

**Releases of Thermally Marked Salmon from Japan
in 1999 and 2000 with a Thermal Mark Plan for
2000 Brood Year Stocks**

by

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Abstract

In April 1999 approximately 4 million chum salmon (1998 brood year) with three thermal mark patterns were released from the Chitose Hatchery in Hokkaido. This was the first trial of thermal otolith marking for anadromous salmon in Japan. The initial aim of thermal mark programs is to provide information for the ocean migration and survival of each regional salmon stock in Japan. Thus we are planning to increase the number of thermal mark releases from hatcheries. A computer-programmed chiller system was developed to control water temperature, producing high quality thermal marks in the otoliths of chum salmon. To increase available thermal mark patterns, we employed narrow rings, which were formed at 12 h intervals. In the spring of 2000, approximately 16 million chum and pink salmon (1999 brood year stocks) will be released from hatcheries after thermally marked. We propose a thermal mark plan for 2000 brood year salmon stocks in Japan.

Introduction

Mass marking of hatchery salmon using otolith thermal marks is an effective tool for stock identification of salmon in high seas (Ignell et al., 1997; Kawana et al., 1999; Urawa et al., 1999) and coastal waters (Hagen et al., 1995; Farley and Munk, 1997; Farley et al., 1999).

In Japan, the initial aim of thermal mark programs is to provide information for the ocean migration and survival of each regional salmon stocks, combining with coastal and high-seas salmon researches. Thus we are planning to increase the number of thermal mark releases from hatcheries (Figure 1). It is suggested that few mark patterns are available when ring number is limited (Hagen, 1999). To increase available patterns, we employ narrow ring spacing, which is formed at 12 h intervals by a computer-programmed water temperature control system. The RBr code scheme is used to describe thermal patterns (Munk and Geiger, 1998).

Releases of 1998 brood year stocks

In April 1999 approximately 4 million chum salmon (1998 brood year) with three thermal mark patterns were released from the Chitose Hatchery in Hokkaido (Table 1). This was the first trial of thermal otolith marking for anadromous salmon in Japan. A computer-programmed chiller system was developed to control water temperature, producing high quality thermal marks in the otoliths of chum salmon during their eyed egg stage (Figure 2).

Releases of 1999 brood year stocks- preliminary information

In the spring of 2000, approximately 16 million thermally marked chum and pink salmon

(1999 brood year stocks) will be released from 5 hatcheries in Hokkaido (Table 2). We adopted two rings as base mark to distinguish Japanese salmon from other stocks, because this code was not commonly used due to its illegibility.

Plan for 2000 brood year stocks

A plan for thermal mark releases of 2000 brood year stocks in Japan is proposed in Table 3. We prepare to release approximately 20 million chum and pink salmon from 5 hatcheries in Hokkaido after being thermally marked with 10 discrete patterns.

Future Plan

We expect that more than a hundred million thermally marked chum salmon may be released in the spring of 2003 (Figure 1). This figure occupies about 5% of total hatchery releases in Japan.

Acknowledgments

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Table 1. Thermal otolith mark releases of chum salmon from Japan in 1999.

No	BROOD YEAR	DATE OF RELEASE (M/D/Y)	SPECIES	COUNTRY	STATE/ PROVINCE	REGION	AGENCY	FACILITY	STOCK	FINAL RELEASE SITE	REARING TREAT-MENT	STAGE	MEAN SIZE AT RELEASE (g/mm)	ACTUAL NUMBER OF TM RELEASED
J-1	1998	04/18/99	CHUM	JAPAN	HOKKAIDO	Japan Sea coast	NASREC	Chitose Hatchery	Ishikari River	Chitose River, Ishikari River system	fed	fry, early run	1.04/52.8	1,227,500
J-2	1998	04/19/99	CHUM	JAPAN	HOKKAIDO	Japan Sea coast	NASREC	Chitose Hatchery	Ishikari River	Chitose River, Ishikari River system	fed	fry, mid run	0.92/49.5	1,406,300
J-3	1998	04/20/99	CHUM	JAPAN	HOKKAIDO	Japan Sea coast	NASREC	Chitose Hatchery	Ishikari River	Chitose River, Ishikari River system	fed	fry, late run	0.91/49.3	1,400,600

No	TM ID	RBr	THERMAL MARK SCHEDULE	TEMP SHIFT DIRECTION	PREHATCH GRAPHIC IMAGE	POSTHATCH GRAPHIC IMAGE	DIGITAL PHOTO IMAGE*	MARK QUALITY	COMMENTS
J-1	Chitose98early	1:1.4	(4X)24C:24H	down (8-4C)		no	yes	excellent	
J-2	Chitose98mid	1:1.4,2.2n	(3X)24C:24H,(1X)24C:48H,(2X)12C:12H	down (8-4C)		no	yes	excellent	
J-3	Chitose98late	1:1.4,2.4n	(3X)24C:24H,(1X)24C:48H,(4X)12C:12H	down (8-4C)		no	yes	excellent	

*Refer to Figure 2.

Table 2. Preliminary information for thermal mark releases of 1999 brood year stocks of chum and pink salmon in Japan.

BROOD YEAR	YEAR OF RELEASE	SPECIES	COUNTRY	STATE/ PROVINCE	REGION	AGENCY	FACILITY	STOCK	FINAL RELEASE SITE	SPAWNING DATE (M/D/Y)	REARING TREATMENT	STAGE	PRELIMINARY NUMBER OF RELEASES	RBr	PREHATCH GRAPHIC	POST-HATCH GRAPHIC	MARKING SYSTEM	TEMP SHIFT DIRECTION
1999	2000	CHUM	JAPAN	HOKKAIDO	Japan Sea coast	NASREC	Chitose Hatchery	Ishikari River	Ishikari River	09/13/99	fed	fry	842,000	1:1.2.2.6n	II IIIII		CHILLER	down (8-4C)
1999	2000	CHUM	JAPAN	HOKKAIDO	Japan Sea coast	NASREC	Chitose Hatchery	Ishikari River	Ishikari River	09/24/99	fed	fry	1,350,000	1:1.2.2.6n	II IIIII		CHILLER	down (8-4C)
1999	2000	CHUM	JAPAN	HOKKAIDO	Japan Sea coast	NASREC	Chitose Hatchery	Ishikari River	Ishikari River	10/08/99	fed	fry	1,415,000	1:1.2.2.6n	II IIIII		CHILLER	down (8-4C)
1999	2000	CHUM	JAPAN	HOKKAIDO	Japan Sea coast	NASREC	Chitose Hatchery	Ishikari River	Ishikari River	10/22/99	fed	fry	1,341,000	1:1.2.2.6n	II IIIII		CHILLER	down (8-4C)
1999	2000	CHUM	JAPAN	HOKKAIDO	West Pacific coast	NASREC	Shizunai Hatchery	Shizunai River	Shizunai River	10/07/99	fed	fry	327,000	1:1.2.2.3	II III		CHILLER	up (6-10C)
1999	2000	CHUM	JAPAN	HOKKAIDO	West Pacific coast	NASREC	Shizunai Hatchery	Shizunai River	Shizunai River	10/07/99	fed	fry	334,000	1:1.2.2.3	II III		CHILLER	down (10-6C)
1999	2000	CHUM	JAPAN	HOKKAIDO	West Pacific coast	NASREC	Shizunai Hatchery	Shizunai River	Shizunai River	10/22/99	fed	fry	1,052,000	1:1.2.2.3	II III		CHILLER	down (10-6C)
1999	2000	CHUM	JAPAN	HOKKAIDO	West Pacific coast	NASREC	Shizunai Hatchery	Shizunai River	Shizunai River	11/05/99	fed	fry	1,186,000	1:1.2.2.3	II III		CHILLER	down (10-6C)
1999	2000	CHUM	JAPAN	HOKKAIDO	West Pacific coast	NASREC	Shizunai Hatchery	Shizunai River	Shizunai River	11/16/99	fed	fry	648,000	1:1.2.2.3	II III		CHILLER	down (10-6C)
1999	2000	CHUM	JAPAN	HOKKAIDO	West Pacific coast	NASREC	Shizunai Hatchery	Shizunai River	Shizunai River	11/16/99	fed	fry	16,000	1:1.2.2.3+3.5	II III	IIII	CHILLER	down (10-6C)
1999	2000	CHUM	JAPAN	HOKKAIDO	West Pacific coast	NASREC	Shikiu Hatchery	Shikiu River	Shikiu River	11/15/99	fed	fry	488,000	1:1.2.2.3n -3.3n	II III III		CHILLER	down (8-4C)
1999	2000	CHUM	JAPAN	HOKKAIDO	West Pacific coast	NASREC	Shikiu Hatchery	Shikiu River	Shikiu River	11/30/99	fed	fry	352,000	1:1.2.2.3n -3.3n	II III III		CHILLER	down (8-4C)
1999	2000	CHUM	JAPAN	HOKKAIDO	West Pacific coast	NASREC	Shikiu Hatchery	Yurappu River	Shikiu River	12/02/99	fed	fry	438,000	1:1.2.2.3n -3.5n	II III IIIII		CHILLER	down (8-4C)
1999	2000	CHUM	JAPAN	HOKKAIDO	West Pacific coast	NASREC	Shikiu Hatchery	Yurappu River	Shikiu River	12/13/99	fed	fry	507,000	1:1.2.2.1n	II I		HEATER	up (8-13C)
1999	2000	CHUM	JAPAN	HOKKAIDO	Nemuro Strait coast	NASREC	Kunbetsu Hatchery	Kunbetsu River	Kunbetsu River	10/12/99	fed	fry	1,107,000	1:1.2.2.4n	II IIII		CHILLER	down (8-4C)
1999	2000	CHUM	JAPAN	HOKKAIDO	Nemuro Strait coast	NASREC	Ichani Hatchery	Ichani River	Ichani River	10/28/99	fed	fry	1,347,000	1:1.2.2.8n	II IIIIIII		CHILLER	down (8-4C)
1999	2000	CHUM	JAPAN	HOKKAIDO	Nemuro Strait coast	NASREC	Ichani Hatchery	Ichani River	Ichani River	11/15/99	fed	fry	2,226,000	1:1.2.2.8n	II IIIIIII		CHILLER	down (8-4C)
1999	2000	PINK	JAPAN	HOKKAIDO	Nemuro Strait coast	NASREC	Ichani Hatchery	Ichani River	Ichani River	09/14/99	fed	fry	997,000	1:1.2.2.6n	II IIIII		CHILLER	down (8-4C)

Table 3. A thermal mark release plan for 2000 brood year stocks of chum and pink salmon in Japan.

No	BROOD YEAR	YEAR OF RELEASE	SPECIES	COUNTRY	STATE/ PROVINCE	REGION	AGENCY	FACILITY	STOCK	FINAL RELEASE SITE	REARING TREATMENT	STAGE	PRELIMINARY NUMBER OF TM RELEASED
J-1	2000	2001	CHUM	JAPAN	HOKKAIDO	Japan Sea coast	NASREC	Chitose Hatchery	Ishikari River	Ishikari River	fed	fry	4,500,000
J-2	2000	2001	CHUM	JAPAN	HOKKAIDO	West Pacific coast	NASREC	Shizunai Hatchery	Shizunai River	Shizunai River	fed	fry	2,150,000
J-3	2000	2001	CHUM	JAPAN	HOKKAIDO	West Pacific coast	NASREC	Shizunai Hatchery	Shizunai River	Shizunai River	fed	fry	350,000
J-4	2000	2001	CHUM	JAPAN	HOKKAIDO	West Pacific coast	NASREC	Shikiu Hatchery	Shikiu River	Shikiu River	fed	fry	1,000,000
J-5	2000	2001	CHUM	JAPAN	HOKKAIDO	Nemuro Strait coast	NASREC	Ichani Hatchery	Ichani River	Ichani River	fed	fry	6,000,000
J-6	2000	2001	CHUM	JAPAN	HOKKAIDO	Okhotsk Sea coast	NASREC	Tokushibetsu Hatchery	Tokushibetsu River	Tokushibetsu River	fed	fry, early	1,400,000
J-7	2000	2001	CHUM	JAPAN	HOKKAIDO	Okhotsk Sea coast	NASREC	Tokushibetsu Hatchery	Tokushibetsu River	Tokushibetsu River	fed	fry, mid	1,400,000
J-8	2000	2001	CHUM	JAPAN	HOKKAIDO	Okhotsk Sea coast	NASREC	Tokushibetsu Hatchery	Tokushibetsu River	Tokushibetsu River	fed	fry, late	700,000
J-9	2000	2001	CHUM	JAPAN	HOKKAIDO	Okhotsk Sea coast	NASREC	Tokushibetsu Hatchery	Tokushibetsu River	Tokushibetsu River	fed	fry, late	700,000
J-10	2000	2001	PINK	JAPAN	HOKKAIDO	Nemuro Strait coast	NASREC	Ichani Hatchery	Ichani River	Ichani River	fed	fry	1,200,000
J-11	2000	2001	PINK	JAPAN	HOKKAIDO	Okhotsk Sea coast	NASREC	Tokushibetsu Hatchery	Tokushibetsu River	Tokushibetsu River	fed	fry	1,000,000

No	TM ID	RBr	PREHATCH GRAPHIC IMAGE	POSTHATCH GRAPHIC IMAGE	MARKING SYSTEM	THERMAL MARK SCHEDULE	TEMP SHIFT DIRECTION	COMMENTS
J-1	Chitose00chum	1:1.2.2.6n	IIIII		CHILLER	(1X)24C:24H,(1X)24C:48H,(6X)12C:12H	down (8-4C)	
J-2	Shizunai00chum	1:1.2-2.3	III		CHILLER	(1X)24C:24H,(1X)24C:72H,(3X)24C:24H	down (10-6C)	
J-3	Shizunai00chum-tr	1:1.2-2.3	III		CHILLER	(2X)24H:24C,(1X)72H:24C,(2X)24H:24C	up (6-10C)	
J-4	Shikiu00chum	1:1.2.2.3n-3.3n	III III		CHILLER	(1X)24C:24H,(1X)24C:48H,(2X)12C:12H,(1X)12C:36H,(3X)12C:12H	down (8-4C)	
J-5	Ichiani00chum	1:1.2.2.8n	IIIIIII		CHILLER	(1X)24C:24H,(1X)24C:48H,(8X)12C:12H	down (8-4C)	
J-6	Tokushibetsu00chum (early)	1:1.2.2.1n-3.4n	IIIII		CHILLER	(1X)24C:24H,(1X)24C:48H,(1X)12C:36H,(4X)12C:12H	down (10-6C)	
J-7	Tokushibetsu00chum (mid)	1:1.2.2.2n-3.3n	II III		CHILLER	(1X)24C:24H,(1X)24C:48H,(1X)12C:12H,(1X)12C:36H,(3X)12C:12H	down (9-5C)	
J-8	Tokushibetsu00chum (late)	1:1.2.2.3n	III		CHILLER	(1X)24C:24H,(1X)24C:48H,(3X)12C:12H	down (9-5C)	
J-9	Tokushibetsu00chum (late-tr)	1:1.2.2.3n-3.2n	III II		CHILLER	(1X)24C:24H,(1X)24C:48H,(2X)12C:12H,(1X)12C:36H,(2X)12C:12H	down (9-5C)	
J-10	Ichiani00pink	1:1.2.2.6n	IIIII		CHILLER	(1X)24C:24H,(1X)24C:48H,(6X)12C:12H	down (8-4C)	
J-11	Tokushibetsu00pink	1:1.2.2.4n	IIII		CHILLER	(1X)24C:24H,(1X)24C:48H,(4X)12C:12H	down (10-6C)	

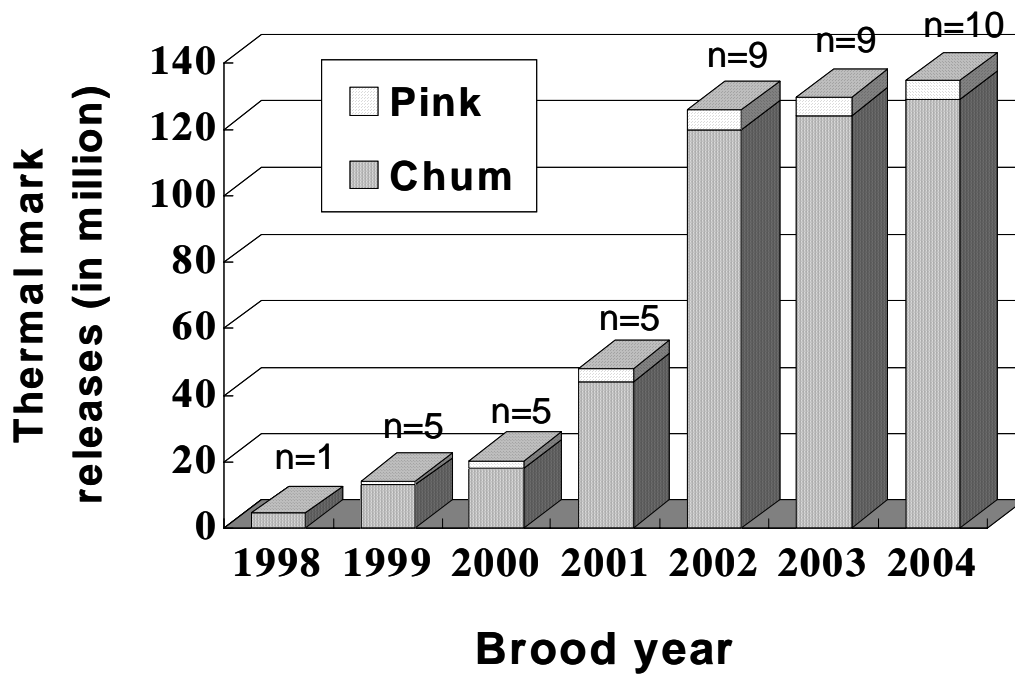
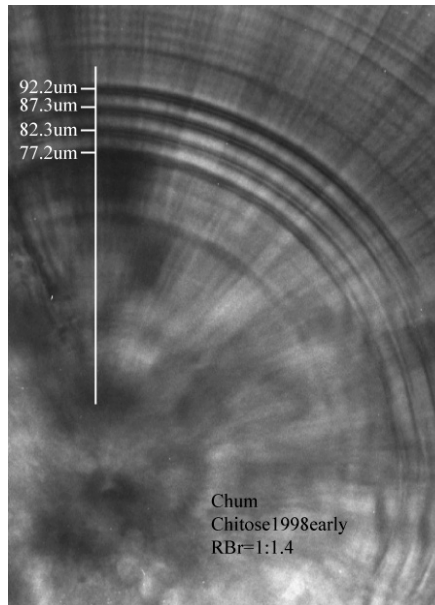
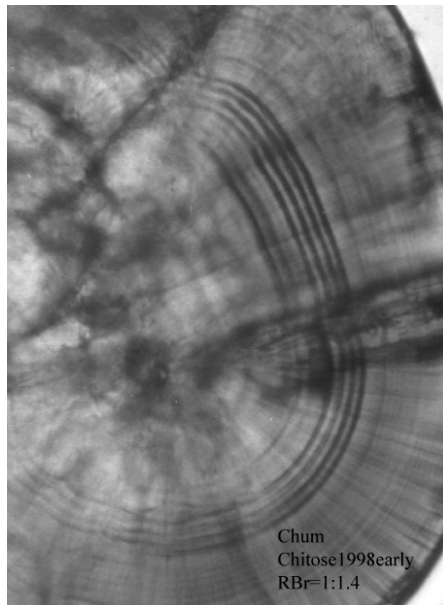
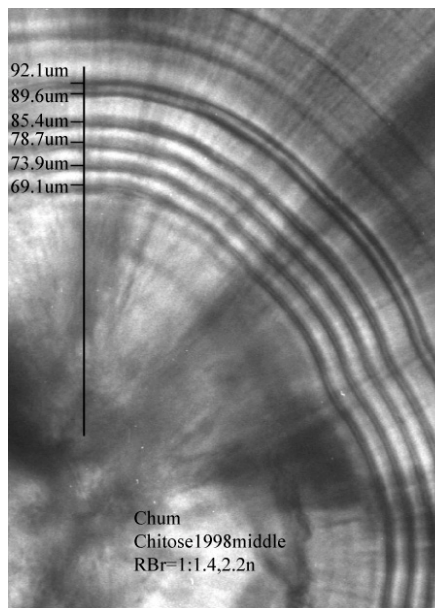
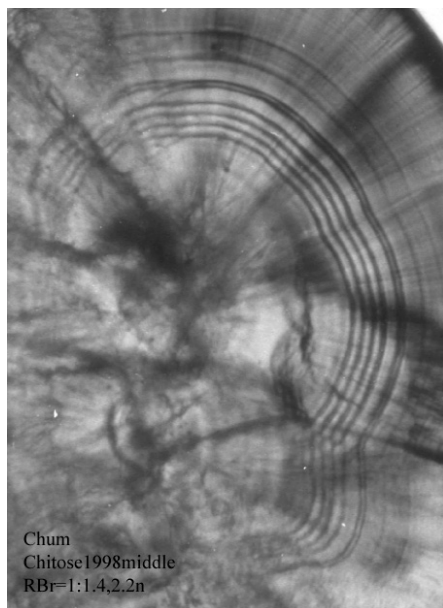


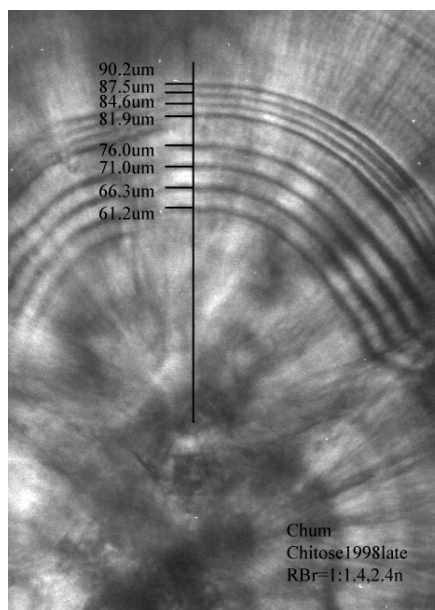
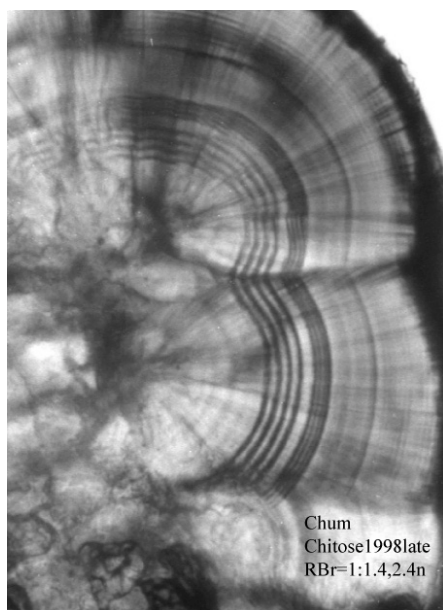
Figure 1. A tentative plan for thermal mark releases of 1998-2004 brood year chum and pink salmon in Japan. Numerals indicate number of hatcheries, from which thermally marked salmon are released. Number of releases may change depending on available budgets and other factors.



Chum salmon
Ishikari River
Chitose98early
RBr, 1:1.4



Chum salmon
Ishikari River
Chitose98mid
RBr, 1:1.4,2.2n



Chum salmon
Ishikari River
Chitose98late
RBr, 1:1.4,2.4n

Figure 2. Thermal mark patterns of chum salmon released from the Chitose Hatchery in 1999.