

# Conservation and enhancement of masu salmon in Hokkaido, Japan

A photograph of a person wearing tan waders holding a large masu salmon (brown trout) in a stream. The fish is held horizontally, with its head to the left and tail to the right. The fish has a dark brown back with lighter, iridescent sides and a pinkish-red belly. Its mouth is open, showing its teeth. The person's hands are visible, holding the fish. The background is a rocky stream bed with some green moss or algae.

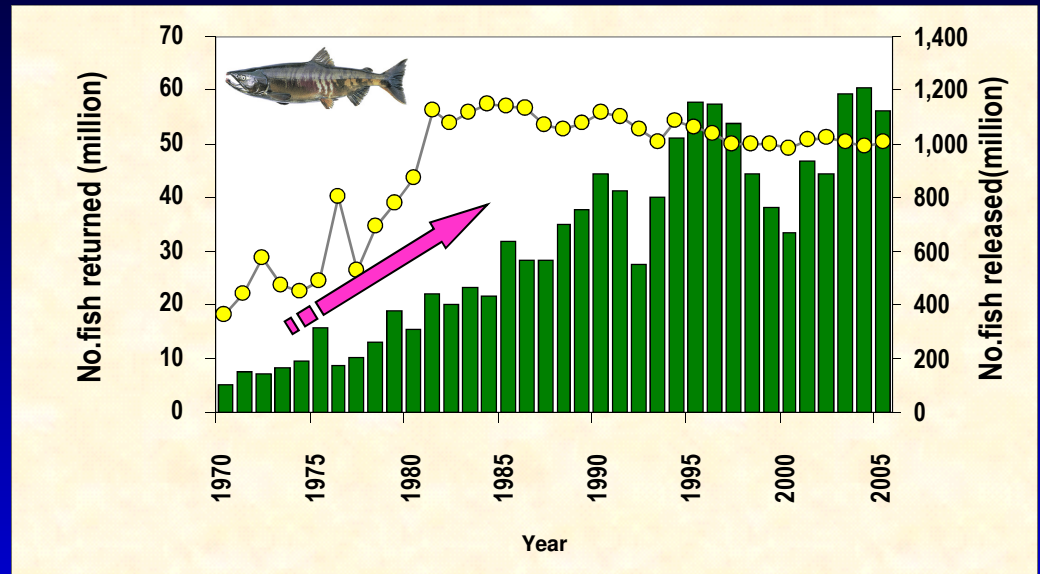
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# Contrast between chum and masu

Chum salmon



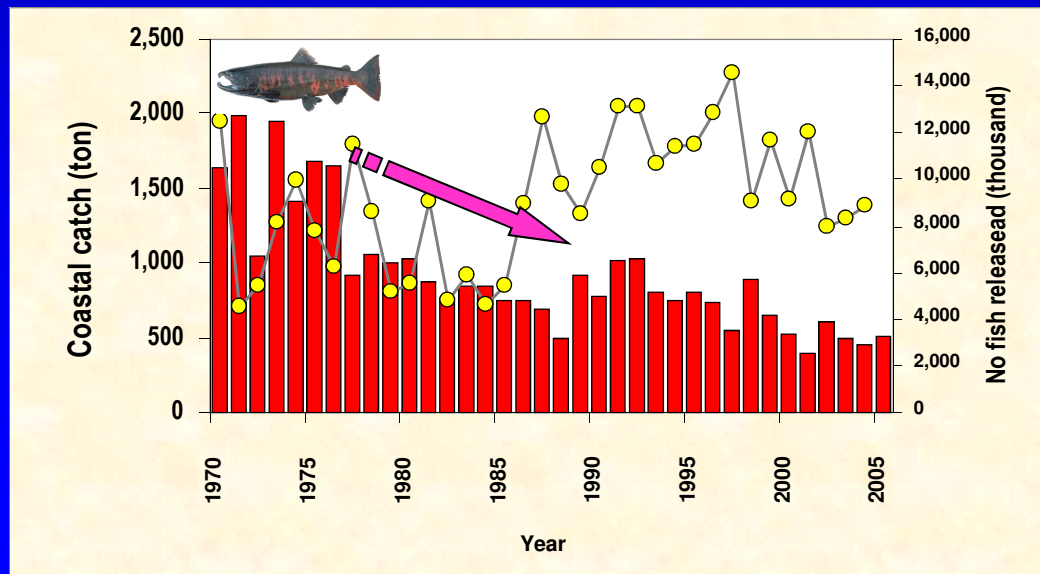
Increase with stocking



Masu salmon



Keep declining despite stocking



Hatchery program dose not contribute to masu salmon stock?



# Effectiveness of stocking



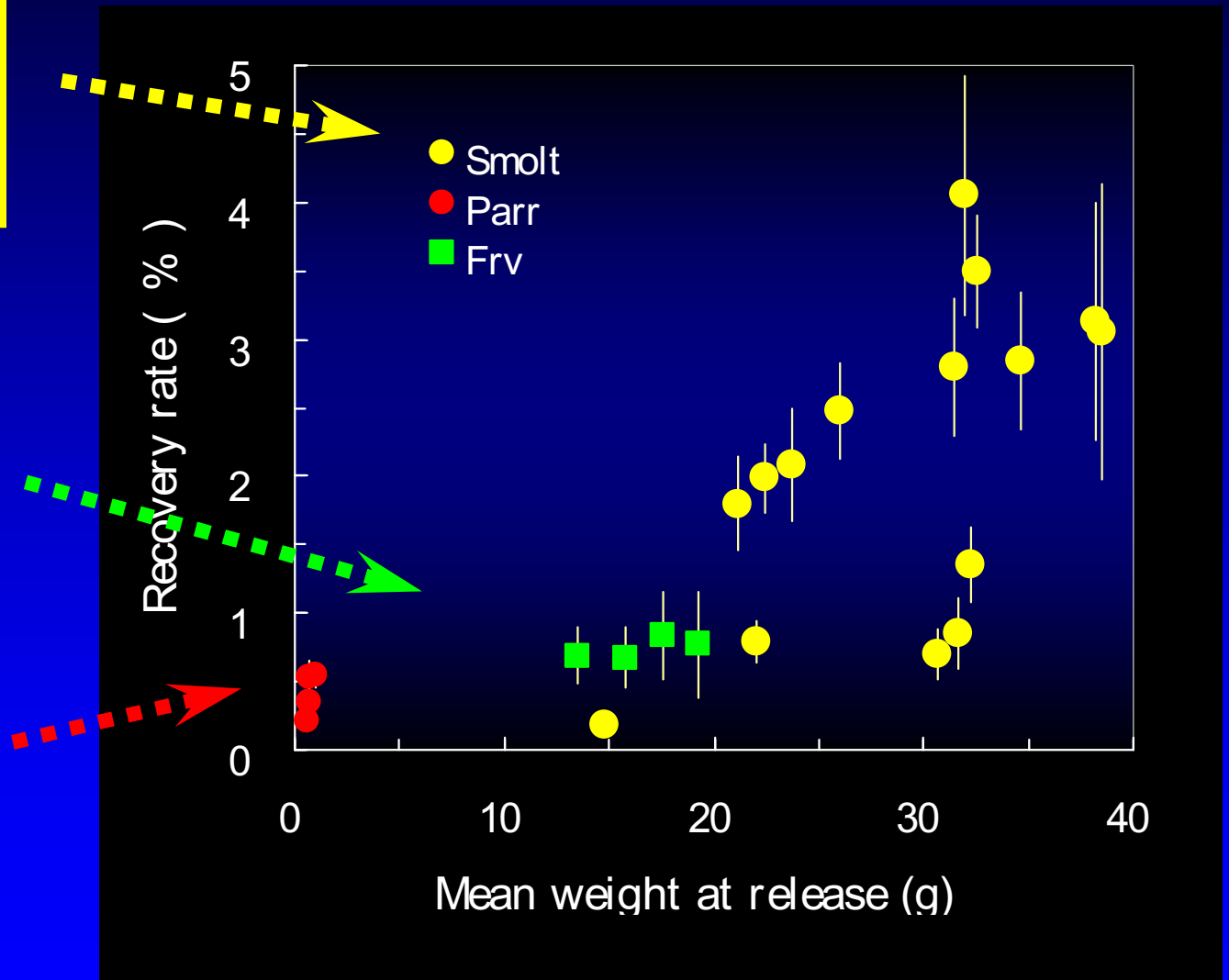
Smolt : 15 ~ 38 g



Parr : 13 ~ 19 g

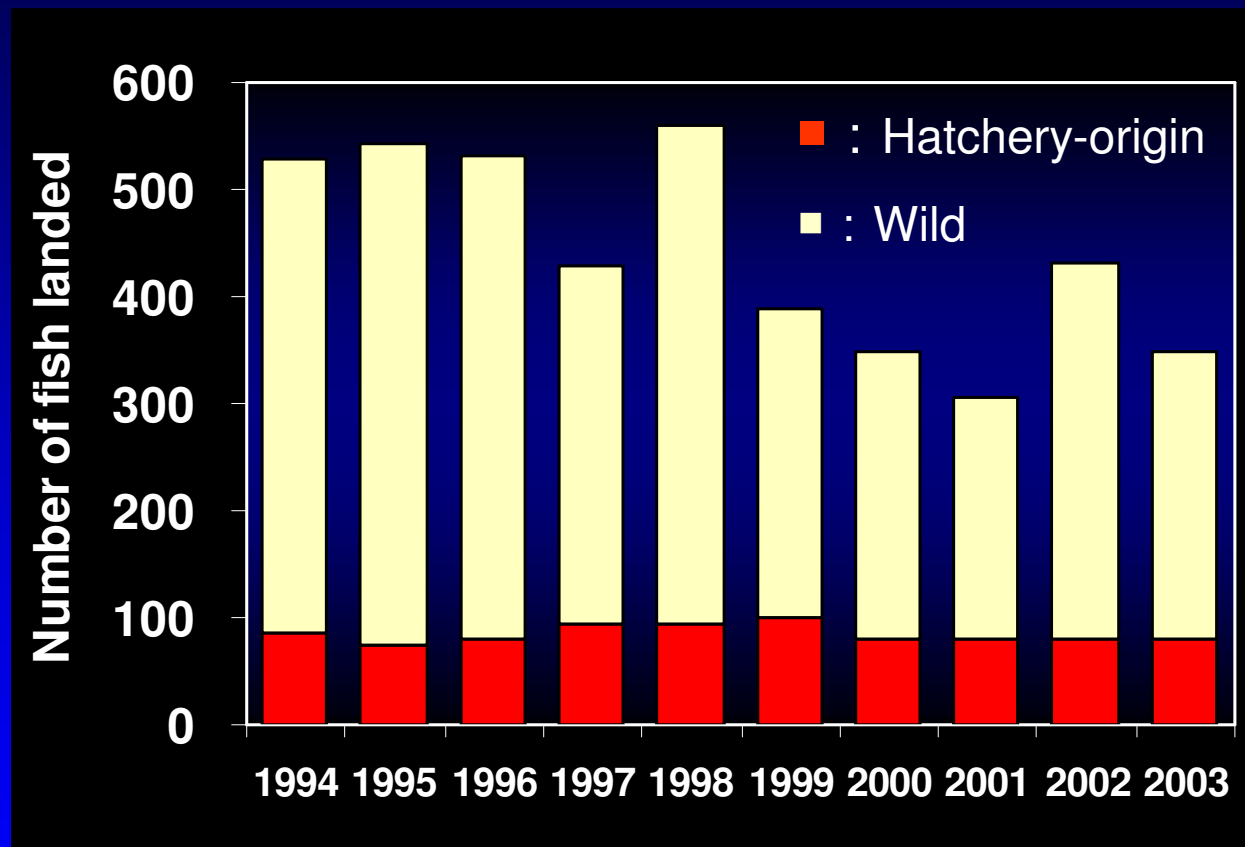


Fry : 0.6 ~ 1 g



( Miyakoshi *et al.* 2001; 2004; 2006 )

# Contribution of hatchery fish to coastal commercial catches (1994-2003)



Hatchery fish consistently contribute to stock enhancement  
But the stock is mainly maintained by wild stock (>74%)

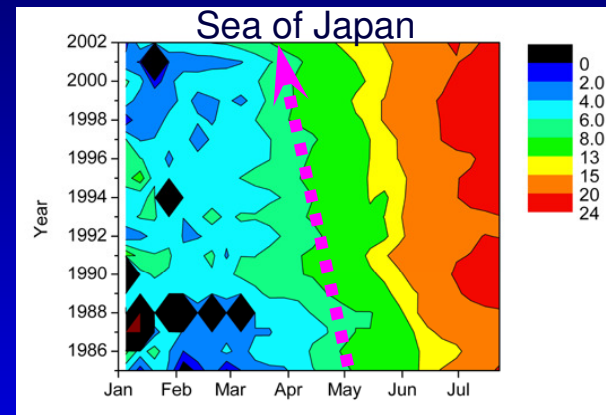
# Why did wild populations decrease ?

## Possible reasons

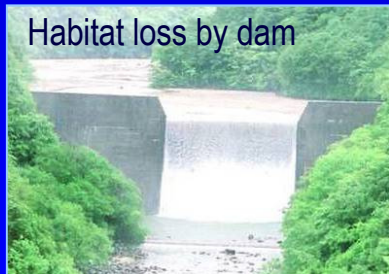
### 1. Overfishing (including recreational fishing)



### 2. Change of ocean environment



### 3. Habitat degradation

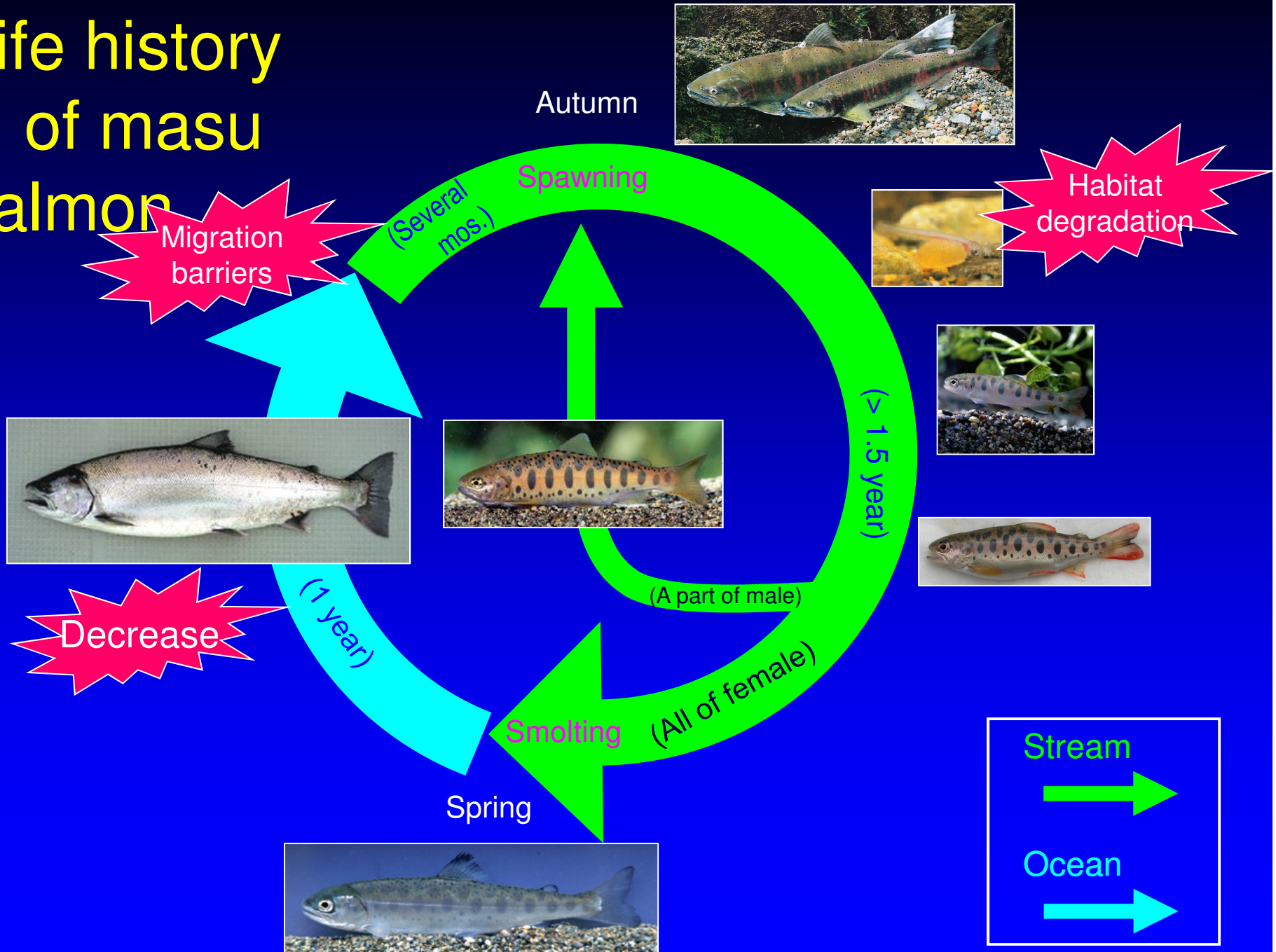


### 4. Fitness decline by hybridization with hatchery fish



All of these would be true

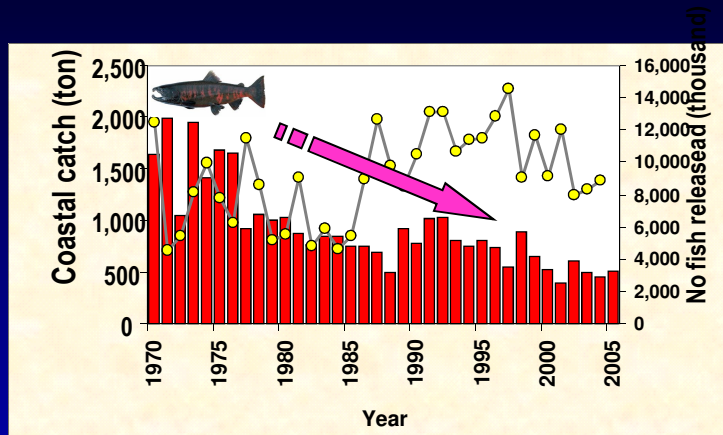
# Life history of masu salmon





# Importance of habitat restoration

Suitable rearing habitat  
for masu salmon



Habitat degradation would  
considerably influenced the stock level

Habitat loss and degradation by dams  
(at least >12,000 dams exist in Hokkaido (Tamate & Hayajiri 2008))



Loss of spawning and nursery habitat



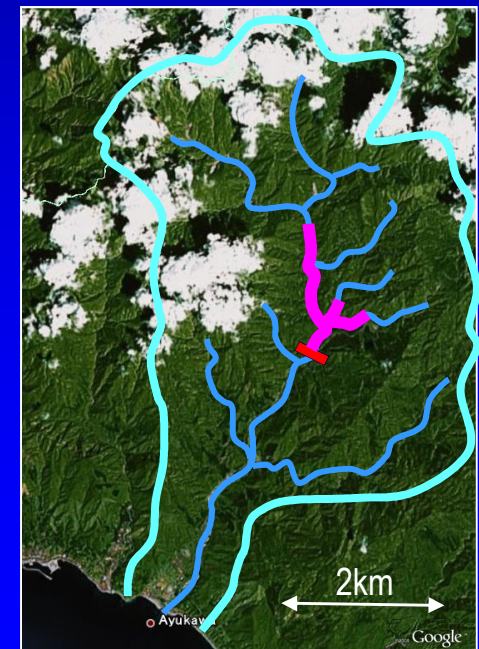
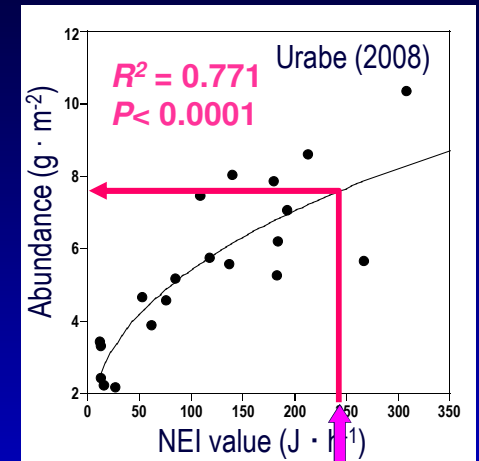
Alteration of substrate condition  
(armoring & sedimentation)

Habitat restoration is  
critical subject for  
stock enhancement

# Estimating the potential recovery in above-dam area

1. Evaluation of habitat quality (NEI value) in the above-dam area through field survey
2. Estimating fish abundance in the above-dam area using fish-habitat regression equation (Urabe 2008)
3. Estimating available area in the above-dam from field survey & GIS analysis
4. Calculating the potential recovery in the above-dam area

17,140 juveniles can recover  
( $\approx$  the effect of stocking effort)

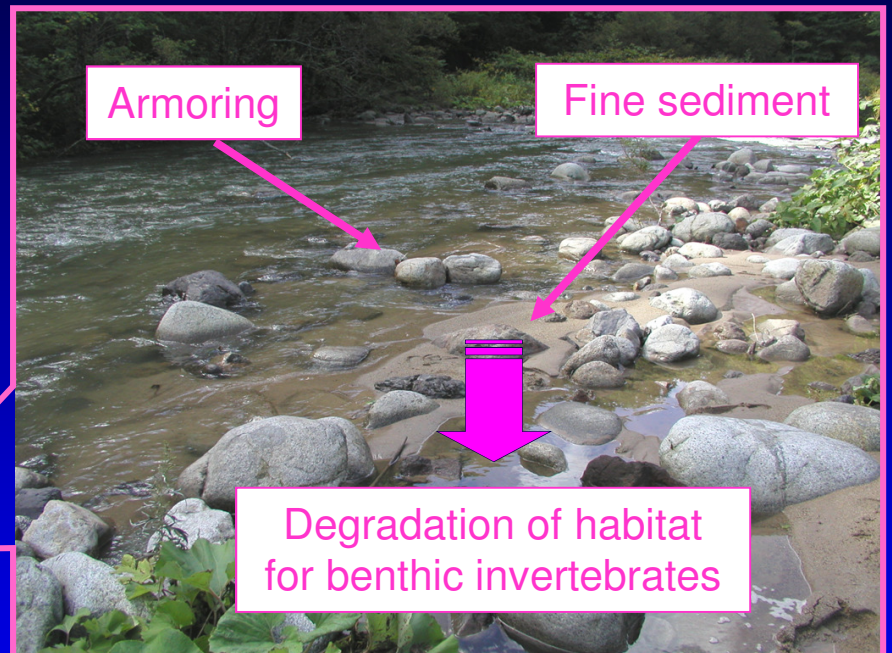
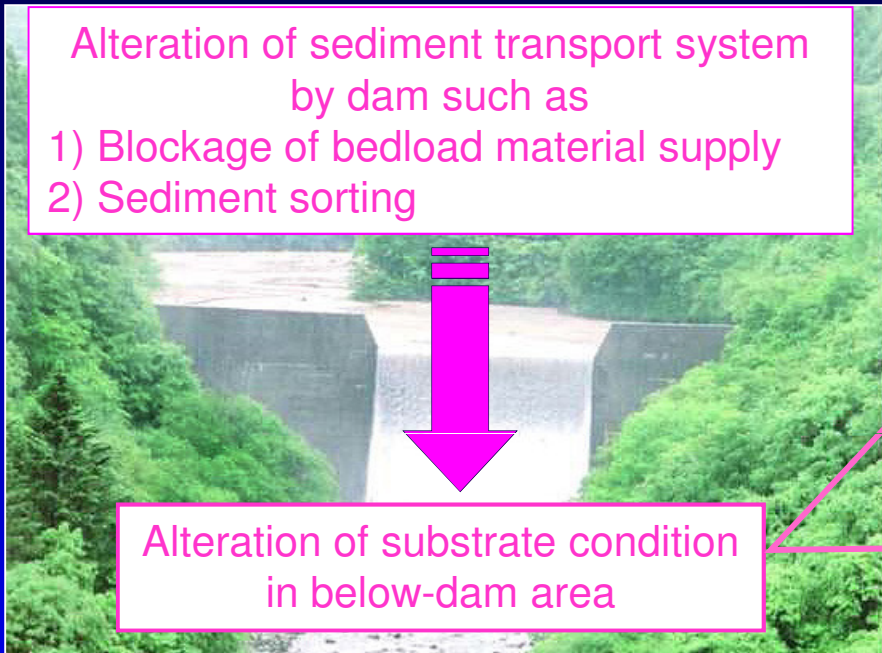




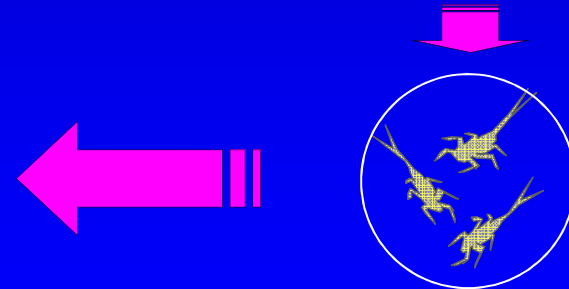
# Estimating the potential recovery in below-dam area

Alteration of sediment transport system by dam such as

- 1) Blockage of bedload material supply
- 2) Sediment sorting



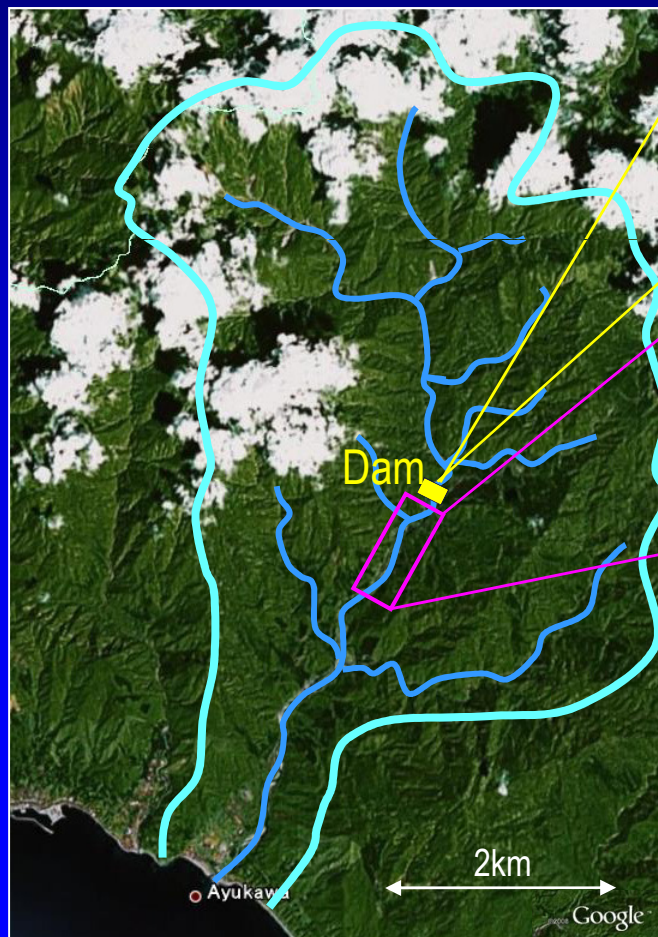
Decline of carrying capacity for masu salmon juveniles



Decrease of prey

# Estimating the potential recovery in below-dam area

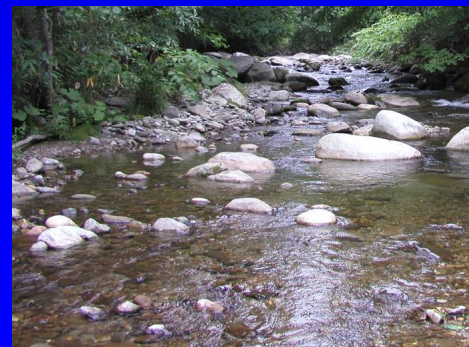
Ken-ichi River watershed



- 1) Blockade of bedload supply
- 2) Sediment sorting



Degradation of substrate condition in below-dam area



If substrate condition is restored,

Carrying capacity increase 40%

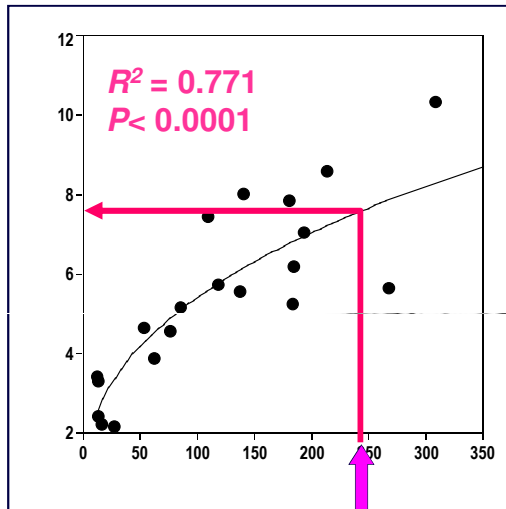


# Restoration of spawning habitat and sediment transport system





# Can masu salmon stock recover by habitat restoration only ?



Quantitative evaluation of population recovery by habitat restoration

17,140 juveniles can recover  
( $\approx$  the effect of stocking effort)



40% increase in carrying capacity



Habitat restoration is quite effective and essential.

Riverine environment in Hokkaido has considerably degraded.

>12,000 low-head dams exist in Hokkaido  
(Tamate & Hayajiri 2008)

If we stop releasing now, stock level of wild populations would critically decrease.

We should carefully and effectively use hatchery fish for stock enhancement.

# Negative impacts of hatchery fish on wild masu salmon

## Knowledge in Hokkaido

- ✓ Transplant caused decline in returning rate of masu salmon (Mayama 1989)
- ✓ Difference in ecological traits (migration behavior, smolt timing, and seaward migration timing) among wild, domestic, and their hybrid smolts (Koyama et al. 1995, 2007)
- ✓ Genetic property of wild masu salmon populations are different among tributaries even in same watershed (Ohkubo 1992, Kitanishi et al. 2009)

Hatchery fish could influence the fitness and genetic property of wild populations

# Hatchery reform

Shift from single enhancement action (releasing)  
to combination of the wild population recovery  
and effective hatchery program

- ✓ Recovery of wild populations by habitat restoration
- ✓ Minimize the negative impacts of hatchery fish on wild populations  
No expansion of releasing areas and number of fish
- ✓ Care for genetic change of the broodstock  
Captive rearing is strictly restricted under 2 generations  
(only 1 generation in principle)

We should examine the effects of those on stock  
enhancement and conservation by researches  
(Partially ongoing)



# Ongoing and future researches for enhancement and conservation

## Ongoing researches

- ✓ Estimating the effects of habitat restoration
  - 1) Estimating the potential recovery of spawning habitat using GIS
  - 2) Monitoring the population dynamics after the restoration
- ✓ Monitoring the status of wild populations
- ✓ Monitoring the change in ecological traits of broodstock

## Future researches (partially ongoing)

- ✓ Researches on establishment of conservation unit
  - 1) Population genetics
  - 2) Development of watershed database  
(information about ecological attributes and land use)

# Summary

- ✓ Decline of masu salmon stock in Hokkaido is caused by decrease of wild populations
- ✓ Recovery of wild populations via habitat restoration is quite effective for stock enhancement
- ✓ Combination of wild population recovery and careful hatchery program is essential
- ✓ Hatchery program should be flexibly and adoptively, continuously modified based on scientific knowledge



Thank you for your attention !

