ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 7, Issue, 04, pp.14322-14324, April, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

REVIEW ARTICLE

SURVEY OF OYSTER BEDS: A REVIEW

[1,*]Ganapathi Naik, M. and [2]Gangadhara Gowda

[1]Department of Aquaculture, College of Fisheries, Mangalore-575002, Karnataka, India
[2]Department of Aquatic Environment Management, College of Fisheries, Mangalore-575002, Karnataka, India

ARTICLE INFO

Article History:
Received 25th January, 2015
Received in revised form
09th February, 2015
Accepted 14th March, 2015
Published online 28th April, 2015

Key words:
Survey,
Oyster,
Ecosystem,
Oyster bed.

ABSTRACT

Oysters are ecosystem engineers that influence ecological processes such as maintenance of biodiversity, population and food web dynamics, nutrient cycling and water quality maintenance. Changes in oyster abundance and distribution can be used as indicators of environmental changes. Documentation of the currently existing oyster beds may enable the future researchers to evaluate future changes to the oyster population.

INTRODUCTION

Unlike other molluscs like clam and mussel, most of the edible oyster beds are clumsy formations and mostly disparate. The horizontal and vertical aggregations of individuals build up one over the other cemented together giving rise to mounds. The oyster reefs so formed usually consist of different size and year groups of oysters with a considerable percentage of dead shells. This makes the population estimation is a difficult task. Moreover, the locations of many oyster beds are not so easy to access. Therefore, understanding of the actual extent of the oyster beds, population density, and magnitude of annual recruitment is not very easy in many countries including India. (Mahadevan and Nagappan, 1987). Changes in the oyster abundance and distribution can take place due to climate variation (Kimmel and Newell, 2007), boating activities (Grizzle *et al*., 2002; Grizzle *et al*., 2004), storm and erosional activities (Ronald and Charles, 2000), pollution, excessive sedimentation and extreme turbidity (Mahadevan and Nagappan Nayar, 1987). Changes in oyster abundance and distribution can be used as indicators of environmental changes (Randal and Charles, 2000). However, it is important to document the currently existing oyster beds so as to enable the future researchers to evaluate future changes to the oyster population. A survey carried out to assess the distribution of oyster beds in Ishahaya Bay, Japan revealed number of oyster beds suitable for oyster exploitation and culture (Jinno, 1998). The survey of North Carolina's oyster beds in 1992 reported 8,327 acres of oyster beds having high-density population and 20,553 acres having low-density population (Jones, 1994). A survey in Delaware Bay oyster beds in New Jersey waters, USA, reported the regime shifts in oyster populations and the influence of MSX and Dermo diseases on population stability (Eric *et al*., 2008). A number of oyster bed surveys documented key stock indices such as abundance, biomass, natural and fishing mortality and recruitment in the States of Virginia (Austin *et al*., 1996), Maryland (Jordan *et al*., 2002), Texas (Jennifer *et al*., 2005), Delware and New Jersey (Smith *et al*., 2005). Intertidal benthic community survey revealed the aggregations of oyster beds along intertidal mud banks of Skardon River, Queensland, USA (Grizzle *et al*., 2005). In a survey, more than 70,400 acres of oyster beds were identified in Delware Bay estuary, USA (Grizzle *et al*., 2008). A survey was carried out to investigate the general composition, distribution and abundance of the major invertebrate species in the Solent area, London and this study reported good number of beds of European oyster, *Ostrea edulis* (Barnes *et al*., 2006). Remote acoustics and the field verifications reported 75 square miles of oyster beds in the Delware Bay (Bartholomew *et al*., 2011).

During 1984, a survey known as "Baylor Survey of Public Oyster Beds" was conducted in estuarine waters to locate and map the naturally productive oyster beds in Virginia, USA. In this survey, 20,000 acres of oyster beds suitable for harvesting were reported (Fullford *et al*., 2007). These areas were reserved for public shellfish harvesting. A survey conducted during 2006-2007 in San Francisco Bay, USA reported concentrated population of *Crassostrea gigas* suitable for commercial

Corresponding author: Ganapathi Naik, M.
Department of Aquaculture, College of Fisheries, Mangalore-575002, Karnataka, India.

harvesting (Andrew Cohen and Anna Weinstein., 2008). Oyster beds (*C. gigas*) were surveyed in Aotea Harbour, U.K and found that they have the potential to alter sediment and water flow characteristics (Durate *et al*., 2008). In a survey by the Chesapeake Bay Programme, fresh oyster beds were found in the Chesapeake Bay suitable for harvesting (Kimmel and Newell, 2007).

A survey has been carried out in Caloosahatchee estuary, Florida, USA to assess the status of Eastern oyster, *Crassostrea viriginica* (Aswani *et al*., 2008). The study revealed that the overall status of oysters in this estuary was below restoration. This was due to too much fresh water inflow into the estuary in the summer months and too little freshwater inflow in the winter month. This disrupted natural patterns of oyster beds and estuarine conditions. Too much fresh water impacted on reproduction, larval recruitment, survival and growth while too little fresh water impacted the survival of oysters due to higher disease prevalence and intensity of *Perkinsus marinus* (a protozoan parasite). A survey of the Duplin River oyster resource within the Sapelo Island National Estuarine Research Reserve, USA yielded 209 oyster beds covering a total area of 4.4ha (Ronald and Charles, 2000). Beds ranged in size from 3,555m² to 3.2m² with a mean size of 208.5 ±33.7m². Within the total area of beds, live oysters covered 13,124m² or 1.3ha. Of the 209 beds, 12 beds had no live oysters (range from 10 to 2268m), while other beds had from 1% to 100% coverage by live oysters. Overall coverage by live oysters within beds in the Duplin River was 30.1%. The mean coverage by live oysters was 62.8±6.9m² with areas of live oysters ranging in size from 0.56 to 6.77.7m². Wilson *et al*. (2005) conducted a survey in the St. Lucie Estuary(SLE) located near Stuart, Florida, USA to characterize the status of water quality(salinity, dissolved oxygen, PH and temperature) and eastern oyster (*Crassostrea virginica*) reproduction and health. The SLE receives water from an intensively drained watershed through a variety of interconnected ditches and canals. Specific indicators of oyster health and recruitment included condition index, gonadal index, and spat settlement and infection intensity of *Perkinsus marinus*. Water pH, salinity, dissolved oxygen and temperature varied among locations and throughout the seasons. Temperatures were highest (31ºC) from June to August and lowest (13 ºC) in January. The salinity ranged from < 1 to 30ppt. Dissolved oxygen was generally > 2mg/l and pH ranged from 7 to 8.5. Spat settlement was always lower in the SLE as compared to the Indian River Lagoon, USA. The majority of spat settlement in the SLE occurred from April to June. Gonadal stage of oysters and condition index varied throughout the seasons. This survey served as a useful benchmark for measuring the success of future projects directed towards management of water quality and enhancement of oyster habitat in the SLE.

A multi-year survey was undertaken to estimate the oyster resources of Gulf coast estuaries, USA using hand-digitized maps derived from field survey and manual aerial photograph interpretation (Burrel, 2003; ASMFC, 2007). Approximately 900 hectare of intertidal oyster beds was found growing along marsh shorelines and in open areas. The information collected in the survey included: bed area extent, oyster strata, estimates of bushels/area, live/total shell volume, shell matrix depth, bottom type and hard clam occurrence. Along the coast of South America, based on the sea surface temperature data obtained from satellite and climate charts, a survey for the analysis of potential geographic range of the Pacific oyster *C. gigas* was conducted (Mauro *et al*., 2010). In this survey, several beds of *C. gigas* were reported. A survey conducted by Eric *et al.* (2008) revealed that the declined of the eastern oyster (*C. virginica*) resources in many estuaries of the east coast of United States. This decline was associated with a declined in the shell resource and ultimately the disappearance of the shell bed. Furthermore, oyster biomass, abundance and harvest in Chsesapeake Bay were in declined trend (Jordan, 2002).

Al-Khayat and Al-Ansi (2008) conducted a survey to study the fauna and flora of the Qatari Water, Arabian Gulf. In this study 18 oyster beds within the Exclusive Economic Zone (EEZ) of Qatar were investigated by scuba diving. Most oyster beds were found in the area with sandy-rocky and coral blocks bottom forms. A survey has been conducted in Mosquito Lagoon, USA to study impact of recreational boating activity on the recruitment and survival of the *C. virginica* on intertidal reefs (Wall *et al*., 2005). This survey revealed that in some oyster beds, rate of recruitment and survival of *C. virginica* were decreased due to the recreational boating activity. Historical changes in intertidal oyster (*C. virginica*) reefs in Florida lagoon potentially related to boating activities (Grizzle *et al*., 2002). Mapping and characterizing oyster (*C. virginica*) beds using acoustic techniques, underwater videography and quadrat counts were done in Great Bay estuary, New Hampshire, USA (Grizzle *et al*., 2004). Remote sensing techniques, GIS, GPS, acoustic detection and digital photography have been used to survey oyster resources in South Carolina, USA (Smith *et al*., 2005; Vincent, 2006), Chesapeak Bay, USA (Smith *et al.*, 2001) and Apalachicola Bay, USA (Twichell *et al*., 2006).

Recently, a survey has been carried out to assess the distribution of oyster beds in the Mulky estuary to inventory the number of oyster beds suitable for oyster exploitation and culture (Ganapathi Naik and Gangadhara Gowda., 2013). There were total 25 oyster beds ranging from 49.17 to 18528.01 m² area. The length of the oyster beds varied from 11.60 to 244.80m. The width varied from 5m to 129.40m. The density of the oysters varied from 35 to 125 No/m². The density of the live and dead oysters varied from 6 to 100 No/m² and 0 to 70 No/m² respectively. The total area of the oyster beds in the Mulky estuary is 53,488.01 m². An area of 32556.36 m² is having high density oyster populations and 20931.65 m² area having low density oyster populations. Among 25 oyster beds, 19 oyster beds are productive in terms of their density per meter square and high number of live oysters per meter square area suitable for oyster exploitation and culture.

Conclusion

Survey of oyster bed is an important aspect to monitor the ecosystem health. Periodical changes in the magnitude of oyster beds indicate the impact of long term changes in environmental factors. The survey of oyster beds in an area is essential to determine the capture/culture supporting biomass.

The healthy oyster beds are always an indication of healthy ecosystem. Therefore, periodical survey of oyster beds of a region is important to evaluate their potential for exploitation.

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