

without any survival value. I find the balance between technology and debate much more satisfactory here than in Carter's earlier book. Her approach and understanding seem to have matured, and localization of function is presented as one strand of evidence rather than as the ultimate solution to knotty abstract problems.

Consciousness has been a particularly fashionable area of enquiry for the past decade, and in this time some 30,000 articles have addressed themselves to the topic. But sadly, as this book makes clear, there is still no agreement either on the phenomena themselves or on the appropriate way to tackle them. Is consciousness the last gasp of cartesian dualism and a conceptual error, possibly reflecting our cultural predilection for a ghost in the machinery of the mind? Is it an adjective rather than a noun, describing the quality of experience rather than a distinct process or experiential context? Or were the behaviourists correct in putting the 'hard problem' of consciousness on one side in order to deal with the supposedly tractable problems of learning and responding? We are said to be waiting for a new Einstein to put consciousness on a secure theoretical footing, but the job is still vacant.

Carter is to be congratulated for her clear journalistic exposition of some key ideas and for avoiding pomposity and arrogance. The volume works, and although it is not a textbook, I shall certainly be recommending it to my second-year undergraduate students as a provocative source of ideas and an entrée into a difficult area. I shall also continue to enjoy the book myself. Good fare deserves digestion at leisure. ■

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Predicting extinction risk

Population Viability Analysis

edited by Steven R. Beissinger &

Dale R. McCullough

University of Chicago Press: 2002. 577 pp.

\$95 (hbk); \$35 (pbk)

Richard Frankham

Population viability analysis (PVA) is an important tool in conservation biology. It is the process of predicting the risk of extinction from the combined effects of the deterministic threats — such as habitat loss, overexploitation, pollution and species introductions — and stochastic threats, including demographic, environmental and genetic fluctuations and catastrophes. This is typically done using stochastic computer simulations. PVA is also used to compare

Still a round after all this time

Ammonites are among the most abundant yet beautifully preserved fossils on Earth. Many have tightly coiled spiral shells, although this *Scaphites nodosus* from the Cretaceous period is partly uncoiled. Although related to the modern-day nautilus, these cephalopods were actually more akin to the octopus, squid and cuttlefish. They died out at roughly the same time as the dinosaurs, after surviving for 300 million years before that. The biology of these extinct animals is the subject of *Ammonites* by Neale Monks and Philip Palmer (Smithsonian Institution Press/The Natural History Museum, \$50 (hbk), \$24.95/£15.95 (pbk)).



alternative management options designed to help threatened species recover. The technique arose in the 1980s but is based on the accumulated knowledge from more than a century of research in demography, ecology and genetics. In some ways it is similar to weather forecasting and the modelling of economics and global climate.

Despite vigorous activity in this field, there have been few overviews of it. This long-awaited book, the authors of which are a veritable who's who of PVA, fills the gap. The book opens with an overview of PVA before moving on to consider the construction of PVA models, how to integrate theory and practice when using PVAs, and finally the future of PVA. The focus is primarily on animals throughout.

The book succeeds in reflecting the breadth of the field, the diversity of opinions about PVA, and its use in conservation biology. The contents are of variable quality, as is common in edited volumes. I found much to applaud and much to disagree with. The highlight for me was the chapter by Mark Shaffer and colleagues on PVA and conservation policy. It was incisive and thoughtful, and had a useful practical perspective, as befits a contribution from a founder of the discipline.

By contrast, the treatment of genetics throughout the book is sometimes dubious.

However, the chapter by Fred Allendorf and Nils Ryman provides a thorough, authoritative survey of the role of genetic factors in PVA. Several chapters refer to the problems of modelling genetic factors in PVA, but these apparent difficulties are largely illusory. VORTEX software can model inbreeding depression well for juvenile survival, and well-known functions can be used for other aspects of the life cycle. Furthermore, the chapter by Sue Haig and Jon Ballou describes work that encompasses inbreeding depression, as do other published papers. There are limited data for parameterizing inbreeding depression, but even that problem is slowly being addressed.

The book arose out of an international symposium in 1999, but many authors have updated their contributions to include more recent material. For example, our subsequent paper (*Nature* **404**, 385–387; 2000) on the predictive accuracy of PVA is referred to by several authors, although some describe its methods and contents incorrectly.

I was disappointed by the perspective provided by the book, despite there being many fine contributions. For example, the relationship of PVA with other related fields, which offer useful methods, analogies and insights, receives only cursory attention. The context of conservation biology as a crisis discipline, in which immediate decisions

must be made on the basis of inadequate data, seems to have been overlooked in many contributions. And several authors refer to alternatives to PVA but fail to point out that the only realistic alternative, human judgement and intuition, is inaccurate.

Deficiencies in data are a serious problem for PVAs of endangered species, as several authors point out. They discuss various remedies, including eliminating problems in data collection, separating the effects of sampling variation and intrinsic variation, and the use of bayesian methods to incorporate uncertainties about parameter values into predictions. However, the use of data from related species receives little attention. Such data may be particularly valuable for variances of input parameters. For example, environmental variation is similar across a range of herbivore taxa (J.-M. Gaillard *et al. Annu. Rev. Ecol. Syst.* **31**, 367–393; 2000). Furthermore, analyses of long-term data sets to estimate the frequency and severity of catastrophes and to ask whether they differ widely across taxa would be highly desirable.

The way to improve PVA is clear, but receives little attention here. It involves cycles of building models, making predictions, testing them, improving the models, and so on, as for all fields involving complex systems. The emphasis in PVA has been on building models, but the testing phase has only just begun. Much more testing is required if the field is to advance swiftly and rationally, as is happening with climate modelling.

Despite some limitations, this volume should serve as a major reference book on PVA for professional scientists, advanced undergraduates and graduate students in conservation biology. ■

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Shock results

Surprise, Uncertainty and Mental Structures

by Jerome Kagan
 Harvard University Press: 2002. 259 pp.
 \$29.95, £20.50

Peter Bryant

Developmental psychology — or at any rate the part that deals with children’s intellectual abilities — is in an awkward position at the moment because it keeps on producing paradoxical and contradictory results. On one hand, a series of ingenious experiments has apparently shown that babies less than one year old possess some remarkable abilities. According to these experiments, infants can discriminate numbers, can add and subtract, and can distinguish cause and effect in both the physical and the social

worlds. On the other hand, a great deal of research on much older children, between the ages of three and about eight years, has apparently demonstrated that children in this age band often have serious difficulties with these same concepts. Their understanding of number appears fragile in such studies, their reasoning about arithmetical operations such as addition and subtraction is often erroneous, there are serious limitations to their grasp of cause and effect, and so on.

The contrast and apparent conflict between these two lines of research are stark and clear. Any suggestion that 6-month-old babies are much cleverer than children four and five years their senior would be highly implausible, and would be anathema to most developmental psychologists — their subject is dedicated to the proposition that intellectual skills improve throughout childhood. Another possible solution to this apparent impasse is to reappraise the work on infants. Are they as smart as this research suggests?

Jerome Kagan, who is a distinguished US developmental psychologist with an interest in children’s emotional and intellectual development, has now provided such a reappraisal in his new book. He is well placed to do so because much of his research has been on children’s expectations and their reactions to congruous and incongruous events. Nearly all of the work that apparently demonstrated various remarkable abilities

in infants used their reaction to novelty and their surprise at unexpected events as a way of measuring such abilities. If, for example, you add one object to another and then show the baby that the product of your actions is three objects, and if the baby is more surprised to see this as the result than she is to see two objects there, you can argue that the baby knows something about addition.

Kagan’s discussion of this pervasive use of babies’ reactions to novel and unexpected events comes in the second half of the book. It is based on ideas, which he expounds in the first part, about the ways in which children and adults form expectations and are surprised when these are not fulfilled. His reasoning is sophisticated and interesting, but his conclusions are easy to summarize. He is highly sceptical of the claims made about the presence of surprising abilities in infants, and argues that their achievements in these studies can be explained without ascribing huge intellectual acumen to them.

Kagan’s reassessment of research on infants is the most important part of his new book. His arguments on the subject are controversial, of course, and should provoke a much-needed discussion. So the book will make a real contribution to the debate, and is definitely worth reading. ■

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Bright eyes? Babies’ responses to surprising results may not be a good guide to their intelligence.

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