Fisheries Research 123–124 (2012) 49–55

Contents lists available at SciVerse ScienceDirect

Fisheries Research

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

Sampling estuarine fish and invertebrates with a beam trawl provides a different picture of populations and assemblages than multi-mesh gillnets

Douglas Rotherham*, Daniel D. Johnson, Caitlin L. Kesby, Charles A. Gray

NSW Department of Primary Industries, Cronulla Fisheries Research Centre of Excellence, PO Box 21, Cronulla, NSW 2230, Australia

ARTICLE INFO

Keywords:
Gillnet
Trawl
Method comparison
Estuary
Australia

ABSTRACT

Although many studies have compared different methods of sampling fish fauna, few have examined differences between active and passive gears over large spatial and temporal scales, which may lead to misleading conclusions about their suitability as sampling tools. Using data from two years of sampling in five estuaries of New South Wales (Australia), we illustrate differences in assemblages and size structures of populations of fish and invertebrates sampled with a beam trawl and multi-mesh gillnets. Multivariate analyses revealed that each method gave a different picture of assemblages of fauna. In general, the beam trawl was more effective than the gillnets in sampling penaeid prawns and several small species of fish. By comparison, the gillnets caught a wide size-range of several fishes of commercial and recreational importance, many of which were mostly absent in catches from the trawl. In some cases, however, differences in assemblages and size-structures of populations between methods depended on the particular estuary or period of time in which sampling was done. These findings not only reinforce the need for pilot studies in identifying suitable sampling gears, but also demonstrate that careful attention must be paid to ensure such studies are replicated over appropriate spatial and temporal scales. Moreover, while sampling with both the trawl and gillnets provided the most comprehensive picture of populations and assemblages, we highlight that the suitability of either sampling method depends on the specific objectives of a study and the particular species (or assemblages of species) of interest.

1. Introduction

A range of active and passive methods, including otter trawls (Smith and Gavaris, 1993; Korsbrekke et al., 2001), beam trawls (Gunderson and Ellis, 1986; Hamer and Jenkins, 2004), seine and gillnets (Degerman et al., 1988; Whitfield et al., 1994), longlines (Simpfendorfer et al., 2002), traps (Kennelly, 1992; Smith and Tremblay, 2003) and underwater video (Willis et al., 2000; Watson et al., 2005), have been used to sample fish and invertebrates in marine, estuarine and freshwater environments. Nevertheless, all of these methods have biases and limitations which may affect the numbers, sizes and types of species that are sampled. Therefore, before commencing any study, it is necessary to identify appropriate methods of sampling (Andrew and Mapstone, 1987).

Ideally, the suitability of different sampling methods should be examined using an experimental approach (Andrew and Mapstone, 1987; Rotherham et al., 2007). It is the case, however, that many studies of fish have been carried out in the absence of any pilot work, with the decision to use one particular type of method perhaps relying on past experience, the results of studies done elsewhere, or common perceptions. For example, trawl nets were initially perceived by Olin and Malinen (2003) and Olin et al. (2009) to be less selective and provide more reliable estimates of species abundance and length distributions than gillnets. Nevertheless, their studies subsequently demonstrated that gillnets and a trawl gave different pictures of the composition of assemblages and size-structures of populations of fish in eutrophic lakes. Indeed, these and many other studies have stressed the need for multiple types of gears to provide the most complete picture of assemblages and size-structures of populations of fish fauna (Olin and Malinen, 2003; Watson et al., 2005; Morrison and Carbines, 2006; Eros et al., 2009; Olin et al., 2009). It remains unclear, however, whether generalisations about sampling with gillnets and trawls are consistent for assemblages of fish or invertebrates in lakes and estuaries in other parts of the world.

Some studies have compared the utility and efficiency of different sampling gears over relatively short periods of time (e.g. within a single week; Olin and Malinen, 2003; Cappo et al., 2004) and in a small number of places (e.g. small part of a single lake or estuary e.g. Guest et al., 2003). Owing to spatial and temporal variability in abundance and size-structure of populations and assemblages, differences between or among sampling gears may depend on the

* Corresponding author. Tel.: +61 2 9527 8432; fax: +61 2 9527 8576.
E-mail address: douglas.rotherham@industry.nsw.gov.au (D. Rotherham).

0165-7836/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.fishres.2011.11.019

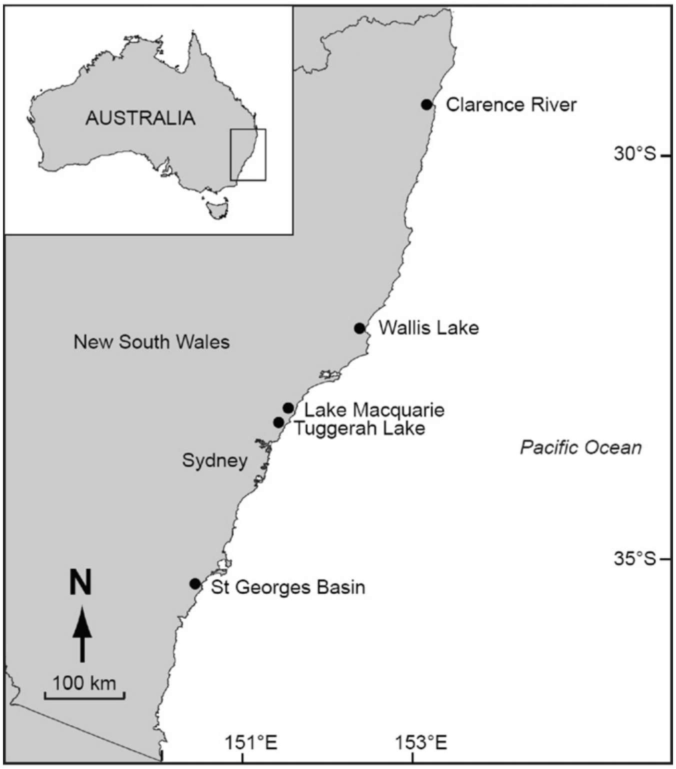

Fig. 1. Locations of estuaries sampled in the study.

spatial and temporal scope of an experiment. Unless the generality of patterns have been examined at different spatial and temporal scales, the suitability of a particular method of sampling may be misleading (Andrew and Mapstone, 1987).

Here, we examine differences in assemblages and size-structures of populations of fish and invertebrates sampled with a beam trawl and multi-mesh gillnets over a two-year period in five estuaries of New South Wales (NSW), Australia. Based on our earlier work (Rotherham et al., 2008a,b; Gray et al., 2009) and results of previous studies done elsewhere (Olin and Malinen, 2003; Olin et al., 2009), we predicted that: (i) the beam trawl and multi-mesh gillnets would sample different assemblages of fish fauna; (ii) for species caught in both gears, the beam trawl and multi-mesh gillnets would catch smaller and larger individuals, respectively; and (iii) patterns would be consistent among estuaries and within and between years.

2. Methods

2.1. Study area

Five estuaries of NSW were sampled with a beam trawl and multi-mesh gillnets over a two-year period as part of a larger study evaluating the status of estuarine fisheries resources. The estuaries sampled included the Clarence River, Wallis Lake, Lake Macquarie, Tuggerah Lake and St. Georges Basin (Fig. 1). All of these estuaries are wave-dominated barrier estuaries with tidal inlets constricted by wave-deposited sand and flood-tidal deltas, but they differ in size and characteristics (see Roy et al., 2001). The Clarence River is a mature, infilled, barrier estuary with a riverine channel which dominates most of the estuarine environment. The remaining estuaries are large, well-mixed, microtidal, coastal lakes. Specific characteristics of each estuary (e.g. water area, catchment area, habitats, etc.) and its catchment have been described elsewhere (Roy et al., 2001).

2.2. Sampling design and methods

2.2.1. Temporal scales

Each estuary was sampled with the beam trawl and gillnets in each of two periods (January–March/April and April/May–July) in each of two years (2008 and 2009). The two sampling periods were approximately 3 months long and separated by at least 4 weeks in each estuary. Results of our previous studies of gillnets (Rotherham et al., 2011) and beam trawls (unpublished data) demonstrated that variation in abundances of fish at temporal scales within 3-month periods (e.g. days, weeks and months) was small compared to variation between 3-month periods and at small spatial scales. Further, in the present study, the order in which each estuary was sampled with each gear (within each period in each year) was selected at random. Thus, we consider that differences between gears are unlikely to be substantially affected by differences related to the particular day, week or month that sampling was done within a 3-month period. Further, sampling at random times within a 3-month period with each gear avoided potential problems of non-independence of data, which may occur if comparisons of gears are done at particular spatial scales simultaneously, or over short periods of time (*sensu* Underwood, 1997).

2.2.2. Beam trawl

The beam trawl was 3-m wide and configured with 41-mm diamond-shaped mesh in the body and 20-mm mesh hung on the bar (i.e. square-shaped) in the codend (see Rotherham et al., 2008a). In each estuary (except for the Clarence River), four sites (separated by 1 km to several km) were randomly selected over relatively flat, predominantly unvegetated sediment interspersed with (or adjacent to) patches of seagrass. In the Clarence River, two sites (selected at random and separated by at least 1 km) were nested within each of two zones (entrance and middle) to account for potential differences in salinity among different sections of the river.

In each sampling period in each year, nine non-overlapping replicates of the beam trawl were sampled at night in each site (Rotherham et al., 2008b). It took two consecutive nights to sample all four sites within an estuary. As explained above, the two nights of sampling were selected at random from within each sampling period. During each night, each replicate trawl was towed for 5 min (see Rotherham et al., 2008b) at speeds of about 1.2 m s^{-1}. The design of trawl sampling was not stratified by depth (i.e. into deep and shallow strata as done for gillnets in some of the estuaries, see below) because there were insufficient trawlable areas available in most of the estuaries sampled to achieve the necessary levels of replication in each strata. Nevertheless, sampling with the trawl was done over a similar range of depths and habitats (predominately unvegetated sediment interspersed with, or adjacent to, patches of seagrass) as sampling done with the gillnets (i.e. from a minimum of about 1 m up to a maximum of about 6 m, see below). After each replicate tow was completed, the contents of the codend were emptied onto a tray and sorted by species. Collection of data included: the total numbers of individuals of each species; and the sizes of economically important finfish (fork length – FL, to the nearest 0.5 cm below).

2.2.3. Multi-mesh gillnets

Each multi-mesh gillnet consisted of seven 20-m panels of different sizes of stretched mesh (36, 44, 54, 63, 76, 89 and 102 mm) connected together in a random order (see Gray et al., 2009). Adjacent panels were separated by 5 m of rope to minimise potential effects of the smaller-mesh panels ‘leading’ larger fish to adjacent panels. The 36- and 44-mm panels were made from monofilament netting with twine diameter of 0.15 mm; the remaining panels had