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Seasonal variation in abundance and stock composition of Atlantic cod (*Gadus morhua* L.) in Placentia Bay, Newfoundland, in relation to fisheries

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Abstract

Atlantic cod (*Gadus morhua*) in Placentia Bay, Newfoundland, exhibit marked seasonal variation in abundance, age composition and size distribution. A theory is developed to account for these variations. To test it, surveys of distribution, abundance and biological traits of cod were conducted seasonally from fall 1998 to spring 2000 and commercial fishery data were gathered. For the main year of this study in 1999, acoustic estimates of abundance were 4.5 million fish in April, mostly spawning and older cod (ages 7–9). Abundance increased four-fold in July, comprised mostly of migrant smaller and younger cod (ages 4–6). By October abundance decreased (5.6 million fish) as summer migrants left the bay, but increased again in November to 6.5 million fish when mostly larger resident fish that moved southward during summer returned to the inner bay where part of the population overwinter. The observed seasonal variability in stock abundance, age, size composition and condition indices (K, HSI and GSI) were consistent with the expectations of the theory. Information on commercial catch rates and landings suggested that resident and non-resident cod were targeted by the fishery in different proportions. Estimated harvest rate reached 33% in November 1999 for resident cod. Results of this study emphasize the need for smaller-scale management strategies that take into consideration seasonal changes in the availability of various stock components.

Keywords: Atlantic cod; Abundance estimate; Harvest rate; Cluster analysis; Geostatistics; Placentia Bay

1. Introduction

Atlantic cod (*Gadus morhua*) in Placentia Bay, Newfoundland (Fig. 1) form part of a stock complex (NAFO subdivision 3Ps) comprised of inshore and offshore populations that intermingle at periods other than spawning (Templeman, 1974, 1979). This stock complex supports a commercial fishery with current annual quota of 15 000 t (Brattey et al., 2003). It has been observed that intermingling of the stock components extends to Placentia Bay, a main centre of the fishery, mainly in late spring and summer (Templeman, 1979; Lawson and Rose, 2000a). However, the relative sizes of the populations present in

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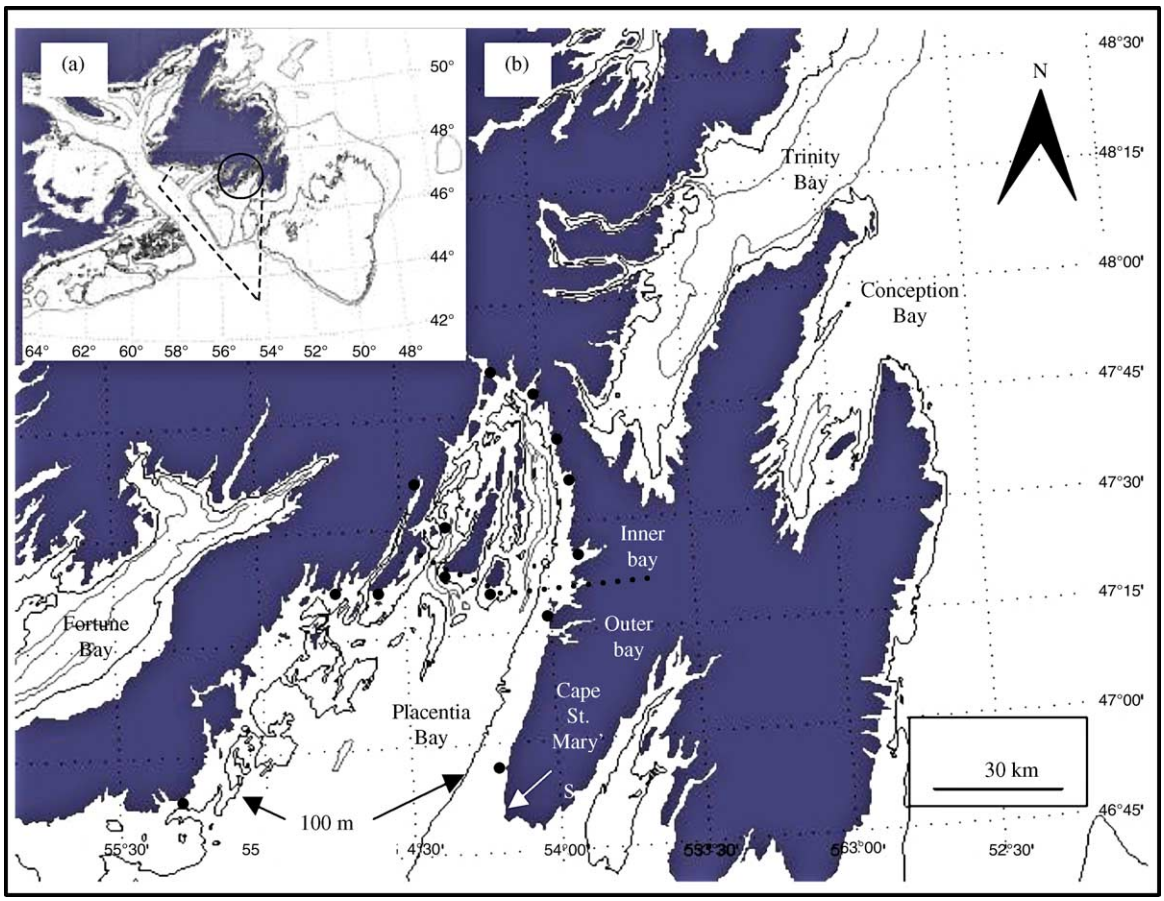

Fig. 1. (a) East coast of North America showing the Northwest Atlantic Fisheries Organization (NAFO) subdivision 3Ps (dashed line) and Placentia Bay (inside circle) on the south coast of Newfoundland and (b) detailed view of the bay showing 100 m depth contour. Black dots represent the locations from where reported commercial fisheries operated. Dotted line indicates the division between the inner and outer bay.

the bay through the year are unknown. Despite concerns about the potential for differential exploitation of the stock subcomponents (FRCC, 2001; DFO, 2003) and in particular of overexploitation of the Placentia Bay fish, there has been little examination of this phenomenon.

Using knowledge acquired in previous studies it is possible to build a theoretical framework for the movements and mixing of cod in Placentia Bay. To begin, there is strong evidence of a local coastal population that spawns in the bay during spring. This stock component spawns most consistently near the head of the bay (Lawson and Rose, 2000b; Robichaud and Rose, 2001, 2002), but also at times over shoals near Cape St. Mary's and Oderin Bank (Templeman, 1979; Lawson and Rose, 2000b). The distribution of cod eggs, larva and juveniles from the head of the bay and along its western side during and after spawning (Robichaud and Rose, 1999; Bradbury et al., 2000) confirms the existence of local spawning. After the spawning season resident fish tend to move southward along the eastern side of the bay and at times may migrate out of the bay and along the Avalon shore as far as Conception Bay and Trinity Bay (northeast coast, Fig. 1). These fish move back into the bay during fall (Brattey et al., 1999a; Lawson and Rose, 2000a). Lawson and Rose (2000a)