

## Compiling and Coordinating Salmon Otolith Marks in the North Pacific

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Otolith marking is an effective tool to determine the hatchery origin of individual salmon in high seas and coastal waters. The North Pacific Rim countries (Canada, Japan, Russia, and USA) are employing this mass marking technique for anadromous salmon study and management. Although the annual total release of hatchery salmon is almost stable around five billion fish, the number of otolith marked salmon released from hatcheries has increased year by year, reaching one billion fish in 2000, which makes up 20% of the total releases (Fig. 1). The number of mark groups is also increasing every year, with 134 mark groups released in 2000 (Fig. 2). This rapid increase promises a high possibility of finding otolith marked fish in ocean samplings.

The otolith marking technology has performed well for salmon management programs in coastal fisheries (Hagen et al. 1995). Recently high seas researchers are focusing on the use of otolith marks for salmon population studies in offshore waters (Ignell et al. 1997; Carlson et al. 2000; Urawa et al. 2000). As the number of mark releases increases, however, it becomes a concern that duplicate otolith marks of salmon originating from different hatcheries will be encountered in ocean samples (Table 1).

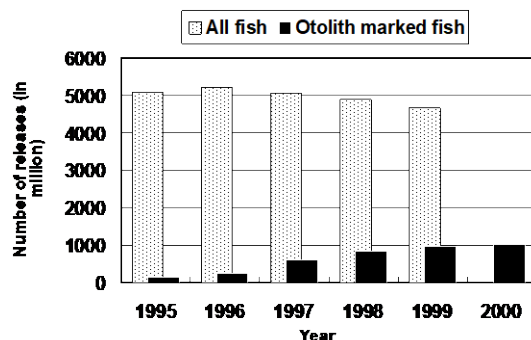
There are practical limits on the number of mark patterns available for use, due to the narrow marking window at hatcheries (Hagen 1999). Complex patterns can increase marking costs for hatcheries and preclude a quick analysis of the patterns for timely stock management. Otolith marking programs usually have highest priority in near-shore management. As a result there has been little coordination within or between countries. In addition, there is no common database for otolith marks of salmon released from hatcheries in the Pacific Rim countries.

These circumstances led to the establishment of the North Pacific Anadromous Fish Commission (NPAFC) *Ad Hoc* Working Group on Salmon Marking in 1998. This group was soon turned into a permanent working group in 1999.

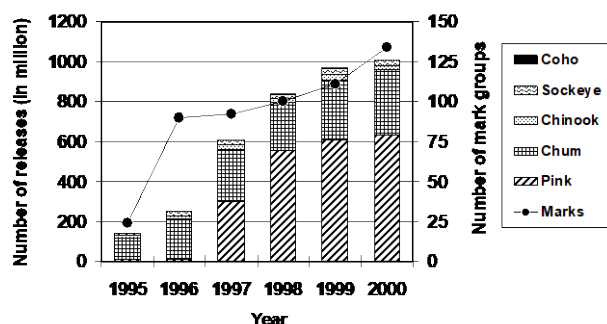
The roles of this working group are:

- (1) coordinating otolith mark patterns among member counties to minimize duplications,
- (2) creating an international database of otolith mark releases,
- (3) exchanging information on the development and standards of otolith mark techniques, and
- (4) exchanging information on the applications of otolith marks for salmon biology and stock management.

**Fig. 1.** Number of salmon released from hatcheries in the North Pacific Rim, 1995–2000. Number of total releases in 2000 is unknown.



**Fig. 2.** Hatchery releases of otolith marked salmon by species, and number of mark groups in the North Pacific Rim countries, 1995–2000.



**Table 1.** Examples of duplicate otolith marks.

Species	Year Brood	RBr code	Stock	Region/Country
Chum	1995	1:1.3	Nitinat River	BC, Canada
Chum	1995	1:1.3	Ola River	Magadan, Russia
Chum	1996	1:1.6	Gastineau	Southeast Alaska, USA
Chum	1996	1:1.6	Wells River	Southcentral Alaska, USA
Chum	1999	1:1.5	Nitinat River	BC, Canada
Chum	1999	1:1.5	Ola River	Magadan, Russia
Pink	1999	1:1.4	A. F. Koernig	Southcentral Alaska, USA
Pink	1999	1:1.4	Gastineau	Southeast Alaska, USA
Sockeye	1998	1:1.4	Tahltan Lake	Southeast Alaska, USA
Sockeye	1998	1:1.4	Hidden Lake	Southcentral Alaska, USA

Base mark codes using a small number of rings are the simplest way to distinguish regions or countries. However, the assignment of country codes is difficult, because of the limited number of distinct codes (Hagen 1999; Munk 1999). To increase mark patterns, we need to develop other marking techniques such as strontium marking (Hagen and Volk 1998; Schroder *et al.* this volume).

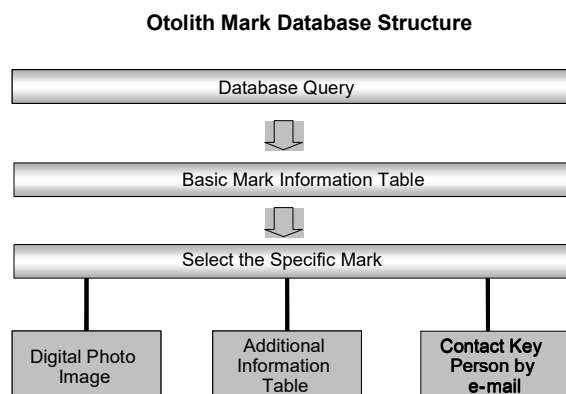
At the present time, careful planning and communication among or within countries are important to minimize the probability of encountering duplicate marks. The working group members agreed on a practical process for mark coordination:

- (1) An otolith mark coordinator should be identified for each country or region. Initially the working group members would serve in this role.
- (2) Each country should submit to NPAFC an otolith mark plan applied for current brood year stocks by the end of July.
- (3) The mark coordinators should identify duplicate marks among the national plans.
- (4) Duplicate marks should be avoided by using modified codes or secondary characters.

In the case of system failure during marking operations, the mark coordinator must immediately notify the other coordinators and mediate the compromised code with other countries or regions.

An Internet-accessible database of otolith mark releases is indispensable for the efficient use of otolith marks in field surveys. We are planning to place an otolith mark database on the NPAFC web site (<http://www.npafc.org>) in cooperation with member countries that furnish information on otolith mark releases at the NPAFC annual meeting (Fig. 3). The database includes: ID#, brood year, date of release, species, country, state/province, region, agency, facility, stock, final release site, stage/size at release, number of releases, RBr code (Munk and Geiger 1998), hatch code (Hagen *et al.* 2000), and a graphic image of mark patterns (Fig. 4). Digital photo images of otolith marks may be also available through the Internet to facilitate the mark identification.

**Fig. 3.** The outline of Internet-accessible database for otolith mark releases.



**Fig. 4.** An example of a database search on the Internet.

Otolith Mark Basic Information		Additional Information	
ID #	J98-01	ID #	J98-01
Mark Type	TM	Date Last Released	4/18/99
Year Brood	1998	State/ Province	Hokkaido
Year Released	1999	Region Released	Japan Sea coast
Species	CHUM	Agency	NASREC
Country	JAPAN	Facility	Chitose Hatchery
Stock	Chitose River	Release Site	Chitose River
RBr Code	1:1.4	Stage	early fed fry
Hatch Code	4H	Weight (g)	1.04
Prehatch Graphic		Length (mm)	52.8
Posthatch Graphic		Total Released	1,227,500
Digital Photo Image	yes	OM ID	chitose98chum -e
Additional Information	yes	Temp. Shift Direct.	down
Contact Person	M. Kawana	Comments	excellent mark

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