Yakima River Summer Chinook Reintroduction:

Life History Characteristics and the Habitat Potential of the Yakima River

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Presentation Outline

I. Modeling Objectives

II. Background Information

1. Historical context and extirpation of summer chinook

III. Analysis

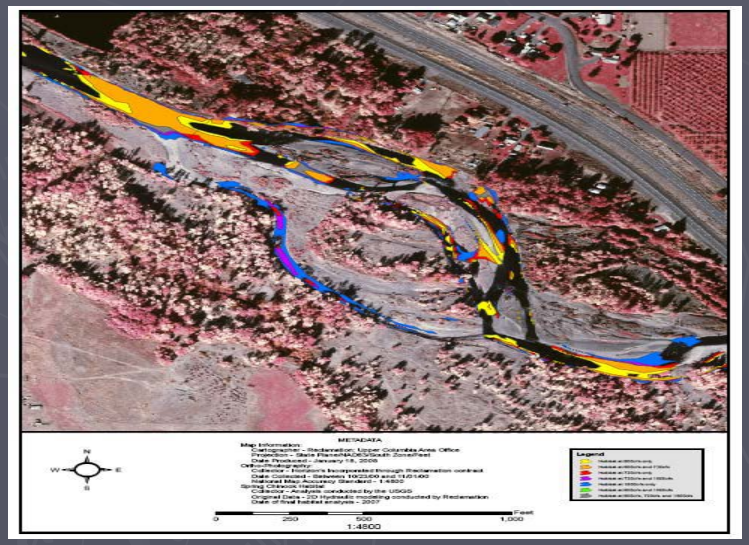
1. The EDT model: Nuts and bolts
2. Demographics & life history characteristics
3. Individual life history pattern analysis
4. Composite life history pattern analysis

Modeling Objectives

I. Integrate Life History with the spatial and temporal characteristics of Yakima River

1. Yakima River habitat: Sufficient to support a viable population of summer chinook?

Habitat: Spatial & temporal

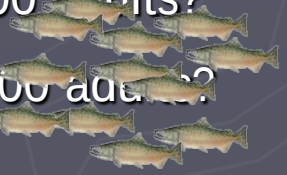


Graphic courtesy of J. Hubble, BOR

Donor Stock Life History Characteristics

200 adults?

+ 2000 adults?



Modeling Objectives

II. Biological hypothesis
   1. Influence of environmental characteristics:
      i. Viable life history patterns
      ii. Local adaptation

III. Adaptive management tool
   1. Assist M&E activities
   2. Artificial production
      i. Broodstock management (use of natural & hatchery origin adults)
      ii. Size and duration (#smolts released, adults needed for program)

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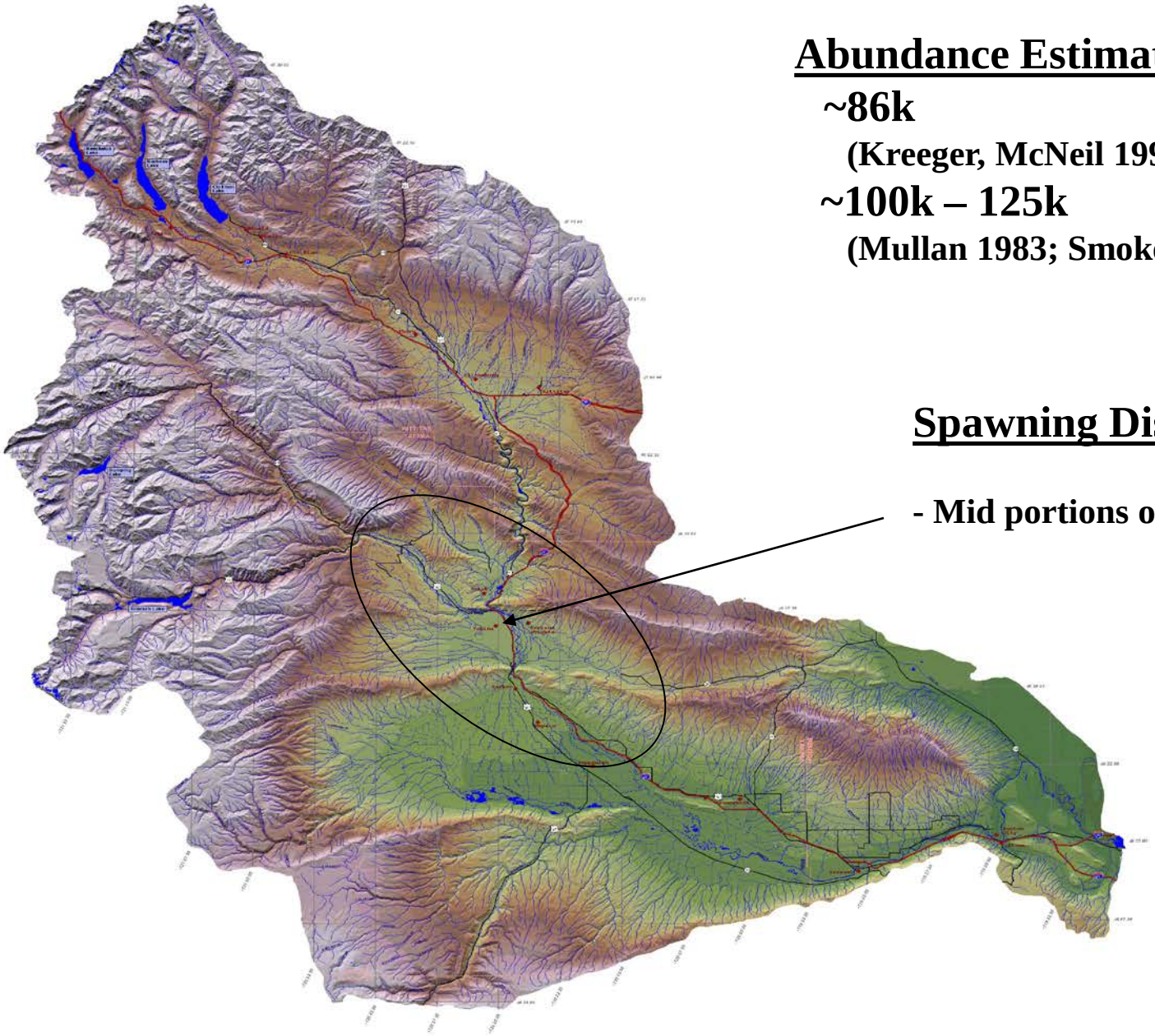
Historical Production of Summer Chinook



Abundance Estimates

~86k

(Kreeger, McNeil 1993)

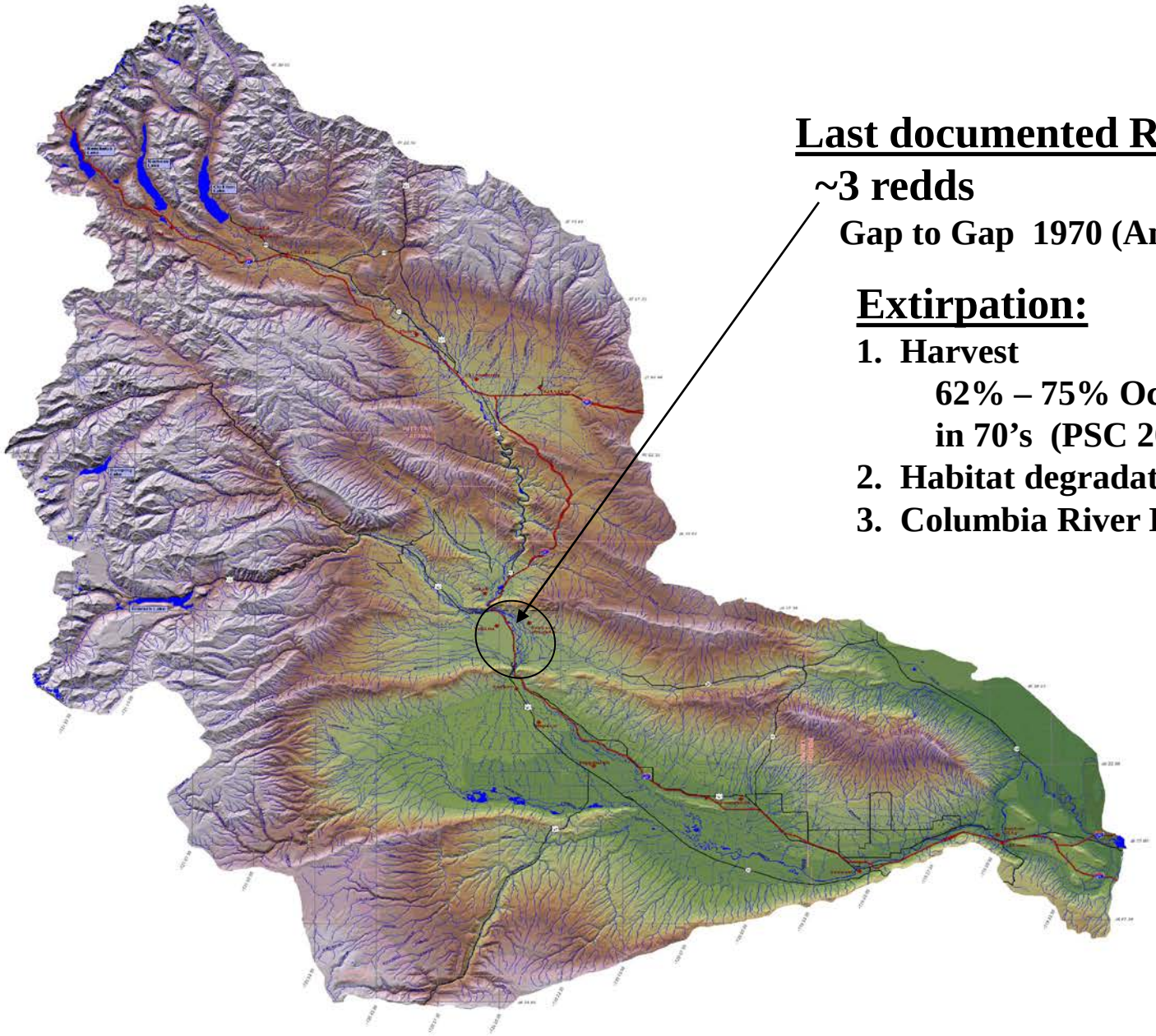
~100k – 125k

(Mullan 1983; Smoker 1956)

Spawning Distribution

- Mid portions of Yakima River

Extirpation of Summer Chinook



Last documented Redds?

~3 redds

Gap to Gap 1970 (Anon 1970)

Extirpation:

1. **Harvest**
   62% – 75% Ocean harvest in 70's (PSC 2004)
2. **Habitat degradation**
3. **Columbia River Hydro development**

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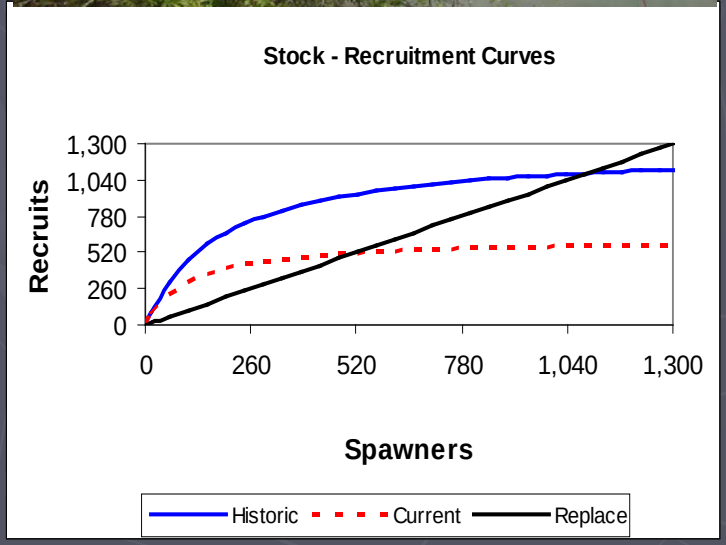
EDT Nuts & Bolts



I. Quality and quantity of available habitat
   1. Numerous abiotic & biotic attributes
      i. Individual stream reaches
         a. Homogenous physical characteristics
   2. Environmental variability
      i. Primary attributes
         a. Seasonal variability

- Spatial and temporal variability

II. Beverton-Holt production function
   1. Quantify productivity & capacity
      i. Across life stages & life history trajectories

III. Life history patterns (trajectories)
   1. User defined
   2. Weekly time step

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Demographics & Life History Characteristics

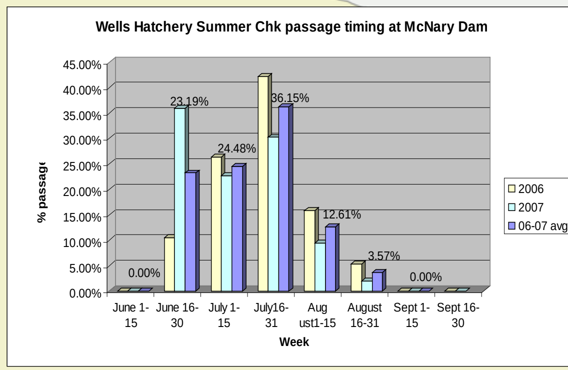
I. Static:
   1. Adult age structure
   2. Sex ratios
   3. Fecundity

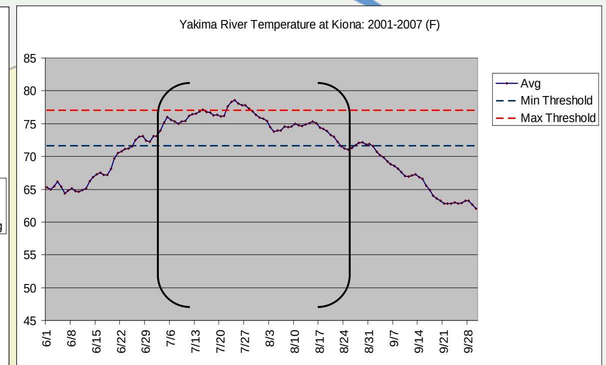
- Good information about donor stock
- Held constant

II. Complex:
   1. Adult migration & Holding
   2. Spawning & Emergence Timing
   3. Juvenile rearing/migration patterns

- Significantly influenced by environment
- Affect survival and natural selection of life history traits

Adult Migration & Holding



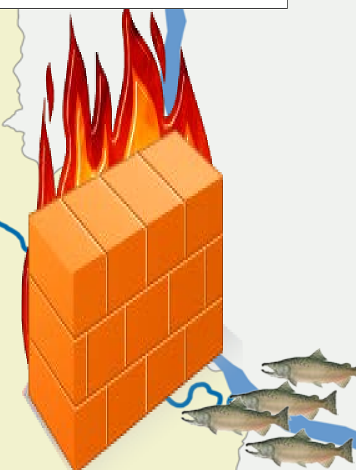


Estimating arrival time to Yakima River:

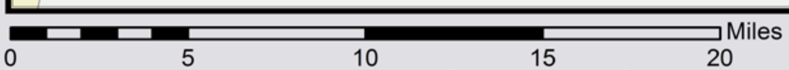
- Calibrated with upper Columbia smr chk
  1. McNary Dam into lower Yakima River

Temperature Profiles of Okanogan River:

1. No holding in Yakima (July & August)
   1. Mainly fish hold in Columbia River regardless of entry timing
2. Hold when temperatures exceed 22 c-



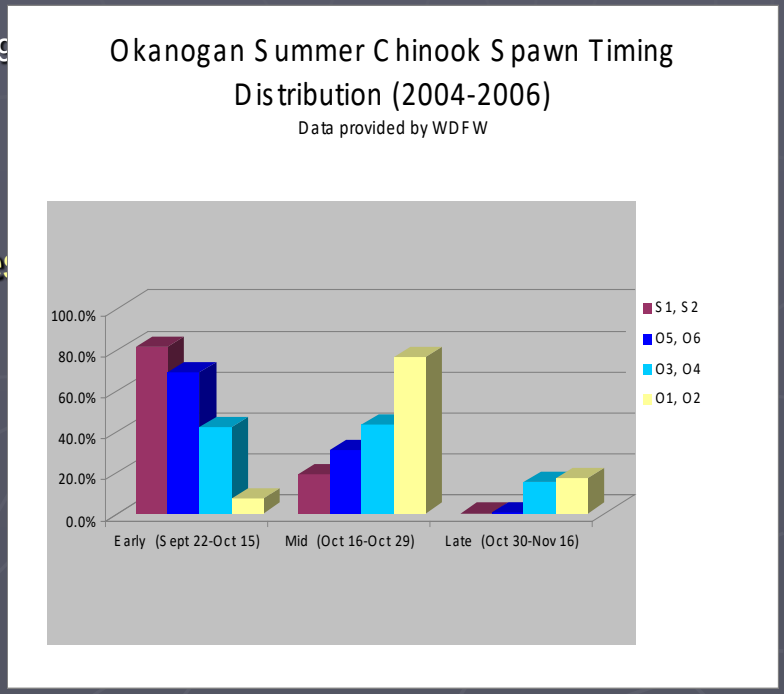
Lower Yakima River



Spawn Timing

I. Spawn Timing:
   1. Influenced & constrained
      - Temps > ~13C
   2. Delayed spawning, pre-spawn mortality
      - (Andrew, Green 1960 as cited by McCullough 199
   3. Acting mechanism
   4. Salmon continue upstream migration
      - Suitable temperatures
      - Commonly spawn earlier at higher latitudes
        - (T. Quinn 2005)

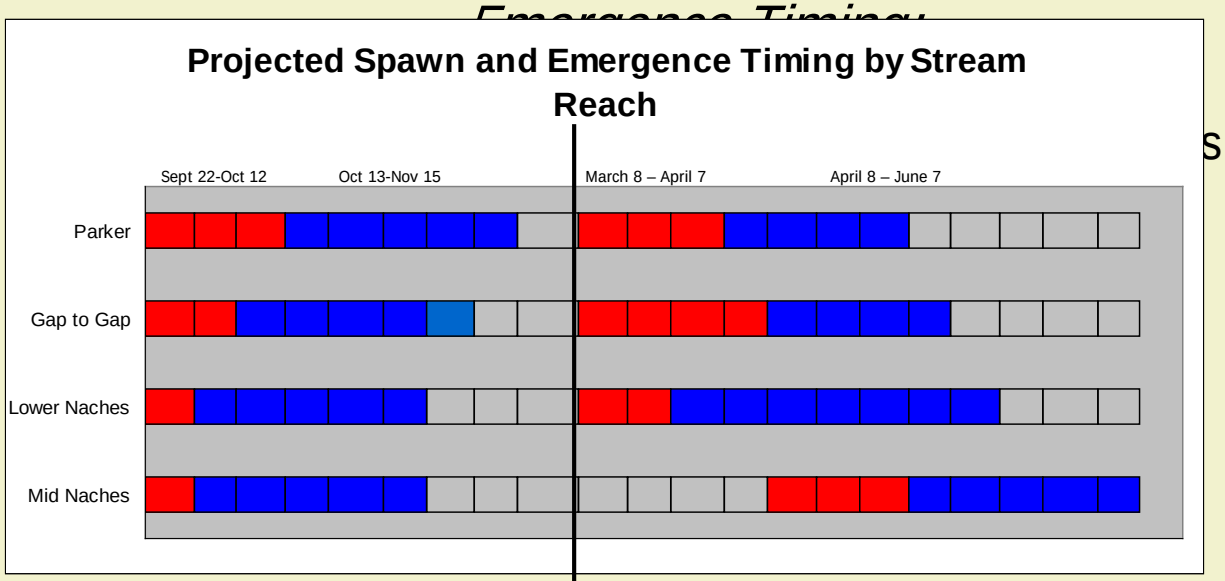
II. Examples:
   1. American River spring Chinook
      - Four weeks earlier than Naches
      - Six weeks earlier than upper Yakima
   2. Okanogan summer Chinook
      - Shift in distribution
        - Higher to lower elevation reaches



Mid Naches Reach

Lower Naches Reach

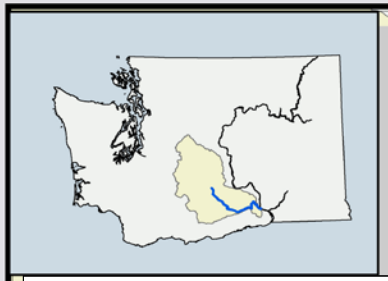
Gap to Gap Reach

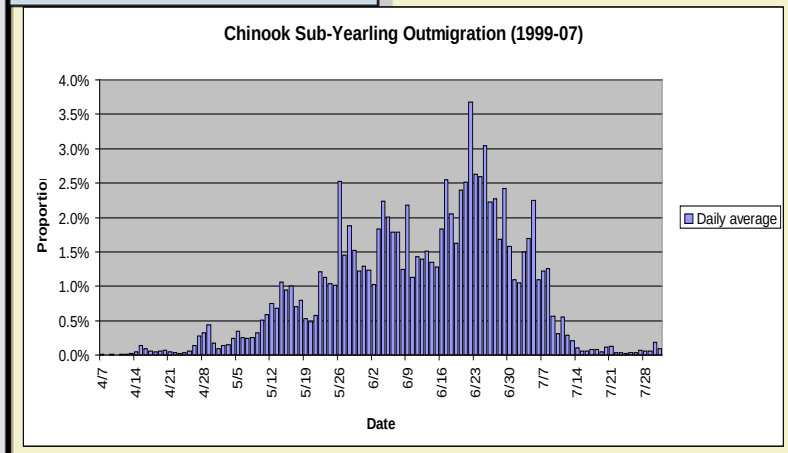


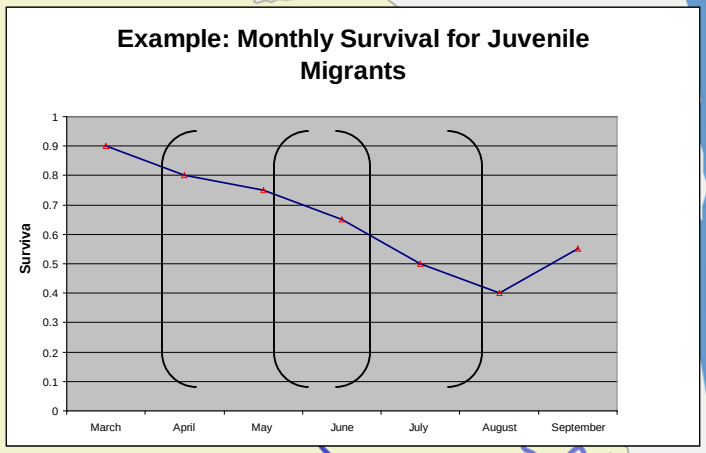
Mid Yakima River

Parker Reach

Spatial & Temporal Effects of Environment: Life-stage Productivity







Columbia River

Yakima R.-1B

Yakima R.-1E

Yakima R.-2

Yakima R.-2A

Yakima R.-2C

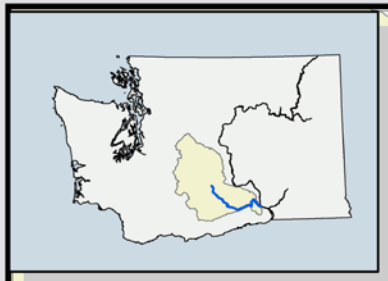
Yakima R.-2D

Yakima R.-2E

Cumulative survival

Lower Yakima River

Miles



Juvenile Rearing/Migration Patterns: (Upper Columbia)

1. Ocean type- Sub yearling Spring/summer movement to Columbia River with continuous rearing to estuary

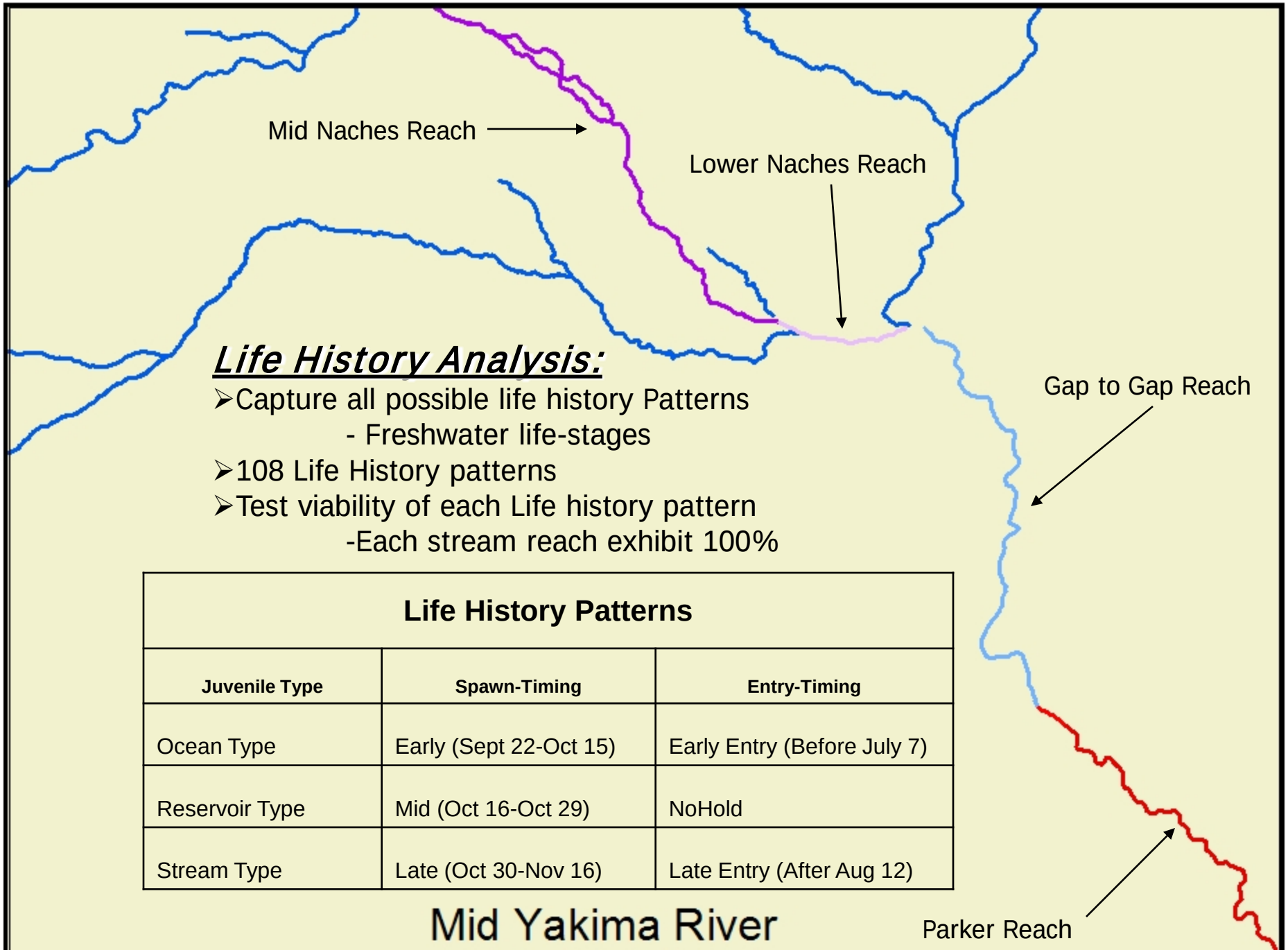
2. Reservoir type- Sub yearling spring/summer movement to Columbia River for over-wintering

3. Stream type- Rear in vicinity of spawning location, migrate following spring as yearling

Lower Yakima River

Miles

0 5 10 15 20



Life History Analysis:

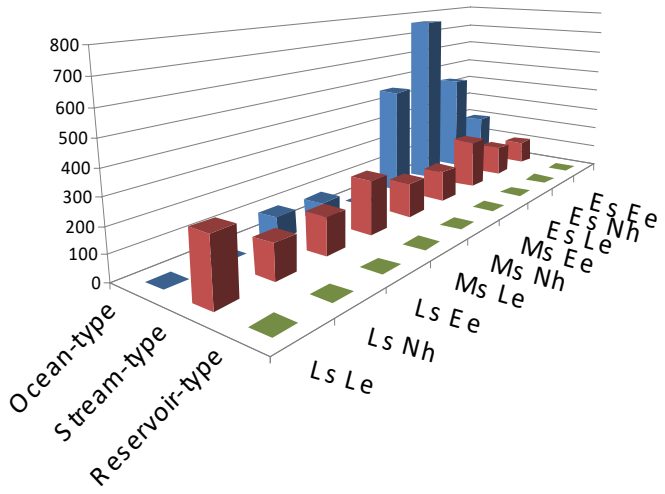
- Capture all possible life history Patterns
  - Freshwater life-stages
- 108 Life History patterns
- Test viability of each Life history pattern
  - Each stream reach exhibit 100%

Life History Patterns		
Juvenile Type	**Spawn-Timing**	**Entry-Timing**
Ocean Type	Early (Sept 22-Oct 15)	Early Entry (Before July 7)
Reservoir Type	Mid (Oct 16-Oct 29)	NoHold
Stream Type	Late (Oct 30-Nov 16)	Late Entry (After Aug 12)

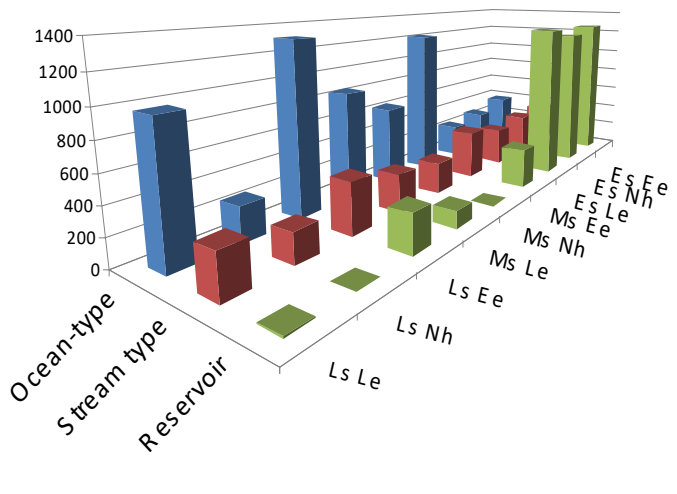
Mid Yakima River

Individual Reach and Life History Pattern Analysis

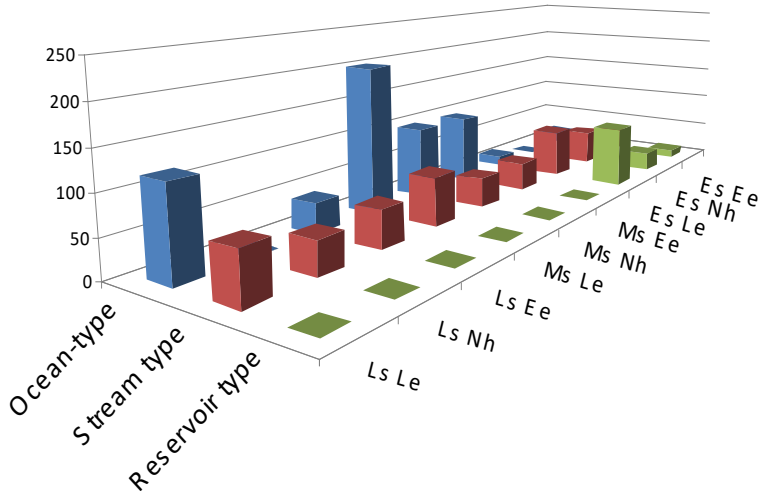
Mid Naches Reach



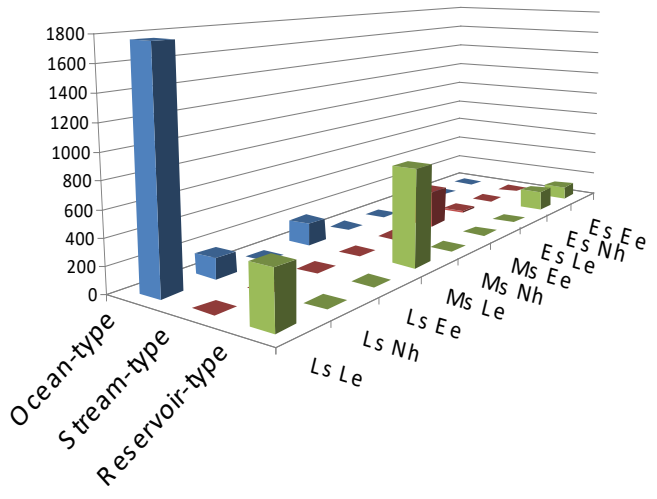
Gap to Gap Reach



Lower Naches Reach



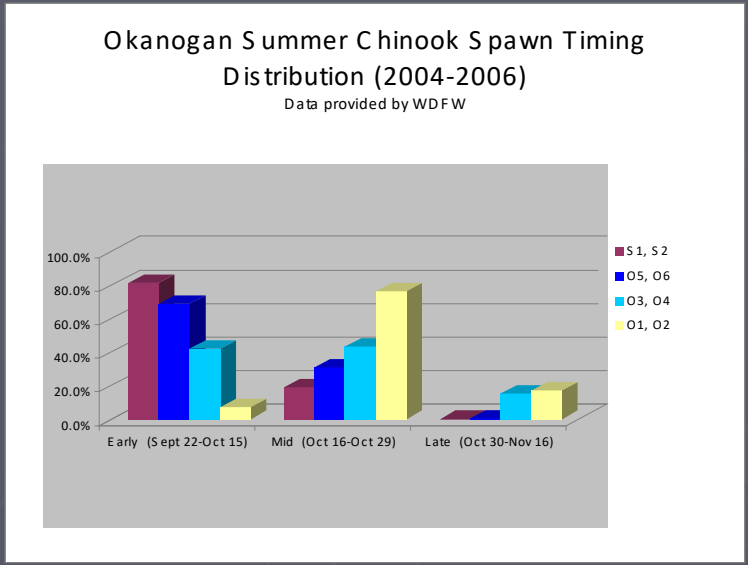
Parker Reach



Composite Life History/Reach Analysis:

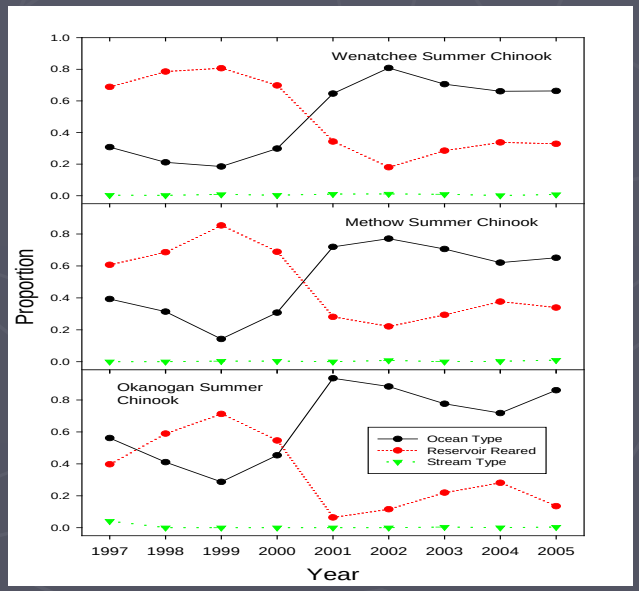
1. Spawn Timing:

Stream Reach	Spawn Timing		
	Early (Sept 22-Oct 15)	Mid (Oct 16-Oct 29)	Late (Oct 30-Nov 16)
Parker	7.0%	76.2%	16.8%
Gap to Gap	41.8%	42.9%	15.4%
Lower Naches	68.7%	30.9%	0.5%
Mid Naches	80.9%	19.2%	0.0%



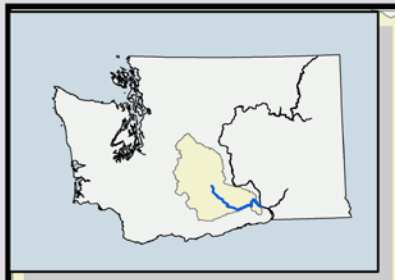
2. Juvenile rearing type composition

-49% Ocean Type
-49% Reservoir Type
-2% Stream Type



Analysis and graph provided by WDFW

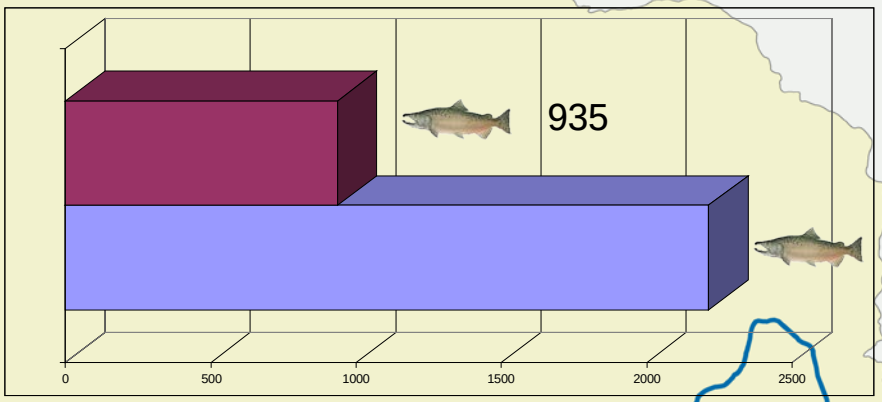
Composite Life History/Reach Analysis:



Adult migration timing:

1.) No Hold

2.) 25% Early/75% Late



Other model assumptions:

-Does not include harvest

-Represents habitat potential of fully adapted population

Lower Yakima River

Miles

0 5 10 15 20

Initial Conclusions

1. Yakima River has potential to support a natural producing population
   - Large capacity but limited productivity (survival)
2. Adult migration timing
   - Significantly influence abundance
3. Spawn timing
   - Initiation of spawning potentially limited by temperature regimes
   - Timing can significantly influence stream reach productivity
4. Emergence timing & Juvenile out-migration timing
   - Temporal characteristics of habitat seem to favor early emergence and out-migration
5. Differences in viable life history patterns across stream reaches will promote and maintain life history diversity of entire population
6. M&E:
   - Monitoring spawn timing: Shifts and or changes in spawn timing may be a strong indicator that local adaptation is occurring

Acknowledgements:

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- WDFW
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Questions?