Biodiversity Conservation Policy Unintentionally Boosted Science Research

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Motivation

- Biodiversity conservation is often viewed as a cost, with benefits largely framed in ecological terms.
  - **Its broader economic and scientific returns remain underexplored and undervalued.**

- Scientific research depends critically on access to data and materials.
  - Living organisms themselves are essential research inputs.
  - Biodiversity conservation may expand the supply of **"research materials".**
  - Protecting species can lower constraints on scientific inquiry and experimentation.

What is this paper about?

- **The Research Question:** Do biodiversity conservation measures matter? Can biodiversity protections fortuitously promote scientific research?

- **The Setting: Seasonal fishing ban along the Yangtze River (3rd largest river)**
  - During breeding season (Spring) of fish, fishing activities were prohibited.
  - Covered Yangtze River Basin for the first time in 2003 & repeated annually.
  - Created favorable conditions for reproduction of Yangtze River fish (YRF).
  - No similar measures for other major rivers at that time or immediately after.

- **The Empirical strategy:**
  - DiD: **YRF vs. Non-YRF** around the introduction of fishing ban.
  - Outcome variables: Scientific research output
    - Research inquiries (**funding events & amounts**), outputs (**publications**), and impact (**citations**, books, awards, patents, public media mention).
  - Ban aimed to protect fishery resources, and not to promote scientific research materials expansion → unintended potential consequence.

What do we find?

- **Fishing ban boosted scientific research related to YRF**
  - No. of funded programs ↑, compared to pre-shock level (the same below).
  - Funding amounts ↑.
  - Associated publications and citations ↑.
  - Other scientific output and public influence:
    - Associated patents, awards, and books ↑
    - Public influence of YRF research ↑
  - Without crowding out other research in terms of talent/funding.

- **Potential mechanism**
  - × Research policies concerning YRF programs.
  - × Increase in public attention to the fishing ban.
  - ✔ Increase in research materials.

Overfishing along the Yangtze River

- Yangtze River (长江), the world's third longest and most water-rich, heavily impacted by human activity (Zhang et al., 2020).
- From 1990 to 2002, fishery resources dropped by 70%, with overfishing being a significant factor (Zhang et al., 2020).

Fishermen working on the Yangtze River

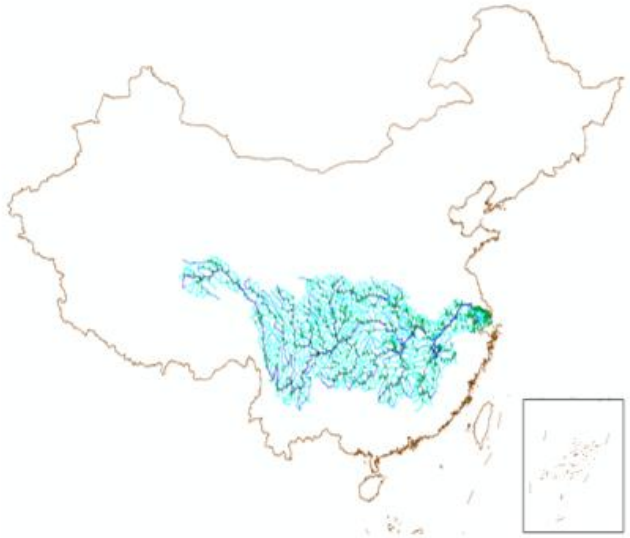
Use ultra-fine mesh to catch fish larvae

The Fishing Ban

- Fishing ban as national policy to reverse YRF decline.

- Implementation of fishing ban in 2003 (the first year)
  - Inspection team:
    - ~400 ships, ~8000 personnel.
  - Violations:
    - 3,309 illegal vessels found; 2,004 illegal cases penalized; ~2 million RMB in fines.
    - 11,991 deep water set & ghost nets dismantled; 70,742 kg fish confiscated.
  - Supporting measures for the ban:
    - Enforced with responsibility agreements
    - Fish stock enhancement targets with 100+ million fish seedlings being released.

- After 2003
  - Continue strict enforcement in breeding seasons.



The Yangtze River Basin in China

Data

Fish species-level dataset from multiple sources

- Fish species in China (Cnfishbase): biological classification (Lu et al., 2023).
- Fish species in Yangtze River: **YRF & non-YRF** (Yang et al., 2022).
- China Red List of Species (2004)-threatened level: extinct (EX), extinct in the wild (EW), critically endangered (CR), endangered (EN), vulnerable (VU)…
- Fish species endemic to Yangtze River upstream (Lin et al., 2019).

1562 fish species: 320 YRF (treatment) & 1242 non-YRF (control)

Research inquiries (funding)—NSF China programs

- Title, summary, keywords, funded year, institution, funding amount
- Variables: **number of funds & funding amount for each fish species, aggregated at fish species-year level** – balanced panel data

Research outputs: Publications, citation (major), books, patents, awards

- Variable: **publications per funded program**
- Variable: 5-year post-publication **citation per publication**

Baseline Regression Results

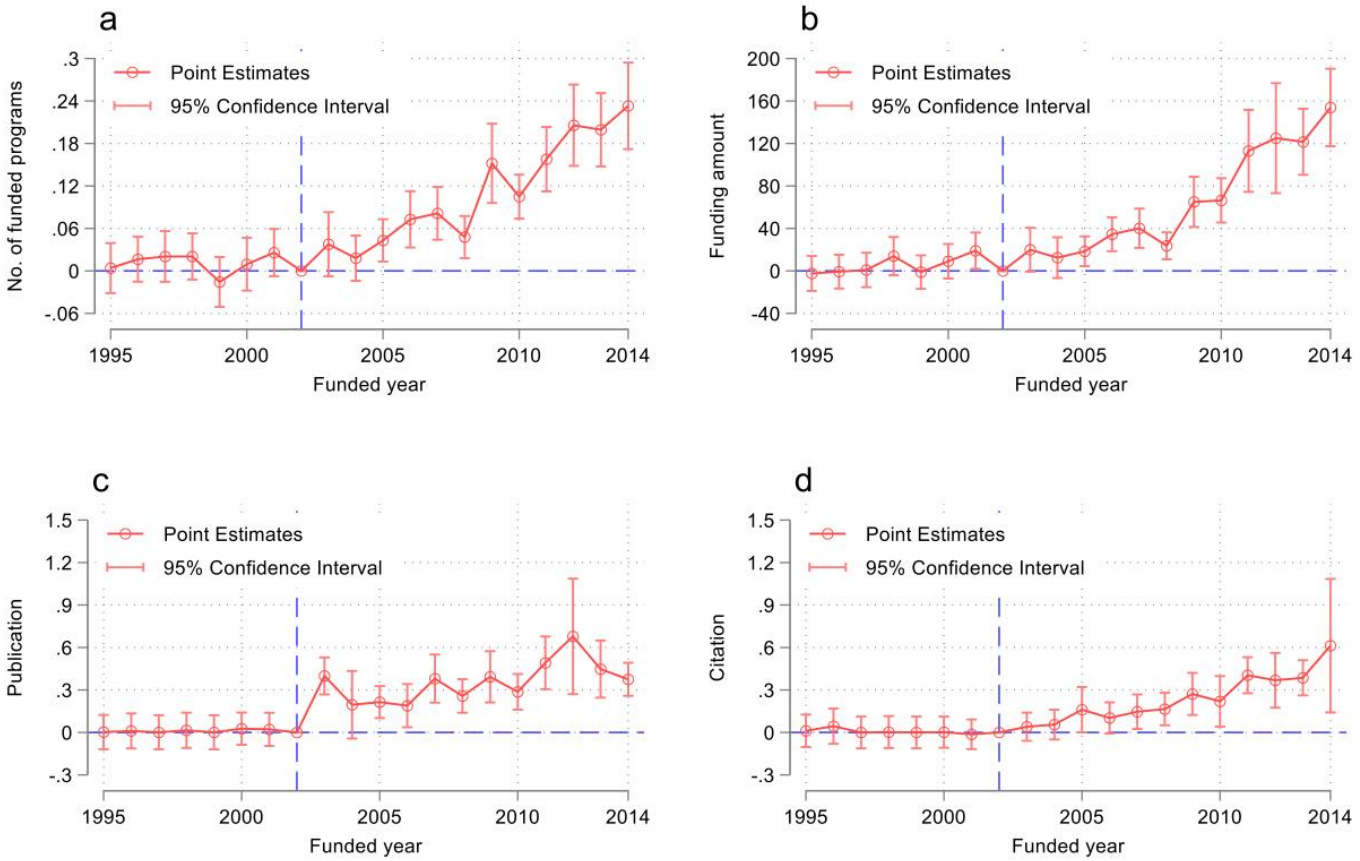
$$ScientificResearch_{f,t} = \alpha + \beta_1 YRF_f \times Post_t + \delta_f + \gamma_t + \varepsilon_{f,t},$$

TABLE 2: BASELINE RESULTS

	Number of funds	Funding amount	Publication	Citation
	(1)	(2)	(3)	(4)
YRF × Post	0.105***	62.848***	0.368***	0.238***
	(0.018)	(11.503)	(0.034)	(0.038)
Species FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.521	0.349	0.193	0.163
Obs	31240	31240	31240	31240

Event Study Findings

$$ScientificResearch_{f,t} = \alpha + \sum_{\tau \neq 2002} \beta_\tau YRF_f \times Year_\tau + \delta_f + \gamma_t + \varepsilon_{f,t}$$



Also significant increases in patents, books, awards, media coverage **(Table 3)**.

Crowd out other non-YRF programs?

- Is there a crowding-out effect on non-YRF research?
  - No, we observed that non-YRF research also increased after the ban.

TABLE A5: CHANGES IN SCIENTIFIC RESEARCH ON NON-YRF

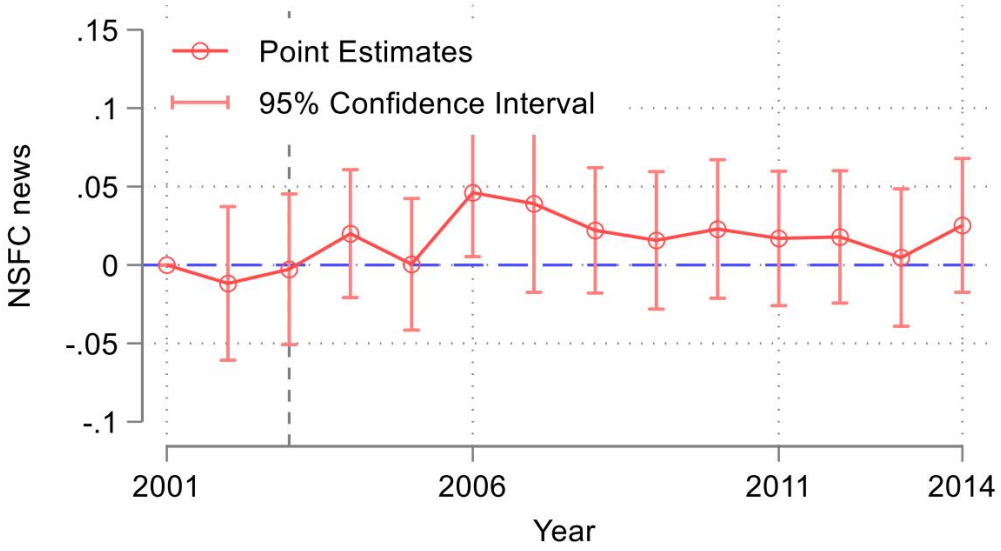
	Number of funds	Funding amount	Publication	Citation
	(1)	(2)	(3)	(4)
Post	0.008***	4.214***	0.047***	0.024***
	(0.002)	(1.018)	(0.008)	(0.005)
Species FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.296	0.206	0.125	0.156
Obs	24840	24840	24840	24840

Channel I: Was it because of policies directed at YRF research?

- Collected “fishing ban” related policy statements from various ministries of central government.
- Top 50 words **do not** include “science” or “research” related terms.

Channel I: Was it because of policies directed at YRF research?

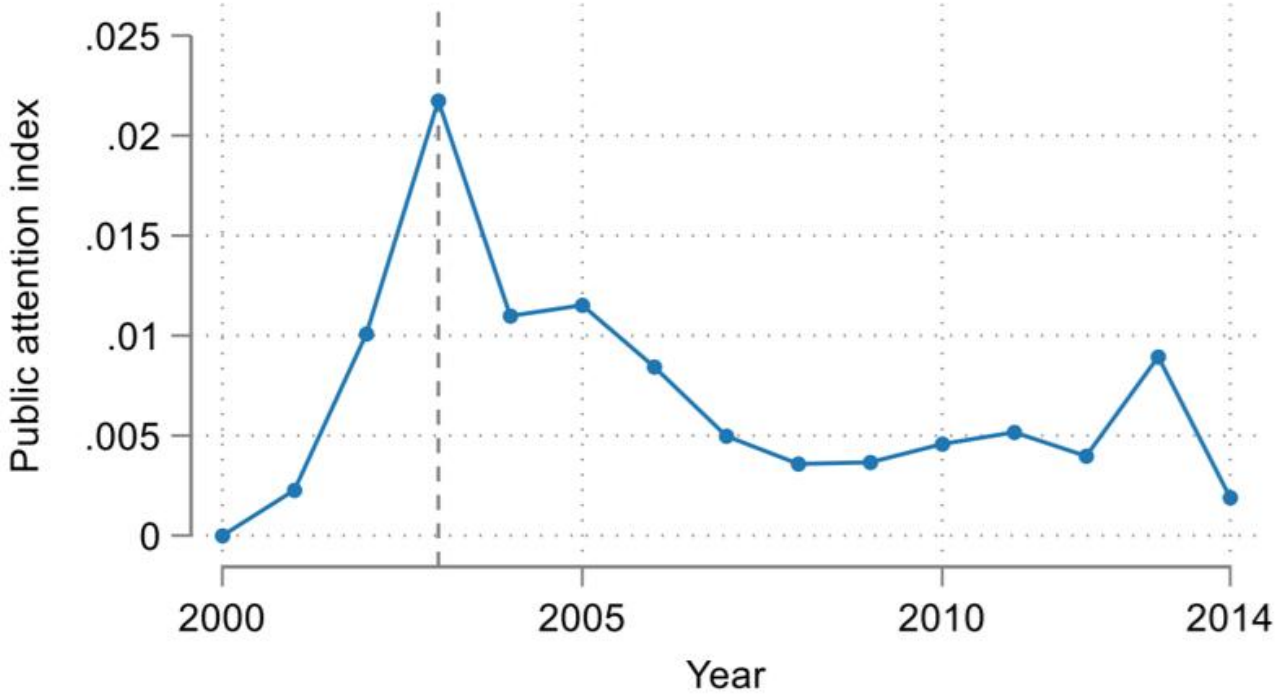
$$\mathbf{1}(News\ on\ Yangtze\ River\ Research)_{i,t} = \alpha + \sum_{t=2001}^{2014} \beta_t\, Year_t + \varepsilon_{i,t}$$



- Did the funding provider publicly express increased support for Yangtze River-related research after the fishing ban?
- Collected all news reports from NSF of China official website.
- No increase in news reports related to research on the Yangtze River.

Channel II: Because of heightened attention to the fishing ban?

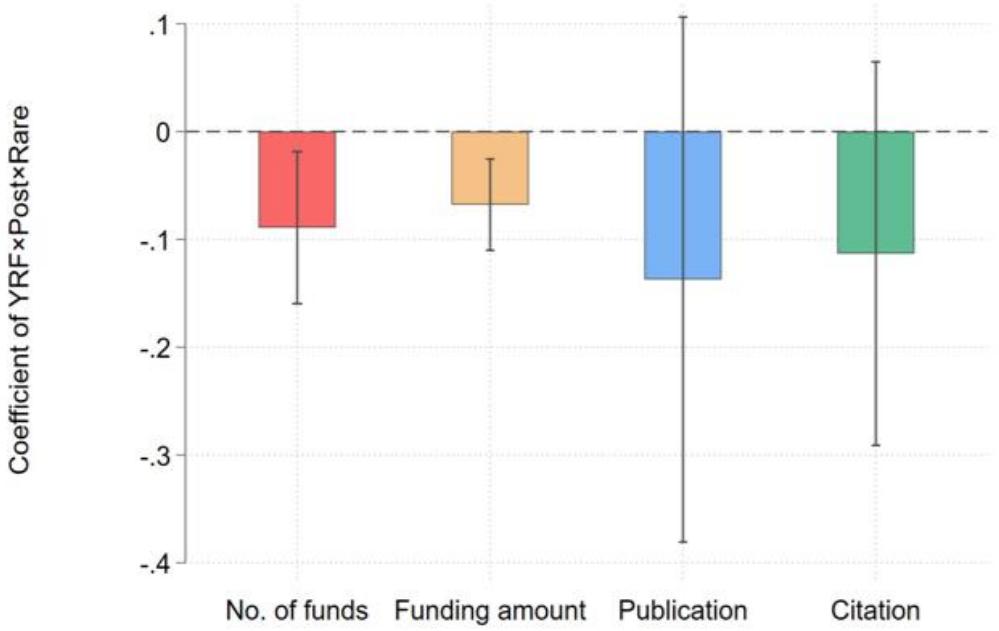
- Public attention to “Yangtze River fishing ban” peaks in 2003, declined afterward.
- Calculated by $\frac{Number\ of\ news\ on\ "Yangtze\ River\ fishing\ ban"}{Number\ of\ news\ on\ "Yangtze\ River"}$



Channel II: Because of heightened attention to the fishing ban?

- Maybe heightened **researcher** attention?
- **Rare fish species** typically capture researcher attention (Angulo et al., 2009; Angulo & Courchamp 2009).
- If "heightened researcher attention" is driver, we expect **increased research** on rare fish species.
- However, not the case.

$$ScientificResearch_{f,t} = \alpha + \beta_1 YRF_f \times Post_t \times Rare_f + \beta_2 YRF_f \times Post_t + \beta_3 Rare_f \times Post_t + \delta_f + \gamma_t + \varepsilon_{f,t}$$



Channel III: Is research boost because of more research materials?

Science research needs extensive repeated experimentation and ample research subjects.

We examine the "research materials" mechanism from three aspects:

(1) Scientists **working near Yangtze** may have advantages in accessing materials.

→ Whether the institution to which the fund recipient belongs is located within the Yangtze River Basin.

(2) Research materials are unavailable for **extinct fish species.**

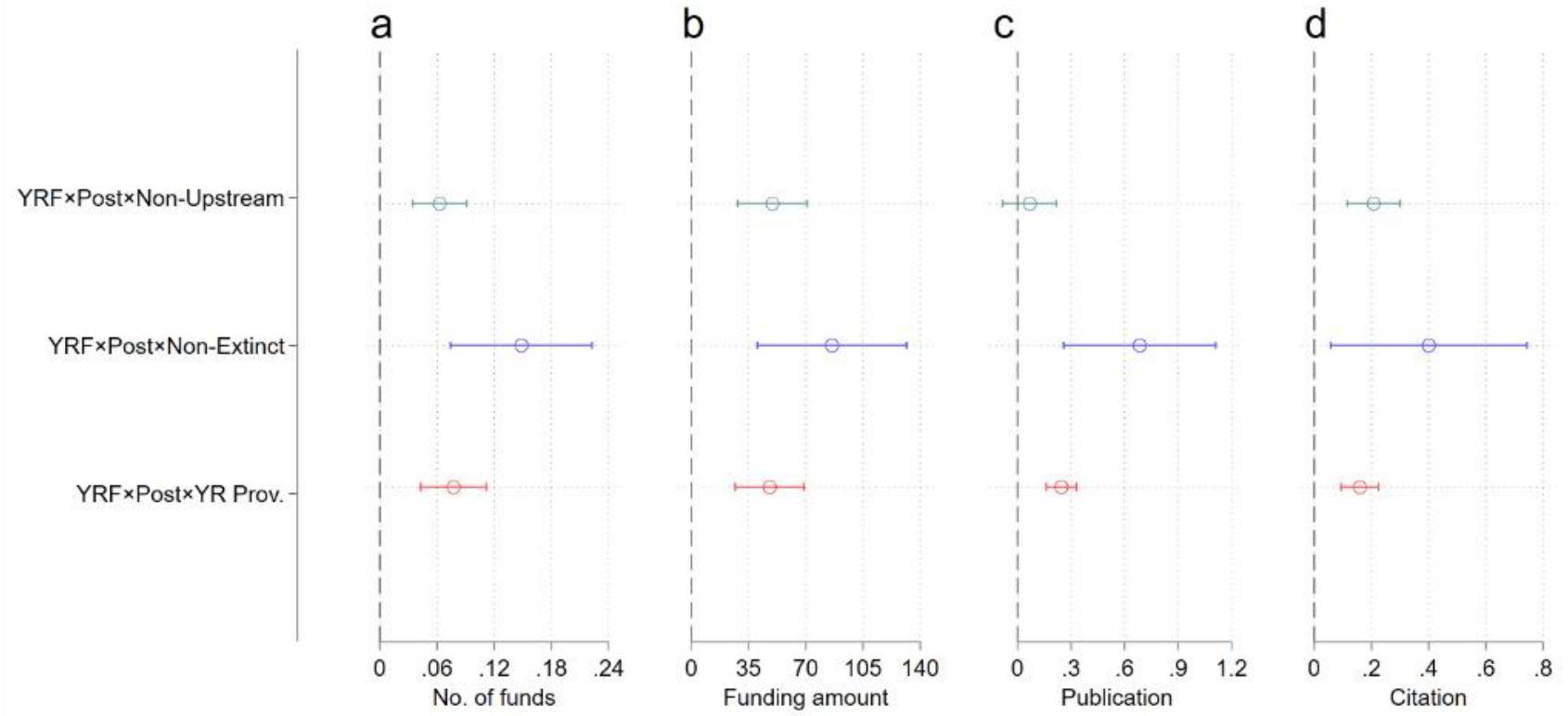
→ Whether the fish species is extinct (or extinct in the wild).

(3) Due to hydropower infrastructure in the **upstream of Yangtze**, recovery effect on fish populations is weaker, thus less materials.

→ Whether the fish species is endemic to the upstream of Yangtze.

Channel III: Is research boost because of more research materials?

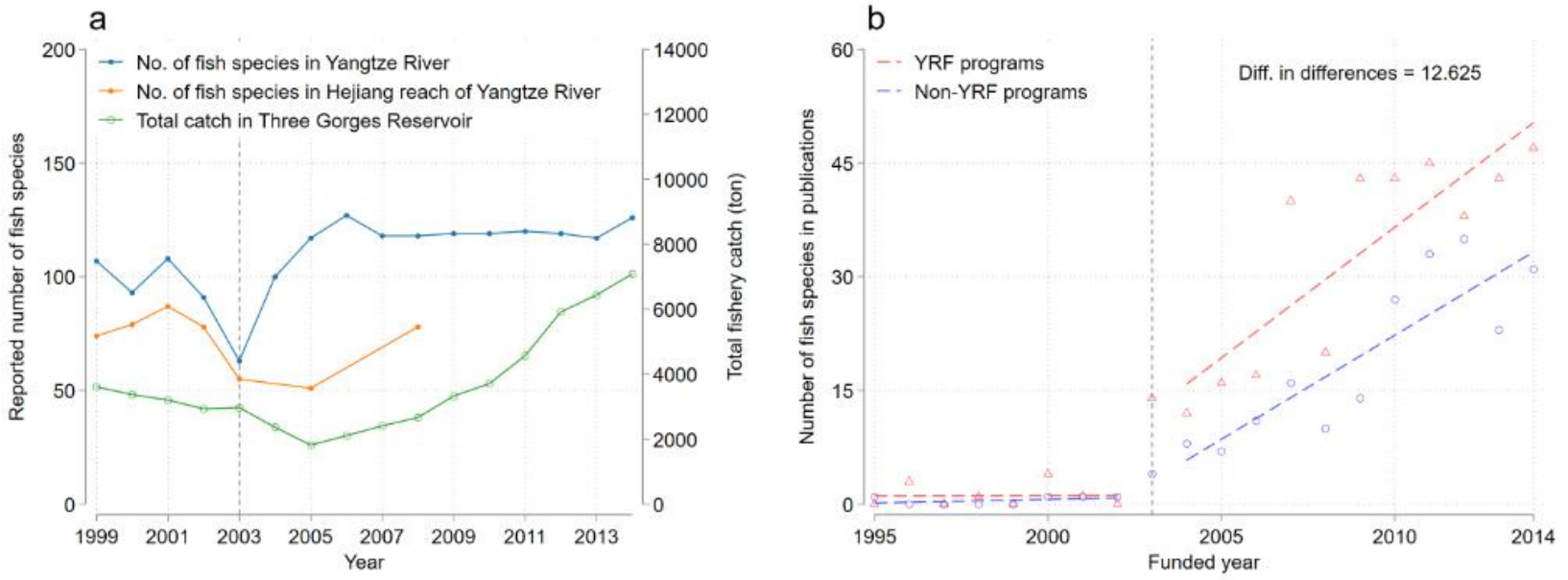
FIGURE 2: HETEROGENEITY OF THE IMPACT OF THE FISHING BAN



Channel III: Is research boost because of more research materials?

- a: trend of declining fish diversity and numbers were reversed.
- b: diversity of YRF research (measured by the number of fish species in publications) increased.

FIGURE 3: INCREASE IN BIOLOGICAL MATERIALS AND NUMBER OF SPECIES IN PUBLICATIONS



What are the key takeaways?

- **Fishing ban in China in 2003 boosted scientific research related to YRF**
  - Number of funded programs increased by 97%, compared to pre-shock levels.
  - Funding amounts increased by 230%.
  - Associated publications and citations increased by 273% and 458%, respectively.
  - Other scientific output and public influence:
    - Associated patents, awards, and books ↑
    - Public influence of YRF research ↑
  - Without crowding out other research in terms of talent/funding

- **Potential mechanisms at work associated with research boost?**
  - × Research policies concerning YRF programs expanded?
  - × Increase in public attention to the fishing ban?
  - ✓ <u>Increase in research materials!</u>

What are the key implications?

- **Implications for conservation policies and science:**
  - Conservation policies can have positive externalities on scientific research.
  - Sustainability initiatives thus facilitate **knowledge creation and dissemination**, serving as **strategic investments** in future science and technology.

- **Factors driving scientific advancement:**
  - Accessible and abundant **research materials** are crucial for scientific advancements, in addition to research funding (Azoulay et al., 2019).
  - These resources enable researchers to conduct comprehensive experiments, validate hypotheses, and push the boundaries of scientific knowledge.