北海道大学

Latest Topic of Stock Assessment

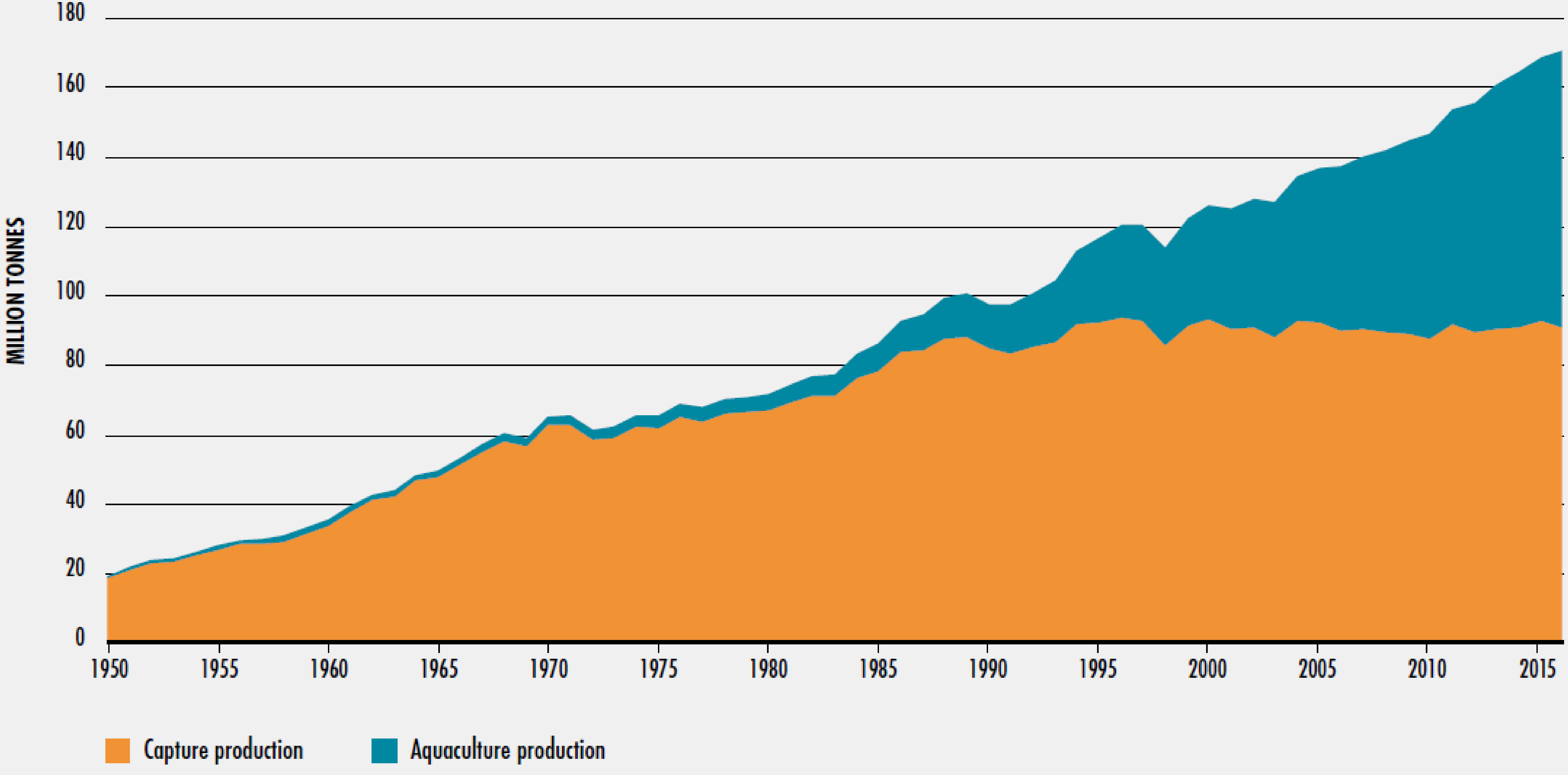
MATSUISHI Takashi Fritz

HOKKAIDO UNIVERSITY

19 SEPTEMBER 2018

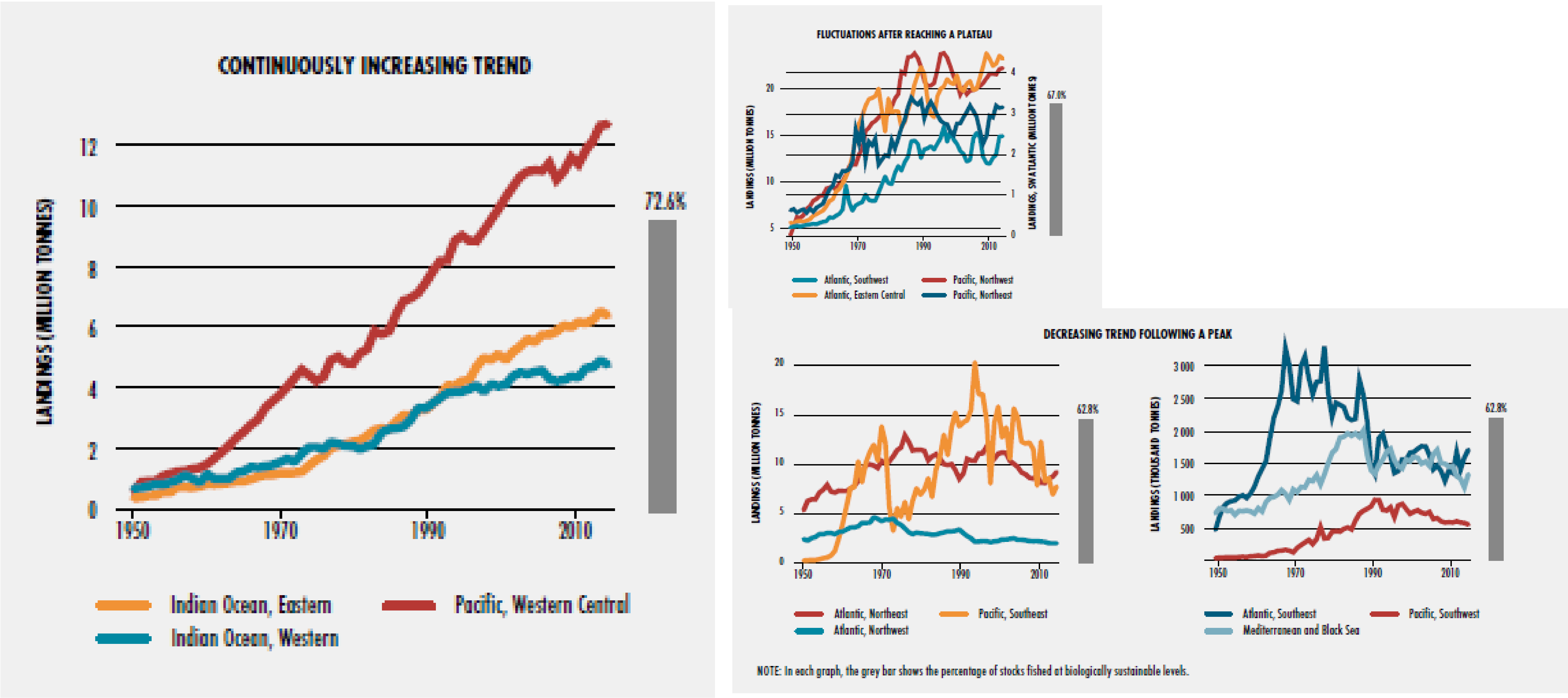

Food and Agriculture
Organization of the
United Nations
2018
THE STATE OF
WORLD FISHERIES
AND AQUACULTURE
MEETING THE SUSTAINABLE
DEVELOPMENT GOALS

FIGURE 1
WORLD CAPTURE FISHERIES AND AQUACULTURE PRODUCTION



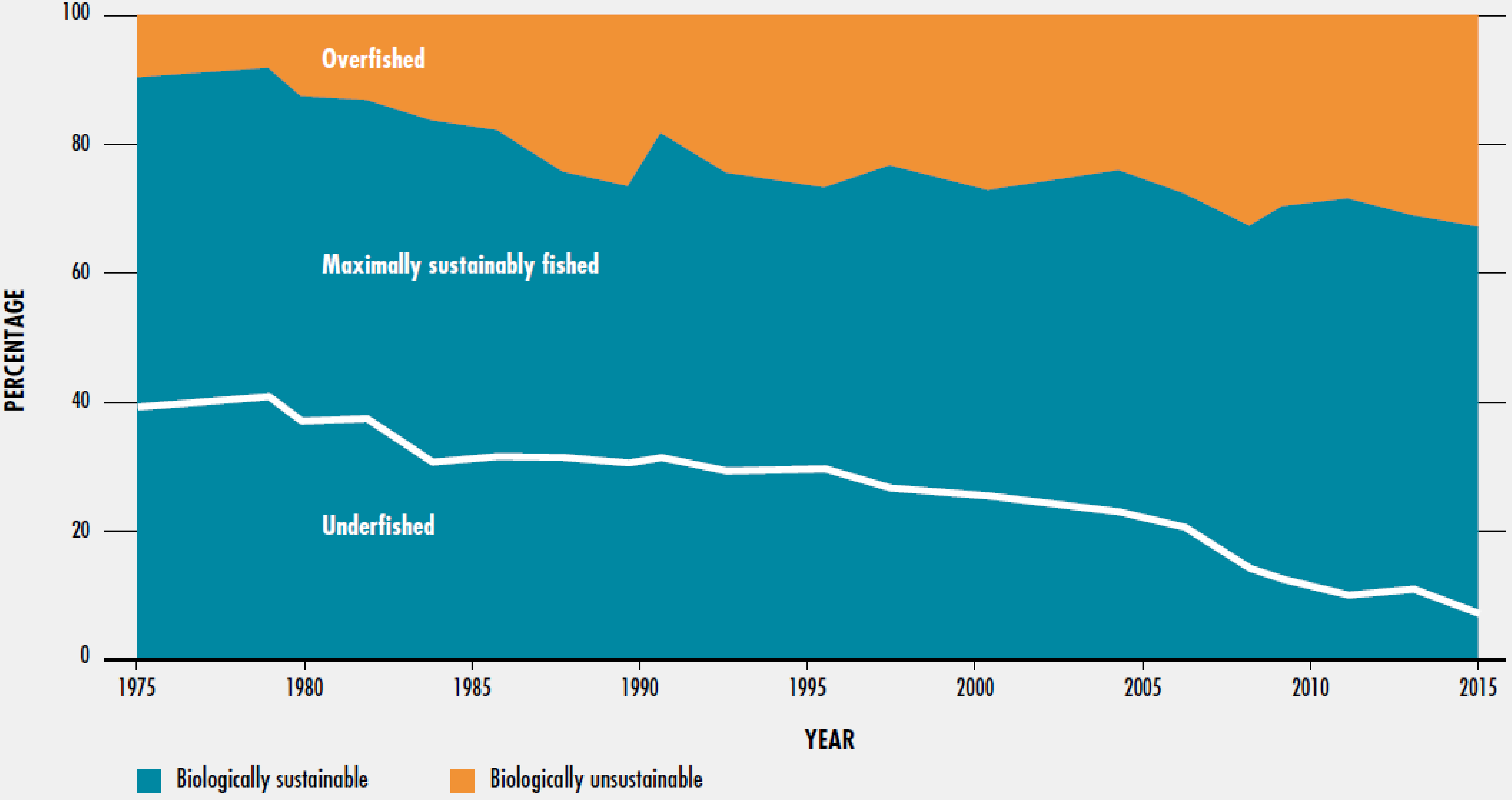
NOTE: Excludes aquatic mammals, crocodiles, alligators and caimans, seaweeds and other aquatic plants

FIGURE 16
THE THREE TEMPORAL PATTERNS IN FISH LANDINGS, 1950–2015

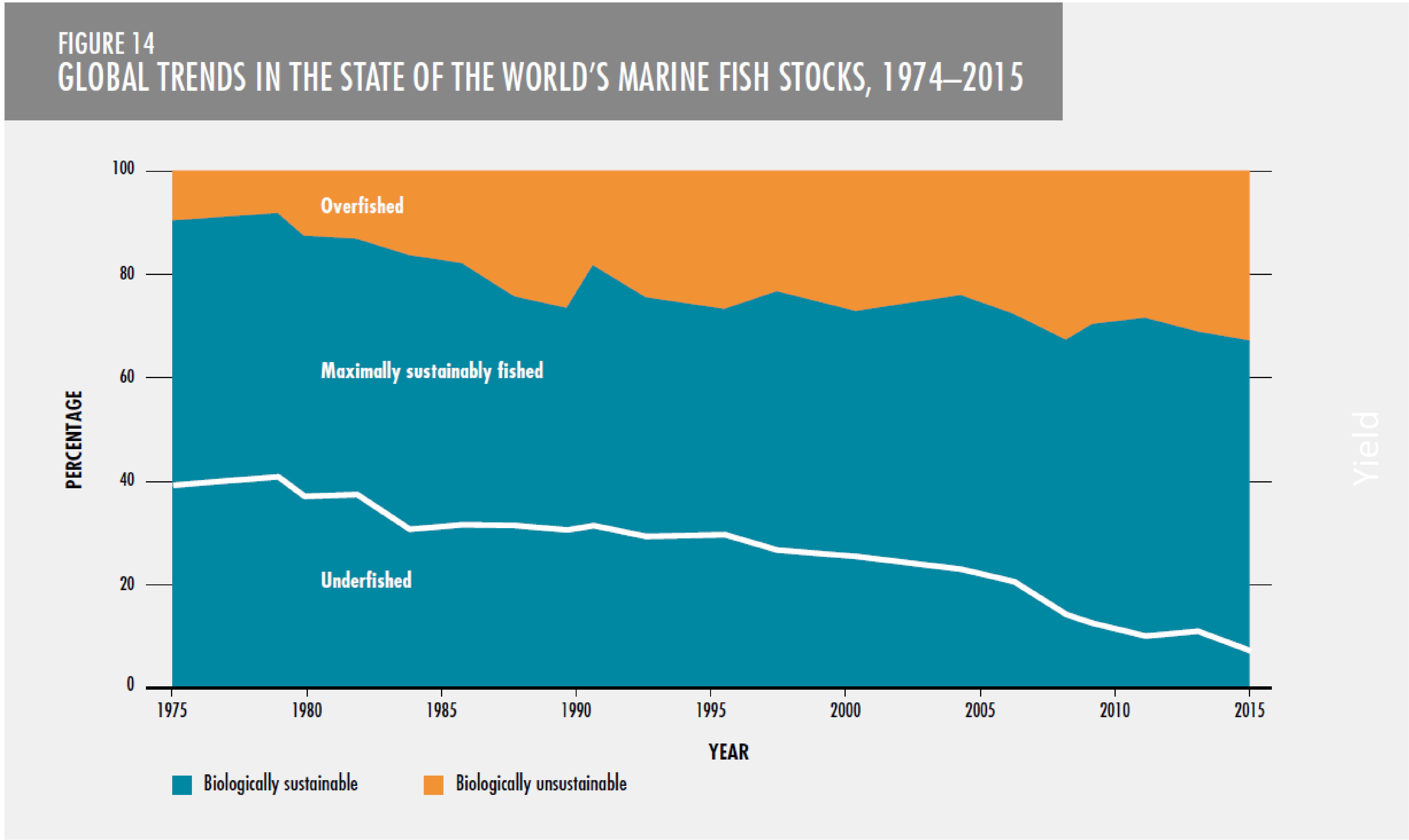


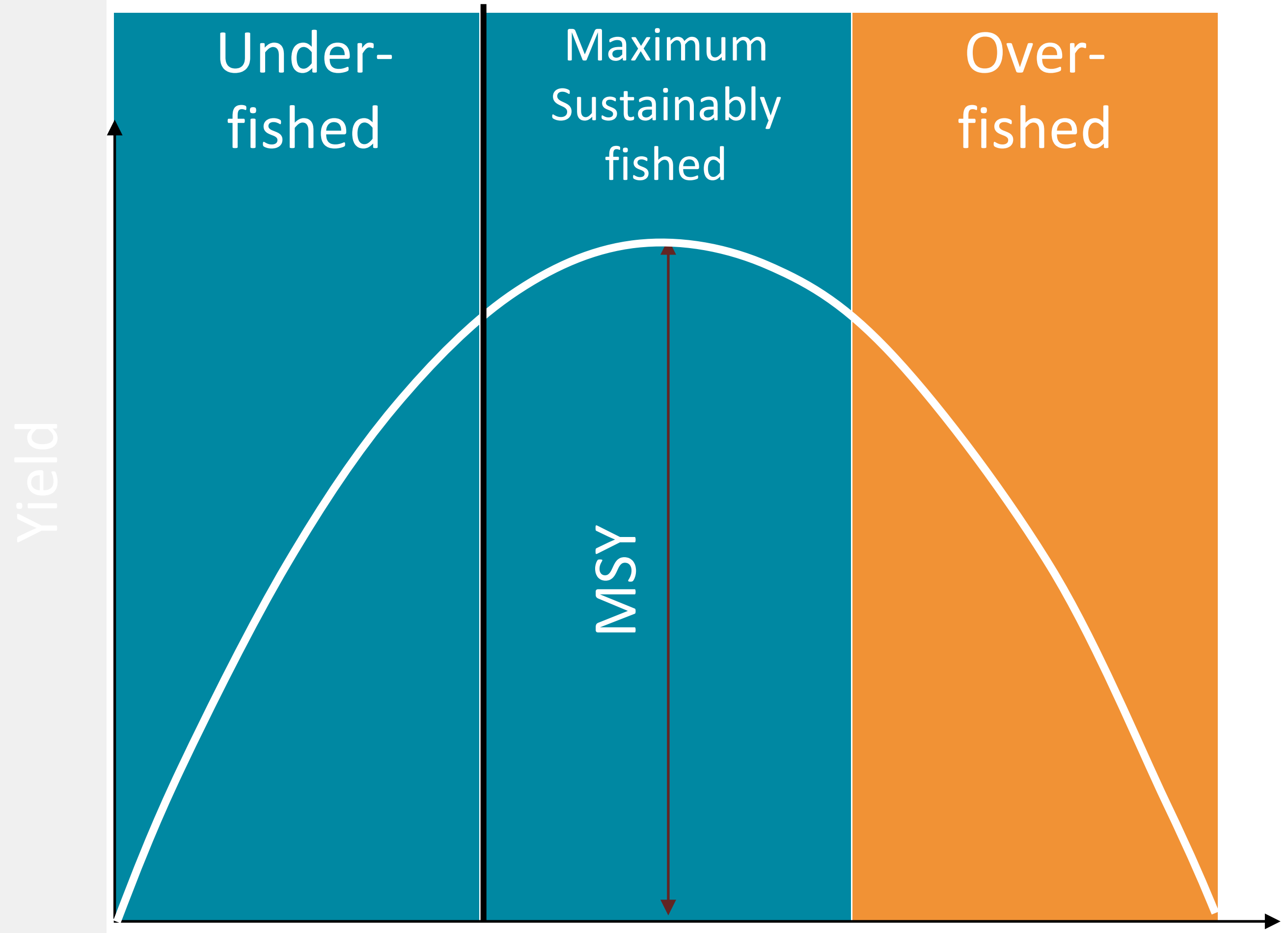
NOTE: In each graph, the grey bar shows the percentage of stocks fished at biologically sustainable levels.

FIGURE 14
GLOBAL TRENDS IN THE STATE OF THE WORLD'S MARINE FISH STOCKS, 1974–2015



Possibility to increase Yield





Evaluation of Feedback Fisheries Management Strategy Applied for Mixed Species Data

MATSUISHI Takashi Fritz
D. Wu, R. Kinashi and
Ledhyane Ika Harlyan
Faculty of Fisheries Sciences,

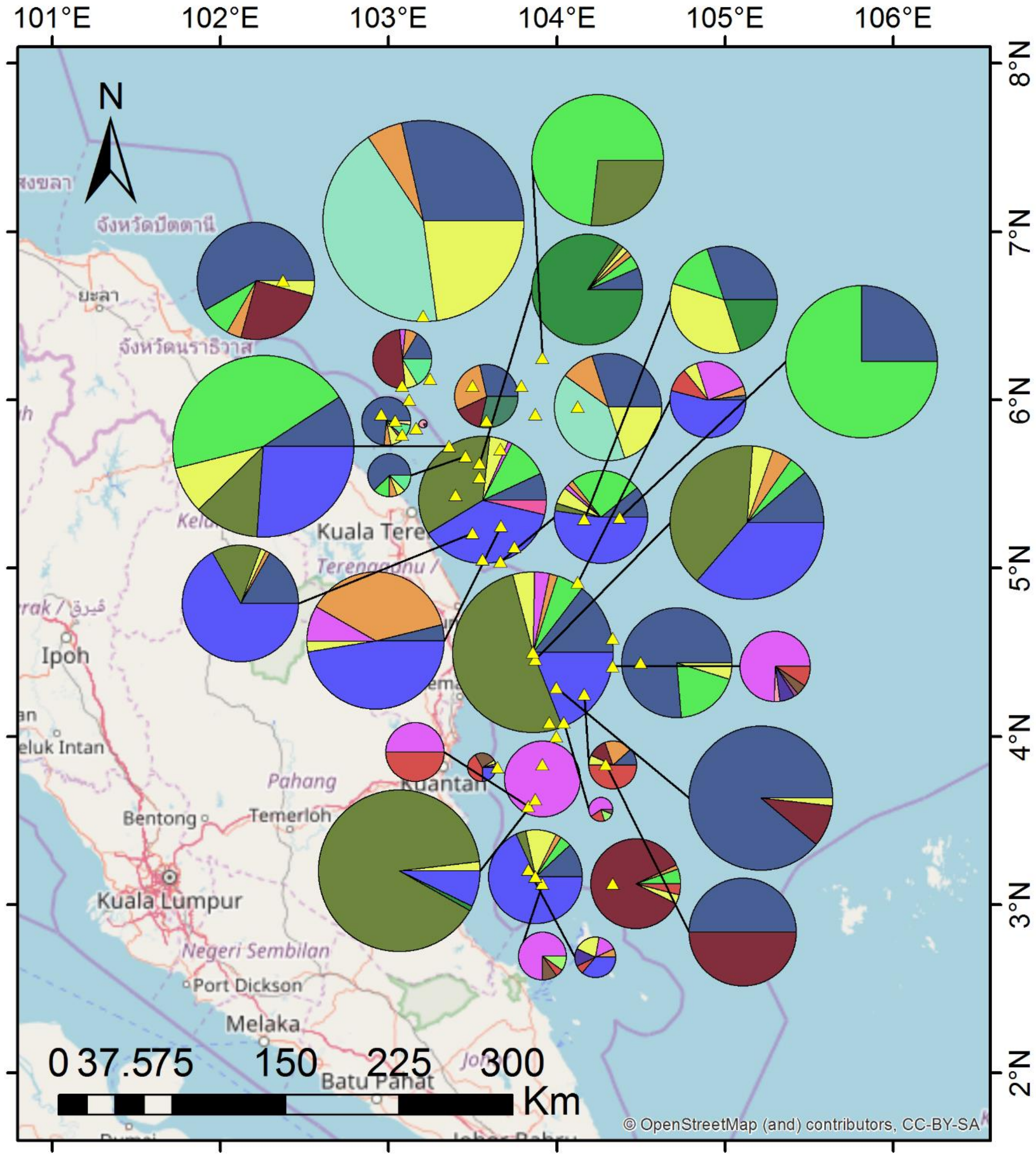
北海道大学
HOKKAIDO UNIVERSITY

Mixed Species Problem

- In tropical countries, Fishery information is sometimes limited
- Catch statistics is not available by species
- Fisheries Management should be applied for multi species gear (purse seine etc)
- Single species population assessment and fisheries management model are not applicable without validation.

Purse Seine Fishery in Kuantan, Malaysia

Species Composition by Purse Seine Vessel in East Cost of Peninsula Malaysia



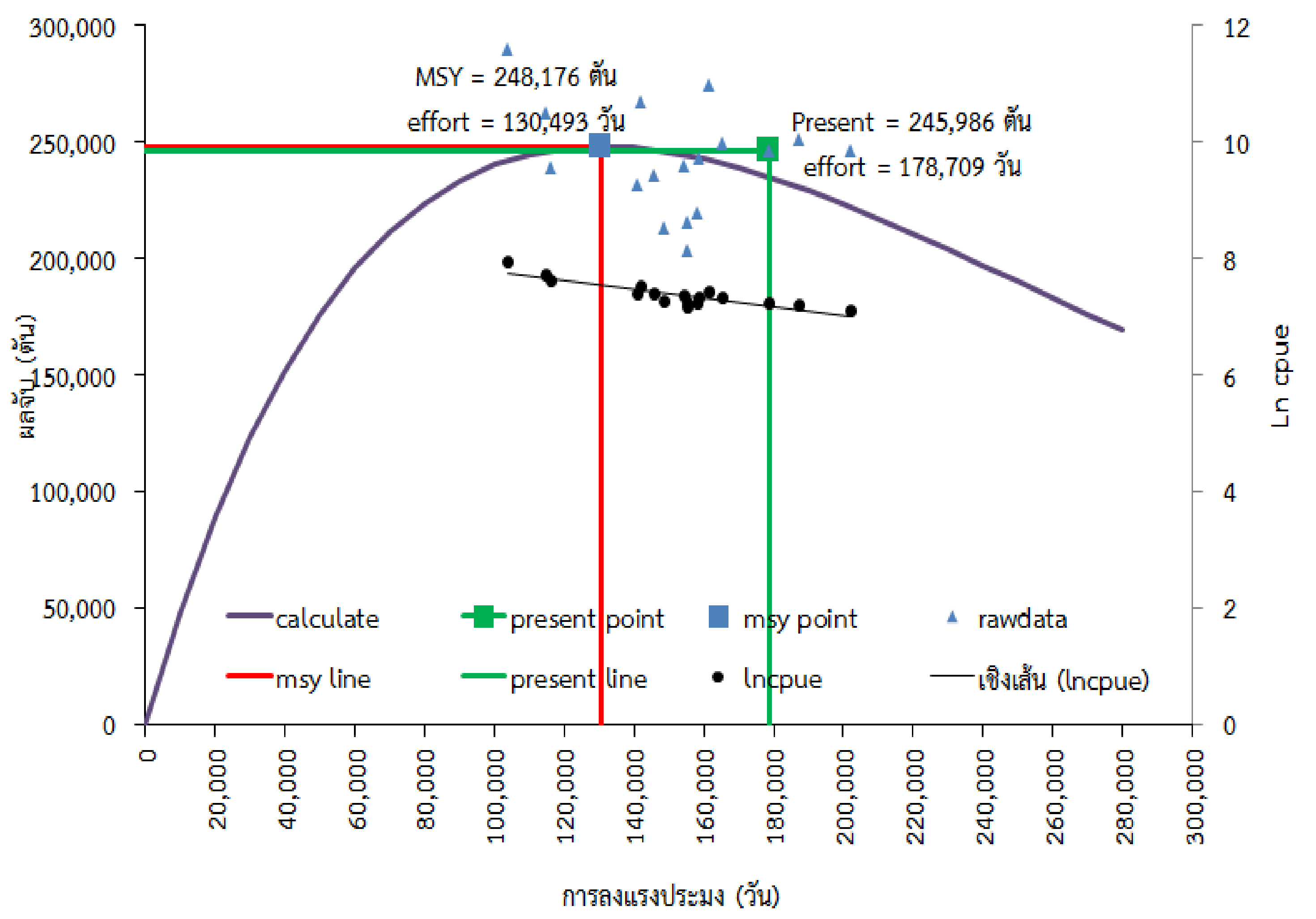
Surveyed on August 2017 with SEAFDEC/MFRDMD Harliyan et al. unpubl. data

Stock Assessment Methods

- Age based method (VPA etc)
  - Aging is difficult for tropical fished
- Production Model
  - Applicable if effort range is wider
- Feedback Control Management
  - Applicable in data poor situation
  - Maybe conservative

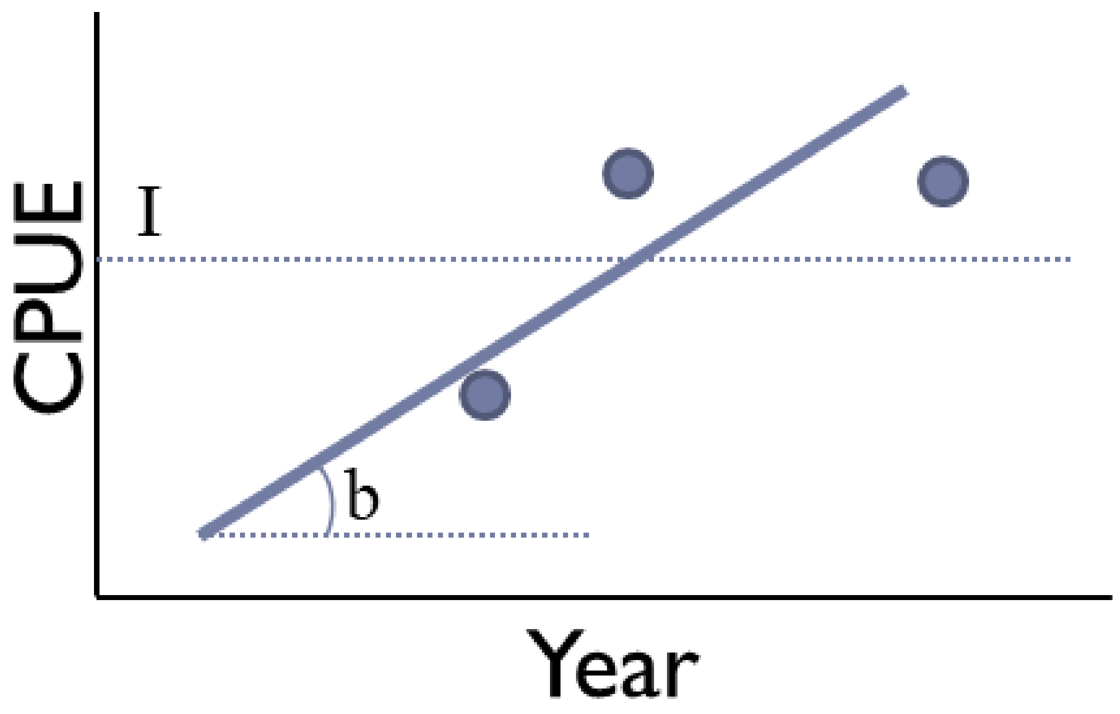
- All are developed for **Single Species Fishery**

Stock Assessment for
Pelagic group
in the Gulf of Thailand



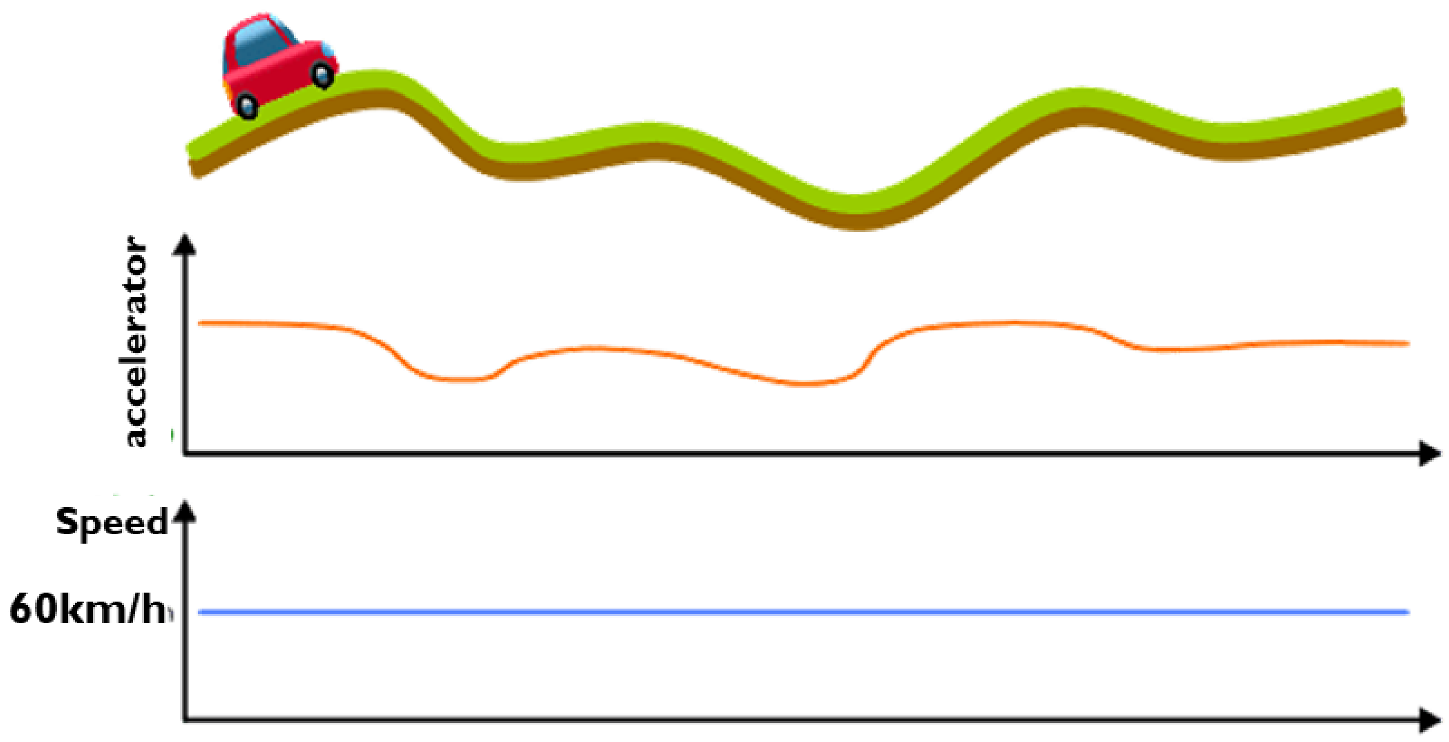
Rule 2-1 in Japanese Stock Assessment Procedure

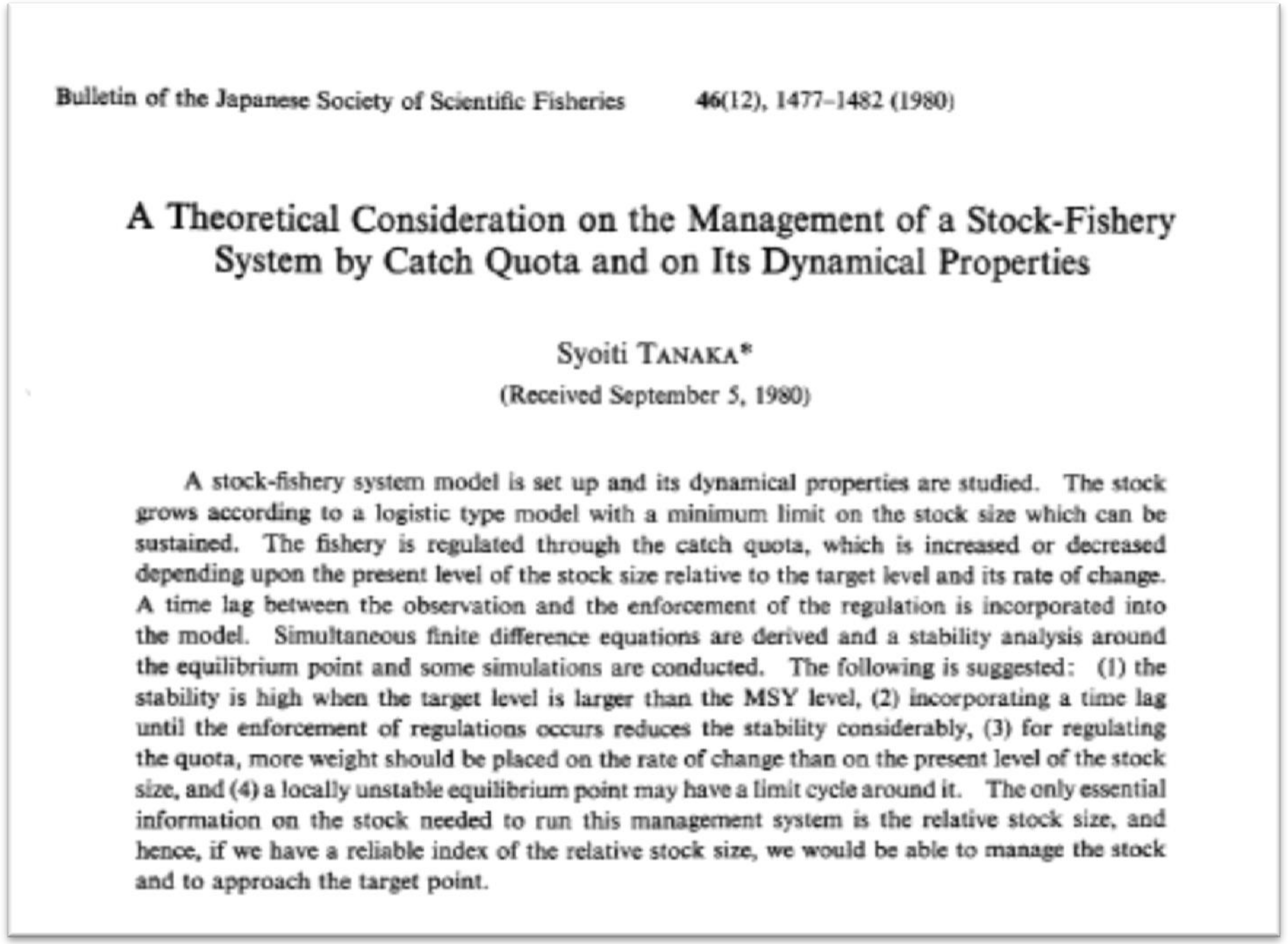
- Applied for **Data Poor Situation**
- Population Estimation is not available
- Data: C, Stock Level, CPUE
- $\mathrm{ABC} = \delta_1 \times C_t \times \gamma_1$
- $\delta_1 = 1.0$ (High)
  1.0 (Middle)
  0.8 (Low)
- $\gamma_1 = 1 + k\,b\,/\,I$
  - k: feedback parameter (1.0)
  - b: tangent of the CPUE for recent 3 years
  - I: Average of the CPUE for recent 3 years



Feedback Effort Control

- The idea is appeared in Tanaka(1980)
  - Tanaka, S. (1980). A theoretical consideration on the management of a stock-fishery system by catch quota and on its dynamical properties. *Bulletin of the Japanese Society of Scientific Fisheries*.
- If the biomass is increasing, more fishing effort can be allowed, and vice versa.





Bulletin of the Japanese Society of Scientific Fisheries 46(12), 1477–1482 (1980)

A Theoretical Consideration on the Management of a Stock-Fishery System by Catch Quota and on Its Dynamical Properties

Syoiti TANAKA*

(Received September 5, 1980)

A stock-fishery system model is set up and its dynamical properties are studied. The stock grows according to a logistic type model with a minimum limit on the stock size which can be sustained. The fishery is regulated through the catch quota, which is increased or decreased depending upon the present level of the stock size relative to the target level and its rate of change. A time lag between the observation and the enforcement of the regulation is incorporated into the model. Simultaneous finite difference equations are derived and a stability analysis around the equilibrium point and some simulations are conducted. The following is suggested: (1) the stability is high when the target level is larger than the MSY level, (2) incorporating a time lag until the enforcement of regulations occurs reduces the stability considerably, (3) for regulating the quota, more weight should be placed on the rate of change than on the present level of the stock size, and (4) a locally unstable equilibrium point may have a limit cycle around it. The only essential information on the stock needed to run this management system is the relative stock size, and hence, if we have a reliable index of the relative stock size, we would be able to manage the stock and to approach the target point.

Aim of this study

- Conduct simulation of **fishing operation** and **management** by **feedback control rule** with **mixed species** situation
- Analyze the result by comparing **MSY** to examine the applicability of the feedback control rule **for the mixed species situation**

Method

- Based on Hiramatsu (2004),
- Three (3) species
  - Population dynamics are independent
  - Caught by same gear (multi-species gear)
  - Catch and CPUE are not divided to species (mixed species data)
- Simulation for 51 years 100 iterations
  - 21 years for constant effort
  - Populations at 1st and 21st year are given (K/2)
  - After 22nd year, caught following Rule 2-1 calculated from mixed species data
  - Catch for each species are proportional to the biomass
  - Observe the population dynamics and catch for each species

Equations

$$B_{y+1} = \left\{B_y + rB_y\left(1 - \frac{B_y}{K}\right)\right\}\exp\left(\sigma_R \varepsilon_y - \frac{1}{2}\sigma_R^2\right) - qX_yB_y$$

$$I_y = \frac{B_y + B_{y+1}}{2}\exp\left(\sigma_I \eta_y - \frac{1}{2}\sigma_I^2\right)$$

K	Carrying Capacity
r	Intrinsic Growth Rate
B_y	Biomass
X_y	Effort
I_y	Population Index
σ_R	s.d. for process error
σ_I	s.d. for observation error

$\varepsilon_y, \eta_y \sim N(0,1)$

Parameters

Case 1

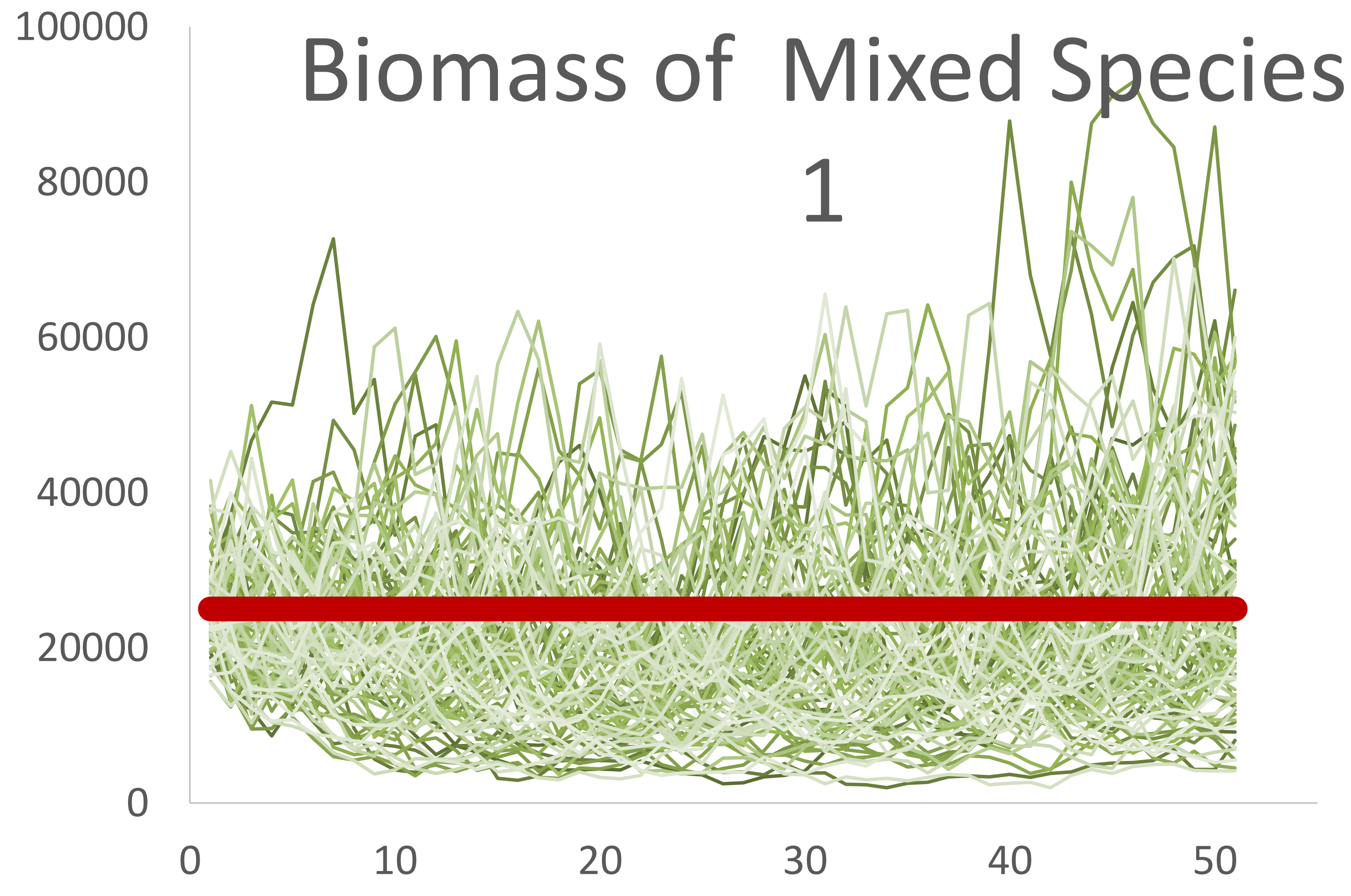
	Sp 1	Sp 2	Sp 3
B0	25,000	10,000	5,000
qE	0.106	0.106	0.106
r	0.2	0.5	1.0
K	50,000	20,000	10,000
Bmsy	25,000	10,000	5,000
MSY	2,500		
Trend	M-M		
Error	**0.2**		

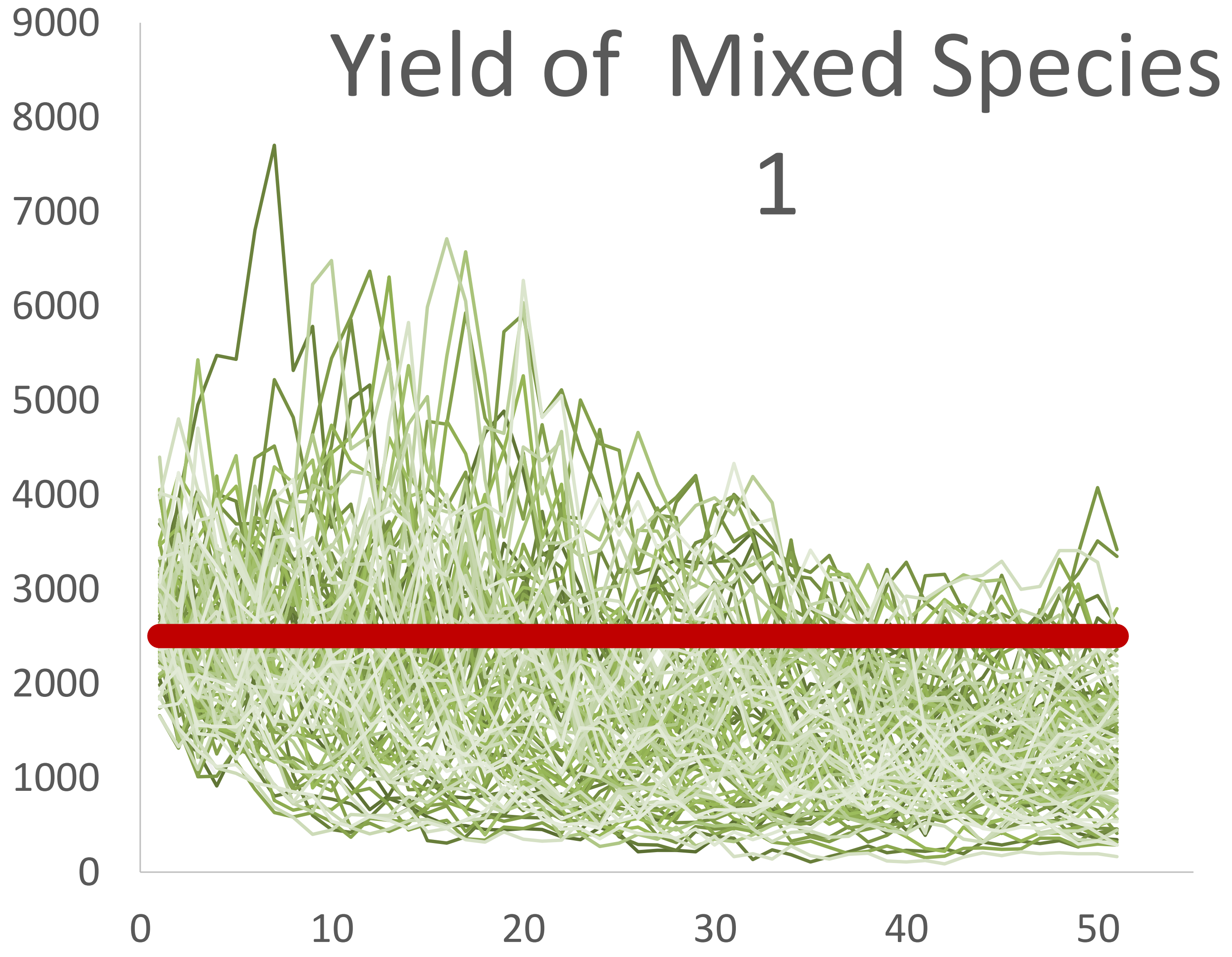
Case 2

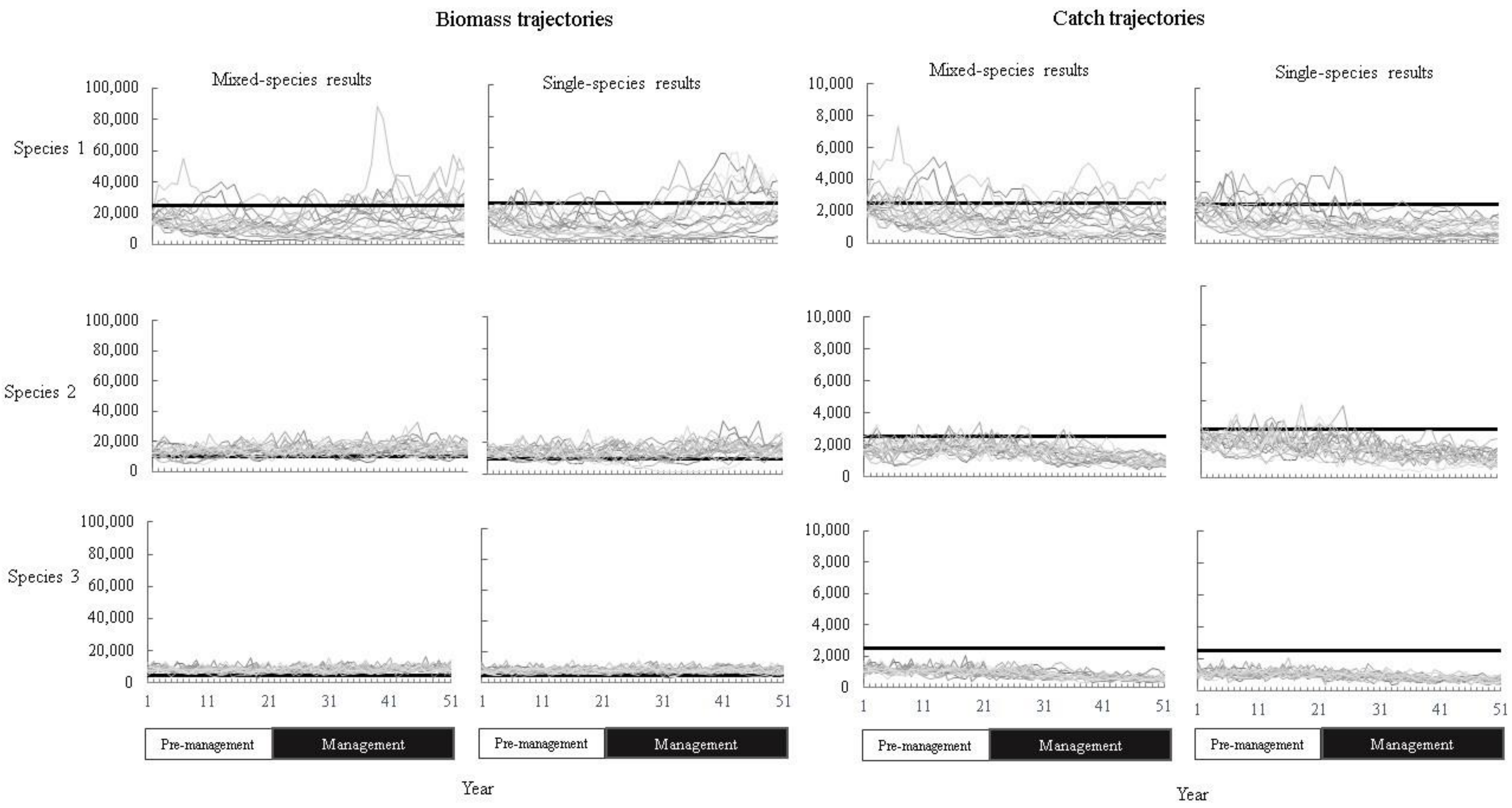
	Sp 1	Sp 2	Sp 3
B0	25,000	10,000	5,000
qE	0.106	0.106	0.106
r	0.2	0.5	1.0
K	50,000	20,000	10,000
Bmsy	25,000	10,000	5,000
MSY	2,500		
Trend	M-M		
Error	**0.3**		

Example of a Result

Case 1







- **Fig. 2.** Biomass and catch trajectories for three species after applying the default feedback harvest control rule to both mixed-species and single-species data, for the most common scenario (B_M – B_M). Only 20 trajectories are shown in each figure; both σ_R and σ_m were fixed at 0.2. Bold horizontal lines through the biomass and catch trajectories, respectively, indicate the B_{MSY} level and MSY level.

Result

Case 1

After Mix Mgmt	Sp 1	Sp2	Sp 3	Total
Yield/MSY	58%	46%	27%	**35%**
B51/Bmsy	99%	166%	176%	**126%**
Failure	0%	0%	0%	**0%**

Single Mgmt	Sp 1	Sp2	Sp 3	Total
Yield/MSY	46%	46%	27%	**30%**
B51/Bmsy	104%	165%	185%	**129%**
Failure	**7%**	0%	0%	**7%**

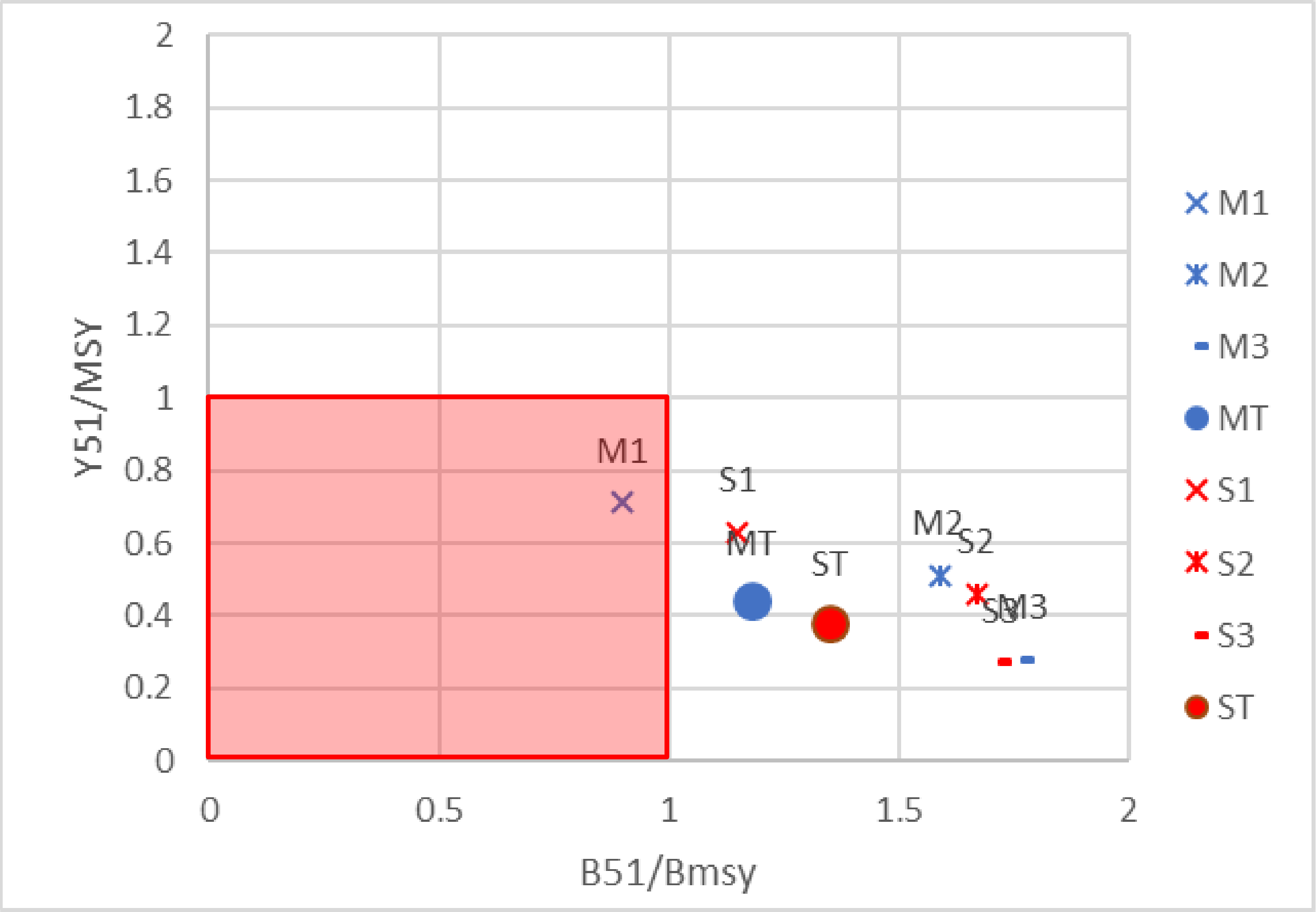
Case 2

After Mix Mgmt	Sp 1	Sp2	Sp 3	Total
Yield/MSY	43%	41%	20%	**25%**
B51/Bmsy	67%	158%	131%	**98%**
Failure	0%	1%	15%	**16%**

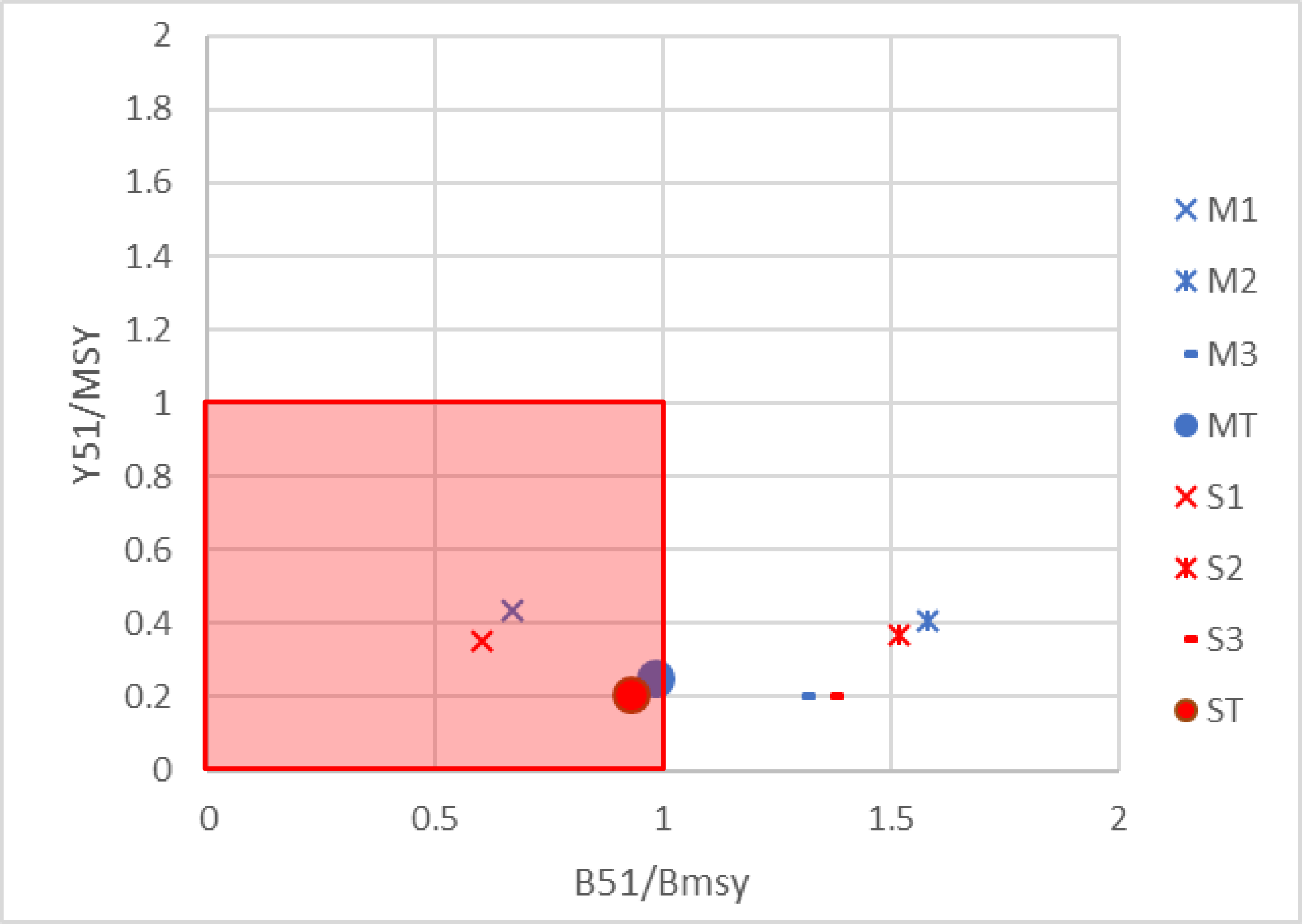
Single Mgmt	Sp 1	Sp2	Sp 3	Total
Yield/MSY	35%	37%	20%	**21%**
B51/Bmsy	60%	152%	137%	**93%**
Failure	23%	0%	16%	**36%**

Result

Case 1



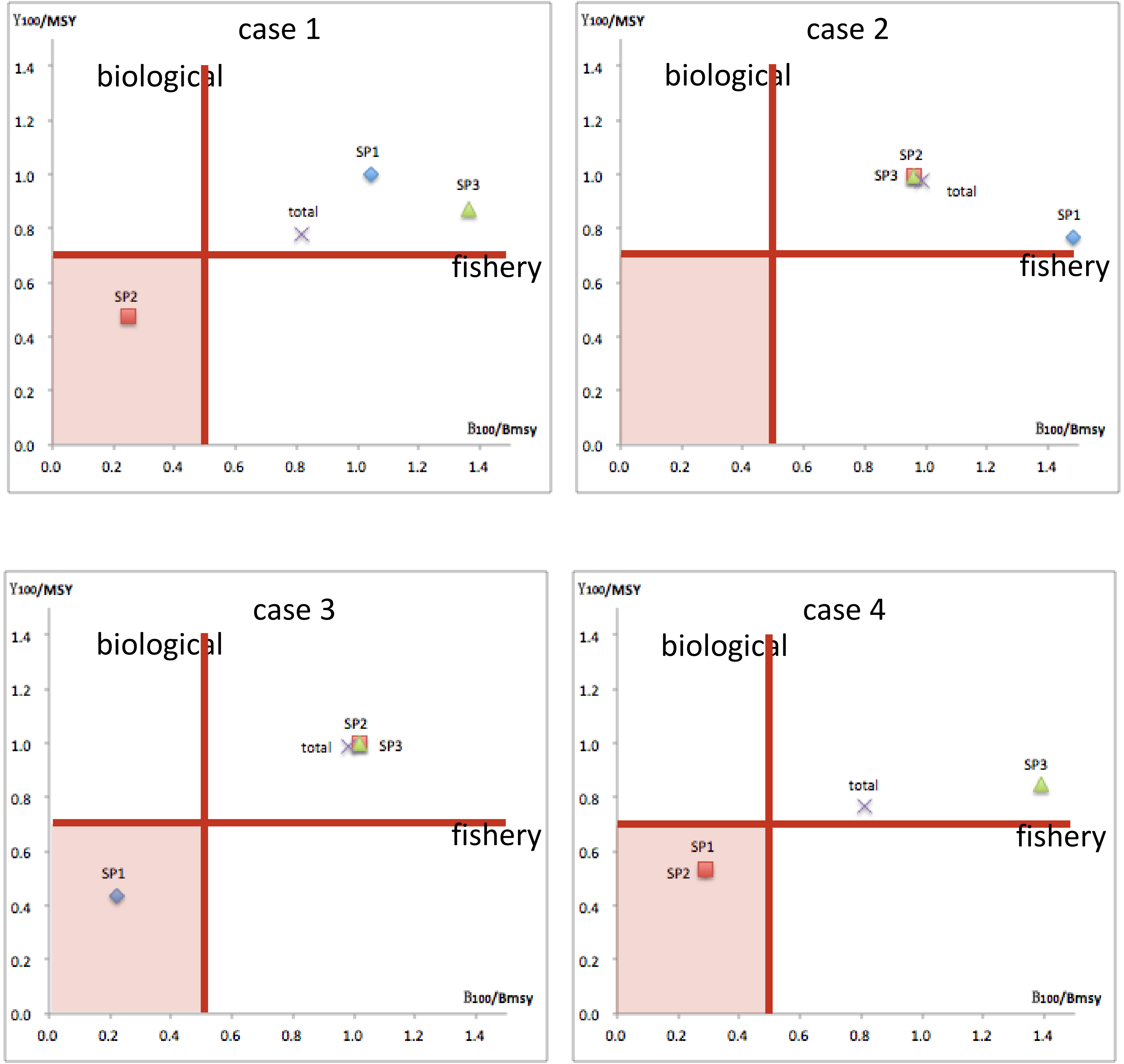
Case 2



Calculation in progress

- More species parameters (*r, K*)
- More parameters for errors (σ_R, σ_I)
- Optimum parameters for the feedback control (*k*, σ)
- Examine the influence of population dynamics before the management
- Examine the influence of duration for calculating CPUE trends (*b*)

Result of Multi-species Production Model

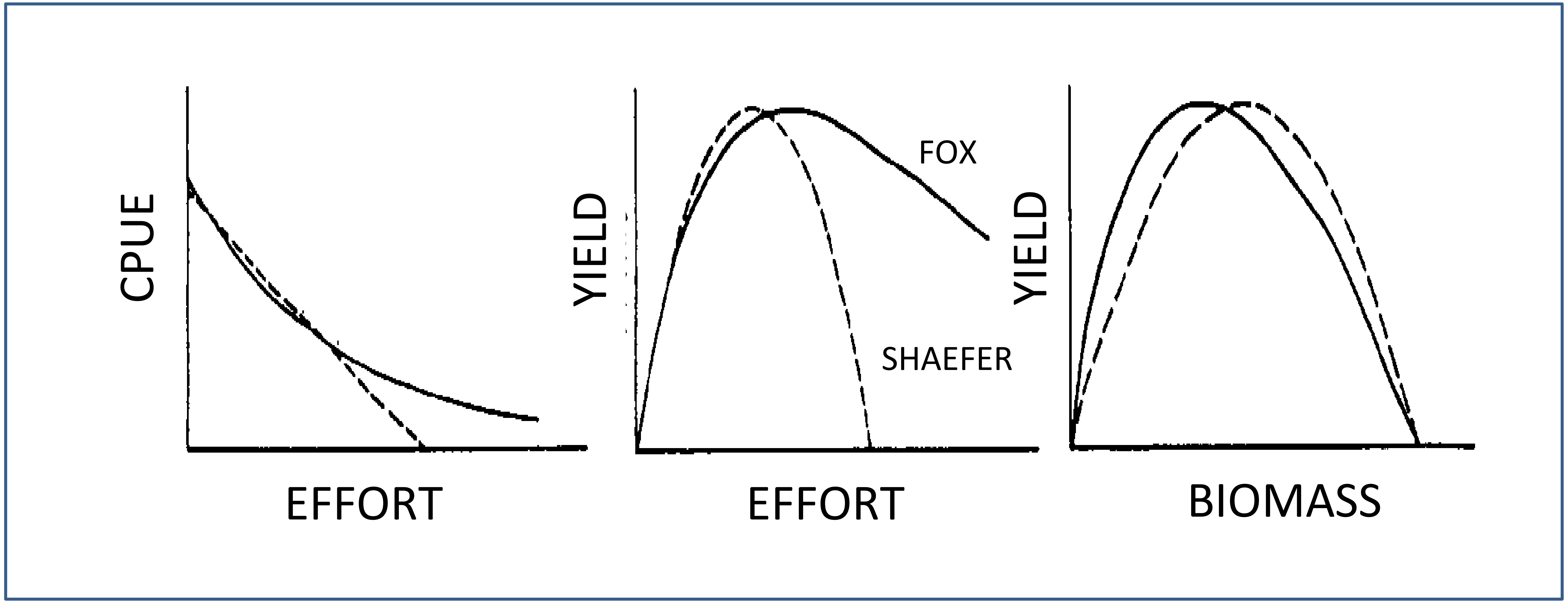


r is different among 3 species
r-L: r is large
r-S: r is small
(L is twice than S)

		SP1	SP2	SP3
case	K	minor	major	major
1	r	L	S	L
2		L	S	S
3		S	L	L
4		S	S	L

Fox Model and Shaefer Model

- Fox model assume the production follows Gompertz curve in stead of Logistic Curve in Schaefer's Model



Conclusion

- Feedback control procedure has a similar performance for mixed species data comparing single species data, as far as in the limited simulation cases.
- For applying the single species model for mixed species data, validity should be assessed through simulation studies.
- Implementation for multi-species, multi-gear situation fishery management should be also carefully considered.
- These researches can contribute sustainable fishery in ASEAN Region.

北海道大学
HOKKAIDO UNIVERSITY