Normative Flow Studies

King County Department of Natural Resources

Water and Land Resources Division

Parametrix, King County, Herrera, & Foster Wheeler

King County Normative Flow Project

Establishing links between flow regimes and aquatic ecosystem health

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Using a normative flow approach to guide river restoration in the PNW

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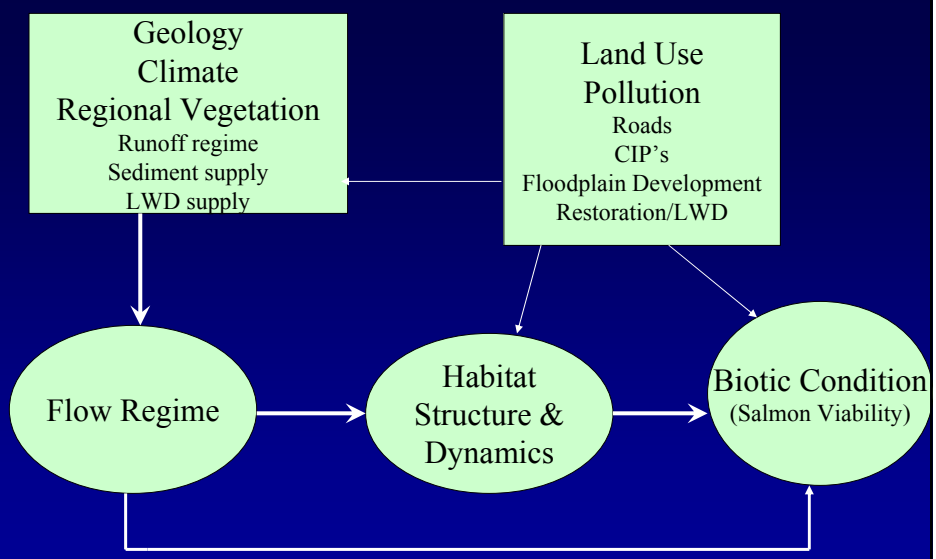
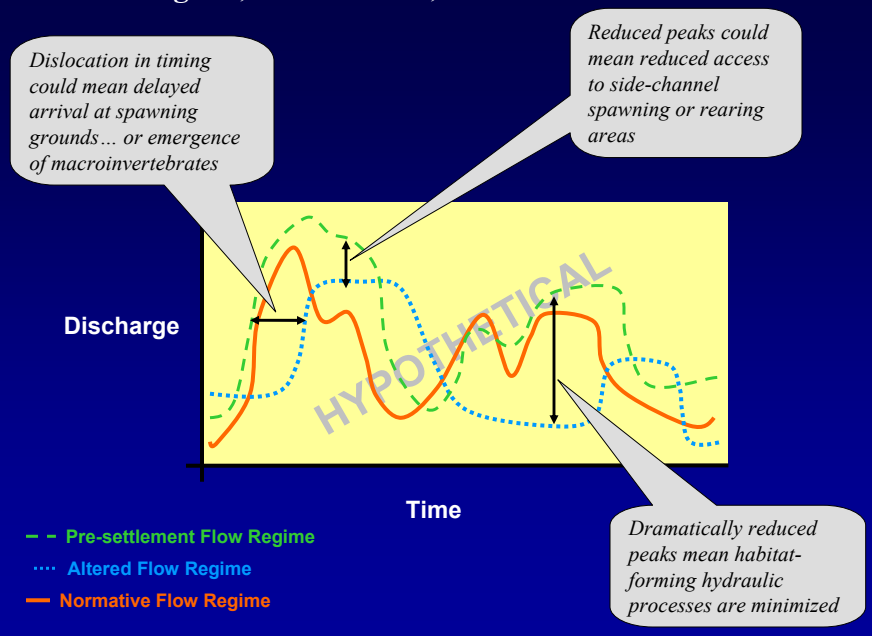
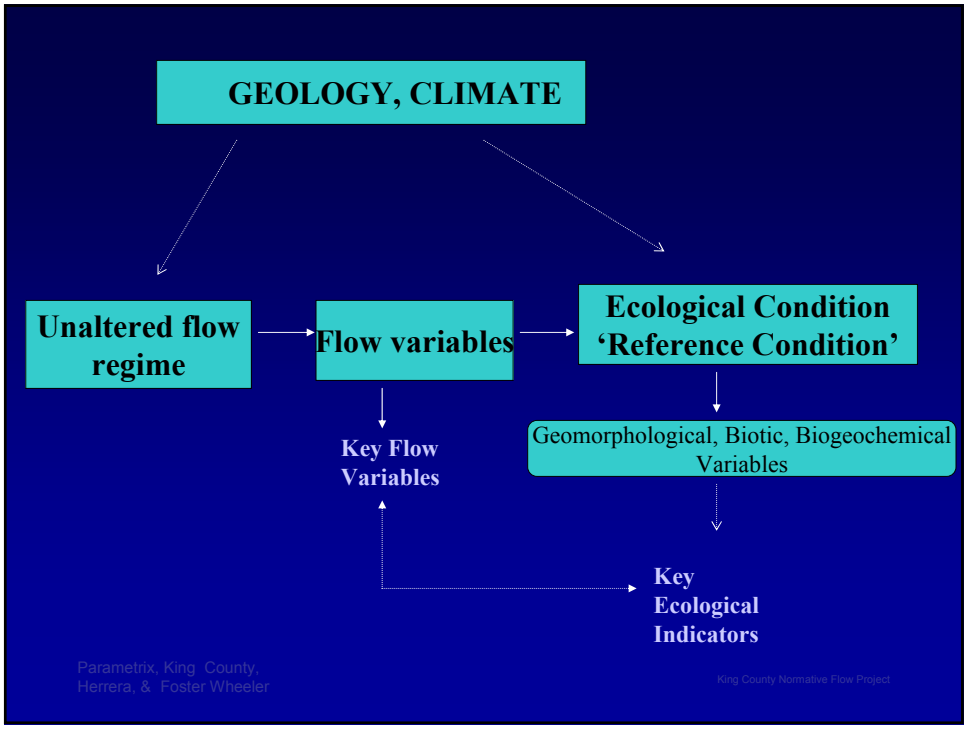
Flow Regimes and Restoration

- Historical conditions
- Ecological processes
- Prioritization
- Design



Natural flow regime, altered flows, normative flows





Why has this not been done in PNW?

- Most information from:
  - Semi-arid/arid regions
  - Hydroelectric/irrigation diversions
- Single-species bias
- Focus on minimum flows
- 'Noise' associated with effects of urbanization
- Several efforts underway (TNC, King Co., Ecology….)

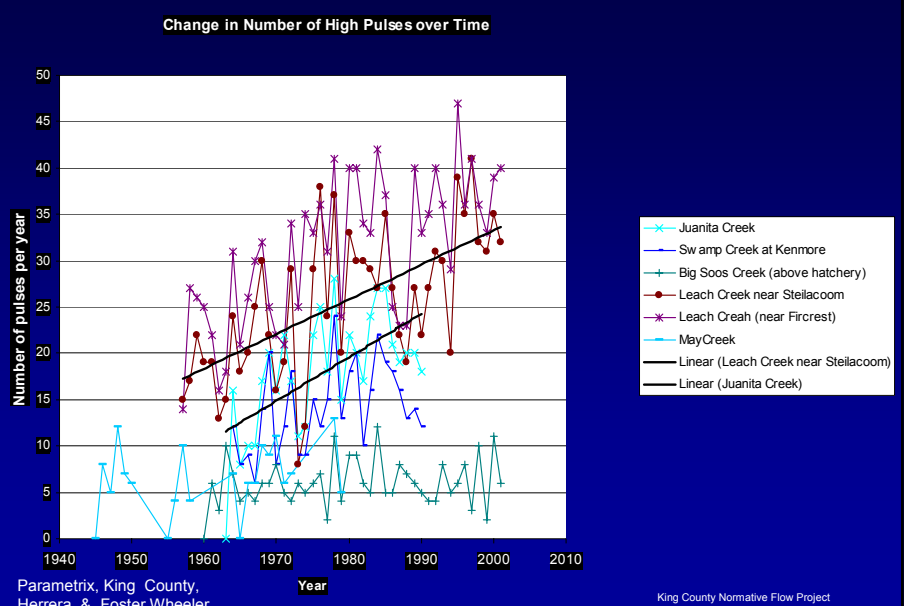
Approach

How have flows been altered?

How has this impacted PNW rivers?

Types of hydrologic alteration

Ecological effects of flow alteration



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Predicted Ecological Effects

- Literature review
  - Focus on 1998-present
  - Most common flow alterations
  - Most common ecological responses
  - Empirical relationships
- What is relevant to PNW?

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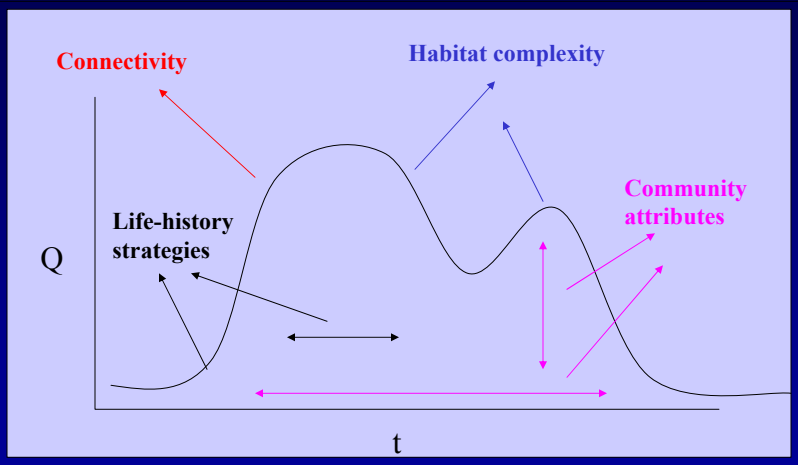
Literature Review: Suites of Common Ecological Effects



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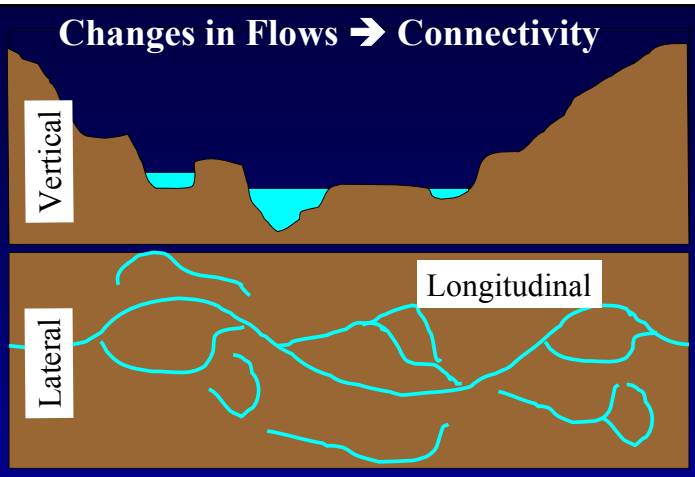
Changes in Flows ➔ Connectivity



Exchange of matter and energy:

- Flood pulse
- Nutrient cycling
- Productivity/food web support

Access to habitats:

- Refugia
- All life-stages

Population Viability:

- Dispersal
- Migration
- Recruitment

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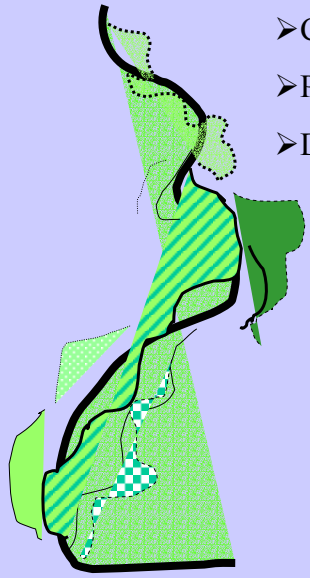
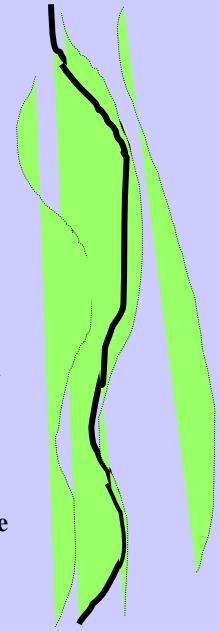
Changes in Flow ➔ Habitat Complexity



- Channel form
- Patch complexity
- Disturbance regime

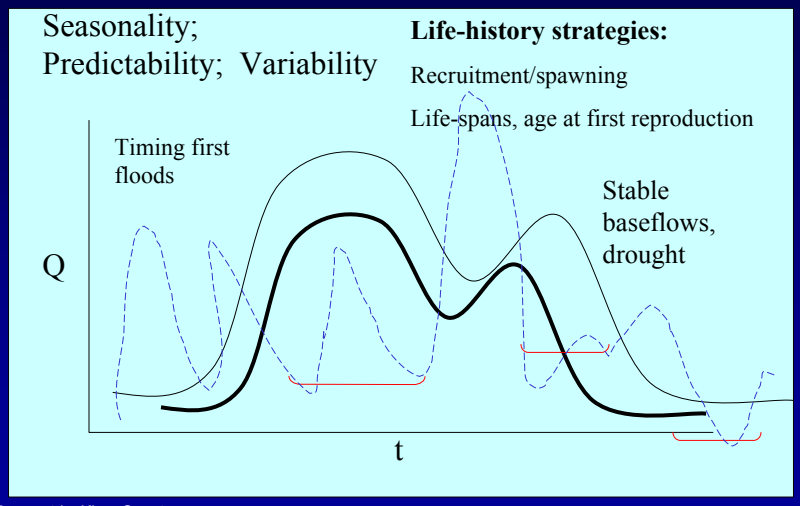
- **Species Diversity**
- **Life-history Diversity**
- **Genetic Diversity**
- **Population Structure**
- **Population Persistence**
- **Productivity**



Complex, Diverse

Simple, Uniform

Changes in Flow ➔Life-history



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Changes in Flow ➔Communities

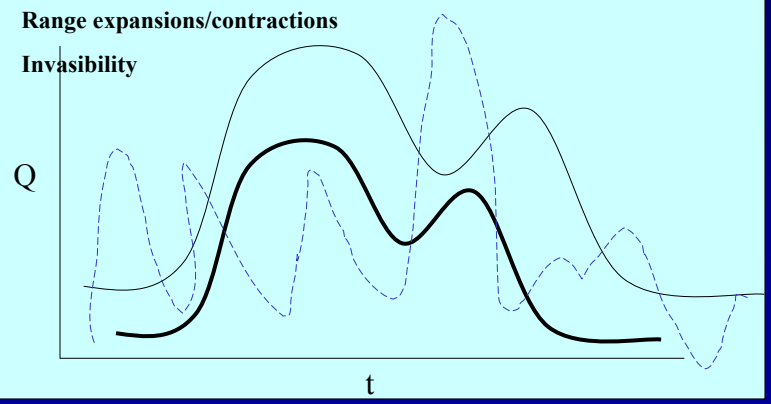
Community attributes:

Diversity

Range expansions/contractions

Invasibility

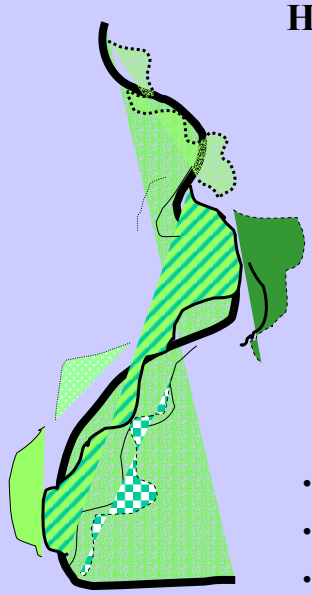
Seasonality;
Predictability; Variability



Evaluate Flow Changes: Indicators and Metrics

- Connectivity
- Habitat Complexity
- Life-history Traits
- Community Attributes

Habitat Complexity



➢ **Spatial**

Number of:

- Geomorphic surfaces
- Channel islands
- Un-vegetated patches

Length channel segments

➢ **Temporal**

- **Patch turnover rates**
- **Structural diversity**
- **Size classes trees**
- **Rates channel migration**

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Life-History Traits

- Relative abundances/Presence-absence of life-history traits:
  - Timing of spawning runs
  - Number of runs
  - Length of reproductive season
  - Short-lived vs. long-lived species
  - Age at first reproduction
  - Generations/year
  - Tolerant/Intolerant

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Approach

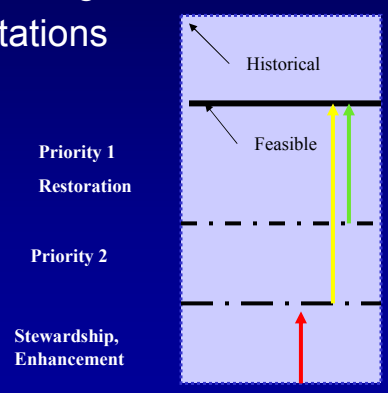
Can we use flow regimes to design better river restoration?

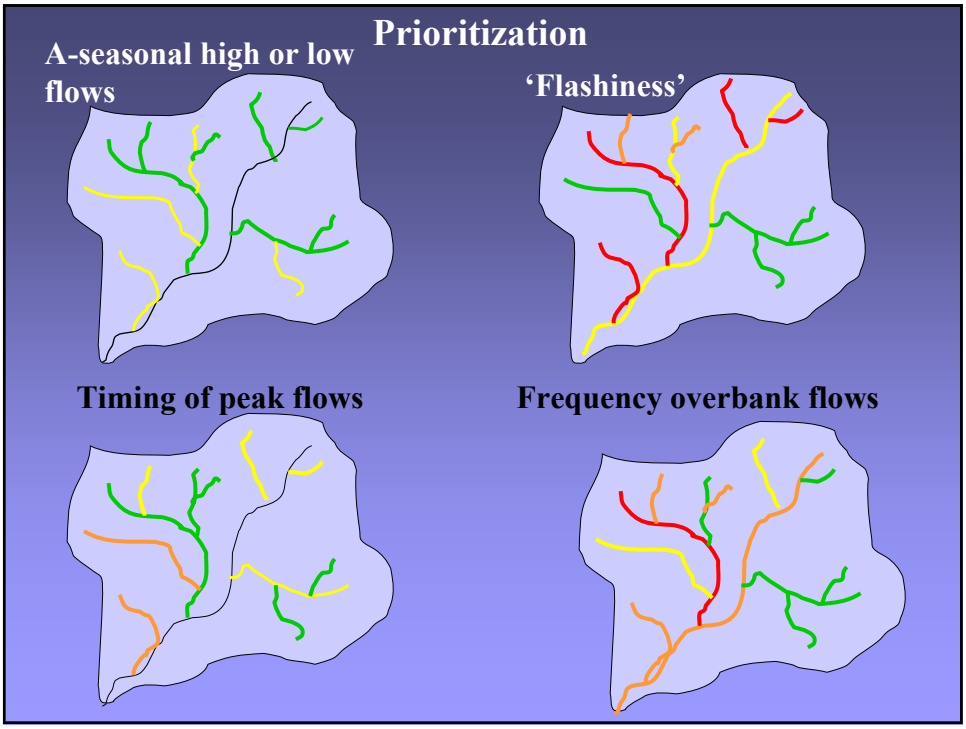
Predict effects of flow alteration on river health

Evaluate restoration actions under range of flow regimes

Flow Regimes and Restoration

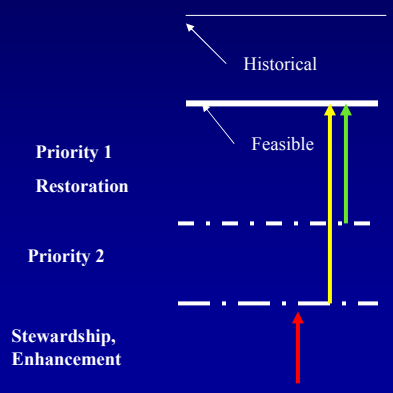
- Historical flow regimes/existing constraints
- Current flow regimes/limitations
- Prioritization
- Design





Restoration Design

- Feasibility
- Potential for success
- Goals and targets



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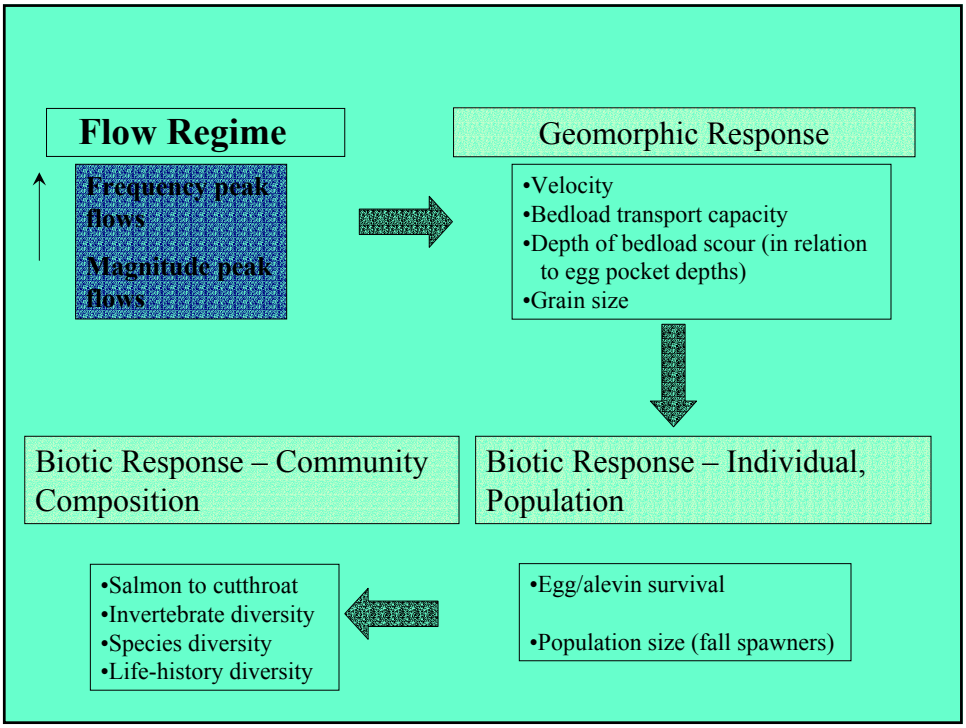
Flow Regime
Frequency peak flows
Magnitude peak flows
Geomorphic Response
•Velocity
•Bedload transport capacity
•Depth of bedload scour (in relation to egg pocket depths)
•Grain size
Biotic Response – Community Composition
Biotic Response – Individual, Population
•Salmon to cutthroat
•Invertebrate diversity
•Species diversity
•Life-history diversity
•Egg/alevin survival
•Population size (fall spawners)