

role to play. Space-borne sensors provide a rapid overview, ground survey gives a detailed local picture, with the information from airborne sensors falling somewhere in between.

In many ways, deciding on the technique to use for a specific task is the easy part. The biggest problem is how to handle the resulting large quantities of data. The solution is a Geographical Information System. Both books discuss the necessity of

setting up such a system but do not go into detail of how this should be done. A method of storing and processing the data is fundamental to any monitoring project and without a satisfactory method the whole project could fail. It is thus important for any monitoring project that the capture, processing and storage of data are closely integrated if they are to succeed.

Together, these two books provide an excellent overview of the moni-

toring techniques available to the ecologist interested in land management. If one book had to be chosen as a basic text then *The Handbook of Ecological Monitoring* is the more comprehensive.

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Phytoplankton and Hierarchies

Phytoplankton Ecology: Structure, Function and Fluctuation

by Graham P. Harris, *Chapman & Hall, 1986. £30 (ix + 384 pages) ISBN 0 412 24330 X*

The field of phytoplankton ecology is rich with data and ideas, but is struggling with basic organizing principles. This search for order has generated several recent books, each with messages. In this book, Harris is pushing his conviction that physical forcing factors and other non-equilibrium processes outweigh all others in affecting phytoplankton structure at all levels of organization. His message is that hierarchy theory is the appropriate organizational tool because scale is a measure of how organisms perceive their environment, and he has organized his book to reflect this classification.

After a preamble in which he lays out his biases, and introduces the organisms, Harris tackles 'ecological theory'. It is this section that will probably raise the most hackles. Here I often found myself thinking 'but what about the work of ...?', and felt that inappropriate references were chosen in many cases. It is certainly not a balanced review, but rather a polemic for the non-equilibrium approach. Harris reviews tenets of equilibrium theory to show that they do not apply to natural situations. Competition is castigated for being based on equilibrium theories that only consider the steady-state solutions. Buried in the middle of a paragraph, however, is the statement 'if we relax the most stringent requirements of equilibrium theory whilst retaining some of the basic concepts, we may find a middle ground which is more realistic' (p. 29). Any ecologist with field experience would surely endorse this statement when applying equilibrium-based predictions to the real world.

The two chapters on the physical and chemical environments of phytoplankton are very well done, with a nice mixture of marine and freshwater examples. The section on defining the scales of interest is the meat of the book, where Harris develops his hierarchy theme with respect to phytoplankton. He starts with the statement that equilibrium theory can only be applied to small closed universes that are rarely found in the real world. However, non-equilibrium is also an extreme viewpoint. Once again, some middle ground is probably appropriate because the different species of phytoplankton really are 'tracking' signals anywhere in the continuum of environmental variability in order to enhance survival, as Harris himself actually acknowledges (p. 107).

He has a harder time dealing with the concepts of biological variability (*r*- through *K*-selection continuum) and how species might track fluctuations of competitors or predators, probably because he so firmly believes that interactions of organisms are too disrupted by physical perturbations. Ecologists do tend to view organisms based on the areas in which they primarily do their field work; Harris has relied heavily for examples on his field experience in Hamilton Harbor, which is obviously a very physically perturbed system. Such a bias could narrow one's view of the full spectrum of algal responses.

The section on measurement of productivity and growth rates again incorporates many examples from both lakes and oceans, and contains the requisite caveats about interpreting such data. It is a good general review, especially for those not immersed in these areas, and serves as a basis for later discussions.

In my opinion, the section on the concept of limiting nutrients is par-

ticularly fine. It is highly synthetic, with many original interpretations of data. Harris stresses the importance of ratios in this section, although he avoids reducing the arguments to the level of phytoplankton species, presumably because many of the experiments that have been performed in this area were 'steady-state' experiments which are in general anathema to him. He addresses the question of limiting nutrients at many different scales, and this chapter essentially introduces many of the ideas presented subsequently.

In the remainder of the book, Harris details examples of phytoplankton responses at many scales of organization. He contends that ecologists have underestimated the true degree of high frequency variance in planktonic environments and not appreciated the importance of the short time constants of the algal response. Harris argues that phytoplankton populations are nowhere near equilibrium, but that there are statistical properties of assemblages of species that allow high-level averaged properties to be discerned. In the sections on seasonal patterns and community organization, he argues strongly against the ideas of 'top down' controls on phytoplankton, largely based on response times of organisms at different trophic levels.

Harris has tied general ecological theory to phytoplankton dynamics, albeit with a very personal view. He takes the stand that phytoplankton are not paradoxical organisms and that they do portray the full spectrum of ecological principles, which should make the study of phytoplankton relevant to all ecologists, aquatic or terrestrial.

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