PATTERNS OF SPATIAL AND TEMPORAL VARIABILITY IN HAWAIIAN SOFT BOTTOM BENTHOS

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

OCEANOGRAPHY

DECEMBER 1996

By

Sheryl An McCarthy

Dissertation Committee:

Edward Laws, Chairperson
E. Alison Kay
Doug Luther
Stephen Smith
Julie Bailey-Brock

ABSTRACT

Temporal and spatial variability in shallow (10-20m), tropical, soft-bottom communities of Mamala Bay, O'ahu, Hawaii are examined. The three objectives of this study are: 1. To determine if temporal variability (lunar periodicity and seasonality) exists in community structure and biomass of Hawaiian soft-bottom benthos. 2. To examine the temporal nature of the benthic response to a freshwater runoff event. 3. To examine spatial variability in Hawaiian soft-bottom benthos and its relationship to freshwater runoff. Benthic samples were obtained monthly from four stations for a period of twenty-five months for examination of seasonal variations. Stations were more intensively sampled (every ten days) for a three month period for examination of lunar periodicity and the impact of a large runoff event. Small scale spatial variability was examined by comparing samples from the crest and trough of sedimentary ripples and samples from sand and rubble areas. Larger scale spatial patterns were examined during the summer (August 1993) and winter (February 1994) by sampling seven equally spaced stations along a 3km transect on the 10m isobath leading east from the Ala Wai Canal. Three additional stations (20m) were sampled in February 1994 to examine depth related changes.

Significant variations exist in the density of major taxonomic groups within the shallow, soft-bottom benthos of Hawaii, yet the dominant taxa are relatively stable. This dominance of a few groups is especially evident within the polychaetes where the Syllidae and Pisionidae are dominant at all stations during all sampling periods. Data suggests that the dominant motile detritivorous and omnivorous polychaete families are ones that have successfully adapted to life in the dynamic wave-swept environment. Total macrofauna densities range from a minimum of 4,910 indiv/m^2 to a maximum of 47,425 indiv/m^2 with biomass ranging from a minimum of 47 mg/m^2 to a maximum of 1091 mg/m^2. The annual range (Maximum station/minimum) varies within stations by a factor of between 2 and 7, yet there is no evidence of a total community response to seasonal changes in the environment. Specific taxonomic groups including annelids and arthropods, appear to show seasonal changes with maximum densities coinciding with maximum and minimum water temperatures. The dominant taxa, density and biomass of the soft bottom communities of this study are consistent with

data available from other shallow tropical and subtropical areas. There is no evidence that large wave events and periods of runoff influence the density or community composition of the benthos on short time scales except for possible negative effects of runoff on ostracods. There is evidence that changes in sediment grain size are responsible for large density fluctuations at Station 1 during the first year of the study. Significant within-month fluctuations in the density of major taxonomic groups exist, with evidence of lunar periodicity in the arthropods (primarily ostracods) with highest densities during the new moon. There are also significant between-year differences in the density of macrofauna: it is possible this difference reflects a pattern spanning several years related 1991-1994 ENSO event and its associated low rainfall.

Although a shallow, wave-swept sedimentary environment would be expected to produce a relatively homogenous biological community associated with the homogenous shifting sediments, small scale (< 30m) differences exist between the crest and trough of sedimentary ripples and between sand and rubble areas. Specifically, higher densities of syllids and copepods are associated with the crest of ripple bedforms. Higher densities, taxonomic richness and benthic biomass are present within samples containing large rubble pieces. On a larger scale, along a 3.0 km transect eastward from the Ala Wai Canal, communities are similar with regards to density, biomass and dominance by motile, detritivorous and omnivorous polychaetes and motile, brooding crustaceans. In contrast, taxonomic diversity differed along the transect, with the Ala Wai sites consistently more diverse than the two Waikiki sites. There is no evidence that runoff from the Ala Wai Canal has a negative impact or is an important structuring mechanism for adjacent soft-bottom shallow water communities. Community composition appears to be related to sediment type as sediment grain size groupings and community taxonomic groupings show similar patterns, with moderately and poorly sorted sediments supporting more diverse communities than well sorted sediments.