



Full length article

Nursery habitats and life history traits of the green tiger shrimp *Penaeus semisulcatus* (De Haan, 1844) in the Saudi waters of the Arabian Gulf



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ABSTRACT

The green tiger shrimp *Penaeus semisulcatus* is one of most productive fisheries in the Saudi waters of the Arabian Gulf. Currently, two artisanal fleets harvest the stock and management is limited to input control measures. Progress to quantitatively-based, sustainability-oriented management is precluded by the lack of basic ecological and biological knowledge. In this study we identify nursery and juvenile habitats, spawning seasons, estimate maturity of females, cohort composition, individual growth, natural mortality, and derive biological reference points. Beach seining and trawl surveys show that coastal embayment systems are important nursery grounds. The population is composed of a maximum of three cohorts born at 6 months intervals. Among three growth models, a 2-parameters version of the Gompertz model was the most supported by the data with individual growth parameters of 57 mm carapace length (CL) asymptotic length and 1.9 yr^{-1} growth rate coefficient. Spawning is continuous along the year with two main peaks in early summer and in December. At 23 mm of CL 50% of females are mature, and at 29 mm CL 95% have reached maturity. Natural mortality was estimated at 2.391 yr^{-1} . Fishing mortality corresponding to a target of 40% of virgin spawning biomass per recruit is 1.3 yr^{-1} . All parameters are estimated with good precision. These life history traits correspond to a short-lived stock whose abundance is driven by recent recruitment pulses.

1. Introduction

The green tiger shrimp *Penaeus semisulcatus* supports one of the most productive and commercially important fisheries in the Arabian Gulf (hereafter the Gulf) and the Sea of Oman. Landings of the green tiger shrimp have increased 5-fold in this region in the past three decades, currently reaching approximately 10 thousand tons, and most of the growth is due to the landings from Saudi Arabia (FAO, 2014). In spite of its growing importance as a fisheries resource, there has been no formal stock assessment of the green tiger shrimp stocks neither in Saudi Arabia nor in the wider western Gulf region (Morgan, 2006; Grandcourt, 2012). In the Saudi waters of the Gulf in particular, management is solely based on input-control measures, specifically licensing and seasonal closures, because the basic biological knowledge necessary to conduct an assessment and design policies for sustainability-oriented management is scant or absent. The main aim of this work is to fill this gap by studying the ecology, life history, and fisheries productivity of the green tiger shrimp in Saudi waters of the Gulf.

In the western Gulf, spawning of the green tiger shrimp was reported to take place during winter and spring (Price and Jones, 1975). Price (1982) observes that most of the protozoa and mysis stages of penaeid shrimps in the zooplankton off the northern part of the Saudi Gulf belonged to the green tiger shrimp, remarking its predominance among shrimp species in the region. From studies of growth patterns, there seems to be a degree of spatial discontinuity in population structure (Ye et al., 2003). In the north-east Iranian Gulf area, analysis of length frequency data from sampling the fishery catch and trawl survey data have revealed a stock with rapid seasonal growth, fast maturation, undergoing over-exploitation (Niamaimandi et al., 2007, 2008).

The green tiger shrimp is widely distributed across the continental shelf in the Indian Ocean, the West Pacific Ocean, and the Eastern Mediterranean Sea. It is exploited by trawlers across its entire distribution, although it has particular importance as a high volume and high value fishery in the Gulf, Thailand and Australia (FAO, 2014). In northern Australia, observational and experimental studies have shown

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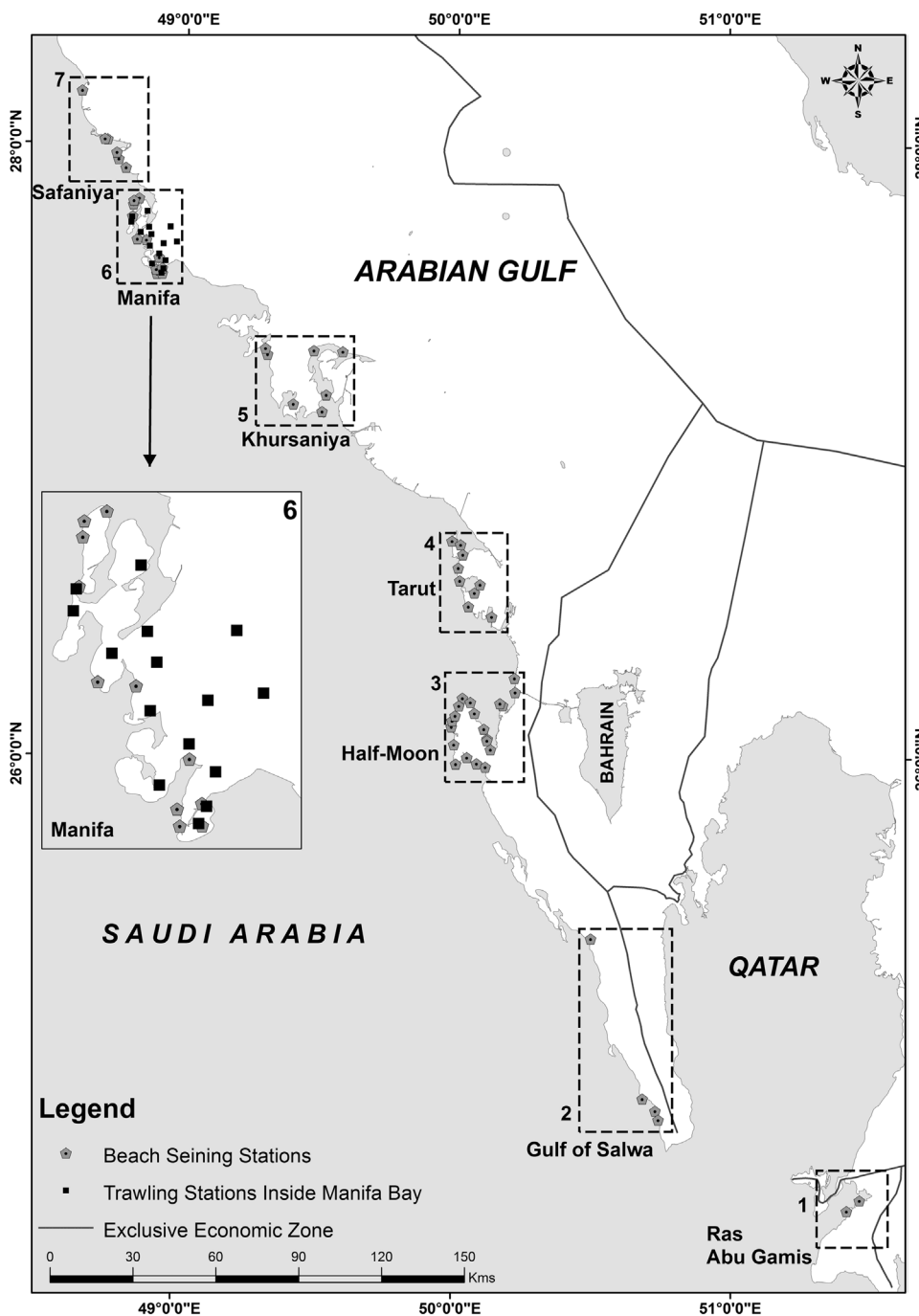


Fig 1. Location of the beach seining and trawling stations (inside Manifa embayment), as well as the landing sites (LS), along the Saudi coasts in the Arabian Gulf, from where samples of *Penaeus semi-sulcatus* were collected.

that juveniles inhabit inshore seagrass and algal beds affording protection from predation (Crococ and van der Velde 1995; Haywood et al., 1995; Kenyon et al., 1995, 1997; Loneragan et al., 1998; Jackson et al., 2001). Hydrodynamic modeling has shown that the transport of larvae from offshore spawning grounds occurs by vertical migration synchronized with tidal cycles (Condie et al., 1999). In the south western Gulf, Abdulqader (1999) has also shown that coastal areas are key nursery habitats for the green tiger shrimp. In the light of the above, several complex embayment systems that are present along the Saudi coast in the Gulf (Fig. 1) are prime candidate habitats to examine for potential role of nursery grounds for the green tiger shrimp.

In this study we lay the groundwork for sustainability-oriented fisheries management of the green tiger shrimp stock in the western Gulf by identifying inshore juvenile habitats and estimating parameters of key life history processes, catch cohort composition, productivity and

biological reference points.

2. Material and methods

2.1. Study area

The Saudi waters in the Gulf cover a territorial area of 27050 km² and extend from the border with Kuwait to the gulf of Salwah (Fig. 1). The Gulf is a shallow sea (< 75 m) and its primary productivity is considered among the highest in the Indian Ocean (Longhurst et al., 1995). It supports a wide diversity of tropical Indo-Pacific flora and fauna (Carpenter et al., 1997) and the coastal habitats are mainly represented by sheltered embayments, saline lagoons, shallow exposed coastal waters, and shallow open waters. Hundreds of offshore oil and gas artificial structures create a network of fishing exclusion areas and

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