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Short Communication

A decadal time-series of recreational fishing effort collected during and after implementation of a multiple use marine park shows high inter-annual but low spatial variability

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ABSTRACT

Recreational fishing is commonly allowed in some areas of multiple-use marine parks but little is known about how fishing effort varies over time. To examine inter-annual and spatial variability, a time-series (1999–2009) of fishing effort was collected at the Jervis Bay Marine Park (JBMP) (Australia). Compared to a previous baseline (1989–1990), effort had doubled to tripled for comparative months, when sampling recommenced during the consultation period for zoning the park. Following the 2002 implementation of the zone plan, effort generally declined, so much so that in February 2009 fishing effort was 88% less than what was observed in February 2000. This decline was not associated with a model, based on the spatially explicit fishing effort data collected during the 1999–2002 consultation period and the pragmatically designed zoning plan, which predicted only 18.5% of fishing effort would be displaced by the 'no-take' sanctuary zones. Over the same period of decline in effort at JBMP, statewide recreational fishing licence sales remained steady or increased slightly. Interestingly, the JBMP fisheries' spatial distribution remained remarkably stable, with no difference in ranked use of the 10 sub-sampled areas used as spatial strata in the study-all of which eventually contained segments of sanctuary zone-either between months, years or pre or post zoning. The time-series suggests that fishing effort can show high inter-annual variable over time at a regional scale, while other aspects of the fishery, such as spatial distributions, remain stable, and that effort can vary significantly even when zoning minimizes impacts on recreational fisheries.

1. Introduction

The recreational sector is recognized as a significant component of the world's marine finfish fisheries (Figueira and Coleman, 2010), especially for inshore waters and highly valued species (McPhee et al., 2002; Coleman et al., 2004; Lewin et al., 2006). In Australia, recreational fishing has been an important part of coastal fisheries over the long term (Lynch, 1966). Participation rates are also higher than global norms, with an estimate of 19.5% of the population fishing at least once each year (Henry and Lyle, 2003). This estimate, however, was derived from a single year (May 2000–April 2001) and like many other countries (Figueira and Coleman, 2010), these types of 'snap-shot' studies predominate.

Recreational fisheries are often managed using input and output controls, such as limits on the total catch per day or trip (bag limits), and restrictions on the minimum size of fish that can be retained (size limits) (Woodward and Griffin, 2003) though these controls do not restrict fishing effort due to increasing population size. Additions to these types of controls are spatial closures, either for fisheries management or conservation. Spatial closures are becoming increasingly common, for instance in the Australian state of New South Wales (NSW) six multiple-use marine parks were zoned for conservation purposes between 2002 and 2007, covering approximately 34% (346,500 ha) of state waters (Read and West, 2010). Within these parks, around 7% (65,839 ha) of state waters are zoned 'no-take' sanctuaries, which are closed to recreational fishing (Banks and Skilleter, 2010). Various other reforms to NSW recreational fisheries occurred at the same time as the implementation of the marine park network, for instance in 2001 a saltwater fishing licence was introduced.

One of the first parks declared in NSW was the Jervis Bay Marine Park (JBMP) (Fig. 1). Although the park's boundary was gazetted in 1998, zoning did not occur till October 2002 (NSW MPA, 2002), following a long period of public consultation. Preliminary results, collected prior to declaration of the zone plan, indicated recreational fishing effort at Jervis Bay had, for comparative months, doubled or tripled since a similar baseline survey conducted 10 years previously (Williams et al., 1993; Lynch et al.,

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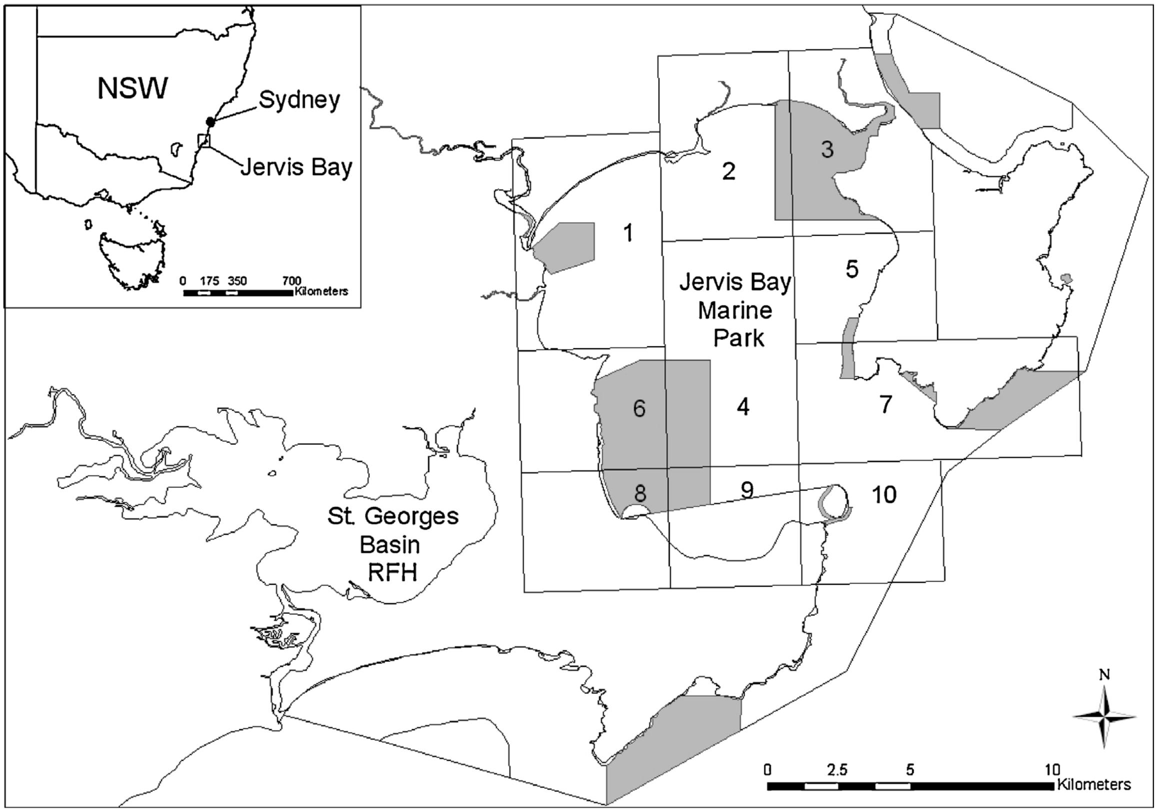

Fig. 1. Jervis Bay Marine Park and the adjacent St. Georges Basin Recreational Fishing Haven (RFH). Numbered boxes are sampled areas used as spatial strata. Gray shaded components of these areas are 'no-take' sanctuary zones.

2004). A fine-scale model of the distribution of fishing effort within Jervis Bay, based on data collected between 1999 and 2002, showed that 17.7 angler h/ha [CI 16–19.4] would be impacted by the proposed sanctuary zones (Lynch, 2008), which translates to 18.5% (+/−3) of observed pre-zoning recreational fishing. The zoning approach at JBMP was pragmatic, with most of the park remaining open to recreational fishing (~80% of the total area) (Lynch, 2006) and similar to other planning schemes, where, following extensive consultation, outcomes are generated for spatial conservation priorities that minimize socio-economic impacts (Fernandes et al., 2005; Stewart and Possingham, 2005; Edgar et al., 2008).

The aims of the paper are to describe a time-series to assess if the large increase in effort compared to the baseline, which provided the context when zoning the park, was the new paradigm and to monitor for within park impacts of the implementation of spatial closures on recreation fishing effort and distribution.

2. Materials and methods

2.1. Site description

NSW is located on the eastern seaboard of Australia between 28° and 37° S. Jervis Bay is approximately 180 km south of the state capital of Sydney, which is the nation's largest city (Fig. 1) (ABS, 2012). JBMP includes a coastal embayment and associated near shore parts of the Tasman Sea (35° 04′ S, 150° 44′ E) and covers 21,704 ha (4345 ha sanctuary zone). The study site was divided into 10 areas previously surveyed during a 1989–1990 baseline study (Williams et al., 1993) (Fig. 1) which included the bay, adjacent Commonwealth waters, and the headlands.

2.2. Fishing effort time-series

From 1999 to 2009, replicated surveys of both boat and shore anglers were undertaken within 25 sample months to establish a time-series of fishing effort. A subset of representative months encompassing known seasonal variation in effort (Williams et al., 1993) – February, April, July, September and December – were sampled. February and December were chosen as they are part of the Austral summer fishing season. April was chosen as it is one of the heaviest used months in the park, with an influx of visitors occurring when Easter holidays fall in this month (Lynch et al., 2004). July was chosen as the low point of seasonal activity and September as the shoulder month. (Further explanations of the sampling frame are provided in S.1.1 supplementary material). Surveys for fishing effort were scheduled with a stratified, random, sampling procedure (Pollock et al., 1994). Strata included sample area (1–10) (Fig. 1), platform (shore vs. boat fishers) and weekdays vs. weekend/public holidays. Sampling probability for each month was set at 12 surveys during weekdays and 8 surveys on weekends/public holidays with start times randomly selected during the 14 h survey day. During each survey, the 10 sample areas were circumnavigated by boat, counting all anglers observed actively fishing in the 180° in front of the survey vessel's helm. Fishing effort was calculated for stratified units (sample area, shore or boat, weekday or weekend/public holiday) using equations derived from Pollock et al., 1994 (see supplementary material S.1.2 theory/calculations, S.1.3 Boat vs. shore fishers and supplementary Fig. 1). As February was the most extensively sampled month and other months surveyed generally complied with the pattern described by February over time, only this month's standard errors of fishing effort were converted to 95% confidence intervals (Fowler et al., 1999) to test if monthly effort varied across years.