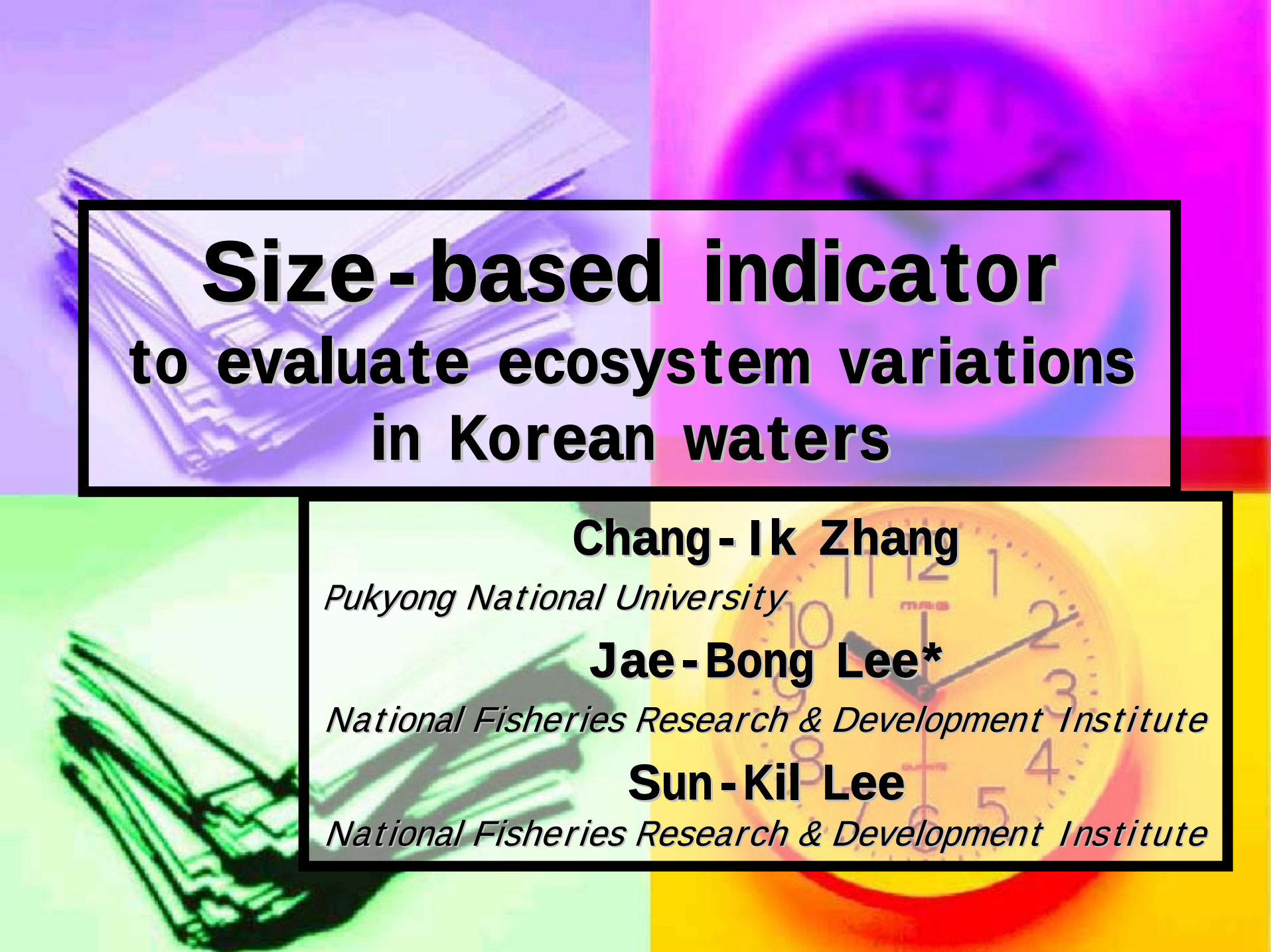




Size-based indicator to evaluate ecosystem variations in Korean waters

Chang - I k Zhang

Pukyong National University

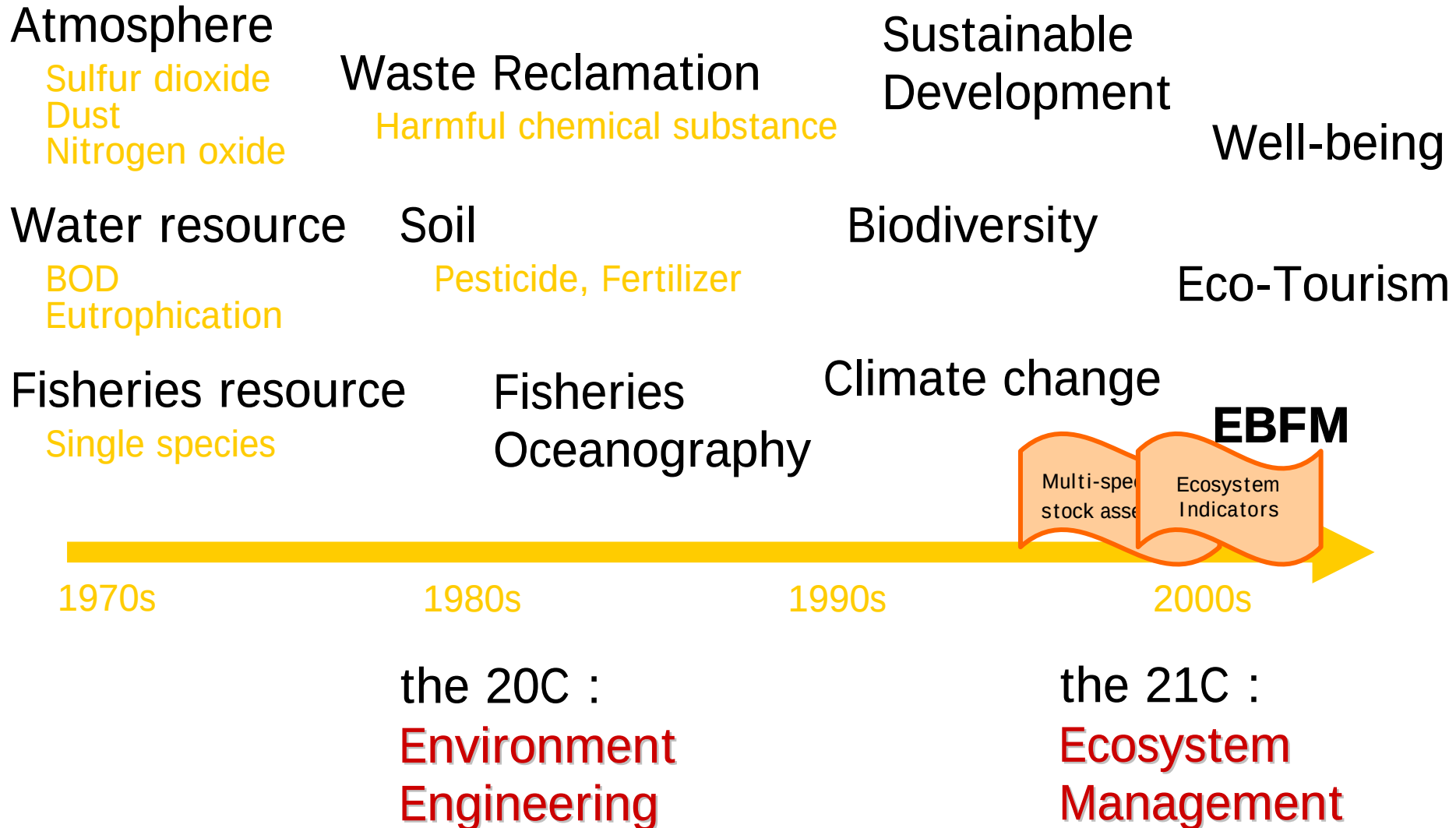
Jae - Bong Lee*

National Fisheries Research & Development Institute

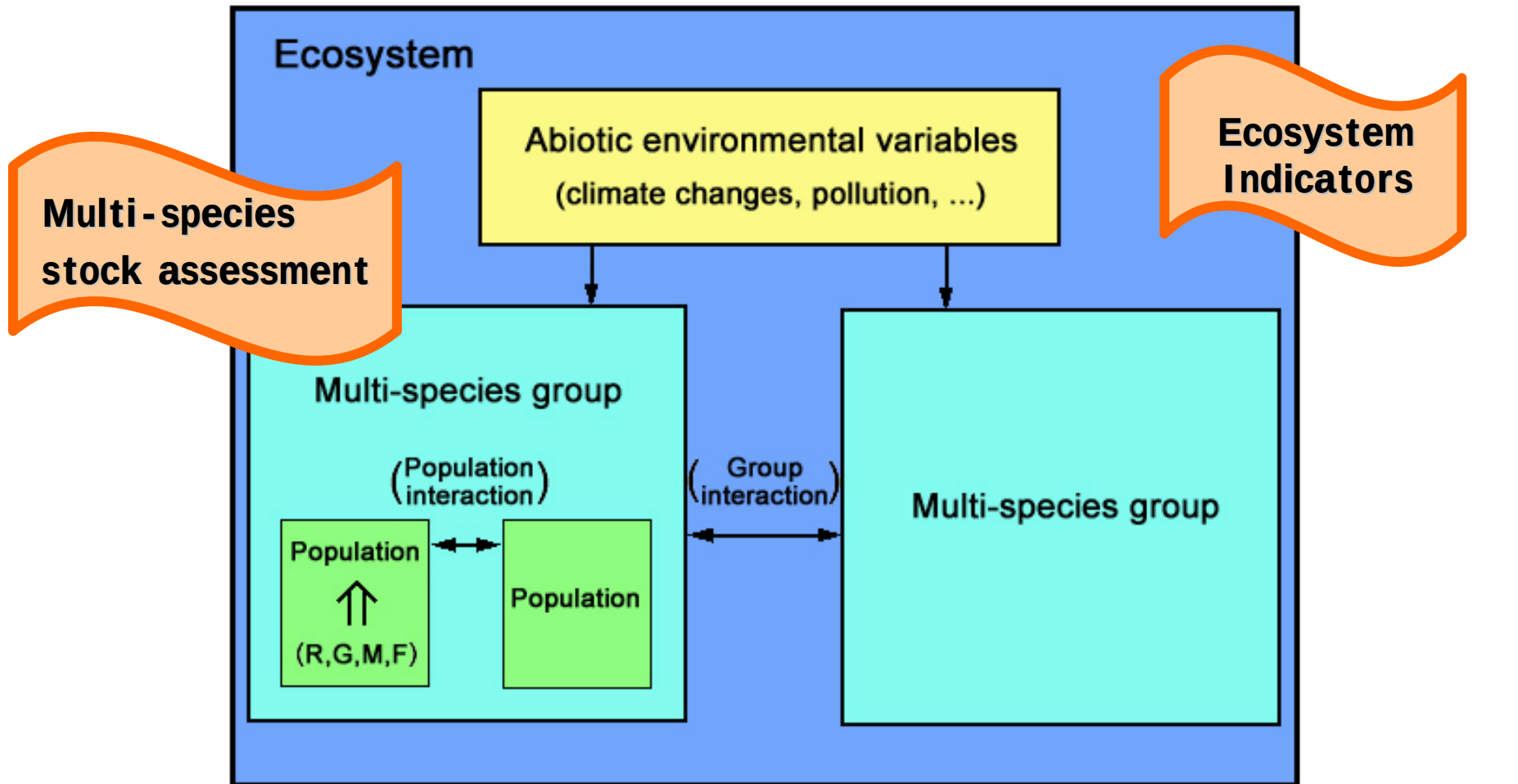
Sun - Kil Lee

National Fisheries Research & Development Institute

From Environment to Ecosystem



Multi-species Level Interactions with Biotic & Abiotic Environments in a Marine Ecosystem

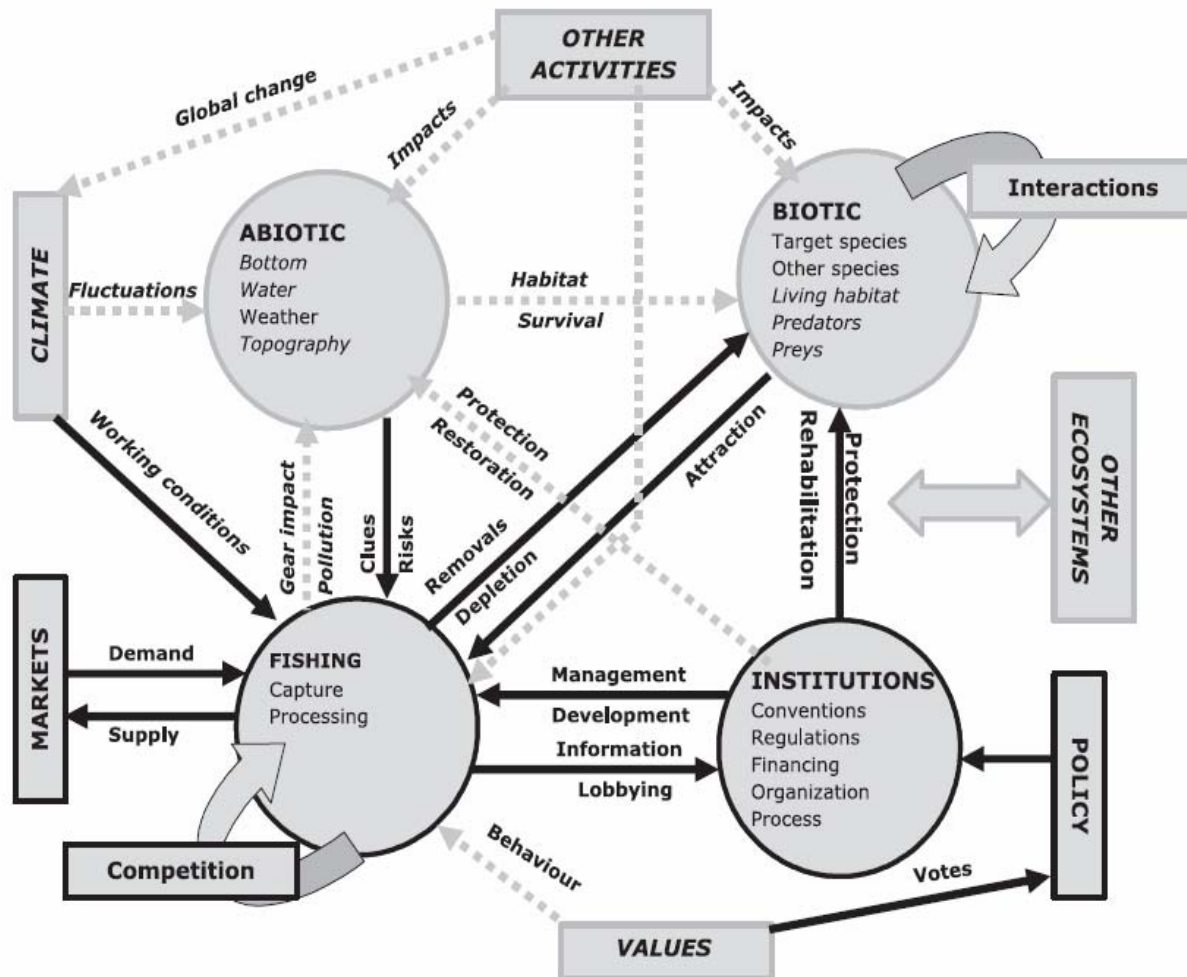


R : recruitment, G : growth, M : natural mortality, F : fishing mortality

after Zhang (2005)

Ecosystem components and interactions for EAF

(Garcia & Cochrane, 2005)



- ❖ Ecosystem indicators and reference values can be of a
 - ✓ bio-ecological,
 - ✓ techno-economical,
 - ✓ socio-cultural nature.
- ❖ Ecosystem indicators and reference values can be relate to objectives and constraints.

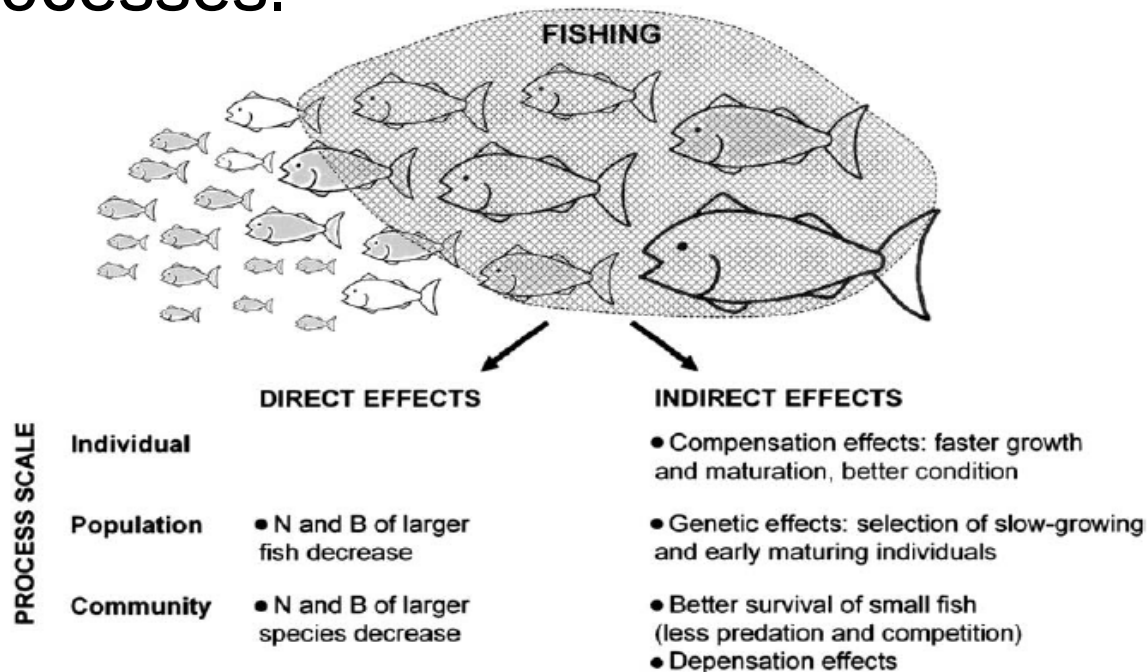
Types of Indicators

(Beth Fulton, 2004, ICES J.Mar.Sci.)

- ❖ Relative biomass (jellies, cephalopods, small pelagics, scavengers, demersal fish, piscivores, top predators (Trophic Level 4+), biogenic habitat (cover))
- ❖ Biomass ratios (Piscivore : Planktivore, Pelagic : Demersal, Infauna : Epifauna)
- ❖ Size spectra (slope, trophic spectra if good diet data)
- ❖ Maximum (or mean) length
- ❖ Total fishery removals (catch+discards+bycatch)
- ❖ Diversity (counts)
- ❖ **Size at maturity (weight & length)**
- ❖ Biophysical (Chl.a, oC, DIN, contaminants)

Size-based Indicator

- ❖ Fishing is always size-selective.
- ❖ SBI may provide a relevant integration of the effects of fisheries on community structure and processes.



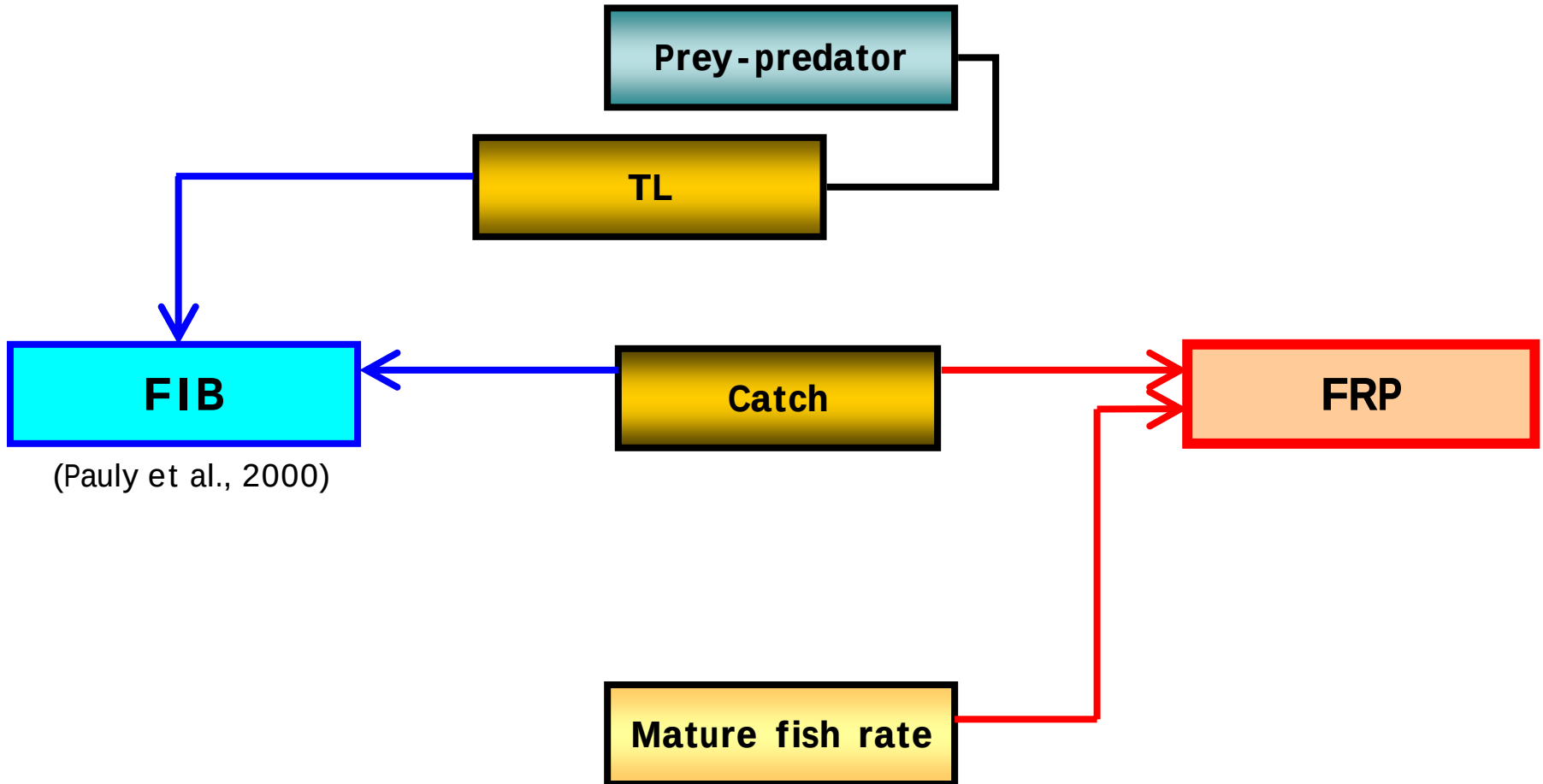
(Shin et al., 2005)

Size-based Indicators

Size at maturity

(Trophic level, Catch, Fishing effort)

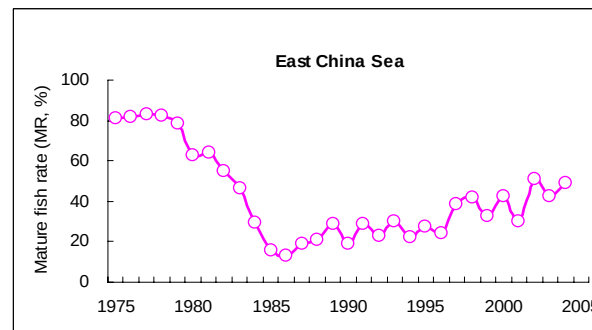
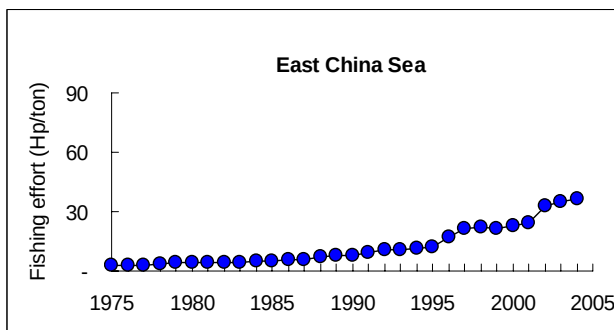
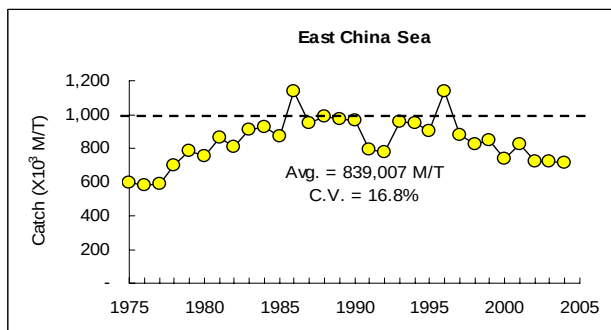
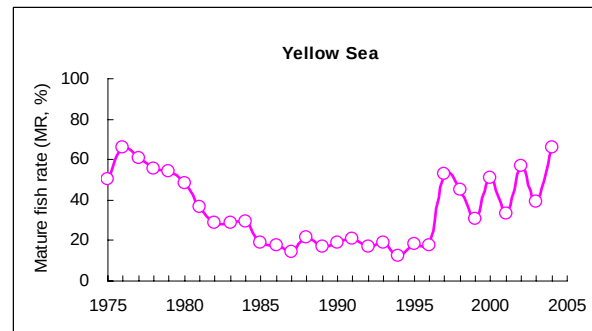
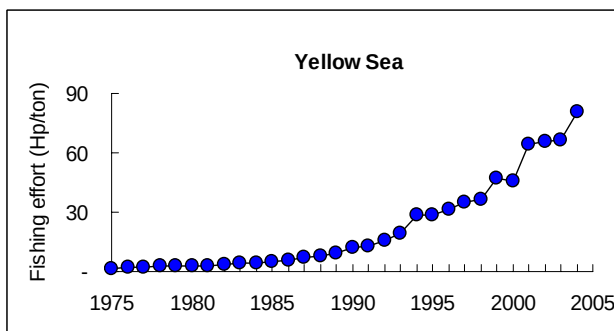
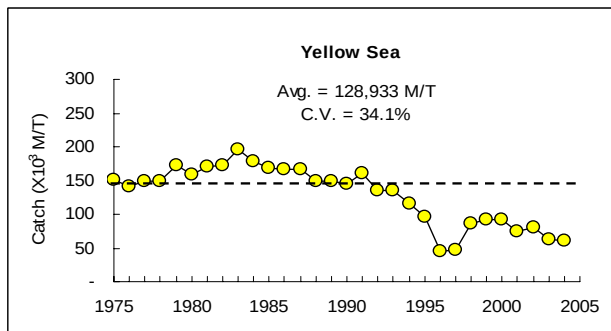
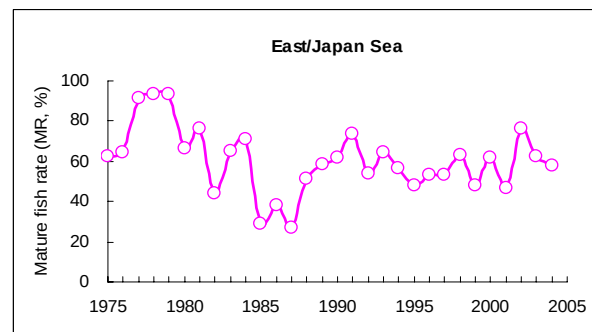
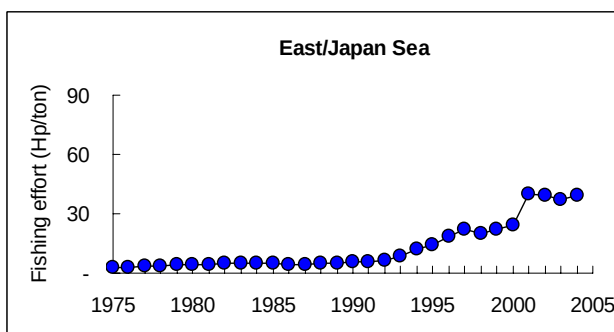
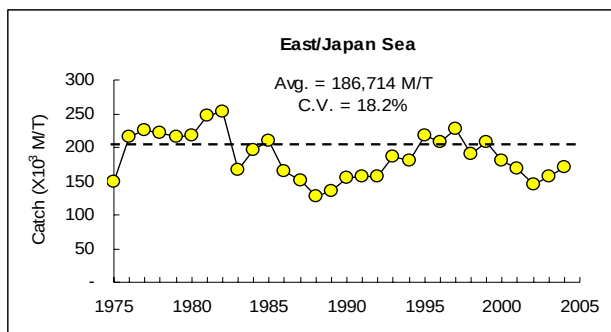
Size-based ecosystem indicators



Fish Reproduction Potential (FRP)

- At the population level, a size-based ecosystem indicator describing the reproductive probability of adult fisheries resources
- Estimated with
 - adult fish composition to total catch,
 - catches by species and by ecosystem,
 - fishery efforts
- $FRP = \text{Biomass} \times \text{Mature fish rate} = y/F \times MR = Y/(qf) \times MR$
- $FRP \text{ index} = \log \{(y_i \times MR_i)/(qf_i)\} - \log \{(y_0 \times MR_0)/(qf_0)\}$

Status of catch, effort, MR of fisheries by area

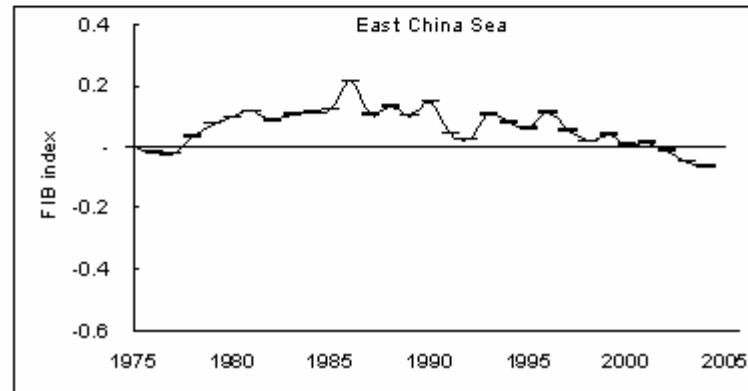
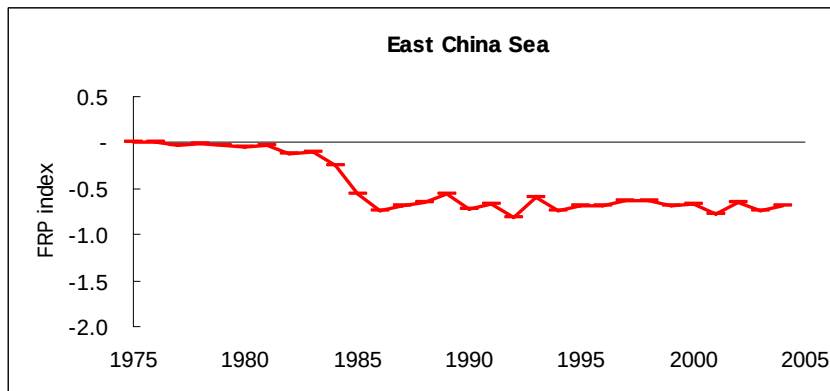
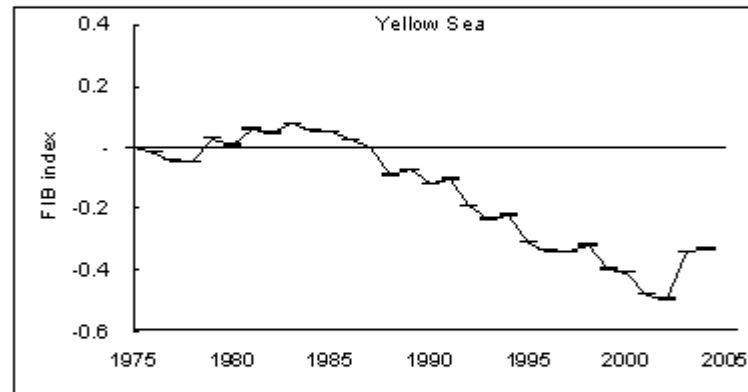
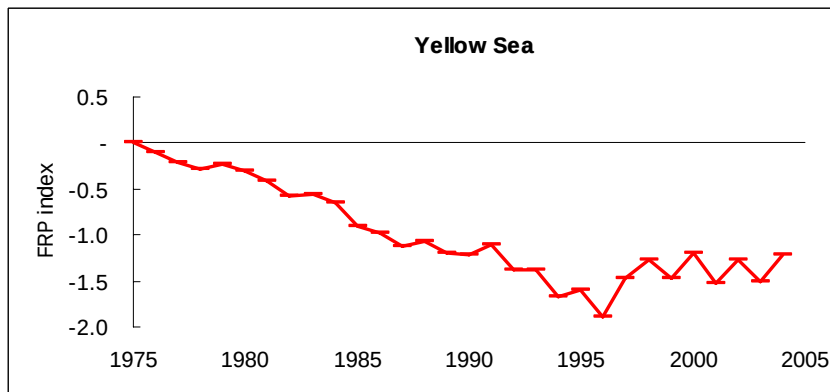
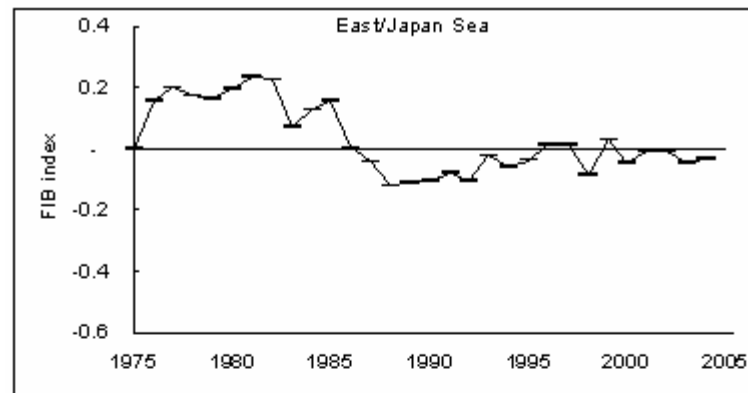
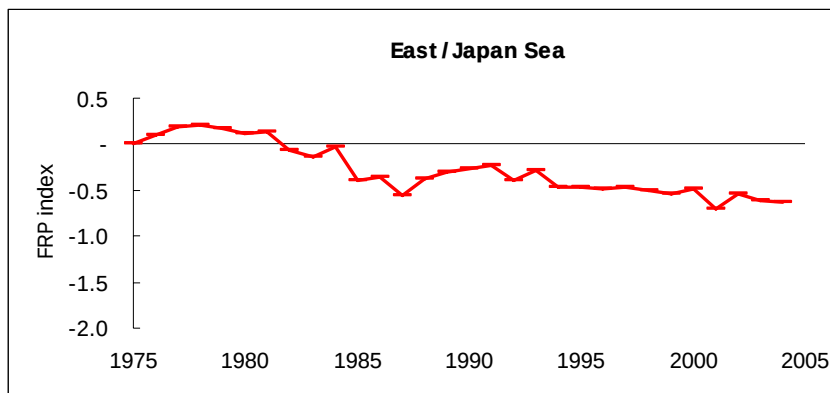


Annual variations in total catch of three ecosystems in Korean waters, 1975~2004. Dotted lines represent total averages.

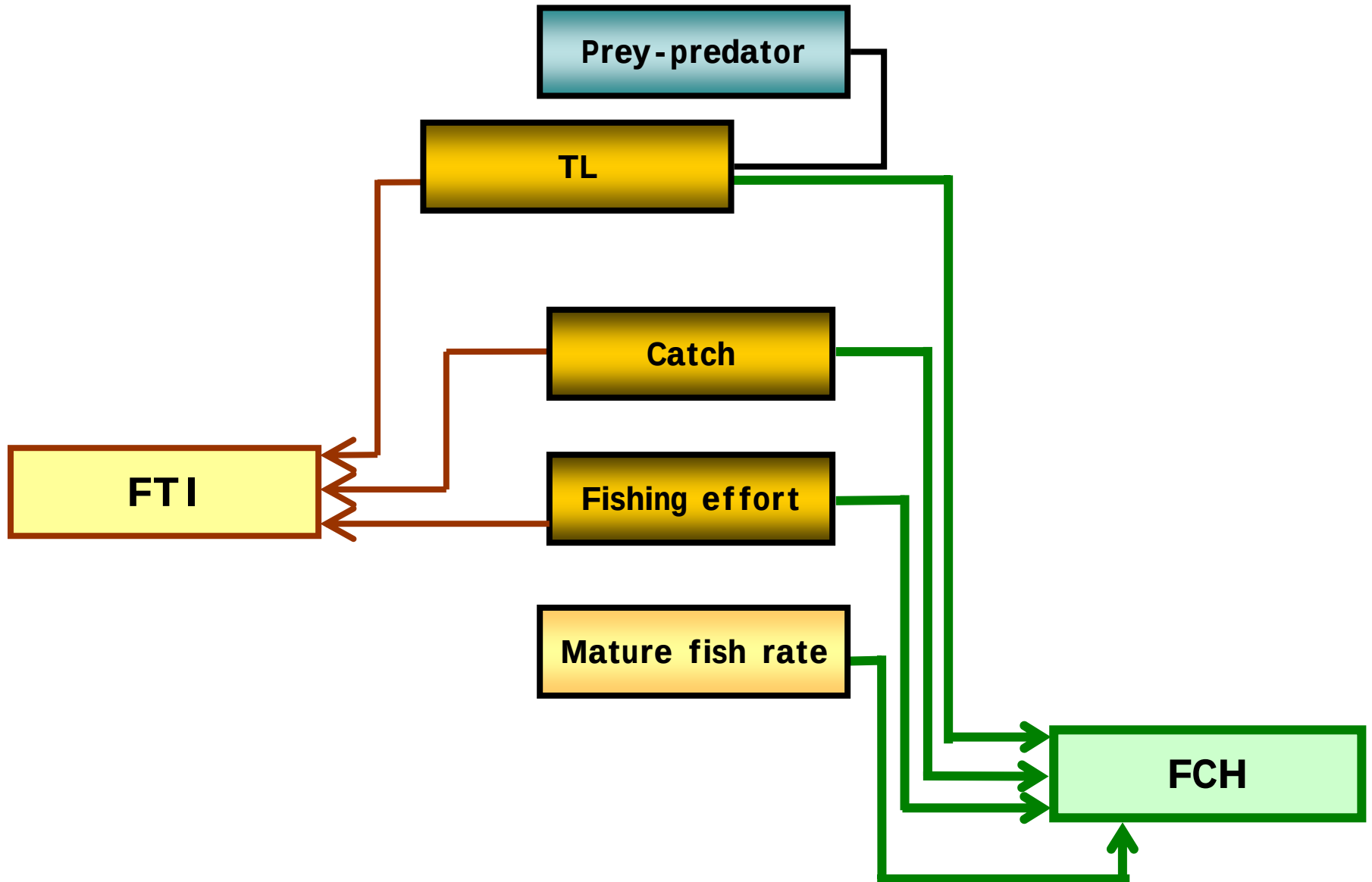
Fishing efforts (Hp/ton) by three ecosystems in Korean waters, 1975~2004.

Mature fish rate (%) by ecosystem in Korean waters, 1975~2004.

FRP & FIB indicators of fishery in Korean waters



Size-based ecosystem indicators

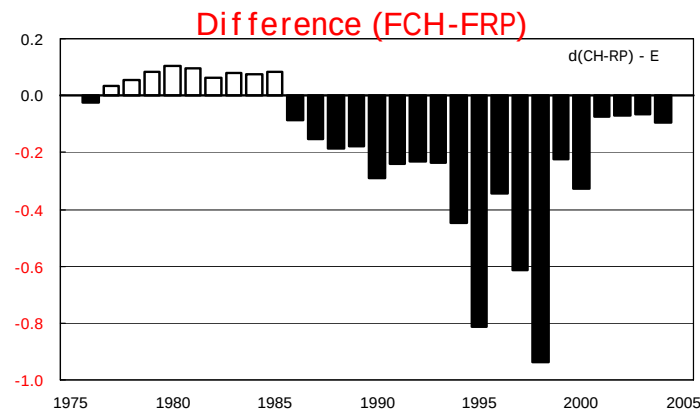
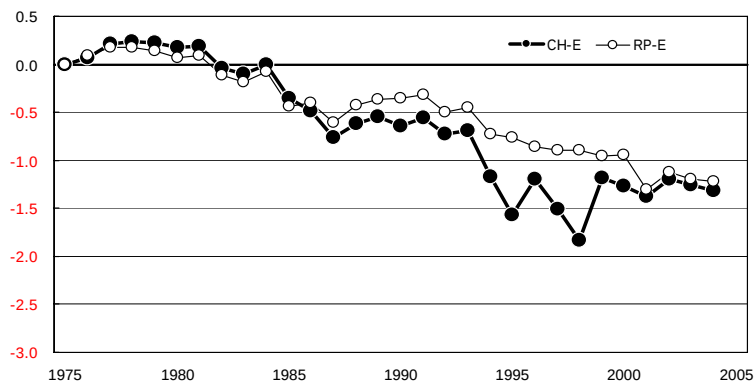


Fish Community Health (FCH)

- At the community level, a size-based ecosystem indicator describing the reproductive probability and trophic level of fish communities in Korean waters
- Estimated with
 - adult fish composition to total catch,
 - trophic level in catch,
 - catches by species and by ecosystem,
 - fishery efforts
- $$\text{FCH} = \text{Biomass} \times \text{Mature fish rate} \times \text{Trophic level}$$
$$= y/F \times \text{MR} \times \text{TL} = Y/(qf) \times \text{MR} \times \text{TL}$$
- $$\text{FCH index} = \log \{(y_i \times \text{MR}_i \times \text{TL}_i)/(qf_i)\} - \log \{(y_0 \times \text{MR}_0 \times \text{TL}_0)/(qf_0)\}$$
 - ❖
$$\text{TL}_i = 0.1 + (\text{TL}_i - \text{min.TL}_i) / (\text{max.TL}_i - \text{min.TL}_i)$$

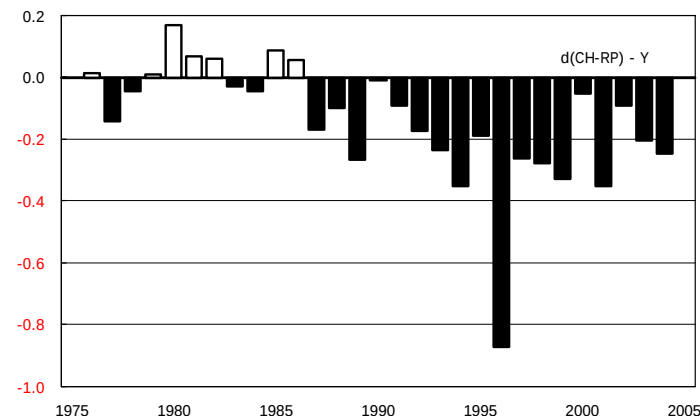
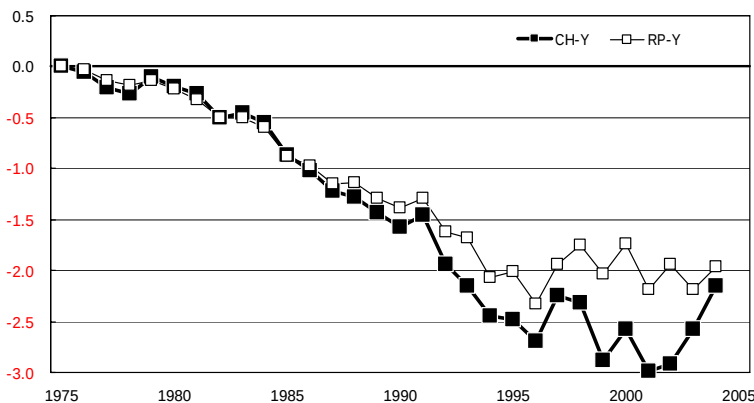
FRP & FCH indicators in Korean waters

East /
Japan
Sea



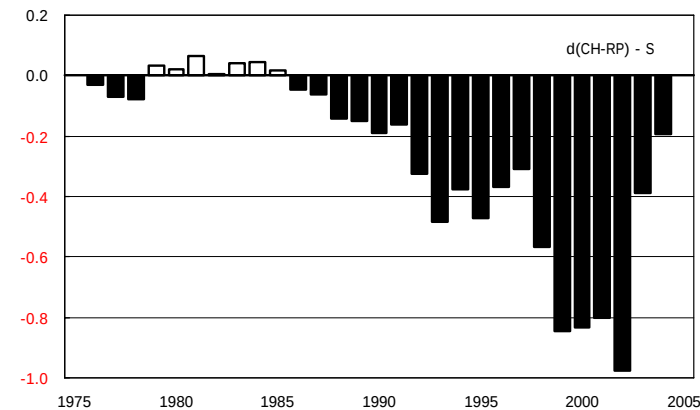
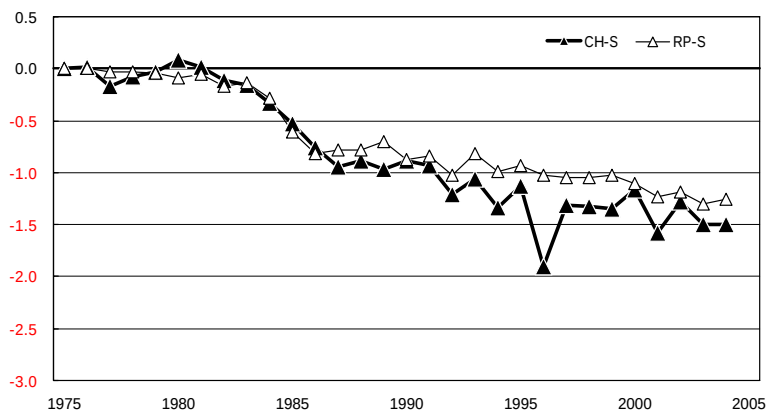
$r = 0.935$
($P < 0.001$)

Yellow
Sea



$r = 0.982$
($P < 0.001$)

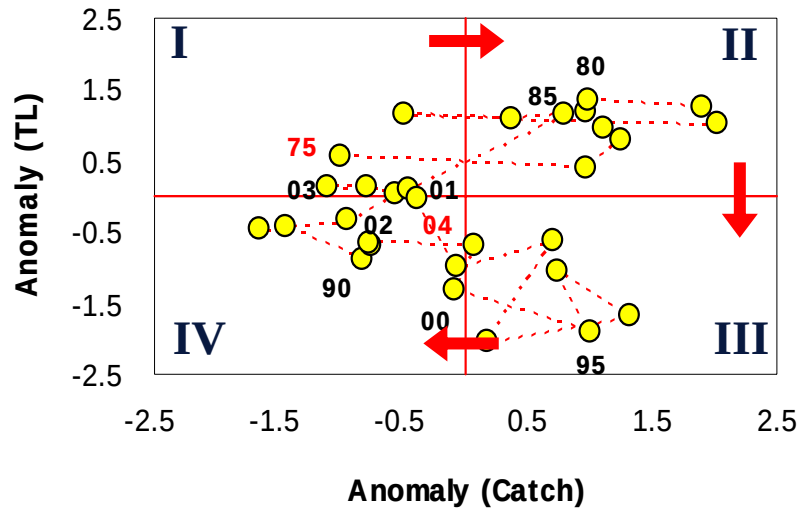
East
China
Sea



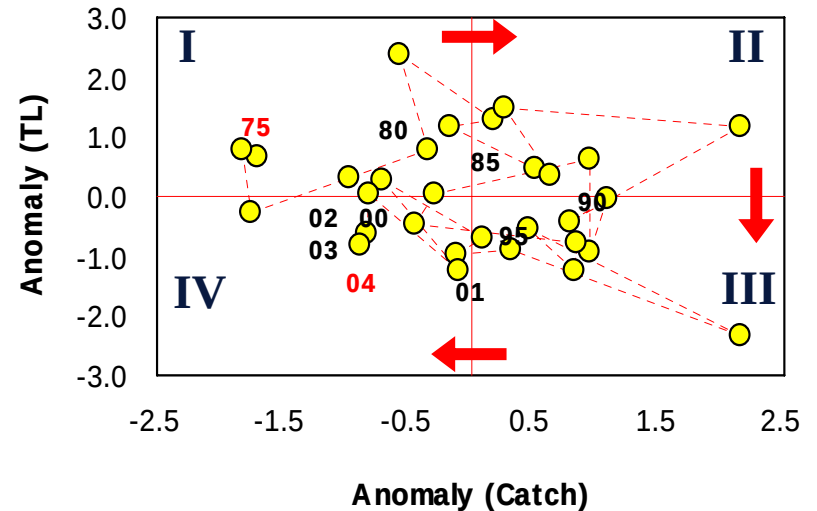
$r = 0.962$
($P < 0.001$)

Trophic Level vs. Yield Production

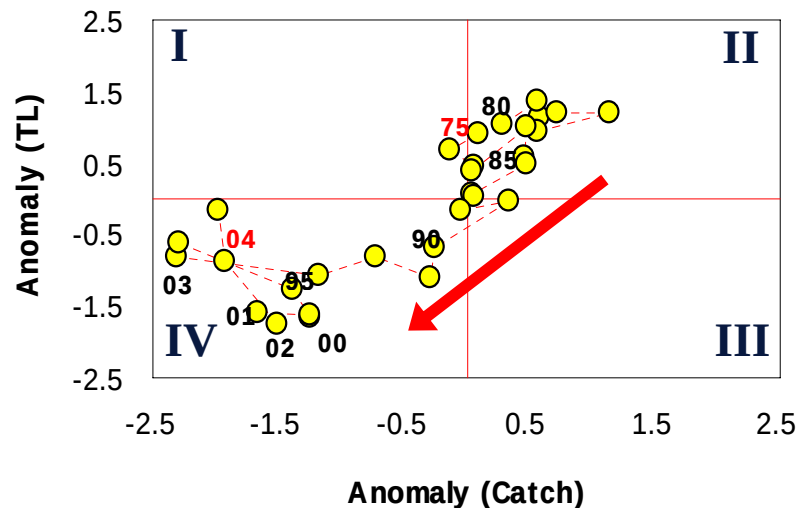
East/Japan Sea



East China Sea



Yellow Sea

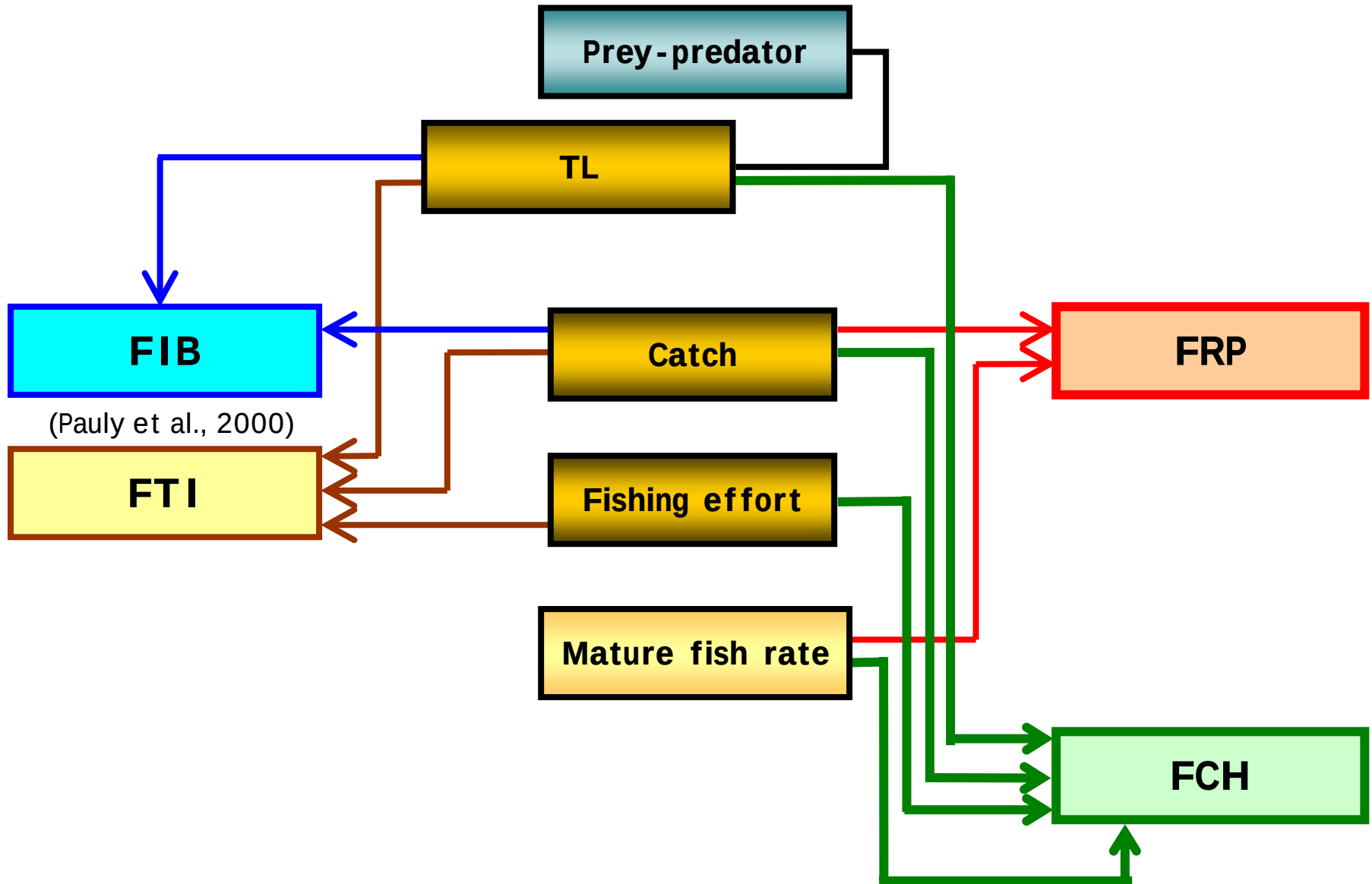


(Lee, 2004)

Summary

- ❖ Definition and meaning of SBIs are consensual within the scientific community
 - the underlying processes of FRP & FCH can be understood by non-scientists.
- ❖ Using SBIs is cost-effective and straightforward
 - FRP & FCH can be calculated from roughly the same sources, and complex models are not required.
- ❖ FCH describes the current status of ecosystem in Korean waters better than fish population level size-based indicator

Size-based ecosystem indicators



Thank you !!