State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

2001-2002 ANNUAL REPORT
TRINITY RIVER STEELHEAD RESIDUALISM REPORT
PROJECT 2b2

Prepared by

Patrick Garrison
Northern California - North Coast Region

Steelhead Research and Monitoring Program
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ABSTRACT

This report presents the preliminary results and progress of a two-phase, five year study to determine if, or to what extent, Trinity River Hatchery steelhead are residualizing in the upper main-stem reaches of the river. Phase 1 has been postponed due to conflicts and problems with the electrofishing boat. Phase 2, a joint venture with NMFS Santa Cruz laboratory, consists of micronutrient analysis of otoliths along with life-history analysis of the corresponding scales from returning hatchery fish. Micronutrient analysis, specifically the ratio of strontium to calcium in the otolith, along with corresponding scales, will set-up baseline levels to determine if and to what extent returning hatchery fish and their maternal lineage are residualizing in the upper river and forgoing their journey to the ocean. I hypothesize that micronutrient analysis of otoliths coupled with a more intensive sampling regime, will reveal if Trinity River hatchery steelhead are residualizing in the upper river.

INTRODUCTION

Trinity River Hatchery (TRH), a mitigation facility, was completed in 1964 as fulfillment of federal license requirements. The California Department of Fish and Game (CDFG) operates TRH with funding from the Bureau of Reclamation. Three species of anadromous salmonids are spawned and reared at TRH. These include fall Chinook or king salmon (*Oncorhynchus tschawytscha*), coho or silver salmon (*O. kisutch*), and fall run steelhead (*O. mykiss*).

[1/] *Steelhead Research and Monitoring Program report, available from: Department of Fish and Game, 50 Ericson Court, Arcata California 95521 (707) 825-4850*

Steelhead trout display a highly variable life-history; juveniles can rear in freshwater for one, two or three years before smoltification, or forgo smoltification altogether and select a resident trout life-history. The progeny of those resident fish can then display any one of the previous life-histories mentioned, possibly reasserting their anadromous status. This natural variability of the steelhead's life-history creates a buffer for a wide variety of problems: weak year classes, poor ocean conditions, catastrophic events, or severe drought conditions. A large steelhead hatchery program, such as that of TRH which releases 600,000-800,000 steelhead smolts annually, adds another component to the mix. Do these hatchery fish display the same life-history variability as their wild counterparts, or are these hatchery fish residualizing or migrating to the ocean in a ratio disproportionate to that of wild fish?

METHODS

Electrofishing Survey of Upper Trinity

Phase 1 of this study proposed to qualitatively electrofish the upper ten miles of the Trinity River below Lewiston by electrofishing boat or raft. Five launches have been selected in the upper river, just upstream of their perspective sections. Catches of steelhead of hatchery and wild origin will be compared using a CPUE model to determine if a significant ratio of hatchery fish are displaying a resident life-history or delaying their downstream migration.

Hatchery Sampling

The Trinity River Hatchery spawns steelhead every Tuesday from January 1 through March 31 of every year. Trinity River Project personnel conduct recovery of incoming steelhead; carefully examining each fish for marks (i.e. spaghetti tags), taking length and determining gender. One to two additional SRAMP personnel are present to take tissue samples of the upper caudal fin and scales from every 10^{th} fish and all residual appearing fish. Residual appearing fish are not spawned with adult steelhead and are thrown back into the river. Additionally, all fish entering the hatchery are given an upper caudal clip to mark their first visit. Steelhead heads containing otoliths are taken from mortalities at the end of the day along with corresponding scales. A more detailed hatchery sampling plan, similar to the one used at Iron Gate Hatchery, is currently being prepared.

Otoliths and scales are currently being analyzed by Chris Donahoe of the National Marine Fisheries Service in Santa Cruz. Future otoliths and scales will be prepared at the Department office in Yreka and analyzed for microchemistry at Oregon State University.

RESULTS

Hatchery Recovery

2,375 steelhead entered TRH during the 2001-02 season. Fish began entering the hatchery ladder sporadically in mid-September (Julian Week 37) and continue to enter sporadically throughout the fall-Chinook spawning run through Christmas. These steelhead are thrown back into the river or held-over at the hatchery until January 1, when steelhead spawning begins at the hatchery (Carrington, personal communication 2002). Migration into the TRH peaked during the third week of January, with a secondary peak in late-February.

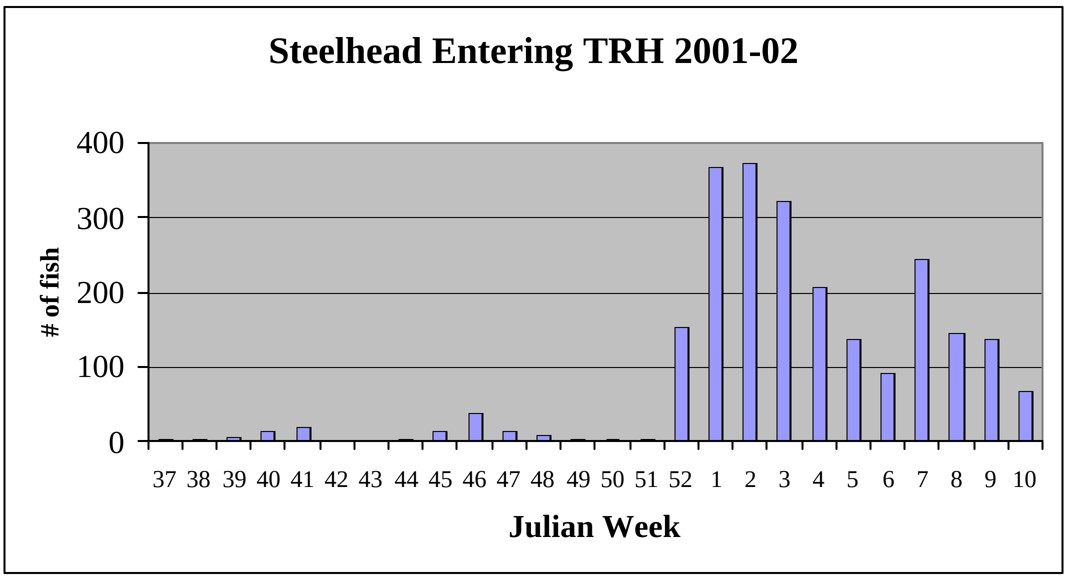

Figure 1. Hatchery intake of steelhead at Trinity River Hatchery (TRH) during 2001/2002 season.

Length Frequency

The mean length of steelhead entering the TRH for the 2001-02 season was 62.5 cm (S.E. =0.162). Length ranged from 21-87 cm. Only 66 fish measured less than 41 cm (16 inches).

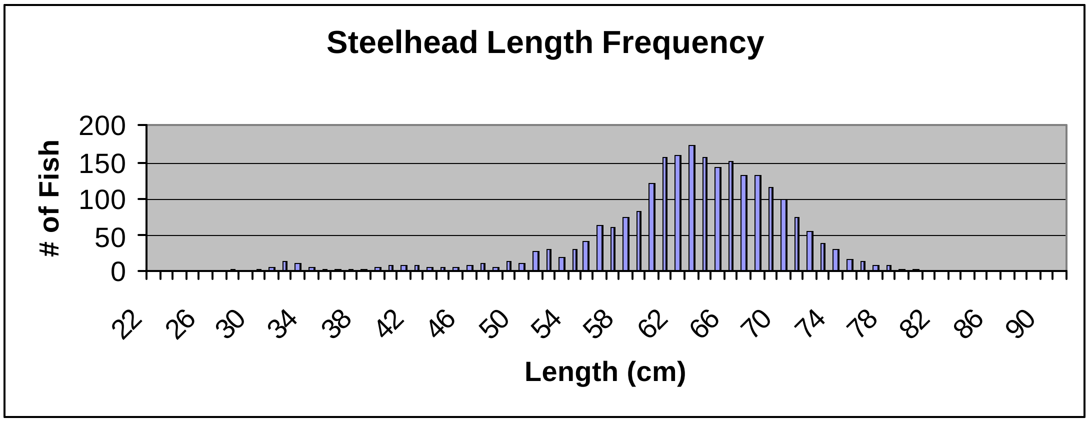

Figure 2. Length-frequency histogram of steelhead entering TRH during 2001-2002 season.

Samples of otoliths and scales were collected from mortalities that entered TRH from January through February 2001. These samples were taken from thirty adult and thirty juvenile steelhead. Samples were dissected and prepared under the direction of Chris Donahoe, National Marine Fisheries Service, Santa Cruz. An additional 12 heads/otoliths with corresponding scales are currently being preserved in the Department freezer if needed or to be prepared in Yreka for analysis at Oregon State University.

DISCUSSION

SRAMP believes that otolith micronutrient analysis will eventually produce the substantial evidence needed to identify if hatchery fish are indeed residualizing in the upper Trinity River. Otolith micronutrient analysis, specifically looking at strontium and calcium isotopes, is the most current technology available to determine saltwater residency of anadromous fish. Ratios of strontium to calcium can now be used to determine anadromous life-history and life-history of the maternal parent.

There are several potential problems inherent to the sampling methodology that could possibly bias or error in examination of hatchery residualism. The greatest source of potential error could be the sole use of mortalities for otolith sampling. Almost all mortalities consist of larger adult fish, when I suspect that returning residual fish would tend towards the smaller sizes. In addition, a majority of the mortalities are from the earlier returning part of the run, while residual fish would most likely return later in the season, closer to when most resident trout spawn. Finally, I would hypothesize that residual fish are less likely to die at the hatchery; they have not had the same drain on their energy stores as their anadromous counterparts, and should be in a healthier post-spawn condition.

Another potential source of bias is the use of the hatchery as a sampling site for residual fish. Intuitively, fish that have already displayed a residual or resident life-history may be less likely to enter a hatchery to spawn when sexually mature; therefore, most samples collected from the hatchery could be skewed towards displaying an anadromous life-history.

Length-frequency analysis of incoming hatchery steelhead in 2001 showed a definite lack of small (<41cm fish) steelhead. Specifically, only 66 of 2376 fish were less than 41 cm. If most residual fish are smaller than their anadromous counterparts, then very few residual fish would be entering TRH.

Hatchery personnel currently identify smaller, heavily spotted, returning steelhead as "residual" or "riverine" fish. These fish are sorted separately, and not spawned with adult steelhead. Sampling for these "riverine" fish should be more intensive, and collections of otoliths from these fish could provide necessary information to solving the residualism question.

Field sampling to examine ratios of hatchery vs. native fish could prove a useful tool to determine if released hatchery fish are delaying their downstream migration and instead are rearing in the upper Trinity River. If hatchery steelhead are postponing their downstream migration, it is questionable if they are permanently occupying the upper river or are just delaying their migration by several months. Migrational studies of downstream steelhead migration on the upper Trinity by the Department found peaks in steelhead out-migration in April, May and early November (Healey, 1970). Subsequent studies in 1974 found that substantial numbers of marked steelhead did not migrate downstream during the May-June trapping period (Haley, 1974). Captured hatchery-reared fish that are presumed to be displaying a residual life-history could possibly be awaiting out-migration in November. This temporary postponement of migration could possibly be displacing wild rearing fish, degrading the wild gene pool, or leading to an unbalance of the proportion of fish with residual life-histories. A comprehensive sampling program of the upper river with use of an electrofishing boat and mark-recapture methodology throughout the season could possibly show if non-migrating hatchery fish are residualizing or just delaying migration for a season. Additional complications could result during winter sampling due to high flows, cold weather, and an inadequate sample size.

Several potential problems exist when using a electrofishing craft on the upper river to capture and quantify juvenile steelhead. Catch rates, capture probabilities and probability of recapture are all low; complicating any mark-recapture model, because of a small sample size and unlikelihood of recapture. Any pseudo-quantitative methodology would most likely involve comparisons of CPUE between hatchery vs. wild juvenile steelhead.

RECOMMENDATIONS

I have several recommendations that may improve sample design, which should subsequently further the understanding of hatchery steelhead life-history, specifically at Trinity River Hatchery.

All future otoliths collected by the Department will be prepared at SRAMP Yreka, and analyzed for microchemistry at Oregon State University. The Department should continue to share and compare otolith and scale information with Chris Donahoe and the NMFS Santa Cruz laboratory.

Sampling of hatchery fish for otoliths and scales should be completed throughout the hatchery season. Also, sampling protocols should be made homologous between Iron Gate Hatchery and TRH sampling teams. A sampling methodology is currently being developed and refined by Bill Chesney of SRAMP Yreka, for use at both IGH and TRH.

Phase 1 (electrofishing of the upper river) needs to be reimplemented on the upper Trinity with use of Yreka's electrified cataraft. Preliminary sampling should show if ratios of hatchery to wild fish are substantially different and if and when additional sampling need occur. Additional river sampling by electrofishing could also be used to collect otoliths and scales from larger in-river trout/steelhead.

A sampling protocol should be initiated to collect otoliths and scales from adult sized hatchery propagated steelhead in the upper river. Sampling for these fish should occur in late summer, when adult anadromous steelhead presence is at its minimum. Also, several residual appearing fish should be sacrificed at TRH for otolith/scale analysis. Current hatchery policy prohibits sacrificing incoming fish that would otherwise live, therefore precluding sampling of presumed residual fish.

Finally, genetic samples should be taken and analyzed along with otolith and scale samples to examine the relationship between different allele frequencies, their corresponding otoliths and scales, and the individual fish's displayed juvenile life-history. We must keep in mind that questions which can be addressed with otolith chemistry are not necessarily answerable with genetic studies, suggesting that genetic and otolith studies complement rather than compete with each other (Campana and Thorrold, 2001).

ACKNOWLEDGEMENTS

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