

# Addressing Critical Uncertainties in the Reintroduction of Chum Salmon to Oregon Tributaries of the Columbia River

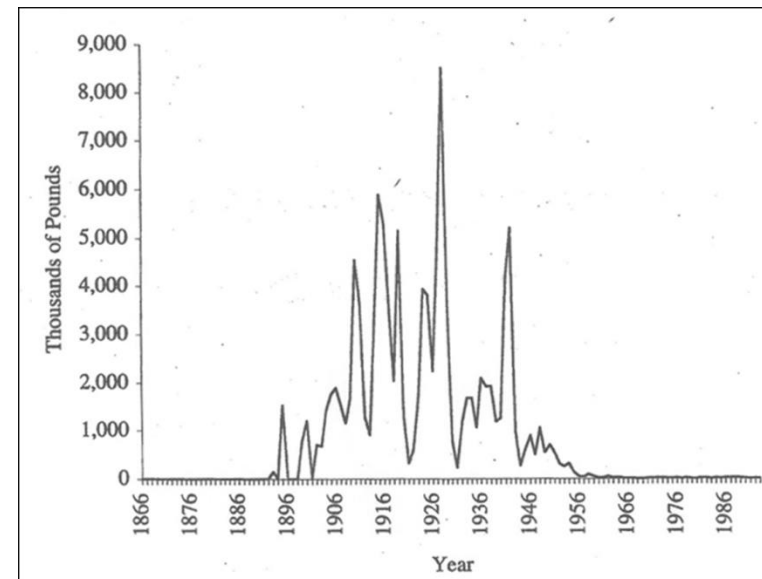
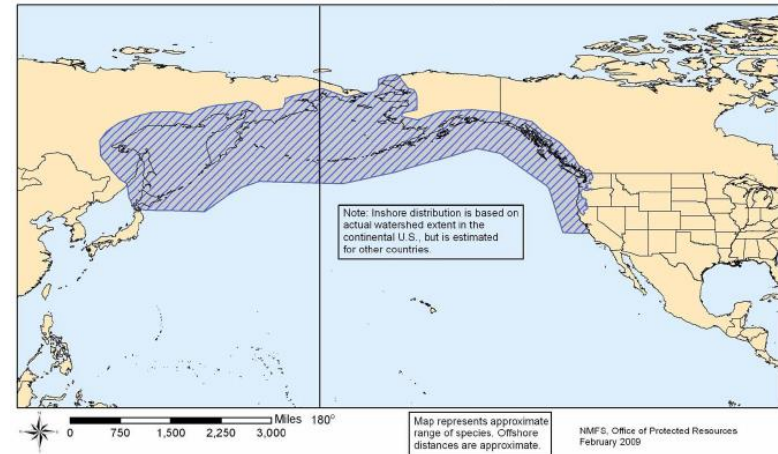


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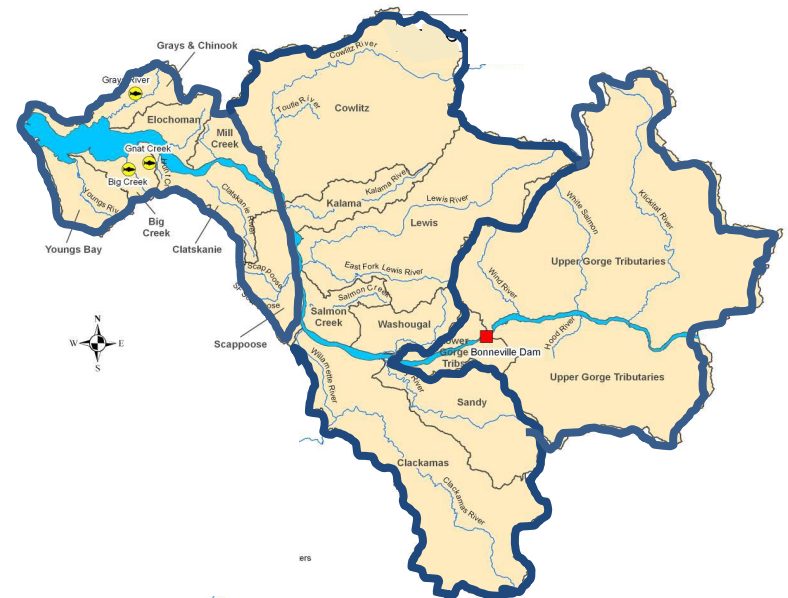
# Historic distribution and abundance

- Most broadly distributed species of salmon
  - Sacramento to Mackenzie River and Russia to Korea
- > 1 million fall-run chum salmon returned to Columbia River Basin
  - Upstream to Celilo Falls (RKM 309) and potentially Little Goose Dam (RKM 638)
  - 7-10% of total salmon returns
  - 8-15 *million* pounds of nutrients
- Precipitous decline in 1930's and 1940's



# Decline and listing

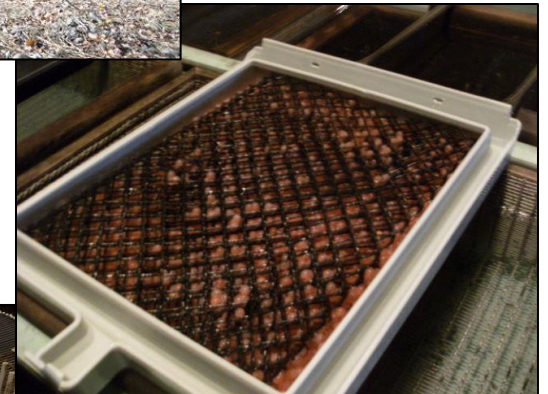
- Declines due to:
  - Loss, degradation of spawning habitat
  - Changes to estuary ecology
  - Altered hydrology
  - Predation/ harvest
- Currently, limited returns
  - 90% of 16 historic populations are extirpated
- Listed as threatened in 1999
  - 3 geographic strata for recovery goal setting





# Four-pronged recovery approach

1. Habitat restoration
  - natural recolonization
2. Spawning Channels/  
Broodstock
  - supplementation and reintroduction
3. Monitor recovery
  - adaptive management framework
4. Identify and address limiting factors



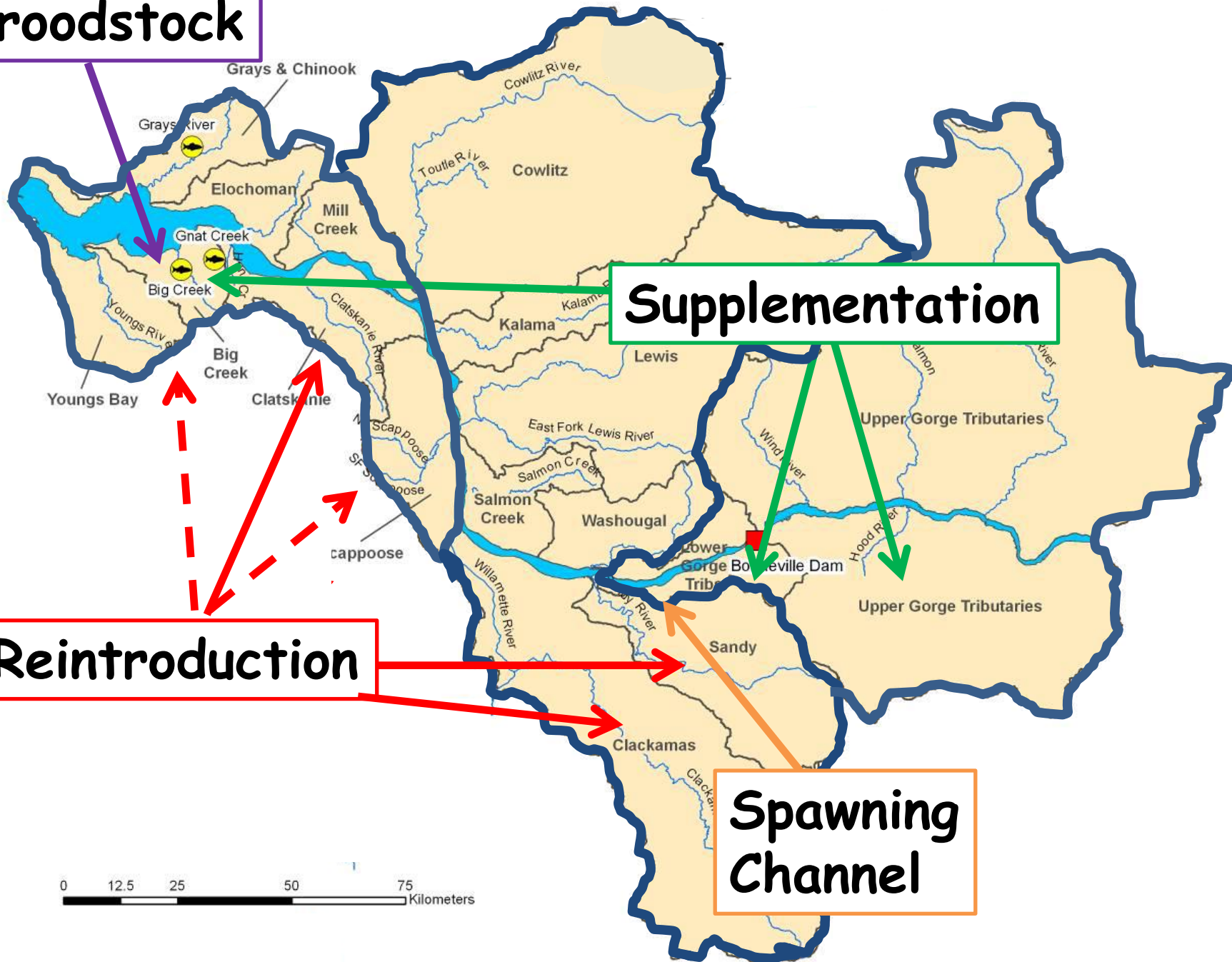
**Broodstock**

**Supplementation**

**Reintroduction**

**Spawning Channel**

0 12.5 25 50 75 Kilometers



# Critical Uncertainties

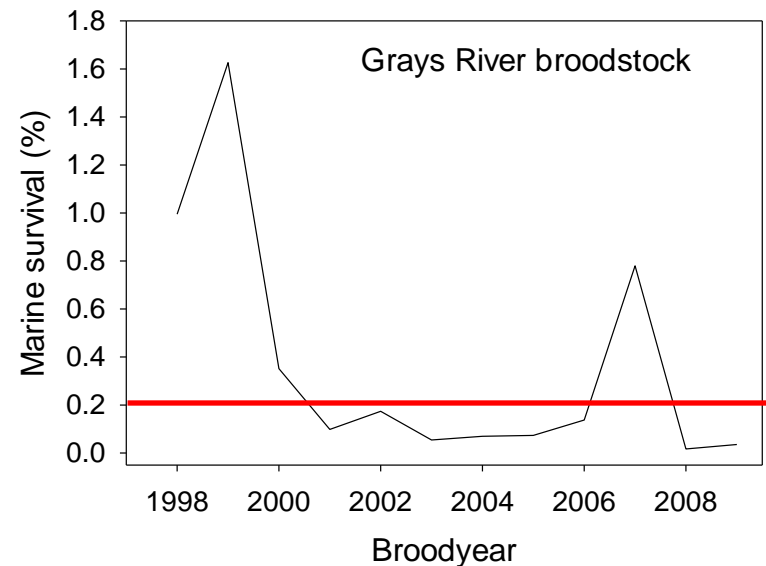
## – How do we reintroduce Chum Salmon?

- Donor populations?
- Which techniques? (life stage? Release goals and timing?)
- Where? (habitat types?, which streams?)

## – How do we know if reintroduction is successful?

- What are freshwater survival rates?
- Are they sufficient to offset poor marine survival?
- Once fish return: assess distribution, genetic and life-history diversity, abundance, etc.

### Marine Survival





# Creating a conservation broodstock

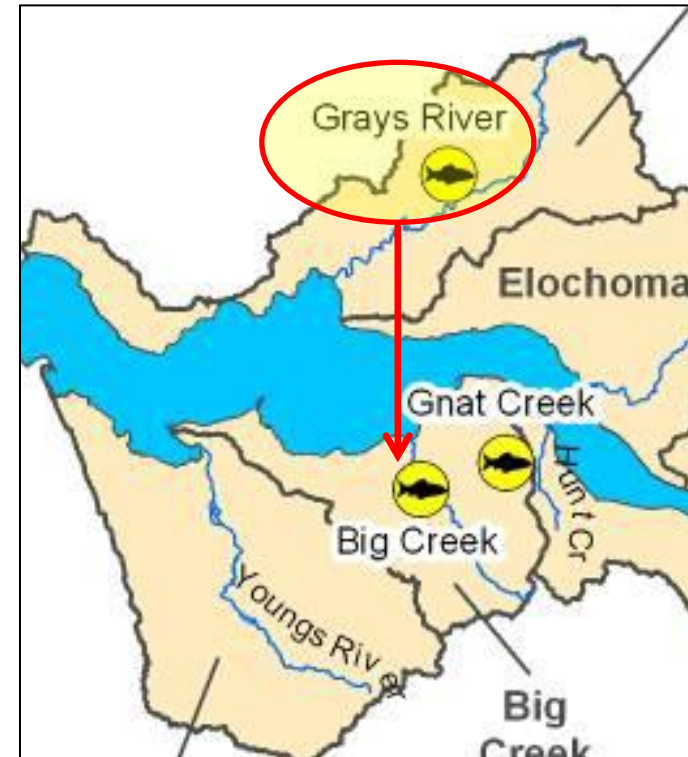
Donor population size, genetic similarity, and proximity to recipient populations

**Source:** Grays River

- Recommended by *Small et al. 2011*

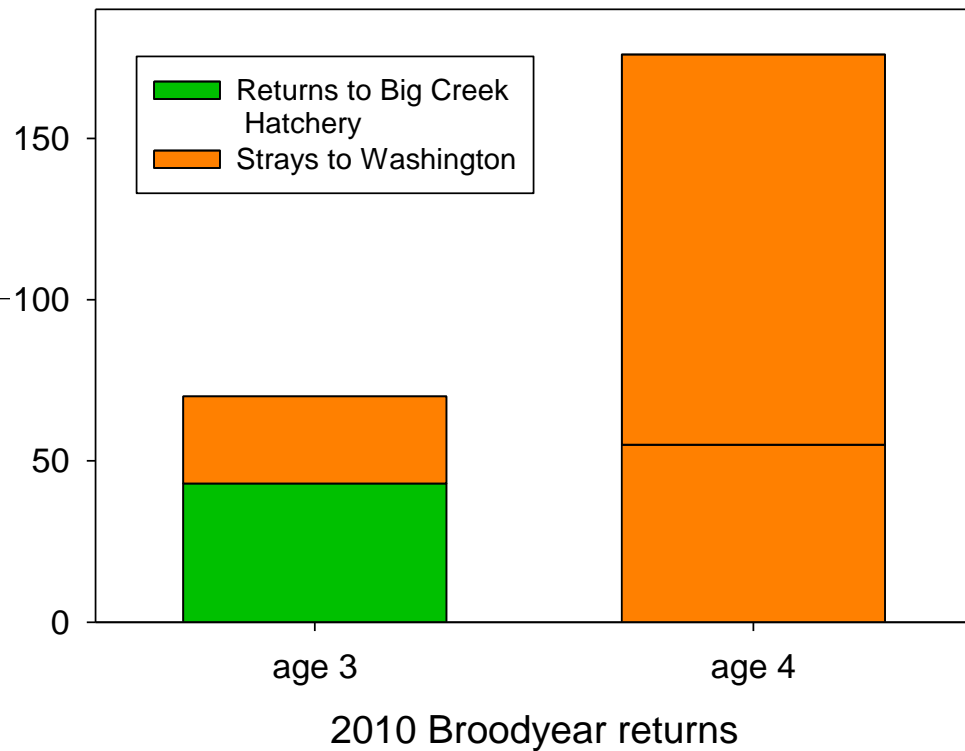
**Oregon hatchery:** Big Creek

- 5 years egg collection at Grays River (>95% wild origin)
- Annually transfer 100k eyed-eggs to Big Creek for rearing and release as fed-fry
- Transition to using Big Creek broodstock returns in 2015



# Broodstock releases and returns

| Release year | # fry   | Source                  |
|--------------|---------|-------------------------|
| 2011         | 107,000 | Grays River             |
| 2012         | 110,000 | Grays River             |
| 2013         | 108,500 | Grays River             |
| 2014         | 101,000 | Grays River             |
| 2015         | 197,000 | Grays River & Big Creek |



## – 2010 brood year

- Age-3 returns = 43; strays = 27
- Age-4 returns = 55; strays = 121
- Stray rate = **60.1%**
- Marine survival (including strays) = **0.22%**

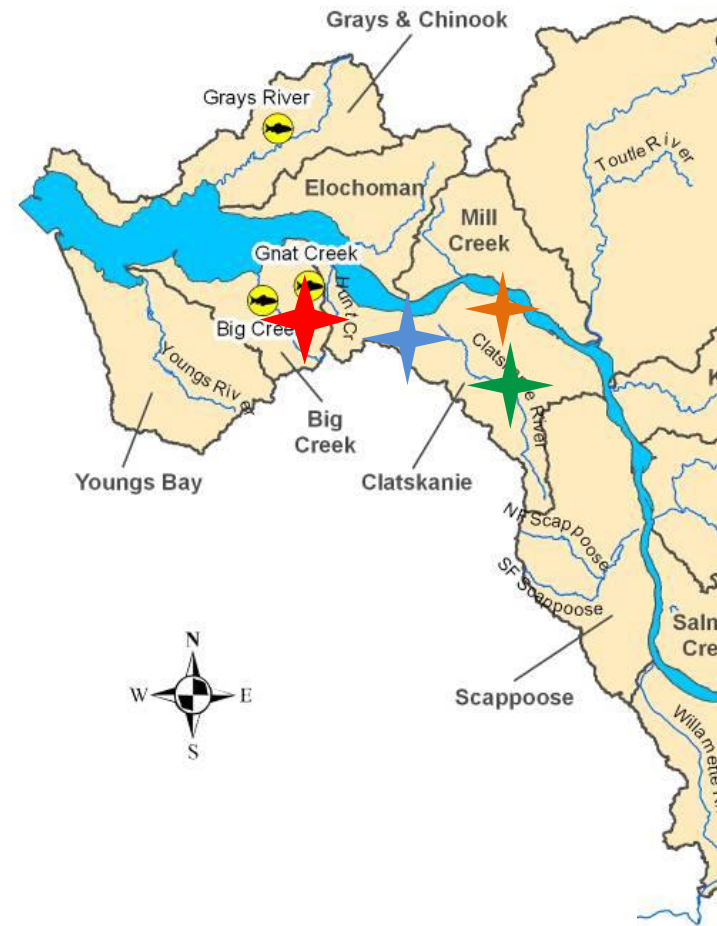
## – 2011 brood year

- Age-3 returns = 107
- Age-3 strays = 17

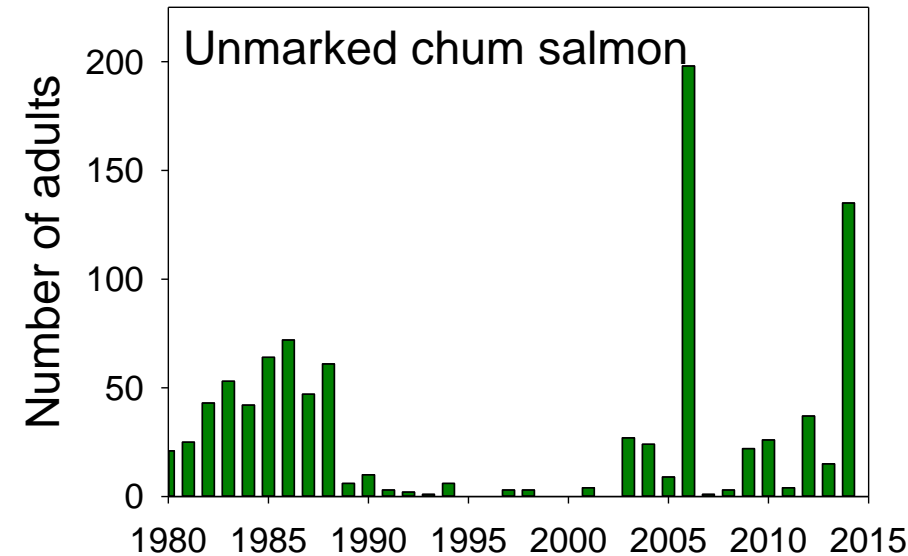


# Experimental Reintroductions

- Objectives:
  - Test different techniques
  - Evaluate success based on freshwater survival rates
- Adults in **Big Creek** released above hatchery 2012-2014
- Broodstock adult returns outplanted in **Graham Creek** (2013) and **Stewart Creek** (2013 and 2014)
- Eyed-eggs from broodstock reared in RSIs in **Perkins Creek** (2014)

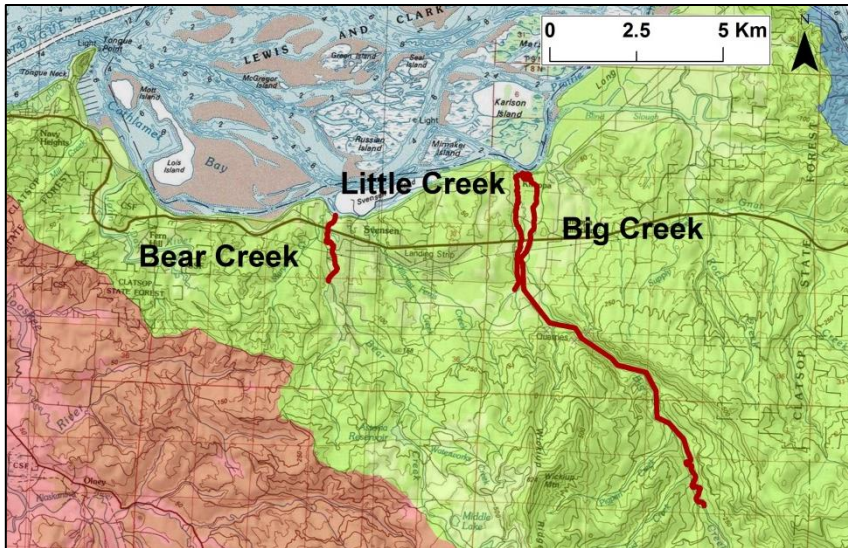


# Wild adults outplanted above Big Creek Hatchery



## Historic disposition

- Chum used to spawn in spring creek before it was diverted to hatchery
- Outplanting in:
  - Little creek
  - Bear creek
- Retained in Big Creek
  - Below hatchery
  - Transported above hatchery



# Wild adults outplanted above Big Creek Hatchery

|                            | 2012   | 2013      | 2014                 |
|----------------------------|--|-----------|----------------------|
| <b>Adults Released</b>     | 13 M, 24 F   | 11 M, 4 F | 68 M, 63 F           |
| Estimated egg deposition   | 60,000   | 10,000    | 154,232              |
| <hr/>                      |  |           |                      |
| <b>Spawn Surveys</b>       |  |           |                      |
| Live fish                  | NA   | 0         | 2                    |
| Carcasses                  | NA   | 0         | 2                    |
| Redds                      | NA   | 0         | 1                    |
| <hr/>                      |  |           |                      |
| Fry Estimate               | 38 fry captured; 0 recaps<br>Using coho fry efficiency:<br>228 | NA        | 13,264<br>(SE = 847) |
| <b>Egg-to-fry survival</b> | <b>0.38%</b>   | <b>NA</b> | <b>8.6%</b>          |



# Broodstock returns outplanted in Graham and Stewart Creeks

## Graham Creek



## Stewart Creek



# Broodstock returns outplanted in Graham and Stewart Creeks

|                                 | 2013<br>Graham               | 2013<br>Stewart     | 2014<br>Stewart      |
|---------------------------------|------------------------------|---------------------|----------------------|
| <b>Adults Released</b>          | 12 M, 10 F                   | 11 M, 10 F          | 6 M, 25 F            |
| F spawned-out carcasses         | 3                            | 6.5                 | 14                   |
| Estimated egg deposition        | 7500                         | 16,250              | 36,988               |
| <b>Spawn Surveys (2-3 / wk)</b> |                              |                     |                      |
| Live fish                       | 4                            | 4                   | 13                   |
| Carcasses                       | 8                            | 12                  | 21                   |
| Redds                           | 4                            | 5                   | 12                   |
|                                 | NA                           |                     |                      |
| Fry Estimate                    | 15 captured,<br>0 recaptured | 4,336<br>(SE = 424) | 10,285<br>(SE = 591) |
| <b>Egg-to-fry survival</b>      | <b>NA</b>                    | <b>26.70%</b>       | <b>27.80%</b>        |



# Eyed-eggs in Perkins Creek

- 20 pair spawned using 2x2 factorial cross
- Collected 47,958 eggs at Big Creek Hatchery
  - 10.5% egg loss, no extra females
- Outplanted 42,911 eyed-eggs on 12 Jan, 2015
- Eyed-egg-to-fry survival in RSIs is **94%**





# Is freshwater survival sufficient?

| Location                           | Year       | Freshwater Survival | Marine Survival Rate needed for R/S >1 |
|------------------------------------|------------|---------------------|--|
| Big Creek                          | 2013       | < 1%                | 8%                                     |
|                                    | 2015       | 8.6%                | > 1%                                   |
| Grays River (WA)                   | 01-09 avg  | 7.95%*              | >1%                                    |
| Stewart Creek                      | 2014       | 26.7%               | > 0.3%                                 |
|                                    | 2015       | 27.8%               | > 0.3%                                 |
| Crazy Johnson (WA)                 | 2013       | 40.4%               | 0.2%                                   |
|                                    | 2014       | 39%                 | 0.2%                                   |
| Duncan Creek Spawning Channel (WA) | 7 year avg | 54%                 | 0.14%                                  |
| Big Creek Hatchery                 | 2014       | 89.5%               | < 0.1%                                 |
| RSI                                | 2014       | 83.5%               | < 0.1%                                 |

\*BY R/S for wild fish / MS for hatchery fish

# Is freshwater survival sufficient?

|                                    |            |                     |        |
|------------------------------------|------------|---------------------|--------|
|                                    |            | Freshwater survival |        |
| Low                                |            | < 1%                |        |
| Big                                |            | 8.6%                |        |
|                                    |            |                     |        |
| Gr                                 |            | 95%                 |        |
| S                                  |            | 6.7%                |        |
|                                    |            | 7.8%                |        |
| Cr                                 |            | 0.4%                |        |
|                                    | 2014       | 39%                 |        |
| Duncan Creek Spawning Channel (WA) | 7 year avg | 54%                 | 0.14%  |
| Big Creek Hatchery                 | 2014       | 89.5%               | < 0.1% |
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# Take home

1. Conservation broodstock now self-sustaining and returns large enough to increase outplanting
2. Experimental reintroductions have demonstrated:
  - Multiple techniques feasible
  - Only eyed-egg reintroduction has high enough survival rates to offset low marine survival
3. Both spawning habitat availability/quality and marine survival limit chum recovery
  - Maintain and increase population artificially with high survival techniques (short term), further research marine survival limitations (mid term), and implement watershed-scale habitat restoration near population centers (long term)



# Acknowledgements

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