Differences in biological characteristics of walleye pollock (*Gadus chalcogrammus*) off the eastern Korean Peninsula during 1960s–2000s

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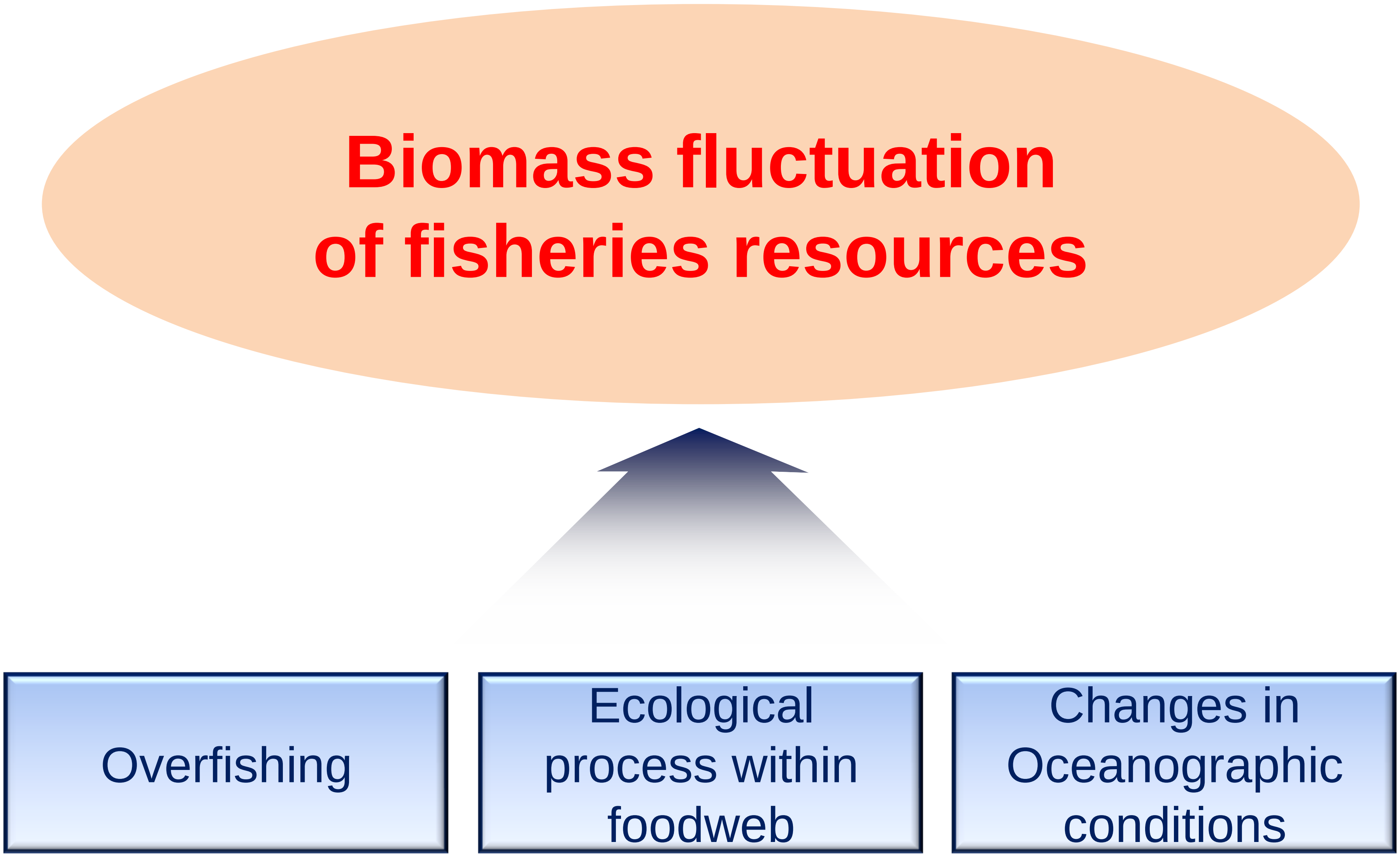
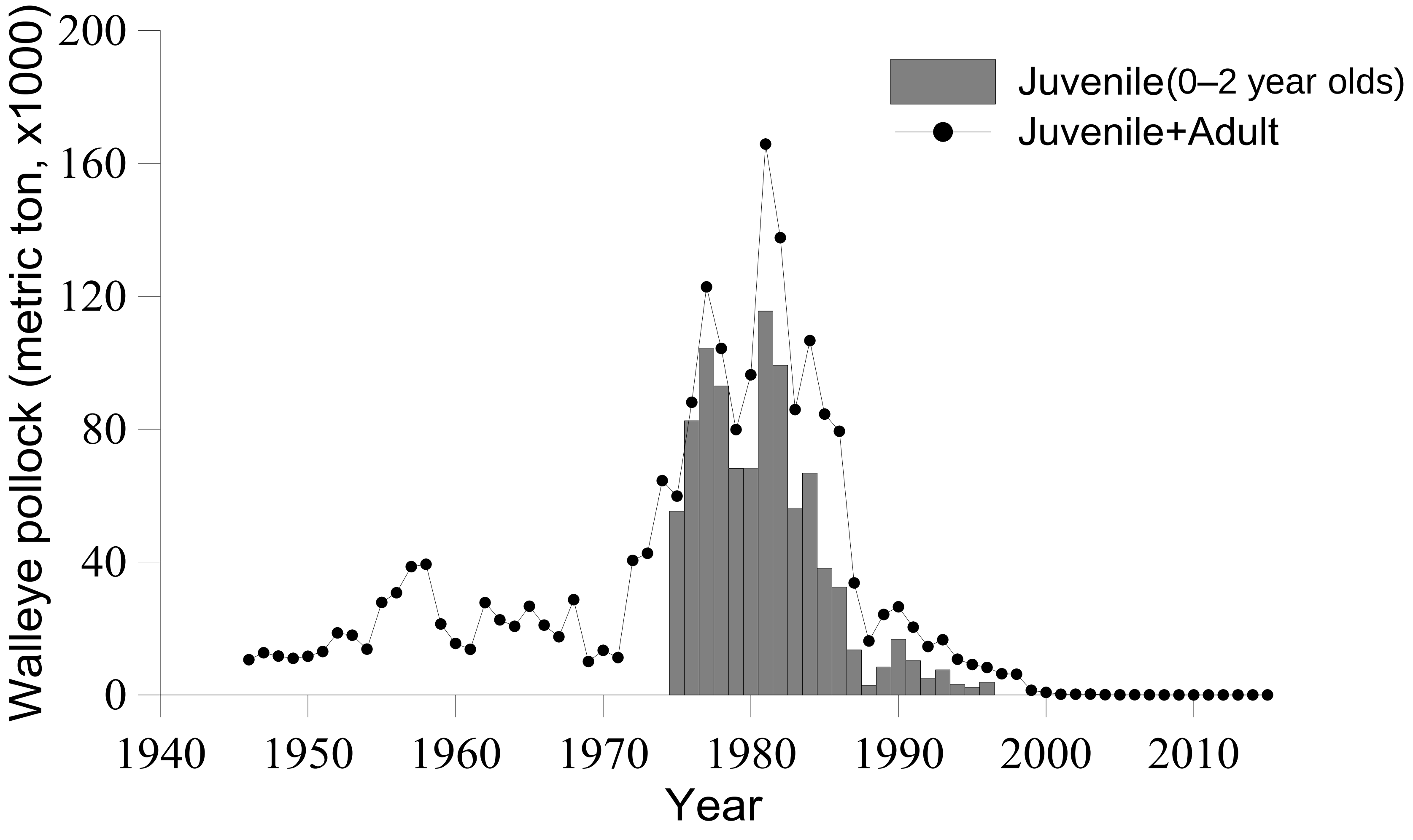
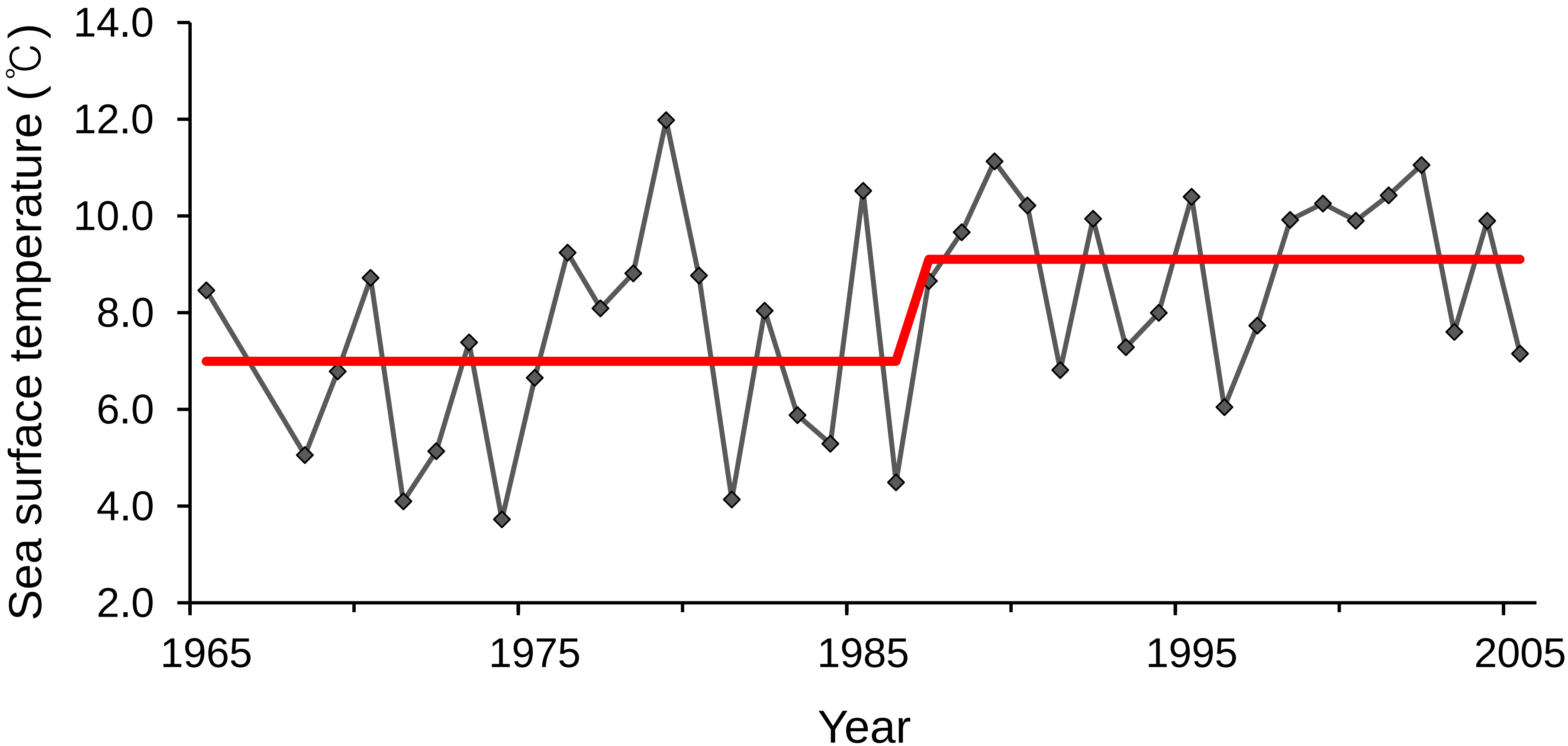
Background & Introduction



Catch variability in walleye pollock in the East Sea (1946–2015)

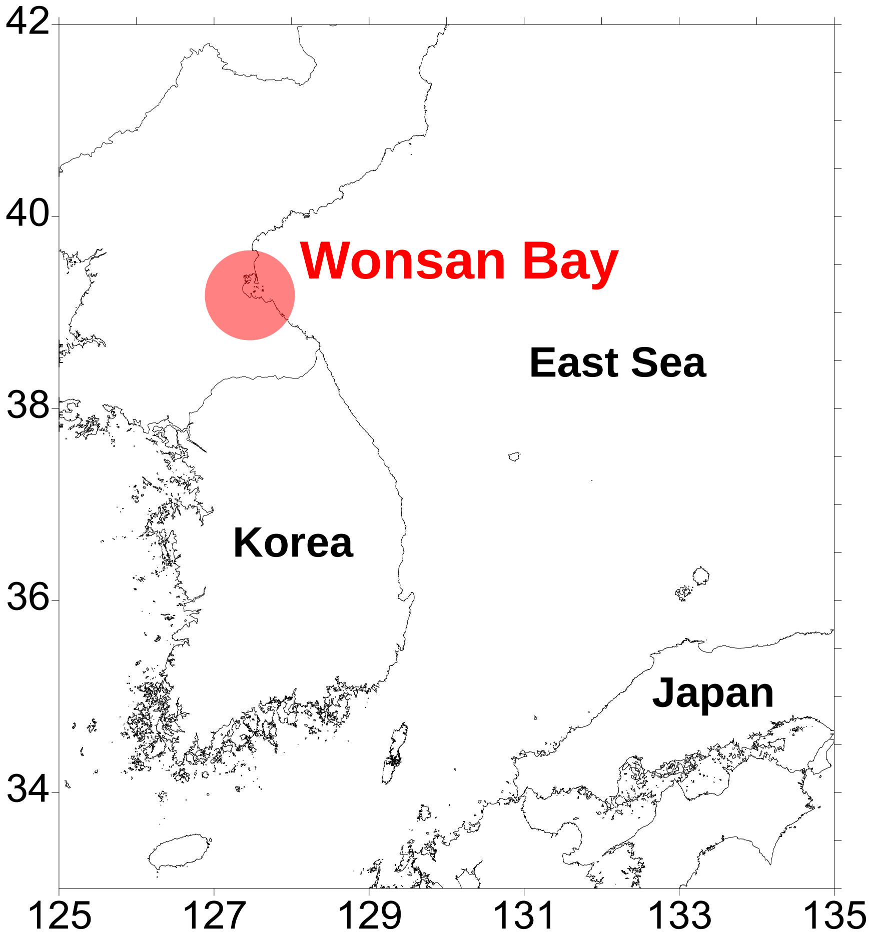


Sea surface temperature in the East Sea (1965–2005)



Korea

Walleye pollock?



Spawning season

- **Dec.~Mar.**

  (Park and Ok, 1986)

Habitat depth

- **Juvenile:**
  - Shallow water
- **Adult:**
  - 200~350m

  (NFRDI, 2010)

Habitat temperature

- **Juvenile:**
  - 2~7℃

  (Nakatani and Maeda, 1984)
- **Adult:**
  - 2~10℃ (most preferable 3~5℃)

  (NFRDI, 2010)

Prey

- **Juvenile:**
  - copepod
  - euphausiid

  (Yamamura et al. 2002)
- **Adult:**
  - euphausiid
  - shrimp
  - cephalopod
  - fish

  (NFRDI, 2010)

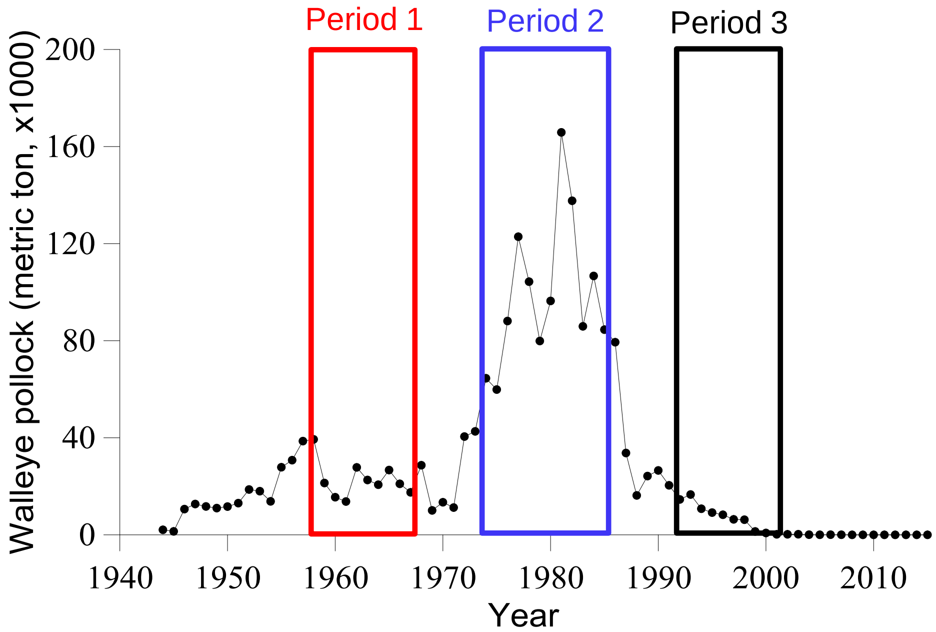
Purposes of this study

- To reveal the change in growth and maturity of pollock during 1960s–2000s off the eastern Korea, and
- To investigate the relationship between environmental change and its impacts on fisheries resources.

Data & Methods

◆ **Biological/Fisheries data**

- National Institute of Fisheries Science (NIFS) scientists subsampled biological parameters (length, weight, maturity, etc.) from Danish seine and Drift gill net fisheries since the late 1950s, and we extracted data from winter season (Nov.-Feb) only.

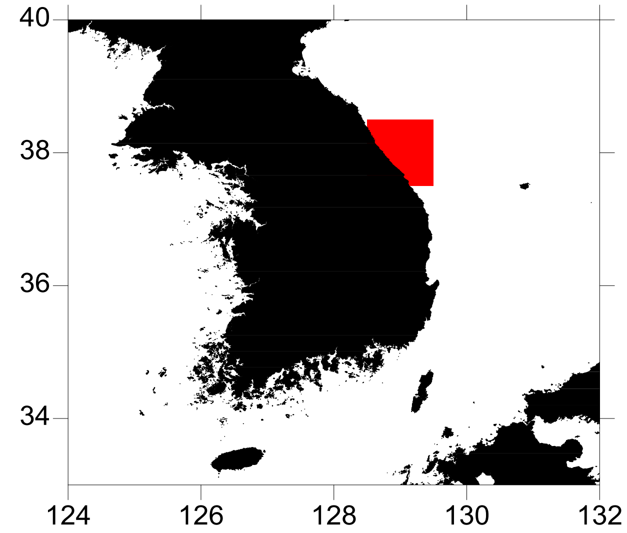


Three stages of fisheries

1) Period 1:
   - Initial period (1958–1968)
2) Period 2:
   - Active period (1973–1985)
3) Period 3:
   - Weak period (1991–2002)

◆ Environmental Data

- NIFS serial oceanographic observation data
- Oceanic environmental data
  : seawater temperature at depth and zooplankton abundance etc.)



< Study area in red color>

◆ Statistical Analysis

- Cross-correlation function (CCF) analysis
  : to see the time-lag effect in correlation between the environment variables and the pollock catch
- Sequential Regime Shift Detector(SRSD)
  : to detect changing phase of seawater temperature

➢ Estimate of Biological Parameter

① von Bertalanffy growth curve

$$L_t = L_\infty (1 - e^{-K(t - t_0)})$$

L_t = length at age t

L = theoretical maximum length (asymptotic)

K = growth coefficient, proportional to rate at which L is reached

t_0 = theoretical age at L = 0 (often negative, or zero)

② Length at 50% maturity

$$P_i = \frac{1}{1 + e^{-K \times (X_i - L_{50})}}$$

P_i= proportion of the mature fish at length X_i

K= instantaneous rate of fish maturation

③ Fulton Condition factor

$$CF = \frac{BW}{FL^3} \times 10^4$$

BW= Body Weight (gram)

FL = Fork Length (cm)

➢ Estimate of Biological Parameter

④ Relative Length Frequency

Bonar (2002) developed a simple method to assess the size structure of a fish population quickly by comparing its sampled length frequency with an average developed for the particular geographic region.

⬇

For comparing particular periods caught in the same geographic region

⑤ PSD (Proportional size distribution)

: to differentiate size distribution of fish and to determine the level of recruitment

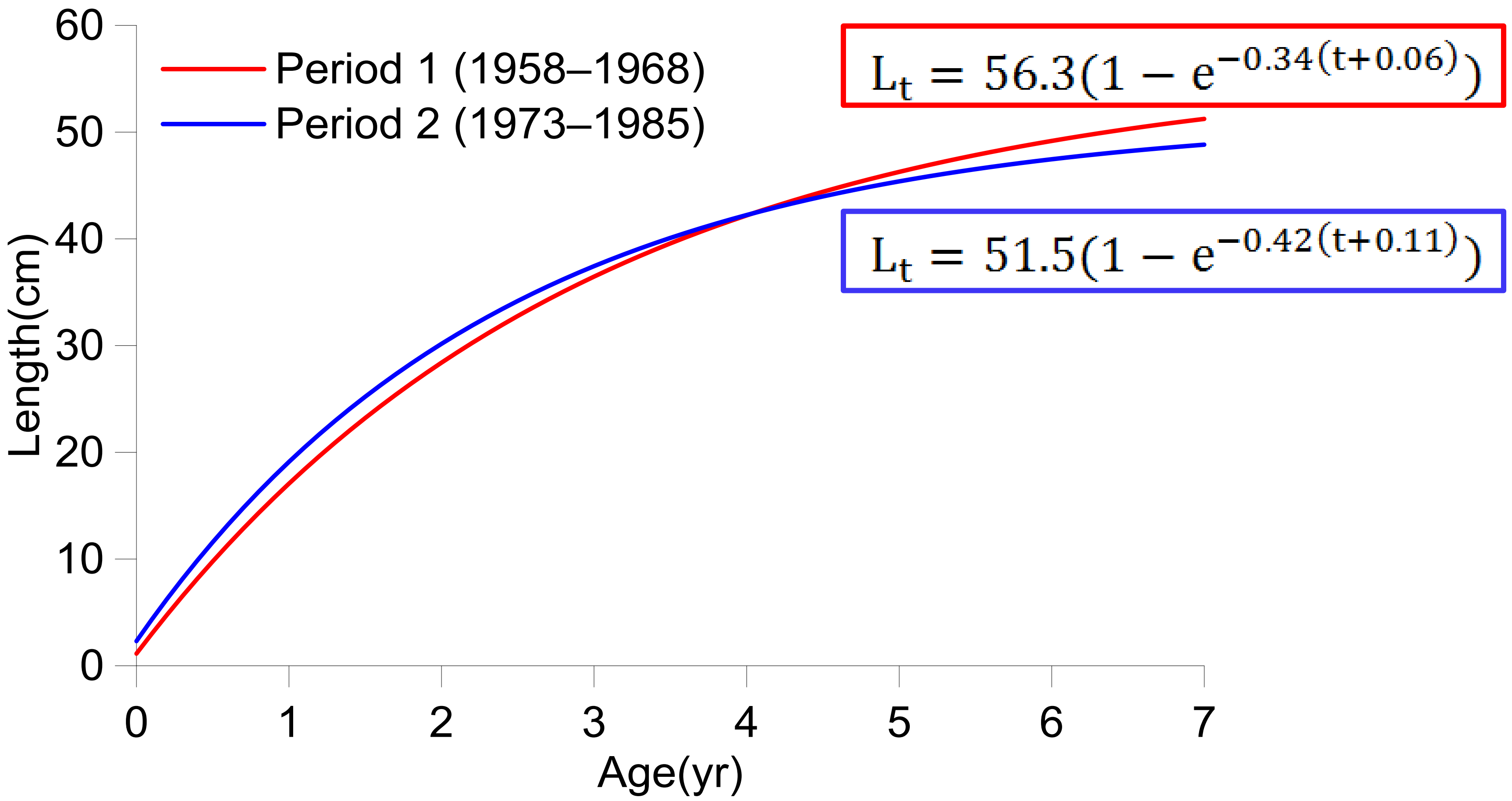
$$PSD = \frac{Number\ of\ fish \geq minimum\ quality\ length}{Number\ of\ fish \geq minimum\ stock\ length} \times 100$$

Stock Length: mean length of first maturity **25cm** (Kang et al, 2013)

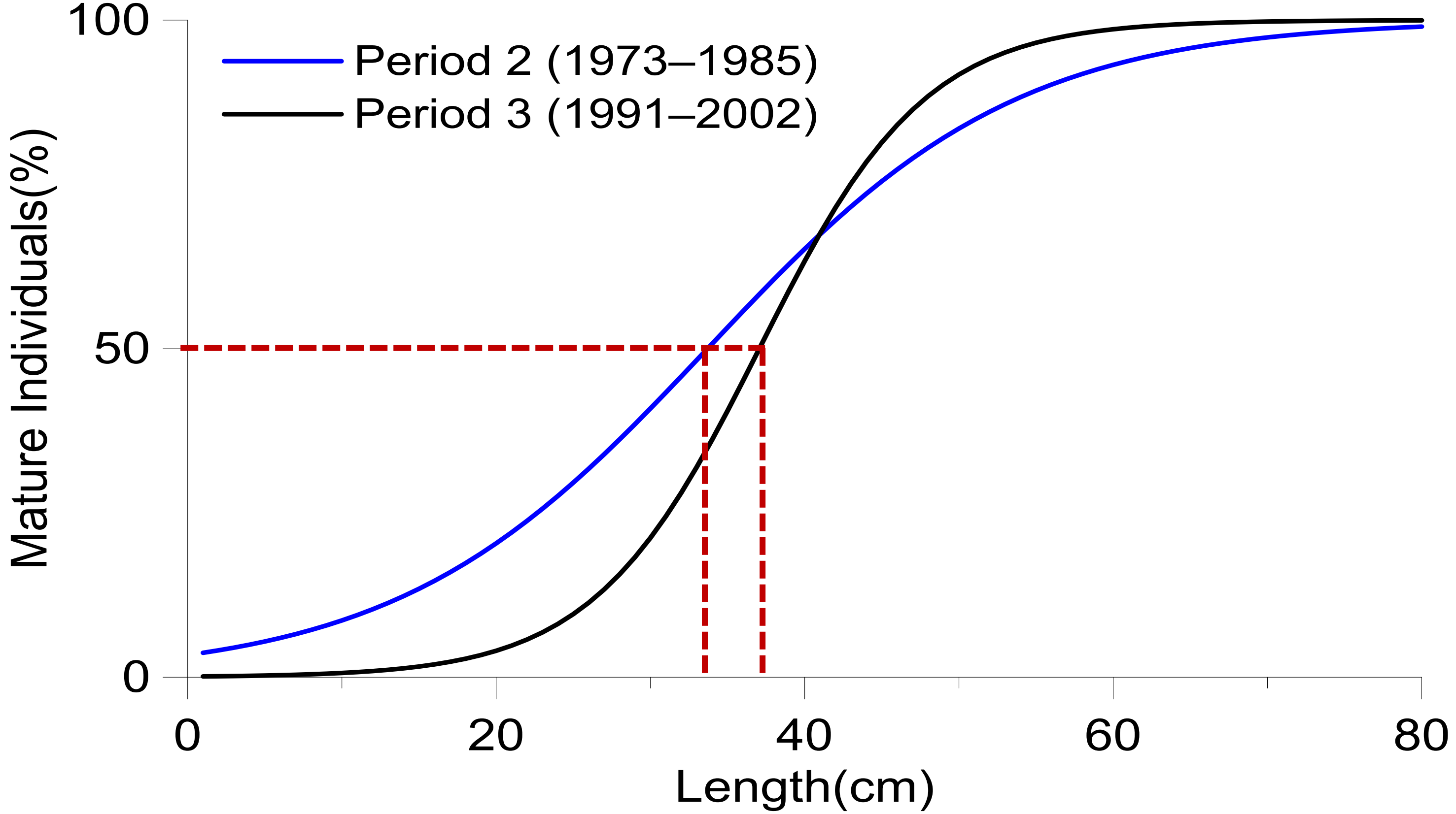
Quality Length: length at 50% maturity **37cm**

Results & Discussion

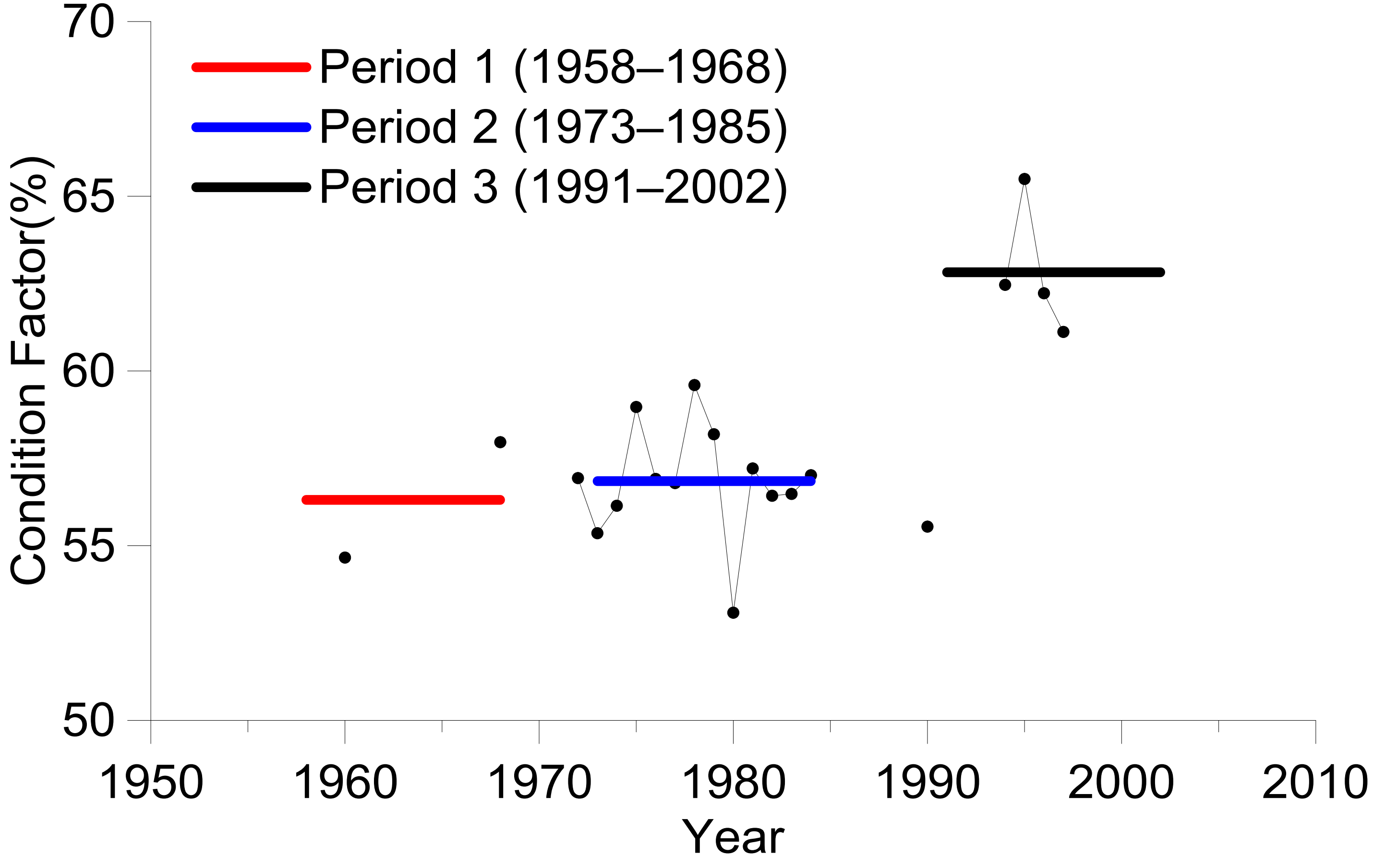
von Bertalanffy growth curve



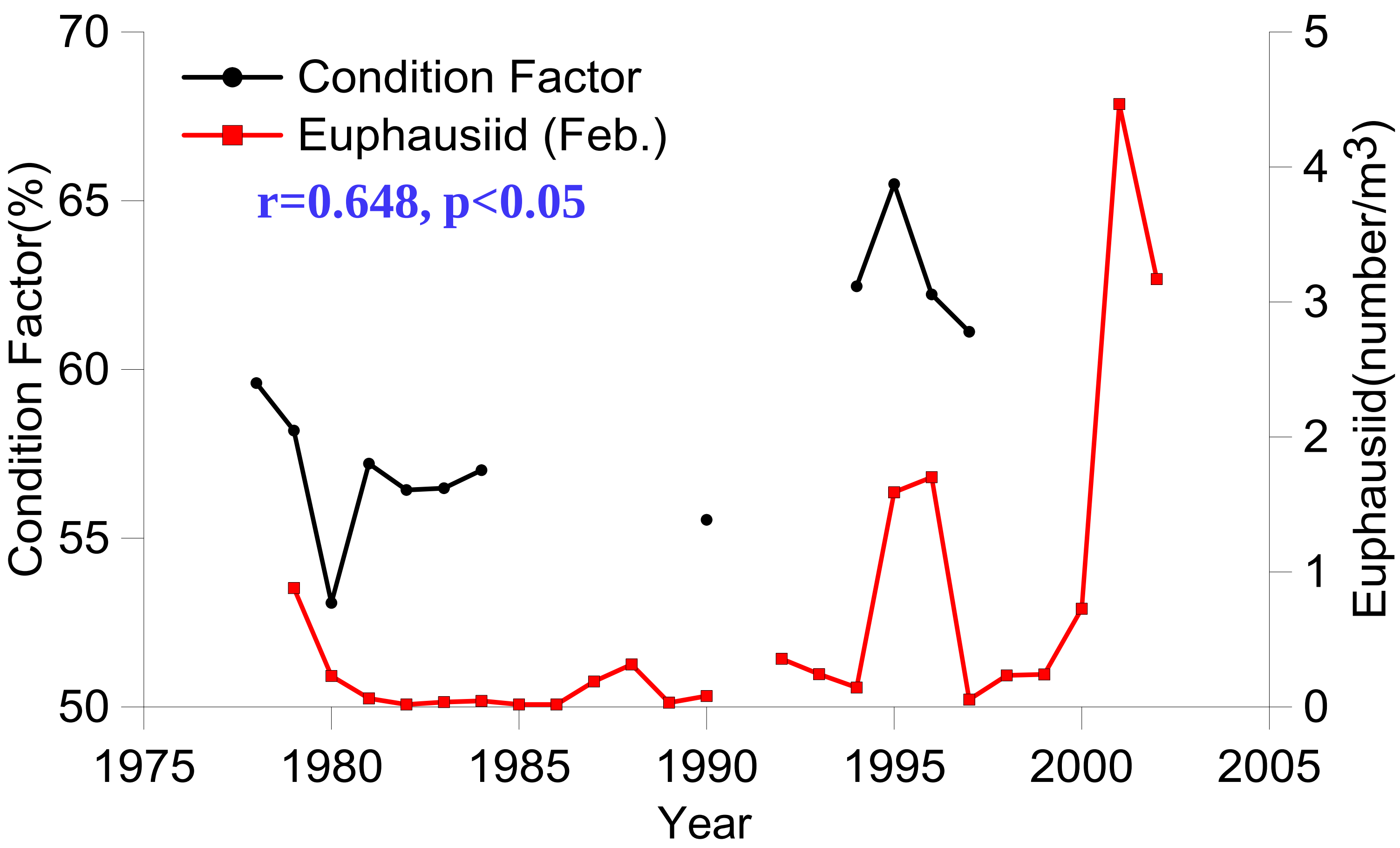
Length at 50% maturity



Condition factor



Condition factor & Euphausiid density



Relative Length Frequency

◆ **3 period**

① Initial period

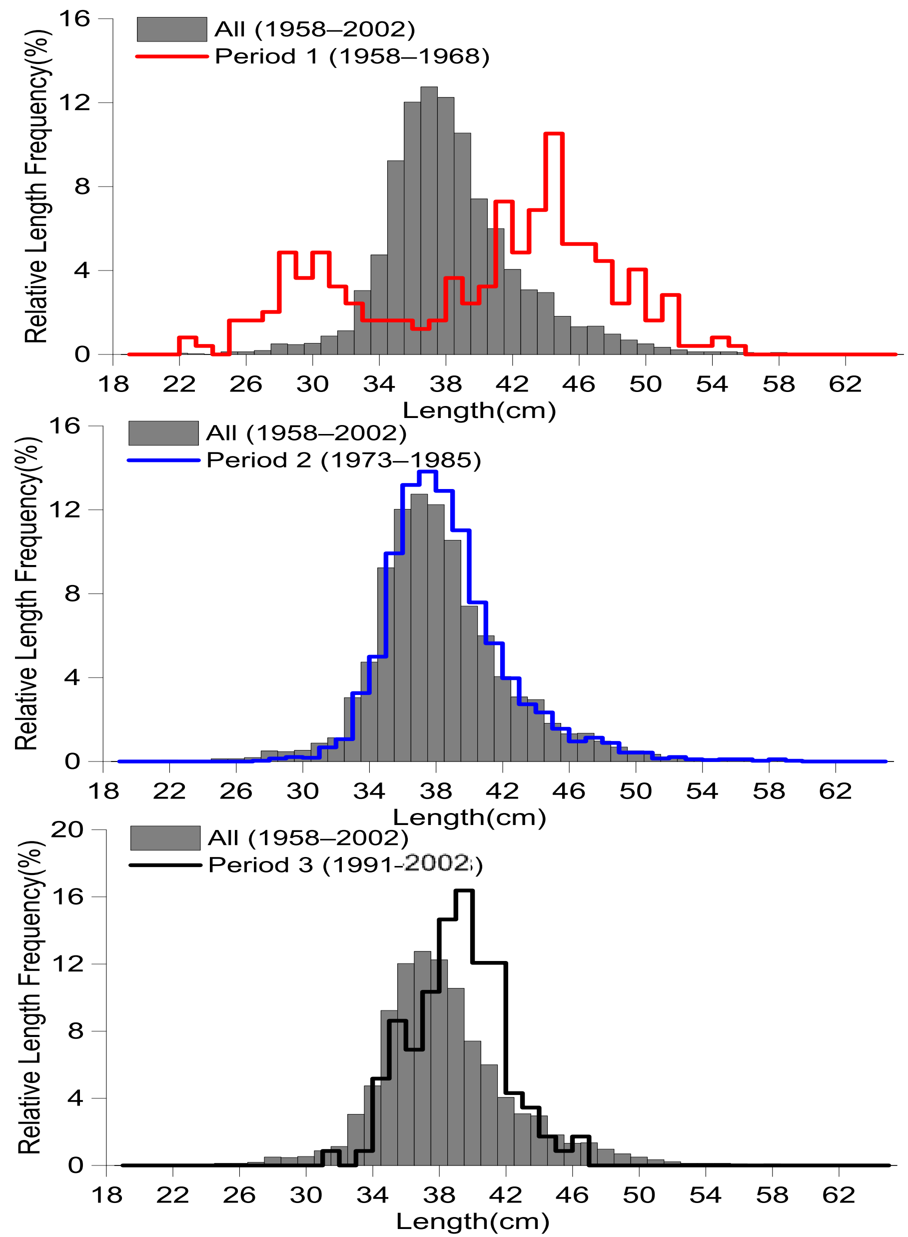
: 1958–1968

② Active period

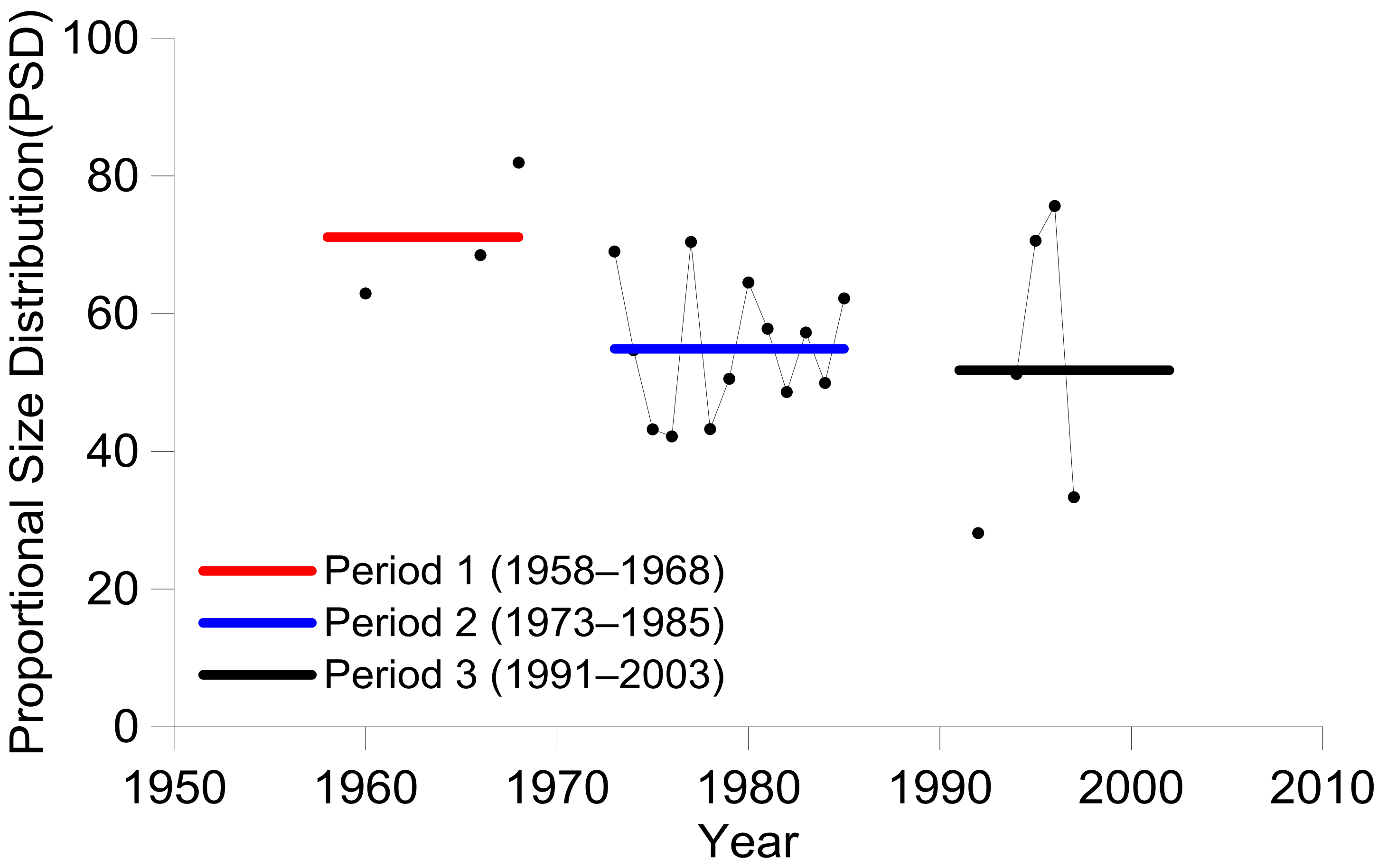
: 1973–1985

③ Weak period

: 1991–2002



Proportional Size Distribution (PSD)

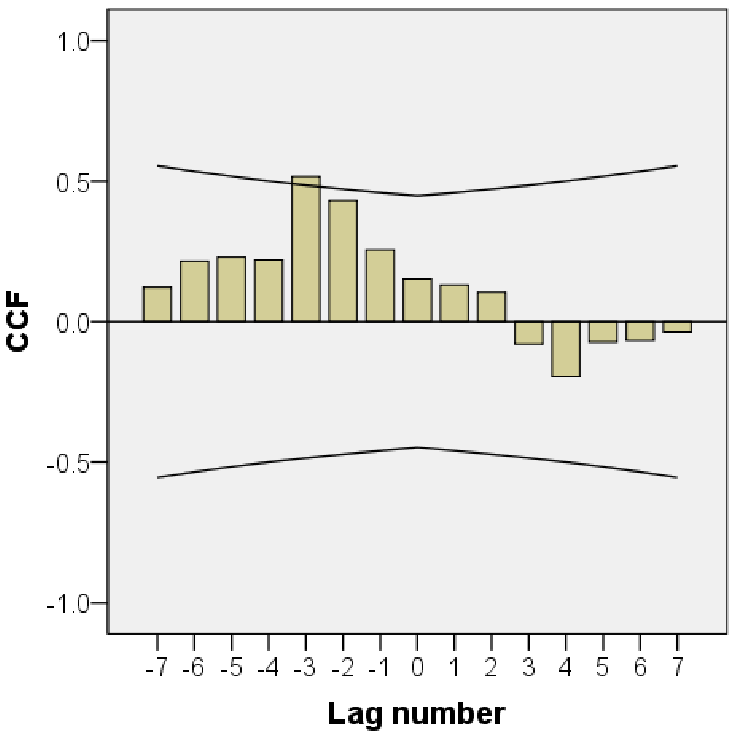


Temperature vs Juvenile catch

- During the 1975–1996
- Seawater temperature in the coastal area in **December** – juvenile catch

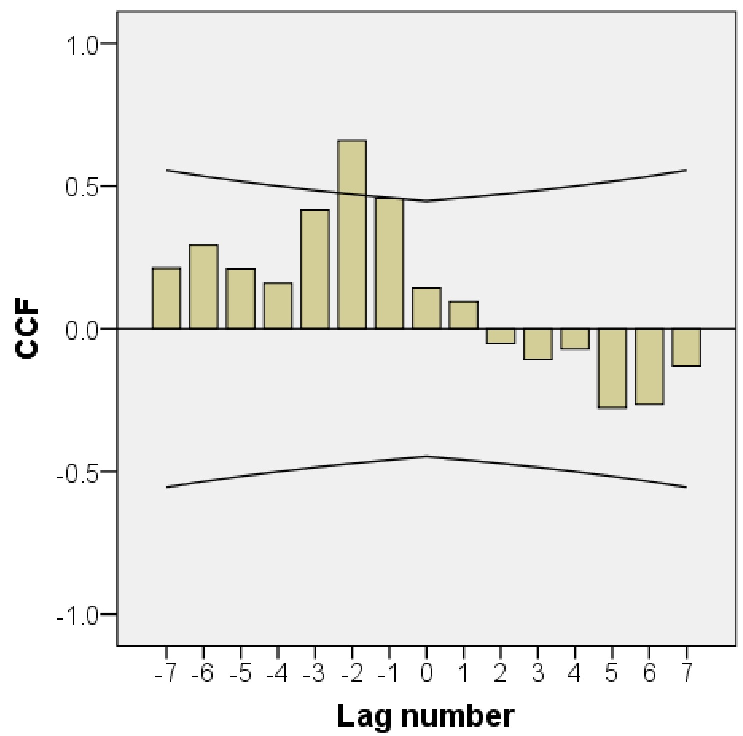
① 10m: **-3, r=0.515, p<0.05**

② 20m: **-3, r=0.507, p<0.05**



③ 75m: **-2, r=0.659, p<0.05**

④ 100m: **-2, r=0.592, p<0.05**



Summary & Conclusion

◆ **Biological characteristics of Korean pollock examined by the progression of fisheries**

Period 1: initial stage from 1958 to 1968

Period 2: active stage from 1973 to 1985

Period 3: weakening stage from 1991 to 2002

1) In the beginning stage of fisheries (Period 1), there were relatively more ‘large fishes’, and fish size decreased as fisheries became active.
2) The length of 50% maturity was 33cm in the active stage of fisheries (Period 2), but it increased to 37cm in the weak period (Period 3)

3) In active stage of fisheries, the length range became narrow, and the numbers in large- and small-size classes were reduced later period.
4) A density-dependent growth mechanism seemed to be acted for Korean pollock. Condition factor and mean length of pollock were larger in weak stage of fisheries than in active period.
5) Relative length frequency showed more ‘small-size fish’ in initial period. Proportional Size Distribution (PSD) reflected that recruitment was relatively higher in the initial stage than in later period.
6) Statistical analysis revealed that there were significant positive correlations between juvenile pollock catch and seawater temperatures in surface layer with time-lags.

Future study

- We need to construct the number of pollock at age using some population dynamic models to explain the recruitment variability of pollock,

- We need to demonstrate the relationship between the biological characteristics and environmental conditions on recruitment variability.