Fisheries Research 181 (2016) 84–92

Contents lists available at ScienceDirect

Fisheries Research

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

Monitoring boat-based recreational fishing effort at a nearshore artificial reef with a shore-based camera

Krystle Keller[a,b,*], Aldo S. Steffe[c], Michael Lowry[d], Jeffrey J. Murphy[e], Iain M. Suthers[a,b]

[a] Ecology & Evolution Research Centre, School of Biological Earth & Environmental Sciences, University of New South Wales, Sydney 2052, Australia
[b] Institute of Marine Science, Chowder Bay Road, Mosman, NSW 2088, Australia
[c] Fishing Survey Solutions Pty. Ltd., 3 Payten Street, Kogarah Bay, NSW 2217, Australia
[d] Port Stephens Fisheries Institute, Locked Bag 1, Nelson Bay, NSW 2315, Australia
[e] NSW Department of Primary Industries, PO Box 5106, Wollongong, Sydney, NSW 2520, Australia

ARTICLE INFO

Article history:
Received 13 July 2015
Received in revised form 12 February 2016
Accepted 31 March 2016
Handled by Prof. George A. Rose.
Available online 13 April 2016

Keywords:
Fishing intensity
Fishing effort
Artificial reef
Digital imagery
Nearshore fishing

ABSTRACT

Recreational fishing effort was quantified at a 700 m^3 steel artificial reef (AR) off coastal Sydney with a shore-based camera (06:00–18:00) over a two-year period. Stratified random sampling was used to select days for analysis of fishing effort from digital images. Fishing effort estimates derived from the digital images were adjusted to account for visibility bias using information from a validation study. The levels of effort recorded in the first two seasons were low as the AR had been recently deployed and colonization of the AR by sessile organisms and fishes was still occurring. The effort intensity (fisher hours per square kilometer) at the Sydney AR was compared with three South Australian ARs and 14 estuarine fisheries in New South Wales (NSW) to provide context for the study. Effort intensity at the AR was found to be up to 12 times higher than that recorded from some estuarine fisheries in NSW. Conversely, the levels of effort intensity at two South Australian ARs were much higher compared to those at the Sydney AR site in both survey years. Effort intensity comparisons showed that the relative levels of usage at Australian ARs were higher than those recorded from estuarine fisheries. The Sydney AR provides diverse fishing opportunities that may be concentrated in a small area. Camera-based technologies can provide a solution for cost effective monitoring of AR sites, providing the accuracy of fishing effort information derived from camera images is validated. Our study has broad implications for other recreational ARs, including many future deployments planned for eastern Australia.

1. Introduction

A recent advance in technology for monitoring recreational fishing effort involves the use of shore-based camera imagery. This Internet Protocol (IP) webcam system can be used to monitor fishing effort at well-defined access points to a fishery (e.g. boat ramps, choke points) and fixed areas such as jetties, wharves, rock groynes (Ames and Schlindler, 2009; Smallwood et al., 2011, 2012) or the surface area above an artificial reef (AR). Camera imagery can reduce long-term program and monitoring costs and can provide a permanent record of activity which can be accessed and processed after the sampling period is complete (Ames and Schlindler, 2009; Smallwood et al., 2011, 2012). Shore-based cameras are becoming widely used for assessing nearshore recreational fishing. In the study by Ames and Schlindler (2009) two digital cameras were mounted to two separate towers, one adjacent to a jetty and the other at the jetty entrance to capture images of passing boats in Newport, Oregon. Smallwood et al. (2011, 2012) fixed cameras to four large groynes to observe recreational fishers in Perth, Western Australia. Similarly, Van Poorten et al. (2015) attached cameras to trees and other high stable permanent structures to record observations of angling effort in 49 small rural lakes in central British Columbia, Canada.

Monitoring recreational fishing effort at ARs is important for determining their effectiveness for enhancing recreational fishing. These structures are built from various materials to create fish habitat and enhance marine ecosystems as well as increase recreational fishing opportunities (Branden et al., 1994; Carr and Hixon, 1997; Cenci et al., 2011). An understanding of temporal patterns of fishing at ARs is also important because fishing effort is positively correlated to the levels of fishing-related mortality (i.e. harvest and

* Corresponding author at: Ecology & Evolution Research Centre, School of Biological Earth & Environmental Sciences, University of New South Wales, Sydney 2052, Australia.
E-mail address: k.keller@unsw.edu.au (K. Keller).

http://dx.doi.org/10.1016/j.fishres.2016.03.025
0165-7836/

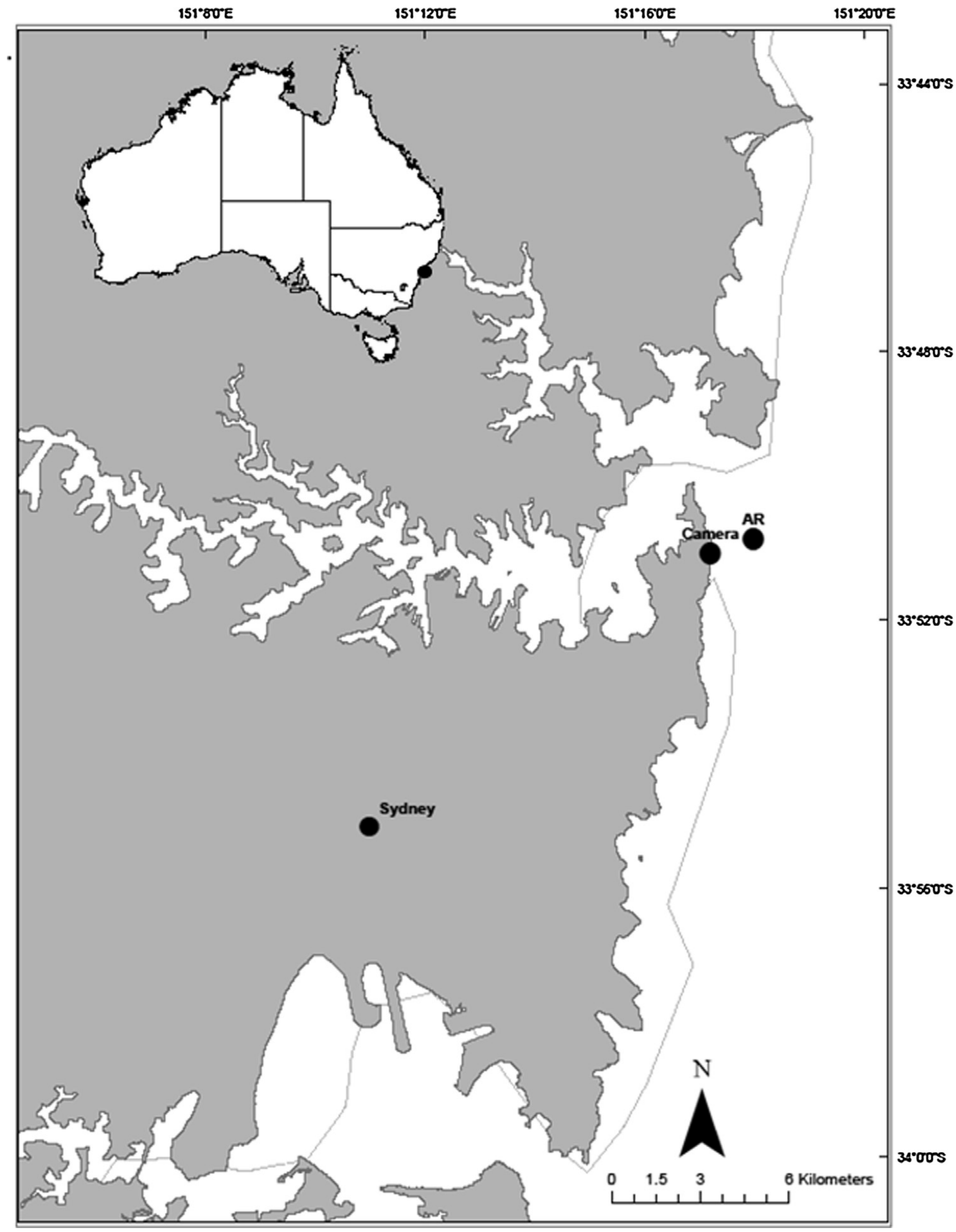

Fig. 1. Location of the Sydney Artificial Reef (AR) and the Old South Head Signal Station (indicated as camera).

release-induced mortality). The success of an AR depends on its ability to enhance fishing opportunities (i.e. increasing the number of fish that are available for capture) while also maintaining the community equilibrium. Few studies have assessed recreational fishing effort at ARs in relation to temporal fishing effort patterns within the region (Buchanan, 1973; McGlennon and Branden, 1994; Tinsman and Whitmore 2006).

Whether ARs enhance the production of fish biomass, or simply attract and aggregate fish is a controversial topic (Bohnsack and Sutherland, 1985; Solonsky, 1985; Bohnsack, 1989; Carr and Hixon, 1997; Folpp et al., 2013; Smith et al., 2015). However, ARs have been viewed as an important resource for preventing localized overfishing by reducing fishing pressure on nearby natural reefs (Bohnsack and Sutherland, 1985; Pickering and Whitmarsh, 1997; Santos and Monteiro, 1998; Folpp et al., 2013; Smith et al., 2015). Furthermore, studies have demonstrated that ARs may provide larger fishing catches compared to natural control reefs (Fabi and Fiorentini, 1994; Carr and Hixon, 1997; Santos and Monteiro, 1998; Whitmarsh et al., 2008; Bortone et al., 2011; Leitão, 2013).

The AR was deployed 1.5 km off the Sydney coast in October 2011, to enhance recreational fishing opportunities. The 42 ton steel structure was designed with many open void spaces and towers that are particularly attractive to fish. The design allows water flows that provide an enhanced supply of nutrient and plankton to the AR ecosystem and can promote the growth of sessile organisms and resident fishes (Connell and Anderson, 1999; Redman and Szedlmayer, 2009). Similar ARs are being deployed elsewhere around Australia, and the need for cost-effective solutions to monitor recreational fishing at these locations is imperative.

The main aim of this study is to estimate recreational boat-based fishing effort at the Sydney AR using a shore-based camera. We also quantify patterns of recreational boat-based fishing

effort at the AR for each season over a two year period, and standardize the fishing effort by area at the AR to allow comparisons