Strategic restoration-development to mitigate fish habitat fragmentation

for low impact hydropower in the Mekong

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ns
l degradation

The last Chinese paddlefish (*Psephurus gladius*) was seen alive in 2003, and they've been declared extinct. Due to their rarity, and untimely demise, there are very few photos of the species.

PHOTOGRAPH BY QIWEI WEI

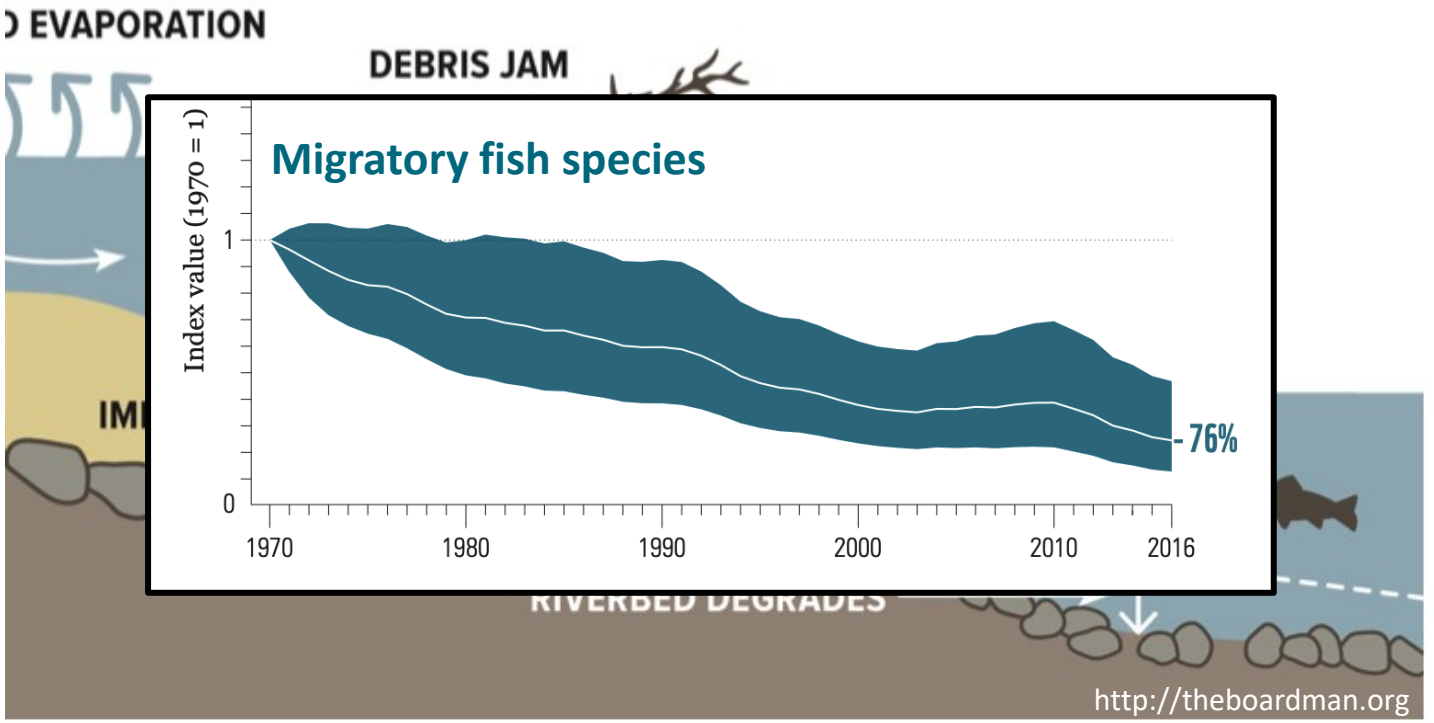
ANIMALS

The Chinese paddlefish, one of world's largest fish, has gone extinct

Native to China's Yangtze River, these fish grew 23 feet in length, but haven't been spotted since 2003.

4 MINUTE READ

BY DOUGLAS MAIN

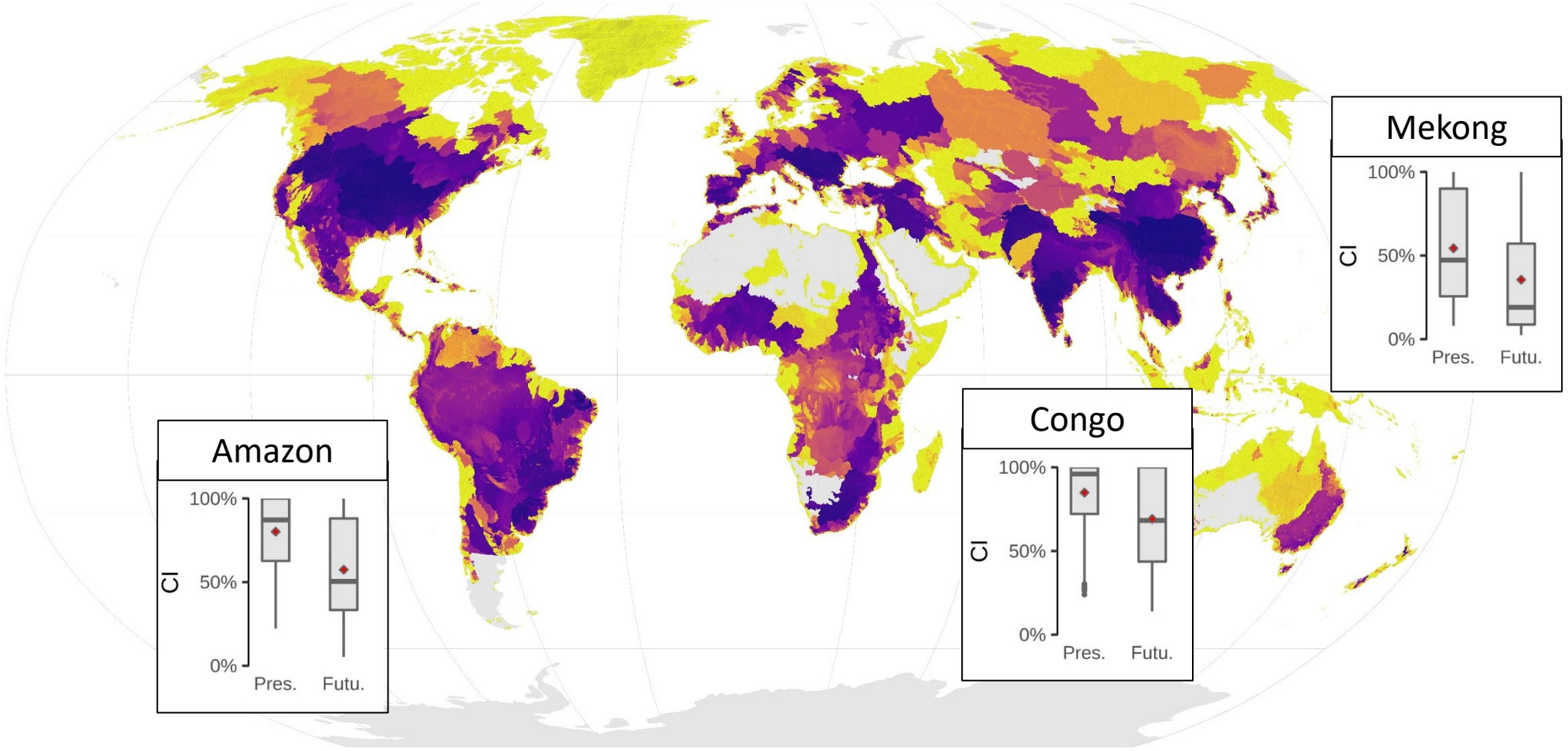


- FLOOD CONTROL
- RECREATION, NAVIGATION, FISH FARMING, (…)

HABITAT LOSS/DEGRADATION:
- CONNECTIVITY LOSS
- FLOW ALTERATION
- TEMPERATURE & CHEMISTRY ALTERATION
- SEDIMENTS & NUTRIENTS RETENTION

Fragmentation impacts on **10,000 freshwater fishes**

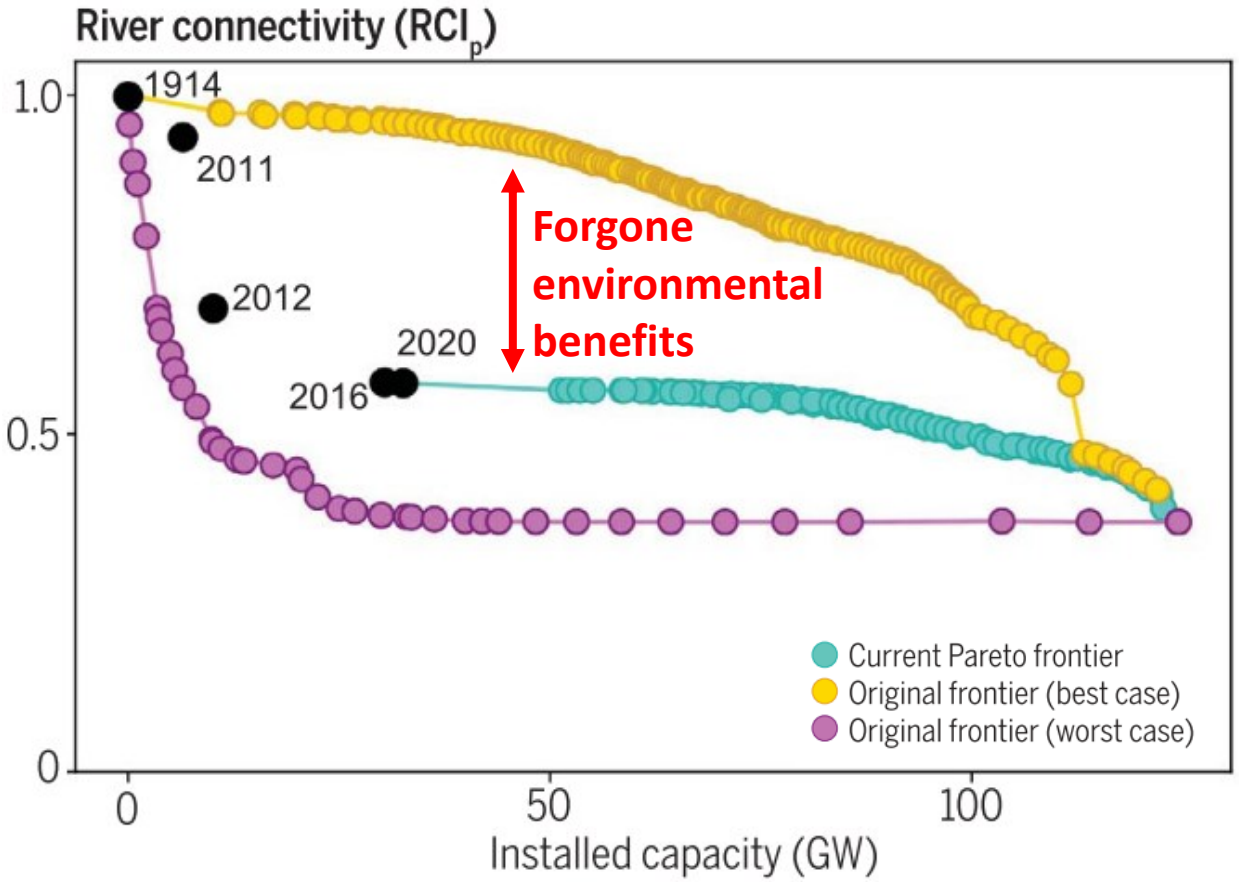
40,000 existing + 3,700 planned dams

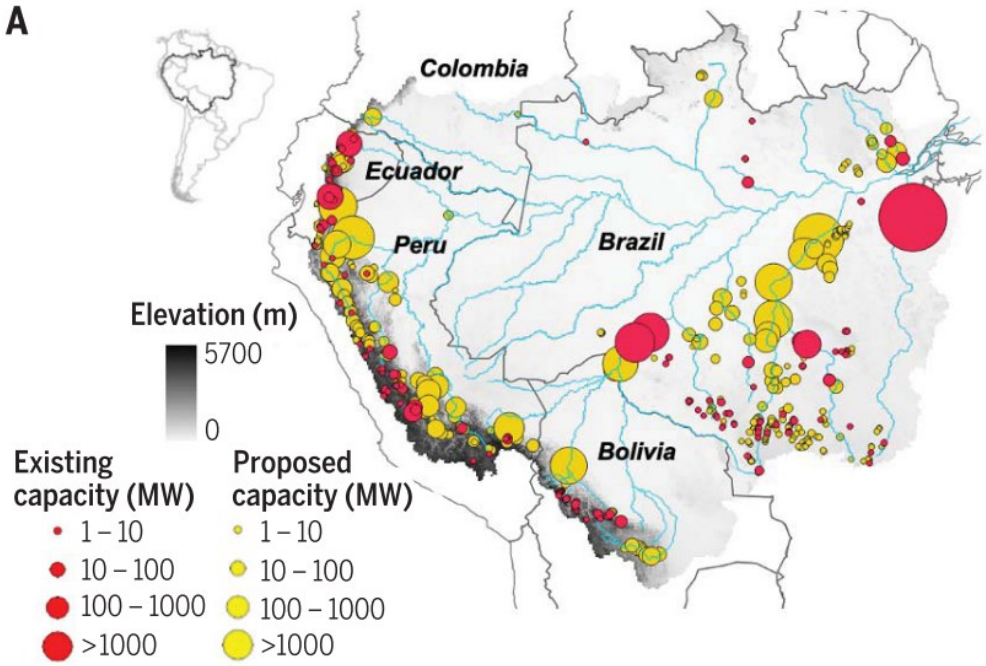


Barbarossa et al., 2020, *PNAS*

Strategic planning of future dams

Forgone environmental benefits of uncoordinated dam planning





Flecker et al., 2022, *Science*

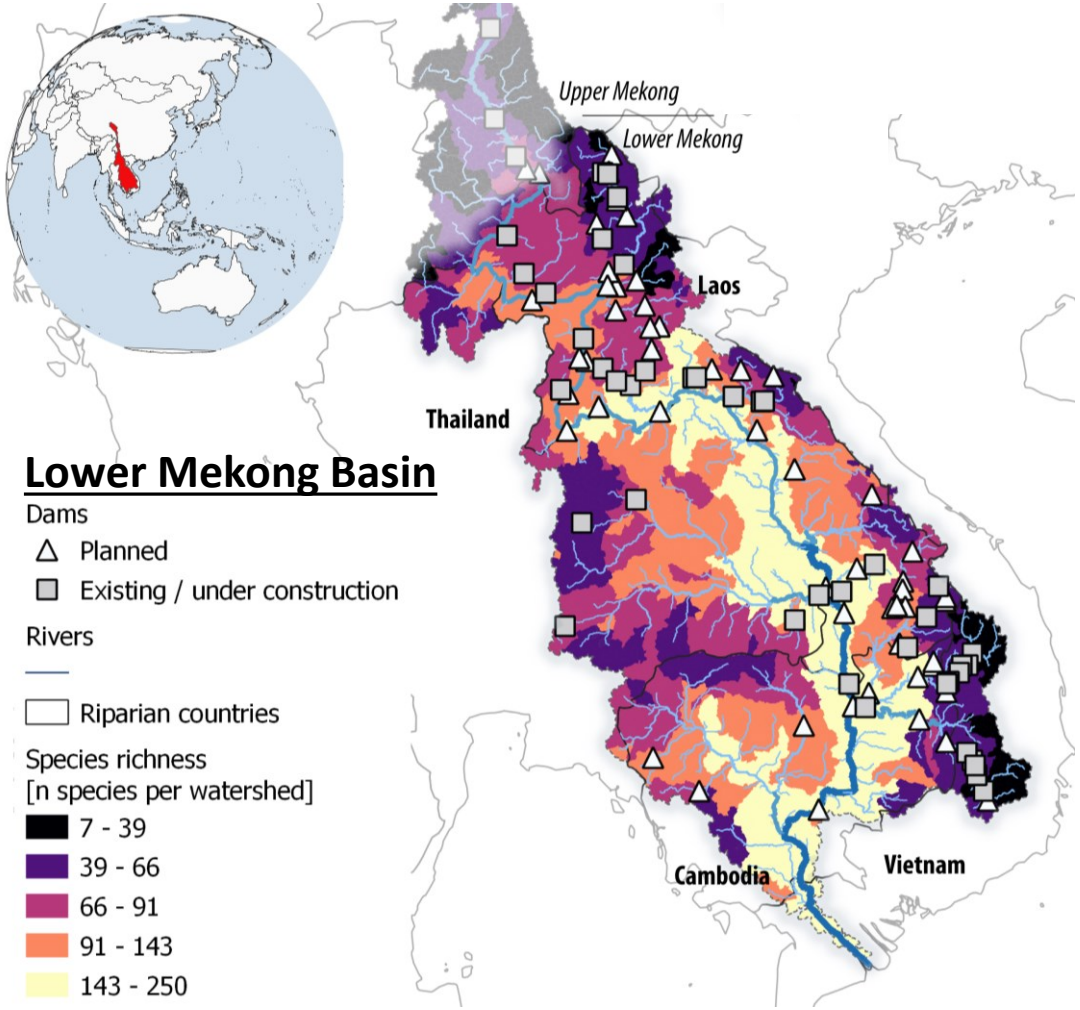
Aim of this study

Strategic restoration-development for sustainable hydropower

policy ambition

- **Scenarios** that consider
  - **Strategic** planning
  - **+ Retroffiting** dams with fishways
  - **+ Removal** of most impactful dams

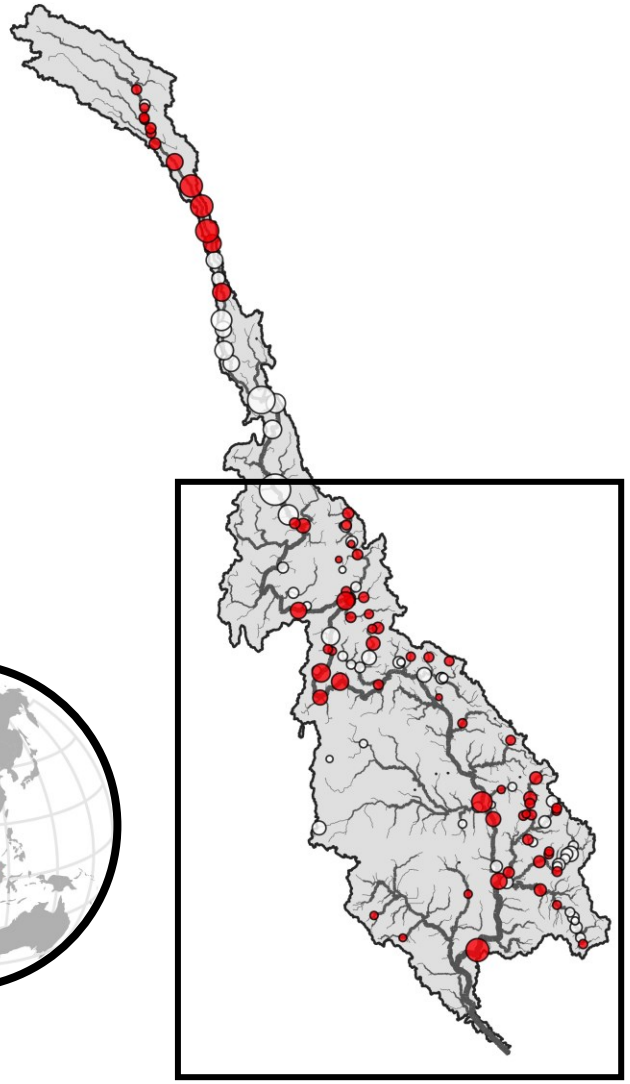
- **Multi-objective optimization:**
  fish habitat frag vs energy production
- **Distribution of fish species:**
  Species-specific connectivity index



Barbarossa & Schmitt, *in review*

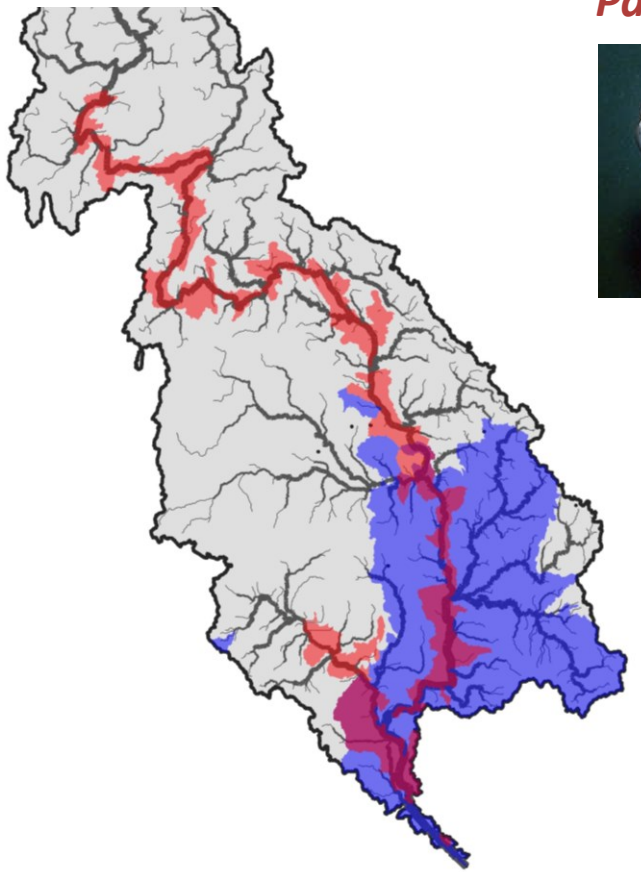
Considering species distribution is key

Example of species distribution in the Mekong



existing
future

Inst. Cap. [MW]
0
1000
2000
3000
4000
5000



Pangasiondon gigas

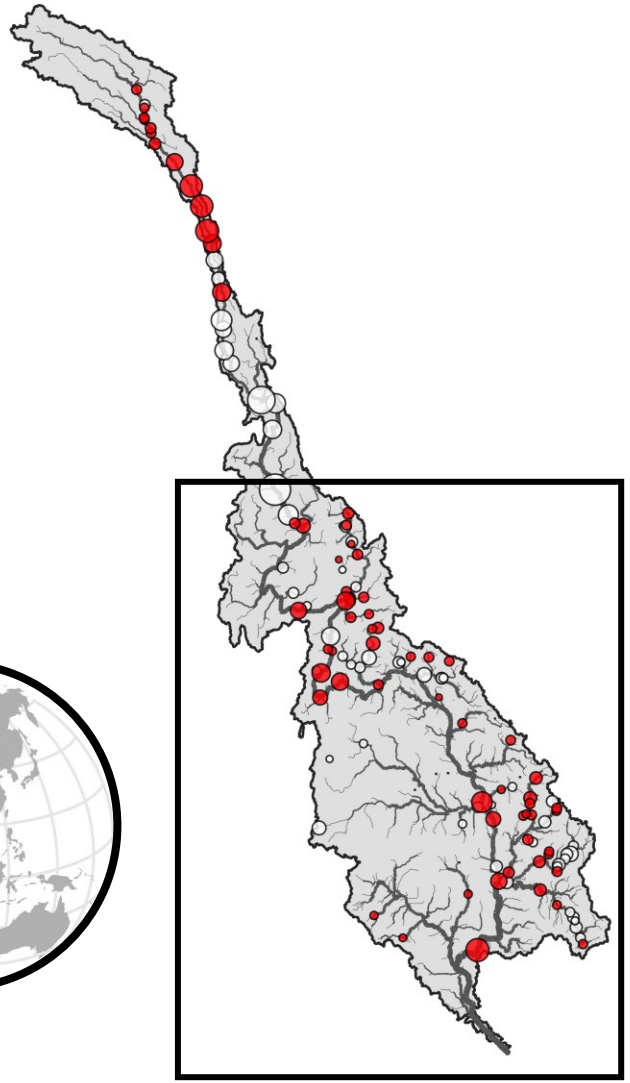
→ CI = 100%

Barbodes rhombeus

→ CI = 100%

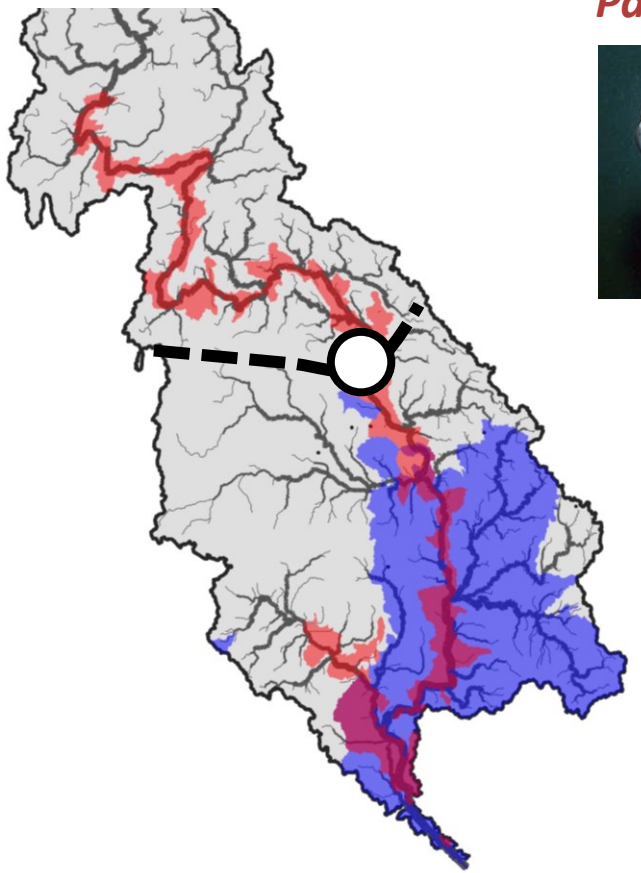
Considering species distribution is key

Example of species distribution in the Mekong



existing
future

Inst. Cap. [MW]
0
1000
2000
3000
4000
5000



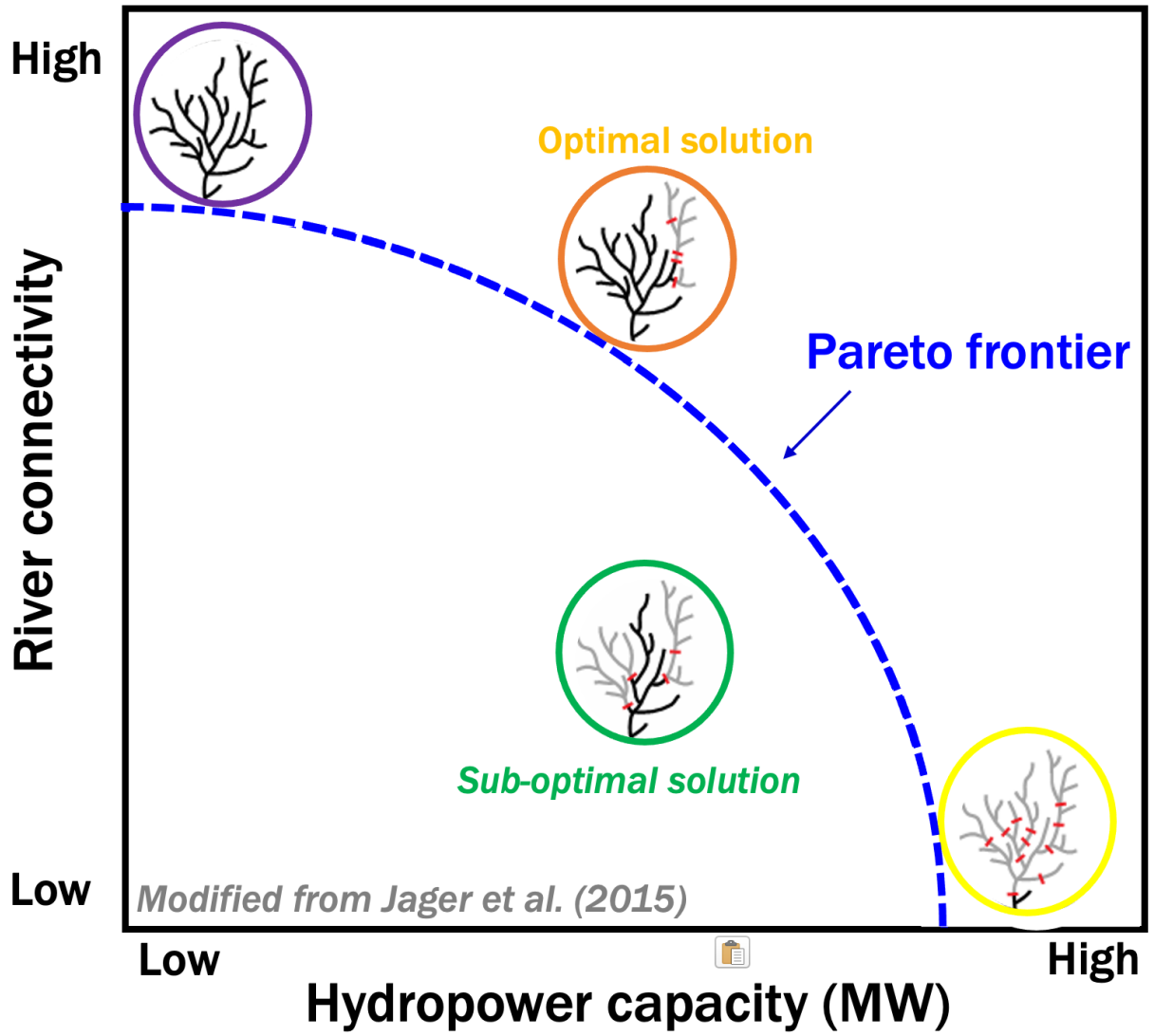
Pangasiondon gigas

→ CI = 60%

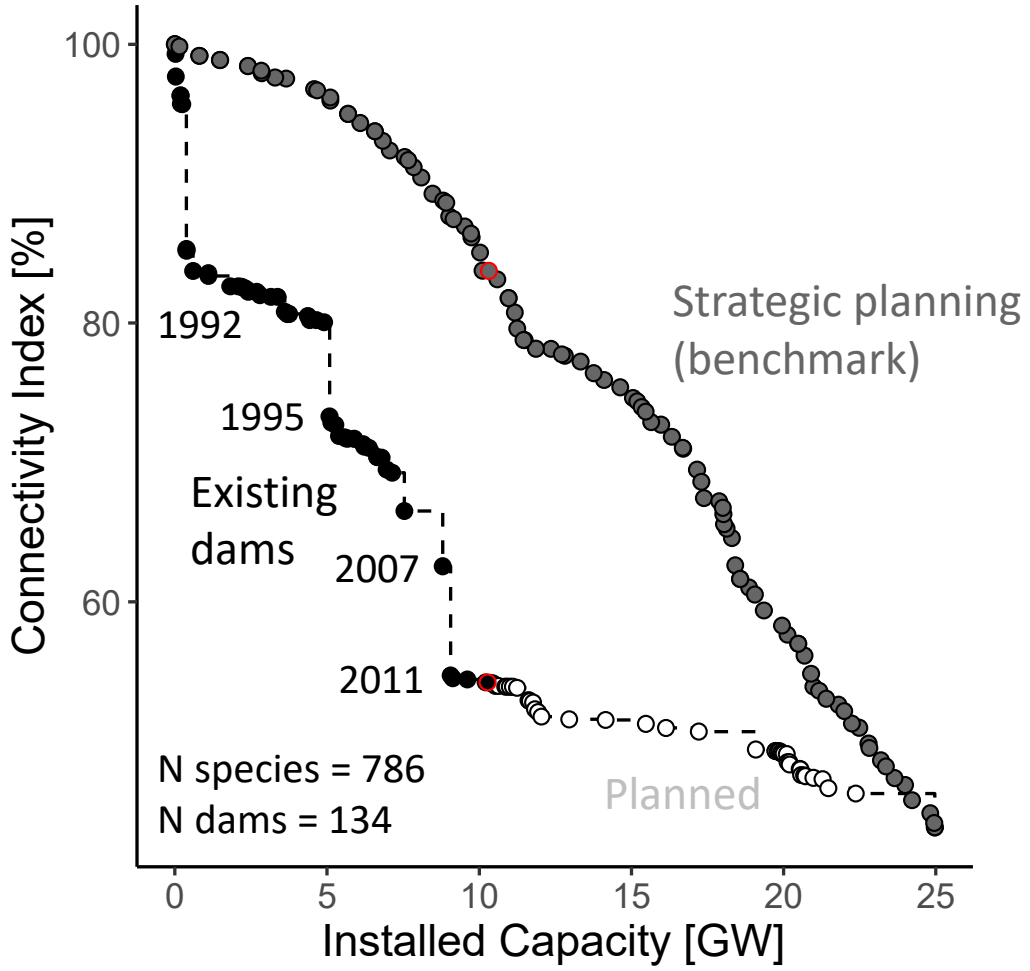
Barbodes rhombeus

→ CI = 100%

A note about pareto frontiers

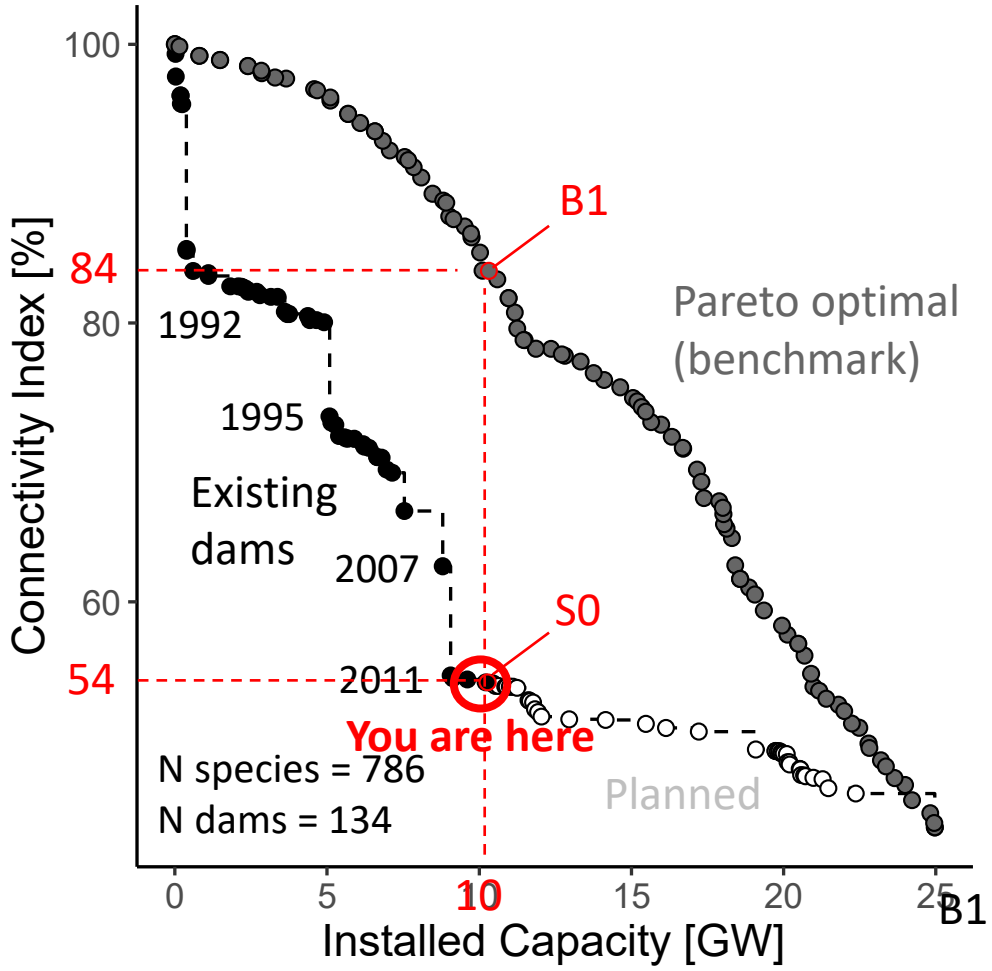


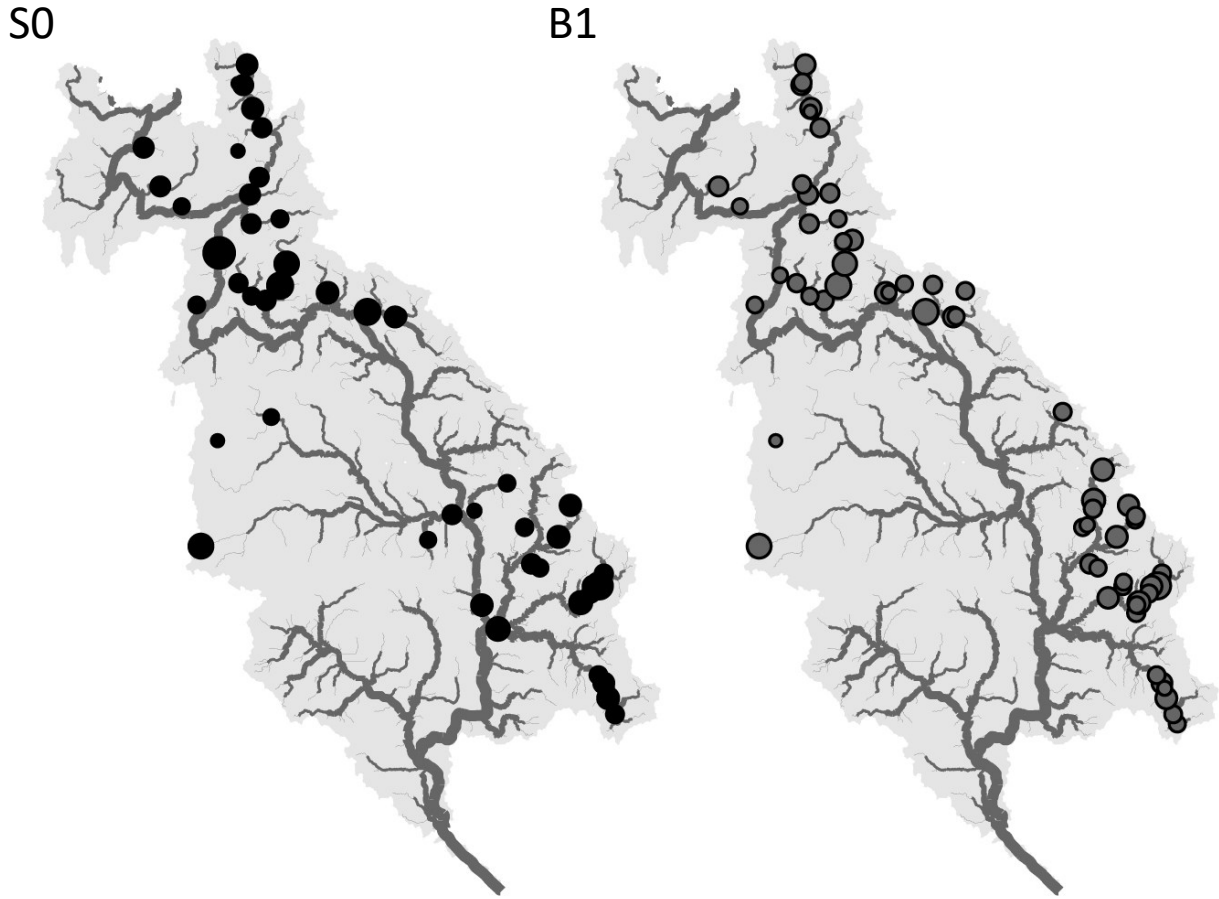
Missed opportunities in the Lower Mekong



Barbarossa & Schmitt, *in review*

Missed opportunities in the Lower Mekong





Barbarossa & Schmitt, *in review*

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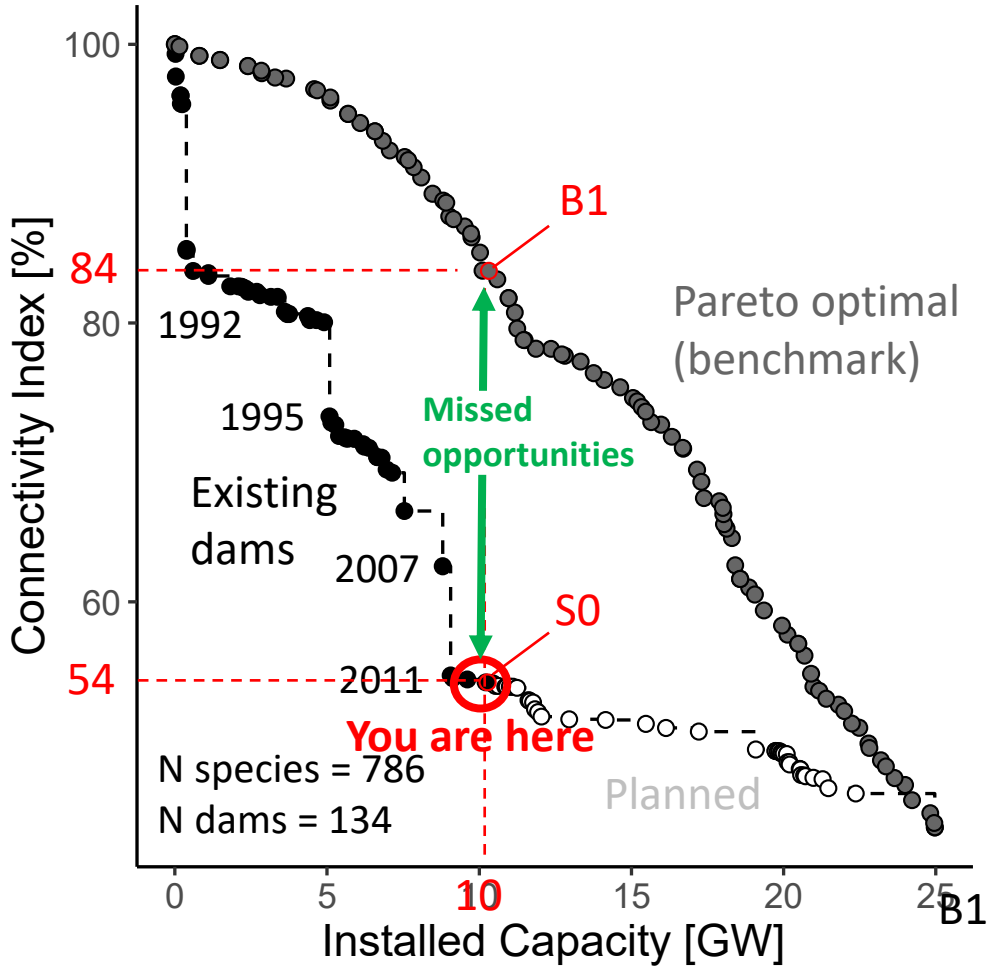

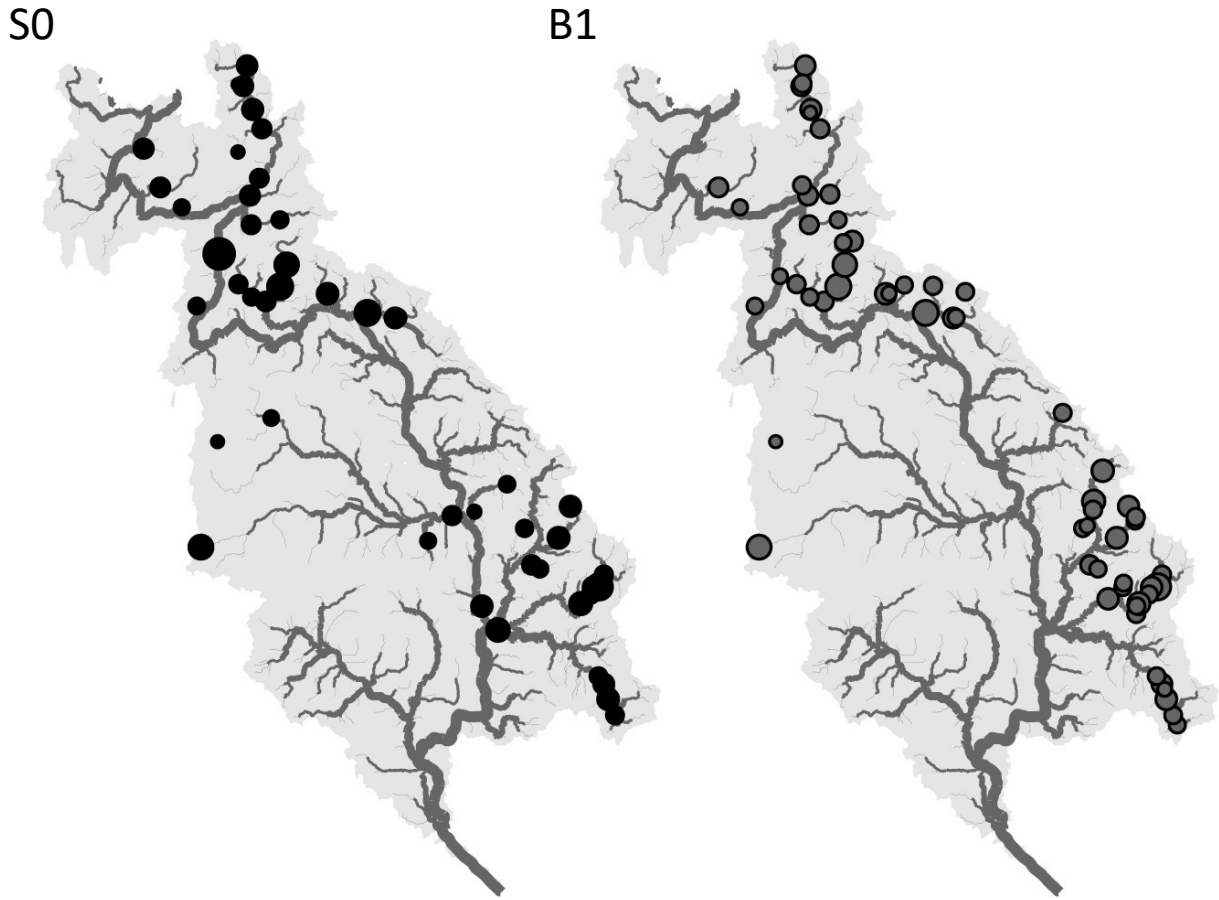

Barbarossa & Schmitt, *in review*

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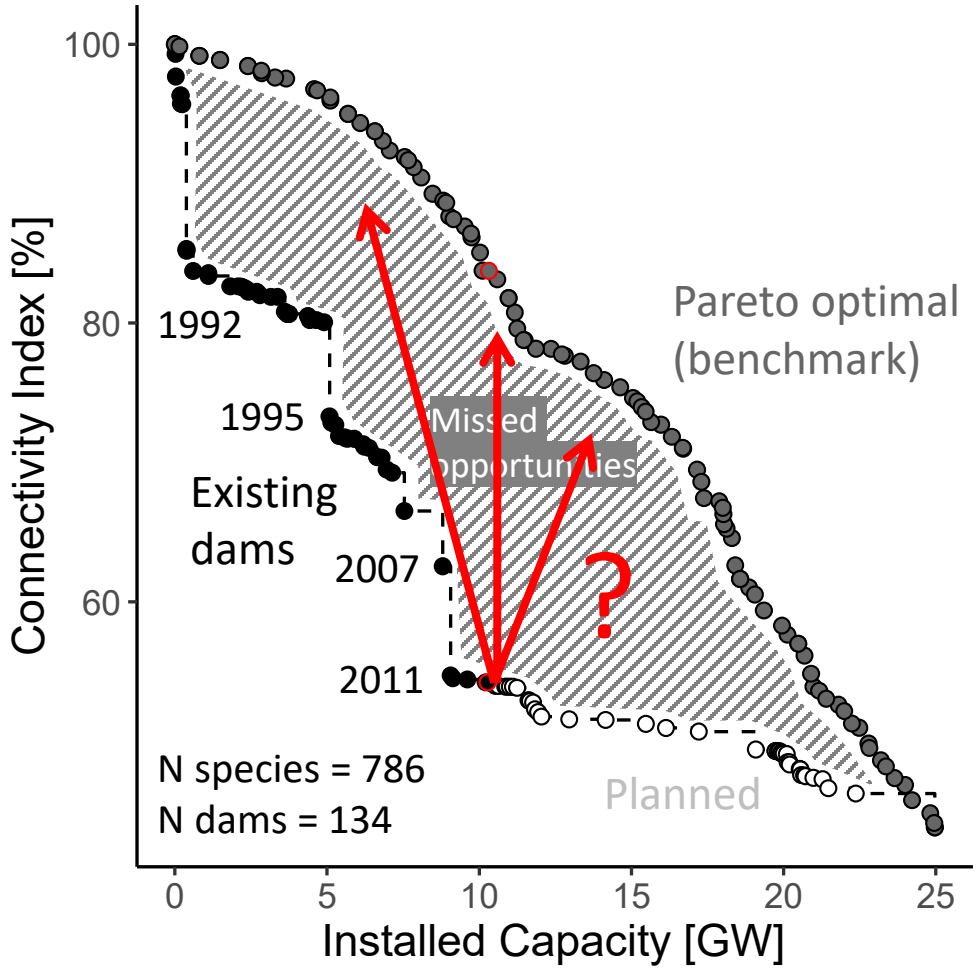

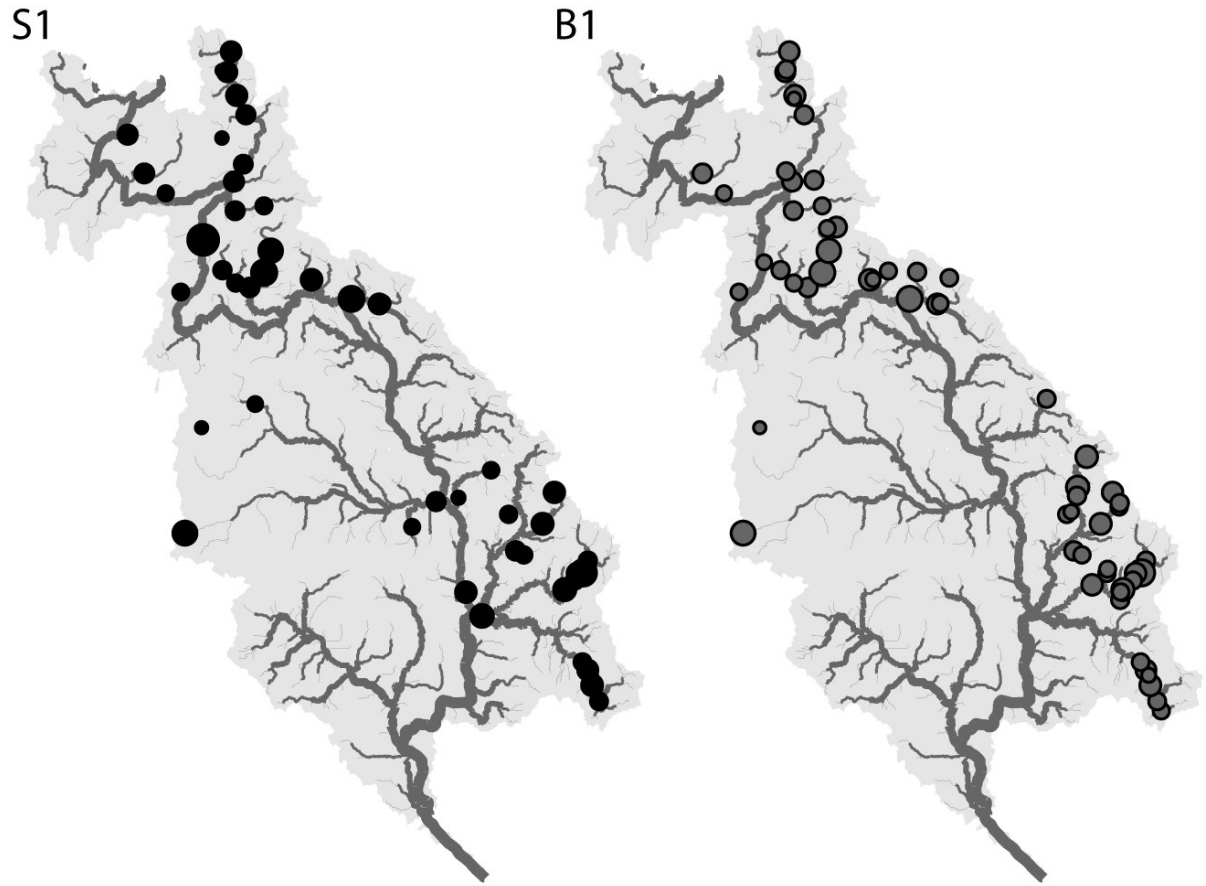

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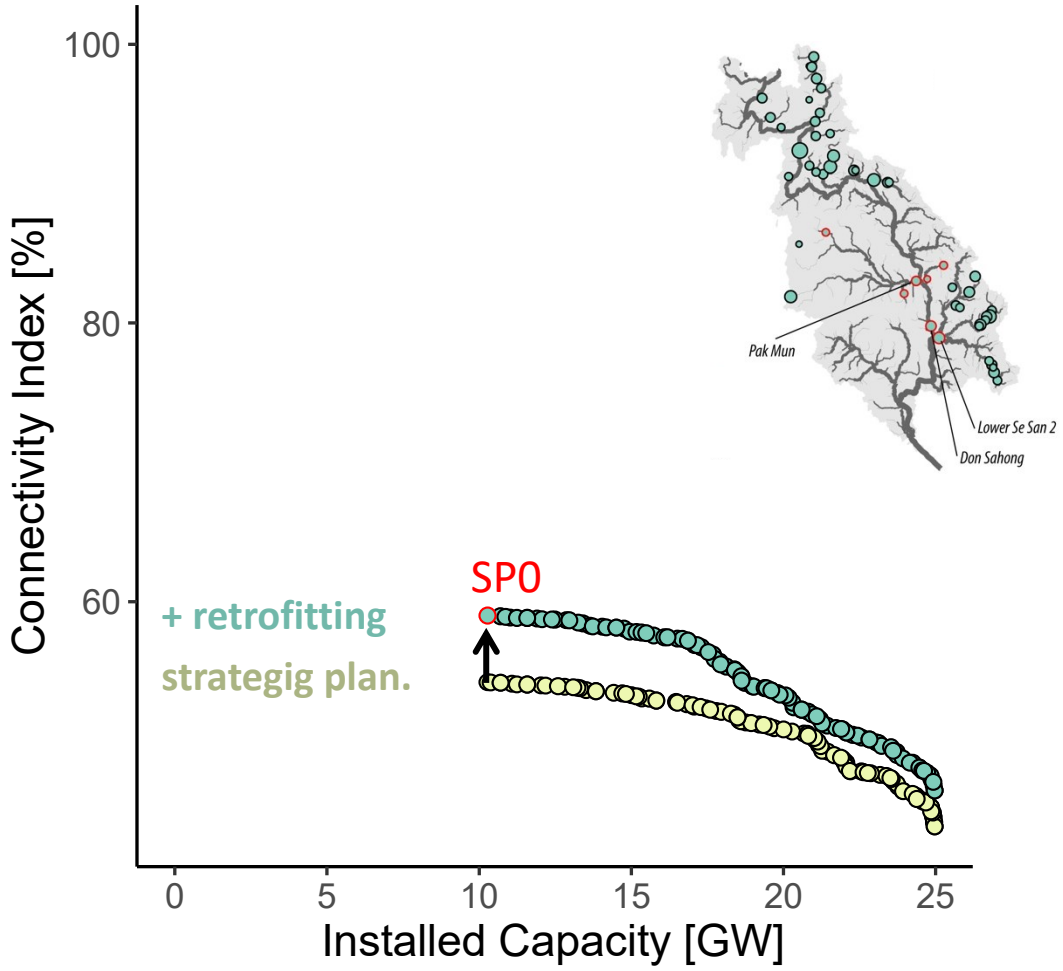
Fishways retrofitting + strategic planning

Retrofitting 7 existing dams with fish passages increase connectivity from 54 to 59% (56-63%)



- Dams that are not in the optimal portfolios and are lower than 50m are retrofitted with **bypass/ladder**
- Probability to cross the barrier for fishway: 30% (10-50% Conf. Int.)

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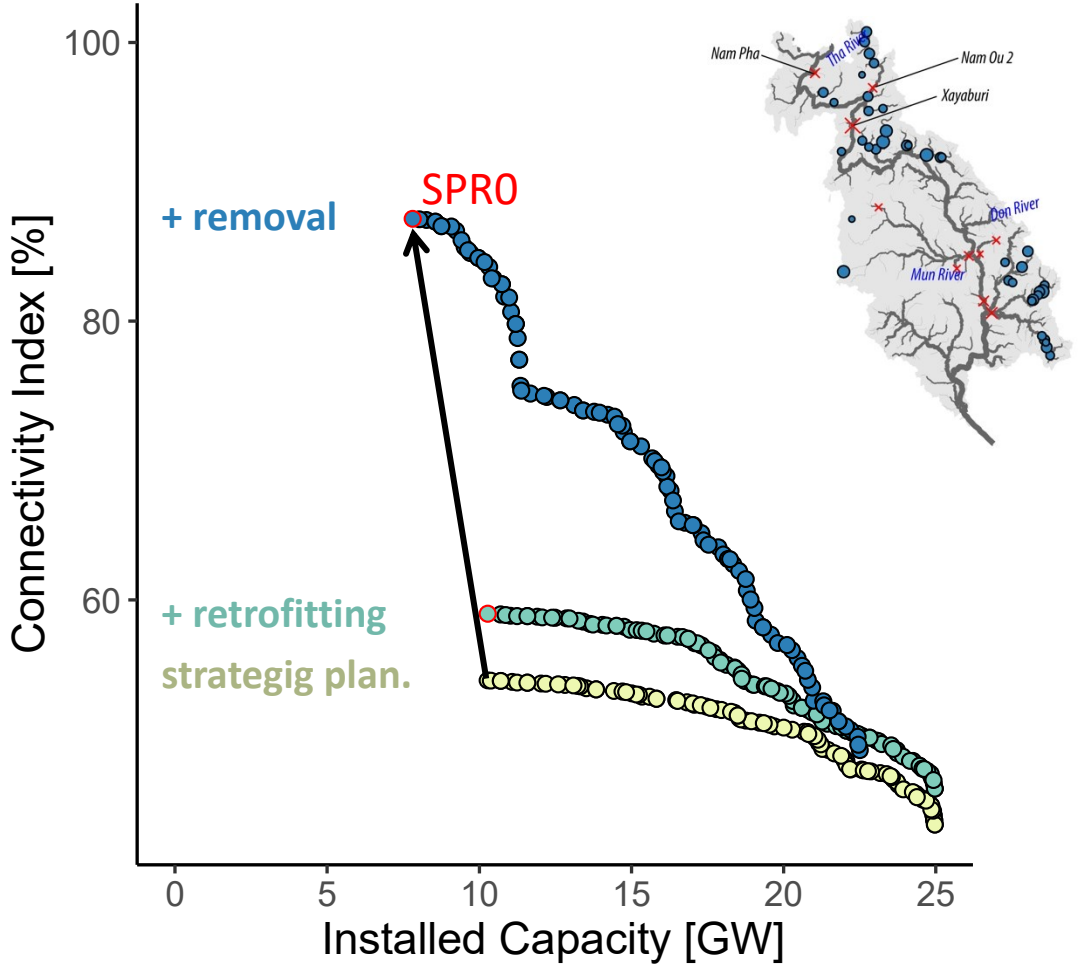
Removal + retrofitting + strategic planning

Removing 10 most impactful dams restores connectivity



- Dams that are not in the optimal portfolios are removed
- We assume that after removal longitudinal connectivity is restored

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Remarks

- Strategic restoration-development as a new paradigm to break locked-in opportunities for sustainable hydropower development
  - Strategic planning alone insufficient
  - Retrofitting with fishways only small benefits
  - Removal effective in restoring connectivity
- However,
  - Removal is a very expensive process, happening in US and EU mostly
  - Estimation of barrier passability in the presence of a bypass system is very uncertain
  - No accounting for local governance and transboundary issues
- Our approach to understand opportunities for:
  - Biodiversity-inclusive hydropower expansion
  - Coordinated dam removal and fishways installation

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