Climate change biology as a predictive science?

Climate Change Biology by L. Hannah. Academic Press, 2010. US$60.00, pbk (416 pages), ISBN 9780123741820

Climate Change Biology by J.A. Newman, M. Anand, H.A. Henry, S.L. Hunt and Z. Gedalof. CABI Press, 2011. US$75.00, pbk (304 pages), ISBN 9781845936709

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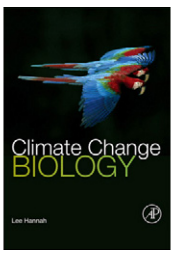

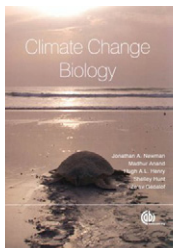

A field has come of age with the recent publication of two text books, both entitled *Climate Change Biology*. Previous books have largely summarized climate science and conservation concerns rather than addressing the drivers and implications of biological responses to climate change. Ultimately, global change biology aims to be a predictive science [1,2]. Here, I consider the progress of this burgeoning field toward this goal, as reflected in these books.

Both books set the stage with an overview of past climates, techniques for their reconstruction and future climate projections. Newman *et al.* then aim to introduce the processes by which species are responding to climate change. Although they thoroughly review physiological impacts on plants, they scarcely address physiological impacts on animals. Additionally, they omit marine systems almost entirely, notably ocean acidification and the chemistry by which it impacts organisms. Hannah provides accessible and informative explanations of ocean acidification as well as most of the other processes by which climate change impacts organisms. However, the explanations are scattered through later chapters focused on how experiments and models can inform predictions. Early chapters (Sections 2 and 3) provide clear descriptions of biological responses to climate change and highlight an excellent selection of the recent literature, but lack an overarching framework to synthesize these responses.

The two books reflect dichotomous responses to pressures to forecast the population, community and ecosystem impacts of accelerating climate change. Their perspectives are consistent with the authors' backgrounds. Hannah, a Conservation International senior fellow focused on applied biodiversity science, offers a call to consider climate change in conservation planning now. The book by Newman *et al.*, which was written by a group of faculty who tend toward experimental methods and ecosystem ecology, emphasizes uncertainty and the challenges of predicting climate change impacts.

Newman *et al.* advocate scaling up from individual physiology to predict climate change impacts. However, in chapter after chapter, they conclude that such upscaling is complicated and outcomes will depend on particularities. Indeed, the book emphasizes ecosystem responses that are contingent on the relative strengths of a myriad of climate–ecosystem feedbacks. The final chapter, a contemplation of the limits to predictability, allows the authors to concede their attempt to portray climate change biology as a predictive science.

By contrast, Hannah focuses on a more phenomenological approach. He arms students with methods with which to go out and design reserve networks aimed at minimizing the impacts of climate change on biodiversity. The final chapters of his book focus on conservation applications. Some topics, such as protected area planning and assisted migration, stem directly from the earlier biological information. Others, including discussions of mitigation techniques and alternative energy, are quite disparate from the biological topics. The book assumes the pragmatic stance that current techniques for predicting climate change responses are sufficient to plan for climate change impacts now. Further discussion of how considering sources of uncertainty in predictive models can inform conservation strategies [3] would improve the book.

Both books would also benefit from expanded treatments of organismal and population biology. A predecessor text book [4] aimed to include 'enough details from areas as diverse as cell biology, genetics, physiology and ecology to explain the basics of why global environmental change matters'. This focus on the basics remains valuable as few students have been trained in all the disciplines relevant to climate change biology. Fewer still have contemplated how to integrate these disciplines to understand organismal impacts.

The most appropriate audiences for each book differ. Hannah provides a clear and compelling account of biological impacts and potential conservation responses that should be engaging to undergraduates, but more advanced readers may miss the detailed treatment of topics characteristic of Newman *et al.* These authors provide a thorough and informative gateway to the field for graduate students

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and researchers, but the text may be too nuanced for undergraduate students.

Researchers have been searching for a middle ground as global change biology strives to become a predictive science [5]. Can one use small-scale experimental studies and detailed observations to determine what biological details are crucial to forecasting climate change response? Can one incorporate these details in broad-scale modeling efforts that tend to omit biological details? Revisions of both books would benefit from converging toward this middle ground. Newman *et al.* might offer approaches to generalize small-scale studies, whereas Hannah might further acknowledge the potential importance of biological details omitted from general approaches.

References

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