3RD
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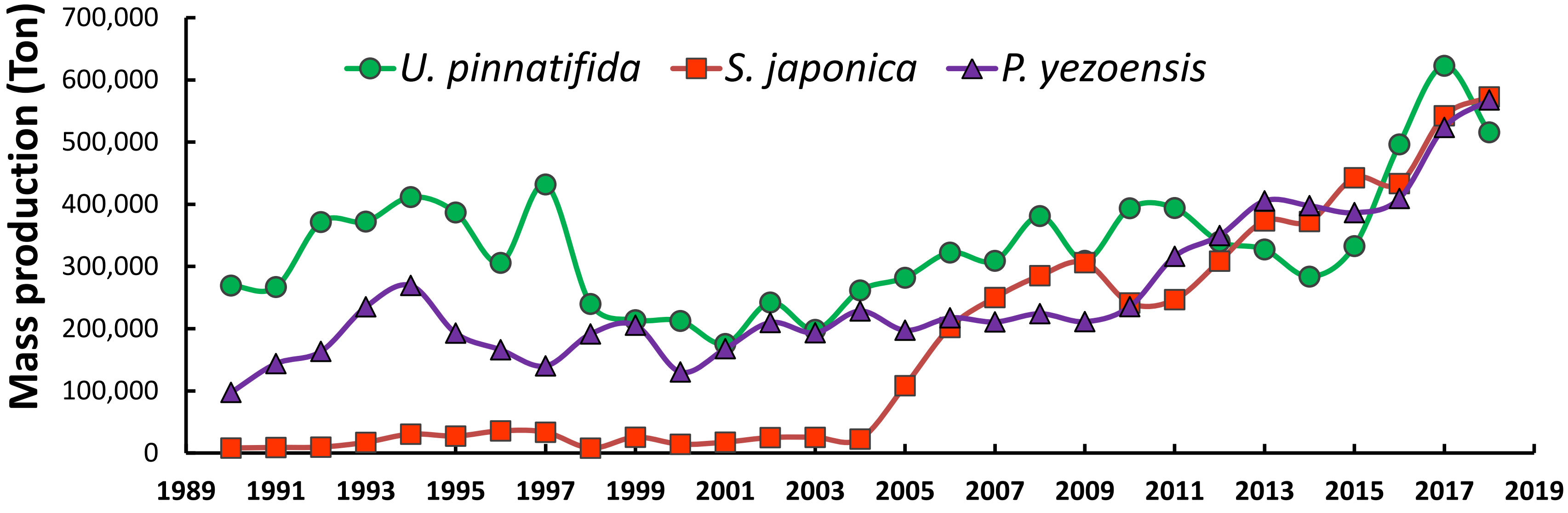
Variation in nutrients uptake by cultured seaweeds and a simple evaluation of *in situ* N demand at laver aquaculture farms in South Korea

JeongHee SHIM
East Sea Fisheries Research Institute
NIFS

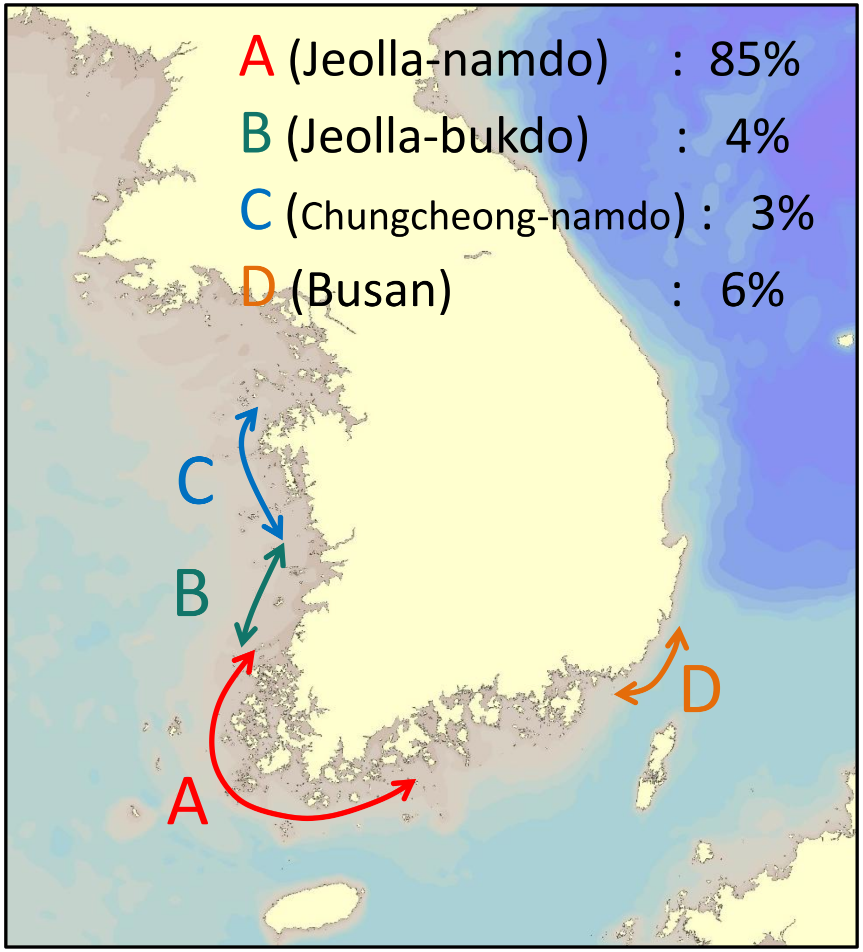
gef
UNDP Empowered lives. Resilient nations.
UNOPS
YSLME UNDP/GEF Yellow Sea Large Marine Ecosystem

Seaweeds Aquaculture production in Korea



- ✓ total production 1,710,000 ton in 2018, 4th biggest country
- ✓ increasing trend, especially *S. japonica* species
- ✓ food, feeding for shells, source of algin
- ✓ also as a raw material of biofuel

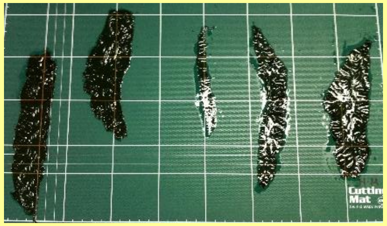
Regional seaweed production rates



U. pinnatifida

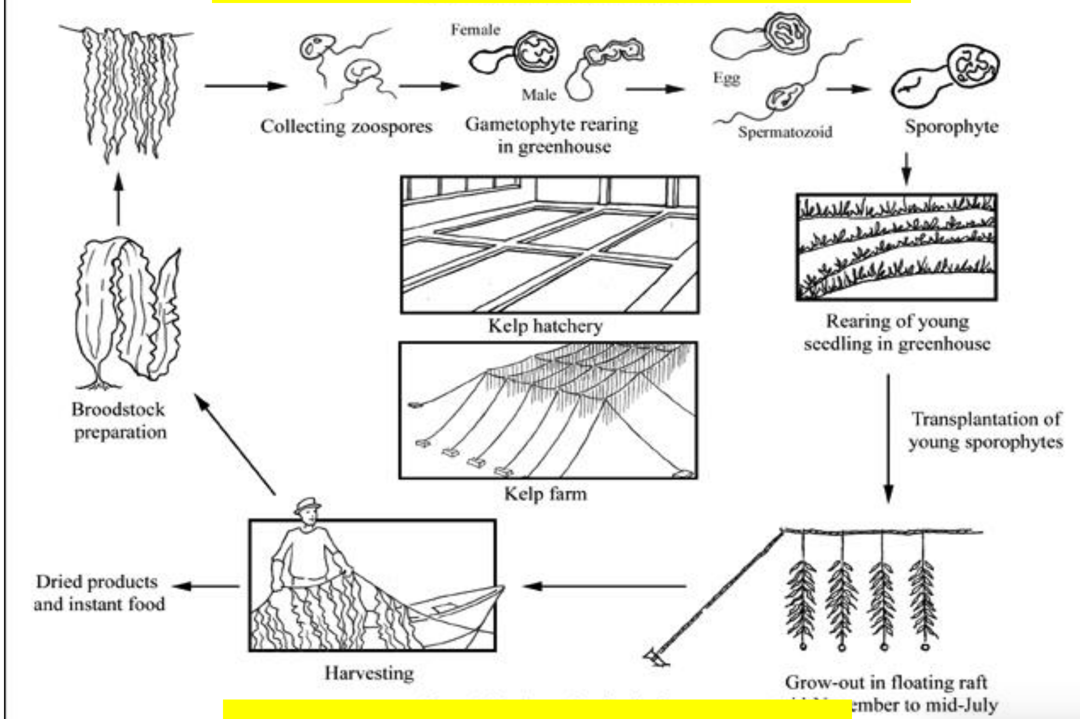
S. japonica

P. yezoensis



Aquaculture cycle of seaweed

Phase I : seed production in hatchery



Phase II : kelp production in farm

Seeding ->

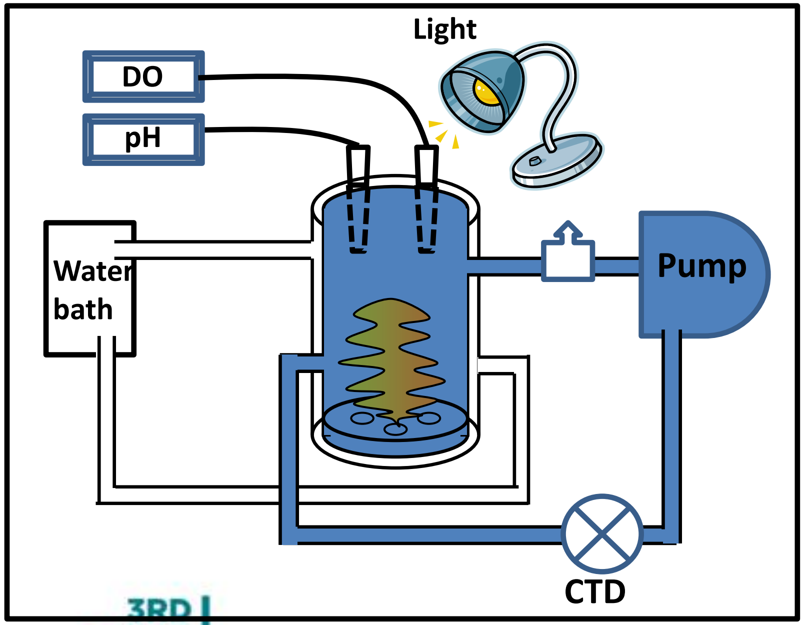
Transplantation ->

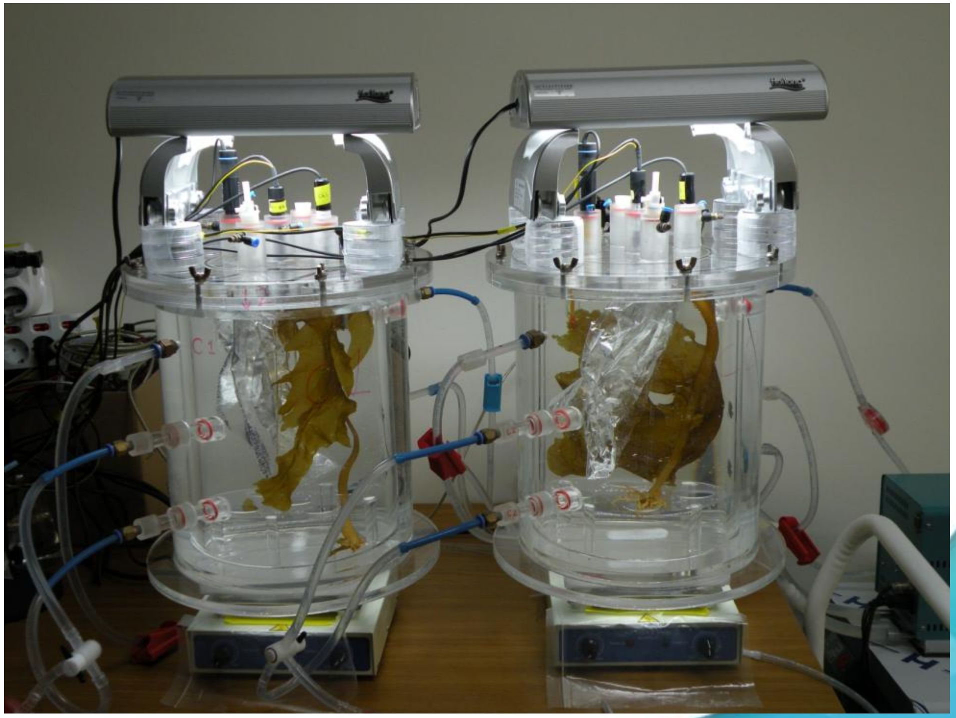
Grow out ->

Harvesting ->

Experimental design for Nutrients uptake

Species	Sampled periods	duration	media	Light (mmol/m^2/s)
U. pinnatifida	Jan.-Mar.	~6 h	Artificial Seawater	80~100 (~5000 lux)
S. japonica	Jan.-May.		Natural Seawater	
P. yezoensis	Nov.-Apr.		Natural Seawater	

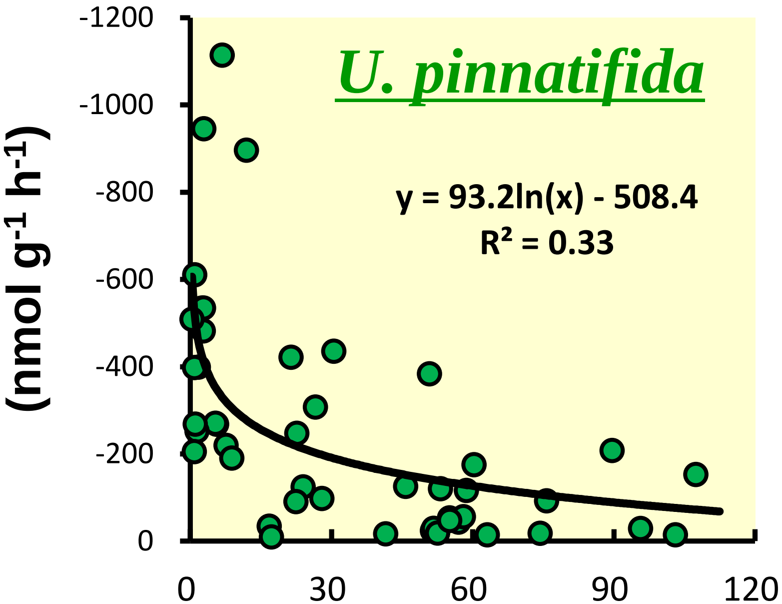


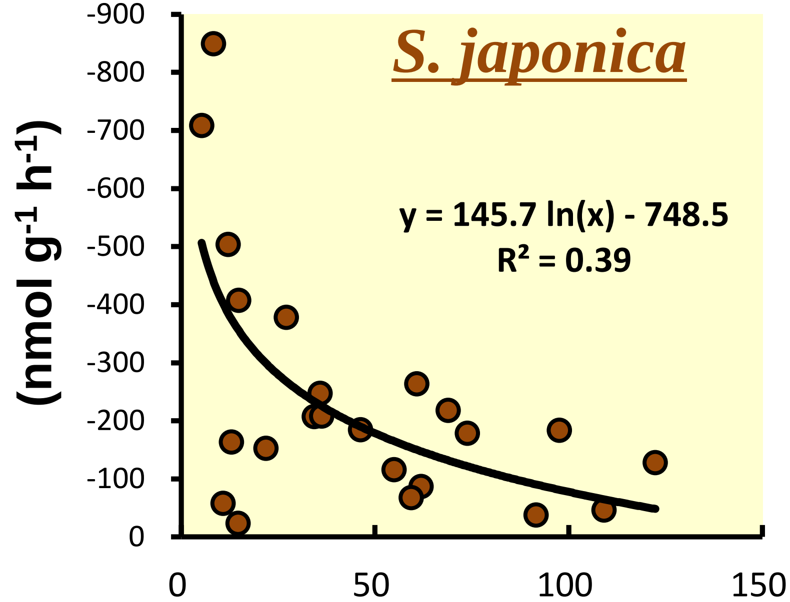


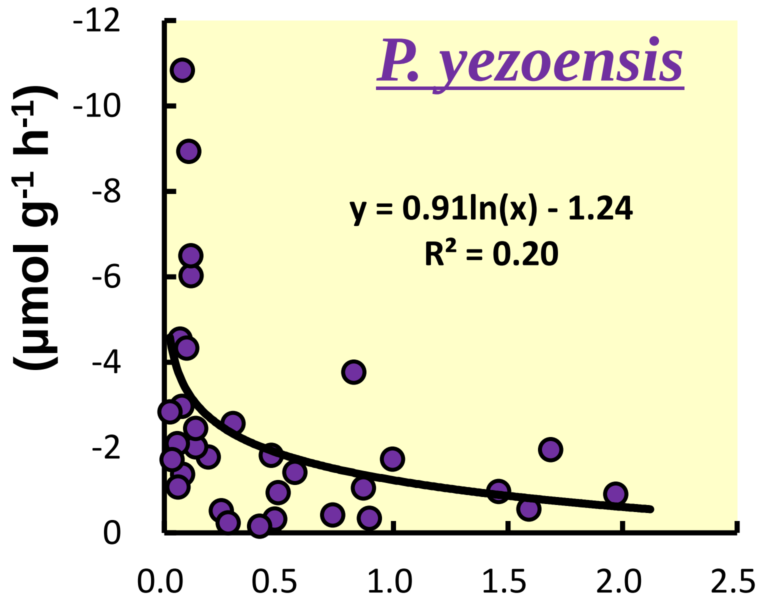
Sampled species description

Species	*U. pinnatifida*	*S. japonica*	*P. yezoensis*
# of species	32	24	60
Sampled period	Jan-Mar	Jan-May	Nov-Apr
Days after sea-planted	76-153	36-99	-
Wet weight (g)	5-107	5-122	0.1-2.1
Surface area (cm^2)	162-1826	157-722	13.5-214.5
Length (cm)	29-152	46-288	6.2-26.5
Width (cm)	4-55	5-22	0.3-29.3

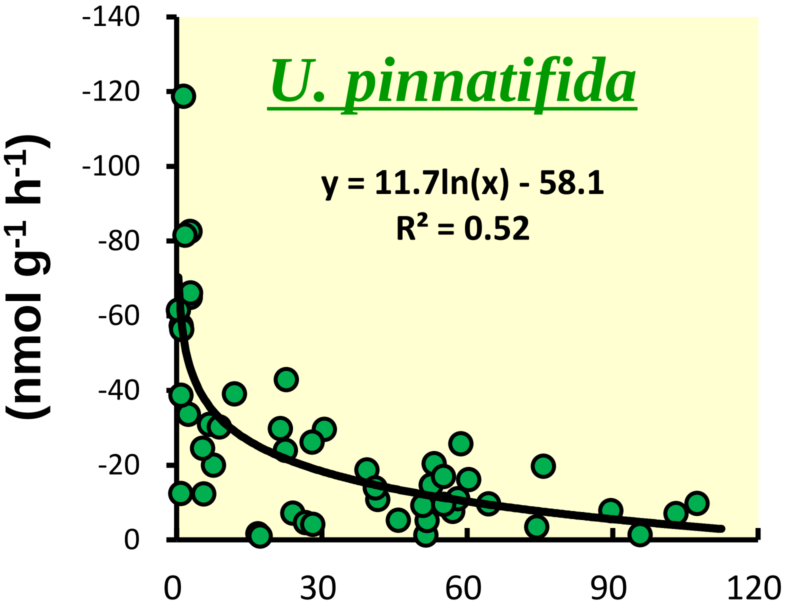
Variations of N uptake rates with wet weight

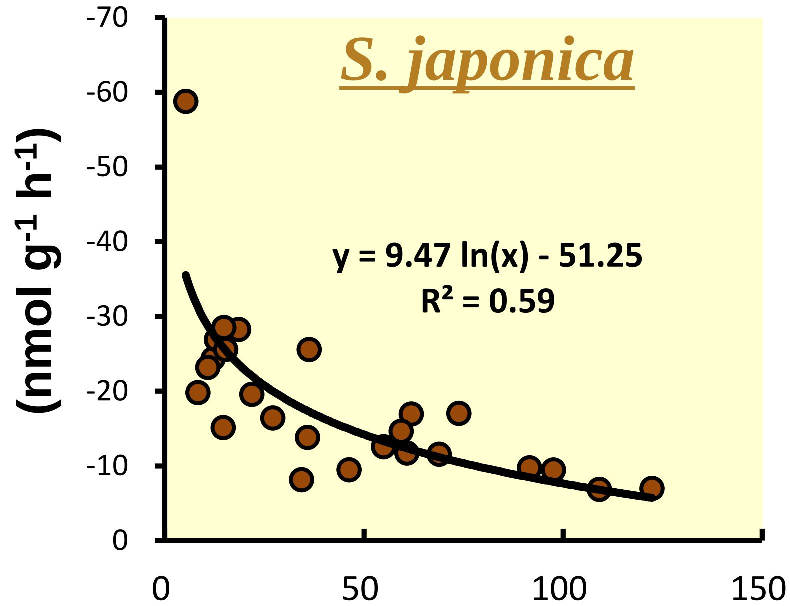


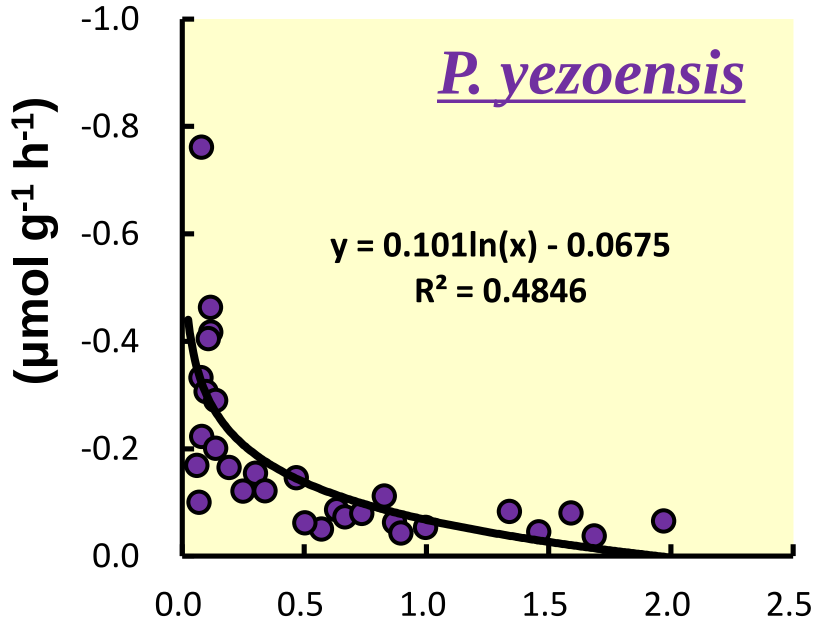




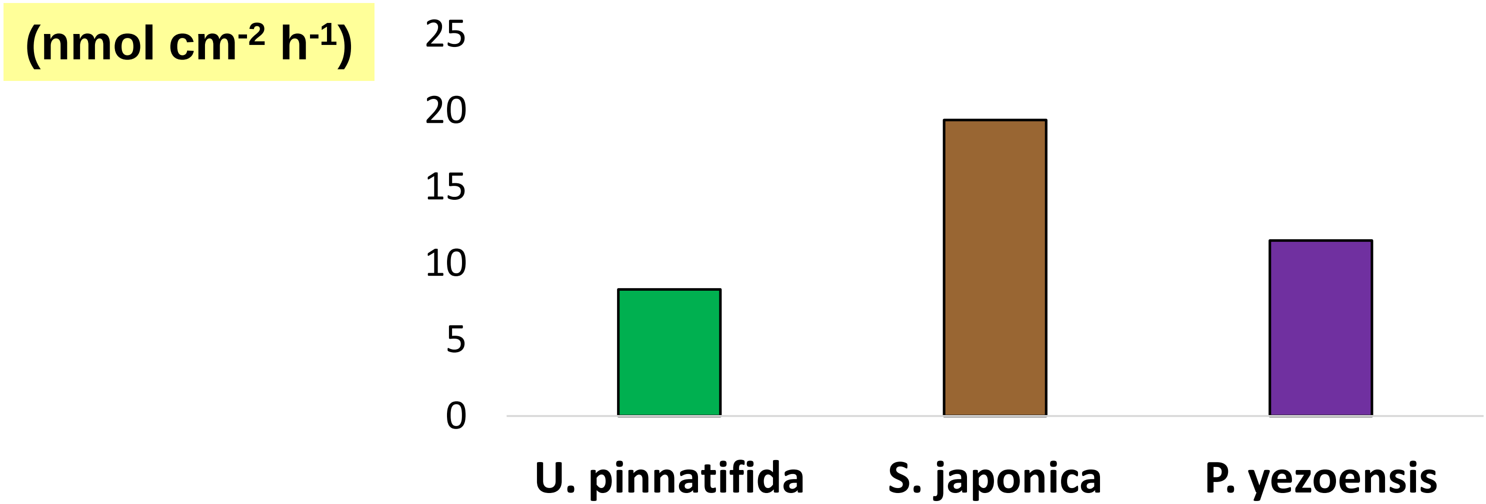
Variations of P uptake rates with wet weight

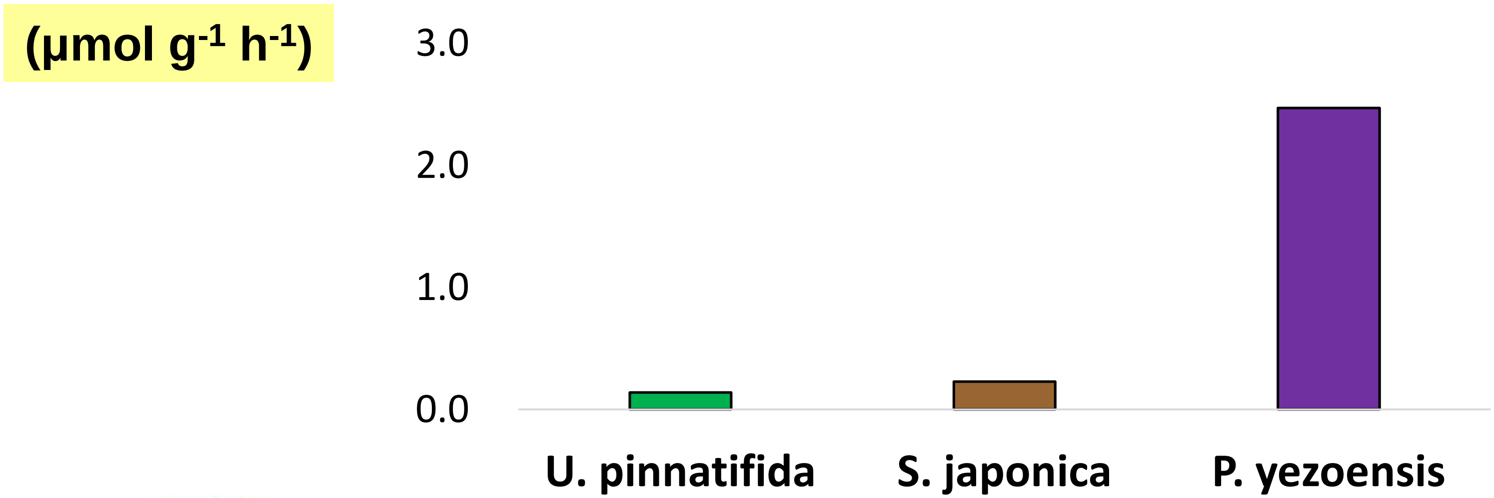






Comparison of N uptake between species

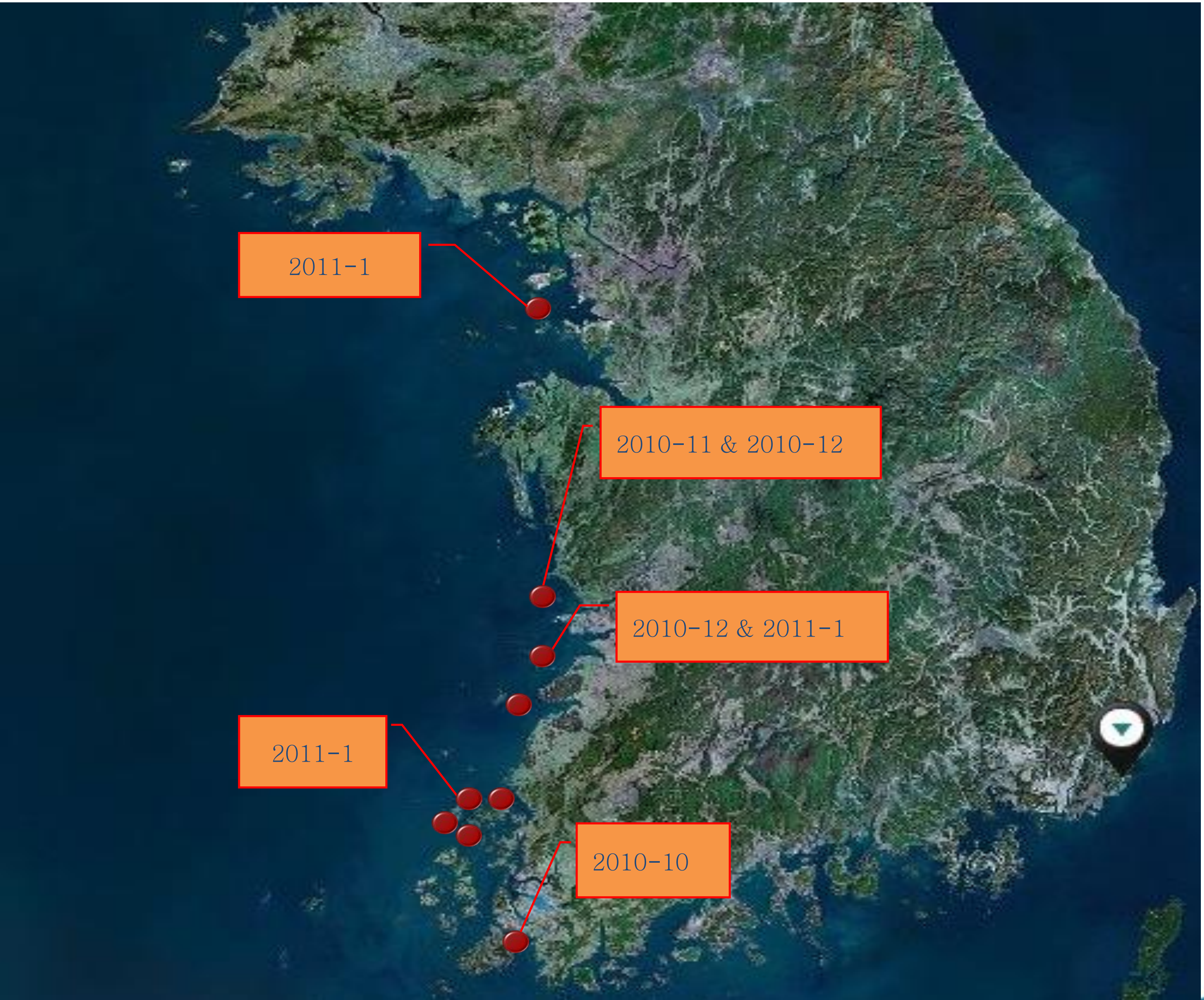




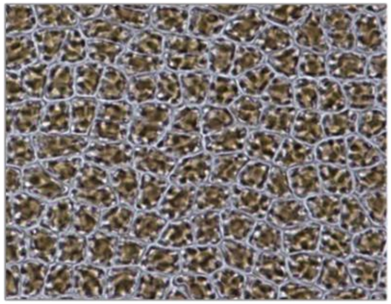
Comparison of uptake rates with other species

Species	Nitrate+Nitrite	Phosphate	Carbon	Reference
	(μmol g_{FW}^{-1} h^{-1})			
Ulva pertusa	0.64			Jun and Chung (1996)
Laminaria digitata			9-20	Tyler & McGlathery (2006)
Undaria pinnatifida	0.14	0.02	7.90	This study
Saccharina japonica	0.23	0.02	8.90	This study
Porphyra yezoensis	2.47	0.18	87.13	This study
	(nmol cm^{-2} h^{-1})			
Saccharina japonica	40-90	2.5-9.0		Ozaki et al. (2001)
Kjellmaniella crassifolia	14-110	0.8-9.0		Ozaki et al. (2001)
Undaria pinnatifida	~8.3	~0.9	~363	This study
Saccharina japonica	19.4	1.5	600	This study
Porphyra yezoensis	11.5	0.8	380	This study

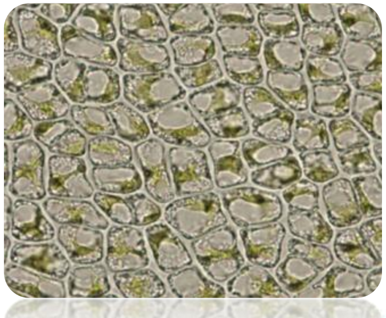
Development of Chlorosis in west coast of Korea



Normal

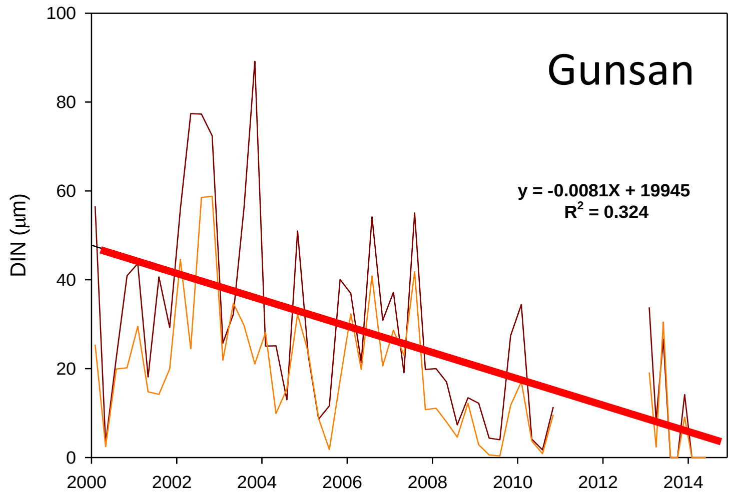


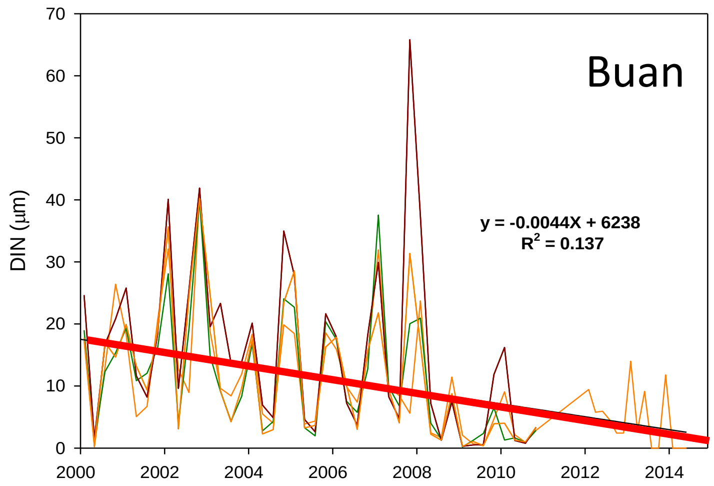
Chlorosis



N conc. variations in west coast of Korea

❖ Decrease of N concentration





Supply

1. Input for land origin
2. Change of currents
3. Strong water stratification

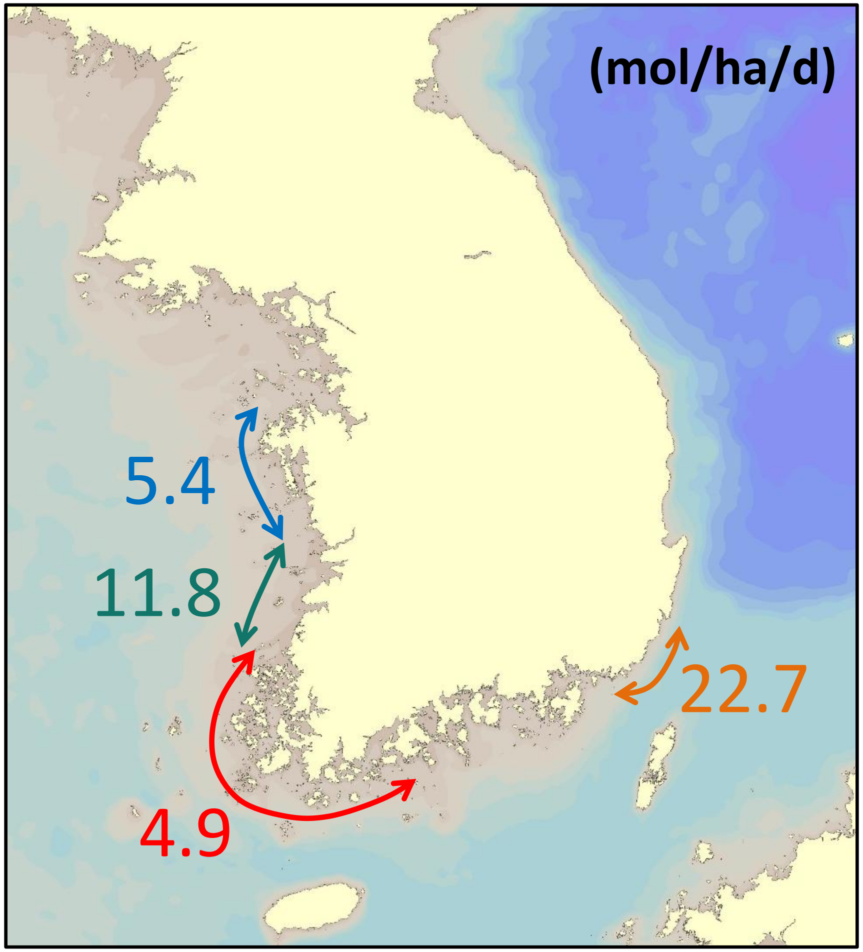
Consumption

1. Increase of culturing farm
2. Competition with diatom
3. Etc…

N demand for culturing *P. yezoensis* at each area in Korea

	month	Jeolla-namdo	Jeolla-bukdo	Chungcheong-namdo	Gyeonggido	Busan
Mass production for each month (ton)	11	6,611	3,048	2,867	546	2,109
	12	20,852	6,720	4,600	1,578	3,862
	1	32,296	5,624	3,872	1,794	3,490
	2	40,168	5,358	4,063	1,714	2,556
	3	51,685	4,601	3,395	1,586	2,953
	4	28,072	1,291	790	1,394	1,188
Area for aquaculture (ha)		**46,074**	**2,817**	**4,536**	**1,107**	**887**
N demand (mol/ha/d)	11	1.1	8.1	4.7	3.7	17.8
	12	3.4	17.9	7.6	10.7	32.7
	1	5.3	15.0	6.4	12.2	29.5
	2	6.5	14.3	6.7	11.6	21.6
	3	8.4	12.2	5.6	10.7	25.0
	4	4.6	3.4	1.3	9.4	10.0

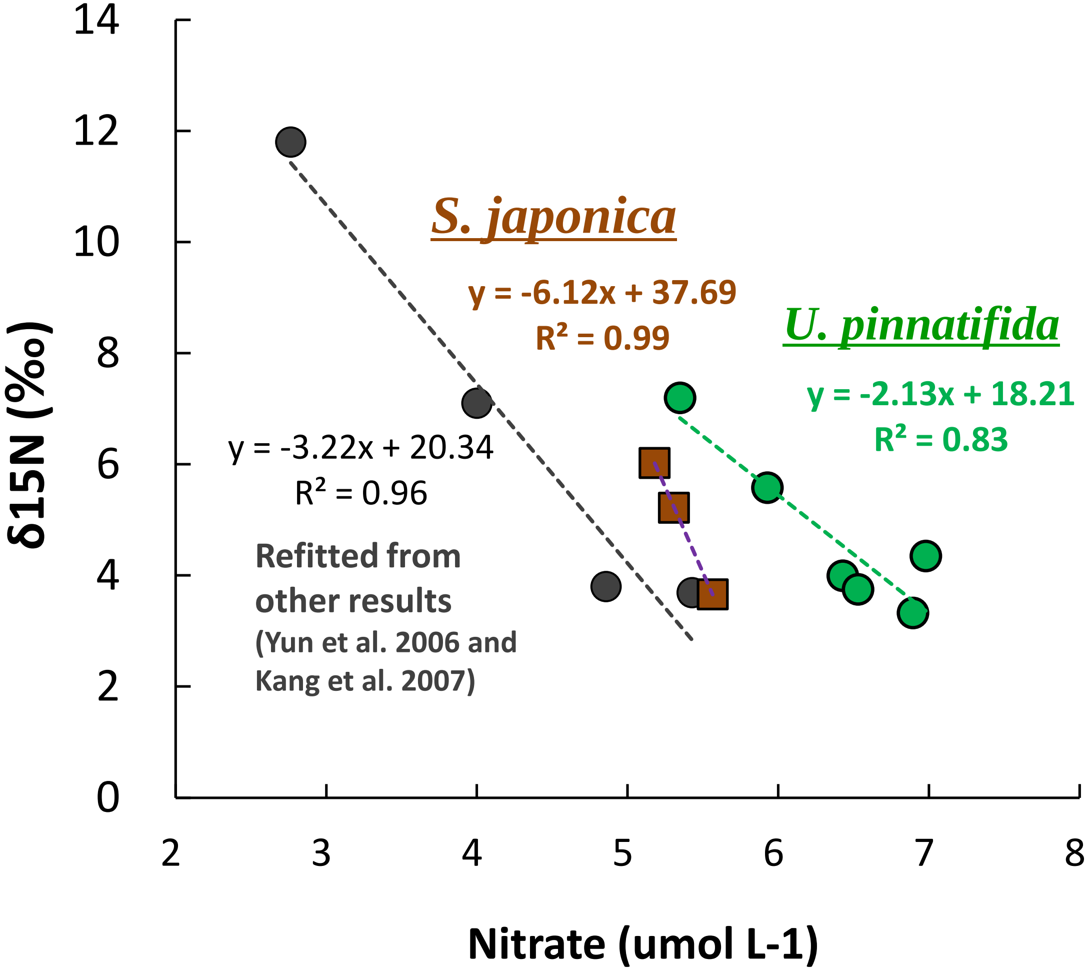
N demand for P. yezoensis production from Nov. to Apr.



DIN conc. in winter season
(μmol/L)

A (Jeolla-namdo) : 10~30
B (Jeolla-bukdo) : 10~20
C (Chungcheong-namdo) : 10~20
D (Busan, in Nakdong Estuary) : 15~25
sporadically very high

Relations of N stable isotope and nitrate concentration



- A very high negative linear correlations between the monthly average $\delta^{15}N$ and nitrate concentrations in the nearby seawaters in both species, as like in the other results.

Summary

- ✓ **Macroalgae, *U. pinnatifida, S. Japonica* & *P. yezoensis* uptake nutrients and CO_2 effectively**
- ✓ **The younger species, the more effective consumer of nutrients and CO_2**
- ✓ **Chlorosis event in west coast of Korea developed mostly due to heavily culture and shortage of land discharge**

THANK YOU~