



Industry acoustic surveys of spawning southern blue whiting on the Bounty Platform, New Zealand



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ABSTRACT

Annual acoustic surveys of spawning southern blue whiting (*Micromesistius australis*) on the Bounty Platform, southeast of New Zealand, have been carried out using industry vessels since 2004. In most years, surveys were carried out from a single vessel, while in 2009, acoustic data were collected from three vessels. The survey approach in all years was the same—vessels with calibrated Simrad ES60/ES70 echosounders and hull-mounted 38 kHz transducers conducted aggregation-based surveys using an adaptive design. Surveys attempted to cover all areas of high southern blue whiting density. In most years there were multiple snapshots of the same aggregation. The resulting biomass was used as a relative estimate of spawning southern blue whiting abundance. There was a very large (seven-fold) increase in estimated biomass of southern blue whiting at the Bounty Platform from 2006 to 2007, which was due to the recruitment of one very strong year class (2002) into the spawning population. The estimated biomass from 2008 was also high, but biomass declined by a factor of four in 2009. The observed decline in acoustic estimates between 2008 and 2009 was too great to be explained solely by fishing and average levels of natural mortality. The very large changes in estimated abundance between years, and also between snapshots within a year, are related mainly to changes in survey temporal and spatial coverage, and illustrate an important limitation on interpretation of aggregation-based acoustic abundance estimates. In each snapshot an unknown proportion of the spawning aggregation is surveyed, and almost certainly not the entire spawning stock. Survey coverage depended on both the amount of survey time available (which is often limited by commercial constraints) and the behaviour of the fish (e.g., the extent and density of the aggregation, and the timing of spawning). It is therefore difficult to incorporate the resulting series of abundance estimates into a formal stock assessment model as a time series. Despite this, industry acoustic surveys of the Bounty Platform have led directly to management decisions and changes in catch limits.

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1. Introduction

Southern blue whiting (*Micromesistius australis*, hereafter SBW) is a gadoid occurring in Sub-Antarctic waters, with known spawning grounds off South America and southeast of New Zealand. SBW is one of New Zealand's largest volume fisheries, with annual landings of between 25 000 t and 40 000 t since 2000 (Ministry for Primary Industries, 2013). Spawning and fishing grounds in New Zealand waters are on the Bounty Platform, Pukaki Rise, Auckland Islands Shelf, and Campbell Island Rise (Fig. 1). Fish from the four areas are treated as separate stocks for stock assessment (Hanchet, 1999). Spawning occurs on the Bounty Platform from mid-August to early September and 3–4 weeks later in the other areas.

SBW form large high density aggregations at depths from 200 to 500 m during spawning and these are estimated using acoustic surveys. A programme to acoustically estimate SBW spawning stock biomass on each New Zealand fishing ground began in 1993. The Bounty Platform, Pukaki Rise, and Campbell Island Rise were each surveyed annually between 1993 and 1995. After the first three annual surveys it was decided to survey these areas less regularly. The Bounty Platform grounds were surveyed in 1997, 1999, and most recently in 2001. The Pukaki area was surveyed in 1997 and 2000. The only on-going series of research vessel surveys is on the Campbell Island Rise grounds, which have been surveyed in 1998, 2000, 2002, 2004, 2006, 2009, 2011, and 2013 (e.g., O'Driscoll et al., 2012). All these research surveys were carried out from R.V. *Tangaroa* using towed transducers and were wide-area surveys intended to estimate spawning SBW and pre-recruits. The results of these research acoustic surveys are the main input into SBW stock assessments (e.g., Ministry for Primary Industries, 2013).

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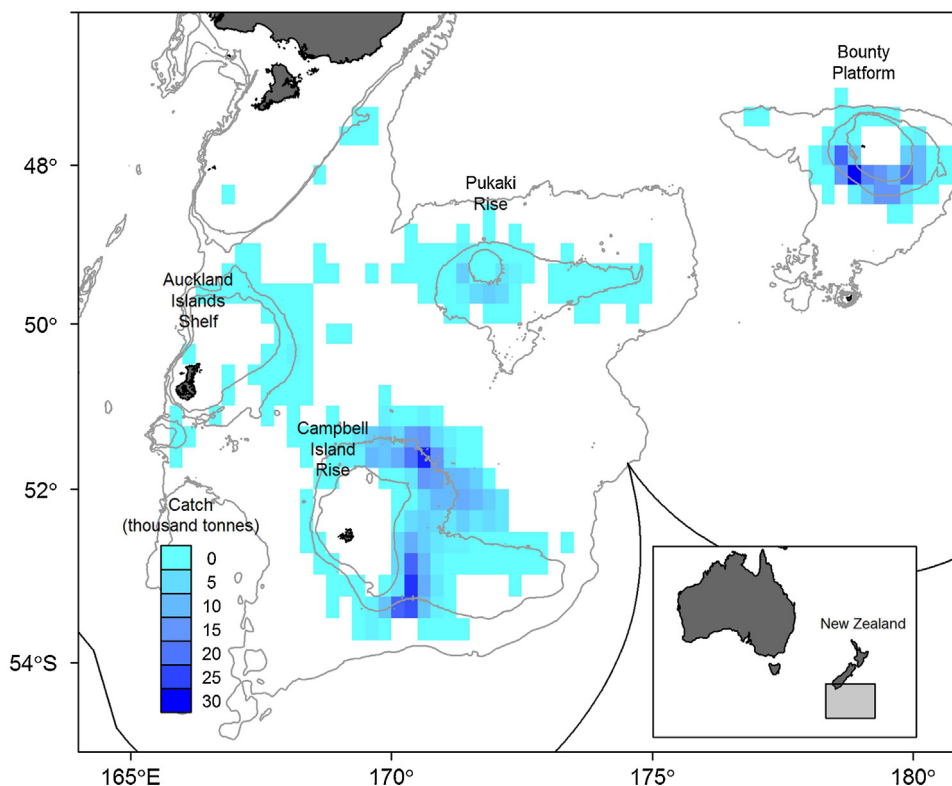


Fig. 1. Location of New Zealand southern blue whiting spawning grounds and fishing areas. Coloured pixels show summed commercial catches in 0.2 degree bins from 1990 to 2013. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

The biomass of the Bounty stock declined over the period of the *Tangaroa* acoustic surveys from 1993 to 2001, and the total allowable commercial catch (TACC) was reduced to 3500 t in 2003 (Table 1). Under New Zealand's quota management system, the cost of fisheries research is recovered from industry participants (Mace et al., 2014), and because of the relatively low value of the Bounty SBW stock in 2003, the research vessel survey of this area was no longer deemed affordable.

A pilot acoustic survey of the Campbell Island grounds, carried out from FV *Aoraki* in 2003, showed that industry vessels with hull-mounted acoustic systems could be used to collect acoustic data on SBW in good weather conditions (less than 25 knots of wind) (O'Driscoll and Hanchet, 2004). O'Driscoll and Hanchet (2004) further demonstrated that snapshots of the main spawning aggregations could be carried out using the processing time between commercial trawls without seriously compromising fishing success (O'Driscoll and Macaulay, 2005). Surveys of spawning SBW from industry vessels using this approach have been carried out annually on the Bounty Platform since 2004.

In this paper we describe the survey design and outcomes of the Bounty SBW surveys from 2004 to 2013. We use this time-series to illustrate the advantages and limitations associated with using aggregation-based acoustic abundance estimates for stock assessment and management.

2. Materials and methods

2.1. Vessels and equipment

Acoustic data were collected from three fishing vessels, each fitted with a Simrad ES60 or ES70 echosounder and hull-mounted split-beam 38 kHz transducer. Echosounders were calibrated

Table 1

Estimated catches and catch limits for southern blue whiting for Bounty Platform from 1990 to 2013. From 1990 to 1998, the fishing year was defined from 1 October to 30 September (i.e., 1990 fishing year was 1 October 1989 to 30 September 1990), but this was changed to 1 April to 31 March in 1999 to reflect the timing of the main fishing season (i.e., 1999 fishing year was from 1 April 1999 to 31 March 2000). Catch limits were introduced for the first time in the 1993 fishing year (n/a, indicates no catch limit in place). SBW were introduced to the Quota Management System on 1 November 1999.

Fishing year	Catch (t)	Catch limit (t)
1990	4430	n/a
1991	10 897	n/a
1992	58 928	n/a
1993	11 908	15 000
1994	3877	15 000
1995	6386	15 000
1996	6508	8000
1997	1761	20 200
1998	5647	15 400
1999	8741	15 400
2000	3997	8000
2001	2262	8000
2002	7564	8000
2003	3812	3500
2004	1477	3500
2005	3962	3500
2006	4395	3500
2007	3799	3500
2008	9863	9800
2009	15 468	14 700
2010	13 913	14 700
2011	6660	6860
2012	6827	6860
2013	4278	4028*

* While the TACC remained at 6860 t in 2013, the catch limit was reduced to 4028 t under a voluntary agreement.

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