Spatial patterns of Yakima River Spring Chinook spawning before and after supplementation.

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Abstract

In the Columbia River basin a number of hatchery supplementation programs have been developed to bolster wild salmon populations. One goal of these programs is to expand populations into habitat that is underutilized without negatively impacting established wild salmon. In particular, many programs utilize satellite acclimation/imprinting facilities to reestablish natural spawning in historically productive stream reaches. To examine the effectiveness of one such program, we studied the spatial distribution of spawning spring Chinook salmon released from the Yakima-Klickitat Fishery Project (YKFP) supplementation program into the upper Yakima River . Specifically, we mapped and compared the spatial patterns of spawning before and after initiation of the YKFP program. In addition, we compared these patterns to spawning patterns over the same time period in a similar unsupplemented spring Chinook population (Naches River, WA). The density of spawners in the upper Yakima River increased and their distribution changed after initiation of supplementation. However, the distribution of redds also changed in the unsupplemented control population during this time period suggesting that the spatial changes we observed may also partly reflect natural shifts in spawning distribution. One area specifically targeted for supplementation, the Teanaway River, demonstrated dramatic increases in the number of salmon spawning over pre-supplementation periods.

Study Site and Methods

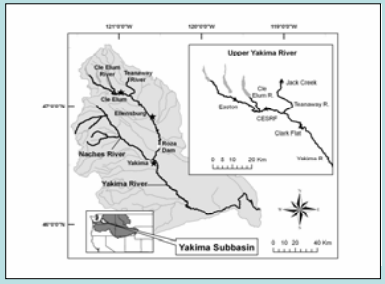


Fig 1. Location of YKFP supplementation hatchery (CESRF) and acclimation/release sites in the Yakima River basin.

YKFP Program and Redd Survey Methods.

• The YKFP supplementation program was initiated in 1997 and adults from this program first spawned in the wild in 2001. Broodstock were collected from the wild population and spawned artificially. Embryos and emergent fry were reared at the central CESRF hatchery for 16 months, coded-wire tagged and then transferred to one of three acclimation/imprinting facilities (Easton, Jack Creek, Clark Flat) for final rearing and release.

•Since 1981, YKFP biologists have conducted comprehensive weekly redd surveys of the upper Yakima and Naches River basins for spring Chinook salmon redds. Redds were marked with flags and dated (Fig. 2). GPS was used to georeference location of the redd markers to a geodatabase for analysis (1-3 m accuracy) (Fig.3).

Fig 2.

Fig 3.

Supplementation increased the number and changed the distribution of upper Yakima River spawners

Fig 4. Spawning distribution of Upper Yakima Spring Chinook. Representative data showing redd locations in a section of the upper Yakima River for 2002-2006. Data illustrates that spawning typically occurs in the same locations each year independent of run size and also shows that many areas consistently have no redds.

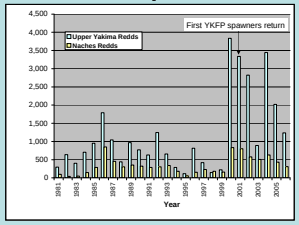


Fig 5. Redd survey totals for the upper Yakima R. and Naches R. (1981 to 2006). The number of spawners increased for both populations during the post-supplementa-tion period (2001-2006) but the average number of redds increased 247% in the upper Yakima vs. 201% for the unsupple-mented Naches River. These results suggest that supplementation increased the number of spawners in the upper Yakima beyond the natural increases associated with improved ocean survival.

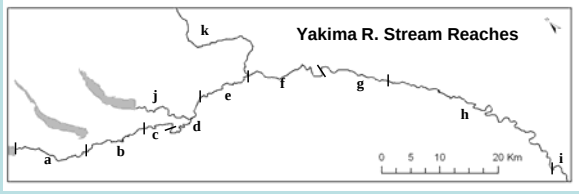


Fig 6. The upper Yakima River was divided into 11 stream reaches (a-k) and surveyed for spring Chinook redds (1981-2006).

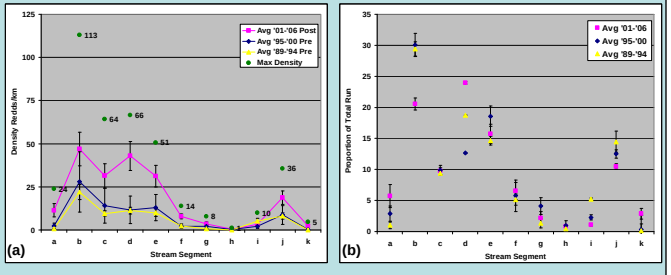


Fig 7. (a) Mean redd densities (± S.E.) and b) Mean proportion of total run (± S.E.) within each reach for six year periods before (1989-1994;1995-2000) and after (2001-2006) supplementation. Redd densities and proportional distribution of spawners varied little between the presupplementation periods but changed significantly after supplementation began. **Fig 7a.** Redd densities increased in almost all reaches after implementation of the YKFP program but the greatest increase occurred in reach (d) where the central CESRF hatchery is located. Based on the maximum densities observed for each reach over the study period (green points), spatial distribution of spawning does not appear to reflect saturation of available habitat within a reach. **Fig 7b.** The distribution of spawners also changed after supplementation was initiated. The greatest changes occurred in reach b (decrease from 29.7 to 20.5 % of the run) and d (increase from from 15.7 to 23.9 % of the run).

Control population numbers and distribution also changed during the post-supplementation period

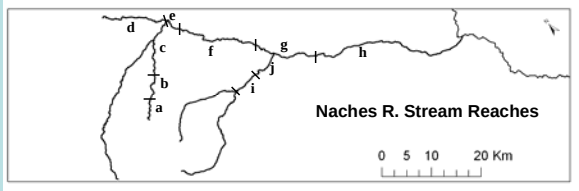


Fig 8a. The Naches River was divided into 10 stream reaches (a-j) and surveyed for spring Chinook redds (1993-2006). The Naches River population is geographically and demographically similar to the upper Yakima River population and was used as an unsupplemented control.

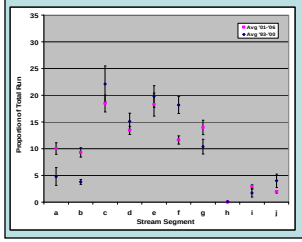
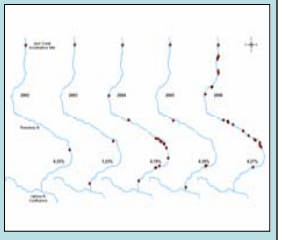


Fig 8b. Mean proportion of total run (± S.E.) within each reach during the periods before (1993-2000) and after (2001-2006) supplementation. The distribution of spawners changed during the period of supplementation but the shifts in distributions were less profound and distinct from those in the upper Yakima River suggesting that spatial shifts are due to a combination of natural variability and supplementation.

Supplementation increased spawners in a targeted tributary

Fig 9. Spatial distribution and percent-age of non-hatchery spawners in the Teanaway River after supplementation. In 2006, the first year offspring of naturally spawning supplementation returned, the percentage of "natural origin" spawners increased from 0.25-1.23 % to 4.27%.These data and an increase in the number of redds from 3.0 (± 1.82) to 69.0 (± 22.1) since the initiation of juvenile releases from the Jack Creek acclimation site suggest that supplementation fish spawned successfully in the wild.



Conclusions

• The number of spawners increased in both populations during the post-supplementation period but increases were greater in the supplemented population suggesting that YKFP program has increased the spawning population.

•The distribution of spawners changed after supplementation was initiated. The greatest changes occurred in the reach where the central CESRF hatchery is located suggesting that supplementation fish may be imprinting to this site.

• The distribution of spawners also changed in the unsupplemented control population but the patterns of change were different, reflecting a shift to more upstream spawning locations.

• The number of redds and natural origin spawners has increased in the targeted Teanaway River indicating this approach may be successful for reintroduction of salmonids into underutilized habitat.

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