PICES-2018 Annual Meeting:

Toward integrated understanding of ecosystem variability in the North Pacific

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Spatial-temporal variations in the distribution and abundance of loligo squids in Shandong offshore of Yellow Sea and Bohai Sea in relation to environmental factors

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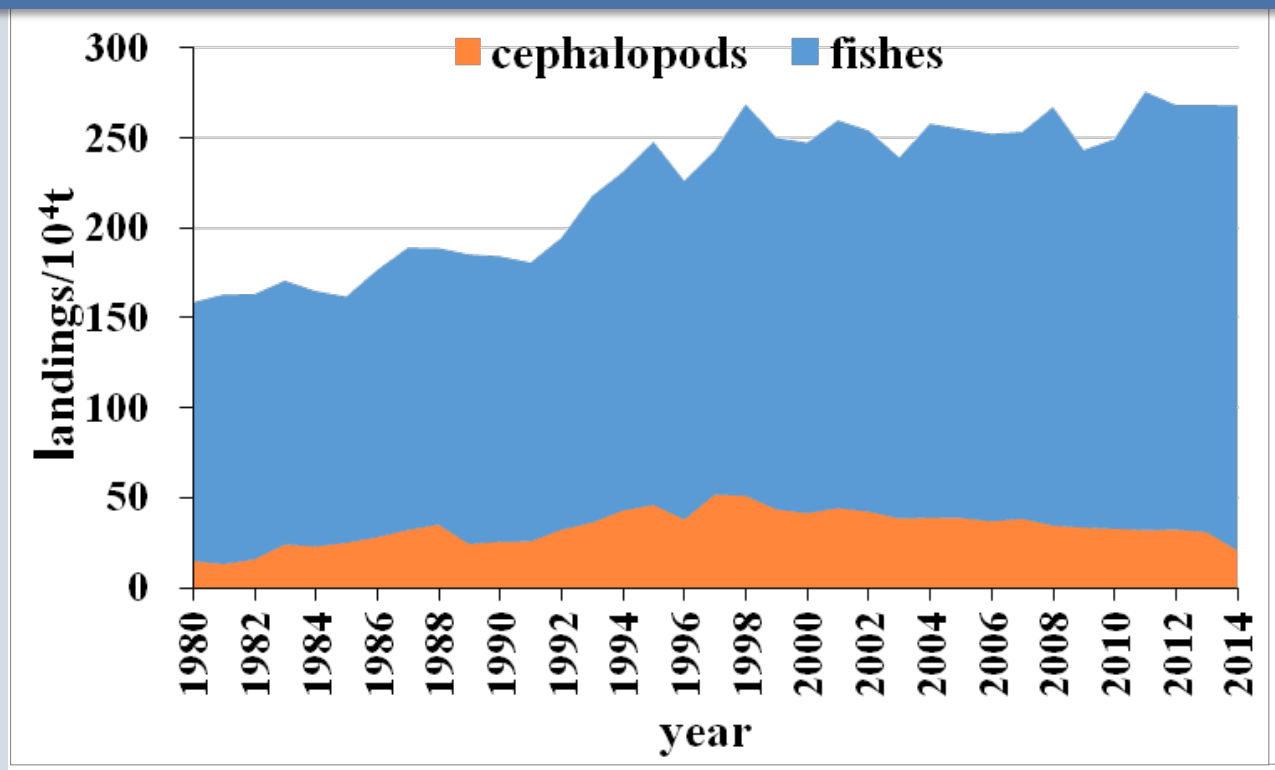
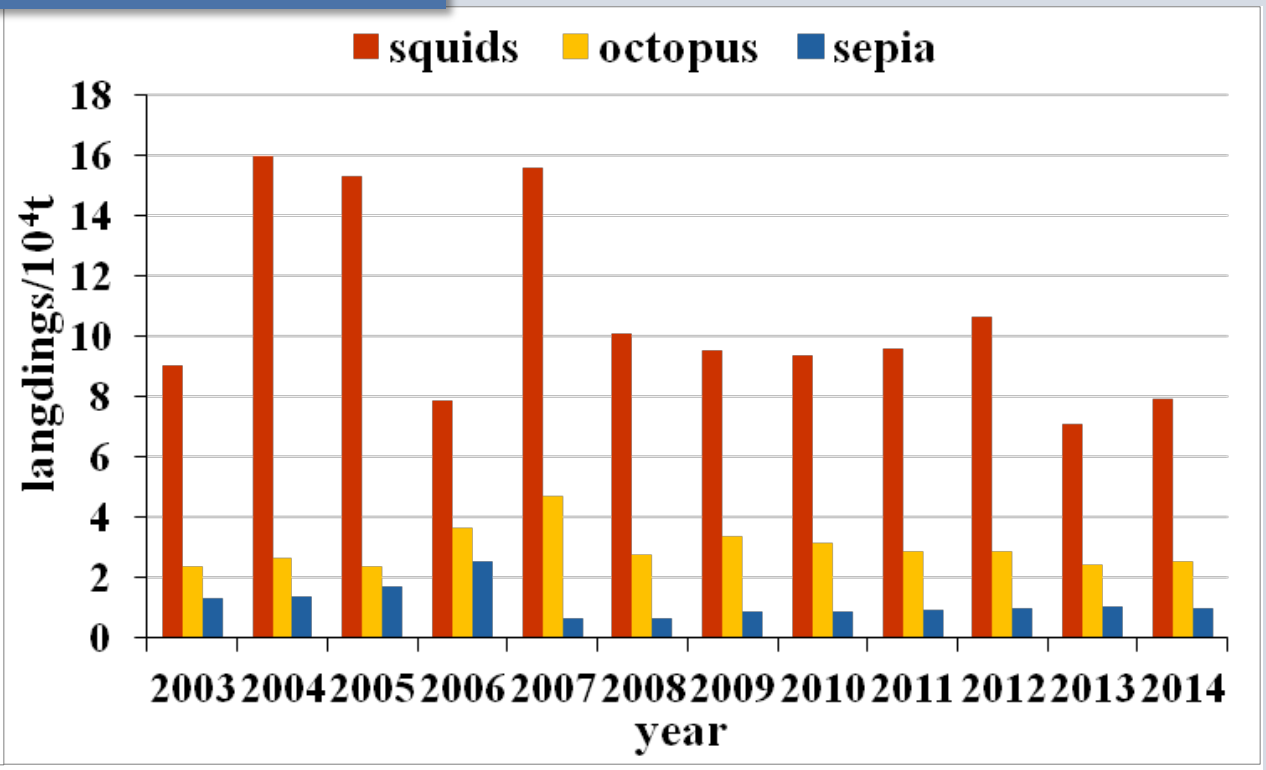


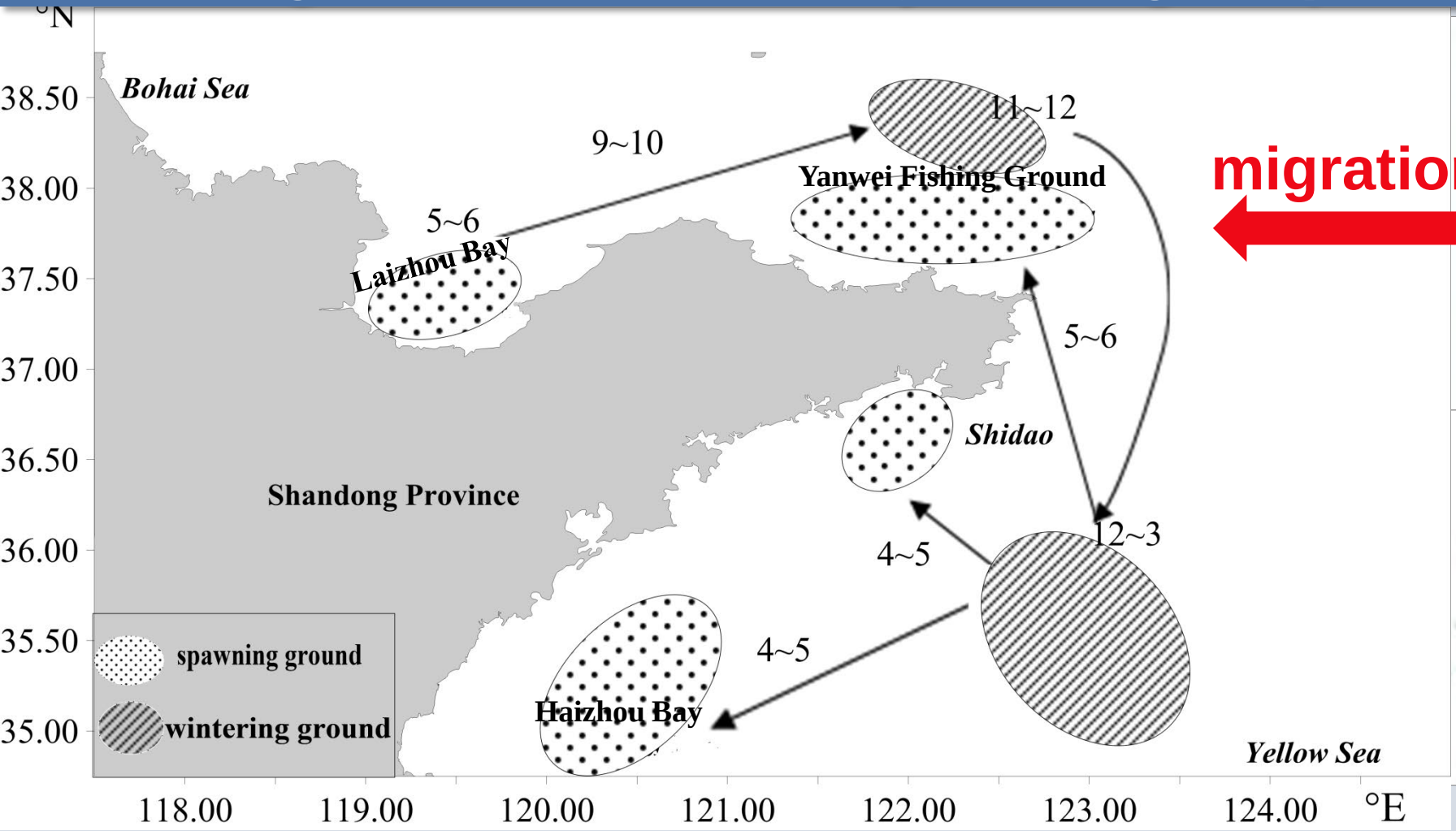


Yellow Sea and Bohai Sea (Source: Sea around us)

Shandong Province (Source:Shandong Fisheries Yearbook)

Among cephalopods in the Yellow Sea and Bohai Sea, loligo squids are the most important group.

1 Background: Life history of loligo squids



migrations

- Semipelagic species
- Wide distribution in YS and BS
- Coastal waters migration for spawning
- Spawning peak from April to June
- 1-year lifespan
- Single reproduction

1 Background: What we want to know

✓*Premise*

r-strategy → **easily susceptible** → **environmental factors**

(Rodhouse, 2005; Pecl et al., 2008)

✓*Purpose*

environmental factors → **?Which** / **?How** → **spatial-temporal variations in the distribution and abundance**

Then → **fluctuation in landings**

✓*Significance*

sustainable utilization and management in the Yellow Sea and Bohai Sea

2 Materials and methods

●Materials

Sampling sites:

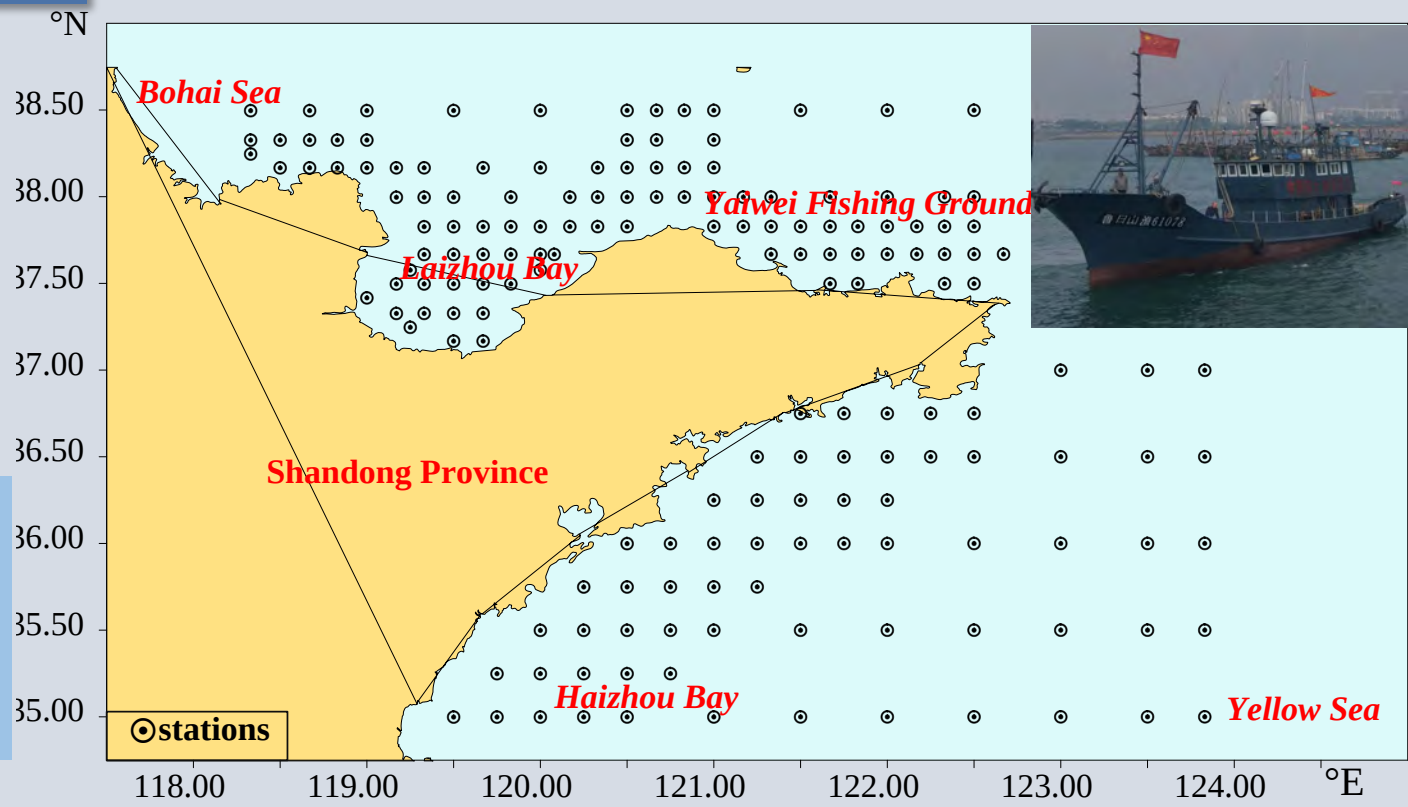
177 stations in Shandong offshore

Sampling time:

201610, 201701, 201705, 201708

Data:

month, longitude-latitude, SST, SSS, Depth, mantle length, body weight, sex and maturity stages



●Methods

Pearson correlation analysis

GAM: $\ln(Y+0.01)=\alpha+Month+s(Depth)+s(SST)+s(SSS)+\varepsilon$

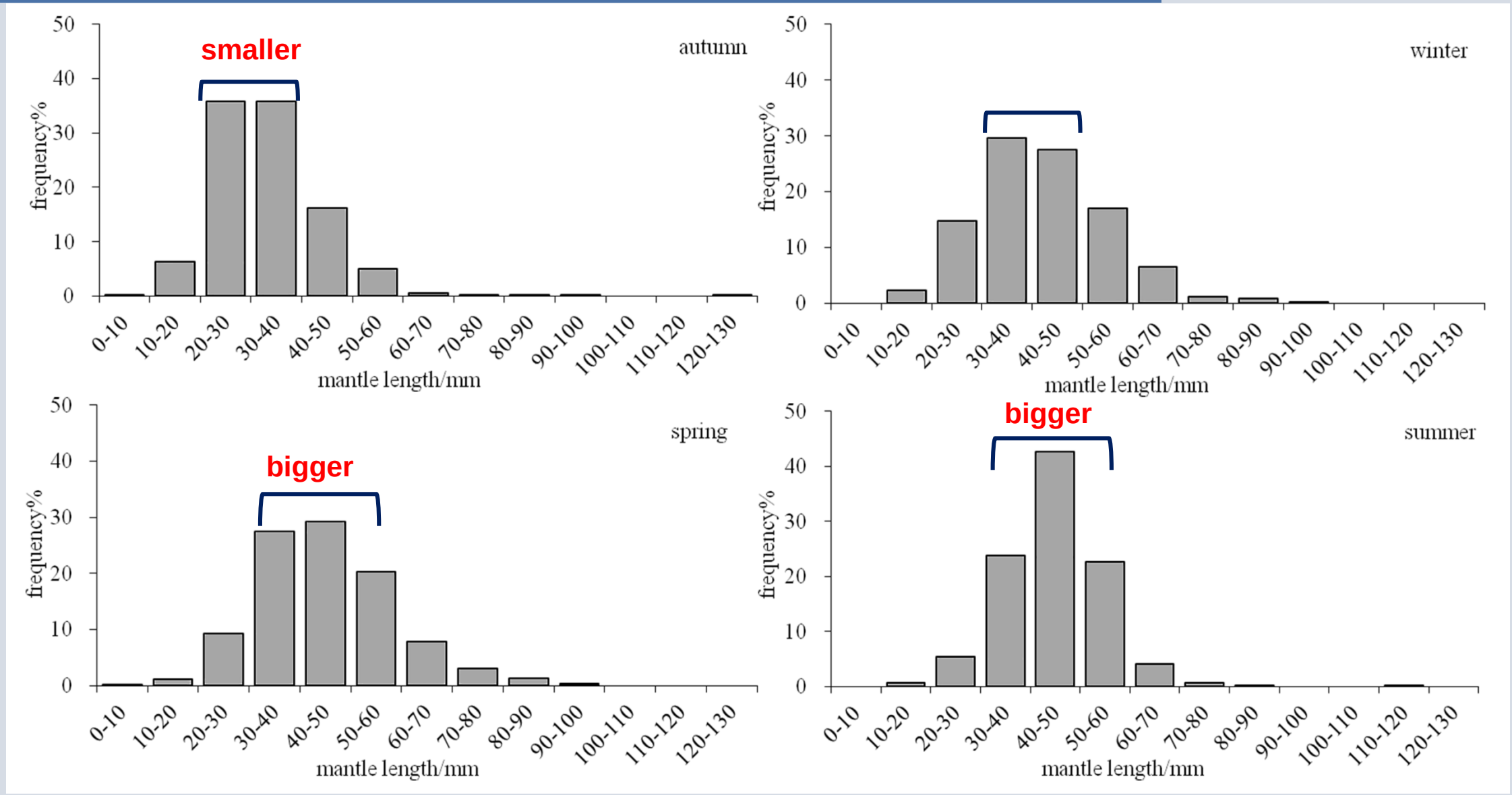
Month-categorical variable
Y-abundance

AIC=2k-2nL

Test the fit degree of model

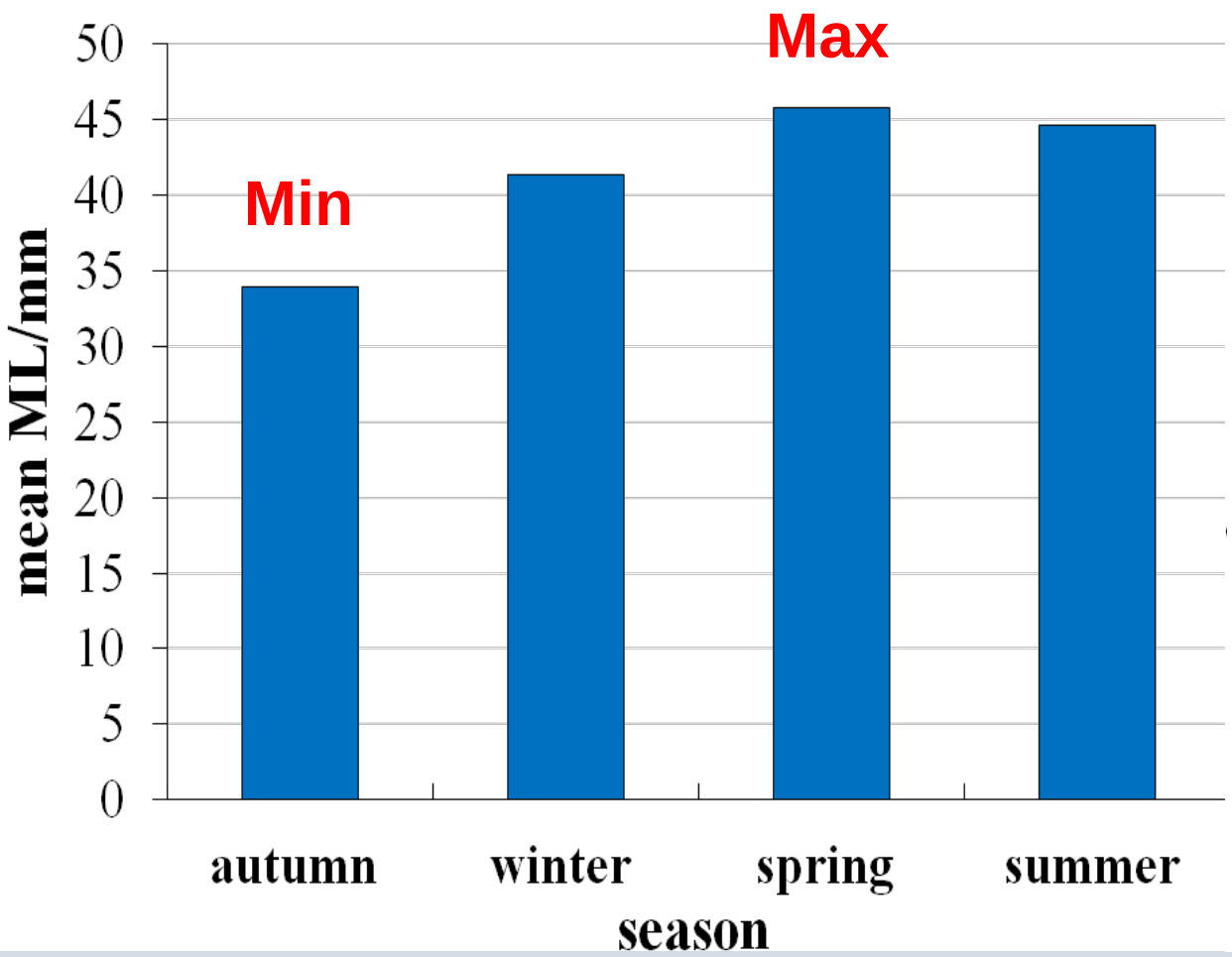
Variance analysis

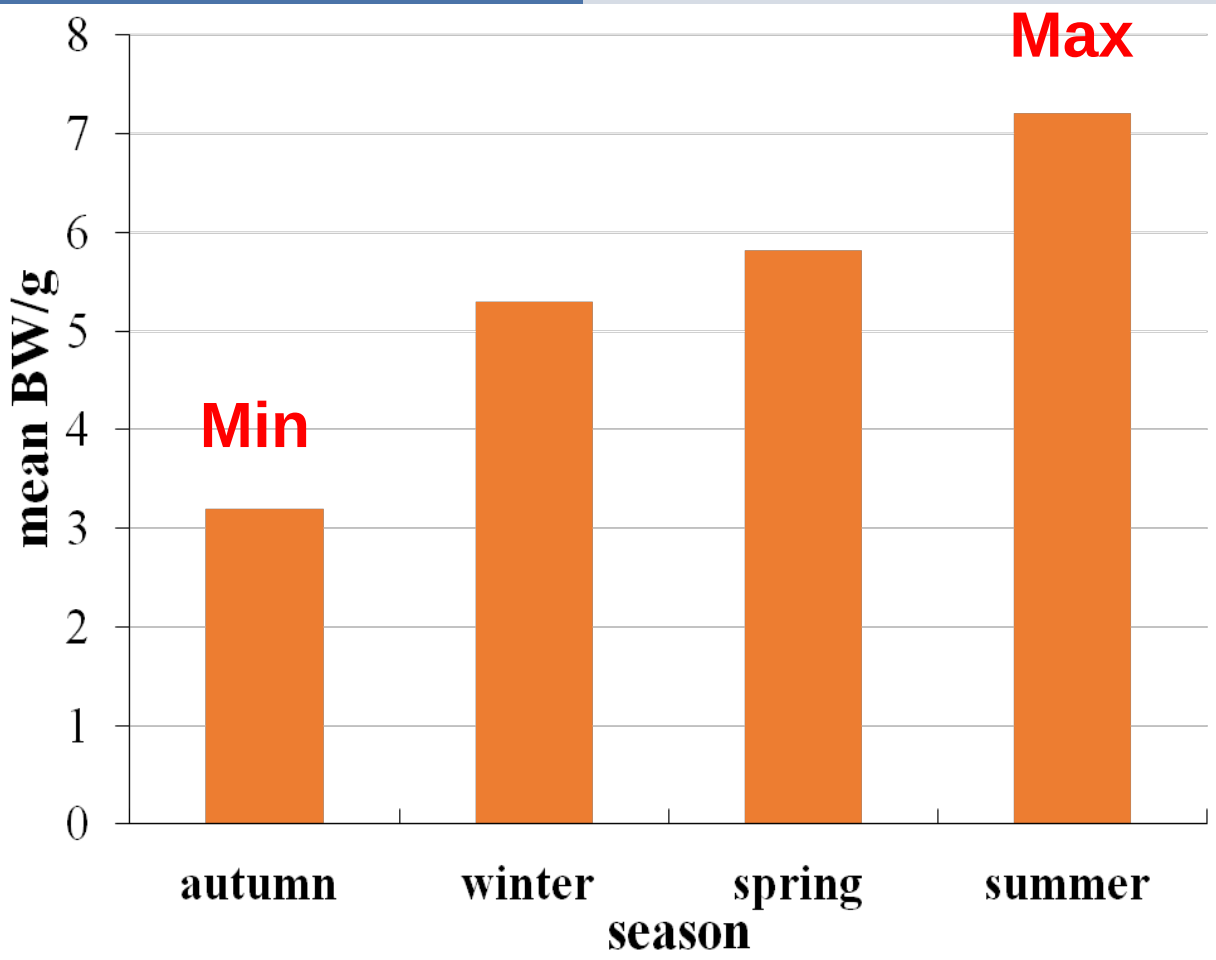
3 Results: Basic biological characteristics



The dominant ML was bigger in spring and summer, while it was smaller in autumn.

3 Results: Basic biological characteristics



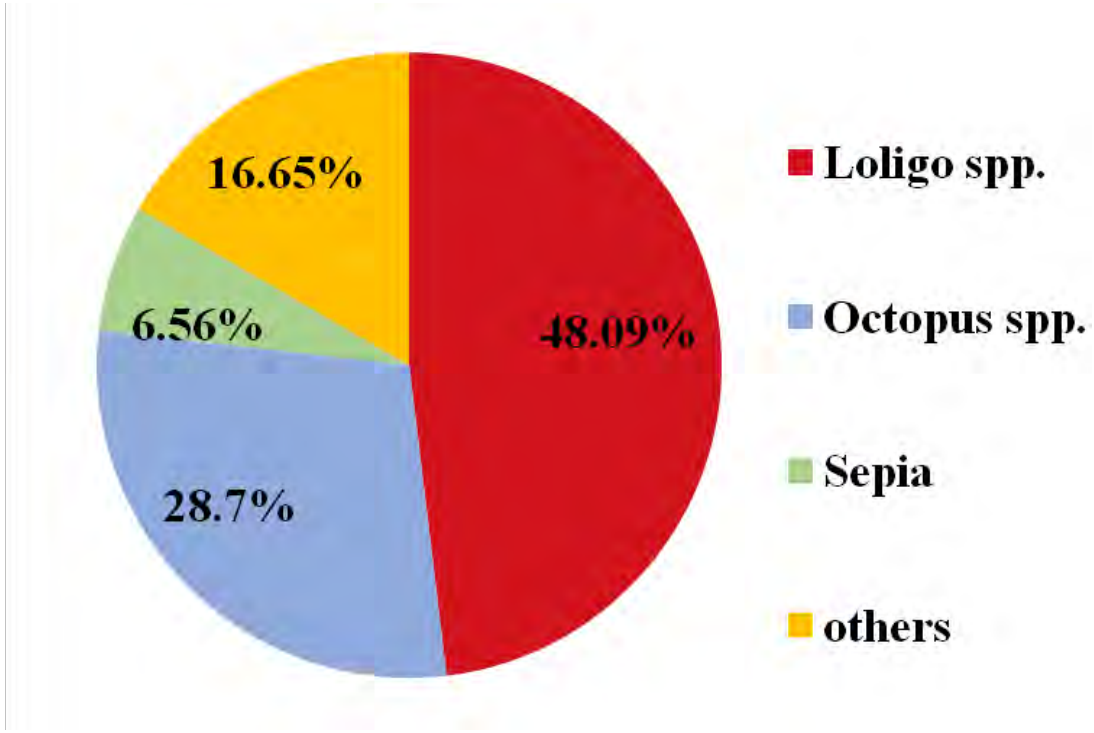


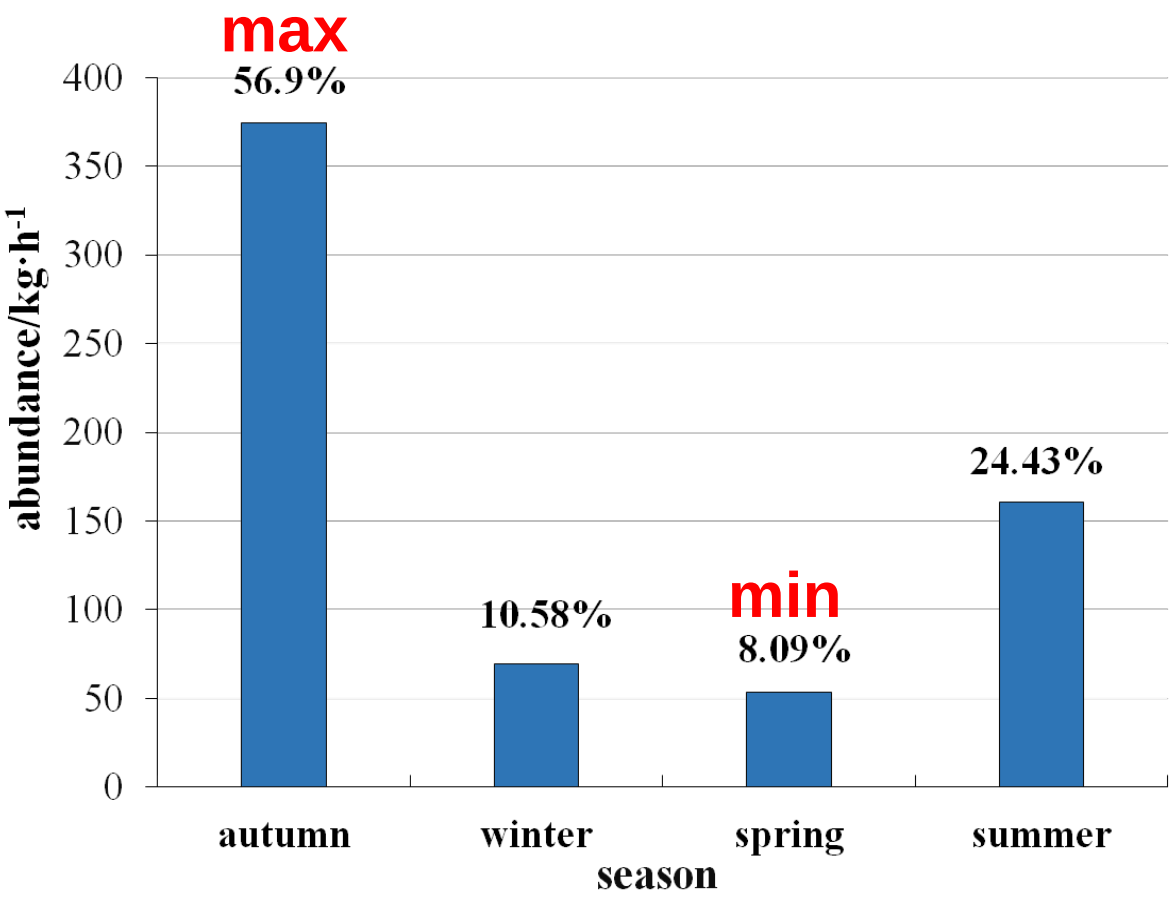
There were ***significant differences*** in ML and BW among seasons($p<0.01^{**}$)

Female:male≈2:1

Summer: mainly Ⅲ-Ⅳ

3 Results: Temporal distribution of loligo squids





Significant differences

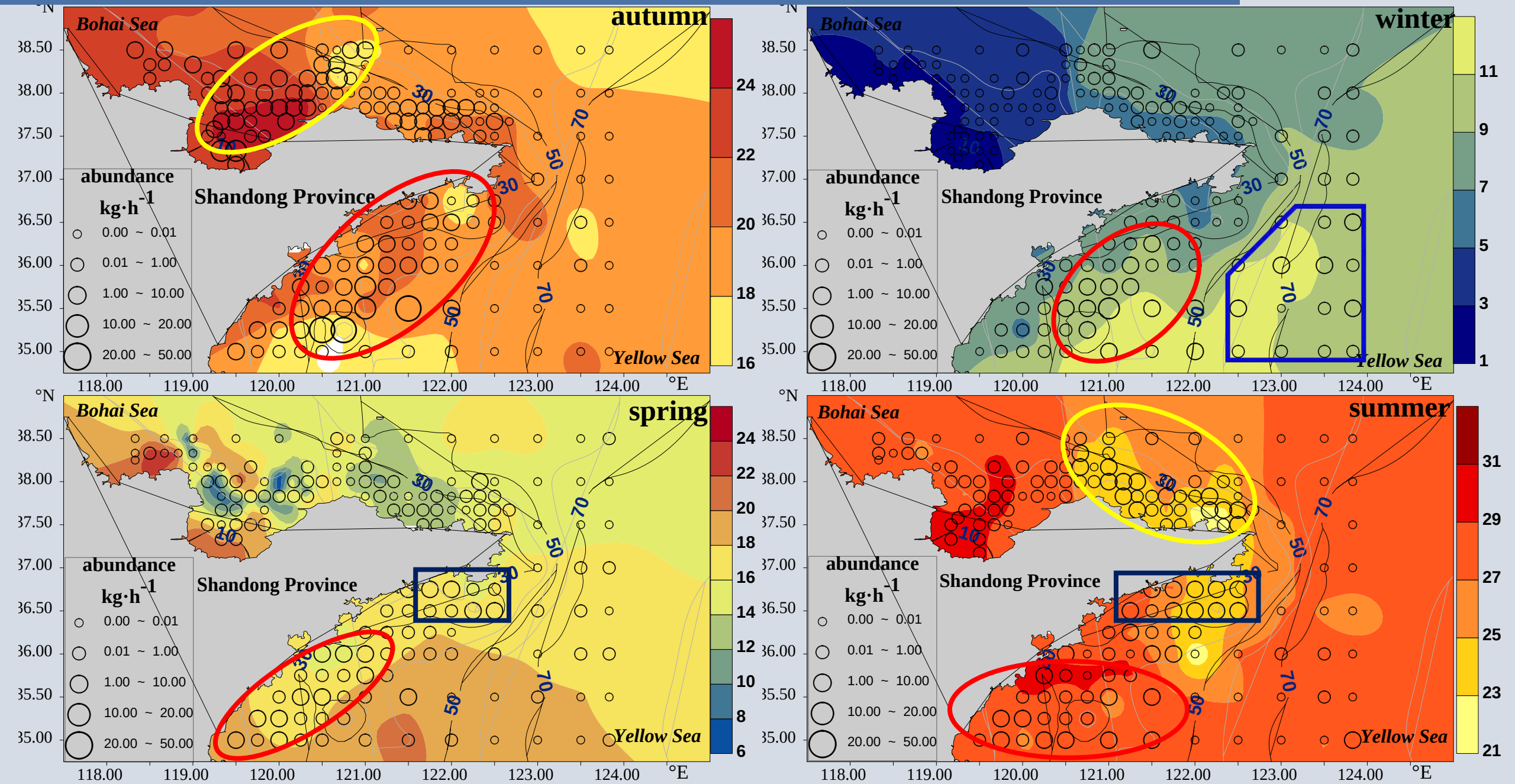
Loligo spp.>Octopus spp. >Sepia>others

Significant differences

autumn>summer >winter>spring

(F=22.37,p<0.001)**

3 Results: Spatial distribution of loligo squids



3 Results: The relationship between abundance and environmental factors

influence factors	autumn	winter	spring	summer
Depth	-0.55**	0.53**	-0.13	-0.16
SST	0.01	0.75**	-0.01	-0.29**
SSS	-0.01	0.29**	-0.004	-0.03

Pearson correlation analysis

variables	df	R^2	DE%	AIC
SST	7.73	0.27	26.8	1792.26
Depth	5.86	0.11	12.6	1866.89
SSS	7.61	0.04	2.7	1912.38

Most important

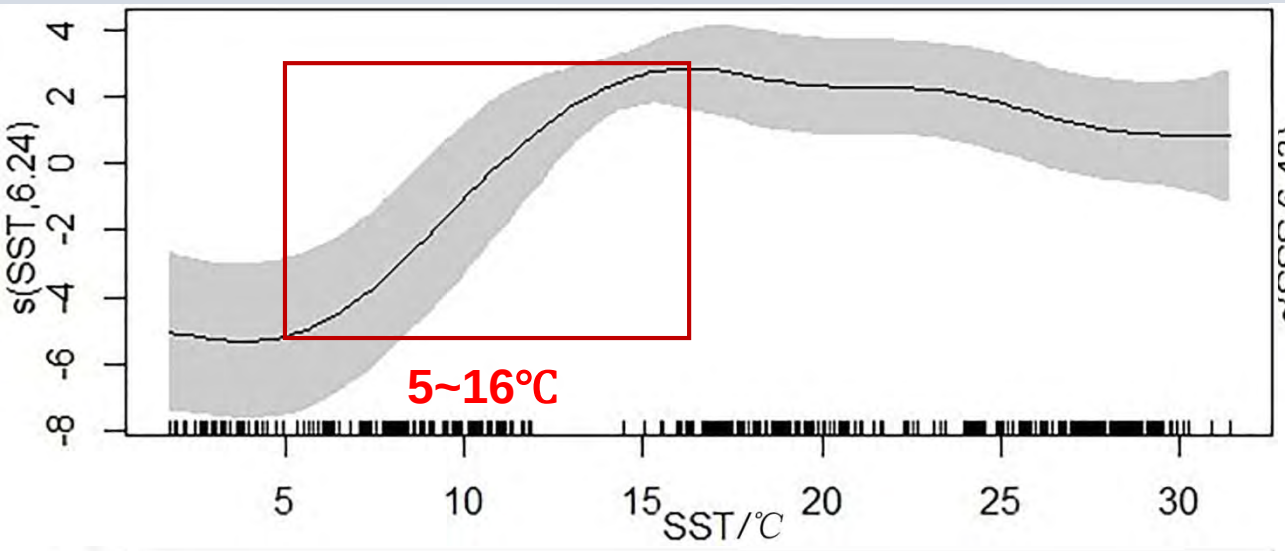
Final DE=43.1%
AIC=1713.23

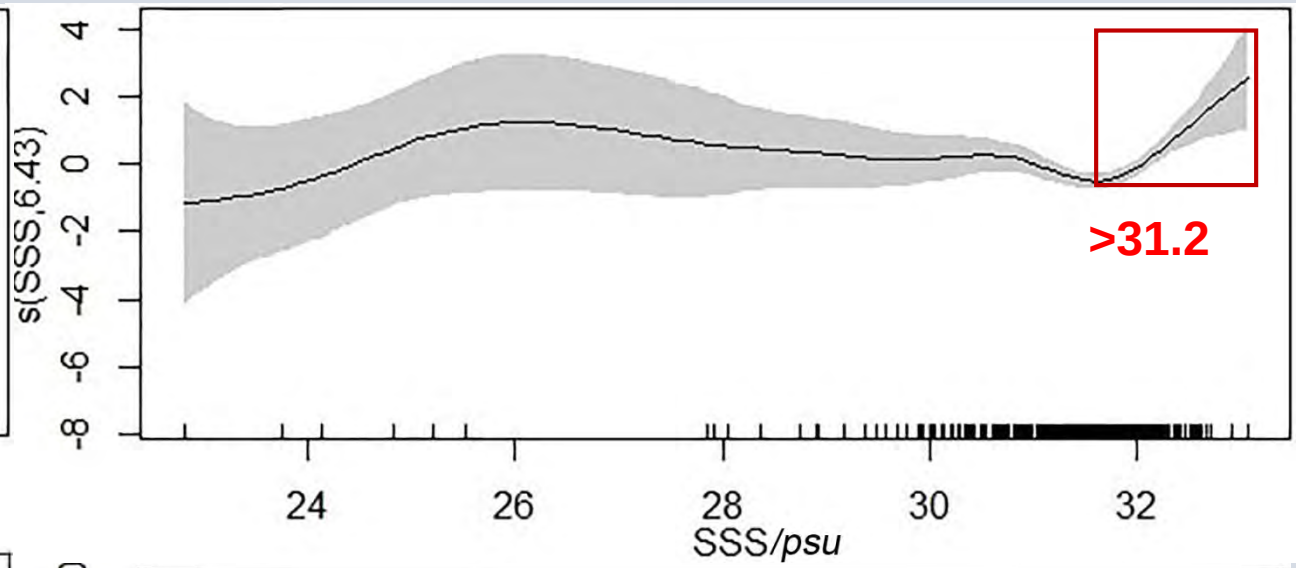
factors	SST	Depth	SSS
F	20.14	9.92	3.46
P	<0.01**	<0.01**	<0.01**

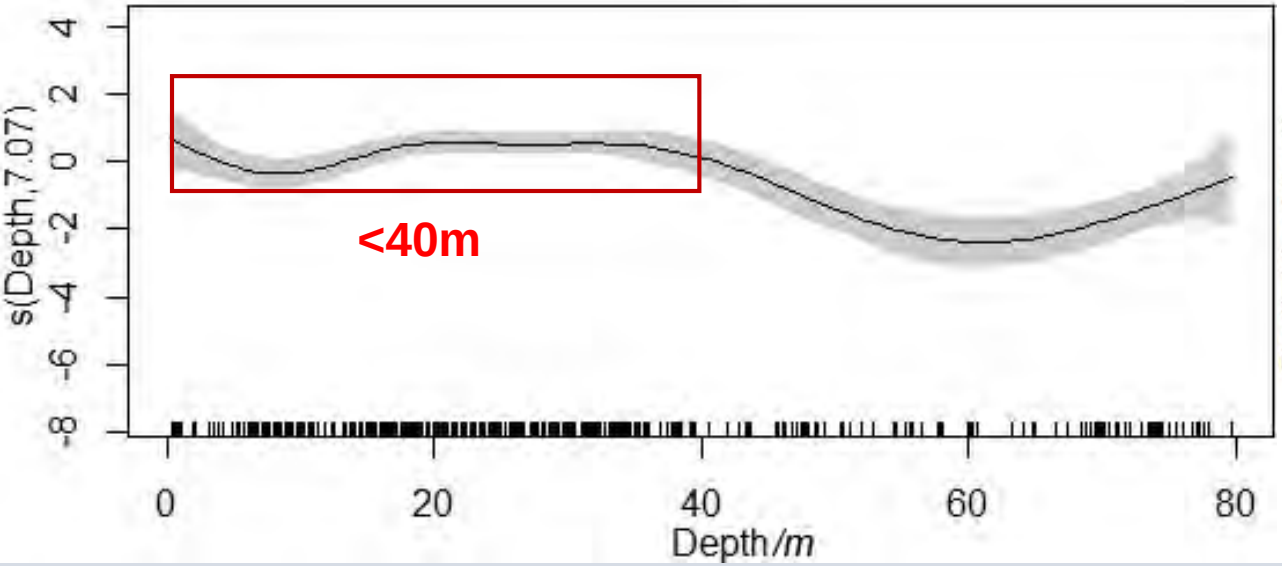
Variance analysis

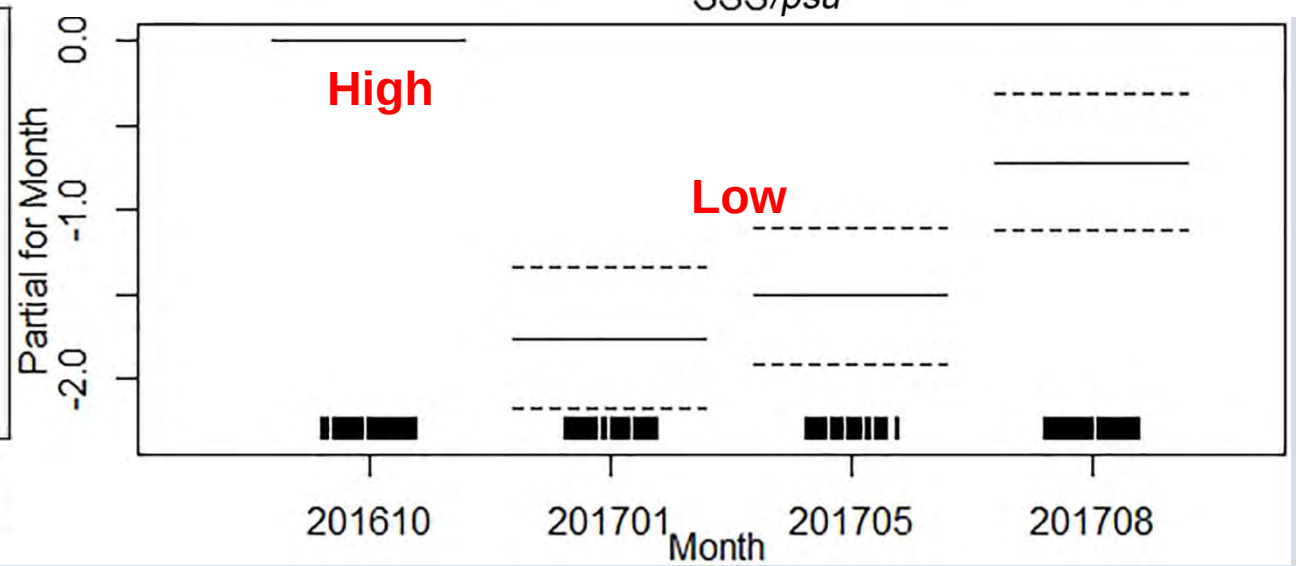
Depth,SST and SSS had significant effects on the abundance of *Ioligo* spp.

3 Results: The relationship between abundance and environmental factors









4 Summary

1. The individuals were *bigger* and had higher gonadal maturity in *spring and summer* in comparison with *autumn*.

2. The abundance of loligo squids exhibited *distinct spatial and temporal variation patterns*, with highest abundance being in *autumn* and highest density occurring within *Haizhou Bay* (the primary spawning ground in YS).

3. *SST*, *water depth*, and *salinity* influenced the spatial-temporal variations in the distribution and abundance of loligo squids. The abundance *increased* with SST (*within 5-16℃*) and with salinity *(>31.2 psu*), and was higher at depths *shallower than 40m*.

5 Discussion

Growth

bigger

Spring
Summer

higher maturity

smaller

Autumn

lower maturity

Spawning peak

Growth period

Spawning and newborn groups

Only newborn groups

Female > Male

Single reproduction

The males die earlier than the females

Spatial-temporal distribution

Temporal distribution

Spatial distribution

significant differences

Environment

Depth

SST

SSS

influence

migrations

spawning

wintering

Future work

- ✓ **Analyzing landings and environmental data over a wider area of the China Seas**

  Exploring these relationships with respect to specific oceanographic processes

- ✓ **Other species**

  Octopus ocellatus* or *Todarodes pacificus

- ✓ **Exploring the relationship between fish and cephalopods**

  Focus on the effects of environmental changes on the predation interactions between them

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Thanks for the financial support from the symposium and your attention!

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