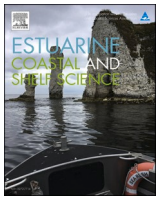
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Long-term declines in hilsa shad landings are associated with fishing pressure and reduced Shatt Al-arab river in northern arabian Gulf

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ABSTRACT

Hilsa shad (*Tenualosa ilisha*) was once among the most abundant fish in the northern Arabian Gulf ('Gulf'), supporting fishers' livelihoods and providing an affordable, nutritious, and reliable food source for local communities. However, since the mid-1990s, hilsa shad landings in the region have declined, with no signs of recovery; Kuwait, for example, has experienced a 90% decline. Yet few studies have investigated the principal causes of this decline. Failing to understand why the hilsa shad population is declining hinders the establishment of effective recovery plans. Here, we fit an assessment model to the time series of hilsa shad landings in Kuwait (i.e., the northern Gulf) to highlight the sustainability status of spawning stock biomass (SSB) and fishing mortality, and to examine the relationship between Shatt Al-Arab River flow rate and hilsa shad landings. The assessment results show that excessive fishing mortality has rendered the current SSB overfished; SSB is around 19% of the sustainable SSB. Additionally, the deterioration of Shatt Al-Arab flow rate is associated with the long-term decline in hilsa shad landings: the mean annual flow rate and landings show a positive correlation, with degraded flow rate in recent years associated with the lowest landings ("no lag": $R^2 = 0.65$ and $p < 0.001$; "1-year lag": $R^2 = 0.67$ and $p < 0.001$; and "two-year lag": $R^2 = 0.28$ and $p = 0.023$). It is unlikely that the Shatt Al-Arab flow rate would be restored in the near future, especially given the importance of freshwater use and the substantial investment already made in upstream water development projects. Alternatively, effective international fisheries management to rebuild the wild hilsa shad population, as well as aquaculture, which could either provide fish directly to fish markets or enhance the wild population through stocking, are likely more attainable solutions.

1. Introduction

Fisheries provide food and jobs to numerous coastal communities around the world. The total production from capture fisheries amounted to 92 million tons in 2024 (FAO, 2026). Furthermore, the primary sector of capture fisheries comprised around half (56%) of the 65.3 million people employed in fisheries and aquaculture (FAO, 2026). Nevertheless, these benefits can be diminished if exploited fish stocks are subject to unsustainable fishing pressure or if the habitats on which they depend during their life-history trajectory are degraded (Brown et al., 2019; Duarte et al., 2020). Evidence shows that declines in catches and abundances can be reversed; however, a basic prerequisite to effective recovery is identifying the key potential contributors to such declines (Hilborn et al., 2020; Ben-Hasan et al., 2017; Melnychuk et al., 2021).

The Arabian Gulf's ('Gulf') marine environment harbors many fish populations that directly contribute to seafood security (Ben-Hasan and Daliri, 2022). While the Gulf's marine environment is characterized by high evaporation and limited precipitation, the northern part receives a major freshwater input from the Shatt Al-Arab River (Sheppard et al., 2010). The Shatt Al-Arab River, formed by the confluence of the Tigris and Euphrates Rivers, creates the largest estuarine system in the region and helps reduce excessive salinity, influencing primary productivity, creating critical nursery areas, and triggering migration behaviour in economically valuable fish species (Al-Yamani et al., 2017, 2021). For

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