A Social-Ecological approach for the full utilization of pelagic species alternation around Japan

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(Renamed in 2016 from the Fisheries Research Agency of Japan)

What is the fisheries “Resources” ?

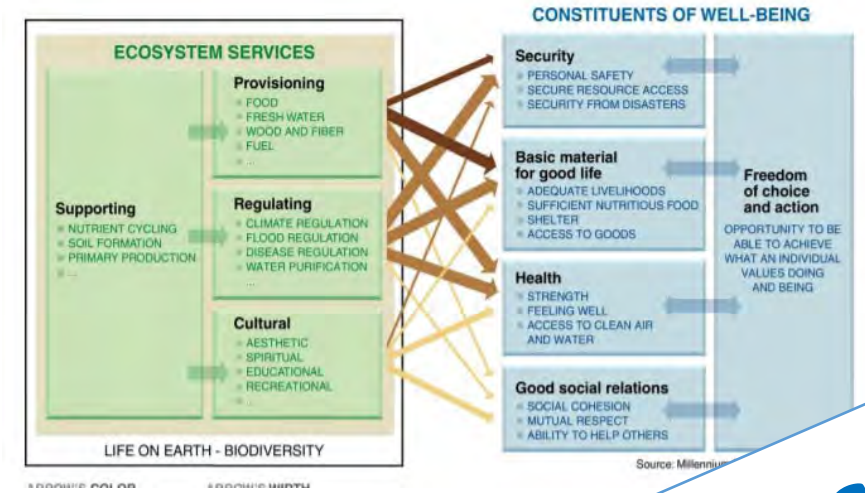
- Zimmermann said “Resources are highly dynamic functional concepts; they are not, they become, they evolve out of the triune interaction of nature, man, and culture…”

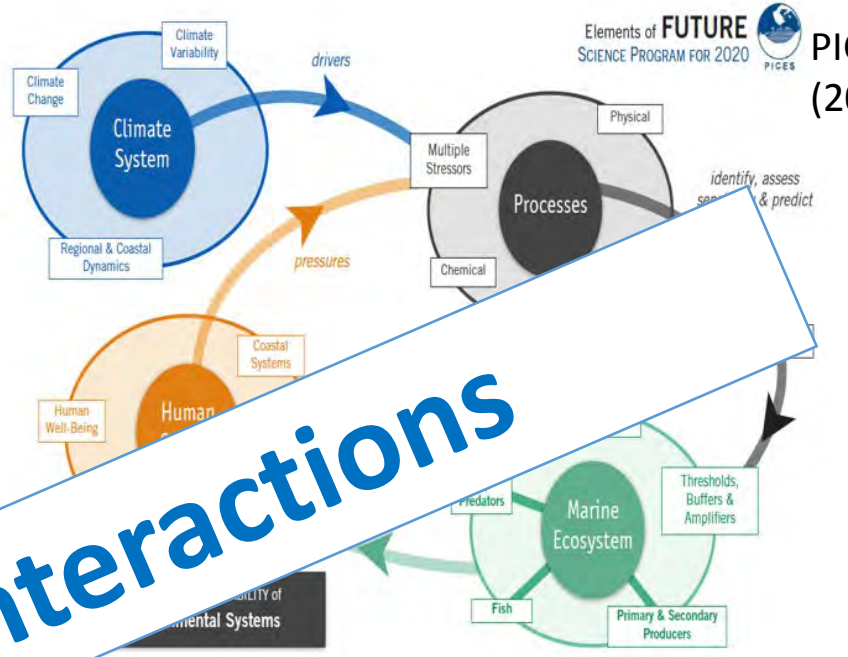
  (1933, World Resources and Industries)

Today we discuss the **interaction between** pelagic species alternation in the North Pacific (**Ecosystem Dynamics**) and its utilization by the Japanese fisheries sector (**Social Dynamics**)
-> **Social-Ecological Systems Approach**

SES Concept Diagrams

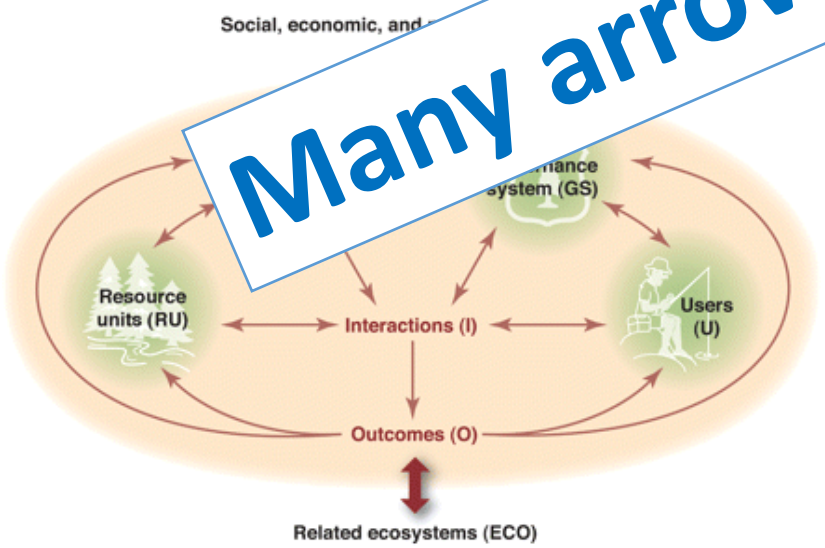
Millennium Ecosystem Assessment (2005)



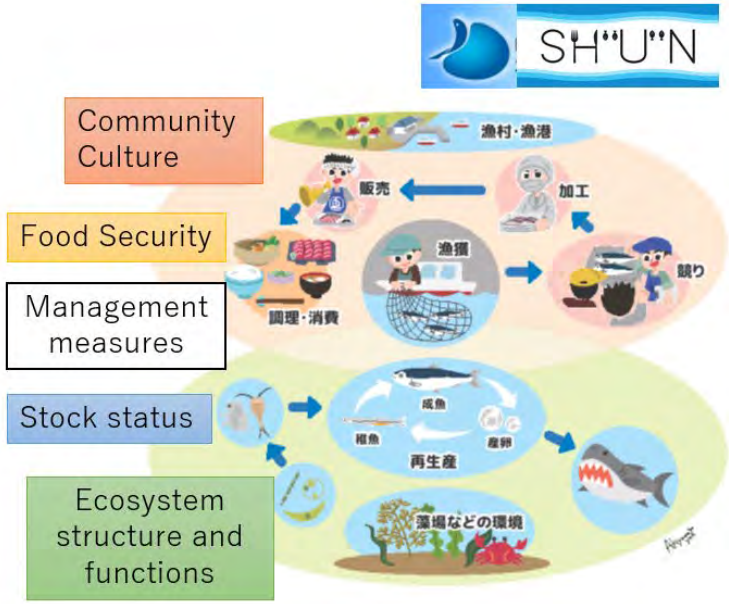


PICES FUTURE SSC (2015)

E. Ost… …325



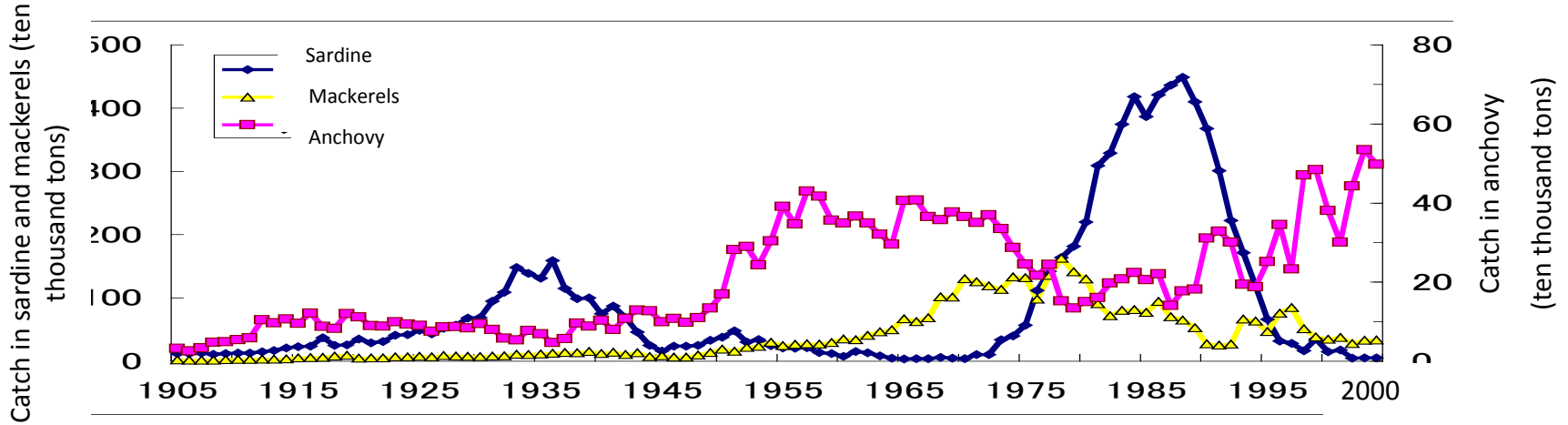
Many arrows, i.e., interactions



FRA (2016)

Case description

- In the north western Pacific of Japan, **chub mackerel and sardine, (and anchovy)** have shown the species alternation phenomena of c.a. 50 years cycle.

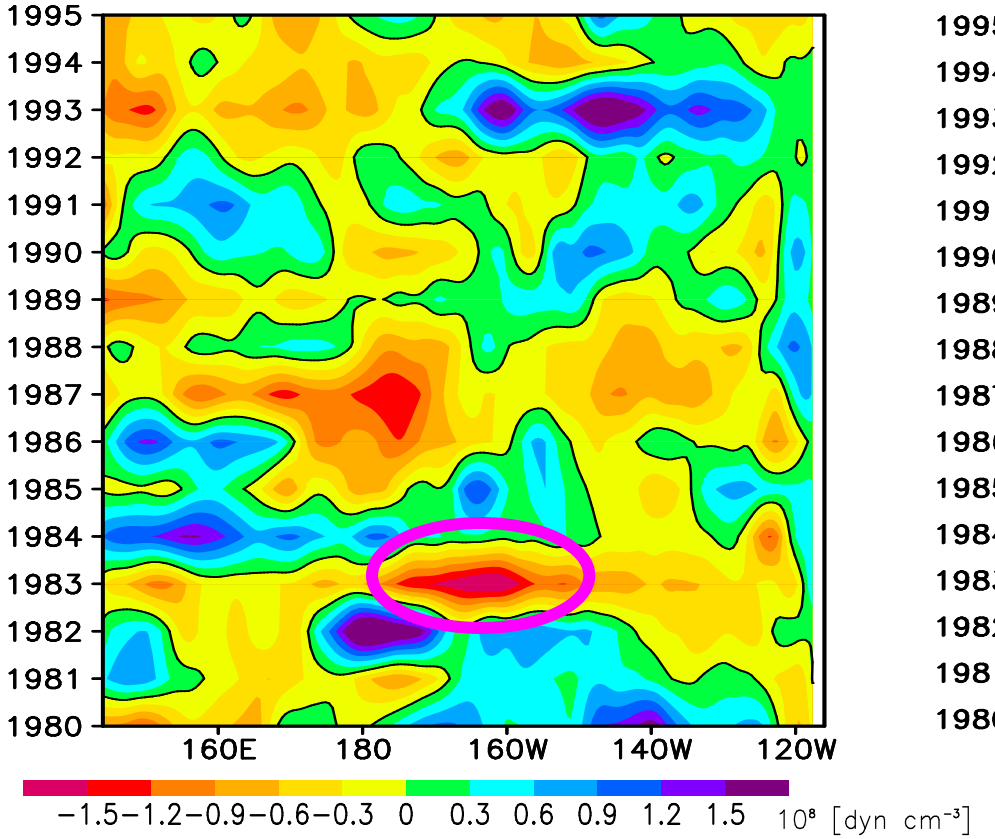


Changes in Japanese catch (MAFF)

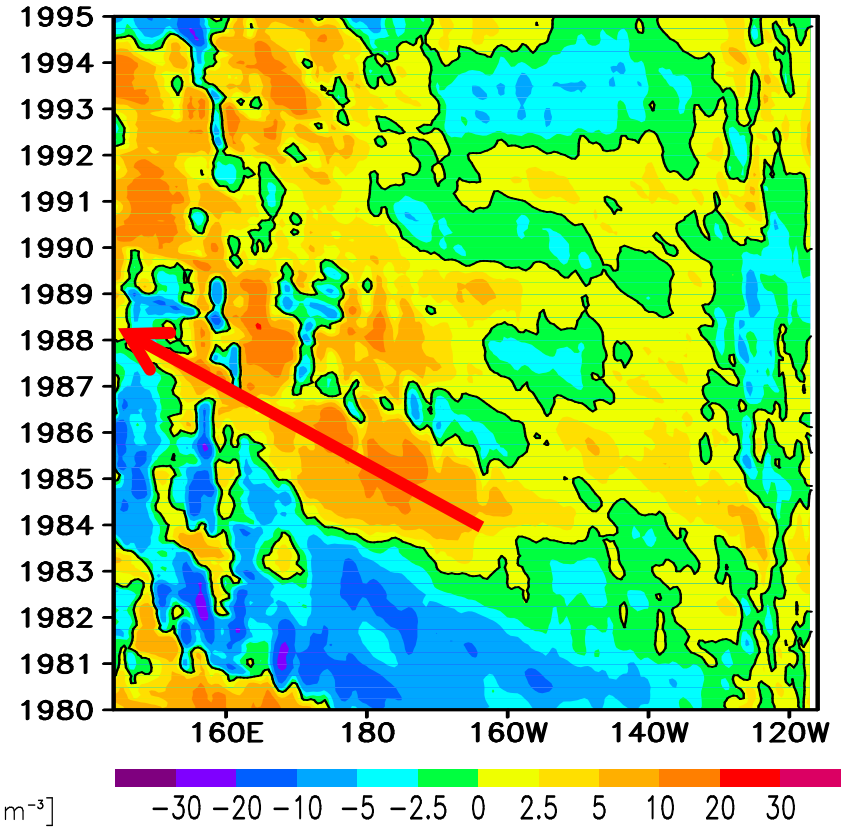
- Each species has specific price and uses. So, above graph is a result of the interactions between ecological system and social system.

Oceanographic Conditions

Wind-driven anomaly (WDA)

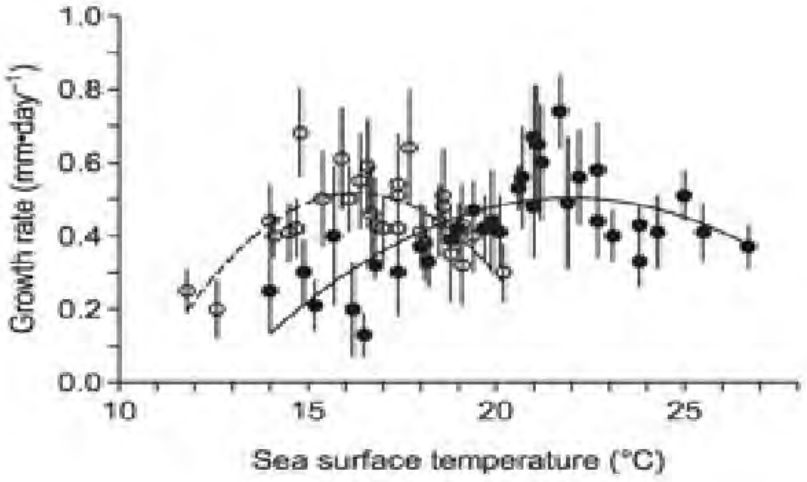


Sea surface anomaly (SSA)



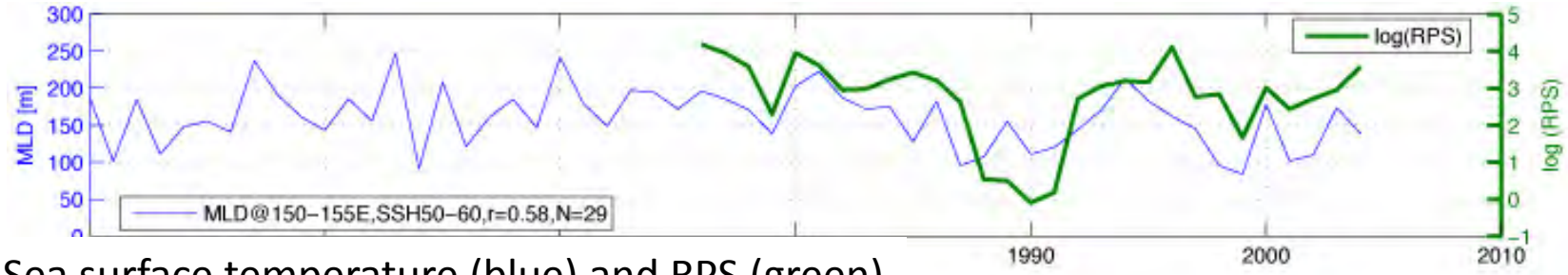
- Negative WDA makes positive SSA
- Positive SSA in 1983 in the Eastern Pacific came to the Western Pacific in 1988 (Saito et al. 2010)

Biological consequence at the Kuroshio Current Axis

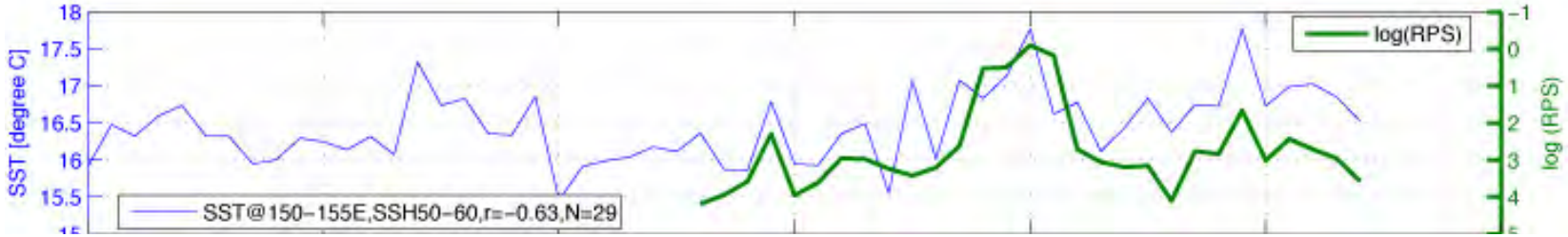


Each species has optimal SST for growth
(Takasuka et al. 2007)

Depth of mixed layer (blue) and Recruitment Per Spawning stock (green)



Sea surface temperature (blue) and RPS (green)



Shallow mixed layer and high SST correlate low success rate in reproduction (RPS) of sardine

Saito et al. (2010)

Large-scale Purse Seine Fishery; the main harvester of sardine, mackerel and anchovy.

- One of the biggest fisheries sectors in Japan.
- Managed by license from the Minister (5 years).
- In the mid-late ’80s, 72 operation units in the Japanese North Pacific area harvested about 2.0 million tons per year, mainly sardine.

Fleet operation type

Main ship (net ship): 135t

2* Transportation ship: 330t

Search ship: 99t

http://www.souhou.jp/fukushima

Solo-operation type: 499t

(http://www.suikei.co.jp)

How the Japanese society utilized 2 million tons of pelagic fish in the 1980s

- In the late ‘70s, we had a good catch of chub mackerel in this area, which is very profitable raw material for processing.
- The fish processing sector accumulated the profit, and invested to big fish freezers and fish-meal/oil plants, i.e., fisheries infrastructure for pelagics.

Popular chub mackerel products (very good business)

Marinated mackerel

http://www.takewa.co.jp/

Fermented and dried

(http://hachinohetokusanhin.8cci.or.jp/)

Canned product

(http://hachinohetokusanhin.8cci.or.jp/)

Tasted by kelp

(http://hachinohetokusanhin.8cci.or.jp/)

Frozen filet

http://www.takewa.co.jp/

Sushi

(http://hachinohetokusanhin.8cci.or.jp/)

How the Japanese society utilized 2 million tons of pelagic fish in the 1980s

- In the late 70s, we had good catch of chub mackerel in the area, which is very profitable raw material for processing sector.
- In this period, the fish processing sector accumulated the profit, and invested to big fish freezers and fish-meal/oil plants, i.e., fisheries infrastructures for pelagics.

- By the mid 80s, these infrastructures had been fully depreciated . So, the big amount of sardine, which is not a money-making species (low price, low rate-of-return), could be utilized as the cheep raw material for processing sector.

Sardine products (not a very good business)

Fish oil & fish meal

> 90%

Frozen whole round

http://gyoryo.com/index.html

Canned products

http://www.shidaya.net/?pid=111895036

http://www.shidaya.net/?pid=113244426

Dried sardine

http://www1.enekoshop.jp/shop/umiichiba/item_detail?category_id=314962&item_id=1788134

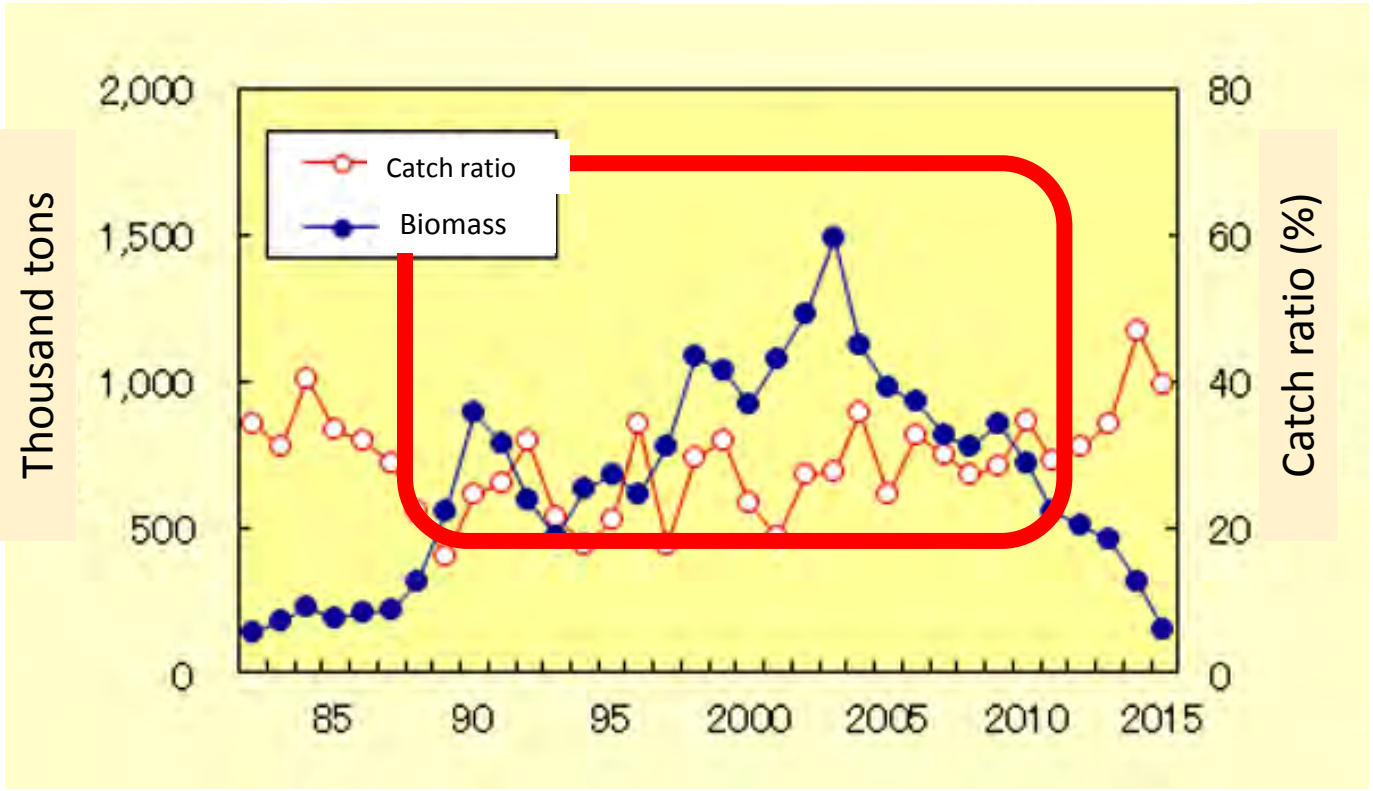
Frozen filet

http://10knot.biz/news/2011/07/07234919.php

Social System

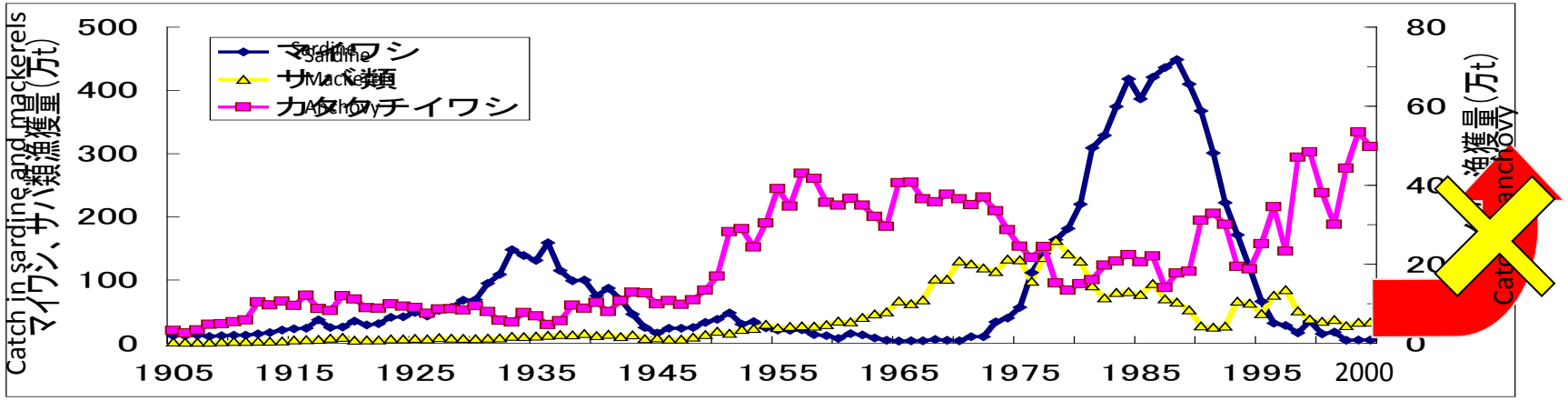
In the ‘90s and ‘00s, we had some stock of anchovy, but could not be the substitute for sardine

Japanese anchovy
(Engraulis japonicas)



- Stock was relatively high in the ‘90s and ‘00s.
- But the main fishing ground was at far south, and the price and quality is not good for the processing sector..
- Now the stock is at the low level (decreased).

The next cycle started

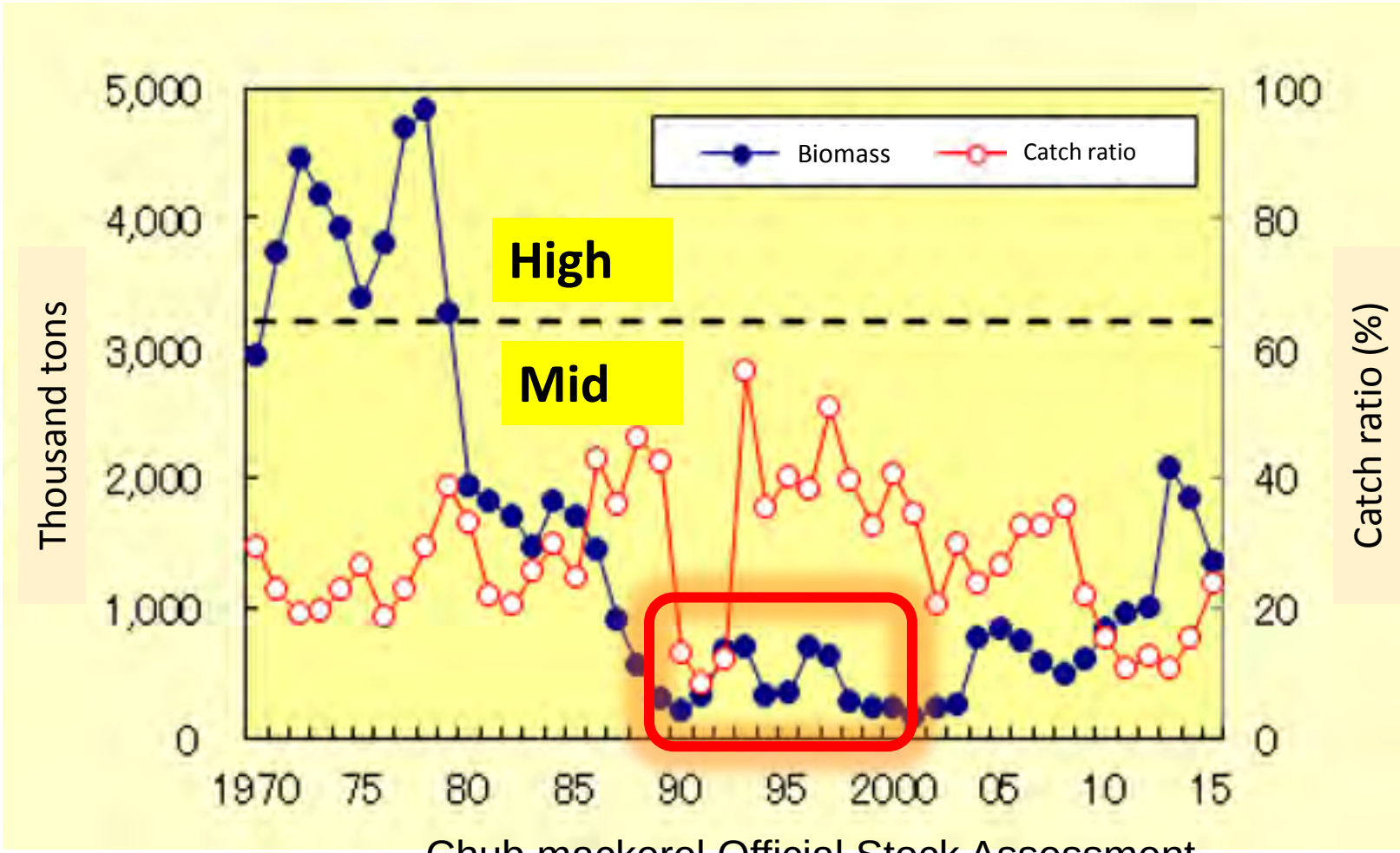


- According to the species alternation theory, chub mackerel catch should have been increased by now.
- However, we have not observed such an increase.

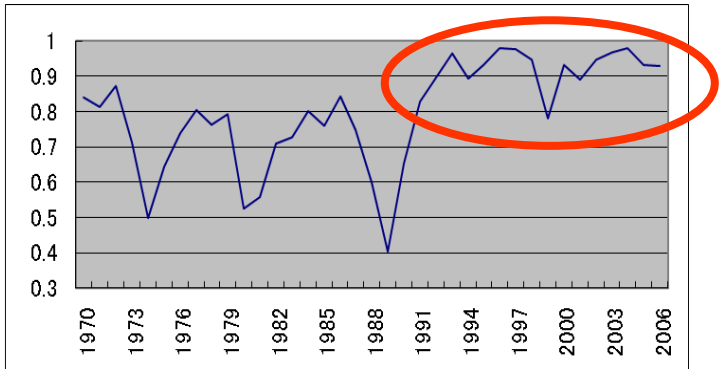
Why?

- We had two strong year classes in the 1990s, but they were overfished!

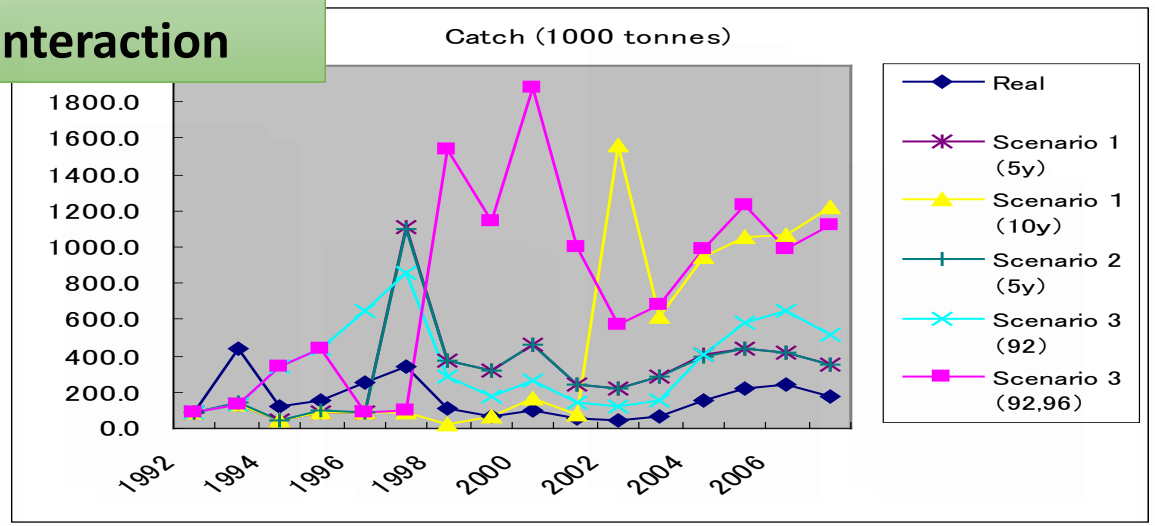
Strong year classes of Chub mackerel in ’92 and ‘96 were overfished!!

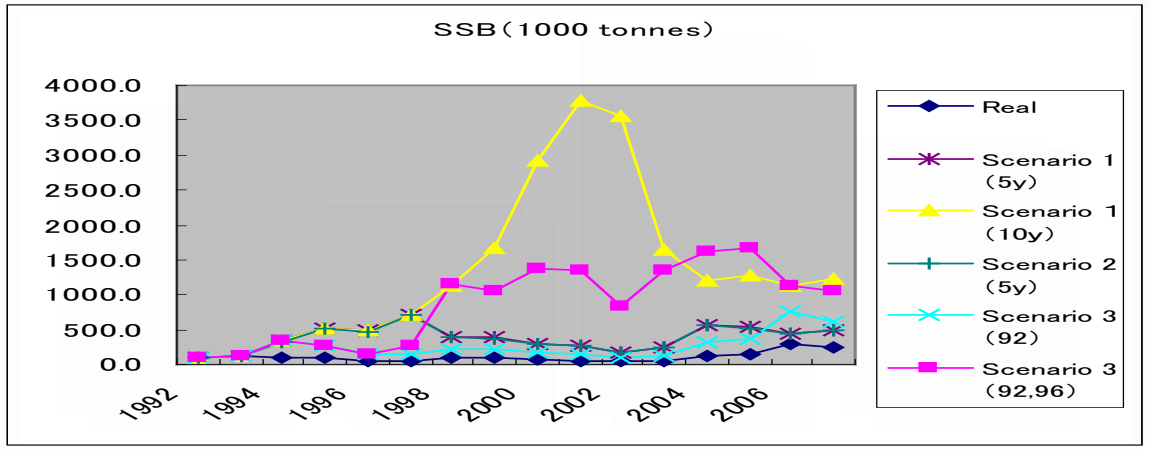


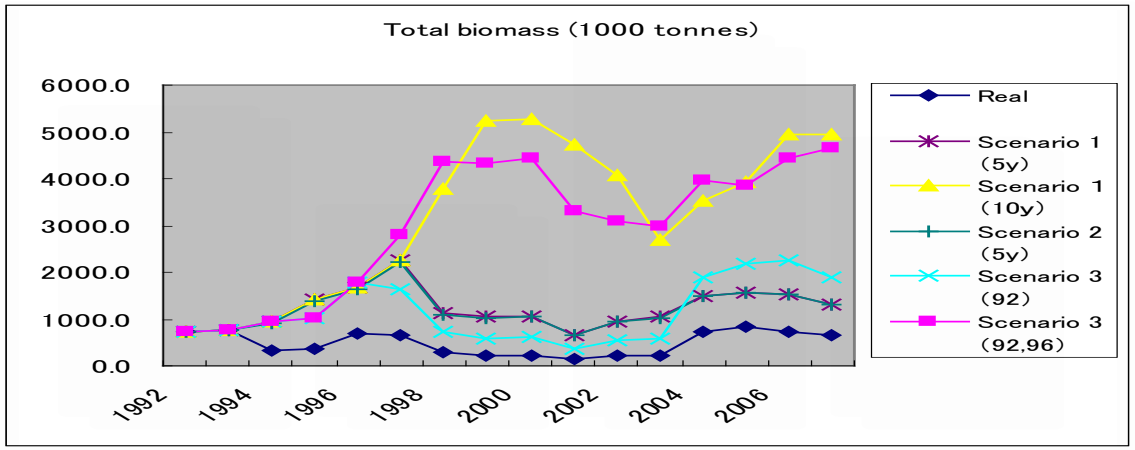
Chub mackerel Official Stock Assessment



Ratio of the small mackerels (0~2 years) in the catch







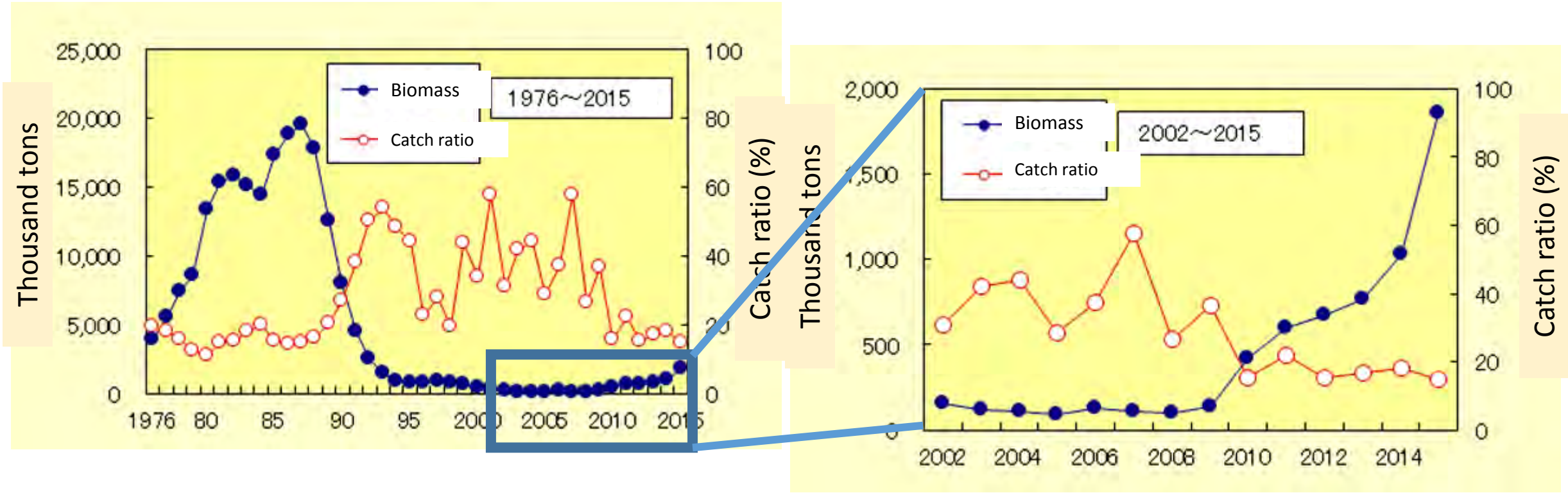
If managed properly, chub mackerel could have recovered by the 2000s

Bio-economic model by Makino and Mitani (2010)

- Just 10% reduction of the vessel construction in the late ‘80s, and protection of ’92 & ‘96 strong year classes for 2 years each (total of 4 years) could have brought us enough recovery as in the ‘70s without the deficit operation (red ink).

Now sardine is rapidly increasing!

-> The order of alternation might change



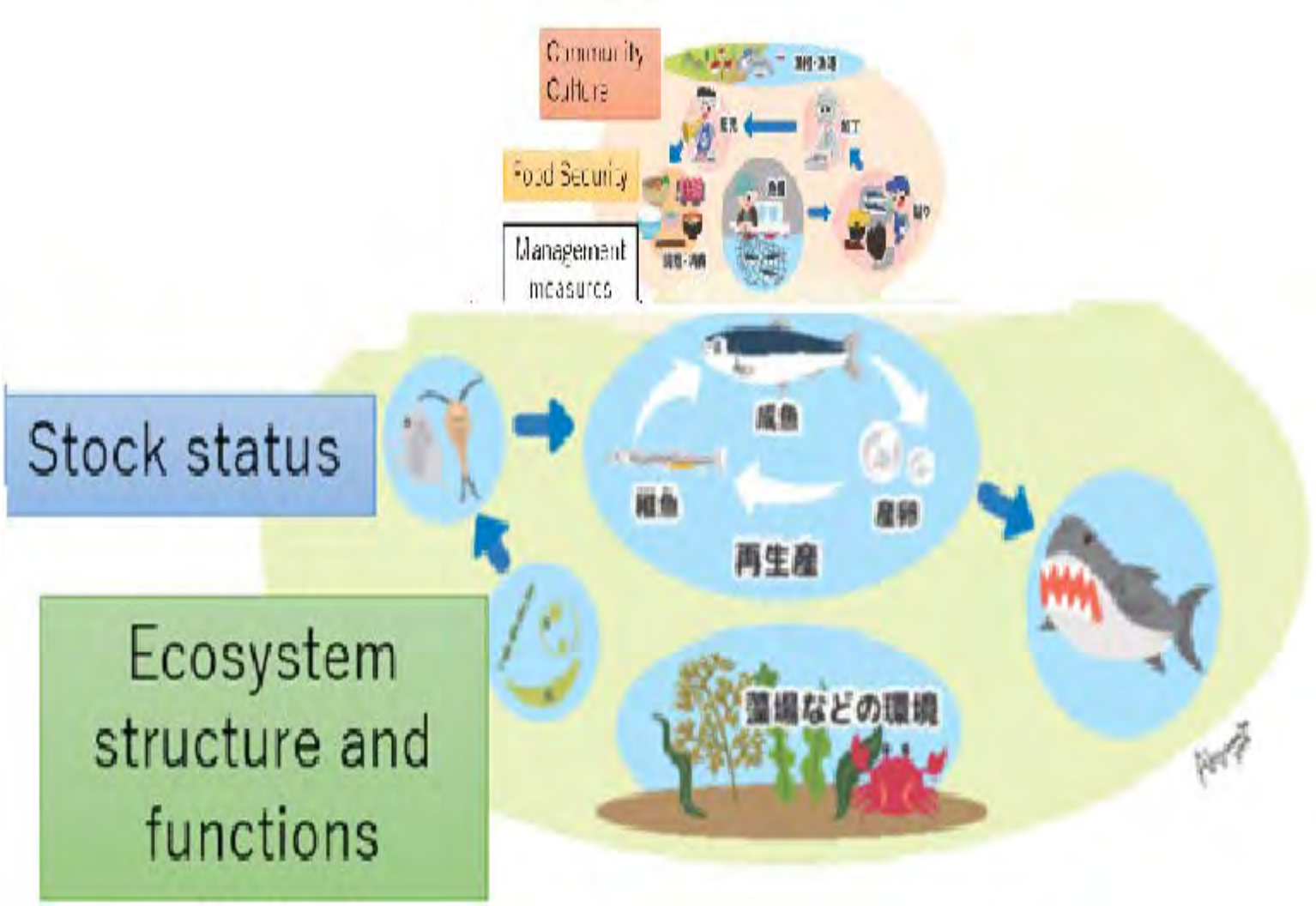
Official Stock Assessment of Japanese sardine
(*Sardinops melanostictus*)

This is a BIG ISSUE in the Social System

- Now almost all of the fish-meal/oil plants invested in the late ‘70s and ‘80s have already closed. For example, in Kushiro city (the largest landing port of sardine in the ’80s), the number of fish-meal/oil plants decreased from 25 to only 2 (Kaneko et al. 2013).

- Sardine is not profitable enough to build new fish-meal/oil plants. So, if sardine increases now, we have no infrastructure to utilize the big biomass in the society. In other words, sardine can not be a big resource as it was in the ‘80s

The concept of fisheries social-ecological systems by FRA

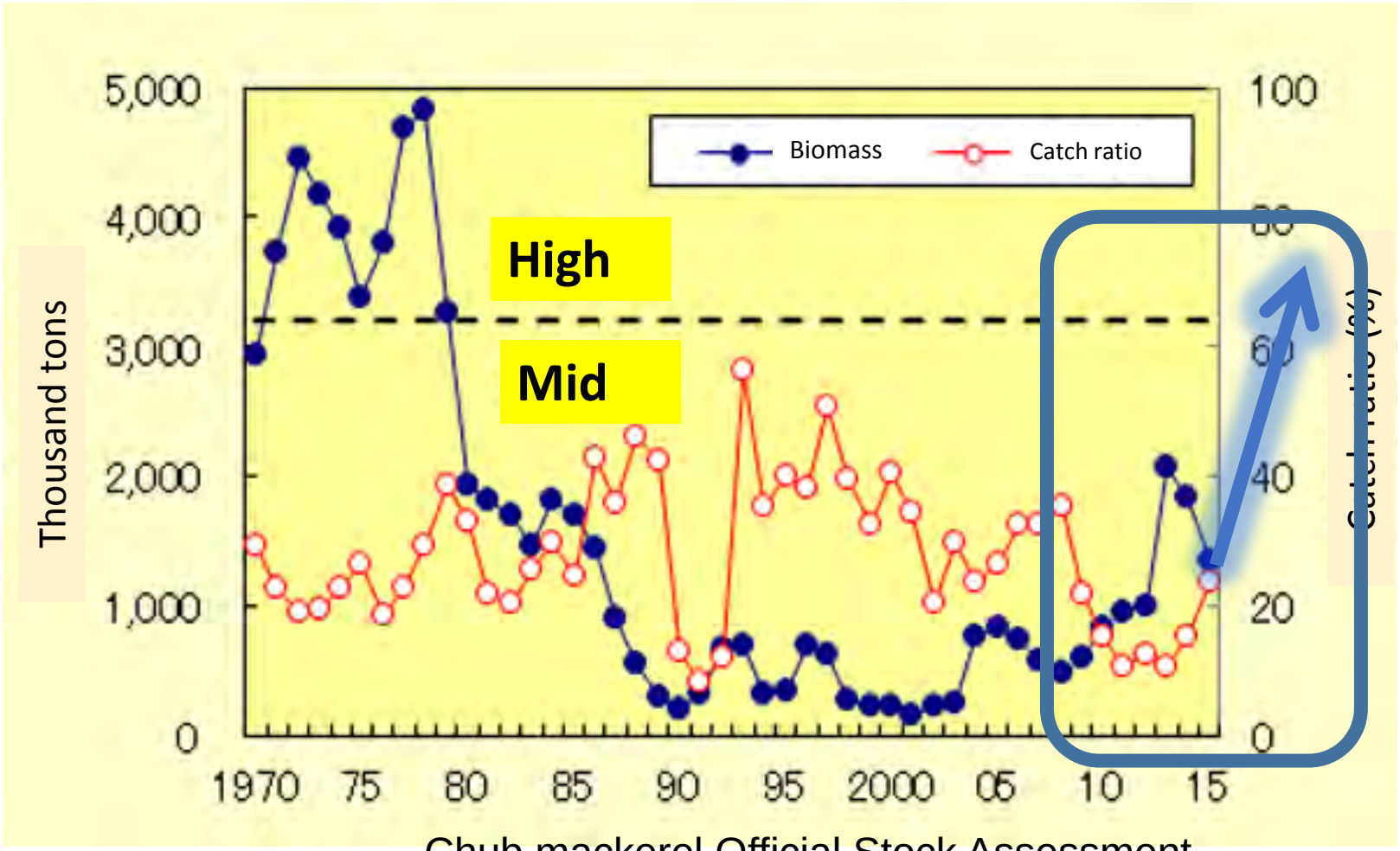


- The thick and smooth interaction between social system (upper circle) and ecological system (lower circle) is important for sustainable fisheries.
- Now, the balance of two systems is distorted.

Then, what we can do now?

1) The most urgent and critical thing is to recover the Chub mackerel as soon as possible. Then, harvest it and accumulate the profits within the processing sector, and invest it to fisheries infrastructure (freezers and fish meal/oil plants), just as we did in the 1970s: SHORT TERM.

Chub mackerel management is showing good results now!



Chub mackerel Official Stock Assessment

- As Dr. Ichinokawa presented, we have introduced variety of management measures for the recovery, including Individual Vessel Quotas (IVQs).
- Now we are waiting for the next strong-year-class!

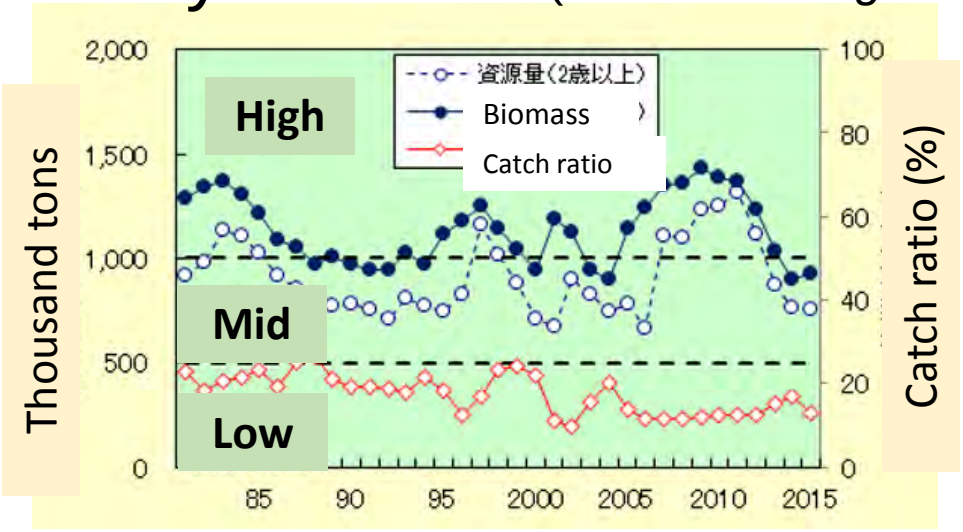
What we can do now?

1) The most urgent and critical thing is to recover the Chub mackerel stock level as soon as possible. Then, harvest it and accumulate the profits within the processing sector, and invest it to fisheries infrastructure (freezers and meal plants), just as the 1970s: SHORT TERM.
2) Make more efforts to utilize the non-pelagic species, e.g., Walleye Pollock or Pacific Cod, which are not fluctuating so much. The profits should be invested to develop the capacity to make new processing techniques or new-recipe as the FOOD CULTURE FOR EATING MORE SARDINE: LONG TERM.

Non-pelagic in this area: more stable species

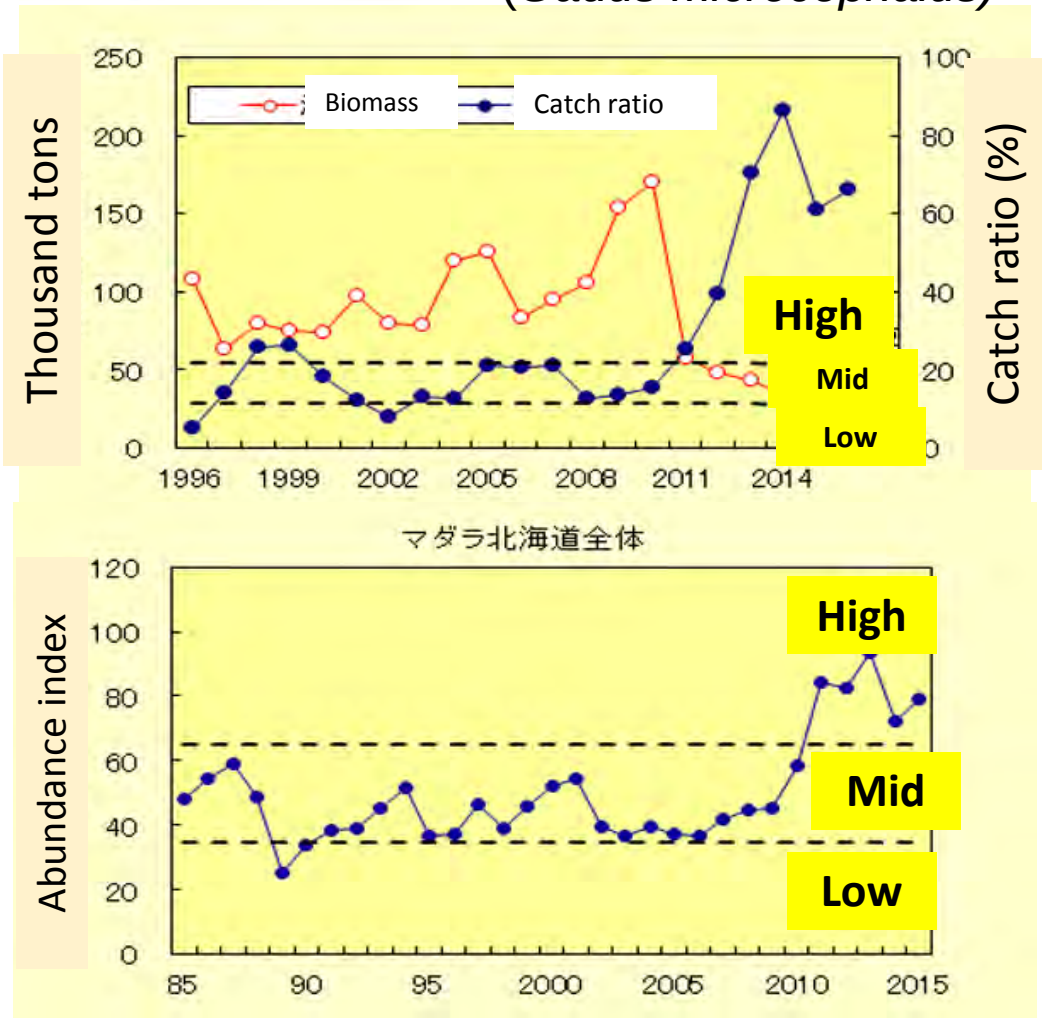
-> they are increasing now!!

Walleye Pollock (*Gadus chalcogrammus*)



Not so bad. We can utilize this more.

Pacific Cod (*Gadus microcephalus*)



Getting better and better, can be the alternative raw-material.

Social System

Walleye pollock

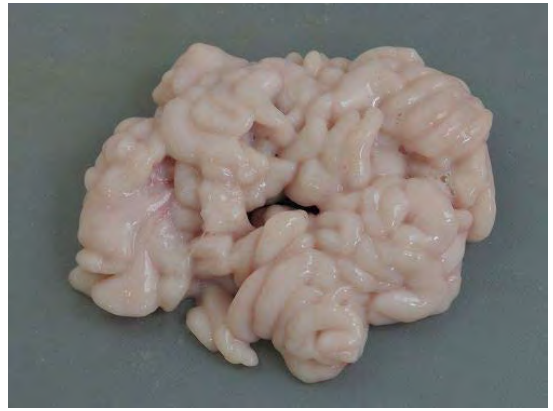
Frozen Surimi

Seasoned cod roe

http://www.sasaya-net.co.jp/

Pacific cod

Fresh

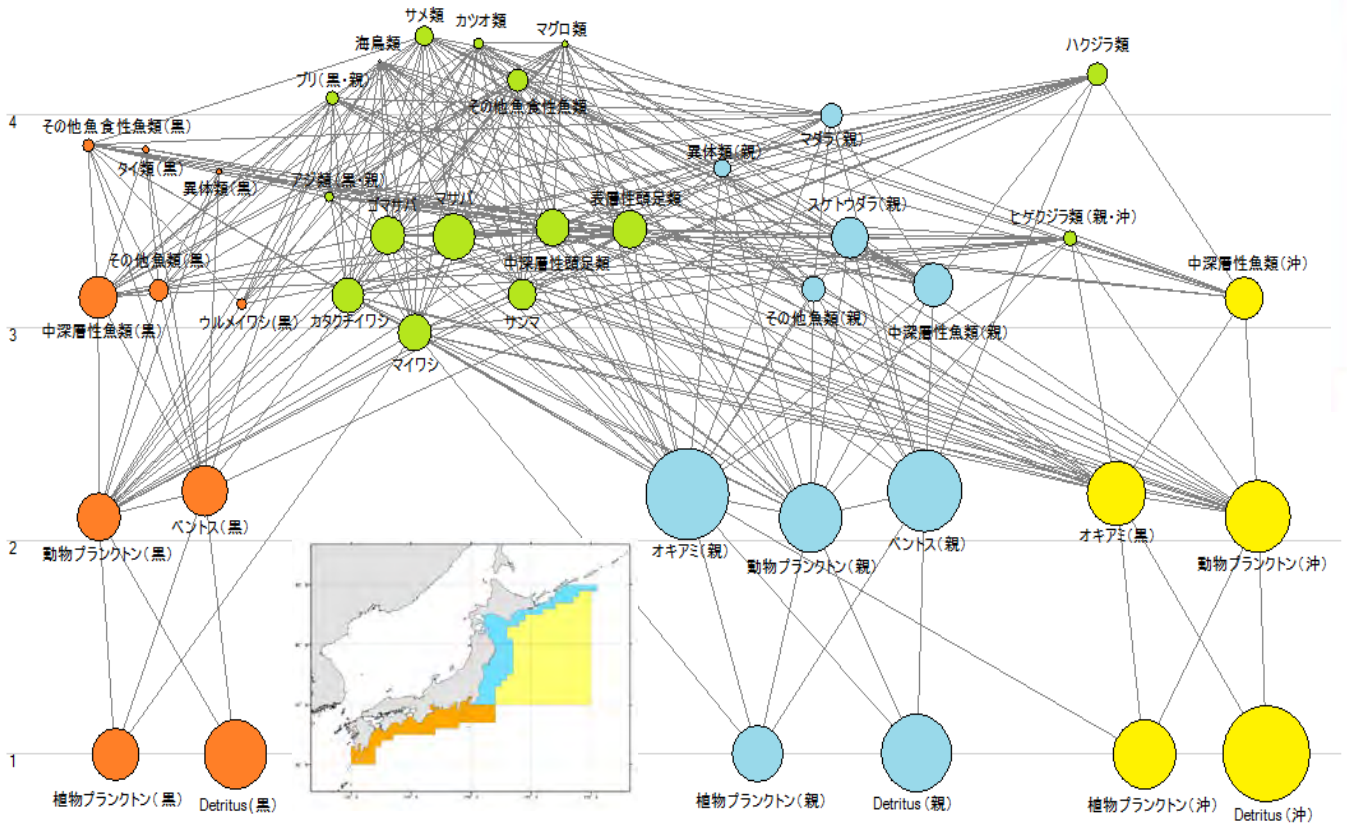


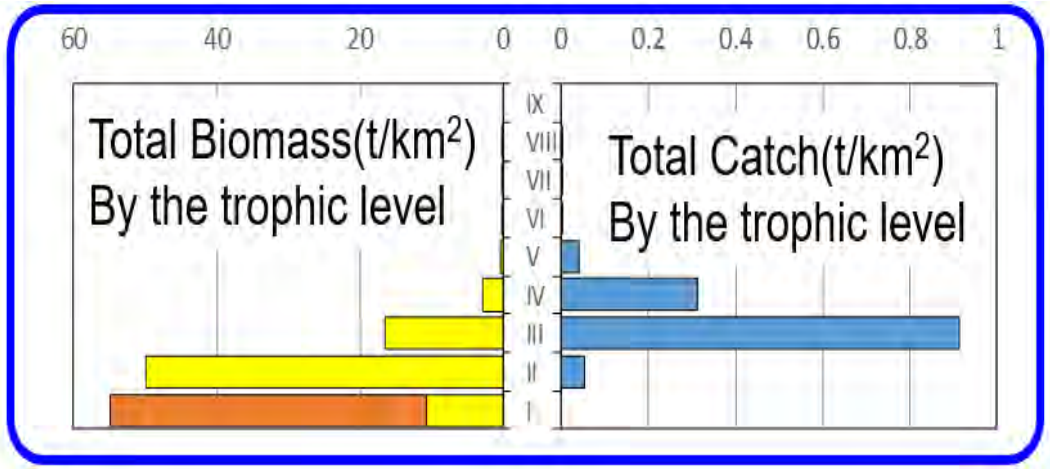
http://www.zukan-bouz.com/

Residuals can be used for fish meal/oil plants.
The demand for aquaculture feed is strong in SEA

Ecopath model of the Japanese Pacific

(Watari, et al. Poster Presentation today: S3-P7)





Kuroshio LME Oyashio LME Offshore

Around Japan, we have a lot of potential biomass to be utilized by the processing sector, especially at the low trophic level.

Summary and prospects

- The social-ecological approach can give us a new viewpoints and insights about the drivers of small pelagic fish resources and their fisheries.

- This Japanese case study shows that, in order to fully utilize the pelagic species in the society, the sequential order of the species alternation, as well as the appropriate combination with non-pelagic species, are important.

- In the future, this type of the integrated SES analysis would show us a priority list of the species to be recovered in a certain ecosystem, and the direction of the new food culture development for achieving the better balance of social-ecological systems.

Thank you very much!