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The Application Of Bar Code Symbology As Applied To Thermal Marking Programs In Washington State

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The thermal marking programs currently in place in Washington State use a bar code symbology to distinguish between release groups. The rationale for this approach was documented in Volk et al. 1994. As practiced in Washington State, each pattern is composed of six thermal rings, which define 5 spaces between the rings. Ring spacing is either narrow or wide. In any given pattern, two of the five spaces will always be one or the other, and the order of their placement produces a unique code. This code symbology is based on an underlying binary pattern and is directly analogous to the discrete '2 in 5' bar code label scheme used world-wide for product inventory control.

An example of this approach can be seen in the patterns applied to the 1997 Cedar River sockeye releases (Table 1). Like most of the other thermal marking projects in Washington, the goal of the program is to evaluate release strategies and fish behavior. The otoliths of outmigrating smolts are examined as well as adults returning to specific locations along the natal streams. The otoliths are not collected from mixed stock fisheries. For the 1997 brood year, nine unique patterns were induced over an 18 to 27 day period after hatching took place. Each pattern consisted of six thermal rings and included ring spacing that consisted of either two narrow spaces and three wide or two wide and three narrow. Using this approach there are potentially 20 distinct codes available from a six thermal rings. For practical purposes only a subset of those patterns are used if a full suite of codes is not needed.

The Cedar River marking program has been taking place since 1993 and the number of fish involved has ranged from 5 to 15 million per year. Along with the bar code symbology, brood years are generally distinguished by using a pre hatch 'toggle' code, which consists of a few thermal rings with variable spacing that are induced while the fish are in the egg stage. In previous years, over 30 distinct codes have been produced at one time by combining pre hatch 'toggle' patterns with the '2 in 5' bar code patterns.

The accuracy of identifying thermal marks in returning adult salmon has been conducted through blind planting of known marked fish in routine processing. The results indicate that accuracy can be high, but the success is quite variable depending on mark quality (Eric Volk, Washington Dept of Fisheries, manuscript in review).

While most thermal marking in Washington State is associated with release studies requiring a large number of codes, one program, conducted in association with Tulalip Indian Tribes, has been examining commercial harvest catches in a local fishery for thermal marks. This program has been underway since 1993 with the purpose of estimating hatchery contribution. Generally, 2 million thermal marked chinook are released each year by the hatchery. Because there is no need to distinguish between marked groups, only one or two bar code patterns are used along with a pre hatch 'toggle' code to distinguish between brood years.

Since thermal marking in Washington is used for purposes associated with specific projects near the release and return locations, there has been little need to combine the marking information into a single reporting format or to distinguish between groups that return to different locations. However given the recent interest in high-seas recoveries of thermal mark otoliths, this information may be of value over the next several years. It is expected that prehatch toggle codes combined with a bar code symbology based on an underlying binary scheme of narrow and wide ring spacings, will remain the basis for identifying thermal releases in Washington State.

Reference:

Volk, E.C., S.L. Schroder, J.J. Grimm, and H.S. Ackley 1994. Use of Bar Code symbology to produce multiple thermal induced otolith marks. *Trans. Amer. Fish. Soc.* 123: 811-816.

Table 1. Thermal Mark induction codes applied to the Cedar River sockeye from the 1997 brood year

INCUBATOR	TAKE DATE	MARK GROUP	START POST-HATCH		END POST-HATCH		PATTERN	SYMBOL
			DATE	DAYS	DATE	DAYS		
K1A	9/25/97	E1	12/23/97	89	12-Jan	109	WWNNN	
K2A	9/29/97	E1	12/27/97	89	16-Jan	109	WWNNN	
K3A	9/29/97	E1	12/27/97	89	16-Jan	109	WWNNN	
K4A	10/1/97	E2	12/29/97	89	19-Jan	110	WNWNN	
K5A	10/1/97	E2	12/29/97	89	19-Jan	110	WNWNN	
K6A	10/6/97	E2	1/6/98	92	28-Jan	114	WNWNN	
K7A	10/6/97	E3	1/7/98	93	28-Jan	114	WNNWN	
K8A	10/7/97	E3	1/7/98	92	28-Jan	113	WNNWN	
K9A	10/7/97	E3	1/6/98	91	29-Jan	114	WNNWN	
K10A	10/7/97	E3	1/8/98	93	29-Jan	114	WNNWN	
K11A	10/9/97	E3	1/9/98	92	30-Jan	113	WNNWN	
K12A	10/9/97	E3	1/9/98	92	30-Jan	113	WNNWN	
K13A	10/13/97	E3	1/9/98	88	31-Jan	110	WNNWN	
K14A	10/13/97	E3	1/11/98	90	31-Jan	110	WNNWN	
S1	10/13/97	E3	1/10/98	89	1-Feb	111	WNNWN	
K15A	10/14/97	M1	1/12/98	90	2-Feb	111	WNNNW	
K16A	10/14/97	M1	1/12/98	90	2-Feb	111	WNNNW	
K17A	10/16/97	M1	1/12/98	88	2-Feb	109	WNNNW	
K18A	10/16/97	M2	1/14/98	90	3-Feb	110	WNWNW	
K19A	10/16/97	M2	1/14/98	90	9-Feb	116	WNWNW	
K20A	10/20/97	M2	1/14/98	86	8-Feb	111	WNWNW	
S2	10/16/97	M3	1/17/98	93	11-Feb	118	WNWNW	
K21A	10/20/97	M3	1/17/98	89	11-Feb	114	WWWNN	
K22A	10/20/97	M3	1/17/98	89	11-Feb	114	WWWNN	
S3	10/20/97	M3	1/17/98	89	11-Feb	114	WWWNN	
K23A	10/22/97	M3	1/19/98	89	13-Feb	114	WWWNN	
K24A	10/22/97	M3	1/20/98	90	12-Feb	113	WWWNN	
K1B	10/27/97	M3	1/25/98	90	21-Feb	117	WWWNN	
K2B	10/27/97	M3	1/25/98	90	21-Feb	117	WWWNN	
K3B	10/28/97	M3	1/26/98	90	20-Feb	115	WWWNN	
K4B	10/28/97	L1	1/26/98	90	16-Feb	111	NWNNW	
K5B	10/28/97	L1	1/26/98	90	16-Feb	111	NWNNW	
K6B	10/30/97	L2	2/3/98	96	25-Feb	118	NWNNN	
K7B	10/30/97	L2	2/3/98	96	25-Feb	118	NWNNN	
K8B	10/30/97	L3	2/3/98	96	26-Feb	119	NNWWN	
K9B	10/30/97	L3	2/2/98	95	23-Feb	116	NNWWN	
K10B	11/3/97	L3	2/1/98	90	22-Feb	111	NNWWN	
K11B	11/3/97	L3	2/1/98	90	22-Feb	111	NNWWN	
K12B	11/3/97	L3	2/1/98	90	22-Feb	111	NNWWN	
K13B	11/6/97	L3	2/3/98	89	24-Feb	110	NNWWN	
K14B	11/6/97	L3	2/3/98	89	24-Feb	110	NNWWN	
S4	11/10/97	L3	2/7/98	89	28-Feb	110	NNWWN	
S5	11/14/97	L3	2/11/98	89	4-Mar	110	NNWWN	
S6	11/20/97	L3	2/17/98	89	10-Mar	110	NNWWN	
S7	11/24/97	L3	2/21/98	89	11-Mar	107	NNWWN	
S8	12/1/97	L3	2/28/98	89	21-Mar	110	NNWWN	
S9	12/5/97	L3	3/4/98	89	25-Mar	110	NNWWN	
S10	12/10/97	L3	3/9/98	89	30-Mar	110	NNWWN	