Population dynamics of Japanese pink salmon

Does climate change explain the recent increasing trend?

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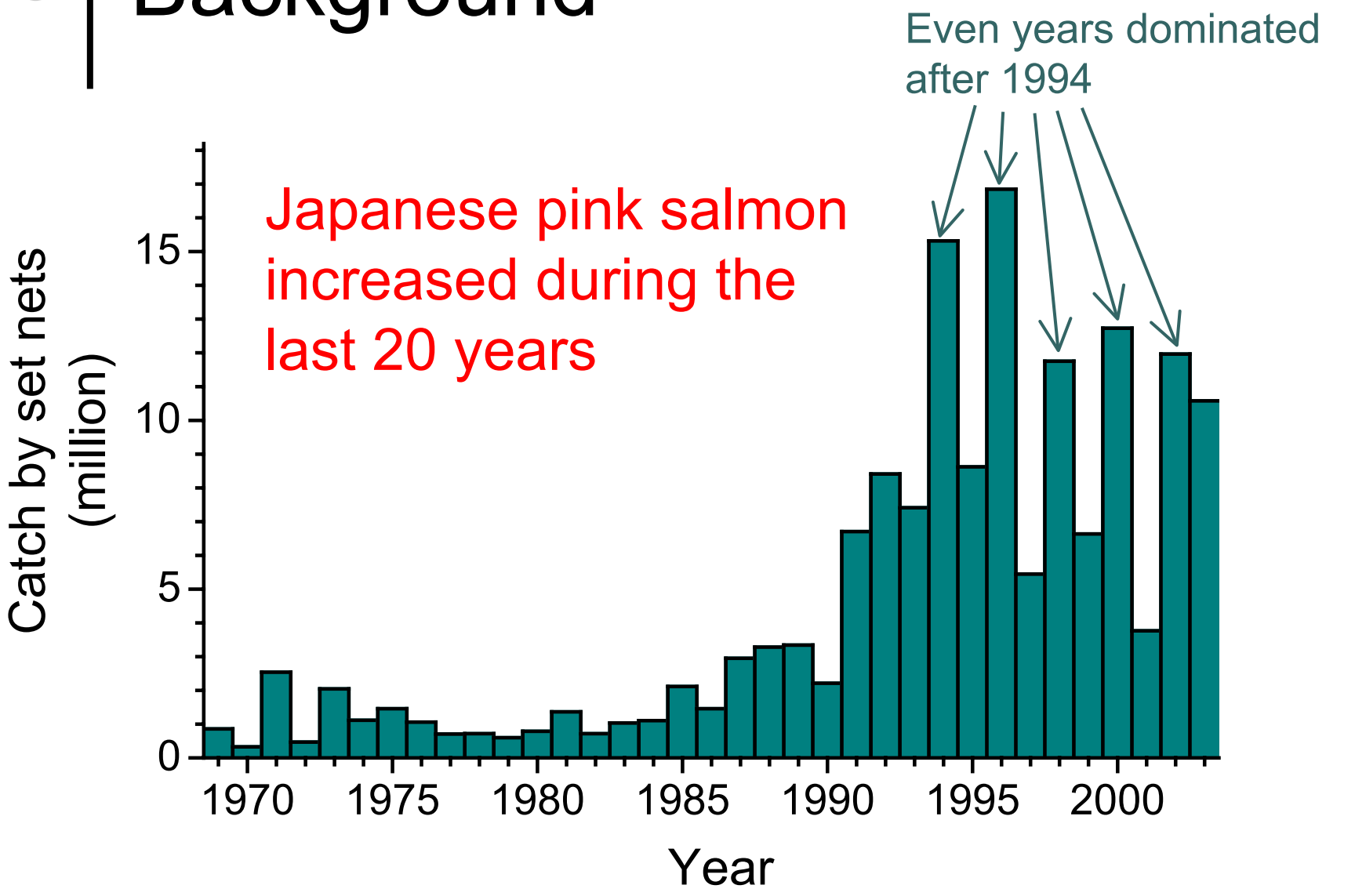
Background



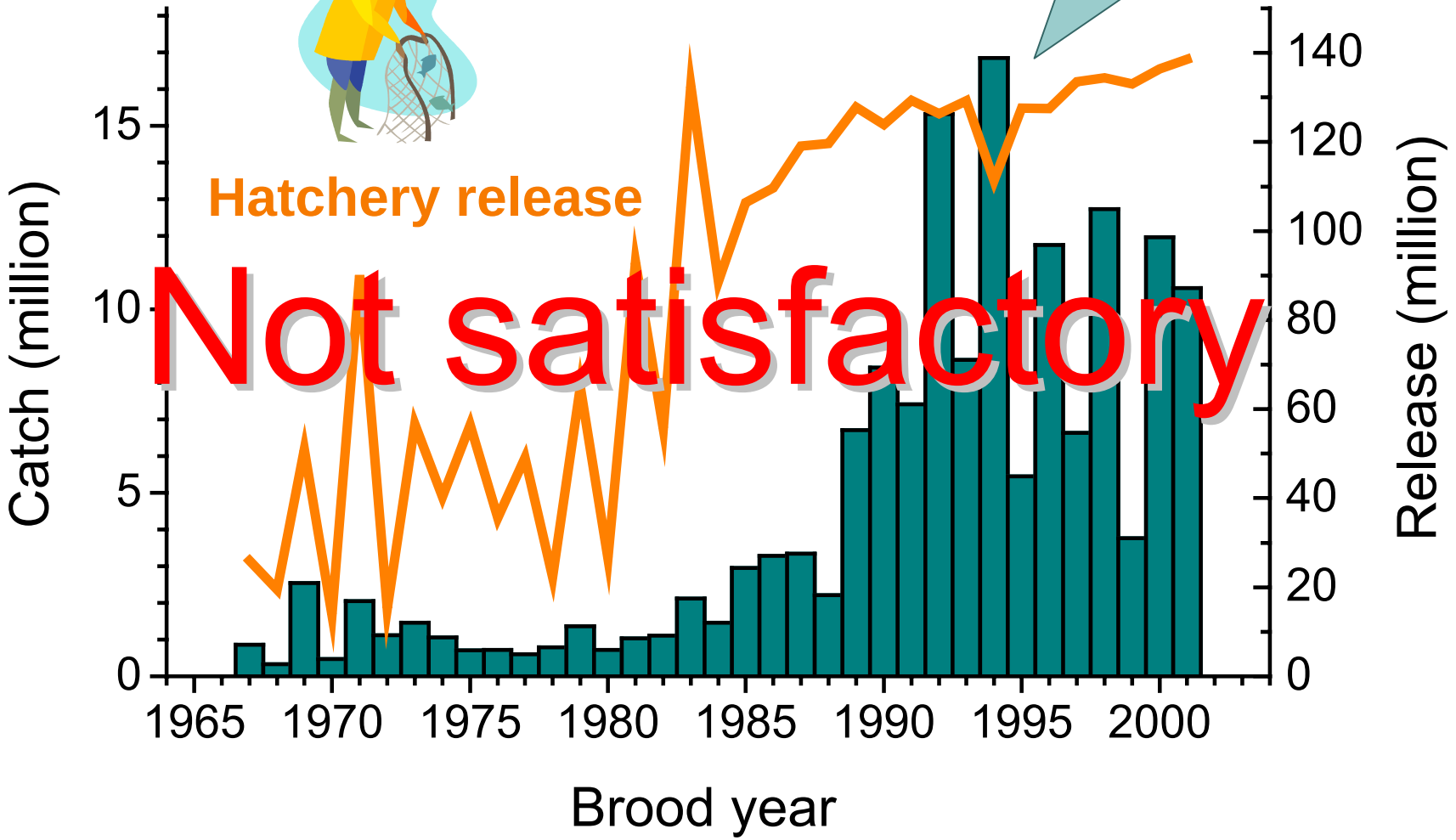
*Assumption: catch approximates population size

Why increased ?

- **Hatchery release**
  - Number of released fry increased during the same period.
- **Climatic variation**
  - Climatic factors affecting population growth of pink salmon were suggested.
  - *e.g.*, winter severity, river discharge, Aleutian low pressure.

Hatchery release

Despite the constant number of fry released, the catch nonetheless fluctuated greatly…



Objective

- Examine the effects of **climatic variation**, **hatchery release** and **density dependence** on the population growth rate of Japanese pink salmon.

Methods

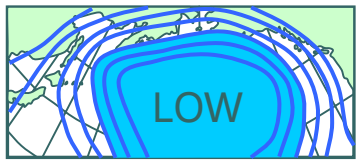
- We used the **stochastic Ricker population model** incorporating several explanatory variables.

- $N_t = N_{t-2} \exp(a + bN_{t-2} + c_1X_1 + c_2X_2 + \ldots \varepsilon_t)$

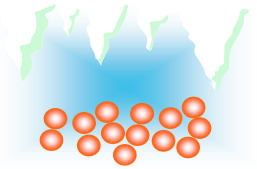
  - Statistical evaluations: likelihood ratio test, AIC, SIC, and parametric bootstrap likelihood ratio (PBLR) test

Explanatory variables

- **Hatchery release**
- **ALPI**

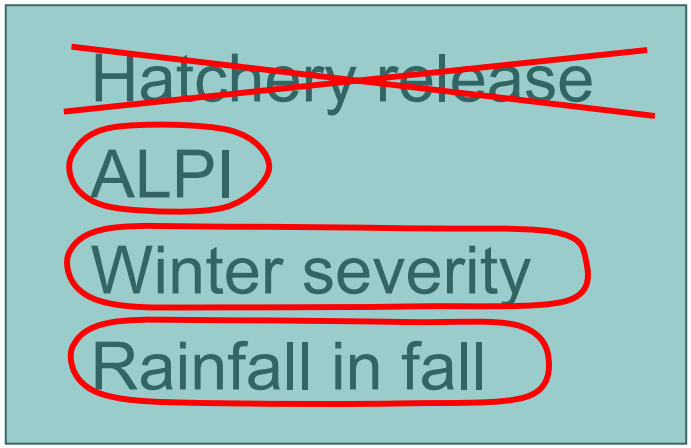


- **Winter severity**
  - Freezing at spawning grounds increase egg mortality.



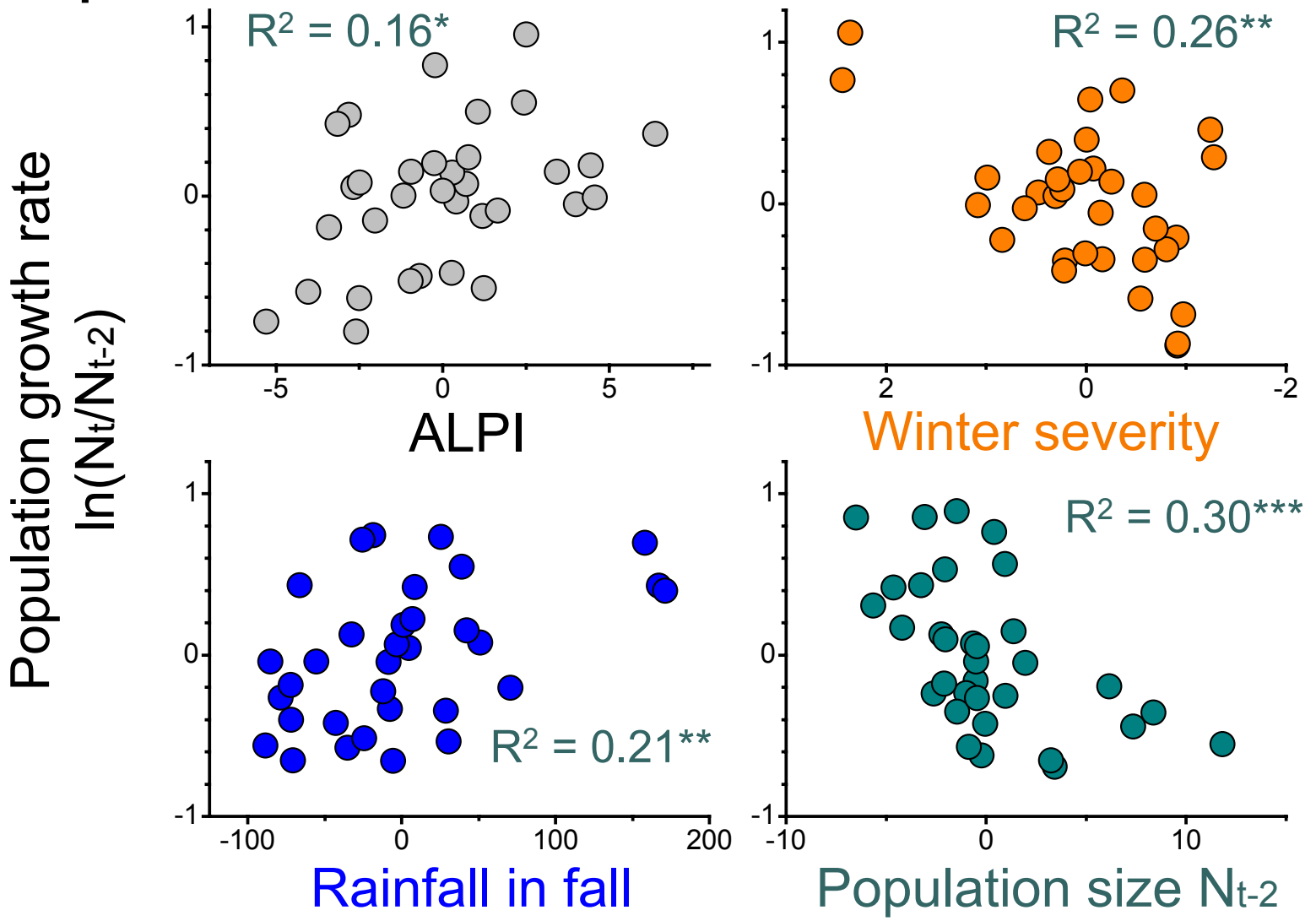
- **Rainfall in fall**
  - High river discharge enhances upstream migration.

Results

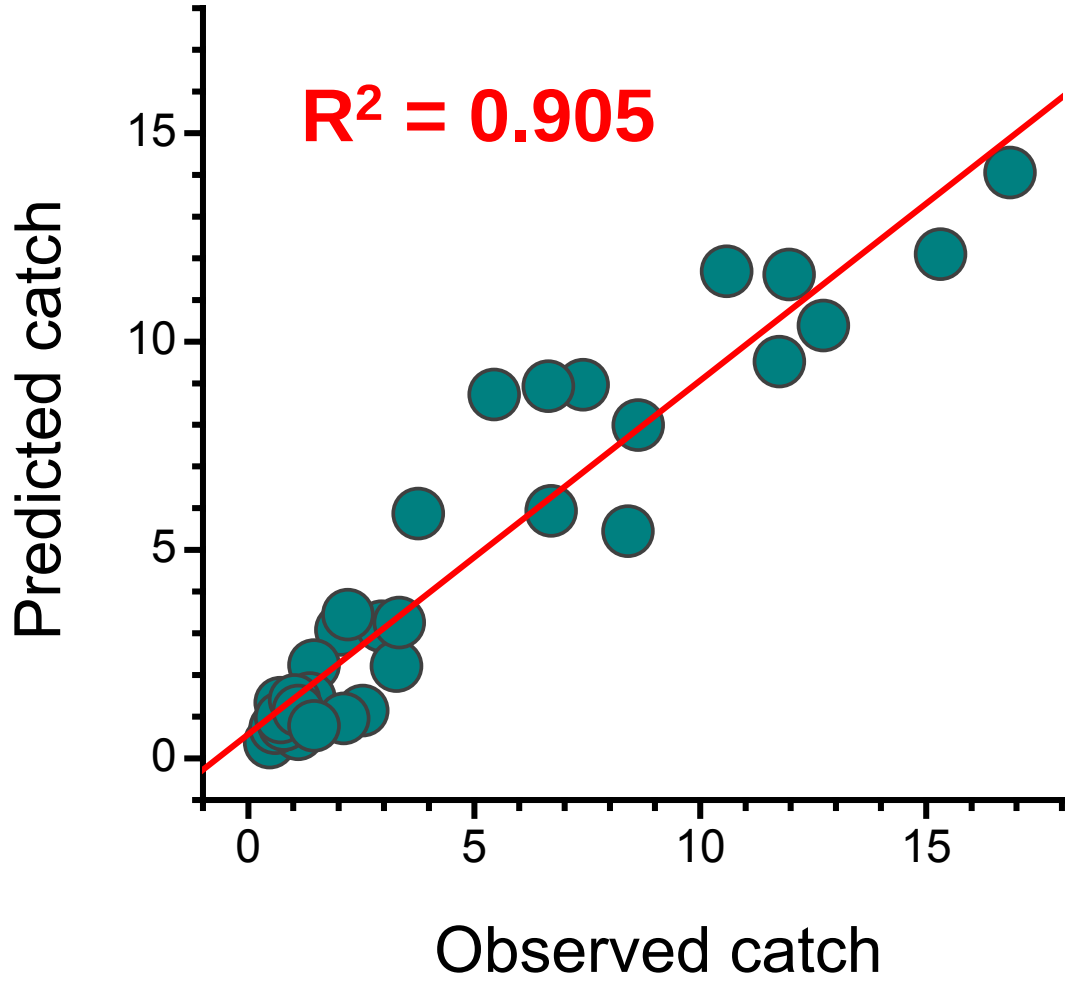


- Model including density dependence and three climatic variables was the best (AIC & SIC).
- Addition of hatchery release did not improve the model.
- PBLR test of Dennis and Taper (1994) identified density dependence.

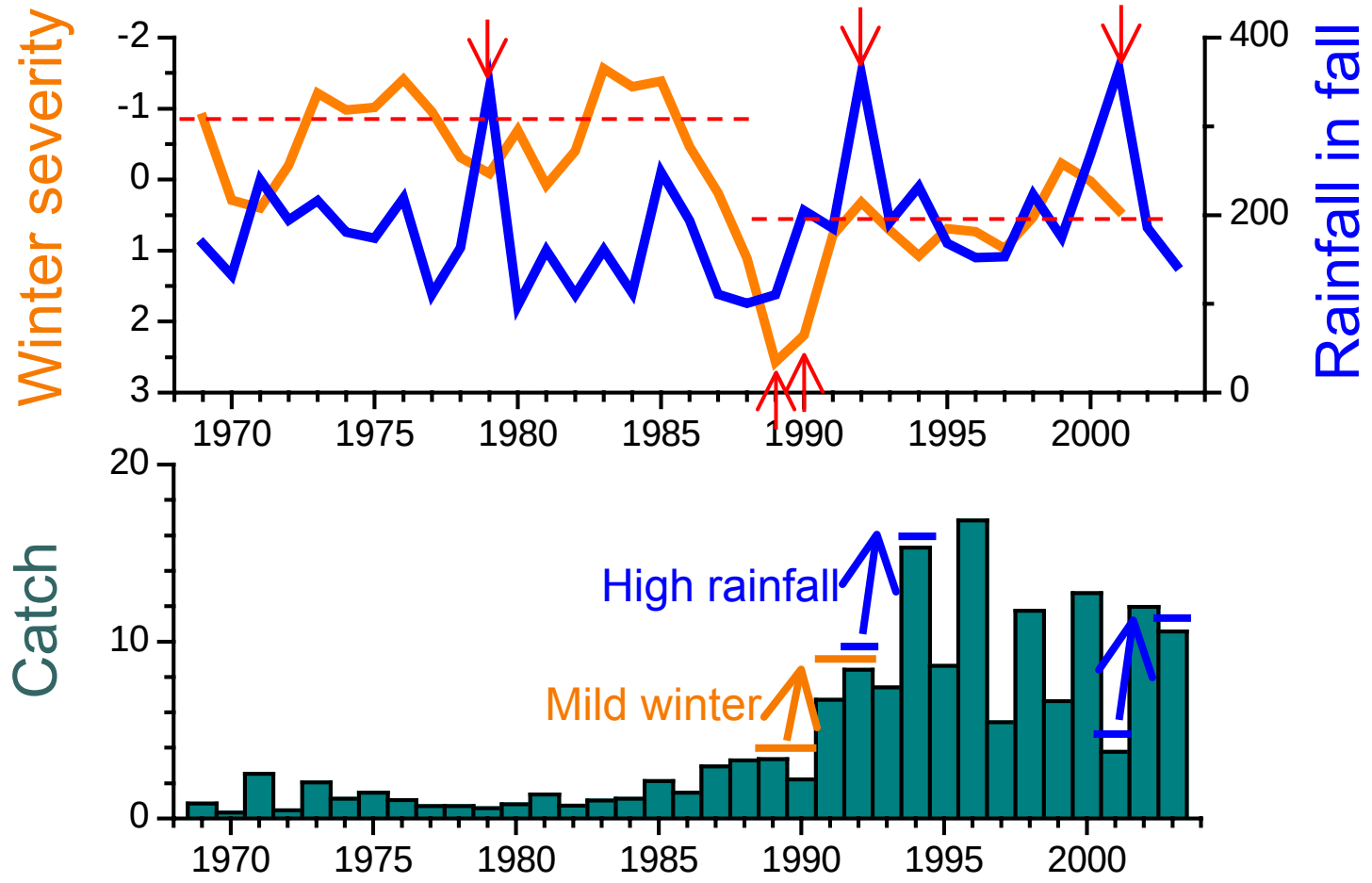
Partial residual plots



Model predictability



Trends in climatic variables



Climatic variations explain recent trends !

Conclusion

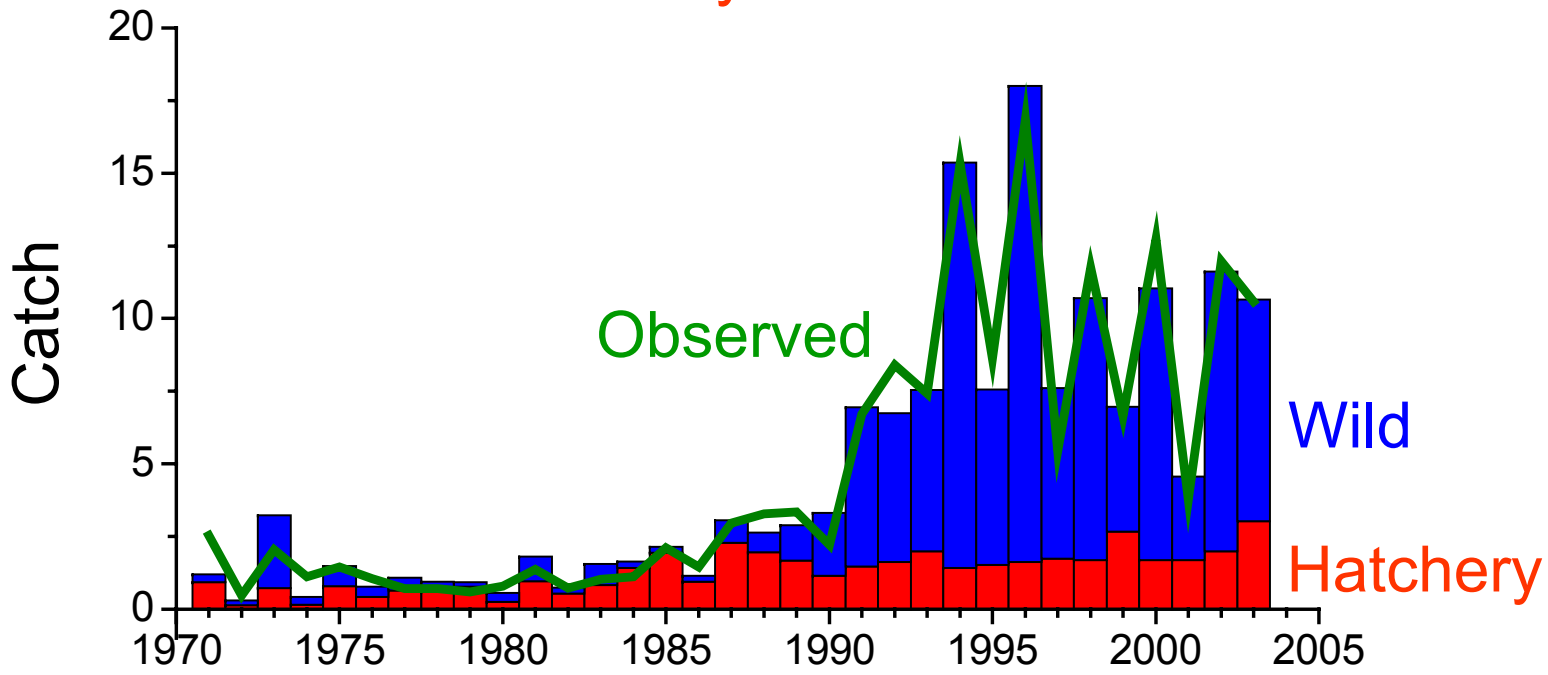
- Climatic variations and density dependence are important.
- Mild winter, high rainfall in fall, and high ALPI enhanced population growth.
- Recent population increase was explained by climate alone, without necessarily involving increased hatchery release.

How much wild salmon ?

- $N_t = \dfrac{N_{t-2} \exp(a + bN_{t-2} + c_1 Temp + c_2 Rain)}{+ R_{t-2} \exp(k + mALPI)}$

Wild

Hatchery

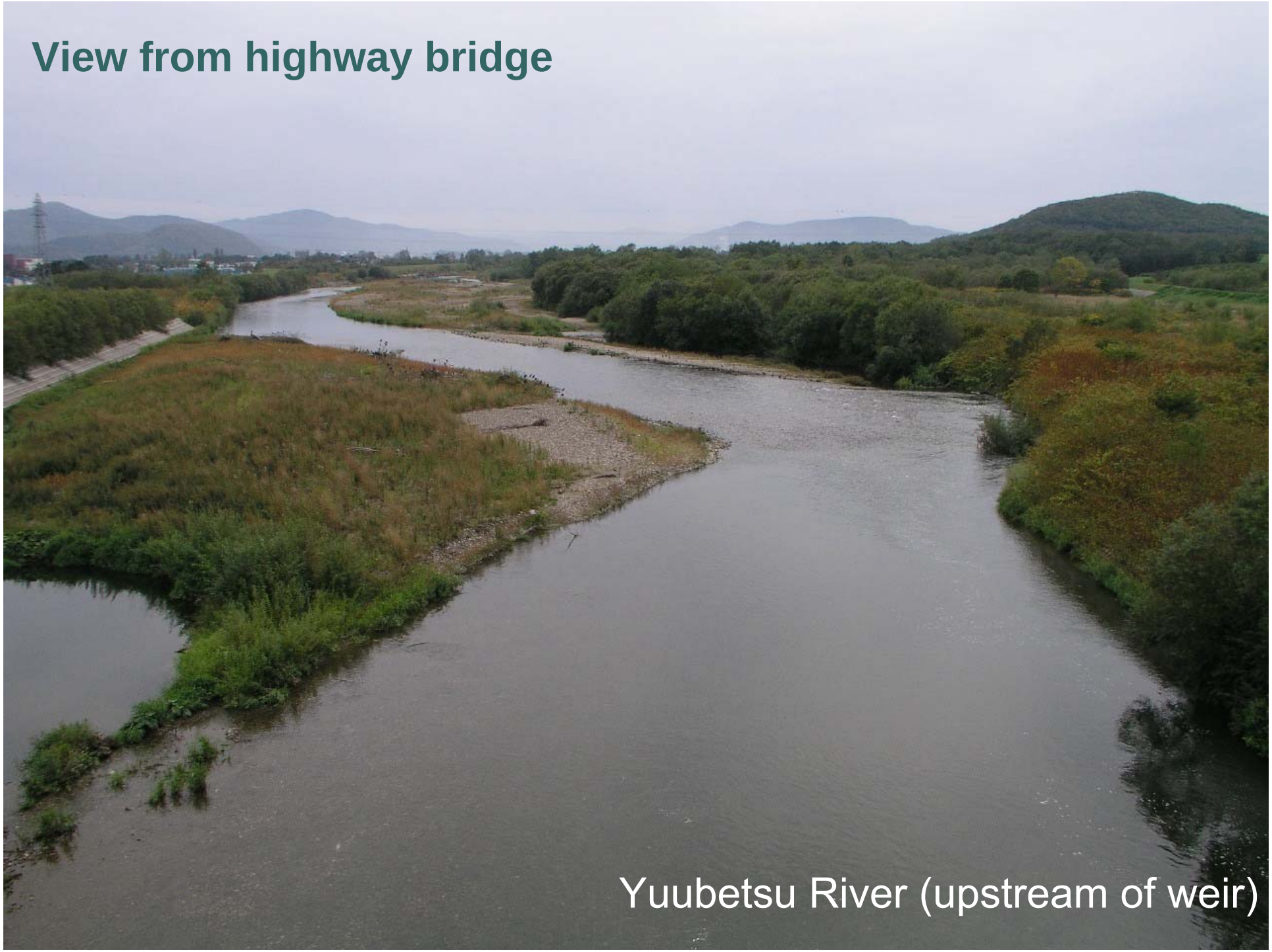


Wild salmon occur in Japan

There are *ca*. 100 spawning rivers. Even though major rivers have weirs to capture hatchery broodstock, natural reproduction may be substantial.


Salmon weir
YAMAHA
Yuubetsu River

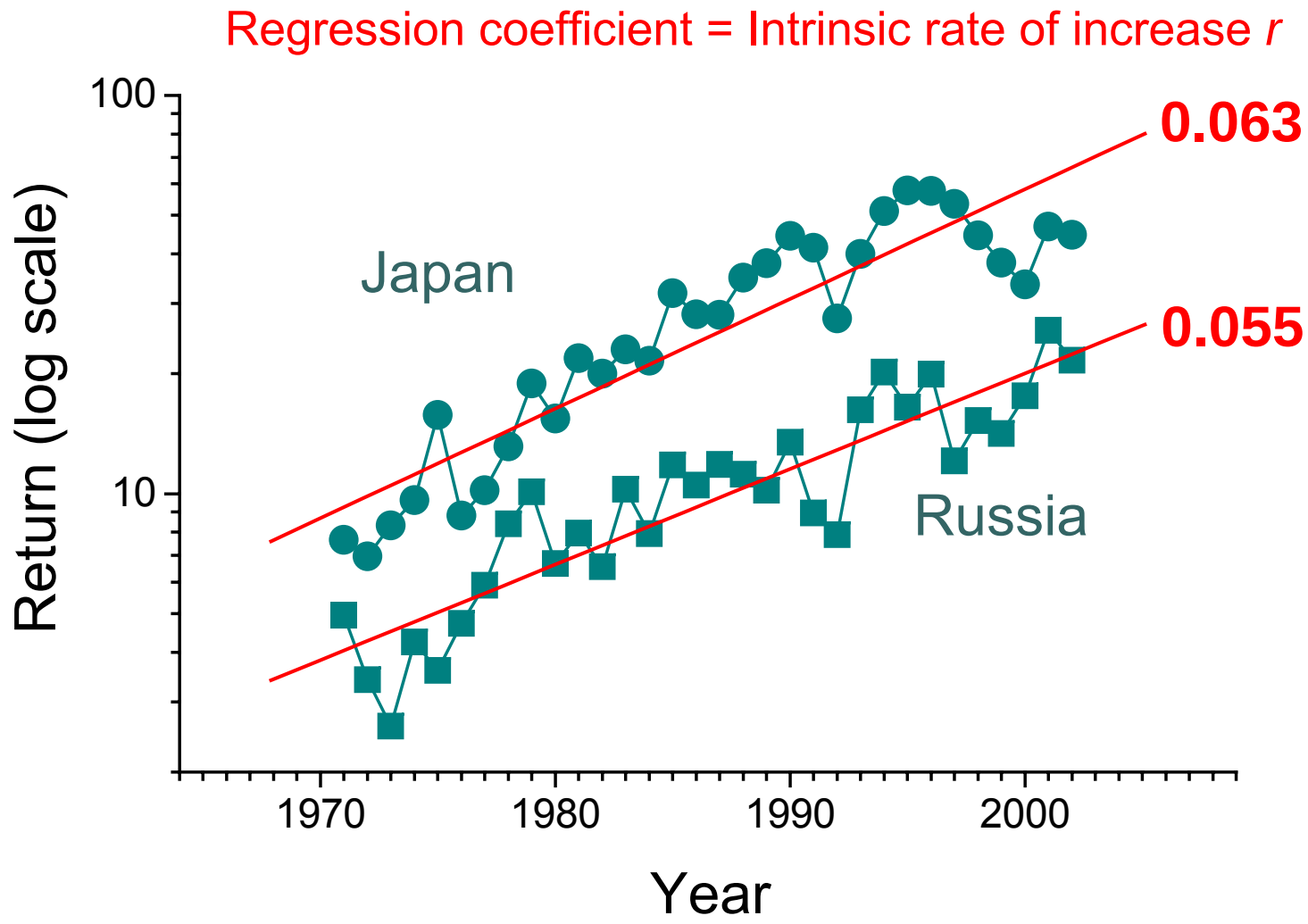
View from highway bridge



Yuubetsu River (upstream of weir)


Under the highway bridge
Zoom out !
Yuubetsu River (upstream of weir)

How are chum salmon ?



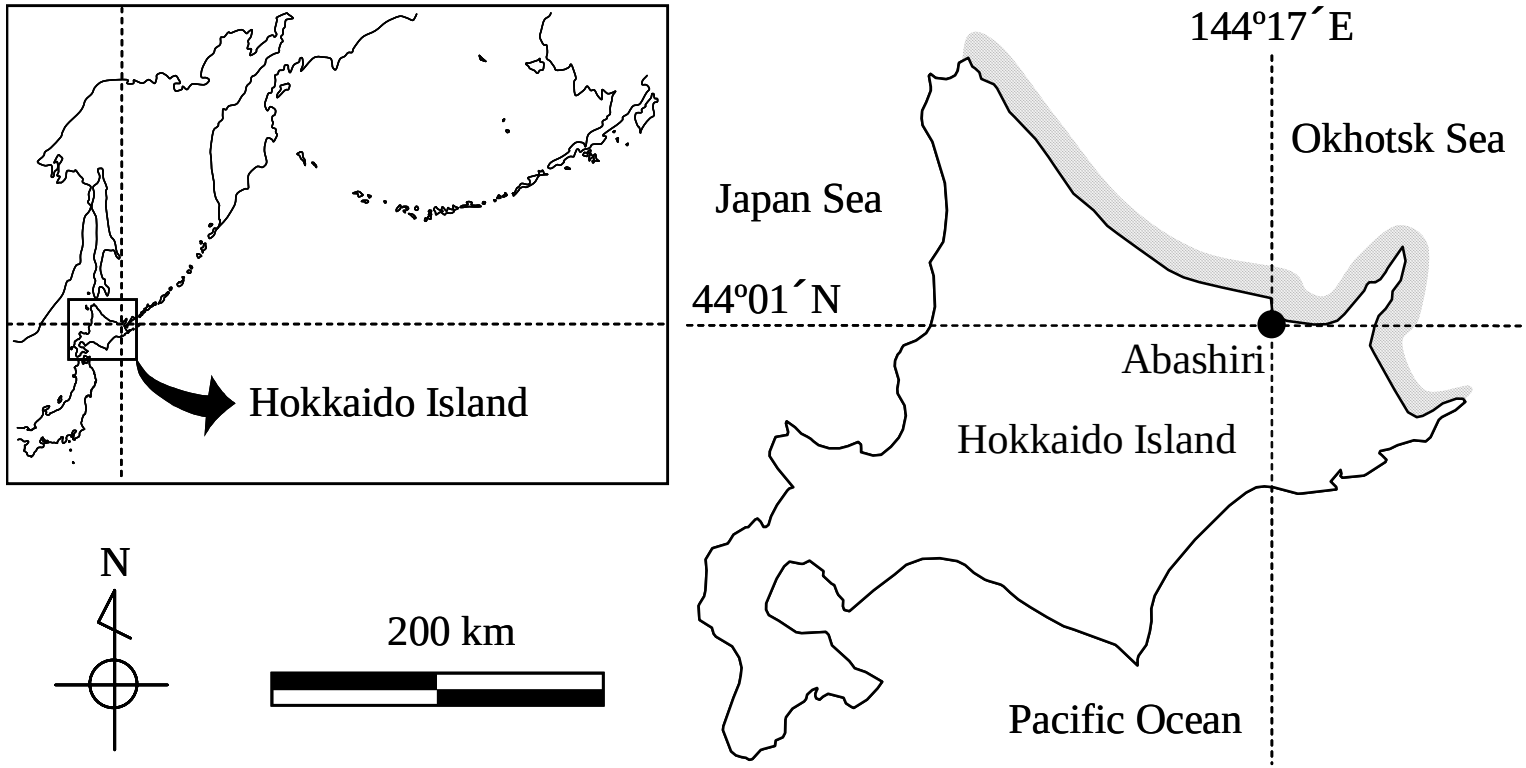
Overall conclusion

- We believe that an environmental explanation for recent increase in Japanese salmon catch is more reasonable than one invoking hatchery program.

Otolith thermal marking
by NSRC (2004)

	Tokushibetsu River	Ichani River
Percentage of fry marked in release	42 %	62 %
Percentage of adult marked in recapture	1 %	4 %

Location


Hokkaido Island
N
200 km
144º17´E
Okhotsk Sea
Japan Sea
44º01´N
Abashiri
Hokkaido Island
Pacific Ocean