

High genetic diversity and limited spatial structure in an endangered, endemic South African sparid, the red steenbras *Petrus rupestris*¹

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The red steenbras *Petrus rupestris* is endemic to South Africa, occurring from False Bay in the Western Cape Province to St Lucia in the province of KwaZulu-Natal. This species, the largest member of the family Sparidae, has undergone a substantial stock decline as a result of overfishing and is considered to be collapsed. Various aspects of its life history, including high residency, predictable migrations, late maturity and longevity, have made it vulnerable to overexploitation. This study analysed the diversity and genetic structure of red steenbras across seven sampling regions, using mitochondrial (control region) and nuclear (S7 intron 1) DNA markers. Mitochondrial DNA haplotype diversity was high (0.976), exceeding that reported for most studied South African fishes. The haplotype network, a low global fixation index ($F_{ST} = 0.012$, $p = 0.058$) and pairwise comparisons indicated limited genetic differentiation among sampling regions and a general lack of strong genetic structure, with the possible exception of the Agulhas Offshore and Transkei regions. Genetic diversity indices based on the S7 intron also indicated very low levels of genetic structuring among sampling regions. A Migrate-n analysis revealed highly asymmetrical migration rates and gene flow among the regions, reflecting aspects of the species' life history. These findings suggest that red steenbras exists as one panmictic population and should be managed as such.

Keywords: fisheries management, haplotype diversity, linefish, Migrate-n, mtDNA control region, panmixia, population genetics, S7 intron 1

Introduction

A state of emergency was declared in the South African linefishery in 2000 (RSA 2000), prompted by mounting evidence of stock declines through overexploitation and the collapse of several species (Pettit et al. 1999; Griffiths 2000; Brouwer and Buxton 2002; Griffiths and Lamberth 2002). The red steenbras *Petrus rupestris* was among the most prominent species affected, being the largest member of the family Sparidae (Smale 1988; Smale and Punt 1991; Hecht and Buxton 1993) and an iconic angling species (Smith and Smith 1986; Heemstra and Heemstra 2004). Griffiths (2000) revealed a decline of more than 80% in catches per unit effort (CPUE) and a 50% reduction in the contribution to the total catch over a 50-year period in the commercial linefishery of the Western Cape and Eastern Cape provinces, including the Transkei region in the southeast. Similarly, Griffiths and Lamberth (2002) reported the red steenbras stock to be 0.2% of unexploited levels, based on CPUE. However, Hecht and Buxton (1993)

revealed increasing CPUE in the Transkei region as a result of limited, condition-dependent access to the resource. Concomitantly, range contractions, both seaward and along the coast, as a result of this exploitation, have been reported (Hecht and Buxton 1993; Griffiths 2000; Kerwath et al. 2019), as have reduced mean sizes in several areas (Buxton and Smale 1989; Smale and Punt 1991; Pettit and Wilke 1993).

Concerns over the red steenbras stock have prompted several management interventions since the formal recognition of the linefishery in 1985 (Kerwath et al. 2019). These included the implementation of input or effort controls, such as a permitting system, a closed season, and size and bag limits, which have been revised over the years. These management interventions were largely unsuccessful, with a further reduction in abundance since the declaration of the emergency (Kerwath et al. 2019), and a moratorium on the catching of red steenbras was adopted in 2012 (Mann 2013; Kerwath et al. 2019). However, this was challenged legally by the recreational skiboat sector and overturned in 2013.

Griffiths and Lamberth (2002) highlighted the life-history characteristics responsible for the vulnerability of red steenbras. As with many exploited sparids, longevity and

¹This article is based on a paper presented at the 5th Southern African Marine Linefish Symposium, held 8–11 July 2019, at Mpekezi Beach Resort, Eastern Cape, South Africa, and is part of the special issue 'Linefish resilience in the Anthropocene', edited by WM Potts, CG Atwood and PD Cowley