

AD-A263 036



ENTATION PAGE

Form Approved
GMB No. 0704-0188

estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering the collection of information, sending comments regarding the burden estimate or any other aspect of this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE March 1993		3. REPORT TYPE AND DATES COVERED Final 10/1/88-4/30/91	
4. TITLE AND SUBTITLE Filaments in the California Current: Effects Upon Primary Production				5. FUNDING NUMBERS N00014-89-J-1523	
6. AUTHOR(S) Thomas L. Hayward					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Marine Life Research Group Scripps Institution of Oceanography University of California, San Diego La Jolla, CA 92093-0227				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Department of the Navy Office of Naval Research Oceanic Biology Program 800 N. Quincy Street, Arlington, VA 22217-5000				10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES					
12a. DISTRIBUTION/AVAILABILITY STATEMENT Unlimited				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) This report reviews ONR supported studies conducted as component of the Coastal Transition Zone (CTZ) ARI program. This project organized and collected data on two cruises which were jointly supported by the State of California, and participated in data collection on a third cruise. The data were used to investigate how mesoscale physical structure affects the nutrient distribution and primary production in the coastal region. An improved understanding of the physical nature of coastal filaments and their effects upon the nutrient distribution and production was developed, and mesoscale coastal eddies were shown to represent an additional physical structure which can strongly enrich the coastal region.					
14. SUBJECT TERMS oceanic biology, primary production, nutrients, mesoscale eddies, eastern boundary currents, filaments				15. NUMBER OF PAGES 4	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT SAR		

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

FILAMENTS IN THE CALIFORNIA CURRENT: EFFECTS
UPON PRIMARY PRODUCTION

Thomas L. Hayward
Marine Life Research Group
Scripps Institution of Oceanography
La Jolla CA 92093
(619) 534-4479
ONMET:T.HAYWARD
INTERNET:thayward@ucsd.edu

CONFIDENTIAL

FINAL TECHNICAL REPORT
MARCH 1993

Accession For	
NTIS CRA&I	☒
DTIC TAB	☒
Unannounced	☐
Justification	
By	
Distribution /	
Availability Codes	
Dist	Avail and/or Special
A-1	

93 4 02 106

93-06947



SP8

OBJECTIVES OF SUPPORTED RESEARCH

The long-range objective of my research is to understand the physical processes which determine the patterns of primary production in the ocean. The focus of this research project has been upon the California Current as an example of eastern boundary current systems. This research project was planned to be a component of the CTZ (Coastal Transition Zone) ARI program. It was previously shown that the large-scale space-time integral new primary production in the California Current is strongly limited by the rate at which new nutrients are supplied to the euphotic zone. Physical processes which affect the nutrient distribution will thus strongly affect patterns of primary production. We are trying to better determine what physical processes affect the nutrient supply to the euphotic zone and how the nutrient input varies in space and time. Few prior direct measurements of primary production had been made in the CTZ study region and an initial component of this program was to measure primary production in the context of the regional physical and chemical structure. In addition to directly measuring production we are also attempting to solve part of the sampling problem imposed by the great spatial and temporal variability in production by determining whether patterns of production and the causal physical forcing processes can be inferred from measurements of the distribution of biogeochemical properties affected by photosynthesis (dissolved oxygen and nutrients).

WORK ACCOMPLISHED

This research project was a component of the Coastal Transition Zone ARI. We collected data on three cruises (SQ86, SQ87 and CTZ88) in the CTZ region. The first two cruises were organized by this project and the ship time and data collection was jointly supported by the State of California and ONR. We participated on the third cruise during the main field year of the ARI by collecting data on dissolved oxygen, chlorophyll and primary production. This project supported other components of the ARI by rapidly processing and distributing the data we collected and by providing a sampling opportunity on the first two cruises for several other investigators.

RESULTS

Cruise SQ86 sampled the central California coastal region during winter conditions when physical forcing was weak and primary production was low. This preliminary cruise was planned to test procedures for deploying satellite tracked drifters in the context of remotely-sensed mesoscale physical structure. The cruise was successful in that we collected background data on winter conditions which provided a useful contrast for the spring conditions with much stronger biological forcing which were sampled later in the program. We learned that it was necessary to deploy drifters further offshore to reduce the chances of their being trapped by coastal kelp beds or going aground. This preliminary cruise contributed to the successful planning of later cruises.

Cruise SQ87 was planned to sample chemical and biological structure in the CTZ region on the same scale as the causal mesoscale physical structure. This cruise was conducted in two legs; the first was a highly resolved survey of physical, chemical and biological structure which sampled a predetermined grid, and the second leg was

devoted to deployment and sampling in the vicinity of an array of satellite tracked drifters in a mesoscale feature mapped on the first leg. The cruise was very successful and resulted in the collection of a large data set which was used by several components of the CTZ program.

We participated in the 1988 survey cruise on R/V Thomas Washington by measuring dissolved oxygen, chlorophyll and primary production on the survey leg.

The data from each of these cruises was processed to final form and distributed to others in the program and the first two cruises which were organized by this project (and which were jointly supported by the State of California throughout the University of California) also provided the opportunity for several other projects in the ARI to collect data at sea.

SIGNIFICANCE OF THE RESULTS

The sampling on cruise SQ87 provided the first strong evidence that the 'upwelling filaments' detected from satellite images are, at least in some cases, really formed by meanders a low-salinity, low-nutrient coastal jet (rather than being composed of high-salinity, high-nutrient upwelled water). The mechanisms by which the coastal region can be enriched by filaments was documented.

We showed that mesoscale eddies in the coastal region can strongly affect the nutrient distribution and patterns of primary production, and that the space-time scales of nutrient inputs may differ from those expected for wind-driven coastal upwelling. Such eddies represent an additional mechanism of enriching eastern boundary current systems, which may have a different connection to local forcing processes than does wind-driven coastal upwelling.

The 'biogeochemical approach' to estimating primary production was evaluated in the coastal region by mapping anomalies in the distributions of dissolved oxygen and nutrients on density surfaces. It was shown that this approach can provide an independent estimate of the increment of new primary production caused by a mesoscale physical feature and that this approach can also be used to constrain the secondary circulation and 'age' of mesoscale features.

PUBLICATIONS

This research project directly supported the following publications. Data collected on the cruises supported by this project were also an important part of several additional publications.

Journal Articles:

Hayward, T.L. and A.W. Mantyla. 1990. Physical, chemical and biological structure of a coastal eddy near Cape Mendocino. *Journal of Marine Research.*, 48:825-850.

Strub, P.T., P.M. Kosro, A. Huyer, K.H. Brink, T.L. Hayward, P.P. Niiler, C. James, R.K. Dewey, L.J. Walstad, F. Chavez, S.R. Ramp, D.L. Mackas, M.S. Swenson, L. Washburn,

J.A. Barth, R.R. Hood, M.R. Abbott, D.C. Kadko, R.T. Barber, D.B. Haidvogel, M.L. Batteen, and R.L. Haney. 1991. The nature of cold filaments in the California Current system. *Journal of Geophysical Research*. 96:14743-14768.

Washburn, L., Kadko, D.C., Jones, B.H., Hayward, T., Kosro, P.M., Stanton, T.P., Ramp, S., and Cowles, T. 1991. Water mass subduction and the transport of phytoplankton in a coastal upwelling system. *Journal of Geophysical Research*. 96:14927-14946.

Hayward, T.L. submitted. The shallow oxygen maximum and primary production. *Deep-Sea Research*.

Abstracts:

Hayward, T.L. and A. Mantyla. 1987. The nutrient distribution and primary production in the coastal transition zone of Northern California. *EOS* 68:1779.

Hayward, T.L. and K.M. Plummer. 1988. Wind-driven nutrient transport into the mixed layer: Spatial and temporal variation. *CalCOFI Conference*, Lake Arrowhead CA, 8-10 November.

Hayward, T.L. 1988. Primary production in the Coastal Transition Zone of Northern California. *EOS*, 69:1261.

Hayward, T.L. 1989. Filaments in the California Current: Effects upon primary production. *CalCOFI Conference*, Scripps Institution of Oceanography, October 25-27.

Strub, P.T., A. Huyer, M. Kosro, M.R. Abbott, T. Cowles, J. Moum, R. Dewey, T.L. Hayward, R. Hood, K. Brink, D.L. Mackas, D.B. Haidvogel, L. Washburn, B.H. Jones, and T. Stanton. 1990. The Nature of the cold filaments in the California Current -- Squirts or meanders. *EOS*, 71: 145.

Hayward, T.L., A.W. Mantyla and K.M. Plummer. 1990. Mesoscale circulation and primary production in the California Current. *CalCOFI Conference*, Asilomar, October 31-November 2.

Data Reports:

Hayward, T.L., A.W. Mantyla, P.P. Niiler and K.M. Plummer. 1990. Physical, chemical and biological data. Cruise SQ87, 28 April-23 May 1987. SIO Reference 90-33.