Impact of major climatic factors on biomass of the main commercial fishes in east China seas

Jilong Wang, Jilong Li and WenboYang
Chinese Academy of Fishery Sciences
E-mail:wbyang@cafs.ac.cn
Tel:+86-010-68673940

OUTLINE

1.Introduction

2.Materials and Methods

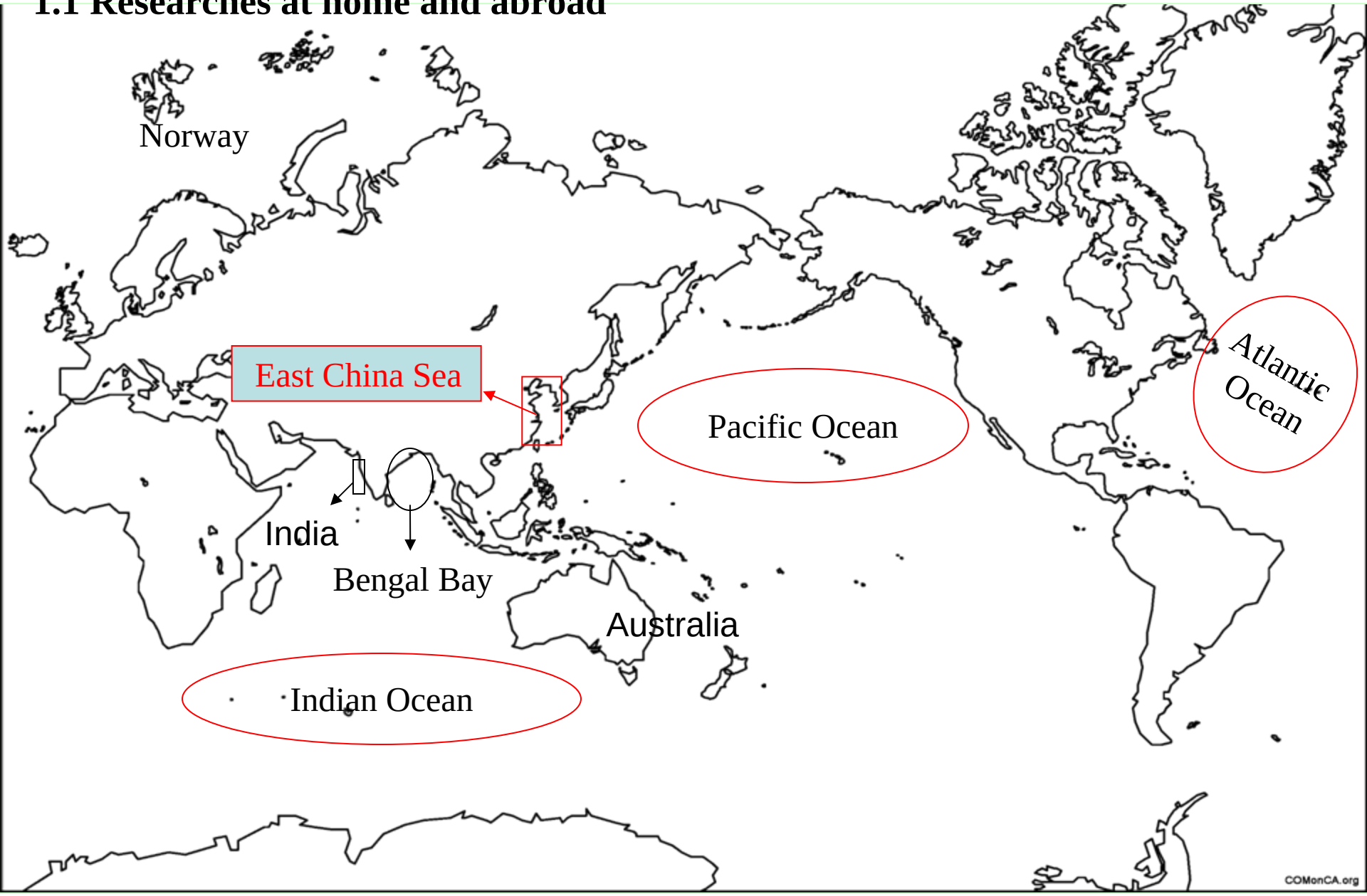
3.Results

4.Discusstion

5.Conclutions

1 Introduction

1.1 Researches at home and abroad



1 Introtuction

1. 2 Impact of Climate and marine environment on fish growth stages

Temperature
Mixing
advection

Process	Environmental factors	Biology characters	Representative spices
Spawn and breed	Temperature	age at sexual maturity	Atlantic cod
	Temperature	Spawning time	Atlantic cod、capelin
	Temperature	Eggs and larvae hatching size	Atlantic cod、mackerel
	Temperature	Incubation time	Atlantic cod
	Small scale disturbance	Larval feeding rate	Atlantic cod、Atlantic herring
Parent and recruit	temperature	Larval feeding success、Reduce prey risk	Atlantic herring、Bluefin tuna、Atlantic cod、The Atlantic salmon
	NAO	——	East blue fin tuna、NorthAlbacore Tuna
	Upwelling	Primary productivity	sardine
	wind direction、advection	juvenile staying in continental shelf waters and feeding success	Atlantic cod
	The current taking away shelf water	Eggs transport、Juvenile fish swimming off continental shelf waters	Many benthic fishes
Growing	Environmental temperature	physiological process（feeding、assimilation、metabolism、excretion）	Normal spices
	Temperature	Feeding season length	Normal spices
	Temperature	Food acquisition	Atlantic cod、capelin
Migration and distribution	Temperature	Habitat range	
	Temperature	Migratory signals	mackerel、the Atlantic shad、Atlantic herring、Atlantic cod、The Atlantic salmon
Natural death	Temperature（low）	——	tilefish、Atlantic cod、Soleidae、
	Temperature（high）	——	Atlantic cod
Fishing death	temperature	Swimming speed	Atlantic cod

2. Materials and methods

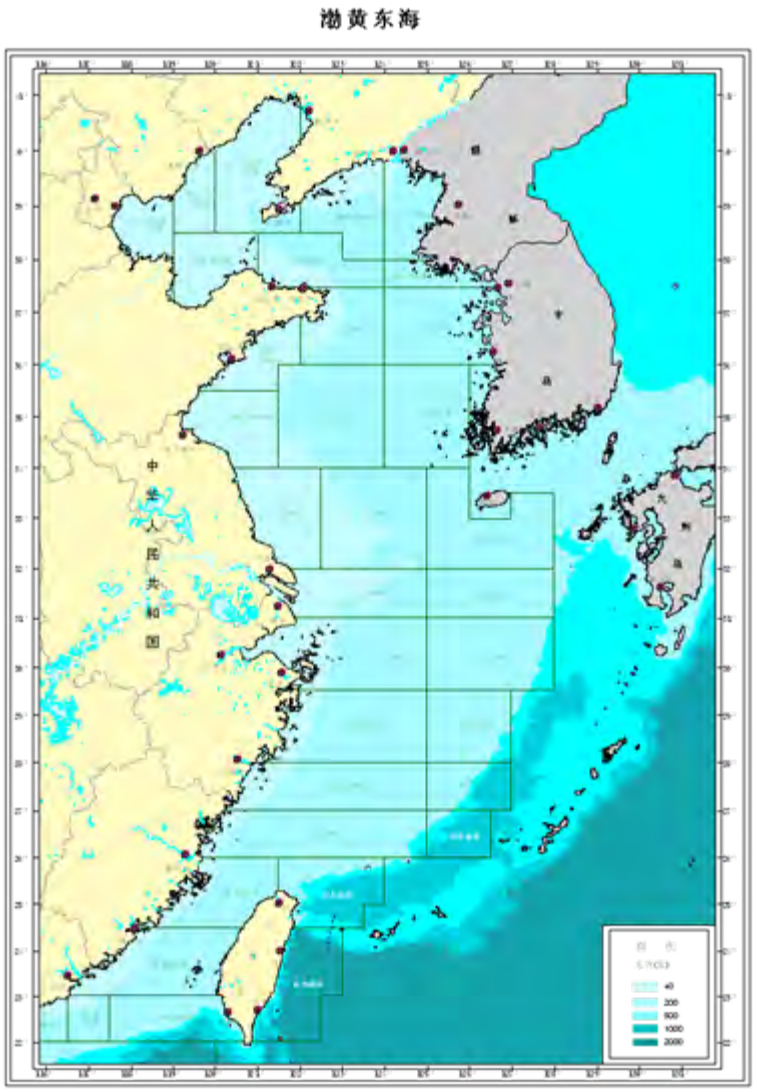
2.1 Study area

1.East China sea：

Cover with:the Bohai sea 、the Yellow sea、the East China sea

2.Climate factors：

Include:SST、Monsoon、Typhoon、Runoff



2. Materials and methods

2.2 Data source

Time serial:
Fishing catch and Fishing Effort：Year1956-1984； Climate factors：Year1951-1984

Data name	Property	Source
Fishing catch	Various seas /Perched water-course	《China Fishery Statistical Yearbook》
Fishing effort	standardizing to horsepower	《Marine Fishery Divisions of Chinese》
SST	Month average	KNMI(Koninklijk Nederlands Meteorologisch Instituut)
Monsoon	Winter/summer month average	KNMI(Koninklijk Nederlands Meteorologisch Instituut)
Typhoon	Wind speed/6 hours	Shanghai Typhoon Institute of China Meteorological Administration
Runoff	The yellow river（Lijin hydrologic station）、The Yangtze River（Datong hydrologic station）	The Ministry of water Resources of the PRC.

2. Materials and methods

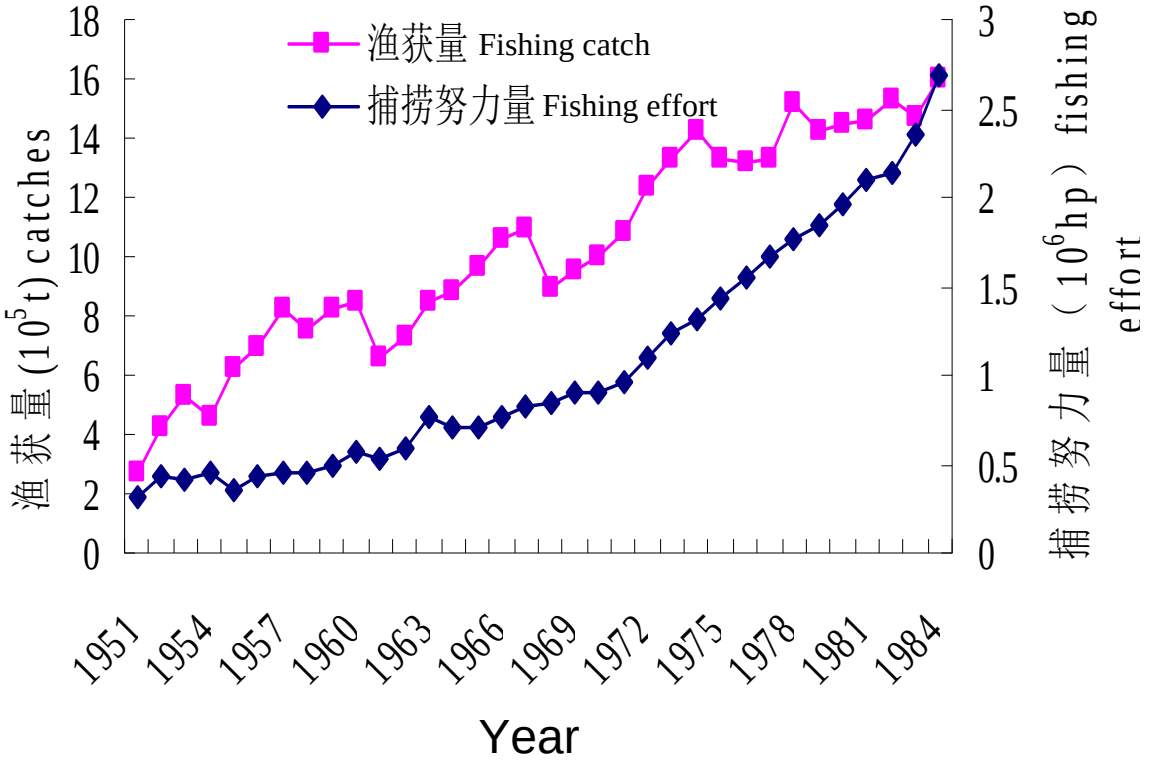
2.3 Data Preprocess

Preprocess: throw off the effects of fishing effort to fishing catch, gained the fishing catch residual

$$y = f \times c \cdot e^{-d \cdot f}$$

$$y' = y - y''$$

f： fishing effort，y''： effort of fishing effort to fishing catch，y'： fishing catch residual，y： fishing catch, c、d and e are constants



2. Materials and methods

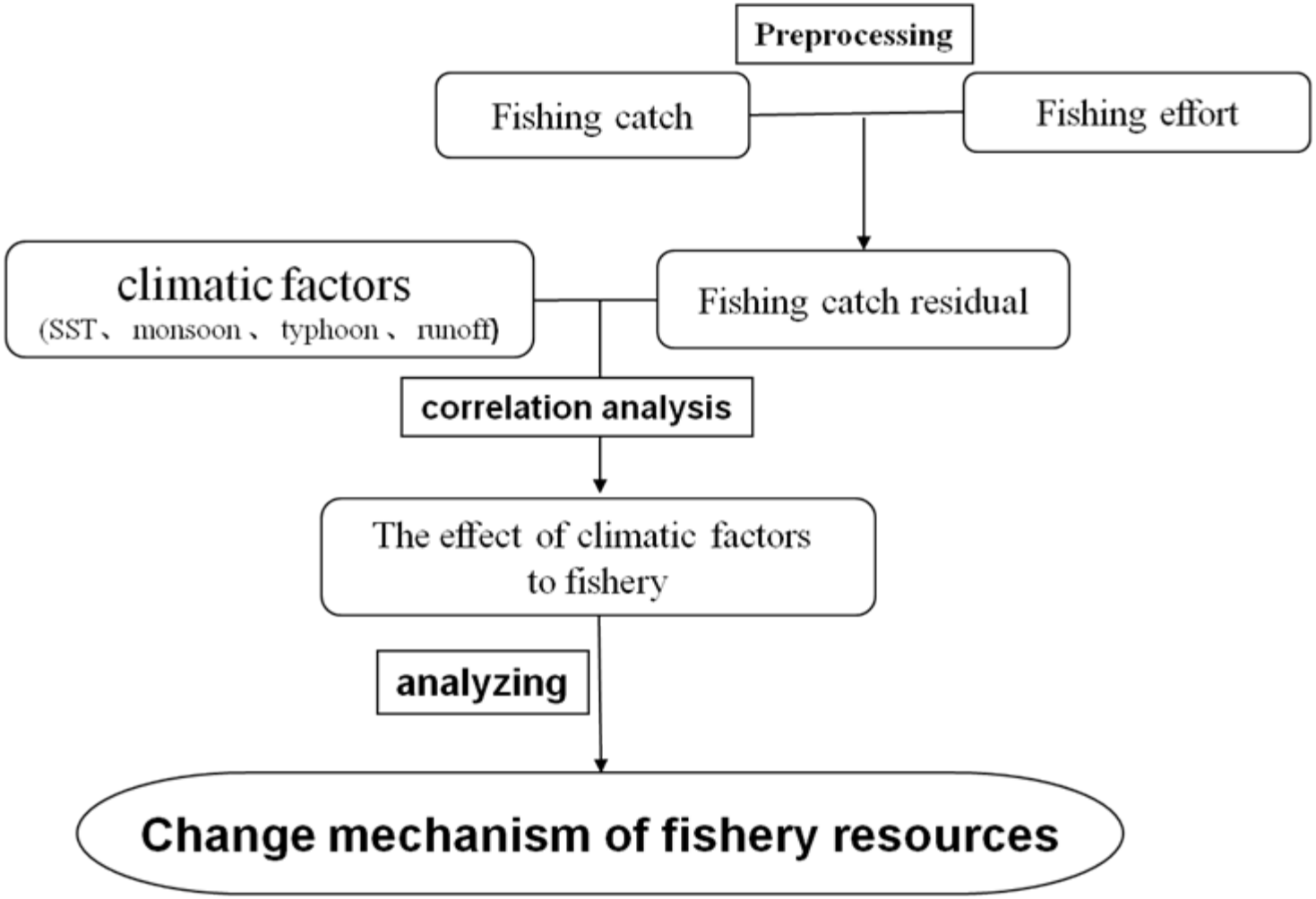
2.4 Correlation analysis

1.analyzed the correlation of major climatic factors (monsoon, typhoon, SST, runoff) with the residual and the ratio of major commercial fishes in east China seas from 1956-1984

2. Calculated the time lags and years of continuity

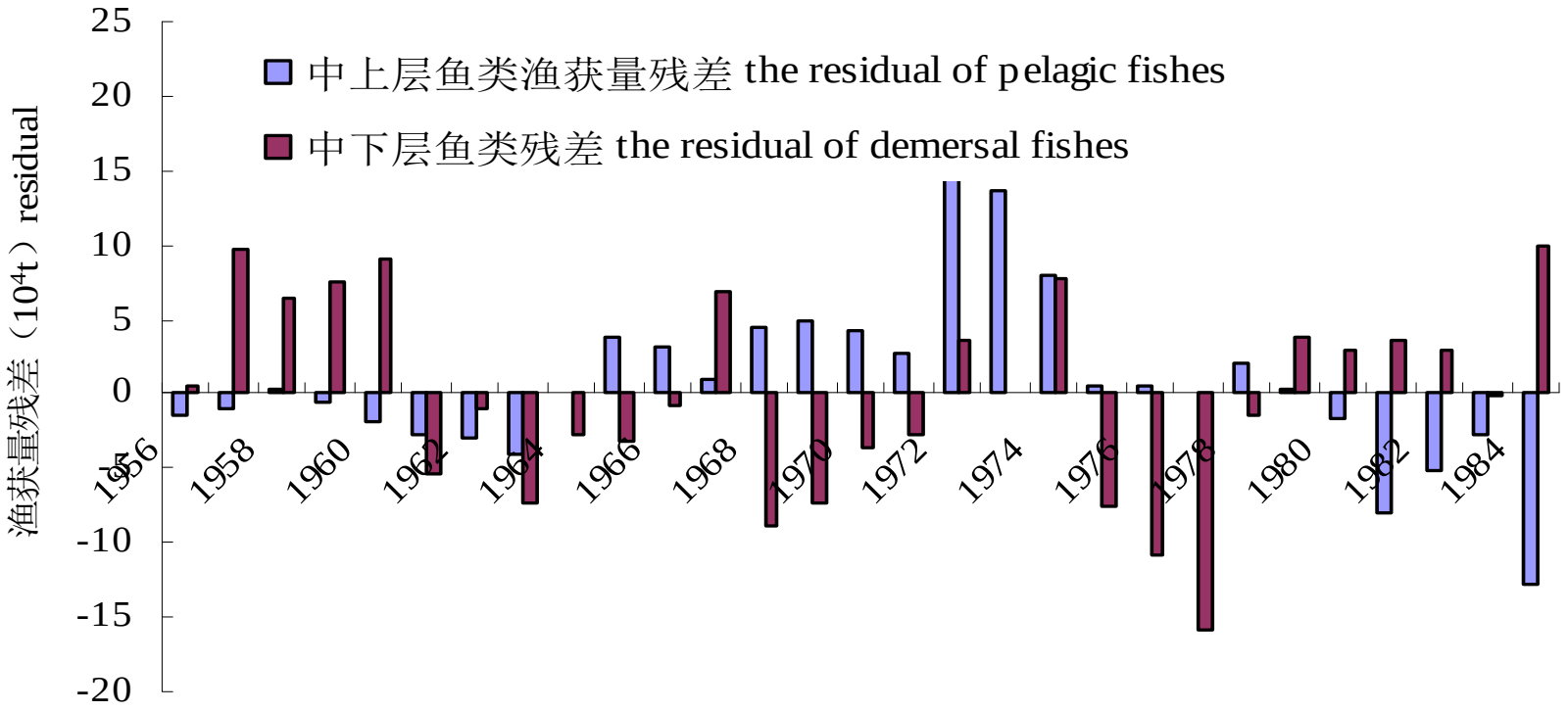
2. Materials and methods

2.5 Technical route



3. Results

3.1 the residual comparison between the pelagic and demersal



Impact of the environment to the pelagic and demersal fishes appears a opposite trend

3. Results

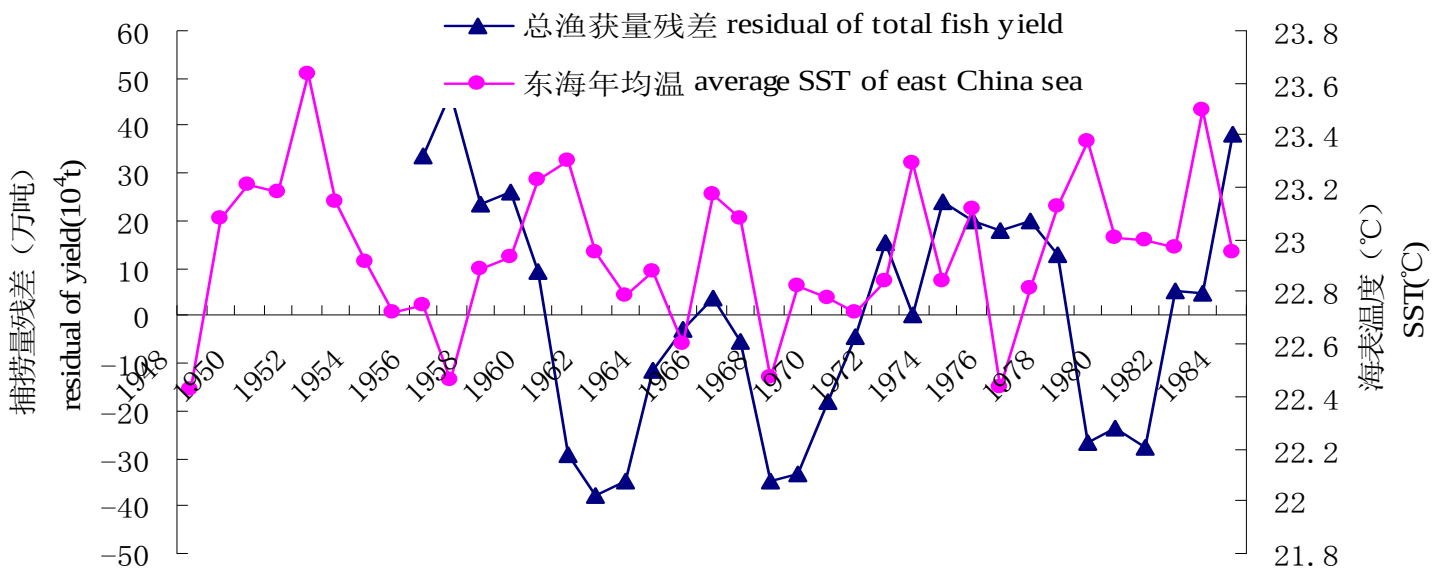
3.2 the impact of SST on the fish biomass

	Main commercial spices	Average SST /Month The Bohai Sea	Average SST /Month The North Yellow Sea	Average SST /Month The South Yellow Sea	Average SST /Month The East China Sea
the pelagiclfishes	*Scomberomorus niphonius*(total)	——	(-)0.468(*)(0)	(-)0.437(*)(0)	(+)0.481(2)Aug.
	Clupea pallasi(total)	(-)0.493(*)(3)Apr.	(+)0.603(**)(0)Apr.	(-)0.581(**)(2)Jun.	——
	the *Pneumatophorus and carangoid*(the Bohai and Yellow Sea)	(-)0.401(*)(2)Sep.	——	——	(+)0.464(*)(4)Oct.
	the *Pneumatophorus and carangoid*(the East China Sea)	(-)0.630(**)(0)Jun.	(+)0.419(*)(4)Mar.	(+)0.466(*)(4)Mar.	(+)0.500(**)(0)Oct.
	the *Pneumatophorus and carangoid*(total)	(-)0.570(**)(0)Jul.	(+)0.418(*)(4)Apr.	(+)0.435(*)(4)Mar.	(+)0.438(*)(0)Oct.
	Ilisha elongta(total)	(+)0.462(*)(1)Jul.	(-)0.507(**)(5)May	(-)0.463(*)(5)May	——
	the pelagicl(total)	(-)0.397(*)(3)Sep.	(-)0.405(*)(3)Oct.	(-)0.404(*)(2)Sep.	——
the demersal fishes	*Pseudosciaena crocea*(the East China Sea)	(+)0.432(*)(1)May	(-)0.383(*)(5)Feb.	(-)0.486(*)(4)Feb.	(-)0.459(*)(0)Jan.
	Pseudosciaena polyactis(the Bohai and Yellow Sea)	——	(-)0.381(*)(3)May	——	——
	Pseudosciaena polyactis(the East China Sea)	——	(-)0.391(*)(5)May	——	——
	Trichiurus haumela(the Bohai and Yellow Sea)	——	(-)0.504(**)(5)May	(-)0.376(*)(5)May	——
	Trichiurus haumela(the East China Sea)	(+)0.376(*)(2)May	(+)0.395(*)(2)May	(-)0.447(*)(5)Feb.	(-)0.392(*)(5)
	Fenneropenaeus chinensis(the Bohai and Yellow Sea)	(+)0.446(*)(0)Apr.	——	——	——
	Fenneropenaeus chinensis(the East China Sea)	(+)0.440(*)(1)Feb.	(+)0.397(*)(1)Feb.	(+)0.459(*)(0)	(+)0.446(*)(0)
	Acetes chinensis(the Bohai and Yellow Sea)	(-)0.428(*)(4)	(-)0.466(*)(1)Feb.	——	(-)0.473(*)(1)Oct.
	Acetes chinensis(the East China Sea)	(-)0.405(*)(0)May	——	——	——
	Sepioidea(the Bohai and Yellow Sea)	(-)0.474(*)(0)Jul.	——	——	(+)0.501(**)(0)Oct.
	Sepioidea (the East China Sea)	(+)0.449(*)(0)Jun.	——	(+)0.514(**)(1)1Feb.	(-)0.382(*)(1)Jan.
	the demersal (total)	(+)0.535(**)(1)Jul.	(-)0.572(**)(4)Mar.	(-)(*)2,Mar.;(+) (*)7,Aug.	(-)(*)(3)1,Oct.;(+) (*)(1)Jul.
	Rhopilema esculentum(the Bohai and Yellow Sea)	(-)0.480(*)(3)	(-)0.458(*)(1)May	——	——
	Total capture	(-)0.472(*)(1)Jul.	(+)0.420(*)(1)Feb.	(+)0.374(*)(1)Feb.	(+)(*)(0)1,Oct.;(-) (*)(1)Jul.

(Notes: - stands for negative correlation;+ stands for positive correlation; the values behind (-/+) stand for the correlation coefficient; * stands for *p*-value <0.05; ** stands for p-value <0.01; the value behind * stands for the time lag; —— stands for no significance of the correlation).

3. Results

3.2 the impact of SST on the fish biomass



1.Change cycle of SST is approximately consistent with the fish biomass ,which is 9-10 years

2.The time lags :4-5 years.

3. Results

3.3 the impact of monsoon on the fish biomass

	Main commercial spices	Winter monsoon The Bohai Sea	Winter monsoon The North Yellow Sea	Winter monsoon The South Yellow Sea	Winter monsoon The East China Sea	Summer monsoon The Bohai Sea	Summer monsoon The North Yellow Sea	Summer monsoon The South Yellow Sea	Summer monsoon The East China Sea
the pelagicl fishes	*Scomberomorus niphonius*(total)	——	——	——	——	——	——	——	——
	Clupea pallasi(total)	(-)0.533(*)(2)	(-)0.592(**)(2)	——	(+)0.573(*)(2)	——	(-)0.497(*)(3)	——	(+)0.476(*)(1)
	the Pneumatophorus and carangoid(the Bohai and Yellow Sea)	(-)0.423(*)(0)	——	——	(+)0.440(*)(3)	——	(-)0.504(**)(0)	——	(-)0.467(*)(0)
	the Pneumatophorus and carangoid(the East China Sea)	——	——	——	(-)0.391(*)(0)	——	——	——	——
	the Pneumatophorus and carangoid(total)	(-)0.503(**)(0)	——	——	——	——	(-)0.450(*)(0)	——	——
	Ilisha elongta(total)	(+)0.709(**)(2)	(+)0.576(**)(0)	(+)0.509(*)(2)	(-)0.434(*)(0)	(+)0.665(**)(1、2)	(+)0.626(**)(1、2)	(+)0.461(*)(0、2)	(+).649(**)(1、2)
	the pelagicl(total)	(-)0.457(*)(0)	——	——	——	——	(-)0.393(*)(0)	——	——
the demersal fishes	*Pseudosciaena crocea*(the East China Sea)	(-).472(**)(0)	(-)0.399(*)(0)	——	——	——	——	——	——
	Pseudosciaena polyactis(the Bohai and Yellow Sea)	(+)0.715(**)(4)	(+)0.592(**)(4)	(+)0.367(*)(4)	——	(+)0.512(**)(3、4)	(+)0.554(**)(3、4)	(+)0.396(*)(3、4)	(+).482(**)(3)
	Pseudosciaena polyactis(the East China Sea)	(+)0.594(*)(5)	(+)0.520(**)(4)	——	——	(+)0.517(**)(2、3)	(+)0.508(**)(4)	(+)0.471(**)(1)	(+)0.476(**)(2、3)
	Trichiurus haumela(the Bohai and Yellow Sea)	——	——	——	(+)0.373(*)(4)	——	——	——	(-)0.385(*)(5)
	Trichiurus haumela(the East China Sea)	(-)0.384(*)(0)	(-)0.368(*)(3)	——	——	——	——	——	——
	Fenneropenaeus chinensis(the Bohai and Yellow Sea)	——	——	——	*(+)0.490(**)(3)*	——	*(-)0.488(**)(4)*	——	——
	Fenneropenaeus chinensis(the East China Sea)	——	——	——	*(+)0.432(*)(4)*	——	——	——	——
	Acetes chinensis(the Bohai and Yellow Sea)	(-)0.488(*)(1)	(-).442(*)(0、1)	——	——	(-)0.574(**)(0、1)	——	(-)0.436(*)(1)	(-).691(**)(1、2)
	Acetes chinensis(the East China Sea)	——	——	——	——	——	——	——	——
	Sepioidea(the Bohai and Yellow Sea)	——	(-)0.463(*)(0)	——	——	——	——	——	——
	Sepioidea (the East China Sea)	——	——	——	——	*(+)0.426(*)(3)*	——	——	——
	the demersal (total)	(+)0.398(*)(1、3)	——	——	(+)0.385(*)(3)	——	——	——	——
	Total capture	——	——	——	(+)0.410(*)(3、4)	——	——	——	——

(Notes: - stands for negative correlation;+ stands for positive correlation; the values behind (-/+) stand for the correlation coefficient; * stands for *p*-value <0.05; ** stands for p-value <0.01; the value behind * stands for the time lag; —— stands for no significance of the correlation).

3. Results

3.4 the impact of typhoon on the fish biomass

	Main commercial spices	Residual--typhoon	Time lags（Year）	Capture proportion--Typhoon	Time lags（Year）
the pelagicl fishes	*Scomberomorus niphonius*(total)	——	——	(+)0.435(*)	3
	Clupea pallasi(total)	——	——	——	——
	the Pneumatophorus and carangoid(the Bohai and Yellow Sea)	——	——	(-)0.546(**)	1
	the Pneumatophorus and carangoid(the East China Sea)	——	——	(-)0.511(**)	0
	the Pneumatophorus and carangoid(total)	——	——	(-)0.560(**)	1
	Ilisha elongta(total)	(+)0.614(**)	0	(+)0.674(**)	0
	the pelagicl(total)	——	——	(-)0.584(**)	1
the demersal fishes	*Pseudosciaena crocea*(the East China Sea)	——	——	(+)0.520(**)	2
	Pseudosciaena polyactis(the Bohai and Yellow Sea)	(+)0.603(**)	1	(+)0.658(**)	1
	Pseudosciaena polyactis(the East China Sea)	(+)0.659(**)	1	(+)0.725(**)	1
	Trichiurus haumela(the Bohai and Yellow Sea)	——	——	(+)0.495(**)	1
	Trichiurus haumela(the East China Sea)	——	——	——	——
	Fenneropenaeus chinensis(the Bohai and Yellow Sea)	(-)0.384(*)	2	——	——
	Fenneropenaeus chinensis(the East China Sea)	——	——	(-)0.442(*)	*4*
	Acetes chinensis(the Bohai and Yellow Sea)	(-)0.454(*)	2	(-)0.476(*)	*5*
	Acetes chinensis(the East China Sea)	(+)0.492(*)	*5*	(-)0.526(**)	*5*
	Sepioidea(the Bohai and Yellow Sea)	(+)0.561(**)	*5*	(-)0.453(*)	0
	Sepioidea (the East China Sea)	(+)0.401(*)	0	(+)0.623(**)	0
	the demersal (total)	——	——	(+)0.638(**)	2
	Total capture	(-)0.461(*)	2	(-)0.627(**)	2

(Notes: - stands for negative correlation;+ stands for positive correlation; the values behind (-/+) stand for the correlation coefficient; * stands for *p*-value <0.05; ** stands for p-value <0.01; the value behind * stands for the time lag; —— stands for no significance of the correlation).

3. Results

3.5 the impact of runoffs on the fish biomass

	Main commercial spices	The Yellow River runoff	The Yangtze River runoff
the pelagicl fishes	*Scomberomorus niphonius*(total)	(+)0.494(*)(1)	(+)0.435(*)(1)1Jan.
	Clupea pallasi(total)	(+)0.473(*)(3)	(-)0.562(**)(1)Aug.
	the Pneumatophorus and carangoid(the Bohai and Yellow Sea)	(+)0.533(**)(2)Feb.	(-)0.510(**)(0)1Feb.；(+)0.381(*)(4)
	the Pneumatophorus and carangoid(the East China Sea)	(+)0.412(*)(3)Apr.	(-)0.444(*)(1)
	the Pneumatophorus and carangoid(total)	(+)0.556(**)(3)Apr.	(-)0.446(*)(1)Mar.
	Ilisha elongta(total)	(+)0.491(*)(2)	(+)0.482(*)(4)Jun.
	the pelagicl(total)	(+)0.625(**)(3)Apr.	(-)0.560(**)(1)Aug.
the demersal fishes	*Pseudosciaena crocea*(the East China Sea)	(+)0.477(**)(4)	——
	Pseudosciaena polyactis(the Bohai and Yellow Sea)	(+)0.498(*)(2)Jul.	(+)0.381(*)(2)Aug.
	Pseudosciaena polyactis(the East China Sea)	(+)0.435(*)(2)Jul.	(+)0.450(*)(3)Feb.
	Trichiurus haumela(the Bohai and Yellow Sea)	——	(+)0.491(*)(1)Mar.
	Trichiurus haumela(the East China Sea)	(+)0.476(*)(3)May	(-)0.379(*)(1)Aug.
	Fenneropenaeus chinensis(the Bohai and Yellow Sea)	(-)0.372(*)(4)Jul.	(-)0.378(*)(0)1Feb.；(+)(2,3)Jun.
	Fenneropenaeus chinensis(the East China Sea)	(-)0.385(*)(1)Mar.	(-)0.388(*)(0)1Jan.
	Acetes chinensis(the Bohai and Yellow Sea)	(-)0.505(*)(0)	(-)0.505(**)(0)1Jan.
	Acetes chinensis(the East China Sea)	(+)0.607(**)(2)May	(+)0.434(*)(2)Oct.
	Sepioidea(the Bohai and Yellow Sea)	(+)0.462(*)(3)	(+)0.475(*)(2)Jul.
	Sepioidea (the East China Sea)	(+)0.386(*)(2)Jul.	(+)0.390(*)(3)
	the demersal (total)	(+)0.435(*)(1)Mar.	(+)0.369(*)(5)
	Rhopilema esculentum(the Bohai and Yellow Sea)	(+)0.525(**)(0)Aug.	(+)0.514(*)(4)
	Total capture	(+)0.486(*)(1)Feb.	(+)0.420(*)(2)

(Notes: - stands for negative correlation;+ stands for positive correlation; the values behind (-/+) stand for the correlation coefficient; * stands for *p*-value <0.05; ** stands for p-value <0.01; the value behind * stands for the time lag; —— stands for no significance of the correlation).

3. Results

3.6 the influence of climatic factors to the fish biomass

Summary:

Climatic factors	the pelagicl fishes	the demersal fishes	Total fishes
SST	-	+（warm months） -（cool months）	———
Moonsoon	-	+	+
Typhoon	-	+	-
Runoff	+	+	+

Notes: - stands for negative correlation;+ stands for positive correlation

4. Discuss

Impacts mechanism of major climatic factors on biomass of the main commercial fishes

Climatic factors	Effect mechanism
SST	Temperature affects sea water stratification, lead to primary and secondary productivity reduce;SST affects the distribution of fishes and ocean primary production which impact the prey of fishes. Match-mismatch； Higher Temperature in favor of spawning of fish and boost respiration
Monsoon	Monsoon affects ocean current, while ocean current impacts the distribution and transformation of nutrient material and the larval and eggs of fishes as well
Typhoon	Typhoon intensifies the admixture of waters, so as to enhance the efficiency of the use of the nutrient material
Runoff	Runoff brings the fresh water and nutrient material into the ocean which provides the necessary condition for the survival and propagation of some fishes. River runoff and ocean currents of east China sea influenced each other

interspecific competition：The reduce of the pelagicl fishes would increase the environmental capacity of the the demersal fishes at the same time.

5. Conclutions

- Different climatic factors have different impacts. Monsoon, typhoon and SST have a negative influence on pelagic fishes, but these factors have a positive impact on demersal fishes (all the P-values of the correlation coefficients were below 0.05).
- Because of differences in depth, upper waters change more significantly than deeper waters. Pelagic fishes encounter the direct impacts of the dynamics of the environment and demersal fishes encounter indirect impacts of transformation of the food web from climate change. The range of the time lags which have continuity was from 0 to 5 year for several years.

Thanks
for Your Attention!