Floodplains Reimagined Chinook Salmon Science Uncertainties and Data Needs

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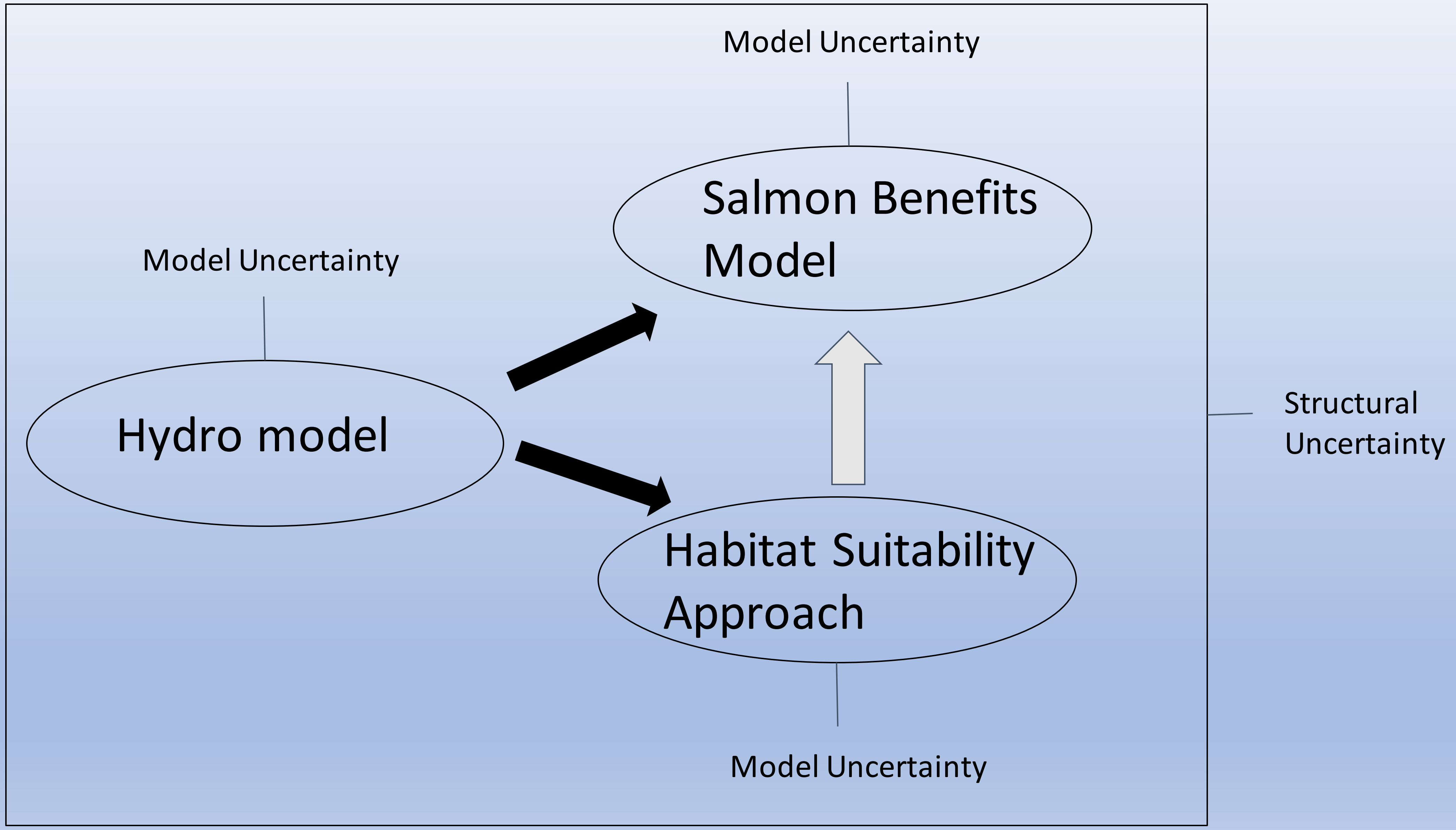
Why Address Scientific Uncertainty in Salmon Benefits Model and Habitat Suitability Criteria?

- The chance of better decision outcomes is increased when uncertainties are transparent, considered, and understood
- Avoid or minimize taking undesired risks or obtaining undesired resource conservation outcomes that are misaligned with stakeholders' interests

Purpose

Presentation today: General description of scientific uncertainty concerning juvenile salmon benefits within Central Valley flood bypass and how the science is applied

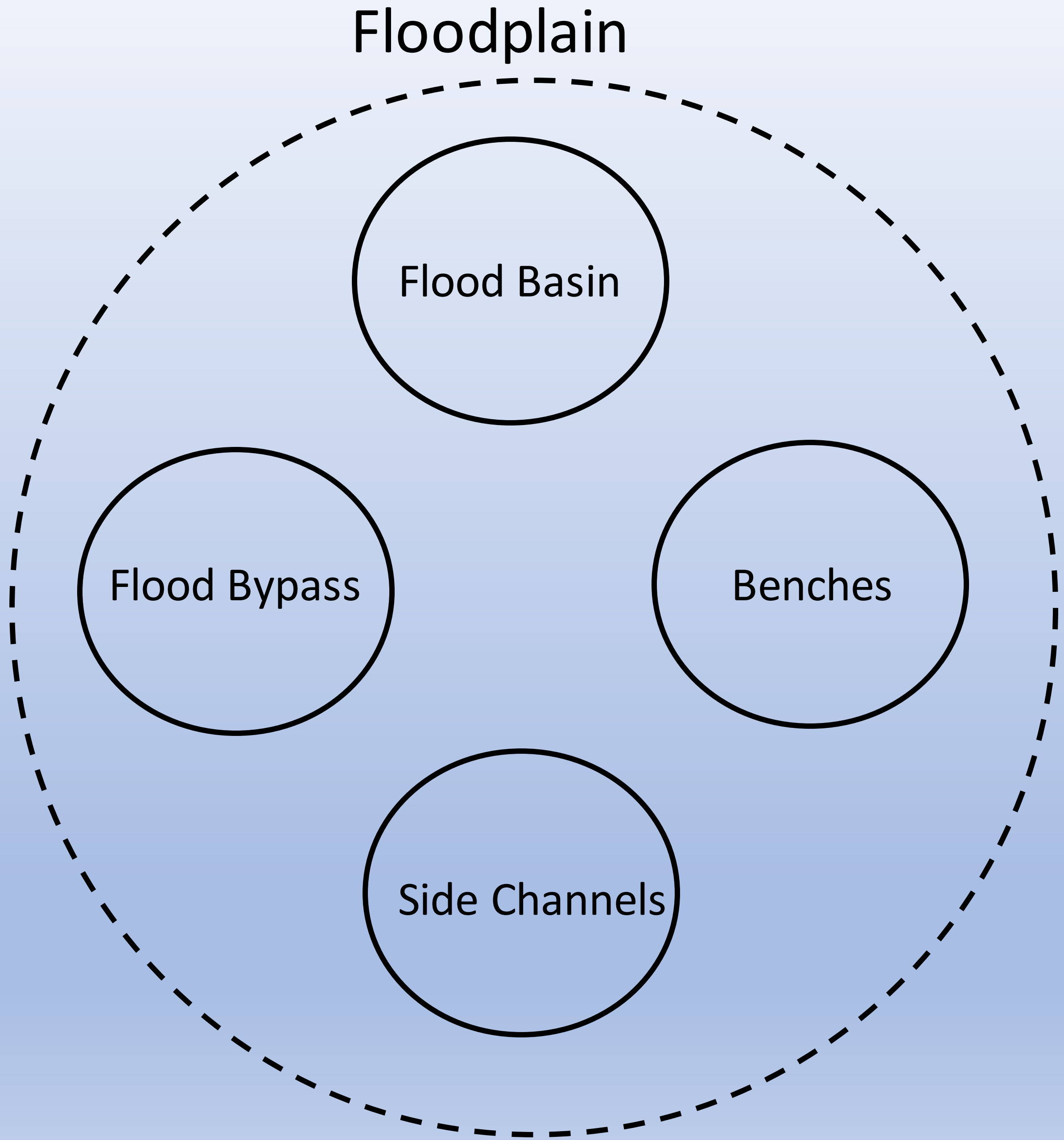
Tech memo: In depth discussion of juvenile salmon uncertainty drilling down on specific topics


Model Uncertainty
Salmon Benefits Model
Model Uncertainty
Hydro model
Structural Uncertainty
Habitat Suitability Approach
Model Uncertainty

Terminology

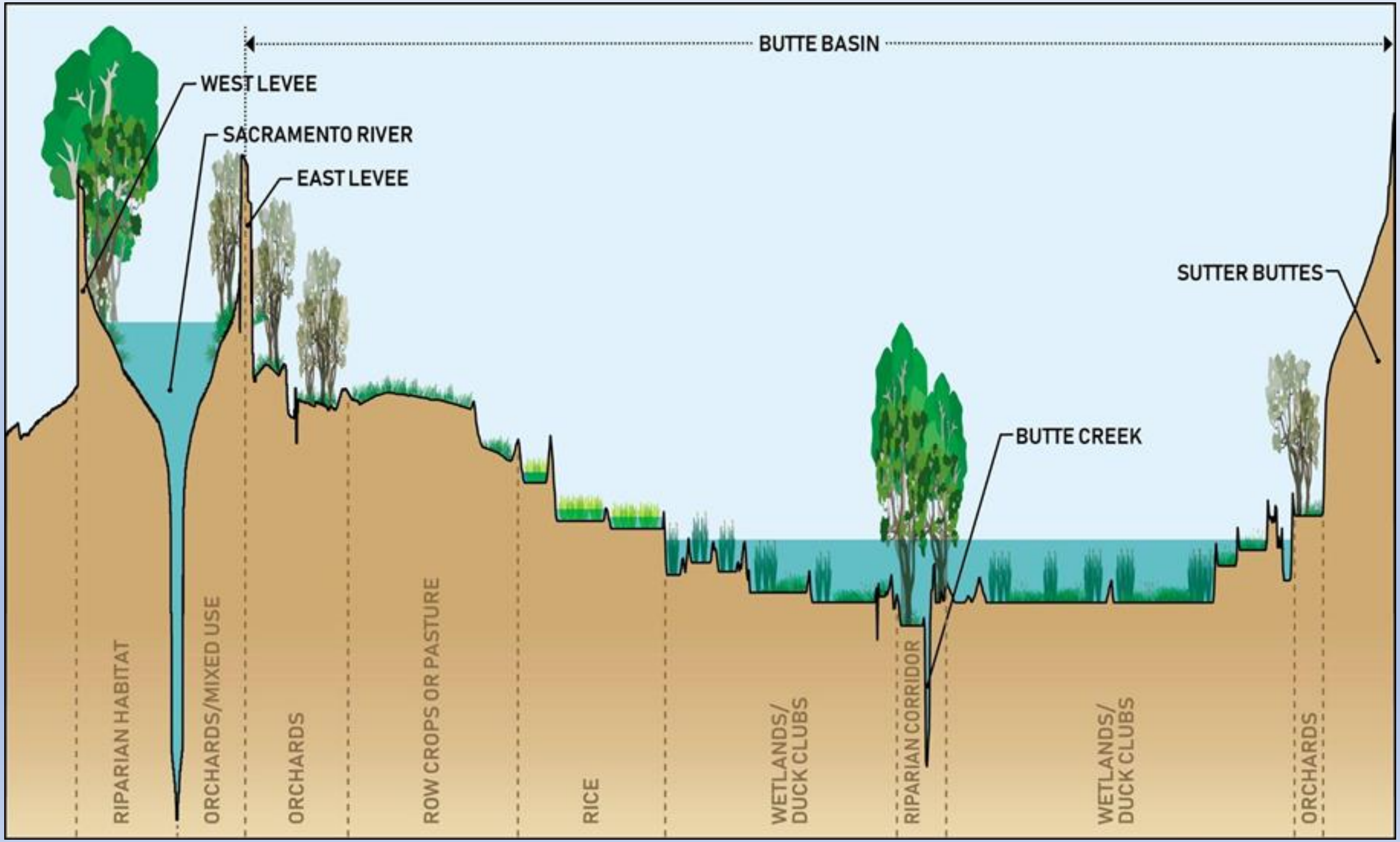
- Habitats
  - Rice/agricultural
  - Wetland
  - Upland
  - Riparian

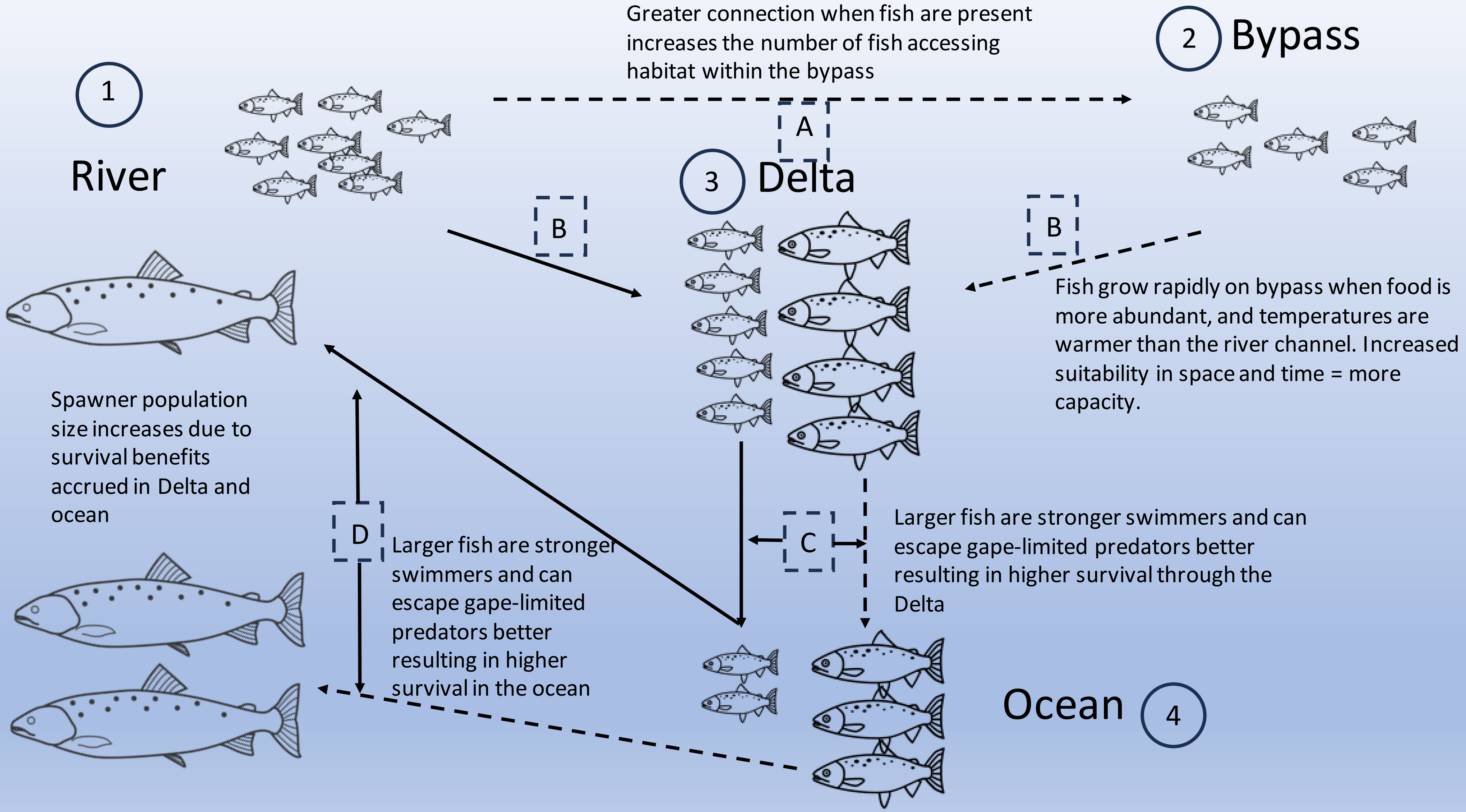
These habitats may not occur in every floodplain component or have the same function/value in each component



Terminology

- Habitats
  - Riparian
  - Wetlands
  - Rice
  - Other ag
  - Uplands




Greater connection when fish are present increases the number of fish accessing habitat within the bypass
1
River
2
Bypass
A
3
Delta
B
B
Fish grow rapidly on bypass when food is more abundant, and temperatures are warmer than the river channel. Increased suitability in space and time = more capacity.
Spawner population size increases due to survival benefits accrued in Delta and ocean
D
Larger fish are stronger swimmers and can escape gape-limited predators better resulting in higher survival in the ocean
C
Larger fish are stronger swimmers and can escape gape-limited predators better resulting in higher survival through the Delta
Ocean
4

Factors Affecting Uncertainties around Potential Salmon Benefits in Flood Bypasses

- Some data on juvenile salmon growth on floodplain landscapes suggest potential benefits for salmon populations
- Scientific understanding is increasing but key information remains incomplete
- Some data show salmon use and growth on floodplain landscapes suggest potential benefits.
- However, most available data on salmon floodplain use and survival is still noisy or equivocal.
- Models use the best available scientific data with several assumptions that may or may not be correct to evaluate scenarios for Floodplains Reimagined – Phase I

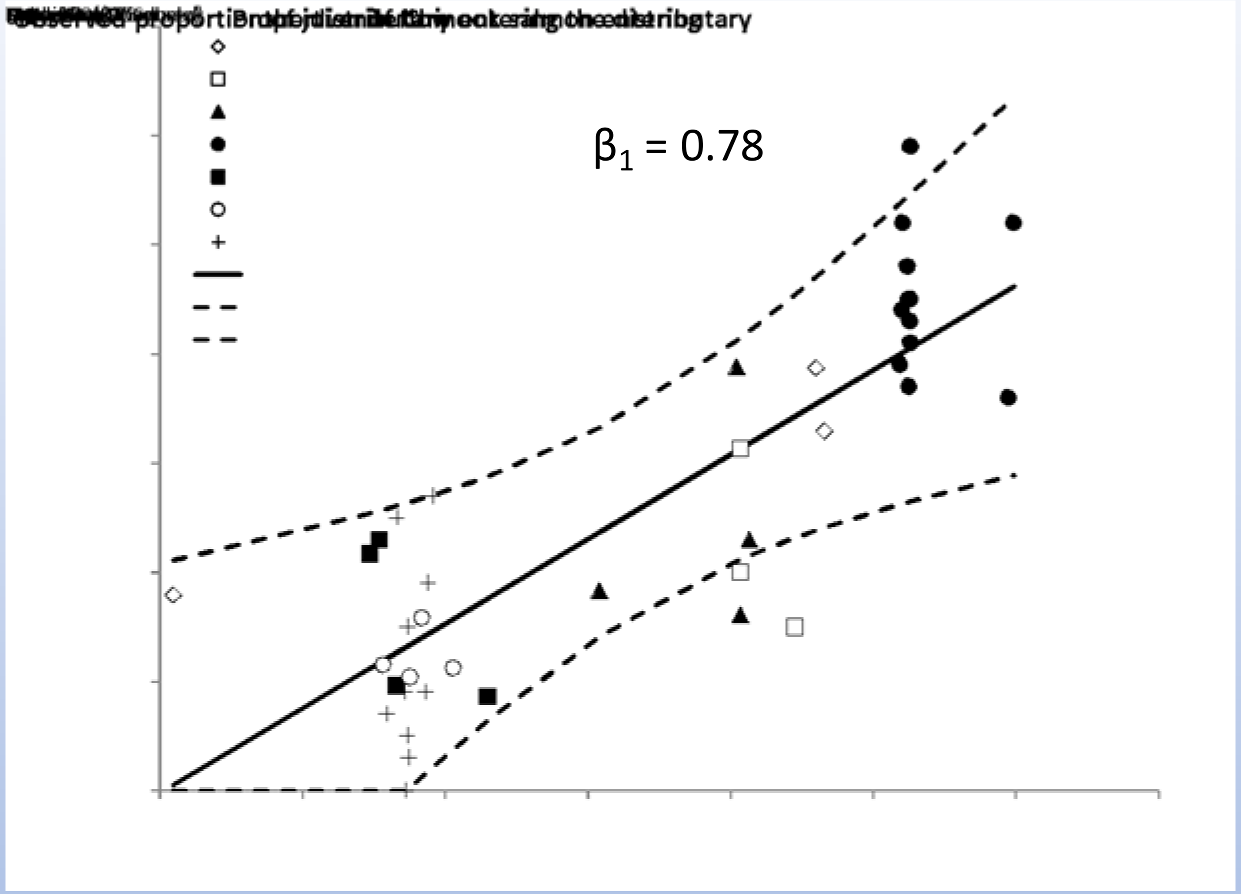
Primary components

1. Movement of juvenile Chinook Salmon into bypasses

1. Habitat use, capacity, growth, behavior and survival in the bypass

1. Outcomes for individuals following exit from the bypass

Movement into Bypass



SBM function

1. Weirs

- Fish move over a weir in direct proportion to flow (1:1)

2. Sacramento Slough

- Linear relationship with river stage until weirs spill

Supporting Data

1. Perry et al. 2015
2. Cavallo et al. 2015

Movement into Bypass (Uncertainty)

- Floodplain observations are largely anecdotal
- Quantitative information based on large smolt-sized fish that are actively migrating through tidal Delta.
- No data at Sacramento Slough

1. Smaller fry and parr are target life stages
2. Fry and parr are rearing rather than migrating
3. Triggers for fish to leave natal habitat unknown
4. Physical structure of junctions may influence entrainment

Movement into Bypass (Research Needs)

1. Environmental conditions that trigger fry/parr movement from spawning grounds
2. What hydrologic characteristics predict movement into bypass
3. Relationships between fish movement over weirs vs. staying in the channel as a function of mechanisms identified in #2 above
4. Junction specific relationships (morphology)

Ecology within bypass (Habitat Suitability)

Juvenile rearing habitat suitability

- Weighted inundated habitat area (suitable acre-days) based on criteria related to timing, duration, depth, velocity, connectivity, and land cover
- Based on scientific literature, precedence, and best professional judgement

Ecology within bypass (Habitat Suitability)

Uncertainties and assumptions

- Connectivity criteria adequately represent the ability of fish to access the available habitat and that accessing the habitat does not involve harm greater than the benefits
- Habitat complexity and availability of refugia on natural land cover types provide higher quality habitat relative to managed agriculture
- Transferability of science from other environments (e.g., in-stream conditions)
- Additional factors not represented in the model (e.g., turbidity) are not accounted for
- Impacts to other life stages, such as adult migration, are not accounted for

Ecology within bypass (Habitat Suitability)

Research needs

- Use and/or preferences for depth and cover type within floodplain environments
- Connectivity and conveyance features and how they affect access, movement, and survival
- Evaluate managed field operations – fish access/egress passage

Ecology within bypass (Survival and Movement)

Survival (SBM)

- Function of flood magnitude (direct relationship)
- Based on theory rather than data

Movement (residence time)

- Function of flood duration (direct relationship)
- Based on Takata et al. (2017) data from Yolo Bypass

Ecology within bypass (Survival and Movement)

Uncertainty

1. Survival
   - No data currently available for life stages of interest (fry/parr)
   - Same values applied across space, time, life stage/size
   - No relevant measure of error
2. Movement
   - Transferable to Butte/Sutter?
   - Transferable to natural-origin fish?
   - Only movement in/out not within bypass (SBM)

Ecology within bypass (Survival and Movement)

Research needs (Survival)

- Estimates of survival for free swimming fry/parr as a function of:
  - Time (e.g. temp, hydrology)
  - Space: Habitat type, region of bypass
  - Life stage/size: Rearing vs. migrating
  - During egress at aggregation points (Sacramento Slough)

Ecology within bypass (Survival and Movement)

Research needs (Movement)

1. How do fry/parr distribute within bypass?
2. What are the mechanisms of movement among habitat patches/selection for patches?
3. What triggers emigration from the bypass back to the main channel?

Ecology within bypass (Growth)

SBM (CWT release recovery)

- Bypass: Butte Creek wild fish (CDFW)
- River: Hatchery fish released in river (CDWR)
- Same rate applied everyday (resampled)

Other sources

- Fish grown in cages within different habitats (wetland, canal, channel, ag)
- Limited otolith data from free swimming fish

Ecology within bypass (Growth)

Uncertainty

- CWT
  - Do not know where fish reared
  - River samples used hatchery fish
  - Differential mortality may mask growth differences
- Cage experiments
  - Cage effects on fish in the channel
  - Mismatched hydrology
  - Floodplain habitats not always better for growth

Ecology within bypass (Growth)

Research needs

- Growth of free-swimming fish under comparable conditions
- Habitat-specific growth rates of free-swimming fish (river and bypass)
- Growth-survival trade-offs
- Temporal change in growth (seasonal, hydrologic cycle)

Outcomes after bypass rearing

Delta

- No function to describe size–based benefit in the Delta.

Ocean

- Size-based benefit (Satterthwaite et al. 2014)
- Application: Only in bad ocean years (Woodson et al. 2013)

Outcomes after bypass rearing

Uncertainty

How do potential benefits of floodplain/bypass rearing translate to the population level?

- Delta
  - No quantitative relationship between size and survival
- Ocean
  - Limited data from a few years

Outcomes after bypass rearing

Research needs

- Where and when does size influence survival (Delta and ocean)?
- Can a population-level effect from differential survival be detected?

Needs summary

SALMON BENEFITS MODEL	HABITAT SUITABILITY APPROACH
Evaluate in-river lateral fish distribution and behavior, and relative entrainment rates at flood basin weir locations. Consideration of differing channel geometries, river reaches, and adjacent habitat types	Use and/or preferences for depth and cover type within floodplain environments
Evaluate juvenile salmon movements and residence times in flood basins	Connectivity and conveyance features and how they affect access, movement, and survival
Evaluate relative rearing survival rates of fry, parr, and pre-smolt life stages in flood basins, including conveyances and outlet, and the river channel	Evaluate managed field operations – fish access/egress passage
Reconcile caged fish growth study rates with free-swimming growth and survival	
Determine if larger size translates to higher survival in Delta and/or ocean (population-level effect)	

Acknowledgements

Carson Jeffres, UCD

Bjarni Serup, CDFW

Brian Ellrott, NMFS