Appendix 3. Returns of chinook salmon coded-wire tagged with 1.1 mm and 1.5 mm coded-wire tags and adult electronic detection.

H. Lee Blankenship[1], D. Thompson[2], G. Vander Haegen[1]

[1]WDFW, 600 Capitol Way North, Olympia, WA, 98501-1091
[2]Northwest Marine Technology, Inc., 2401 Bristol Ct. SW, Olympia, WA, 98502

In Washington, anadromous salmon have historically been, and are still, economically and culturally important. However, many salmon populations have declined to the lowest levels ever recorded, resulting in drastic reductions in the sport and commercial fisheries. In 1993, the Washington State Legislature mandated mass marking of appropriate hatchery salmon to allow the possibility of selective fisheries for exploitation of healthy stocks, while protecting weak stocks. Excision of the adipose fin was chosen as the mass mark for hatchery fish because it is easily identified by anglers, the associated mortality is low compared to the excision of other fins, and it is inexpensive to apply (PSMFC 1992). In a selective fishery, anglers could retain salmon missing an adipose fin, but must release those with an adipose fin.

Before 1996, a missing adipose fin had signified the presence of an internal coded-wire tag (CWT). Sequestering the adipose clip to designate a hatchery reared fish therefore meant that the presence of a CWT could not be determined from this clip. Using a second fin clip, such as a right or left ventral clip to designate the presence of a CWT was unacceptable because of the high associated mortality. Therefore, electronic detection was chosen for recovering CWT salmon. Four tools are used to electronically detect CWTs: a portable hand-held wand, a V-shaped portable sampling detector, and two rectangular tunnel detectors, the R-8000 and the R-9500, all manufactured by Northwest Marine Technology. Recreational fisheries and fish recovered during spawning ground surveys generally will be sampled using the hand-held wand detector, and commercial fisheries and hatchery rack recoveries generally will be sampled using the tunnel detectors.

The standard length of a CWT is 1.1 mm. A portable wand detector can detect this tag from a distance of 20 mm. However, on a large salmon, the tag may be more than 20 mm from the surface, and could go undetected by the wand. The detection distance can be increased to 30 mm by using 1.5 mm CWT, and therefore decrease the number of missed tags. However, using a longer CWT could interfere with an internal compass, or damage the olfactory nerves and increase straying or reduce survival (Morrison and Zajac 1987, Morrison et al. 1990, Habicht et al. 1998). To further enhance detectability, "new" wire was manufactured with a stronger magnetic moment than "old" wire, such that the magnetic moment of the new 1.5 mm wire is about 200% stronger than that of the old 1.1 mm wire. The magnetic moment of 1.1 mm new wire is about 60% stronger than that of the old 1.1 mm wire (Northwest Marine Technology, pers. comm.)

This study had two objectives: first, to test whether using 1.5 mm CWT affects adult hatchery rack returns compared to 1.1 mm wire, and second, to test whether 1.5 mm CWT can be detected with greater accuracy than 1.1 mm CWT using a wand detector. Hatchery rack returns represent only part of the overall survival to adult. However, if the longer and larger magnetic moment tags reduced survival or increased straying, the effects would be measurable at the hatchery rack.

Methods

This study was done at Hupp Springs, Soos Creek and Kendall Creek hatcheries, all owned and operated by the Washington Department of Fish and Wildlife (WDFW). Hupp Springs and Soos Creek hatcheries are in South Puget Sound, Kendall Creek Hatchery is on the Nooksack River in North Puget Sound. At each hatchery, equal numbers of 1994 brood year chinook were simultaneously tagged with either old 1.1 mm or new 1.5 mm coded wire tags and marked with an adipose fin clip (Table 1). Standard WDFW procedures were used for tagging (Schurman and Thompson, 1990). The tagged fish were mixed into the same rearing vessel and reared until release as either yearlings or subyearlings. At 21 days after tagging, quality control checks were performed on about 1500 chinook from each study group to determine CWT loss and poor adipose fin clip rates. Release numbers were adjusted accordingly.

Table 1: Tagging and release parameters, 1994 brood year chinook.

Hatchery	Race	Tag Code	# Tagged Fish Released	Tag Type	Release Stage	Mean FPP Tagged	Mean Length Tagged (mm)	% Tag Retention
Hupp Springs	Spring	635828	127,094	1.1 mm, Old Wire	Subyearling	160	65	98.2
Hupp Springs	Spring	635833	127,786	1.5 mm, New Wire	Subyearling	160	65	98.8
Hupp Springs	Spring	635827	43,662	1.1 mm, Old Wire	Yearling	190	61	97.7
Hupp Springs	Spring	635832	44,094	1.5 mm, New Wire	Yearling	190	61	98.9
Soos Creek	Fall	635826	149,740	1.1 mm, Old Wire	Subyearling	92-248 (range)	77-56 (range)	98.5
Soos Creek	Fall	635831	150,986	1.5 mm, New Wire	Subyearling	92-248 (range)	77-56 (range)	99.1
Kendall Creek	Spring	635829	90,412	1.1 mm, Old Wire	Subyearling	180	62	98.8
Kendall Creek	Spring	635834	85,370	1.5 mm, New Wire	Subyearling	180	62	98.8
Kendall Creek	Spring	635830	82,544	1.1 mm, Old Wire	Yearling	140	67	99.8
Kendall Creek	Spring	635835	80,691	1.5 mm, New Wire	Yearling	140	67	99.4

At the three hatcheries in the fall 1998, returning adults were examined for CWT using a hand-held wand detector. If no CWT was detected, the fish was passed through an R9500 rectangular tunnel detector. In this way, the fish were sorted into three groups: CWT detected using only the wand, CWT not detected using the wand, but detected with the rectangular detector, and no CWT detected. All fish with CWT were measured, the sex noted, and the snout removed for CWT recovery. At Kendall Creek Hatchery, coded-wire tags from the first group of fish spawned was recovered by visual identification of fish missing their adipose fin because the electronic detection equipment was unavailable.

These 261 heads are included in calculations of the percent return. At Hupp Springs, one extra tag was recovered by visual identification of a fish missing its adipose fin.

Results

Tag Retention

There was no significant difference in tag retention between the old 1.1 mm wire and the new 1.5 mm wire at release ($t=0.31$, $p<0.05$). These retention rates help confirm the statement "WDFW and CDFO tagging supervisors believe that length-and-a-half CWTs can be easily placed in 60 mm (2.2 g) salmon" (SFEC 1995).

Tag Detection

On average, the wand detected 454/500 (90.8%) of the old 1.1 mm wire tags, and 500/503 (99.4%) of the new 1.5 mm wire tags it was exposed to (Table 2).

Table 2: Tag detections and adult returns. Because only the 1998 rack recoveries are currently available, the estimates of adult returns are preliminary. Superscript letters indicate where a chi-square analysis indicated a significant difference in hatchery rack returns at the 0.05 level between the fish tagged with 1.1 mm and 1.5 mm wire within each release type. NSD = no significant difference in hatchery rack returns.

Tag Code	Tag Type	Release Stage	# Detected with Wand	# Missed with Wand	% Detected	% Return
Hupp Springs, Spring Chinook						
635828	1.1 mm, Old Wire	Subyearling	37	0	100	0.03[NSD]
635833	1.5 mm, New Wire	Subyearling	42	0	100	0.03[NSD]
635827	1.1 mm, Old Wire	Yearling	6	0	100	0.01[a]
635832	1.5 mm, New Wire	Yearling	18	0	100	0.04[a]
Soos Creek, Fall Chinook						
635826	1.1 mm, Old Wire	Subyearling	77	19	80.2	0.06[NSD]
635831	1.5 mm, New Wire	Subyearling	102	1	99.0	0.07[NSD]
Kendall Creek, Spring Chinook						
635829	1.1 mm, Old Wire	Subyearling	327	27	92.4	0.54[NSD]
635834	1.5 mm, New Wire	Subyearling	334	2	99.4	0.53[NSD]
635830	1.1 mm, Old Wire	Yearling	7	0	100	0.02[b]
635835	1.5 mm, New Wire	Yearling	4	0	100	0.01[b]

The mean size of fish with undetected tags was significantly larger than the mean size of fish with tags the wand could detect ($t=9.24$, $p<0.001$). However, the sizes of fish with undetected tags fell within the range of sizes with detected tags (Figure 1). That is, there was no cut off after which a tag could no longer be detected, but as a fish grew larger, the probability of detecting its tag declined. Because males tend to be larger, the probability of missing a tag was significantly higher in males than in females ($\chi^2=28.246, p<0.001$).

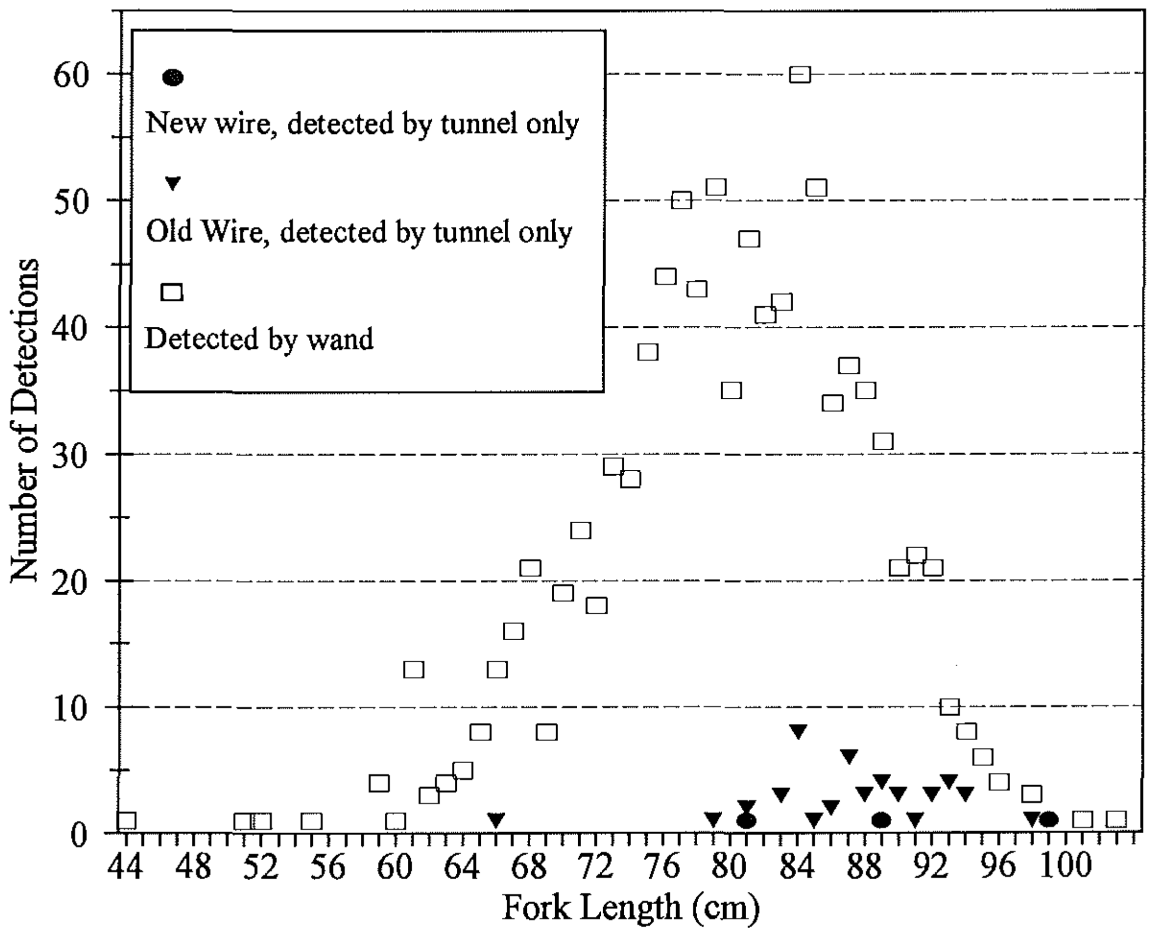

Figure 1: Fork lengths of fish detected by the wand or missed by the wand and detected by the rectangular tunnel detector. The mean size of the fish with missed tags was significantly larger than the mean size of fish with detected tags ($p=9.24$, $p<0.05$).

<u>Hatchery Rack Returns</u>

Hatchery rack returns were estimated by dividing the number of tags recovered at the hatchery racks in 1998 by the number of tags released. Because only one year of rack recovery data is available, these are preliminary estimates. For all hatcheries combined, preliminary tag recoveries (Table 2) show no significant difference in hatchery rack returns between fish tagged with old 1.1 mm wire compared to fish tagged with new 1.5 mm wire. Separately, significantly more Hupp Springs spring chinook released at age 1+ and tagged with new 1.5 mm wire returned than those tagged with old 1.1 mm wire. Conversely, significantly more Kendall Creek spring chinook released at age 1+ and tagged with old 1.1 mm wire returned than those tagged with new 1.5 mm wire. The yearling groups from Hupp Springs and Kendall Creek both had low return rates.

<u>Discussion</u>

The wand detected 91% of old 1.1 mm wire tags it was exposed to, and 99% of the new 1.5 mm wire tags. Thus, the stronger magnetic moment of the new wire improved detectability by about 8%. This improved tag detectability will result in a substantial number of tag recoveries when the total number of fish checked in a year is considered. The preliminary hatchery rack recoveries show that this improved detectability did not compromise chinook adult returns to the hatchery.

Because the wand was able to detect a CWT in the largest fish, it is likely that the techniques of the person using the wand plays a significant role in detection success, and that the correct technique is especially important for larger fish. When a wand is to be used for CWT recovery, the possibility of missed tags disproportionately representing fish larger than 80 cm needs to be considered. This bias will be greatly minimized by using the new, 1.5 mm wire and by careful use of the wand. An alternative approach to 1.5 mm wire would be to use the portable sampling detector for fish greater than 80 cm fork length.

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