Ecological Indicators 44 (2014) 108–119

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Ecological condition and value of oyster reefs of the Southwest Florida shelf ecosystem

Aswani K. Volety[a,*], Lesli Haynes[a], Patricia Goodman[a], Patricia Gorman[b]

[a] Vester Marine Field Station and Coastal Watershed Institute, Florida Gulf Coast University, 10501 FGCU Boulevard, Fort Myers, FL 33965, United States
[b] South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, FL 33406, United States

ARTICLE INFO

Article history:
Received 25 August 2013
Received in revised form 3 March 2014
Accepted 12 March 2014

Keywords:
Ecological indicator
Oysters
Everglades restoration
Water quality
Conceptual model

ABSTRACT

The eastern oyster *Crassostrea virginica* is prolific and their reefs are dominant features along the estuaries and coastal areas in the Gulf of Mexico including those along the Southwest Florida coast. This paper examines the ecological and indirect economic value of oysters and the ecosystem services they provide. Drivers of change in reefs as well as various factors (pressures) that affect oyster reefs are examined. Using the monitoring data from on-going studies, this study examined various metrics of oyster health, reproduction and survival to develop an index to create an overall state of oyster reefs in the Southwest Florida estuaries. Based on existing data, oyster reefs in Southwest Florida estuaries are at "caution", but stable. Restoration of a more natural freshwater inflow, minimizing nutrient and contaminant input as well as decreased sedimentation will enable oyster reefs to expand and thrive.

1. Introduction

Oysters, *Crassostrea virginica*, are natural components of estuaries along the eastern seaboard of the US as well as estuaries in the Gulf of Mexico and were once abundant in the estuaries in both southwest and southeast Florida (RECOVER, 2007). In the Caloosahatchee, Loxahatchee, Lake Worth Lagoon, and St. Lucie Estuaries (Northern Estuaries of the Everglades), oysters have been identified as a Valued Ecosystem Component (VEC; Chamberlain and Doering, 1998a,b). The Eastern oyster (*C. virginica*) once supported a Native American subsistence fishery prior to and during early European colonization of North America (Quitmyer and Massaro, 1999) and today continues to be an important economic and ecological resource to coastal inhabitants (Ingle and Smith, 1949; Coen et al., 1999; Gutierrez et al., 2003). Along the southwest Florida coast, oysters exist within the estuarine and coastal areas as extensive reefs or isolated clusters or attach to prop roots of red mangroves, often extending out at the base of mangroves.

The historical coastal complex of South Florida was distinctly estuarine with freshwater discharging through natural channels, as sheet flow across coastal wetlands and ground water flow, as general pore seepage, and as individual artesian springs emerging from karst pipes. As a result, conditions were favorable for the oyster, *C. virginica*, to flourish and build small to extensive oyster banks and bars. In a few areas on the southwest coast, new oyster growth appears to have shifted farther inland along channels and interior bays (Volety, unpublished results). Oysters have an even greater temporal and spatial impact to South and Southwest Florida because of the sedimentation associated with their reef development. Oyster reef development occurred along the Southwest Florida coast over the last 3500 years, with reef development having a significant impact on coastal geomorphology (Volety et al., 2008, 2009a; Wohlpart, 2007). As reefs become emergent at low tide they become the centers for red mangrove propagule settlement, and reefs transform into mangrove-forested islands. These islands entrap freshwater and predispose the region to estuarine conditions (Parkinson, 1989; Wohlpart, 2007). In the present day, oyster reefs are extensive along Charlotte Harbor to the Ten Thousand Islands, with reef development decreasing southeast of Chatham River toward Everglades National Park (Savarese et al., 2004; Volety et al., 2009b). In estuaries north of Lostman's and Broad Rivers, oysters are also found on the prop roots of red mangroves fringing the inner bays (Fig. 1). In most of the estuaries, oyster reef coverage ranged between 5 and 20 acres (Volety and Savarese, 2001; Savarese et al., 2004; Volety et al., 2009a).

Information presented in this manuscript was collected as part of the MARine and EStuarine goal-setting (MARES) project that aims to develop characteristics of south Florida coastal Marine Ecosystems that are sustainable and provide diverse ecosystem services encompassing ecological and human dimensions (Loomis et al., 2014). There was a significant harvest as recently as the 1990s (Charlotte, Lee and Collier Counties) and continues as a very

* Corresponding author. Tel.: +1 239 590 7216.
E-mail addresses: avolety@fgcu.edu, avolety@yahoo.com (A.K. Volety).

http://dx.doi.org/10.1016/j.ecolind.2014.03.012
1470-160X/

minor industry today (Lee County); illegal and unmonitored recreational harvest occurs. However, oyster reefs and other shellfish are extremely important for their ecological services. Therefore, in addition to describing measures of oyster health, human dimension attributes such as "why do we care about oyster reefs" are included in this paper with most of the emphasis on their ecological services. Based on the measured attributes, we propose a "state-of-the-oyster reefs" indicator in the Southwest Florida shelf ecosystem and describe various factors that influence the state of oyster reefs.

1.1. Ecological role of oyster reefs – attributes that people care about

Oyster reefs in the southwest Florida shelf support attributes of the marine environment about which people care. These attributes are directly related to ecosystem services provided by the Southwest Florida coastal and marine ecosystem and include:

- Diverse fish, crustaceans and other invertebrate populations by providing critical nursery, food and habitat for recreationally and commercially important species
- Natural filter for phytoplankton, detritus, bacteria and contaminants resulting in enhanced water clarity and improved water quality
- Prevention of coastal erosion and boat wake mitigation
- Carbon sequestration
- Sentinels for environmental monitoring

1.1.1. Secondary habitat and trophic transfer

Oysters provide habitat for other estuarine species that have significant recreational and commercial value. Grabowski and Peterson (2007) estimated that an acre of oyster reef sanctuary with a life span of about 50 years will result in ~$40,000 in additional value of commercial finfish and crustacean fisheries. Oysters are also ecologically important: they improve water quality by filtering particles from the water and serve as prey and habitat for many other animals (Coen et al., 1999). For example, oyster reefs have been identified as essential fish habitat for resident and transient species (Breitburg, 1999; Coen et al., 1999). The reef-resident and transient organisms (Wells, 1961; Zimmerman et al., 1989; Myers and Ewel, 1990; Breitburg, 1999; Lenihan et al., 2001) are consumed by finfish and crustacean species that may be recreationally or commercially valuable (Grabowski et al., 2005; Grabowski and Peterson, 2007, Harding and Mann, 2001) and thus oyster reefs are considered essential fish habitat (USDOC, 1997).

Harding and Mann (2001) suggested that oyster reefs may provide higher diversity and availability of food or a greater amount of higher quality food compared to other habitats. Oyster reefs restored on mudflats have higher juvenile fish abundances compared to reefs restored in vegetated areas and this could potentially cause an increase in fish productivity in an estuary (Grabowski et al., 2005). Additionally, oyster shells and the interstitial spaces provide space for settlement and refuge from predation, thereby increasing the recruitment, growth and survival of oysters on reefs (Coen et al., 1999). Several species of fishes have been identified as oyster reef residents and include the naked goby *Gobiosoma bosc*, Florida blenny *Chasmodes saburrae*, striped blenny *Chasmodes bosquianus*, feather blenny *Hypsoblennius hentz*, skilletfish *Gobiesox*

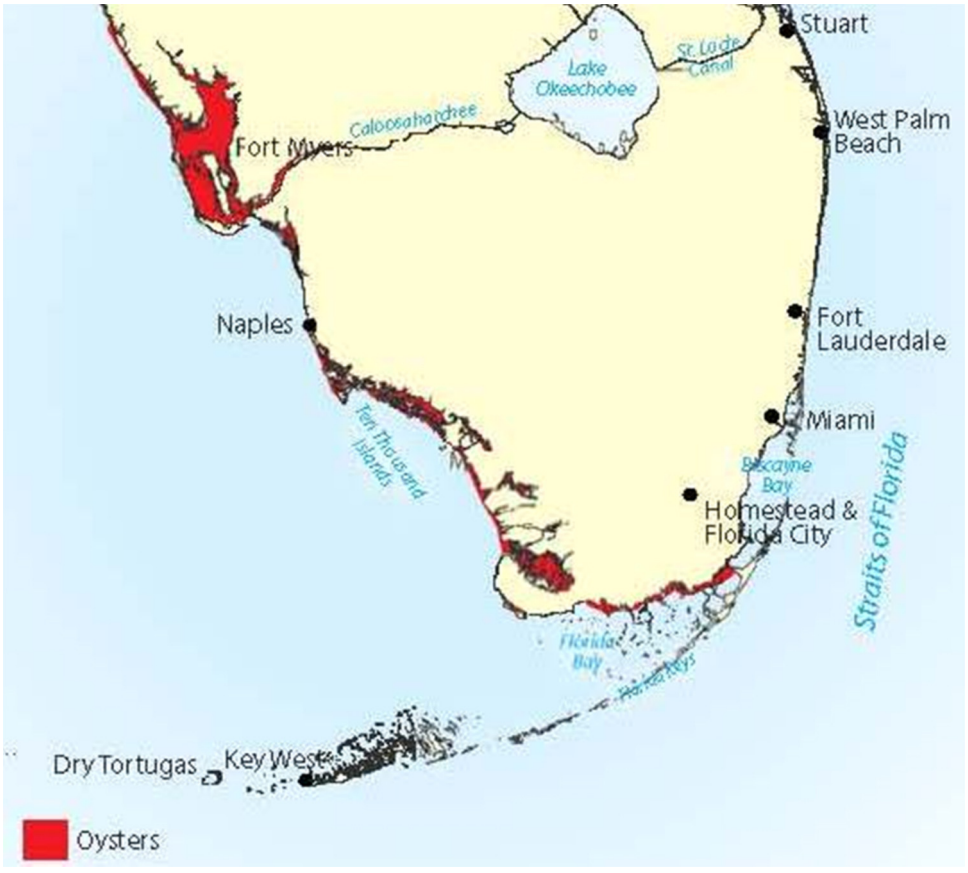

Fig. 1. Geographical distribution of oyster reefs along the estuarine and coastal region of the Southwest Florida shelf system.