

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

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Unit price

× Fish Wet weight

× Catch number

= Income **How to maximize**

1) Unit price

2) Return ratio => catch number

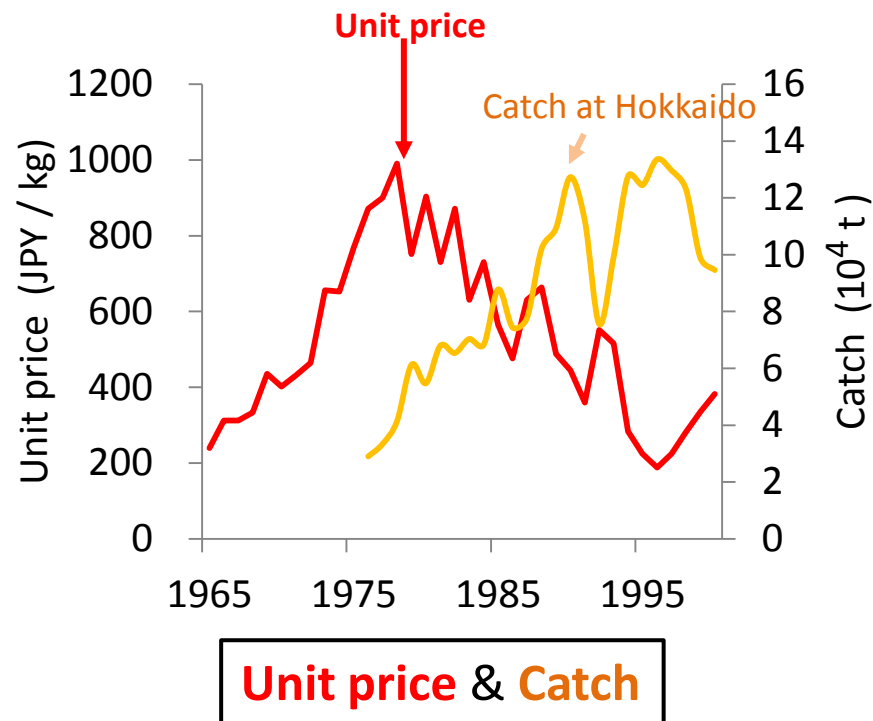
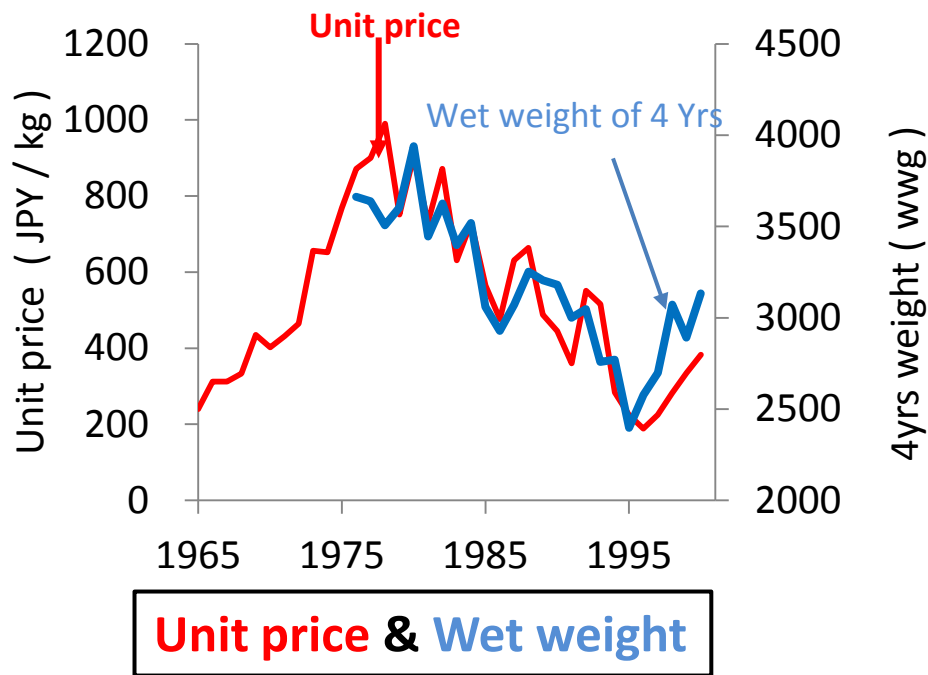
3) Wet weight (Ind⁻¹)

Unit price \times Fish Wet weight \times Catch number = Income

1) Unit price

2) Return ratio

3) Wet weight (Ind⁻¹)



Unit price: Multiple regression

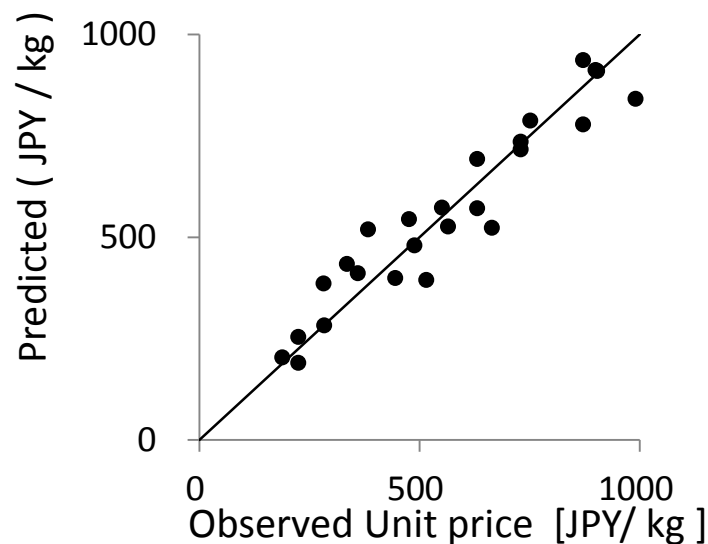
$$y = 0.499 x_1 - 0.530 x_2 \quad (r = 0.922)$$

(data : normalized)

y: Unit price

x₁ : Wet weight of Ocean age 4

x₂ : Catch at Hokkaido area

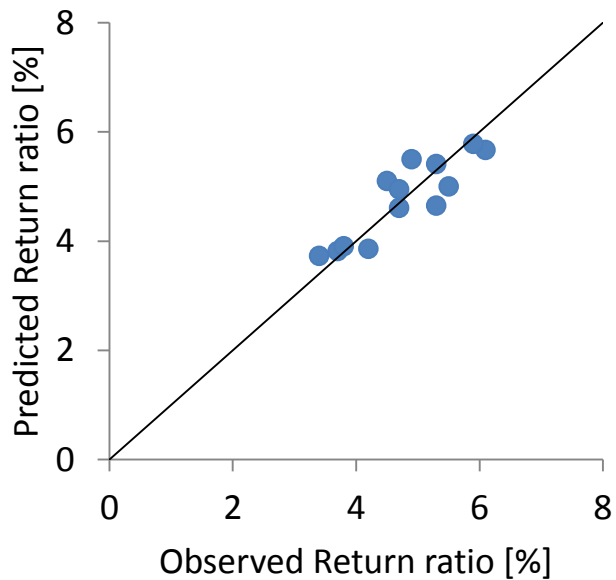
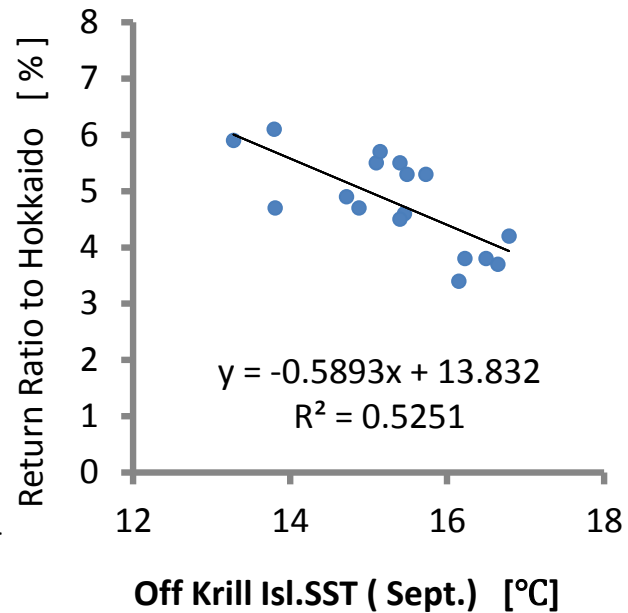
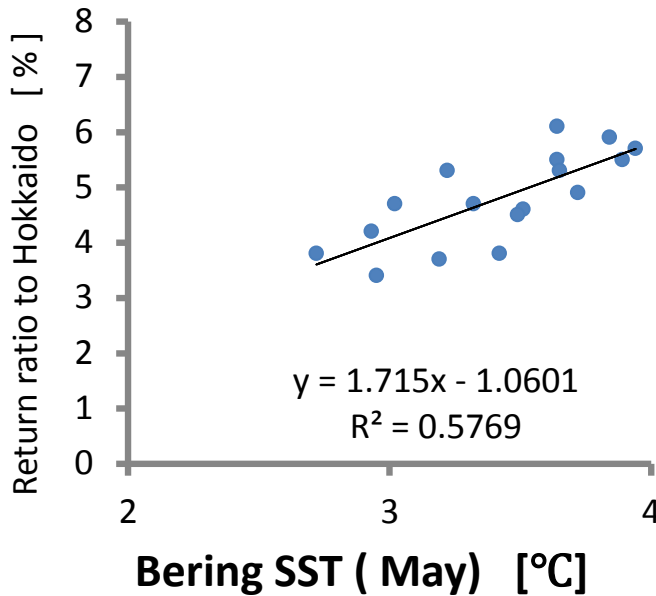
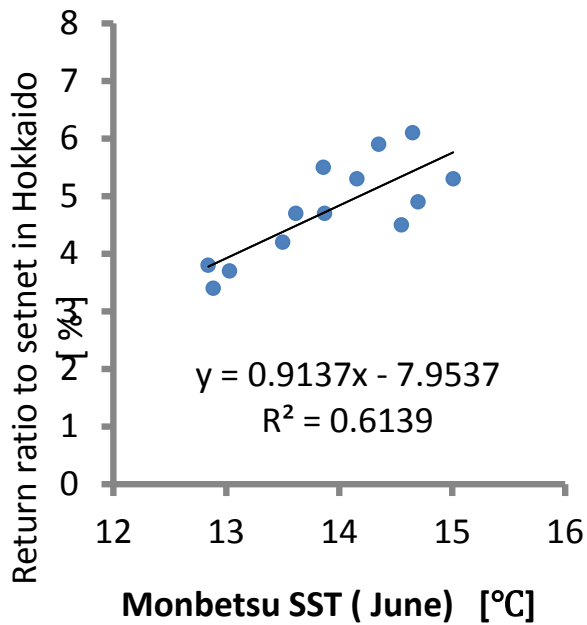


Unit price \times Fish Wet weight \times Catch number = Income

1) Unit price

2) Return ratio

3) Wet weight (Ind⁻¹)



Multiple regression

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

(for normalized data)

($r: 0.880$)

y : Return ratio

x_1 : Monbetsu SST x_2 : Bering SST x_3 : Off Krill Isl. SST

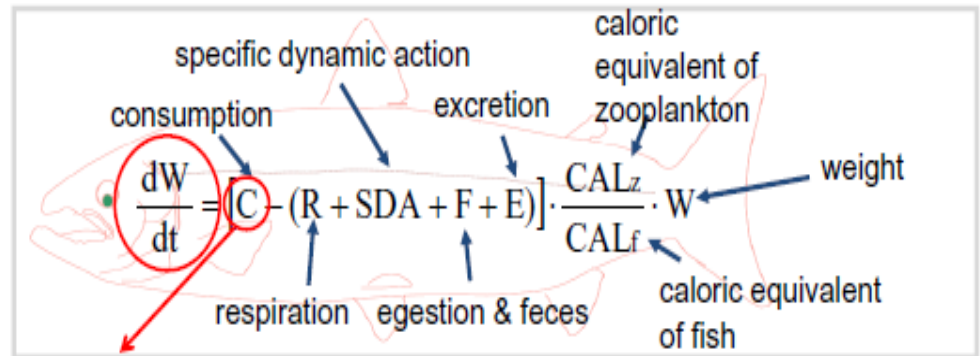
Unit price \times Fish Wet weight \times Catch number = Income

1) Unit price

2) Return ratio

3) Wet weight (Ind⁻¹)

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

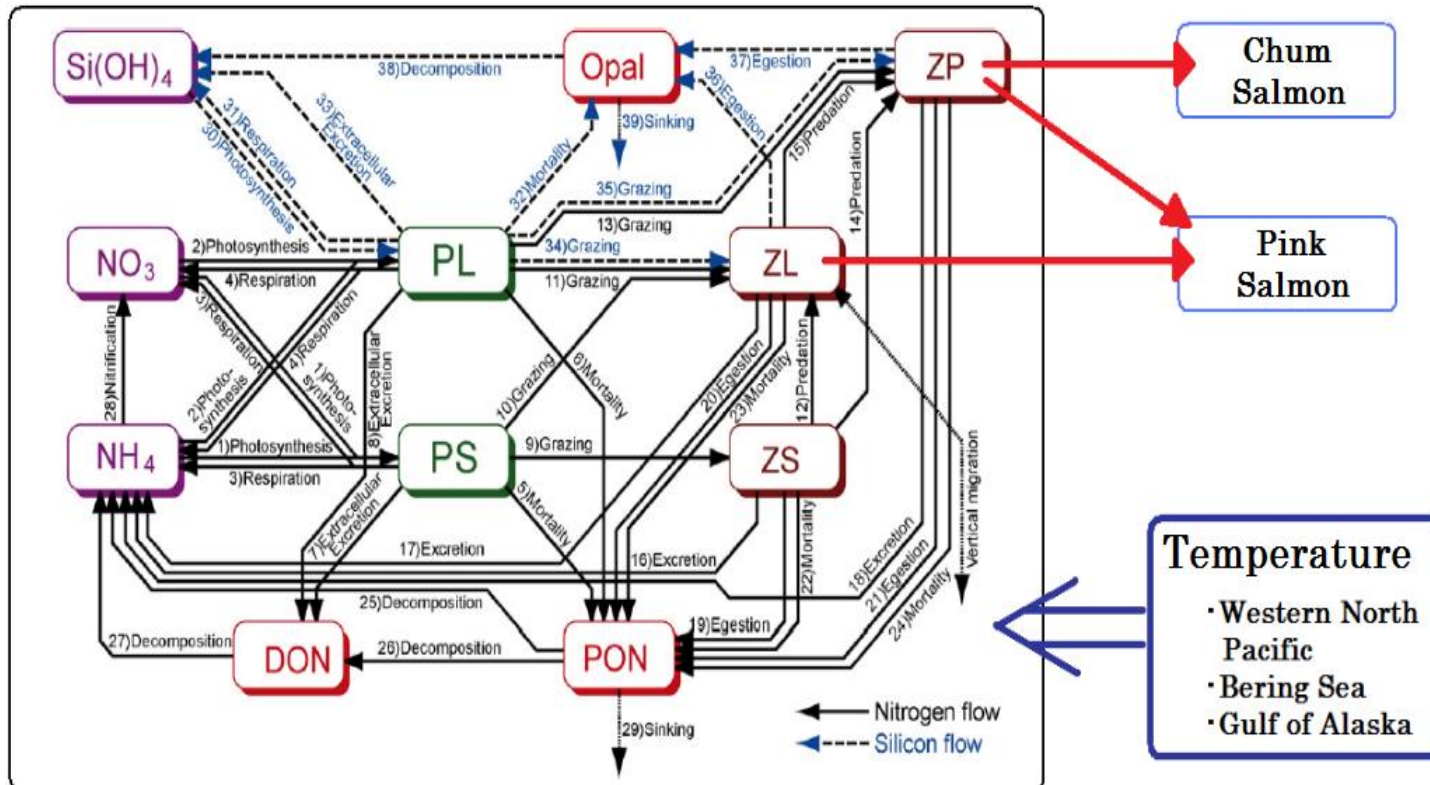


$$C = C_{MAX} \cdot \rho \cdot f_c(T)$$

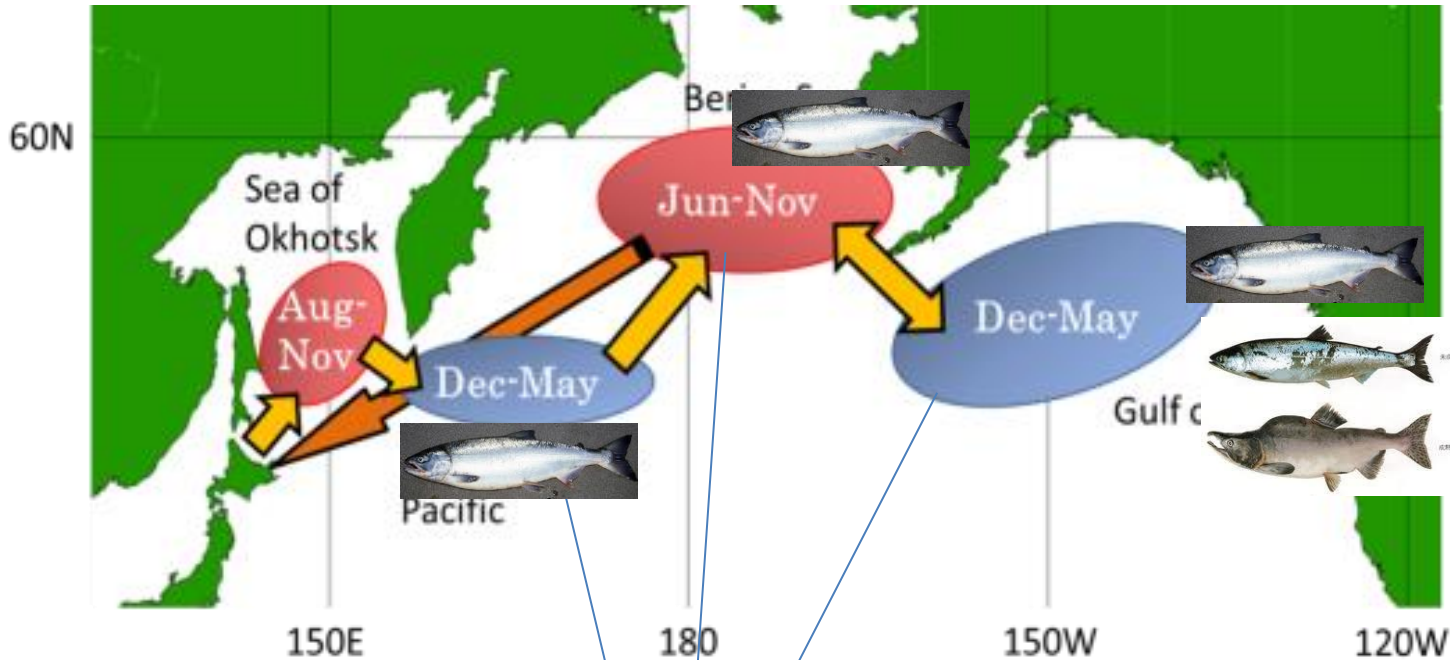


NEMURO.FISH

NEMURO



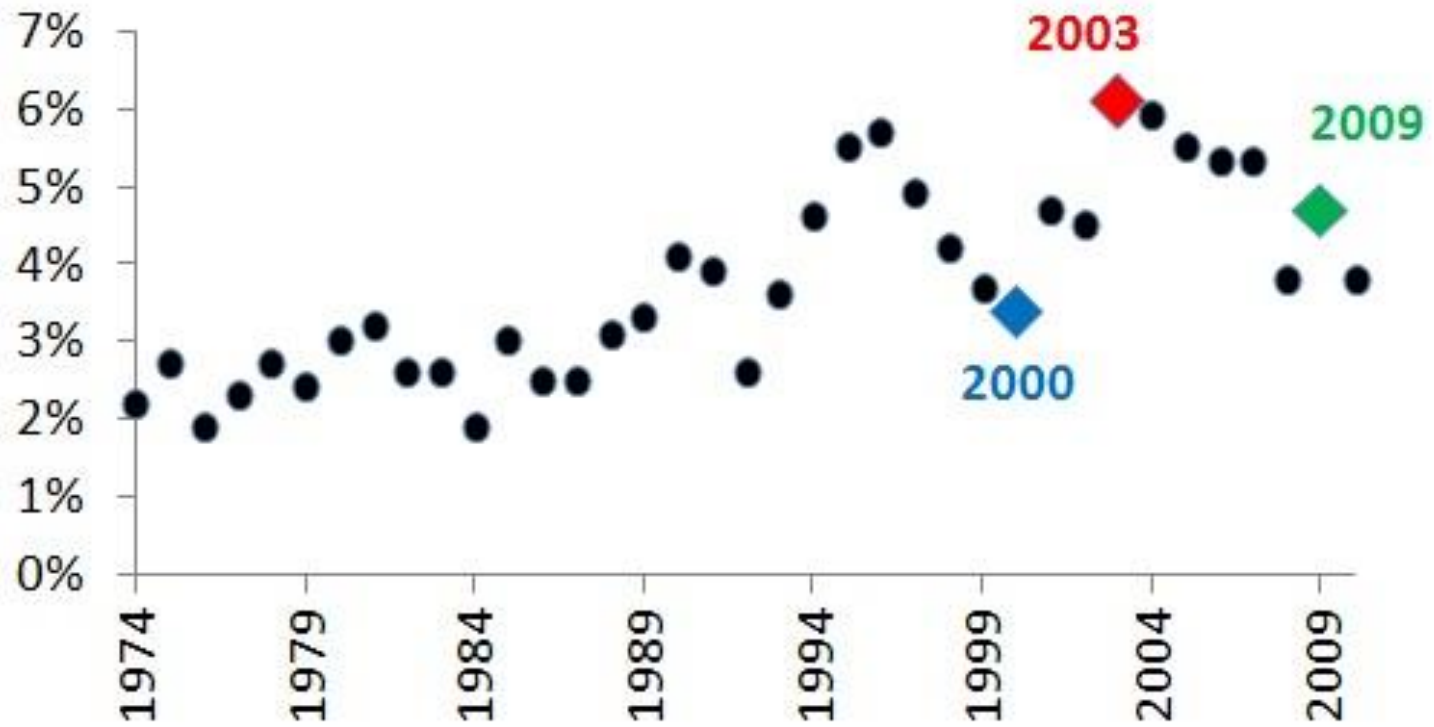
Migration Patterns



4000km^3

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

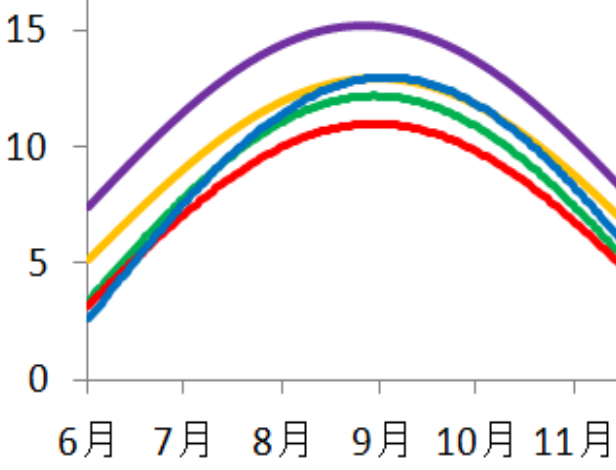
Return ratio to Hokkaido



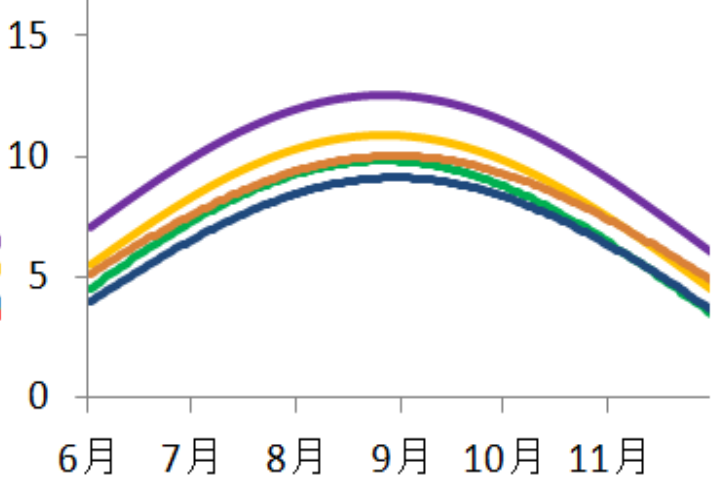
Temperature - NEMURO Box model

Methods

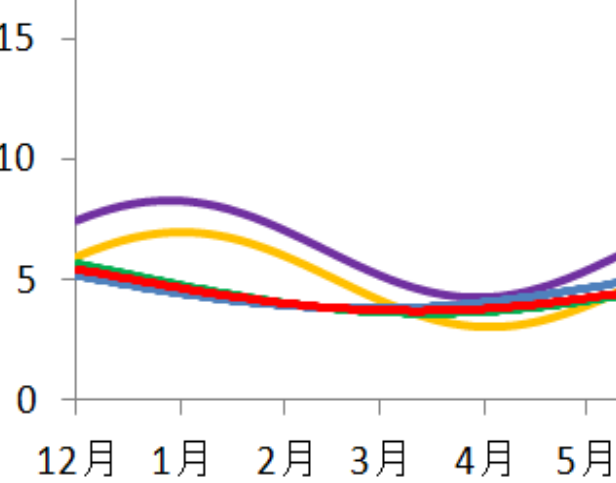
Okhotsk



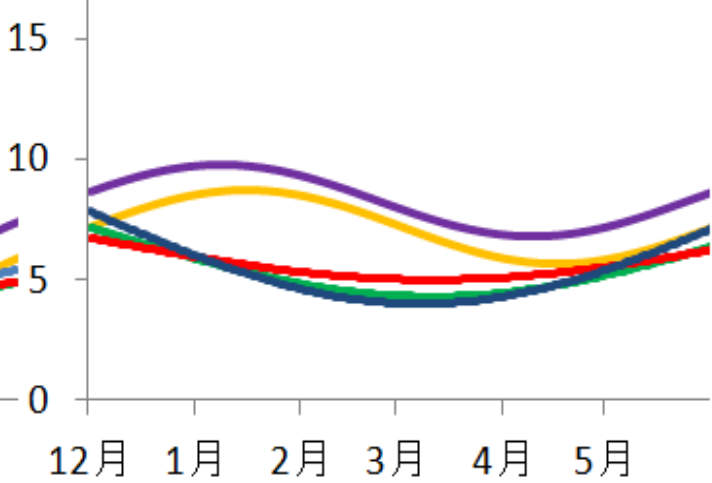
Bering



N-W Pacific



Gulf of Alaska



- 2003
- 2009
- 2000
- 2050
- 2095

2000, 2003, 2009年
NOAA Optimum
Interpolation (OI) Sea
Surface Temperature
(SST) V2

2050, 2095年
IPCC SRES A1B
(Kawamiya et al., 2007)

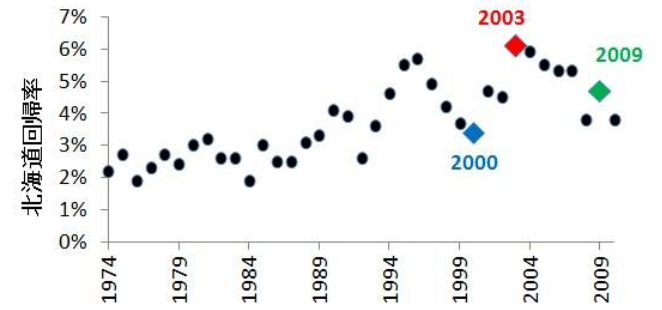
Other Physical Condition for NEMURO Box model

Nutrient at bottom of Mixed layer: WOA

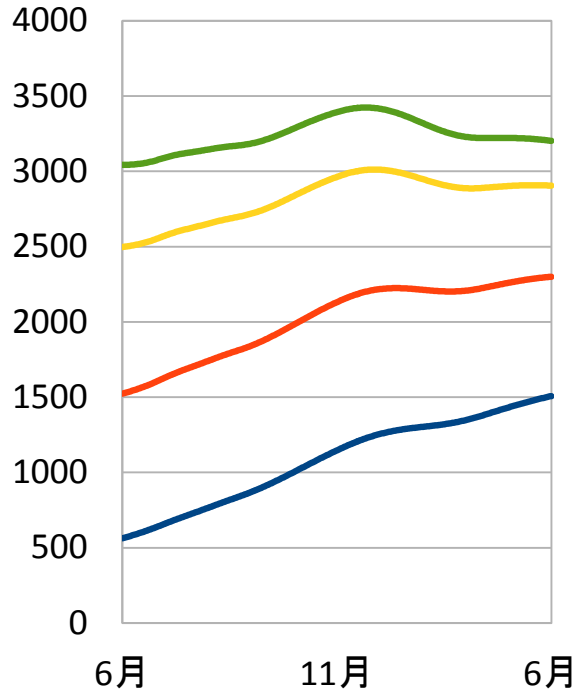
Mixed layer depth: WOA

result

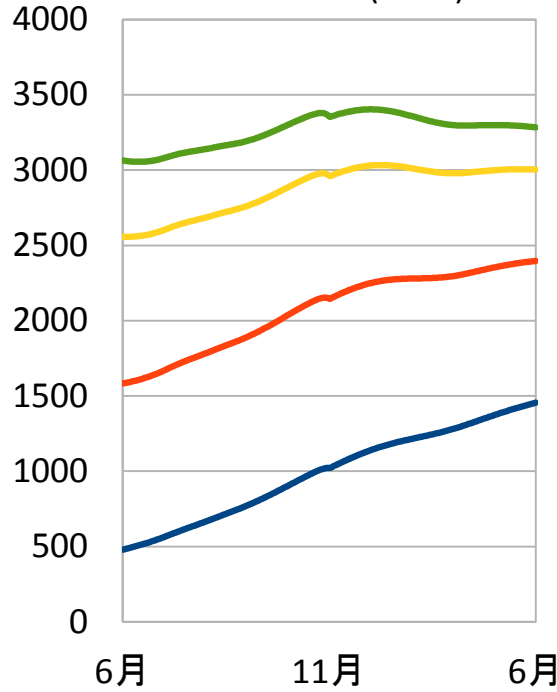
Wet weight



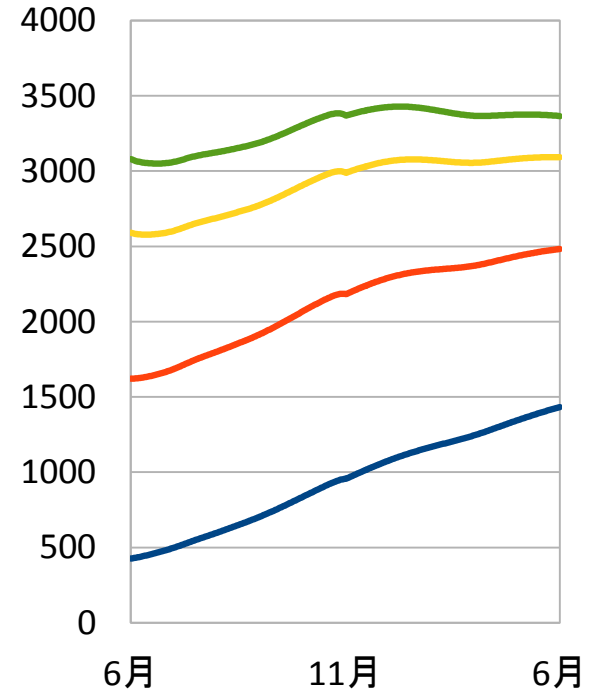
High(2003)



Normal(2009)

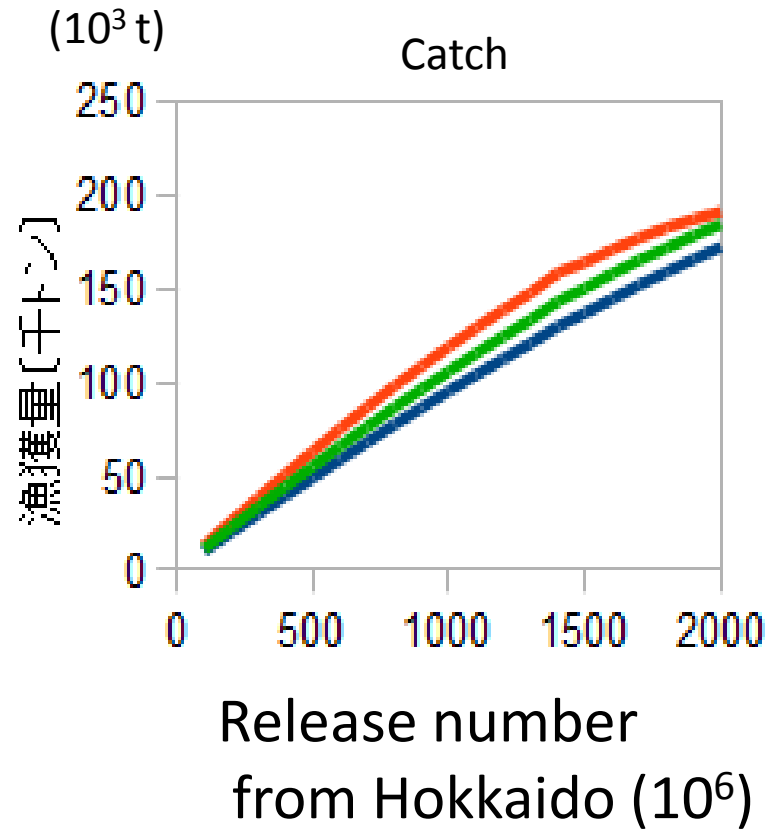
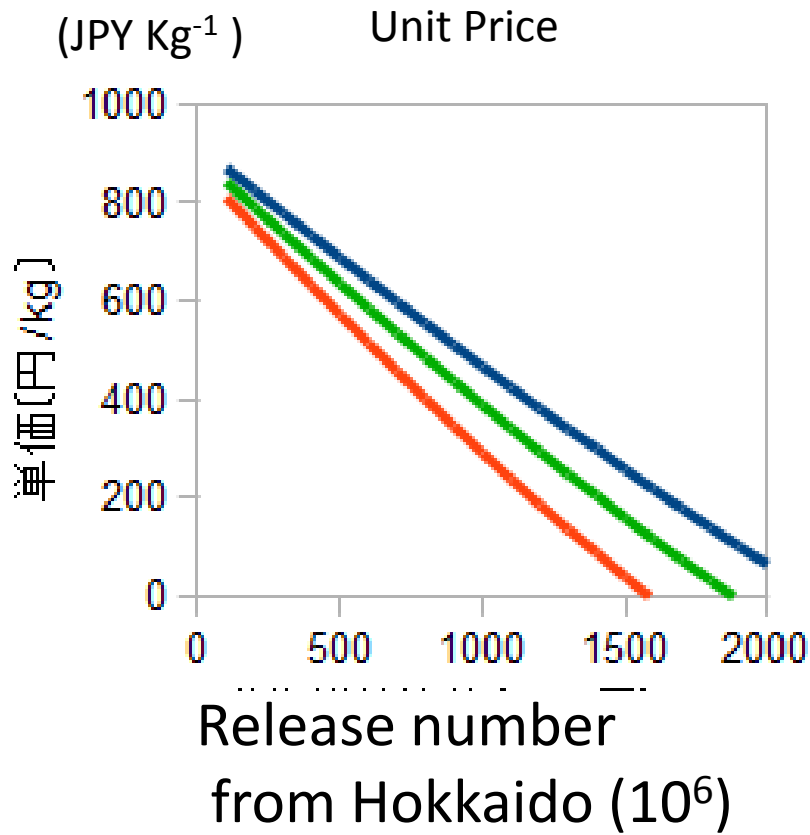
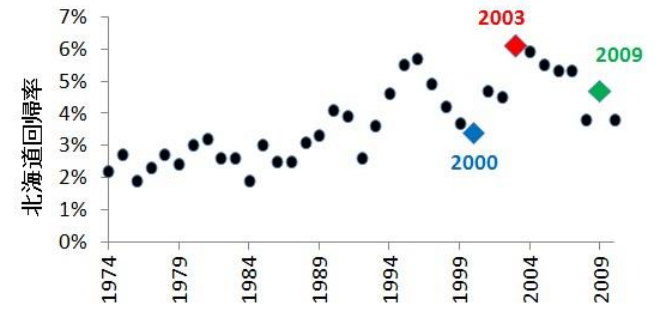


Low(2002)

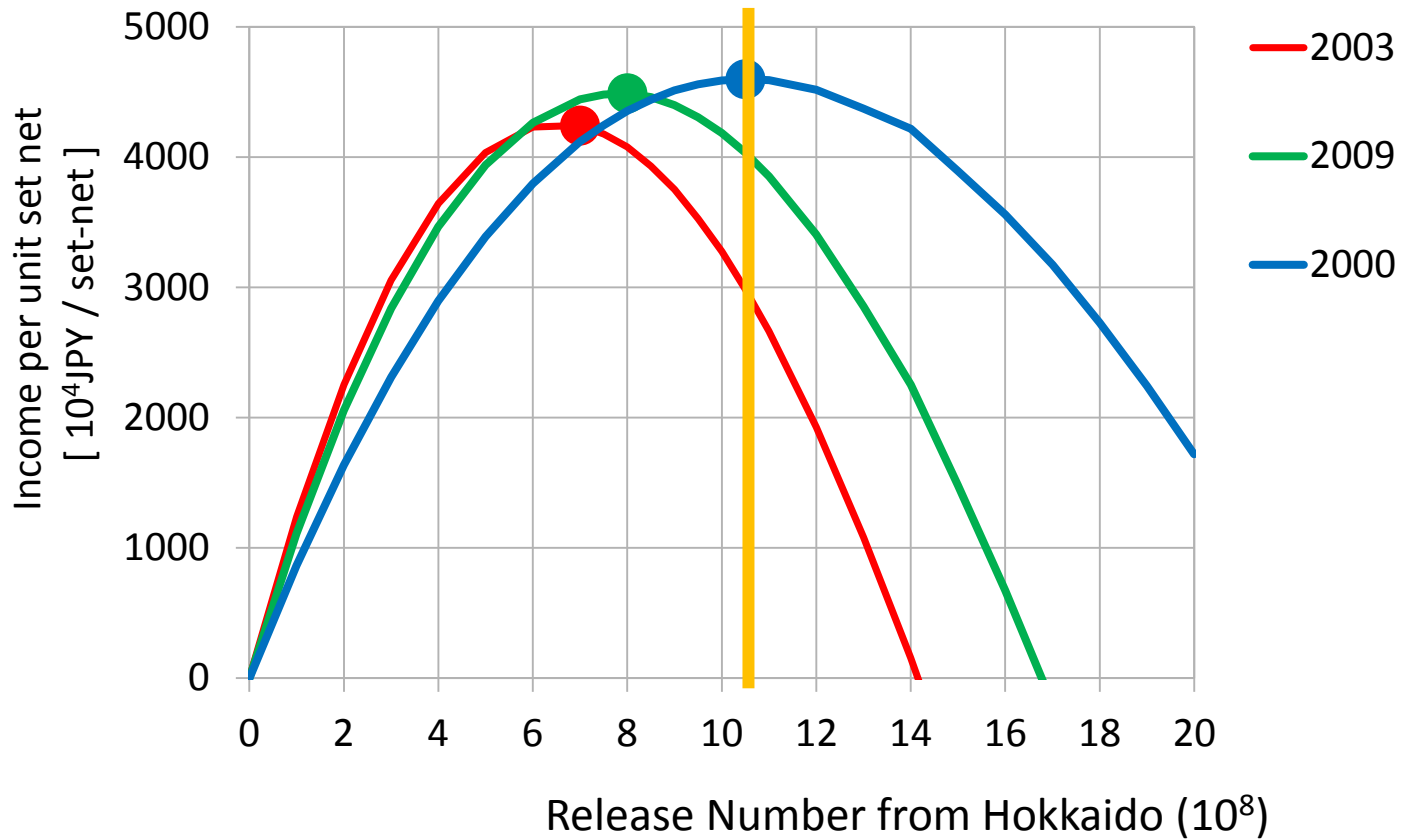
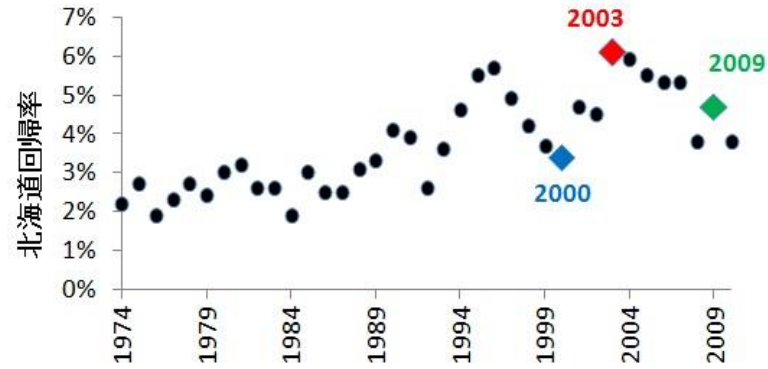


Release number = 5×10^8

result

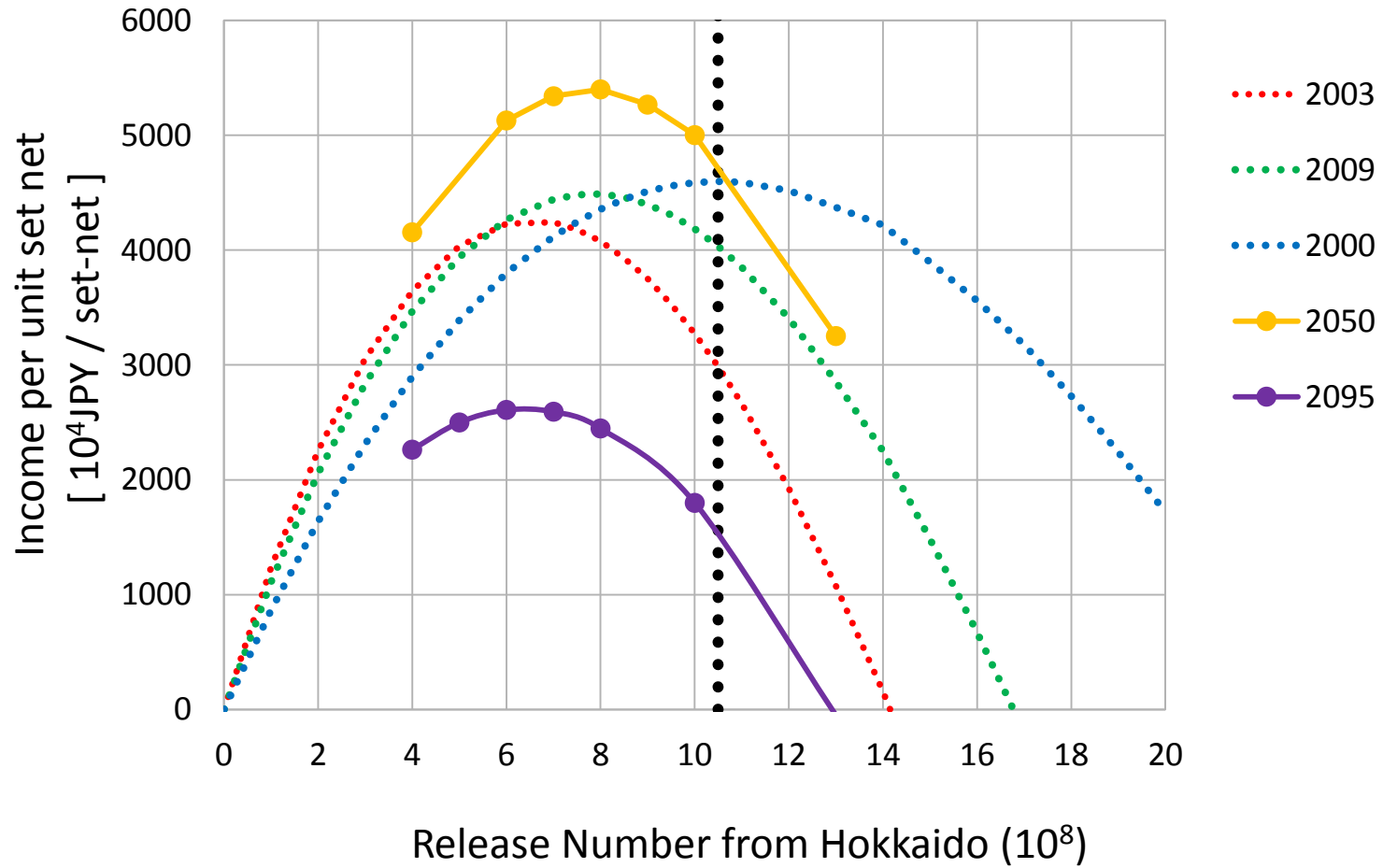


result



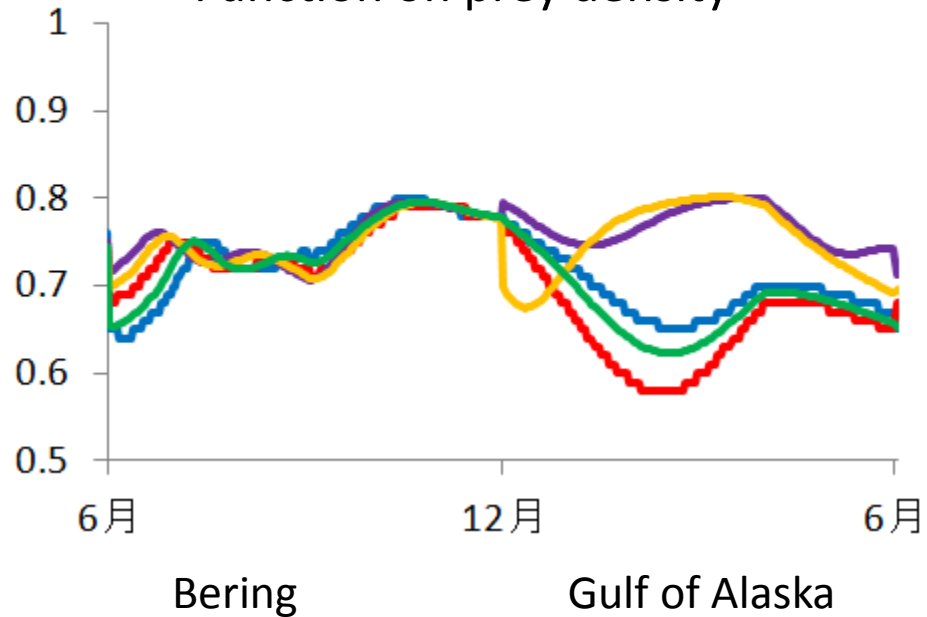
result

• After GLOBAL Warming

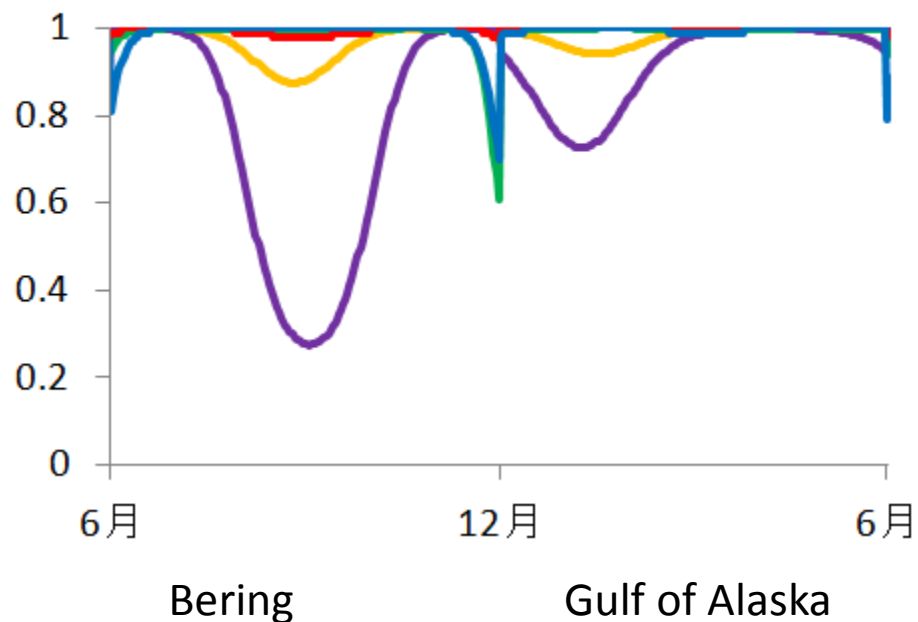


— 2003 — 2009 — 2000 — 2050 — 2095

Function on prey density



Function on temperature



Year	2000	2009	2003	2050	2095
Predicted return ratio(%)	3.45	4.72	5.60	4.99	6.07
Observed return ratio(%)	3.4	4.7	6.1	–	–



Minke whale



Japanese common squid



Japanese anchovy



Steller sea lion



Chum salmon



Japanese sardine



Walleye pollock

Thank you