Ecosystem approach for management of artificial release of chum salmon from Japan coupled with NEMURO and NEMURO.FISH

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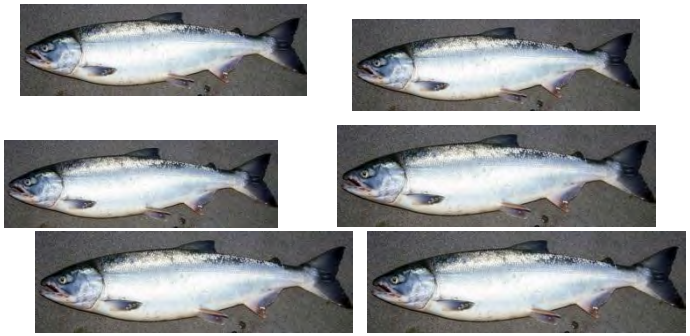
$10000 *1 =10000



$2000*6=12000

$500*12=6000

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))

Constraint Condition

The constraining condition is the **carrying capacity** of North Pacific, which is calculated by a two-way version of NEMURO (i.e., the prey density = ZP and ZL in NEMURO, decreases by grazing by fish).

Evaluation (Cost Function)

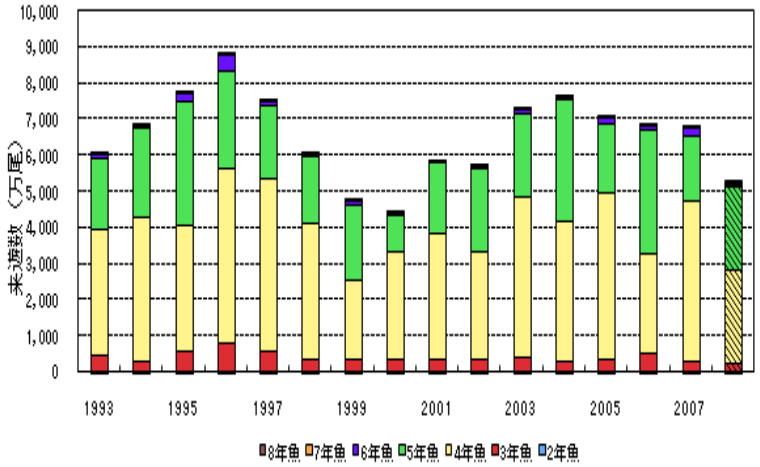
The total **income of fisherman** :

Income[yen]＝**Catch**[kg] × **Unit price**[yen/kg]

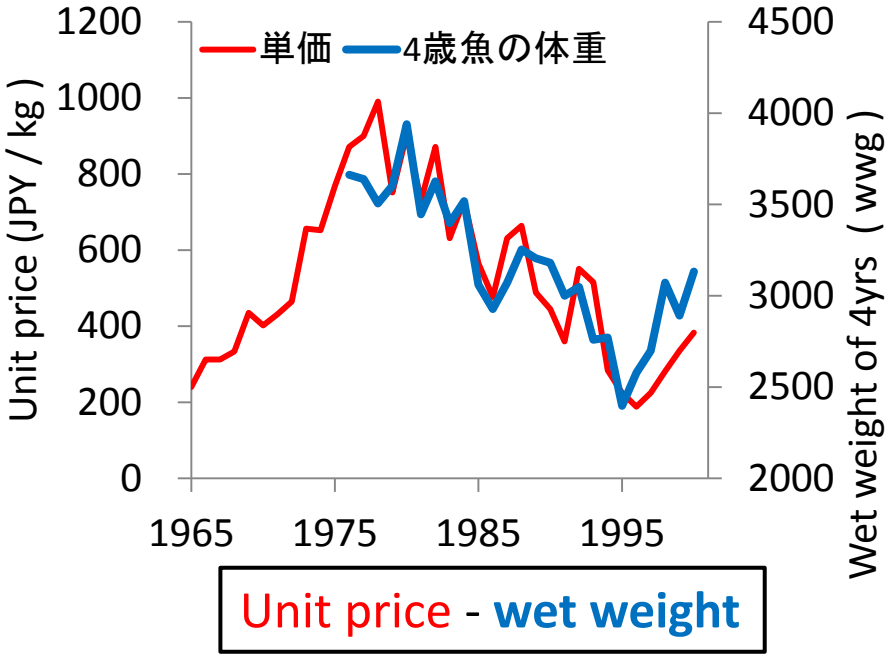
where:

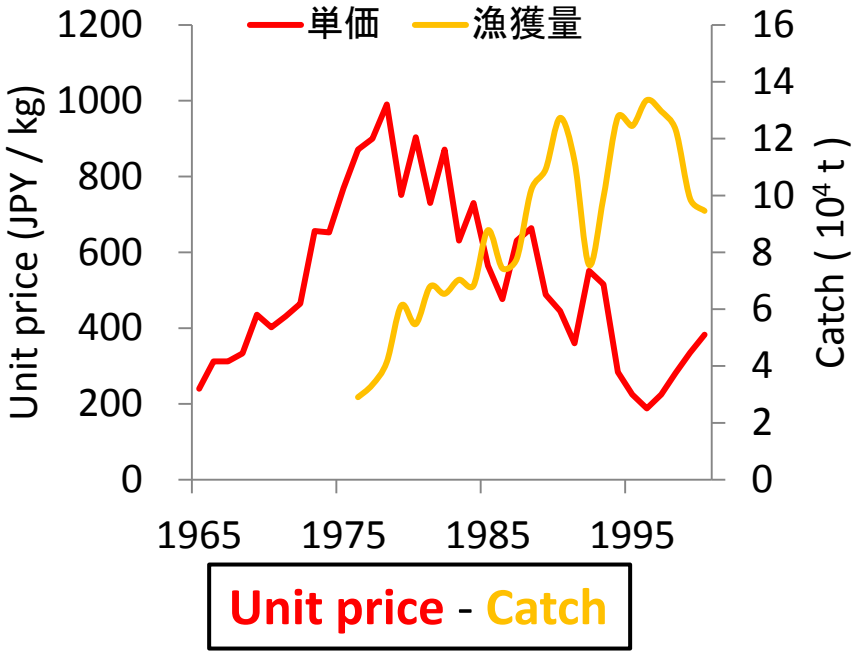
Catch[kg]= **No. of catch**[ind.] x (**Wt**. at ocean age 3[kg] x 62.9% + **Wt**. at ocean age 4[kg] x 37.1%)

No of catch[ind]= No. of release[ind.] **x Return ratio** x 90%



1) Unit price
2) Return ratio
3) Wet weight (Ind^{-1})





Unit price：multi regression

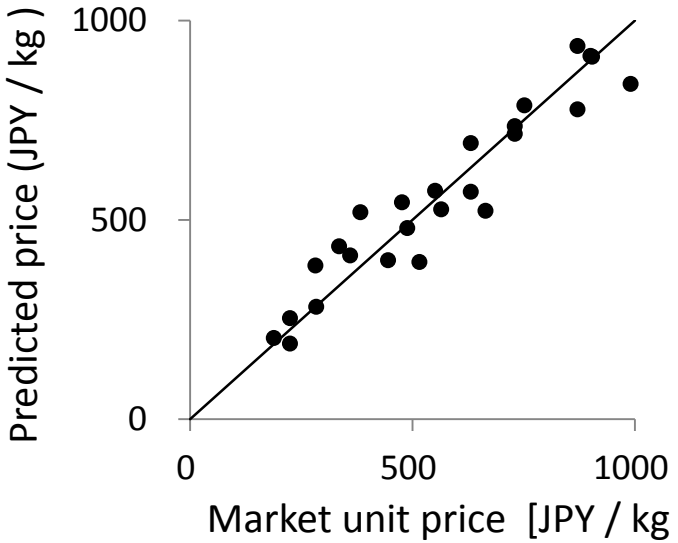
$y = 0.499\ x_1 - 0.530\ x_2 \quad r = 0.922$

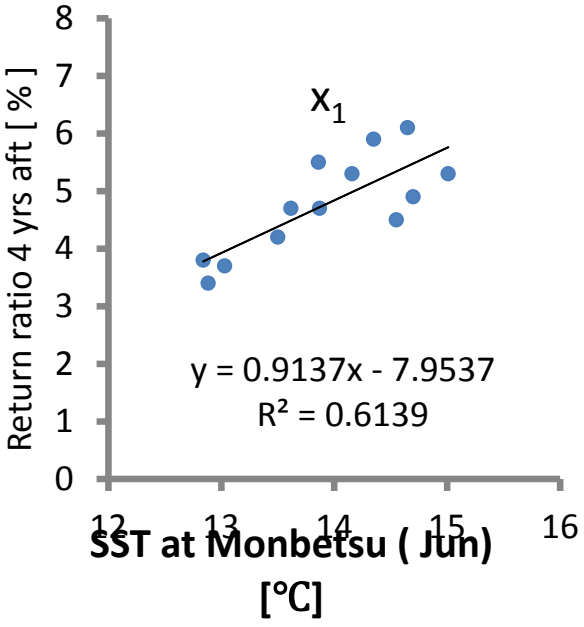
（For normalize data）

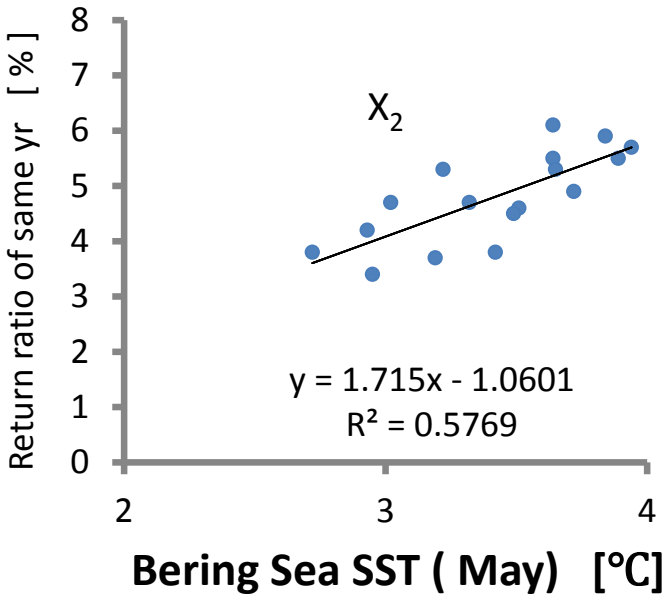
y：unit price (JPY/Kg)

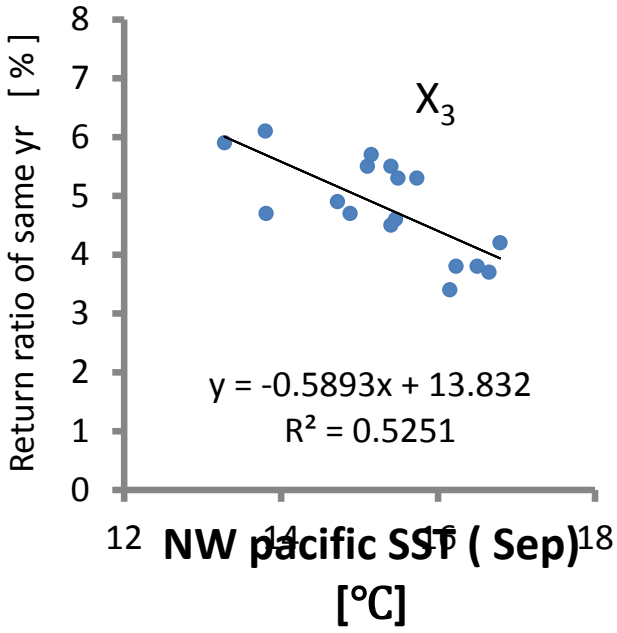
x_1 ： wet weight of 4 yrs ocean age

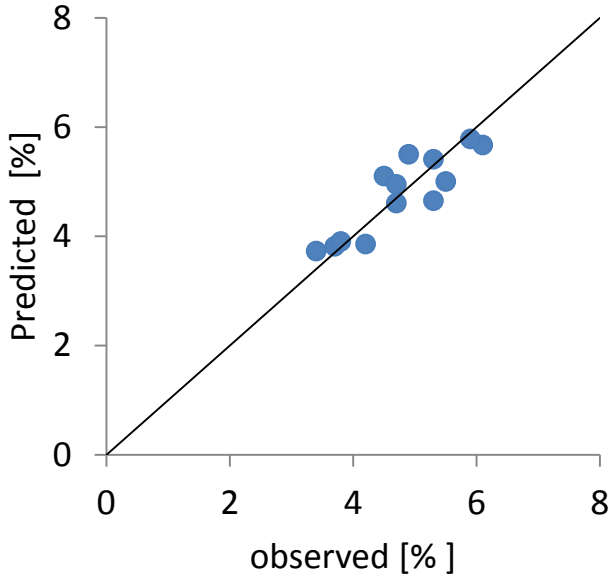
x_2 ： catch











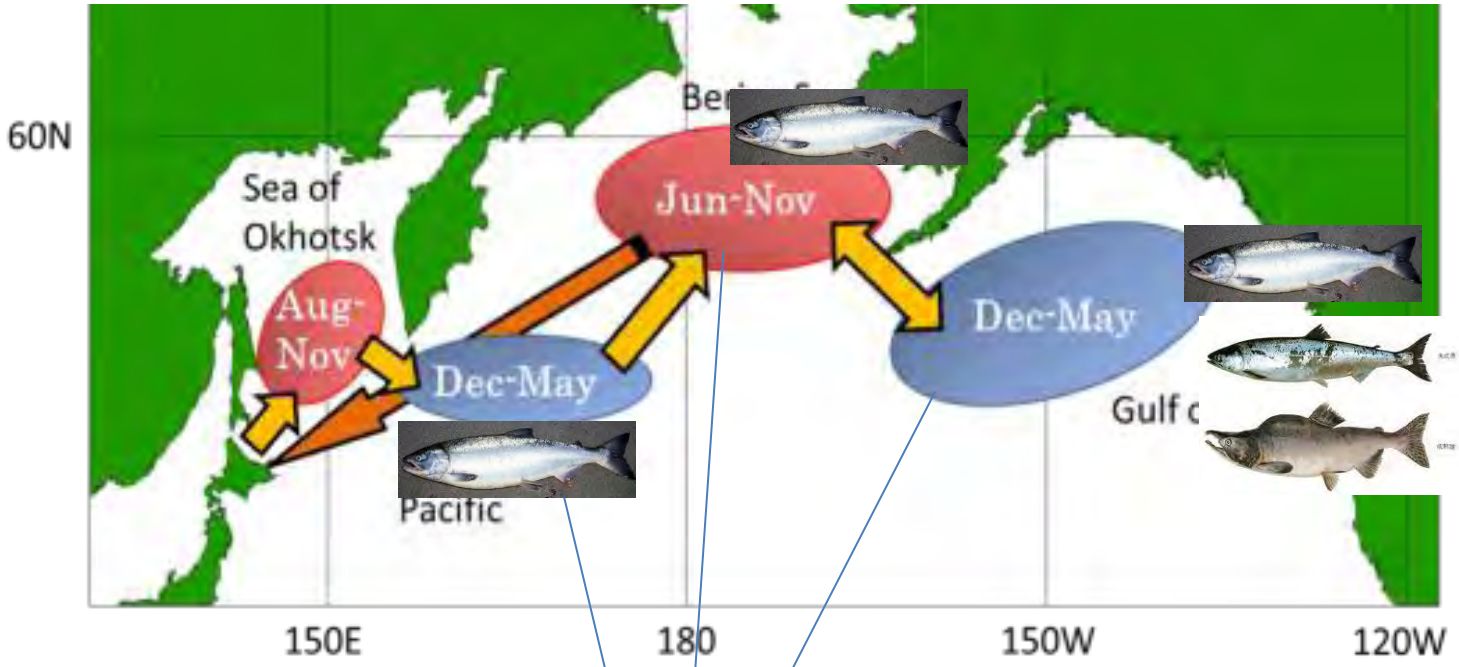
Multiple linear regression

$$y = -0.0449 + 0.443x_1 + 0.274x_2 - 0.327x_3$$

(For normalized data)

r : 0.880

Migration Patterns

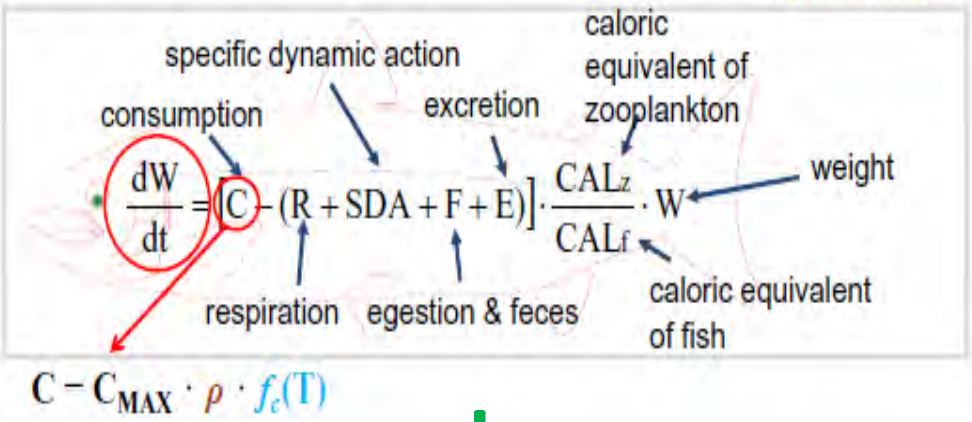


$4000km^{-3}$

200km*200km*100m

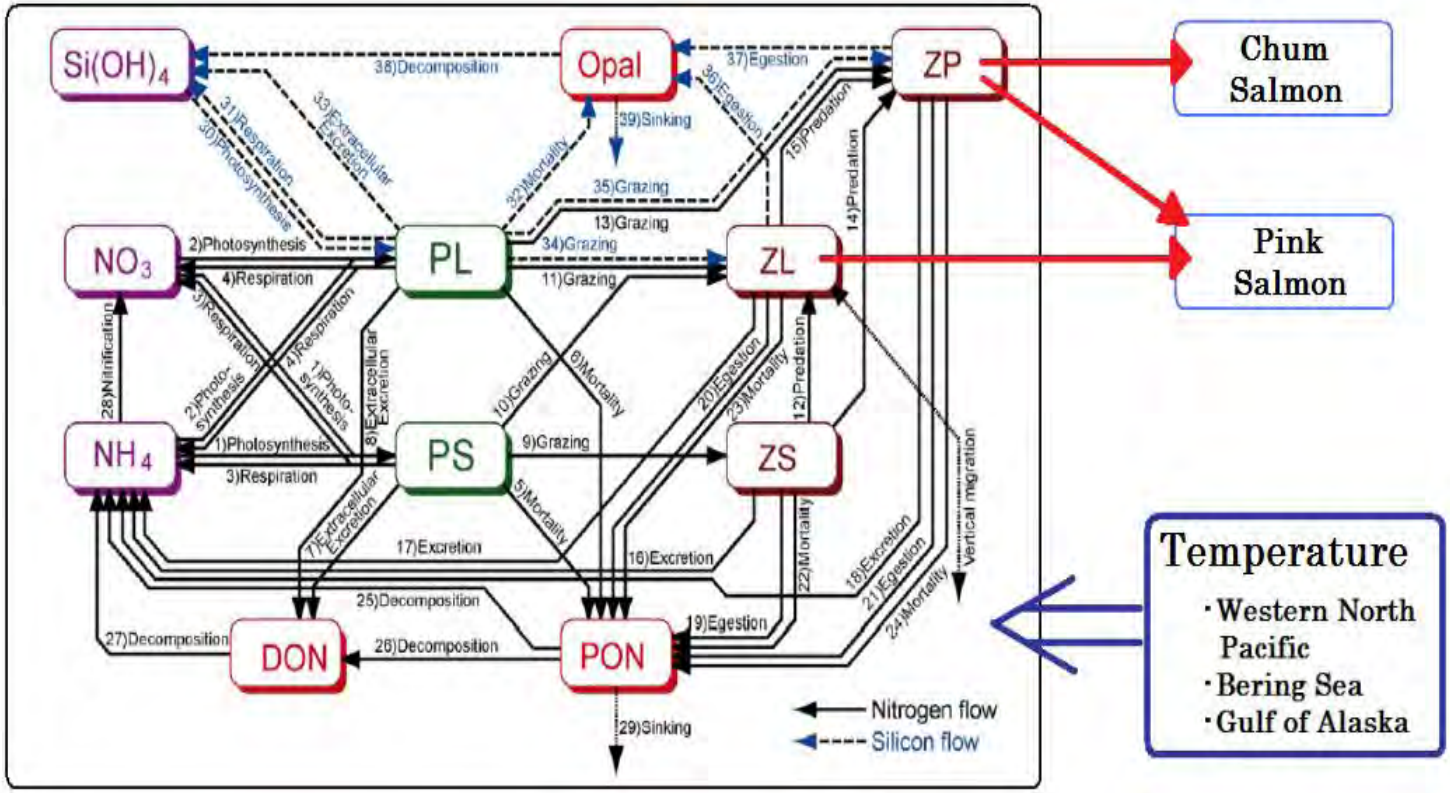
The **individual weight** of salmon was determined by respiration and consumption terms as function of water temperature and prey density.

Rudstum(1988)



NEMURO

+ NEMURO.FISH

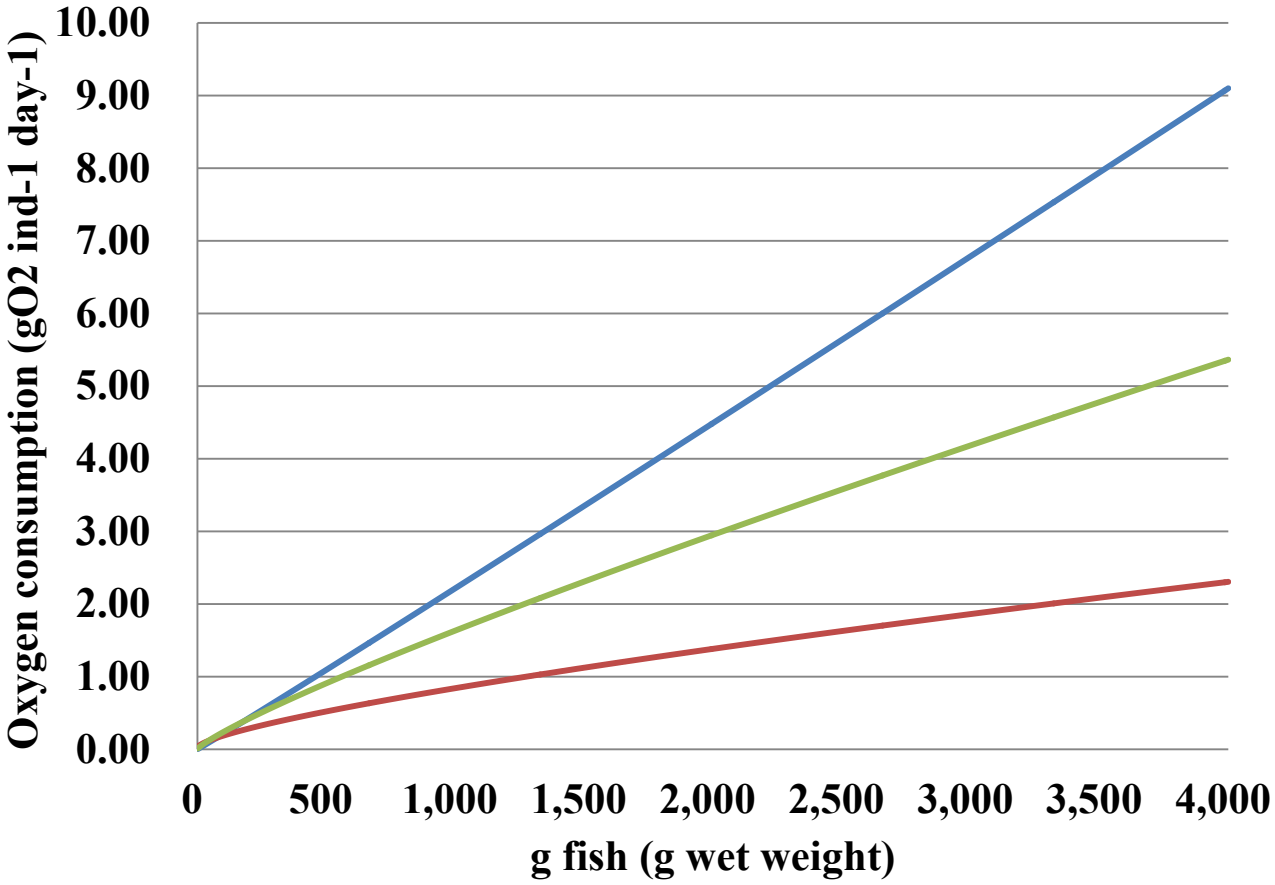


Stage	Age(day)	Period	Region
1	1-182	6/1-11/30	OH
2	183-365	12/1-5/31	WNP
3	366-547	6/1-11/30	BS
4	548-730	12/1-5/31	GA
5	731-912	6/1-11/30	BS
6	913-1095	12/1-5/31	GA
7	1096-1277	6/1-11/30	BS
8	1278-1460	12/1-5/31	GA
9	1461-1642	6/1-11/30	BS

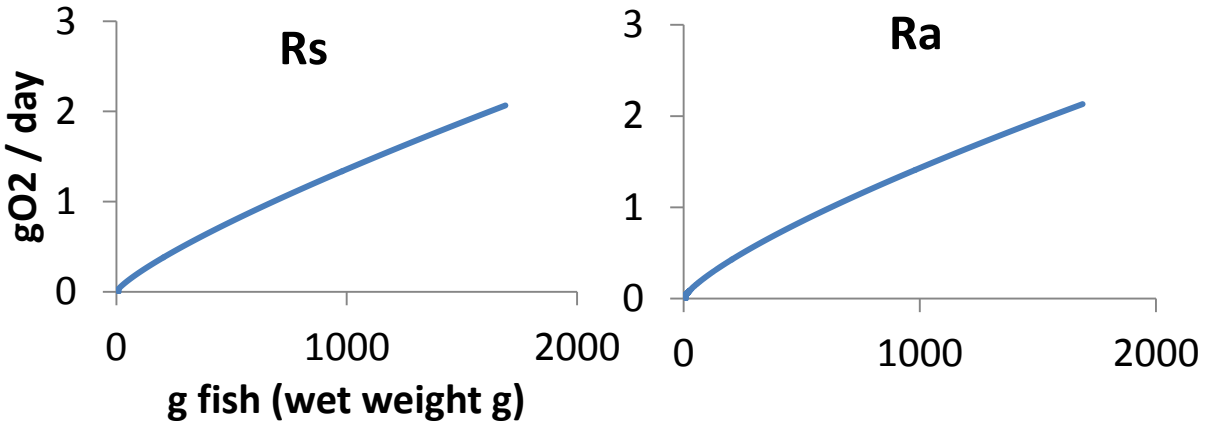
Table1.Stage of chum salmon's migration.

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

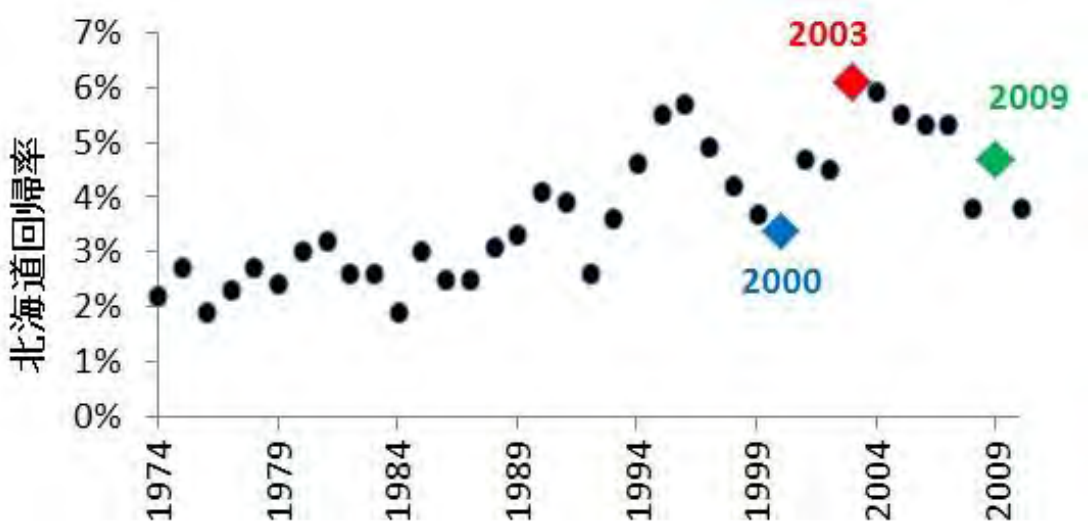
Respiration

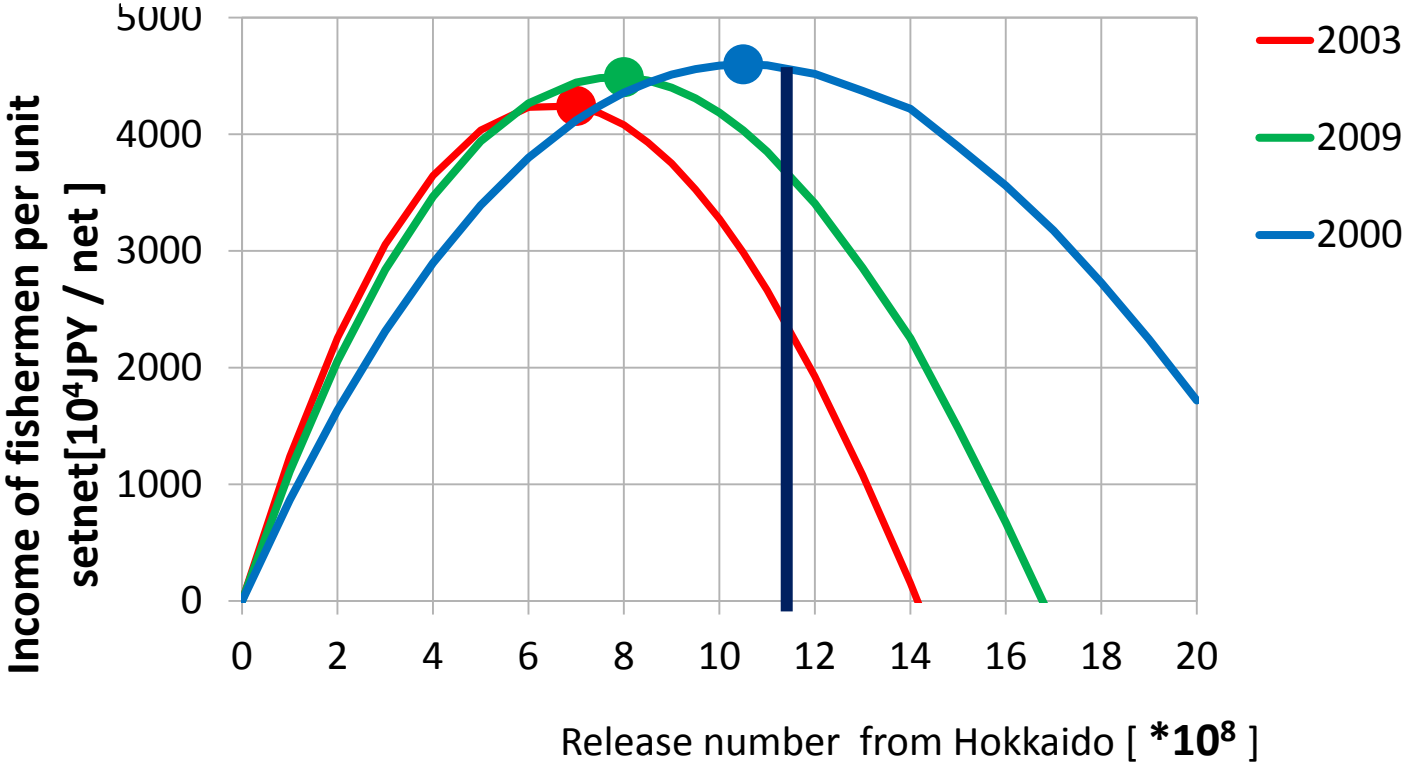


Kamezawa et al. (2007)
Trundel et al. (2004)
Megrey et al. (2002)

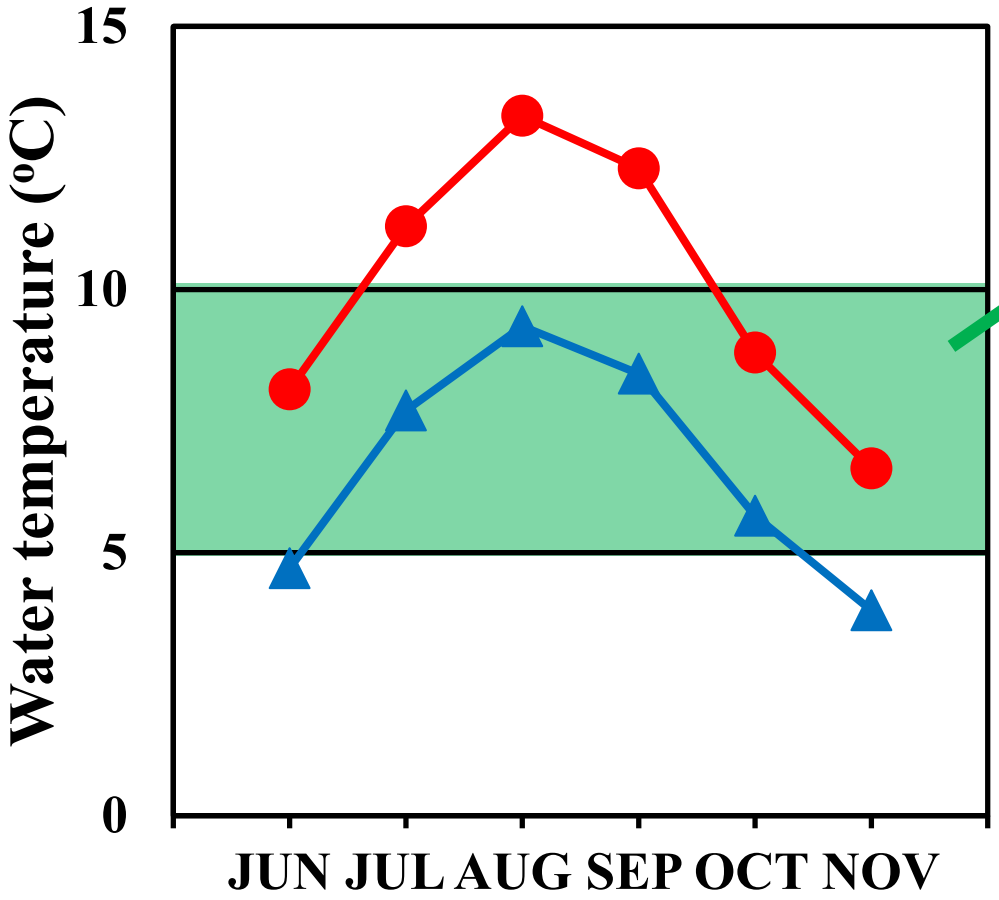


← Ware(1978)


北海道回帰率
7%
6%
5%
4%
3%
2%
1%
0%
1974
1979
1984
1989
1994
1999
2004
2009
2003
2009
2000


Income of fishermen per unit setnet[10⁴JPY / net]
5000
4000
3000
2000
1000
0
0
2
4
6
8
10
12
14
16
18
20
Release number from Hokkaido [*10⁸]
2003
2009
2000

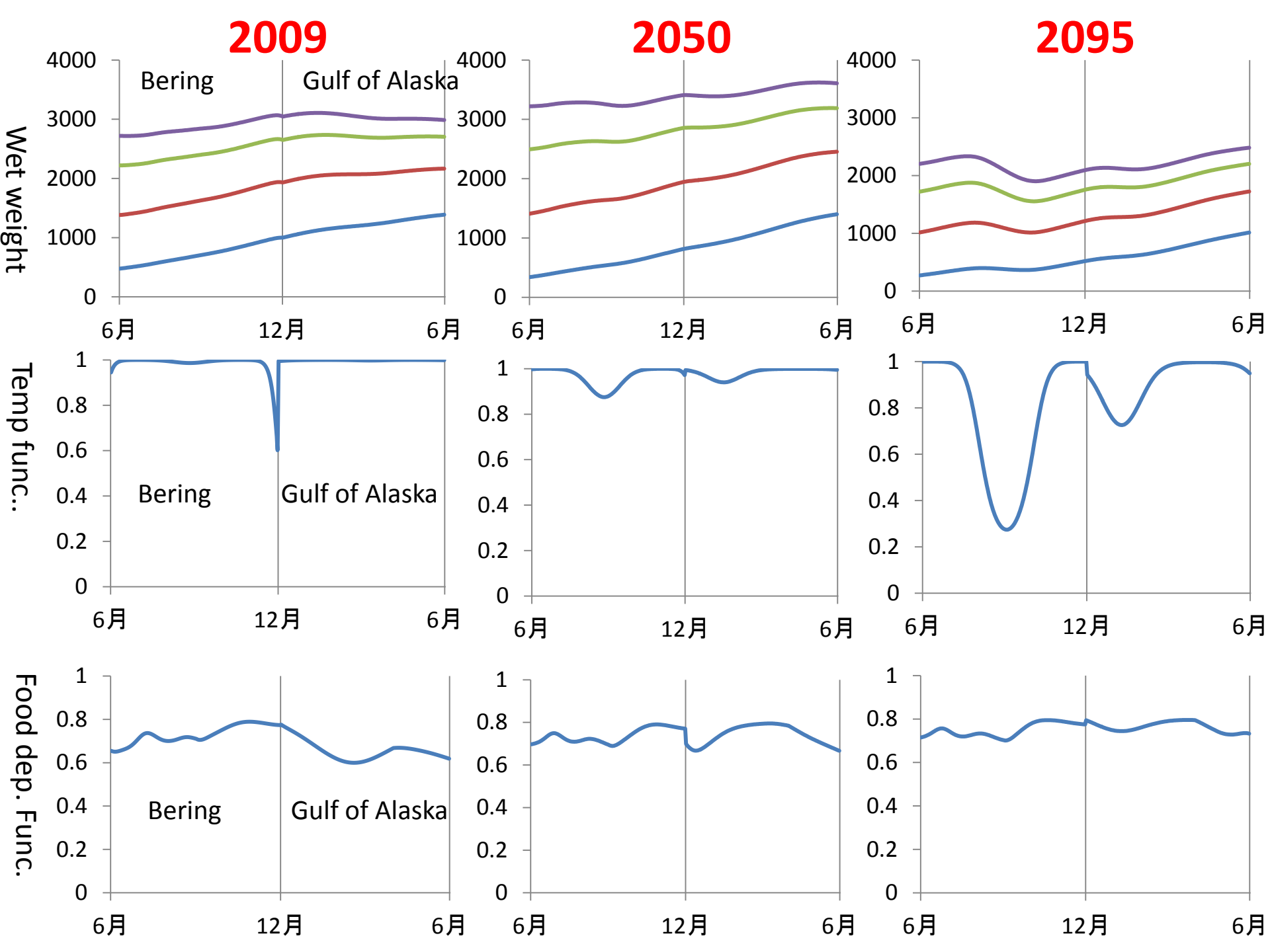
SST in the Bering Sea
Present & 2095yr under the SRES-A1B



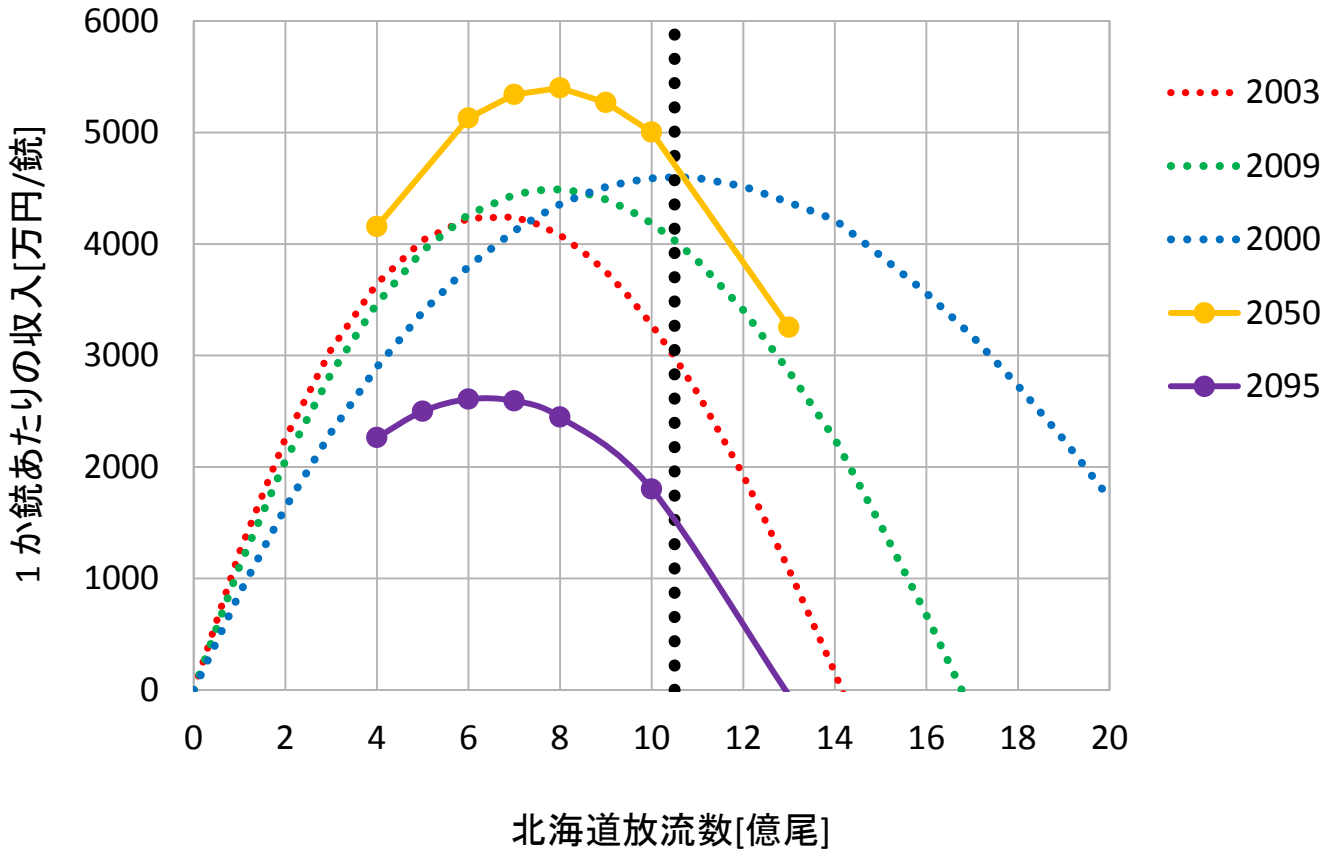
Optimal Temp. for chum salmon
: 5°C – 10°C
(Kishi et al., 2010)

WOA05

2095-A1B
(Kawamiya et al., 2005)


2009
2050
2095
Wet weight
Temp func..
Food dep. Func.
Bering
Gulf of Alaska
4000
3000
2000
1000
0
1
0.8
0.6
0.4
0.2
6月
12月

- **After global warming (A2)**



Thank you

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