Fisheries Research xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Fisheries Research

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

Experiences with the use of bioeconomic models in the management of Australian and New Zealand fisheries

Sean Pascoe[a,*], Viktoria Kahui[b], Trevor Hutton[a], Catherine Dichmont[a]

[a] CSIRO Oceans and Atmosphere, PO Box 2583, Brisbane, QLD 4001, Australia
[b] Department of Economics, University of Otago, PO Box 56, Dunedin, 9054, New Zealand

ARTICLE INFO

Article history:
Received 19 October 2015
Received in revised form 11 January 2016
Accepted 11 January 2016
Available online xxx

Keywords:
Bioeconomic model
Australia
New Zealand
Fisheries management

ABSTRACT

Australian and New Zealand fisheries are considered the best managed in the world. Much of this is due to the explicit recognition of the role of incentives in the management of fisheries, and the benefits that can be achieved through the maximisation of economic returns as a key management objective. However, while management of fisheries in Australia is supported through the application of bioeconomic models, these play virtually no role in fisheries management in New Zealand. This discrepancy is a direct result of the differing emphasis on how economic objectives are achieved, with Australia targeting maximum economic yield (MEY) while New Zealand targets maximum sustainable yield. We present case studies from Australia illustrating how bioeconomic models have been developed to support fisheries management and briefly discuss the situation in New Zealand. While economic considerations are important in both countries, we find that the explicit MEY target in Australian Commonwealth managed fisheries has been a key driver for the development and use of bioeconomic models in fisheries management.

1. Introduction

In 2010, a global review ranked both New Zealand and Australia in the top set of countries for marine resource management (Alder et al., 2010). This ranking was based on a broad range of factors around sustainability and profitability of the industries, but largely reflects the recognition of the importance of economic drivers in the management of commercial fisheries. In New Zealand, this has largely manifested itself in the widespread adoption of individual transferable quotas (ITQs) as the main management mechanism (Batstone and Sharp, 1999; Bess, 2005; Pearse and Walters, 1992), which provides appropriate incentives for fishers to focus on profit maximisation rather than wasting resources on racing to fish (with resultant over-capacity which is common in many fisheries worldwide). The adoption of such a market based mechanism is recognition that fisheries can be both profitable and sustainable if the appropriate incentives are provided to fishers.

In Australia, both market-based and more traditional effort-based management controls have been adopted on a fishery-by-fishery basis, aimed at ensuring appropriate incentives are a key part of all management systems. Australian fisheries have also explicitly embraced economic objectives in the development of management plans and targets. While economic objectives are common in most management systems around the world, Australian Commonwealth management fisheries have adopted maximum economic yield (MEY) as an explicit and dominant management objective, with biomass and fishing mortality at MEY as management targets.

With an explicit recognition of economic drivers as fundamental to effective management, the development of bioeconomic models to support management has been important in Australia. While the use of bioeconomic models per se for supporting management is more limited in New Zealand, economic analysis has played a major role more broadly in fisheries management. In this paper, we review the development and use of bioeconomic models in Australian and New Zealand fisheries. The aim of the review is to illustrate how the models evolved over time, how they have been used for management support, and the general lessons learnt as a result.

First, a general overview of the management systems in each country is presented. Next, the development and use of bioeconomic models in the case study fisheries is detailed. Finally, general implications of the usefulness of the different types of models are discussed.

* Corresponding author.
E-mail address: sean.pascoe@csiro.au (S. Pascoe).

http://dx.doi.org/10.1016/j.fishres.2016.01.008
0165-7836/© 2016 Published by Elsevier B.V.

2. Management systems overview

The type of bioeconomic model and its potential role in supporting fisheries management is largely a function of the objectives of management and the management systems that are in operation. In this section, a brief overview of management systems in the two countries is presented to place the subsequent discussion of the individual models in context.

Responsibility for Australian fisheries management is shared between the different States and the Commonwealth (i.e. Federal Government). While States have primacy in management responsibility for the first three nautical miles under the Constitution, recognition that fisheries resources often extend beyond this has led to the development of a series of offshore constitutional settlements (OCS), under which management responsibility is fully divested in either the State or Commonwealth (Haward, 1989).[1]

Management of Australian fisheries varies between the States and also Commonwealth jurisdictions, largely reflecting the different characteristics of the fisheries and the relative importance of each management objective. The Commonwealth Fisheries Harvest Strategy Policy and Guidelines specify that managers should aim to achieve maximum economic yield (MEY) in the fishery (DAFF, 2007). Economic objectives are also included in most State fisheries policies, although the importance of these varies (Jennings et al., 2016; Pascoe et al., 2013a). All Australian fisheries are limited entry, with additional management also through either individual transferable catch or effort quotas, or other effort based management systems. The role that industry plays in shaping fisheries management also varies from jurisdiction to jurisdiction, and between fisheries within jurisdictions. Some fisheries have adopted formal well-established and supported co-management models (e.g., the Northern Prawn Fishery), while others involve industry through advisory groups (e.g. the South Eastern and Southern Shark and Finfish Fishery). In some States (e.g. Queensland), no formal mechanism for industry involvement exists.

In contrast, New Zealand has a single jurisdiction with no demarcation between national and local fisheries, and has adopted a single over-arching approach to fisheries management, namely the ITQ system. ITQs are well defined rights to harvest a percentage share of a species- and area-specific total allowable catch (TAC),[2] and owners are assigned annual catch entitlements (ACE) based on their quota holdings and the TAC (Lock and Leslie, 2007), i.e. once the TAC is known for a given year, the kilogram equivalent of each quota share is transferred to the respective owners on the first day of the fishing year as ACE. Quota owners can sell their ACE while retaining their long-term ownership, with the result of reduced transaction costs and enhanced flexibility. Economic theory suggests that the ITQs and ACE, which are freely traded in a competitive market, generate price signals that provide valuable information about profitability and sustainability of the fishery. In a study covering 33 species and more than 150 markets for quotas in New Zealand, Newell et al. (2005) found evidence of economic rational behaviour and efficient fisheries management.

ITQ management in New Zealand also embraces broader social, economic and sustainability objectives, with the aim that the value New Zealanders obtain from the sustainable use of fisheries and protection of the aquatic environment is maximised (Peacey and Connor, 2007). The Fisheries 2030 strategy (Ministry of Fisheries, 2009) identifies two key long term goals for NZ fisheries:

- Fisheries resources are used in a manner that provides greatest overall economic, social and cultural benefit; and
- The capacity and integrity of the aquatic environment, habitats and species are sustained at levels that provide for current and future use.

Despite the importance of economic and social objectives of management in New Zealand, most TACs are aimed at achieving maximum sustainable (rather than economic) yield. While ITQs provide a highly efficient solution on how to harvest the TAC, residual externalities can remain. Fish stocks that are heterogeneous in density, location and unit value during the season can lead to inefficient fishing practices that dissipate rent (Costello and Deacon, 2007). New Zealand's ITQ policy making has evolved dynamically over time to address a myriad of issues such as catch balancing, localised depletions, etc. making it one of the most advanced ITQ systems in the world (Mace et al., 2013).

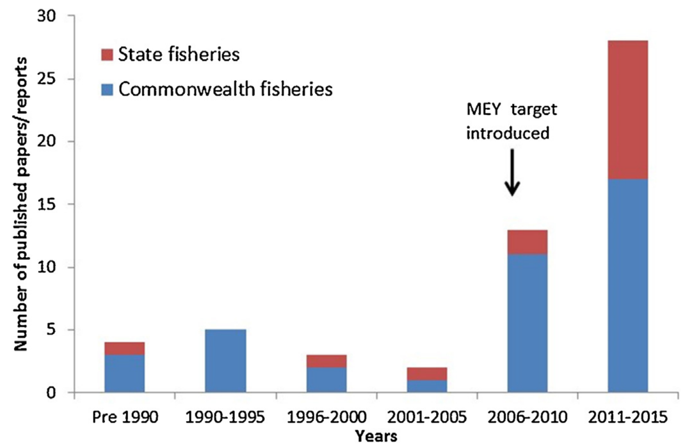

Fig. 1. Number of Australian fisheries bioeconomic model based papers and reports produced over time.

3. Bioeconomic models in Australian fisheries

The development and application of bioeconomic models in Australia has, in recent years, largely been driven by the shift in policy emphasis to an MEY target in Commonwealth fisheries. Prior to 2006, only a few models were developed (Fig. 1), mostly aimed at addressing particular management issues (e.g. seasonal closures).[3]

In 2007, the Commonwealth Harvest Strategy Policy and Guidelines (DAFF, 2007) was formally released with an explicit objective of achieving MEY in Commonwealth fisheries. This policy shift had been anticipated for several years, and formed the rationale for a large scale buyback program in Commonwealth fisheries in 2006 as part of the transition process to the MEY target (Vieira et al., 2010). This in turn required a shift in fisheries advice from biological to bioeconomic, and the need for bioeconomic models as inputs into the management process.

[1] While each OCS differs depending on the particular circumstances, as a general rule fisheries resources that are solely or largely contiguous to a single State are largely managed by the State, while fisheries resources that straddle States, or occur fully outside State territorial waters, are largely managed by the Commonwealth. There are, of course, exceptions to this general rule. OCS arrangements are also needed to manage fisheries resources in Australia's exclusive economic zone, which extends to 200NM and this is outside State jurisdiction.

[2] The TAC is divided into total the allowable commercial catch (TACC) and non-commercial catch (TANC) except for deepwater fisheries where only commercial catch occurs. For ease of reference, the TAC in this paper is synonymous to the TACC.

[3] Full references for the bioeconomic modelling papers identified and depicted in Fig. 1 are given in the supporting information. Only papers that outlined bioeconomic models developed for fisheries management purposes are presented. Purely theoretical papers, and papers relating to marine reserves have been excluded.