Can the “10-year fishing ban” rescue biodiversity of the Yangtze River?

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Rivers and their lakes are among the world’s most important ecosystems supporting high biodiversity and providing various services through connections with vast landscapes. Reconciling exploitation with sustainability remains one of the world’s greatest challenges to maintain and/or recover the health of river ecosystems and hence their biodiversity and ecosystem services.[1] As one of the major national initiatives toward building “ecological civilization” and an extensive

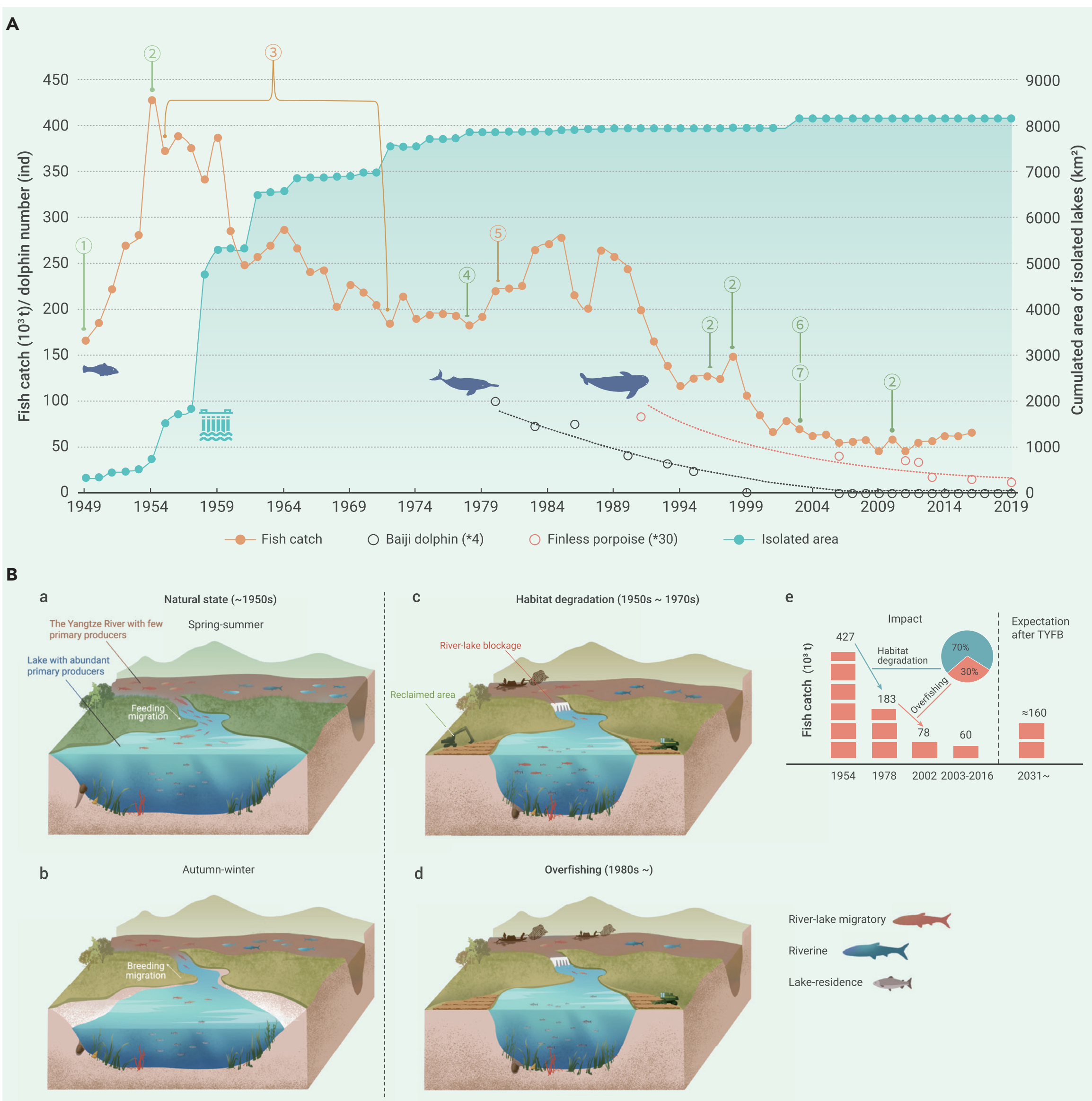

Figure 1. Multiple stressors threating the river-lake ecosystems of the middle and lower Yangtze Basin with collapse of fish catch during the past decades (A) Changes in fish catch and population size of freshwater dolphins and various significant associated events in the Yangtze River. (1) Founding of PR China; (2) extreme flooding events; (3) intensive lake reclamation and river-lake blockage; (4) re-form & opening-up policy starting in 1978; (5) wide application of high-efficiency fishing gear; (6) initiation of spring fishing moratorium policy; (7) operation of the Three Gorges Dam initiated. (B). The river-lake ecosystems under different conditions. Natural state (a, b), states after reclamation and blockage (c) and overfishing (d), and relative contributions of habitat degradation and overfishing to fish catch declines and expected fish catch after the TYFB plan (e).

protection of the Yangtze River in China, a "10-year fishing ban" plan (TYFB) was launched from January 2021. The TYFB aims at recovering the fish stocks and aquatic biodiversity across the Yangtze River Basin (YRB), one of the areas with the largest fish catch and richest aquatic biodiversity in the world. According to the plan, all activities concerning harvesting of natural fishery resources are prohibited within specified areas, including the mainstream of the Yangtze River, the two remaining river-connected large lakes (Lake Poyang and Lake Dongting), seven important tributaries, 332 aquatic life reserves, and other important waters. The implementation of TYFB is having a great influence on the local fisheries. However, it remains unclear whether the expected goal of recovering fish stocks and biodiversity can be achieved solely through TYFB as overfishing might not be the only important factor threatening the Yangtze ecosystem.

Overfishing and habitat degradation (lake reclamation and fragmentation, which mainly refers to river-lake isolation) may be the two key factors threatening aquatic biodiversity in the Yangtze River.[2] To evaluate their relative importance, we collected long-term data of fish catches, dam construction, and historical as well as recent data on the population of both the Baiji dolphin and the finless porpoise, the two top predators in the Yangtze River system. Accordingly, we highlight the critical importance of supplementing the TYFB with a plan for reconnecting the river with the isolated lakes to achieve the goal of efficient recovery of the fish stock as well as of the aquatic biodiversity and functioning of the YRB.

DYNAMICS OF FISH CATCHES AND DOLPHIN POPULATIONS

The fish catch in the mid-lower Yangtze River and its branches reached a historical maximum of 427,000 tons in 1954, followed by a nearly 85% decline to only 66,000 tons in 2016 (Figure 1). Both Baiji dolphin and finless porpoise also experienced rapid declines in the river. No consistent recession, however, was found for fish catch and finless porpoise populations in the two large river-connected lakes.

In the middle and lower Yangtze River, a fluent river-lake ecosystem is formed through hydrological connectivity (Figures 1B–a and b). The clear lakes are rich in various food resources for fishes. In contrast, much lower primary production has been documented in the turbid river due to a high sand content. Abundance of planktonic preys in the river was less than 1/7 of that in the adjacent lakes.[2] Thus, to utilize food resources efficiently and to better adapt to the great seasonal fluctuation of water levels in the monsoon climate, many fish have evolved into a migratory life history (e.g., silver carp, bighead carp, grass carp, and black carp), feeding in lakes but breeding in the river. When blocked (Figures 1B–c), these migratory fishes can only maintain very small populations in the river due to extreme scarcity of food resources and cannot survive naturally in the lakes, eventually resulting in a dramatic decline of fish stocks in the river. Overfishing has caused a further fish stock decline (Figures 1B–d).

The first catch decline (1954–1972) coincided with lake reclamation and the large-scale construction of dams/floodgates between the river and the lakes (Figure 1). Particularly, the greatest catch decline during 1959 and 1960 occurred just after the greatest rate of isolation (nearly 3,000 $km^2\ a^{-1}$) during 1958–1959. Lake reclamation mostly took place between the 1950s and 1970s, a period during which 39% (10,000 km^2) of the total lake area (25,828 km^2) was reclaimed.[3]

A second, significant catch decline (during the 1990s) started in a period with wide application of highly efficient fishing gear. While habitat degradation likely drove the first catch decline in the 1950s–1970s as the fishing effort was small and the fishing gear had relatively low efficiency, overfishing led to the second catch decline in the 1990s, a period with low lake reclamation and river-lake isolation. The cumulative effects of habitat degradation certainly contributed to the second catch decline. The tragic population declines of Baiji dolphins and finless porpoises could be partly attributed to starvation due to fish collapse and intentional and accidental slaughter during fishing. The rapid decline of the Baiji dolphin right after the start of the wide application of high-efficiency fishing nets in the early 1980s corroborates our suggestion. The effect of the Three Gorges Dam (TGD) from 2003 on fish assemblages is complicated.[2] It seems likely that the operation of the TGD contributed at least in part to the second catch decline in conjunction with intensive fishing in recent years. Positive effects can be found from various flooding events as suggested by catch increases in the year or the subsequent year of flooding events. This is likely due to better river-lake connectivity, although we cannot discount the introduction of fishes escaping from aquaculture lakes or fishponds during the moderate and extreme flooding events.

EXPECTATIONS FOR TYFB AND SUGGESTIONS

The overall catch decline during the periods of habitat degradation and overfishing was found to be about 350,000 tons in a comparison of differences between 2002 (the year before the operation of the TGD) and 1954 (the year with the historical maximum) (Figures 1B–e). A rough estimation suggests that habitat degradation likely contributed to about 70% (based on the catch difference between 1954 and 1978) of the total decline and overfishing the remaining 30% (the catch difference between 1978 and 2002). The contribution of overfishing could be even less than 30% if taking into account the effects of chemical pollutants, which were exacerbated after the re-form and open-up policy. Therefore, it is foreseeable that the implementation of TYFB will at most lead to a recovery rate of 30% of aquatic animal resources; for example, a fish catch of around 160,000 tons can probably be expected after the termination of TYFB in 2031. The fishing ban is of course of significance for the protection of freshwater megafauna as overexploitation or incidental capture as by catch has been widely reported as a potentially significant threat to many megafauna species.[4] Other factors such as transportation noise merit consideration for the recovery of sensitive species such as the endangered dolphins.

TYFB alone, however, may not be sufficient to reverse the situation as expected. TYFB only removes the top-down factor on fish but does not produce an increase in food resources (the bottom-up factor) of fish. It is therefore needed to reopen the free-flowing channels between feeding and breeding locations. This would expectedly accelerate the recovery of fishery resources both in the lakes and in the river. Finless porpoises can also benefit from the recovery of their food resources, the fishes. Clearly it is not feasible to reconnect the dam-segregated lakes to the Yangtze River all at once, due to the critical needs of flood control and other considerations. Local measures of pollution control and habitat restoration are thus of critical importance for the development of fish populations in those isolated lakes.

Enhanced river-lake hydrological connectivity can also augment the overall biodiversity and resources of aquatic organisms by promoting habitat diversity through hydrological disturbance. A certain degree of hydrological disturbance of lakes may also prevent massive growth of phytoplankton and hence reduce the probability of cyanobacteria blooms. To mitigate the impacts of future climate changes, river-lake reconnection will expectedly improve the capacity of flood regulation and the adaptation ability to events such as extreme droughts and floods.[5] Once sufficient recovery of fish stocks is achieved, regulated fishing may be possible as a rational exploitation of natural resources, creating a harmonious relationship between humans and nature.

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DECLARATION OF INTERESTS

The authors declare no competing interests.