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*Thermal mark patterns Applied to Salmon from Alaska,  
Washington and Oregon for Brood Year 1999 and Some  
Proposed Marks for Brood Year 2000*

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## **Abstract**

In the States of Washington and Alaska, mass marking salmon through the method of otolith thermal marking is proving to be an effective research and management tool in a variety of situations. However the specific needs and applications for marking are not same in each state. This document contains a report of thermal mark patterns applied to salmon stocks from the 1999 brood year. It includes release numbers where known and mark patterns applied in Alaska, Washington, Oregon and by Treaty Tribes

## **Summary of Alaska thermal marking programs**

In Alaska, the primary use of thermal marking is to provide information about the contribution of hatchery fish, primarily pink, chum and sockeye, to commercial and cost-recovery fisheries during the summer fishing season. Several on-going programs use this information as an aid to the in-season management of mixed stock fisheries and hatcheries use the information to evaluate the success of various release strategies. In research applications, thermal marks have been used to answer questions regarding lake survival and to provide information on straying rates of returning adults. In addition the presence of otolith thermal marks is being used to determine the origin of juvenile and immature salmon obtained in high seas collections. In many instances thermal marks are being applied in hatcheries without a directed sampling program in place. The reasons vary but it is primarily done in situations where the marks cost little to apply and there is an anticipation that a sampling program maybe put together by the time the fish return.

Thermal mark patterns are assigned annually by the Alaska Department of Fish and Game with consideration based on the constraints of the hatchery, management needs to identify those stocks and presence of a funded program to recover the thermal patterns. Thermal marking is expected to expand in the next couple of years and there is increasing difficulties in apply unique thermal patterns.

A list of thermal marks applied to hatchery reared salmon in Brood Year 1999 is shown in Table 1. The number released to date is over 900 million from 49 different marking groups. Included is the first strontium mark fish released by Gulkana Hatchery as part of a new program. The otolith pattern is presented both as the Rbr notation (Munk and Geiger 1998 ) with slight modifications by Hagen (1999) as well as the equivalent Hatch Notation. The Hatch Notation is similar to the RBr code in that thermal rings are considered to be grouped into bands of rings that are evenly spaced. The primary difference is that the hatch event is denoted with an 'H' and the position in the code indicates what rings are formed pre or post hatch. Both notations are shown in the tables as well as graphic representation of the mark.

Information regarding thermal marked patterns and numbers of released fish in Alaska is available from the Alaska Dept. of Fish and Game's Coded Wire Tag and Otolith Processing Laboratory database

For the marks applied to the 2000 brood stock, the intention in Alaska is to apply similar patterns as in previous years. There is slight increase in the number of hatcheries applying thermal marks, though at this point the pattern that will be laid down by all facilities have not been evaluated. Effort is being made to avoid duplicate marks where possible.

## **Summary of Washington, Oregon and Treaty Tribe thermal marking programs**

In Washington State, mass-marking of hatchery salmon with thermally-induced otolith marks (Volk et al., 1994) is primarily focussed on evaluating the success of hatchery supplementation efforts associated with declining stocks and to answer a number of specific research questions where identification of hatchery fish at various life history stages is important. Otolith marks have also been employed to evaluate stray rates, select adults for spawning in mixed-stock hatchery spawning aggregations and as an aid to pre-season and in-season management of fisheries.

A summary of thermal marks applied to the 1998 brood year from Washington State is provided in NPAFC document 445 (table 3). Table 2 in this report provides a Summary of marks applied to the 1999 brood year releases from Washington State. Table 3 contains a summary of marks applied by Treaty tribe hatcheries in Washington, while table 4 contains a preliminary report of marks applied to hatchery stocks in Oregon State. Because emphasis on otolith thermal marking in these programs are generally focussed upon identification of many groups within a stock rather than mixed fisheries with potential contributions from many hatcheries, marks are often redundant between hatchery stocks. In addition, due to constraints in some facilities, temperature changes may take place during the hatching period and the location of the hatch event in the mark may be variable.

Marking of brood year 2000 fish is expected to be similar in scope to that reported above.

## **References**

- Munk K.M. and Geiger, H.J. 1998. Thermal Marking of Otoliths: the "RBr" Coding Structure of Thermal Marks (NPAFC Doc. 367). Alaska Department of Fish and Game, Juneau Alaska 99801-5526 19p.
- Hagen, P. 1999. A modeling approach to address the underlying structure and constraints of thermal mark codes and code notation. (NPAFC Doc. 395 ). 12p. Alaska Dept. Fish and Game, Juneau Alaska. 99801-5526
- Hagen, P., H.J. Geiger, E.C. Volk, and J.J. Grimm. 1999. Releases of Thermally Marked Salmon from Alaska and Washington in 1999. (NPAFC Doc. 445). 6 p. Alaska Dept. Fish and Game, Juneau Alaska. 99801-5526

Table 1. Summary of thermal mark codes applied to the 1999 brood year hatchery salmon in Alaska.

SPECIES: SOCKEYE										
ID#	MARK TYPE	BROOD YEAR	RELEASE YEAR	DATE LAST RELEASED	SPECIES	STATE/ PROVINCE	REGION	RELEASE AGENCY	FACILITY	STOCK
A1	TM	1999	2001		SOCKEYE	AK	SOUTHCENTRAL	CIAA	TRAIL LAKES	BEAR LK
A2	TM	1999	2000		SOCKEYE	AK	SOUTHCENTRAL	CIAA	TRAIL LAKES	HIDDEN LK 244-30
A3	TM	1999	2001		SOCKEYE	AK	SOUTHCENTRAL	CIAA	TRAIL LAKES	BEAR CR 231-30
A4	TM	1999	2000		SOCKEYE	AK	SOUTHCENTRAL	CIAA	TRAIL LAKES	BEAR LK
A5	TM	1999	2000		SOCKEYE	AK	SOUTHCENTRAL	CIAA	TRAIL LAKES	BIG LK
A6	TM	1999	2000		SOCKEYE	AK	SOUTHCENTRAL	PGHC	PORT GRAHAM	
A7	TM	1999	2001		SOCKEYE	AK	SOUTHCENTRAL	PWSA	MAIN BAY	MAIN BAY
A8	SM	1999	2000		SOCKEYE	AK	SOUTHCENTRAL	PWSA	GULKANA	
A9	TM	1999	2000	01-Jun-00	SOCKEYE	AK	SOUTHEAST	DIPC	SNETTISHAM	SNETTISHAM
A10	TM	1999	2000	27-May-00	SOCKEYE	AK	SOUTHEAST	DIPC	SNETTISHAM	S-TAHLTAN LAKE
A11	TM	1999	2000	26-Jun-00	SOCKEYE	AK	SOUTHEAST	DIPC	SNETTISHAM	S-TAHLTAN LAKE
A12	TM	1999	2000	01-Jun-00	SOCKEYE	AK	SOUTHEAST	DIPC	SNETTISHAM	S-TATSAMENIE LAKE
A13	TM	1999	2001		SOCKEYE	AK	SOUTHEAST	DIPC	SNETTISHAM	SNETTISHAM
A14	TM	1999	2001		SOCKEYE	AK	SOUTHEAST	DIPC	SNETTISHAM	SNETTISHAM
A15	TM	1999	2001		SOCKEYE	AK	SOUTHEAST	DIPC	SNETTISHAM	SNETTISHAM
A16	TM	1999	2001		SOCKEYE	AK	SOUTHEAST	DIPC	SNETTISHAM	SNETTISHAM
A17	TM	1999	2000		SOCKEYE	AK	SOUTHEAST	DIPC	SNETTISHAM	CHILKAT LK 115-32
A18	TM	1999	2000	18-May-00	SOCKEYE	AK	SOUTHEAST	PWHA	KLAWOCK RIVER	KLAWOCK LK
A19	TM	1999	2000		SOCKEYE	AK	SOUTHEAST	SSRA	BURNETT INLET	HUGH SMITH LK 101-30
A20	TM	1999	2000		SOCKEYE	AK	SOUTHEAST	SSRA	BURNETT INLET	HUGH SMITH LK 101-30
A21	AD+CWT+TM	1999	2001		SOCKEYE	AK	SOUTHEAST	SSRA	BURNETT INLET	MCDONALD LAKE

ID#	Mark Name	STAGE	WEIGHT	LENGTH	TOTAL RELEASED	RBr code	Hatch Code	Pre-hatch Graphic	PostHatch Graphic	COMMENT
A1	BearLK99Sock	SMOLT				1:1.6	6H			
A2	HiddenLK99Sock	FRY				1:1.4,2.2	4,2H			
A3	TustLK99Sock	SMOLT				2:1.3,2.3	H3,3			
A4	BearLK99Sock(fry)	FRY				1:1.3	3H			
A5	BigLK99Sock	FRY				1:1.3,2.2	3,2H			
A6	EnglishBay99Sock	FRY				1:1.5,2.2	5,2H			
A7	MainBay99	SMOLT				1:1.3,2.2	3,2H			
A8	Gulkana99	FRY			24000000	NA	NA		I	STRONTIUM MARK
A9	SWT99	FRY	0.15		520778	1:1.5,2.3n	5,3nH			
A10	Tahlitan99	FRY	0.13		2228339	2:1.6	H6			
A11	Tuya99	FRY	0.12		866530	2:1.4	H4			
A12	Tats99	FRY	0.15		350139	2:1.5	H5			
A13	Snett99ES	SMOLT			1500000	1:1.4,2.4	4,4H			Early - Small
A14	Snett99EL	SMOLT			1500000	1:1.3,2.3n	3,3nH			Early - Large
A15	Snett99LS	SMOLT			1500000	1:1.4,2.3n	4,3nH			Late - Small
A16	Snett99LL	SMOLT			1500000	1:1.3,2.4n	3,4nH			Late - Large
A17	Chilkat99	FRY			2500000	1:1.5,2.4n	5,4nH			
A18	Klawock99	FEED FRY	0.25	28	335061	1:1.5	5H			
A19	HughSmith99(Early)	FRY				1:1.2, 2.2,3.2	2,2,2H			Early
A20	HughSmith99(Late)	FRY				1:1.2, 2.2,3.2	2,2,3H			Late
A21	NeckLake99	SMOLT				1:1.3,2.3n	3,3nH			

Table 1 (continued). Summary of thermal mark codes applied to the 1999 brood year hatchery salmon in Alaska

SPECIES: PINK

ID#	MARK TYPE	BROOD YEAR	RELEASE YEAR	DATE LAST RELEASED	SPECIES	STATE/ PROVINCE	REGION RELEASE	AGENCY	FACILITY	STOCK
A22	TM	1999	2000		PINK	AK	SOUTHCENTRAL	PGHC	PORT GRAHAM	PORT GRAHAM
A23	TM	1999	2000	17-May-00	PINK	AK	SOUTHCENTRAL	PWSA	A F KOERNIG	A F KOERNIG
A24	TM	1999	2000	24-May-00	PINK	AK	SOUTHCENTRAL	PWSA	A F KOERNIG	A F KOERNIG
A25	TM	1999	2000	04-May-00	PINK	AK	SOUTHCENTRAL	PWSA	A F KOERNIG	A F KOERNIG
A26	TM	1999	2000	08-Jun-00	PINK	AK	SOUTHCENTRAL	PWSA	CANNERY CREEK	CANNERY CR
A27	TM	1999	2000	08-Jun-00	PINK	AK	SOUTHCENTRAL	PWSA	CANNERY CREEK	CANNERY CR
A28	TM	1999	2000	08-Jun-00	PINK	AK	SOUTHCENTRAL	PWSA	CANNERY CREEK	CANNERY CR
A29	TM	1999	2000	19-May-00	PINK	AK	SOUTHCENTRAL	PWSA	WALLY NOERENBERG	WALLY NOERENBERG
A30	TM	1999	2000	16-May-00	PINK	AK	SOUTHCENTRAL	PWSA	WALLY NOERENBERG	WALLY NOERENBERG
A31	TM	1999	2000	12-May-00	PINK	AK	SOUTHCENTRAL	VFDA	SOLOMON GULCH	SOLOMON GULCH 221-60
A32	TM	1999	2000	08-May-00	PINK	AK	SOUTHEAST	AKI	PORT ARMSTRONG	PORT ARMSTRONG
A33	TM	1999	2000	09-May-00	PINK	AK	SOUTHEAST	DIPC	GASTINEAU	GASTINEAU

ID#	Mark Name	STAGE	WEIGHT	LENGTH	TOTAL		Hatch Code	Pre-hatch			COMMENT
					RELEASED	RBr code		Graphic	PostHatch	Graphic	
A22	PTGraham99	FEED FRY				1:1.4,2.2	4,2,H				
A23	AFK99	FEED FRY	0.5		41219084	1:1.4+2.3	4H3				Accessory Mark Faint
A24	AFK99	FEED FRY	0.47		47348271	1:1.4	4H				
A25	AFK99	FEED FRY	0.39		53970337	1:1.4+2.4	4H4				Accessory Mark Faint
A26	CCH99	FEED FRY	0.34		17127248	1:1.3,2.3+3.3	3,3H3				
A27	CCH99	FEED FRY	0.34		99769000	1:1.3,2.3	3,3H				
A28	CCH99	FEED FRY	0.34		15340069	1:1.3,2.3+3.4	3,3H4				
A29	WHN99	FEED FRY	0.5		30989973	1:1.8+2.3	8H3				
A30	WHN99	FEED FRY	0.4		85079366	1:1.8	8H				
A31	SGH99	FEED FRY	0.5		195763690	1:1.6	6H				
A32	PTArm99Pink	FEED FRY	0.63	45	21600000	1:1.3	3H				Not 100% Mark
A33	DIPAC99Pink	FEED FRY	0.9		1681918	1:1.4	4H				

Table 1 (continued). Summary of thermal mark codes applied to the 1999 brood year hatchery salmon in Alaska.

SPECIES: CHUM, CHINOOK, COHO

ID#	MARK TYPE	BROOD YEAR	RELEASE YEAR	DATE LAST RELEASED	SPECIES	STATE/ PROVINCE	REGION	RELEASE	AGENCY	FACILITY	STOCK
A34	TM	1999	2000	26-May-00	CHUM	AK	SOUTHCENTRAL	PWSA	WALLY NOERENBERG	WALLY NOERENBERG	
A35	TM	1999	2000	16-May-00	CHUM	AK	SOUTHCENTRAL	PWSA	WALLY NOERENBERG	WALLY NOERENBERG	
A36	TM	1999	2000	19-May-00	CHUM	AK	SOUTHEAST	DIPC	GASTINEAU	GASTINEAU	
A37	TM	1999	2000	19-May-00	CHUM	AK	SOUTHEAST	DIPC	GASTINEAU	GASTINEAU	
A38	TM	1999	2000	10-May-00	CHUM	AK	SOUTHEAST	DIPC	GASTINEAU	GASTINEAU	
A39	TM	1999	2000	02-Jun-00	CHUM	AK	SOUTHEAST	DIPC	GASTINEAU	GASTINEAU	
A40	TM	1999	2000	14-May-00	CHUM	AK	SOUTHEAST	DIPC	GASTINEAU	GASTINEAU	
A41	TM	1999	2000	21-May-00	CHUM	AK	SOUTHEAST	NSRA	HIDDEN FALLS	HIDDEN FALLS	
A42	TM	1999	2000	24-Apr-00	CHUM	AK	SOUTHEAST	NSRA	MEDVEJIE	HIDDEN FALLS	
A43	AD+CWT+TM	1999	2001		CHINOOK	AK	SOUTHEAST	DIPC	GASTINEAU	GASTINEAU	
A44	AD+CWT+TM	1999	2001		CHINOOK	AK	SOUTHEAST	NSRA	MEDVEJIE	MEDVEJIE	
A45	AD+CWT+TM	1999	2001		CHINOOK	AK	SOUTHEAST	NSRA	HIDDEN FALLS	HIDDEN FALLS	
A46	TM	1999	2001		COHO	AK	SOUTHCENTRAL	CIAA	TRAIL LAKES	BEAR LK	
A47	TM	1999	2001		COHO	AK	SOUTHCENTRAL	PWSA	WALLY NOERENBERG		
A48	AD+CWT+TM	1999	2001		COHO	AK	SOUTHEAST	AKI	PORT ARMSTRONG		
A49	AD+CWT+TM	1999	2001		COHO	AK	SOUTHEAST	DIPC	GASTINEAU	GASTINEAU	

ID#	Mark Name	STAGE	WEIGHT	LENGTH	TOTAL RELEASED	RBr code	Hatch Code	PreHatch Graphic	PostHatch	Graphic	COMMENT
A34	WHN99CHUM	FEED FRY	1.62		76306351	1:1.5	5H				
A35	PtChalmer99	FEED FRY			23995577	1:1.3	3H				
A36	DIPAC99Chum	FEED FRY	1.55		44496455	1:1.6	6H				
A37	DIPAC99Chum	FEED FRY	1.7		27878900	1:1.6+2.3	6H3				
A38	DIPAC99Chum	FEED FRY	1.42		15100000	1:1.6+2.5	6H5				
A39	DIPAC99Chum	FEED FRY	4.04		8722507	1:1.6+2.6	6H6				LATE, LARGE FRY
A40	DIPAC99Chum	FEED FRY	1.61		9010000	1:1.6+2.4	6H4				
A41	HiddenFalls99Chum	FEED FRY	2		38689735	1:1.3,2.3	3,3H				
A42	DeepInlet99	FEED FRY	1.68		13057000	1:1.4,2.3	4,3H				
A43	DIPAC99Chin	SMOLT				2:1.4	H4				
A44	Medvejie99Chin	SMOLT				1:1.3,2.3	3,3H				
A45	HiddenFalls99Chin	SMOLT				1:1.4,2.2	4,2H				
A46	TrailLake99Coho	FEED FRY				1:1.3	3H				
A47	WHN99Coho	SMOLT				1:1.3	3H				
A48	PtArm99Coho					1:1.3	3H				
A49	Dipac99Coho	SMOLT				1:1.4	4H				

Table 2. Summary of thermal mark codes applied to the 1999 brood year hatchery salmon in Washington State

Species	Marking Location	Release Location	Release stage	Number Released (*1000)	Hatch Code	Pattern
Fall Chinook	Lilliwaup Hatchery	Duckabush River	Fry	50	3,2H	
Fall Chinook	Long Live the Kings	Skokomish River	Fry	50	2,1,2H	
Fall Chinook	Long Live the Kings	Hamma Hamma River	Fry	50	1,4H	
Spring Chinook	Kendall Creek Hatchery	Nooksack River	Yearling	2500*	2,2H1,2,1,1	
Spring Chinook	Kendall Creek Hatchery	Nooksack River			2,2H2,2	
Spring Chinook	Kendall Creek Hatchery	Nooksack River			2,2H2,3,1	
Spring Chinook	Kendall Creek Hatchery	Nooksack River			2,2H2,6	
Spring Chinook	Kendall Creek Hatchery	Nooksack River			2,2H2,1,1,1	
Spring Chinook	Kendall Creek Hatchery	Nooksack River			2,2H1,4,1,1	
Spring Chinook	Kendall Creek Hatchery	Nooksack River			2,2H1,4,1,1	
Spring Chinook	Kendall Creek Hatchery	Nooksack River			2,2H3,3	
Spring Chinook	Kendall Creek Hatchery	Nooksack River			6H	
Spring Chinook	Kendall Creek Hatchery	Nooksack River			2,3H	
Spring Chinook	Kendall Creek Hatchery	Nooksack River			3,1H	
Spring Chinook	Dungeness Hatchery	Dungeness River		842*	4H,4	
Spring Chinook	Dungeness Hatchery	Dungeness River			12 **	
Coho	Hurd Creek Hatchery	Snow Creek	Fry	8	2,1,1H	
Coho	Hurd Creek Hatchery	Andrews Creek	Fry	8	1,1,2H	
Coho	Hurd Creek Hatchery	Crocker Lake	Fry	15	1,3H	
Summer Chum	Dungeness Hatchery	Salmon Creek	Fry	32	3H	
Summer Chum	Dungeness Hatchery	Chimacum Creek	Fry	41.5	2,2H	
Summer Chum	Lilliwaup Hatchery	Hamma Hamma River	Fry	28	1,3H1,3	
Summer Chum	Lilliwaup Hatchery	Hamma Hamma River	Fry	28	3,1H	
Summer Chum	Lilliwaup Hatchery	Lilliwaup River	Fry	17	4H4	
Summer Chum	Big Beef Creek Hatchery	Big Beef Creek	Fry	40	2,2H4,1,1	
Chum	Grays River Hatchery	Chinook River	Fry	134	3,1H2,3	
Chum	Grays River Hatchery	Grays River	Fry	66	1,3H4,1	
Summer Chum	Hurd Creek Hatchery	Jimmycomelately Creek	Fry	4.1	9 **	
Sockeye	Landsburg Hatchery	Cedar River	Fry	675	4H3,1,2	
Sockeye	Landsburg Hatchery	Cedar River	Fry	739	4H1,1,4	
Sockeye	Landsburg Hatchery	Cedar River	Fry	859	4H1,3,2	
Sockeye	Landsburg Hatchery	Cedar River	Fry	949	4H1,2,2	

\* aggregate total for all releases combined  
 \*\* 'run on marks' - location of hatching variable

Table 3. Preliminary summary of thermal mark codes applied to the 1999 brood year hatchery salmon by Treaty Tribes in Washington State

Species	Marking Location	Release Location	Number Released (*1000)	Hatch code	Pattern
Summer Chinook	Tulalip Hatchery	Snohomish River	100	3H4	
Fall Chinook	Tulalip Hatchery	Snohomish River	1900	2,3H4	
Sockeye	Makah Hatchery	Lake Ozette	22	1,3,1H	
Sockeye	Makah Hatchery	Ozette River	22	2,2,1H	

Table 4. Preliminary summary of thermal mark codes applied to the 1999 brood year hatchery salmon by Oregon State.

Species	Marking Location	Release Location	Number Released (*1000)	Hatch code	Pattern
Spring Chinook	Marion Forks Hatchery	Marion Forks	6,000*	3,4 **	
Spring Chinook	Marion Forks Hatchery	Marion Forks		8 **	
Spring Chinook	Marion Forks Hatchery	Clackamas River		1,7 **	
Spring Chinook	Marion Forks Hatchery	Clackamas River		1,7 **	
Spring Chinook	McKenzie Hatchery	McKenzie River		7,1 **	
Spring Chinook	Willamette Hatchery	S. Santiam River		8 **	
Spring Chinook	Willamette Hatchery	S. Santiam River		6 **	
Spring Chinook	Willamette Hatchery	S. Santiam River		1,3,3n,2**	
Spring Chinook	Willamette Hatchery	S. Santiam River		1,7 **	
Spring Chinook	Willamette Hatchery	Willamette River		1,7 **	
Spring Chinook	McKenzie Hatchery	McKenzie River		1,2n,1,8 **	
Spring Chinook	McKenzie Hatchery	McKenzie River		2n,2,8 **	
Spring Chinook	McKenzie Hatchery	McKenzie River		4,7,1*	
Spring Chinook	McKenzie Hatchery	McKenzie River		4,4,3 *	
Spring Chinook	McKenzie Hatchery	McKenzie River		4,4,2,1 **	

\*aggregate total for all releases combined  
 \*\* 'run on marks' location of hatching is variable