MODEL Task Team

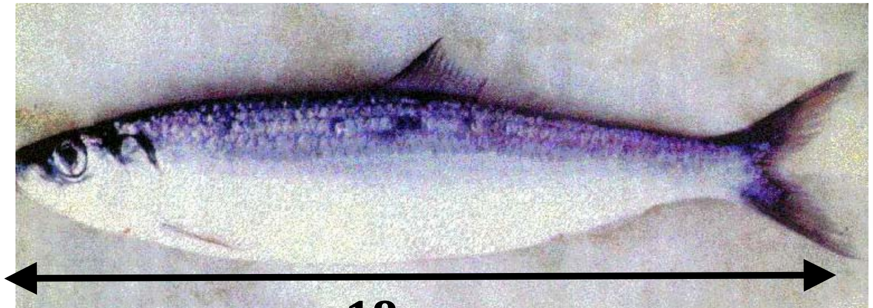
NEMURO
NEMURO.FISH
Dynamic link
Coupled with population dynamics model
PEST
Regional comparison
E-NEMURO
3D-NEMURO
ECOPATH/ECOSIM+NEMURO
Ecological Modelling special volume
Future perspectives
Support by Heiwa-Nakajima, FRA, APN

MODEL Task Team
Result of coupled lower trophic level - fish models (NEMURO.FISH)

Shin-ichi Ito
Bernard. A. Megrey
Francisco E. Werner
Michio J. Kishi

NEMURO
North Pacific Ecosystem Model for Understanding Regional Oceanography

NEMURO.FISH
NEMURO For Including Saury and Herring



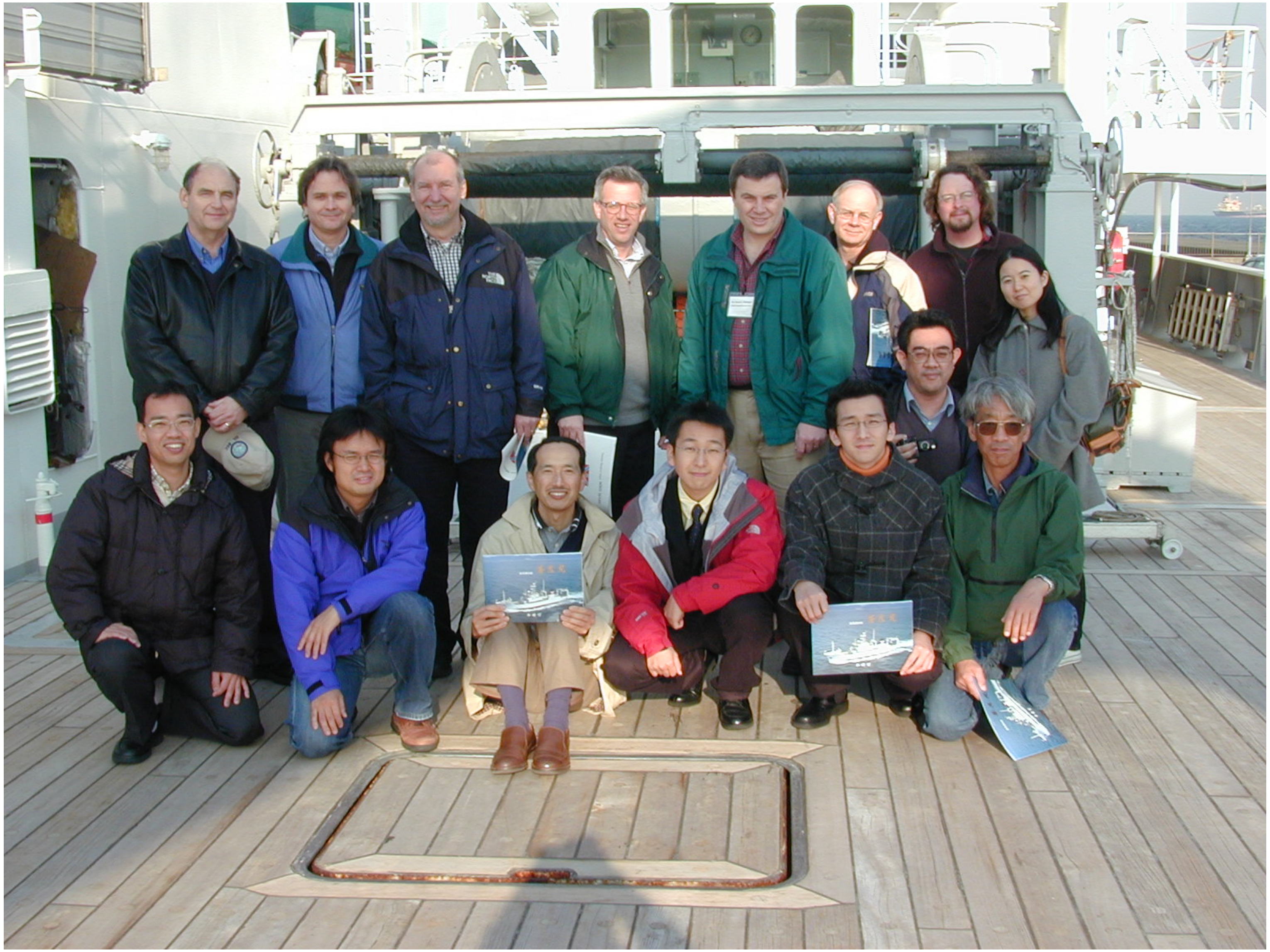
18 cm

30 cm

Workshop 2000

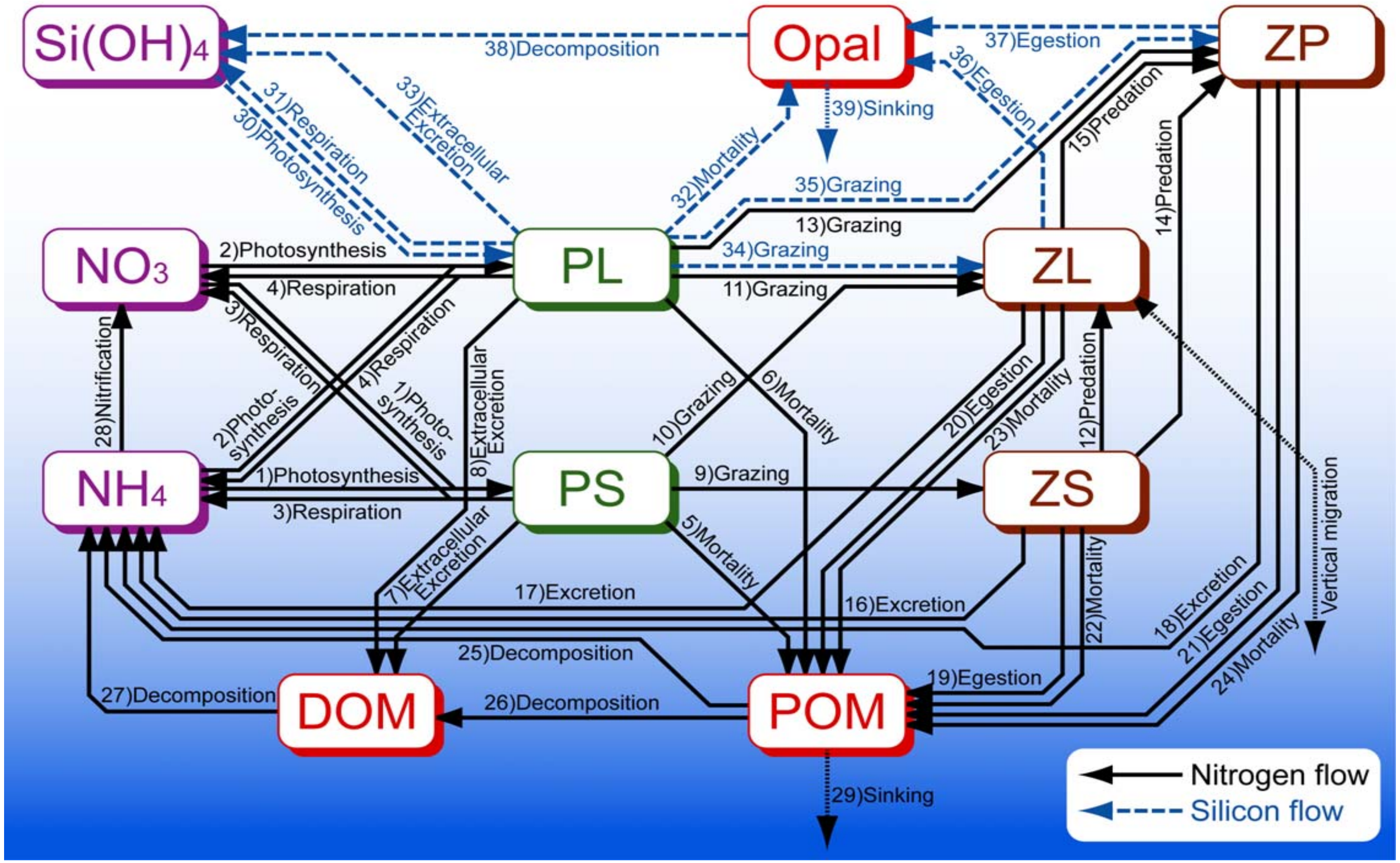
Workshop 2002

Workshop 2003



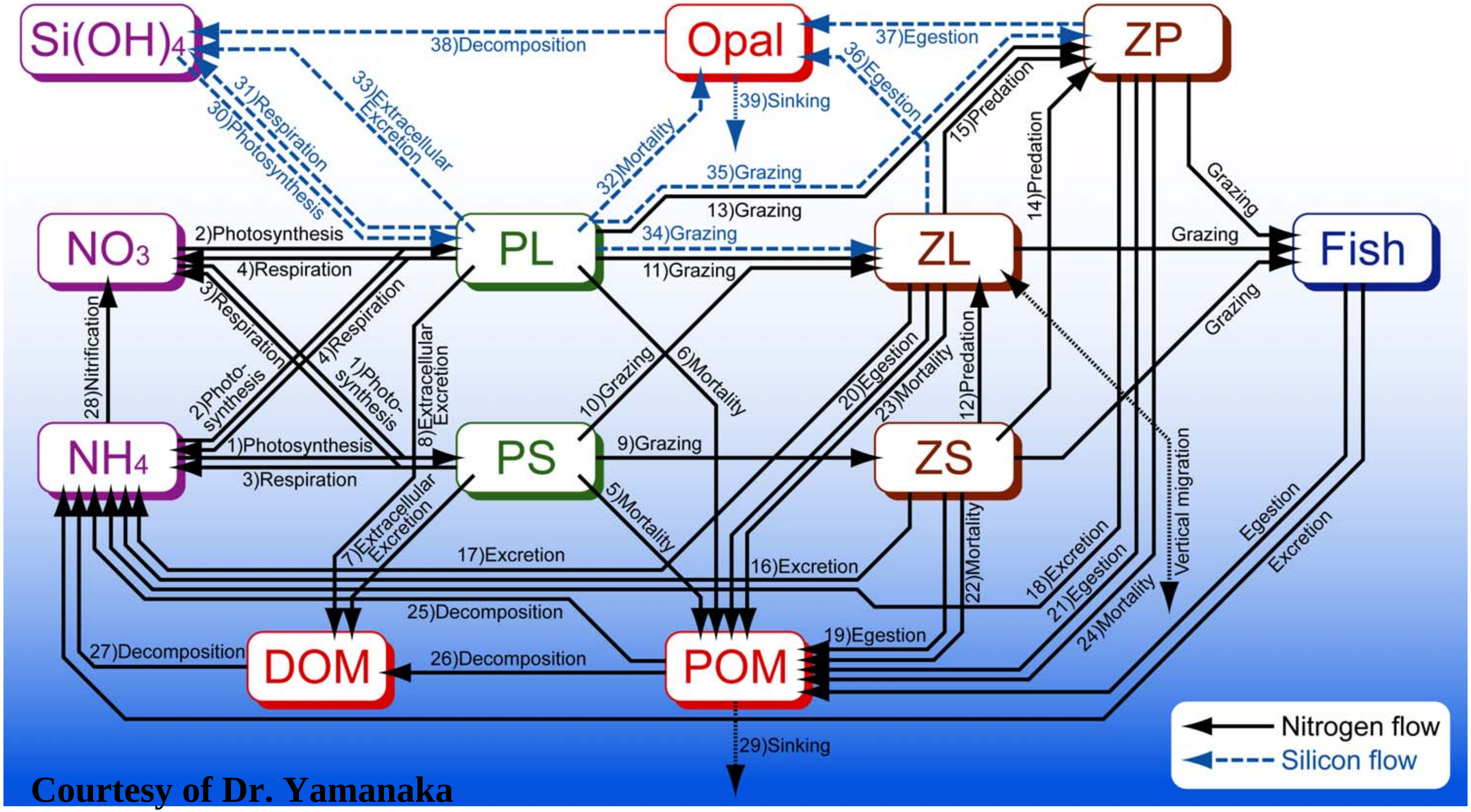
PICES-APN Workshop 2004

NEMURO



Courtesy of Dr. Yamanaka

NEMURO.FISH



Courtesy of Dr. Yamanaka

Bioenergetics Model for herring and saury

$$\frac{dW}{W \cdot dt} = \left[C - (R + S + F + E + P)\right] \cdot \frac{CAL_z}{CAL_f}$$

change of weight

C: consumption

R: respiration (loses through metabolism)

S: specific dynamic action (digesting food)

F: egestion

E: excretion

P: egg production

Dynamic linkage between LTL & HTL

$$\frac{dW}{W \cdot dt} = \left[C - (R + S + F + E + P)\right] \cdot \frac{CAL_z}{CAL_f}$$

NH4

PON

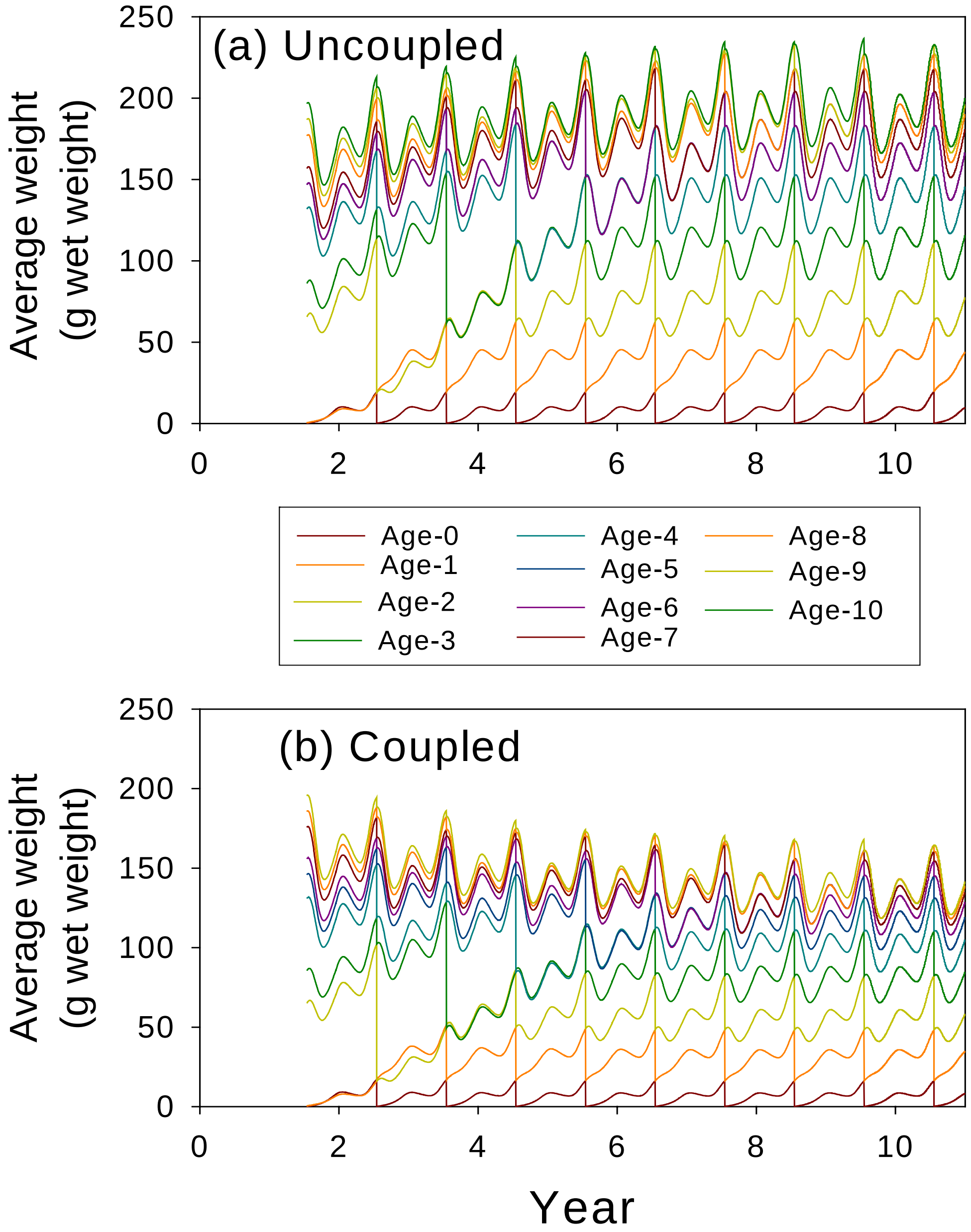
$dN/dt = -(F+M)\,N$

Population dynamics model

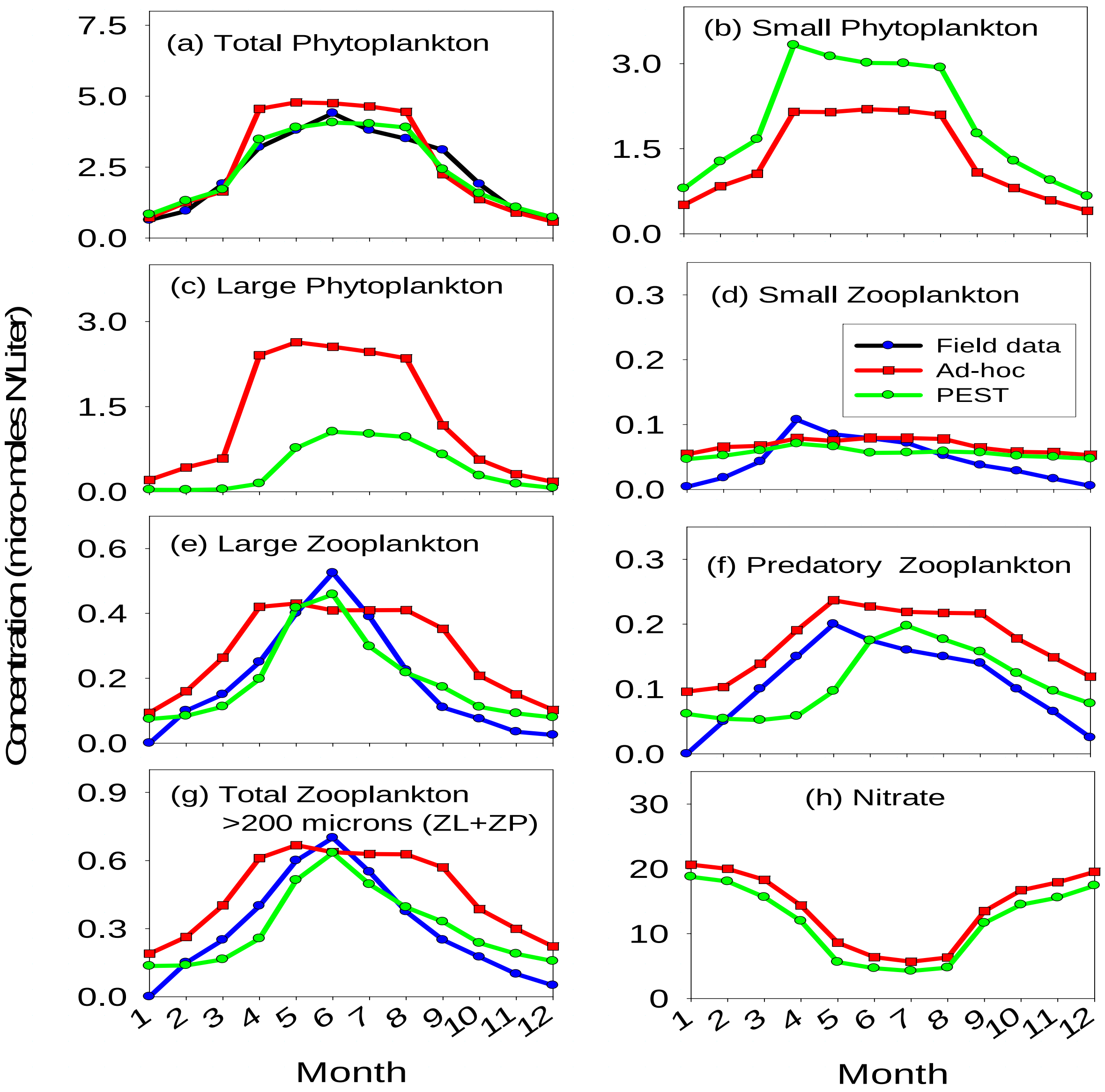
Decrease ZS, ZL, ZP

Effect of Dynamic Linkage and Predation Pressure

- Reduction in large zooplankton
- Slower herring growth



PEST: a free software to make optimal parameter calibration



Field data

Ad-hoc calibration

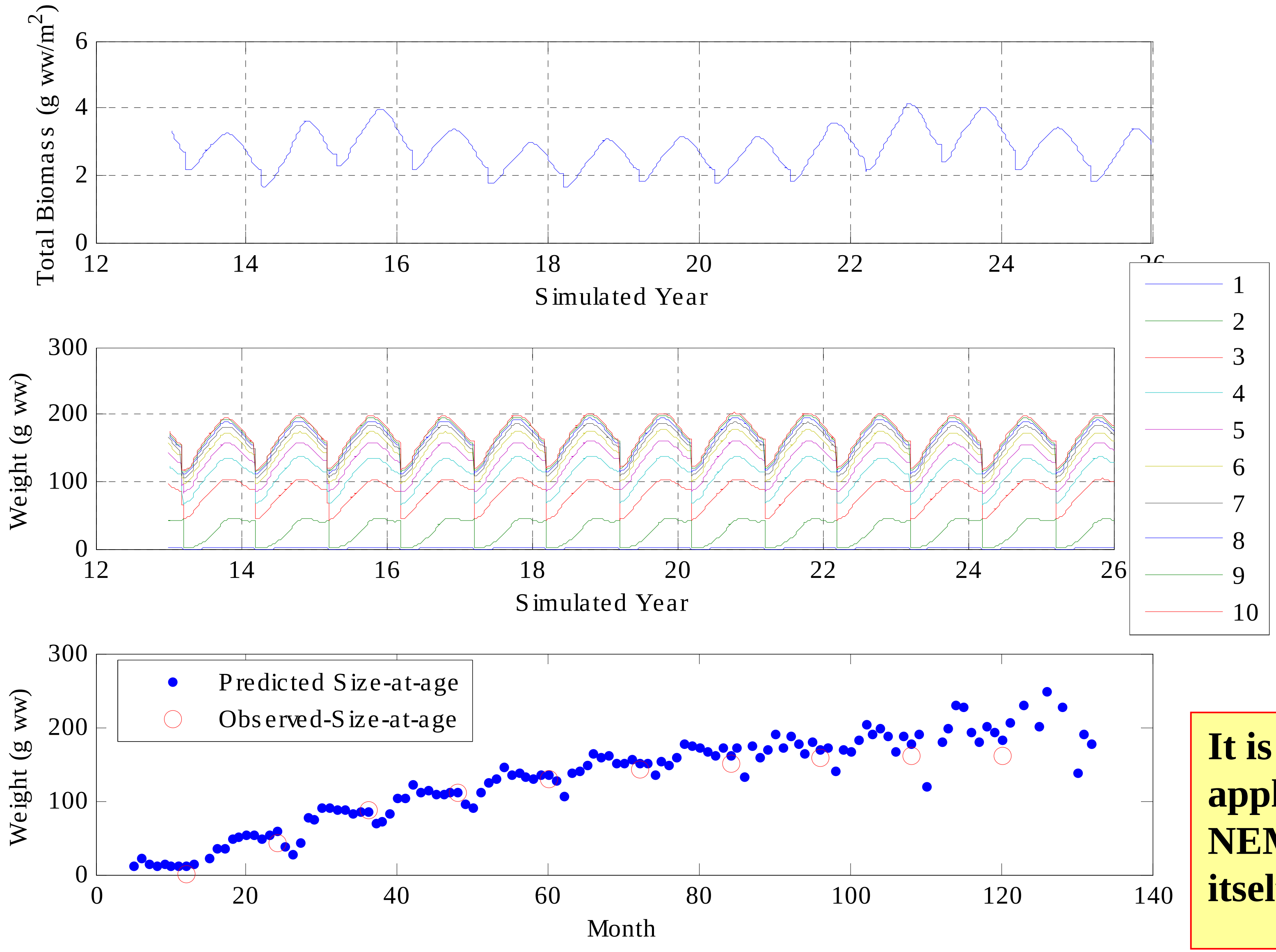
PEST

PEST gives better fits to observed data.
PEST is automated and independent to any models.
It is easy to calibrate model parameter than adjoint method.

PEST enables NEMURO to be applied any stations which has seasonal LTL data.

Rose et al. (in prep.)

PEST to NEMURO.FISH

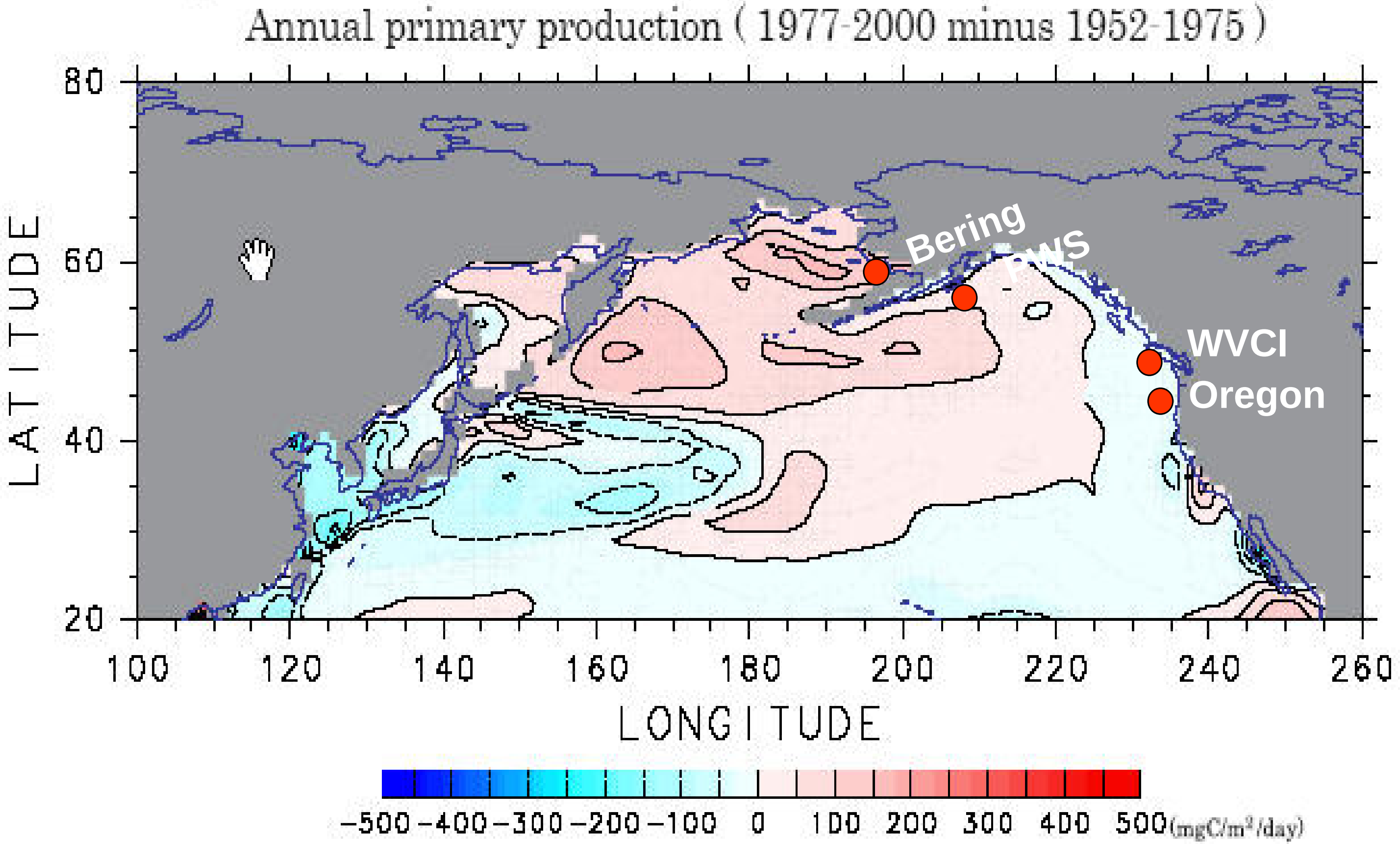


It is possible to apply PEST to NEMURO.FISH itself.

Bern et al. (in prep.)

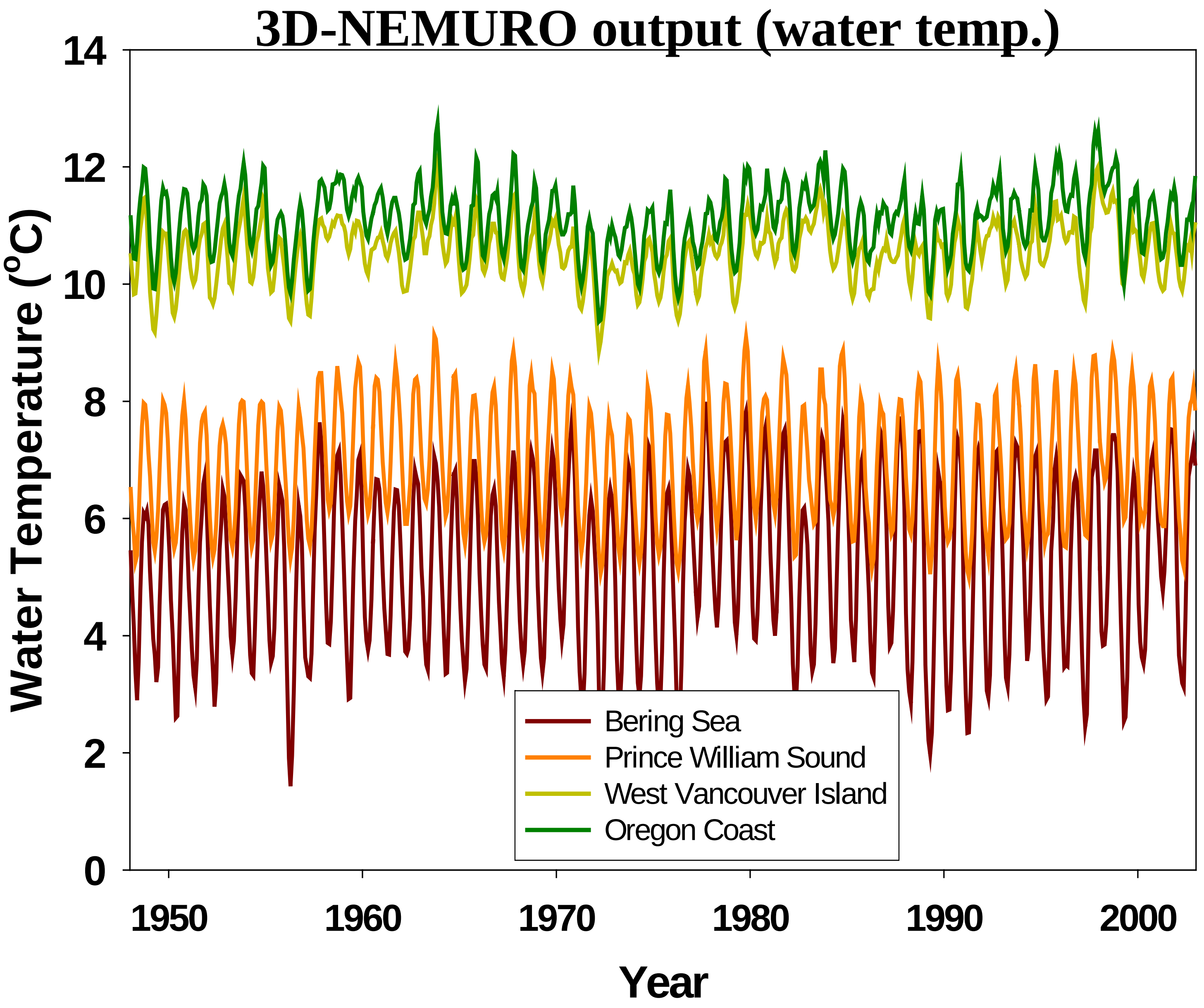
Regional comparison

3D-NEMURO LTL input to NEMURO.FISH



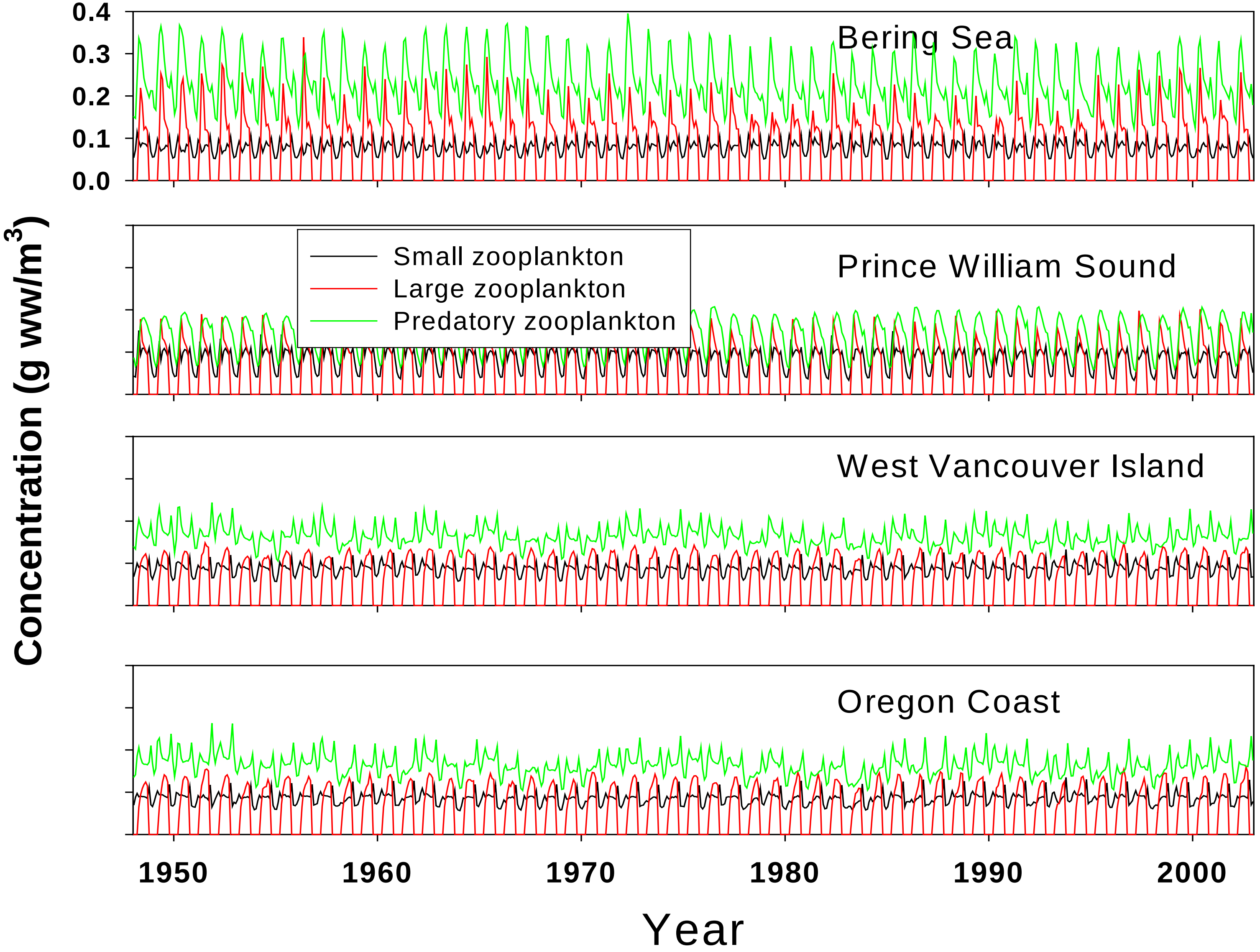
Aita-Noguchi et al. (submitted)

Regional comparison



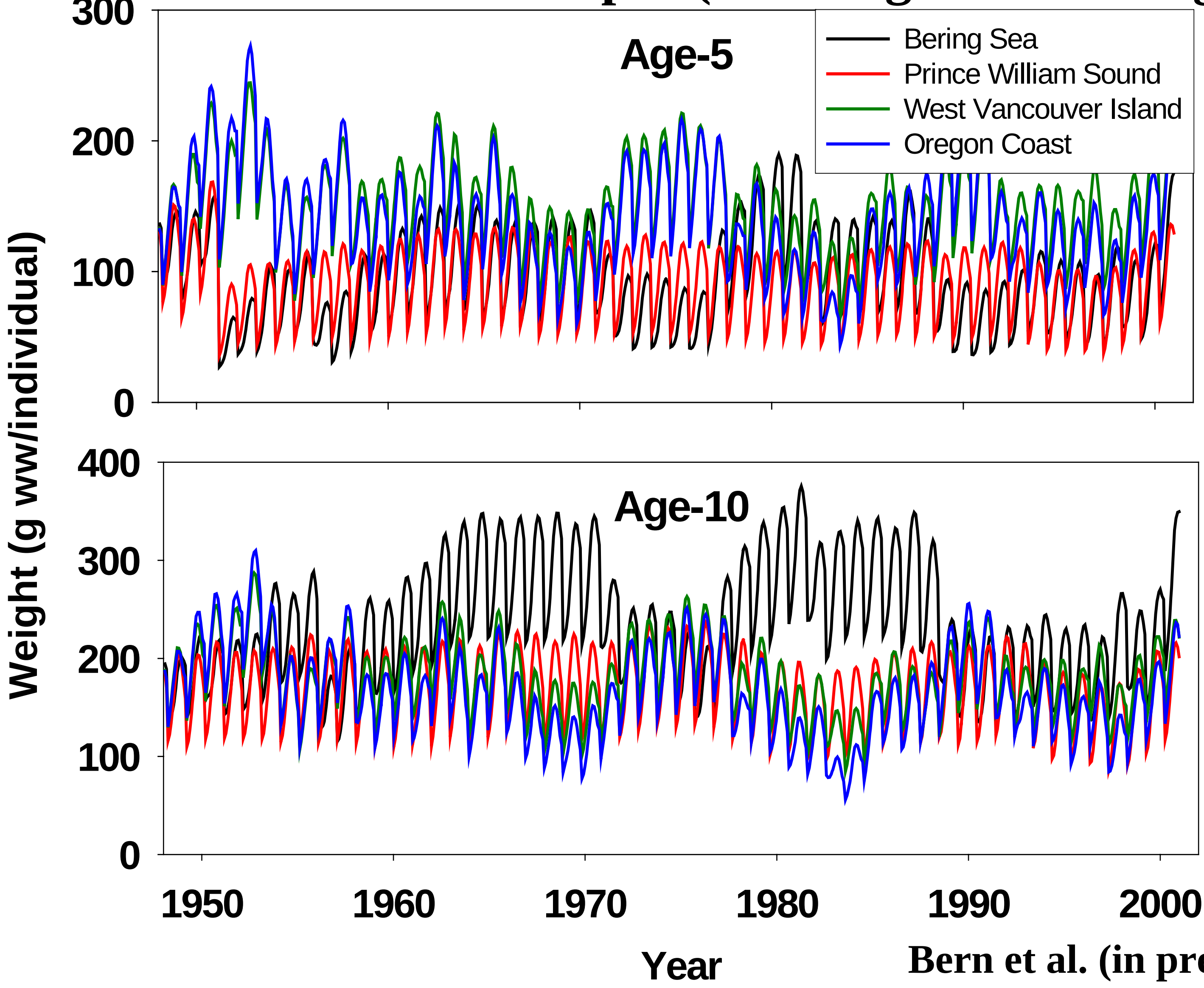
Regional comparison

3D-NEMURO output (zooplankton)



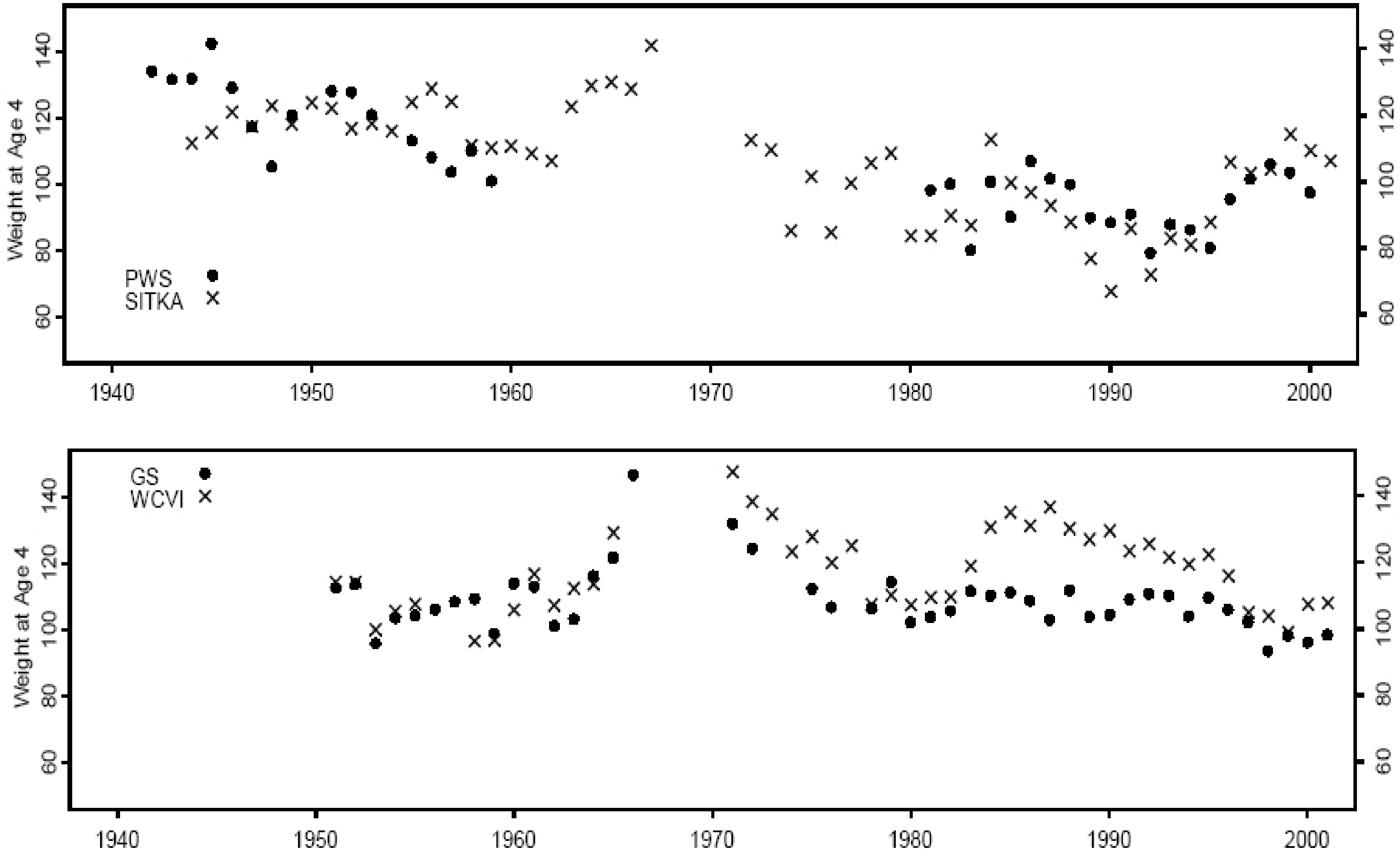
Regional comparison

NEMURO.FISH output (wet weight of Herring)



Bern et al. (in prep.)

Example of Field data



Schweigert, Funk, Oda, and Moore. 2002. Herring size-at-age variation in the North Pacific. PICES Scientific Report 20, pp 47-57.

Life History of Pacific Saury with Oceanographic Features

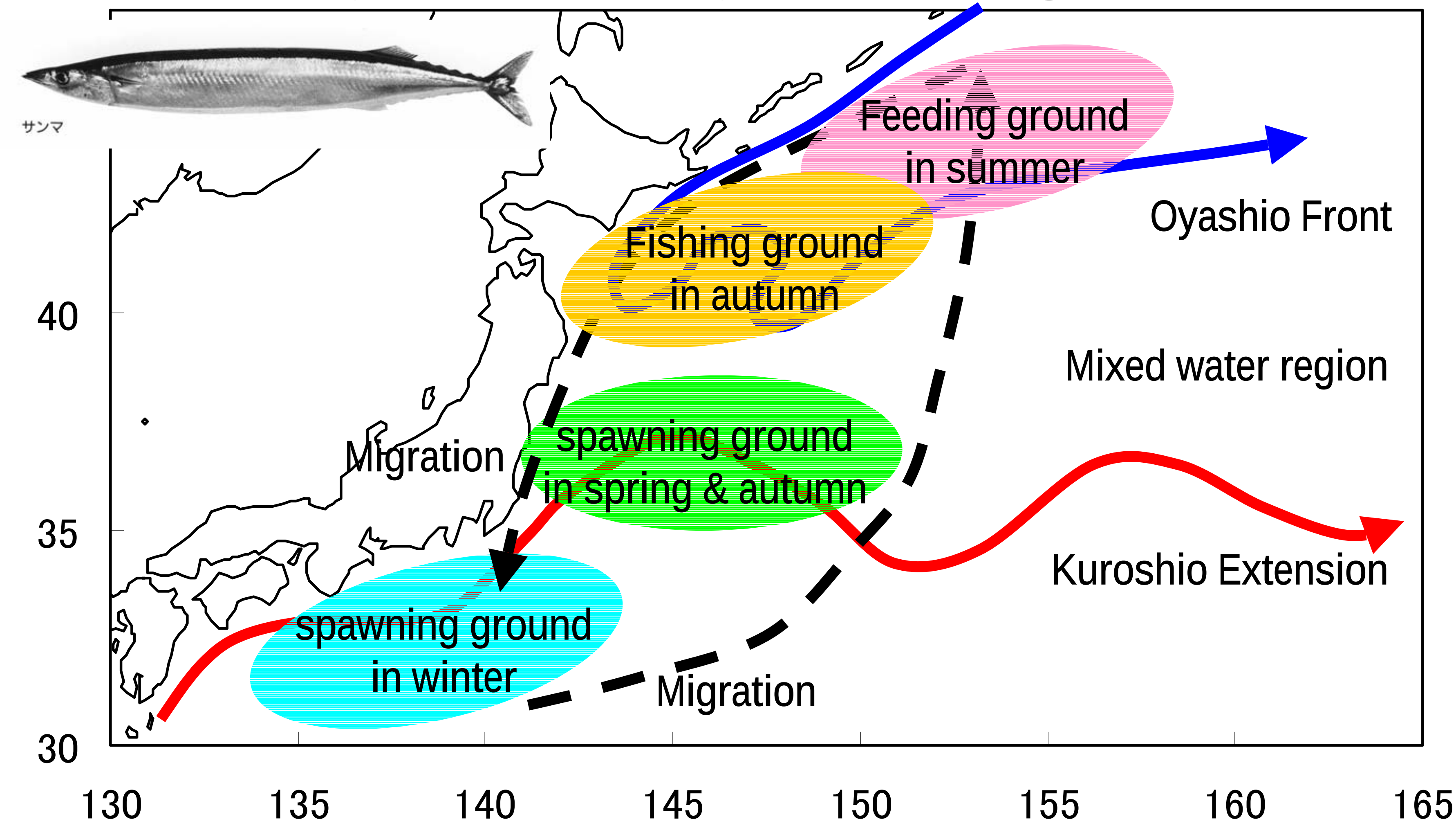


Fig.1 Schematic picture of life history of Pacific saury (*Cololabis Saira*). Spawning of the saury starts in September and continues until June, shifting the location between the mixed water region and Kuroshio region. The main spawning season is winter. The juveniles are advected to the Kuroshio extension region and migrate to the Oyashio region through the mixed region for feeding. After sufficient feeding they migrate back to the Kuroshio region for spawning. On the back migration, fishing ground is made around Japanese coastal zone.

Ito et al. (2002)

3-box version

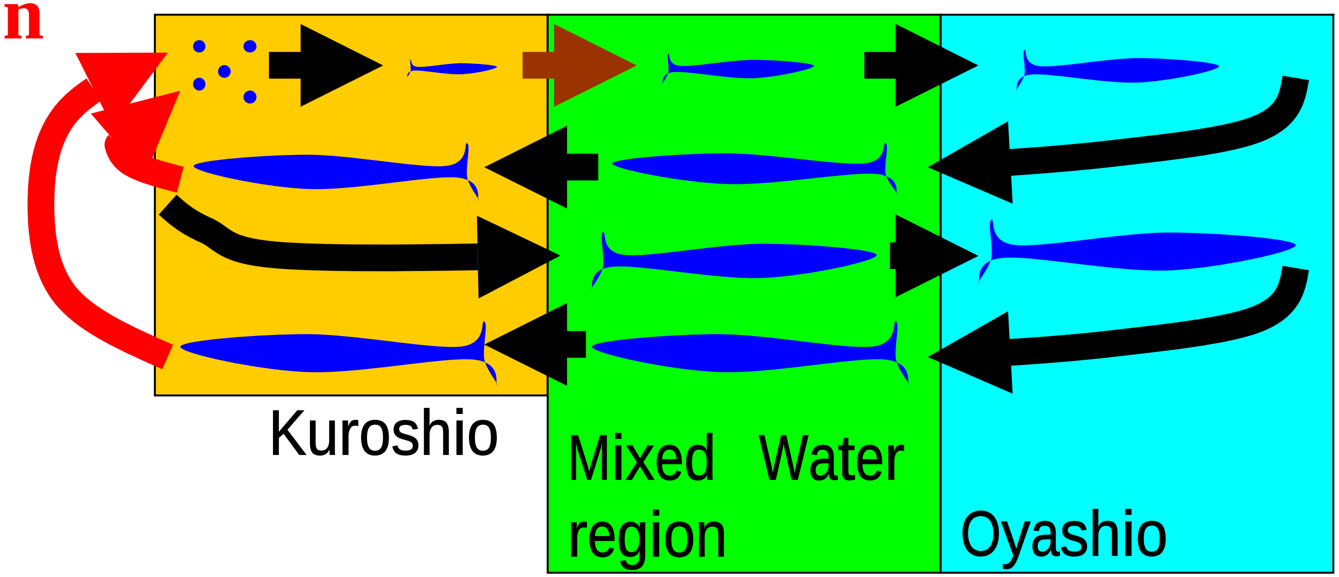
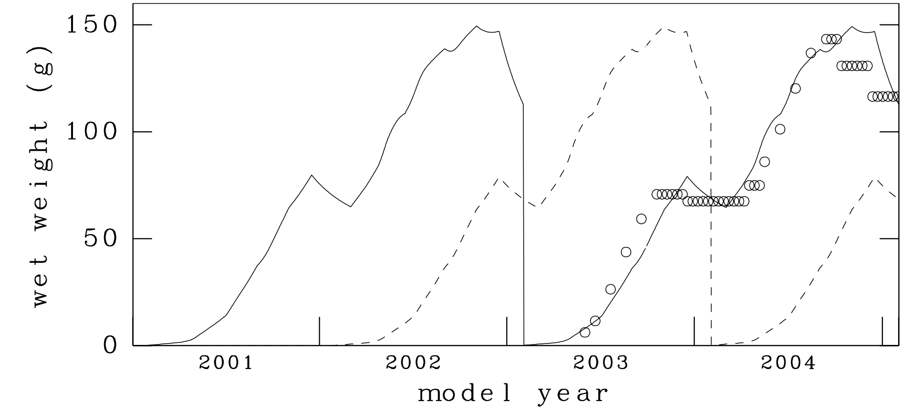


Table 2. Life stages of Pacific saury in the saruy bioenergetics model

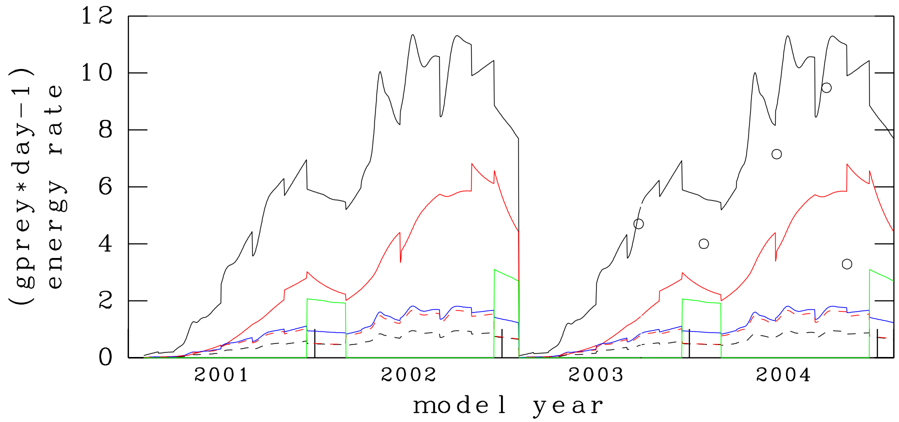
Stage	period	model-day	region
larvae	Feb.01-Feb.28	1- 28	Kuroshio
juvenile & young	Mar.01-Jun.30	29-150	mixed region
small	Jul.01-Oct.31	151-273	Oyashio
adult	Nov.01-Dec.14	274-317	mixed region
adult matured	Dec.15-Feb.28	318-393	Kuroshio
adult	Mar.01-Jun.14	394-499	mixed region
adult	Jun.15-Oct.31	500-638	Oyashio
adult	Nov.01-Dec.14	639-682	mixed region
adult matured	Dec.15-Jan.31	683-730	Kuroshio

9 life stages

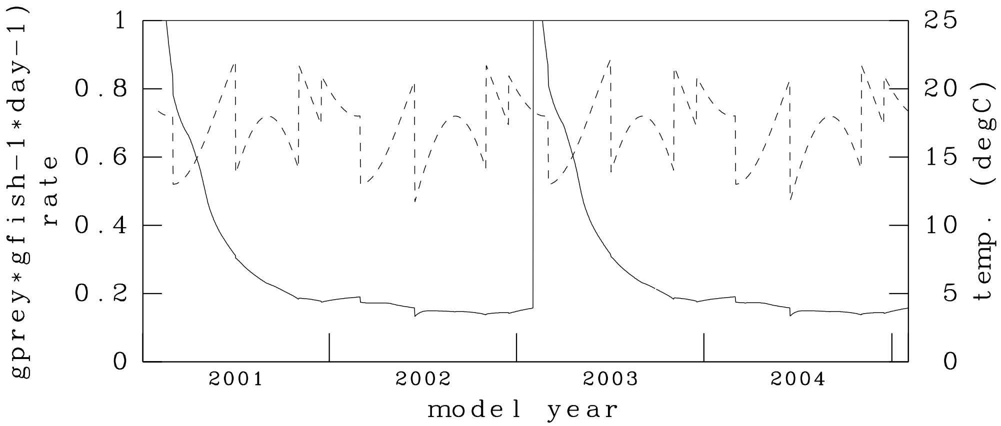
Ito et al. (2004)



Simulated wet weight & observed growth (Kurita et al.)



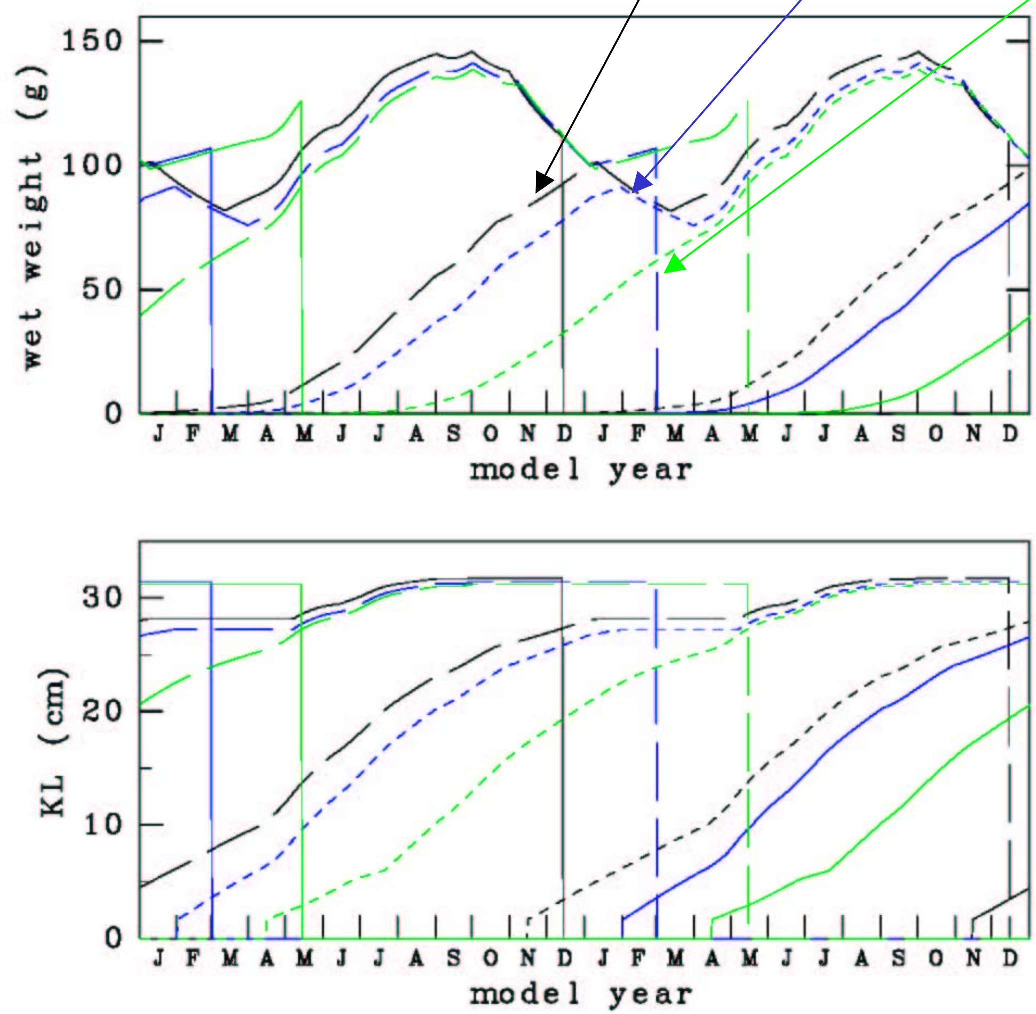
Terms of the bioenergetics equation
- **black solid: consumption**
- **red solid: respiration**
- **blue solid: egestion**
- **black dotted: excretion**
- **red dotted: specific dynamic action**
- **green: egg production**
- **open circle: observed consumption by Kurita (2002)**



maximum consumption rate multiplied by temperature function (solid line) & water temperature (dotted line).

Ito et al. (2004)

comparison: autumn, winter, spring spawned saury



Pacific saury spawns from autumn to spring.

growth rate of juvenile :
winter > spring > autumn

time span for becoming 30 cm adult saury:
spring < winter < autumn

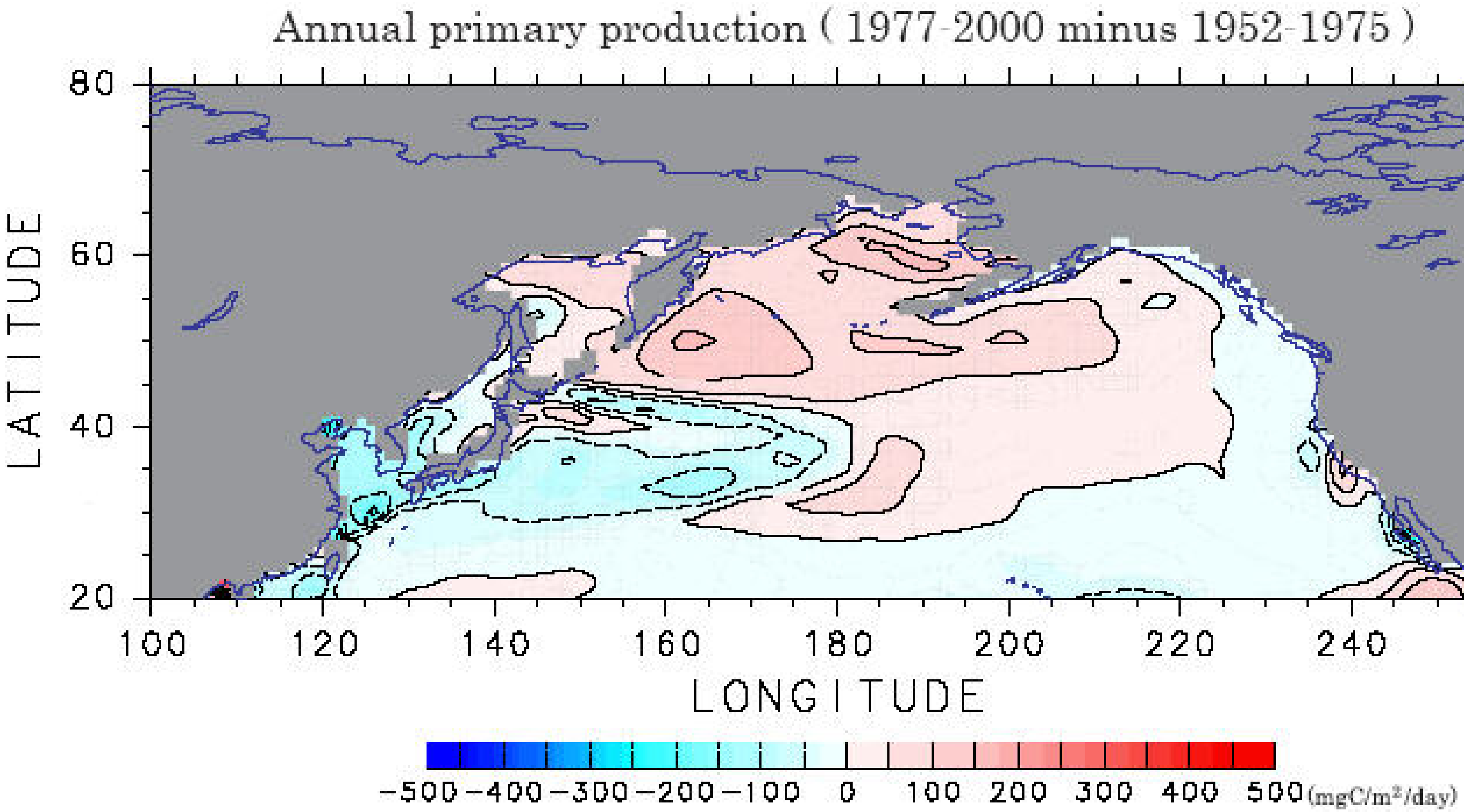
Autumn & winter cohort spawn at first & second year. Spring cohort only spawns at second year.

Similar to observation

Mukai et al. (in prep.)

Extension to 3D Global NEMURO

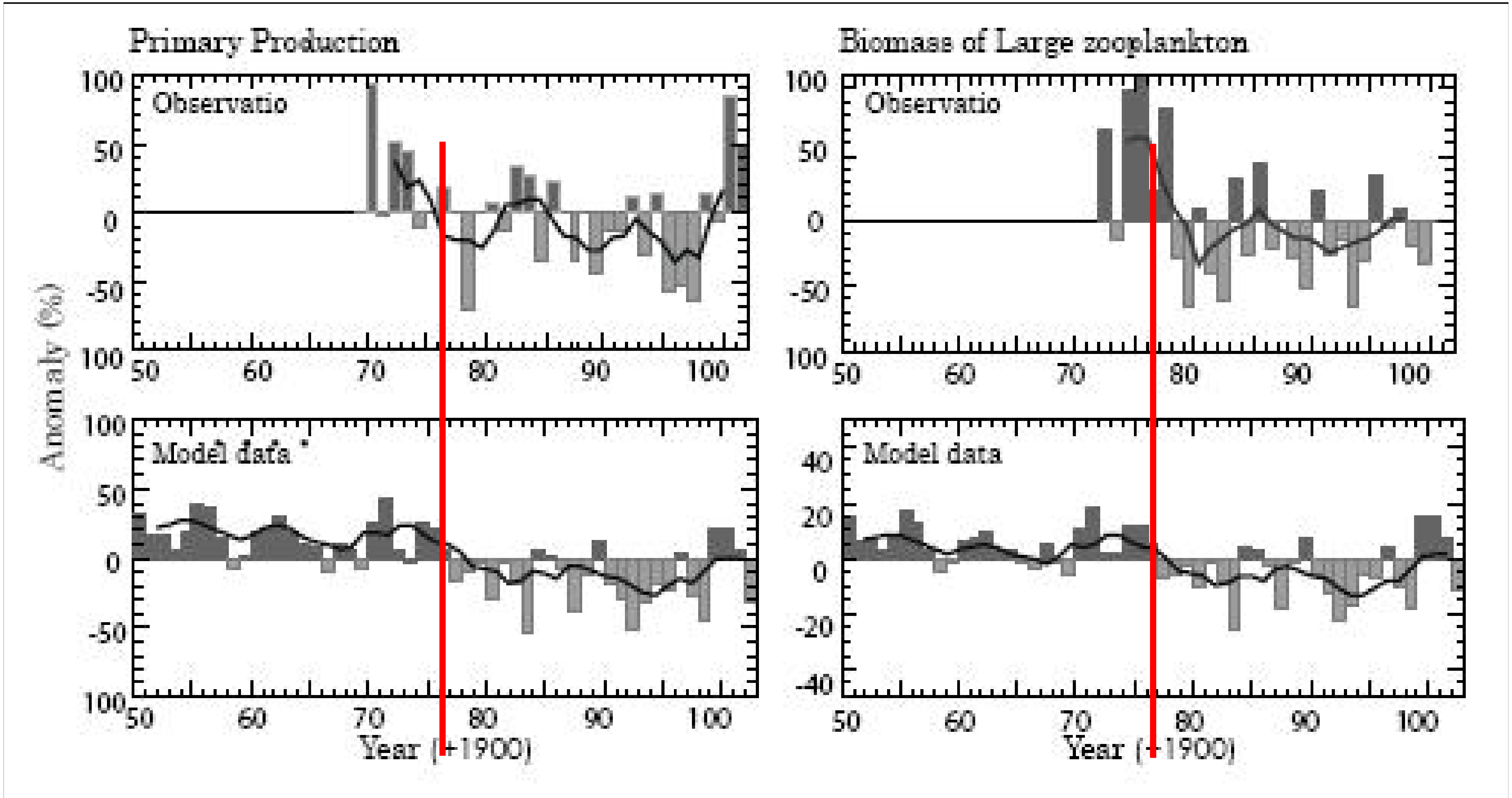
Primary production relative to Regime Shift



Aita-Noguchi et al. (submitted)

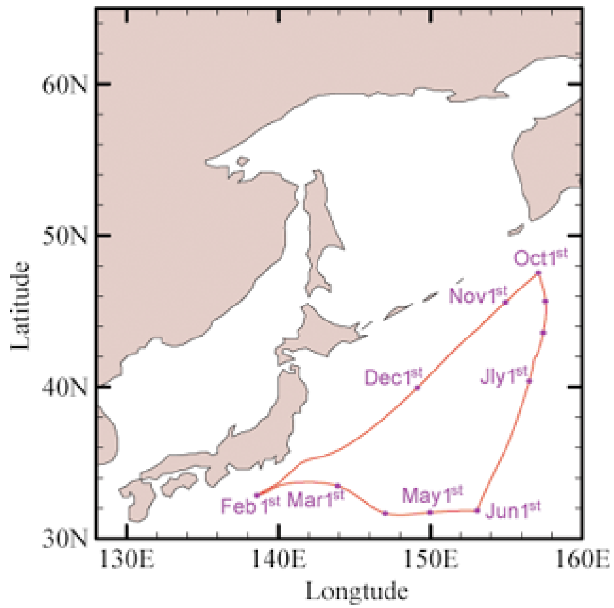
Extension to 3D Global NEMURO

Primary production & zooplankton response to Regime Shift



Aita-Noguchi et al. (submitted)

Fish migration with 3D-NEMURO



Saury track by Lagragian model

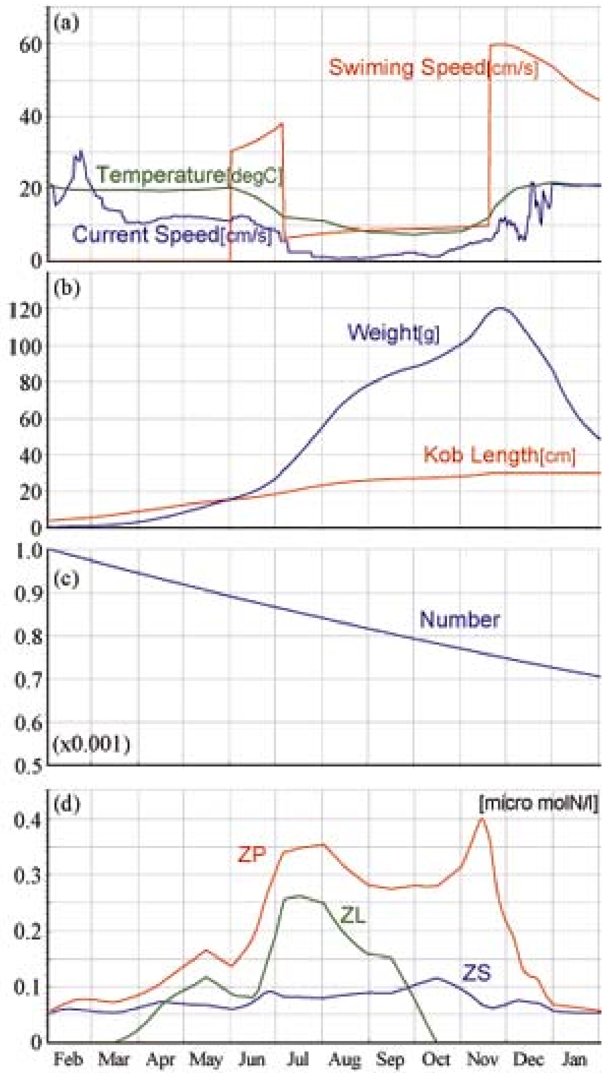
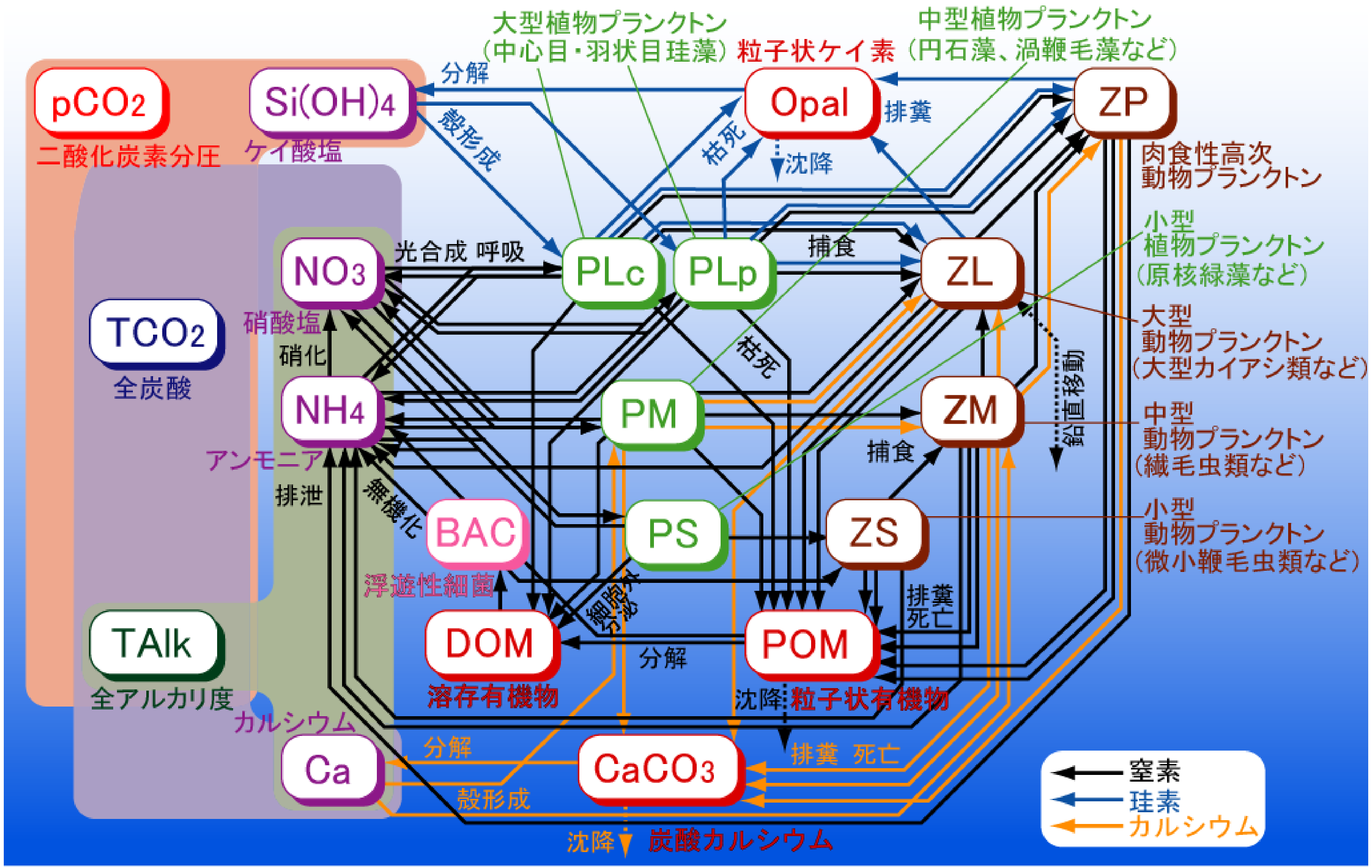


Fig. 2
(a)swimming speed, current speed, temperature where the saury exists,
(b), body length and body weight,
(c) number of saury,
(d) concentration of zooplankton of the point where the saury exists which is given from the results files calculated by 3-D NEMURO model.

Courtesy of Dr. Yamanaka

eNEMURO

From Subtropical to Subarctic



Future Perspective

1. Regional comparison

PESTed NEMURO+NEMURO.FISH is useful

apply NEMURO.FISH to other species

sardine, anchovy, mackerel, squid, …..

2. Regime Shift

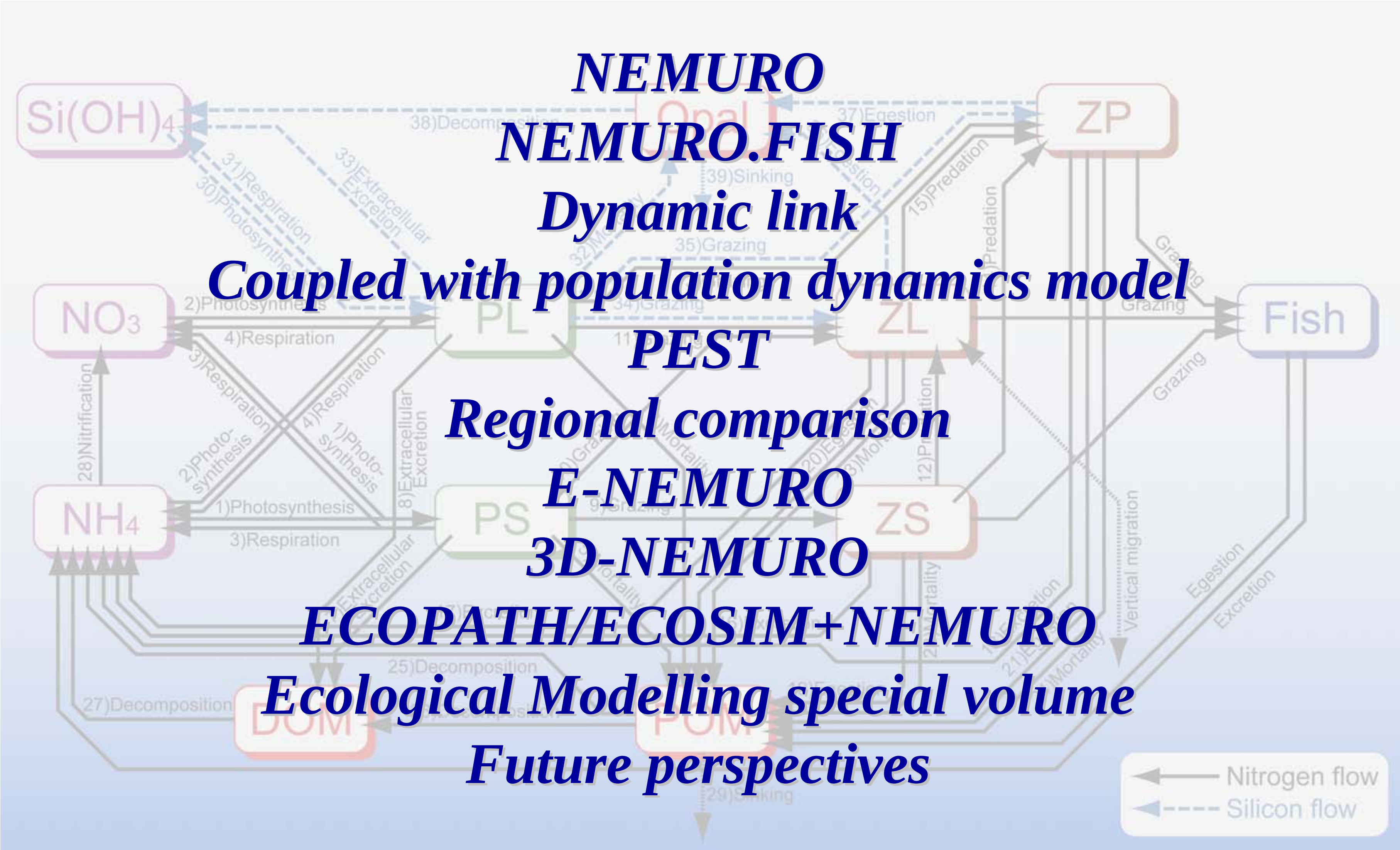
PESTed NEMURO+ NEMURO.FISH

3D-eNEMURO + NEMURO.FISH

3. Global Change

3D-eNEMURO + NEMURO.FISH

History of MODEL Task Team



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ECOPATH/ECOSIM+NEMURO

Ecological Modelling special volume

Future perspectives

Funding & Support

1. **Heiwa-Nakajima Foundation of Japan**
2. **Japan International Science and Technology Exchange Center**
3. **City of Nemuro Japan**
4. **Fisheries Research Agency (FRA) of Japan**
5. **Asia Pacific Network (APN)**

North Pacific Marine Science Organization (PICES)

Collaboration of

NEMURO&NEMURO.FISH member