Diversity and Distributions (1998) **4**, 77–86

BIODIVERSITY RESEARCH

Examination of the 'founder effect' in biodiversity research: patterns and imbalances in the published literature

ROBERT FRANCE and CATHERINE RIGG *Harvard University, Graduate School of Design, 48 Quincy St, Cambridge, MA 02138 USA and Department of Geography, University of Toronto, 100 St. George St, Toronto, Ontario, Canada M5S 3G3*

Abstract. We reviewed 2524 articles published from 1987 to 1995 in five international journals, *Conservation Biology*, *Biological Conservation*, *Biodiversity and Conservation*, *Ecological Applications*, and the *Journal of Applied Ecology*, to assess patterns and imbalances in biodiversity research in the following subject areas: locations where research was conducted, types of organisms studied, types of ecosystems studied, types of methodologies used, and types of stresses investigated. Biodiversity research was found to be narrowly focused with little deviation from its initial course set of being a discipline concerned largely with the implications of forest habitat loss on charismatic terrestrial megafauna; i.e. the 'founder effect' is very much in evidence. The 'sleeping dragon' of ignored marine biodiversity is really symptomatic of a wider problem, and can perhaps be referred to as a 'hibernating hydra' of many imbalances due to, for example, under-representations of research from developing nations, or on amphibians and invertebrates, alpine and arctic systems, sociological components and chemical stresses etc. It is time to take steps to actively awaken the creature so that conservation biology/applied ecology can become more pluralistic in scope.

Key words. Biodiversity research, literature review, 'founder effect'.

INTRODUCTION

'Self-congratulation has taken an extreme form in our new science of conservation biology, as workers define and redefine the field'—Murphy (1989)

Quantitative analyses of the scientific literature provide insight into many attributes of interest (e.g. Merton, 1968; de Solla Price, 1975; Taubes, 1983; Cooley & Golley, 1984; Martin Irvine & Stevens, 1990; Cohen, 1991; Resh & Yamamoto, 1994; Rigler & Peters, 1995; Statzner, Resh & Kolzina, 1995), and when approached on a comparative basis (e.g. de Solla Price, 1986; Peters, 1991; Peters *et al*., 1996; Peters, 1997; France, 1998; France, Peters & Rigg, 1998), allow assessment of the relative strengths and weaknesses of the discipline(s) under investigation. However, much of the emphasis on attempting to understand just what a 'conservation biologist' is (e.g. Soule, 1985, 1987; Murphy, 1988, 1989; Deshmukh, 1989; Noss, 1989), and how this may or may not differ from a 'wildlife biologist' (e.g. Teer, 1988; Thomas & Salwasser, 1989; Wagner, 1989; Bolen, 1989; Edwards, 1989; Yahner, 1990), has been discursive in nature. The few attempts at quantitative literature analyses have been concerned with particular questions and perhaps published in locations not routinely read by conservation biologists (Jensen & Krausman, 1993; Bunnell & Dupuis, 1994, 1995). Our goal in the present paper was to provide the first comprehensive and quantitative review of the subjects covered by both conservation biologists and applied ecologists in the selected primary literature on biodiversity.

A decade ago, Kaufman (1988) called attention to the fact that 'biodiversity has yet to receive the support it deserves from marine ecologists', referring to the issue as a 'sleeping dragon'. Despite the statement that the editors of *Conservation Biology* had expressed 'strong interest in publishing more' work on marine biodiversity, Irish & Norse (1996) found that of 742 papers published in the journal since its conception, only thirty-seven (5%) were specifically marine, sixty-nine (9%) were specifically freshwater, whereas 496

© 1998 Blackwell Science Ltd

(37%) were specifically terrestrial in scope. The fact that these authors found the same imbalance in their review of a widely read textbook on conservation biology, led them to believe that the problem was not just endemic to the pages of this particular journal. As a result, Irish & Norse (1996) concluded that 'our science exhibits the founder effect: conservation biology has not deviated from the course they [the terrestrial biologists Soule and Wilcox in their seminal 1980 book] set'. This results in 'our profession's [continued] inattention to marine biodiversity' (Murphy & Duffus, 1996).

Other scientists have likewise decried (hampered somewhat by the absence of detailed empirical evidence) the lack of attention paid to such topics as parasites (Windsor, 1995), invertebrates (Wilson, 1987), terrestrial megafauna (Terborgh, 1988), non-rainforest issues (Redford, Taber & Simonetti, 1990), and taxonomy (Disney, 1989; Ehrenfield, 1989) in biodiversity research. Do such prevalent imbalances really exist in conservation biology/applied ecology? An informal layperson survey by us confirmed that the impression the public has of our profession is one that is primarily if not exclusively concerned with 'the effects of tropical deforestation on birds and mammals'. This is of course understandable given the publicity of celebrity attention paid to that particular issue. But do the pages of our professional journals also support what Irish & Norse (1996) referred to as the 'founder effect'?

METHODS

Our assessment of biodiversity research represented by conservation biology and applied ecology was based on the detailed analysis of papers published in five international peer-reviewed journals: *Conservation Biology* (CB), *Biological Conservation* (BC), *Biodiversity and Conservation* (BDC), *Ecological Applications* (EA) and the *Journal of Applied Ecology* (JAE) over the 9 years from 1987 to 1995, the former date being selected as it was when CB began publication. EA began publication in 1991 and BDC in 1992. A total of 2524 papers (BC = 870, JAE = 683, CB = 484, EA = 281, BDC = 206) were carefully examined in their entirety, unlike some previous literature reviews whose analyses have been based on surveying only the title, author information and abstract.

We were interested in documenting journal differences in: (a) the locations where research was conducted, (b) the types of organisms studied, (c) the types of ecosystems studied, (d) the types of methodologies used in the various studies, and (e) the types of stresses investigated.

Study location was categorized into 'North America', 'Central and South America', 'Europe', 'Asia', 'Africa' and 'Pacifica'. Particular countries located within each geographic category can be found in France *et al.* (1998). A 'World' designation represented general discussion papers regarding the effects of human development etc. on global flora or fauna. Sample sizes (number of individual studies) were 856 for BC, 202 for BDC, 481 for CB, 280 for EA, and 682 for JAE.

Study organisms were categorized as 'birds', 'herps' (reptiles and amphibians), 'fish', 'mammals', 'plants' (including fungi and aquatic vascular macrophytes), 'all taxa' (discussion papers dealing with organisms in general) and 'other' (denoting process-oriented papers such as soil nutrient cycling etc.). Papers which involved more than one type of organism (e.g. species interactions) received fractional values of 1/2 or 1/3 (never less), and would be rounded to whole integers when tallying totals. Sample sizes were 873 for BC, 206 for BDC, 484 for CB, 274 for EA, and 664 for JAE.

Study systems were categorized as 'forest', 'grassland and agriculture', 'marine', 'freshwater', 'wetland' (including estuaries in addition to freshwater systems), 'reserve and island' systems grouped together (i.e. 'closed' systems usually concerned with endangered or endemic species), 'urban' studies (any region of human population density from village to major city), 'lab and modelling' studies grouped together (due to their relatively low frequency and involving the development of either a human constructed or hypothetical study system), 'all study systems' (usually general discussion papers in which the study system was of little significance), and 'other' (any study system which did not conveniently fall into any of the other categories, such as deserts, rocks, caves, mountains or tundra). Sample sizes were 880 for BC, 210 for BDC, 483 for CB, 275 for EA, and 675 for JAE.

The various methods of investigation employed were categorized as 'field observational', 'field experimental', 'discussion paper' (no primary research but citation of previous studies), 'theoretical modelling', 'lab experimental', 'data compilation' (manipulation and secondary-analysis of data from a variety of different studies) and 'sociological survey' (questionnaires, interviews etc. usually regarding perception of species,

reserves etc.). Papers which involved more than one type of methodology were apportioned as described previously. Sample sizes were 876 for BC, 205 for BDC, 475 for CB, 281 for EA and 690 for JAE.

The types of stress most frequently investigated by various reviewed studies were categorized as 'habitat loss' (deforestation, agricultural expansion etc.), 'physical chemistry' (geochemical cycling, toxicants and all types of pollution), 'human exploitation' (hunting and harvesting of both terrestrial and aquatic systems), 'global change' (climate warming, droughts, floods etc.), 'interspecific relations' (species regulations/dynamics, competition etc.), and 'population viability' (population dynamics due to stress, issues of genetic diversity etc.). Studies investigating more than one type of stress were apportioned as before. Sample sizes were 616 for BC, 90 for BDC, 372 for CB, 224 for EA and 496 for JAE.

It is important to recognize the limitations in the approach taken in this review. Here, we assume that the measure of biodiversity research can be assessed through an analysis of publications in these few selected international journals. We recognize of course that a strong case can be made at the onset that there may very well be an inverse relationship between the publication performance of conservation biologists/applied ecologists and the true valued utility of their efforts toward biodiversity; i.e. the age-old chestnut underlying the dichotomy between 'them that write about what should be done' and 'them that actually do something'. There is no doubt that publication of papers concerned with biodiversity is predominantly limited to those with the greatest luxury of reflective time, namely academics (67% of all papers in CB for instance—Jensen & Krausman 1993). Nevertheless, there is a common belief that such efforts do make a substantial contribution to the way our profession evolves (Temple, 1993), and do have an influence on how non-academic managers, busy working in the 'front-line trenches', conduct their important jobs.

Secondly, the actual selection of which particular journals to be reviewed in any such analysis is bound to fraught with ensuing biases. In our case, we have concentrated on only international, putatively non-specialized, English publications. Three of these are flagship journals for their respective societies: CB for the Society of Conservation Biology, EA for the Ecological Society of America, and JAE for the British Ecological Society. We therefore ignore the publication efforts of conservation biologists/applied ecologists which might appear in more regionally or linguistically limited productions. We also ignore the possibility that because reviewers may be parochially-biased due to an incomplete knowledge of the global literature (Wardle, 1995), this may lead to regional differences in acceptance rates (Miller & Levin, 1994), which in turn may dissuade conservation biologists/applied ecologists in developing nations from submitting their work to the five journals selected for this analysis (discussed in France *et al*. (1998)). Finally, we assume that the other possible avenues available for publication on any of our selected topics are equal, such that someone wanting to publish a paper on arctic freshwater fish or invertebrates has about the same selection of journal choices and therefore likelihood of selecting one of the five journals we have chosen here, than does an individual searching for a location in which to publish her/his work on tropical birds or mammals. In other words, the research published in the five journals we have selected, represents an accurate reflection of the current state of our profession.

RESULTS

Study location

The proportional representation of study locations (Fig. 1) shows that about half of all papers in CB are based in North America, whereas about half of all papers in JAE are Europe based. EA is shown to be the most geographically limited of the five journals, with almost three-quarters of all papers being based in North America. BC and BDC demonstrate the most geographically balanced study effort. African studies subsume from 1 to 18% of the total research effort across all journals, whereas those based in Central and South America represent 3–10% of the total research production. Antarctic and Arctic regions are not shown in the figure as the number of study locations in these regions were too small to be clearly displayed in the pie charts (i.e. always less than 1%).

Study organisms

Considerable differences were found in the proportional breakdown of research on various organisms among the five journals (Fig. 2). About half the papers published in the two applied ecology journals, EA and JAE, were based on plants, whereas this represented only 20–31% of the research effort in the other conservation biology journals. The major contributor in BDC was 'all' taxa

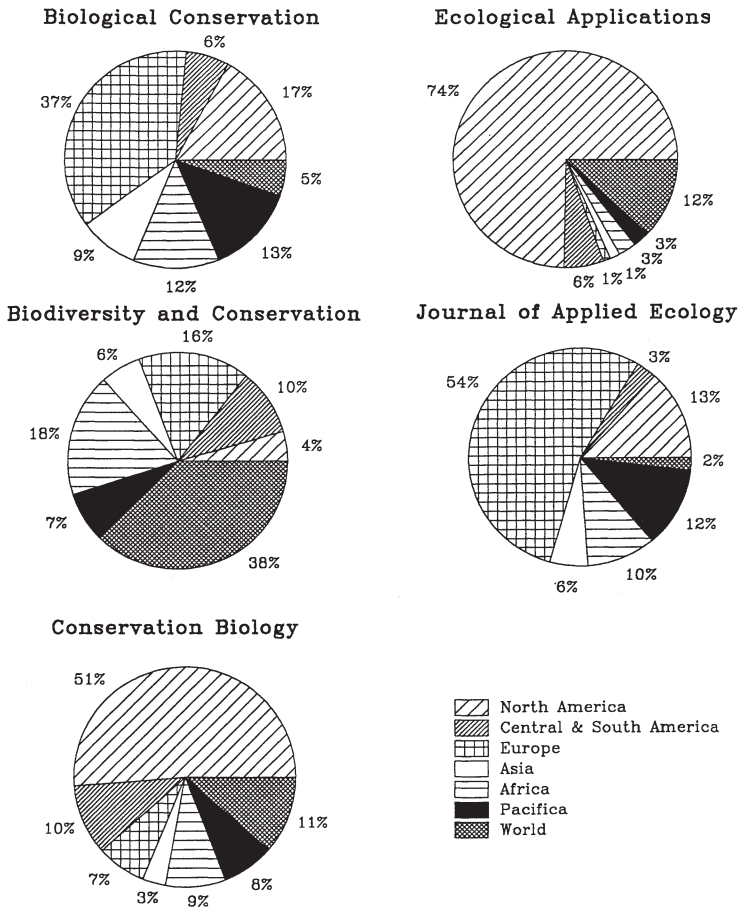

Fig. 1. Regional representation of study location in biodiversity research published in the five journals.

which reflects the high proportion of general discussion papers in this journal (discussed below). Some taxa are under-represented across all five journals: reptiles and amphibians from 1 to 6%, fish from 1 to 9%, invertebrates from 3 to 8% and insects from 4 to 13% of all organisms studied.

Study system

The five reviewed journals displayed a greater diversification in terms of study systems (Fig. 3) than they did either for study organisms (Fig. 2) or study locations (Fig. 1). The most prevalent system of study across all journals was forests (20–39%); the least studied natural systems were urban centres or reserves and islands (<1–16%), marine systems (3–7%) and freshwaters (4–12%). Laboratory and modelling studies represented 2–8% of the total research effort. JAE is distinct in its high proportion (43%) of studies on grasslands and agricultural systems.

Study methodology

Considerable variability was evident in the proportional representation of different study methodologies among the five journals (Fig. 4). Over half of the papers published in BDC consisted of general discussions. About half of the papers appearing in BC and CB were based on field observations. Experimental field studies were proportionally higher (20–33%) in the applied ecology journals, EA and JAE, than in the conservation biology journals (5–10%). The

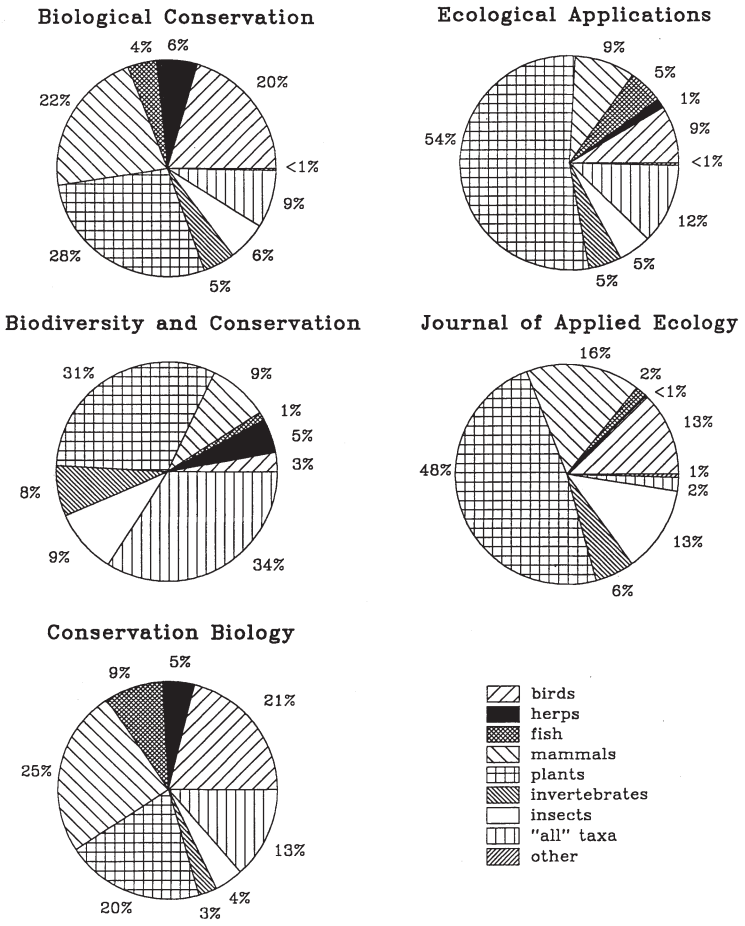

Fig. 2. Proportional representation of biodiversity research on various study organisms published in the five journals.

applied ecology journals completely eschewed sociological studies, whereas these did appear, although very infrequently, in the three conservation biology journals. Laboratory-based studies contributed only rarely (3–7%) to biodiversity research.

Agents of study stress

The five journals differed in the relative proportions of stresses documented in their respective pages (Fig. 5). The most prevalent studied agent of stress in all five journals was habitat loss (19–43%). Half of the papers published in JAE were concerned with interspecific relations. Issues of physical/chemical stress figured twice as prominently in the two applied ecology journals, EA and JAE (15–19%), than in the conservation biology journals, CB, BC and BDC (3–7%). The three conservation biology journals spent more space dealing with issues of human exploitation of resources (8–19%), than did the two applied ecology journals (4%). Studies of population viability (generally dealing with genetics) were more highly represented in CB and BDC (20–25%) than in the other journals (<1–6%). Issues of global change represented about a quarter of the studies in EA, much more than in the other journals (5–8%).

DISCUSSION

Considerable differences were found to exist in the published literature of biodiversity research

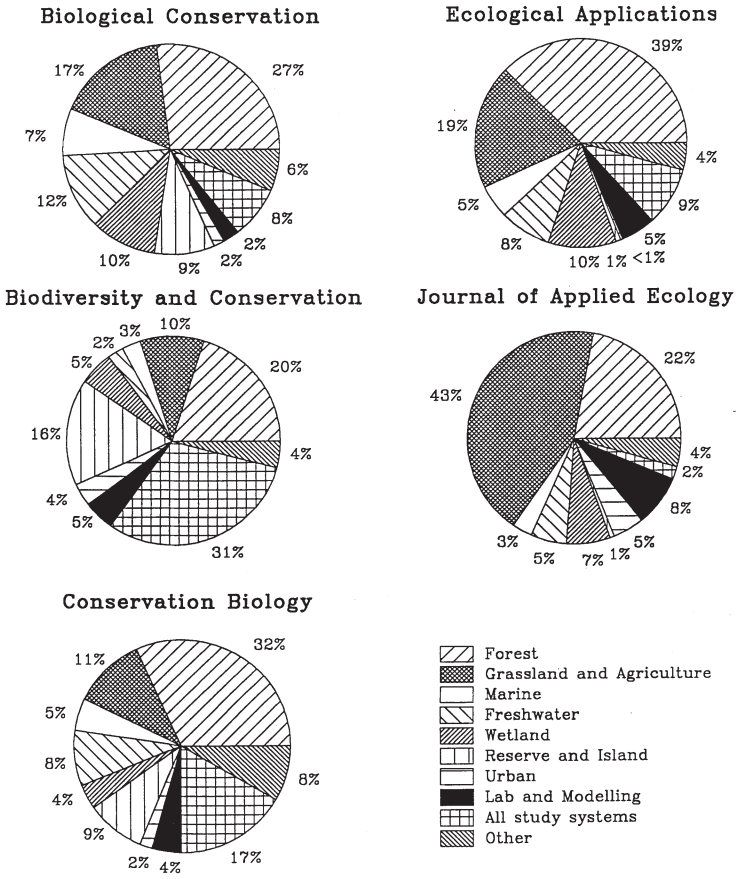

Fig. 3. Proportional representation of biodiversity research on various study systems published in the five journals.

(conservation biology/applied ecology) with respect to the most prominent subject areas covered by the five reviewed journals. We can summarize these differences by creating a prolix for each journal based on its published literature to date. In this fashion, BC = 'field observations pertaining to the *Biological Conservation* of European birds and mammals in relation to forest habitat loss'; BDC = 'general discussion papers on the *Biodiversity and Conservation* of all global taxa due to habitat losses in all types of ecosystems'; CB = 'field observations pertaining to the *Conservation Biology* of North American birds and mammals in relation to forest habitat loss'; EA = 'the *Ecological Applications* of field observations and theoretical modelling for studying the effects of global change on North American plants'; and JAE = 'the *Journal of Applied* observational and experimental field *Ecology* of European grassland and agricultural plants with respect to interspecific relations'.

The perception of biodiversity research as having a limited world view restricted to tropical issues is incorrect. The observation that about half of all papers published in the five reviewed journals are based in either North America or Europe is no surprise considering that that is where most of the authors themselves originate (France *et al.*, 1998). The proportionally low representation of research from developing nations is often a simple reflection of the disparity between their GNPs compared to those of developed nations (France *et al.*, 1998). Because research productivity is closely related to the size of research grants (Peters *et al.*, 1996), rich nations will consequently direct more money to science in general, and thereby produce more published research (Peters,

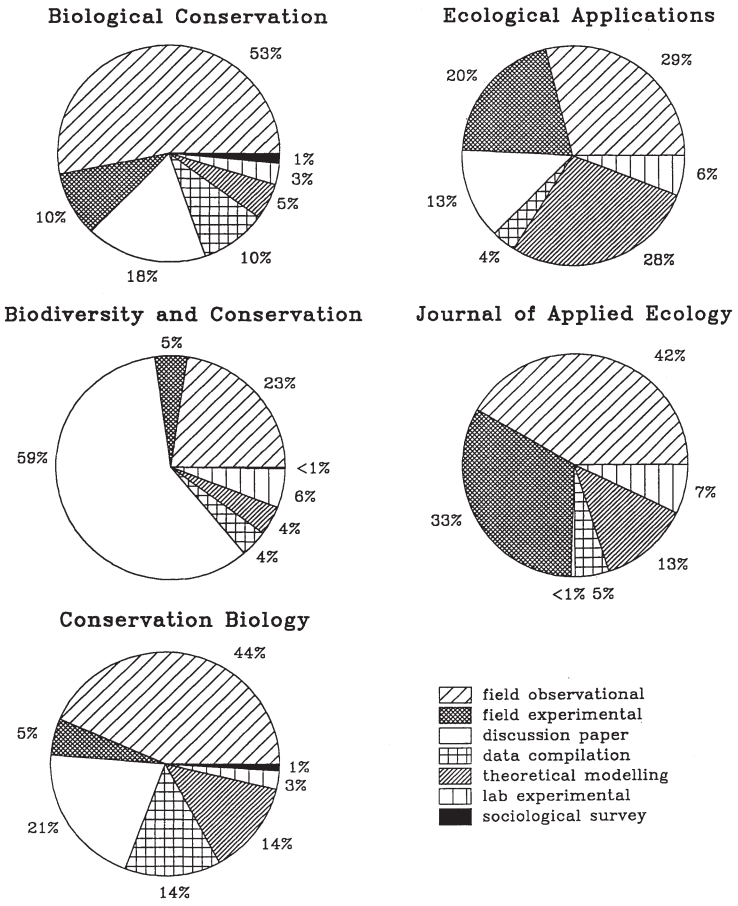

Fig. 4. Proportional representation of biodiversity research using various study methodologies published in the five journals.

1997). Simply put, more money to developing nations means more biodiversity research being undertaken there (France *et al.*, 1998).

The present review gives credence to the concerns raised by others that the published biodiversity research is really quite narrow in focus. Specifically, Irish & Norse (1996) are correct when they posit that the 'founder effect' is prevalent. Although it is possible that those conservation biologists/applied ecologists studying non-'founder effect' organisms/systems/topics may primarily publish elsewhere, absence of their research efforts within the pages of the five international, putatively 'general' journals reviewed here, is detrimental to all. Science is richer and operates more imaginatively and productively when practiced pluralistically, not monistically. Entomologists, herpetologists, limnologists, and polar biologists interested in biodiversity can all benefit from the research efforts of terrestrial mammologists, ornithologists and forest ecologists published in the five journals examined in this review. Likewise, one would expect the reciprocal to hold true as well.

A quick glance at the editorial boards of the journals reviewed here suggests that they are mainly composed of individuals well established within the 'founder effect' paradigm of biodiversity research. It may very well be argued, however, that it makes little sense to 'staff' an editorial board with non-'founder effect' pundits if they will have little to do due to an absence of submissions from colleagues within their particular subdisciplines. The question then becomes how to go about encouraging non-'founder effect' conservation

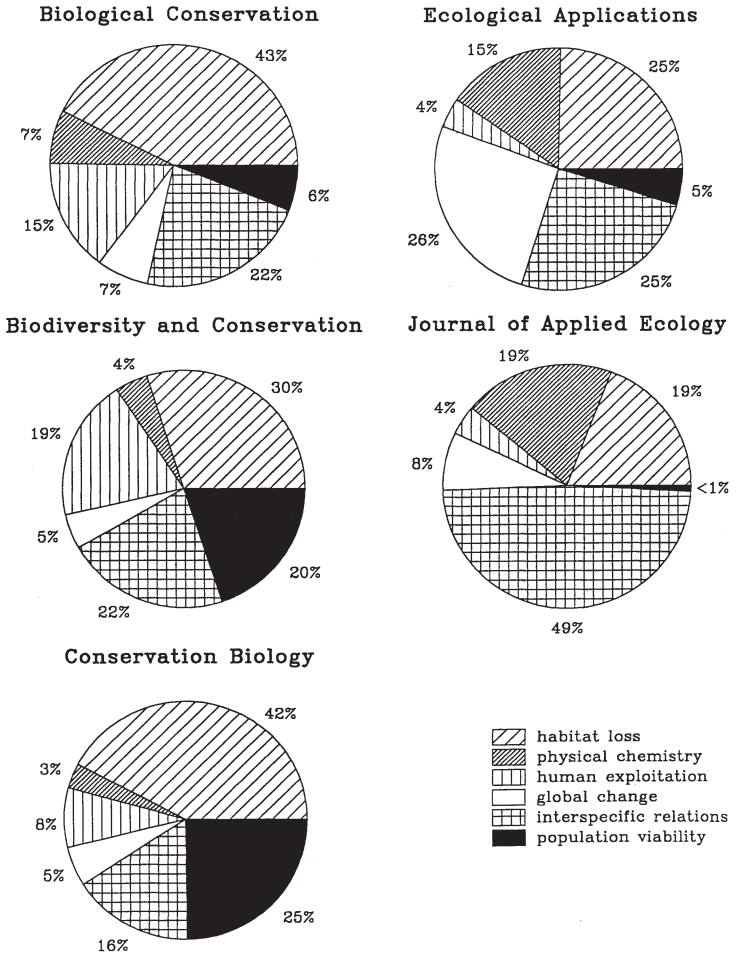

Fig. 5. Proportional representation of biodiversity research on various agents of stress.

biologists/applied ecologists to submit their papers to the premier five international 'general' journals? There is no doubt that researchers submit manuscripts to those journals that are highly regarded and in which they feel their efforts will be treated sympathetically with constructive reviews from their colleagues, as well as reaching an audience of like-minded and appropriately appreciative peers (remember that over two-thirds of these papers are written by academics operating under adjudicative pressures in which completely altruistic motivations to global biodiversity may not always be the paramount rasion d'etre for publication).

How then do we evolve to a more pluralistic profession, and not scare away potential submitters presently dissuaded from letting their research find a home within our journals which are now dominated by a prevalent 'founder effect' (i.e. all the prolixae generated here agreed with casual impressions that our colleagues had of each of these particular journals)? One can imagine many ways to perhaps go about this, none free of debate: active solicitation? special thematic issues? affirmative action? etc.

As this review illustrates, Kaufman's (1988) 'sleeping dragon' of imbalanced biodiversity research is really a 'hibernating hydra'. It is time to seriously begin to address ways in which to prod the beastie awake. Otherwise, the problematic creature will sink back into

antiquated mythology, suggested at periodically by conservation biologists/applied ecologists only in passing perhaps by that quaint Cassandra-phrase used by early cartographers to fill in their lacunae of unknown territories: 'Here there be dragons. . . .'. Sleeping.

ACKNOWLEDGMENTS

This project was funded by the Work Study Program of McGill University and the operating grant of Robert Peters. With warm dedication to the memories of Robert Peters and Jack Christie who were always concerned with putting research about aquatic science in general, or freshwater fish in particular, into the framework of the larger science picture.

REFERENCES

Bolen, E.G. (1989) Conservation biology, wildlife management, and spaceship earth. *Wildl. Soc. Bull.* **17,** 351–354.

Bunnell, F.L. & Dupuis, L.A. (1994) Canadian-based literature: implications to conservation and management. *Ecoscience,* **1,** 87–92.

Bunnell, F.L. & Dupuis, L.A. (1995) *Conservation Biology's* literature revisited: wine or vinaigrette? *Wildl. Soc. Bull.* **23,** 56–62.

Cohen, J.E. (1991) Size, age and productivity of scientific and technical research groups. *Scientiometrics,* **20,** 395–416.

Cooley, J. & Golley, F. (1984) *Trends in ecological research in the 1980's.* NATO Conference Series 1. Vol. 7. Plenum Publ. Corp. New York.

Deshmukh, I. (1989) On the limited role of biologists in biological conservation. *Conserv. Biol.* **3,** 521–522.

Disney, R.H.I. (1989) Does anyone care? *Conserv. Biol.* **4,** 414.

Edwards, T.C. (1989) The Wildlife Society and the Society for Conservation Biology: strange but unwilling bedfellows. *Wildl. Soc. Bull.* **17,** 340–343.

Ehrenfeld, D. (1989) Is anyone listening? *Conserv. Biol.* **4,** 415.

France, R. (1998) Putting genes back into their lab bottles: much ado about nothing? *Conserv. Biol.* **12**, 500–501.

France, R., Peters, R. & Rigg, C. (1998) Comparative assessment of regional representation and research productivity of conservation biologists and applied ecologists. *Ecoscience*, in press.

Irish, K.E. & Norse, E.A. (1996) Scant emphasis on marine biodiversity. *Conserv. Biol.* **10,** 680.

Jensen, M.N. & Krausman, P.R. (1993) *Conservation Biology's* literature: new wine or just a new bottle? *Wildl. Soc. Bull.* **21,** 199–203.

Kaufman, L. (1988) Marine biodiversity: the sleeping dragon. *Conserv. Biol.* **2,** 307–308.

Martin, B.R., Irvine, J. & Stevens, K. (1990) Recent trends in the output and impact of British *Science. Sci. Publ. Policy,* **17,** 14–26.

Merton, R.K. (1968) The Matthew effect in science. *Science* **159,** 56–63.

Miller, L.N. & Levin, S.A. (1994) Report of the Editors-in-Chief, Ecology, *Ecological Monographs*, and *Ecological Applications*. *ESA Bull.* **75,** 233–236.

Murphy, D.G. (1988) Conservation biology and scientific method. *Conserv. Biol.* **2,** 203–204.

Murphy, D.G. (1989) Conservation and confusion: wrong species, wrong scale, wrong conclusions. *Conserv. Biol.* **3,** 82–84.

Murphy, D.G. & Duffus, D.A. (1996) Conservation biology and marine biodiversity. *Conserv. Biol.* **10,** 311–312.

Noss, R.F. (1989) Who will speak for biodiversity? *Conserv. Biol.* **3,** 202–203

Peters, R.H. (1991) *A critique for ecology*. Cambridge University Press, Cambridge.

Peters, R.H. (1997) The ecology of science policy. *Lake, Reserv. Mgmnt.* **12,** 407–419.

Peters, R.H., Ball, G. Carignan, R., Hebert, P.D.N. & Prepas, E.E. (1996) An assessment of research in evolution and ecology supported by the National Sciences and Engineering Research Council of Canada. *Can. J. Fish. Aquat. Sci.* **53,** 670–680.

Price, D.J. de Solla. (1975) *Science since Babylon*. Yale University Press. New Haven.

Price, D.J. de Solla. (1986) *Little science, big science . . . and beyond*. Columbia University Press. New York.

Redford, K.H., Taber, A. & Simonetti, J.A. (1990) There is more to biodiversity than the tropical rain forests. *Conserv. Biol.* **3,** 328–340.

Resh, V.H. & Yamamoto, D. (1994) International collaboration in freshwater ecology. *Freshw. Biol.* **32,** 613–624.

Rigler, F.H. & Peters, R.H. (1995) *Science and limnology*, 239pp. The Ecology Institute, Oldendorf/Luhe, Germany.

Soule, M.E. (1985) What is conservation biology? *BioScience* **35,** 727–734.

Soule, M.E. (1987) History of the Society for Conservation Biology: how and why we got here. *Conserv. Biol.* **1,** 4–5.

Statzner, B., Resh, V.H. & Kobzina, N.G. (1995) Scale effects on impact factors of scientific journals: ecology compared to other fields. *Oikos,* **72,** 440–443.

Taubes, G. (1983) Measure for measure in science. *Science*, **260,** 884–886.

Teer, J.G. (1988) Conservation biology. The science of scarcity. Book review. *J. Wildl. Mgmnt.* **52,** 570–572.

Temple, S.A. (1993) Is the Society for Conservation Biology having an impact? *Conserv. Biol.* **6,** 160.

Terbough, J. (1988) The big things that run the world – a sequel to E.O. Wilson. *Conserv. Biol.* **2,** 402–403.

Thomas, J.W. & Salwasser, H. (1989) Bringing

conservation biology into a position of influence in natural resources management. *Conserv. Biol.* **3,** 123–127.

Wagner, F.H. (1989) American wildlife management at the crossroads. *Wildl. Soc. Bull.* **17,** 354–360.

Wardle, D.A. (1995) Journal citation impact factors and parochial citation practices. *ESA Bull.* **76,** 102–104.

Wilson, E.O. (1987) The little things that run the world (the importance and conservation of invertebrates). *Conserv. Biol.* **1,** 344–346.

Windsor, D.A. (1995) Equal rights for parasites. *Conserv. Biol.* **9,** 1–2.

Yahner, R.H. (1990) Wildlife management and conservation biology revisited. *Wildl. Soc. Bull.* **18,** 348–350.