Digital Map from Dr. William Bowen California State University Northridge

Sacramento River
Suisun Bay
Sacramento-San Joaquin Delta
San Joaquin River
Stationary Habitat --- Geometry

Dynamic Habitat ---
Hydrodynamics, ocean conditions, weather

Biological Conditions

Environment
Estuarine habitat conceptual model
(Peterson 2003)

Stationary Habitat

Dynamic Habitat

Production Area

Tidal and River Flow

Pelagic Recruitment
Cascade of responses to altered flow

Natural Hydrologic Regime

Natural Drivers:
- Climate
- Atmospheric rivers
- Orographics
- Topography
- Forest Vegetation-Soil
- Valley morphology
- GW dynamics
- River network structure

Basin scale

Local scale

Jan          Jul          Dec

Historical Floodplain activation
Hydrologic processes, flow regime, and resulting ecological characteristics are unique per stream segment.

**Local hydrologic controls** modify flow regime; **local valley geomorphology** influences habitat structure

**Upstream catchment controls** determine natural flow regime per river segment

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Catchment-scale hydrology and local flow modifications determine dynamic stream flow regimes;  

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Local valley-scale, stationary, geomorphic setting influences habitat  

Habitats and Populations are potentially different at sites 1 - 5
Cascade of responses to altered flow

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Natural Drivers:
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Basin scale
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Local scale
- Forest Vegetation-Soil
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Sources of alteration:
- Forest management
- Dams
- Inter-basin transfers
- Impervious surfaces
- Land use
- Levees/Channelization
- GW withdrawals

Altered Flow Magnitude, Timing, Duration, Frequency, & Rate of Change

Hydrologic processes, flow regime, and resulting ecological characteristics are unique per stream segment.

1. Local hydrologic controls modify flow regime; local valley geomorphology influences habitat structure
2. Upstream catchment controls determine natural flow regime per river segment
3. Local valley-scale, stationary, geomorphic setting influences habitat
4. Habitats and Populations are potentially different at sites 1-5
Cascade of responses to altered flow

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Altered Flow Magnitude, Timing, Duration, Frequency, & Rate of Change

Δ Water Quality
- Sediment & turbidity
- Salinity, DO & temperature
- Nutrients & toxics

Δ Aquatic Habitat
- Depth, width, slope, & sinuosity
- Substrate texture
- Current structure
- Land/water interface
- LSZ location

Proximate Stressors:

Degraded Habitat
Cascade of responses to altered flow

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**Degraded Habitat**

**Proximate Stressors:**
- Reproductive success & timing
- Food availability
- Competition & predation
- Physiology & behavior

**Impaired Growth, Reproduction, and Survival of Native Populations**
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Local hydrologic controls modify flow regime; local valley geomorphology influences habitat structure.

Upstream catchment controls determine natural flow regime per river segment.

Catchment-scale hydrology and local flow modifications determine dynamic stream flow regimes;

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**Impaired Growth, Reproduction, and Survival of Native Populations**
1873 Delta:
Long residence time
Marsh connections
Two rivers connect to bay
Waterways dendritic
Modern delta

Short residence times

Rip-rapped

Cross Delta flows

Rare San Joaquin connection to bay

Waterways web-like
Cascade of responses to altered flow

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Impaired Growth, Reproduction, and Survival of Native Populations
Population Dynamics of Estuarine Populations

**Climate Change Effects**

- **Sea Level Rise & Ocean Characteristics**
  - Trends

- **Habitat Change**
  - Depth & Elevation
  - Turbidity & Salinity

- **Landscape Change**
  - Size
  - Connectivity

**Temperature**

- Timing
- Frequency
- Degree
- Duration

**Precipitation & Storm Effects**

- Events
  - Floods
  - Drought

**Population Stressors**

- Temperature extremes
- Habitat for prey, competitors, predators, and disease
- Access to Habitat
- Patch Configuration
- Survival
- Reproductive Success
- Alien Invasions
- Longevity and Fecundity
- Recovery Speed

**Plant & Animal Sensitivity**

**Population Dynamics of Estuarine Populations**

**Effects Elsewhere on Migratory Species**

**Stressors Other than Climate Change**
How much water do fish need?
Conceptual Model: Physical effects on estuarine ecosystem

Physical Habitat

Transport/Retention

Direct physical influences

Hydrodynamic Forcing:
- Freshwater inflow
- Oceanic variability
- Wind

Stratification

Inputs

Fish Production

Zooplankton Production

Benthic Production

Phytoplankton Production

Microbial Production

Nutrient Input

Organic Input

Key feedback loop

Material flows