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Total marine fisheries catches in the Persian/Arabian Gulf from 1950 to 2010

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HIGHLIGHTS

- Catch data are inaccurate and when estimated result in distinctly different baselines.
- Catches in the Gulf are potentially underestimated by a factor of two from 1950 to 2010.
- Artisanal catches contributed 75% of total catches, followed by industrial (4%).
- Discards, mainly from shrimp trawlers, correspond to 18% of total landed catch.

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ABSTRACT

Fisheries formed the basis of the Gulf's economy for hundreds of years, and yet present-day statistical catch data remain inaccurate. When estimated, these catches often result in distinctly different baselines for historical catches, raising questions about how closely officially reported data resemble reality and the sustainability of certain management decisions. Here, we 'reconstruct' the contribution of missing sectors for all countries surrounding the Gulf (Bahrain, Iran, Iraq, Kuwait, Qatar, Saudi Arabia, and the UAE) from 1950 to 2010. Since the 1950s, Gulf countries have primarily reported their artisanal and industrial catches and have substantially misreported their discards, recreational, subsistence, and illegal fishing sectors. Our results suggest all countries in the Gulf under-report their catches, with the exception of the UAE, which over-report theirs. We show that regionally, officially reported catches potentially underestimate capture fisheries by a factor of two between 1950 and 2010, and that discards, mainly from shrimp trawlers, correspond to 18% of total landed catch. We discuss the discrepancy between reported and estimated catches, as well the policy implications for the region's fisheries, food security, and marine ecosystems generally.

1. Introduction

The Persian/Arabian Gulf[1] is a semi-enclosed body of water, situated within a subtropical, hyper-arid region of the Middle East. It is bounded by the Shatt al-Arab river delta in the northwest and by the Strait of Hormuz in the southeast (Fig. 1). It is bordered by Bahrain, Iran, Iraq, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates (UAE), all of whom are 1978 signatories of the Regional Organization for the Protection of the Marine Environment (ROPME).

The Gulf supports highly productive coastal habitats, including intertidal mudflats, seagrass, algal beds, mangroves, and coral reefs (Price, 1993; Sheppard et al., 2010; Sale et al., 2011). These habitats support important commercial fisheries as well as endangered species such as the green turtle (*Chelonia mydas*) and the dugong (*Dugong dugon*). Though the Gulf supports a variety of productive habitats, and contains a number of endemic species, it is less biologically diverse than the adjacent Indian Ocean due to extreme environmental conditions (Khan and Munawar, 2002; Sale et al., 2011).

For hundreds of years prior the discovery of oil, the region was sparsely populated by nomadic and semi-nomadic people, who depended on fishing, pearling, and maritime trade through dhows (Streeter, 1886; Lorimer, 1915; Villiers, 1940). Indeed, archeological records indicate that fisheries have been a significant economic activity for the people of the region since the 6th millennium BC (Beech, 2002). However, the discovery of oil in the late 1930s and

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[1] The name of this body of water remains contentious so we use the term "Gulf" to avoid offending either party.

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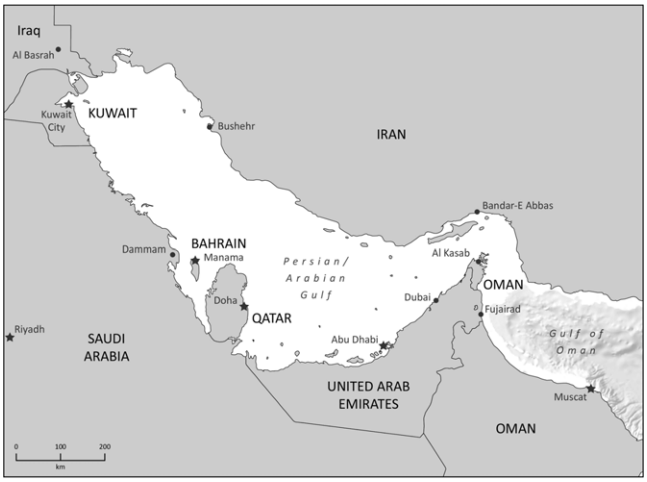

Fig. 1. Map of the Gulf.

the subsequent industrial boom in the 1970s brought enormous wealth to the region, and with it intense economic activity with far reaching environmental, social, and cultural implications for the Gulf's ecosystems (Khan and Munawar, 2002). Presently, fisheries are the second most important natural resource after oil and gas, and the most important renewable resource (Carpenter, 1997; Sale et al., 2011; Grandcourt, 2012). Besides their contribution to the region's food security, fisheries also provide a source of income, cultural heritage, and recreational opportunities to the Gulf's coastal population.

Present-day fisheries are multi-species and multi-gear, and mostly artisanal in nature, with the exception of trawlers in Kuwait, Saudi Arabia, and Iran that target shrimp a few months out of the year. Qatar and Bahrain closed their industrial shrimp fisheries in 1993 and 1998 respectively. Traditional wooden dhows and fiberglass boats are currently the most common vessels, while hook-and-line, gillnets, hemispherical wire traps (*gargoor*), and weirs (*hadrah*) are the most common gears. In general, fisheries predominantly target demersal species in the south and west, while shrimp and pelagic fish species are targeted in the north (Sale et al., 2011; Grandcourt, 2012). According to the United Nations Food and Agriculture Organization (FAO), the fishery potential in the Gulf is estimated to be 550,000 *t* annually, or eight times greater than that of the Gulf of Oman (Kardovani, 1995; Sale et al., 2011).

Data-driven fisheries assessment and management is variable among political jurisdictions in the region, with each littoral state having its own federal policies, legal instruments, and regulations (Grandcourt, 2012). Existing fisheries regulations aim to control effort, however many species in the Gulf are presently overfished and fishing effort exceeds that needed to extract Maximum Sustainable Yield (MSY) for most demersal species (Samuel, 1988; El Sayed, 1996; Grandcourt et al., 2003; Dadzie et al., 2005; Grandcourt et al., 2010; Grandcourt, 2012). Similarly, stocks of pelagic species such as the kingfish, *Scomberomorus commerson* and shrimp are overfished (Siddeek et al., 1999). In addition, stock assessments are rare and most catch data are recorded to family level only, making it impossible to use single-species approaches for assessments, for example catch-at-age models (Sale et al., 2011).

Since its establishment in 2001 the aim of the Regional Commission for Fisheries (RECOFI), has been to "promote the development, conservation, rational management and best utilization of living marine resources, as well as the sustainable development of aquaculture". In 2012 RECOFI agreed on minimum data reporting that includes catch and effort data separated by gear. However, these data are not readily disseminated and certain sectors such as catches by weirs are missing (Al-Abdulrazzak and Pauly, 2014). In addition, the 2012 decision is based on each member country setting their own standards, which can result in no reporting at all, as was the case in 2013 when Oman, Kuwait, and the UAE, failed to report their catches (Al-Abdulrazzak and Pauly, 2014). Moreover, the submission of discard data is considered voluntary.

The Gulf is changing rapidly due to numerous industrial, residential, and tourism development activities (Sheppard et al., 2010). Meaningful ecological baselines are rare due to extensive ongoing projects such as the artificial Palm Jumeirah Island in Dubai or the extensive land reclamation near Manama, Bahrain, many of which remain confidential for alleged commercial or security reasons (Sheppard et al., 2010). This is one of the main reasons why Gulf marine ecosystems are so poorly understood and why regional coordination efforts are rarely effective (Sheppard et al., 2010). In addition, the Gulf's population has grown dramatically since the discovery of oil, subsequently driving up fisheries exploitation in order to meet demand. The increased demand coincided with the mechanization of fishing fleets, enhancing fishing capacity and exerting further pressure on the region's marine resources.

Since its creation in 1945, it has been the FAO's mandate to collect, analyze and distribute information related to nutrition, food, and agriculture, including fisheries, to assess global trends in hunger and malnutrition. The FAO's global capture fishery database, or FishStat (www.fishstat.org), is the only global sources of time series of national fisheries landings (Garibaldi, 2012), and has provided essential data for a number of global fisheries studies (Swartz et al., 2010; Watson et al., 2012). However, despite their wide usage, studies have called into question the reliability of FAO data (Watson and Pauly, 2001; Clarke et al., 2006; Zeller et al., 2006; Al-Abdulrazzak and Pauly, 2013b). Because member countries voluntarily report their catches and other fishery statistics, the quality of the FAO database is only as good as each country's capacity and political willingness for statistical collection and estimation (Watson and Pauly, 2001; Bhathal and Pauly, 2008; Jacquet et al., 2010). It is generally recognized that the contribution of many sectors, especially those from small-scale fisheries, are frequently absent or substantially under-reported (Zeller et al., 2006, 2007; Le Manach et al., 2012; Al-Abdulrazzak and Pauly, 2013b).

Despite the historical importance of fisheries in the Gulf, the region's fisheries remain understudied and catch data remain inaccurate (Al-Abdulrazzak and Pauly, 2013a,b). Here, an established catch reconstruction approach was used to estimate total marine fisheries catches for all countries in the Gulf from 1950 to 2010 to evaluate the overall magnitude of misreporting and establish more accurate historical baselines.

2. Methods

Official data, as reported by Bahrain, Iran, Iraq, Kuwait, Qatar, Saudi Arabia, and the UAE were extracted from the FAO's FishStat database and served as the baseline for the analysis. Minuscule catches from the east coast of the Musandam Peninsula, an exclave of Oman whose short coastline lies within the Gulf, are not included here (but see Khalfallah et al., 2015).

Data from national agencies were compiled and compared to FAO data, but no differences were found. Because Saudi Arabia and the UAE also have coasts on the Red Sea and the Gulf of Oman respectively, the reported national data for each coast were disaggregated and the catch reconstructed separately.

The conceptual framework of the catch reconstruction method as outlined by previous studies (Zeller et al., 2006, 2007; Jacquet et al., 2010; Le Manach et al., 2012) was followed. After locating