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# The effects of harvesting of the South African kelp (*Ecklonia maxima*) on kelp population structure, growth rate and recruitment

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## Abstract

*Ecklonia maxima* is an economically important kelp in South Africa. The harvested kelp is used mainly as feed for cultured *Haliotis midae* (abalone) on farms all along the South African South and West Coast. The effects that different harvesting methods have on the growth of sub-canopy kelps, kelp population structure and kelp recruitment were tested in a kelp bed at Bordjies Rif near Cape Town. Two 30 × 10 m sites were set up, about 100 m apart, in near monoculture stands of *E. maxima*. Each 30 × 10 m area was subdivided into three treatments. In treatment 1 (T1) the whole 'head' of each kelp sporophyte that reached the surface was cut off between the bulb and the primary blade ('lethal' method). In treatment 2 (T2) ('non-lethal' method), the secondary fronds of all sporophytes that reached the surface were cut 20–30 cm from their junction with the primary blade, and removed. In the control plot, the kelp plants were not treated. Harvesting treatments were done approximately every four months, at low spring tide, from 3 March 2003 to 3 November 2003 (three treatments). The effects of harvesting on the kelps depend largely on the size of plant and the time the fronds were removed; however, no seasonal pattern could be observed. The different treatments had no effect on the growth rate, population structure or recruitment of the kelp. This means that factors other than light play an important role in the growth, structure and recruitment of the kelp beds in False Bay. Results are discussed in relation to current commercial harvesting practices.

## Introduction

The commercial use of seaweeds in South Africa began during the Second World War when agar from Japan became unavailable in Britain (Anderson et al., 1989). This may have been the impetus needed to start the South African seaweed industry in the early 1950's (Isaac & Molteno, 1953). Seaweed was mainly collected as beach-cast material, dried and then exported (Anderson et al., 1989). A number of seaweed species are harvested commercially in South Africa but the kelp *Ecklonia maxima* is harvested in the largest quantities (Anderson et al., 2003). The amount of fresh kelp fronds harvested for abalone feed in South Africa increased exponentially from less than one ton (wet) in 1992 to more than 6000 tons (wet) in 2003 mainly due to the increase in the number of abalone farms along the South African West Coast. Abalone require about 7% of their body mass of kelp per day: to produce 100 t of abalone, to a size between 50–70 mm in diameter, requires 5 t of freshly harvested kelp daily (Levitt et al., 2002). It is likely that the harvesting pressure on kelp beds will increase as more abalone farms are constructed along the South African west coast and existing farms expands.

The South African coastline is divided into 23 concession areas in which successful applicants have the right to harvest one specified seaweed resource. Fourteen of these concession areas have kelp in them, the main species in the south being *Ecklonia maxima*. Levitt et al. (2002) studied the regrowth of *Ecklonia maxima* and the understorey biota after harvesting, but

knowledge of the effects of harvesting is still very limited. In South Africa kelp is harvested by various methods. When stipe and fronds are required divers cut the stipe at the bottom just above the holdfast, thus killing the plant. This method is not used for abalone feed and is not considered further here. Only fronds (blades) are used for abalone feed, and there are two methods of frond-harvesting. In the first method the whole 'head' of the kelp sporophyte is cut off between the bulb at the top of the stipe and the primary blade (Figure 2). This is an easy way of harvesting, but it kills the plant. In the second method, the secondary fronds are cut 20–30 cm from the junction with the primary blade (Figure 2). Levitt et al. (2002) showed that the latter type of harvesting does not kill the plant, because the meristematic zone at the base of the secondary fronds is unharmed. The fronds continue to grow, and Levitt et al. (2002) calculated that this non-lethal harvesting method ultimately gives yields that are 4–5 times higher than the 'lethal' method. Both of these frond-harvesting methods alter the state of the canopy in a kelp bed.

Reports from other countries indicate that dense kelp canopy can decrease the amount of light that penetrates to the bottom by more than 90% (Norton et al., 1982; Kimura & Foster, 1984; Schiel & Nelson, 1990). Removing kelp canopies can increase the abundance of understory plants (Kimura & Foster, 1984; Sharp & Pringle, 1990) because light is one of the factors affecting their growth (Schroeter et al., 1995). We therefore hypothesized that removal or thinning (by cutting the distal fronds) of the surface canopy of *E. maxima*, would, through its effect on light penetration, result in an increase in the relative growth rate of the subcanopy kelp plants. Furthermore, we expected an increase in kelp recruits (juvenile sporophytes) and ultimately in the number of subcanopy kelp plants, which would alter the population structure of harvested beds. This study investigated the effects of these two methods of frond-harvesting (of the canopy) on the growth (stipe elongation) rate, recruitment, and population structure of the sub-canopy of the kelp *E. maxima*.

## Materials and methods

### *Study site*

A site was selected on the Cape Peninsula, about 60 km south of Cape Town, at Bordjies Rif (18°27′48″E, 34°18′54″S) (Figure 1), where no previous harvesting had taken place. The substratum is of medium relief

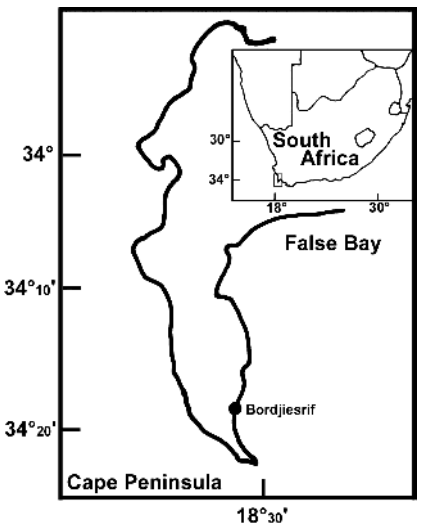


*Figure 1.* Location of Bordjies Rif in South Africa.

Table Mountain sandstone with 1–1.5 m gullies and mixed vertical/horizontal aspect. The homogeneous stand of kelp (*Ecklonia maxima*) is fairly dense (~8 plants $m^{-2}$) and the bed is between 70–100 m wide and 300–400 m long. The study site is in a partially sheltered bay that allows for favorable working conditions most of the time.

### *Experimental design*

Two areas, each 30 × 10 m, were marked out parallel to the shore (Figure 2; ABCD) with weights and stainless steel eyebolts fixed to the rock with epoxy putty. The corners were marked with small sub-surface buoys. Each 30 × 10 m area was then subdivided

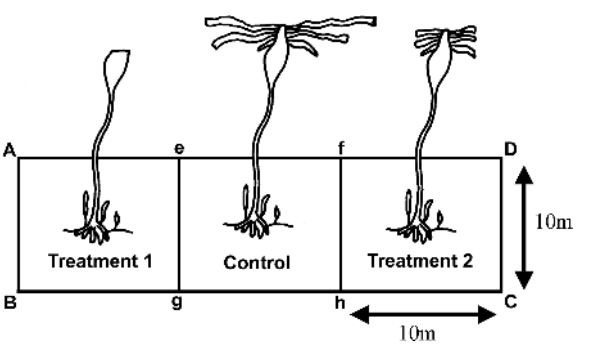


*Figure 2.* Treatment 1 (T1), where the whole head was harvested just above the bulb (lethal). Treatment 2 (T2), where only the fronds were harvested, 20–30 cm from the primary blade (non-lethal). The centre plot was the control (C, no treatment).