Conservation principles of naturally spawning salmonids in Hokkaido, Japan

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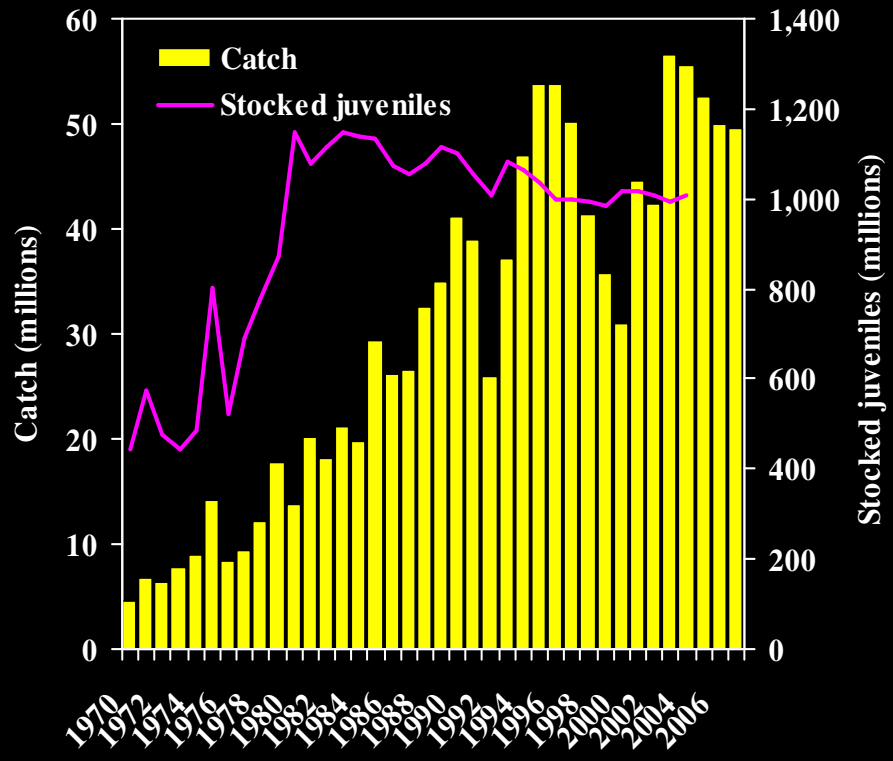
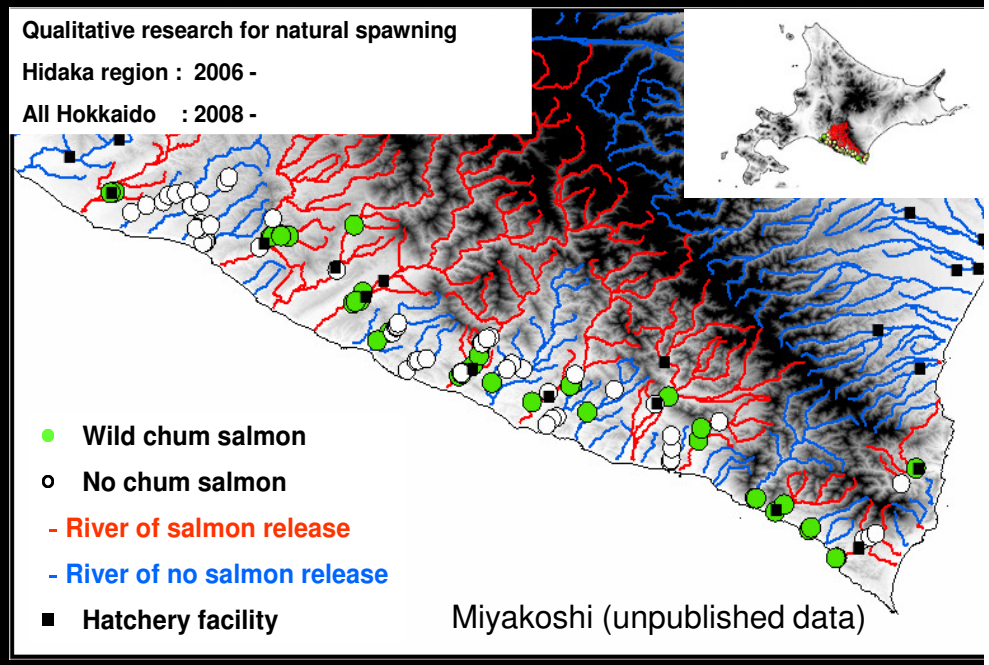
Wild salmon in Japan had been maintained by “Tanegawa No Seido”, a kind of Wild Salmon Conservation Act in the Edo period before founding of USA in 1776. Even commercial fishing was not allowed in the Tanegawa rivers. Mr. Buheiji Aoto made natural channels in the river in 1767 so that chum salmon naturally spawned. However, it was changed to hatchery-based management using modern techniques which was introduced from USA in 1888 due to active enhancement in the Meiji period.





Chum salmon in Hokkaido have been carried out by hatchery-based management since late 1880s. Chum abundance has increased due to improvement of hatchery techniques since 1970s and better ocean condition since 1980s (Kaeriyama, 1999), especially eastern Hokkaido.

While genetic diversity of Hokkaido chum were reported to be lower than those of Russian and North American chum (Altukhov et al., 2000), recent mtDNA analysis could not reconfirm low genetic diversity of Hokkaido chum (Beacham et al., 2008),

Although the number of streams where naturally spawn were ca 100 in 1960s (Akiba et al.1966), recent investigation (Miyakoshi et al. in 2009 SOS conference) shows natural spawning still exists in ca 100 streams.

Status of Hokkaido pink salmon, and stocked juveniles

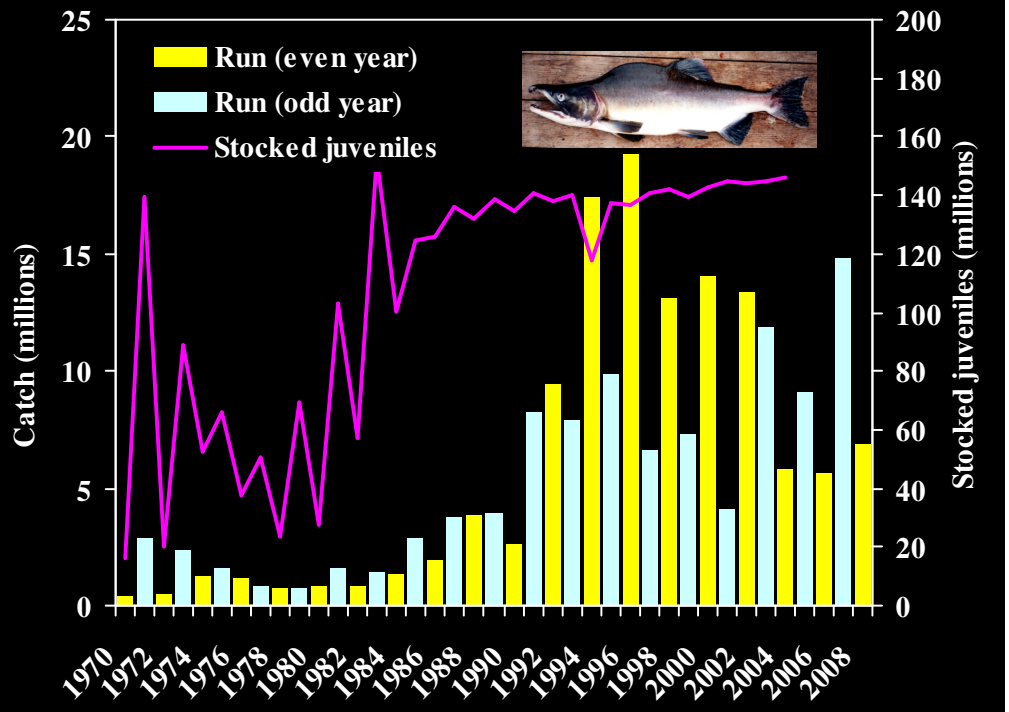
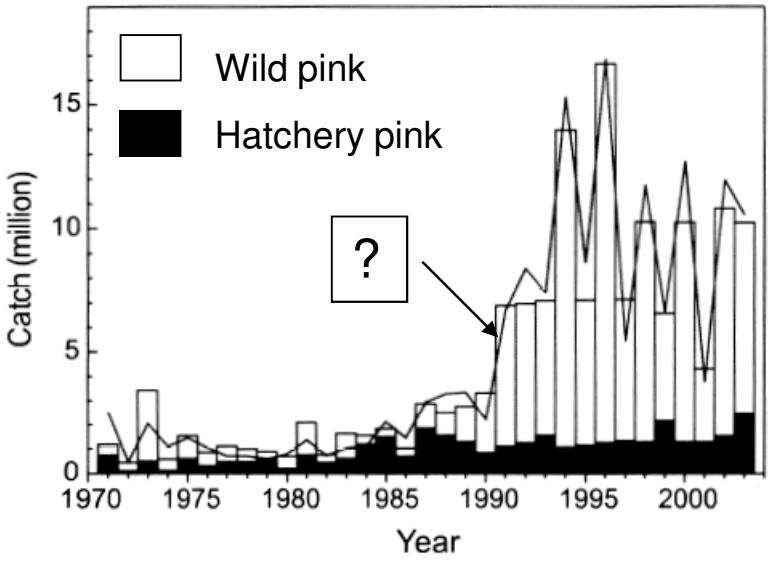


Fig. 2. Estimated catches of Japanese pink salmon (*Oncorhynchus gorbuscha*) that originated from natural spawning (solid bars) and hatcheries (open bars) using the best population model. The line indicates observed catches.

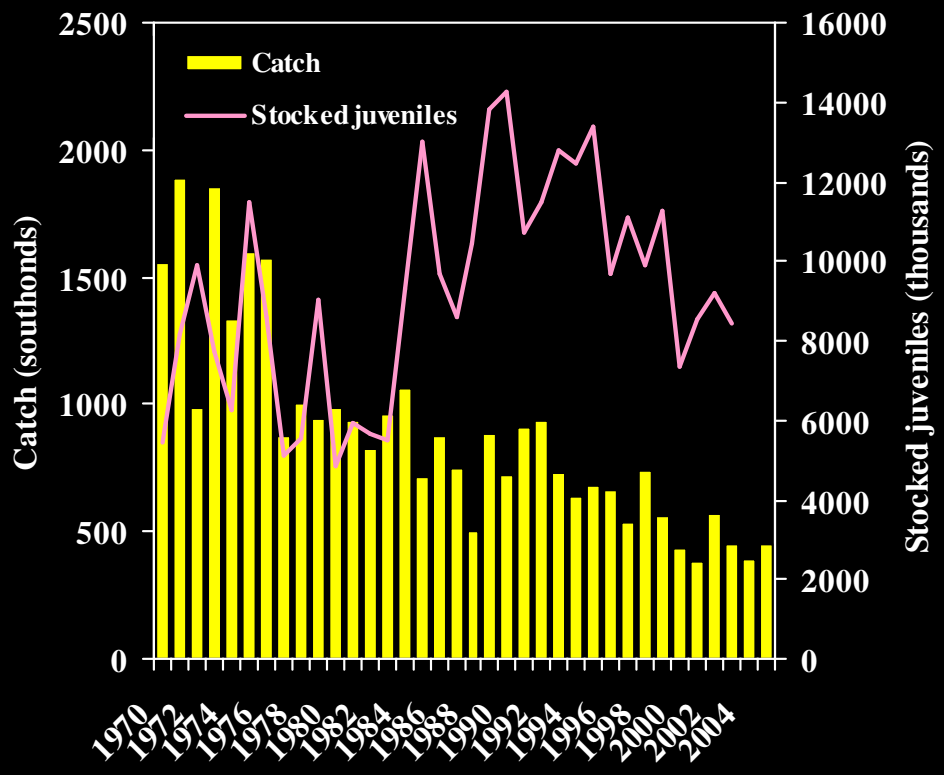


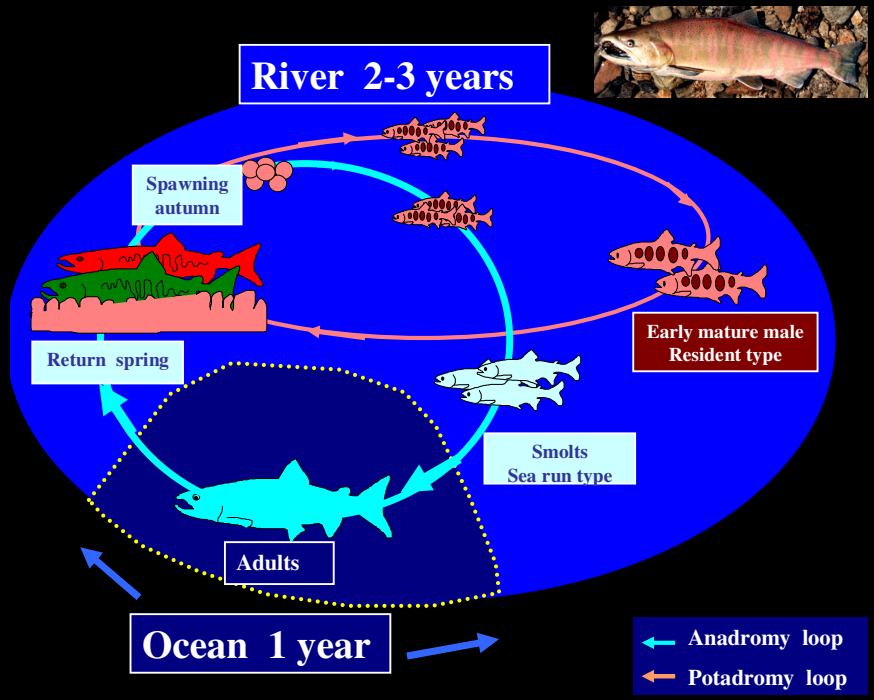
Pink salmon live in mainly eastern Hokkaido and remained low level until 1980s. But since early 1990s they have increased sharply in both even and odd years.

Morita et al. (2006) concluded that recent increase could be largely explained by climate change, with increased hatchery release having little effect.

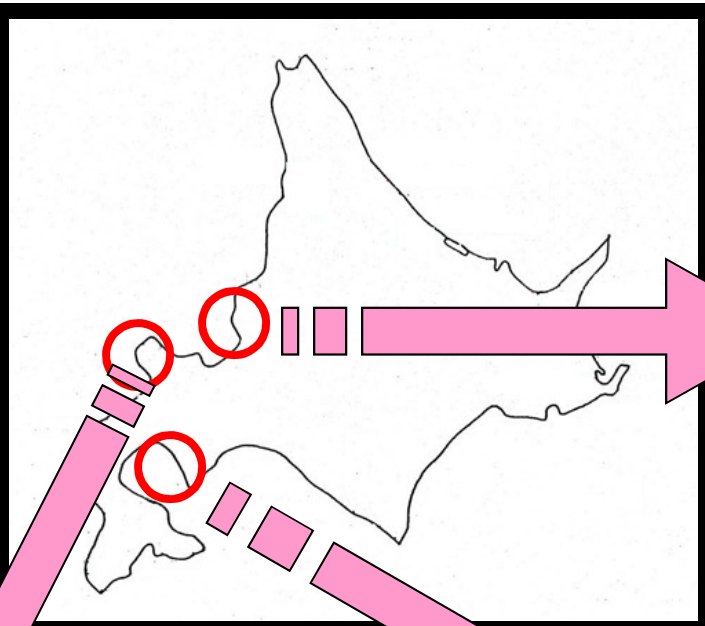
As a recent study (Torao, unpublished data) observed high recapture rate (63%) of hatchery pink in the natal stream and highly straying (1-4%, marks / total catch) in many streams within 60km, more accurately quantitative research is needed to evaluate the stocking effectiveness of hatchery.

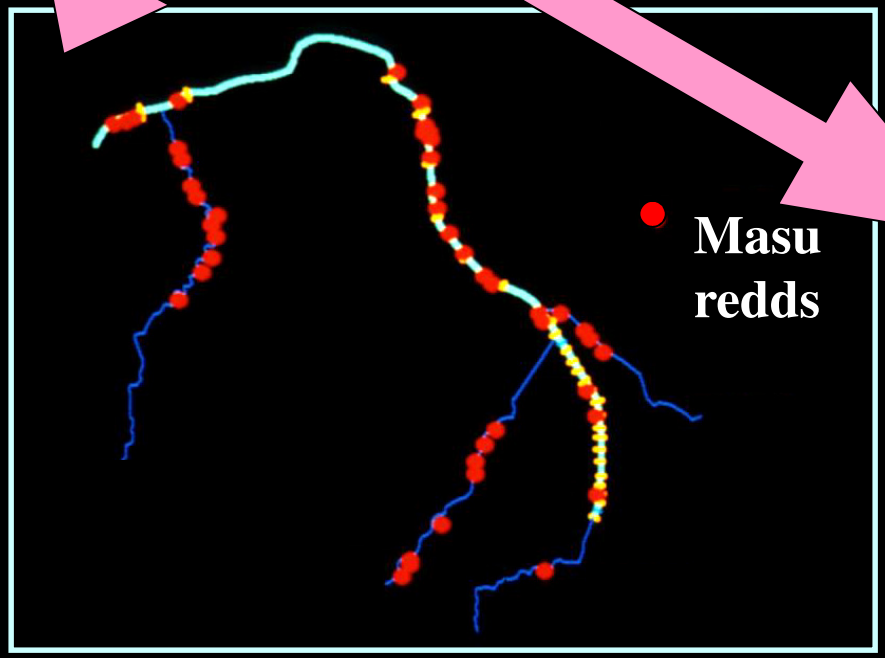
Status of Hokkaido masu salmon, and stocked juveniles



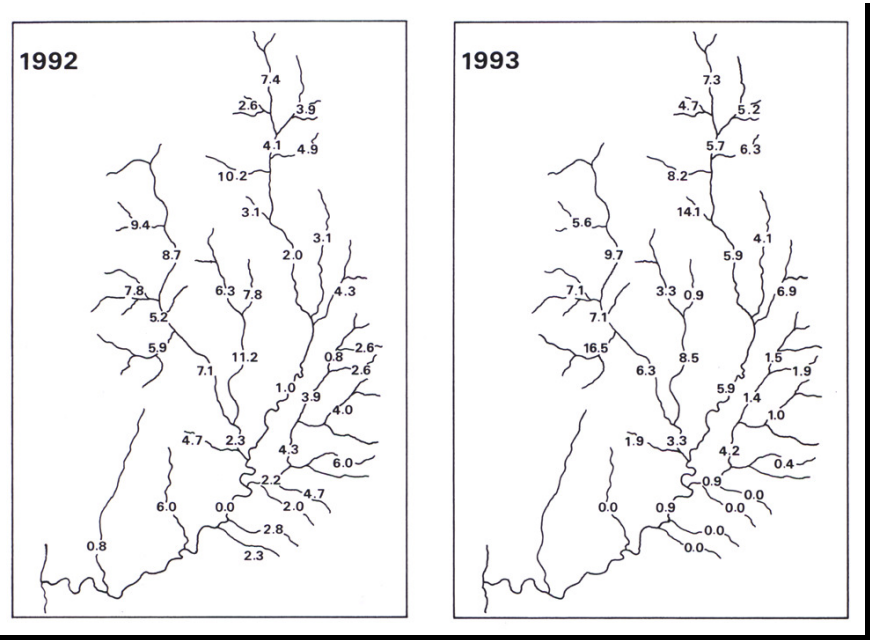


Masu salmon have been decreasing despite many costly efforts including hatchery activity because their life history is freshwater-dependent and freshwater environments were getting worse due to man-made constructions such as dams and chanellization.

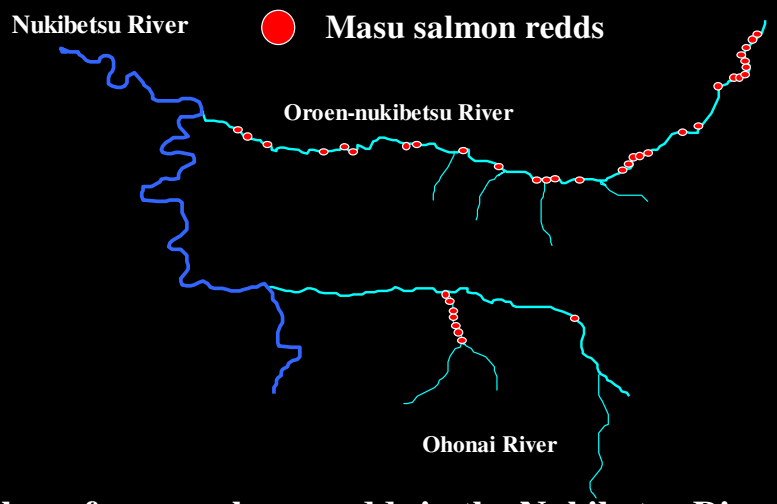




Number of masu salmon redds in the Shakotan River of mid-western part of Hokkaido (Yanai et al., 1996)

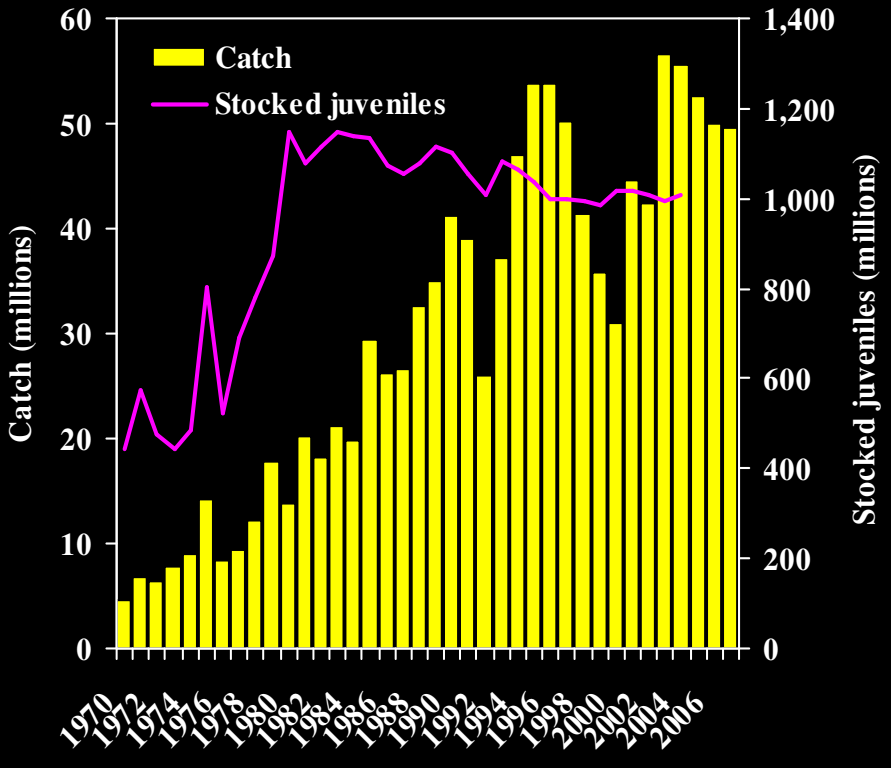


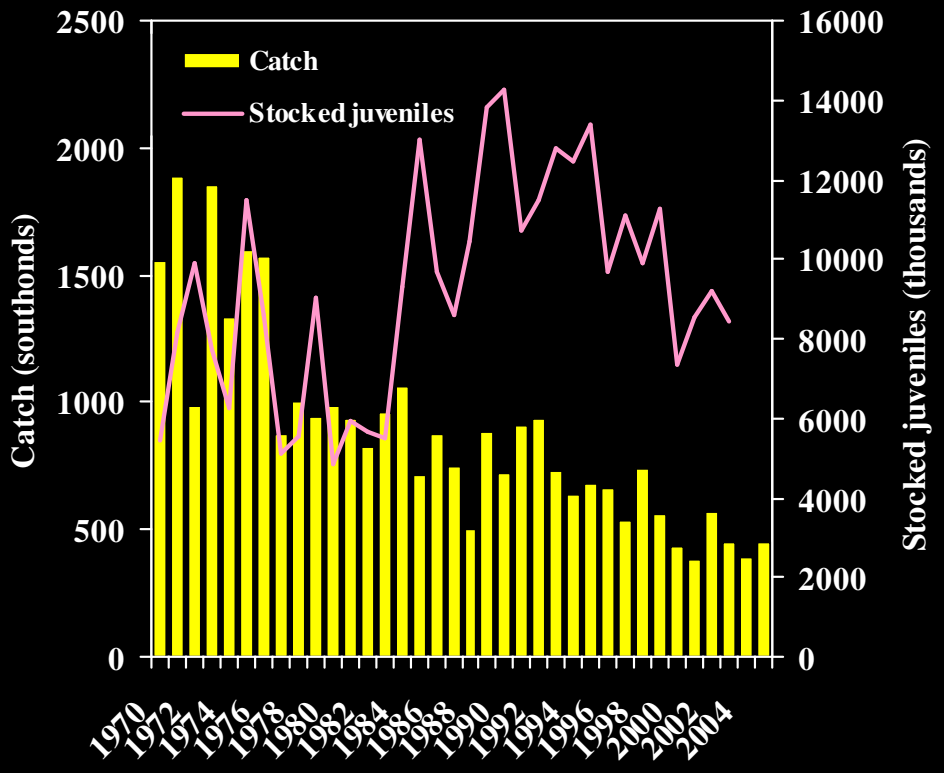
Number of masu salmon redds per km in the Atsuta River of mid-western Hokkaido (Sugiwaka et al., 1999)



Number of masu salmon redds in the Nukibetsu River of southern Hokkaido (Omori, 1998)

While hatchery-based management in Hokkaido has been successful for chum salmon, masu salmon still remain at the low levels because of different life history and delegation of freshwater environments.

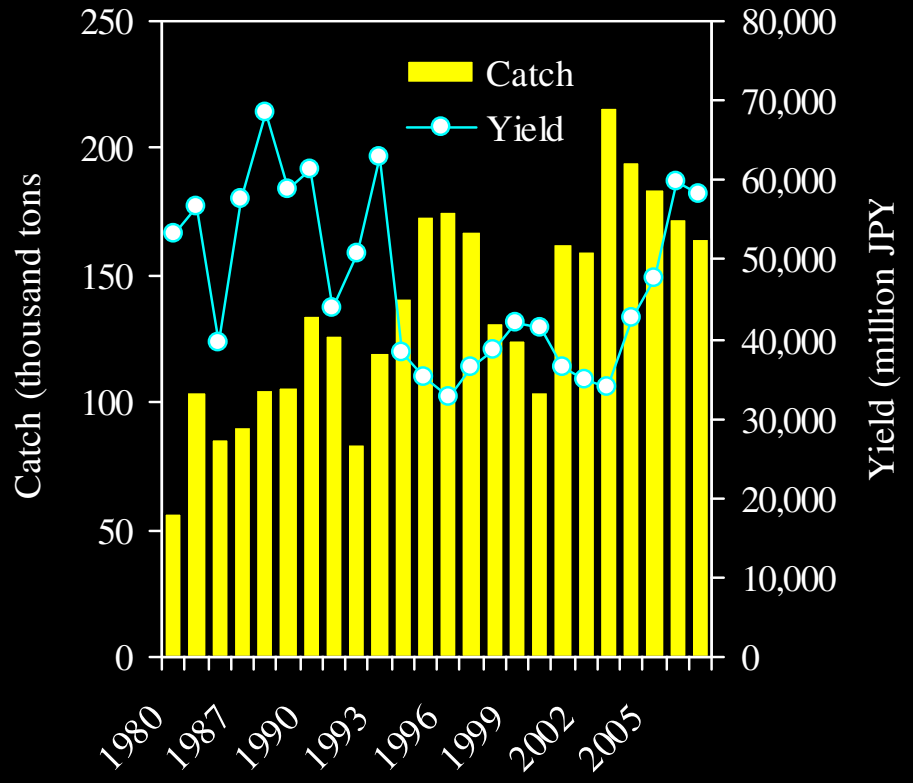


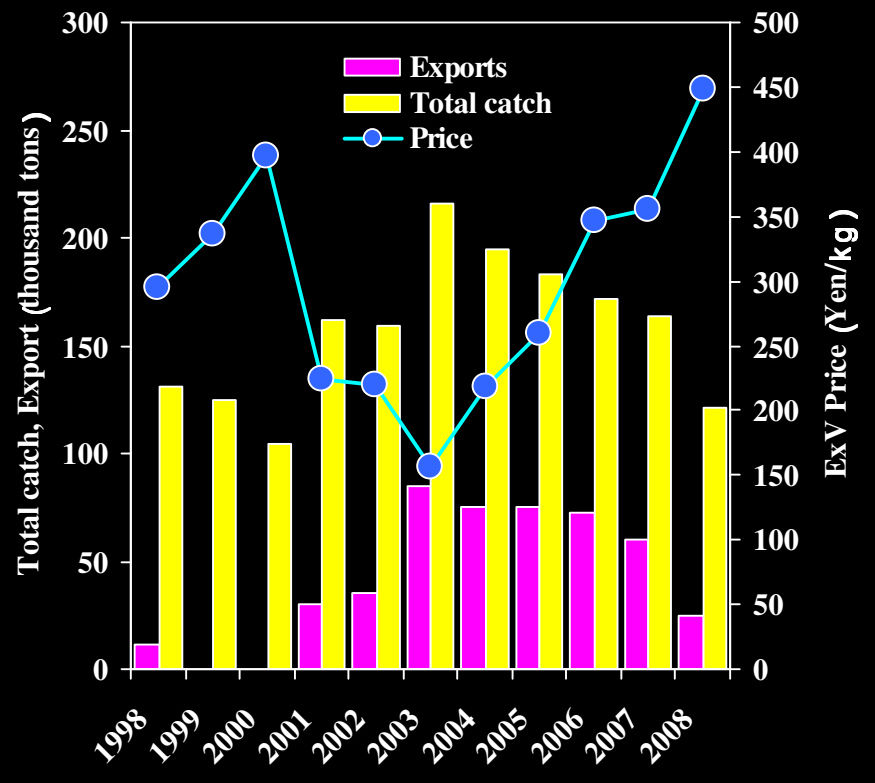


Therefore, in order to enhance masu salmon we have to change from only hatchery programs to combination of hatchery programs and wild conservation. In addition, chum salmon also are needed to conserve wild ones for the following reasons.

Chum yields decreased dramatically in mid 1990s with increase in catch, but have been recovered since 2004 due to export to Europe and North America via China fish processors (See the figure). However, Alaskan MSC-certified salmon also have joined the China market.

Therefore, the Hokkaido Federation of Fisheries Cooperative Association challenged to take MSC certification for Hokkaido chum salmon set net fishery to maintain profitable position to export.





The TAB of MSC confirmed that it is likely that the Hokkaido chum salmon fishery meets the newly developed 'MSC Scope Criteria for Enhanced Salmon Fisheries' as described below.

The Hokkaido fishery is this regarded by MSC as being in 'transitional scope' at this time. The fishery does not currently contain all the elements required under S3 (wild salmon management).

To comply with the MSC standard, the current focus on culture-based management in the Hokkaido fishery will need to change to one defined instead by wild stock management objectives.

From the paper by Beacham et al. (2008) reviewed to date, it is MSCs understanding that the historic management of the enhancement activities in this fishery has not led to irreversible negative impacts on the wild genome.

What is the present status of wild salmon management in Hokkaido?

Commercial and game fisheries are legally prohibited in the all rivers around Hokkaido in order to conserve wild salmon and to catch hatchery salmon for enhancement programs in freshwater.

But, sustainable escapement goals and management plan for wild salmon have not been completed, as biological survey and monitoring of wild/natural salmon such as adult counting have not always been carried out in the freshwater.

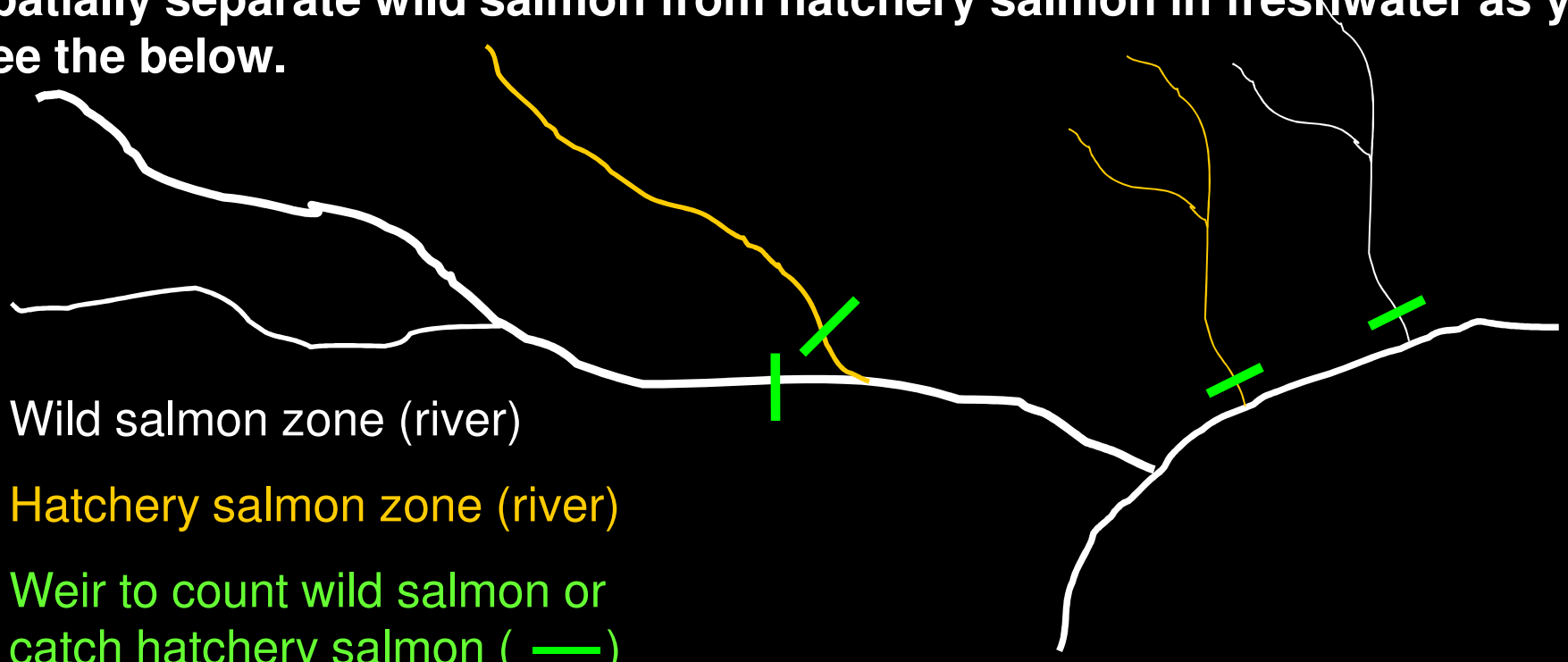
First, we have to make a wild salmon policy as well as that in hatchery management policy which has been established.

Secondly, we have to accumulate the data set on wild salmon to separate from hatchery salmon.

Wild salmon policy

Some ideas have been thought to make a wild salmon policy not only to conserve wild salmon and biological diversity of hatchery origin salmon but also restoration programs to rehabilitate freshwater environments to create better fish habitats, on the basis of 5 regional stocks around Hokkaido (Beacham et al., 2008).

A harmony between ecosystem and coexistence of wild and hatchery salmon could be achieved on the basis of the zone management to spatially separate wild salmon from hatchery salmon in freshwater as you see the below.



There are three different types of rivers on the basis of hatchery activity in Hokkaido.

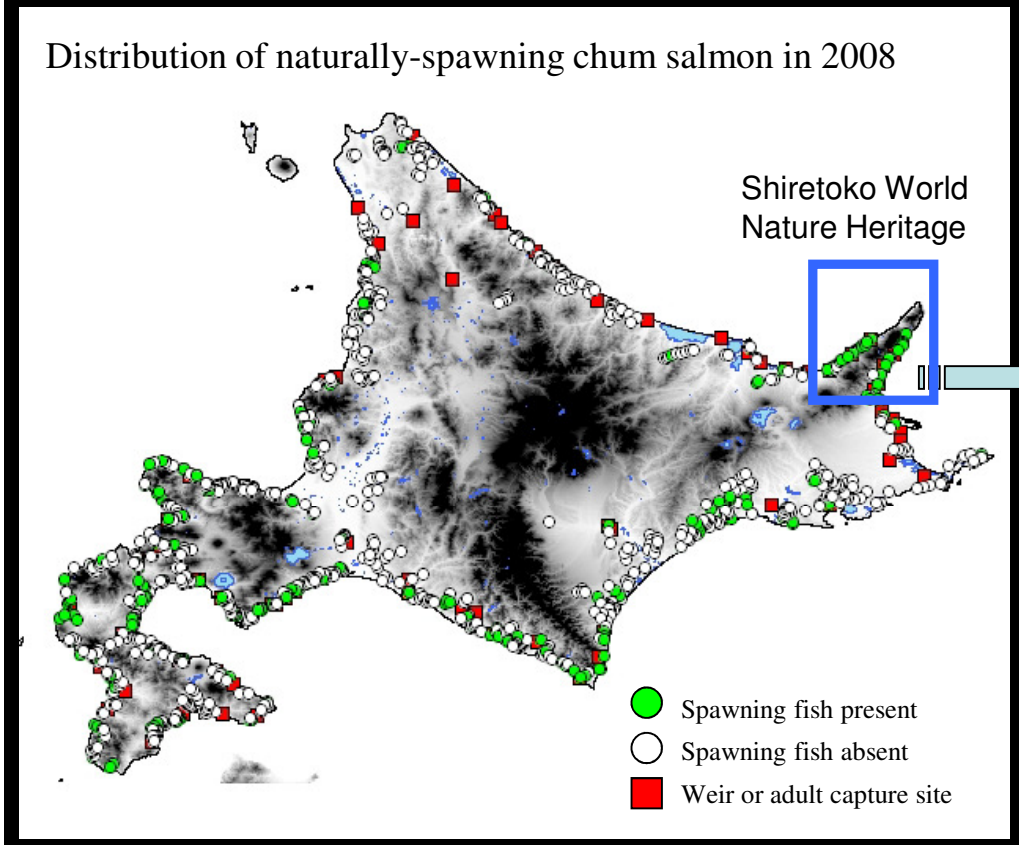
1. **Hatchery salmon juveniles have never been released or stopped. (Wild Salmon River)**
2. **Hatchery salmon juveniles are released, and returned adults are captured in the rivers. (Mix Salmon River, a-1, 2, 3)**
3. **Hatchery salmon juveniles are released, but returned adults are not captured. (Mix Salmon River, b type). They will naturally spawn.**
   >> MSC criteria tells us that their progenies are identified to be wild when hatchery-origin adults naturally spawn on the conditions of the same genetic origin.

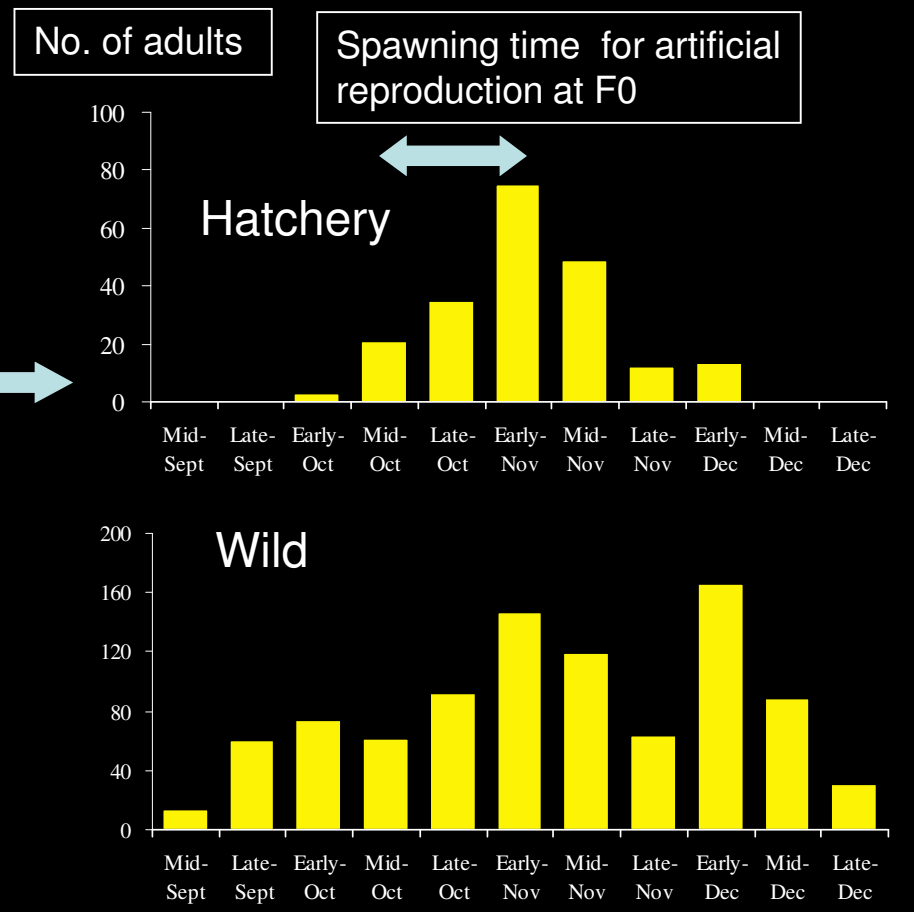
Table This is showing the classification of rivers which are used by chum salmon, and data source

	Type	Hatchery	Adult	Catch location	Escapement	Biological Data			
		Release	Catch	(Mainly with weir)	Goal	Release #	Catch #(♂♀)	Age, Length	Wild escapement*1
Wild Salmon River		No	No	—	No	—	—	No	No
	a-1	Yes	Yes	Near the Mouth of River	Yes (Mix)	Yes	Yes (Mix)	Some (Mix)	No identification
Mix Salmon River	a-2	Yes	Yes	Tributary	Yes (Mix?)	Yes	Yes (Mix?)	Some (Mix?)	No identification
(Wild and Hatchery)	a-3	Yes	Yes	Hatchery	Yes	Yes	Yes	Some	-
	b	Yes	No	—	No	Yes	No	No	No

*1Biologica surveys have been conducted to get qualitative and quantitative data of escapement and spawning for wild salmon since 2007.

Now, we have qualitatively investigated natural spawning and habitat conditions in streams around Hokkaido since three years ago on the basis of three different types of rivers (please come to Miyakoshi et al. in the session 5A to get more).





(Data from Miyakoshi et al. in 2009 SOS conference)

(Data from Sasaki et al. unpublished)

Next step, we have partly practiced quantitative research and monitoring such as adult counting and biological data from this year to estimate tentative escapement goals of wild chum salmon.

Ecosystem-based sustainable conservation and management programs

- **Biological monitoring (Hatchery + Wild)**
  - Carrying capacity in the ocean related to climate change and global warming
  - Body size & age composition of a population
  - Genetic & reproductive characteristics
- **Separation (zone management) of wild and hatchery salmon populations in freshwater**
  - to protect genetic diversity and endemism, and recreational and commercial salmon fisheries
- **Rehabilitation of wild salmon populations & natural riparian ecosystem**
  - Establishment of nursery and spawning areas in rivers
  - Rehabilitations of wild chum and pink salmon
  - Conservation of wild masu salmon
  - Exclusion and non-introduction of exotic fishes

Conservation principles of natural spawning of salmonids in Hokkaido, Japan

We need to establish the strategy to coexist wild and hatchery salmon for ecosystem-based sustainable conservation and management programs succeeding to the will of Mr. Aoto as samurai salmon.