Hatchery Influence on the Estuarine Life Histories of Juvenile Salmon

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Salmon River Estuary

Columbia River Estuary

Hypothesis:

Hatchery programs may prevent river basins from realizing their full productive or resilience potential by limiting phenotypic expression by salmon

Direct effects:

Salmon rearing patterns and behaviors in the estuary

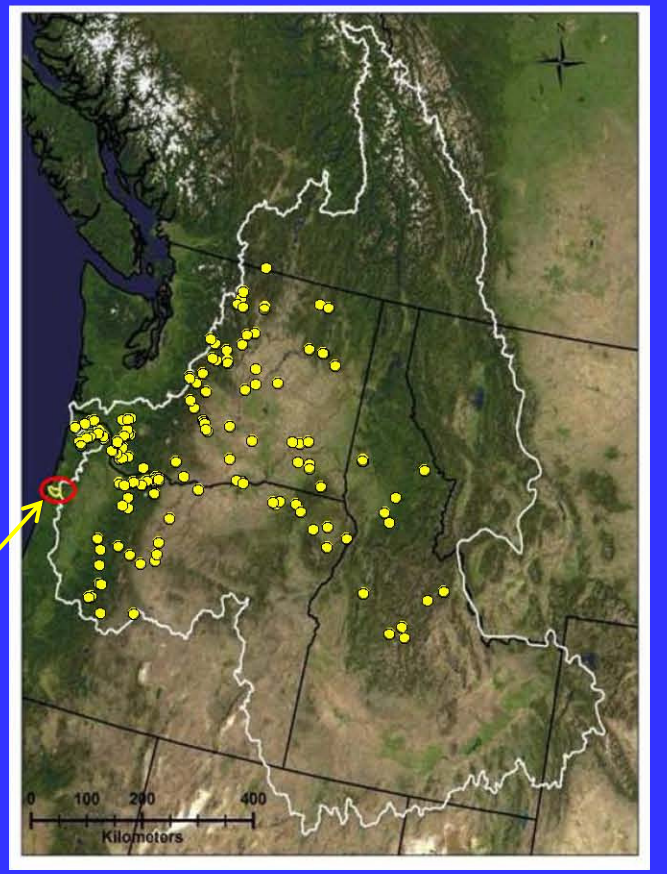
Indirect effects:

Naturally spawning hatchery fish that, in turn, may modify estuary rearing patterns and behaviors

Hatchery Influence in the Columbia and Salmon River Estuaries

	Columbia River	Salmon River
Basin size (km^2)	660,480	194
Total hatcheries	64	1
Hatchery production	~135,000,000 (all spp.)	~200,000 (Chinook)
Annual run	~1,500,000	~3,000-5,000
% Hatchery returns	~80%	~50%

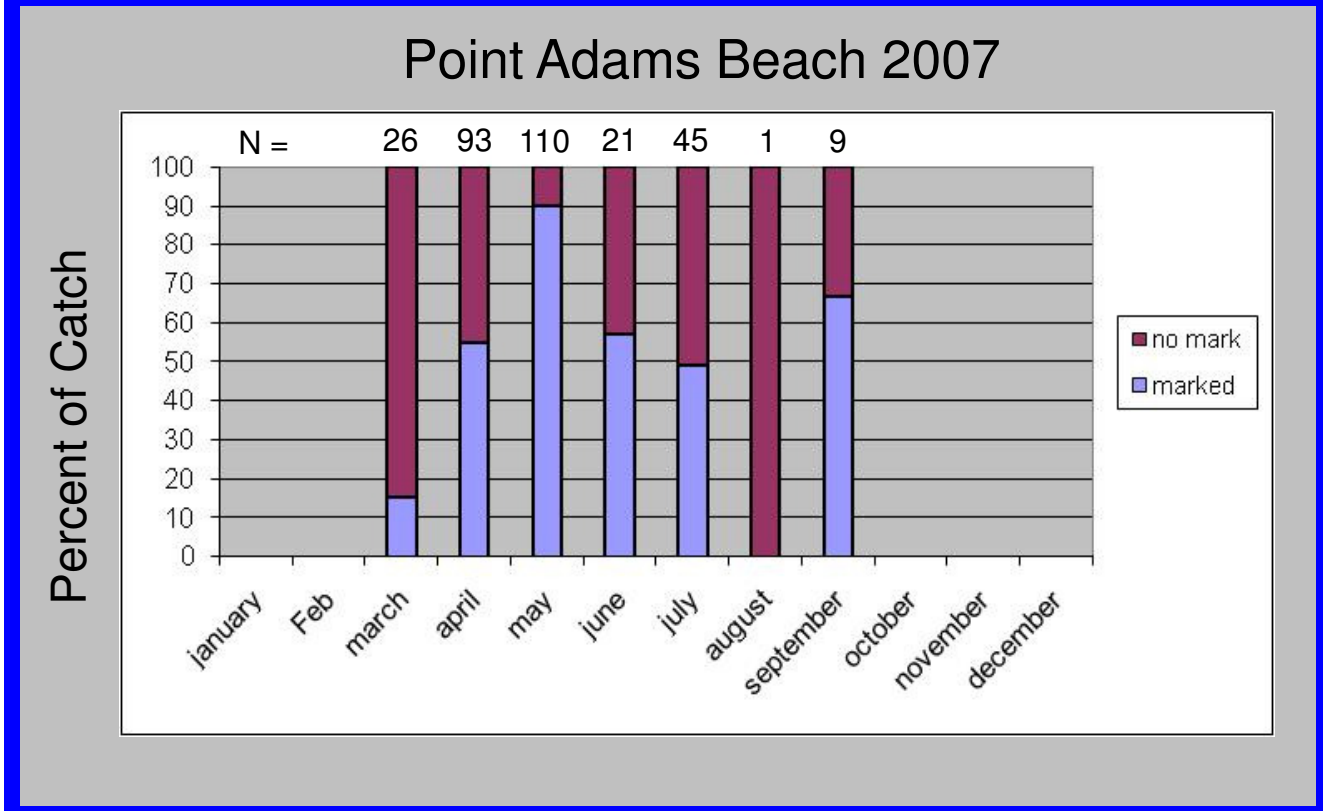
Columbia River Basin



Salmon River Basin

Percent of Marked Subyearling Chinook Salmon

Lower Columbia River Estuary



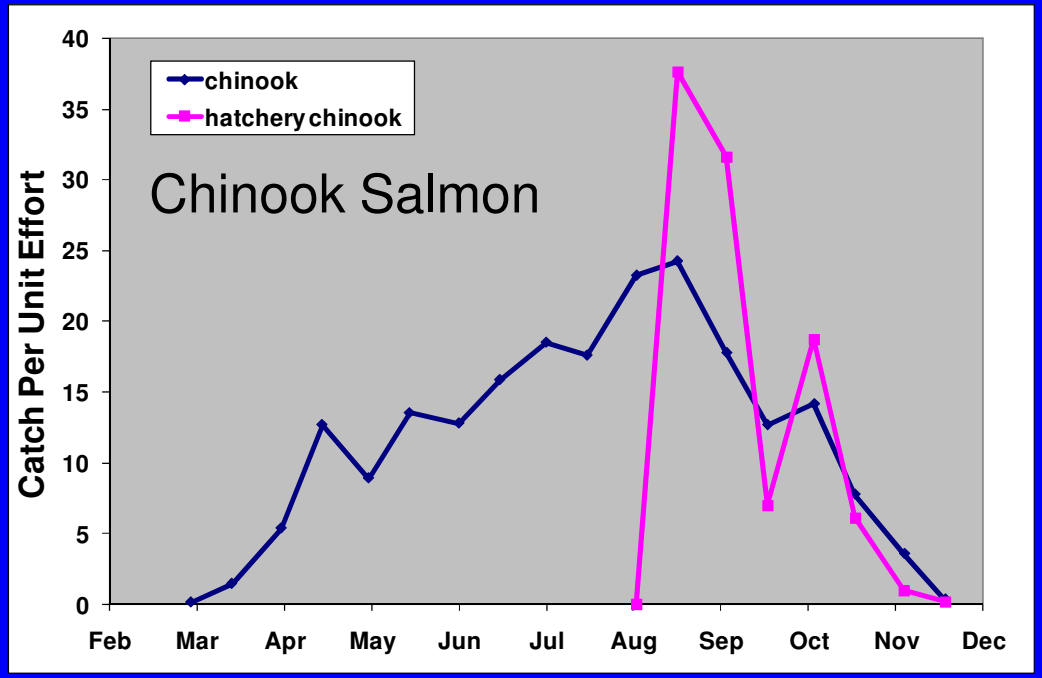
% of Marked Fish in Beach Seine

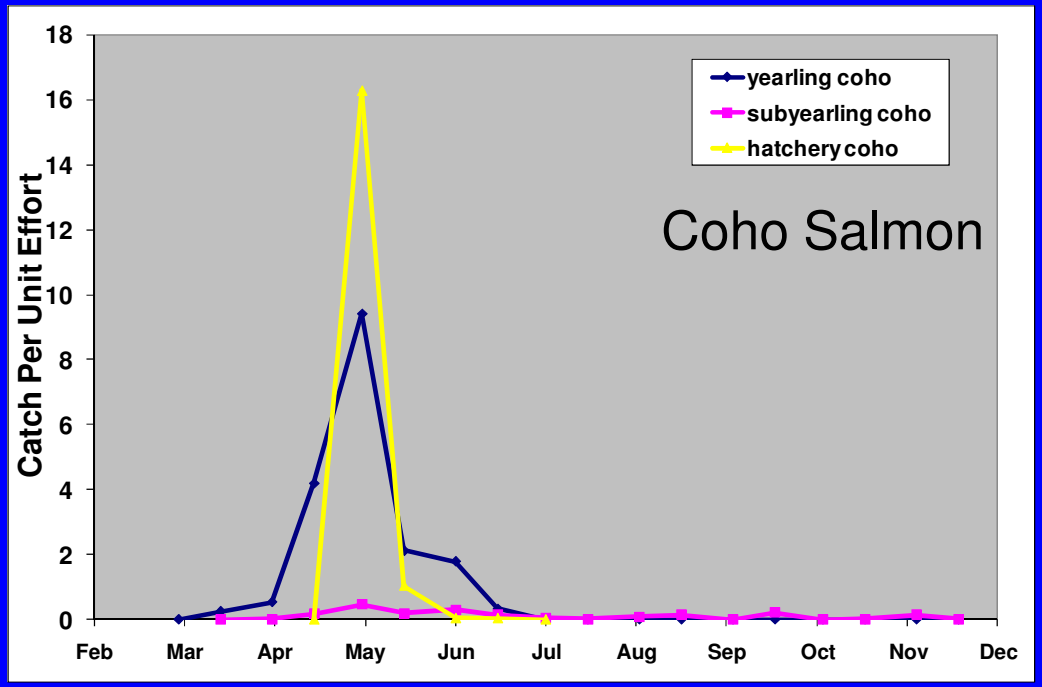
2002-06	10%
2007-08	62%

~85% of hatchery Chinook marked since 2007

Temporal Abundance of Hatchery and Wild Chinook and Coho Salmon

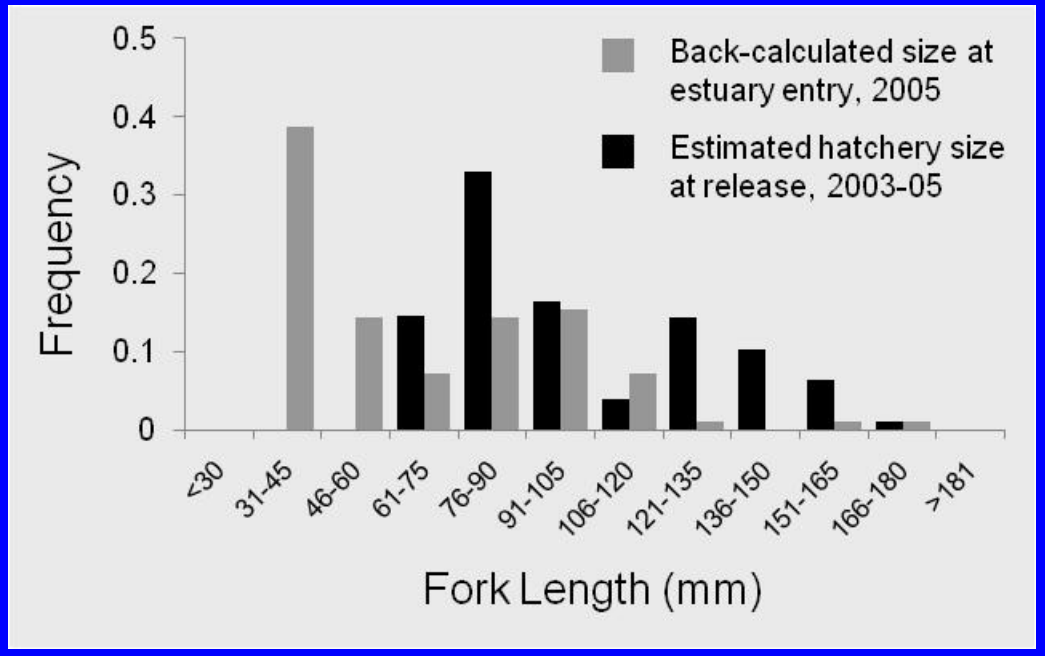
Salmon River Estuary
1998 - 2002



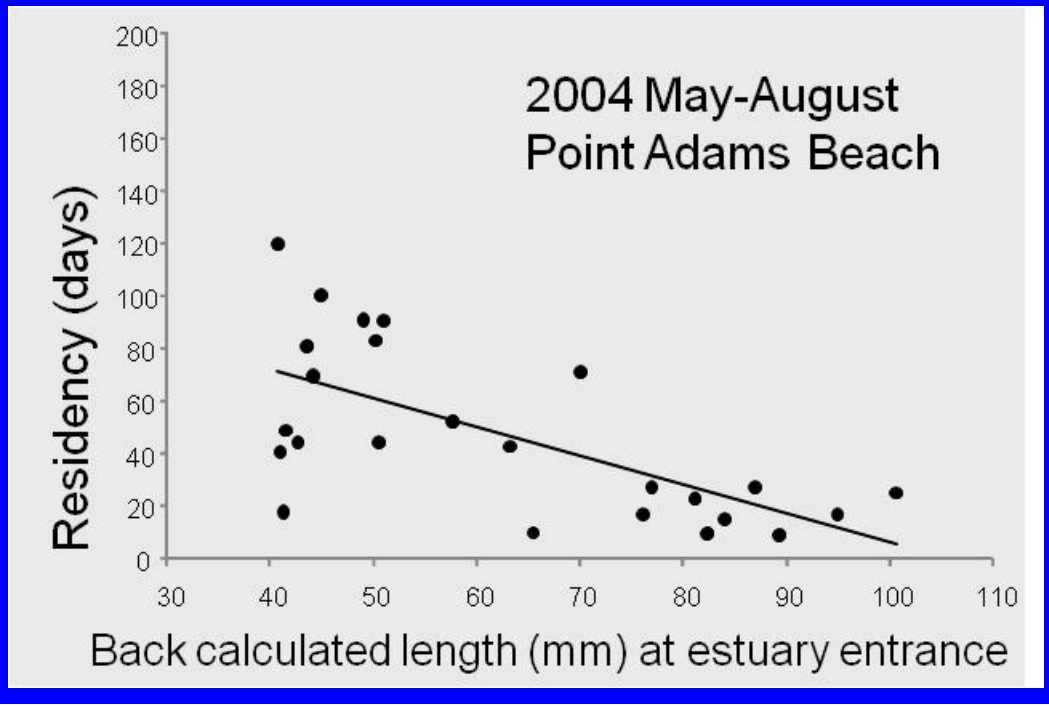


Fish Size and Residency Columbia River Estuary

>50% of hatchery fish released averaged >90 mm



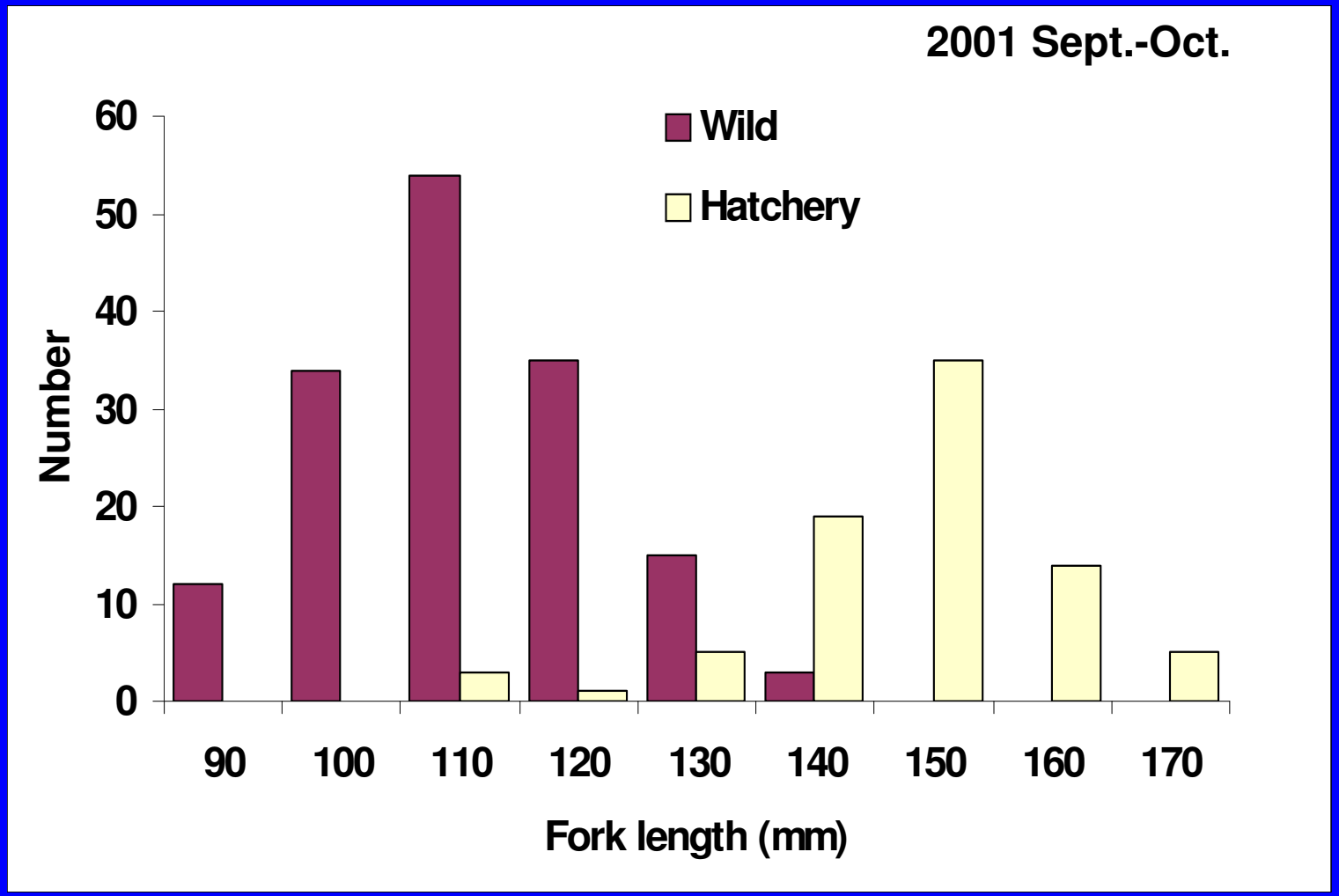
Estuary residence time decreases with fish size



From Campbell 2010

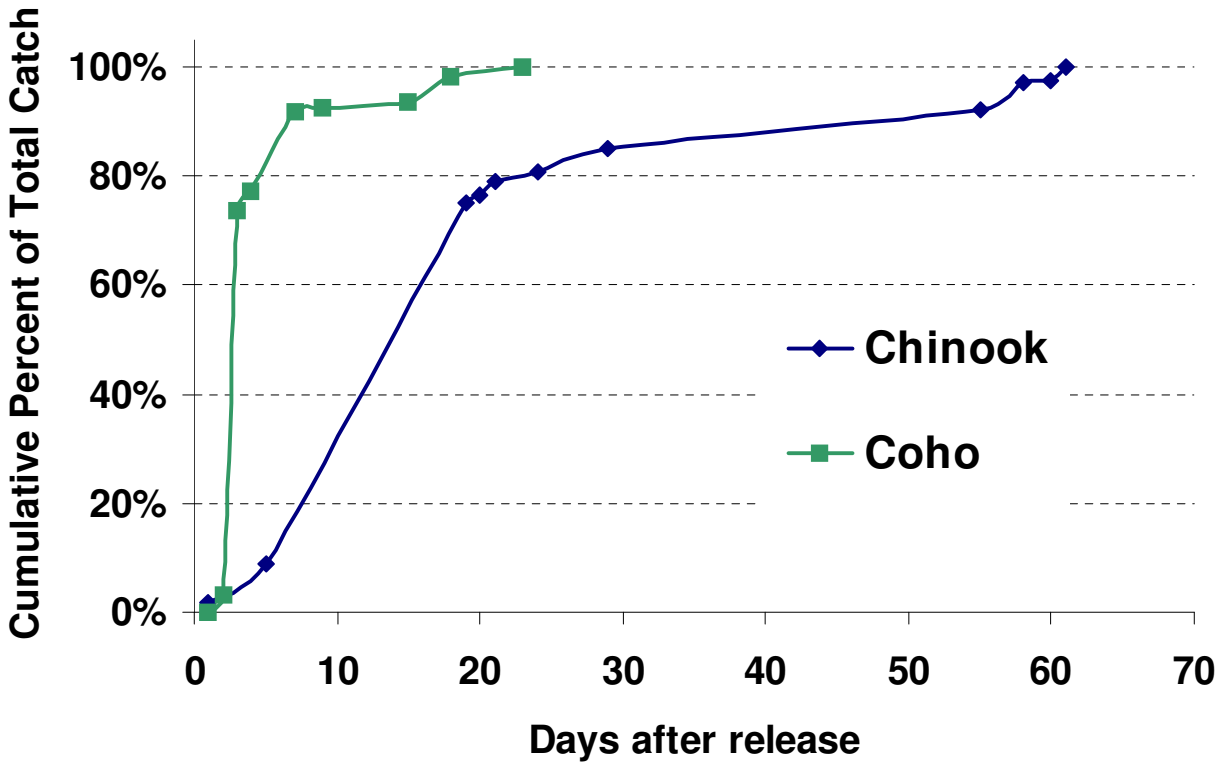
Hatchery and Wild Chinook Salmon Lengths

Salmon River Estuary



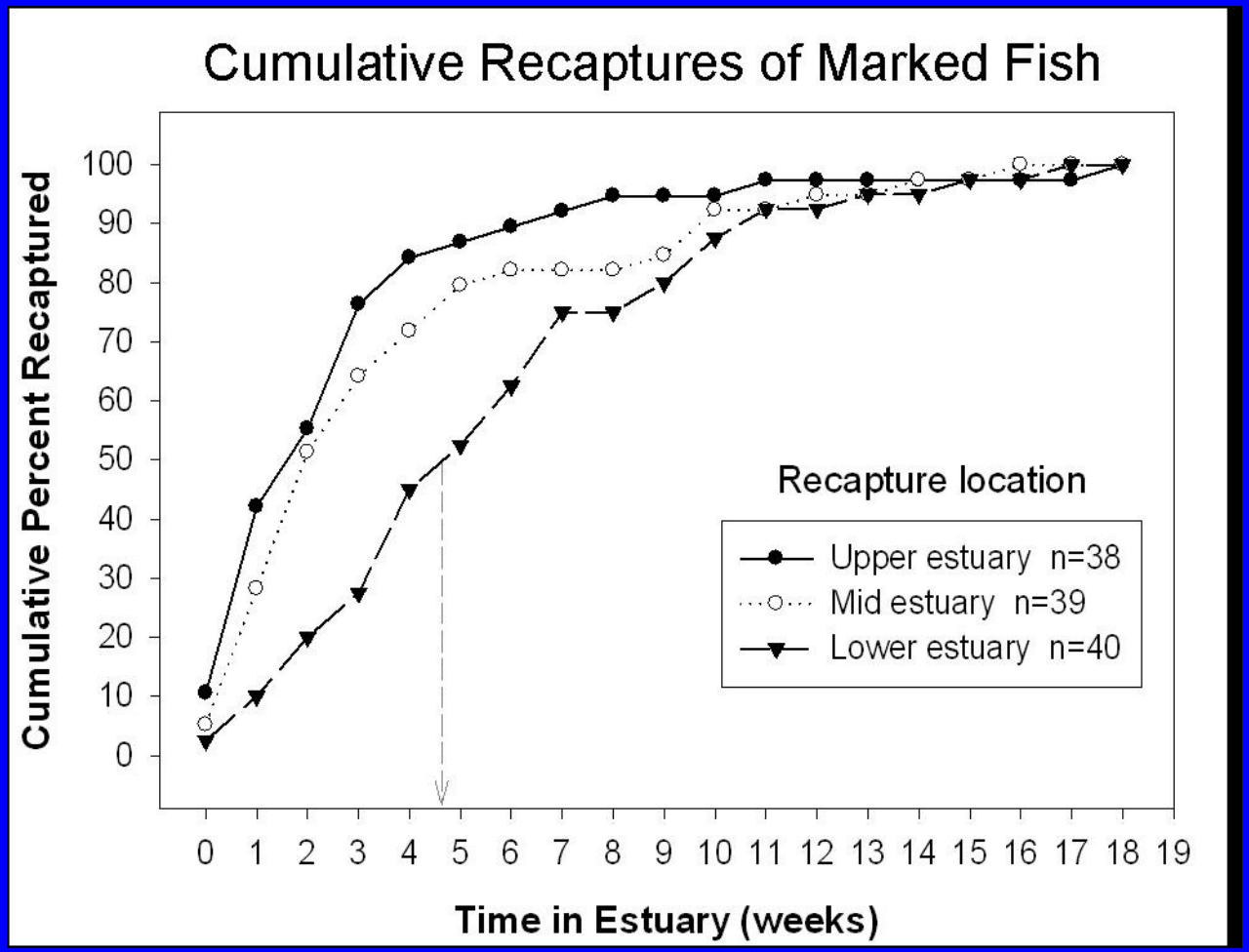
Estuary Residency of Hatchery Coho and Chinook Salmon

Salmon River Estuary
1997 - 2001

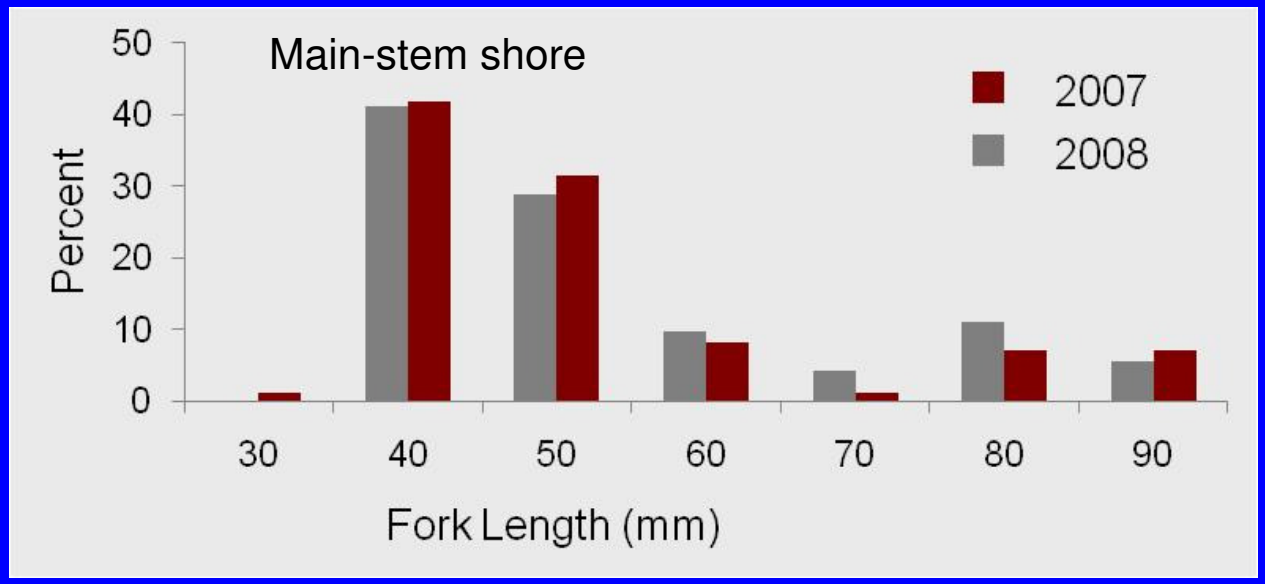


Estuary Residency of Wild Juvenile Chinook Salmon by Estuary Zone

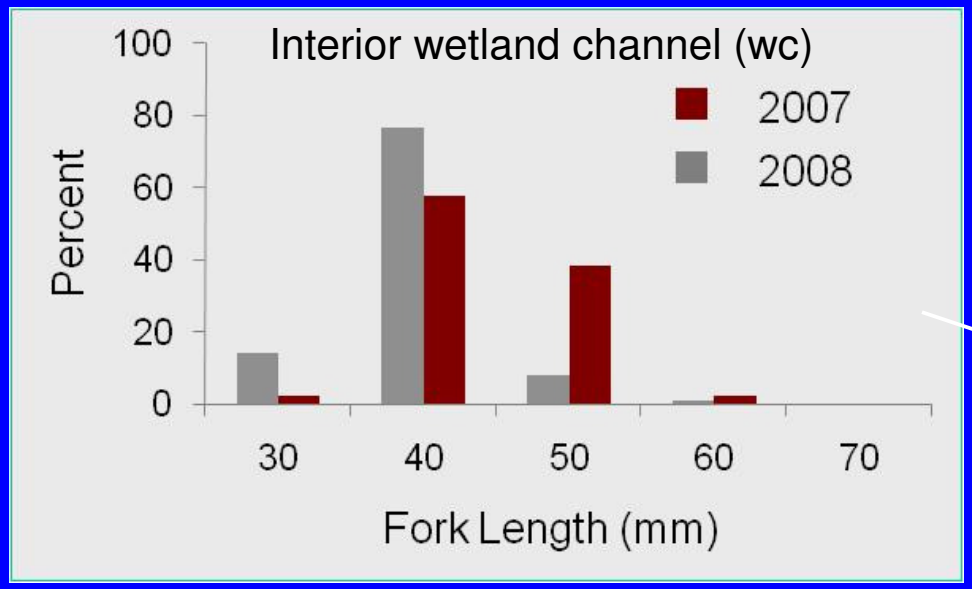
Salmon River Estuary 2002



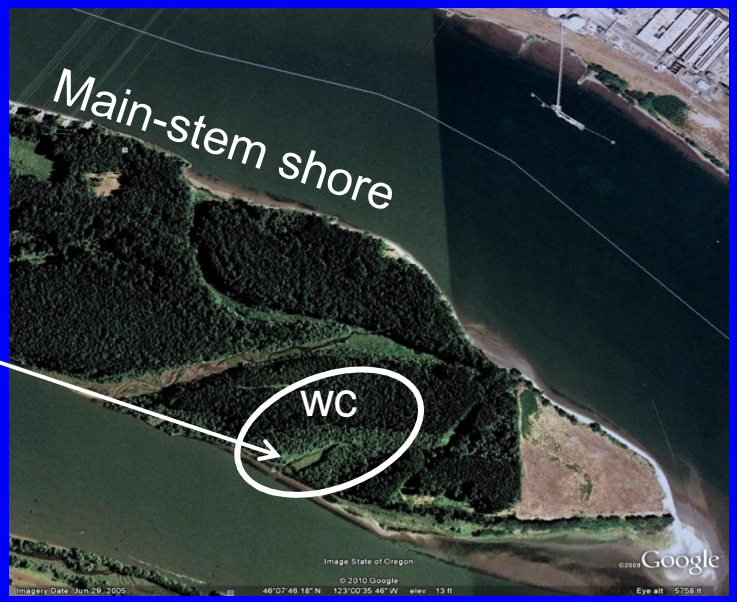
Size-Specific Habitat Use by Columbia River Chinook Salmon



Percent Marked		
	2007	**2008**
Main-stem	11.7	22
Wetland Channel	1.0	7.0

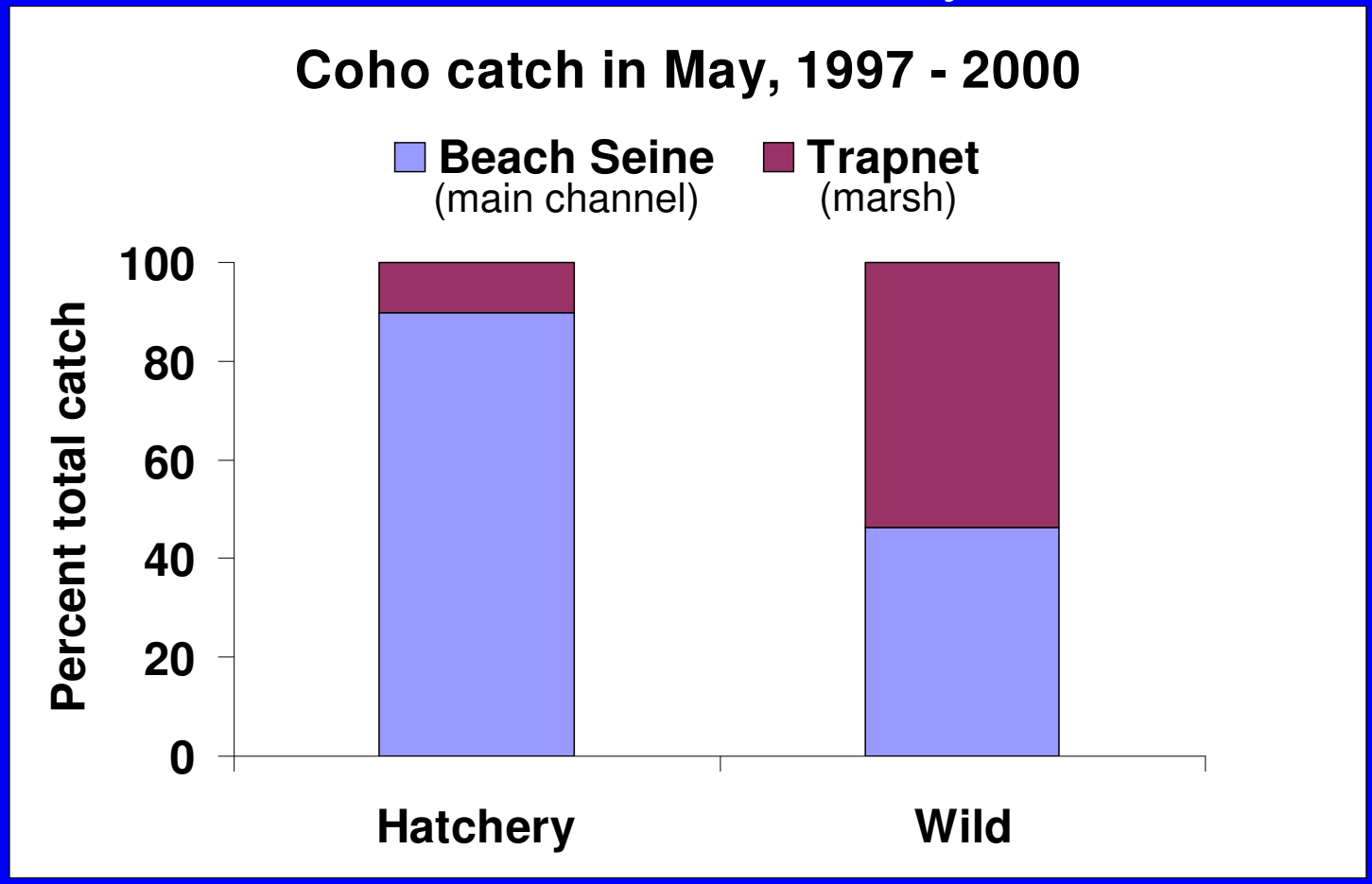


Lord Island



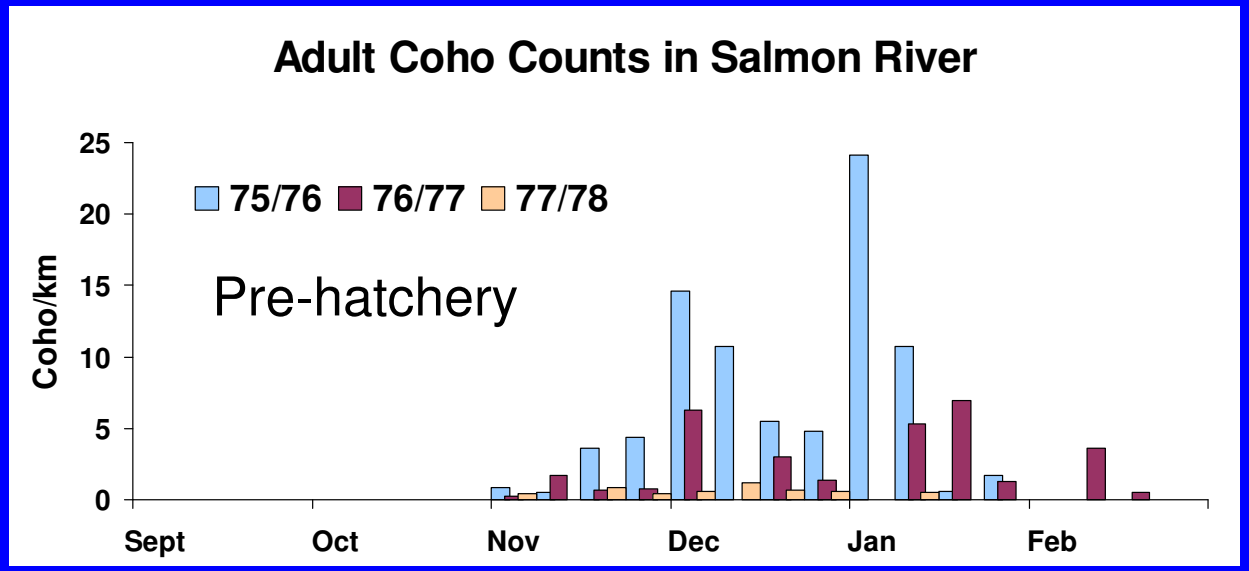
Habitat Selection by Hatchery and Wild Coho Salmon

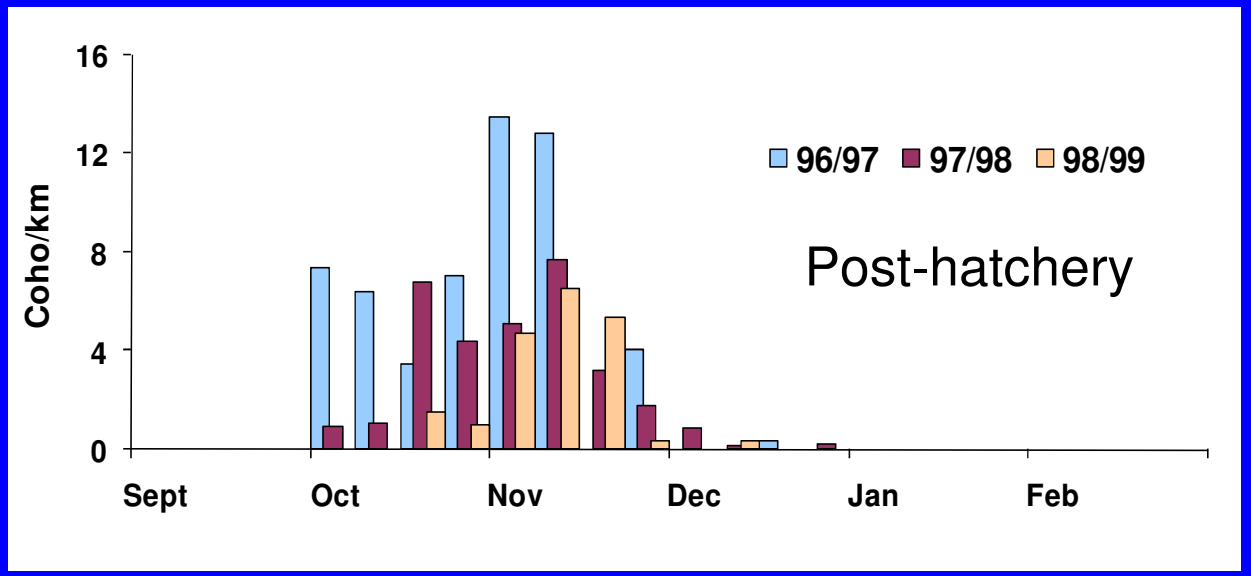
Salmon River Estuary



Indirect Hatchery Effects on the Estuary :

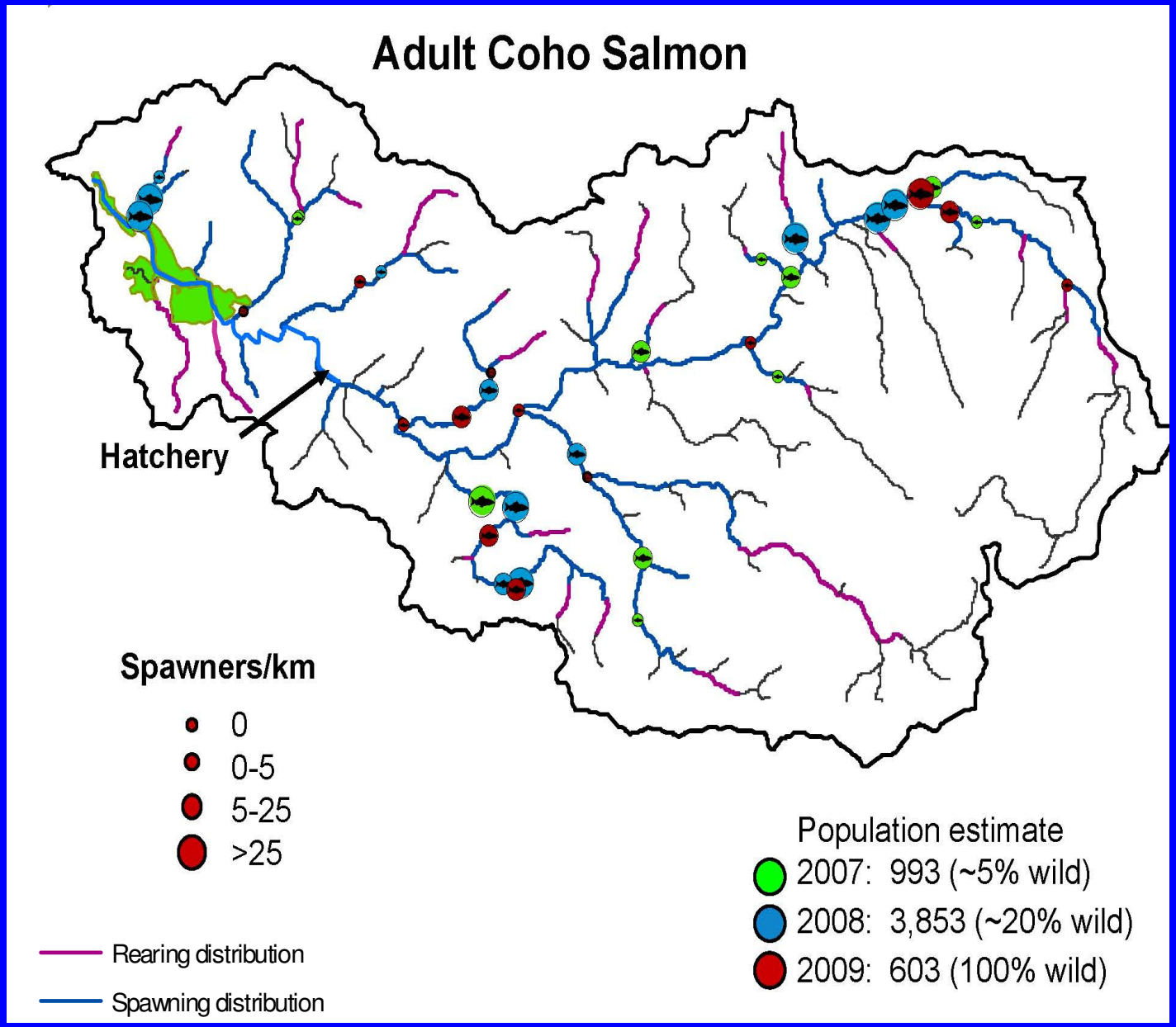
Coho Salmon Spawning Time





Indirect Hatchery Effects on the Estuary:

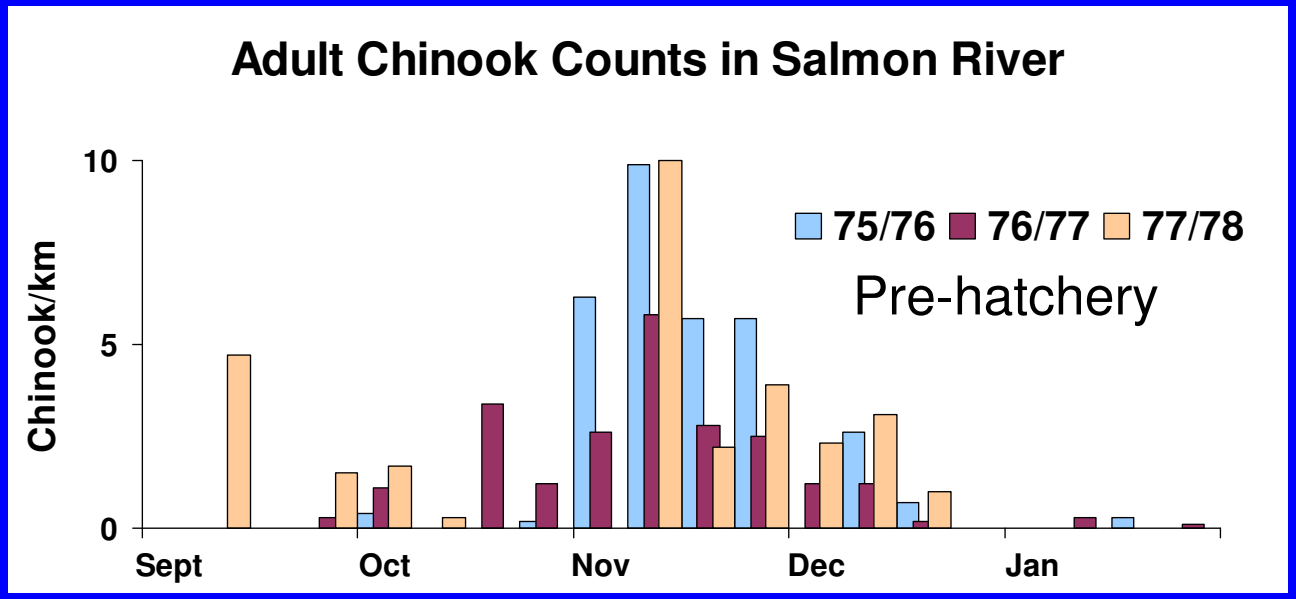
Spawning Distribution in Salmon River

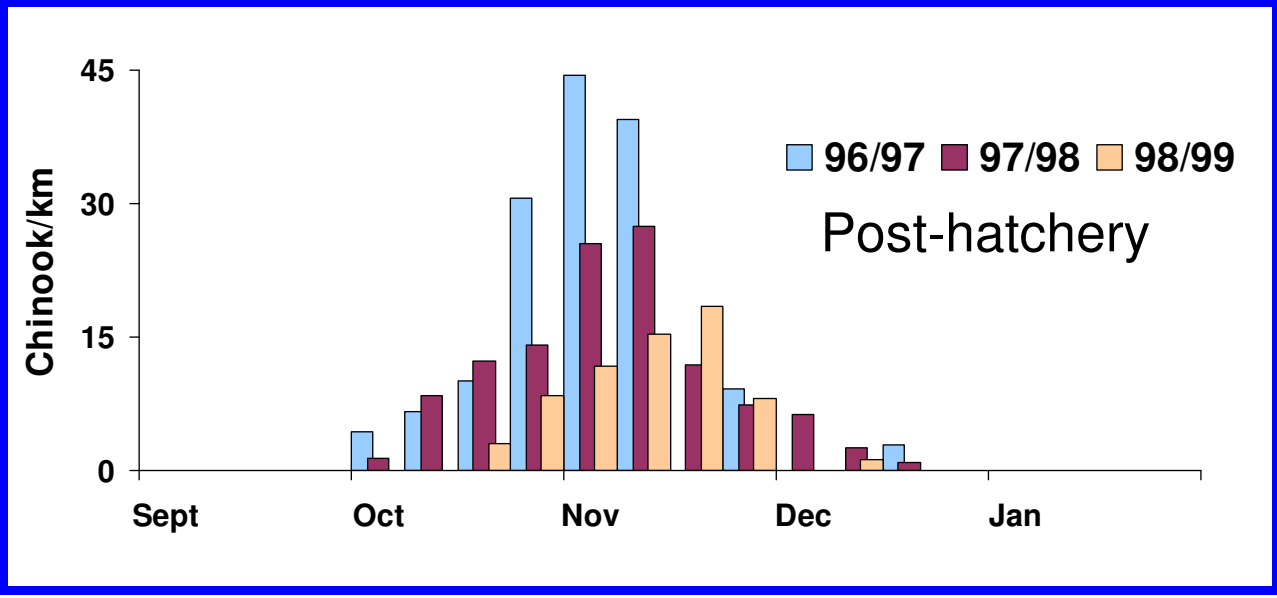


Indirect Hatchery Effects on the Estuary:

Chinook Salmon Spawning Time

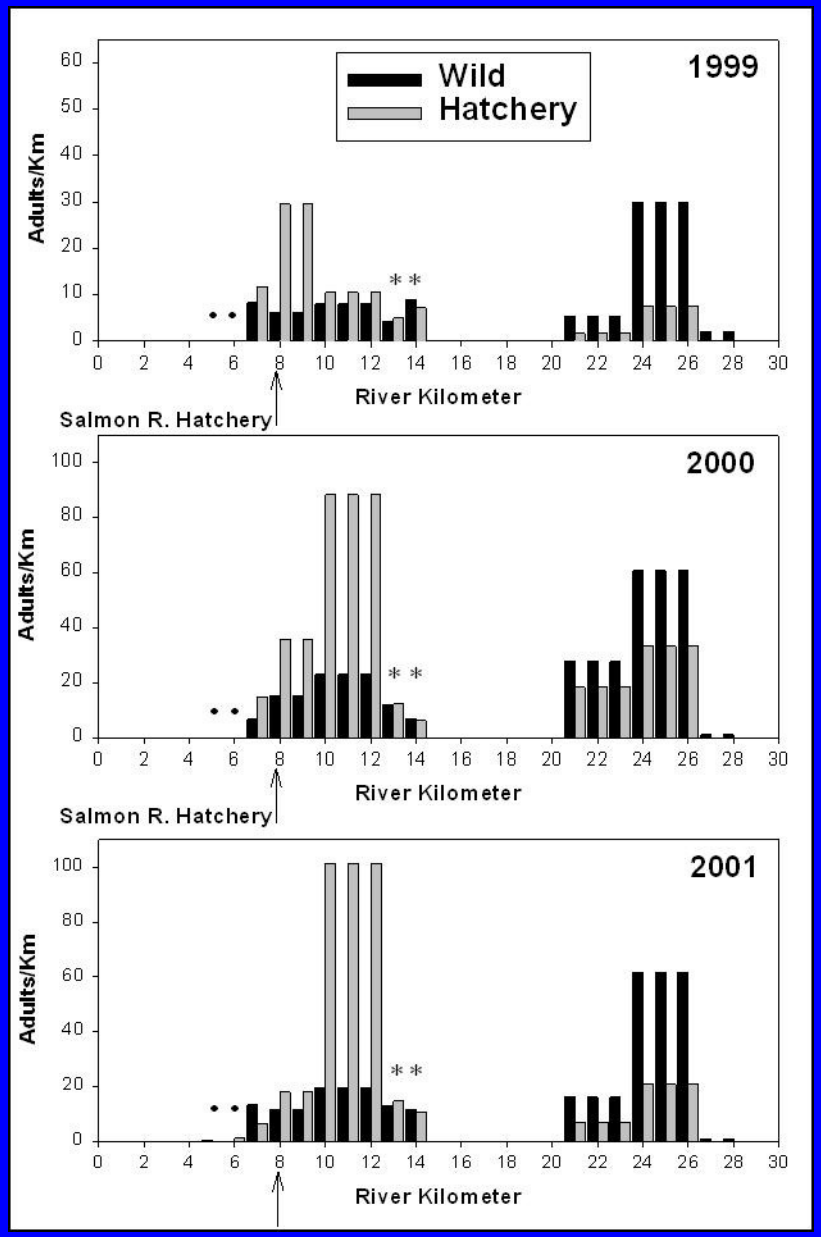
- Directional selection not as obvious
- Spawning timing has narrowed





Indirect Hatchery Effects:
Chinook Salmon Spawning Distribution, Salmon River Basin

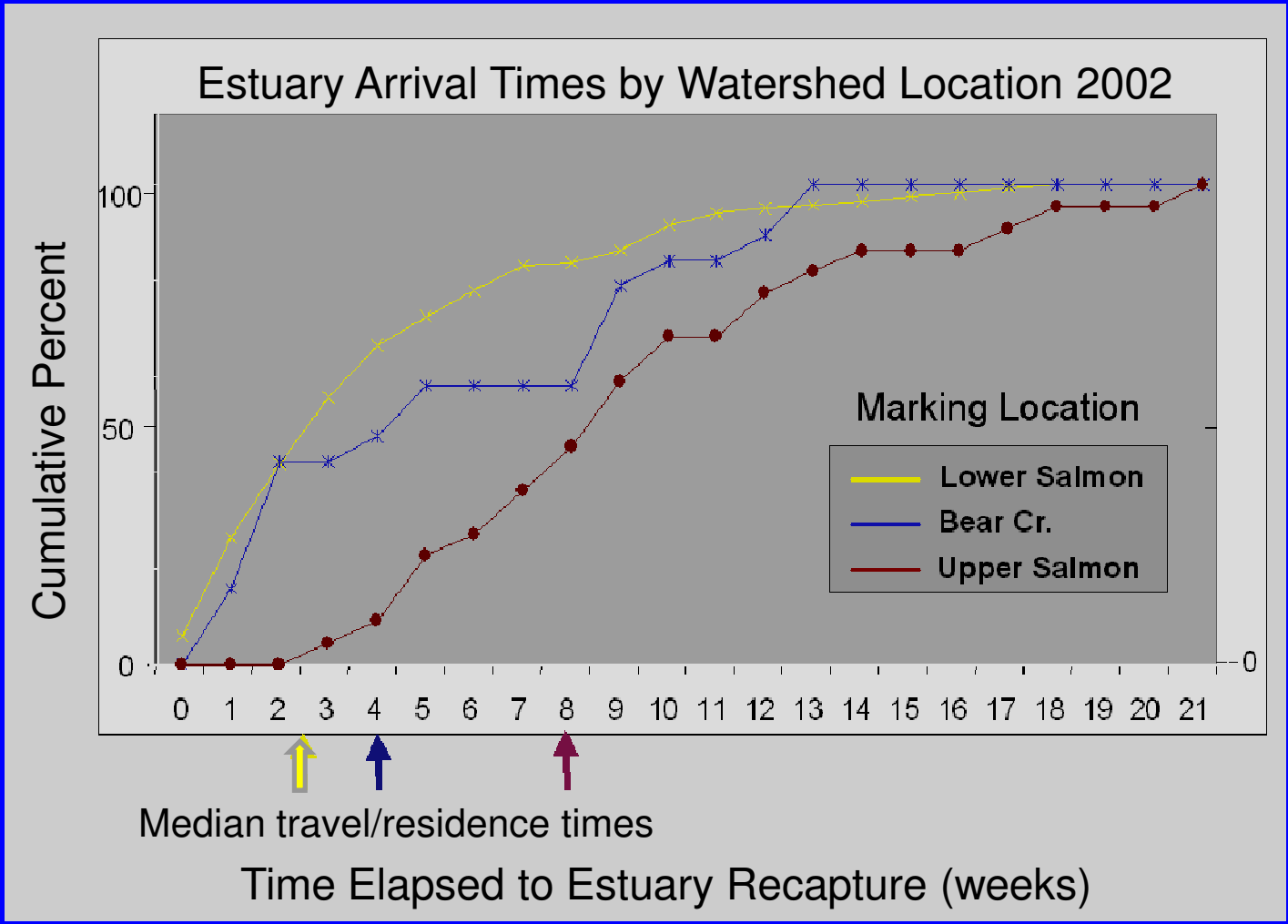
- High % of hatchery fish spawn near hatchery, just above the estuary
- Lower basin spawners earliest
- Higher % of wild fish found in traditional spawning areas



Indirect Hatchery Effects:

Effects of spawner distribution on estuary use by Salmon River Chinook

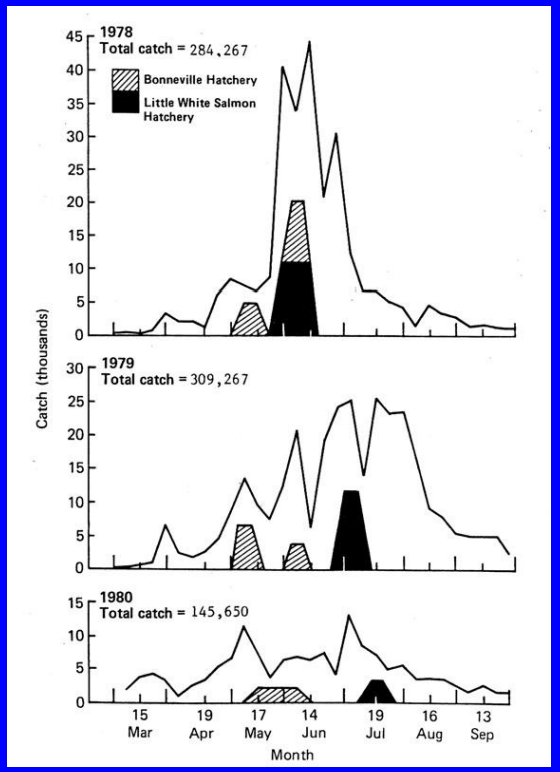
- Fish low in the basin arrive earliest and at small sizes
- Fish high in the basin rear longer in fresh water, arrive later



In basins dominated by hatchery production, salmon interactions in the estuary are a downstream expression of hatchery practices

- Hatchery location → time of arrival
- Timing and number of fish released → temporal patterns of abundance and migration
- Size at release → residence times, habitat use, prey selection, ocean entry

Columbia River Estuary



From Dawley et al. (1986)

Conclusions

- Hatcheries “reallocate space” by replacing the dispersed distributions and emergence times of naturally spawned fish with point sources of similarly sized individuals released in concentrated pulses
- Intensive hatchery production diminishes behavioral complexity, including diversity of estuarine rearing strategies and ocean entry times by juvenile salmon
- Replacement of natural production with hatchery fish may cause productive estuarine habitat opportunities to be underutilized
- Concentration of spawning time and distribution further simplifies salmon life histories and may create “mismatches” in estuarine/ocean environments

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