ELECTRONIC CODED-WIRE TAG DETECTION EQUIPMENT STUDY DURING THE 1996 TREATY COHO FISHERY

Cynthia Pratt
and
Tim Flint

Fish Management Program
Freshwater Resources Division
Puget Sound Sampling Unit

May 1997

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Mass marking hatchery coho by removing the adipose fin has been proposed as a tool to allow additional fishing opportunity while protecting wild coho stocks. To preserve the use of the coded-wire tag (CWT), however, it will be necessary to sample commercial, sport and tribal catches with electronic detection equipment. The Washington Department of Fish and Wildlife (WDFW) Puget Sound Sampling staff tested the electronic detection equipment to recover CWT fish snouts in treaty fisheries during the fall of 1996. The project goal was to determine the reliability, feasibility and sampling effort necessary to sample Puget Sound salmon fisheries, assuming that mass marking of hatchery coho will occur. Two types of electronic detectors were tested, a hand-held Wand and an electronic tube (R-8). Three objectives were specified:

- Test the reliability of CWT detection in the commercial fisheries using electronic CWT detectors.
    - Estimate the proportion of tagged coho detected by the electronic detection equipment.
    - Estimate the proportion of coho where tags were detected but no tag was present.
- Test the feasibility of using electronic Wand and R-8 detectors in various field sampling situations.
- Estimate the amount of sampling effort increase, if any, that will occur when using the equipment.

The commercial coho fisheries in September were assumed to provide adequate samples for the study. The sampling design criteria was for 5,000 coho per site. It was also assumed that if the Wand or R-8 tested positively at busy, more complex sites, then the equipment could be used at slower, less complex sites. Sites were chosen with these two assumptions in mind. However, for the 1996 season, coho returns were depressed, and the 5,000 coho samples per site were not achieved. The total number of fish sampled during the entire study was 6,481 coho for all sites.

Limited testing of the Wand also occurred during the Puget sound recreational fishery. The recreational sampling results will be presented in a subsequent report.

METHODS

Two samplers, one additional staff person and one seasonal employee, were assigned to sample the commercial fisheries in the Puyallup River, for a total of 15 days. Two primary sampling sites on the Puyallup River were used, beneath the 11th Street Bridge and at the Railroad Bridge. Other sites in other areas were added when possible.

The Treaty commercial fishery in the Puyallup River was chosen as the primary sampling area since tagged coho with and without adipose fins would be returning. Thus, a missing adipose fin would not serve as a reliable visual indicator for the presence of a CWT. Also, there would be four different groups of coho with CWT's: 1) standard length CWT's (1 mm) in fish adipose-clipped; 2) one and a half length CWT's (1.5 mm) in fish not adipose-clipped; 3) standard length CWT's in fish not adipose-clipped; and 4) standard length CWT's in fish adipose-clipped. There were also tagged and adipose-clipped coho from a freshwater lake net pen release expected to return to the Puyallup River.

Besides the Puyallup River, six days of sampling occurred in Area 13D, near Arcadia, a commercial area in south Puget Sound. Other commercial areas were only minimally studied by WDFW staff due to lack of available R-8 detectors. The R-8 was used three days in Area 11 (at Northern Fish Company in Tacoma), two days at the Duwamish River (First Avenue South Bridge), and one day in Bellingham at the Trident Fish Company (not included in this analysis). Figure 1 shows the commercial sampling areas where tests were conducted. The Appendix contains photos of each area.

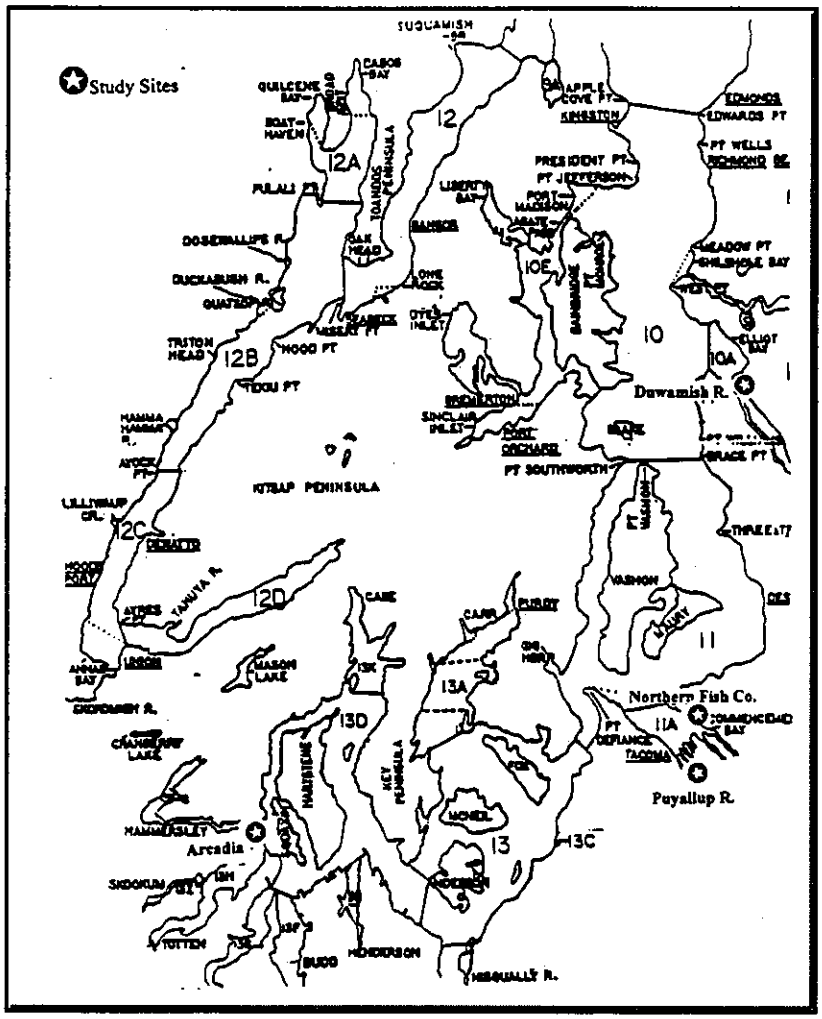

Figure 1. The commercial sampling areas where tests were conducted.

Puyallup River (81B)

Sampling occurred four days per week at the Puyallup River from September 1 through September 26, 1996, until fishing stopped due to a fishing accident. The sample design called for paired tests using 100 fish per sample. However, this was not possible due to low coho returns, low fishery effort, and the availability of buyers. Therefore, each paired test was divided into as close a number of fish for each as possible, aiming for 100 per sample. For instance, if 90 fish were sampled with the R-8, they were to sample 90, or close to 90 fish visually. The Wand was also compared with a paired visual sample. A visual sample amounted to determining if the adipose fin was absent or present.

To start the R-8 test, the R-8 was turned on, a small quantity of water poured in the R-8, and the timer started. One person took one fish at a time from a tote and inserted it in the R-8, same side down. This same person counted the fish. A person at the exit end of the R-8 sorted each fish by whether a tag was detected (it beeped or not) and whether the adipose fin was present or not. As soon as the last fish exited the R-8 the timer was turned off. Fish that were not adipose-clipped and no CWT detected (no beep) were placed in the buyer's tote, and the other fish processed. Fish were measured (fork length to the nearest centimeter), snouts were removed and whether a fish was adipose-clipped and a CWT detected was recorded on each snout label and coded on a mark sampling form. The processing of the fish (measuring and snout removal) was the same for each test and timing did not include this processing time.

The R-8 was designed with an automatic gate which sorts fish that beep (tag detected) from those which don't beep. However, the gate was not used for these tests due to problems with initial malfunctioning and the lack of its availability.

The Wand test was similar to the R-8 test. The difference at the Puyallup River was that fish were removed from the scale inside the buyer's truck and then sorted into tubs inside the truck. The sample started by turning on the Wand, starting the timer, and moving the Wand over each snout. Each fish with a CWT detected (beep) was placed in an empty tub (one for adipose clipped and one for non-adipose-clipped fish). Each fish with no CWT detected (no beep) and an adipose clip was placed in another tub. The fish were then processed as above. When a visual sample was performed to correspond with the R-8 or Wand test, a corresponding number of fish was placed in a tote. The timer was started and each fish was lifted and visually inspected for adipose clips. Adipose-clipped fish were then segregated for processing.

With one exception, whenever either the R-8 or Wand detected a CWT (beeped) the snout was taken to the WDFW CWT Lab for tag removal and reading. Samplers noted in their field books whether there was undue sand on the samples, or any other problems that may have affected the sample. Sand and mud was noted on samples from some days. Therefore, it became standard practice that the person inserting fish into the R-8 would run a finger and thumb over the body of the fish as it was placed inside the R-8. This did not appreciably slow the procedure and could be applied uniformly throughout the testing period. It did not guarantee that all sand was eliminated, however. As will be discussed later, it appeared that sediment did cause some false detections (tag detected but none found during lab dissection).

Area 11, Northern Fish Company

Sampling was similar to that conducted at the Puyallup River, except tests were conducted inside the fish processing plant, where there was a level floor. This eliminated the need to adjust the R-8's slope and provided samplers with a water hose to lubricate inside the R-8. While the R-8 could be used with the cutting table, sampling times did not coincide with the cutting times so fish were placed into tubs as they were at the Puyallup River. Wand tests were similar as before. The Wand also has a light as well as a sound (beep) that detects the presence of a CWT. The light was often relied on instead of the sound (beep) due to the noise inside the plant.

Duwamish River (80B)

This area was similar to the Puyallup River sampling sites. To use the R-8, fish needed to be handled more than either the Wand tests or the visual tests. Fish were sampled by taking individual fish out of a larger tote, running the Wand over the snout, then placing the fish in the appropriate smaller tubs in a buyer truck. The visual comparison was performed the same way.

Arcadia (13D)

Fish arrived from a commercial boat (after sunset and into the night) and were placed into a buyer's scale hung over the water. Once 40 to 50 fish were in the scale, they were weighed and rinsed with buckets of water, a procedure performed by the buyer. The fish from the scale were then dumped into a ½ size tote (2x4x4 feet) which was floating below the scale. A sampler would guide the floating tote into shore and pull it up the beach as far as possible. Fish then were transferred to other tubs for sampling. The R-8 needed to be placed far up on shore because of the tide and slope of the beach. All other procedures were the same.

RESULTS

Test results have been broken down by reliability, feasibility, and sampling effort and then by overall comparisons and each area's results. In order to analyze the data according to the three criteria previously described, samplers were required to write out each day's observations. They were to note what worked well, what did not work well, problems, and anything unusual. These observations are included in the feasibility section.

Table 1 shows Puyallup River commercially collected CWT's by release groups. The standard length, non-adipose-clipped fish (63 50 05) and the 1.5 mm length, non-adipose-clipped fish (63 58 25) were recovered at about the same rate. The standard length, adipose-clipped fish (63 52 58) released from a net pen in Lake Kapowsin (Puyallup system) were recovered at the highest rate, while the standard length, adipose-clipped fish (63 54 51) were recovered at an intermediate rate.

Table 1. Puyallup River Tag Recoveries.

Puyallup River CWT Release	Tags Released	Tags Recovered	Tags Recovered/ Tags Released
63 43 33 standard length adipose-clipped	1,073	2	.0019
63 50 05 standard length no adipose clip	20,395	21	.0010
63 58 25 1.5 length no adipose clip	20,166	19	.0009
63 54 51 standard length adipose-clipped	44,097	61	.0014
63 52 58 Lake Kapowsin standard length adipose-clipped	49,985	103	.0021
Total		206	

Eight different tag codes were recovered from the Duwamish River, four tag codes from Area 11, and seven tag codes from 13D. There was one unreadable tag code from the Duwamish River, as well. All of these tags were from adipose-clipped coho and were standard length CWT's. These recoveries are not listed separately for this analysis.

Reliability Test

Table 2 shows the total number of coho sampled for each area. A total of 6,481 coho were sampled including 1,707 with the Wand, 1,512 with the R-8, and 3,262 visually. Most of the sampling effort occurred on the Puyallup River and Arcadia (Area 13D). Tables 3 through 5 show the results of the Wand, R-8, and visual samples. The primary objective in testing the electronic detection equipment was whether the detectors missed the presence of a CWT. If significant numbers of tags were missed, the integrity of the CWT would be compromised.

A second objective was to determine whether significant numbers of tags were detected when no tags were actually present. This result would not compromise the integrity of the CWT but could substantially increase the number of snouts taken to the WDFW CWT Lab for dissection.

Table 2. Total coho sampled by study area.

AREAS	PUYALLUP RIVER	DUWAMISH RIVER	NO. FISH CO.- AREA 11	ARCADIA - AREA 13D	Total
Wand	620	130	22	935	1707
R-8	818	259	11	424	1512
VISUAL	1335	389	37	1501	3262
TOTAL FISH SAMPLED	2773	778	70	2860	6481

Wand

Eighty-five adiposed-clipped coho were tested with the Wand (Table 3). Out of the 85 adipose-clipped coho, 78 had verified tags in the CWT Lab. Of the 78 adipose-clipped, tagged fish, the Wand never failed to detect the presence of a coded-wire tag, i.e., 100 percent detection rate.

Table 3. Coded-wire tag detection of adipose-clipped and non-adipose-clipped coho using hand-held Wand detectors[1].

Wand		Adipose-Clipped Coho					Non-Adipose-Clipped Coho			
Area	Total Sampled	Total Adipose Clips	Wand did not Detect		Wand Detected		Non-Adipose-Clips	Wand did not Detect	Wand Detected	
			Tag	No Tag	Tag	No Tag			Tag	No Tag
Puyallup R.	620	51	0	2	48	1	569	548	14	7
Duwamish R.	130	10	0	1	8	1	120	118	1	1
No. Fish - Ar. 11	22	2	0	0	2	0	20	20	0	0
Arcadia - 13D	935	22	0	0	20	2	913	913	0	0
Totals	1707	85	0	3	78	4	1622	1599	15	8

[1] Actual presence of tag was determined in the WDFW Coded-Wire Tag Lab.

Also, 4 of 7 adipose-clipped, untagged fish sampled with the Wand were false detections. A false detection means that a tag was detected (beeped) but no tag was found in the CWT lab. For non-adipose-clipped, untagged coho sampled with a Wand, 8 false detections were recorded out of 1,607 sampled. Combining the adipose-clipped and non-adipose-clipped untagged samples, 0.74 percent (0.32% - 1.16% CI_{95}) were false detections (Table 6).

R-8

Eighty-seven adiposed-clipped coho were tested with the R-8 (Table 4). Out of 87 adipose-clipped coho, 80 had verified tags in the CWT Lab. Of the 80 adipose-clipped, tagged fish, the R-8 failed to detect the actual presence of 1 CWT, a detection rate of 98.89.

Table 4. Coded-wire tag detection of adipose-clipped and non-adipose-clipped coho using R-8 tube detectors[2].

R-8		Adipose-Clipped Coho					Non-Adipose-Clipped Coho			
Area	Total Sampled	Total Adipose Clips	Wand did not Detect		Wand Detected		Non-Adipose-Clips	Wand did not Detect	Wand Detected	
			Tag	No Tag	Tag	No Tag			Tag	No Tag
Puyallup R.	818	54	1	1	50	2	764	728	26	10
Duwamish R.	259	20	0	0	19	1	239	236	0	3
No. Fish - Ar. 11	11	1	0	0	1	0	10	10	0	0
Arcadia - 13D	424	12	0	0	9	3	412	405	0	7
Totals	1512	87	1	1	79	6	1425	1379	26	20

[2] Actual presence of tag was determined in the WDFW Coded-Wire Tag Lab.

Table 5. Coded-wire tag detection using visual identification of missing adipose fin[3].

VISUAL		Adipose-Clipped Coho		
Area	Total Sampled	Total Adipose Clips	Adipose-Clipped	
			Tag	No Tag
Puyallup River	1335	78	70	8
Duwamish River	389	40	38	2
No. Fish.- Area 11	37	4	2	2
Arcadia - Area 13D	1501	32	25	7
Totals	3262	154	135	19

[3] Actual presence of tag was determined in the WDFW Coded-Wire Tag Lab and all non-adipose-clipped coho were assumed to be untagged.

Also, six out of seven adipose-clipped, untagged coho sampled with the R-8 were false detections. For non-adipose-clipped, untagged coho sampled with the R-8, 20 of 1,399 were false detections. Combining the adipose-clipped and non-adipose-clipped, untagged samples, 1.85 percent (1.14% - 2.55% CI_{95}) were false detections (Table 6). In addition to these false detections, there were eleven non-adipose-clipped coho that beeped initially in one Duwamish River sample. These fish had considerable sand and mud on them. They were subsequently washed off and put back through the R-8. The fish did not beep (no tags detected) a second time. The samplers believed that the initial false detections were due to the sediment, however, none of the snouts were taken for verification in the lab.

Table 6. Percent of false detections (tag detected but not present) for Wand, R-8 and visual tests[4].

	SAMPLE SIZE	NUMBER OF FALSE DETECTIONS	PERCENT FALSE DETECTIONS	PERCENT STANDARD ERROR	95 % CONFIDENCE INTERVAL
WAND	1614	12	0.74%	0.21%	0.32%-1.16%
R-8	1406	26	1.85%	0.36%	1.14%-2.55%
VISUAL	3127	19	0.61%	0.14%	0.34%-0.88%

[4] For visual sampling, all adipose-clipped snouts were taken to the WDFW Coded-Wire Tag Lab for disectin and all non-adipose-clipped fish were assumed to be untagged.

Visual

Of 3,127 untagged coho sampled during the visual tests, 19 (0.61 %, 0.34% - 0.88%, CI_{95}) were false detections. This result assumed that all non-adipose-clipped coho were untagged.

In summary, tests indicated that both the Wand and the R-8 were very reliable in detecting the presence of a CWT, only missing one tag out of 158 adipose-clipped, tagged coho sampled with the electronic detection equipment. False detection rates for the Wand and the R-8 were 0.74 percent and 1.85 percent, respectively. These percentages were higher than visual sampling but the difference between the Wand and visual sampling was not significant at the 95 percent confidence level.

It was documented in sampling field notes that the Wand did pick up noise easily from other equipment, or metal, which caused it to beep. These issues are discussed under Feasibility.

Feasibility Test - R-8

The R-8 was placed on a gurney to allow for maneuverability. While this worked better than the stationary legs that were originally on the R-8, there were still some problems when the R-8 was used in the field. Other problems also arose when sampling fish outdoors.

At the Puyallup River and the Arcadia site (13D) it was difficult to find a level surface. On the Puyallup River, the work site which was finally used was a graveled, rutted surface and was up a small bank from the river. It was difficult to level the R-8 and achieve a proper angle. The first site tried at the Puyallup River (11th Street Bridge) the buyer used the narrow, rock-sided boat ramp which prevented the samplers from setting up close to the buyer. They then tried setting up on a pavement area, quite a distance from the buyer which required carrying the fish over to the R-8. As a consequence, they changed their sampling location to the Railroad Bridge. The Arcadia site also required that the R-8 be placed some distance from where the fish were being purchased. The slope where the buyer was located was too steep and logistically fish could not be taken directly from the fish tote and placed through the R-8. This necessitated additional handling of fish when using the R-8.

Handling was a significant concern with the buyers. At Arcadia, the buyer felt that the fish dropping into the sampling tubs from the mouth of the R-8 caused bruising. While this could be argued, the perception of mis-handling, and/or over-handling caused a problem at this site. Samplers were not allowed to use the R-8 shortly after that and resorted to Wand and visual sampling thereafter. Even at the Duwamish site, while the buyer was cooperative, he, too, was worried about additional handling of fish.

Another problem documented by the field crew was fish not passing through the R-8 easily. During days when it was not raining, fish would stick inside the tube of the R-8. The problem occurred at all sites but could be alleviated by pouring water into the tube. At the Puyallup River, one to five gallons of water was needed to process 100 fish. Since the sampling site was up a bank, away from the water, this required samplers to carry the buckets up a steep grade frequently. This was time consuming and strenuous. At the indoor sampling area, Northern Fish Company, a water hose was available which prevented the fish from sticking. During one of the two days of sampling on the Duwamish it rained heavily. This not only prevented the fish from sticking, but it also may have cut down on additional false detections.

The sorting gate designed for the R-8 malfunctioned and was removed early on in the sampling season. A switch malfunctioned which was subsequently repaired. The gate was not available to the Puget Sound sampling crew after it was repaired and will be tested further in 1997. If all R-8's had the device, and it worked properly, processing time and handling should be reduced considerably.

Some problems during initial sampling with the R-8 occurred. Personnel found it difficult to accurately adjust the delay and gain knobs, and the manual was unclear.

At the Northern Fish Company and at the Duwamish River site, noise was a problem. The indoor site made it difficult to hear the beep on either the Wand or R-8 due to noise from forklifts, processing machinery and shop radios. While the Wand had a light to rely on, the R-8 did not. At the Duwamish River there was noise from traffic and construction in the area. Whether this caused additional sampling errors is not known although no missed tags (tags that were not detected with the equipment) were recovered at the Duwamish River site. Conceivably, tagged, unmarked fish could have been missed if samplers could not hear the beep from the equipment. The reverse may also be true. If they thought they heard a beep, but it was noise from other equipment or traffic in the area, they would take a snout that did not have a tag.

Sampling in the dark at Arcadia, proved to be a problem when using the tube. The mechanics of transporting fish from the scale to the R-8 and following through with the sampling procedure was difficult when there was just a headlight.

Feasibility Test - Wand

Often, sampling occurs inside of the buyer's truck. When using a Wand in this situation, metal would set off the detector. Extra care needed to be taken in all situations, to make sure the Wand was away from metal. During outside sampling when it rained, samplers wore rain gear. The metallic rain gear snaps had to be avoided when using the Wand.

Most concerns voiced by samplers were that increased care needed to be taken when sampling too close to metal objects, possibly slowing fish sampling, and the Wand was heavy if used for large amounts of fish. The Wand is weighted more near the end of the rod rather than near the handle and the handle is too large for small to medium size hands.

The Wand also received positive feedback. The light on the Wand was useful in high noise areas. Samplers also felt that in many situations, despite increases in time, the Wand provided better access to commercial fish than the R-8.

Sampling Effort

Samples were paired by one electronic detector sample with one visual sample. When there was no directly comparable sample, the sample was not used in the sampling time analysis. Therefore, some total sample sizes for areas will not be the same as in other sample analyses.

Table 7 shows the number of paired time tests taken. A total of 48 paired tests were performed. While personnel tried to perform an equal number of tests with both types of detectors, this was not always possible, and in Area 11, there were minimal samples taken.

Table 7. Number of paired tests completed by area that compared time to sample for coded-wire tags using electronic tag detection methods versus visual identification.

Paired Tests	Puyallup River	Duwamish River	No. Fish Co. -Area 11	Arcadia - Area 13D	Total
Wand/Visual	11	3	2	9	25
Tube/Visual	13	4	1	5	23
Total	24	7	3	14	48

Length of time was standardized, since not all samples contained the exact number of fish. All processing test times using the electronic equipment have been divided by seconds per fish, multiplied by 100 and divided by 60 to get the number of minutes per 100 fish.

Table 8 shows the average sampling time for each site, for the Wand, R-8 and visual sampling based on 100 coho sampled. Figure 2 illustrates the differences in time to sample 100 coho per area per equipment and visual sampling. In all areas, time to sample increased using both the Wand and the R-8 over visual sampling. Since the timer did not start until the fish were ready to be placed into the tube of the R-8 or picked up to sample with the Wand, the indicated time differences should be considered a minimum. The handling time which was required to use equipment, particularly the R-8 is in addition to these averages. In addition, the average times for the R-8 included use of two people rather than one person used for both the visual and Wand tests.

Table 8. Sampling rates at different locations comparing different sampling methods for detecting coded-wire tagged coho in Puget Sound terminal commercial fisheries [5,6].

COMMERCIAL SAMPLING LENGTH OF TIME TESTS			
LOCATION	SAMPLING METHOD	TOTAL SAMPLED	MIN. PER 100 FISH
80B	R-8 (TUBE)	259	7.00
Duwamish River	WAND	130	7.68
	VISUAL	389	2.27
AREA			
81B	R-8 (TUBE)	818	6.37
Puyallup River	WAND	620	5.48
	VISUAL	1335	2.20
AREA			
11	R-8 (TUBE)	11	5.75
No, Fish Co.	WAND	22	6.28
	VISUAL	37	2.70
AREA			
13D	R-8 (TUBE)	459	5.47
Arcadia	WAND	935	4.98
	VISUAL	1370	3.20

[5] Only samples that have been paired with one other equipment test were used. Therefore, sample totals are less than in other tables.

[6] Timed tests for the R-8 were with the use of two people versus one person used for the Wand and Visual tests.

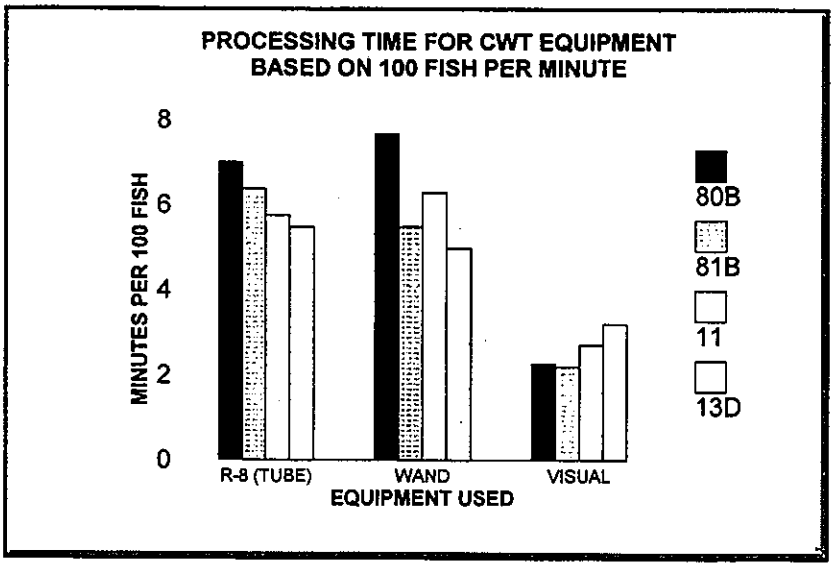

Figure 2. The differences in time to sample 100 coho per area per equipment and visual sampling.

For the R-8, at the Puyallup River site, sampling increased by just under three times the length of visual sampling. Other sites were as follows: Duwamish - three times longer, Area 11 (at the fish plant) - two times longer, and in Area 13D (Arcadia) - 1-3/4 times longer.

The Wand, too, showed considerable increase in sampling time. The following increases were as follows: Puyallup River - 2-½ times longer, Duwamish River - 3-1/3 times longer, Area 11 - 2-1/3 times, and in 13D - 1-½ times. A number of fish in Area 13D (Arcadia) were sampled in evening or nighttime conditions. This might have affected the length of time needed to use equipment. It is important to remember that Puyallup coho are generally smaller than coho in other areas, and handling larger fish may have increased the time. In Area 11, sampling with the Wand took longer than using the R-8 although the sample size was very small. However, according to field observations, the R-8 was much easier to use indoors.

CONCLUSIONS AND RECOMMENDATIONS

Based on the test results, the R-8 and Wand appear to be highly reliable in detecting CWT's in coho, at least at the sites studied for the 1996 terminal commercial net fishery. Only one missed tag (tag not detected by the equipment but dissected from the snout at the CWT lab) was found out of a total of 158 adipose-clipped, tagged coho sampled. The study showed that tags were not missed by the electronic sampling equipment.

The reverse situation, detecting a tag when none exists (false detections) occurred more frequently. While many of these false detections were probably due to sediment on the fish, there was no easy way to eliminate the sediment, without additional time, and water was not easily available at most sites. The rate of false detections was low (0.74 percent for the Wand and 1.85 percent for the R-8). The rate of false detections for visual sampling was significantly lower than the R-8 but not significantly different than the Wand.

It appeared that most of the false detections from electronic sampling were from fish associated with mud or sand. Where sediment is a problem, procedures could be developed to rinse fish before they are screened by either the Wand or an R-8.

Even though there were too few samples to really test the equipment in a larger volume sampling situation, it is apparent that sampling fish at some buyers locations with the R-8 will be difficult. Fish will have to be handled more than visual sampling and it may not be practical to use the R-8 at some locations.

Fish in all locations except at Northern Fish Company which is indoors, required handling the fish at least twice more than during visual sampling. This caused tension with some buyers, and slowed the samplers, even though the additional time to move fish was not included in any of the time tests.

The Wand could be used at most locations where fish were being bought. If there was no additional interference, the Wand often was preferred over the R-8 by samplers even though it was slower than visually sampling fish and became heavy when large numbers of fish were sampled.

WDFW used two crew members for this study. Two people were necessary since one person fed the fish down the R-8 and the other retrieved and sorted out any fish that had an adipose fin clip or that beeped. Two were

needed to carry the tubloads of fish to the sampling area and then back to the buyer. The crew felt that it was important that one stay with the equipment while the other fetched water from the riverbank, or other necessary items from the truck. With visual sampling, two samplers are generally only required when encountering large quantities of fish. This needs to be addressed when future commercial sampling requires staff to use electronic detectors. The time it takes to sample a commercial fishery is critical when there are an abundance of fish. The study indicates that there is an increase in sampling time when using either piece of electronic equipment. While some of the time could be decreased by the use of the gate and counter on the R-8, there will still probably be additional sampling time needed due to the logistics of an area, and the need to handle fish more often. Further tests of the R-8 with the gate and counter should be conducted to determine whether it is practical to sample with one person instead of two.

Noise is a problem both in a fish processing company and outdoors, due to traffic, forklift equipment, and radios. The samplers stated that it would be helpful to have a light on the R-8 to rely on when they have difficulty hearing over the noise. Even with the sorting gate in place, the light and sound would help determine if the gate was functioning properly.

Due to coho not easily sliding through the R-8, there should be some way to provide water down the tube. Possibly a small water pump could be used. Otherwise, samplers must manually pull the fish out of the R-8 or haul buckets of water up from the river or Puget Sound.

In summary, the reliability of the electronic equipment tested appears high. Modifications to the detection equipment could be made to increase its efficiency. Additional sampling staff will be needed to maintain current sampling rates if electronic detection is universally utilized in terminal net fisheries. Consideration should be given to other logistical problems encountered during the 1996 season and changes incorporated for testing during the 1997 season. Additional Wands and R-8's with diverter gates and counters should be available during 1997 to familiarize all sampling staff with electronic sampling equipment. Familiarization with the different equipment and their respective attributes will better enable samplers to determine which piece of equipment is best suited for a particular site and volume of fish.

APPENDIX

Figure 3. The Puyallup River site during the electronic equipment (R-8) study period.

Figure 4. Inside the Northern Seafood Company's fish processing plant during the electronic equipment (R-8) study.

Figure 5. Sampling with the electronic equipment (R-8) at the Duwamish River during the study period.

Figure 6. Using the electronic equipment (R-8) at Arcadia during the study period. The bank drops off steeply from the truck door to the water edge.

Figure 7. A demonstration using the electronic wand.