Data Compilation and Preliminary Time Series Analysis of Abundance of a Dominant Intertidal Kelp Species in Relation to the 1997/1998 El Niño Event

Kristen L.D. Milligan,[1] Colin D. Levings [2] and Robert E. DeWreede[1]

[1] *Botany Department*
University of British Columbia
Vancouver, British Columbia, V6T 1Z4
Canada
e-mail: milligan@monmouth.com

[2] *Department of Fisheries and Oceans, Canada*
Coastal and Marine Habitat Science Section
West Vancouver Laboratory, 4160 Marine Drive
West Vancouver, British Columbia, V7V 1N6
Canada

Introduction

The primary goal of this study was to document effects of the 1997/1998 El Niño event on intertidal macroalgal abundance in Barkley Sound, British Columbia, Canada. Population fluctuations in the dominant intertidal kelp species *Hedophyllum sessile* were documented from June 1991 to May 1998. The extensive baseline data prior to 1997 provides a database to evaluate current intertidal kelp population trends from summer 1997 to the present. The authors recognize that the spatial scale of this survey is limited. However, this data set is unique for Barkley Sound since it is the only known long-term population study compiled for this geographic area. Eight sites were sampled in Trevor Channel (Figure 1). The most detailed surveys were taken at four sites on Prasiola Point.

These data provide a solid baseline against which present trends in macroalgal biomass and densities can be compared. The 1997/1998 El Niño increased coastal, Northeast Pacific water temperatures during approximately May 1997 to March 1998. The peak temperatures ranged from 17°C to more than 18°C (unpublished data from the Institute of Ocean Sciences, Canada). These temperatures and associated low nutrient levels (Zimmerman and Kremer, 1984) have the potential to negatively affect the sporophyte production and maintenance of kelp populations. These *Hedophyllum sessile* data from before, during, and after the 1997/1998 El Niño can thus be used to evaluate impacts of this warm-water event on kelp populations in the intertidal zone.

Hedophyllum sessile (Laminariales, Phaeophyceae) is found in the mid-intertidal zone on shores in the northeast Pacific Ocean, ranging from Attu Island, Alaska to northern California (Widdowson, 1965). The juvenile plant has a short flattened stipe (up to 5 cm) which rapidly disappears as the blade becomes sessile on the holdfast. Adult plants are characterized by a large blade (up to 0.6 m^2 total surface area) and no stipe, attached by numerous haptera (root-like attachment structures) arising from the thickened basal margins of the plant. Juveniles recruit in spring and summer months. *H. sessile* is a dominant intertidal kelp species which forms dense canopies within which various invertebrate and fish species are found. For example, *H. sessile* provides substratum and habitat for spawning Pacific Herring.

Methods

Data collected

Data collected were: kelp percent cover, adult and juvenile density, reproductive status, a biomass index, and cover of various understory species. Data on *Hedophyllum sessile*'s adult and juvenile density at Prasiola Point were included in this report because they directly quantify mortality. These data were arranged in a time series to evaluate trends in these parameters.

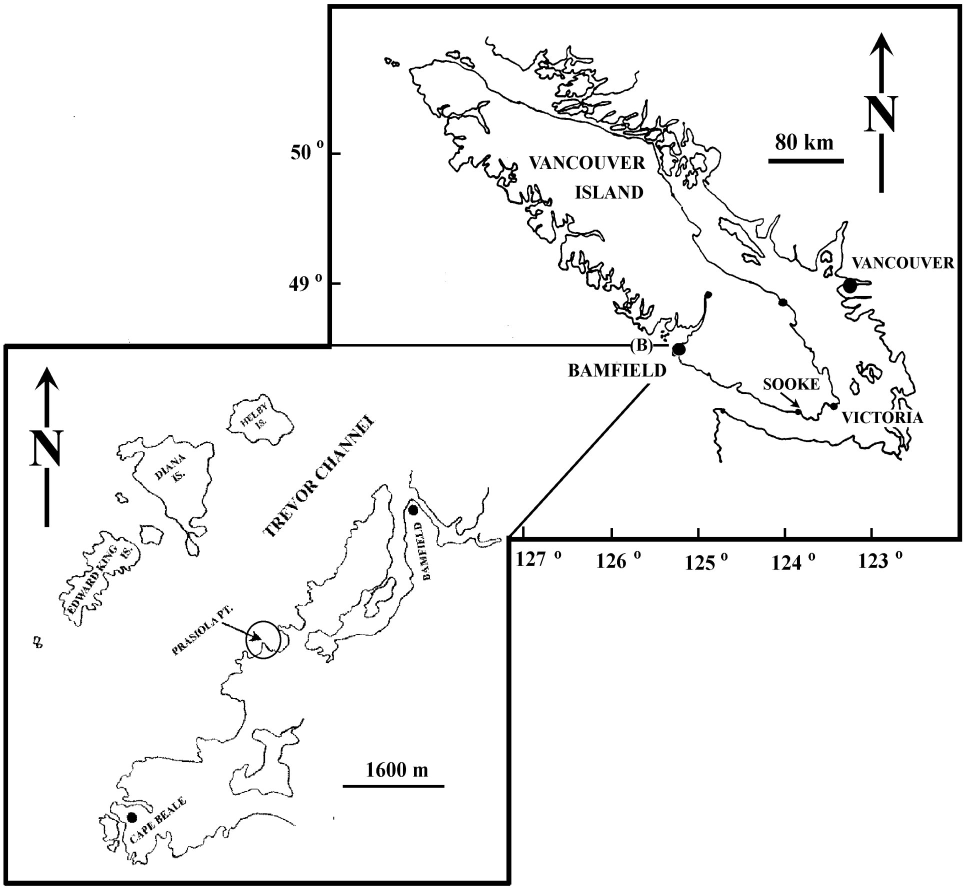

Figure 1. *Hedophyllum sessile sampling locations in Barkley Sound, British Columbia. In total, eight sites in Trevor Channel were sampled. Four sites at Prasiola Point (encircled on the left-hand map of Trevor Channel) were intensively studied. This report only includes data from Prasiola Point.*

Historical data compiled

Historical data on juvenile and adult densities were compiled from Druehl and Elliott (1996) and from DeWreede's macroalgal monitoring program (unpublished data, see acknowledgments). These data were examined for continuous time series and for compatibility of data sets between sites and times. Four sites from Druehl and Elliott (1996) and all DeWreede's sites (a total of four at Prasiola Point) were chosen for re-sampling in spring 1998. Druehl and Elliott's sites were not analyzed for trends because data were not consistent enough to provide a reliable baseline.

Data collected and analyzed for post-El Niño status

Historical sites were visited in May 1998. At Prasiola Point, adult density and juvenile densities (# per m^2) were quantified by randomly placing twenty 0.25 m × 0.25 m quadrats on permanent transect lines in the middle of the *Hedophyllum sessile* zone. All of the sites at Prasiola Point were pooled to produce a single, continuous data series from 1991 to 1998. Because different sites at Prasiola Point were sampled in different years, any given date in the 1991–1998 time series had a total of 20 quadrats, except in May 1998 when the total number of quadrats sampled was 40.

Results

Juvenile and adult densities were negatively affected from June 1997 to February 1998 (Figures 2 and 3). Peak recruitment normally occurs in late spring/early summer months. June 1997 was unique from all other sample dates because (in a site which always had successful recruitment) it was the first documented summer month with zero recruitment

(Figure 2). Data from the most recent field sampling (May 1998) indicated that juvenile densities were similar to those found in spring and summer months in 1991 to 1996 (e.g. April and June 1996; Figure 2).

In May 1998, adult densities in previously dense kelp beds were low and there was no apparent increasing trend in adult densities. These beds will only recover if the newly recruited juveniles (in May 1998; Figure 2) survive.

Conclusion

Recruitment of *Hedophyllum sessile* sporophytes was measured on Prasiola Point in 1991, 1992, 1995, 1996, 1997, and 1998. June 1997 was the first summer date during this time period when there was no recruitment. Low juvenile densities were reported in subsequent sample dates, with juvenile densities recovering in May 1998. The low 1997 recruitment event presumably correlates with effects of El Niño-induced oceanographic conditions such as high water temperature and associated low nutrient concentrations (Zimmerman and Kremer, 1984; Deysher and Dean, 1986). Low sporophyte recruitment in 1997 was followed by low adult density. Extremely low adult densities in May 1998 on Prasiola Point may thus be a result of the previous year's recruitment failure.

These data suggest that *Hedophyllum sessile* was negatively impacted from May 1997 to the present and is recovering. This also indicates that if water temperatures (and/or a correlated variable such as nutrient concentrations) had remained at a level which physiologically stresses algal production, these kelp populations would continue to decline. However, this prediction can only be appropriately tested by monitoring other kelp beds in Barkley Sound for trends related to water temperature (and nutrient concentrations). This study also demonstrates that an extensive monitoring program for inshore macroalgal habitats is a valuable tool for evaluating effects of environmental change.

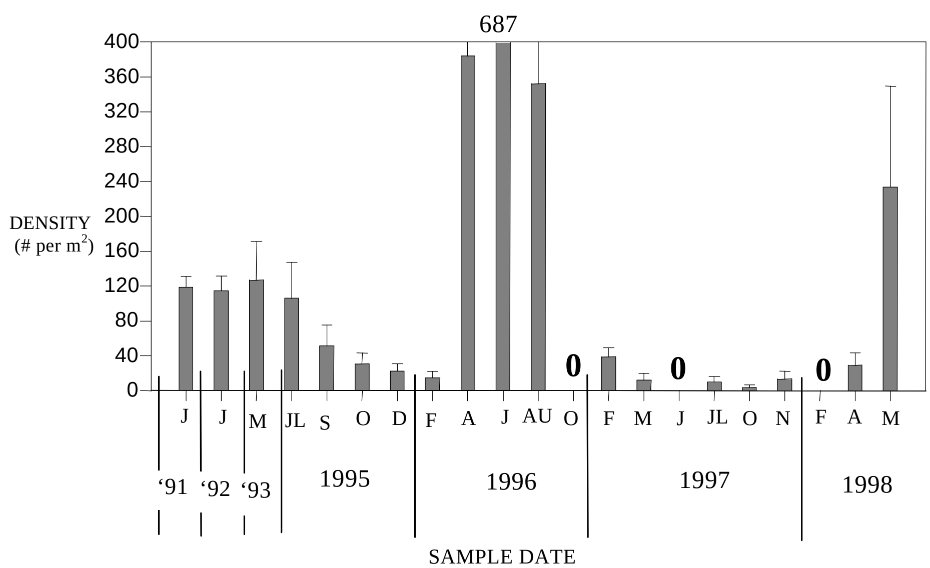

Figure 2. *Juvenile sporophyte density. Densities (+ SE; n = 20 for all dates except May 1998 when n = 40) are pooled means for all sites sampled at each time. Months are abbreviated: A = April, AU = August, D = December, F = February, J = June, JL = July, M = May, N = November, O = October, S = September. "687" above J-96 is the mean density. "**0**" indicates zero individuals.*

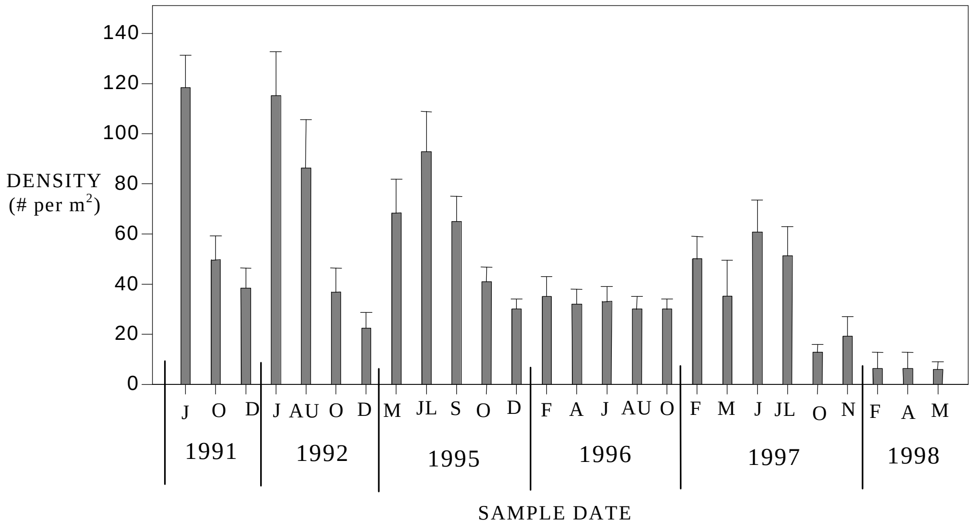

Figure 3. *Adult sporophyte density. Densities (+ SE; n = 20 for all dates except May 1998 when n = 40) are pooled means for all sites sampled at each time. Months are abbreviated: A = April, AU = August, D = December, F = February, J = June, JL = July, M = May, N = November, O = October, S = September.*

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