

# Ecosystem approach for management of artificial release of chum salmon from Japan based on a bioenergetic model coupled with NEMURO

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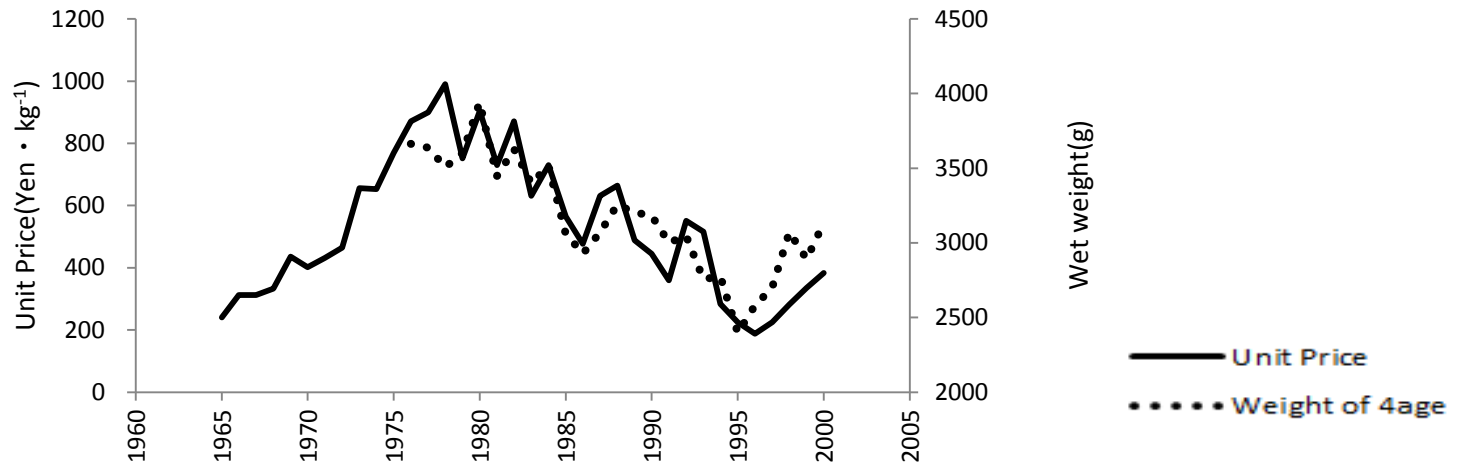


# Purpose of this study

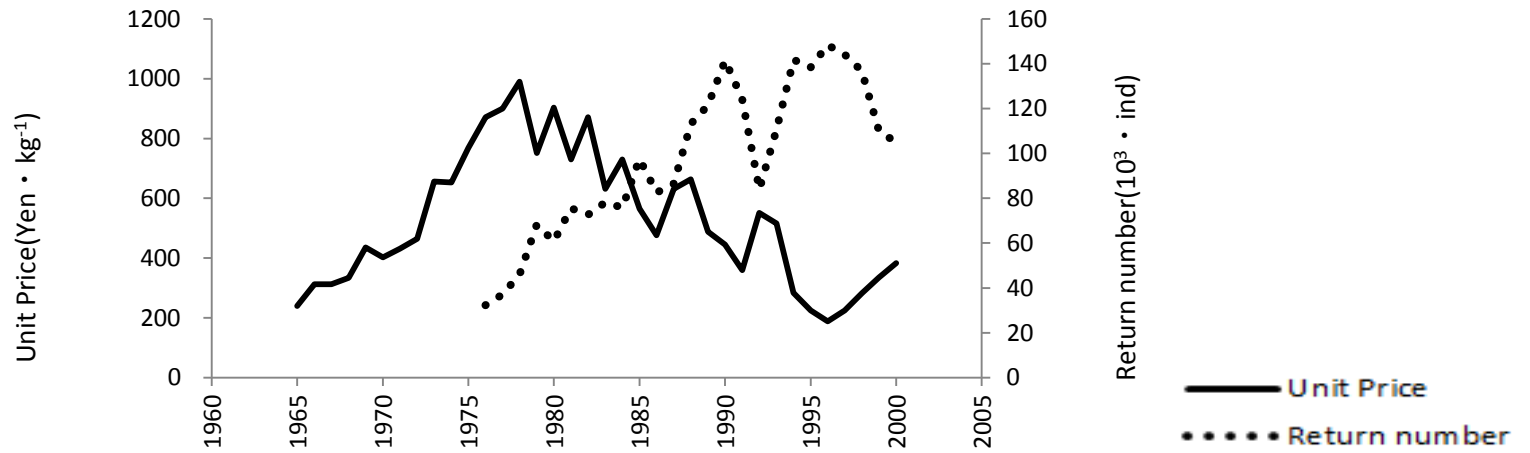
To maximize the income of **Japanese** fishermen by catching chum salmon, how many chum salmon should be released from **Japan**? (very selfish (not shellfish))



- 1) Unit price**
- 2) Return ratio**
- 3) Wet weight (Ind<sup>-1</sup>)**



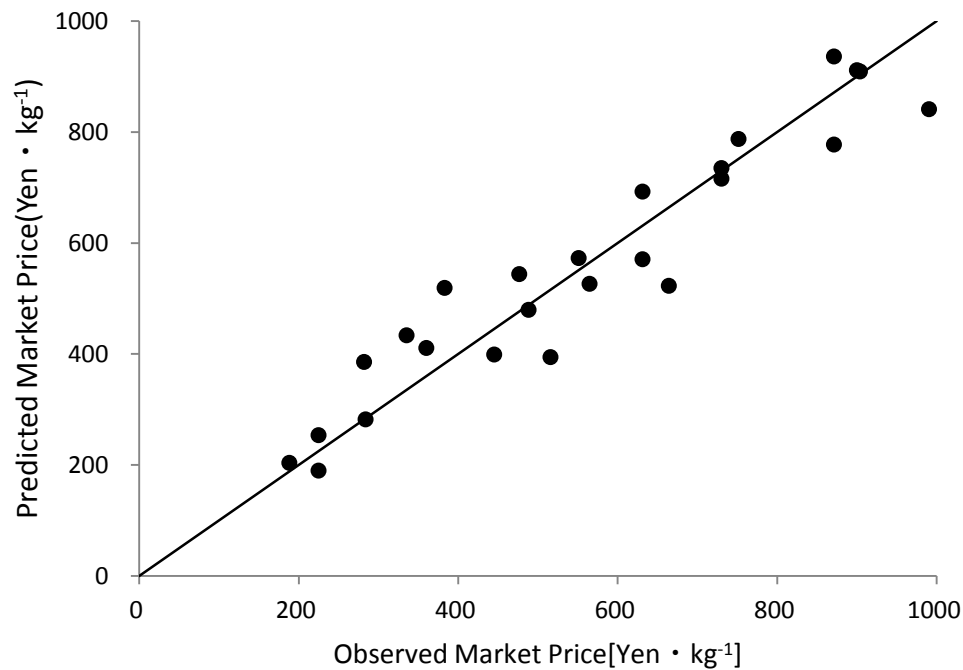
Relationship between **unit price**(solid line) and **wet weight** of ocean age 4(dotted line).



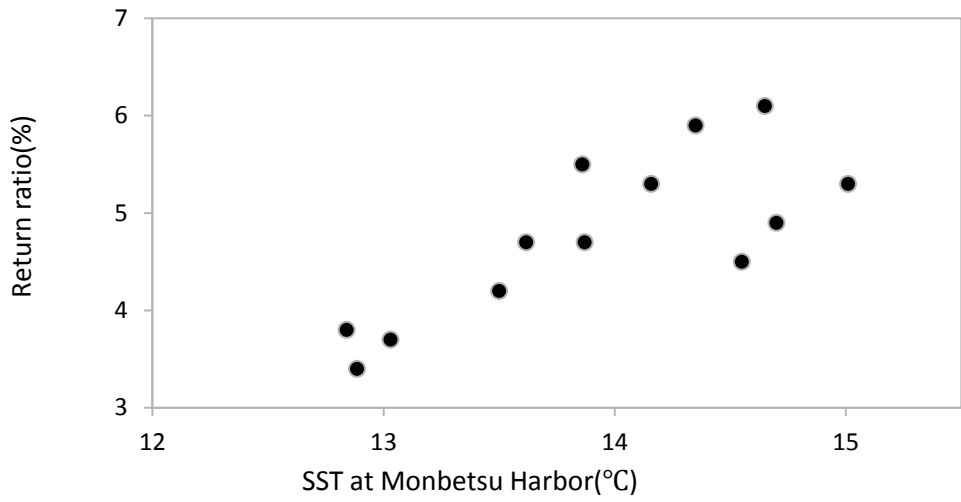
Relationship between **unit price**(solid line) and **return number**(dotted line).



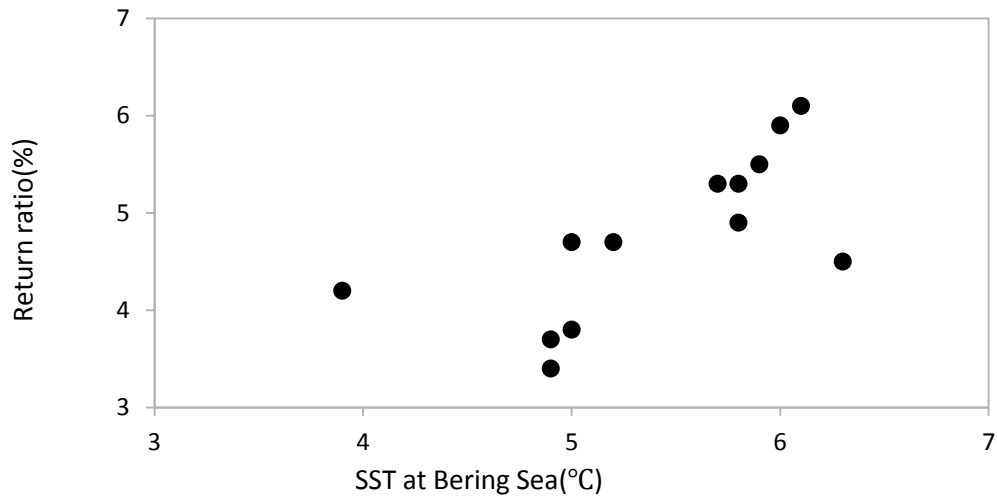
**Unit Price** ( $\text{kg}^{-1}$ ) = Func (wet weight, return number)  
(simple regression)



Comparison between predicted market price and observed market price.



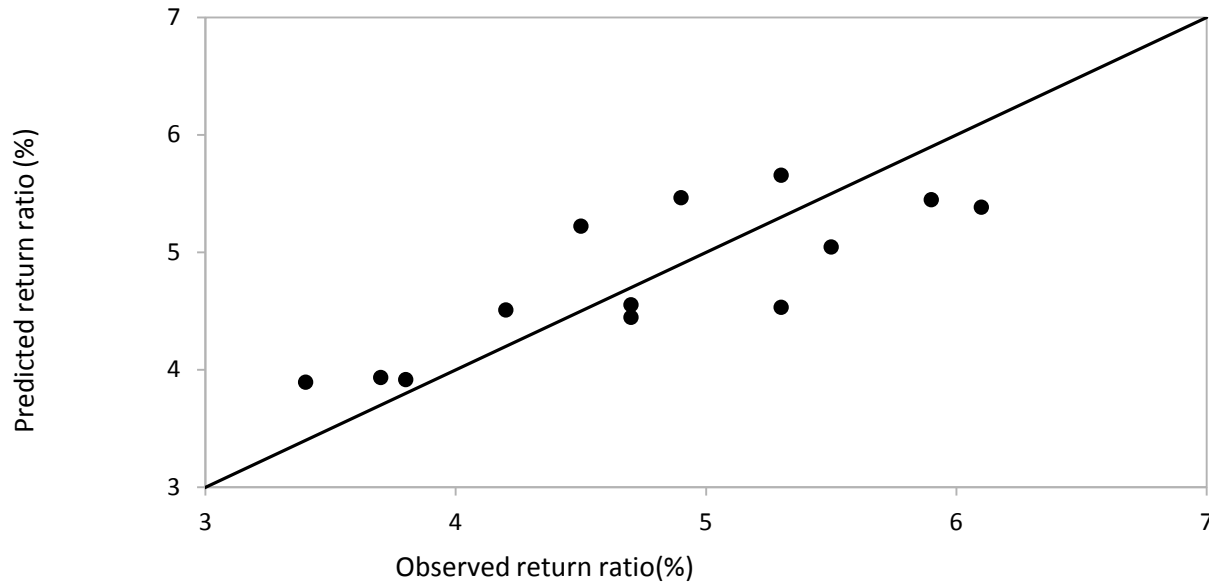
Correlations between **return ratio** and **SST** in June 3yrs before the return year at Monbetsu Harbor.



Correlations between **return ratio** and **SST** in June at Bering Sea.



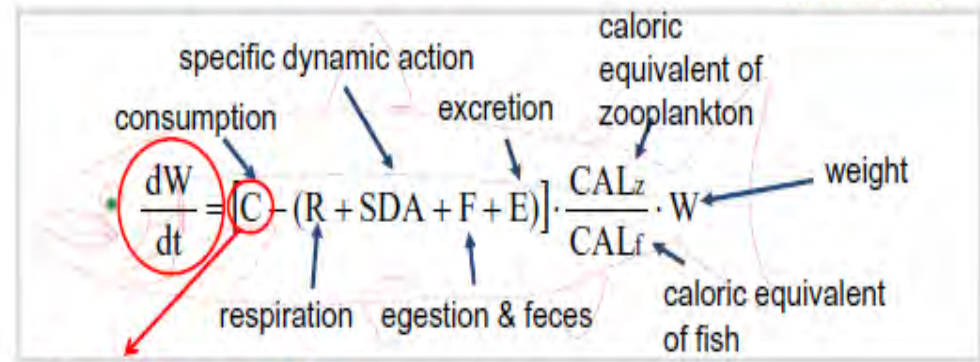
**Return ratio** = Func (SST of Monbetsu, SST of Bering Sea)  
(regression)



Comparison between predicted return ratio and observed return ratio.



The **individual weight** of salmon was determined by respiration and consumption terms as function of water temperature and prey density.

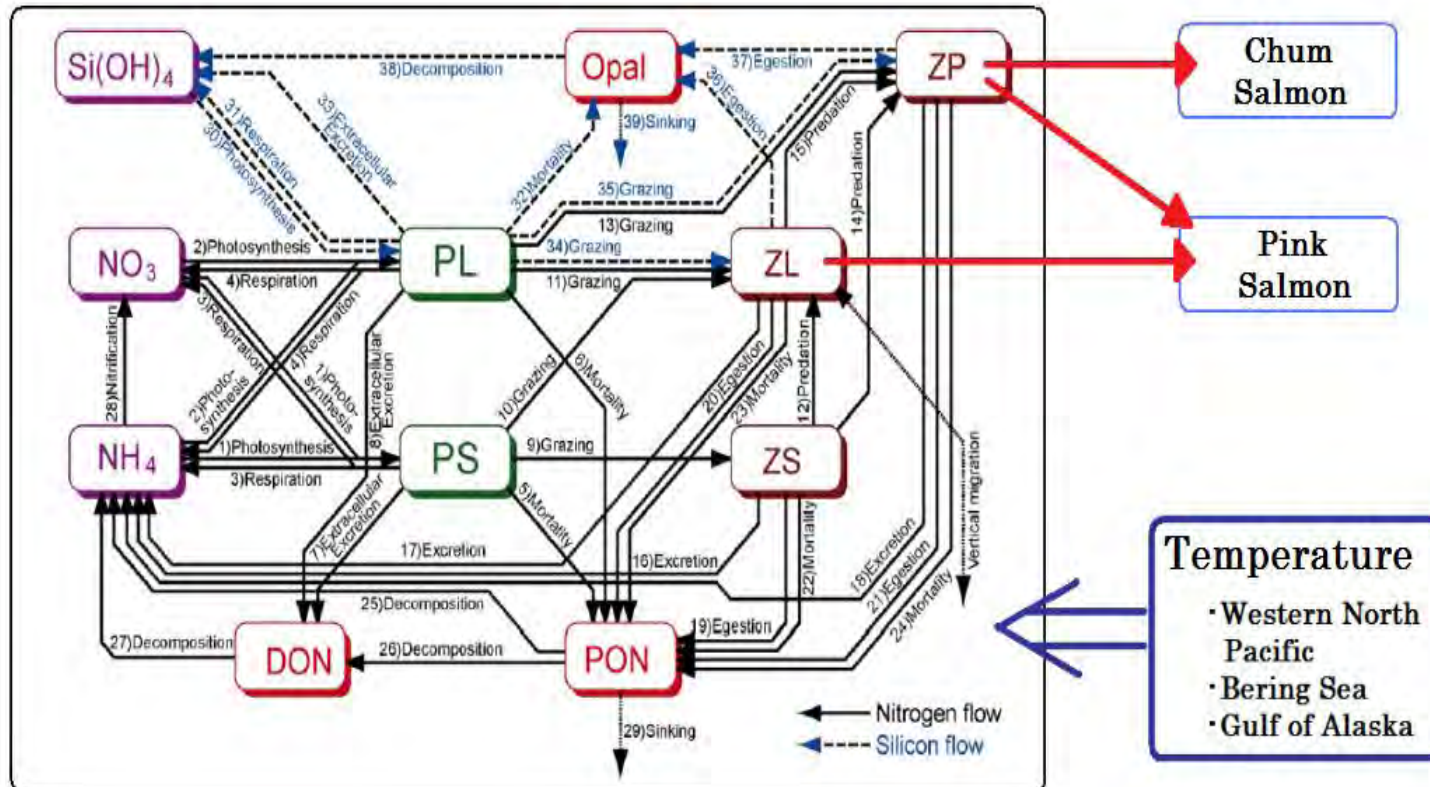


$$C = C_{MAX} \cdot \rho \cdot f_c(T)$$

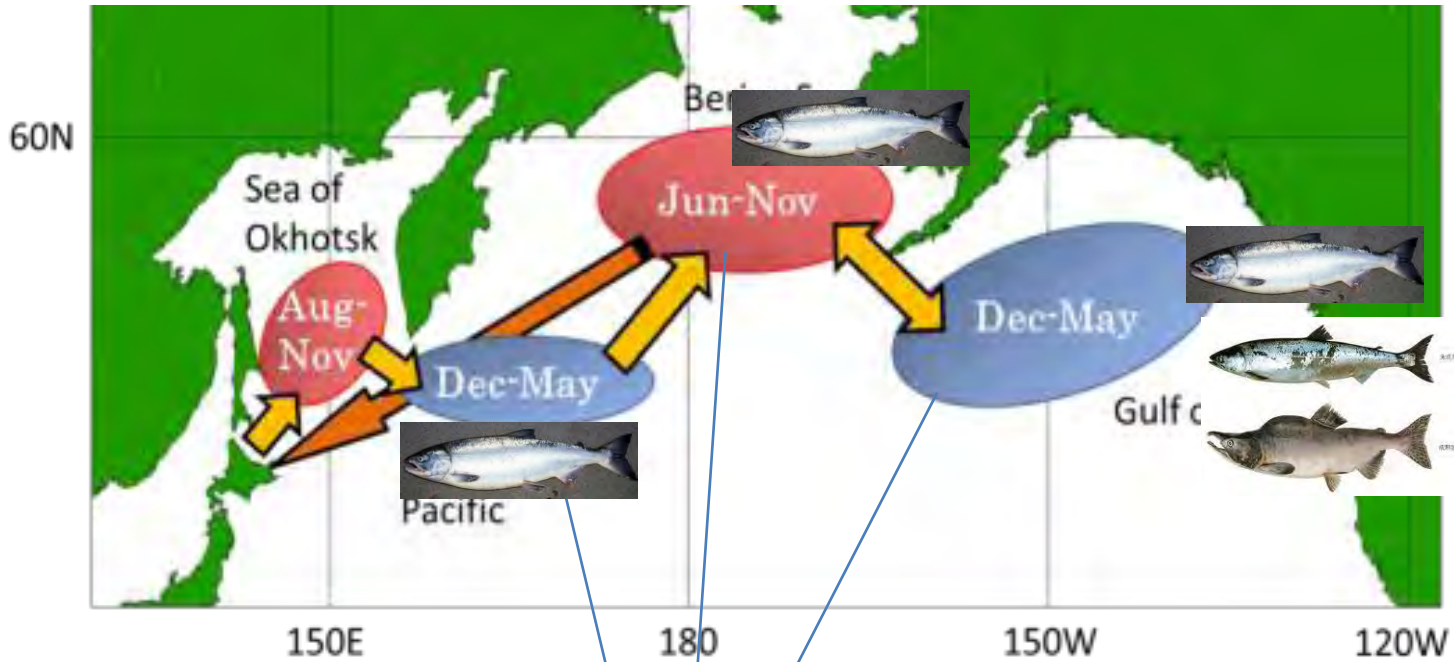


NEMURO.FISH

NEMURO



# Migration Patterns



$4000\text{km}^{-3}$

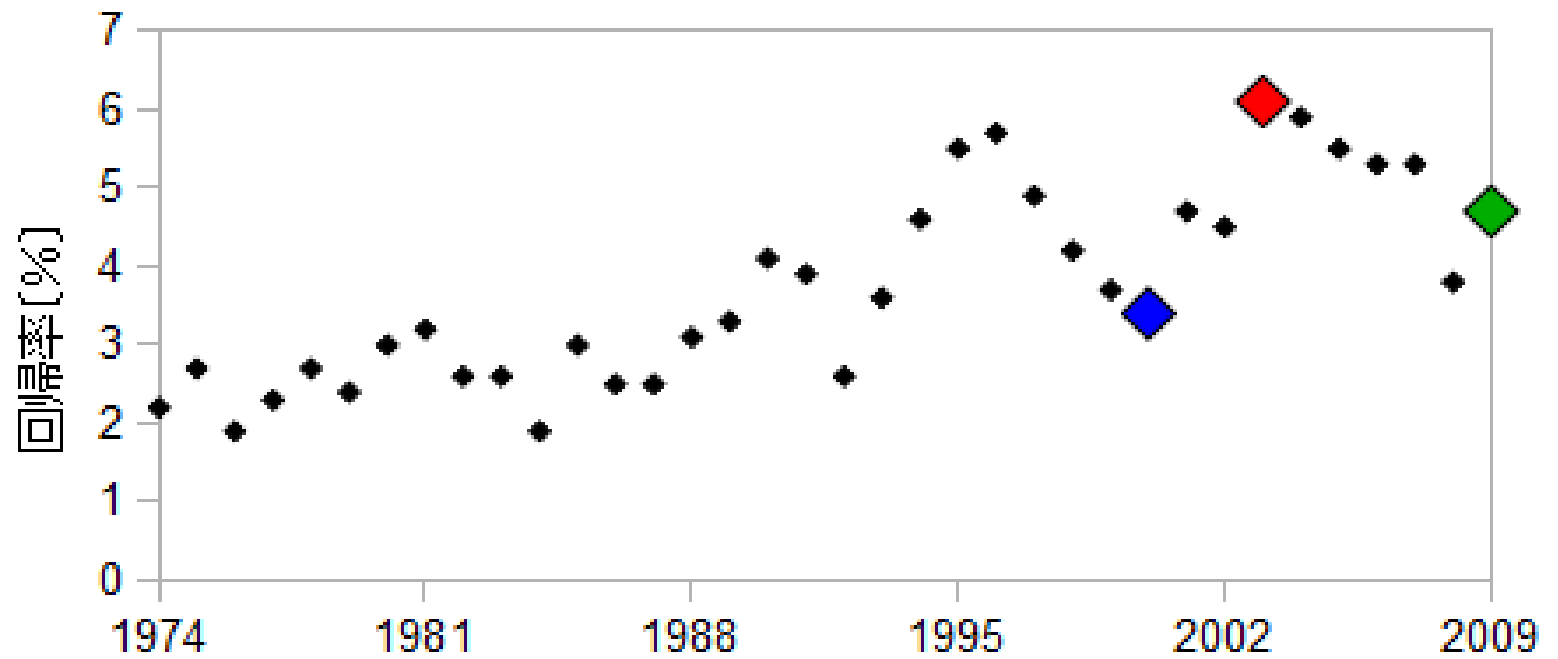
$200\text{km} * 200\text{km} * 100\text{m}$

Stage	Age(day)	Period	Region
1	1-182	6/1-11/30	OH
2	183-365	12/1-5/31	WNP
3	366-547	6/1-11/30	BS
4	548-730	12/1-5/31	GA
5	731-912	6/1-11/30	BS
6	913-1095	12/1-5/31	GA
7	1096-1277	6/1-11/30	BS
8	1278-1460	12/1-5/31	GA
9	1461-1642	6/1-11/30	BS

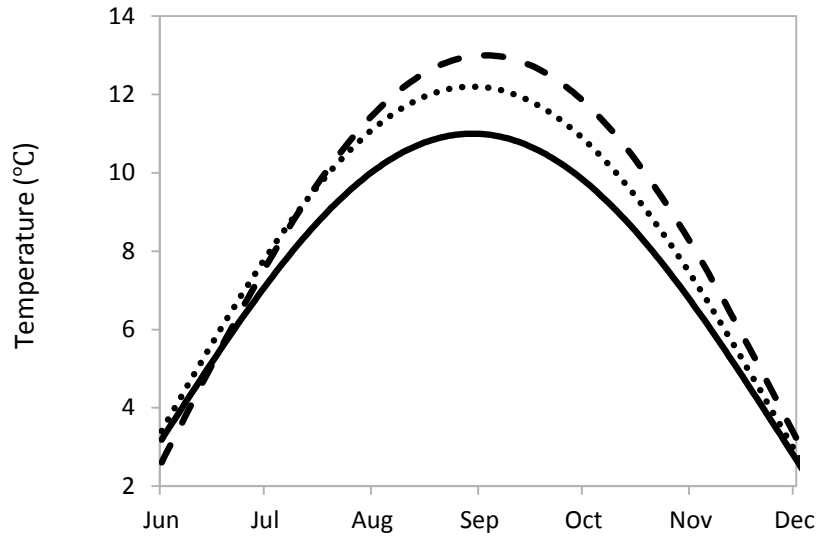
Table1.Stage of chum salmon's migration.

Stage	Period	Types of Zooplankton	
		ZL	ZP
1	4/20-7/31	○	×
2	8/1-10/16	○	○
3	10/16-9/14	×	○

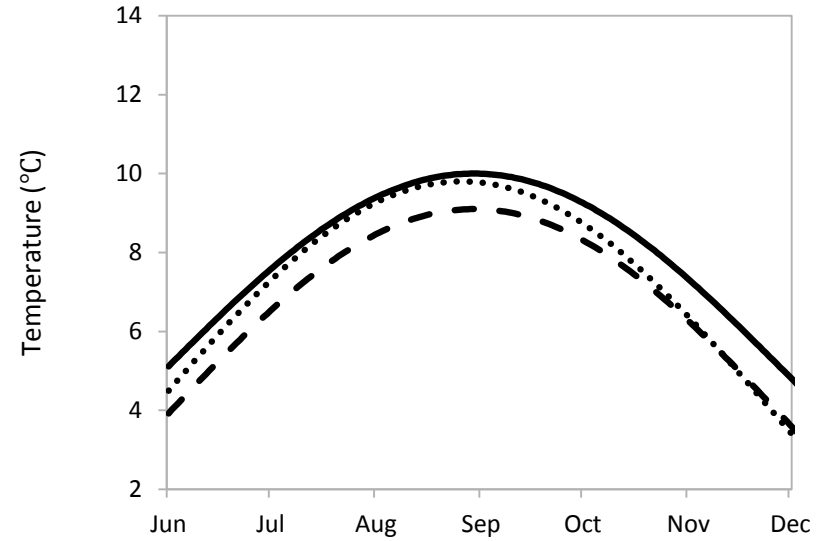
# Return ratio of Hokkaido chum salmon



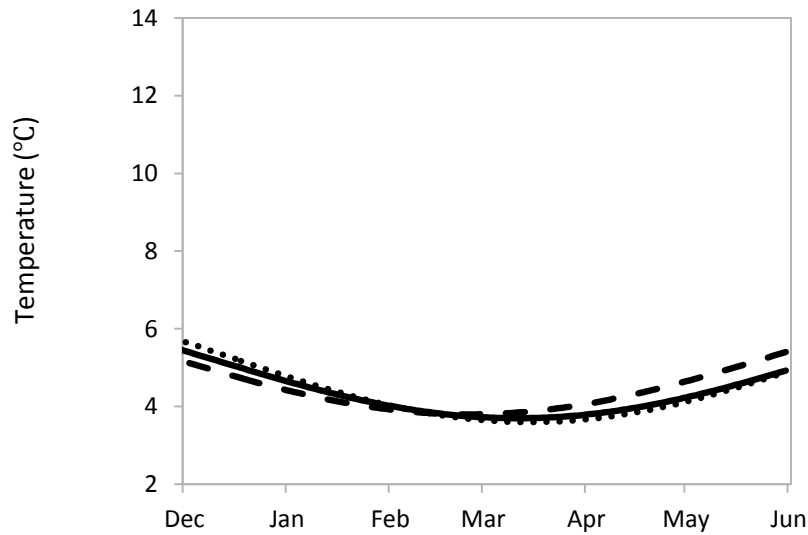
Sea of Okhotsk



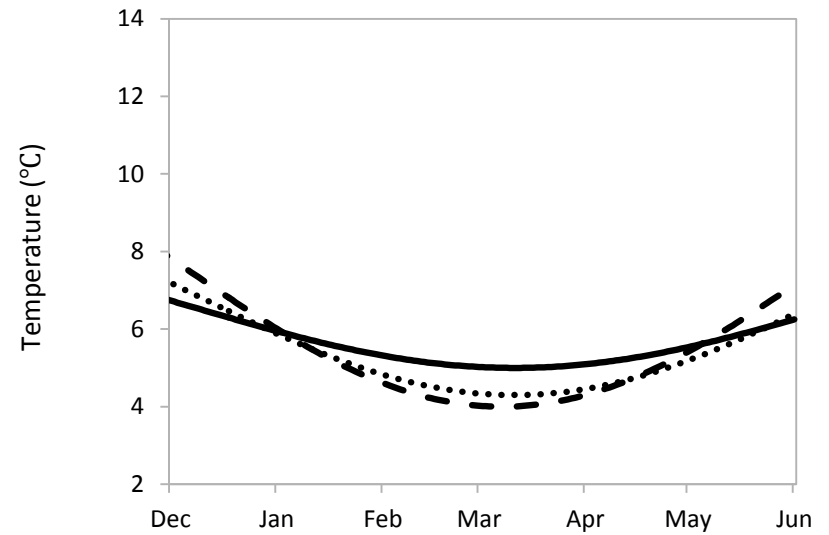
Bering Sea



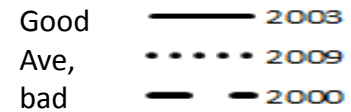
North western Pacific



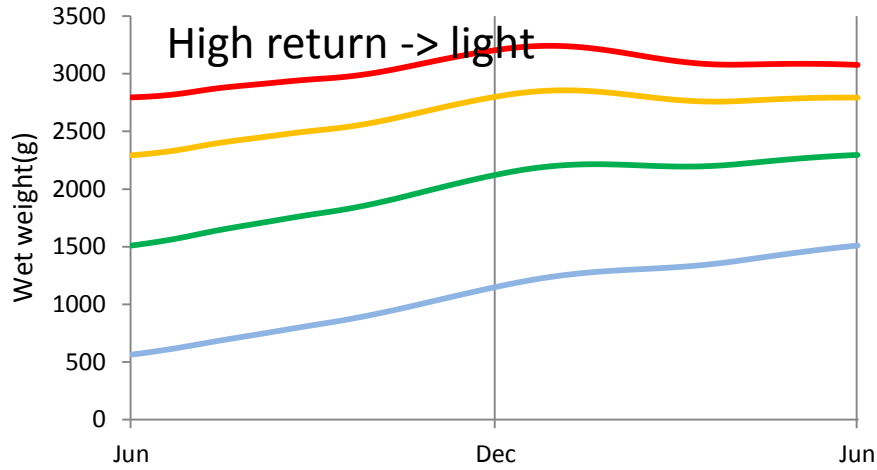
Gulf of Alaska



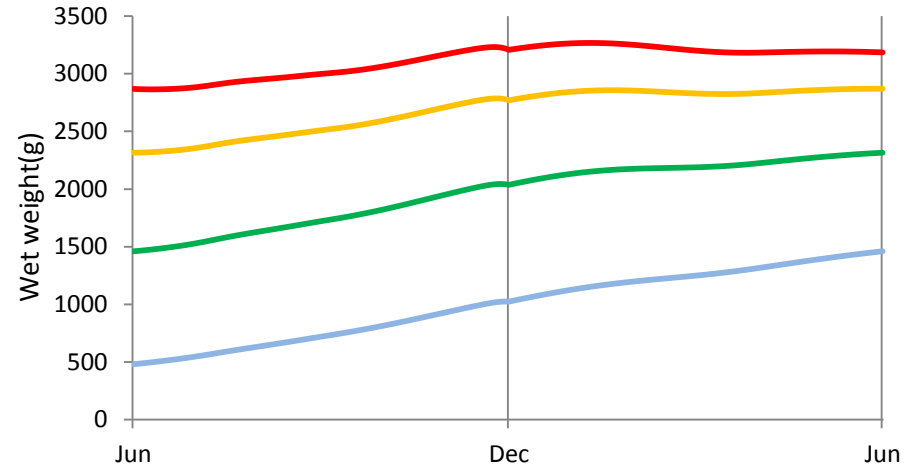
Temperature in each box.



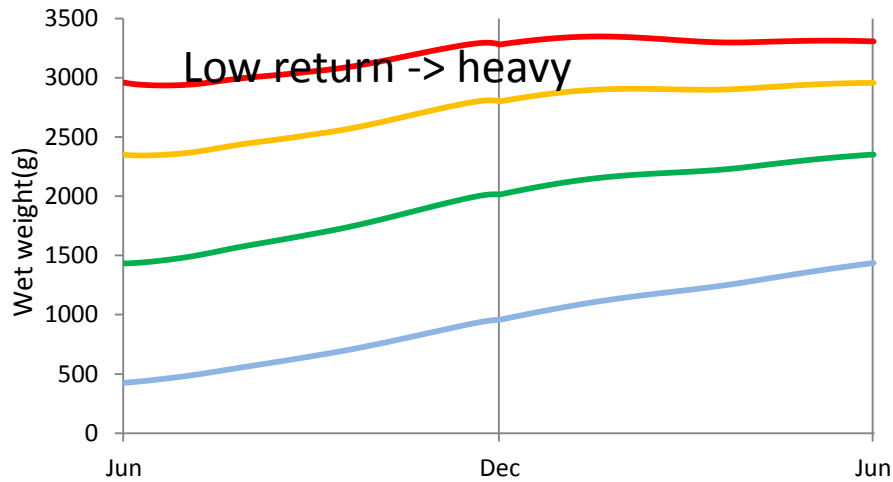
**2003**



**2009**



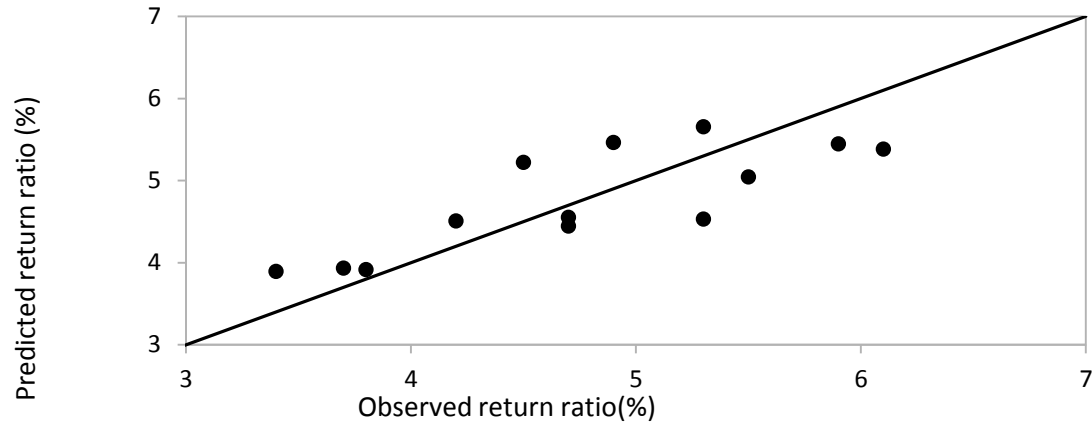
**2000**



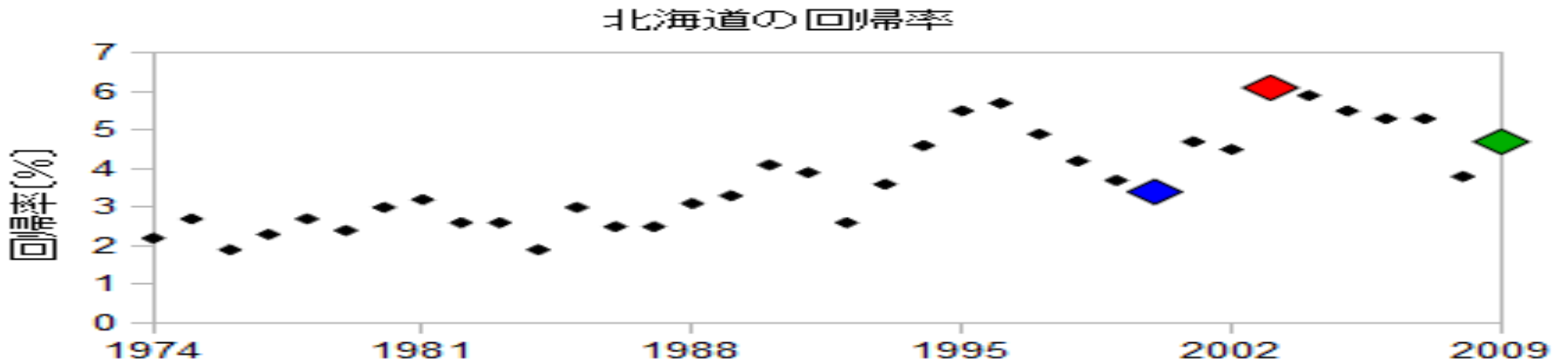
- Weight4
- Weight3
- Weight2
- Weight1

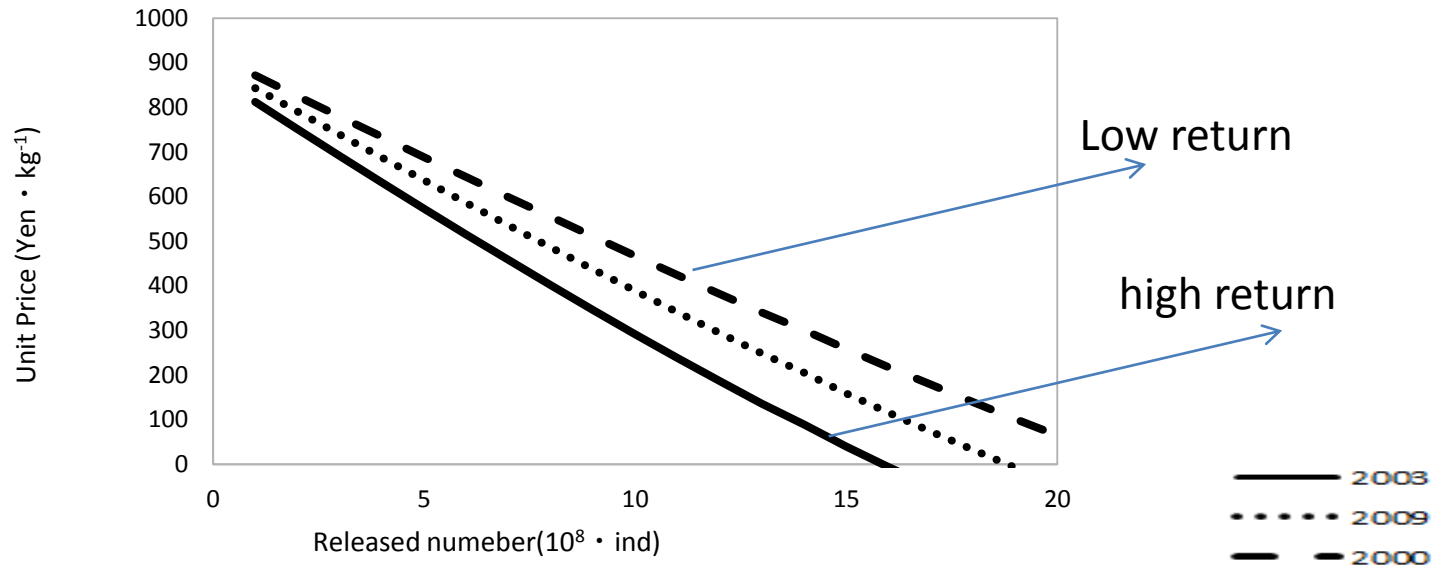
Fig12.Result of chum salmon's growth (Wet weight).

Return ratio = Func (SST of Monbetsu, SST of Bering Sea)

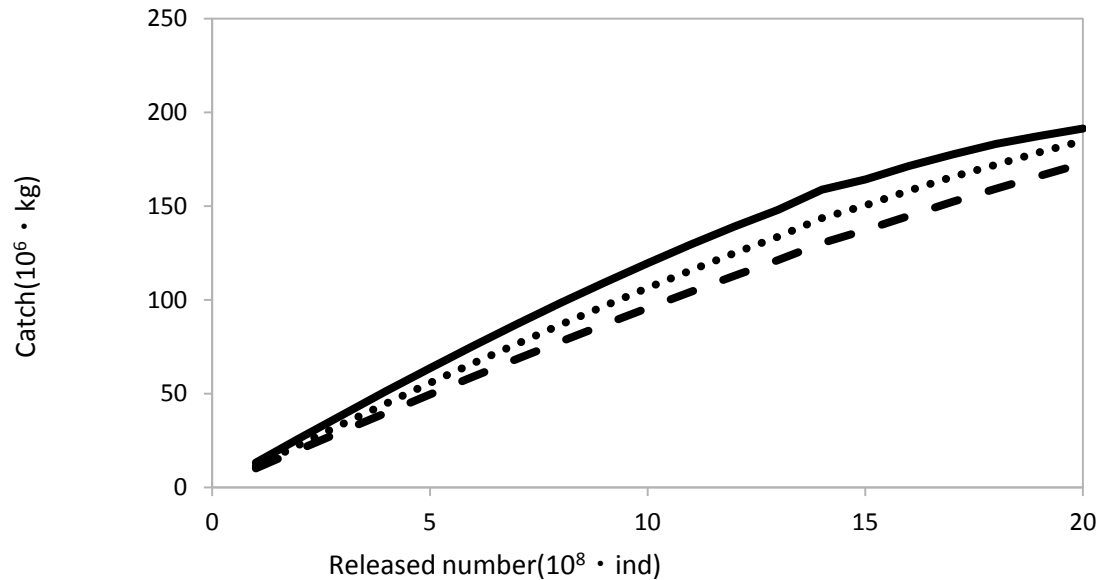


Year	2003	2009	2000
Predicted return ratio (%)	5.6	4.72	4.07



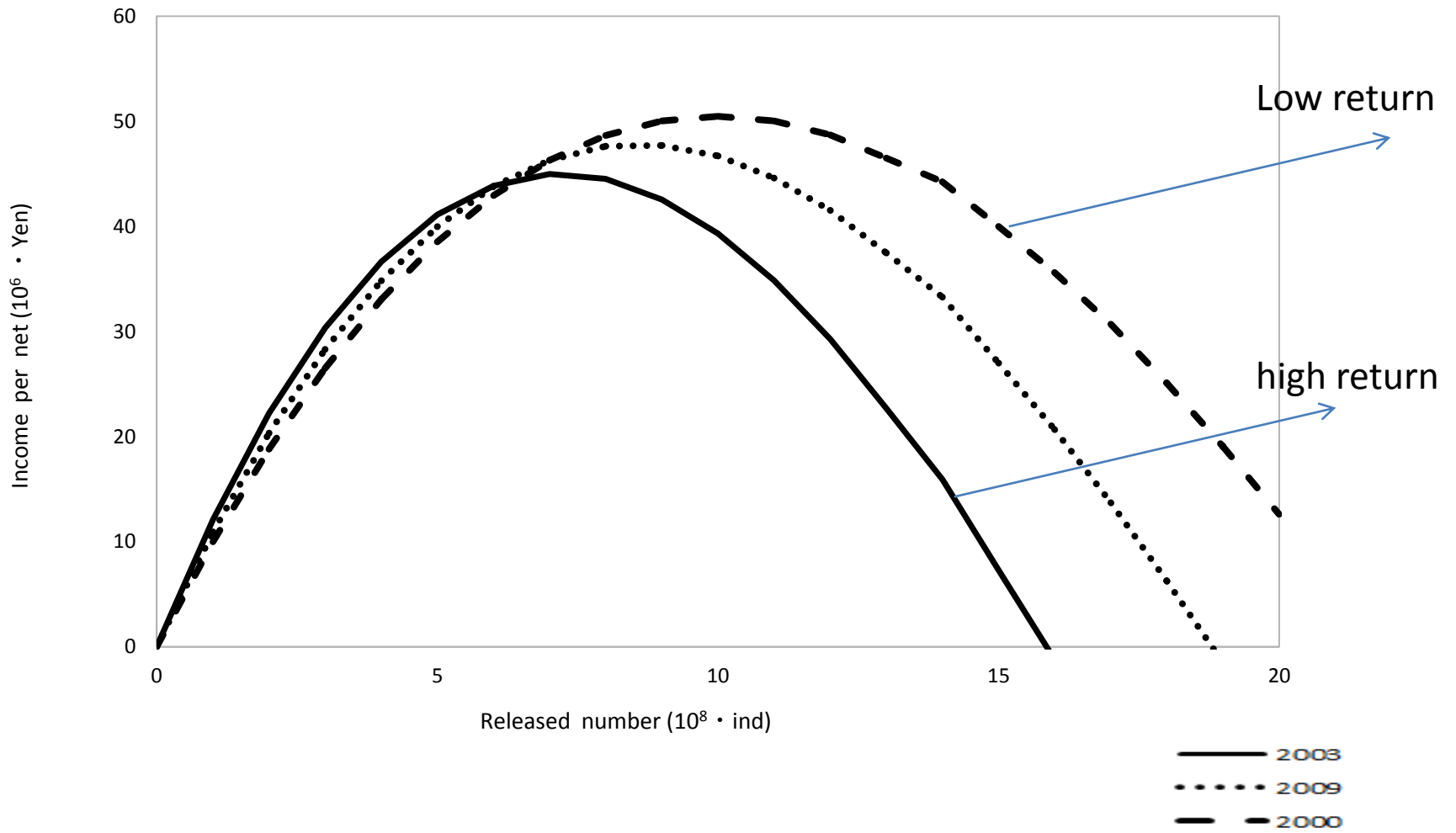


Change in unit price for released number.



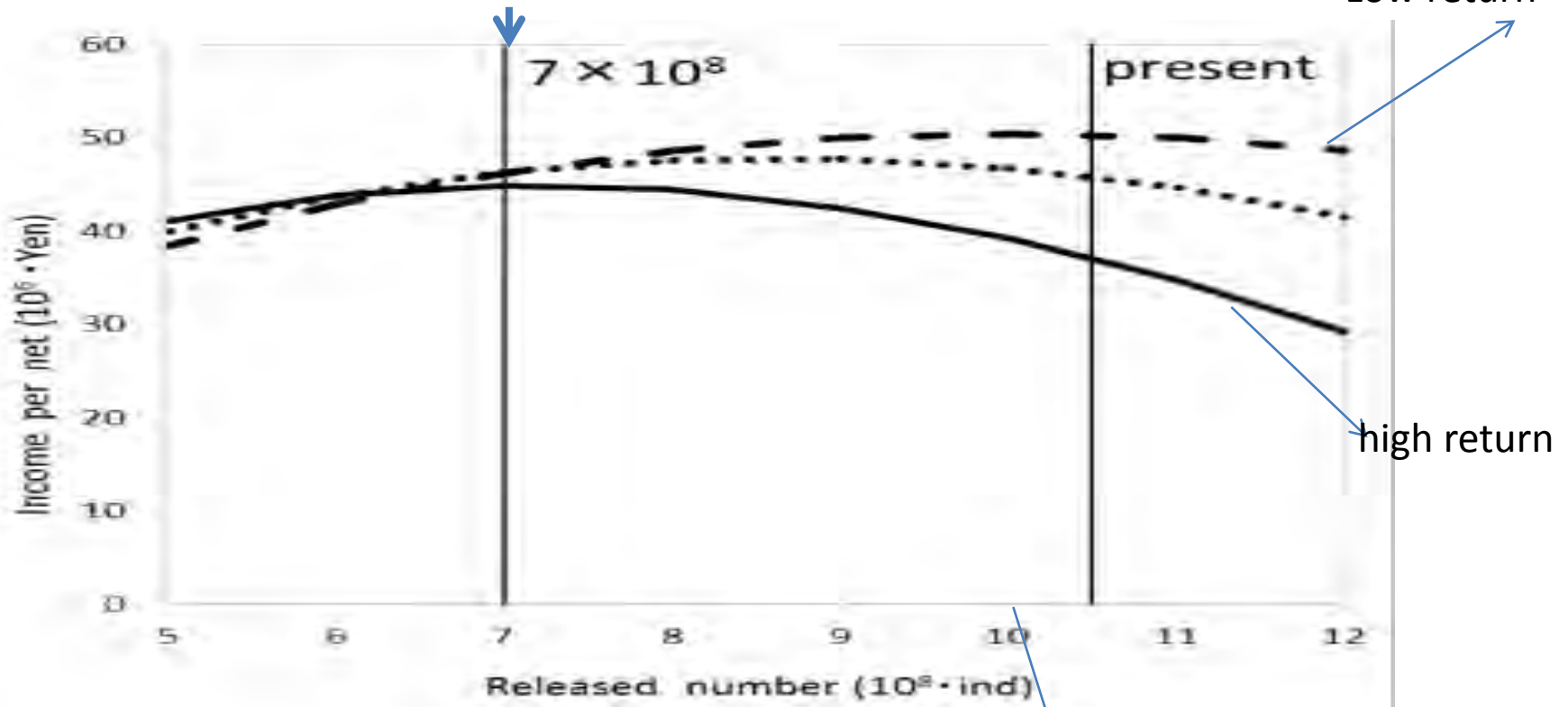
Change in catch for released number.





Result of income per net for released number.

Keep same price every year



enlarged figure.

One billion

# Conclusion

Do not change the release number except from Japan, in order to prove my hypothesis.

Do not change the demand in Japan, but eat 'salmon' in order to prove my hypothesis.



Minke whale



Japanese common squid



Japanese anchovy



Steller sea lion



Chum salmon



Japanese sardine



Walleye pollock

Thank you