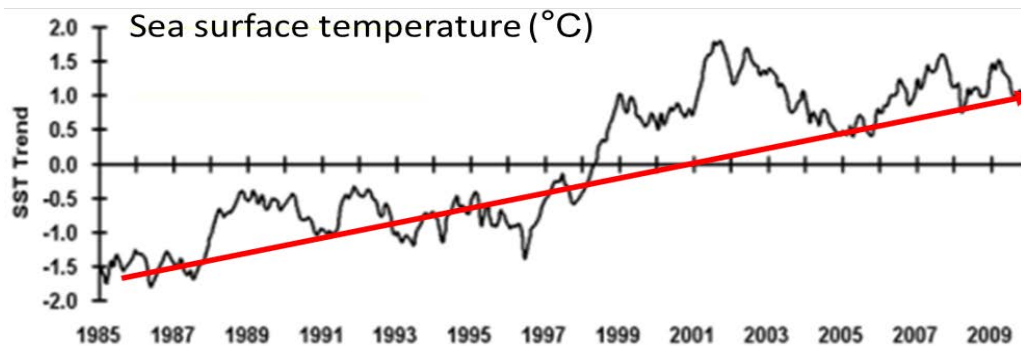


# Signature of Global Warming on Dynamics of Anchovy *Engraulis japonicus* Stock in the Yellow Sea

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- *Laboratory for Marine Fisheries Science and Food Production Processes, Qingdao National Laboratory for Marine Science and Technology, Qingdao 266237;*

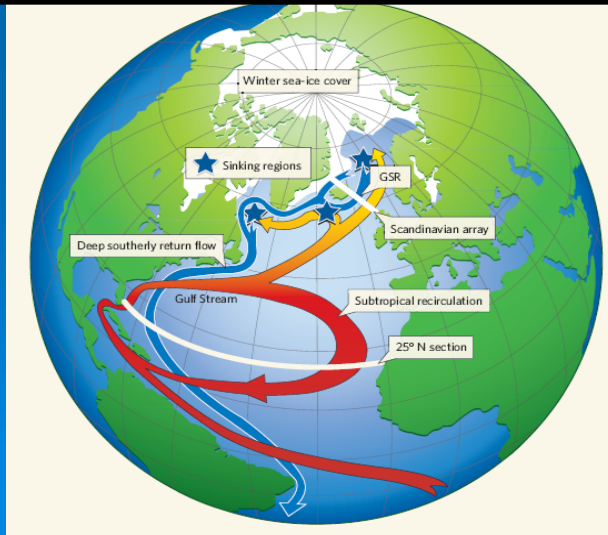


Yellow Sea Fisheries Research  
Institute



# The oceans are changing rapidly

- Global “warming unequivocal” “*Very high confidence*” that due to forcing by human activities”; By 2100, temperatures could increase by **1.1° C – 6.4° C**
- Sea levels may rise by **18 to 59 cm.**
- Recent studies (Nature geoscience & Science) suggests sea level rise could be at **80 to 200 cm**



# Climate change report: 'The worst is yet to come' – as it happened

Threat of climate change is no longer distant, finds the Intergovernmental Panel on Climate Change.

- Climate change 'already affecting food supply'
- Great Barrier reef, native Australian species in danger
- The poor will suffer most from climate change
- 'Hellish monotony' of climate change report

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Helen Davidson and Adam Vaughan  
theguardian.com, Monday 31 March 2014 11:16 BST

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## New climate change report d... threats to global security, possibilities of violent conflict

IVAN SEMENIUK - SCIENCE REPORTER

The Globe and Mail

Published Sunday, Mar. 30 2014, 10:53 PM EDT

Last updated Monday, Mar. 31 2014, 1:56 PM EDT

# NEWS SCIENCE & ENVIRONMENT



## Climate impacts 'overwhelming' - UN

COMMENTS (1872)



By Matt McGrath

Environment correspondent, BBC News, Yokohama, Japan

## NEWS & VIEWS

NATURE, May, 2013

## Climate change at the dinner table

An innovative use of catch statistics shows that climate change has already influenced the composition of species in fisheries around the world, and thereby the fish that we eat. SEE LETTER P365

MARK R. PAYNE

Fisheries scientists tend to view climate change as a dark cloud on the horizon: potentially problematic in the future, but not of immediate concern. Over the multi-decadal to centennial scale, warming, acidification and deoxygenation of the oceans are expected to have significant impacts on marine ecosystems and fisheries'. By contrast, other problems, such as the global overfishing crisis, are immediate and pressing and have rightly garnered the field's attention for the past decade. However, on page 365 of this issue, *Chang et al.*'s present startling evidence that global fisheries catches have already changed in a manner associated with the warming trend — climate change is suddenly an unexpected guest at dinner.

Changes in the spatial distribution of species are one of the major predicted impacts of climate change on marine ecosystems'. Marine

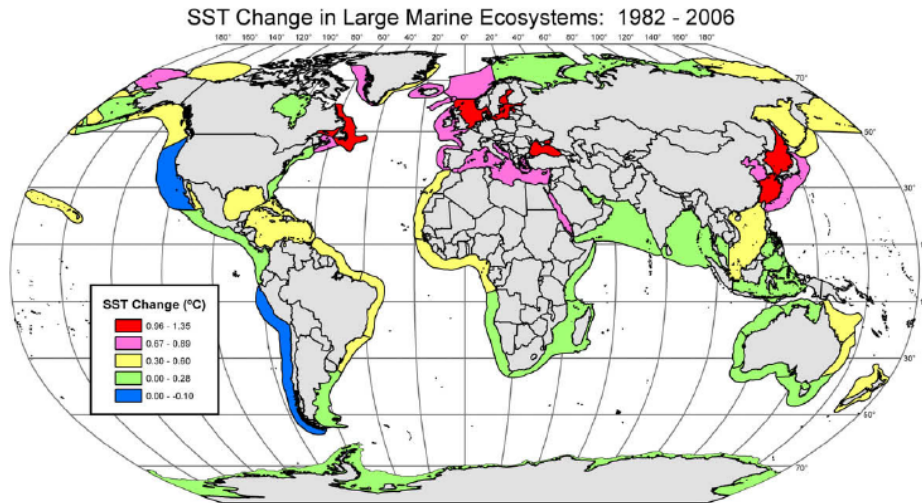


## Panel's Warning on Climate Risk: Worst Is Yet to Come

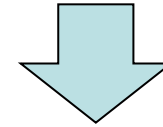
By JUSTIN GILLIS MARCH 31, 2014



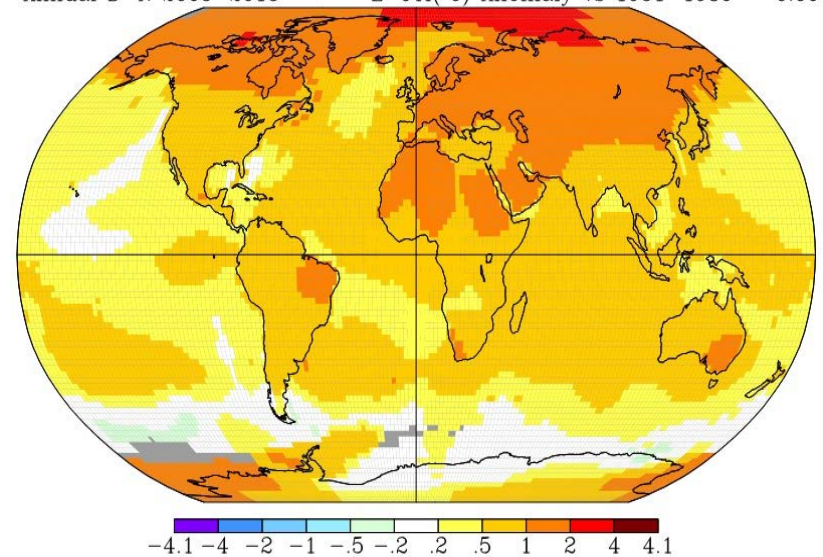
# Climate change



Atmospheric surface temperature anomaly  
(average 2005-2015 relative to 1951-1980)



Annual D-N 2005-2015 L-OTI(°C) Anomaly vs 1951-1980 0.66

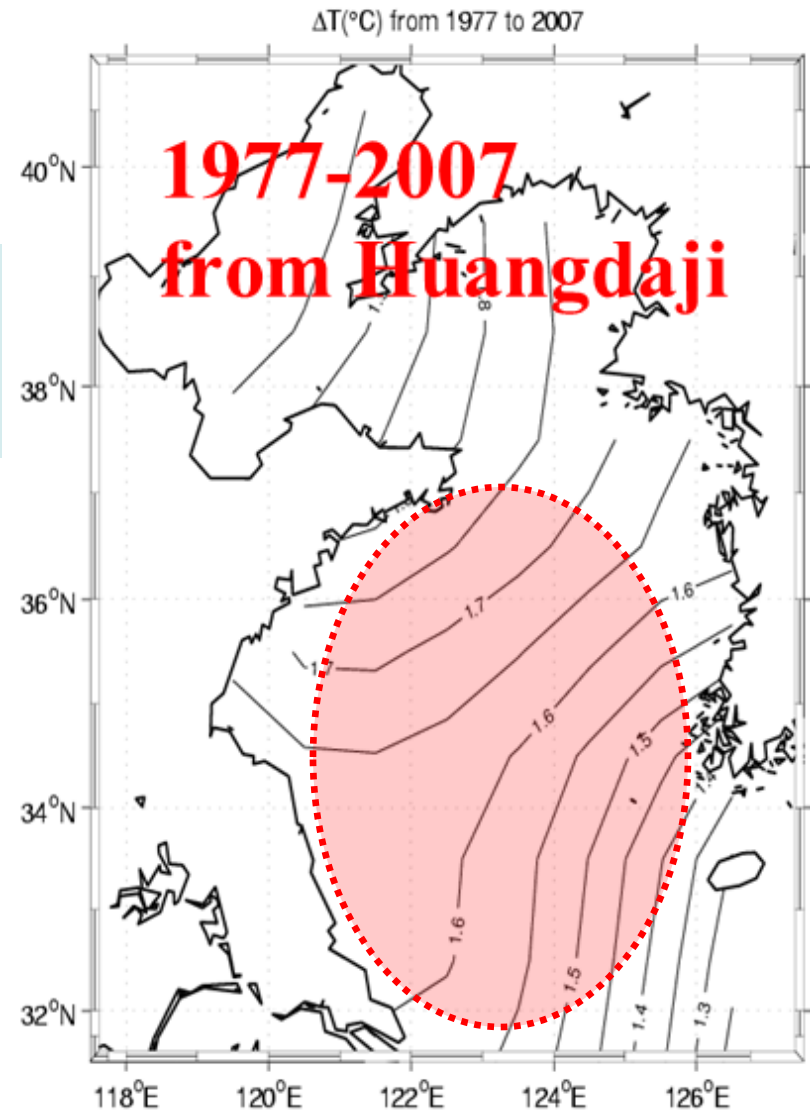


- **The rapid warming** in 1982–2006 was confined to the Subarctic Gyre, European Seas, and East Asian Seas.
- **The most rapid warming was observed in the land-locked or semi-enclosed** European and East Asian Seas (Baltic Sea, North Sea, Black Sea, Japan Sea/East Sea, and East China Sea) and also over the Newfoundland–Labrador Shelf. (Belkin, 2009)

# SST warming in the Yellow Sea

SST in the Yellow Sea increased by **0.67°C** during 1982-2006 (Belkin,2009)

SST in the Yellow Sea increased by **1.4-1.9°C** during 1977-2007, the rise of SST gradually increased from the Yellow Sea to the Bohai Sea(Huang, 2010)



# Effects of Climate change on fish



Directly affect

Marine Fisheries

Fish Production

Indirectly affect

Fish Growth

Fish Migration

FISH PRODUCTION



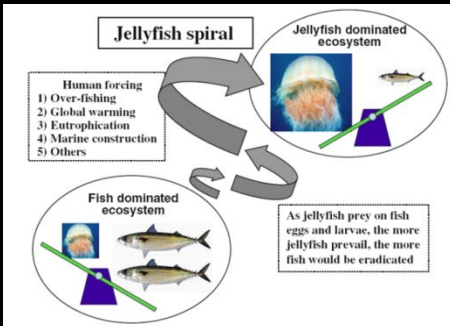
Temperature



Rainfall

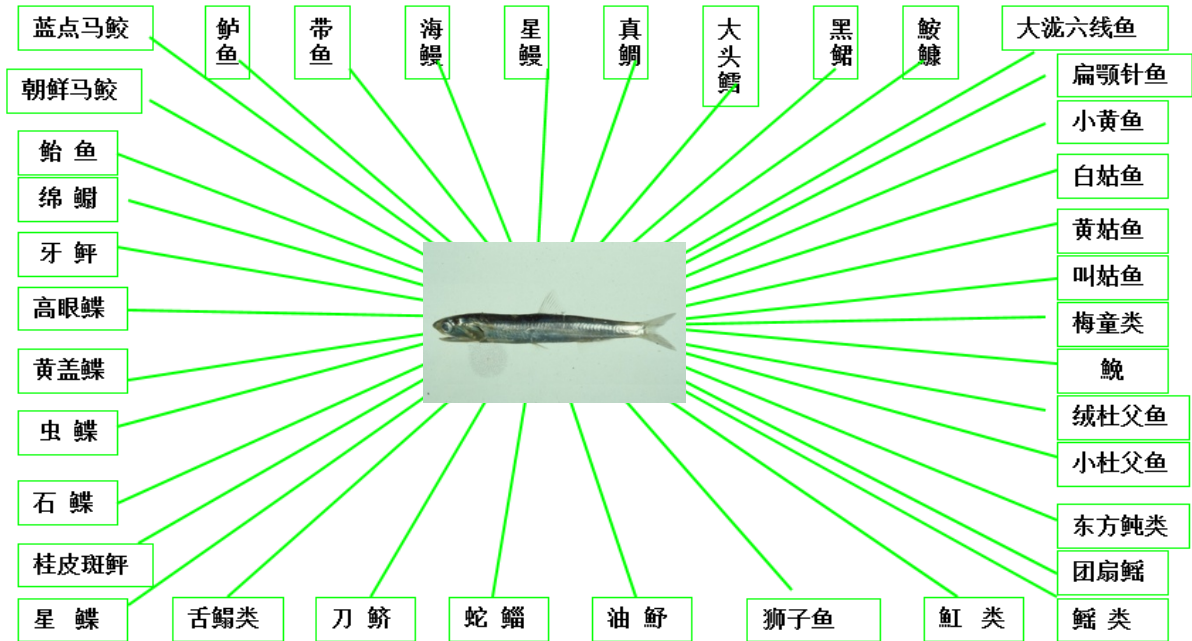


Hydrology





# Anchovy in the Yellow Sea



# Multi-stressors during anchovy life history

- Reclamation

- Pollution

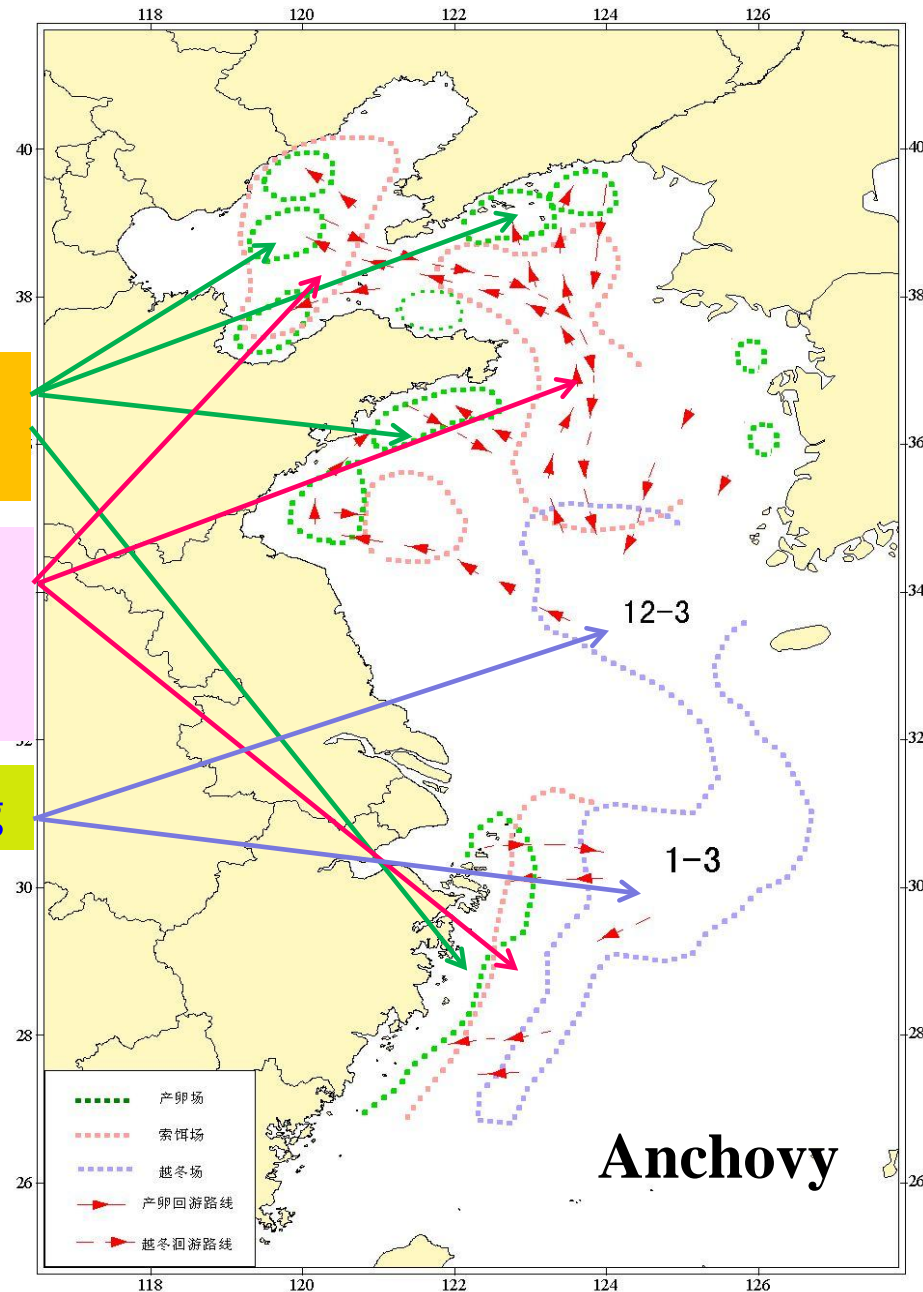
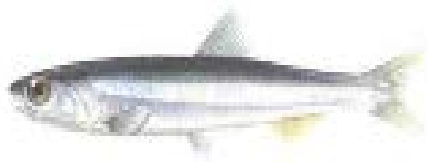
- Overfishing

- Climate change

Spawning,  
Hatching

Fish larvae  
and juvenile  
feeding

Overwintering





# Japanese anchovy in the YS showed opposite changing trend when compared with northern anchovy

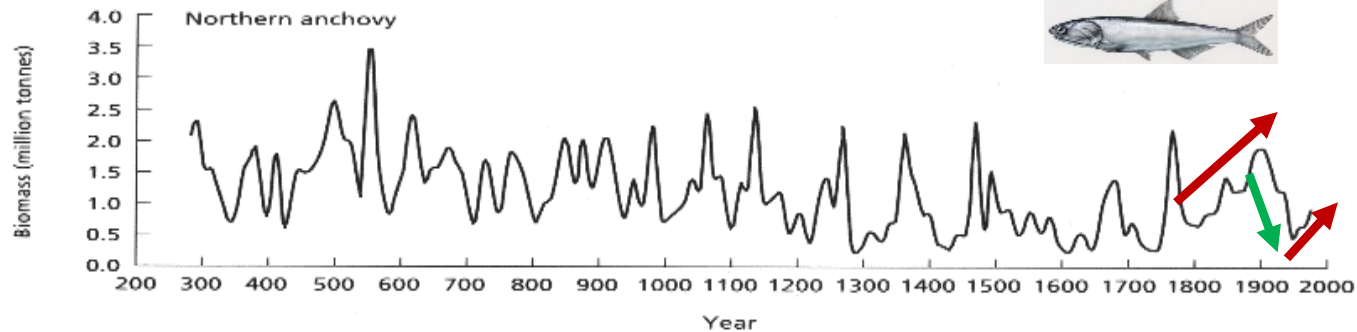
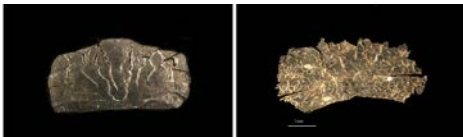
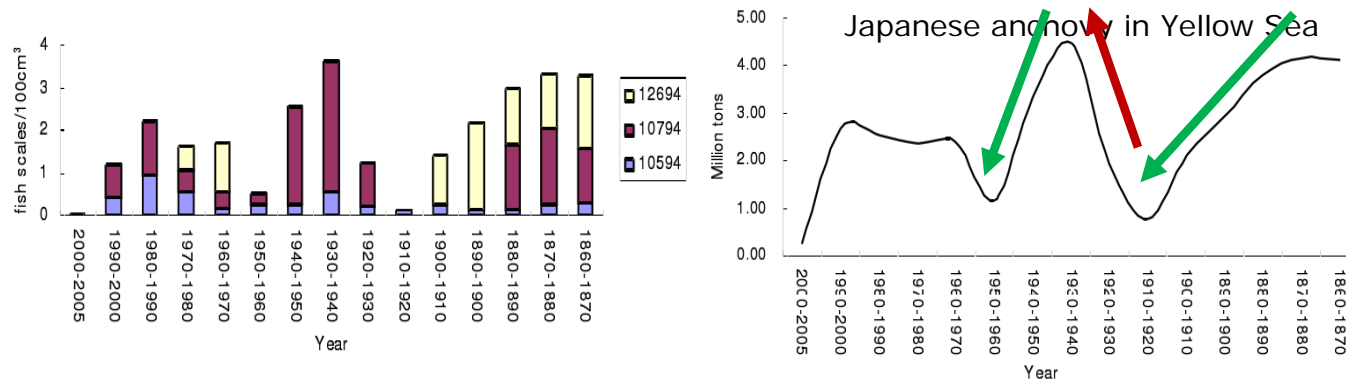
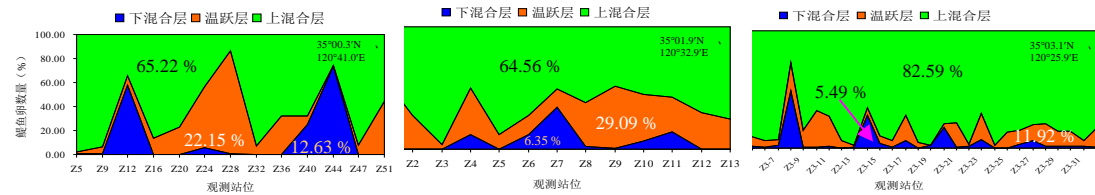
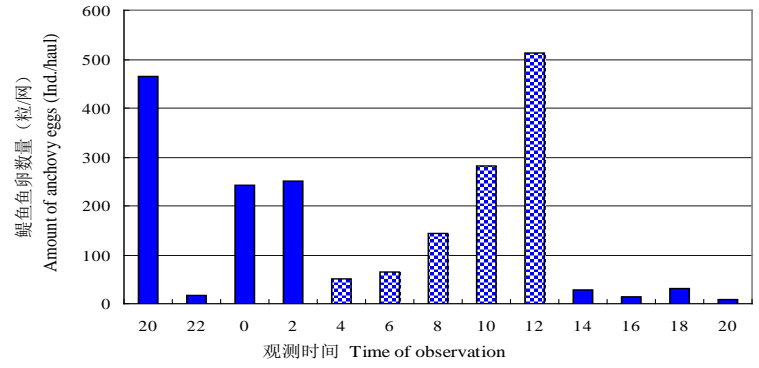
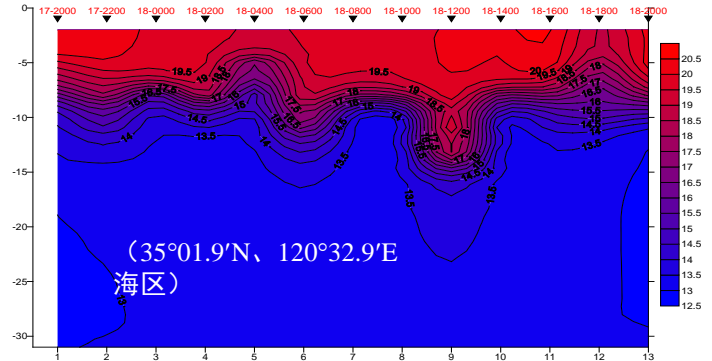
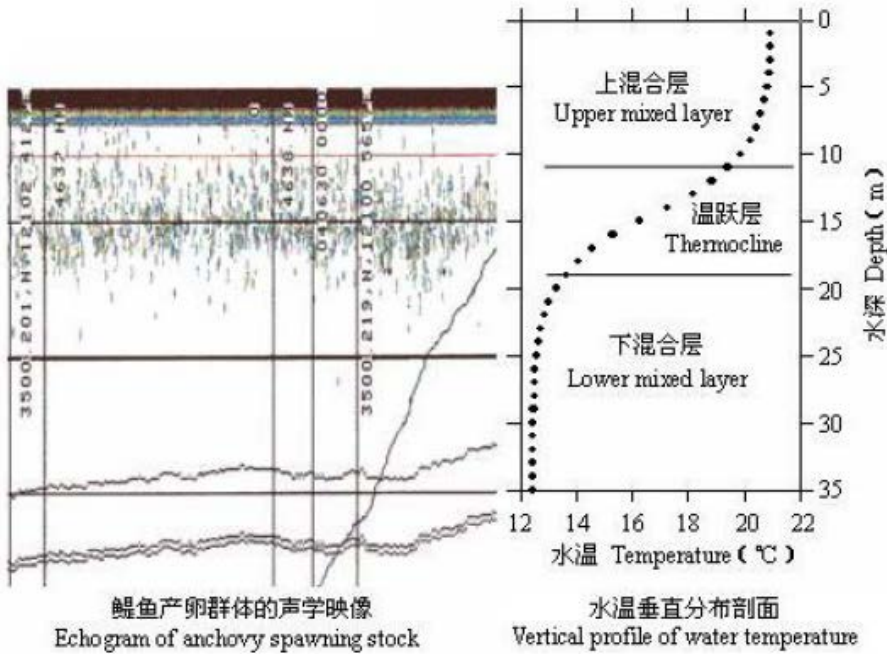


Fig. 4.1 Historical estimates of Pacific sardine and northern anchovy biomass off California. Biomass was estimated from scale deposition rates (density) in two sediment cores from the anoxic Santa Barbara basin. Scale deposition rate was assumed proportional to stock biomass because such relationships can be demonstrated using contemporary data. After Baumgartner *et al.* (1992).



# Water temperature significantly impacted anchovy distribution



2002年6月20-21日水团追踪观测 鳀鱼卵数量的空间分布

6月17-18日水团追踪观测 鳀鱼卵数量的空间分布

6月27-30日水团追踪观测 鳀鱼卵数量的空间分布

(Wan et al, 2008)

# Mortality of Japanese anchovy egg

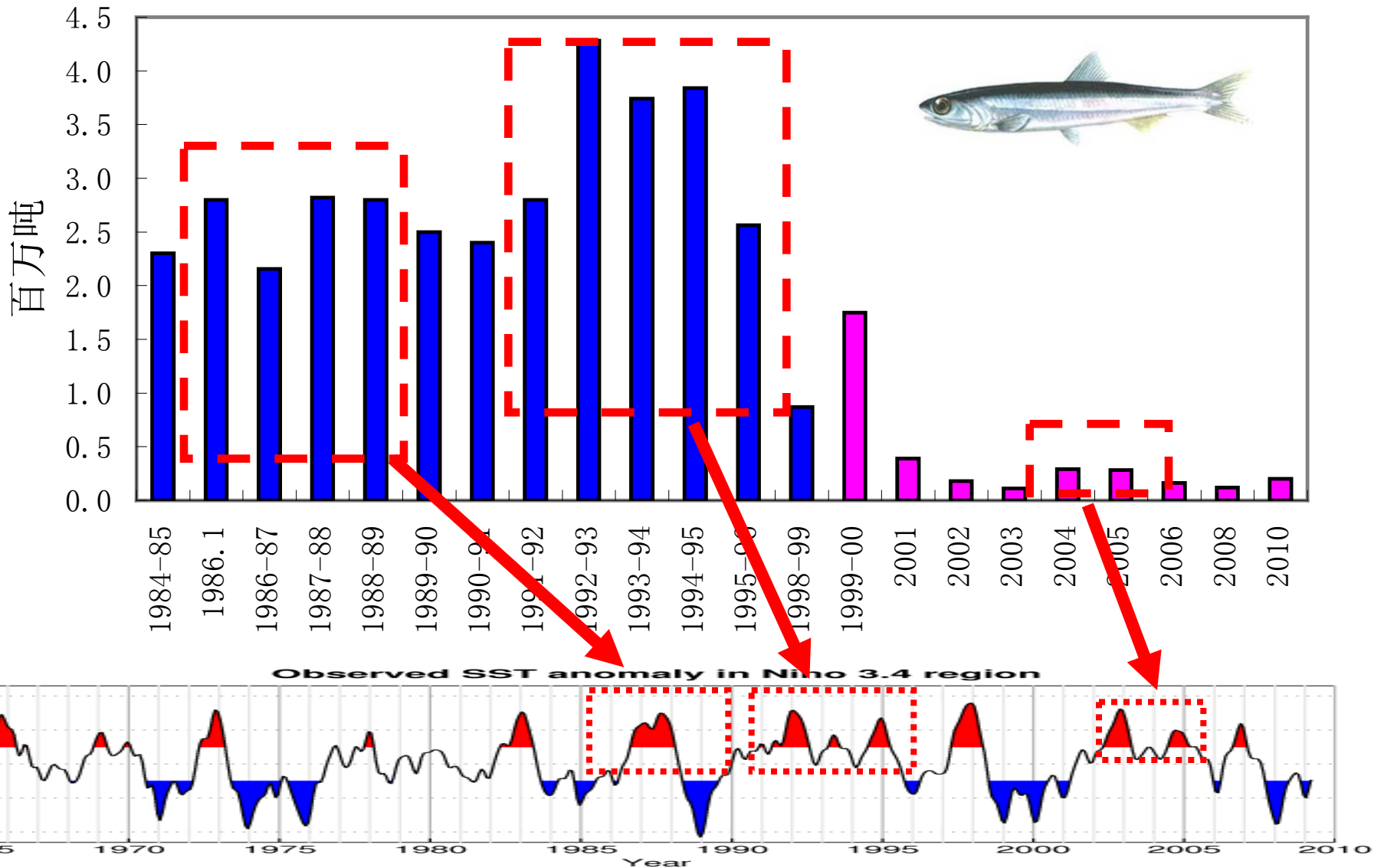


Sea areas	Survey time	Egg number (ind)	Natural mortality rate (%)
Southern Shandong peninsula	2000/06/13-06/18	28,907	83.41
	2001/05/16-07/6	86,872	84.87
	2002/06/05-06/20	51,231	81.34
	2003/06/11-06/17	175,115	80.42
	2004/06/10-06/19	124,510	75.22
	2008/05-06	10,035	84.68
	<b>Total</b>	<b>150,506</b>	<b>82.95</b>
East China Sea and Yellow Sea	2001/03/26-04/24	14,379	88.09
Yellow Sea	1998/05/15-2000/12/18	59,838	83.57
Bohai Sea	1998/05/25-10/16	118,933	91.33
	1992/08/08-1993/06/07	2,722,102	85.61
Yellow Sea	1985/03/11-1988/06/14	800,999	64.10

- Since the 1990s, the mortality of Japanese anchovy egg in the Yellow Sea greatly increased--
- 1985-1988 (64%)
- 1998-2000 (83%)
- 2000-2008 (77-88%)

# Biomass

## Interannual changes of anchovy biomass in the Yellow Sea

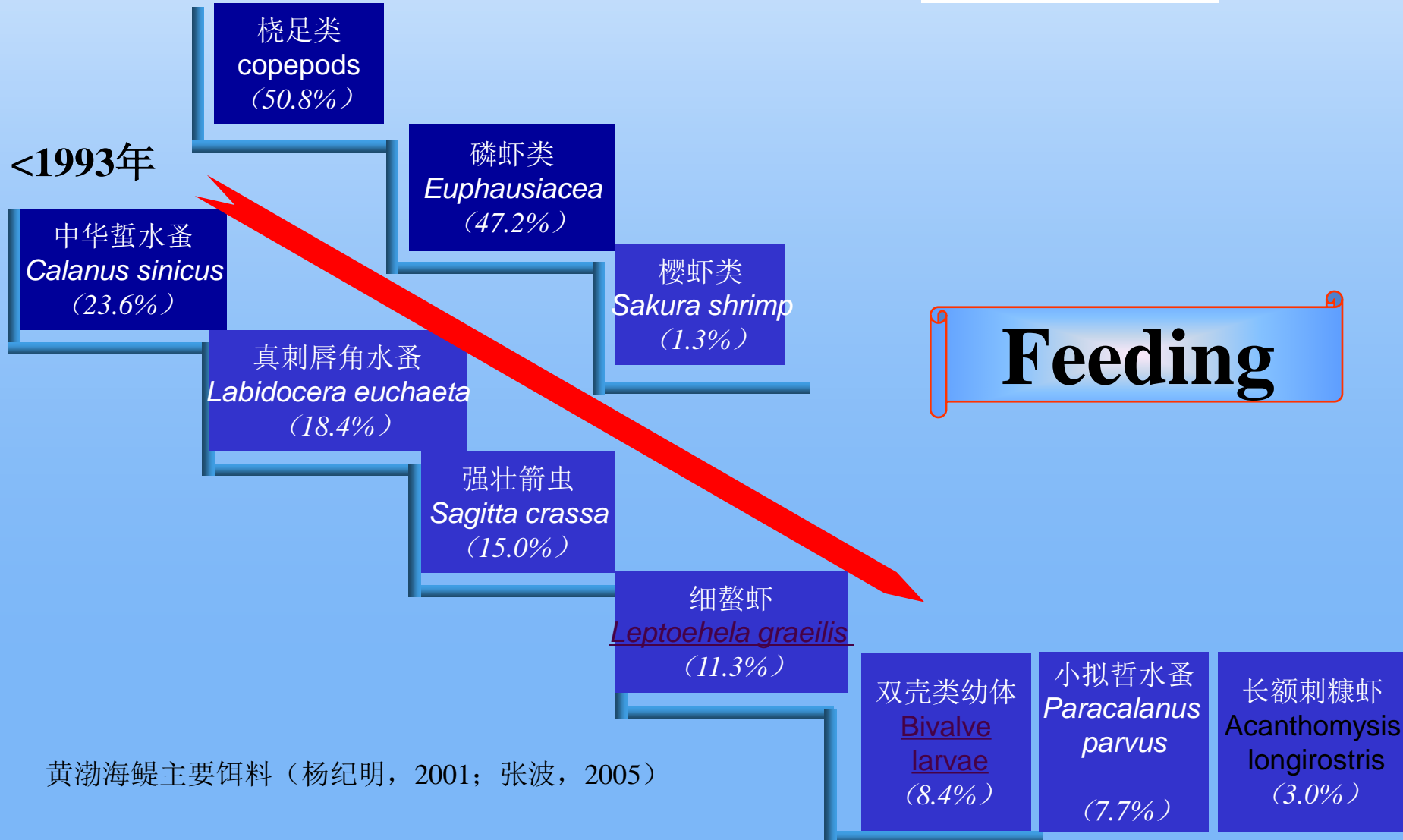


/data/obs/sst/NMC/make\_enso\_plot.R Tue Mar 31 09:58:58 2009



2000-2001年

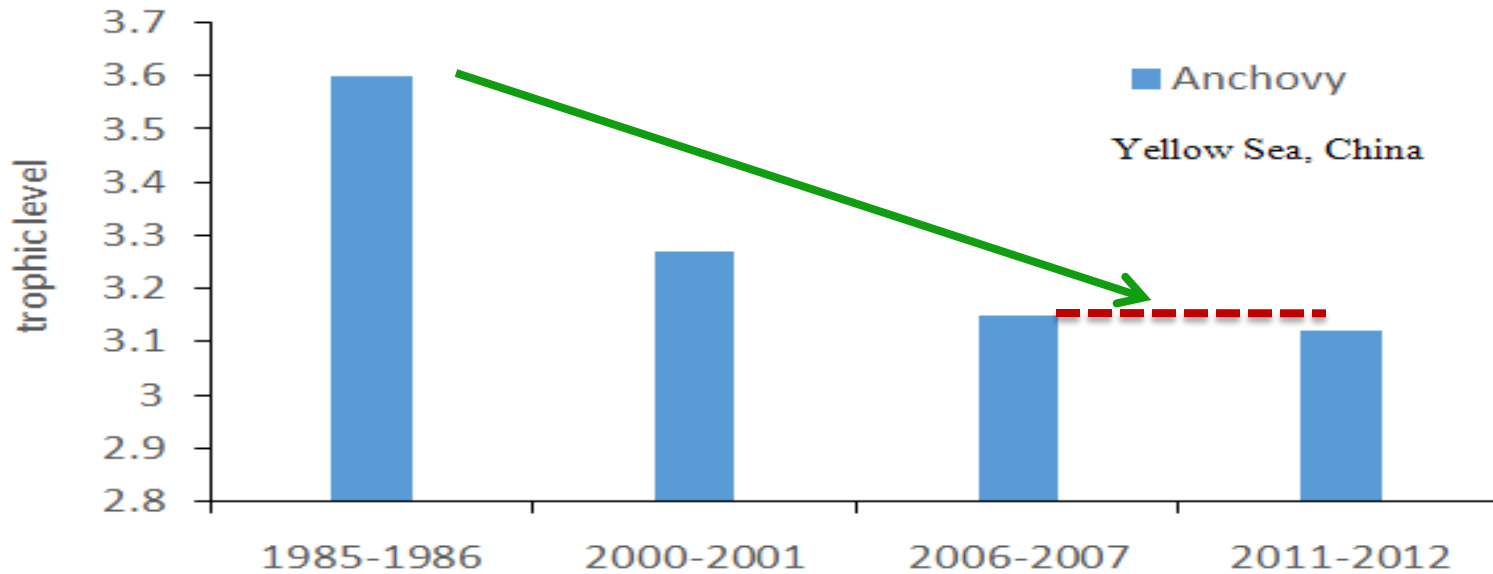
<1993年



Feeding

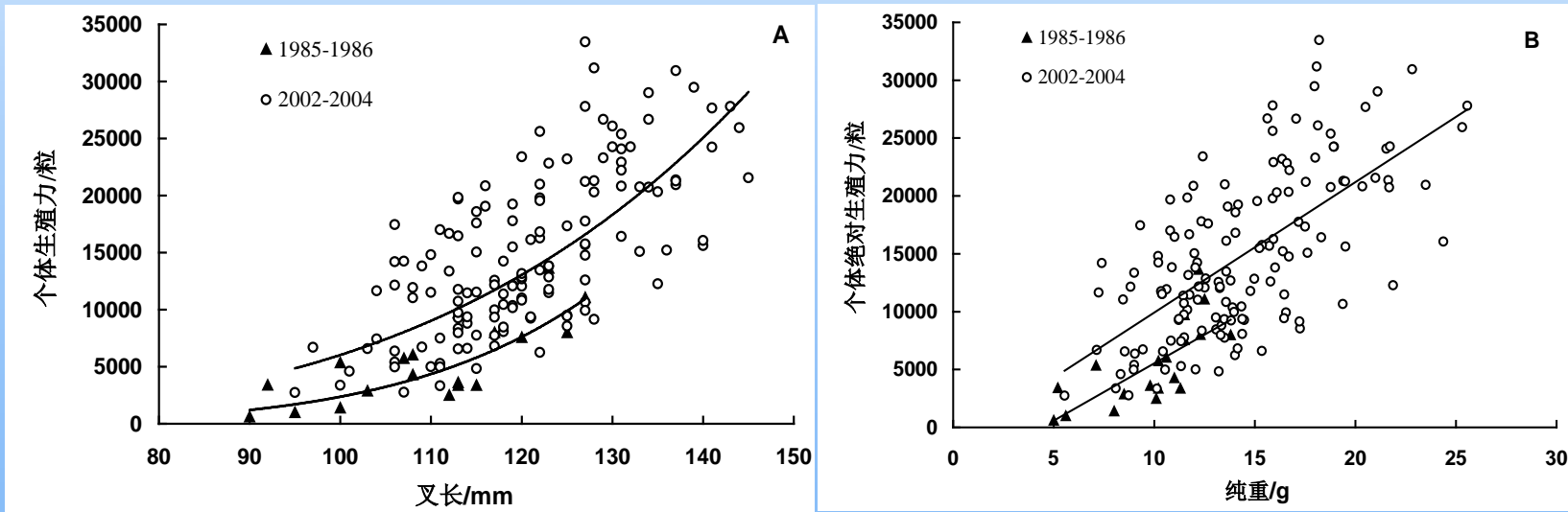
黄渤海鲈主要饵料（杨纪明，2001；张波，2005）

# Anchovy in the Yellow Sea



Zhang & Tang, 2004;  
Zhang et al, 2012;  
Zhang et al, 2013 14

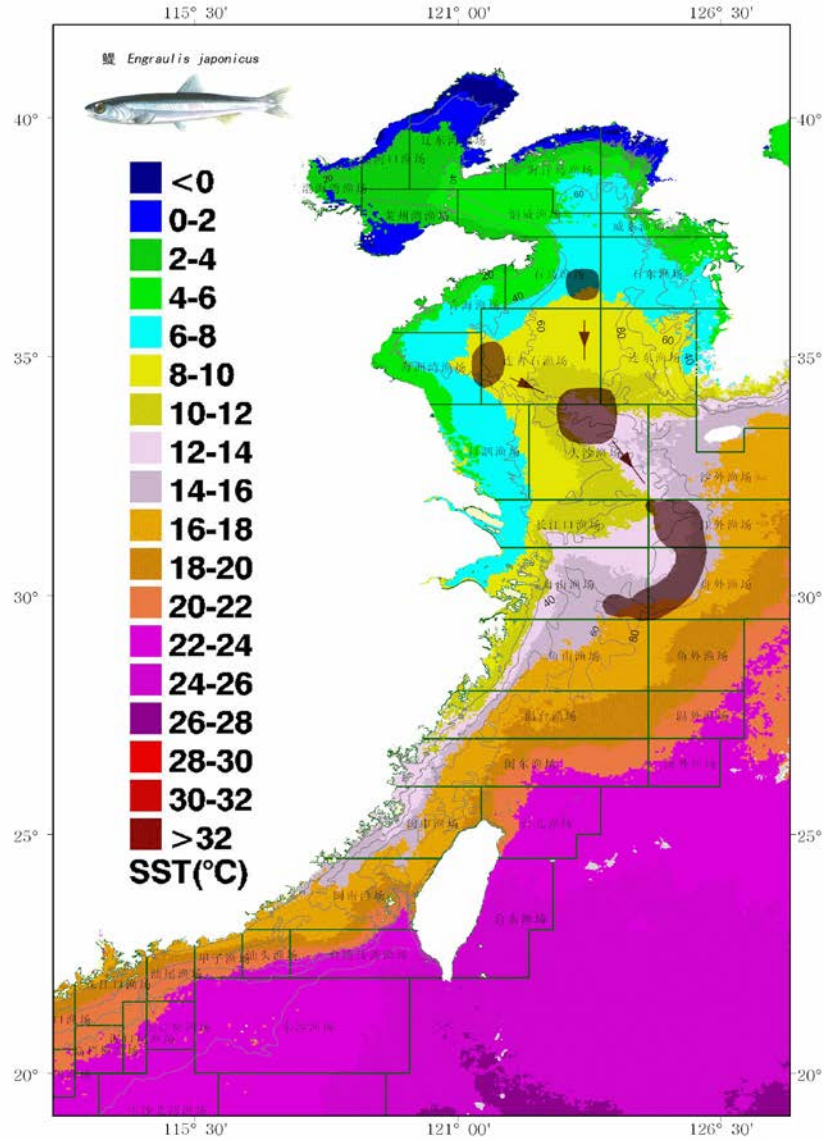
# Reproduction



The absolute fecundity and A: with fork length; B: with pure body weight.

The absolute fecundity of Japanese anchovy in 2002-2004 was significantly higher than that in 1985-1986 in the Yellow Sea.

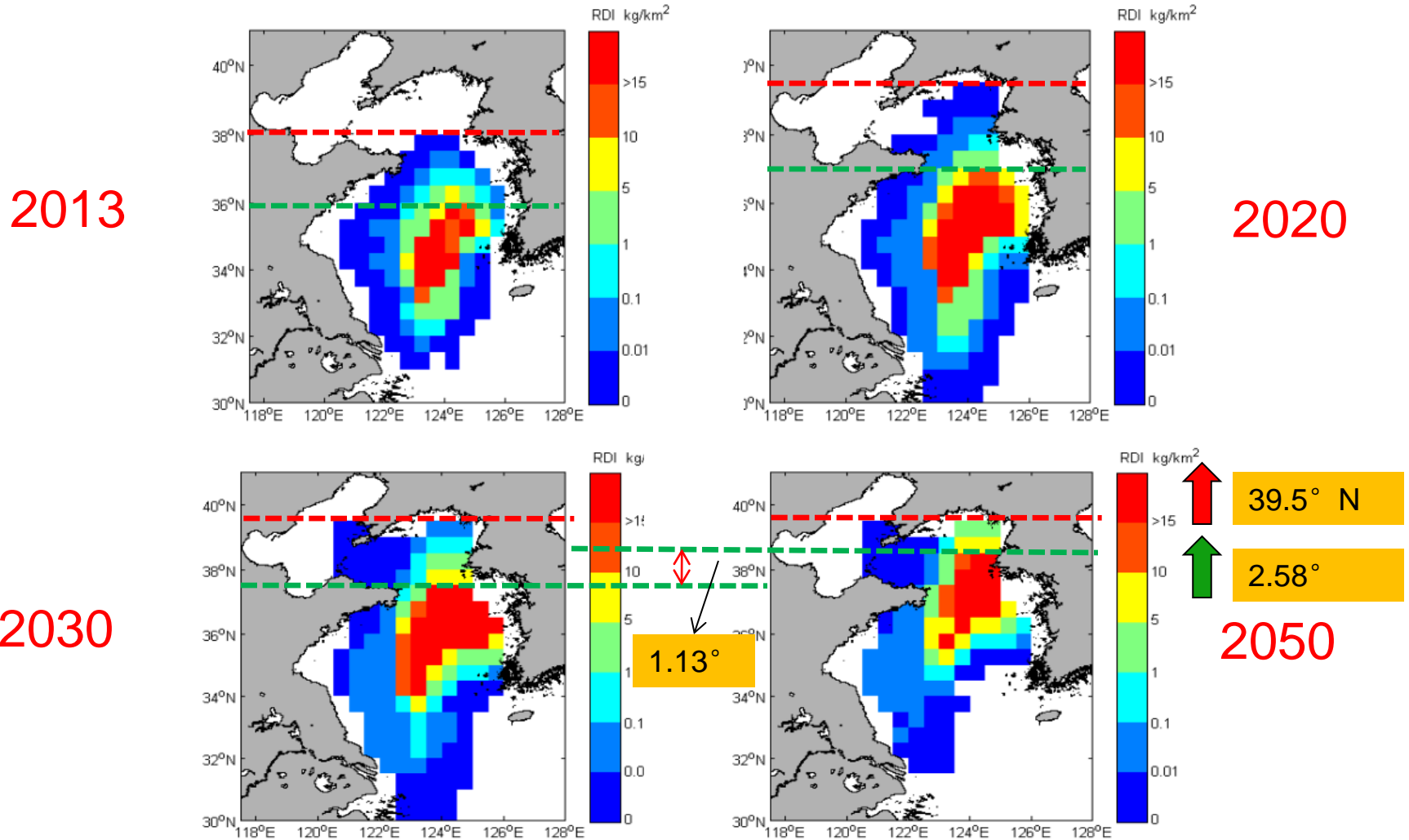
1月鳀鱼位置分布图



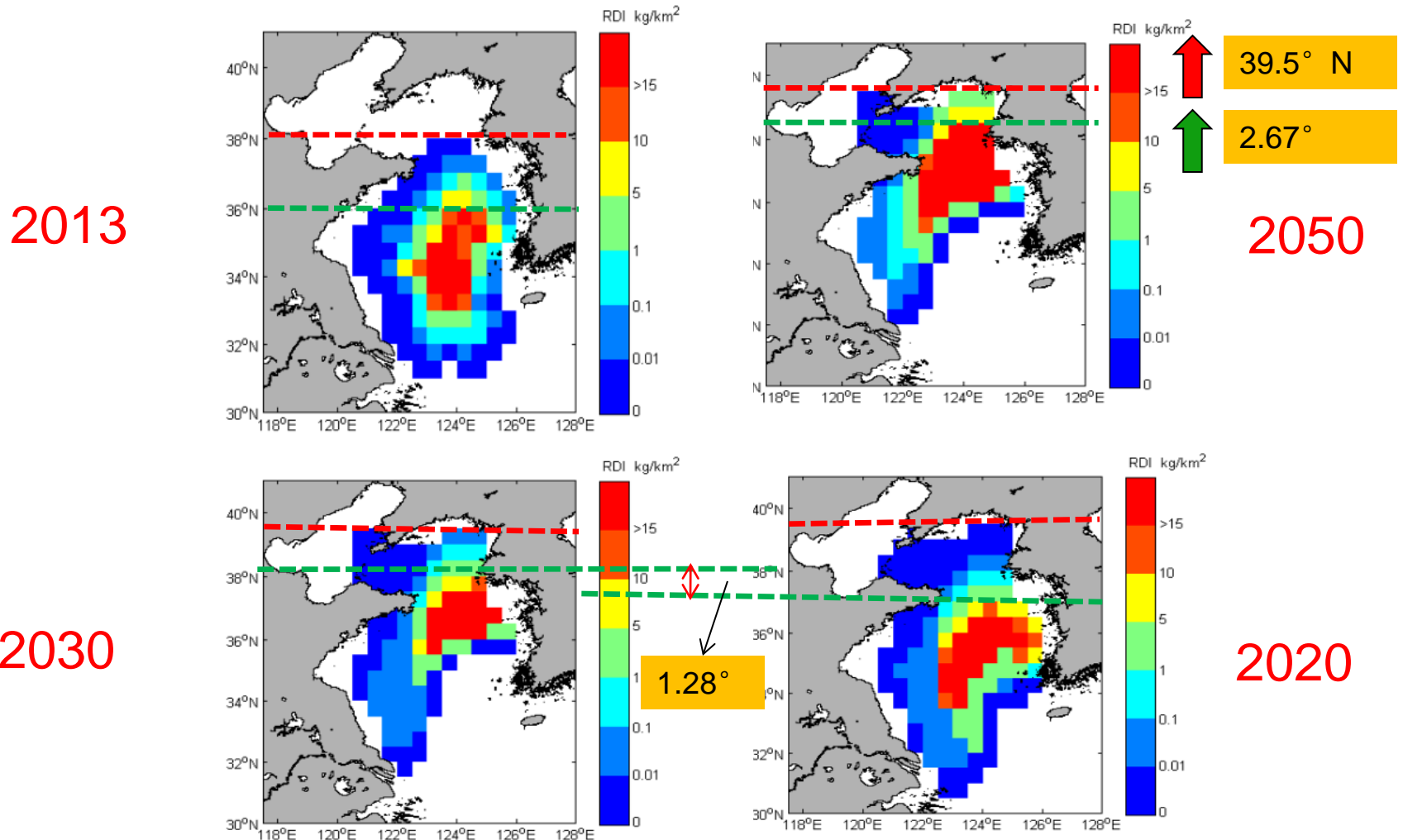


# Distribution projection of wintering anchovy stock in the Yellow Sea (RCP 2.6)

Dynamic Bioclimate Envelope Model (revised by Cheung, 2008)



# Distribution projection of wintering anchovy stock in the Yellow Sea (RCP 8.5)



# Some ongoing works

- Separate the effects of climate change with the other factors;
- Climate change-induced evolution in fishery species in the Yellow Sea;
- Signature of climate change on fishery species diversity in China coastal waters;



# Acknowledgements



Dr. Xianshi Jin



Prof. Bo Zhang



Dr. Zhongyi Li



Dr. Qun Lin



Dr. Xiaodong Bian



Dr. Qing Wu



Dr. Yunlong Chen



Dr. William Cheung



Fangqun Dai



Empowered lives.  
Resilient nations.





**Thank you for  
your attention!**

Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences  
中国水产科学研究院黄海水产研究所; [www.ysfri.ac.cn](http://www.ysfri.ac.cn)