

Abstract

Sea cucumbers (class Holothuroidea) are a group of marine invertebrates which provide an important source of livelihood for many artisanal fishers throughout the world, particularly for the developing countries in the tropical and subtropical regions. Over the past few decades the decline of sea cucumber populations has been seen in many regions due to overexploitation and lack of proper management measures.

This thesis addresses the stock status of commercial sea cucumber species in the coastal waters of Sri Lanka and possible management measures to ensure their sustainable utilization. The stock status of commercial sea cucumbers was evaluated using data collected from an Underwater Visual Census (UVC) and fishery dependent surveys carried out off the east and northwest coasts of Sri Lanka in 2008 and 2009. Of the 25 sea cucumber species identified, 21 species are commercially important and 11 species were predominant in the commercial catches. The total abundance of sea cucumbers was higher off the northwest coast (62.3×10^6 nos) than the east coast (11.9×10^6 nos) and low-value species were predominant in both survey areas. *Holothuria edulis* was the most abundant species in numbers while *Holothuria atra* had the highest stock biomass. In both regions, commercial fishery predominantly relies on two nocturnal species: *Holothuria spinifera* and *Thelenota anax*. *H. spinifera* had the highest contribution (73%) to the total landings off the northwest coast while this was provided by from *T. anax* (93%) off the east coast. Density estimates indicate that all the sea cucumber stocks in the coastal waters of Sri Lanka are at critical level (<30 ind ha^{-1}) except for 3 stocks (*H. atra*, *H. edulis* and *H. spinifera*) off the northwest coast and one stock (*H. edulis*) off the east coast.

Biological aspects of *H. atra* and *H. edulis*, which were found to have potential to contribute to future fisheries, were further investigated. High densities of *H. atra* were found in the shallow (<10 m) seagrass beds and *H. edulis* was commonly reported in shallow reef flats and rocky habitat. Although these two species favoured a similar range of sediment mean grain size (0.7-1.2 mm) and gravel content (15-25%), they have different preferences towards the sediment organic content making it possible for them to have separate niches. When the reproductive biology of *H. atra* was evaluated using gonadosomatic indices and histology of gonads, a synchronous seasonal gametogenesis with some asynchrony among individuals was revealed. Further, this population was sexually active throughout the year having peak spawning in April and October. The main spawning event coincided with the highest temperatures and the size at first

sexual maturity of *H. atra* was 16 cm.

Estimates of average natural mortality (M) for sea cucumbers are important findings of this study. Two approaches; simple linear regression and random effects models, were used in this analysis and the estimated values were 0.50 yr^{-1} and 0.45 yr^{-1} , respectively. The random effects model predicted lower natural mortality (M) for nocturnal species than for the diurnal species.

A number of possible management measures were identified, including limiting the exploitation of some commercial species, setting of total allowable catch (TAC) limit and minimum landing size (particularly for highly abundant species), implementation of routine monitoring, reporting of commercial landings and implementation of marine protected areas (MPAs). A multi-area bulk biomass model was used to design MPAs off the east coast of Sri Lanka and spatial management through marine reserves is seen to have potential to rebuild the highly depleted sea cucumber populations.

Apart from the management of local sea cucumber resources, the information gained through this study is important for updating the regional and global sea cucumber catch statistics as well as to contribute information for the implementation of regional management programmes.