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An ecological assessment of Foul and Folly Bays, Morant wetlands area, Jamaica using Ecopath with Ecosim

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ABSTRACT

The Morant wetlands bays (Foul and Folly Bays) are contiguous with the Great Morass, a large wetland located at the extreme eastern end of the island of Jamaica. A multidisciplinary ecological assessment of the bays was conducted from April 2007–May 2008 aimed at generating a baseline of conditions to confirm the trophic status and importance of the area thus providing support for its designation as a protected area. Water column assessment included zooplankton and phytoplankton collections for 12 months at 11 stations. Zooplankton tows were conducted using a 200 μm net (0.5 m hoop diameter) contemporaneous with 5 l Niskin bottle casts for phytoplankton. Zooplankton abundances were determined for nine functional groups (calanoids, cyclopoids, harpacticoids, nauplii, copepodites, carnivores: medusa and chaetognaths, larvaceans and larvae) for which equivalent biomass was generated using conversion factors based on previous studies in Jamaica. Total phytoplankton biomass (mg Chl *a* m^{-3}) was determined directly using filtration (onto a 0.7 μm filter) and fluorometry while detritus was estimated using the model. Ecopath with Ecosim 5.1 was then used to model the trophic interactions of the planktonic community in the Morant wetlands bays. 116 different taxa of zooplankton were identified with a mean total abundance ranging from 282 ± 56 to 3459 ± 752 animals m^{-3} across the annual cycle. Total phytoplankton biomass (Chlorophyll *a*) ranged from 0.14 ± 0.04 to 0.34 ± 0.2 mg m^{-3} across the annual cycle. A similar study in a pristine bay (Discovery Bay) on the north coast of Jamaica indicated mean zooplankton abundances between 1077 ± 191 and 3794 ± 87 animals m^{-3} and phytoplankton biomass between 0.4 and 0.8 mg m^{-3}. The plankton parameters suggest that Foul and Folly Bays are even more pristine than Discovery Bay and the Ecopath model indicated that unlike Discovery Bay, these Morant wetlands bays were far more resilient and therefore able to recover from stresses (e.g. eutrophication). However, there is still need for protection of this pristine area as the high abundance of larvae coupled with fast flowing currents through the bays provides evidence that this area could be an important source of larvae to other areas of Jamaica's south coast.

1. Introduction

Characterisation of the trophic status of coastal waters can be difficult, especially when attempting to apply the terms oligotrophic, mesotrophic and eutrophic, which were originally developed by limnologists for use in isolated lakes (Vollenweider et al., 1998). In many cases a suite of water column parameters are assessed for each area, followed by an application of terms with specific limits to what is a relative condition. It has become widely accepted that the term oligotrophic indicates a lack of enrichment, eutrophic indicates "nutrient rich" and mesotrophic refers to the intermediary condition. However, the unambiguous characterization of coastal waters which have ill-defined boundaries is often left to, and based on, the researcher's objectives, experiences and frame of reference.

The Ecopath model, was first developed for use in estimating standing stock and production budget of coral reef fish in the northwestern Hawaiian islands (Polovina, 1984; Polovina and Ow, 1993). The model was later modified for use in any kind of aquatic ecosystem by Christensen and Pauly (1992) and called Ecopath II. Pauly et al. (2000) later developed Ecopath with Ecosim for evaluating ecosystems. While this mass-balance modelling approach is widely used for incorporating ecosystem considerations into fisheries science, it can be applied to any area or aquatic system for

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which biomass, diets, and other parameters are known for the target organisms. Ecopath models have therefore been applied to various systems and thus used to model energy flow between elements (phytoplankton, periphyton, zooplankton and fish) by Angelini and Petrere (1993), between marine mammals, their prey and fisheries (Blanchard et al., 2002), between major components of ecosystems (Wolff, 2002) or within components like the planktonic community (Persad and Webber, 2009). In most cases the model is being used as an unbiased means of comparison with other ecosystems so as to indicate trophic status (Fetahi and Mengistou, 2007) and ultimately provide insights into the structure and functioning of the water bodies (Xu et al., 2011) Ecosystem modelling using Ecopath with Ecosim can even be important in supporting ecosystem approaches to management and sustainable resource use (Wolff, 2002) and has been used to indicate the effect of management and mediation on restored systems (Espinosa-Romero et al., 2011; Frisk et al., 2011).

The Morant wetlands bays are located at the extreme south eastern end of the island of Jamaica and are contiguous with an extensive mangrove swamp called the Great Morass (Fig. 1). The area is therefore "up-stream" of other major south coast bays and cays and has been proposed to be a major source of larvae for replenishment to these coastal areas west of the bays. In the absence of any previous ecological assessment, the area was assumed to be pristine and this study of the plankton formed part of a multidisciplinary investigation aimed at generating a baseline of conditions. The main aim of this ecological assessment was to determine the status of the benthic and pelagic communities so as to support the area being assigned protected area status or the creation of a marine reserve. The benthic surveys revealed that the bays were shallow (0–5 m depths) with extensive seagrass beds (Foster, 2010) and patchy reefs with low coral cover (Chin, 2011; Chin et al., 2014). The most extensive benthic community was comprised of algae (Byrd, 2008). The pelagic community and the plankton were therefore thought to be good descriptors of the status of the bays.

The plankton are usually an important aspect of any ecological evaluation due to their ability to be indicators of water quality (Moore and Sander, 1976; Alvarez-Cadena et al., 1996; Webber and Webber, 1997; Siokou-Frangou et al., 1998; Bianchi et al., 2003; Webber et al., 2005; Campbell et al., 2008; Casé et al., 2008; Boyer et al., 2009) and their importance in the energy flow through marine ecosystems (Roff et al., 1990; Hairston and Hairston, 1993; Webber and Roff, 1995a,b; Maury et al., 2007). Furthermore, the assessment of larval stages will indicate their relative importance within the area and potential for export to areas west of the bays. Studies elsewhere have advised that sound knowledge of the locality is important in determining the size and location of reserves (Crowder et al., 2000) and hence appropriate management options. The research therefore aims to provide baseline data on the water quality and plankton of the Morant wetlands bays and to use the Ecopath model to assist with the designation of trophic status of the waters and the need for management of the area.

2. Material and methods

2.1. Plankton sampling

Eleven stations were sampled throughout the Morant Wetlands bays over a 12 month period from April 2007 to May 2008 (June 2007 was not sampled). The stations were sited both inside and just outside the reefal barrier of the bays (Fig. 1) and represented the possible water qualities in the area. Phytoplankton samples were collected from mid-water depth using a 5 L Niskin closing bottle. Zooplankton samples were obtained by horizontal tows using a 200 μm mesh plankton net with 0.5 m hoop diameter (UNESCO, 1968). A calibrated General Oceanics Inc. flow meter was used with the net to determine volume of seawater filtered.

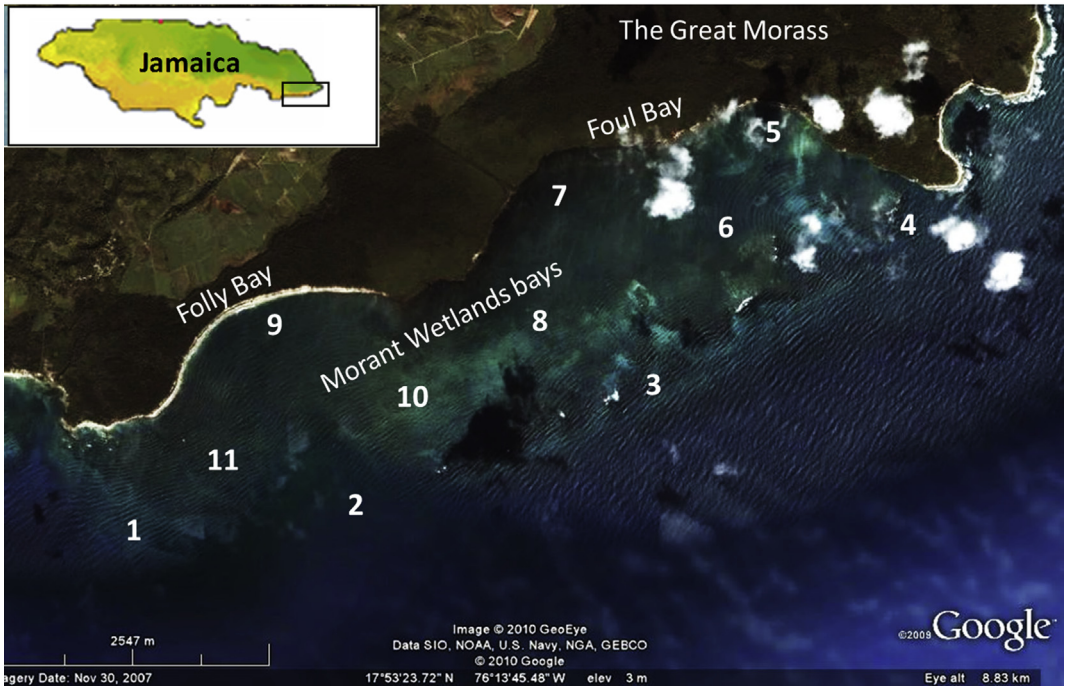

Fig. 1. Google Earth image of the Morant Wetlands area showing the bays and the 11 stations.