Genetic Stock Identification of Juvenile Chinook Salmon in the Columbia River Estuary: Results from Estuary-wide Surveys, 2010 - 2011

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Why an estuary-wide genetics survey?

Estuary restoration is key for the recovery of threatened and endangered stocks of Columbia River salmon because the estuary provides a productive nursery ground for juvenile salmon.

- Near-shore and off-channel areas sampled in recent estuary surveys are occupied by Chinook salmon juveniles from several genetically distinct stock groups.

- With the exception of spring run fish from interior basin, juveniles from all Chinook salmon ESUs frequent these shallow water areas with a variety of alternative habitat pathways for migration and feeding.

- Stock-specific patterns of habitat use vary widely:
  - spatially (e.g., lower vs upper estuary)
  - temporally (spring vs summer)
  - by juvenile life-history type (fry, fingerling, yearling)

Why an estuary-wide genetics survey?

Strategic restoration planning will benefit from an estuary-wide description of stock-specific Chinook salmon distributions.

- In the current study, the consistent timing, frequency, and scale of the sampling provides the first synoptic view of these distributions.

- Objective of current study:

  Characterize the seasonal and spatial distribution of Chinook salmon genetic stock groups in near-shore habitats throughout the estuary

  Emphasis is on tidal reaches from Rkm 75 to Bonneville Dam.

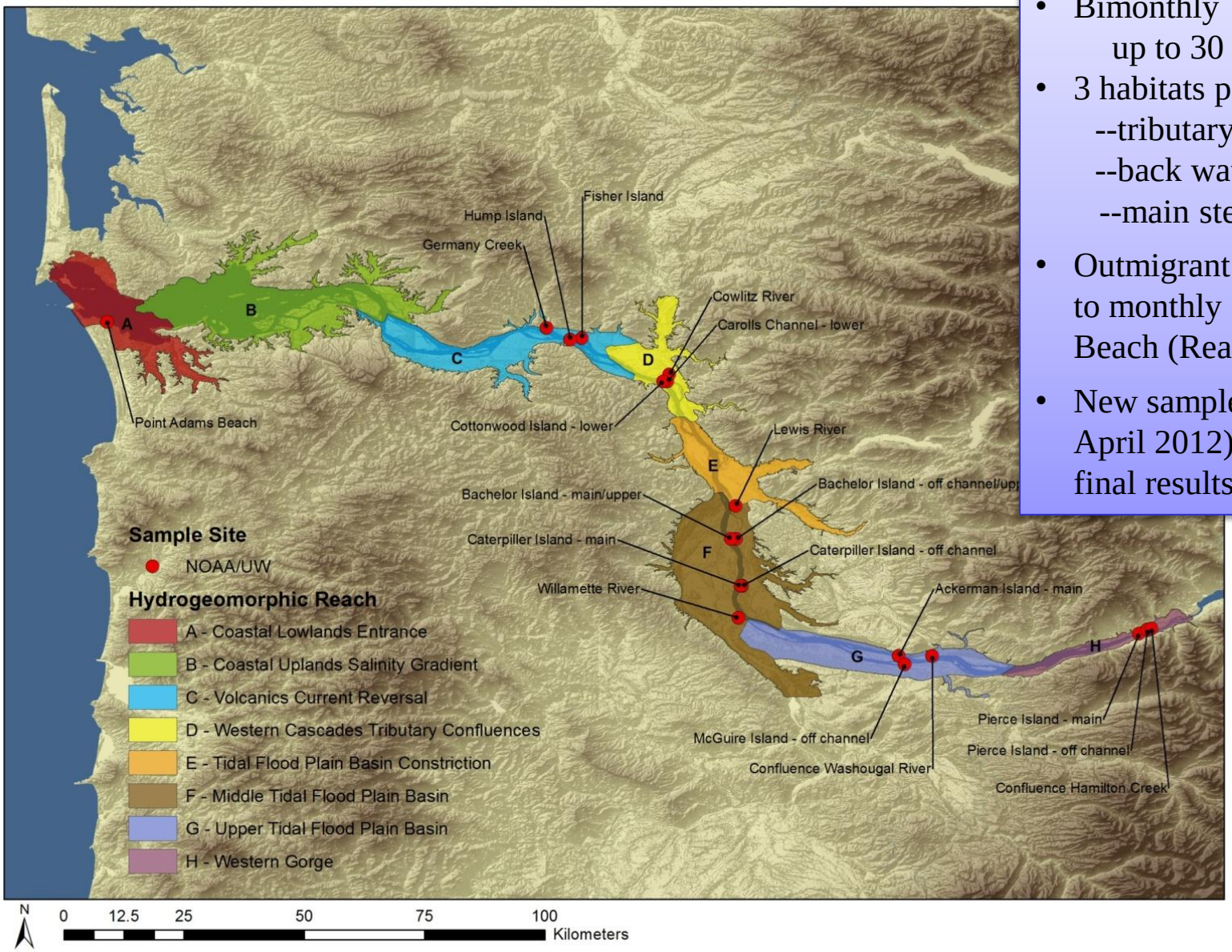
NOAA / UW Estuary-Wide Genetics Survey

How are genetic stock groups distributed throughout the estuary?

"Simultaneous" sampling across the estuary

- bimonthly beach seine surveys (for two years)
- hydrogeomorphic reaches C – H
- three habitats (in close proximity) per reach
  - main-stem channel
  - back water
  - tributary confluence systems (near the main-stem channel)
- outmigrant stocks sampled at Point Adams Beach (Reach A)
- fin clips from up to 30 juvenile Chinook salmon per site

NOAA / UW Estuary Genetics Surveys
2010 - 2011



- Bimonthly
  up to 30 samples per site
- 3 habitats per reach (C-H):
  --tributary confluence
  --back water
  --main stem
- Outmigrant stocks biweekly to monthly at Point Adams Beach (Reach A)
- New samples (February-April 2012) will be added to final results

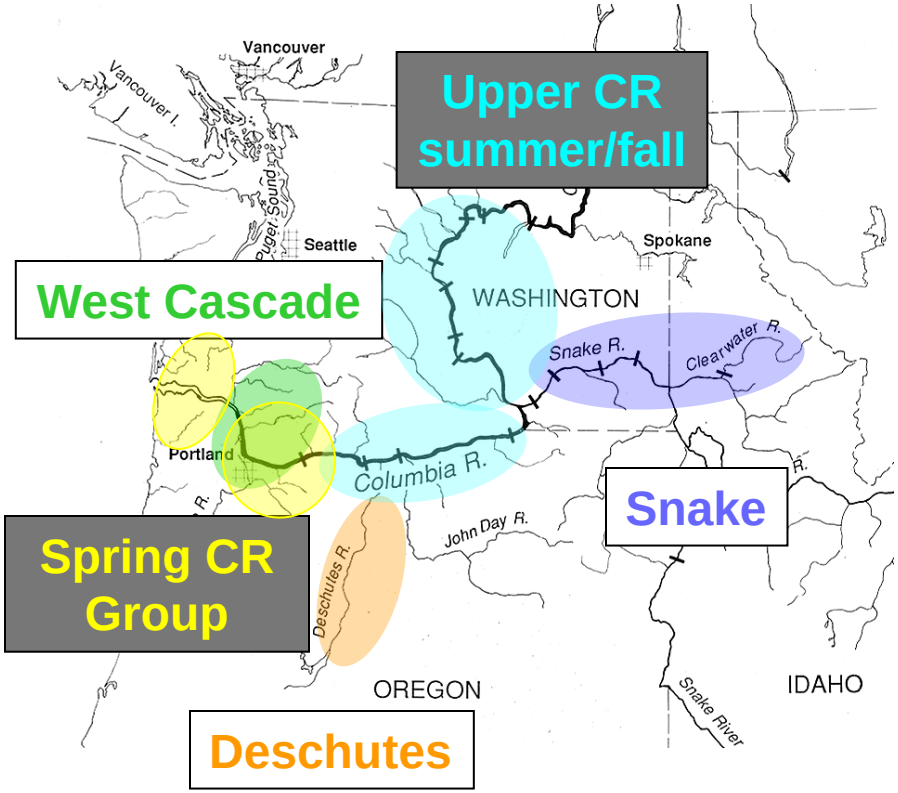
Microsatellite DNA-based estimates of genetic stock origins

- "Baseline" of standardized DNA data for CR Chinook salmon
  GAPS (Genetic Analysis of Pacific Salmonids)
- Genetic stock origins are *estimated*
  - not *determined*, as with tags
- Estimates are to major genetic stock groups (e.g., ESU)
- Genetically distinct populations exist within the genetic stock groups ("cryptic" in this analysis)
- Past and ongoing transplants of hatchery fish confound geographic sources of genetic stocks

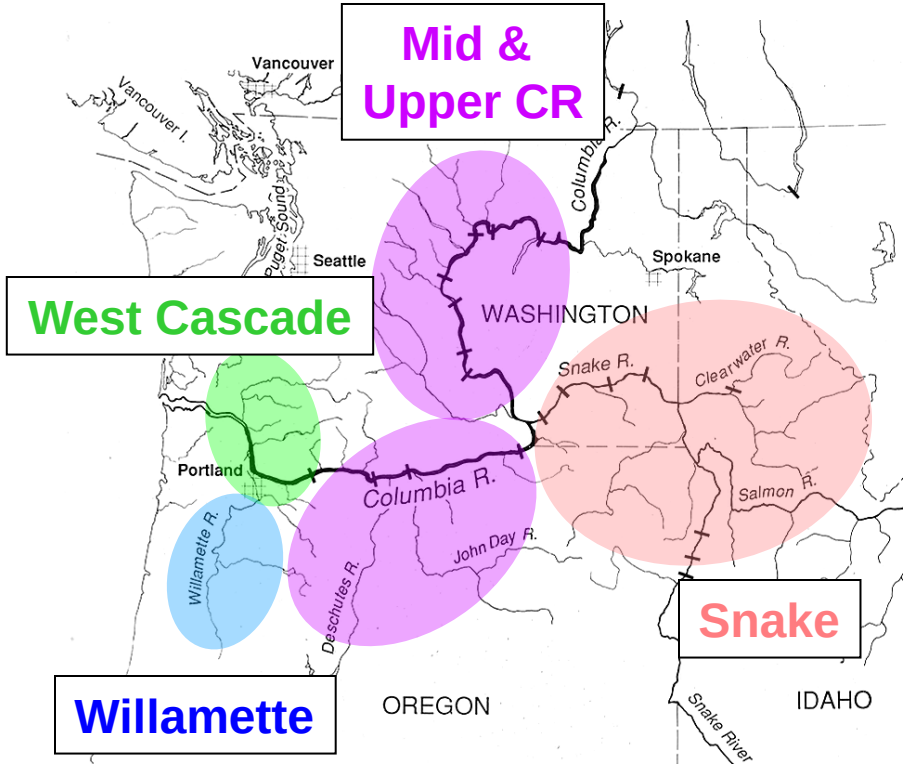
Columbia River Basin Chinook Salmon

Genetic Stock Groups Resolved with GAPS Microsatellite Loci

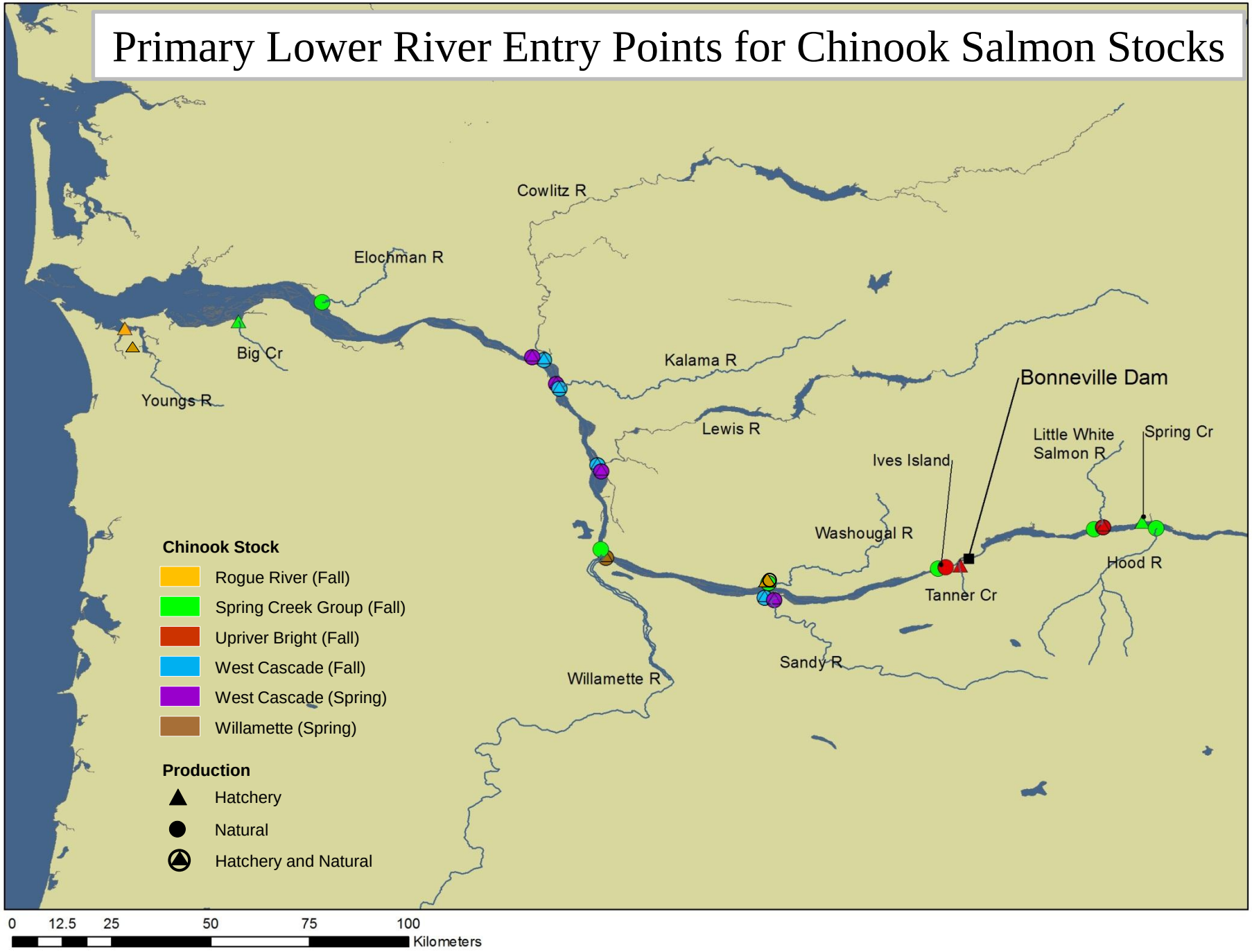
Fall Run



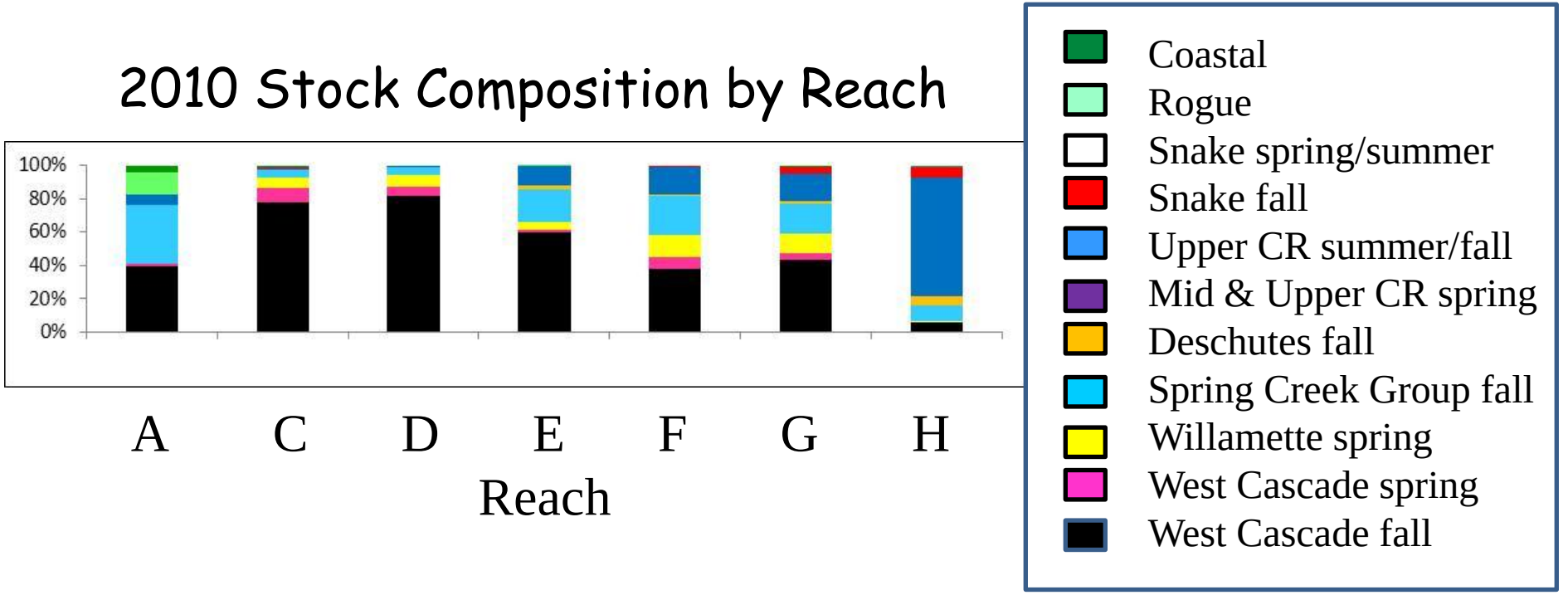
Spring Run



Primary Lower River Entry Points for Chinook Salmon Stocks



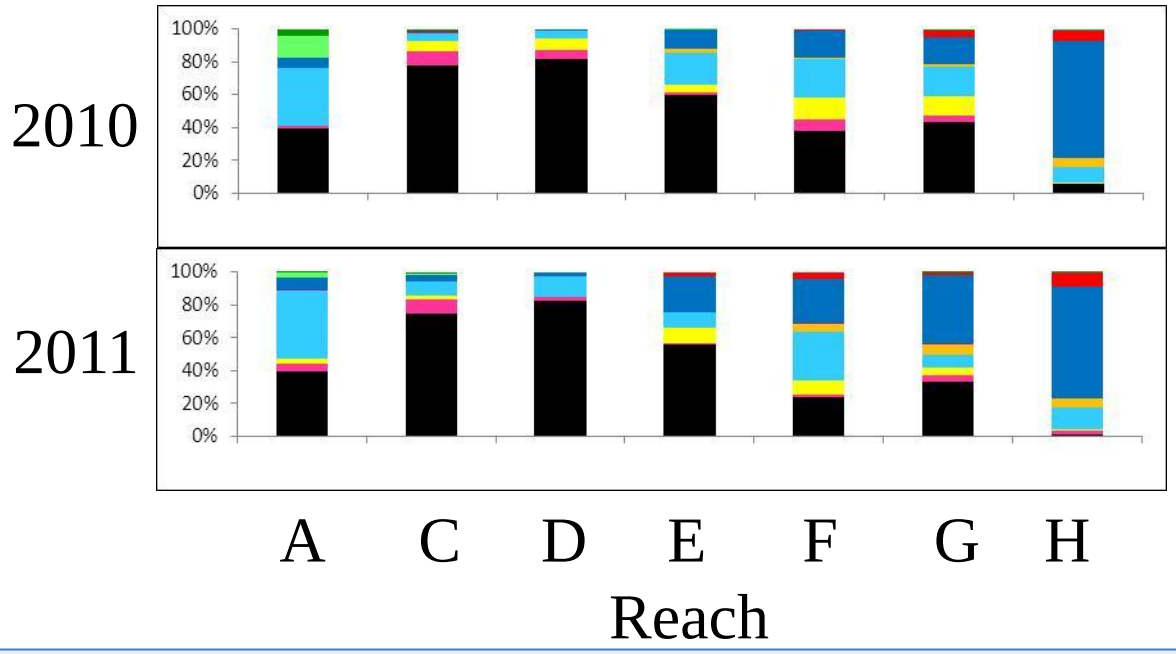
Stock compositions differ among reaches



- **West Cascade falls predominate in C - E**
- **West Cascade and Willamette springs and Spring Creek Group falls in most reaches**
- **Upper CR summer/fall in upper reaches, especially H**
- **Small proportions of Snake falls in the upper estuary**
- **Rogue and coastal fish in Reach A**

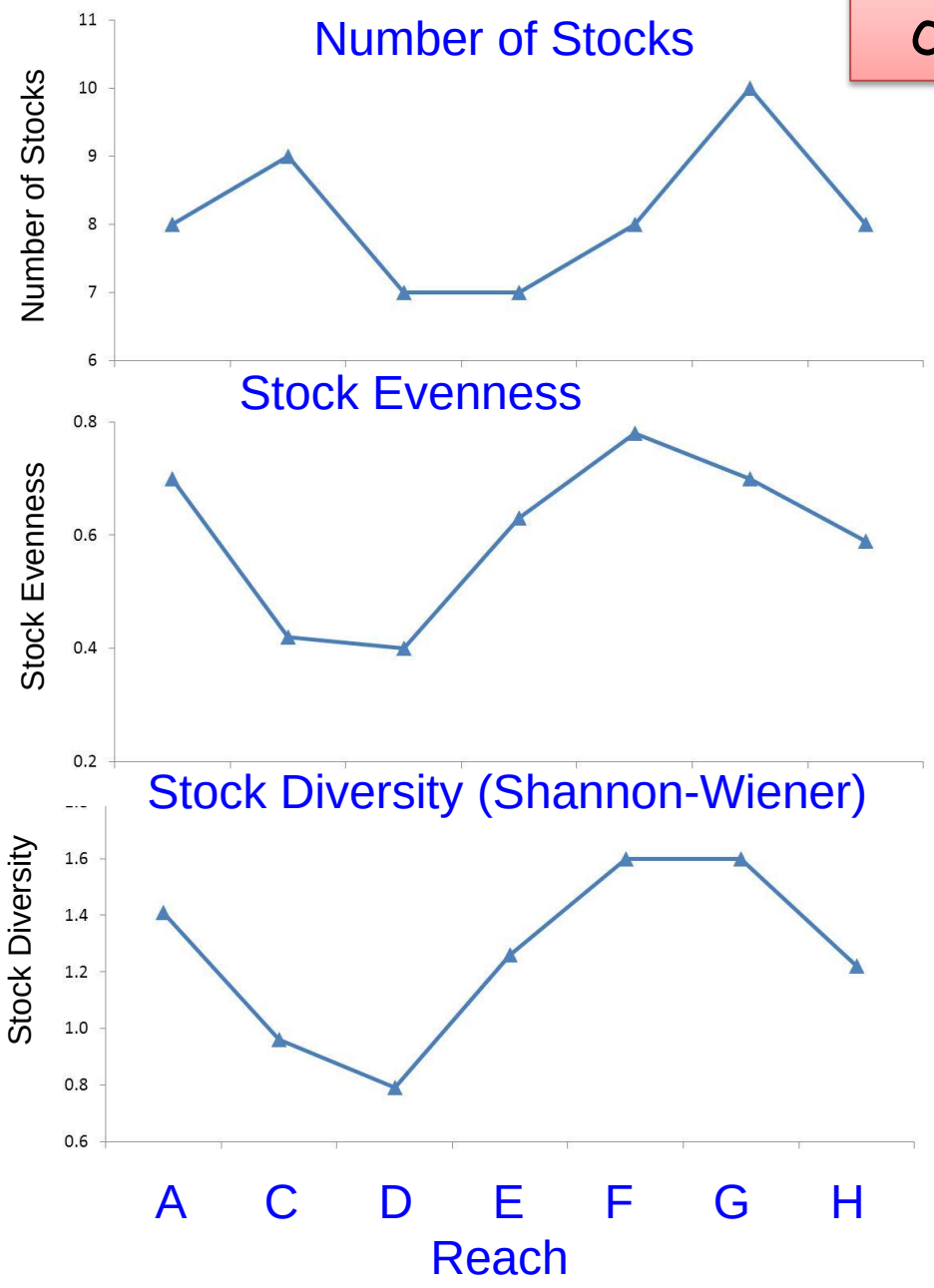
Stock compositions in the two years are similar

Stock Composition by Reach and Year



- **Patterns are consistent among years**
- **But …**
  - **A few significant differences (e.g., in reaches A & G)**
  - **Genotypic variability among years is much greater than variability in stock composition**
- **Years combined:**
  - **Significant differences (genotypic and stock composition) among all reaches except C and D**
  - **E and F are also very similar**

How does stock diversity compare among the reaches?



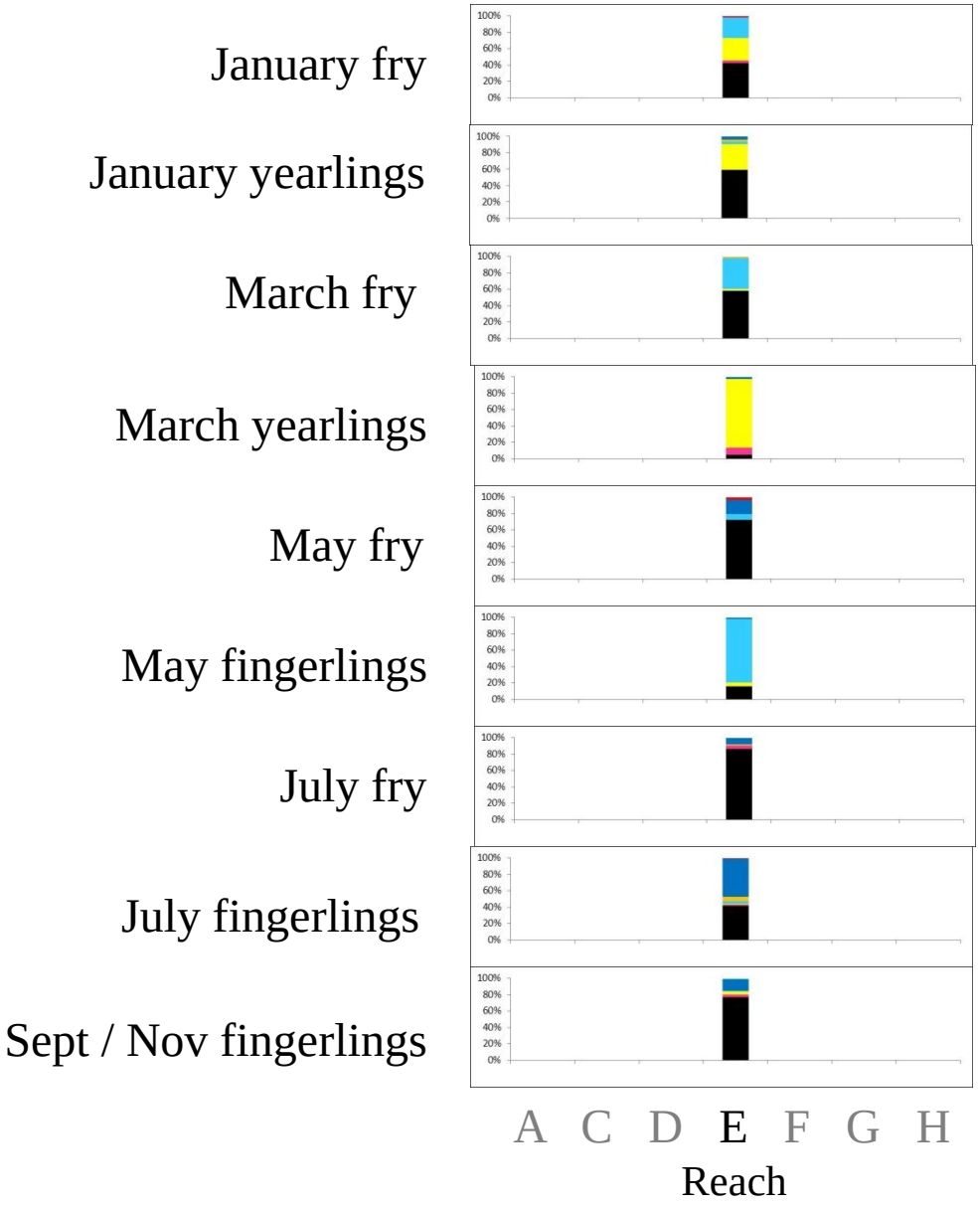
- Stock diversity greatest in upper estuary (Reaches F & G)

  and in lower estuary (Reach A)

- Lowest diversity in Reaches C & D

- Intermediate levels of diversity observed in Reaches E & H

Reach E Stock Compositions by Month and Life-history type



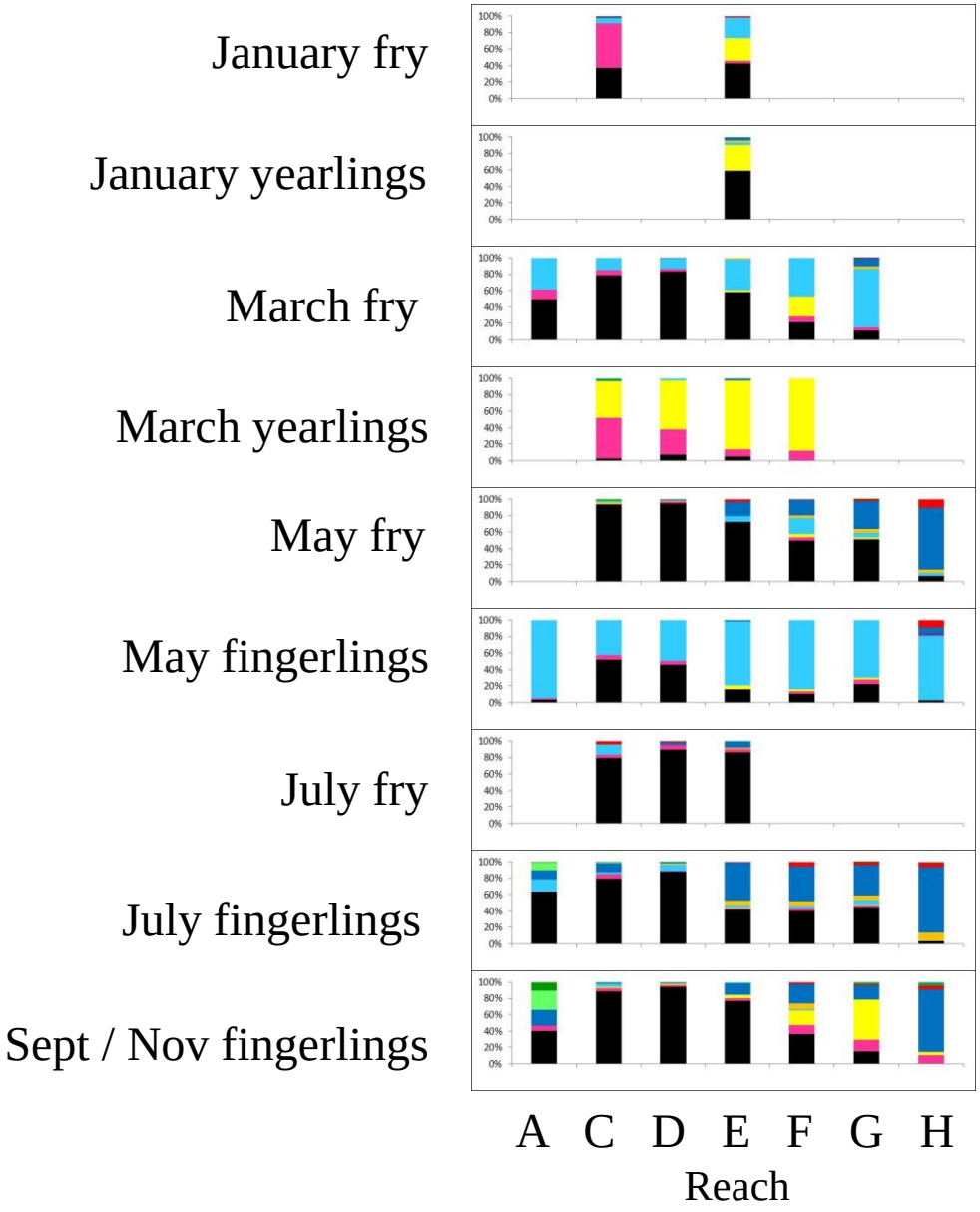
Fry ≤ 60mm

Fingerling > 60mm

Yearling by size and month

- Coastal
- Rogue
- Snake spring/summer
- Snake fall
- Upper CR summer/fall
- Mid & Upper CR spring
- Deschutes fall
- Spring Creek Group fall
- Willamette spring
- West Cascade spring
- West Cascade fall

Stock Compositions by Month and Life-history type



Reach-scale spatial structure

within -

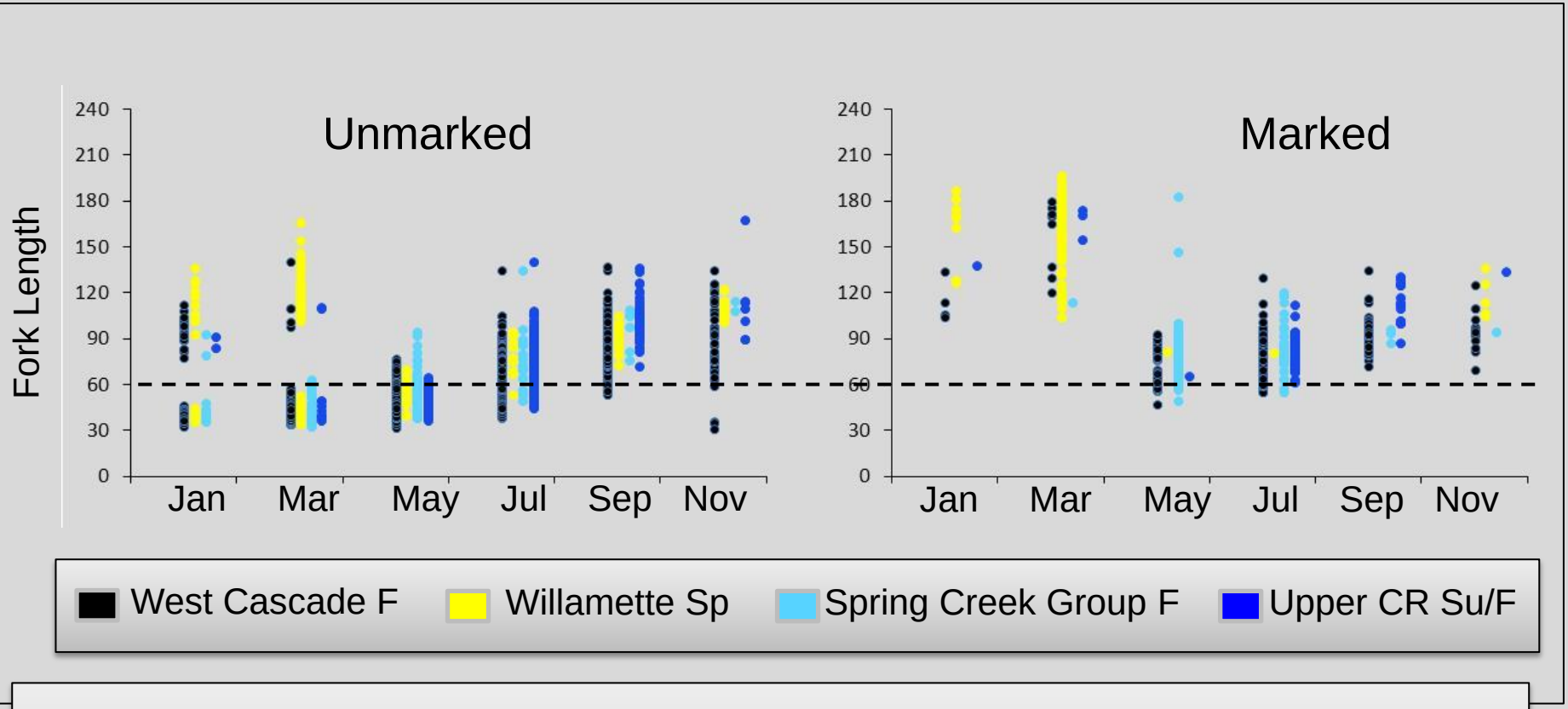
-- a “single” temporal snapshot

-- a size-based life-history type

- Coastal
- Rogue
- Snake spring/summer
- Snake fall
- Upper CR summer/fall
- Mid & Upper CR spring
- Deschutes fall
- Spring Creek Group fall
- Willamette spring
- West Cascade spring
- West Cascade fall

Fish size by month, stock, hatchery mark

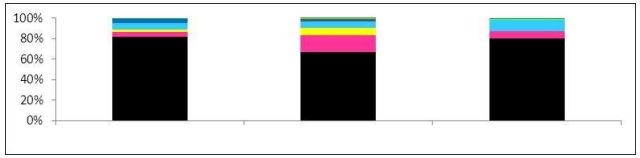
Four Major Stocks are Shown

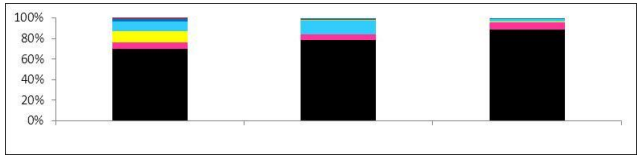


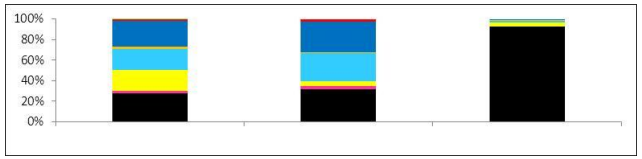
Naturally Produced Fish	Hatchery fish
Highly variable in size	Compact size distribution
All 4 stocks express multiple life-histories	Less diversity (defined by size and time)
Fry present 7 months or more	Fry nearly absent

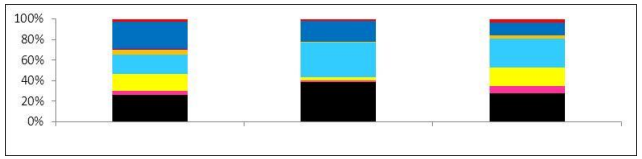
Stock Compositions by Habitat Type

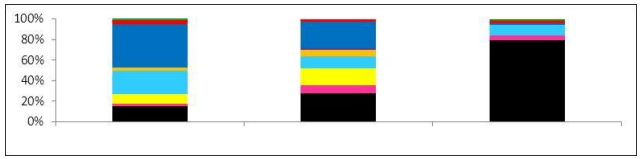
Confluence Site

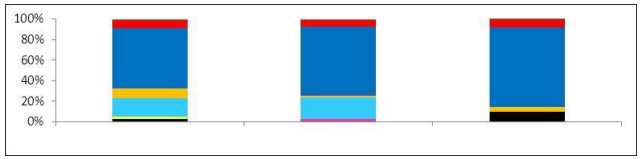
C  Germany Cr

D  Cowlitz R

E  Lewis R

F  Willamette R

G  Washougal R

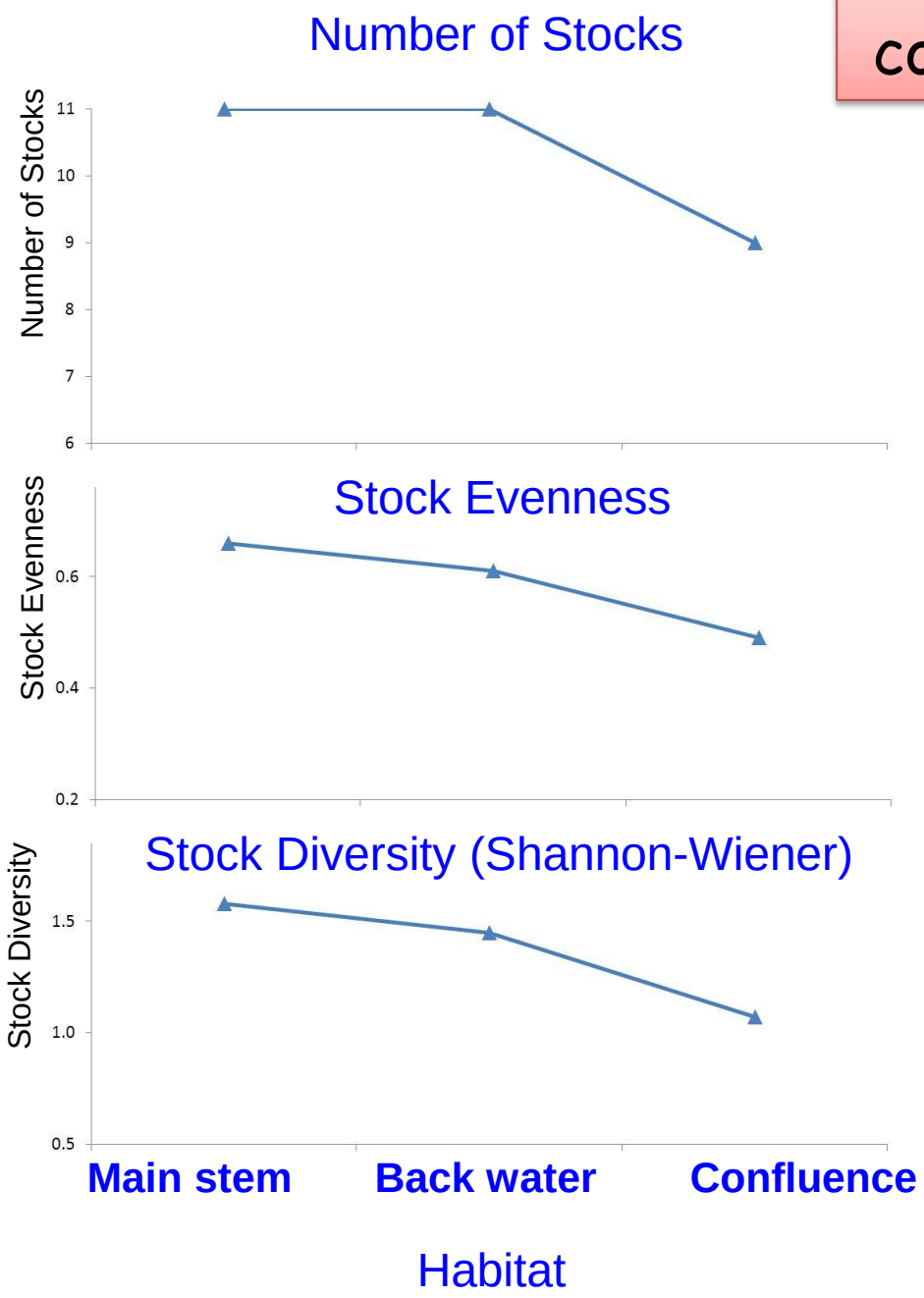
H  Hamilton Cr

Main stem Back water Confluence

Local production predominate at many confluences sites?

- Coastal
- Rogue
- Snake spring/summer
- Snake fall
- Upper CR summer/fall
- Mid & Upper CR spring
- Deschutes fall
- Spring Creek Group fall
- Willamette spring
- West Cascade spring
- West Cascade fall

How does stock diversity compare among habitat types?



- Diversity values are similar in main stem and back channel habitats
- Diversity is lower in confluence habitats
  -- likely due to larger numbers of locally produced fish

Findings 2010 - 2011 Surveys

- Nearshore estuary habitats were occupied by 11 genetically distinct stocks
- Stock compositions varied seasonally and by life-history type in all reaches
- Spatial structure in stock compositions ---
  Stock proportions differed among reaches: overall and also within temporal "snapshots" and for each life-history type
- Reaches C and D were similar (and E was most like F)
- Stock diversity was greatest in F and G (and lowest in C and D)
- Life-history variability (defined by size and time) was greater for naturally produced fish than for hatchery fish. This pattern was consistent among stocks.
- Our confluence sites had less stock diversity than main stem and back water sites (except for Willamette River).

Management Implications

- The juvenile Chinook salmon occupying nearshore habitats in the estuary are from several genetically distinct stocks. Habitat improvements may therefore benefit populations in multiple Chinook salmon ESUs.

- However, stock diversity is not uniform across the estuary or among sites. Improvements to habitats in reaches F and G may benefit a particularly diverse array of Chinook salmon populations. We are conducting focus studies in additional Reach F habitats as a follow up to these initial findings.

- Specific stocks may be particularly affected by management actions in some reaches (e.g., West Cascade fall Chinook salmon in reaches C and D, Upper Columbia summer/fall stock in Reach H, etc.). However, impacts on minor stocks should not be overlooked.

Management Implications

- Monitoring efforts need to consider seasonal patterns to stock-specific rearing and migration pathways. Autumn or winter sampling is likely to provide a different picture of Chinook salmon habitat use than sampling during periods of peak abundances.

- Estuarine habitat restoration should be coordinated with hatchery and harvest management. For example, habitat restoration may provide little benefit in areas where local populations are being replaced with or "swamped" by non-natal stocks produced in large-scale fishery augmentation projects.

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