

Comparative tag retention, clip quality, and injuries of juvenile
spring Chinook salmon marked by an automated marking trailer
and manual marking trailer at Warm Springs NFH

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Title: Comparative tag retention, clip quality, and injuries of juvenile spring Chinook salmon marked by an automated marking trailer and manual marking trailer at Warm Springs NFH

This assessment addresses U.S. Fish and Wildlife Service objectives relating to operation, monitoring, and evaluation of marking trailers used at National Fish Hatcheries in the Columbia River basin.

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Summary

An automated marking trailer and a hand (manual) marking trailer were used to mark and coded-wire tag the brood year 2005 spring Chinook salmon at Warm Springs NFH during May of 2006. In a controlled side by side evaluation of fish marked in the two trailer types, fish were sampled during an early, middle, and late evaluation period. A total of 300 manually marked fish and 296 automated marked fish were visually examined for the presence of injuries and fin clip quality. Injury rates of fish did not differ between trailer types, with overall injury rates ranging between 4% and 13%. None of the injuries were considered to be life-threatening. Clip quality differed between fish marked in the automated trailer and fish marked in the manual trailer, with 5% of manually marked fish having no clip compared to less than 1% for automated marked fish. Manually marked fish also had a higher rate of partially clipped fins. Tag retention rates for automated marked fish averaged over 97%, while manually marked fish had an average tag retention rate of 87%. No difference in the average marking to release mortality rate were observed, although manually marked fish experienced a higher variability in mortality among raceways. Release to adult survival information will be monitored in the future to evaluate any differences between the two trailer types. Overall, the automated fish marking trailer had higher clip quality and tag retention with no increase in injury rates or marking to release survival when compared to the manual marking trailer. The results of this study should not be the sole determinant of whether to use an automated or manual trailer. Availability of trailers and markers, costs, mark type, hatchery goals, disease concerns, employment opportunities, and many other factors should also be considered by hatchery managers when deciding on a marking and tagging program at their hatchery.

Introduction

Fin clipping (marking) and coded-wire tagging (tagging) of juvenile salmonids prior to release from hatcheries is a standard method for assessing survival and fisheries contribution. Marking is also used to differentiate hatchery fish from wild fish for management and evaluation purposes. Traditionally, marking and tagging of juvenile salmon and steelhead has been done by hand (manually), with a marking crew handling each individual fish, manually clipping the adipose fin, and inserting a coded-wire tag into the fish's snout (Schurman and Thompson 1990). Manually marked fish are usually crowded and netted out of hatchery raceways, transported to the marking trailer, and are placed into an MS-222 anesthetic bath prior to marking and tagging. A new type of marking and tagging trailer, called the AutoFish System Model SCT-6, has been developed by Northwest Marine Technology, Inc. in which fish are sorted by size, marked, and coded-wire tagged using an automated system. Fish are crowded and netted in a similar manner as for manual marking, however the automated system does not require fish to be anesthetized and the fish are not individually handled. The Columbia River Fisheries Program Office Marking Program purchased three AutoFish trailers and is currently using the trailers at several locations around the region, in addition to several of the manual trailers that have been used historically.

At Warm Springs National Fish Hatchery (NFH), all spring Chinook salmon (*Oncorhynchus tshawytscha*) are adipose fin clipped and coded-wire tagged prior to release. The goal of the hatchery, identified in the 2002-2006 Warm Springs NFH Operational Plan, was to have a minimum coded-wire tag retention rate of 95%. For brood years 1993 to 2000, 2002, and 2003, the average annual tag-retention rate for fish that were marked manually was 93% (range of 85% to 97%), with the average annual tag-retention rate falling below the 95% minimum seven out of the ten years that tagging was done manually. For brood years 2001 and 2004, the automated marking trailer was used to mark and tag fish in an attempt to increase the tag-retention rate. The average tag-retention rate for these two brood years was 97% and 99%, respectively. While the tag-retention rate of fish marked using the automated marking trailer was high during the two years of operation, concerns have been raised about the potential impact to fish marked and tagged using the automated trailer. When the automated trailer was used for the 2004 brood year, hatchery staff expressed concern about the number of fish that appeared to have "compressed" heads or other injuries. It was thought that the adapter plates which hold fish in place while they are marked and tagged in the automated trailer may have resulted in the compression of the head region of the fish. Injuries to fish were noted immediately after tagging, as well as several weeks after tagging (Mike Paiya, U.S. Fish and Wildlife Service, personal communication).

The long-term impact to fish marked and tagged using the automated trailer is not known. Northwest Marine Technology, Inc, the Washington Department of Fish and Wildlife, and the U.S. Geological Survey have initiated a comprehensive study comparing the injury rates of fish marked using the automated trailer and fish marked using the traditional manual method (Lee Blankenship, Northwest Marine Technology, Inc, personal communication). Preliminary results of the study indicate a high level of injuries using both the automated and manual systems, with no differences between the

two systems. Injuries to fish were mainly attributed to the initial netting of fish from the raceways, prior to marking and tagging (Dianne Elliott, U.S. Geological Survey, personal communication).

In an attempt to address the concerns raised as a result of the marking of the 2004 brood at Warm Springs NFH, a study plan was developed to evaluate the use of an automated marking trailer at Warm Springs NFH. An automated marking trailer and a manual marking trailer were used to mark and coded-wire tag the brood year 2005 spring Chinook salmon at Warm Springs NFH. In this report, we compare tag retentions, mark quality, injury rates, and marking to release mortality between fish marked and tagged using an automated trailer and fish marked and tagged using a conventional manual trailer. A future report will look at release-to-adult survival rates.

Methods

Warm Springs NFH is operated by the U.S. Fish and Wildlife Service in cooperation with the Confederated Tribes of the Warm Springs Reservation of Oregon to produce spring Chinook salmon for Tribal and sport harvest opportunities and to conserve wild fish populations. The hatchery is located at river km 14 on the Warm Springs River, a tributary of the Deschutes River. For this study, juvenile spring Chinook salmon from brood year 2005 were coded-wire tagged (tagged) and adipose fin-clipped (marked) at Warm Springs NFH. Prior to the study, fish were hatched and reared according to standard hatchery rearing practices. Unmarked juvenile fish were moved from the hatchery's indoor rearing facility and placed into four holding raceways (raceways 7-10) approximately 1 month prior to initiation of tagging and marking. For the tagging and marking evaluation, treatments were defined as fish marked and tagged using a manual marking trailer and fish marked and tagged using an automated marking trailer. Marking and tagging occurred between May 4 and May 11, 2006, with one manual marking trailer and one automated marking trailer operating side-by side.

Unmarked fish were crowded from one of the four holding raceways and an experienced fish handler netted out a number of fish and distributed them either to the manual or automated trailer for marking. The same fish handler was used during the entire study period and fish were distributed randomly to each trailer. Once fish were distributed to the marking trailers, tagging and marking proceeded according to standard marking procedures. Twenty raceways, raceways 11 to 30, were designated for evaluation, with approximately 25,500 fish tagged, marked, and placed into each of the twenty raceways. Ten raceways of fish were marked using the manual trailer and ten raceways of fish were marked using the automated trailer, with individual coded-wire tag codes used for each raceway (Appendix A). An additional six raceways of fish were tagged and marked for general hatchery production but were not included in this evaluation. Release strategies, feeding schedules, and other hatchery treatments were uniformly applied so that the two mark types were treated equally.

In the manual trailer, an experienced member from the U.S. Fish and Wildlife Service's marking program trained and supervised a marking crew of four to six markers. The majority of markers had minimal prior experience tagging and clipping fish (Chuck Fuller, USFWS, personal communication). Marking and tagging followed procedures

outlined in Schurman and Thompson (1990). Manually marked fish were anesthetized in a bath of MS-222, tagged using a Mark IV tag injector (Northwest Marine Technology, Inc) and the adipose fin was clipped by hand using scissors. Fish were then passed through a pipe into a hatchery raceway. In the automated trailer, an experienced member from the U.S. Fish and Wildlife Service's marking program oversaw the operation of the electronic equipment and monitored fish health while an experienced marker worked in the rear of the trailer to tag and mark fish that were "rejected" by the automated system in a similar manner as marking and tagging in the manual trailer. Rejections were usually due to the sizes of fish, i.e. fish either too large or too small to be tagged by the automated system. Overall rejection rates were around 5% of the total population. Fish tagged and clipped by the automated system were not anesthetized, however the "rejects" were anesthetized. A technician from Northwest Marine Technologies was present during the initial marking period in order to calibrate and fine-tune the automated trailer. Several problems were encountered in the automated trailer during the initial marking periods, primarily having to do with the marking (fin-clipping) mechanism. Adjustments to the marking mechanism were made throughout the early portion of the study.

For the injury and mark quality evaluation, sampling was stratified into early (May 4 and 5), middle (May 9 and the morning of May 10), and late (afternoon of May 10 and May 11) periods. During each sampling period, approximately 100 fish marked and tagged using the manual trailer and 100 fish marked and tagged using the automated trailer were sampled. A two person crew consisting of a fish collector and a fish evaluator were designated prior to the initiation of the study. The same collector and evaluator were used throughout the entire evaluation. The fish collector was responsible for selecting fish for evaluation while the fish evaluator was responsible for ranking the clip quality and injury rate of the fish. The evaluator was isolated in a room in the hatchery feed building and was unaware of which trailer the sample fish were from. At the beginning of each sample period, the fish collector flipped a coin to randomly select which trailer, automated or manual, to collect fish from. The collector then would collect 10 to 20 fish from the outflow of the selected trailer and transport them to the evaluator in a five gallon water filled bucket. The collector recorded the trailer type, time of collection, and coded-wire tag code for the sampled fish. Each bucket of fish had a unique bucket ID number. The evaluator was made aware of the ID number so that the evaluator rankings could be matched up with the trailer type during subsequent analysis. Fish were anesthetized using MS-222, individually placed on a measuring board, and visually examined for injuries and clip-quality. Once all fish in a bucket were evaluated, the collector returned the fish to the appropriate raceway. The collector again flipped a coin to determine which trailer to sample from and this procedure was repeated until approximately 100 fish were sampled from each trailer type for each sample period.

Injury rankings and clip-quality were assigned by the fish evaluator according to pre-established ranking guidelines (Appendix B and C). The fish evaluator would examine both sides of the fish and rank any visible injuries. Injury severity was ranked on a scale of 1-no injury, 2-minor injury (visible but not life-threatening), 3-major injury (potentially life-threatening), and 4-injury not due to marking (skeletal deformation, fungus, emaciation, etc.). Injuries were also classified according to injury location (head, body, or fin). Clip quality was ranked as either 1-clipped (>75% of fin clipped), 2-partial clip (25%-75% of fin clipped), 3-no clip (<25% of fin clipped), or 4-severe clip (large,

exposed wound at clip location). Digital photographs of each fish were taken using a Canon PowerShot S90 digital camera mounted on a tri-pod, and fork lengths were recorded.

Tag retention sampling occurred on October 3 and 10, 2006. Approximately 500 fish from each of the 20 study raceways were randomly netted out of the raceway, anesthetized, and scanned for the presence of a coded-wire tag using a V-detector (Northwest Marine Technology, Inc). The number of fish with tags and without tags was recorded for each raceway and tag code. Hatchery staff also recorded monthly mortalities of fish from each raceway. Release to adult survival will be estimated by recovering coded-wire tags from a subsample of returning adults in 2008, 2009, and 2010.

Mean fork lengths of fish for each treatment (automated marking and manual marking) and for each sampling period (early, middle, late) were calculated. Within treatments, mean lengths for each sampling period were compared using analysis of variance (ANOVA). Mean lengths were compared between treatments for each sample period using Students t-test. Chi-square analyses were used to detect differences in injury rates, injury types, and clip quality both within and between treatments. Within each treatment, injury rates during each sample period were compared using chi-square analysis. If no differences were found, injury rates were pooled and injury rates between treatments were then compared. Injury location by sampling period was compared within treatments. Clip quality, or the ratio of good clips, partial clips, no clips, and severe clips, were compared within treatments by sampling period. If differences were found, clip quality between treatments were compared by sampling period. Tag retention rates were ranked from lowest to highest and differences between treatments were tested using the Mann-Whitney test.

Results

Length frequency distributions of fish are shown in Figure 1. Overall, mean lengths were 67.1 mm (SD=3.4) for auto trailer fish and 66.6 mm (SD=3.9) for manual trailer fish. Fish sampled during the early period were smaller than fish sampled during the middle and late periods for each treatment (auto trailer, $F=15.74$, $p<.001$; manual trailer, $F=6.62$, $p<.01$). Comparing fish between treatments, mean fish lengths were similar during the early and middle sampling periods but were statistically different in the late sampling period, although the difference was less than 1.2 mm (Table 1).

The number of observed injuries for each marking system (automated and manual) are shown in Table 2. No injuries were classified as major injuries during the evaluation. Observed injury rates did not differ between the three sampling periods for fish marked using the auto-trailer ($\chi^2=1.80$, $df=2$, $p>.05$) nor for fish marked using the manual trailer ($\chi^2=5.14$, $df=2$, $p>.05$). Pooling the sampling period data, injury rates did not differ between fish marked using the auto-trailer and fish marked using the manual trailer ($\chi^2=0.04$, $df=1$, $P>.05$).

Length Frequency

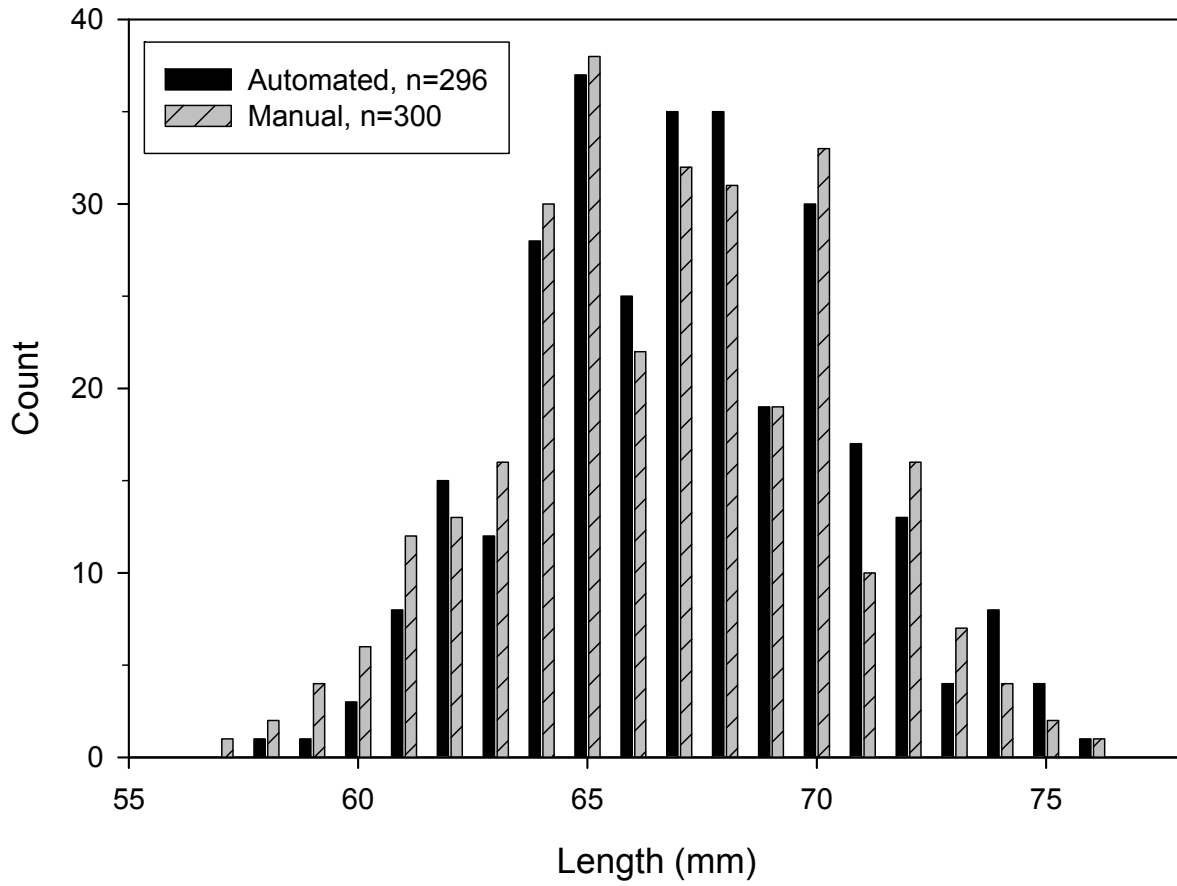


Figure 1. Length frequency distribution of fish evaluated for injuries and clip quality for the manual and automated marking trailers.

Table 1. Mean length of fish sampled from the automated and manual marking trailers, number of fish sampled, and standard deviation (SD); ns=no significant difference between the two treatments.

Period	Automated Trailer			Manual Trailer			P
	Mean Length (mm)	N	SD	Mean Length (mm)	N	SD	
Early	65.6	100	3.18	65.6	100	3.34	ns
Middle	68.0	100	3.11	67.5	100	4.27	ns
Late	67.7	96	3.45	66.6	100	3.70	<.05

Table 2. Injury rates of fish marked using an automated and a manual marking trailer. All injuries were classified as minor. No differences were found between the two trailer types (chi-square, $\alpha=0.05$).

Period	Automated Trailer				Manual Trailer			
	Injured	Not Injured	Total	Injury Rate (%)	Injured	Not Injured	Total	Injury Rate (%)
Early	11	89	100	11.0	13	87	100	13.0
Middle	6	94	100	6.0	4	96	100	4.0
Late	10	86	96	10.4	9	91	100	9.0
Total	27	269	296	9.1	26	274	300	8.7

For fish marked using the auto-trailer, the location of injury (head, body, or fin), differed between sampling periods ($\chi^2=15.42$, $df=4$, $p<.01$). Injuries to the head were more common during the early sampling period (Table 3). For fish marked in the manual trailer, the location of injury did not differ between sampling periods ($\chi^2=4.73$, $df=4$, $p>0.05$).

Table 3. Location of injuries identified during sampling for fish marked in the two types of trailers. The number of fish examined for each period and trailer type was 100, except for the late automated trailer period in which 96 fish were examined.

Period	Automated Trailer				Manual Trailer			
	Head	Body	Fin	Total	Head	Body	Fin	Total
Early	11	0	0	11	8	4	1	13
Middle	2	1	3	6	2	1	1	4
Late	2	3	5	10	6	0	3	9
Total	15	4	8	27	16	5	5	26

The ratio of good clips (ranking of 1) to poor clips (ranking of 2, 3, or 4) in the manual trailer differed by sampling period, with the poorest clip quality occurring during the early sampling period ($\chi^2=9.74$, $df=2$, $p<.01$). The quality of fin clips did not differ by sampling period for fish marked using the auto-trailer ($\chi^2=0.815$, $df=2$, $p>.05$). Clip quality differed between fish marked using the auto-trailer and fish marked using the manual trailer during each sampling period, with fish marked using the automated trailer having a higher ratio of good quality clips during each sampling period (Table 4). For manually marked fish, 5% (15 out of 300) did not have a clip compared to less than 1% (1 out of 296) for automated marked fish.

Table 4. Adipose fin clip quality rankings for fish marked in two types of marking trailers, with results of chi-square comparisons between treatments; (good=>75% of fin clipped, partial=25-75% of fin clipped, none=0-25% of fin clipped, and severe=large exposed wound in clip area).

Period	Automated Trailer				Manual Trailer				χ^2	P
	Good	Partial	None	Severe	Good	Partial	None	Severe		
Early	91	6	0	3	57	33	8	2	34.7	<.001
Middle	89	6	0	5	77	18	4	1	11.3	0.01
Late	89	3	1	4	71	25	3	1	24.3	<.001

Tag retention rates are shown in Table 5. Tag retention for auto-trailer tagged fish was higher than tag retention for manually tagged fish ($U=100$, $p<.001$). The mean tag retention rate for fish tagged using the auto-trailer was 97.7% compared to a mean tag-retention rate of 87.4% for manually tagged fish. Looking within treatments, the ratio of tagged to untagged fish in the manual trailer was lower during the early sampling period compared to the middle and late sampling periods ($\chi^2=20.11$, $df=1$, $p<.001$). No

differences in the ratio of tagged to untagged fish were observed between sampling periods for the auto trailer.

Table 5. Tag retention rates for fish marked using an automated marking trailer and a manual marking trailer. Fish were sampled on October 3 and 10, 2006.

Raceway	Automated Trailer			Raceway	Manual Trailer		
	With Tags	Without Tags	Retention Rate (%)		With Tags	Without Tags	Retention Rate (%)
16	493	12	97.6	11	410	99	80.6
17	489	11	97.8	12	451	49	90.2
18	489	11	97.8	13	433	67	86.6
19	491	14	97.2	14	445	62	87.8
20	484	16	96.8	15	445	55	89.2
21	491	13	97.4	16	452	53	89.5
22	624	7	98.9	17	546	62	89.8
23	500	5	99.0	18	586	69	89.5
24	510	12	97.7	19	465	59	88.7
25	484	17	96.6	20	477	105	82.0
Mean			97.7				87.4

The number of fish tagged and marked each day is shown in Table 6. The mean number of fish marked and tagged per day during the clip quality and injury evaluation (May 4, 5, 9, 10, and 11) was 25,285 for the manual marking trailer and 38,350 for the automated trailer.

Table 6. Number of fish marked and tagged by the manual and automated marking trailers in 2006 at Warm Springs NFH.

Date	Manual	Automated
5/3/06	--	12,753 ^a
5/4/06	19,050	12,753 ^a
5/5/06	25,637	25,507
5/8/06	20,307	51,220
5/9/06	28,449	51,130
5/10/06	28,671	51,181 ^b
5/11/06	24,617	51,181 ^b
5/12/06	23,906	42,581 ^c
5/15/06	25,075	42,581 ^c
5/16/06	31,356	42,581 ^c
5/17/06	13,806	--
Total	240,874	383,468

^a Average of 5/3 and 5/4 totals for the automated marking trailer.

^b Average of 5/10 and 5/11 totals for the automated marking trailer.

^c Average of 5/12, 5/15, and 5/16 total for the automated marking trailer.

Mortality rates for each raceway are reported in Appendix A. Mean mortality rates were similar for both groups of fish, however rates were more variable for manually marked fish than for automated marked fish. Mortality rates did not differ between the two groups in June ($p=0.19$), one month after tagging and marking. At the end of June, the mean mortality rate for manually marked fish was 0.28% (range=0.17 to 0.76; variance= 0.029) compared to 0.22% (range=0.16 to 0.28; variance=0.002) for automated trailer marked fish. At release the following spring, 10 months after marking and tagging, mortality rates again did not differ ($p=0.15$) with manually marked fish having a mean mortality rate of 0.69% (range=0.35 to 1.59; variance=0.131) and automated trailer marked fish having a mean mortality rate of 0.51% (range=0.43 to 0.60; variance=0.003).

Discussion

There were no differences in injury rates between fish marked in an automated trailer and fish marked in a manual trailer. Overall injury rates were very low throughout the length of the study, ranging from 4% to 13% of the total fish that were examined. This contrasts the study conducted by the U. S. Geological Survey at several Washington Department of Fish and Wildlife hatcheries. In the U.S. Geological Survey study, injury rates of over 70% were observed for fish marked in both manual and automated trailers (Diane Elliot, U.S. Geological Survey, personal communication). The difference in injury rates between the two studies may be due to the way injuries were identified. In the current study, injuries were identified by visual observation of obvious external injuries. In the U.S. Geological Survey study, fish were placed in a 0.1% aqueous fast green FCF bath which stains injured surface tissues. Injuries were then determined by the presence of the dye. The use of the dye likely resulted in the detection of less severe injuries than would be possible using visual examination alone. Methods to develop computer analysis techniques to better understand the severity of injuries identified by the dye are currently being investigated. It should also be noted that the majority of injuries in the USGS study were thought to have resulted from netting and handling of fish prior to marking and tagging (Diane Elliott, U.S. Geological Survey, personal communication).

One objective of this study was to compare injury rates between the two types of marking trailers. Unaided visual observation of injuries provided a coarser level of injury detection than if a dye test were used, however the impetus for the study was concern raised from hatchery personnel who noticed possible external injuries from previous marking experiences. The methods used in this study were designed to identify visible injuries to juvenile fish, and to determine whether there were differences in injury rates between fish marked in the two trailer types. It is likely that if a dye were used, overall observed injury rates would have been higher, however it is our opinion that the same conclusions would have been reached, specifically that injury rates do not appear to differ between trailer types.

The impact of injuries, whether observed visually or with a dye, on the health of the fish can be measured by monitoring survival of fish post-marking and by monitoring the disease levels in the fish. Overall mortality rates prior to release were similar for both trailer types, consistent with the results of the injury observation evaluation, but the variability in mortality rates for raceways of manual trailer fish was much higher than automated trailer raceways. Of particular note, the last raceway that was manually

marked, raceway 11, had a marking to release mortality rate of 1.59%, more than twice the rate of the highest automated trailer raceway. Fatigue of markers over time, differences in daily marking personnel, or other unknown factors may have caused the increased variability in mortality rates. Release to adult survival rates will be estimated based on coded-wire tag recoveries from subsequent adult returns in 2008, 2009, and 2010. Adult survival information will be presented in a subsequent report.

The differences in clip quality between fish marked in the two trailer types should be considered when determining marking and tagging procedures in the future. Poor clip quality could result in a reduction in the overall catch in both the sport and Tribal fisheries. Sport harvest of spring Chinook salmon in the Deschutes River is typically restricted to retention of hatchery fish only (hatchery fish identified by the absence of an adipose fin). Partially clipped or unclipped hatchery fish would need to be returned to the river if caught in a sport fishery. Tribal harvest in the Deschutes River is regulated by the Confederated Tribes of the Warm Springs Reservation of Oregon and harvest of unclipped spring Chinook salmon is usually limited based on predicted returns of wild spring Chinook to the Warm Springs River. Clip quality will be evaluated in subsequent adult returns to Warm Springs NFH from the 2005 brood year.

Warm Springs NFH is managed to minimize impacts to wild fish populations in the Warm Springs River. One objective of the hatchery's management plan is to limit the number of hatchery fish upstream of the hatchery on the wild fish spawning grounds (CTWSRO and USFWS 2007). Since 1990, 100% of juvenile fish reared and intended for release from Warm Springs NFH have been coded-wire tagged. The comprehensive tagging program at the hatchery was instituted so that an automated passage system, which detects the presence of a tag and diverts tagged fish into hatchery holding ponds, could be used to pass wild (untagged) fish upstream of the hatchery without being handled by hatchery staff. Reducing the handling of wild fish is thought to reduce the prespawning mortality of fish upstream of the hatchery. A detailed description of the passage system and prespawning mortality in the Warm Springs River can be found in Olson et al. 2004.

Retention of coded-wire tags is essential for the efficient operation of the automated passage system and protection of the wild fish populations in the Warm Springs River. The 2007-2011 Warm Springs NFH Operational Plan has raised the tag retention goal from 95% to 97% (CTWSRO and USFWS 2007). In this study, fish tagged using the automated trailer had an average retention rate of over 97%, meeting the tag retention goal. Fish tagged in the manual trailer, however, had an average retention rate of just over 87%, well below the goal. Tag retention rates for manual trailer fish were also much more variable than rates for automated trailer fish. These results are consistent with the tag retention rates found at Warm Springs NFH since brood year 1993 (Figure 2). Low tag retention rates may impact the wild spring Chinook salmon population in the Warm Springs River. If the automated passage system is operated during years when adults are returning with low tag retentions, a larger number of hatchery fish may be passed upstream than is acceptable as outlined in the Operations Plan. If the automated passage system is not used, the handling of wild fish will increase and higher prespawning mortality rates may result.

Tag Retention by Brood Year Warm Springs NFH

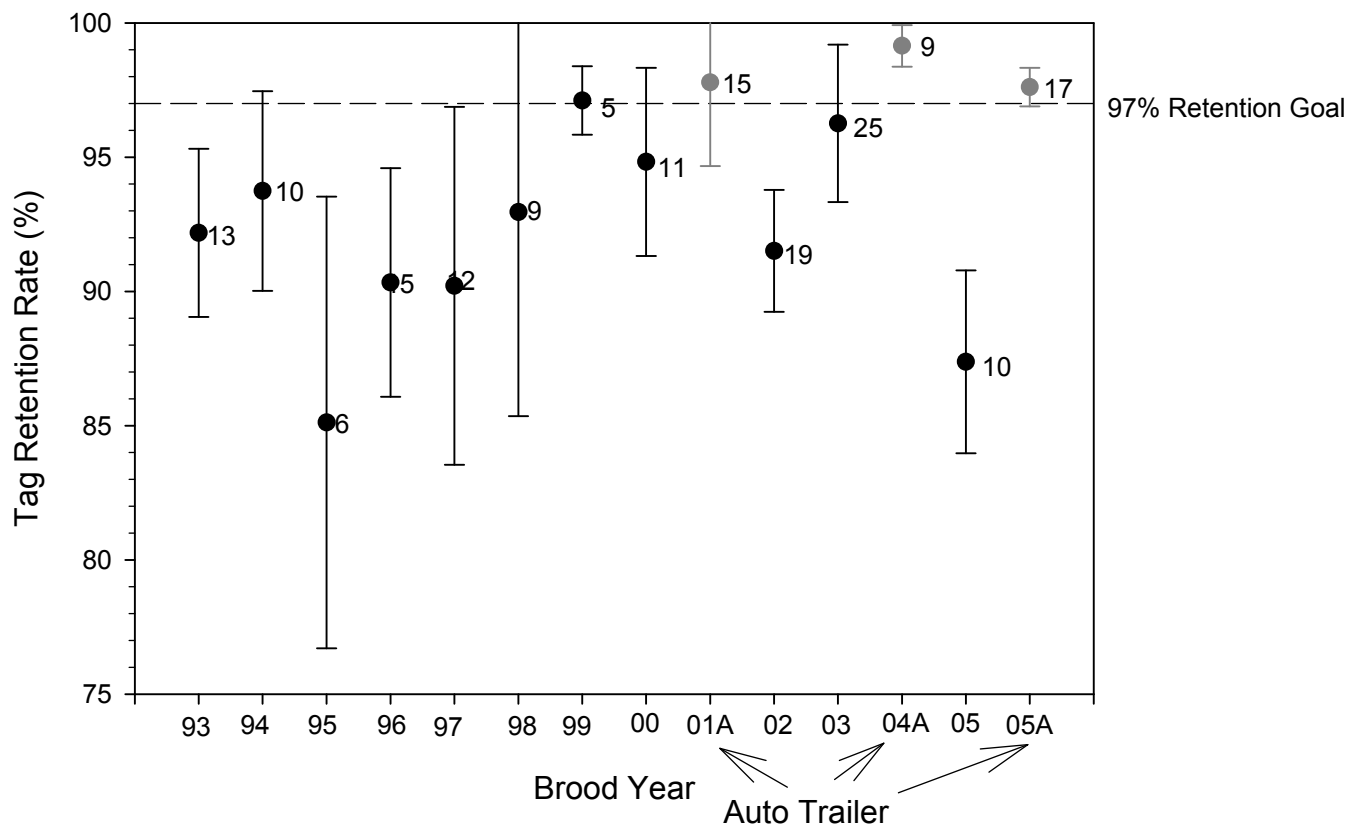


Figure 2. Tag retention rates for spring Chinook salmon marked and tagged at Warm Springs NFH, brood years 1993 to 2005. All brood years were tagged using a manual trailer except for brood years 2001, 2004, and part of 2005. The number of tag groups is given, error bars are 1 standard deviation.

The results of this study show that the use of an automated marking and tagging trailer can increase the clip quality and tag retention rates of fish marked at Warm Springs NFH when compared to a manual marking and tagging trailer. Injury rates and raceway survival were similar for both trailers. Adult return rates will be evaluated using coded-wire tag recoveries to detect any survival differences between fish marked and tagged in the two trailer types. A report detailing the adult survival rates will be completed in 2011. We recommend that similar evaluations be conducted at other national fish hatcheries in order to provide more insight on the effectiveness of the two trailer types in marking and tagging fish at different locations, with different species, and during different time periods. Manual trailers might still meet many management objectives, particularly with increased training of the marking staff. The results of this study should not be the sole determinant of whether to use an automated or manual trailer. Availability of trailers and markers, marker experience, costs, mark type, hatchery goals, disease concerns, employment opportunities, and many other factors should also be

considered by hatchery managers when deciding on a marking and tagging program at their hatchery.

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Appendix A

Ponding Plan for Brood Year 2005

Raceway	Description	Trailer Type	Treatment	Release Time	CWT	#	Mark-to-Release Mortality Rate (%)
1	Slope	Auto	Ery Control	Production	53081	25,513	
2	Slope	Auto	Ery Control	Production	53082	25,533	
3A	Slope	Auto	Ery Control	Production	54546,54547	12,859	
3B	Slope	Auto	Ery Double	Production	52582	12,784	
4	Slope	Auto	Ery Double	Production	53077	25,510	
5	Slope	Auto	Ery Double	Production	53079	25,544	
6	Slope					Empty	
7	Slope					Empty	
8	Slope					Empty	
9	Slope					Empty	
10	Slope					Empty	
11	Unlined	Manual	Ery Double	Spring	52583	10,646	1.59
12	Unlined	Manual	Ery Double	Spring	53083	25,514	0.96
13	Unlined	Manual	Ery Double	Spring	53084	25,514	0.72
14	Unlined	Manual	Ery Double	Spring	53085	25,538	0.60
15	Unlined	Manual	Ery Double	Spring	53086	25,534	0.67
16	Unlined	Auto	Ery Double	Spring	53075	25,509	0.52
17	Unlined	Auto	Ery Double	Spring	53076	25,507	0.51
18	Unlined	Auto	Ery Double	Spring	53087	25,677	0.55
19	Unlined	Auto	Ery Double	Spring	53088	25,670	0.60
20	Unlined	Auto	Ery Double	Spring	53089	25,547	0.58
21	Lined	Auto	Ery Double	Fall/Spring	53090	25,583	0.50
22	Lined	Auto	Ery Double	Fall/Spring	53091	25,553	0.47
23	Lined	Auto	Ery Double	Fall/Spring	53092	25,667	0.44
24	Lined	Auto	Ery Double	Fall/Spring	53093	25,507	0.48
25	Lined	Auto	Ery Double	Fall/Spring	53094	25,507	0.44
26	Lined	Manual	Ery Double	Fall/Spring	53095	25,519	0.38
27	Lined	Manual	Ery Double	Fall/Spring	53096	26,049	0.58
28	Lined	Manual	Ery Double	Fall/Spring	53097	25,520	0.57
29	Lined	Manual	Ery Double	Fall/Spring	53098	25,526	0.35
30	Lined	Manual	Ery Double	Fall/Spring	53099	25,514	0.45

Appendix B

Injury Ranking Guidelines

Severity of Injury

1=No Injury Visible

2=Minor injury: visible but not life-threatening

3=Major Injury: visible, potentially life-threatening

4=Injury not due to marking, must be **obvious** (skeletal deformation, large fungus/growth, emaciated)

Type of Injury

Head Injury

Eye: Minor=slight discoloration, small tear in membrane
Major=bulged, hemorrhaged, missing

Gill/Operculum: Minor=minor bleeding, superficial damage to operculum/isthmus
Major=severe bleeding, tearing, or creasing of opercle/gill arches, inverted gill arches, isthmus tear

Head:
(dorsal, above eye) Minor=small head trauma, slight discoloration/indentation
Major=severe head trauma, pronounced indentation, or disfigurement

Body Injury

Body Minor=small bruising/discoloration (<0.5cm) on one side
Major=large bruising, widespread discoloration (>0.5cm) on at least one side

Descaling Minor=<20% descaling on one side
Major= \geq 20% descaling on one side

Fin Injury

Minor=split fin, small fraying at ends
Major=multiple splits in caudal or dorsal fin, severe fraying, enough to impair swimming ability

Fin Clip Quality

1=Adipose fin clipped >75% of fin clipped, even with dorsal line

2=Partial fin clip, 25% to 75% of fin clipped

3=No fin clip, <25% of fin clipped

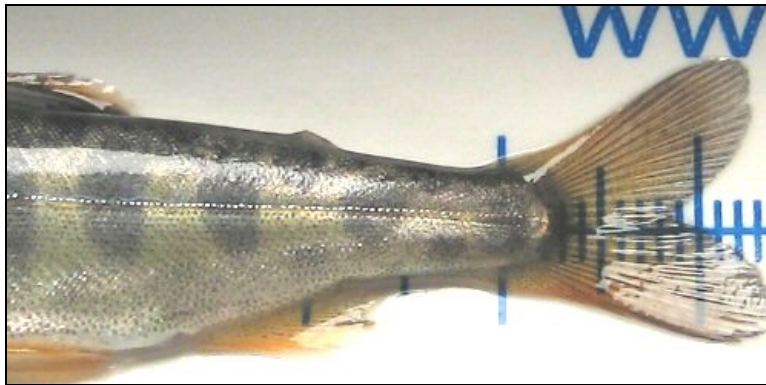
4=Severe clip, large exposed wound in clip area

Appendix C

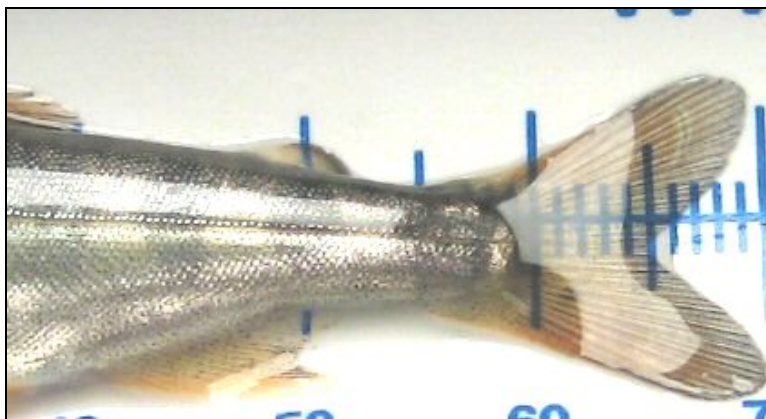
Examples of Clip Quality Rankings



Clip Ranking 1-Good Clip



Clip Ranking 2-Partial Clip



Clip Ranking 3-No Clip