# Rarity and Richness Hotspots in British Columbia

GEOFFREY G.E. SCUDDER

Department of Zoology and Biodiversity Research Centre, University of British Columbia, 6270 University Boulevard, Vancouver, BC, V6T 1Z4, Canada, email scudder@zoology.ubc.ca

**Abstract:** Georeferenced distributional databases for vascular plants, some vertebrate groups, and many insect taxa have been used to prepare maps that show rarity and richness biodiversity hotspots in British Columbia. These hotspots are coincidental for the various terrestrial taxa, and the rarity and richness hotspots also coincide. The opportunities and challenges this poses for biodiversity conservation are discussed.

**Key Words:** rarity, richness, hotspots, British Columbia

## Introduction

British Columbia (B.C.) has a great diversity of ecosystems and habitats (Meidinger and Pojar 1991). As a result, B.C. has a rich biota (Cannings and Cannings 1996) and greater biodiversity than other provinces of Canada.

One of the three main objectives of the Convention on Biological Diversity (CBD) is to conserve this biodiversity. Article 7(a) of the CBD calls for the identification of the components of biodiversity that are important for its conservation. Within the Canadian Biodiversity Strategy, Strategic Direction 2.4(c) calls for the conducting of biological inventories based upon a number of criteria, including threatened and endangered species and areas of high diversity.

In British Columbia, the Protected Areas Strategy (PAS) Gap Analysis Workbook (Province of British Columbia 1993) requires the mapping of rare/endangered species' occurrences. Step 1 in the PAS Goal 2 calls for the identification of sites of high species richness. Scott et al. (1987) note that focusing on species-rich areas offers the most efficient and cost-effective way to retain maximal biological diversity in a minimal area.

Hotspots are increasingly being delineated to help set priorities for biodiversity conservation (Reid 1998). The term 'hotspot' was used by Myers (1988, 1990) to indicate regions of the world that combine particularly high species richness, endemism, and threat. This concept of hotspot was followed by Mittermeier et al. (1998); however, the term 'biodiversity hotspot' is now most commonly used with reference to regions of high species richness at a more confined geographic level (Reid 1998). As such, the term has been used, for example, in terrestrial areas of Europe (Prendergast et al. 1993; Williams et al. 1996; Williams, Humphries et al. 2000; Araújo and Williams 2001), the United States (Dodson et al. 1997), Australia (Curnutt et al. 1994), and Africa (Lombard 1995; Howard et al. 1998; Williams, Wisz et al. 2000), as well as in tropical marine areas (Roberts et al. 2002).

One important question asked in many conservation biology studies, and relevant in British Columbia, is whether certain well known and easily surveyed taxa can be used as surrogates for overall biodiversity. To date, both positive and negative relationships between taxa have been discovered (Reid 1998; Harcourt 2000; Vessby et al. 2002). Possible reasons for these varied results include differences in the type of diversity estimate used, the selection of taxa, and the temporal and spatial scales at which the studies were performed (Flather et al. 1997).

The aim of the research summarized herein was to determine the location of rarity and richness biodiversity hotspots in British Columbia, and to see if these coincide in a range of taxa. Since additions to the databases are being made, and because results are preliminary, no actual maps are included in this short paper.

## Materials and Methods

Computerized databases on recorded species' occurrences for a broad range of well studied taxa in British Columbia were obtained or developed, and georeferenced. Occurrences and hotspots were mapped using ArcView GIS and WORLDMAP (Williams 1996), the latter custom modified for the province by Dr. P. Williams of the Natural History Museum in London. Mapping was done at a 1:50,000 scale.

Data were obtained for COSEWIC-listed (endangered, threatened, and special concern) species (COSEWIC 2003), provincial red-listed (endangered or threatened) species (CDC 2004), and terrestrial and freshwater invertebrates listed as potentially rare and endangered (Scudder 1994, 1996). Total species richness analyses were based on data obtained or developed for vascular plants, small mammals, reptiles, amphibians, freshwater fishes, dragonflies and damselflies (Odonata), stoneflies (Plecoptera), true bugs (Heteroptera), butterflies (Lepidoptera), neuropteroid insects (Megaloptera, Neuroptera, Raphidioptera), carabid beetles (Coleoptera: Carabidae), and diaptomid copepods (Crustacea). We are still seeking and assembling data on birds, large mammals, and more groups of insects and other invertebrates, as well as nonvascular plants. We also have an expanding database on alien species.

In this presentation, I consider only the terrestrial biota; however, it should be noted that a wide range of taxa are covered within this category.

## Results

The results of the rarity analyses show that hotspots occur in three main areas, namely the South Okanagan, the Lower Mainland, and southeastern Vancouver Island plus the Gulf Islands. The rarity hotspots for the many taxa are coincident.

Results of the total richness analyses for all the terrestrial groups studied show that these same three areas of the province are also the richness hotspot areas. Here again, the richness hotspots for the various taxa are coincident.

## Discussion

The situation with respect to the coincidence of hotspots in British Columbia thus appears to be quite different from that reported by Prendergast et al. (1993) in Britain. These researchers found that in the British Isles, the richness hotspots for the different taxa did not coincide. The authors also noted that the rarity hotspots for taxa did not coincide with the richness hotspots.

The reason for the difference in British Columbia may, at least in part, relate to the nature of the terrain and the very different ecosystems, vegetation, and habitats that occur across this terrain. Much of British Columbia is either high elevation alpine or coniferous forest. There are few low elevation areas and few grassland habitats. It is clear that the rarity and richness biodiversity hotspots are in these latter areas.

These same lowland and grassland areas are experiencing ever expanding urban development along with consequent loss and fragmentation of habitat. These areas also have little land area set aside as protected areas that can function for biodiversity protection. The general lack of coincidence of the top rarity hotspots with protected areas in British Columbia has already been documented (Scudder 2003). The mapping we have done shows that, not unsurprisingly, the high rarity and richness hotspots also coincide with alien species hotspot areas.

These circumstances pose major challenges for biodiversity conservation. In the South Okanagan, Lower Mainland, and southeastern Vancouver Island and the Gulf Islands, there are few opportunities for adding additional protected areas. Most of the land is privately owned, and land purchase is very expensive. Even where habitat fragments remain, they are small, isolated, degraded, and usually invaded by alien taxa.

There are also few opportunities left for large vertebrate conservation within these three areas because large reserves are now precluded. Conservation of large vertebrates will primarily have to be accomplished elsewhere in the province; however, there are undoubtedly still many opportunities to establish what Diamond (1986) calls "vest-pocket reserves". These are small reserves that are well suited to plants and invertebrates. Municipal, regional, and local parks, greenways, and golf courses could play such a role: roadsides, right-of-ways, and areas under power lines could also play a role. These areas can be the key to the conservation of plants, invertebrates, and some of the smaller and/or vagile vertebrates in the main hotspots in the province. Such vest-pocket reserves, in most cases, will require intensive management and habitat manipulation. This may not be a central focus of biodiversity conservation elsewhere in British Columbia, but it will have to be a main focus in these provincial rarity and richness biodiversity hotspot areas. Expanded education activities and committed stewardship will obviously be essential.

## Acknowledgments

I am indebted to the many people and agencies that have developed and aided in the development of the databases and made these available: they will be listed and fully

acknowledged in the full and detailed publication of this research. I am indebted to Launi Lucas and Leanna Warman for the management of the databases and the analyses undertaken. Dr. P. Williams kindly provided the WORLDMAP software and custom modified it for application in British Columbia. The research was supported by a research grant from the Natural Sciences and Engineering Research Council of Canada and funding from the British Columbia Ministry of Water, Land and Air Protection.

## References

Araújo, M.B., and P.H. Williams. 2001. The bias of complementarity hotspots toward marginal populations. Conservation Biology **15**:1710–1720.

Cannings, R., and S. Cannings. 1996. British Columbia: a natural history. Greystone Books, Vancouver, British Columbia. 310 pp.

Conservation Data Centre (CDC). 2004. Provincial Red and Blue Lists. Available from http://srmwww.gov.bc.ca/atrisk/red-blue.htm (accessed 1 March 2004).

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2003. COSEWIC assessment results, November 2003. Committee on the Status of Endangered Wildlife in Canada, Environment Canada, Ottawa, Ontario. 44 pp.

Curnutt, J., J. Lockwood, H.-K. Luh, P. Nott, and G. Russell. 1994. Hotspots and species diversity. Nature **367**:326–327.

Diamond, J. 1986. The design of a nature reserve system for Indonesian New Guinea. Pages 485–503 in M.E. Soulé, editor. Conservation biology. The science of scarcity and diversity. Sinauer Associates, Inc., Sunderland, Massachusetts.

Dodson, A.P., J.P. Rodriguez, W.M. Roberts, and D.S. Wilcove. 1997. Geographic distribution of endangered species in the United States. Science **275**:550–553.

Flather, C.H., K.R. Wilson, D.J. Dean, and W.C. McComb. 1997. Identifying gaps in conservation networks: of indicators and uncertainty in geographic-based analyses. Ecological Applications **7**:531–542.

Harcourt, A.H. 2000. Coincidence and mismatch of biodiversity hotspots: a global survey for the order, Primates. Biological Conservation **93**:163–175.

Howard, P.C., P. Viskanic, T.R.B. Davenport, F.W. Kigenyi, M. Baltier, C.J. Dickinson, J.S. Lwanga, R.A. Matthews, and A. Balmford. 1998. Complementarity and the use of indicator groups for reserve selection in Uganda. Nature **394**:472–475.

Lombard, A.T. 1995. The problems with multi-species conservation: do hotspots, ideal reserves and existing reserves coincide? South African Journal of Zoology **30**:145–163.

Meidinger, D., and J. Pojar, editors. 1991. Ecosystems of British Columbia. Special Report Series No. 6. British Columbia Ministry of Forests, Victoria, British Columbia. 330 pp.

Mittermeier, R.A., N. Myers, J.B. Thomsen, G.A.B. da Fonseca, and S. Olivieri. 1998. Biodiversity hotspots and major tropical wilderness areas: approaches to setting conservation priorities. Conservation Biology **12**:516–520.

Myers, N. 1988. Threatened biotas: "hot spots"in tropical forests. Environmentalist **8**:187–208.

Myers, N. 1990. The biodiversity challenge: expanded hot-spots analysis. Environmentalist **10**:243–256.

Prendergast, J.R., R.M. Quinn, J.H. Lawton, B.C. Eversham, and D.W. Gibbons. 1993. Rare species, the coincidence of diversity hotspots and conservation strategies. Nature **365**:335–337.

Province of British Columbia. 1993. A protected areas strategy for British Columbia. Gap analysis workbook for regional protected areas teams. Working draft—June 1993. Province of British Columbia, Victoria, British Columbia. 41 pp. plus appendices 1–13.

Reid, W.V. 1998. Biodiversity hotspots. Trends in Ecology and Evolution **13**:275–280.

Roberts, C.M., C.J. McClean, J.E.N. Veron, J.P. Hawkins, G.R. Allen, D.E. McAllister, C.G. Mittermeier, F.W. Schueler, M. Spalding, F. Wells, C. Vynne, and T.B. Werner. 2002. Marine biodiversity hotspots and conservation priorities for tropical reefs. Science **295**:1280–1284.

Scott, J.M., B. Csuti, J.D. Jacobi, and J.E. Estes. 1987. Species richness. A geographic approach to protecting future biological diversity. BioScience **37**:782–788.

Scudder, G.G.E. 1994. An annotated systematic list of the potentially rare and endangered freshwater and terrestrial invertebrates in British Columbia. Occasional Paper 2. Entomological Society of British Columbia. 92 pp.

Scudder, G.G.E. 1996. Terrestrial and freshwater invertebrates of British Columbia: priorities for inventory and descriptive research. Working paper 09/1996. Research Branch, British Columbia Ministry of Forests, and Wildlife Branch, British Columbia Ministry of Environment, Lands and Parks. Victoria, British Columbia. 206 pp.

Scudder, G.G.E. 2003. Biodiversity conservation and protected areas in British Columbia. Available from http://www.zoology.ubc.ca/biodiversity/hotspots/hotspot_report.pdf.

Vessby, K., B. Söderström, A. Glimskär, and B. Svensson. 2002. Species-richness correlations of six different taxa in Swedish seminatural grasslands. Conservation Biology **16**:430–439.

Williams, P.H. 1996. WORLDMAP IV WINDOWS: software and help document 4.1. Privately distributed by the author. The Natural History Museum, London. Available from http://nhm.ac.uk/science/projects/worldmap/.

Williams, P., D. Gibbons, C. Marqules, A. Rebelo, C. Humphries, and R. Pressey. 1996. A comparison of richness hotspots, rarity hotspots, and complementary areas for conserving diversity in British birds. Conservation Biology **10**:155–174.

Williams, P., C. Humphries, M. Araújo, R. Lampinen, W. Hagemeijer, J.-P. Gasc, and T. Mitchell-Jones. 2000. Endemism and important areas for representing European biodiversity: a preliminary exploration of atlas data for plants and terrestrial vertebrates. Belgian Journal of Entomology **2**:21–46.

Williams, P., M. Wisz, C. Rahbek, J. Moore, L. Hansen, N. Burgess, T. Brooks, and A. Balmford. 2000. Quantitative methods at the Congolese forest priority-setting workshop. 30 March–2 April 2000, Libreville, Gabon, WWF-U.S. 16 pp.