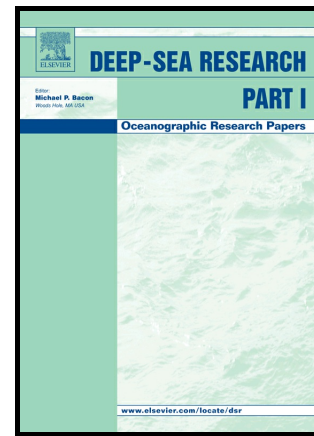


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Diverse foraging strategies by a marine top predator: sperm whales exploit pelagic and demersal habitats in the Kaikōura submarine canyonGuerra M.^{1*}, Hickmott L.^{2,3}, van der Hoop J.⁴, Rayment W.¹, Leunissen E.¹, Slooten E.¹, Moore M.⁵¹ University of Otago, Dunedin, New Zealand² Scottish Oceans Institute, University of St Andrews, St Andrews, UK³ Open Ocean Consulting, Petersfield, Hants, UK⁴ Aarhus University, Aarhus, Denmark⁵ Woods Hole Oceanographic Institution, Woods Hole, USA

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Running page head: Foraging behaviour of sperm whales**Key words:** submarine canyon; sperm whale; foraging; Kaikoura; echolocation; demersal**ABSTRACT**

The submarine canyon off Kaikōura (New Zealand) is an extremely productive deep-sea habitat, and an important foraging ground for male sperm whales (*Physeter macrocephalus*). We used high-resolution archival tags to study the diving behaviour of sperm whales, and used the echoes from their echolocation sounds to estimate their distance from the seafloor. Diving depths and distance above the seafloor were obtained for 28 dives from six individuals. Whales foraged at depths between 284 and 1433 m, targeting mesopelagic and demersal prey layers. The majority of foraging buzzes occurred within one of three vertical strata: within 50 m of the seafloor, mid-water at depths of 700-900 m, and mid-water at depths of 400-600 m. Sperm whales sampled during this study performed more demersal foraging than that reported in any previous studies – including at Kaikōura in further inshore waters. This suggests that the extreme benthic productivity of the Kaikōura Canyon is reflected in the trophic preferences of these massive top predators. We found some evidence for circadian patterns in the foraging behaviour of sperm whales, which might be related to vertical movements of their prey following the deep scattering layer. We explored the ecological implications of the whales' foraging preferences on their habitat use, highlighting the need for further research on how submarine canyons facilitate top predator hotspots.

1. INTRODUCTION

Submarine canyons are complex topographic features that cross continental margins all over the globe, connecting the shallow continental shelves to deep ocean basins (Shepard & Dill 1966). They are extremely productive, serving as hotspots of benthic and pelagic biomass and diversity (De Leo *et al.* 2010, Vetter *et al.* 2010, van Oevelen *et al.* 2011), and are key habitats for top predators, including deep-diving cetaceans (Yen *et al.* 2004, Moors-Murphy 2014). Despite being globally numerous, submarine canyons are poorly studied, and the drivers behind their exceptional productivity are not well understood (De Leo *et al.* 2010; Moors-Murphy 2014).

The Kaikōura Canyon, off the east coast of New Zealand (Fig. 1), has been described as the most productive non-chemosynthetic habitat recorded to date in the deep sea (De Leo *et al.* 2010). It harbours exceptional biomass of infaunal and epifaunal invertebrates, including nematodes, and also benthic-feeding fish (De Leo *et al.* 2010; Leduc *et al.* 2012). Furthermore, the presence of many top-predators targeting mesopelagic prey (e.g., Benoit-Bird *et al.* 2004, Boren *et al.* 2006) suggests that the area hosts a highly productive pelagic system.

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