Marine Policy 52 (2015) 59–67

Contents lists available at ScienceDirect

Marine Policy

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

Successful local marine conservation requires appropriate educational methods and adequate enforcement

G.J. Watson [a,*], J.M. Murray [b], M. Schaefer [c], A. Bonner [d]

[a] Institute of Marine Sciences, School of Biological Sciences, University of Portsmouth, Ferry Road, Portsmouth PO4 9LY, UK
[b] Centre for Environment, Fisheries and Aquaculture Science, Pakefield Road, Lowestoft, Suffolk NR33 0HT, UK
[c] Department of Geography, University of Portsmouth, Buckingham Building, Lion Terrace, Portsmouth PO1 3HE, UK
[d] Gardline, Endeavour House, Admiralty Road, Great Yarmouth, Norfolk NR30 3NG, UK

ARTICLE INFO

Article history:
Received 23 September 2014
Received in revised form
20 October 2014
Accepted 20 October 2014
Available online 21 November 2014

Keywords:
Nereis (Alitta) virens
Marine protected area
MPA
Education
Polychaete
Bait collection

ABSTRACT

MPAs and stakeholder education are marine conservation cornerstones, but data to assess adherence to regulations and the success of educational methods are missing. Local MPAs have been established to protect inter-tidal mudflats and shore users from bait collection which is a contentious worldwide issue. Video cameras monitored activity and confirmed if collectors adhered to the rules at three UK sites with different MPA systems. An educational approach (a voluntary code leaflet) was also assessed through stakeholder discussion and observation. Fareham Creek and Dell Quay supported a considerable number of collectors with none observed at Pagham Harbour. At Fareham Creek bait dug areas were evident in discrete patches in unprotected and protected areas, but observed collectors mainly used the latter. The failure to exclude collectors is due to the lack of enforcement. At Dell Quay virtually all dug areas were outside protected areas and was confirmed by the camera footage. Success is attributed to regular on-the-ground 'unofficial' enforcement by the managing NGO. Of the retailers, 75% had heard of the code and the majority stated they followed it. However, none of the 26 collectors observed followed a key rule (e.g. backfilling holes). Local marine conservation is relatively cheap and can be effective, but only if: management matches the *actual* pressure; scientific evaluation for all components (including education) is integrated from the beginning; adequate site enforcement is included; education methods are active, two-way and sustained.

1. Introduction

1.1. MPAs as conservation tools

Marine protected areas (MPAs) are now the major focus of marine conservation with over 5000 areas identified in 2010 [23]. Sizes range from 0.001 km^2 to 640,000 km^2 [37] and a recent global assessment has confirmed that size is a critical requirement of success [13]. Globally the mean size of MPAs is 544 km^2, however, a more detailed investigation confirms that approximately 1200 are less than 1 km^2 and another 1400 are less than 10 km^2 [40]. The majority of MPAs are, therefore, small in extent and defined as 'local' by Pressey et al. [28]. Economic drivers and the devolution of power down to communities mean that local partnerships are often preferred by government [30], so local MPAs will usually have been established and managed by locally-focussed organisations.

[13], amongst many others, highlighted the requirement of enforcement for MPA success. However, direct studies on enforcement are extremely limited. Ceccherelli et al. [8] used site accessibility as a proxy for human activity, but did not measure activity directly. Guidetti et al. [18] and Sala et al. [32] grouped reserves into three levels of enforcement, but again did not measure the actual levels of adherence. The impact of illegal fishing in MPAs for a temperate invertebrate fishery was recently investigated, however, the assessment was initially not quantitative and then pseudoreplicated [24]. No study has, therefore, used empirical field data to assess adherence to local MPA regulations.

Often associated with local MPAs is the inclusion of stakeholder education [29], which in all its diverse forms (e.g. face-to-face discussions, workshops, leaflets, websites, notice boards etc) is seen as a vital tool in protecting biodiversity and can change people's attitudes [17,9]. There is a long history of educational material to support local marine conservation and MPAs, and although many MPAs have an integrated educational strategy (e.g. [29,19]), few (e.g. [21]) have empirically assessed the educational and outreach response, leading Cooke et al. [10] to highlight

* Corresponding author. Tel.: +44 23 92845798.
E-mail address: gordon.watson@port.ac.uk (G.J. Watson).

http://dx.doi.org/10.1016/j.marpol.2014.10.016
0308-597X/

an urgent need to assess compliance to (success of) educational or voluntary codes of conduct.

1.2. Case study: Bait collection

Invertebrate species are increasingly exploited for fisheries with a dramatic rise in catch levels in recent decades [4]. The risks of over exploitation and the consequences to the ecosystems are, therefore, significant. Bait collection is the harvesting of organisms for use as bait for angling and has been an integral part of coastal life for generations. Accurate assessments of the industry are lacking, but with up to 2% of all adults in England going sea fishing [5] and more worldwide it is a substantial component of many coastal economies [26,16,11,36]. The vast majority of these people will rely on wild-collected bait, but it is a highly contentious issue (it remains a UK public right to collect bait for personal use, but not commercially). This results in the polarisation of collectors and those managing marine resources and the associated coastal communities. Ragworms (e.g. *Nereis* [*Alitta*] *virens*) are a major group collected by digging with a fork and the impacts on sediments, benthic communities, birds and shore users have received considerable attention (e.g. [3,15,33,38]).

European Marine Sites are set up to manage marine and coastal resources in a sustainable way; their aim is to enable already established activities to continue, but in ways that do not threaten the nature conservation interest. The Solent region European Marine Site (SEMS) contains a number of internationally important MPAs designated under the EU Directives as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) as well as Ramsar sites and local nature reserves. Inter-tidal mud flats are key habitats for SACs and many SPAs recognise this habitat as an important sub-feature for birds. However, the SEMS is utilised by approximately 40,000 active sea anglers [16] and has extensive soft sediment, which gives great scope for exploitation of this resource for bait. Surprisingly, EMS-level designations have not been employed to manage bait collection. Instead, management has been devolved to the local level through specific byelaws combined with educational methods to protect the inter-tidal mud flats and the associated birds that utilise them. This has resulted in a range of local site-specific management strategies that are running concurrently and are in close proximity to each other.

1.3. Local management

Fareham Creek is a key bait collection area within the Portsmouth Harbour SPA [16]. An additional MPA (a Special Nature Conservation Order [SNCO]) to protect inter-tidal areas has been in force since 2003/4 with commercial collection within the area prohibited (Fig. 1). Dell Quay in Chichester Harbour is also important [16], but it contains a large number of intertidal moorings and jetties used by recreational boat-users. Consequently the local NGO implemented an MPA with a byelaw to prohibit bait collection within 15 m of any mooring or 6 m of any structure to protect vessels and moorings and to minimise the risk of injury (Fig. 2). Pagham Harbour is a Local Nature Reserve and SPA and a recently designated Marine Conservation Zone located at the east end of the Solent. An additional level of management was established involving zonation and licensing, and managed by the local management organisation. Only those who hold an annual permit are able to collect bait and there is also a bag limit of 0.5 kg per visit. Collection is restricted to two areas with access to Zone B from 1st April to 31st August and access to Zone A from 1st September to 31st March (Fig. 3).

Fowler [16] was the first to propose the use of a voluntary code of conduct to minimise the impacts of bait collection through education. The code was developed by local stakeholders and includes ten points, although only five relate directly to the impacts and sustainability of bait collection (Table 1); the others cover general shore awareness/safety. A working group was established within the local management authority and posters and 42,000 leaflets were produced to maximise exposure.

Using a novel assessment method (remote Closed Circuit Television [CCTV] cameras) to record and quantify bait collection activity, the efficacy of the three local MPAs established to manage bait collection has been evaluated. Retail surveys (angling shops) have provided a direct assessment of the awareness of the voluntary code of conduct and stakeholders' compliance, whilst field-based CCTV observations have provided quantitative data on the level of adherence to the code.

2. Materials and methods

2.1. Mapping the extent of bait collection

Sites were surveyed over spring tides in August and September 2011 with surveying happening approximately three hours either side of low tide. A biotope survey assessment of the sites was conducted and bait collected areas mapped using Differential Global Positioning System (DGPS) (approximately 10 cm accuracy), in conjunction with hand-drawings of habitat boundaries on aerial photographs (scale 1: 10,000). Points were recorded by walking along the outer boundary of dug areas and any polygons considered too small to be mapped with DGPS, were numbered on the aerial photograph. Bait dug areas matched in the field were then digitised in GIS (ArcGIS 10.2.2).

2.2. CCTV installation and video analysis

Two Sanyo HD 4600 cameras with external hard-drives were used for direct recording and were rotated among the sites. The cameras at Dell Quay were located inside a building to face north and south (Fig. 2). At Fareham Creek cameras were placed in Residents' houses giving coverage of the lower part of the SNCO and the adjacent sediment outside (Fig. 1). Cameras at Pagham Harbour were sited to monitor areas known to be used for bait collection (Fig. 3). Cameras were set up twice at each site during 2011 and 2012 with the expectation that they would record continuously for one tidal cycle (approximately 14 days) for each run. However, battery failure and other circumstances meant that some periods were not recorded (see Table 2 for details).

Video starting one hour before the predicted low tide time from the nearest tidal station until two hours after low tide was viewed during which time the number and location of collectors were recorded. A one hectare grid was overlaid on the aerial view of each site and the time spent by each collector (digging, walking and boating) in each hectare recorded. Both day and night tides were analysed as collecting is only dependent on the tide. Although the cameras have near-infrared capability and can record in low light conditions, records of activity in the dark were reliant on a collector's head torch. If this made the precise location of the collector difficult to ascertain data were excluded from any spatial analysis. Low tides were also assigned to one of three categories (occurring in the dark, light or both [e.g. dawn or dusk]) and the percentage number of tides in these categories with collectors calculated. Correspondence with the UK Government's Information Commissioner's Office confirmed that personal data legislation did not apply to the collected images.

2.3. Educational evaluation

As the majority of bait purchased is from retailers and it is also estimated that 75% of anglers are not affiliated to any angling association [15] the most appropriate way of assessing the code