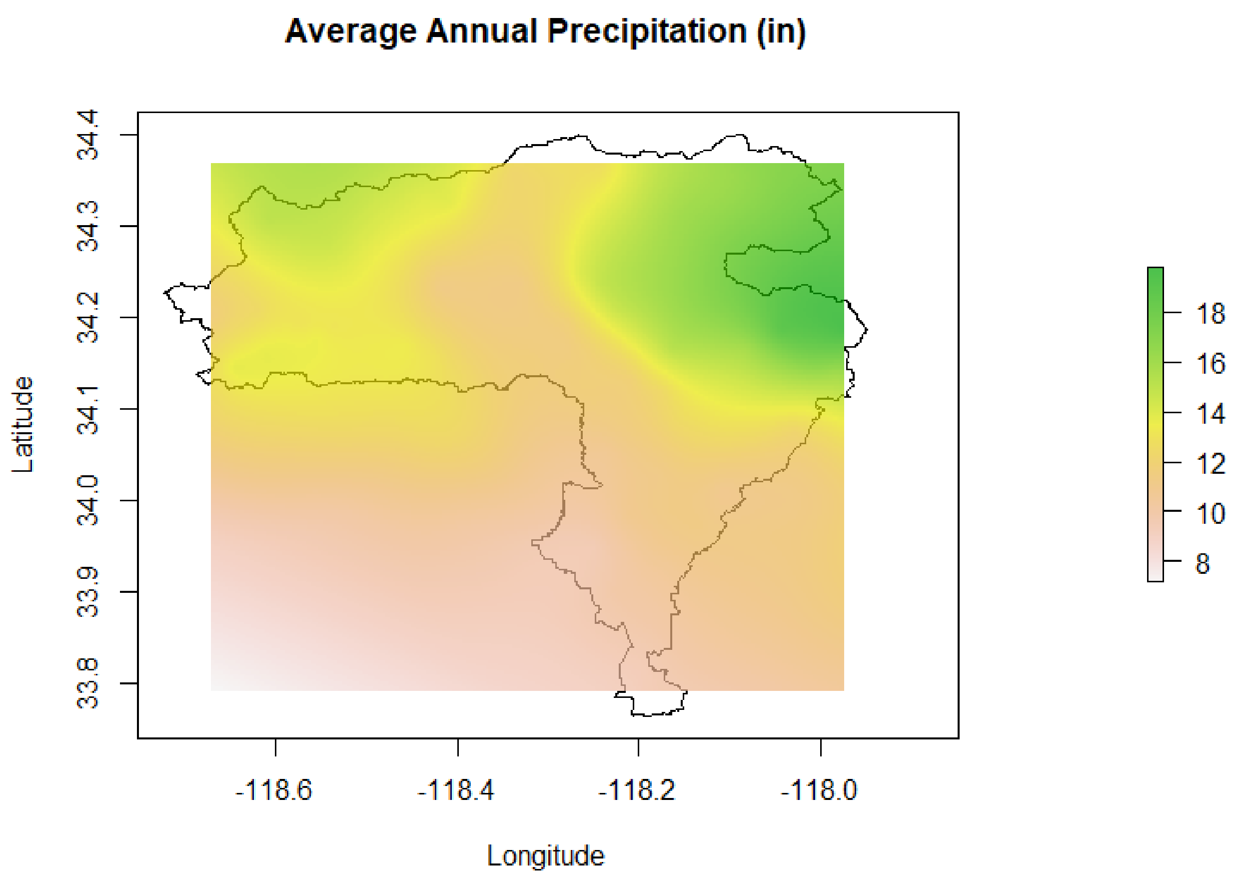


<u>Output</u>
Timeseries



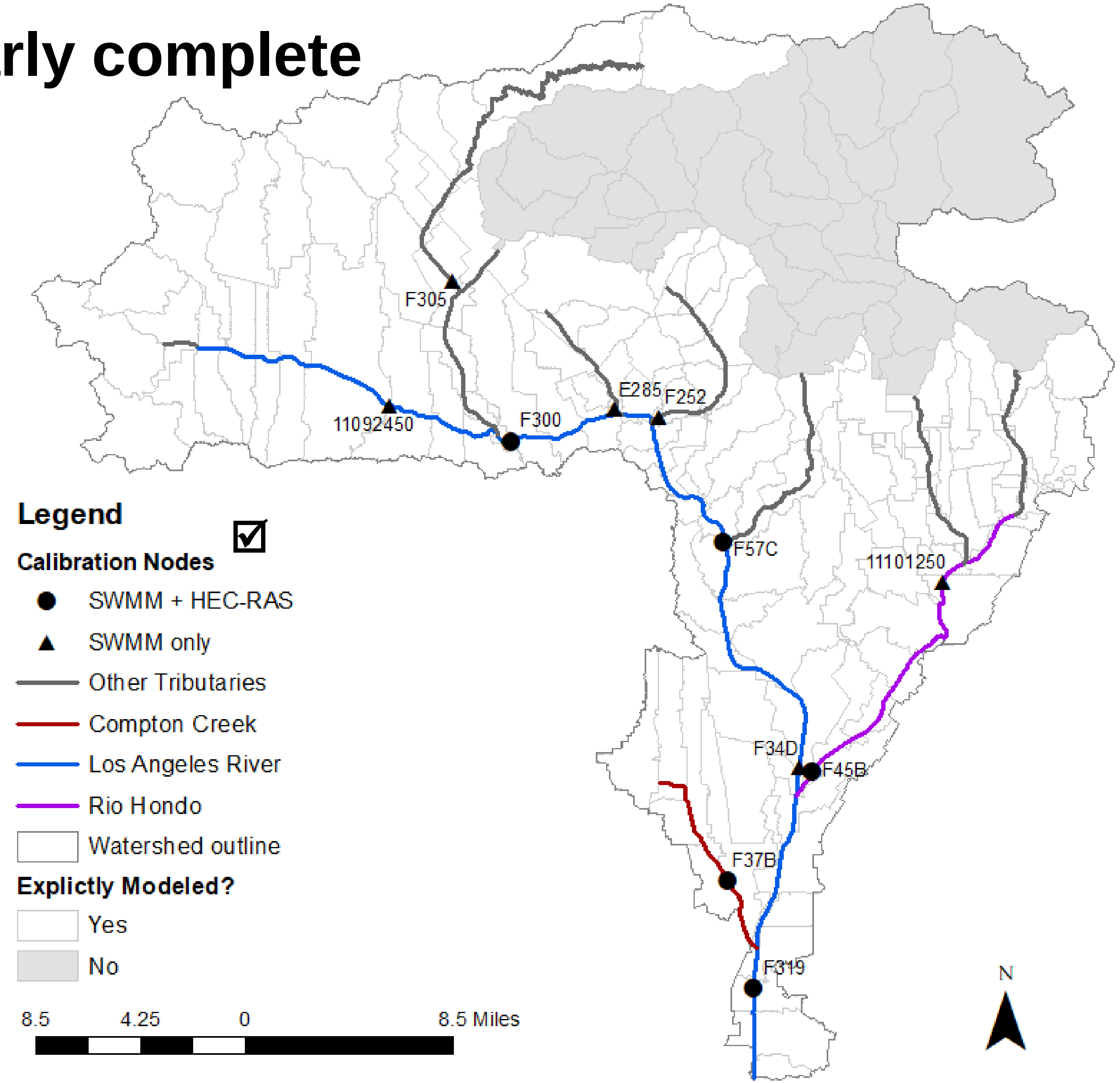
Major updates since last meeting

- Inclusion of WRP discharge and urban baseflow
- Precipitation data spatially interpolated by kriging
- Re-delineation around Sepulveda basin to provide appropriate data for habitat modeling



Model calibration is nearly complete

- ☑ **HEC-RAS (hydraulics)**
  - 5 gages
  - Manual adjustment of Manning's n
- ☐ **SWMM (hydrology)**
  - 11 gages
  - Automated scatter search (NGSA-II) of 500 solutions
  - Adjustment of % directly connected imperviousness, Manning's n, depression storage, catchment width, hydraulic conductivity



SWMM Model Calibration

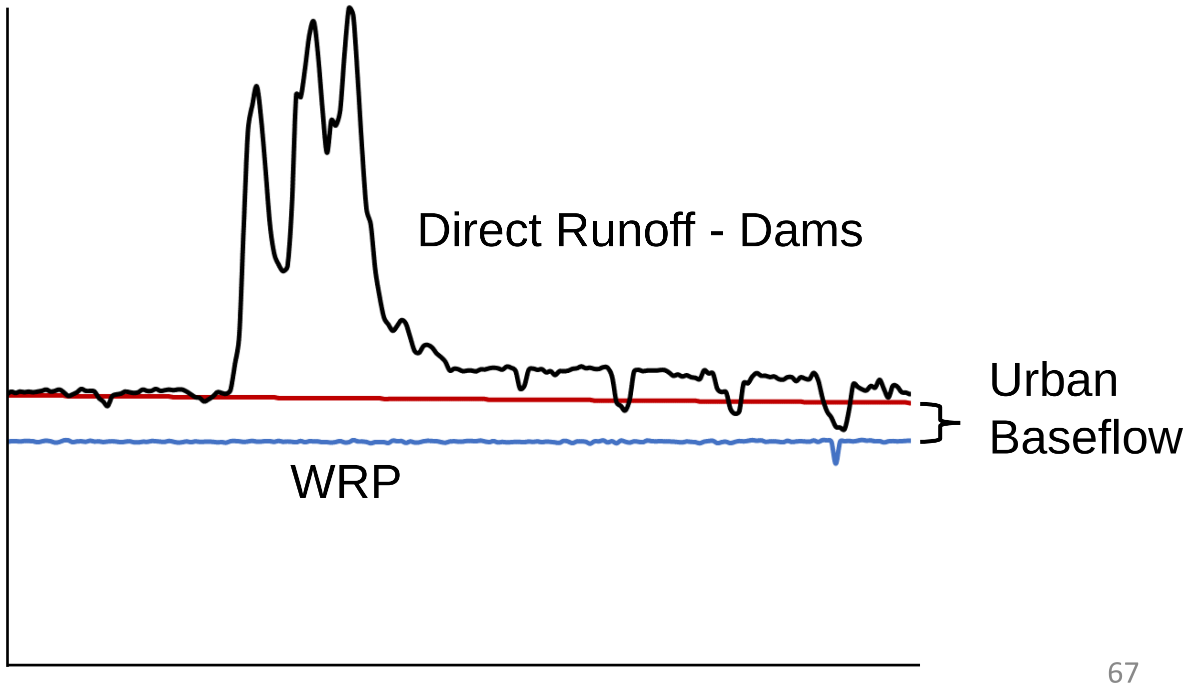
$$Q_{tot\_sim} = Q_{direct\_runoff} + Q_{baseflow} - Q_{dam}$$

$$Q_{tot\_sim} = Q_{direct\_runoff} + Q_{WRP} + Q_{upwelling} + Q_{industrial} + Q_{drool} - Q_{dam}$$

$$Q_{tot\_sim} = Q_{direct\_runoff} + Q_{WRP} + Q_{urban\_baseflow} - Q_{dam}$$

- Q_{direct_runoff}: Simulated in SWMM
- Q_{WRP}: Observed from Cities
- $Q_{urban\_baseflow}$: Estimated from observed
- Q_{dam}: Observed from LA County or USACE

Calibrate Q_{tot_sim} to Q_{tot_obs}



SWMM Calibration

Calibration WY 2014–2017; Validation WY 2011–2013

Flow Gage	Gage Description	Calibration Statistics (daily)			Validation Statistics (daily)		
		NSE	% Bias	R^2	NSE	% Bias	R^2
F305	Pacoima Diversion	0.47	0.1	0.51	0.36	-57	0.68
E285	Burbank Western Channel	0.72	3.3	0.75	0.73	-9.1	0.85
F252	Verdugo Wash	0.67	-0.1	0.69	0.74	-21.1	0.75
11092450	LAR above Sepulveda	0.92	-2.9	0.92	0.86	-3.5	0.88
F300	LAR below Tujunga Wash	0.95	0.4	0.95	0.91	2.4	0.93
F57C	LAR above Arroyo Seco						
F34D	LAR above Rio Hondo						
F319	LAR below Wardlow Rd.						
F37B	Compton Creek	0.68	-11.7	0.68	0.66	39.1	0.85
11101250	Rio Hondo above Whittier Narrows	0.85	0.2	0.86	0.76	-35.1	0.76
F45B	Rio Hondo above LAR						

Ongoing work

Hydraulics

- Expand HEC-RAS model above Sepulveda dam
  - Need cross-sectional data within soft-bottom portion.
- Create rating curves for additional outputs: shear stress and stream power
- Add tidal influence near outlet

Hydrology

- Address model issues within Rio Hondo → add spreading basins
- Finish calibration on mainstem

Additional cross section locations

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Additional cross section locations

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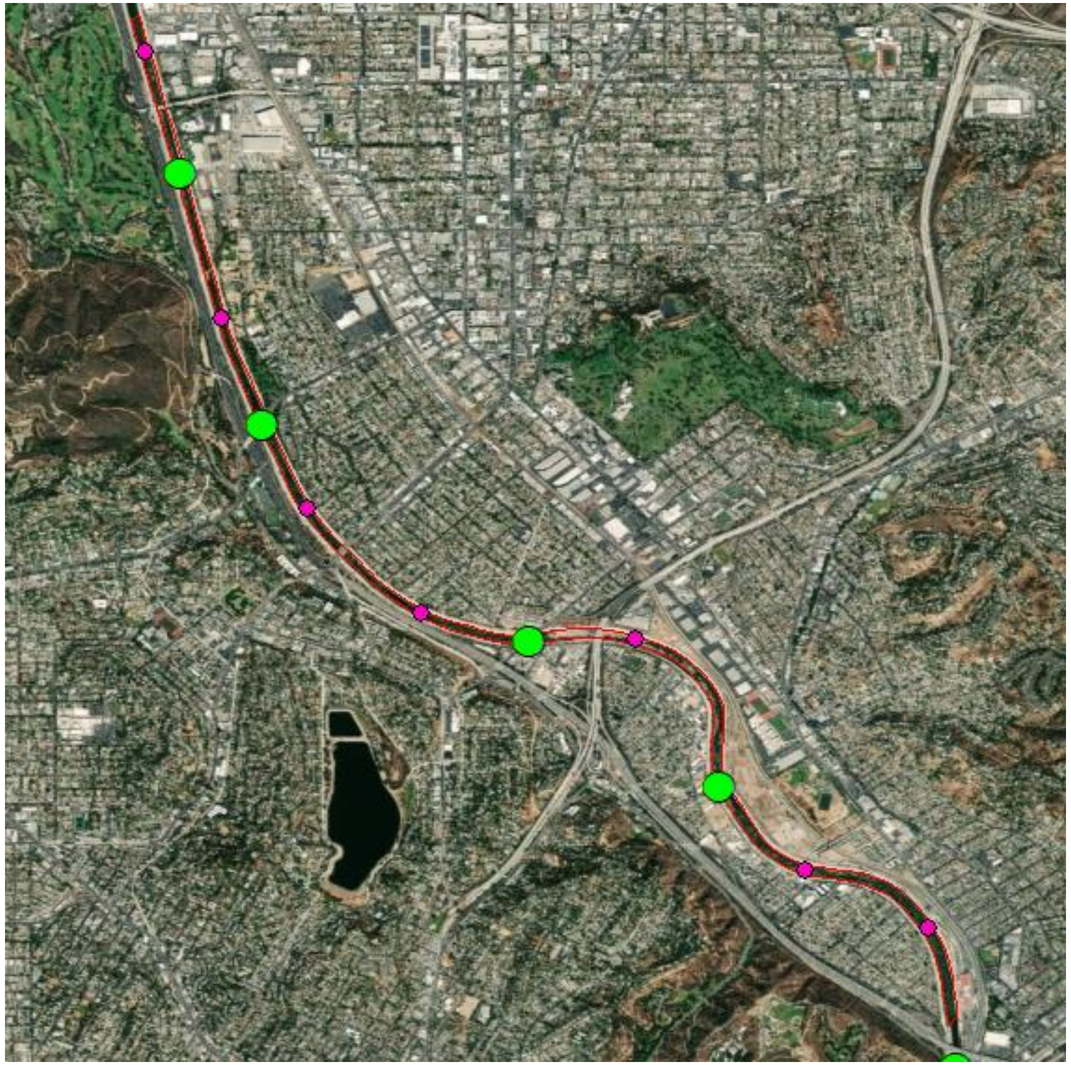

Water Quality

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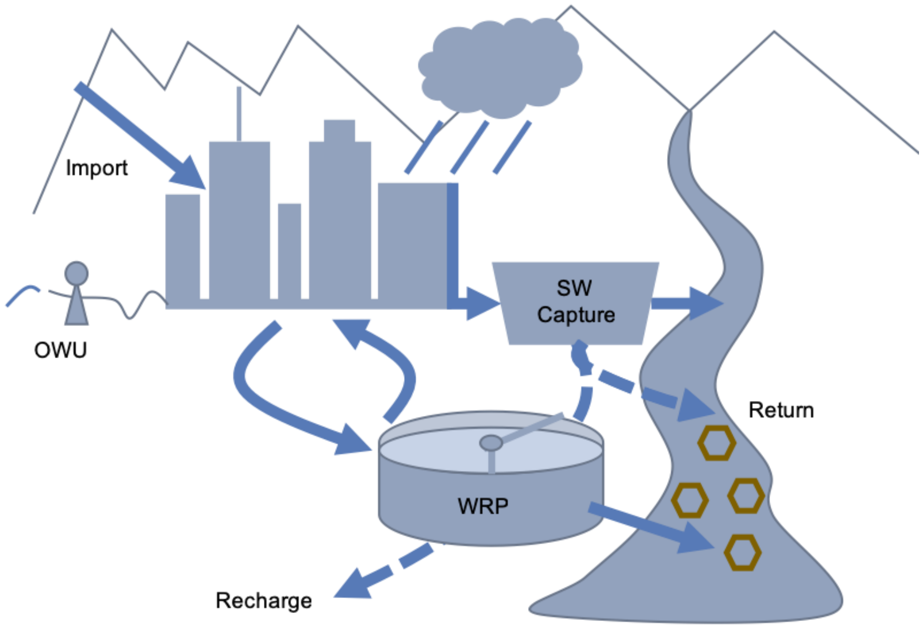

PURPOSE

- Simulate water quality in the LA River mainstem

PARAMETERS

- Temperature
- Metals: Copper, Lead, Zinc
- TSS
- Specific conductance

APPROACH

- SWWM coupled with HEC-RAS
- HEC-RAS and iTree Cool River for temperature

Water Quality Data

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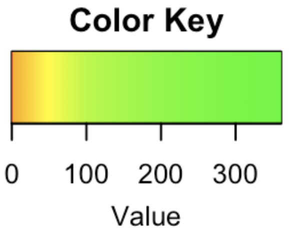
Downloaded Data

- CEDEN (2006–2018)
- Mass Emissions (2006–2015)
- MS4 (2015–2018)



WQ Sample Points

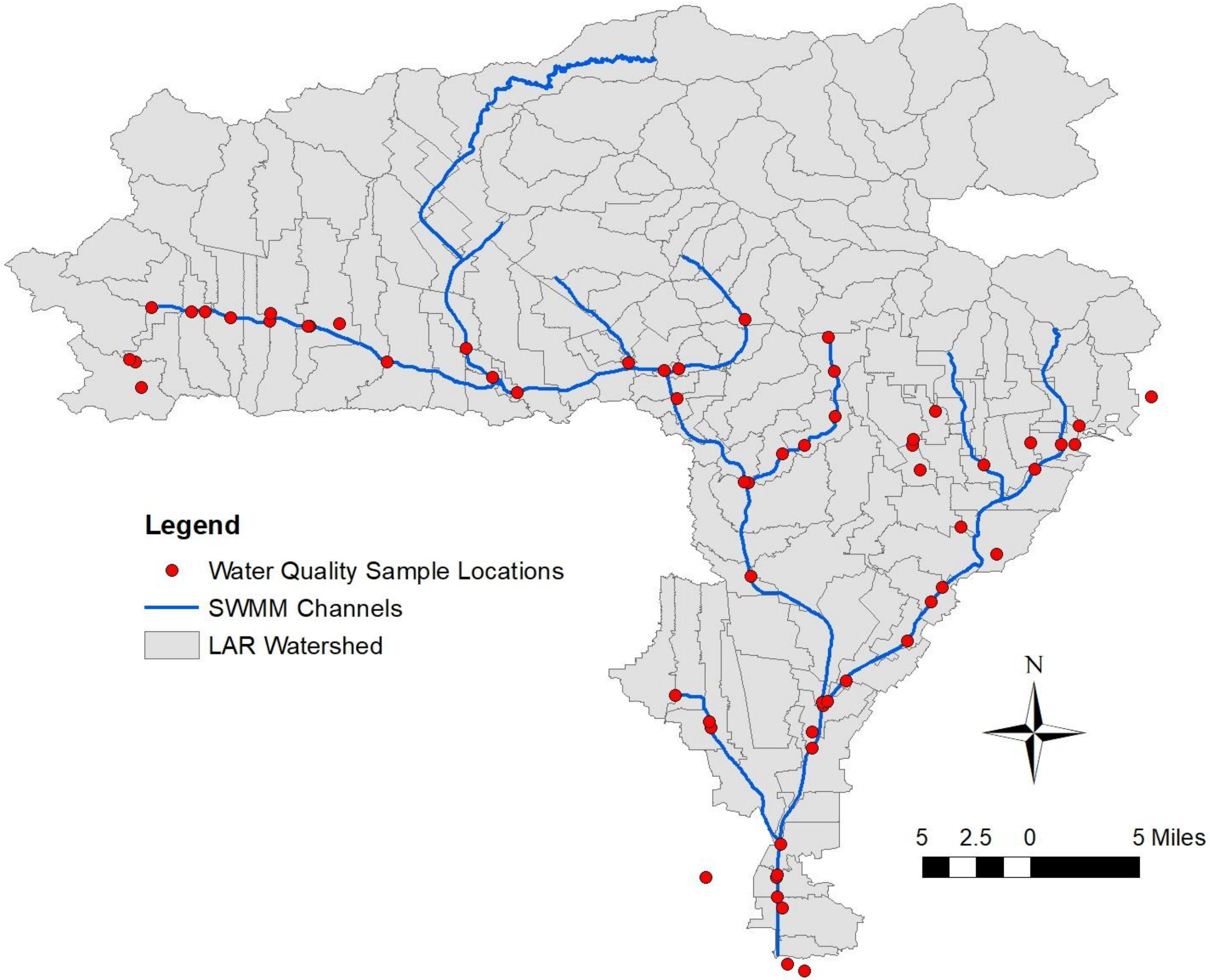
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Copper, Total	6	6	10	7	6	6	11	6	8	159	182	156	71
Lead, Total	6	6	10	7	6	6	11	6	10	155	179	153	73
Zinc, Total	6	6	10	7	6	6	11	6	8	146	172	146	67
Copper, Dissolved	6	6	10	7	6	6	11	6	5	142	177	150	65
Lead, Dissolved	0	0	0	0	0	0	0	0	3	138	174	147	69
Zinc, Dissolved	0	0	0	0	0	0	0	0	1	129	167	140	61
Specific Conductance	0	0	0	0	0	0	6	6	17	56	27	59	31
Total Suspended Solids	0	0	0	0	0	0	10	8	12	341	361	274	106

Needed Data

Temperature, TSS, metals, and specific conductance data for:

- WRP discharges
- Mass emissions data at Wardlow pre-2006
- MS4 pre-2015
- What else?

Water Quality Data



Approach to Water Quality Modeling

- Model with SWMM
- Designate land use to sampling location
- Simulate pollutants using Event Mean Concentrations (EMC)
- Calibrate model with observed data
- Apply flow scenarios

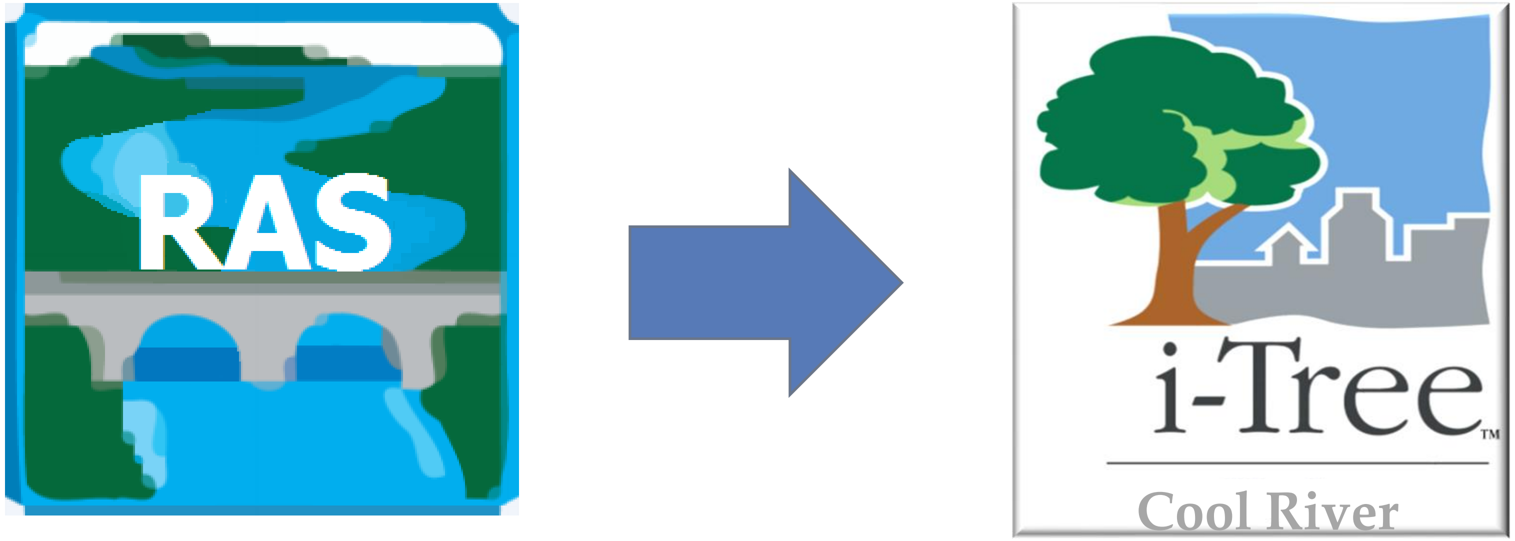
We are particularly interested in the dilution of TSS, metals, and specific conductance moving away from WRPs during dry weather periods.

Temperature Modeling

- **Simulation methodology**

The steady state HEC-RAS model is coupled with USDA FS i-Tree Cool River model for temperature modeling

  - i-Tree Cool River was updated to capture thermal impact of river basin restoration on river flows estimated by the HEC-RAS.



(Abdi et al., 2020a&b, a: J. Environmental Management & b: MethodsX)

- **Study reaches on LA River and tributaries**
  - Three main reaches
  - Two tributary reaches
- **Simulation Process in i-Tree Cool River**
  - Inputs:
    - Boundary Condition data

A nonlinear regression relationship (Mohseni et al. 1998) between air temperature and water temperature has been created for creating the boundary condition input data.

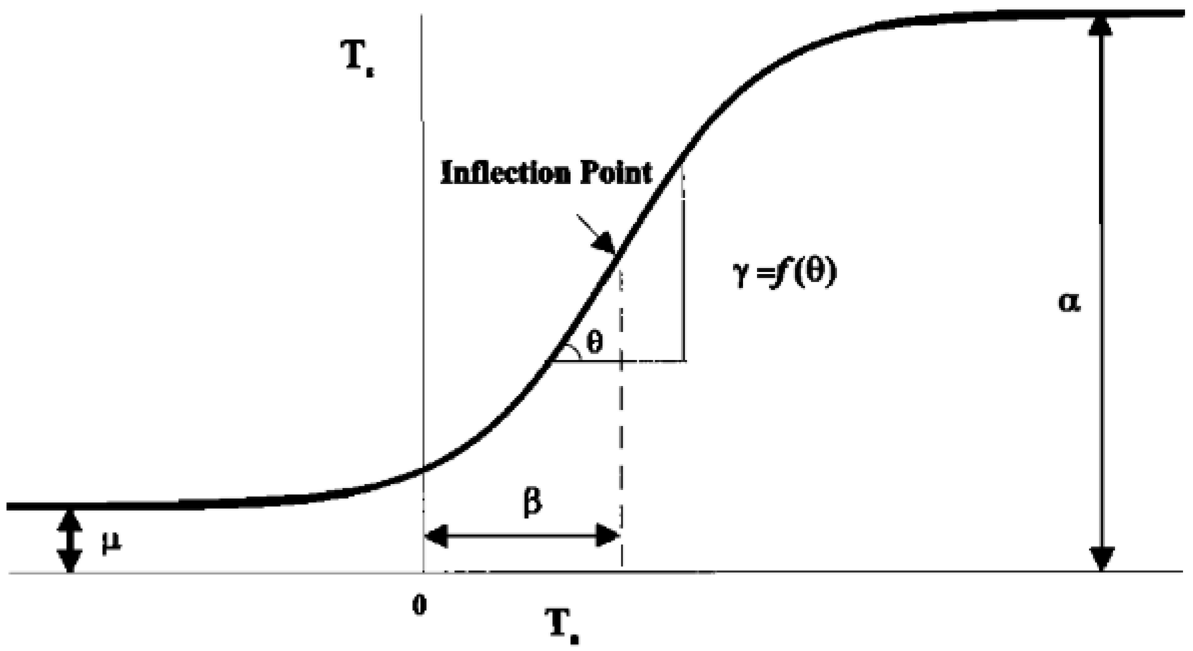
- **Simulation Process in i-Tree Cool River**
  - Inputs:
    - Boundary Condition data

      Nonlinear regression relationship (Mohseni et al. 1998) using a C code

$$T_s = \mu + \frac{\alpha - \mu}{1 + e^{\gamma(\beta - Ta)}}$$

$$\gamma = \frac{4 tan\theta}{\alpha - \mu}$$

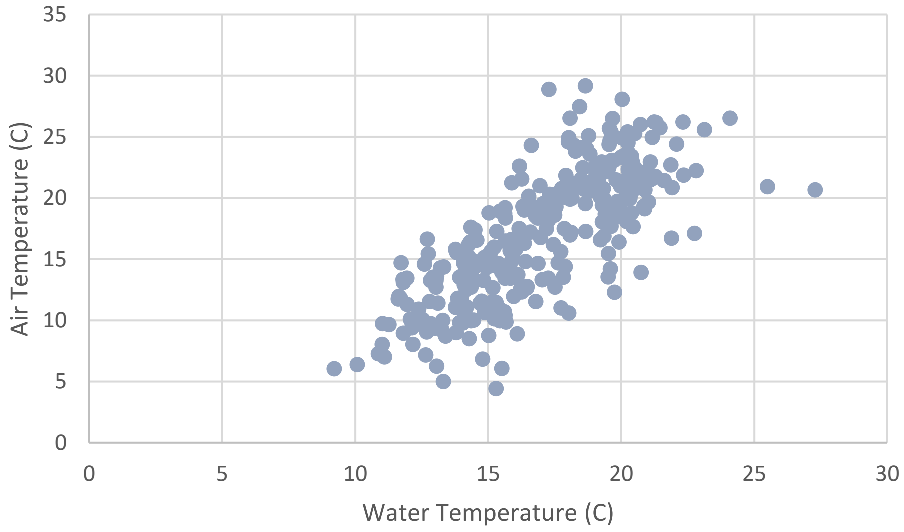
T_S: Stream temperature (C)
T_a: Air temperature (C)

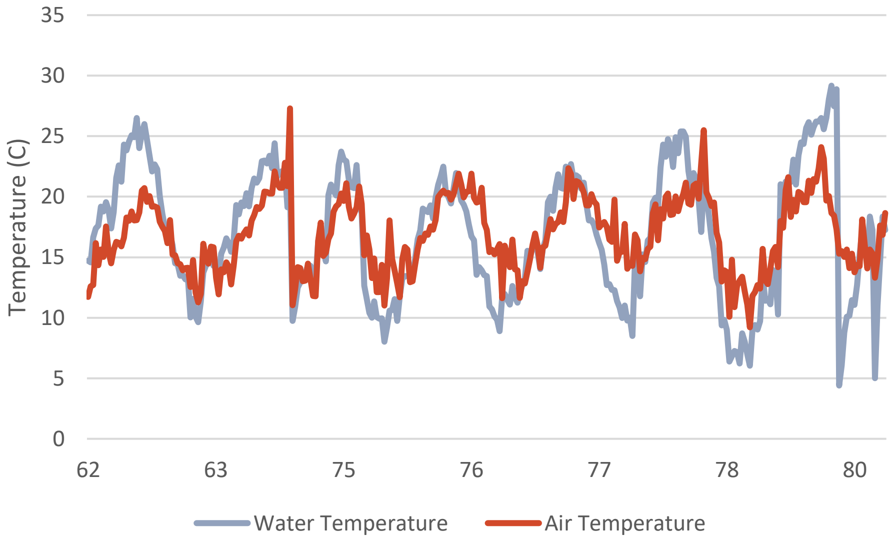


- **Simulation Process in i-Tree Cool River**
  - Inputs:
    - Boundary Condition data

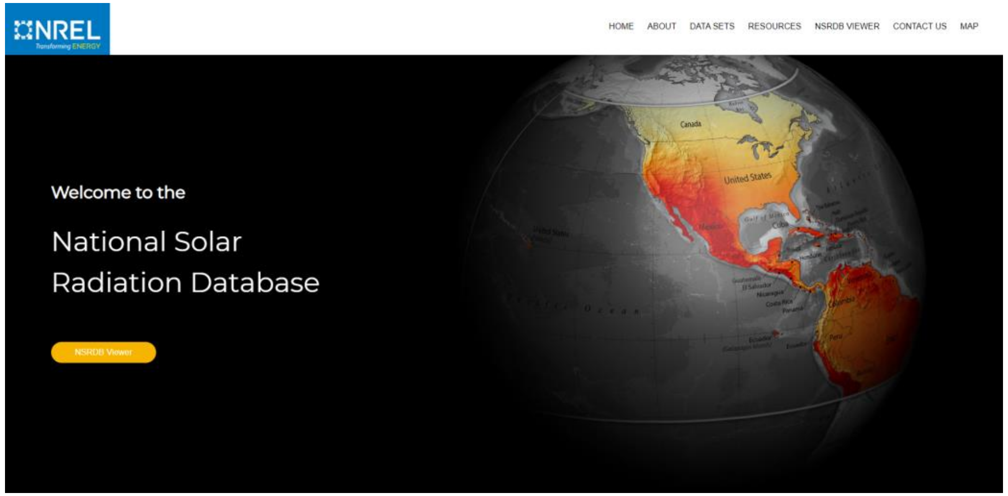
Reference point – USGS Gage
(USGS ID# 10261500)

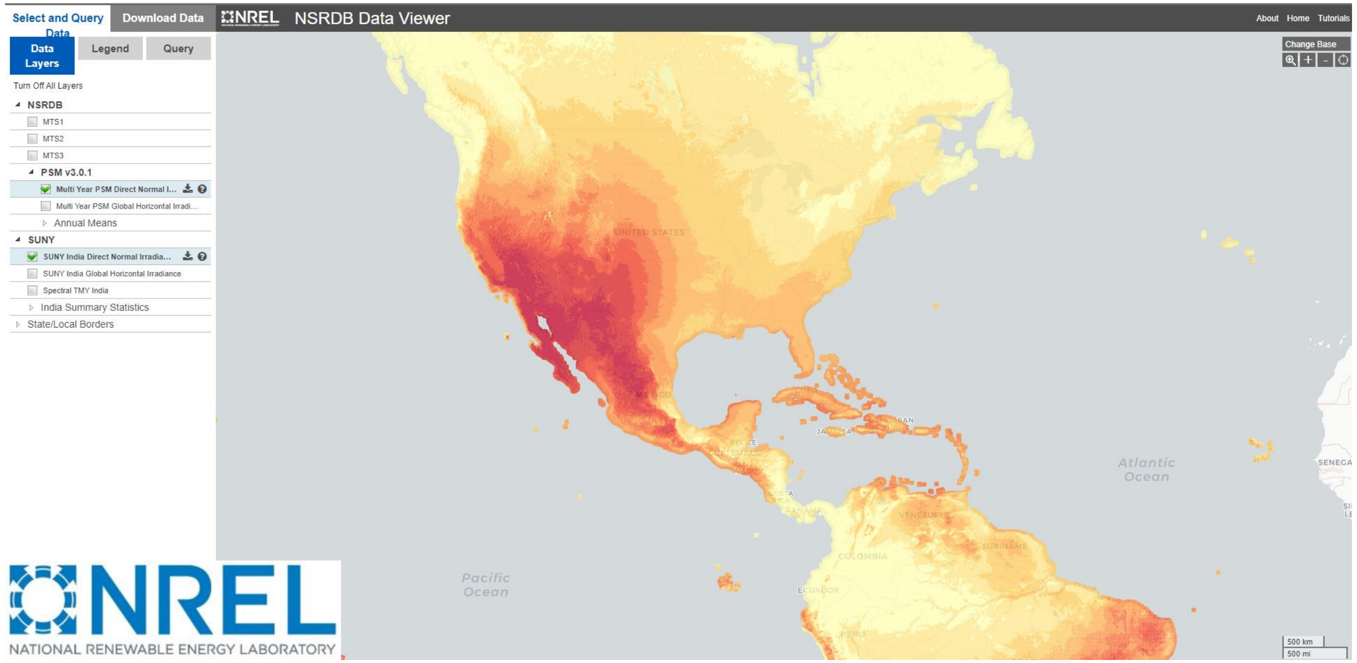
Stream gaging Station no.	Weather Station no.	Distance between Stream gage and weather station	Elevation Difference between Stream gage and weather station	no. of data points	NSC	RMSE (C)	Ta ave	Ts ave	Ts max	α	β	γ	μ
10261500	**23174**	**122.2**	**-99**	**313**	**0.65**	**3.19**	**16.9**	**16.95**	**29.16**	**32.48**	**15.19**	**0.16**	**0**

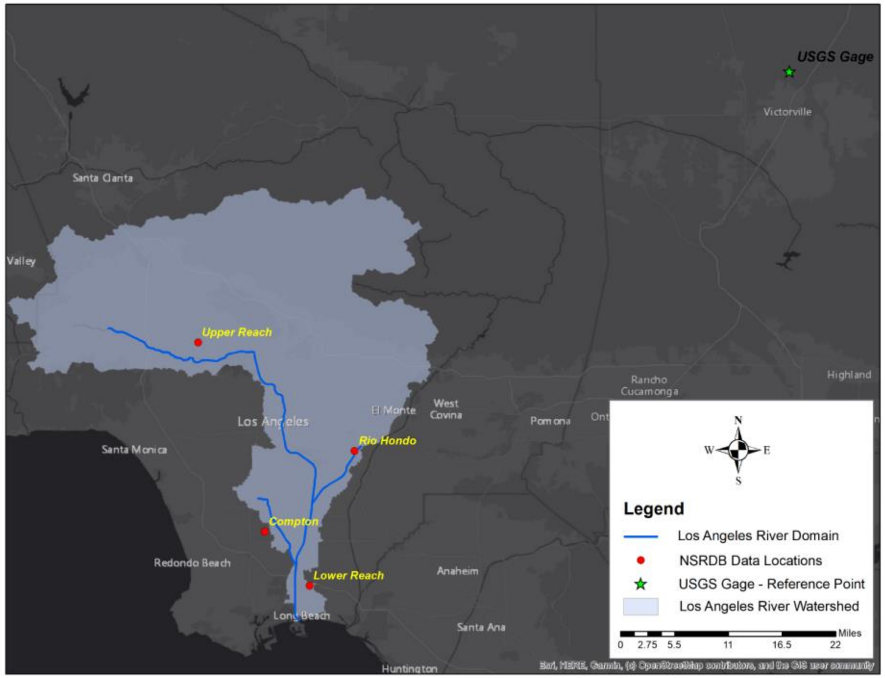




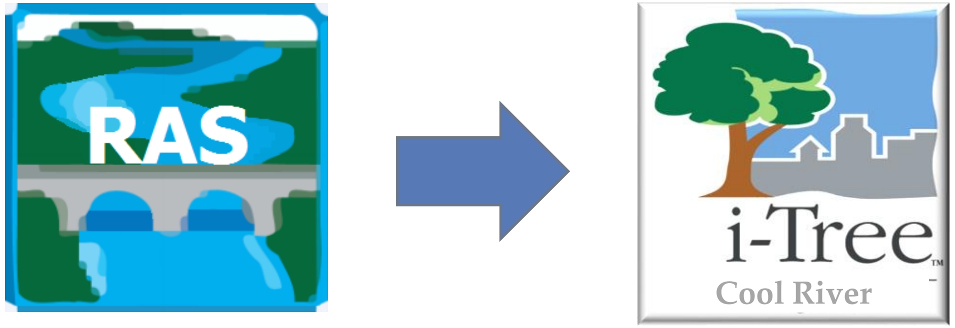
- **Simulation Process in i-Tree Cool River**
  - Inputs:
    - Weather data
    - Solar radiation data
      - Air temperature
      - Relative humidity
      - Wind speed
      - Direct and Diffuse shortwave radiations
      - Etc.







- **Simulation Process in i-Tree Cool River**
  - Inputs:
    - Morphology data
      - Discharge, Q (m^3/s);
      - Minimum channel elevation (m)
      - Water surface elevation (m)
      - Velocity in channel, V (m/s);
      - Top width, w (m),
      - Flow area (m^2); and
      - Wetted perimeter (m)



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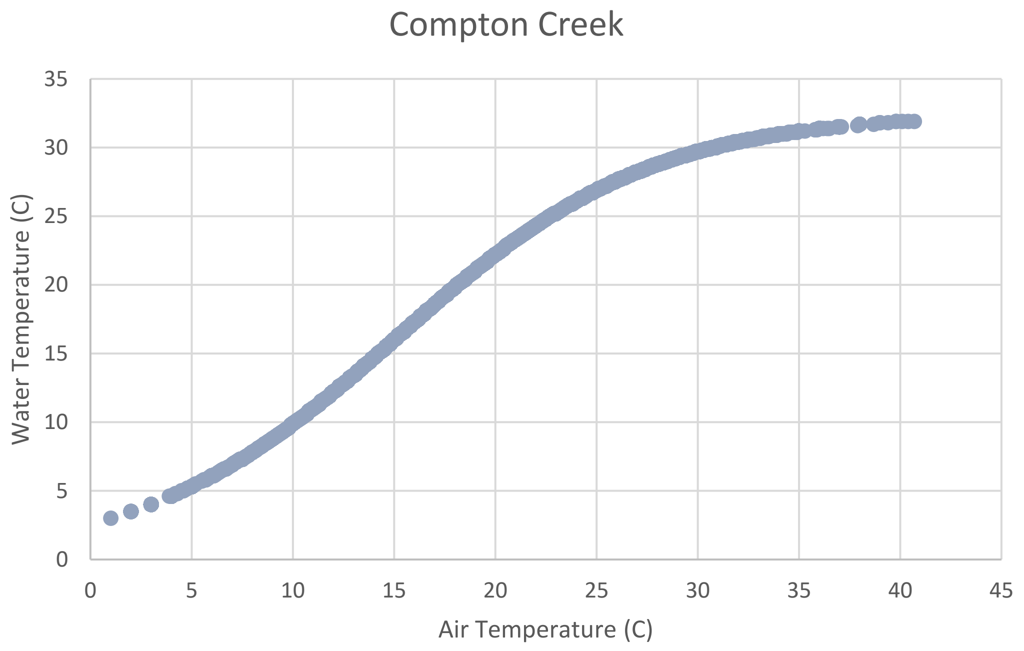
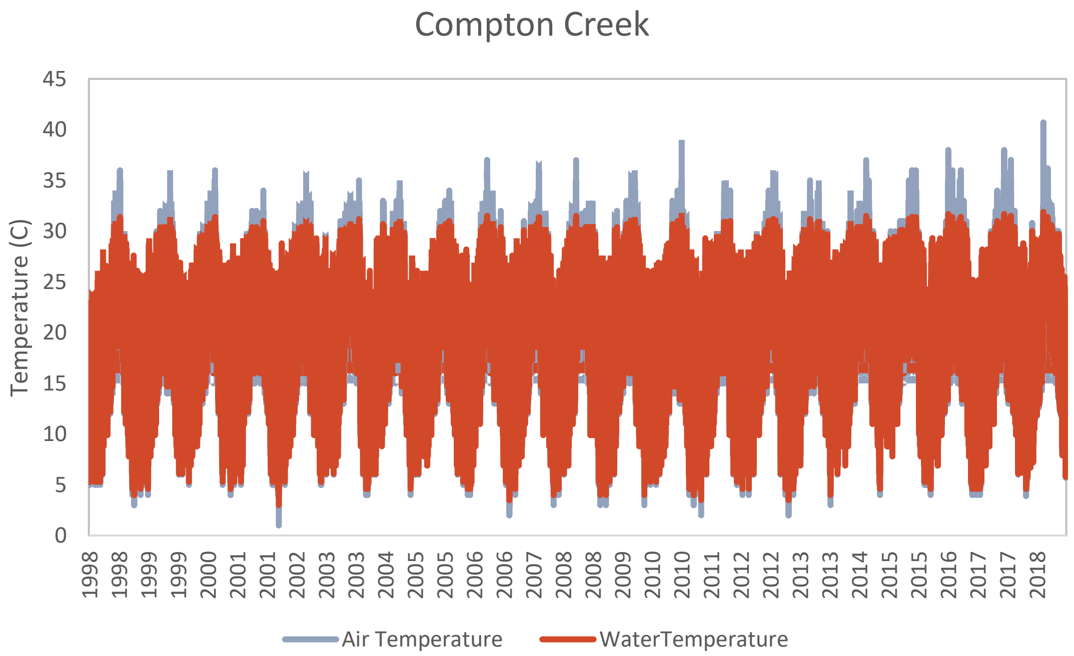
- **Temperature Simulation: Compton Creek**
  - Boundary Condition data calculation



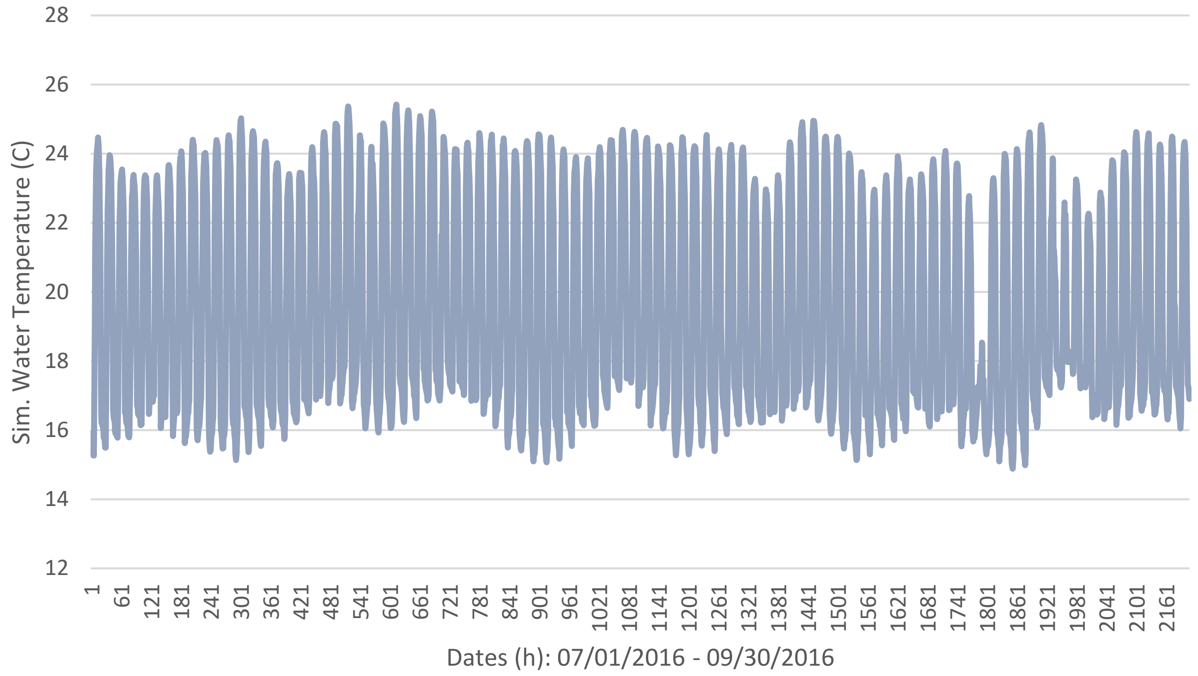


- **Temperature Simulation: Compton Creek**
  - HEC-RAS Results based on observed flow data
  - Simulation Period: 07/01/2016 – 09/30/2016 (Summer time)

Variable	Q total (cms)	Min Ch Elev (m)	W.S. Elev (m)	Vel Chnl (m/s)	Top Width (m)	Flow Area (m2)	W.P. Total (m)	Depth (m)
Average value (L = ~13.5 km)	0.02 = 0.72 cfs	6.37	6.40	0.30	3.60	0.074 = 0.79 ft2	3.62	0.024 = 0.94 in

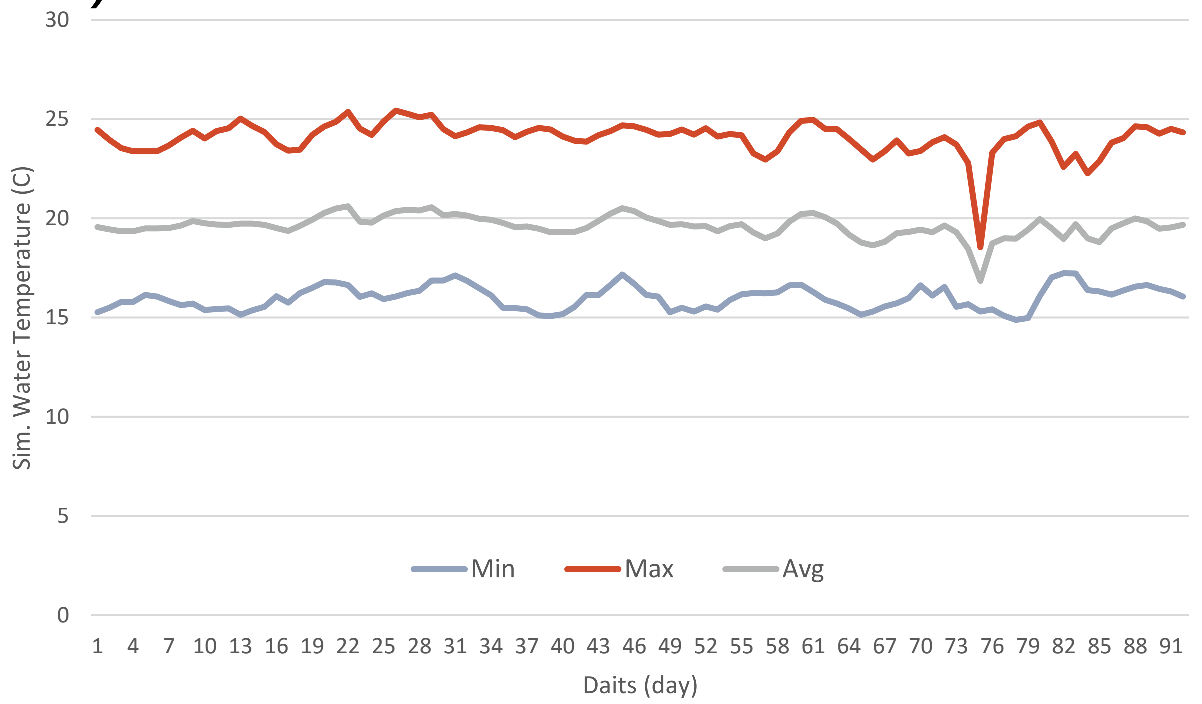
- i-Tree Cool River model results
  - Time step: 1 Hour
  - Intervals: 100 m

Min Sim. Temperature: 14.6 C
Max Sim. Temperature: 24.4 C
Avg. Sim. Temperature: 19.1 C



- **Temperature Simulation: Compton Creek (preliminary results)**
  - Simulation Period: 07/01/2016 – 09/30/2016 (Summer time)
  - i-Tree Cool River model results
    - Time step: 1 Hour (2208 ts)
    - Intervals: 100 m (13583 m)

Needs Calibration/validation

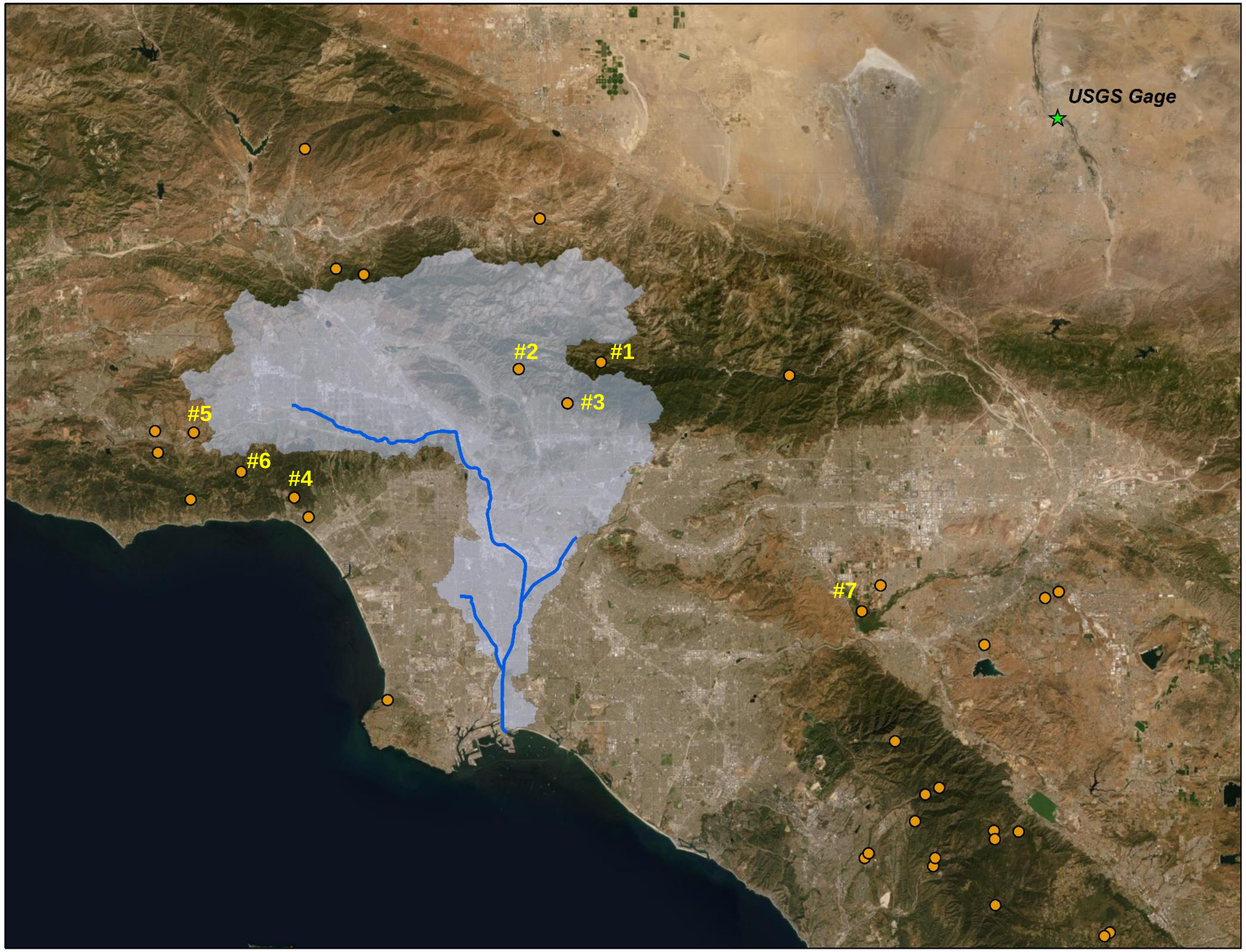


- **Temperature Simulation:**
  - Calibration
  - Validation

Obs. Temp. data (USGS, SWAMP, SMC)

- Basically outside of the LAR watershed
- Mostly located in mountainous areas

Sta. Number	Data Count (daily)	Average temp. (C)
1	380	12.8
2	185	15.6
3	172	18.3
4	73	20.2
5	111	19.7
6	62	17.8
7	94	22.5

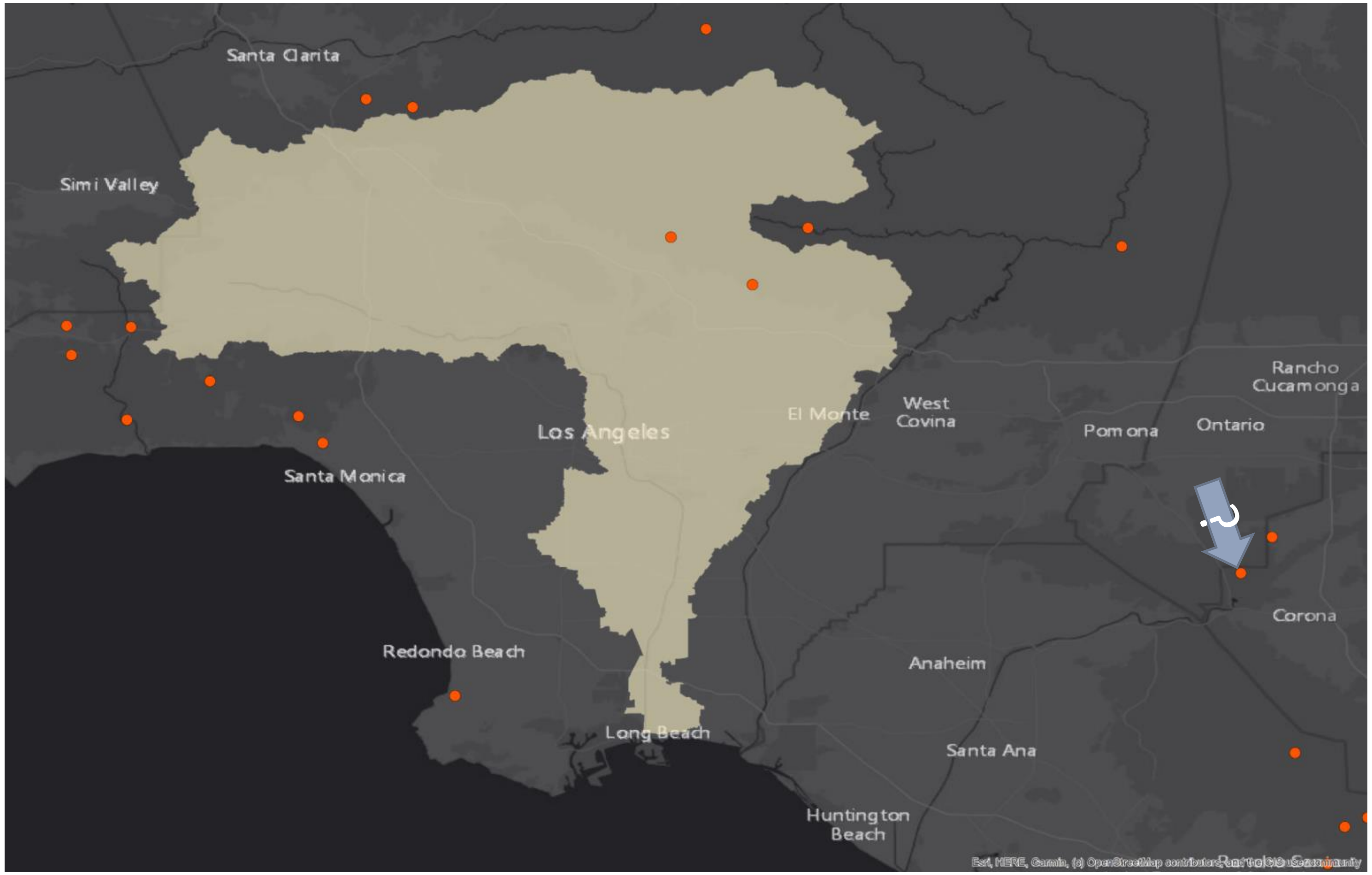


- **Temperature Simulation:**
  - Calibration
  - Validation

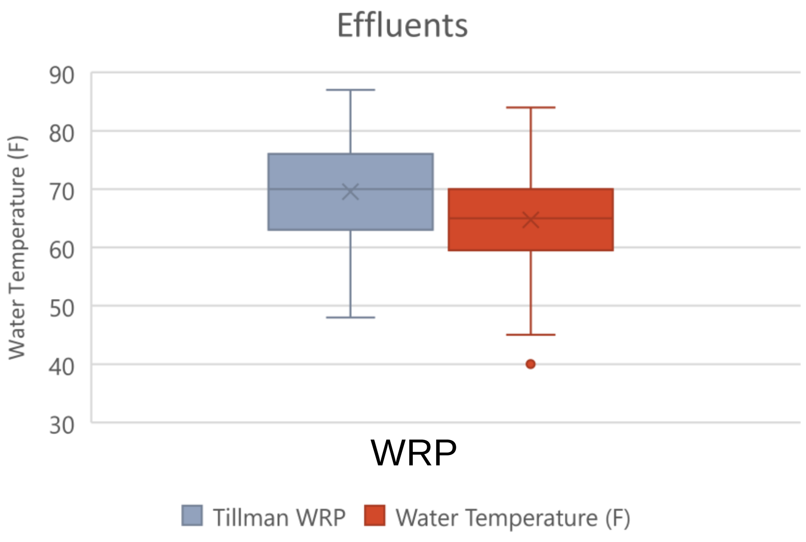
<u>One option</u>
Obs. Temp. data (USGS, SWAMP, SMC)

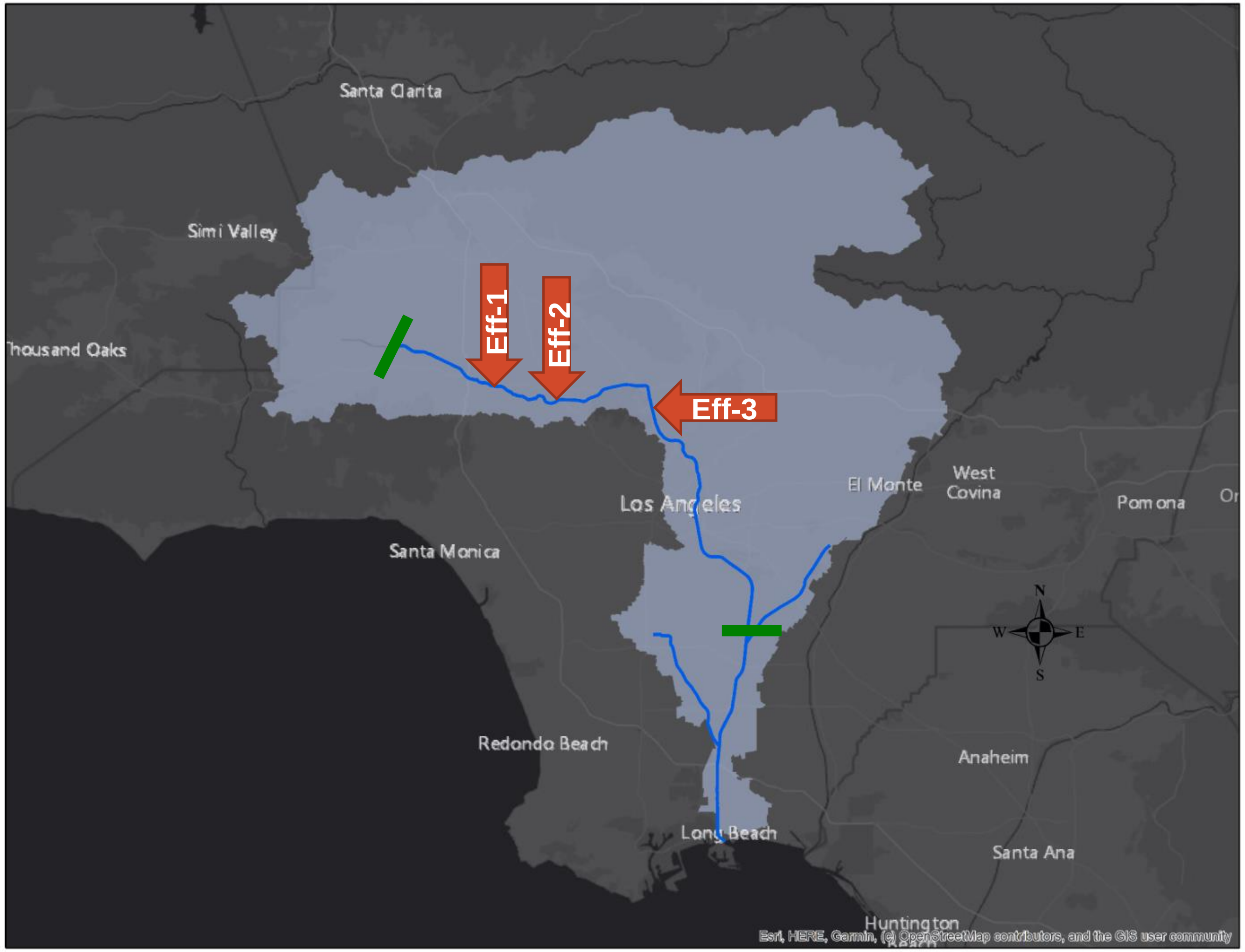
<u>Other option</u>
Recording data in some places across the domain using ibuttons

<u>How about the TAC group? Any data??</u>



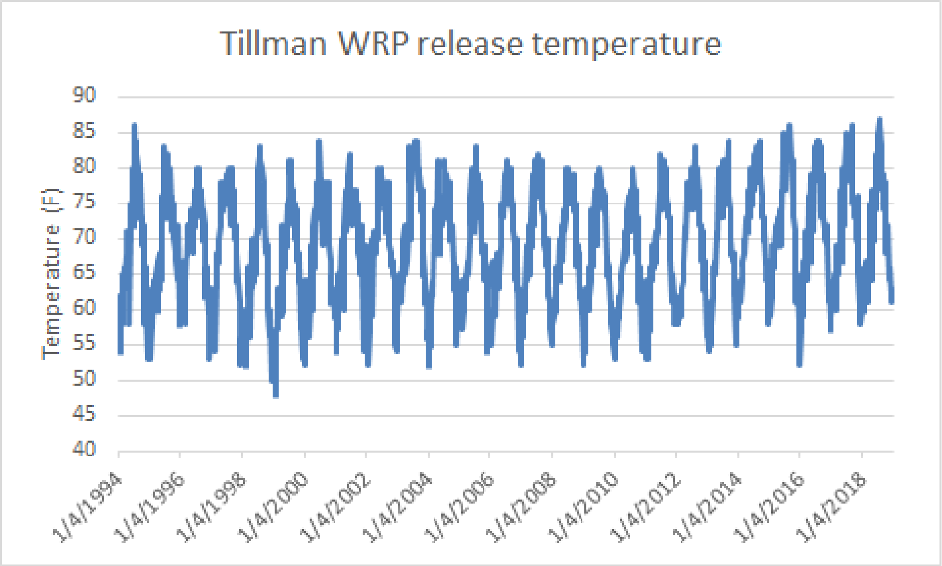
- **Temperature Simulation on MR-1**
  - Eff-1: Tillman WRP
  - Eff-2: Burbank WRP
  - Eff-3: Glendale WRP





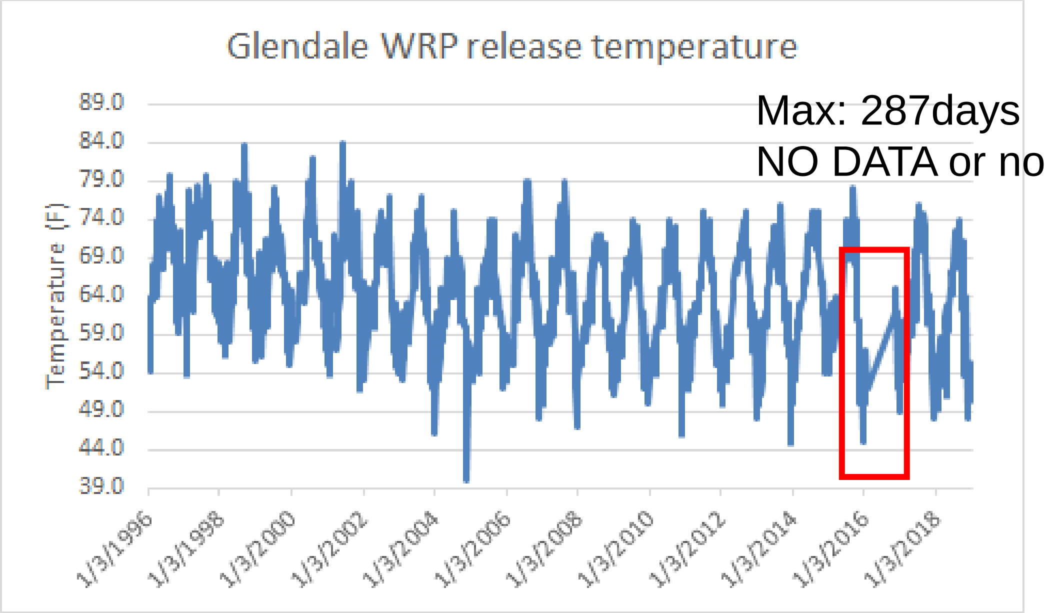
Tillman & Glendale WRPs:

- Time step for the Tillman: 6 days fixed
- Time step for the Glendale:
  - Min: 1 day; Max: 287days (01/26/2016 - 11/08/2016)
  - Mode: 7 days; Average: 7.7 days



No data for Burbank

Could be considered similar to other two WRPs



Max: 287days
NO DATA or no effluent?

Key Modeling Questions for TAC

- HEC-RAS and SWMM Scenarios:
  - Do we have any cross-sectional data for the soft bottom area within Sepulveda basin?
  - Is there someone we can talk to who is very familiar with the stormwater capture master plan as we develop our scenarios?
- Temperature, TSS, metals, and specific conductance data for:
  - WRP discharges
  - Mass emissions data for S10 at Wardlow pre-2006
  - MS4 pre-2015
  - What else?
- Stream Temperature Data Needs/Options:
  - Need observed temperature data for calibration/validation in urban areas
  - Collect observed data in summertime using ibuttons?
  - Use air temperature to adjust the temperature for the water?

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Approach and Example Scenario Curves

FLOW MANAGEMENT SCENARIO ANALYSIS

Consideration of Management Scenarios

- Varying amounts of **reduced discharge** from three water reclamation plants

- **Stormwater capture** along Rio Hondo and Compton Creeks
  - Other areas of stormwater capture associated with LA County Master Plan

- **Restoration** along Compton, Rio Hondo, Arroyo Seco
  - Implications for water consumption
  - Constraints on restoration goals

Sensitivity Curves Approach

- Develop curves based on sensitivity of response of specific reaches
  - Based on different flow (or hydraulic metrics)
  - Based on different seasonal flow conditions

- Evaluates effects of changes in key hydrologic, hydraulic, or temperature properties vs. specific management scenarios

- Can be used to accommodate many different scenarios or combinations of scenarios
  - Flexible and adaptable

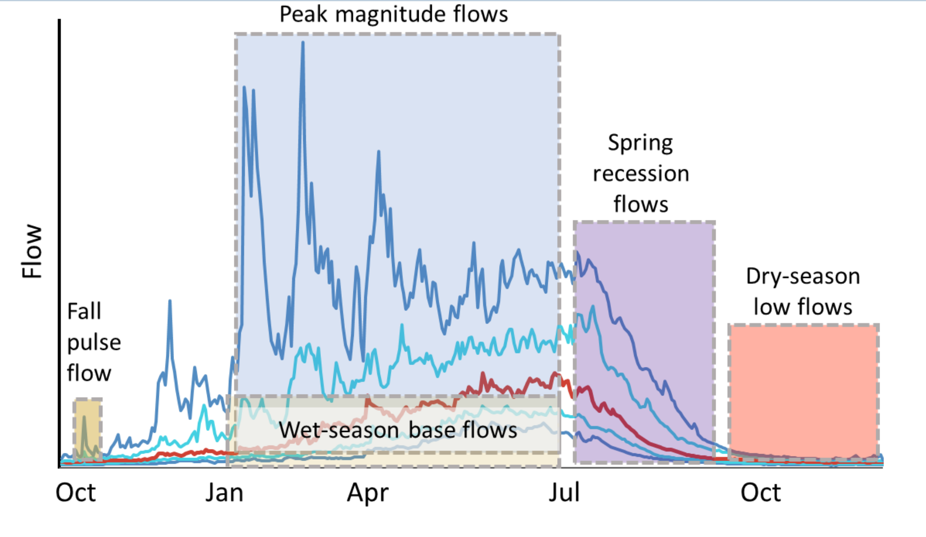
Development of Sensitivity Curves

- Run models under a wide range of discharge and retention conditions
- Predict changes in flow, velocity, depth, and temperature associated with different amounts of discharge and "capture"
- Plot response of key variables to ranges of discharge and capture

Development of Sensitivity Curves - Example

- Discharge is assessed at LA County flow gage 57C (LAR above Arroyo Seco)
- Reuse is defined as percent reduction from historic discharge (WY 2011 to WY 2017) from each of the three WRPs
- Results are based on a Monte Carlo simulation of 500 reuse scenarios
- ***Average discharge to LAR*** is an estimated average discharge over the 8 year period. It was determined by multiplying the reuse by the median discharge for each WRP. For example:
  - 75% Tillman, 25% Burbank, 50% Glendale = 0.75*45 cfs + 0.5*19 cfs + 0.25* 9 cfs = 45 cfs
  - Historic discharge is around 73 cfs

Functional Flow Metrics



Metrics not related to any specific organism.

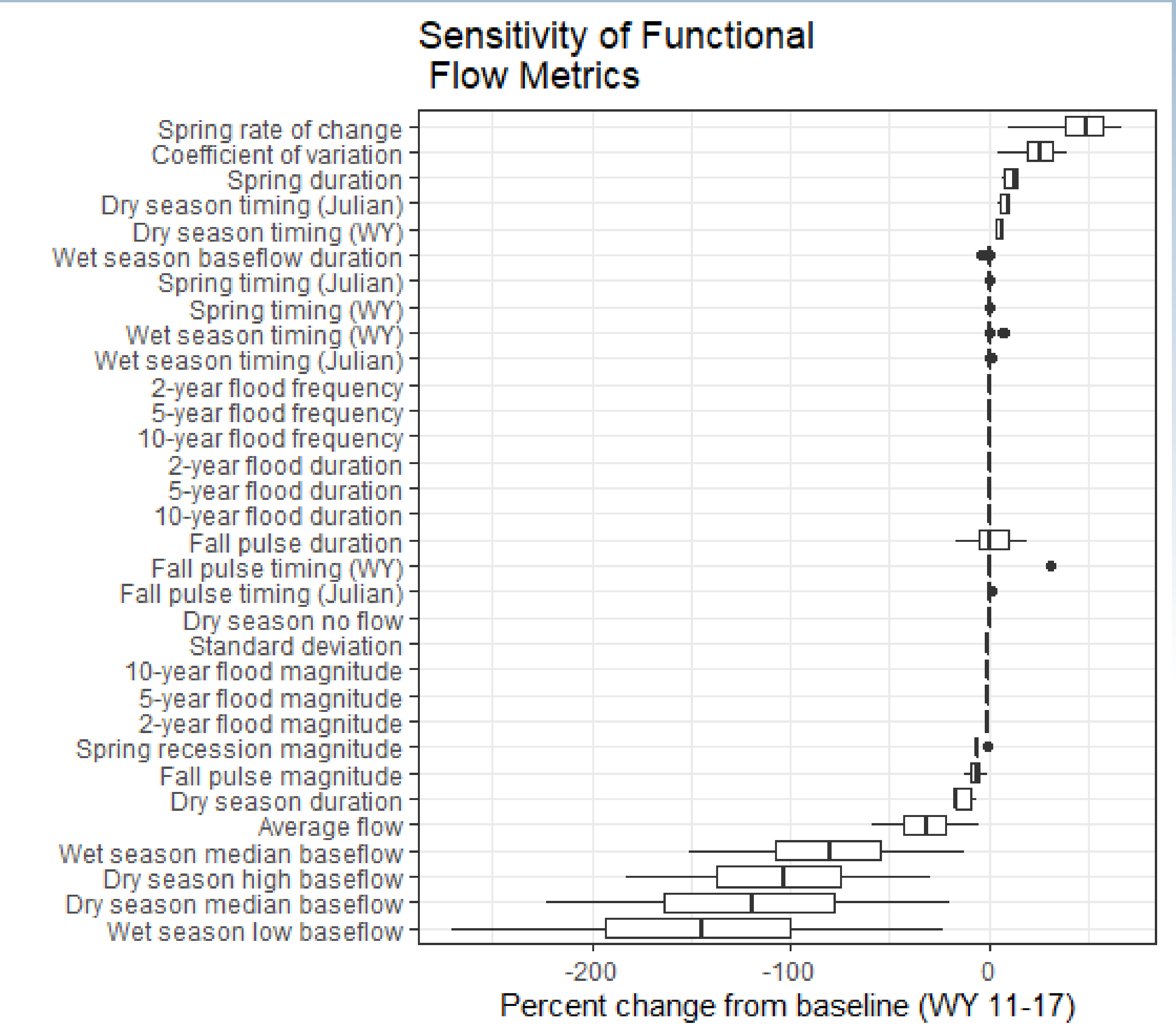
Metrics relate to general health based on *reference conditions*

Yarnell et al., 2019

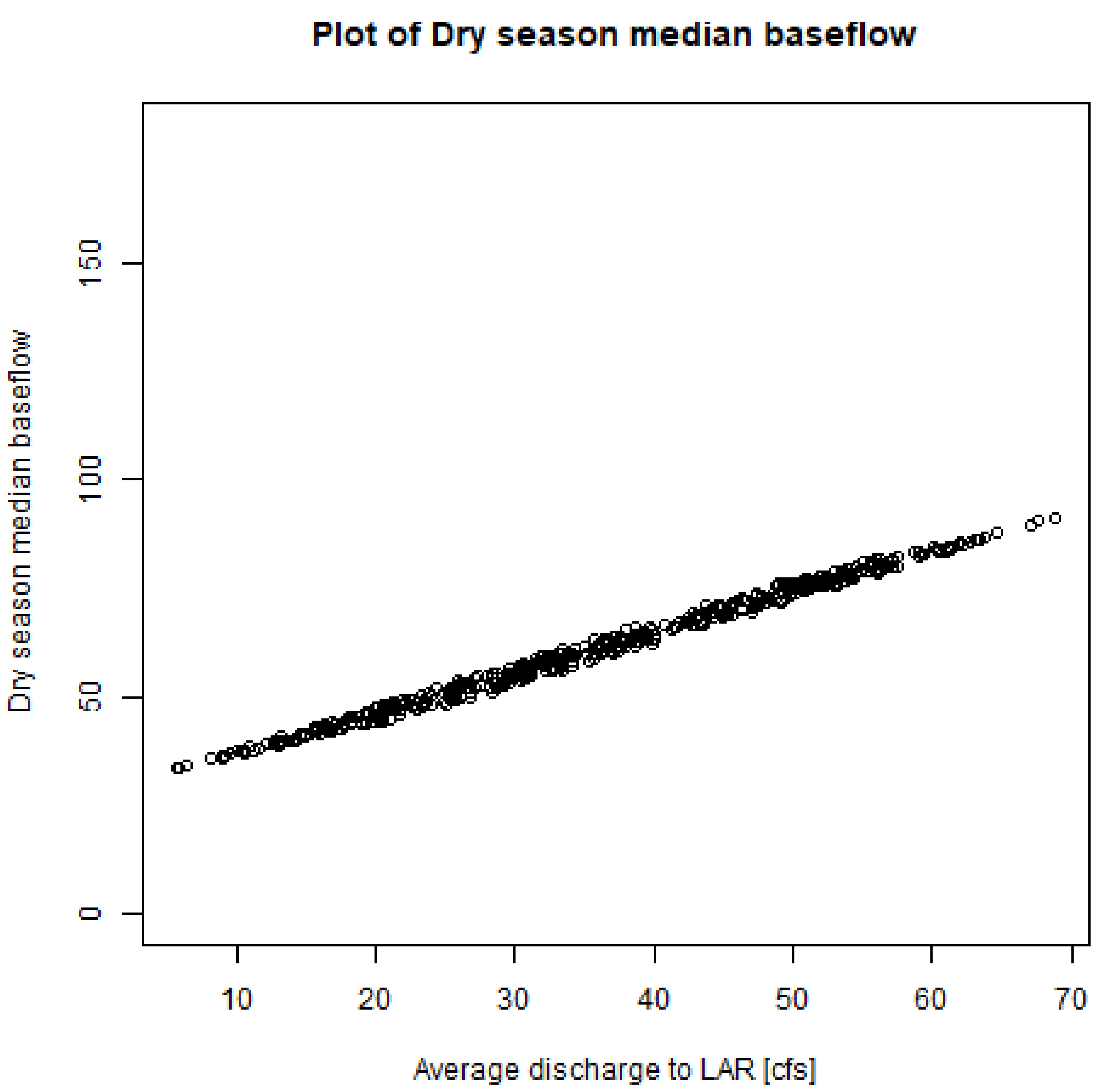
Flow Component	Flow Characteristic	Flow Metric
Fall pulse flow	Magnitude (cfs)	Peak magnitude of fall season pulse event (maximum daily peak flow during event)
	Timing (date)	Start date of fall pulse event
	Duration (days)	Duration of fall pulse event (# of days start-end)
Wet-season base flows	Magnitude (cfs)	Magnitude of wet season baseflows (10th and 50th percentile of daily flows within that season, including peak flow events)
	Timing (date)	Start date of wet season
	Duration (days)	Wet season baseflow duration (# of days from start of wet season to start of spring season)
Peak flow	Magnitude (cfs)	Peak-flow magnitude (50%, 20%, 10% exceedance values of annual peak flow --> 2, 5, and 10 year recurrence intervals)
	Duration (days)	Duration of peak flows over wet season (cumulative number of days in which a given peak-flow recurrence interval is exceeded in a year).
	Frequency	Frequency of peak flow events over wet season (number of times in which a given peak-flow recurrence interval is exceeded in a year).
Spring recession flows	Magnitude (cfs)	Spring peak magnitude (daily flow on start date of spring-flow period)
	Timing (date)	Start date of spring (date)
	Duration (days)	Spring flow recession duration (# of days from start of spring to start of summer base flow period)
	Rate of change (%)	Spring flow recession rate (Percent decrease per day over spring recession period)
Dry-season base flows	Magnitude (cfs)	Base flow magnitude (50th and 90th percentile of daily flow within summer season, calculated on an annual basis)
	Timing (date)	Summer timing (start date of summer)
	Duration (days)	Summer flow duration (# of days from start of summer to start of wet season)

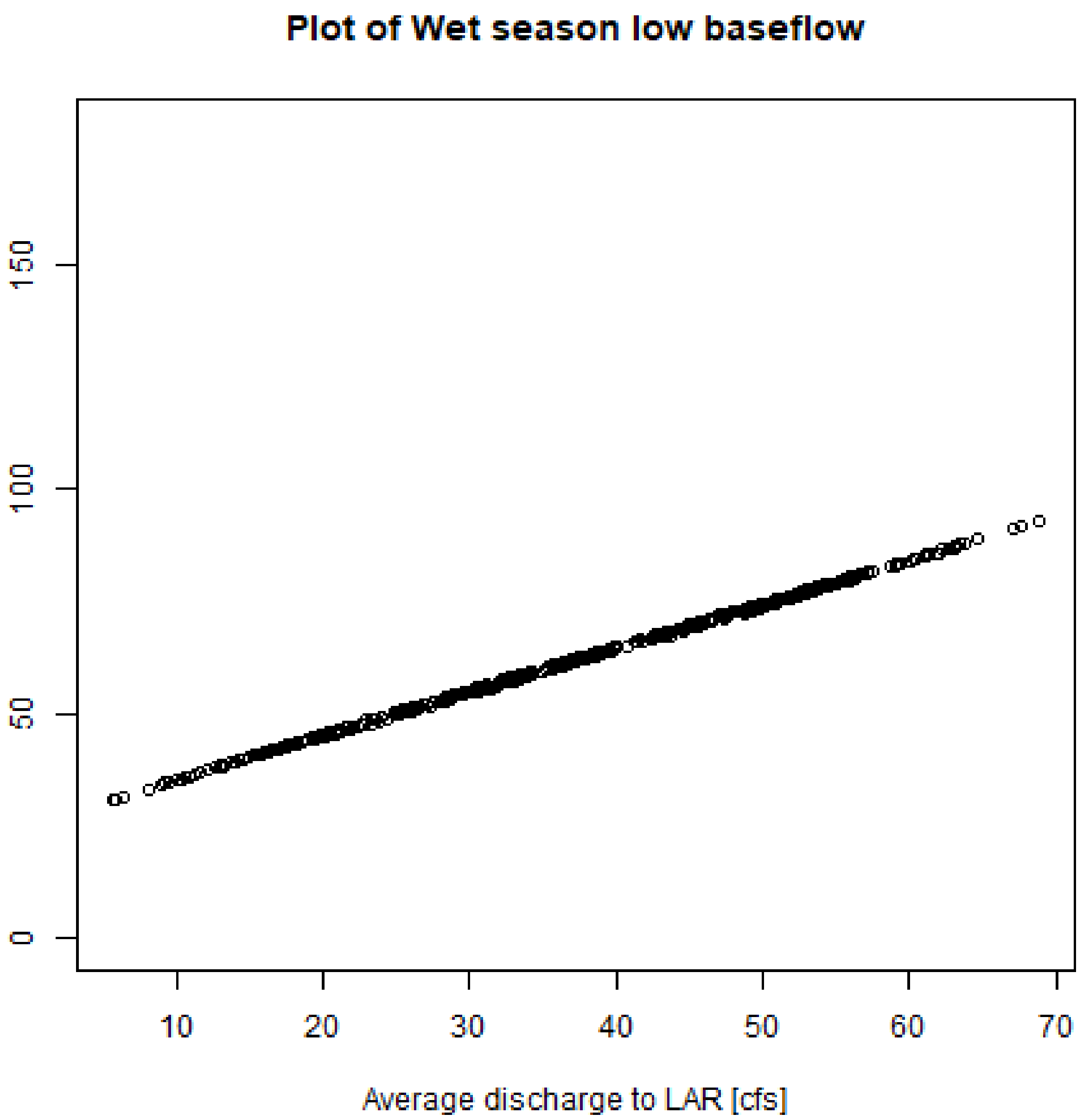
- **Baseflow, spring rate of change**, and **dry season days with no flow** are *most* sensitive to changes in reuse

- **Peak flows, spring timing**, and **wet season timing** are *least* sensitive

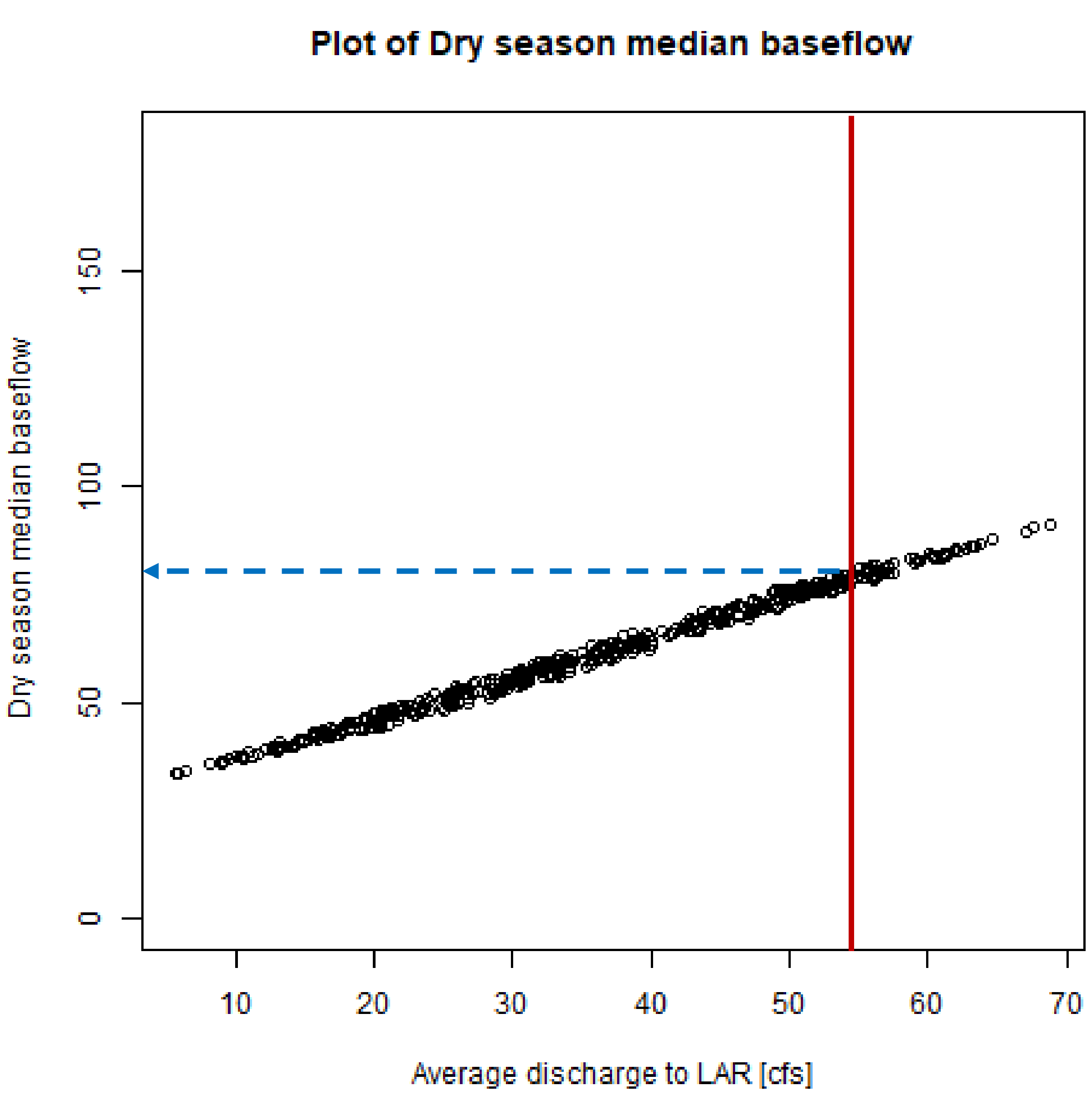


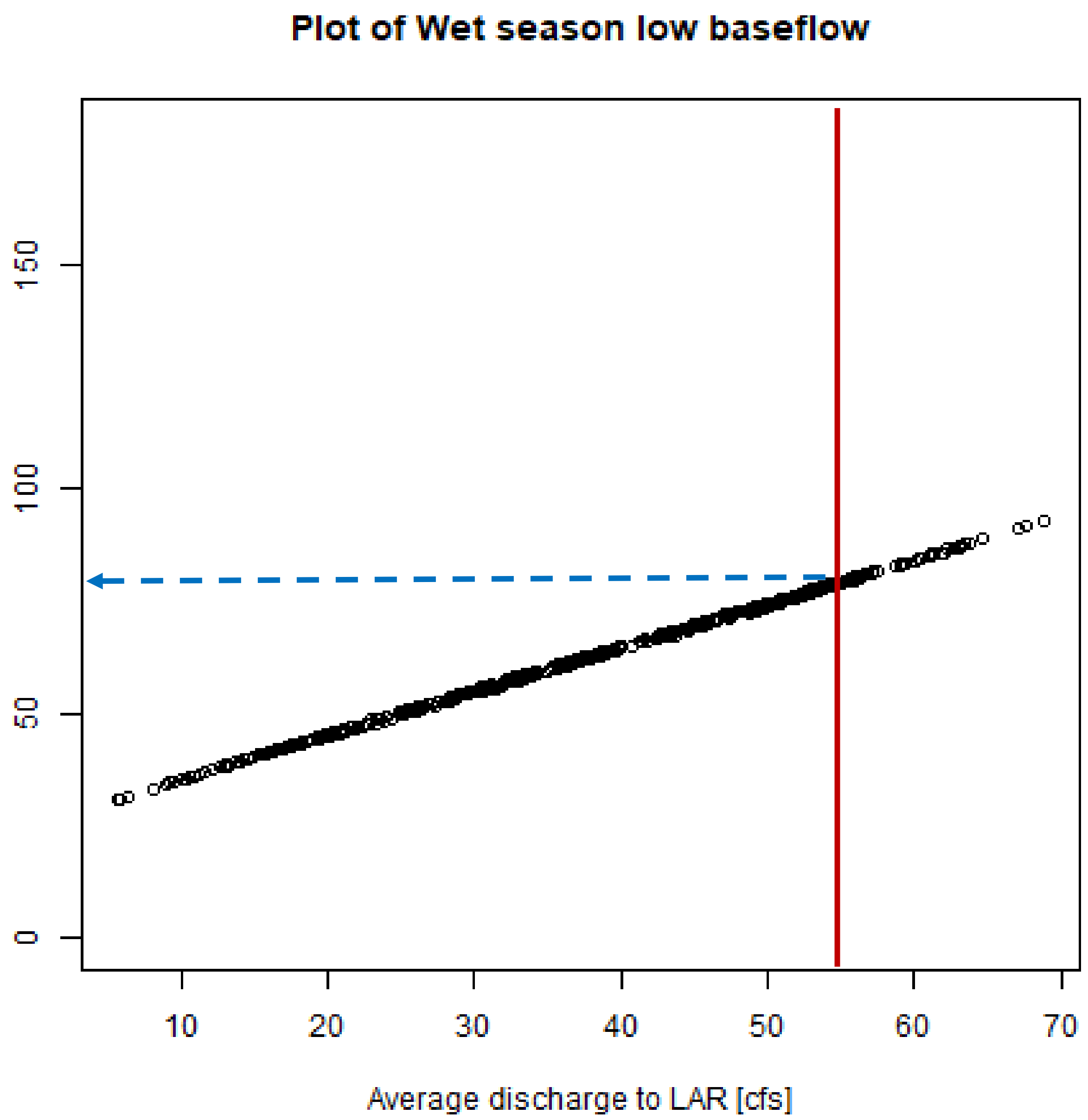
Sensitivity Curves – Most Sensitive Metrics



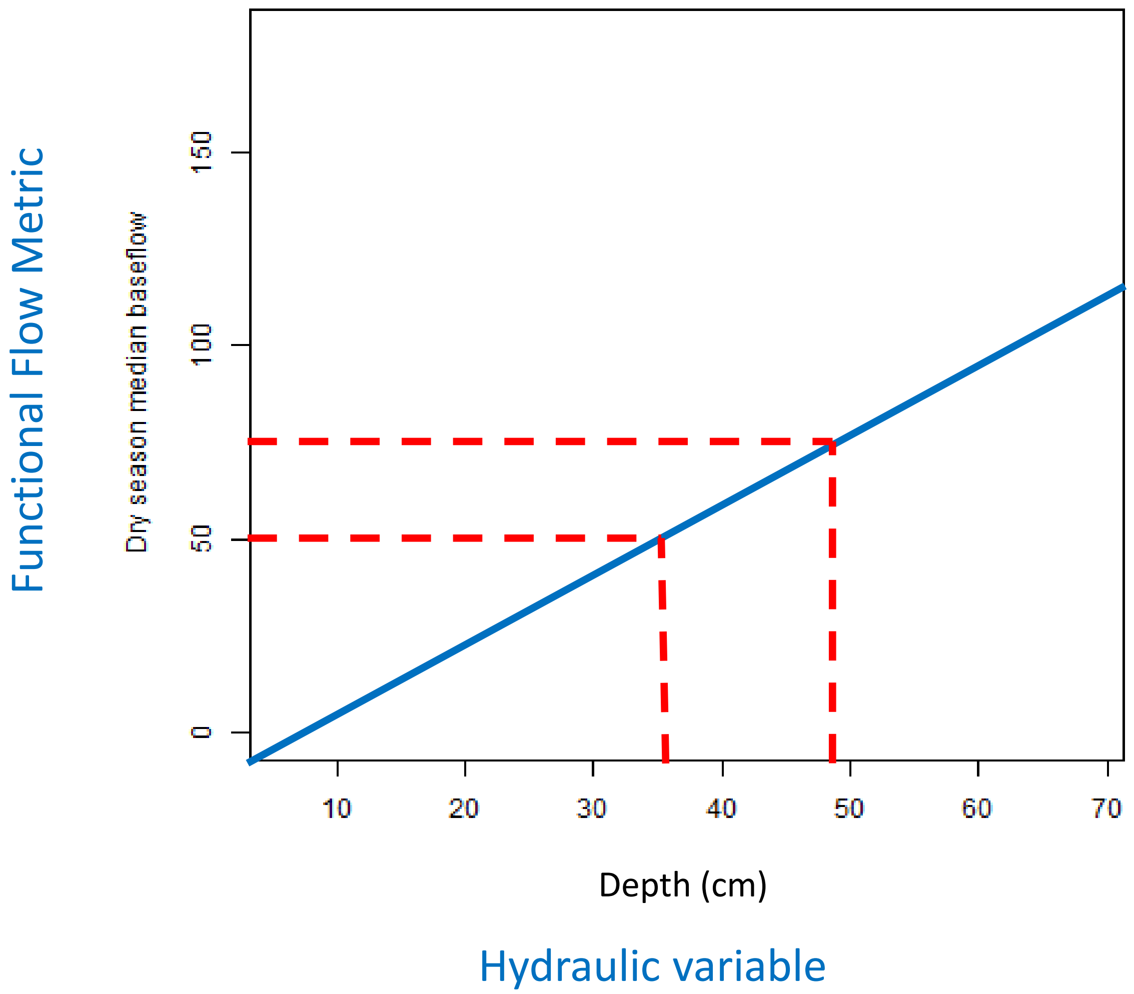


Example – 25% Reduction in Avg. WRP Discharge





Example: Relating hydraulic variables to flow metrics



Hydraulic variables, e.g. Depth, from HEC-RAS can all be related to functional flow metrics

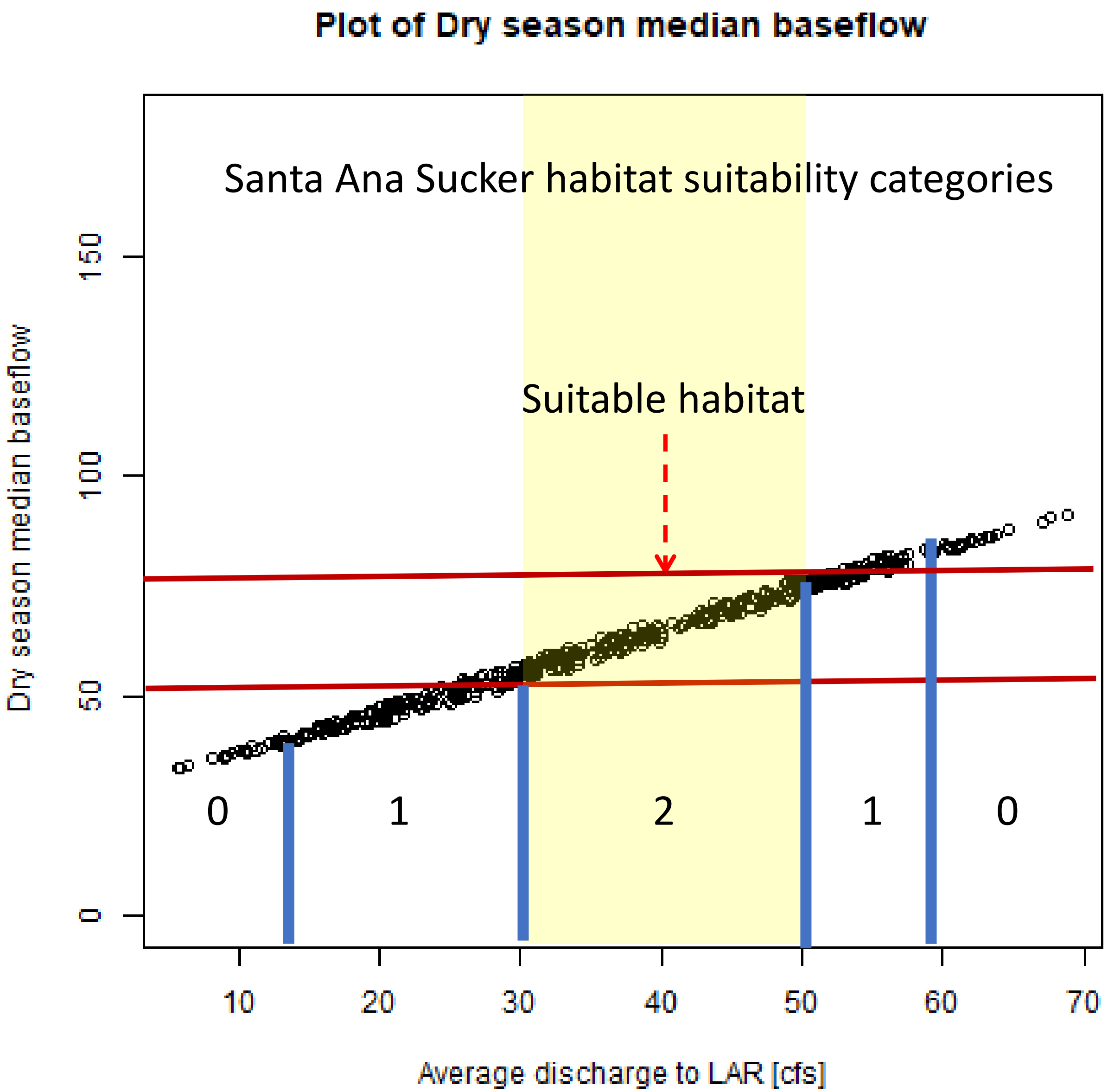
We can then relate the habitat requirements of the species to the functional flow metrics

We then use the functional flow metrics to find the appropriate discharge values from WRP

Hypothetical Example

Example – Ecological Effects

Hypothetical Example



Code	Suitability
0	Unsuitable
1	Intermediate
2	Suitable

Next Steps

- Implement **stormwater capture scenarios** based on SCMP
- Create curves for **other variables**, such as temperature, depth.
- Create similar curves **at key locations** on the mainstem, Rio Hondo, and Compton Creek
- Test **sensitivity of metrics to stormwater capture** scenarios – likely affect peak flow metrics

  → Use to inform how we measure species response

Stormwater Capture Master Plan

BMP sizes of 1.5, 1.2, and 1 times the 85th percentile storm depth were applied for categories A, B, and C, respectively.

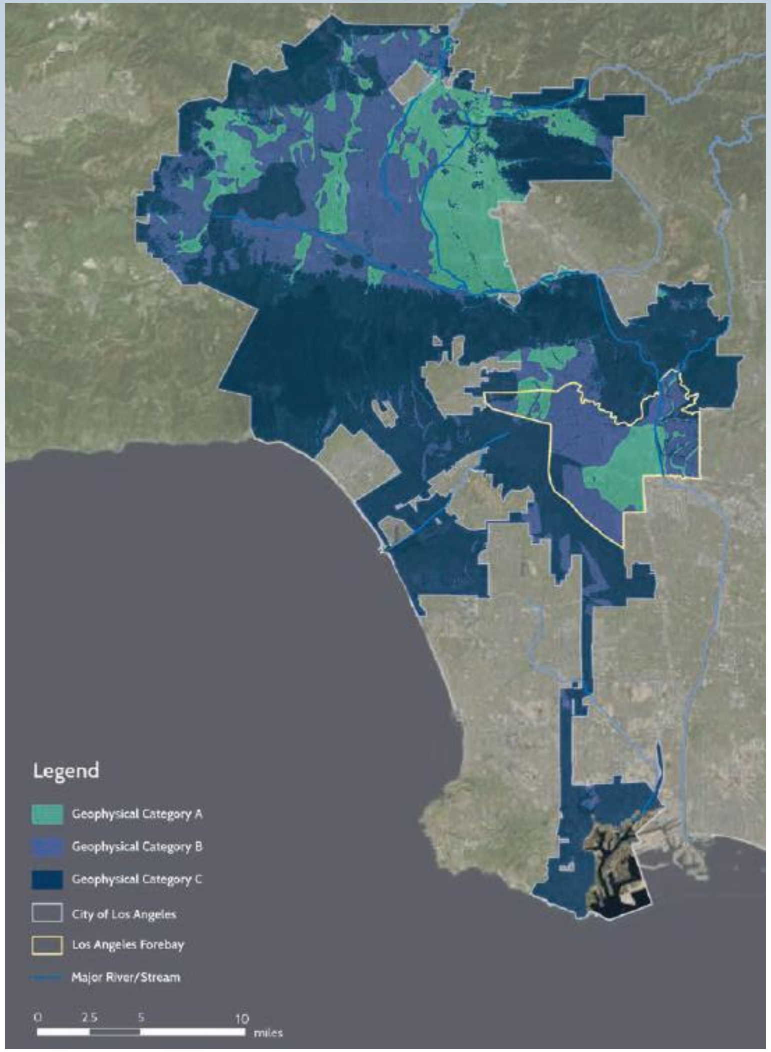


Table 5. BMP Implementation Rates for Geophysical Categorization in the Conservative Scenario

Land use	A	B	C
High Density Single Family Residential	35%	25%	15%
Low Density Single Family Residential with Moderate Slope	30%	20%	10%
Low Density Single Family Residential with Steep Slope	22%	12%	2%
Multi-family Residential	35%	25%	15%
Commercial	37%	27%	17%
Institutional	57%	47%	37%
Industrial	50%	40%	30%
Transportation	52%	42%	32%
Secondary Roads	47%	37%	27%

Table 6. BMP Implementation Rates for Geophysical Categorization in the Aggressive Scenario

Land use	A	B	C
High Density Single Family Residential	50%	40%	30%
Low Density Single Family Residential with Moderate Slope	40%	30%	20%
Low Density Single Family Residential with Steep Slope	25%	15%	5%
Multi-Family Residential	50%	40%	30%
Commercial	55%	45%	35%
Institutional	95%	85%	75%
Industrial	80%	70%	60%
Transportation	85%	75%	65%
Secondary Roads	75%	65%	55%

Questions for the TAC

- General feedback on the sensitivity curve approach?
- What is the baseline of comparison?
- What physical variables should we be developing curves around?
- How should we combine results from multiple sensitivity curves?
  - Averaging, geometric mean, limiting factor?

Action Items and Next Steps

- Validate Sucker (cold water) and Willow (riparian) habitat models
  - TAC input
- Set up Zoom meeting to discuss remaining habitat models
  - TAC input on conceptual models and thresholds
- Refine example flow management scenario outputs
  - TAC and Stakeholder input
- Fill data gaps:
  - Water quality data
- Next TAC meeting – **early July** – web-based or in-person?
  - Flow management scenarios and water quality modeling

Questions

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