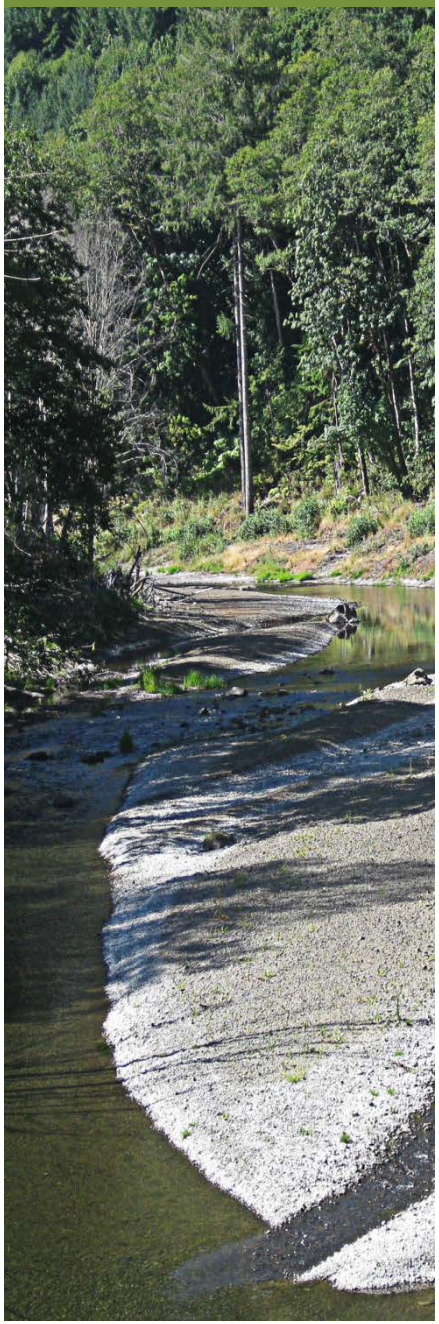
# Chehalis Basin Strategy: Reducing Flood Damage and Enhancing Aquatic Species

*Aquatic Species Enhancement Plan*

*Technical Committee Meeting*
*Olympia, Washington*
*May 7-8, 2014*



# Aquatic Species Enhancement Plan

- Background information and biological context
- WDFW field data collection
  - Riverscape survey
  - Juvenile and adult fish movement (PIT and radio telemetry) Habitat limiting factors
- Habitat enhancement actions
- Climate changes
- Summary and next steps
- Discussion

# Preliminary Results - Effects of Flood Retention Alternatives on Aquatic Species

- Background information and biological context
- Salmon
  - Ecosystem Diagnosis & Treatment (EDT) model results
  - Shiraz model results
- Other fish
- Non-fish
- Next steps

# Background Information – Selected Species

- 24 key species modeled
  - Salmon (EDT and Shiraz) – 4
  - Other fish – 11
  - Non-fish – 7
  - Exotics – 2 (three additional species considered stressors)

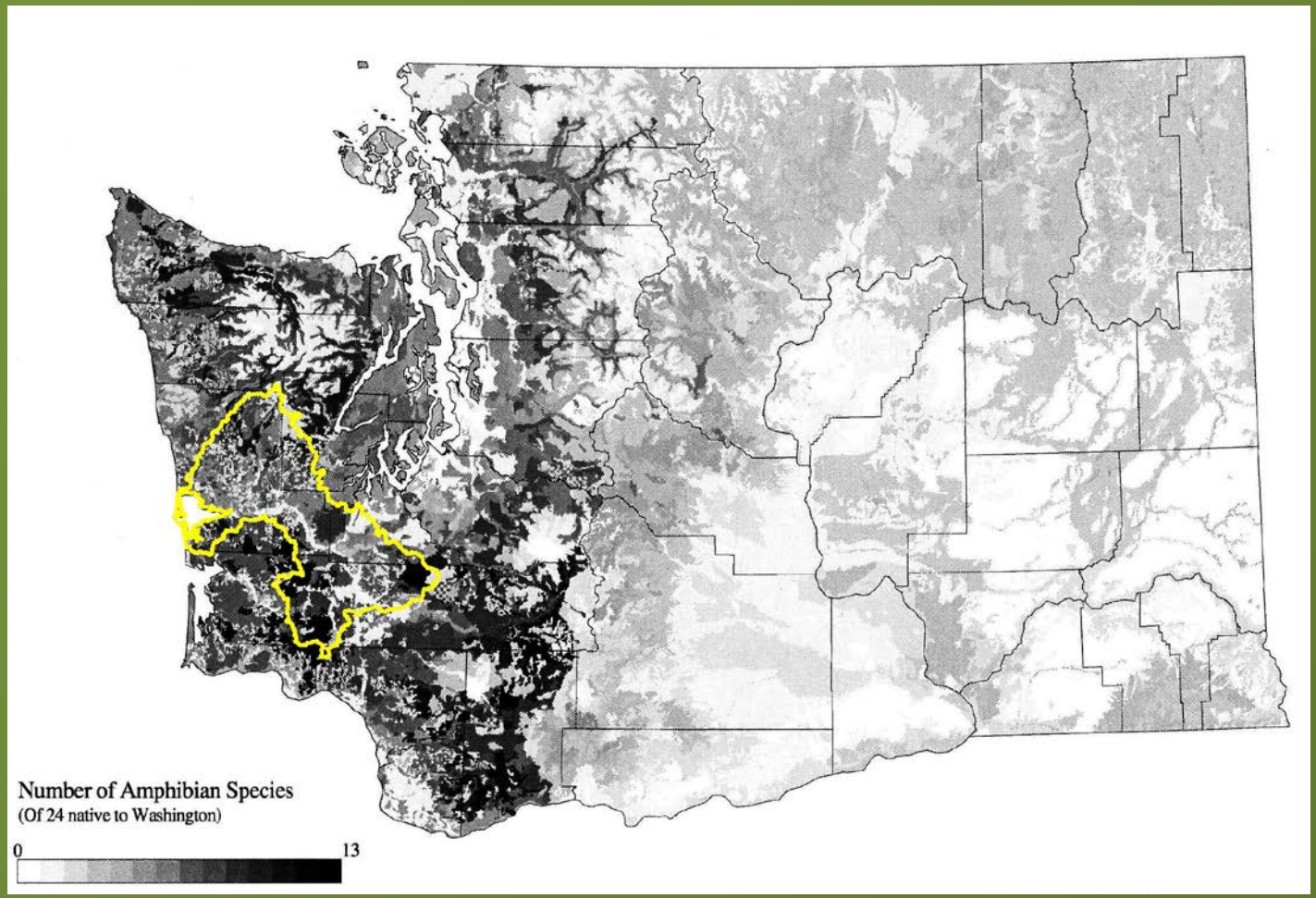
# Background Information – Species Status

- ESA-listed species
  - Eulachon
  - Bull trout
- State species of concern
  - Olympic mudminnow
- Petitioned for ESA listing
  - Oregon spotted frog (August 2014)

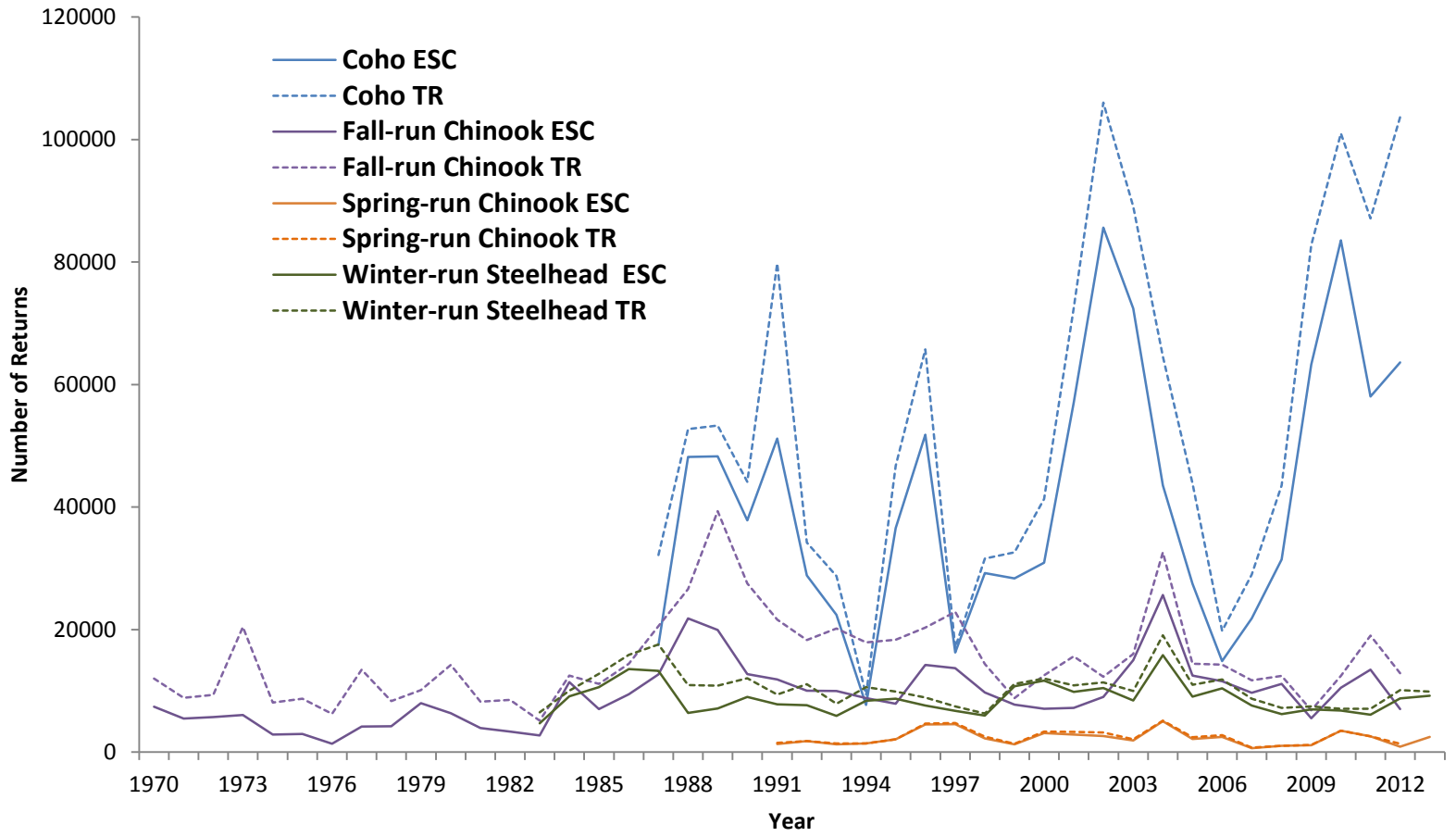
# Background Information – Other Fish and Non-fish Species

- Historical and current population information very limited in Basin.
- Olympic mudminnow unique; center of distribution
- Chum salmon the exception; geo mean of total run size since 2003 = 25,116 fish (no clear trend)
- Highest species richness of amphibians in Washington State; also highest at risk in the state
- Potential Oregon spotted frog listing
- Most extensive floodplain off-channel habitats in Washington State; occupied by seven species of stillwater-breeding amphibians

# Native Amphibian Species Richness



# Background – Salmon Trends (WDFW Data)



# Salmon – Geo Means of WDFW Spawner Index Data (2003–2012)

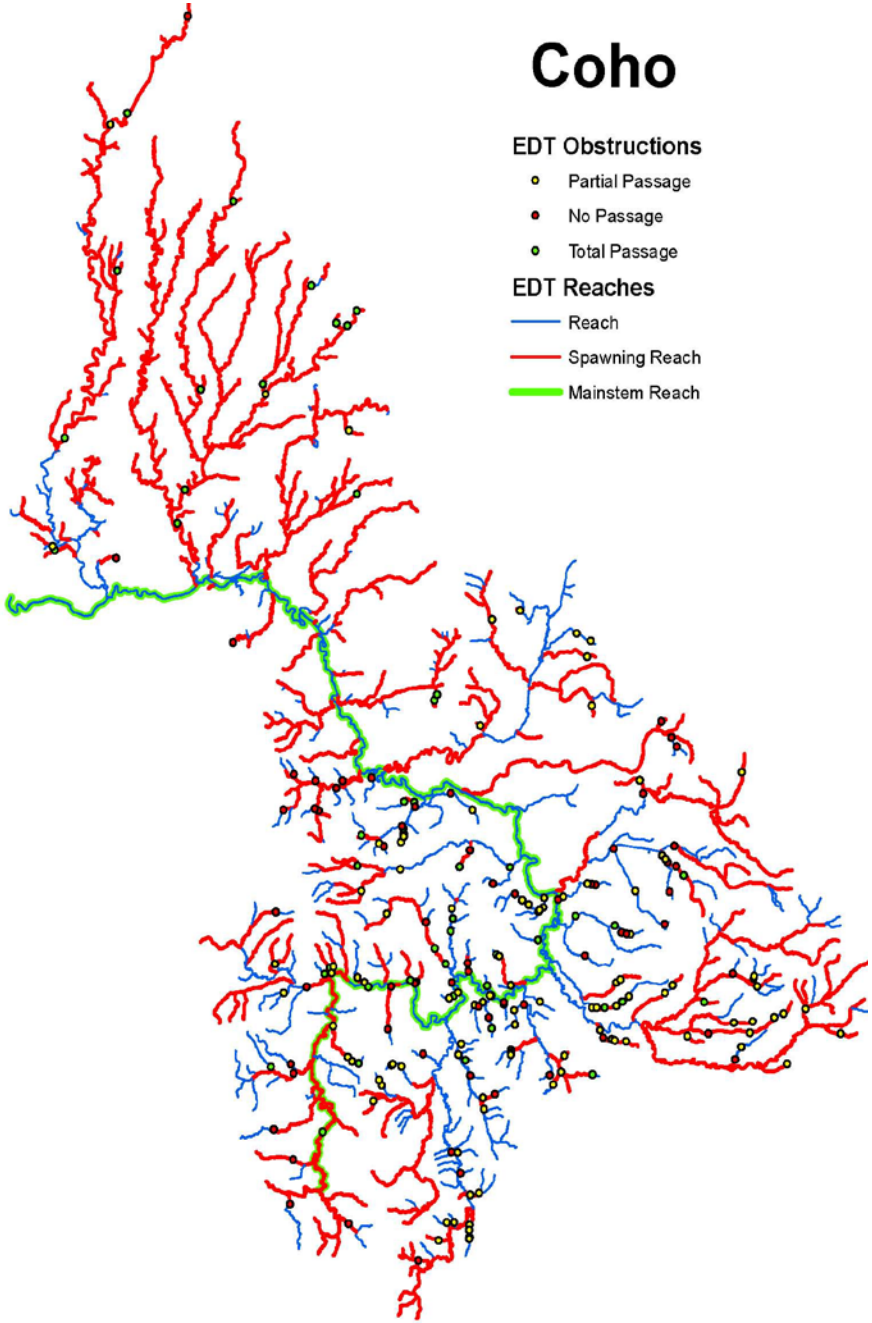
| Species | Total Run | Escapement | Post-harvest Productivity (R/S) |
|---|---|---|---|
| Spring Chinook Salmon | 1,933 | 1,766 | 0.9 |
| Fall Chinook Salmon | 14,165 | 11,264 | 1.0 |
| Coho Salmon | 58,567 | 42,039 | 1.1 |
| Winter-run Steelhead | 9,513 | 8,346 | 0.8 |

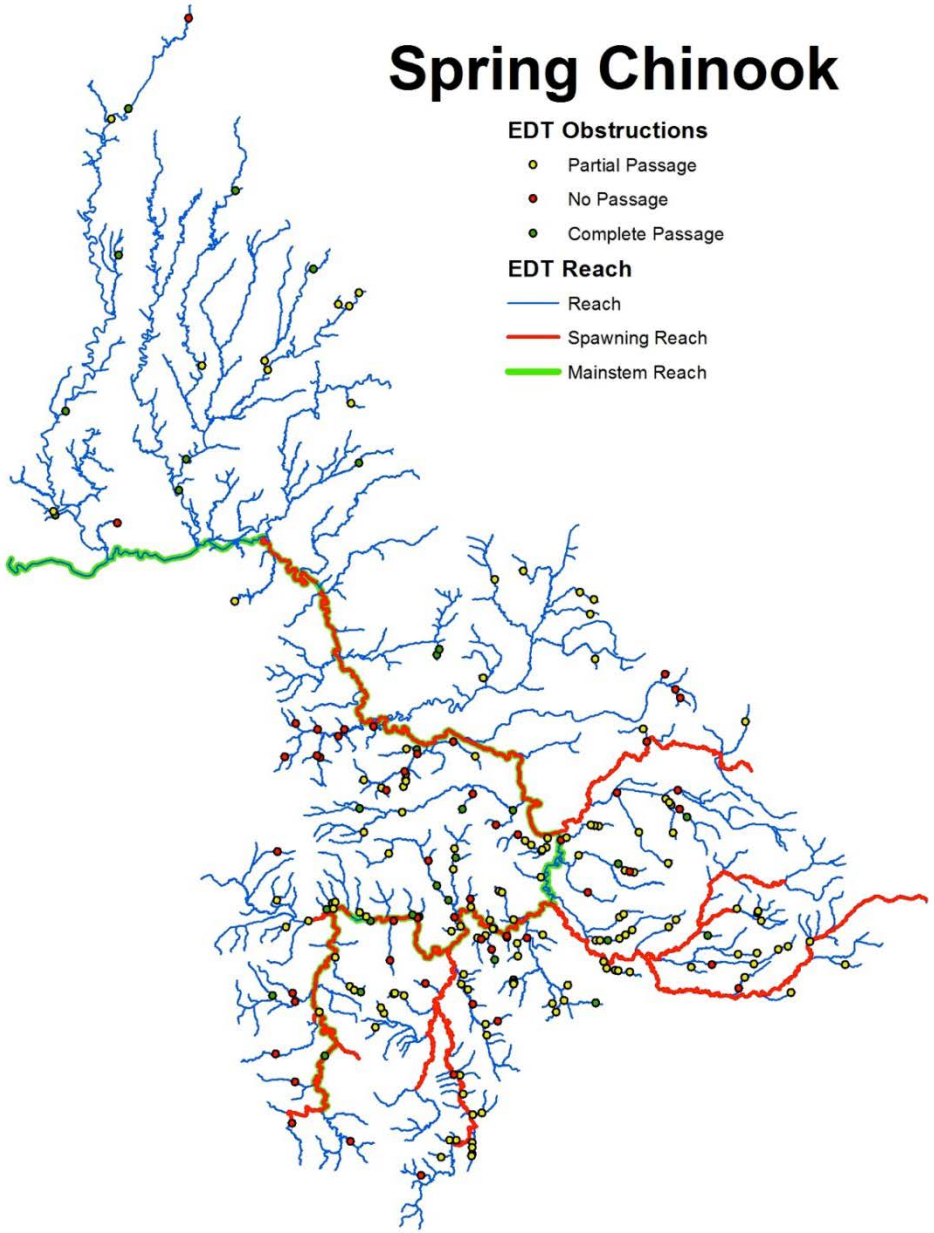
# Salmon – Habitat Potential (EDT)

| Species | Current | Intrinsic | Habitat Impairment |
|---|---|---|---|
| Spring Chinook Salmon | 1,083 | 14,436 | 92% |
| Fall Chinook Salmon | 22,810 | 44,367 | 49% |
| Coho Salmon | 27,430 | 106,068 | 74% |
| Winter-run Steelhead | 3,686 | 7,501 | 51% |

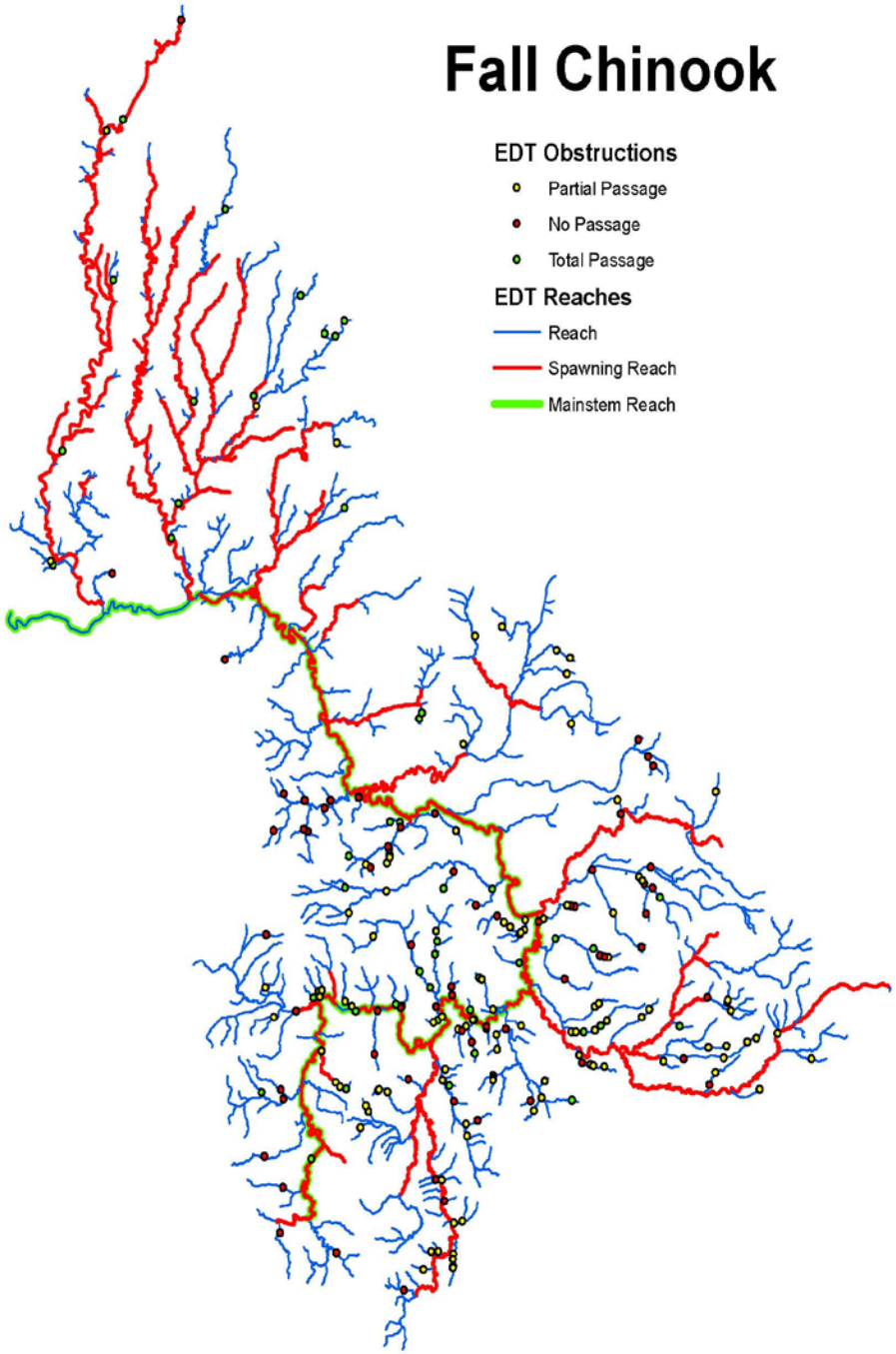
# Salmon – VSP Attributes from EDT

| Species | Productivity (returns/ spawner) | Capacity (fish) | Equilibrium Abundance (fish) | Diversity (proportion of successful life histories) |
|---|---|---|---|---|
| Spring Chinook Salmon | 3.9 | 2,971 | 1,083 | 49.1% |
| Fall Chinook salmon | 5.4 | 29,834 | 22,810 | 76.3% |
| Coho Salmon | 5.5 | 33,813 | 27,430 | 71.1% |
| Winter-run Steelhead | 10.7 | 4,282 | 3,640 | 72.8% |

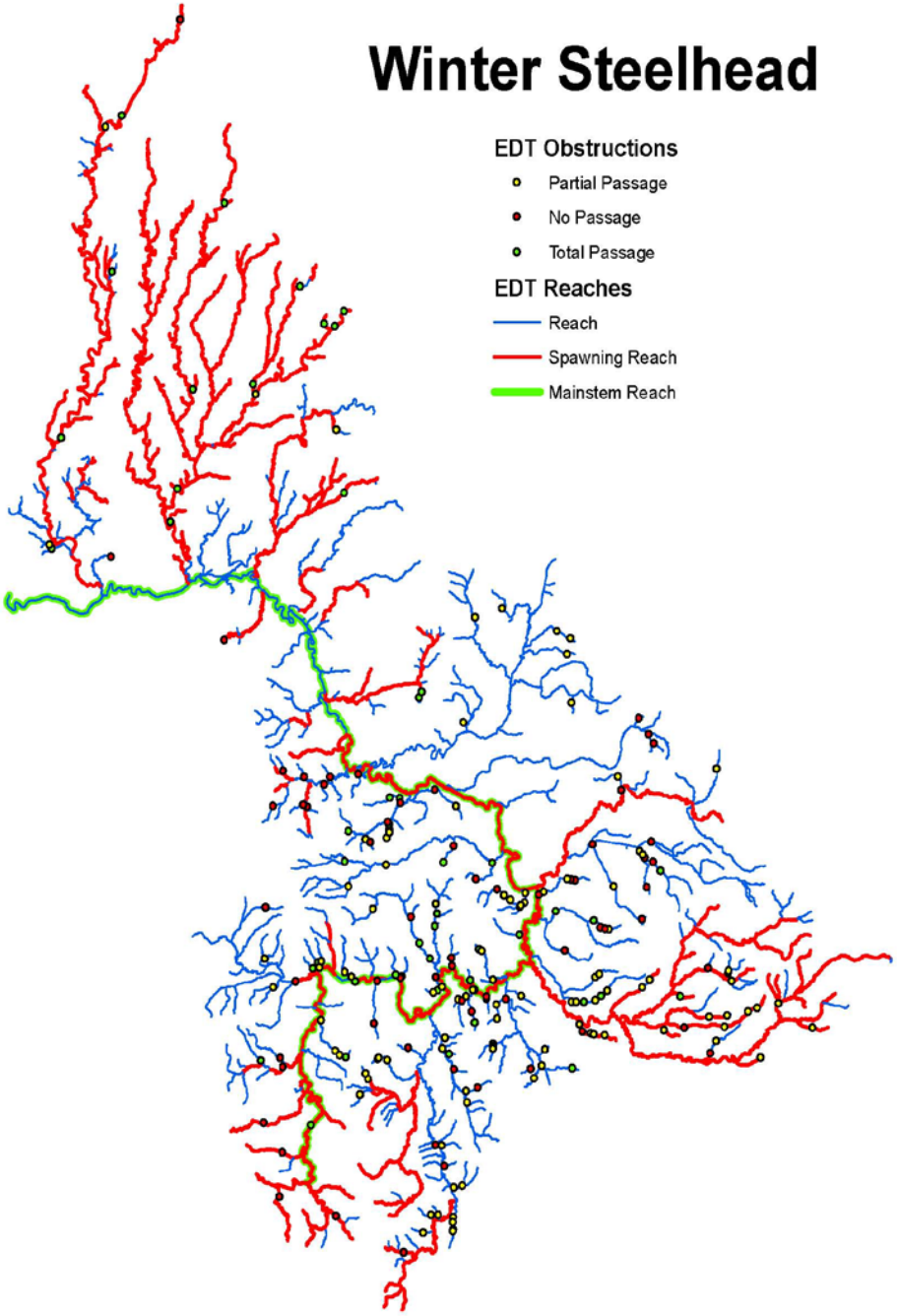

Coho
EDT Obstructions
Partial Passage
No Passage
Total Passage
EDT Reaches
Reach
Spawning Reach
Mainstem Reach


Spring Chinook
EDT Obstructions
Partial Passage
No Passage
Complete Passage
EDT Reach
Reach
Spawning Reach
Mainstem Reach

# Fall Chinook




# Winter Steelhead



# WDFW presentations

# Habitat Limiting Factors

# Methods

- Smith and Wenger (2001)
  - Habitat factors limiting salmonid abundance and production within the Chehalis Basin
- Ecosystem Diagnosis & Treatment Model (2014)
  - Modeled the habitat used by salmonids within the Chehalis Basin (current condition compared to intrinsic condition)
- Input and reviews by technical team member experts and local experts

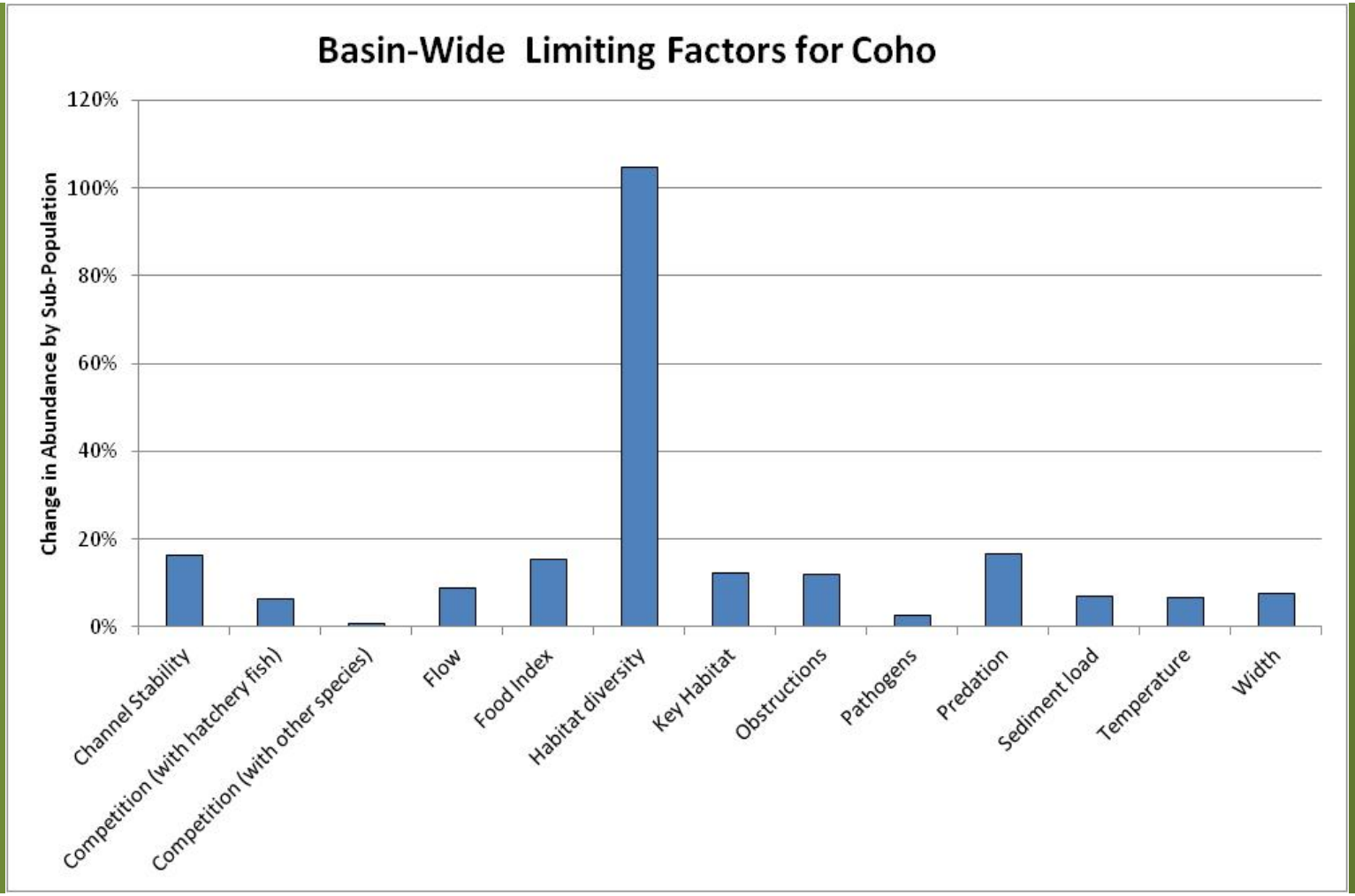
# Smith and Wenger

| SUB-BASIN UNITS | LIMITING FACTORS |
|---|---|
| Wynoochee River | Floodplain habitat; Sediment; Riparian habitat; Stream flows; Water quality |
| Satsop River | Migration barriers; Sediment; Channel stability; Riparian habitat; Stream flows; Water quality |
| Lower Chehalis Tributaries | Floodplain habitat; Sediment; Habitat diversity; Riparian habitat; Stream flows; Water quality |
| Lower Chehalis Mainstem | Floodplain habitat; Sediment; Habitat diversity; Riparian habitat; Stream flows; Water quality |
| Black River | Migration barriers; Floodplain habitat; Sediment; Riparian habitat; Stream flows; Water quality |
| Scatter Creek | Sediment; Channel stability; Riparian habitat; Stream flows; Water quality |
| Skookumchuck River | Migration barriers; Floodplain habitat; Sediment; Channel stability; Habitat diversity; Riparian Habitat; Stream flows; Water quality |
| Newaukum River | Migration barriers; Floodplain habitat; Sediment; Habitat diversity; Riparian Habitat; Stream flows; Water quality |
| Middle Chehalis Tributaries | Migration barriers; Floodplain habitat; Sediment; Habitat diversity; Riparian Habitat; Stream flows; Water quality |
| South Fork Chehalis | Migration barriers; Sediment; Channel stability; Habitat diversity; Riparian Habitat; Stream flows; Water quality |
| Upper Chehalis | Migration barriers; Floodplain habitat; Sediment; Channel stability; Habitat diversity; Riparian Habitat; Stream flows |

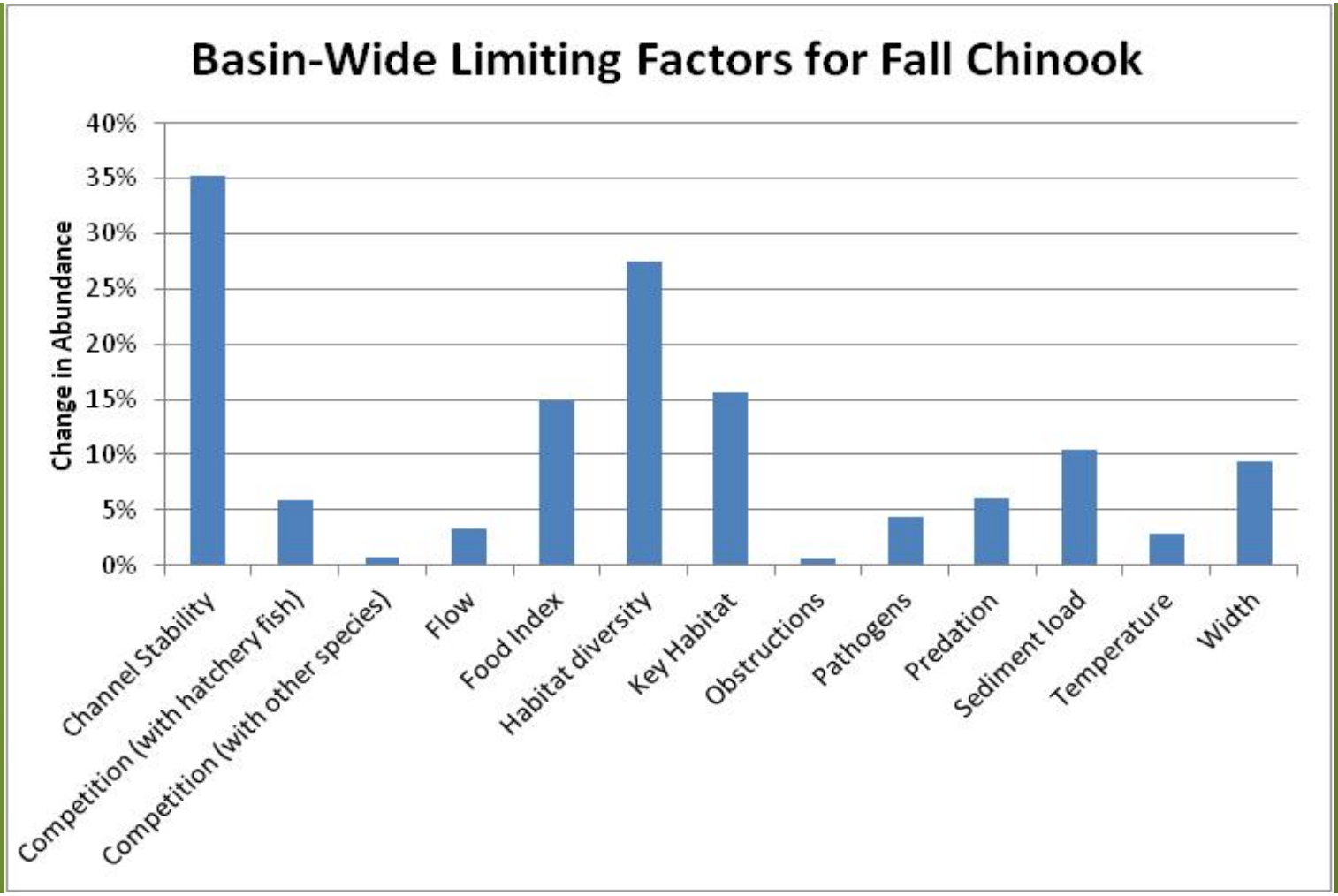
# Summary

- No single limiting factor
- Most prevalent are riparian degradation, water quality, sedimentation, and associated issues

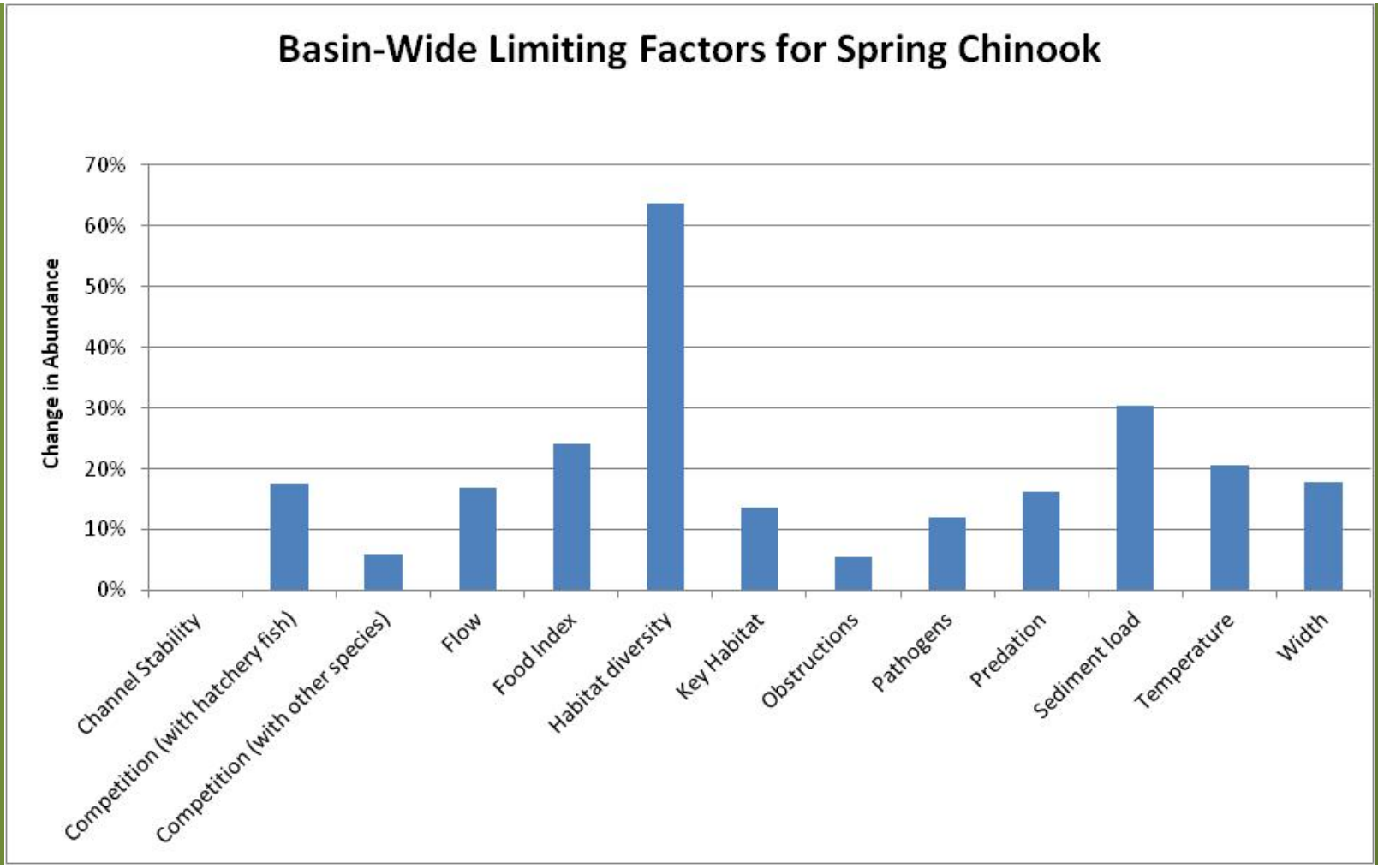
# EDT - Coho


Basin-Wide Limiting Factors for Coho
Change in Abundance by Sub-Population
120%
100%
80%
60%
40%
20%
0%
Channel Stability
Competition (with hatchery fish)
Competition (with other species)
Flow
Food Index
Habitat diversity
Key Habitat
Obstructions
Pathogens
Predation
Sediment load
Temperature
Width

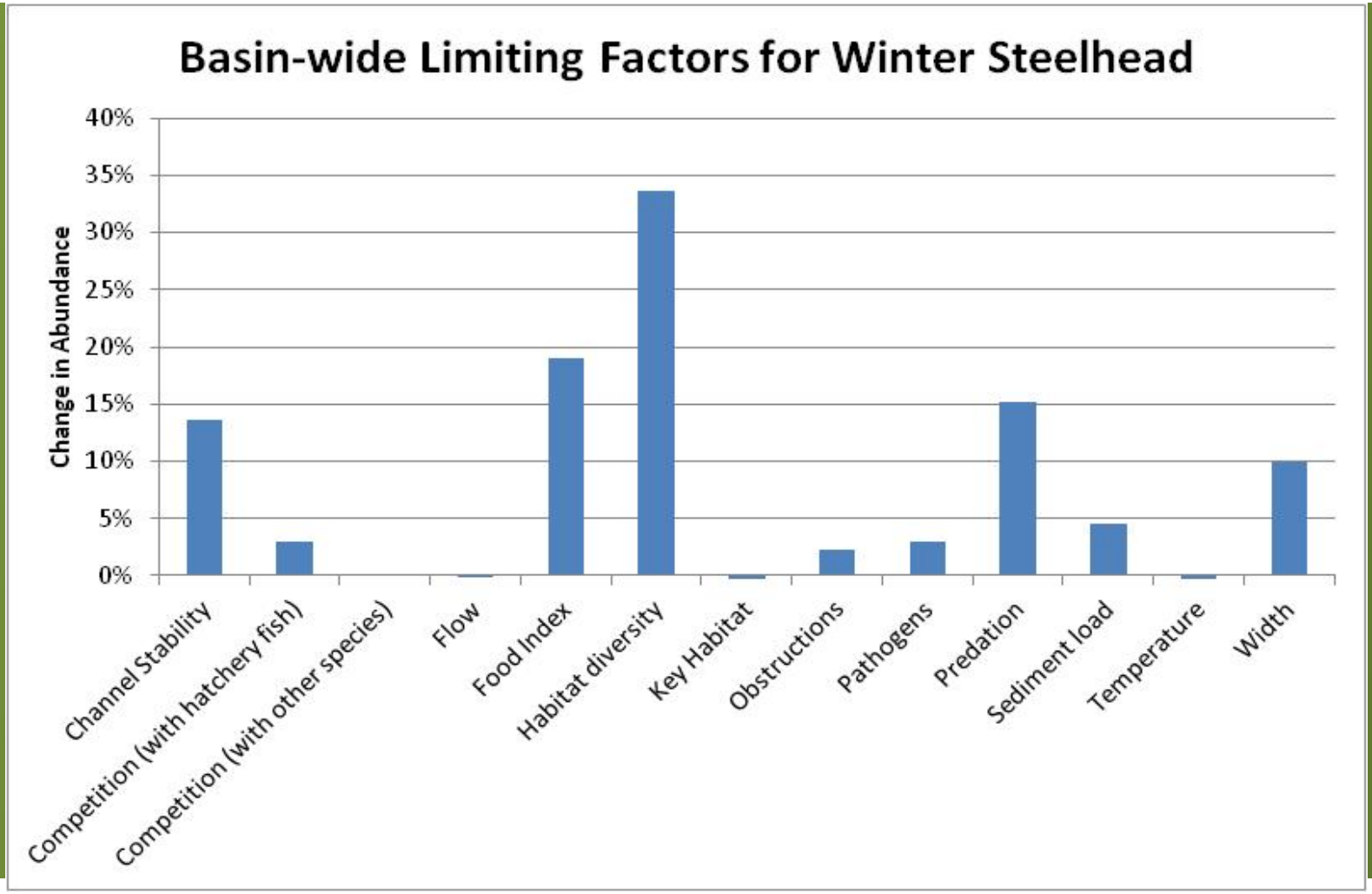
# EDT – Fall Chinook



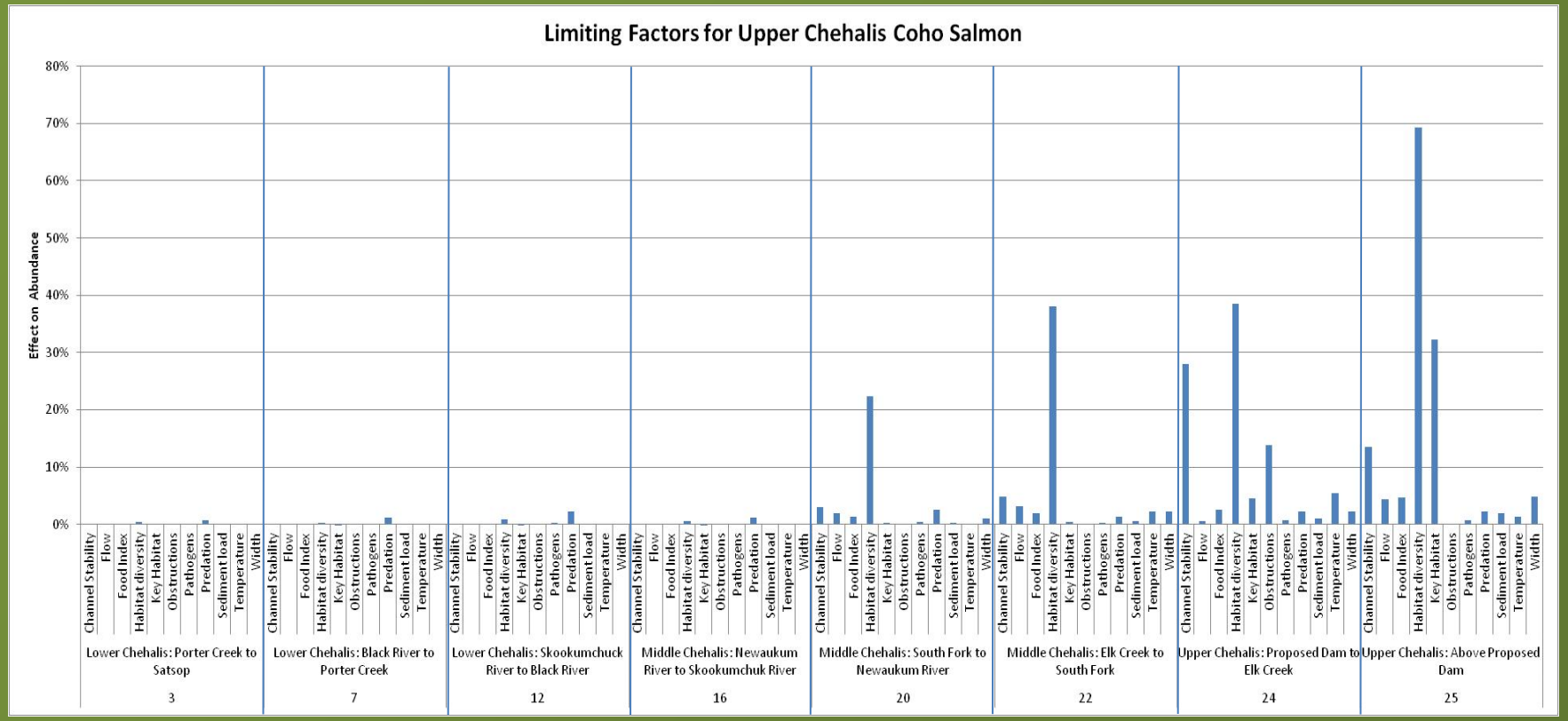
# EDT – Spring Chinook



# EDT – Winter Steelhead



# Limiting Factors for Upper Chehalis Coho Salmon



# EDT Commonalities

- Lack of Habitat Diversity (lack of wood)
- Channel stability (channelization and lack of connectivity to floodplains)

# Habitat Enhancement

# Actions to Address Limiting Factors

- Focus on salmon due to lack of information for other species
- Actions identified in 3-day workshop and WDFW follow up workshop
- Identified actions will be modelled for salmon using EDT
- Qualitatively assessed for Other Fish and Non-Fish

# Summary of Identified Actions

- Remove/improve barriers to fish passage (culverts)
- Riparian Enhancement/Restoration/Preservation
  - In upper areas where forest practices are important
  - In lower areas where agriculture and development are impacting the rivers

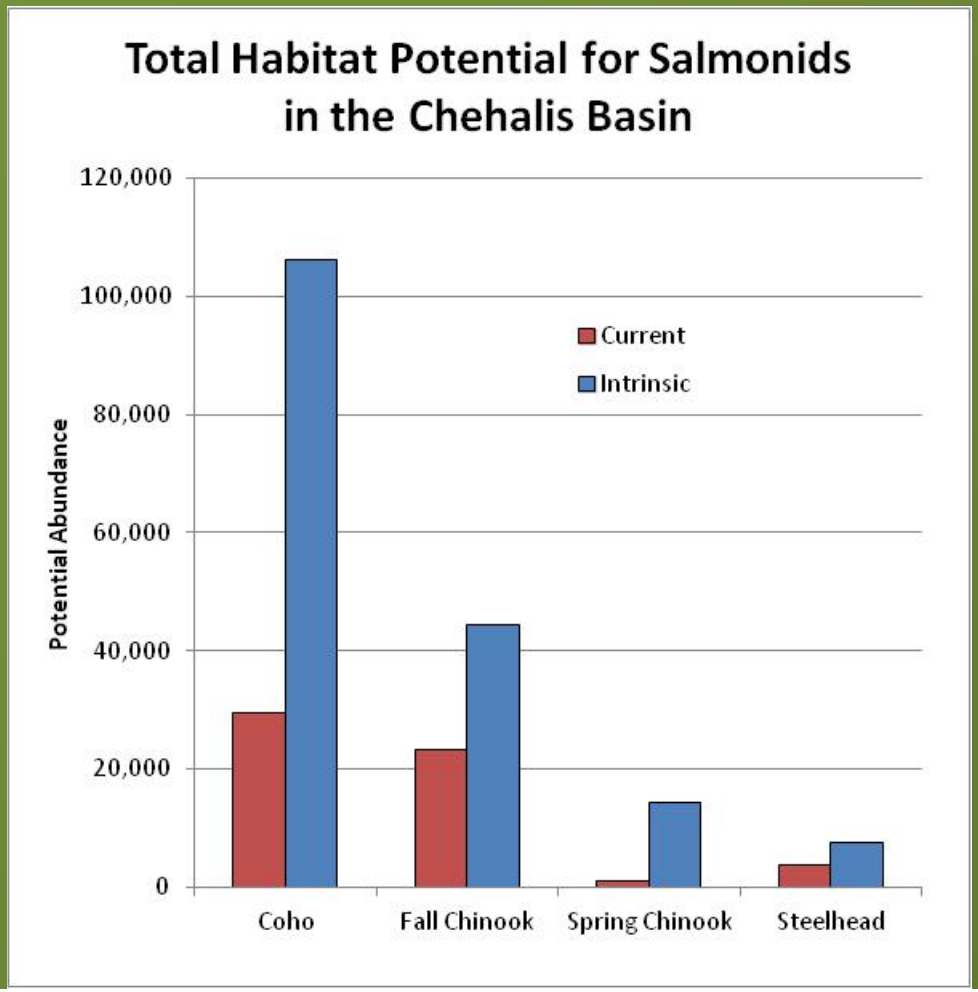
# Summary of Identified Actions (con't)

- Add in-water wood structure – site specific depending on geomorphology and need
  - Sediment trapping structures
  - Large wood placement
  - In-stream log cribs
- Floodplain re-connection
  - Potentially reconnect oxbows in specific areas that won't exacerbate invasive predator issues
  - Remove levees
  - Allow river to move within the floodplain
- Education

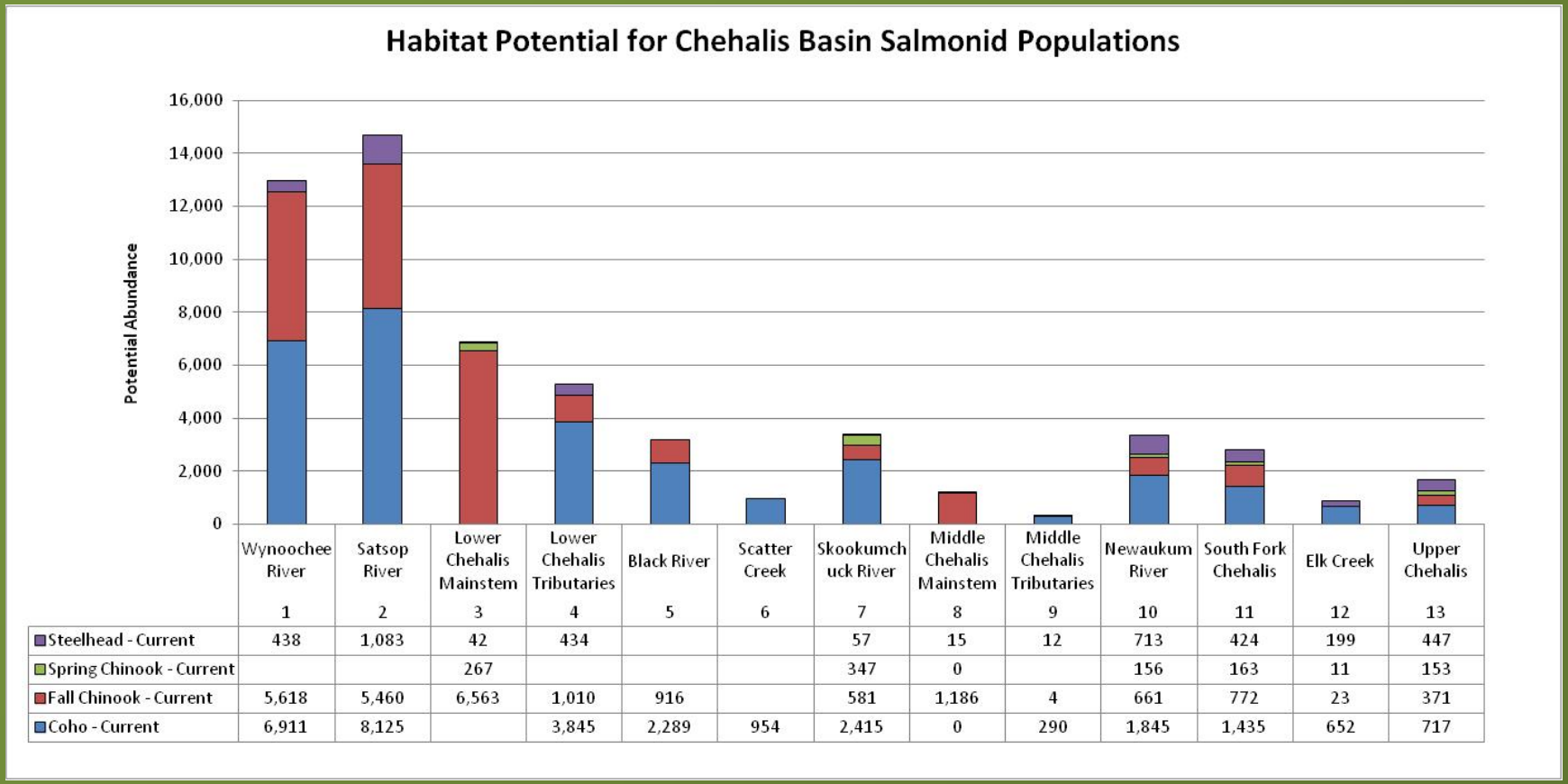
# Summary of Identified Actions (con't)

- Modeled to date:
  - Upper basin riparian restoration for managed forests
  - Barrier removal

# Salmonid Habitat Potential: Chehalis Basin

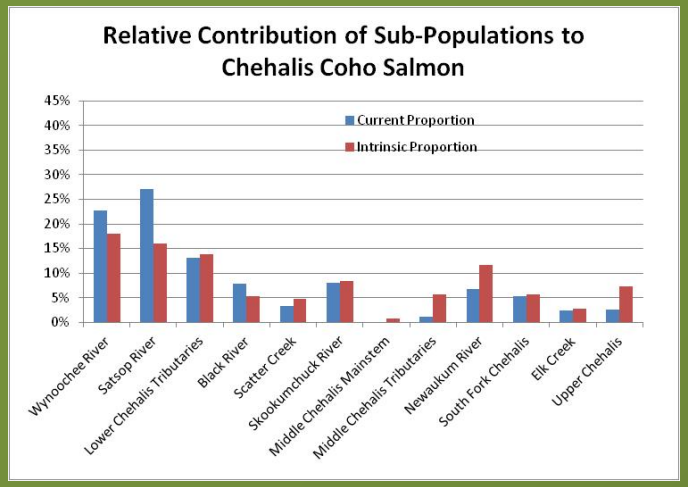


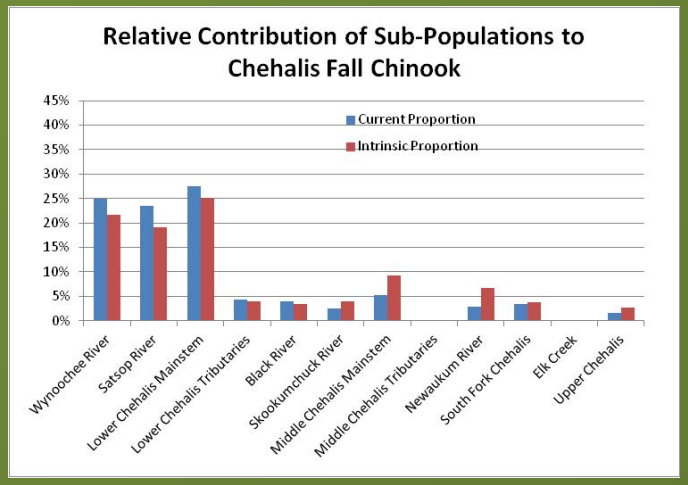
# Salmonid Habitat Potential by Sub-Population

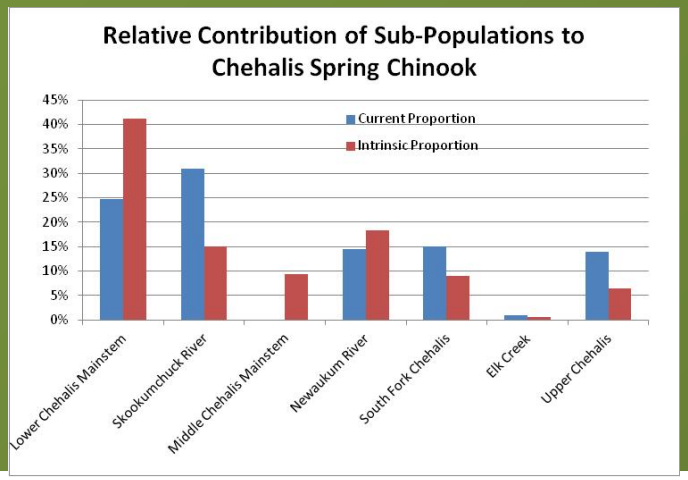


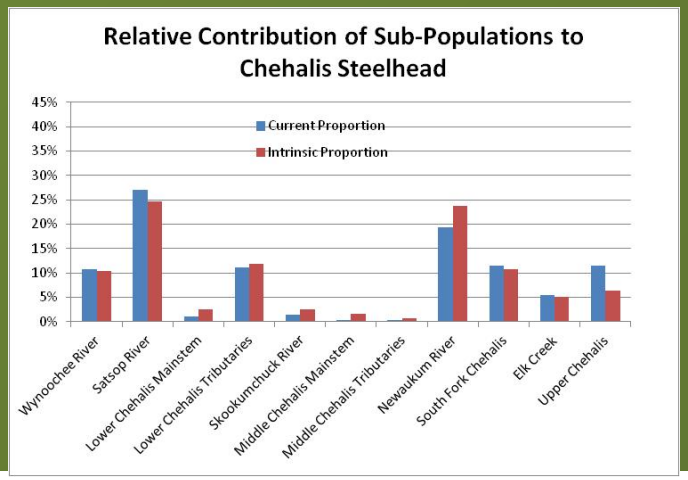

| | Wynoochee River 1 | Satsop River 2 | Lower Chehalis Mainstem 3 | Lower Chehalis Tributaries 4 | Black River 5 | Scatter Creek 6 | Skookumchuck River 7 | Middle Chehalis Mainstem 8 | Middle Chehalis Tributaries 9 | Newaukum River 10 | South Fork Chehalis 11 | Elk Creek 12 | Upper Chehalis 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Steelhead - Current | 438 | 1,083 | 42 | 434 | | | 57 | 15 | 12 | 713 | 424 | 199 | 447 |
| Spring Chinook - Current | | | 267 | | | | 347 | 0 | | 156 | 163 | 11 | 153 |
| Fall Chinook - Current | 5,618 | 5,460 | 6,563 | 1,010 | 916 | | 581 | 1,186 | 4 | 661 | 772 | 23 | 371 |
| Coho - Current | 6,911 | 8,125 | | 3,845 | 2,289 | 954 | 2,415 | 0 | 290 | 1,845 | 1,435 | 652 | 717 |

# Relative Contribution of Sub-Populations to Species Total Abundance

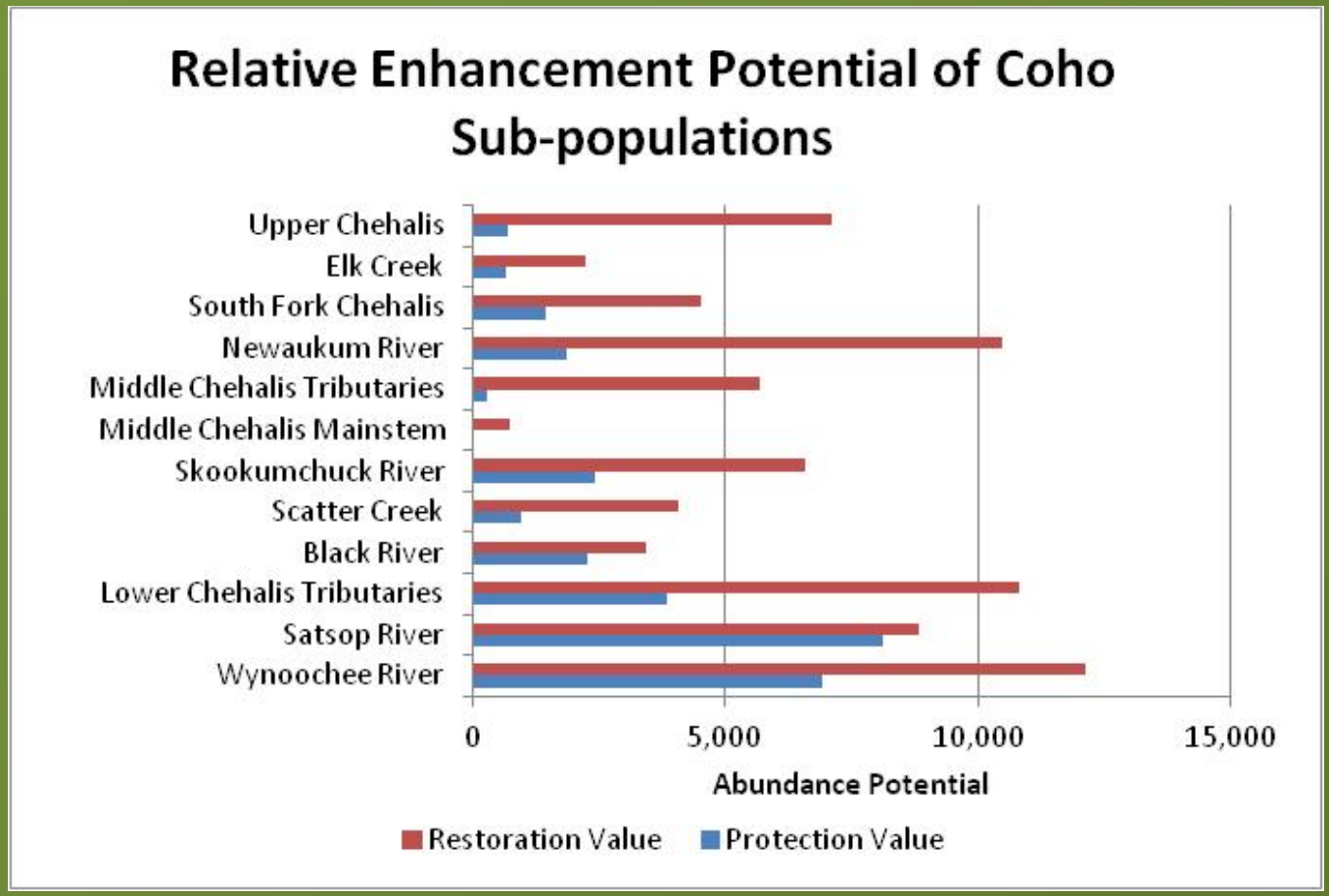


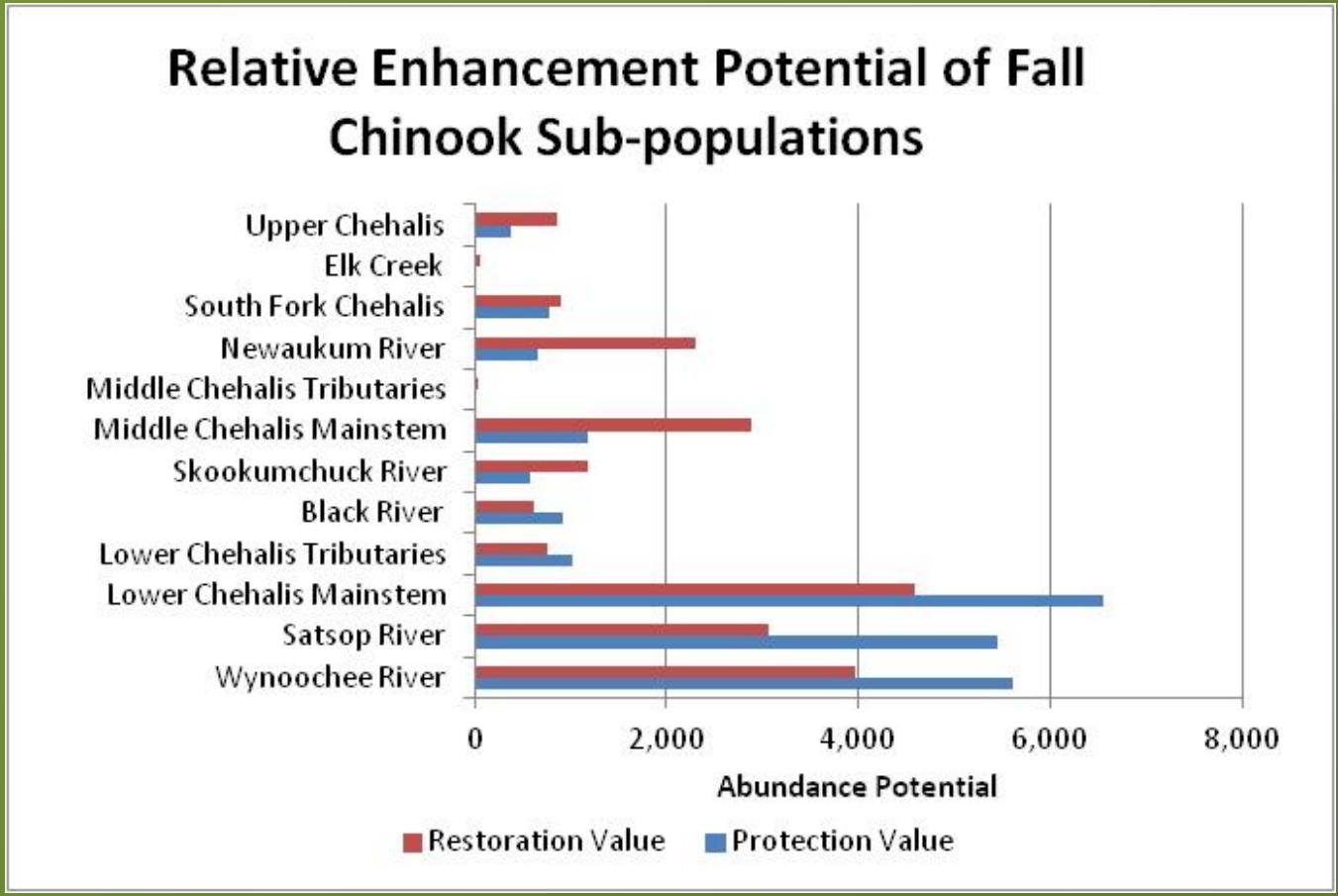



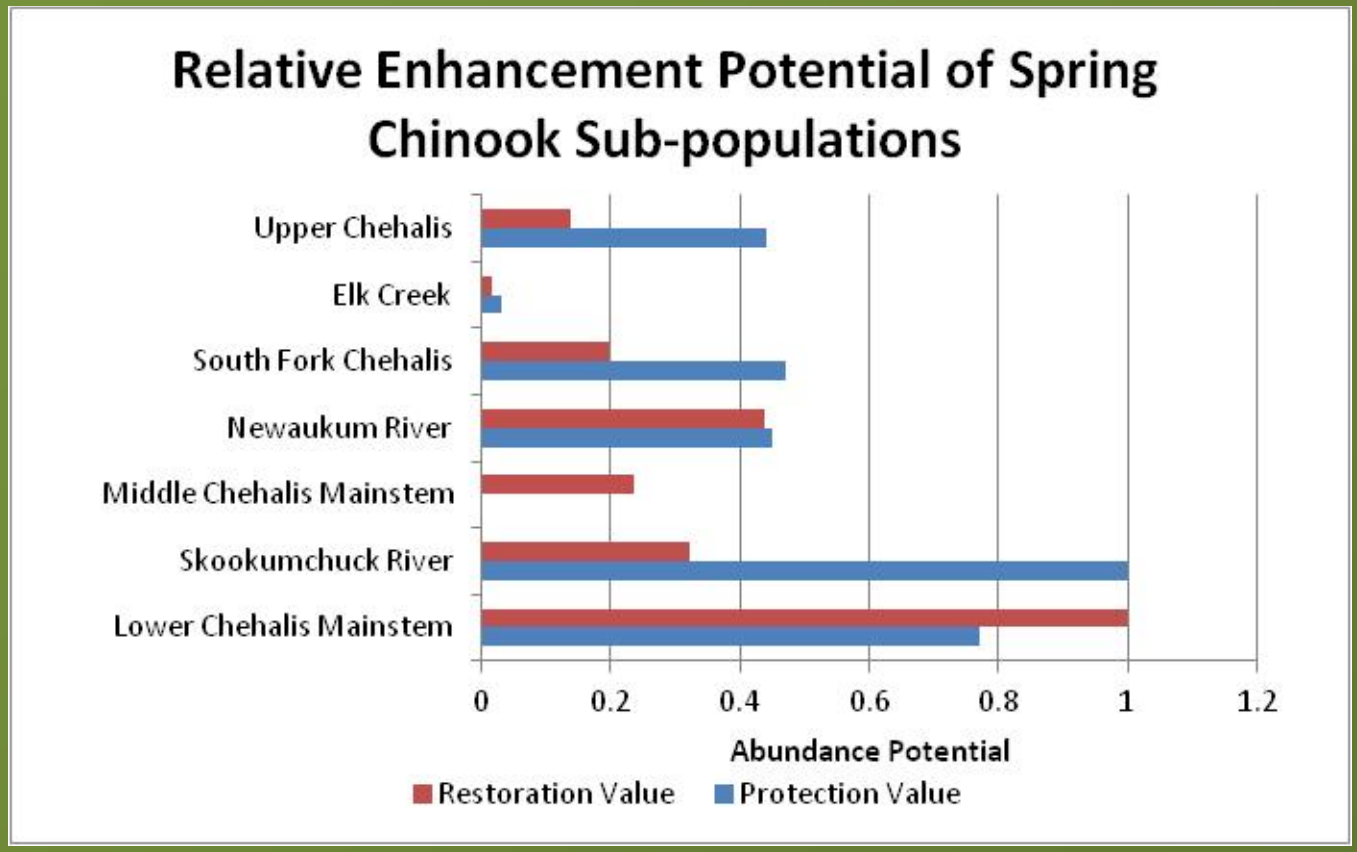
# Enhancement Opportunities at the Chehalis Basin Scale: Coho Salmon



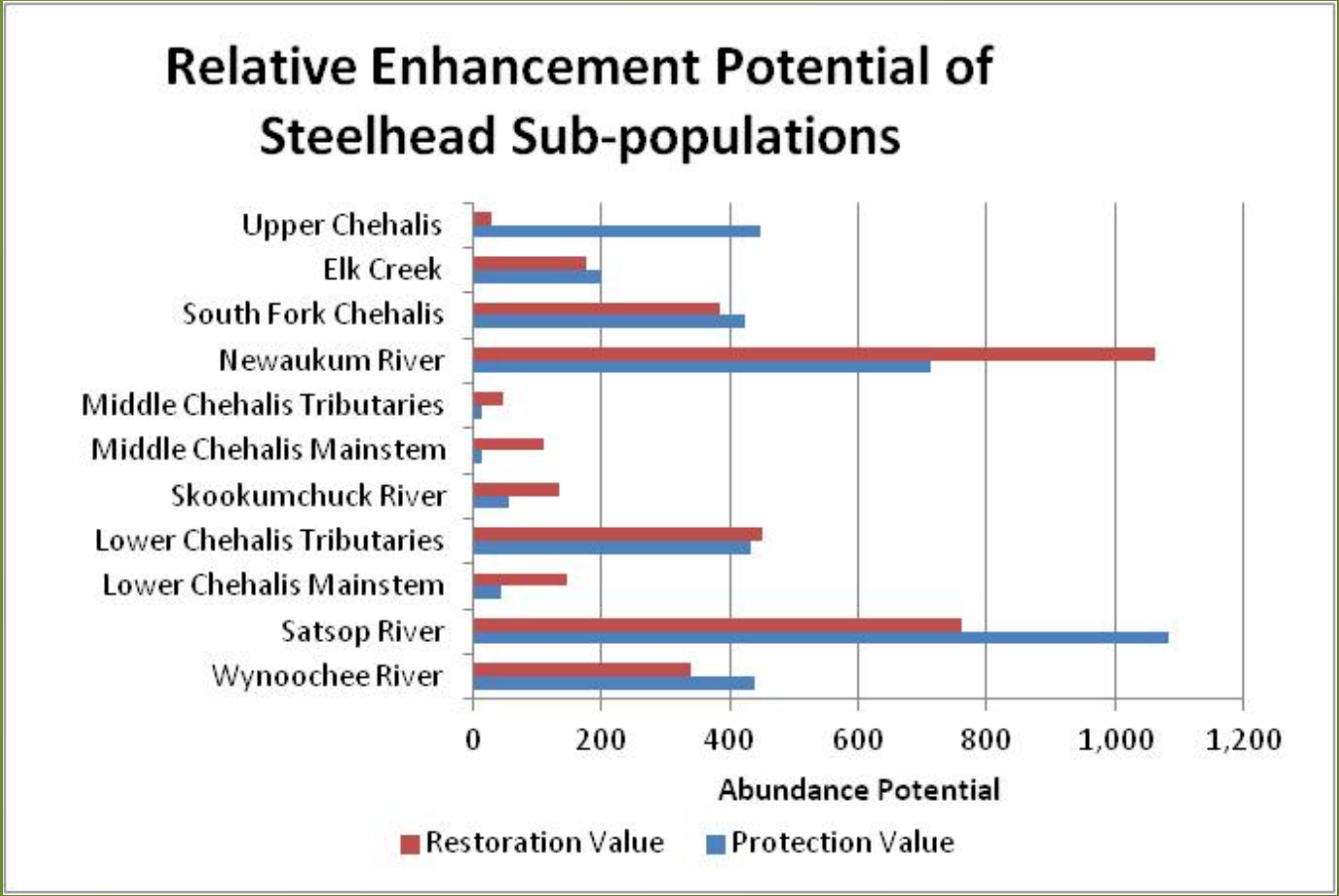
# Enhancement Opportunities at the Chehalis Basin Scale: Fall Chinook



# Enhancement Opportunities at the Chehalis Basin Scale: Spring Chinook

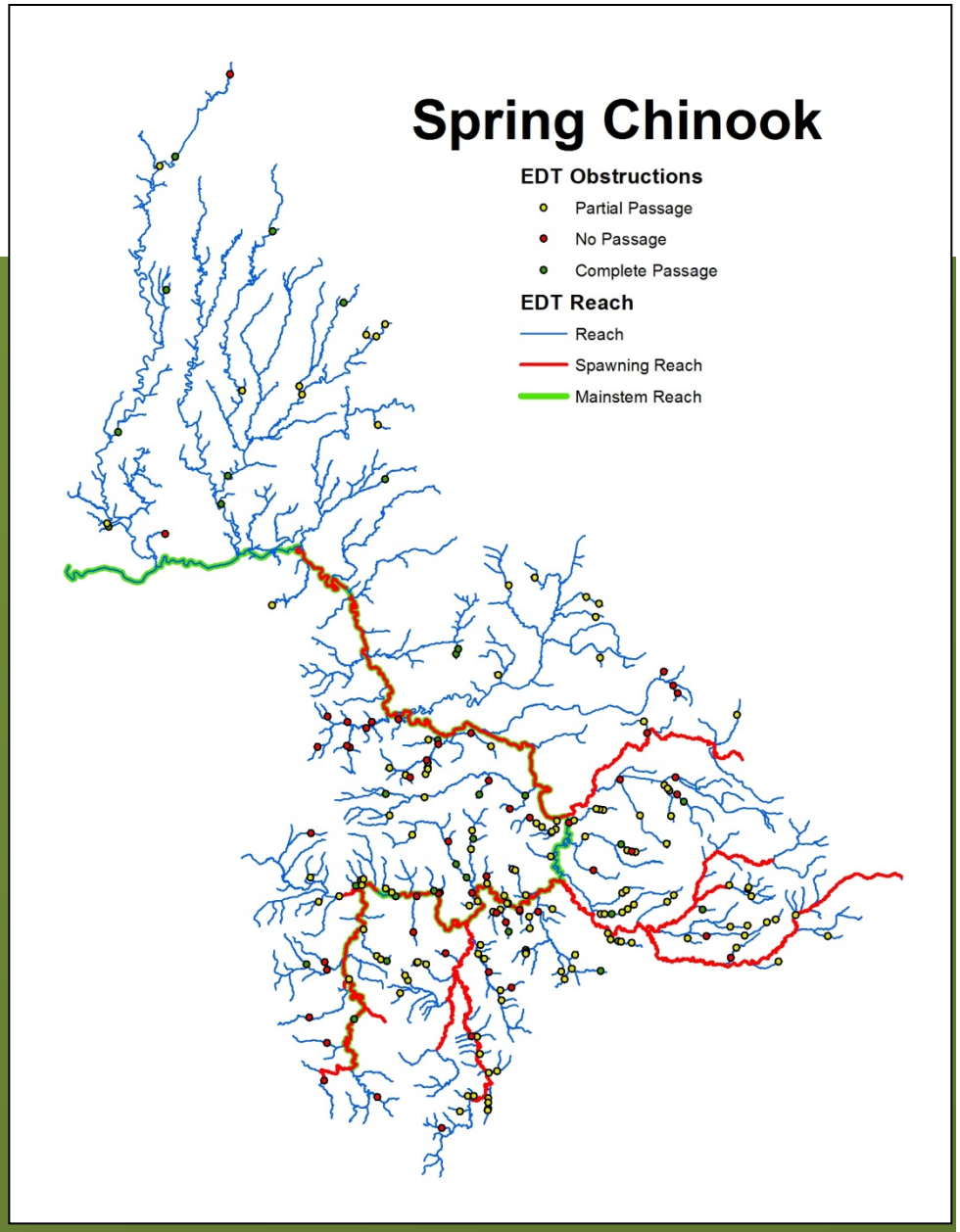


# Enhancement Opportunities at the Chehalis Basin Scale: Steelhead



# Obstructions

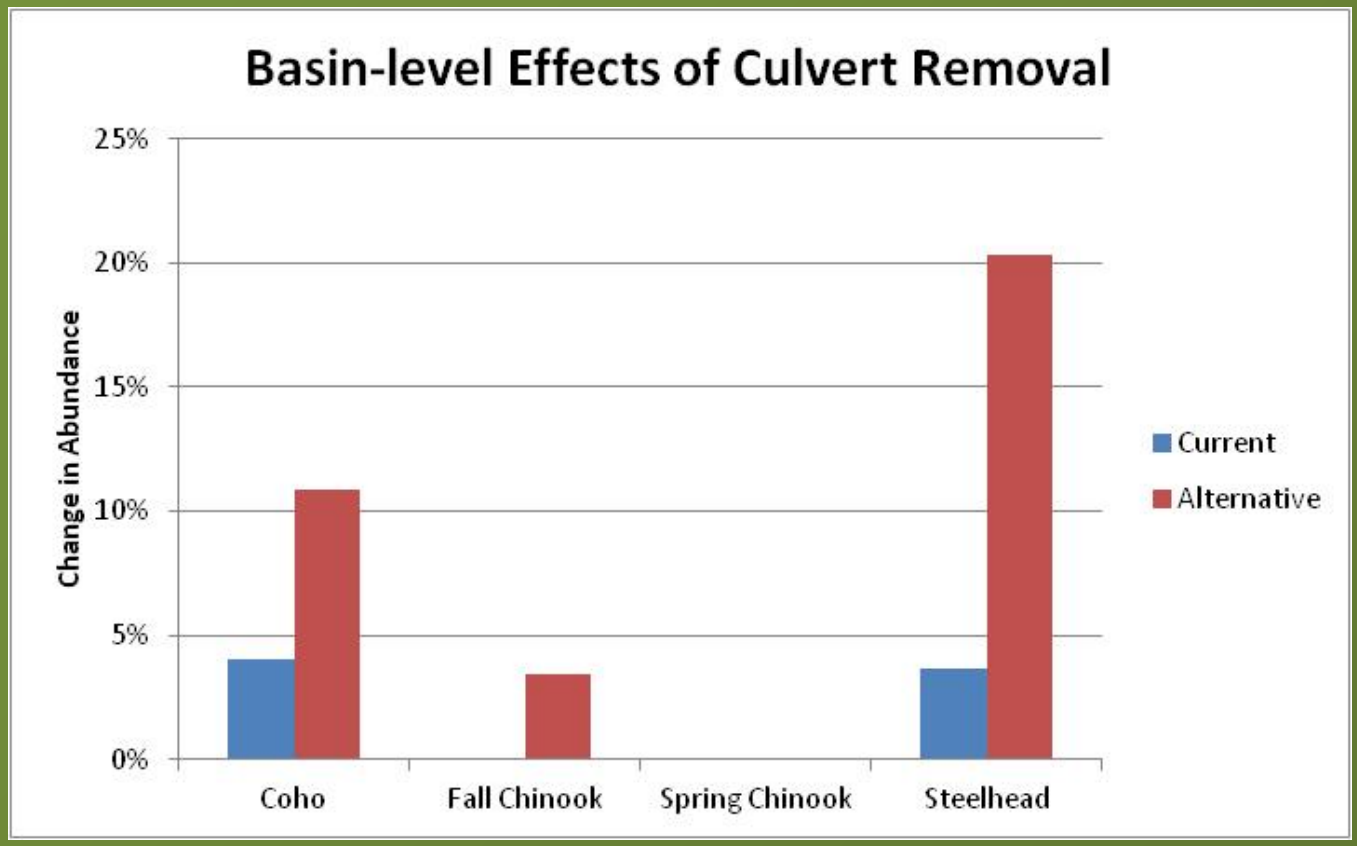
- Obstructions evaluated only if below a spawning reach
- Obstructions from available databases
- Unrated obstruction = 100% passage (base condition)
- Alternative: Assume unrated obstructions = 50% blockage



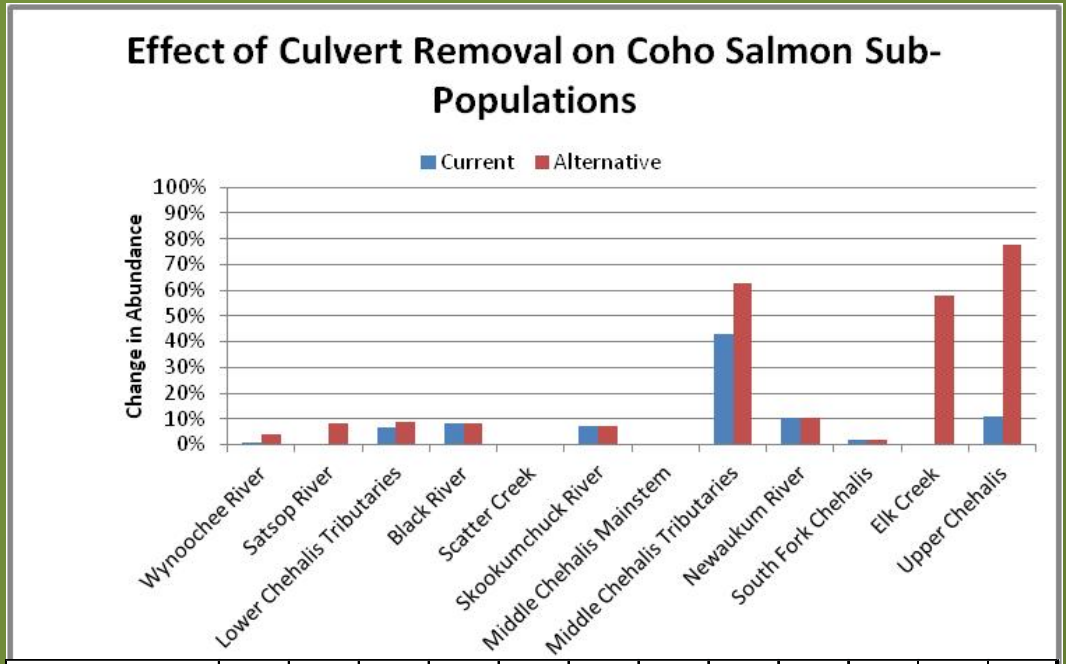
# Obstructions to Adult Fish Passage in Chehalis EDT model

| Subbasin | Reaches | Obstructions | Partial Blockage | Complete Blockage | 100% Passage | Not Rated |
|---|---|---|---|---|---|---|
| Above Elk Creek | 121 | 18 | 5 | 9 | 0 | 4 |
| Black River | 61 | 7 | 7 | 0 | 0 | 0 |
| Lower Chehalis Mainstem | 31 | 0 | 0 | 0 | 0 | 0 |
| Lower Chehalis Tributaries | 298 | 40 | 13 | 16 | 0 | 11 |
| Middle Chehalis Mainstem | 31 | 1 | 0 | 0 | 0 | 1 |
| Middle Chehalis Tributaries | 220 | 69 | 32 | 19 | 1 | 17 |
| Newaukum River | 117 | 24 | 19 | 4 | 0 | 1 |
| Satsop River | 152 | 10 | 1 | 0 | 0 | 9 |
| Scatter Creek | 15 | 3 | 0 | 3 | 0 | 0 |
| Skookumchuck River | 74 | 16 | 6 | 8 | 0 | 2 |
| South Fork Chehalis River | 154 | 28 | 18 | 7 | 0 | 3 |
| Wynoochee River | 104 | 8 | 2 | 2 | 0 | 4 |
| Total in EDT | 1378 | 224 | 103 | 68 | 1 | 52 |

# Species Effects of Culvert Removal in the Chehalis Basin

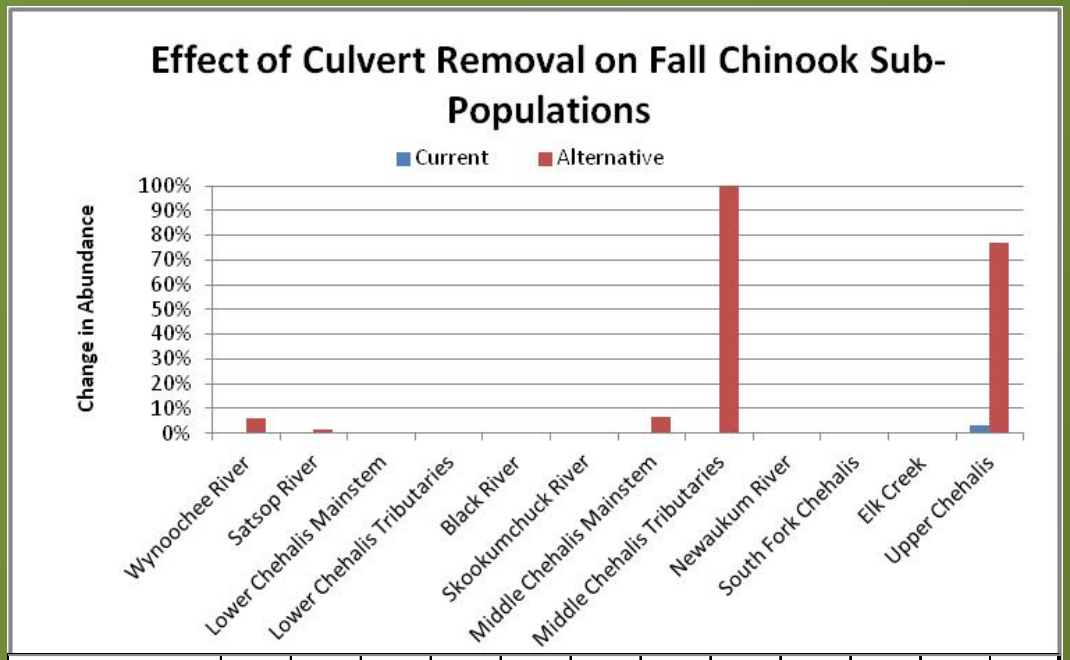


# Effect of Obstruction Removal on Coho Sub-Populations



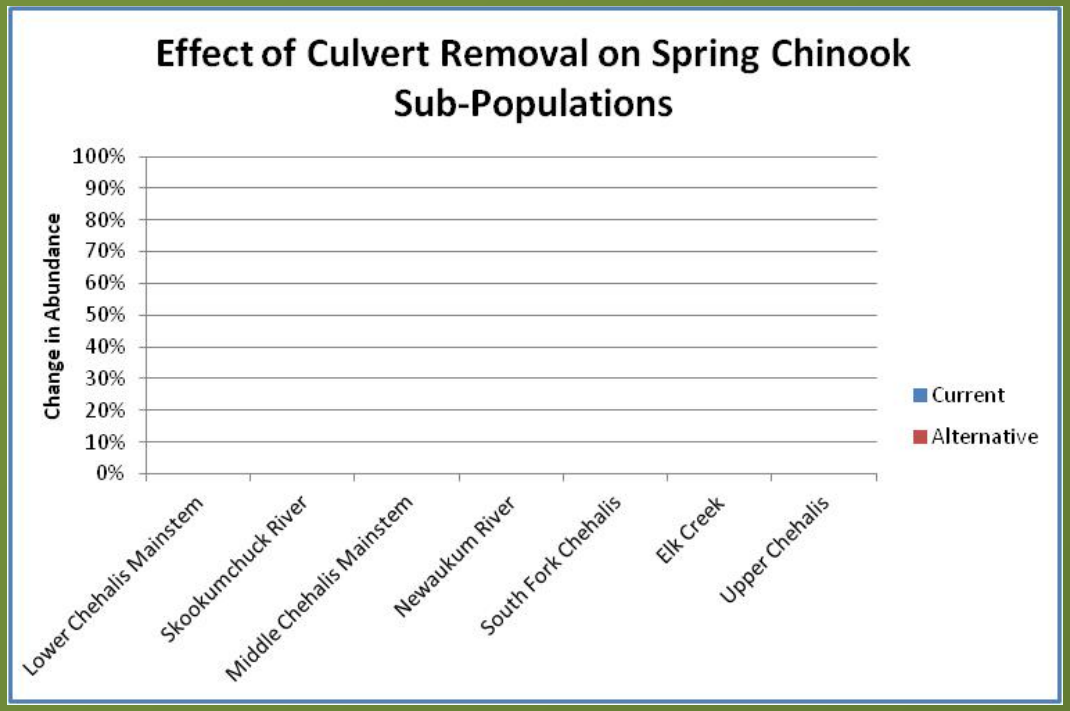

| | Wynoochee River | Satsop River | Lower Chehalis Tributaries | Black River | Scatter Creek | Skookumchuck River | Middle Chehalis Mainstem | Middle Chehalis Tributaries | Newaukum River | South Fork Chehalis | Elk Creek | Upper Chehalis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Current Base | 2 | - | 253 | 190 | - | 166 | - | 218 | 213 | 27 | - | 85 |
| Alternative Base | 255 | 623 | 330 | 190 | - | 166 | - | 320 | 216 | 27 | 379 | 606 |

# Effect of Obstruction Removal on Fall Chinook Sub-populations

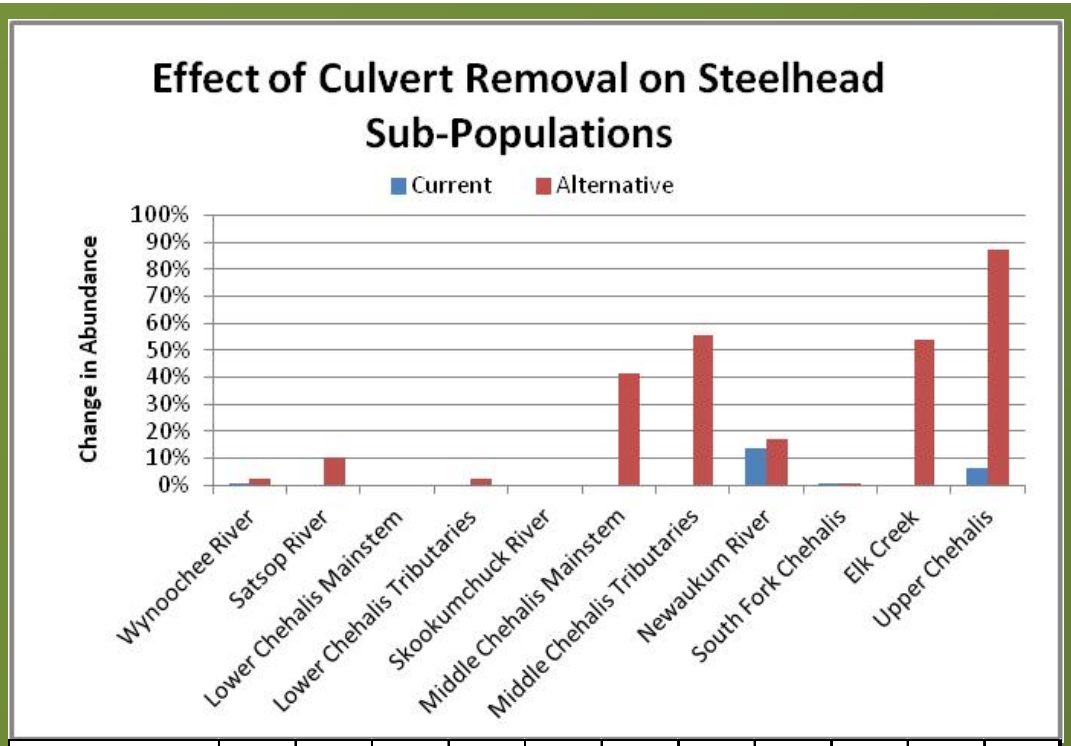



| | Wynoochee River | Satsop River | Lower Chehalis Tributaries | Black River | Scatter Creek | Skookumchuck River | Middle Chehalis Mainstem | Middle Chehalis Tributaries | Newaukum River | South Fork Chehalis | Elk Creek | Upper Chehalis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Current Base | - | - | - | - | - | - | - | - | - | - | - | 12 |
| Alternative Base | 354 | 70 | - | - | - | - | 76 | 4 | - | - | - | 283 |

# Effect of Obstruction Removal on Spring Chinook Sub-populations

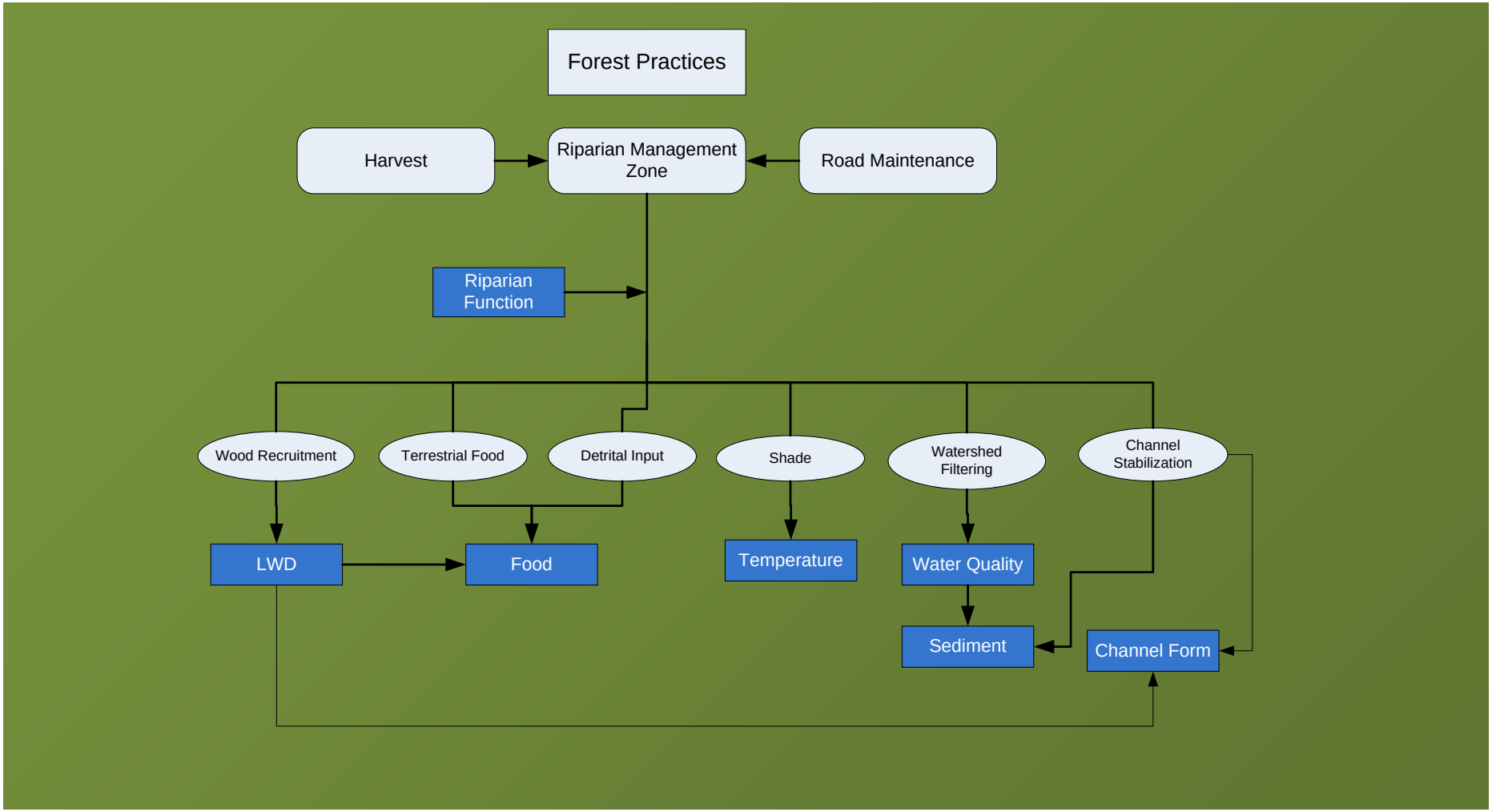


# Effect of Obstruction Removal on Steelhead Sub-populations



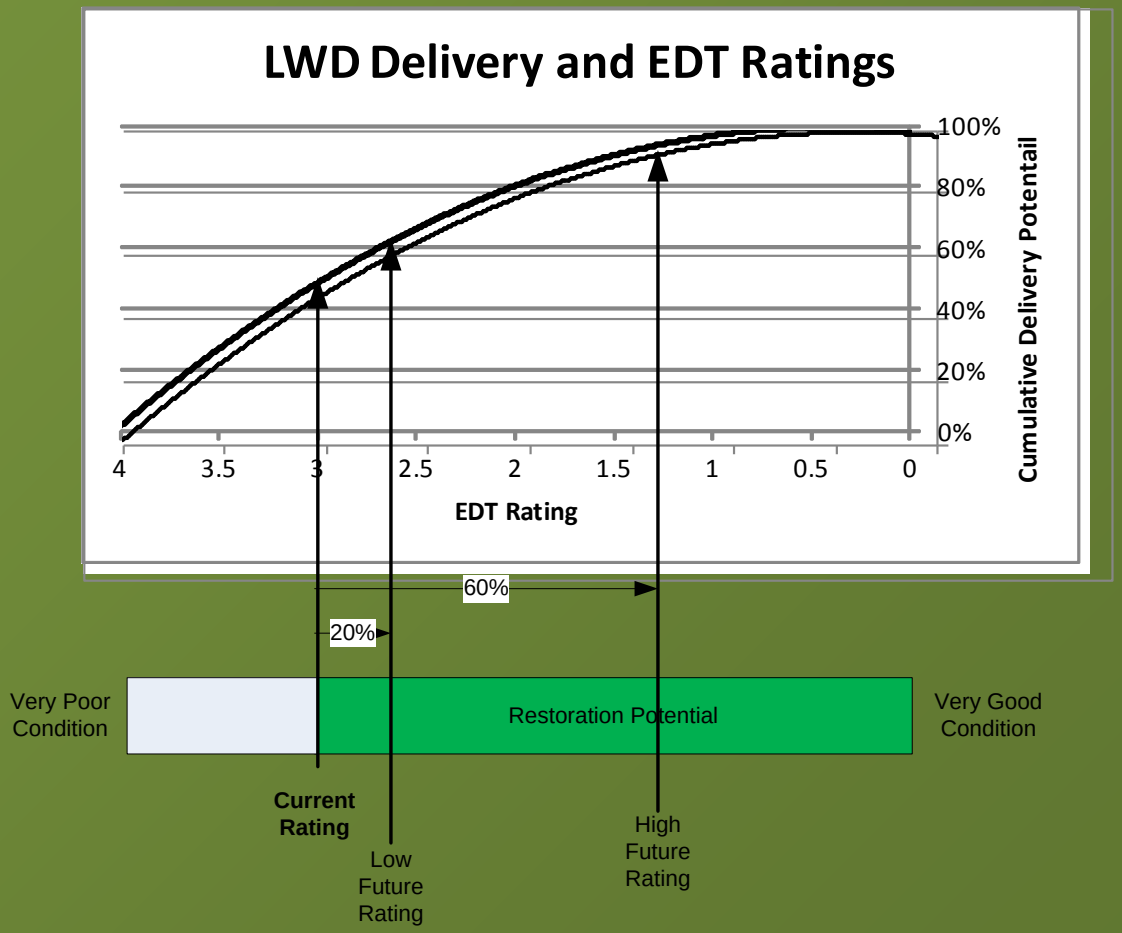

| | Wynoochee River | Satsop River | Lower Chehalis Mainstem | Lower Chehalis Tributaries | Skookumchuck River | Middle Chehalis Mainstem | Middle Chehalis Tributaries | Newaukum River | South Fork Chehalis | Elk Creek | Upper Chehalis |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Current Base | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 110 | 0 | 0 | 29 |
| Alternative Base | 8 | 100 | 0 | 10 | 0 | 6 | 7 | 142 | 0 | 107 | 396 |

# Riparian Zone Conceptual Model



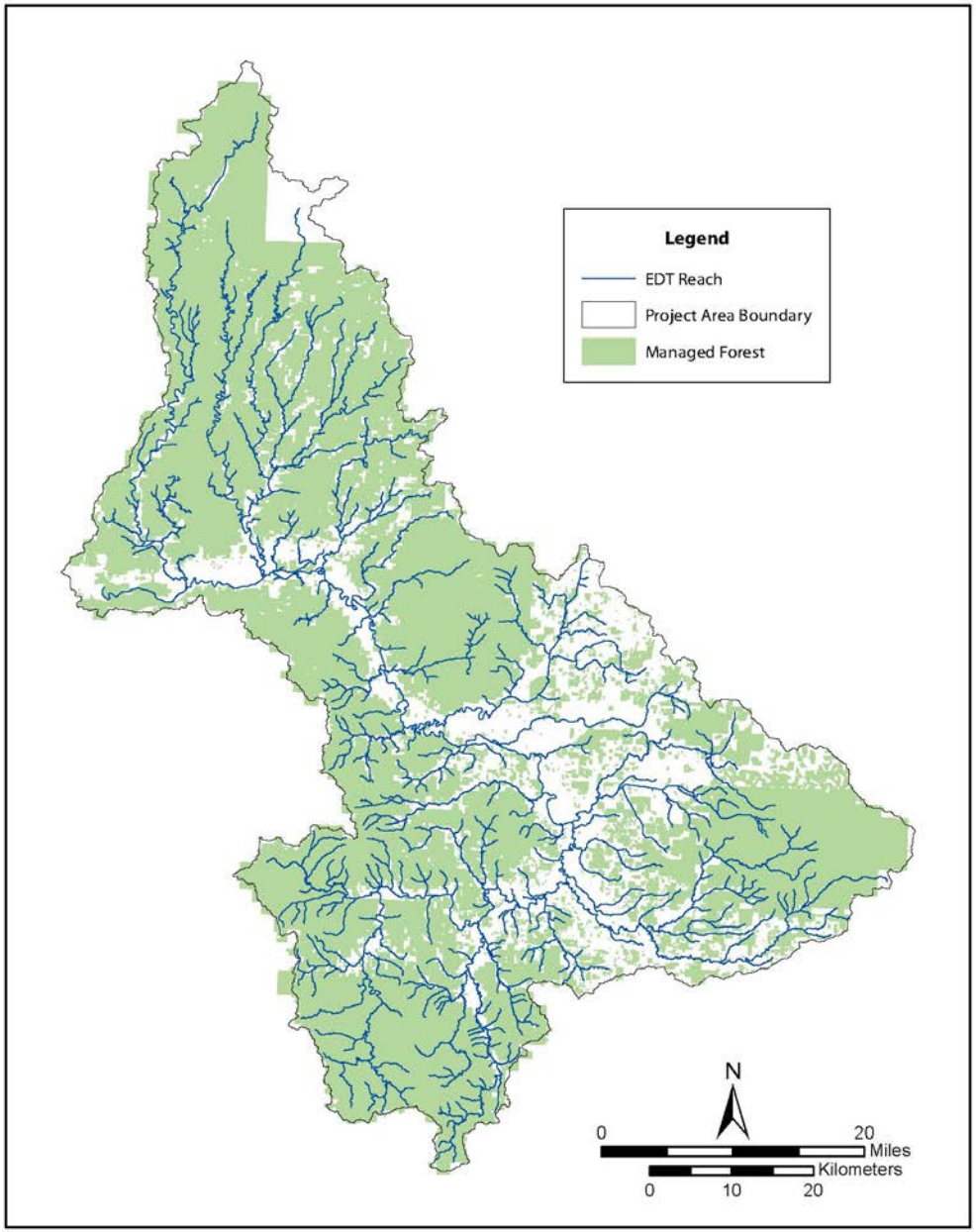
# Riparian Enhancement

- Evaluated two future states for riparian conditions in managed forests
- Changes were made to all reaches in managed forests

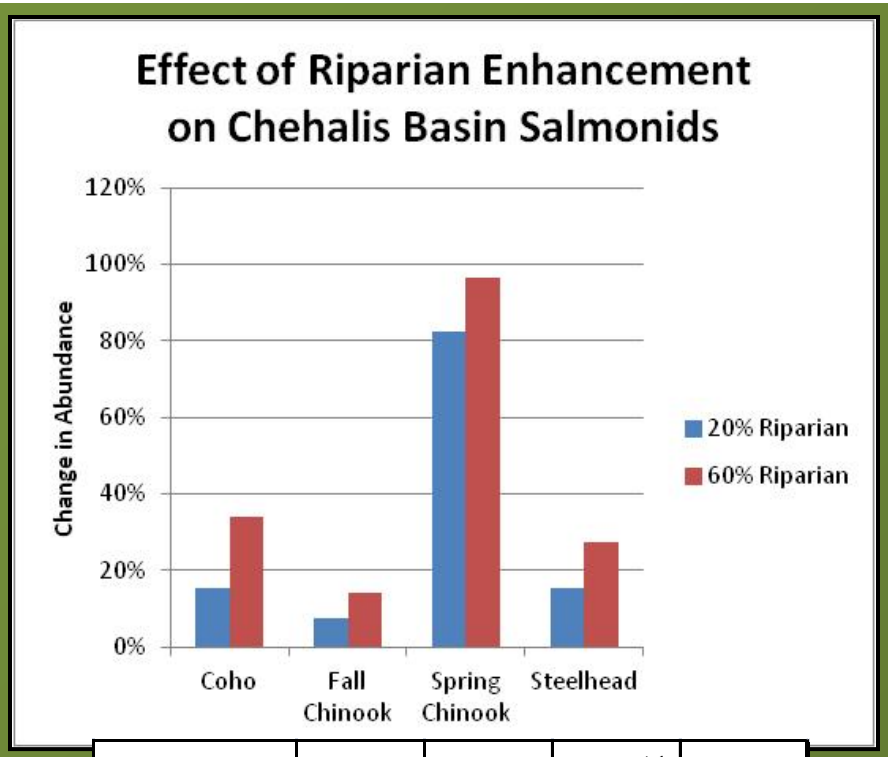


# Riparian

Extent of managed forest in Chehalis Basin

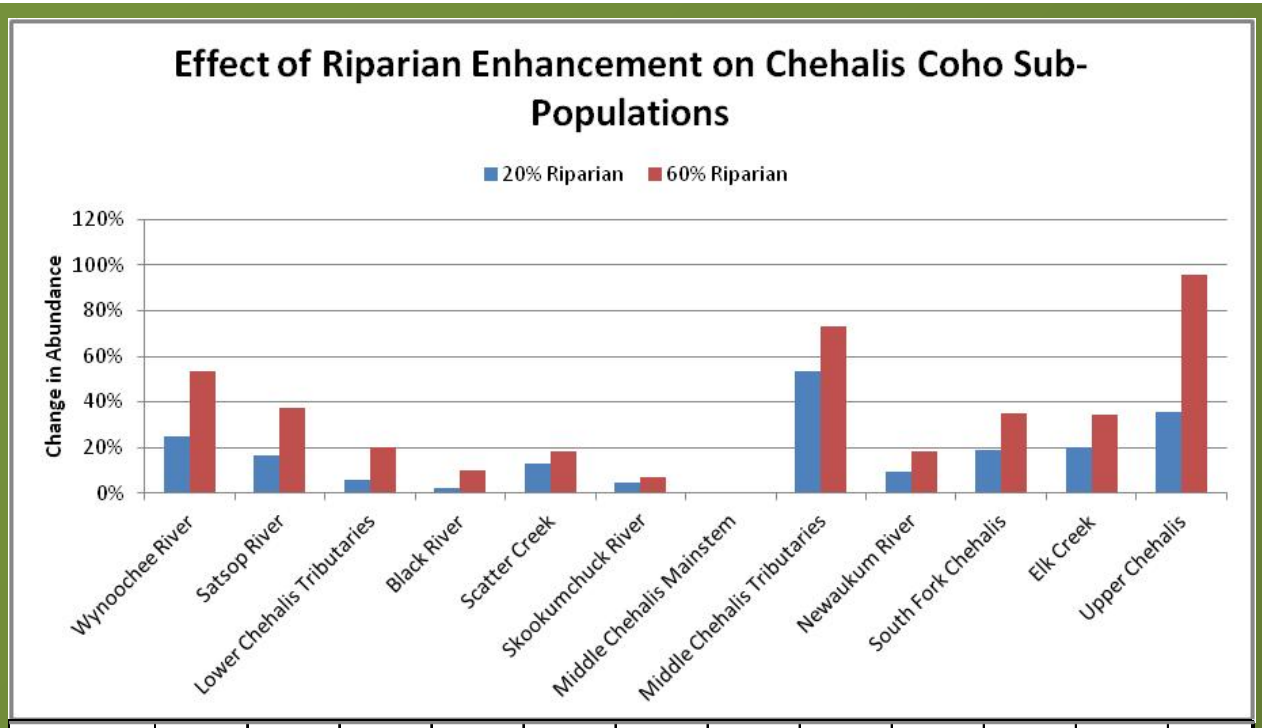


# Species-Level Effects of Riparian Enhancement




| | Coho | Fall Chinook | Spring Chinook | Steelhead |
|---|---|---|---|---|
| 20% Riparian | 4,239 | 1,680 | 894 | 560 |
| 60% Riparian | 9,321 | 3,250 | 1,046 | 1,013 |

# Effect of Riparian Enhancement on Coho

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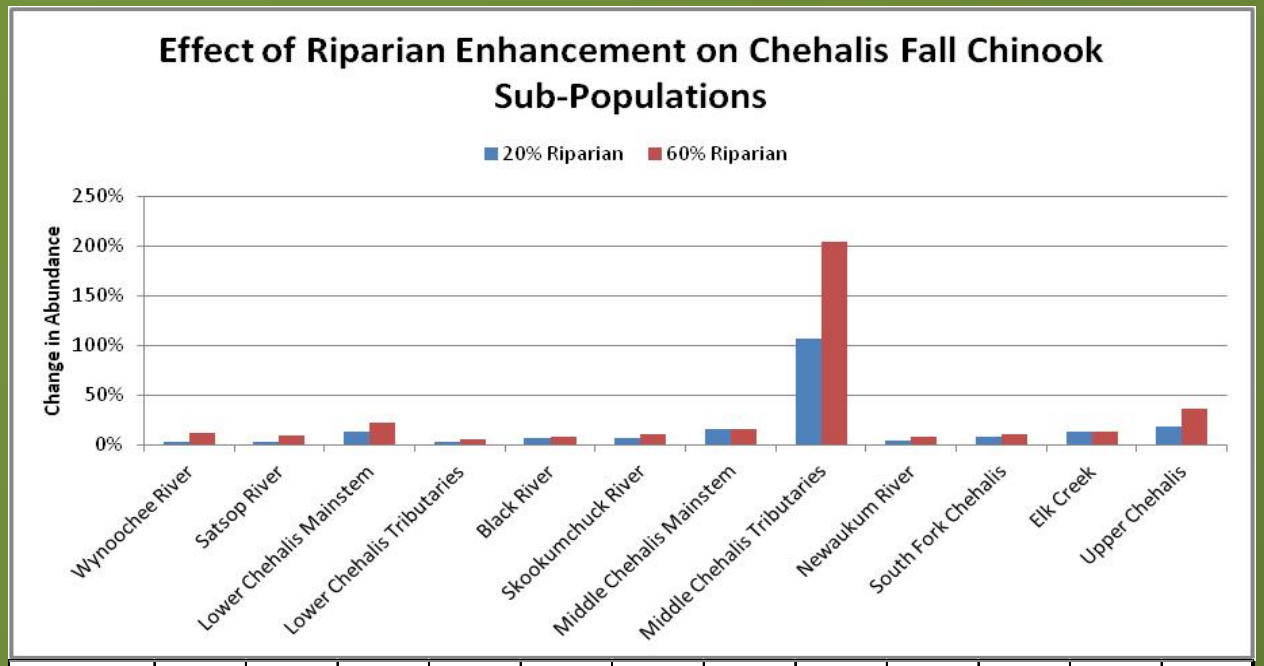
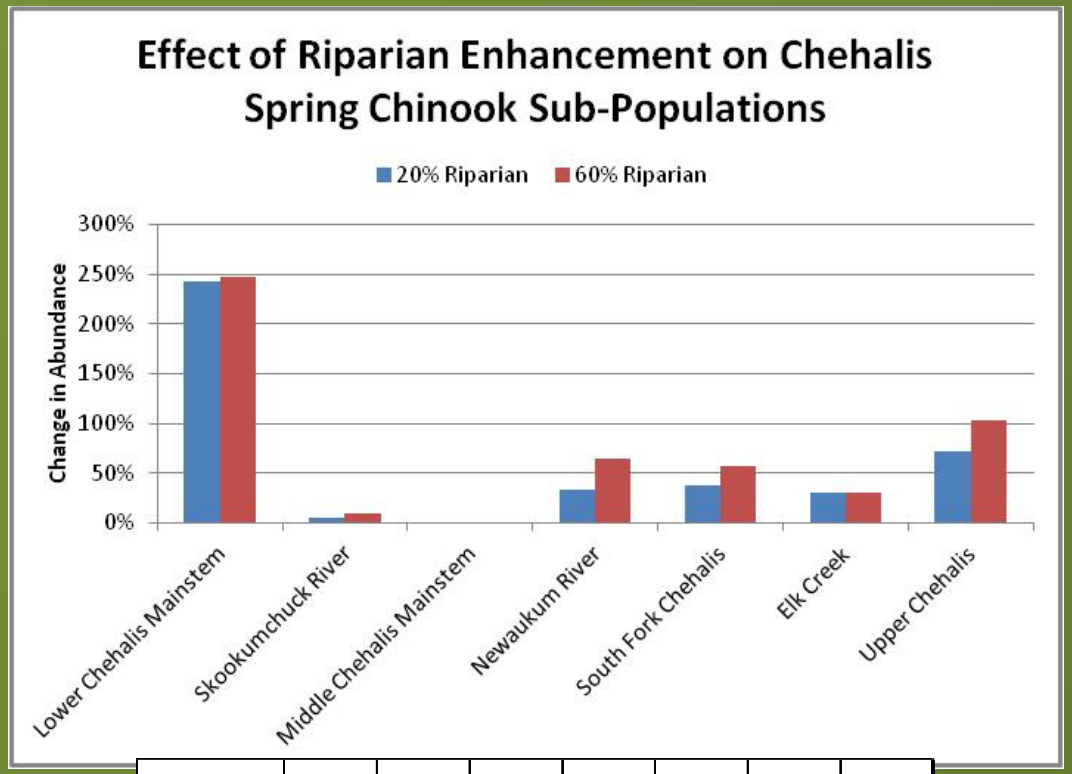
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20% Riparian | 1,543 | 1,217 | 198 | 50 | 116 | 102 | 29 | 156 | 173 | 275 | 132 | 248 |
| 60% Riparian | 3,340 | 2,775 | 716 | 209 | 168 | 149 | 29 | 211 | 334 | 505 | 222 | 662 |

# Effect of Riparian Enhancement on Fall Chinook



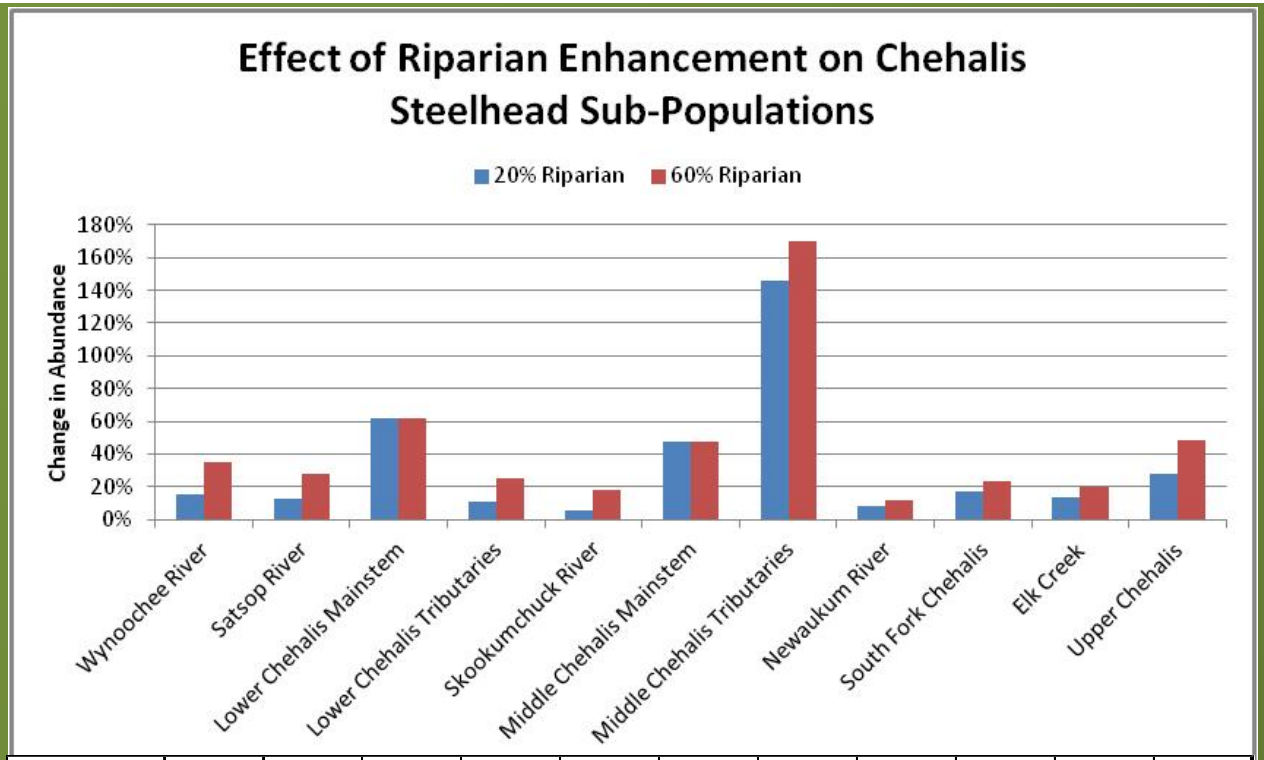

| | Wynoochee River | Satsop River | Lower Chehalis Mainstem | Lower Chehalis Tributaries | Black River | Skookumchuck River | Middle Chehalis Mainstem | Middle Chehalis Tributaries | Newaukum River | South Fork Chehalis | Elk Creek | Upper Chehalis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20% Riparian | 208 | 179 | 815 | 25 | 58 | 39 | 190 | 4 | 32 | 63 | 3 | 64 |
| 60% Riparian | 668 | 508 | 1,404 | 59 | 76 | 63 | 195 | 7 | 53 | 84 | 3 | 132 |

# Effect of Riparian Enhancement on Spring Chinook




| | Lower Chehalis Mainstem | Skookumchuck River | Middle Chehalis Mainstem | Newaukum River | South Fork Chehalis | Elk Creek | Upper Chehalis |
|---|---|---|---|---|---|---|---|
| 20% Riparian | 650 | 17 | 0 | 53 | 63 | 3 | 108 |
| 60% Riparian | 662 | 30 | 0 | 101 | 93 | 3 | 157 |

# Effect of Riparian Enhancement on Steelhead




| | Wynoochee River | Satsop River | Lower Chehalis Mainstem | Lower Chehalis Tributaries | Skookumchuck River | Middle Chehalis Mainstem | Middle Chehalis Tributaries | Newaukum River | South Fork Chehalis | Elk Creek | Upper Chehalis |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 20% Riparian | 59 | 129 | 26 | 46 | 3 | 7 | 18 | 57 | 71 | 27 | 117 |
| 60% Riparian | 138 | 275 | 26 | 104 | 9 | 7 | 21 | 85 | 101 | 39 | 208 |

# Other Fish


Northern Pikeminnow


Olympic Mudminnow


Redside Shiner


Largescale Sucker


Longnose Dace


Sculpin (6 species)

# Other Fish

- Limited available information for these species in particular for the Chehalis Basin
- Limiting factors are based on known limiting factors for species and not known to be limiting in the basin
- Available information and best professional judgment was used

# Other Fish

| SPECIES | LIFE-STAGE | HABITAT REQUIREMENTS | POSSIBLE LIMITING FACTORS |
|---|---|---|---|
| **Pacific lamprey** | Adult spawning | Gravel substrate at pool tails and in riffles | Living space with suitable coarse, silt-free substrate – sufficient current velocity is key to maintaining silt-free substrate |
| **Pacific lamprey** | Larvae | Silty backwater along mainstem reaches and tributaries | Depositional area protected from high velocity current; these are successional habitats, but changes in sediment transport (deposition and flushing) could change rate of succession and/or change connectivity among habitats |
| **White sturgeon** | Feeding adults | Lower mainstem pools | Living space with sufficient depth, including marine access –this species is not strongly dependent on the Chehalis River Basin but is thought to move into the river from Grays Harbor to forage, possibly for freshwater mussels; no known spawning or rearing in the Chehalis Basin; migration upstream can be to above the Black River |
| **Chum salmon** | Spawning | Gravel substrate at pool tails and in riffles | Freshwater limiting factors for chum salmon are largely restricted to spawning and incubation, with flood scour and superimposition (crowding) being the two factors most likely limiting them; spatial range includes reaches up to the Black River; chum salmon can use a diversity of spawning habitat water depths and channel size |
| **Eulachon** | Spawning | Located primarily in the lower Basin and dependent on sand and pea-sized gravel for spawning | Freshwater limiting factors for eulachon are largely restricted to river conditions and spawning, with lack of appropriate substrate the most likely limiting factor; Eulachon are present in the Wynoochee and Satsop rivers; once juveniles emerge from the substrate they are flushed out with flow |

# Other Fish

| SPECIES | LIFE-STAGE | HABITAT REQUIREMENTS | POSSIBLE LIMITING FACTORS |
|---|---|---|---|
| **Speckled dace** | Adults | Mainstem pools | Living space with suitable coarse silt-free substrate – sufficient current velocity is key to maintaining silt-free substrate; in the absence of any studies on limiting factors, living space is the most likely limiting factor |
| **Speckled dace** | Spawning | Gravel substrate at pool tails and in riffles | Living space with suitable coarse silt-free substrate – sufficient current velocity is key to maintaining silt-free substrate |
| **Largescale sucker** | Adults | Mainstem pools; there is a close association of largescale suckers and mountain whitefish | Living space with suitable coarse silt-free substrate might be a limiting factor for these long-lived fish – sufficient current velocity is key to maintaining silt-free substrate |
| **Largescale sucker** | Spawning | Pool tailouts with less specific substrate | Similar hydraulic and substratum needs to rainbow trout and other smaller-bodied salmonids |
| **Largescale sucker** | Fry | Silty backwater habitats on the mainstem and in tributaries | Require depositional areas protected from high velocity current during summer; these are successional habitats, but changes in sediment transport (deposition and flushing) could change the rate of succession and/or change connectivity |

# Other Fish

| SPECIES | LIFE-STAGE | HABITAT REQUIREMENTS | POSSIBLE LIMITING FACTORS |
|---|---|---|---|
| **Reticulate sculpin** | All life stages | Mainstem pools | Living space with suitable coarse silt-free substrate may be a limiting factor – sufficient current velocity is key to maintaining silt-free substrate |
| **Riffle sculpin[1]** | All life stages | Silty backwater habitats on the mainstem and in tributaries | Vegetated depositional areas protected from high velocity current; these are successional habitats, but changes in sediment transport (deposition and flushing) could change rate of succession and/or change connectivity; access to cooler water temperatures could also be limiting |
| **Olympic mudminnow** | All life stages | Oxbow lakes and off-channel marshes | Maintain water level while minimizing invasion by non-native predators; potential impacts to their habitats are similar to those listed for previous habitats; non-native predators (primarily bass) are believed to be a major limiting factor |
| **Largemouth bass (non-native predator)** | All life stages | Oxbow lakes and off-channel marshes | Off-channel, low-velocity habitats with abundant food sources. |
| **Smallmouth bass (non-native predator)** | All life stages | Mainstem and off-channel | Moderately low-velocity habitats with abundant food sources (somewhat colder-adapted than largemouth bass) |

# Other Fish Summary

- Silt free substrate is important to many  of these species
- Non-native predators are likely negatively impacting many of these species
- Floodplain connectivity is important to many of these species

# Non Fish

Northern red legged Frog

Oregon Spotted Frog

Andrew O'Connor

Northwestern Salamander

Western Toad

Pacific Treefrog

# Non-Fish

- Similar to Other Fish, very limited information on limiting factors in the Chehalis Basin
- Many limiting factors are based on known limiting factors for species and not known to be limiting in the basin
- Available information and best professional judgment was used

# Non-Fish

| Focal Species | Species Limiting Factors in the Chehalis Basin |
|---|---|
| **Northern red-legged frog** | Lack of upland forest adjacent to off-channel breeding habitat due to conversion of land use such as agriculture.<br><br>Presence of warm water exotic predators, American bullfrog, and several fish species such as sunfish, yellow perch, smallmouth bass, and bullhead catfish. |
| **Western toad** | Lack of off-channel habitat with shallow, low flow, and unvegetated conditions.<br><br>Presence of non-native invasive vegetation such as reed canarygrass in open water habitat.<br><br>Lack of quality upland prairie habitat adjacent to aquatic habitat. |
| **Oregon spotted frog** | Presence of warm water exotic predators, American bullfrog, and several fish species such as sunfish, yellow perch, smallmouth bass, and bullhead catfish.<br><br>Presence of nonnative exotic vegetation such as reed canarygrass that forms a monoculture in aquatic habitats, affecting breeding habitat in particular.<br><br>Lack of open canopy adjacent to aquatic breeding habitat. |
| **Coastal tailed frog** | Lack of in-stream LWD.<br><br>Lack of adjacent mature upland forest as a source of LWD.<br><br>Warmer water temperatures (data gap, additional research needed).<br><br>Quality of adjacent upland habitat conditions (data gap, additional research needed). |

# Non-Fish

| Focal Species | Species Limiting Factors in the Chehalis Basin |
|---|---|
| **Van Dyke's salamander** | Lack of little disturbed riparian habitats.<br><br>Lack of LWD in intermediate decay classes in riparian habitat. |
| **Western pond turtle** | Presence of warm water exotic predators, American bullfrog, and several fish species such as sunfish, yellow perch, smallmouth bass, and bullhead catfish.<br><br>Lack of quality (open) upland prairie habitat adjacent to aquatic habitat.<br><br>Degraded prairie habitat due to the presence of nonnative invasive vegetation.<br><br>Lack of LWD in off channel or open water habitat. |
| **Beaver** | Identifying limiting factors for beaver within the Chehalis Basin is difficult due to the lack of existing information on beaver presence.<br><br>In general, limiting factors for beaver typically include the quality of riparian habitat and the presence of deciduous trees. |

# Non-Fish Summary

- Exotic aquatic predators is probably limiting to all Key amphibian species and the turtle.
- Suitable juxtaposed aquatic and riparian habitats are likely limiting for Northern red-legged frog, western toad and the turtle, although the type of riparian habitat and width desired varies with the species.
- Older seral stage coniferous forest that can produce large wood may be limiting for coastal tail frog and Van Dyke's salamander.
- Information on distribution and abundance of all non-fish taxa remains a major gap that needs address to better direct options.

# Other Fish

| KEY SPECIES | SALMON RESTORATION ACTIONS | | | | OTHER RESTORATION ACTIONS | | NOTES |
|---|---|---|---|---|---|---|---|
| | BARRIER REMOVAL | RIPARIAN ENHANCEMENT | IN WATER WOOD STRUCTURE | FLOODPLAIN RECONNECTION | INVASIVE PREDATOR MANAGEMENT | INVASIVE VEGETATION MANAGEMENT | |
| **Chum salmon** | + | + | + | + | + | + | Chum would benefit from all salmon restoration projects (except perhaps those aimed primarily at juvenile salmonids) |
| **Eulachon** | u | + | + | u | u | u | |
| **Pacific lamprey** | + | + | + | n | u | u | |
| **White sturgeon** | + | + | u | u | u | u | |
| **Olympic mudminnow** | u | u | u | n | + | u | |
| **Speckled dace** | + | + | + | + | u | u | |
| **Largescale sucker** | + | + | + | + | u | u | |
| **Riffle sculpin** | u | u | u | u | u | u | |
| **Reticulate sculpin** | u | u | u | u | u | u | |
| **Smallmouth bass** | + | u | + | + | u | u | |
| **Largemouth bass** | + | u | + | + | u | u | |

Notes:
*n* = neutral
*u* = unknown

# Other Fish

- Projects would likely be positive to neutral
  - Silt reduction
  - In channel habitat complexity
  - Habitat complexity including off-channel connection
- Removal of non-native predators would likely be beneficial
- Due to the lack of data, specifics of a project design and location should be reviewed on a case-by-case basis to determine potential impacts by species

# Non-Fish

| KEY SPECIES | SALMON RESTORATION ACTIONS | | | | OTHER RESTORATION ACTIONS | | NOTES |
|---|---|---|---|---|---|---|---|
| | BARRIER REMOVAL | RIPARIAN ENHANCEMENT | IN WATER WOOD STRUCTURE | FLOODPLAIN RECONNECTION | INVASIVE PREDATOR MANAGEMENT | INVASIVE VEGETATION MANAGEMENT | |
| Northern red-legged frog | +/- | ++ | n | +/- | ++ | +/- | Barrier removal and reconnection to off channel habitat would be positive as long as they do not introduce invasive predators |
| Western toad | +/- | - | n | n | + | + | Barrier removal would be positive as long as they do not introduce invasive predators |
| Oregon spotted frog | n | - | u | u/- | + | + | Reconnection to off channel habitat would be unknown as long as they do not introduce invasive predators. If predators are introduced, it would be negative. |
| Coastal tailed frog | + | + | ++ | n | n | n | |
| Van Dyke's salamander | + | ++ | n | n | n | u | |
| Western pond turtle | + | - | ++/n | + | + | + | Basking sites would be very beneficial if they are lacking and would be neutral if not lacking |
| North American beaver | + | ++ | u | + | n | n | |

Notes:
*n* = neutral
*u* = unknown

# Non-Fish Habitat Enhancement

- Removal of aquatic exotic predators and/or habitat modification to disfavor aquatic exotic predators can help several non-fish species.
- Preservation of riparian areas suitable to the upland needs of several species that is juxtaposed to their required aquatic habitat will help Western toad, Northern Red-legged Frog, and Western Pond Turtle.
- Set asides in coniferous forest to generate older seral stage stands will help Coastal tailed Frog and Van Dyke's salamander.

# Climate change

# ASEP Climate Change

Analysis addresses:

- How would climate change affect species compared to the continuation of existing conditions?

# Climate Change Information Sources

- Climate Impacts Group (CIG) at University of Washington
  - State of Knowledge Report- Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers, 2013 (http://cses.washington.edu/cig/)
  - Site-specific projections for Chehalis Basin (http://warm.atmos.washington.edu/2860/products/sites/)
- Wild Fish Conservancy
  - Climate Change in the Chehalis River and Grays Harbor Estuary, 2013. (http://wildfishconservancy.org/resources/publications/wild-fish-runs/climate-change-chehalis-river-grays-harbor-estuary)

# Climate Change Parameters

- Water temperature
- Streamflow
  - Average monthly flow
  - Peak flows
  - Low flows
- Sea level rise effects on estuary and lower river

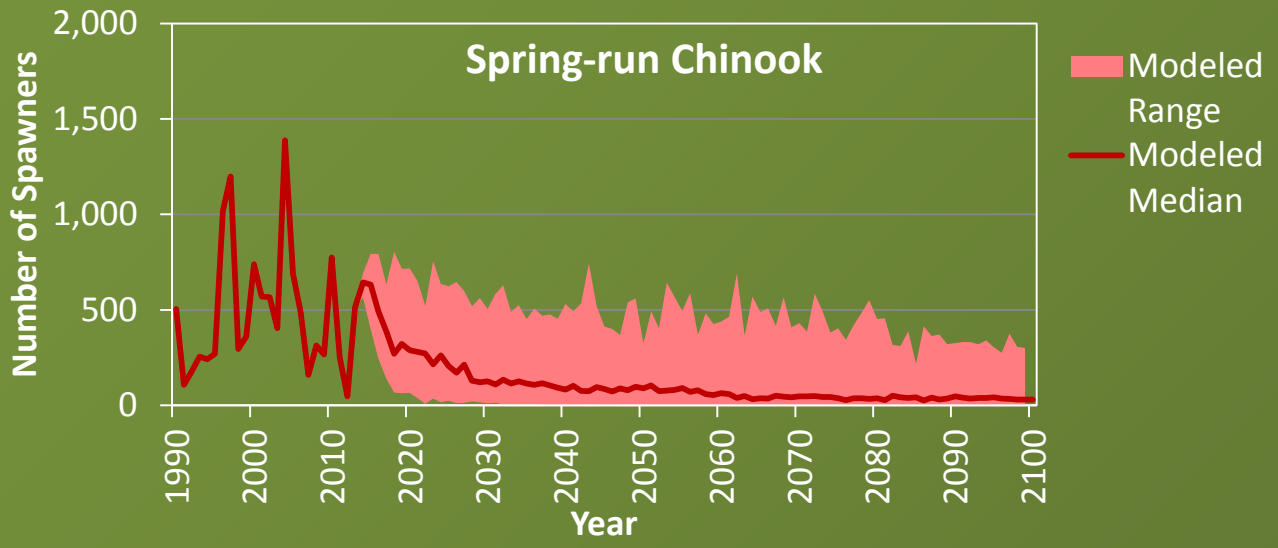
# Climate Change Scenario

- A1B greenhouse gas emissions scenario
  - A medium scenario in which greenhouse gas emissions increase to peak in mid-21st century then decline in the final decades

# Climate Change – Salmon

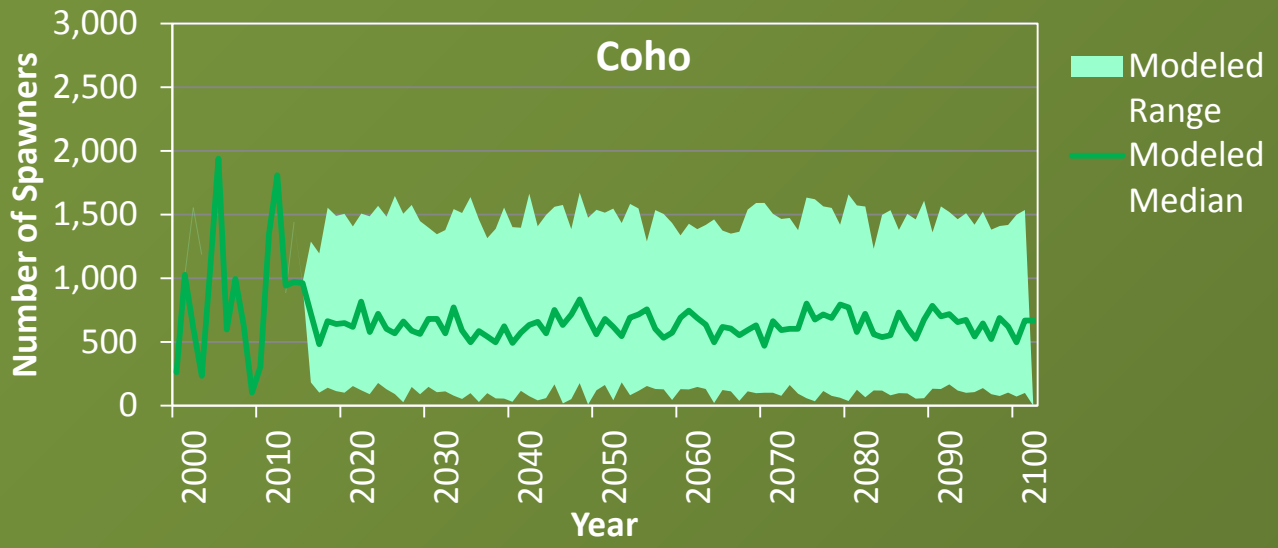
- Adjusted habitat capacities based on estimated changes in streamflows
- Adjusted environmental conditions (water temperature and flows)

# Climate Change – Spring Chinook



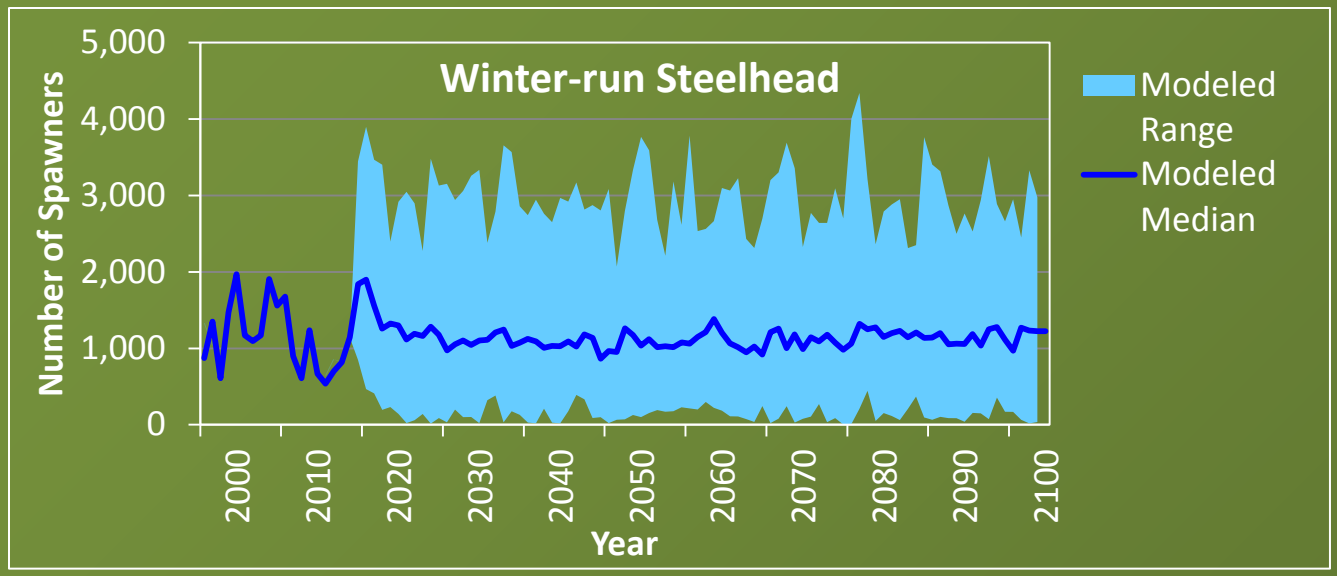

- Declining Trend Over Time
- Reduced Compared to Continuation of Existing Conditions
- “Immediate” Changes Once Parameter Changes Are Input

# Climate Change – Coho




- Slight Increase Compared to Continuation of Existing Conditions
- "Immediate" Changes Once Parameter Changes Are Input

# Climate Change – Fall Chinook




- Reduced Compared to Continuation of Existing Conditions
- “Immediate” Changes Once Parameter Changes Are Input
- High variability among estimates

# Climate Change – Summary of Preliminary Salmon Results

- Reduced numbers of Chinook and Steelhead estimated with climate change in all scenarios
- Slight increase in coho numbers between climate change and the continuation of existing conditions

# Climate – positive restoration actions

- Barrier removal: can aid access to cooler streams
- Floodplain reconnection: can ameliorate temperature increases by hyporheic flow
- Aggrading incised channels: restores aquifer storage, increases summer base flow, lowers summer temperatures, increases habitat diversity
- Actions that restore stream flow: ameliorate low flows and increase diversity

# Climate – positive restoration actions

- Restoring riparian habitat: cools streams, provides organic matter, increases wood supply and habitat diversity, and reduces fine sediments
- Reducing erosion and sediment delivery: improves habitat diversity, increases pool depth, narrows widened channels
- Instream rehabilitation: improves habitat diversity, provides cover, improves sediment storage

# Climate change – Other fish and non-fish species - methods

- PHABSIM (flow), HSI, and correlative approaches:
  - Quantity, location, connectivity, and timing of suitable habitat conditions related to specific life history requirements
  - Projected changes in temperature relative to identified temperature preferences or lethal thresholds for species
  - Magnitude of projected changes are averages (variability around the averages are important)
  - Changes in species competitive and predatory interactions possibly resulting from greater overlap in distribution
  - Sea level rise

# Climate change – other fish and non-fish species

- Response highly variable
- Depends on species thermal preferences (adaptations), life stage, location (reach)
- In general
  - Warm adapted species benefit from climate change and impacted by releases from multi-purpose dam
  - Cool adapted species impacted by climate change and benefit from releases from multi-purpose dam

# Climate change – PHABSIM results

| Species | Life history | Climate | Multi-purpose dam |
|---|---|---|---|
| Pac. lamprey | Spawning | - ≤ 2% | + ≤ 15% |
| | Rearing | + ≤ 3% | - ≤ 13% |
| LM and SM bass | Spawning | + ≤ 5% | - ≤ 36% |
| | Rearing | + ≤ 3% | -≤ 17% |
| Speckled dace | Spawning | + ≤ 1% | - ≤ 5% |
| | Rearing | + ≤ 1% | - 5 to + 0.6% |
| Largescale sucker | Spawning | - 2 to + 1% | - 8 to + 22% |
| | Rearing | + ≤ 2% | - 8 to + 0.4% |
| Mountain whitefish | Spawning | - ≤ 4% | + ≤ 9% |
| | Rearing | - ≤ 4% | + ≤ 22% |
| W. Toad | | + ≤ 1% | - ≤ 7% |

# Climate change – correlative analysis

- Lack information on off-channel temperatures
- Warming temperatures likely favor exotic predators; potential negative effect on native fish and non-fish species utilizing off-channel habitats
- Increases in winter flows could increase floodplain inundation
- Decreases in summer flows could decrease connectivity of off-channel habitats
- Some amphibians have specific thermal requirements
- Effects of sea level rise: uncertain

# Summary

- Limiting Factors
  - Temperature
  - Lack of Wood
  - Channel Diversity
  - Floodplain Connection
- Restoration Actions
  - Culvert Removal
  - Wood
    - Riparian protection, enhancement, and restoratin
    - Placement
  - Off Channel Connection Projects

# Summary Salmon Restoration

| | Change in Current Abundance | | | |
|---|---|---|---|---|
| | Obstruction Removal | | Riparian Enhancement | |
| | Low | High | Low | High |
| **Coho** | 4% | 11% | 15% | 34% |
| **Fall Chinook** | 0% | 3% | 7% | 14% |
| **Spring Chinook** | 0% | 0% | 83% | 97% |
| **Steelhead** | 4% | 20% | 15% | 27% |

# Preliminary Costs for Culvert Removal

| Sub Population Area | Culvert Obs. | Avg. Project Cost | | |
|---|---|---|---|---|
| | | Low = $150,000 | Medium =$210,000 | High =$290,000 |
| Above Elk Creek | 7 | $ 1,050,000 | $ 1,470,000 | $ 2,030,000 |
| Black River | 7 | $ 1,050,000 | $ 1,470,000 | $ 2,030,000 |
| Lower Chehalis Mainstem | 0 | $ - | $ - | $ - |
| Lower Chehalis Tributaries | 32 | $ 4,800,000 | $ 6,720,000 | $ 9,280,000 |
| Middle Chehalis Mainstem | 0 | $ - | $ - | $ - |
| Middle Chehalis Tributaries | 65 | $ 9,600,000 | $ 13,440,000 | $ 18,560,000 |
| Newaukum River | 23 | $ 3,450,000 | $ 4,830,000 | $ 6,670,000 |
| Satsop River | 1 | $ 150,000 | $ 210,000 | $ 290,000 |
| Scatter Creek | 2 | $ 300,000 | $ 420,000 | $ 580,000 |
| Skookumchuck River | 11 | $ 1,650,000 | $ 2,310,000 | $ 3,190,000 |
| South Fork Chehalis River | 20 | $ 3,000,000 | $ 4,200,000 | $ 5,800,000 |
| Wynoochee River | 4 | $ 600,000 | $ 840,000 | $ 1,160,000 |
| Total in EDT | 172 | $ 25,650,000 | $ 35,910,000 | $ 49,590,000 |

Notes: Totals have been rounded up to the nearest $100,000, averages per culvert have been rounded up to the nearest $10,000.

# Summary – Other Fish and Non Fish

- Salmon restoration projects would have a positive to neutral effect on most Other Fish and Non-Fish species.
- Off channel projects should be assessed on a case by case basis to determine potential effects on Other Fish and non-Fish species.

# ASEP Climate Change Summary

# Next steps – additional analyses

- EDT adjustments:
  - Incorporate WDFW mainstem habitat data
  - Incorporate tributary water temperature monitoring data
  - Floodplain inundation using HECRAS
- EDT – effect of 2007 flood on upper basin habitat
- EDT – climate change
- Shiraz – iterations
  - Stair step climate over time
  - Existing conditions – coho and steelhead

# Next steps – additional analyses

- Analyze I-5 alternatives
- Other fish – no additional analyses
- Non-fish – no additional analyses
- Address technical review comments

# Questions