Eco-hydrological Studies on the Four Major Chinese Carps Spawning Habitat Restoration for Yangtze River

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CONTENTS

- Introduction
- Primary Results
- Summary

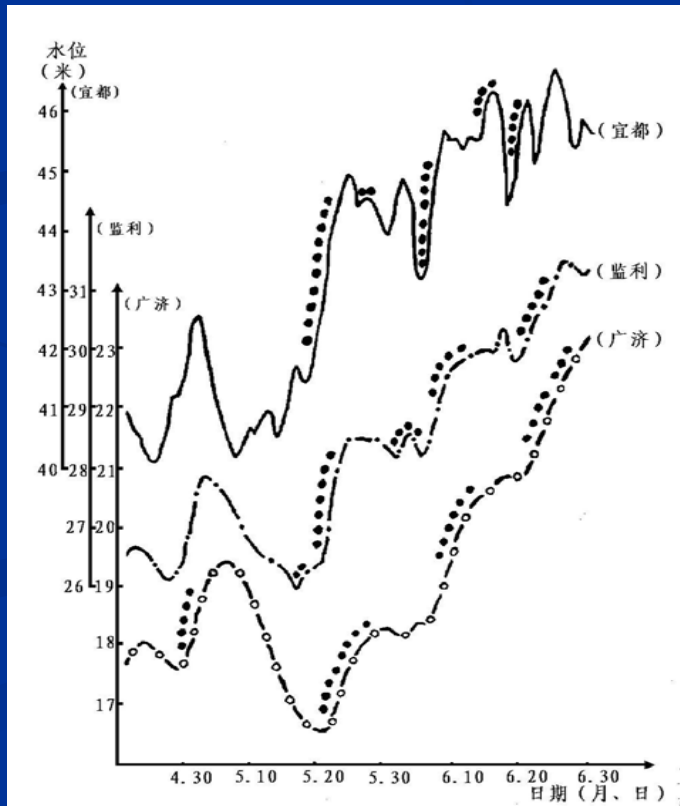
INTRODUCTION

- ✓ the Yangtze River ---- major freshwater fishery
- ✓ the four major Chinese Carps
  - o a major role in China's freshwater fishery
  - o food resources for some rare and severely-endangered aquatic animals

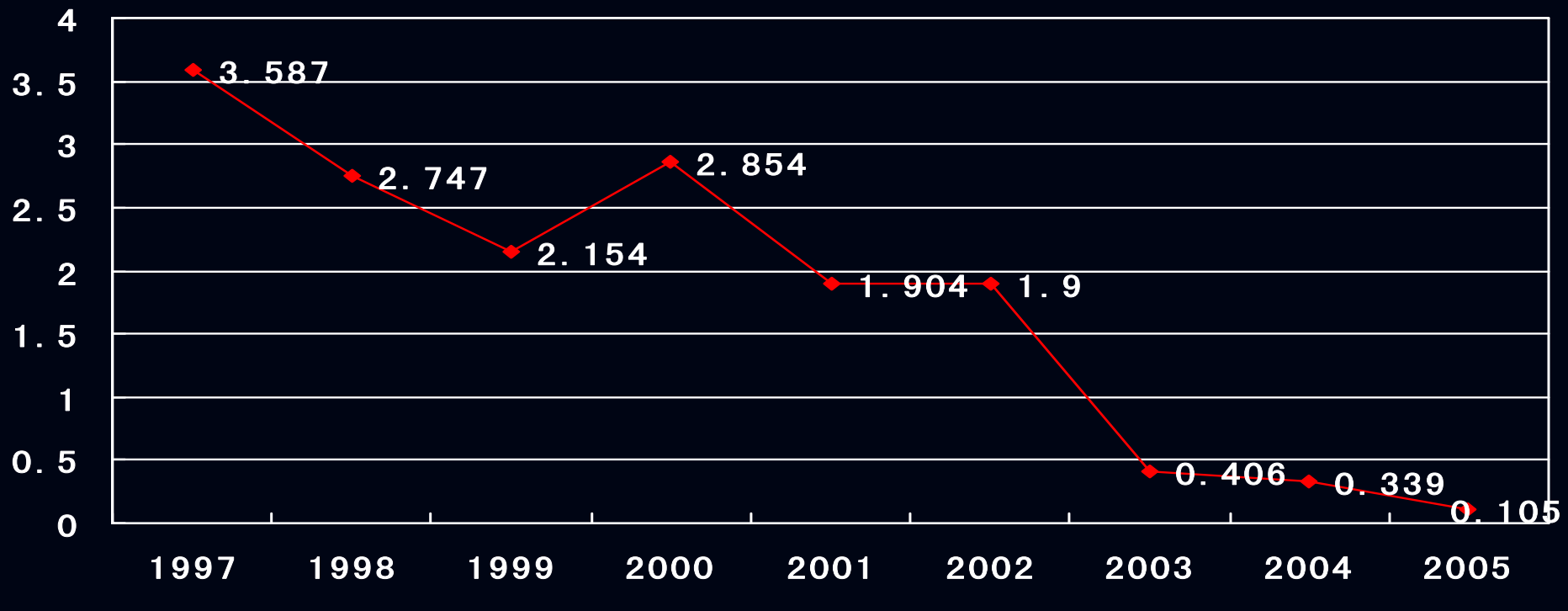
INTRODUCTION

Basic features of the four major Chinese Carps' spawning

- Spawning floating eggs
- Taking about 110 hr to grow into fry (recently hatched fish)
- Spawning season: from May to June
- Flow condition for spawning: water swelling
- Water temperature for spawning: >18°c



INTRODUCTION



INTRODUCTION

Habitat Restoration

- Fishing Ban
- Pollution Control
- Artifical Flood

INTRODUCTION

Joint Studies by

- China Institute of Water Resources and Hydropower Research
- China Three Gorges Project Coorperation
- Yangtze River Fishery Research Institute
- Institute of Hydroecology

PRIMARY RESULTS

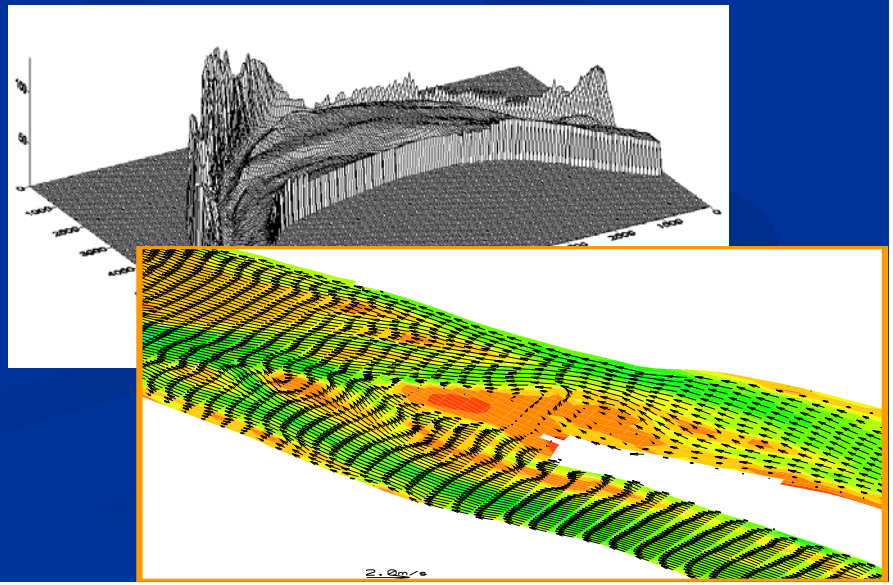
----Features of spawning fields

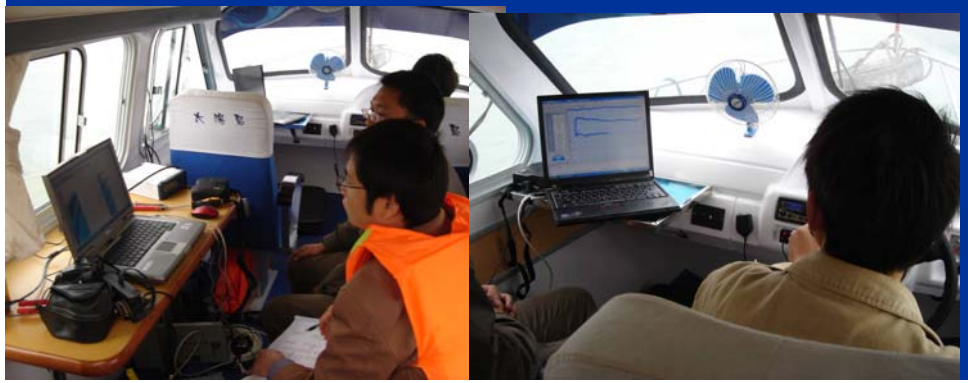
Investigation of spawning fields

(2004-2007, 30 fields)

Topography & Flow analysis

Spawning field locations investigated in 1986

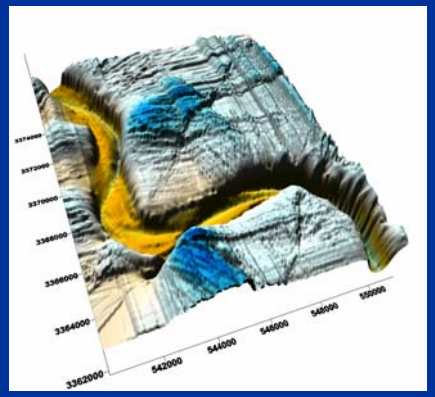




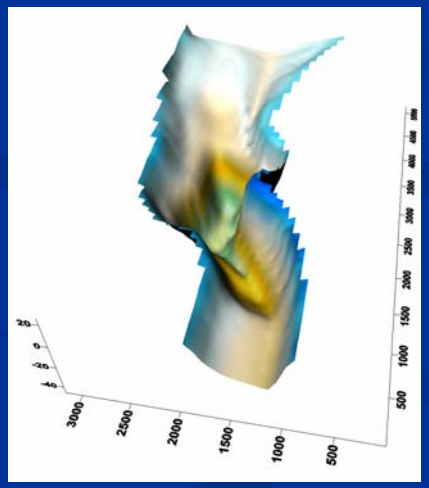
PRIMARY RESULTS

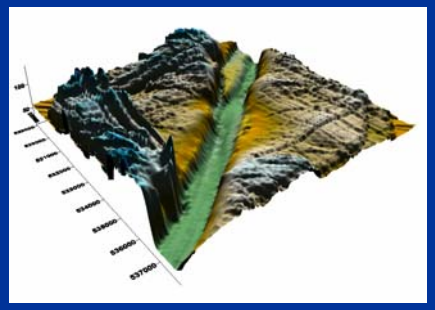
----Features of spawning fields

- **Three Basic Types of Spawning Field**



Type 1: sinuosity





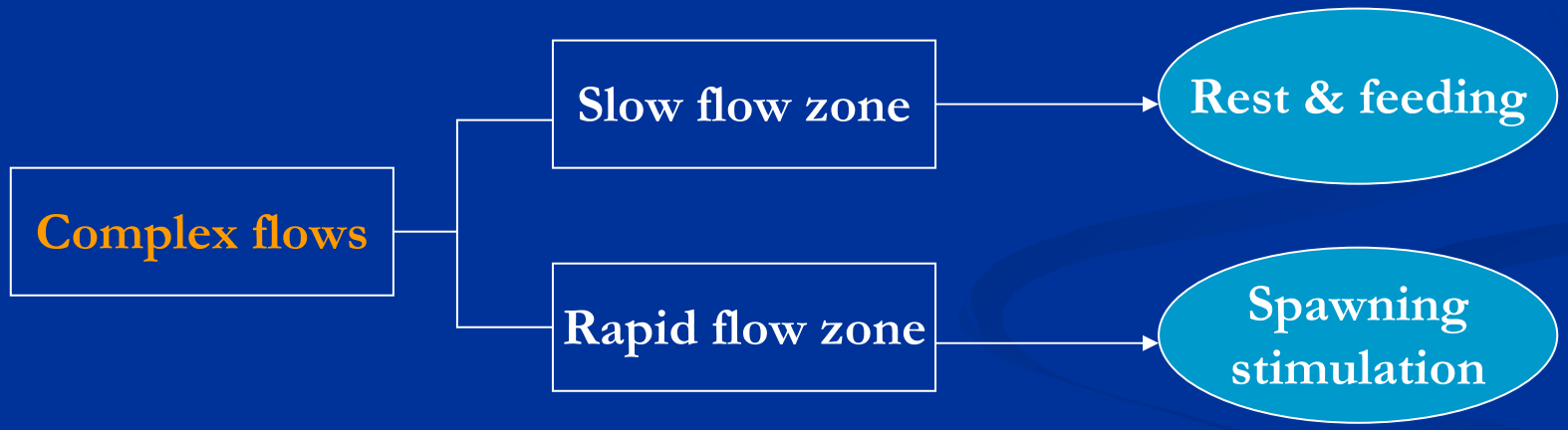
Type 3: canyon

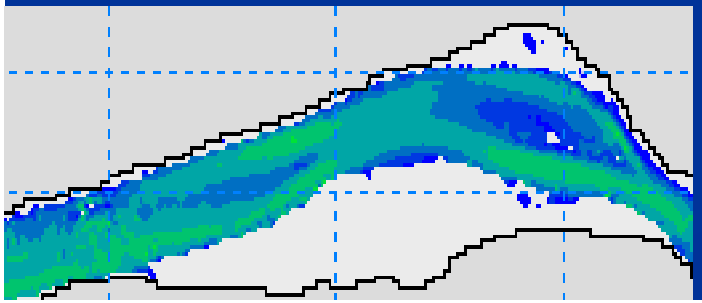
Type 2: deep pool

PRIMARY RESULTS

----Features of spawning fields

- Common ground on flow





Slow flow zone: v=0-0.5m/s

Rapid flow zone: v=1-2m/s

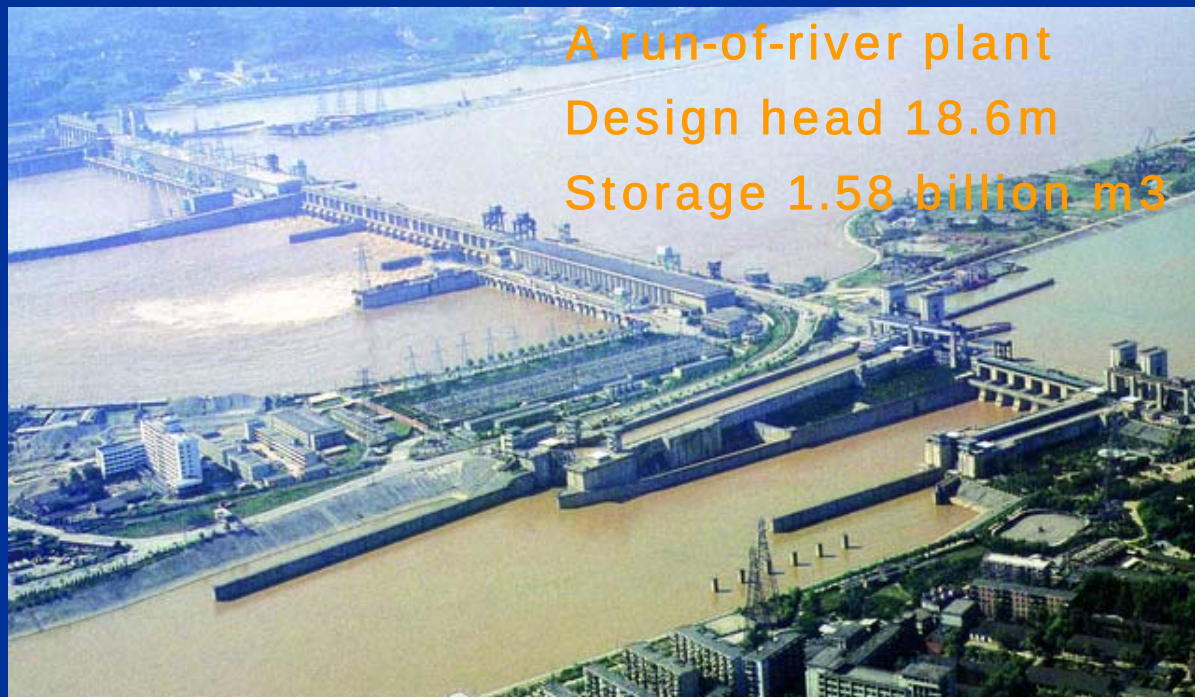
PRIMARY RESULTS

----Impacts of Gezhouba Hydropower Plant

Hydrological data series: 1961-2000

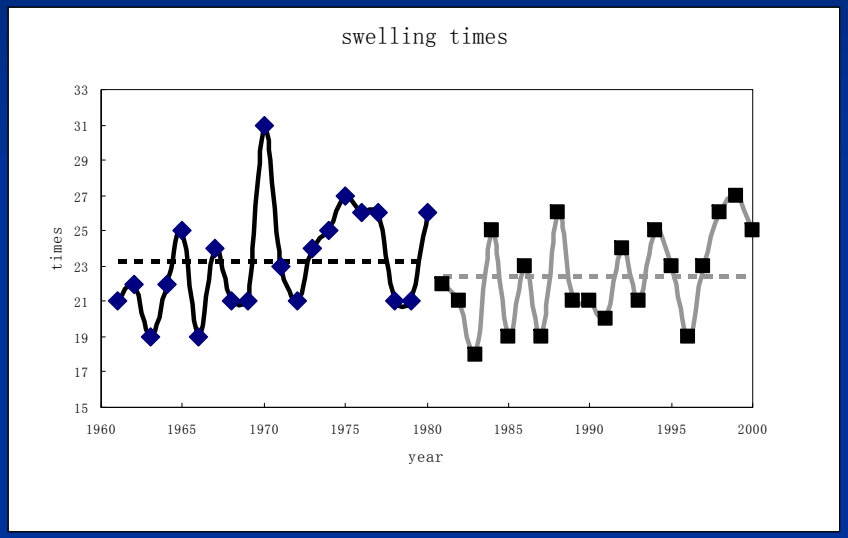
1961-1980: without the dam

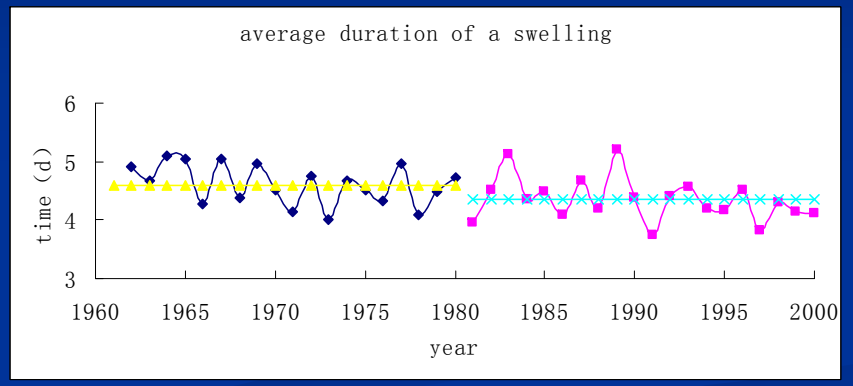
1981-2000: with the dam

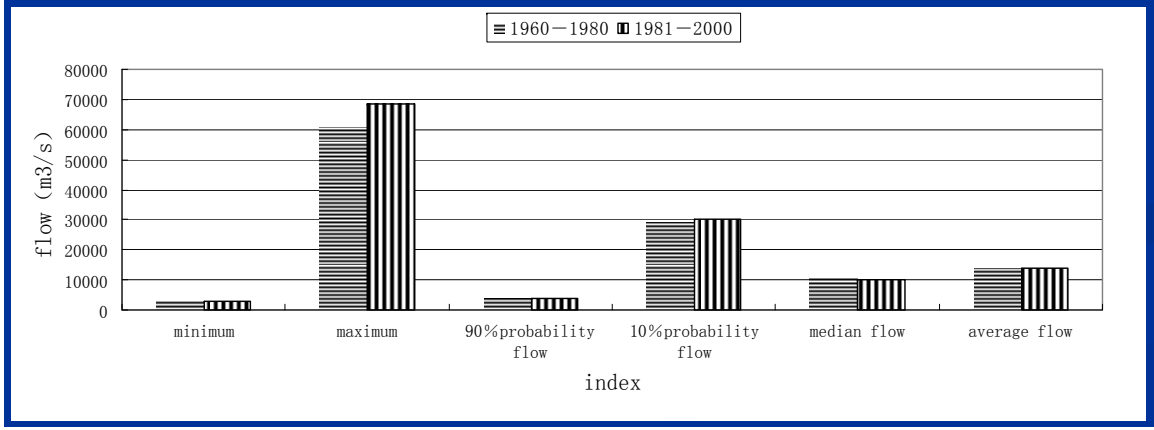


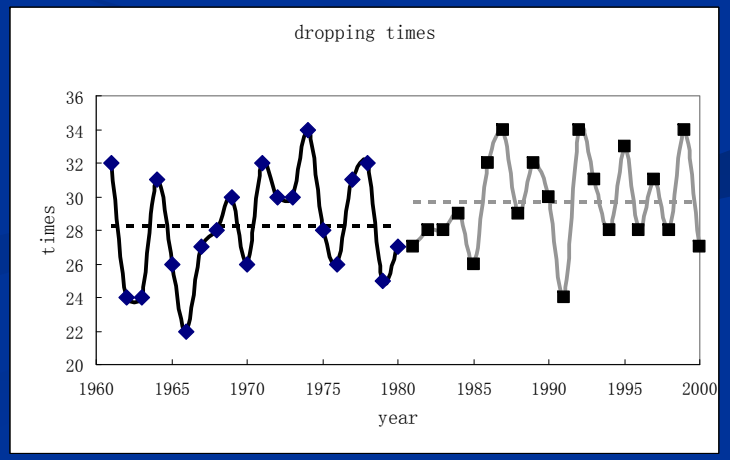
PRIMARY RESULTS

----Impacts of Gezhouba Hydropower Plant









PRIMARY RESULTS

----Impacts of Gezhouba Hydropower Plant

Index	1960-1980	1981-2000
Swelling times	23.3	22.4
Dropping times	28.3	29.7
Average duration of a swelling (d)	4.6	4.4
Average duration of a dropping (d)	7.1	5.7
Total swelling days (d)	106	97
Total dropping days (d)	197	167
Maximum flow increase in a swelling day(M^3/S)	9695	11385
Maximum flow decrease in a dropping day(M^3/S)	6260	7335

Other influencing factors:

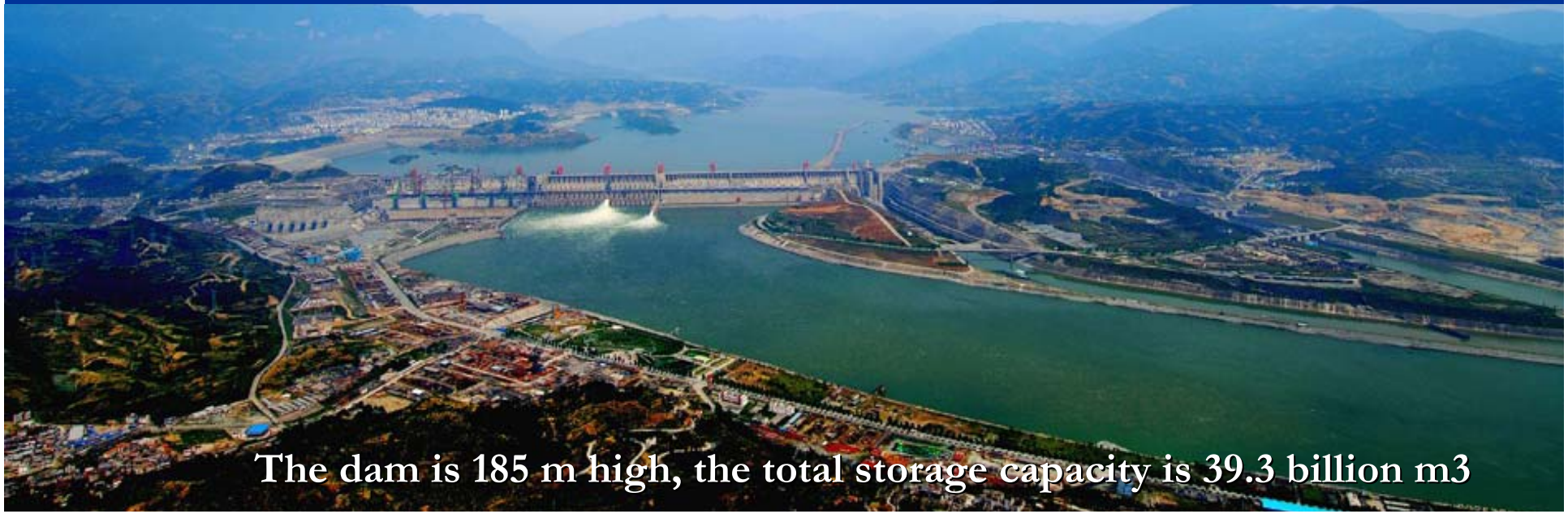
- ✓Climate change
- ✓Upstream storage

PRIMARY RESULTS

----Impacts of Three Gorges Reservoir

Reservoir flow condition for spawning

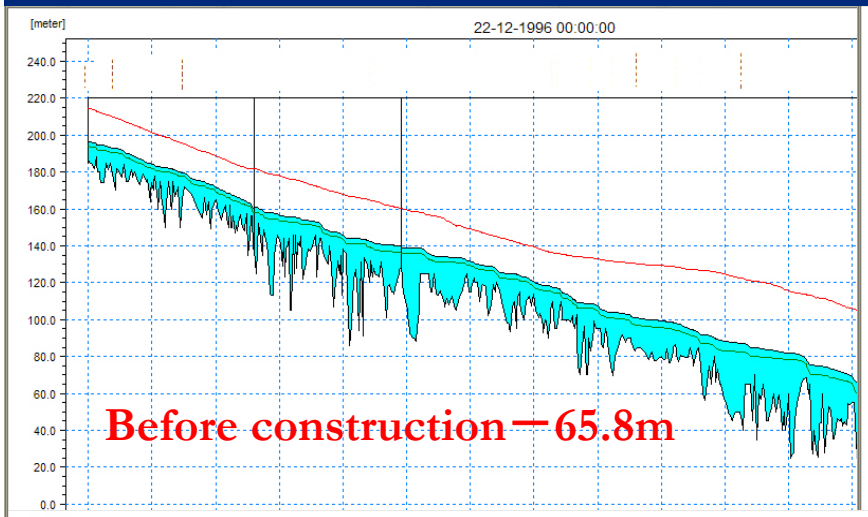
- Numerical modeling
- Scenario analysis

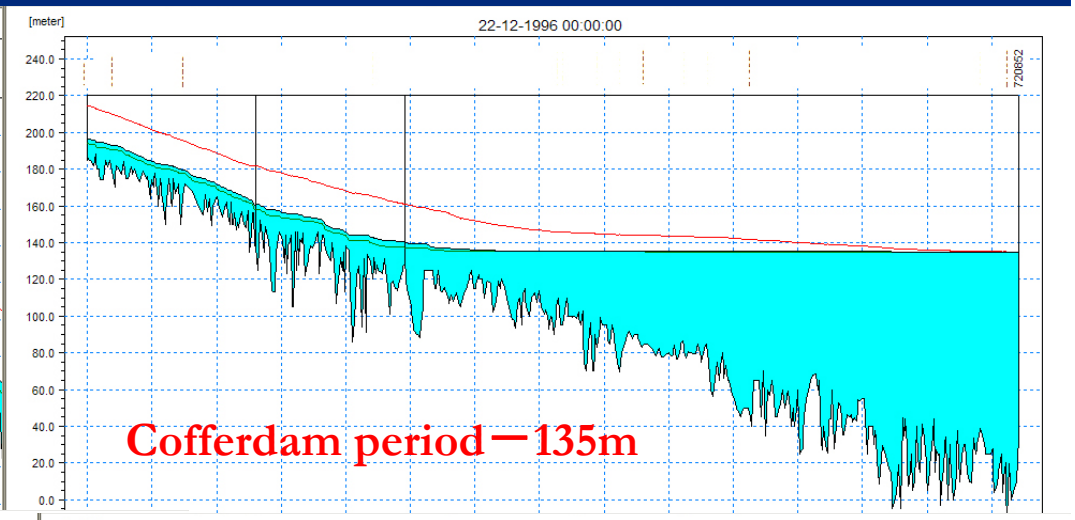


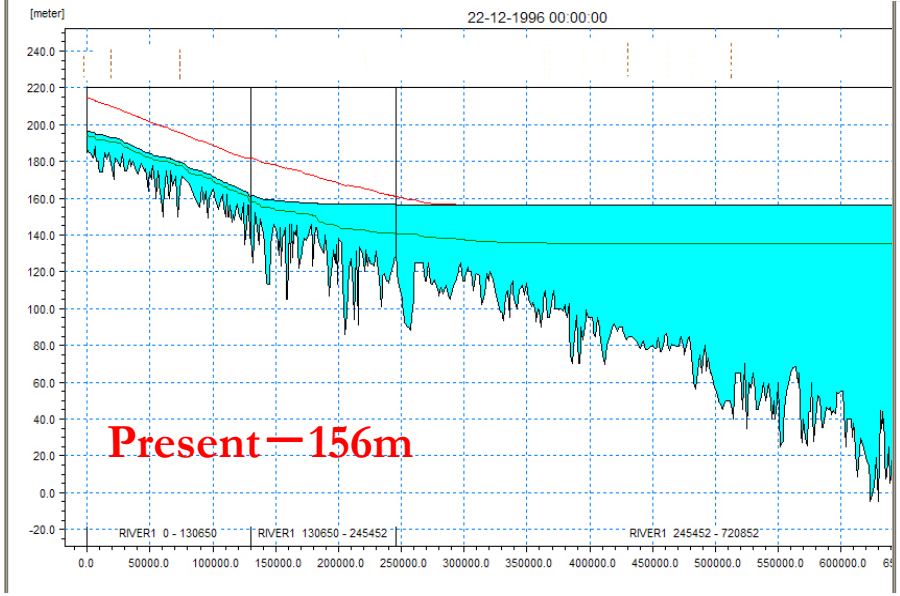
The dam is 185 m high, the total storage capacity is 39.3 billion m3

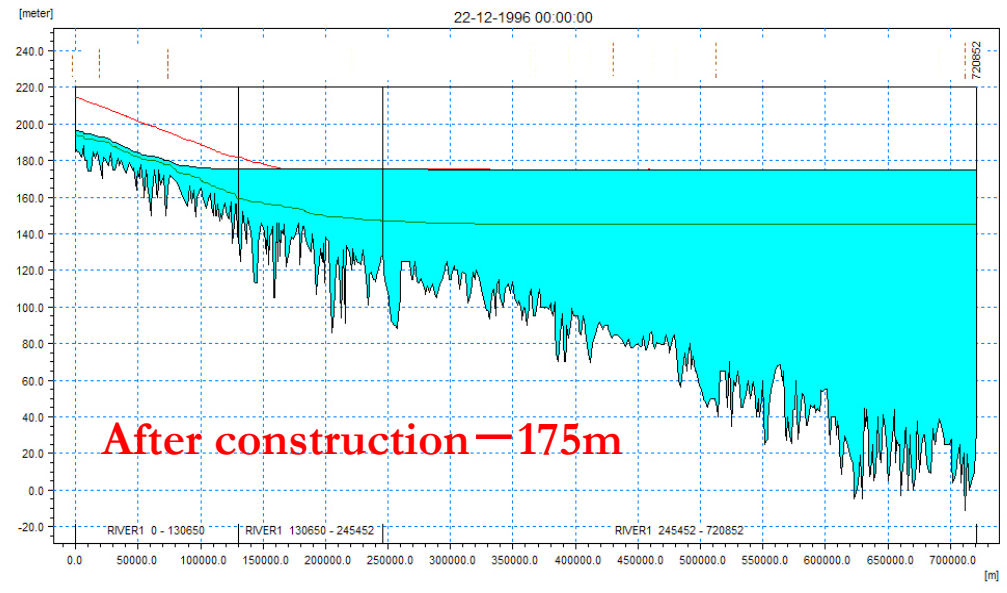
PRIMARY RESULTS

----Impacts of Three Gorges Reservoir





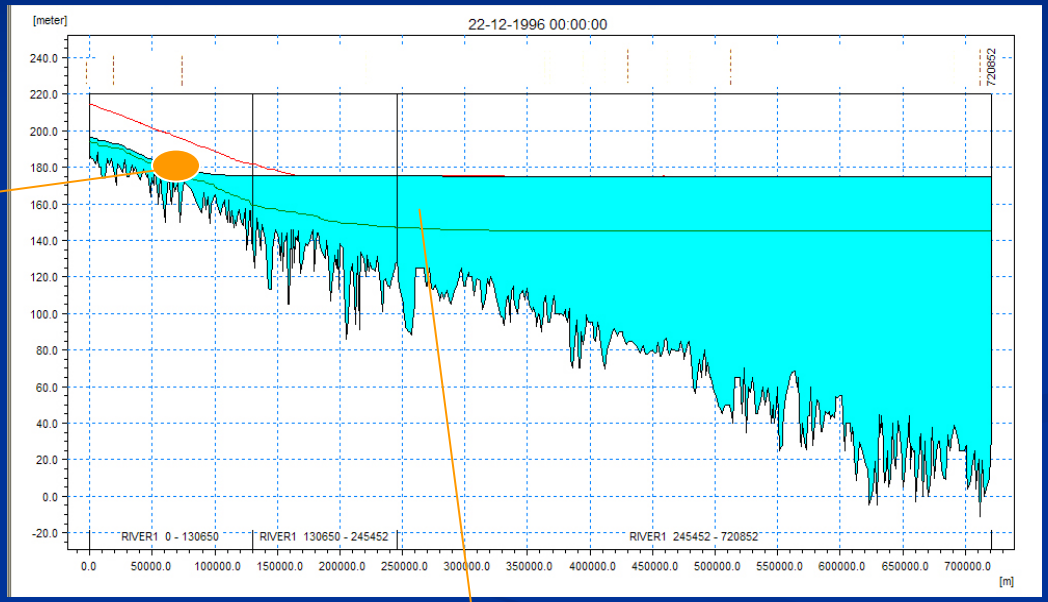




PRIMARY RESULTS

----Impacts of Three Gorges Reservoir

Will Chongqing spawning field still exist?

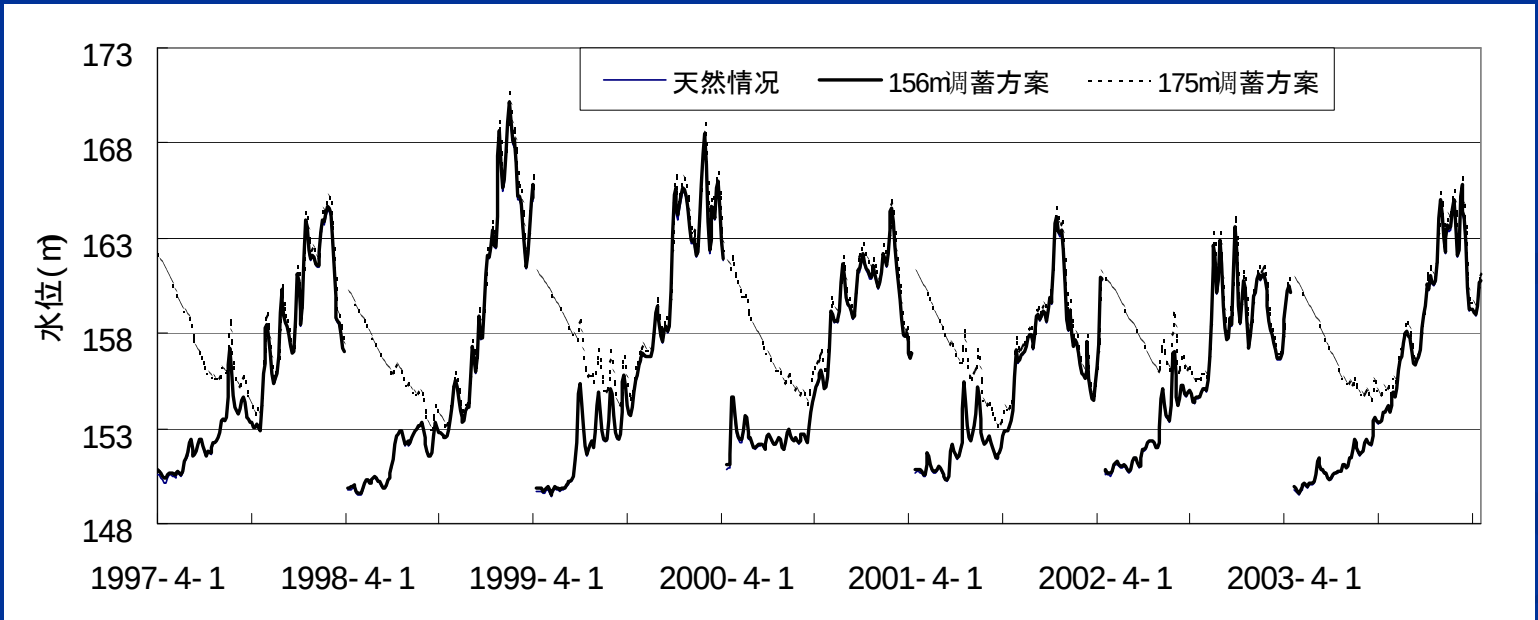


No spawning field exists in the reservoir

PRIMARY RESULTS

----Impacts of Three Gorges Reservoir

Flow conditions at Chongqing spawning field during spawning season (from April to July)

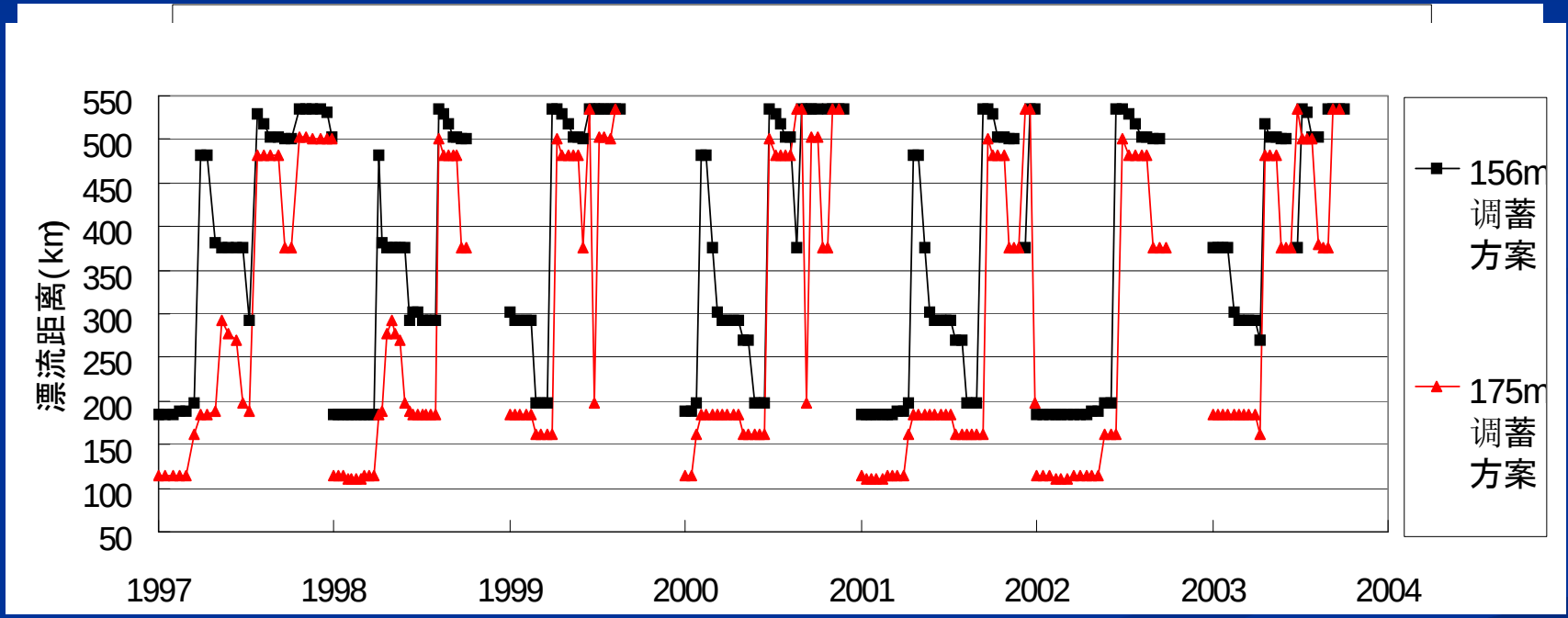


- 156m: no difference compared with natural state
- 175m：change a lot before the middle ten days of June, change little after

PRIMARY RESULTS

----Impacts of Three Gorges Reservoir

Calculation of floating distance & floating time



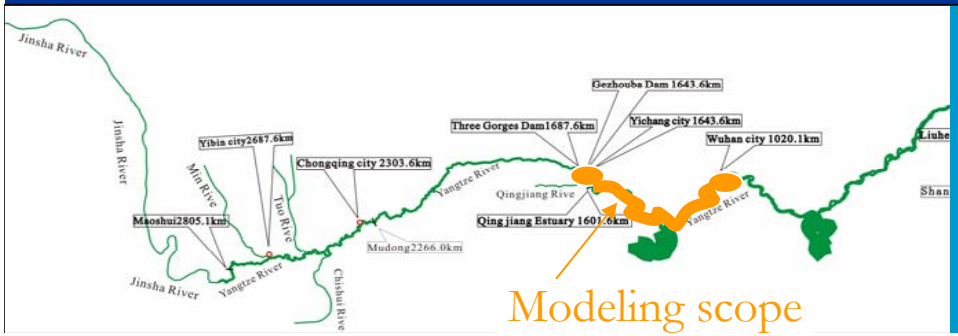
- The floating time in May is less than 110 hours, eggs may sink and die
- The floating time in last ten days of June is enough for eggs to survive into fry

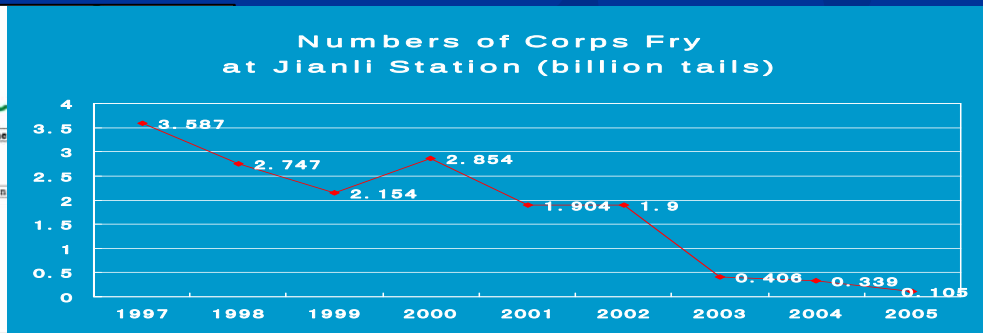
PRIMARY RESULTS

----Impacts of Three Gorges Reservoir

Downstream impact analysis

- ✓ Methodology: numerical modeling
- ✓ Data series: 1997-2002 (before) +2003-2006 (after)
- ✓ Modeling scope: Yichang city to Wuhan city (600 km)
- ✓ Hydrological indexes selected: times of flooding, duration of flood swelling, initial flow of a flood, daily increasing rate of flow, and daily increasing rate of water level etc.





PRIMARY RESULTS

----Impacts of Three Gorges Reservoir

Hydrological Index Comparsion before and after Three Gorges Reservoir's Storage (Jianli Station)

index	1997–2002	2003–2006
Times of flooding	4–5	2–5
duration of Flood swelling（d）	5. 67–7. 25	5. 67–7. 33
Initial flow of a flood（m^3/s）	5500–35000	4500–20000
Daily increasing rate of flow($m^3/s/d$)	93–4543	71–5045
Daily increasing rate of water level (m/d)	0. 3–0. 6	0. 24–0. 5
Interval of adjacent floods (d)	4–27	5–25

No obvious difference occurred

PRIMARY RESULTS

----Eco-hydrological conditions for spawning

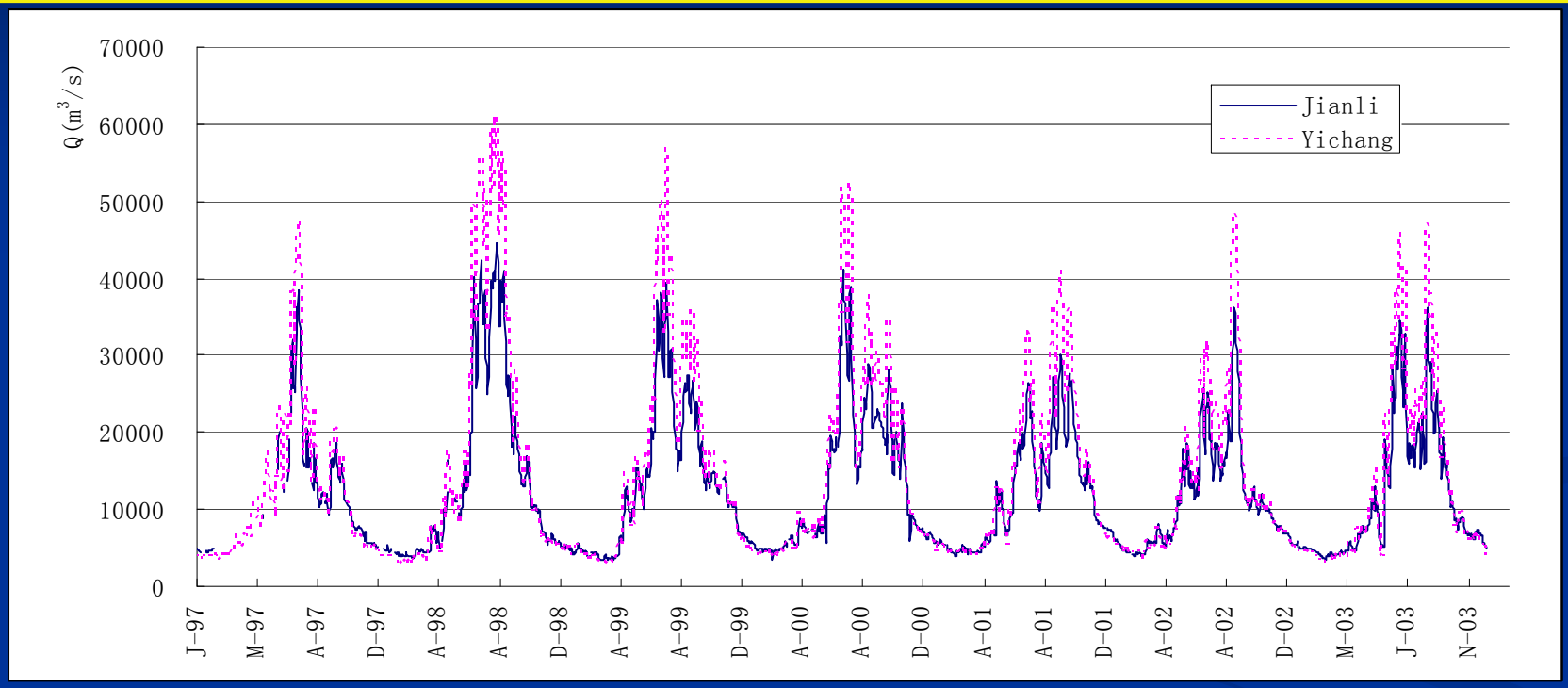
Eco-hydrological conditions needed for corps' spawning

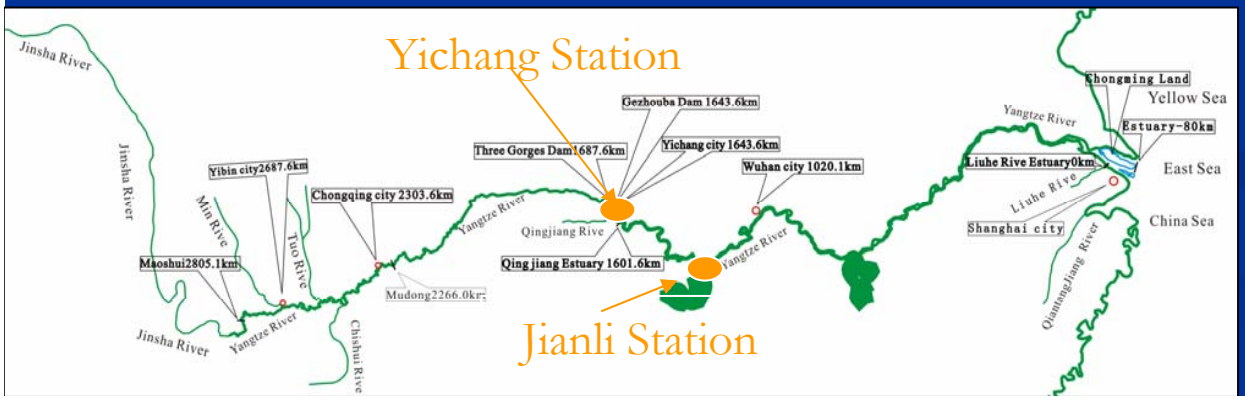
Relationship between fry number and hydrological characteristics at Yichang Station

Eco-hydrological characteristics at Yichang Station

PRIMARY RESULTS

----Eco-hydrological conditions for spawning





Correlation coefficient=0.94

PRIMARY RESULTS

----Eco-hydrological conditions for spawning

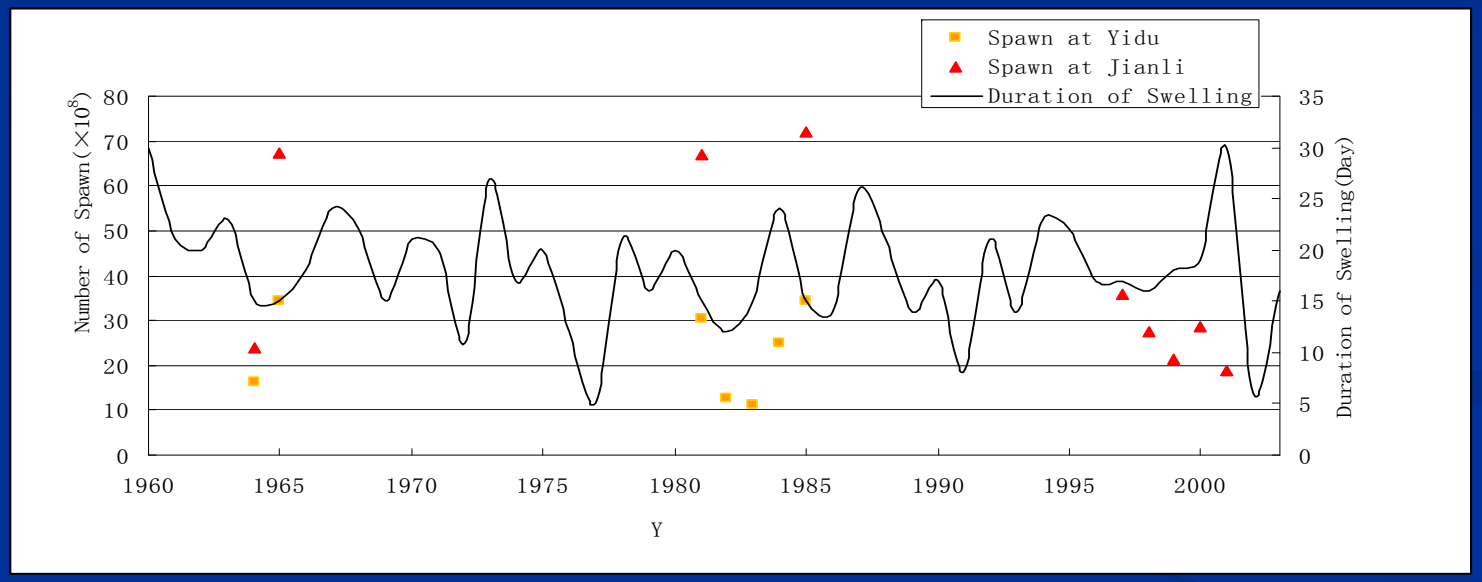
Downstream fry numbers and flood features at Yichang

year	1964	1965	1981	1982	1983	1984	1986	1997	1998	1999	2000	2001
Fry number at Yidu (billion)	1.62	3.45	3.05	1.25	1.12	2.48	3.45					
Fry number at Jianli (billion)	2.39	6.75	6.70				7.20	3.59	2.75	2.15	2.85	1.90
Total days of swelling at Yichang	11	22	16	14	14	34	21	28	14	20	27	36
Total times of swelling at YIchang	2	3	3	2	2	5	3	4	2	3	4	5
Average days of a flood at Yciang	5.5	7.7	5.3	7.0	7.0	6.8	7.0	7.0	7.0	6.7	6.8	7.2

PRIMARY RESULTS

----Eco-hydrological conditions for spawning

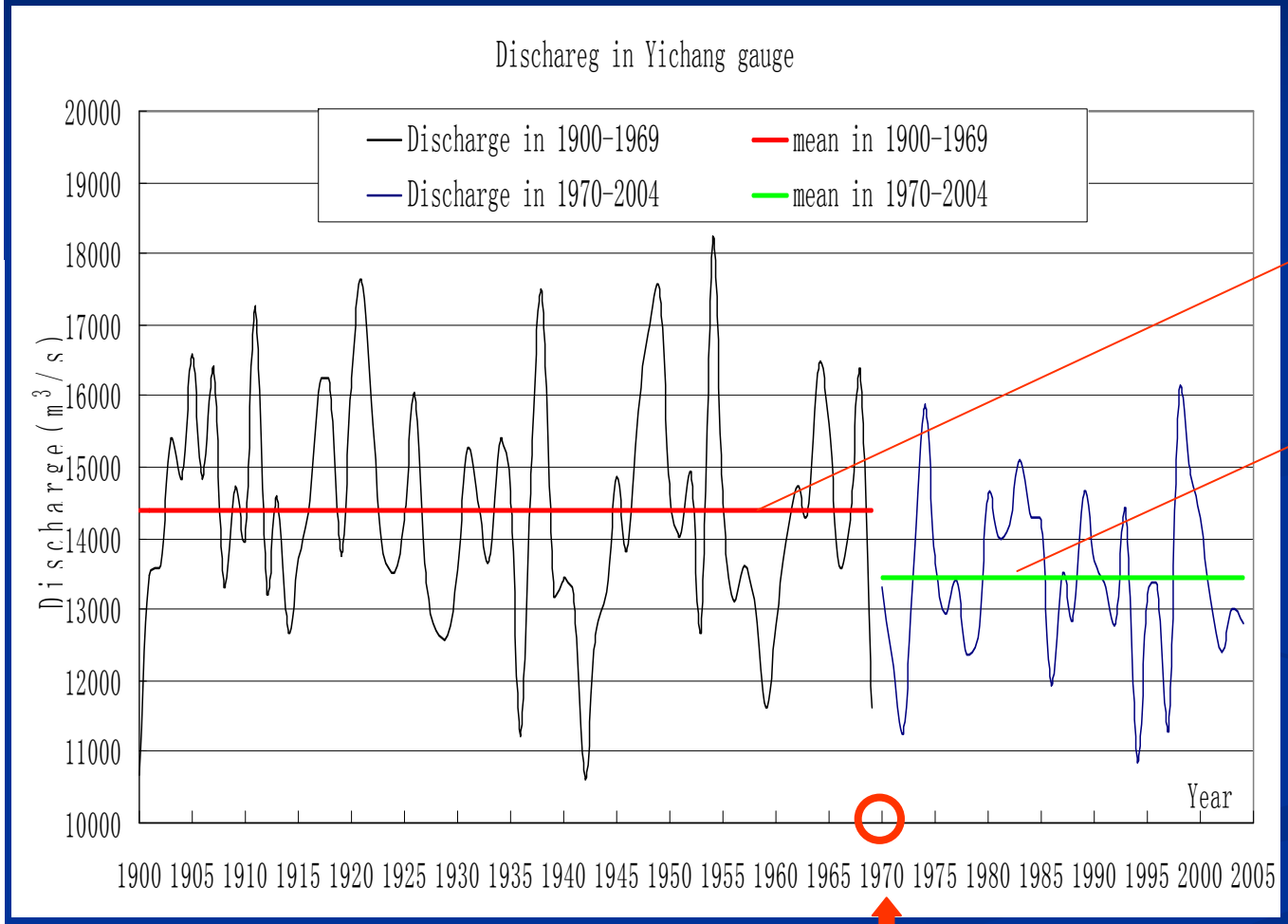
Relationship between downstream fry numbers and flood features at Yichang



Correlation coefficient between fry number and total swelling days during spawning season =0.72

PRIMARY RESULTS

----Eco-hydrological conditions for spawning



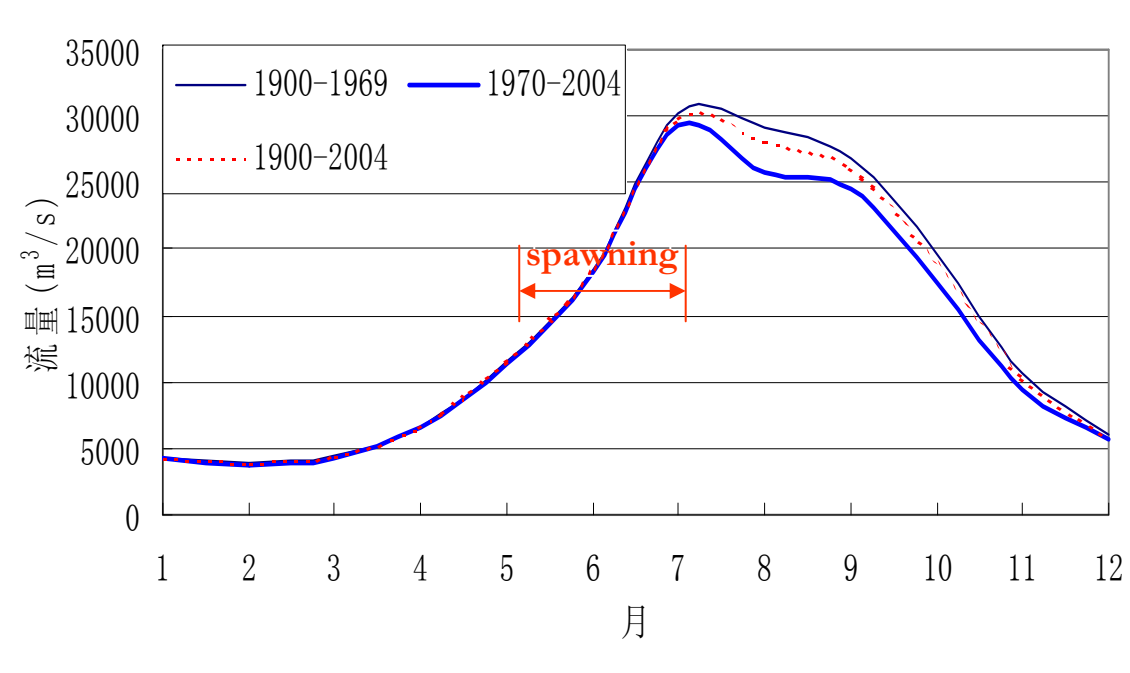
14375m3/s

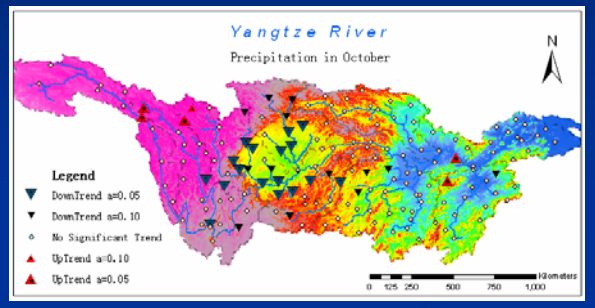
13438 m3/s

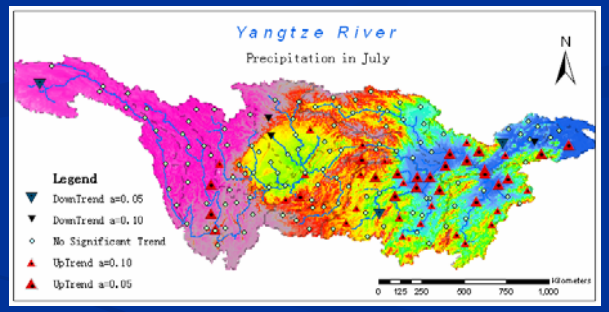
Dividing point at 1970

PRIMARY RESULTS

----Eco-hydrological conditions for spawning

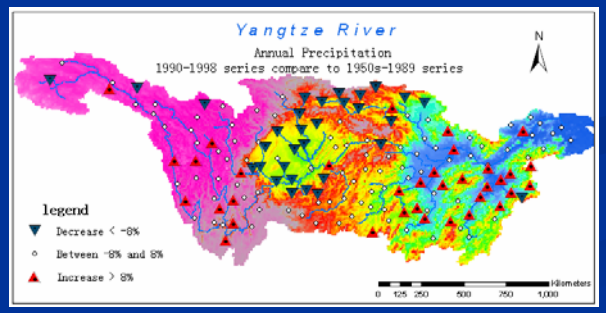


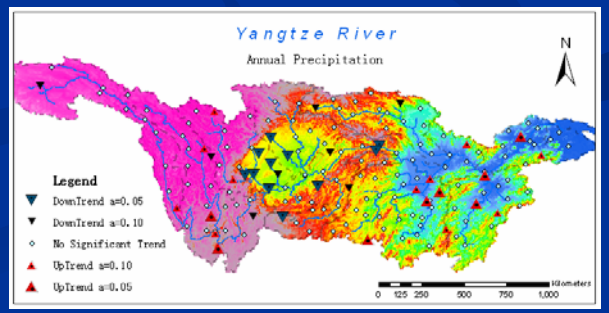




A decrease tendency of

Rainfall since 1950's

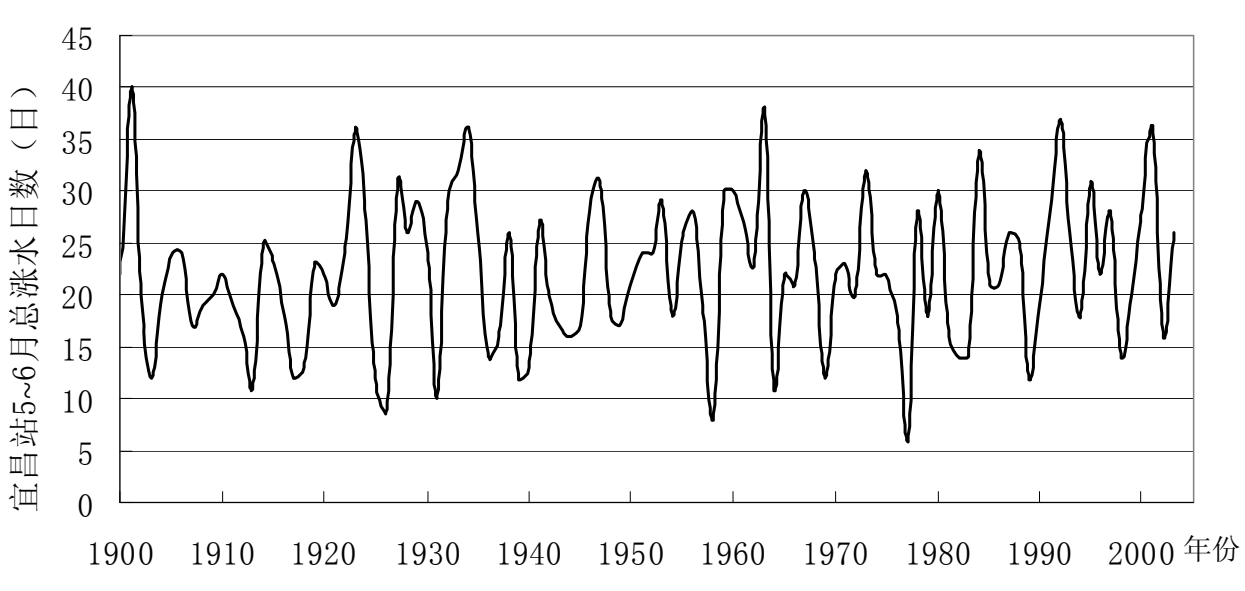




PRIMARY RESULTS

----Eco-hydrological conditions for spawning

Total swelling days (TSD) during spawning season



Maximum TSD = 40 days（1901）

Minimum TSD = 6 days（1977）

Average TSD = 22.1 days

Standard deviation =7.2

The TSD during the spawning season should be maintained 22.1±7.2 days through Three Gorges Reservoir operation

SUMMARY

1. Three types of spawning fields exist, whichever has a slow flow zone and rapid flow zone
2. As a run-of-river plant, Gezhouba hydropower plant has little impacts on four major Chinese corps spawning
3. Spawning fields in the Three Gorges Reservoir will no longer exist while the Chongqing spawning field at the end of reservoir may survive
4. No obvious impact of Three Gorges Reservoir being observed At present, the impact may occur as the storage level rise up to 175m
5. The TSD during the spawning season should be maintained 22.1±7.2 days

THANK YOU FOR YOUR ATTENTION