Remote sensing of seabird environments

J. Christopher Haney

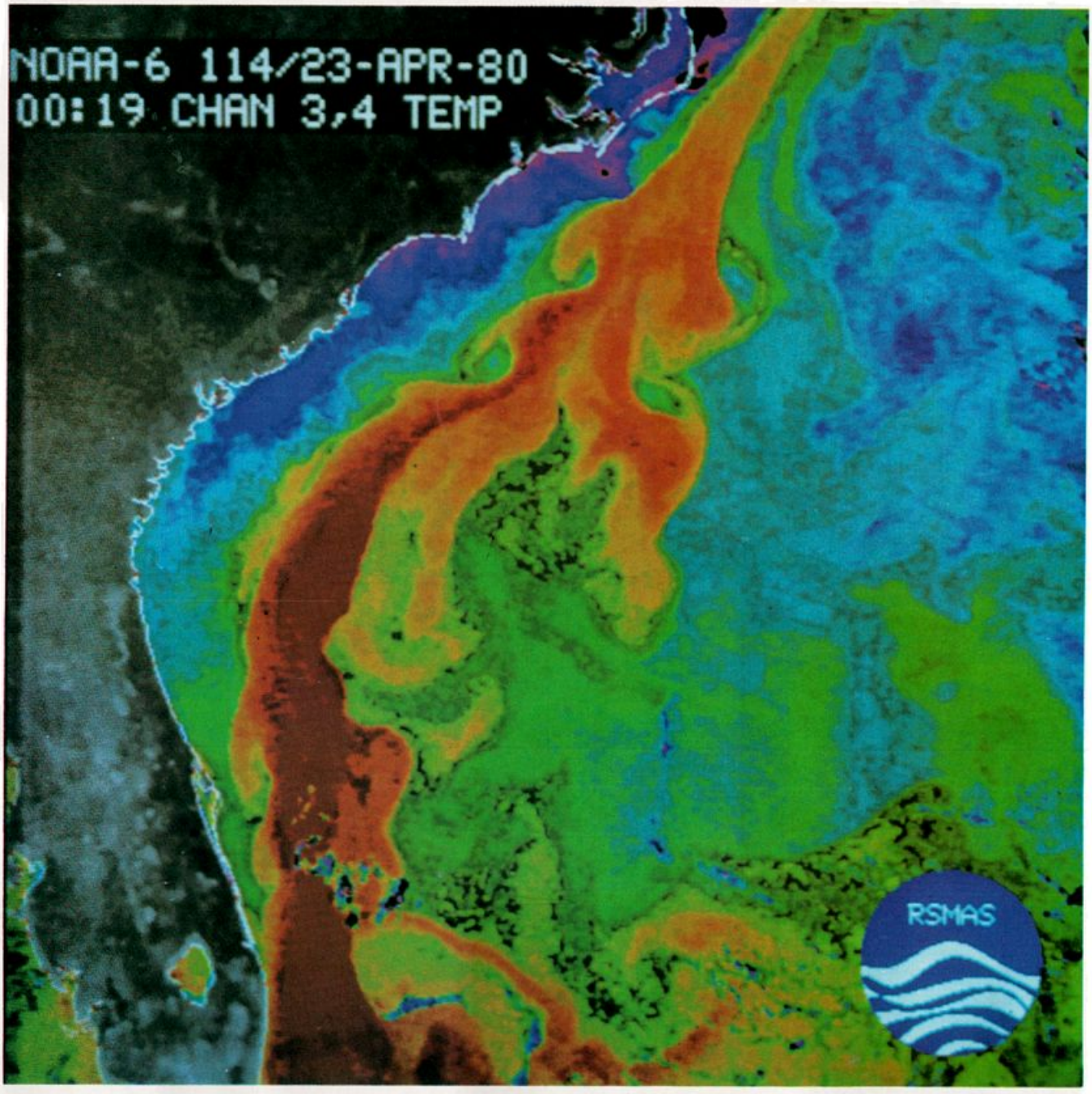
*Graphics by SUEMAC**

Satellite-derived hydrographic data promise to be among the most important tools in the future for measuring and interpreting dynamic attributes of seabird environments.

SHORT AND LONG-TERM RELATIONships of seabirds to marine environments in the western Atlantic Ocean were examined from 1982–1985 using both shipboard survey information, and an oceanographic data set drawn from very high resolution infrared composites. With these, seabird species compositions, distribution, and abundance showed strong correlations with satellite-detected oceanic conditions. Individual species and species assemblages displayed significant affinities for temporary water masses associated with Gulf Stream eddies (Haney 1986a). Changes in seabird abundances were significantly correlated with the size or frequency of satellite-detected ocean fronts at weekly, monthly, and yearly intervals (Haney and McGillivary 1985a, b).

Habitat selection by seabirds at fronts was studied by first calculating the mean position of the front with Gulf Stream System Flow Charts compiled by the National Oceanic and Atmospheric Administration (Olson *et al.*, 1983). The frequency of frontal positions was analyzed and outlined by region. Finally, histograms of frontal positions were plotted based on 10 kilo-

* 2428 Abercorn Street, Savannah, Georgia 31402



Satellite image of sea surface temperatures off the southeastern United States. *Light hues indicate warm waters and dark hues cold waters. The image is derived from very high resolution radiometry and was prepared by Evans and Brown of the University of Miami. Such composite photographs are the basis for Gulf Stream System Flow Charts.*

meter cross-shelf intervals (distance offshore).

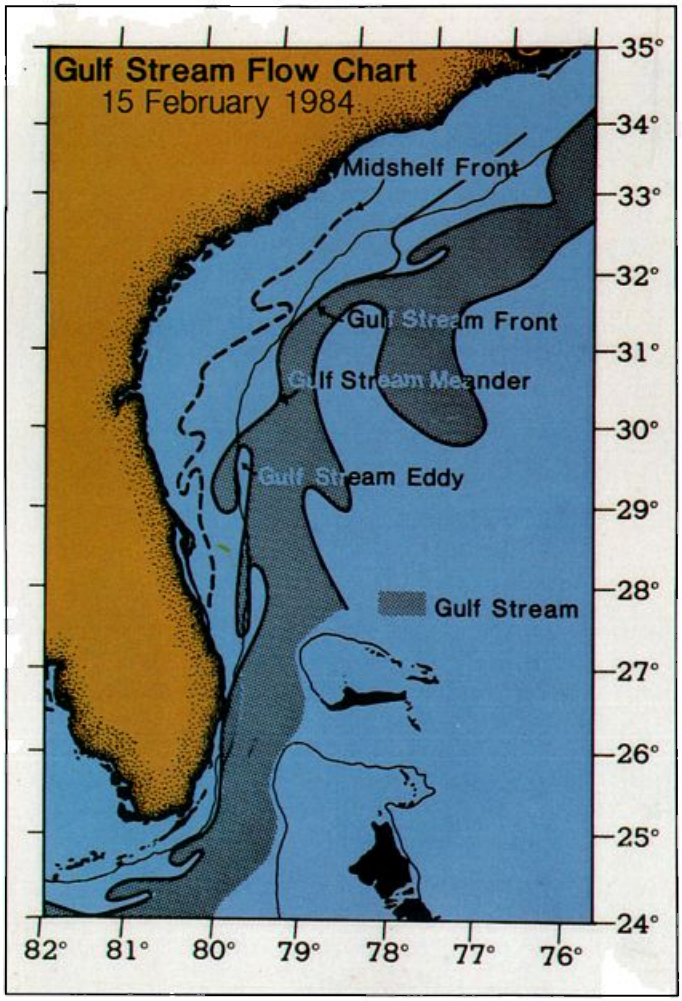
Seabirds were also attracted to temporary (2–14 day) upwelling zones at Gulf Stream eddies (Yoder *et al.*, 1981) and a strong linear relationship existed between the size of the upwelling zone (eddy) and seabird biomass and abundance (Haney 1986b). The eddy sizes were derived from satellite charts. These data suggested that the responses of seabirds to different environmental episodes (eddies) were unique.

Remote sensing data were successfully used to characterize seabird habitats, measure the frequency and duration of oceanic processes important to marine birds, and, to construct spatial boundaries for surface features that most affect seabirds.

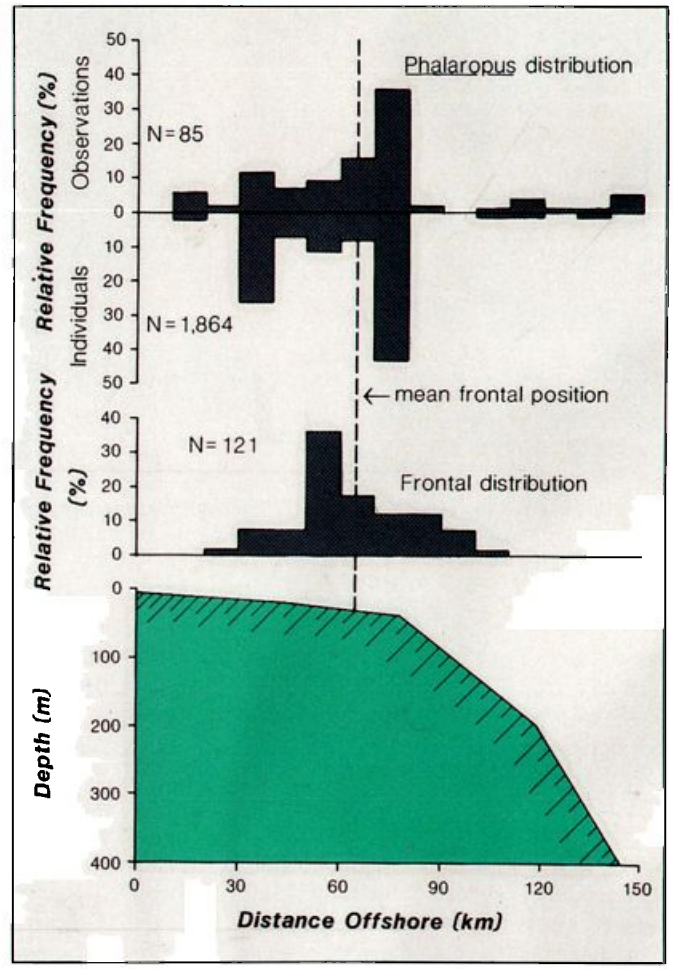
Satellite-derived hydrographic data promise to be among the most important tools for measuring and interpreting dynamic attributes of seabird environments in the future.

REFERENCES

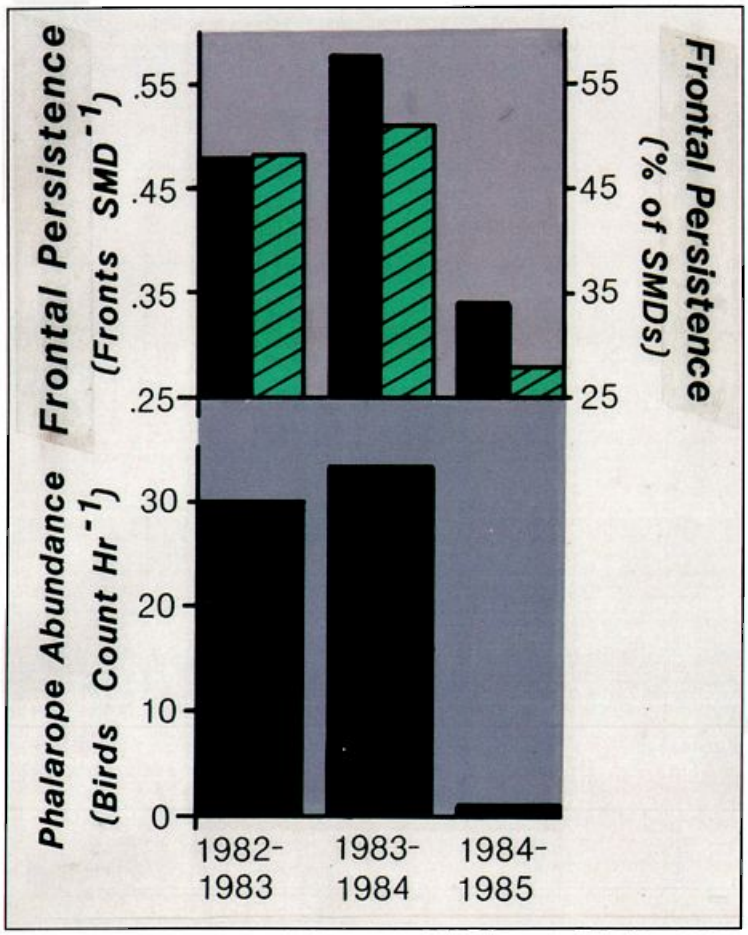
HANEY, J.C. 1986a. Seabird segregation at Gulf Stream frontal eddies. Marine Ecology Progress Series 28:279–285.



Schematic diagram of a Gulf Stream Flow Chart. *This chart depicts the principal water masses, currents, and hydrographic fronts in the study area. Over 240 Gulf Stream Flow Charts were used to characterize seabird habitats off the southeastern United States during the period 1982–1985.*

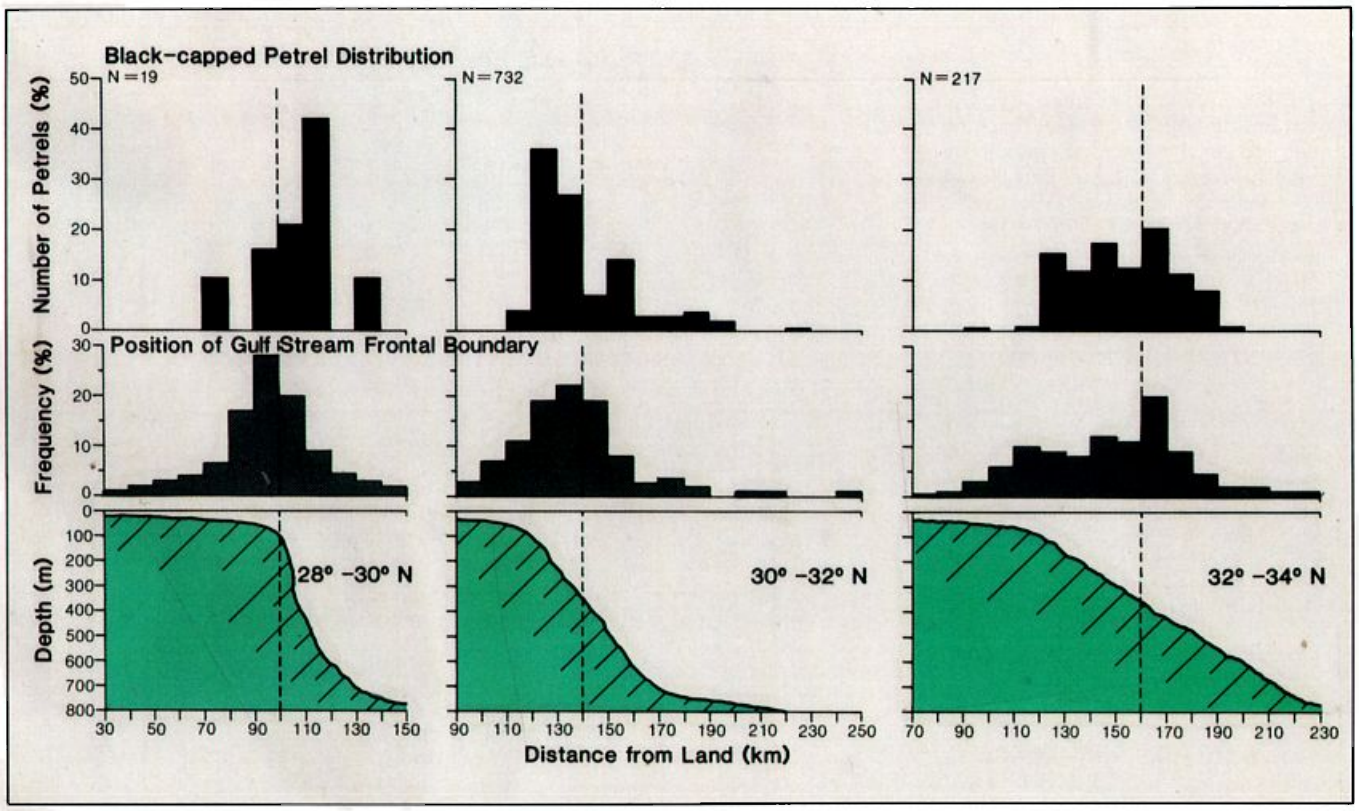


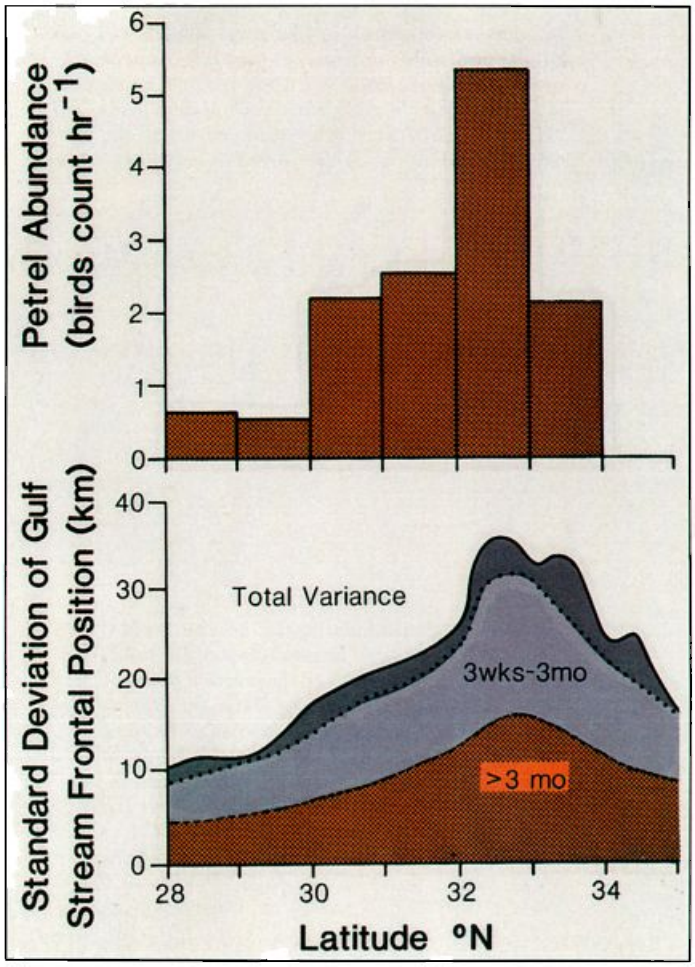
Phalarope distribution for the three year study period *corresponded closely to the position of the midshelf front, a preferred foraging site for phalaropes; 93% of individual phalaropes and 81% of phalarope flocks were seen within a 50 kilometer cross-shelf interval. The probability of frontal occurrence within this interval was 79%.*



Interannual variability in phalarope abundances and habitat availability. *Phalaropes were less common during the winter of 1984–1985 when midshelf fronts were less available as foraging sites. Frontal persistence and phalarope abundances were calculated for fall and winter, October–March. SMD = satellite map day.*

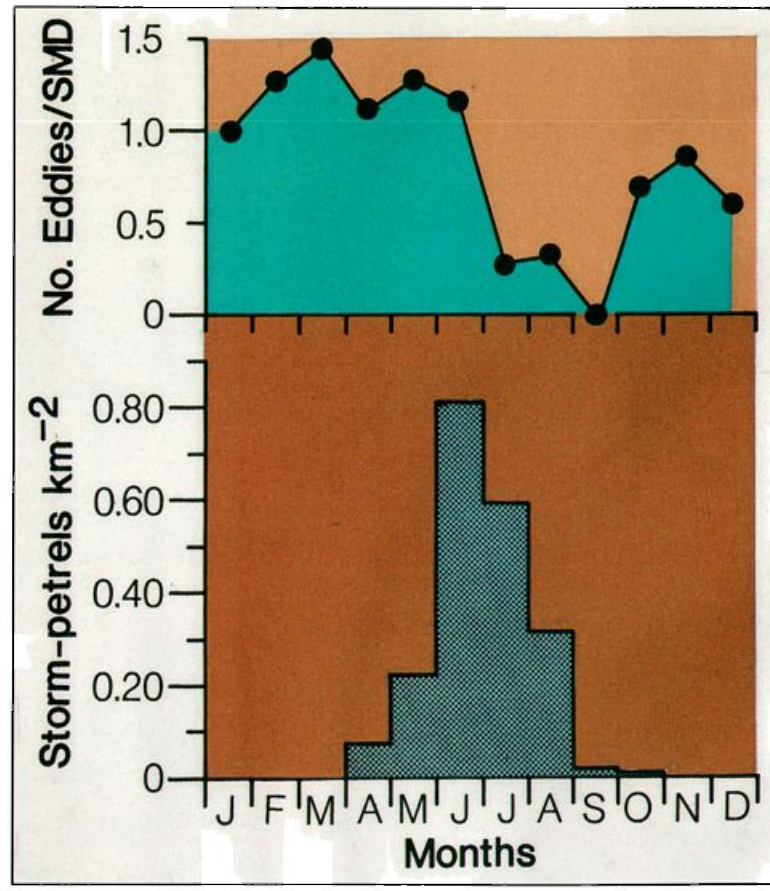
Cross-shelf distribution of the Black-capped Petrel *(Pterodroma hasitata)* **and its relationship to bathymetry, distance from land, and the position of the western Gulf Stream frontal boundary.** *Petrel abundances were converted to frequency histograms of cross-shelf locations of individual birds (N = sample size) using 10 kilometer intervals. Frequency histograms of Gulf Stream frontal positions are based on long-term satellite observations from three intervals of latitude off the southeastern United States. Vertical dashed lines show mean frontal position. Although petrel distribution changes with latitude relative to water depth and distance offshore, distribution with respect to frontal position remains constant. Broader cross-shelf distribution of petrels at higher latitudes corresponded to increases in the range of cross-shelf frontal meandering.*





Black-capped Petrels were most abundant between 32° and 33° North latitude, *where remote sensing indicated that the amplitude of Gulf Stream frontal meandering was greatest. Meandering of the stream causes upwelling and increased productivity.*

Storm-petrels appear off the coast of the southeastern United States only when eddies cause upwelling. *Storm-petrel abundances declined between June and September as upwelling associated with eddies became less frequent. A monthly index of eddy upwelling was calculated by counting the number of eddies per available satellite map day (SMD).*



—— 1986b. Seabird affinities for Gulf Stream frontal eddies: Responses of mobile marine consumers to episodic upwelling. *Journal of Marine Research* 44: 361–384.

—— and P.A. McGILLIVARY. 1985. Aggregations of Cory's Shearwaters (*Calonectris diomedea*) at Gulf Stream Fronts. *Wilson Bull.* 97:191–200.

——. 1985b. Midshelf fronts in the South Atlantic Bight and their influence on seabird distribution and seasonal abundance. *Biological Oceanography* 4:401–430.

OLSON, D.B., O.B. BROWN, and S.R. EMMERSON. 1983. Gulf Stream frontal statistics from Florida Straits to Cape Hatteras derived from satellite and historical data. *Journal of Geophysical Research* 88:4569–4577.

YODER, J.A., L.P. ATKINSON, T.N. LEE, H.H. KIM, and C.R. McCLAIN. 1981. Role of Gulf Stream frontal eddies in forming phytoplankton patches on the outer southeastern shelf. *Limnology and Oceanography* 26:1103–1110.

——*Department of Zoology, University of Georgia, Athens, Georgia 30602*