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Waterbirds as indicators of ecosystem health in the coastal marine habitats of southern Florida: 1. Selection and justification for a suite of indicator species

John C. Ogden[1], John D. Baldwin[a], Oron L. Bass[b], Joan A. Browder[c], Mark I. Cook[d], Peter C. Frederick[e], Peter E. Frezza[f], Rafael A. Galvez[g], Ann B. Hodgson[h], Kenneth D. Meyer[i], Lori D. Oberhofer[b], Ann F. Paul[j], Pamela J. Fletcher[k], Steven M. Davis[l], Jerome J. Lorenz[f,*]

[a] Department of Biological Sciences, Florida Atlantic University, 3200 College Avenue, Davie, FL 33314, USA
[b] Everglades National Park, South Florida Natural Resources Center, 40001 State Road 9336, Homestead, FL 33034-6733, USA
[c] NOAA National Marine Fisheries Service, Southeast Fisheries Science Center, 75 Virginia Beach Drive, Miami, FL 33149, USA
[d] Everglades Systems Assessment Section, South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, FL 33146-4680, USA
[e] Department of Wildlife Ecology and Conservation, 110 Newins-Ziegler Hall, University of Florida, Gainesville, FL 32611, USA
[f] Audubon Florida, Everglades Science Center, 115 Indian Mound Trail, Tavernier, FL 33070, USA
[g] Florida Keys Hawkwatch, Tropical Audubon Society, 5530 Sunset Drive, Miami, FL 33143, USA
[h] Resource Designs, Inc., P.O. Box 311, Brooksville, FL 34605, USA
[i] Avian Research and Conservation Institute, 411 N.E. 7 Street, Gainesville, FL 32601, USA
[j] Audubon Florida, Florida Coastal Islands Sanctuaries, 410 South Ware Boulevard, Suite 702, Tampa, FL 33619, USA
[k] University of Florida, Florida Sea Grant College Program, 803 McCarty Drive, Gainesville, FL 32611, USA
[l] Ibis Ecosystem Associates Inc., 11086 Esteban Drive, Ft. Myers, FL 33912, USA

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ABSTRACT

The coastal marine environment is currently under threat from many anthropogenic pressures that were identified by the MARES project. Indicators of ecosystem health are needed so that targets can be set to guide protection and restoration efforts. Species of birds that are dependent on coastal habitats are ubiquitous along the coasts of southern Florida. Generally referred to as waterbirds, these species, although not all taxonomically related, share a common dependency on the marine environment for food, nesting habitat, or both. A suite of waterbirds was selected based on their perceived sensitivity to pressures in multiple coastal habitat types. The list of species was refined on the basis of a review of life history for characteristics that might make the species particularly vulnerable. Each selected species was then evaluated for sensitivity to the identified pressures using a hierarchical assessment that took into account the sensitivity, severity, and the temporal and spatial scales of the indicator to the given pressures. The selected suite of indicators was collectively sensitive to all the pressures except one.

1. Introduction

For centuries, humans have used the coastal marine ecosystems of southern Florida for sustenance, recreation, and economic gain. Like many coastal ecosystems around the world, however, burgeoning human populations, overuse of natural resources, and development have had significant impacts on the southern Florida landscape, causing the loss of much of the habitat and living resources that make this region a special and valued place. The National Oceanic and Atmospheric Administration has made a concerted effort to restore and maintain these habitats for the future. Part of that effort was to establish the MARES (MARine and Estuarine goal Setting) project to facilitate ecosystem-based management of southern Florida's coastal marine ecosystems (Fig. 1; http://www.sofla-mares.org). The overall project goal was to reach a scientifically based consensus on the defining characteristics and fundamental regulating processes of southern Florida's coastal resources that are both sustainable and capable of providing the diverse ecosystem services upon which our society depends.

* Corresponding author. Tel.: +1 305 852 5318.
E-mail address: jlorenz@audubon.org (J.J. Lorenz).
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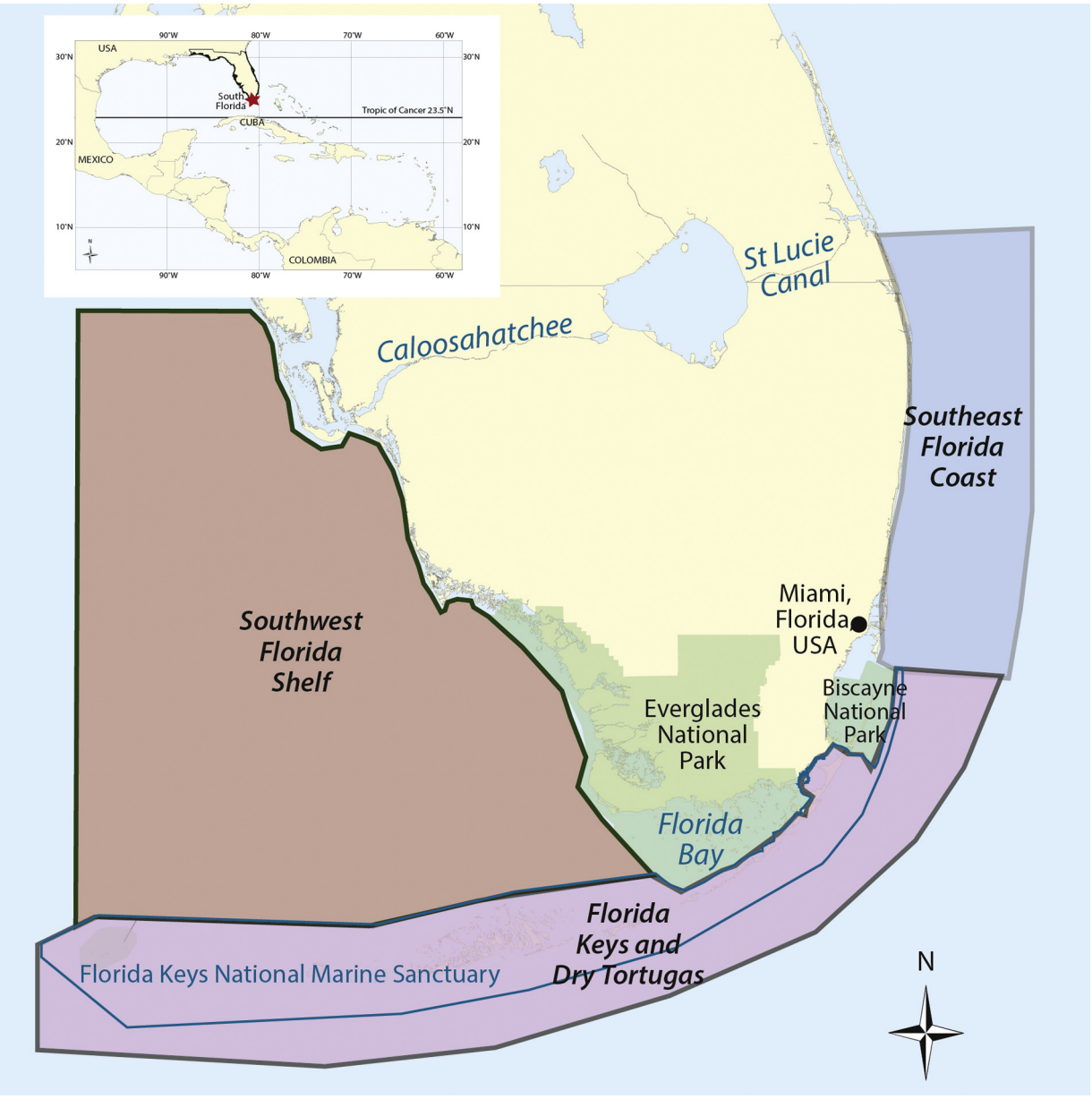

Fig. 1. The MARES domain includes three zones: the Southwest Florida Shelf, Florida Keys and Dry Tortugas, and Southeast Florida Coast.

MARES convened 124 relevant experts (both natural system and human dimensions scientists), stakeholders, and agency representatives in a series of workshops to reach consensus on our understanding of the natural process that make the coastal environments so valuable. The final step in the MARES process was to identify indices of ecosystem health that document trajectories toward (or away from) a sustainable and satisfactory condition.

One of the earliest products from MARES was the identification of drivers and pressures that affect coastal marine habitats in southern Florida (Tables 1 and 2). Drivers are human activities that are the underlying cause of change in the coastal marine ecosystem and reflect human needs. Drivers can be any combination of human and institutional actions or processes. Pressures are the particular manifestations of drivers within the ecosystem and are the physical, chemical, and biological mechanisms that directly cause change in the ecosystem. There is an inherent hierarchical scale consisting of drivers, which are the ultimate expression of human needs and desires, and pressures, which are the proximate factors affecting the ecosystem. For example, human population growth leads to increased energy requirements that are met through the burning of fossil fuels. Burning fossil fuels (Driver) leads to the emission of carbon dioxide (CO_2) into the atmosphere, which is transferred to the ocean, producing ocean acidification that directly affects the ecosystem (Pressure).

Birds have been frequent choices as biological indicators (Caro and O'Doherty, 1999) because they are often high in trophic webs, are important energetic components of ecosystems, show remarkable movement abilities in response to both adversity and opportunity, and are conspicuous and relatively easy to quantify in space and time. However, early efforts to use birds as indicators have met with varying success, and not a little criticism (e.g., Morrison, 1986; Temple and Wiens, 1989; Niemi et al., 1997). While this is partly because of poor definition of terms and goals, and insufficient data linking avian parameters to ecological attributes of interest, there are always important pitfalls in collecting and interpreting data about bird populations. First, it is crucial to distinguish between monitoring birds to understand avian populations, and using birds as indicators of some other attribute