2008 Columbia River Estuary Conference: *Ecosystem Restoration*

RESOLVING UNCERTAINTY NECESSARY TO CONDUCT STRATEGIC RESTORATION IN THE COLUMBIA RIVER ESTUARY TO SUPPORT RECOVERY OF WILD SALMON

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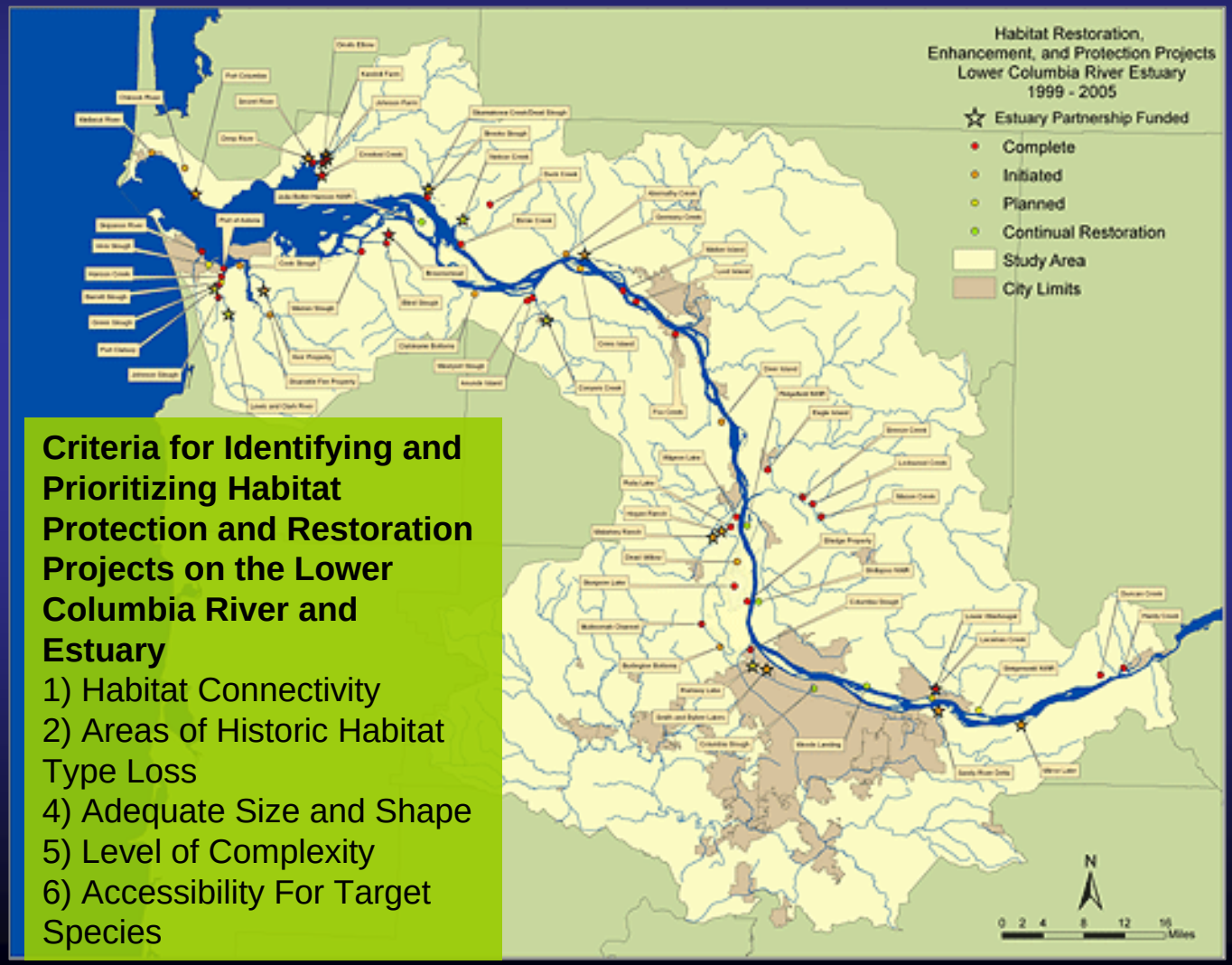
CONTRIBUTION OF ECOSYSTEM RESTORATION, ENHANCEMENT AND PROTECTION ACTIONS

- comprehensive
- diverse
- opportunistic
- haphazard
- expedient
- identified and designed with optimum contribution to salmon recovery in mind?

…..is “build it and they will come” a viable strategy?



Criteria for Identifying and Prioritizing Habitat Protection and Restoration Projects on the Lower Columbia River and Estuary

1) Habitat Connectivity
2) Areas of Historic Habitat Type Loss
4) Adequate Size and Shape
5) Level of Complexity
6) Accessibility For Target Species

STRATEGIC PLANNING

"*Strategic planning* [as opposed to general enhancement] *aims to address a specified outcome such as conserving populations of a species, protecting groups of species, retaining all species and their associated functions, or reintroducing species that have disappeared from an area.*"

Lambeck, R.J., and R.J. Hobbs 2002 Landscape and Regional Planning for Conservation: Issues and Practicalities. Pp. 360-380 in K.J. Gutzwiller (ed.) Applying Landscape Ecology in Biological Conservation. Springer

FACTORS CONTRIBUTING TO UNCERTAINTY

Are we using our understanding or conducting research to resolve uncertainty in:

1. salmon species and life history variability?
2. metrics of contribution to salmon recovery?
3. organization of estuary?
4. appropriate scales and organization of restoration?
5. metapopulation structure and status?

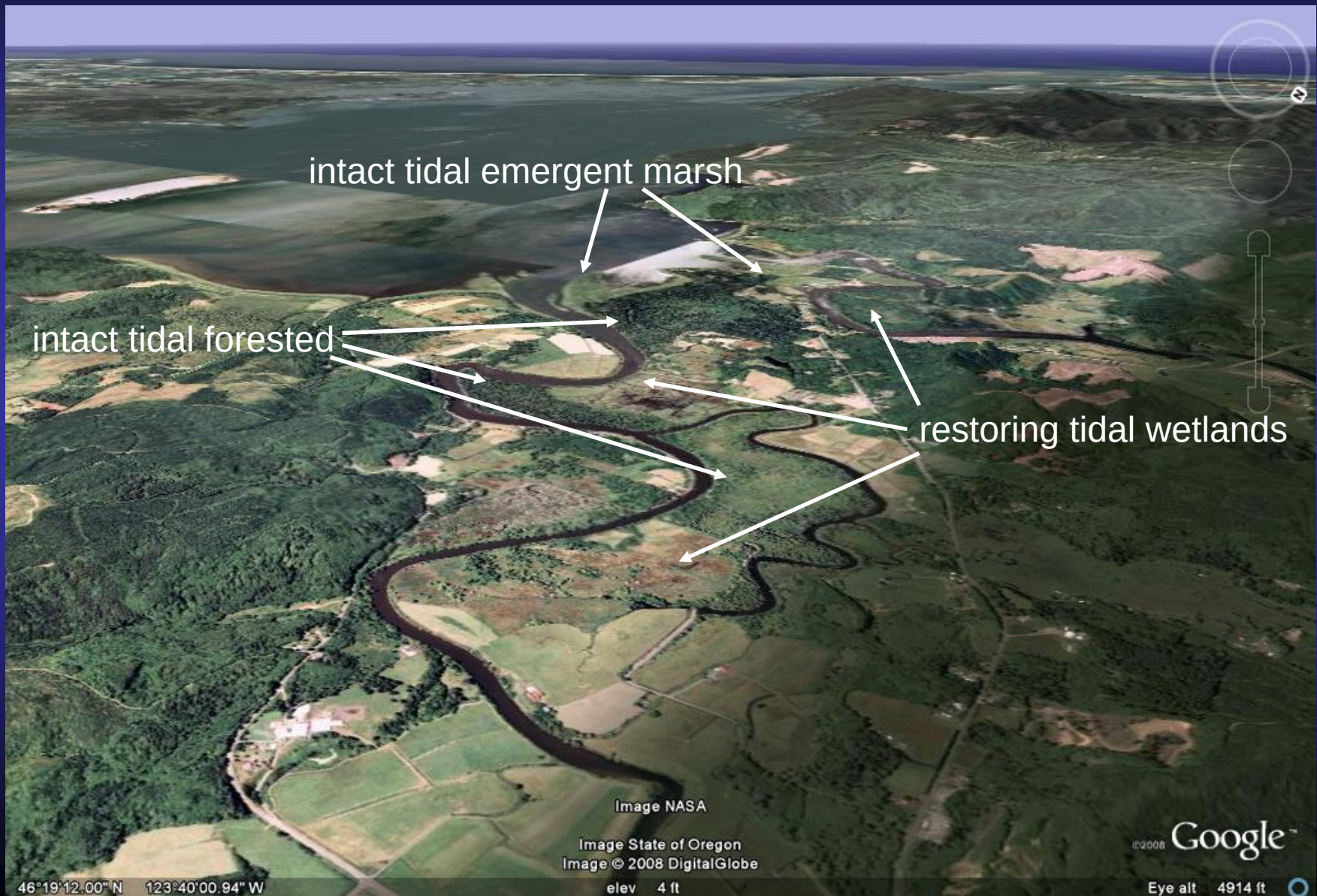
1. SALMON SPECIES AND LIFE HISTORY VARIABILITY

- focus on ocean-type due to stronger dependence on shallow water habitat (but, what about stocks that have variable ocean- vs. stream-type composition?)
- emphasis on ocean-type Chinook, chum and, to a lesser (than warranted?) extent coho
- not all ocean-type salmon are alike….they appear to interact with the landscape differently

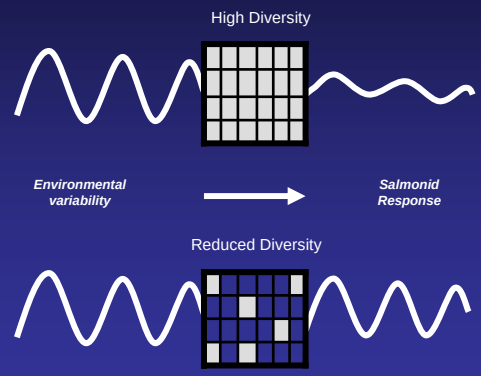
1. SALMON SPECIES AND LIFE HISTORY VARIABILITY

SPECIES	WATERSHED EMIGRATION	ESTUARINE RESIDENCE	POSSIBLE LIFE HISTORY TYPES	ESTUARINE HABITAT CHARACTERISTICS AND OCURRENCE
pink	immediate and rapid; as fry	very short; ~2 weeks	1	shallow water
chum	immediate; as fry	short-moderate; 2-3 weeks	10	shallow shorelines in brackish, euryhaline waters; emergent marsh and scrub-shrub forested sloughs and tidal channels; eelgrass and mud/sandflats
sockeye	rapid; as fry	often extensive; 1 week-5 months	1	tidal marshes in oligohaline-brackish waters
coho	variable; as fry and fingerlings	long? may involve protracted summer or overwintering, with return upstream to rear?	1-5?	off-channel sloughs and beaver ponds on oligohaline surgeplain; scrub-shrub, forested tidal wetland channels; may have high fidelity
Chinook	variable; rapid as fry, longer as fingerlings	extremely variable; days to 6 months	36	oligohaline-euryhaline wetlands and shallows; localized in brackish waters

1. SALMON SPECIES AND LIFE HISTORY VARIABILITY



2. METRICS OF CONTRIBUTION TO SALMON RECOVERY

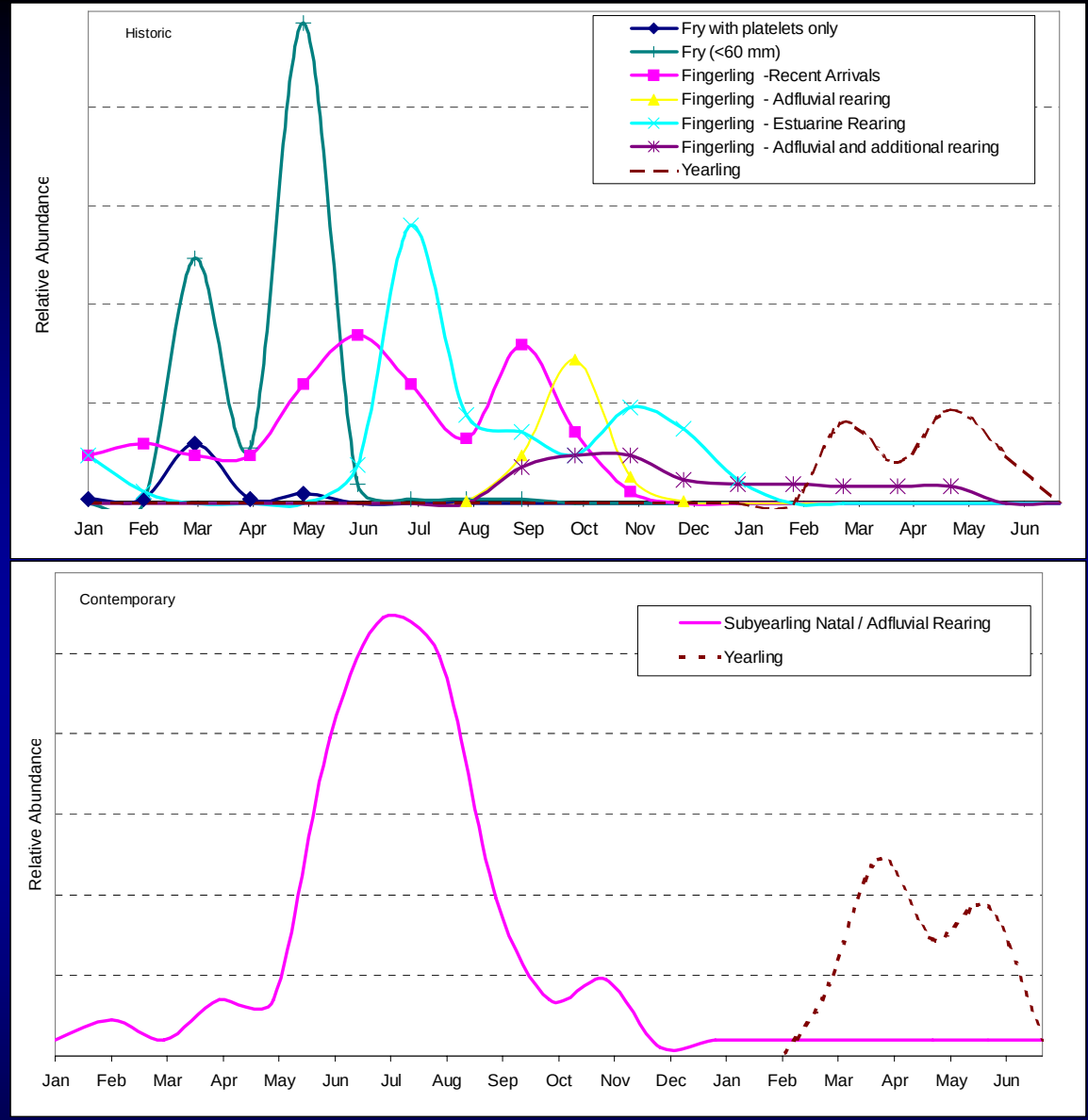


- focus on rebuilding resilience, not optimum production *per se*
- spatial (habitat) losses linked to sustainability of production
- for some species and life history types, estuarine habitat (restoration) has potential to recover metapopulation diversity degraded in watershed, harvest and hatcheries
- need to understand factors limiting diversification of juvenile salmon behavior in estuary

2. METRICS OF CONTRIBUTION TO SALMON RECOVERY

- salmon have evolved complex life cycles that require an extended chain of habitats—different habitat requirements and responses to habitat conditions
- geographic pattern and richness of populations depend on the number of different habitat combinations (pathways) that allow life-cycle closure
- salmon resilience and productivity in a variable environment depends on life-history diversity, which reflects the variety of habitat opportunities
- salmon recovery requires restoring opportunities for diverse life history expression

HISTORIC LOSS IN JUVENILE CHINOOK SALMON LIFE HISTORY DIVERSITY IN THE COLUMBIA RIVER ESTUARY

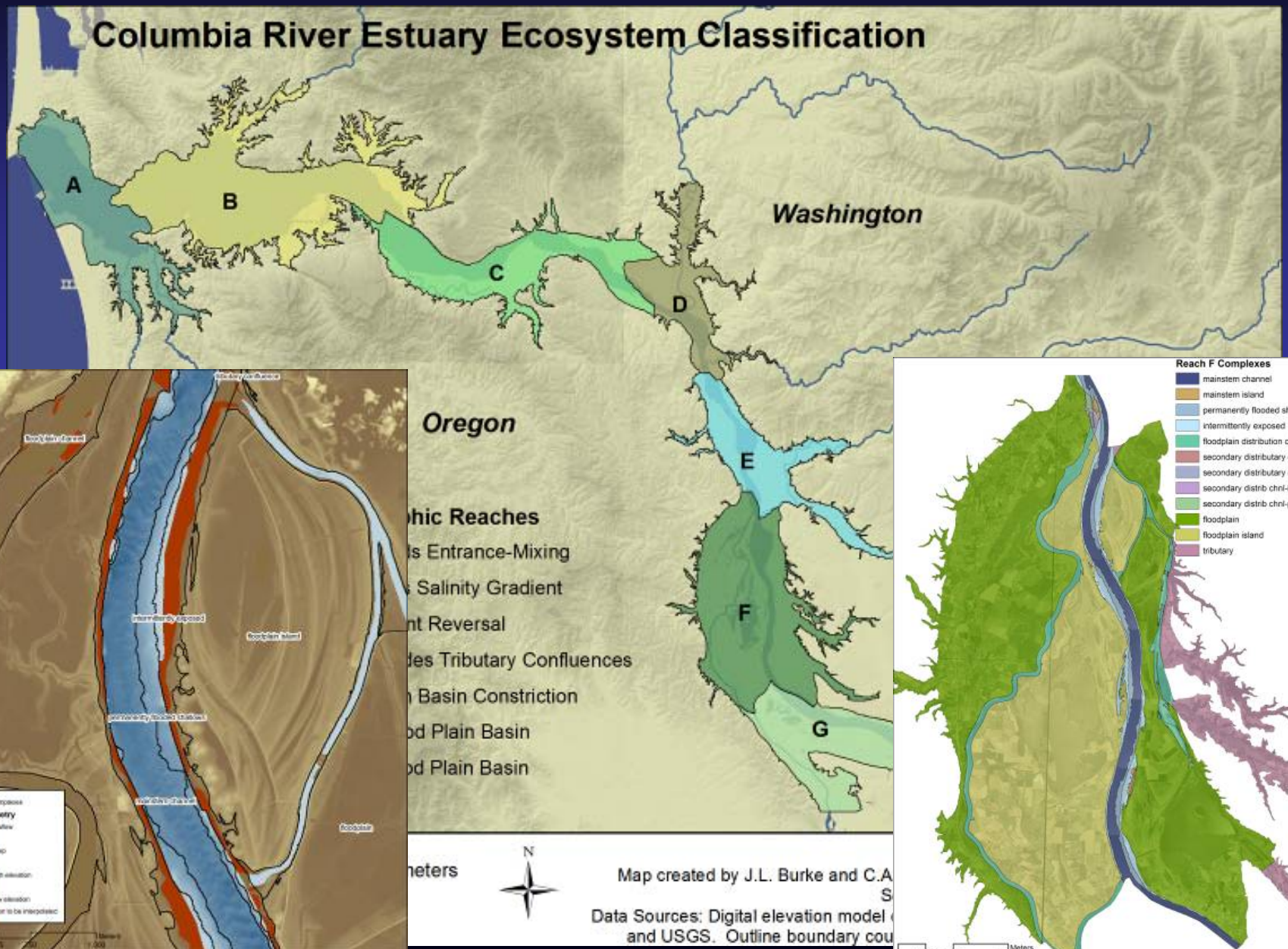


Historic and contemporary early life history types for one-brood year of chinook salmon in the Columbia River estuary. Historic timing and relative abundance based on historic sampling throughout the lower estuary (Rich 1920). Contemporary timing and relative abundance derived from Dawley et al. (1985) sampling at Jones Beach (Bottom et al. in prep.)

3. ORGANIZATION OF ESTUARY

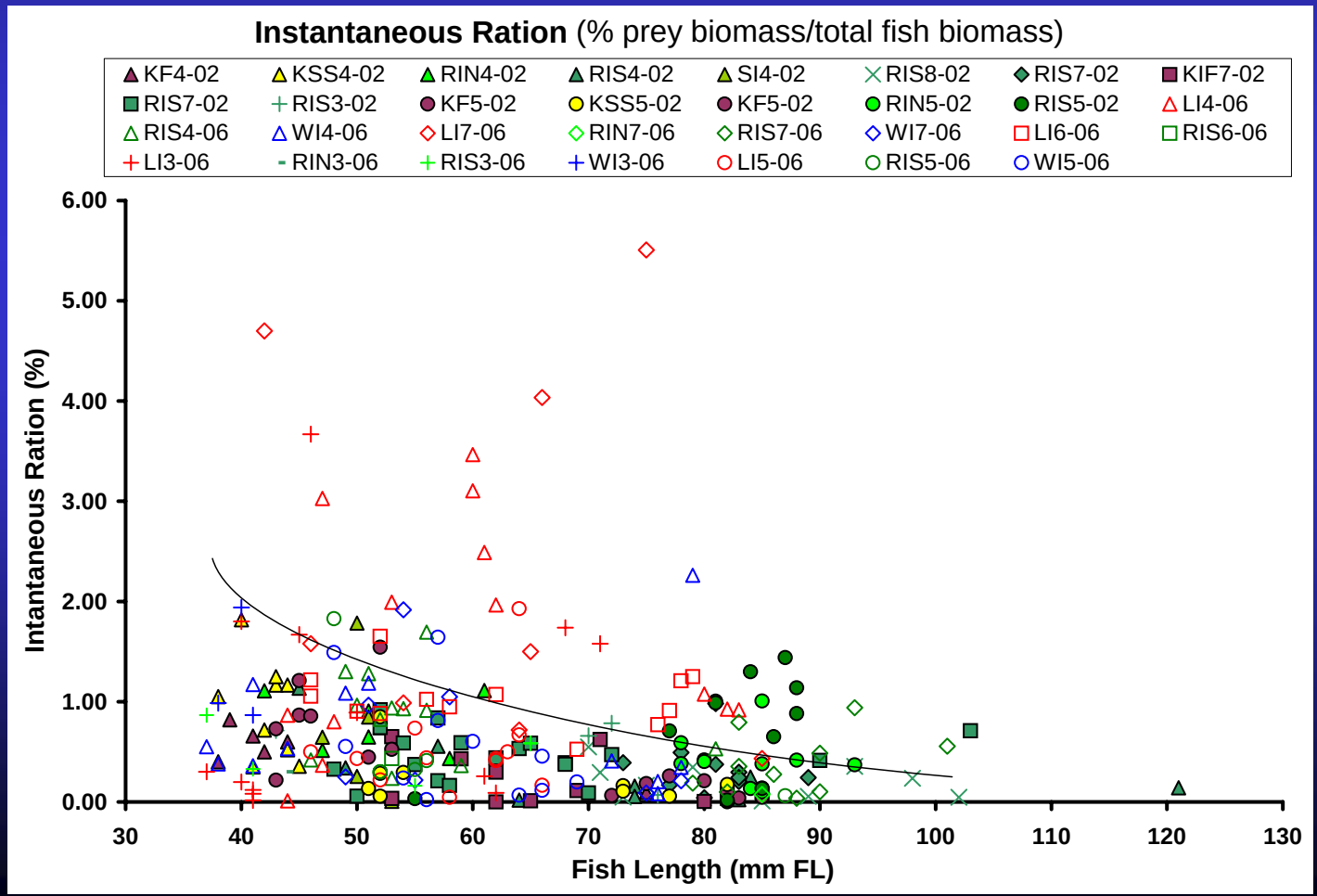
- Position matters!
- Habitat opportunities vary along breadth of estuarine gradient
  - hydrological, geomorphic and ecological characteristics change with fluvial-tidal transition
  - complex structure of Columbia River estuary likely contributed to salmon diversity
  - species and life history type defines habitat opportunities
  - does metapopulation watershed also define opportunities?
- What habitats and positions cannot be substituted?

3. ORGANIZATION OF ESTUARY



4. APPROPRIATE SCALE AND ORGANIZATION OF RESTORATION

Indices of Juvenile Chinook Foraging Success in Different Tidal Wetland Habitats of Lower Columbia River Estuary 2002-2006

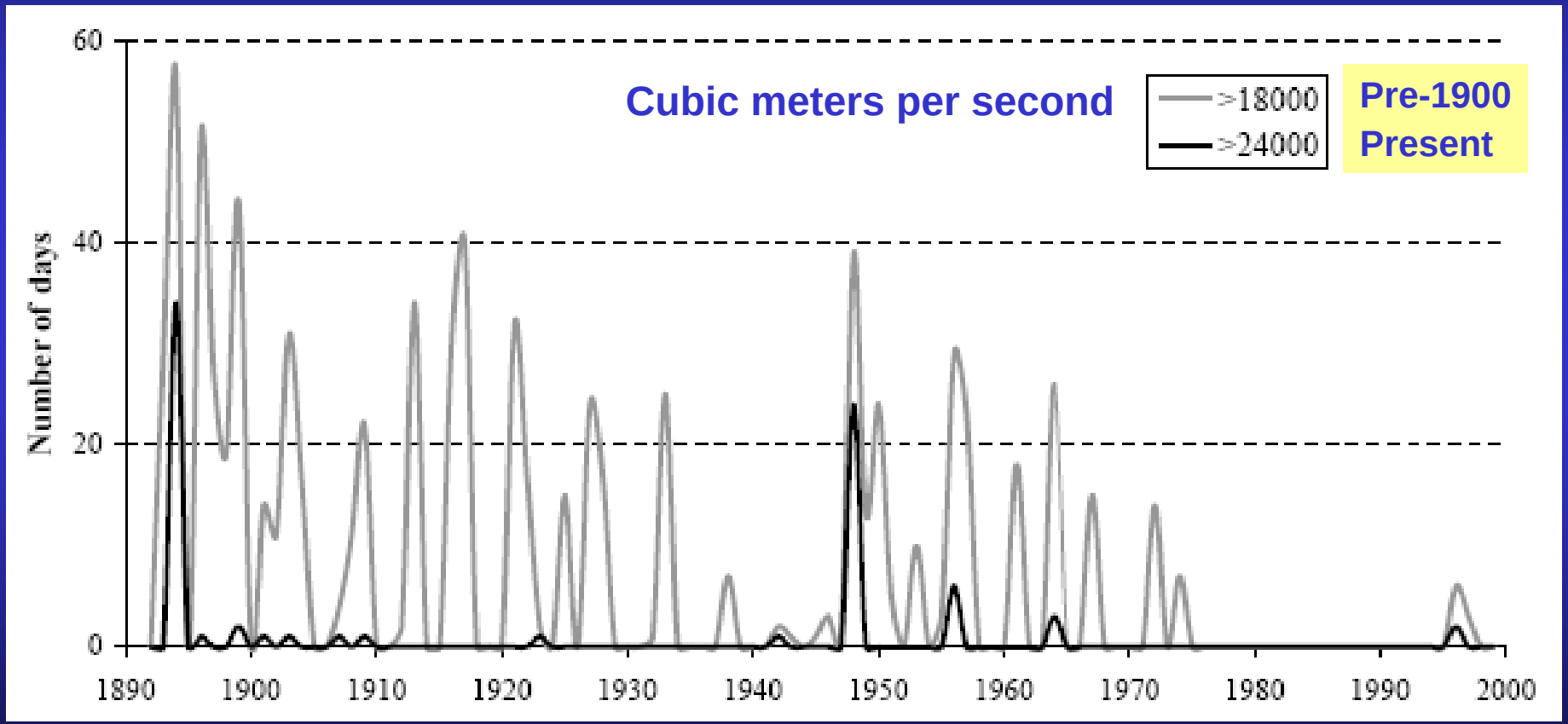


4. APPROPRIATE SCALE AND ORGANIZATION OF RESTORATION

- What is limiting…..at what scale?
  - area? mosaic/complexity? connectivity?
- Under what conditions is density dependence likely to be a factor?
- What is the appropriate scale for connectivity? e.g., how close/far is close/far enough?
- Is ecosystem impairment at a scale we can't solve by habitat restoration?
  - What ecosystem processes guarantee self-sustaining salmon habitats?
  - Has the system lost the capacity for salmon ecosystem resilience?

4. APPROPRIATE SCALE AND ORGANIZATION OF RESTORATION

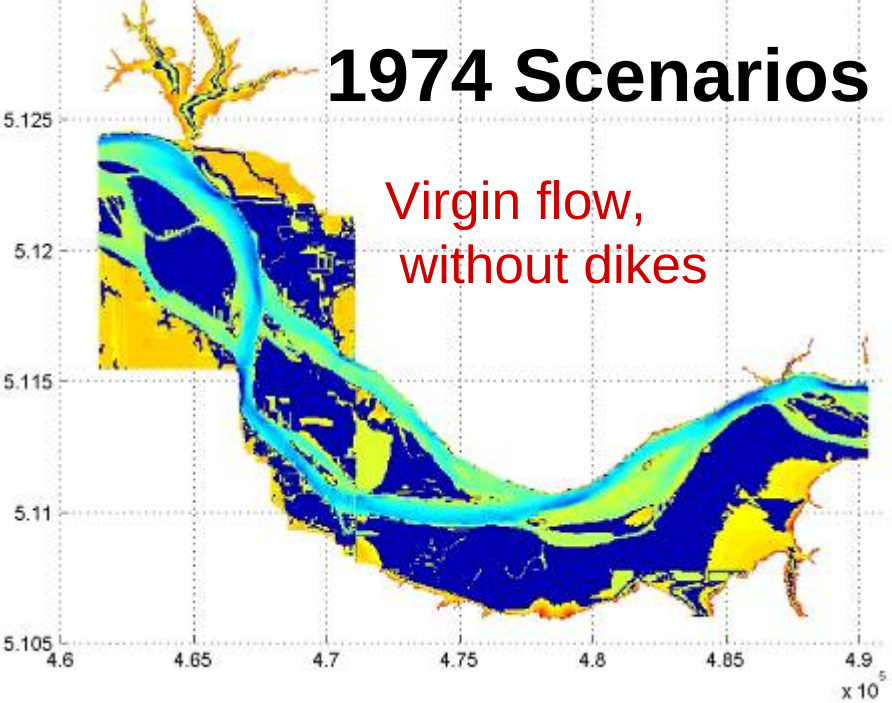
Columbia River Overbank Flow—historic to present



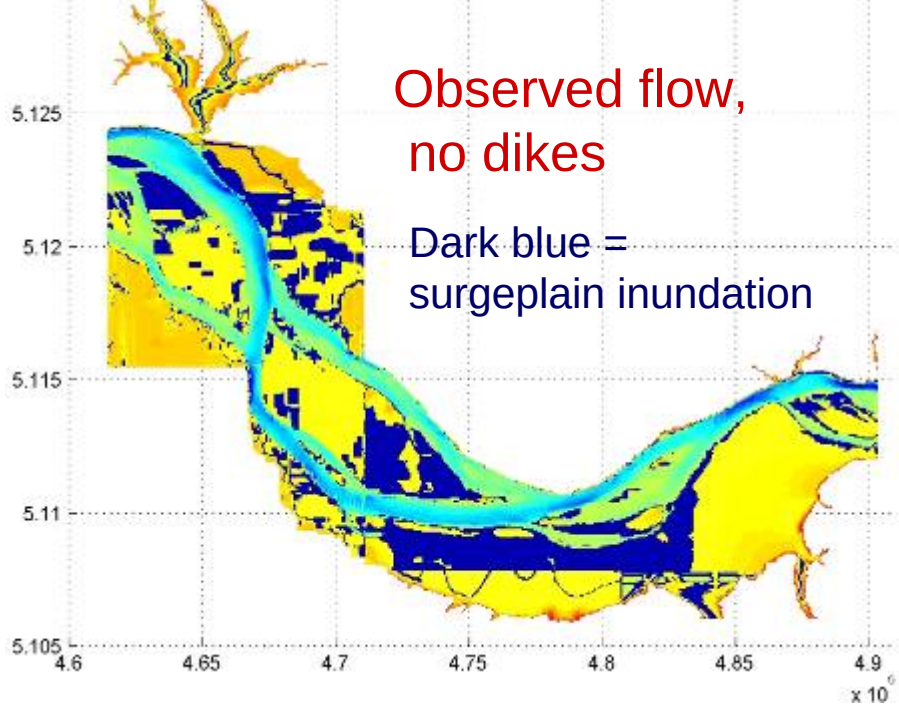
Data adapted from USGS records

Source: D. Jay, PSU

1974 Scenarios –

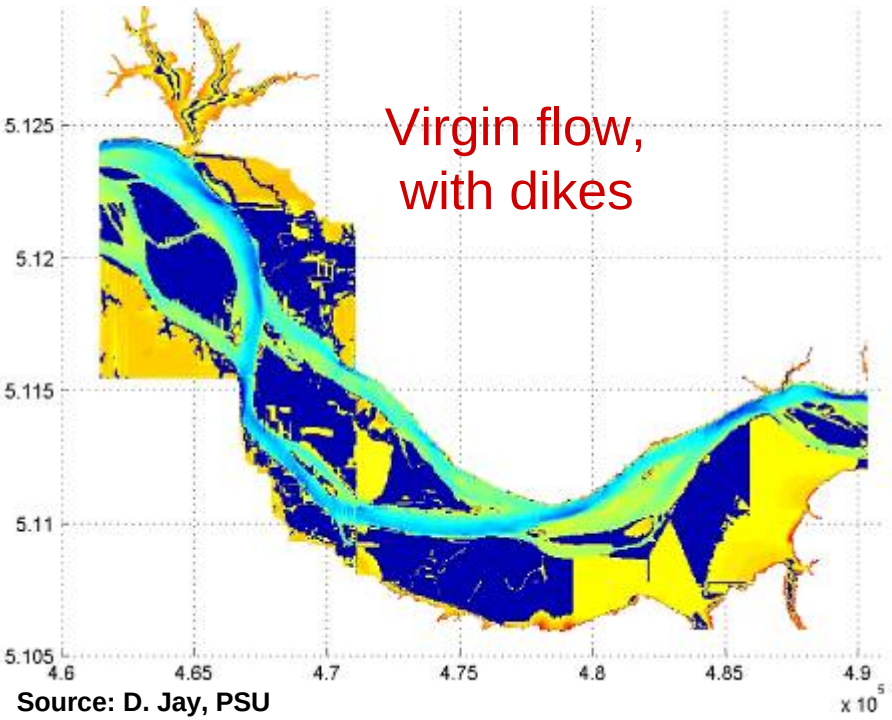


Virgin flow,
without dikes

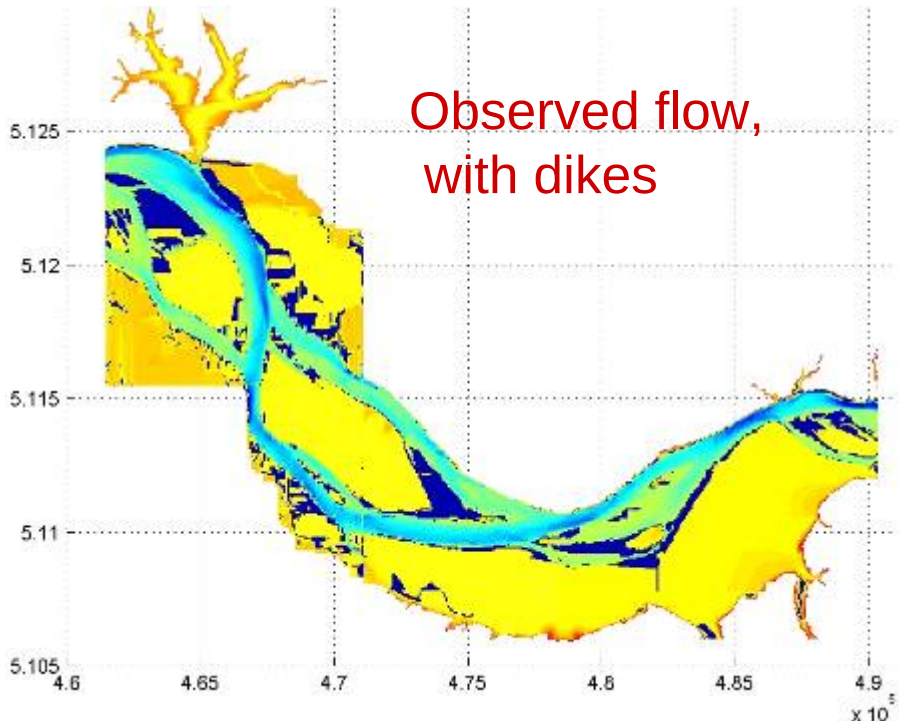


Observed flow,
no dikes

Dark blue =
surgeplain inundation



Virgin flow,
with dikes

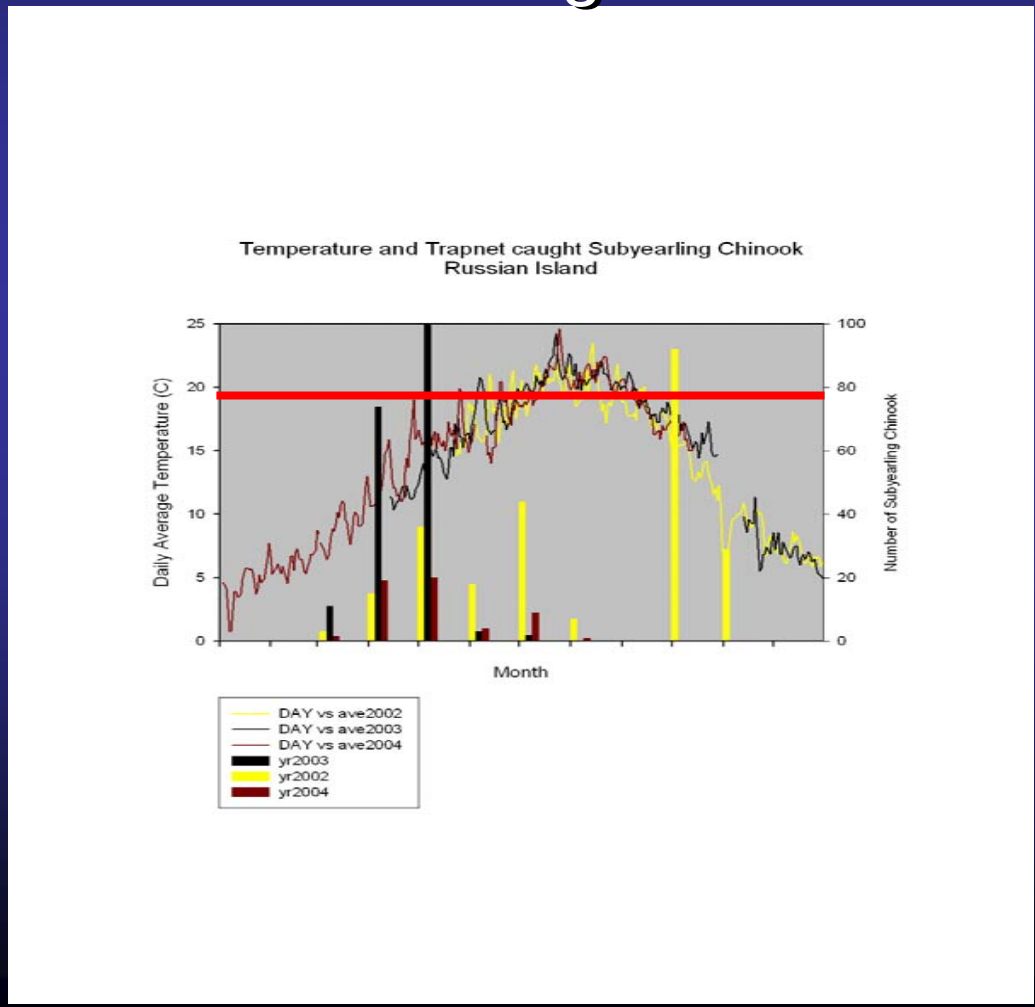


Observed flow,
with dikes

Source: D. Jay, PSU

4. APPROPRIATE SCALE AND ORGANIZATION OF RESTORATION

Thermal Regime and Subyearling Chinook Abundances in Russian Island Emergent Marsh 2002-2204



…but, scrub-shrub and forested tidal wetlands are less vulnerable

5. METAPOPULATION STRUCTURE AND STATUS

- Distribution of salmon metapopulations is not homogeneous in the estuary!
- Is rearing spatially discrete?—varying by life history type?
- Is restoration targeting metapopulations / stocks most in need of habitat and increased resilience?

GAPS MICROSATELLITE DNA BASELINE FOR COLUMBIA RIVER BASIN
13 Loci 36 Populations 3845 Fish

Genetic groups (hatchery and wild) for assignments of estuary fish:

***MUCR Sp: Mid- and Upper Columbia River spring run**
e.g., Carson Hatchery, John Day River, Upper Yakima River, Warm Springs Hatchery, Wenatchee Hatchery and River

UCR Su/F: Upper Columbia Basin summer and fall run
e.g., Hanford Reach (upriver brights), Methow River, Wenatchee River, Wells Hatchery summers

***SR Sp: Snake River spring run**
e.g., Imnaha River, Minam River, Rapid River Hatchery, Secech River, Tucannon Hatchery and River, Newsome Creek, West Fork Yankee Creek

***SR F: Snake River fall run**
e.g., Lyons Ferry Hatchery

DR F: Deschutes River fall run
e.g., upper and lower Deschutes River

***WR Sp: Willamette River spring run**
e.g., Mckenzie Hatchery and River, North Santiam Hatchery and River, North Fork Clackamas River

***WC Sp: Western Cascade Range Tributaries spring run**
e.g., Cowlitz Hatchery, Kalama Hatchery, Lewis Hatchery

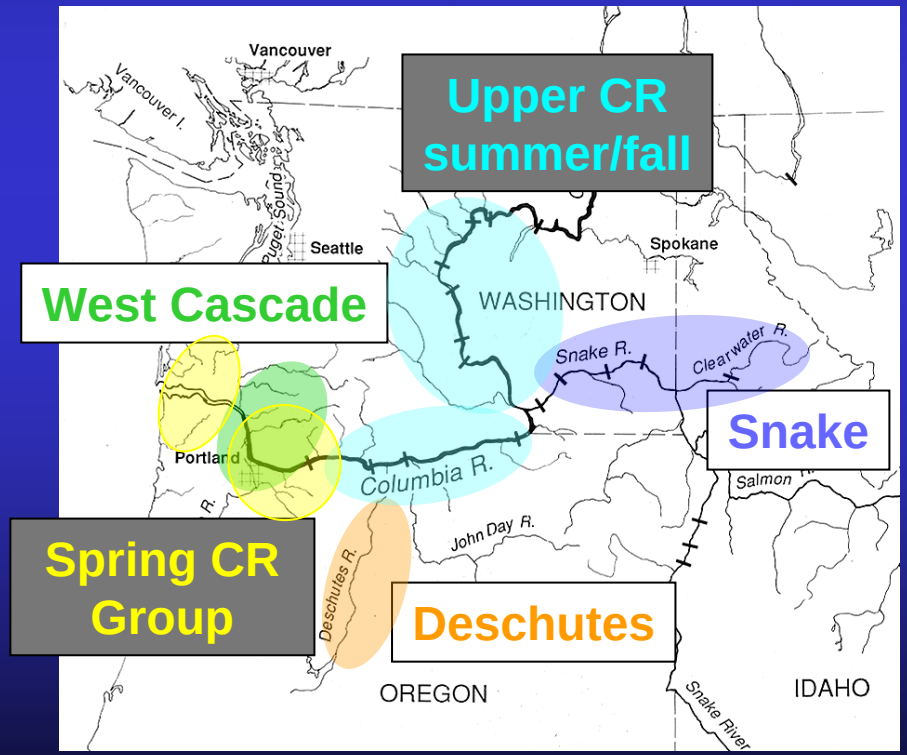
***WC F: Western Cascade Range Tributaries fall run**
e.g., Cowlitz Hatchery, Lewis River, Sandy River

***SCG F Spring Creek Group ("tule") fall run (Columbia Gorge and Coastal Range tributaries)**
e.g., Spring Creek Hatchery, Big Creek Hatchery, Abernathy Hatchery, Elochomin River, Willamette River

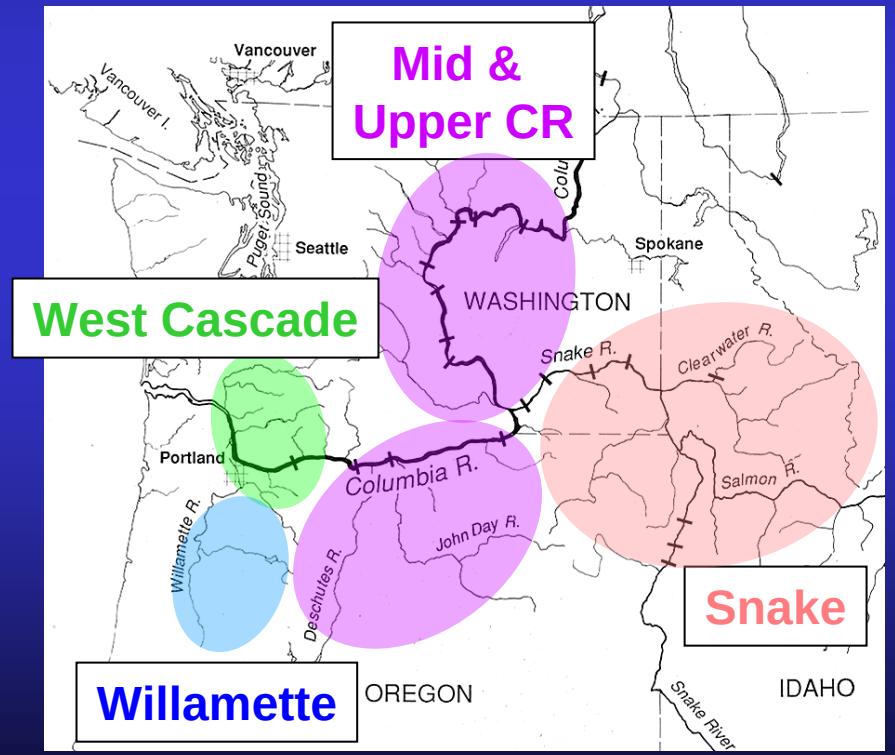
COLUMBIA RIVER BASIN CHINOOK SALMON

Genetic Stock Groups Resolved with GAPS Microsatellite Loci

Fall Run

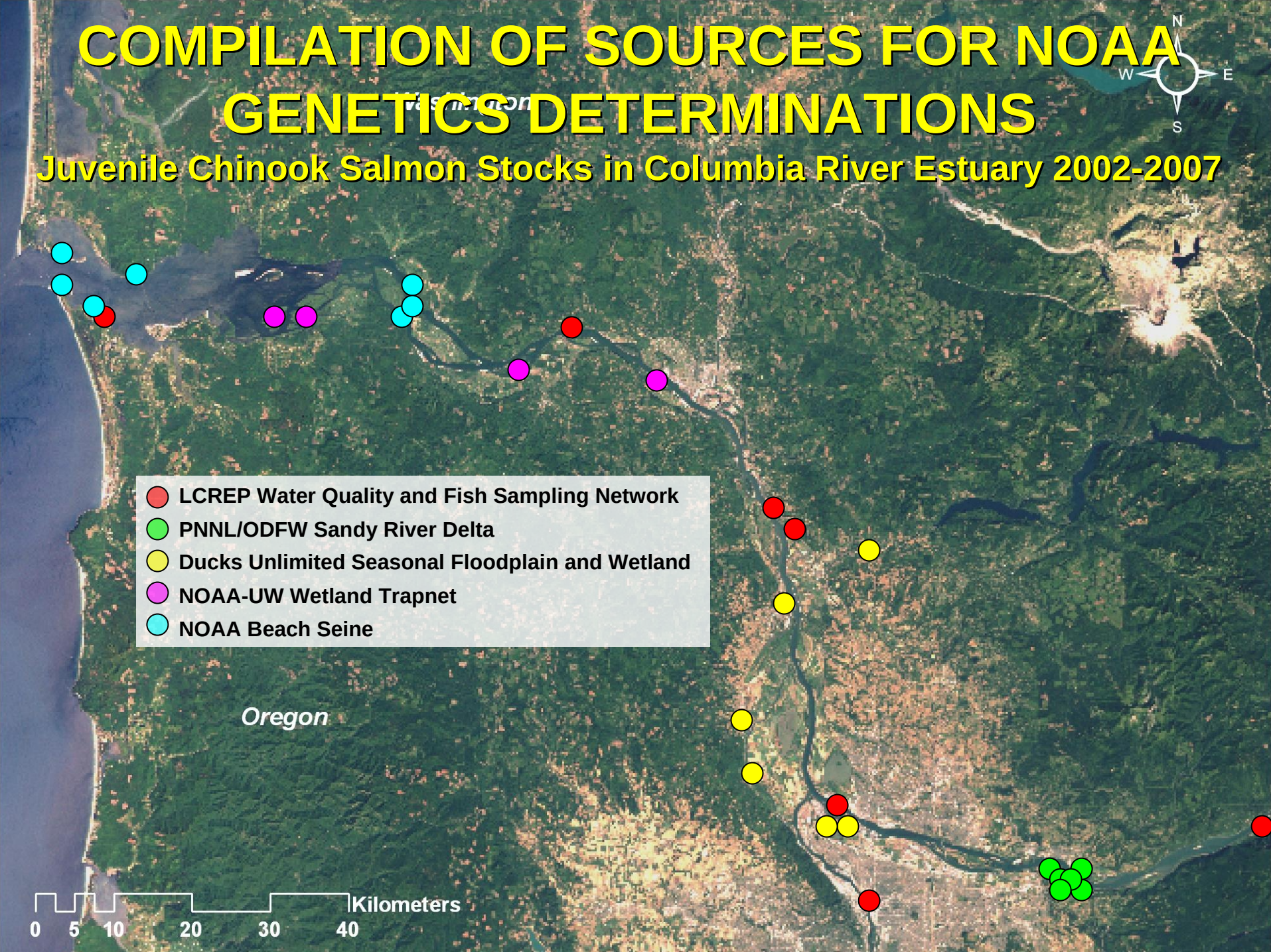


Spring Run

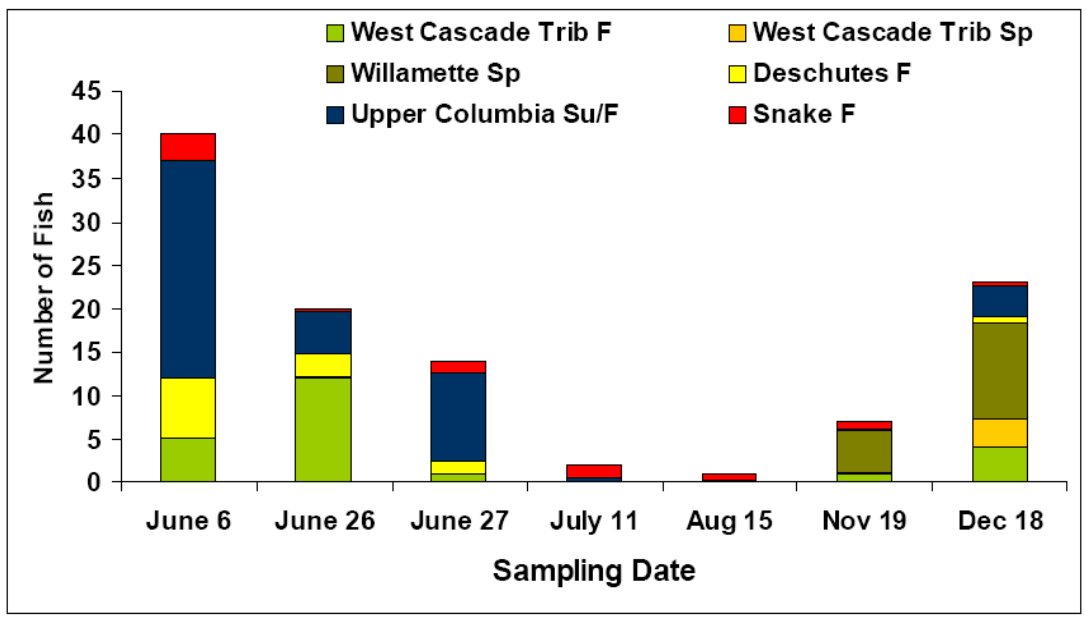


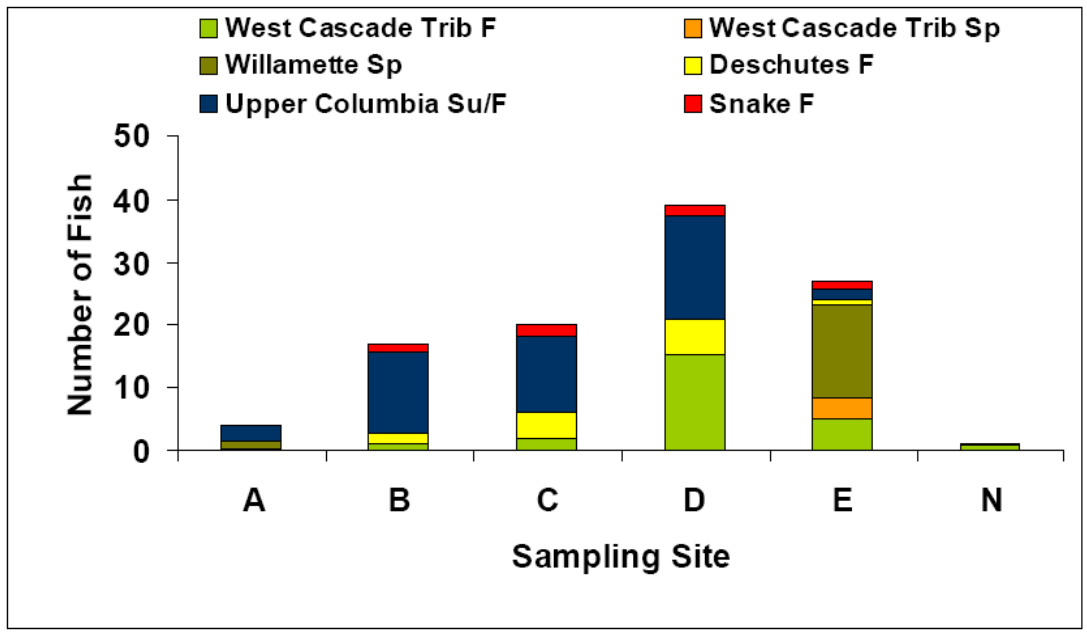
COMPILATION OF SOURCES FOR NOAA GENETICS DETERMINATIONS

Juvenile Chinook Salmon Stocks in Columbia River Estuary 2002-2007



PNNL/ODFW SANDY RIVER SITES 2007



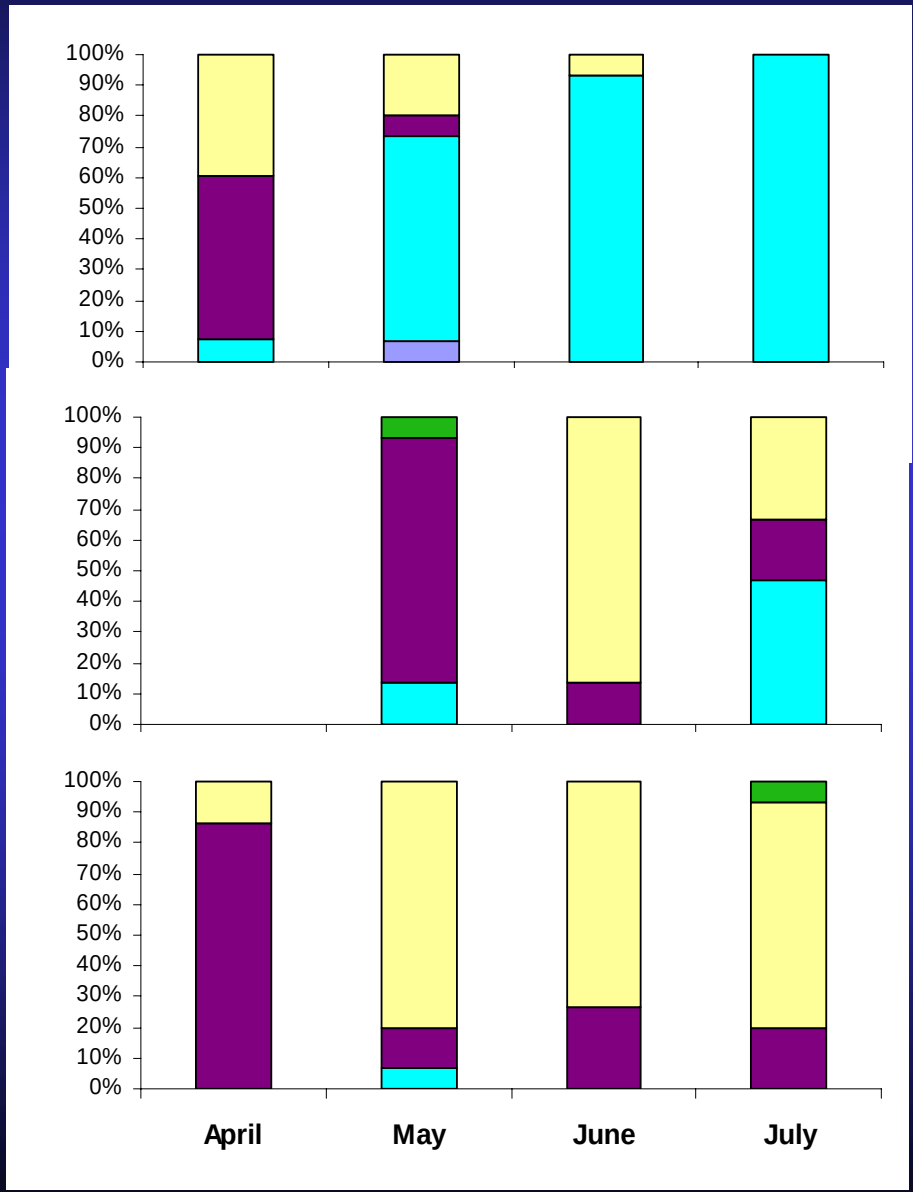


SUBYEARLING CHINOOK STOCK COMPOSITIONS AT THREE LCREP SITES 2005

Warrendale

Confluence

Columbia City



Interior Sp

Interior Su / F

WC F

WC Sp

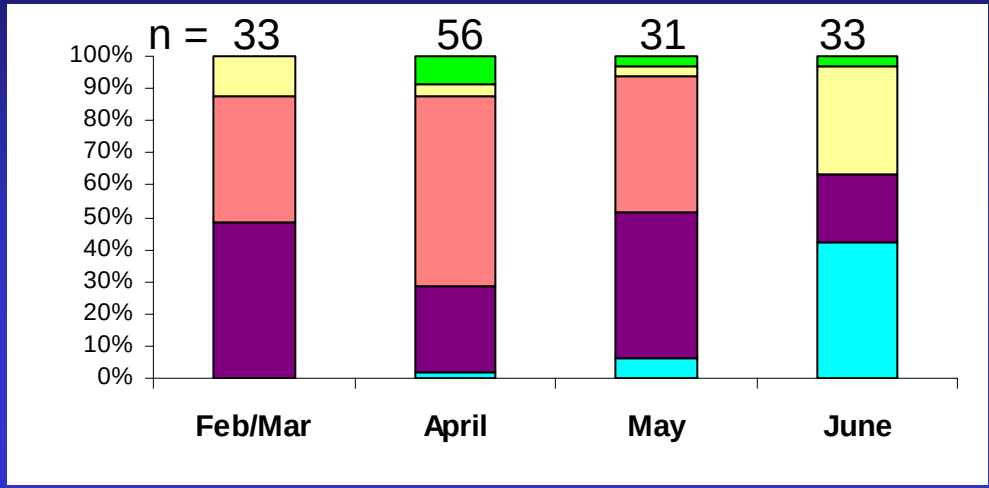
SCG F

UWR Sp

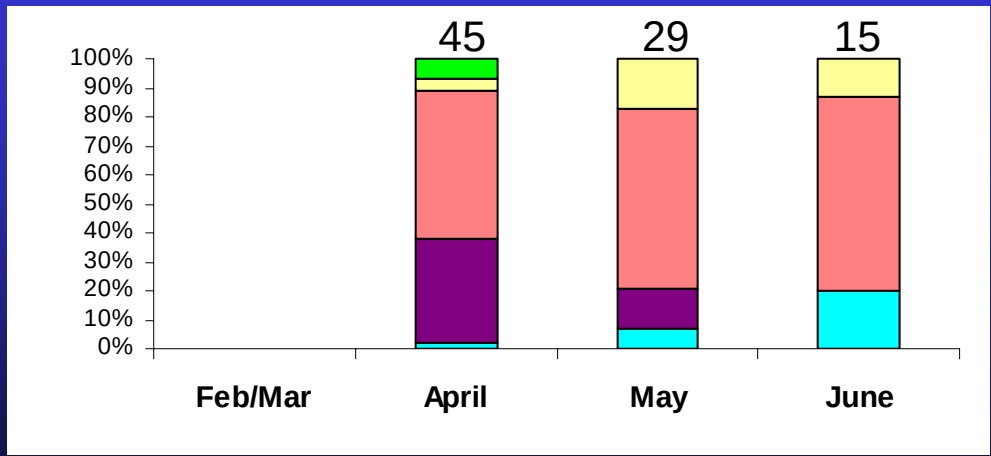
Samples (15 fish per site/month) from LCREP Study Lyndal Johnson et al.

SUBYEARLING CHINOOK STOCK COMPOSITION IN LOWER WILLAMETTE RIVER

Ducks Unlimited Wetland Sites 2005 / 2006



LCREP & DU Willamette R Portland Sites

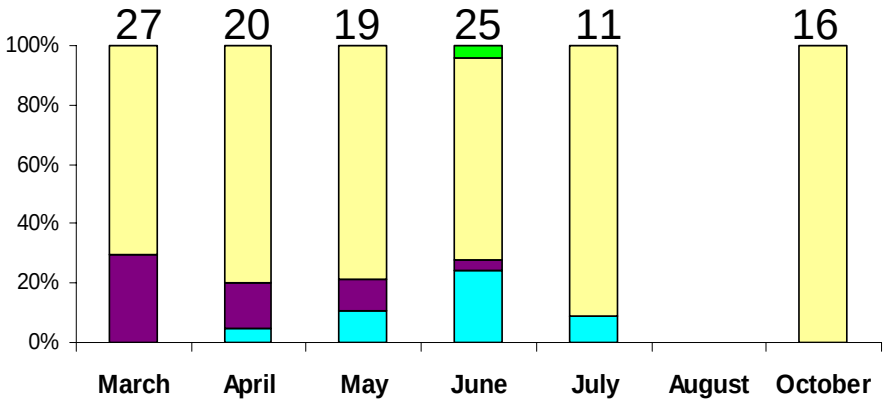


Interior Sp
Interior Su / F
WC F
WC Sp
SCG F
UWR Sp

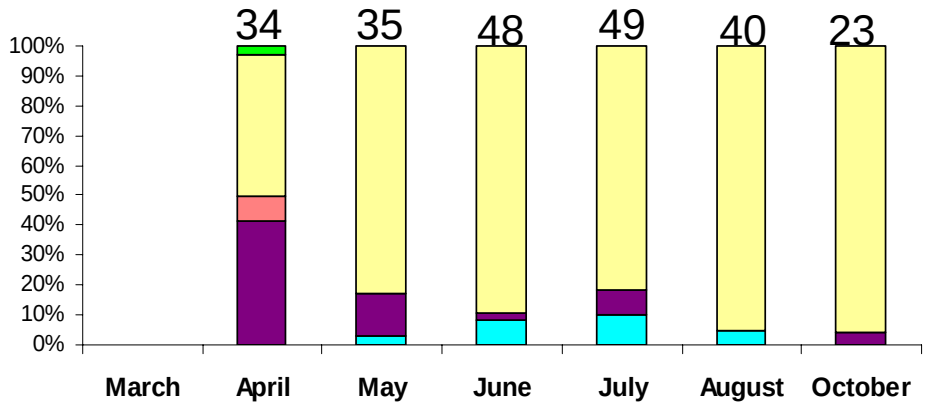
Ducks Unlimited Samples From Cyndi Baker
April Willamette R. sample includes both DU and LCREP fish

SUBYEARLING CHINOOK STOCK COMPOSITIONS LORD AND WALLACE ISLANDS 2006

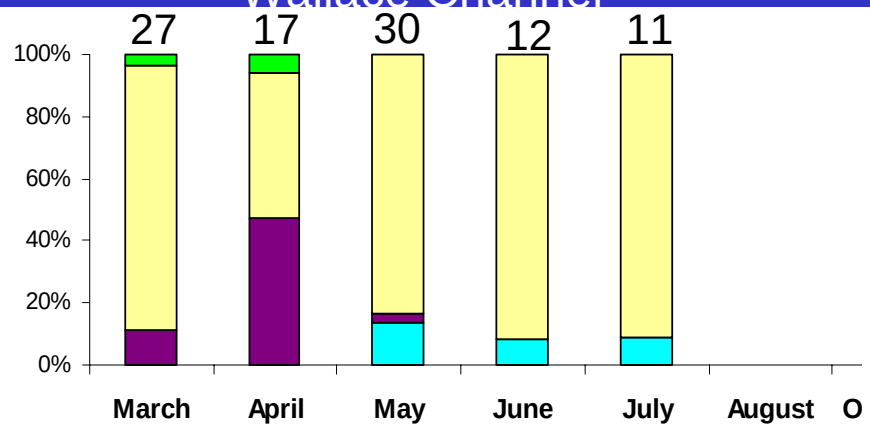
Lord Channel



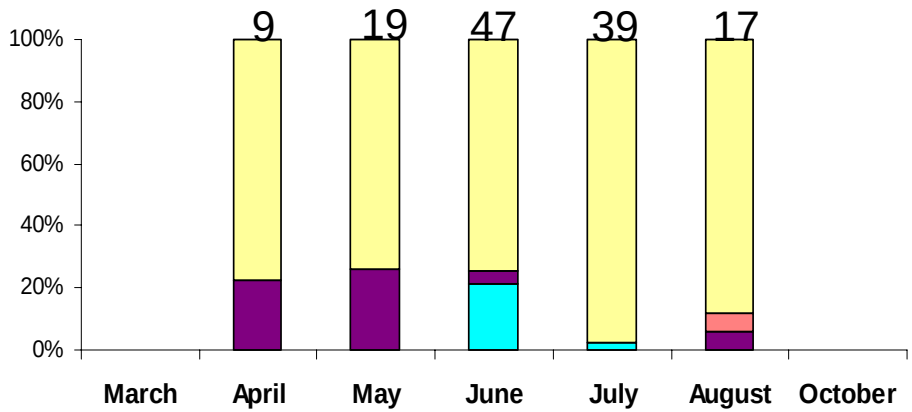
Lord Mainstem



Wallace Channel



Wallace Mainstem



Interior Sp

Interior Su / F

WC F

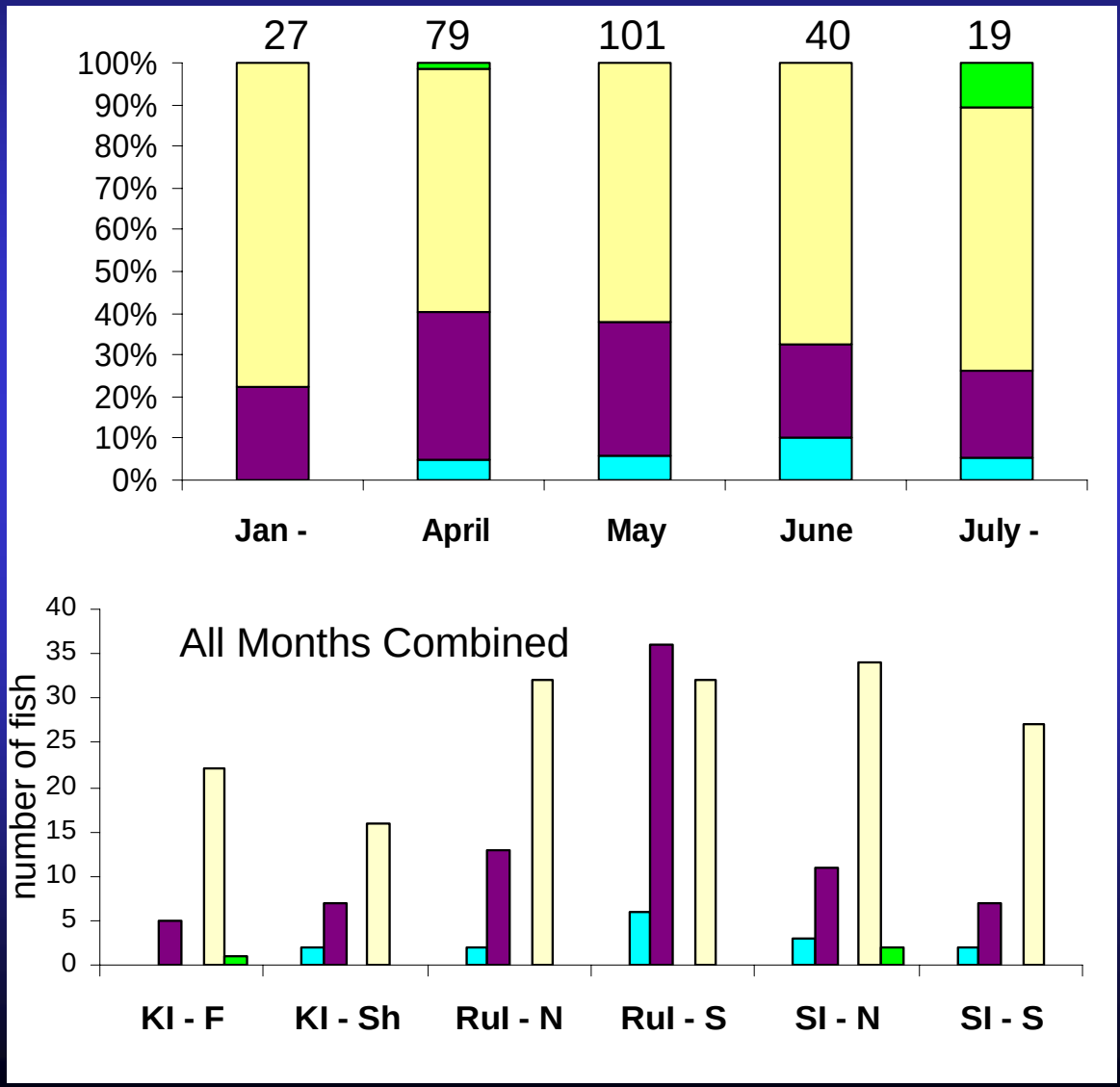
WC Sp

SCG F

UWR Sp

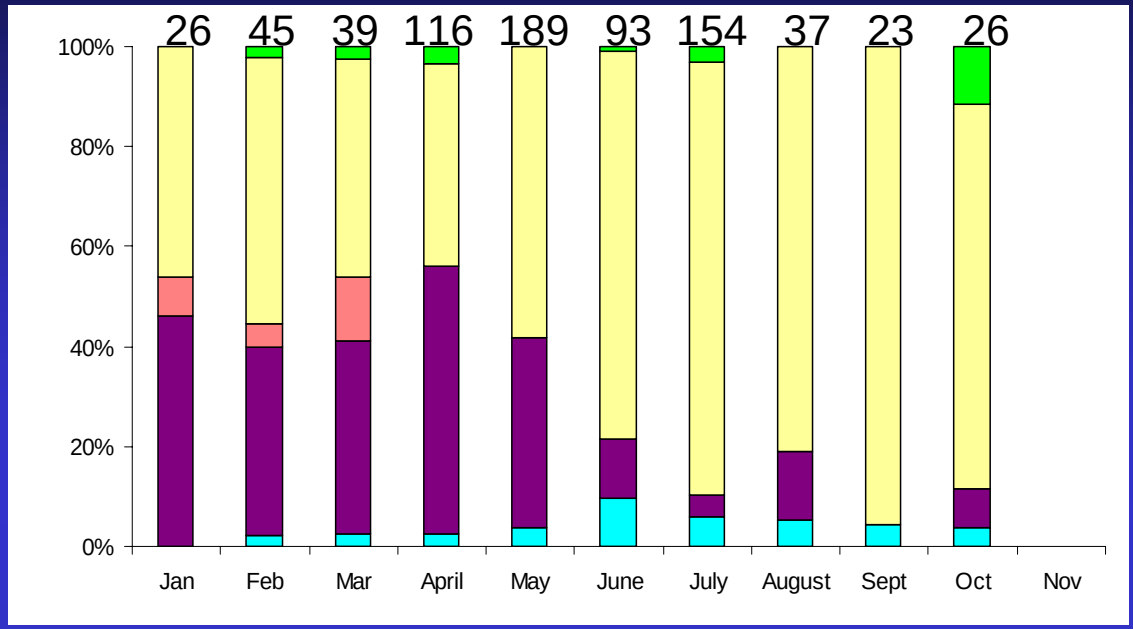
CHINOOK STOCK COMPOSITIONS AT ESTUARY TRAPNET SITES 2003

All Sites Combined

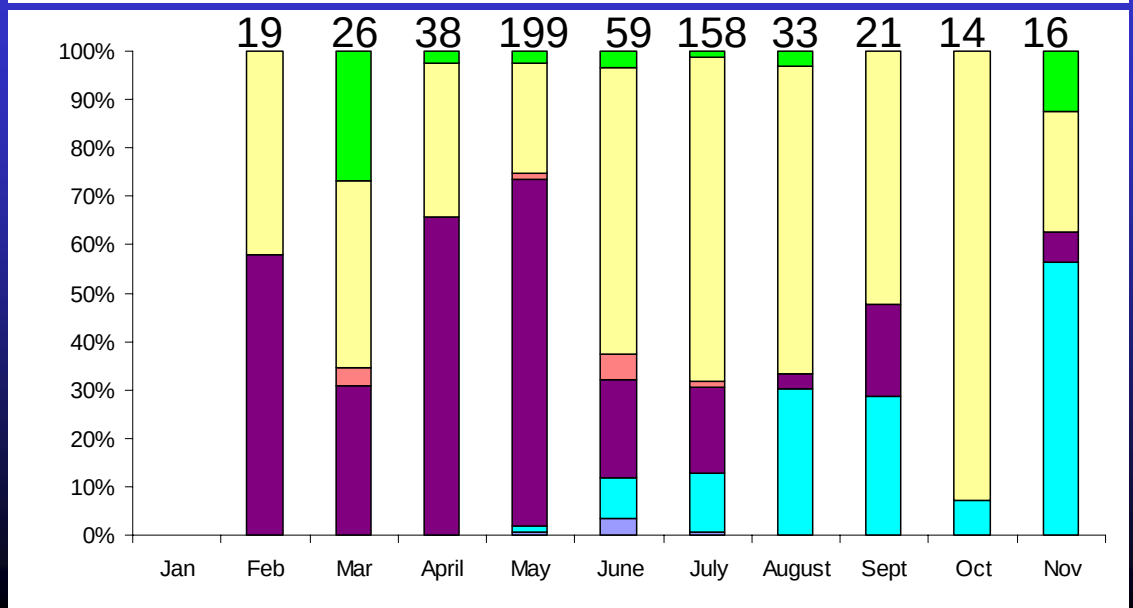


CHINOOK STOCK COMPOSITIONS LOWER COLUMBIA RIVER BEACH SEINE 2002 -2005

Tidal Freshwater
LES UCC ETI

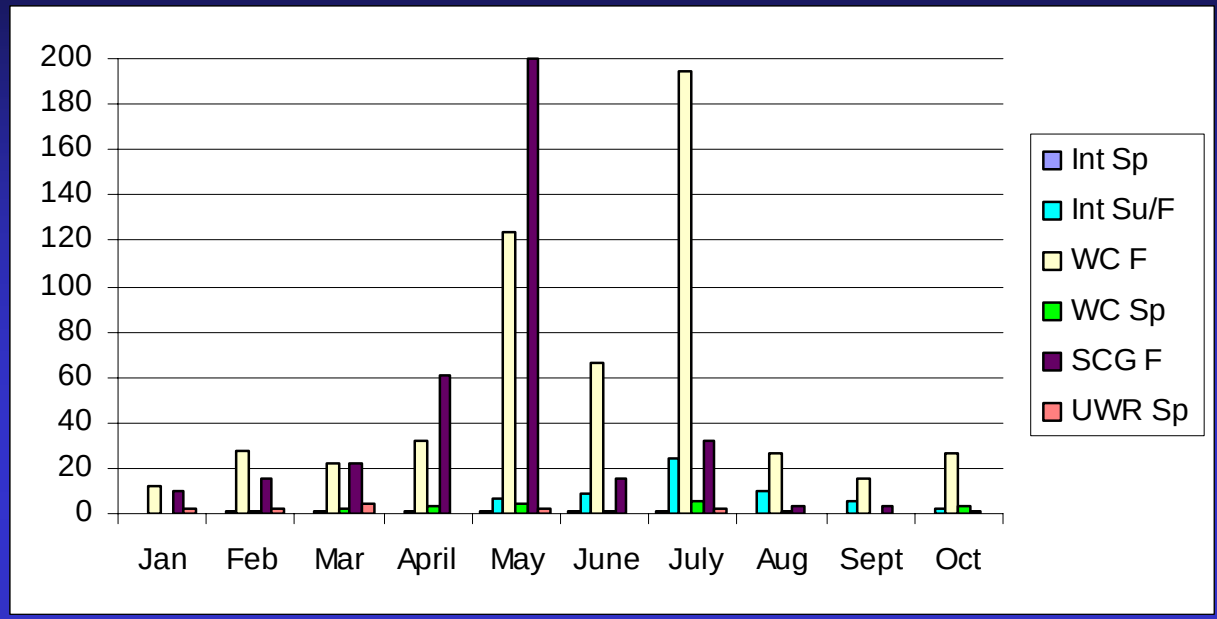


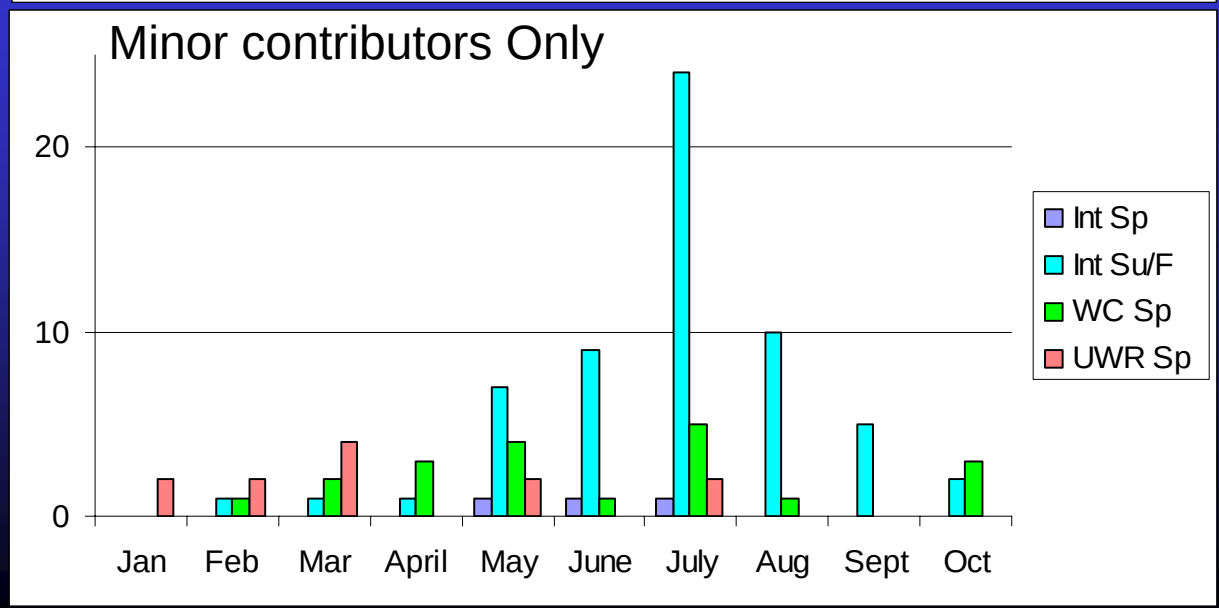
Middle & Lower
PE PAB
WSI CS



- Interior Sp
- Interior Su / F
- WC F
- WC Sp
- SCG F
- UWR Sp

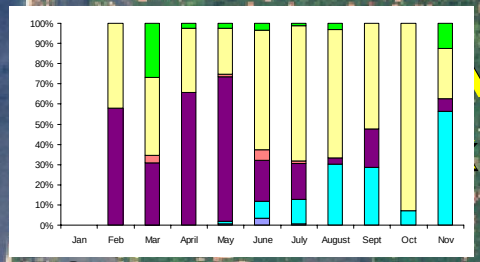
FREQUENCY DISTRIBUTIONS OF SOURCE STOCKS OF JUVENILE CHINOOK (beach seine sites and years combined)

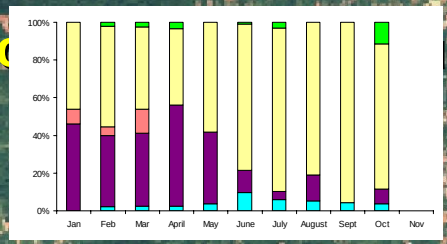


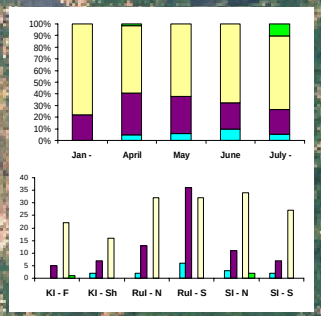


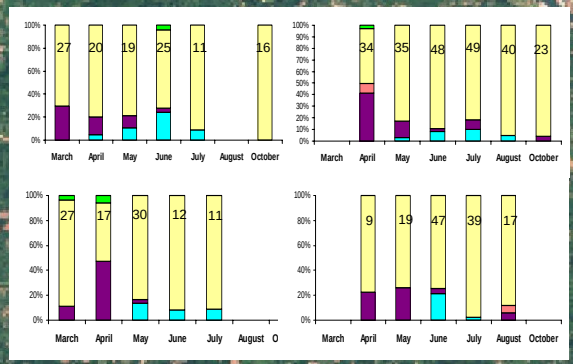
COMPILATION OF SOURCES FOR NOAA
NETICS DETERMINATIONS

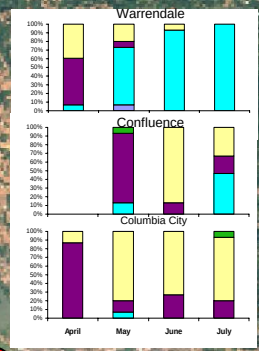
Salmo mbia River Estuary 2002-2007

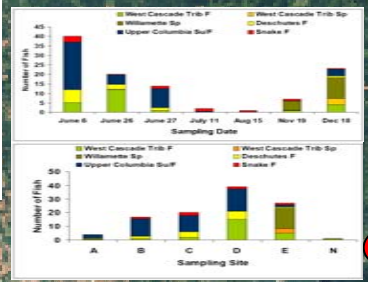


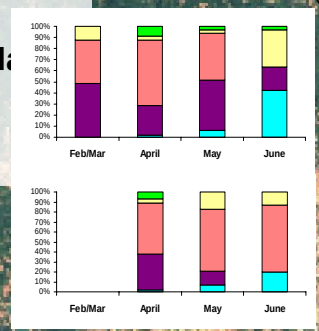












- LCREP Water Quality and Fish Sampling Network
- PNNL/ODFW Sandy River Delta
- Ducks Unlimited Seasonal Floodplain and Wetl
- NOAA-UW Wetland Trapnet
- NOAA Beach Seine

Oregon

0 5 10 20 30 40 Kilometers

N
W
E
S

ADDRESSING UNCERTAINTIES IN RESTORATION STRATEGIES

- While we are undoubtedly enhancing Columbia River estuarine ecosystems, if we are specifically targeting estuarine restoration for salmon recovery, we are not going about it strategically…….not planning where, what, sequence, metrics of salmon response, etc.
- Need to understand how variability in estuarine physiographic and ecological settings support salmon population patterns and richness
- Develop principles for landscape organization and restoration scaling

ADDRESSING UNCERTAINTIES IN RESTORATION STRATEGIES (*cont.*)

- Test for "hotspots" and other spatially-explicit features
  - species/life history types
  - at-risk metapopulations
- Integrate restoration with preservation, especially were different habitats and juvenile salmon habitat requirements may be synergistic, e.g., forested and tributary floodplain wetlands
- Plan for the 'long-haul'…..what is the vision of the estuary in 2050? Be less expedient and *ad hoc*…..ecosystem and salmon restoration take time and (adaptive) assessment.

ADDRESSING UNCERTAINTIES IN RESTORATION STRATEGIES (*cont.*)

- Still need to evaluate whether large-scale, systematic alterations, such as surgeplain flooding and high temperatures, ultimately constrain recovery (and of which metapopulations)
- We're beginning to acquire the tools and the knowledge…..it's time to be more strategic about using them.

THANKS!

Perpetual acknowledgements to whole NOAA-UW-OHSU-PSU-WDFW-CRESTet al. research team, and USACE, BPA and UW support