



## Distribution and abundance of skates (*Bathyraja* spp.) on the Kerguelen Plateau through the lens of the toothfish fisheries

G.B. Nowara<sup>a,\*</sup>, P. Burch<sup>a,b</sup>, N. Gasco<sup>c</sup>, D.C. Welsford<sup>a</sup>, T.D. Lamb<sup>a</sup>, C. Chazeau<sup>c</sup>, G. Duhamel<sup>c</sup>, P. Pruvost<sup>c</sup>, S. Wotherspoon<sup>a,b</sup>, S.G. Candy<sup>a,1</sup>

<sup>a</sup> Australian Antarctic Division, Department of the Environment, 203 Channel Highway, Kingston, Tasmania 7050, Australia

<sup>b</sup> Institute for Marine and Antarctic Studies, University of Tasmania, Private Bag 49, Hobart, Tasmania 7001, Australia

<sup>c</sup> Museum national d'histoire naturelle, Sorbonne Universities, Département des milieux et peuplements aquatiques, UMR 7208 BOREA (MNHN-CNRS-UPMC-IRD-UCB), CP 26, 43 rue Cuvier, 75231 Paris Cedex 05, France

### ARTICLE INFO

#### Article history:

Received 31 March 2016

Received in revised form 21 July 2016

Accepted 22 July 2016

Handled by Prof. George A. Rose

#### Keywords:

*Bathyraja* sp.

Sub-Antarctic

By-catch

Zero-inflated models

GAM and GLM

### ABSTRACT

Three species of skate, *Bathyraja eatonii*, *B. irrasa* and *B. murrayi*, are commonly taken as incidental by-catch in Patagonian toothfish (*Dissostichus eleginoides*) longline and trawl fisheries, and the mackerel icefish (*Champsocephalus gunnari*) trawl fishery on the Kerguelen Plateau (KP) in the southern Indian Ocean. Data from fishery observations for 1997–2014 shows that the three skates were widely distributed across the Kerguelen Plateau, showing different spatial distributions, linked mainly with depth. Off Heard Island and McDonald Islands (HIMI), in the southern part of the KP, *B. eatonii* and *B. irrasa* were most abundant to the north and northwest of Heard Island, out to the edge of the Australian Exclusive Economic Zone (EEZ), and were caught down to depths of 1790 m and 2059 m respectively. The smallest species, *B. murrayi*, occurred mainly in the shallower waters down to 550 m, and was most abundant to the north and northeast, close to Heard Island. Around Kerguelen Islands, in the northern part of the KP, skates were most abundant between the 500 m and 1000 m contours circling and extending from the islands.

Catch rates were modelled using zero-inflated GAMs and GLMs. The catch rates of skates from the trawl fisheries in the Australian EEZ surrounding Heard Island and McDonald Islands have shown little evidence of depletion on the main trawl fishing grounds, although there is evidence of a decrease in the average total length of *B. eatonii*. The marine reserves and the conservation measures employed by the Commission for the Conservation of Antarctic Marine Living Resources in the HIMI fisheries, appear to provide effective protection for the skates, at least in the shallower waters where the trawl fisheries operate. *B. irrasa* taken in the deeper waters where longline fishing occurs have shown a slight decline in catch rate over the years of the HIMI fishery. Although all skates are returned to the water from this fishery, survival rates are unknown and careful monitoring should continue to assess the status of these stocks. There appears to be little change in the abundance of the skate species at Kerguelen in the time period.

This study provides the first review of skate by-catch across both the HIMI and Kerguelen fisheries. Ongoing monitoring of species specific by-catch levels and further research to determine the important life history parameters of these species are required, particularly for *B. irrasa* which is taken in both trawl and longline fisheries.

Crown Copyright © 2016 Published by Elsevier B.V. All rights reserved.

### 1. Introduction

The Kerguelen Plateau (KP) is the largest peri-insular plateau in the Southern Ocean and is located in the Indian Ocean Sector.

A longline fishery for Patagonian toothfish, *Dissostichus eleginoides*, operates in the northern part of the Kerguelen Plateau, in the French Exclusive Economic Zone (EEZ) around Kerguelen Island. In the southern part, trawl fisheries target both toothfish and mackerel icefish, *Champsocephalus gunnari*, and a longline fishery targets toothfish, operating in the Australian EEZ surrounding Heard Island and McDonald Islands (HIMI). In addition to the target species, incidental by-catch of skates, sharks, other finfish and invertebrates are taken. Skates (Rajiformes) are the most abundant by-catch in these fisheries at HIMI and second most abundant at Kerguelen

\* Corresponding author.

E-mail address: [gabrielle.nowara@aad.gov.au](mailto:gabrielle.nowara@aad.gov.au) (G.B. Nowara).

<sup>1</sup> Present address: SCANDY Statistical Modelling Pty. Ltd., 70 Burwood Dr, Blackmans Bay, TAS 7052, Australia.

(grenadiers, *Macrourus* spp., are first), and are caught across the KP area. Three species of skates are caught, *Bathyraja eatonii*, *B. irrassa* and *B. murrayi*, which are distributed mostly on the KP, but with occasional reported occurrences in other areas of the Southern Ocean.

A demersal gear fishery has occurred on the KP since the 1970's targeting four main species, endemic to the Southern Ocean: mackerel icefish, Patagonian toothfish, marbled notothen (*Notothenia rossii*) and grey notothen (*Lepidonotothen squamifrons*) (Duhamel and Williams, 2011). The fishery for Patagonian toothfish in the high seas off the Kerguelen Islands began in 1984/85 when it was exploited by former USSR trawlers (Lord et al., 2006). Longlining commenced in 1990/91, and by 2001/02 became the only fishing method, with annual catches of about 5000 t of toothfish since 1993/94 (Lord et al., 2006; Duhamel et al., 2011). Soon after the declaration of the French EEZ in 1979, an observer program was established to record biological measurements of the target and by-catch species in this fishery, with 100% observer coverage (Duhamel et al., 2011; Gasco, 2011). As of 2014, there were seven vessels fishing in the EEZ. The fishery is managed by Terres Australes et Antarctiques Françaises. Fishing is prohibited in waters shallower than 500 m and generally occurs at depths between 500 and 2000 m (Gasco, 2011).

The Australian offshore fishery around HIMI began as a trawl fishery with one vessel in 1997. It was joined by a longlining vessel in 2003, and a second longliner entered the fishery in 2008. In 2013 and 2014 the number of vessels in the longline fishery had risen to three. There has been 100% observer coverage with two observers on all trips since the commencement of the fishery, enabling the collection of a comprehensive time series of data on the catch and biological observations. The fishery is managed by the Australian Fisheries Management Authority (AFMA) under the precautionary principles of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). This includes measures to ensure that the spawning stock of fished species are maintained at a level which ensures stable recruitment, and that the size of the stocks do not fall to levels which compromise the ecological relationships in the food web. This is achieved through conservation measures and an annual catch quota on toothfish and by-catch species, based on stock assessments.

Of the three species of skate most commonly taken as by-catch in these fisheries, the most frequently caught species in the trawl fisheries at HIMI is *B. eatonii*, which can grow to over 120 cm total length (TL) and inhabit depths to 1100 m (Duhamel et al., 2005). *B. irrassa* can grow to 139 cm TL and is found at depths of 300–1700 m (Duhamel et al., 2005). *B. irrassa* is the most commonly caught species in the longline fisheries across the Kerguelen Plateau. *B. murrayi* is the smallest of the three species and can grow to 70 cm TL. It is found at 30 to 650 m, but is more common at shallower depths (Duhamel et al., 2005).

Skates are known to be long-lived, late-maturing and with relatively low fecundity, making them susceptible to over-exploitation, even when taken as by-catch (Stevens et al., 2000; Dulvy et al., 2000). Tagging experiments by Australian scientists have shown that the skates at HIMI generally did not move very far, and were recaptured on average only 4 M (7.5 km) from their release point, even though the majority had been at liberty for several years (Nowara et al., 2013). This is another characteristic which can make them vulnerable to localised depletion. Few studies have looked at survival rates of skates in fisheries where skates are not targeted but are returned to the water after being incidentally caught (Endicott and Agnew, 2004; Laptikhovskiy, 2004).

Preliminary stock assessments of by-catch species at HIMI used a Generalised Yield Model to calculate a sustainable catch limit for *Bathyraja* spp. of 50–210 t (Constable et al., 1998). This work led to CCAMLR setting an annual catch limit of 120 t for the HIMI fishery

(SC-CAMLR, 1997). A limit on the catch of skates has been in place since the commencement of an Australian fishery, with the current catch limit not to exceed 120 t in any one season (1 December to 30 November in the next year) (CCAMLR, 2014a; Conservation measure 33-02). A 'move on' rule also applies, so that if skate by-catch in any one haul exceeds 2 t then the vessel must not use that method of fishing within 5 M of the area for 5 days (CCAMLR, 2014a; Conservation measure 33-02). The Kerguelen fishery also has a move on rule based on observer monitoring. If the catch rate of skates is greater than 50 per 1000 hooks, the captain must set the next line at least 2 nautical miles from the previous haul.

The aim of this study was to look at the occurrence of skates across the Kerguelen Plateau to describe the abundance, distribution, and depth pattern of the three species. The changes in abundance over time were examined in order to evaluate the impact that fisheries were having on the skate populations on the Kerguelen Plateau.

## 2. Methods

### 2.1. On-board data collection

At HIMI, geographical coordinates, time of setting and hauling, effort, and the duration of the trawl net tow or longline set were recorded for each haul. Catch numbers for the entire haul and biological measurements of a sub-sample of the toothfish, icefish and by-catch were taken. Skates in the trawl fisheries were identified to species and measured (total length and wing span) when they came aboard in the net and a biological sub-sample was weighed, sexed and assigned a gonad stage.

In the HIMI longline fishery, the counting and identification of skates involved two separate processes because most skates were cut off the line and returned to the water, either before they come over the side or shortly after, to maximise their chance of survival. Random biological sampling of up to ten skates occurred for each haul (Supplementary material S1.1). Skates taken for biological samples were always identified to species. Secondly, observations for 40% of each line during hauling recorded catch (numbers) by species or taxon grouping. Skates were identified to species level where possible, but sometimes only to genus level (*Bathyraja* sp.) or order level (Rajiformes).

In addition, similar data to those collected in the trawl fisheries were collected during an annual trawl survey, the Random Stratified Trawl Survey (RSTS), which is a biological survey to examine the abundance of toothfish, icefish and by-catch species in HIMI waters down to 1000 m. Approximately 150 hauls are carried out across the plateau and have been conducted in each year since the commencement of the Australian fishery in 1997.

The trawl net used in both the commercial toothfish fishing and during the RSTS at HIMI has remained consistent throughout the duration of the trawl fishery. A Champion 4-panel bottom trawl with a headline height of 38.5 m and a mesh size of 152 mm (Nowara et al., 2006) was used for 95% of the hauls. The same Champion net with a small mesh cod end liner (50–60 mm mesh size) was used during all RSTS survey hauls (Nowara et al., 2006). In the longline fishery at HIMI, auto longline gear with an integrated weight line was standard for the duration of the fishery, except for the first three trips where there was a mixture of integrated weight line and externally weighted line.

All vessels in the Kerguelen longline fishery have operated using a standardised integrated weight auto longline since observers began collecting reliable data on skate by-catch in 2008. Prior to December 2014, most skates caught were kept and retained, though some were cut off the line and did not come on board, or were later discarded. From the 2014/15 CCAMLR year (1 December 2014–30

Download English Version:

<https://daneshyari.com/en/article/4542602>

Download Persian Version:

<https://daneshyari.com/article/4542602>

[Daneshyari.com](https://daneshyari.com)