Current Status of IFRAME

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Keynote Lecture at 18th PICES in 2009

Outline

- IFRAME as an EAF
- Application of the approach
- Recent improvement in IFRAME

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Working Group on Ecosystem-based management science and its application to the North Pacific *(Oct. 2004 -)*

Acronym: WG-19

Parent Committees: MEQ, FIS

Co-Chairman: Glen Jamieson <JamiesonG@pac.dfo-mpo.gc.ca>

Co-Chairman: Chang-Ik Zhang <cizhang@pknu.ac.kr>

Co-Chairman: Patricia Livingston <Pat.Livingston@noaa.gov>

Mailing List (WGEBM Members only)

Terms of reference:

1. Describe and implement a standard reporting format for EBM initiatives (including more than fishery management) in each PICES country, including a listing of the ecosystem based management objectives of each country.
2. Describe relevant national marine ecosystem monitoring approaches and plans and types of models for predicting human and environmental influences on ecosystems. Identify key information gaps and research and implementation challenges.
3. Evaluate the indicators from the 2004 Symposium on "Quantitative Ecosystem Indicators for Fisheries Management" for usefulness and application to the North Pacific.
4. Review existing definitions of "eco-regions" and identify criteria that could be used for defining ecological boundaries relevant to PICES.

Why ecosystem-based fisheries management?

- Shortcomings of a single species management

  - Lead to over-fishing

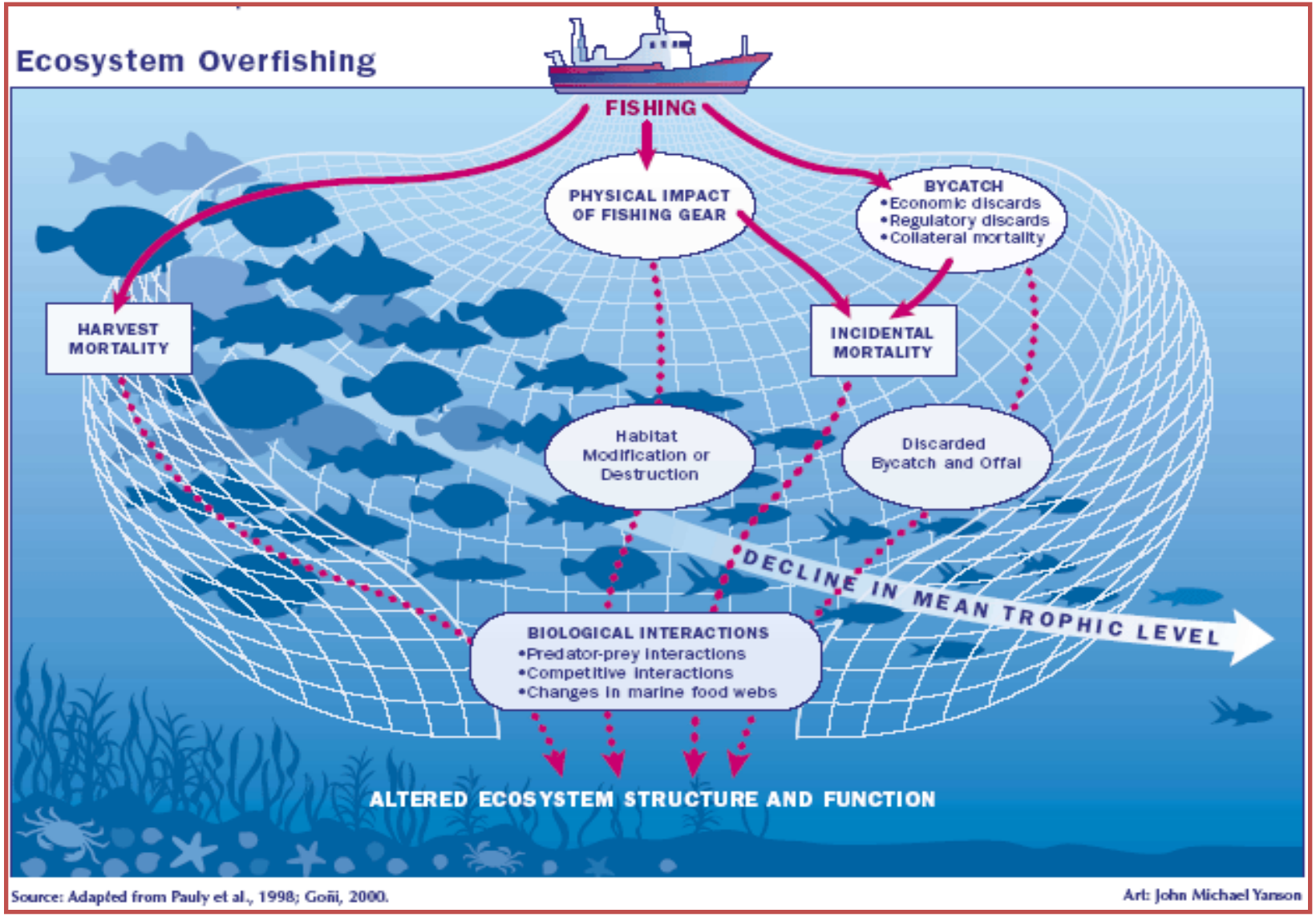
  - Limited management: only focus on sustainability

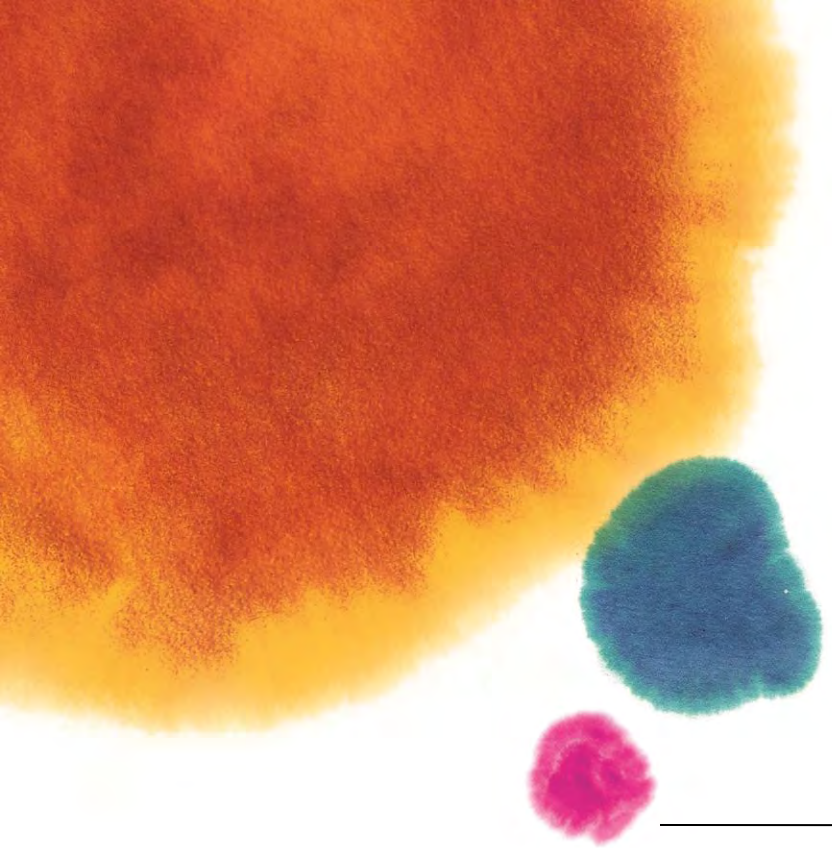
- Reykjavik Declaration (2002), FAO (2003): stressed implementation of ecosystem approach to fisheries (EAF)

- WSSD (2002): encouraged the application of the ecosystem-based approach of fishery by 2010

- UNCSD (2012) stressed the application of the EAF again

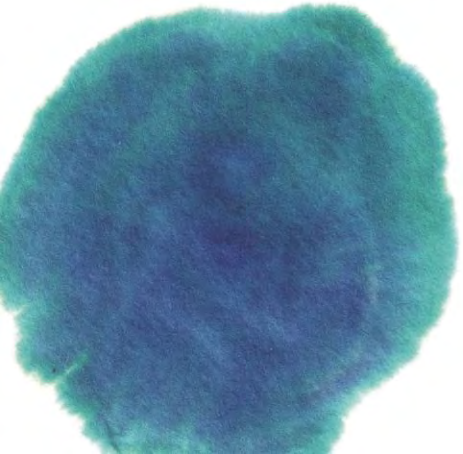
Ecosystem Effect of Fishing





IFRAME

as an EAF

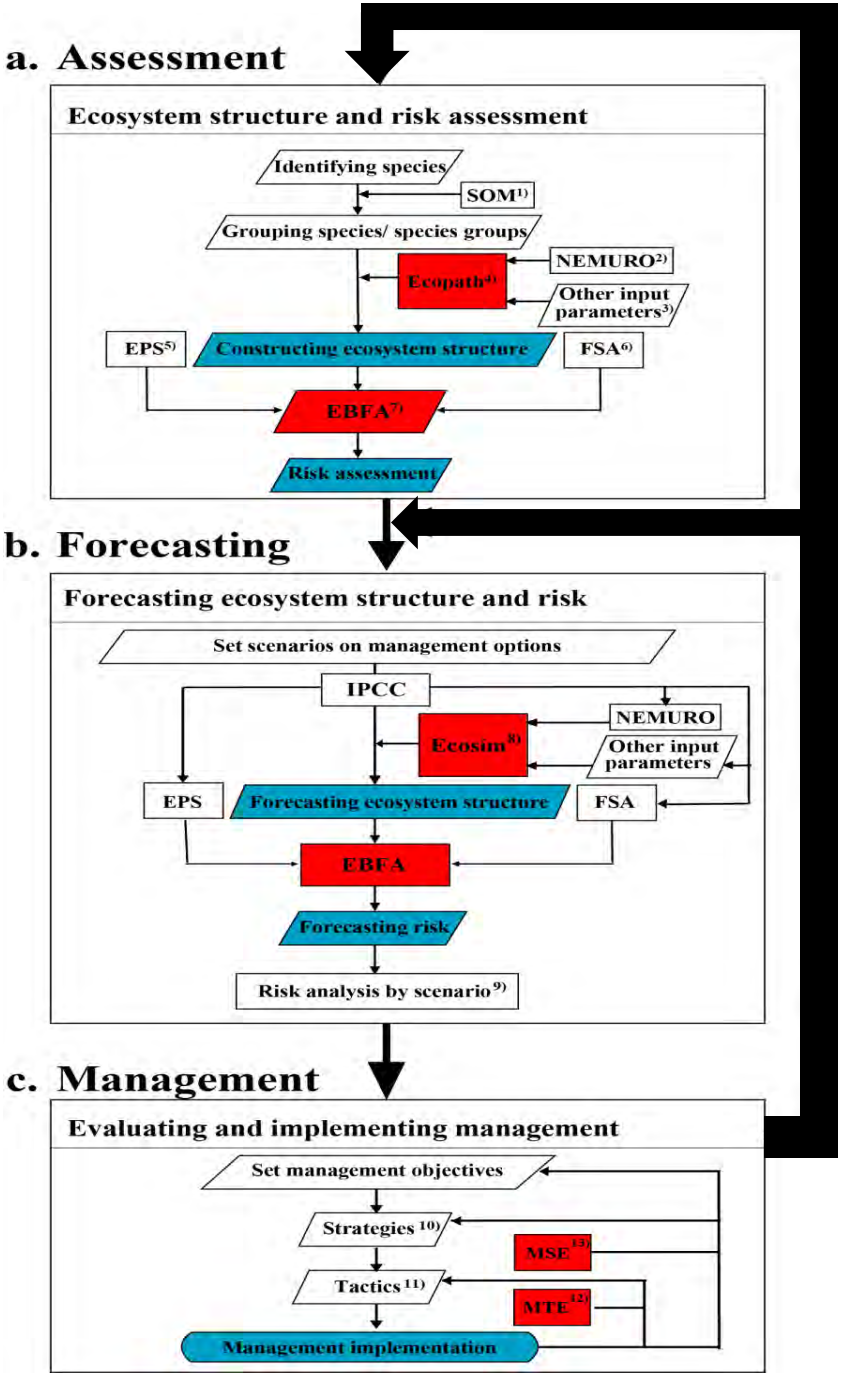


IFRAME

Integrated Fisheries Risk Analysis Method for Ecosystems

ICES Journal of Marine Science

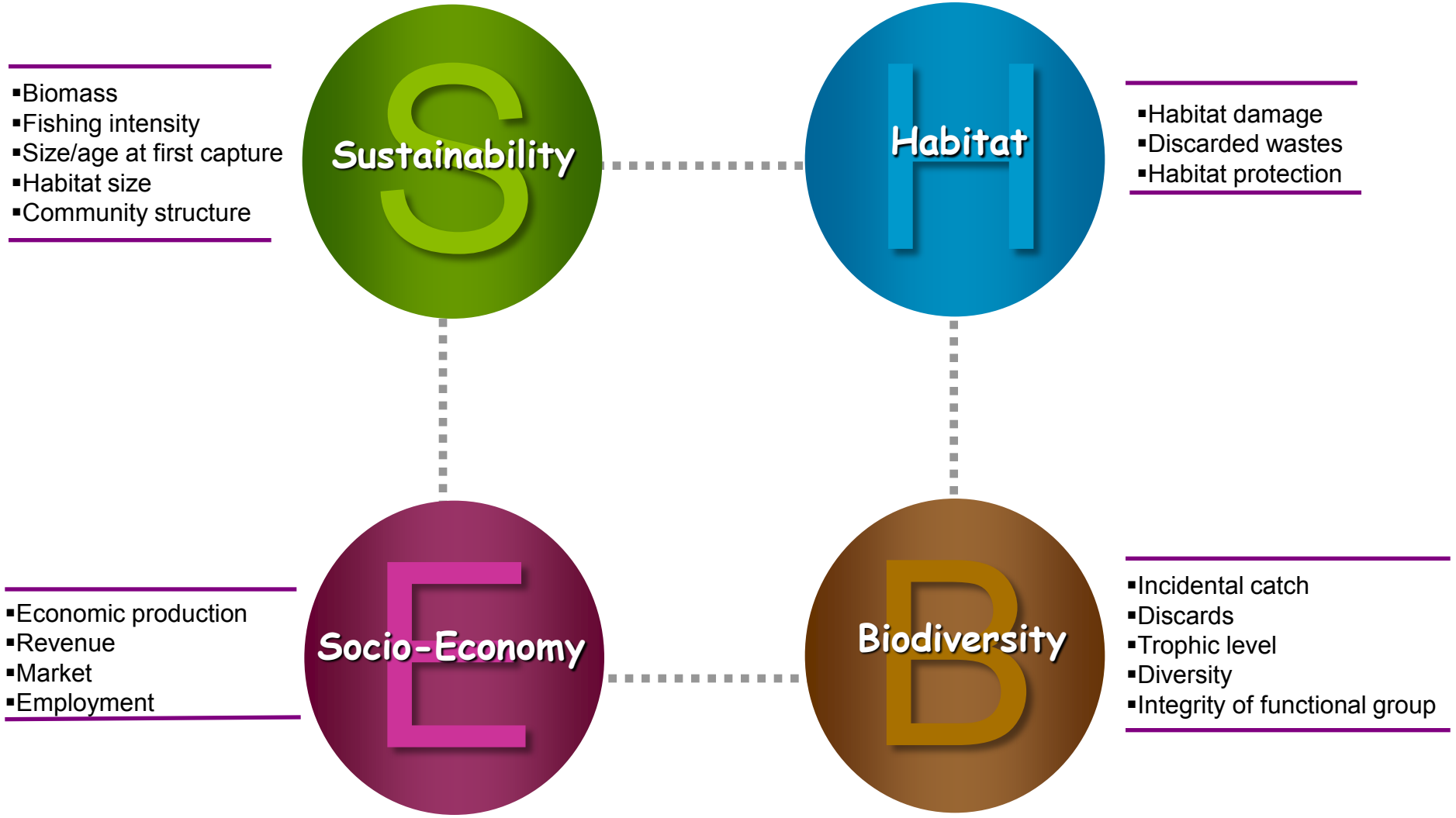
by Zhang et al. (2011)



IFRAME: 2 tier system

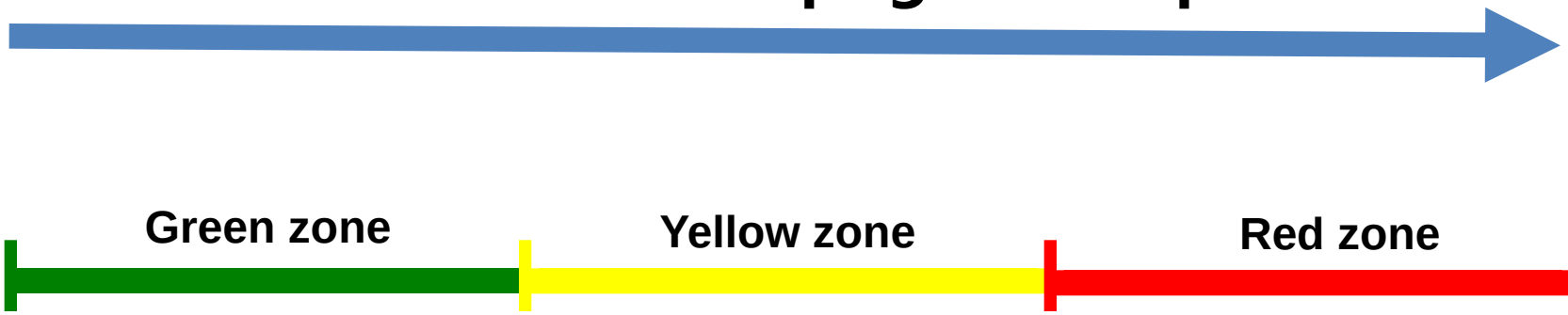
Tier	Method	Level of information
1	Quantitative analysis	High
2	Semi-quantitative or Qualitative Analysis	Low

Management objectives, attributes & indicators



Reference Points (RP) and Risks

Increased anthropogenic impact



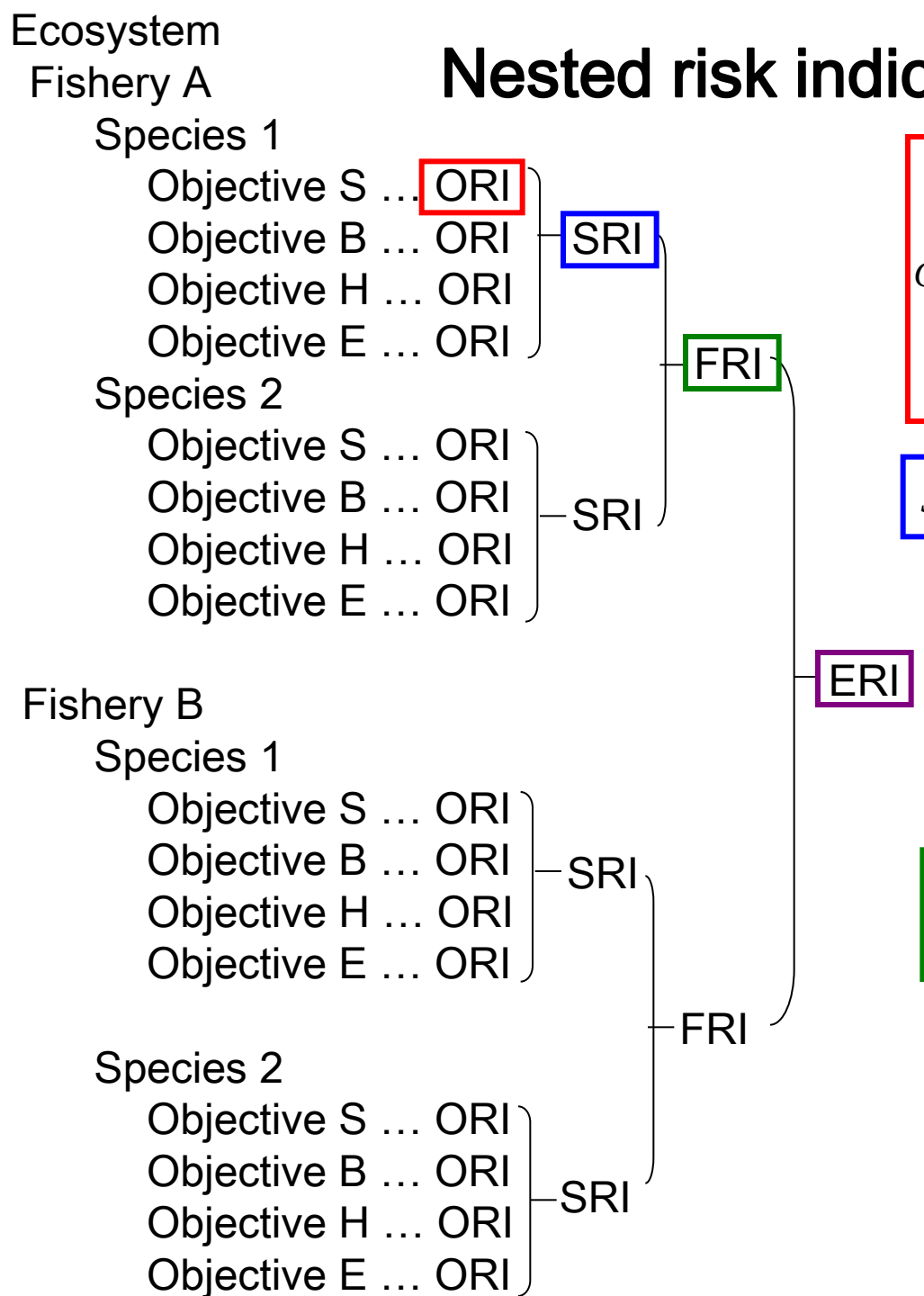
Undisturbed **Target RP** **Limit RP**

$$RS_i = \left(\frac{I_{target} - Ii}{I_{target} - Ilimit}\right) + 1$$

where, if $RS_i<0$, $RS_i=0$, and if $RS_i>3$, $RS_i=3$

Improved by proper management

Nested risk indices of IFRAME



$$ORI = \frac{\sum_{i-1}^{n} I_i W_i}{\sum_{i=1}^{n} Wi}$$

I_i : Score of indicator i
W_i : Weighting factor of indicator i
n : Number of indicators

$$SRI = \lambda_S ORI_S + \lambda_B ORI_B + \lambda_H ORI_H + \lambda_E ORI_E$$

$\lambda_S, \lambda_H, \lambda_B, \lambda_E$: Weighting value for objectives

$$\sum \lambda = 1.0$$

ORI_S : Sustainability risk index
ORI_B : Biodiversity risk index
ORI_H : Habitat risk index
ORI_E : Socio-economic risk index

$$FRI = \frac{\sum B_i SRI_i}{\sum B_i}$$

B_i : Biomass or biomass index of species i

$$ERI = \frac{\sum C_i FRI_i}{\sum C_i}$$

C_i : Catch of fishery

Objectives of FUTURE Implementation Strategy

1. **Understanding Critical Processes in the North Pacific (Obj.1)**

Three key questions were adopted as priorities for FUTURE research activities:

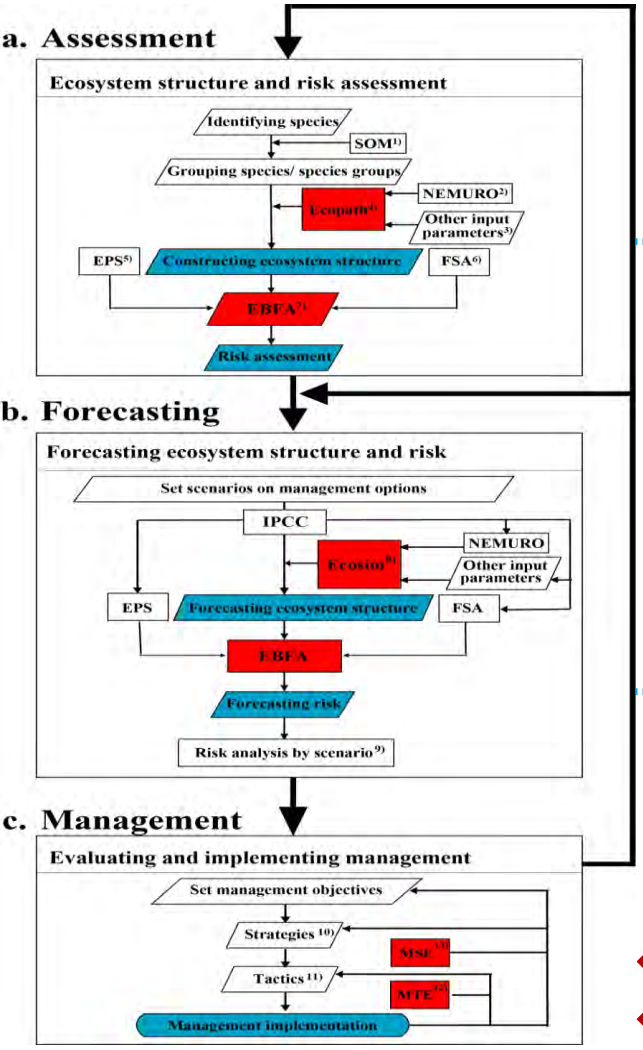
- What determines an ecosystem's intrinsic resilience and vulnerability to natural and anthropogenic forcing? (**Q1**)
- How do ecosystems respond to natural and anthropogenic forcing, and how might they change in the future? (**Q2**)
- How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems? (**Q3**)

2. **Status, Outlooks, Forecasts and Engagement (Obj.2)**

--→ Basic knowledge for implementing EAM

IFRAME approach reflects FUTURE objectives

IFRAME approach — FUTURE AP — FUTURE Obj.s & Qs



←----- **AICE,** COVE — **Obj.1-Q1&Q3**

----→ **Status Reports (S**OFE) — **Obj.2**

←----- **COVE,** AICE — **Obj.1-Q2**

----→ **Outlooks & Forecasts (**S**OF**E) — **Obj.2**

←----- COVE, AICE for feedback and evaluation — **Obj.1-Q1-Q3**

←----- **Engagement (**SOF**E)** — **Obj.2**

Utility of the IFRAME approach

…

- *Seven representative classes of models were selected to illustrate the utility of the approach for assessing climate change impacts on higher trophic level species.*

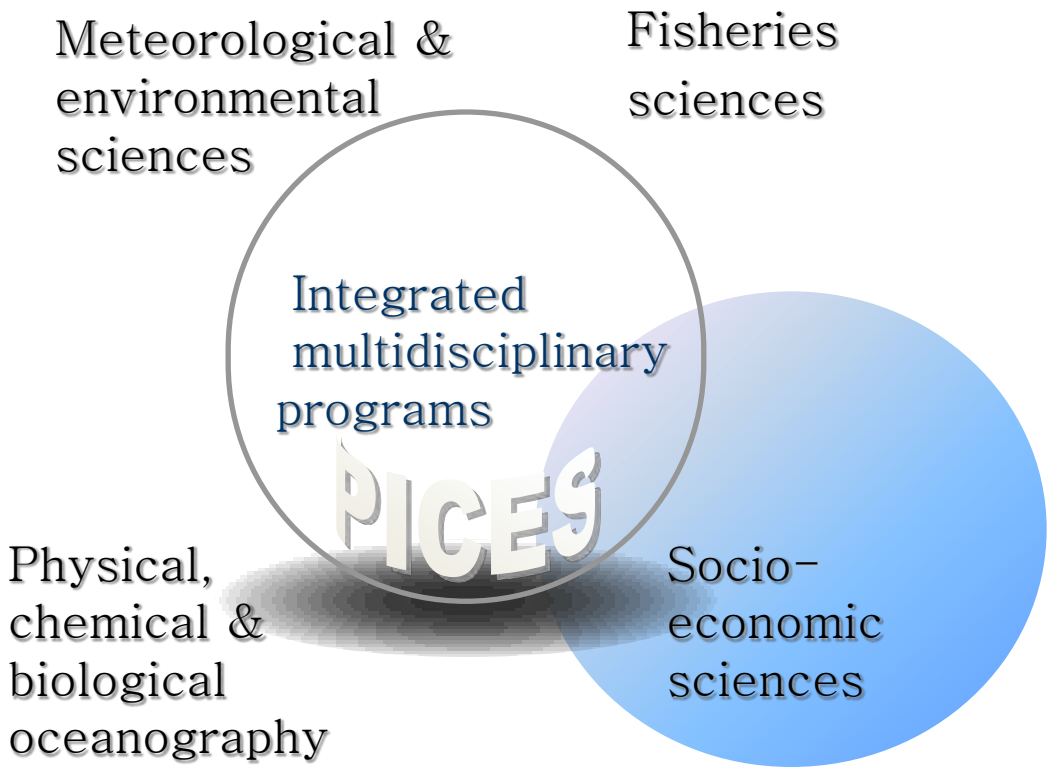
  ….

- *The IFRAME modeling approach was best suited to evaluate the performance of the mitigation strategies relative to….*

(Hollowed et al. (2012), Climate Change)

Approach to scientific need for EAM

We need strengthen links among



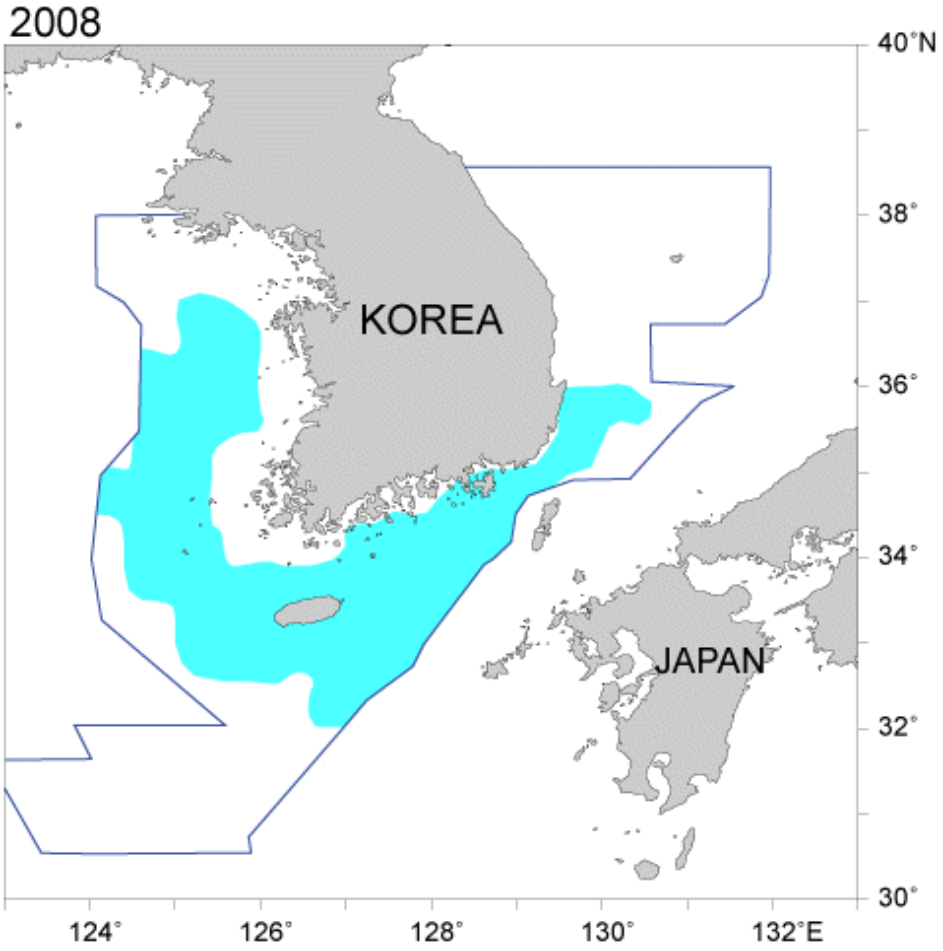
Application

of the approach

Application of IFRAME

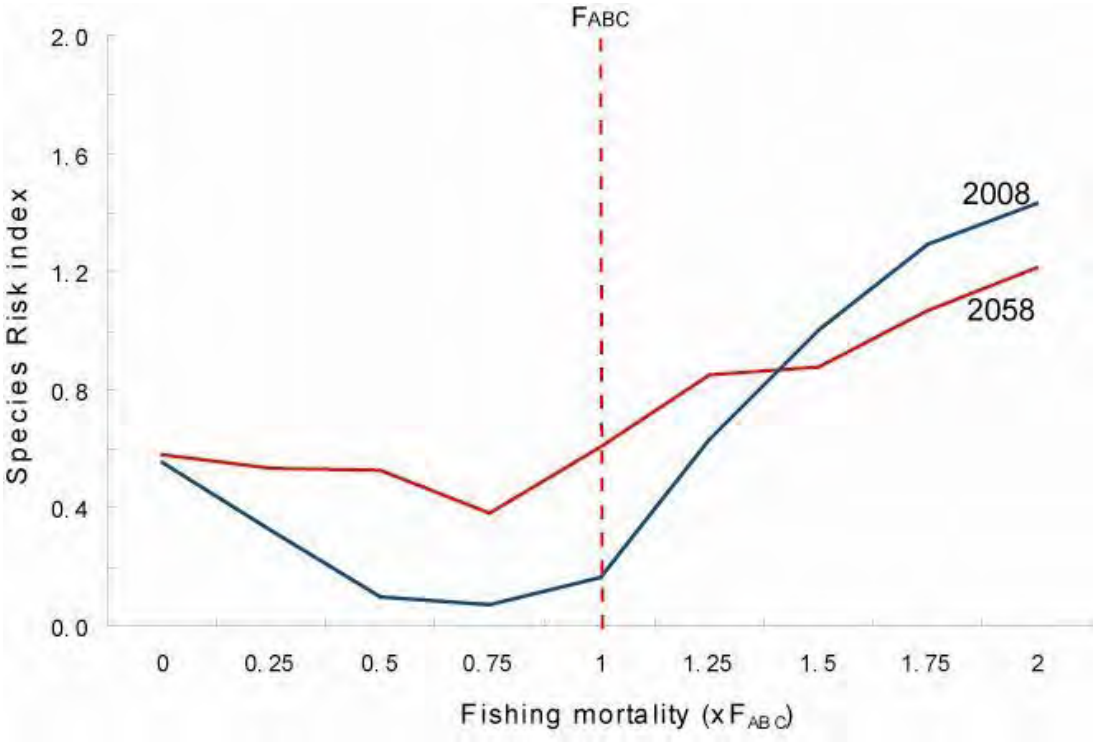
- Korean purse seine fishery (*Zhang et al., 2009*)
- Tongyeong marine ranch ecosystem in Korea (*Zhang et al., 2009*)
- Korean chub mackerel biomass and production (*Lee et al., 2012*)
- Kenyan coral-reef fisheries (*Barasa, 2013*)
- Yellow Sea fisheries (*Lee, 2014*)
- Korean coastal artisanal fisheries (*Yoon, 2014*)
- Taean marine ranch fisheries in Korea (*Zhang et al., 2014*)
- Eastern Bering Sea trawl fishery (*Hollowed et al., in preparation*)
- Taiwan Strait fishery (*Lan et al., in preparation*)
- Indian Ocean tuna fishery (*Lan et al., in preparation*)
- Red Sea fisheries (*Mahdy, in preparation*)

Prediction of Habitat distribution of chub mackerel



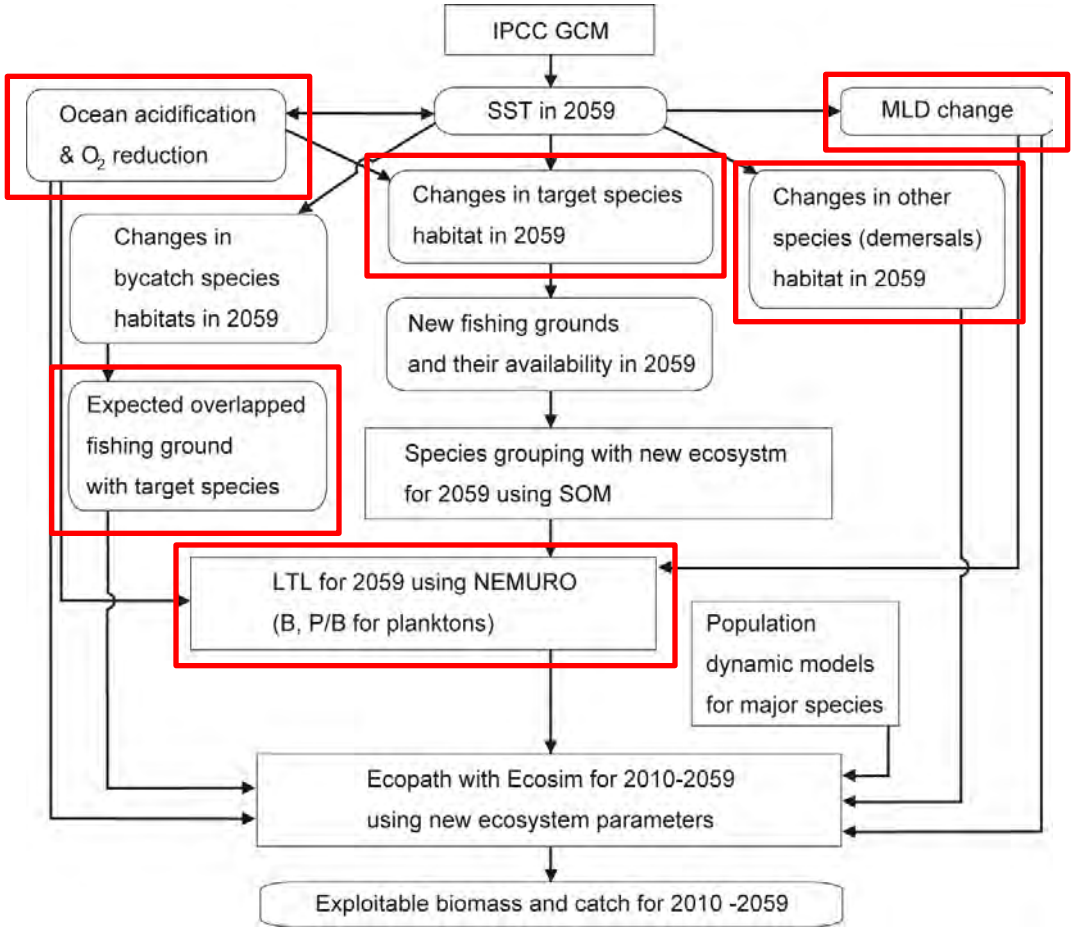
- SST range: 14.4-22.5℃
- Faster northward movement than results of Cheung's and ellipse's in the Japan/East Sea
- The main habitat area of chub mackerel will be outside of the South Korean EEZ in Japan/East Sea in 2108

Species Risk Indices of chub mackerel

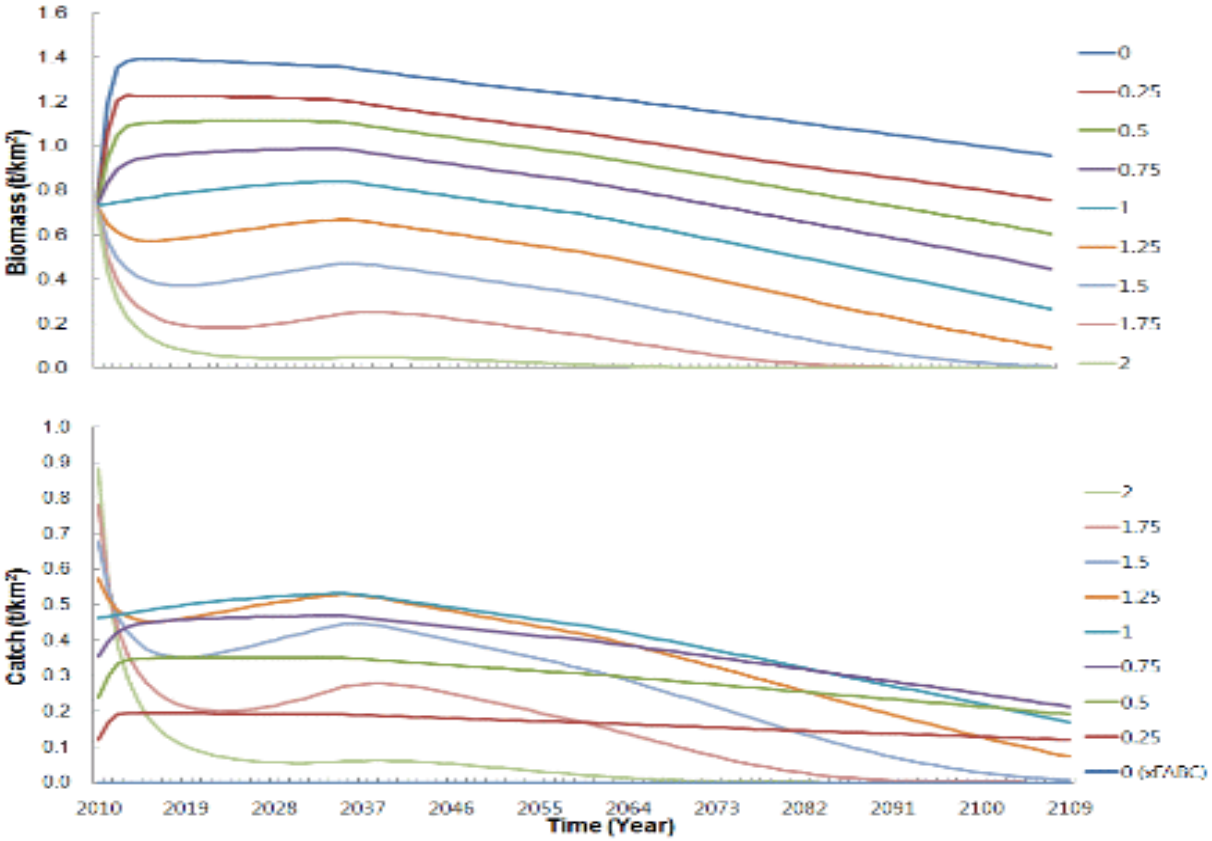


- SRI for 2058 : higher than that of 2008 from zero F to $1.25F_{ABC}$
- SRI: lowest with $0.75F_{ABC}$ in 2008 and 2058
- Fishing with F_{ABC} level will cause ecological overfishing, suggesting to reduce the F level to $0.75F_{ABC}$

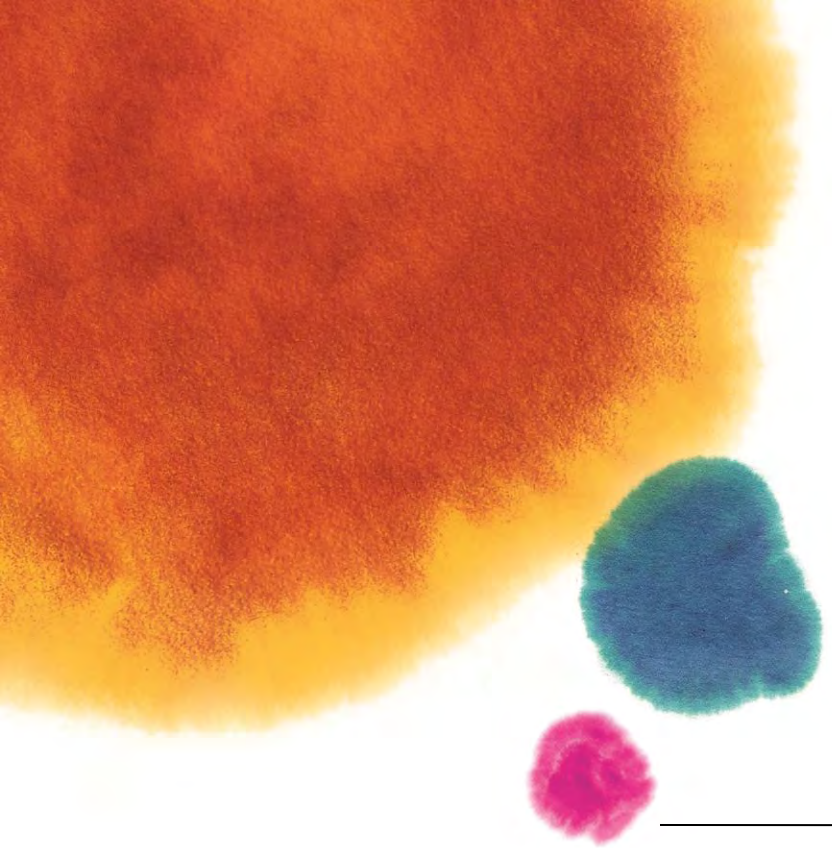
Projection of exploitable biomass



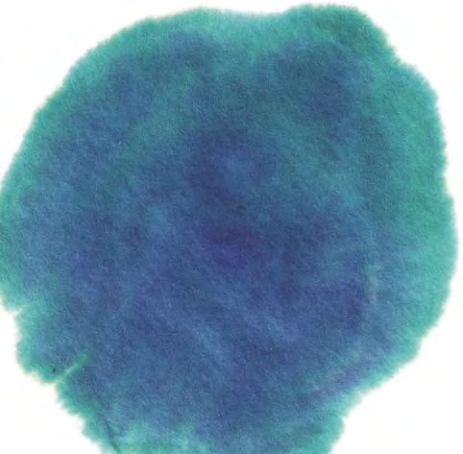
Exploitable Biomass and catch of chub mackerel by controlling F-value



- Biomass and catch were decreased by increasing fishing mortality
- Fishing mortality should be reduced in the future because of the collapse in biomass of chub mackerel over F_{ABC}



Improvements in IFRAME



Recent improvements in IFRAME

- Revision of methods for estimating risk score (RS) and fishery risk index (FRI) (*H.W. Park, 2013, Ph.D*)
- Projection of future biomass, fishing ground and fishery production under changing climate (*J.H. Lee, 2013 Ph.D*)
- Development of indicators and reference points for coral-reef fisheries (*I.W. Barasa, 2013 M.Sc*)
- Development of Tier 2 semi-quantitative analysis (*M.W. Lee, 2014 Ph.D*)
- Calibration study for Tier 1 and Tier 2 assessments (*S.C. Yoon, 2014, Ph.D*)
- Roadmap for implementing IFRAME for Korean fisheries (*Zhang et al., 2014. Ocean and Coastal Management*)

Criteria of risk states for Tier 2 semi-quantitative approach using discrete data (Lee, 2014)

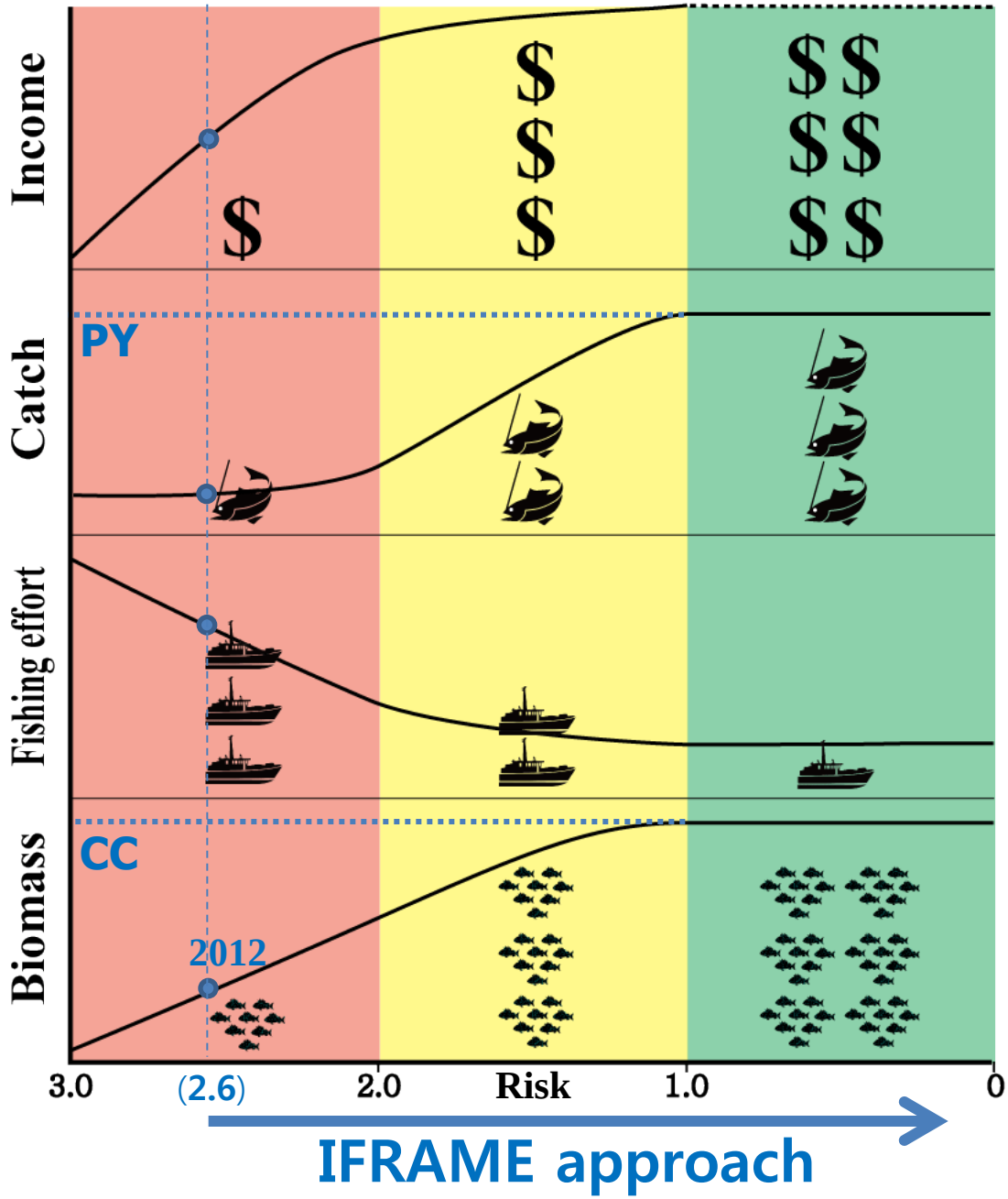
Magnitude	Abundance	Condition	Likelihood	Risk Score	Range(%)
Extremely small	Never or None	Optimal or best	High degree of undertrained	0	<5%
Small	Part or a few	Negligible	Highly unlikely	0.5	5-20%
Moderately small	Some	Minor	Unlikely	1.0	20-40%
Average	Considerable or Average	Moderate	Ambiguous	1.5	40-60%
Moderately large	Many or Major	Major	Likely	2.0	60-80%
Large	Most	Severe	Highly likely	2.5	80-95%
Extremely large	All	Catastrophic, Worst	High degree of certainty Evident	3.0	>95%

Reference points for Tier 2 semi-quantitative approach (Lee, 2014)

Example, reference point for biodiversity

Attribute	Indicator	Issue	Indicator status						
			Better than target			Between target and limit		Beyond limit	
			0	0.5	1.0	1.5	2.0	2.5	3.0
Total bycatch	Bycatch rate (BC/C)	1. Weight ratio of non target(except top X species in catch) species in catch	Catch of non target species is extremely small	Catch of non target species is small	Catch of non target species is moderately small	Catch of non target species is average	Catch of non target species is moderately large	Catch of non target species is large	Catch of non target species is extremely large
Total discards	Discards rate (D/C)	1. Ratio of discarded fish in catch	Amount of discarded fish is extremely small	Amount of discarded fish is small	Amount of discarded fish is moderately small	Amount of discarded fish is average	Amount of discarded fish is moderately large	Amount of discarded fish is large	Amount of discarded fish is extremely large
Diversity	Diversity index (DI)	1. Existence of species composition data by scientific survey or catch data 2. Change of species number 3.Dominant species change in catch	There are sufficient time series data (more than recent 5 years) on species composition by scientific survey, Number of species is unchanged Dominant species is unchanged	There are sufficient time series data (more than recent 5 years) on species composition by catch data, Number of species is unchanged Dominant species is unchanged	There are time series data (recent 3-5 years) on species composition by catch data, Number of species is unchanged Dominant species is unchanged	There are part of data (less than recent 3 years) on species composition by catch data, Number of species is part decreased Dominant species is part changed	There are part of data (less than recent 3 years) on species composition by catch data, Number of species is some decreased Dominant species is some changed	There are part of data (less than recent 3 years) on species composition by catch data, Number of species is considerable decreased Dominant species is considerable changed	There are part of data (less than recent 3 years) on species composition by catch data, Number of species is most decreased Dominant species is most changed

IFRAME approach for improving fisheries (Zhang et al., 2014)



Thank you