Ecology and Recruitment of eels *Anguilla japonica* in Korea

- Eel production

  eel culture, catch and production
- Biology on

  glass eels, young and silver eels
- Research and management plan

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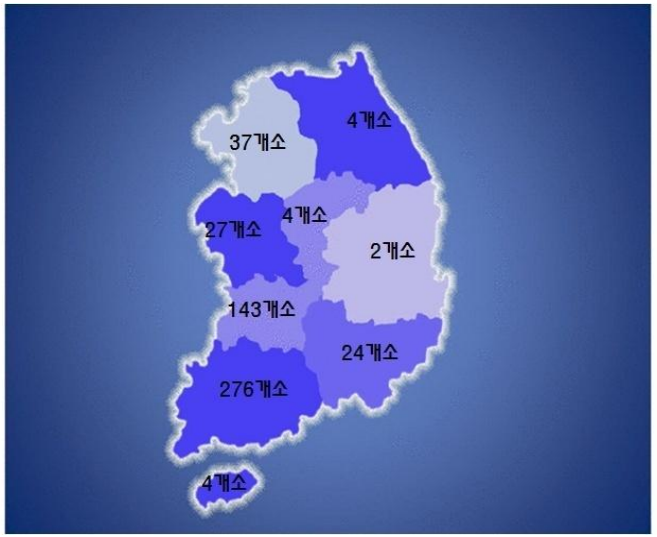
Eel Culture in Korea

Total number of eel farms and total area

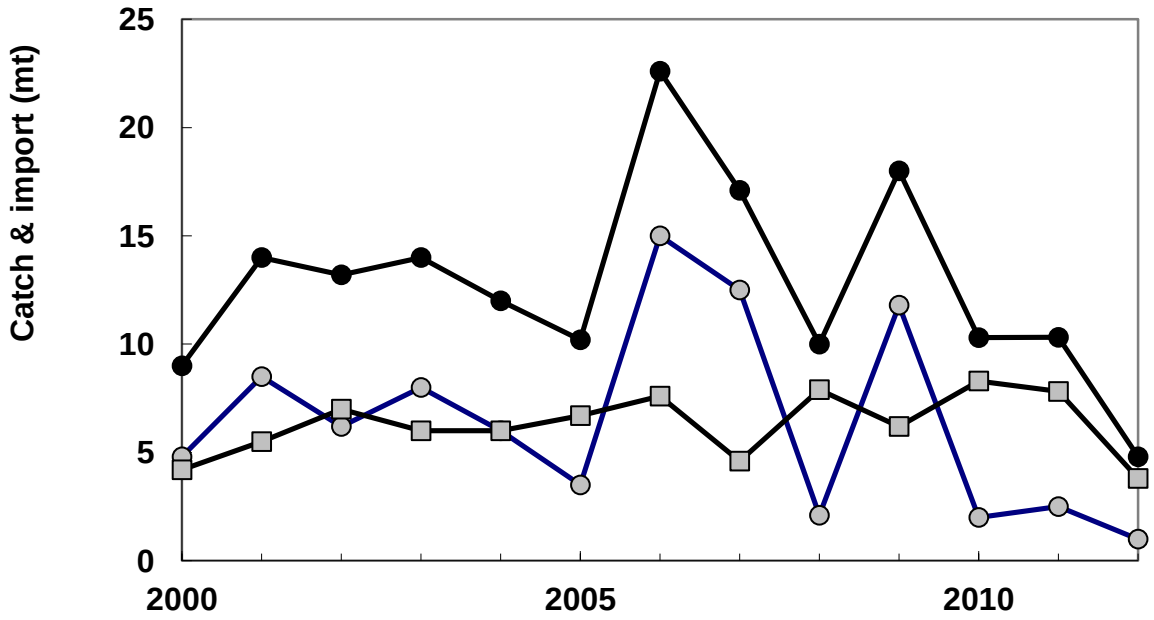
Year	1990	1995	2000	2007	2010
n	216	270	269	468	521
Area (ha)	118	99	115	214	222

- Culture area increased sharply in early 2000
  by increase of eel consumption
  because of foot-and-mouth disease,
  'mad-cow' disease and bird flu.

- More than half of them did not culture eels in 2012
  due to short supply of glass eels
- More than half of eel restaurants are changed into other items



Catch and import of glass eels



In 2012 season

Total 8.3 mt
Import 7.00 mt
Domestic 1.3 mt

Import: *A. japonica* 2.0 mt
***A. rostrata* 2.0 mt**
tropical eels 3.0 mt

Consumption

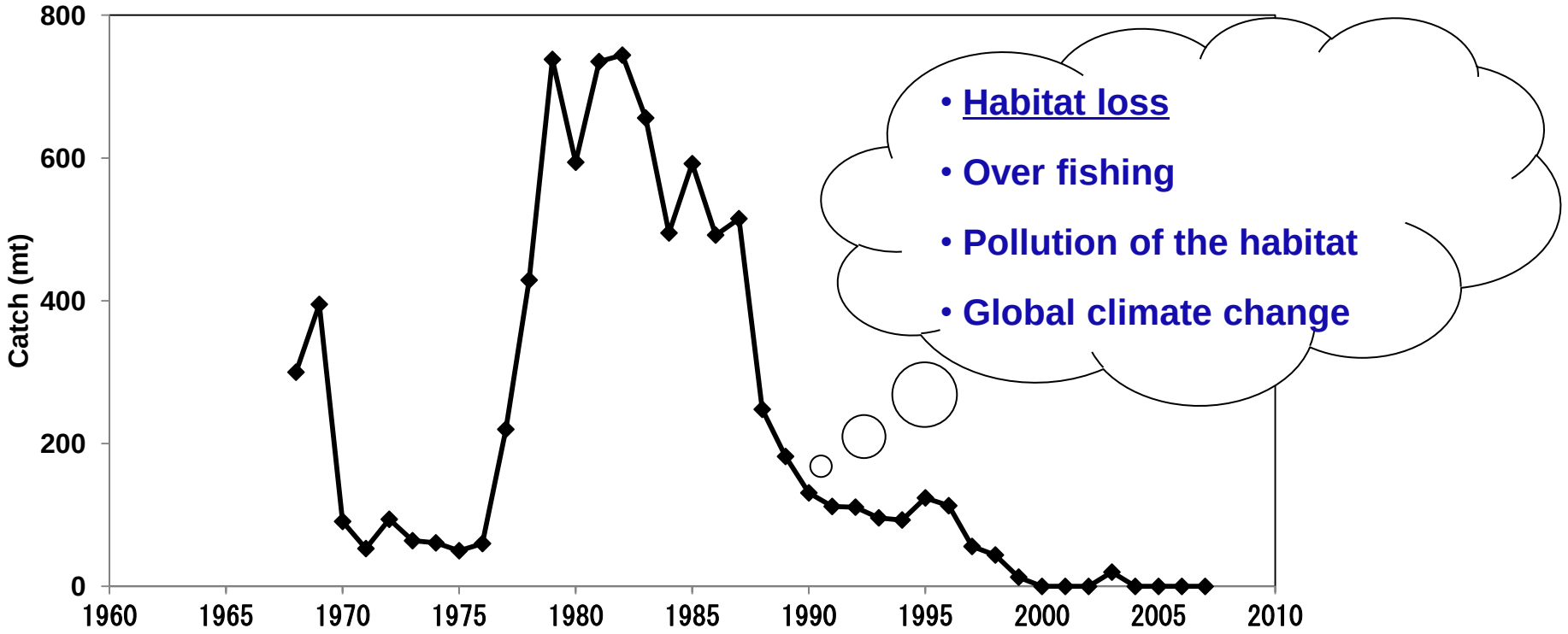
Price of fully grown eels (February 2012) : KW/kg

2p	3p	4p	5p
49,000	52,000	57,000	60,000

Price will increase after the consumption of 2011 stock.

> Increase of eel restaurants changed into others, and……

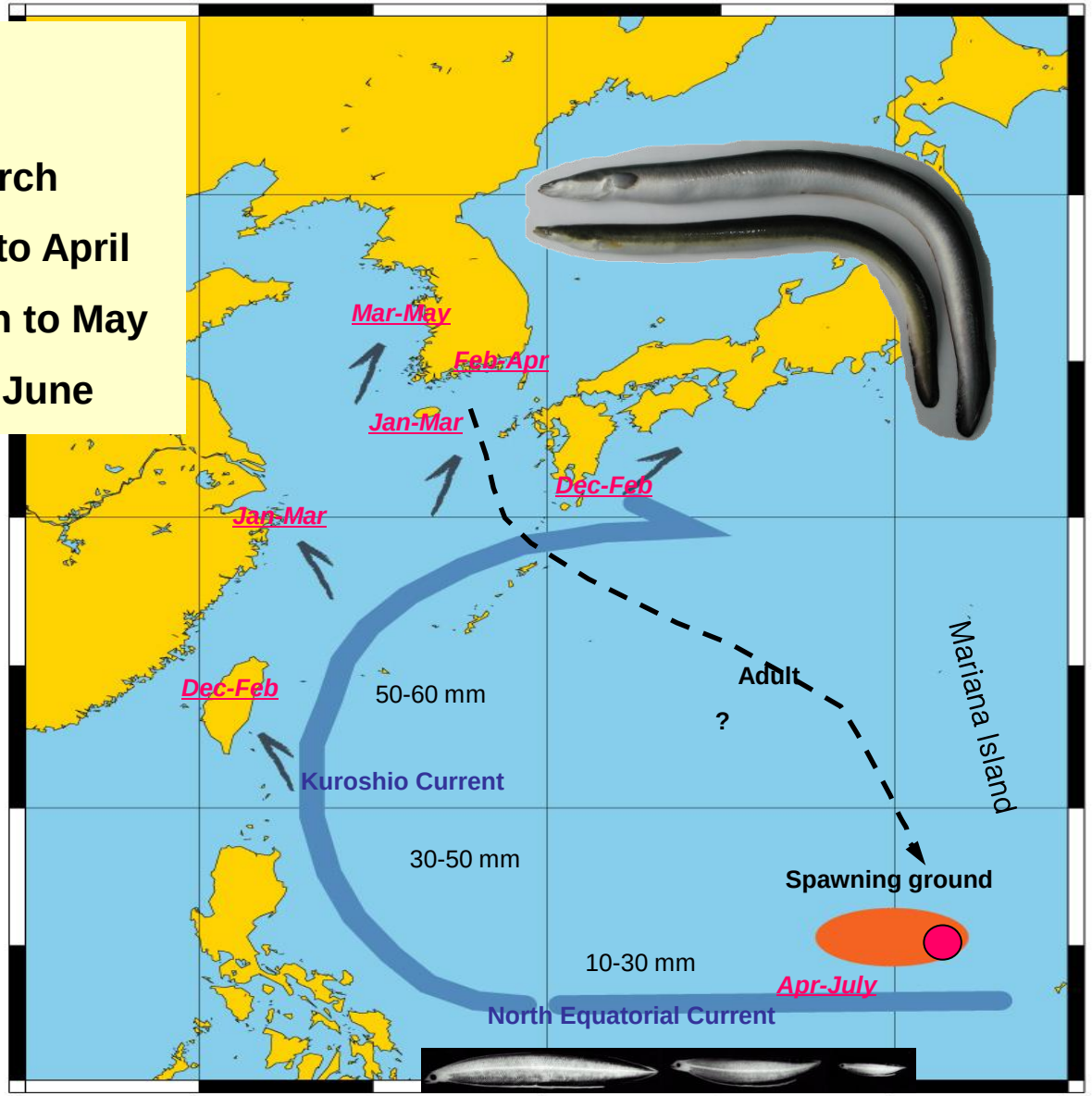
Wild eel catch in Korea



Upstream migration of glass eels

- **Main season**

- Jeju : January to March
- S. coasts : February to April
- mid W coasts : March to May
- N W coasts : April to June



Assessment of eel populations

- **Monitoring the recruitment of glass eels**

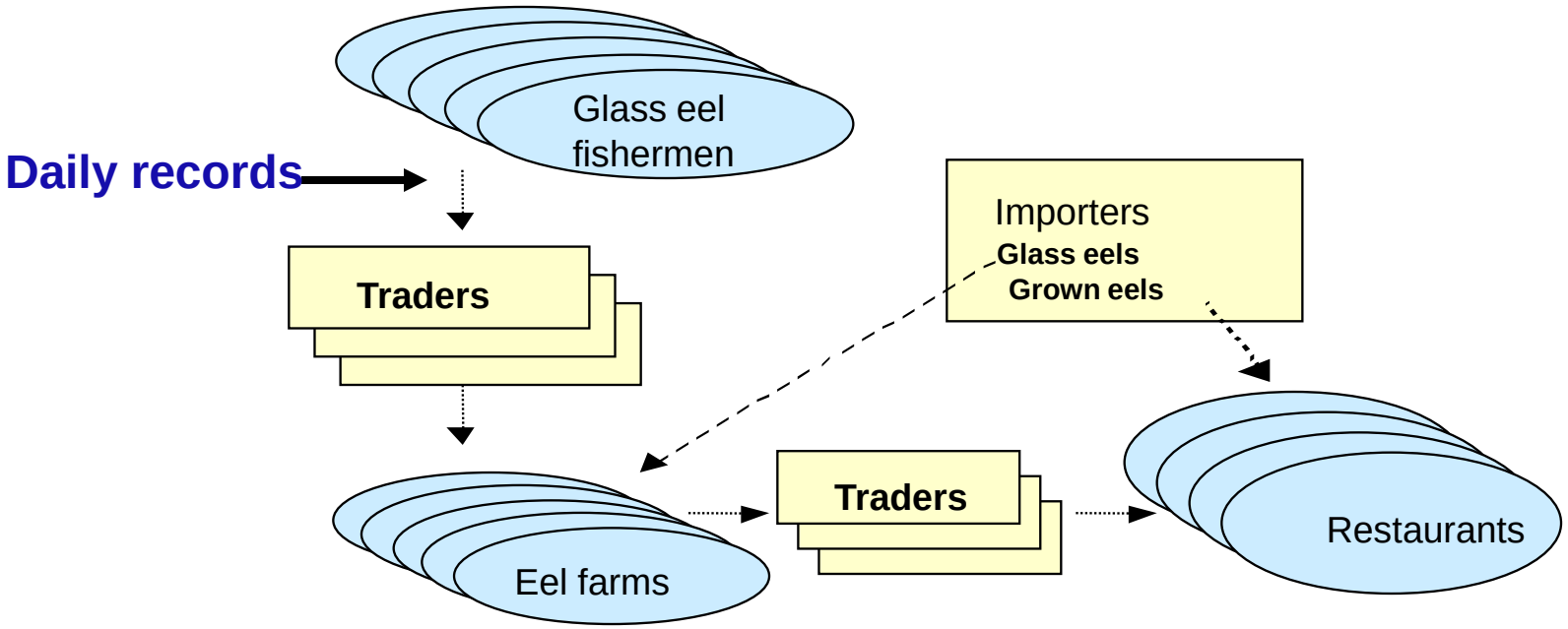
  Collection of daily catch data of glass eels in the 3 large river estuaries

- **Ecology of yellow and silver eels**

- **Biology such as sex ratio, age, growth, migration….**

  using eel samples from the 3 large river estuaries

Eel trading system
- Collection of glass eel catch data



Collection of daily trade records from 2-3 glass eel fishermen from the estuaries in Han River (1993-), Geum River (2001-) and Nakdong River (2003-)

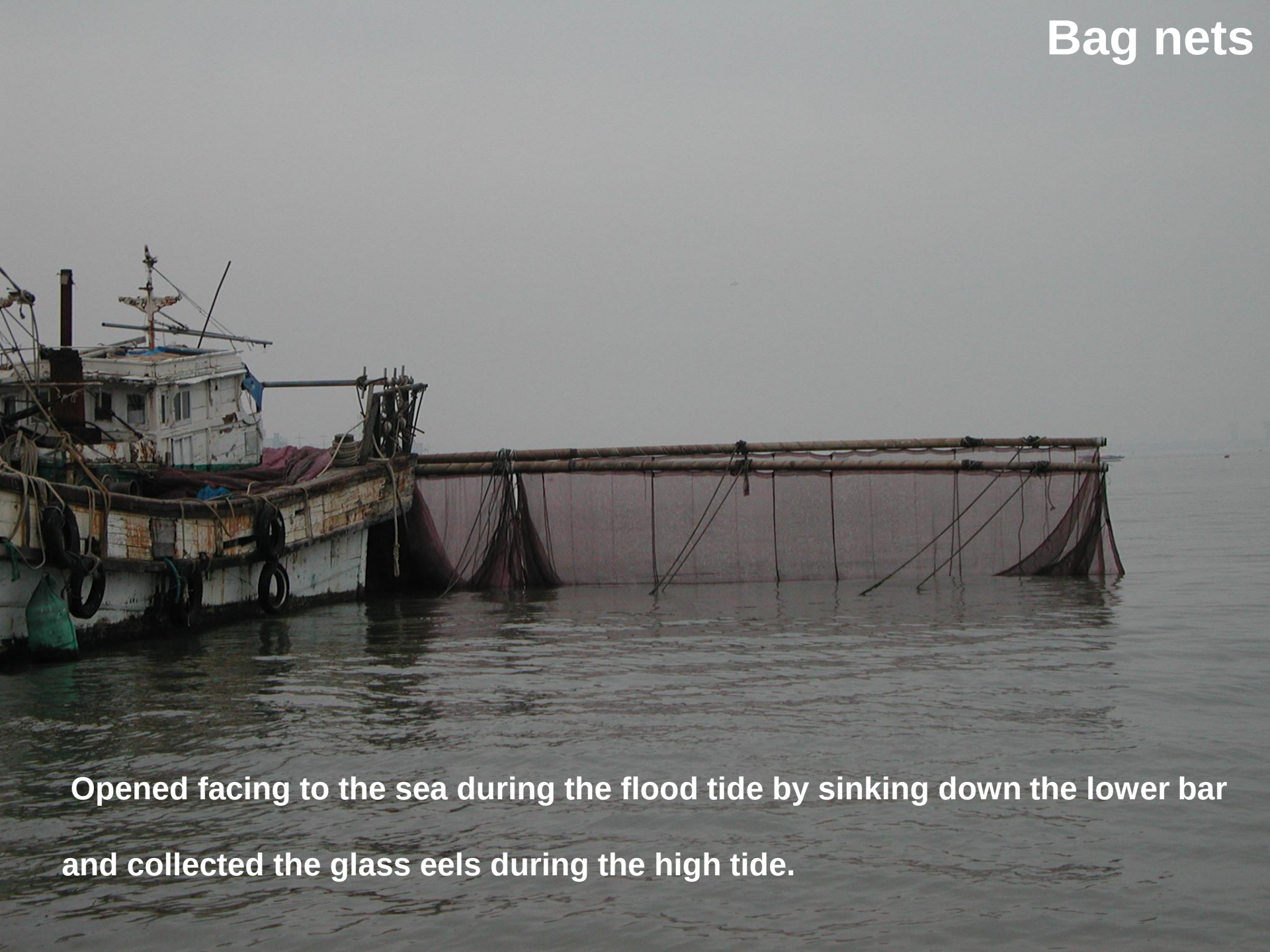
Fishing gears of glass eels

- **Jeju : Scoop nets**
  Few fishing since 1999
- **Main land: scoop nets in some**
  Weirs in the tidal channels
  Bag nets using tidal currents

Bag nets

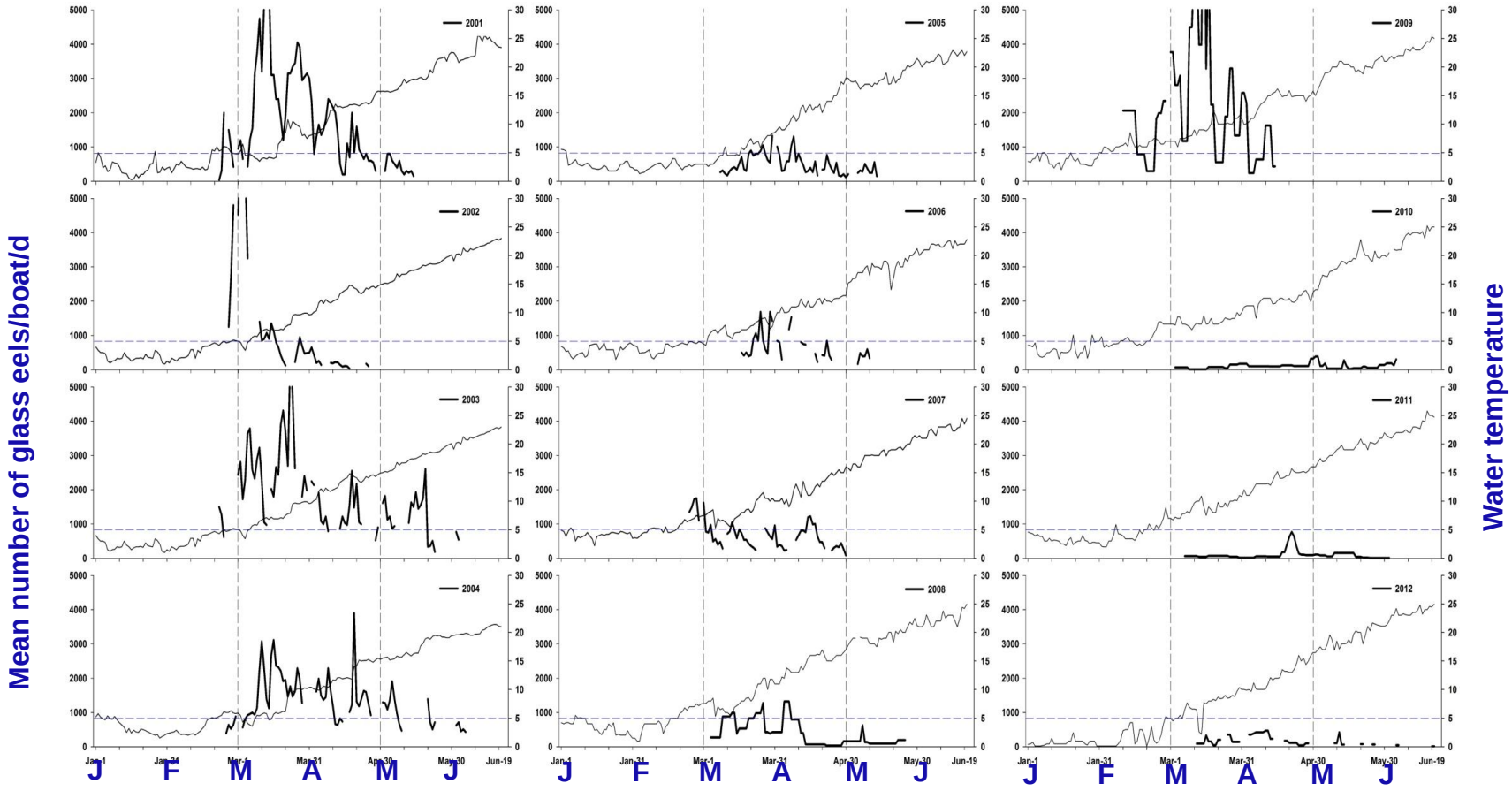
- Using tidal currents in the western coastal waters.

Bag nets



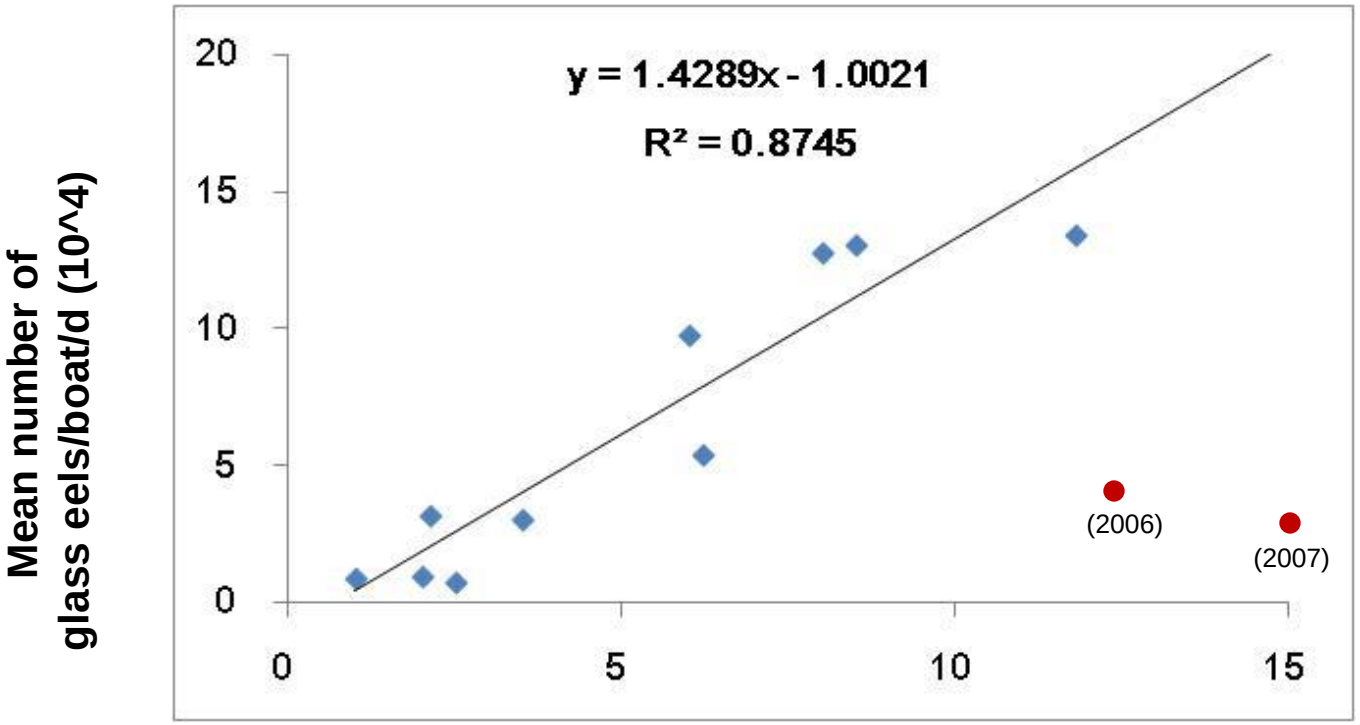
Opened facing to the sea during the flood tide by sinking down the lower bar and collected the glass eels during the high tide.

Daily catch rate and water temperature in Geum River estuary from 2001 to 2012



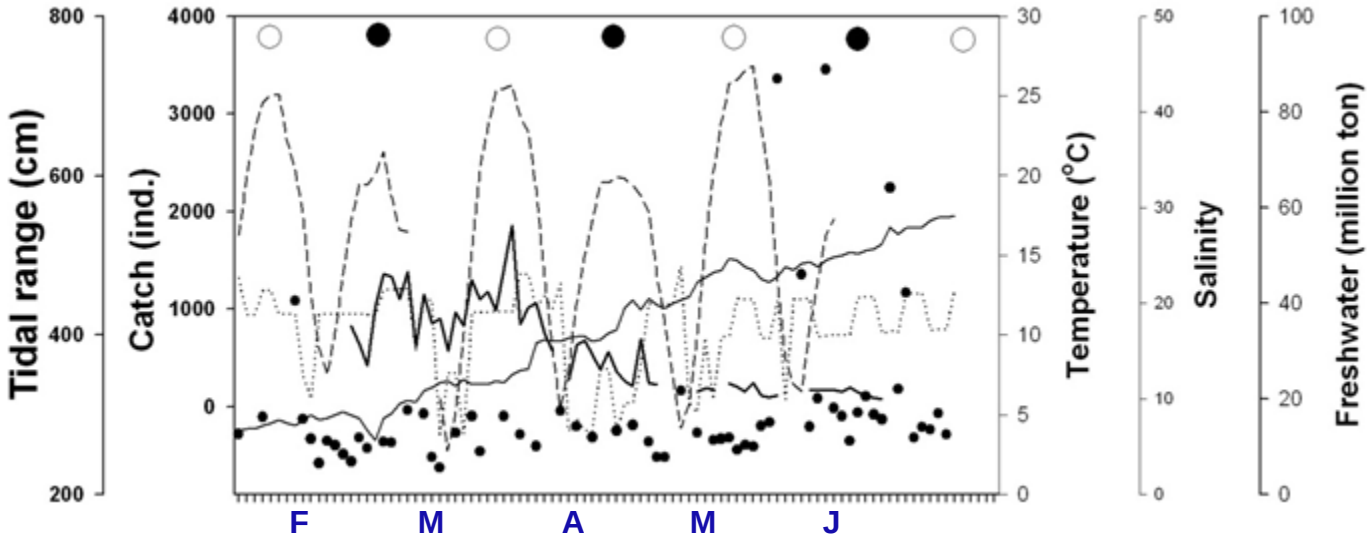
- Glass eels began to be caught from the end of February when water temperature raised over 15°C, to the end of May when the water temperature raised over 15°C.
- However, the catch rates were low and fish season became later since 2010.

Relationship between catch rate in Geum River and total catch in Korea



➢ Similar annual catch rate among estuaries

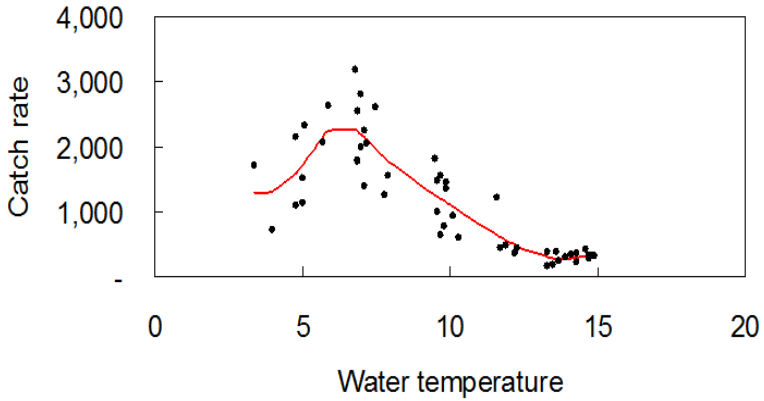
Short term variation of catch rate of glass eels in Geum River estuary in 2003



- Cloud cover
- Precipitation
- Wind speed
- Atm pressure

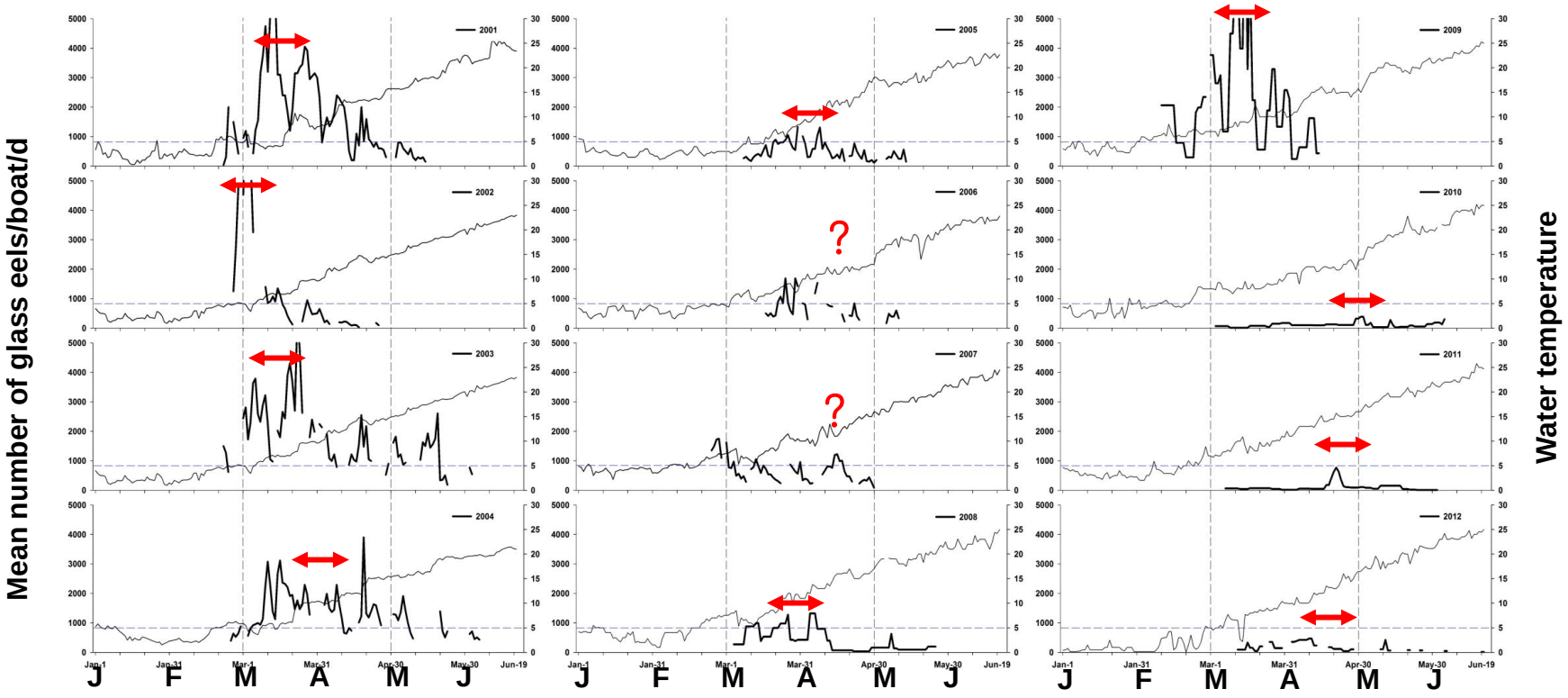
Environment factors affecting to catch rate in 2003 by generalized additive model (GAM)

	edf	Chi-Square	p-value
Tidal range	1	12.9	<0.01
Temperature	4.2	248.4	<0.01
Salinity	1	4.2	<0.05
R-sq.(adj) = 0.78, Deviance explained = 80.1% , n = 72			



Temperature ranged from 4.5 to 15°C showing a peak at ca. 7°C

Factors affecting annual catch rate



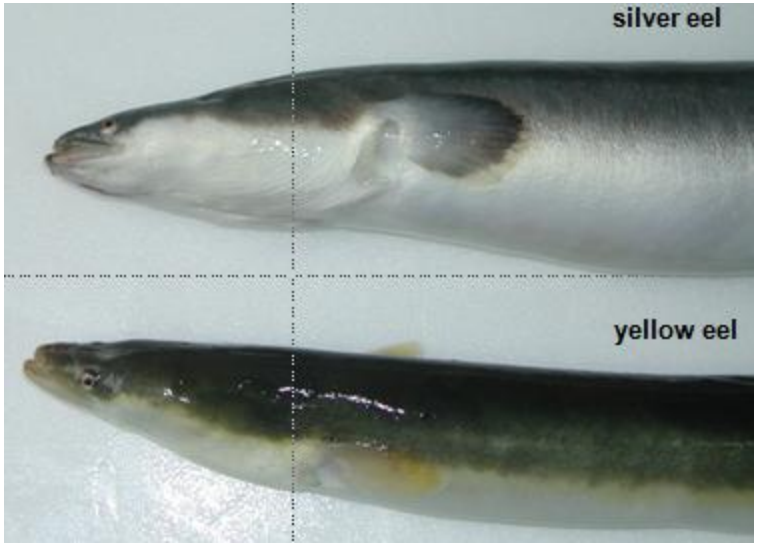
- **Time of peak catch,**
  earlier, in early to mid March during the years of high catch,
  later, in mid April to early May during the years of low catch

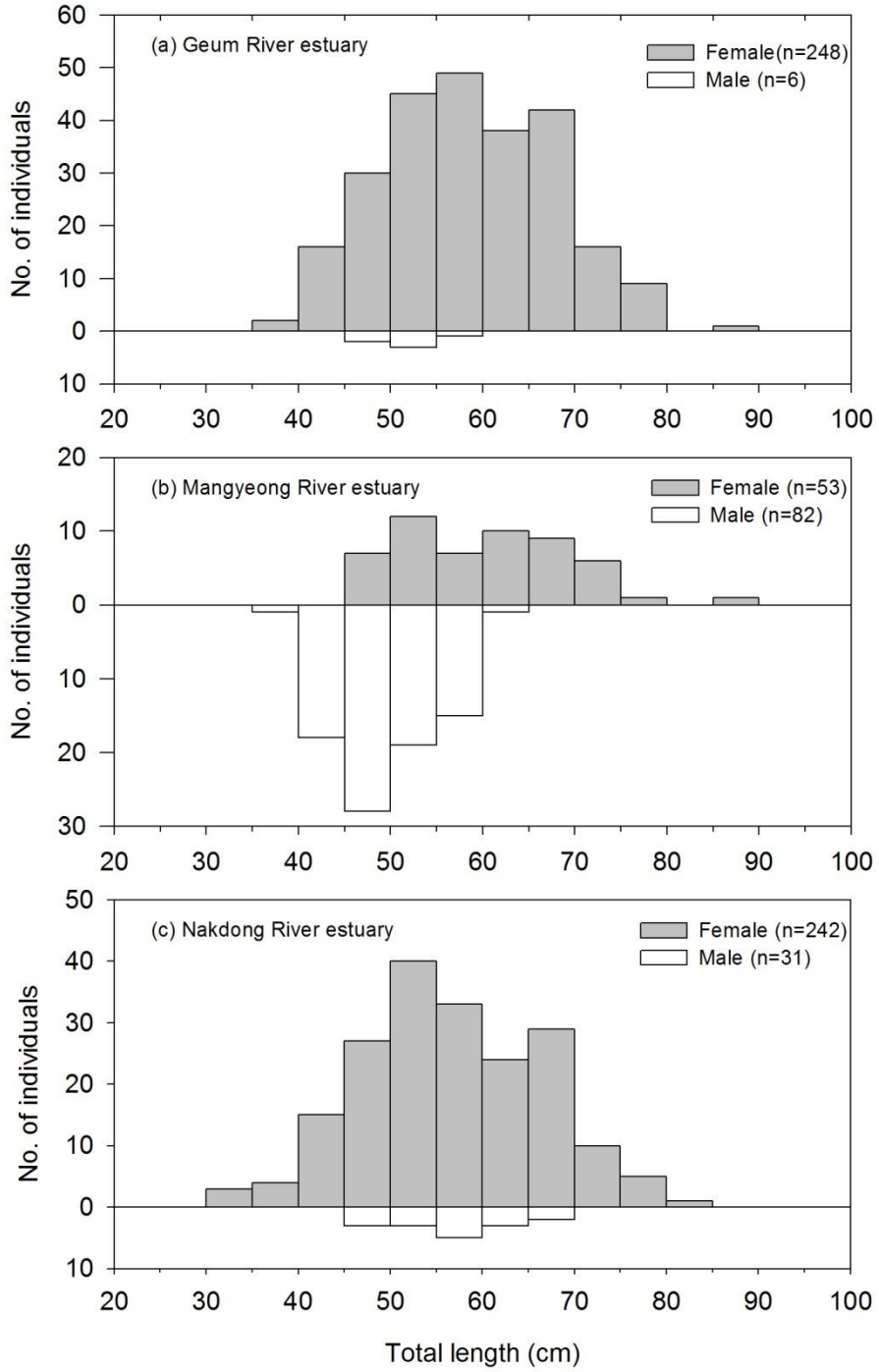
- **Since 2010, fishing season became later up to early June.**

Sex ratios of silver eels

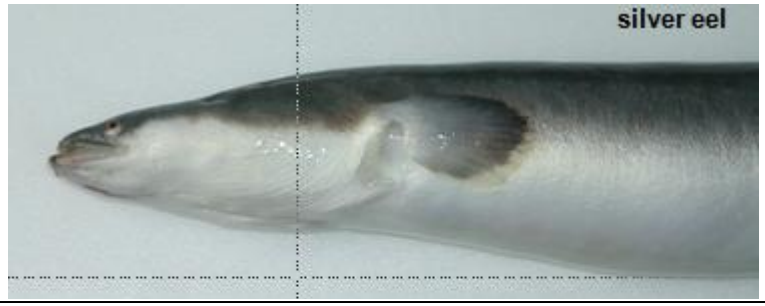
Estuaries	F	M	*p*
Geum R.	117	6	< 0.001
ManG. R.	42	41	>0.05
Nakdong R.	126	27	< 0.001

Sr/Ca ratios



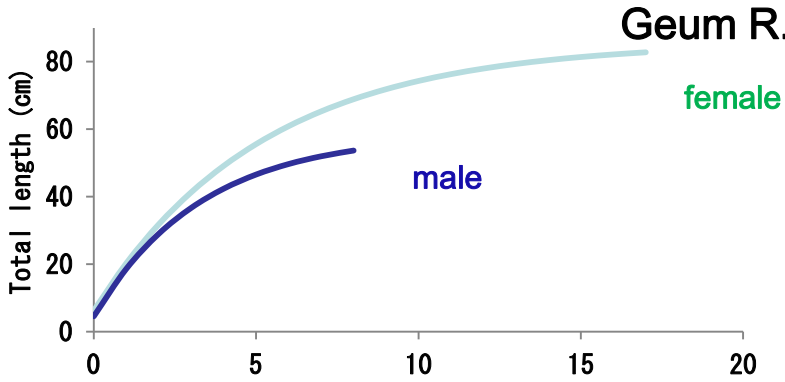


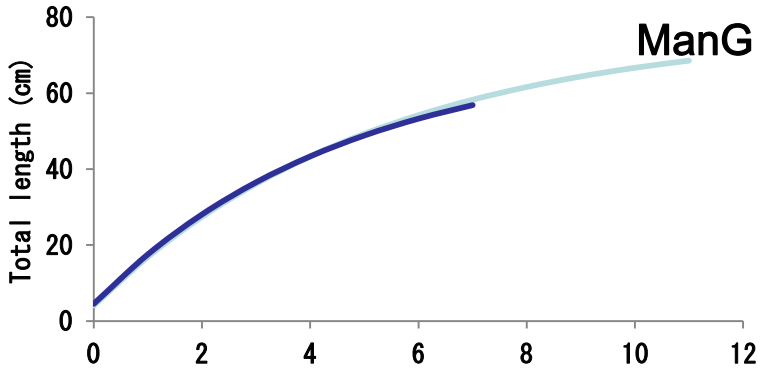
Age and Size of silver eels

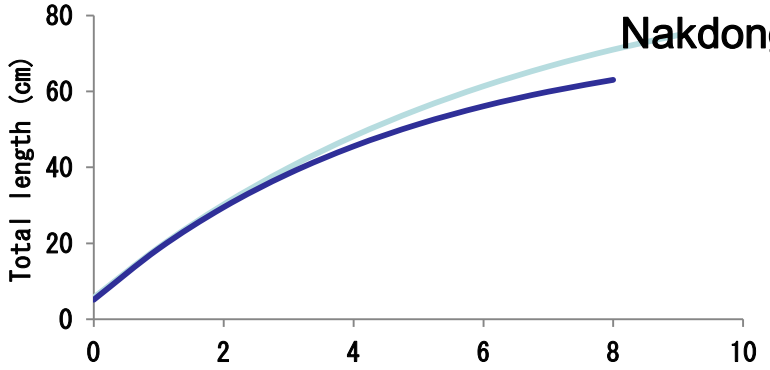


Estuaries	Sex	Age±SD (range)	TL±SD cm (range)	BW±SD g (range)
Geum R.	F	6.3±2.5 (3-17)	65.6±6.9 (47.0-85.7)	463.7±186.1 (140-1029)
	M	7.3±1.5 (4-8)	51.9±3.5 (48.7-58.5)	180.8±29.1 (141-221)
Mangyeong R.	F	6.9±1.8 (4-11)	62.2±8.7 (48.3-87.5)	418.5±206.5 (148-1040)
	M	5.4±0.9 (4-7)	52.2±4.9 (43.2-62.3)	231.0±76.3 (115-458)
Nakdong R.	F	7.0±1.0 (5-9)	64.9±5.7 (52.2-81.5)	454.2±135.3 (163-909)
	M	6.4±0.8 (5-8)	58.2±4.8 (50.0-66.9)	317.8±77.4 (187-530)

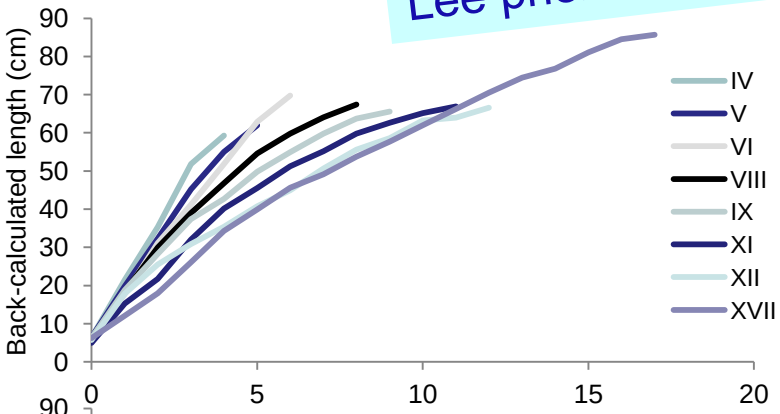
Growth in total length (female)

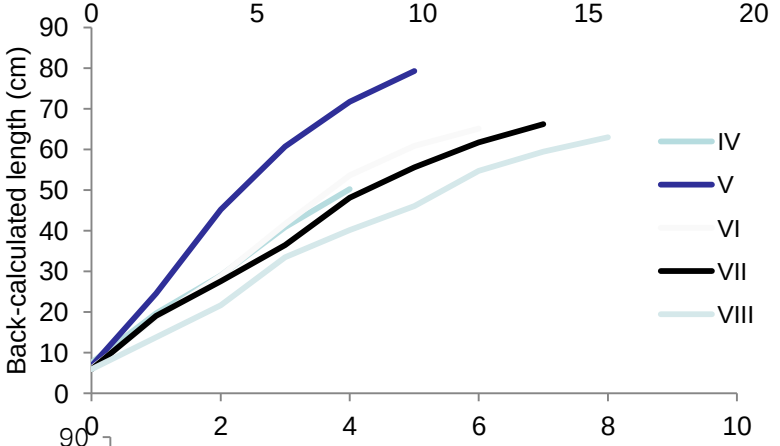


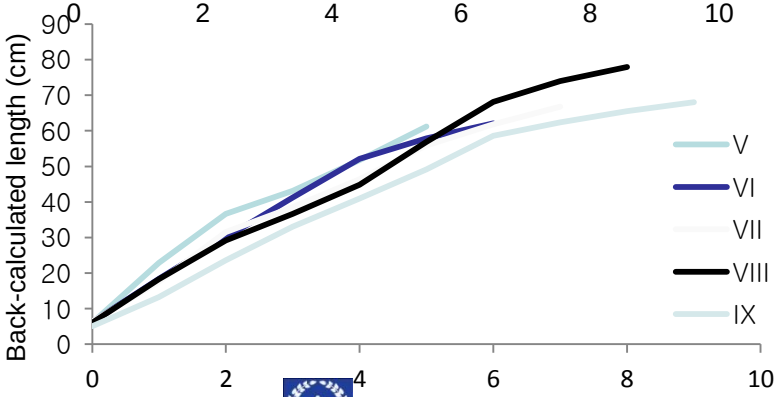




Lee phenomena







Management of eel resources

Short-term

- Development of culture techniques of foreign eels

Mid-term

- Release of young eels
- Construction eel pass
- Regulation of fishery on glass eels and yellow/silver eels

Long-term

- Artificial mass production of glass eels
- Amelioration of habitat environment

Researches on eel resource to date

- **Culture techniques of foreign eels**

  such as *A. rostrata, A. bicolor, and others…..*

  >> Cooperative research of NFRDI, Eel Culture cooperative and Fishery institute of Cheonnam Province

- **Eel larvae culture**

- **Eel research teams, NFRDI**

  >> cultured leptocephali up to 250 d (metamorphosing stage)

- **Release of young eels**

- **Young eels have been released by local governments having dams in the upper reaches of the rivers**

  >> The species were checked before release, but any monitoring researches after release have not yet been done.

Researches on eel resource to date

- **Monitoring the recruitment of glass eels**
  - **Data of daily catch are available in some estuaries,**
    and can be collected from the glass eel fishermen on daily trade amount

- **Biology and ecology of yellow and silver eels**

- **Basic biology such as sex ratio, age, growth, and habitat use has been studied in some rivers.**
- **More data have to be collected for assessment of eel populations such as geographic distribution of eel density, age composition ….**

Technical approach

- **Dam effect and eel pass/eel ladders**

- Upstream migration of eels blocked by river mouth dams,

and urgent need to construct/ modify eel specific pass/ladders

cf) Dams in Japan: in the upper reaches of the rivers, Taiwan and China ???

- Downstream migration of silver eels:

> They can migrate during the gate opening after autumn rains

cf) In Europe, the downstream silver eels were injured

by the turbines in the electric power stations or mills

- **Fishery management**

- Reducing the fishing efforts on glass eels and silver eels

Inter-governmental organization

- **Annual EASEC meetings since 1998**
- **Meetings among eel industry peoples**

- **Present status of eel culture**
- **Assessment and management of eel populations**

Declarations by the NGOs are only an agreement, but has no restriction.

- **Urgent need of the supports from the governments**

- Mid- and long-term research fund for assessment and management plan of eel populations

- Convention and rules for the management of international fish

cf) - North Pacific Anadromous Fish Commission (Korea, Japan, U.S.A, Canada and Russia)

- International Whaling Commission (IWC)

- Western and Central Pacific Fisheries Commission (WCPFC)

- European Eel WG in ICES/EIFAC

➢ **Government supports the scientific committee for**

- data collection for stock assessment

- meeting for data exchange and establishment of action plan for management

East Asia Eel Resource Consortium > East Asia Eel Resource Commission