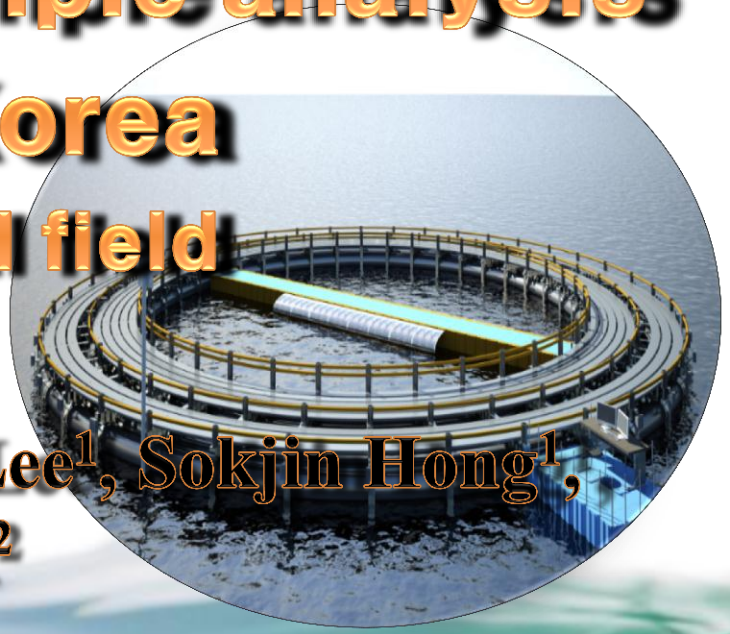
The application example analysis of IMTA in Korea
- Environmental field



Hyung Chul Kim[1], Won Chan Lee[1], Sokjin Hong[1], Mi Seon Park[2]

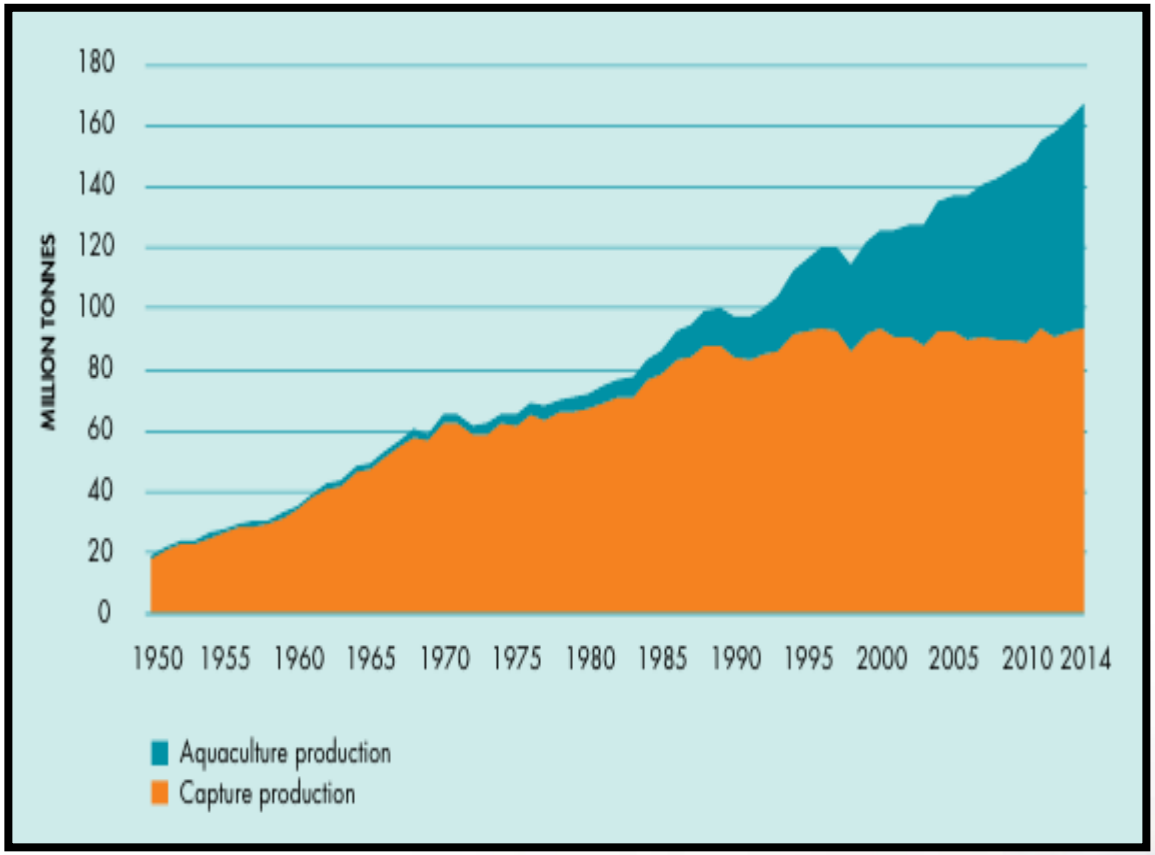
[1] Marine Environment Research Division, NIFS, Korea
[2] Southeast Sea Fisheries Research Institute, NIFS, Korea

Contents

1. Background

Global Aquaculture Production

By FAO, 2016

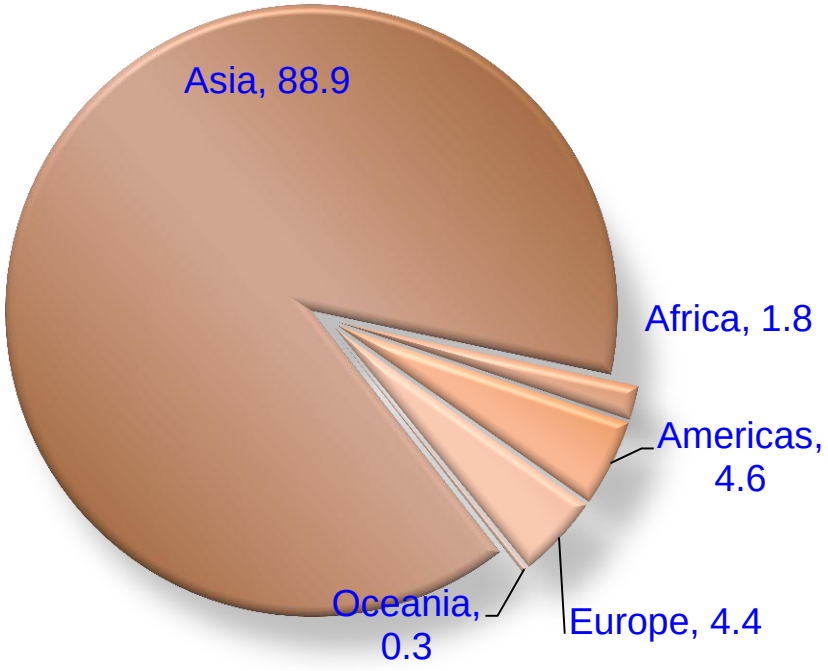


Maintain wild fisheries, increase aquaculture

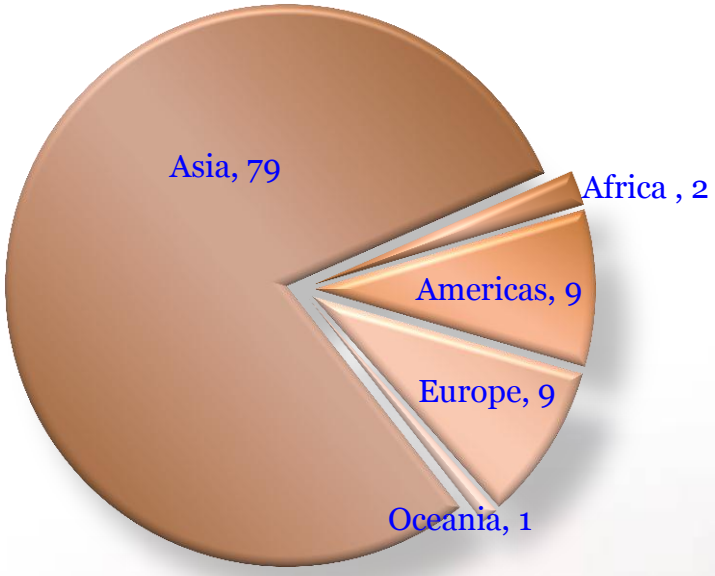
Qauntity and Value of Aquaculture

By John et al., 2010

World aquaculture by quantity, 2008, %



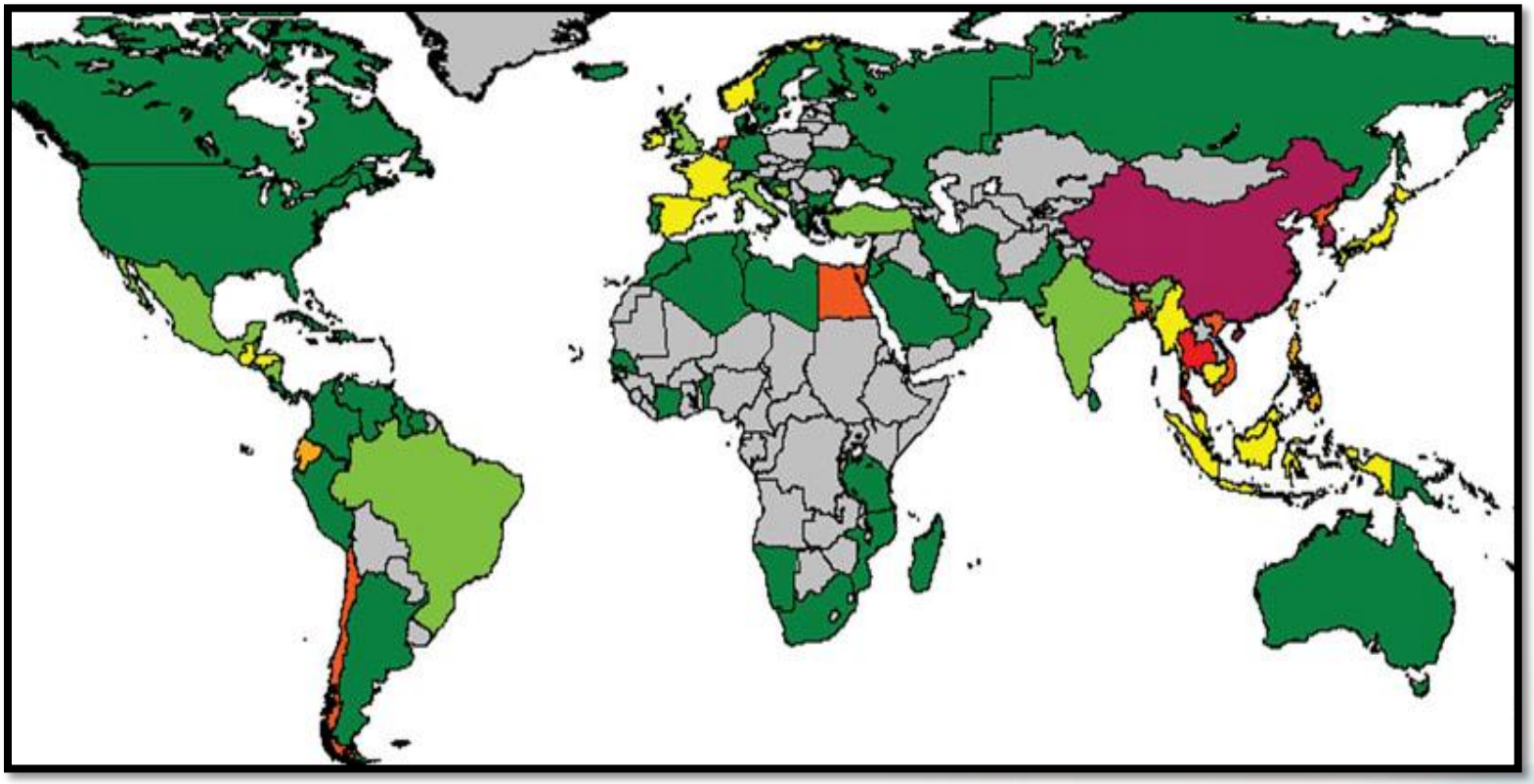
World aquaculture by Value, 2008, %



52 Million Tons(World) *vs* 34 Million Tons(China)

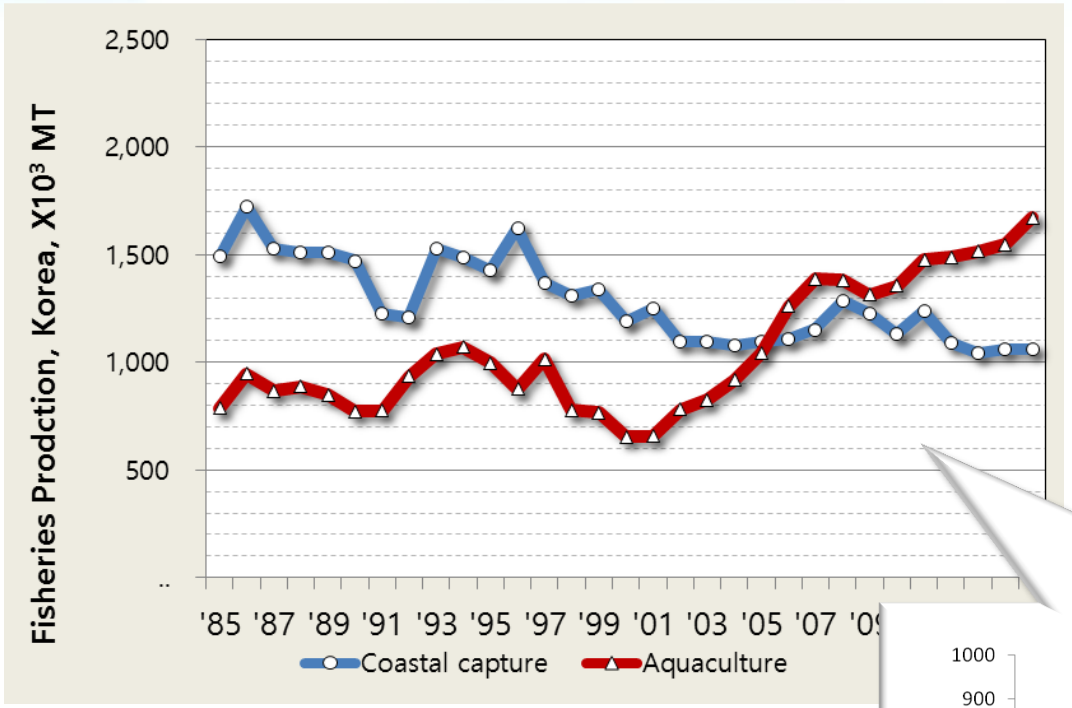
Production per coastline length

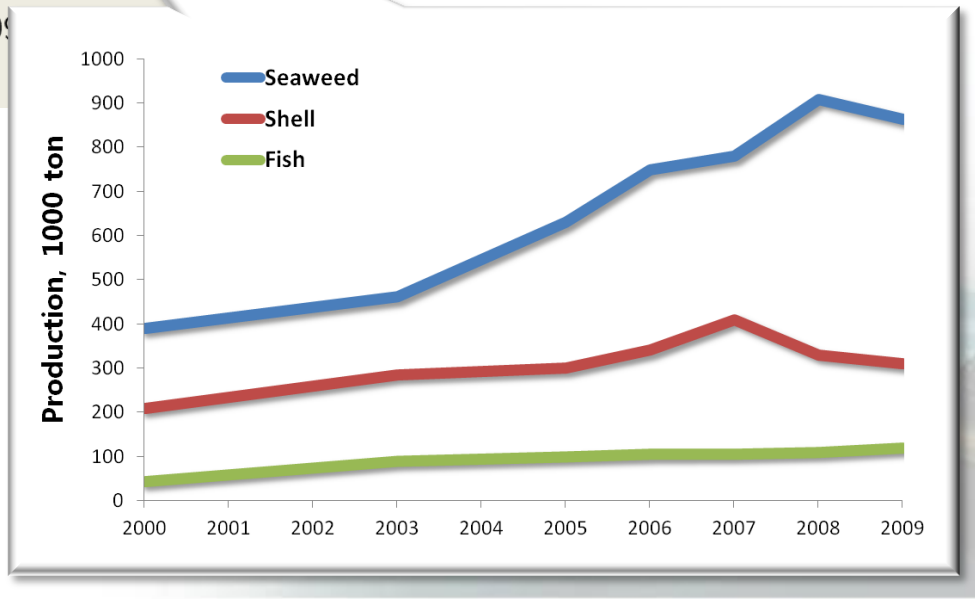
Unit: Kg/km/year **By FAO, 2009**



<10, 10~25, 25~50, 50~100, 100~250, 250~500, **500<**

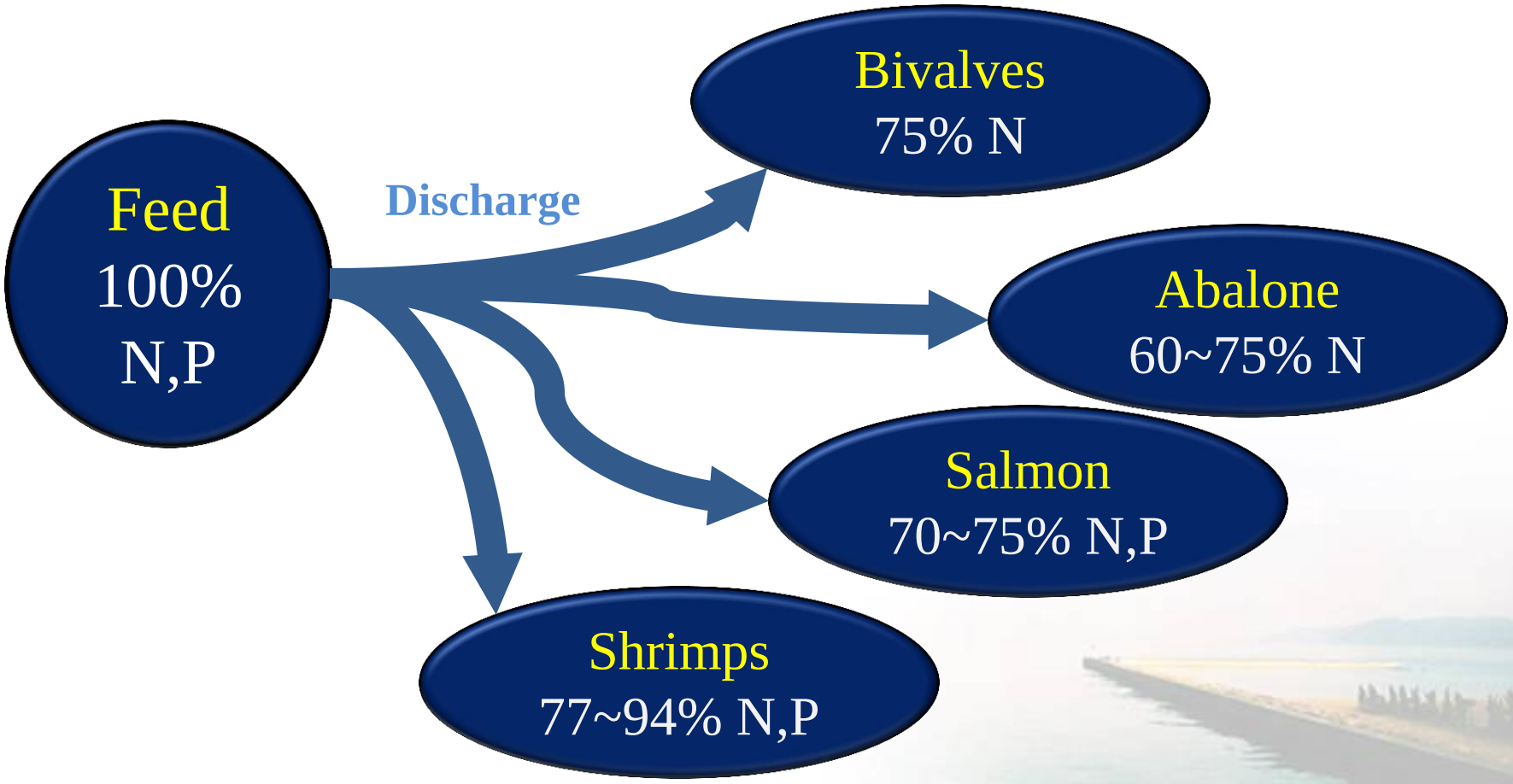
The Trend of Korean Aquaculture





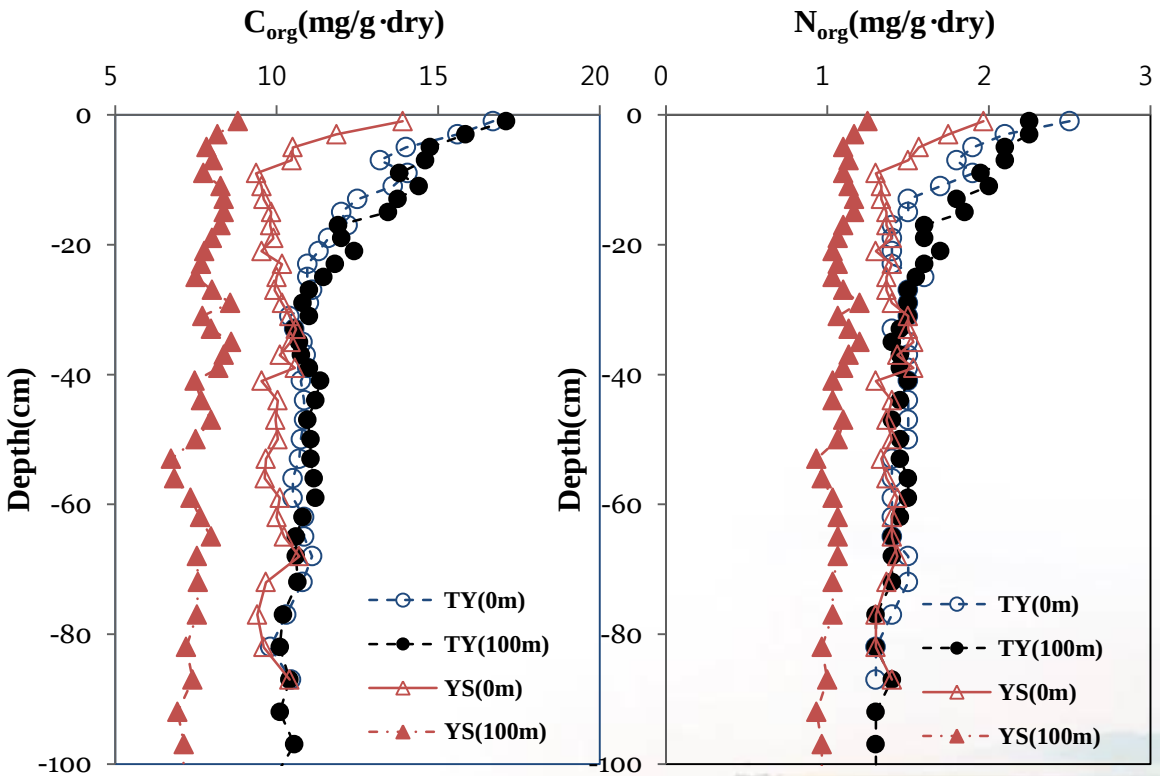
Mariculture Nutrient wastes

By Troell et al., 2003



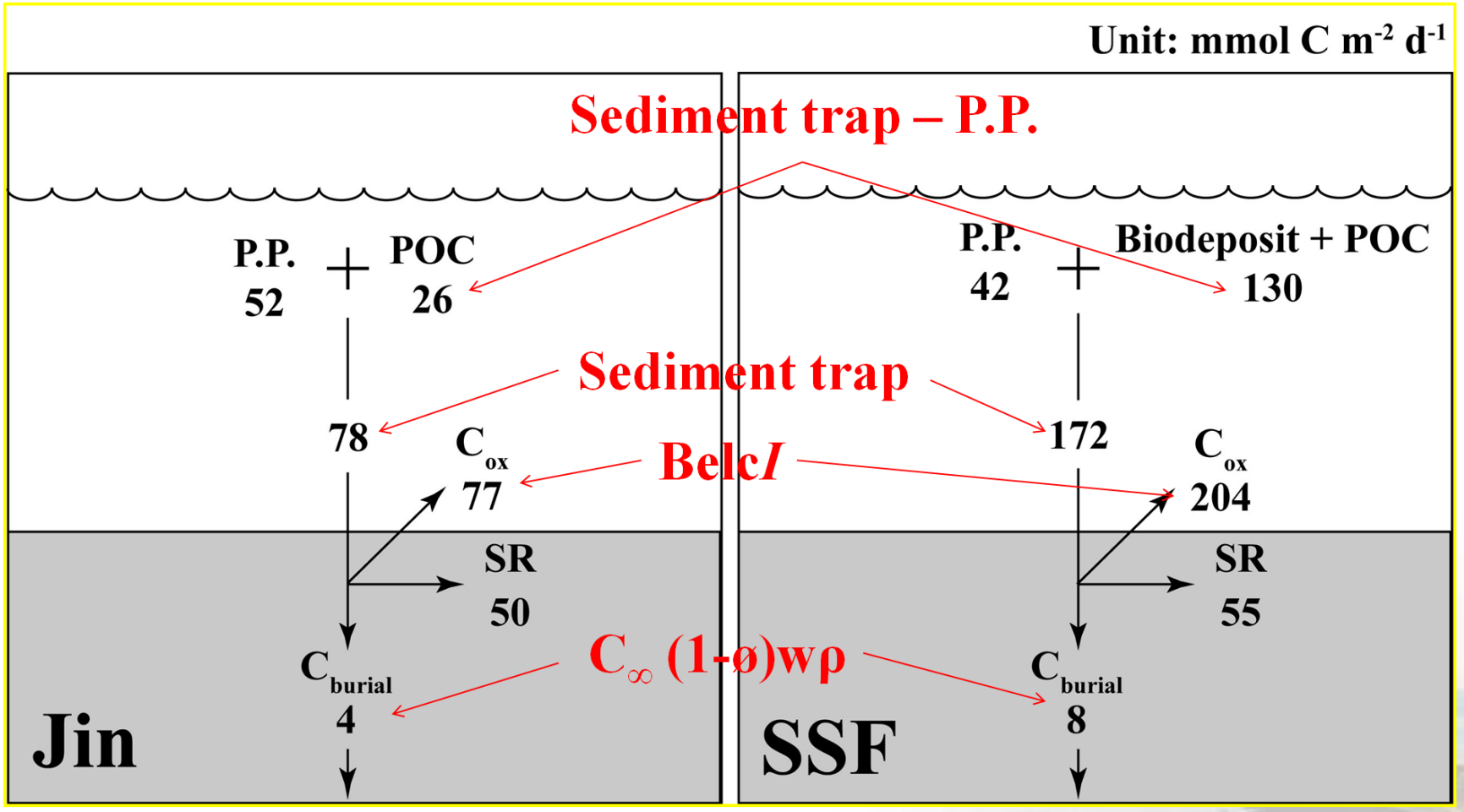
Marine impact of finfish cage aquaculture

By MIFFAF, 2011



Carbon cycle in sea squirt farm

By Lee et al., 2012



2 folds higher in SSF(Sea Squirt Farm) than control site

EBM & IMTA

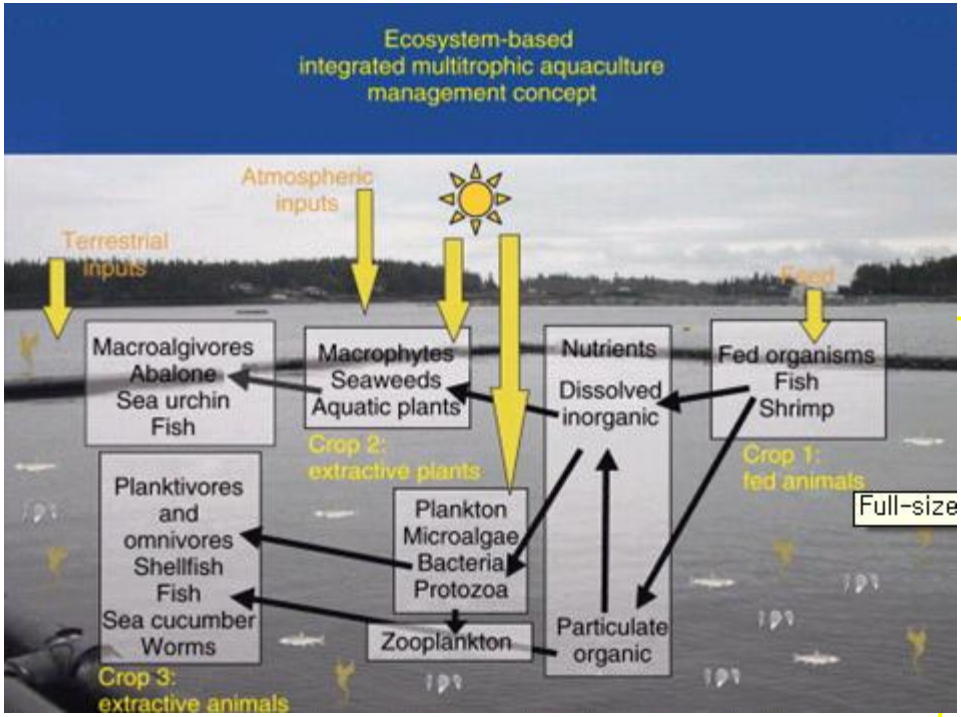
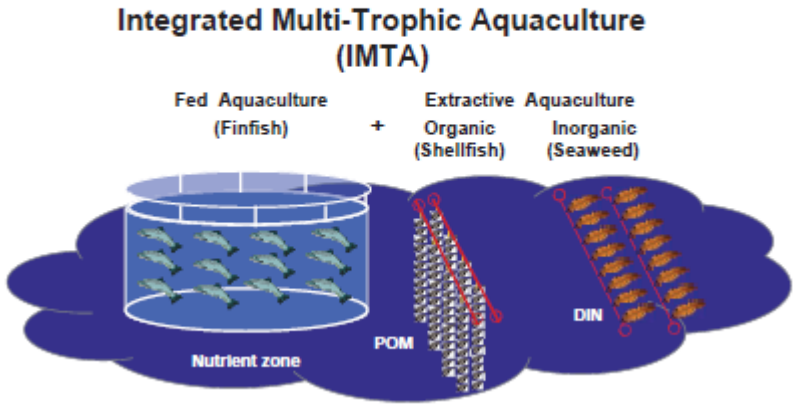
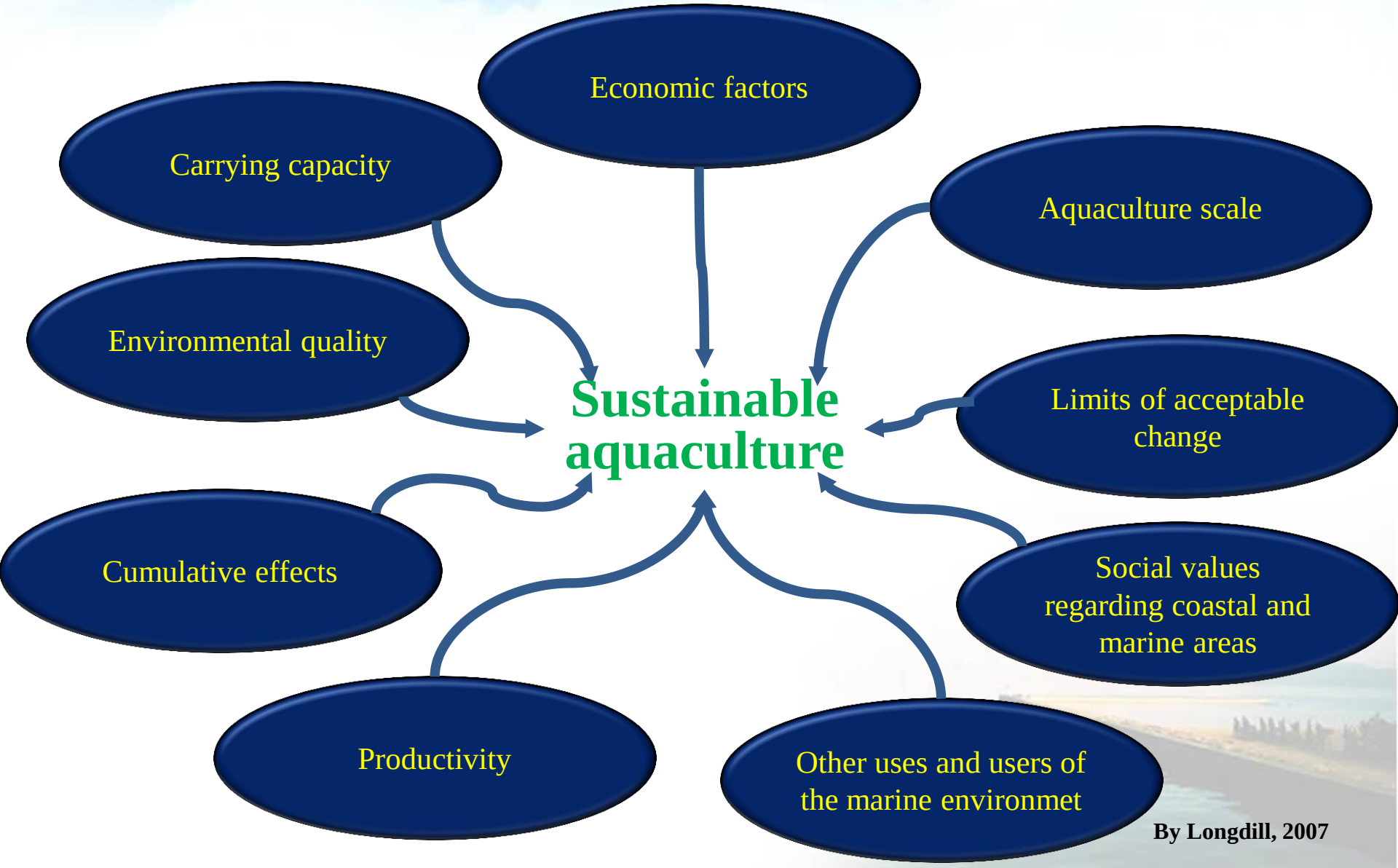


FIGURE 2
Conceptual diagram of an integrated multi-trophic aquaculture (IMTA) operation combining fed aquaculture (finfish) with organic extractive aquaculture (shellfish), taking advantage of the enrichment in particulate organic matter (POM), and inorganic extractive aquaculture (seaweeds), taking advantage of the enrichment in dissolved inorganic nutrients (DIN)



Source: Chopin (2006).

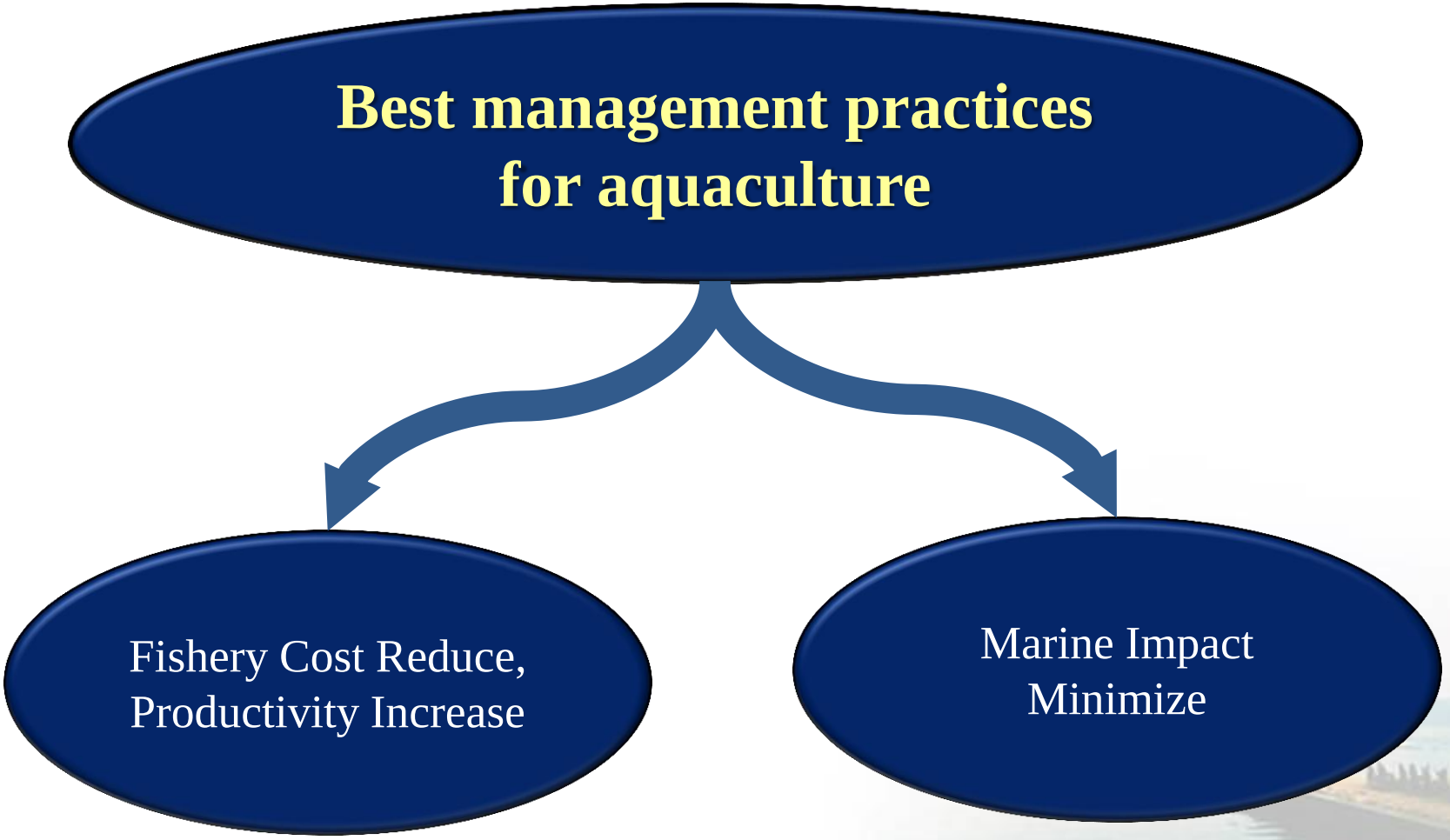
IMTA & Sustainable Aquaculture



By Longdill, 2007

BMPs

NIFS


Best management practices for aquaculture
Fishery Cost Reduce, Productivity Increase
Marine Impact Minimize

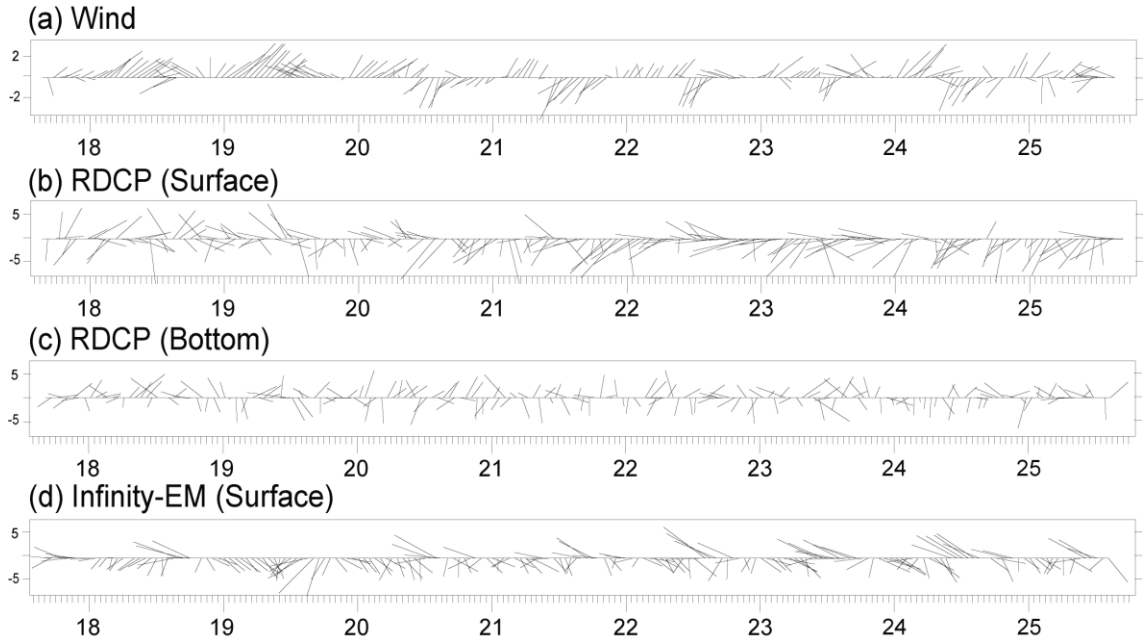
2. Materials and Methods

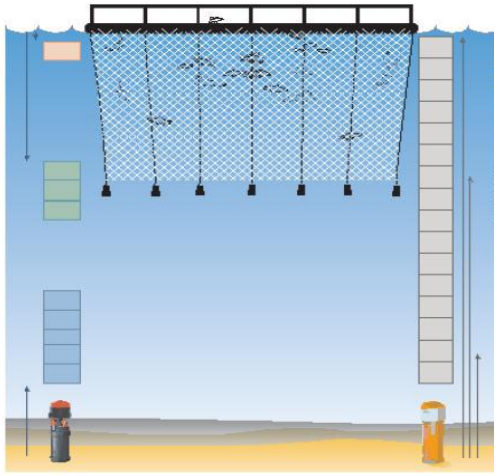
♣ Environmental Research

- Research period : 1st 2011~2012/ 2nd 2016~2018
- Sites : IMTA facility and control site
- Research items
  - Sediment qualities(COD, IL, AVS, TN, TOC)
  - Settlement of organic materials(SPM)
  - Chemical composition of SPM(POC, PON)
  - Sediment oxygen demands(SOD)
  - Nutrients release loads from sediments(DIN, DIP)
  - Chemical composition of aquaculture organisms(POC, PON)
  - Current measurement with RDCP

♣ Current measurement

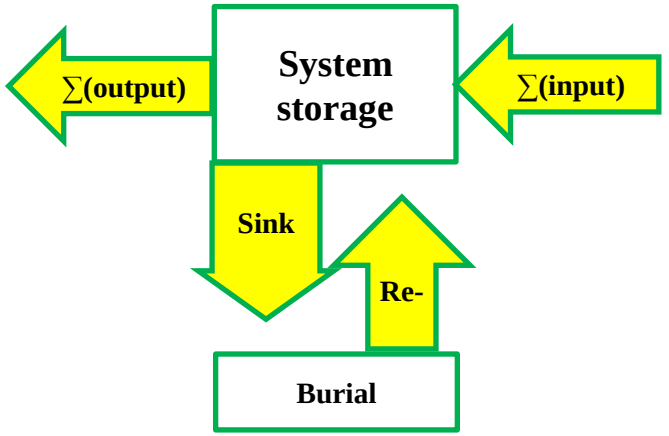
- Period : 2012. 5. 17. 16:00 ~ 5. 25. 14:00



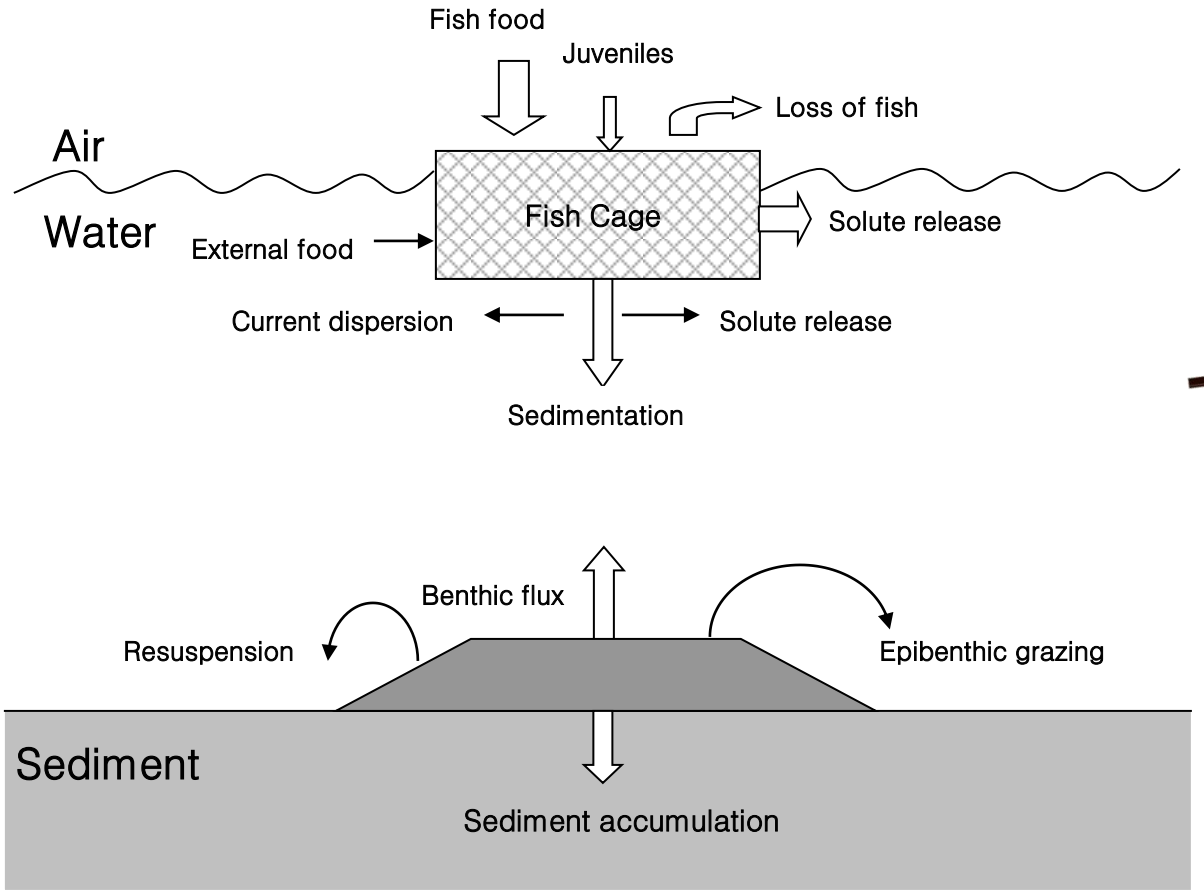


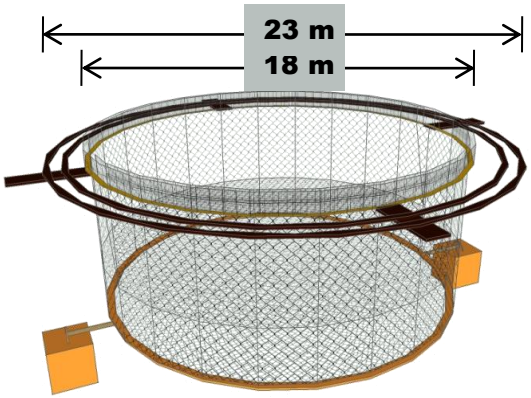
- NW & SE direction prevails at Infinity-EM measurement site
- 3 cm/sec of average current speed
- Similar patterns with the data on March and November, 2011

♣ Material budget of IMTA



- Schematic diagram

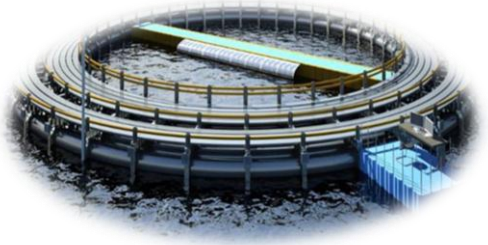




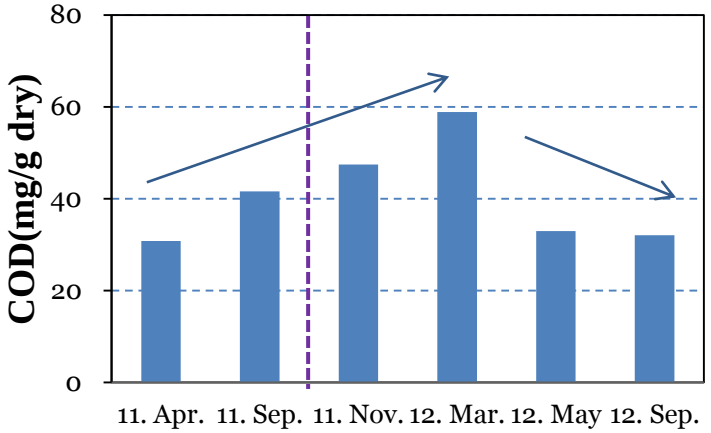
- Cage area: 254 m^2
- Feeding amount : 6,774 kg (2011.9.01~2012.8.31)
- Juveniles : 1,285 kg (101,206 fish/ ave. 9.3 cm, 12.7 g)

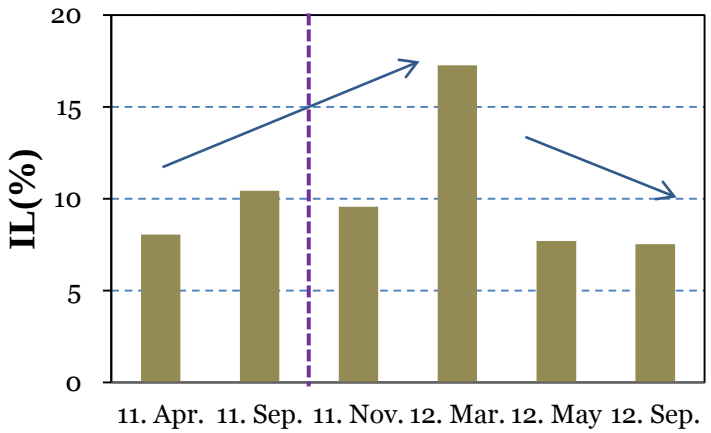
3. Results

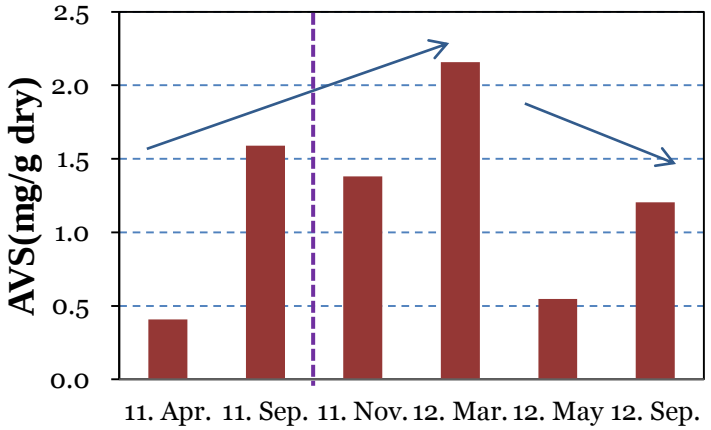
♣ Comparison of the environment with before and after IMTA facility establishment(1)



● Sediment qualities

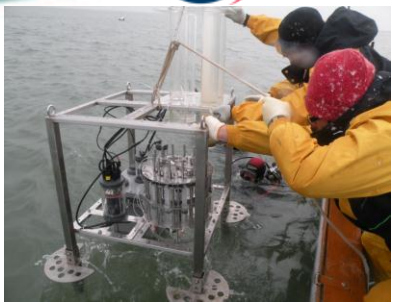




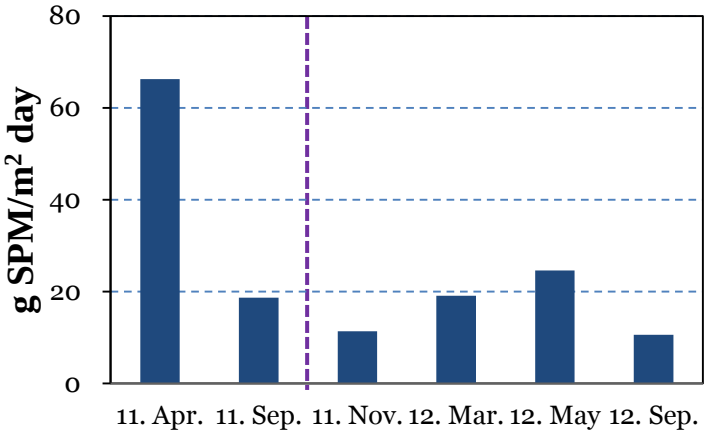


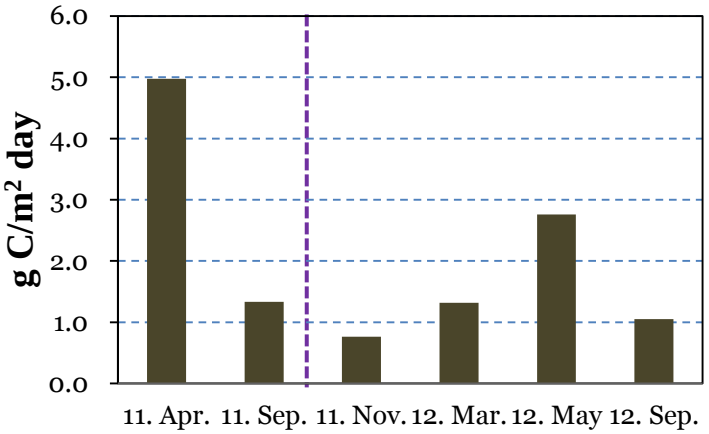
- Increase of organic material concentrations after establishment of IMTA rather than before
- Sediment qualities are improved since May, 2012 (low concentrations compared with the before establishment of IMTA facility)

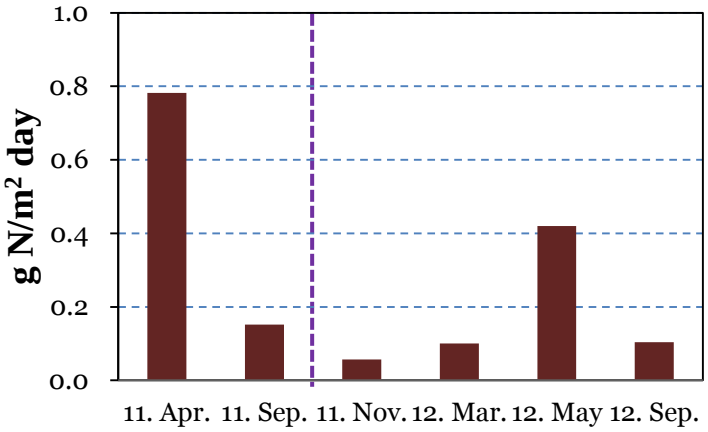
♣ Comparison of the environment with before and after IMTA facility establishment(2)



- Settlement amounts of SPM & chemical compositions

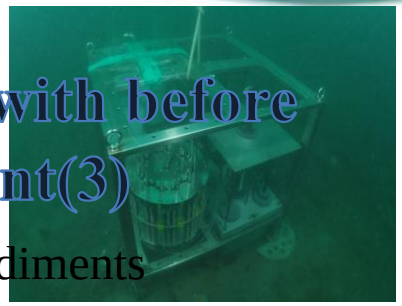




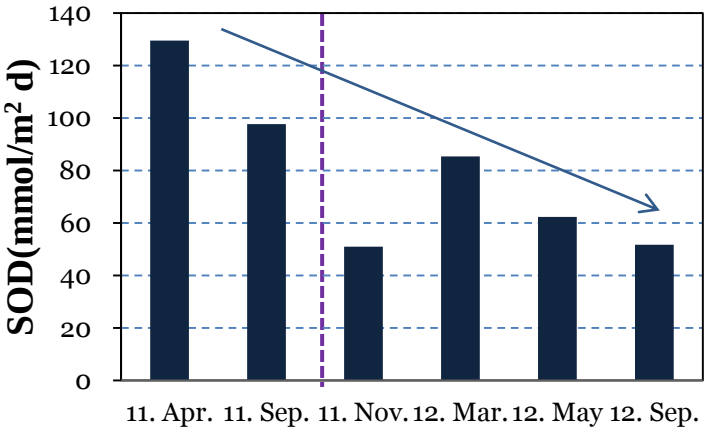


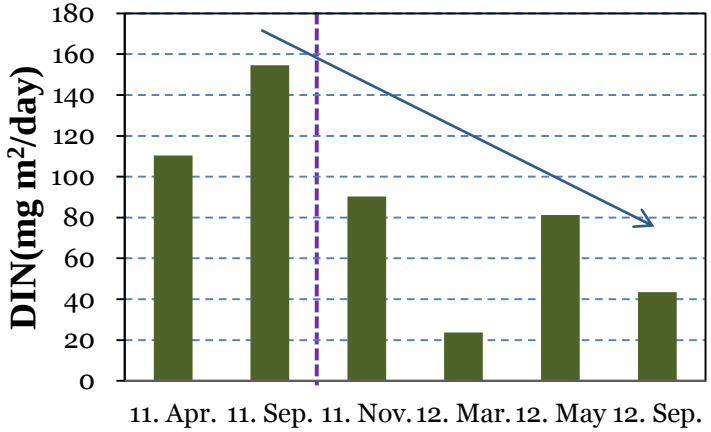
- Settlement amounts of SPM are similar and/or less than the before(except April, 2011)
- Relatively higher concentrations of POC & PON after establishment of IMTA compared with the before
- This means the effects of aquaculture activities(e.g. feeding, metabolism of fish, etc.)

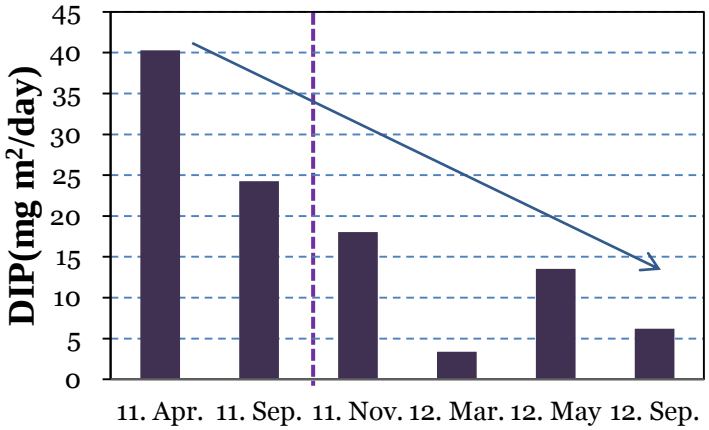
♣ Comparison of the environment with before and after IMTA facility establishment(3)



- SOD & nutrients(DIN, DIP) release from sediments







- Decrease of SOD after establishment of IMTA facility compared with the before
- Decrease of efflux from sediments after establishment of IMTA facility
-This indicates the right function of IMTA

4. Conclusion

- Sediment qualities are improved at IMTA farm since May 2012, almost 8 months later of starting the IMTA activities.

- Settlement amounts of SPM are similar and/or less than the before construction of IMTA facility, but POC & PON concentrations of SPM are relatively higher compared with the before. This indicates the effects of IMTA activities(e.g. Feeding, metabolism of fish, etc.).

- Decrease of SOD and nutrient release from sediments are obvious at IMTA site.

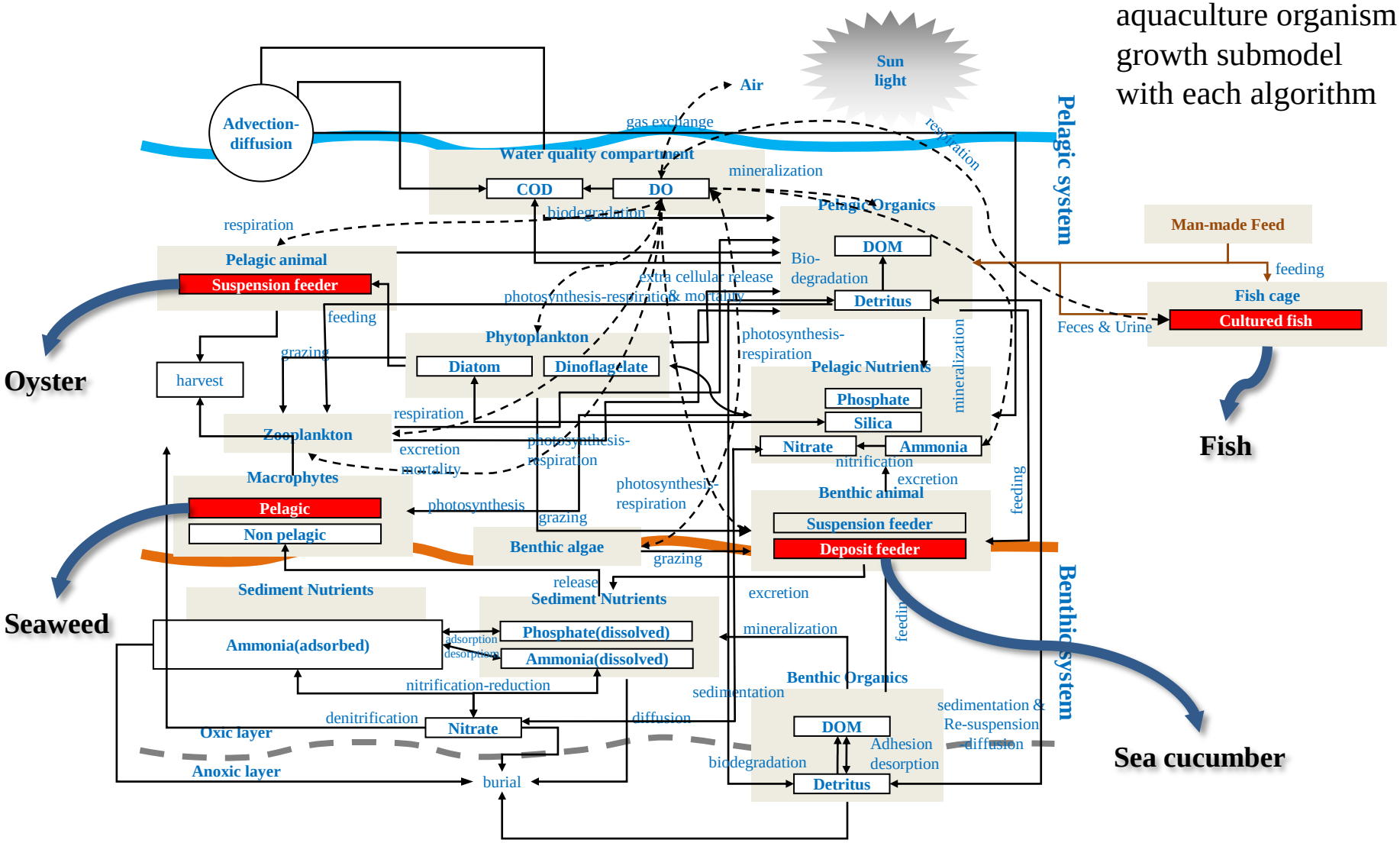
- Feeding and harvest effects are higher than the case of non IMTA farm, and also sedimentation and burial flux are 3.6~5.5 folds lower, that indicate the right functions of IMTA technology.

- The following directions for future research were identified. (1) understand in detail the important biological/biochemical processes of IMTA system. (2) focus to include factors affecting IMTA organisms growth and metabolism. (3) numerical calculation of carrying capacity in IMTA system is necessary.

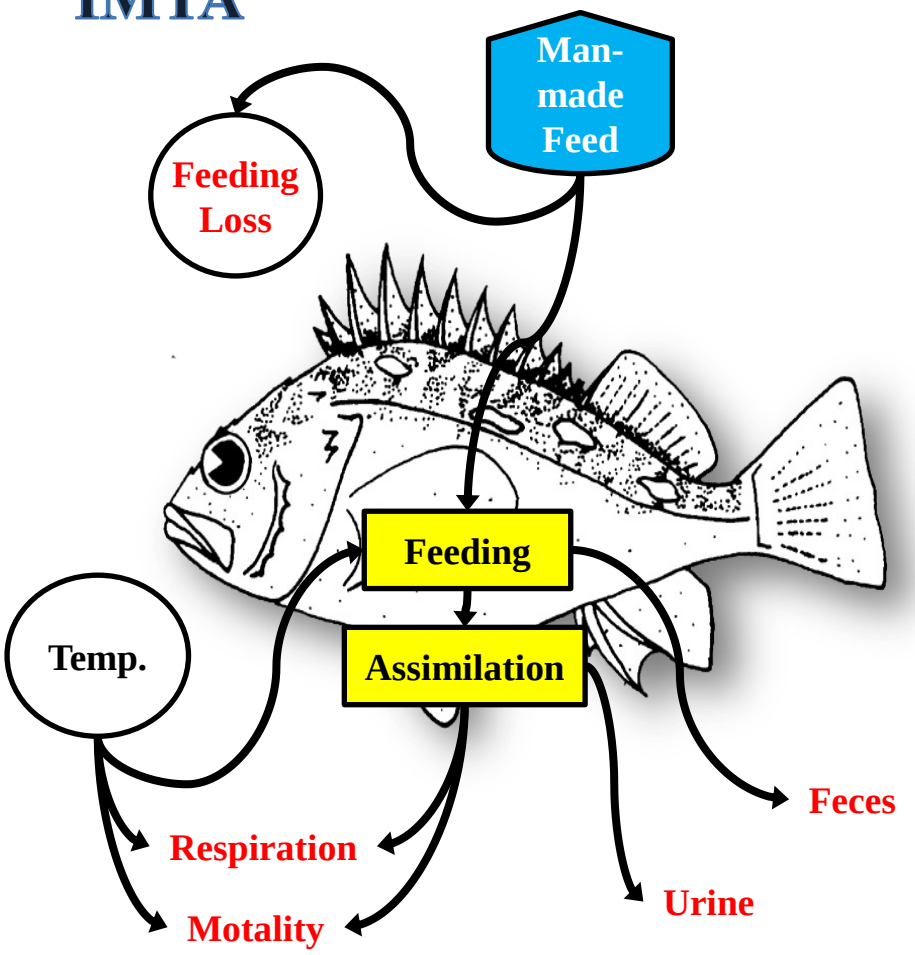
Future direction

♣ Estimation of carrying capacity of IMTA farm

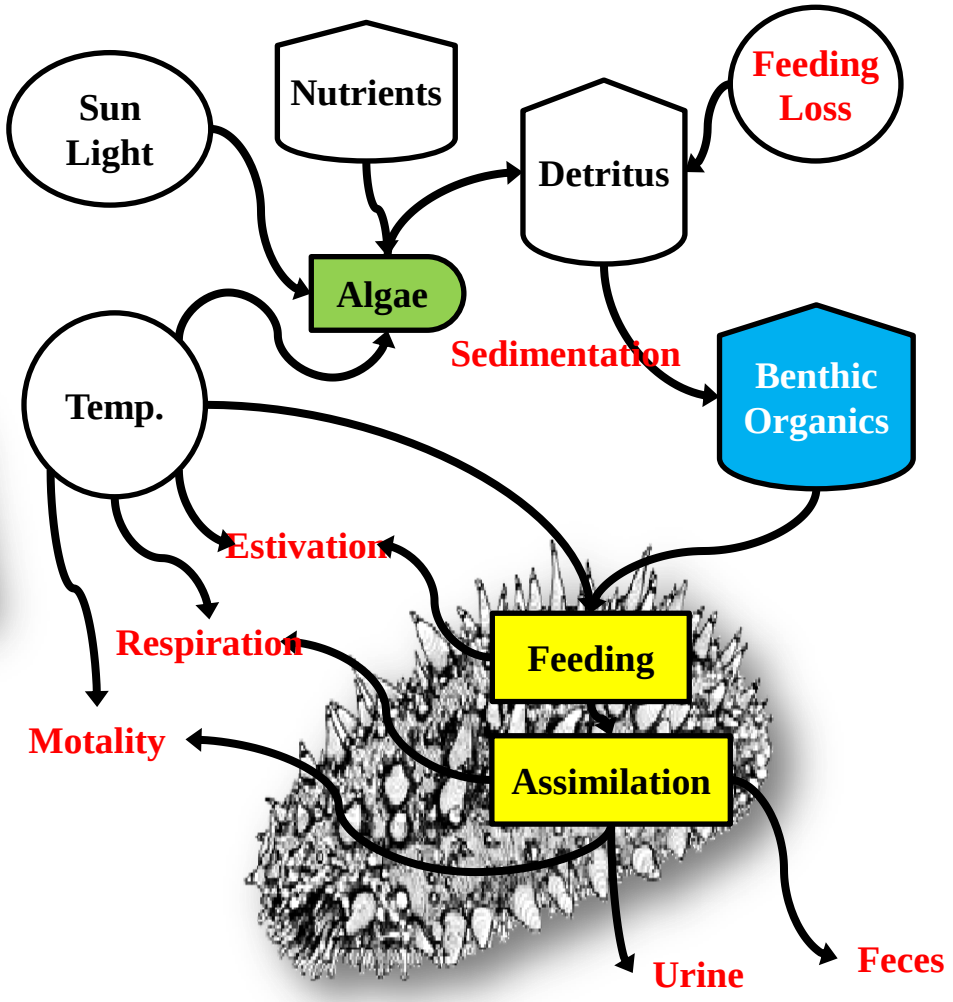
- Establishment of aquaculture organism growth submodel with each algorithm



♣ Algorithms of aquaculture organisms growth & metabolism in IMTA

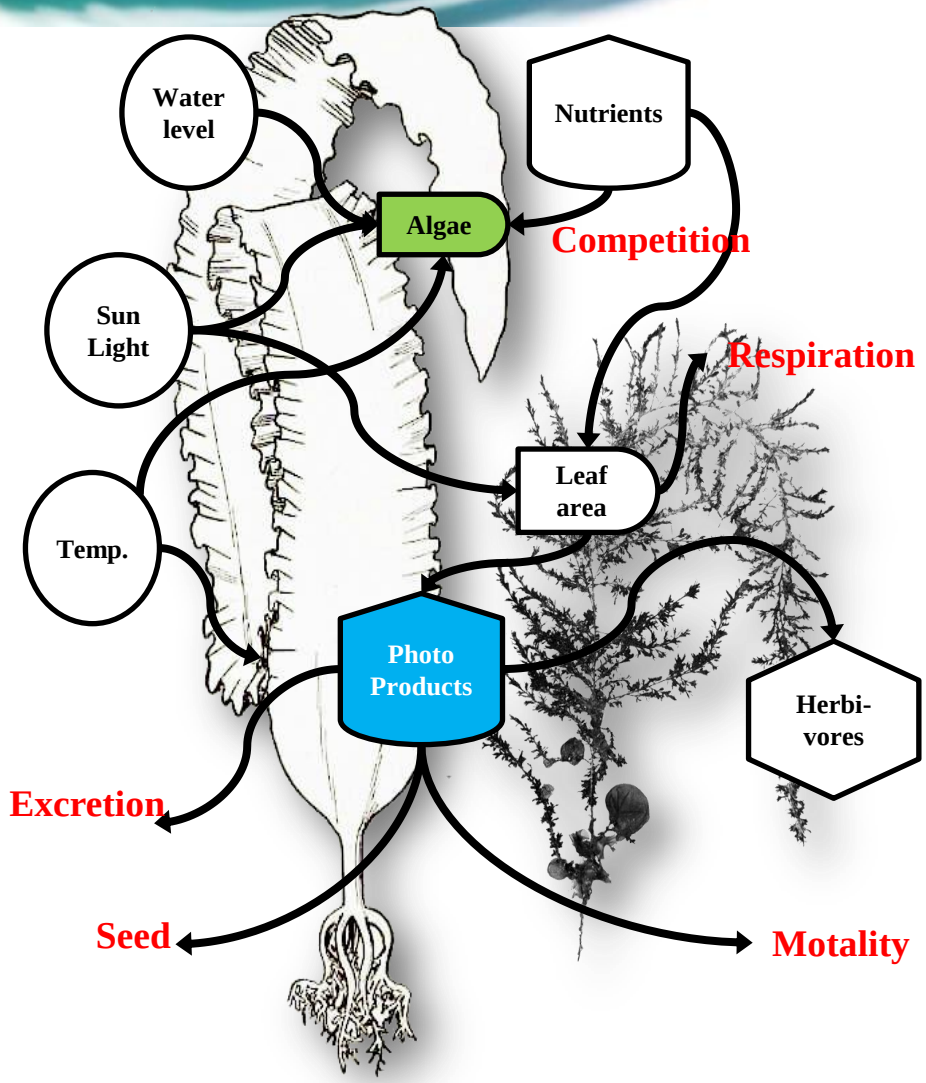


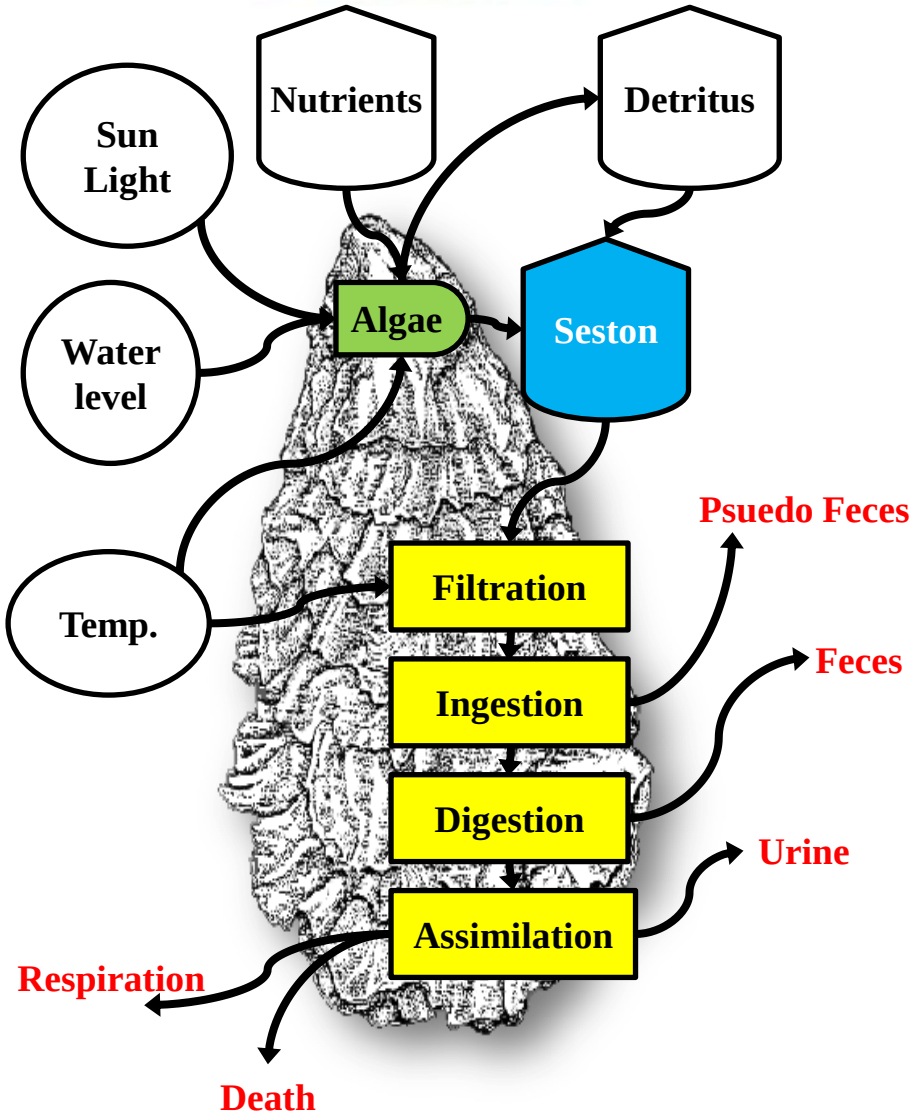
Rockfish



- Consider of estivation(above 19℃)

Sea cucumber





- Consist of *Saccharina japonica* & *Sargassum fulvellum*
- Food competition between phytoplankton and seaweed

Seaweeds

- Consider of SFG(Scope For Growth)

Oyster

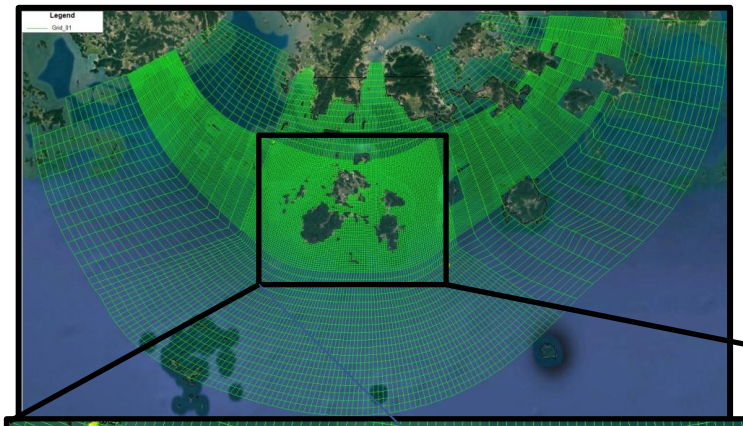
♣ Environmental research

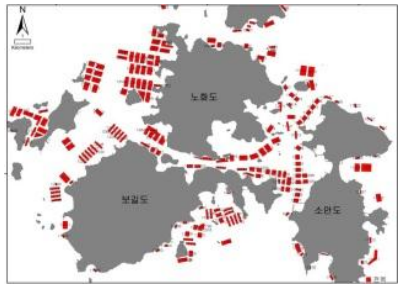
- Sediment quality measurements are need over 2 times at the before and after removal of IMTA facility
- Analysis of chemical composition(C, N) of each aquaculture organism

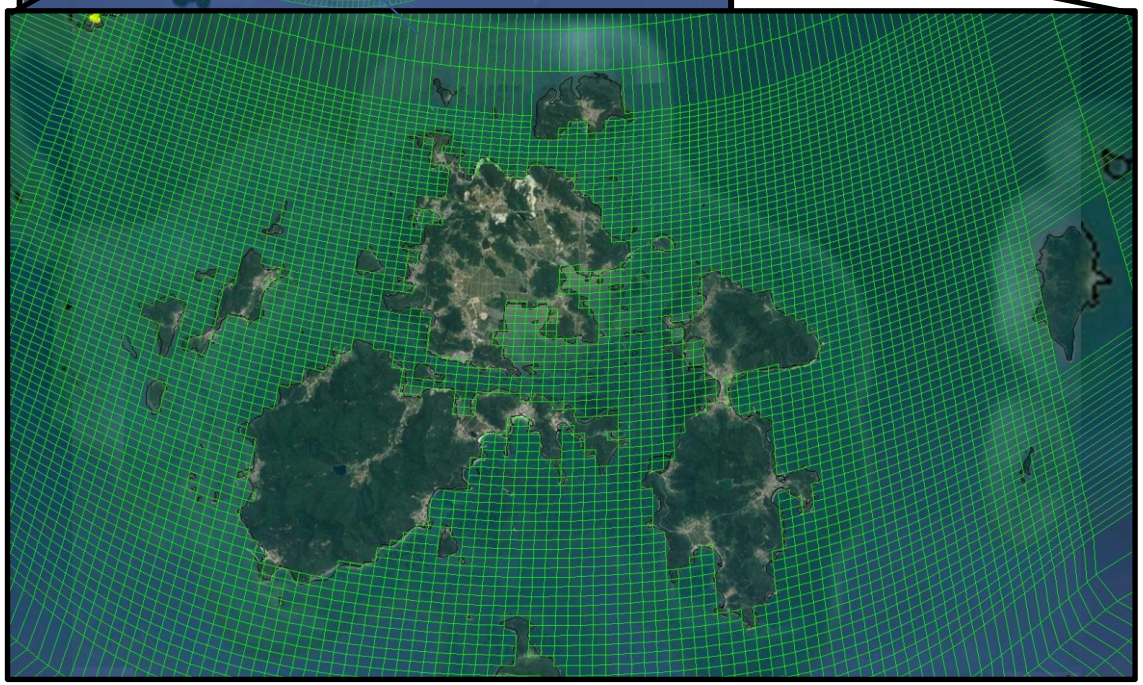
♣ Estimating carrying capacity of IMTA farm

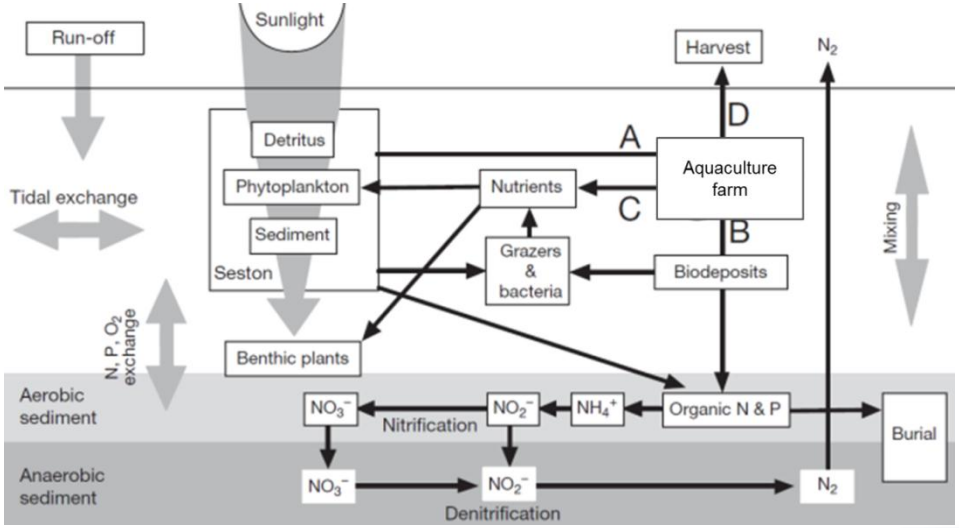
- Sensitivity analysis & verification of the ecosystem model coupled with each aquaculture organism growth submodel
- Scenario analysis with increase and/or decrease of each variables and functions in IMTA carrying capacity model
- Estimation of optimum productivity of each aquaculture organism in IMTA farm

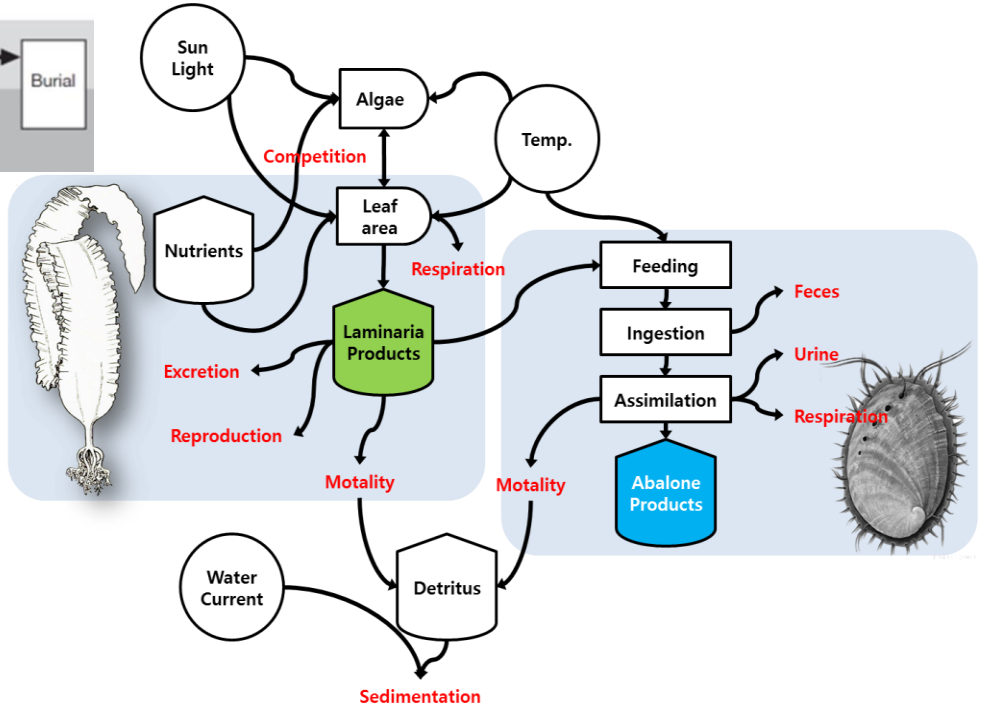
♣ Another IMTA, abalone and seaweed








Run-off
Sunlight
Harvest
N_2
Detritus
A
D
Phytoplankton
Nutrients
Aquaculture farm
Tidal exchange
C
Sediment
B
Mixing
Seston
Grazers & bacteria
Biodeposits
N, P, O_2 exchange
Benthic plants
Aerobic sediment
NO_3^-
Nitrification
NO_2^-
NH_4^+
Organic N & P
Burial
Anaerobic sediment
NO_3^-
NO_2^-
N_2
Denitrification


Sun Light
Algae
Temp.
Competition
Leaf area
Nutrients
Respiration
Laminaria Products
Feeding
Ingestion
Feces
Urine
Assimilation
Respiration
Excretion
Reproduction
Motality
Motality
Abalone Products
Water Current
Detritus
Sedimentation

THANK YOU!