EFFECTS OF CODED-WIRE TAGGING ON THE SURVIVAL OF SPRING CHINOOK SALMON

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ABSTRACT

The second study year encompassed similar activities to the first, with some modification. In terms of otolith marking, all spring chinook at each facility were marked by a series of scheduled incubation water depressions. Modifications to our work plan included a somewhat later initiation of otolith marking, a shortening of cold water exposure duration for Cowlitz fish at the alevin stage, and the use of on-station personnel for conducting actual water manipulations for otolith marking. Protocols for efficient computerized collection of otolith band data were established and exploratory data collections initiated. Most of this was aimed at documentation of variability in the induced otolith pattern as a result of measurement technique and inherent biological variation in growth rates of individual otoliths. When fish had reached their appropriate size, Coded-Wire Tags were applied in specific proportions to untagged fish at each hatchery, and all untagged fish were electronically counted. Separate tag codes were applied to groups representing various rearing or release strategies at each hatchery.

INTRODUCTION

The Coded-Wire Tag (CWT) identification system (Bergman et al. 1968) has become a major management and research tool for salmonid fishery agencies on the west coast of North America since its initial use in the mid-1960s. In 1986, over 50 Pacific salmon agencies collectively tagged and released 42 million fish (Johnson, 1987). However, since its initial use, there has been relatively little work done on the combined effects of handling, CWT implantation, and adipose marking.

While some researchers suggest that the effects of Coded-Wire Tagging are minimal (Thrower and Smoker, 1984; Elrod and Schneider, 1986), other studies indicate some detrimental effects. Bergman (1968) showed a 4% difference between survival of tagged-only coho salmon (Oncorhynchur kisutch) and control fish after eight months of rearing, and an 8.5% reduced survival due to tagging and removal of adipose and pectoral fins. Furthermore, Blankenship and Hanratty (1990) showed that trapping and handling of coho salmon smolts resulted in a 16% reduction in survival. Morrison and Zajac (1987) have also documented mainstem olfactory nerve damage from improperly placed wire tags. In view of their widespread importance to Columbia Basin salmonid management, the Hatchery Effectiveness Technical Working Group of the Northwest Power Planning Council identified the effects of CWT implantation as its fifth most important item needing investigation.

Ideally, to examine the total effects of the CWT and adipose mark, one must look at the differences in adult survival between tagged fish and controls. The main problem impeding such a study is the ability to identify the controls or “unmarked” population.

Alternative methods of marking the controls impose their own stress which would certainly confuse the results of such a study. A solution to this problem lies in the recent discovery that specific banding patterns can be induced into fish otoliths through simple environmental manipulations of temperature, feeding periodicity, and photoperiod. Although earlier laboratory studies have induced otolith marks as a means to validate increment periodicity, recent investigations have shown that specific and unique patterns may be easily induced simultaneously into the otoliths of large hatchery populations of salmonids using similar techniques (Brothers, 1985; Volk et al., 1987; Volk et al.,1990).

In approaching this problem, three hatcheries in Oregon and Washington have been selected as test sites and are described below along with their recent production and adult returns:

Carson Hatchery is operated by the U. S. Fish & Wildlife Service and is located on the Wind River near the town of Carson, Washington. The hatchery is 171 river miles from the mouth of the Columbia River and above one major hydroelectric dam. Spring water is used for incubation and is approximately 43°F. Spring chinook are reared in raceways and one dirt pond measuring 18,000 cubic feet. The hatchery's production of 1.9 million smolts is all released as yearlings. Approximately 4,000 to 6,000 adults return to the hatchery each year.

South Santiam Hatchery is operated by the Oregon Department of Fish & Wildlife and is located on the North Fork of the Santiam River which is a tributary to the Willamette near the town of Foster, Oregon. The hatchery is 242 river miles from the mouth of the Columbia River. Water from Foster dam reservoir is used for incubation. About one-third of the spring chinook are released in the fall

with two-thirds released as yearlings in the spring. The hatchery releases approximately 1 million spring chinook and 4,000 to 5,000 adults are trapped each year.

Cowlitz Hatchery is operated by the Washington Department of Fisheries and is located on the Cowlitz River, a tributary of the Columbia River near the town of Salkum, Washington. The hatchery is 120 river miles from the mouth of the Columbia River. Well water is used for incubation and fish are released as yearlings and as zero-age smolts in June. The hatchery releases approximately 3.1 million smolts, with 2,500,000 fish released in June and 600,000 as yearlings. Approximately 8,000-14,000 adults are trapped each year.

At each facility, we will mark the entire production of spring chinook with otolith marks and 33% with Coded-Wire Tags. The otolith marks will serve as a means to identify control fish so that straying of non-facility fish into the hatchery can be accounted for. Coded-Wire Tag groups will be employed for each of three brood years at each hatchery to determine the variance associated with random sampling error. Tag loss prior to release will be determined and all fish released will be individually counted

The goal of this study is to test the hypothesis . . ι juvenile spring chinook which have been handled, anesthetized, adipose fin-clipped, and Coded-Wire Tagged do not return as adults to hatcheries in lower proportions than adults from juveniles released which were not Coded-Wire Tagged.

Adult returns to the hatcheries from the three tagged brood years will be censused for Coded-Wire Tags and otolith marks in order to determine survival rates of Coded-Wire

Tagged and control (otolith marked) fish. Analysis of proportions with a normal approximation to the binomial distribution will be used to develop confidence limits on the proportion of tagged fish in the population. If a significant difference is noted between proportions of tagged and untagged fish (P<O.O5), then the null hypothesis will be rejected. If the null hypothesis is rejected, we will determine precisely the difference in survival rates between the Coded-Wire Tagged groups and the untagged groups. Our sample sizes will be sufficient to detect a relative difference of 7-10% depending upon rates of hatchery rack returns for each hatchery and brood year.

OTOLITH MARKING

In the second year of this study egg takes began in early August at Carson Hatchery, late August at Cowlitz Hatchery and September at South Santiam Hatchery. Development times for embryos at Cowlitz and Carson hatcheries change little from year to year due to rather constant incubation water temperatures at both locations. As a result, it is relatively easy to plan schedules well into the future. In contrast, the water temperatures at Willamette, where South Santiam fish were otolith marked, fluctuate broadly resulting in variable egg development rates from year to year. Thus, marking schedules required somewhat more monitoring on a short-term basis at this facility.

In mid-September, we began the otolith marking procedure on the embryos at Carson Hatchery. Embryonic development was followed until the first signs of otolith calcification were evident after approximately 500 fahrenheit temperature units had accumulated. Our experience from last year suggested that otolith marking procedures were initiated somewhat earlier than necessary and due to the variability in development rates and the timing of otolith formation in these embryos, some fish did not receive the first induced otolith band.

Furthermore, because of the way that otoliths were prepared, it was often difficult or labor intensive to make clear the very first band. As a result, during this year's marking procedure, we delayed the initiation of otolith marking to approximately 650-700 accumulated temperature units.

We induced marks onto any given lot of embryos by exposing them to cold water for a period of four to eight hours. Each of these temperature drops produced an obvious, optically dense band in their otoliths. The shifts between relatively warm and relatively cold water sources occurred instantaneously by simply turning one source off and the other on. The cold water exposures continued throughout embryonic development on a pre-determined schedule until several days before hatching, producing a regularly repeating band pattern within the otolith. At this point, marking was interrupted until the embryos had hatched. Shortly thereafter, marking episodes resumed on alevins until that particular egg take group was ready for ponding. Cold water exposure periods for aleveins were 24 hours long at the Carson and Willamette facilities, however, cold water exposure times for Cowlitz alevins were shortened to twelve hours. In contrast to last year, we attempted to place a very similar band pattern on all fish at each hatchery, rather than to distinguish each egg take with a unique pattern.

At the time of ponding for each egg take group at each facility, samples of marked fish were preserved in 95% ethanol for future analysis of otolith patterns. Samples were taken from each group which received marks at the same time as well as from different compartments or stacks within these groups to be sure that all fish were effectively marked regardless of their location in the incubation unit. Otoliths from all of these samples were dissected, mounted and prepared according to the standard methodology developed at WDF. Initial examination of specimens from each hatchery suggested that otolith marking was again

successful.

ANALYSIS OF SPECIMENS

A prerequisite to characterizing the mark patterns of juvenile fishes was to install and become aquainted with our new computerized image analysis system. This is a key component to the characterization of juvenile patterns and later recovery of otolith marks in adults. As we reported to you last year, we have invested significant time into learning the use of this software and hardware. While we continue to make improvements in our data collection capabilities, we have developed a process whereby patterns can be efficiently scored according to a standardized procedure using the image analysis equipment.

During the past year, in addition to establishing the protocols for computerized data collection we have also been evaluating the inherent variability in our pattern measurements through repeat measures of the same specimen and through measurements of the same pattern from a number of individuals in the same treatment. We are comparing the difference between right and left elements as well. Furthermore, we have begun the process of having other technicians score the same elements as the main investigator, so that they can become aquainted with the process.

There was one major change in the way that otolith marking was achieved this year, in that temporary fish culturists were employed as on-site marking personnel. As we outlined in a previous report, this situation saved dollars for the project since travel expenses for Olympia based personnel to travel these distances were exhorbitant. This situation has worked well for us and we hope to employ the same people for out last marking episode to maintain continuity.

Application of CWT'S and Enumeration of Controls

During the second year of the "CWT Effects Study" the application of CWT's and enumeration of controls was accomplished at each of the three hatcheries involved. A total of 1905,778 spring chinook were Coded-Wire Tagged and 3,810,240 controls were counted. In addition 319,997 spring chinook were tagged at Carson Hatchery for a BKD study, also funded by BPA.

Similar tagging, and enumeration procedures were employed at each hatchery. Standard WDF tagging procedures were employed as recommended by PMFC (1983). Prior to tagging, fish were crowded in a raceway, netted, and poured into a five-gallon bucket. Each bucket carried a standardized amount of water and fish by volume so that each bucket contained approximately the same amount of fish numerically. Tagged to untagged ratio was 1:2 so every third bucket went to the tagging trailer and the other two went to an electronic counter.

Fish that appeared to be too small for tagging (generally less than 55mm fork length), deformed, or injured were sorted and eliminated from the study. Counts were taken from both the tagging trailer and the counting trough to assure that both groups were sorting and destroying similar numbers of fish (less than 1%).

Although it appeared that the fish heing enumerated by physical count during the first year's tagging were not being stressed beyond levels which they would experience during a normal "pond split", at the start of the project an electronic counter was thought to be the best method of counting. However, an electronic counter which fit the parameters of the project design and had an accuracy rate

equivalent or better than physical counts (less than 1% error) could not be found. Half-way into the first tagging season (1990) however, a new electronic counter entered the market which appeared suitable. The counter was tested at Carson Hatchery and proved to be very satisfactory. However , by the time it was purchased and delivered, the tagging for the first year was near completion. During the second year however we utilized the Bioscanner Counting Tub extensively with excellent results. The electronic counter was continuously checked and calibrated for accuracy by hand-counting 10-20 percent of the fish in a similar fashion as was done to all the fish the first year.

The study design for this project could be met by simply applying one tag code to that portion of each hatchery's production which is designated to be tagged. However, to enlist the cooperation and to provide a possible benefit for the persons in charge of the hatcheries involved, they were told that separate tag codes could be applied to distinct groups within the production (i.e., different release times, rearing vessels, etc.) as long as the design of the overall study was not compromised. Each hatchery organization took advantage of the offer and, consequently, several tag codes were applied at each facility. Each tag group, however, was treated the same and each tag group had the same tagged to untagged ratio as the rest of the hatchery. Although the tag codes will most likely all be grouped within each facility for the purposes of this study, a detailed accounting for each hatchery is given below.

Cowlitz Hatchery - At WDF's Cowlitz Hatchery (Table 1) a total of 713,383 (33%) fish were Coded-Wire Tagged and 1,425,468 (67%) were counted as controls for a total production of 2,138,851 and a tagged to untagged ratio of 1:2. At Cowlitz,

the spring chinook production is divided into 0+ age releases and l+ yearling releases. The 0+ age release fish are further divided into a May, June, and July release. Each of these releases contain separate tag codes. The yearling release group is held in separate raceways until they are released. Personnel at Cowlitz took advantage of this situation and asked for separate tag codes for each raceway and conducted a study with a gallimycin treatment for bacterial kidney disease. The 0+ release fish were tagged from March 5 to March 26 and averaged 130/lb. in size. The yearling release groups were tagged from April 9 to April 23 and averaged lOO/lb.

Carson Hatchery - At USFWS's Carson Hatchery (Table 2) a total of 745,274 (33%) fish were Coded-Wire Tagged and 1,490,805 (67%) were counted as controls for our study for a total production of 2,235,805 and a tagged to untagged ratio of 1:2. Separate tag codes were applied to the different rearing vessels employed at Carson (two different sized dirt ponds and concrete raceways). In addition about 100,000 fish are scheduled to be released off-station into Spring Creek and Umatilla River so we tagged and counted these fish in a similar fashion in case they returned to Carson where they were initially reared.

In addition, at Carson Hatchery a BKD study was started which was also funded by BPA. Since we were already tagging at Carson and all of the fish for the BKD study needed to be tagged we agreed to tag these fish too. They will not be part of the "CWT Effects Study" but the contract was amended to include funds for the BKD tagging. We tagged a total of 319,997 spring chinook for the BKD study in addition to our study fish. The fish at Carson were tagged from May 1 to May 30 and averaged 165/lb. in size.

South Santiam Hatchery - At ODFW's South Santiam Hatchery (Table 3) the fish released are progeny from adults that returned to the hatchery and are initially reared at Willamette and Dexter hatcheries before being brought to South Santiam for final rearing and release. The tagging took place at Willamette Hatchery. A total of 447,121 fish were Coded-Wire Tagged (33%) and 894,241 (67%) were counted as controls for a total production of 1,341,362 and a tagged to untagged ratio of 1:2. There are three major releases at South Santiam and each was given an individual tag code. The first is a fall release of fish in November. This is followed by two yearling type releases in the spring. The fish at Willamette were tagged from June 5 to June 26 and averaged approximately 125/lb.

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Table 1. COWLITZ HATCHERY 1991 TAGGING AND ENUMERATION

Tag Code	Tagged	Counted	Naturals	Group
63/39/30	68,324	135,349	6	May release
63/39/31	75,003	150,000	0	June release
63/39/32	75,000	149,593	7	July release
63/08/61	90,263	180,528	2	May extra rel.
Subtotal	308,600	615,875	15(.002%)	0+ reiease
63/40/41	34,112	68,224	3	Gallimycin
63/40/45	33,562	67 136	0	Gallimycin
63/40/46	33,695	67,401	0	Gallimycin
63/40/47	33,658	67,316	1	Gallimycin
63/40/48	33,781	67,562	1	Gallimycin
63/40/49	33,708	67,416	3	Gallimycin
63/40/50	33,700	67,400	3	Gallimycin
63/40/51	33,707	67,414	0	Gallimycin
63/40/52	33,700	67,404	0	Gallimycin
63/40/53	33,697	67,403	4	Gallimycin
63/40/54	33,700	67,400	3	Gallimycin
63/40/55	33,759	67,517	0	Gallimycin
Subtotal	404,783	809,593	l8(.OOl%)	1+ release
Total	713,383	1,425,468	33(.0015%)	

Prcduction Total

Table 2. CARSON HATCHERY 1991 TAGGING AND ENUMERATION

Tag Code	Tagged	Counted	Naturals	Group
63/40/41	382,566	765,123	49	Middle Stand.
63/40/42	162,050	324,086	2	Lower Girt
63/40/43	133,714	267 ,428	9	Upper Cirt
05/26/17	27,208	53,415	0	Spring Cr.
05/22/30	6,422	12,844	0	Spring Cr.
63/39/62	33,314	66,629	0	Umatilla rel.
Subtotal	745,274	1,490,531	60(.003%)	
63/39/39	41,847		0	BKD Study
63/40/34	41,310		1	BKD Study
63/40/35	40,855		3	BKD Study
63/40/36	40,615		0	BKD Study
63/40/37	39,411		2	BKD Study
63/40/38	36,557		0	BKD Study
63/40/39	39,397		0	BKD Study
63/40/40	40,005		1	BKD Study
Subtotal	319,997		7(.002%)	
Total	1,065,271	1,490,531	67(.0026%)	

Production Total 2,555,802

Table 3. WILLAMETTE 1591 TAGGING AND ENUMERATION

Tag Code	Tagged	Counted	Naturals	Group
07/56/26	166,672	333,357	34	November Rel.
07/56/28	113,611	**227,222**	34	Spring Rel.
07/56/27	**166,832**	**333,662**	**20**	Spring Rei.
Total	437,121	893,241		

Production Total 1,341,362