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The commercial fishery for ocean leatherjackets (*Nelusetta ayraudi*, Monacanthidae) in New South Wales, Australia.

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Abstract

The ocean leatherjacket (*Nelusetta ayraudi*) has a long history of commercial exploitation in New South Wales, Australia. Records of reported landings indicate that substantial peaks of between 600 and 900 tonnes per annum occurred during the 1920s and again during the 1950s. These peaks were followed by large declines, which suggest that this species is vulnerable to over-exploitation. In recent years from 2000/01 to 2006/07, annual commercial landings of ocean leatherjackets using oceanic demersal fish traps and demersal otter trawl have increased from 134 to 430 tonnes. Between 2003 and 2005 ocean leatherjackets in commercial landings ranged approximately between 22 and 65 cm in total length. Ocean leatherjackets were fully recruited to the fishery at two years of age, with the majority of the catch (83%) aged either two or three years. The instantaneous total mortality rate was estimated from an age-based catch curve as 1.1. Natural mortality was estimated as approximately 0.5, based on a maximum age of 6 years. Yield per recruit indicated that under current levels of exploitation the yield per recruit would be maximized at a length at first harvest of 35 cm in total length.

Introduction

Monacanthids, commonly referred to as ‘filefish’ and ‘leatherjackets’, are harvested in large quantities throughout the world. Major fisheries exist throughout Asia in coastal waters of Japan, Korea, China, Vietnam and Taiwan (Murakami and Onbe 1967; Kakuda 1976; 1978; Shiqin and Hu Yachu 1980; Park 1985; Kawase and Nakazono 1994; Minquan 1994; Chen et al. 1997; Wei-Zhong et al. 1998; Daug 2002; FAO 2004; 2006). Smaller fisheries also exist in Chile, Antigua Barb (Caribbean), Ukraine, New Zealand (FAO 2004; 2006), the Canary Islands region (Mancera-Rodriguez and Castro-Herandez 2004) and Australia (Lindholm 1984; Grove-Jones and Burnell 1991; Kailola et al. 1993). In Australian waters the majority of leatherjackets are taken from the southern half of the continent (below 30ºS) in cooler temperate waters using

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commercial fishing methods such as demersal fish and prawn trawls, traps, seines and gillnets, as well as by hook and line by commercial and recreational fishers. Australia contains the highest diversity of monacanthids in the world, with a total of 59 species being recorded (Hoese et al. 2006). The ocean leatherjacket (*Nelusetta ayraudi*) is one the largest monacanthids in the world and is the dominant monacanthid species harvested from Australian waters (Kailola et al. 1993).

There has been a long history of exploitation of ocean leatherjackets in New South Wales (NSW) waters off the southeastern coast of Australia, with the first catches in the Sydney Fish Markets recorded in March 1884 (Klaer, 2001). The ocean leatherjacket fishery increased greatly at the turn of the 19th century with the introduction of steam trawlers to offshore fishing grounds with annual catches increasing to 682 tonnes by 1922 (Klaer, 2001). Today, the largest fisheries for ocean leatherjackets are in South Australia and NSW, with catches in each state usually exceeding 400 tonnes (unpublished data). The majority of ocean leatherjackets in these states are taken using demersal fish traps (Stewart & Ferrell, 2003), however large catches are also taken by demersal trawls. In NSW, ocean leatherjackets are the 2nd most valuable species within the demersal trap fishery, behind snapper (*Pagrus auratus*) (NSW Department of Primary Industries catch records). The fishery for ocean leatherjackets extends the length of the coast of NSW, with the fishing season varying with latitude. Fish are targeted on the southern NSW coast during summer and autumn, while it is a winter fishery on the far northern NSW coast.

The management of monacanthid fisheries in Australia, specifically those for ocean leatherjackets, has been limited by a lack of knowledge of their biology and the composition of sizes or ages in landings. In NSW, there are no specific management regulations for harvesting ocean leatherjackets. Rather, catches are controlled through general gear regulations in the multispecies demersal trap and trawl fisheries. There is currently no regulated minimum legal length for ocean leatherjackets or any other leatherjacket species. Given that monacanthids, and particularly ocean leatherjackets, are considered vulnerable to overfishing, the aim of this paper is to provide the first comprehensive description of the fishery for ocean leatherjackets in NSW and therefore, enable improved management of the fishery. Specifically, we: (i) describe trends in historical landings and the sizes and ages in commercial landings; (ii) use catch composition data in association with biological information to estimate instantaneous mortality rates through catch curve analysis; and (iii) model yield per recruit to estimate the optimal size at first harvest. Finally, we make recommendations for improved management of the ocean leatherjacket fishery in NSW based on these results.

Materials and methods

Information on historical catch records was obtained from the NSW Department of Primary Industry catch records database from 1940 onwards. These records are supplied by commercial fishers as a regulated requirement of their fishing licences, and provide information such as species captured, quantities retained, areas fished and, since 1997, the methods used. Reported catch weights of ocean leatherjackets generally refer to trunk weights (i.e., after all fish are headed and gutted).The lengths of a total of 4383 ocean leatherjackets landed by the commercial demersal trap fishery in NSW between 2003 and 2005 were measured either at the Sydney Fish Markets, regional fishermen's cooperatives or onboard commercial fishing vessels. All fish were measured as total length (TL), to the nearest whole centimetre below the true length.

Estimates of the age compositions in the commercial landings of ocean leatherjackets were derived from the estimated ages of fish sampled during 2003 and 2004. Ocean leatherjackets were representatively sampled each month from commercial catches and an estimate of the age of each of these sampled fish was made by counting opaque zones in sectioned otoliths (Miller, 2007).

Estimates of instantaneous total mortality (Z) were made from the slope of the descending arm of the catch curve (i.e. by fitting a regression to the natural logarithm of age frequency against age for all fully recruited age classes). An estimate of natural mortality (M) was made after the method of Hoenig (1983) for exploited populations based on either 1% or 5% attaining the maximum age for the species, where the maximum reported age for ocean leatherjackets is approximately 6 years (Miller 2007). Estimates of fishing mortality (F) were made by subtracting the estimates of M from Z.

Yield per recruit analysis (YPR) was done using a variant of the Beverton & Holt (1957) model described in www.fishbase.org as case III. The model describes YPR in terms of exploitation rate (E = F / Z) and size at first capture (length at capture / L_∞). This approach was used because in the present study we required information that was related to fish length rather than age. Input parameters included the von Bertalanffy growth function parameters L_∞ = 88.5 cm, k = 0.16 year^{-1}, t_0 = - 0.57 years (Miller, 2007) and estimates of mortality rates.

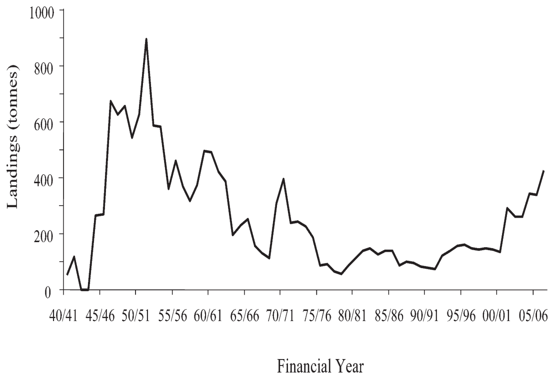

Figure 1. Historical commercial landings of ocean leatherjackets in New South Wales.

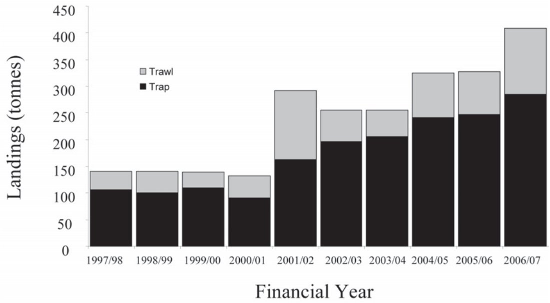

Figure 2. Landings of ocean leatherjackets by demersal trap and demersal trawling fisheries in New South Wales since 1997/98.

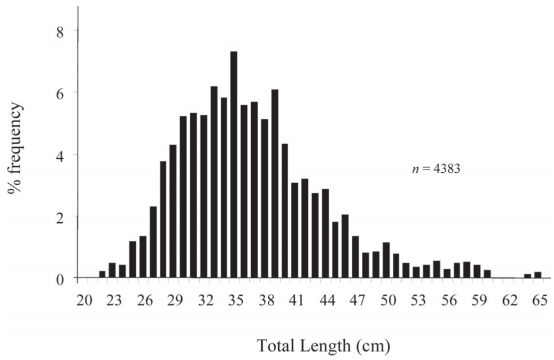

Figure 3. The sizes of ocean leatherjackets landed by the New South Wales demersal trap fishery between 2003 and 2005.

Results

Historical records show that commercial landings of ocean leatherjackets in NSW in the early 1950s increased to levels of those experienced in the early 1920s (Klaer 2001) (Fig. 1). In 1951/1952, a total of 900 tonnes of leatherjackets were reportedly captured. A breakdown of fisheries contributing to the capture of the largest records identified a developing demersal trap fishery in the north of the state, which captured 480 tonnes. Catches declined to 318 tonnes in 1957/1958, with further declines observed in 1968/1969 to 112 tonnes and 56 tonnes by 1978/1979. In recent years, however, catches of ocean leatherjackets have steadily increased from 134 tonnes in 2000/01 to 430 tonnes during 2006/07 with the latter having an estimated value of AUD$1.1 million market value. Catches of ocean leatherjackets have increased in both of the major fishing sectors (trap and trawl) since 1997/98, with an aver age of 73% of the annual catch being captured using fish traps (Fig. 2).

The sizes of ocean leatherjackets in commercial trap catches between 2003 and 2005 ranged between 22 and 65 cm, and had a median size of 36 cm (Fig. 3). The age composition of landi ngs showed that ocean leatherjackets were fully recruited at 2 years of age (Fig. 4). The bulk of the fishery (83%) consisted of fish aged 2 and 3 years old.

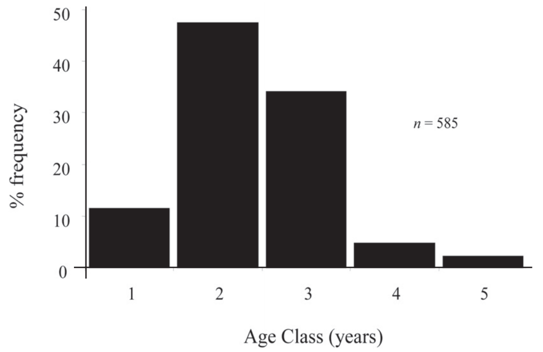

Figure 4. The age composition of ocean leather jackets in landings of the New South Wales demersal trap fishery during 2003/04.

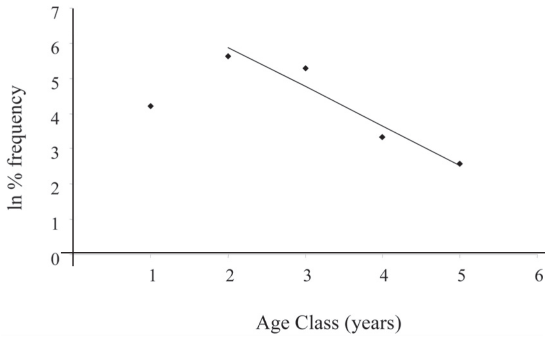

Figure 5. Catch curve for ocean leatherjackets from 2003 to 2004.

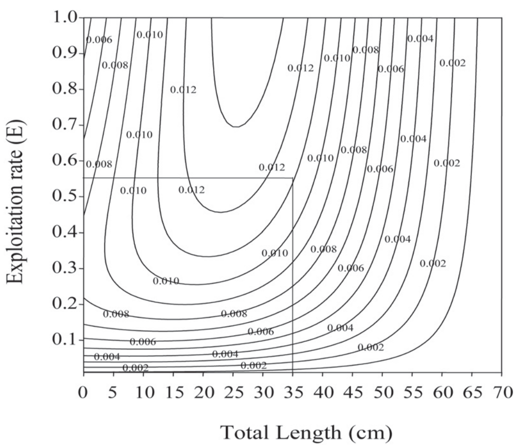

Figure 6. Yield per recruit isopleths for ocean leatherjackets. The lines indicate the current level of exploitation rate and the corresponding length at which the yield per recruit is maximized.

The estimate of Z made from the descending arm of the catch curve for ocean leatherjackets aged between 2 and 5 years old was 1.1 (Fig. 5). The estimate of M based on either 1% or 5% of fish attaining the maximum age of 6 years ranged between 0.50 and 0.77. Due to the relatively short nature of the study and the fact that ocean leatherjackets are reported to attain larger sizes (70 cm - Hutchins & Swainston, 1999) than we observed (65 cm), it was assumed that ocean leather jackets can attain ages of greater than 6 years. Given this, we believe that the more realistic estimate of M is based on 5% of fish attaining 6 years old (M = 0.50) and therefore the most probable estimate of F = 0.6 (1.1 – 0.5) and exploitation rate (E) = 0.55.

The yield per recruit analysis indicated that at the most probable level of current exploitation the yield per recruit of ocean leatherjackets is maximized at 35 cm (Fig. 6). Using less precautionary (lower) estimates of M resulted in the yield per recruit being maximized at slightly smaller sizes.

Discussion

Monacanthids are captured in very large numbers in commercial fisheries throughout Asia primarily by large stern fish trawling vessels. In contrast, commercial fisheries for monacanthids in Australia are relatively small, with the majority of the catch captured by either small-scale demersal fish trawls or demersal fish traps in the southern half of the continent. Nevertheless, the fishery for ocean leatherjackets in NSW is extremely important locally and so the information provided in this paper should be carefully considered when formulating future improvements to the fisheries management strategies for those fishing methods.

Historical catch information suggests that the ocean leatherjacket stock in NSW was fished down during the 1920s (Klaer, 2001) when they were heavily targeted by steam demersal trawlers, and again during the 1950s as a result of trawling operations and a developing trap fishery. These factors indicate that although current landings are increasing, ocean leatherjackets are vulnerable to overfishing and that any further increases in effort may cause stock declines.

The sizes of ocean leatherjackets landed by commercial fishers in NSW indicate that much of the catch is of juvenile sized fish (< 35 cm) (Figure 4). Currently, fishers in the oceanic demersal trap fishery must use 50 mm hexagonal wire mesh in their traps. These traps have been demonstrated to be highly size-selective for ocean leatherjackets, but would retain almost all fish > 25 cm in total length (Stewart & Ferrell, 2003). However, the introduction of escape panels of 50 x 75 mm welded mesh, which are to be made compulsory in fish traps in NSW by late 2008, most likely will result in traps selecting ocean leatherjackets at sizes > 35 cm in total length (their size at sexual maturity - Miller, 2007).

The age composition of ocean leatherjackets in the NSW demersal trap fishery was found to be similar to those reported in other monacanthid fisheries in Australia and around the world with the majority of fish captured between two and five years old and the oldest fish not exceeding 10 years (Kakuda, 1979; Chien and Hu, 1980; Park 1985; Grove-Jones and Burnell, 1991; Peristiwady and Geistdoerfer 1991; Chen et al. 1998; Mancera-Rodriguez and Castro-Hernandez, 2004). This emphasises that globally, monacanthids have fast growth rates and so become vulnerable to capture from an early age.

The estimates of mortality rates indicated that M was similar to F and therefore that the current exploitation rate was approximately 0.5 which is generally considered to be sustainable (Gulland, 1970). The yield per recruit analysis indicated that yield could be improved if the size at first harvest for ocean leatherjackets was increased to 35 cm. Although the implementation of escape panels of larger mesh will in turn select ocean leatherjackets at approximately 35 cm (Stewart & Ferrell, 2003), there are currently no regulated restrictions on the sizes of ocean leatherjackets able to be retained. The information presented here may therefore, assist managers in the consideration of a minimum legal length on ocean leatherjackets as an appropriate management tool.

In NSW, both recreational and trawl fishers catch substantial quantities of small ocean leatherjackets and a minimum legal length may help to protect these juveniles. Although, there are currently no estimates of discard mortality for ocean leatherjackets, discard mortality may be high as ocean leatherjackets suffer from barotrauma-related injuries being surfaced from relatively shallow (< 30 m) depths and they may also be damaged during trawling (pers. obs.). Research is needed to investigate the rates of mortality of discards from demersal trawling and trapping operations.

The level of protection of populations of ocean leatherjackets in NSW has increased with the introduction of area-closures through the past ten or so years. These area closures include recreational fishing havens, marine protected areas such as marine parks, aquatic reserves and marine components of national parks and nature reserves. Given that ocean leatherjackets appear to be vulnerable to over-exploitation, it will be important to maintain these area closures in years to come. In addition, continued monitoring of the sizes and ages in landings is required so as to assess changes in population structure resulting from the currently increasing level of exploitation.

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