



# Effects of increasing nutrient loads on the competition and succession between two predominant red tide algae of East China Sea

Reporter : Yuping Zhou

The Tutor : Jiangtao Wang



**Background**



**Experiments**



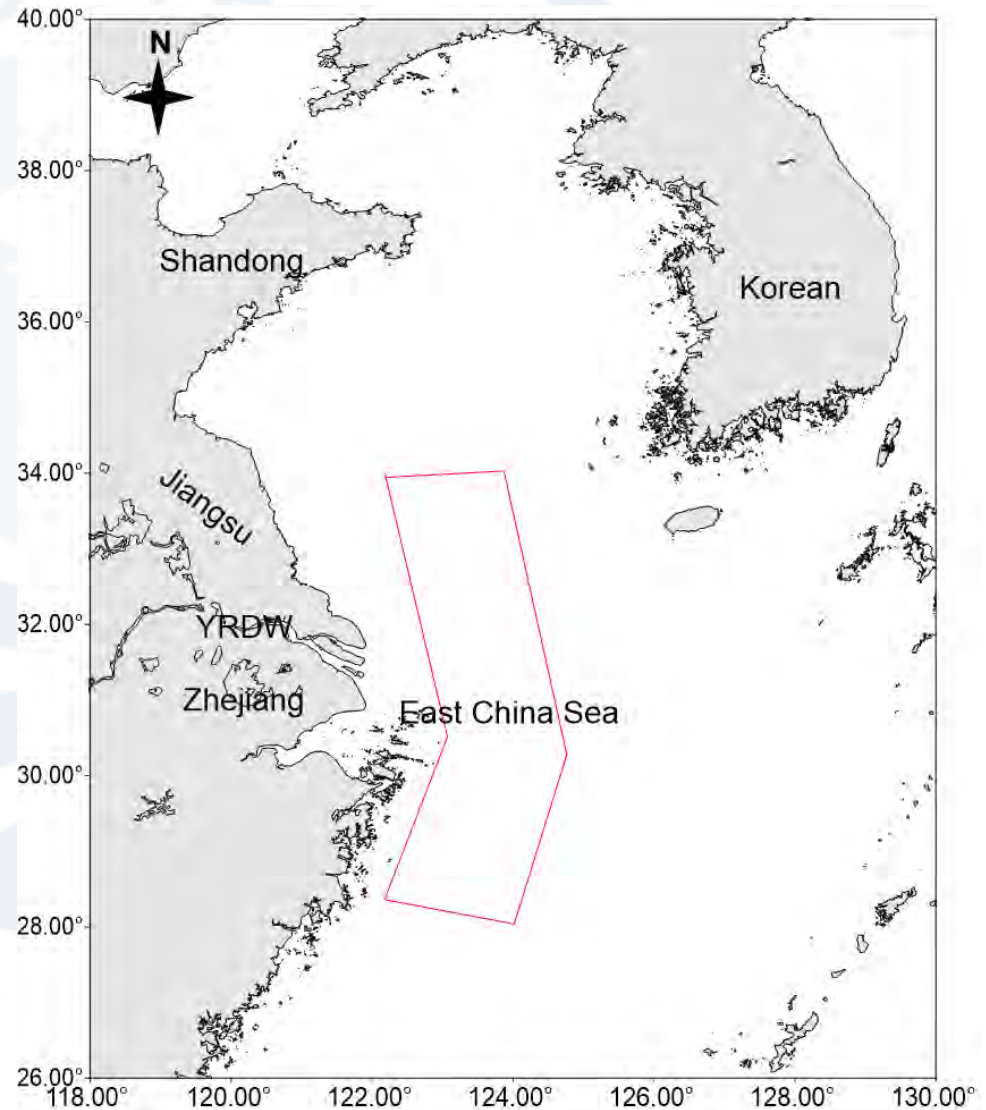
**Conclusions**



**Acknowledge**

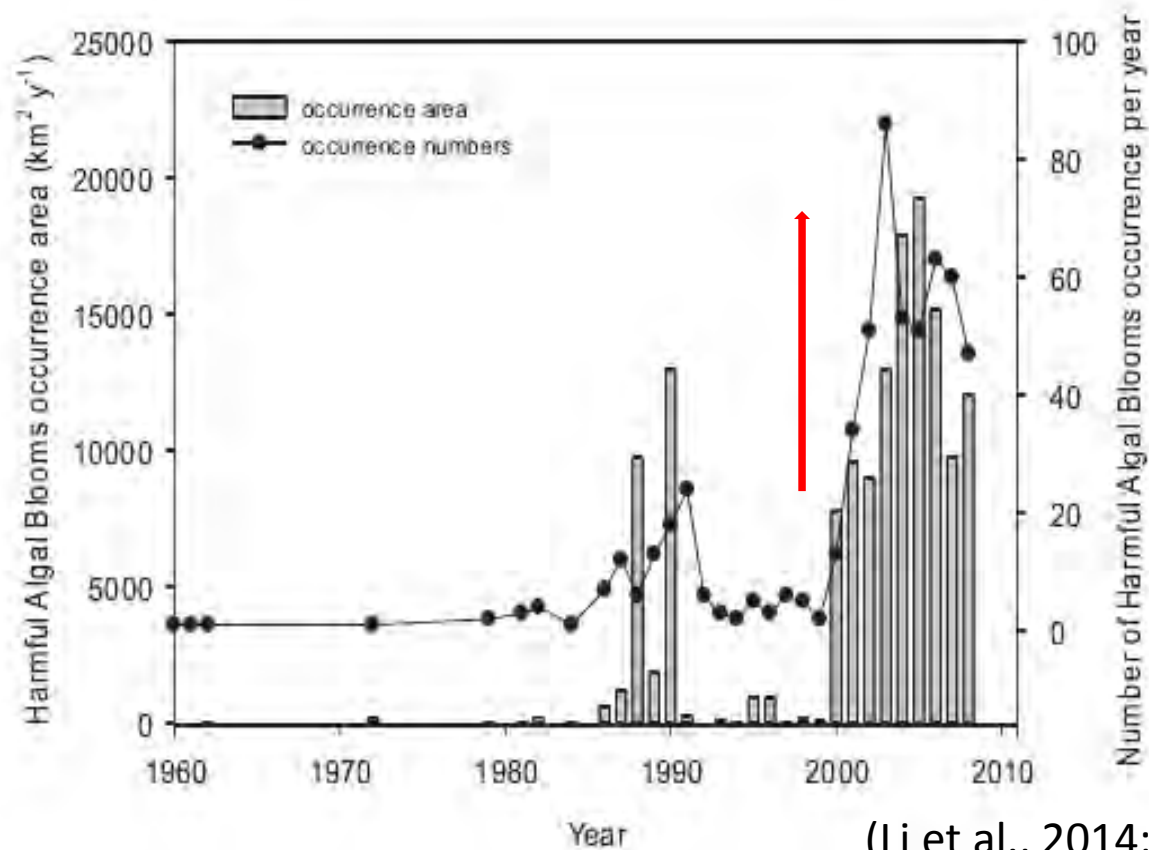
## ECS

- Harmful algal blooms (HABs) have become a global phenomenon that impacts the coastal nations worldwide.
- In East China Sea, there are several Frequent HAB Areas experiencing extensive eruption of harmful algae and phytoplankton community change.



(Xu et al., 1994)

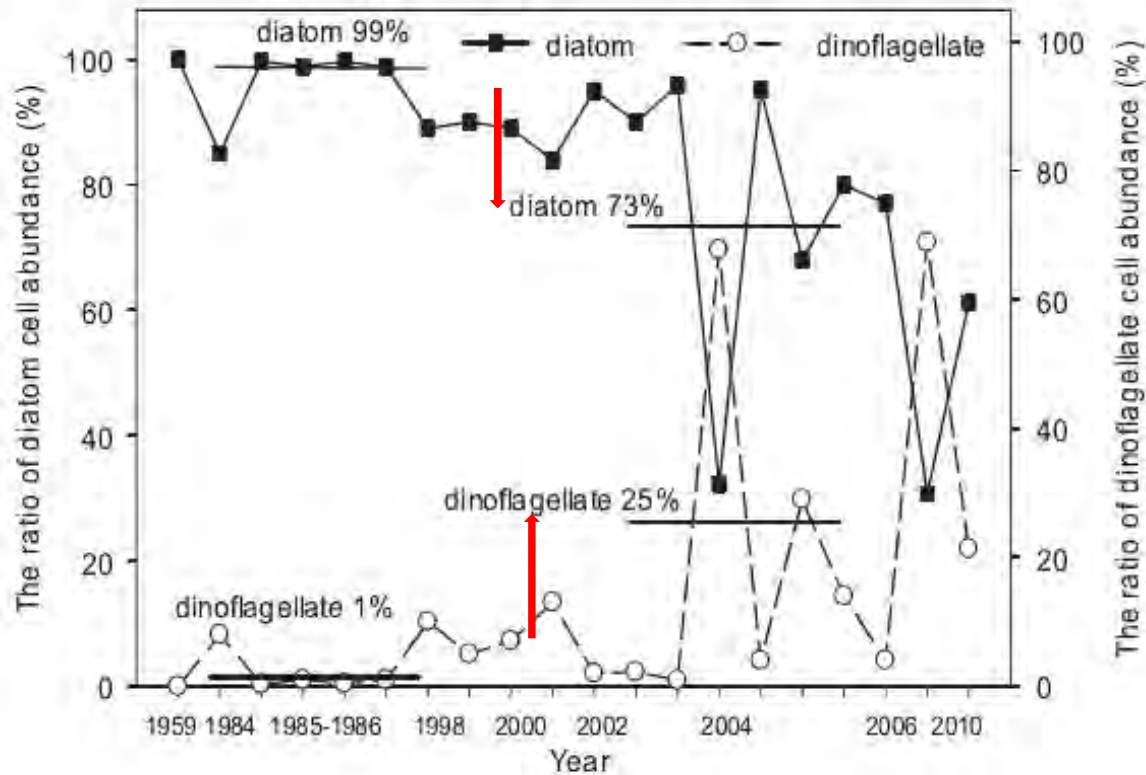
## HAB in the ECS



(Li et al., 2014; Zhou et al., 2008)

HAB occurrence area has experienced anomalous changes since the 1980s and there was a notable increase after 2000

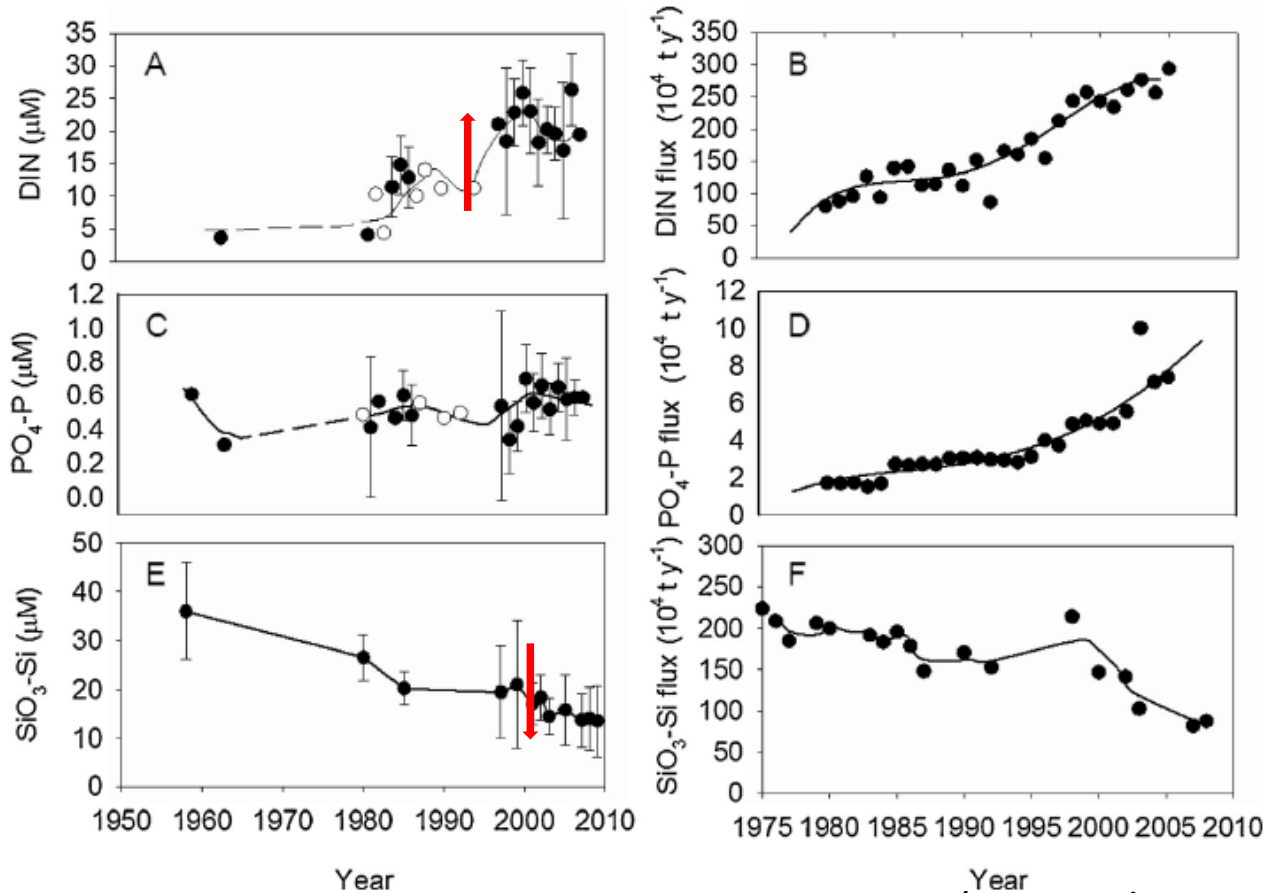
## HAB Community in the ECS



(Li et al., 2014; Wang et al., 2012)

- Since 2000, phytoplankton composition started to change and diatom decreased sharply from 99% to 73%, while algae cell abundance increased sharply from 1% to 25%.
- From 1959 to 2000, diatom was dominant algae with the cell abundance exceeding 80%, whereas dinoflagellate was below 3%.

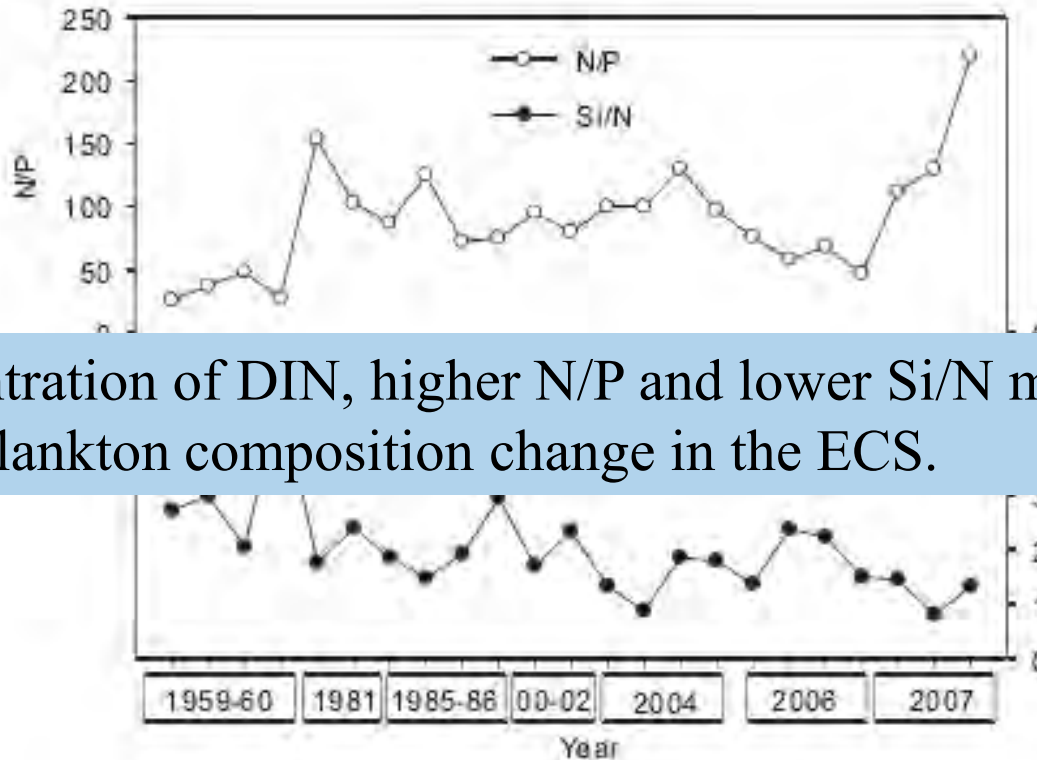
## Nutrients and their fluxes in the ECS



(Sun et al., 2008; Li et al., 2014)

- Since 1980, DIN concentration and flux have abruptly increased that was explained by the high level of its fertilizer and the presence of chemical plants along the Changjiang River.
- By contrast, Si concentration and flux presented notably decreasing trend during the past 30 years.

## Nutrients structure in the ECS

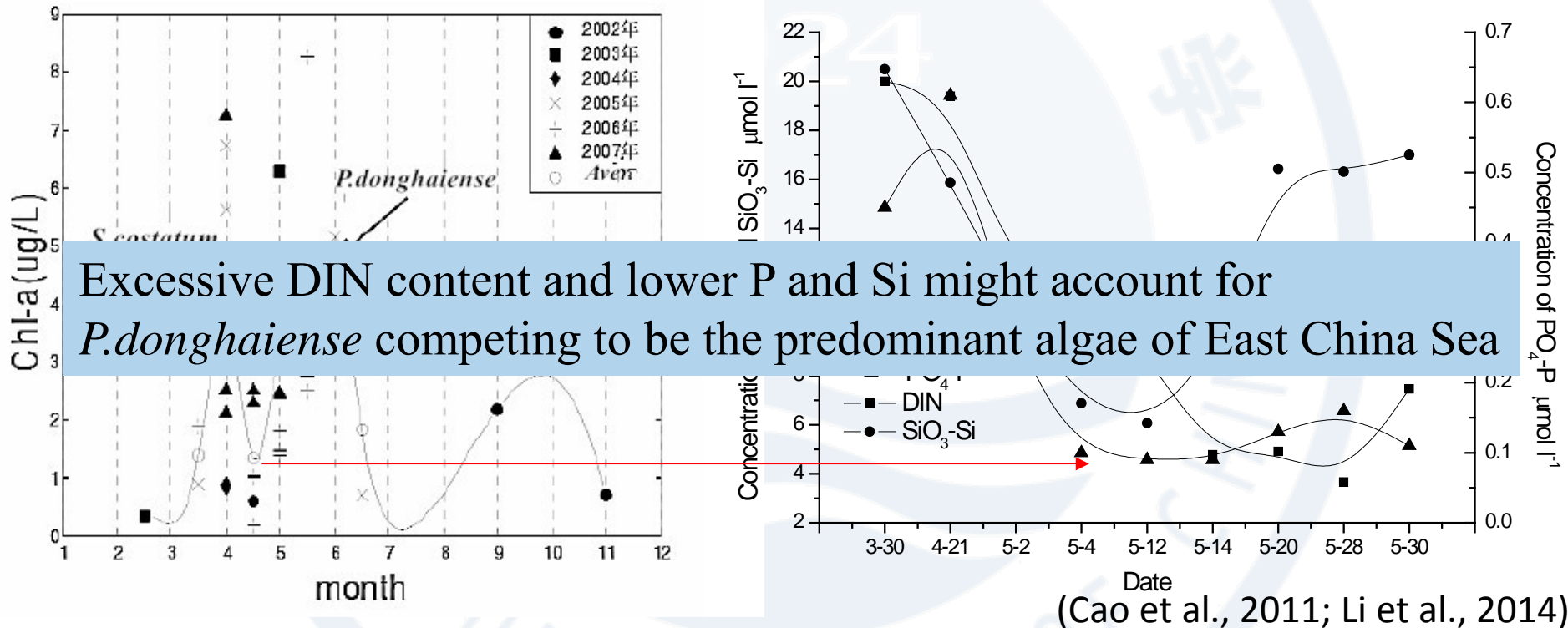


Higher concentration of DIN, higher N/P and lower Si/N might account for the phytoplankton composition change in the ECS.

(Wang et al., 2012)

- A clear increase in N/P was found, and N/P was approximately 40 during 1960s and then sharply increased to 120 in 1985, and continually increased to 200 in 2007.
- Si/N ratio decreased dramatically from 5 in 1960s to 2.5 of 1990s, and then decreased to 1.0 in 2007.

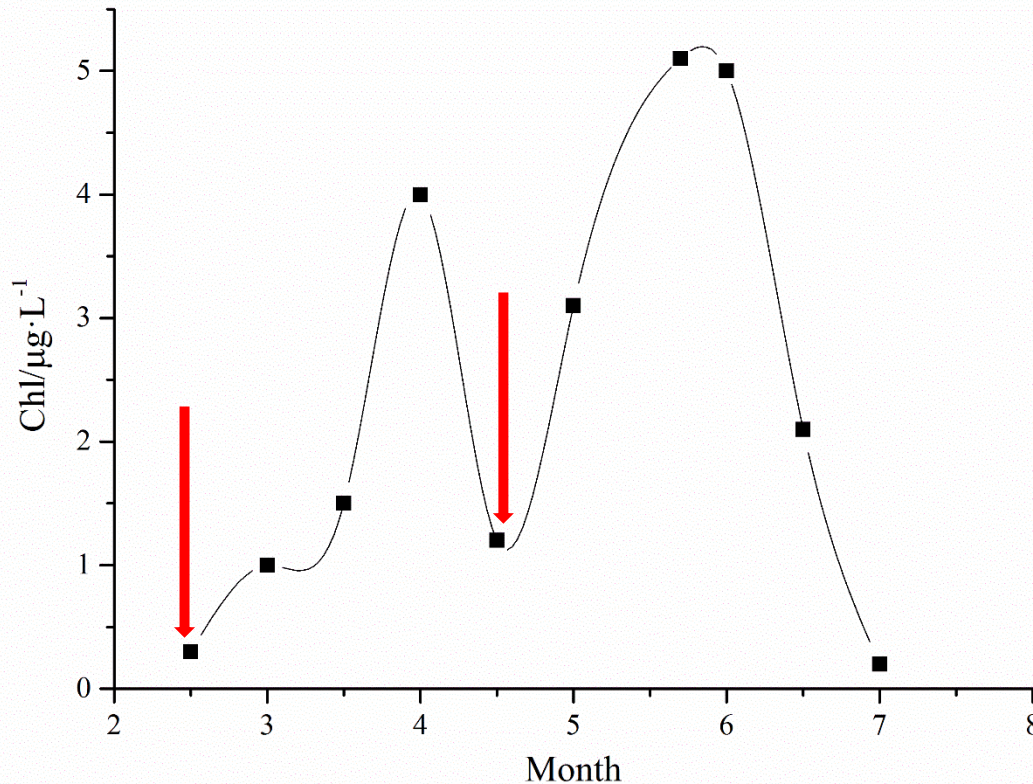
## Algal competition and succession in the ECS



- Chl a data from 2002 to 2007 exhibited a seasonal succession from *S. costatum* of April to *P. donghaiense* of May . When *S. costatum* almost disappeared, P and Si concentration have decreased to the lowest value, while DIN did not.



## Experiment method



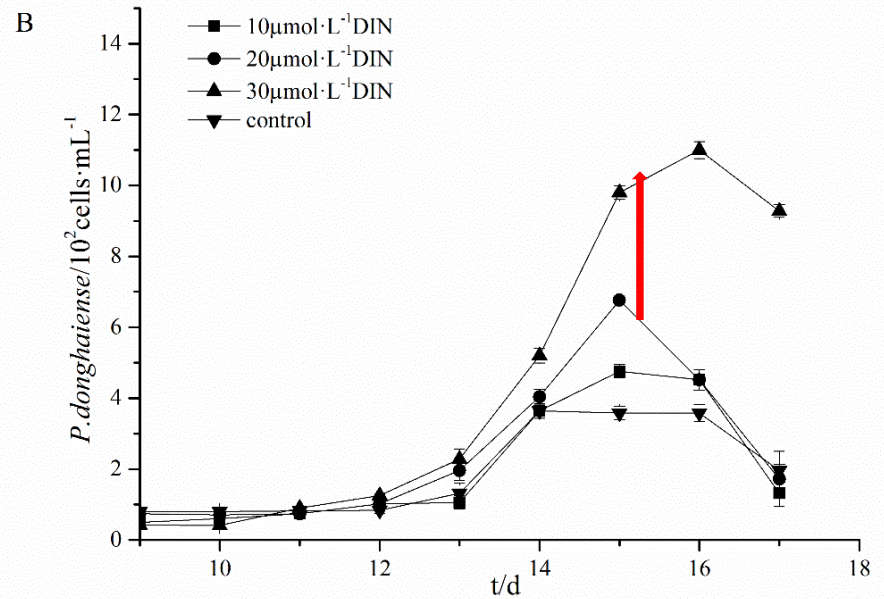
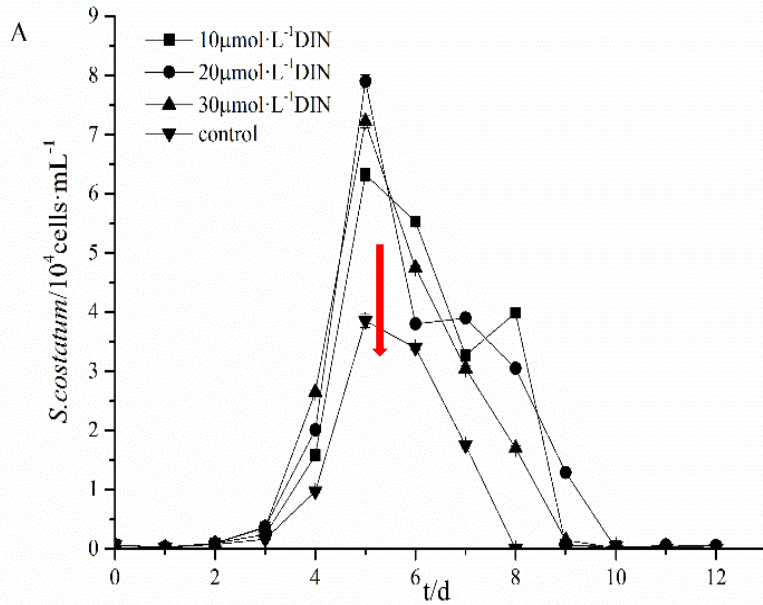
- *S. costatum* and *P. donghaiense* were mixed into all cultures with initial nutrient
- When *S. costatum* almost disappeared, cultures were resupplied with nutrient

## Field mesocosm experiment

No.	Initial concentration/ $\mu\text{mol}\cdot\text{L}^{-1}$		
	DIN	$\text{PO}_4\text{-P}$	Si
A	10	1.49	15
B	20	1.49	15
C	40	1.49	15
Control	10	1.49	7.1

- Control was cultured with initial seawater, and the experimental groups were cultured with different DIN concentrations
- When *S.costatum* almost disappeared, cultures were resupplied with initial nutrient content

# Experiments

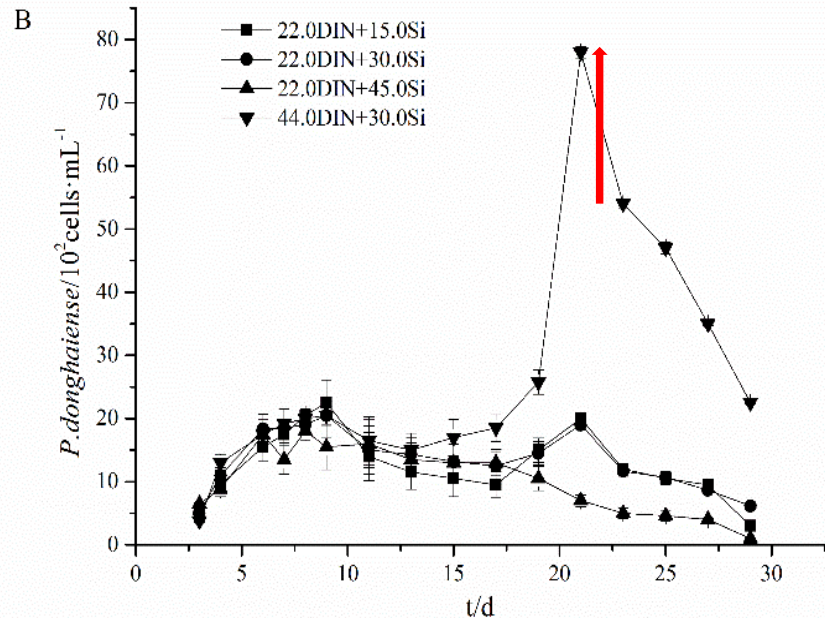
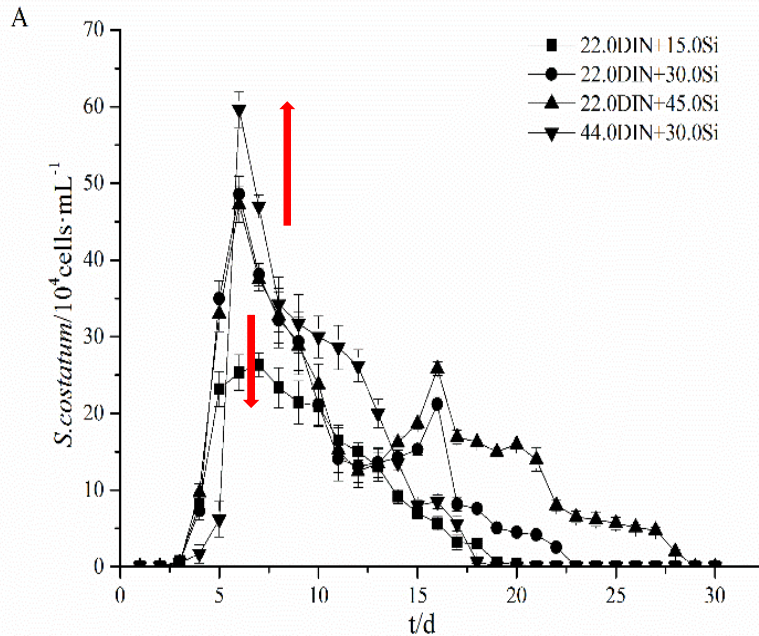


- Lower Si concentration limited the growth of *S. costatum*,
- Higher concentration of DIN stimulated the growth and maximum concentration of *P. donghaiense*

## Indoors experiment

No.	Initial concentration/ $\mu\text{mol}\cdot\text{L}^{-1}$				Resupplied concentration/ $\mu\text{mol}\cdot\text{L}^{-1}$		
	DIN	$\text{PO}_4\text{-P}$	Si	N/Si	DIN	$\text{PO}_4\text{-P}$	Si
A	22.0	0.8	15.0	1.5	22.0	0.8	15.0
B	22.0	0.8	30.0	0.9	22.0	0.8	15.0
C	22.0	0.8	45.0	0.5	22.0	0.8	15.0
D	44.0	0.8	30.0	2.0	22.0	0.8	15.0

- All cultures were initially added with different DIN and Si, and the experiments were cultured under different N/Si
- When *S.costatum* almost disappeared, cultures were resupplied with constant nutrient

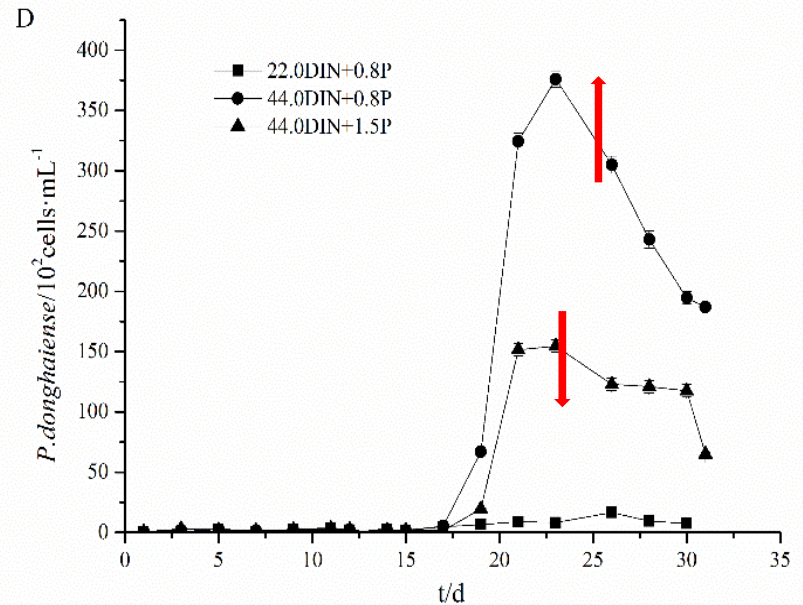
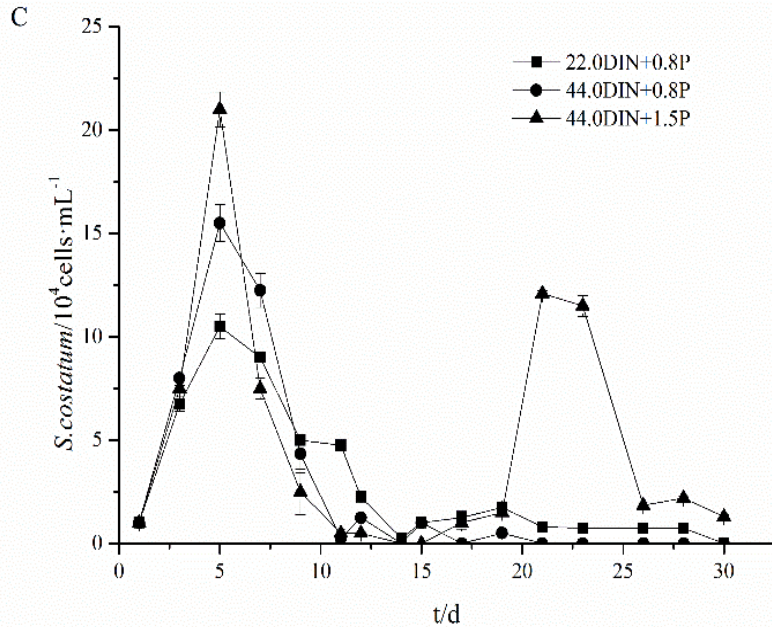


- Lower Si concentration limited the growth of *S. costatum*, and when N/Si was less than 1, the addition of DIN would stimulate its growth
- Higher N/Si caused by higher concentration of DIN would stimulate the growth and abundance of *P. donghaiense*

No.	Initial concentration/ $\mu\text{mol}\cdot\text{L}^{-1}$				Resupplied concentration/ $\mu\text{mol}\cdot\text{L}^{-1}$		
	DIN	$\text{PO}_4\text{-P}$	Si	N/Si	DIN	$\text{PO}_4\text{-P}$	Si
A	22.0	0.8	11.0	2	22.0	0.8	11.0
B	44.0	0.8	11.0	4	22.0	0.8	11.0
C	44.0	1.5	11.0	4	22.0	0.8	11.0

- All cultures were cultured with higher N/Si ( $\text{N/Si} > 1$ ), and they were cultured with different DIN and P
- When *S. costatum* almost disappeared, cultures were resupplied with constant nutrient content

# Experiments



- Higher N/Si would stimulate the cell abundance of *P.donghaiense*
- The excessive P would stimulate the recrudescence of *S.costatum*, and decrease the relative abundance of *P.donghaiense*.

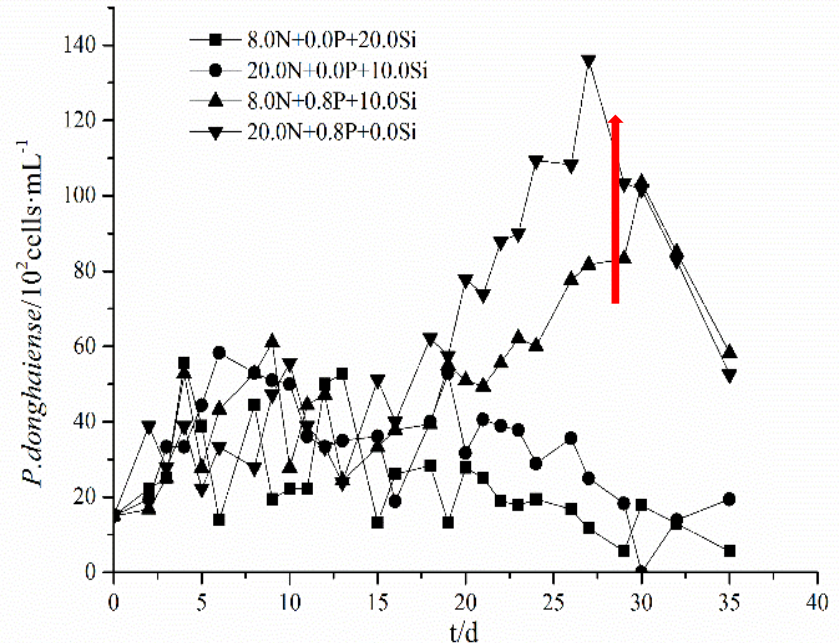
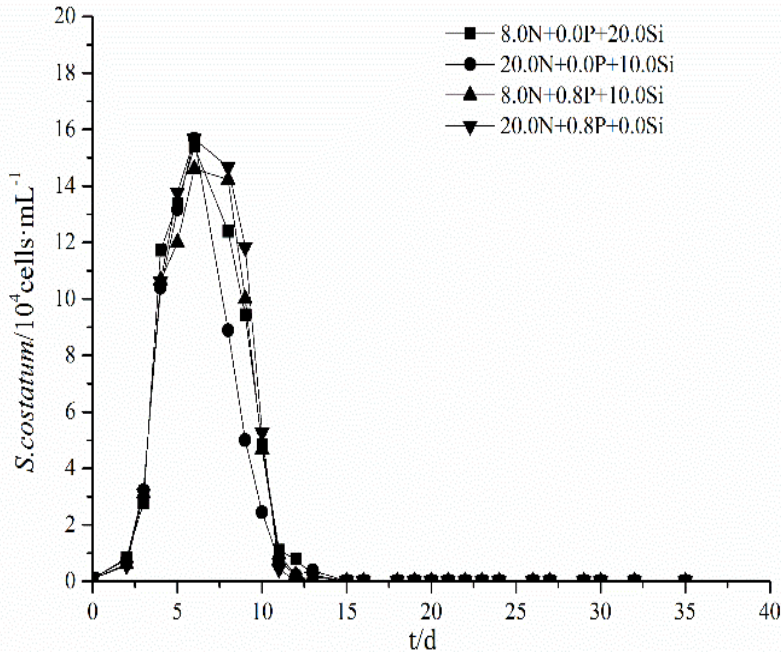
## Outdoors experiment

No.	Initial concentration/ $\mu\text{mol}\cdot\text{L}^{-1}$				Resupplied concentration/ $\mu\text{mol}\cdot\text{L}^{-1}$		
	DIN	PO <sub>4</sub> -P	Si	N/Si	DIN	PO <sub>4</sub> -P	Si
A	20.0	0.8	20.0	1.5	8.0	0.0	20.0
B	20.0	0.8	20.0	0.9	20.0	0.0	10.0
C	20.0	0.8	20.0	0.5	8.0	0.8	10.0
D	20.0	0.8	20.0	2.0	20.0	0.8	0.0

- All experiments were cultured initially with constant nutrient content
- When *S.costatum* almost disappeared, they were resupplied with different DIN, P and Si



# Experiments



- When the culture were resupplied with P, excessive DIN would stimulate the growth of *P. donghaiense* to be the predominant algae.
- The culture resupplied with higher Si and without P would inhibit the recrudescence of *S. costatum*

- Large flux of DIN account for the increased occurrence area and number of HAB in ECS.
- Higher N/P ratio and N/Si led by higher DIN concentration would accelerate the dominance of *P. donghaiense*, and account for the increased abundance of dinoflagellate.
- Managers must be aware of the negative implications of not managing N loading into this system as N may significantly impact red algae bloom size and structure.

## Acknowledge

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- I gratefully appreciate the guidance of my tutor Jiangtao Wang.
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**Thanks for your listening!**