Special Project by the Ministry of Environment, Japan (2014-2018)
S-13
Development of Coastal Management Method to Realize the Sustainable Coastal Sea

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Development of Coastal Management Method to Realize the Sustainable Coastal Sea (2014-2018)

P.I.; T.Yanagi

Theme 1

1．Seto Inland Sea

Decrease of fish catch
High biodiversity and production
Control of nutrients concentration

Theme 2

2. Sanriku coastal sea

Recovery from Tsunami-damage
Satoumi creation
Material flux from forest to coastal sea

Theme 3

3. Japan Sea coastal area

Intergovernmental management
Spillover effect of MPA
Future forecast of ecosystem

Theme 4

4．Social and Human sciences

Economic value of ecosystem service
MPA and fisheries
Satoumi story for citizen

Theme 5

Integrated numerical model development

Synthesis

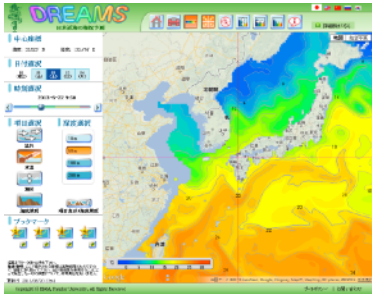
Philosophy for coastal sea management
Measures for establishment of sustainable coastal sea area
Integrated model as a support tool for policy makers

Integrated Coastal Sea

Model

Environmental Policy

visualization



Committee（Three types）

1.5 million US$/year

Realize clean, productive and prosperous coastal sea (Satoumi)

Global dispatching

Clean and productive = moderate transparency and high fish catch

Too clean and poor

Dirty and poor

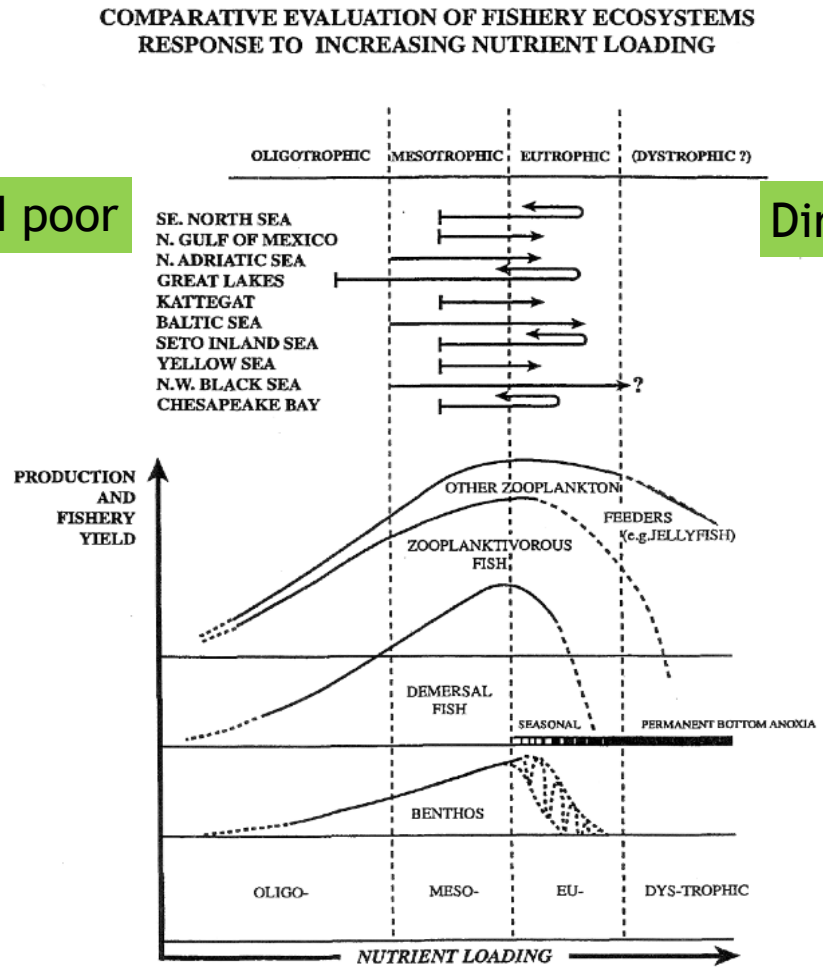


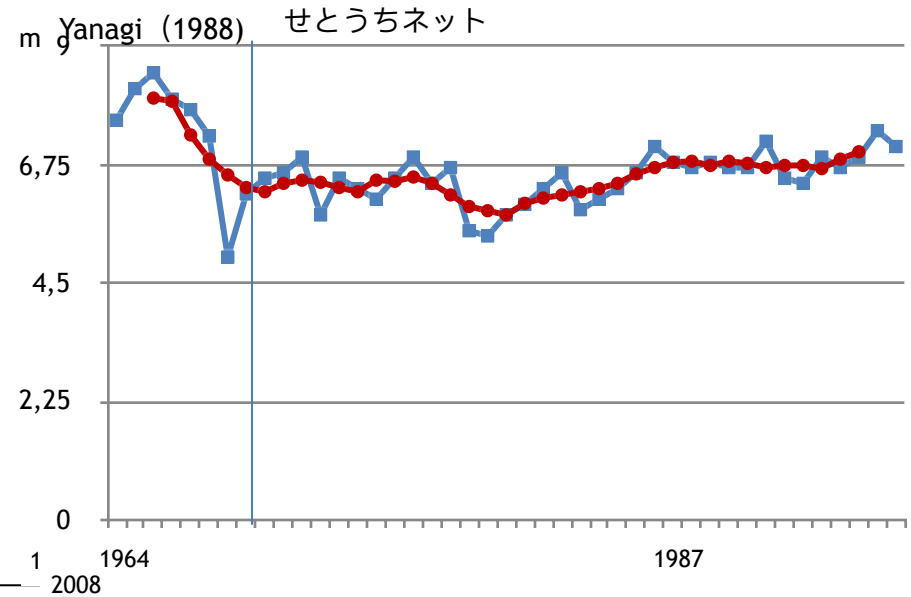
Fig. 1. Comparative evaluation of fishery response to nutrients based on data from around the world (modified and redrawn from Caddy, 1993). Each curve represents a general guild of species and their reaction to increasing nutrient supplies. The top part of the figure lists recent trends for various systems around the world. Vertical dashed lines separate general categories of organic production that result from different levels of nutrients.

Diaz, 2001

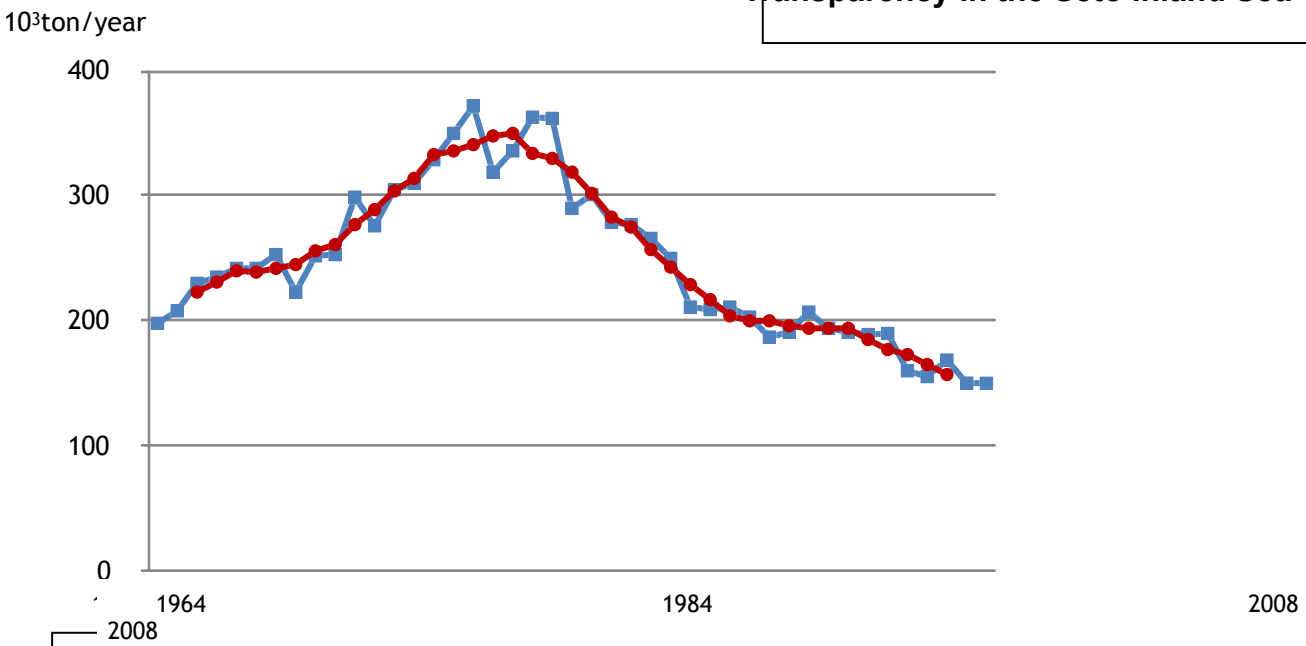
TRANSPARENCY

Relationship between transparency and fish catch in the Seto Inland Sea

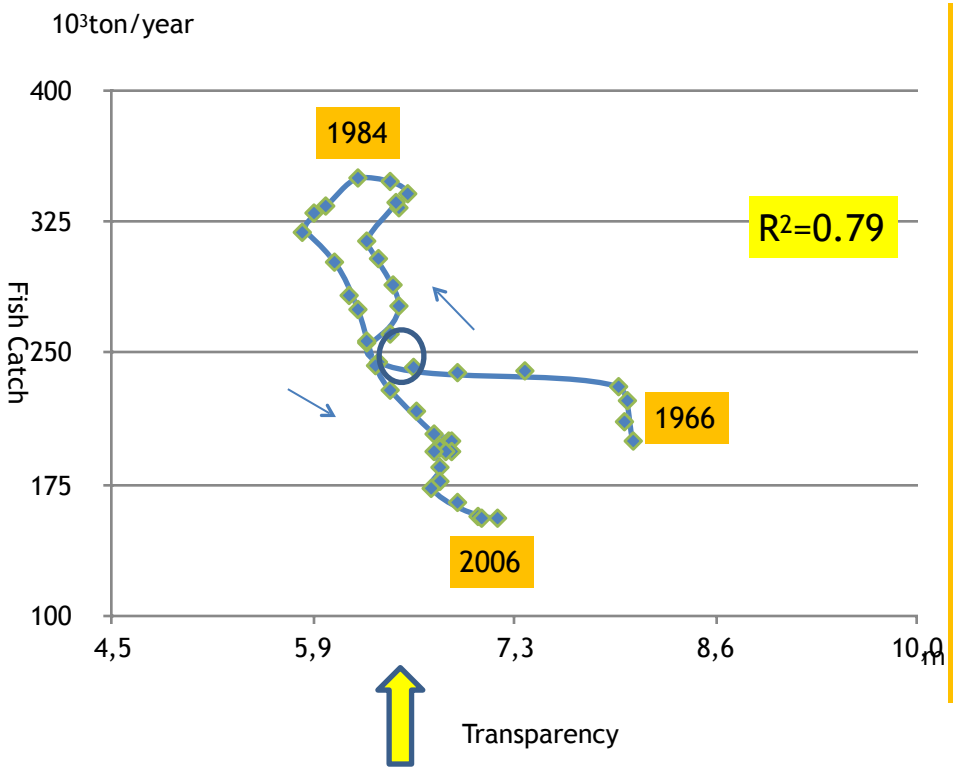
Not unique



Transparency in the Seto Inland Sea（red：5 year-running mean）



Fish catch in the Seto Inland Sea（red：5 year-running mean）



Hysteresis of fish catch

eutrophication: plankton feeder increase
oligotrophication: fish feeder increase
bate decrease—long life merit

Multi solution (one transparency-double fish catches

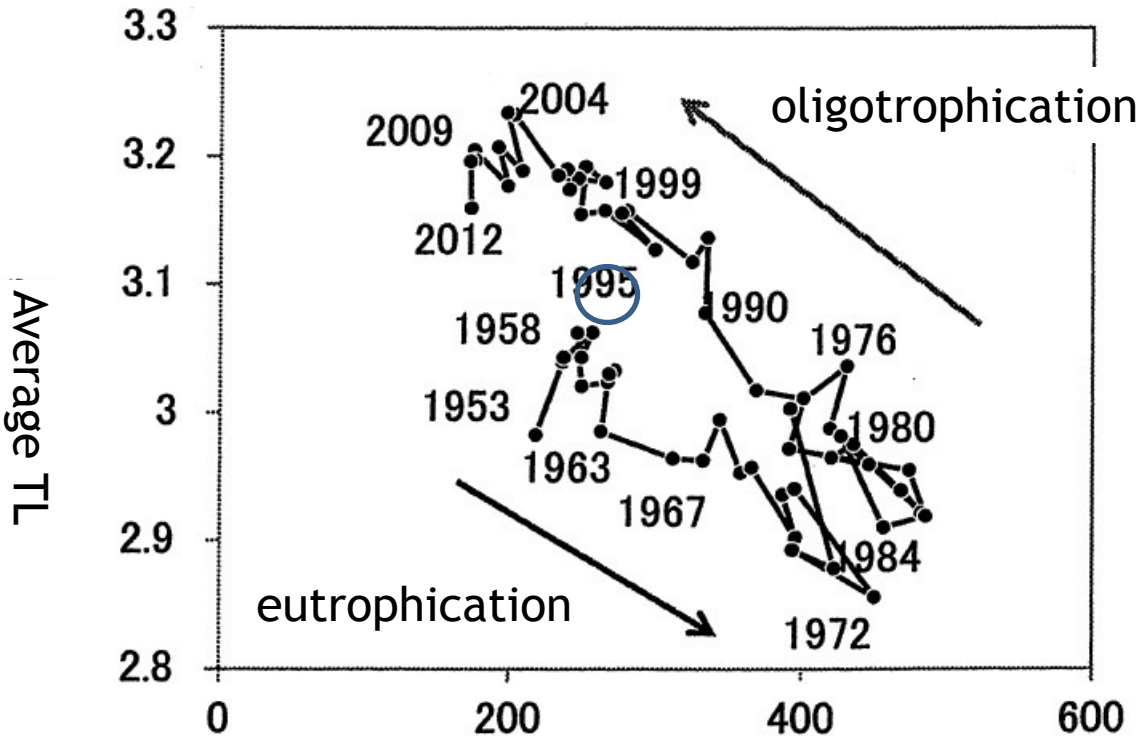
1)hypoxia
benthos decrease→detritus food chain decrease
2)eutrophication—tidal flats (50%) ・sea-grass beds 6
fish resources reproduction decrease
3)Jelly fish increase—zooplankton decrease
。。。

Transparency and fish cathc in the Seto Inland Sea (5year running mean)

Target transparency: about 6.5m (fish catch-about250,000 ton)
because biodiversity decreases at maximum fish catch (climax)

Make similar figure in each Nada or Bay
Decide target transparency in each Nada or Bay

Hysteresis of average TL(Trophic Level)

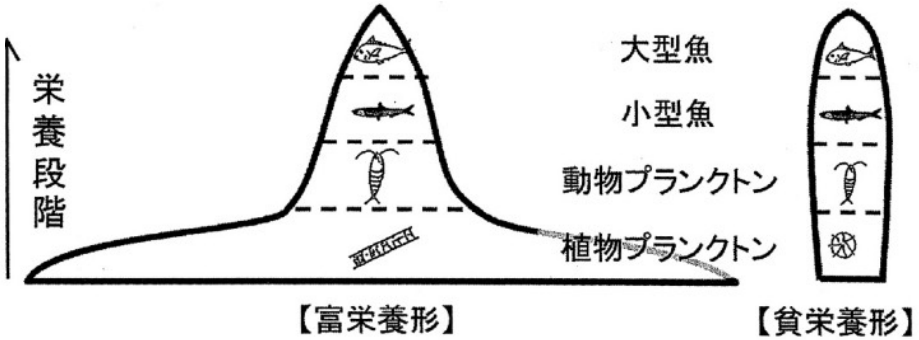


Fish catch 1000 ton

eutrophication：
plankton feeder fish
high primary transfer→
low trophic level（low T

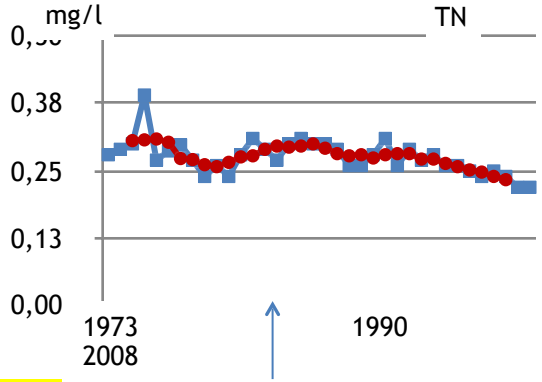
pligotrophication：
fish feeder fish
high higher transfer
→
high trophic level（high

Tanda et al.(2015)

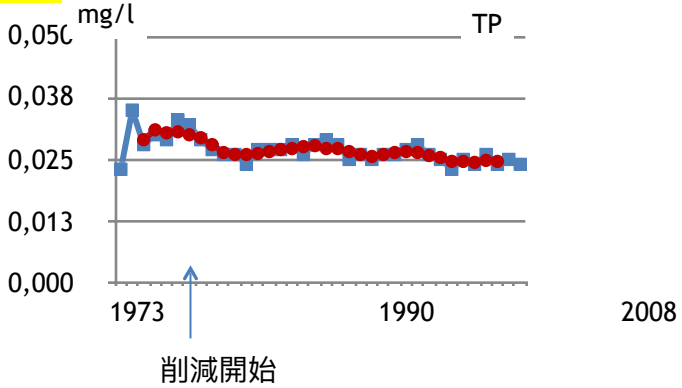


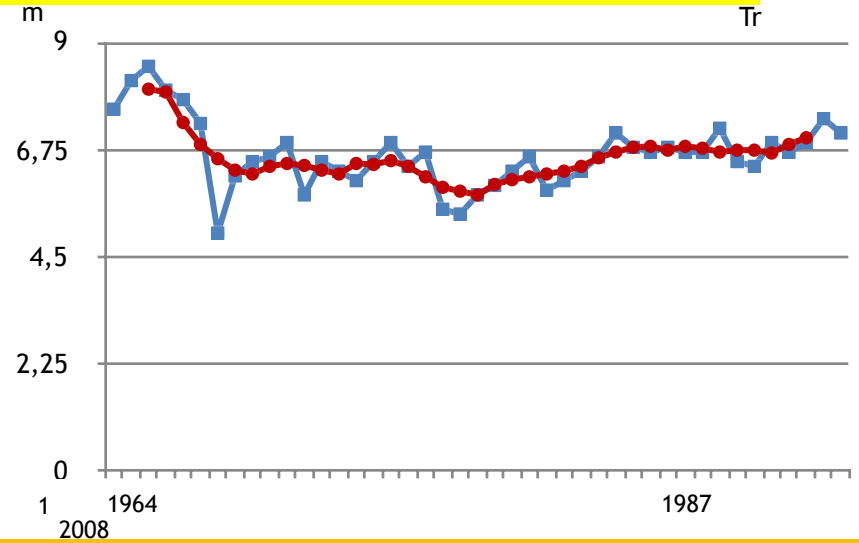
2004→2012 TL decrease?　— high fish catch of higher TL fish?

transparency：Chl.a（SS、CDOM)－nutrients



N/P＝16.2



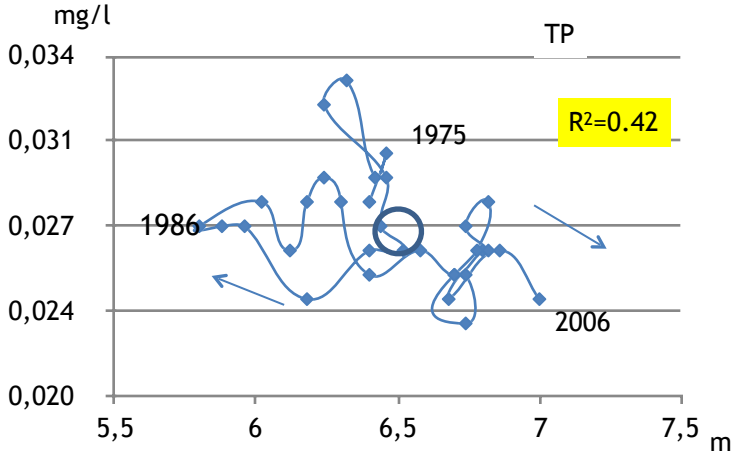


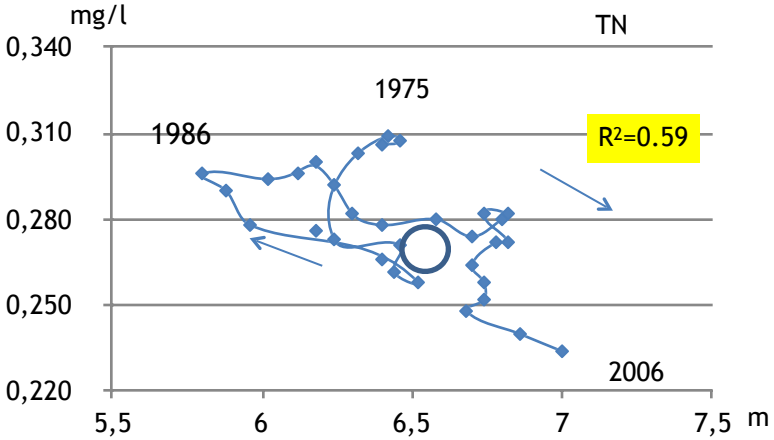
ＤＯＮ、ＤＯＰ release flux from bottom

eutrophication：release small or low TN－DON S （PON・DIN same） － small cellar excr
microbial loop active－large fish catch

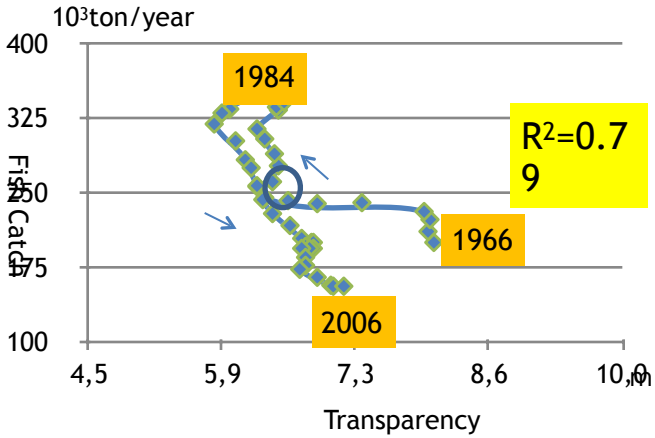
oligotrophication：release large or high TN、TP－DON L－ large cellar excreation
microbial not active－small fish catch

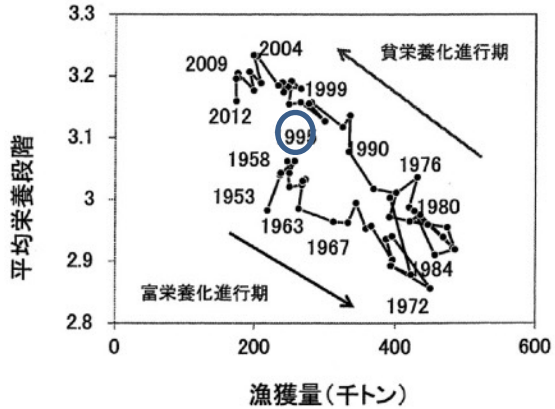
TN：high correlation－N limitting except Osaka and Hiroshima Bays

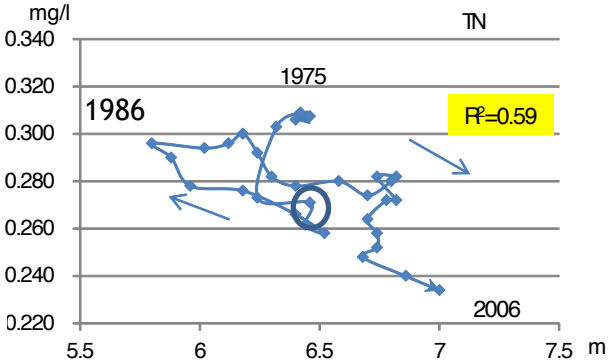


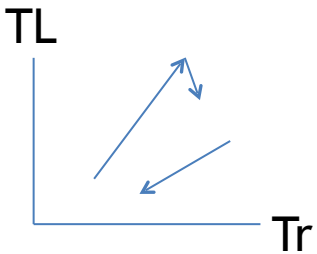


Reason of hysteresis





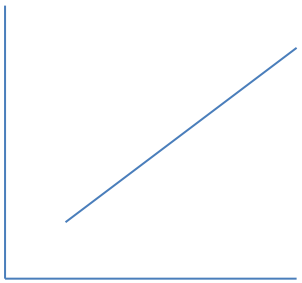




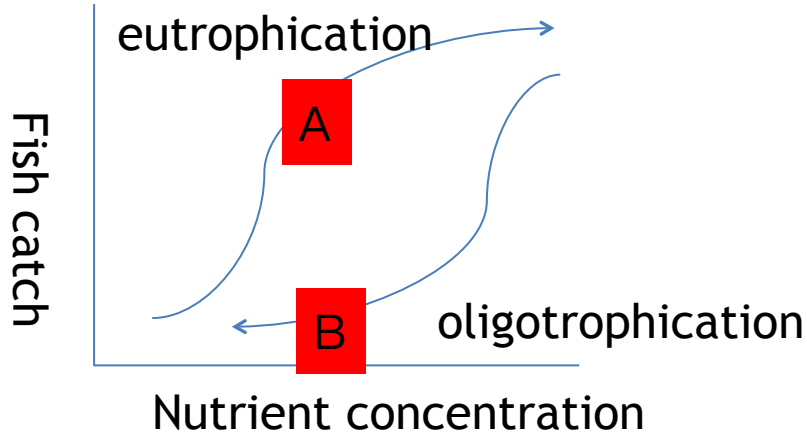
- Accumulation of organic matter to bottom→positive（TN・TP）、negative（fish catch・average TL）
- Tkeoka and Murao（1997）

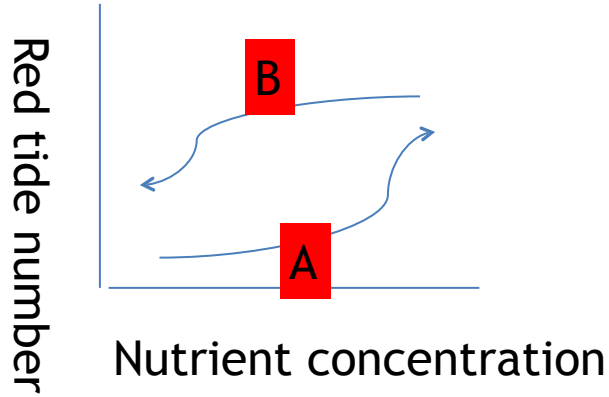
Mutual interaction between water quality and sediment quality

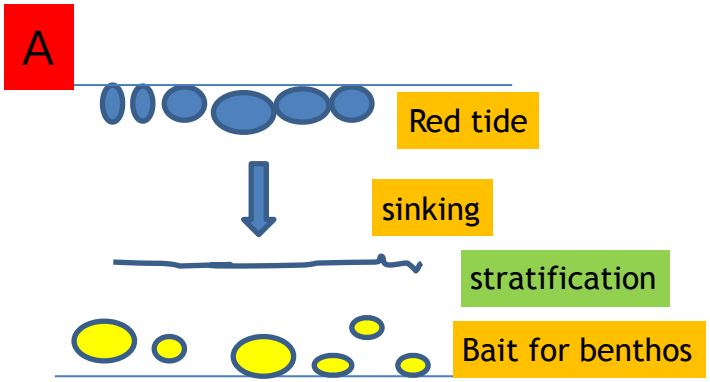
Beaker (linear)

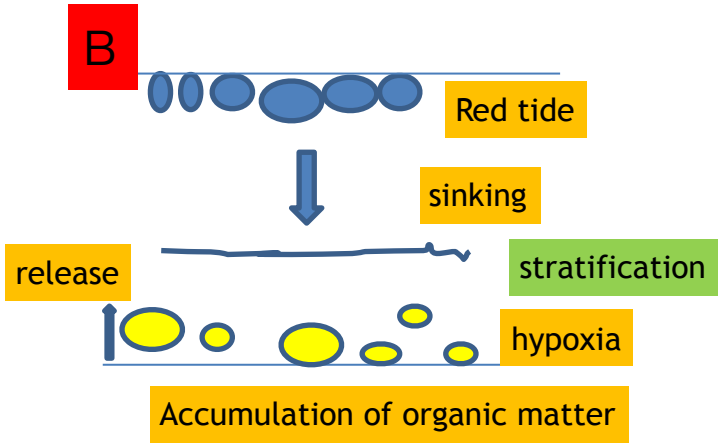


Field (non linear)









Future

- Sediment sampling in the Seto Inland Sea（M.E.）
- ①1981-1987、②1991-1996、③2001-2005、④2016-

- ①、②、③　no change
- Eastern part：　④ 2016: species and individual numbers increase：　30 years after the load reduction

- Recover benthos＝detritus food chain recover
- Release flux reduction

→　new equilibrium－clean and productive Seto Inland Sea

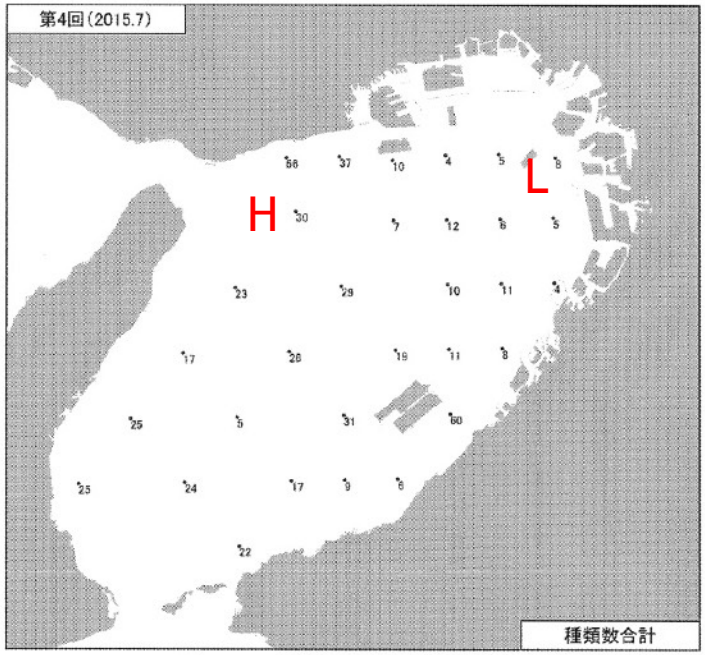


図 5-156 大阪湾 底生生物種類数合計

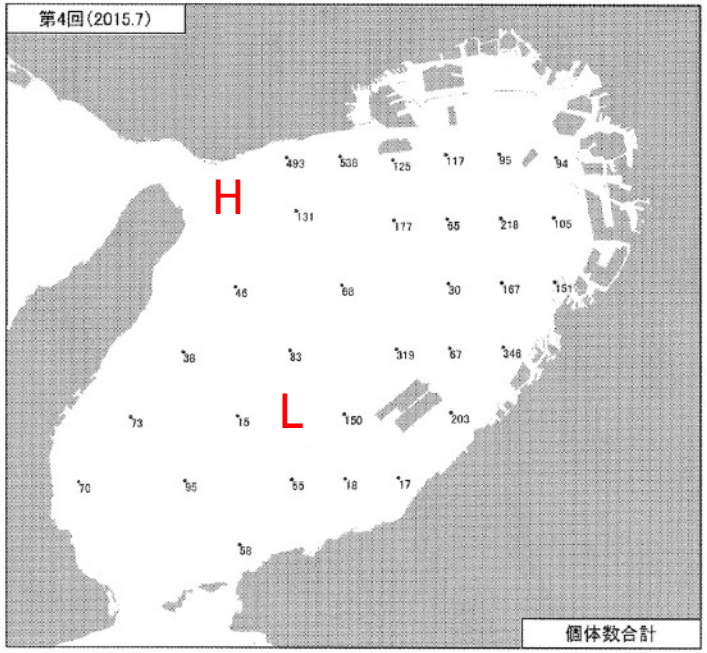
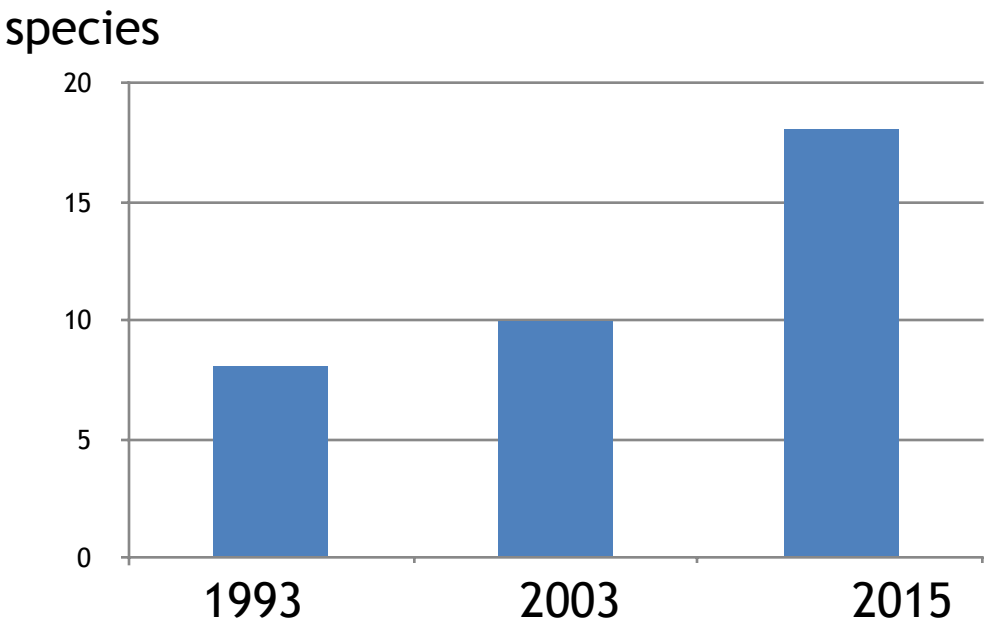
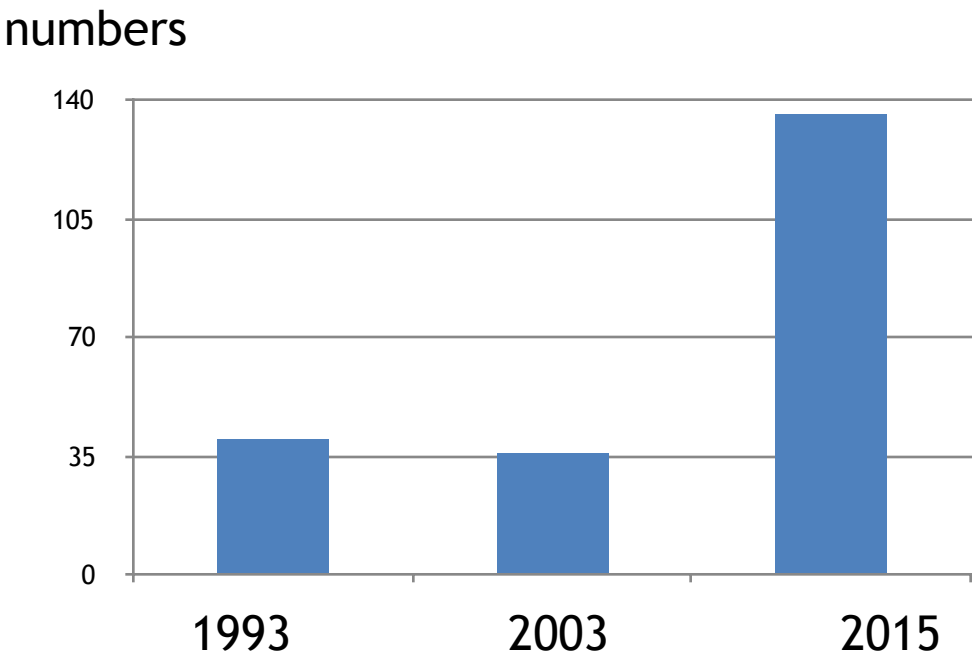
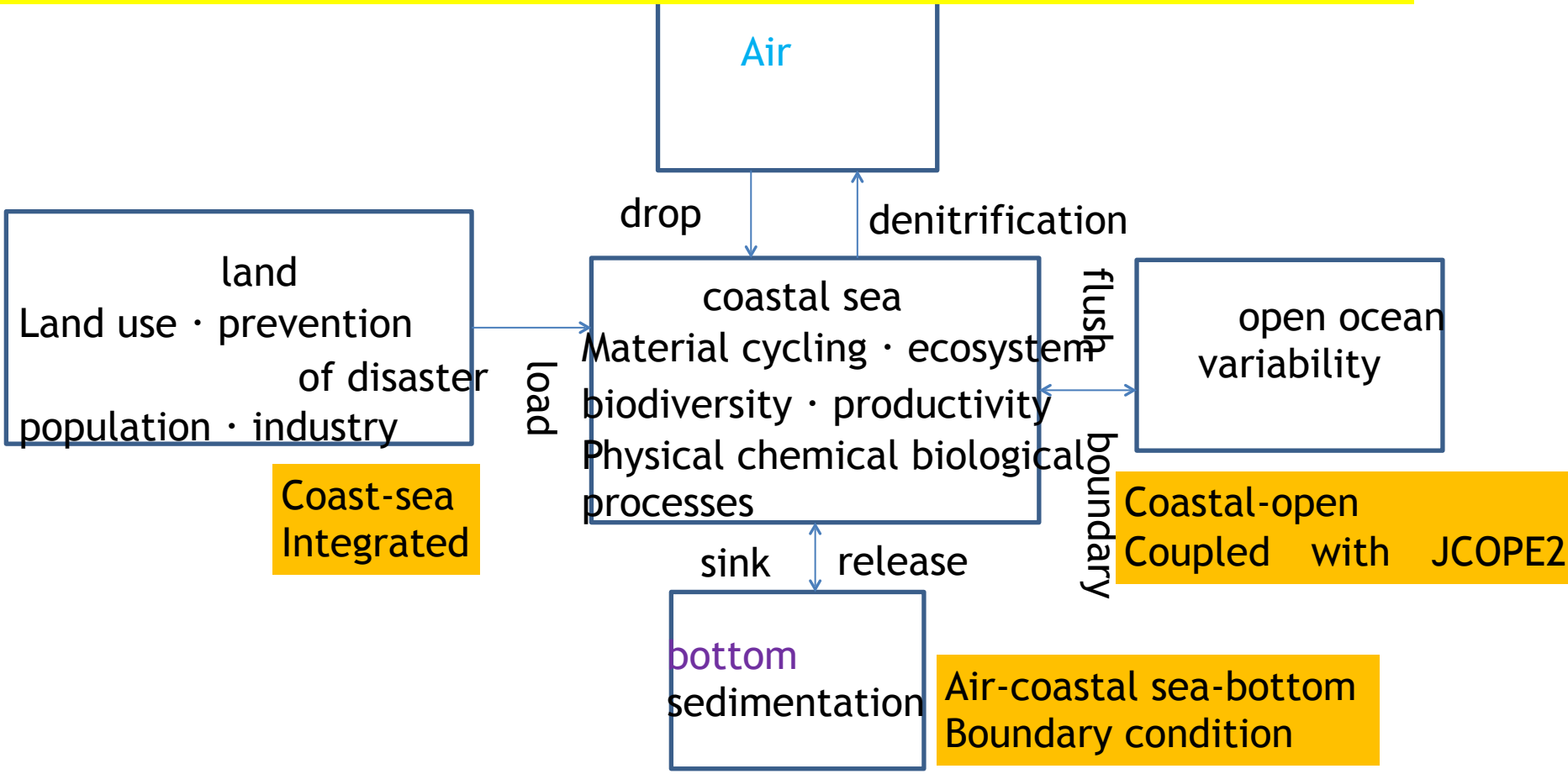


図 5-157 大阪湾 底生生物個体数合計





Integrated numerical model（land＋sea, natural ＋social sciences)

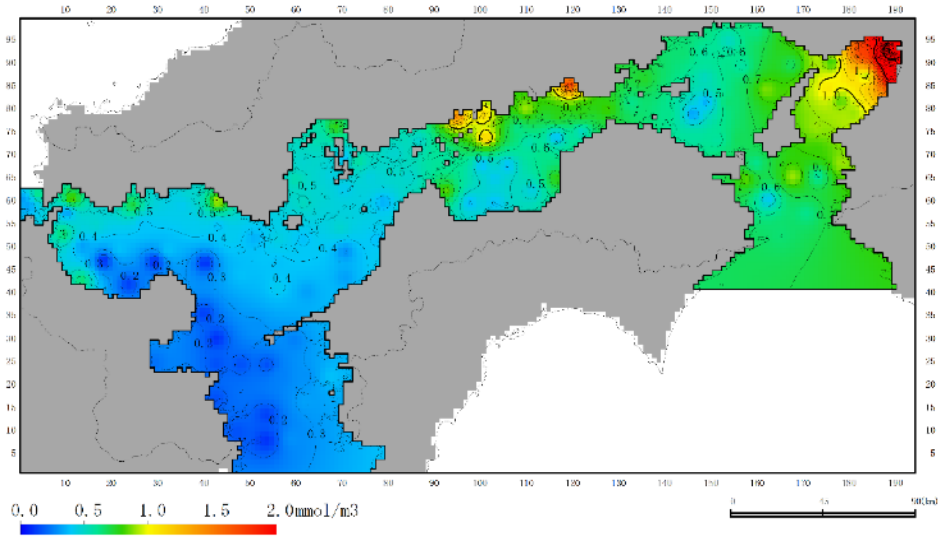


Shizukawa model：aquaculture（oyster・scallop・sea algae・salmon）environmental capacity

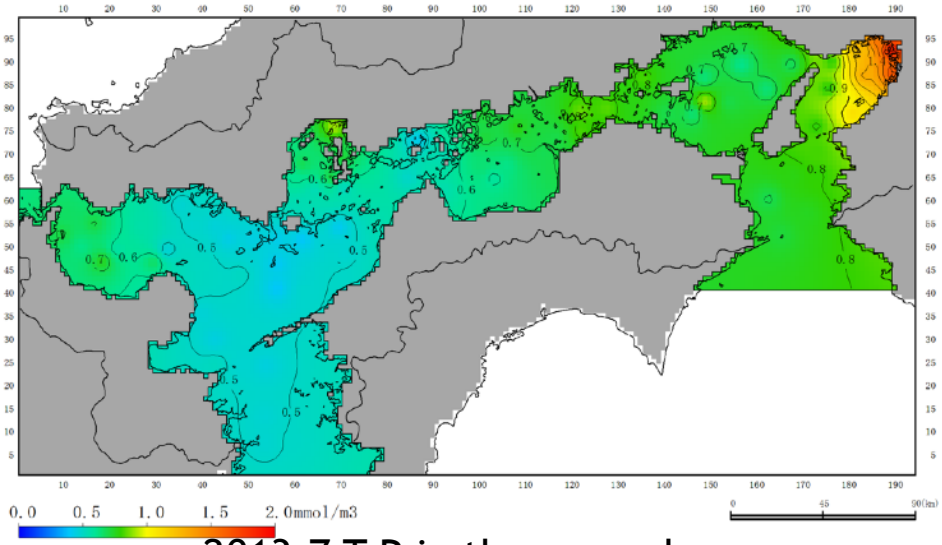
Toyama Bay model: change of Tsushima Warm Current and load from land

Seto Inland Sea model：load and nutrients concentration, increase of fish resources

T-P in the upper layer

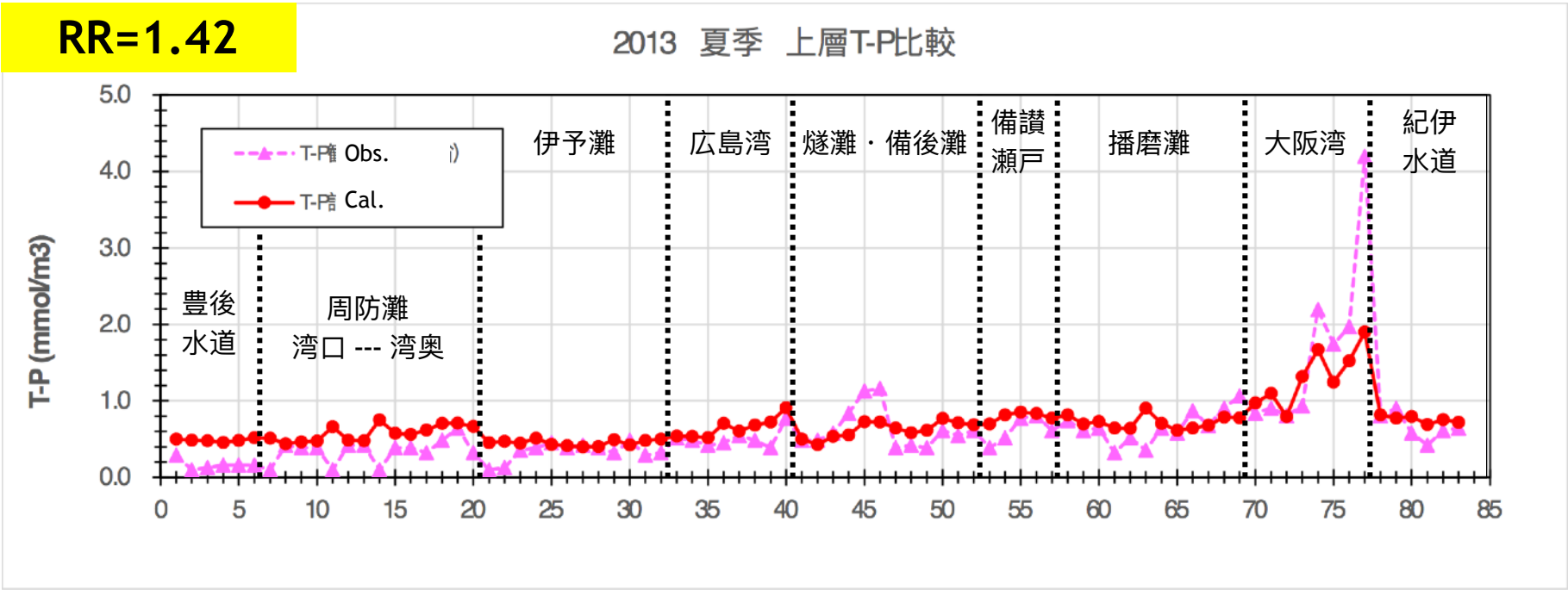


2013.7 T-P in the upper layer
(field observation)



2013.7 T-P in the upper layer
(calculation)

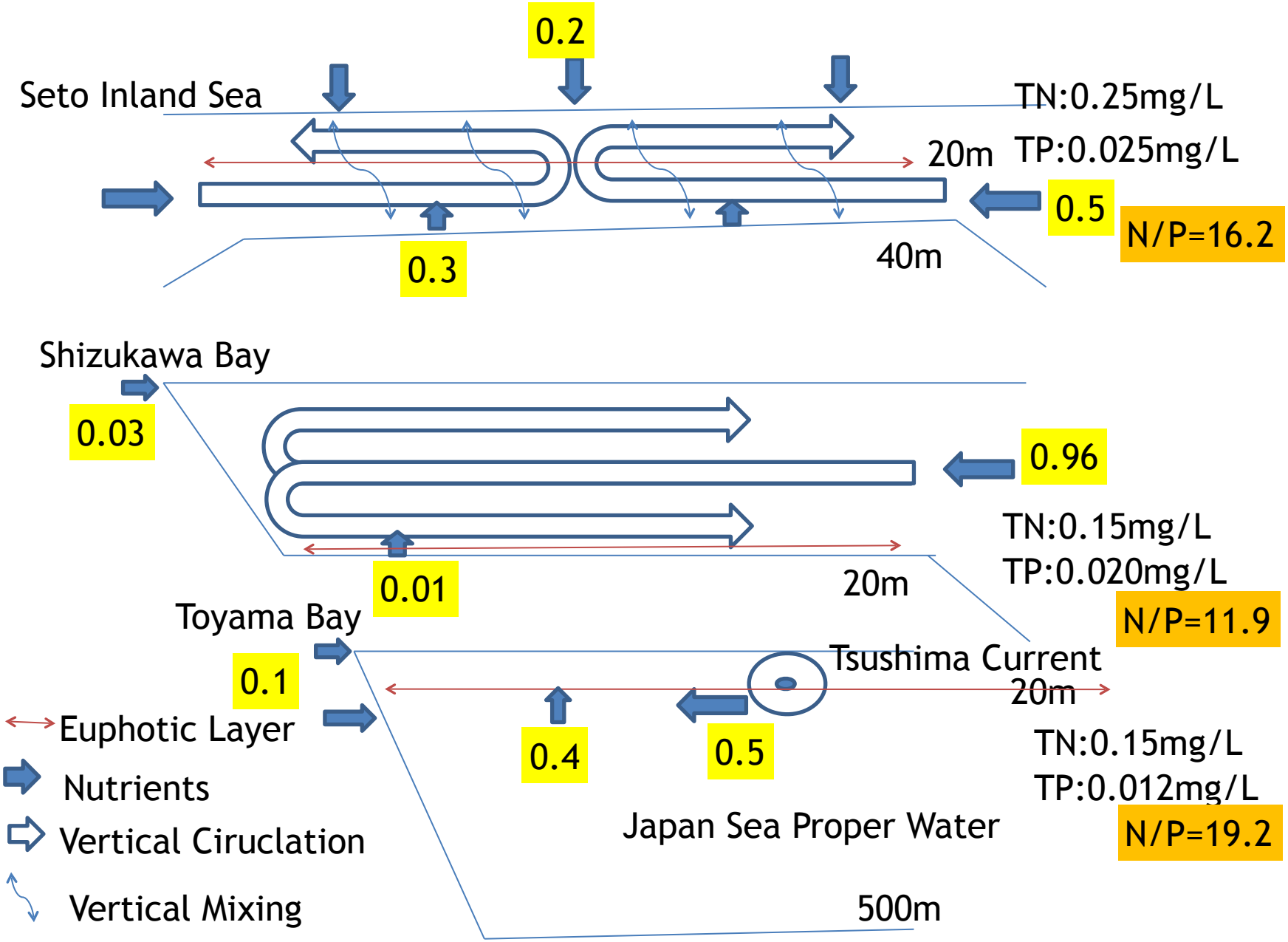
RR=1.42

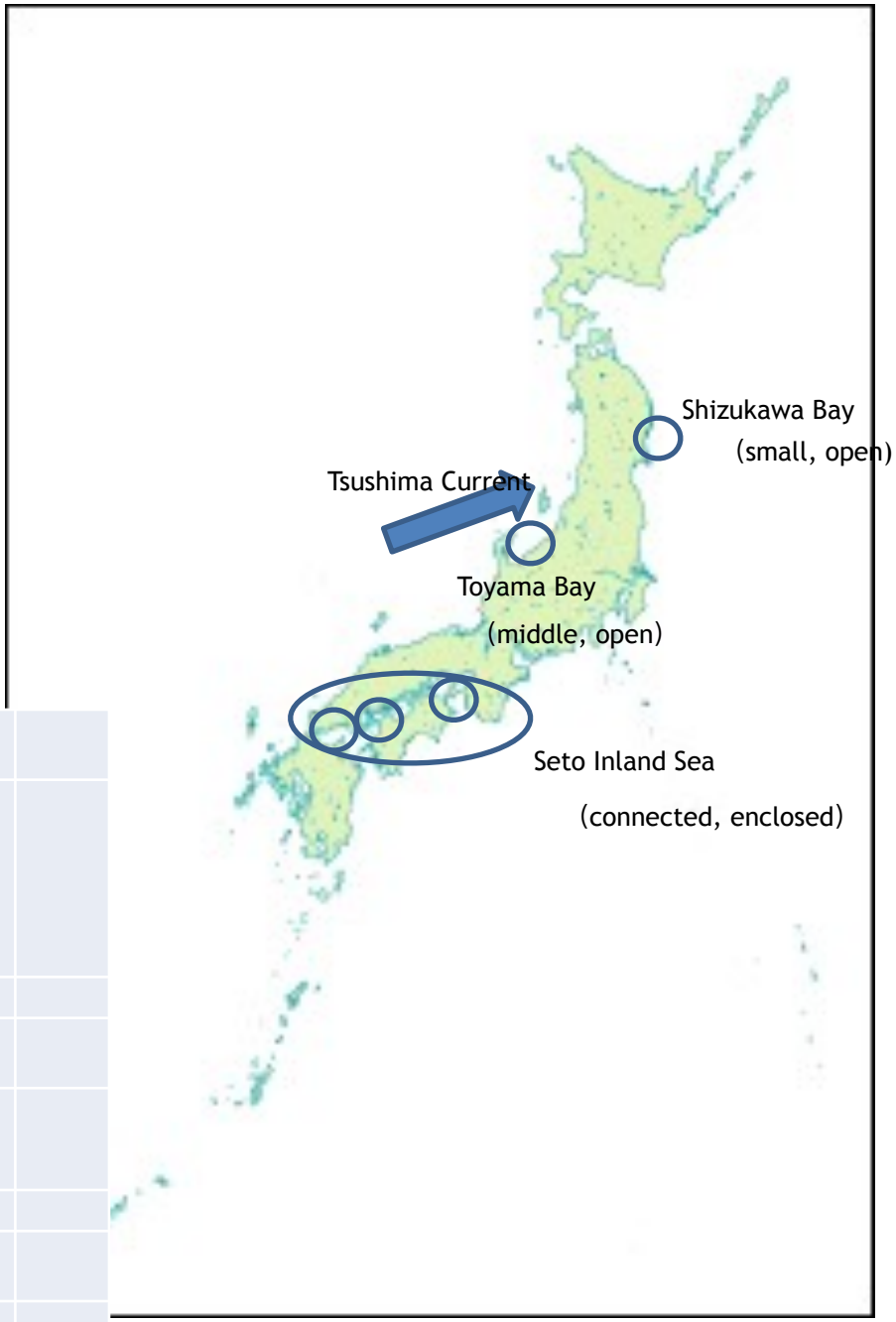


Output of Seto Inland Sea model

1）hole area：target transparency、TP・TN concnentration
(6.5m、TP=0.027mg/L、TN=0.27mg/L)
target TP・TN loads（ ton/day、 ton/day）、
present loads （ %、 %）。
transparency and TP/TN in the case of 0 loads

2）Hiroshima Bay：target transparency（ m)
target TP・TN cocnentration（ mg/L、 mg/L)
target loads（ ton/day、 ton/day）、
present loads（ %、 %）。
effect of tidal flats and sea-grass beds rehabilitation


Seto Inland Sea
0.2
TN:0.25mg/L
TP:0.025mg/L
20m
0.5
N/P=16.2
0.3
40m
Shizukawa Bay
0.03
0.96
TN:0.15mg/L
TP:0.020mg/L
0.01
20m
N/P=11.9
Toyama Bay
0.1
Tsushima Current
20m
Euphotic Layer
0.4
0.5
TN:0.15mg/L
TP:0.012mg/L
Nutrients
Vertical Ciruclation
Japan Sea Proper Water
N/P=19.2
Vertical Mixing
500m

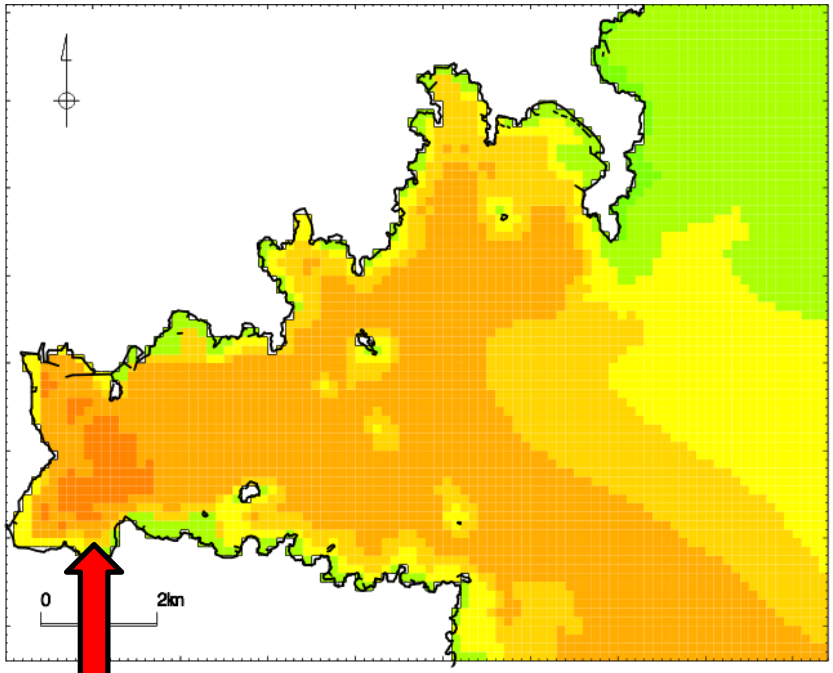


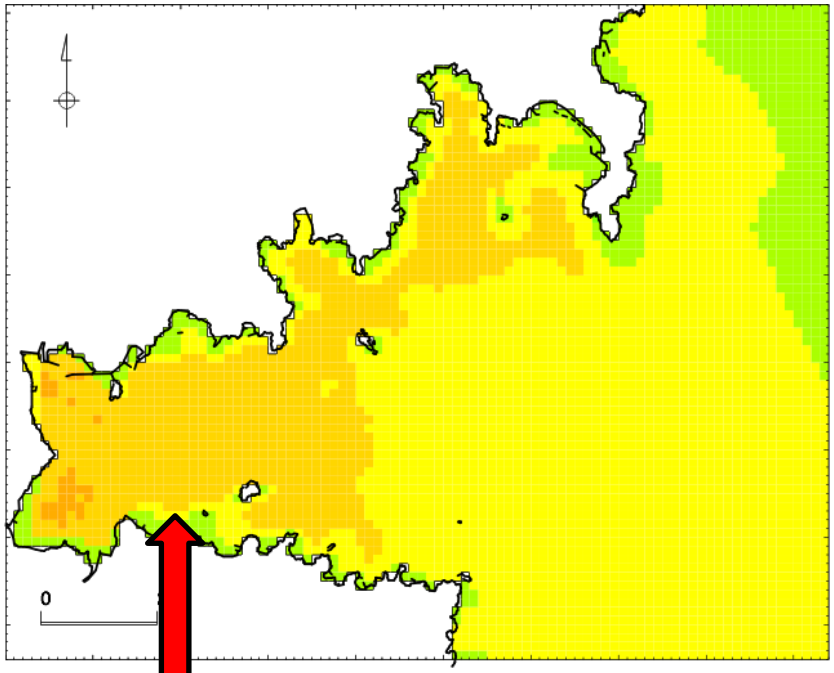
Small,open, Oyashio and Kuroshio					
Shidukawa Bay			Ago, Sukumo, Ohunato Bays		
Small, enclosed, connected, Land					
Seto Inland Sea			Tokyo, Ise Bays		
Middle, open, Tsushima Current					
			Karatsu,		

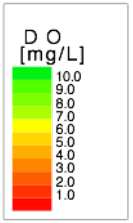
DO distribution in the bottom layer

Before Tsunami(2009.9.15)

present（2014.9.15）







Less than 4mg/L in the bay head

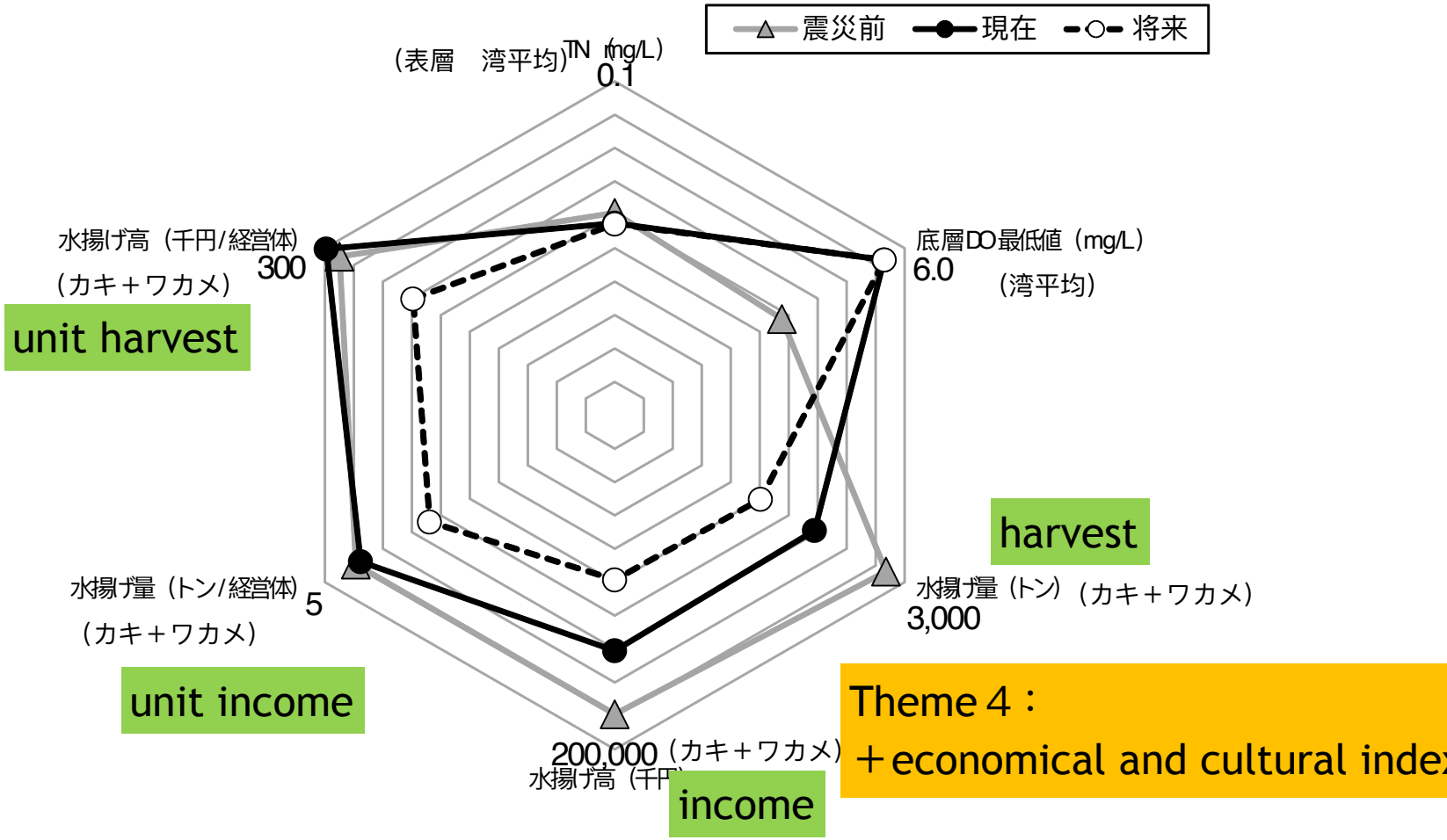
No hypoxia

ASC認証

Hypoxia in the bay during summer

※環境省「水質汚濁に係る生活環境の保全に関する環境基準の見直し」
によると、底層DOが4mg/L以下になると、貧酸素への耐性の低い生物
の生息に影響が出る可能性あり

Temporal change of sustainability index



注）①将来：南三陸町の将来計画目標年（2020）の流入負荷量を推計．なお，将来の漁業経営体数については現在と同じとした．
②将来のカキ筏台数＝現在と同じ（震災前の１／３）と仮定．　将来のワカメ筏台数＝現在の２／３と仮定．
③底層DO最低値　：　湾内の各メッシュの年間最低値を平均した．
④TN　：　湾内の各メッシュの表層の値（１年間）を平均した．

Synthesis
including integrated numerical model

- Philosophy for coastal management (human and sea, use and conservation, food security…)

  Natural, social and human sciences
- Parameters for the sustainable coastal sea area (transparency, bottom DO, area of tidal flat and sea weed, nutrients concentration……)

  Field survey, modeling
- Governance for realizing the measures

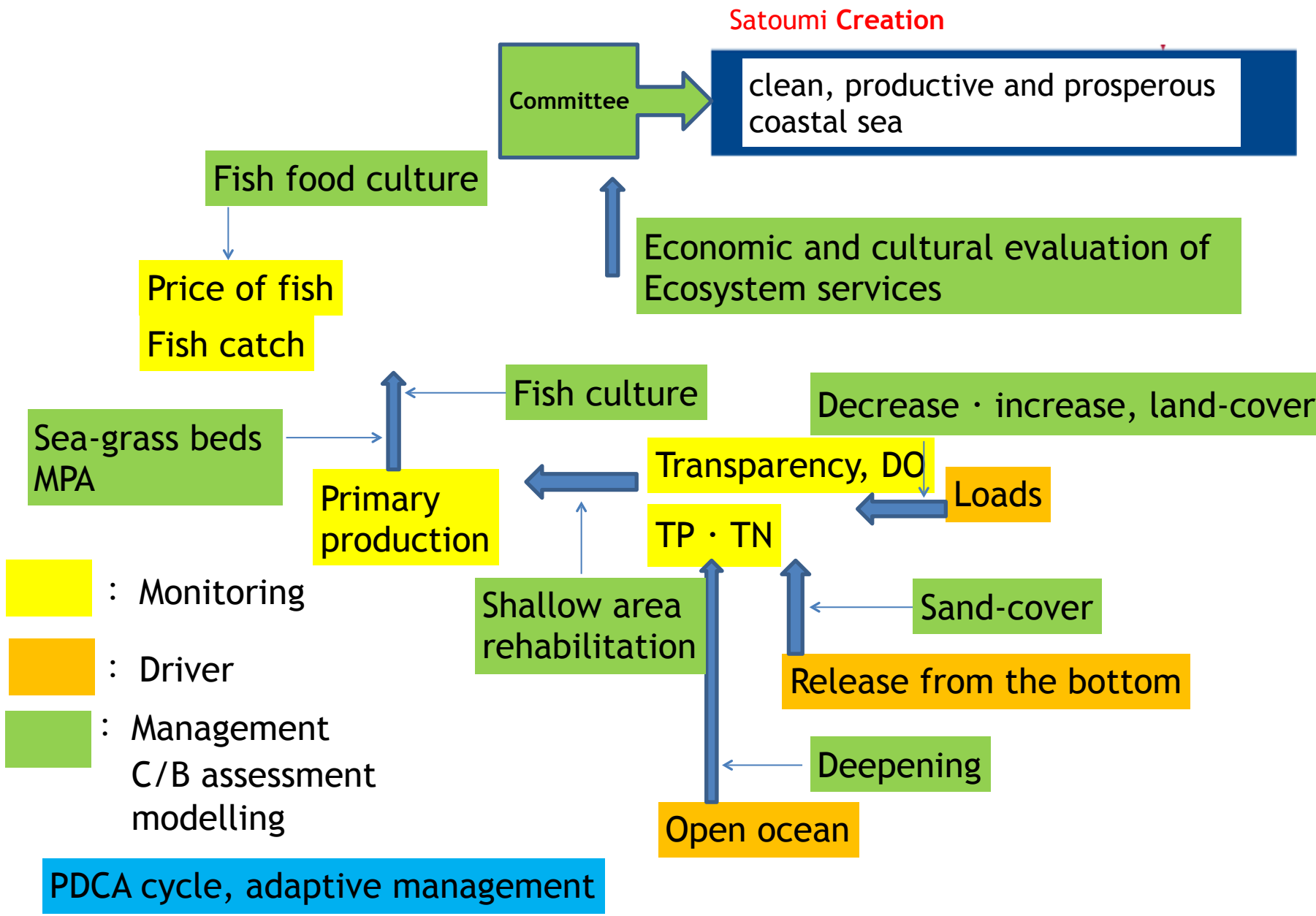
  Committee, visualization of model results
- Parameters of sustainability

  population, GNP,… in the coastal sea area

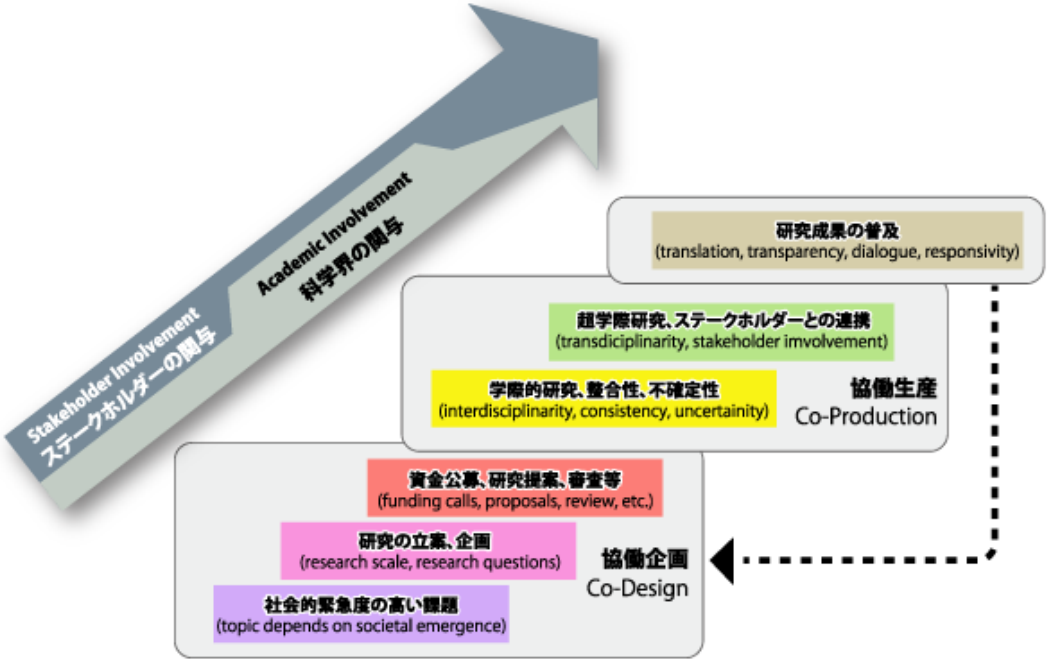
- Integrated numerical model as a support tool for policy makers

  Integrated model of natural, social and human sciences

Development of Coastal Management Method to Realize the Sustainable Coastal S



Future Earth (2015-2024) by ICSU



- Sustainability → Future-ability
- Natural, Social and Cultural Sciences → Trans-disciplinary Science → Design Science

"What is the future earth?, future coastal sea?"

- Integrated knowledge scientists, policy makers, stakeholders….