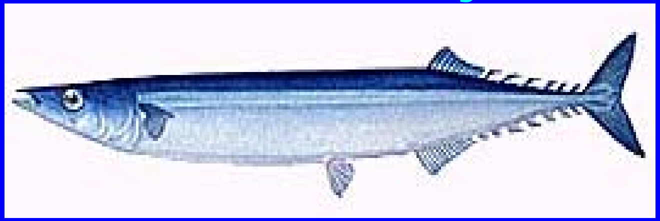
Hi, I am saury!



PICES 12th Annual Meeting
Seoul, Korea Oct. 14, 2003

Impacts of fishing and climate changes on the population dynamics of Pacific saury in the northwestern Pacific: a model approach

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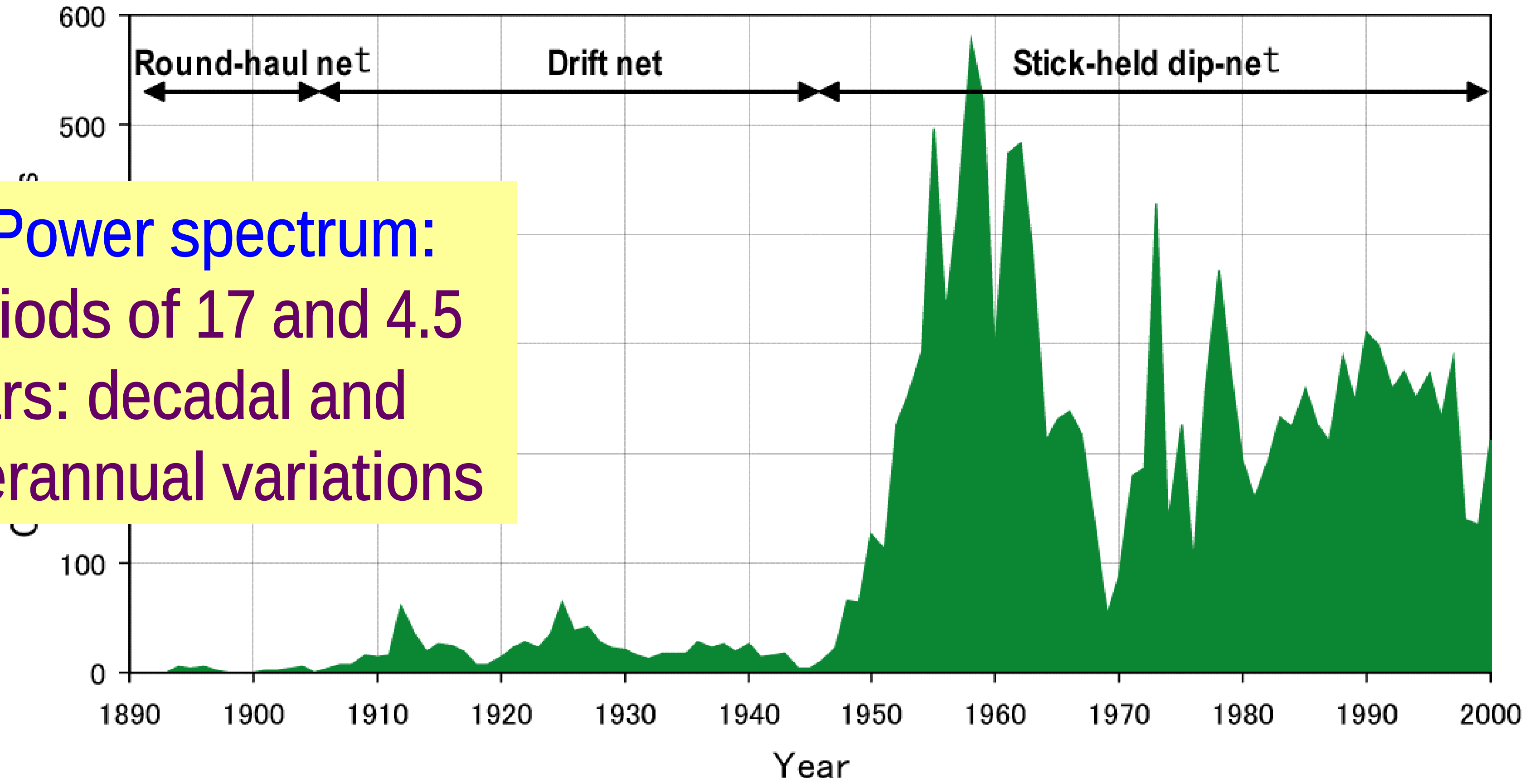
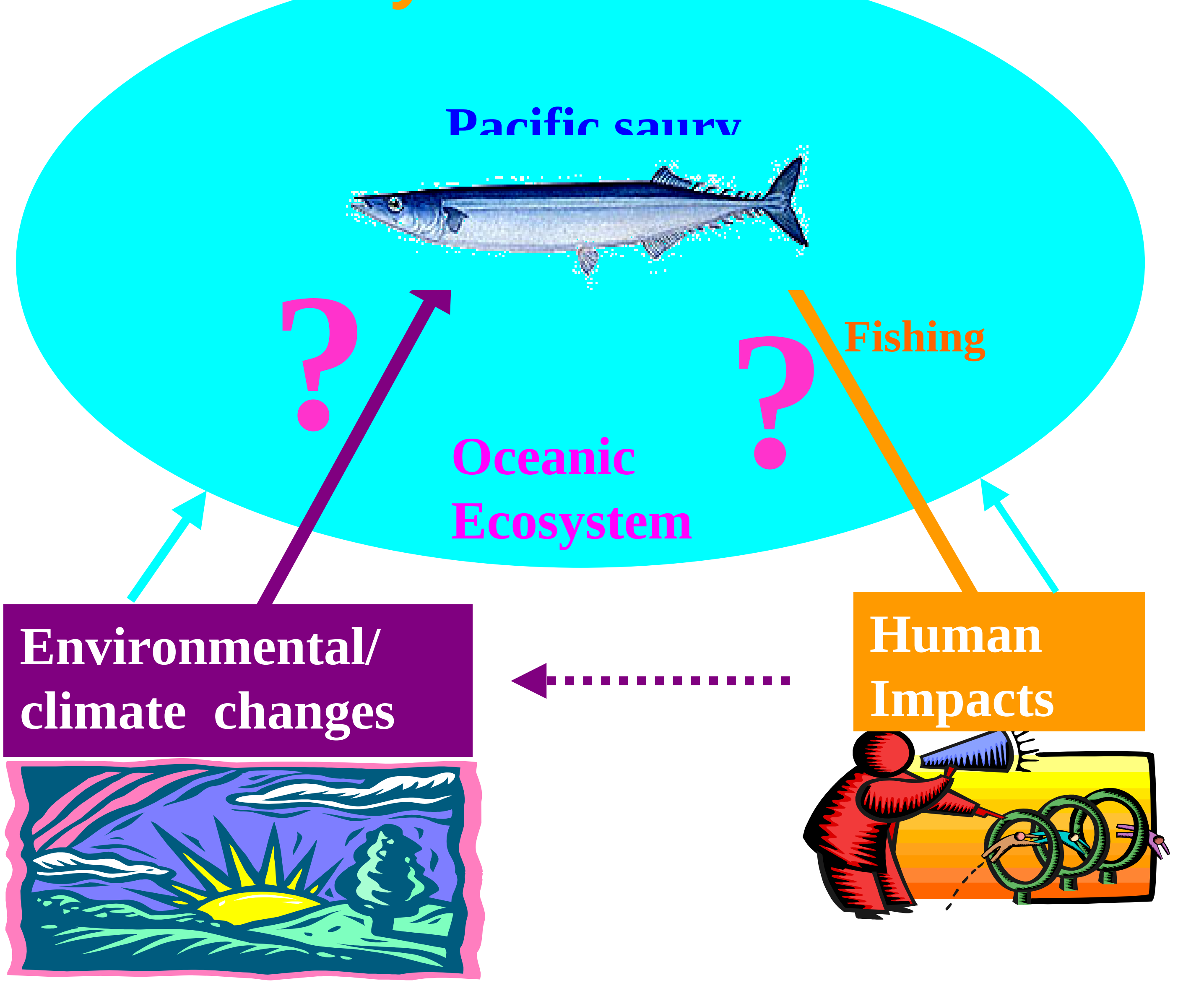
Japanese catch of Pacific saury:1894-2000



Power spectrum:

Periods of 17 and 4.5 years: decadal and interannual variations

Pacific Saury and the Environment



TWO OBJECTIVES

1. To ... reby oc... ed to the p... ury.

Our presentations in the previous PICES meeting,

Details are published in Tian et al. (2002,2003)

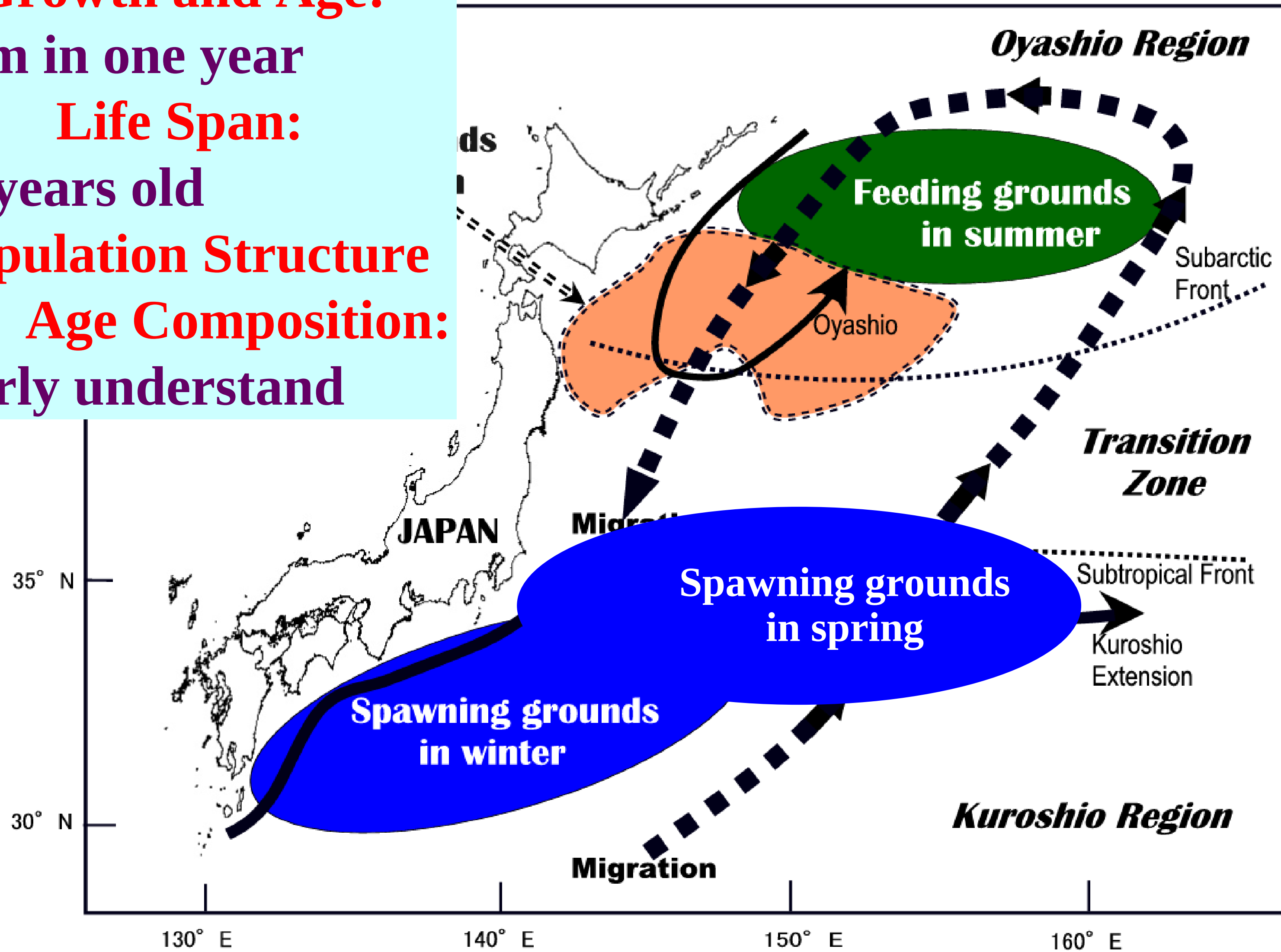
2. To dev... dynamics mo... g the c...

Today's presentation.

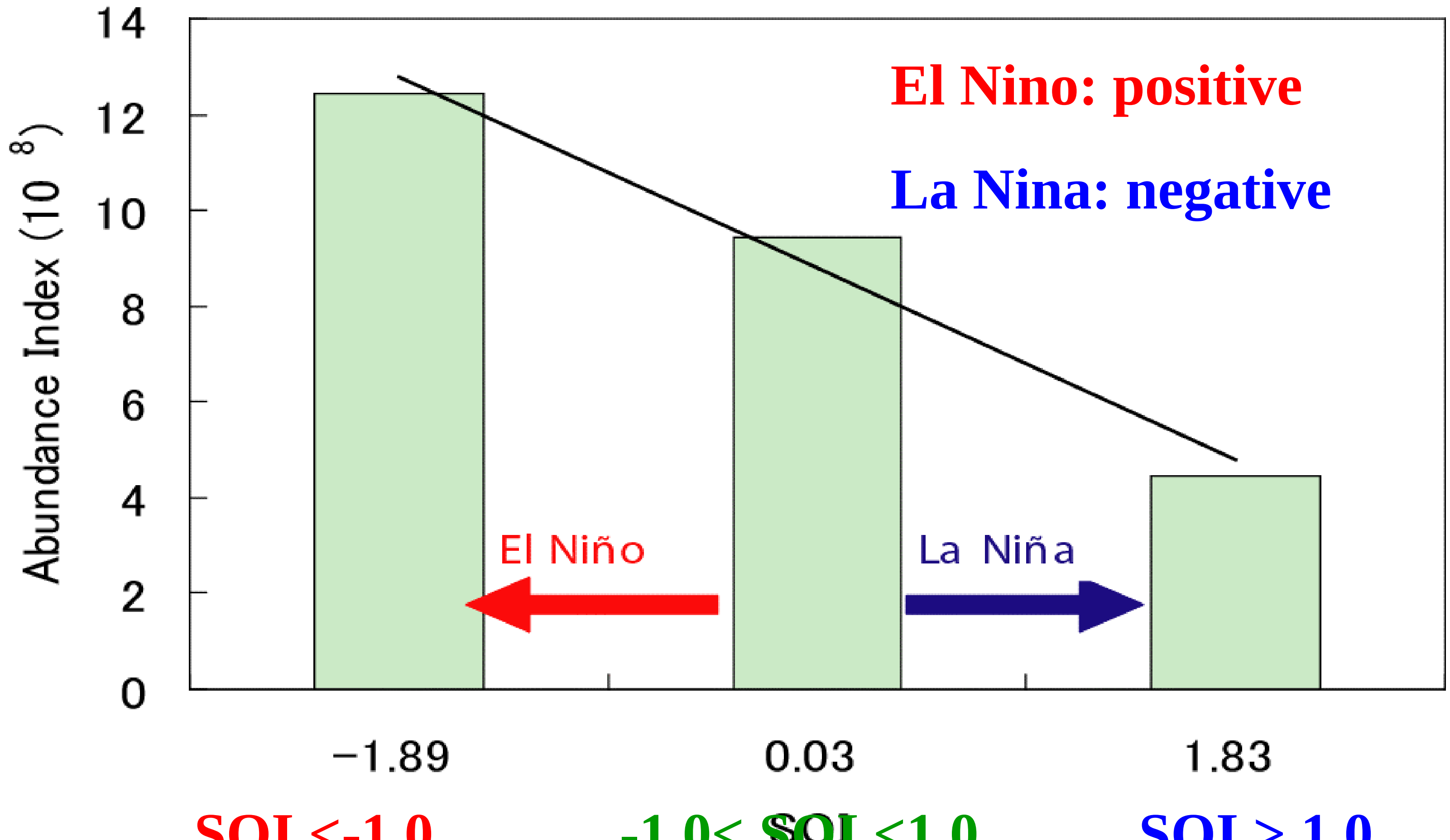
Tian et al. (in press), Fish. Oceanogr.

Life History of Pacific Saury with Oceanographic Features

Growth and Age:
30cm in one year
Life Span:
1-2 years old
Population Structure and Age Composition:
Poorly understand

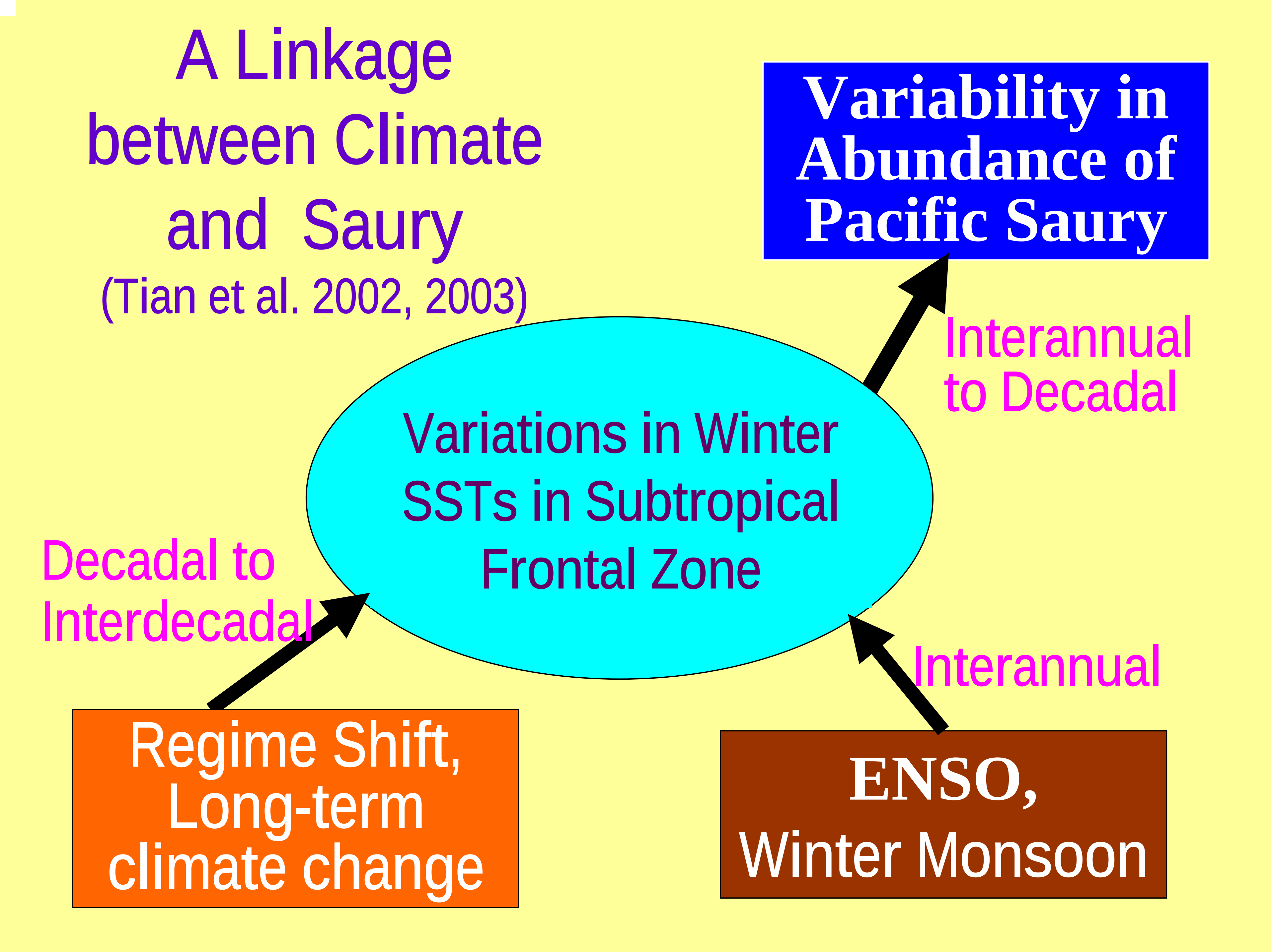


Effects of ENSO on Large Size Saury



SOI <-1.0 | -1.0< SOI <1.0 | SOI > 1.0

15 El Nino Year | 24 Normal Year | 10 La Nina Year

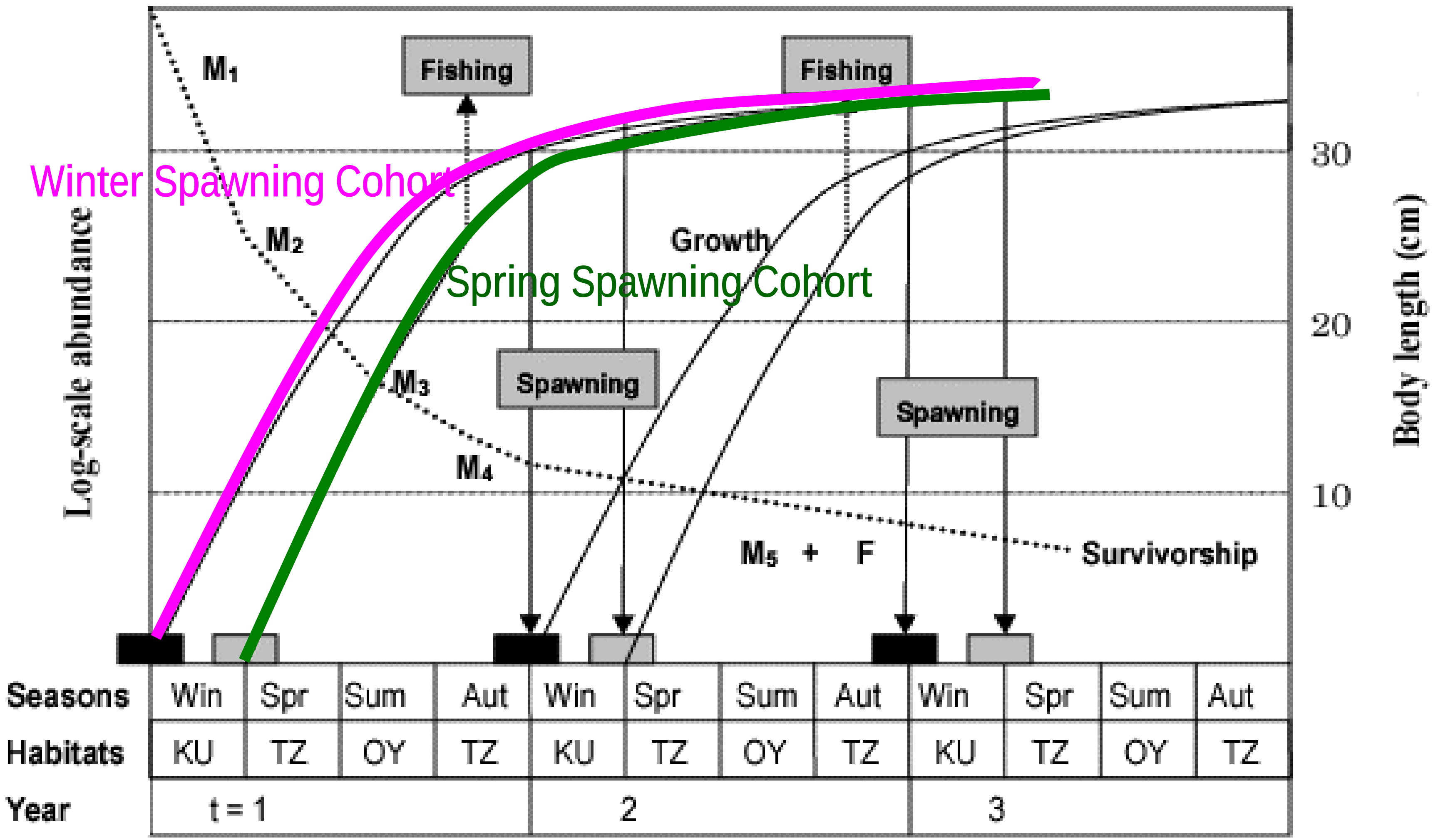

A Linkage between Climate and Saury
(Tian et al. 2002, 2003)
Variability in Abundance of Pacific Saury
Interannual to Decadal
Variations in Winter SSTs in Subtropical Frontal Zone
Decadal to Interdecadal
Interannual
Regime Shift, Long-term climate change
ENSO, Winter Monsoon

The Points of the Saury Model

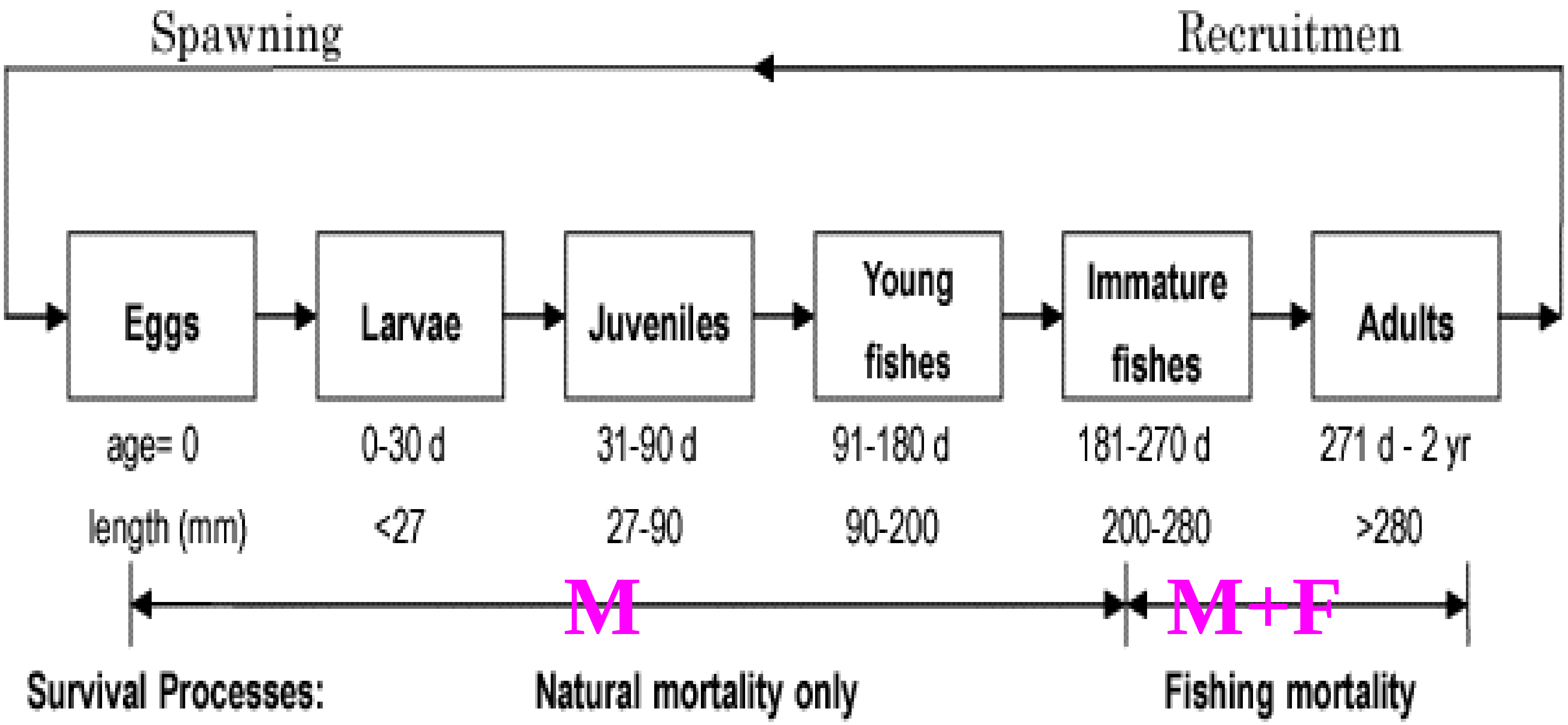
- A number of spawning cohorts (SC) : winter SC plays an important role in recruitment
- Large-scale migration pattern from Kuroshio to Oyashio
- Winter SSTs in the Kuroshio (linking with ENSO) has a large impact on saury。
- Impacts of the environment are different at different life stage.

Life Cycle Model

Life Cycle Model for Saury



Division of Life Stages for Saury



Basic Equations of the Model

Growth $$\frac{d\,L_{t,j}}{dt} = G_{t,j}\,L_{t,j} \qquad (1)$$

$$W_{t,j} = aL_{t,j}^{b}$$

Survival $$\frac{d\,N_{t,i,j}}{dt} = -(M_{t,i,j} + F_{t,i,j})\,N_{t,i,j} \qquad (2)$$

Catch $$\frac{dC_{t,i,j}}{dt} = F_{t,i,j}\,N_{t,i,j} \qquad (3)$$

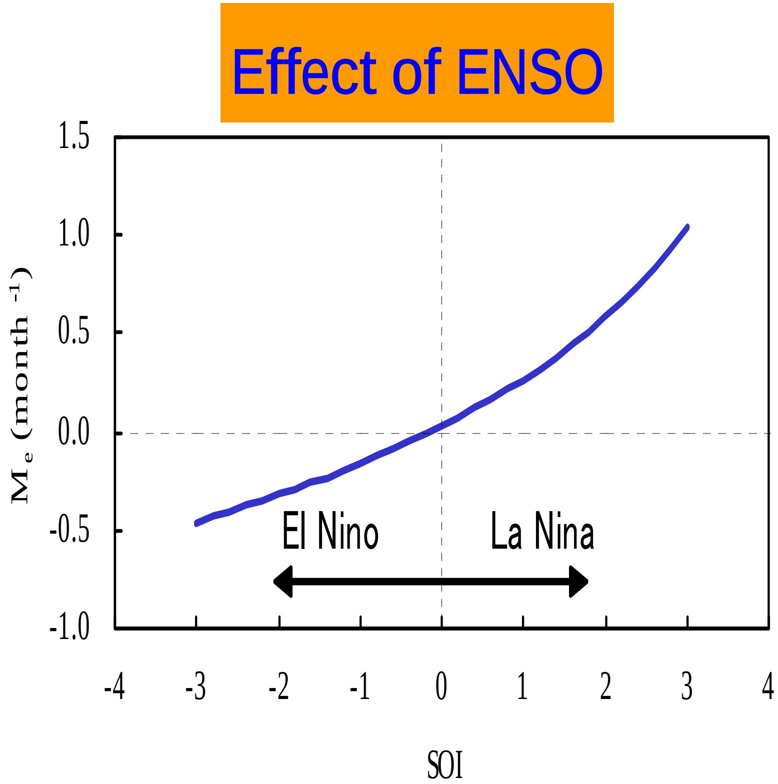
$$P_t = \frac{\sum_{i=1}^{2}\sum_{j=4}^{5}(C_{t,i,j}\,W_{t,j})}{X_t}$$

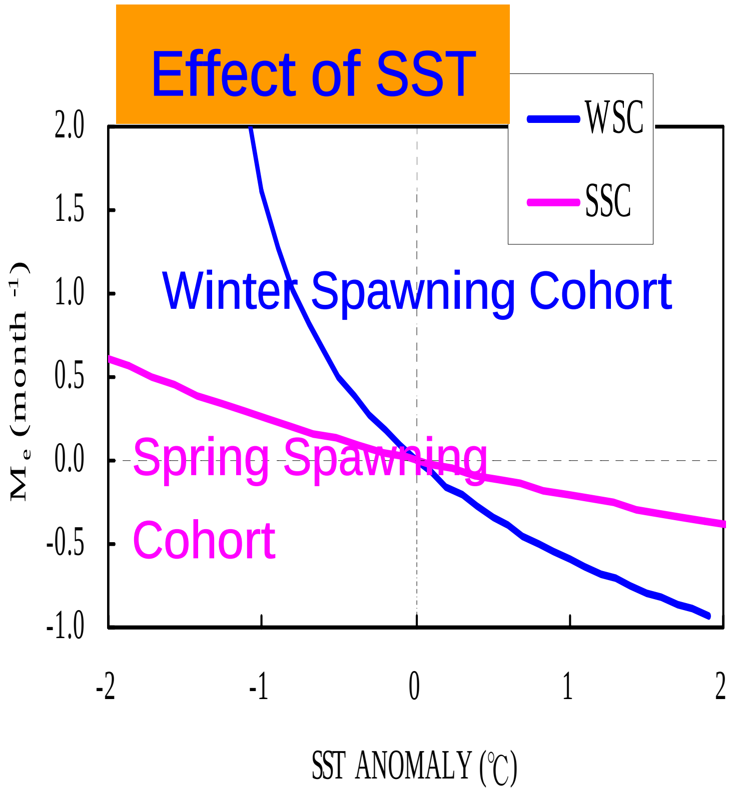
Reproduction $$E_t = \sum_{i=1}^{2}\sum_{j=4}^{5}(N_{t,i,j}\,h_i\,r) \qquad (4)$$

Modeling the effect of environment

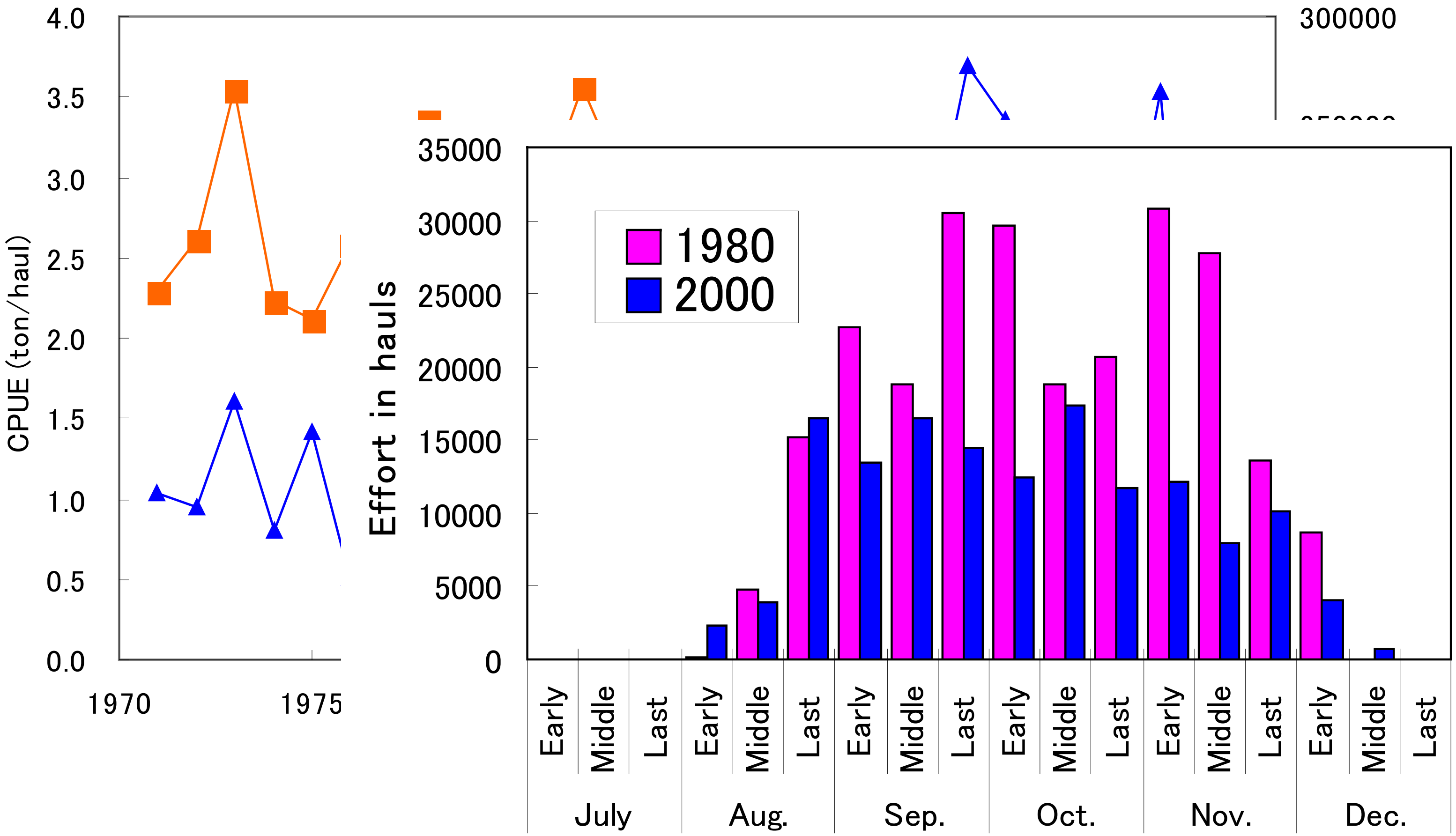
for example: winter SST→juvenile stage $M_t = M_c + M_e$

M_c : constant; $M_e = f(SST)$





Fishing Effort and CPUE (F=qX)

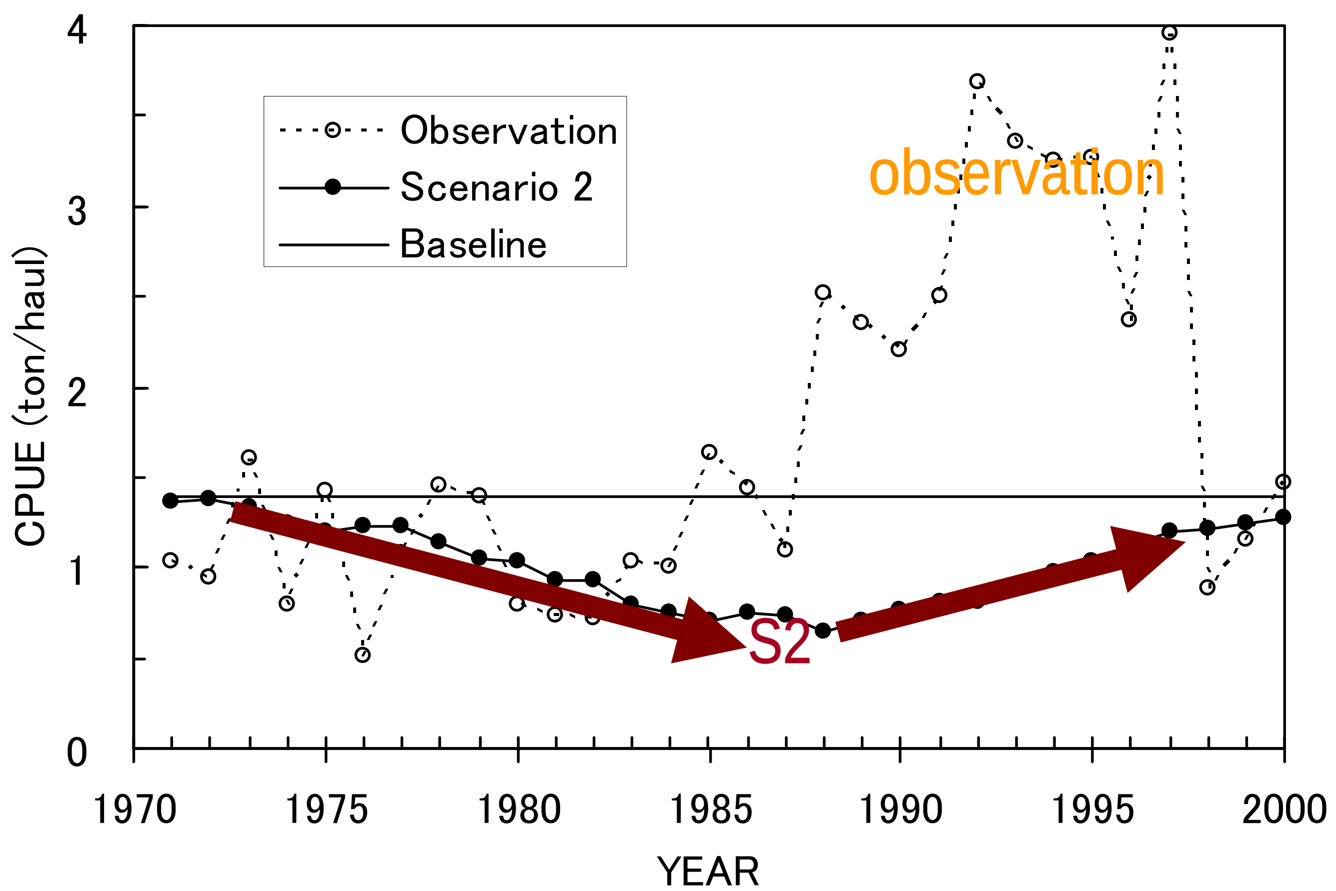


Simulation Scenarios and Conditions

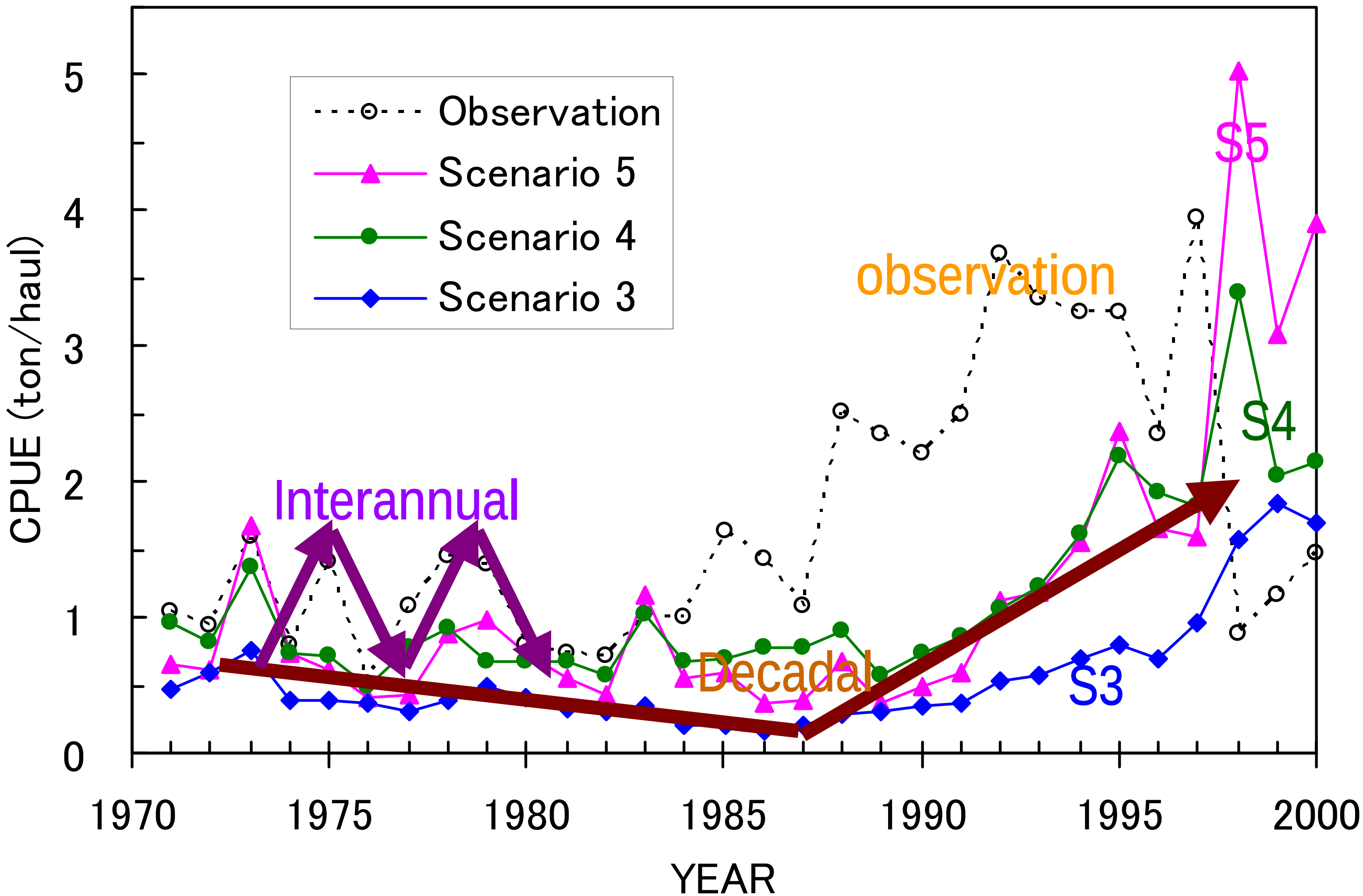
Scenario	Fishing effort	SST-KU for WSC	ENSO events	SST-TZ for SSC	Note
1	-	-	-	-	Baseline simulation
2	+	-	-	-	Effect of Fishing
3	+	+	-	-	Effect of SST on WSC
4	+	-	+	-	Effect of ENSO on WSC
5	+	+	+	+	Effect of SST on SSC
6	-	+	+	+	Effect of environment only

Simulation period **S1-5: 30 years 1971-2000**
S6 : 50 years 1951-2000

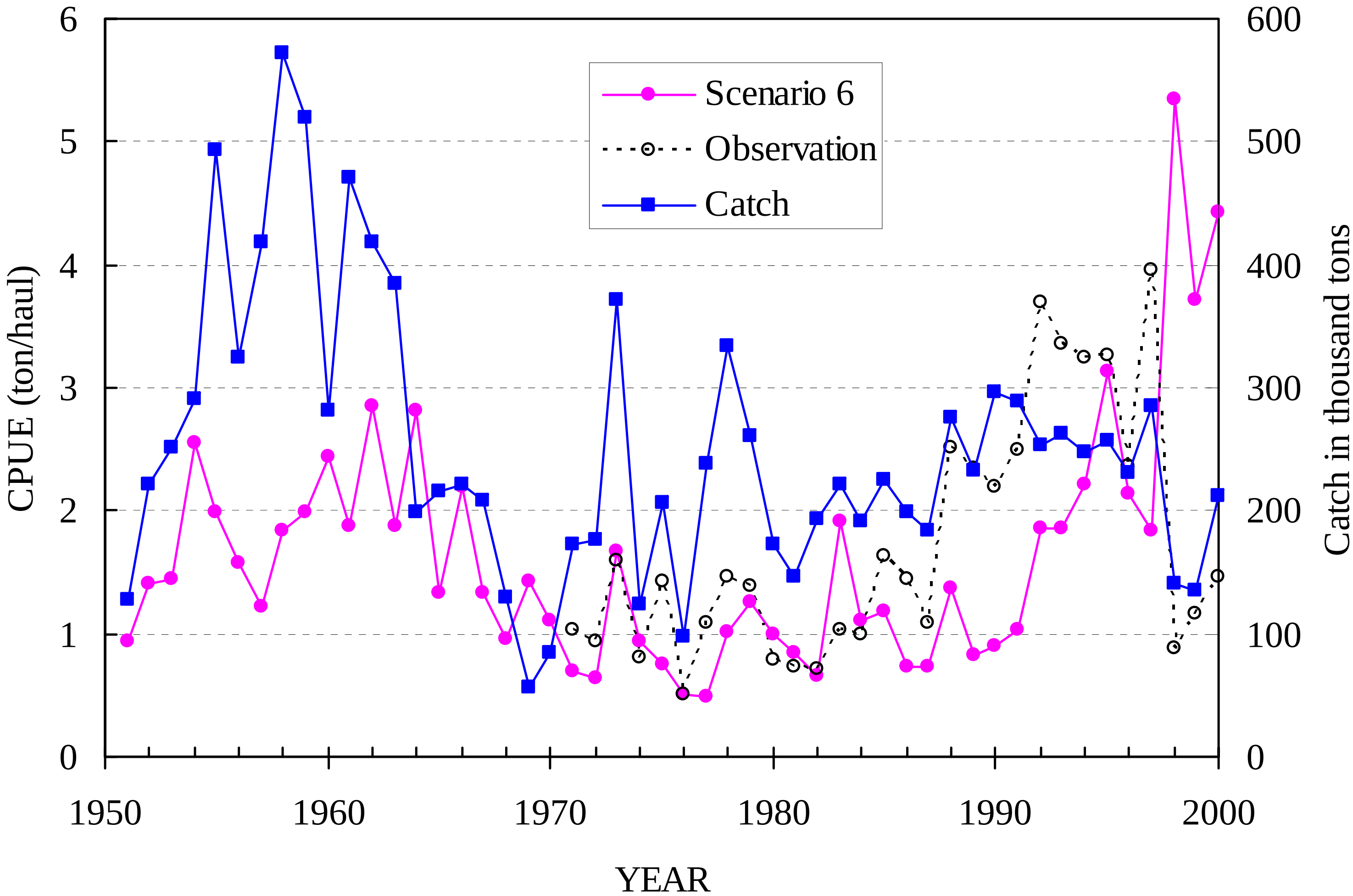
RESULTS: Impact of Fishing



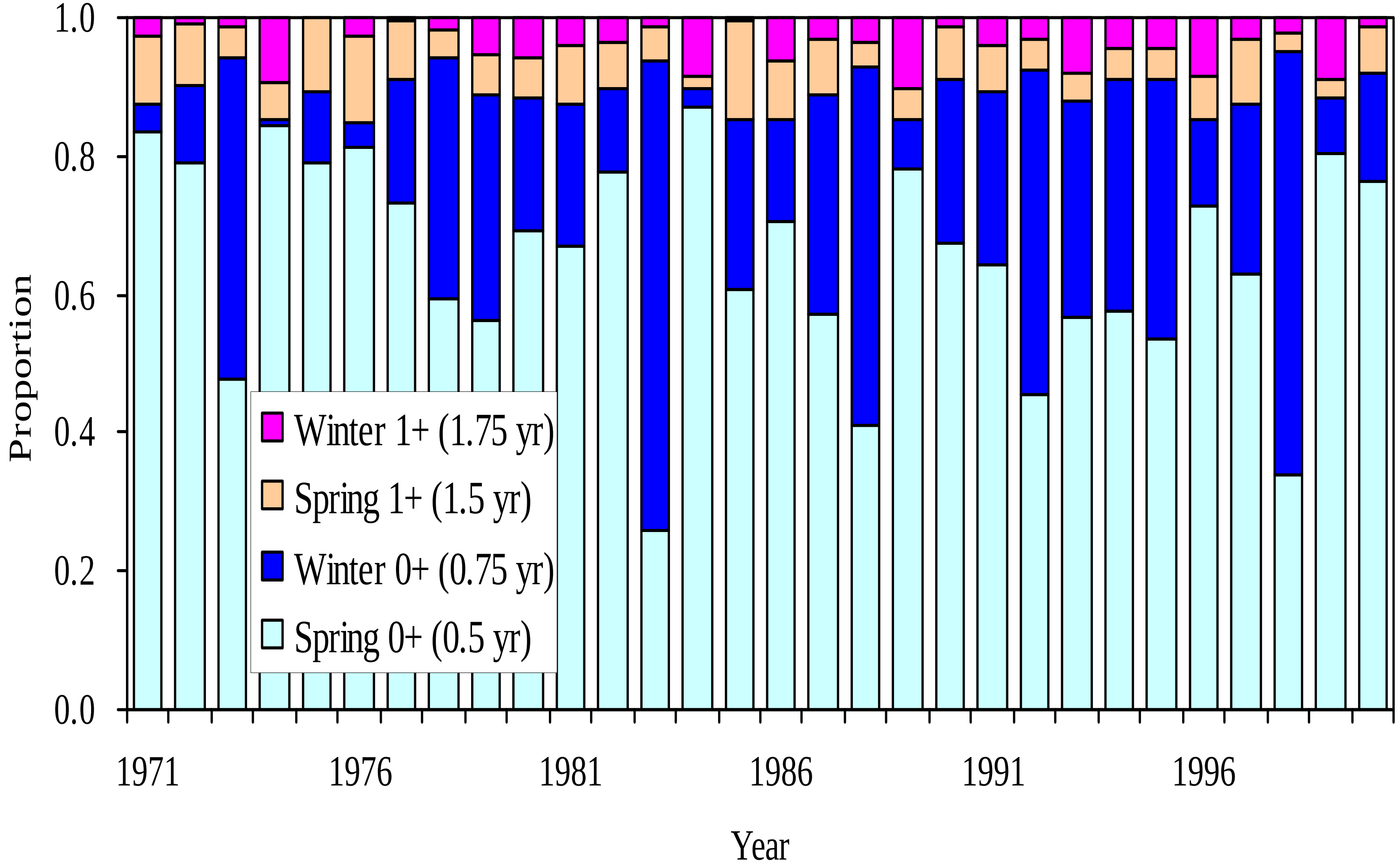
Effects of Fishing and Environment



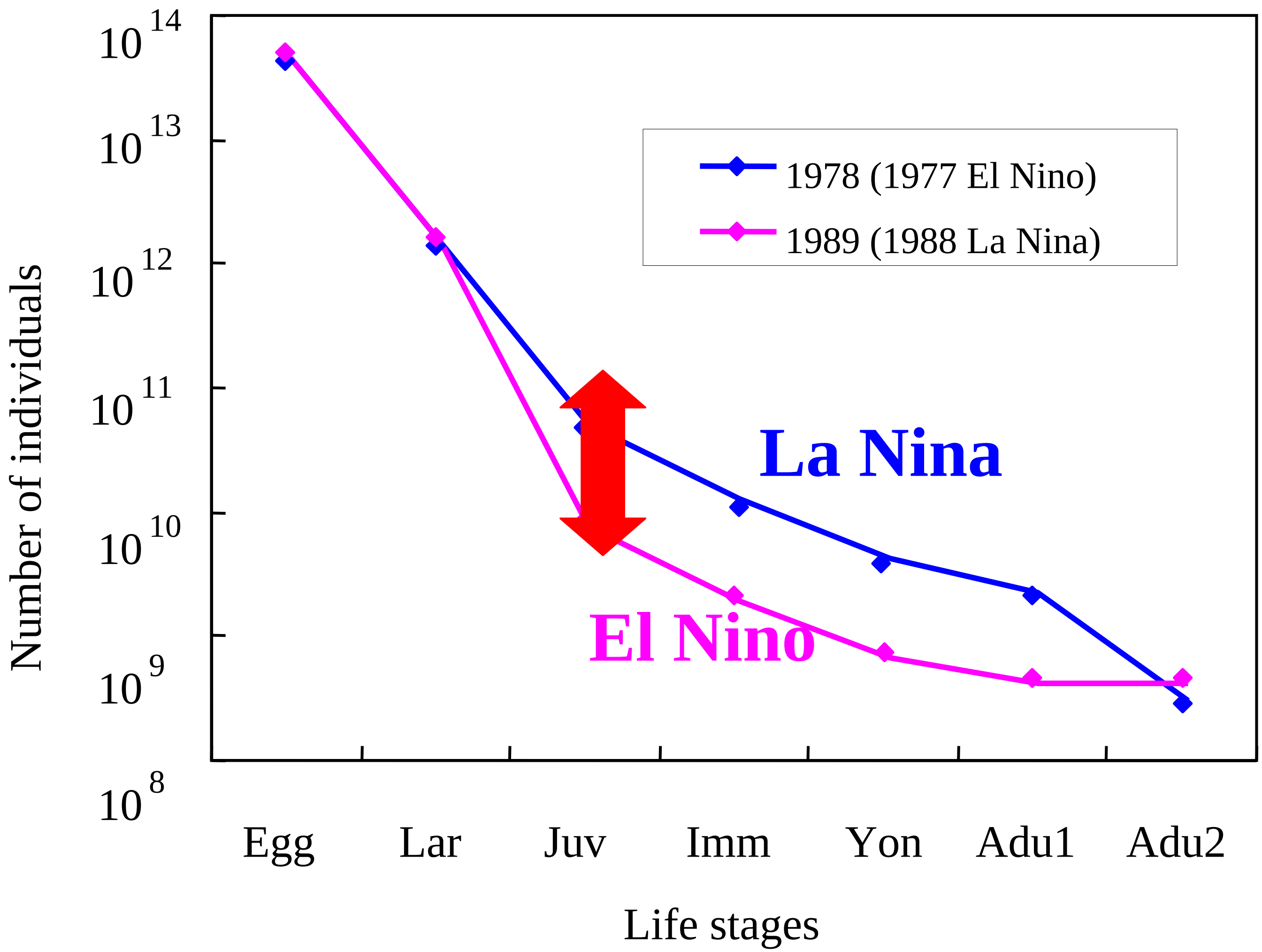
Effect of Environment Only (1951-2000)



Simulated Population Structure of Saury（from Scenario 5）



Effect of ENSO（Scenario 4）



CONCLUSIONS (1)

- A life cycle model incorporating the effect of oceanic-climate changes and life history information is useful to explore the mechanisms of population dynamics for Pacific saury.
- Large variations both in the abundance and size composition do not result from fishing, but are forced by environmental factors.

CONCLUSIONS (2)

- ENSO have marked impacts on the interannual variation in the abundance, while SSTs in the Kuroshio region are largely associated with decadal regime shifts in the abundance of saury.
- The population structure of saury is composed of 4 classes in age composition but of two groups in the size composition, and the populations are dominated by the 0+ classes of the two spawning cohorts.

まとめ その1

- サンマの生活史，環境変動の影響等を考慮したサンマの個体群動態モデルを作成し，サンマの資源変動のメカニズムについてシミュレーションを行った。
- 高い漁獲努力はサンマの資源を減少させる原因の一つであるが，サンマ資源の大きい（年）変動を決定するものではない。
- 黒潮水域の冬季水温および**ENSO**の影響を考慮したモデルでは，サンマ資源の長期変動と大きい年変動を概ねに再現できた。このことは，気候変動が黒潮水域の冬季水温を介して冬発生群の仔稚魚の生残に影響するで，サンマ資源変動に大きい影響を及ぼすことを示唆する。

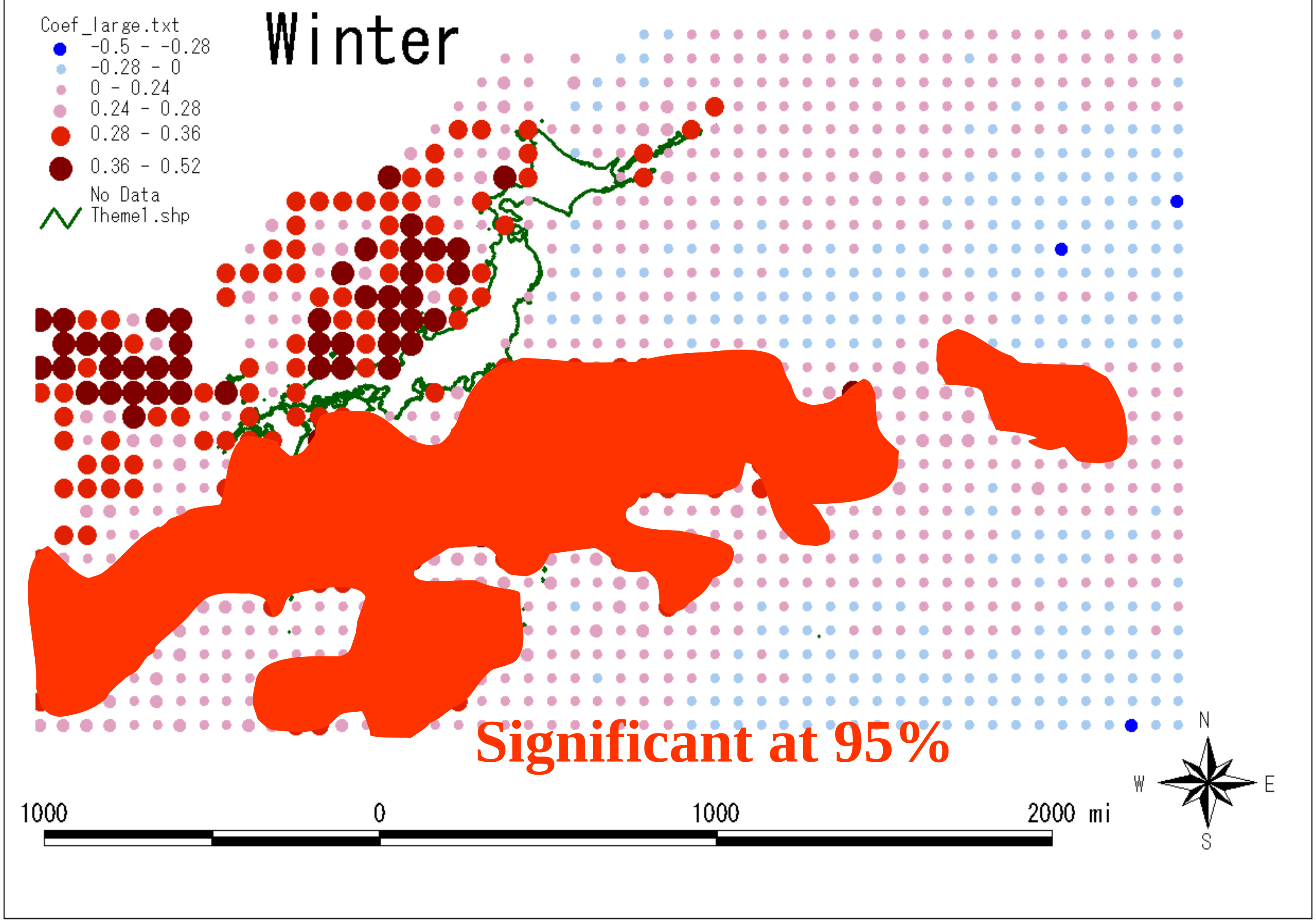
まとめ　その２

- サンマ資源の長期変動傾向は概ね環境変動の影響のみで説明できる。
- SOIを指数として，ENSOの影響を考慮したモデルでは，サンマ資源変動傾向をよく再現できたことは，前年のSOI指数を予測指標として用いることが出来ることを示している。
- サンマの生活史モデルによって，サンマの資源構造および気候変動からサンマの資源変動に至るメカニズムを解明する手がかりを得た。

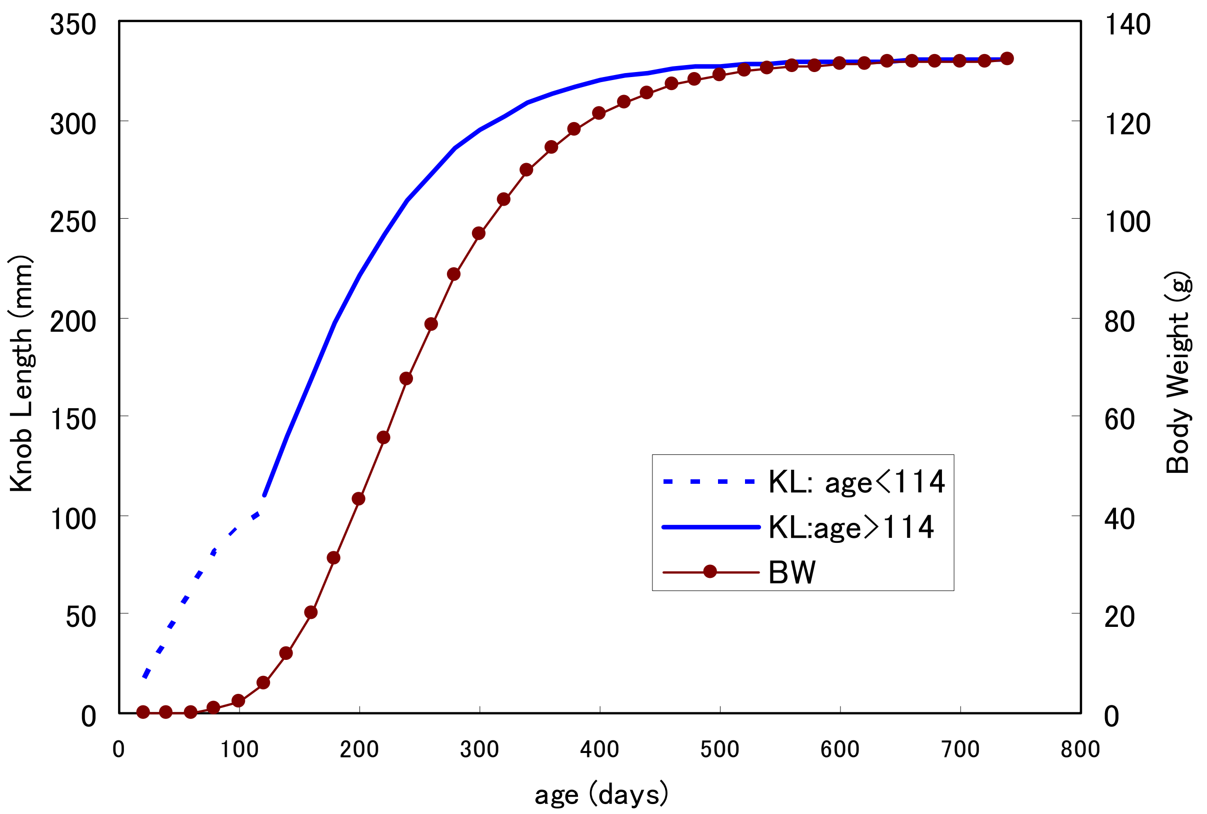
今後の課題

- モデルの改良および他魚種への適用
- 成長過程における環境の影響を考慮していない。
- 餌の変動や高次の捕食者の影響のモデル化
- 将来の予測を行う:**ENSO**が指標として
- モデルの詳細は**VENFISH**特集号として**Fish. Oceanogr.** に掲載される予定

SST and Large Size Saury



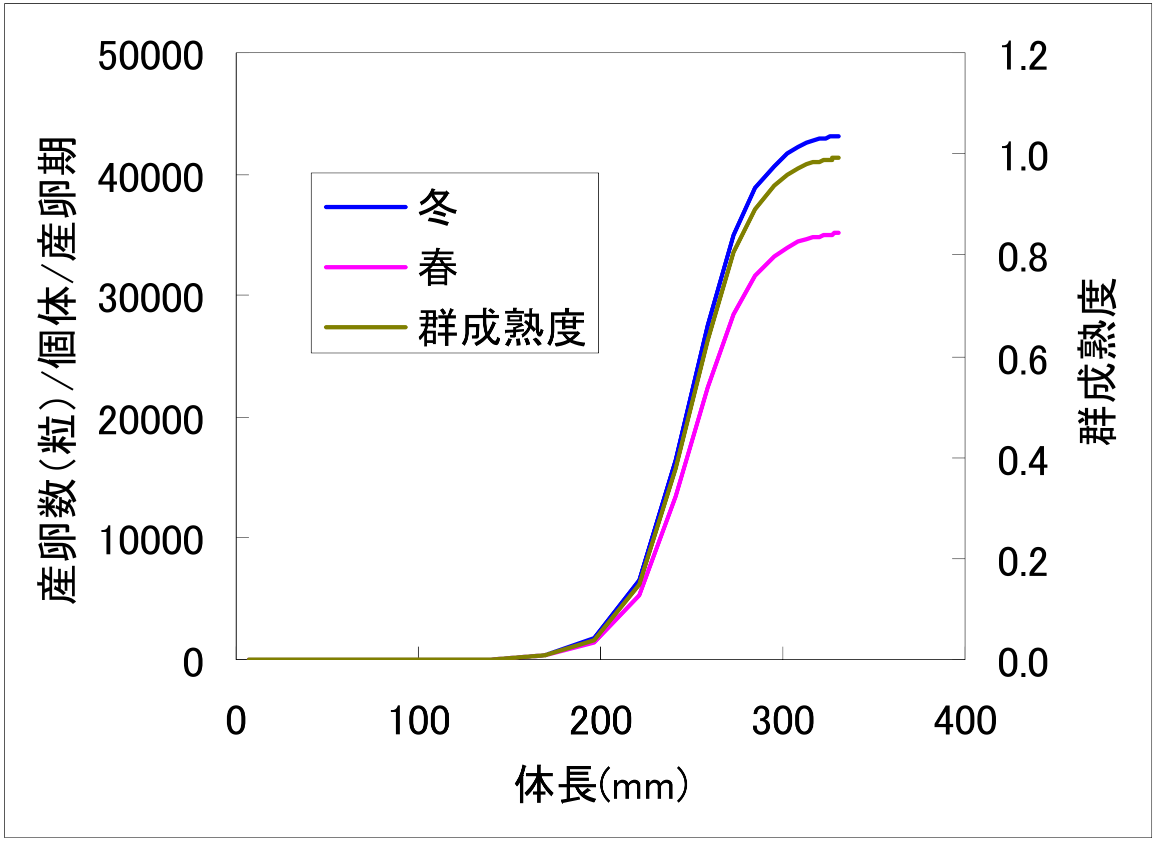
成長式：　Watanabe and Lo (1988)



再生産過程

総産卵量=産卵親魚数・1日1尾産卵数・産卵日数・性比・群成熟度

栗田(2001)を参考に定式化



Large Size Saury and Winter SST