

Freshwater Restoration

Chapter 10 of the Skagit Chinook Recovery Plan

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SKAGIT RIVER SYSTEM
COOPERATIVE



Skagit
Watershed
Council

Federal Endangered Species Act-Review

- Recovery Plans are required by 4(f) of ESA
- Take is allowed under 4(d) of ESA
 - Threatened species
 - Requires Recover plan
 - 4(d) Take = harassment
 - Harvest
 - Hatcheries
 - Hydropower
 - Habitat
 - Scientific Collection (Section 10)



Juvenile Chinook Salmon (Photo: U.S. Fish and Wildlife Service)

Recovery Plan Components

- Recovery Plans must include
 - A description of site-specific management actions necessary to achieve species recovery.
 - Objective, measurable criteria which, when met, would result in a determination that the species be delisted.
 - Estimates of the time and costs required to achieve the plan's goal
- NOAA is the authorize agency to develop and implement recovery plans for anadromous fish species.

Skagit Chinook Recovery Plan

- Centered on Chinook Salmon biology
- Identify factors that limit Skagit River Chinook
 - Population size
 - Population growth
 - Spatial Structure
 - Diversity
- Lists Limiting Factors (4 H's)
- Lists Actions
 - Harvest
 - Artificial Production
 - Habitat Protection
 - Restoration *** (Skagit Watershed Council)
 - Continued Research and Monitoring
- Sets measurable criteria for recovery
 - Total adult run size
 - Adult spawner to adult recruit productivity



SRSC staff

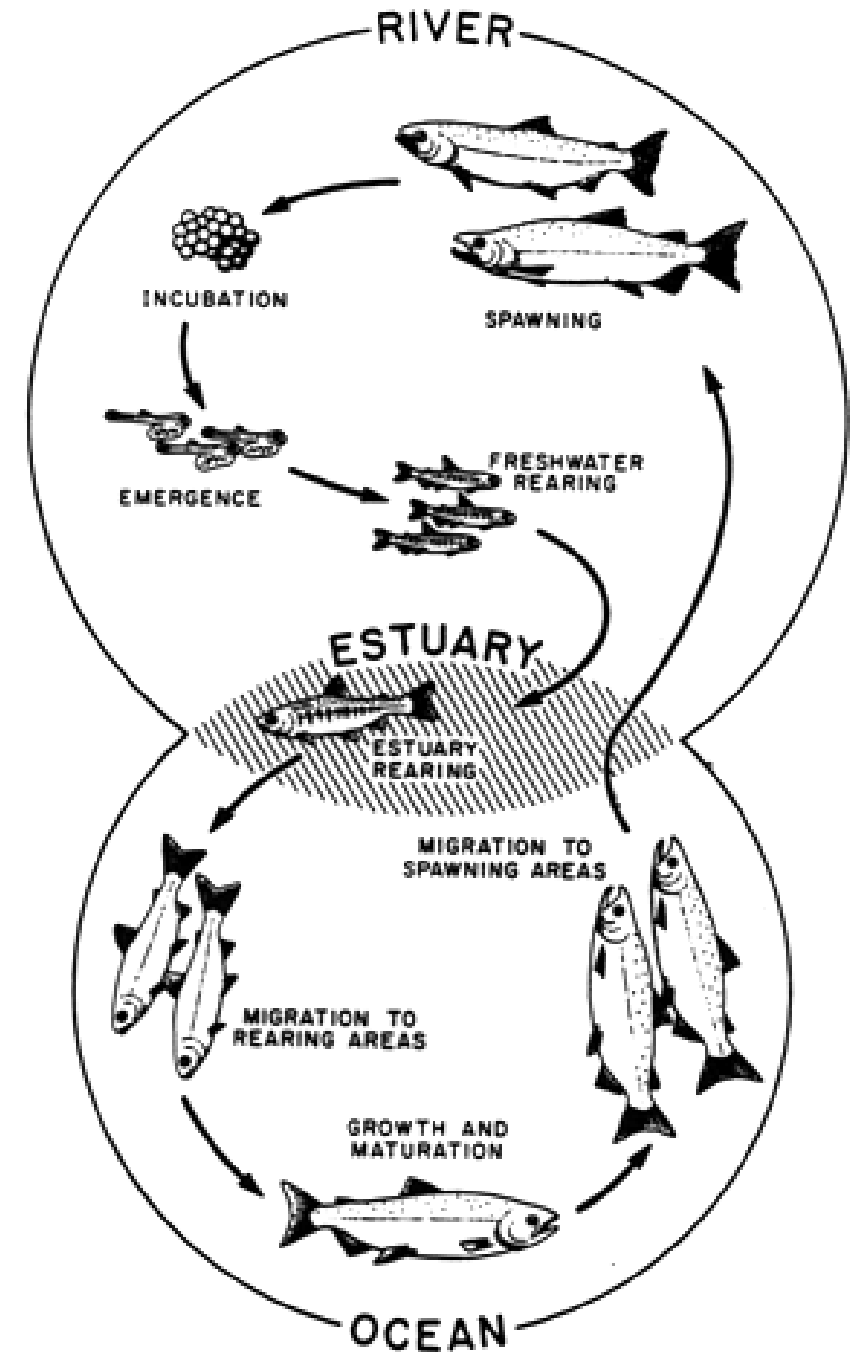
Skagit Chinook Recover Plan

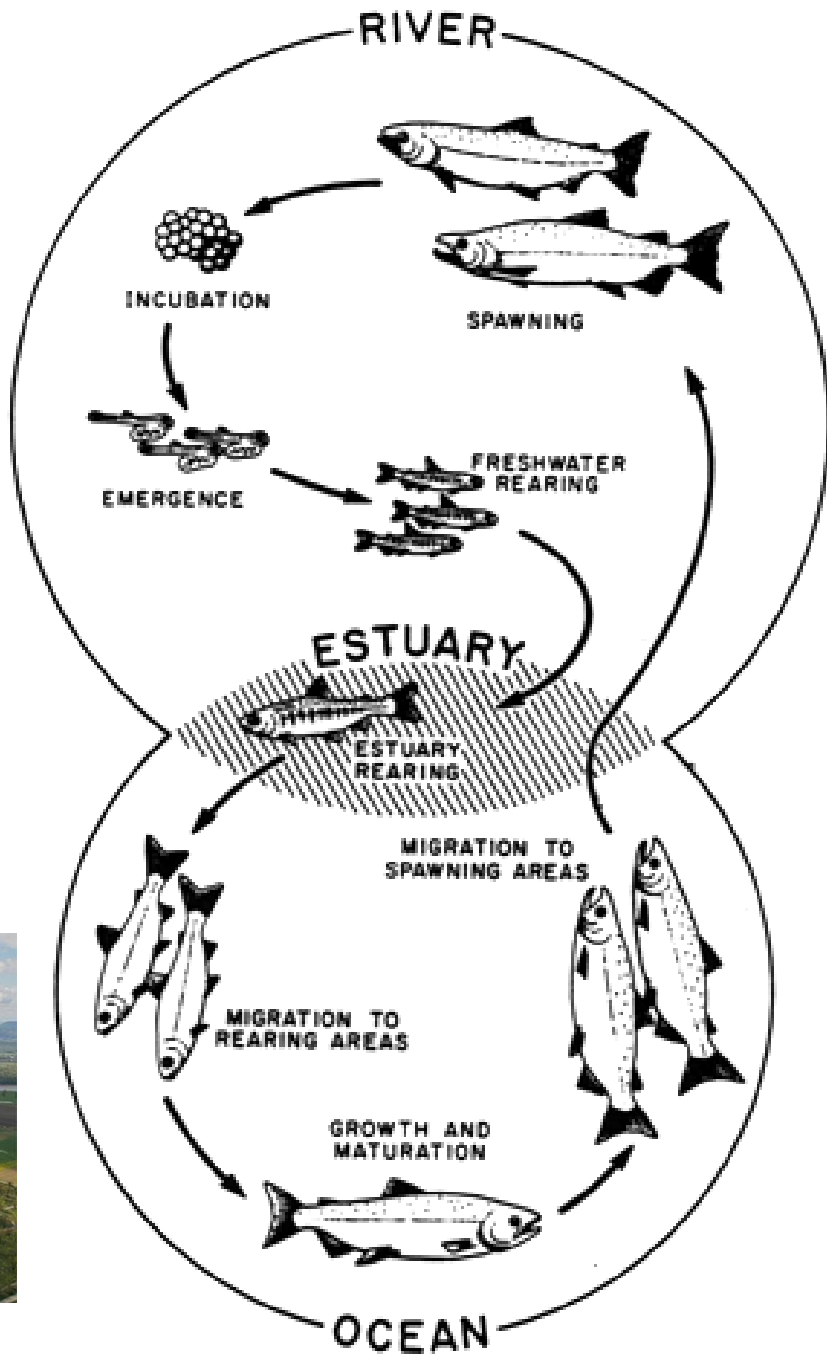
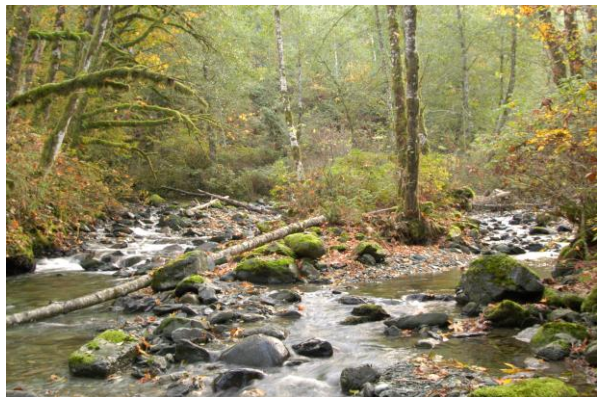
<http://skagitcoop.org/wp-content/uploads/Skagit-Chinook-Plan-13.pdf>

Skagit Recovery Plan pg xii

Chinook Life Cycle

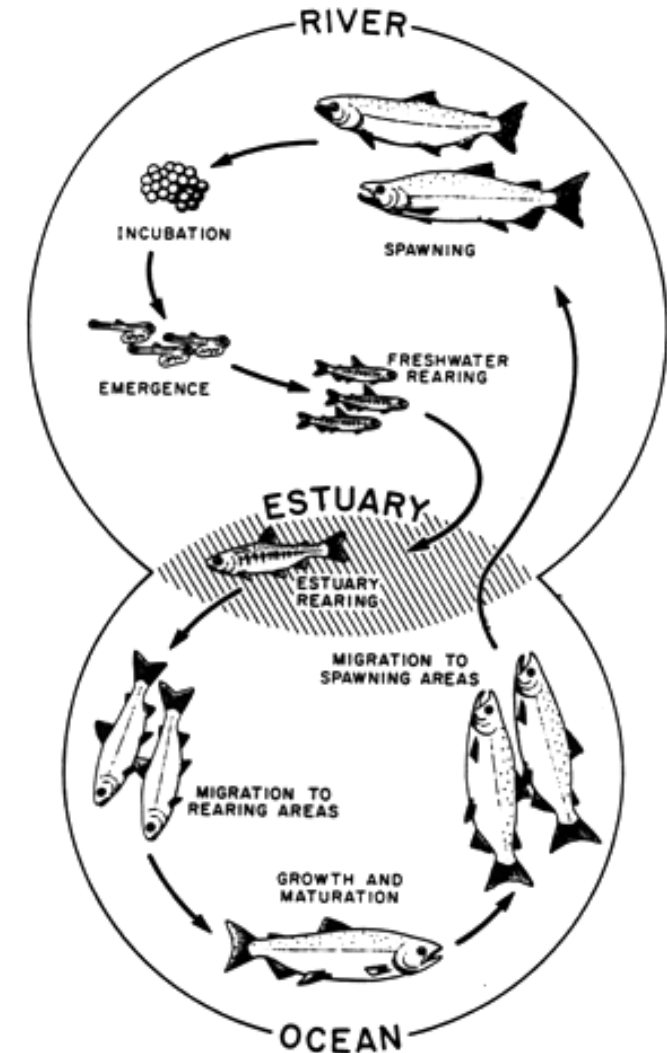
- Recovery must consider the **Whole life cycle** from spawning grounds to the ocean
- Chinook productivity is dependent on migratory pathways and the habitats used



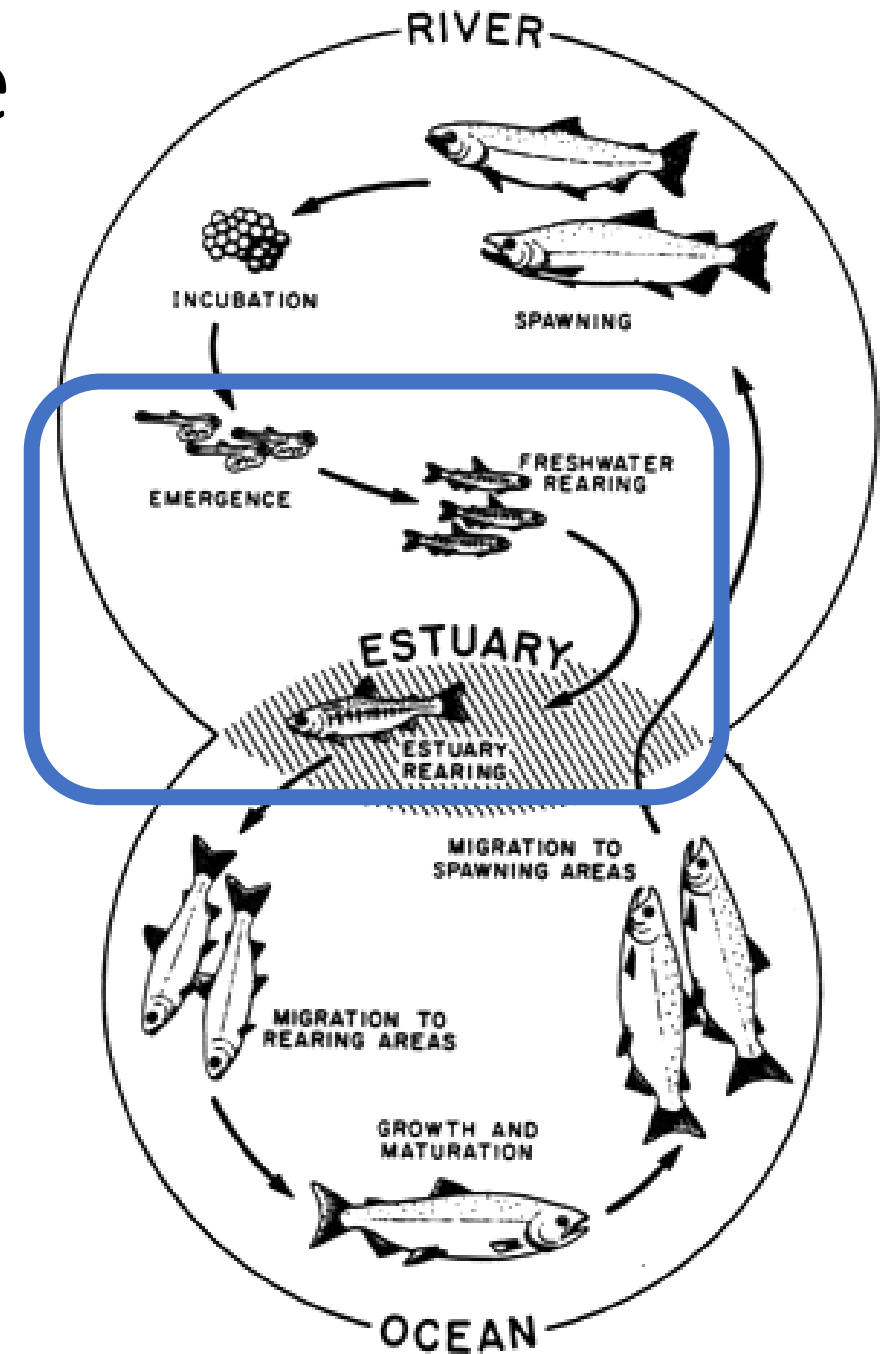
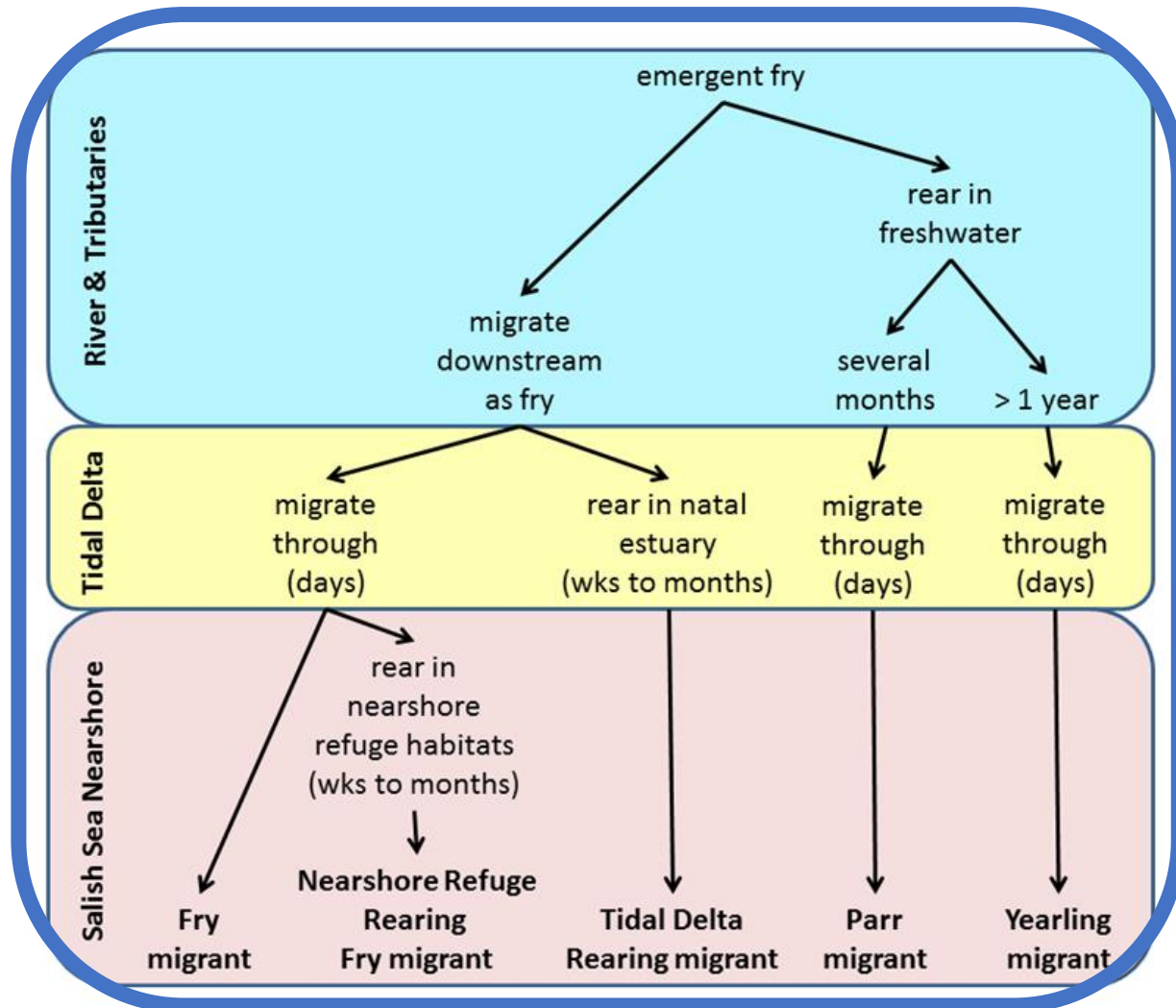


Recovery Planning within the Life Cycle

- Spawning and incubation
- Freshwater rearing
 - Floodplains
 - Nontidal Delta
- Tidal delta rearing
- Nearshore rearing
- Ocean Survival

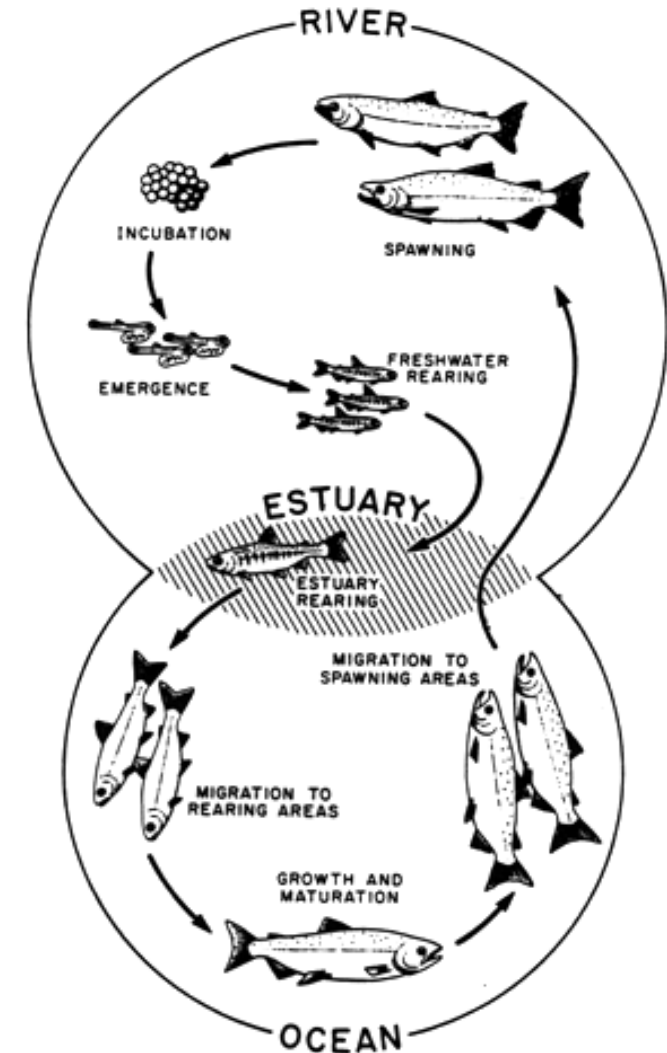


Multiple Pathways to Complete the Cycle



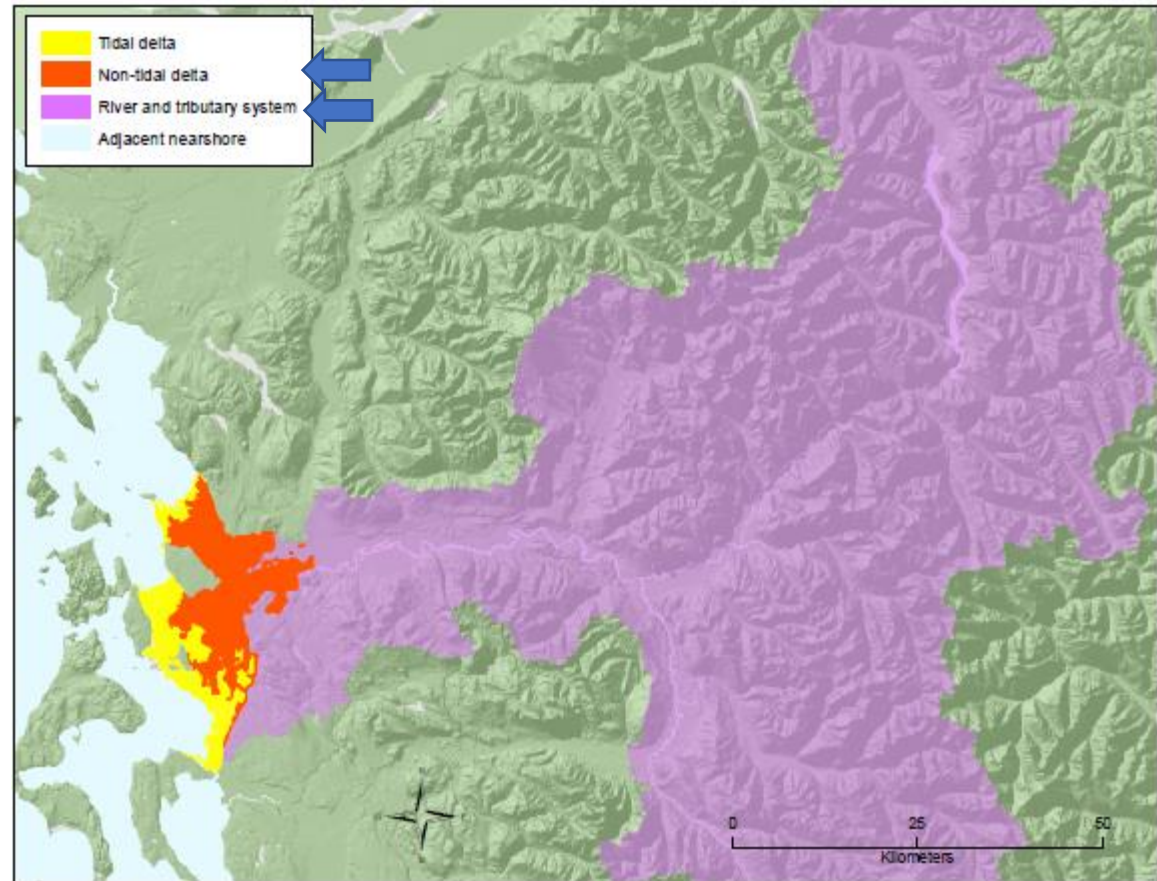
Recovery Planning within the Life Cycle

- Spawning and incubation* (Seixas & Veldhuisen Spring 2023)
- Freshwater rearing
 - Floodplains
 - Nontidal Delta
- Tidal delta rearing* (Beamer & Hood 2022)
- Nearshore rearing* (Beamer & Hood 2022)
- Ocean Survival* (Ruff, McClure & Dixon 2022)



Recovery Planning within the Life Cycle

- Spawning and incubation
- Freshwater rearing
 - Floodplains ←
 - Nontidal Delta ←
- Tidal delta rearing
- Nearshore rearing
- Ocean Survival



Nontidal Delta

- 98% of the nontidal delta lost
- Potential Restoration Listed
 - Salem LC
 - River Bend
 - Cottonwood Slough
 - Britt Slough

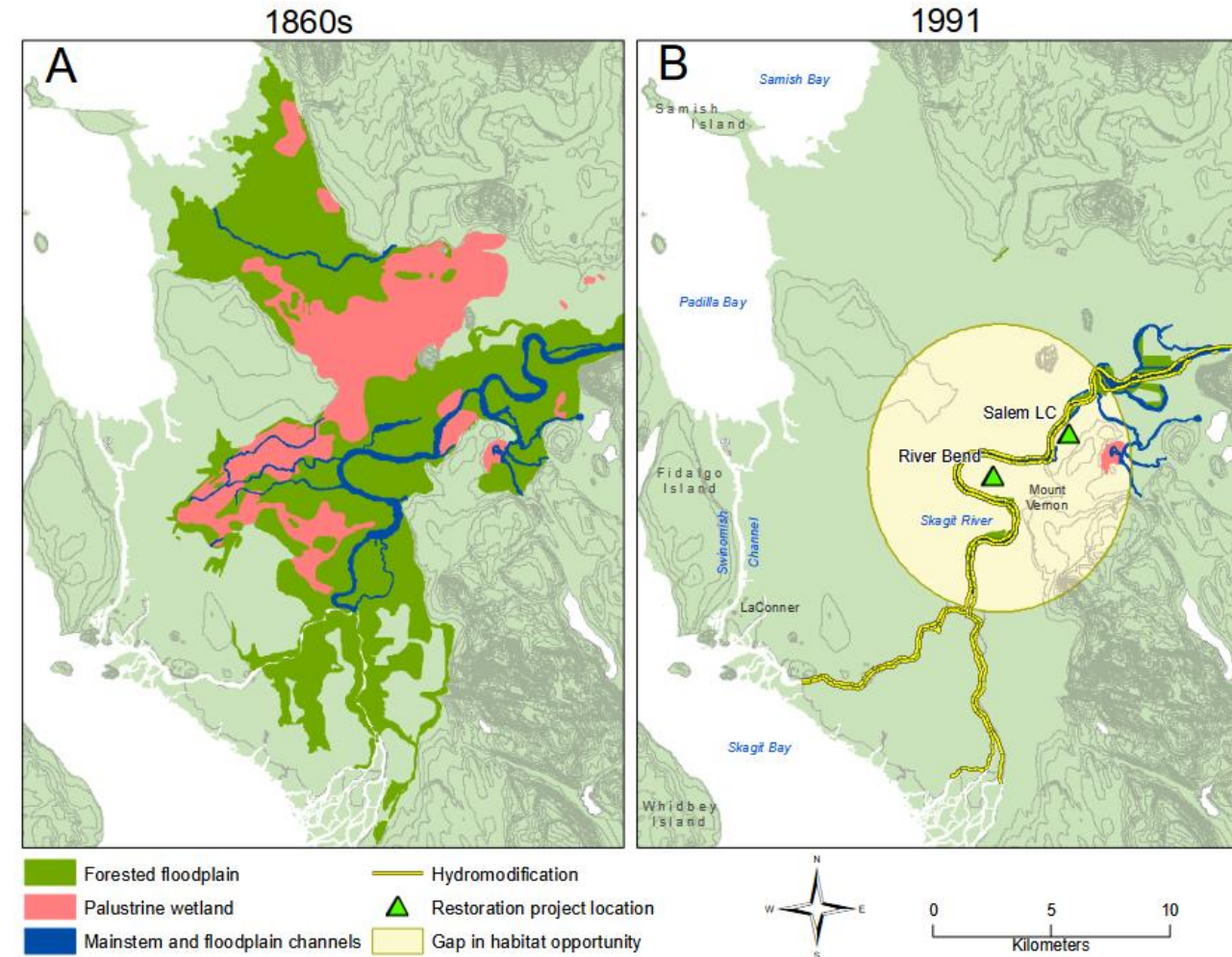
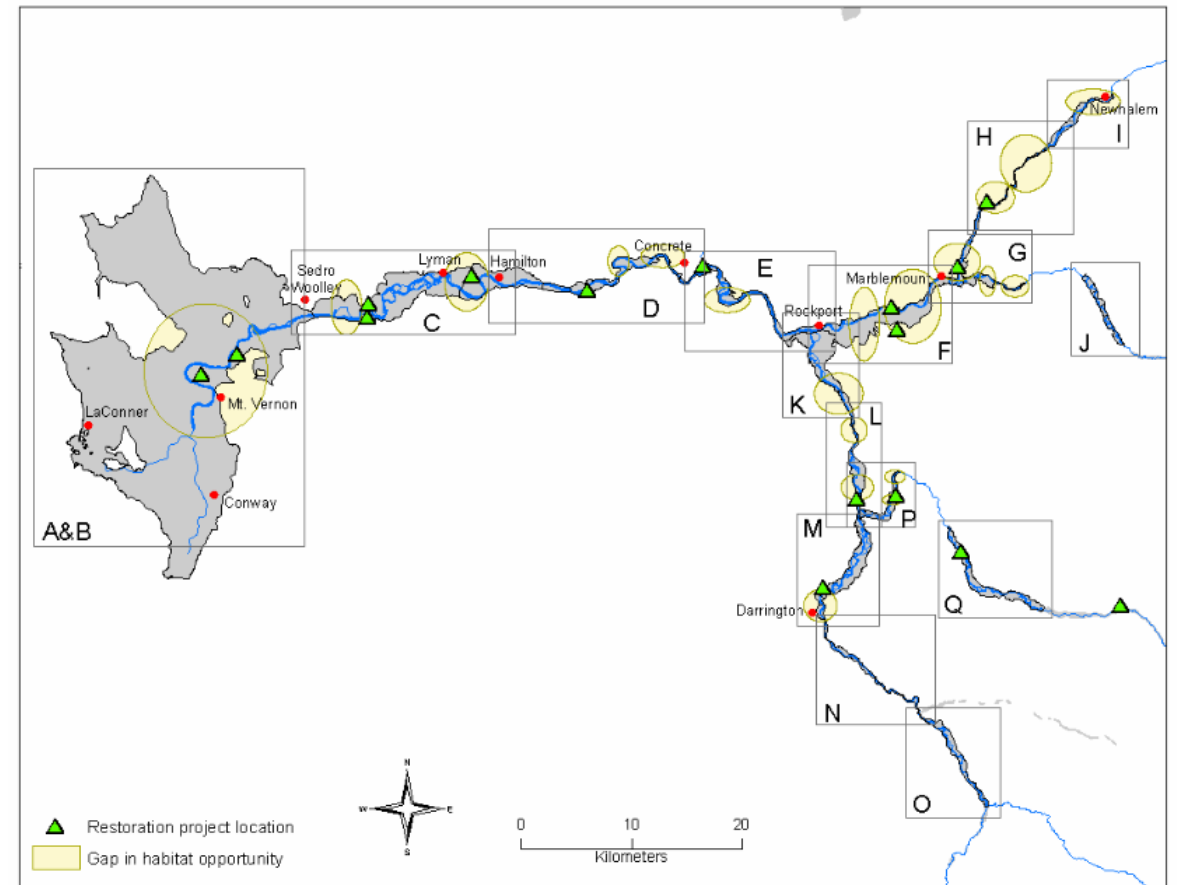
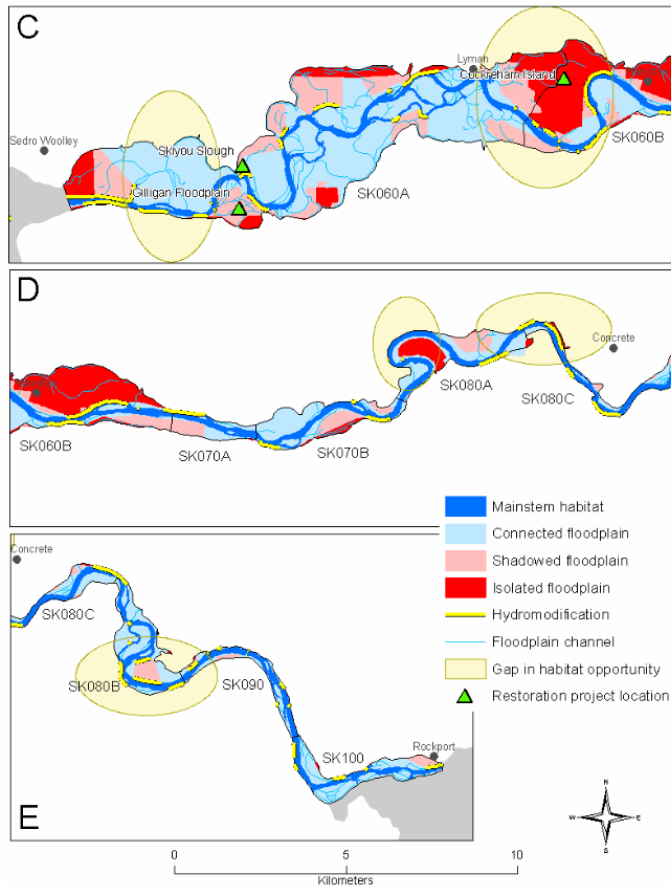


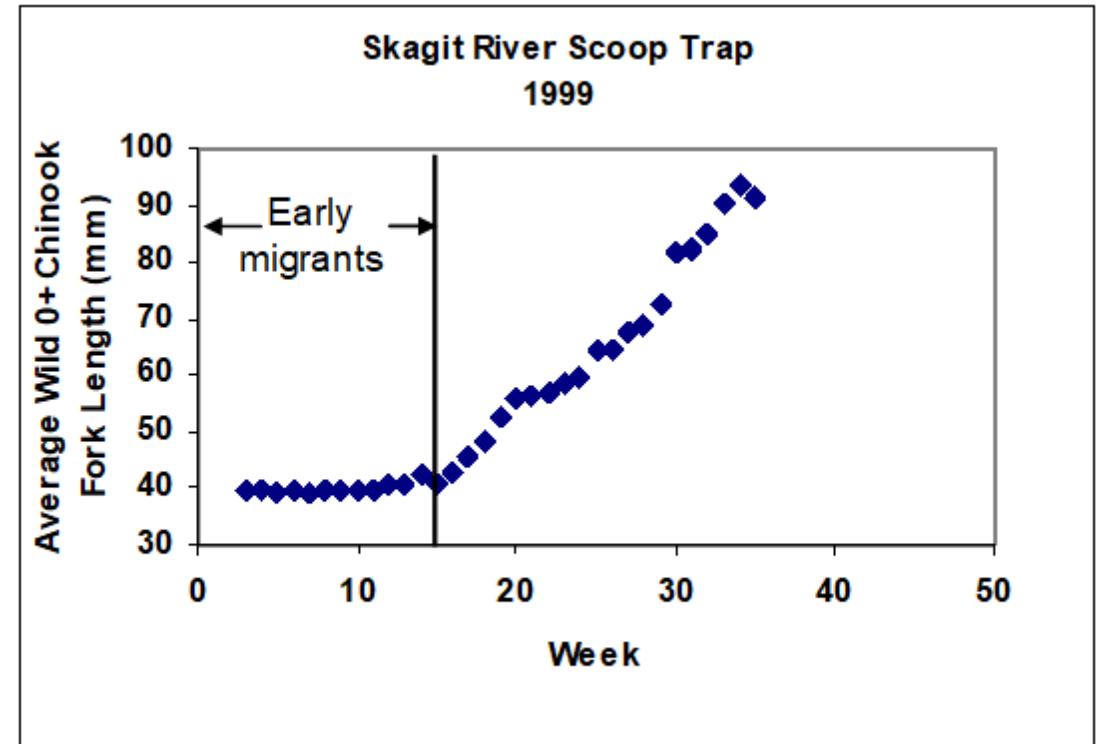
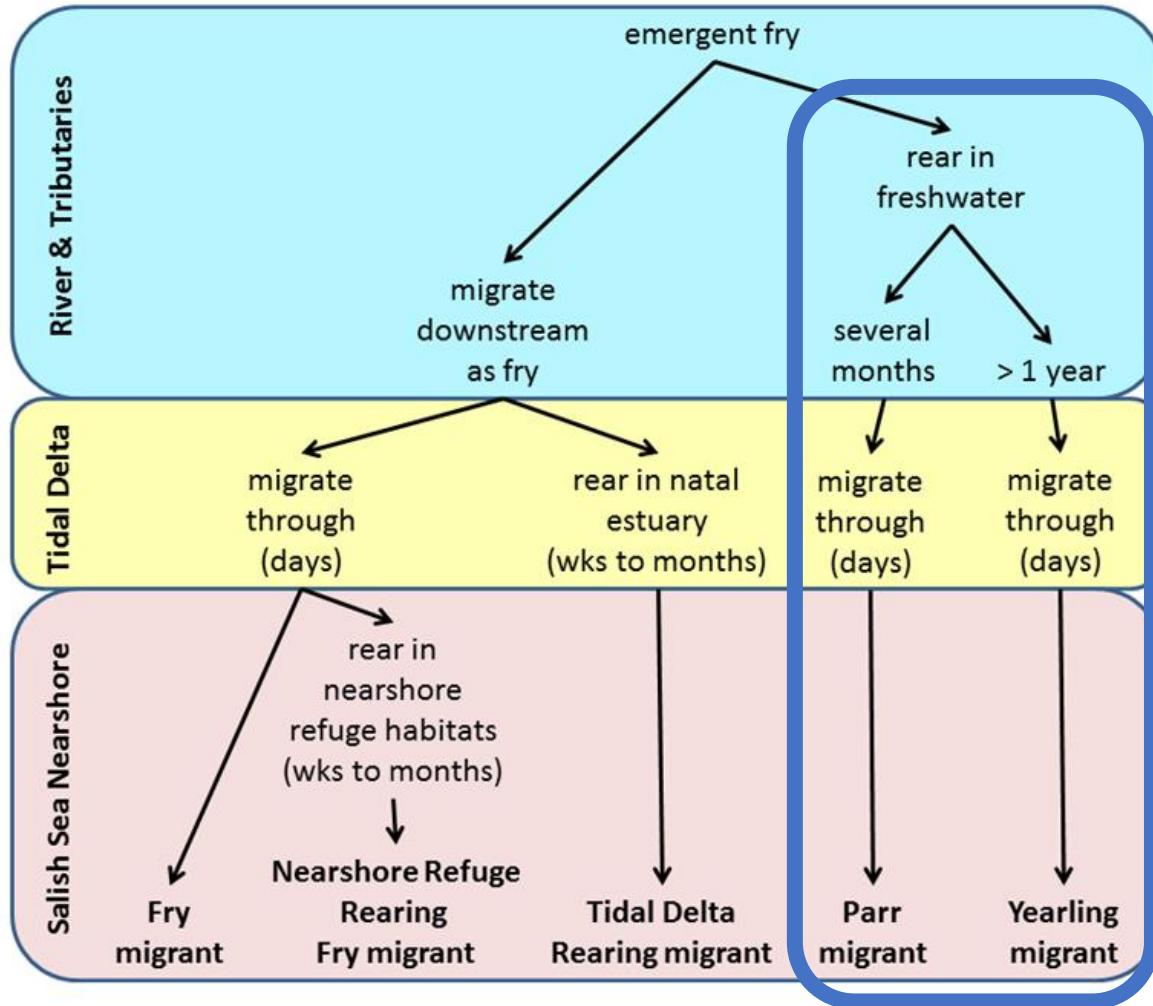
Figure 10.2. Floodplain areas for the non-tidal delta portion of the Skagit River. The map shows changes to floodplain and mainstem habitats. Historic conditions (A) were reconstructed by Collins (2000) and current conditions (B) were assessed using 1991 orthophotos by Beamer et al. (2000b).

Habitat Change Analysis

Floodplain Hydromodifications 28.6% loss



Floodplain Rearing



Juvenile Chinook in Floodplains

- Before Recovery Plan adoption
 - Juvenile Chinook consistently in Skagit floodplain areas (Hayman 1996)
 - 5x higher juvenile Chinook densities along natural banks compare to rip-rap (Beamer and Henderson 1998)
 - Floodplain habitats important for juvenile Chinook salmon rearing success (Sommer et al. 2001)
- After Recovery Plan adoption
 - More complex floodplains improve Chinook rearing (Hall et al. 2018)
 - Increasing amount of floodplain habitat can increase rearing capacity (Bond et al. 2018)

Evidence for Density Dependence-Freshwater

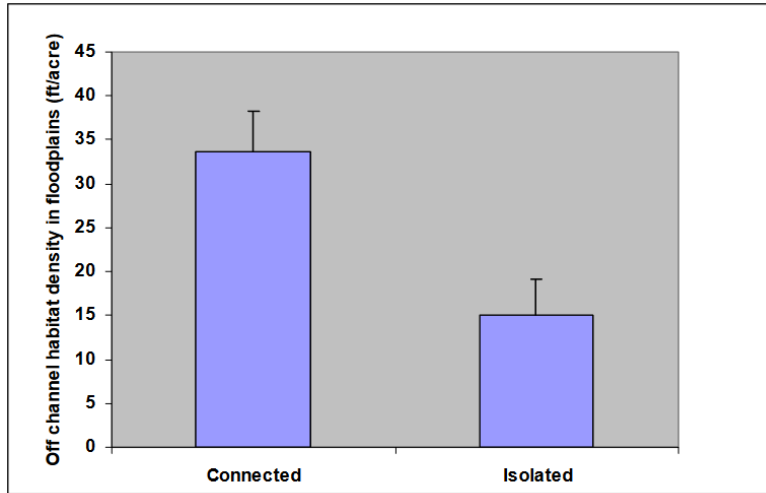
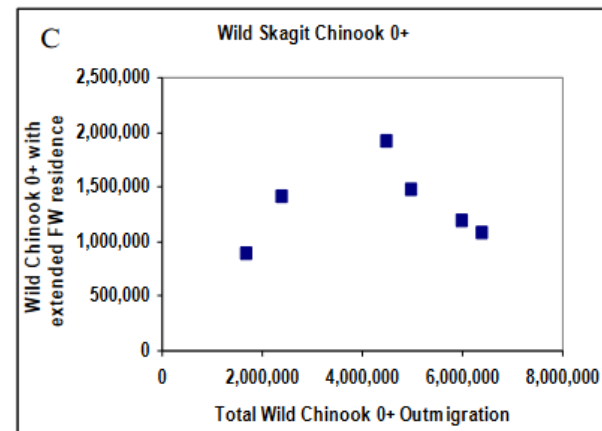
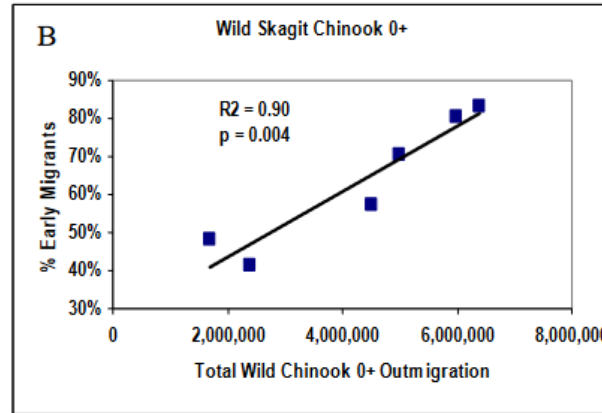


Figure 4.3. Average (and standard error) off-channel habitat density in connected and isolated floodplains. Data from 31 large mainstem reaches in the Skagit River Basin. Off-channel habitat density is significantly lower in isolated floodplain areas (paired T-test, $P = 0.0015$).



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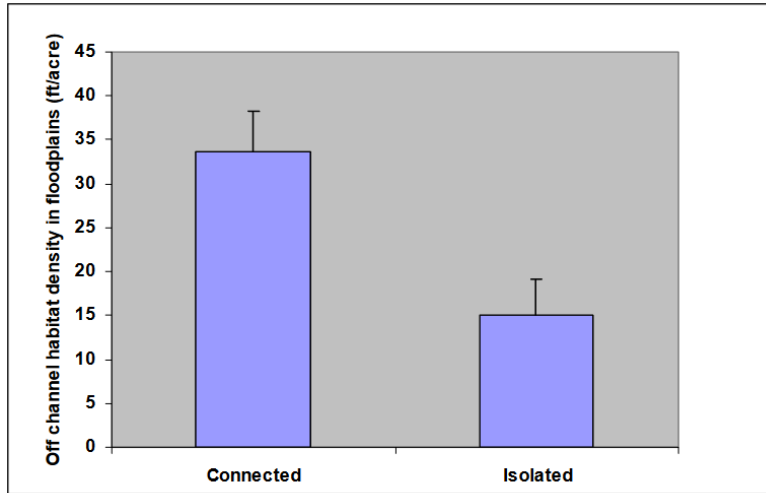
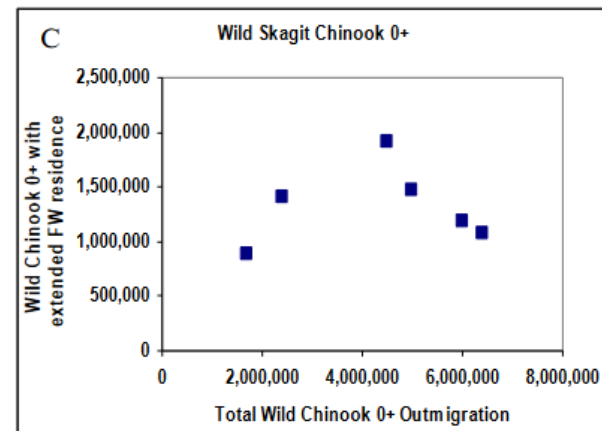
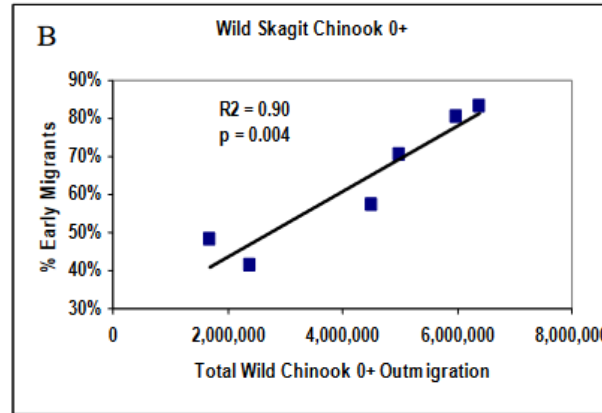
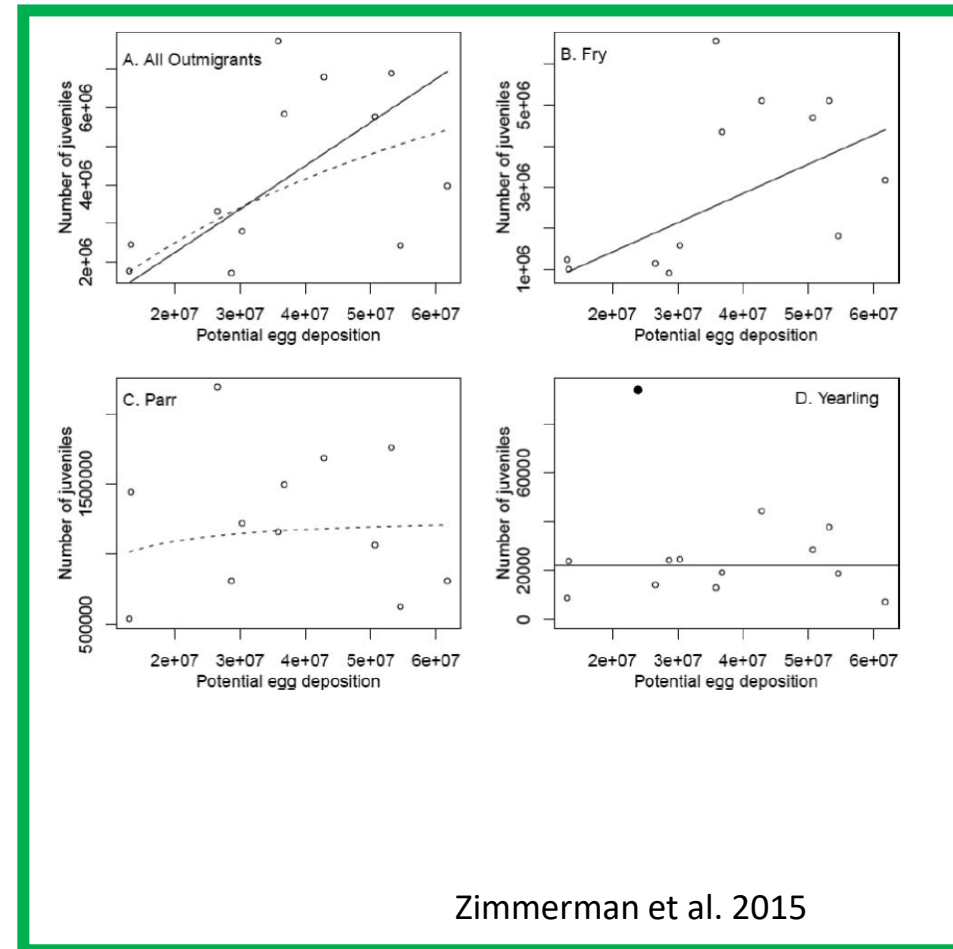


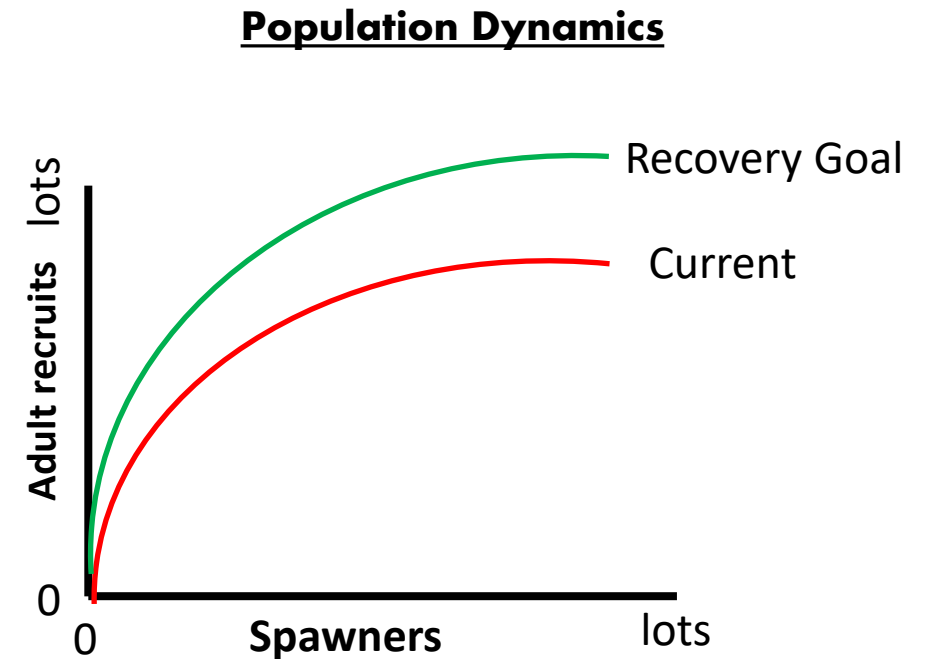
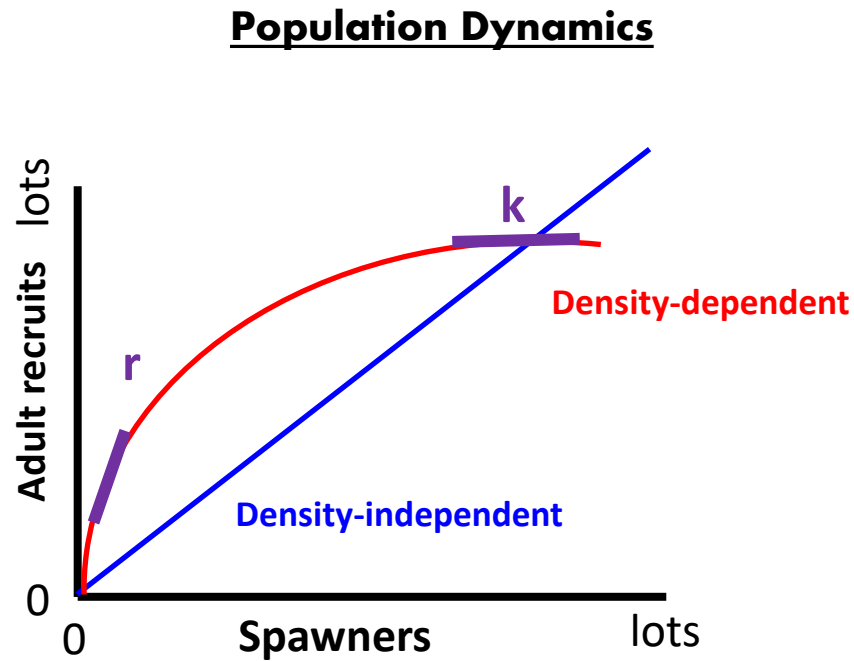
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Corroborating Evidence Since SRP



Setting Measurable Criteria for Recovery



Density Dependent regulation is when the size or growth of population vary with the population density

Skagit Recovery Goal

Skagit Chinook fall into six different populations: Upper Cascade springs, Suiattle springs, Upper Sauk springs, Lower Skagit falls, Upper Skagit summers, and Lower Sauk summers. The following two tables show where we are today, and what the recovery goals are at the point of MSY.

Percent of adult recruitment goals at MSY for wild Skagit Chinook salmon achieved by implementing all proposed restoration actions.

Marine Survival	Recovery Goal (Adults per Year)	Before Plan Actions		After Plan Actions		Percent Change
		Adults per Year	Percent of Goal	Adults per Year	Percent of Goal	
Low Regime	40,600	20,369	50.2%	29,991	73.9%	+23.7%
High Regime	124,000	59,774	48.2%	88,012	71.0%	+22.8%

Percent of productivity goals at MSY for wild Skagit Chinook salmon achieved by implementing all proposed restoration actions.

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Low Regime	3.4	1.7	50.2%	2.5	73.9%	+23.7%
High Regime	5.8	5.1	86.8%	7.4	127.8%	+41.0%

Skagit Recovery Plan pg Xii developed from EDT Model

https://salishsearestoration.org/images/0/06/Lestelle_et_al_2004_EDT_model_structure.pdf

Freshwater Capacity

Table 16.5. Changes in capacity or population for Skagit origin juvenile Chinook at Equilibrium Escapement

Habitat	Life Stage or Life History Strategy	Current Capacity	Restored Capacity
Spawning and egg incubation	Fry	17,900,000*	22,800,000* (27% increase)
Freshwater	Yearling	107,000	140,000 (31% increase)
	Parr migrant	1,300,000	1,700,000 (31% increase)
Estuary/Nearshore	Tidal Delta	2,250,000	3,600,000 (60% increase)
	Pocket Estuary	70,000	220,000 (214% increase)

*There is no limitation to emergent fry capacity.

Skagit Recovery Plan pg 284



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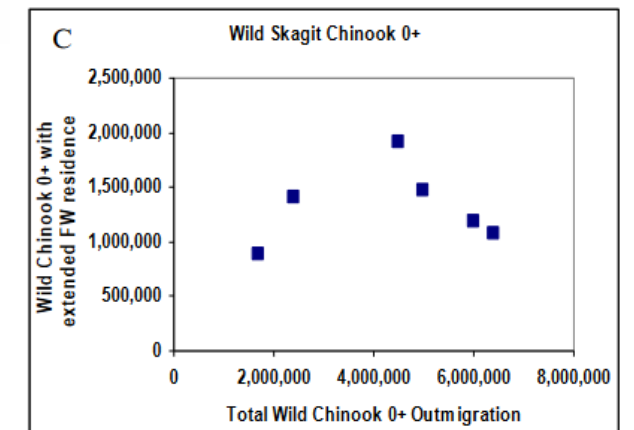
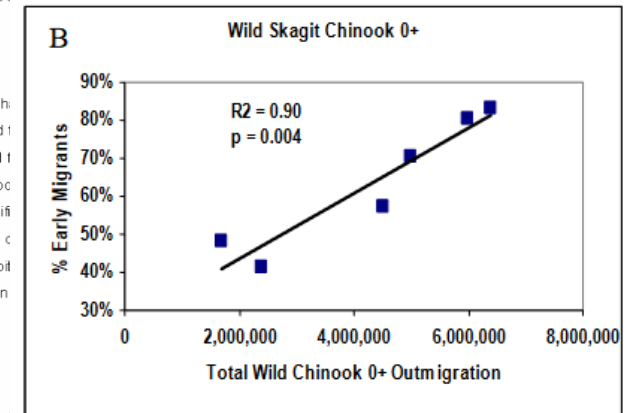
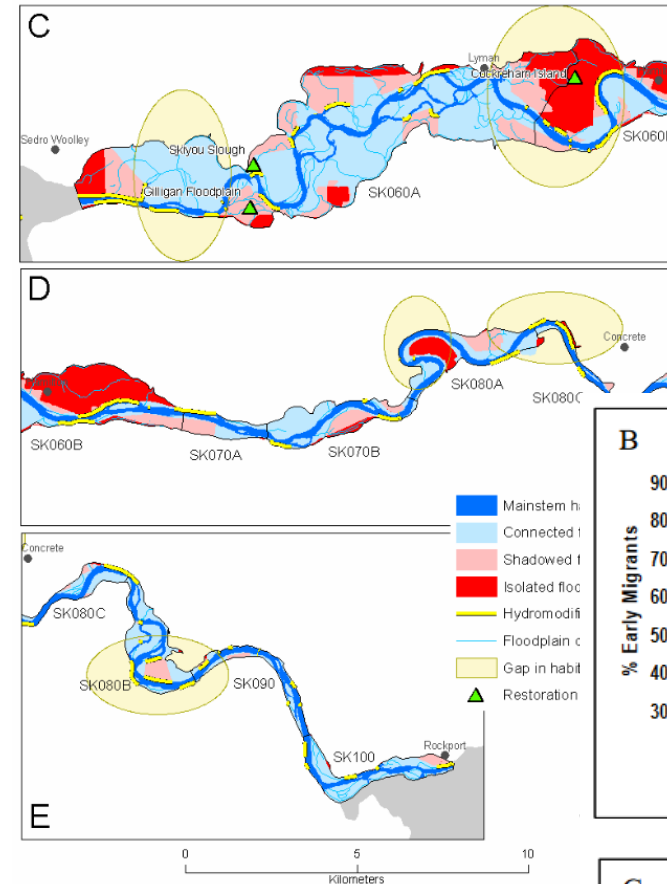
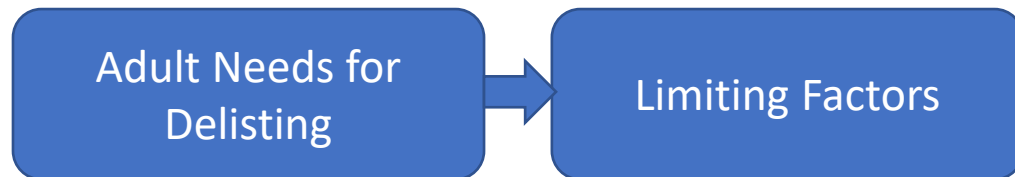
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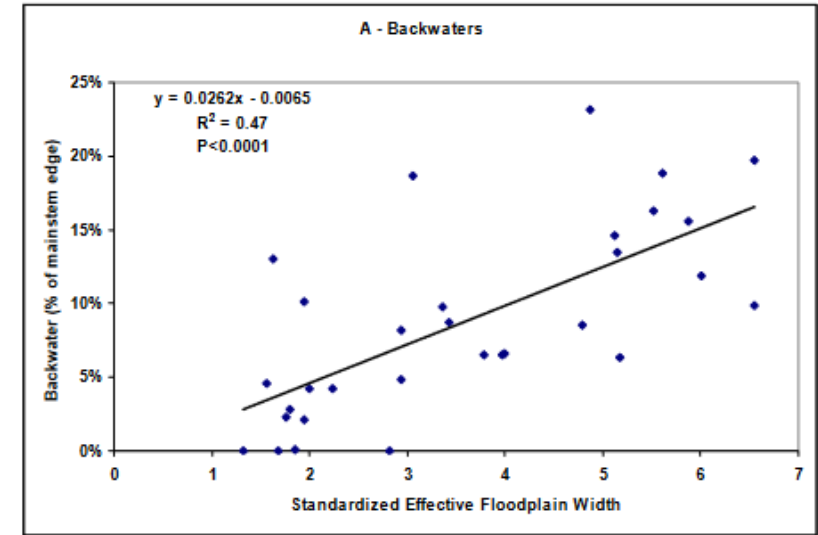


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Skagit Recovery Plan
Appendix C pg 20

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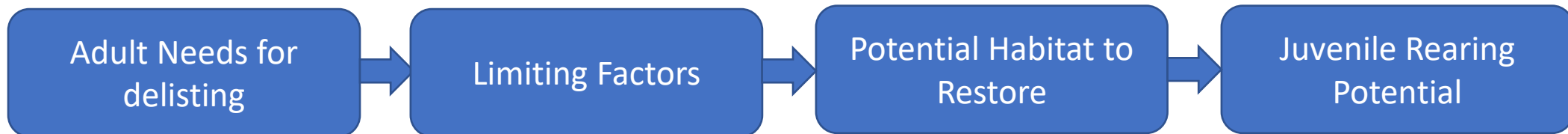
Table 6.3. Assumed capacity for parr migrant Chinook salmon by habitat type.

Habitat type for large rivers (channels > 50 m wide)	Assumed capacity (fish/m ²)	Source
Natural backwater	1.780	Hayman et al. 1996
Hydromodified backwater	0.639	Hayman et al. 1996 (scaled by bank ratio)
Natural bar	0.440	Hayman et al. 1996
Hydromodified bar	0.158	Hayman et al. 1996 (scaled by bank ratio)
Natural bank	0.970	Hayman et al. 1996
Hydromodified bank	0.348	Hayman et al. 1996
Mid-channel areas	0.001*	NOAA, unpublished
Off-channel habitat	486 (per hectare)	Hayman et al. 1996

*This value was for riffles. We believe this represents the appropriate juvenile Chinook density in the larger channels because velocities are high and our limited data from mid channel habitat does not find rearing sub yearling Chinook salmon.

Skagit Recovery Plan Appendix C pg 23

- How do you derive the number?



Freshwater Capacity

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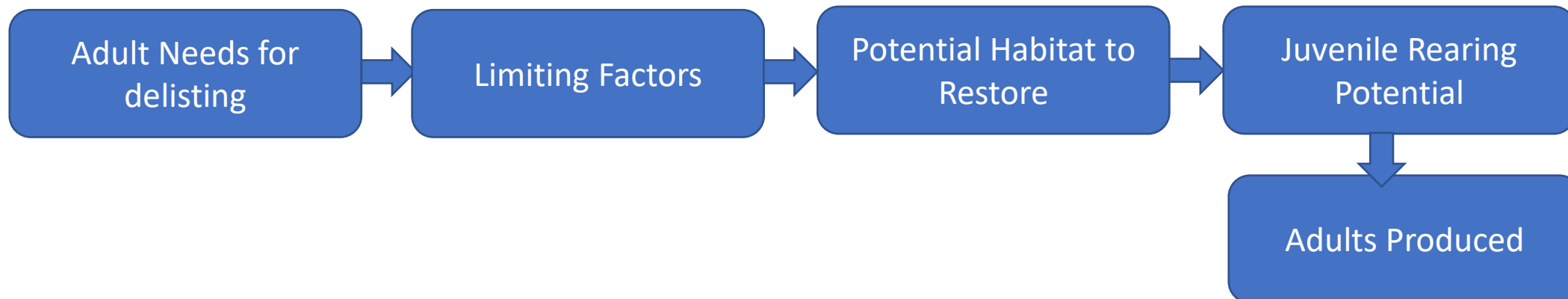
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Life History Type	High Marine Survival	Low Marine Survival
Parr Migrant	0.518%	0.109%
Yearling	1.191%	0.251%

Skagit Recovery Plan Appendix C pg 4

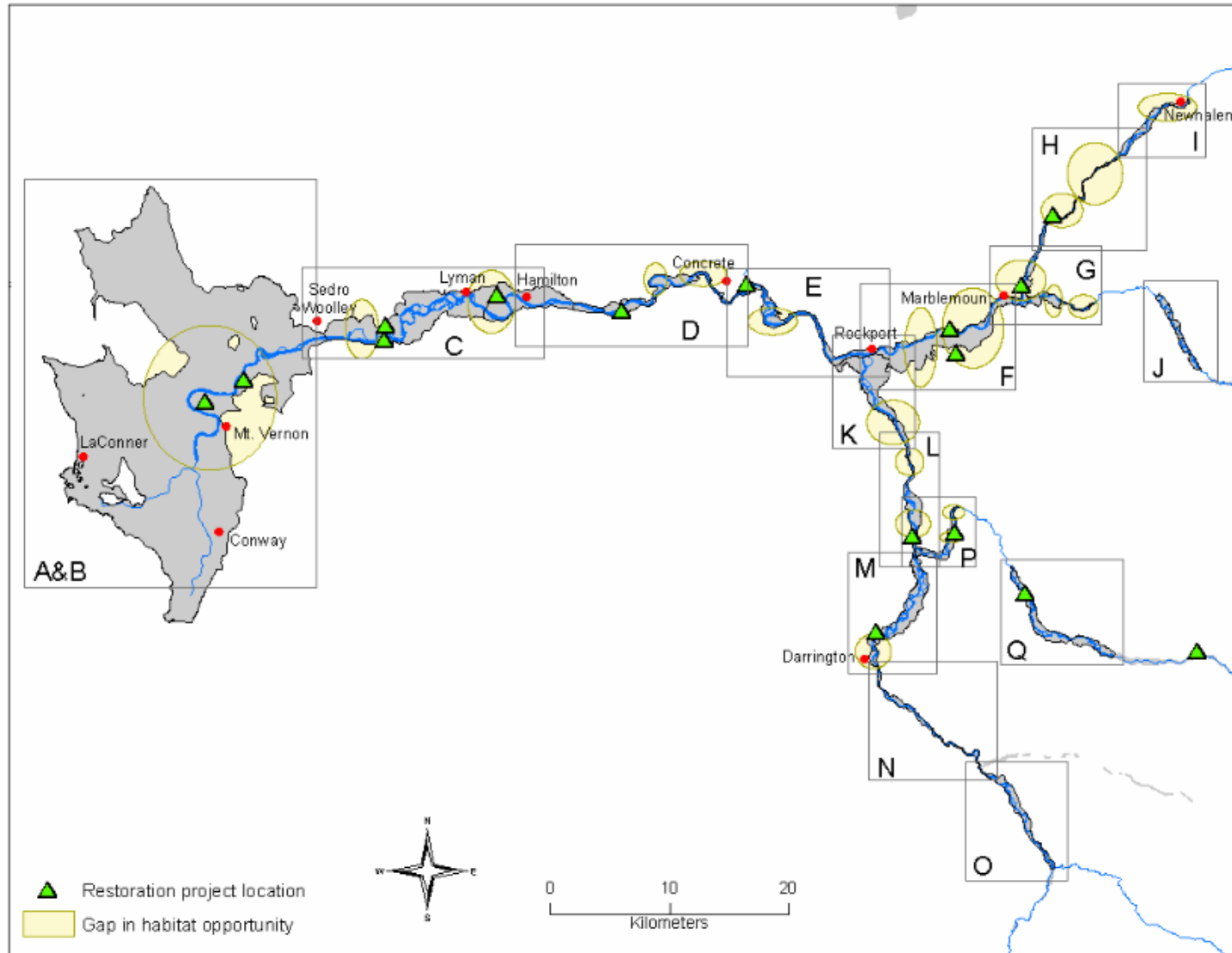
- How do you derive the number?



Restoration Site Selection, Ch. 10

- Largest benefit to Chinook Salmon Recovery
 - Reconnecting isolated rearing habitats
 - Restoring hardened streambanks (to encourage channel formation)
 - Setback infrastructure where beneficial
 - Otherwise, soften bank armor
 - Filling gaps in longitudinal rearing habitat availability
- Cost effective
- Community impacts

Possible FW Restoration Sites



Restoration in the Non-Tidal Delta

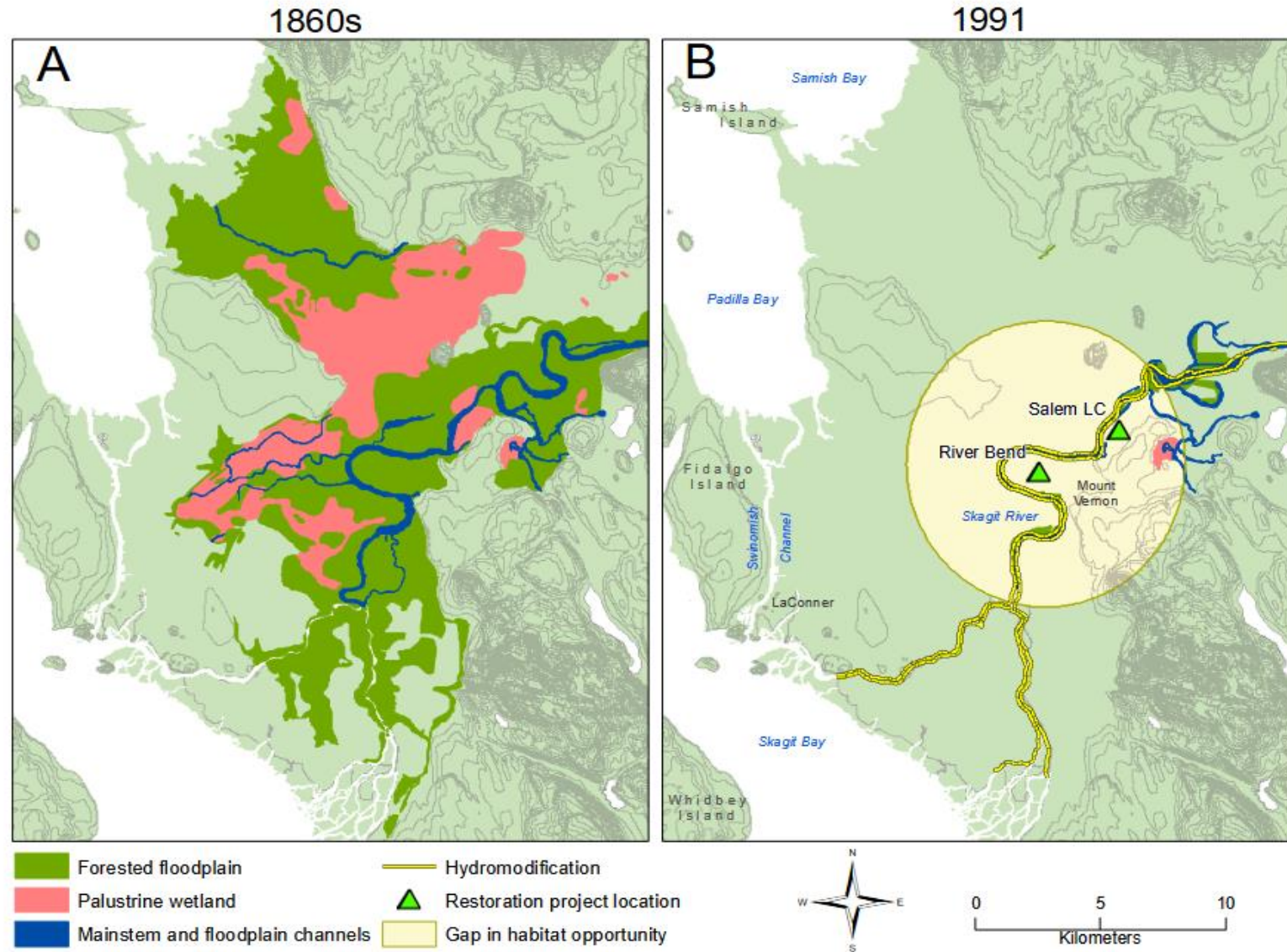
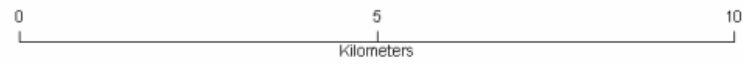
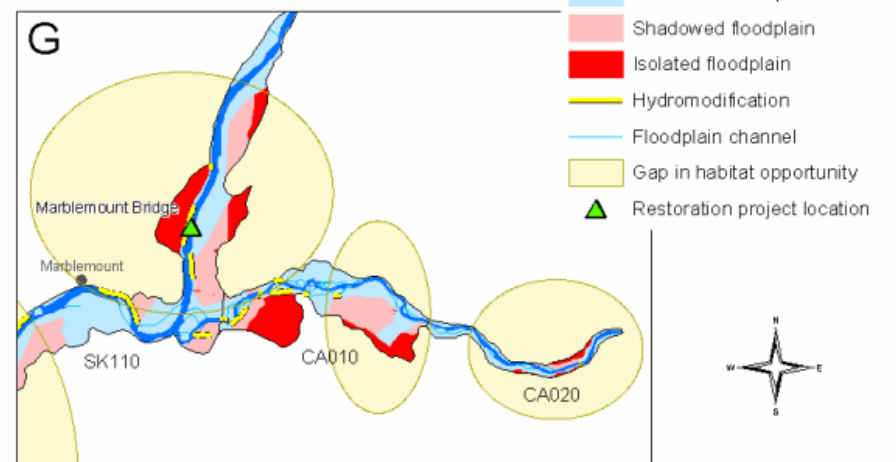
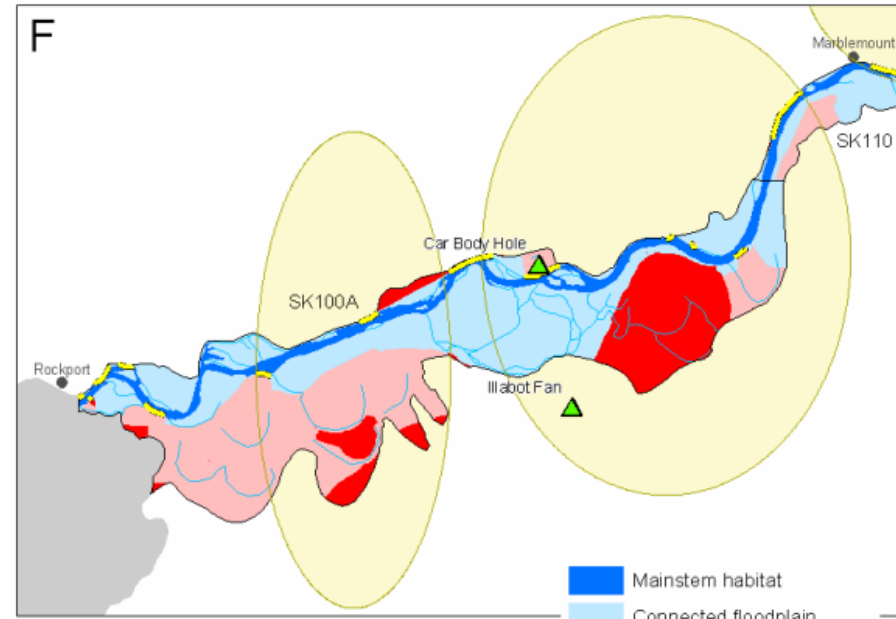
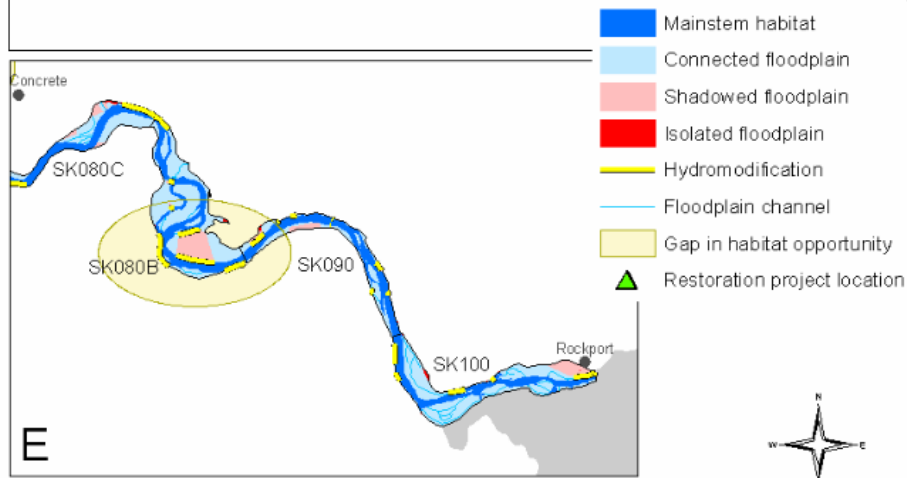
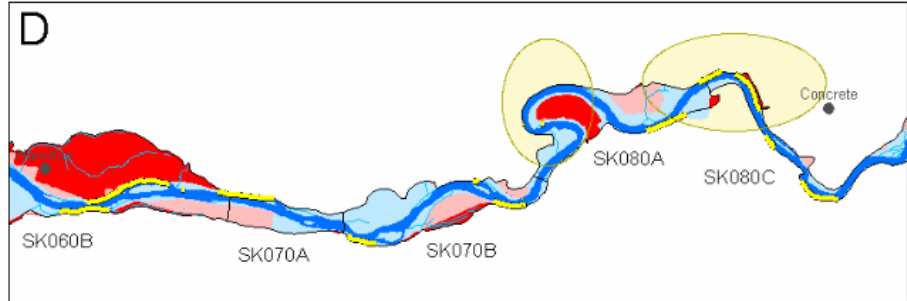
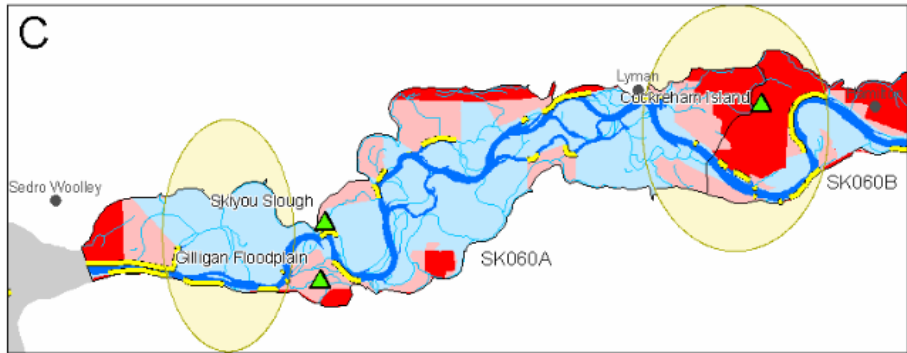
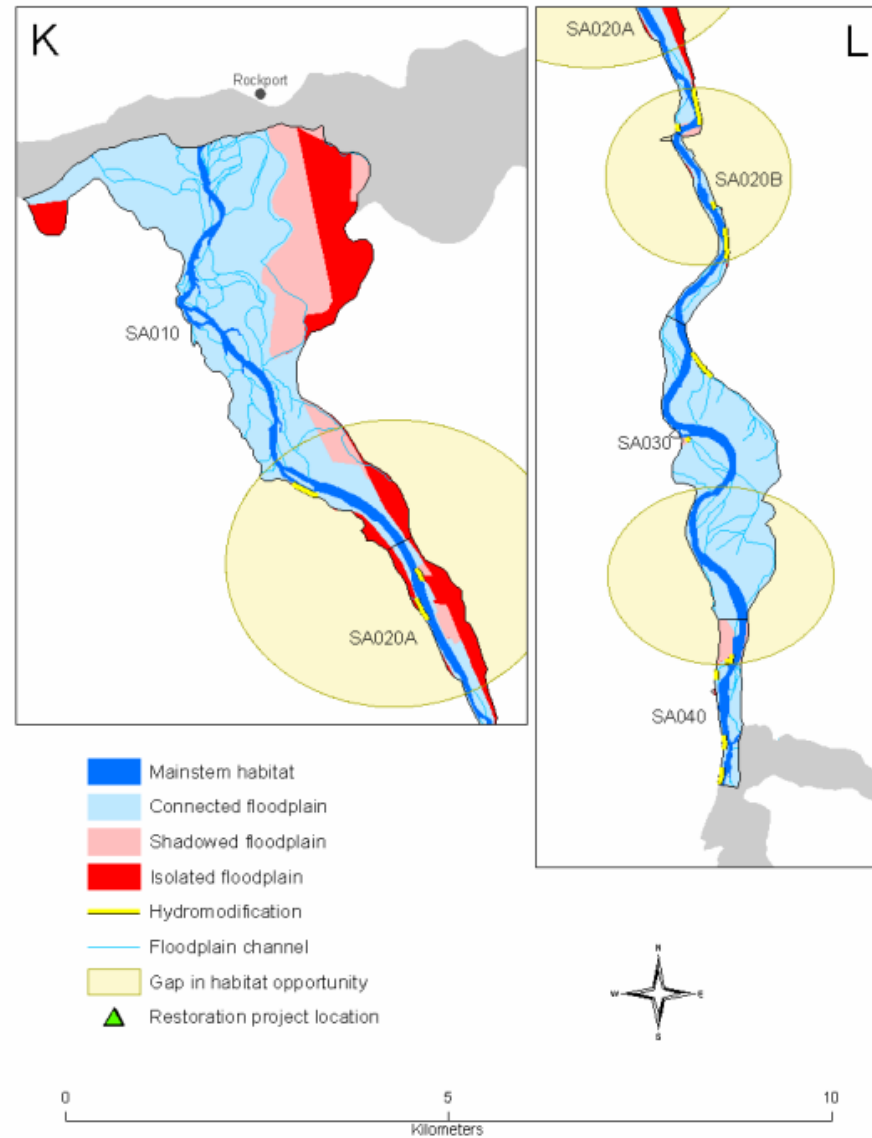
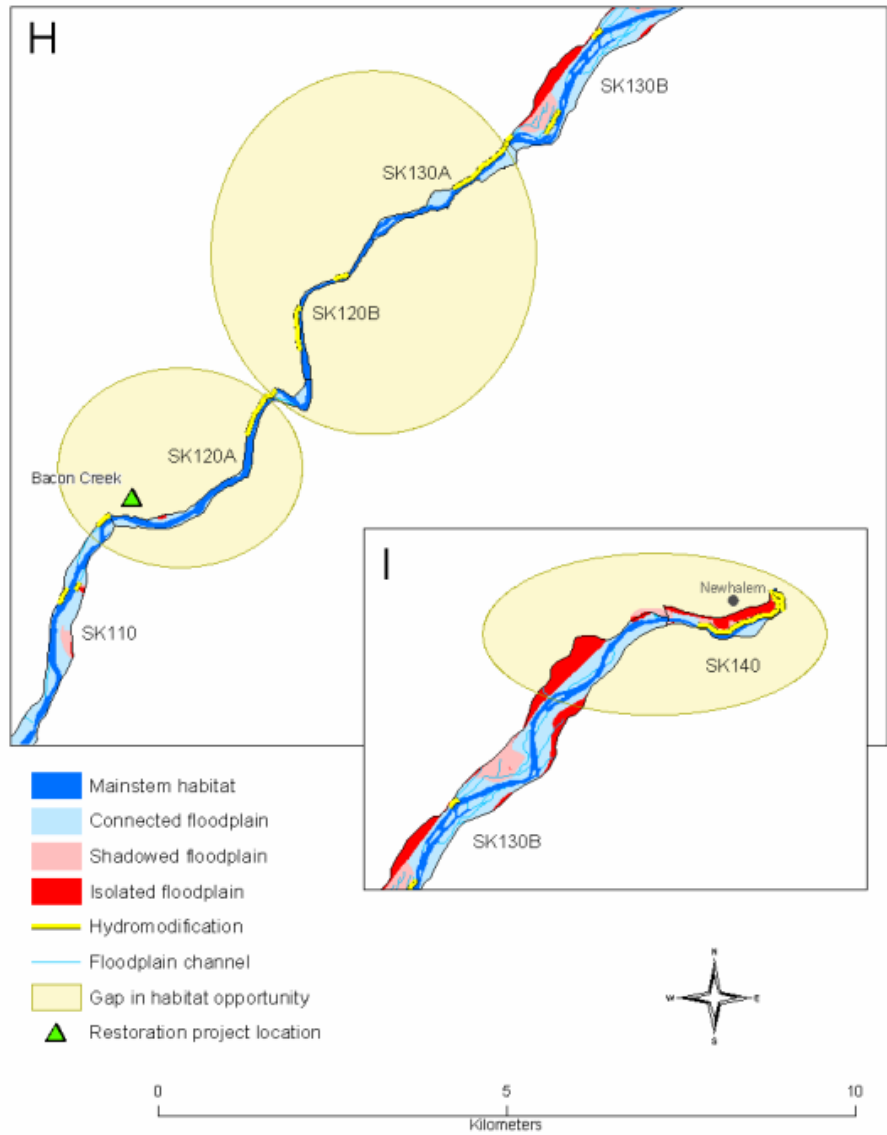
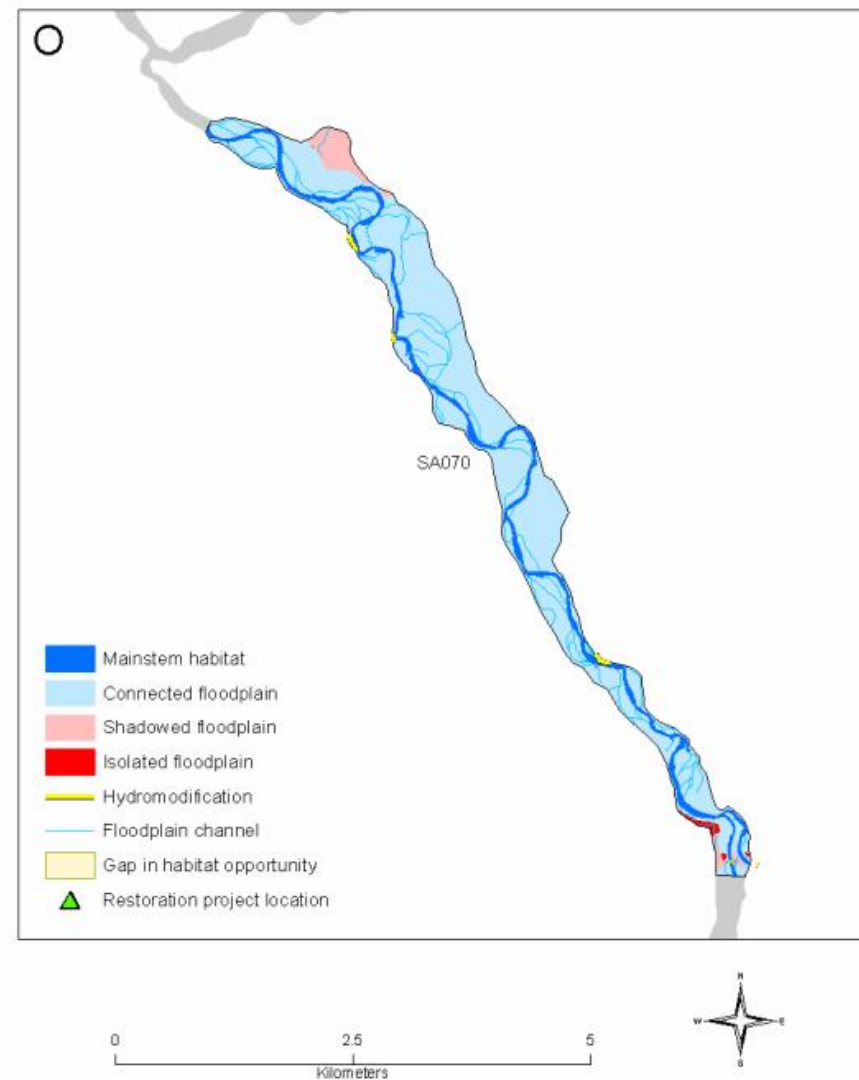
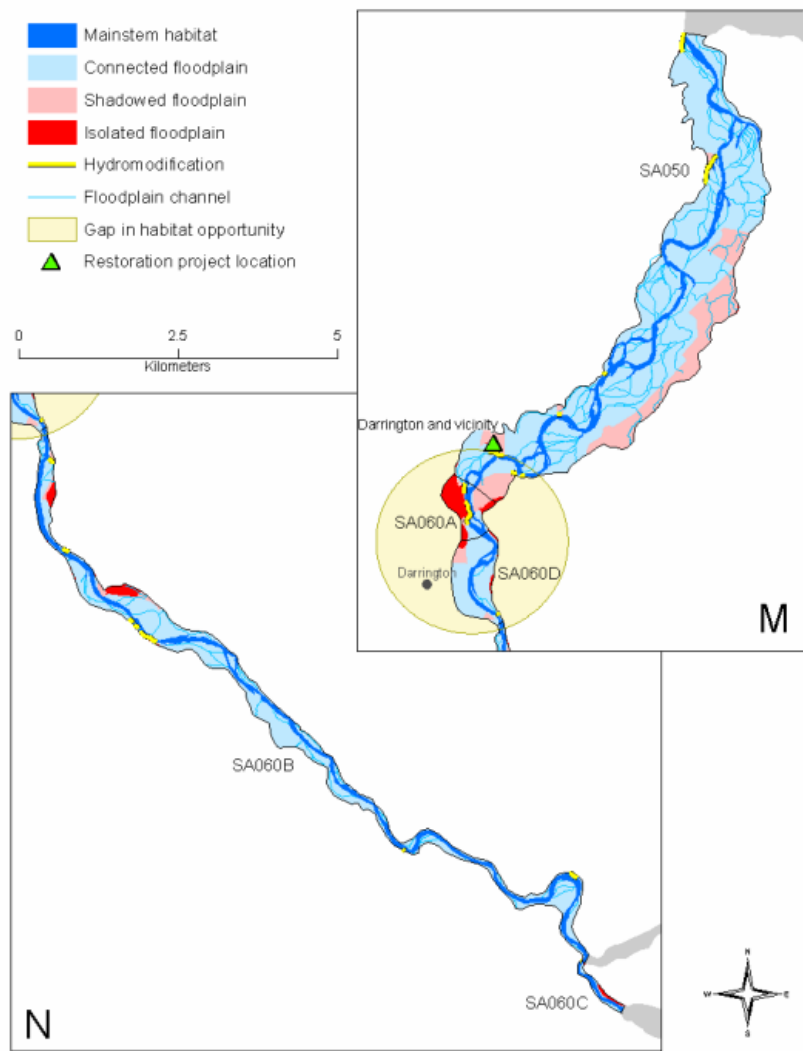


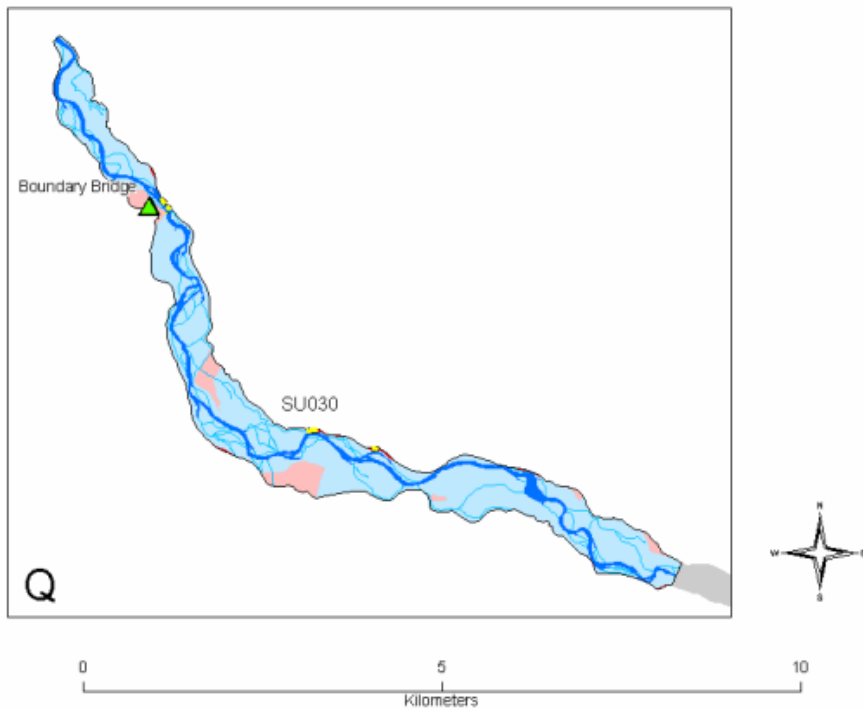
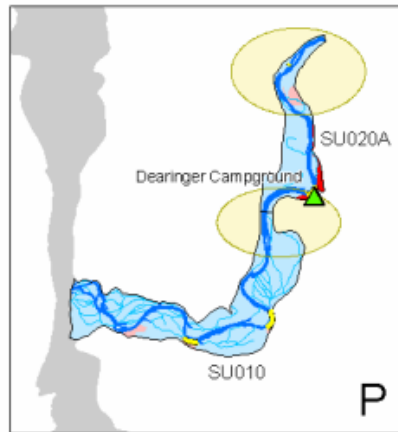
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- Mainstem habitat
- Connected floodplain
- Shadowed floodplain
- Isolated floodplain
- Hydromodification
- Floodplain channel
- Gap in habitat opportunity
- Restoration project location



Skagit Chinook Rearing Reaches and Possible Habitat Restoration Actions

Table 10.3. Priority river reaches identified in floodplain habitat based on gaps in backwater and off channel habitat opportunity.

River/Rearing Range	Downstream River KM*	Upstream River KM	Possible Actions
Skagit River: all stocks	14.3	26.3	Cottonwood Is., Britt Sl., Nookachamps, Sterling Reach, River Bend, Salem LC
	26.3	28.6	Gilligan Floodplain, Skiyou
	41.6	48.2	Cockreham Island
	61.9	65.5	
	67.9	70.5	
	79.3	85.7	
Skagit River: upper Skagit summers and upper Cascade springs	96.6	98.9	
	100.3	106.6	Car Body Hole
	109.5	113.4	Marblemount Bridge
Skagit River: upper Skagit summers	116.8	120.4	Bacon Creek
	120.5	126.3	
	131.5	135.5	
Cascade River: upper Skagit summers	2.9	4.6	
	6.4	7.9	
Sauk River: All Sauk and Suiattle stocks	5.4	9.3	
	10.1	12.4	
	16.6	19.0	Government Bridge
Sauk River: L. Sauk summers and upper Sauk springs	31.7	35.2	Darrington and vicinity
Suiattle River: Suiattle springs	5.2	6.2	Dearinger Park
	7.9	9.3	

*Note: River KM on the Skagit River is measured upstream from the bifurcation of the North and South Forks located in the delta near Mount Vernon

- ~19 possible actions/sites identified
- Of those, 4 have been partially restored
- Cottonwood Slough
- Britt Slough
- Salem LC
- Illabot Fan
- Post-Chinook Plan “projects”
- Robinson RD orphaned rock
- Lyman Slough
- Cumberland Creek Slough
- Davis Slough
- Barnaby Slough Phase 1
- Pressentin Park channel
- Bryson Road armor
- Sauk Prairie bridge and slough
- Suiattle riprap
- Alluvial Fans: Nookachamps, Day, Hansen, Downey Creeks

Gaps in Knowledge

- Listed in the SRP
 - Yearling rearing habitat was unknown at the time of the SRP*
 - Continue estimating marine survival for specific life history types
- Other Gaps
 - Seasonally disconnected floodplain habitats*
 - Population specific freshwater productivity
 - Alluvial fan as floodplain transitions in predicting fish benefits**

*Future presentations

**Proposed