

# Assessing the conservation effectiveness of protected areas for fishes with dam impacts

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## Objectives

Global freshwater ecosystems are facing unprecedented threats. Setting protected areas (PA) is prevalent for fish conservation worldwide. Owing to inadequate planning, the effectiveness of PAs tends to be lower than expected, especially under stresses such as construction of dams. The Yellow River is one of the longest rivers in the world and had the earliest human activities and hydropower development in China. This study used spatial analysis method to assess the effectiveness of PAs for the conservation of endangered and endemic fishes in the Yellow River. Trait-based methods were also used to analyze the current and potential impact of dams towards fish conservation.

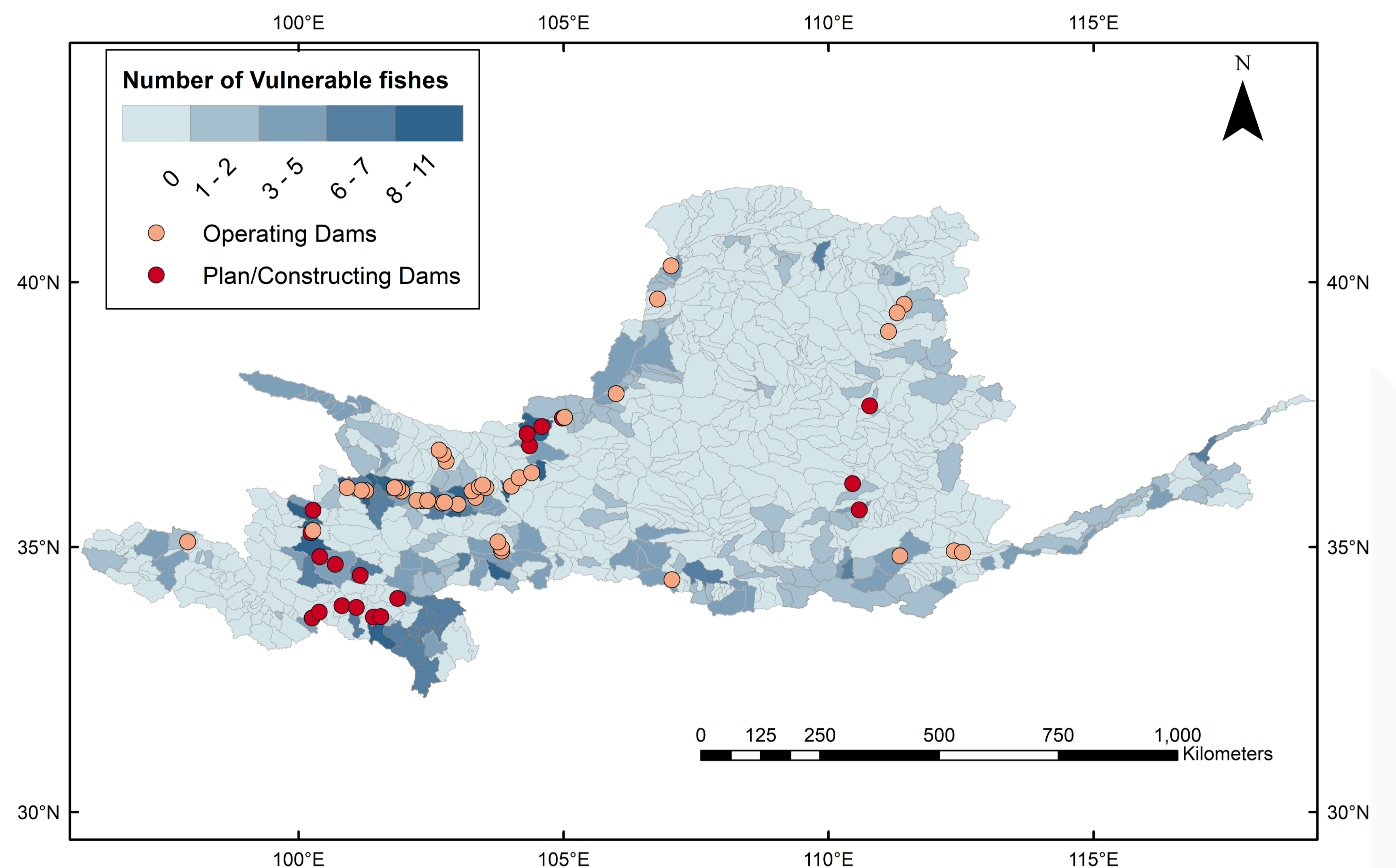
## Methods

To assess the conservation effectiveness of PAs for 35 endangered or endemic species in the Yellow River, 48 Nature Reserves, 46 National Aquatic Germplasm Reserves and more than 40 operating/planning dams were compiled in analysis. The Yellow River Basin was divided into 846 subcatchments.

To assess the effectiveness of PAs, spatial relationship between fish habitats and PAs was compared and the numbers of targeted PAs for each fish were analyzed. A subcatchment was considered protected if there was at least one PA overlaid with it. The non-parametric Wilcoxon test was used to assess the difference in the number of targeted PAs and the coverage ratio between species groups. The Spearman rank sum correlation was used to analyze the relationships of the species' numeric traits, maximum body size in this study, with the number of targeted PAs.

## Results

Results showed that seven endemic but narrowly-distributed fishes (e.g. *Triplophysa shaanxiensis*) were completely absent from existing conservation of PAs, while fishes in the Source and Upper reaches had better conservation efforts. No significant difference in PA numbers between endemic and non-endemic species was found; fishes listed as endangered and fishes with larger body size had more PAs targeting them. Dams overlapped most with habitats of vulnerable fishes in the Source and Upper reaches. Vulnerable species such as *Gobiobotia homalopteroidea* were less covered by PAs and called for better conservation.

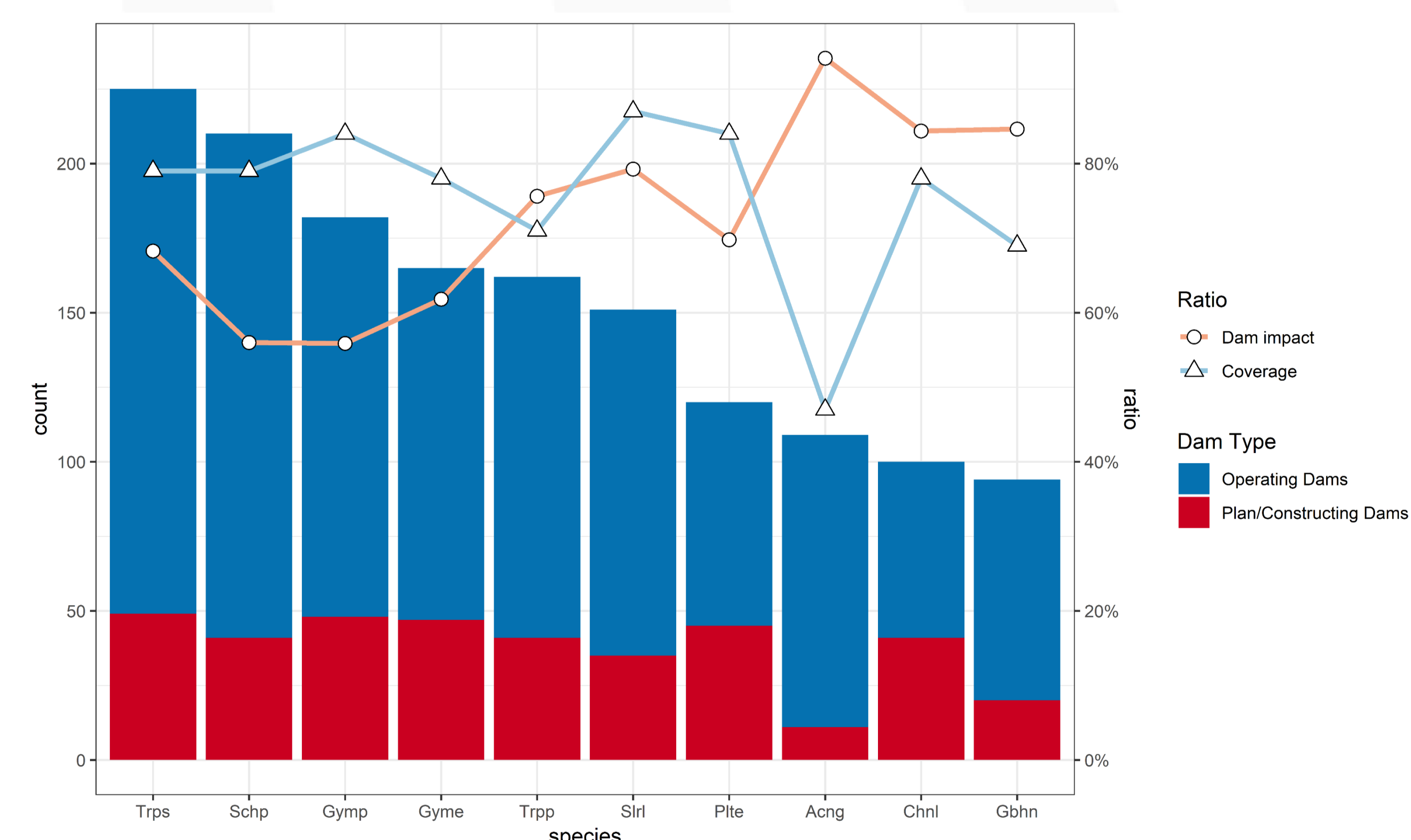


**Figure 1** Distribution of dams and fishes with traits vulnerable to dams in the Yellow River\*

\* Dams are classified into "Operating Dam" and "Plan/Constructing Dam". Vulnerable fishes are defined as fishes with at least one trait vulnerable to dam. Diversity of vulnerable fishes are aggregated and displayed by subcatchments.

## Conclusions

The results stressed the importance of conservation planning in areas with construction of dams. We recommend using systematic conservation planning method in the Yellow River to allocate limited conservation resources more efficiently and take into account the neglected endemic species. The analysis framework we used could aid researchers in developing regions to assess both the impact of dams and the conservation effectiveness of existing PAs and validate the importance of systematic conservation planning in freshwater ecosystem.



**Figure 2** Species with the highest ratios of dam impacted or protected area (PA) covered habitats\*

\*Trps, *Triplophysa siluroides*; Schp, *Schizopygopsis pylzovi*; Gymp, *Gymnodiptychus pachycheilus*; Gyme, *Gymnocypris eckloni eckloni*; Trpp, *T. pappenheimi*; Srlr, *Silurus lanzhouensis*; Plte, *Platypharodon extremus*; Acng, *Acanthogobio guentheri*; Chnl, *Chauchia labiosa*; Gbhn, *Gobio huanghensis*.