Is reduced freshwater flow in Tigris-Euphrates rivers driving fish recruitment changes in the Northwestern Arabian Gulf?

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ABSTRACT

Like fishing, natural regime shifts and human-induced environmental changes are often equally important factors in driving fish stock declines. In the Northwestern Arabian Gulf, many fish stocks are declining, raising questions about the reduction in the flow of Tigris-Euphrates rivers. Here we investigate the relationship between Tigris-Euphrates river flow and the estimated recruitment patterns from assessment models. We found a positive correlation between the estimated finfish recruitment trends and the flow of Tigris-Euphrates rivers. Additionally, the assessment model showed remarkably weak compensation ratio, likely indicating a reduction in the productivity of nursery area of two finfish stocks but not in that of the crustacean stock. Our investigation would be very critical in providing guidelines to the government agencies in the Northwestern Arabian Gulf as well as countries of Tigris-Euphrates basins: to consider the impacts associated with reductions in Tigris-Euphrates river flows on the ecosystem services of the region.

1. Introduction

A variety of studies have thoroughly explored the relationship between freshwater flow, (e.g., river flow and rainfall), and estuarine fish stocks (Drinkwater and Frank, 1994; Gillanders and Kingsford, 2002; Robins et al., 2005). Attempting to understand such relationship is crucial; biological processes such as growth and recruitment of many nearshore fish stocks are governed by the seasonality and magnitude of freshwater discharged into the marine system (Copeland, 1966; Aleem, 1972; Drinkwater, 1986). Although the correlation between freshwater flow and fisheries production does not imply causation for many reasons, (e.g., confounding effects of stock size and fishing intensity (Walters and Collie, 1988) and the likelihood of type I error (Potter et al., 2001)), underpinning basic factors driving fish recruitment is profound from a fisheries management perspective (Tyler, 1992).

The Arabian Gulf experiences high salinity due to high evaporation from the long and hot summers. However, the excessive salinity is offset by the convergence of Tigris-Euphrates rivers forming Shatt Al Arab river, the main source of freshwater input to the Northwestern Arabian Gulf (referred to as the Gulf hereafter) (Fig. 1). Many commercial fish stocks in the Gulf are declining; the most probable causes are overfishing and human-induced environmental changes (Al-Husaini et al., 2015). In Kuwait, landings for most commercial finfish stocks have

drastically declined over time, most of which began declining around the year 1995 with no sign of recovery (Kuwait's Central Statistical Office, 1979–2015) (Fig. 2). In addition to the unregulated fishing pressure, a major environmental issue is raising concerns about the potential impacts on nearshore fisheries; significant water diversion activities and dam constructions in Tigris-Euphrates river basins are drastically reducing flows of freshwater discharged into the Gulf (Issa et al., 2014; Abdullah et al., 2015). Several studies have also identified additional anthropogenic stressors in the Gulf, including coastal development and landfill, discharge of untreated sewage and the release of significant amount of brine associated with desalination plants (Bishop, 1999; Saeed et al., 2012). However, unlike these anthropogenic stressors, the relationship between freshwater flow and nearshore fish stocks and fisheries has been studied extensively with numerous case studies around the world (see Gillanders and Kingsford (2002) for a comprehensive review) showing that, in most cases, alteration of freshwater flow lead to changes in the biomass of fish and shellfish communities.

Nilsson et al. (2005) reported that besides Mae Khlong river in Thailand, Tigris-Euphrates rivers (or Shatt Al Arab) are the most heavily regulated systems in Asia with 26 planned or under construction dams. The ecological and oceanographic rules of Tigris-Euphrates rivers in the Gulf ecosystem are critical; they contribute to the overall
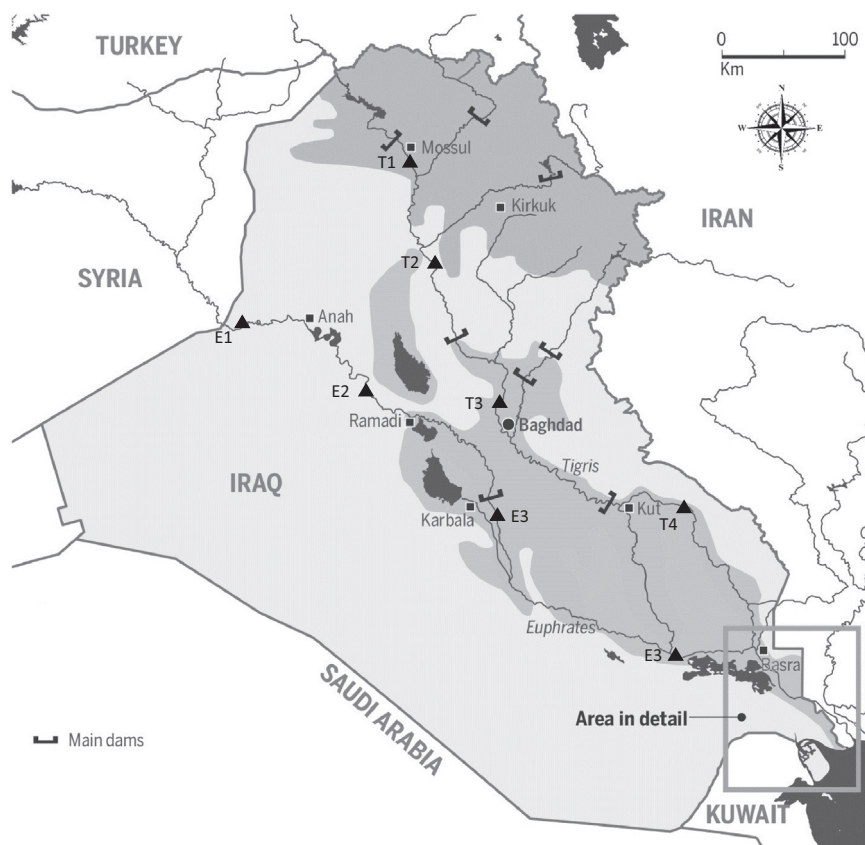

Fig. 1. Map of Tigris-Euphrates rivers, showing the locations of the flow-gaging stations within Tigris (▲ T1, T2, T3, T4) and Euphrates (▲ E1, E2, E3, E4) basins (Reproduced from Lawler, 2016).
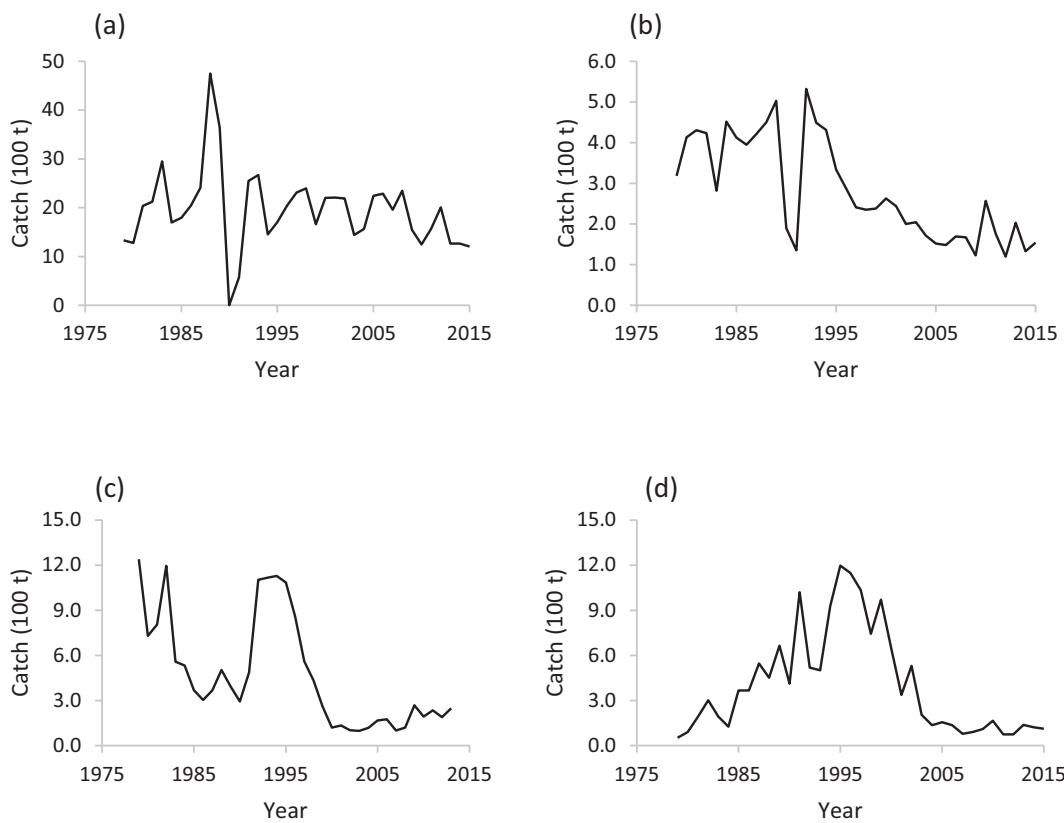

Fig. 2. Historical catches for four species in Kuwait waters. (a) historical catches for the tiger shrimp (*Penaeus semisulcatus*) recorded over the period 1965–2015, (b) historical catches for the orange-spotted grouper (*Epinephelus coioides*) recorded over the period 1979–2015, (c) historical catches for the silver pomfret (*Pampus argenteus*) recorded over the period 1979–2015, (d) historical catches for hilsa shad (*Tenualosa ilisha*) recorded over the period 1979–2015.