Sites Project
Functional Flow and Operational Parameter Development and Evaluation

July 16, 2019

California Department of Fish and Wildlife

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Outline of Discussion

- Functional Flows Approach
  - Conceptual model of functional flows
- Study Reach Characterization of Ecological/Biological Functions
- Operational Parameter Review and Evaluation

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Functional Flow Approach

- Process-based approach that preserves the most important aspects of variability of a natural flow regime to which native species have adapted.
- Preservation of key aspects of the flow regime, or *functional flow components*.
- Important functional flow components in California rivers are:
  - **Wet-season initiation flows:** move nutrients downstream, initiate migration
  - **Peak magnitude flows:** transport sediment, restructure/maintain river corridors
  - **Spring-recessional flows:** migratory cues, activate off-channel habitat
  - **Dry-Season low flows:** favors native, anadromous species

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Functional Flow Approach

- Provides alternative strategy from minimum instream flows for allocating water budgets.
- Functional flow components are targeted to support specific ecological processes, while minimum instream flow targets may not.
- The functional flow approach also offers flexibility during changing conditions (wet and dry years), which is critical to ensure most efficient allocation of water.

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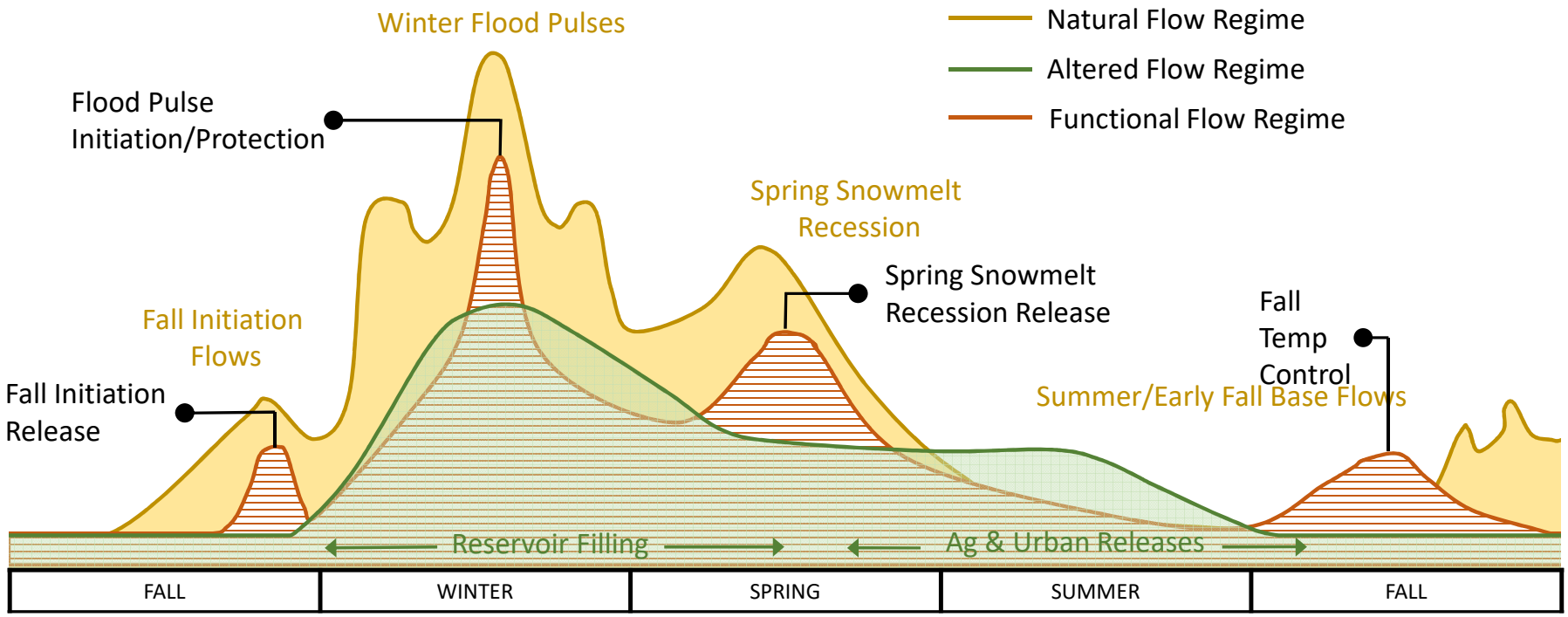

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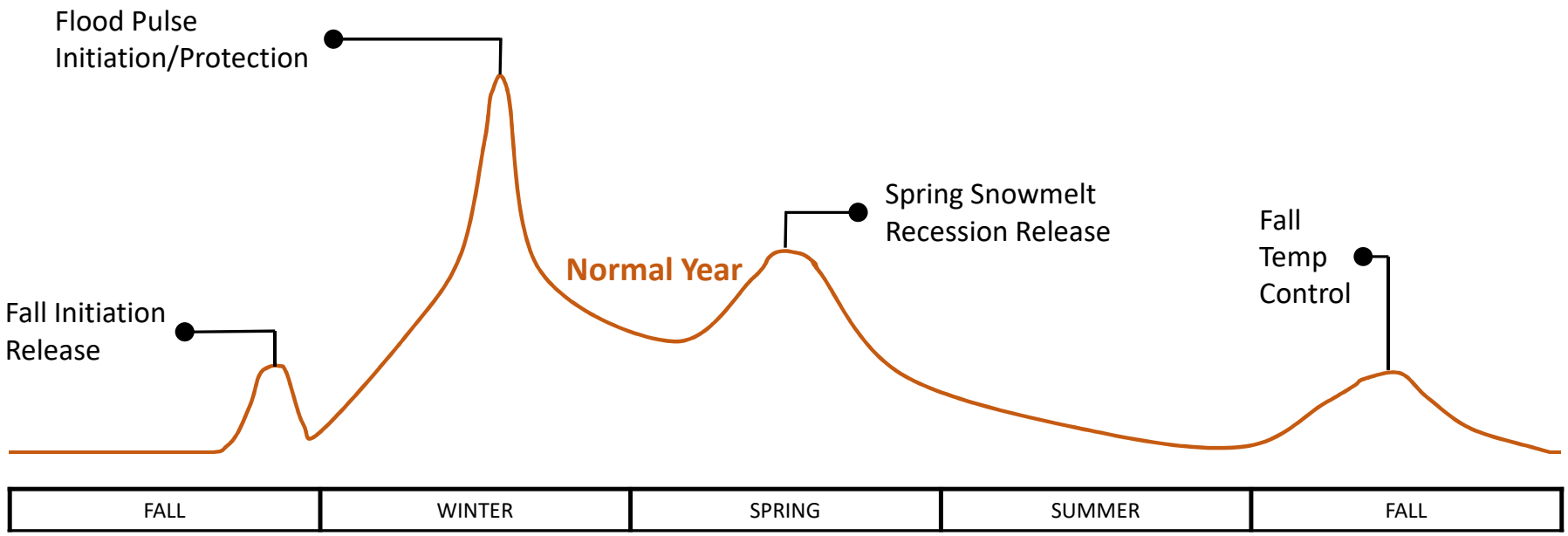

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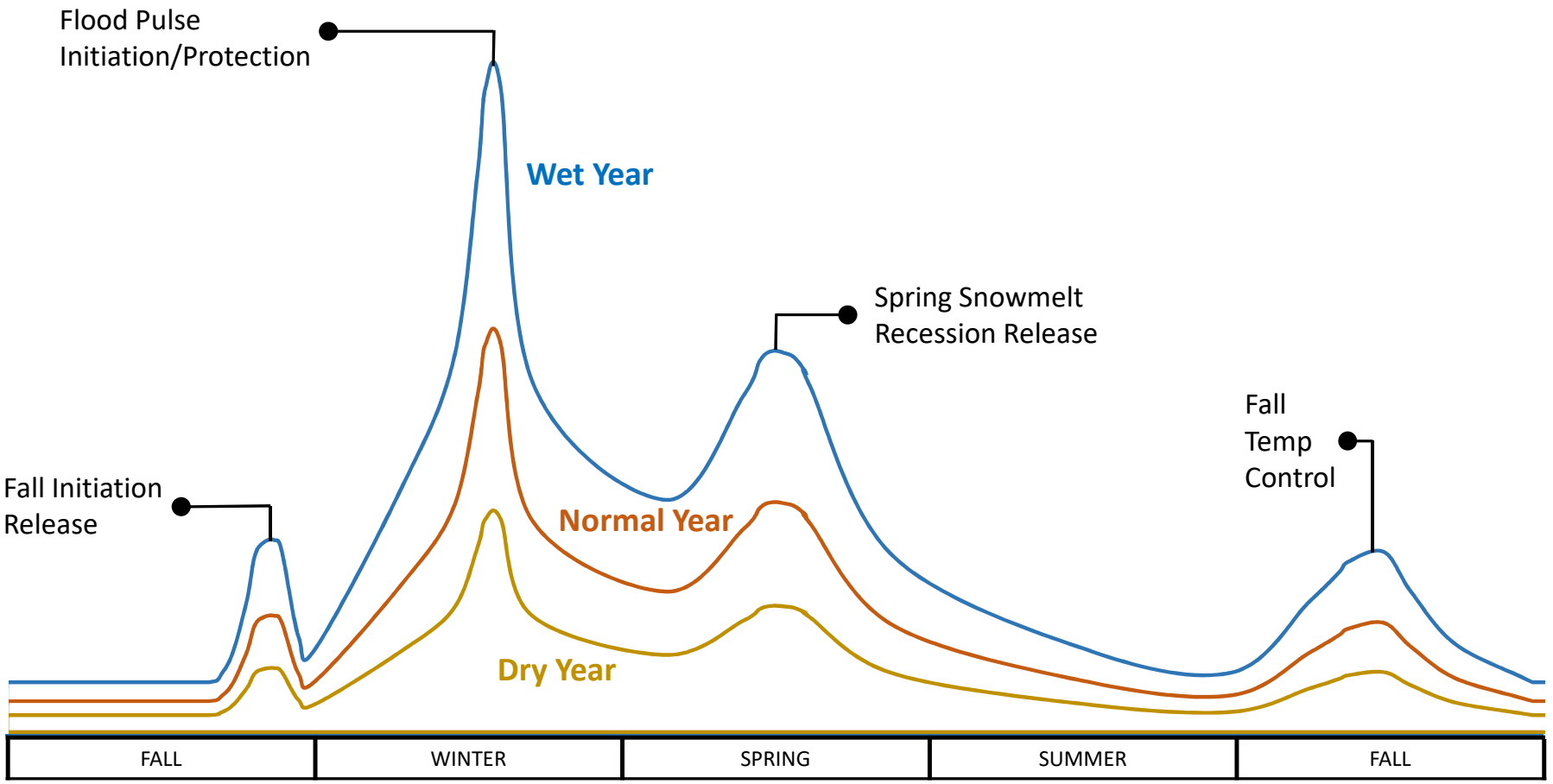

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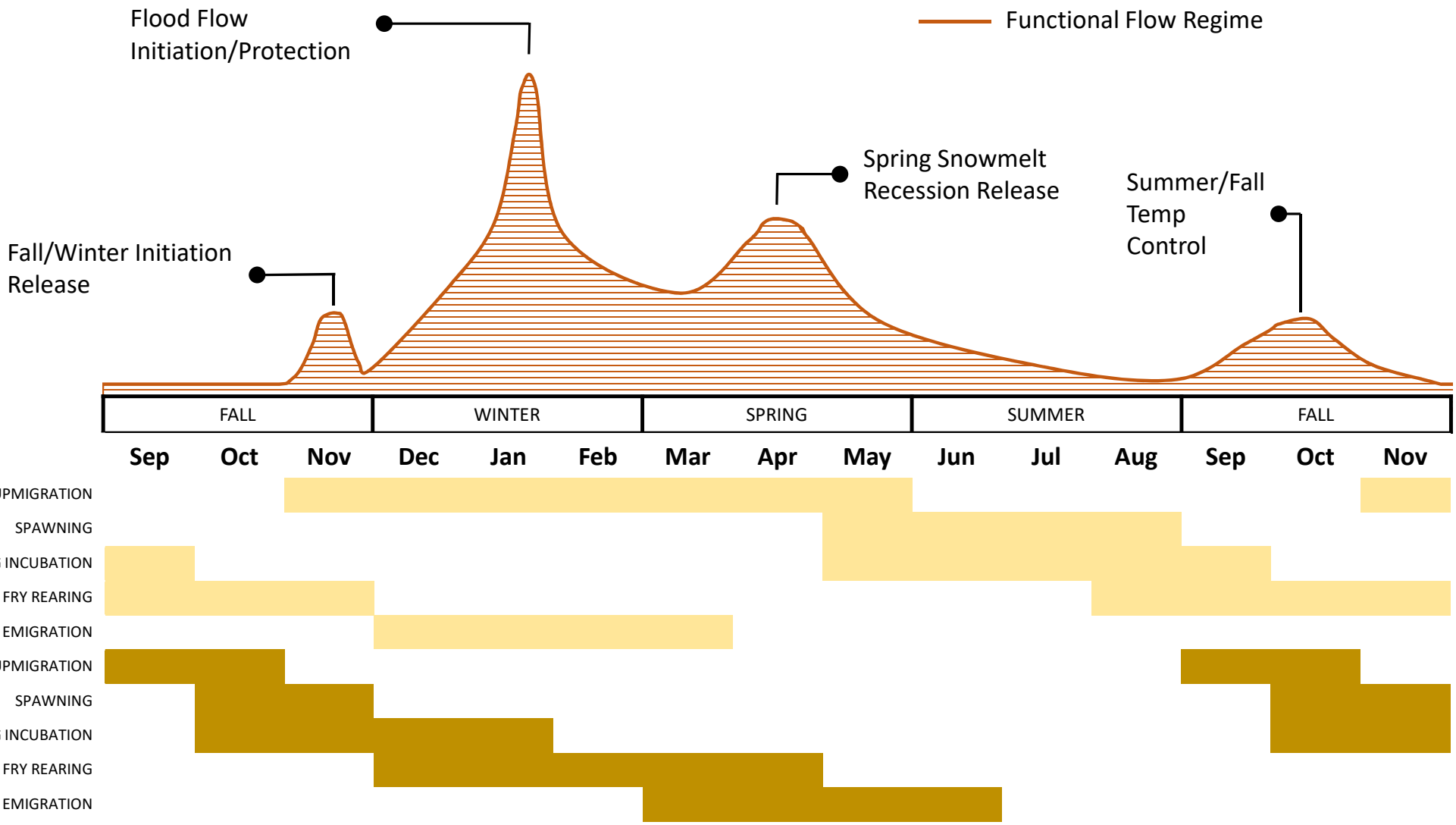

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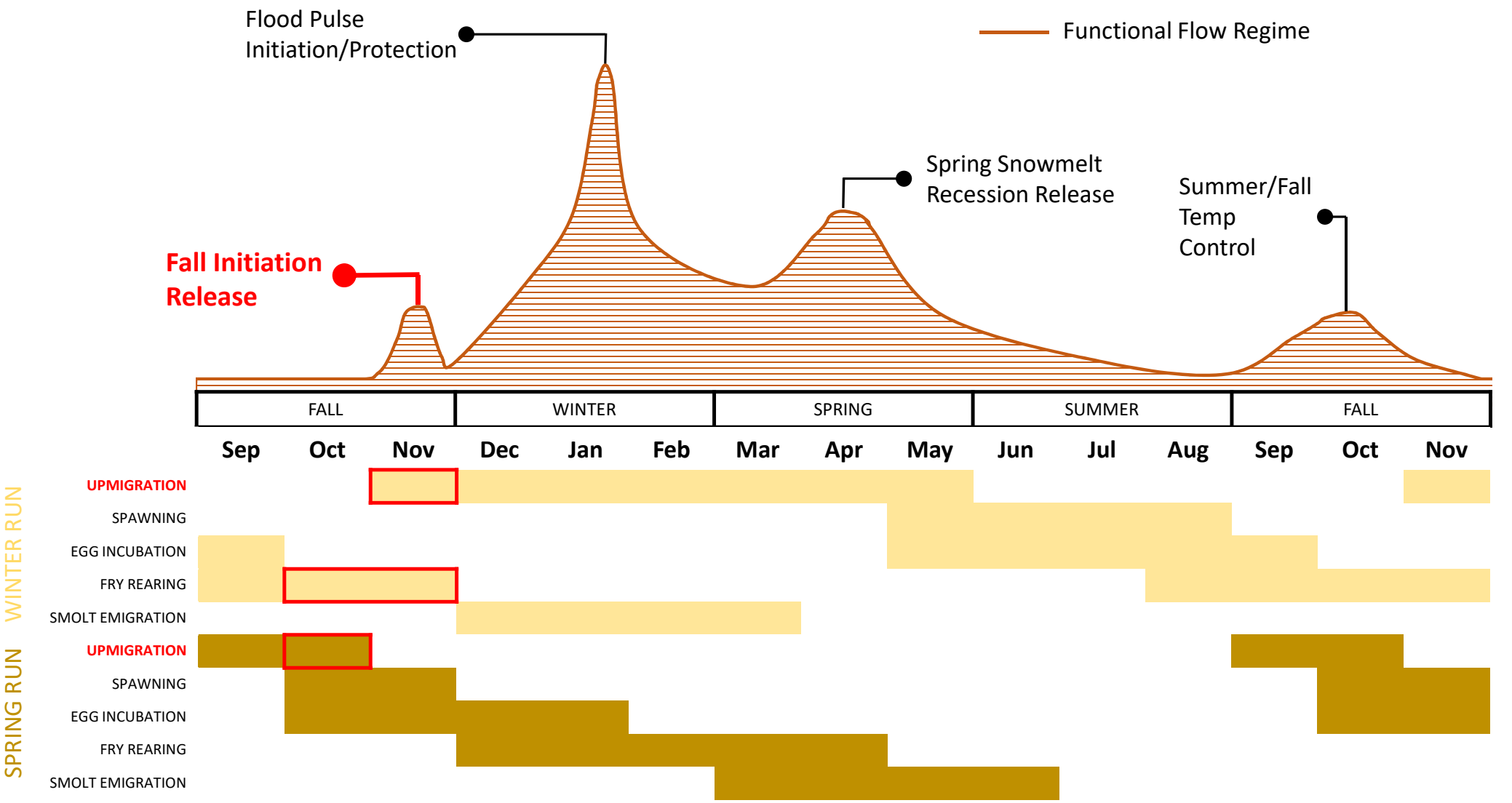

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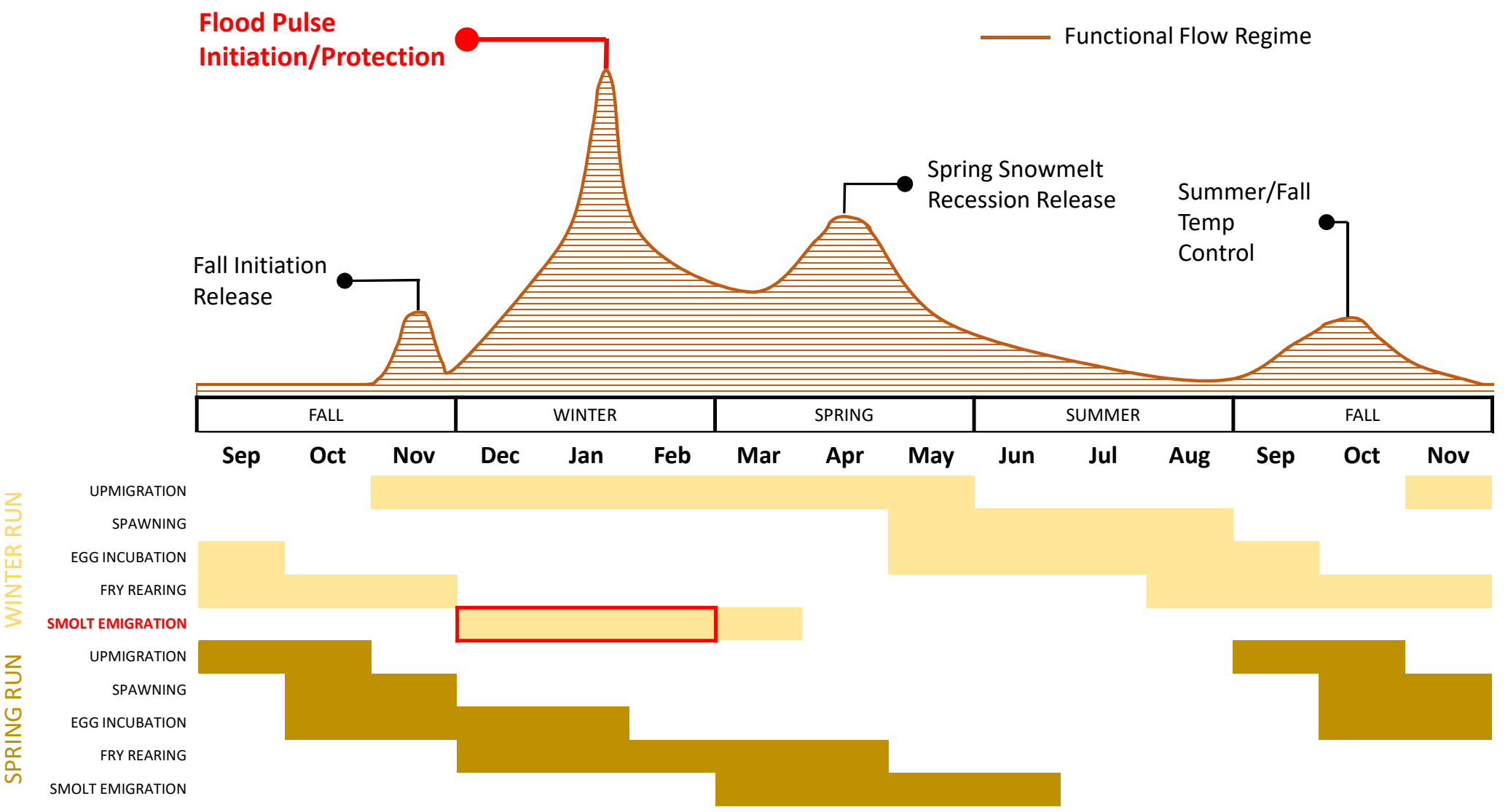

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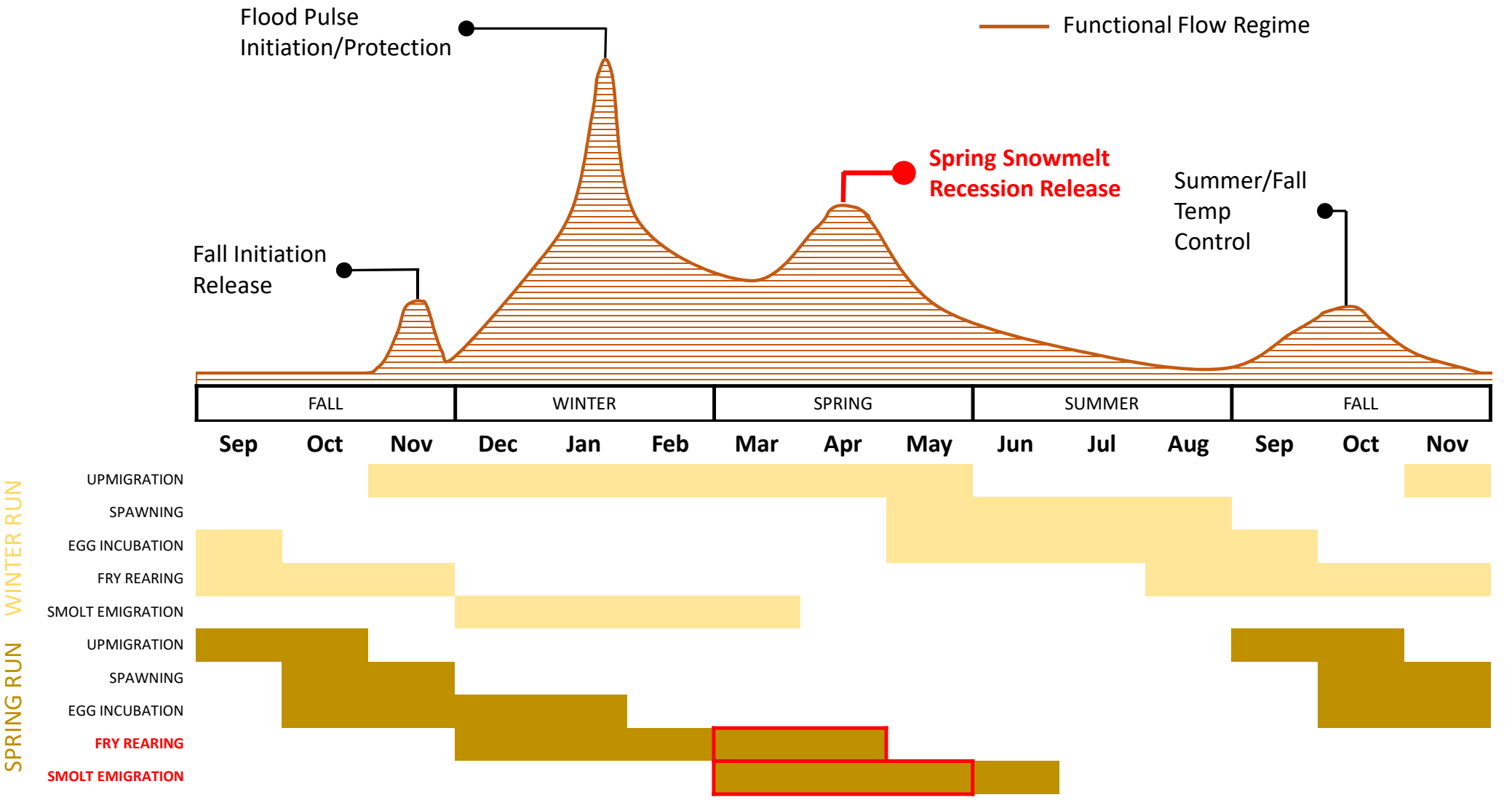

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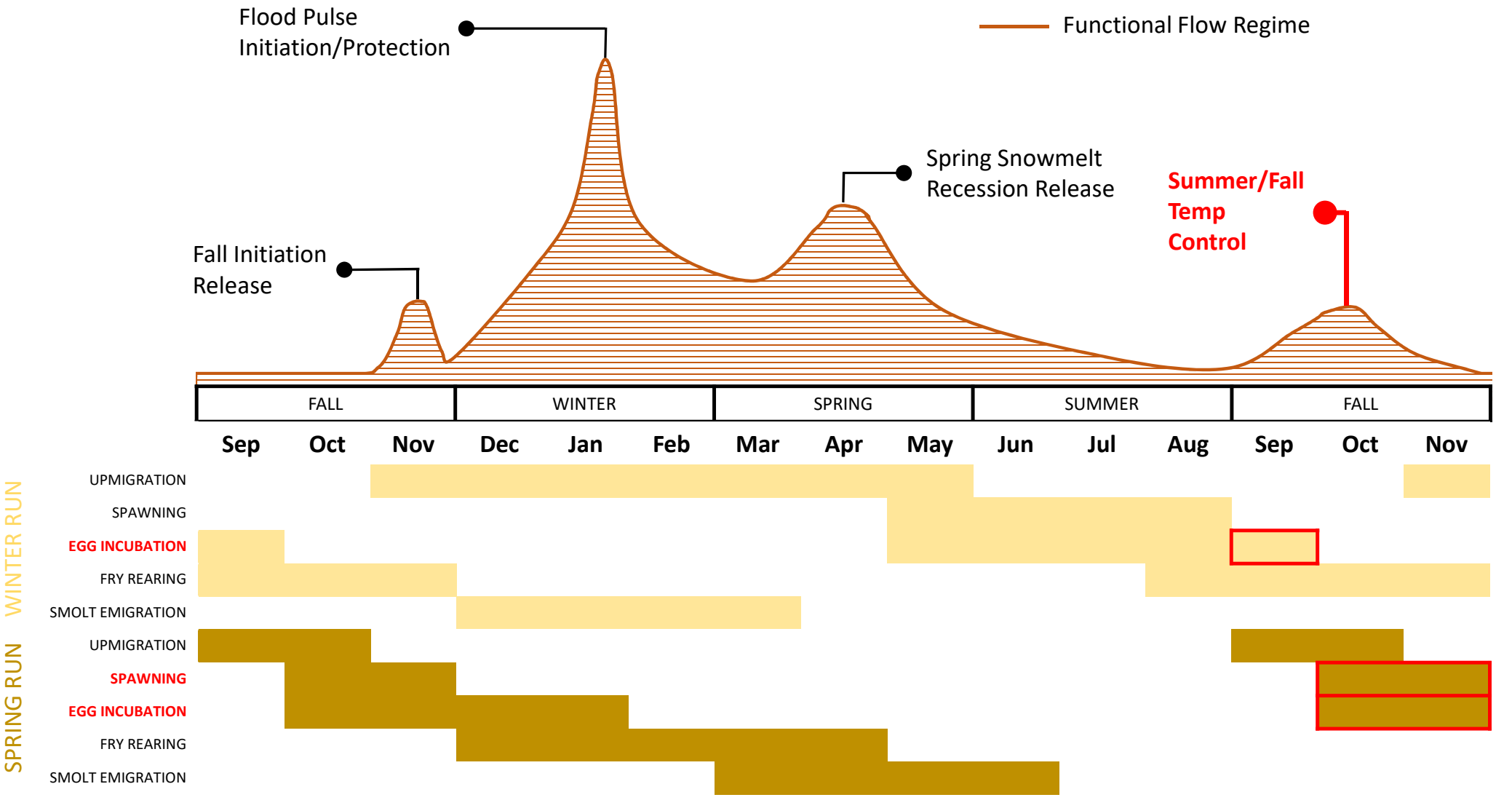

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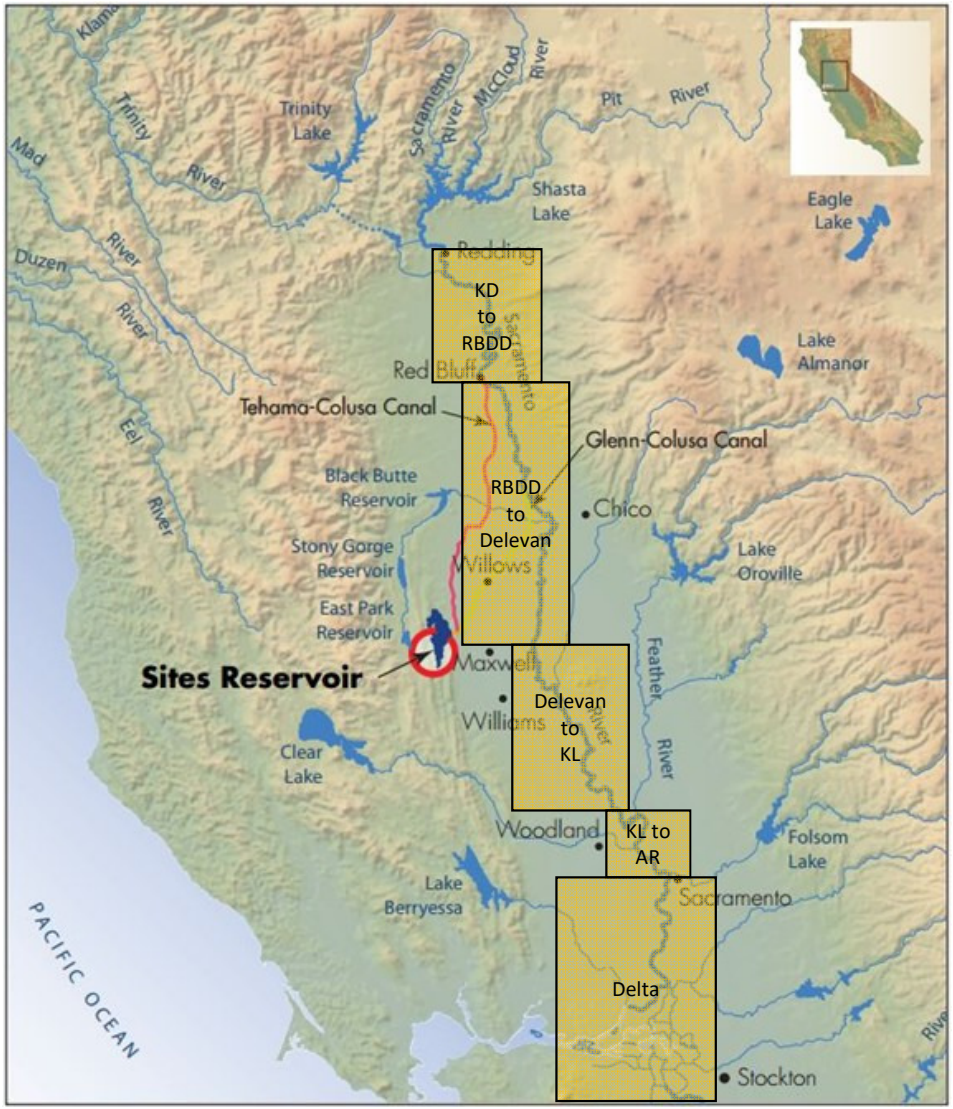
Study reaches



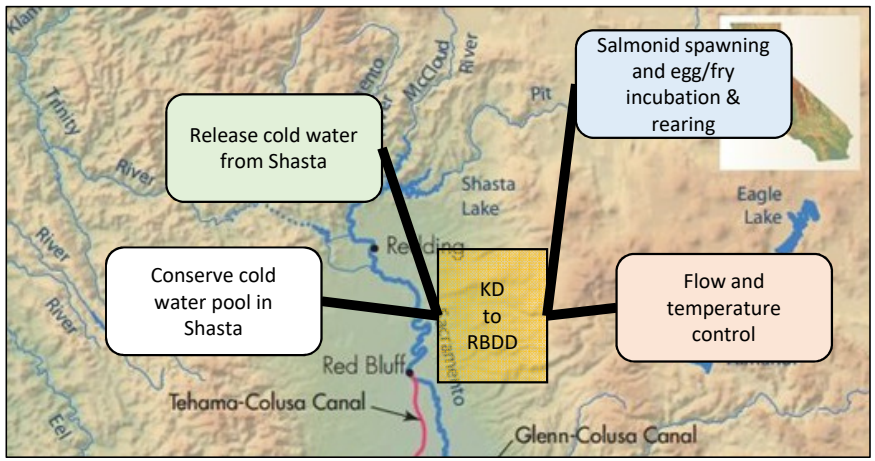
- Reach-scale characterization
  - Species/life-stages/timing
  - Primary ecological functions
    - Drivers
- Operational influence and evaluation
  - Sites operational component/influence
  - Ecological/ biological functions
    - Species/life stages
    - Objectives
    - Parameters/drivers
    - Period of interest
  - Analytical tools and approach
    - Tools
    - Description/parameters
    - Evaluation criteria/metric
- Considerations for refinements
  - Refined operations development and analysis
  - Adaptive management

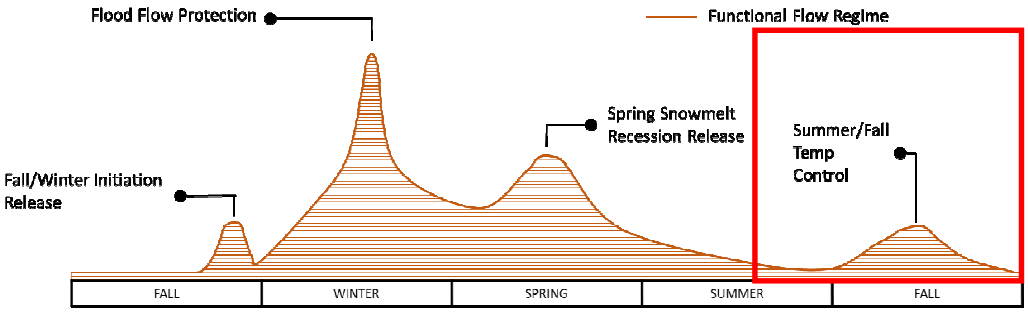
Sites-related Operations

Species / Life Stage / Timing

Ecological Objectives

Criteria / Constraints





- Keswick Dam to Red Bluff Diversion Dam
  - Winter-run and Spring-run Chinook Salmon
    - Spawning
    - Egg incubation to fry emergence
    - Migration
  - Major tributaries
    - Clear, Cottonwood, and Battle creeks
  - Primary Functions
    - Coldwater management (migration, holding, spawning, egg to fry emergence)
    - Driver – Shasta Reservoir coldwater pool

Functional Flows

- Summer/Fall Temp Control
  - Winter-run spawning/egg incubation (Summer)
  - Spring-run spawning/egg incubation (Fall)

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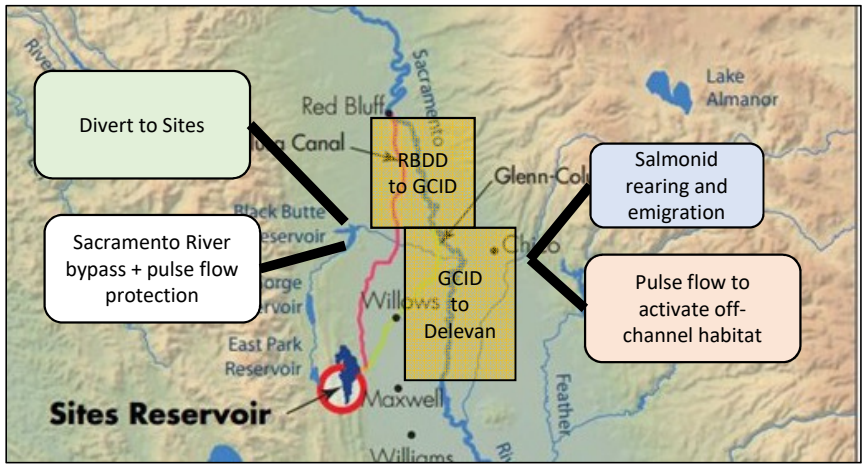
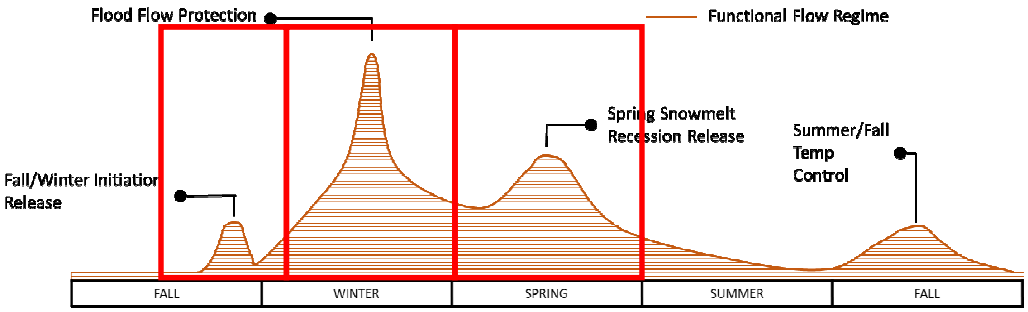
Sites-related Operations

Species / Life Stage / Timing

Ecological Objectives

Criteria / Constraints





- Red Bluff Diversion Dam to Colusa (Delevan)
  - Winter-run and Spring-run Chinook Salmon
    - Migration (adult and juvenile)
    - Rearing
  - Major tributaries
    - Antelope, Mill, Deer, Big Chico, Stoney Cks
  - Bypasses/weirs
    - Sutter/ Moulton, Colusa
  - Primary Functions
    - Active geomorphic reach
    - Habitat complexity, refugia, turbidity, shaded riverine aquatic
    - Driver – flow events

Functional Flows

- Fall/Winter Initiation Release
  - Winter-run adult upmigration
  - Spring-run adult upmigration
- Flood Flow Protection
  - Winter-run emigration
  - Off-channel habitat activation/deactivation
- Spring snowmelt recession release
  - Spring-run rearing
  - Spring-run emigration
  - Off-channel habitat activation/deactivation

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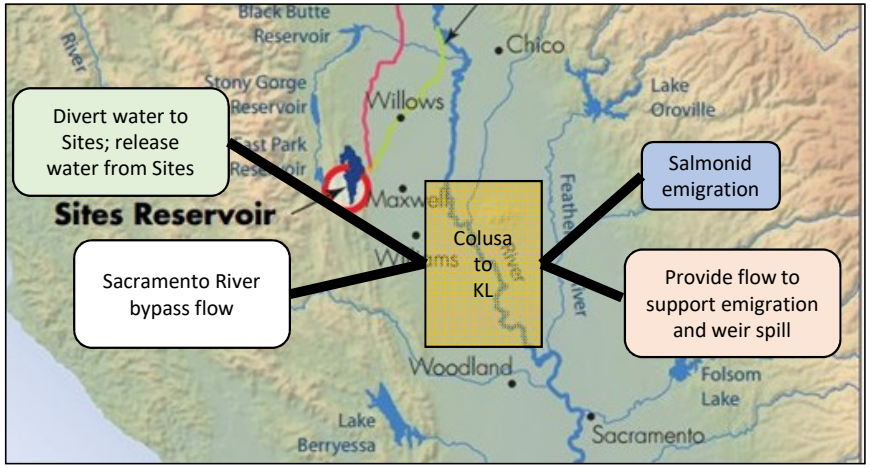
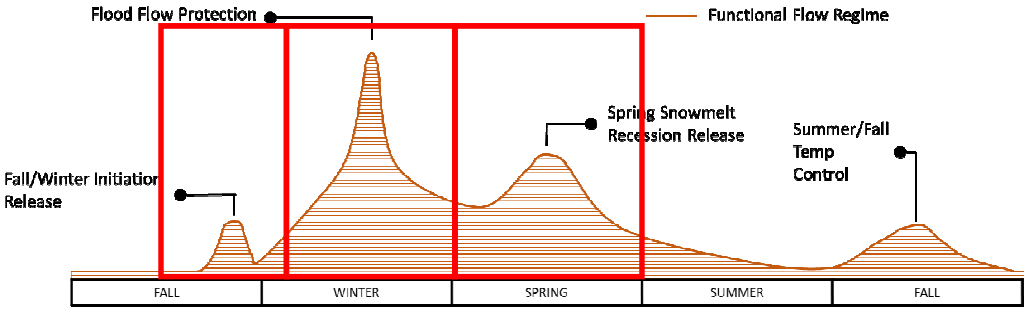
Sites-related Operations

Species / Life Stage / Timing

Ecological Objectives

Criteria / Constraints





- Colusa (Delevan) to Knights Landing
  - Winter-run and Spring-run Chinook Salmon
    - Migration (adult and juvenile)
    - Rearing (limited)
  - Major tributaries
    - None
  - Bypasses/weirs
    - Sutter/ Tisdale
  - Primary Functions
    - Limited ecological functions – confined by levees, limited SRA
    - Driver – Tisdale Weir spills

Functional Flows

- Fall/Winter Initiation Release
  - Winter-run adult upmigration
  - Spring-run adult upmigration
- Flood Flow Protection
  - Winter-run emigration
  - Bypass activation
- Spring snowmelt recession release
  - Spring-run emigration
  - Bypass activation

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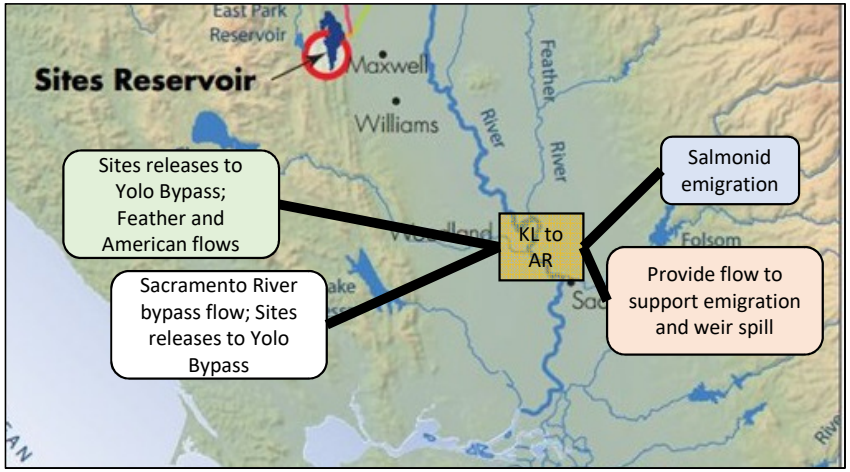
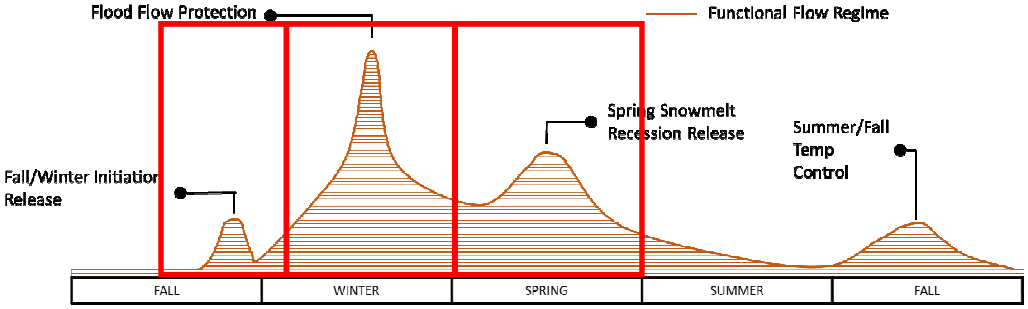
Sites-related Operations

Species / Life Stage / Timing

Ecological Objectives

Criteria / Constraints





- Knights Landing to American River
  - Winter-run and Spring-run Chinook Salmon
    - Migration (adult and juvenile)
    - Rearing (limited)
  - Major tributaries
    - Feather River, Sutter Bypass, America River
  - Bypasses/weirs
    - Yolo/ Fremont, Sacramento
  - Primary Functions
    - Limited ecological functions – confined by levees, limited SRA
    - Driver – Fremont Weir spills

Functional Flows

- Fall/Winter Initiation Release
  - Winter-run adult upmigration
  - Spring-run adult upmigration
- Flood Flow Protection
  - Winter-run emigration
  - Bypass activation
- Spring snowmelt recession release
  - Spring-run emigration
  - Bypass activation

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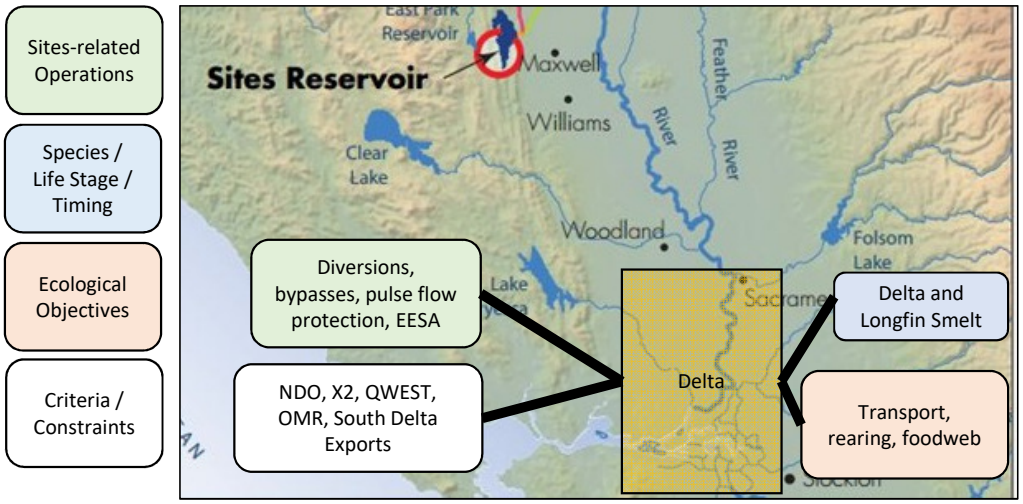

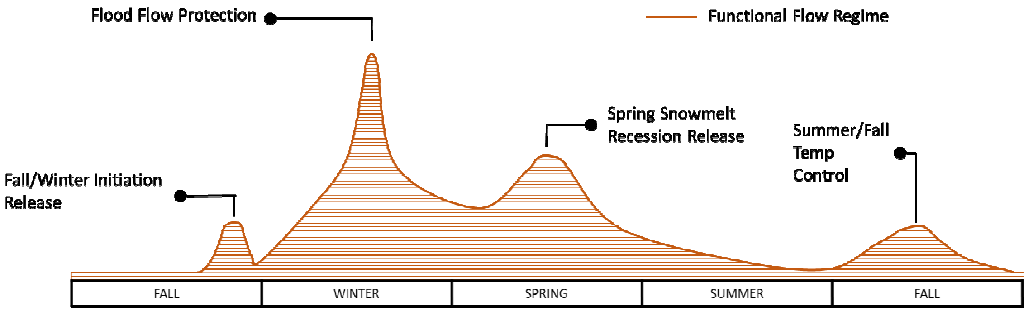

- Delta
  - Winter-run and Spring-run Chinook Salmon
    - Migration (adult and juvenile)
    - Rearing (limited)
  - Delta and Longfin Smelt (all life stages)
  - Major tributaries
    - Multiple tributaries and distributaries
  - Primary Functions
    - Tidally-influence estuary, transport processes, low salinity zone
    - Driver – Sac River inflows, CVP/SWP exports, net Delta outflow

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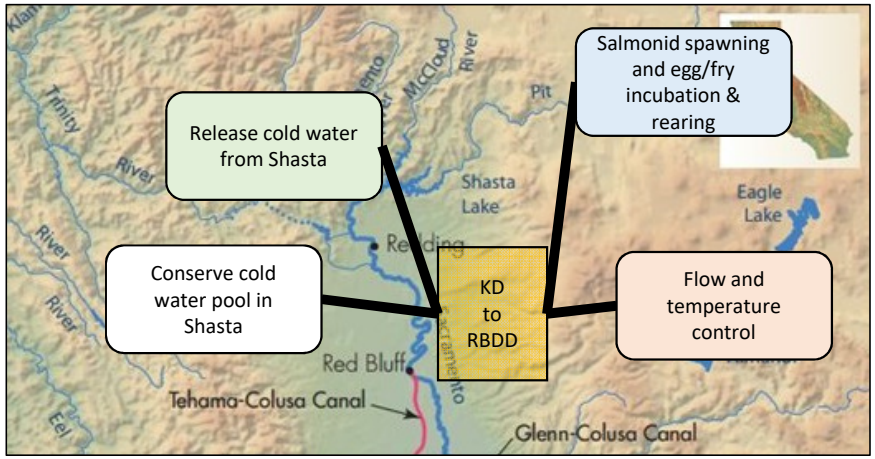
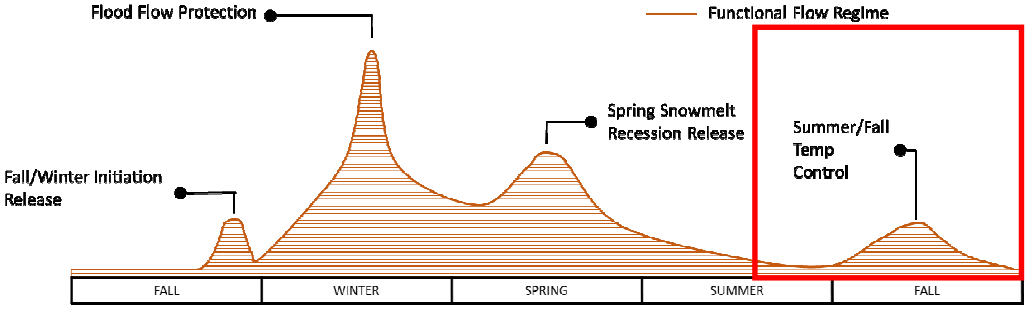
Sites-related Operations

Species / Life Stage / Timing

Ecological Objectives

Criteria / Constraints





Operational Component		Geography	Biological/ Ecological Functions			Period of Interest												Analytical Tools / Approach		
Type and location	Quantity (volume)	Region or reach	Primary species/life stage of concern	Ecological and Biological Objective(s)	Parameter/ driver	Life-stage (OBAN); season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Tool	Description (parameters)	Evaluation Criteria/ Metrics
Shasta Reservoir and Sacramento River; FR, AR	Conserved volume, coldwater pool, variable	Keswick to RBDD	WRCS, SRCS; spawning, eggs/alevins to fry	Flow/temp control; survival	Flow, temp	Eggs/alevins Fry													CALSIM; CE-QUAL-W2; USRDOM, OBAN + Henderson; SALMOD	Daily flow and temp, life-cycle, survival	Change in flow-survival (OBAN + Henderson); SALMOD

Considerations for Refined Operations Development and Analysis				Considerations for Adaptive Management			
Sites Diversion Operational Considerations	Ecological Enhancement Water Account Considerations	Ecological Considerations	Performance Considerations	Objective	Mechanism	Trigger	Contingency Measure/ Action
Trade-offs: EESA developed through Sites diversions and releases	EESA-1 (coldwater pool); EESA-2 (SR temp); EESA-8 (SR augment); EESA-3,4 (Feather/American)	Flow/temp, variability, pulse	Change in flow-survival in OBAN	Survival	Flow, temp, turbidity	Flow, temp, redd/egg incubation, RB screw trap	SR augment

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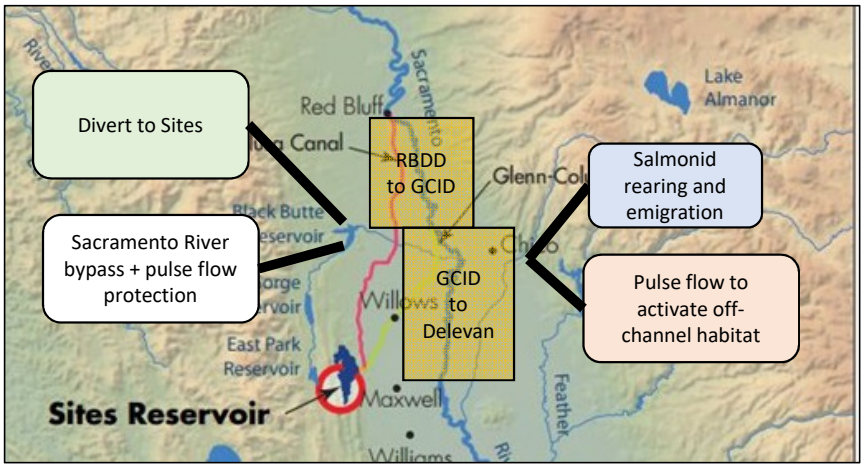
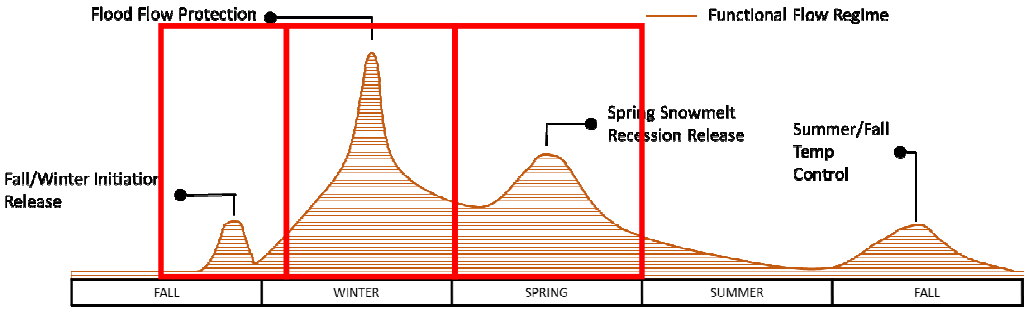
Sites-related Operations

Species / Life Stage / Timing

Ecological Objectives

Criteria / Constraints





Operational Component			Geography	Biological/ Ecological Functions			Period of Interest												Analytical Tools / Approach		
Type and location	Quantity (volume)	Bypasses/ Pulse Flow Protection	Region or reach	Primary species/life stage of concern	Ecological and Biological Objective(s)	Parameter/ driver	Life-stage (OBAN); season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Tool	Description (parameters)	Evaluation Criteria/ Metrics
Red Bluff PP Ham City PP Delevan PP	2100 1800 2000	3250 4000 5000	Red Bluff to Colusa	WRCS, SRCS, juvenile outmigrants	Geomorphic processes; overbank flows; survival	Flow, temp, turbidity, refugia, predation	Fry Juveniles													USRDOM, HEC, OBAN + Henderson; SALMOD	Daily flow and temp, eco events, life-cycle, survival	Change in events, flow-survival (OBAN + Henderson); SALMOD

Considerations for Refined Operations Development and Analysis				Considerations for Adaptive Management			
Sites Diversion Operational Considerations	Ecological Enhancement Water Account Considerations	Ecological Considerations	Performance Considerations	Objective	Mechanism	Trigger	Contingency Measure/ Action
Bypasses, pulse protection, diversion prioritization	EESA-8 (SR augment)	Flow variability, pulse, turbidity	Change in events; flow-survival in OBAN	Ecological processes for improved survival	Flow events	Off-channel habitat activation.	Floodplain restoration/ enhancement (functional flow)

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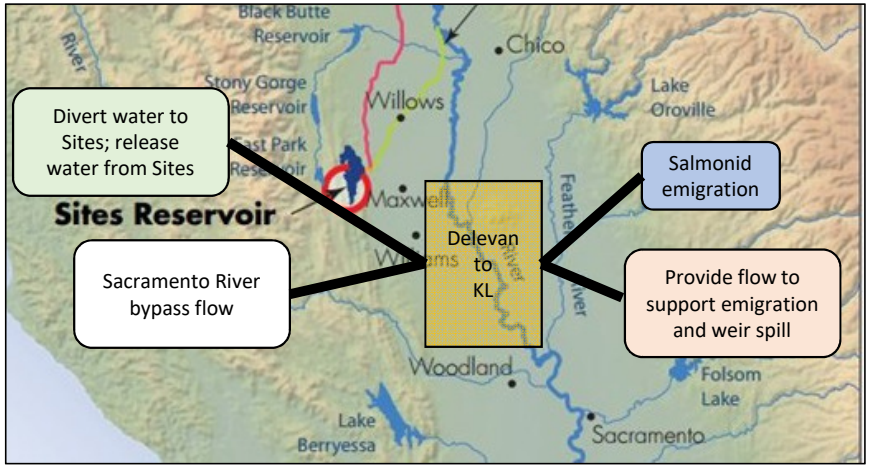
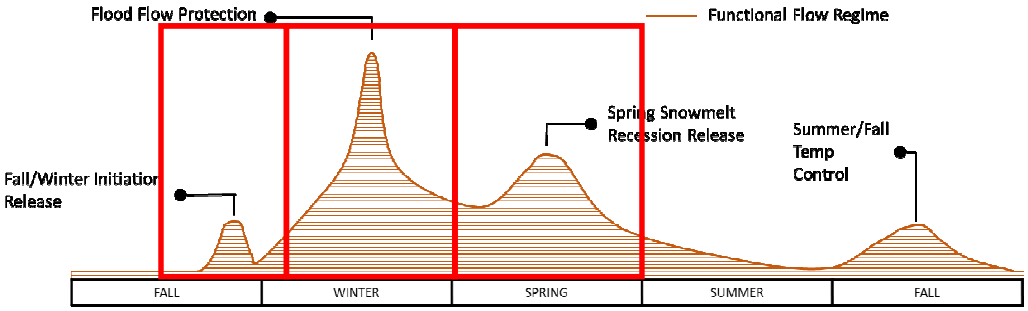
Sites-related Operations

Species / Life Stage / Timing

Ecological Objectives

Criteria / Constraints





Operational Component Geography			Biological/ Ecological Functions			Period of Interest												Analytical Tools / Approach		
Type and location		Region or reach	Primary species/life stage of concern	Ecological and Biological Objective(s)	Parameter/ driver	Life-stage (OBAN); season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Tool	Description (parameters)	Evaluation Criteria/ Metrics
Weirs/ Bypasses	Colusa, Moulton, Tisdale weirs	Colusa to Knights Landing	WRCS, SRCS, juvenile outmigrants	Floodplain, rearing, growth	Spill/innundation frequency and duration	Winter-spring flows													USRDOM	Daily flow, weir spills (frequency, duration, magnitude)	Change in spill/ inundation events (timing, frequency [spills per model period], duration [no. days], magnitude [area inundated])

Considerations for Refined Operations Development and Analysis				Considerations for Adaptive Management			
Sites Diversion Operational Considerations	Ecological Enhancement Water Account Considerations	Ecological Considerations	Performance Considerations	Objective	Mechanism	Trigger	Contingency Measure/ Action
Sites diversions and bypass flows		Surrogate floodplain innundation	Spill event (frequency, duration, magnitude)	Bypass inundation		Wier spills	Sites diversion bypass flows

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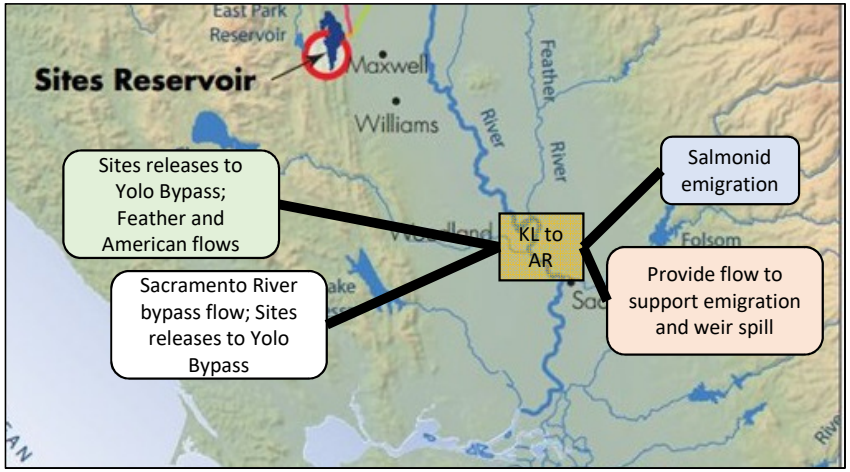

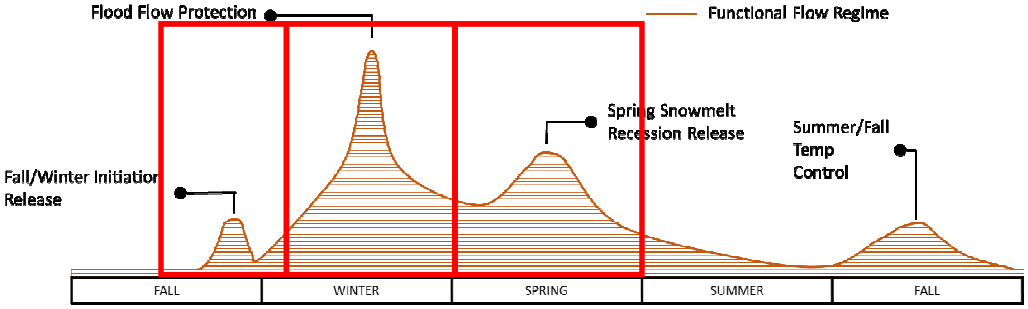

Operational Component Geography			Biological/ Ecological Functions			Period of Interest												Analytical Tools / Approach		
Type and location		Region or reach	Primary species/life stage of concern	Ecological and Biological Objective(s)	Parameter/ driver	Life-stage (OBAN); season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Tool	Description (parameters)	Evaluation Criteria/ Metrics
Weirs/ Bypasses	Fremont, Sacramento weirs	Knights Landing to AR (Delta)	WRCS, SRCS, juvenile outmigrants	Floodplain, rearing, growth	Spill/innundation frequency and duration	Winter-spring flows													USRDOM	Daily flow, weir spills (frequency, duration, magnitude)	Change in spill/ inundation events (timing, frequency [spills per model period], duration [no. days], magnitude [area inundated])

Considerations for Refined Operations Development and Analysis				Considerations for Adaptive Management			
Sites Diversion Operational Considerations	Ecological Enhancement Water Account Considerations	Ecological Considerations	Performance Considerations	Objective	Mechanism	Trigger	Contingency Measure/ Action
Sites diversions and bypass flows	EESA-5 Yolo Bypass Flow Enhancement	Surrogate floodplain innundation	Sill event (frequency, duration, magnitude)	Bypass innundation		Wier spills	Sites diversion bypass flows

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Sites-related Operations

Species / Life Stage / Timing

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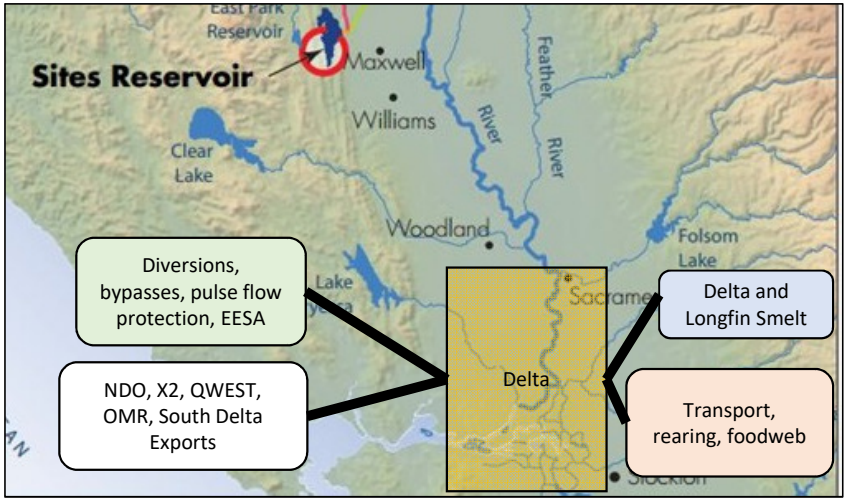

Operational Component	**Geography**	**Biological/ Ecological Functions**			**Period of Interest**												**Analytical Tools / Approach**		
Type and location	Region or reach	Primary species/life stage of concern	Ecological and Biological Objective(s)	Parameter/ driver	Life-stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Tool	Description (parameters)	Evaluation Criteria/ Metrics
Delta outflow; south Delta exports	Delta	WRCS, SRCS, DS, LFS	Survival, food production, larval transport	Transport, position of LSZ														CALSIM, DSM, PTM	Outflow, LSZ	Sac River inflow, NDO, posiiton of X2/LSZ, QWEST, OMR, CVP/SWP exports

Considerations for Refined Operations Development and Analysis				**Considerations for Adaptive Management**			
Sites Diversion Operational Considerations	Ecological Enhancement Water Account Considerations	Ecological Considerations	Performance Considerations	Objective	Mechanism	Trigger	Contingency Measure/ Action
Sites diversions and bypass flows	EESA-5 Yolo Bypass Flow Enhancement						

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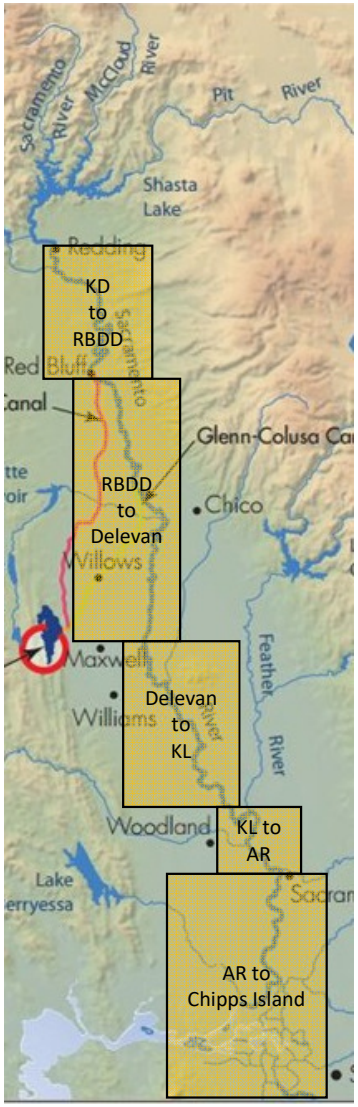
Criteria / Constraints	Sites-related Operations	Species, Life Stage, Timing	Ecological Objectives
Conserve cold water pool in Shasta	Release cold water from Shasta	Salmon spawning and egg/fry incubation & rearing	Flow and temperature control
Sacramento River bypass + pulse flow protection	Divert water to Sites	Salmon rearing and emigration	Pulse flow to activate off-channel habitat
Sacramento River bypass flow	Divert water to Sites; release water from Sites	Salmon emigration	Provide flow to support emigration and weir spill
Sacramento River bypass flow; Sites releases to Yolo Bypass	Sites releases to Yolo Bypass; Feather R. and American R. outflows	Salmon emigration	Provide flow to support emigration and weir spill
NDO, X2, QWEST, OMR, South Delta Exports	Diversions, bypasses, pulse flow protection, EESA	Delta and Longfin Smelt	Transport, rearing, foodweb



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