BOOK REVIEWS

Amphibians in Decline: Canadian Studies of a Global Problem, edited by David M. Green. 1997. Society for the Study of Amphibians and Reptiles. Herpetological Conservation 1. 338 pp. Softcover. US $39 + $3 shipping & handling. ISBN 0-916984-40-0.

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This comprehensive book is an impressive collection of individual papers covering the broad scope of current research (all papers include research post 1990) related to amphibian declines in Canada. It was a pleasure to read the book as the breadth of content and methodologies used gives the reader a complete overview of the extent of research involved in trying to understand the current status of Canadian amphibians. Unfortunately, this made me realize that the work over the past seven years is only the tip of the iceberg and an enormous amount of research is necessary to resolve this complex problem, involving many species and many potential causes (known and unknown).

As mentioned in the foreword, this book is a collection of papers on research developed and presented in isolation. Consequently, it is not a coordinated effort aimed at documenting and understanding amphibian declines at a national scale. This problem is also evident in other countries and may result partly from the geographical isolation of research institutes. Research should reflect a communal concern to resolve a national problem and should be coordinated at either a species or subject level. Wildlife managers should focus on determining the current status of populations, and research teams on resolving specific hypotheses to explain observed declines (i.e., natural population dynamics, disease, UV, radiation etc.) coordinated at a species level (rather than political boundaries). The message from this book is clear, the problem is immense and scientists must work together to examine specific hypotheses and replicate research among species and across latitudinal boundaries.

The first chapter presents a good example of the broad surveys needed to assess the factors influencing the distribution and abundance of amphibians. This study allows us to evaluate the biological factors determining species distributions (i.e., the presence/absence of fish), the stochastic nature of species distributions and, when replicated over many years, allows assessment of the status of species on a regional scale. This is exactly what is urgently needed to assess amphibian populations throughout the world. The following chapters (2–6) present intensive studies on the population dynamics of particular species at given localities, providing a basis for understanding amphibian population dynamics at the population level. Chapter 7 presents a fine example of metapopulation dynamics, and dispersal characteristics among populations. This information is crucial for managing species in fragmented landscapes. The broad survey result, presented in Chapter 8, provides a good example of using calling survey data (albeit for a single species) for rapid assessment of population numbers compared with historical data to determine population declines.

The potential role of conservation genetics is presented in Chapters 9, 10 and 28. Their application is clearly lacking from research to date and field ecologists should collaborate with

geneticists (for example, providing the toe-clips from population studies) to utilize the advantages of population genetics. In Chapters 11 (three papers), 12, 13 and 14, a variety of methods are used to assess the status of amphibian populations in particular provinces. Calling surveys are used to identify species-habitat relationships in agricultural landscapes in Chapter 15, and a good evaluation of the technique is presented in Chapter 16. The use of artificial covers for assessing salamander populations is evaluated in Chapters 17 and 18 and a method for sub-sampling aquatic frogs is presented in Chapter 19 (see discussion below). Potential impacts of forestry activities are described in Chapters 20 and 21, followed by an assessment of the potential impacts of global warming and increased UV radiation on amphibian populations in Chapter 22. The potential changes in amphibian populations at four ponds resulting from changes in water acidity is presented in Chapter 23. Experimental analyses of herbicides and pesticides on egg and larval survival are assessed in Chapter 24, followed by an assessment of agriculture on amphibian deformities (potentially related to herbicide/pesticide residues) in Chapter 25. The role of disease in amphibian declines is well reviewed in Chapter 26. Chapter 27 presents an alternative view on larval surveys and the use of chemical control for introduced species.

The final chapter provides a good overview of the problems associated with assessing amphibian populations and the important distinction between "population size" and "population numbers". The stochastic nature of amphibian populations makes the former difficult to interpret without long term data. The latter (as presented in Chapter 1) is more appropriate for rapid assessment of population status. Finally, a summary of the current status of each species (within each province) is presented in Appendix 1, a suitable basis for management and conservation agencies. The declines are generally attributed to direct anthropological causes yet declines are prevalent in western Canada where human populations are less concentrated.

The large number of authors with a wide range of experience make this book a significant contribution to our understanding of amphibian biology. Many provide excellent examples of methodology and experimental design, however the range of experience of the authors results in some papers lacking rigorous scientific integrity. As for any journal article the reader must consider the experimental design, the results obtained, and the limits on the conclusions reached. In several cases substantial results were overlooked in the discussion, or conclusions are presented without data to support them. One frequent limitation in experimental design results from surveying less than five populations (sometimes within a single waterbody) that may not represent broad patterns for a species. This may result from the limitations imposed by working with endangered species for which only a few sites may be available, but should be avoided whenever possible.

Surprisingly, this book contains little evidence of frog declines in Canada (although see Appendix 1 for species accounts) and no evidence of declines in any of the salamanders. Predicted causes for amphibian declines result from a complex suite of potential (habitat modification, pesticides and herbicide pollution, etc.), postulated (global climate change, disease, acid rain, etc.), and unexplained causes (Chapter 8).

These potential causes are most likely acting independently (although several factors may be acting at the same time) upon each species in each province. Observed declines are associated with habitat destruction, fragmentation and degradation (Appendix 1, however, see Chapter 8). Fortunately, appropriate management actions can be instigated (e.g., forestry regulations, planning urban and agricultural expansion) as political action is clearly the only way to mitigate these anthropogenic effects. The predicted influence of global warming and increased UV radiation on amphibian assemblages once again reminds us of the need for all countries to ensure they are doing everything possible to reduce the local emissions responsible for changing the global environment.

For biologists working on unexplained declines in relatively pristine areas (e.g., eastern Australia, the Rocky Mountains of North America, Central America, and the Andes or Atlantic Forest regions of South America) this volume provides little insight into determining the cause of these declines. Contrary to the conclusion of this book, I believe the fundamental cause of these declines may still be global, however I agree that the primary way of determining the cause of declines will ultimately depend on research at the local scale.

Reflections on several important points raised in this volume include:

1) The sheer amount of research needed is a daunting task and priorities based on rapid assessment are urgently required. A good initiative is presented by Kristiina Ovaska (Chapter 22). However, in her model, the conservation status for each species was included as an independent variable. To create a predictive model that will identify which species are susceptible to global change, current conservation status could be used as the dependent variable. The resulting model would identify the species characteristics which are significantly associated with population declines, also a list of species predicted to be most susceptible to the proposed global changes could be generated.

2) Large-scale surveys are required to document population declines (e.g., Chapters 1, 8, 12, 15, 16, 17, 18 and 28), however, surveys were often restricted to individual species or habitats (water bodies) and/or provincial-political boundaries. Determining species priorities will greatly assist this forbidding task.

3) The variety of methodologies presented provides useful techniques but each contains inherent biases that must be considered in their interpretation and hence application. Adequate surveying often requires species-specific survey techniques. For example, the survey methods in Chapter 1 only sampled species that reproduce in permanent ponds, calling surveys on road transects (Chapters 14–16) only detect vocal species from ponds and not stream-dwelling species, and the use of artificial covers is only effective for some species of salamanders and not others (Chapters 17 and 18). The transect survey method in Chapter 19 may be effective, however no comparison is made with alternative methods. Research on appropriate methodologies would be more productive if compared with alternative methods either in the same place at the same time, or with published results from other studies (e.g., Chapter 16). Alternatively, a single methodology could have been used to compare their efficiency at answering certain ecological questions.

4) Broad scale surveys are urgently required to determine the current status of all species at the "population number" scale (e.g., Chapter 1). Intensive mark-recapture studies provide important baseline data on how individual populations fluctuate (Chapters 2–6), however, they are of limited benefit as they rarely differentiate between immigration, emigration, birth, and mortality. The labor-intensive fieldwork required obtaining this detailed information on population dynamics limits the scope of these studies to a few sub-populations (at the pond or stream level). Sites of high abundance are usually chosen, and without adequate replication across the distribution of the species, these studies do not provide information at the species level. For example, the dynamics of a sub-population will not represent a species if it is a "sink" population. Subsequently, intensive mark and recapture

studies contribute little to our understanding of population declines. However as stated in the editor's final chapter, they will provide valuable information on the dynamics of amphibian populations that may be extremely useful in identifying the cause of a population decline.

Finally, I cannot agree with the conclusions of Chapter 27, supported in the final chapter by Green, suggesting that larval surveys are "largely inapplicable to monitoring the health or persistence of a population." First, there are no data presented to support this contention. The complex life-history of amphibians makes it difficult to pinpoint the most important life stage for population regulation (e.g., Chapter 5). Clearly combined survival at all stages (embryo, larval, juvenile, and adult) influence population size. Studies on population dynamics and regulation must consider all life-history stages.

Several papers presented in this book demonstrate the value of larval surveys (Chapter 1). In the study by Green (Chapter 5), the number of calling males in any year could not be related to the number in the previous year, suggesting that the adult population is regulated by larval recruitment. Unfortunately, larval abundance was not monitored in that study and the role of larval recruitment as a crucial stage in the life-history of this species could not be assessed. Clearly, to understand the "population demographics" of any amphibian species, both larval and adult populations must be considered.

Regarding the question of "population number" the presence of larvae represents the likelihood of reproductive success and hence would be a better indicator of population persistence than the presence of adults. While this may vary for a few ephemeral pond-breeding species (where larval mortality may reach 100 %), most species in Canada appear to breed in more permanent water bodies and larvae are present for extensive time periods (some overwintering). The results of Chapter 7 also demonstrated the value of larval surveys. In that study the presence of adults did not reflect reproductive success as only one pond produced metamorphs (i.e., source vs sink populations). This study demonstrates that the mobility of adults makes adult population estimates difficult to interpret (as mentioned above). Furthermore, tadpole surveys can be useful when searching for remaining populations of species that have significantly declined, particularly for species with a cryptic adult life stage (e.g., *Taudactylus* species in Australia).

Monitoring both larval and adult stages allows us to assess the relative importance of any water body to the success/survival of the species (Chapter 1). For "population number" long-term monitoring of any life-history stage can be surveyed and all are suitable as indices of population status. Larval surveys are often much easier to employ, and are not subject to the immediate climatic effects that limit the activity of adults to certain conditions or particular times of year.

In summary, the book is a credit to the editor, it has an ample scattering of black and white photos that allow overseas readers to visualize the species they are reading about and there are few typographical errors. Reading the book in its entirety provokes constructive thoughts on this global phenomenon and clearly provides insight into appropriate methodologies and direction for future research. The reasonable price and invaluable contents of this book make it a must for anyone interested in amphibian declines.