Electronic Detection of Coded-Wire Tags in Chinook Salmon: A Comparison of Two Techniques Using a "Wand" Detector

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Introduction

Since 1977 the adipose fin clip has been used to indicate the presence of a coded-wire tag (CWT) in anadromous salmon from Alaska to California. Recent fisheries management decisions have changed the status of the adipose clip in chinook and coho. Beginning in 1995, the adipose fin clip has been used to identify (mass-mark) hatchery coho stocks, including non-coded-wire tagged fish, in Oregon, Washington, and Southern British Columbia. Beginning in 1998, the adipose clip has also been used to identify certain hatchery chinook stocks in Oregon and Washington. The choice to use the adipose mark, in the absence of another suitable external mark, was accompanied by a decision to change the regional coho and chinook CWT sampling system from visual identification to electronic detection.

The two primary devices for electronic CWT field sampling are a portable hand-held "wand", and a stationary "tunnel" detector. In 1995 these two pieces of equipment were tested on coho salmon in several agency studies (PSC 1997). When the results of the various studies were combined, CWT detection rates of 99% were found for both pieces of equipment. The capability of CWT electronic sampling equipment has not, however, been extensively tested on chinook. Of particular concern is the capability of the hand held "wand" to detect standard length tags (1.1 mm) in larger chinook. The manufacturer of the wand, Northwest Marine Technology, guarantees a detection depth of 20 mm for standard length tags. Because of the large size of chinook heads, especially in the older age classes (i.e. age 4 and 5), a significant percentage of coded-wire tags can reside at a depth greater than 20 mm (PSMFC 1995).

Preliminary wand investigations, all using the standard technique, have resulted in the following detection rates for standard length tags in chinook: A study by the Alaska Department of Fish and Game found a 98% detection rate (ADF&G 1995); a study by the Northwest Indian Fisheries Commission (NWIFC) and the US Fish and Wildlife Service found a detection rate of 99% (Olson et al. 1999); a study by the Canadian Department of Fisheries & Oceans (CDF&O 1999) found a 96% detection rate; and a study by Washington Department of Fish and Wildlife (WDFW) found a detection rate of 91% (Blankenship et al. 1999). In all studies the missed tags tended to be in larger fish. In 2000, investigations by WDFW (Vander Haegen and Blankenship 2000) indicated that using the wand inside of the mouth (i.e. rubbing the wand on the palate) may provide higher detection rates than the standard method (i.e. rubbing the wand on the exterior surface of the snout).

The purpose of this study was to measure the CWT detection rates of two different wand techniques on hatchery returns of chinook salmon: 1) The standard technique – where the fish is held by the gill area and the wand tip is rubbed on the surface of the snout, in brisk anterior to posterior strokes, moving across the snout from one eye to the other; and 2) The mouth technique – where the fish is held by the gill area with the mouth agape, and the wand tip is rubbed on both sides of the roof of the mouth, in brisk anterior to posterior strokes. A secondary purpose was to measure the CWT detection rate of the "tunnel" detector on hatchery returns of chinook salmon. This information will be used in developing a standardized technique for sampling adult chinook with the wand.

Study Sites

This study occurred in the fall of 2000 on chinook salmon returning to three hatcheries: 1) Nisqually Hatchery at Clear Creek, 2) Grovers Creek Hatchery, and 3) Makah National Fish Hatchery. Nisqually Hatchery at Clear Creek is operated by the Nisqually Tribe, and is located on the lower Nisqually River in south Puget Sound. Grovers Creek Hatchery is operated by the Suquamish Tribe and is located at the mouth of Grovers Creek, a stream on the Kitsap Peninsula that flows into mid-Puget Sound. Makah National Fish Hatchery (NFH) is operated by the U.S. Fish and Wildlife Service (USFWS) and is located on the Sooes River, which flows into the Pacific Ocean on the extreme north coast of Washington. All of the facilities have a history of tagging juvenile chinook and sampling adult returns for CWTs. All of the expected returning tag groups were originally tagged with standard length wire.

Methods

Detection Methods: Sampling with the equipment was conducted by NWIFC employees. The sampling was conducted during spawning days and the majority of the carcasses had been spawned. Sampling was primarily limited to adult age classes (ages 3 – 5). In general, all fish were sampled with both methods of the wand and then sent through a model R9500 tunnel detector. The tunnel detector was equipped with a sorting gate which automatically separates tagged from untagged fish. The samplers were asked to sample the fish as if it was a typical sampling situation (i.e. don't spend an inordinate amount of time on an individual fish). For any fish that indicated a tag detection with only one of the wanding methods, the fish was re-sampled to investigate the original determination. In order to conduct the sampling within the ongoing hatchery operations, the actual testing protocols varied slightly between facilities.

At the Nisqually Hatchery at Clear Creek, the hatchery crew pre-sampled all fish for tags with the tunnel detector. This electronic sampling was due to the fact that the hatchery was expecting 2 year old (jack) returns from a double-index tag group (an indicator group where one tag code has an adipose clip and a corresponding group is unmarked). The tunnel detector mechanically sorted all tagged fish into a tote. Additional unmarked fish were then added to the tote to "salt" the sample with non-tagged fish. Each fish was then sampled with both wand techniques and then re-sent through another tunnel. The sampler was not aware of the amount of salted fish and

was asked to avoid looking at the adipose fin area prior to sampling. CWT sampling procedures followed directly after electronically sampling each fish, avoiding the need to individually label each fish. Sampling occurred on four days.

At the Grovers Creek hatchery all adipose marked fish were placed on a wooden spawning rack with their ventral side up. Additional unmarked fish were also added to this sample. Fish were individually labeled with non-magnetic numbered Floy tags or paper tags. Each fish was then sampled with both wand techniques and then sent through the tunnel detector. The sampler was not aware of the number of salted fish and was not able to see the adipose area of the fish while wanding. This was accomplished by lifting the fish by the gill area, with the dorsal part of tail section remaining hidden by the rack. Sampling occurred on five days.

At Makah NFH, arrangements were made so that all of the adipose marked returns were sampled on the final day of spawning. The hatchery crew had removed all adipose marked fish from previous spawning days and stored them in a freezer. These frozen fish were allowed to thaw for 24 hrs prior to being laid out for sampling. Additional unmarked fish were also added to the sample. Prior to sampling, the tissue surrounding the adipose fin area was removed from all fish (to mask the adipose mark) and each fish was labeled with a non-magnetic numbered Floy tag. All fish were first sampled by the standard wanding technique, and then the sampling was repeated by a different sampler using the mouth wanding technique. Following sampling, all fish were sent through the tunnel detector. Some of the fish still had partially frozen heads at the time of sampling.

CWT Recovery: After attempting detection with the electronic equipment, standard CWT sampling procedures were followed. For Grovers Creek and Makah NFH this involved processing all adipose marked fish (visual sampling) regardless of the results of the electronic detection tests. For Clear Creek this involved processing all fish where the hatchery's tunnel detector had indicated a tag (electronic sampling). The electronic detection information was recorded on sampling forms, with the individual fish label numbers. Each fish was measured for fork length, sexed, and the snouts were removed and placed in individual bags with the corresponding fish number on the head label. Validation and recovery of CWTs was completed at the WDFW CWT laboratory (for the tribal hatcheries), or the Lacey USFWS dissection laboratory (for Makah NFH), using standard CWT recovery procedures. In a few cases, the length or sex information could not be reconciled between the field data and the laboratory data.

Statistical Analysis: Fisher's exact test, using the chi-square statistic (Conover, 1980), was used to test for significant differences ($\alpha = 0.05$) between detection rates.

Results

Results of Wanding Tests: A total of 479 hatchery chinook were sampled for CWTs with electronic detection equipment. Dissection and recovery in the laboratory determined that 368 of the fish contained CWTs. The detection equipment was tested prior to each sampling event, and no problems were encountered with the detection equipment used.

The results of the detection tests are displayed in Tables 1 - 3. As indicated in Table 1, when all sites are combined the standard wanding technique detected all but one of the tags (99.7% detection rate). In comparison, the mouth wanding technique missed 15 of the tags (95.9% detection rate). These differences were found to be highly significant ($P \leq 0.001$). The one tag that was missed with the standard technique was also missed with the mouth technique. Surprisingly, this fish was not particularly large (82 cm). In all cases where the tag was detected with the standard method, but missed with the mouth method, subsequent re-sampling confirmed the original result.

Differences in detection rates between sexes were also compared (Table 2). During sampling it was noted that the morphological difference (i.e. the elongated kype of the mature males) had a subtle influence on positioning of the wand inside the mouth. The detection rate for mouth wanding was lower in males (94.3 %) than females (97.4 %). However, this difference was not found to be statistically significant ($P = 0.173$).

Results of Tunnel Detector Tests: Results of the detection capability of the tunnel were available from sampling at Grovers Creek and Makah NFH (Table 1). At these two sites all adipose marked fish (318 total) were tested and then sent to the recovery labs for final verification. All 279 tags were detected from the fish passed through the equipment (100 % detection rate).

Table 1. Detections of Coded-wire Tags, by Facility.

Facility	Number Sampled	Number CWTs in Sample	Number of Detections (%)		
			Standard Wand	Mouth Wand	R 9500 Tunnel
Clear Creek Hatchery	106	89	89 (100.0)	87 (97.8)	N/A
Grovers Creek Hatchery	302	233	233 (100.0)	224 (96.1)	233 (100.0)
Makah National Hatchery	71	46	45 (97.8)	42 (91.3)	46 (100.0)
Combined Facilities	479	368	367 (99.7)	353 (95.9)	279 (100.0)

Table 2. Detections of Coded-wire Tags, by Sex.

Sex	Number CWTs in Sample	Number of Detections (%)		
		Standard Wand	Mouth Wand	R 9500 Tunnel
Males	159	158 (99.4)	150 (94.3)	159 (100.0)
Females	195	195 (100.0)	190 (97.4)	195 (100.0)
Total	354	353 (99.7)	340 (96.1)	354 (100.0)

Fish Size vs. Tag Detection: The length of fish with missed tags was compared with the length of the entire sampling population (Table 3 and Figure 1). As shown in Figure 1, the length frequency of fish with missed tags had a different distribution than the entire sample. No tags were missed by the wand in any fish < 75 cm in length.

Table 3. Missed Detections of Coded-wire Tags, by Length Frequency.

Length (cm)	Number CWTs in Sample	Number Missed (%) [1]		
		Standard Wand	Mouth Wand	R 9500 Tunnel
50-54	1	0 (0.0)	0 (0.0)	0 (0.0)
55-59	7	0 (0.0)	0 (0.0)	0 (0.0)
60-64	11	0 (0.0)	0 (0.0)	0 (0.0)
65-69	24	0 (0.0)	0 (0.0)	0 (0.0)
70-74	62	0 (0.0)	0 (0.0)	0 (0.0)
75-79	70	0 (0.0)	2 (2.9)	0 (0.0)
80-84	89	1 (1.1)	3 (3.4)	0 (0.0)
85-89	63	0 (0.0)	7 (11.1)	0 (0.0)
90-94	23	0 (0.0)	1 (4.4)	0 (0.0)
95-99	6	0 (0.0)	0 (0.0)	0 (0.0)
100-104	1	0 (0.0)	1 (100.0)	0 (0.0)
Total	357	1 (0.3)	14 (3.9)	0 (0.0)

[1] Percentages are calculated within a length range.

False Detections: False detections (i.e. where the equipment indicates the presence of a tag, but a tag is not found in the recovery lab) occasionally occur when using electronic detection equipment. These can result from pieces of metal within the fish (e.g. a fish hook) or magnetic particles (e.g. sediment or rust) on the surface of the fish. In this investigation, seven fish produced a false detection. These resulted from the following equipment/technique combinations: Four from the tunnel only, two from a combination of the tunnel and the standard wand technique, and one from a combination of the tunnel and the mouth wanding technique.

Discussion

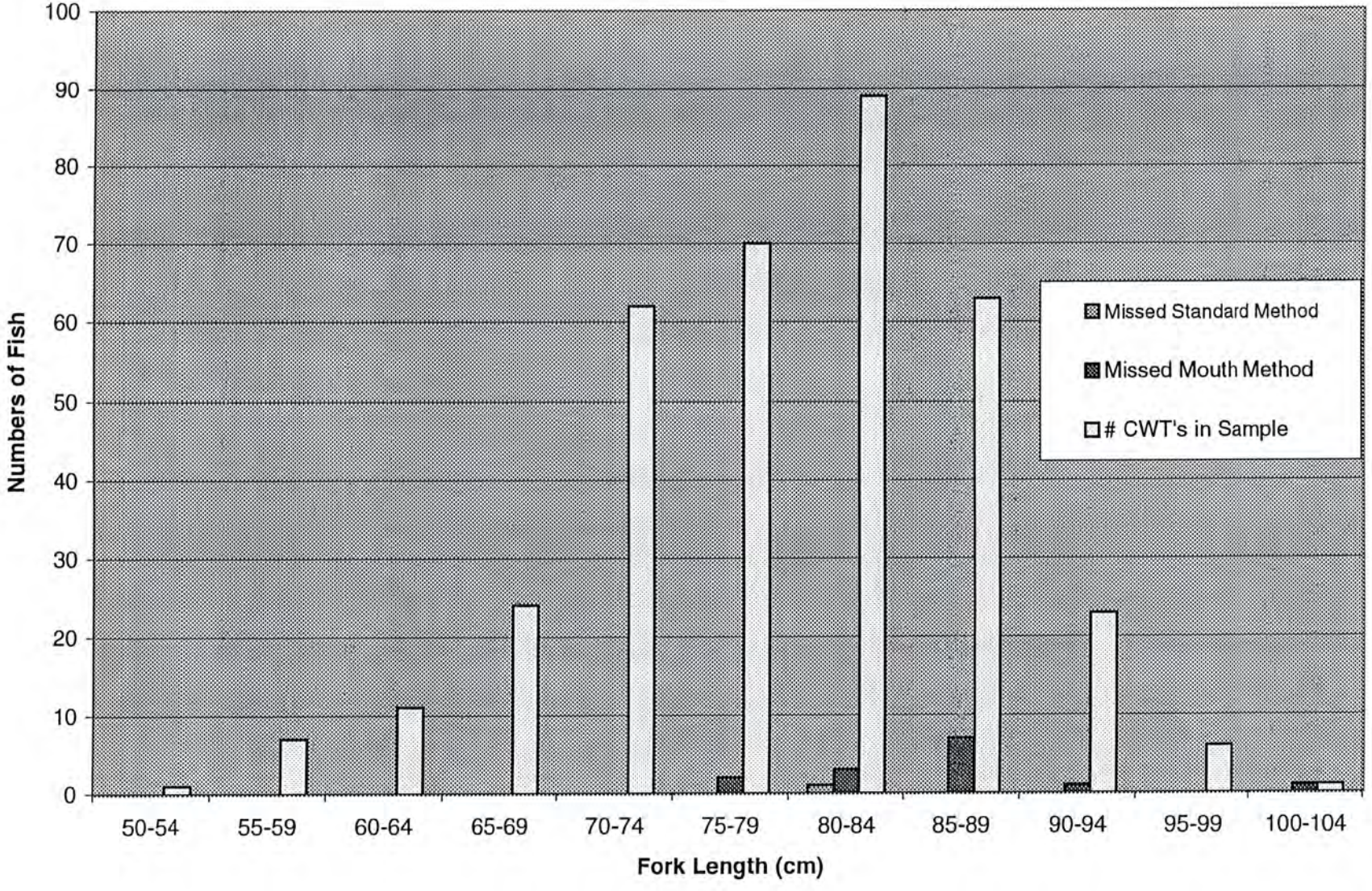
Relatively high rates of tag detection in hatchery chinook were found with both methods of wanding. However, the standard technique on the outside of the snout (99.7 % detection rate) proved superior to the technique on the inside of the mouth (95.9 % detection rate).

The tunnel detector successfully detected all of the tags. This detection capability, combined with its automatic counter and sorting gate, make this the method of choice where high volumes of fish are involved. All of the fish in this study were spawned prior to sampling and fit through the R9500 tunnel. However, because of the dimensions of the tunnel chute (9.5 in. width by 4.75

in. height) a certain percentage of unspawned/whole chinook (i.e. fishery samples) will be too large to fit through the tunnel and will require wand sampling.

Standardized CWT sampling procedures are an integral part of maintaining the integrity of the coastwide CWT program. Wands will be needed for sampling chinook on spawning grounds and in recreational fisheries. They will also be used in many hatchery and commercial fishery sampling situations. Adult (age 3) adipose mass-marked chinook will begin returning to the Pacific Northwest in the summer of 2001. It is therefore important that a reliable and standardized wanding technique be in place by that time. The results of this study will be compared with other ongoing agency studies and used in developing a recommendation for a standardized chinook wanding technique.

Figure 1. Missed Wand Detections Using Standard and Inside Mouth Techniques



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