SOME ASPECTS OF MATERIAL DYNAMICS AND ENERGY FLOW IN A KELP FOREST IN MONTEREY BAY, CALIFORNIA

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Some Aspects of Material Dynamics and Energy Flow in a Kelp Forest in Monterey Bay, California

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ABSTRACT

The standing crop, production, and loss of Macrocystis pyrifera (L.) C. Agardh were measured during a 2.5 year study in a kelp forest in central California. The influence of various physical and biotic factors on the production of drift kelp (whole plants and fragments larger than detritus particles, which are detached from the substrate) was determined. The species composition, standing crop, export, and decomposition of benthic drift algae and seagrasses were studied, as well as the utilization of this food source by the batstar, Patiria miniata Brandt. The role of the drift pathway in the flow of materials and energy in the kelp forest community is discussed.

The standing crop of M. pyrifera averaged 3.5 kg wet weight/m^2; seasonal measurements ranged from 0.7 to 6.3 kg/m^2. Temporal changes in plant density (number of plants) and plant size (number of fronds) were attributed to a periodic cycle of plant loss and recruitment. Seasonal variation in maximum frond size depended on the

intensity of water movement.

The rate of frond addition by tagged plants varied directly with plant size. The growth rate of individually tagged fronds increased with increasing frond size to a maximum rate which averaged 40 blades/month (5.5 m in length, 0.9 kg) during most of the study, but increased to 60 blades/month (7.5 m in length, 1.5 kg) from February through October, 1975.

The estimated net kelp production, which included biomass lost as drift kelp (but not as detritus or dissolved organic material), varied from 0.4 to 3.0 kg/m^2 per month and averaged 23 kg/m^2 per year (2.2 kg dry weight/m^2 per year).

Production of drift kelp ranged from 0.3 to 4.0 kg/m^2 per month. Losses of individually tagged plants and fronds showed water movement intensity and tangling with detached plants to be the primary factors influencing drift kelp production. Part of this production is exported from the forest and may provide an important source of allocthonous energy to other marine communities.

Macrocystis pyrifera always comprised at least half of the standing crop of benthic drift algae and seagrasses which averaged 0.15 kg/m^2 in 12 permanent sampling plots. Species composition remained relatively constant over time; however, the benthic drift standing crop fluctuated

greatly: it was highest in summer despite low drift production, because low water movement intensity allowed accumulation; and lowest in winter when rates of both drift production and export were high. The turnover rate of the drift standing crop was estimated to be 18 times per year. Monthly export rates, measured with artificial drifters, ranged from 10 to 90%. Wet weight loss of drift kelp in 5 mm mesh litter bags averaged 40% per month. Benthic herbivores were estimated to consume at least 90 gm of drift material/m^2 per month.

Patiria miniata showed no repeated seasonal changes in their population density, averaging 4.1 batstars/m^2 in the kelp forest, or in their pyloric caecal and gonadal indices. More than 60% of their food items consisted of drift algae and seagrasses, although preferential feeding behavior was displayed for animal macrodetritus. No preference was shown for specific types of drift plant material. The nutritive value of drift kelp increased with aging, as evidenced by differences in the pyloric caecal indices of batstars fed in the laboratory.

The importance of the drift pathway is related to the spatial and temporal availability of drift plant material to benthic consumers. Drift kelp provides a means of conserving materials and energy within the forest community, as well as a pathway of export to other marine communities.