NEW PRODUCTION AND THE f-RATIO IN A MESOSCALE EDDY IN THE LEE OF THE ISLAND OF HAWAI'I

A THESIS SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY
OF HAWAI'I IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

OCEANOGRAPHY

DECEMBER 1994

by

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SUMMARY

The major objective of this research was to examine the effects of a mesoscale eddy on new production and the f-ratio in Hawaiian waters in the lee of the Island of Hawai'i. Three different stations were sampled, each representing a different region of the eddy. Station 2 most closely represented the open ocean and was least affected by eddy upwelling. Station 6 was located inside the leading edge of the eddy, and Station 10 was closest to the center of the eddy. Differences in parameters measured at these stations indicated that waters inside the eddy were enhanced in terms of nitrate concentration, nitrate uptake, and f, the ratio of new:total production, relative to waters outside the eddy. This might be expected to result in an increase in primary production in the center of the eddy, but such was not the case. The depressed primary production at Station 10 might have been the result of a combination of factors including iron limitation, upwelling of toxic metals (e.g. copper), physiological shifts in the phytoplankton from carbon production to nitrogen uptake, and reduced total insolation at this station relative to the others.

Examination of parameters within each region of the eddy included the relationship of nitrate uptake rate (i.e., new production) with nitrate concentration, f with nitrate uptake rate, f with nitrate concentration, and f with primary production for each station. Stations 2 and 6, although occupying different regions of the eddy, were similar in that they were both nitrate-depleted relative to Station 10. Stations 2 and 6 showed trends similar with respect to each other (although different in magnitude) and different from Station 10 in every case but one. The exception is the relationship of f with nitrate uptake rate. At every station the f-ratio increased with increasing nitrate

uptake rate, a trend undoubtedly heavily influenced by spurious correlation.

One might argue that the hypotheses posed in Chapter 1 may be invalid for an eddy because of an implied requirement for steady-state conditions. I would argue that the condition of steady-state is less important in this study than the nutritional status of the phytoplankton population: The data were consistent with the hypotheses at the nitrate depleted stations (Stations 2 and 6) but inconsistent at the nitrate-replete station (Station 10).

The major ecological implications of this study can be summarized as follows: A cyclonic eddy found in the lee of the Island of Hawai'i resulted in an input of nitrate into the euphotic zone relative to waters outside the eddy. This new nitrogen enhanced new production (measured as nitrate uptake rate) within the eddy relative to waters outside the eddy by a factor of ~10. The f-ratios measured in this system spanned the range of 0-0.83. Overall, f increased in the eddy relative to waters outside the eddy by a factor of 10. Because cyclonic eddies are persistent features in the Hawaiian Islands, they potentially play a significant role in the overall productivity of local waters.

In addition to the testing of the hypotheses, several other noteworthy points came to light during this study. First, wind speed at Upolu Point Airport was not a useful predictor of eddy formation as per the criteria of Patzert (1969). Second, $^{15}NO_3^-$ additions as low as 50 nM were found to enhance nitrate uptake rates in 24 h incubations where initial ambient nitrate concentrations were $\leq$ 50 nM. This addition is generally considered to be non-contaminating, and a 50 nM $^{15}NO_3^-$ spike is often used in recently published studies. Using 24 h $^{15}NO_3^-$ data for samples with initial nitrate concentrations $\leq$50 nM in this study would have resulted in gross overestimations of nitrate uptake rates, and consequently f-ratios, for these samples. Finally, using changes in nitrate concentration to measure nitrate uptake rates may be most appropriate in samples with initial nitrate concentrations of 70-360 nM. Above 1000 nM changes in concentration may be swamped by the sample signal. Below 50 nM little or no nitrate uptake was observed.